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Investigation of Tritium in Groundwater at Site 300

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**Lawrence
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INVESTIGATION OF TRITIUM IN GROUNDWATER AT SITE 300

EXECUTIVE SUMMARY

In 1984, landfill monitoring wells at Site 300, a Lawrence Livermore National Laboratory (LLNL) explosive test site, revealed the presence of groundwater contaminated with tritium, a radioactive isotope of hydrogen. These tritium levels were in excess of the State of California drinking water standard. A major investigation was initiated that included a search of records concerning tritium use, disposal, and previous analyses, and a survey of tritium levels in soil, vegetation, and water in contaminated and potentially contaminated areas. Over 50 boreholes were drilled for this investigation to characterize the local hydrogeology and tritium distributions, and a network of soil moisture and groundwater monitoring points was installed. This report presents the work completed through the end of September 1985: the records search; records for drilling completed as part of this study; characterization of the geology, hydrology, and tritium distributions in the contaminated area; and an initial assessment of the probable tritium sources, pathways, and migration rates.

Records indicate that approximately 22,000 curies of tritium were shipped to Site 300 for use in high explosives experiments during the period 1963-1978; most of the usage occurred from 1963 to 1970. Approximately 95% of the total tritium was expended in West Firing Area experiments at Building 850, and most of the balance was used at Building 851. Only a few experiments involving small amounts of tritium were conducted in the East Firing Area (Building 802). Records of landfill usage indicate that Pit 3, which is now closed, probably received most of the tritium-containing waste from the early firing table experiments. Pits 4 and 5, also closed, were in use after 1968 and presumably received some contaminated waste. Little or no tritium experimentation has been carried out since Pit 7, the currently active landfill, was opened.

The records search and initial reconnaissance sampling and drilling confirmed that all of the groundwater contamination observed originated from

sources in or near the West Firing Area landfills (Pits 3, 4, 5, and 7) and Building 850; subsequent detailed studies were focused on that area.

The near-surface geology and hydrogeology of the study area are dominated by the shallow interbedded claystones, siltstones, and sandstones of the Neroly Formation. These beds dip to the northeast, and support a laterally extensive, perched water table that generally follows the formation bedding and is less than 25 ft below the land surface under the lowest portions of the valleys. The bedrock is covered by a variable thickness of alluvial fill in the valleys and stream channels; the landfills are constructed primarily in this alluvium.

Groundwater flow throughout the area is to the east or northeast and presently follows the bedding within the Neroly Formation. Fracture systems locally convey groundwater, and may locally provide interconnections between permeable, sandstone beds through otherwise impermeable finer-grained strata. Aquifer tests and measured hydraulic gradients indicate that the most probable present flow velocities are on the order of a few tens of meters per year. North of Building 850, the contemporary water table is continuous through both bedrock and alluvial sequences, but tritium distributions indicate that some southeastward flow through the valley alluvium may occur when the water table rises. To the east of Building 850, there appears to be groundwater discharge to the Doall Road stream channel, which provides a hydrologic connection to the East Firing Area near Pit 2.

Beneath most of the Pit 7 complex, no water-bearing zones have been found below the perched aquifer to a depth of over 300 ft. A second aquifer exists below the Building 850 area; it is monitored by Well #8 and shows no evidence of tritium contamination. Recent examination of hydrologic and chemical data suggests that this second aquifer may extend as far northwest as well K7-5.

Tritium contaminant plumes in the soil and groundwater have been bounded on all sides by hydrologic divides or by monitoring installations showing background tritium levels, or by both. One major plume originates from Pit 3 and trends northeast with the perched groundwater flow. Contamination also occurs east and southeast of Pit 5 and appears to be moving northeast with the groundwater, but identification of the source is complicated by evidence of past southeastward water flow through the alluvium during periods of elevated water tables. The existence of one or more tritium source areas in Pit 5 seems likely, but has not been conclusively proven. East of Building 850, contaminant tritium is moving eastward in the regional aquifer and also along

the Doall Road stream channel, which cuts across and then parallels the groundwater flow pattern. The source of this tritium is apparently close to Building 850, and is presently believed to be in an area of sandy fill material just northeast of the firing table. This identification is tentative, as no records exist for the area and the groundwater contamination has not been traced back through the soil zone to this area.

Both hydrologic and tritium distribution evidence suggests that the groundwater contamination in the landfill area may have originated with landfill flooding during the unusually wet 1982 and 1983 water years, when the high rainfall resulted in elevated water tables in the vicinity of the disposal pits.

In the Building 850 area, historical data show that tritium has been reaching the groundwater since before 1970; however, a recent pulse of tritium release appears to have been superimposed on the pre-existing pattern. Unusually high stream flow in 1982-1983 appears to have been responsible for transport of contaminated water out of the Doall Road streambed into the water table of the East Firing Area around Pit 2. In both the landfill and 850 areas, groundwater flow in the perched bedrock aquifer is consistent in direction, but may exhibit variations in velocity as a result of recharge fluctuations. The stream or alluvial subflow is episodic and highly dependent on water table elevations.

Estimates suggest that an amount of tritium on the order of 10 curies is now in groundwater and soil moisture outside the source areas. The amount of total tritium in the sources is unknown, but a few hundred curies is an estimated upper limit. If this estimate is conservative, a significant fraction of the source tritium may already have been dispersed to the groundwater system. Migration rates in the regional groundwater system suggest that a time period of 20 to 50 years will be required before the contaminant plumes approach the Site 300 boundary. Dispersion and radioactive decay will act to reduce contaminant concentrations during the transport process. The present location and flow direction of the contamination poses no short-term threat to any water supply or potable water aquifer either on Site 300 or in the downgradient direction offsite.

Continued monitoring and further investigations are in progress to refine our models and predictions of tritium source locations, release mechanisms, and flow rates and directions. Results of these studies will be published in later reports.

INTRODUCTION

We have investigated the tritium contamination found in groundwater in some of the landfills and experimental areas of LLNL's Site 300. The LLNL activities that used tritium at Site 300 were conducted in accordance with the standards of the Atomic Energy Commission, and later with those of the Department of Energy (DOE). The DOE standards for radiation protection (Manual 5480.1) permit tritium concentrations in water up to 0.003 $\mu\text{Ci/ml}$ (3,000,000 pCi/l).

LLNL installed an initial series of landfill monitoring wells in 1982 to meet Resource Conservation and Recovery Act (RCRA) groundwater monitoring requirements. Tritium was one of the constituents measured in quarterly samples from these wells. Although tritium levels in these monitoring wells were initially lower than the State of California drinking water standard (20,000 pCi/l), elevated values were observed beginning in 1984. None of the wells with tritium concentrations in excess of 20,000 pCi/l are drinking water supply wells nor are they in close proximity to supply wells.

Unless otherwise noted, the tritium discussed in this report is in the form of tritiated water, in which one of the hydrogen atoms of the water molecule is replaced by a tritium atom. This is the form of greatest concern from a health standpoint.

Tritium (^3H) is a radioactive isotope of the element hydrogen; it is a weak beta-particle emitter with a half-life of 12.26 years. Except where tritium activities are specifically identified as "decay-corrected", all values reported are the activity at the time of analysis. Because of the relatively short half-life of tritium, some types of comparisons require that older data be corrected for radioactive decay. This is done according to the equation

$$A_t = A_{t_0} e^{-\lambda(t-t_0)} \quad (1)$$

where

- A_t = activity at t , the time of decay correction,
- A_{t_0} = activity at t_0 , the time of original measurement,
- λ = the decay constant for tritium, $5.65 \times 10^{-2} \text{yr}^{-1}$,
- e = the natural logarithm base.

SITE DESCRIPTION

Site 300 is the LLNL field test site. It is located in the Altamont Hills (Figs. 1 and 2) and is used primarily for high explosive and materials testing and experimentation. The areas of Site 300 of primary concern from the standpoint of this investigation are those portions of the East and West Firing Areas (Fig. 3) containing the waste disposal pits and the firing tables, which are buildings where high explosive experiments are conducted.

The areas of concern from the standpoint of this investigation are portions of the East and West Firing Areas. Included in the East Firing Area (B, Fig. 3) are the Building 801 and 802 firing tables and waste disposal Pits 1 and 2. Of these, Pit 1 is active and Pit 2 is inactive. The West Firing Area (A, Fig. 3) includes the Building 850 and 851 firing tables, Pit 7 (active), and Pits 3, 4, and 5 (inactive). All wells, piezometers, lysimeters, and other pertinent features in the East and West Firing areas appear on the base map (Plate 1, inside back cover).

The two firing areas are separated by a range of hills, but there is a surface drainage connection through a ravine that originates east of Building 850 and discharges near the west side of Pit 2. Plate 1 shows a portion of this drainage ditch. A geologic map (Fig. 4) of the north portion of Site 300 illustrates the topographic and geologic features of the area; the geology is described in detail later in this report.

Figure 1. Locations of Site 300 and Lawrence Livermore National Laboratory on a map of the San Francisco Bay area.

Figure 2. View of part of the Pit 7 complex, taken to the west from the ridge separating East and West Firing Areas, shows typical terrain at Site 300. Pits 3 and 7 and a portion of Pit 5 are visible. Monitoring installations in the right and center foreground (NC7-25, NC7-13, NC7-23, NC7-30, and NC7-32) are along the longitudinal axis of the major contaminant plume.

Figure 3. Site 300 map showing the locations of wells, springs, and boreholes that predate the present study; the approximate boundaries of the East and West Firing Areas are marked, as are the locations of landfills in the Pit 7 and Pit 1 complexes.

Map Legend

Lithologic Units

- Qa Alluvium
- Qls Landslide deposits
- Qta₂ Terrace Alluvium
- Qta₁ Terrace Alluvium
- Tps Nonmarine conglomerates, sands and clays (Tps unit of Dibblee, 1980)

Unconformity

Neroly Formation

- Tnsc₂ Interbedded siltstone, sandstone and clay
- Tngl₂ Upper conglomerate
- Tnbs₂ Upper blue sandstone, some interbedded clay, tuff, and limestone
- Tnsc₁ Interbedded sandstone, siltstone and clay, some tuff, massive sandstone at bottom
- Tngl₁ Lower conglomerate, contains lenses of blue sandstone
- Tnbs₁ Lower blue sandstone with interbedded clay and tuff. Lower claystone/siltstone unit shown on section.

Cierbo Formation

- Tt Tesla Formation - Eocene

Unconformity

- Kgv Great Valley Sequence - Upper Cretaceous

Map Symbols

- Contour Interval — 1325 —
- Roads/Trails — — — — —
- Borehole Location — K7-2
- Fault — — — — —
- Anticline — — — — —
- Syncline — — — — —
- Inferred — — — — —
- Bedding strike and dip — — — — —
- Vertical — — — — —
- Horizontal — — — — —
- Unconformity — — — — —
- Landslide — — — — —
- Contact — — — — —

Figure 4. Geologic map and section of the northern portion of Site 300 (after Raber and Carpenter¹) shows topography and locations of monitoring wells installed in 1982.

HISTORY OF TRITIUM USE AND DISPOSAL 1958-1982

Tritium Shipments

Between 1963 and 1978, high explosive experiments involving some form of tritium were conducted at Site 300. Because some details of these experiments are still classified, the following summary of tritium use and disposal is all that can be presented in this report. The classified information has been reviewed, and contains no information on the amount, form, or location of waste tritium.

A thorough review of available shipping records, Site 300 operations records, and experimental plans and results has been conducted by J. A. Sketchley. We believe that the composite picture obtained from these sources is sufficiently complete and accurate for the purposes of this investigation.

Shipping records show that a total of 22,670 curies of tritium was transferred to Site 300 during the period indicated, primarily during the years 1963 to 1970. After 1970, the total transferred was 1,170 curies and the maximum shipment per year was 240 curies. The annual shipment records appear in Table 1.

Table 1. Annual inventories of ^3H shipments to Site 300.

Year	^3H (Ci)	[] ^a	Year	^3H (Ci)	[] ^a
1963	3400	[974]	1974	160	[86]
1964	2400	[728]	1975	50	[28]
1965	5700	[1830]	1976	10	[6]
1966	2100	[714]	1977	120	[76]
1967	500	[180]	1978	240	[161]
1968	3900	[1485]	1979	0	-
1969	1600	[645]	1980	0	-
1970	1900	[810]	1981	0	-
1971	160	[72]	1982	0.13	-
1972	220	[105]	1983	0.04	-
1973	210	[116]	1984	0	-

Total shipments: 22,670 curies [8,006]^a

^aOriginal values decay-corrected to mid-1985.

It should be noted that through 1970 the shipment inventories were rounded off to the nearest 100 curies, and from 1971 through 1978 to the nearest 10 curies. The shipment totals thus have an uncertainty of several hundred curies. Operating and storage procedures make it reasonable to assume that experimental use expended the tritium shortly after receipt at Site 300. Since experiments were occasionally aborted or performed with less than the maximum planned amount of tritium, the shipment totals are an upper limit on the experimental use.

Experimental and operations records document the expenditure of approximately 20,900 curies; this is in reasonable agreement with shipment records in view of the qualifications noted above.

Less than 200 curies was expended at Building 802, and approximately 1,000 curies at Building 851. Approximately 95% of the tritium used at Site 300 was expended at Building 850, the location where all individual experiments involving large quantities of tritium (more than 160 curies) were conducted. Over 99% of the tritium used at Site 300 was expended in the West Firing Area (Buildings 850 and 851).

Most of the tritium used was in the form of tritium gas (T_2 , where $T = {}^3H$). However, solid lithium titride (6LiT) was also used. Solid tritium was employed in experiments that expended a total of approximately 1,100 curies. This value is an upper limit on the activity of solid-phase tritium, because some experiments contained both solid and volatile forms and the surviving records do not enable us to determine exact proportions.

Tritium Disposal

Waste from the firing table experiments was disposed of in the pits serving the firing areas: Pits 3, 4, 5, and 7 for Buildings 850 and 851; Pits 1 or 2 for Buildings 801 and 802. Only Pit 7 and Pit 1 are still used; the others are inactive. The waste is made up of equipment and handling materials, metallic parts, and firing table debris consisting of dirt, sand, gravel, and concrete. The dates of use and general characteristics of the waste disposal pits are summarized in Table 2.

In the West Firing Area, Pit 7 should contain little if any tritium, because it was excavated at approximately the same time that major tritium experimentation ended. The upper end of Pit 7 is still open; only the lower portion has been filled. Pits 3 and 4, and some cells of Pit 5, were the

Table 2. Landfill usage, Site 300 firing areas.

East Firing Area				West Firing Area			
Pit #	Active period	Depth (ft)	Overburden (ft)	Pit #	Active period	Depth (ft)	Overburden (ft)
1	1961(open)	15	0-5	3	1958-1967	12-14	>3
2	1956-1960	12-14	2 ^a	4	1968-1974 ^b	unk	>3
				5	1968-1978 ^c	10	>3
				7	1978(79) ^d (open)	10-16	>3

^aOriginally open; covered in 1982.

^bSome records show closure date of 1969; a small pit.

^cSome records show closure date of 1979.

^dExact date of first use still to be determined.

disposal pits in use during the period of high tritium use at Building 850, and hence should be considered potential contamination sources. Because the use dates of Pit 4 and older portions of Pit 5 overlap, further research will be required to determine which of these two locations is the most likely repository for contaminated waste. On the basis of field observations and anecdotal information, it appear likely that the lower (south) part of Pit 5 was never excavated, although blueprints show that plans were made to do so. This portion of Pit 5 is drawn with a dashed line on Plate 1.

In the East Firing Area, Pit 2 should be free of tritium, and although Pit 1 and the Building 802 area may contain some tritium, the total possible inventory is quite small compared with the potential inventory at Building 850 and its associated disposal sites.

In addition to the experimental waste placed in the pits, volatile explosion products are released to the atmosphere, and small amounts of particulate ejecta may be distributed over the ground surface within a few hundred meters of the firing tables.

We have also received indications that sand and gravel associated with firing table experiments may have been used as fill material at one or more locations in the immediate vicinity of Building 850.

Attempts to assess the relative potential for environmental contamination of the possible tritium-containing sites are necessarily speculative, because we lack detailed knowledge about the final physical and chemical forms of the tritium and the relative amounts volatilized during the experiments.

Based on available information, we believe that the small amount of gaseous tritium that was not promptly volatilized would be primarily in the form of either tritiated water sorbed onto solid detritus or hydroxides or similar combustion products formed in the explosions. These tritiated compounds are readily exchangeable with water and constitute a source of mobile tritium which would migrate freely with soil moisture or groundwater movement. Additionally, some residual ${}^6\text{LiT}$ may have been present in the solid waste. This compound is quite unstable in the presence of moisture and reacts rapidly to release tritiated water (HTO), so this tritium would also be readily available for hydrologic transport. Additionally, it is possible that the high temperatures and pressures of the explosive experiments may have left behind some compounds in which the tritium is not freely exchangeable with the hydrogen in water. Although somewhat reactive, these compounds may release tritium to the surrounding water slowly so that the rate of release to the environment would be governed by the rate of leaching from the contaminated waste as well as by hydrologic transport.

A reasonable upper-limit estimate is that no more than a few percent of the total tritium inventory expended would have been retained or disposed of as solid waste. This would yield a total maximum contaminant source on the order of a few hundred curies or less (decay corrected to present activity), most but not all of which would probably be readily soluble or exchangeable with water.

PREVIOUS MONITORING PROGRAMS

Two previous monitoring programs were carried out at Site 300: the LLNL Site Environmental Monitoring Program (SEMP) and the Hazardous Waste Assessment Project (HWAP). SEMP was initiated in 1971 and has operated continuously since then. In 1985, SEMP was reorganized and its activities continued under the Environmental Quality Verification Program (EQVP). Subsequent references to EQVP should be understood to include the data and procedures previously identified with SEMP. The HWAP landfill characterization program installed monitoring wells during 1981-1983 and obtained initial tritium data; routine monitoring since 1983 has been carried out by EQVP (formerly SEMP).

Under these programs, large quantities of data have been published in formal technical reports.¹⁻¹⁵ In general, they show little evidence of

tritium contamination. This negative evidence is used here to establish the expected levels of tritium in the uncontaminated portions of the Site 300 environment. These reports also indicate specifically the sites and observations that show the effects of local contaminant tritium. These earlier data are discussed in detail in the tritium results section (see "Tritium Distribution") later in this report.

Throughout this report, the tritium activities discussed are the values measured at the time of analysis. Because tritium has a half-life of 12.26 years, significant decay corrections are necessary if older data are compared with more recent results. For example, the current activity of an isolated tritium sample would be about 50% of the activity observed in 1973 and 25% of the activity observed in 1960.

EQVP Tritium Results

In EQVP, samples of groundwater, surface water, and vegetation are collected and analyzed for tritium activity from various locations over the entire Site 300 area. Records of rainfall and tritium activity in rainfall are also kept. The sampling and analytical methods used in EQVP and a discussion of the precision, accuracy, and interpretation of the tritium data are in Appendix C.

Tritium in Water. Both present and discontinued sampling locations for water are shown in Fig. 5. Water sampling locations 1 through 7 are deep wells, completed below the surface of the local water table. Location 20 is the rainfall collection station, and the remaining water sampling points are creeks, ponds, or springs.

In the available data, only one EQVP water sampling location has consistently shown elevated tritium. Location 25 (see Fig. 5), a spring which seeps into the surface drainage channel below the Building 850 West Disposal Area, has had tritium levels $\geq 100,000$ pCi/l whenever it was sampled. This spring, known as the Well #8 spring, is shown on Plate 1 and discussed in more detail below. Individual elevated values were reported for locations 21 and 26 in the early 1970s, but repeated resampling has failed to confirm any evidence of contamination. It is now impossible to determine whether these values resulted from real but transient episodes of environmental contamination, sample contamination during or after collection, or analytical problems.

Figure 5. Environmental Quality Verification Program (EQVP) water and vegetation sampling locations in and adjacent to Site 300.

The record of rainfall tritium activity permits us to establish an upper limit on the activity of local recharge to the soil moisture and groundwater bodies. Collections were sporadic in the early years of the program, but for the last 10 years, no individual monthly rainfall composite has exceeded 250 pCi/l. Annual arithmetic averages of the monthly composite activities are below 200 pCi/l, and for the past several years have been near or less than 100 pCi/l. Rainfall tritium records for the U.S. Geological Survey (USGS) collection station in Menlo Park have been obtained for the years 1958 to 1981, and are in satisfactory agreement with the Site 300 data for the period of overlapping records.

This suggests that Site 300 rainfall has not been affected by major local sources of tritium contamination over the last decade. It also suggests that the USGS record can be used as a proxy to determine what uncontaminated rainfall activities should have been prior to the initiation of local sampling. The highest Menlo Park activity recorded was 1770 pCi/l in June 1963. Annual average activities during the high fallout years (1961 to 1964) were well above present levels, but less than the 1770 pCi/l maximum; they would have decayed to 25% to 30% of their initial value by the present time.

Based upon the discussion here and in Appendix C, a reasonable estimate of this tritium activity of uncontaminated recharge to the groundwater over the past 5 years appears to be 100 pCi/l; water values in excess of 300 pCi/l are suggestive of local tritium sources.

Tritium in Vegetation. Determination of baseline values for vegetation tritium activity is more complex than estimating recharge activities for water samples. The plants sampled are grasses and small shrubs. They have high water turnover rates and their free-water tritium activity is a complex function of soil moisture and air moisture activity over a short period prior to sampling. Annual or even monthly average rainfall activities are not a particularly satisfactory basis for estimation of the actual ranges of relevant activities. The situation is further complicated by the fact that evapotranspiration may result in a small but measurable enrichment of the heavy isotopes in the liquid phase.

Based on a limited amount of theoretical data and empirical review of our own data and that of others, we treat vegetation activities of less than 500 pCi/l as within the range of normal, uncontaminated variation, 500 pCi/l to 2000 pCi/l as suspicious but not conclusive, and over 2000 pCi/l as probably indicative of a local tritium source.

Vegetation sampling sites are also shown in Fig. 5. Only two locations show consistent or credible evidence of contamination: location 6, just east of the south end of Pit 3, and location 13, about 50 m down slope from water sampling location 25.

Hazardous Waste Assessment Project (HWAP)

In 1981, the HWAP study^{1,2} of the hydrology, geology, and groundwater chemistry associated with Site 300 landfills was initiated. As part of this study, 17 boreholes were drilled and completed for groundwater sampling in the vicinity of the various landfills. Eight of these boreholes had multiple-depth completions. Groundwater samples from all borehole completion depths were analyzed for tritium, as were samples from all existing wells and springs at Site 300 (Fig. 3).

The only locations showing tritium in excess of normal ambient levels were boreholes K7-1, K7-3, K2-1C, and K2-4. The initial levels measured were all less than the California groundwater standard of 20,000 pCi/l. Following completion of this project in 1983, a quarterly groundwater monitoring program was established for the landfill monitoring wells, which were analyzed for tritium and other constituents. In March 1984, water tritium levels in wells K7-3, K7-1, and K2-1C reached or exceeded 20,000 pCi/l. The Regional Water Quality Control Board (RWQCB) was notified and the Site 300 Groundwater Tritium Investigation, which is the subject of this report, was planned and initiated.

CURRENT INVESTIGATION

OBJECTIVES AND PLANNING

General Study Objectives

In July 1984, LLNL personnel met with State and Regional Water Quality Control Board staff members in Sacramento to discuss the tritium groundwater contamination and to review other aspects of Site 300 landfill and groundwater quality monitoring. At this meeting, and in subsequent discussions, objectives of the tritium groundwater investigation and specific plans for the first phase of the investigation were discussed and approved.

The primary emphasis of this investigation is to develop an understanding of the tritium contamination and water transport. Tritium is by far the most mobile of the potential contaminants located in the landfills; analyses for other possible contaminants can be added later on the basis of the hydro-geologic data and contaminant transport models developed for tritium.

RWQCB Reports

An interim letter report to the RWQCB was made in March 1985. A data update was submitted in June 1985. This report covers all results through September 1985 and includes some data from October and November 1985. The results of monitoring programs, modeling efforts, and follow-up investigations now in progress will be reported during the latter part of 1986.

Phase 1: July 1984 - February 1985

Objectives. Five objectives were initially established for the groundwater tritium investigation:

- o Identify and characterize the tritium source or sources of groundwater contamination in and near the Pit 7 complex in the West Firing Area.
- o Determine whether or not there is any local contribution of tritium from the Pit 1 complex to groundwater in the Elk Ravine drainage.

- o Characterize the saturated and unsaturated zone transport pathways for the released tritium.
- o Evaluate the potential for offsite tritium transport or contamination of deeper aquifers.
- o Establish an expanded monitoring network to study the movement of present groundwater contamination and to give timely warning of future releases.

In addition to these specific objectives, agreement was reached with the RWQCB on the general approach to the investigation and on additions to the monitoring network around Pits 1 and 7 requested by the State. Because of uncertainties about the locations and nature of tritium sources and the details of local hydrogeology, the investigation was planned and conducted in phases. This allowed the efficient use of short-term results in planning subsequent work, and ensured that available resources were directed towards questions of highest priority.

Operational Plan. Phase 1 of the groundwater tritium investigation included the following major efforts:

- o Search historical records for data from sampling boreholes drilled into the water table.
- o Perform a preliminary reconnaissance of the tritium levels of vegetation and surface soil samples.
- o Take an initial vadose zone (<20 ft) soil sample survey at the time of installation of lysimeters and unsaturated zone soil moisture monitoring instruments.
- o Design a groundwater investigation on the basis of the record search, the preliminary reconnaissance, and the results of the vadose zone survey described above.
- o Install a network of piezometers, monitoring wells, and deep lysimeters.
- o Establish a program to monitor water levels, soil moisture, and the tritium content of samples from all relevant sampling points.

Phase 2: March 1985 - September 1985

Meetings between LLNL and RWQCB personnel were held in October 1984 at Site 300 and in February 1985 in Sacramento to summarize the progress and present the results of the study through February 1985.

Objectives. The following Phase 2 objectives were established as extensions and more detailed expansions of the general project objectives identified as part of Phase 1:

- o Identify the source or sources believed to be present near Building 850.
- o Resolve whether separate sources of tritium contamination exist in Pit 5 and Pit 3 or whether all the observed contamination in that area is due solely to a source in Pit 3.
- o Identify, and to the extent possible, characterize the sources of tritium contamination of groundwater by location, areal extent, depth, and types of materials.
- o Characterize the tritium transport mechanisms and pathways to and within the contaminated groundwater bodies.
- o Characterize in detail the vertical and lateral extent of the existing contamination plume.
- o Develop a working model of the hydrology of the area.

Operational Plan. The following activities were scheduled for completion prior to the end of September 1985:

- o Sample monitor wells, piezometers, and lysimeters for tritium monthly and water levels weekly (approximately).
- o Add new installations to the monitoring and sampling schedule as they are completed.
- o Sample surface runoff whenever surface flow occurs.
- o Characterize in detail the core samples obtained from further drilling, including laboratory porosity and permeability measurements.
- o Obtain groundwater velocity estimates from aquifer tests on wells and piezometers.
- o Monitor the variation in water levels and tritium activities over time and compare with geologic sections from core and borehole samples.
- o Perform additional coring along suspected tritium transport pathways.
- o Install fully instrumented vadose zone sites close to Pit 3.
- o Perform deep coring and piezometer and monitoring well installations around Building 850.

All planned activities have been carried out, and we have either met or made substantial progress toward meeting all of the objectives. Because of delays in the delivery of laboratory equipment, we have not obtained

laboratory porosity and permeability data in time for inclusion in this report. Only small amounts of surface runoff data were obtained, because rainfall amounts and patterns during 1984-1985 produced very little runoff and stream flow. Further data in these areas will be presented in a subsequent report. The status of project objectives and plans for completion are detailed in the final section ("Conclusions") of this report.

METHODS

In order to characterize the tritium plume and locate the area of tritium distribution, we performed reconnaissance sampling; planned and carried out a drilling program; and collected and analyzed samples of soil-moisture tritium, shallow soil, vegetation, and surface water. We instituted a continuing program to monitor tritium activities in Site 300 groundwater. We also further investigated the geology and hydrogeology of the area in order to characterize the aquifers underlying the Site 300 area.

The tritium monitoring wells, lysimeters, piezometers, and neutron probes are characterized in Appendix A. The drilling, installation, development, sampling, and aquifer test methodologies customarily used are described there.

Individual borehole and completion log summaries for the holes drilled under this monitoring program are given in Appendix B. Wells drilled during earlier projects, but still used as sample collection sites or as sources of geohydrologic data, are also included in Appendix B. The tritium activities of the soil moisture samples collected during drilling are printed on the log summary sheets. The locations of all lysimeters, piezometers, wells, and neutron probes are shown on the base map (Plate 1, inside back cover).

Shallow soil, surface water, and vegetation samples were collected and analyzed for tritium activities according to the description in Appendix C. The samples were collected from the locations shown in Figs. 6 and 7; the tritium activities of individual samples are tabulated in Appendix D.

The tritium activities of groundwater samples and the water table elevations at each routinely sampled installation are compiled chronologically in Appendix E; Appendix F contains a summary of annual precipitation by water year at Site 300 and detailed rainfall records by calendar year.

Groundwater Analysis and Monitoring

Groundwater was sampled when it was encountered in each borehole. After the wells or piezometers were installed, developed, and surveyed, they were incorporated into an ongoing monitoring program that initially included water elevation measurement at approximately weekly intervals and monthly tritium analysis. Since June 1985, both water elevation measurements and tritium samples have been taken on a monthly basis. Lysimeter samples are also analyzed for tritium on a monthly basis. Tritium and elevation results for each installation are given in Appendix E. One set of surface water samples from drainage ditches and puddles was collected following a rainy period (Appendix D). Because there was no sustained and very little episodic stream flow in the 1984-1985 rainy season, it was not possible to obtain surface water samples on a consistent basis.

Figure 6. Tritium activities (pCi/l) of moisture from shallow soil samples taken < 5 ft deep at Site 300. Locations are keyed to tritium data in Table D1, Appendix D.

Figure 7. Tritium activities (pCi/l) in samples of moisture from vegetation and in surface water from Site 300. Locations are keyed to tritium data in Tables D2 and D3 in Appendix D.

RESULTS

Geology

Most of the geologic and hydrogeologic knowledge acquired about the West Firing Area prior to the present study came from the Site 300 HWAP Project done in 1981-1982.^{1,2} Six exploratory holes and monitoring wells, K7-1 through K7-6, were placed surrounding the Pit 7 complex (Fig. 3 and Plate 1) for this waste assessment project. These borings showed that the stratigraphy indicated a sequence of northeast dipping beds, but the groundwater data for the Pit 7 area indicated a general southeastwardly groundwater flow. In the present study, we drilled 47 borings in the West Firing Area and 6 borings in the East Firing Area. The borings were logged and sampled (see Appendix A for methods and Appendix B for core logs). These results have added more detail to the geologic understanding of the area and refined our knowledge of the groundwater characteristics.

The Pit 7 complex is located near the northwestern head of a valley that slopes toward the southeast at about 2 to 5 degrees. The northwestern margin of the complex, which is the active portion of Pit 7, is about 100 ft south of the crest of the drainage divide that defines the upper limit of the valley. Parallel ridges to the northeast and southwest rise about 160 and 400 ft above the valley floor respectively (Fig. 4).

The valley is underlain by alluvial fill consisting of interbedded sands, silts, and clay with occasional gravel lenses. The eastern half of the area is steeper than the western half; thus, less colluvium and alluvium is found and more bedrock exposures are present on the ridge slopes. The bedrock underlying the area is the Neroly Formation, which is made up of distinctive blue-weathering sandstone and sandy siltstone, coarse conglomerates of well rounded, vesicular, andesitic pebbles and cobbles, and interbedded tuffaceous shales. Leaf fossils indicate a Miocene to Pliocene age, and vertebrate (Neohippus) remains indicate a Pliocene age for parts of the Neroly Formation.¹

Underlying the Neroly Formation is the Cierbo Formation that consists of interbedded coarse, friable sandstones, carbonaceous brown shales, and some tuffs. The Cierbo Formation is fairly micaceous and contains Ostrea bourgeosii, a shallow fresh-to-brackish water pelecypod, which is the only common diagnostic fossil in the Cierbo Formation.¹

Deep exploratory borehole K7-4, located at the northwestern limit of the project area, bottomed at 314.0 ft in interbedded turbidite sandstones and silty shales believed to be correlative with the late Cretaceous Panoche Formation. The Panoche Formation underlies the Tertiary sequence and was mapped by Dibblee¹⁶ as exposed west of the project area; this formation may also have been encountered at depth in well K7-3.

Figure 8 gives the locations of the five geologic cross-sections in the West Firing Area that are shown in Figs. 9 through 13. The sections have been developed from the logs of boreholes near the Pit 7 complex and Building 850. Cross-sections A-A' and B-B' are placed in areas where the regional bedrock and the alluvial fill, respectively, are most prominent; they show subsurface relationships in the study area oriented parallel to the trend of the valley. Cross-sections C-C', D-D', and E-E' are oriented normal to the valley, and are approximately coincident with the axes of the major contaminant plumes.

The regional dip was calculated from the cross-sections as 10 degrees to the northeast and the regional strike as N 18 W. These values are approximate, as it is difficult to determine the strike and dip of the beds accurately from outcrops because of large scale cross-bedding in the bedrock formations. The axis of the valley in the study area is subparallel to the regional strike; thus, the cross-sections that parallel the valley axis show only a slight apparent dip to the bedrock layers while cross-sections oriented normal to the valley show approximately true dips.

Cross-section A-A' (Fig. 9) is located on the eastern slope of the valley where there is the minimum amount of alluvial cover. The section is oriented subparallel to the regional strike of the bedrock sequence. There is a distinct stratigraphic change in this section between NC7-25 in the northwest and NC7-27 in the southeast. In NC7-25, there are thick (10- to 20-ft) sandstone beds, which are devoid of major interbedding and are overlain by a prominent conglomerate bed. In NC7-26, the conglomerate bed has thinned to about 1 ft thick with a 10- to 15-ft, sandy siltstone bed overlying it. The massive blue sandstone is still present in NC7-26, but shows interbedding of 2- to 12-in.-thick claystone beds in the lower part of the section. NC7-27 shows the same general stratigraphy as NC7-25 and NC7-26, but the water-bearing blue sandstone that is present at depth in the two previous borings has pinched out, and claystone interbeds within the massive blue sandstone have greatly increased in thickness.

Section B-B' (Fig. 10) is a section down the center of the alluvial valley. The alluvial cover in this area ranges from 2 ft thick (NC7-10) to 25 ft thick (NC7-14). The alluvium is made up of alternating beds of clay, sand, silt, and some gravel. The bedrock underlying the alluvium has a stratigraphy consistent with that of section A-A'. Correlations between the two sections can be seen in cross-sections C-C' through E-E'.

Section C-C' (Fig. 11) is of considerable interest, because the area between K7-6 and NC7-30 contains waste landfill Pits 3 and 7. This section corresponds to the longitudinal axis of the northernmost contaminant plume (see Fig. 17 below).

Section D-D' (Fig. 12) crosses through the center of the study area and the panhandle portion of Pit 5, which is located between NC7-18 and NC7-6 in this cross-section. This section is designed to depict the geology under the middle contaminant plume at the study site and to show the difference in alluvial cover between the east and the west sides of the valley.

Section E-E' (Fig. 13) underlies the Building 850 Firing Table and extends to Doall Road on the east. In this section, a large amount of claystone interbedding is found in the blue sandstone near NC7-27. This section identifies the geology of beds containing the southernmost contaminant plume in the study area. The section includes fill material east of Building 850 that is not characteristic of other portions of the area.

Based on the tritium results presented in Appendices D and E and discussed below, we have concluded that there are no local sources of significant groundwater tritium contamination in the East Firing Area. The localized tritium contamination in that area is attributed to stream channel transport from Building 850 along the Doall Road ravine. Consequently, a detailed geologic and hydrogeologic characterization of the Pit 1 complex has a relatively low priority in the overall project objectives and has not been completed for this report.

LEGEND

Qcl	Colluvium and Alluvium (Quaternary) unconsolidated valley fill and slopewash material
Silty gravel
Sand
Silt
Clay
Tn	Neroly formation (Miocene - Pliocene) Swampy - shallow marine, well consolidated material
Conglomerate
Sandstone
Siltstone
Claystone
Tmss	Cierbo formation (Miocene) Shallow marine - bay sediment, well consolidated material undifferentiated sandstones claystones and siltstones
Ground water level as of 8/27-29/85
T. D. 73.0'	Total depth of boring
NC7-25	Well location and number
CP D-D'	Crossing point of section D-D'
TP	Turning point along present section

Figure 9. Geologic cross-section A-A'.
See Fig. 8 for location; legend on
facing page.

Figure 10. Geologic cross-section B-B'.
See Fig. 8 for location; legend faces
Fig. 9.

Figure 11. Geologic cross-section C-C'. See Fig. 8 for location; legend faces Fig. 9.

Figure 12. Geologic cross-section D-D'. See Fig. 8 for location; legend faces Fig. 9.

Hydrogeology

Overview. The dominant hydrogeologic feature underlying the Pit 7 complex and the Building 850 area is a laterally extensive, perched aquifer. The aquifer itself occurs mainly within a sandstone sequence that locally contains conglomerate interbeds. Other portions of the aquifer are composed of fracture systems in otherwise impermeable claystone and siltstone beds. The perching horizon appears to be claystone-siltstone interbeds that lack open fractures within the Neroly formation. This aquifer extends from west of wells K7-6 and NC7-44 (upgradient of Pit 7 and Building 850, respectively) to the Elk Ravine Fault on the east. It appears to be continuous from a short distance south of the surface drainage divide north of Pit 7 to south of Building 850.

The perched aquifer is overlain, and in places intersected, by alluvial material in the valley. The landfills of the Pit 7 complex were constructed within the valley alluvium and underlying bedrock.

The previous deep drillings in the Pit 7 area described by Raber and Carpenter¹ encountered no other water-bearing zones to a total depth of over 300 ft. In the vicinity of Building 850, records for Well #8 (an abandoned production well) show that it was cased through the perched aquifer at a depth of 30 ft. Deeper water-bearing zones were encountered at depths of 55 ft and 126 ft. The well was perforated at depths of 54-62 ft, 78-102 ft, and 126-138 ft. The tritium data discussed below indicate that there is no significant communication between the perched aquifer and these deeper aquifers in the Well #8 area.

Recent examination of hydrologic and chemical data for monitoring well K7-5 suggests that this well may also have intersected the second water-bearing zone. With the exception of one possibly erroneous sample report, water from this well has background levels of tritium.

Infrequent surface flow of water can occur sporadically during the winter months, especially during wet years. The major drainage patterns (Plate 1) follow the southeasterly trend in the valley alluvium from the Pit 7 complex to the Doall Road ravine, and then east along that ravine to the East Firing area, where surface flow is to the southeast.

Our understanding of the groundwater hydrogeology east of the Elk Ravine Fault is based on the work of Raber and Carpenter¹, who described multiple water-bearing zones east of the fault and a northeastward direction of flow in the uppermost aquifer. Monitoring well records since that time and the recent

installation of additional monitoring wells near Pit 1 tend to confirm that analysis.

Groundwater Flow Directions and Elevations. Water table elevation gradients conform closely to the dip of the bedding in the Neroly formation. Figure 14 shows hand-plotted contours of water elevations for August 1985. Data used are from the NC-series of monitoring wells and piezometers. Elevations observed in the K-series of wells, with the exception of K7-5, are consistent with those shown in Fig. 14. Groundwater gradients are approximately 1:10 (10%) with flow directions east to northeast. Contour plots for other dates over the course of this study have been prepared; gradients and directions show relatively little variation, and Fig. 14 is presented as typical.

We have considered the question of whether the alluvial and bedrock sections of the perched aquifer should be treated separately. We conclude that over the period of this study no significant distinction can be made. Groundwater gradients appear to be continuous across the bedrock-alluvium contacts. There is a substantial amount of evidence, however, from tritium distributions (discussed below) and from earlier groundwater elevation data, that the alluvial fill is capable of permitting the flow of groundwater southeastward from the landfills along the axis of the valley when the water table is elevated above present levels.

Following initial studies, Raber and Carpenter¹ deduced groundwater flow directions of south-southeast to southeast under the Pit 7 complex, based on average water table elevations during the period October 1982 to January 1983 in wells K7-1, K7-3, K7-5, and K7-6. These conclusions can be understood and reinterpreted by considering the data in Fig. 15 and comparing these results with Fig. 14.

First, we note that water table variations in these wells over the course of the present study (late 1984 to present) have been relatively small and consistent, in agreement with our observation that contours and gradients based on the more extensive set of observations have shown little change.

The earlier groundwater gradient estimates appear to have been affected by three factors. First, elevations were averaged over a time period when water levels were rising rapidly, and at different rates, in all of the wells. Second, the plots strongly suggest that the December 1982 elevation value for well K7-1 is erroneous. Third, we note that although K7-6, K7-3, and K7-1 all conform well to the regional contours in Fig. 14, K7-5 consistently is

Figure 14. Water table elevation contours for the perched aquifer. Data collected August 27-29, 1985; contour interval 20 ft.

Figure 15. Groundwater elevation and rainfall, Pit 7 area, 1981-1985.

anomalously low. Piezometer NC7-18, approximately 100 ft southeast of K7-5, consistently shows water elevations over 10 ft higher. The chemical data presented by Carpenter and Peifer² indicate significant differences in groundwater chemistry between K7-5 and the other K7 wells, supporting the hypothesis that the aquifer tapped by K7-5 may not be continuous with that sampled by the other installations.

Figure 15 illustrates another point of interest. Wells K7-1 and K7-3 are completed beneath the thickest part of the alluvial fill. Their response to the unusually wet winters of 1981-1982 and 1982-1983 (rainfall was 79% above average for the two-year period; see Appendix F) is considerably slower than the responses of the upgradient wells. This suggests that the alluvium, which may be expected to have higher porosity but lower hydraulic conductivity than the bedrock, can function as a temporary storage reservoir and may exhibit ponding in response to increased recharge. In view of the complex bedding in both the alluvium and the bedrock, it is quite possible that this could result in transient, shallow groundwater flow to the southeast through the alluvium as suggested by the early data.

It is also noteworthy that water levels in K7-1, K7-3, and K7-6 all rose to within 12 to 16 ft of the ground surface at their maximum recorded elevations, and that no data are available for the spring of 1983 when rainfall records suggest that the actual maximum may have occurred. Since the landfill pits were excavated through the alluvial material into the bedrock in the same area to a nominal depth of 15 ft, it is very possible that saturated conditions occurred in the lower portions of the pits during 1983.

Aquifer Test Results. Field tests to determine aquifer characteristics were conducted at monitoring wells NC7-25, NC7-26, and NC7-28, and at piezometers NC7-11, NC7-16, and NC7-23. Because these installations have very low sustainable yields (typically $< 1/2$ gpm), pump drawdown tests proved to be impractical. Instead, bail tests were performed on the piezometers and slug tests on the monitoring wells. Methods and calculations are described in Appendix A.

Although there is no practical alternative, slug and bail tests have several major disadvantages. The volume of water added or removed is small, so the response is characteristic of only a small volume of aquifer immediately adjacent to the installation. One result of this is that the response is very sensitive to details of well completion and development. Another result is that even if one successfully characterizes the hydrologic microenvironment in

the immediate vicinity of the well, the results may not be generalizable if the formation is heterogeneous. The Neroly formation, with its highly variable interbedding, weathering, and fracturing, is definitely a non-uniform aquifer.

A second set of problems with slug and bail tests is related to the calculational methods for data reduction and interpretation. A number of semi-empirical methods are available for calculation of formation hydraulic conductivities from variable head test results; however, none have been developed for our specific type of installation, in which a cased, partially penetrating well is screened both above and below the water table. In view of the sensitivity of the method to completion details and near-well environment, this is a serious problem.

We have calculated hydraulic conductivities by three commonly used procedures. (See Appendix A for a discussion of methods and parameter values used.) These results are tabulated in Table 3. The methods of Hvorslev¹⁷ and Cooper et al.¹⁸ were both designed for installations with a constant screened interval completely below the water table at all times; we modified these methods by using an approximation for the time-averaged length of effective screened interval over the course of the test. The variant of a method employed by the Naval Facilities Engineering Command (as cited by Cedergren¹⁹), which was designed for uncased wells, is clearly the most appropriate calculational approach for our piezometer bail tests. We have not yet ascertained if it is equally valid for slug tests, but the internal consistency of the data sets in Table 3 suggests that it is.

Table 3. Hydraulic conductivities (K) in cm/s calculated from aquifer test data by three separate methods.

Installation	Method		
	U.S. Navy (Ref. 19)	Hvorslev (Ref. 17)	Cooper, et al. (Ref. 18)
NC7-25 ^a	8.9×10^{-6}	6.3×10^{-5}	1.4×10^{-4}
NC7-26 ^a	9.9×10^{-5}	9.6×10^{-4}	1.4×10^{-3}
NC7-28 ^a	2.1×10^{-5}	3.0×10^{-4}	5.7×10^{-4}
NC7-11 ^b	1.3×10^{-4}	1.6×10^{-3}	6.9×10^{-3}
NC7-16 ^b	6.2×10^{-5}	1.3×10^{-3}	5.7×10^{-3}
NC7-23 ^b	5.7×10^{-7}	9.4×10^{-6}	5.7×10^{-6}

^aMonitoring well; slug test.

^bPiezometer; bail test.

Although we adopt the hydraulic conductivity values calculated from the Navy method as most appropriate, we include the other results to emphasize the uncertainties inherent in these determinations. Using three commonly accepted calculational approaches, we obtain values for K ranging over nearly two orders of magnitude. Although the Hvorslev and Cooper et al. methods are nominally adapted to the same hydrologic situation, their results differ by factors of 2 to 5. A similar variation within the results of any one method can be obtained by considering the effects of experimental uncertainties, the inexactness of the type curve fitting, etc. It is clearly optimistic to consider the hydraulic conductivity values to be more precise than order-of-magnitude estimates.

The purpose of field determinations of K is the ultimate calculation of groundwater velocities using Darcy's Law:

$$v_p = \frac{K \frac{dh}{dl}}{n} , \quad (2)$$

where

- v_p = pore velocity,
- K = hydraulic conductivity,
- n = effective porosity,
- dh/dl = hydraulic gradient.

Table 4 presents estimated pore velocities in meters/yr calculated from the values tabulated. As laboratory porosity determinations have not yet been completed, we use porosity values based on ranges reported in the literature. Clearly, this introduces additional uncertainty into the final result, making the calculated velocity values order-of-magnitude estimates at best.

The results indicate that the most probable groundwater velocities in the study area are in the range of a few meters per year to a few tens of meters per year under present conditions of water table elevation and gradient. As will be seen, the groundwater tritium distributions (presented below) can be used as a tracer to estimate flow velocities; the results thus obtained are generally consistent with but arguably more accurate than those based on hydrologic calculations.

Table 4. Groundwater velocity estimates (v_p) in m/yr calculated from the values tabulated for porosity, gradient, and hydraulic conductivities (K).

Installation	Formation	Porosity ^a	Gradient ^b	K (cm/s) ^c	v_p (m/yr)
NC7-25	sandstone	0.15 (.05-.30)	0.1	8.9×10^{-6}	1.9
NC7-26	sandstone	0.15 (.05-.30)	0.1	9.9×10^{-5}	20.8
NC7-28	sandstone	0.15 (.05-.30)	0.1	2.1×10^{-5}	4.4
NC7-11	claystone	0.05 (0 -.10)	0.1	1.3×10^{-4}	81.9
NC7-16	claystone	0.05 (0 -.10)	0.1	6.2×10^{-5}	39.1
NC7-23	claystone	0.05 (0 -.10)	0.1	5.7×10^{-7}	0.4

^aEstimated value used in calculation (range of literature values).

^bEstimated for study area as a whole from contours in Fig. 14.

^cHydraulic conductivities from Navy method, Table 3.

Stream Discharge. There are several lines of evidence indicating that the streambed in Doall Road ravine acts as a discharge zone for groundwater flow east of Building 850. In addition to the tritium distributions discussed below, this is supported by the existence of the spring below NC7-10, where water seeps into the stream channel and is sampled from a pipe driven horizontally into the steeply sloping channel. In addition, piezometer NC7-45 immediately adjacent to the channel shows much lower water elevations than would be predicted from a smooth interpolation of the regional contours defined by NC7-27 to the north and NC7-29 to the south. These observations, combined with the fact that surface flow occurs only infrequently and during periods of high rainfall, strongly suggests that there is lateral subsurface flow occurring within the deeper portions of the stream channel alluvium.

Local Effects. The foregoing material has been written as a general regional view of the hydrogeology; it is strongly supported by the data as a whole. When results are examined on a well-by-well basis, it is clear that we are dealing with numerous hydrogeologic microenvironments within the overall regional framework.

Two examples may be cited. At piezometer NC7-12, the first water encountered was roughly 5 ft higher in elevation and almost an order of magnitude higher in tritium concentration than the values established after the installation had equilibrated for 2 to 3 months. This was probably due to a small perched water body, supported on or in a clay lens in the alluvium, that had stored water representing the higher water table of 1983--in effect, a perched water body stranded above the main regional perched aquifer. A different situation is represented by NC7-10, where water levels rose rapidly

by several feet once a water-bearing zone was encountered in a previously dry hole. This indicates the presence of a confining layer, which is consistent with the presence of a spring downslope from NC7-10 in a steep section of the stream channel.

These observations emphasize the hydrologic consequences of the geologic determination that both the alluvium and the bedrock are stratigraphically complex with a high degree of interbedding. Changes in recharge that result in water table variations may therefore have effects on groundwater flow velocity or direction that cannot be predicted from the assumption of a homogeneous aquifer.

Finally, one man-made, local effect on the hydrology of Pit 3 merits discussion. Pit 7, which is both topographically and hydrologically above Pit 3, was excavated into the bedrock in 1978. Although the south end has been backfilled, the unused portion of the access to Pit 7 upgradient from Pit 3 remains an open excavation 15 ft deep, which bottoms in claystone. The surface of the open portion of the pit slopes to the southeast. Although we presently have no evidence to confirm or refute the hypothesis, we consider it possible that the unfilled portion of the excavation could cause either enhanced recharge or lateral vadose zone flow at the level of the pit floor; this would increase the chances of water input into Pit 3.

Tritium Distribution

General. This section describes the distribution of contaminant tritium in the study area. Historical samples, reconnaissance samples from nearsurface soil, vegetation, and water, vadose zone samples, and groundwater samples are treated in separate subsections. Because of the volume of data presented in Appendices B and E, this section consists primarily of a summary of the trends and patterns in tritium distribution. Specific points or data sets are included only to the extent that they are particularly illustrative or form the basis for subsequent discussions or interpretations.

Historical. Time series analyses are an important tool for evaluating contaminant mobilization and migration rates, and can assist in source characterization. The present study has been in progress for only slightly over a year, and the record of data from most installations spans less than a full seasonal cycle. However, data obtained from monitoring programs initiated

earlier can provide some insight into tritium distributions and variations over time.

The EQVP (SEMP) program discussed in the Introduction has detected sporadically elevated vegetation tritium values in locations near the southeast corner of Pit 3 and near the stream channel just below the Well #8 spring.

Tritium values from the landfill monitoring wells installed in 1981-1982 have been recorded on an approximately quarterly basis since late 1982. Of these wells, the only ones which showed elevated tritium, either originally or on subsequent sampling, were K7-1, K7-3, K2-4, and K2-1C (the upper sampling point in a multiple depth completion). Well K7-5 has consistently yielded background values; it was reported by a contract laboratory to have an activity of 4,000 pCi/l on one occasion, but we believe this to be an error, because a sample taken from Well K2-4 at the same time was reported to have background levels. An interchange of samples is consistent with the time series from both wells.

Table 5 presents the history of tritium activity in all four wells. Well K2-4 is hydrologically anomalous; it appears to tap a partially confined, shallow aquifer, and to be influenced both by the Doall Road ravine stream channel and by local groundwater flow. The others are more straightforward; K7-1 is downgradient from the southern end of Pit 5 and K7-3 is downgradient from the northern end of Pit 5. K2-1 is in the East Firing Area slightly southeast of where the Doall Road stream crosses the Elk Ravine Fault.

The Well #8 spring located in the stream channel south of NC7-10 was sampled during the period 1971-1973; it was dropped from the sampling schedule after the access point was blocked, but was reopened and sampled as part of the present study. Although the record is unfortunately discontinuous, the data provide us with the oldest information on tritium-contaminated groundwater in the study area. Table 6 summarizes the information available on tritium activities in the water from this spring. Because the interval over which data was collected spans at least one half-life of tritium, both the original measurements and values decay-corrected to mid-1985 are presented.

Reconnaissance Sampling. Appendix D presents the results of reconnaissance sampling of soil, vegetation, groundwater, and surface water. Although most of the sampling was oriented toward identification of contaminated locations within the study area, additional samples of groundwater were collected from other wells, from a standpipe which penetrates the water table

Table 5. Chronology of tritium activities (pCi/l) in monitoring wells.

Date	Well K7-1		Well K7-3		Well K2-1C		Well K2-4	
8/82	3,300	± 157	2,150	± 143	1,026	± 126	14,130	± 226
11/82	7,000	± 1,000	7,000	± 1,000	-		7,000	± 1,000
7/83	14,000	± 1,000	8,000	± 1,000	-		-	
10/83	17,000	± 1,000	11,000	± 1,000	-		-	
3/84	20,000	± 1,000	43,000	± 1,000	21,000	± 1,000	-	
5/84	20,400	± 730	58,800	± 1,300	-		4,180	± 270
6/84	21,400	± 750	-		34,000	± 2,000	-	
7/84	23,800	± 800	55,200	± 1,300	-		-	
9/84	23,500	± 500	72,400	± 800	33,600	± 500	6,250	± 290
10/84	23,700	± 300	65,800	± 530	-		-	
2/85	21,500	± 450	86,900	± 900	37,200	± 560	3,250	± 240
3/85	19,500	± 780	93,600	± 2,810	-		980	± 530
6/85	27,500	± 1380	101,000	± 3,030	46,300	± 1,850	1,070	± 490
8/85	24,700	± 1240	93,200	± 2,800	45,600	± 1,820	1,360	± 570
10/85	29,000	± 1450	105,000	± 3,150	48,000	± 1,920	970	± 465

Table 6. Historical tritium activity data from the Well #8 Spring.

Date	Original value (pCi/l)		Decay-corrected (pCi/l)	
	maximum	average	maximum	average
1971 ^a	7.2 X 10 ⁵ ± 2%	5.8 X 10 ⁵	3.3 X 10 ⁵	2.6 X 10 ⁵
1972 ^b	8.1 X 10 ⁵ ± 2%	7.7 X 10 ⁵	3.9 X 10 ⁵	3.7 X 10 ⁵
1973 ^c	8.5 X 10 ⁵ ± 2%	6.9 X 10 ⁵	4.3 X 10 ⁵	3.5 X 10 ⁵
06-11-84	1.6 X 10 ⁵ ± 2%		1.5 X 10 ⁵	
06-21-84	1.7 X 10 ⁵ ± 2%		1.6 X 10 ⁵	
07-13-84	1.8 X 10 ⁵ ± 2%		1.7 X 10 ⁵	
09-06-84	2.13 X 10 ⁵ ± 1.8%		2.0 X 10 ⁵	
09-18-84	2.11 X 10 ⁵ ± 0.6%		2.0 X 10 ⁵	
09-26-84	2.12 X 10 ⁵ ± 0.6%		2.0 X 10 ⁵	
10-24-84	2.33 X 10 ⁵ ± 0.6%		2.3 X 10 ⁵	
10-26-84	2.33 X 10 ⁵ ± 0.6%		2.3 X 10 ⁵	
01-04-85	2.37 X 10 ⁵ ± 1.0%		2.3 X 10 ⁵	
02-01-85	2.58 X 10 ⁵ ± 2%		2.5 X 10 ⁵	
02-27-85	2.18 X 10 ⁵ ± 12%		2.1 X 10 ⁵	
03 -- 85	2.88 X 10 ⁵ ± 2%		2.8 X 10 ⁵	
05 -- 85	3.08 X 10 ⁵ ± 2%		3.1 X 10 ⁵	
06 -- 85	3.48 X 10 ⁵ ± 1%		3.5 X 10 ⁵	
07 -- 85	3.62 X 10 ⁵ ± 1%		3.6 X 10 ⁵	

^aReference 3^bReference 4^cReference 5

near Building 851, and from a spring at the northeast boundary of Site 300 (collection station 20, Fig. 5). All these samples had background levels of tritium. Surface water samples were taken from standing water in drainage channels within the West Firing Area and from flowing streams downstream from the Pit 1 complex and Building 802. These also had background levels of tritium.

Figure 6 shows the locations of the shallow soil samples collected within the study site, and Fig. 7 shows the locations of vegetation and surface water samples. Both maps use symbols sized to give a semi-quantitative indication of the tritium levels observed.

In the West Firing Area, high (10^5 - 10^7 pCi/l) tritium activities were observed in vegetation samples taken from locations on and immediately adjacent to Pit 3 and on the northern portion of Pit 5. Moderately elevated (10^3 - 10^5 pCi/l) tritium levels were found in plants within about 50 m of these areas; samples from and adjacent to the central and southern portions of Pit 5 showed background levels. Around Building 850, an apparently random distribution of plant activities ranging from background to 10^4 pCi/l was observed. The only elevated plant tritium level observed in the East Firing Area was from a sample collected from the Doall Road stream channel upstream from Pit 2; all samples from the immediate vicinities of Pits 1 and 2 were at background levels.

Shallow soil sample activities showed somewhat lower values, but with a distribution similar to that observed for the vegetation. Samples from Pits 1, 2, and 7 were at background levels, and the only East Firing Area soil sample showing any elevation was west of Pit 2 in the Doall Road ravine. One soil sample from the Pit 3 overburden had an activity of 4.5×10^5 pCi/l; other samples from the Pit 3 and northern Pit 5 area were in the 10^3 - 10^5 pCi/l range. East of Building 850 in an area of sandy fill, near-surface samples ranged in activity from 10^3 pCi/l to 2×10^5 pCi/l. A series of somewhat deeper, 4.7-ft to 6.6-ft samples were taken in the 850 area and in or next to the drainage channel from the 850 corporation yard along the Doall Road stream. East of Building 850 and in the corporation yard area (gravel fill), these deeper soil activities were generally about 10^4 pCi/l, although one sample with an activity of 1.4×10^5 pCi/l was taken from just east of the main road adjacent to Building 850. Samples from the Doall Road stream area in the central and eastern portions of the ravine were about 10^5 pCi/l, but at the west end of the ravine, values of about 3×10^4 pCi/l were found. These

more westerly locations were topographically higher and farther south than the sample sites further to the east.

Vadose Zone and Groundwater Distributions. Figure 16 is a hand-drawn contour plot of vadose zone tritium activities, based on the maximum activity encountered in soil samples taken at depths of 11-15 ft when the boreholes were drilled. Figure 17 is a similar contour plot of groundwater tritium activities based on samples collected during August 1985. These plots are for illustrative purposes and are not based on rigorous interpolations or extrapolations; Appendix E contains the data set which defines groundwater distributions over time and space, and the soil data are contained in Appendix B. The shallow soil reconnaissance samples reported above were not used in constructing these contours; their inclusion would result in extending the vadose zone activity contours westward toward Building 850 and in connecting the contours at the west and east ends of Doall Road.

The activity in the 11- to 15-ft depth range was used as the basis for contouring, because a number of borehole profiles showed activity maxima in this depth range. This is an unexpected feature; the normal assumptions of recharge by vertical percolation of water through the soil column and horizontal groundwater flow can explain contaminant soil profiles which increase, decrease, or remain constant with depth, depending on their location with respect to the contaminant source. The mid-depth maximum and its implications are discussed in more detail below.

In order to reduce the large amount of tritium data to some manageable patterns and to provide a basis for relating soil profiles, water activities, and the trends in groundwater activities over time, Table 7 was prepared. This table summarizes data for most of the NC-series boreholes (soil tritium samples were not taken from K-series boreholes, or from NC7-29 or NC2-5). This table lists the boreholes by number and type of installation. Boreholes are listed in groups from north to south. Each group roughly approximates a transect along the direction of groundwater flow; within groups, the boreholes are listed from west (upgradient) to east. The data compiled for each borehole include: (1) the magnitude (exponent to base 10) of the maximum ^3H activity (pCi/l) found in soil samples, and the depth at which the sample with maximum activity was taken; (2) the magnitude of the free water ^3H activity initially encountered at the water table (if reached), and the approximate depth of the first saturated zone; (3) the form of the soil tritium profile (i.e., whether activity increases, decreases, or remains constant with depth,

Figure 17. Distribution of groundwater tritium activities in the East and West Firing Areas for samples collected Aug. 27-29, 1985. Contours are for visual emphasis only.

Table 7. Soil tritium profile characteristics and trends in the relationship between groundwater and soil ^3H .

Installation (type) ^a	Tritium in soil		1st water table		Soil profile type ^b	H_2O : soil	Water table ^3H trend ^c
	Max. ^3H (10 ^{exp})	Depth (ft)	^3H (10 ^{exp})	Depth (ft)			
NC7-24 (P)	3	24	3	32 ^d	I	?	I (V) ^h
NC7-30 (P)	6	11.5	5	25.8	M	<	D
NC7-32B (L)	6	11.5	-	-	M	=	C
NC7-23 (P)	6	11.1	6	18 ^d	M	=	C
NC7-13 (L)	6	15.6	6	-	M	=	C
NC7-25 (W)	5	65.0	5	64.2	C	=	I
NC7-47 (W)	2	-	2	-	-	-	- ^f
NC7-5A (L)	3	6.0	-	-	D	=	C
NC7-1 (L)	4	6.3	-	-	D (M)	>	C (V)
NC7-34 (P)	4	6.3	3	20.3	D (M)	=	D, C (V)
NC7-2 (L)	4	9.0	-	-	M	=	C (V)
NC7-3 (L)	4	8.0	-	-	M	>	C
NC7-4 (L)	3	8.0	-	-	D	>	C ^f
NC7-17 (P)	2	-	-	25.5	C	=	C ^f
NC7-36 (P)	4	5.4	2	18 ^d	D	=	C ^f
NC7-37 (P)	5	20.7	5	19	I	=	I
NC7-39B (L)	5	20.7	-	-	I	=	C
NC7-7 (L)	5	11-16	-	-	I	=	C
NC7-40 (P)	5	20.3	5	21	I	<	D
NC7-42A (L)	5	20.3	-	-	-	=	C
NC7-42B (L)	5	20.3	-	-	-	=	C
NC7-8 (L)	5	10.7	-	-	M	=	C
NC7-18 (P)	2	-	2	14.8 ^d	C	=	C ^f
NC7-6 (L)	5	16.3	-	-	M	=	C
NC7-16 (P)	5	20.7	5	19	I	=	D
NC7-22 (P)	2	-	3	32 ^d	C (I)	>	D, I ^g
NC7-26 (W)	3	65.6	2	67.2	C (I)	>	C
NC7-21 (P)	4	25.2	3 ^e	15 ^{d-e}	I (M)	>	I
NC7-12 (P)	5	16.0	5 ^e	16	I	=	D
NC7-20 (P)	2	-	4	32 ^d	C	?	I ^h
NC7-15 (P)	3	17.0	3	15 ^d	I	=	D (V)
NC7-17 (P)	2	-	2	25.5	C	=	C ^f
NC7-19 (P)	5	10.8	4	17.8	M	=	I, C
NC7-14 (P)	4	5.3	4	24 ^d	D (M)	<	C
NC7-44 (W)	2	-	2	-	C	=	C ^f
NC7-28 (W)	5	39.6	5	38.4	I	=	vi
NC7-9 (L)	4	20.6	-	-	I	>	C (V)
NC7-11 (P)	4	19.8	4	15 ^d	I	=	I

Table 7. (Continued)

Installation (type) ^a	Tritium in soil		1st water table		Soil profile type ^b	H ₂ O: soil	Water table ³ H trend ^c
	Max. ³ H (10 ^{exp})	Depth (ft)	³ H (10 ^{exp})	Depth (ft)			
NC7-27 (W)	4	80.9	4	80	I	>	D,C(V)
NC7-43 (P)	5	45.5	5	45	C	=	D
NC7-10 (P)	5	10.6	5	10	I	=	D
NC7-46 (P)	3	24.3	2	28.9	(M?)	(<?)	C ^h
NC7-45 (W)	3	30.4	2	33	C	=	C
NC2-2 (L)	5	15.0	-	-	I	=	C
NC2-3 (L)	3	15.0	-	-	I	(=?)	C
NC2-4 (L)	3	14.8	-	-	I	=	C

^aLysimeter (L), piezometer (P), monitoring well (W).

^bTritium trend with increasing depth: increase (I), decrease (D), constant (C), mid-depth maximum (M).

^cTritium trend with time: increase (I), decrease (D), constant (C), variable (V). Two symbols mean a change in trend (e.g., D,C is an initial decrease to a constant value).

^dNo saturation observed in drilling; hole filled slowly by seepage.

^eValue changed rapidly over first 1 to 3 months of observation.

^fApproximately background.

^gElevated soil ³H just above water table.

^hNo soil sample coincident with water table.

ⁱElevated soil ³H below water table.

and whether there is a mid-depth maximum); (4) a comparison of the ³H activity of the free water at the water table with that of the total soil moisture at the same depth (equal to $\pm 20\%$, greater than, or less than); and (5) the change in water table ³H activity over time (increasing, decreasing, constant, or variable).

The available data indicate that tritium contamination of the groundwater in the West Firing Area is limited to the perched aquifer. In the Pit 7 area, there are no discernible aquifers below the perched aquifer to a depth of at least 300 ft. In those holes from which soil samples were taken well below the present water table (e.g., NC7-25), tritium activities were at background levels. In the Building 850 area, the second aquifer is monitored by Well #8, which shows background tritium levels (most recent sample, October 1985). In the limited region of contamination east of the Elk Ravine Fault, we do not have information on the depth of penetration of the tritium, because the deeper installations in well K2-1 are inoperative.

The areal extent of groundwater tritium contamination may be seen from the contours in Fig. 17. Relatively high levels of ^3H (10^5 - 10^6 pCi/l) are found in NC7-30, NC7-23, NC7-25, NC7-37, NC7-40, NC7-16, NC7-21, NC7-28, NC7-11, NC7-10, and the Well #8 spring. Upgradient, background levels are found in K7-6, K7-5, NC7-17, NC7-36, NC7-18, and NC7-44, indicating that there are no contamination sources west of the Pit 7 complex and Building 850. East of the Pit 7 complex, contaminant ^3H is found at a distance of 80 m from the pits (NC7-25) and 210 m from Building 850 (NC7-27), but not at a distance of 360 m (NC7-47) in the north or 480 m in the south (NC7-46). We attribute a slight elevation in soil moisture ^3H above the present water table in NC7-46 to high-water spillover from the Doall Road stream and not to groundwater flow through the perched aquifer.

We have previously identified the Doall Road stream channel as a discharge region for the shallow groundwater flow. Tritium values on the order of 10^5 pCi/l are associated with the channel, but they do not extend laterally any significant distance into the adjacent formations, as shown by low tritium values found in NC7-45, NC7-46, and K2-4. East Firing Area contamination due to stream outflow is limited to a region around K2-1 (approximately 1000 m from the presumed source at Building 850); no contaminant tritium is observed in K2-2 and K2-3 in the north, the Pit 1 wells to the east, or NC2-5 to the south. NC7-29 to the south of the 850 area also shows background levels.

The vadose zone tritium contours generally show patterns similar to but more limited in extent than the groundwater contours. East of Pit 3 and Building 850, both soil and groundwater contours follow the regional groundwater flow. East and south of Pit 5, however, the contours bend southeast along the topographic gradient and the groundwater maximum is displaced to the southeast of the vadose zone maximum. This suggests that flow on or within the alluvium has a component aligned with the surface drainage.

Another point worthy of note about the vadose zone distributions is that the maximum tritium values in some locations are above the present water table and displaced downgradient from the pit boundaries. Figure 18 is a vertical section along a transect across Pit 3 and boreholes NC7-30, NC7-23, NC7-13, and NC7-25. This shows that the soil tritium maximum is approximately 15 ft above the present water table and 100 ft east of the pit boundary. The groundwater activity maximum along the transect is similarly displaced to the east, but activity differences are not as great as they are for soil moisture.

Figure 18. A vertical section of tritium activities of soil moisture and groundwater in the vadose zone near Pit 3. One $\mu\text{Ci}/\ell = 10^6 \text{ pCi}/\ell$.

The detailed stratigraphy of boreholes NC7-13, NC7-23A, NC7-30, NC7-1, and NC7-2 suggests the presence of a slightly more permeable zone at approximately the level of the mid-depth maximum, underlain by less permeable material. As noted above, the elevation of the mid-depth tritium maximum corresponds well with the estimated maximum water table elevation during early 1983.

DISCUSSION

We can draw only tentative conclusions regarding the two major areas of concern in this study. The probable locations of contaminant sources and the rates and mechanisms of contaminant movement presented here are inferred from the existing data, but cannot at present be completely defined.

As explained elsewhere, it is clear that Pits 1, 2, 4, and 7 are not contributing significantly to groundwater tritium contamination. The existence of a source in Pit 3 is beyond doubt, and some source close to Building 850 must exist; both the groundwater elevation contours and the tritium distributions make it virtually impossible to connect the ^3H activity in well NC7-28 with the Pit 7 complex.

The situation with respect to Pit 5 is not as clear. Elevated ^3H levels are found immediately east of the pit (NC7-37, NC7-40); however, there is strong evidence for southeastward transport of contaminated water in the alluvium, so it is possible that Pit 5 may have been contaminated by spillover from Pit 3. The strongest argument against this hypothesis is based on soil profiles in NC7-2 and NC7-3; the mid-depth maxima observed here are an order of magnitude lower in activity than values found to the north and south, suggesting that Pit 5 is an independent source. The number and location of possible sources within Pit 5 is even more difficult to ascertain. The pit slopes southward, and its floor undoubtedly underwent some compaction as a result of excavation, use, and subaerial exposure. If saturated conditions occurred within the pit, water could be expected to flow easily down the axis of the pit. The occurrence of high ^3H levels at NC7-37 may suggest a source in the northern portion of the pit; elevated values farther to the south may reflect other sources, or may be the result of transport of contaminated water through the waste materials in the pit or the surrounding alluvium.

In discussing contaminant transport rates and mechanisms, we will consider first the northern portion of the Pit 7 complex, then the valley alluvium to the south, and finally the groundwater and stream-flow system to the east of Building 850.

In the vicinity of Pits 3 and 5, a number of lines of evidence converge to provide an explanation of the sequence of events leading to tritium release and transport. We note that monitoring wells K7-1 and K7-3 were exhibiting rising water levels in late 1982; water levels in these wells reached a

maximum level at least 10 ft above the present water table by mid-1983. Tritium levels in those wells, which were originally only slightly above background, began to rise at or just after the water level increase; tritium levels reached a transient maximum in mid-1984 to late 1984, decreased briefly, and afterward resumed an increasing trend.

As pointed out above, a number of soil profiles show maximum tritium values 10 ft to 16 ft above the present water table; several of these are at some distance from tritium sources, but the maxima are all in or immediately beneath the alluvium.

It may be seen from Table 7 that the groundwater in the westernmost contaminated installations has been decreasing in activity during late 1984 and 1985, while activities in the wells and piezometers farther to the east have been increasing. Disequilibrium between total soil moisture and the freely flowing groundwater is probably the result of the recent arrival of flowing groundwater that has not yet had time to equilibrate by diffusion with the relatively immobile water in soil micropores. Close to the sources, the groundwater tends to be lower in activity than soil moisture, but the relationship is reversed at the more distant installations.

Based on these observations, we believe that in the area east and south of Pits 3 and 5 we are observing the movement of a pulse of contaminated tritium, which was released to the soil and groundwater when the rising water table saturated at least the lower portions of Pit 3 and possibly Pit 5 during 1982 or early 1983. If this is the source of the contaminant tritium, its occurrence in NC7-25 but not in NC7-47 suggests a migration velocity ≥ 25 m/yr but < 200 m/yr. These estimates are consistent with the range of groundwater pore velocities estimated from aquifer tests.

East of Pit 5 and farther to the southeast, there is some evidence for high tritium activities in the present vadose zone and the patterns of change in the groundwater tritium activities are similar, but the total eastward displacement of the contaminant plume is not as great (NC7-26 shows low but increasing tritium levels). Since estimated groundwater velocities are at least as great here as in the Pit 3 area, this suggests that the arrival of the tritium pulse in the regional aquifer may have occurred later here. This would be consistent with a delay induced by southeastward transport through the upper layers of the alluvium from the Pit 3 area.

Evidence for a recent pulsed release of tritium seems strong, but we must consider the question of whether earlier releases occurred. The low values

observed initially in K7-1 and K7-3 suggest that they did not; these values probably are reasonably representative of formation water, because the boreholes were drilled with air-mist and developed with air, and the groundwater chemistry stabilized shortly after completion (Carpenter and Peifer²). In any event, the estimated flow velocities in combination with the background levels observed in NC7-47 suggest that the major contamination occurred within the last decade. We suspect that the high rainfall period of 1981-1983 caused higher water tables in the Pit 3 area than did previous wet years because the unfilled portion of Pit 7 (excavated in 1978) immediately upgradient of the pit enhanced water input to Pit 3.

In the vicinity of Building 850, the interpretation of tritium transport is more complicated. Data from 1971 to 1973 on the Well #8 spring indicate that groundwater contamination was comparable to present levels, so tritium has been reaching the groundwater for over 15 years. However, evidence for a pulsed flow is superimposed on this pattern. Well K2-1 showed a sharp increase in tritium downgradient from the Doall Road stream in 1984, and activities in NC7-10, NC7-11, and the Well #8 spring are increasing while activities in NC7-28 are decreasing. These data suggest a flow velocity on the order of 60 m/yr, but the earlier data from the Well #8 spring combined with background levels in NC7-46 indicate a velocity < 30 m/yr in the perched aquifer.

Although not conclusively proven, it seems likely that much of the contaminated groundwater originating near 850 is discharged into the Doall Road streambed, where the alluvium acts as a temporary storage basin. The high recharge of 1981-1983 appears to have had two effects: it superimposed a pulse of tritium injection on the pre-existing groundwater contamination, which we are now seeing as it moves into the NC7-10 and NC7-11 area; it also flushed some of the tritium stored in soil moisture out of the streambed into the area around K2-1. Although the average transport velocity along the stream channel appears to be 50-70 m/yr, this is a potentially misleading calculation, because the actual flow is not steady-state, but depends on the patterns of episodic high recharge and runoff events. A similar argument applies to the alluvial transport in the valley southeast of the Pit 7 complex. Tritium appears to have moved 50 to 200 m southeast (depending on the assumed location of the source) in approximately two years, but there is little if any water or tritium movement in that direction at present.

Overall, long-term tritium transport velocities appear to be on the order of a few tens of meters per year. This is reasonably consistent with the

order-of-magnitude pore velocity estimates derived from aquifer tests. It is possible that groundwater flow rates are variable and dependent on recharge and water table fluctuations; if that is the case, the observed contaminant displacements may be the result of brief periods of rapid flow (a few hundred m/yr) superimposed on longer periods of much slower flow. The range of values required to support this model is also consistent with the range of values derived from aquifer testing.

In the direction of present groundwater flow, the Site 300 boundary is ≥ 1.2 km from contaminated groundwater areas. Extrapolation of the present average flow directions and rates indicates that at least 20 to 50 years will be required for the existing contaminant plumes to reach the Site 300 boundary. During hydrologic transport, water activity will be reduced by both radioactive decay and dispersion. The highest groundwater activity value found in this study (NC7-23) will have been reduced to 20,000 pCi/l by decay alone in approximately 70 years. If natural dispersion and dilution processes afford a further activity reduction by a factor of two or greater (which is a fairly conservative estimate), the contaminated water will be at or below drinking water standards for tritium before it moves offsite.

The question of the tritium inventory in the contaminated soil and groundwater can be addressed, albeit very approximately. The total surface area estimated to be within the tritium concentration contours in Figs. 6 and 7, when combined with the thickness of the saturated zone and porosity and soil moisture estimates, suggest that the contaminated groundwater contains about 7 curies of tritium, and the unsaturated soil moisture at least 1 curie. These inventories are conservative, as the contours almost certainly underestimate the streambed inventory and assume no significant extension beyond the most distant points of observed contamination. If our original estimate of the probable amount of tritium remaining from the experiments (a few hundred curies at most) is correct, it implies that a small but significant fraction of the available tritium has already been mobilized from the sources into the groundwater. If the actual amount of waste tritium was considerably smaller than this upper-limit estimate, a substantial fraction of the available tritium may have been mobilized and removed from the primary sources.

CONCLUSIONS

In this section we summarize the conclusions reached on the basis of the information presented in this report. These are organized into major topic areas reflecting the objectives of the investigation described above. Some of the conclusions appear to be certain beyond reasonable doubt; others, qualified as "probable" or "likely," represent our best scientific judgment based on the available data, and are subject to revision or refinement as more data become available and more detailed and quantitative interpretations are developed. We also identify those points about which we are presently unable to reach a credible conclusion.

SOURCES OF GROUNDWATER TRITIUM CONTAMINATION

Two tritium source areas have been definitely identified. One is in Pit 3, probably in the central or southern portion of the pit, or both. This is consistent with the history of tritium experimentation and landfill usage as well as with field data. A second source exists in the vicinity of Building 850, between wells NC7-28 and NC7-44. The evidence suggests that this source may be an area of sand fill between Building 850 and NC7-28, but this has not been conclusively demonstrated. The source does not appear to be diffuse surface contamination by blast ejecta, since NC7-44 underlies an area which is well within range of firing table "fallout" and which shows moderately elevated vegetation activities. However, water sampled by well NC7-44 shows background tritium levels. There is also a possibility that smaller secondary sources may exist east of Building 850 in an area roughly bounded by NC7-43, NC7-19, and NC7-14, but this is quite uncertain. A source or sources in the vicinity of Building 850 are also consistent with the history of tritium use at Site 300.

It appears possible that there are one or more sources in Pit 5. The existence and exact locations of these are uncertain because there are clear indications that southeastward movement of contaminated water can occur in the valley alluvial fill, so the contaminated groundwater plumes east of Pit 5 may represent spillover from the Pit 3 source, or redistribution of uncontaminated tritium within Pit 5.

Both the historical records and the field data show that Pit 7, the currently active landfill, is not a source of tritium contamination of the groundwater.

There is no tritium contamination in the groundwater around Pit 1 (active), and strong evidence indicates that the limited area of contamination south and west of Pit 2 (inactive) is the result of tritium transport from Building 850 along the streambed paralleling Doall Road. We conclude that there are no local sources of tritium contamination in the Pit 1 complex.

Buildings 851 and 802, where relatively small amounts of tritium were expended, have not been investigated as thoroughly as the areas of known contamination. However, the limited groundwater data available from these areas support the inference, based on tritium use records, that they are not significant sources of groundwater contamination.

TRITIUM TRANSPORT MECHANISMS, RATES, AND PATHWAYS

Throughout the investigated portions of the West Firing Area, contaminated groundwater appears to be moving east to northeast in the perched aquifer, which is consistent with the direction of the hydraulic gradient. Based on aquifer tests and the present gradient, calculated velocities are a few tens of meters per year. Tritium front displacements, when combined with reasonable estimates of the time of contaminant injection into the groundwater, agree with these velocity estimates. The hydrogeology of the East Firing Area is not as well characterized, but data from monitoring wells around the Pit 1 complex indicate that surface groundwater flow in this area is also generally toward the northeast.

Near the Pit 7 complex, the soil moisture profiles, the tritium activity histories of monitoring wells installed prior to this study, and the activity changes in the more recently installed wells all suggest that we are observing a recently released pulse of tritium. We believe that this is the result of high recharge and an elevated water table (probably including pit flooding) caused by the unusually high rainfall in the water years 1982 and 1983, possibly enhanced by the excavation of Pit 7 upgradient of Pits 3 and 5.

In the Building 850 area, historical data indicate that groundwater contamination at or above present levels dates back at least to 1971. It seems probable that the 850 area, unlike the landfills, has been functioning as a long-term, quasi-steady-state source of tritium to the groundwater.

In both contaminated areas, surface drainage channels or the alluvial fill, or both, appear to divert some of the contaminated water into flow patterns governed by the surface topography. Because the observed tritium displacement patterns in the alluvium do not correspond to present hydraulic gradients or velocity measurements, we believe that this process is episodic and occurs during periods of high water table or high runoff. Available data suggest that subsurface flow in the alluvium is the primary mechanism, but we cannot eliminate the possibility of surface stream transport.

EXTENT AND AMOUNT OF CONTAMINATION

All contaminant plumes have been identified and their maximum horizontal extents bounded by monitoring wells and piezometers that yield background levels of tritium. Downgradient monitoring wells are in position to detect any further advance of the two major plumes originating from Pit 3 and Building 850.

In the West Firing Area, the contaminated groundwater is contained within a shallow perched aquifer. In the northern portion of the Pit 7 complex, deep borings have shown that there is no significant deeper aquifer within 100 m of the surface. In the vicinity of Building 850, a deeper aquifer exists; it is sampled by Well #8, which has consistently shown background levels of tritium. On the east side of the Elk Ravine Fault, the contaminated water flowing out of the Doall Road stream channel mixes into the general, upper regional, groundwater-bearing zone. However, wells in the Pit 1 area indicate that ^3H has not as yet moved a significant distance downgradient in this area.

The maximum groundwater tritium concentrations observed are slightly less than 10^6 pCi/l in NC7-23 and NC7-28; concentrations at both of these monitoring points are presently decreasing. More typical high concentration values are in the 100,000 to 600,000 pCi/l range.

The total tritium inventory outside of the landfills is conservatively estimated to be 7 curies in the groundwater and 1 curie in the soil moisture. This is at least several percent of the maximum total tritium estimated to be available for transport to the ground water. This estimate, in conjunction with the observation that the wells closest to the major tritium sources show a trend of decreasing tritium concentrations, suggests that a significant fraction of the total available tritium may have already been displaced from the original source location into the surrounding soil and groundwater.

POTENTIAL FOR OFFSITE TRANSPORT OR WATER SUPPLY CONTAMINATION

The contaminated perched aquifer contains only a small volume of water, has a very low yield, and the water is of poor quality. It is neither used nor likely to be used as a water supply.

In the direction of the regional groundwater flow, the Site 300 boundary is approximately 1.2 km from the closest contaminant plume; the nearest offsite water supply is at a substantially greater distance. On the basis of the estimated groundwater velocities, it will be decades before the plume could move offsite. During this travel time, radioactive decay, dispersion, and dilution by recharge and by mixing in the deeper aquifer east of the Elk Ravine Fault will greatly reduce the peak tritium concentrations, probably to levels below the drinking water standard.

Within the Site 300 boundaries, there are no active water supply wells downgradient from the contaminant plumes; the closest well is Well #1, which is monitored regularly for tritium and which is a reserve rather than a primary supply well. This well is not presently in use.

We conclude that the tritium contamination poses no short-term threat to human health or to any potable water supply, and may on more detailed analysis prove to pose no threat in the longer term.

FUTURE WORK

Although the initial investigation has been completed, a substantial amount of monitoring, follow-up investigation, and further interpretation is planned for 1986. The work described below is based on technical plans; the proposed budget is under review, and the actual amount accomplished will depend on the level of funding available.

MONITORING

We will continue to analyze tritium samples from and measure water levels in all installations on a monthly basis through June 1986. Unless the data indicate that monthly samples are necessary, we expect to move to a quarterly sampling schedule at that time. We have installed automated stream samplers in the drainage channels south of K7-1 and south of NC7-10. These should ensure collection of samples in the event of transient surface flow. We are measuring moisture profiles in the neutron probe access tubes every two weeks; we expect these data, in conjunction with samples from the vadose zone monitoring stations, to improve our understanding of vadose zone transport processes in the vicinity of the pits.

FURTHER INVESTIGATIONS

We intend to conduct further sampling of the sandpile near Building 850, which is a suspected tritium source; this will be done on a systematic sample grid basis. We plan to put several test borings into the excavated portion of Pit 7 to determine if groundwater is present immediately upgradient of Pit 3, and the response to recharge in this area. We will develop and test (slug or pump tests, as appropriate) more of the monitoring wells to refine our information on formation permeabilities and groundwater flow velocities. Laboratory porosity and permeability determinations will be made on core samples already on hand; the results will be used to refine our estimates of groundwater flow velocity. Drive points will be installed at selected locations in Pits 3 and 5; soil gas samples will be collected and the tritium content of the moisture analyzed in an effort to determine more precisely the

locations of tritium sources. These drive points will also serve as piezometers in the event of saturated conditions within the pits.

INTERPRETATION

In addition to ongoing review and interpretation of newly acquired data, we will conduct a more detailed review of water elevations, their changes over time, and responses to seasonal recharge, if any. This should improve our understanding of the local hydrology and the rate and variability of water transport. In addition, we will undertake some simple predictive modeling of contaminant plume movement to quantify the probable effects of dispersion, dilution, and decay on the observed tritium concentrations as the contaminant plumes migrate. This will help to determine whether additional monitoring points are needed and will provide data relevant to the question of remedial action.

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PMB/

APPENDIX A: DRILLING, INSTALLATION, DEVELOPMENT, TESTING, AND SAMPLING METHODS

MONITORING NETWORK

The locations of wells, piezometers, and lysimeters in use for monitoring tritium in groundwater at Site 300 are shown in Plate 1. The methods used to drill, install and develop, test, and sample these locations are described here. The details of a particular installation and any deviations from these standard procedures are noted on the logs of individual boreholes in Appendix B.

DRILLING METHODS

Drilling at Site 300 was carried out utilizing an Ingersoll-Rand TH60 rotary drill, a Mobile B-53 combination auger and rotary rig, a Simco 2800 auger, and a Massey-Ferguson backhoe with a rotary powerhead adapter. The drilling methods employed included solid stem and hollow stem augering, air/mist rotary and wireline coring. With all methods, a minimum amount of water was added during drilling and the boreholes were dry and clean prior to mudding that occurred at or below the water table. Subsurface conditions generally required that for air rotary drilling and wireline coring, a casing be emplaced in the first 10 ft to 20 ft beneath the surface to facilitate the removal of cuttings during drilling.

INSTALLATION AND DEVELOPMENT

Monitoring Wells

Installation. Monitoring well boreholes were reamed to a 9.0-in.-diameter with an air rotary technique and then installed with a 5-in., threaded joint PVC casing. Completion details are provided on the log summary sheets in Appendix B.

Development. Well development is done so that true hydraulic conductivities can be determined and to allow representative groundwater samples to be taken over time. In initial well development, water was air lifted out of the casing repeatedly until the water was clear. Final

development of wells in the West Firing Area was done with a surge block technique if the well had 5 ft or more of water standing in the casing. A 3-3/4-in.-diameter by 1-1/2-ft aluminum plunger lowered to the bottom of the well was used as a surge block. The wells were surged for 30-min periods in order of increasing tritium concentrations. To further minimize the possibility of cross-contamination, the surge block was rinsed with clean water and dried between wells.

Piezometers

The piezometers were assembled at the site from PVC schedule 80 pipe with 2.25-in. O.D. and nominal 1.9-in. I.D., 10-ft lengths of perforated screen, connectors, and caps. The perforated casing is fabricated at LLNL in 10-ft lengths. The perforation screen pattern is four 0.25-in.-diameter holes spaced evenly around the pipe and drilled at each linear inch of pipe. The perforations are covered with stainless steel (SS) screen and clamps.

PVC connectors join the perforated screens to the casing pipe, and then SS connectors are screwed onto the casings and screens. PVC caps are installed at the bottom and the top of the assembly. The bottom caps are secured with SS screws and the surface caps with a locking pin.

One piezometer (NC7-43) was installed using 3-in., schedule 40 PVC pipe and a 10-ft length of commercially available, horizontally slotted screen. Except for these differences, installation was the same as for the 2-in. piezometers.

Installation. Piezometer boreholes were augered to a diameter of 4.5 in. or 6.0 in. and installed with the assemblies described above. Completion methods included placing the casing assembly 6 in. above the borehole bottom with clean #3 sand added below the casing and to the annulus up to 5 ft above the top of the casing screen. On top of the #3 sand, a 2- to 3-ft layer of #0 sand was added and the borehole annulus was grouted to the surface with Portland cement and clean water. Specific details are provided on the log summary sheets in Appendix B.

Development. Final development of piezometers in the West Firing Area was done with the same surge block technique used for the monitoring wells. Piezometers were surged for 15 min with a 1-3/4-in.-diameter, 2-ft long acrylic block. To minimize the possibility of cross-contamination, the

piezometers were developed in order of increasing tritium concentration and the surge block was cleaned between piezometers.

Lysimeters

The lysimeters installed at Site 300 are the Soilmoisture pressure-suction soil water sampler, Model #1910, which has a manufacturer-recommended maximum depth of 50 ft. This lysimeter is 24 in. long with a 2.0-in. O.D. and a 2-bar ceramic cup. The access lines are 0.25-in.-O.D. and 0.125-in.-I.D. polyethylene tubing that extends from the lysimeter to the ground surface.

Installation. Lysimeters were installed in four different groups, depending upon the drilling methods employed and the objectives of the installation. The surface access hardware for all the lysimeters is standardized; it is constructed of fixed tubing connectors, bellow needle valves, and a protective cover.

The first group of lysimeters was emplaced approximately 15 ft below the surface in 12-in. boreholes drilled using a solid stem flight auger. The units included in this group are NC7-1, NC7-2, NC7-3, NC7-4, NC2-2, NC2-3, and NC2-4. A hand-operated, 3.25-in. bucket auger was used to extend each borehole by 0.5 ft to 1.0 ft beyond the initial depth drilled with the flight auger. Units were placed into the 3.25-in. borehole extension and dry, 200-mesh silica flour was used to cover the ceramic cup and half of the lysimeter. Then a 2-ft layer of 0.25-in.-diameter sieved natural cuttings was added from the level of the installation, followed by a 1.0-ft layer of dry bentonite pellets. The hole was backfilled to within 3 ft to 5 ft of the surface with natural cuttings, and then grouted to the surface.

A second group of lysimeters was installed using the same procedure as that described above, except that a smaller, 4.5-in. borehole was drilled with a solid stem flight auger and some emplacements were at a depth of 20 ft. These lysimeters are at the following locations: NC7-5A, NC7-6, NC7-7, NC7-8, and NC7-9.

A third group of lysimeters was installed in 4.5-in. boreholes drilled with a hollow stem flight auger. These units were installed as dual emplacements in the following boreholes: NC7-32, NC7-39, and NC7-42. The lysimeter units were completely covered with dry silica flour and isolated with layers of bentonite pellets and grout. PVC tubing 1 in. in diameter was

used to protect the access lines extending from the top of the lysimeter to the surface.

The fourth group of lysimeters was installed at depths of 40 to 45 ft below the surface in 4.0-in.-diameter boreholes drilled with an air rotary drill. These boreholes include NC1-2A, NC1-3A, NC1-5A, and NC7-8A. In these installations, the lysimeter bodies were completely covered with a 200-mesh silica slurry and isolated with bentonite and grout layers; the access lines were protected using 1-in. PVC tubing. Completion details for all lysimeter installations are provided on the log summary sheets in Appendix B.

Neutron Probe Access Tube Installation

A 5.0-in borehole was drilled using a hollow stem flight auger for installation of each aluminum neutron probe outer access tube (nominal 5-in. O.D.). The casing (welded closed at the bottom) was driven into the borehole and an annular space was dug 18-in. deep around the top of the casing. The annular space was filled with grout to prevent surface water from channeling down the casing. An inner aluminum tube with a 2.25-in. O.D. was then centered in the outer casing to provide a guide for the neutron probe. An adapter was placed on the casing system to interface with the neutron probe instrument box and provide a cover to prevent water from entering the casing.

AQUIFER TESTING

The wells and piezometers selected for testing had sustainable yields of $<1/2$ gpm, which made drawdown testing impractical. Therefore two alternative testing methods were used to determine the aquifer conductivities. A slug test method was used in the wells selected for testing (NC7-25, NC7-26, and NC7-28), and a recovery test was used in the piezometers tested (NC7-11, NC7-16, and NC7-23). In order to measure water level changes during these tests, two types of water level recording instruments were used: a float gauge and a bubbler gauge. Both instruments measure water levels over time and record analog data onto charts for further analysis and interpretation.

The slug test used for the monitoring wells was carried out by first removing 10 to 20 gallons of water from each well and storing this water in plastic carboys. When the water levels in each well returned to equilibrium, the pumped water stored at the surface was quickly poured into the well, and

water level changes were monitored immediately using the recorders described above. By performing the slug test with water previously pumped from the same well, cross-contamination and dilution of the formation water was avoided.

Because the piezometers yielded very low amounts of water, we were able to bail them to dryness and then measure the recovery rate. After all detectable water was bailed from the piezometers, a bubbler gauge water level recorder was inserted and data collected over the period of recovery.

Calculation of Hydraulic Conductivity

Three separate approaches to the calculation of the hydraulic conductivity (K) of the aquifer were used: the "Navy" method¹, the method of Hvorslev², and the method from Cooper et al³. Table A1 summarizes the values used for the variables in the three equations.

The Navy equation used was the one developed for an uncased hole:

$$K = (R/16DS) (h_2 - h_1) (t_2 - t_1)^{-1}, \quad (A1)$$

where

R = borehole radius,

D = height of static water table above the bottom of the casing,

S = a shape factor determined from type curves,

h_1 = water level displacement at time t_1 ,

h_2 = water level displacement at time t_2 .

This method is valid for cases where $D/R < 50$; this condition was met for all installations. In all methods, we used the borehole radius rather than the casing radius, because the sandpack and screen are demonstrably much more permeable than the formation. This means that the formation surface area exposure (hence, borehole dimension) controls the rate of recovery, so it is a satisfactory approximation to neglect sandpack and casing effects.

In the Hvorslev method, a plot of $\log (H/H_0)$ vs time is made, which should be linear. H is the difference between the equilibrium water level and the observed water level at time t, and H_0 is the maximum water level difference from the static value. The basic time lag T_0 is the time at which $\log (H/H_0) = 0.37$, and is determined from the plot.

Hvorslev's original equation is

$$K = r^2 \ln(L/R) / 2LT_0, \quad (A2)$$

where

- r = casing radius,
- R = radius of the screened interval,
- L = length of screened or uncased borehole,
- T_0 = basic time lag.

This approach was developed for a piezometer with a screened interval that is always completely below the water table. In our use (piezometer screened above and below water table; water level always within the screened interval), the borehole radius is used for both r and R. Some approximation must be used for L, the effective length of the screened interval, which varies with the water level. We selected H at T_0 as the best approximation for the time-averaged value of L.

Application of the Hvorslev method has several problems:

- o There is no provision for the effects of water flow into the unsaturated medium above the water table in the slug tests.
- o The validity of our approximation of L is open to question.
- o This method depends on an accurate determination of start time and a quasi-instantaneous addition or removal of water.

Because the sandpacks required 2 to 5 minutes to equilibrate, we had to graphically subtract this response and rescale the formation response curve that remained. Because of the sandpack equilibrium and because the bailing process required several minutes, the actual start time of the test is uncertain. This is not significant for NC7-23, NC7-25, and NC7-28, but for NC7-11, NC7-16, and NC7-26, the uncertainty is of the same magnitude as T_0 ; using an initial time at the end of the bailing process almost certainly results in an artificially small value for T_0 and, therefore, in values of K which are too large.

The method of Cooper et al. also plots H/H_0 vs log time (see the Hvorslev method above). The best fit is then found to a family of type curves for different values of α where $\alpha = S$, the storage coefficient. After the curve is matched, the time t at which $Tt/r_c^2 = 1$ on the master plot is determined, where T = transmissivity and r_c = casing radius (the borehole

Table A1. Variables used in three methods of calculating hydraulic conductivity from slug and bail test data.

Variables	Installations					
	NC7-11	NC7-16	NC7-23	NC7-25	NC7-26	NC7-28
<u>Hvorslev:</u>						
T ₀ (sec)	438	468	73,440	15,030	629	3,240
R (cm)	5.72	5.72	5.72	11.43	11.43	11.43
L (cm)	52.8	67.2	53.0	195	378	192
<u>Navy:</u>						
R (cm)	5.72	5.72	5.72	11.43	11.43	11.43
D (cm)	94	107	112	168	314	328
S --	3.2	3.5	3.8	2.4	2.9	2.8
t ₁ (sec)	120	60	7,200	1,200	240	290
h ₁ (cm)	80	86	78	70	128	122
t ₂ (sec)	720	1,050	90,000	7,200	960	3,740
h ₂ (cm)	17	21	21	40	37	30
<u>Cooper et al:</u>						
t (min)	1.5	1.6	1,800	82	4.2	20
r _c (cm)	5.72	5.72	5.72	11.43	11.43	11.43
b (cm)	52.8	67.2	53.0	195	375	192

radius in our case). Then $T = r_c^2/t$ and $K = Tb$ where b = effective aquifer thickness.

This method assumes a fully penetrating well with a screened interval below the water table. Its application to our case has problems similar to those of the Hvorslev method, specifically those arising from start time uncertainties in the wells with prompt recoveries. We are thus forced to use for b the same approximation used for L in the Hvorslev case.

Overall, the Navy method seems to be the most appropriate; it is the only one designed for a borehole that is open across the water table, and its accuracy does not depend on an accurate determination of initial time. It is clearly the method of choice for the bail tests; we have not yet reviewed the original derivations to determine if it is equally applicable to slug tests.

MONITORING AND SAMPLING PROCEDURES

Wells

Water levels are measured monthly from the surveyed casing tops at monitoring wells NC7-25, NC7-26, NC7-27, NC7-28, NC7-29, NC7-44, NC7-47, K7-1, K7-3, K7-5, K7-6, K7-7, K2-1, K2-4, and NC2-5. The monitoring wells are presently sampled once a month. Submersible pumps have been installed in some of the wells, and in those wells, we follow the conventional practice of pumping four casing volumes before sampling. The wells not equipped with pumps are sampled using a small bailer that holds a 30-ml vial, which is thoroughly washed and dried between samples. Dedicated submersible pumps are scheduled to be installed in wells NC7-25, NC7-26, and NC7-28.

Piezometers

All piezometer water levels are measured once a month from the surveyed casing tops. Samples are collected once a month from piezometers NC7-10, NC7-11, NC7-12, NC7-14, NC7-15, NC7-16, NC7-17, NC7-18, NC7-19, NC7-20, NC7-21, NC7-22, NC7-23, NC8-24, NC7-30, NC7-34, NC7-36, NC&-37, NC7-40, NC7-43, NC7-45, and NC7-46. Sampling is done with a small bailer that holds a 30-ml vial. The bailer is cleaned thoroughly between samples.

Lysimeters

Monthly collections are made from the shallow lysimeters (NC7-1, NC7-2, NC7-3, NC7-4, NC2-2, NC2-3, NC2-4, NC7-5A, NC7-6, NC7-7, NC7-8, NC7-9, NC7-13, NC7-32A, NC7-32B, NC7-39A, NC7-39B, NC7-42A, and NC7-42B) after they have been under a vacuum level of 50 centibars for 24 hr to 48 hr. Samples are removed from the lysimeter using nitrogen gas pressure applied at the surface. A 60-ml subsample is collected when possible, and any extra sample is discarded. Lysimeters remain at atmospheric pressure between samplings. The deep lysimeters, K7-8A, K1-2A, K1-3A, and K1-5A, are sampled upon request, using the same procedures described above.

Neutron Probe

Soil moisture measurements are made at the four neutron probe locations (NC7-31, NC7-35, NC7-38, and NC7-41) every two weeks when blast schedules permit. These measurements are taken at 3, 6, 9, 12, and 15 feet below the ground surface.

SAMPLING METHODS

Vegetation

Vegetation samples consist of the green leaves and stems of grasses and annual plants. Depending on availability, a sample may consist of a single plant or parts of several plants collected within a radius of a few meters. Samples are double bagged in plastic bags in the field, stored in a cooler with ice or dry ice, and placed in a freezer on arrival at the laboratory.

Soil

When solid stem augering is done with the backhoe, soil samples are taken every five feet with a hand-operated bucket auger. When the sampling depth is reached, the flight auger is removed from the hole and the bucket auger is employed. Because removal of the flight auger causes cuttings to fall to the bottom, hand-augered samples are discarded until an undisturbed stratum is reached, based on the last depth of the flight auger and on hand sampling observations (e.g., encounter with firm, undisturbed material). The sample is collected only after it is certain that undisturbed material has been penetrated. Samples are extracted from the bucket auger immediately after collection, placed into a wide-mouth screw-capped glass jar and sealed tightly with the lid. Samples are frozen on arrival at the laboratory. The bucket is wire-brushed between samples, and is washed between samples when the area is suspected to contain high levels of tritium. In the shallow boreholes, the bucket auger is used with extension handles to a depth of 25 ft. Sample depths are measured from calibration marks on the handle.

Use of the bucket auger is impractical at depths greater than 25 ft and deeper samples are collected by hand from the auger flights. These samples are

therefore less precisely characterized as to depth and are more vulnerable to contamination.

Hollow stem augering with the Simco 2800 allows sampling with a split tube sampler. A 140-lb weight is used to drive the sampler into the formation as well as to provide useful penetration information. The sampler is removed from the borehole immediately after sampling is completed. The split tube assembly is opened, the sample is removed, and is placed into a screw-capped glass jar for tritium analysis. The split tube sampler is cleaned between samples to avoid cross-contamination.

Sampling with the Ingersol-Rand TH60 and the Mobile B-53 is done primarily by wireline coring. When the core barrel is removed from the borehole, the entire core sample is transferred to an inspection bench. Appropriate subsamples are taken and placed into screw-capped glass jars for tritium analysis. Remaining core materials are retained in weather-resistant boxes. The core barrel is cleaned between samples to avoid cross-contamination.

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APPENDIX B: BOREHOLE LOGS

Individual borehole and completion log sheets are included in this appendix for all the boreholes completed for tritium monitoring and for those pre-existing boreholes in the areas of tritium contamination. Logs of monitoring wells installed during earlier projects are also in a previously published data report.¹

The log forms are designed for consistency and to consolidate as much of the relevant information as possible for each installation. There are, however, some minor differences between the formats used to report logs of holes drilled with LLNL equipment and those drilled with contractor's equipment. Soils and geologic logging for all boreholes was performed by LLNL personnel. Geophysical logging was performed on the deep, contract-drilled boreholes and these data are included on the log sheets. Geophysical logging was not done in the shallow auger holes drilled with LLNL equipment.

Soil tritium and moisture content results from core samples are included on both types of log form although the format differs slightly. No soil tritium data is included for boreholes drilled before August 1984.

Tritium values for soil moisture are expressed in exponential notation ($2.5E2 = 2.5 \times 10^2$ or 250); all units are pCi/l. For samples with an activity indistinguishable from background, the abbreviation LOS (limit of sensitivity) indicates an uncontaminated sample, i.e., an activity normally less than 200 to 300 pCi/l. Appendix C contains a more extensive discussion of sampling and analytical procedures.

The percent of water on the summary sheets was determined on a wet weight basis. The following notation is used on the summary sheets for boreholes drilled with LLNL flight auger equipment.

Piezometer completion

S3 = #3 sand
S0 = #0 sand
G = grout

Lysimeter completion

SF = 200-mesh silica flour
SC = 1/4-in. sieved cuttings
B = bentonite pellets
C = borehole cuttings
G = grout

REFERENCES

1. David W. Carpenter and Dennis W. Peifer, Supplementary Data Report Site 300 Chemical and Hydrogeological Assessment, Lawrence Livermore National Laboratory, Livermore, CA, UCID-19801 (1983).

TEST BOREHOLE: NC7-1

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed	Geologic log	Geologic description	Notes
5	4.7	4.55E4 (.065)	14.7	G		0-4.5 - <u>Sandy Clay</u> (CL) dark brown moderately plastic, about 30% fine to medium sand. Scattered fine gravels. Roots up to 2 feet - dry to damp.	Logging D. Carpenter
	6.3	6.97E4 (.076)	15.1	C		4.5-6.3 - <u>Silty Sand</u> (SM) yellow to red brown, about 10% pebbles. Some sandstone fragments. Encountered desicated sandstone at 6 feet.	Hole location coordinates N428193.7 E1694339.4 Ground elevation 1361.4
10	8.0	4.05E4 (.059)	16.9	B		6.3-7.5 - <u>Silty Sand</u> (SM) to sandstone gradation zone.	Date(s) drilled 8/22/84 Drilling method Backhoe 12" flight auger
15	15.1	1.33E4 (.027)	19.5	SC SF		7.5-8.0 - <u>Sandstone</u> greenish, hard with some fragments. 8.0-14.0 - <u>Sandy Claystone</u> grayish brown with reddish brown Fe oxidation staining, some sand suggests possible sandstone interbeds at 9 feet and 12 feet. 14.0-15.1 - <u>Claystone</u> grayish and fairly micaceous. Ashy texture. TOTAL DEPTH = 15.1 feet	Water level First encountered Depth Date None Comments Lysimeter installed 8/29/84 Lysimeter cup at 15.0'
20							
25							
30							
35							
40							

TEST BOREHOLE: NC7-2

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed	Geologic log	Geologic description	Notes
							Logging
				G		0-3.0 - <u>Sandy Clay</u> (CC) dark brown, 30% fines, moderately plastic, roots - damp.	D. Carpenter
5	4.8	9.73E2 (2.1)	9.5			3.0-6.0 - <u>Clayey Sand</u> (SC) dark brown 40% sand, 20% gravel @ 4" max - damp.	Hole location coordinates N428238.3 E1694410.9
	7.0	4.98E3 (.028)	12.1			6.0-7.0 - Gradation Zone.	Ground elevation 1353.9
10	9.0	1.43E4 (.039)	14.0			7.0-7.5 - <u>Sandstone</u> abundant pebbles @ 1" diameter max.	Date(s) drilled 8/22/84
				B			Drilling method Backhoe 12" flight auger
				SC			Water level First encountered Depth Date
15	15.0	6.86E3 (.21)	20.7	SF		7.5-14.0 - <u>Shaly Claystone</u> gray and brown hard, some sandstone interbeds Fe oxidation staining.	No water encountered
						14.0-15.0 - <u>Sandy Claystone</u> gray to brown with brown fine to medium sand clasts with sandstone interbeds - damp.	Comments Lysimeter installed 8/29/84
						TOTAL DEPTH = 15.0 feet	Lysimeter cup at 15.0'
20							
25							
30							
35							
40							

TEST BOREHOLE: NC7-3

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed		Geologic log	Geologic description	Notes
5	5.0	2.20E4 (.046)	11.0		G		0-5.0 - <u>Gravelly Sandy Clay</u> (SC) dark brown gravels up to 1-2", 10% gravels with fine sand.	Logging B. Qualheim
	8.0	5.89E4 (.011)	11.1		C		5.0-10.0 - <u>Silty Sand</u> (SM) dark brown minor gravels up to 1". Dark brown, gravels <1/2", hard drilling - very dry.	Hole location coordinates N428283.5 E1694493.6 Ground elevation 1346.5
10					B			
	15.0	1.96E4 (.043)	18.7		SC SF		10.0-15.0 - <u>Sandy Silt</u> (SM) brown, some pebbles and 1-2" gravels. 15.0-15.1 - <u>Silty Clay</u> (CL) orange brown minor pebbles about 10% - slightly damp. TOTAL DEPTH = 15.1 feet	Date(s) drilled 8/22/84 Drilling method Backhoe 12" flight auger Water level First encountered Depth Date None encountered Comments Lysimeter installed 8/29/84 Lysimeter cup at 15.0'
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20								
25								
30								
35								
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B-5

TEST BOREHOLE: NC7-4

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed	Geologic log	Geologic description	Notes
							Logging B. Qualheim
5	5.5	1.52E3 (.22)	9.7	G		0-7.0 - <u>Clayey Silt</u> (ML) dark brown 20% gravels.	
	8.0	1.75E3 (.23)	16.0	C		3.0-7.0 - 10% pebbles, some medium to coarse, light colored sand.	Hole location coordinates N428124.5 E1694384.2
10	9.5	1.45E3 (.22)	15.0	B		7.0-8.0 - <u>Shaly Claystone</u> gray, cemented interbedded with clayey siltstone, Fe oxide stained.	Ground elevation 1361.3
				SC			
15	15.0	1.46E2 (1.3)	21.3	SF		8.0-12.0 - <u>Claystone</u> gray, cemented hard, some silty clay, dry.	Date(s) drilled 8/22/84
						12.0-15.0 - <u>Sandy Siltstone</u> yellowish brown, some claystone interbeds.	Drilling method Backhoe 12" flight auger
20						TOTAL DEPTH = 15.0 feet	Water level First encountered Depth Date
25							None
30							Comments Lysimeter installed 8/29/84
35							Lysimeter cup at 15.0' depth
40							

TEST BOREHOLE: NC7-5A

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed	Geologic log	Geologic description	Notes
5	6.0	5.35E3 (.16)	15.9	G		0-2.0 - Fill material.	Logging
						2.0-3.5 - <u>Sandy Clay</u> (CH) dark brown, 70% highly plastic fines, 30% fine to medium sand, damp.	D. Carpenter
10	10.0	4.06E3 (.15)	17.4	C		3.5-7.0 - <u>Decomposed Sandstone</u> , orange brown, dry.	Hole location coordinates N428174.1 E1694315.0 Ground elevation
				B		5.0-7.0 - <u>Scattered Claystone</u> and volcanic pebbles, 2" max.	1365.2
15	16.5	5.86E2 (1.1)	19.6	SC		7.0-16.2 - <u>Clayey Siltstone</u> gray brown, hard, damp.	Date(s) drilled 9/12/84
				SF		10.0 - Grades to clayey siltstone, yellow brown, some coarse sand, damp to moist.	Drilling method 4.5" flight auger backhoe mounted
20						14.0 - <u>Clayey Siltstone</u> , gray with yellow mottling, damp to moist.	Water level First encountered Depth Date
25						TOTAL DEPTH = 16.2 feet	None
30							Comments Lysimeter installed 9/17/84
35							Lysimeter cup at 15.6'
40							

TEST BOREHOLE: NC7-6

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed	Geologic log	Geologic description	Notes
5	5.8	4.51E3 (.15)	15.9	G		0-3.0 - <u>Clayey Sand</u> (SC) gray brown 60% sand, 20% moderately plastic fines, dry.	Logging D. Carpenter
10	10.2	6.00E4 (.048)	15.9	c		3.0-13.0 - <u>Sandy Clay</u> (CL) dark brown, moderately plastic, 30% fine sand, damp to moist. At 10', 40% fine to coarse sand, mottled brown-gray-orange, damp to moist. Large cobbles at 12.5'.	Hole location coordinates N427741.1 E1694961.8 Ground elevation 1315.7
15	16.3	1.10E5 (.0066)	21.7	B		13.0-19.0 - <u>Clayey Siltstone</u> (highly weathered) greenish-gray brown, low plasticity, moist.	Date(s) drilled 9/12/84
20	21.0	3.66E4 (.037)	28.6	SC SF		19.0-21.0 - <u>Silty Claystone</u> mottled gray and yellow brown, moist.	Drilling method Backhoe 4.5" flight auger
25						TOTAL DEPTH = 21 feet	Water level First encountered Depth Date None 9/12/84 19.3' 9/17/84 Comments
30							Lysimeter installed 9/17/84
35							Lysimeter cup at 20.0'
40							

TEST BOREHOLE: NC7-7

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed		Geologic log	Geologic description	Notes
5	5.7	2.92E4 (.032)	12.2		G		0-8.5 - <u>Sandy Clay</u> (CL-ML) dark brown, 60% low plasticity fines, 30% sand, 10% gravels, 1" max, dry. Grades damp with increasing size plasticity below 2' depth.	Logging D. Carpenter
10	11.2	1.01E5 (.0061)	13.5		C		8.5-15.0 - <u>Clayey Sand</u> (SC-CL) brown, 50% sand, 45% fines, 5% gravels, damp.	Hole location coordinates N428163.6 E1694657.3 Ground elevation 1335.0
15	16.0	1.01E5 (.0061)	10.2		B		Fragments of gray siltstone present at 11'.	Date(s) drilled 9/12/84
20					SC			Drilling method Backhoe 4.5" flight auger
25					SF		15.0-16.0 - <u>Clayey Sand</u> (SC-SM) brown, 70% sand, 10% gravels, 20% low plasticity fines, damp.	Water level First encountered Depth Date
30							TOTAL DEPTH = 16.0 feet	None Comments
35								Lysimeter installed 9/17/84
40								Lysimeter cup at 15.6'

TEST BOREHOLE: NC7-8

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed	Geologic log	Geologic description	Notes
5	5.3	8.90E3 (.019)	12.9	G		0-2.0 - <u>Gravelly Clay</u> (CL) dark brown, 60% fines, 20% sand, 20% gravel - 1" max, roots upper 1 foot, dry.	Logging D. Carpenter
10	10.7	1.99E5 (.001)	11.1	C		2.0-10.67 - <u>Sandy Clay</u> (CL) dark brown, 60% fines, 30% sand, 10% gravels, damp.	Hole location coordinates N427860.4 E1694973.0 Ground elevation 1314.2
15	15.5	1.54E5 (.077)	11.8	B		At 5.5', color change to brown, damp to moist.	Date(s) drilled 9/12/84
				SC		10.67-15.0 - <u>Silty Clay</u> (CL-ML) brown to dark brown 80% fines, 20% sand, some gravels to 1" dia., moist.	Drilling method Backhoe mounted 4.5" flight auger
				SF		15.0-15.5 - <u>Clayey Sand</u> (SC) dark brown 50% sand, 10% gravels, 40% fines, moist.	Water level First encountered Depth Date
20						TOTAL DEPTH = 15.5 feet	None
25							Comments
30							Lysimeter installed 9/17/84
35							Lysimeter cup at 15.5'
40							

B-10

B-11

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed	Geologic log	Geologic description	Notes
							Logging
5	6.0	3.95E2 (2.0)	17.4		G	0-11.0 - <u>Clayey Silt</u> (ML) light brown, no gravels - damp.	M. Ruggieri
						Some gravels color change to darker brown.	D. Carpenter
10	10.7	7.31E2 (2.1)	17.9		C	Becoming cemented - moist.	Hole location coordinates N426432.7 E1696037.4 Ground elevation 1292.3
15	15.7	3.59E3 (.14)	17.3			11.0-16.0 - <u>Silty Clay</u> (CL) dark brown cemented, uniform - moist.	Date(s) drilled 9/18/84
					B	Softer drilling.	Drilling method Backhoe 4.5" flight auger
20	20.6	1.25E4 (.021)	16.0		SC	20.0-20.6 - <u>Silty Sand</u> (SM) brown fine grained sand with 10% angular sandstone fragments.	Water level First encountered Depth Date
					SF		None
25						TOTAL DEPTH = 20.6 feet	Comments Lysimeter installed 9/26/84 Lysimeter cup at 20.5'
30							
35							
40							

TEST BOREHOLE: NC7-10

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed		Geologic log	Geologic description	Notes
5	5.5	1.29E5 (.007)	16.5	G		G	0-2.0 - <u>Silty Gravel</u> (GM) dark brown angular to rounded pebbles - dry.	Logging D. Carpenter Hole location coordinates N426309.9 E1696490.5 Ground elevation 1221.5 Date(s) drilled 9/18/84 10/22/84 Drilling method Backhoe 4.5" flight auger Water level First encountered Depth Date 10' 9/18/84 Comments Water rose rapidly to 4.8', then dropped to 5.3'. Borehole re-entered and drilled to 15.5' on 10/22/84. Piezometer installed 10/23/84. Screen inter. 5-15'.
				S ₀		S ₀	2.0-4.5 - <u>Silty Sand</u> (SM) brown scattered sandstone fragments - damp.	
				S ₃		S ₃	4.5-10.0 - <u>Clayey Siltstone</u> brown, slight plastic. Interbedded sandstone layers - damp.	
10	10.6	4.54E5 (.018)	27.0	S ₃		S ₃	10.0-10.6 - <u>Silty Sandstone</u> purple brown, hard drilling - wet.	
15							10.6-15.5 - <u>Silty CST</u> brown, V.F. gv plastic.	
20							At 14 slightly saturated.	
25							TOTAL DEPTH = 15.5 feet	
30								
35								
40								

TEST BOREHOLE: NC7-11

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed		Geologic log	Geologic description	Notes
5	5.5	1.57E3 (.12)	13.2	G	G		0-4.0 - <u>Silty Gravel</u> (GM) dark brown, rounded material, sandstone pebbles.	Logging D. Carpenter Hole location coordinates N426502.4 E1696376.5 Ground elevation G.E. = 1240.9 Date(s) drilled 9/18/84 10/22/84 Drilling method Backhoe 4.5" flight auger Water level First encountered Depth Date 15' 10/22/85 Comments Re-entered hole 10/22/84 found water at 15'. Later went down to 15.11' 11/13/84. Piezometer installed 10/22/84. Screen interval 9.5- 19.5'
				S ₀	S ₀		4.0-5.5 - <u>Sandy Clay</u> (CC) dark brown, 75% fines, 25% sand - damp.	
10	10.6	2.30E3 (.13)	14.0	S ₃	S ₃		5.5-19.8 - <u>Silty Claystone</u> brown, decomposed silty clay fragments, low placity - damp.	
15	15.8	2.37E4 (.028)	15.2	S ₃	S ₃		TOTAL DEPTH = 19.8 feet	
20	19.8	3.76E4 (.038)	15.4					
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30								
35								
40								

B-13

TEST BOREHOLE: NC7-12

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed		Geologic log	Geologic description	Notes
5	5.8	1.10E2 (1.1)	14.1	G	G		0-5.5 - <u>Sandy Clay</u> (CL) dark brown 75% fines, 20% sand, 5% gravels, roots to .5' - dry.	Logging D. Carpenter Hole location coordinates N427240.4 E1695627.1 Ground elevation 1282.5 Date(s) drilled 9/18/84 10/18/84 Drilling method Backhoe 4.5" flight auger Water level First encountered Depth Date 16' 9/18/84 Comments 9/18/84 observed H ₂ O seepage in borehole. 10/18/84 re-entered borehole. Did not observe standing H ₂ O at borehole bottom or at 20' depth. Piezometer installed 10/18/84; interval screen 16-26'.
10	11.2	2.57E3 (.24)	18.2	S ₀	S ₀		5.5-10.0 - Color change to reddish brown and more slightly <u>Silty Clay</u> (CL-ML) - damp.	
15	16.0	1.48E5 (.01)	20.0	S ₃	S ₃		10.0-11.0 - Back to <u>Sandy Clay</u> yellowish brown.	
20	20.8	1.21E5 (.085)	24.3	S ₃	S ₃		11.0-13.0 - <u>Silty Sand</u> (SM) yellowish brown 60% fine to medium sand, 40% fines - damp.	
25							13.0-15.8 - <u>Clay</u> (CL) yellowish brown 80% fines, 20% sand - moist.	
30							15.8-16.0 - <u>Clayey Sand</u> (SC-SM) yellowish brown 60% medium sand, 40% low plasticity fines - wet.	
35							16.0-20.5 - <u>Clayey Sand</u> (SC-CL) yellow brown, ~50% mud + fines, 40% F-CSE sand, 10% F claystone gvl. var. moist to wet. @ 20.0 thin interbeds of gray sand formed gr. wet.	
40							20.5-26.8 - Highly weathered CST gray with abundant Fe-oxide stains, interbeds of yellow brown F gr. silty sand. @ 24.0 greenish brown, some Fe-oxide stains - moist.	
							TOTAL DEPTH = 26.8 feet	

TEST BOREHOLE: NC7-13

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed		Geologic log	Geologic description	Notes
5	5.6	1.49E4 (.038)	10.9		G		0-7.5 - <u>Sandy Clay</u> (CL), dark brown, 70% fines, 20% sand, 10% gravels (3/4" max) roots to 1' depth, dry. At 5.6', grades damp.	Logging D. Carpenter Hole location coordinates N428449.9 E1694486.1 Ground elevation 1347.6 Date(s) drilled 9/18/84 Drilling method Backhoe 4.5" flight auger Water level First encountered Depth Date None Comments Lysimeter installed 9/26/84 Lysimeter cup at 19.8' depth
10	10.5	8.08E5 (.040)	10.9		C		7.5-11.0 - <u>Sandy Silt</u> (ML) yellowish brown 60% fines, 40% sand, dry to damp.	
15	15.6	8.10E6 (.041)	12.2				11.0-15.0 - <u>Silty Sand</u> (SM) brown, fine to coarse grained, damp (decomposed sandstone).	
					B		15.0-17.0 - <u>Sandy Siltstone</u> brown to yellowish brown, some clay, damp.	
					SC			
20	20.5	6.72E6 (.034)	19.0		SF		17.0-20.5 - <u>Silty Claystone</u> light yellow brown, orange mottling and caliche filaments. TOTAL DEPTH = 20.5 feet	
25								
30								
35								
40								

TEST BOREHOLE: NC7-14

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed		Geologic log	Geologic description	Notes
5	5.3	7.68E4 (.077)	15.9	G	G		0-3.0 - <u>Sandy Silt</u> (SM) brown - dry. 3.0-5.0 - <u>Clayey Silt</u> (ML) cemented - moist. 5.0-10.0 - <u>Sandy Clay</u> (SC) 2" rounded cemented rocks - moist.	Logging M. Ruggieri B. Qualheim Hole location coordinates N426653.3 E1696283.4 Ground elevation 1253.9
10	10.7	1.17E4 (.036)	11.1				10.0-12.0 - <u>Sandy Gravel</u> (GM) 1/2 in pebbles. 12.0-15.0 - <u>Sandy Clay</u> (SC) slightly plastic cemented - moist.	Date(s) drilled 10/5/84 10/22/84 Drilling method
15	15.5	2.26E4 (.045)	15.7	S ₀	S ₀		15.0-25.0 - <u>Clayey Sand</u> (SC) dark brown medium-fine grained sand - moist. Color change to gray brown - moist.	
20	20.5	2.56E4 (.049)	16.5	S ₃	S ₃		25.0-27.0 - <u>Silty Claystone</u> chocolate brown highly weathered - moist. TOTAL DEPTH = 27.0 feet	Backhoe 4.5" flight auger Water level First encountered Depth Date 25' 10/22/84
25	25.3	1.72E4 (.041)	19.0					Comments Re-entered borehole and extended length to 27.0' on 10/22/84. Piezometer installed 10/22/84; screened interval 16.5-26.5'.
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35								
40								

TEST BOREHOLE: NC7-15

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed		Geologic log	Geologic description	Notes
5	6.4	2.13E2 (2.0)	16.7	G	G		0-14.0 - <u>Sandy Clay</u> (CL-SC) dark brown low plasticity, 55% fines, 40% sand, 5% gravels, damp-dry. Brown.	Logging D. Carpenter Hole location coordinates N26805.2 E1695927.1 Ground elevation 1266.3 Date(s) drilled 10/18/84 Drilling method Backhoe 4.5" flight auger Water level First encountered Depth Date Seepage at 15' 10/18/84 Comments Piezometer installed 10/18/84 Screened interval 15.5-25.5'
10	10.5	1.65E2 (1.7)	17.6	S ₀	S ₀		14.0-16.0 - <u>Clayey Silt</u> (ML) yellow brown, firm, slightly plastic, damp.	
15				S ₃	S ₃		16.0-17.0 - <u>Sandy Clay</u> (CL) dark brown, 70% fines, 30% sand, moist.	
	17.0	4.19E3 (.26)	26.0				17.0-21.0 - <u>Silty Sand</u> (SM) dark yellow brown, 60% fine sand, 40% fines. Gravels at 20'.	
20				S ₃	S ₃		21.0-23.0 - <u>Clay</u> (CL) dark brown, some sand.	
25							23.0-26.25 - <u>Silty Claystone</u> olive brown, Fe staining, some pebbles, low plasticity Grades greenish blue at 25'.	
30							TOTAL DEPTH = 26.3 feet	
35								
40								

B-17

TEST BOREHOLE: NC7-16

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed		Geologic log	Geologic description	Notes
5	6.0	2.26E4 (.046)	16.3	G	G		0-6.5 - <u>Clayey Sand</u> (SC-CL) dark brown, 50% sand, 50% fines, roots to 6" depth, dry.	Logging D. Carpenter Hole location coordinates N427787.0 E1695136.0 Ground elevation G.E. = 1307.9 Date(s) drilled 10/5/84 10/18/84 Drilling method Backhoe 4.5" flight auger Water level First encountered Depth Date 19.0' 10/5/84 Comments Extended borehole on 10/18/84. Piezometer installed 10/18/84. Screened interval 16.0-26.0'.
10	10.8	1.07E5 (.0094)	10.4	S ₀	S ₀		6.5-11.0 - <u>Silt</u> (ML) brown, slightly plastic, some sand, dry.	
15	15.7	3.87E5 (.020)	10.1	S ₃	S ₃		11.0-15.0 - <u>Sandy Clay</u> (CL) brown, moderately plastic, rounded gravels to 1" max. size.	
20	20.7	4.23E5 (.021)	23.1	S ₃	S ₃		15.0-19.5 - <u>Silty Sand</u> (SM-ML) brown, 50% fines, 45% sand, 5% fine gravel.	
25							19.5-21.0 - <u>Sandy Silt</u> (ML) brown, slight plastic, 40% sand, many claystone and siltstone fragments.	
30							21.0-23.0 - <u>Interbedded Sandstone and Sandy Siltstone</u> , orange brown, highly weathered, augers to low plasticity sandy silt.	
35							23.0-26.5 - <u>Claystone</u> gray with orange brown staining, moderately indurated, moist.	
40							TOTAL DEPTH = 26.5 feet	

TEST BOREHOLE: NC7-17

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed		Geologic log	Geologic description	Notes
5	5.5	3.93E2 (2.0)	19.7	G	G		0-10.0 - <u>Sandy Clayey Silt</u> (ML-CL) dark brown, medium-fine grained material well sorted, some sandstone fragments orange mottling, little gravels.	Logging M. Ruggieri D. Young Hole location coordinates N427977.5 E1694250.1 Ground elevation 1385.7 Date(s) drilled 10/5/84 12/14/84 Drilling method Backhoe 4.5" flight auger Water level First encountered Depth Date 24'6" 12/14/84 Comments Borehole extended on 12/14/84 Piezometer installed 12/18/84 Screened interval 20.5-30.5'
10	10.7	<2.22E2	25.7				10.0-15.0 - <u>Sandy Siltstone</u> tan, little clay, dark brown sandstone fragments, orange mottling, well sorted.	
15	15.6	5.40E1 (5.4)	21.6	S ₀	S ₀		15.0-19.5 - <u>Silty Sandstone</u> tan, medium-fine grained, well sorted, little gravels, orange mottling, gravels up to 1-1/2" diameter.	
20	20.0	2.65E2 (2.0)	16.3	S ₃	S ₃		19.5-31.5 - <u>Sandy Siltstone</u> tan, some dark sandstone grains, little gravels, gravels up to 1/2 inch diameter.	
25	25.5	1.73E2 (1.7)	20.8				TOTAL DEPTH = 31.5 feet	
30								
35								
40								

B-19

TEST BOREHOLE: NC7-18

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed		Geologic log	Geologic description	Notes
5	5.7	3.20E2 (2.1)	23.3	G	G		0-15.0 - <u>Sandy Clay</u> (CL) dark brown moderately plastic, roots to 6", 25% sand, 75% fines with 1/4" gravels.	Logging D. Carpenter
10	10.7	2.30E2 (2.0)	21.3	S ₀	S ₀		15.0-26.0 - <u>Silty Claystone</u> olive brown, traces of Fe oxide staining, 10% fine sand.	Hole location coordinates N427678.9 E1694850.7 Ground elevation 1328.83
15	15.9	2.22E2	24.0	S ₃	S ₃		TOTAL DEPTH = 26 feet	Date(s) drilled 10/18/84
20	20.6	1.36E2 (1.4)	25.2	S ₃	S ₃			Drilling method Backhoe 4.5" flight auger
25	26.1	1.05E2 (1.1)	27.5					Water level First encountered Depth Date 17.2' 12/14/84
30								Comments 2.0' cave between drilling date and piezometer install. on 12/14/84.
35								Screened interval 13.5'-23.5'.
40								

TEST BOREHOLE: NC7-19

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed	Geologic log	Geologic description	Notes
5	5.5	7.03E4 (.077)	11.6	G	G	0-3.5 - <u>Gravelly Sandy Silt</u> (ML) brown 5% gravels - moist.	Logging B. Qualheim Hole location coordinates N426739.9 E1696089.4 Ground elevation G.E. = 1260.6 Date(s) drilled 10/31/84 Drilling method Backhoe 4.5" flight auger Water level First encountered Depth Date 17.8' 10/31/85 Comments Piezometer installed 11/1/84 Screened interval 14.5-24.5'
10	10.8	1.56E5 (.016)	14.0	S ₀	S ₀	3.5-10.0 - <u>Sandy Silt</u> (ML) brown, 5% gravels - moist.	
15	15.4	2.72E4 (.050)	17.8	S ₃	S ₃	10.0- <u>Silty Claystone</u> minor gravels (1/4-1/2" diameter) - slightly damp.	
						@ 11.0 - <u>Claystone</u> with light gray claystone stringers.	
						@ 15.0 - <u>Silty Claystone</u> - damp.	
						@ 17.0 - <u>Silty Claystone</u> - wet.	
						@ 23.0 - Color change blue gray.	
						TOTAL DEPTH = 25.0 feet	
20				S ₃	S ₃		
25							
30							
35							
40							

TEST BOREHOLE: NC7-20

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed		Geologic log	Geologic description	Notes
							0-10.0 - <u>Silty Sand</u> (SM) light brown, 5% gravels - dry.	Logging B. Qualheim M. Ruggieri Hole location coordinates N427304.9 E1695734.5 Ground elevation 1292.18 Date(s) drilled 10/31/84, 12/4/84, 12/14/84 Drilling method Backhoe 4.5" flight auger Water level First encountered Depth Date 32.2' 12/14/84 Comments Re-entered and extended borehole 12/4/84. Re-enter and extended bore- hole 12/14/84. Piezometer installed 12/14/84; screened interval 25.7-35.7'
5	5.8	3.73E2 (2.3)	10.9	G	G		10.0-15.0 - <u>Silty Clay</u> (CL) light brown slightly plastic - dry.	
10	10.5	3.59E2 (2.0)	18.9				15.0-17.0 - <u>Sandy Silt</u> (SM) brown to light gray, fine grained - dry.	
15	15.5	1.57E2 (2.4)	13.0	G	G		17.0-18.0 - <u>Clayey Silt</u> (ML) light brown - dry.	
20	20.5	3.31E2 (2.1)	14.7	S ₀	S ₀		18.0-26.5 - <u>Sandy Silt</u> (SM) brown, slightly plastic minor clays - damp.	
25				S ₃	S ₃		26-36 - <u>Clay Silt</u> (ML) light brown, slightly moist.	
30				S ₃	S ₃		TOTAL DEPTH = 36.3 feet	
35								
40								

TEST BOREHOLE: NC7-21

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed		Geologic log	Geologic description	Notes
5	6.2	2.60E2 (2.3)	14.8	G	G		0-10.0 - <u>Silty Clay</u> (CL) brown plastic, some pebbles - dry. 10.0-20.0 - <u>Clayey Silt</u> (ML) brown, slightly plastic, minor pebbles - dry. Cemented siltstone interbeds - gray.	Logging B. Qualheim M. Ruggieri Hole location coordinates N427672.1 E1695383.9 Ground elevation 1301.15 Date(s) drilled 10/31/84 12/4/84 Drilling method Backhoe 4.5" flight auger Water level First encountered Depth Date 21.8' 12/4/84 Comments Re-entered and extended borehole 12/4/84. Installed piezometer 12/7/84. Screened interval 19.0-25.0'.
10	11.3	7.26E2 (2.1)	15.8	S ₀	S ₀		20.0-25.0 - <u>Sandy Siltstone</u> brown, some clays, pebbles - damp.	
15	15.5	9.51E3 (.33)	13.2	S ₃	S ₃		25.0-25.24 - <u>Claystone</u> light gray plastic, minor pebbles - dry.	
20	20.3	1.87E3 (.23)	16.0	S ₃	S ₃		25.0-29.8 - <u>Clay Siltstone</u> brown.	
25	25.2	2.31E4 (.047)	13.2	S ₃	S ₃		TOTAL DEPTH = 29.8 feet	
30								
35								
40								

TEST BOREHOLE: NC7-22

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed		Geologic log	Geologic description	Notes
5	5.8	2.35E2 (2.1)	14.7	G	G		0-7.0 - <u>Silty Clay</u> (CL) brown, probably colluvium, dry. Slightly damp.	Logging M. Ruggieri Hole location coordinates N427838.6 E1695278.6 Ground elevation 1309.25 Date(s) drilled 11/1/84 12/4/84 Drilling method Backhoe 4.5" flight auger Water level First encountered Depth Date Dry 11/01/84 32.7' 12/07/84 Comments Re-entered and extended borehole 12/4/84. Installed piezometer 12/7/84. Screened interval 25.0-35.0'.
10	10.7	2.76E2 (2.3)	13.5	G	G		7.0-26.0 - <u>Sandy Silt</u> (SM) gray brown, probably colluvium, cemented, slightly damp. Some gravels, brown, At 16', some gravel 1" diameter. Gray brown, slightly moist.	
15	15.8	<3.85E2	11.0	S ₀	S ₀		26.0-30.0 - <u>Sandy Silt</u> (ML) moist. 30.0-36.0 - <u>Clayey Silt</u> (ML-CL) moist. @ 35.0 - wet.	
20	20.5	<3.24E2	10.7	S ₃	S ₃		TOTAL DEPTH = 36.0 feet	
25	26.0	3.23E3 (.25)	13.7	S ₃	S ₃
30								
35								
40								

TEST BOREHOLE: NC7-23

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed		Geologic log	Geologic description	Notes
5	6.1	2.95E5 (.030)	14.9	G	G		0-4.5 - <u>High Organics</u> (Pt) dark brown.	Logging M. Ruggieri R. Elwood Hole location coordinates N428422.1 E1694455.2 Ground elevation 1345.81 Date(s) drilled 11/1/84 12/6/84 Drilling method Backhoe 4.5" flight auger Water level First encountered Depth Date 22' 12/6/84 Comments Re-entered and extended borehole 12/6/84. Installed piezometer 12/7/84. Screened interval 19.5-29.5'.
10	11.1	8.09E6 (.080)	14.6	S ₀	S ₀		4.5-25.0 - <u>Clayey Silt</u> (ML) dark brown, moist. At 13' grades, orange brown, some gravels. At 22', light orange brown.	
15	15.6	3.76E6 (.037)	12.2				25.0-30.0 - <u>Silty Claystone</u> light brown, slightly orange, containing 1/16" gravels, not well indurated.	
20	20.4	1.59E6 (.016)	15.6	S ₃	S ₃		At 26', less silt. Below 27', bluish to greenish gray with brown mottling.	
25	25.2	8.97E5 (.090)	15.0	S ₃	S ₃		TOTAL DEPTH = 30.0 feet	
30								
35								
40								

TEST BOREHOLE: NC7-23A

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed	Geologic log	Geologic description	Notes
5						0-8.5 - <u>Clayey Sand</u> (SC-CL) - Grading to <u>Sandy Clay</u> (CL), moderate plasticity, grades downward from 40% fine to coarse sand, 10% rounded gravel to 30% mostly fine sand, trace of fine gravel, dark brown to brown - dry to damp.	Logging D. Carpenter D. Young
10						8.5-14.0 - <u>Sandy Silt</u> (ML) - Non-plastic, about 30% fine to very fine sand, brown - damp.	Hole location coordinates Not surveyed
15	14.5-16.0**	3.94E6 (.039)	13.2			12.0-14.0 - Grades to very <u>Silty Sand</u> (SM) with trace of fine gravel - moist. 14.0-14.7 - <u>Sandy Clay</u> (CL) - Moderate plasticity, 30% fine and medium sand, brown - damp.	Ground elevation Not surveyed
20	19.5-19.8**	2.18E6 (.022)	12.7			14.7-17.5 - <u>Silty Sand</u> - Grading to <u>Sandy Silt</u> (SM-ML), about 50% fine sand, 50% non-plastic fines, scattered rounded gravel, 1" max. size, brown - damp.	Date(s) drilled 5/10/85 5/13/85
25	24.3-25.1**	7.52E5 (.075)	21.0			17.5-22.0 - <u>Sandstone</u> - Fine and medium grained, silty to clayey, very hard, brown with orange and red staining - damp. 22.0-24.3 - <u>Sandy Claystone</u> - Intensely weathered, 30-40% fine and medium ashy sand, brown to yellow brown - moist.	Drilling method Simco 2800 H.S. auger
30						24.3-25.1 - <u>Clayey Sandstone with Sandy Claystone Interbeds</u> , intensely weathered, sand fine to medium grained, mottled orange and slightly greenish brown - damp to moist. Beds dip 10°.	Water level First encountered Depth Date None
35							Comments Borehole backfilled with clay soil 5/14/85
40							**1.5" split tube sample

TEST BOREHOLE: NC7-24

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed		Geologic log	Geologic description	Notes
5	5.7	6.00E2 (2.1)	9.6	G	G		0-5.0 - <u>Silty Clay</u> (CL) dark brown - dry. 5.0-17.0 - <u>Sandy Silt</u> (ML) dark brown, low amount of gravel - dry. Sandy clayey silt, brown, some mottling - moist.	Logging Ruggieri Elwood Hole location coordinates N428598.8 E1694280.7 Ground elevation 1356.79 Date(s) drilled 11/1/84 12/8/84 Drilling method Backhoe 4.5" flight auger Water level First encountered Depth Date 31.8' 12/7/84 Comments Re-entered and extended borehole 12/6/84. Installed piezometer 12/7/84. Screened interval 24.5-34.5'.
10	10.5	6.40E2 (2.1)	11.5	G	G		Sandy silt, light gray brown - moist. 17.0-20.0 - <u>Clayey Siltstone</u> dark brown, moderately plastic, mottled.	
15	15.5	7.98E2 (2.1)	10.0				20.0-21.0 - <u>Silty Claystone</u> light brown, friable, orange brown inclusions.	
20				S ₀	S ₀		21.0-25.0 - <u>Sandy Clay</u> (CL) moderately plastic, some silt.	
25	24.3	2.22E3 (2.3)	17.6	S ₃	S ₃		25.0-28.0 - <u>Sandy Clayey Silt</u> (ML) reddish brown, black sand - moist.	
30				S ₃	S ₃		28.0-33.0 - <u>Clay</u> (CL) reddish brown, 5-10% medium to coarse grains.	
35							33.0-36.0 - <u>Sandy Clay</u> (CL) reddish brown, medium size sand, very plastic, 10-20% sand.	
40							TOTAL DEPTH = 36 feet	

B-27

LOG: MONITORING WELL NC7-25

SOIL SAMPLE DATA

Depth (ft)	Soil ³ H (pCi/l +/- 2 s.d.)	H ₂ O (WE %)
25.6	<3.51E2	8.73
35.0	<3.83E2	14.6
45.5	3.23E2 (2.7E2)	13.2
55.0	<2.70E2	25.0
60.0	1.97E3	16.9
65.0	1.69E5 (1.7E3)	15.2
70.0	1.69E3	21.1
72.7	7.53E2 (2.1E2)	11.4

LOG: MONITORING WELL NC7-26

SOIL SAMPLE DATA			
Depth (ft)	Soil ³ H (pCi/l +/- 2 s.d.)		H ₂ O (WE %)
25.0	2.36E2	(1.8E2)	12.2
34.8	2.86E2	(1.8E2)	13.2
45.1	6.63E2	(2.0E2)	12.8
55.2	<2.37E2		15.8
65.6	4.51E3	(2.6E2)	15.9
75.3	<2.68E2		11.4

LOG: MONITORING WELL NC7-27

LOG: MONITORING WELL NC7-28

0-12 **FILL**, gravel, sandstone, and claystone fragments, debris such as wood and metal, some dark brown clay.

12 - -29.9 **QUATERNARY COLLUVIUM**
Clayey Silt and Sandy Silt (ML), dark brown, unconsolidated, difficult to core

29.0-50.0 **TERTIARY SEDIMENTARY ROCKS**
 29.0-30.4 **Clayey Siltstone**, brown, ~50% silt, 50% clay
 30.4-34.3 **Claystone**, brown, brittle, fractured, hard

34.3-35.1 **Silty Sandstone**, brown-gray, fine to medium grained
 35.1-38.8 **Claystone**, light gray, ~40% silt, Fe-oxide stained.

38.8-43.5 **Sandstone**, silty, brown, fine to medium grained, small claystone bed at 41.6", Fe-oxide stains

43.5-50.0 **Claystone**, slightly silty, ~30% silt, blue-gray, some Fe-oxide stain.

Notes

Geologic Logging

D. Carpenter
 B. Qualheim
 R. Elwood

Geophysical Logging

Geo-Hydro Data Inc.

Hole Location:

East of bldg. 850

Coordinates:

N: 426,497.4
 E: 1,695,984.9

Elevation: Gr: 1297.1
 M.P.: 1298.14

Dates Drilled

12/13-14/84

Detailed Notes:

* Key: Drilling and Sampling Log

Rotary drilled, air mist
 0-19.5'—11.5" fishtail bit

Run 5 19.5-50.0—HQ
 wireline core—enlarged
 to 9" prior to well
 completion

* Key: Well Completion

Cement Grout
 #0 sand
 #3 sand
 Bentonite pellets
 5" potable PVC casing
 Screened section (0.015
 slots)
 Centralizers
 Cuttings

Water Level Data

Date	Time	Depth (below M.P.)
1/4/85	—	38.42
1/29/85	—	38.58

SOIL SAMPLE DATA

Depth (ft)	Soil ³ H (pCi/l +/- 2 s.d.)	H ₂ O (wt %)
29.3	7.46E2 (2.1E2)	22.8
34.1	5.01E4 (6.4E2)	6.64
36.6	5.55E5 (5.6E3)	20.6
39.6	7.33E5 (7.4E3)	20.9
44.1	4.25E5 (4.3E3)	15.2
47.3	1.70E4 (4.1E2)	20.9

LOG: MONITORING WELL NC7-29

TEST BOREHOLE: NC7-30

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed		Geologic log	Geologic description	Notes
5	5.5	2.42E6 (.024)	13.4	G	G		0-4.0 - <u>Silty Clay</u> (CL) - brown, moderately plastic, some weathered sandstone (1" dia.) - moist.	Logging R. Elwood Hole location coordinates N428385.5 E1694429.8 Ground elevation 1348.3 Date(s) drilled 3/12/85 Drilling method 4-1/2" flight auger backhoe mounted Water level First encountered Depth Date 25'9" 3/13/85 Comments Piezometer installed 3/14/85. Screened interval 24.5-34.5'.
10	11.5	5.25E6 (.052)	10.9				4.0-7.5 - <u>Sandy Clay</u> (CL) - brown, slightly plastic angular sandstone fragments (3/4" dia.) - very moist.	
15	16.0	2.74E6 (.027)	18.0	S ₀	S ₀		7.5-19.0 - <u>Sandy Silt</u> (ML) - light brown, fine gravel, some coarse gravel (color change to brown) (change, less clay content).	
20	20.3	1.55E6 (.015)	20.6				19.0-21.0 - <u>Claystone</u> - light grey blue.	
25	25.0	1.40E6 (.014)	17.5	S ₃	S ₃		21.0-35.0 - <u>Silty Clay</u> (CL) - brown to light grey, slightly plastic - moist. (Weathered material)	
30	30.0	1.62E6 (.016)	17.8				TOTAL DEPTH = 35.0 feet	
35								
40								

B-34

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed		Geologic log	Geologic description	Notes
					G			Logging
								See NC7-30
5								Hole location coordinates N428390.8 E1694424.0 Ground elevation
10							Satellite borehole to NC7-30	Not surveyed
15							TOTAL DEPTH = 20.0 feet	Date(s) drilled 3/12/85
20								Drilling method 4.5" backhoe mounted flight auger
25								Water level First encountered Depth Date
30								None
35								Comments Located 8 feet north of NC7-30.
40								Neutron probe access tube installed.

TEST BOREHOLE: NC7-32

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed	Geologic log	Geologic description	Notes
5				G			Logging
				SF			See NC7-30
10				B			Hole location coordinates
				G			N428396.6
				B			E1694418.5
15							Ground elevation
				SF			1348.6
20						Satellite borehole to NC7-30	Date(s) drilled
				B		TOTAL DEPTH = 24.7 feet	3/12/85
25							Drilling method
							4.5" backhoe mounted flight auger
30							Water level
							First encountered
35							Depth Date
40							None
							Comments
							Located 16 ft. north of NC7-30.
							Lysimeters installed 3/14/85 at 8.5' and 19.0' depths.

TEST BOREHOLE: NC7-34

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed		Geologic log	Geologic description	Notes
5							Borehole not logged or sampled TOTAL DEPTH = 35.0 feet	Logging See NC7-1 and NC7-36 Hole location coordinates N428203.5 E1694358.8 Ground elevation 1359.4 Date(s) drilled 12/20/84 Drilling method Backhoe 4.5" flight auger Water level First encountered Depth Date 24.7' 12/21/84 Comments Piezometer installed 12/21/84. Screened interval 24.5-34.5'
10				G	G			
15								
20	20.3	5.78E3 (.28)	22.8	S ₀	S ₀			
25				S ₃	S ₃			
30								
35				S ₃	S ₃			
40								

TEST BOREHOLE: NC7-35

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed	Geologic log	Geologic description	Notes
5				G			Logging See NC7-1
10							Hole location coordinates N428198.7 E1694349.9 Ground elevation
15							Not surveyed
20						Satellite borehole to NC7-1	Date(s) drilled 12/21/84
25						TOTAL DEPTH = 20.0 feet	Drilling method 4.5" backhoe mounted flight auger
30							Water level First encountered Depth Date
35							None
40							Comments Located 8 ft. east of NC7-1 Neutron probe access tube installed

TEST BOREHOLE: NC7-36

B-38

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument Installed		Geologic log	Geologic description	Notes
5	5.4	1.69E4 (.042)	20.6	G	G		0-0.5 - <u>Clay</u> (CL) dark brown, probably fill, moist.	Logging D. Peifer Hole location coordinates N428203.5 E1694358.8 Ground elevation 1358.0 Date(s) drilled 12/20/84 12/27/84 Drilling method Backhoe 4.5" flight auger Water level First encountered Depth Date 21' 12/20/84 18.7' 12/27/84 Comments Re-entered and drilled out borehole 10' of cave in most. sand 12/27/84. Installed piezometer 12/27/84. Sampling interval 14.5-34.5'.
10	10.8	3.37E2 (2.1)	22.7	S ₀	S ₀		0.5-1.5 - <u>Sandy Siltstone</u> brown-orange brown, very fine sand, soft.	
15	15.0	2.11E2 (2.1)	20.0	S ₃	S ₃		1.5-5.0 - <u>Sandy Silty Claystone</u> orange brown, fine sand, damp.	
20	20.3	2.39E2 (1.8)	26.2	S ₃	S ₃		5.0-5.5 - <u>Silty Claystone</u> very little sand, gray clay mottling, some gravels.	
25	25.0	3.00E2 (2.0)	27.3	S ₃	S ₃		5.5-9.5 - <u>Sandy Siltstone</u> light brown - tan, very fine sand, hard, some Fe staining.	
30				S ₃	S ₃		9.5-12.0 - <u>Silty Sandstone</u> orange brown, friable, highly weathered.	
35	35.0	3.08E2 (2.1)	23.5	S ₃	S ₃		12.0-15.6 - <u>Sandy Silty Claystone</u> light greenish gray with Fe staining.	
40				S ₃	S ₃		15.6-16.0 - <u>Sandy Siltstone</u> light gray green with orange weathered mottling.	
				S ₃	S ₃		16.0-19.3 - <u>Silty Claystone</u> light green gray, damp.	
				S ₃	S ₃		19.3-20.3 - <u>Sandy Siltstone</u> olive with orange mottling, soft - crumbly.	
				S ₃	S ₃		20.3-36.0 - <u>Silty Claystone</u> green-gray with orange mottling, contains fine sand.	
							TOTAL DEPTH = 36.0 feet	

TEST BOREHOLE: NC7-37

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed		Geologic log	Geologic description	Notes
5	5.2	1.83E3 (.22)	15.7	G	G		0-9.0 - <u>Sandy Clay</u> (CL) - brown, some cobbles (2" dia.), 5% fine gravel - dry (more silt) (sandstone fragments).	Logging R. Elwood Hole location coordinates N428133.0 E1694653.3 Ground elevation 1335.6 Date(s) drilled 3/13/85 Drilling method 4-1/2" flight auger backhoe mounted Water level First encountered Depth Date 19' 3/13/85 Comments Piezometer installed 3/14/85. Screened interval 14.5-24.5'.
10	10.7	8.66E4 (.090)	11.9	S ₀	S ₀		9.0-12.0 - <u>Sandy Silt</u> (ML) - brown, 40% clay - slightly damp.	
15	15.8	1.05E5 (.011)	19.0	S ₃	S ₃		12.0-20.0 - <u>Sandy Clay</u> (CL) - brown, increasing gravel, claystone fragments present - damp (sandstone fragments present).	
20	20.7	1.95E5 (.02)	27.9	S ₃	S ₃		20.0-20.7 - <u>Clayey Sand</u> (SC) - greenish grey - moist.	
25							20.7-24.0 - <u>Clay</u> (CL) - green, 5-10% sand - wet.	
30							24.0-25.0 - <u>Silty Clay</u> (CL) - brown, 45% sand, coarse and silty clay, oxidation present - damp.	
35							TOTAL DEPTH = 25.0 feet	
40								

TEST BOREHOLE: NC7-38

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed		Geologic log	Geologic description	Notes
					G			Logging See NC7-37 Hole location coordinates N428139.6 E1694697.6 Ground elevation Not surveyed Date(s) drilled 3/13/85 Drilling method 4.5" backhoe flight auger Water level First encountered Depth Date None Comments NC7-38 is 8 ft. north of NC7-37. Neutron probe access tube installed.
5								
10								
15								
20							Satellite borehole to NC7-37	
25							TOTAL DEPTH = 16.0 feet	
30								
35								
40								

B-40

TEST BOREHOLE: NC7-39

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed	Geologic log	Geologic description	Notes
5				G			Logging
				S ₃			See NC7-37
				SF			Hole location coordinates
				G			N428145.2
10				B			E1694642.5
							Ground elevation
				SF			1336.0
15							Date(s) drilled
							3/13/85
							Drilling method
							4.5" flight auger backhoe mounted
20						Satellite borehole to NC7-37	Water level
							First encountered
							Depth Date
25						TOTAL DEPTH = 16.0 feet	None
							Comments
30							NC7-39 is located 16 ft. north of NC7-37.
							Lysimeters installed 5/3/85 at 7.5' and 14.8' depths.
35							
40							

B-41

TEST BOREHOLE: NC7-40

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed		Geologic log	Geologic description	Notes
5	5.8	3.05E4 (.052)	17.0	G		G	0-3.5 - <u>Organic Silt</u> (ML) - organic matter, some gravels - damp.	Logging D. Young Hole location coordinates N427869.1 E1694892.7 Ground elevation 1316.0 Date(s) drilled 3/14/85 Drilling method 4.5" backhoe mounted flight auger Water level First encountered Depth Date Initially none 21.0' 3/15/85 Comments Piezometer installed 4/4/85. Screened interval 16.5-26.5'.
10	10.8	5.74E5 (.058)	19.5	S ₀		S ₀	3.5-11.6 - <u>Sandy Clayey Silt</u> (ML) - low plasticity, 30-40% clay, 20% medium sand - dry to damp.	
15	14.9	2.60E5 (.026)	26.0	S ₃		S ₃	11.6-14.5 - <u>Sandy Silty Clay</u> (CL) - medium to light brown, 20% angular pebbles, low plasticity - damp.	
20	20.3	2.79E5 (.028)	28.2				14.5-23.0 - <u>Clayey Sandy Silt</u> (ML) - tan, low plasticity, 20% pebbles, Fe oxidation staining (1/2"), siltstone, pebbles present - dry.	
25	25.5	1.23E5 (.013)	21.0	S ₃		S ₃	23.0- <u>Sandy Clayey Siltstone</u> - light brown to tan, fine to medium grained sands, Fe oxidation staining - dry.	
30	30.5						@ 31.0 - moist material encountered.	
35	35.6						TOTAL DEPTH = 35.5 feet	
40								

B-42

TEST BOREHOLE: NC7-41

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed		Geologic log	Geologic description	Notes
					G			Logging See NC7-40 Hole location coordinates N427875.0 E1694887.3 Ground elevation Not surveyed Date(s) drilled 3/14/85 Drilling method 4.5" backhoe mounted flight auger Water level First encountered Depth Date None Comments 8 ft. northwest of NC7-40 Neutron probe access tube installed
5								
10								
15								
20							Satellite borehole to NC7-40	
25							TOTAL DEPTH = 20.0 feet	
30								
35								
40								

TEST BOREHOLE: NC7-42

B-44

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed	Geologic log	Geologic description	Notes
5				G			Logging See NC7-40
				B			Hole location coordinates N427884.1 E1694879.5 Ground elevation 1318.0
10				SF			Date(s) drilled 3/14/85
				B			Drilling method 4.5" backhoe mounted flight auger
				G			Water level First encountered Depth Date
				B			None
15				SF			Comments 16 ft. northwest of NC7-40
				B			Lysimeters installed 3/21/85 at 8.5' and 15.2' depths
20						Satellite borehole to NC7-40 TOTAL DEPTH = 20.0 feet	
25							
30							
35							
40							

LOG: MONITORING WELL NC 7-43

Depth (ft)	Drilling & Sampling Log	% Recovery	Tritium (pCi/L)	% H ₂ O	Well Completion	Graphic Log	Geologic description	Notes
0							0-0.25 <u>FILL</u> Gravel and asphalt.	Geologic Logging: D. Carpenter M. Ruggeri Hole Location: Coordinates: N 426,329.1 E 1,696,176.8 Gr. Elev. 1286.3 M.P. Elev. 1291.3 Dates Drilled: 5/7 and 5/14-15/85 Drilling Method: Simco 2800 H.S. auger. On 5/1/85 drilled to 34.8' using 4-1/2" flight auger. sampling as indicated. On 5/14-15/85 hole enlarged to 6" nominal size using hollow-stem augers. sampling as indicated. Augered interval (1) Grab sample taken with hand auger or from auger flights. (2) 1-1/2" split tube sampler Key: Well Completion Cement Grout #0 sand #3 sand 5" potable PVC casing Screen section (0.015" slots) Water Level Data: 5/1/85: Hole dry at 34.25 5/15/85: Water encountered at 45' while drilling 5/15/85: 43' below ground surface at 1500 hours Piezometer installed 5/17/85 screened interval 39.5-49.5'.
0.25-1.0	(1)		2.53E2 (1.1)	20.6			<u>QUATERNARY COLLUVIUM</u> Sandy Clay (CL): Moderate plasticity, about 20% angular rock fragments. Dark brown, dry roots throughout.	
1.0-50.25	(1)						<u>TERTIARY SEDIMENTARY ROCKS</u> 1.0-8.0 Claystone grading to Clayey Siltstone: Variable silt and fine sand content. Light and dark brown, damp to moist.	
8.0-12.0	(1)		3.76E2 (1.1)	19.0			Silty Sandstone: Very fine grained, locally grades to <u>Sandy Siltstone</u> . Dark gray brown, moist.	
12.0-13.5	(1)		4.10E2 (1.1)	17.5			Sandstone: Fine and medium grained, trace of silt. Dark gray brown, dries blue gray, moist.	
13.5-28.0	(1)						Silty Claystone: Variable silt and fine sand content. Mostly hard, cemented. Dark gray brown to dark brown with scattered Fe and Mn oxide stains and traces of caliche, moist.	
28.0-34.25	(1)		3.88E2 (1.1)	19.5				
34.25-40.0	(1)		2.16E2 (1.1)	20.4				
40.0-50.25	(1)							
50.25-55.0	(1)							
22-25	(2)	100					Red brown <u>Claystone</u> interbeds.	Water Level Data: 5/1/85: Hole dry at 34.25 5/15/85: Water encountered at 45' while drilling 5/15/85: 43' below ground surface at 1500 hours Piezometer installed 5/17/85 screened interval 39.5-49.5'.
28-29.5	(2)	100					Sandy Siltstone grading to Silty Sandstone: Sand very fine to medium grained. Very hard, cemented. Dark gray brown, dries blue gray, moist.	
29.5-34.25	(2)	100					Claystone: Hard to very hard. Scattered thin <u>Silty Sandstone</u> interbeds. Dark brown, moist.	
34.25-40.0	(2)	100					Silty Sandstone grading to Sandy Siltstone: Sand fine to medium grained, trace of 1/2" pebbles. Purplish brown, moist.	
40.0-50.25	(2)	100					Claystone: Locally silty with about 10% very fine sand. Moderately hard to hard. Gray to brown with scattered Fe-oxide stains.	
40.0-45.0	(2)	100					Damp to moist.	
45.0-50.25	(2)	100					Saturated. Scattered <u>Siltstone</u> interbeds.	
50.25-55.0	(2)	100						
55.0-60.0	(2)	100						
60.0-65.0	(2)	100						

TD50.25

SOIL SAMPLE DATA

Depth (ft)	Soil ³ H (pCi/l +/- 2 s.d.)	H ₂ O (wt %)
4.8	2.53E2 (1.1E2)	20.6
9.3	3.76E2 (1.1E2)	19.0
14.5	4.10E2 (1.1E2)	17.5
19.3	3.88E2 (1.1E2)	19.5
24.3	2.16E2 (1.1E2)	20.4
34.8	<2.92E2	17.6
40.8	3.36E4 (5.4E2)	19.3
45.5	2.56E5 (2.6E3)	22.1

LOG: MONITORING WELL NC7-44

Depth (ft)	Drilling & Sampling Log*	% Core Recovery	RQD	Well Completion†	Graphic Log	Discontinuity Description	Geologic description	Notes
0								Geologic Logging D. Peifer D. Carpenter
5								Hole Location: West of Building 850
10								Coordinates: N. 426.362.4 E. 1.695.384.1
15								Elevations: M.P. 1354.83 Gr. 1354.7
20								Dates Drilled: 7/17-18/85
25								Detailed Notes:
30								*Key: Drilling and Sampling Log H Air rotary drilled, HQ size (1) 1 1/2" split-spoon sample Run HQ wireline core run, air 9 Air rotary drilled, 9" size (hole enlarged to 9" nominal size, 0-39.5' following completion of coring).
35								†Key: Well Completion Cuttings Grout #0 sand #3 sand 4 1/2" o.d. potable PVC casing Screen section (0.015 slots)
40								Water Level Data: Date Time Depth 7/17/85 1600 Water noted at 38.5' while drilling 7/18/85 0800 30.5' (below gr.)
41.0								

TEST BOREHOLE: NC7-45

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed	Geologic log	Geologic description	Notes
5	4.6*	1.73E2 (1.1)	12.6			0-1.0 - <u>Sandy Clay (CL)</u> - Moderate plasticity, 30% fine to coarse sand, trace of sandstone gravel, 2" max. size, dark brown - dry.	Logging D. Carpenter M. Ruggieri Hole location coordinates N425880.5 E1696762.6 Ground elevation 1180.2 Date(s) drilled 5/1-2/85 5/9/85 Drilling method Simco 2800 H.S. auger and S.S. auger Water level First encountered Depth Date 33' 5/9/85 Comments 5/2/85 - Borehole dry at 25.3'; 5/10/85 - Water at 24.0' below ground surface. * Hand auger sample **1.5" split tube sample Screened interval at 23.0-33.0'.
10	8.9*	2.52E2 (1.1)	11.7	G	G	1.0-3.5 - <u>Silty Sand (SM)</u> - 55% fine and medium sand, trace fine sandstone gravel, 45% non-plastic fines, dark brown - dry to damp.	
15	14.0-15.5**		19.1			3.5-6.5 - <u>Sandy Clay (CL)</u> - Moderate plasticity, 30% fine and medium sand, dark brown - damp.	
20	18.9-20.2**	<4.03E2	23.7	S ₀	S ₀	6.5-19.5 - <u>Sandy Claystone</u> - Poorly lithified, intensely weathered 10-40% fine to medium sand, brown to dark brown with yellow and red brown Fe-oxide stains - damp to moist.	
25	23.8-25.3**	<3.64E2	27.4	S ₃	S ₃	18.9-19.5 - Scattered coarse sand - very moist.	
30	29.2-30.7**	3.26E3 (.24)	21.3	S ₃	S ₃	19.5-20.2 - <u>Clayey Siltstone</u> - Slightly plastic, abundant very fine sand, mottled orange and greenish brown, scattered caliche - moist.	
35	34.0-35.5**	4.46E2 (1.2)	33.4			20.2-24.5 - <u>Sandy Claystone</u> - Increasing fine sand with depth, yellow brown - wet.	
40						24.5-34.2 - <u>Silty Claystone</u> - Up to 20% very fine to medium quartz sand, gray green, scattered caliche veinlets and black Mn-oxide stains.	
						24.5-30.7 - Variably damp to very moist.	
						30.7-34.2 - Saturated, yellow brown and green mottling.	
						34.2-35.5 - <u>Siltstone</u> - About 10% very fine, ashy sand, yellow brown, damp to moist. Scattered 1/4-1" thick interbeds of	

gray-green Claystone; bedding dips 10°.

TOTAL DEPTH = 35.5 feet

TEST BOREHOLE: NC7-46

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed		Geologic log	Geologic description	Notes
5				G	G		0-0.25 - <u>Sandy Silt</u> (ML) - Non-plastic, 40% fine to coarse grained sand, trace sandstone gravel, dark brown, dry, roots.	Logging D. Carpenter M. Ruggieri D. Young Hole location coordinates N426588.7 E1697527.0 Ground elevation 1128.5 Date(s) drilled 5/16-17/85 Drilling method Simco 2800 H.S. auger Water level First encountered Depth Date 24.2' 5/17/85 Comments Water rose to 22.3' below surface **1.5" split tube sample Screened interval at 18.0-28.0'.
10	9.0-9.4**			S ₀	S ₀		0.25-7.0 - <u>Silty Sand</u> (SM) - About 60% fine and medium sand, 30% non-plastic fines, 10% fine sandstone gravel, brown - dry.	
							7.0-9.0 - <u>Sandstone</u> - Hard drilling, cemented, blue-gray - dry.	
							9.0-11.0 - <u>Sandy Siltstone</u> - Purplish brown, dries gray, scattered caliche - damp.	
15	13.9-14.4**	3.00E2 (1.9)	18.8	S ₃	S ₃		11.0-20.0 - <u>Claystone</u> - Purplish brown to blue-gray, well cemented, scattered Fe-oxide stains - damp. Color change to brown, Fe-oxide stains. Color change to blue-gray claystone, plastic, not well cemented.	
20	18.8-19.3**	1.06E3 (.20)	16.4				20.0-21.0 - <u>Sandstone</u> - Medium to fine grained, well sorted, cemented, dark brown - damp.	
							21.0-25.0 - <u>Claystone</u> - Silty, dark brown to blue-gray, 5-10% sand - damp.	
25	23.9-24.3**	2.49E3 (.23)	18.4	S ₃	S ₃		25.0-26.0 - <u>Sandstone</u> - Well sorted, 15-20% silt, dark gray, well cemented, fractured - wet.	
30							26.0-28.0 - <u>Interbedded Claystone and Sandstone</u> - Thin layers no more than 1" thick.	
35							28.0-28.9 - <u>Siltstone</u> - Slightly cemented, 20% sand, 30% clay, dark blue-green - wet.	
40							TOTAL DEPTH = 28.9 feet	

B-48

2

LOG: MONITORING WELL K7-1

LOG: MONITORING WELL K7-2

GEOLOGIC DESCRIPTION (cont.)

132.4-132.9: Sandstone: Coarse grained, gray.

132.9-136.0: Siltstone: Gray, interbeds of sand as above, dips approximately horizontal, hard. # 133.5: No more sand interbeds.

136.0-137.5: Claystone: Light gray. Develops prominent shrinkage cracks and fissility on drying.

137.5-138.0: Sandstone: Medium to coarse grained, gray. 137.5-137.7: White opaline silica cement.

138.0-141.6: Sandy Siltstone: Fine grained sand, gray, hard, interbeds of silty sandstone, fine grained, up to 1/2". Develops fissility on drying.

141.2: Bedding dips 5° average.

141.6-148.5: Sandstone: Coarse grained, light gray, mild HCl reaction. Some pebbles up to 1/4". Core loss zone. Sandstone, coarse grained, light gray. Large 1" voids, HCl reaction.

148.5-158.5: Silty Sandstone: Medium grained, slightly friable, coarsening with depth, beds dip 35°. 149.3-149.4 - 149.8-150.3: Black laminae.

Core loss zone. Sandstone, coarse grained, gray, moderately friable.

158.5-163.5: Sandstone: Coarse grained, dark gray, interbed of claystone 1" thick, gray-green, beds dip about 15°-20°. # 163.1: Some claystone fragments, gray-green.

163.5-167.9: Silty Sandstone: Medium to coarse grained, gray, friable. Scattered black carbonaceous fragments up to 1/4" throughout. Core loss in this material. # 136.6: Black laminae. At bottom contact, 2" thick black carbonaceous layer.

167.9-168.5: Sandy Siltstone: Fine grained, green-gray.

168.5-173.5: No recovery.

173.5-181.0: Sandy Claystone: Green-gray, grading less sandy with depth. Develops shrinkage cracks on drying. Core loss zone.

181.0-183.5: Sandstone: Coarse grained, hard, light gray, solution voids, calcareous cement.

183.5-187.3: Silty Sandstone: Fine grained-grading medium to coarse grained, gray.

185.5: Beds dip about 20°. # 186.0: Sandstone friable, poorly sorted.

187.3-188.1: Sand/Siltstone beds: Fine grained sand, laminated, dip 0°-20°.

188.1-188.5: Sandstone: Coarse grained, gray, hard. Silty matrix, poorly sorted.

188.1 + 188.3: Green clay nodules.

LOG: MONITORING WELL K7-3

SHEET 1 OF 2

LOG: MONITORING WELL K7-3 (continued)

SHEET 2 OF 2

Depth (feet)	Run	Core	Blow Count	Well Completion	Graphic Log	DISCONTINUITY DESCRIPTION	GEOLOGIC DESCRIPTION	RESISTIVITY	NATURAL GAMMA	S. P.	7-7 DENSITY LOG	NOTES
160	Run 13	93	N/A			154.3-154.9: Broken zone.	164.0-164.5: Sandstone: As above, coarse grained, light green, some pyrite blebs.					
160	Run 14	66	N/A				164.5-165.7: Siltstone: Fine grained, green, very friable, mica increasing with depth.					
170	Run 15	90	N/A			167.2: Bedding dips 25°.	165.7-165.9: Siltstone: As above, but darker zone, same texture.					
170	Run 16	82	10	0.5'		170.7-171.2: Joint, dips 60°, splits core, smooth surface.	165.9-167.5: Siltstone: Green with blue-green shale blebs, dark bands define bedding.					
180	Run 17	48	18	0.5'		171.6: Joint or bedding plane, dips 30°, rough surface.	167.5-168.2: Siltstone: Blacker than above, organic chips.					
180	Run 18	14	32	0.45'		177: Core mechanically (?) broken to chips.	168.2-169.5: Shale: Black, very hard and competent. 169.1-169.2: Sandy.					
190	Run 19	0	0				169.5-169.8: Claystone: Dark green-gray.					
190	Run 20	50	25	0.45'			169.8-170.3: Silty Sandstone: Coarse grained, green, easily friable.					
200	Run 21	52	15	0.4'			170.3-171.4: Silty Claystone: Dark green-gray, hard, black shaley interbeds.					
200	Run 22	48	0				171.4-171.9: Silty Sandstone: Medium grained, dark green-gray, friable with strong finger pressure, grades finer and siltier with depth.					
210	Run 23	40	0				171.9-178.4: Silty Sandstone: Fine to coarse grained, green-gray, hard, grades friable and coarser with depth. Core broken up at end of run. Probable core loss in this material. 177.3-177.9: Blebs of clay and green sand.					
210	Run 24	66	31	1.1'			178.0: Sandstone grades very friable, beds dip about 20°.					
220	Run 25	104	73	0.85'			178.4-178.6: Slightly Silty Claystone interbed, dark gray-green.					
220	Run 26	54	7	0.33'			178.6-179.0: Sandstone: Medium grained, white, carbonate cemented with black stringers at contact.					
230	Run 27	26	0	0.25'			179.0-184.0: Core loss in run-unable to determine depths. Claystone at top of core grading to Silty Sandstone, dark green-gray.					
230	Run 28	86	48	0.6'			184-189: No Recovery. Probably Sandstone.					
240	Run 29	80	33	0.92'			189.0-193.1: Sandstone: Medium to coarse grained, green-gray, relatively clean, loose, grades to fine to medium silty sandstone. Probable core loss in this material. #192.6: Silty Clay interbed.					
240	Run 30	88	58	0.8'			193.1-194.1: Sandy Siltstone: Fine grained, grades to Silty Claystone, gray.					
250	Run 31	86	78	1.0'			194.1-194.3: Shale: Black.					
250	Run 32	46	15	0.4'			194.3-195.0: Silty Sandstone: Fine grained, friable with moderate finger pressure. Probable core loss in this material.					
260	Run 33	88	78	1.5'			195.0-199.3: Interbedded Shale and Siltstone, hard, gray, beds dip about 25°.					
260	Run 34	84	10	0.5'			199.3-203.0: Clayey sandstone, fine to medium sand (predominantly fine), dark gray, loose. Probable core loss in this material.					
270	Run 35	98	0				203.0-204.0: Silty Sandstone: Fine grained, gray, friable with difficulty.					
270	Run 36	0	0				204.0-209.0: Silty Sandstone: Gray, friable, becomes coarser and cleaner with depth, bedding plane dips 15°. #208.95: Carbonaceous material in bedding planes. Very friable in bottom 1 ft. of run. 205.0-209.0: Core loss zone.					
280	Run 37	68	23	1.1'			209.0-211.3: Sandstone: As above, bedding dips 10°.					
280	Run 38	60	7	0.3'			211.3-211.7: Claystone: Dark gray.					
290	Run 39	72	17	0.85'			211.7-212.6: Silty Claystone: Fine grained, gray, stringers of brownish organics.					
290	Run 40	0	0				212.6-212.85: Shale: Black, fissile, stringers of black organic material, bed dips about 10°-15°.					
300	Run 41	2	0	0.1'			212.85-213.7: Silty Sandstone: Coarse grained, gray, hard, grades to medium grained toward bottom of run.					
300	Run 42	100	10	0.4'			213.7-216.0: Silty Claystone: Gray, pockets of gray coarse sand up to 2" thick. #213.7: Sharp but wavy contact. 215.2: Bedding plane, dips 50°.					
3040							216.0-217.5: Silty Sandstone: Medium to coarse grained, gray (217.1-217.3, very clean).					
							217.5-218.4: Claystone with pockets of medium to coarse sand, gray, grades sandier with depth.					
							218.4-219.2: Silty Sandstone: Medium to coarse grained, hard, friable.					
							#218.0: Bedding plane, dips 10°.					
							219.2-220.3: Claystone: Gray, becomes sandier with depth.					
							220.3-223.5: Silty Sandstone: Medium to coarse grained, grades finer with depth. Core loss in this material.					
							223.5-231.3: Silty Sandstone: Medium to coarse grained, gray, hard, slightly friable, Claystone interbeds. Coarsens and becomes much cleaner and less friable towards bottom.					
							231.3-232.2: Sandy Siltstone: Fine grained, gray.					
							232.2-233.3: Claystone: Dark gray, grades silty towards bottom, bedding dips 10°-15°.					
							233.3-233.7: Siltstone: As above, gray.					
							233.7-234.2: Claystone: As above, dark gray.					
							234.2-236.7: Sandy Siltstone: Fine grained. 234.4-234.7 and 235.6-236.7: Claystone interbeds.					
							236.7-237.5: Sandy Siltstone: Gray.					
							237.5-239.6: Silty Sandstone: Medium to coarse grained, gray, becomes coarse and clean downward. Scattered pebbles up to 1" at bottom. Bottom contact dips 25°.					
							239.6-242.2: Sandy Siltstone: Fine grained, gray, grades to medium to coarse Silty Sandstone.					
							242.2-244.7: Silty Sandstone: Medium grained, gray, friable. #243.5: Grades to coarse Silty Sandstone.					
							244.2-250.75: Silty Sand: Medium grained, gray, loose unconsolidated. Hardens at 245.5' and below. Coarsening at 246.0', then grading back to medium grained. 246.5-246.7: Claystone interbed, dark gray. 247.1: Carbonaceous stringers. 247.9: Claystone interbed, as above. 248.2: Stringer of red-brown material. 249.3: Carbonaceous bleb.					
							250.4-250.75: Sand becomes friable.					
							250.75-254.1: Dark gray Claystone and Siltstone interbedded, bedding dips about 20° average.					
							254.1-264.2: Sandy Siltstone: Fine grained, gray, hard.					
							264.2-274.0: Silty Claystone: Gray-green, grades to fine Sandy Claystone with depth.					
							269.0-274.0: No core recovery.					
							274.0-277.9: Sandy Claystone: Fine grained, gray. Hard, but broken extensively mechanically and along bedding(?), into 1" segments, dips 10°-20°.					
							277.9-279.0: Claystone: No sand, massive, no fractures.					
							279.0-283.0: Silty Claystone: Dark gray, hard. 279.5-279.8: Sandy Siltstone interbed. 279.8-281.0: Pockets of medium grained Silty Sandstone.					
							283.0-286.0: Silty Sandstone: Medium grained sand, gray, friable with difficulty. #285.0: Grades to fine Silty Sandstone. Broken into segments and fragments. 284.3-284.4: Claystone interbed, gray.					
							286.0-286.6: Very finely interbedded black Shale beds and gray fine to medium Sandstone. Beds dip about 10°. Friable with difficulty on edges of core.					
							286.6-300.0: Poor to no recovery. Probably continued Sandstone as above.					
							#286.6: Silty sandstone, fine to medium grained, gray, very friable.					
							#294.0: Recovered 1" piece of carbonate cemented sandstone.					
							300.0-301.2: Shale: Dark gray-black.					
							301.2-304.0: Claystone: Dark gray, uniform and non-friable. #303.0: Pyrite nodule, 1/4" diameter.					
							304.0: White carbonate cemented Sandstone, one 2" fragment, moderate HCl reaction.					

LOG: MONITORING WELL K7-4

SHEET 1 OF 2

LOG: MONITORING WELL K7-4 (continued)

SHEET 2 OF 2

LOG: MONITORING WELL K7-5

LOG: MONITORING WELL K7-6

LOG: MONITORING WELL K7-7

Depth (ft)	* Drilling Log	** Well Completion	Graphic Log	Geologic Description	Notes												
0				0-10 QUATERNARY ALLUVIAL DEPOSITS 0-5 Sandy Clay (CL-ML) : Low to moderate plasticity, about 30% sand grading finer with depth. Dark brown, 0-0.5 Moist, roots. 0.5-5 Damp. 0-3.5 About 10% volcanic gravel, 2" max. size; locally grades to Clayey Sand (SC).	Geologic Logging: D. W. Carpenter Geophysical Logging: Hole not logged Hole Location: SE of Pit 5 Coordinates: N: 427,470.8 E: 1,695,414.1 Elevation: Gr: 1294.2 M.P.: 1296.50 Dates Drilled: 11/13 -14/84 Detailed Notes: * Key: Drilling Log <div><div></div>Rotary drilled, air, 0-3.5' <div></div>10-3/4" bit <div></div>3.5-21.0 9" bit</div>												
5				5-10 Silty Sand (SM) : Non-plastic, about 5% rounded gravel, 2" max. size. Slightly reddish brown, damp.													
10				10-21.0 TERTIARY SEDIMENTARY ROCKS 10-16 Sandstone : Fine to medium grained, silty, moderately hard in place. Dark brown, dries blue. Moist to very moist. 13-16 Trace of pebbles.													
15				16-19 Interbedded Sandstone and Conglomerate : Sandstone fine to coarse grained. Conglomerate, rounded volcanic pebbles to 1" size in sandstone matrix. Dark brown, wet. 19-20 Sandy Claystone : Poorly lithified, yellow brown to olive, frequent Fe-oxide stains, moist. 20-21 Claystone : Moderately hard. Brown and gray with Fe-oxide stains, wet.	* Key: Well Completion <div><div></div>Cement Grout <div></div>#0 sand <div></div>#3 sand <div></div>5" potable PVC casing <div></div>Screen section (0.015" slots) <div></div>Cuttings</div> Water Level Data: <table><thead><tr><th>Date</th><th>Time</th><th>Depth</th></tr></thead><tbody><tr><td>11/14/84</td><td>0930</td><td>17.1' (open hole, below gr.)</td></tr><tr><td>1/4/85</td><td>—</td><td>19.5 (below M.P.)</td></tr><tr><td>1/29/85</td><td>—</td><td>19.58 (below M.P.)</td></tr></tbody></table>	Date	Time	Depth	11/14/84	0930	17.1' (open hole, below gr.)	1/4/85	—	19.5 (below M.P.)	1/29/85	—	19.58 (below M.P.)
Date	Time	Depth															
11/14/84	0930	17.1' (open hole, below gr.)															
1/4/85	—	19.5 (below M.P.)															
1/29/85	—	19.58 (below M.P.)															
T.D. 21.0'																	

LOG: MONITORING POINT K7-8 and K7-8A

TEST BOREHOLE: NC2-1

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed	Geologic log	Geologic description	Notes
5	5.0	4.88E2 (2.1)	13.7			0-6.5 - <u>Clayey Silt</u> (ML) dark brown, 20% gravels, 1-2" diameter angular. Well rounded gravels. 6.5-7.0 - <u>Claystone</u> (CL) gray to brown, well cemented, slightly shallow. TOTAL DEPTH = 7.0 feet	Logging B. Qualheim Hole location coordinates N427184.8 E1698963.3 Ground elevation 1048.92 Date(s) drilled 8/23/81 Drilling method Backhoe 12" flight auger Water level First encountered Depth Date None Comments Unable to drill deeper due to rejection. Refilled borehole with cuttings.
10							
15							
20							
25							
30							
35							
40							

B-60

TEST BOREHOLE: NC2-2

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument Installed	Geologic log	Geologic description	Notes
5	5.0	1.90E2 (1.9)	11.4	G		0-15.0 - <u>Clayey Silt</u> (ML) dark brown, 30% gravels, 1-2" diameter.	Logging B. Qualheim
	7.0	5.80E2 (2.1)	14.9	C		10% gravels, very plastic, 20% clays, very silty.	Hole location coordinates N427625.1 E1698348.6
10	9.3	7.23E2 (2.1)	13.2	B		40% gravels; brown, 10% gravels.	Ground elevation 1064.8
				SC			
15	15.0	2.34E3 (.21)	14.0	SF		TOTAL DEPTH = 15 feet	Date(s) drilled 8/23/84
20							Drilling method Backhoe 12" flight auger
25							Water level First encountered Depth Date None
30							Comments Lysimeter installed 8/30/84
35							Lysimeter cup at 14.5' depth
40							

TEST BOREHOLE: NC2-3

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument installed	Geologic log	Geologic description	Notes
5	5.0	1.95E2 (2.0)	16.2	G		0-14.83 - <u>layey Silt</u> (ML) dark brown, some pe les. Minor gravels, slightly plastic.	Logging B. Qualheim
10	9.5	2.85E2 (2.0)	17.6	C		10% gravels, 1-2" diameter.	Hole location coordinates N427629.7 E1698350.7 Ground elevation 1064.3
15	9.5	9.70E3 (.34)	14.8	B		TOTAL DEPTH = 14.8 feet	Date(s) drilled 8/23/84
				SC			Drilling method Backhoe 12" flight auger
				SF			Water level First encountered Depth Date None
20							Comments Lysimeter installed 8/30/84
25							Lysimeter cup at 14.5' depth
30							
35							
40							

TEST BOREHOLE: NC2-4

Depth (ft)	Sample depth	Tritium (pCi/L)	% H ₂ O	Instrument Installed		Geologic log	Geologic description	Notes
5	5.5	3.09E4 (.053)	9.5		G		0-14.0 - <u>Clayey Silt</u> (ML) dark brown, 30% angular to subrounded gravel, 1-2" diameter, slightly damp. 14.0-15.0 - <u>Sandy Silt, Clayey Silt, and Gravel Interbedded</u> dark brown, gravel 1-2" size, wet. TOTAL DEPTH = 15.0 feet	Logging B. Qualheim Hole location coordinates N426957.9 E1698134.6 Ground elevation 1087.3 Date(s) drilled 8/23/84 Drilling method Backhoe 12" flight auger Water level First encountered Depth Date None Comments Lysimeter installed 8/30/84 Lysimeter cup at 15.0' depth
					C			
					B			
					SC			
10	9.7	7.13E4 (.078)	10.9		SF			
15	15.0	1.29E5 (.010)	15.8					
20								
25								
30								
35								
40								

B-63

LOG: MONITORING WELL NC2-5

LOG: MONITORING WELL K2-1

SHEET 1 OF 2

LOG: MONITORING WELL K2-1(continued)

SHEET 2 OF 2

LOG: MONITORING WELL K2-2

SHEET 1 OF 2

LOG: MONITORING WELL K2-2 (continued)

SHEET 2 OF 2

					DISCONTINUITY DESCRIPTION	GEOLOGIC DESCRIPTION						
					NO SAMPLE RECOVERED. Drilled very fast. 156.8-157.0: Faint blue line describing plane. Dip 70°, ends within core. 157.0: Fracture, dip 100°. Probably mechanical; 157.8: Joint, dip 50°, rough. 158.1: Joint, dip 300°, rough; 158.25: Joint, dip 250°, rough; 158.4: Joint, dip 300°, rough. 158.6: Fracture, dip 150°. 159-159.2: Highly broken along horizontal mechanical breaks. 159.3-159.4: Rough fracture, avg. dip 30°, probably mechanical. 159.75-161.0: Core loss due to plugged core barrel.	93.7-99.3: Claystone: Greenish-grey, massive, black carbonaceous fragments; develops shrinkage cracks on drying. CORE LOSS BELOW 95.5 per driller. Highly slickensided internally, not on fractures. #97.5-99.3: Represented by 0.5' highly fractured claystone. (Possible Fault zone). 99.3-102.25: Poorly sorted Sandstone: Fine-coarse w/occasional 1/4" angular clasts, greenish-grey w/2" black carbonaceous mottling; slight reaction w/HCl @100.9. Trace coarse sand-sized red chert. 102.25-102.5: Claystone: Greenish-grey w/black carbonaceous fragments + shrinkage clast. Very slight HCl reaction. 102.5-103.6: Caving material? Crushed + broken greenish-grey Claystone. (Possible Fault). 103.6-106.8: Sandy Claystone: Greenish-grey, as # 102.25-102.5; 1/4" fragments crush w/strong finger pressure. Scrapings work to clayey silt. 104.5-104.8: Caving material? Crushed + broken greenish-grey claystone. 106.8-110.0: Clayey Sandstone: Fine-medium grained w/occasional coarse angular clasts. Greenish grey w/black carbonaceous mottling; finer grained below 108.0. #110.0: Swirled bedding plane, avg. dip 150°. 110.0-118.65: Sandstone: Becoming coarser + more friable. Breaks w/moderate hammer blow. Black, dries dark to light grey. Dark grey non-calcareous, light grey highly calcareous. Varies fine to coarse grain size. #115.1-115.8: Increased clay content w/abundant white opaline angular fragments. No HCl reaction. #116.7-116.8 + 116.9-117.0: Beds of clay shale, dip 100°. #117.1-118.1: Medium to coarse Sandstone, friable, appears permeable. #118.1: 1/4" chert fragment. 118.65-149.0: Clean, medium-coarse Sandstone: Poorly-sorted w/angular chert, shale and tuffaceous gravel clasts; max. 1-1/2". Dark grey, dries light grey, local clayey zones to 1/2". No HCl reaction, bedding plane dips 120°, friable. #125: Medium-coarse, very friable, clean sandstone. Poorly sorted, 1/2" sub-angular gravel clasts. #140: Recovered 0.5' of medium-coarse sand, clean, friable sandstone as above, 1/2" diameter rounded pebbles. #143: Brown mud return to surface (claystone interbed?). #145-149: Recovered 1' of very friable, medium sandstone. Occasional siltstone clasts up to 1". 149.0-156: Harder, coarse Sandstone with 1/2" rounded pebbles. Calcareous, friable, increasing carbonate downward; grey, becomes lighter downward. 156-157: Sandstone: Black, medium-grained + friable. Clean, well-sorted. Some pyrite dries bluish-grey. 157-159.3: Fine, sandy Claystone: Greenish-black with thin white stringers, non-reactive w/HCl. Slight shrinkage cracking on drying. 159.3-159.75: Silty Sandstone: Fine-medium grained. Dark grey, dries light green-grey. FRIABLE. 159.75-161.0: No recovery.						

LOG: MONITORING WELL K2-3

LOG: MONITORING WELL K2-4

SHEET 1 OF 2

LOG: MONITORING WELL K2-4

SHEET 2 OF 2

APPENDIX C: TRITIUM PROCESSING AND ANALYTICAL METHODS

The sample processing and analytical methods used are in general identical to or derived from those employed in LLNL's Environmental Quality Verification Program (EQVP). The laboratory procedures, standardization and intercalibration, and quality assurance methods are described in detail in an appendix to an earlier report¹ by Griggs, Gonzalez, and Buddemeier. The descriptions that follow are an overview of the general methods used.

SAMPLING PROCESSING

Moisture is extracted from soil and vegetation samples by freeze-drying. The frozen sample is weighed, placed in a vacuum flask, attached to a trap line, and evacuated.

Vegetation samples are held under vacuum (with cryogenic trapping of the sublimed water) for 3 to 4 days at room temperature. Soil samples may be treated in the same fashion, but are more often processed for 1 day at room temperature followed by 1 day at 100°C to 125°C. Studies have shown that either procedure gives the same values for both tritium activity and moisture content. The same studies show that moisture content values obtained by this method approximate those found by oven drying, the standard soil analysis technique.

Water samples are generally untreated prior to analysis. If samples are extremely turbid, they are passed through a 0.45- μ m filter.

TRITIUM ANALYSIS

All water samples are analyzed by liquid scintillation counting. The laboratory has one Packard Tri-Carb LSC counter and two Beckman 9800 counters dedicated to low-level environmental determinations. The systems are calibrated against each other and the laboratory participates in EPA and DOE inter-laboratory calibration programs. Samples are counted in sets containing appropriate blanks and quench standards. In a normal determination, each sample is counted for four 50-min periods. The activity reported is the average over all counting periods ± 2 std dev based on counting statistics. When the uncertainty (2 std dev) is greater than 100% of the calculated

activity, the result is reported as $<(\text{activity} + 2 \text{ std dev})$. When the calculated activity is $\leq$ background, the value is assumed to be $<4 \times \text{std dev of background}$. These values are in some cases reported as limit of sensitivity (LOS), which is approximately 200 to 300 pCi/l for a normal counting set.

Some of the "reconnaissance" samples (shallow soil, vegetation, and surface water) reported in Appendix D were counted for a single period and a shorter total time and therefore have a higher uncertainty or limit of detection than normally achieved by the standard analytical method.

EQVP water samples are analyzed using electrolytic enrichment techniques that provide considerably higher sensitivity, but are quite time consuming. Because the detection limit for unenriched counting is approximately at the upper end of the activity range for uncontaminated environmental water samples, we consider these procedures satisfactory for the purposes of the present study.

CONTAMINATION AND SAMPLE INTEGRITY

The methods employed have all been demonstrated to provide adequate sample protection over the range of activities normally found in EQVP samples (0 to 10,000 pCi/l).

However, the present study encounters samples spanning six orders of magnitude (0 to 1,000,000 pCi/l) with localized and relatively unpredictable hot spots. Because of this, low levels of cross-contamination in the field, particularly in initial soil and water sampling operations, cannot be rigorously excluded. We therefore recommend that small differences in activity and very low levels of "contamination" (several hundred to a few thousand pCi/l) be regarded as suspect until verified by repeated sampling or by comparison with a credible model.

REFERENCES

1. K. S. Griggs, M. A. Gonzalez, and Robert W. Buddemeier, Environmental Monitoring at the Lawrence Livermore Laboratory 1982 Annual Report, Lawrence Livermore National Laboratory, Livermore, CA, UCRL-50027-82 (1983).

APPENDIX D: TRITIUM IN SHALLOW SOIL, VEGETATION, AND SURFACE WATER

Appendix D presents the results of reconnaissance sampling of vegetation, soil, and surface water. Vegetation and soil sampling procedures were previously described in Appendix A; sample storage, processing, and analytical procedures were described in Appendix C.

All soil samples described in this appendix were collected with a hand-operated bucket auger after an initial hole was dug by hand (1-ft to 3-ft sample depth) or augered with a backhoe-mounted flight auger (5-ft to 7-ft sample depth).

Water samples are grab samples collected from water standing or flowing in drainage channels or streambeds close to or downstream from suspected tritium sources.

Table D1. Tritium activity in samples of shallow soil from Site 300.

Key ^a	Pit #	Location	Depth (ft)	Sampling Date	Tritium	
					pCi/l	pCi/l
1	1	1	1.3	7/18/84	<6.80E2	-
2	1	2	2.0	7/18/84	<BKGD	N/A
3	2	1	2.0	7/18/84	<BKGD	N/A
4	2	2	2.3	7/18/84	<5.50E2	-
5	3	1	2.0	7/18/84	4.48E5	3.80E3
6	3	2	2.0	7/18/84	5.29E3	5.20E2
7	3	3	2.0	7/18/84	4.72E3	5.00E2
8	5	1	1.8	7/18/84	1.91E3	4.00E2
9	5	2	2.5	7/18/84	1.08E3	3.80E2
10	5	3	2.0	7/18/84	1.56E3	4.00E2
11	7	2	2.5	7/18/84	<4.90E2	-
12	7	4	2.0	7/18/84	<BKGD	N/A
13	B850	15	1.2	1/29/85	3.96E3	2.50E2
14	B850	16	1.0	1/29/85	2.80E4	4.90E2
15	B850	17	1.0	1/29/85	6.54E3	2.90E2
16	B850	18	2.2	1/29/85	2.09E5	2.10E3
17	B850	19	2.0	1/29/85	1.77E4	4.10E2
18	B850	22	1.0	1/29/85	1.15E3	2.00E2
19	B850	23	1.3	1/29/85	2.18E3	2.20E2
20	2	SS1	5.2	8/22/85	<4.02E2	N/A
21	2	SS2	4.7	8/22/85	<3.69E2	N/A
22	2	SS3	5.9	8/22/85	1.90E3	2.30E2
23	DR ^b	SS4	6.0	8/22/85	1.10E5	1.10E3
24	DR ^b	SS5	5.8	8/22/85	1.03E5	1.10E3
25	DR ^b	SS6	5.3	8/22/85	3.28E4	5.40E2
26	SPR ^c	SS7	6.5	8/22/85	3.51E4	5.60E2
27	B850	SS8	6.5	8/22/85	1.90E3	2.30E2
28	B850	SS9	6.6	8/23/85	8.81E3	3.30E2
29	B850	SS10	6.0	8/23/85	1.15E4	3.50E2
30	B850	SS11	6.1	8/23/85	8.06E3	3.10E2
31	B850	SS12	6.0	8/26/85	1.35E4	3.50E2
32	B850	SS13	5.9	8/26/85	1.38E5	1.40E3
33	B850	SS14	5.9	8/26/85	1.18E3	2.20E2
34	B850	SS15	6.1	8/26/85	3.16E3	2.50E2
35	B850	SS16	6.5	8/26/85	5.03E3	2.70E2
36	B850	SS17	6.0	8/26/85	2.23E3	2.50E2
37	B850	SS18	6.5	8/26/85	9.68E3	3.30E2

^aKey to sampling locations shown on Figure 6.^bDuall Road.^cWell #8 Spring.

Table D2. Tritium activity in samples of vegetation from Site 300.

Key ^a	Pit #	Location	Sampling Date	Tritium	
				pCi/l	pCi/l
1	1	1	7/18/84	1.44E3	4.00E2
2	1	2	7/18/84	3.71E2	3.50E2
3	2	2	7/18/84	3.57E2	3.50E2
4	2	3	7/18/84	<6.20E2	-
5	2	4	7/18/84	1.96E4	8.40E2
6	3	1	7/18/84	6.89E6	1.40E4
7	3	2	7/18/84	1.77E6	7.20E3
8	3	3	7/18/84	6.05E5	4.20E3
9	3	4	8/22/84	1.42E6	7.10E2
10	3	5	8/22/84	5.02E3	1.90E2
11	4	1	7/18/84	2.77E4	1.00E3
12	4	2	8/22/84	<2.60E2	-
13	5	1	7/18/84	1.72E6	7.20E3
14	5	3	7/18/84	2.59E6	9.40E2
15	5	4	8/22/84	2.44E3	1.60E2
16	5	5	8/22/84	<2.60E2	-
17	5	6	8/22/84	3.76E2	1.30E2
18	5	7	8/22/84	1.55E2	1.20E2
19	7	1	7/18/84	3.79E2	3.50E2
20	7	1	7/18/84	1.59E3	4.00E2
21	7	3	7/18/84	1.26E3	3.90E2
22	B850	1	8/22/84	1.24E4	2.60E2
23	B850	2	8/22/84	1.01E4	2.30E2
24	B850	3	8/22/84	4.39E2	1.30E2
25	B850	4	8/22/84	6.88E3	2.10E2
26	B850	5	8/22/84	1.63E2	1.30E2
27	B850	6	8/22/84	7.57E2	1.30E2
28	B850	7	1/24/85	3.09E2	1.80E2
29	B850	8	1/24/85	6.18E2	2.00E2
30	B850	9	1/24/85	1.60E3	2.10E2
31	B850	10	1/24/85	4.21E2	2.00E2
32	B850	11	1/24/85	4.50E2	1.90E2
33	B850	12	1/24/85	3.83E2	1.90E2
34	B850	13	1/24/85	1.52E3	2.10E2
35	B850	14	1/24/85	3.51E3	1.90E2
36	B850	15	1/29/85	9.24E3	3.20E2
37	B850	16	1/29/85	4.68E3	2.60E2
38	B850	17	1/29/85	4.14E4	5.90E2
39	B850	18	1/29/85	1.23E4	3.60E2
40	B850	19	1/29/85	5.66E3	2.70E2
41	B850	20	1/29/85	<4.10E2	-
42	B850	21	1/29/85	<3.50E2	-

^aKey to sampling locations shown on Figure 7.

Table D3. Tritium activity in samples of surface water from Site 300.

Key ^a	Location	Sampling Date	Tritium		Source
			pCi/l	<u>±</u>	pCi/l
_b	21	1/18/85	<2.36E2	-	spring
_b	21	2/ 8/85	<2.15E2	-	spring
_b	20	1/18/85	2.18E2	-	spring
_b	B851	1/18/85	2.53E2	-	standpipe
1	A	9/26/84	<2.12E2	-	seepage
2	B	2/11/85	<3.17E2	-	culvert
3	C	2/11/85	<4.19E2	-	culvert
4	D	2/11/85	LOS ^c	-	ditch
5	E	2/11/85	<3.09E2	-	puddle
6 ^d	F	2/11/85	<1.88E2	-	streamflow
7	G	7/18/84	<4.20E2	-	streamflow
8	G	2/11/85	<2.45E2	-	streamflow

^aKey to sampling locations shown on Figure 7.

^bShown in Figure 5.

^cLOS (limit of sensitivity); indistinguishable from background, probably <200 pCi/l.

^dNear M83; See Plate 1.

APPENDIX E: Water Elevation and Tritium Results

These individual data sheets for each installation routinely sampled combine basic information about the installation with an easily updated chronological record of water sample tritium activities and water table elevations. For convenience, sheets are included for the pre-existing (K-series) monitoring wells as well as for the installations completed since the beginning of the present project (NC-series).

Tritium activities are reported in exponential notation (e.g., $3.1\text{E}3 = 3.1 \times 10^3$ or 3,100 pCi/l). The forms contain the results from the analysis of all samples collected through the first week of October 1985.

The following keys are used in the Notes column on the individual data sheets:

- EM equipment malfunction
- WR well recovering from prior pumping
- HC Hazard Control analysis
- NC no sample collected

WATER DATA

Borehole: NC7-1

Date Drilled: 8/22/84

Completed: 8/29/84

Installation: Lysimeter

Depths: TD = 15.1'

Sampled interval: 15.0'

Location: N428193.7 E1694339.4

Ground Elevation: 1361.4'

Casing Elevation: N/A

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
12/18/84	-	-	Flush
01/04/85	-	-	Flush
01/14/85	-	-	Flush
01/22/85	8.08E3 (3.1E2)	-	Sampled
03/01/85	7.16E3 (3.0E2)	-	Sampled
03/29/85	7.21E3 (3.0E2)	-	Sampled
05/03/85	7.06E3 (3.0E2)	-	Sampled
05/29/85	6.86E3 (3.0E2)	-	Sampled
06/24/85	6.91E3 (3.0E2)	-	Sampled
07/25/85	7.01E3 (3.1E2)	-	Sampled
08/29/85	6.71E3 (3.0E2)	-	Sampled
10/04/85	6.80E3 (2.9E2)	-	Sampled

WATER DATA

Borehole: NC7-2

Date Drilled: 8/22/84

Completed: 8/29/84

Installation: Lysimeter

Depths: TD = 15.0'

Sampled interval: 15.0'

Location: N428238.3 E1694410.9

Ground Elevation: 1356.92'

Casing Elevation: N/A

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
12/18/84	-	-	Flush
01/04/85	-	-	Flush
01/14/85	-	-	Flush
01/22/85	6.12E3 (2.9E2)	-	Sampled
03/01/85	5.23E3 (2.8E2)	-	Sampled
03/29/85	7.20E3 (3.0E2)	-	Sampled
05/03/85	5.25E3 (2.8E2)	-	Sampled
05/29/85	4.99E3 (2.7E2)	-	Sampled
06/24/85	5.33E3 (2.8E2)	-	Sampled
07/25/85	5.16E3 (2.8E2)	-	Sampled
08/28/85	-	-	NS
10/04/85	5.42E3 (2.8E2)	-	Sampled

WATER DATA

Borehole: NC7-3

Date Drilled: 8/22/84

Completed: 8/29/84

Installation: Lysimeter

Depths: TD = 15.0'

Sampled interval: 15.0'

Location: N428283.5 E1694493.6

Ground Elevation: 1346.5'

Casing Elevation: N/A

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
12/18/85	-	-	Flush
01/04/85	-	-	Flush
01/14/85	-	-	Flush
01/22/85	5.58E4 (6.9E2)	-	Sampled
03/01/85	5.37E4 (6.7E2)	-	Sampled
03/29/85	5.32E4 (6.6E2)	-	Sampled
05/03/85	-	-	NS
06/24/85	-	-	NS
07/25/85	-	-	NS
08/28/85	-	-	NS
10/04/85	-	-	NS

WATER DATA

Borehole: NC7-4

Date Drilled: 8/22/84

Completed: 8/29/84

Installation: Lysimeter

Depths: TD = 15.0'

Sampled interval: 15.0'

Location: N428124.5 E1694384.2

Ground Elevation: 1361.3'

Casing Elevation: N/A

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
12/18/84	-	-	Flush
01/04/85	-	-	Flush
01/14/85	-	-	Flush
01/22/85	6.38E2 (1.9E2)	-	Sampled
03/01/85	4.68E2 (1.9E2)	-	Sampled
03/29/85	5.10E2 (1.9E2)	-	Sampled
05/03/85	5.38E2 (1.9E2)	-	Sampled
06/24/85	4.04E2 (1.9E2)	-	Sampled
07/25/85	5.60E2 (2.0E2)	-	Sampled
08/29/85	3.74E2 (2.1E2)	-	Sampled
10/04/85	-	-	NS

WATER DATA

Borehole: NC7-5A

Date Drilled: 9/12/84

Completed: 9/17/84

Installation: Lysimeter

Depths: TD = 16.2'

Sampled interval: 15.6'

Location: N428174.1 E1694315.0

Ground Elevation: 1365.2'

Casing Elevation: N/A

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
12/18/84	-	-	Flush
01/04/85	-	-	Flush
01/14/85	-	-	Flush
01/22/85	4.70E2 (2.1E2)	-	Sampled
03/01/85	2.10E2 (1.8E2)	-	Sampled
03/29/85	2.76E2 (1.8E2)	-	Sampled
05/03/85	<3.47E2	-	Sampled
05/29/85	2.07E2 (1.7E2)	-	Sampled
06/24/85	<3.65E2	-	Sampled
07/25/85	<2.97E2	-	Sampled
08/29/85	2.44E2 (2.2E2)	-	Sampled
10/04/85	1.81E2 (1.8E2)	-	Sampled

WATER DATA

Borehole: NC7-6

Date Drilled: 9/12/84

Completed: 9/17/84

Installation: Lysimeter

Depths: TD = 21.0'

Sampled interval: 20.0'

Location: N427741.1 E1694961.8

Ground Elevation: 1315.7'

Casing Elevation: N/A

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
12/18/84	3.93E4 (5.9E2)	-	Sampled
01/04/85	-	-	Flush
01/14/85	-	-	Flush
01/22/85	4.63E4 (6.2E2)	-	Sampled
03/01/85	4.93E4 (6.4E2)	-	Sampled
03/29/85	4.82E4 (6.3E2)	-	Sampled
05/03/85	4.54E4 (6.2E2)	-	Sampled
05/29/85	4.39E4 (6.0E2)	-	Sampled
06/24/85	4.07E4 (5.9E2)	-	Sampled
07/25/85	4.11E4 (6.1E2)	-	Sampled
08/29/85	4.21E4 (6.2E2)	-	Sampled
10/04/85	4.00E4 (6.1E2)	-	Sampled

WATER DATA

Borehole: NC7-7

Date Drilled: 9/12/84

Completed: 9/17/84

Installation: Lysimeter

Depths: TD = 16'

Sampled interval: 15.6'

Location: N428163.6 E1694657.3

Ground Elevation: 1335.0'

Casing Elevation: N/A

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H</u> <u>(pCi/l +/- 2 s.d.)</u>	<u>Water Elev.</u> <u>(ft)</u>	<u>Notes</u>
12/18/84	-	-	Flush
01/04/85	-	-	Flush
01/14/85	-	-	Flush
01/22/85	1.03E5 (1.1E3)	-	Sampled
03/01/85	9.93E4 (1.0E3)	-	Sampled
03/29/85	9.60E4 (9.9E2)	-	Sampled
05/03/85	9.95E4 (1.0E3)	-	Sampled
05/29/85	9.61E4 (9.9E2)	-	Sampled
06/24/85	1.01E5 (1.0E3)	-	Sampled
07/25/85	1.03E5 (1.1E3)	-	Sampled
08/29/85	1.01E5 (1.1E3)	-	Sampled
10/04/85	9.96E4 (1.0E3)	-	Sampled

WATER DATA

Borehole: NC7-8

Date Drilled: 9/12/84

Completed: 9/17/84

Installation: Lysimeter

Depths: TD = 15.5'

Sampled interval: 15.5'

Location: N427860.4 E1694973.0

Ground Elevation: 1314.2'

Casing Elevation: N/A

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
12/18/84	-	-	Flush
01/04/85	-	-	Flush
01/14/85	-	-	Flush
01/22/85	1.74E5 (1.8E3)	-	Sampled
03/01/85	1.67E5 (1.7E3)	-	Sampled
03/29/85	1.67E5 (1.7E3)	-	Sampled
05/03/85	1.63E5 (1.7E3)	-	Sampled
05/29/85	1.64E5 (1.7E3)	-	Sampled
06/24/85	-	-	NS
07/25/85	-	-	NS
08/29/85	1.67E5 (1.7E3)	-	Sampled
10/04/85	-	-	NS

WATER DATA

Borehole: NC7-9

Date Drilled: 9/18/84

Completed: 9/26/84

Installation: Lysimeter

Depths: TD = 20.6'

Sampled interval: 20.5'

Location: N426432.7 E1696037.4

Ground Elevation: 1292.3'

Casing Elevation: N/A

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H</u> <u>(pCi/l +/- 2 s.d.)</u>	<u>Water Elev.</u> <u>(ft)</u>	<u>Notes</u>
12/18/84	-	-	Flush
01/04/85	-	-	Flush
01/14/85	-	-	Flush
01/15/85	1.86E4 (4.3E2)	-	Sampled
01/22/85	2.06E4 (4.7E2)	-	Sampled
03/01/85	1.99E4 (4.5E2)	-	Sampled
03/29/85	1.46E4 (4.0E2)	-	Sampled
05/03/85	1.38E4 (3.9E2)	-	Sampled
05/29/85	1.60E4 (4.1E2)	-	Sampled
06/24/85	1.84E4 (4.3E2)	-	Sampled
07/25/85	2.23E4 (4.7E2)	-	Sampled
08/29/85	2.32E4 (4.6E2)	-	Sampled
10/04/85	2.48E4 (4.8E2)	-	Sampled

WATER DATA

Borehole: NC7-10

Date Drilled: 9/18/84, 10/22/84

Completed: 10/23/84

Installation: Piezometer

Depths: TD = 15.5'

Sampled interval: 5.0-15.0'

Location: N426309.9 E1696490.5

Ground Elevation: 1221.5'

Casing Elevation: 1225.0'

Remarks:

Monitoring Record

Date	Water ³ H (pCi/l +/- 2 s.d.)	Water Elev. (ft)	Notes
09/26/84	4.71E5 (1.9E3)	-	-
10/22/84	4.64E5 (2.3E3)	-	-
11/02/84	4.67E5 (4.7E3)	-	-
11/13/84	-	1215.3	-
12/07/84	4.61E5 (4.6E3)	-	-
12/11/84	4.52E5	-	-
01/04/85	-	1216.3	-
01/22/85	4.63E5 (4.7E3)	1216.3	-
01/29/85	-	1216.3	-
02/05/85	-	1216.2	-
02/13/85	-	1216.2	-
02/20/85	-	1216.1	-
02/28/85	4.38E5 (4.4E3)	1216.3	-
03/08/85	-	1215.6	-
03/15/85	-	1215.6	-
03/21/85	-	1215.6	-
03/28/85	4.41E5 (4.4E3)	1215.6	-
04/04/85	-	1215.6	-
04/09/85	-	1215.6	-
04/17/85	-	1215.7	-
04/26/85	-	1215.6	-
05/03/85	4.24E5 (4.3E3)	1215.6	-
05/10/85	-	1215.5	-
05/16/85	-	1215.5	-
05/24/85	-	1216.0	-
05/26/85	4.04E5 (4.1E3)	-	-

05/28/85	-	1216.0	-
06/06/85	-	1215.9	-
06/19/85	-	1215.9	-
06/22/85	4.12E5 (4.1E3)	-	-
06/25/85	-	1215.9	-
07/24/85	4.19E5 (4.2E3)	1215.9	-
08/29/85	3.87E5 (3.9E3)	1216.1	-
10/04/85	3.78E5 (3.8E3)	1216.0	-

WATER DATA

Borehole: NC7-11

Date Drilled: 9/18/84, 10/22/84

Completed: 10/22/84

Installation: Piezometer

Depths: TD = 19.8'

Sampled interval: 9.5-19.5'

Location: N426502.4 E1696376.5

Ground Elevation: 1240.9'

Casing Elevation: 1244.0'

Remarks:

Monitoring Record

Date	Water ³ H (pCi/l +/- 2 s.d.)	Water Elev. (ft)	Notes
09/26/84	3.86E4 (3.9E2)	-	-
10/22/84	3.85E4 (5.8E2)	-	-
11/02/84	5.36E4 (6.6E2)	-	-
11/13/84	-	1225.0	-
12/07/84	6.85E4 (7.5E2)	-	-
12/11/84	6.70E4	-	-
01/04/85	-	1225.2	-
01/22/85	6.48E4 (7.4E2)	1225.1	-
01/29/85	-	1225.0	-
02/05/85	-	1224.9	-
02/13/85	-	1225.1	-
02/20/85	-	1224.7	-
02/28/85	7.43E4 (7.8E2)	1224.6	-
03/08/85	-	1224.7	-
03/15/85	-	1224.7	-
03/21/85	-	1224.7	-
03/28/85	8.05E4 (8.4E2)	1224.9	-
04/04/85	-	1224.8	-
04/09/85	-	1224.7	-
04/17/85	-	1224.6	-
04/26/85	-	1224.6	-
05/03/85	8.68E4 (9.0E2)	1224.5	-
05/10/85	-	1224.5	-
05/16/85	-	1224.5	-
05/24/85	-	1224.4	-
05/26/85	9.25E4 (9.6E2)	-	-

05/28/85	-	1224.4	-
06/06/85	-	1224.3	-
06/19/85	-	1224.3	-
06/22/85	1.09E5 (1.1E3)	-	-
06/25/85	-	1224.2	-
07/24/85	1.20E5 (1.2E3)	1224.1	-
08/29/85	1.28E5 (1.3E3)	1224.5	-
10/04/85	1.39E5 (1.4E3)	1224.4	-

WATER DATA

Borehole: NC7-12

Date Drilled: 9/18/84, 10/18/84

Completed: 10/18/84

Installation: Piezometer

Depths: TD = 26.8'

Sampled interval: 16.0-26.0'

Location: N427240.4 E1695627.1

Ground Elevation: 1282.5'

Casing Elevation: 1285.5'

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
09/26/84	1.47E5 (8.8E2)	-	-
11/02/84	5.36E4 (6.6E2)	-	-
11/13/84	-	1270.3	-
12/07/84	5.94E4 (7.1E2)	-	-
12/11/84	5.93E4	-	-
01/04/85	-	1266.1	-
01/22/85	3.02E4 (5.2E2)	1265.8	-
01/29/85	-	1265.8	-
02/05/85	-	1265.9	-
02/13/85	-	1266.1	-
02/20/85	-	1265.7	-
02/28/85	2.54E4 (4.8E2)	1265.6	-
03/08/85	-	1265.5	-
03/15/85	-	1265.5	-
03/21/85	-	1265.5	-
03/28/85	2.58E4 (4.8E2)	1265.5	-
04/04/85	-	1265.5	-
04/09/85	-	1265.4	-
04/17/85	-	1265.3	-
04/26/85	-	1265.3	-
05/03/85	2.64E4 (4.9E2)	1265.2	-
05/10/85	-	1265.2	-
05/16/85	-	1265.1	-
05/24/85	-	1265.0	-
05/26/85	2.47E4 (4.7E2)	-	-
05/28/85	-	1265.0	-

06/06/85	-	1265.0	-
06/19/85	-	1264.9	-
06/22/85	2.15E4 (4.5E2)	-	-
06/25/85	-	1264.8	-
07/24/85	2.16E4 (4.5E2)	1264.7	-
08/28/85	2.15E4 (4.5E2)	1264.7	-
10/04/85	2.21E4 (4.5E2)	1264.5	-

WATER DATA

Borehole: NC7-13

Date Drilled: 9/18/84

Completed: 9/26/84

Installation: Lysimeter

Depths: TD = 20.5'

Sampled interval: 19.8'

Location: N428449.9 E1694486.1

Ground Elevation: 1347.6'

Casing Elevation: N/A

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H</u> <u>(pCi/l +/- 2 s.d.)</u>	<u>Water Elev.</u> <u>(ft)</u>	<u>Notes</u>
01/04/85	-	-	Flush
01/14/85	-	-	Flush
01/22/85	7.81E6 (7.5E4)	-	Sampled
03/01/85	7.58E6 (7.4E4)	-	Sampled
03/29/85	7.54E6 (7.3E4)	-	Sampled
05/03/85	7.51E6 (7.3E4)	-	Sampled
05/29/85	7.33E6 (7.1E4)	-	Sampled
06/24/85	7.47E6 (7.4E4)	-	Sampled
07/25/85	7.75E6 (7.6E4)	-	Sampled
08/29/85	7.49E6 (7.3E4)	-	Sampled
10/04/85	7.38E6 (7.3E4)	-	Sampled

WATER DATA

Borehole: NC7-14

Date Drilled: 10/5/84, 10/22/84

Completed: 10/22/84

Installation: Piezometer

Depths: TD = 27.0'

Sampled interval: 16.5-26.5'

Location: N426653.3 E1696283.4

Ground Elevation: 1253.9'

Casing Elevation: 1256.9'

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H</u> <u>(pCi/l +/- 2 s.d.)</u>	<u>Water Elev.</u> <u>(ft)</u>	<u>Notes</u>
11/13/84	-	1229.4	-
12/07/84	1.12E4 (3.9E2)	-	-
12/11/84	1.07E4	-	-
01/04/85	-	1229.2	-
01/22/85	1.14E4 (3.5E2)	1229.2	-
01/29/85	-	1229.2	-
02/05/85	-	1229.5	-
02/13/85	-	1229.5	-
02/20/85	-	1229.2	-
02/28/85	1.13E4 (3.5E2)	1229.1	-
03/08/85	-	1229.0	-
03/15/85	-	1229.1	-
03/21/85	-	1229.0	-
03/28/85	1.15E4 (3.5E2)	1229.0	-
04/04/85	-	1229.0	-
04/09/85	-	1229.1	-
04/17/85	-	1229.0	-
04/26/85	-	1229.0	-
05/03/85	1.13E4 (3.5E2)	1228.7	-
05/10/85	-	1228.8	-
05/16/85	-	1228.8	-
05/24/85	-	1228.8	-
05/26/85	1.17E4 (3.5E2)	-	-
05/28/85	-	1228.7	-
06/06/85	-	1228.7	-
06/19/85	-	1228.6	-

06/22/85	1.21E4 (3.6E2)	-	-
06/25/85	-	1228.5	-
07/24/85	1.25E4 (3.7E2)	1228.4	-
08/28/85	1.19E4 (3.6E2)	1228.5	-
10/04/85	1.14E4 (3.5E2)	1228.4	-

WATER DATA

Borehole: NC7-15

Date Drilled: 10/5/84

Completed: 10/18/84

Installation: Piezometer

Depths: TD = 26.3'

Sampled interval: 15.5-25.5'

Location: N426808.2 E1695927.1

Ground Elevation: 1266.3'

Casing Elevation: 1269.3'

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
11/02/84	3.81E3 (2.5E2)	-	-
11/13/84	-	1248.9	-
12/07/84	4.26E3 (2.7E2)	-	-
12/11/84	3.92E3	-	-
01/04/85	-	1248.9	-
01/22/85	4.30E3 (2.6E2)	1248.8	-
01/29/85	-	1248.9	-
02/05/85	-	1249.9	-
02/13/85	-	1250.0	-
02/20/85	-	1249.6	-
02/28/85	3.64E3 (2.5E2)	1249.6	-
03/08/85	-	1249.6	-
03/15/85	-	1249.6	-
03/21/85	-	1249.6	-
03/28/85	3.50E3 (2.4E2)	1249.6	-
04/04/85	-	1249.6	-
04/09/85	-	1249.6	-
04/17/85	-	1249.5	-
04/26/85	-	1249.4	-
05/03/85	3.26E3 (2.4E2)	1249.4	-
05/10/85	-	1249.4	-
05/16/85	-	1249.3	-
05/24/85	-	1249.3	-
05/26/85	2.85E3 (2.3E2)	-	-
05/28/85	-	1249.3	-
06/06/85	-	1249.3	-

06/19/85	-	1249.2	-
06/22/85	2.63E3 (2.1E2)	-	-
06/25/85	-	1249.1	-
07/24/85	2.96E3 (2.5E2)	1249.0	-
08/28/85	2.95E3 (2.4E2)	1249.1	-
10/04/85	2.87E3 (2.4E2)	1249.0	-

WATER DATA

Borehole: NC7-16

Date Drilled: 10/05/84, 10/18/84 Completed: 10/18/84

Installation: Piezometer

Depths: TD = 26.5' Sampled interval: 16-26'

Location: N427787.0 E1695136.0

Ground Elevation: 1307.9' Casing Elevation: 1310.9'

Remarks:

Monitoring Record

Date	Water ³ H (pCi/l $\pm$ 2 s.d.)	Water Elev. (ft)	Notes
10/05/84	-	1288.9	-
10/18/84	4.11E5 (2.1E3)	-	-
11/02/84	3.61E5 (3.6E3)	-	-
11/13/84	3.41E5	1286.2	-
12/07/84	3.57E5 (3.6E3)	-	-
12/14/84	-	1286.2	-
12/21/84	-	1288.0	-
12/27/84	-	1287.8	-
01/04/85	-	1287.9	-
01/14/85	-	1287.9	-
01/22/85	3.41E5 (3.4E3)	1287.8	-
01/29/85	-	1287.7	-
02/05/85	-	1287.6	-
02/13/85	-	1287.5	-
02/20/85	-	1287.2	-
02/28/85	3.17E5 (3.2E3)	1287.2	-
03/08/85	-	1287.0	-
03/15/85	-	1287.0	-
03/21/85	-	1286.9	-
03/28/85	3.09E5 (3.1E3)	1286.8	-
04/04/85	-	1286.7	-
04/09/85	-	1286.6	-
04/17/85	-	1286.5	-
04/26/85	-	1286.4	-
05/03/85	2.94E5 (3.0E2)	1286.2	-

05/10/85	-	1286.1	-
05/16/85	-	1286.1	-
05/24/85	-	1286.1	-
05/26/85	2.78E5 (2.8E3)	-	-
05/28/85	-	1286.0	-
06/06/85	-	1285.9	-
06/19/85	-	1285.7	-
06/22/85	2.75E5 (2.8E3)	-	-
06/25/85	-	1285.6	-
07/24/85	2.76E5 (2.8E3)	1285.3	-
08/28/85	2.59E5 (2.6E3)	1285.2	-
10/04/85	2.52E5 (2.6E3)	1285.0	-

WATER DATA

Borehole: NC7-17

Date Drilled: 10/5/84, 12/14/84

Completed: 12/18/84

Installation: Piezometer

Depths: TD = 31.5'

Sampled interval: 20.5-30.5'

Location: N427977.5 E1694250.1

Ground Elevation: 1385.7'

Casing Elevation: 1388.7'

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
12/19/84	<2.05E2	-	-
01/04/85	-	1361.1	-
01/22/85	1.96E2 (1.8E2)	1361.0	-
01/29/85	-	1360.9	-
02/05/85	-	1361.5	-
02/13/85	-	1361.4	-
02/20/85	-	1361.2	-
02/28/85	<2.20E2	1361.2	-
03/08/85	-	1361.0	-
03/15/85	-	1361.0	-
03/21/85	-	1361.0	-
03/28/85	<2.15E2	1360.9	-
04/04/85	-	1360.9	-
04/09/85	-	1360.9	-
04/17/85	-	1360.8	-
04/26/85	-	1360.8	-
05/03/85	2.06E2 (2.0E2)	1360.8	-
05/10/85	-	1360.7	-
05/16/85	-	1360.7	-
05/24/85	-	1360.7	-
05/26/85	<2.57E2	-	-
05/28/85	-	1360.7	-
06/06/85	-	1360.6	-
06/19/85	-	1360.6	-
06/22/85	<2.13E2	-	-
06/25/85	-	1360.5	-

07/24/85	<3.56E2	1360.5	-
08/28/85	<2.27E2	1360.7	-
10/04/85	1.88E2 (1.7E2)	1360.7	-

WATER DATA

Borehole: NC7-18

Date Drilled: 10/5/84, 10/18/84

Completed: 12/13/84

Installation: Piezometer

Depths: TD = 26.1'

Sampled interval: 13.5-23.5'

Location: N427678.9 E1694850.7

Ground Elevation: 1328.83'

Casing Elevation: 1331.8'

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
12/19/84	<3.69E2	-	-
01/04/85	-	1312.0	-
01/22/85	<3.32E2	1311.0	-
01/29/85	-	1310.8	-
02/05/85	-	1311.2	-
02/13/85	-	1312.6	-
02/20/85	-	1312.4	-
02/28/85	<2.62E2	1312.0	-
03/08/85	-	1311.4	-
03/15/85	-	1311.1	-
03/21/85	-	1311.0	-
03/28/85	<1.10E2	1310.8	-
04/04/85	-	1310.6	-
04/09/85	-	1310.6	-
04/17/85	-	1310.5	-
04/26/85	-	1310.4	-
05/03/85	<2.76E2	1310.2	-
05/10/85	-	1310.3	-
05/16/85	-	1310.2	-
05/24/85	-	1310.1	-
05/26/85	<2.05E2	-	-
05/28/85	-	1310.1	-
06/06/85	-	1310.1	-
06/19/85	-	1310.0	-
06/22/85	<2.70E2	-	-
06/25/85	-	1310.0	-

07/24/85	<3.41E2	1309.8	-
08/28/85	<3.68E2	1309.9	-
10/04/85	<9.40E1	1309.8	-

WATER DATA

Borehole: NC7-19

Date Drilled: 10/31/84

Completed: 11/01/84

Installation: Piezometer

Depths: TD = 25.0'

Sampled interval: 14.5'-24.5'

Location: N426739.9 E1696089.4

Ground Elevation: 1260.6'

Casing Elevation: 1263.6'

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
11/02/84	2.06E4 (4.4E2)	-	-
11/13/84	-	1243.7	-
12/07/84	2.65E4 (5.0E2)	-	-
12/11/84	2.71E4	-	-
01/04/85	-	1243.7	-
01/22/85	3.00E4 (5.2E2)	1243.7	-
01/29/85	-	1243.6	-
02/05/85	-	1243.7	-
02/13/85	-	1243.9	-
02/20/85	-	1243.6	-
02/28/85	3.04E4 (5.2E2)	1243.4	-
03/08/85	-	1243.3	-
03/15/85	-	1243.3	-
03/21/85	-	1243.3	-
03/28/85	3.00E4 (5.1E2)	1243.9	-
04/04/85	-	1243.7	-
04/09/85	-	1243.5	-
04/17/85	-	1243.3	-
04/26/85	-	1243.2	-
05/03/85	3.07E4 (5.2E2)	1243.2	-
05/10/85	-	1243.1	-
05/16/85	-	1243.1	-
05/24/85	-	1243.1	-
05/26/85	3.08E4 (5.1E2)	-	-
05/28/85	-	1243.1	-
06/06/85	-	1242.9	-

06/19/85	-	1242.9	-
06/22/85	3.06E4 (5.2E2)	-	-
06/25/85	-	1242.9	-
07/24/85	3.15E4 (5.3E2)	1242.8	-
08/28/85	3.11E4 (5.3E2)	1243.0	-
10/04/85	3.01E4 (5.2E2)	1242.9	-

WATER DATA

Borehole: NC7-20

Date Drilled: 10/31/84

Completed: 12/14/84

Installation: Piezometer

Depths: TD = 36.3'

Sampled interval: 25.7-35.7'

Location: N427304.9 E1695734.5

Ground Elevation: 1292.2'

Casing Elevation: 1295.2'

Remarks: re-entered and extended borehole 12/04/85 and 12/14/85

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
12/19/84	2.44E4 (4.8E2)	-	-
01/04/85	-	1260.3	-
01/22/85	2.25E4 (4.6E2)	1260.0	-
01/29/85	-	1259.9	-
02/05/85	-	1259.9	-
02/13/85	-	1260.0	-
02/20/85	-	1259.6	-
02/28/85	2.37E4 (4.6E2)	1259.5	-
03/08/85	-	1259.4	-
03/15/85	-	1259.4	-
03/21/85	-	1259.3	-
03/28/85	2.75E4 (5.0E2)	1259.3	-
04/04/85	-	1259.4	-
04/09/85	-	1259.3	-
04/14/85	-	1259.1	-
04/26/85	-	1259.1	-
05/03/85	3.08E4 (5.2E2)	1259.0	-
05/10/85	-	1258.9	-
05/16/85	-	1258.9	-
05/24/85	-	1258.9	-
05/26/85	3.31E4 (5.3E2)	-	-
05/28/85	-	1258.9	-
06/06/85	-	1258.9	-
06/19/85	-	1258.8	-
06/22/85	4.15E4 (6.0E2)	-	-

06/25/85	-	1258.7	-
07/24/85	4.40E4 (6.2E2)	1258.6	-
08/28/85	4.82E4 (6.4E2)	1258.7	-
10/04/85	5.24E4 (6.6E2)	1258.7	-

WATER DATA

Borehole: NC7-21

Date Drilled: 10/31/84, 12/04/84

Completed: 12/07/84

Installation: Piezometer

Depths: TD = 29.8'

Sampled interval: 19.0-29.0'

Location: N427672.1 E1695383.9

Ground Elevation: 1301.2'

Casing Elevation: 1304.2'

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
11/02/84	9.23E3 (3.2E2)	-	-
11/13/84	-	1285.0	-
12/07/84	1.53E5 (1.6E3)	-	-
12/11/84	1.49E5	-	-
01/04/85	-	1281.1	-
01/22/85	1.82E5 (1.9E3)	1280.0	-
01/29/85	-	1280.0	-
02/05/85	-	1279.5	-
02/13/85	-	1279.5	-
02/20/85	-	1279.2	-
02/28/85	1.96E5 (2.0E3)	1279.0	-
03/08/85	-	1279.0	-
03/15/85	-	1279.0	-
03/21/85	-	1278.9	-
03/28/85	1.99E5 (2.0E3)	1278.8	-
04/04/85	-	1278.8	-
04/09/85	-	1278.8	-
04/17/85	-	1278.6	-
04/26/85	-	1278.5	-
05/03/85	2.08E5 (2.1E3)	1278.5	-
05/10/85	-	1278.4	-
05/16/85	-	1278.5	-
05/24/85	-	1278.5	-
05/26/85	2.10E5 (2.1E3)	-	-
05/28/85	-	1278.4	-
06/06/85	-	1278.4	-

06/19/85	-	1278.3	-
06/22/85	2.09E5 (2.1E3)	-	-
06/25/85	-	1278.3	-
07/24/85	2.22E5 (2.3E3)	1278.0	-
08/28/85	2.22E5 (2.3E3)	1278.0	-
10/04/85	2.17E5 (2.2E3)	1277.8	-

WATER DATA

Borehole: NC7-22

Date Drilled: 11/1/84, 12/4/84

Completed: 12/7/84

Installation: Piezometer

Depths: TD = 36.0'

Sampled interval: 25.0-35.0'

Location: N427838.6 E1695278.6

Ground Elevation: 1309.3'

Casing Elevation: 1312.3'

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
12/07/84	7.32E3 (3.1E2)	-	-
12/11/84	7.33E3	-	-
01/04/85	-	1277.1	-
01/22/85	6.59E3 (2.9E2)	1277.0	-
01/29/85	-	1276.9	-
02/05/85	-	1276.8	-
02/13/85	-	1276.6	-
02/20/85	-	1276.6	-
02/28/85	6.04E3 (2.8E2)	1276.3	-
03/08/85	-	1276.2	-
03/15/85	-	1276.3	-
03/21/85	-	1276.0	-
03/28/85	6.37E3 (2.8E2)	1276.1	-
04/04/85	-	1276.0	-
04/09/85	-	1276.1	-
04/17/85	-	1276.0	-
04/26/85	-	1276.1	-
05/03/85	6.74E3 (2.9E2)	1275.8	-
05/10/85	-	1275.6	-
05/16/85	-	1275.8	-
05/24/85	-	1275.6	-
05/26/85	7.36E3 (3.0E2)	-	-
05/28/85	-	1275.6	-
06/06/85	-	1275.6	-
06/19/85	-	1275.6	-
06/22/85	8.43E3 (3.2E2)	-	-

06/25/85	-	1275.4	-
07/24/85	9.14E3 (3.3E2)	1275.3	-
08/28/85	1.04E4 (3.4E2)	1275.2	-
10/04/85	1.09E4 (3.4E2)	1275.0	-

WATER DATA

Borehole: NC7-23

Date Drilled: 11/1/84, 12/6/84

Completed: 12/7/84

Installation: Piezometer

Depths: TD = 30.0'

Sampled interval: 19.5-29.5'

Location: N428422.1 E1694455.2

Ground Elevation: 1345.8'

Casing Elevation: 1348.8'

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
11/13/84	-	1327.9	-
12/07/84	1.18E6 (1.2E4)	-	-
12/11/84	1.16E6 -	-	-
01/04/85	-	1322.3	-
01/22/85	1.10E6 (1.1E4)	1322.2	-
01/29/85	-	1322.1	-
02/05/85	-	1322.5	-
02/13/85	-	1322.5	-
02/20/85	-	1322.2	-
02/28/85	1.06E6 (1.1E4)	1322.0	-
03/08/85	-	1321.9	-
03/15/85	-	1321.9	-
03/21/85	-	1321.8	-
03/28/85	1.04E6 (1.0E4)	1321.7	-
04/04/85	-	1321.7	-
04/09/85	-	1321.5	-
04/17/85	-	1321.4	-
04/26/85	-	1321.5	-
05/03/85	1.01E6 (1.0E4)	1321.9	-
05/10/85	-	1321.1	-
05/16/85	-	1321.0	-
05/24/85	-	1320.9	-
05/26/85	9.87E5 (9.9E3)	-	-
05/28/85	-	1320.9	-
06/06/85	-	1320.8	-
06/19/85	-	1320.5	-

06/22/85	9.76E5 (9.8E3)	-	-
06/25/85	-	1320.4	-
07/24/85	1.00E6 (1.0E4)	1320.0	-
08/28/85	9.73E5 (9.7E3)	1320.0	-
10/04/85	9.62E5 (9.6E3)	1319.6	-

WATER DATA

Borehole: NC7-24

Date Drilled: 11/1/84, 12/6/84

Completed: 12/7/84

Installation: Piezometer

Depths: TD = 36.0'

Sampled interval: 24.5-34.5'

Location: N428598.8 E1694280.7

Ground Elevation: 1356.8'

Casing Elevation: 1359.8'

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
12/07/84	4.65E3 (2.7E2)	-	-
12/11/84	4.69E3 -	-	-
01/04/85	-	1324.0	-
01/22/85	4.93E3 (2.7E2)	1324.0	-
01/29/85	-	1324.0	-
02/05/85	-	1323.7	-
02/13/85	-	1323.7	-
02/20/85	-	1323.5	-
02/28/85	4.46E3 (2.6E2)	1323.3	-
03/08/85	-	1323.3	-
03/15/85	-	1323.4	-
03/21/85	-	1323.3	-
03/28/85	4.48E3 (2.6E2)	1323.2	-
04/04/85	-	1323.3	-
04/09/85	-	1323.2	-
04/17/85	-	1323.2	-
04/26/85	-	1323.1	-
05/03/85	4.42E3 (2.6E2)	1323.1	-
05/10/85	-	1323.0	-
05/16/85	-	1323.1	-
05/24/85	-	1323.1	-
05/26/85	5.11E3 (2.7E2)	-	-
05/28/85	-	1323.0	-
06/06/85	-	1323.1	-
06/19/85	-	1322.9	-
06/22/85	6.53E3 (2.9E2)	-	-

06/25/85	-	1322.9	-
07/24/85	7.54E3 (3.0E2)	1322.8	-
08/28/85	8.73E3 (3.2E2)	1322.9	-
10/04/85	8.18E3 (3.1E2)	1322.7	-

WATER DATA

Borehole: NC7-25

Date Drilled: 12/7/84

Completed: 12/10/84

Installation: Well

Depths: TD = 73'

Sampled interval: 54-69'

Location: N428518.4 E1694633.5

Ground Elevation: 1364.3'

Casing Elevation: 1365.5'

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
12/13/84	1.28E5 (1.3E2)	-	-
12/19/84	1.26E5 -	-	-
01/04/85	-	1301.3	-
01/22/85	1.87E5 (1.9E3)	1301.3	-
01/29/85	-	1301.2	-
02/05/85	-	1301.2	-
02/13/85	-	1300.3	-
02/20/85	-	1300.9	-
02/28/85	2.20E5 (2.2E3)	1300.9	-
03/08/85	-	1300.8	-
03/15/85	-	1300.9	-
03/21/85	-	1300.8	-
03/28/85	2.36E5 (2.4E3)	1300.7	-
04/04/85	-	1300.7	-
04/09/85	-	1300.8	-
04/17/85	-	1300.8	-
04/26/85	-	1300.8	-
05/03/85	2.62E5 (2.6E2)	1300.6	-
05/10/85	-	1300.7	-
05/16/85	-	1300.7	-
05/24/85	-	1300.7	-
05/26/85	2.56E5 (2.6E3)	-	-
05/28/85	-	1300.7	-
06/06/85	-	1300.8	-
06/19/85	-	1300.7	-
06/22/85	2.61E5 (2.6E3)	-	-

06/25/85	-	1300.6	-
07/24/85	2.82E5 (2.8E3)	1300.6	-
08/28/85	2.76E5 (2.8E3)	1300.9	-
10/04/85	2.87E5 (2.9E3)	1300.8	-

WATER DATA

Borehole: NC7-26

Date Drilled: 11/30/84

Completed: 12/3/84

Installation: Well

Depths: TD = 81.4'

Sampled interval: 63-78'

Location: N427977.6 E1695382.5

Ground Elevation: 1326.6'

Casing Elevation: 1328.8'

Remarks:

Monitoring Record

Date	Water ³ H (pCi/l +/- 2 s.d.)	Water Elev. (ft)	Notes
12/07/84	3.06E2	-	-
12/13/84	<3.48E2	-	-
01/04/85	-	1262.8	-
01/22/85	2.23E2 (2.2E2)	1262.8	-
01/29/85	-	1262.6	-
02/05/85	-	1261.6	-
02/13/85	-	1261.2	-
02/20/85	-	1261.1	-
02/28/85	2.19E2 (1.0E2)	1261.1	-
03/08/85	-	1261.0	-
03/15/85	-	1261.0	-
03/21/85	-	1260.8	-
03/28/85	2.13E2 (1.8E2)	1260.9	-
04/04/85	-	1260.8	-
04/09/85	-	1260.9	-
04/17/85	-	1260.8	-
04/26/85	-	1260.8	-
05/03/85	3.55E2 (2.0E2)	1260.6	-
05/10/85	-	1260.5	-
05/16/85	-	1260.4	-
05/24/85	-	1260.6	-
05/26/85	4.40E2 (1.9E2)	-	-
05/28/85	-	1260.4	-
06/06/85	-	1260.4	-
06/19/82	-	1260.4	-
06/22/85	6.96E2 (2.0E2)	-	-

06/25/85	-	1260.2	-
07/24/85	6.38E2 (2.0E2)	1260.1	-
08/28/85	8.01E2 (2.1E2)	1260.2	-
10/04/85	8.13E2 (2.0E2)	1258.9	-

WATER DATA

Borehole: NC7-27

Date Drilled: 12/14/84

Completed: 12/14/84

Installation: Well

Depths: TD = 90'

Sampled interval: 74-89'

Location: N426630.5 E1696611.1

Ground Elevation: 1279.7'

Casing Elevation: 1281.7'

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
12/21/84	8.54E4 (8.9E2)	-	-
01/04/85	-	1194.7	-
01/22/85	8.31E4 (8.7E2)	1193.8	-
01/29/85	-	1193.6	-
02/05/85	-	1193.6	-
02/13/85	-	1193.6	-
02/20/85	-	1193.0	-
02/28/85	7.90E4 (8.3E3)	1192.9	-
03/08/85	-	1192.8	-
03/15/85	-	1193.6	-
03/21/85	-	1193.0	-
03/28/85	7.60E4 (7.9E2)	1193.0	-
04/04/85	-	1193.0	-
04/09/85	-	1193.3	-
04/17/85	-	1193.3	-
04/26/85	-	1193.5	-
05/03/85	7.50E4 (7.9E2)	1193.4	-
05/10/85	-	1193.5	-
05/16/85	-	1193.6	-
05/24/85	-	1193.8	-
05/26/85	7.34E4 (7.7E2)	-	-
05/28/85	-	1193.8	-
06/06/85	-	1194.0	-
06/19/85	-	1194.2	-
06/22/85	7.51E4 (7.9E2)	-	-
06/25/85	-	1194.2	-

07/24/85	7.52E4 (7.9E2)	1194.6	-
08/28/85	7.57E4 (8.0E2)	1195.3	-
10/04/85	7.57E4 (7.9E2)	1195.3	-

WATER DATA

Borehole: NC7-28

Date Drilled: 12/14/84

Completed: 12/14/84

Installation: Well

Depths: TD = 50'

Sampled interval: 28-43'

Location: N426497.4 E1695984.9

Ground Elevation: 1297.0'

Casing Elevation: 1298.1'

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
12/19/84	1.03E4 (3.5E2)	-	-
01/04/85	-	1259.8	-
01/15/85	2.11E5 (2.1E3)	-	-
01/22/85	2.76E5 (2.8E3)	1259.7	-
01/29/85	-	1259.6	-
02/05/85	-	1259.5	-
02/13/85	-	1259.4	-
02/20/85	-	1259.1	-
02/28/85	5.43E5 (5.4E3)	1259.2	-
03/08/85	-	1259.1	-
03/15/85	-	1259.1	-
03/21/85	-	1259.1	-
03/28/85	5.60E5 (5.6E3)	1259.1	-
04/04/85	-	1259.0	-
04/09/85	-	1259.0	-
04/17/85	-	1259.1	-
04/26/85	-	1259.0	-
05/03/85	5.58E5 (5.6E3)	1258.8	-
05/10/85	-	1258.9	-
05/16/85	-	1258.9	-
05/24/85	-	1258.9	-
05/26/85	5.31E5 (5.3E3)	-	-
05/28/85	-	1258.9	-
06/06/85	-	1258.8	-
06/19/85	-	1258.7	-
06/22/85	5.55E5 (5.6E3)	-	-

06/25/85	-	1258.7	-
07/24/85	5.62E5 (5.7E3)	1259.1	-
08/28/85	5.66E5 (5.7E3)	1258.9	-
10/04/85	4.74E5 (4.8E3)	1258.9	-

WATER DATA

Borehole: NC7-29

Date Drilled: 12/10/84

Completed: 12/10/84

Installation: Well

Depths: TD = 59'

Sampled interval: 41-56'

Location: N425127.7 E1696492.9

Ground Elevation: 1252.08'

Casing Elevation: 1253.8'

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
12/13/84	<3.73E2	-	-
01/04/85	-	1204.9	-
01/22/85	2.27E2 (1.8E2)	1204.9	-
01/29/85	-	1204.9	-
02/05/85	-	1205.8	-
02/13/85	-	1205.7	-
02/20/85	-	1205.3	-
02/28/85	<3.13E2	1205.3	-
03/08/85	-	1205.1	-
03/15/85	-	1205.2	-
03/21/85	-	1205.1	-
03/28/85	<2.05E2	1205.0	-
04/04/85	-	1205.0	-
04/09/85	-	1205.0	-
04/17/85	-	1204.9	-
04/26/85	-	1205.0	-
05/03/85	<3.52E2	1204.9	-
05/10/85	-	1204.9	-
05/16/85	-	1204.9	-
05/24/85	-	1204.7	-
05/26/85	<2.05E2	-	-
05/28/85	-	1204.7	-
06/06/85	-	1204.7	-
06/19/85	-	1204.5	-
06/22/85	<3.90E2	-	-
06/25/85	-	1204.5	-

07/24/85	<3.37E2	1204.3	-
08/28/85	<3.62E2	1204.3	-
10/04/85	<2.40E2	1204.1	-

WATER DATA

Borehole: NC7-30

Date Drilled: 3/12/85

Completed: 3/14/85

Installation: Piezometer

Depths: TD = 35.0'

Sampled interval: 24.5-34.5'

Location: N428385.5 E1694429.8

Ground Elevation: 1348.3'

Casing Elevation: 1351.3'

Remarks:

Monitoring Record

<u>Date</u>	³ H <u>(pCi/l +/- 2 s.d.)</u>	<u>Water Elev.</u> <u>(ft)</u>	<u>Notes</u>
03/28/85	7.21E5 (7.2E3)	-	-
05/03/85	6.95E5 (7.0E3)	-	-
05/24/85	-	1321.3	-
05/26/85	7.25E5 (7.3E3)	-	-
05/28/85	-	1321.1	-
06/06/85	-	1321.0	-
06/19/85	-	1320.8	-
06/22/85	7.11E5 (7.153)	-	-
06/25/85	-	1320.6	-
07/24/85	6.69E5 (6.7E3)	1320.2	-
08/28/85	6.36E5 (6.4E3)	1320.2	-
10/04/85	6.11E5 (6.1E3)	1319.9	-

WATER DATA

Borehole: NC7-32

Date Drilled: 3/12/85

Completed: 3/14/85

Installation: Lysimeter A

Depths: TD = 25.0'

Sampled interval: 8.0'

Location: N428396.6 E1694418.5

Ground Elevation: 1348.6'

Casing Elevation: N/A

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H</u> <u>(pCi/l +/- 2 s.d.)</u>	<u>Water Elev.</u> <u>(ft)</u>	<u>Notes</u>
05/29/85	-	-	NS
07/25/85	-	-	NS
08/29/85	-	-	NS
10/04/85	-	-	NS

WATER DATA

Borehole: NC7-32

Date Drilled: 3/12/85

Completed: 3/14/85

Installation: Lysimeter B

Depths: TD = 25.0'

Sampled interval: 19.0'

Location: N428396.6 E1694418.5

Ground Elevation: 1348.6'

Casing Elevation: N/A

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H</u> <u>(pCi/l +/- 2 s.d.)</u>	<u>Water Elev.</u> <u>(ft)</u>	<u>Notes</u>
05/29/85	2.41E6 (2.4E4)	-	-
07/25/85	2.53E6 (2.5E4)	-	-
08/29/85	2.54E6 (2.5E4)	-	-
10/04/85	2.36E6 (2.3E4)	-	-

WATER DATA

Borehole: NC7-34

Date Drilled: 12/20/84

Completed: 12/21/84

Installation: Piezometer

Depths: TD = 35'

Sampled interval: 24.5-34.5'

Location: N428203.5 E1694358.8

Ground Elevation: 1359.4'

Casing Elevation: 1362.4'

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
12/20/84	5.78E3 (2.8E2)	-	-
12/21/84	4.94E3 (2.7E2)	-	-
01/04/85	-	1339.2	-
01/22/85	3.65E3 (2.5E2)	1338.9	-
01/29/85	-	1338.9	-
02/05/85	-	1338.6	-
02/13/85	-	1340.0	-
02/20/85	-	1339.7	-
02/28/85	2.42E3 (2.3E2)	1338.2	-
03/08/85	-	1338.1	-
03/15/85	-	1337.9	-
03/21/85	-	1337.8	-
03/28/85	2.00E3 (2.2E2)	1337.8	-
04/04/85	-	1337.7	-
04/09/85	-	1337.6	-
04/17/85	-	1337.5	-
04/26/85	-	1337.4	-
05/03/85	1.61E3 (2.2E2)	1337.3	-
05/10/85	-	1337.3	-
05/16/85	-	1337.2	-
05/24/85	-	1337.0	-
05/26/85	1.59E3 (2.1E2)	-	-
05/28/85	-	1336.9	-
06/06/85	-	1336.7	-
06/19/85	-	1336.6	-
06/22/85	2.06E3 (2.2E2)	-	-

06/25/85	-	1336.5	-
07/24/85	2.01E3 (2.3E2)	1336.4	-
08/28/85	1.63E3 (2.2E2)	1336.6	-
10/04/85	1.67E3 (2.1E2)	1336.5	-

WATER DATA

Borehole: NC7-36

Date Drilled: 12/20/84

Completed: 12/27/84

Installation: Piezometer

Depths: TD = 36.0'

Sampled interval: 14.5-34.5'

Location: N428070.5 E1694418.9

Ground Elevation: 1358.0'

Casing Elevation: 1361.0'

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
12/21/84	<4.53E2	-	-
01/04/85	-	1340.0	-
01/22/85	2.43E2 (2.1E2)	1339.9	-
01/29/85	-	1339.8	-
02/05/85	-	1339.8	-
02/13/85	-	1341.5	-
02/20/85	-	1341.1	-
02/28/85	<2.14E2	1339.5	-
03/08/85	-	1339.3	-
03/15/85	-	1339.3	-
03/21/85	-	1339.2	-
03/28/85	<1.57E2	1339.2	-
04/04/85	-	1339.1	-
04/09/85	-	1339.0	-
04/17/85	-	1339.0	-
04/26/85	-	1338.8	-
05/03/85	3.00E2 (1.9E2)	1338.7	-
05/10/85	-	1338.6	-
05/16/85	-	1339.6	-
05/24/85	-	1338.5	-
05/26/85	<2.35E2	-	-
05/28/85	-	1338.5	-
06/06/85	-	1338.4	-
06/19/85	-	1338.3	-
06/22/85	<2.84E2	-	-
06/25/85	-	1338.2	-

07/24/85	2.57E2 (2.0E2)	1338.2	-
08/28/85	<3.59E2	1338.4	-
10/04/85	<1.50E2	1338.3	-

WATER DATA

Borehole: NC7-37

Date Drilled: 3/13/85

Completed: 3/14/85

Installation: Piezometer

Depths: TD = 25.0'

Sampled interval: 14.5-24.5'

Location: N428133.0 E1694653.3

Ground Elevation: 1335.6'

Casing Elevation: 1338.6'

Remarks:

Monitoring Record

Date	Water ³ H (pCi/l +/- 2 s.d.)	Water Elev. (ft)	Notes
03/28/85	1.94E5 (2.0E3)	-	-
05/03/85	1.98E5 (2.0E3)	-	-
05/24/85	-	1315.3	-
05/26/85	2.02E5 (2.1E3)	-	-
05/28/85	-	1315.2	-
06/06/85	-	1315.0	-
06/19/85	-	1314.7	-
06/22/85	1.98E5 (2.0E3)	-	-
06/25/85	-	1314.6	-
07/24/85	2.02E5 (2.1E3)	1314.1	-
08/28/85	2.18E5 (2.2E3)	1313.7	-
10/04/85	2.25E5 (2.3E2)	1313.3	-

WATER DATA

Borehole: NC7-39

Date Drilled: 3/13/85

Completed: 5/03/85

Installation: Lysimeter A

Depths: TD = 16.0'

Sampled interval: 7.5'

Location: N428145.2 E1694642.5

Ground Elevation: 1336.0'

Casing Elevation: N/A

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H</u> <u>(pCi/l +/- 2 s.d.)</u>	<u>Water Elev.</u> <u>(ft)</u>	<u>Notes</u>
06/24/85	-	-	NS
07/25/85	-	-	NS
08/29/85	-	-	NS
10/04/85	-	-	NS

WATER DATA

Borehole: NC7-39

Date Drilled: 3/13/85

Completed: 5/03/85

Installation: Lysimeter B

Depths: TD = 16.0'

Sampled interval: 14.9'

Location: N428145.2 E1694642.5

Ground Elevation: 1336.0'

Casing Elevation: N/A

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H</u> <u>(pCi/l +/- 2 s.d.)</u>	<u>Water Elev.</u> <u>(ft)</u>	<u>Notes</u>
06/24/85	6.58E4 (7.6E2)	-	-
07/25/85	6.87E4 (7.8E2)	-	-
08/29/85	6.78E4 (7.7E2)	-	-
10/04/85	6.55E4 (4.6E2)	-	-

WATER DATA

Borehole: NC7-40

Date Drilled: 3/14/85

Completed: 4/4/85

Installation: Piezometer

Depths: TD = 35.5'

Sampled interval: 16.5-26.5'

Location: N427869.1 E1694892.7

Ground Elevation: 1316.7'

Casing Elevation: 1319.7'

Remarks:

Monitoring Record

<u>Date</u>	Water ³ H <u>(pCi/l +/- 2 s.d.)</u>	Water Elev. <u>(ft)</u>	<u>Notes</u>
05/03/85	1.93E5 (2.0E2)	-	-
05/24/85	-	1299.5	-
05/26/85	1.81E5 (1.8E3)	-	-
05/28/85	-	1299.5	-
06/06/85	-	1299.4	-
06/19/85	-	1299.4	-
06/22/85	1.71E5 (1.7E3)	-	-
06/25/85	-	1300.3	-
07/24/85	1.71E5 (1.7E3)	1299.0	-
08/28/85	1.63E5 (1.7E3)	1299.0	-
10/04/85	1.58E5 (1.6E3)	1299.0	-

WATER DATA

Borehole: NC7-42

Date Drilled: 3/14/85

Completed: 3/21/85

Installation: Lysimeter A

Depths: TD = 18.0'

Sampled interval: 8.5'

Location: N427884.1 E1694879.5

Ground Elevation: 1318.0'

Casing Elevation: N/A

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H</u> <u>(pCi/l +/- 2 s.d.)</u>	<u>Water Elev.</u> <u>(ft)</u>	<u>Notes</u>
06/24/85	-	-	NS
07/25/85	-	-	NS
08/29/85	3.86E5 (3.9E3)	-	-
10/04/85	3.76E5 (3.8E3)	-	-

WATER DATA

Borehole: NC7-42

Date Drilled: 3/14/85

Completed: 3/21/85

Installation: Lysimeter B

Depths: TD = 18.0'

Sampled interval: 15.2'

Location: N427884.1 E1694879.5

Ground Elevation: 1318.0'

Casing Elevation: N/A

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H</u> <u>(pCi/l +/- 2 s.d.)</u>	<u>Water Elev.</u> <u>(ft)</u>	<u>Notes</u>
05/29/85	2.77E5 (2.8E3)	-	-
06/24/85	2.85E5 (2.9E3)	-	-
07/25/85	2.99E5 (3.0E3)	-	-
08/29/85	2.85E5 (2.9E3)	-	-
10/04/85	2.79E5 (2.8E3)	-	-

WATER DATA

Borehole: NC7-43

Date Drilled: 5/01/85, 5/14-15/85

Completed: 5/17/85

Installation: Piezometer

Depths: TD = 50.3'

Sampled interval: 39.5-49.5'

Location: N426329.1 E1696176.8

Ground Elevation: 1286.3'

Casing Elevation: 1291.3'

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
05/15/85	2.12E5 (2.1E3)	-	-
05/24/85	-	1245.2	-
05/26/85	1.04E5 (1.1E3)	-	-
05/28/85	-	1245.1	-
06/06/85	-	1245.0	-
06/19/85	-	1244.9	-
06/22/85	9.55E4 (9.9E2)	-	-
06/25/85	-	1246.1	-
07/24/85	9.30E4 (9.7E2)	1245.6	-
08/28/85	8.12E4 (8.5E2)	1245.1	-
10/04/85	5.87E4 (7.0E2)	1245.6	-

WATER DATA

Borehole: NC7-44

Date Drilled: 7/17-18/85

Completed: 7/18/85

Installation: Well

Depths: TD = 41.0'

Sampled interval: 29-39'

Location: N426362.4 E1695384.1

Ground Elevation: 1354.8'

Casing Elevation: 1354.7'

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
07/16/85	<2.13E2	-	-
07/25/85	<2.18E2	1317.9	-
08/28/85	<2.27E2	1319.6	-
10/04/85	<2.80E2	1320.7	-

WATER DATA

Borehole: NC7-45

Date Drilled: 5/01-02/85, 5/09/85 Completed: 5/15/85

Installation: Piezometer

Depths: TD = 35.5' Sampled interval: 24.4-34.5'

Location: N425880.5 E1696762.6

Ground Elevation: 1180.2' Casing Elevation: 1183.2'

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H</u> <u>(pCi/l +/- 2 s.d.)</u>	<u>Water Elev.</u> <u>(ft)</u>	<u>Notes</u>
05/10/85	3.07E2 (2.1E2)	-	-
05/24/85	-	1155.6	-
05/26/85	<2.05E2	-	-
05/28/85	-	1155.7	-
06/06/85	-	1155.5	-
06/19/85	-	1155.5	-
06/22/85	2.35E2 (1.9E2)	-	-
06/25/85	-	1155.5	-
07/24/85	3.23E2 (2.0E2)	1155.4	-
08/28/85	2.83E2 (2.2E2)	1155.7	-
10/04/85	3.66E2 (1.9E2)	1155.8	-

WATER DATA

Borehole: NC7-46

Date Drilled: 5/16-17/85

Completed: 5/17/85

Installation: Piezometer

Depths: TD = 28.9'

Sampled interval: 18.4-28.4'

Location: N426588.5 E1697527.0

Ground Elevation: 1128.5'

Casing Elevation: 1131.5'

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H</u> <u>(pCi/l +/- 2 s.d.)</u>	<u>Water Elev.</u> <u>(ft)</u>	<u>Notes</u>
05/17/85	<2.34E2	-	-
05/24/85	-	1106.5	-
05/26/85	<2.05E2	-	-
05/28/85	-	1106.5	-
06/06/85	-	1106.5	-
06/19/85	-	1106.5	-
06/22/85	<2.53E2	-	-
06/25/85	-	1106.5	-
07/24/85	<3.45E2	1106.5	-
08/28/85	<4.50E2	1106.5	-
10/04/85	1.97E2 (1.8E2)	1106.8	-

WATER DATA

Borehole: NC7-47

Date Drilled: 7/9-12/85

Completed: 7/12/85

Installation: Well

Depths: TD = 70.0'

Sampled interval: 54-64'

Location: N429407.0 E1695339.3

Ground Elevation: 1264.9'

Casing Elevation: 1266.7'

Remarks:

Monitoring Record

<u>Date</u>	Water ³ H (pCi/l +/- 2 s.d.)	Water Elev. (ft)	<u>Notes</u>
07/10/85	<4.28E2	-	-
07/25/85	<2.42E2	1204.9	-
08/28/85	<3.67E2	1205.3	-
10/04/85	<2.38E2	1205.3	-

WATER DATA

Borehole: K7-1

Date Drilled: 7/19-23/82

Completed: 7/23/82

Installation: Well

Depths: TD = 177.5'

Sampled interval: 23.5-41.9'

Location: N427875.8 E1694981.4

Ground Elevation: 1316.0'

Casing Elevation: 1318.0'

Remarks: Multiple completion installed before current study

Monitoring Record

Date	Water ³ H (pCi/l +/- 2 s.d.)	Water Elev. (ft)	Notes
08/82	3.30E3 (1.6E2)	-	-
11/82	7.00E3 (1.0E3)	-	-
07/83	1.40E4 (1.0E3)	1304.6	-
10/83	1.70E4 (1.0E3)	1302.2	-
03/84	2.00E4 (1.0E3)	1302.7	-
05/84	2.04E4 (7.3E2)	1300.0	-
06/84	2.14E4 (7.5E2)	-	-
07/84	2.38E4 (8.0E2)	1297.9	-
09/84	2.35E4 (5.0E2)	1295.8	-
10/84	2.37E4 (3.0E2)	1296.2	-
01/05/85	1.95E4 (4.2E2)	-	-
01/16/85	-	1295.7	-
02/05/85	1.95E4 (4.2E2)	-	EM
02/13/85	2.15E4 (4.5E2)	1293.8	-
02/20/85	-	1295.3	-
03/01/85	-	1295.1	-
03/08/85	-	1295.2	-
03/15/85	-	1295.3	-
03/21/85	-	1295.2	-
03/29/85	2.08E4 (4.4E2)	-	-
04/04/85	-	1295.2	-
04/09/85	-	1295.2	-
04/17/85	-	1295.1	-
04/26/85	-	1295.0	-
05/03/85	-	1294.9	-
05/10/85	-	1294.9	-

05/13/85	2.20E4 (4.3E2)	-	-
05/16/85	-	1295.1	-
05/24/85	-	1294.9	-
05/28/85	-	1294.8	-
06/06/85	-	1294.7	-
06/19/85	-	1294.6	-
06/25/85	2.24E4 (4.3E2)	1294.5	-
07/24/85	2.45E4 (4.6E2)	-	-
08/28/85	2.50E4 (4.8E2)	1294.4	-
10/04/85	2.57E4 (4.8E2)	1294.3	-

WATER DATA

Borehole: K7-3

Date Drilled: 8/2-6/82

Completed: 8/6/82

Installation: Well

Depths: TD = 304.0'

Sampled interval: 26.0-58.0'

Location: N428203.6 E1694696.3

Ground Elevation: 1336.0'

Casing Elevation: 1337.9'

Remarks: Installed before current study

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
08/82	2.15E3 (1.4E2)	-	-
11/82	7.00E3 (1.0E3)	-	-
07/83	8.00E3 (1.0E3)	1322.6	-
10/83	1.10E4 (1.0E3)	1320.3	-
03/84	4.30E4 (1.0E3)	1319.9	-
05/84	5.88E4 (1.3E3)	1318.7	-
07/84	5.52E4 (1.3E3)	1316.6	-
09/84	7.24E4 (8.0E2)	1315.8	-
10/84	6.58E4 (5.3E2)	1315.1	-
01/05/85	1.27E5 (1.3E3)	-	-
01/16/85	-	-	EM
02/05/85	1.27E5 (1.3E3)	1314.5	-
02/05/85	1.37E5 (3.0E3)	-	HC
02/13/85	8.69E4 (9.0E2)	-	WR
02/20/85	-	1314.3	-
03/01/85	-	1314.2	-
03/08/85	-	1314.1	-
03/15/85	-	1314.2	-
03/21/85	-	1314.1	-
03/29/85	8.45E4 (8.8E2)	-	-
04/04/85	-	1314.0	-
04/09/85	-	1314.0	-
04/17/85	-	1314.0	-
04/26/85	-	1314.0	-
05/03/85	-	1304.2	WR
05/10/85	-	1313.8	-

05/15/85	8.57E4 (8.9E2)	-	-
05/16/85	-	1313.8	-
05/24/85	-	1313.7	-
05/28/85	-	1313.8	-
06/06/85	-	1313.6	-
06/19/85	-	1313.5	-
06/25/85	8.07E4 (8.4E2)	1313.5	-
07/24/85	9.01E4 (9.4E2)	-	-
08/28/85	9.07E4 (9.4E2)	1313.2	-
10/04/85	9.53E4 (9.9E2)	1313.0	-

WATER DATA

Borehole: K7-5

Date Drilled: 9/22-23/82

Completed: 9/23/82

Installation: Well

Depths: TD = 94.0'

Sampled interval: 25.2-94.0'

Location: N427740.5 E1694747.7

Ground Elevation: 1339.1'

Casing Elevation: 1340.1'

Remarks: Installed before current study

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
08/82	3.6E1 (7E0)	-	-
07/83	-	1301.8	-
10/83	-	1301.7	-
03/84	<1.0E3	1304.3	-
05/84	4.00E3 (1.0E3)	1302.5	-
09/84	<5.0E2	1300.3	-
10/84	<5.0E2	1300.5	-
01/16/85	-	1303.0	-
02/13/85	-	1302.9	-
02/19/85	<2.44E2	1300.1	-
03/01/85	-	1301.7	-
03/08/85	-	1301.4	-
03/15/85	-	1301.2	-
03/21/85	-	1300.8	-
03/29/85	<2.05E2	1301.5	-
04/04/85	-	-	-
04/09/85	-	-	-
04/17/85	-	-	-
04/26/85	-	-	-
05/03/85	-	1299.9	-
05/10/85	-	-	-
05/13/85	<2.55E2	-	-
05/16/85	-	-	-
05/24/85	-	-	-
05/28/85	-	1299.0	-
06/06/85	-	-	-

06/19/85	-	-	-
06/25/85	-	-	-
07/24/85	<2.65E2	-	-
08/22/85	<2.27E2	-	-

WATER DATA

Borehole: K7-6

Date Drilled: 9/24-27/82

Completed: 9/27/82

Installation: Well

Depths: TD = 92.0'

Sampled interval: 23.0-58.5'

Location: N428081.2 E1693990.2

Ground Elevation: 1411.0'

Casing Elevation: 1412.3'

Remarks: Multiple completion installed before current study

Monitoring Record

Date	Water ³ H (pCi/l +/- 2 s.d.)	Water Elev. (ft)	Notes
08/82	3.8E1 (7E0)	-	-
07/83	-	1391.0	-
10/83	-	1390.2	-
03/84	<1.0E3	-	-
09/84	<5.0E2	1390.2	-
10/84	<5.0E2	1390.2	-
01/16/85	-	1389.2	-
02/13/85	<2.14E2	1378.8	WR
02/20/85	-	1389.1	-
03/01/85	-	1389.1	-
03/08/85	-	1389.0	-
03/15/85	-	1389.0	-
03/21/85	-	1388.9	-
03/29/85	<2.21E2	1389.9	-
04/04/85	-	-	-
04/09/85	-	1389.0	-
04/17/85	-	-	-
04/26/85	-	-	-
05/03/85	-	1389.1	-
05/10/85	-	-	-
05/15/85	<2.05E2	-	-
05/16/85	-	-	-
05/24/85	-	-	-
05/28/85	-	1388.9	-
06/06/85	-	-	-
06/19/85	-	-	-

06/25/85
07/24/85

<3.10E2⁻

-
-

-
-

WATER DATA

Borehole: K7-7

Date Drilled: 11/13/84

Completed: 11/13/84

Installation: Well

Depths: TD = 21'

Sampled interval: 9-19'

Location: N427470.8 E1695414.1

Ground Elevation: 1294.6'

Casing Elevation: 1296.5'

Remarks:

Monitoring Record

Date	Water ³ H (pCi/l +/- 2 s.d.)	Water Elev. (ft)	Notes
12/07/84	2.35E4 -	-	-
12/13/84	2.34E4 (4.7E2)	-	-
01/04/85	-	1277.0	-
01/22/85	2.79E4 (5.0E2)	1276.9	-
01/29/85	-	1276.9	-
02/05/85	-	1276.8	-
02/13/85	-	1276.8	-
02/20/85	-	1276.6	-
02/22/85	3.60E4 (5.6E2)	-	-
02/28/85	2.73E4 (4.9E2)	1276.5	-
03/08/85	-	1276.5	-
03/15/85	-	1276.5	-
03/21/85	-	1276.4	-
03/29/85	3.60E4 (5.5E2)	1276.5	-
04/04/85	-	1276.3	-
04/09/85	-	1276.3	-
04/17/85	-	1276.3	-
04/26/85	-	1276.2	-
05/03/85	3.67E4 (5.6E2)	1276.3	-
05/10/85	-	1276.1	-
05/16/85	-	1276.1	-
05/18/85	3.83E4 (5.7E2)	-	-
05/24/85	-	1276.1	-
05/26/85	3.44E4 (5.4E2)	-	-
05/28/85	-	1276.1	-
06/06/85	-	1276.1	-

06/19/85	-	1275.9	-
06/22/85	3.59E4 (5.6E2)	-	-
06/25/85	-	1275.9	-
07/24/85	3.90E4 (5.9E2)	1277.2	-
08/28/85	4.20E4 (6.0E2)	1275.7	-
10/04/85	4.10E4 (5.9E2)	1275.8	-

WATER DATA

Borehole: K7-8A

Date Drilled: 12/20/84

Completed: 1/14/85

Installation: Lysimeter

Depths: TD = 46.0'

Sampled interval: 45.8'

Location: N428764.6 E1694031.6

Ground Elevation: 1380.9'

Casing Elevation: N/A

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H</u> <u>(pCi/l +/- 2 s.d.)</u>	<u>Water Elev.</u> <u>(ft)</u>	<u>Notes</u>
05/29/85	<2.05E2	-	-
06/24/85	<3.78E2	-	-
07/25/85	<2.65E2	-	-
08/30/85	<2.43E2	-	-

WATER DATA

Borehole: NC2-2

Date Drilled: 8/23/84

Completed: 8/30/84

Installation: Lysimeter

Depths: TD = 15.0'

Sampled interval: 14.5'

Location: N427625.1 E1698348.6

Ground Elevation: 1064.8'

Casing Elevation: N/A

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H</u> <u>(pCi/l +/- 2 s.d.)</u>	<u>Water Elev.</u> <u>(ft)</u>	<u>Notes</u>
01/04/85	-	-	Flush
01/14/85	-	-	Flush
01/22/85	2.28E3 (2.2E2)	-	Sampled
03/01/85	2.35E3 (2.3E2)	-	Sampled
03/29/85	2.00E3 (2.1E2)	-	Sampled
05/03/85	2.13E3 (2.2E2)	-	Sampled
05/29/85	2.32E3 (2.3E2)	-	Sampled
06/24/85	2.15E3 (2.3E2)	-	Sampled
07/25/85	2.40E3 (2.4E2)	-	Sampled
10/04/85	2.37E3 (2.3E2)	-	Sampled

WATER DATA

Borehole: NC2-3

Date Drilled: 8/23/84

Completed: 8/30/84

Installation: Lysimeter

Depths: TD = 14.8'

Sampled interval: 14.5'

Location: N427629.7 E1698350.0

Ground Elevation: 1064.3'

Casing Elevation: N/A

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H</u> <u>(pCi/l +/- 2 s.d.)</u>	<u>Water Elev.</u> <u>(ft)</u>	<u>Notes</u>
01/04/85	-	-	Flush
01/14/85	-	-	Flush
01/22/85	6.77E3 (3.0E2)	-	Sampled
03/01/85	6.22E3 (2.9E2)	-	Sampled
03/29/85	6.62E3 (2.9E2)	-	Sampled
06/24/85	6.30E3 (2.9E2)	-	Sampled
07/25/85	6.70E3 (3.0E2)	-	Sampled
08/30/85	-	-	NS
10/04/85	-	-	NS

WATER DATA

Borehole: NC2-4

Date Drilled: 8/23/84

Completed: 8/30/84

Installation: Lysimeter

Depths: TD = 15.0'

Sampled interval: 15.0'

Location: N426957.9 E1698134.6

Ground Elevation: 1087.3'

Casing Elevation: N/A

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H</u> <u>(pCi/l +/- 2 s.d.)</u>	<u>Water Elev.</u> <u>(ft)</u>	<u>Notes</u>
01/04/85	-	-	Flush
01/14/85	-	-	Flush
01/18/85	1.43E5 (1.5E3)	-	Sampled
03/01/85	1.40E5 (1.4E3)	-	Sampled
03/29/85	1.43E5 (1.5E3)	-	Sampled
06/24/85	1.44E5 (1.5E3)	-	Sampled
07/25/85	-	-	NS
08/30/85	-	-	NS
10/04/85	-	-	NS

WATER DATA

Borehole: NC2-5

Date Drilled: 11/29/84

Completed: 11/29/84

Installation: Well

Depths: TD = 56.0'

Sampled interval: 40-55'

Location: N426856.9 E1699747.0

Ground Elevation: 1032.3'

Casing Elevation: 1034.2'

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
12/03/84	<3.58E2	-	-
01/10/84	<2.05E2	-	-
01/16/85	-	990.7	-
01/18/85	2.72E2 (2.0E2)	-	-
01/22/85	-	990.7	-
02/13/85	-	990.5	-
02/20/85	-	990.2	-
03/01/85	<2.14E2	990.0	-
03/08/85	-	989.8	-
03/15/85	-	-	-
03/21/85	-	989.7	-
03/29/85	<2.05E2	989.5	-
04/04/85	-	989.4	-
04/09/85	-	989.7	-
04/17/85	-	990.0	-
04/26/85	-	990.0	-
05/03/85	<2.09E2	990.1	-
05/10/85	-	990.0	-
05/16/85	-	990.0	-
05/24/85	-	989.8	-
05/26/85	<2.05E2	-	-
05/28/85	-	989.7	-
06/06/85	-	989.4	-
06/19/85	-	989.9	-
06/22/85	<2.96E2	-	-
06/25/85	-	990.0	-

07/24/85	<3.12E2	990.4	-
08/28/85	<2.27E2	990.8	-
10/04/85	2.02E2 (1.8E2)	990.7	-

WATER DATA

Borehole: K2-1C

Date Drilled: 6/2-14/82

Completed: 6/14/82

Installation: Well

Depths: TD = 234.3'

Sampled interval: 58.1-85.0'

Location: N427185.0 E1698962.6

Ground Elevation: 1049.0'

Casing Elevation: 1049.3'

Remarks: Multiple completion installed before current study

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
08/82	1.03E3 (1.3E2)	-	-
07/83	-	1003.3	-
03/84	2.10E4 (1.0E3)	1007.3	-
06/84	3.40E4 (2.0E3)	1005.4	-
09/84	3.36E4 (5.0E2)	1003.6	-
01/16/85	-	982.9	EM
02/05/85	3.50E4 (5.4E2)	999.1	-
02/05/85	3.80E4 (1.7E3)	-	HC
02/13/85	-	982.6	EM
02/22/85	3.72E4 (5.6E2)	998.5	-
03/01/85	-	998.5	-
03/08/85	-	998.3	-
03/15/85	-	-	-
03/21/85	-	998.1	-
03/29/85	3.91E4 (5.8E2)	997.8	-
04/04/85	-	998.1	-
04/09/85	-	997.7	-
04/14/85	3.91E4 (5.7E2)	-	-
04/17/85	-	997.6	-
04/26/85	-	997.6	-
05/03/85	-	-	-
05/10/85	-	998.2	-
05/16/85	-	998.1	-
05/24/85	-	997.3	-
05/28/85	-	997.0	-
06/06/85	-	996.9	-

06/19/85	-	996.9	-
06/25/85	3.76E4 (5.3E2)	996.6	-
07/24/85	-	-	-
08/28/85	4.38E4 (6.2E2)	996.4	-
10/04/85	4.60E4 (6.3E2)	997.0	-

WATER DATA

Borehole: K2-2

Date Drilled: 5/19-28/82

Completed: 5/28/82

Installation: Well

Depths: TD = 161.0'

Sampled interval: 120.0-155.4'

Location: N427625.2 E1698347.7

Ground Elevation: 1064.4'

Casing Elevation: 1068.4'

Remarks: Multiple completion installed before current study

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
3/1/85	-	1023.1	-
4/9/85	-	1022.5	-

WATER DATA

Borehole: K2-3

Date Drilled: 6/14-15/82

Completed: 6/15/82

Installation: Well

Depths: TD = 80.0'

Sampled interval: 50.0-78.5'

Location: N427630.0 E1698349.7

Ground Elevation: 1064.0'

Casing Elevation: 1065.9'

Remarks:

Monitoring Record

Date	Water ³ H (pCi/l +/- 2 s.d.)	Water Elev. (ft)	Notes
3/1/85	-	1016.3	-
4/9/85	-	1016.1	-
05/24/85	-	-	-
05/26/85	<2.05E2	-	-
05/28/85	-	1025.6	EM

WATER DATA

Borehole: K2-4

Date Drilled: 9/28-30/82

Completed: 9/30/82

Installation: Well

Depths: TD = 206.5'

Sampled interval: 18.0-59.0'

Location: N426954.2 E1698153.5

Ground Elevation: 1087.6'

Casing Elevation: 1089.6'

Remarks: Installed before current study

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
08/82	1.41E4 (2.3E2)	-	-
11/82	7.00E3 (1.0E3)	-	-
05/84	4.18E3 (2.7E2)	1074.3	-
09/84	6.25E3 (2.9E2)	1072.1	-
01/05/85	<3.57E2	-	-
01/16/85	-	1050.8	EM
02/05/85	<3.89E2	1071.8	-
02/05/85	9.65E2 (4.5E2)	-	HC
02/15/85	3.25E3 (2.4E2)	1050.6	EM
02/20/85	-	1071.6	-
02/28/85	-	1071.6	-
03/01/85	-	1071.6	-
03/08/85	-	1071.5	-
03/15/85	-	-	-
03/21/85	-	1071.5	-
03/29/85	3.86E2 (1.9E2)	1071.3	-
04/04/85	-	1071.4	-
04/09/85	-	1071.2	-
04/14/85	3.37E3 (2.4E2)	-	-
04/17/85	-	1071.0	-
04/26/85	-	1071.0	-
05/03/85	-	-	-
05/10/85	-	1070.8	-
05/16/85	-	1070.7	-
05/24/85	-	1070.8	-
05/28/85	-	1070.7	-

06/06/85	-	1070.5	-
06/19/85	-	1070.4	-
06/25/85	6.72E2 (2.0E2)	1070.3	-
07/24/85	-	-	-
08/28/85	9.00E2 (2.1E2)	1070.0	-
10/04/85	8.04E2 (2.0E2)	1069.8	-

WATER DATA

Borehole: K1-1C

Date Drilled: 8/20-30/82

Completed: 8/30/82

Installation: Well

Depths: TD = 377.5'

Sampled interval: 92.0-113.5'

Location: N427775.0 E1699060.4

Ground Elevation: 1073.7'

Casing Elevation: 1075.0'

Remarks: Multiple completion well

Monitoring Record

<u>Date</u>	<u>Water ³H</u> <u>(pCi/l +/- 2 s.d.)</u>	<u>Water Elev.</u> <u>(ft)</u>	<u>Notes</u>
02/21/85	-	985.2	-
04/18/85	-	984.5	-
06/09/85	<2.82E2	-	-
06/11/85	-	984.0	-
09/17/85	-	983.0	-

WATER DATA

Borehole: K1-2

Date Drilled: 08/12-17/82

Completed: 8/17/82

Installation: Well

Depths: TD = 284.0'

Sampled interval: 123.1-172.5'

Location: N427893.7 E1699450.6

Ground Elevation: 1105.6'

Casing Elevation: 1106.0

Remarks: Multiple completion well

Monitoring Record

<u>Date</u>	<u>Water ³H</u> <u>(pCi/l +/- 2 s.d.)</u>	<u>Water Elev.</u> <u>(ft)</u>	<u>Notes</u>
02/21/85	<2.14E2	979.8	-
04/16/85	4.09E2 (1.9E2)	-	-
04/18/85	-	979.2	-
07/25/85	-	978.4	-
08/25/85	<4.09E2	-	-

WATER DATA

Borehole: K1-2A

Date Drilled: 11/26/84

Completed: 11/29/84

Installation: Lysimeter

Depths: TD = 42.0'

Sampled interval: 42.0'

Location: N427892.1 E1699469.9

Ground Elevation: 1104.5'

Casing Elevation: N/A

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H</u> <u>(pCi/l +/- 2 s.d.)</u>	<u>Water Elev.</u> <u>(ft)</u>	<u>Notes</u>
01/18/85	<2.05E2	-	-
03/01/85	-	-	NS
07/25/85	<3.42E2	-	-

WATER DATA

Borehole: K1-3

Date Drilled: 8/23-24/83

Completed: 8/24/83

Installation: well

Depths: TD = 171.0'

Sampled interval: 151.0-171.0'

Location: N428047.2 E1699257.2

Ground Elevation: 1105.7'

Casing Elevation: 1106.8'

Remarks: Installed before current study

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
01/18/85	<2.05E2	-	-
02/21/85	<2.21E2	-	-
04/16/85	<2.05E2	-	-
04/18/85		977.4	-
07/25/85	<2.90E2	976.8	-
08/25/85	2.35E2 (2.3E2)	-	-

WATER DATA

Borehole: K1-3A

Date Drilled: 11/27/84

Completed: 11/29/84

Installation: Lysimeter

Depths: TD = 41.7'

Sampled interval: 41.7'

Location: N428048.5 E1699255.1

Ground Elevation: 1105.8'

Casing Elevation: N/A

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H</u> <u>(pCi/l +/- 2 s.d.)</u>	<u>Water Elev.</u> <u>(ft)</u>	<u>Notes</u>
03/01/85	<3.06E2	-	-
03/29/85	<2.44E2	-	-
05/29/85	<2.05E2	-	-

WATER DATA

Borehole: K1-4

Date Drilled: 8/18-19/83

Completed: 8/19/83

Installation: Well

Depths: TD =201.0'

Sampled interval: 185-200'

Location: N428316.3 E1699229.8

Ground Elevation: 1119.8'

Casing Elevation: 1120.9'

Remarks: Installed before current study

Monitoring Record

<u>Date</u>	<u>Water ³H (pCi/l +/- 2 s.d.)</u>	<u>Water Elev. (ft)</u>	<u>Notes</u>
02/21/85	<2.14E2	-	-
04/16/85	<2.05E2	-	-
04/18/85	-	970.8	-
07/25/85	<2.89E2	971.2	-
08/25/85	<2.27E2	-	-

WATER DATA

Borehole: K1-5

Date Drilled: 11/19-21/84

Completed: 11/21/84

Installation: Well

Depths: TD = 198.7'

Sampled interval: 163-183'

Location: N428485.8 E1699057.0

Ground Elevation: 1128.6'

Casing Elevation: 1130.8'

Remarks:

Monitoring Record

Date	Water ³ H (pCi/l +/- 2 s.d.)	Water Elev. (ft)	Notes
03/01/85	-	964.3	-
03/25/85	<2.05E2	-	-
05/24/85	-	-	-
05/26/85	<2.05E2	-	-
05/27/85	<2.05E2	-	-
05/28/85	-	963.7	-
06/06/85	-	-	-
06/19/85	-	-	-
06/25/85	-	-	-
07/24/85	-	963.8	-
08/13/85	-	963.6	-
08/24/85	<2.27E2	-	-

WATER DATA

Borehole: K1-5A

Date Drilled: 11/26/84

Completed: 11/29/84

Installation: Lysimeter

Depths: TD = 40.5'

Sampled interval: 40.5'

Location: N428482.9 E1699061.6

Ground Elevation: 1128.6'

Casing Elevation: N/A

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H</u> <u>(pCi/l +/- 2 s.d.)</u>	<u>Water Elev.</u> <u>(ft)</u>	<u>Notes</u>
01/18/85	<2.01E2	-	-
03/01/85	<2.14E2	-	-
03/29/85	<2.05E2	-	-
05/29/85	<2.97E2	-	-

WATER DATA

Borehole: K1-6

Date Drilled: 11/14-19/84

Completed: 11/19/84

Installation: Well

Depths: TD = 117.4'

Sampled interval: 95-115'

Location: N427736.6 E1699628.2

Ground Elevation: 1087.2'

Casing Elevation: 1088.6'

Remarks:

Monitoring Record

<u>Date</u>	<u>Water ³H</u> <u>(pCi/l +/- 2 s.d.)</u>	<u>Water Elev.</u> <u>(ft)</u>	<u>Notes</u>
03/01/85	-	979.7	-
05/24/85	-	-	-
05/26/85	<2.05E2	-	-
05/28/85	-	979.2	-

APPENDIX F: SITE 300 RAINFALL RECORDS

This appendix contains detailed rainfall records by calendar year for the Site 300 meteorological station beginning in 1980. Long term rainfall data for two stations at Site 300 were presented by Raber and Carpenter¹.

The site meteorological station is located approximately 3 km southeast of the Pit 7 complex at an elevation of 1230 ft and is the best available representation of conditions in the study area. The average annual precipitation (1966-1985) for the site station was 10.73 in. The average annual precipitation (1960-1982) for a second station located in the Site 300 General Services Area at 515-ft elevation was 10.00 in. The water year (Oct.-Sep.) precipitation totals for the site meteorological station are:

<u>Water year</u>	<u>in./year</u>
1966	6.96
1967	13.33
1968	7.78
1969	13.29
1970	9.23
1971	13.14
1972	4.75
1973	16.08
1974	14.09
1975	12.48
1976	4.85
1977	6.18
1978	10.48
1979	9.48
1980	9.44
1981	9.13
1982	16.90
1983	19.91
1984	8.38
1985	<u>8.77</u>
Annual average	10.73

Table F1. Site 300 rainfall record for the 1980 calendar year (in./day).

Date	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.-Oct.	Nov.	Dec.
1	0.02	-	-	-	-	-	-	-	-	-
2	-	-	0.21	-	-	-	0.49	-	-	-
3	-	-	0.01	-	-	-	-	-	-	0.34
4	-	-	-	0.16	-	-	-	-	-	0.10
5	-	-	0.20	0.24	-	-	-	-	-	-
6	-	-	0.24	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-
8	0.17	-	-	-	-	-	-	-	-	-
9	0.35	-	-	-	0.05	-	-	-	-	-
10	0.30	-	-	-	-	-	-	-	-	-
11	0.25	-	-	-	-	-	-	-	-	-
12	0.11	-	-	-	-	-	-	-	-	-
13	0.43	-	-	-	-	-	-	-	-	-
14	0.03	0.22	-	-	-	-	-	-	-	-
15	0.11	0.24	-	-	-	-	-	-	-	-
16	0.01	0.38	-	-	-	-	-	-	-	-
17	0.28	0.07	-	-	-	-	-	-	-	-
18	-	0.21	-	-	-	-	-	-	-	-
19	-	0.44	-	-	-	-	-	-	-	-
20	-	0.37	-	0.02	-	-	-	-	-	-
21	-	0.07	-	0.08	-	-	-	-	-	0.15
22	-	0.05	-	0.17	-	-	-	-	-	0.02
23	-	-	-	-	0.06	-	-	-	0.12	-
24	-	-	-	-	-	-	-	-	-	-
25	-	-	0.20	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-
27	-	0.21	-	-	-	-	-	-	-	-
28	-	-	-	0.02	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-
31	-	-	0.01	-	-	-	-	-	-	-
	<u>2.06</u>	<u>2.26</u>	<u>0.87</u>	<u>0.69</u>	<u>0.11</u>	<u>0.00</u>	<u>0.49</u>	<u>0.00</u>	<u>0.12</u>	<u>0.61</u>

TOTAL, 1980 rainfall: 7.21 in.

Table F2. Site 300 rainfall record for the 1981 calendar year (in./day).

Date	Jan.	Feb.	Mar.	Apr.	May	Jun.-Sep.	Oct.	Nov.	Dec.
1	-	-	0.30	-	-	-	-	-	-
2	-	-	0.09	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-
4	-	-	0.22	-	-	-	0.13	-	-
5	-	-	-	-	-	-	-	0.12	-
6	-	-	-	-	-	-	-	0.02	0.01
7	0.01	-	-	-	-	-	0.01	-	0.01
8	-	0.28	-	-	-	-	-	-	0.04
9	-	0.04	-	-	-	-	-	-	0.04
10	-	0.03	-	-	-	-	0.01	-	-
11	-	0.01	-	-	-	-	-	-	-
12	-	-	0.12	-	-	-	-	0.50	0.06
13	-	0.04	0.28	-	-	-	-	1.30	0.03
14	-	0.06	-	-	-	-	-	-	-
15	0.02	-	0.20	-	-	-	-	-	-
16	0.01	-	-	-	-	-	-	0.09	-
17	0.01	-	-	-	-	-	-	0.05	-
18	-	-	0.14	0.37	0.15	-	-	-	0.17
19	-	0.01	0.34	0.15	-	-	-	-	0.03
20	0.02	-	0.02	-	-	-	-	-	0.11
21	-	-	0.16	-	-	-	-	0.12	-
22	0.22	-	-	-	-	-	-	0.02	-
23	0.07	-	-	-	-	-	-	0.04	-
24	-	0.09	-	-	-	-	-	0.03	-
25	-	0.12	0.10	-	-	-	-	-	-
26	0.53	-	0.05	-	-	-	-	0.08	-
27	0.86	-	-	-	-	-	0.08	0.26	-
28	0.62	0.01	-	-	-	-	0.54	-	0.75
29	0.14	-	-	-	-	-	0.01	-	0.20
30	2.51	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	0.01
	<u>5.02</u>	<u>0.69</u>	<u>2.02</u>	<u>0.52</u>	<u>0.15</u>	<u>0.00</u>	<u>0.78</u>	<u>2.63</u>	<u>2.06</u>

TOTAL, 1981 rainfall: 13.87 in.

Table F3. Site 300 rainfall record for the 1982 calendar year (in./day).

Date	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul., Aug.	Sep.	Oct.	Nov.	Dec.
1	0.33	-	0.26	0.06	-	-	-	-	-	-	-
2	-	-	0.16	-	-	-	-	-	-	-	0.01
3	0.30	-	-	0.16	-	-	-	-	-	-	-
4	0.69	-	-	0.10	-	-	-	-	-	-	0.01
5	0.13	-	-	0.04	-	-	-	-	-	-	0.01
6	-	-	-	0.01	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	0.03	-
9	-	-	0.18	-	-	-	-	-	-	0.91	-
10	-	-	0.25	0.41	-	-	-	-	-	0.04	-
11	-	-	0.43	0.07	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-
13	-	0.20	-	-	-	-	-	-	-	-	-
14	-	0.37	0.20	-	-	-	-	-	-	-	-
15	-	0.99	-	-	-	-	-	0.04	-	-	-
16	-	0.02	0.21	-	-	-	-	0.27	-	0.01	-
17	0.04	-	0.34	-	-	-	-	0.59	-	0.14	-
18	0.02	-	0.10	-	-	-	-	0.02	-	0.89	-
19	0.25	-	-	-	-	-	-	-	-	0.04	-
20	-	-	-	-	-	-	-	-	-	-	0.09
21	-	-	-	-	-	-	-	-	0.01	-	0.01
22	-	-	-	-	-	-	-	-	-	0.30	0.95
23	-	-	-	-	-	-	-	0.45	-	0.05	0.27
24	-	-	-	-	-	-	-	0.12	-	-	-
25	-	-	-	-	-	-	-	0.70	0.55	-	-
26	0.04	-	0.06	-	-	-	-	-	0.03	-	-
27	-	0.01	0.19	-	-	-	-	-	-	0.01	-
28	0.35	-	0.02	-	-	-	-	-	-	0.11	-
29	-	-	0.19	-	-	0.29	-	-	0.07	0.30	-
30	-	-	0.53	-	-	0.03	-	-	0.31	0.42	-
31	-	-	1.21	-	-	-	-	-	-	-	-
	2.15	1.59	4.33	0.85	0.00	0.32	0.00	2.19	0.97	3.25	1.35

TOTAL, 1982 rainfall: 17.00 in.

Table F4. Site 300 rainfall record for the 1983 calendar year (in./day).

Date	Jan.	Feb.	Mar.	Apr.	May	Jun., Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1	-	-	0.25	-	-	-	-	-	0.03	-	-
2	-	-	0.21	-	-	-	-	-	-	-	-
3	-	-	0.27	-	-	-	-	-	-	-	0.29
4	-	-	-	-	-	-	-	-	-	-	-
5	0.01	0.11	0.19	-	0.02	-	-	-	-	-	-
6	0.01	0.64	0.17	-	-	-	-	-	-	-	-
7	-	0.22	-	-	-	-	-	-	-	-	-
8	-	0.07	-	-	-	-	-	-	-	0.08	-
9	-	-	-	-	-	-	-	-	-	0.18	0.32
10	-	-	0.76	-	-	-	-	-	-	0.99	0.08
11	-	0.05	-	-	-	-	-	-	-	-	0.31
12	-	0.11	0.42	-	-	-	-	-	-	0.02	-
13	-	0.06	0.50	-	-	-	-	-	-	0.32	-
14	-	-	-	-	-	-	-	-	-	-	0.02
15	0.01	-	-	-	-	-	-	-	-	-	-
16	0.25	-	0.10	-	-	-	-	-	-	0.20	-
17	-	-	0.16	-	-	-	-	-	-	0.49	-
18	0.37	0.37	0.02	0.10	-	-	-	-	-	-	-
19	0.11	-	-	0.02	-	-	0.63	-	-	0.15	-
20	-	-	0.07	0.23	-	-	-	-	-	0.55	-
21	0.04	-	-	-	-	-	-	-	-	-	-
22	1.51	-	0.18	-	-	-	-	-	-	0.02	0.70
23	-	-	0.12	-	-	-	-	-	-	0.90	0.10
24	0.02	0.15	0.36	0.07	-	-	-	-	-	-	0.44
25	-	-	-	0.21	-	-	-	-	-	-	0.10
26	0.96	0.35	0.10	-	-	-	-	-	-	-	0.08
27	0.11	0.49	0.22	0.65	-	-	-	-	-	-	-
28	0.43	0.75	-	0.26	-	-	-	-	-	-	-
29	0.03	-	-	0.16	-	-	-	0.02	0.19	-	-
30	-	-	-	0.07	-	-	-	0.57	0.04	-	0.20
31	-	-	-	-	-	-	-	-	-	-	0.02
	3.86	3.37	4.10	1.77	0.02	0.00	0.63	0.59	0.26	3.90	2.66

TOTAL, 1983 rainfall: 21.16 in.

Table F5. Site 300 rainfall record for the 1984 calendar year (in./day).

Date	Jan.	Feb.	Mar.	Apr.	May-Aug.	Sep.	Oct.	Nov.	Dec.
1	-	-	-	0.10	-	-	-	-	-
2	-	-	-	-	-	-	-	-	0.17
3	-	-	-	-	-	-	-	-	0.01
4	-	-	-	-	-	-	-	-	-
5	0.01	-	-	-	-	-	-	-	0.02
6	0.01	-	-	-	-	-	-	0.20	-
7	0.01	-	-	-	-	-	-	0.30	-
8	0.03	-	-	0.08	-	-	-	0.33	-
9	0.05	0.21	-	-	-	-	-	-	0.20
10	0.01	-	-	0.02	-	-	-	0.15	0.07
11	0.01	0.02	-	-	-	-	0.34	0.01	-
12	-	0.12	-	-	-	-	-	0.21	-
13	-	-	0.11	-	-	-	-	0.29	-
14	-	-	0.03	-	-	-	-	-	-
15	0.02	-	0.07	-	-	-	-	0.03	0.37
16	0.16	-	0.15	-	-	-	0.49	0.19	-
17	-	-	-	-	-	-	-	0.12	-
18	-	-	-	0.16	-	0.02	-	0.04	0.03
19	-	-	-	0.06	-	-	-	-	0.01
20	-	-	-	-	-	-	-	0.01	-
21	-	-	-	-	-	-	-	-	-
22	0.10	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	0.24	0.01
25	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	0.25
27	-	-	-	-	-	-	-	0.48	-
28	-	-	-	-	-	-	-	0.09	-
29	-	-	-	-	-	-	0.12	-	0.01
30	-	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-
	<u>0.41</u>	<u>0.35</u>	<u>0.36</u>	<u>0.42</u>	<u>0.00</u>	<u>0.02</u>	<u>0.95</u>	<u>2.69</u>	<u>1.15</u>

TOTAL, 1984 rainfall: 6.35 in.

Table F6. Site 300 rainfall record for the 1985 calendar year (in./day).

Date	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul., Aug.	Sep.	Oct.	Nov.	Dec.
1	-	0.10	0.06	-	-	-	-	-	-	-	-
2	-	-	0.01	-	-	0.20	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-
4	-	-	0.02	-	-	-	-	-	-	-	-
5	-	-	0.06	-	-	-	-	-	-	-	-
6	-	-	0.12	-	-	-	-	-	0.01	-	-
7	0.39	-	0.05	-	-	-	-	0.01	-	-	-
8	0.01	0.64	-	-	-	-	-	0.03	-	-	-
9	0.08	-	-	-	-	-	-	0.02	0.08	0.31	-
10	-	-	0.26	-	0.01	-	-	-	-	0.10	-
11	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	0.23	-	-	-	-	-	-	-
17	-	-	-	0.24	-	-	-	-	-	-	-
18	-	-	0.08	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	0.32	-	-
21	0.01	-	-	-	-	-	-	-	0.42	-	-
22	0.01	-	-	-	-	-	-	-	-	-	-
23	0.02	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-	-	-
26	-	-	0.57	-	-	-	-	-	-	-	-
27	-	-	0.43	-	-	-	-	-	-	-	-
28	0.18	-	0.14	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-
	0.70	0.74	1.80	0.48	0.01	0.20	0.00	0.06	0.81	---	---

TOTAL, 1985 rainfall to November 10: 4.80 in.

REFERENCES

1. Ellen Raber and David W. Carpenter, Eds., An Evaluation of the Hydrogeology and Groundwater Chemistry Associated with Landfills at LLNL's Site 300, Lawrence Livermore National Laboratory, Livermore, CA, UCRL-53416 (1983).

Plate 1. Locations of boreholes, wells, springs, disposal pits, key roads and buildings, and major surface drainage channels in the area of interest in the East and West Firing Areas of Site 300.

Data as of Sept. 30, 1985.