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ABSTRACT

Lawrence Livermore National Laboratory (LLNL) has conducted a long-term single-pass continuous-flow (SPCF) leaching test of the glass waste form PNL 76-68. Leaching rates of Np, Pu and various stable elements were measured at 25° and 75°C with three different solutions and three different flow rates. The purposes of the study were: 1.) to compare SPCF leaching results with the results of a modified IAEA leach test performed by Pacific Northwest Laboratories (PNL); 2.) to establish elemental leach rates and their variation with temperature, flow rate and solution composition; and 3.) to gain insight into the leaching mechanisms.

The LLNL and PNL leach tests yielded results which appear to agree within experimental uncertainties.

The magnitude of the leach rates determined for Np and the glass matrix elements is 10^{-5} grams of glass/cm^2 geometric solid surface area/day. The rates increase with temperature and with solution flow rate, and are similar in brine and distilled water but higher in a bicarbonate solution. Other cations exhibit somewhat different behavior, and Pu in particular yields a much lower apparent leach rate, probably because of sorption or precipitation effects after release from the glass matrix.

After the initial few days, most elements are leached at a constant rate. Matrix dissolution appears to be the most probable rate controlling step for the leaching of most elements.

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I. INTRODUCTION

In order to evaluate the safety of geologic repositories for storage of nuclear waste, information is needed concerning the potential for radionuclide release in the event that ground water contacts the waste. Information on the release of radionuclides from the waste form, from empirical data to an understanding of leaching mechanisms, is needed for safety assessments and as input for radionuclide migration experiments and models. This report examines the release of plutonium, neptunium and other elements from a simulated waste glass (PNL 76-68). The glass contained stable isotopes of the full complement of fission product elements, plus plutonium and neptunium to the extent expected to be present in high-level waste. This permitted chemically realistic studies to be conducted without the radiochemical interferences and radiation fields that would be encountered with a fully radioactive waste.

The objective of this report is to present the results from and compare two different leach test methods: a modified IAEA leach test conducted at the Pacific Northwest Laboratory and a single-pass continuous flow (SPCF) test performed at Lawrence Livermore National Laboratory. The comparison was undertaken to determine whether quasi-static (IAEA) leach tests yield results relevant to a dynamic flowing groundwater environemnt. Both tests used glass prepared from the same melt, and similar solutions and temperatures were employed. In addition to the common temperature of 25°C, the LLNL test also used 75°C to gain insight into the temperature dependence of radionuclide release into flowing solutions.

This report is primarily a description of the LLNL SPCF leach test (Bead Leach I). A thorough description of the PNL modified IAEA leach test as well as a description of the glass bead preparation can be found in PNL-3152.[1] However, since one of the objectives of this report is to compare the results from these two leach test methods, parts of PNL-3152 are recapitulated in this report.

The use of the single-pass continuous-flow test methodology is being carried on at LLNL in a subsequent test (Bead Leach II). That experiment incorporates rock material in order to address more complex and realistic waste/rock interactions. The primary objective is to study the sorption of freshly leached elements onto rock columns located downstream from the leaching cell.

II. MATERIALS AND METHODS

A. PREPARATION AND CHARACTERIZATION OF THE DOPED GLASS

The preparation and characterization of the doped glass used in this study has been discussed in PNL-3152.[1]

The simulated high level waste glass used in both the LLNL and PNL work was doped with "mock" fission products, ^{238}U, ^{237}Np, and ^{239}Pu at levels expected in actual waste glass. Mock fission products (stable isotopes of fission product elements) were used in order to avoid conducting experiments in a high radiation field while maintaining a realistic chemical composition.

The molten glass was dropped from an orifice onto a warm (500°C) plate where hemispherical beads (with a diameter of ca. 7 mm) were formed. The beads were then annealed and cooled to room temperature. A microstructural examination was performed at PNL which included x-ray diffraction, metallography, and alpha-radiography.[1] The beads were then used in the two leaching tests described in this report.

At LLNL, air dried beads were weighed before and after leaching. Initial geometric surface areas were calculated from detailed measurements on individual beads. The specific surface areas of selected beads were measured after leaching by a Kr adsorption technique. The leached beads have been archived for possible future studies.

B. LEACH TEST PROCEDURES

1. PNL Modified IAEA Leach Test

The PNL modified IAEA leach test procedure has been described elsewhere.[1,2] The original IAEA test was described by Hespe.[3] In that test, a static leaching test is interrupted at predetermined sampling intervals when the leachate is decanted and replaced with fresh leachant. The PNL modified IAEA test was similar and differed mainly in the sampling frequencies and the leaching apparatus. In both of these quasi-static tests, solution saturation is a potential problem. The periodic leachant renewal is an attempt to eliminate the possible saturation effect. However, it is questionable whether these tests can be a valid simulation of the leaching behavior of flowing ground water. Since LLNL has developed a truly dynamic flowing test, one goal of this study was to determine if the PNL "simulated" flowing experiment really was equivalent to an actual flowing experiment. The chemical arguments for the importance of flowing experiments, where solution saturation problems are less likely, have been addressed elsewhere.[7]

The PNL modified IAEA leach test utilized twenty beads in contact with 300 ml of leachant. The beads were suspended in the leachant in a nylon-mesh basket. The leachant was contained in a polypropylene jar. Three leachants were used. One was saturated salt brine made by dissolving reagent grade chemicals in deionized water to approximate the composition of WIPP Brine "B".[1] Another leachant was a synthetic high bicarbonate ground water (0.03 N $NaHCO_3$). The final leachant used in the comparative test was deionized water.

The temperature for this test was 22 ± 2°C. No attempt was made to isolate the leachant and samples from the atmosphere so that it can be assumed that the Eh of the system was mildly oxidizing because of initial equilibration with atmospheric O_2.

Leachates were sampled and replaced with fresh leachant every day for the first 4 days, weekly for the next 8 weeks, then monthly for the remainder of the study. Samples were analyzed for pH, Eh, silicon, ^{237}Np, and ^{239}Pu.

Incremental leach rates and cumulative fractions leached were calculated on the basis of release of Si, ^{237}Np and ^{239}Pu, and plotted against time.[1]

2. LLNL SPCF Leach Test

The LLNL SPCF leach testing methodology has been described in detail previously.[4,5,6,7] It is essentially a system where the leachant flows through a cell containing the waste form, and the resultant leachate is collected and analyzed. The advantage of this system is that it more nearly simulates the conditions of a flooded repository where ground water flows through a natural aquifer. Figure 1 is a schematic diagram of the SPCF test.

Figure 2 is a schematic diagram of the Bead Leach I experimental matrix. It is a statistically designed factorial experiment with partial replication. Variables for the experiment are flow rate (3 values), temperature (25^0 and 75^0) and leachant composition (3 solutions). Channels with beads not doped

Schematic Diagram of the Continuous Flow Leach Test

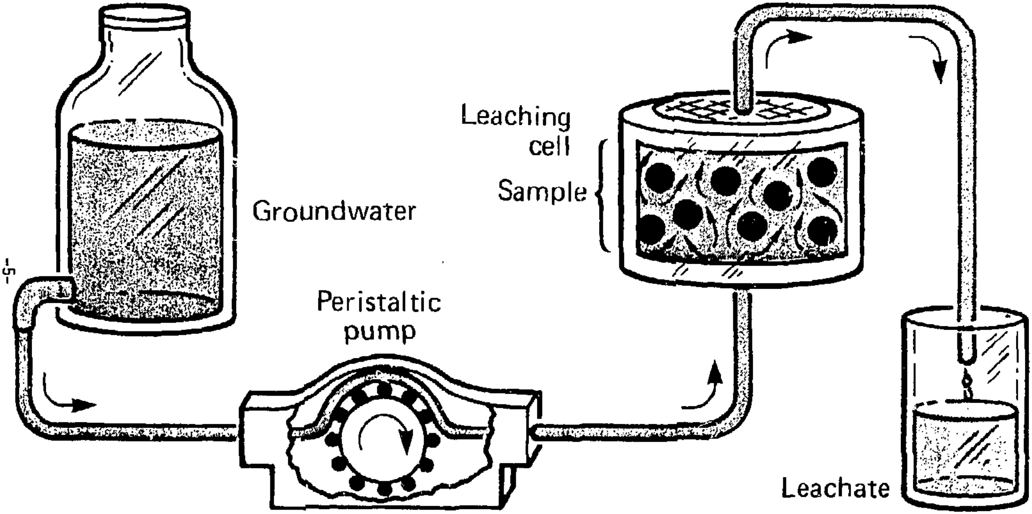


Figure 1

Bead Leach I Experimental Design Matrix

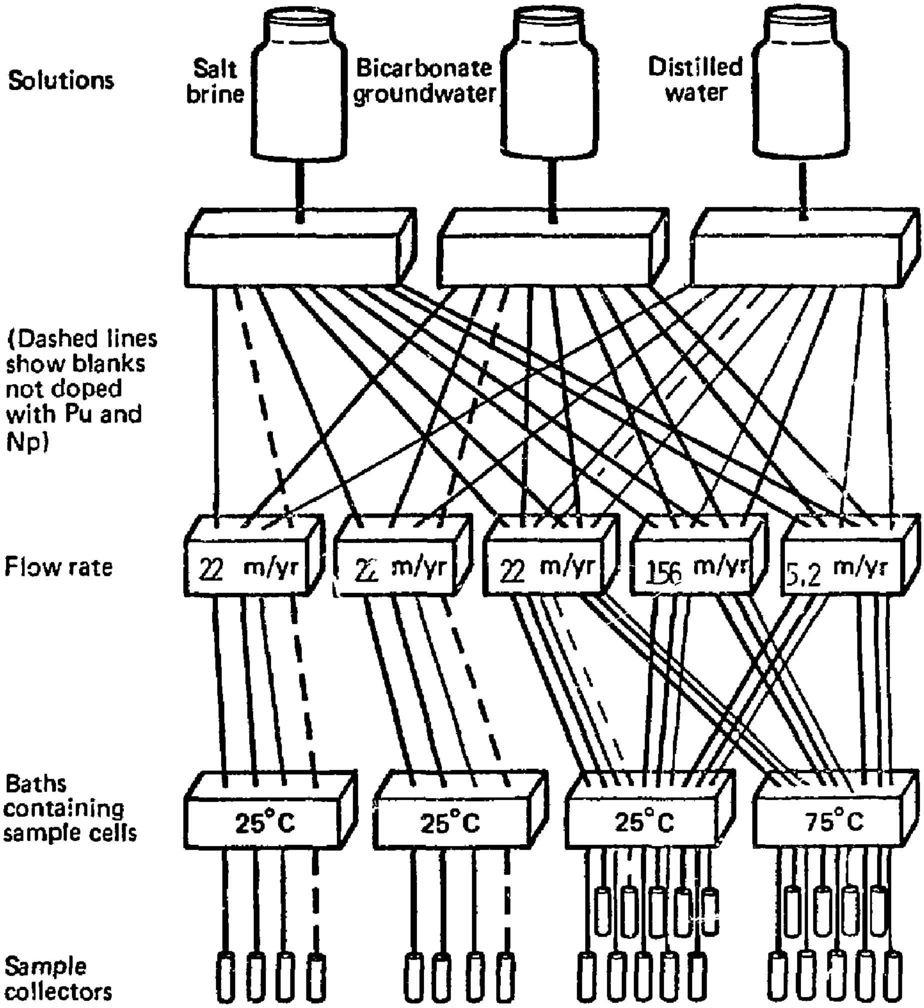


Figure 2

with ^{237}Np and ^{239}Pu were used as radiochemical blanks. In order to reduce the size of the experiment, blank runs and replicates were included only in the medium flow rate, 25°C portion of the experiment. The final design resulted in an experiment with 27 channels, 4 temperature control baths, and 5 peristaltic pumps. A 28th channel was added as a check on possible flow system effects. It was a medium flow rate, 25°C, bicarbonate channel which differed from the other channels of that type only in that the cell contained no micropore filter (see below) and the leachant inflow entered the top of the cell.

Table 1 summarizes the characteristics of both the PNL and LLNL tests for comparison. Some minor differences exist between the experiments. PNL used deionized water while LLNL used distilled water for the third leachant. The PNL temperature was 22 ± 2°C while the comparable LLNL temperature was 25 ± 0.5°C. One difference not noted in Table 1 is that beads in the PNL test see three "simulated" flow rates during the experiment. This is because the leachant renewal intervals are changed from daily, to weekly, to monthly on <u>each</u> sample. With the LLNL experiment, the beads in each cell are subjected to only one flow rate throughout the duration of the experiment. Effects of various flow rates on leaching can be monitored throughout the experiment. A similar experiment could be designed with the modified IAEA test by assigning intervals of leachant renewal which were different for various samples and which did not change for the duration of the study.

In the LLNL test, leachant flow rates (Q) of 300, 43 and 10 cm^3/day were used. The cell sample compartment has a cross sectional area (A) of 2.84 cm^2 and volume of 2.00 cm^3; the eight beads contained in each cell had a total volume of 0.72 cm^3. The average linear flow velocity rate

Table 1. A Comparison of the PNL Modified IAEA Leach Test and LLNL SPCF Leach Test of PNL 76-68 Glass

	PNL	LLNL
Glass Composition (PNL 76-68)	same	same
Leachants	"synthetic" sat. WIPP Brine	"synthetic" sat. WIPP Brine
	0.03N $NaHCO_3$	0.03N $NaHCO_3$
	Deionized Water	Distilled Water
Temperatures	22 ± 2°C	25°C and 75°C (± 0.5°C)
Method of Leachant Exchange	Static with Periodic Leachant Renewal*	Continuously flowing 300 cm^3/day 43 cm^3/day 10 cm^3/day
Beads/Cell	20	8
Cell Volume	300 cm^3	2 cm^3
Equivalent Leachant Exchange Rate (cm^3 leachant/bead/day)*	15 (daily renewal) 2.1 (weekly renewal) 0.5 (monthly renewal)	37.5 (Fast) 5.4 (Medium) 1.3 (Slow)

* See text for explanation.

is given by Q/nA where n = volumetric porosity, [(V cell - V sample) /V cell]. The three velocities thus calculated are 156, 22, and 5.2 m/yr. These may be compared to typical groundwater velocities, which range from 1.5 to more than 500 m/yr.[8]

In order to compare these two experiments and to investigate possible solution saturation effects, it is helpful to calculate the volume of leachant per day potentially interacting with each bead. In the PNL test there were 15 cm^3 of leachant/bead/day in the system during the daily leachant renewal period. Similarly there were 2.1 cm^3 of leachant/bead/day during the weekly leachant renewal period and 0.5 cm^3 of leachant/bead/day during the monthly leachant renewal period. This is a "step-wise" approximation of a flow rate. For the flowing test, the calculation is straight forward. There were 37.5, 5.4, and 1.3 cm^3 of leachant/bead/day passing through the fast, medium, and slow flow rate cells, respectively. The "equivalent leachant exchange rates" for both tests are similar.

The SPCF leach test cells have been described previously.[5] Figure 3 is a schematic drawing of the SPCF leaching cell. All plumbing was constructed of plastic to minimize effects on leachant composition and loss of leached species from the leachate. However, a variety of plastics were used throughout the system and their individual effects on the solution chemistry are unknown. We have investigated loss of ^{237}Np and ^{239}Pu onto various components of the system. The results of that study will be presented later in this report.

The cells are designed to allow for the option of placing polycarbonate micropore membrane filters between the filter grids at both the inlet and outlet end of the sample cell in order to prevent any particulates from

SINGLE PASS CONTINUOUS FLOW LEACHING CELL

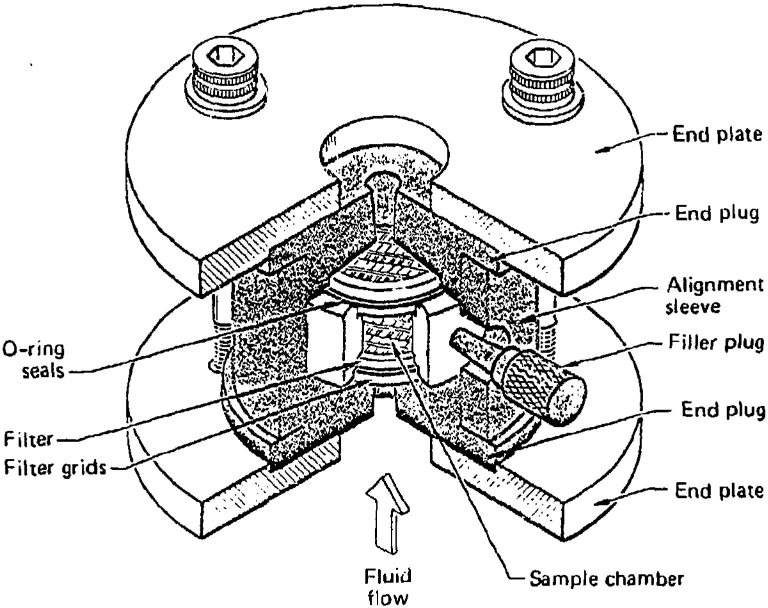


Figure 3

entering or exiting the cell. The use of 0.1 μm membrane filters in channels 1-27 (it was omitted from channel 28 as a test) complicated maintenance of the leachant flow through the cell since air bubbles, which formed in the lines and cells, would not pass through these filters. This slowed or stopped the flow of leachant and required excessive maintenance. Use of a coarser filter would be preferable. Since there is an 0.2 μm cartridge filter between each leachant supply carboy and the cells the added cell inlet filters are probably unnecessary, but some form of outlet filter is desirable to prevent particulate breakdown products from entering the leachate collection.

After weighing and geometric surface area determination, eight beads were loaded into each cell. When the cells were loaded and assembled, the three screws holding each cell together were tightened equally using a small torque wrench. The outlet hole and side access hole were then plugged and air pressure (140 kPa) was directed into the cell through the inlet hole. The pressurized cell was then immersed in water. If no bubbles appeared after several minutes, the cell was assumed to be leak proof and ready for incorporation into the experiment.

The plumbing lines from the leachant manifolds to the collection bottles, including the peristaltic pump tubing, were preassembled without the cells so that all were the same length. This removed any possible differential effects on solution composition due to variable lengths of tubing for each channel. The system from the leachant supply carboys through, and including, the plastic leachate collection bottles, was flushed with previously prepared leachant. This also afforded the opportunity to let the pumps run for a few days to check for faulty pumps or plumbing.

After flushing the system, the manifold valves were closed in preparation for installing the cells into the flow path to begin the experiment. The outflow tubes and the collection bottles were emptied of flushing solution. The cells were installed, placed into the appropriate temperature control baths, and the pump was begun. The starting time was noted when the cell was first filled with leachant.

The temperature baths were started a few days prior to beginning the leaching experiment so that the temperature had stabilized to the correct value. The three 25°C baths were filled with distilled water. A coil filled with circulating chilled water (ca. 15°C) prevented these baths from exceeding 25°C since the heaters always had a cold "sink" to work against in case the laboratory room temperature exceeded 25°C. The 75°C baths were filled with mineral oil and required no cooling since the temperature was well above room temperature. An improvement to our method of temperature control for the higher temperatures (40°C to 90°C) has been suggested by D. Strachan, PNL,[9] who used ovens instead of baths in his adaptation of the LLNL flow tests. The ovens allowed for easier observation of leaks, prevented corrosion of the cells, prevented algae growth on the outside of the cells, and eliminated oil contamination of the beads if the cell side-plug needed to be removed to withdraw air bubbles.

Table 2 presents the sampling schedule for this experiment. All leachate was collected for the 420 days duration of the experiment. Individual scheduled samples were acidified and analyzed for a suite of radionuclides, mock fission products, and glass matrix elements. The leachate collected between the scheduled samplings was combined and saved as historical samples. The

Table 2. Sampling Schedule for Bead Leach I Experiment

Elapsed Days	Historical Sample	Sample for Analysis	Analysis Performed a	b	c
1		X	X	X	
2		X	X	X	
3		X	X	X	
4-6		X	X	X	
7-10	X				X
11		X	X		
12-19	X				X
20		X	X		
21-36	X				X
37		X	X	X	
38-67	X				X
68		X	X	X	
69-119	X				X
120		X	X		
121-229	X				
230		X	X	X	
231-419	X				X
420		X	X	X	

a. Pu and Np (alpha spectrometry), all channels

b. Optical Emission Spectroscopy (ICP-OES), all channels; see Appendix 7 for list of elements

c. X-ray Fluorescence Analysis (XRF), selected channels and elements; see Appendix 6.

sampling schedule was adopted to provide equally spaced data points on a log-log plot of leach rate against time.

C. ANALYTICAL PROCEDURES

1. PNL Modified IAEA Leach Test

Analytical procedures used for this test can be found in Bradley et. al.[1]

2. LLNL SPCF Leach Test

The leachate samples were collected in marked, cleaned, weighed polyethylene bottles. After each sample was collected, collection into the composite leachate bottles was continued. The elapsed time from the start of the experiment was recorded for the beginning and end of each sampling interval. The leachate samples were then weighed to determine the amount of solution which had been collected during the sampling interval. This information (with corrections for density in the case of brine) was used for flow rate and leach rate calculations. Conductivity, pH and Eh were measured at room temperature for each sample. Measured volumes of concentrated HNO_3, based on the leachate volumes, were then added to each leachate sample to produce an 8N HNO_3 solution. This concentration was chosen because the actinide chemistry required solutions to be adjusted to this concentration prior to performing the actinide separations. The acid content also stabilized the actinides and assured that they remained in solution.

Analysis for Pu and Np in the leachates was done by alpha-spectrometry. For the distilled water and bicarbonate leachates, 100 μl aliquots of each leachate solution were counted directly after careful evaporation on a Pt disc followed by several minutes of heating in the hottest part of a Meeker-burner flame. The Meeker-burner heat-treatment stabilized the Np and Pu on the discs as oxides. Counting times of 5-7 days per sample were required to complete the analyses but lengthy radiochemical purification procedures were avoided by direct alpha-counting. The analysis of the brine solutions required radiochemical purification procedures in order to separate the Np and Pu from the brine salts. The procedure developed to analyze these brine leachates has been described in detail by Rego.[11] Basically, the separation of neptunium and plutonium from brine solutions was achieved by keeping the solution dilute, attaining equilibrium with chemical yield tracers, removing the interfering salts, and then proceeding with the normal techniques of organic extraction with thionyltrifluoroacetone. The separated fractions of neptunium and plutonium were electroplated onto platinum plates and counted on an alpha-spectrometer.

Aliquots of the bicarbonate and distilled water leachates taken for Optical Emission Spectroscopy - Inductively Coupled Plasma (ICP) analyses were diluted to a nitric acid concentration of <4.0 N, and a subsample was titrated with 1.0 N NaOH to determine exact HNO_3 concentration. Calibration data were obtained using standard ICP solutions. Calibration standards with HNO_3 concentration ranging from 1.64 N to 8.10 N were prepared from an ICP standard solution. From the standard data, correction curves were constructed for each element analyzed. These curves were used to correct the ICP results on leachate samples for the effects of HNO_3 concentration. Peck et al.[10] have described the ICP analytical capability at LLNL.

Aliquots of a number of leachate samples collected during the intervals between the scheduled samples (the "historical" samples described previously) were specifically prepared for x-ray fluorescence (XRF) analysis. Large volumes (up to 300 cm^3) of the bicarbonate and distilled water leachates were acidified to 0.1N HNO_3 and evaporated to dryness in the presence of powdered cellulose. The residual cellulose was pelletized and analyzed with an XRF spectrometer. The procedures used have been described in detail by Bazan et al.[12]

In order to evaluate loss of radionuclides from the leachate by sorption onto the rubber O-ring, cell walls, outlet end cap, filter, grid and tubing, selected portions of the system were analyzed. Outlet filters from all of the 75°C cells were dissolved and analyzed for Np and Pu. The outlet filter grids, cell barrels, and outlet end-caps for all but one 75°C channel were leached with concentrated nitric acid and analyzed for Np and Pu retention. O-rings from four 75°C channel cells were also leached with concentrated nitric acid and the leachate analyzed for Np and Pu. The outlet lines from the cells to the collection containers were leached and analyzed in a similar fashion for four of the 75°C channels. Various cell parts from eight 25°C channels were leached and the total leachate samples from the cells parts of each channel were analyzed. Results of this "cell-part" sorption study can be found in the following section.

D. CALCULATIONS

All leaching data from both the LLNL and PNL leaching studies were entered into a computer data base program. Raw analytical data were converted to both "leach rate" data and "cumulative-fraction leached" data for each element and radionuclide analyzed. The correction factors used were: brine density (1.19 g/cm^3), dilution of leachates by water and acid, aliquot factors, counting efficiency for Np and Pu, and an acid correction factor for the ICP analysis.

Leach rate data were calculated from the equation:

$$R_i = \frac{(\rho a_i V_i)}{(A_o)(SA)} \qquad (1)$$

where:

a_i = dpm/gram leachate or grams element/gram leachate

A_o = initial activity (dpm/grams glass) or elemental composition (grams element/grams glass) for the glass beads

V_i = volume leachate collected per day (cm^3/day)

ρ = leachate density (g/cm^3)

SA = average geometric surface area of beads (cm^2) = 11.128 cm^2 per 8-bead sample

i = channel number

R_i = grams glass leached/cm^2 · day, based on the element or radionuclide analyzed.

Cumulative fraction leached, C_{im}, for the i^{th} channel up to and including the m^{th} day, was calculated from the equation:

$$C_{im} = \sum_{n \leq m} \frac{(SA)\overline{R}_{in}\Delta T_n}{W_{oi}} \qquad (2)$$

where:

SA = geometric surface area of beads (11.128 cm^2),

W_{oi} = total weight of glass beads in i^{th} cell (grams),

$\overline{R}_{in}$ = average leach rate between n^{th} and (n-1)th days (grams glass/cm^2 day), and

ΔT_n = time (days) between n^{th} and (n-1)th days.

III RESULTS

The large quantities of data generated from this experiment have been organized into appendices. In presenting these results, we first identify and briefly discuss each of the appendices or data sets, then present a statistical analysis of some of the radionuclide leaching characteristics, and conclude with a brief discussion of the overall results and a comparison of the two (PNL and LLNL) leach tests.

The results of the PNL static leach tests as given in PNL-3152[1] and by D. J. Bradley (personal communication) are presented in Appendix 1.

A. CHARACTERIZATION OF THE BEADS.

1. Chemical Composition

The composition of the doped PNL-76-68 beads as determined by PNL[1] is given in Table 3.

2. Surface Area

The total geometric surface area of the 8-bead sample ensemble was determined by dimensional measurement and calculation to be 11.128 cm^2. Since the average weight of eight beads was 2.846 grams, this corresponds to an approximate mean specific geometric surface area of 3.95×10^{-4} m^2/g.

The blank (undoped) beads from channels 2, 12 and 22 were measured by Krypton BET at the end of the leaching experiment. The results are presented in Table 4. No adsorption surface area measurements were made on the unleached beads, however, cored monoliths of undoped PNL 76-68 have been measured by Krypton BET for other experiments. The results are included in

Table 3. Composition of PNL 76-68 Simulated High Level Waste Glass

Glass Composition (wt %)

SiO_2	40.0	La_2O_3	0.53
Na_2O	12.5	Pr_6O_{11}	0.53
Fe_2O_3	9.6	$^{237}NpO_2$	0.46
B_2O_3	9.5	P_2O_5	0.46
ZnO	5.0	Cr_2O_3	0.40
$^{238}UO_2$	4.2	SrO	0.37
TiO_2	3.0	Sm_2O_3	0.32
MoO_3	2.2	TeO_2	0.26
CaO	2.0	Y_2O_3	0.21
ZrO_2	1.7	NiO	0.20
Nd_2O_3	1.65	Rh_2O_3	0.17
CeO_2	1.19	Rb_2O	0.13
RuO_2	1.07	Eu_2O_3	0.070
Cs_2O	1.03	Gd_2O_3	0.050
BaO	0.56	$^{239}PuO_2$	0.046
PdO	0.53	CdO	0.033
		Ag_2O	0.031

Table 4 for comparison, although the additional surface roughness introduced by coring means that this number should be considered an upper limit on the BET surface area of the unleached beads. Adsorption surface areas are in all cases 2-3 orders of magnitude greater than geometric surface areas. The results suggest that the brine and distilled water treatments produced a significant increase in adsorption surface area over the course of the experiment, while the bicarbonate treatment did not.

Table 4: Surface Areas, Undoped PNL-76-68

Method	Sample	Treatment		Area
Geometric	Unleached Beads	None		0.000395 m^2/g
Kr BET	Cored Monolith	None		0.085 m^2/g
Kr BET	Channel 2	Brine	25°C-40ml/day	0.397 m^2/g
Kr BET	Channel 12	$NaHCO_3$	25°C-40ml/day	0.015 m^2/g
Kr BET	Channel 22	H_2O	25°C-40ml/day	0.329 m^2/g

3. Bead Weights

Beads weights before and after leaching are presented and discussed in Appendix 2.

B. SOLUTION CHARACTERIZATION

1. Sample Volumes, Times and Flow Rates

Appendix 3 contains two tables. One summarizes collection volumes, times and derived flow rates for all samples. The other presents the average flow rate, with percent standard deviation, for each channel.

2. pH, Eh and Conductivity

Appendix 4 presents tabulated data on the measured pH, Eh and conductivity of the leachate samples. Measurements were made with standard commercially available electrodes or cells. The brine and distilled water leachates and leachants were neutral or acidic, the bicarbonate definitely basic.

3. Leachate and Leachant Analyses

a. Solution Concentration Data

Appendix 5 gives the Np and Pu activities of the leachate solutions, in disintegrations per minute per cm^3 of solution. The number below each value is the percent standard deviation based on counting statistics only. Zero values denote no analysis. The data entries for neptunium and plutonium for all the brine channels (1-9), channel 24, and days 2 and 3 for channel 10 represent analyses of chemically separated samples. Channels 2, 12, and 22 were loaded with undoped beads and may be considered as approximate blanks for the alpha-emitter determinations; however, no blank corrections have been made to the Np and Pu data for the other channels .

Appendix 6 presents analytical data obtained by x-ray fluorescence. These are the only analytical data obtained for the composite samples collected between the scheduled sampling days. Ca, Sr, Mo, U and Zn were analyzed by ICP as well as XRF (see Appendix 7). Agreement between the two methods is satisfactory for Mo. For Sr the XRF data are 5-10 times greater than the ICP concentrations. For U (channel 14 only) XRF values are about twice the ICP values. XRF values are lower than ICP values for Zn (by a factor of 3-10) and Ca (by a factor of 2-3). The XRF values are also considerably less variable than the ICP results. The reasons for these differences are not readily apparent, but in view of the differences in sampling and sample treatment the XRF data should probably be considered the more reliable and accurate.

Appendix 7 presents the ICP concentration data for the stable elements, given in micrograms per cm^3 of solution. Zero values denote no analysis; "less than" values indicate a concentration which after leachant blank correction was below the detection limit reported for that element at the time of analysis. Channels 2, 12 and 22 differed from the replicate channels in that the beads were from a different glass preparation and were not doped with Pu and Np; for the purposes of stable element analyses these channels might be expected to behave similarly to the comparable replicates, and in any case should show no effects attributable to included alpha emitters. See Appendix 7 for a more detailed discussion of the detection limits.

b. Leach Rates and Cumulative Fractions Leached

Appendix 8 gives the calculated incremental leach rates and cumulative fractions leached for Pu and Np; Appendix 9 gives comparable data for the stable elements, ICP and XRF results are presented in separate tables.

Appendices 10-14 contain graphical presentations of the data on leach rate, cumulative fraction leached, flow rate and pH as functions of time.

For the incremental leach rates based on ICP data, the zero and "less than" entries have the same significance as in the concentration data tables. In calculating the Cumulative Fraction Leached (CFL) the zero values are ignored; when a "less than" value is encountered the numerical value is used in the calculation and that and all subsequent CFL values are tabulated as "less than". Because of this convention, care must be exercised in assessing the significance of CFL "less than" values. For example, in the case of Fe, only the day 3 incremental values for channels 15 and 27 are below detection limits. Since these data points represent only a small fraction of the total leach time, the later CFL values are probably almost as valid as those of the other channels in spite of being technically upper limit values. By contrast, a CFL value calculated over a whole sequence of upper limits is at best a very generous ceiling on the possible value. For the ICP leach rate data the rate tables should be consulted to evaluate the significance of individual CFL "less than" values. XRF data presented in Appendix 9 were calculated differently and are not subject to this constraint (see Appendix 9 for explanation). It should be noted however, that the XRF data points plotted in Appendices 10-14 are derived from the same computer algorithms used for the ICP data.

Two other points should be noted with regard to the leach rate calculations. The first point is that because of the logarithmic time sequence of sampling, the final two or three data points are very heavily weighted in the CFL calculation, and error or random variation in these points will have a disproportionate effect on the final CFL. The second point is that the incremental leach rate calculation is in terms of the amount of material originally present in the glass. Although valid from the inventory standpoint, this implicit constant source approximation will distort the apparent chemical behavior if a significant fraction of the element in question is leached. In the present case, Np, B, Si, Mo, Ca and Na all have channels which show day 420 CFL values in the 10-20% range; for some channels Ni and Cd also have CFL results which, although technically upper limits, suggest final leach values well in excess of 10%.

Some very high values are noted. If we disregard the bicarbonate Na values as unreliable because of the large blank correction, we still find day 420 values in excess of 30% for Mo (channel 16) and in excess of 50% for Na (channel 25). Ca has six channels with a final CFL in excess of 20%, including one (channel 16) which indicates 100% leach. If we reconsider these results in terms of the XRF results for some of the same elements, we find further internal evidence that some of the ICP analyses are biased and the XRF data are probably more reliable. Appendix 9 contains a comparison of ICP and XRF day 420 CFL values for those channels and elements measured by both techniques. If we extend this comparison to other channels, scaling the ICP day 420 CFL results with the XRF/ICP concentration ratios would reduce the maximum Ca leach values to the 30-50% range, would increase the Sr maximum values to the 20% range (which is more consistent with the chemically similar Ca), would increase U values to a level comparable with Np, and would leave Mo unchanged while reducing Zn. In addition to being chemically reasonable and reinforcing the probable validity of the XRF data relative to the ICP, these results definitely indicate that the total fraction leached for a number of elements approached at least 20%. This is not inconsistent with the observed weight losses, a number of which were in the 5-15% range (Appendix 2).

4. Actinide Holdup on the Experimental Apparatus

Considerable effort was expended to determine the amount of holdup of ^{237}Np and ^{239}Pu on the cell parts and exit lines. Particular interest was generated by the observation that Pu apparent leaching rates at 75°C were equal to or less than the values at 25°C and as much as 2-3 orders of magnitude less than the corresponding Np rates. Various cell parts were treated with concentrated HNO_3 and these acid leachates were analyzed for Pu and Np. Table 5 provides the Np holdup data for the apparatus. This was calculated from the total dpm of Np collected in leachate during the whole experiment and the dpm observed on the cell parts by dividing the amount held up on the cell parts by the total amount collected from the cell parts and in the leachate. For a variety of cell parts and plumbing, the fraction of Np lost to the apparatus is insignificant.

Plutonium data were calculated in an identical fashion. Those data are shown in Table 6. The outlet lines analyzed were from the 75°C channels only; an insignificant amount of Pu was held up on these lines. The outlet filters were dissolved and analyzed for all eight 75°C channels. Except for channel 5 (brine, 75°C, medium flow rate), which held up an amount equal to 10% of the total collected, no other filter held up a significant portion of the Pu. The outlet O-ring seals were analyzed for four 75°C channels. One contained 18.7% of the total activity the rest very little. The remaining cell parts were analyzed for all eight channels. For the hot, slow channels, 33.5% of the Pu collected was retained from the brine, and 68.7% from the distilled water. The bicarbonate channel cell parts held up much less plutonium, a total of 15.3%. For some 25°C channels, all of the parts were analyzed as a group and only an insignificant portion of the Pu was retained. Even for the two hot, slow channels where the amount of Pu on the cell parts was 55.2% and 69.0% of the totals collected, the amount of Pu lost does not account for the 2-3 orders of magnitude lower leach rate observed for Pu than for all the other elements analyzed.

Table 5. Np Residual Activity on Leaching System Parts (% of Total Activity Collected)

Channel (Temp, Flow)[a]	Outlet Lines	Outlet Filters	Outlet O-rings	Other Cell Parts[b]	All Parts
1 (C,M)					0.11
3 (C,M)					0.11
5 (H,M)		0.038		0.015	0.05
7 (H,F)	1.0×10^{-4}	2.0×10^{-4}			0.0003
9 (H,S)			0.023	0.089	0.11
10 (C,M)					0.33
11 (C,M)					0.86
14 (H,M)	0.001	1.0×10^{-4}	0.015	0.024	0.04
15 (C,F)					0.36
16 (H,F)		0.001		0.044	0.04
18 (H,S)	0.003	0.013	0.13	0.027	0.17
19 (C,M)					4.1
20 (C,M)					1.1
23 (H,M)		0.001		0.11	0.11
25 (H,F)	<0.001	9.2×10^{-3}	0.013	0.013	0.04
26 (C,S)					7.3
27 (H,S)		4.0×10^{-4}		0.27	0.27

a. H = 75°C, C = 25°C; F,M,S, = Fast, Medium, Slow Flow Rates

b. Cell parts are grids, inner cell, end caps, and connector (see Fig. 1)

Table 6. Pu Residual Activity on Leaching System Parts
(% of Total Activity Collected)

Channel (Temp, Flow)[a]	Outlet Lines	Outlet Filters	Outlet O-rings	Other Cell Parts[b]	All Parts
1 (C,M)					0.9
3 (C,M)					0.6
5 (H,M)		9.6		11.6	21.2
7 (H,F)	0.013	0.04			0.05
9 (H,S)			18.7	33.5	52.2
10 (C,M)					0.8
11 (C,M)					2.4
14 (H,M)	0.09	0.14	1.9	13.1	15.2
15 (C,F)					1.7
16 (H,F)		0.07		0.50	0.57
18 (H,S)	1.7	1.4	4.1	8.1	15.3
19 (C,M)					0.8
20 (C,M)					1.2
23 (H,M)		0.10		1.5	1.6
25 (H,F)	0.39	0.11	0.83	3.8	5.1
26 (C,S)					3.0
27 (H,S)		0.30		68.7	69.0

a. H = 75°C, C = 25°C; F,M,S, = Fast, Medium, Slow Flow Rates

b. Cell parts are grids, inner cell, end caps, and connector (see Fig. 1)

IV. STATISTICAL ANALYSIS OF LEACH RESULTS

A. INTRODUCTION

The statistical analysis of the leach data was planned to aid in the summarization of the data, to assist in interpreting the experimental results and to help in developing meaningful conclusions based on these results. Specifically, the statistical analysis was planned to help in meeting two objectives of the LLNL continuous flow leach experiment:

- o to investigate the leaching mechanism.
- o to investigate the effect of leachant composition, flow rate and temperature on the leach rate or concentration of solid in solution.

To assist in meeting these objectives, the statistical analysis of the experimental data was separated into two primary phases:

- o The dissolution mechanism was investigated by constructing models for the cumulative fraction of the solid material leached.
- o The effects of solution, flow rate and temperature were investigated by comparing the concentration of solids in solution for different experimental conditions.

Section B briefly describes the experimental design used to accumulate the data. Emphasis in this section is placed on discussing the constraints inherent in the experimental setup which influenced the design and the data analysis. A description of the data analysis and a summary of the results of the statistical analysis is in Section C.

One of the models specifically used and tested is that of constant leachate concentration. This model implies a leach rate which is constant over time, and a cumulative fraction leached which is a linear function of time. There are several reasons for adopting this model. First, qualitative examination of the data sets reveal that after the first one to three days of leaching the concentration values cease to show any discernably consistant trend with time. Second, the design of the experiment (constant flow rates, solutions far from saturation) and the assumptions of the calculation (constant surface area and chemical source) make steady-state leaching the most reasonable hypothesis to test. Finally, similar results have been observed by other investigators.[13]

B. EXPERIMENTAL DESIGN

The design of the continuous flow leaching experiment was based on assessing the leaching of materials from a waste form for several combinations of 'simulated' repository conditions. The variables used to describe the repository conditions and their experimental values (levels) were:

Variable	Levels
Leachant composition (solution):	Brine; Bicarbonate ($NaHCO_3$), distilled water
Volume flow rate:	10; 43; 300 cm^3/day
Bath temperature:	25°, 75°C

To accomodate the dependence of leaching on time. samples were accumulated at several points over 420 days. The sampling points were at roughly equal intervals on a logarithmic scale - 1, 2, 3, 6, 11, 20, 37, 68, 120, 230 and 420 days.

The experimental design and subsequent data analysis were conditioned on two constraints:

1. The physical layout of the experimental apparatus required that several sample channels be grouped together in a single temperature bath.
2. The number of combinations of experimental conditions which could be accomodated was limited.

An experimental design which allows for samples grouped together under identical conditions (e.g. in the same temperature bath) is called a split-plot design. Specifically, for the leaching experiment all samples at a given temperature were located in the same temperature bath. Similarly, all channels at a given flow rate were all controlled by the same instrument. For each combination of flow rate and temperature, separate channels were used for each of the 3 solutions.

Due to the limited number of channels that could be used, only one combination of flow rate and temperature, (i.e. 43 cm^3/d, 25°C), was replicated. This combination was replicated three times using all three solutions. This replication was one source of an estimate of experimental variation. A schematic diagram of the experimental matrix is shown in Figure 2.

C. STATISTICAL ANALYSIS

The following three response variables were used in the analysis:

- o Incremental leach rate, R_{in}, for the ith channel (i=1, 2,...,28) at the nth day (n=1, 2, 3, 6, 11, 20, 37, 68, 120, 230, 420), where the identity for R_{in} is given in Equation 1 o Cumulative fraction leached, C_{im}, for the ith channel up to and including the mth day. The identity for C_{im} is given in Eqn. 2 as

$$C_{im} = \sum_{n \leq m} \frac{(SA)\overline{R}_{in}\, \Delta T_n}{W_{oi}} \qquad (2)$$

where

SA - surface area of beads (cm^2) - 11.128 cm^2

W_{oi} - total weight of glass bead in ith cell (g) - 2.82g

R_{in} - an 'average' leach rate between the nth and (n-1)st days (g/cm^2-day)

ΔT_n - time (days) between nth and (n-1)st days

o Concentration, c_{in}, of an element in the leachate of the ith channel at the nth day,

$$c_{in} = \frac{(SA)\, A_o\, \overline{R}_{in}}{\rho V_i} \qquad (3)$$

where

A_o - initial activity for the glass beads

V_i - volume leachate collected per day

ρ - leachate density [see Equation (1)]

Individual statistical analyses were done for ^{237}Np and ^{239}Pu. Less extensive analyses were performed on the other elements.

1. Statistical Analysis of Cumulative Fraction Leached

The primary goal of this portion of the analysis of the experimental data was to develop a mathematical model to describe the cumulative fraction leached as a function of time. The model will be used as a qualitative measure for suggesting the dominant leaching mechanism. Specifically, if the 'best' model for cumulative fraction leached, as a function of time, t, is a linear function in t, i.e.

$$CFL(t) = \beta_0 + \beta_1 t + E \qquad (4)$$

where CFL(t) denotes the observed cumulative fraction leached, β_0 and β_1 are the coefficients of the model, and E denotes the experimental variation, this suggests that matrix dissolution is the dominant leaching mechanism. It may be noted that integration of a constant rate over time will yield a cumulative fraction leached which is a linear function of t. On the other hand, if the 'best' model involves the square root of time, i.e.

$$CFL(t) = \beta_0 + \beta_1 t^{1/2} + E \qquad (5)$$

this suggests that elemental diffusion may be the dominant leaching mechanism.

Estimates of the coefficients β_0 and β_1 of the models in Eqns. 4 and 5 are summarized in Table 7. To contrast how the cumulative fraction leached increases over t under the different experimental conditions the estimates of the slope, β_1, are plotted as a function of flow rate in Figures 4 and 5 for ^{237}Np and ^{239}Pu respectively. The estimates for Eqn. 4 are labeled 1 and those from Eqn. 5 are labeled 2.

A review of plots of the observed cumulative fraction leached and estimated cumulative fraction leached based on the models in Eqns. 4 and 5 lead to the following conclusions:(*)

(*) Cold = 25°C, Hot = 75°C
Slow = 10 cm^3/day, Med. = 43 cm^3/day, Fast = 300 cm^3/day
BI = bicarbonate, BR = brine, DW = distilled water

Table 7. Coefficients for Models Describing Cumulative Fraction Leached

		^{237}Np				^{239}Pu			
		$y = \beta_0 + \beta_1 t$		$y = \beta_0 + \beta_1 t^{1/2}$		$y = \beta_0 + \beta_1 t$		$y = \beta_0 + \beta_1 t^{1/2}$	
		$\beta_0 (X10^{-5})$	$\beta_1 (X10^{-6})$	$\beta_0 (X10^{-4})$	$\beta_1 (X10^{-5})$	$\beta_0 (X10^{-5})$	$\beta_1 (X10^{-7})$	$\beta_0 (X10^{-6})$	$\beta_1 (X10^{-6})$
SLOW	COLD	4.861	2.893	-1.088	5.825	1.331	2.672	-1.792	5.461
	HOT	-17.472	55.421	-30.467	109.48	.006	.440	-2.243	.873
BR MED.	COLD	4.578	4.196	-1.791	8.399	1.620	3.551	-5.366	7.476
	HOT	2.042	109.98	-59.244	220.84	0	1.630	-8.223	3.186
FAST	COLD	5.251	7.128	-3.278	14.241	2.148	8.556	-27.655	3.186
	HOT	-57.004	328.25	-185.91	663.18	.097	20.314	-112.07	41.263
SLOW	COLD	4.918	7.609	-3.672	15.354	2.960	6.334	-9.299	13.400
	HOT	226.01	72.848	-23.614	156.27	.169	.261	.018	.562
BI MED.	COLD	3.124	9.461	-4.778	18.97	4.429	13.639	-37.454	28.56
	HOT	25.545	330.60	-178.01	666.58	.150	3.548	-17.222	7.760
FAST	COLD	12.271	8.996	-3.910	18.466	7.282	20.703	-50.589	43.25
	HOT	180.09	464.42	-237.65	939.31	1.123	19.572	-94.910	39.35
SLOW	COLD	5.332	2.035	-.585	4.113	.963	1.722	-.421	3.567
	HOT	-83.988	5.918	-34.712	106.57	.012	.172	-.667	.324
DW MED.	COLD	5.436	3.940	-1.669	8.032	1.874	3.694	-2.950	7.674
	HOT	-205.48	130.71	-81.769	248.62	-1.153	4.205	-28.592	7.617
FAST	COLD	5.066	3.149	-1.154	6.408	1.805	6.340	-18.854	13.116
	HOT	76.032	118.83	-57.447	239.80	3.419	25.920	-114.18	53.256

Slopes of Cumulative Fraction Leached vs. Time and $(Time)^{1/2}$ Plotted Against Flow Rate for ^{237}Np.

1. $CFL(t) = \beta_0 + \beta_1 t \; (x10^{-6})$

2. $CFL(t) = \beta_0 + \beta_1 t^{1/2} (x10^{-5})$

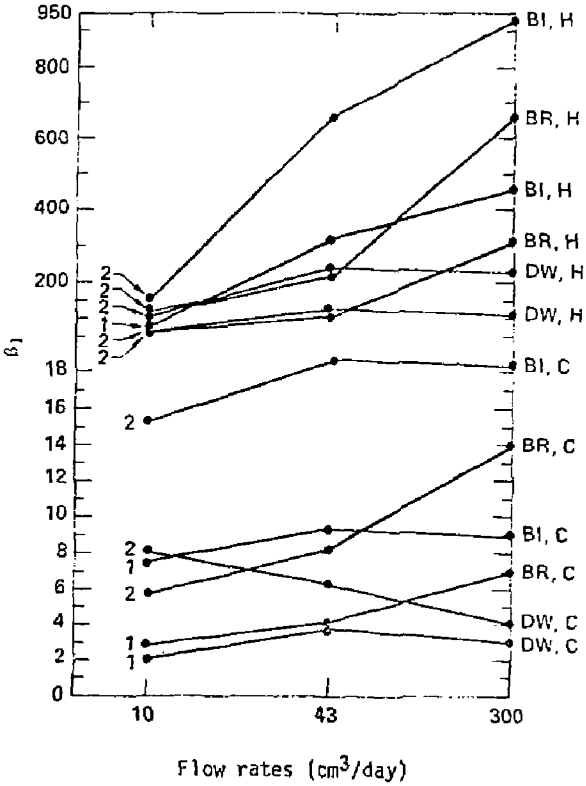
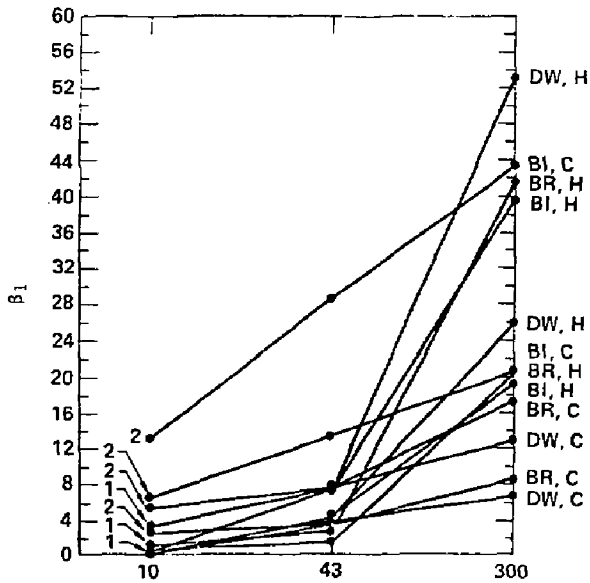


Figure 4

Slopes of Cumulative Fraction Leached vs. Time and $(Time)^{1/2}$ Plotted Against Flow Rate for ^{239}Pu.

1. $CFL(t) = \beta_0 + \beta_1 t \; (x10^{-7})$

2. $CFL(t) = \beta_0 + \beta_1 t^{1/2} (x10^{-6})$



Flow rates (cm^3/day)

Figure 5

- For ^{237}Np, the model linear in t (i.e., Eqn. 4) fits the data very well for all combinations of solution, flow rate and temperature except:
  - BI, SLOW, HOT, when the model linear in $t^{1/2}$ (Eqn. 5) was a better fit
  - DW, MED., HOT, and DW, SLOW, HOT, when neither model fit very well

  Figures 6 and 7 (BR, MED., COLD) contrast the fit of the two models when Eqn. 4 was 'best', Figures 8 and 9 (BI, SLOW, HOT) describe the fit of the two models when Eqn. 5 was 'best', and Figures 10 and 11 (DW, MED., HOT) illustrate the situation when neither model fit very well.

Based on the results for ^{237}Np it appears that matrix dissolution is the dominant leaching mechanism.

- For ^{239}Pu the choice of the 'best' model is not as distinct. A review of plots of the observed data and estimated cumulative fraction leached indicates that Eqn. 4, i.e. the model linear in t, fit 'best' for
  - BR, MED, HOT
  - BR, FAST, COLD and HOT
  - BR, SLOW, COLD and HOT
  - BI, MED, HOT
  - BI, FAST, HOT
  - DW, FAST, HOT

Data and Model Comparison for ^{237}Np (Brine, Medium, Cold)
Cumulative Fraction Leached Plotted Against Time.

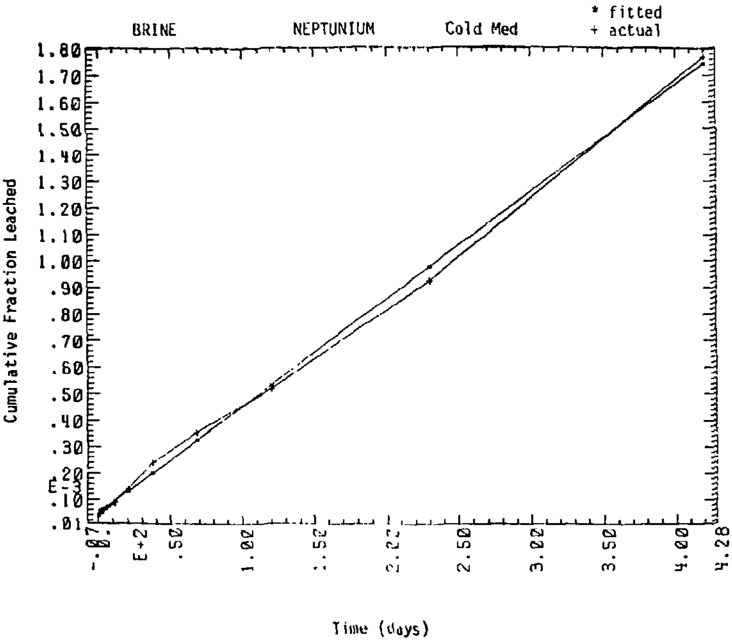


Figure 6

Data and Model Comparison for ^{237}Np (Brine, Medium, Cold)
Cumulative Fraction Leached Plotted Against (Time)$^{1/2}$.

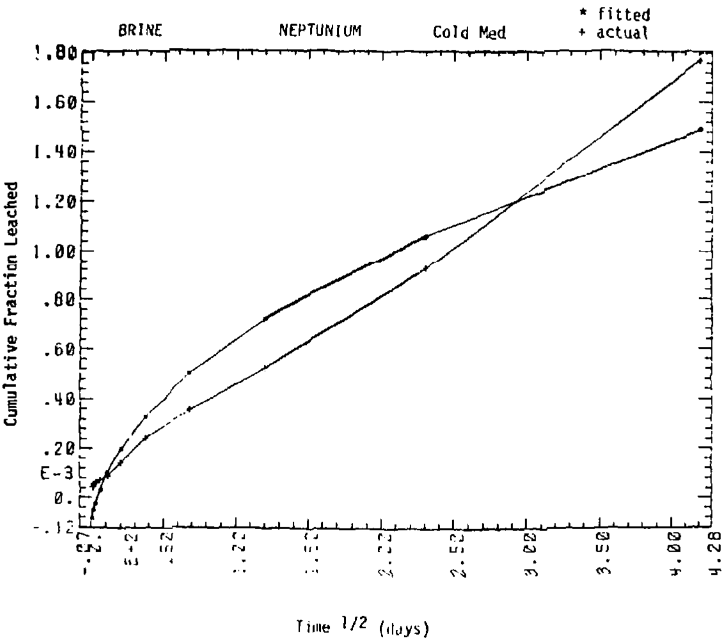


Figure 7

Data and Model Comparison for ^{237}Np (Bicarbonate, Slow, Hot)
Cumulative Fraction Leached Plotted Against Time.

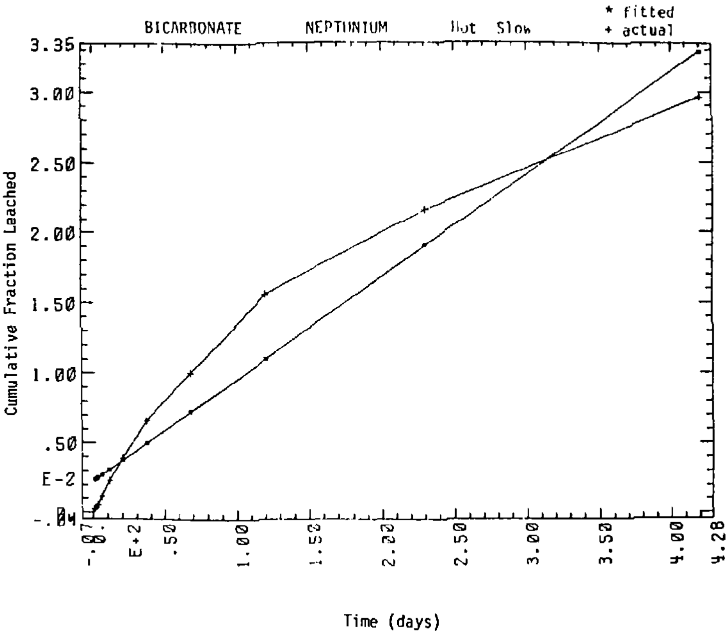


Figure 8

Data and Model Comparison for ^{237}Np (Bicarbonate, Slow, Hot)
Cumulative Fraction Leached Plotted Against $(Time)^{1/2}$.

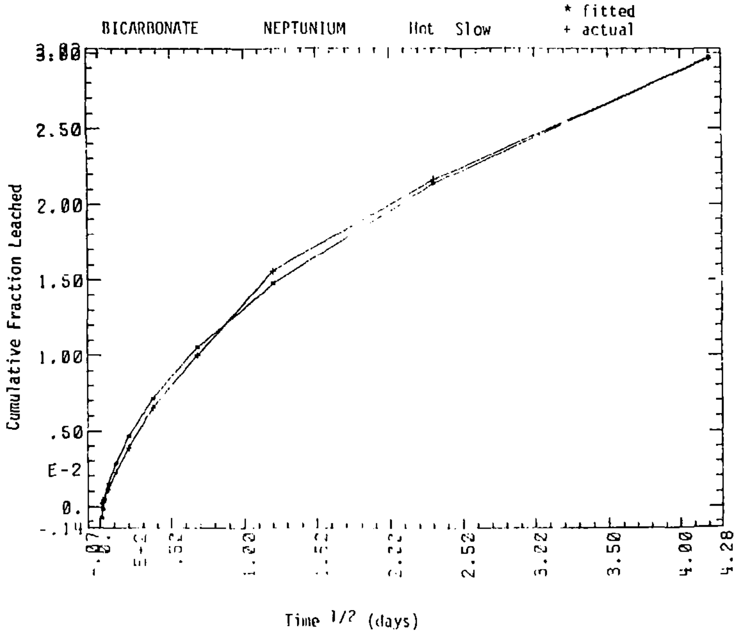


Figure 9

Data and Model Comparison for ^{237}Np (Distilled Water, Medium, Hot) Cumulative Fraction Leached Against Time.

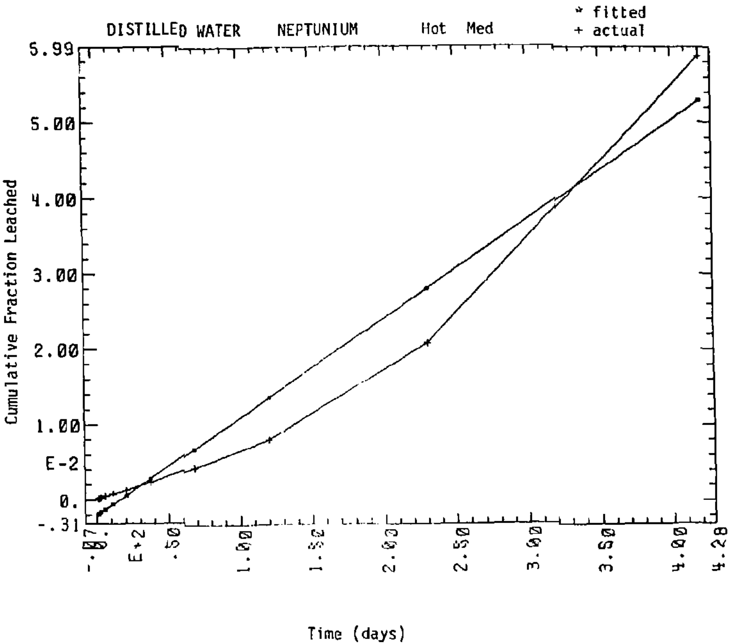


Figure 10

Data and Model Comparison for ^{237}Np (Distilled Water, Medium, Hot) Cumulative Fraction Leached Against $(Time)^{1/2}$.

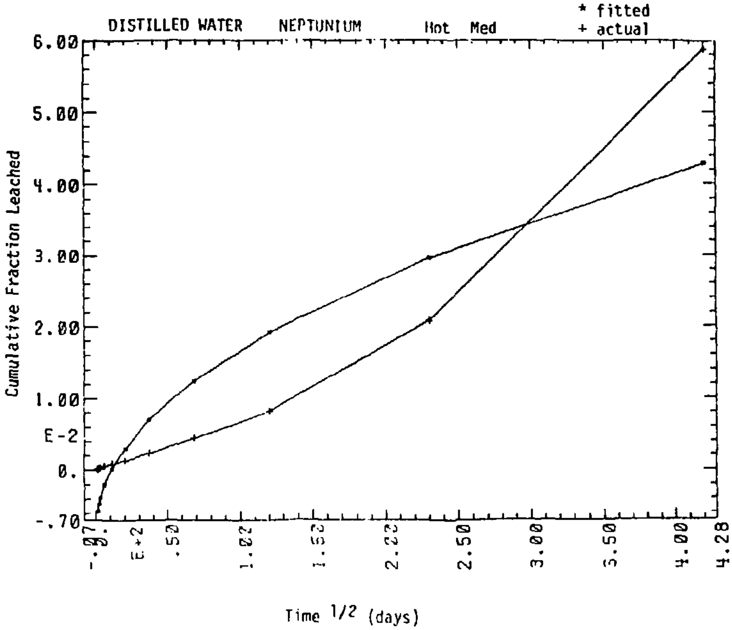


Figure 11

whereas Eqn. 5, i.e. the model linear in $t^{1/2}$, fit 'best' for

- MED, COLD and all 3 solutions
- BI, FAST, COLD
- BI, SLOW, COLD and HOT
- DW, FAST, COLD
- DW, SLOW, COLD

Again, neither model fit very well for

- DW MED, HOT
- DW, SLOW, HOT

Figures 12 and 13, (BR, MED, COLD) illustrate the fit of the model when Eqn. 5 is 'best', Figures 14 and 15 (BR, SLOW, HOT) contrast the model fits when Eqn. 4 is 'best, and Figures 16 and 17 (DW, MED, HOT) illustrate the situation when neither model is adequate.

Thus, based on the ^{239}Pu cumulative fraction leached it is not clear that a dominant leaching mechanism follows either model.

For several other elements, specifically, boron, silicon, calcium, sodium and molybdenum, the same models were fit to the observed data, In general the fit of the data was not as good as it was for ^{237}Np and ^{239}Pu.
However, when the models did fit the model linear in time (i.e. Eqn. 4) seemed to be better. The exception to this was sodium in the bicarbonate solution when the square-root model did better. The cases for which neither model fit very well were characterized by data which appeared to be increasing with the square of t. (See Figures 11 and 17 for typical plots of the observed data). Thus, it appears that a model of the form

Data and Model Comparison for ^{239}Pu (Brine, Medium, Cold)
Cumulative Fraction Leached Plotted Against Time.

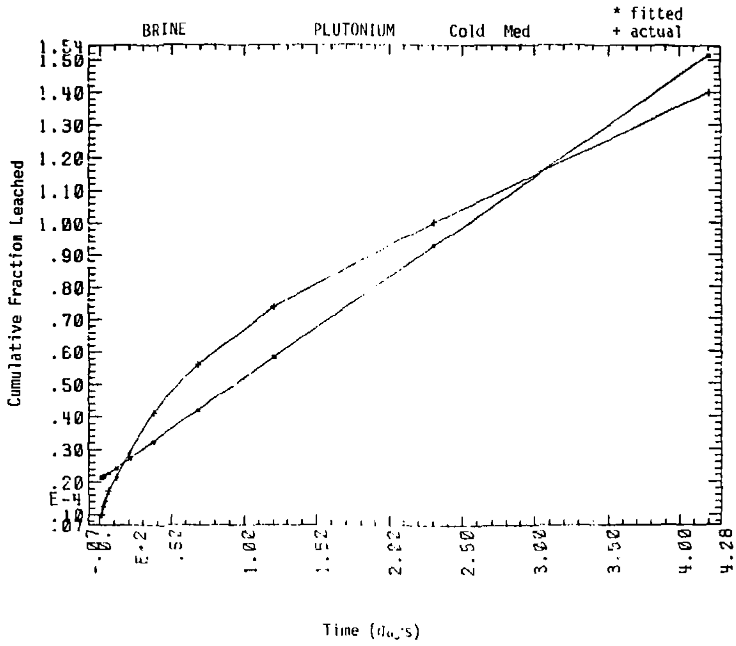


Figure 12

Data and Model Comparison for ^{239}Pu (Brine, Medium, Cold)
Cumulative Fraction Leached Plotted Against $(Time)^{1/2}$.

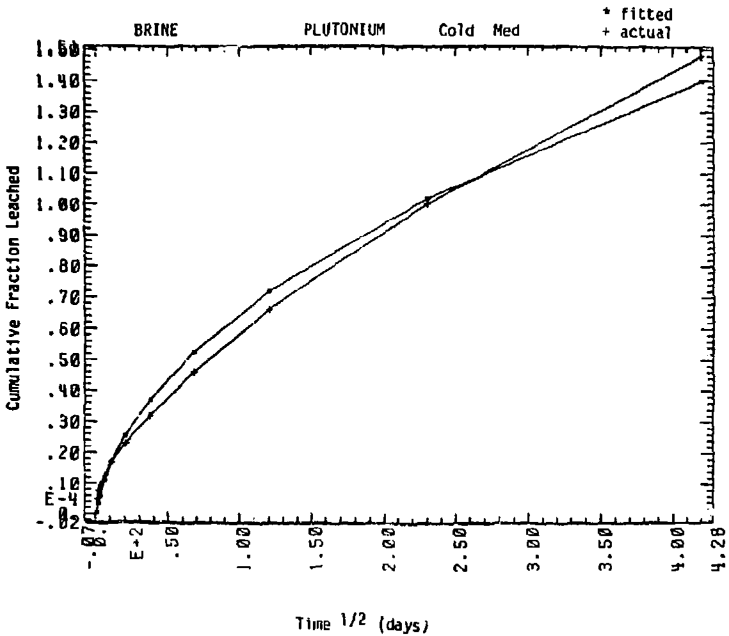


Figure 13

Data and Model Comparison for ^{239}Pu (Brine, Slow, Hot)
Cumulative Fraction Leached Plotted Against Time.

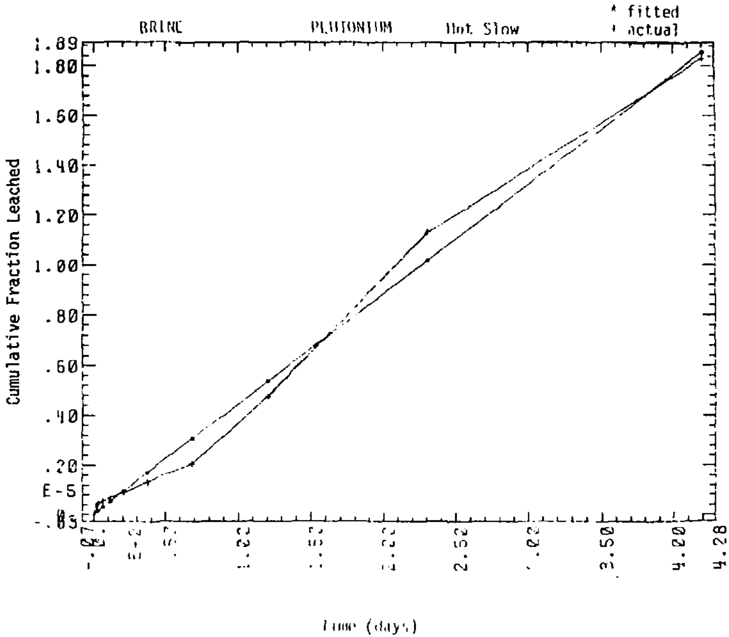


Figure 14

Data and Model Comparison for ^{239}Pu (Brine, Slow, Hot)
Cumulative Fraction Leached Plotted Against $(Time)^{1/2}$.

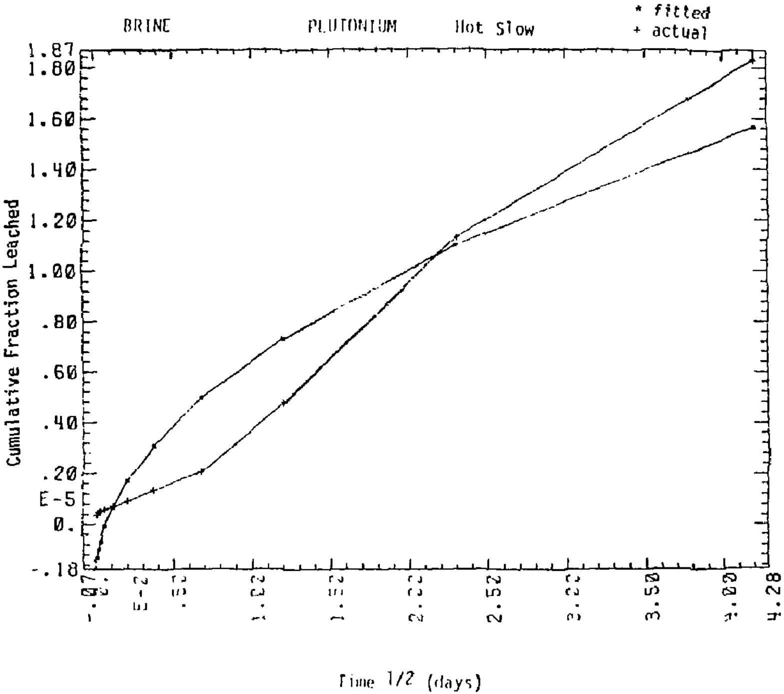


Figure 15

Data and Model Comparison for ^{239}Pu (Brine, Medium, Slow)
Cumulative Fraction Leached Plotted Against Time.

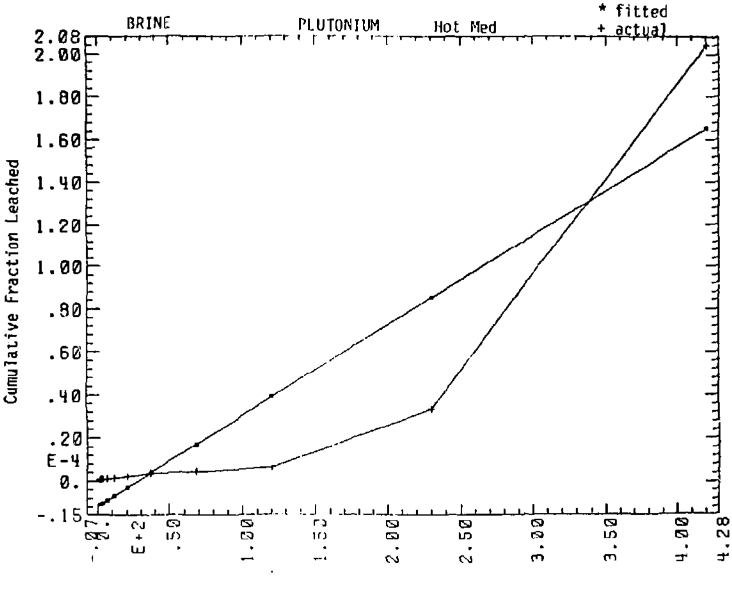


Figure 16

Data and Model Comparison for ^{239}Pu (Brine, Medium, Slow)
Cumulative Fraction Leached Plotted Against $(Time)^{1/2}$.

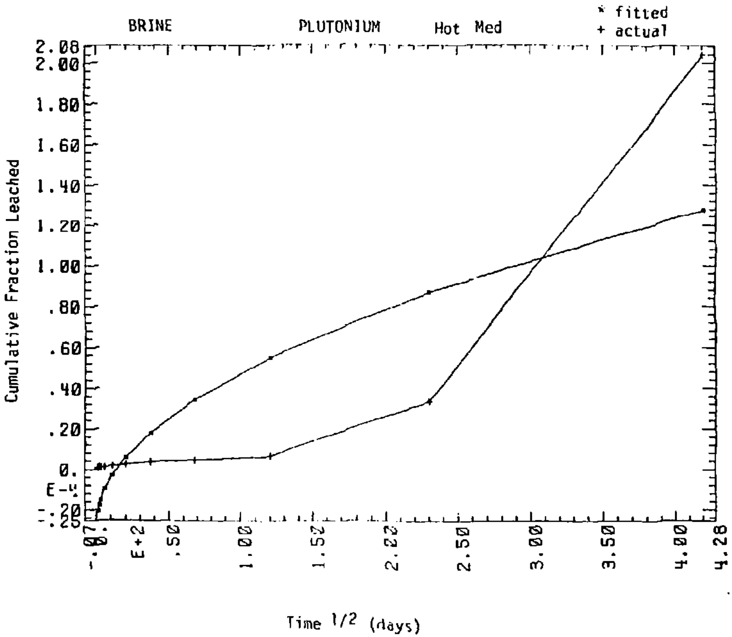


Figure 17

$$y = \beta o + \beta_1 t + \beta_2 t^2 + E \qquad (6)$$

would likely fit the data reasonably well. This suggests that element amounts are accumulating at a rate increasing ($\beta_2 > 0$) or decreasing ($\beta_2 < 0$) over time Equation 6 was not fit to any of the data.

In general, an analysis of the cumulative fraction leached data seems to suggest that the dominant leaching mechanism is matrix dissolution. However, some data, particular ^{239}Pu, do not conform to this. These results are based on a qualitative review of the data. Additional data (e.g. at more intervening times) would be needed to further develop models which describe the leaching mechanism.

2. Statistical Analysis of Concentration

This portion of the data analysis is based on a constant concentration model, i.e. a process in which the concentration of an element (e.g. ^{237}Np) in solution remains constant over time. The data analyzed is the concentration (dpm/cm^3 for Np, Pu or $\mu g/cm^3$ for the other elements) of an element in a one day sample. See Section IV A for a discussion of the relationship between constant concentration and constant leach rate models.

A review of the concentration data clearly indicated the concentration decreased during the first few days. Thus, the first 3 days were deleted from this analysis and the concentration for the 8 sampled days starting at day 6 was used in this analysis. Also, since concentration is measured in dpm or μg, it is necessary to recognize that the experimental variation in the data will be a function of the magnitude of the observations. Specifically, it is assumed that the experimental standard deviation is proportional to the mean. See Table 8 for a listing of the percent variation for the replicate channels.

Table 8. Estimated Concentration and Variation for ^{237}Np in Leachates

EXPERIMENTAL CONDITION

Solution	Flow Rate	Temp	Estimated Concentration	Standard Deviation	Proportionality Constant, k (percent)
BR	MED	COLD	1.580	0.254	16.08
		HOT	44.125	4.659	10.56
	FAST	COLD	0.433	.164	37.88
		HOT	16.812	3.884	23.10
	SLOW	COLD	5.116	0.765	14.95
		HOT	66.912	14.061	21.01
BI	MED	COLD	3.800	0.530	13.95
		HOT	128.250	15.691	12.23
	FAST	COLD	0.799	0.355	44.43
		HOT	32.462	6.304	19.42
	SLOW	COLD	15.403	5.800	37.66
		HOT	230.180	140.186	60.90
DW	MED	COLD	1.513	1.175	77.66
		HOT	37.300	23.175	62.13
	FAST	COLD	0.250	0.070	28.00
		HOT	9.468	2.482	26.21
	SLOW	COLD	3.845	1.547	40.23
		HOT	75.900	50.783	66.91

The initial step in this analysis is to test the adequacy of the constant concentration assumption. To make this test, the concentration, c(t), was fit to the model

$$c(t) = \theta + E \qquad (7)$$

where θ denotes the constant concentration, E represents the experimental variation such that the expected value $\mathcal{E}(E)=0$, and the standard deviation $\sigma(E)=k\theta$, where k denotes the proportionality constant. Note that in this case k is also the coefficient of variation.

The constant concentration model in Eqn. (7) was not adequate for the ^{239}Pu data. A typical plot of the fit to the ^{239}Pu data is given in Figure 18. Eliminating 3 additional days and only fitting the last 5 samples did not improve the fit.

The constant concentration model fit the ^{237}Np data reasonably well. The estimated concentration, experimental standard deviation and proportionality constant, or coefficient of variation k, are summarized in Table 8. A typical plot of the ^{237}Np data with the constant concentration model is given in Figure 19. Figure 20 is a plot of the standard deviation versus the mean for the concentration data using brine as the leachant. It suggests a constant proportion experimental variation, as assumed.

A statistical test was used to test the constant concentration model for the ^{237}Np data. The test is based on comparing the estimated coefficient of variation, k, derived from the replicated channels with that estimated from the fit of the constant model in Eqn. (7). The k^2 values for the

Comparison of Data with Constant Concentration Model
for ^{239}Pu (Brine, Medium, Cold).

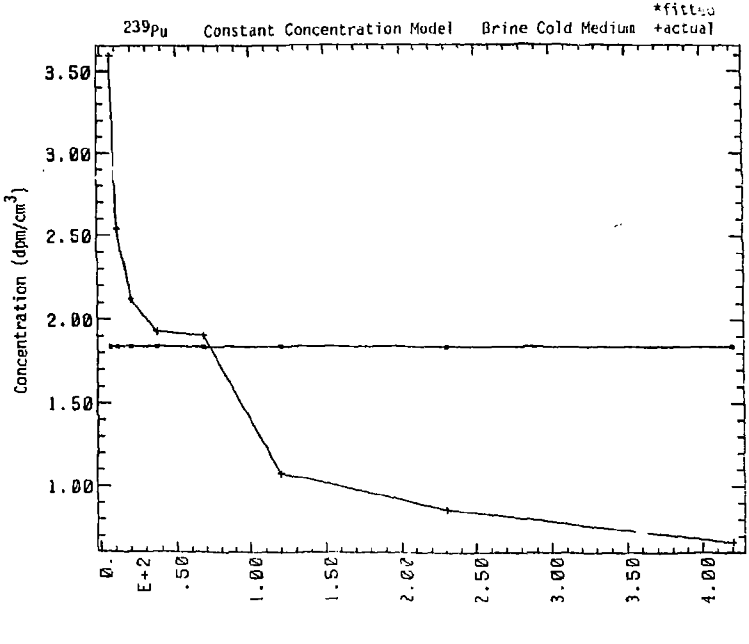


Figure 18

Comparison of Data with Constant Concentration Model
for ^{237}Np (Brine, Medium, Cold).

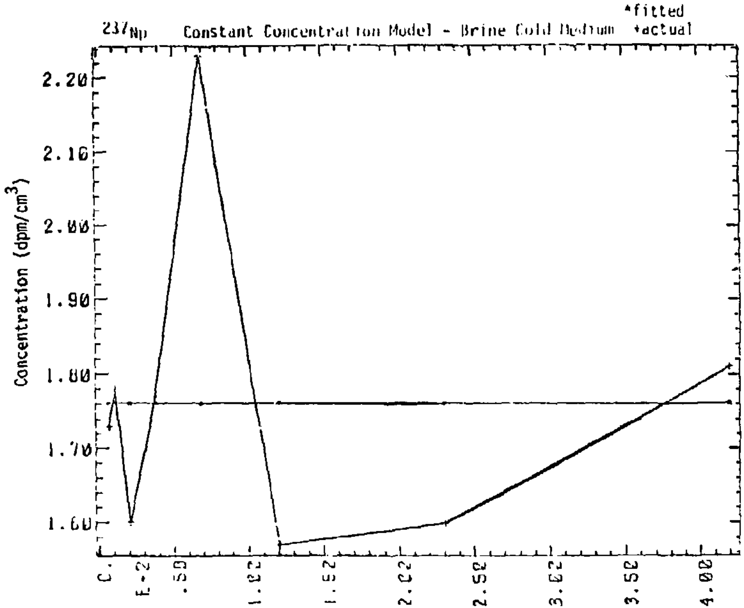
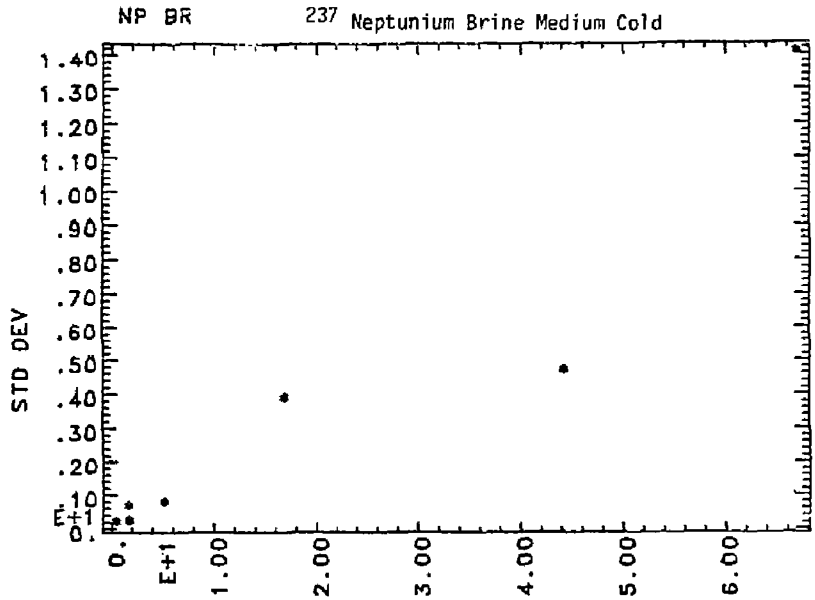


Figure 19

Standard Deviation vs. Mean Concentration for ^{237}Np (Brine, Medium, Cold).



Mean Concentration (dpm/cm^3)

Figure 20

replicated channels are based on an average of k^2 over the last 8 samples (see Table 8). Table 9 summarizes these estimates.

Table 9. Squares of the Coefficient of Variation for 25°C, Medium Flow Rate Channels

Solution	Replicates, k^2_R	Equation (7), k^2_E	Ratio, k^2_E/k^2_R
BR	0.0283	0.0420	1.48
BI	0.0231	0.0197	0.85
DW	0.2266	0.5486	2.42

The statistical test is based on the ratio, k^2_E/k^2_R, being an F-statistic with parameters or degrees of freedom $\nu_1=24$, $\nu_2=16$. There is no reason to reject the constant model for BR and BI; however, the constant model for DW would be rejected at a 5% level of significance (but not at a 2.5% level). A review of the DW data indicates a significant amount of variation in channel 21 which could be the primary reason for the larger value of k^2_E relative to k^2_R in this case.

Accepting the constant concentration model, Eqn. (7), the second phase of the data analysis was to assess if the experimental variables (solution, temperature and flow rate), have an effect on the level of ^{237}Np concentration in solution. The standard statistical procedure for making this assessment is to compare the concentration level for the different combinations of solution, temperature and flow rate. Since the experimental variation is proportional to the concentration level, the appropriate statistic for comparison is based on the ratio of the concentration levels at the various experimental conditions. Mathematically, the statistic actually used was the natural logarithm of the ratio (Under the assumed proportional standard deviation, the logarithm has a constant standard deviation equal to k).

A review of the plots of the standard deviation versus the mean (e.g. Figure 20) indicated it was reasonable to assume that the coefficient of variation was different for the 3 solutions, but that we could assume it was constant over the other experimental conditions. The proportionality constants used in making the comparisons are given in Table 10.

Table 10 Coefficients of Variation, k, for ^{237}Np in Different Leachates

Solution	k
Br	0.18
BI	0.54
DW	0.68

To illustrate the analysis used for assessing the effect of the experimental variables, consider the comparison of the concentration of ^{237}Np in the leachate at 25°C versus the concentration at 75°C. The data is summarized in Table 11. Notationally C_1 (C_2) denotes the concentration at 75°C (25°C). The test statistic used to compare concentration at 25°C and 75°C is

$$T = \Delta/\sigma(\Delta) \qquad (9)$$

where $\Delta = \ln(C_1/C_2)$ and $\sigma(\Delta)$ denotes the estimated standard deviation of Δ. Under the assumed model and the hypothesis of no difference in concentration at 25°C and 75°C, the distribution of T is approximately a standard normal distribution. Thus, if the value of T is greater than 1.96 (at a 5% significance level) or 2.32 (at a 1% significance level), it is appropriate to conclude that the concentrations are different at the two temperatures. A review of the data in Table 11 indicates that T is large for all combinations of solution and flow rate. Thus, we are able to conclude: 'Temperature has a significant effect on the concentration level'. More specifically, 'Concentration is significantly higher at 75°C than it is at 25°C'.

Table 11. Temperature Effects on ^{237}Np Concentration in Leachates

Solution	Flow Rate	$\Delta = Ln\ (C_1/C_2)$	Standard Deviation of $\Delta, \sigma(\Delta)$	T
BR	S	3.33	0.0900	37.0
	M	3.28	0.0735(1)	44.6
	F	3.66	0.0900	40.7
BI	S	2.70	0.2700	10.0
	M	3.52	0.2205(1)	16.0
	F	3.70	0.2700	13.7
DW	S	2.98	0.3400	8.8
	M	3.20	0.2776(1)	11.5
	F	3.62	0.3400	10.6

(1) Because of the replication, the average concentration at $43 cm^3$/day flow rate, 25°C is based on 24 observations rather than 8 samples as for the other conditions, thus reducing the standard deviation of the mean.

Given that temperature has a significant effect, it could be asked if the temperature effect changes for different solutions (i.e. in statistical terminology, is there a temperature by solution interaction?). Again, a review of the Δ's in Table 11 suggests that the difference in concentration at 25°C and 75°C, at the same flow rate, is the same for all three solutions. A statistical test, similar to that described above, in fact leads to that conclusion: 'The effect of temperature on the concentration of ^{237}Np in solution is the same for all 3 solutions, i.e. there is no temperature by solution interaction.'

Additional hypotheses, e.g. the concentration level varies with flow rate. were also considered and tested using statistics like that in Eqn. (9). Based on these tests, the following conclusions are suggested: For the concentration of ^{237}Np in solution,

- o There is a significant temperature effect; concentration at 75°C is greater than at 25°C.
- o The temperature effect is the same for all 3 solutions.
- o The temperature effect increases with flow rate; thus, the ratio of the concentrations at 75°C and 25°C is greater at the fast flow rate (300 cm^3/day) than it is at the slow flow rate (10 cm^3/day)
- o There is a significant flow rate effect; specifically the concentration level is greatest at the slow flow rate and decreases as flow rate is increased.
- o The flow rate effect can be considered the same for the 3 solutions.
- o The effect of flow rate changes with temperature for BR and BI but not DW, there is a flow rate by temperature interaction for BR and BI. (The reason we did not observe a difference in the effect of flow rate at 25°C and 75°C for DW is likely due to the larger experimental variation for DW.)
- o The concentration in BI is significantly different (greater) than it is in the other solutions; concentrations in BR and DW differ significantly at the fast flow rate.
- o The concentration differences between solutions are the same at both temperatures.

o The BI versus DW difference is the same for all flow rates; the BR versus BI difference is different at the slow and fast rates.

Some of these conclusions are clearly seen by reviewing a plot of the natural logarithm of concentration versus flow rate, for different combinations of solution and temperature, as given in Figure 21.

The conclusions given above are based on an analysis of the experimental data. These conclusions must be treated as suggestive since they are based on some assumptions (e.g. a constant concentration model for all solutions, proportional standard deviations) which seem reasonable but which are subject to review. Physical interpretations of some of these results are included in the discussion section.

V. DISCUSSION

A. COMPARISON OF PNL AND LLNL LEACH TESTS

The PNL and the LLNL 25°C leach tests may be compared over time without regard for the fact that the PNL leachant exchange rate varies over the course of the test. Table 12 summarizes data from Appendices 1 and 8, comparing the cumulative fraction leached values for comparable times in the PNL and LLNL procedures. At day 3 the PNL CFL values are generally similar to the LLNL medium flow results for both Np and Pu. The same is true at days 60-68 and 420-427 for the Pu in both bicarbonate and distilled waters, but the brine Pu results from the PNL test are slightly lower than the lowest LLNL results. In the case of Np, the day 60-68 comparison shows PNL data comparable to the LLNL slow flow channels. At day 420-427 the two tests

^{237}Np Log_e Concentration vs. Flow Rate for Different Temperatures and Solutions.

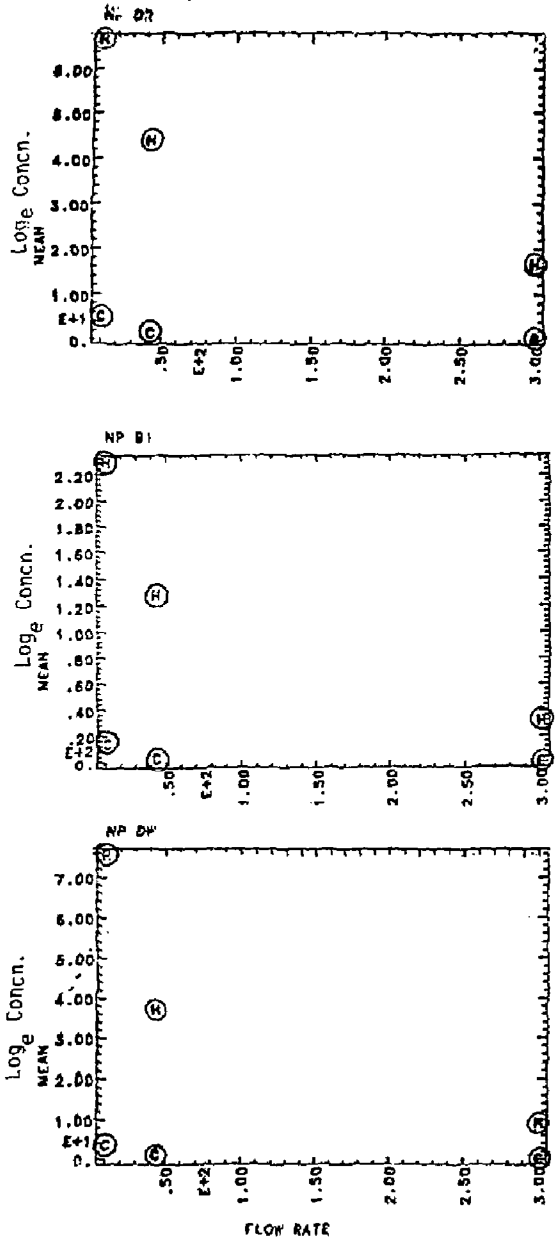


Figure 21

Table 12: Comparison of PNL and LLNL Cumulative Fraction Leached Results

Solution	Test	Rate	Element	CFL DAY:	Both 3	PNL 60	LLNL 68	LLNL 420	PNL 427
Brine	PNL		Np		6.0E-5	2.7E-4			6.0E-4
	LLNL	Slow			5.7E-5		2.5E-4	1.3E-3	
		Med			6.0E-5		3.2E-4	1.8E-3	
		Fast			8.1E-5		5.4E-4	3.1E-3	
Bicarb	PNL		Np		6.4E-5	4.9E-4			3.2E-3
	LLNL	Slow			3.9E-5		6.3E-4	3.2E-3	
		Med			6.5E-5		6.7E-4	4.0E-3	
		Fast			8.0E-5		7.7E-4	3.7E-3	
Dist. H_2O	PNL		Np		6.2E-5	2.1E-4			6.5E-4
	LLNL	Slow			6.4E-5		1.9E-4	9.0E-4	
		Med			6.2E-5		2.9E-4	1.6E-3	
		Fast			5.5E-5		3.0E-4	1.4E-3	
Brine	PNL		Pu		1.2E-5	2.8E-5			4.5E-5
	LLNL	Slow			1.4E-5		3.4E-5	1.2E-4	
		Med			1.1E-5		4.9E-5	1.5E-4	
		Fast			1.7E-5		9.4E-5	3.7E-4	
Bicarb	PNL		Pu		2.9E-5	1.5E-4			5.8E-4
	LLNL	Slow			1.3E-5		1.0E-4	2.8E-4	
		Med			2.7E-5		1.8E-4	5.8E-4	
		Fast			3.9E-5		2.6E-4	8.9E-4	
Dist. H_2O	PNL		Pu		1.7E-5	6.3E-5			1.5E-4
	LLNL	Slow			9.0E-6		2.4E-5	7.9E-5	
		Med			1.5E-5		5.3E-5	1.7E-4	
		Fast			1.2E-5		8.2E-5	2.8E-4	

agree for Np in bicarbonate but the PNL final CFL is somewhat lower than the LLNL slow channel results for the other two solutions.

An alternative comparison is to consider the equivalent leachant exchange rates of the two experiments, as discussed in the Introduction and tabulated in Table 1. Figure 22 presents such a comparison for the Np Incremental Leach Rate data from Appendices 1 and 8. The LLNL data points are obtained by averaging the R values for days 4-420 for the appropriate channels. The PNL data points for the 0.5 and 1.3 cm^3/bead/day values were obtained by averaging the R values measured after monthly and weekly solution changes, respectively; the 15 cm^3/bead/day value represents the average R for days 2-4 (day 1 was omitted because of the rapid initial change in leach rate observed in both procedures). For the slow and medium exchange rates the two tests agree reasonably well for bicarbonate and distilled water; the LLNL brine rates are appreciably higher than PNL values. The comparison at higher exchange rates is obscured by the fact that PNL data at this rate come only from the first 4 days of the expriment and by an unexplained drop in the LLNL distilled water leach rate.

In general, both comparative approaches indicate that the LLNL SPCF test at slow or medium flow rates produces results equivalent to those obtained from the PNL test.

B. COMPARISON OF ELEMENTAL LEACHING BEHAVIOR

1. Comparisons Based on Total Fraction Leached

Selection of a single numerical value for comparison of elemental behavior is complicated by the facts that Pu clearly does not adhere to a constant leach-rate model and that the ICP data sets are noisy and near de-

Comparison of PNL and LLNL Leach Test Results.
(open symbols: PNL; solid symbols: LLNL)

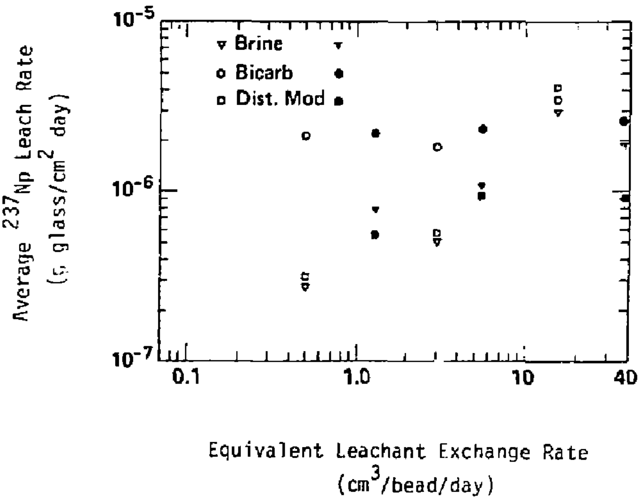


Figure 22

tection limits in many cases. Although its shortcomings have been commented on above, the total fraction leached (C.F.L. on day 420) is a convenient summary index for comparisons; the comments which follow are based on comparison of those values and their ratios. Stable element evaluations are based primarily on ICP data, except where the XRF results provide valid comparisons not otherwise available (e.g., U). See, however, the discussion of the relative merits of the XRF and ICP data in section III B3.

a. Experimental Tests

Channel 28, installed as a test of flow direction and filter effects, produced results in good agreement with the control channels (10, 11 and 13) for all elements except Mo, which appeared in slightly higher concentrations in Ch 28.

For the stable elements, the blank (undoped beads) channels agreed well with the comparable replicate channels for all elements except Zn (in both bicarbonate and distilled water) and Mo and B (distilled water only). In each of the exceptions the element was leached more strongly from the blank.

We conclude that the details of filter and solution flow characteristics do not significantly affect the experimental results, and that the presence or absence of the transuranic nuclides in the glass does not influence the leaching behavior of the other elements.

b. Temperature Effects

If we consider the ratios of total fraction leached at 75° to that at 25° for the same solutions and flow rates, we find that Np, B, and Si have ratios greater than 5 and usually greater than 10; although the data are scanty, the few results available (Appendix 9) suggest that U also belongs in this group.

Ti, Zn, Ca, Fe (bicarbonate) and Na (distilled water) all have ratios less than 5. Fe (distilled water) is borderline. Mo is uncertain, and the rest cannot be determined except for Pu, which shows ratios generally less than unity.

c. Solution Effects

Np, Pu, B, Si, U and Ca are leached more rapidly by the bicarbonate solution than by distilled water under comparable conditions. Mo and Sr may be leached slightly faster by the bicarbonate, and for Fe, Ni, Ti and Zn there does not appear to be any clear or major differences between the solutions.

d. Flow Rate Effects

If we consider the ratio of total fraction leached at fast flow to that at slow flow for the same temperature and solution, we find that Np, B, Si and probably U (see comments under b. above) have ratios less than 5, while Fe (bicarbonate), Ti, Zn, Ca, and Na (distilled water) have ratios greater than 5. Fe (distilled water) and Mo do not fit either pattern clearly, and Pu has low ratios at 25° and high ratios at 75°.

2. Leach Rate Comparisons

In the bicarbonate solution at 75°, Np, B and Si have incremental leach rates in the range of 1-30 x 10^{-5} grams glass/cm^2-day. The 25° values are less certain because of detection limit problems, but appear to be smaller by factors of 10-50. Mo and Ca leach rates are higher than the 1-30x10^{-5} range at both temperatures, Ti is lower at both temperatures, and Fe and Zn have higher leach rates at 25° and lower at 75°. Pu has apparent leach rates generally about two orders of magnitude less than Np.

In distilled water, the Np, B and Si leach rates are less than (typically about one third) the rates in bicarbonate. Since Ti, Mo, Fe, Zn, Ca and Na leach rate values do not show a similar solution dependence, their distilled water leach rates are comparable to or higher than the comparable Np, B and Si rates at both temperatures.

Figure 23 presents a summary log-log plot of the range covered by all the leach rate data as a function of time (the Pu results are not included in this plot).

C. LEACHING MECHANISMS

From the foregoing discussion it may be seen that the elements fall rather naturally into three groups. Pu is in a class of its own as far as apparent leaching behavior is concerned Np, B, Si and possibly U share a set of common solution, temperature and flow rate responses; and the other elements for which adequate comparative data exist (Fe, Mo, Ti, Zn, Ca and Na) are generally similar to each other in terms of their leaching behavior and distinctly different from the other classes.

Si and B are glass matrix elements; they and the elements with similar leaching characteristics (Np, probably U) probably are controlled by congruent dissolution of the borosilicate glass matrix. Since natural silicates dissolve considerably more quickly in alkaline than in acid media[14] the differences between bicarbonate and the other solutions are consistent with the observed pH characteristics.

Most of the observed elemental behaviors may be explained by the following sequence of events:

Simplified Graph of All the SPCF Data

(without ^{239}Pu)

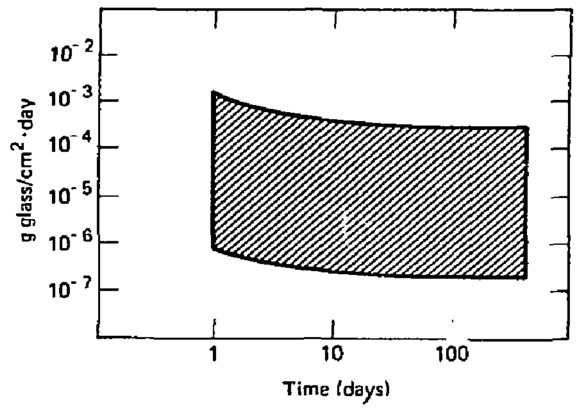


Figure 23

1. The initially high and decreasing leach rates observed during the first few days may be interpreted as the result of an initial corrosive attack on the glass surface during which a hydrous layer of predominately matrix element oxides is formed. This reaction has a half-life of about one day at 25° and considerably less at 75°.

2. Thereafter the constant leach rates suggest that the glass behaves as a Type IV surface,[15] with reactions controlled primarily by the thickness and solution rate of the porous and slightly soluble hydrous layer.

3. In the bicarbonate (basic) solution BET specific surface area (Table 4) does not increase significantly with leaching and leach rates of the matrix elements are comparable to those of the other elements. This suggests that congruent dissolution is the dominant mechanism. In the more acidic solutions the matrix is less soluble and leaching produces higher BET specific surface areas; some cation leach rates are greater than matrix element leach rates. Selective cation leaching may be occurring in these solutions, but the relative constancy of the observed leach rates indicates that matrix dissolution remains the rate-controlling step.

4. It is generally recognized that Pu has a strong tendency to be sorbed on surfaces, this behavior is a complex function of the Pu oxidation states.[16] trace concentrations of organic complexing agents[17], and the available surfaces. In view of this and the system sorption results reported above, we suggest that the observed Pu behavior is controlled by sorption and/or precipitation (probably largely on the hydrous surface layers on the beads) rather than by its actual leaching characteristics.

Although this conceptual model explains qualitatively most of the observed behavior, the strong flow rate dependence and in particular the lack of temperature dependence of some of the stable element apparent leach rates is puzzling and seems to merit further investigation. The mobility, speciation, and sorption characteristics of Pu in the leaching process would also be of interest as a subject for future research.

VI CONCLUSIONS

Based on the foregoing results, the following are considered the primary results of this study:

1. The LLNL (dynamic) and PNL (static) leach test methods yield comparable results. The minor differences observed cannot be ascribed to any fundamental inadequacy in either test.

2. After the first few days of leaching, most elements appear to be leached at a nearly constant rate. Matrix dissolution is suggested as the most probable rate-controlling step.

3. For Np and the glass matrix elements (Si, B) leach rates are of the magnitude of 10^{-1} g glass/cm^2 day. The observed rates:

   a. increase with increasing temperature,

   b. increase with increasing flow rate, and

   c. are higher in bicarbonate solution than in brine or distilled water (which yield similar rates).

4. Pu has a much lower apparent leach rate than the other elements; this is probably due to sorption or precipitation after leaching rather than to actual differences in leaching.

ACKNOWLEDGMENTS

Many people contributed to the success of these leaching studies. J. S. Schweiger performed much of the laboratory work. A. Langhorst conducted the ICP analyses. Mr. Larry Golen of the Mathematics and Statistics Division (Computations Department) at LLNL assisted in the development and application of software used in the stati.tical analyses of the leach data.

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D. G. Coles initiated this work at LLNL, and is presently on the staff of the Battelle Pacific Northwest Laboratory.

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APPENDIX 1

PNL Static Leach Test Results

Results of Pacific Northwest Laboratory modified IAEA leach test. See text for discussion, and ref. 1 for a more detailed report. The data shown were taken directly from laboratory data sheets supplied by P.N.L. (D. Bradley, personal communication).

SAMPLE ID P-1-1 WASTE FORM PNL 76-68 GLASS SOLUTION BRINE

INITIAL CONCENTRATION Pu $5.6 \times 10^7 \frac{dpm}{gm}$ SURFACE AREA 27.82 cm^2 TEMPERATURE 25°C

Np $6.4 \times 10^6 \frac{dpm}{gm}$

		1	2	3	4	5	6	7	8	9	10
SERIES		1	2	3	4	5	6	7	8	9	10
LEACH TIME (Days)		1	2	3	4	11	18	25	32	39	46
SAMPLE DATES	BEGIN	8-15-77	8-16-77	8-17-77	8-18-77	8-19-77	8-26-77	9-1-77	9-9-77	9-16-77	9-23-77
	END	8-16-77	8-17-77	8-18-77	8-19-77	-8-26-77	9-1-77	9-9-77	9-16-77	9-23-77	9-30-77
SOLUTION pH		7.0	7.1	7.1	7.2	7.1	6.9	7.1	6.8	6.3	6.6
SOLUTION COND. μmho/cm		>140,000									
SOLUTION Si CONC. ppm		NA	NA	NA	NA	NA	1.6	1.6	1.6	.054	.054
LEACHATE pH		5.5	5.4	5.5	5.7	7.0	7.0	7.0	7.0		5.3
LEACHATE COND. μmho/cm											
LEACHATE Si CONC. ppm		1.3	1.3	1.4	1.4	1.39	1.38	1.69	1.75		.19
Pu	dpm/ml	13.3	3.0	.47	1.86	1.66	.77	1.16	1.0	1.47	1.94
	LEACH RATE g/cm^2-day	2.6 E-6	5.8 E-7	9.1 E-8	3.6 E-7	4.6 E-8	2.1 E-8	3.2 E-8	2.8 E-8	4.0 E-8	5.3 E-8
	ΣFRACTIONS LEACHED	9.8 E-6	1.2 E-5	1.2 E-5	1.4 E-5	1.5 E-5	1.6 E-5	1.6 E-5	1.7 E-5	1.8 E-5	2.0 E-5
Np	dpm/ml	6.0	2.4	.9	1.96	2.2	1.37	2.73	1.16	2.6	4.05
	LEACH RATE g/cm^2-day	1.0 E-5	4.0 E-6	1.5 E-6	3.3 E-6	5.3 E-7	3.3 E-7	6.6 E-7	2.8 E-7	6.3 E-7	9.7 E-7
	ΣFRACTIONS LEACHED	3.9 E-5	5.4 E-5	6.0 E-5	7.3 E-5	8.7 E-5	9.6 E-5	1.1 E-4	1.2 E-4	1.4 E-4	1.6 E-4

SAMPLE ID P-1-1 WASTE FORM PNL 76-68 GLASS SOLUTION BRINE

INITIAL CONCENTRATION Pu 5.6×10^{7} $\frac{dpm}{gm}$ SURFACE AREA 27.82 cm^2 TEMPERATURE 25°C

Np 6.4×10^{6} $\frac{dpm}{gm}$

		11	12	13	14	15	16	17	18	19	20
SERIES		11	12	13	14	15	16	17	18	19	20
LEACH TIME		53	60	91	121	151	182	212	242	274	303
SAMPLE DATES	BEGIN	9-30-77	10-7-77	10-14-77	11-14-77	12-14-77	1-13-78	2-13-78	3-15-78	4-14-78	5-15-78
	END	10-7-77	10-14-77	11-14-77	12-14-77	1-13-78	2-13-78	3-15-78	4-14-78	5-15-78	6-14-78
SOLUTION pH		6.2	6.8	6.7	6.2	6.1	6.4	6.4	6.1	6.2	5.7
SOLUTION COND. µmho/cm		>140,000									
SOLUTION Si CONC. ppm		.054							2.17	2.17	
LEACHATE pH			6.0	6.5		6.6		6.6		6.6	
LEACHATE COND. µmho/cm											
LEACHATE Si CONC. ppm			.13	.27		.27		2.35		2.35	
^{239}Pu	dpm/ml	4.3	6.6	3.9	3.6	3.4		2.8		1.0	
	LEACH RATE g/cm²-day	1.2 E-7	1.8 E-7	2.5 E-8	2.3 E-8	2.2 E-8		1.[illegible] E-8		6.2 E-9	
	ΣFRACTIONS LEACHED	2.3 E-5	2.8 E-5	3.1 E-5	3.3 E-5	3.6 E-5	3.8 E-5	4.0 E-5	4.2 E-5	4.2 E-5	4.3 E-5
^{239}Np	dpm/ml		9.4	8.8		6.1		3.2		2.3	
	LEACH RATE g/cm²-day		2.3 E-7	4.8 E-7		3.4 E-7		1.8 E-7		1.2 E-7	
	ΣFRACTIONS LEACHED	2.1 E-4	2.7 E-4	3.3 E-4	3.7 E-4	4.1 E-4	4.4 E-4	4.6 E-4	4.8 E-4	4.9 E-9	5.2 E-4

SAMPLE ID P-1-1 WASTE FORM PNL 76-68 GLASS SOLUTION BRINE

INITIAL CONCENTRATION Pu $5.6 \times 10^7 \frac{dpm}{gm}$ SURFACE AREA 27.82 cm^2 TEMPERATURE 25°C

Np $6.4 \times 10^6 \frac{dpm}{gm}$

SERIES			21	22	23	24	25	26	27	28	29	30
LEACH TIME			333	364	395	427	459	487	517	546	576	607
SAMPLE DATES		BEGIN	6-14-78	7-14-78	8-14-78	9-14-78	10-16-78	11-16-78	12-15-78	1-16-79	2-14-79	3-16-79
		END	7-14-78	8-14-78	9-14-78	10-16-78	11-16-78	12-15-78	1-16-79	2-14-79	3-16-79	4-16-79
SOLUTION pH			6.6	6.7	6.2	6.6	6.6	6.9	6.9	6.9	6.9	6.9
SOLUTION COND. μmho/cm			>140,000									
SOLUTION Si CONC. ppm				1.88	1.88	2.15	2.15	1.64	1.64	1.70	1.70	1.79
LEACHATE pH			6.5		6.5		5.5		6.3		5.3	
LEACHATE COND. μmho/cm												
LEACHATE Si CONC. ppm			2.38		2.44		2.27		1.72		2.26	
^{239}Pu	dpm/ml		< .8				< .9					
	LEACH RATE g/cm^2-day		<5.1 E-9				<5.6 E-9					
	ΣFRACTIONS LEACHED		4.4 E-5	4.4 E-5	4.5 E-5	4.5 E-5	4.6 E-5					
^{237}Np	dpm/ml		4.6				<1.4					
	LEACH RATE g/cm^2-day		2.6 E-7				<7.6 E-8					
	ΣFRACTIONS LEACHED		5.4 E-4	5.7 E-4	5.9 E-4	6.0 E-4	6.1 E-4					

SAMPLE ID P-1-4 WASTE FORM PNL 76-68 GLASS SOLUTION $NaHCO_3$

INITIAL CONCENTRATION Pu $5.6 \times 10^7 \frac{dpm}{gm}$ SURFACE AREA 27.82 cm^2 TEMPERATURE 25°C

Np $6.4 \times 10^6 \frac{dpm}{gm}$

		1	2	3	4	5	6	7	8	9	10
SERIES		1	2	3	4	5	6	7	8	9	10
LEACH TIME		1	2	3	4	11	18	25	32	39	46
SAMPLE DATES	BEGIN	8-15-77	8-16-77	8-17-77	8-18-77	8-19-77	8-26-77	9-1-77	9-9-77	9-16-77	9-23-77
	END	8-16-77	8-17-77	8-18-77	8-19-77	8-26-77	9-1-77	9-9-77	9-16-77	9-23-77	9-30-77
SOLUTION pH		8.4	8.2	8.4	8.5	8.4	8.5	8.4	8.5	8.3	8.2
SOLUTION COND. μmho/cm		2600	2600	2510	2620	2530	2450	2420	2470	2380	2200
SOLUTION Si CONC. ppm							.035	.035	.035	.033	
LEACHATE pH		8.2	8.7	8.7	8.9	9.3	9.3	9.2	9.3		9.5
LEACHATE COND. μmho/cm											
LEACHATE Si CONC. ppm		.15	.14	.11	.12	.34	.37	.29	.35		.23
Pu	dpm/ml	23.7	9.9	5.6	8.8	23.3	19.2	12.1	21.6	20.6	19.5
	LEACH RATE g/cm²-day	4.6 E-6	1.9 E-6	1.1 E-6	1.7 E-6	6.4 E-7	5.3 E-7	3.3 E-7	5.9 E-7	5.7 E-7	5.4 E-7
	ΣFRACTIONS LEACHED	1.7 E-5	2.5 E-5	2.9 E-5	3.5 E-5	5.3 E-5	6.7 E-5	7.6 E-5	9.1 E-5	1.1 E-4	1.2 E-4
Np	dpm/ml	5.7	2.0	2.2	2.2	8.9	3.1	7.7	6.2	6.8	7.5
	LEACH RATE g/cm²-day	9.6 E-6	3.4 E-6	3.7 E-6	3.7 E-6	2.1 E-6	7.5 E-7	1.9 E-6	1.5 E-6	1.6 E-6	1.8 E-6
	ΣFRACTIONS LEACHED	3.7 E-5	5.0 E-5	6.4 E-5	7.8 E-5	1.4 E-4	1.6 E-4	2.0 E-4	2.4 E-4	2.9 E-4	3.4 E-4

SAMPLE ID P-1-4 WASTE FORM PNL 76-68 GLASS SOLUTION $NaHCO_3$

INITIAL CONCENTRATION Pu 5.6×10^7 dpm/gm SURFACE AREA 27.82 cm^2 TEMPERATURE 25°C

Np 6.4×10^6 dpm/gm

SERIES		11	12	13	14	15	16	17	18	19	20
LEACH TIME		53	60	91	121	151	182	212	242	274	303
SAMPLE DATES	BEGIN	9-30-77	10-7-77	10-14-77	11-14-77	12-14-77	1-13-78	2-13-78	3-15-78	4-14-78	5-15-78
	END	10-7-77	10-14-77	11-14-77	12-14-77	1-13-78	2-13-78	3-15-78	4-14-78	5-15-78	6-14-78
SOLUTION pH		8.1	8.4	8.4	8.6	8.4	8.5	8.5	8.5	8.4	8.3
SOLUTION COND. µmho/cm		2050	2280	2330	2300	2300	2250	2250	2200	2150	2200
SOLUTION Si CONC. ppm							.036	.036	.036	.036	.06
LEACHATE pH			9.4	9.5		9.6		9.2		9.2	
LEACHATE COND. µmho/cm											
LEACHATE Si CONC. ppm			.36	1.04		.70		.96		1.06	
Pu	dpm/ml	21.9	24.2	40.6	37.6	34.6		52.6		52.6	
	LEACH RATE g/cm^2-day	6.0 E-7	6.7 E-7	2.6 E-7	2.4 E-7	2.2 E-7		3.4 E-7		3.2 E-7	
	ΣFRACTIONS LEACHED	1.4 E-4	1.5 E-4	1.8 E-4	2.1 E-4	2.4 E-4	2.7 E-4	3.1 E-4	3.5 E-4	3.9 E-4	4.2 E-4
Np	dpm/ml		13.4	27.0		17.6		26.9		21.4	
	LEACH RATE g/cm^2-day		3.2 E-6	1.5 E-6		9.9 E-7		1.5 E-6		1.1 E-6	
	ΣFRACTIONS LEACHED	4.1 E-4	4.9 E-4	6.6 E-4	8.1 E-4	9.2 E-4	1.1 E-3	1.2 E-3	1.4 E-3	1.5 E-3	1.7 E-3

SAMPLE ID P-1-4 WASTE FORM PNL 76-68 GLASS SOLUTION $NaHCO_3$

INITIAL CONCENTRATION Pu $5.6 \times 10^7 \frac{dpm}{gm}$ SURFACE AREA 27.82 cm^2 TEMPERATURE 25°C

Np $6.4 \times 10^6 \frac{dpm}{gm}$

SERIES		21	22	23	24	25	26	27	28	29	30
LEACH TIME		333	364	395	427	459	487	517	546	576	607
SAMPLE DATES	BEGIN	6-14-78	7-14-78	8-14-78	9-14-78	10-16-78	11-16-78	12-15-78	1-16-79	2-14-79	3-16-79
	END	7-14-78	8-14-78	9-14-78	10-16-78	11-16-78	12-15-78	1-16-79	2-14-79	3-16-79	4-16-79
SOLUTION pH		8.6	8.6	9.1	8.7	8.6	8.5	8.4	8.6	8.6	8.8
SOLUTION COND. µmho/cm		2320	2950	2840	2300	2700	2600	2600	3000		
SOLUTION Si CONC. ppm		.06	.03	.03	.036	.036	.031	.031	0.064	.064	.036
LEACHATE pH		9.2		9.1		9.2		8.9		9.2	
LEACHATE COND. µmho/cm											
LEACHATE Si CONC. ppm		1.22		1.44		.12		1.27		.16	
Pu	dpm/ml	45.8				63.1					
	LEACH RATE g/cm²-day	2.9 E-7				3.8 E-7					
	ΣFRACTIONS LEACHED	4.6 E-4	4.9 E-4	5.3 E-4	5.8 E-4	6.2 E-4					
Np	dpm/ml	33.2				98.9					
	LEACH RATE g/cm²-day	1.9 E-6				5.2 E-6					
	ΣFRACTIONS LEACHED	1.9 E-3	2.2 E-3	2.7 E-3	3.2 E-3	3.8 E-3					

SAMPLE ID P-1-5 WASTE FORM PNL 76-68 GLASS SOLUTION Deionized Water

INITIAL CONCENTRATION Pu $5.6 \times 10^7 \frac{dpm}{gm}$ SURFACE AREA 27.82 cm^2 TEMPERATURE 25°C

Np $6.4 \times 10^6 \frac{dpm}{gm}$

		1	2	3	4	5	6	7	8	9	10
SERIES		1	2	3	4	5	6	7	8	9	10
LEACH TIME		1	2	3	4	11	18	25	32	39	46
SAMPLE DATES	BEGIN	8-15-77	8-16-77	8-17-77	8-18-77	8-19-77	8-26-77	9-1-77	9-9-77	9-16-77	9-23-77
	END	8-16-77	8-17-77	8-18-77	8-19-77	8-26-77	9-1-77	9-9-77	9-16-77	9-23-77	9-30-77
SOLUTION pH		6.3	6.1	6.1	6.1	6.1	6.0	6.4	6.2	6.0	7.1
SOLUTION COND. μmho/cm		1.1	1.5	1.7	1.65	2.1	1.5	1.32	2.6	1.05	1.4
SOLUTION Si CONC. ppm		NA	NA	NA	NA	NA	< .01	< .01	< .01	< .01	
LEACHATE pH		6.3	6.5	6.3	7.4	6.1	6.0	6.1	5.4		6.7
LEACHATE COND. μmho/cm		2.59	1.54	1.7	1.56	1.5	1.46	2.50	2.03		2.1
LEACHATE Si CONC. ppm		.11	.07	.05	.02	.07	.059	.08	.052		.072
Pu	dpm/ml	15	5.6	2.4	6.1	8.5	4.7	16.2	4.2	5.1	6.1
	LEACH RATE g/cm²-day	2.9 E-6	1.1 E-6	4.6 E-7	1.2 E-6	2.3 E-7	1.3 E-7	4.5 E-7	1.2 E-7	1.4 E-7	1.6 E-7
	ΣFRACTIONS LEACHED	1.1 E-5	1.5 E-5	1.7 E-5	2.2 E-5	2.8 E-5	3.2 E-5	4.4 E-5	4.7 E-5	5.1 E-5	5.5 E-5
Np	dpm/ml	4.4	3.0	2.1	2.0	3.1	1.4	3.4	2.0	2.5	3.1
	LEACH RATE g/cm²-day	7.4 E-6	5.1 E-6	3.5 E-6	3.7 E-6	7.5 E-7	3.4 E-7	8.0 E-7	4.8 E-7	4.2 E-7	7.5 E-7
	ΣFRACTIONS LEACHED	2.9 E-5	4.8 E-5	6.2 E-5	7.5 E-5	9.5 E-5	1.0 E-4	1.3 E-4	1.4 E-4	1.6 E-4	1.8 E-4

SAMPLE ID P-1-5 WASTE FORM PNL 76-68 GLASS SOLUTION Deionized Water

INITIAL CONCENTRATION Pu $5.6 \times 10^7 \frac{dpm}{gm}$ SURFACE AREA 27.82 cm^2 TEMPERATURE 25°C

Np $6.4 \times 10^6 \frac{dpm}{gm}$

SERIES		11	12	13	14	15	16	17	18	19	20
LEACH TIME		53	60	91	121	151	182	212	242	274	303
SAMPLE DATES	BEGIN	9-30-77	10-7-77	10-14-77	11-14-77	12-14-77	1-13-78	2-13-78	3-15-78	4-14-78	5-15-78
	END	10-7-77	10-14-77	11-14-77	12-14-77	1-13-78	2-13-78	3-15-78	4-14-78	5-15-78	6-14-78
SOLUTION pH		5.8	6.1	7.1	6.5	6.4	6.0	5.8	6.8	6.5	6.0
SOLUTION COND. µmho/cm		1.7	2.05	7.2	1.63	.95	.02	1.1	.08	2.6	1.95
SOLUTION Si CONC. ppm							.006	.006	.006	.006	.009
LEACHATE pH			6.5	6.4		6.5		6.8		6.8	
LEACHATE COND. µmho/cm			1.8	3.6		1.8		1.73		1.32	
LEACHATE Si CONC. ppm			.076	.29		.14		.15		.14	
Pu	dpm/ml	5.4	4.6	8.8	8.1	7.5		16.2		9.7	
	LEACH RATE g/cm^2-day	1.4 E-7	1.3 E-7	5.7 E-8	5.2 E-8	4.8 E-8		1.0 E-7		5.8 E-8	
	ΣFRACTIONS LEACHED	5.9 E-5	6.3 E-5	6.9 E-5	7.5 E-5	8.1 E-5	9.0 E-5	1.0 E-4	1.1 E-4	1.2 E-4	1.3 E-4
Np	dpm/ml		2.33	8.5		4.3		4.9		4.9	
	LEACH RATE g/cm^2-day		5.6 E-7	4.6 E-7		2.4 E-7		2.8 E-7		2.6 E-7	
	ΣFRACTIONS LEACHED	1.9 E-4	2.1 E-4	2.6 E-4	3.1 E-4	3.3 E-4	3.6 E-4	3.9 E-4	4.2 E-4	4.6 E-4	4.9 E-4

SAMPLE ID P-1-5 WASTE FORM PNL 76-68 GLASS SOLUTION Deionized Water

INITIAL CONCENTRATION Pu $5.6 \times 10^7 \frac{dpm}{gm}$ SURFACE AREA 27.82 cm^2 TEMPERATURE 25°C

Np $6.4 \times 10^6 \frac{dpm}{gm}$

SERIES		21	22	23	24	25	26	27	28	29	30
LEACH TIME		333	364	395	427	459	487	517	546	576	607
SAMPLE DATES	BEGIN	6-14-78	7-14-78	8-14-78	9-14-78	10-16-78	11-16-78	12-15-78	1-16-79	2-14-79	3-16-79
	END	7-14-78	8-14-78	9-14-78	10-16-78	11-16-78	12-15-78	1-16-79	2-14-79	3-16-79	4-16-79
SOLUTION pH		5.8	5.8	5.5	6.2	5.8	6.0	6.6	6.2	6.3	6.5
SOLUTION COND. μmho/cm		1.43	1.33	2.1	1.7	2.6	1.9	1.5	1.5	2.5	1.05
SOLUTION Si CONC. ppm		.009	.005	.005	.004	.004	< .01	< .01	.011	.011	< .01
LEACHATE pH		6.8		6.7		6.7		8.1		6.8	
LEACHATE COND. μmho/cm		1.41		1.64		1.42		1.32		2.24	
LEACHATE Si CONC. ppm		.19		.16		.14		.21		.27	
Pu	dpm/ml	7.7				9.9					
	LEACH RATE g/cm^2-day	4.9 E-8				6.4 E-4					
	ΣFRACTIONS LEACHED	1.3 E-4	1.4 E-4	1.4 E-4		1.6 E-4					
Np	dpm/ml	5.9				6.2					
	LEACH RATE g/cm^2-day	3.3 E-7				3.4 E-7					
	ΣFRACTIONS LEACHED	5.3 E-4	5.7 E-4	6.1 E-4	6.5 E-4	6.8 E-4					

APPENDIX 2

Bead Weights Before and After Leaching.

Some samples were withdrawn prior to final weighing, so the reported final weight for many channels is based on a normalization of the final weight of 6 beads rather than the true final weight for all 8 beads. The mean initial weight of the 8-bead sets is 2.846 g with a standard deviation of 2.1%. Because of these uncertainties in the initial weights of individual beads, weight losses based on normalized final weights should not be considered significant unless they exceed 2%. The greater weight losses are significant although imprecise, and the final weights in those channe's where all eight beads were retained yield accurate differences.

Bead Weights Before and After Leach

Channel	Solution	Flow	Temp (°C)	Orig. Wt. (g)	Final Wt. (g)	Wt. (g)	% Loss
1	Brine	Med	25	2.7631	2.7778	+0.0145	-0.531[c]
2	Brine	Med	25	2.8236	2.7464	-0.0772	2.73
3	Brine	Med	25	2.8952	2.9012[a]	+0.0060	-0.206[c]
4	Brine	Med	25	2.8064	2.8019	-0.0045	0.16
5	Brine	Med	75	2.8567	2.7356[a]	-0.1211	4.24
6	Brine	Fast	25	2.9042	2.9015[a]	-0.0027	0.39
7	Brine	Fast	75	2.9102	2.7739[a]	-0.1363	4.68
8	Brine	Slow	25	2.8212	2.8552[a]	+0.0340	-1.20[c]
9	Brine	Slow	75	2.7523	2.6607[a]	-0.0916	3.33
10	Bicarb	Med	25	2.7653	2.7247[ab]	-0.0394	1.42
11	Bicarb	Med	25	2.8316	2.9412[ab]	+0.1096	-3.87[c]
12	Bicarb	Med	25	2.7765	2.7619	-0.0146	0.53
13	Bicarb	Med	25	2.8523	2.8752[ab]	+0.0229	-0.80[c]
14	Bicarb	Med	75	2.9749	2.6673[a]	-0.3076	10.34
15	Bicarb	Fast	25	2.7843	2.8147[a]	+0.0304	-1.09[c]
16	Bicarb	Fast	75	2.9006	2.4785[ab]	-0.4221	14.55
17	Bicarb	Slow	25	2.7839	2.7491[ab]	-0.034E	1.25
18	Bicarb	Slow	75	2.9212	2.7799[a]	-0.1413	4.84
19	Dist.	Med	25	2.8809	2.8564	-0.0725	2.60
20	Dist.	Med	25	2.8432	2.8052[a]	-0.0380	1.34
21	Dist.	Med	25	2.9083	2.9187[a]	+0.0104	-0.36[c]
22	Dist.	Med	25	2.7549	2.7170	-0.0289	1.05

Channel	Solution	Flow	Temp (°C)	Orig. Wt. (g)	Final Wt. (g)	Wt. (g)	% Loss
23	Dist.	Med	75	2.8460	2.6341[a]	-0.2119	7.44
24	Dist.	Fast	25	2.9101	2.9365[ab]	+0.0264	-0.91[c]
25	Dist.	Fast	75	2.8356	2.6549[a]	-0.1807	6.37
26	Dist.	Slow	25	2.8547	2.8997[a]	+0.0450	-1.58[c]
27	Dist.	Slow	75	2.8812	2.7779[a]	-0.1033	3.59
28	Bicarb.	Med	25	2.8336	2.7575	-0.0761	2.69

Notes: a. Calculated from final weight of 6 out of 8 beads.
b. Incomplete transfer; small amount lost to filter.
c. Apparant Weight gain.

APPENDIX 3

Sample Volumes, Times and Flow Rates

a) Tabulation of sample volumes (cm^3), collection times (days) and flow rates (cm^3/day) for the LLNL leach test.

b) Average flow rate and percent standard deviation for each channel, calculated from flow rates measured on the sampling days.

TABULATION OF SAMPLE VOLUMES, SAMPLE TIME AND FLOWRATES

CHANNEL/DAY		1	2	3	6	11	20	37	68	120	230	420
VOLUME	1	54.3500	54.4500	52.8300	166.9800	58.7400	56.7800	57.6800	59.9000	77.0200	65.0200	57.6200
DELT TIME	1	0.9900	0.9890	0.9600	3.0300	1.0510	1.0140	1.0190	1.0220	1.3850	1.0680	1.0200
FLOWRATE	1	46.1336	46.2652	46.2447	45.3100	46.9661	47.0555	47.5608	49.2526	46.7312	51.1598	47.4708
VOLUME	2	53.1000	55.7100	54.2500	171.8500	60.6900	59.0200	60.8400	61.4700	77.3200	63.0000	56.8100
DELT TIME	2	0.9580	0.9890	0.9600	3.0300	1.0510	1.0140	1.0190	1.0220	1.3650	1.0680	1.0200
FLOWRATE	2	46.5781	47.3358	47.4877	47.6606	48.5252	48.3119	50.1728	50.5435	47.6006	49.5704	46.8034
VOLUME	3	53.8000	55.7500	54.1400	171.1800	59.8600	57.7800	44.3700	45.8200	82.5500	68.8400	63.6300
DELT TIME	3	0.9570	0.9900	0.9590	3.0300	1.0510	1.0140	1.0190	1.0220	1.3650	1.0680	1.0200
FLOWRATE	3	47.2415	47.3220	47.4409	47.4748	47.7017	47.8842	36.5905	37.6753	50.8203	54.1655	52.4221
VOLUME	4	48.8100	49.7400	48.5200	152.9300	53.5300	51.8600	52.5000	53.2500	73.0400	64.9100	69.1700
DELT TIME	4	0.9730	0.9910	0.9600	3.0280	1.0510	1.0140	1.0190	1.0220	1.3650	1.0680	1.0200
FLOWRATE	4	42.1550	42.1779	42.4720	42.4414	42.8004	42.9781	43.2950	43.7846	44.9657	51.0732	56.9863
VOLUME	5	51.0900	53.0500	49.9200	153.9200	58.7800	54.0800	58.3100	50.6000	50.0500	62.9000	59.0000
DELT TIME	5	0.9850	1.0280	0.9620	3.0100	1.1910	1.0410	1.1210	0.9750	0.8810	1.0680	1.0200
FLOWRATE	5	43.5966	43.3656	43.6066	42.9716	41.4735	43.6555	43.7110	43.6113	47.7399	49.4917	48.6077
VOLUME	6	370.5300	364.3400	356.2100	1125.1100	395.2500	399.8200	417.1000	396.1200	439.2700	356.4700	413.4900
DELT TIME	6	1.0000	0.9900	0.9590	3.0290	1.0510	1.0140	1.0190	1.0220	1.3650	1.0680	1.0200
FLOWRATE	6	311.3697	309.2607	312.1336	312.1395	316.0256	331.3444	343.9688	325.7084	270.4282	280.4819	340.6574
VOLUME	7	325.8300	352.3100	331.1200	1027.7600	396.5600	361.5000	376.5100	333.9300	631.0000	388.9700	450.6200
DELT TIME	7	0.9550	1.0280	0.9620	3.0100	1.1910	1.0410	1.1210	0.9750	0.8810	1.0680	1.0200
FLOWRATE	7	286.7086	287.9950	289.2433	286.9315	279.8016	291.8170	282.2435	287.8087	601.8753	306.0539	371.2473
VOLUME	8	45.4700	49.3600	39.9600	38.4400	12.9000	12.3800	12.0600	11.2800	17.0000	13.4300	13.1200
DELT TIME	8	0.9870	0.9890	0.9610	2.9800	1.0510	1.0140	1.0190	1.0220	1.3650	1.0680	1.0200
FLOWRATE	8	38.7134	41.9403	34.9426	10.8398	10.3143	10.2597	9.9455	9.2749	10.4667	10.5671	10.8090
VOLUME	9	12.0200	13.2200	12.4000	38.4400	14.8400	13.3500	14.5800	12.6000	24.5300	15.8400	13.3900
DELT TIME	9	0.9930	1.0280	0.3620	3.0100	1.1910	1.0410	1.1210	0.9750	0.8810	1.0680	1.0200
FLOWRATE	9	10.1720	10.8067	10.8318	10.7317	10.4707	10.7766	10.9296	10.8597	23.3978	12.4531	11.0375
VOLUME	10	44.8500	45.8200	39.5200	141.5900	50.9600	48.9900	23.7600	52.8900	67.6600	56.3800	50.8300
DELT TIME	10	0.9730	0.9870	0.9600	3.0300	1.0510	1.0140	1.0190	1.0220	1.3650	1.0680	1.0200
FLOWRATE	10	46.0946	46.4235	41.1667	46.7294	48.4872	48.3136	23.3170	51.7515	49.5604	52.7903	49.8333
VOLUME	11	41.1300	42.0800	40.7600	127.4300	43.6700	43.3000	37.2600	44.4500	61.1900	48.9800	50.7400
DELT TIME	11	0.9720	0.9880	0.9590	3.0300	1.0510	1.0140	1.0190	1.0220	1.3650	1.0680	1.0200
FLOWRATE	11	42.3148	42.5911	42.5026	42.0561	41.5509	42.7022	36.5653	43.4932	44.8278	45.8614	49.7451
VOLUME	12	40.1100	41.7100	40.4700	123.8200	44.5600	43.1400	43.9500	44.5600	61.3400	51.0100	49.9000
DELT TIME	12	0.9590	0.9880	0.9590	3.0300	1.0510	1.0140	1.0190	1.0220	1.3650	1.0680	1.0200
FLOWRATE	12	41.8248	42.2166	42.2002	40.8647	42.3977	42.5444	43.1305	43.6008	44.9377	47.7622	48.9216
VOLUME	13	42.8200	43.5700	0.0000	132.9700	46.7300	44.2100	46.2700	46.8300	63.1200	55.5100	51.9700
DELT TIME	13	0.9690	0.9890	0.9600	3.0280	1.0510	1.0140	1.0190	1.0220	1.3650	1.0680	1.0200
FLOWRATE	13	44.1899	44.0546	0.0000	43.9135	44.1624	43.5996	45.4073	45.8219	46.2418	51.9757	50.9510

TABULATION OF SAMPLE VOLUMES, SAMPLE TIME AND FLOWRATES

CHANNEL/DAY		1	2	3	6	11	20	37	68	120	230	420
VOLUME	14	43.2500	39.1900	42.5300	132.1400	50.8900	45.7000	49.7800	43.5000	67.8500	55.4800	47.3600
DELT TIME	14	0.9810	1.0280	0.9620	3.0100	1.1910	1.0410	1.1210	0.9750	0.8810	1.0680	1.0200
FLOWRATE	14	44.0877	38.1226	44.2100	43.9003	42.7288	43.9001	44.4068	44.6154	77.0148	51.9476	46.4314
VOLUME	15	275.5700	273.0300	266.4900	794.3400	292.3200	279.2000	275.9000	207.5100	224.8500	255.5000	190.3600
DELT TIME	15	0.9950	0.9890	0.9600	3.0270	1.0510	1.0140	1.0190	1.0220	1.3650	1.0680	1.0200
FLOWRATE	15	276.9548	276.0667	277.5937	262.4102	278.1351	275.3452	270.7556	203.0431	164.7253	239.2322	186.6275
VOLUME	16	275.6800	299.4000	280.4000	876.5200	339.3400	310.9400	353.0200	315.6900	309.0000	267.5400	231.0000
DELT TIME	16	0.9530	1.0280	0.9620	3.0100	1.1910	1.0410	1.1210	0.9750	0.8810	1.0680	1.0200
FLOWRATE	16	289.2760	291.2451	291.4761	291.2027	284.9202	298.6936	314.9153	323.7846	350.7378	250.5056	226.4706
VOLUME	17	10.1700	10.0700	9.8600	31.3100	10.8500	9.6500	10.5300	10.0200	14.2800	10.5900	11.4600
DELT TIME	17	1.0050	0.9870	0.9610	3.0280	1.0510	1.0140	1.0190	1.0220	1.3650	1.0680	1.0200
FLOWRATE	17	10.1194	10.2026	10.2601	10.3402	10.3235	9.5168	10.3337	9.3043	10.4615	9.9157	11.2353
VOLUME	18	9.9900	9.3100	10.0600	29.2800	11.0300	10.6500	11.6000	10.0700	12.6700	11.2000	11.0800
DELT TIME	18	0.9910	1.0280	0.9620	3.0100	1.1910	1.0410	1.1210	0.9750	0.8810	1.0680	1.0200
FLOWRATE	18	10.0807	9.0564	10.4574	9.7276	9.2611	10.2305	10.3479	10.3282	14.3814	10.4869	10.8627
VOLUME	19	44.4200	45.3600	44.0300	138.5200	48.4800	47.4000	48.4900	50.4000	65.7200	54.5100	64.0600
DELT TIME	19	0.9760	0.9860	0.9600	3.0300	1.0510	1.0140	1.0190	1.0220	1.3650	1.0680	1.0200
FLOWRATE	19	45.5123	46.0041	45.8646	45.7162	46.1275	46.7456	47.5859	49.3151	48.1465	51.0393	62.8039
VOLUME	20	41.0000	41.7600	40.5600	126.8400	42.2300	41.1000	45.3500	38.5600	56.1700	53.2900	53.3300
DELT TIME	20	0.9780	0.9870	0.9600	3.0290	1.0510	1.0140	1.0190	1.0220	1.3650	1.0680	1.0200
FLOWRATE	20	41.9223	42.2999	42.2500	41.8762	40.1808	40.5325	44.5044	37.7299	41.1502	49.8970	52.2843
VOLUME	21	41.5000	42.5200	41.3700	129.0500	43.4800	44.7600	47.0600	46.9400	63.0500	58.8900	50.5700
DELT TIME	21	0.9680	0.9880	0.9600	3.0270	1.0510	1.0140	1.0190	1.0220	1.3650	1.0680	1.0200
FLOWRATE	21	42.8719	43.0364	43.0937	42.6330	41.3701	44.1420	46.1825	45.9295	46.1905	55.1404	49.5784
VOLUME	22	39.1200	40.8600	39.7900	124.7500	43.9900	40.6500	43.9600	45.2700	63.3800	54.4500	49.9400
DELT TIME	22	0.9600	0.9860	0.9600	3.0290	1.0510	1.0140	1.0190	1.0220	1.3650	1.0680	1.0200
FLOWRATE	22	40.7500	41.4402	41.4479	41.1852	41.8554	40.0888	43.1403	44.2955	46.4322	50.9831	48.9608
VOLUME	23	42.0900	30.1500	40.6600	127.8000	48.9500	45.2900	49.9300	43.9100	44.5100	56.6600	49.5600
DELT TIME	23	0.9820	1.0280	0.9620	3.0100	1.1910	1.0410	1.1210	0.9750	0.8810	1.0680	1.0200
FLOWRATE	23	42.8615	29.3288	42.2661	42.4585	41.0999	43.5062	44.5406	45.0359	50.5221	53.0524	48.5882
VOLUME	24	272.5900	273.8200	267.5700	846.3700	292.2000	286.0200	290.2800	298.9400	423.9700	162.6000	289.3400
DELT TIME	24	0.9840	0.9880	0.9590	3.0280	1.0510	1.0140	1.0190	1.0220	1.3650	1.0680	1.0200
FLOWRATE	24	277.0224	277.1457	279.0094	279.5145	278.0209	282.0710	284.8675	292.5049	310.6007	152.2472	283.6667
VOLUME	25	234.7700	294.3200	277.1700	860.5100	331.4600	301.1500	285.4700	273.2000	226.9000	254.0500	260.5700
DELT TIME	25	0.9490	1.0280	0.9620	3.0100	1.1910	1.0410	1.1210	0.9750	0.8810	1.0680	1.0200
FLOWRATE	25	247.3867	286.3035	288.1185	285.8837	278.3039	289.2891	254.6566	280.2051	257.5482	237.8745	255.4608
VOLUME	26	10.1500	10.3200	10.0400	31.8600	11.0400	10.5800	10.7800	10.7900	14.8400	12.5400	11.6400
DELT TIME	26	1.0050	0.9870	0.9600	3.0200	1.0510	1.0140	1.0190	1.0220	1.3650	1.0680	1.0200
FLOWRATE	26	10.0995	10.4559	10.4583	10.5218	10.5043	10.4339	10.5790	10.5577	10.8718	11.7416	11.4118
VOLUME	27	13.7400	13.8500	8.2700	25.4900	3.1300	9.6000	2.4300	19.7900	18.4800	20.5900	10.5800
DELT TIME	27	0.9880	1.0280	0.9620	3.0100	1.1910	1.0410	1.1210	0.9750	0.8810	1.0680	1.0200
FLOWRATE	27	13.9069	13.4728	8.5967	3.4604	2.6280	9.2219	2.1677	20.2974	20.9762	19.2790	10.3725
VOLUME	28	36.6900	48.9100	46.9400	144.2500	54.7600	45.9300	57.6700	50.9600	50.5400	72.8100	46.5000
DELT TIME	28	0.8200	1.0280	0.9620	3.0100	1.1790	1.0410	1.1210	0.9750	0.8810	1.0680	1.0200
FLOWRATE	28	44.7439	47.5778	48.7942	47.9236	46.4461	44.1210	51.4451	52.2667	57.3666	68.1742	45.5882

CHANNEL	AVERAGE FLOWRATE	PCT S.D.
1	47.378	3.254
2	48.290	2.799
3	46.976	11.513
4	45.012	10.488
5	44.711	5.847
6	313.956	7.199
7	321.702	29.391
8	16.007	73.764
9	12.040	31.626
10	45.861	17.667
11	43.110	7.427
12	43.673	5.822
13	41.874	33.848
14	47.397	21.813
15	246.445	17.050
16	292.112	11.408
17	10.228	4.260
18	10.475	13.402
19	48.624	10.305
20	43.148	9.955
21	45.470	8.702
22	43.689	6.269
23	43.933	13.984
24	272.425	15.066
25	269.185	6.979
26	10.694	4.460
27	11.763	55.522
28	50.404	13.971

APPENDIX 4

pH, Eh and Conductivity Data.

Eh values were generally unstable, and should be considered approximate. Brine conductivities were not measured. The leachant solutions were not measured except for pH measurements when the supply tanks were replenished on day 23. At this time the old brine solution had pH = 6.55, and the new solution pH 7.25. The old bicarbonate solution had a pH of 8.69, the new, 8.52. The distilled water was not measured, but tap distilled water typically has a pH of 6-7.

TABLE OF PH MEASUREMENTS

CHANNEL/DAY	1	2	3	6	11	20	37	68	120	230	420
				BRINE							
1	7.10	7.01	7.08	6.94	7.99	7.00	6.82	6.88	6.74	6.85	6.65
2	7.15	7.13	7.13	6.97	6.92	7.05	7.02	6.99	5.56	6.98	6.72
3	7.09	7.06	7.03	6.83	6.80	6.97	6.88	6.77	6.08	6.89	6.58
4	7.08	7.02	7.07	6.72	6.98	6.96	6.90	6.87	5.72	6.91	6.43
5	7.16	7.13	7.16	6.05	7.07	7.09	6.05	6.97	6.91	7.00	6.58
6	7.02	6.99	6.83	6.79	7.07	6.60	6.80	6.84	5.16	6.89	6.91
7	7.03	7.03	6.90	6.85	6.91	6.89	6.77	6.65	4.98	6.97	6.86
8	6.98	6.96	6.84	6.79	7.06	6.93	6.51	6.67	6.33	6.90	6.71
9	7.29	7.22	7.13	6.98	7.17	6.99	6.68	6.93	6.94	7.07	6.88
				BICARBONATE							
10	9.16	9.13	9.17	9.06	9.53	9.08	9.23	9.08	9.10	8.99	9.08
11	9.08	9.12	9.29	9.06	9.32	9.10	9.16	9.12	9.14	9.06	9.12
12	9.10	9.11	9.38	9.09	9.46	9.11	9.15	9.13	9.15	9.04	9.10
13	9.08	9.10	0.	9.05	9.42	9.10	9.11	9.12	9.12	9.02	9.08
14	9.10	9.19	9.55	9.10	9.19	9.10	9.15	9.30	9.14	8.99	9.11
15	8.83	8.83	8.94	8.90	8.89	8.83	8.84	8.93	8.94	8.85	8.91
16	8.80	8.87	8.93	9.25	8.87	8.81	8.79	8.89	8.92	8.85	8.93
17	9.31	9.35	9.44	9.40	9.56	9.33	9.39	9.37	9.30	9.26	9.37
18	9.29	9.36	9.45	9.48	9.52	9.32	9.26	9.46	9.21	9.30	9.34
				DIST.WATER							
19	6.82	6.25	6.28	6.35	5.83	5.86	5.65	5.74	5.79	4.26	5.71
20	6.85	6.42	6.41	7.04	6.94	5.78	5.75	5.16	5.67	5.66	5.70
21	6.82	6.39	6.48	6.38	5.97	5.85	5.75	5.70	5.78	5.64	5.69
22	6.72	6.53	6.76	6.77	6.50	6.49	6.35	6.08	6.35	6.39	6.20
23	7.34	7.09	7.30	7.33	6.86	6.82	6.83	6.84	6.84	6.77	6.20
24	6.22	5.91	6.42	6.32	5.84	5.83	5.73	5.68	5.45	5.66	5.60
25	6.53	6.51	6.93	6.91	6.30	6.40	6.20	6.35	6.20	5.93	5.98
26	7.33	6.96	7.13	6.81	6.02	5.98	5.81	5.08	5.40	5.72	5.53
27	7.60	7.35	7.85	7.59	7.62	7.28	0.	3.13	6.54	7.01	5.81
				BICARBONATE							
28	9.14	9.18	9.24	9.22	9.50	9.33	9.07	9.24	9.08	8.98	9.08

TABLE OF EH MEASUREMENTS (MV)

CHANNEL/DAY	1	2	3	6	11	20	37	68	120	230	420
BRINE											
1	344.00	432.50	331.00	415.00	401.00	427.00	353.00	460.00	480.00	490.00	229.00
2	344.50	441.00	325.00	421.00	424.50	434.00	414.00	474.00	473.00	487.00	422.00
3	340.00	443.00	239.00	423.00	424.50	441.00	402.00	459.00	478.00	478.00	435.00
4	342.00	440.50	304.00	405.00	414.50	443.00	457.00	468.00	487.00	477.00	439.00
5	363.00	441.00	315.00	409.00	389.00	436.00	415.40	469.00	475.00	462.00	220.00
6	391.00	441.00	338.00	433.00	332.00	436.00	418.00	384.00	444.00	469.00	428.00
7	428.00	439.00	289.00	391.00	422.50	434.00	425.50	412.00	457.00	464.00	426.00
8	437.00	441.50	291.00	403.00	432.50	440.50	418.00	394.00	473.00	462.00	433.00
9	406.00	350.00	259.00	292.50	438.50	443.50	414.00	390.00	477.00	460.00	421.00
BICARBONATE											
10	0.	0.	229.00	303.00	261.00	181.00	237.00	375.00	369.00	337.00	270.00
11	268.00	289.00	217.00	279.50	296.50	244.50	240.00	313.00	275.00	350.00	280.00
12	277.00	305.00	214.00	289.00	243.50	249.50	238.00	376.00	403.50	358.00	260.00
13	289.00	297.00	0.	267.00	260.50	261.00	239.50	345.00	435.00	349.00	267.00
14	275.00	307.00	233.00	374.50	260.50	272.00	238.50	334.50	287.00	356.00	260.00
15	299.00	358.00	246.50	256.00	285.50	296.00	260.00	320.00	441.00	367.00	275.00
16	303.00	352.00	246.00	242.00	300.00	290.00	259.50	314.00	439.00	354.00	254.00
17	214.50	245.00	221.50	240.50	232.50	264.00	222.50	331.00	391.00	339.00	244.00
18	208.50	245.00	237.00	254.00	241.50	294.00	229.00	360.00	411.00	321.00	255.00
DIST.WATER											
19	317.00	371.00	374.00	387.00	451.00	418.00	410.00	500.00	595.00	494.00	519.00
20	314.00	423.00	370.00	350.00	345.50	420.00	421.00	497.00	502.00	437.00	503.00
21	338.50	350.00	368.00	382.00	399.50	414.00	422.50	456.00	513.00	464.00	465.00
22	355.00	343.30	336.00	365.00	357.00	389.50	390.50	439.50	511.00	459.00	433.00
23	362.50	322.50	330.00	354.00	345.00	355.00	361.25	423.00	428.00	439.00	408.00
24	430.00	366.50	377.00	400.00	416.50	440.50	442.50	427.50	539.00	441.00	475.00
25	510.00	393.00	355.00	342.50	414.00	429.50	396.00	416.00	421.00	387.00	430.00
26	350.00	340.00	350.50	346.00	455.50	447.50	415.50	390.00	444.00	397.00	465.00
27	400.00	343.00	332.00	316.00	366.00	381.00	0.	433.00	420.00	471.00	352.00
BICARBONATE											
28	0.	0.	355.00	281.50	239.00	258.00	257.50	402.00	395.00	350.00	250.00

TABLE OF CONDUCTIVITY MEASUREMENTS (US)

CHANNEL/DAY	1	2	3	6	11	20	37	68	120	270	420
BRINE											
1	0.00	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
9	0.11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BICARBONATE											
10	0.	0.	2550.00	2570.00	2630.00	2550.00	2520.00	2410.00	2480.00	2500.00	2350.00
11	2500.00	2580.00	2520.00	2510.00	2680.00	2590.00	2500.00	2480.00	2500.00	2450.00	2350.00
12	2600.00	2580.00	2490.00	2520.00	2620.00	2580.00	2490.00	2500.00	2500.00	2420.00	2320.00
13	2600.00	2590.00	0.	2520.00	2600.00	2570.00	2500.00	2500.00	2500.00	2400.00	2250.00
14	2620.00	2600.00	2580.00	2580.00	2580.00	2580.00	2500.00	2550.00	2580.00	2480.00	2315.00
15	2520.00	2540.00	2500.00	2500.00	2520.00	2510.00	2450.00	2470.00	2500.00	2400.00	2220.00
16	2540.00	2550.00	3320.00	2540.00	2520.00	2520.00	2470.00	2450.00	2510.00	2350.00	2320.00
17	0.00	0.00	0.	2600.00	0.	0.	0.	0.	2470.00	0.	2403.00
18	0.10	0.08	0.	2630.00	0.	0.	0.	0.	0.	0.	2400.00
DIST. WATER											
19	27.80	2.41	2.11	1.92	199.00	1.71	5.71	2.00	5.45	9.15	5.20
20	13.94	3.33	2.19	12.80	6.81	2.12	2.95	10.08	2.13	5.93	2.30
21	9.02	2.40	1.88	1.09	1.30	1.88	0.97	1.99	2.99	2.25	5.80
22	11.32	2.95	2.72	2.99	3.01	3.92	2.62	8.98	10.58	14.80	3.42
23	49.90	10.38	8.70	8.68	11.91	9.51	7.30	10.15	7.80	8.25	5.15
24	25.40	1.07	1.10	1.16	2.31	2.05	1.32	2.95	1.80	2.70	1.62
25	7.70	2.28	2.01	2.21	2.00	2.27	1.99	2.68	2.48	8.50	1.58
26	0.08	0.07	0.	3.62	0.	0.	0.	0.	3.23	2.33	3.32
27	220.00	0.07	0.	30.00	0.	0.	0.	16.00	25.20	12.20	1.80
BICARBONATE											
26	0.	0.	2530.00	2550.00	2620.00	2580.00	2490.00	2580.00	2440.00	2480.00	2400.00

APPENDIX 5

Leachate Np and Pu Concentrations (dpm/cm^3)

Leachate Neptunium and Plutonium activities in disintegrations per minute per cm^3 of solution. The percent uncertainty (one standard deviation) based on counting statistics only is immediately below each concentration value. Note that the beads in channels 2, 12, and 22 were not doped with Pu or Np, so may serve as blank evaluations. No blank corrections to the data have been made. A zero denotes no analysis.

TABLE OF CONCENTRATIONS (DPM/CM3 LEACHED)
NEPTUNIUM

CHANNEL/DAY	1	2	3	6	11	20	37	68	120	230	420
1 BRIN COLD MED	1.67E+01	3.82E+00	2.25E+00	1.36E+00	1.25E+00	1.33E+00	1.37E+00	1.23E+00	1.18E+00	1.46E+00	1.76E+00
	8.17E-01	1.35E+00	1.08E+00	1.70E+00	1.[illegible]E+00	1.51E+00	1.41E+00	1.97E+00	6.55E-01	2.03E+00	9.59E-01
2 BRIN COLD MED	1.09E-01	4.09E-01	1.86E-01	6.30E-04	6.30E-02	4.27E-01	5.70E-02	4.47E-01	1.27E-01	1.37E-01	6.55E-03
	1.11E+01	3.28E+00	4.20E+00	1.00E+02	7.27E+00	2.15E+00	6.25E+00	2.40E+00	2.15E+00	6.65E+00	1.67E+01
3 BRIN COLD MED	1.64E+01	5.71E+00	2.35E+00	1.70E+00	1.70E+00	1.00E+00	1.77E+00	2.23E+00	1.57E+00	1.60E+00	1.81E+00
	7.87E-01	6.03E-01	1.12E+00	1.27E+00	1.79E+00	2.19E+00	2.02E+00	1.00E+00	5.93E-01	2.42E+00	1.16E+00
4 BRIN COLD MED	1.81E+01	4.36E+00	2.37E+00	1.67E+00	1.83E+00	1.56E+00	1.75E+00	1.87E+00	1.56E+00	1.35E+00	1.30E+00
	9.41E-01	1.70E+00	1.09E+00	1.46E+00	1.40E+00	3.39E+00	1.57E+00	1.92E+00	6.30E-01	2.40E+00	1.28E+00
5 BRIN HOT MED	5.64E+01	4.91E+01	4.50E+01	3.97E+01	4.98E+01	4.46E+01	4.24E+01	4.80E+01	4.99E+01	3.83E+01	4.03E+01
	3.25E-01	3.70E-01	2.60E-01	3.20E-01	3.61E-01	4.33E-01	4.75E-01	3.24E-01	1.20E-01	2.62E-01	2.37E-01
6 BRIN COLD FAST	3.11E+00	1.34E+00	3.46E-01	2.04E-01	7.[illegible]E-01	3.68E-01	3.34E-01	3.65E-01	4.55E-01	5.92E-01	2.07E-01
	1.23E+00	1.31E+00	2.32E+00	2.34E+00	2.35E+00	4.09E+00	6.71E+00	3.88E+00	1.04E+00	2.18E+00	2.19E+00
7 BRIN HOT FAST	1.57E+01	2.76E+00	3.40E+00	1.77E+01	1.50E+01	1.41E+01	1.66E+01	2.57E+01	1.70E+01	1.34E+01	1.47E+01
	6.33E-01	3.69E-01	6.90E-01	4.77E-01	4.22E-01	6.37E-01	3.36E-01	6.20E-01	1.83E-01	4.06E-01	2.49E-01
8 BRIN COLD SLOW	1.69E+01	6.42E+00	2.95E+00	5.30E+00	5.37E+00	5.20E+00	4.32E+00	6.00E+00	4.92E+00	5.72E+00	3.53E+00
	9.31E-01	1.36E+00	9.64E-01	7.02E-01	1.18E+00	1.62E+00	9.79E-01	1.49E+00	4.36E-01	8.34E-01	1.32E+00
9 BRIN HOT SLOW	3.28E+02	1.02E+02	8.76E+01	8.20E+01	6.79E+01	5.77E+01	4.71E+01	5.78E+01	5.91E+01	6.89E+01	7.38E+01
	3.06E-01	1.85E-01	5.35E-01	3.21E-01	4.87E-01	6.09E-01	6.18E-01	5.10E-01	7.65E-01	2.54E-01	1.74E-01
10 BICA COLD MED	1.30E+01	6.61E+00	4.55E+00	3.49E+00	3.19E+00	3.70E+00	3.72E+00	3.69E+00	3.50E+00	3.27E+00	3.71E+00
	2.17E+00	5.5[illegible]-01	5.22E-01	4.20E+00	3.63E+00	3.06E+00	3.15E+00	4.60E+00	4.71E+00	4.02E+00	3.69E+00
11 BICA COLD MED	1.30E+01	9.00E+00	5.90E+00	2.00E+00	4.60E+00	3.67E+00	5.14E+00	4.18E+00	3.44E+00	3.09E+00	4.01E+00
	2.09E+00	2.21E+00	3.42E+00	5.03E+00	3.01E+00	3.37E+00	2.95E+00	4.37E+00	3.85E+00	4.50E+00	3.83E+00
12 BICA COLD MED	2.74E-02	1.24E-01	5.30E-01	8.00E-02	4.79E-02	4.46E-02	7.91E-02	1.79E-01	5.84E-03	1.79E-01	1.43E-01
	5.00E+01	1.96E+01	1.46E+01	3.02E+01	2.80E+01	3.02E+01	2.18E+01	1.86E+01	1.00E+02	1.83E+01	2.00E+01
13 BICA COLD MED	1.30E+01	3.92E+00	0.	4.43E+00	4.45E+00	4.22E+00	3.80E+00	4.12E+00	4.26E+00	3.10E+00	3.41E+00
	2.21E+00	2.19E+00	0.	4.04E+00	3.13E+00	3.11E+00	3.05E+00	3.85E+00	3.63E+00	4.32E+00	4.12E+00
14 BICA HOT MED	1.57E+02	1.37E+02	1.20E+02	1.31E+02	1.45E+02	1.46E+02	1.26E+02	1.43E+02	1.10E+02	1.11E+02	1.13E+02
	6.83E-01	5.45E-01	7.79E-01	7.50E-01	5.65E-01	5.30E-01	5.53E-01	6.73E-01	7.78E-01	7.36E-01	7.20E-01
15 BICA COLD FAST	3.13E+00	1.09E+00	9.06E-01	1.21E+00	6.23E-01	9.26E-01	4.03E-01	1.07E+00	1.15E+00	7.56E-01	2.47E-01
	4.[illegible]E+00	6.02E+00	8.45E+00	6.[illegible]E+00	9.41E+00	5.94E+00	7.27E+00	7.18E+00	7.20E+00	8.39E+00	1.47E+01
16 BICA HOT FAST	3.[illegible]E+01	3.09E+01	2.60E+01	4.50E+01	3.28E+01	3.49E+01	2.83E+01	2.65E+01	2.50E+01	3.35E+01	2.98E+01
	1.07E+00	1.26E+00	1.50E+00	1.01E+00	1.20E+00	9.39E-01	9.02E-01	1.33E+00	1.33E+00	1.13E+00	1.31E+00
17 BICA COLD SLOW	2.[illegible]E+01	2.30E+01	1.92E+01	2.71E+01	1.74E+01	1.37E+01	1.54E+01	1.43E+01	9.07E+00	1.78E+01	8.65E+00
	1.63E+00	1.90E+00	1.97E+00	1.41E+00	2.15E+00	1.70E+00	1.20E+00	2.07E+00	2.62E+00	1.84E+00	2.60E+00
18 BICA HOT SLOW	4.12E+02	3.32E+02	2.[illegible]E+02	3.68E+02	4.10E+02	3.72E+02	2.14E+02	1.95E+02	1.37E+02	1.04E+01	1.29E+02
	4.60E-01	5.00E-01	5.[illegible]E-01	4.3[illegible]E-01	4.43E-01	3.19E-01	3.46E-01	5.43E-01	6.95E-01	1.93E+00	3.19E-01
19 DIST COLD MED	1.36E+01	9.38E+00	4.17E+00	1.61E+00	1.50E+00	1.70E+00	1.19E+00	1.04E+00	1.34E+00	3.79E-01	9.75E-01
	2.29E+00	2.60E+00	4.02E+00	7.91E+00	6.02E+00	5.14E+00	4.60E+00	7.53E+00	5.94E+00	8.[illegible]E+00	9.62E+00
20 DIST COLD MED	1.39E+01	7.[illegible]E+00	2.[illegible]E+00	1.[illegible]E+00	1.63E+00	1.0[illegible]E+00	7.1[illegible]E-01	3.72E+00	5.23E-01	1.[illegible]	[illegible]E-01
	2.31E+00	2.91E+00	6.00E+00	[illegible]	5.95E+00	6.3[illegible]E+00	5.[illegible]E+00	4.2[illegible]E+00	7.62E+00	8.57E+00	9.95E+00
21 DIST COLD MED	1.91E+01	9.[illegible]	4.97E+00	1.[illegible]E+00	1.58E+00	1.41E+00	9.70E-01	1.78E+00	6.00E+00	9.6[illegible]E-01	3.34E-01
	2.43E+00	2.53E+00	4.2[illegible]	[illegible]	6.29E+00	[illegible]	5.10E+00	5.[illegible]E+00	2.90E+00	9.81E+00	1.64E+01
22 DIST COLD MED	1.28E-01	1.41E-01	1.10E-02	1.[illegible]E-01	8.[illegible]E-02	1.[illegible]E-01	[illegible]E-02	1.47E-01	5.40E-03	1.34E-01	1.35E-01
	2.37E+01	2.[illegible]E+01	1.0[illegible]	[illegible]	2.[illegible]E+01	[illegible]	1.5[illegible]E+01	2.13E+01	1.00E+02	2.10E+01	2.36E+01
23 DIST HOT MED	5.12E+01	5.[illegible]E+01	[illegible]	[illegible]	2.00E+01	2.[illegible]E+01	2.[illegible]E+01	2.27E+01	2.62E+01	5.79E+01	8.71E+01
	1.30E+00	1.17E+00	1.[illegible]E+00	1.[illegible]E+00	1.73E+00	1.[illegible]E+00	1.11E+00	1.[illegible]E+00	1.57E+00	9.74E-01	9.80E-01
24 DIST COLD FAST	3.00E+00	[illegible]	[illegible]E-01	[illegible]	2.07E-01	[illegible]	2.0[illegible]E-01	2.2[illegible]E-01	1.67E-01	2.01E-01	1.73E-01
	6.40E-01	2.[illegible]	1.70E+00	1.[illegible]	1.83E+00	[illegible]	2.1[illegible]E+00	1.30E+00	1.71E+00	1.50E+00	2.77E+00
25 DIST HOT FAST	1.5[illegible]E+01	1.2[illegible]E+01	1.1[illegible]E+01	1.[illegible]E+01	1.2[illegible]E+01	[illegible]	5.[illegible]	3.[illegible]	8.10E+00	9.30E+00	8.17E+00
	2.23E+00	2.15E+00	2.[illegible]	2.[illegible]	2.07E+00	[illegible]	[illegible]	2.[illegible]	2.48E+00	2.47E+00	3.27E+00
26 DIST COLD SLOW	2.67E+01	[illegible]	5.1[illegible]E+01	7.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.[illegible]	[illegible]	2.72E+00
	1.07E+00	1.5[illegible]E+00	2.[illegible]	[illegible]	4.30E+00	[illegible]	[illegible]	5.71E+00	5.19E+00	4.[illegible]	3.92E+00
27 DIST HOT SLOW	7.92E+01	[illegible]E+01	5.[illegible]E+01	[illegible]	2.80E+01	[illegible]	[illegible]	3.[illegible]	3.[illegible]E+01	6.0[illegible]E+01	1.87E+02
	9.27E-01	3.76E-01	[illegible]	8.71E-01	1.30E+00	[illegible]	1.[illegible]	1.[illegible]	[illegible]	[illegible]E-01	5.12E-01
28 BICA COLD MED	1.0[illegible]E+01	6.37E+00	5.2[illegible]E+00	[illegible]	[illegible]	2.1[illegible]	[illegible]	3.[illegible]	[illegible]	1.[illegible]	2.90E+00
	2.1[illegible]	3.20E+00	2.[illegible]	[illegible]	[illegible]	4.[illegible]	[illegible]	5.[illegible]	4.[illegible]	[illegible]	3.0[illegible]E+00

TABLE OF CONCENTRATIONS (PCI/CM3 LEACHED)
PLUTONIUM

CHANNEL/DAY	1	2	3	6	11	20	37	68	120	230	420
1 BRIN COLD MED	3.30E+01	8.72E+00	5.32E+00	3.53E+00	2.27E+00	[illegible]	1.00E+00	1.26E+00	9.97E-01	[illegible]	7.93E-01
	4.37E-01	1.07E+02	1.11E+00	2.38E+00	1.91E+00	2.15E+00	[illegible]	1.52E+00	1.68E+00	3.94E+00	3.30E+00
2 BRIN COLD MED	6.50E-02	6.30E-02	1.70E-02	1.02E-03	[illegible]	1.71E-02	3.26E-01	2.20E-01	1.23E-01	5.40E-02	5.03E-02
	7.80E+00	1.44E+01	2.29E+01	1.00E+02	[illegible]	2.04E+01	[illegible]	3.34E+00	[illegible]	3.67E+00	1.20E+01
3 BRIN COLD MED	1.62E+01	9.34E+00	5.60E+00	3.30E+00	[illegible]	[illegible]	[illegible]	1.91E+00	1.80E+00	5.54E-01	6.85E-01
	4.00E-01	9.02E-01	1.00E+00	1.97E+00	[illegible]	[illegible]	[illegible]	1.40E+00	1.70E+00	2.01E+00	4.72E+00
4 BRIN COLD MED	1.81E+01	8.12E+00	3.48E+00	3.87E+00	[illegible]	[illegible]	[illegible]	1.63E+00	1.71E+00	3.50E-01	3.90E-01
	3.81E-01	1.17E+00	1.10E+00	1.33E+00	[illegible]	1.07E+00	1.12E+00	1.32E+00	1.45E+00	2.65E+00	4.07E+00
5 BRIN HOT MED	6.47E+00	6.39E-01	3.16E-01	1.00E-01	[illegible]	2.21E-01	5.33E-01	4.49E-01	5.10E-01	6.77E-01	5.50E-01
	5.31E-01	4.75E+00	3.15E+00	[illegible]	1.42E+01	1.34E+01	[illegible]	4.61E+00	2.07E+00	2.41E+00	5.55E+00
6 BRIN COLD FAST	7.59E+00	2.30E-01	9.47E-01	5.30E-01	[illegible]	[illegible]	3.33E-01	5.90E-01	5.01E-01	4.12E-01	2.94E-01
	6.30E+01	1.31E+00	5.47E+00	2.77E+00	[illegible]	4.41E+00	3.21E+00	4.20E+00	2.00E+01	3.80E+00	4.24E+00
7 BRIN HOT FAST	[illegible]	[illegible]	5.01E-02	2.74E-01	[illegible]	[illegible]	6.51E-01	1.60E+00	1.07E+00	1.14E+00	7.03E-01
	1.17E+00	1.22E+00	2.94E+00	5.74E+00	[illegible]	3.70E+00	2.20E+00	3.01E+00	1.03E+00	1.63E+00	3.51E+00
8 BRIN COLD SLOW	3.91E+01	9.17E+00	7.11E+00	2.95E-01	7.41E+00	[illegible]	6.33E+00	1.09E+00	6.07E+00	3.40E+00	2.69E+00
	2.32E-01	1.07E+00	9.09E-01	5.07E+00	2.70E+00	[illegible]	1.37E+00	1.29E+00	7.60E-01	1.63E+00	4.49E+00
9 BRIN HOT SLOW	5.13E+00	1.33E+00	7.08E-01	3.60E-01	3.45E-01	3.64E-01	3.49E-01	3.18E-01	3.24E-01	5.52E-01	4.09E-01
	1.17E+00	3.15E+00	3.32E+00	4.57E+00	[illegible]	[illegible]	[illegible]	4.65E+00	[illegible]	6.41E+00	7.61E+00
10 BICA COLD MED	5.02E+01	2.15E+01	1.59E+01	1.10E+01	1.07E+01	1.00E+01	7.63E+00	6.30E+00	4.77E+00	3.07E+00	3.65E+00
	1.10E+00	4.27E+01	4.19E-01	2.50E+00	2.01E+00	1.00E+00	2.20E+00	3.44E+00	4.10E+00	3.33E+00	3.60E+00
11 BICA COLD MED	5.03E+01	2.95E+01	1.77E+01	7.60E+00	1.20E+01	8.13E+00	1.02E+01	6.03E+00	2.70E+00	2.15E+00	3.50E+00
	1.04E+00	1.22E+00	1.07E+00	3.18E+00	1.59E+00	2.17E+00	2.08E+00	3.30E+00	4.49E+00	5.40E+00	4.10E+00
12 BICA COLD MED	9.50E-02	4.70E-03	3.41E-01	1.60E-01	8.70E-02	5.00E-02	7.16E-03	6.18E-03	5.84E-03	2.69E-01	2.20E-02
	2.07E+01	1.00E+02	1.80E+01	2.00E+01	2.13E+01	2.58E+01	2.23E+01	1.00E+02	1.00E+02	1.49E+01	5.00E+01
13 BICA COLD MED	5.43E+01	2.60E+01	0.	1.24E+01	1.27E+01	9.41E+00	8.72E+00	6.95E+00	5.23E+00	3.57E+00	3.71E+00
	1.08E+00	1.20E+00	0.	2.37E+00	1.27E+00	2.02E+00	2.02E+00	2.90E+00	3.27E+00	4.07E+00	3.95E+00
14 BICA HOT MED	1.02E+01	7.93E-01	6.30E-01	1.13E+00	1.84E+00	1.83E+00	7.43E-01	5.99E-01	7.90E-01	1.43E+00	9.61E-01
	2.71E+00	7.14E+00	1.03E+01	3.02E+00	5.30E+00	4.70E+00	7.22E+00	3.08E+00	9.21E+00	[illegible]	7.80E+00
15 BICA COLD FAST	1.41E+01	4.40E+00	[illegible]	4.00E+00	3.34E+00	2.03E+00	1.20E+00	1.57E+00	1.72E+00	1.54E+00	6.17E-01
	[illegible]	3.30E+00	4.51E+00	6.20E+00	4.80E+00	3.37E+00	4.12E+00	5.92E+00	5.79E+00	5.00E+00	9.33E+00
16 BICA HOT FAST	[illegible]	5.32E-01	3.52E-01	1.31E+00	1.28E+00	1.32E+00	9.57E-01	3.10E-01	3.77E-01	1.40E+00	1.12E+00
	3.27E+00	3.74E+00	1.00E+01	5.72E+00	5.00E+00	[illegible]	4.00E+00	7.52E+00	7.15E+00	5.90E+00	6.79E+00
17 BICA COLD SLOW	[illegible]	7.45E+01	4.37E+01	5.74E+01	3.42E+01	2.97E+01	1.22E+01	8.00E+00	5.43E+00	3.70E+00	8.37E+00
	1.07E+00	1.06E+00	1.29E+00	9.72E-01	1.50E+00	1.20E+00	1.22E+00	2.76E+00	3.30E+00	2.03E+00	2.72E+00
18 BICA HOT SLOW	1.37E+01	2.34E+00	1.20E+00	9.27E-01	1.72E+00	1.19E+00	3.47E-01	3.27E-01	4.24E-01	3.49E-01	8.62E-03
	2.51E+00	6.15E+00	7.56E+00	8.27E+00	[illegible]	4.31E+00	[illegible]	1.70E+01	[illegible]	1.32E+01	1.09E+02
19 DIST COLD MED	[illegible]	1.92E+01	9.91E+00	[illegible]	2.60E+00	3.07E+00	1.05E+00	1.80E+00	7.13E-01	6.94E-01	2.78E+00
	1.61E+00	1.00E+00	2.51E+00	1.50E+00	[illegible]	3.08E+00	4.07E+00	5.95E+00	3.15E+00	9.37E+00	6.44E+00
20 DIST COLD MED	3.17E+01	1.54E+01	3.06E+00	4.16E+00	2.74E+00	1.67E+00	1.88E+00	2.10E+00	8.22E-01	9.38E-01	1.25E+00
	1.52E+00	2.09E+00	3.70E+00	4.07E+00	4.80E+00	5.27E+00	1.54E+00	5.72E+00	8.83E+00	7.93E+00	8.39E+00
21 DIST COLD MED	[illegible]	1.73E+01	8.30E+00	[illegible]	[illegible]	2.36E+00	1.25E+00	1.95E+00	1.93E+00	6.10E-01	1.53E-01
	1.61E+00	1.07E+00	2.90E+00	[illegible]	4.03E+00	4.30E+00	4.10E+00	5.72E+00	5.10E+00	9.01E+00	2.43E+01
22 DIST COLD MED	[illegible]	1.26E-01	1.10E-02	[illegible]	5.02E-02	1.00E-01	[illegible]	3.04E-02	5.46E-03	6.11E-03	1.84E-02
	[illegible]	2.10E+01	1.00E+02	[illegible]	3.30E+01	2.13E+01	1.71E+01	2.30E+01	1.00E+02	1.00E+02	7.07E+01
23 DIST HOT MED	[illegible]	5.31E-01	3.76E-01	[illegible]	2.23E-01	5.00E-01	1.00E-01	7.27E-02	1.57E-01	1.37E+00	4.42E+00
	[illegible]	1.15E+01	1.71E+01	1.41E+01	1.67E+01	9.15E+00	1.14E+01	2.80E+01	1.99E+01	6.33E+00	4.05E+00
24 DIST COLD FAST	4.72E+00	1.24E+00	1.59E+00	7.59E-01	4.52E-01	6.01E-01	8.03E-01	3.15E-01	3.02E-01	3.23E-01	5.09E-01
	5.90E-01	2.09E+00	2.03E+00	2.29E+00	2.07E+00	4.31E+00	2.90E+00	2.41E+00	3.70E+00	1.02E+01	3.41E+00
25 DIST HOT FAST	[illegible]	1.67E+00	1.70E+00	1.97E+00	3.08E+00	3.11E+00	1.31E+00	1.64E+00	1.87E+00	1.47E+00	1.31E+00
	3.37E+00	[illegible]	5.73E+00	6.25E+00	4.17E+00	3.51E+00	7.60E+00	5.29E+00	5.17E+00	6.21E+00	8.15E+00
26 DIST COLD SLOW	5.10E+01	3.51E+01	5.17E+01	1.07E+01	4.41E+00	2.61E+00	[illegible]	2.02E+00	[illegible]	3.31E+00	2.03E+00
	1.41E+00	1.54E+00	2.15E+00	1.21E+00	[illegible]	3.03E+00	[illegible]	[illegible]	5.24E+00	5.70E+00	4.55E+00
27 DIST HOT SLOW	4.01E+00	3.49E-01	1.05E-01	1.09E-01	[illegible]	1.40E-01	[illegible]	1.06E-01	6.07E-03	2.41E-01	4.39E-01
	3.30E+00	1.51E+01	1.51E+01	[illegible]	1.20E+01	1.67E+01	[illegible]	3.73E+01	1.00E+02	1.52E+01	1.07E+01
28 BICA COLD MED	5.43E+01	2.41E+01	1.50E+01	1.22E+01	[illegible]	5.30E+00	4.11E+00	4.30E+00	[illegible]	1.30E+00	5.07E+00
	[illegible]	1.54E+00	1.69E+00	[illegible]	[illegible]	[illegible]	4.90E+00	4.27E+00	[illegible]	6.31E+00	2.70E+00

APPENDIX 6

XRF Concentration Data ($\mu g/cm^3$)

Stable element concentrations in leachate, determined by X-ray floures-cence. Concentrations are reported as micrograms element per cm^3 of solution. The value in parenthesis is the percent standard deviation of the analysis based on counting statistics alone. Note that these analyses were performed on the composite samples collected between the normal sampling days. Reported values are $\geq$ 5 X detection limit in all cases. The results are not corrected for leachant blanks; see Appendix 7 for estimates of blank values.

Concentrations (μg/cm^3) in Composite Samples,

by XRFA (± % std. dev)

Channel	Element	DAYS 7-10	12-19	21-36	38-67	69-119	231-419
14 (BI,HO,ME)	Sr	0.077 (1.0)	0.086 (3.2)	0.082 (3.3)	0.076 (3.5)	0.078 (3.4)	0.095 (3.1)
"	Zr	0.027 (2.0)	0.069 (4.5)	0.079 (4.1)	0.051 (5.8)	0.055 (5.2)	0.056 (5.4)
"	Mo	0.32 (0.7)	0.34 (1.6)	0.34 (1.6)	0.33 (1.6)	0.33 (1.6)	0.44 (1.4)
"	U	0.82 (0.6)	0.87 (1.2)	0.89 (1.2)	0.82 (1.2)	0.84 (1.2)	1.09 (1.1)
"	Cs	0.21 (0.9)	0.21 (1.2)	0.23 (1.4)	0.22 (1.4)	0.22 (1.4)	0.28 (1.0)
"	Ba	0.051 (2.2)	0.056 (2.7)	0.057 (3.1)	0.044 (3.3)	0.067 (2.9)	0.057 (2.6)
Ch 23 (DI,HO,ME)	Ca	0.25 (5.0)			0.13 (6.0)		
"	Sr	0.040 (0.7)			0.040 (0.7)		
"	Mo	0.19 (0.5)			0.20 (0.5)		
"	U	0.004 (5.8)			0.004 (4.1)		
"	Cs	0.13 (0.8)			0.14 (0.6)		
"	Ba	0.026 (1.9)			0.028 (1.4)		
"	Zn	0.012 (2.2)			0.012 (1.9)		

APPENDIX 7

ICP Concentration Data ($\mu g/cm^3$)

a. Leachate concentration (*micrograms per* cm^3) of stable elements as determined by ICP. These are net values, corrected for leachant blanks.

b. Leachant concentrations (solution blank values).

If the blank-corrected concentration is less than the reported detection limit, the concentration is reported as "< (detection limit)". Note that detection limits are empirically determined, so are not completely constant over time; hence differences between those reported with the blank (leachant) analyses and those associated with the leachate analyses.

The reported detection limit is four times the standard deviation of an average of ten blank runs. The blank used is distilled water which has been passed through a Millipore Ion Exchange system. A value ten times the blank standard deviation (2.5 x the detection limit reported here) is often taken as the "least quantifiable limit"; this normally corresponds to an analytical precision of about 10%. Because of extra acidification and dilution steps in the leachate sample preparation process, this limit is probably too low for the samples reported on here. The accuracy and precision of the XRF and radionuclide determinations must be considered more reliable than the ICP data.

TABLE OF CONCENTRATIONS (UG/CM2 LEACHED)
[illegible]
DETECTION LIMIT= .030

CHANNEL/DAY	1	2	3	6	37	63	230	420
10 BICA COLD MED	1.13E-01	<3.00E-02	<3.00E-02	<3.00E-02	5.45E-02	<3.00E-02	3.69E-01	<3.00E-02
11 BICA COLD MED	4.71E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02
12 BICA COLD MED	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02
13 BICA COLD MED	3.88E-02	<3.00E-02	0.	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02
14 BICA HOT MED	7.64E-01	6.51E-01	6.73E-01	6.52E-01	6.50E-01	6.90E-01	6.47E-01	6.09E-01
15 BICA COLD FAST	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02
16 BICA HOT FAST	1.43E-01	2.61E-01	1.30E-01	1.41E-01	1.30E-01	1.22E-01	1.70E-01	1.53E-01
17 BICA COLD SLOW	1.27E-01	6.09E-02	5.26E-02	5.84E-02	6.42E-02	5.54E-02	4.00E-02	3.54E-02
18 BICA HOT SLOW	2.52E+00	1.80E+00	1.45E+00	2.00E+00	1.97E+00	2.14E+00	1.94E+00	1.29E+00
19 DIST COLD MED	5.48E-02	3.23E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02
20 DIST COLD MED	5.66E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02
21 DIST COLD MED	4.51E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02
22 DIST COLD MED	1.11E-01	4.14E-02	5.33E-02	6.43E-02	5.41E-02	1.12E-01	6.20E-02	7.14E-02
23 DIST HOT MED	7.13E-01	3.71E-01	3.74E-01	3.91E-01	3.91E-01	4.21E-01	2.59E-01	2.27E-01
24 DIST COLD FAST	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02
25 DIST HOT FAST	6.72E-02	[illegible]	4.40E-02	4.90E-02	5.04E-02	4.73E-02	6.51E-02	3.71E-02
26 DIST COLD SLOW	1.76E-01	1.11E-01	1.75E-01	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02
27 DIST HOT SLOW	1.59E+00	1.20E+00	6.34E-01	1.40E+00	0.	9.23E-01	7.21E-01	1.01E+00
28 BICA COLD MED	4.77E-02	1.76E-01	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02	<3.00E-02

TABLE OF CONCENTRATIONS (UG/CM3 LEACHED)
CADMIUM DETECTION LIMIT= .003

CHANNEL/DAY	1	2	3	6	37	68	230	420
10 BICA COLD MED	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03
11 BICA COLD MED	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03
12 BICA COLD MED	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03
13 BICA COLD MED	<3.00E-03	<3.00E-03	0.	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03
14 BICA HOT MED	<3.00E-03	<3.00E-03	<3.00E-03	4.10E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03
15 BICA COLD FAST	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03
16 BICA HOT FAST	<3.00E-03	<3.00E-03	<3.00E-03	3.17E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03
17 BICA COLD SLOW	<3.00E-03	<3.00E-03	<3.00E-03	4.69E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03
18 BICA HOT SLOW	<3.00E-03	<3.00E-03	<3.00E-03	4.80E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03
19 DIST COLD MED	<3.00E-03	<3.00E-03	<3.00E-03	1.10E-02	<3.00E-03	5.87E-03	<3.00E-03	<3.00E-03
20 DIST COLD MED	<3.00E-03	<3.00E-03	<3.00E-03	1.16E-02	<3.00E-03	6.69E-03	<3.00E-03	<3.00E-03
21 DIST COLD MED	<3.00E-03	<3.00E-03	<3.00E-03	1.15E-02	<3.00E-03	6.07E-03	<3.00E-03	<3.00E-03
22 DIST COLD MED	<3.00E-03	<3.00E-03	<3.00E-03	1.59E-02	<3.00E-03	6.26E-03	5.36E-03	<3.00E-03
23 DIST HOT MED	<3.00E-03	<3.00E-03	<3.00E-03	7.34E-03	<3.00E-03	6.29E-03	<3.00E-03	<3.00E-03
24 DIST COLD FAST	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03	1.49E-02
25 DIST HOT FAST	<3.00E-03	<3.00E-03	<3.00E-03	3.79E-03	<3.00E-03	3.80E-03	<3.00E-03	<3.00E-03
26 DIST COLD SLOW	<3.00E-03	<3.00E-03	<3.00E-03	3.67E-03	<3.00E-03	<3.00E-03	3.24E-03	<3.00E-03
27 DIST HOT SLOW	4.02E-02	<3.00E-03	<3.00E-03	5.72E-03	0.	9.53E-03	<3.00E-03	<3.00E-03
28 BICA COLD MED	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03	<3.00E-03

TABLE OF CONCENTRATIONS (UG/CM3 LEACHED)
IRON
DETECTION LIMIT= .002

CHANNEL/DAY	1	2	3	6	37	68	230	420
10 BICA COLD MED	1.14E-01	5.48E-02	4.09E-02	6.10E-02	1.80E-01	1.29E-01	7.54E-02	1.82E-01
11 BICA COLD MED	5.37E-02	<2.00E-03	2.69E-02	3.84E-02	5.37E-02	5.72E-02	6.91E-02	1.85E-01
12 BICA COLD MED	4.49E-01	1.03E-01	3.46E-02	3.46E-02	3.14E-02	5.71E-02	6.30E-02	1.93E-01
13 BICA COLD MED	3.01E-02	3.35E-02	0.	5.02E-02	5.96E-02	<2.00E-03	3.65E-02	1.80E-01
14 BICA HOT MED	1.05E-01	5.14E-02	3.77E-02	3.27E-01	2.98E-02	5.74E-02	5.22E-02	2.05E-01
15 BICA COLD FAST	6.31E-03	2.33E-02	<2.00E-03	1.69E-02	1.62E-02	2.57E-02	3.02E-02	1.99E-01
16 BICA HOT FAST	9.51E-03	2.57E-02	1.15E-02	1.46E-02	1.64E-02	2.02E-02	2.68E-02	1.85E-01
17 BICA COLD SLOW	2.59E-01	2.47E-01	4.35E-01	3.04E-02	6.07E-02	7.70E-02	7.00E-02	3.90E-01
18 BICA HOT SLOW	1.43E-01	3.72E-01	8.82E-02	7.21E-02	5.52E-02	2.96E-01	4.57E-02	3.68E-01
19 DIST COLD MED	2.98E-02	4.02E-02	3.71E-02	7.39E-02	5.01E-02	3.17E-02	4.86E-01	1.92E-01
20 DIST COLD MED	2.31E-02	1.09E+00	1.54E-02	3.43E-02	5.12E-02	5.51E-02	5.84E-02	2.02E-01
21 DIST COLD MED	2.67E-02	2.26E-02	1.90E-02	3.82E-02	1.08E-01	4.70E-02	2.04E-01	1.92E-01
22 DIST COLD MED	5.09E-02	2.68E-02	1.94E-02	7.94E-02	3.32E-02	5.57E-02	1.46E-01	1.87E-01
23 DIST HOT MED	3.82E-02	6.19E-02	5.39E-02	3.42E-02	2.13E-02	8.17E-02	4.03E-02	1.88E-01
24 DIST COLD FAST	3.16E-03	2.32E-02	8.43E-03	4.90E-03	1.26E-02	8.09E-03	6.77E-02	1.43E-01
25 DIST HOT FAST	<2.00E-03	6.81E-02	8.07E-03	1.15E-02	1.54E-02	3.15E-02	2.26E-02	1.50E-01
26 DIST COLD SLOW	2.22E-01	7.28E-02	1.22E-01	4.14E-02	6.93E-02	1.05E-01	9.11E-02	3.57E-01
27 DIST HOT SLOW	8.65E-01	2.11E-01	<2.00E-03	7.92E-02	0.	5.53E+00	5.52E-02	3.75E-01
28 BICA COLD MED	9.69E-02	8.13E-02	2.88E-02	6.54E-02	1.47E-02	8.57E-02	2.20E-02	2.07E-01

TABLE OF CONCENTRATIONS (UG/CM3 LEACHED)
MOLLY
DETECTION LIMIT= .010

CHANNEL/DAY	1	2	3	6	37	68	230	420
10 BICA COLD MED	3.57E-02	<1.00E-02	1.59E-02	8.24E-02	1.07E-02	1.63E 02	1.13E-02	2.78E-01
11 BICA COLD MED	3.40E-02	3.12E-01	<1.00E-02	5.93E-02	1.05E-02	2.70E-02	1.30E-02	3.12E-01
12 BICA COLD MED	5.16E-02	<1.00E-02	1.70E-02	7.51E-02	1.09E-02	4.40E-02	3.10E-02	3.18E-01
13 BICA COLD MED	1.22E-02	<1.00E-02	0.	5.32E-02	1.36E-02	<1.00E-02	<1.00E-02	2.87E-01
14 BICA HOT MED	4.12E-01	3.57E-01	3.60E-01	4.30E-01	3.90E-01	3.97E-01	<1.00E-02	6.53E-01
15 BICA COLD FAST	<1.00E-02	<1.00E-02	<1.00E-02	1.69E-02	<1.00E-02	<1.00E-02	<1.00E-02	3.26E-01
16 BICA HOT FAST	6.18E-02	1.44E-01	6.94E-02	9.54E-02	6.12E-02	7.52E-02	8.76E-02	3.52E-01
17 BICA COLD SLOW	8.58E-02	5.95E-02	4.09E-02	5.94E-02	2.81E-02	5.74E-02	2.02E-02	5.51E-01
18 BICA HOT SLOW	1.42E+00	1.05E+00	8.26E-01	1.11E+00	1.08E+00	1.23E+00	1.08E+00	1.26E+00
19 DIST COLD MED	6.17E-02	2.01E-02	<1.00E-02	8.33E-02	3.12E-02	4.57E-02	4.71E-02	3.02E-01
20 DIST COLD MED	4.31E-02	2.56E-02	1.34E-02	7.37E-02	2.82E-02	5.75E-02	3.60E-02	2.90E-01
21 DIST COLD MED	3.44E-02	2.53E-02	1.31E-02	4.46E-02	2.77E-02	4.75E-02	2.41E-02	3.20E-01
22 DIST COLD MED	1.35E-01	5.10E-02	6.05E-02	1.27E-01	7.71E-02	1.07E-01	8.82E-02	3.67E-01
23 DIST HOT MED	3.73E-01	2.24E-01	2.21E-01	2.91E-01	2.10E-01	2.65E-01	1.74E-01	4.12E-01
24 DIST COLD FAST	1.20E-02	1.70E-02	2.99E-02	<1.00E-02	1.55E-02	<1.00E-02	4.13E-02	2.14E-01
25 DIST HOT FAST	<1.00E-02	6.70E-02	2.01E-02	5.22E-02	2.84E-02	5.51E-02	3.44E-02	2.67E-01
26 DIST COLD SLOW	1.10E-01	8.55E-02	1.64E-01	3.78E-02	4.12E-02	4.70E-02	6.51E-02	5.80E-01
27 DIST HOT SLOW	9.20E-01	7.13E-01	<1.00E-02	8.60E-01	0.	5.31E-01	4.11E-01	1.13E+00
28 BICA COLD MED	1.76E-02	<1.00E-02	<1.00E-02	4.73E-02	<1.00E-02	1.70E-02	<1.00E-02	3.16E-01

TABLE OF CONCENTRATIONS (UG/CM3 LEACHED)
NICKEL DETECTION LIMIT= .010

CHANNEL/DAY	1	2	3	6	37	68	230	420
10 BICA COLD MED	<1.00E-02	1.62E-02	<1.00E-02	1.37E-02	1.08E-02	<1.00E-02	<1.00E-02	1.08E-01
11 BICA COLD MED	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	2.45E-02	<1.00E-02	1.27E-01
12 BICA COLD MED	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	1.17E-01
13 BICA COLD MED	<1.00E-02	<1.00E-02	0.	2.35E-02	<1.00E-02	1.99E-02	<1.00E-02	1.24E-01
14 BICA HOT MED	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	1.62E-02	<1.00E-02	1.30E-01
15 BICA COLD FAST	<1.00E-02	<1.00E-02	<1.00E-02	2.35E-02	<1.00E-02	1.19E-02	<1.00E-02	1.35E-01
16 BICA HOT FAST	<1.00E-02	<1.00E-02	<1.00E-02	1.86E-02	<1.00E-02	<1.00E-02	<1.00E-02	1.24E-01
17 BICA COLD SLOW	1.16E-02	<1.00E-02	<1.00E-02	1.46E-02	<1.00E-02	2.76E-02	<1.00E-02	2.17E-01
18 BICA HOT SLOW	1.13E-02	<1.00E-02	<1.00E-02	2.45E-02	<1.00E-02	<1.00E-02	<1.00E-02	2.26E-01
19 DIST COLD MED	1.15E-02	<1.00E-02	<1.00E-02	2.29E-02	1.43E-02	1.01E-02	1.34E-02	1.00E-01
20 DIST COLD MED	<1.00E-02	<1.00E-02	<1.00E-02	4.35E-02	<1.00E-02	3.45E-02	1.00E-02	1.13E-01
21 DIST COLD MED	<1.00E-02	<1.00E-02	<1.00E-02	2.05E-02	<1.00E-02	3.40E-02	<1.00E-02	1.13E-01
22 DIST COLD MED	1.68E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	4.06E-02	<1.00E-02	1.34E-01
23 DIST HOT MED	1.22E-02	<1.00E-02	<1.00E-02	1.91E-02	<1.00E-02	2.37E-02	3.50E-02	1.52E-01
24 DIST COLD FAST	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	1.50E-02	<1.00E-02	1.14E-02	8.57E-02
25 DIST HOT FAST	2.02E-02	<1.00E-02	<1.00E-02	1.57E-02	<1.00E-02	1.22E-02	1.58E-02	9.81E-02
26 DIST COLD SLOW	2.91E-02	<1.00E-02	<1.00E-02	<1.00E-02	2.55E-02	1.69E-02	1.46E-02	2.26E-01
27 DIST HOT SLOW	1.90E-02	<1.00E-02	6.90E-02	1.71E-02	0.	3.06E-02	<1.00E-02	2.10E-01
28 BICA COLD MED	1.30E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	2.68E-02	<1.00E-02	1.36E-01

TABLE OF CONCENTRATIONS (UG/CM3 LEACHED)
SILICON DETECTION LIMIT= .010

CHANNEL/DAY	1	2	3	6	37	68	230	420
10 BICA COLD MED	1.59E+00	3.94E-01	3.07E-01	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	1.93E-01
11 BICA COLD MED	1.54E+00	1.52E-01	2.77E-01	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	1.77E-01
12 BICA COLD MED	4.46E-01	2.15E-01	1.73E-01	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	1.19E-01
13 BICA COLD MED	1.06E+00	3.30E-01	0.	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	1.18E-01
14 BICA HOT MED	5.04E+00	4.49E+00	4.37E+00	1.61E+00	2.75E+00	1.98E+00	3.19E+00	3.79E+00
15 BICA COLD FAST	1.53E-01	2.40E-01	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	6.78E-02
16 BICA HOT FAST	1.13E+00	2.13E+00	9.73E-01	<1.00E-02	2.50E-01	<1.00E-02	6.00E-01	9.76E-01
17 BICA COLD SLOW	4.44E+00	1.16E+00	6.70E-01	<1.00E-02	<1.00E-02	<1.00E-02	6.41E-02	4.94E-01
18 BICA HOT SLOW	3.39E+00	3.93E+00	3.14E+00	1.16E+01	9.50E+00	1.15E+01	8.51E+00	7.77E+00
19 DIST COLD MED	1.36E+00	3.86E-01	2.88E-01	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	7.74E-02
20 DIST COLD MED	1.77E+00	3.67E-01	2.21E-01	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	6.98E-02
21 DIST COLD MED	1.40E+00	3.97E-01	2.60E-01	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	5.09E-02
22 DIST COLD MEL	1.45E+00	3.90E-01	3.42E-01	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	3.19E-01
23 DIST HOT MED	4.76E+00	3.04E+00	2.90E+00	2.14E-01	1.06E+00	3.37E-01	1.40E+00	1.57E+00
24 DIST COLD FAST	3.30E-01	2.72E-01	9.38E-02	1.87E-01	<1.00E-02	4.71E-02	<1.00E-02	4.30E-02
25 DIST HOT FAST	6.37E-01	1.00E+00	4.65E-01	<1.00E-02	<1.00E-02	<1.00E-02	3.01E-01	3.20E-01
26 DIST COLD SLOW	4.48E+00	1.19E+00	1.93E+00	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	1.92E-01
27 DIST HOT SLOW	8.61E+00	7.12E+00	3.95E+00	6.21E+00	0.	3.73E+00	2.95E+00	6.26E+00
28 BICA COLD MED	3.08E-01	4.69E-01	2.23E-01	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	1.05E-01

TABLE OF CONCENTRATIONS (UG/CM3 LEACHED)
STRONTIUM DETECTION LIMIT= .010

CHANNEL/DAY	1	2	3	6	37	68	230	420
10 BICA COLD MED	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
11 BICA COLD MED	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
12 BICA COLD MED	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
13 BICA COLD MED	<1.00E-02	<1.00E-02	0.	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
14 BICA HOT MED	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	1.29E-02	2.80E-02
15 BICA COLD FAST	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
16 BICA HOT FAST	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
17 BICA COLD SLOW	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
18 BICA HOT SLOW	<1.00E-02	<1.00E-02	<1.00E-02	9.13E-02	7.63E-02	7.48E-02	5.74E-02	3.61E-02
19 DIST COLD MED	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
20 DIST COLD MED	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
21 DIST COLD MED	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
22 DIST COLD MED	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
23 DIST HOT MED	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
24 DIST COLD FAST	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
25 DIST HOT FAST	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
26 DIST COLD SLOW	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
27 DIST HOT SLOW	<1.00E-02	<1.00E-02	<1.00E-02	3.11E-02	0.	1.81E-02	1.61E-02	6.59E-02
28 BICA COLD MED	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02

TABLE OF CONCENTRATIONS (UG/CM3 LEACHED)

TITANIUM

DETECTION LIMIT= .001

CHANNEL/DAY	1	2	3	6	37	68	230	420
10 BICA COLD MED	<1.00E-03	<1.00E-03	9.83E-02	1.12E-01	7.07E-02	6.71E-02	<1.00E-03	3.60E-02
11 BICA COLD MED	9.78E-02	5.54E-02	1.01E-01	1.22E-01	1.09E-01	7.94E-02	<1.00E-03	4.09E-02
12 BICA COLD MED	8.73E-02	9.65E-02	9.76E-02	1.20E-01	9.05E-02	7.57E-02	<1.00E-03	4.10E-02
13 BICA COLD MED	8.35E-02	9.46E-02	0.	7.00E-02	8.02E-02	7.41E-02	<1.00E-03	4.06E-02
14 BICA HOT MED	8.80E-02	8.94E-02	9.50E-02	1.16E-01	8.24E-02	7.57E-02	<1.00E-03	4.30E-02
15 BICA COLD FAST	4.87E-02	1.20E-01	5.83E-02	5.05E-02	5.94E-02	6.37E-02	<1.00E-03	4.40E-02
16 BICA HOT FAST	4.91E-02	1.08E-01	5.73E-02	4.52E-02	4.60E-02	4.39E-02	<1.00E-03	3.78E-02
17 BICA COLD SLOW	1.70E-01	1.67E-01	1.32E-01	3.33E-02	8.45E-02	7.34E-02	<1.00E-03	7.42E-02
18 BICA HOT SLOW	1.67E-01	1.91E-01	1.31E-01	3.59E-02	7.49E-02	8.29E-02	<1.00E-03	7.19E-02
19 DIST COLD MED	8.28E-02	9.17E-02	9.01E-02	1.16E-01	8.28E-02	6.74E-02	<1.00E-03	3.52E-02
20 DIST COLD MED	8.57E-02	9.55E-02	1.01E-01	1.05E-01	8.92E-02	8.78E-02	<1.00E-03	3.52E-02
21 DIST COLD MED	8.52E-02	9.49E-02	9.95E-02	1.16E-01	8.72E-02	7.31E-02	<1.00E-03	3.73E-02
22 DIST COLD MED	9.50E-02	9.99E-02	1.01E-01	1.05E-01	9.26E-02	7.55E-02	<1.00E-03	3.73E-02
23 DIST HOT MED	8.54E-02	1.34E-01	1.01E-01	1.17E-01	8.20E-02	7.87E-02	<1.00E-03	3.74E-02
24 DIST COLD FAST	4.78E-02	1.16E-01	5.99E-02	4.72E-02	5.70E-02	4.73E-02	<1.00E-03	3.04E-02
25 DIST HOT FAST	5.58E-02	1.09E-01	5.44E-02	4.30E-02	6.49E-02	4.70E-02	<1.00E-03	3.00E-02
26 DIST COLD SLOW	1.56E-01	1.39E-01	2.02E-01	2.59E-02	8.01E-02	6.14E-02	<1.00E-03	6.82E-02
27 DIST HOT SLOW	1.16E-01	1.37E-01	1.59E-01	3.17E-02	0.	7.25E-02	<1.00E-03	6.89E-02
28 BICA COLD MED	<1.00E-03	<1.00E-03	9.12E-02	2.83E-02	7.12E-02	6.47E-02	<1.00E-03	4.24E-02

TABLE OF CONCENTRATIONS (UG/CM3 LEACHED)
URANIUM
DETECTION LIMIT= .040

CHANNEL/DAY	1	2	3	6	37	68	230	420
10 BICA COLD MED	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02
11 BICA COLD MED	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02
12 BICA COLD MED	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02
13 BICA COLD MED	<4.00E-02	<4.00E-02	0.	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02
14 BICA HOT MED	2.66E-01	2.74E-01	2.97E-01	1.30E-01	3.70E-01	3.41E-01	5.42E-01	5.70E-01
15 BICA COLD FAST	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02
16 BICA HOT FAST	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02
17 BICA COLD SLOW	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02
18 BICA HOT SLOW	2.48E+00	1.59E+00	1.46E+00	2.70E+00	2.09E+00	2.34E+00	2.09E+00	9.22E-01
19 DIST COLD MED	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02
20 DIST COLD MED	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02
21 DIST COLD MED	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02
22 DIST COLD MED	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02
23 DIST HOT MED	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02
24 DIST COLD FAST	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02
25 DIST HOT FAST	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02
26 DIST COLD SLOW	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02
27 DIST HOT SLOW	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	0.	<4.00E-02	<4.00E-02	<4.00E-02
20 BICA COLD MED	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02	<4.00E-02

TABLE OF CONCENTRATIONS (UG/CM3 LEACHED)
ZINC
DETECTION LIMIT= .005

CHANNEL/DAY	1	2	3	6	37	68	230	420
10 BICA COLD MED	5.56E-01	9.03E-02	7.04E-02	6.54E-02	3.12E-02	4.95E-02	3.82E-02	2.35E-02
11 BICA COLD MED	8.40E-02	6.05E-02	4.64E-02	6.83E-02	4.25E-02	5.35E-02	4.70E-02	3.52E-02
12 BICA COLD MED	1.45E-01	1.46E-01	1.44E-01	1.80E-01	2.05E-01	1.75E-01	1.53E-01	1.10E-01
13 BICA COLD MED	7.50E-02	6.68E-02	0.	8.39E-02	4.17E-02	5.57E-03	3.51E-02	1.97E-02
14 BICA HOT MED	9.64E-02	6.20E-02	5.66E-02	8.41E-02	6.78E-02	7.50E-02	4.51E-02	5.58E-02
15 BICA COLD FAST	5.27E-02	4.07E-02	2.44E-02	3.79E-02	2.05E-02	5.95E-02	2.39E-02	1.20E-02
16 BICA HOT FAST	3.47E-02	8.00E-02	3.59E-02	5.23E-02	7.70E-02	4.27E-02	4.78E-02	2.66E-02
17 BICA COLD SLOW	2.79E-01	2.87E-01	6.69E-02	6.09E-02	7.02E-02	1.49E-01	5.97E-02	5.52E-02
18 BICA HOT SLOW	8.55E-02	1.20E-01	9.20E-02	7.38E-02	6.75E-02	4.11E-01	4.21E-02	9.45E-02
19 DIST COLD MED	9.31E-02	1.44E-01	7.82E-02	9.91E-02	5.80E-02	7.06E-02	<5.00E-03	3.22E-02
20 DIST COLD MED	1.04E-01	1.32E-01	8.87E-02	1.08E-01	5.59E-02	9.49E-02	4.80E-02	2.95E-02
21 DIST COLD MED	8.49E-02	1.42E-01	8.04E-02	9.07E-02	6.57E-02	7.27E-02	5.02E-02	2.43E-02
22 DIST COLD MED	4.10E-01	3.30E-01	3.31E-01	3.83E-01	3.43E-01	3.90E-01	3.81E-01	3.76E-01
23 DIST HOT MED	4.75E-02	5.98E-02	6.65E-02	7.83E-02	4.37E-02	9.28E-02	1.09E-01	1.71E-01
24 DIST COLD FAST	8.73E-02	7.42E-02	2.90E-02	3.51E-02	3.25E-02	2.93E-02	4.99E-02	1.21E-02
25 DIST HOT FAST	1.01E-01	1.55E-01	6.67E-02	7.95E-02	9.43E-02	1.07E-01	1.42E-01	4.20E-02
26 DIST COLD SLOW	9.13E-02	1.94E-01	7.02E-01	1.88E-01	1.10E-01	1.43E-01	1.20E-01	7.08E-02
27 DIST HOT SLOW	6.94E-02	4.23E-01	4.62E-02	5.00E-02	0.	1.17E-01	5.85E-02	8.38E-02
28 BICA COLD MED	1.72E-01	5.62E-02	3.64E-02	7.8[illegible]E-02	3.47E-02	5.37E-02	2.59E-02	2.55E-02

TABLE OF CONCENTRATIONS (UG/CM3 LEACHED)
CALCIUM
DETECTION LIMIT= .002

CHANNEL/DAY	1	2	3	6	37	68	230	420
10 BICA COLD MED	7.64E+00	9.41E-01	1.89E+00	2.67E-01	2.61E-01	2.00E-01	2.94E-01	3.74E-01
11 BICA COLD MED	2.40E+00	4.25E-01	3.74E-01	3.68E-01	3.09E-01	2.66E-01	2.45E-01	1.31E+00
12 BICA COLD MED	6.15E-01	5.89E-01	4.02E-01	3.32E-01	3.63E-01	2.31E-01	4.67E-01	3.14E-01
13 BICA COLD MED	6.51E-01	3.91E-01	0.	2.48E-01	2.75E-01	2.25E-01	2.24E-01	1.38E-01
14 BICA HOT MED	1.92E+00	5.77E-01	9.69E-01	6.04E-01	6.21E-01	5.26E-01	4.05E-01	3.57E-01
15 BICA COLD FAST	3.46E-01	3.60E-01	2.09E-01	1.55E-01	1.61E-01	7.11E-01	1.59E-01	8.50E-02
16 BICA HOT FAST	2.00E-01	7.06E-01	1.34E+00	2.05E-01	1.29E+00	2.51E-01	3.65E-01	1.53E-01
17 BICA COLD SLOW	1.56E+01	1.04E+00	4.59E-01	6.29E-01	4.61E-01	1.04E+00	5.49E-01	2.89E-01
18 BICA HOT SLOW	2.12E+00	1.29E+00	7.48E-01	5.93E-01	8.93E-01	4.47E+00	6.75E-01	1.10E+00
19 DIST COLD MED	8.99E-01	2.86E-01	[illegible].45E-01	3.74E-01	2.20E-01	1.36E-01	1.60E-01	4.34E-01
20 DIST COLD MED	7.33E-01	4.89E-01	3.47E-01	2.08E+00	2.36E-01	1.56E-01	3.24E-01	2.57E-02
21 DIST COLD MED	5.78E-01	3.33E-01	2.16E-01	2.79E-01	2.05E-01	1.80E-01	1.53E-01	5.49E-02
22 DIST COLD MED	5.92E-01	2.85E-01	2.48E-01	7.24E-01	2.87E-01	4.95E-01	1.34E-01	5.78E-02
23 DIST HOT MED	7.94E-01	8.76E-01	4.33E-01	6.00E-01	2.95E-01	3.71E-01	4.21E-01	1.80E-01
24 DIST COLD FAST	4.67E-01	3.00E-01	1.33E-01	1.59E-01	1.67E-01	1.48E-01	1.92E-01	3.69E-02
25 DIST HOT FAST	2.49E-01	3.77E-01	1.46E-01	1.29E-01	2.09E-01	2.07E-01	2.25E-01	3.14E-02
26 DIST COLD SLOW	2.09E+00	9.34E-01	1.13E+00	3.03E-01	3.25E-01	4.01E-01	4.64E-01	1.59E-01
27 DIST HOT SLOW	1.32E+00	1.16E+00	7.29E-01	1.10E+00	0.	9.55E-01	4.19E-01	7.55E-01
28 BICA COLD MED	3.23E+00	6.11E+00	2.62E-01	5.82E-01	3.15E-01	2.08E-01	1.99E-01	2.33E-01

TABLE OF CONCENTRATIONS (UG/CMS LEACHED)
SODIUM
DETECTION LIMIT= .010

CHANNEL/DAY	1	2	3	6	37	68	200	420
10 BICA COLD MED	8.04E+01	1.09E+02	9.39E+01	3.53E+00	9.50E+01	4.68E+01	7.97E+01	<1.00E-02
11 BICA COLD MED	9.42E+01	<1.00E-02	3.64E+01	1.21E+00	1.04E+02	3.90E+01	7.76E+01	3.14E+01
12 BICA COLD MED	7.87E+01	4.16E+01	4.60E+01	<1.00E-02	1.08E+02	4.50E+01	7.10E+01	1.91E+01
13 BICA COLD MED	7.08E+01	5.88E+01	0.	<1.00E-02	9.75E+01	4.80E+01	6.90E+01	1.79E+00
14 BICA HOT MED	8.32E+01	3.79E+01	4.35E+01	7.27E+00	1.01E+02	3.97E+01	6.72E+01	<1.00E-02
15 BICA COLD FAST	6.52E+01	7.40E+02	2.28E+01	1.19E+01	7.20E+01	3.50E+01	4.79E+01	<1.00E-02
16 BICA HOT FAST	5.43E+01	7.25E+02	1.98E+02	1.26E+01	8.24E+01	3.38E+01	6.29E+01	7.41E+00
17 BICA COLD SLOW	1.36E+02	3.71E+01	<1.00E-02	<1.00E-02	1.12E+02	7.16E+01	1.50E+02	<1.00E-02
18 BICA HOT SLOW	1.32E+02	5.95E+01	<1.00E-02	2.52E+01	1.34E+02	2.06E+02	1.58E+02	<1.00E-02
19 DIST COLD MED	5.46E+00	4.15E+00	4.91E-01	1.20E+00	1.62E+00	4.00E-01	2.04E+00	2.60E-01
20 DIST COLD MED	2.62E+00	7.62E-01	4.67E-01	1.09E+00	1.31E+00	1.37E+00	1.80E+00	2.00E-01
21 DIST COLD MED	1.69E+00	6.44E-01	4.36E-01	6.75E-01	8.07E-01	6.35E-01	8.91E-01	6.46E-01
22 DIST COLD MED	3.14E+00	5.66E-01	6.42E-01	6.06E-01	9.62E-01	7.43E-01	3.05E+00	3.16E-01
23 DIST HOT MED	1.28E+01	2.59E+00	2.12E+00	2.21E+00	2.16E+00	2.18E+00	2.04E+00	9.70E-01
24 DIST COLD FAST	5.16E+00	4.72E-01	2.31E-01	2.01E-01	6.40E-01	3.10E-01	9.09E-01	1.52E-01
25 DIST HOT FAST	1.56E+00	9.47E-01	4.47E-01	4.00E-01	9.06E-01	4.74E-01	2.61E+00	2.54E-01
26 DIST COLD SLOW	9.83E+00	2.32E+00	1.11E+01	6.11E-01	1.24E+00	5.90E-01	2.10E+00	5.25E-01
27 DIST HOT SLOW	4.60E+01	6.20E+00	8.06E+00	7.61E+00	0.	3.62E+00	3.13E+00	3.68E+00
28 BICA COLD MED	6.66E+01	5.21E+01	3.35E+01	2.49E+01	9.05E+01	5.59E+01	8.25E+01	<1.00E-02

Leachant Blank Analytical Values and ICP Detection Limits ($\mu g/cm^3$)

Element	Det. Limit	Bicarbonate Days 0-23	Bicarbonate Days 24-420	Dist. H_2O June, 1978
B	0.005	0.005	n.d.	0.002
Cd	0.001	n.d.	0.002	0.001
Ca	0.001	0.048	0.041	0.001
Fe	0.002	0.002	n.d.	n.d.
Mo	0.007	0.021	0.029	0.012
Ni	0.011	n.d.	n.d.	0.005
[illegible]	0.008	0.125	0.074	0.019
Na	0.008	676	625	0.010
Sr	0.007	0.004	n.d.	n.d.
Ti	0.002	n.d.	n.d.	0.001
U	0.040	n.d.	n.d.	n.d.
Zn	0.004	0.002	0.004	0.001
Zr		0.012	0.007	n.d.

n.d. = not detectable

APPENDIX 8

Incremental and Cumulative Leach Results for ^{237}Np and ^{239}Pu

Incremental leach rates (R, in grams glass leached per cm^2-day) and cumulative fractions leached (CFL) for Np and Pu. See text for equations and calculation method. A zero in the rate table signifies "not analyzed"; the CFL calculation routine replaces this with the average of the adjacent data points for the purposes of cumulation.

NEPTUNIUM LEACHRATE IN BRINE (G/CM2.DAY)

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	68	120	230	420
1	COLD	MED	1.08E-05	2.48E-06	1.46E-06	8.86E-07	8.24E-07	8.79E-07	9.17E-07	8.50E-07	7.73E-07	1.05E-06	1.17E-06
			8.17E-01	1.35E+00	1.08E+00	1.70E+00	1.52E+00	1.51E+00	1.41E+00	1.97E+00	6.56E-01	2.03E+00	9.59E-01
3	COLD	MED	1.09E-05	3.79E-06	1.77E-06	1.15E-06	1.19E-06	1.07E-06	9.10E-07	1.18E-06	1.12E-06	1.22E-06	1.33E-06
			7.87E-01	6.03E-01	1.12E+00	1.27E+00	1.79E+00	2.19E+00	2.88E+00	1.80E+00	5.96E-01	2.42E+00	1.16E+00
4	COLD	MED	1.07E-05	2.58E-06	1.39E-06	9.92E-07	1.10E-06	9.40E-07	1.07E-06	1.15E-06	9.81E-07	9.70E-07	1.04E-06
			9.41E-01	1.70E+00	1.09E+00	1.4[illegible]E+00	1.48E+00	3.39E+00	1.57E+00	1.92E+00	6.30E-01	2.48E+00	1.28E+00
5	HOT	MED	3.33E-05	2.99E-05	2.75E-05	2.39E-05	2.90E-05	2.73E-05	2.60E-05	2.94E-05	3.34E-05	2.66E-05	2.75E-05
			3.28E-01	3.70E-01	2.60E-01	3.29E-01	3.61E-01	4.08E-01	4.75E-01	3.24E-01	1.28E-01	2.62E-01	2.37E-01
6	COLD	FAST	1.36E-05	5.82E-06	1.51E-06	1.29E-06	3.36E-06	1.71E-06	1.61E-06	1.67E-06	1.73E-06	2.33E-06	1.42E-06
			1.23E+00	1.31E+00	2.52E+00	2.34E+00	2.35E+00	4.09E+00	6.71E+00	3.08E+00	1.04E+00	2.18E+00	2.19E+00
7	HOT	FAST	6.30E-05	1.12E-05	1.41E-05	7.12E-05	6.02E-05	5.76E-05	6.66E-05	1.04E-04	1.44E-04	5.76E-05	7.64E-05
			6.33E-01	8.69E-01	6.90E-01	4.77E-01	4.22E-01	6.37E-01	3.56E-01	6.20E-01	1.83E-01	4.06E-01	2.49E-01
8	COLD	SLOW	9.20E-06	3.78E-06	1.45E-06	8.36E-07	7.77E-07	7.49E-07	6.55E-07	7.81E-07	7.22E-07	8.48E-07	5.36E-07
			9.31E-01	1.36E+00	9.64E-01	7.02E-01	1.18E+00	1.62E+00	9.79E-01	1.49E+00	4.[illegible]5E-01	8.34E-01	1.32E+00
9	HOT	SLOW	4.67E-05	1.64E-05	1.33E-05	1.24E-05	1.01E-05	8.73E-06	7.2[illegible]E-06	[illegible].30E-06	1.94E-05	1.55E-05	1.14E-05
			3.06E-01	1.85E-01	5.35E-01	3.21E-01	4.87E-01	6.09E-01	6.18E-01	5.10E-01	7.66E-01	2.54E-01	1.74E-01

NEPTUNIUM LEACHRATE IN BICARBONATE (G/CM2.DAY)

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	68	120	230	420
10	COLD	MED	8.42E-06	4.30E-06	2.63E-06	2.29E-06	2.17E-06	2.51E-06	1.22E-06	2.68E-06	2.43E-06	2.39E-06	2.59E-06
			2.17E+00	5.50E-01	5.23E-01	4.22E+00	3.69E+00	3.06E+00	3.15E+00	4.60E+00	4.71E+00	4.02E+00	3.69E+00
11	COLD	MED	8.25E-06	5.73E-06	3.52E-06	1.73E-06	2.69E-06	2.20E-06	2.64E-06	2.55E-06	2.17E-06	1.99E-06	2.80E-06
			2.09E+00	2.21E+00	3.42E+00	5.05E+00	3.01E+00	3.37E+00	2.93E+00	4.37E+00	3.85E+00	4.50E+00	3.83E+00
13	COLD	MED	8.26E-06	5.52E-06	0.		2.73E-06	2.78E-06	2.58E-06	2.44E-06	2.65E-06	2.76E-06	2.32E-06	2.44E-06
			2.21E+00	2.19E+00	0.		4.04E+00	3.13E+00	3.11E+00	3.05E+00	3.38E+00	3.63E+00	4.32E+00	4.12E+00
14	HOT	MED	9.71E-05	7.30E-05	7.93E-05	8.09E-05	8.73E-05	9.00E-05	7.88E-05	8.97E-05	1.19E-04	8.10E-05	7.35E-05
			6.88E-01	5.45E-01	7.79E-01	7.50E-01	6.06E-01	5.30E-01	6.63E-01	6.73E-01	7.78E-01	7.36E-01	7.28E-01
15	COLD	FAST	1.21E-05	4.23E-06	3.54E-06	4.45E-06	2.43E-06	3.58E-06	1.53E-06	3.04E-06	2.68E-06	2.54E-06	6.46E-07
			4.45E+00	6.02E+00	8.45E+00	6.59E+00	9.41E+00	5.94E+00	7.27E+00	7.18E+00	7.20E+00	8.33E+00	1.47E+01
16	HOT	FAST	1.37E-04	1.24E-04	1.18E-04	1.86E-04	1.29E-04	1.46E-04	1.25E-04	1.20E-04	1.33E-04	1.25E-04	9.46E-05
			1.37E+00	1.26E+00	1.50E+00	1.04E+00	1.26E+00	9.39E-01	9.02E-01	1.33E+00	1.36E+00	1.18E+00	1.31E+00
17	COLD	SLOW	3.58E-06	3.34E-06	2.76E-06	3.93E-06	2.52E-06	1.84E-06	2.24E-06	1.96E-06	1.33E-06	2.45E-06	1.36E-06
			1.86E+00	1.90E+00	1.97E+00	1.41E+00	2.15E+00	1.70E+00	1.30E+00	2.07E+00	2.53E+00	1.84E+00	2.68E+00
18	HOT	SLOW	5.83E-05	4.22E-05	3.88E-05	5.03E-05	5.32E-05	5.35E-05	3.11E-05	2.83E-05	2.77E-05	2.41E-06	1.07E-05
			4.60E-01	5.06E-01	5.05E-01	4.32E-01	4.43E-01	3.19E-01	3.46E-01	5.43E-01	6.95E-01	1.93E+00	8.16E-01
28	COLD	MED	8.34E-06	4.25E-06	3.60E-06	2.58E-06	2.62E-06	1.31E-06	1.60E-06	2.46E-06	2.62E-06	1.76E-06	1.90E-06
			2.16E+00	3.20E+00	2.94E+00	3.52E+00	3.62E+00	4.25E+00	6.07E+00	5.51E+00	4.39E+00	5.47E+00	3.86E+00

NEPTUNIUM LEACHRATE IN DIST.WATER (G/CM2.DAY)

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	60	120	230	420
19	COLD	MED	8.69E-06	6.06E-06	2.68E-06	1.03E-06	1.02E-06	1.11E-06	7.92E-07	7.22E-07	9.07E-07	6.23E-07	8.60E-07
			2.25E+00	2.60E+00	4.02E+00	7.91E+00	6.02E+00	5.14E+00	4.80E+00	7.03E+00	5.94E+00	8.35E+00	9.62E+00
20	COLD	MED	8.20E-06	4.65E-06	1.83E-06	7.41E-07	9.21E-07	6.14E-07	4.49E-07	1.97E-06	5.67E-07	8.81E-07	6.50E-07
			2.31E+00	2.91E+00	6.00E+00	8.94E+00	5.95E+00	6.54E+00	5.94E+00	4.29E+00	7.62E+00	5.87E+00	9.95E+00
21	COLD	MED	7.91E-06	5.67E-06	2.58E-06	8.75E-07	9.06E-07	8.74E-07	6.03E-07	1.15E-06	3.91E-06	7.45E-07	2.22E-07
			2.43E+00	2.53E+00	4.24E+00	8.36E+00	6.39E+00	5.65E+00	5.10E+00	6.03E+00	2.98E+00	7.81E+00	1.64E+01
23	HOT	MED	3.08E-05	2.22E-05	2.60E-05	1.58E-05	1.20E-05	1.57E-05	1.66E-05	1.75E-05	1.86E-05	4.31E-05	5.94E-05
			1.30E+00	1.17E+00	1.62E+00	1.39E+00	1.73E+00	1.27E+00	1.11E+00	1.49E+00	1.57E+00	9.74E-01	9.80E-01
24	COLD	FAST	1.17E-05	1.55E-06	1.04E-06	9.81E-07	1.04E-06	1.09E-06	8.17E-07	1.17E-06	7.28E-07	8.14E-07	6.88E-07
			6.40E-01	2.02E+00	1.76E+00	1.88E+00	1.86E+00	2.27E+00	2.18E+00	1.55E+00	1.71E+00	1.59E+00	2.77E+00
25	HOT	FAST	5.42E-05	4.97E-05	4.77E-05	4.97E-05	5.05E-05	4.41E-05	1.94E-05	3.03E-05	2.95E-05	3.10E-05	2.93E-05
			2.25E+00	2.15E+00	2.22E+00	2.49E+00	2.03E+00	1.88E+00	3.74E+00	2.59E+00	2.48E+00	2.47E+00	3.27E+00
26	COLD	SLOW	3.74E-08	5.02E-06	7.53E-06	1.05E-06	5.84E-07	4.56E-07	3.37E-07	5.85E-07	3.72E-07	6.39E-07	4.38E-07
			1.97E+00	1.56E+00	2.16E+00	2.16E+00	4.50E+00	2.77E+00	6.03E+00	5.71E+00	5.19E+00	4.40E+00	3.92E+00
27	HOT	SLOW	1.55E-06	1.57E-05	6.93E-06	1.07E-05	3.61E-06	7.80E-06	1.16E-06	1.13E-05	9.87E-06	1.63E-05	2.72E-05
			9.37E-01	9.76E-01	8.56E-01	6.71E-01	1.33E+00	8.19E-01	1.61E+00	1.95E+00	1.35E+00	9.65E-01	5.13E-01

PLUTONIUM LEACHRATE IN BRINE (G/CM2.DAY)

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	68	120	230	420
1	CO ?	MED	2.45E-06	6.48E-07	3.95E-07	2.63E-07	1.72E-07	1.03E-07	1.20E-07	9.95E-08	7.41E-08	4.55E-08	6.04E-08
			4.37E-01	1.07E+00	1.11E+00	2.38E+00	1.91E+00	2.15E+00	1.50E+00	1.59E+00	1.46E+00	3.94E+00	2.35E+00
3	COLD	MED	1.24E-06	7.48E-07	4.27E-07	2.74E-07	1.94E-07	1.63E-07	1.13E-07	1.16E-07	8.85E-08	7.62E-08	5.60E-08
			4.00E-01	9.85E-01	1.09E+00	1.97E+00	2.59E+00	1.92E+00	1.82E+00	1.42E+00	1.20E+00	2.81E+00	4.72E+00
4	COLD	MED	1.23E-06	5.50E-07	3.74E-07	2.64E-07	2.56E-07	1.95E-07	1.31E-07	1.30E-07	1.16E-07	6.97E-08	9.06E-08
			3.81E-01	1.17E+00	1.10E+00	1.83E+00	8.56E-01	1.84E+00	1.02E+00	1.32E+00	1.46E+00	2.05E+00	4.02E+00
5	HOT	MED	4.53E-07	4.66E-08	2.21E-08	1.34E-08	1.52E-08	1.55E-08	3.70E-08	3.10E-08	3.98E-08	5.39E-08	4.32E-08
			5.51E-01	4.79E+00	5.15E+00	8.64E+00	1.02E+01	1.34E+01	2.92E+00	4.64E+00	2.29E+00	2.41E+00	5.95E+00
6	COLD	FAST	3.84E-06	1.49E-07	4.75E-07	3.41E-07	2.03E-07	3.55E-07	3.01E-07	3.09E-07	2.52E-07	1.85E-07	1.61E-07
			6.30E-01	1.31E+00	5.44E+00	2.77E+00	6.32E+00	4.48E+00	3.20E+00	4.20E+00	2.00E+01	3.86E+00	4.24E+00
7	HOT	FAST	2.34E-06	1.14E-07	2.71E-08	1.26E-07	1.42E-07	2.59E-07	2.98E-07	8.72E-07	1.03E-06	5.62E-07	4.20E-07
			1.17E+00	1.22E+00	2.36E+00	5.74E+00	6.17E+00	5.70E+00	2.20E+00	3.01E+00	1.63E+00	1.63E+00	3.51E+00
8	COLD	SLOW	2.43E-06	6.18E-07	3.99E-07	5.14E-09	1.23E-07	1.12E-07	1.00E-07	1.83E-08	1.07E-07	5.82E-08	4.66E-08
			2.53E-01	1.07E+00	9.88E-01	5.87E+00	2.70E+00	2.00E+00	1.57E+00	1.29E+00	7.36E-01	1.63E+00	4.46E+00
9	HOT	SLOW	8.33E-08	2.03E-08	1.23E-08	6.20E-09	5.80E-09	6.30E-09	6.12E-09	5.55E-09	1.97E-08	1.11E-08	7.24E-09
			1.17E+00	3.15E+00	3.39E+00	4.52E+00	3.88E+00	4.37E+00	5.29E+00	4.65E+00	3.36E+00	6.44E+00	7.60E+00

PLUTONIUM LEACHRATE IN BICARBONATE (G/CM2.DAY)

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	68	120	230	420
10	COLD	MED	3.75E-06	1.60E-06	1.03E-06	8.29E-07	8.18E-07	7.90E-07	2.05E-07	5.40E-07	3.65E-07	2.86E-07	3.08E-07
			1.10E+00	4.37E-01	4.99E-01	2.38E+00	2.04E+00	1.05E+00	2.20E+00	3.44E+00	4.12E+00	0.93E+00	3.62E+00
11	COLD	MED	3.82E-06	2.02E-06	1.21E-06	5.15E-07	8.31E-07	6.10E-07	6.01E-07	3.86E-07	1.02E-07	1.58E-07	2.80E-07
			1.04E+00	1.26E+00	1.97E+00	3.13E+00	1.83E+00	2.17E+00	2.08E+00	3.30E+00	4.49E+00	5.40E+00	4.10E+00
13	COLD	MED	3.85E-06	1.84E-06	0.	9.12E-07	8.89E-07	6.63 07	6.36E-07	5.11E-07	3.90E-07	2.98E-07	3.04E-07
			1.09E+0D	1.28E+00	0.	2.37E+00	1.87E+00	2.08E+00	2.02E+00	2.99E+00	3.27E+00	4.07E+00	3.95E+00
14	HOT	MED	7.19E-07	4.87E-08	4.69E-08	7.96E-08	1.26E-07	1.28E-07	5.29E-08	7.16E-0ö	9.77E-08	1.23E-07	7.17E-08
			2.71E+00	7.14E+00	1.08E+01	8.08E+00	5.39E+00	4.75E+00	7.22E+00	8.06E+00	9.21E+0D	6.39E+00	7.88E+00
15	COLD	FAST	6.26E-06	1.95E-06	1.42E-06	2.10E-06	1.04E-06	1.30E-06	5.45E-07	5.12E-07	4.75E-07	5.93E-07	1.85E-07
			2.10E+00	3.00E+00	4.51E+00	3.25E+00	4.86E+00	3.34E+00	4.12E+00	5.92E+00	5.79E+00	5.83E+00	9.33E+00
16	HOT	FAST	2.71E-06	2.94E-07	3.05E-07	7.05E-07	5.77E-07	6.32E-07	4.84E-07	4.26E-07	5.50E-07	5.62E-07	4.06E-07
			3.29E+00	8.74E+00	1.00E+01	5.72E+00	6.39E+00	4.82E+00	4.90E+00	7.58E+00	7.16E+00	5.98E+00	6.79E+00
17	COLD	SLOW	1.28E-06	1.22E-06	7.69E-07	9.53E-07	5.70E-07	3.56E-07	2.76E-07	1.26E-07	9.16E-08	1.39E-07	1.51E-07
			1.05E+00	1.06E+00	1.26E+00	9.72E-01	1.53E+00	1.30E+00	1.25E+00	2.76E+00	3.39E+00	2.63E+00	2.72E+00
18	HOT	SLOW	2 13E-07	3.26E-08	2.02E-08	1.53E-08	2.57E-08	3.03E-08	5.79E-09	6.59E-09	9.79E-09	5.88E-09	1 50E-10
			2.58E+00	6.15E+00	7.50E+00	8.36E+00	6.82E+00	4.54E+00	6.57E+00	1.20E+01	1.25E+01	1.32E+01	1.00E+02
28	COLD	MED	3.90E-06	1.84E-06	1.32E-06	9.41E-07	9.97E-07	4.15E-07	3.40E-07	3.61E-07	2.64E-07	1.51E-07	4.44E-07
			1.07E+00	1.64E+00	1.64E+00	1.97E+00	1.99E+00	2.56E+00	4.50E+00	4.87E+00	4.68E+00	6.31E+00	2.70E+00

PLUTONIUM LEACHRATE IN DIST.WATER (G/CM2.DAY)

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	68	120	230	420
19	COLD	MED	1.94E-06	1.45E-06	7.30E-07	3.56E-07	1.93E-07	2.30E-07	1.26E-07	1.05E-07	5.50E-08	5.69E-08	2.20E-07
			1.61E+00	1.80E+00	2.61E+00	4.55E+00	4.69E+00	3.83E+00	4.07E+00	6.95E+00	8.16E+00	9.37E+00	6.44E+00
20	COLD	MED	2.14E-06	1.05E-06	5.48E-07	2.80E-07	1.77E-07	1.03E-07	8.81E-08	1.27E-07	5.44E-08	7.52E-00	1.05E-07
			1.53E+00	2.08E+00	3.70E+00	4.93E+00	4.60E+00	5.27E+00	4.54E+00	5.72E+00	8.33E+00	7.96E+00	8.39E+00
21	COLD	MED	1.96E-06	1.19E-06	5.92E-07	3.83E-07	1.95E-07	1.69E-07	9.58E-08	1.46E-07	1.40E-07	5.40E-08	1.22E-08
			1.65E+00	1.87E+00	2.99E+00	4.28E+00	4.66E+00	4.36E+00	4.32E+00	5.72E+00	5.18E+00	9.81E+00	2.43E+01
23	HOT	MED	1.81E-07	2.59E-08	2.56E-08	1.74E-08	1.47E-08	3.49E-08	7.72E-09	5.33E-09	1.36E-08	1.17E-07	3.45E-07
			5.72E+00	1.16E+01	1.71E+01	1.41E+01	1.67E+01	9.13E+00	1.74E+01	2.89E+01	1.96E+01	6.32E+00	4.35E+00
24	COLD	FAST	2.11E-06	5.51E-07	5.78E-07	3.41E-07	2.05E-07	2.72E-07	3.67E-07	1.48E-07	1.66E-07	7.93E-00	2.32E-07
			5.90E-01	2.89E+00	2.06E+00	2.29E+00	2.37E+00	4.31E+00	2.93E+00	3.41E+00	3.70E+00	1.02E+01	3.44E+00
25	HOT	FAST	2.34E-06	7.70E-07	7.99E-07	9.04E-07	1.37E-06	1.44E-06	5.37E-07	7.39E-07	7.75E-07	5.62E-07	5.36E-07
			3.67E+00	5.86E+00	5.79E+00	6.25E+00	4.17E+00	3.51E+00	7.60E+00	5.89E+00	5.17E+00	6.21E+00	8.16E+00
26	COLD	SLOW	8.42E-07	5.89E-07	8.69E-07	1.72E-07	7.44E-08	4.37E-08	4.09E-08	5.04E-08	3.60E-08	4.36E-08	3.72E-08
			1.41E+00	1.54E+00	2.15E+00	1.81E+00	4.27E+00	3.03E+00	5.86E+00	6.50E+00	6.64E+00	5.70E+00	4.55E+00
27	HOT	SLOW	1.07E-07	7.54E-09	2.56E-09	2.71E-09	2.28E-09	2.20E-09	6.21E-10	3.47E-09	2.04E-10	7.48E-09	7.21E-09
			3.80E+00	1.51E+01	1.51E+01	1.43E+01	1.80E+01	1.64E+01	2.36E+01	3.70E+01	1.00E+02	1.52E+01	1.07E+01

NEPTUNIUM CUMULATIVE FRACTIONAL LEACH (CFL) IN BRINE

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	68	120	230	420
1	COLD	MED	4.34E-05	5.34E-05	5.93E-05	7.01E-05	8.71E-05	1.18E-04	1.79E-04	2.93E-04	4.59E-04	8.6[illegible]E-04	1.71E-03
3	COLD	MED	4.18E-05	5.64E-05	6.31E-05	7.66E-05	9.91E-05	1.37E-04	2.02E-04	3.31E-04	5.56E-04	1.05E-03	1.97E-03
4	COLD	MED	4.24E-05	5.26E-05	5.81E-05	7.01E-05	9.09E-05	1.26E-04	1.94E-04	3.35E-04	5.49E-04	9.74E-04	1.73E-03
5	HOT	MED	[illegible].30E-04	2.46E-04	3.53E-04	6.36E-04	1.24E-03	2.11E-03	3.06E-03	7.21E-03	1.36E-02	2.60E-02	4.58E-02
6	COLD	FAST	5.20E-05	7.43E-05	8.01E-05	9.51E-05	1.43E-04	2.26E-04	3.34E-04	5.35E-04	8.65E-04	1.72E-03	3.08E-03
7	HOT	FAST	2.41E-04	2.83E-04	3.37E-04	1.16E-03	2.60E-03	4.38E-03	8.36E-03	1.05E-02	4.33E-02	8.39E-02	1.32E-01
8	COLD	SLOW	3.63E-05	5.12E-05	5.69E-05	6.59E-05	8.26E-05	1.09E-04	1.56E-04	2.47E-04	3.97E-04	7.38E-04	1.25E-03
9	HOT	SLOW	1.89E-04	2.55E-04	3.09E-04	4.61E-04	7.21E-04	1.02E-03	1.56E-03	2.57E-03	5.57E-03	1.30E-02	2.33E-02

NEPTUNIUM CUMULATIVE FRACTIONAL LEACH (CFL) IN BICARBONATE

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	63	120	230	420
10	COLD	MED	3.39E-05	5.12E-05	6.18E-05	8.97E-05	1.34E-04	2.18E-04	3.43E-04	5.97E-04	1.12E-03	2.18E-03	4.08E-03
11	COLD	MED	3.24E-05	5.50E-05	6.88E-05	8.94E-05	1.35E-04	2.18E-04	3.81E-04	7.07E-04	1.18E-03	2.07E-03	3.85E-03
13	COLD	MED	3.22E-05	5.37E-05	0.	8.61E-05	1.40E-04	2.32E-04	3.98E-04	7.16E-04	1.25E-03	2.34E-03	4.09E-03
14	HOT	MED	3.63E-04	5.36E-04	9.33E-04	1.85E-03	3.69E-03	6.33E-03	1.16E-02	2.14E-02	4.20E-02	8.15E-02	1.36E-01
15	COLD	FAST	4.84E-05	6.54E-05	7.95E-05	1.34E-04	1.98E-04	3.06E-04	4.76E-04	7.71E-04	1.35E-03	2.49E-03	3.69E-03
16	HOT	FAST	5.26E-04	1.00E-03	1.45E-03	3.63E-03	7.04E-03	1.12E-02	1.99E-02	3.45E-02	5.99E-02	1.14E-01	1.93E-01
17	COLD	SLOW	1.43E-05	2.76E-05	3.87E-05	8.65E-05	1.48E-04	2.23E-04	3.63E-04	6.31E-04	9.64E-04	1.80E-03	3.23E-03
18	HOT	SLOW	2.22E-04	3.89E-04	5.31E-04	1.11E-03	2.26E-03	3.68E-03	6.55E-03	1.00E-02	1.56E-02	2.16E-02	2.96E-02
28	COLD	MED	3.28E-05	4.95E-05	6.36E-05	9.44E-05	1.54E-04	2.13E-04	3.10E-04	5.61E-04	1.08E-03	1.99E-03	3.35E-03

NEPTUNIUM CUMULATIVE FRACTIONAL LEACH (CFL) IN DIST.WATER

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	68	120	230	420
19	COLD	MED	3.36E-05	5.70E-05	6.73E-05	7.94E-05	9.91E-05	1.36E-04	1.90E-04	2.91E-04	4.51E-04	7.75E-04	1.32E-03
20	COLD	MED	3.21E-05	5.03E-05	5.75E-05	6.63E-05	8.28E-05	1.09E-04	1.44E-04	2.98E-04	5.48E-04	8.60E-04	1.42E-03
21	COLD	MED	3.03E-05	5.19E-05	6.16E-05	7.20E-05	8.90E-05	1.19E-04	1.67E-04	2.75E-04	7.72E-04	1.74E-03	2.09E-03
23	HOT	MED	1.20E-04	2.07E-04	3.05E-04	4.93E-04	8.01E-04	1.24E-03	2.30E-03	4.36E-03	8.06E-03	2.08E-02	5.87E-02
24	COLD	FAST	4.47E-05	5.06E-05	5.45E-05	6.60E-05	8.53E-05	1.21E-04	1.82E-04	3.04E-04	4.80E-04	8.12E-04	1.35E-03
25	HOT	FAST	2.13E-04	4.08E-04	5.95E-04	1.19E-03	2.33E-03	3.79E-03	5.84E-03	9.08E-03	1.55E-02	2.81E-02	5.04E-02
26	COLD	SLOW	1.46E-05	3.41E-05	6.35E-05	7.59E-05	9.09E-05	1.09E-04	1.35E-04	1.93E-04	2.87E-04	5.04E-04	8.39E-04
27	HOT	SLOW	5.97E-05	1.20E-04	1.47E-04	2.73E-04	4.20E-04	6.03E-04	6.81E-04	1.65E-03	3.79E-03	9.15E-03	2.50E-02

PLUTONIUM CUMULATIVE FRACTIONAL LEACH (CFL) IN BRINE

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	68	120	230	420
1	COLD	MED	9.85E-06	1.25E-05	1.41E-05	1.73E-05	2.14E-05	2.62E-05	3.42E-05	4.88E-05	6.65E-05	9.29E-05	1.33E-04
3	COLD	MED	4.76E-06	7.64E-06	9.28E-06	1.25E-05	1.69E-05	2.28E-05	3.16E-05	4.59E-05	6.58E-05	1.00E-04	1.48E-04
4	COLD	MED	4.87E-06	7.05E-06	8.53E-06	1.17E-05	1.68E-05	2.46E-05	3.55E-05	5.20E-05	7.69E-05	1.17E-04	1.77E-04
5	HOT	MED	1.76E-06	1.95E-06	2.03E-06	2.19E-06	2.52E-06	2.99E-06	4.76E-06	8.85E-06	1.61E-05	3.54E-05	7.10E-05
6	COLD	FAST	1.47E-05	1.53E-05	1.71E-05	2.11E-05	2.60E-05	3.57E-05	5.70E-05	9.44E-05	1.49E-04	2.41E-04	3.66E-04
7	HOT	FAST	8.96E-06	9.40E-06	9.50E-06	1.10E-05	1.40E-05	2.03E-05	3.83E-05	1.09E-04	2.99E-04	6.19E-04	9.73E-04
8	COLD	SLOW	9.58E-06	1.20E-05	1.36E-05	1.37E-05	1.51E-05	1.92E-05	2.68E-05	3.35E-05	4.60E-05	8.17E-05	1.21E-04
9	HOT	SLOW	3.37E-07	4.31E-07	4.81E-07	5.57E-07	6.90E-07	8.93E-07	1.32E-06	2.05E-06	4.75E-06	1.13E-05	1.93E-05

PLUTONIUM CUMULATIVE FRACTIONAL LEACH (CFL) IN BICARBONATE

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	68	120	230	420
10	COLD	MED	1.51E-05	2.15E-05	2.57E-05	3.58E-05	5.22E-05	8.07E-05	1.17E-04	1.71E-04	2.64E-04	4.07E-04	6.33E-04
11	COLD	MED	1.50E-05	2.30E-05	2.77E-05	3.39E-05	4.76E-05	7.22E-05	1.13E-04	1.74E-04	2.31E-04	3.04E-04	4.67E-04
13	COLD	MED	1.50E-05	2.22E-05	0.		3.30E-05	5.04E-05	7.67E-05	1.20E-04	1.91E-04	2.80E-04	4.27E-04	6.49E-04
14	HOT	MED	2.69E-06	2.87E-06	3.05E-06	3.95E-06	6.28E-06	1.01E-05	1.56E-05	2.29E-05	3.95E-05	8.32E-05	1.52E-04
15	COLD	FAST	2.50E-05	3.28E-05	3.85E-05	6.40E-05	9.32E-05	1.35E-04	1.96E-04	2.64E-04	3.64E-04	5.93E-04	8.91E-04
16	HOT	FAST	1.04E-05	1.15E-05	1.27E-05	2.09E-05	3.50E-05	5.35E-05	8.92E-05	1.43E-04	2.42E-04	4.76E-04	8.26E-04
17	COLD	SLOW	5.12E-06	1.00E-05	1.31E-05	2.46E-05	3.90E-05	5.49E-05	7.63E-05	1.02E-04	1.24E-04	1.74E-04	2.84E-04
18	HOT	SLOW	8.10E-07	9.34E-07	1.01E-06	1.19E-06	1.66E-06	2.52E-06	3.63E-06	4.36E-06	6.00E-06	9.15E-06	1.13E-05
28	COLD	MED	1.53E-05	2.26E-05	2.77E-05	3.90E-05	6.13E-05	8.21E-05	1.07E-04	1.50E-04	2.14E-04	3.00E-04	5.21E-04

PLUTONIUM CUMULATIVE FRACTIONAL LEACH (CFL) IN DIST.WATER

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	68	120	230	420
19	COLD	MED	7.51E-06	1.31E-05	1.59E-05	2.01E-05	2.50E-05	3.23E-05	4.38E-05	5.80E-05	7.36E-05	9.74E-05	1.98E-04
20	COLD	MED	8.36E-06	1.25E-05	1.46E-05	1.79E-05	2.22E-05	2.70E-05	3.35E-05	4.70E-05	6.49E-05	9.28E-05	1.59E-04
21	COLD	MED	7.50E-06	1.21E-05	1.43E-05	1.88E-05	2.39E-05	3.00E-05	3.85E-05	5.34E-05	8.20E-05	1.24E-04	1.48E-04
23	HOT	MED	7.08E-07	8.10E-07	9.10E-07	1.12E-06	1.48E-06	2.29E-06	3.64E-06	4.42E-06	6.37E-06	3.35E-05	2.04E-04
24	COLD	FAST	8.07E-06	1.02E-05	1.24E-05	1.63E-05	2.13E-05	2.94E-05	5.04E-05	8.15E-05	1.12E-04	1.63E-04	2.76E-04
25	HOT	FAST	9.17E-06	1.22E-05	1.53E-05	2.61E-05	5.30E-05	9.69E-05	1.60E-04	2.38E-04	3.94E-04	6.71E-04	1.08E-03
26	COLD	SLOW	3.28E-06	5.58E-06	8.97E-06	1.10E-05	1.32E-05	1.52E-05	1.80E-05	2.37E-05	3.22E-05	4.92E-05	7.69E-05
27	HOT	SLOW	4.15E-07	4.44E-07	4.54E-07	4.86E-07	5.41E-07	6.09E-07	6.98E-07	9.48E-07	1.31E-06	2.90E-06	8.25E-06

APPENDIX 9

a) Mean Incremental and Extrapolated Cumulative Leach Rates for Stable Elements (XRF)

The XRF analyses (Appendix 6) yielded results which were nearly time-invariant and the samples analyzed were not the same as those used for the ICP analyses. We therefore calculated weighted mean leachate concentrations from the data of Appendix 6 and used the glass concentrations (Table 3), mean flow rates (Appendix 3) and bead weights (Appendix 2) to calculate a mean leach rate (g glass/cm^2 day). These values were then used to calculate the extrapolated cumulative fraction leached for day 420. For comparison, day 420 CFL values have been excerpted from the ICP-based tables and included in a separate column. Individual leach rate and CFL values, calculated as described in the text, are plotted in Appendices 12 and 13.

b) Incremental and Cumulative Leach Rates for Stable Elements (ICP)

Incremental leach rates (R, in grams glass leached per cm^2-day) and cumulative fractions leached (CFL) for stable elements determined by ICP. See text for equations and calculation method. A zero in the rate table signifies "not analyzed", and the CFL calculation replaces it with the average of the adjacent R values. A "less than" rate value is derived from the detection limit for those samples where the net concentration (Appendix 7) was below detection limits. In the CFL calculation, the detection limit value is used when present and all CFL values incorporating any "less than" rate data are identified as "less than".

BORON LEACHRATE -ICP- (G/CM2.DAY)

AVERAGE DETECTION LIMIT= 3.16E-07 SLOW 1.36E-06 MEDIUM 9.48E-06 FAST

CHAN	SOLN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	37	68	230	420
10	BICA	COLD	MED	1.58E-05	<4.25E-06	<3.77E-06	<4.28E-06	3.88E-06	<4.74E-06	5.85E-05	<4.57E-06
11.	BICA	COLD	MED	6.08E-06	<3.90E-06	<3.89E-06	<3.85E-06	<3.35E-06	<3.98E-06	<4.20E-06	<4.56E-06
12	BICA	COLD	MED	<3.83E-06	<3.87E-06	<3.87E-06	<3.74E-06	<3.95E-06	<3.99E-06	<4.38E-06	<4.40E-06
13	BICA	COLD	MED	5.23E-06	<4.04E-06	0.	<4.02E-06	<4.16E-06	<4.20E-06	<4.76E-06	<4.67E-06
14	BICA	HOT	MED	1.03E-04	7.57E-05	9.09E-05	8.74E-05	8.92E-05	9.51E-05	1.03E-04	8.63E-05
15	BICA	COLD	FAST	<2.64E-05	<2.59E-05	<2.54E-05	<2.40E-05	<2.48E-05	<1.86E-05	<2.19E-05	<1.71E-05
16	BICA	HOT	FAST	1.30E-04	2.32E-04	1.[illegible]5E-04	1.25E-04	1.25E-04	1.21E-04	1.30E-04	1.06E-04
17	BICA	COLD	SLOW	3.92E-06	1.90E-06	1.65E-06	2.16E-06	2.02E-06	1.78E-06	1.33E-06	2.93E-06
18	BICA	HOT	SLOW	7.79E-05	4.98E-05	4.62E-05	5.94E-05	6.23E-05	6.75E-05	6.21E-05	4.25E-05
19	DIST	COLD	MED	7.59E-06	4.54E-06	<4.20E-06	<4.19E-06	<4.36E-06	<4.52E-06	<4.68E-06	<5.75E-06
20	DIST	COLD	MED	7.25E-06	<3.88E-06	<3.87E-06	<3.84E-06	<4.08E-06	<3.46E-06	<4.57E-06	<4.79E-06
21	DIST	COLD	MED	5.91E-06	<3.94E-06	<3.95E-06	<3.91E-06	<4.23E-06	<4.21E-06	<5.05E-06	<4.54E-06
22	DIST	COLD	MED	1.38E-05	5.24E-06	6.75E-06	8.08E-06	7.13E-06	1.52E-05	9.74E-06	1.07E-05
23	DIST	HOT	MED	9.33E-05	3.33E-05	4.82E-05	5.07E-05	5.32E-05	5.78E-05	4.19E-05	3.30E-05
24	DIST	COLD	FAST	<2.54E-05	<2.54E-05	<2.56E-05	<2.56E-05	<2.61E-05	<2.69E-05	<1.39E-05	<2.60E-05
25	DIST	HOT	FAST	5.08E-05	7.77E-05	3.87E-05	4.35E-05	3.92E-05	4.05E-05	4.73E-05	2.90E-05
26	DIST	COLD	SLOW	5.41E-06	3.53E-06	5.62E-06	<9.64E-07	<9.69E-07	<9.67E-07	<1.08E-06	<1.05E-06
27	DIST	HOT	SLOW	6.73E-05	5.08E-05	1.80E-05	3.70E-05	0.	5.72E-05	4.25E-05	3.19E-05
28	BICA	COLD	MED	6.51E-06	2.55E-05	<4.47E-06	<4.39E-06	<4.71E-06	<4.79E-06	<6.25E-06	<4.18E-06

CADMIUM LEACHRATE -ICP- (G/CM2.DAY)

AVERAGE DETECTION LIMIT= 3.54E-06 SLOW 1.52E-05 MEDIUM 1.06E-04 FAST

CHAN	SOLN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	37	68	230	420
10	BICA	COLD	MED	<4.73E-05	<4.77E-05	<4.23E-05	<4.80E-05	<2.39E-05	<5.31E-05	<5.42E-05	<5.12E-05
11	BICA	COLD	MED	<4.34E-05	<4.37E-05	<4.36E-05	<4.32E-05	<3.75E-05	<4.46E-05	<4.71E-05	<5.11E-05
12	BICA	COLD	MED	<4.29E-05	<4.33E-05	<4.33E-05	<4.19E-05	<4.43E-05	<4.48E-05	<4.90E-05	<5.02E-05
13	BICA	COLD	MED	<4.54E-05	<4.52E-05	0.	<4.51E-05	<4.66E-05	<4.70E-05	<5.34E-05	<5.23E-05
14	BICA	HOT	MED	<4.53E-05	<3.91E-05	<4.54E-05	6.16E-05	<4.56E-05	<4.52E-05	<5.33E-05	<4.77E-05
15	BICA	COLD	FAST	<2.84E-04	<2.83E-04	<2.85E-04	<2.69E-04	<2.78E-04	<2.00E-04	<2.46E-04	<1.92E-04
16	BICA	HOT	FAST	<2.97E-04	<2.99E-04	<2.99E-04	3.16E-04	<3.23E-04	<3.32E-04	<2.57E-04	<2.32E-04
17	BICA	COLD	SLOW	<1.04E-05	<1.05E-05	<1.05E-05	1.66E-05	<1.06E-05	<1.01E-05	<1.02E-05	<1.15E-05
18	BICA	HOT	SLOW	<1.03E-05	<9.30E-06	<1.07E-05	1.60E-05	<1.06E-05	<1.06E-05	<1.08E-05	<1.12E-05
19	DIST	COLD	MED	<4.67E-05	<4.72E-05	<4.71E-05	1.73E-04	<4.08E-05	9.91E-05	<5.24E-05	<6.45E-05
20	DIST	COLD	MED	<4.30E-05	<4.34E-05	<4.34E-05	1.66E-04	<4.57E-05	8.64E-05	<5.12E-05	<5.37E-05
21	DIST	COLD	MED	<4.40E-06	<4.42E-05	<4.42E-05	1.67E-04	<4.74E-05	9.55E-05	<5.66E-05	<5.09E-05
22	DIST	COLD	MED	<4.18E-05	<4.25E-05	<4.25E-05	2.24E-04	<4.43E-05	9.48E-05	9.87E-05	<5.03E-05
23	DIST	HOT	MED	<4.40E-05	<3.01E-05	<4.34E-05	1.07E-04	<4.57E-05	9.64E-05	<5.45E-05	<4.99E-05
24	DIST	COLD	FAST	<2.84E-04	<2.85E-04	<2.86E-04	<2.87E-04	<2.92E-04	<3.00E-04	<1.56E-04	1.44E-03
25	DIST	HOT	FAST	<2.54E-04	<2.94E-04	<2.96E-04	3.71E-04	<2.61E-04	3.70E-04	<2.44E-04	<2.62E-04
26	DIST	COLD	SLOW	<1.04E-05	<1.07E-05	<1.07E-05	1.32E-05	<1.09E-05	<1.08E-05	1.30E-05	<1.17E-05
27	DIST	HOT	SLOW	1.91E-04	<1.38E-05	<8.82E-06	1.66E-05	0.	6.62E-05	<1.98E-05	<1.06E-05
28	BICA	COLD	MED	<4.59E-05	<4.80E-05	<5.01E-05	<4.92E-05	<5.28E-05	<5.37E-05	<7.00E-05	<4.68E-05

IRON LEACHRATE -ICP- (G/CM2.DAY)

AVERAGE DETECTION LIMIT= 9.07E-09 SLOW 3.90E-08 MEDIUM 2.72E-07 FAST

CHAN	SOLN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	37	68	230	420
10	BICA	COLD	MED	6.92E-06	3.34E-06	2.21E-06	3.75E-06	5.53E-06	8.80E-06	5.23E-06	1.19E-05
11	BICA	COLD	MED	2.99E-06	<1.12E-07	1.50E-06	2.12E-06	2.58E-06	3.27E-06	4.17E-06	1.21E-05
12	BICA	COLD	MED	2.47E-05	5.69E-06	1.92E-05	1.86E-06	1.78E-06	3.27E-06	4.01E-06	1.24E-05
13	BICA	COLD	MED	1.75E-06	1.94E-06	0.	2.90E-06	3.56E-06	<1.21E-07	2.63E-06	1.20E-05
14	BICA	HOT	MED	6.08E-06	2.57E-05	2.19E-06	1.89E-05	1.74E-06	3.37E-06	3.57E-06	1.25E-05
15	BICA	COLD	FAST	2.30E-06	8.47E-06	<7.30E-07	5.82E-06	5.77E-06	6.85E-06	9.50E-06	4.90E-05
16	BICA	HOT	FAST	3.62E-06	9.84E-06	4.42E-06	5.60E-06	6.80E-06	8.60E-06	8.74E-06	5.52E-05
17	BICA	COLD	SLOW	3.45E-06	3.32E-06	5.87E-06	4.14E-07	8.25E-07	9.93E-07	9.23E-07	5.76E-06
18	BICA	HOT	SLOW	1.90E-06	4.43E-06	1.21E-06	9.23E-07	7.51E-07	4.02E-06	6.30E-07	5.26E-06
19	DIST	COLD	MED	1.78E-06	2.43E-06	2.24E-06	4.44E-06	3.13E-05	2.05E-06	3.26E-05	1.59E-05
20	DIST	COLD	MED	1.27E-06	6.08E-05	8.55E-07	1.89E-06	3.00E-06	2.73E-06	3.83E-06	1.39E-05
21	DIST	COLD	MED	1.51E-06	1.28E-06	1.08E-06	2.14E-06	6.58E-06	2.84E-06	1.47E-05	1.25E-05
22	DIST	COLD	MED	2.73E-06	1.46E-06	1.08E-06	3.98E-06	1.09E-06	3.24E-06	9.81E-06	1.20E-05
23	DIST	HOT	MED	2.15E-06	2.39E-06	3.00E-06	1.91E-06	1.25E-06	4.84E-06	2.81E-06	1.20E-05
24	DIST	COLD	FAST	1.15E-06	8.47E-06	3.09E-06	1.83E-06	4.71E-06	3.11E-06	1.36E-05	5.35E-05
25	DIST	HOT	FAST	<6.51E-07	2.56E-05	3.06E-06	4.31E-06	5.15E-06	1.16E-05	7.06E-06	5.03E-05
26	DIST	COLD	SLOW	2.95E-06	1.00E-06	1.68E-06	5.73E-07	9.65E-07	1.47E-06	1.41E-06	5.36E-06
27	DIST	HOT	SLOW	1.58E-05	3.74E-06	<2.26E-08	8.82E-07	0.	1.48E-04	1.40E-06	5.11E-06
28	BICA	COLD	MED	5.70E-06	5.09E-06	1.85E-06	4.12E-06	9.95E-07	5.69E-06	2.04E-06	1.24E-05

MOLLY LEACHRATE -ICP- (G/CM2.DAY)

AVERAGE DETECTION LIMIT= 2.04E-07 8.77E-07 6.12E-06
SLOW MEDIUM FAST

CH	SOLN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	37	68	230	420
10	BICA	COLD	MED	9.73E-06	<2.75E-06	3.86E-06	2.28E-05	1.48E-06	4.98E-06	3.52E-06	8.13E-05
11	BICA	COLD	MED	8.51E-06	7.85E-05	<2.51E-06	1.47E-05	2.28E-06	7.16E-06	3.76E-06	9.18E-05
12	BICA	COLD	MED	1.28E-05	<2.50E-06	4.24E-06	1.81E-05	5.06E-06	1.13E-05	8.81E-06	9.19E-05
13	BICA	COLD	MED	3.19E-06	<2.61E-06	0.	1.38E-05	5.01E-06	<2.71E-06	<3.07E-06	8.66E-05
14	BICA	HOT	MED	1.07E-04	8.05E-05	9.42E-05	1.12E-04	9.99E-05	1.05E-04	<3.07E-06	1.79E-04
15	BICA	COLD	FAST	<1.64E-05	<1.63E-05	<1.64E-05	2.63E-05	<1.60E-05	<1.20E-05	<1.41E-05	3.59E-04
16	BICA	HOT	FAST	1.06E-04	2.48E-04	1.20E-04	1.64E-04	1.14E-04	1.44E-04	1.30E-04	4.71E-04
17	BICA	COLD	SLOW	5.14E-06	3.59E-06	2.48E-06	3.63E-06	1.71E-05	3.33E-06	1.18E-06	3.66E-05
18	BICA	HOT	SLOW	8.48E-05	5.63E-05	5.11E-05	6.41E-05	6.53E-05	7.53E-05	6.59E-05	8.10E-05
19	DIST	COLD	MED	1.66E-05	5.46E-06	<2.71E-06	2.25E-05	3.78E-06	1.33E-05	1.42E-05	1.12E-04
20	DIST	COLD	MED	1.07E-05	6.39E-06	3.34E-06	1.82E-05	7.41E-06	1.28E-05	1.09E-05	8.98E-05
21	DIST	COLD	MED	8.71E-06	6.44E-06	3.34E-06	1.12E-05	7.56E-06	1.29E-05	7.86E-06	9.37E-05
22	DIST	COLD	MED	3.25E-05	1.25E-05	1.48E-05	3.09E-05	1.97E-05	2.80E-05	2.66E-05	1.06E-04
23	DIST	HOT	MED	9.44E-05	3.88E-05	5.53E-05	7.31E-05	5.52E-05	7.06E-05	5.47E-05	1.18E-04
24	DIST	COLD	FAST	1.96E-05	2.92E-05	4.93E-05	<1.65E-05	2.60E-05	<1.73E-05	3.72E-05	4.09E-04
25	DIST	HOT	FAST	<1.46E-05	1.15E-04	3.42E-05	8.82E-05	4.27E-05	9.12E-05	7.65E-05	4.03E-04
26	DIST	COLD	SLOW	6.55E-06	5.29E-06	1.01E-05	2.35E-06	2.58E-06	2.94E-06	4.52E-06	3.91E-05
27	DIST	HOT	SLOW	7.56E-05	5.68E-05	<5.08E-07	4.31E-05	0.	6.37E-05	4.69E-05	6.91E-05
28	BICA	COLD	MED	4.65E-06	<2.81E-06	<2.89E-06	1.34E-05	<3.04E-06	5.24E-06	<4.03E-06	8.52E-05

NICKEL LEACHRATE -ICP- (G/CM2.DAY)

AVERAGE DETECTION LIMIT= 1.97E-06 (SLOW) 8.48E-06 (MEDIUM) 5.91E-05 (FAST)

CHAN	SOLN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	37	68	230	420
10	BICA	COLD	MED	<2.63E-05	4.30E-05	<2.35E-05	3.65E-05	1.44E-05	<2.96E-05	<3.02E-05	3.08E-04
11	BICA	COLD	MED	<2.42E-05	<2.43E-05	<2.43E-05	<2.40E-05	<2.09E-05	6.09E-05	<2.62E-05	3.60E-04
12	BICA	COLD	MED	<2.39E-05	<2.41E-05	<2.41E-05	<2.34E-05	<2.47E-05	<2.49E-05	<2.73E-05	3.28E-04
13	BICA	COLD	MED	<2.53E-05	<2.52E-05	0.	5.90E-05	<2.60E-05	5.22E-05	<2.97E-05	3.60E-04
14	BICA	HOT	MED	<2.52E-05	<2.18E-05	<2.53E-05	<2.51E-05	<2.54E-05	4.14E-05	<2.97E-05	3.46E-04
15	BICA	COLD	FAST	<1.58E-04	<1.58E-04	<1.59E-04	3.52E-04	<1.55E-04	1.31E-04	<1.37E-04	1.44E-03
16	BICA	HOT	FAST	<1.65E-04	<1.66E-04	<1.67E-04	3.10E-04	<1.80E-04	<1.85E-04	<1.43E-04	1.60E-03
17	BICA	COLD	SLOW	6.73E-06	<5.83E-06	<5.86E-06	8.65E-06	<5.91E-06	1.54E-05	<5.67E-06	1.39E-04
18	BICA	HOT	SLOW	6.53E-06	<5.18E-06	<5.98E-06	1.36E-05	<5.92E-06	<5.90E-06	<5.99E-06	1.40E-04
19	DIST	COLD	MED	3.00E-05	<2.63E-05	<2.62E-05	5.90E-05	4.01E-05	5.12E-05	3.92E-05	3.89E-04
20	DIST	COLD	MED	<2.40E-05	<2.42E-05	<2.42E-05	1.04E-04	<2.54E-05	7.45E-05	2.86E-05	3.39E-04
21	DIST	COLD	MED	<2.45E-05	<2.46E-05	<2.46E-05	6.96E-05	<2.64E-05	9.16E-05	<3.15E-05	3.19E-04
22	DIST	COLD	MED	3.92E-05	<2.37E-05	<2.37E-05	<2.35E-05	<2.47E-05	1.03E-04	<2.91E-05	3.75E-04
23	DIST	HOT	MED	2.90E-05	<1.60E-05	<2.42E-05	4.63E-05	<2.55E-05	6.10E-05	1.06E-04	4.22E-04
24	DIST	COLD	FAST	<1.58E-04	<1.58E-04	<1.59E-04	<1.60E-04	2.54E-04	<1.67E-04	9.91E-05	1.39E-03
25	DIST	HOT	FAST	2.85E-04	<1.64E-04	<1.65E-04	2.57E-04	<1.46E-04	1.96E-04	2.15E-04	1.43E-03
26	DIST	COLD	SLOW	1.69E-05	<5.98E-06	<5.98E-06	<6.01E-06	1.54E-05	1.02E-05	9.82E-06	1.48E-04
27	DIST	HOT	SLOW	1.51E-05	<7.70E-06	3.39E-05	8.26E-06	0.	3.55E-05	<1.10E-05	1.29E-04
28	BICA	COLD	MED	3.33E-05	<2.72E-05	<2 79E-05	<2.74E-05	<2.94E-05	8.02E-05	<3.90E-05	3.54E-04

SILICON LEACHRATE -ICP- (G/CM2.DAY)

AVERAGE DETECTION LIMIT= 1.67E-08 SLOW 7.16E-08 MEDIUM 5.00E-07 FAST

CHAN	SOLN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	37	68	230	420
10	BICA	COLD	MED	3.54E-05	8.83E-06	6.11E-06	<2.26E-07	<1.13E-07	<2.50E-07	<2.55E-07	4.66E-06
11	BICA	COLD	MED	3.15E-05	3.12E-06	5.68E-06	<2.03E-07	<1.77E-07	<2.10E-07	<2.21E-07	4.26E-06
12	BICA	COLD	MED	9.01E-06	4.39E-06	3.53E-06	<1.97E-07	<2.08E-07	2.11E-07	<2.31E-07	2.82E-06
13	BICA	COLD	MED	2.26E-05	7.02E-06	0.	<2.12E-07	<2.19E-07	<2.21E-07	<2.51E-07	2.91E-06
14	BICA	HOT	MED	1.07E-04	8.27E-05	9.32E-05	3.41E-05	5.86E-05	4.26E-05	7.91E-05	8.49E-05
15	BICA	COLD	FAST	2.05E-05	3.20E-05	<1.34E-06	<1.27E-06	<1.31E-06	<9.00E-07	<1.16E-06	6.11E-06
16	BICA	HOT	FAST	1.58E-04	2.99E-04	1.37E-04	<1.41E-06	3.81E-05	<1.56E-06	7.26E-05	1.07E-04
17	BICA	COLD	SLOW	2.17E-05	5.71E-06	3.35E-06	<4.99E-08	<4.99E-08	<4.73E-08	3.07E-07	2.68E-06
18	BICA	HOT	SLOW	1.65E-05	1.72E-05	1.59E-05	5.44E-05	4.75E-05	5.79E-05	4.31E-05	4.07E-05
19	DIST	COLD	MED	2.98E-05	8.57E-06	6.37E-06	<2.21E-07	<2.30E-07	<2.30E-07	<2.48E-07	2.35E-05
20	DIST	COLD	MED	3.57E-05	7.49E-06	4.50E-06	<2.02E-07	<2.15E-07	<1.82E-07	<2.41E-07	1.76E-06
21	DIST	COLD	MED	2.89E-05	8.26E-06	5.40E-06	<2.06E-07	<2.23E-07	<2.22E-07	<2.66E-07	1.41E-06
22	DIST	COLD	MED	2.84E-05	7.81E-06	5.85E-06	<1.99E-07	<2.08E-07	<2.14E-07	<2.49E-07	7.54E-06
23	DIST	HOT	MED	9.86E-05	4.31E-05	5.92E-05	4.30E-05	2.32E-05	7.33E-06	3.59E-05	3.69E-05
24	DIST	COLD	FAST	4.41E-05	3.64E-05	1.26E-05	2.52E-05	<1.38E-06	6.65E-06	<7.35E-07	5.89E-06
25	DIST	HOT	FAST	7.61E-05	1.38E-04	3.46E-05	<1.38E-06	<1.23E-06	<1.35E-06	4.14E-05	3.95E-05
26	DIST	COLD	SLOW	2.18E-05	6.01E-06	9.86E-06	<5.08E-08	<5.11E-08	<5.10E-08	<5.67E-08	1.06E-06
27	DIST	HOT	SLOW	5.78E-05	4.63E-05	1.39E-05	3.36E-05	0.	3.67E-05	2.65E-05	3.14E-05
28	BICA	COLD	MED	1.75E-05	1.08E-05	5.32E-06	<2.31E-07	<2.48E-07	<2.52E-07	<3.29E-07	2.32E-06

STRONTIUM LEACHRATE -ICP- (G/CM2.DAY)

AVERAGE DETECTION LIMIT= 9.64E-07 (SLOW) 4.15E-06 (MEDIUM) 2.89E-05 (FAST)

CHAN	SOLN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	37	68	230	420
10	BICA	COLD	MED	<1.29E-05	<1.30E-05	<1.15E-05	<1.31E-05	<6.52E-06	<1.45E-05	<1.48E-05	<1.39E-05
11	BICA	COLD	MED	<1.18E-05	<1.19E-05	<1.19E-05	<1.18E-05	<1.02E-05	<1.22E-05	<1.28E-05	<1.39E-05
12	BICA	COLD	MED	<1.17E-05	<1.18E-05	<1.18E-05	<1.14E-05	<1.21E-05	<1.22E-05	<1.34E-05	<1.37E-05
13	BICA	COLD	MED	<1.24E-05	<1.23E-05	0.	<1.23E-05	<1.27E-05	<1.28E-05	<1.45E-05	<1.43E-05
14	BICA	HOT	MED	<1.23E-05	<1.07E-05	<1.24E-05	<1.23E-05	<1.24E-05	<1.25E-05	1.87E-05	3.74E-05
15	BICA	COLD	FAST	<7.75E-05	<7.72E-05	<7.76E-05	<7.34E-05	<7.57E-05	<5.60E-05	<6.69E-05	<5.22E-05
16	BICA	HOT	FAST	<8.09E-05	<8.15E-05	<8.15E-05	<8.14E-05	<8.81E-05	<9.06E-05	<7.01E-05	<6.33E-05
17	BICA	COLD	SLOW	<2.83E-06	<2.85E-06	<2.87E-06	<2.89E-06	<2.89E-06	<2.74E-06	<2.77E-06	<3.14E-06
18	BICA	HOT	SLOW	<2.32E-06	<2.53E-06	<2.92E-06	2.48E-05	2.21E-05	2.16E-05	1.68E-05	1.10E-05
19	DIST	COLD	MED	<1.27E-05	<1.29E-05	<1.28E-05	<1.28E-05	<1.33E-05	<1.38E-05	<1.43E-05	<1.76E-05
20	DIST	COLD	MED	<1.17E-05	<1.18E-05	<1.18E-05	<1.17E-05	<1.24E-05	<1.06E-05	<1.40E-05	<1.46E-05
21	DIST	COLD	MED	<1.20E-05	<1.20E-05	<1.21E-05	<1.19E-05	<1.29E-05	<1.28E-05	<1.54E-05	<1.39E-05
22	DIST	COLD	MED	<1.14E-05	<1.16E-05	<1.16E-05	<1.15E-05	<1.21E-05	<1.24E-05	<1.43E-05	<1.37E-05
23	DIST	HOT	MED	<1.20E-06	<8.20E-06	<1.18E-05	<1.19E-05	<1.25E-05	<1.26E-05	<1.48E-05	<1.36E-05
24	DIST	COLD	FAST	<7.75E-05	<7.75E-05	<7.80E-05	<7.82E-05	<7.97E-05	<8.18E-05	<4.26E-05	<7.93E-05
25	DIST	HOT	FAST	<6.92E-05	<8.01E-05	<8.06E-05	<8.00E-05	<7.12E-05	<7.04E-05	<6.65E-05	<7.14E-05
26	DIST	COLD	SLOW	<2.82E-06	<2.92E-06	<2.93E-06	<2.94E-06	<2.96E-06	<2.95E-06	<3.28E-06	<3.19E-06
27	DIST	HOT	SLOW	<3.89E-06	<3.77E-06	<2.40E-06	7.38E-06	0.	1.03E-05	8.67E-06	1.91E-05
28	BICA	COLD	MED	<1.25E-05	<1.33E-05	<1.36E-05	<1.34E-05	<1.44E-05	<1.46E-05	<1.91E-05	<1.20E-05

TITANIUM LEACHRATE -ICP- (G/CM2.DAY)

AVERAGE DETECTION LIMIT= 1.74E-08 7.49E-08 5.22E-07
SLOW MEDIUM FAST

CHAN	SOLN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	37	68	230	420
10	BICA	COLD	MED	<2.33E-07	<2.34E-07	2.04E-05	2.64E-05	8.32E-06	1.75E-05	<2.67E-07	9.05E-06
11	BICA	COLD	MED	2.09E-05	1.19E-05	2.17E-05	2.58E-05	2.02E-05	1.74E-05	<2.32E-07	1.03E-05
12	BICA	COLD	MED	1.84E-05	2.06E-05	2.08E-05	2.47E-05	1.97E-05	1.67E-05	<2.41E-07	1.01E-05
13	BICA	COLD	MED	1.98E-05	2.10E-05	0.	1.55E-05	2.02E-05	1.71E-05	<2.62E-07	1.04E-05
14	BICA	HOT	MED	1.96E-05	1.72E-05	2.14E-05	2.56E-05	1.85E-05	1.71E-05	<2.62E-07	1.01E-05
15	BICA	COLD	FAST	6.81E-05	1.67E-04	8.17E-05	6.69E-05	8.12E-05	6.53E-05	<1.21E-06	4.15E-05
16	BICA	HOT	FAST	7.17E-05	1.59E-04	8.43E-05	6.65E-05	7.45E-05	7.18E-05	<1.26E-06	4.32E-05
17	BICA	COLD	SLOW	8.67E-06	8.60E-06	6.83E-06	1.74E-06	4.41E-06	3.63E-06	<5.01E-08	4.21E-06
18	BICA	HOT	SLOW	8.50E-06	8.71E-06	6.94E-06	1.76E-06	4.91E-06	4.32E-06	<5.29E-08	3.94E-06
19	DIST	COLD	MED	1.90E-05	2.13E-05	2.15E-05	2.68E-05	1.99E-05	1.60E-05	<2.58E-07	1.11E-05
20	DIST	COLD	MED	1.81E-05	2.04E-05	2.14E-05	2.21E-05	1.98E-05	1.67E-05	<2.52E-07	9.30E-06
21	DIST	COLD	MED	1.84E-05	2.06E-05	2.16E-05	2.50E-05	2.03E-05	1.69E-05	<2.78E-07	9.33E-06
22	DIST	COLD	MED	1.95E-05	2.09E-05	2.12E-05	2.19E-05	2.02E-05	1.69E-05	<2.57E-07	9.23E-06
23	DIST	HOT	MED	1.85E-05	1.99E-05	2.15E-05	2.50E-05	1.84E-05	1.79E-05	<2.68E-07	9.17E-06
24	DIST	COLD	FAST	6.69E-05	1.65E-04	8.43E-05	6.66E-05	8.20E-05	6.98E-05	<7.69E-07	4.35E-05
25	DIST	HOT	FAST	7.09E-05	1.57E-04	7.92E-05	6.20E-05	8.33E-05	6.64E-05	<1.20E-06	3.87E-05
26	DIST	COLD	SLOW	7.97E-06	7.31E-06	1.60E-05	1.37E-06	4.28E-06	3.27E-06	<5.93E-08	3.93E-06
27	DIST	HOT	SLOW	0.15E-06	9.29E-06	6.52E-06	1.36E-06	0.	7.43E-06	<9.73E-08	3.61E-06
28	BICA	COLD	MED	<2.26E-07	<2.40E-07	2.25E-05	6.85E-06	1.85E-05	1.71E-06	<3.44E-07	9.76E-06

URANIUM LEACHRATE -ICP- (G/CM2.DAY)

AVERAGE DETECTION LIMIT= 3.19E-07 SLOW 1.37E-06 MEDIUM 9.57E-06 FAST

CHAN	SOLN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	37	68	230	420
10	BICA	COLD	MED	<4.27E-06	<4.30E-06	<3.81E-06	<4.32E-06	<2.16E-06	<4.79E-06	<4.89E-06	<4.61E-06
11	BICA	COLD	MED	<3.92E-06	<3.94E-06	<3.93E-06	<3.89E-06	<3.38E-06	<4.03E-06	<4.24E-06	<4.60E-06
12	BICA	COLD	MED	<3.87E-06	<3.91E-06	<3.91E-06	<3.78E-06	<3.99E-06	<4.04E-06	<4.42E-06	<4.53E-06
13	BICA	COLD	MED	<4.09E-06	<4.08E-06	0.	<4.06E-06	<4.20E-06	<4.24E-06	<4.81E-06	<4.72E-06
14	BICA	HOT	MED	2.71E-05	2.41E-05	3.04E-05	1.40E-05	3.80E-05	3.52E-05	6.51E-05	6.13E-05
15	BICA	COLD	FAST	<2.56E-05	<2.55E-05	<2.57E-05	<2.43E-05	<2.51E-05	<1.86E-05	<2.21E-05	<1.73E-05
16	BICA	HOT	FAST	<2.68E-05	<2.70E-05	<2.70E-05	<2.70E-05	<2.91E-05	<3.00E-05	<2.32E-05	<2.10E-05
17	BICA	COLD	SLOW	<9.37E-07	<9.44E-07	<9.50E-07	<9.57E-07	<9.56E-07	<9.07E-07	<9.18E-07	<1.04E-06
18	BICA	HOT	SLOW	5.79E-05	3.33E-05	3.53E-05	6.27E-05	5.00E-05	5.50E-05	5.07E-05	2.32E-05
19	DIST	COLD	MED	<4.21E-06	<4.26E-06	<4.24E-06	<4.23E-06	<4.40E-06	<4.56E-06	<4.72E-06	<5.81E-06
20	DIST	COLD	MED	<3.88E-06	<3.91E-06	<3.91E-06	<3.88E-06	<4.12E-06	<3.49E-06	<4.62E-06	<4.84E-06
21	DIST	COLD	MED	<3.97E-06	<3.98E-06	<3.99E-06	<3.95E-06	<4.27E-06	<4.25E-06	<5.10E-06	<4.59E-06
22	DIST	COLD	MED	<3.77E-06	<3.84E-06	<3.84E-06	<3.81E-06	<3.99E-06	<4.10E-06	<4.72E-06	<4.53E-06
23	DIST	HOT	MED	<3.97E-06	<2.71E-06	<3.91E-06	<3.93E-06	<4.12E-06	<4.17E-06	<4.91E-06	<4.50E-06
24	DIST	COLD	FAST	<2.56E-05	<2.56E-05	<2.58E-05	<2.59E-05	<2.64E-05	<2.71E-05	<1.41E-05	<2.63E-05
25	DIST	HOT	FAST	<2.29E-05	<2.65E-05	<2.67E-05	<2.65E-05	<2.36E-05	<2.59E-05	<2.20E-05	<2.36E-05
26	DIST	COLD	SLOW	<9.35E-07	<9.68E-07	<9.68E-07	<9.74E-07	<9.79E-07	<9.77E-07	<1.09E-06	<1.06E-06
27	DIST	HOT	SLOW	<1.29E-06	<1.25E-06	<7.96E-07	<7.84E-07	0.	<1.88E-06	<1.78E-06	<9.60E-07
28	BICA	COLD	MED	<4.14E-06	<4.40E-06	<4.52E-06	<4.44E-06	<4.76E-06	<4.84E-06	<6.31E-06	<4.22E-06

ZINC LEACHRATE -ICP- (G/CM2.DAY)

AVERAGE DETECTION LIMIT= 3.63E-06 (SLOW) 1.67E-07 (MEDIUM) 1.16E-06 (FAST)

CHAN	SOLN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	37	68	230	420
10	BICA	COLD	MED	5.77E-05	9.43E-06	6.52E-06	6.88E-06	1.64E-06	5.77E-06	4.54E-06	2.64E-06
11	BICA	COLD	MED	8.00E-06	5.80E-06	4.44E-06	6.51E-06	3.50E-06	5.23E-06	4.93E-06	3.98E-06
12	BICA	COLD	MED	1.37E-05	1.38E-05	1.36E-05	1.66E-05	1.99E-05	1.72E-05	1.64E-05	1.21E-05
13	BICA	COLD	MED	7.46E-06	6.62E-06	0.	8.29E-06	4.26E-06	5.74E-06	4.11E-06	2.25E-06
14	BICA	HOT	MED	9.56E-06	5.32E-06	5.63E-06	8.31E-06	6.78E-06	7.53E-06	5.27E-06	5.83E-06
15	BICA	COLD	FAST	3.28E-05	2.53E-05	1.52E-05	2.24E-05	1.25E-05	2.72E-05	1.29E-05	5.05E-06
16	BICA	HOT	FAST	2.26E-05	5.24E-05	2.42E-05	3.43E-05	5.46E-05	3.11E-05	2.70E-05	1.36E-05
17	BICA	COLD	SLOW	6.35E-06	6.59E-06	1.54E-06	1.42E-06	1.63E-06	3.29E-06	1.33E-06	1.39E-06
18	BICA	HOT	SLOW	1.94E-06	2.45E-06	2.17E-06	1.62E-06	1.57E-06	9.56E-06	9.94E-07	2.31E-06
19	DIST	COLD	MED	9.54E-06	1.50E-05	8.07E-06	1.02E-05	6.22E-06	7.83E-06	<5.74E-07	4.55E-06
20	DIST	COLD	MED	9.80E-06	1.26E-05	8.44E-06	1.02E-05	5.60E-06	8.06E-06	5.49E-06	3.47E-06
21	DIST	COLD	MED	8.16E-06	1.38E-05	7.80E-06	9.47E-06	6.83E-06	7.52E-06	6.23E-06	2.72E-06
22	DIST	COLD	MED	3.84E-05	3.07E-05	3.09E-05	3.55E-05	3.33E-05	3.92E-05	4.37E-05	4.14E-05
23	DIST	HOT	MED	4.58E-06	3.93E-06	6.32E-06	7.49E-06	4.38E-06	9.40E-06	1.30E-05	1.87E-05
24	DIST	COLD	FAST	5.44E-05	4.63E-05	1.82E-05	2.21E-05	2.08E-05	1.93E-05	1.71E-05	7.69E-06
25	DIST	HOT	FAST	5.65E-05	1.00E-04	4.32E-05	5.12E-05	5.41E-05	6.74E-05	7.59E-05	2.41E-05
26	DIST	COLD	SLOW	2.08E-06	4.57E-06	1.65E-05	4.46E-06	2.62E-06	3.41E-06	3.34E-06	1.82E-06
27	DIST	HOT	SLOW	2.17E-06	1.29E-05	8.94E-07	1.12E-06	0.	5.36E-06	2.54E-06	1.96E-06
28	BICA	COLD	MED	1.73E-05	6.01E-06	4.00E-06	8.43E-06	4.02E-06	6.32E-06	3.95E-06	2.62E-06

CALCIUM LEACHRATE -ICP- (G/CM2.DAY)

AVERAGE DETECTION LIMIT= 4.33E-08 1.86E-07 1.30E-06
SLOW MEDIUM FAST

CHAN	SOLN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	37	68	230	420
10	BICA	COLD	MED	2.21E-03	2.74E-04	4.88E-04	7.84E-05	3.82E-05	6.76E-05	9.77E-05	1.17E-04
11	BICA	COLD	MED	6.39E-04	1.14E-04	1.00E-04	9.73E-05	9.11E-05	7.81E-05	7.05E-05	4.08E-04
12	BICA	COLD	MED	1.62E-04	1.83E-04	1.07E-04	8.54E-05	9.84E-05	6.33E-05	1.40E-04	9.65E-05
13	BICA	COLD	MED	1.81E-04	1.08E-04	0.	6.84E-05	7.84E-05	6.47E-05	7.30E-05	4.42E-05
14	BICA	HOT	MED	3.66E-04	1.38E-04	2.69E-04	1.67E-04	1.73E-04	1.40E-04	1.52E-04	1.04E-04
15	BICA	COLD	FAST	6.03E-04	6.24E-04	6.79E-04	2.56E-04	2.74E-04	9.07E-04	2.55E-04	9.97E-05
16	BICA	HOT	FAST	5.09E-04	1.29E-03	2.46E-03	3.76E-04	2.53E-03	5.11E-04	5.77E-04	2.18E-04
17	BICA	COLD	SLOW	9.93E-04	6.69E-05	2.94E-05	4.15E-05	2.99E-05	6.40E-05	3.40E-05	2.04E-05
18	BICA	HOT	SLOW	1.35E-04	7.33E-05	4.97E-05	3.62E-05	5.81E-05	2.90E-04	4.45E-05	7.51E-05
19	DIST	COLD	MED	2.57E-04	8.25E-05	7.10E-05	1.07E-04	6.59E-05	4.23E-05	5.13E-05	1.71E-04
20	DIST	COLD	MED	1.93E-04	1.30E-04	9.22E-05	5.46E-04	6.60E-05	3.67E-05	1.01E-04	8.43E-06
21	DIST	COLD	MED	1.56E-04	9.01E-05	5.86E-05	7.46E-05	5.94E-05	5.19E-05	5.30E-05	1.71E-05
22	DIST	COLD	MED	1.52E-04	7.42E-05	6.45E-05	1.87E-04	7.23E-05	1.20E-04	5.90E-05	1.78E-05
23	DIST	HOT	MED	2.14E-04	1.61E-04	1.15E-04	1.84E-04	8.25E-05	1.05E-04	1.40E-04	5.60E-05
24	DIST	COLD	FAST	8.14E-04	5.22E-04	2.32E-04	2.79E-04	2.99E-04	2.73E-04	1.84E-04	6.57E-05
25	DIST	HOT	FAST	3.83E-04	6.77E-04	2.65E-04	2.31E-04	3.35E-04	3.64E-04	3.37E-04	5.04E-05
26	DIST	COLD	SLOW	1.32E-04	5.14E-05	7.55E-05	2.01E-05	2.16E-05	2.66E-05	3.42E-05	1.14E-05
27	DIST	HOT	SLOW	1.15E-04	1.00E-04	3.94E-05	5.88E-05	0.	1.22E-04	5.07E-05	4.92E-05
28	BICA	COLD	MED	9.09E-04	1.83E-03	8.02E-05	1.75E-04	1.02E-04	6.84E-05	8.52E-05	6.68E-05

SODIUM LEACHRATE -ICP- (G/CM2.DAY)

AVERAGE DETECTION LIMIT= 3.34E-08 SLOW 1.44E-07 MEDIUM 1.00E-06 FAST

CHAN	SOLN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	37	68	230	420
10	BICA	COLD	MED	3.59E-03	4.92E-03	3.74E-03	1.60E-04	2.14E-03	2.35E-03	4.07E-03	<4.83E-07
11	BICA	COLD	MED	3.86E-03	<4.12E-07	1.50E-03	4.94E-05	3.69E-03	1.52E-03	3.44E-03	1.51E-03
12	BICA	COLD	MED	3.19E-03	1.70E-03	·1.88E-03	<3.96E-07	4.27E-03	1.94E-03	3.32E-03	9.03E-04
13	BICA	COLD	MED	3.[illegible]3E-03	2.51E-03	0.	<4.25E-07	4.29E-03	2.13E-03	3.48E-03	8.61E-05
14	BICA	HOT	MED	3.55E-03	1.40E-03	1.86E-03	3.09E-04	4.32E-03	1.71E-03	3.38E-03	<4.50E-07
15	BICA	COLD	FAST	1.48E-02	1.98E-01	6.13E-03	2.96E-03	1.89E-02	6.95E-03	1.11E-02	<1.81E-06
16	BICA	HOT	FAST	1.52E-02	2.05E-01	5.58E-02	3.56E-03	2.51E-02	1.05E-02	1.52E-02	1.63E-03
17	BICA	COLD	SLOW	1.33E-03	3.66E-04	<9.94E-08	<1.00E-07	1.12E-03	6.80E-04	1.52E-03	<1.08E-07
18	BICA	HOT	SLOW	1.29E-03	5.21E-04	<1.01E-07	2.38E-04	1.34E-03	2.03E-03	1.60E-03	<1.05E-07
19	DIST	COLD	MED	2.42E-04	1.85E-04	2.18E-05	5.32E-05	7.45E-05	2.23E-05	1.01E-04	1.63E-05
20	DIST	COLD	MED	1.06E-04	3.12E-05	1.91E-05	4.41E-05	5.63E-05	5.01E-05	8.84E-05	1.42E-05
21	DIST	COLD	MED	7.01E-05	2.68E-05	1.82E-05	2.79E-05	3.61E-05	2.82E-05	4.70E-05	3.10E-05
22	DIST	COLD	MED	1.24E-04	2.28E-05	2.57E-05	2.42E-05	4.02E-05	3.19E-05	1.50E-04	1.50E-05
23	DIST	HOT	MED	5.29E-04	7.35E-05	8.68E-05	9.11E-05	9.32E-05	9.50E-05	1.05E-04	4.57E-05
24	DIST	COLD	FAST	1.39E-03	1.27E-04	6.47E-05	5.45E-05	1.77E-04	8.79E-05	1.34E-04	4.17E-05
25	DIST	HOT	FAST	3.73E-04	2.62E-04	1.25E-04	1.11E-04	2.23E-04	1.29E-04	6.00E-04	6.29E-05
26	DIST	COLD	SLOW	9.61E-05	2.35E-05	1.13E-04	6.22E-06	1.27E-05	6.73E-06	2.45E-05	5.91E-06
27	DIST	HOT	SLOW	6.20E-04	8.09E-05	6.71E-05	6.24E-05	0.	7.12E-05	5.85E-05	3.70E-05
28	BICA	COLD	MED	2.89E-03	2.40E-03	1.58E-03	1.15E-03	4.51E-03	2.[illegible]0E-03	5.45E-03	<4.41E-07

BORON CUMULATIVE FRACTIONAL LEACH (CFL)

AVERAGE DETECTION LIMIT= 3.16E-07 (SLOW) 1.36E-06 (MEDIUM) 9.48E-06 (FAST)

CHAN	SOLN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	37	68	230	420
10	BICA	COLD	MED	6.38E-05	<8.09E-05	<9.61E-05	<1.48E-04	<6.55E-04	<1.21E-03	<2.18E-02	<4.56E-02
11	BICA	COLD	MED	2.39E-05	<3.92E-05	<5.45E-05	<1.01E-04	<5.37E-04	<9.99E-04	<3.59E-03	<6.84E-03
12	BICA	COLD	MED	<1.54E-05	<3.09E-05	<4.64E-05	<9.19E-05	<5.69E-04	<1.00E-03	<3.78E-03	<7.13E-03
13	BICA	COLD	MED	2.04E-05	<3.62E-05	<0.	<8.38E-05	<5.77E-04	<1.10E-03	<3.91E-03	<7.38E-03
14	BICA	HOT	MED	3.85E-04	6.68E-04	1.01E-03	2.00E-03	1.22E-02	2.29E-02	8.13E-02	1.48E-01
15	BICA	COLD	FAST	<1.01E-04	<2.02E-04	<3.04E-04	<5.96E-04	<3.61E-03	<6.30E-03	<1.94E-02	<3.41E-02
16	BICA	HOT	FAST	5.00E-04	1.39E-03	1.84E-03	3.30E-03	1.81E-02	3.27E-02	1.11E-01	1.96E-01
17	BICA	COLD	SLOW	1.57E-05	2.33E-05	2.99E-05	5.61E-05	3.14E-04	5.57E-04	1.55E-03	3.16E-03
18	BICA	HOT	SLOW	2.97E-04	4.86E-04	6.62E-04	1.35E-03	8.50E-03	1.62E-02	5.52E-02	9.27E-02
19	DIST	COLD	MED	2.93E-05	4.69E-05	<6.31E-05	<1.12E-04	<6.23E-04	<1.17E-03	<4.03E-03	<7.83E-03
20	DIST	COLD	MED	2.84E-05	<4.35E-05	<5.87E-05	<1.04E-04	<5.83E-04	<1.05E-03	<3.58E-03	<7.04E-03
21	DIST	COLD	MED	2.26E-05	<3.77E-05	<5.28E-05	<9.82E-05	<5.80E-04	<1.10E-03	<3.95E-03	<7.41E-03
22	DIST	COLD	MED	5.57E-05	7.69E-05	1.04E-04	2.03E-04	1.15E-03	2.61E-03	1.07E-02	1.85E-02
23	DIST	HOT	MED	3.65E-04	4.95E-04	6.93E-04	1.29E-03	7.55E-03	1.43E-02	4.50E-02	7.29E-02
24	DIST	COLD	FAST	<9.70E-05	<1.94E-04	<2.92E-04	<5.89E-04	<3.64E-03	<6.88E-03	<1.94E-02	<3.38E-02
25	DIST	HOT	FAST	1.99E-04	5.04E-04	6.56E-04	1.17E-03	6.16E-03	1.10E-02	3.22E-02	6.64E-02
26	DIST	COLD	SLOW	2.11E-05	3.49E-05	5.68E-05	<6.82E-05	<1.85E-04	<3.05E-04	<9.46E-04	<1.73E-03
27	DIST	HOT	SLOW	2.60E-04	4.56E-04	5.26E-04	9.60E-04	0.	1.23E-02	4.26E-02	6.97E-02
28	BICA	COLD	MED	2.56E-05	1.26E-04	<1.43E-04	<1.96E-04	<7.47E-04	<1.33E-03	<4.75E-03	<8.61E-03

CADMIUM CUMULATIVE FRACTIONAL LEACH (CFL)

AVERAGE DETECTION LIMIT= 3.54E-06 SLOW 1.52E-05 MEDIUM 1.06E-04 FAST

CHAN	SOLN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	37	68	230	420
10	BICA	COLD	MED	<1.90E-04	<3.82E-04	<5.52E-04	<1.14E-03	<5.56E-03	<1.06E-02	<4.53E-02	<8.53E-02
11	BICA	COLD	MED	<1.71E-04	<3.43E-04	<5.14E-04	<1.03E-03	<5.92E-03	<1.11E-02	<4.01E-02	<7.65E-02
12	BICA	COLD	MED	<1.72E-04	<3.46E-04	<5.19E-04	<1.03E-03	<6.37E-03	<1.21E-02	<4.23E-02	<7.99E-02
13	BICA	COLD	MED	<1.77E-04	<3.53E-04	<0.	<8.88E-04	<6.42E-03	<1.23E-02	<4.38E-02	<8.27E-02
14	BICA	HOT	MED	<1.69E-04	<3.16E-04	<4.85E-04	<1.19E-03	<7.33E-03	<1.26E-02	<4.19E-02	<7.76E-02
15	BICA	COLD	FAST	<1.14E-03	<2.27E-03	<3.41E-03	<6.68E-03	<4.05E-02	<7.14E-02	<2.18E-01	<3.82E-01
16	BICA	HOT	FAST	<1.14E-03	<2.29E-03	<3.42E-03	<7.12E-03	<4.49E-02	<8.39E-02	<2.67E-01	<4.44E-01
17	BICA	COLD	SLOW	<4.15E-05	<8.34E-05	<1.25E-04	<3.27E-04	<1.99E-03	<3.32E-03	<9.83E-03	<1.80E-02
18	BICA	HOT	SLOW	<3.94E-05	<7.48E-05	<1.16E-04	<3.01E-04	<1.85E-03	<3.10E-03	<9.53E-03	<1.74E-02
19	DIST	COLD	MED	<1.80E-04	<3.63E-04	<5.45E-04	<2.57E-03	<1.55E-02	<2.48E-02	<7.18E-02	<1.14E-01
20	DIST	COLD	MED	<1.68E-04	<3.38E-04	<5.08E-04	<2.48E-03	<1.50E-02	<2.34E-02	<6.66E-02	<1.05E-01
21	DIST	COLD	MED	<1.68E-04	<3.37E-04	<5.07E-04	<2.45E-03	<1.49E-02	<2.37E-02	<7.05E-02	<1.09E-01
22	DIST	COLD	MED	<1.69E-04	<3.41E-04	<5.13E-04	<3.26E-03	<1.96E-02	<2.87E-02	<9.16E-02	<1.48E-01
23	DIST	HOT	MED	<1.72E-04	<2.90E-04	<4.59E-04	<1.73E-03	<1.08E-02	<1.95E-02	<6.60E-02	<1.04E-01
24	DIST	COLD	FAST	<1.09E-03	<2.18E-03	<3.27E-03	<6.60E-03	<4.08E-02	<7.71E-02	<2.17E-01	<7.97E-01
25	DIST	HOT	FAST	<9.97E-04	<2.15E-03	<3.31E-03	<7.73E-03	<4.58E-02	<8.44E-02	<2.75E-01	<4.62E-01
26	DIST	COLD	SLOW	<4.04E-05	<8.23E-05	<1.24E-04	<2.80E-04	<1.72E-03	<3.06E-03	<1.06E-02	<1.97E-02
27	DIST	HOT	SLOW	7.39E-04	<7.92E-04	<8.27E-04	<1.02E-03	<0.	<1.10E-02	<3.71E-02	<4.82E-02
28	BICA	COLD	MED	<1.80E-04	<3.72E-04	<5.60E-04	<1.16E-03	<7.34E-03	<1.38E-02	<5.22E-02	<9.54E-02

IRON CUMULATIVE FRACTIONAL LEACH (CFL)

AVERAGE DETECTION LIMIT= 9.07E-09 SLOW 3.90E-08 MEDIUM 2.72E-07 FAST

CHAN	SOLN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	37	66	230	420
10	BICA	COLD	MED	2.78E-05	4.13E-05	5.02E-05	9.60E-05	6.77E-04	1.61E-03	6.14E-03	1.27E-02
11	BICA	COLD	MED	1.17E-05	<1.22E-05	<1.81E-05	<4.34E-05	<3.30E-04	<6.09E-04	<3.05E-03	<9.11E-03
12	BICA	COLD	MED	9.90E-05	1.22E-04	1.29E-04	1.52E-04	3.77E-04	7.04E-04	3.05E-03	9.28E-03
13	BICA	COLD	MED	6.83E-06	1.44E-05	0.	4.88E-05	4.39E-04	<6.62E-04	<1.53E-03	<6.95E-03
14	BICA	HOT	MED	2.28E-05	3.24E-05	4.06E-05	2.55E-04	1.41E-03	1.71E-03	3.76E-03	9.46E-03
15	BICA	COLD	FAST	9.19E-06	4.30E-05	<4.59E-05	<1.17E-04	<8.32E-04	<1.64E-03	<6.91E-03	<2.90E-02
16	BICA	HOT	FAST	1.39E-05	5.16E-05	6.86E-05	1.34E-04	8.60E-04	1.79E-03	7.17E-03	3.04E-02
17	BICA	COLD	SLOW	1.38E-05	2.70E-05	5.05E-05	5.55E-05	1.33E-04	2.49E-04	8.65E-04	3.39E-03
18	BICA	HOT	SLOW	7.24E-06	2.41E-05	2.87E-05	3.94E-05	1.37E-04	4.25E-04	1.82E-03	3.94E-03
19	DIST	COLD	MED	6.88E-06	1.63E-05	2.49E-05	7.70E-05	8.26E-04	9.46E-04	1.17E-03	8.09E-03
20	DIST	COLD	MED	4.97E-06	2.43E-04	2.46E-04	2.69E-04	5.66E-04	9.25E-04	3.00E-03	9.57E-03
21	DIST	COLD	MED	5.77E-06	1.07E-05	1.48E-05	3.97E-05	5.64E-04	1.13E-03	6.55E-03	1.64E-02
22	DIST	COLD	MED	1.10E-05	1.69E-05	2.12E-05	7.00E-05	4.32E-04	7.66E-04	5.02E-03	1.34E-02
23	DIST	HOT	MED	8.41E-06	1.77E-05	2.95E-05	5.21E-05	2.41E-04	6.16E-04	2.97E-03	8.47E-03
24	DIST	COLD	FAST	4.41E-06	3.68E-05	4.86E-05	6.99E-05	4.62E-04	9.37E-04	6.09E-03	3.04E-02
25	DIST	HOT	FAST	<2.55E-06	<1.03E-04	<1.15E-04	<1.67E-04	<7.40E-04	<1.77E-03	<7.55E-03	<2.89E-02
26	DIST	COLD	SLOW	1.15E-05	1.54E-05	2.19E-05	2.87E-05	1.22E-04	2.75E-04	1.18E-03	3.67E-03
27	DIST	HOT	SLOW	6.11E-05	7.55E-05	<7.56E-05	<8.60E-05	<1.	<1.81E-02	<6.33E-02	<6.57E-02
28	BICA	COLD	MED	2.24E-05	4.24E-05	4.96E-05	9.88E-05	4.02E-04	8.31E-04	3.28E-03	8.66E-03

MOLLY CUMULATIVE FRACTIONAL LEACH (CFL)

AVERAGE DETECTION LIMIT= 2.04E-07 SLOW 8.77E-07 MEDIUM 6.12E-06 FAST

CHAN	SOLN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	37	68	230	420
10	BICA	COLD	MED	3.91E-05	<5.02E-05	<6.57E-05	<3.44E-04	<1.81E-03	<2.23E-03	<4.98E-03	<3.73E-02
11	BICA	COLD	MED	3.35E-05	3.42E-04	<3.52E-04	<5.28E-04	<1.54E-03	<2.14E-03	<5.59E-03	<4.12E-02
12	BICA	COLD	MED	5.12E-05	<6.12E-05	<7.82E-05	<2.99E-04	<1.71E-03	<2.77E-03	<9.27E-03	<4.75E-02
13	BICA	COLD	MED	1.24E-05	<2.26E-05	<0.	<1.86E-04	<1.30E-03	<1.78E-03	<3.60E-03	<3.68E-02
14	BICA	HOT	MED	4.02E-04	7.03E-04	1.05E-03	2.32E-03	1.45E-02	2.69E-02	<5.30E-02	<1.23E-01
15	BICA	COLD	FAST	<6.55E-05	<1.31E-04	<1.96E-04	<5.16E-04	<2.11E-03	<4.89E-03	<1.33E-02	<1.55E-01
16	BICA	HOT	FAST	4.05E-04	1.36E-03	1.81E-03	3.73E-03	2.01E-02	3.55E-02	1.21E-01	3.39E-01
17	BICA	COLD	SLOW	2.05E-05	3.49E-05	4.40E-05	8.89E-05	4.15E-04	7.41E-04	2.19E-03	1.65E-02
18	BICA	HOT	SLOW	3.23E-04	5.38E-04	7.32E-04	1.47E-03	9.13E-03	1.75E-02	6.03E-02	1.13E-01
19	DIST	COLD	MED	6.42E-05	8.53E-05	<9.58E-05	<3.60E-04	<2.20E-03	<3.57E-03	<1.21E-02	<5.84E-02
20	DIST	COLD	MED	4.18E-05	6.69E-05	7.99E-05	2.97E-04	1.83E-03	3.10E-03	1.06E-02	4.79E-02
21	DIST	COLD	MED	3.33E-05	5.80E-05	7.08E-05	2.01E-04	1.30E-03	2.57E-03	8.95E-03	4.58E-02
22	DIST	COLD	MED	1.31E-04	1.82E-04	2.42E-04	6.21E-04	3.75E-03	6.85E-03	2.46E-02	7.53E-02
23	DIST	HOT	MED	3.69E-04	5.21E-04	7.37E-04	1.61E-03	9.30E-03	1.70E-02	5.56E-02	1.20E-01
24	DIST	COLD	FAST	7.51E-05	1.87E-04	3.75E-04	<5.67E-04	<3.10E-03	<5.73E-03	<2.25E-02	<1.64E-01
25	DIST	HOT	FAST	<5.74E-05	<5.08E-04	<6.42E-04	<1.69E-03	<9.52E-03	<1.78E-02	<6.97E-02	<2.48E-01
26	DIST	COLD	SLOW	2.55E-05	4.62E-05	8.56E-05	1.13E-04	4.11E-04	7.55E-04	3.10E-03	1.92E-02
27	DIST	HOT	SLOW	2.92E-04	5.11E-04	<5.13E-04	<1.02E-03	<0.	<1.33E-02	<4.75E-02	<8.98E-02
28	BICA	COLD	MED	1.82E-05	<2.93E-05	<4.06E-05	<2.01E-04	<1.18E-03	<1.68E-03	<4.56E-03	<3.78E-02

NICKEL CUMULATIVE FRACTIONAL LEACH (CFL)

AVERAGE DETECTION LIMIT= 1.97E-06 (SLOW) 8.48E-08 (MEDIUM) 5.91E-05 (FAST)

CHAN	SOLN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	37	68	230	420
10	BICA	COLD	MED	<1.06E-04	<2.79E-04	<3.74E-04	<8.20E-04	<3.94E-03	<6.80E-03	<2.62E-02	<1.55E-01
11	BICA	COLD	MED	<9.51E-05	<1.91E-04	<2.86E-04	<5.73E-04	<3.30E-03	<8.62E-03	<3.60E-02	<1.80E-01
12	BICA	COLD	MED	<9.58E-05	<1.93E-04	<2.89E-04	<5.74E-04	<3.55E-03	<6.73E-03	<2.36E-02	<1.58E-01
13	BICA	COLD	MED	<9.85E-05	<1.97E-04	<0.	<8.97E-04	<5.95E-03	<1.09E-02	<3.65E-02	<1.81E-01
14	BICA	HOT	MED	<9.43E-05	<1.76E-04	<2.70E-04	<5.55E-04	<3.47E-03	<7.36E-03	<2.83E-02	<1.62E-01
15	BICA	COLD	FAST	<6.33E-04	<1.26E-03	<1.90E-03	<6.17E-03	<3.71E-02	<5.53E-02	<1.41E-01	<7.40E-01
16	BICA	HOT	FAST	<6.34E-04	<1.27E-03	<1.91E-03	<5.53E-03	<3.43E-02	<5.60E-02	<1.58E-01	<7.92E-01
17	BICA	COLD	SLOW	2.69E-05	<5.02E-05	<7.37E-05	<1.79E-04	<1.07E-03	<2.45E-03	<9.23E-03	<6.41E-02
18	BICA	HOT	SLOW	2.49E-05	<4.46E-05	<6.74E-05	<2.25E-04	<1.36E-03	<2.05E-03	<5.64E-03	<5.84E-02
19	DIST	COLD	MED	1.16E-04	<2.18E-04	<3.19E-04	<1.01E-03	<6.89E-03	<1.26E-02	<4.06E-02	<1.98E-01
20	DIST	COLD	MED	<9.38E-05	<1.88E-04	<2.83E-04	<1.52E-03	<9.20E-03	<1.55E-02	<4.79E-02	<1.84E-01
21	DIST	COLD	MED	<9.38E-05	<1.88E-04	<2.82E-04	<1.09E-03	<6.68E-03	<1.40E-02	<5.18E-02	<1.79E-01
22	DIST	COLD	MED	1.58E-04	<2.54E-04	<3.50E-04	<6.39E-04	<3.65E-03	<1.20E-02	<5.48E-02	<2.09E-01
23	DIST	HOT	MED	1.16E-04	<1.82E-04	<2.77E-04	<8.26E-04	<5.11E-03	<1.04E-02	<6.22E-02	<2.58E-01
24	DIST	COLD	FAST	<6.06E-04	<1.21E-03	<1.82E-03	<3.68E-03	<2.83E-02	<5.39E-02	<1.36E-01	<6.75E-01
25	DIST	HOT	FAST	1.12E-03	<1.76E-03	<2.41E-03	<5.47E-03	<2.96E-02	<5.04E-02	<1.78E-01	<7.90E-01
26	DIST	COLD	SLOW	6.56E-05	<8.09E-05	<1.12E-04	<1.83E-04	<1.49E-03	<3.08E-03	<9.36E-03	<6.76E-02
27	DIST	HOT	SLOW	5.84E-05	<8.82E-05	<2.19E-04	<3.16E-04	<0.	<5.60E-03	<1.97E-02	<7.10E-02
28	BICA	COLD	MED	1.31E-04	<2.38E-04	<3.47E-04	<6.74E-04	<4.11E-03	<1.09E-02	<4.78E-02	<1.94E-01

SILICON CUMULATIVE FRACTIONAL LEACH (CFL)

AVERAGE DETECTION LIMIT- 1.67E-08 SLOW 7.16E-08 MEDIUM 5.00E-07 FAST

CHAN	SOLN	TEMP	FLOW	SAMPLING DAYS 1	2	3	8	37	68	230	420
10	BICA	COLD	MED	1.42E-04	1.78E-04	2.02E-04	<2.05E-04	<2.26E-04	<2.50E-04	<4.13E-04	<2.29E-03
11	BICA	COLD	MED	1.24E-04	1.36E-04	1.58E-04	<1.61E-04	<1.84E-04	<2.08E-04	<3.45E-04	<2.01E-03
12	BICA	COLD	MED	3.61E-05	5.37E-05	6.78E-05	<7.02E-05	<9.54E-05	<1.22E-04	<2.65E-04	<1.42E-03
13	BICA	COLD	MED	8.83E-05	1.16E-04	0.	<1.18E-04	<1.44E-04	<1.72E-04	<3.20E-04	<1.49E-03
14	BICA	HOT	MED	4.01E-04	7.11E-04	1.06E-03	1.45E-03	6.04E-03	1.27E-02	4.87E-02	1.07E-01
15	BICA	COLD	FAST	8.17E-05	2.10E-04	<2.15E-04	<2.30E-04	<3.90E-04	<5.35E-04	<1.22E-03	<3.97E-03
16	BICA	HOT	FAST	6.05E-04	1.75E-03	2.28E-03	<2.30E-03	<4.70E-03	<6.90E-03	<3.01E-02	<9.51E-02
17	BICA	COLD	SLOW	8.68E-05	1.10E-04	1.23E-04	<1.24E-04	<1.30E-04	<1.36E-04	<2.51E-04	<1.38E-03
18	BICA	HOT	SLOW	8.89E-05	1.20E-04	1.69E-04	5.16E-04	6.78E-03	1.30E-02	4.32E-02	7.33E-02
19	DIST	COLD	MED	1.15E-04	1.48E-04	1.73E-04	<1.75E-04	<2.02E-04	<2.31E-04	<3.82E-04	<1.33E-03
20	DIST	COLD	MED	1.40E-04	1.69E-04	1.87E-04	<1.89E-04	<2.14E-04	<2.39E-04	<3.73E-04	<1.12E-03
21	DIST	COLD	MED	1.11E-04	1.42E-04	1.63E-04	<1.65E-04	<1.91E-04	<2.18E-04	<3.68E-04	<9.76E-04
22	DIST	COLD	MED	1.15E-04	1.46E-04	1.74E-04	<1.77E-04	<2.02E-04	<2.29E-04	<3.79E-04	<3.36E-03
23	DIST	HOT	MED	3.85E-04	5.54E-04	7.85E-04	8.37E-04	2.53E-03	4.35E-03	1.78E-02	4.46E-02
24	DIST	COLD	FAST	1.69E-04	3.08E-04	3.56E-04	6.50E-04	<2.18E-03	<2.68E-03	<4.94E-03	<7.34E-03
25	DIST	HOT	FAST	2.99E-04	8.42E-04	1.10E-03	<1.11E-03	<1.27E-03	<1.43E-03	<1.48E-02	<4.47E-02
26	DIST	COLD	SLOW	8.51E-05	1.09E-04	1.47E-04	<1.48E-04	<1.54E-04	<1.60E-04	<1.94E-04	<6.07E-04
27	DIST	HOT	SLOW	2.23E-04	4.02E-04	4.56E-04	8.50E-04	0.	9.27E-03	2.85E-02	4.96E-02
28	BICA	COLD	MED	6.86E-05	1.11E-04	1.32E-04	<1.35E-04	<1.64E-04	<1.94E-04	<3.75E-04	<1.36E-03

STRONTIUM CUMULATIVE FRACTIONAL LEACH (CFL)

AVERAGE DETECTION LIMIT= 9.64E-07 (SLOW) 4.15E-06 (MEDIUM) 2.89E-05 (FAST)

CHAN	SOLN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	37	68	230	420
10	BICA	COLD	MED	<5.19E-05	<1.04E-04	<1.50E-04	<3.10E-04	<1.51E-03	<2.88E-03	<1.24E-02	<2.32E-02
11	BICA	COLD	MEO	<4.65E-05	<9.33E-05	<1.40E-04	<2.80E-04	<1.61E-03	<3.02E-03	<1.09E-02	<2.08E-02
12	BICA	COLD	MED	<4.69E-05	<9.42E-05	<1.42E-04	<2.81E-04	<1.74E-03	<3.29E-03	<1.15E-02	<2.18E-02
13	BICA	COLD	MED	<4.82E-05	<9.63E-05	<0.	<2.42E-04	<1.75E-03	<3.34E-03	<1.19E-02	<2.25E-02
14	BICA	HOT	MED	<4.61E-05	<8.60E-05	<1.32E-04	<2.72E-04	<1.70E-03	<3.14E-03	<1.24E-02	<3.22E-02
15	BICA	COLD	FAST	<3.10E-04	<6.18E-04	<9.28E-04	<1.82E-03	<1.10E-02	<1.95E-02	<5.93E-02	<1.04E-01
16	BICA	HOT	FAST	<3.10E-04	<6.23E-04	<9.36E-04	<1.88E-03	<1.19E-02	<2.25E-02	<7.24E-02	<1.21E-01
17	BICA	COLD	SLOW	<1.13E-05	<2.27E-05	<3.42E-05	<6.93E-05	<4.26E-04	<7.86E-04	<2.56E-03	<4.79E-03
18	BICA	HOT	SLOW	<1.07E-05	<2.04E-05	<3.15E-05	<3.19E-04	<3.07E-03	<5.65E-03	<1.72E-02	<2.72E-02
19	DIST	COLD	MEO	<4.92E-05	<9.89E-05	<1.48E-04	<2.98E-04	<1.86E-03	<3.53E-03	<1.23E-02	<2.39E-02
20	DIST	COLD	MED	<4.59E-05	<9.22E-05	<1.38E-04	<2.78E-04	<1.74E-03	<3.18E-03	<1.09E-02	<2.15E-02
21	DIST	COLD	MED	<4.59E-05	<9.19E-05	<1.38E-04	<2.77E-04	<1.75E-03	<3.32E-03	<1.20E-02	<2.26E-02
22	DIST	COLD	MED	<4.60E-05	<9.29E-05	<1.40E-04	<2.81E-04	<1.75E-03	<3.33E-03	<1.20E-02	<2.27E-02
23	DIST	HOT	MED	<4.69E-05	<7.89E-05	<1.25E-04	<2.66E-04	<1.73E-03	<3.25E-03	<1.17E-02	<2.22E-02
24	DIST	COLD	FAST	<2.96E-04	<5.93E-04	<8.91E-04	<1.80E-03	<1.11E-02	<2.10E-02	<5.92E-02	<1.03E-01
25	DIST	HOT	FAST	<2.72E-04	<5.86E-04	<9.02E-04	<1.86E-03	<1.10E-02	<2.01E-02	<6.50E-02	<1.16E-01
26	DIST	COLD	SLOW	<1.10E-05	<2.24E-05	<3.38E-05	<6.87E-05	<4.24E-04	<7.93E-04	<2.75E-03	<5.13E-03
27	DIST	HOT	SLOW	<1.50E-05	<2.96E-05	<3.89E-05	<1.25E-04	<0.	<2.24E-03	<8.02E-03	<1.82E-02
28	BICA	COLD	MED	<4.81E-05	<1.01E-04	<1.55E-04	<3.15E-04	<2.00E-03	<3.76E-03	<1.42E-02	<2.60E-02

TITANIUM CUMULATIVE FRACTIONAL LEACH (CFL)

AVERAGE DETECTION LIMIT= 1.74E-08 (SLOW) 7.49E-08 (MEDIUM) 5.22E-07 (FAST)

CHAN	SOLN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	37	68	230	420
10	BICA	COLD	MED	<9.36E-07	<1.88E-06	<8.41E-05	<4.07E-04	<2.53E-03	<4.21E-03	<9.94E-03	<1.35E-02
11	BICA	COLD	MED	8.21E-05	1.29E-04	2.14E-04	5.23E-04	3.31E-03	5.66E-03	<1.12E-02	<1.51E-02
12	BICA	COLD	MED	7.39E-05	1.56E-04	2.40E-04	5.40E-04	3.28E-03	5.60E-03	<1.10E-02	<1.50E-02
13	BICA	COLD	MED	7.71E-05	1.59E-04	0.	3.43E-04	2.51E-03	4.83E-03	<1.03E-02	<1.42E-02
14	BICA	HOT	MED	7.32E-05	1.38E-04	2.18E-04	5.09E-04	3.04E-03	5.09E-03	<1.02E-02	<1.38E-02
15	BICA	COLD	FAST	2.72E-04	8.39E-04	1.27E-03	2.08E-03	1.13E-02	2.06E-02	<4.19E-02	<5.80E-02
16	BICA	HOT	FAST	2.75E-04	8.85E-04	1.21E-03	1.98E-03	1.03E-02	1.90E-02	<4.16E-02	<5.78E-02
17	BICA	COLD	SLOW	3.47E-05	6.90E-05	9.64E-05	1.17E-04	5.03E-04	1.02E-03	<2.19E-03	<3.81E-03
18	BICA	HOT	SLOW	3.24E-05	6.56E-05	9.20E-05	1.12E-04	4.50E-04	9.37E-04	<2.25E-03	<3.69E-03
19	DIST	COLD	MED	7.35E-05	1.56E-04	2.39E-04	5.53E-04	3.32E-03	5.58E-03	<1.09E-02	<1.50E-02
20	DIST	COLD	MED	7.10E-05	1.51E-04	2.35E-04	4.98E-04	3.03E-03	5.31E-03	<1.06E-02	<1.42E-02
21	DIST	COLD	MED	7.05E-05	1.49E-04	2.32E-04	5.23E-04	3.19E-03	5.47E-03	<1.07E-02	<1.42E-02
22	DIST	COLD	MED	7.89E-05	1.63E-04	2.49E-04	5.18E-04	3.14E-03	5.53E-03	<1.11E-02	<1.47E-02
23	DIST	HOT	MED	7.23E-05	1.50E-04	2.34E-04	5.32E-04	3.14E-03	5.34E-03	<1.09E-02	<1.44E-02
24	DIST	COLD	FAST	2.56E-04	8.97E-04	1.21E-03	1.98E-03	1.08E-02	2.01E-02	<4.17E-02	<5.77E-02
25	DIST	HOT	FAST	2.70E-04	8.94E-04	1.20E-03	1.94E-03	1.08E-02	1.90E-02	<4.07E-02	<5.55E-02
26	DIST	COLD	SLOW	3.11E-05	5.96E-05	1.22E-04	1.38E-04	4.84E-04	9.53E-04	<1.99E-03	<3.47E-03
27	DIST	HOT	SLOW	3.15E-05	6.74E-05	9.26E-05	1.08E-04	0.	1.17E-03	<3.45E-03	<4.81E-03
28	BICA	COLD	MED	<8.87E-07	<1.83E-06	<9.00E-05	<1.72E-04	<1.73E-03	<3.89E-03	<9.26E-03	<1.30E-02

URANIUM CUMULATIVE FRACTIONAL LEACH (CFL)

AVERAGE DETECTION LIMIT= 3.19E-07 (SLOW) 1.37E-06 (MEDIUM) 9.57E-06 (FAST)

CHAN	SOLN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	37	68	230	420
10	BICA	COLD	MED	<1.72E-05	<3.45E-05	<4.98E-05	<1.03E-04	<5.01E-04	<9.54E-04	<4.09E-03	<7.69E-03
11	BICA	COLD	MED	<1.54E-05	<3.09E-05	<4.63E-05	<9.28E-05	<5.33E-04	<1.00E-03	<3.62E-03	<6.90E-03
12	BICA	COLD	MED	<1.55E-05	<3.12E-05	<4.68E-05	<9.29E-05	<5.75E-04	<1.09E-03	<3.82E-03	<7.20E-03
13	BICA	COLD	MED	<1.60E-05	<3.19E-05	<0.	<8.00E-05	<5.78E-04	<1.11E-03	<3.95E-03	<7.45E-03
14	BICA	HOT	MED	1.01E-04	1.92E-04	3.05E-04	4.64E-04	3.50E-03	7.74E-03	3.74E-02	8.20E-02
15	BICA	COLD	FAST	<1.02E-04	<2.05E-04	<3.07E-04	<6.02E-04	<3.66E-03	<6.44E-03	<1.96E-02	<3.45E-02
16	BICA	HOT	FAST	<1.03E-04	<2.06E-04	<3.10E-04	<6.24E-04	<3.94E-03	<7.46E-03	<2.40E-02	<3.99E-02
17	BICA	COLD	SLOW	<3.74E-06	<7.62E-06	<1.13E-05	<2.29E-05	<1.41E-04	<2.60E-04	<8.47E-04	<1.59E-03
18	BICA	HOT	SLOW	2.20E-04	3.47E-04	4.82E-04	1.21E-03	7.79E-03	1.41E-02	4.62E-02	7.27E-02
19	DIST	COLD	MED	<1.63E-05	<3.27E-05	<4.91E-05	<9.88E-05	<6.14E-04	<1.17E-03	<4.06E-03	<7.90E-03
20	DIST	COLD	MED	<1.52E-05	<3.05E-05	<4.53E-05	<9.19E-05	<5.76E-04	<1.05E-03	<3.61E-03	<7.10E-03
21	DIST	COLD	MED	<1.52E-05	<3.04E-05	<4.57E-05	<9.15E-05	<5.78E-04	<1.10E-03	<3.98E-03	<7.48E-03
22	DIST	COLD	MED	<1.52E-05	<3.07E-05	<4.62E-05	<9.30E-05	<5.80E-04	<1.10E-03	<3.97E-03	<7.50E-03
23	DIST	HOT	MED	<1.55E-05	<2.91E-05	<4.14E-05	<8.81E-05	<5.74E-04	<1.08E-03	<3.88E-03	<7.35E-03
24	DIST	COLD	FAST	<9.80E-05	<1.96E-04	<2.95E-04	<5.95E-04	<3.68E-03	<6.95E-03	<1.96E-02	<3.42E-02
25	DIST	HOT	FAST	<8.99E-05	<1.94E-04	<2.98E-04	<6.14E-04	<3.69E-03	<6.65E-03	<2.15E-02	<3.84E-02
26	DIST	COLD	SLOW	<3.64E-06	<7.42E-06	<1.12E-05	<2.27E-05	<1.40E-04	<2.62E-04	<9.10E-04	<1.70E-03
27	DIST	HOT	SLOW	<4.97E-06	<9.79E-06	<1.29E-05	<2.21E-05	<0.	<3.43E-04	<1.46E-03	<2.46E-03
28	BICA	COLD	MED	<1.63E-05	<3.36E-05	<5.13E-05	<1.04E-04	<6.61E-04	<1.25E-03	<4.71E-03	<8.60E-03

ZINC CUMULATIVE FRACTIONAL LEACH (CFL)

AVERAGE DETECTION LIMIT= 3.88E-08 SLOW 1.67E-07 MEDIUM 1.16E-06 FAST

CHAN	SOLN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	37	68	230	420
10	BICA	COLD	MED	2.32E-04	2.70E-04	2.96E-04	3.[illegible]1E-04	9.00E-04	1.30E-03	4.72E-03	7.44E-03
11	BICA	COLD	MED	3.14E-05	5.42E-05	7.16E-05	1.49E-04	7.51E-04	1.30E-03	4.52E-03	7.81E-03
12	BICA	COLD	MED	5.48E-05	1.10E-04	1.65E-04	3.67E-04	2.03E-03	5.00E-03	1.59E-02	2.66E-02
13	BICA	COLD	MED	2.91E-05	5.49E-05	0.	1.53E-04	9.01E-04	1.53E-03	4.62E-03	6.95E-03
14	BICA	HOT	MED	3.58E-05	5.57E-05	7.68E-05	1.71E-04	1.04E-03	1.87E-03	5.65E-03	9.57E-03
15	BICA	COLD	FAST	1.31E-04	2.32E-04	2.93E-04	5.65E-04	2.70E-03	5.26E-03	1.81E-02	2.49E-02
16	BICA	HOT	FAST	8.67E-05	2.08E-04	3.81E-04	7.80E-04	6.07E-03	1.11E-02	2.92E-02	4.38E-02
17	BICA	COLD	SLOW	2.54E-05	5.17E-05	5.79E-05	7.51E-05	2.64E-04	5.82E-04	2.06E-03	3.09E-03
18	BICA	HOT	SLOW	7.39E-06	1.67E-05	2.50E-05	4.37E-05	2.41E-04	9.03E-04	4.06E-03	5.26E-03
19	DIST	COLD	MED	3.68E-05	9.46E-05	1.26E-04	2.45E-04	1.22E-03	2.09E-03	<4.59E-03	<6.56E-03
20	DIST	COLD	MED	3.83E-05	8.75E-05	1.20E-04	2.42E-04	1.19E-03	2.05E-03	6.31E-03	9.61E-03
21	DIST	COLD	MED	3.12E-05	8.39E-05	1.14E-04	2.24E-04	1.18E-03	2.06E-03	6.29E-03	9.62E-03
22	DIST	COLD	MED	1.55E-04	2.79E-04	4.04E-04	8.40E-04	5.13E-03	9.03E-03	3.68E-02	6.92E-02
23	DIST	HOT	MED	1.79E-05	3.33E-05	5.80E-05	1.47E-04	8.56E-04	1.70E-03	8.53E-03	2.04E-02
24	DIST	COLD	FAST	2.08E-04	3.85E-04	4.55E-04	7.12E-04	3.24E-03	5.69E-03	1.69E-02	2.58E-02
25	DIST	HOT	FAST	2.22E-04	6.14E-04	7.84E-04	1.39E-03	7.76E-03	1.52E-02	5.96E-02	9.66E-02
26	DIST	COLD	SLOW	8.09E-06	2.59E-05	9.03E-05	1.43E-04	5.06E-04	9.43E-04	3.06E-03	4.95E-03
27	DIST	HOT	SLOW	8.39E-06	5.83E-05	6.17E-05	7.48E-05	0.	8.50E-04	3.26E-03	4.90E-03
28	BICA	C	MED	6.80E-05	9.16E-05	1.07E-04	2.08E-04	9.53E-04	1.59E-03	4.77E-03	7.20E-03

CALCIUM CUMULATIVE FRACTIONAL LEACH (CFL)

AVERAGE DETECTION LIMIT= 4.33E-08 SLOW 1.86E-07 MEDIUM 1.30E-06 FAST

CHAN	SOLN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	37	68	230	420
10	BICA	COLD	MED	8.90E-03	1.00E-02	1.20E-02	1.29E-02	2.01E-02	2.70E-02	8.05E-02	1.62E-01
11	BICA	COLD	MED	2.51E-03	2.96E-03	3.35E-03	4.51E-03	1.59E-02	2.65E-02	7.35E-02	2.52E-01
12	BICA	COLD	MED	6.48E-04	1.38E-03	1.81E-03	2.85E-03	1.43E-02	2.45E-02	9.03E-02	1.80E-01
13	BICA	COLD	MED	7.06E-04	1.13E-03	0.	1.94E-03	1.08E-02	1.97E-02	6.30E-02	1.06E-01
14	BICA	HOT	MED	1.37E-03	1.89E-03	2.89E-03	4.79E-03	2.44E-02	4.29E-02	1.31E-01	2.22E-01
15	BICA	COLD	FAST	2.41E-03	4.91E-03	7.62E-03	1.07E-02	4.35E-02	1.20E-01	4.93E-01	6.26E-01
16	BICA	HOT	FAST	1.95E-03	6.91E-03	1.63E-02	2.07E-02	1.96E-01	3.73E-01	7.11E-01	9.92E-01
17	BICA	COLD	SLOW	3.97E-03	4.24E-03	4.35E-03	4.86E-03	9.25E-03	1.53E-02	4.68E-02	6.73E-02
18	BICA	HOT	SLOW	5.13E-04	7.92E-04	9.79E-04	1.40E-03	6.98E-03	2.20E-02	1.28E-01	1.71E-01
19	DIST	COLD	MED	9.93E-04	1.31E-03	1.59E-03	2.85E-03	1.31E-02	1.97E-02	4.88E-02	1.30E-01
20	DIST	COLD	MED	7.56E-04	1.26E-03	1.63E-03	8.12E-03	4.42E-02	5.06E-02	9.42E-02	1.35E-01
21	DIST	COLD	MED	5.96E-04	9.40E-04	1.16E-03	2.03E-03	9.94E-03	1.57E-02	4.90E-02	7.43E-02
22	DIST	COLD	MED	6.12E-04	9.12E-04	1.17E-03	3.47E-03	1.34E-02	3.32E-02	9.70E-02	1.26E-01
23	DIST	HOT	MED	8.36E-04	1.47E-03	1.92E-03	4.10E-03	2.00E-02	3.14E-02	1.07E-01	1.80E-01
24	DIST	COLD	FAST	3.11E-03	5.11E-03	5.99E-03	9.24E-03	4.35E-02	7.84E-02	2.19E-01	3.09E-01
25	DIST	HOT	FAST	1.50E-03	4.16E-03	5.20E-03	7.95E-03	4.24E-02	8.49E-02	3.02E-01	4.45E-01
26	DIST	COLD	SLOW	5.16E-04	7.56E-04	1.05E-03	1.29E-03	3.81E-03	6.82E-03	2.59E-02	4.27E-02
27	DIST	HOT	SLOW	4.46E-04	8.33E-04	9.85E-04	1.67E-03	0.	2.34E-02	7.59E-02	1.12E-01
28	BICA	COLD	MED	3.57E-03	1.07E-02	1.11E-02	1.32E-02	2.98E-02	4.00E-02	8.77E-02	1.44E-01

SODIUM CUMULATIVE FRACTIONAL LEACH (CFL)

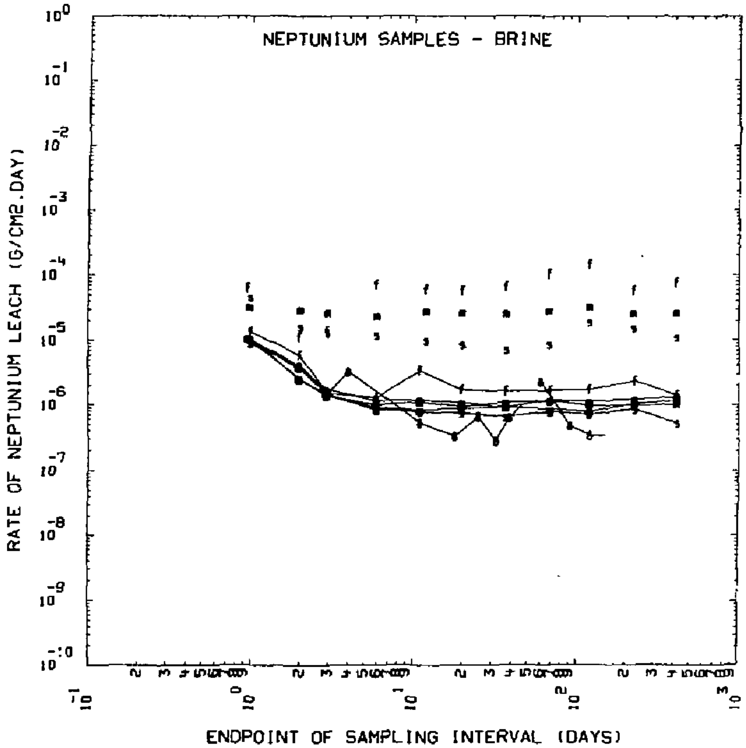
AVERAGE DETECTION LIMIT= 3.34E-08 1.44E-07 1.00E-06
SLOW MEDIUM FAST

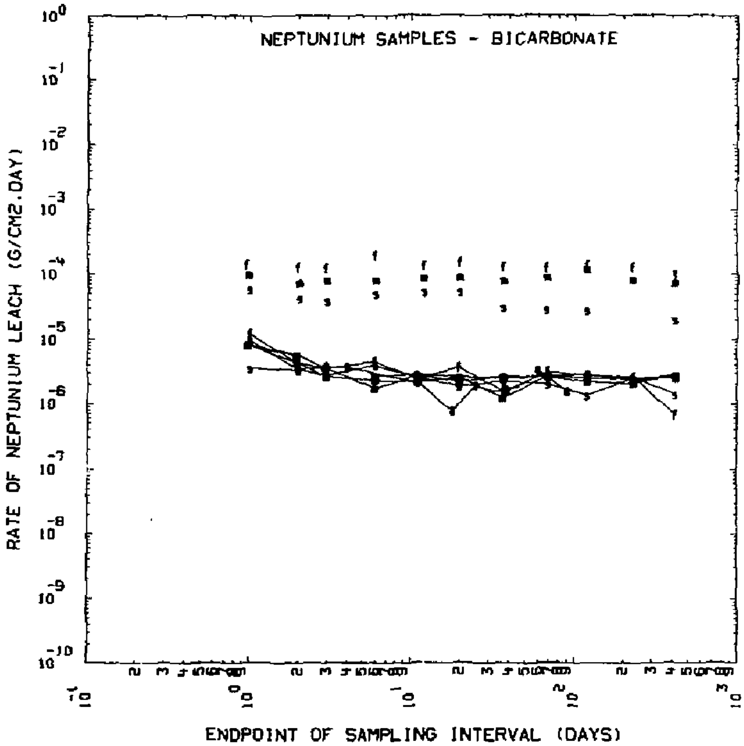
CHAN	SOLN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	37	68	230	420
10	BICA	COLD	MED	1.44E-02	3.43E-02	4.93E-02	5.13E-02	1.98E-01	4.88E-01	2.57E+00	<4.11E+00
11	BICA	COLD	MED	1.52E-02	<1.52E-02	<2.11E-02	<2.16E-02	<2.56E-01	<5.79E-01	<2.15E+00	<3.99E+00
12	BICA	COLD	MED	1.20E-02	1.96E-02	2.71E-02	<2.71E-02	<3.00E-01	<6.93E-01	<2.39E+00	<3.98E+00
13	BICA	COLD	MED	1.18E-02	2.16E-02	0.	<2.16E-02	<2.88E-01	<6.84E-01	<2.45E+00	<3.75E+00
14	BICA	HOT	MED	1.33E-02	1.65E-02	2.55E-02	2.90E-02	3.04E-01	6.49E-01	2.16E+00	<3.34E+00
15	BICA	COLD	FAST	5.91E-02	8.50E-01	8.74E-01	9.10E-01	2.29E+00	3.92E+00	9.73E+00	<1.39E+01
16	BICA	HOT	FAST	5.84E-02	8.43E-01	1.06E+00	1.10E+00	2.84E+00	4.92E+00	1.29E+01	1.90E+01
17	BICA	COLD	SLOW	5.32E-03	6.79E-03	<6.79E-03	<6.79E-03	<7.84E-02	<1.93E-01	<9.01E-01	<1.47E+00
18	BICA	HOT	SLOW	4.92E-03	6.90E-03	<6.90E-03	<9.65E-03	<1.05E-01	<3.07E-01	<1.41E+00	<1.98E+00
19	DIST	COLD	MED	9.34E-04	1.65E-03	1.73E-03	2.36E-03	1.00E-02	1.59E-02	5.44E-02	9.70E-02
20	DIST	COLD	MED	4.17E-04	5.39E-04	6.14E-04	1.14E-03	7.23E-03	1.39E-02	5.76E-02	9.53E-02
21	DIST	COLD	MED	2.68E-04	3.71E-04	4.40E-04	7.64E-04	4.56E-03	8.48E-03	3.17E-02	5.98E-02
22	DIST	COLD	MED	5.01E-04	5.93E-04	6.97E-04	9.94E-04	5.04E-03	9.68E-03	6.91E-02	1.32E-01
23	DIST	HOT	MED	2.07E-03	2.36E-03	2.70E-03	3.78E-03	1.49E-02	2.63E-02	8.80E-02	1.44E-01
24	DIST	COLD	FAST	5.30E-03	5.78E-03	6.03E-03	6.66E-03	2.05E-02	3.66E-02	1.05E-01	1.68E-01
25	DIST	HOT	FAST	1.46E-03	2.49E-03	2.98E-03	4.30E-03	2.47E-02	4.59E-02	2.73E-01	5.17E-01
26	DIST	COLD	SLOW	3.75E-04	4.66E-04	9.05E-04	9.79E-04	2.13E-03	3.33E-03	1.32E-02	2.43E-02
27	DIST	HOT	SLOW	2.33E-03	2.71E-03	2.96E-03	3.70E-03	0.	1.97E-02	5.92E-02	9.40E-02
28	BICA	COLD	MED	1.13E-02	2.08E-02	2.70E-02	4.08E-02	3.90E-01	8.36E-01	3.42E+00	<5.43E+00

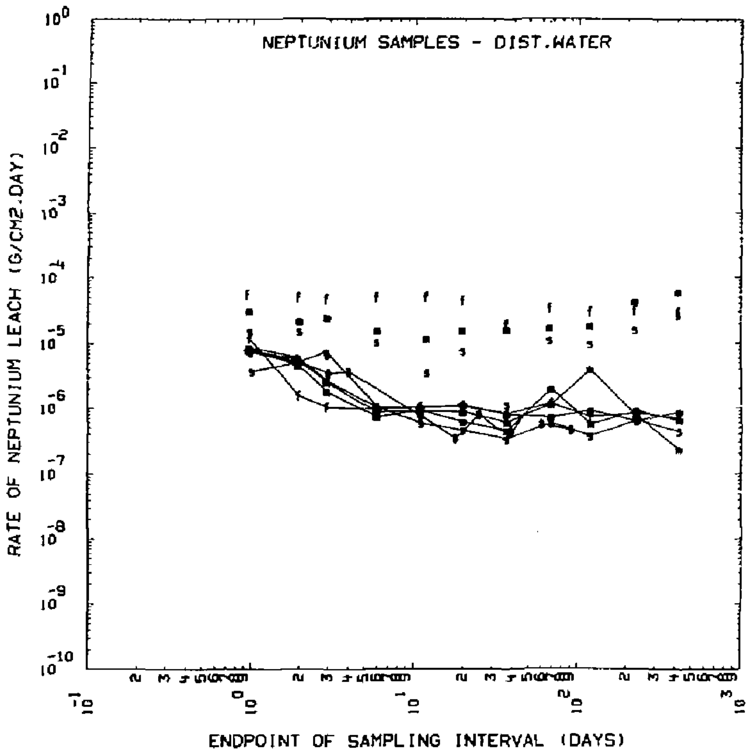
APPENDIX 10

Graphs of Log Leach Rate Data Against Log Time for ^{237}Np and ^{239}Pu

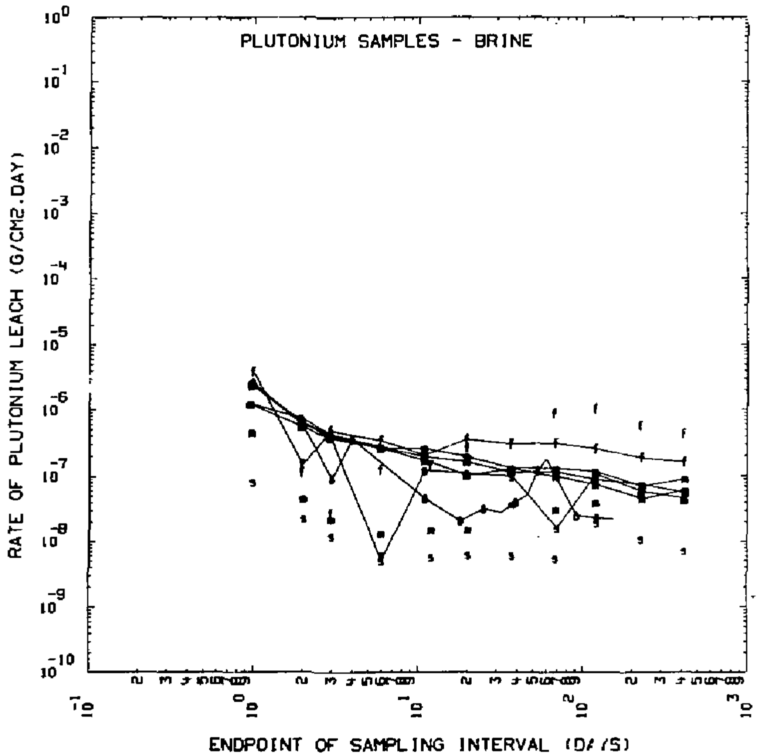
Symbols f, m, s are for the fast, medium, and slow flow rate channels. Symbols without connecting lines are 75°C data. Symbols with connecting lines are the 25°C data. The PNL data are shown as "delta" (δ) symbols and are connected with lines since these data, obtained at 22°C, should be comparable to the 25°C data.

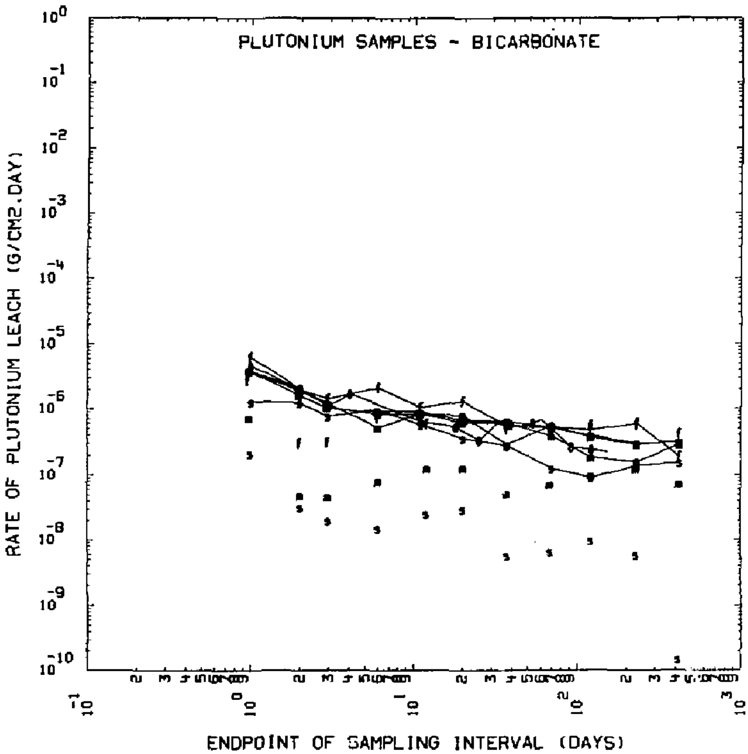

NEPTUNIUM SAMPLES - BRINE
RATE OF NEPTUNIUM LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

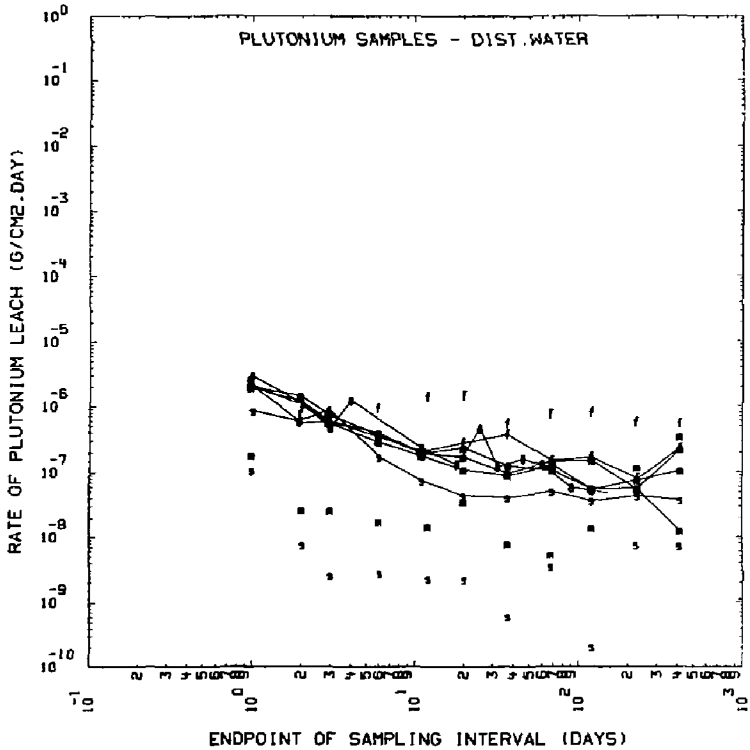

NEPTUNIUM SAMPLES - BICARBONATE
RATE OF NEPTUNIUM LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)



NEPTUNIUM SAMPLES - DIST.WATER
RATE OF NEPTUNIUM LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)


PLUTONIUM SAMPLES - BRINE
RATE OF PLUTONIUM LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)


PLUTONIUM SAMPLES - BICARBONATE
RATE OF PLUTONIUM LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

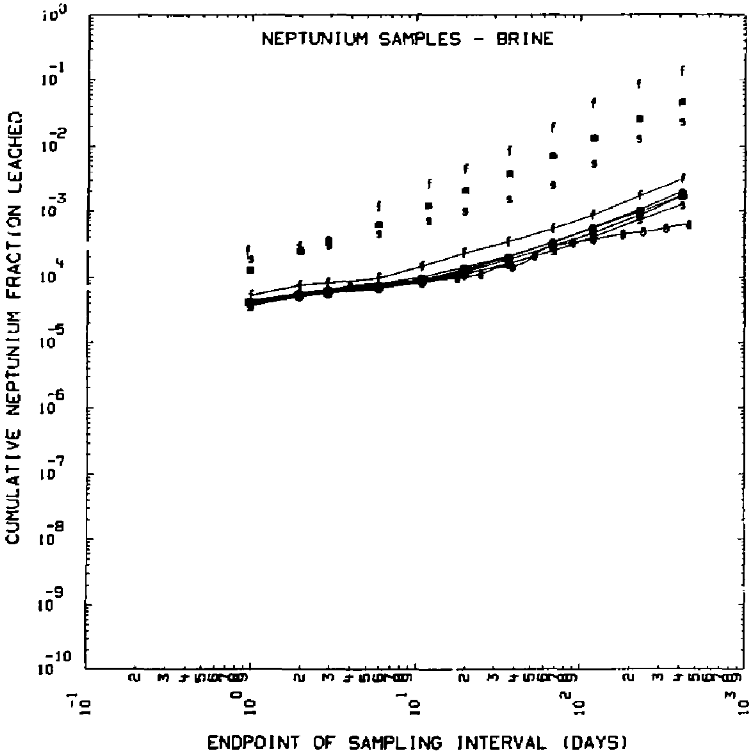


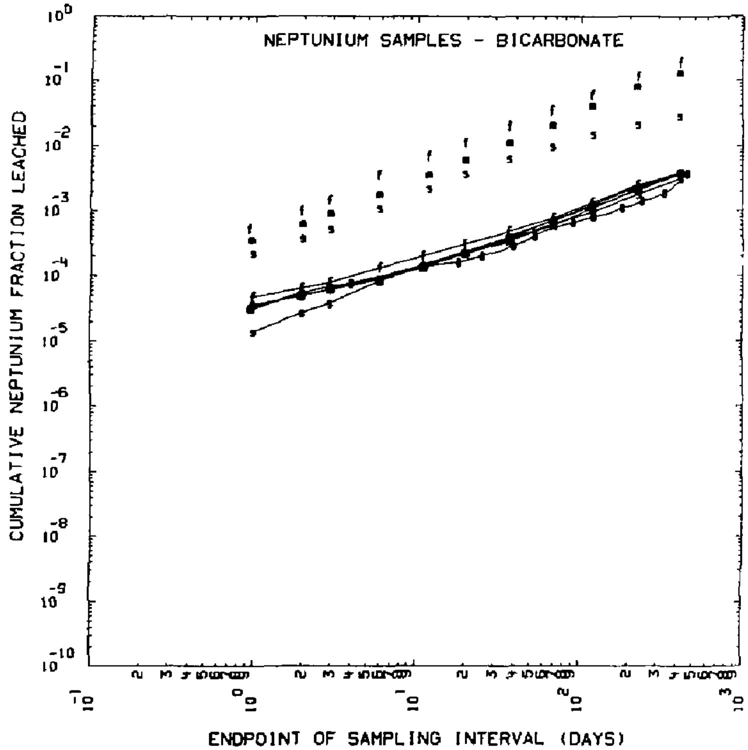
PLUTONIUM SAMPLES - DIST.WATER
RATE OF PLUTONIUM LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

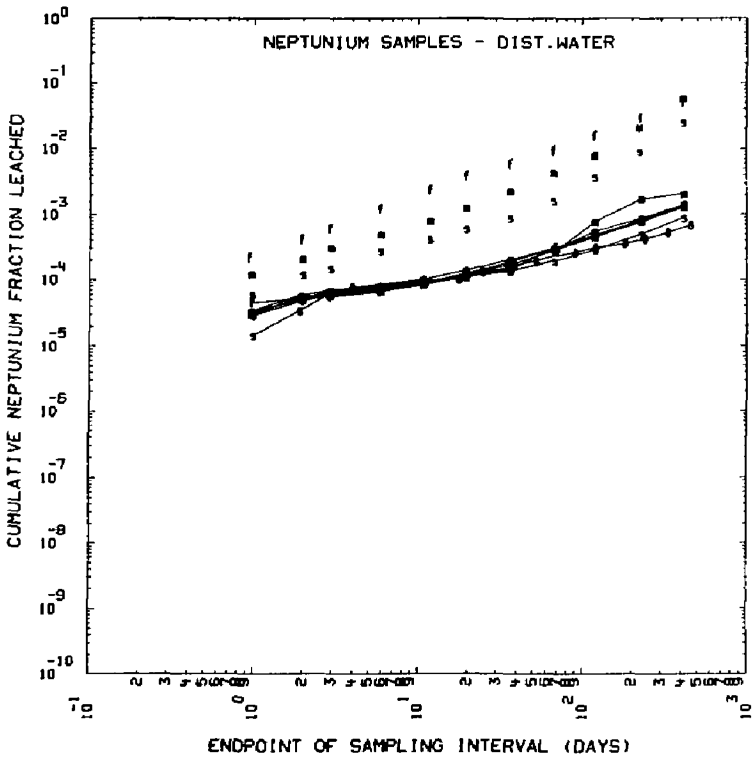
APPENDIX 11

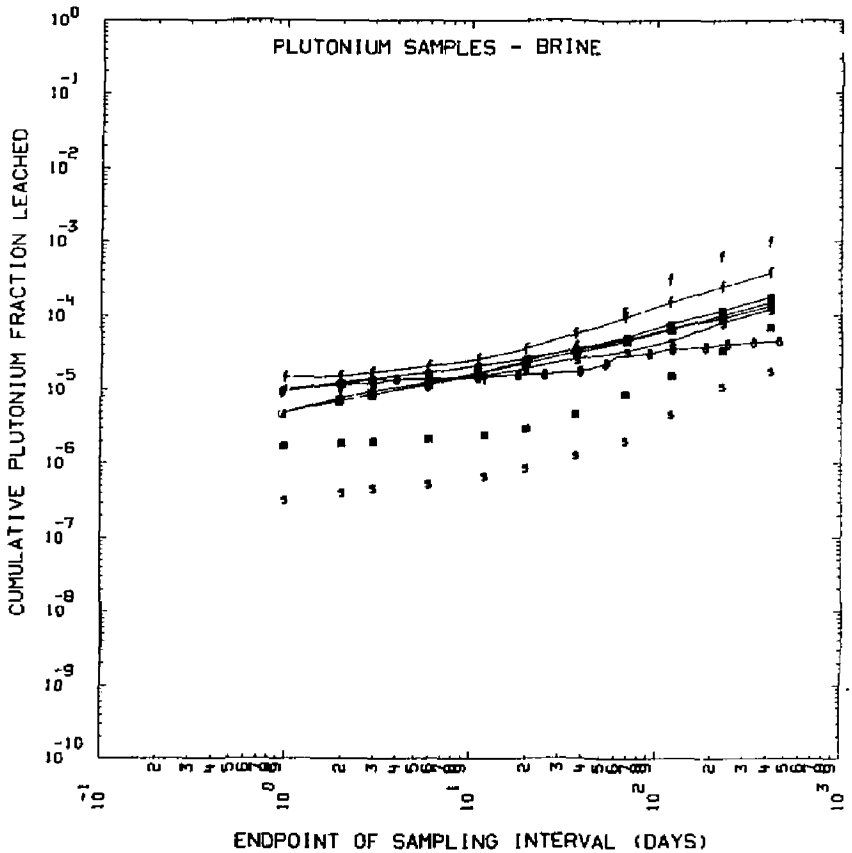
Graphs of Log Cumulative-Fraction Leached Against Log Time for ^{237}Np and ^{239}Pu

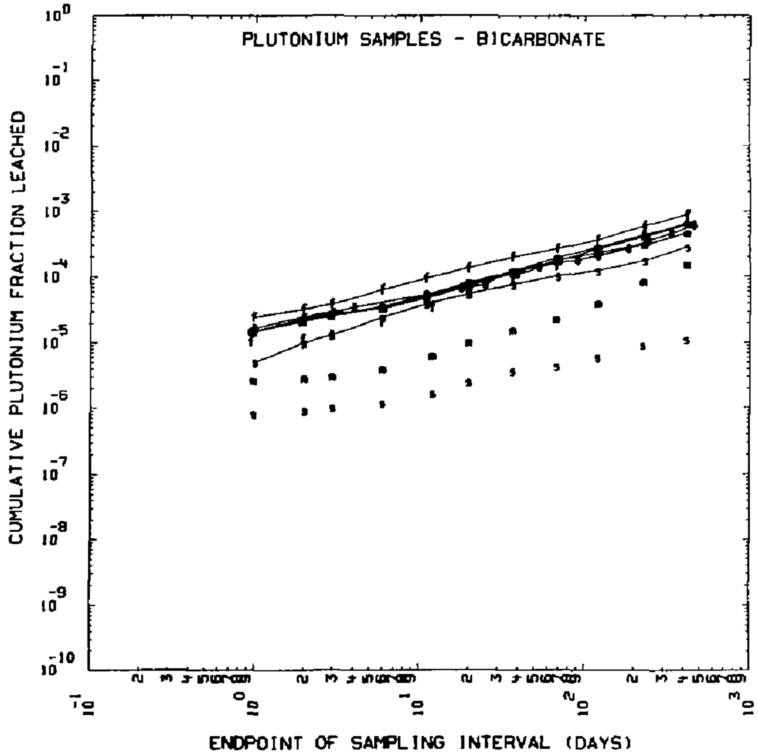
An explanation for the meaning of the various symbols can be found in Apendix 10.


NEPTUNIUM SAMPLES - BRINE
CUMULATIVE NEPTUNIUM FRACTION LEACHED
ENDPOINT OF SAMPLING INTERVAL (DAYS)

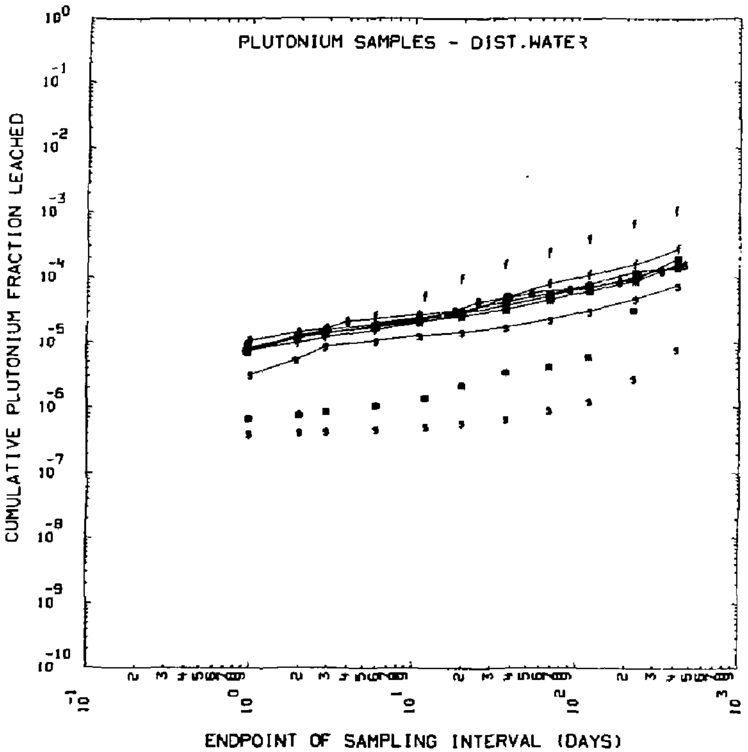

NEPTUNIUM SAMPLES - BICARBONATE
CUMULATIVE NEPTUNIUM FRACTION LEACHED
ENDPOINT OF SAMPLING INTERVAL (DAYS)


NEPTUNIUM SAMPLES - DIST.WATER
CUMULATIVE NEPTUNIUM FRACTION LEACHED
ENDPOINT OF SAMPLING INTERVAL (DAYS)


PLUTONIUM SAMPLES - BRINE
CUMULATIVE PLUTONIUM FRACTION LEACHED
ENDPOINT OF SAMPLING INTERVAL (DAYS)



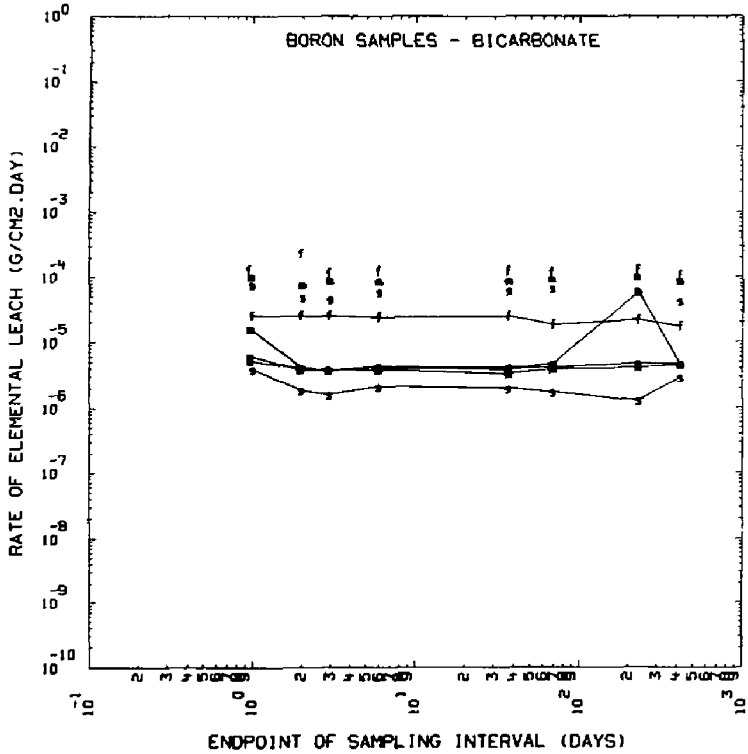
PLUTONIUM SAMPLES - BICARBONATE
CUMULATIVE PLUTONIUM FRACTION LEACHED
ENDPOINT OF SAMPLING INTERVAL (DAYS)

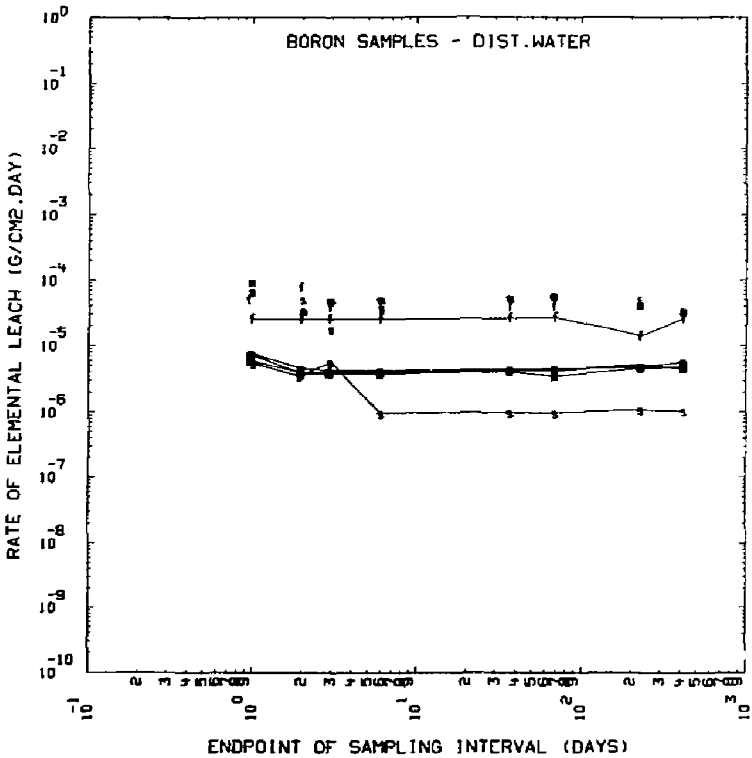

PLUTONIUM SAMPLES - DIST.WATER
CUMULATIVE PLUTONIUM FRACTION LEACHED
ENDPOINT OF SAMPLING INTERVAL (DAYS)

APPENDIX 12

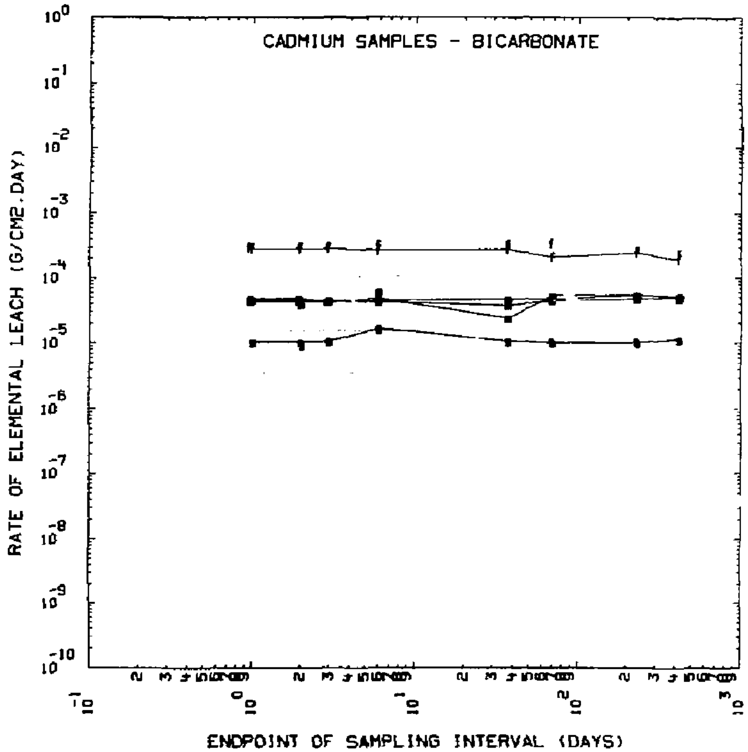
Graphs of Log Leach Rate Data Against Log Time for the ICP and XRF Analysis for B.L. 1

As with Appendixes 10 and 11, f, m, and s refer to fast, medium, and slow flow rate channels, respectively. Connected lines are the 25°C data and unconnected lines are the 75°C. Since only one bicarbonate channel (14, medium flow, 75°C) and one distilled water channel (23, medium flow, 75°C) were analyzed using the XRF method, these data are represented with a "gamma" (γ) symbol. The dotted lines represent the value of the leach rate corresponding to the ICP detection limit for the slow (lowest line), medium (middle line) and fast (upper line) flow rates.

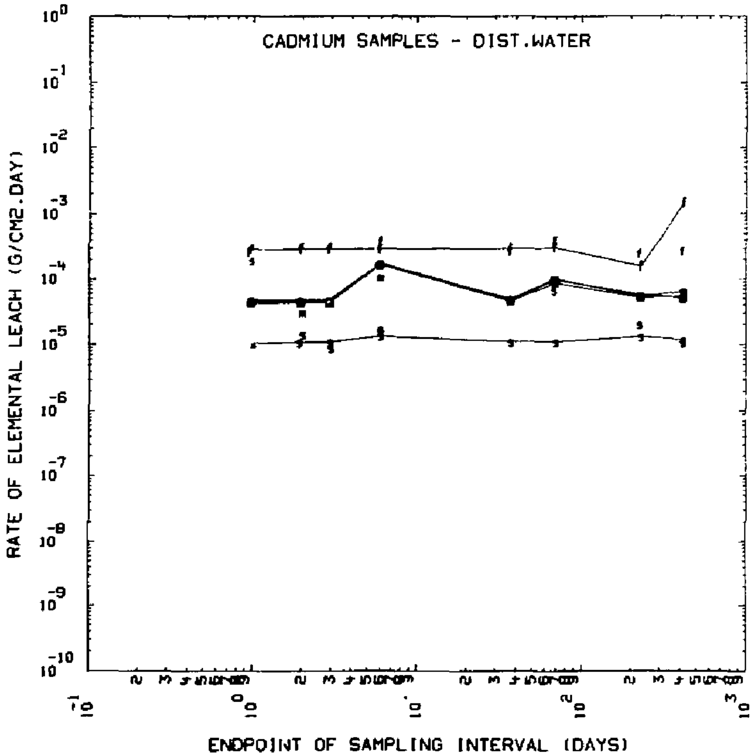

BORON SAMPLES - BICARBONATE
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)



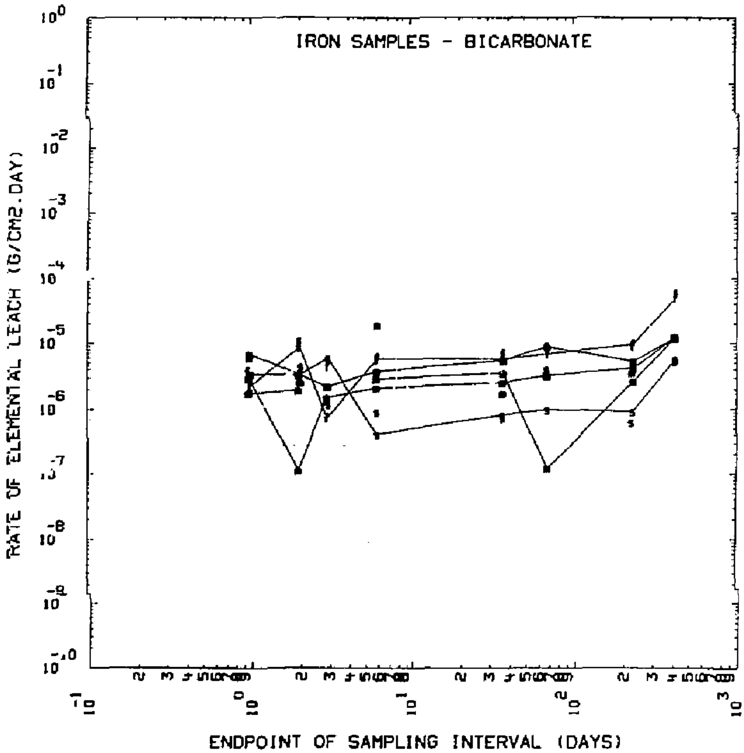
BORON SAMPLES - DIST.WATER
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

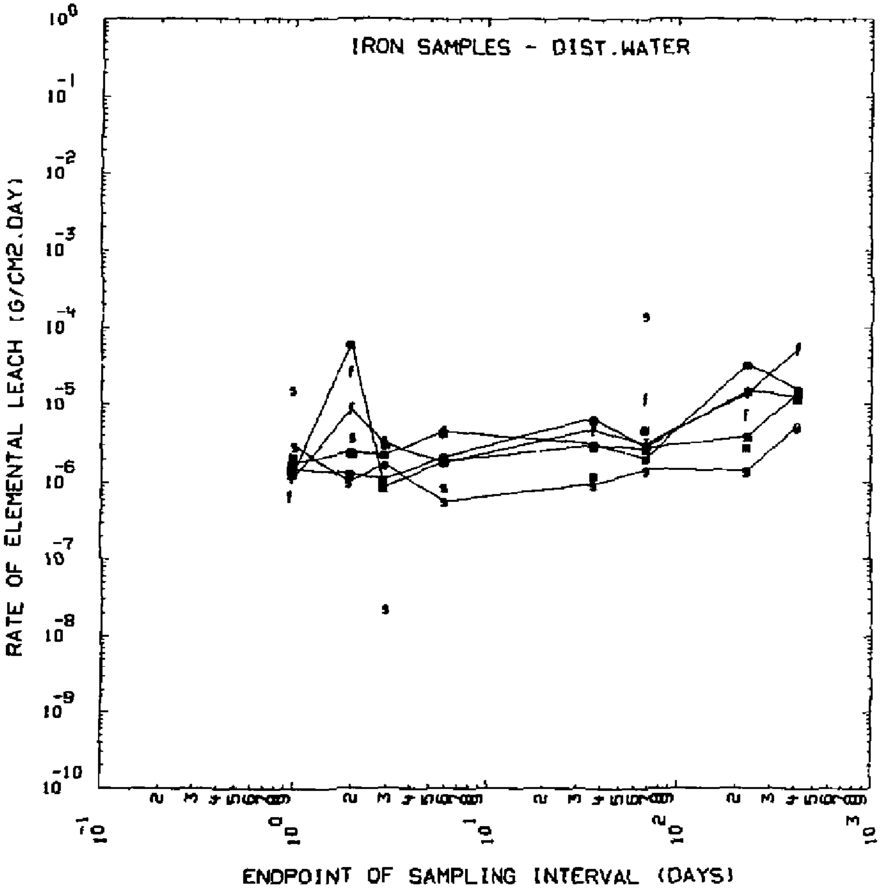


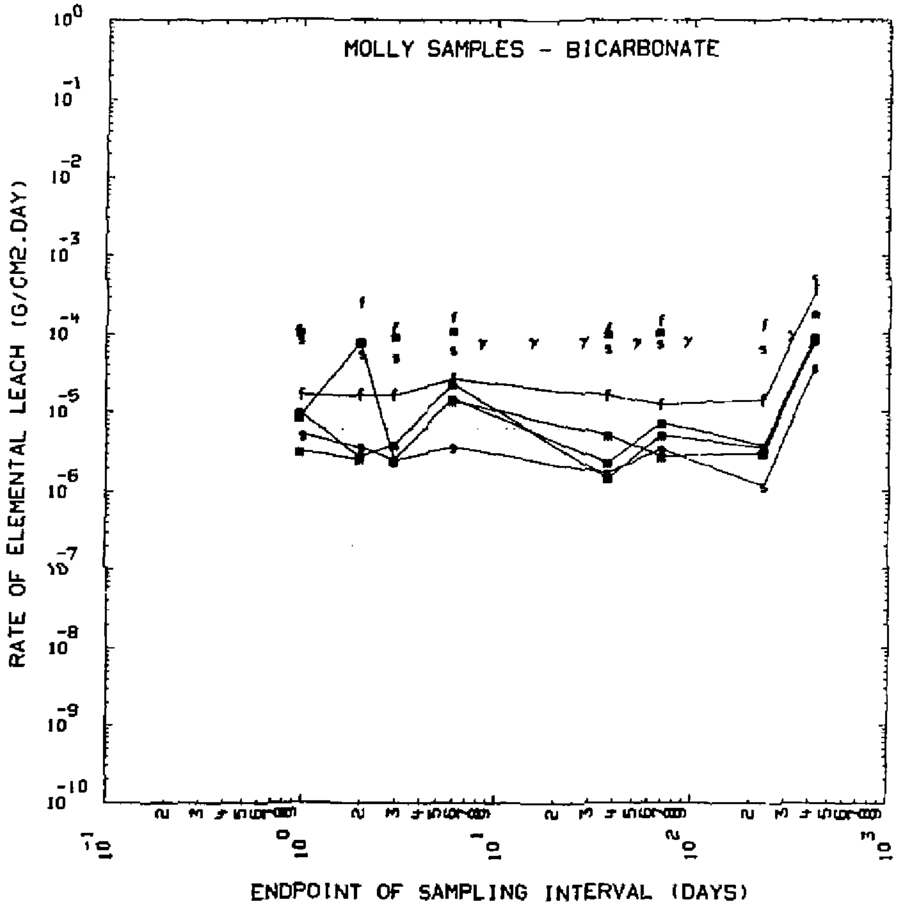
CADMIUM SAMPLES - BICARBONATE
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

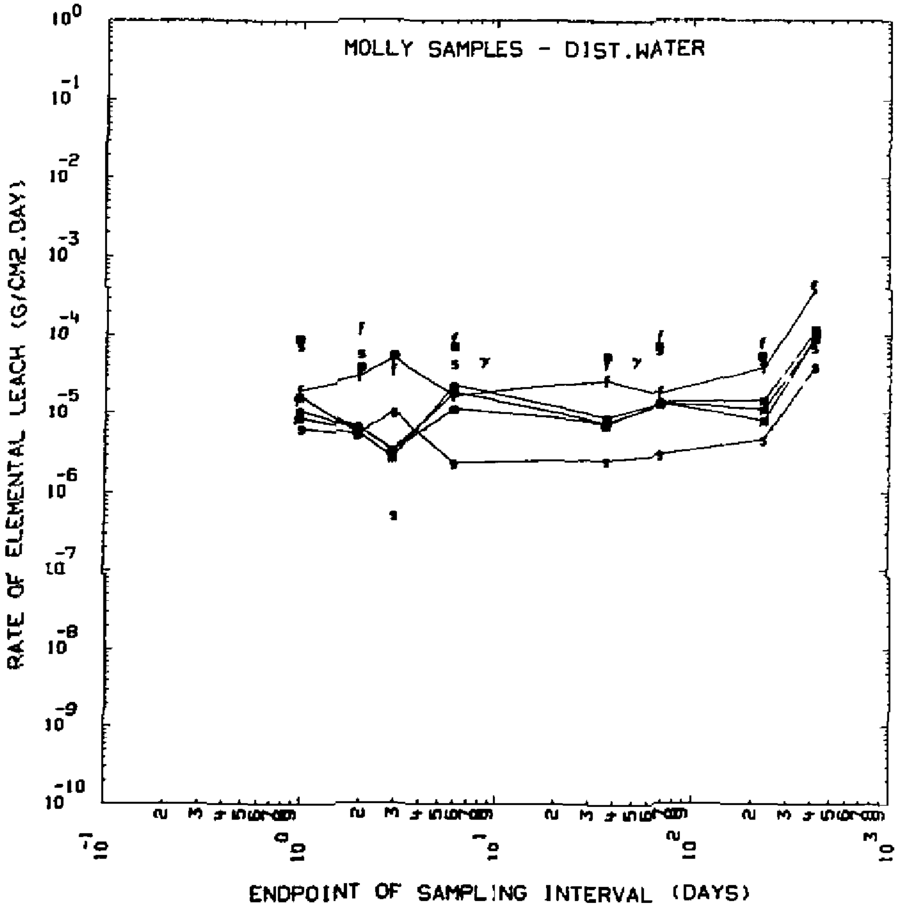


CADMIUM SAMPLES - DIST.WATER
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

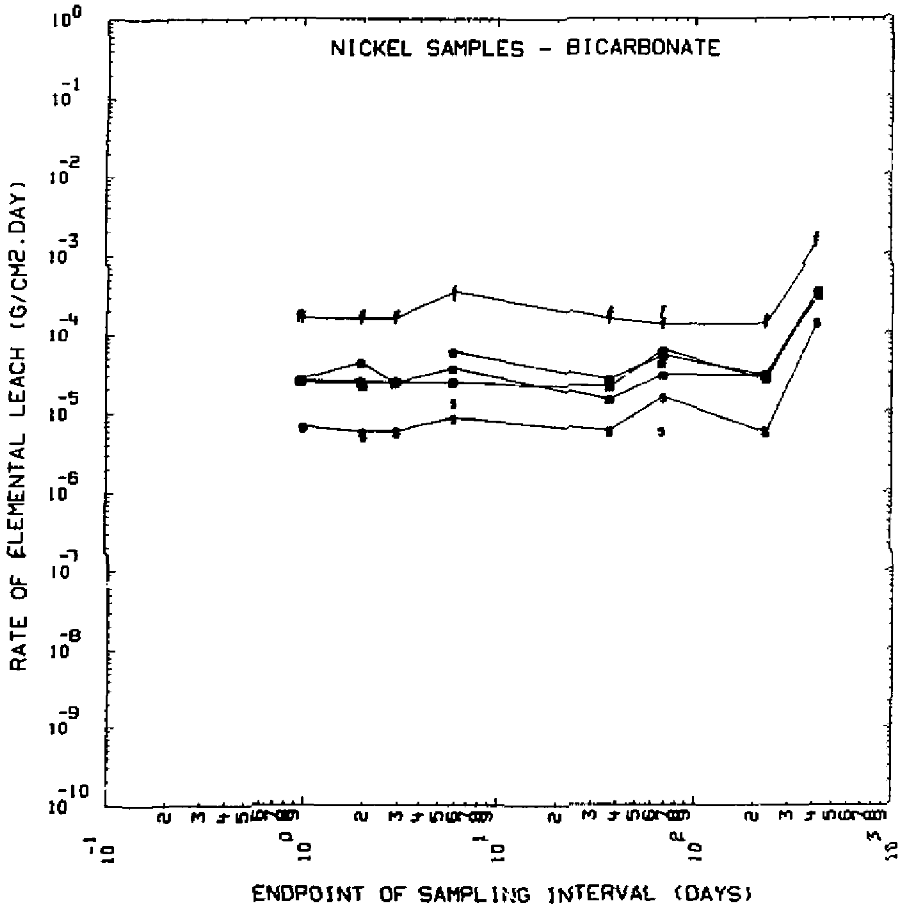

IRON SAMPLES - BICARBONATE
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

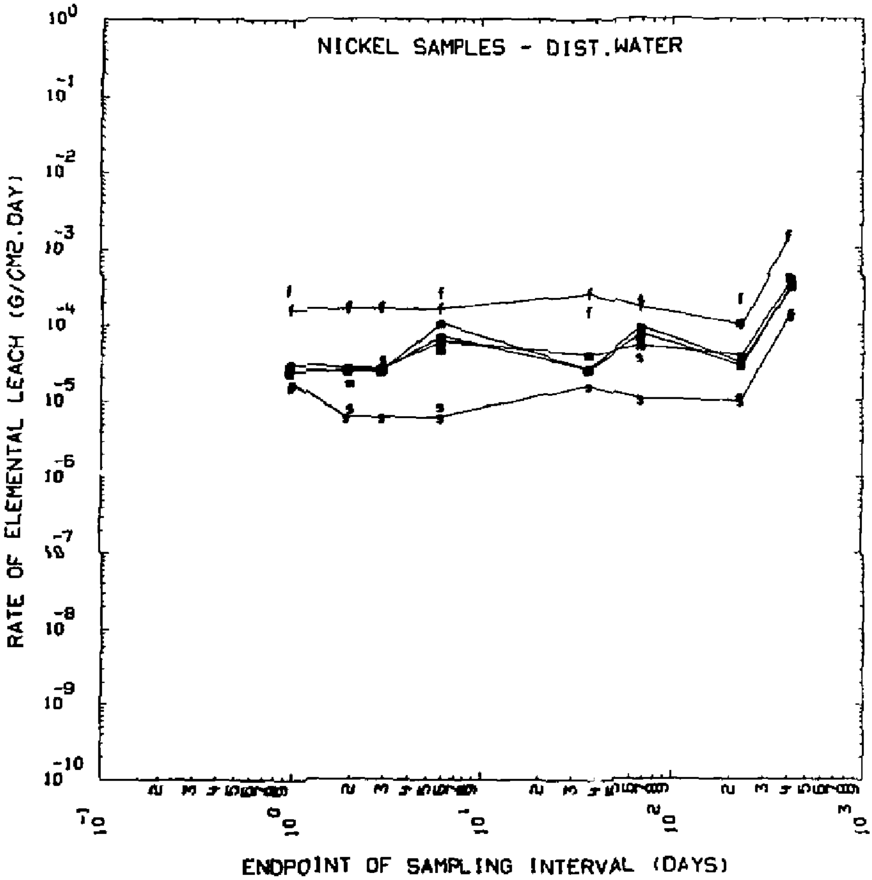

IRON SAMPLES - DIST.WATER
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

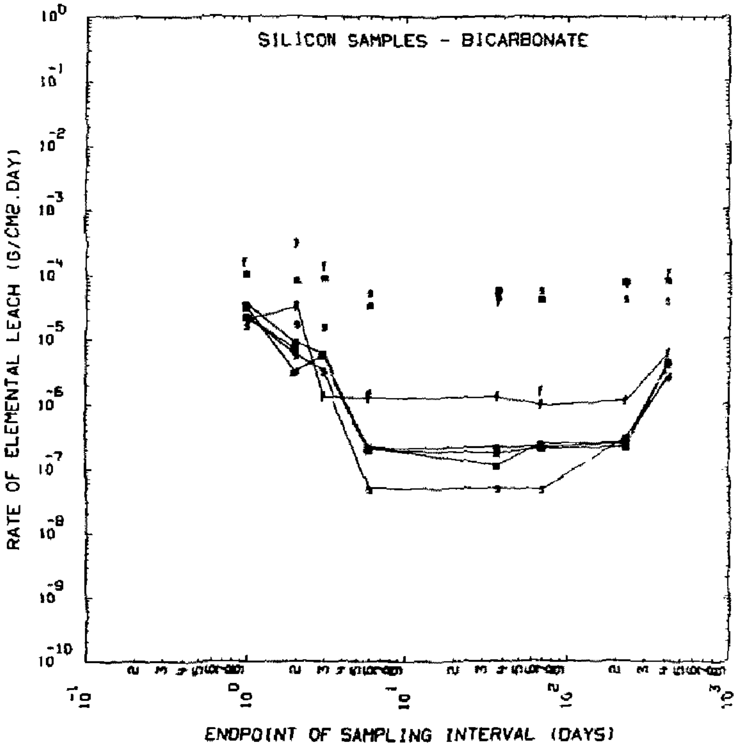

MOLLY SAMPLES - BICARBONATE
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

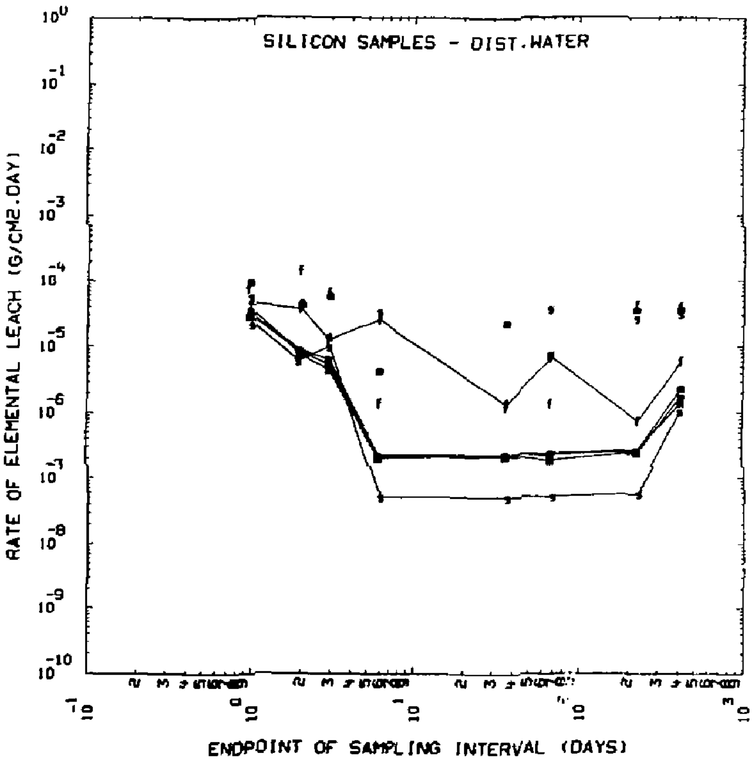


MOLLY SAMPLES - DIST.WATER
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

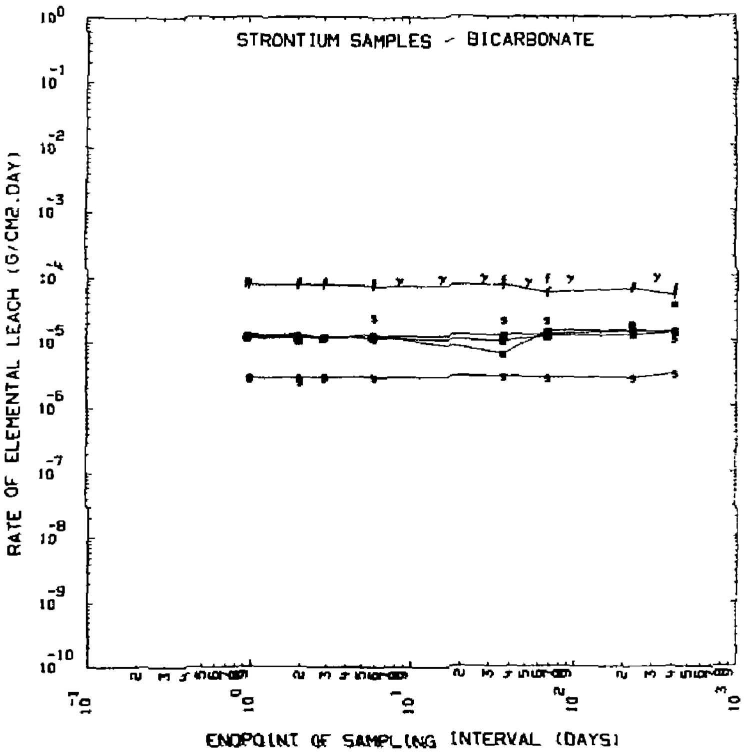

NICKEL SAMPLES - BICARBONATE
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)


NICKEL SAMPLES - DIST.WATER
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

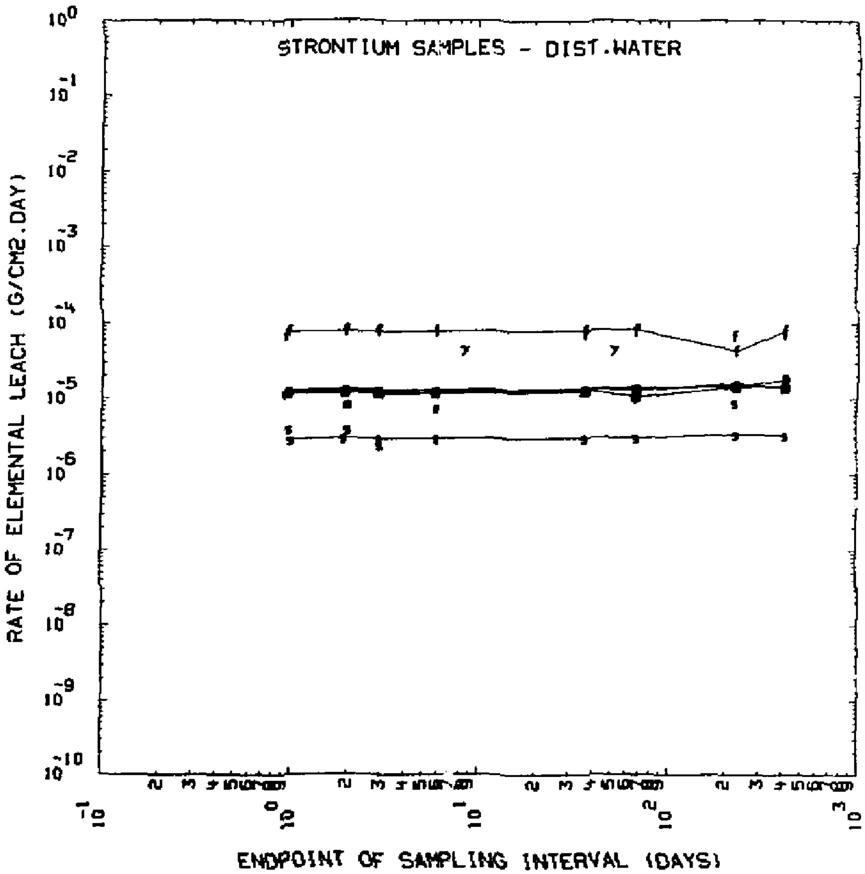

SILICON SAMPLES - BICARBONATE
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)



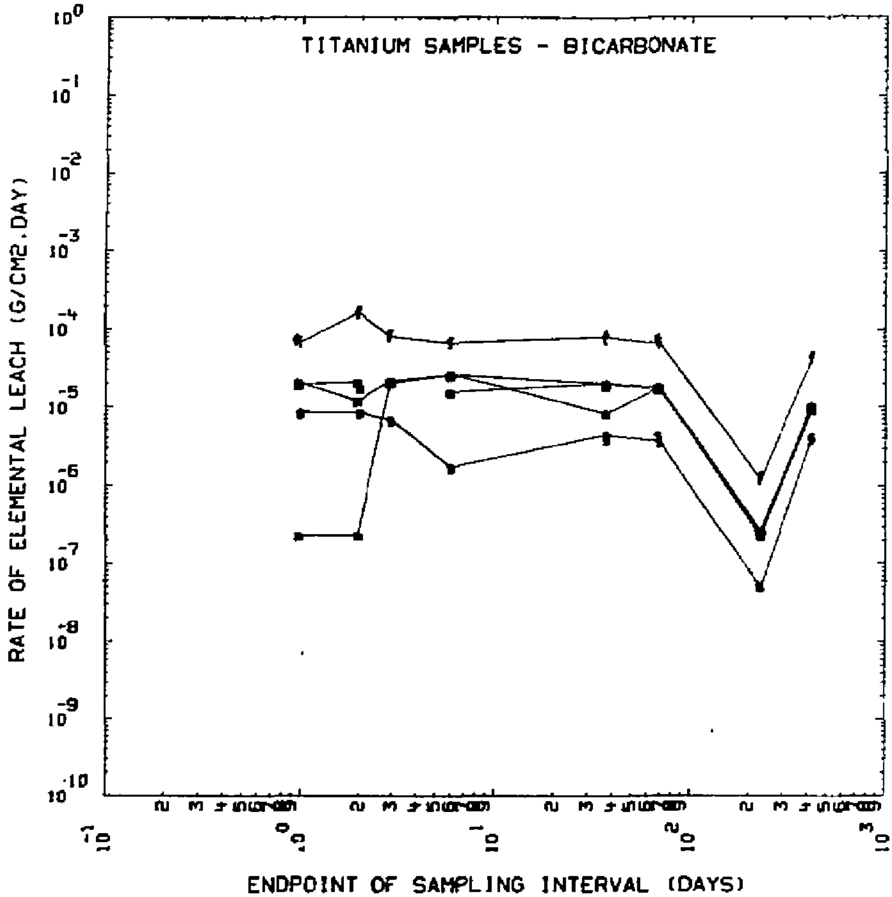
SILICON SAMPLES - DIST.WATER
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)



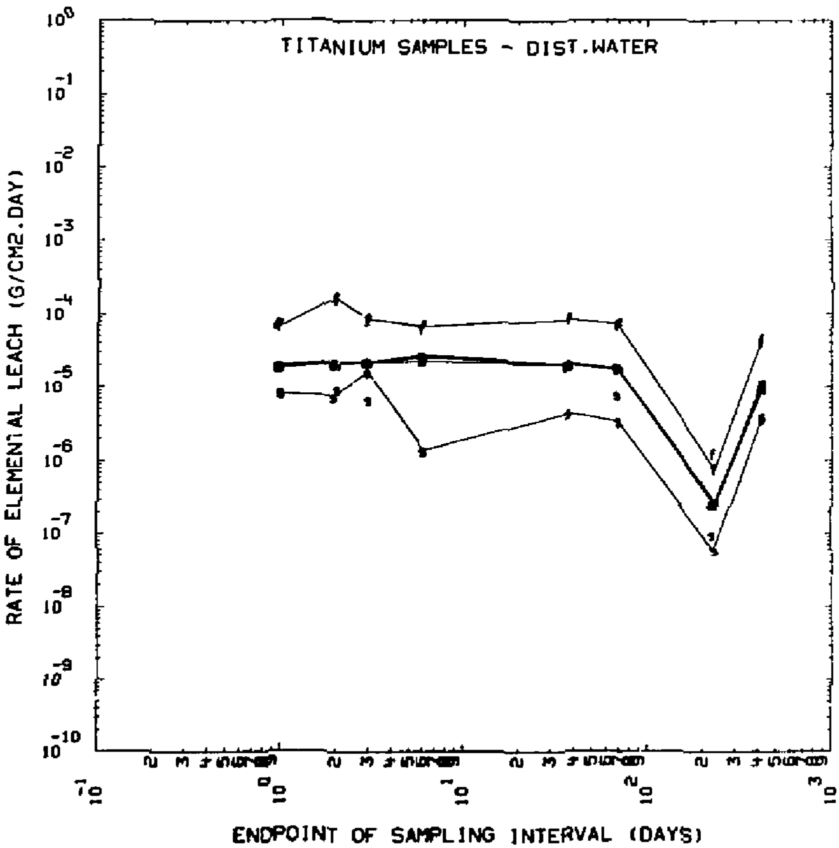
STRONTIUM SAMPLES - BICARBONATE
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

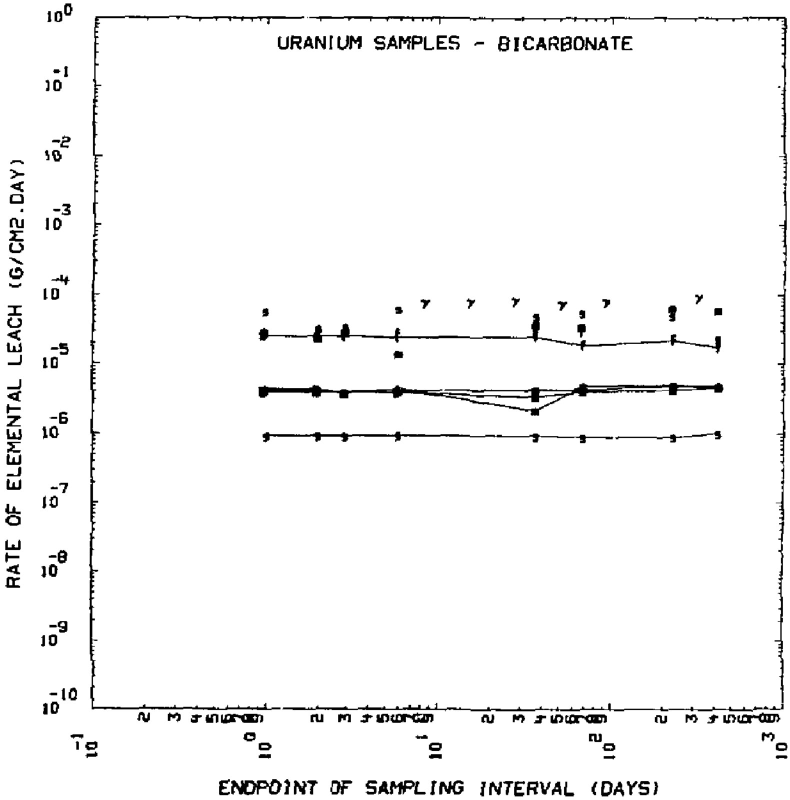


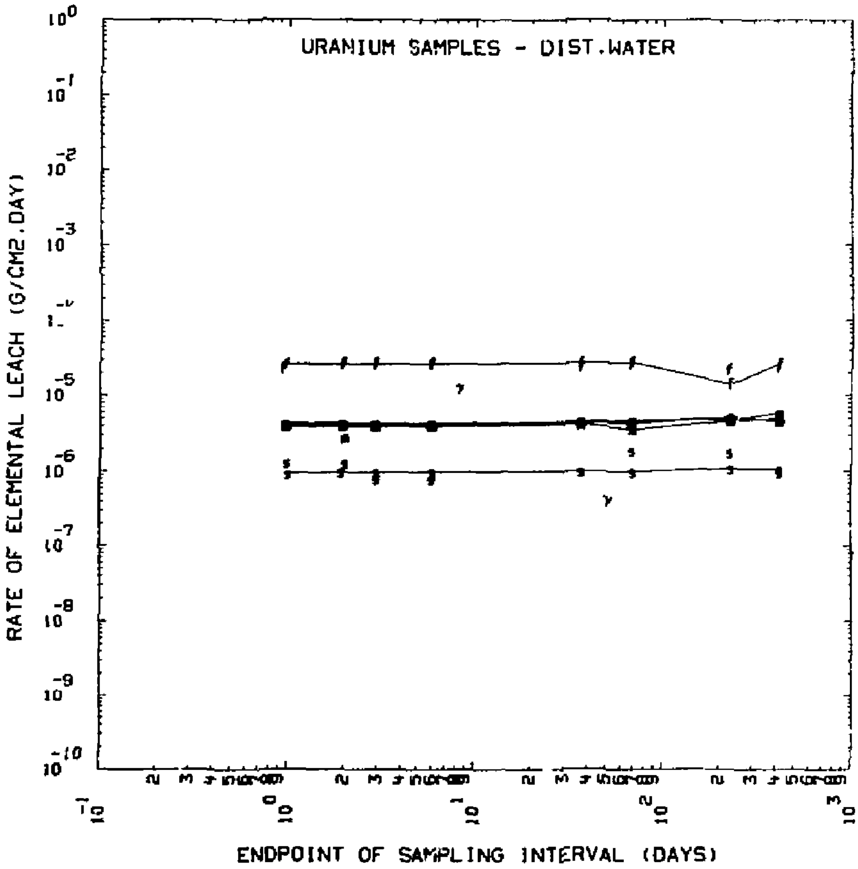
STRONTIUM SAMPLES - DIST.WATER
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

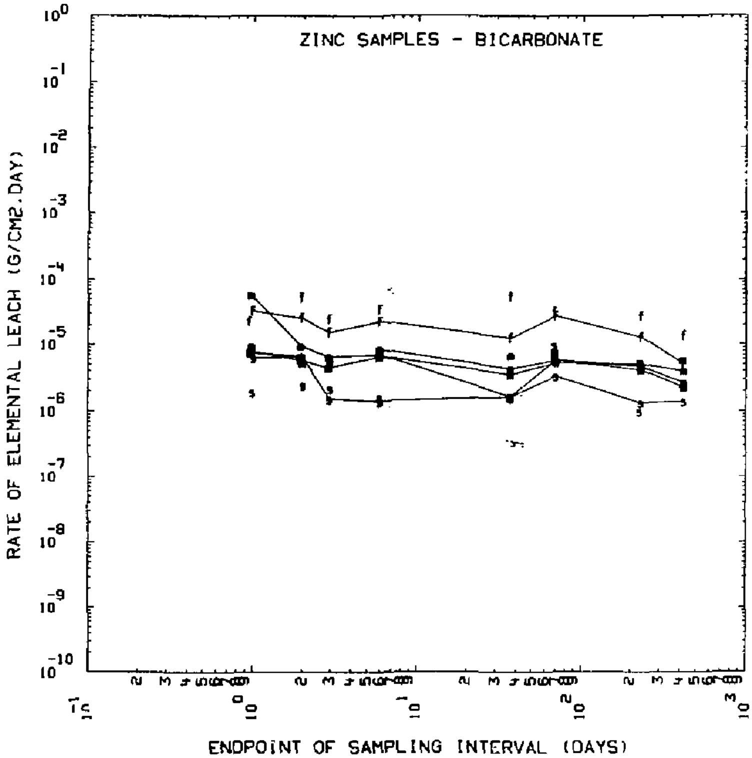


TITANIUM SAMPLES - BICARBONATE
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

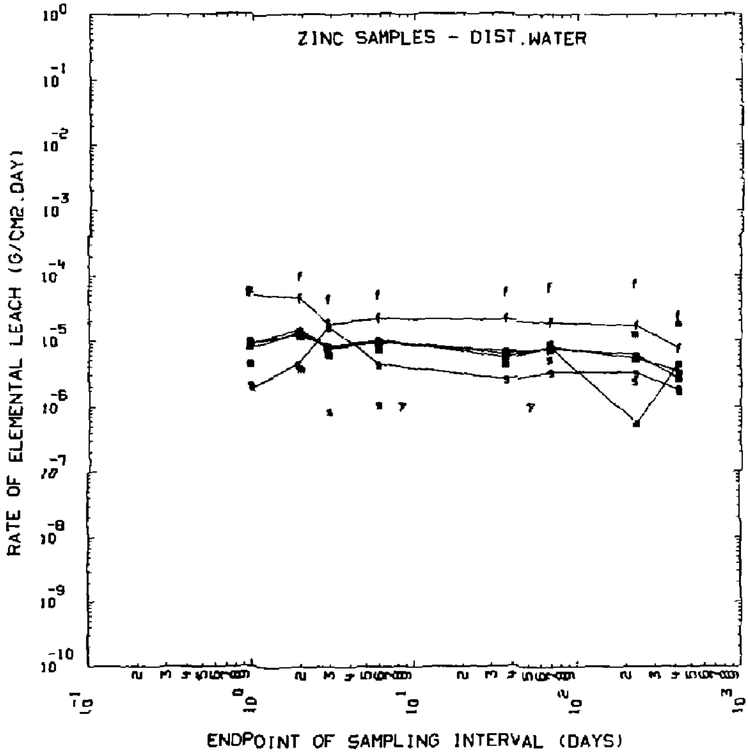

TITANIUM SAMPLES - DIST.WATER
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)


URANIUM SAMPLES - BICARBONATE
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

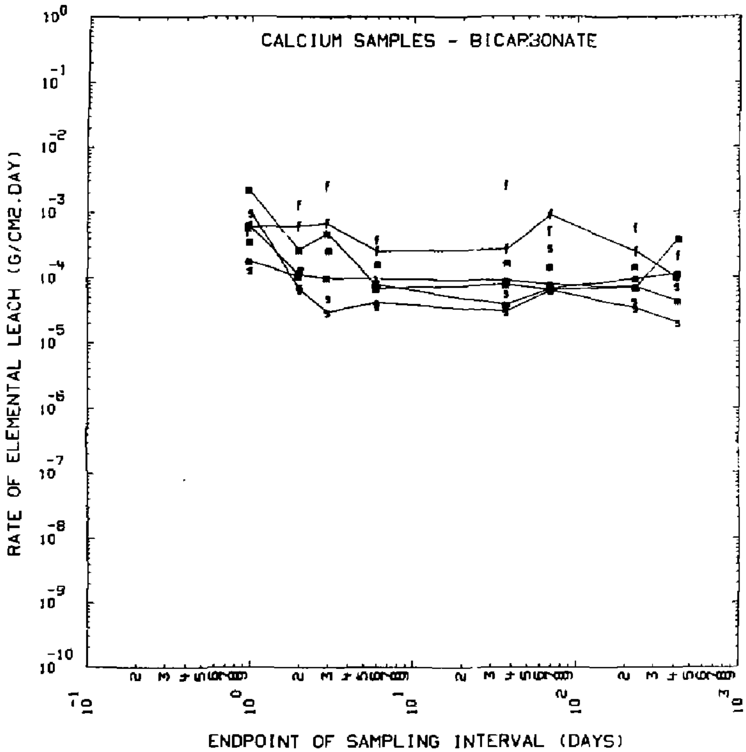

URANIUM SAMPLES - DIST.WATER
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

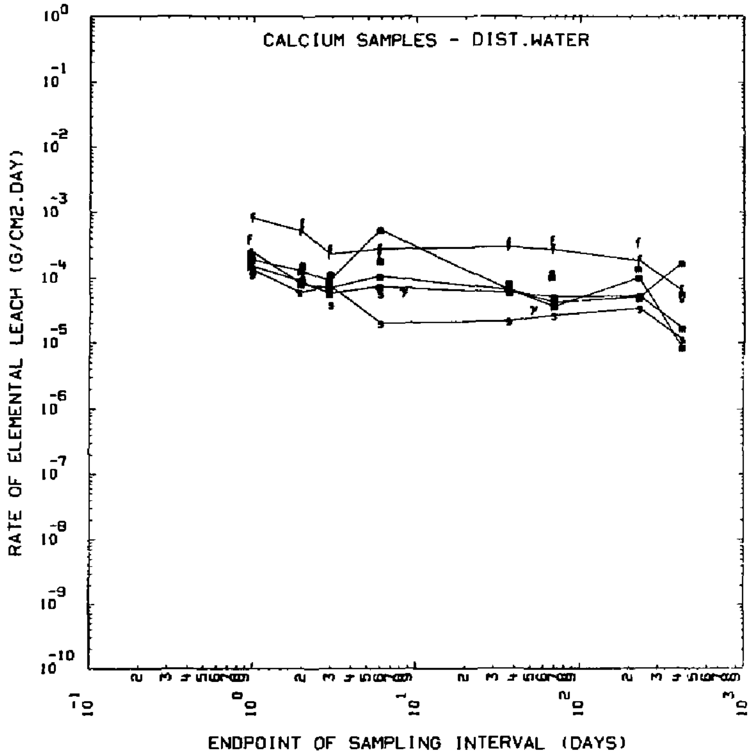


ZINC SAMPLES - BICARBONATE
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

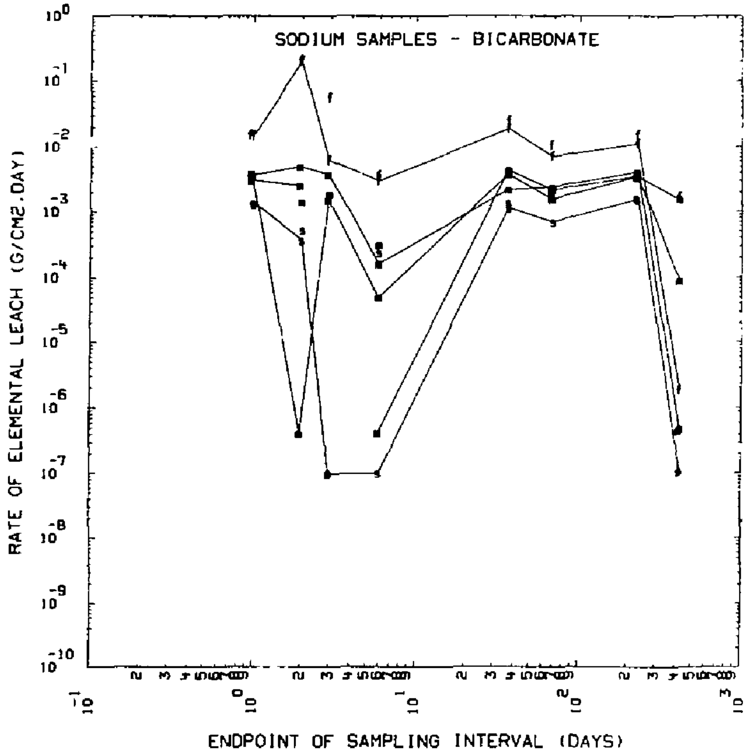


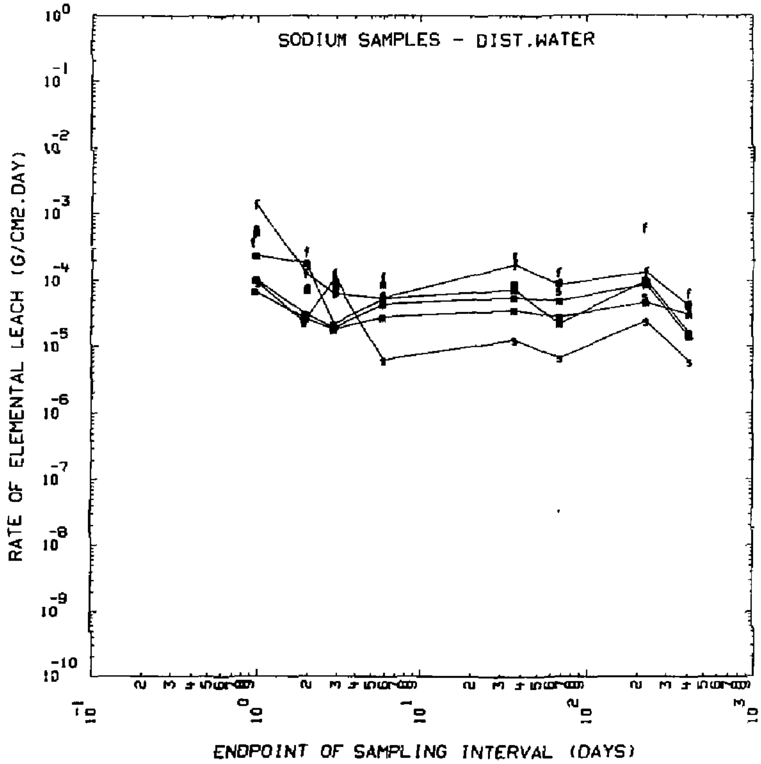
ZINC SAMPLES - DIST.WATER
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)


CALCIUM SAMPLES - BICARBONATE
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

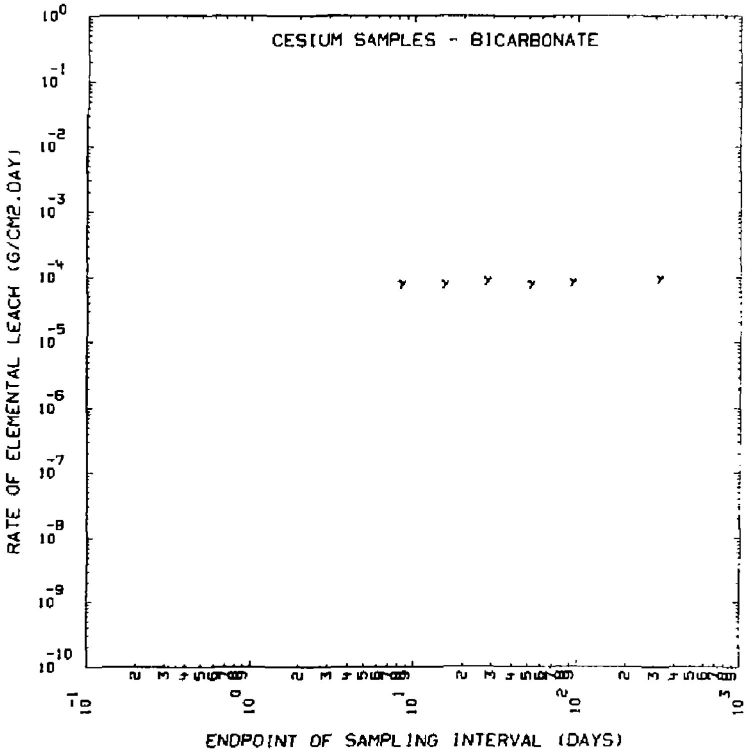


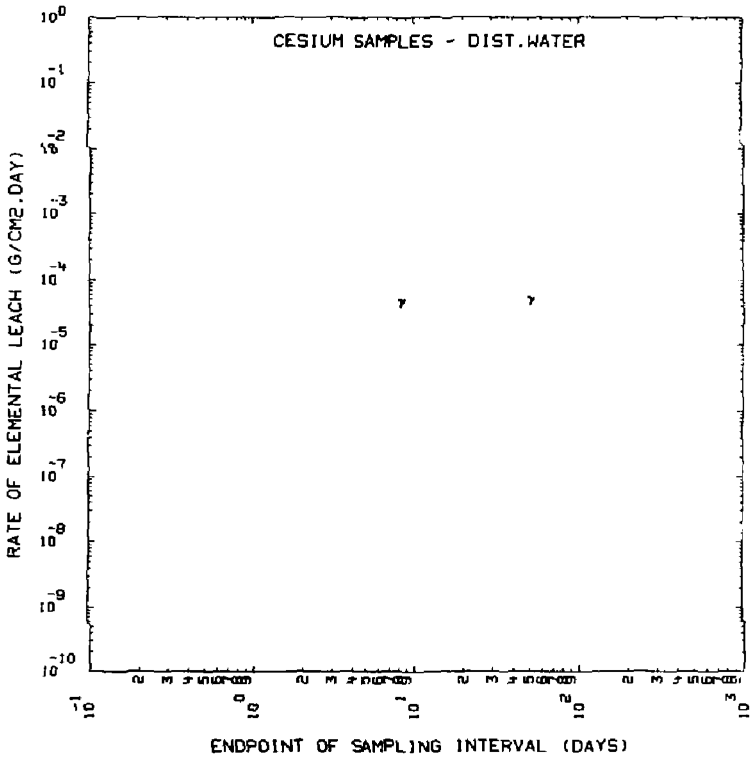
CALCIUM SAMPLES - DIST.WATER
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)


SODIUM SAMPLES - BICARBONATE
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

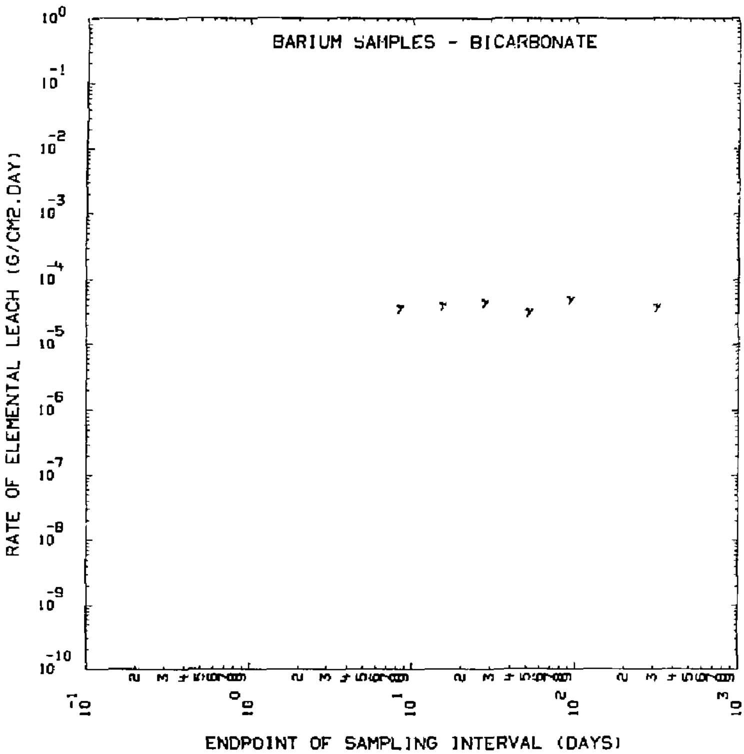


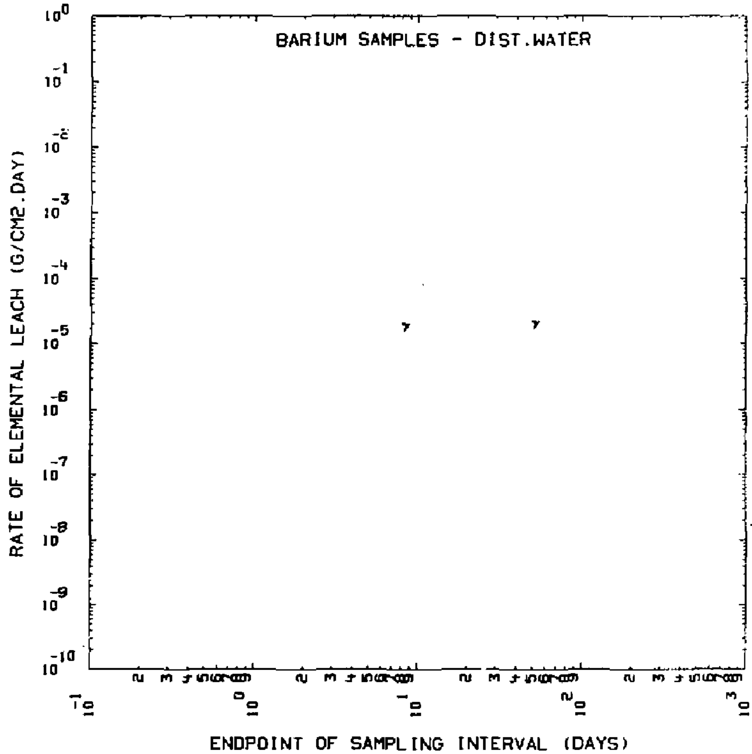
SODIUM SAMPLES - DIST.WATER
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

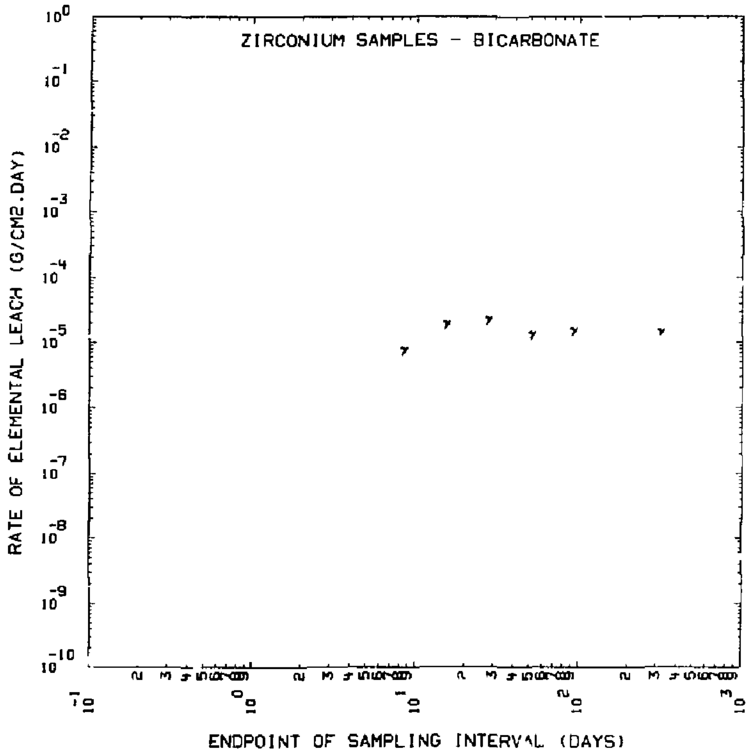

CESIUM SAMPLES - BICARBONATE
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

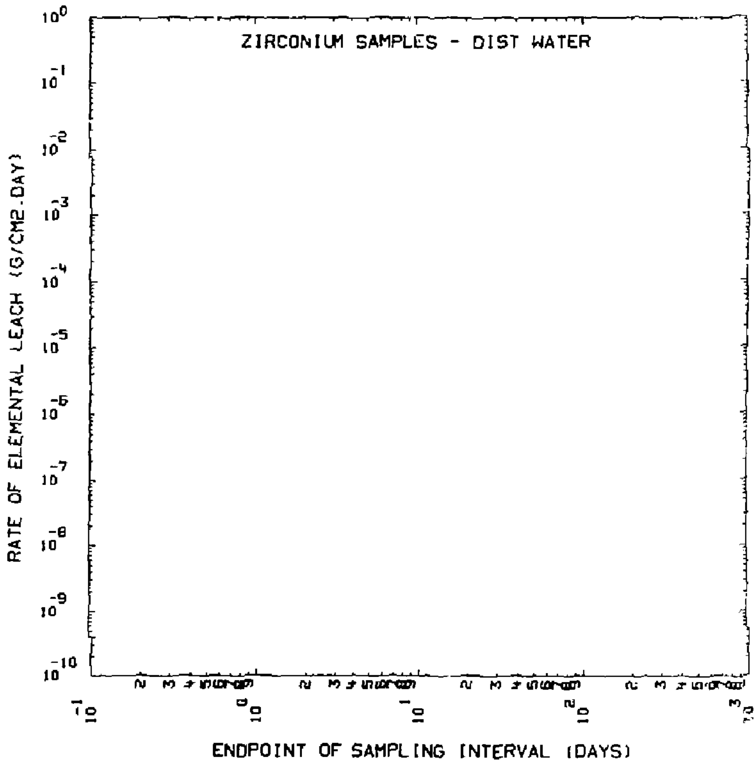


CESIUM SAMPLES - DIST.WATER
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)


BARIUM SAMPLES - BICARBONATE
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)


BARIUM SAMPLES - DIST.WATER
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

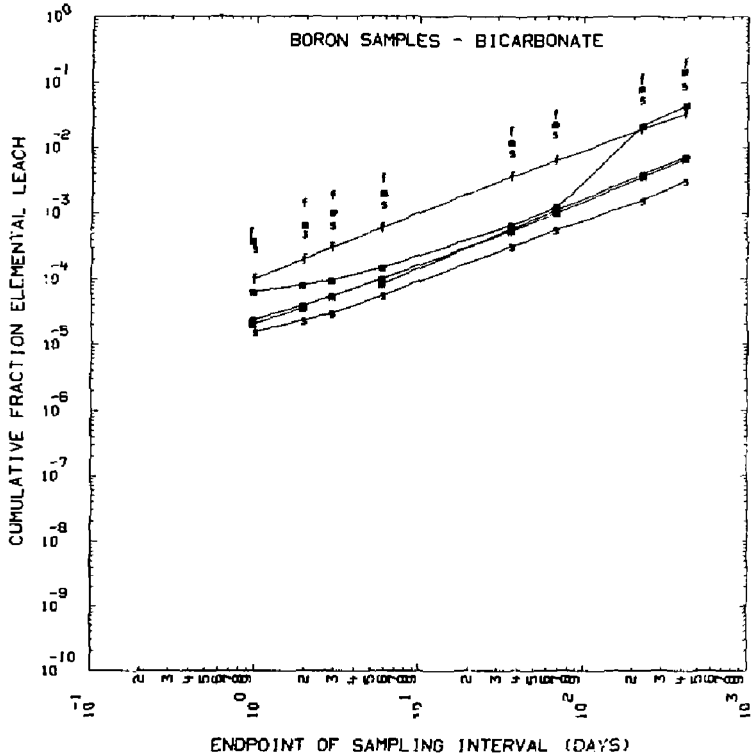

ZIRCONIUM SAMPLES - BICARBONATE
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)


ZIRCONIUM SAMPLES - DIST WATER
RATE OF ELEMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

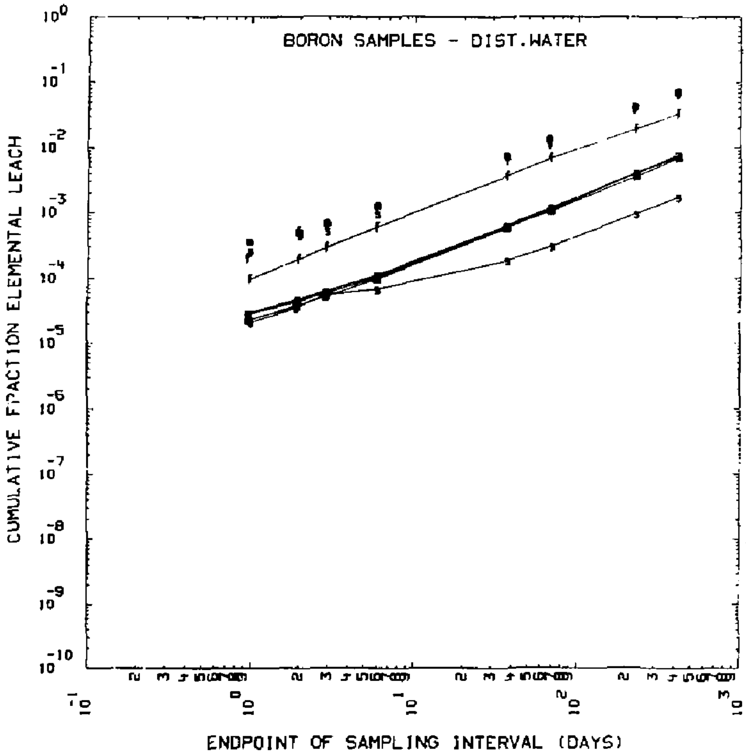
APPENDIX 13

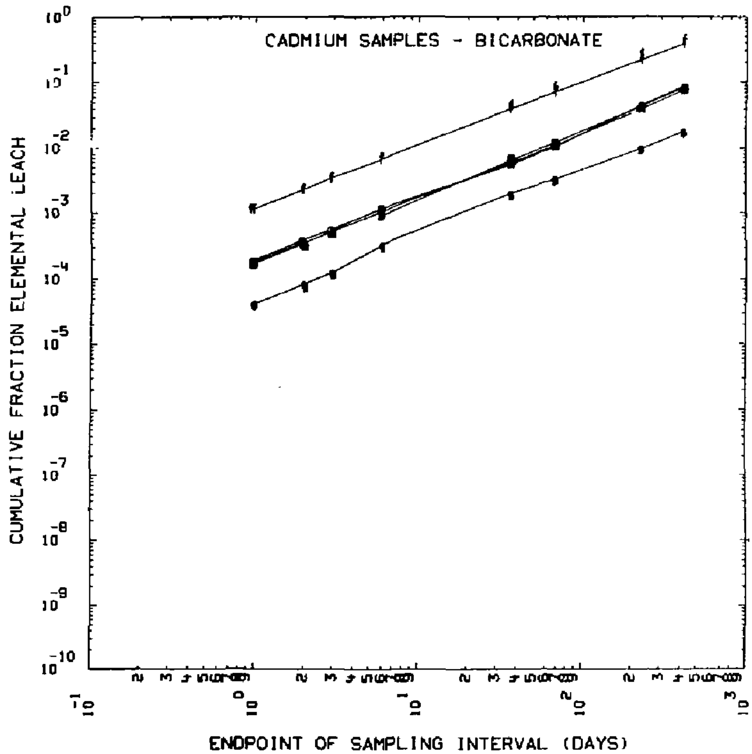
Graphs of Log Cumulative-Fraction Leached Against Log Time for the ICP and XRF Analysis for B.L.1

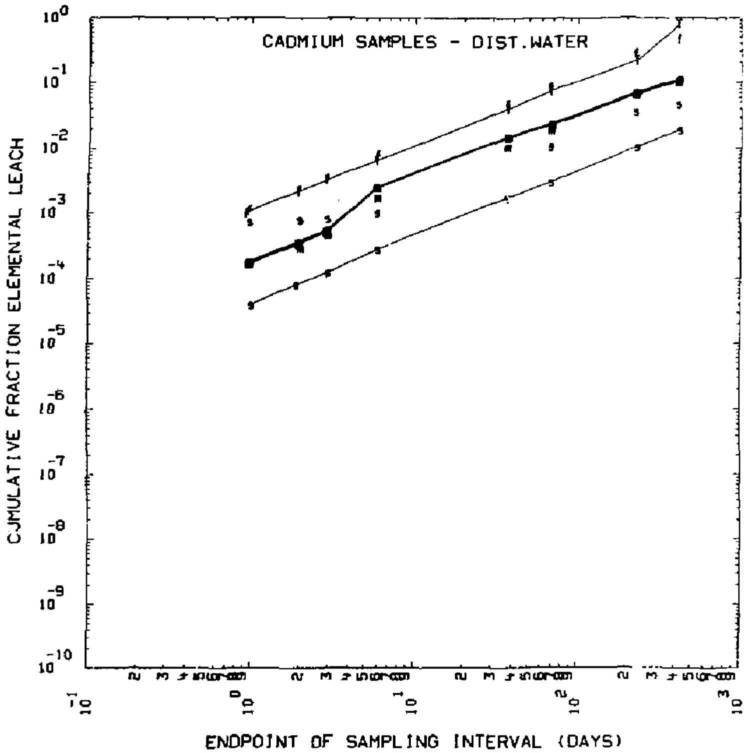
See Appendix 12 for discussion of the symbols used.



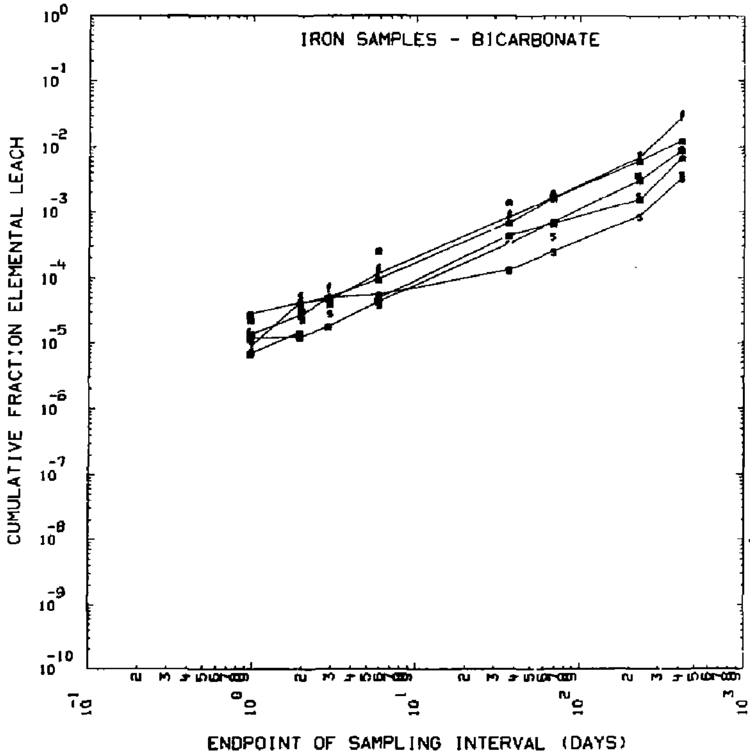
BORON SAMPLES - BICARBONATE
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)

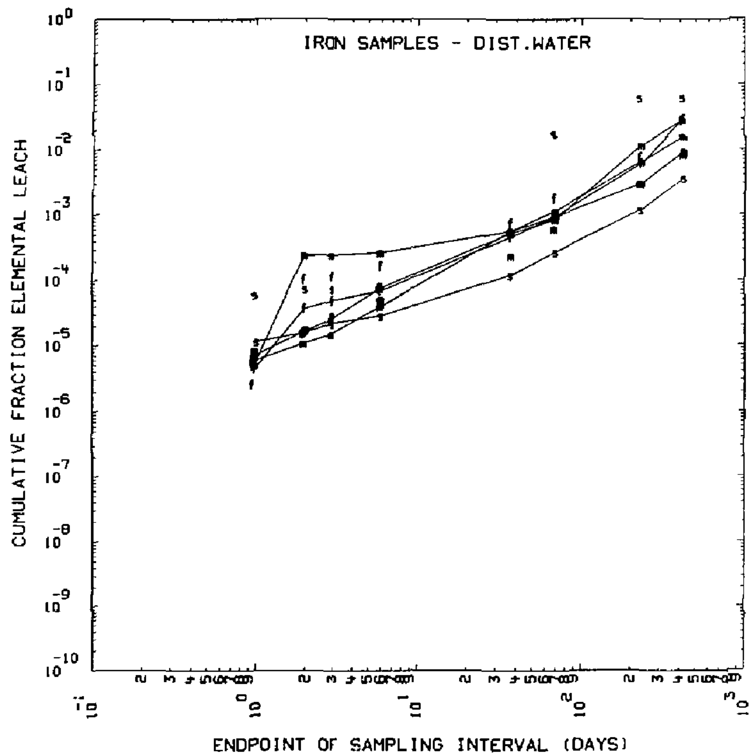

BORON SAMPLES - DIST.WATER
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)

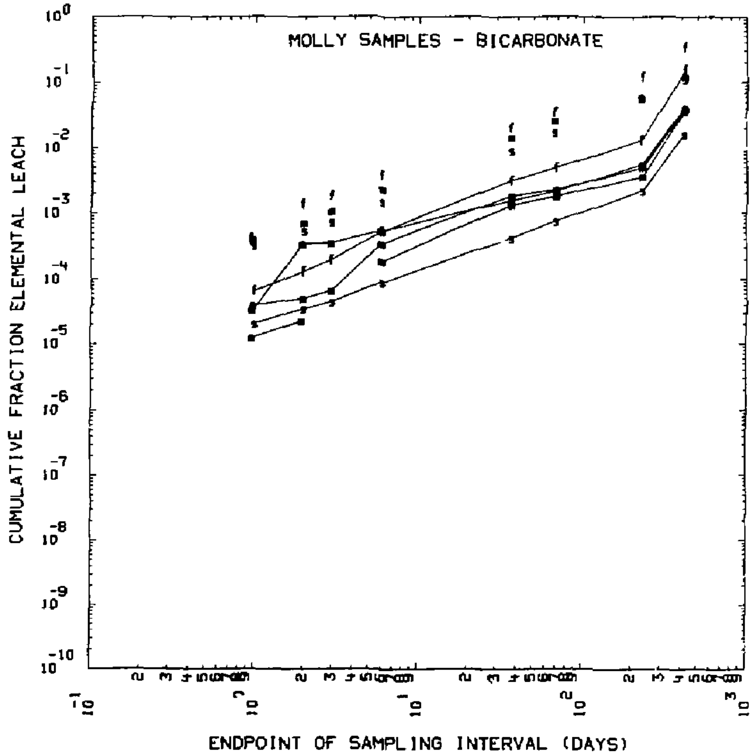

CADMIUM SAMPLES - BICARBONATE
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)



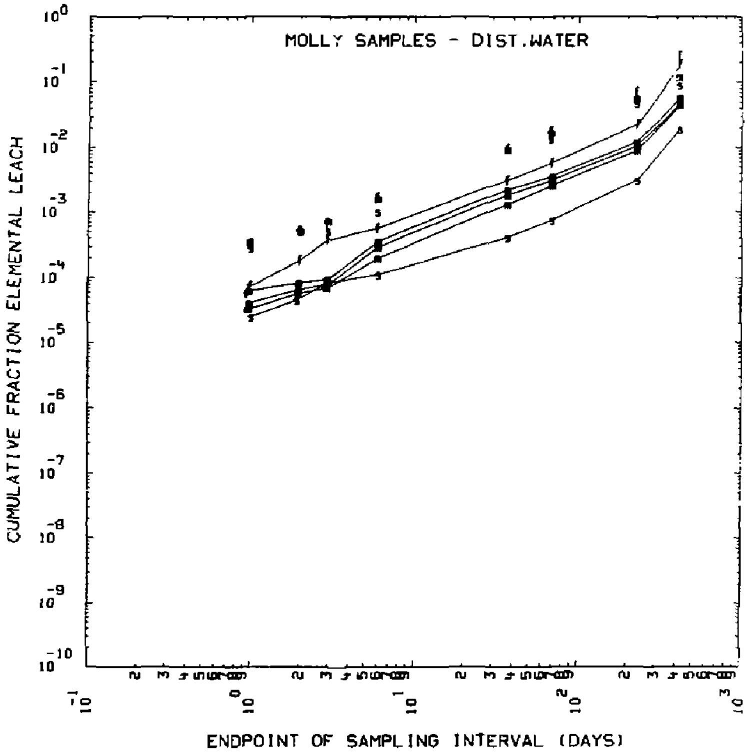
CADMIUM SAMPLES - DIST.WATER
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)


IRON SAMPLES - BICARBONATE
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)

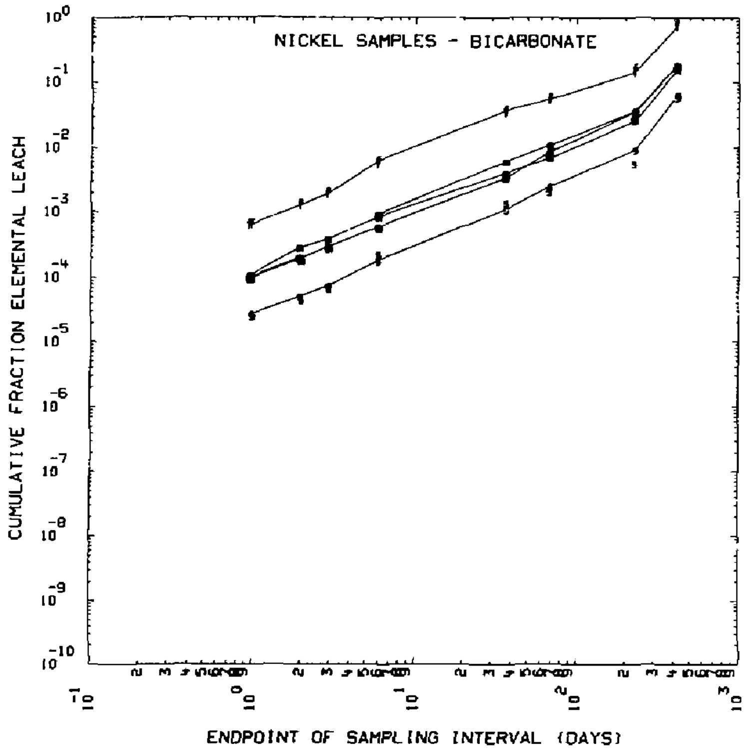

IRON SAMPLES - DIST.WATER
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)



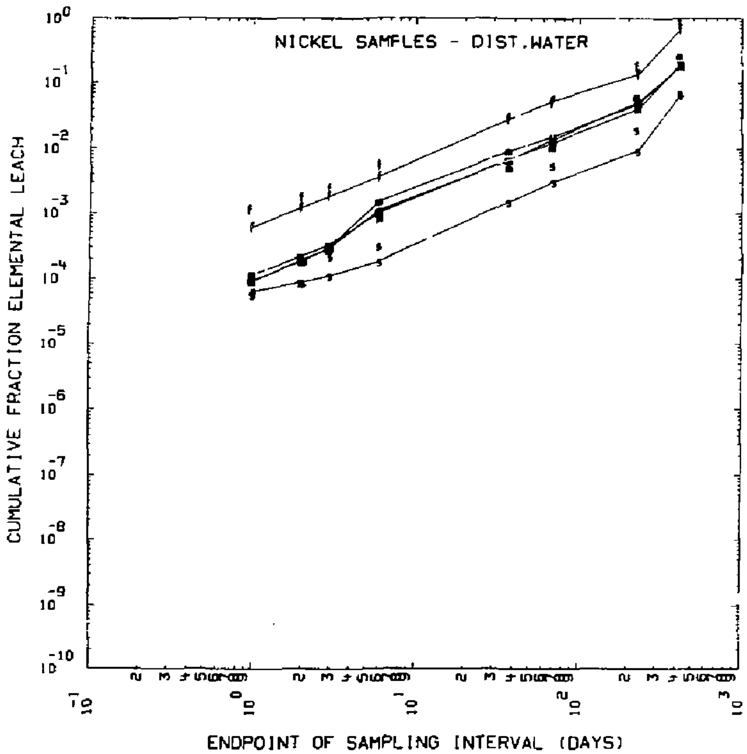
MOLLY SAMPLES - BICARBONATE
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)

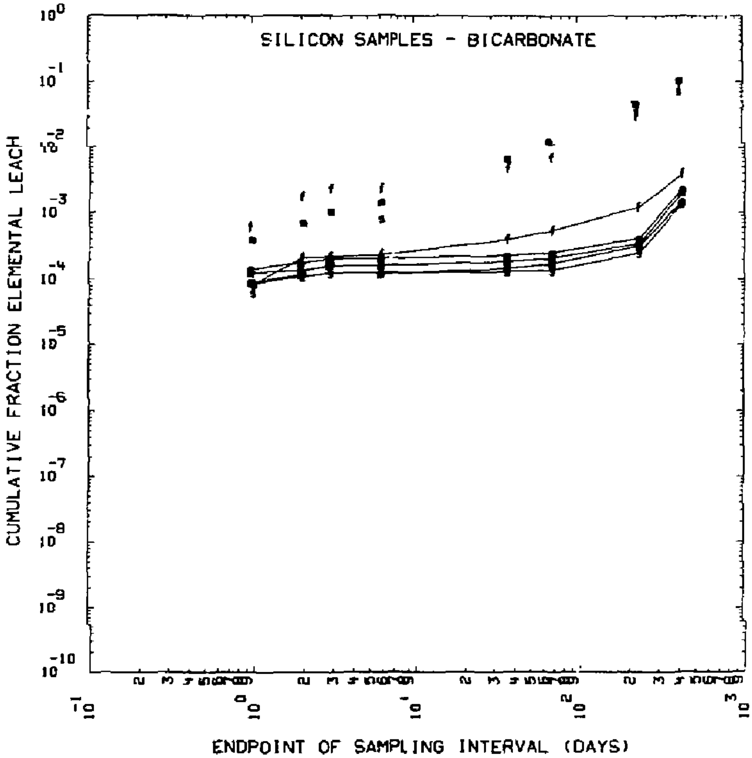


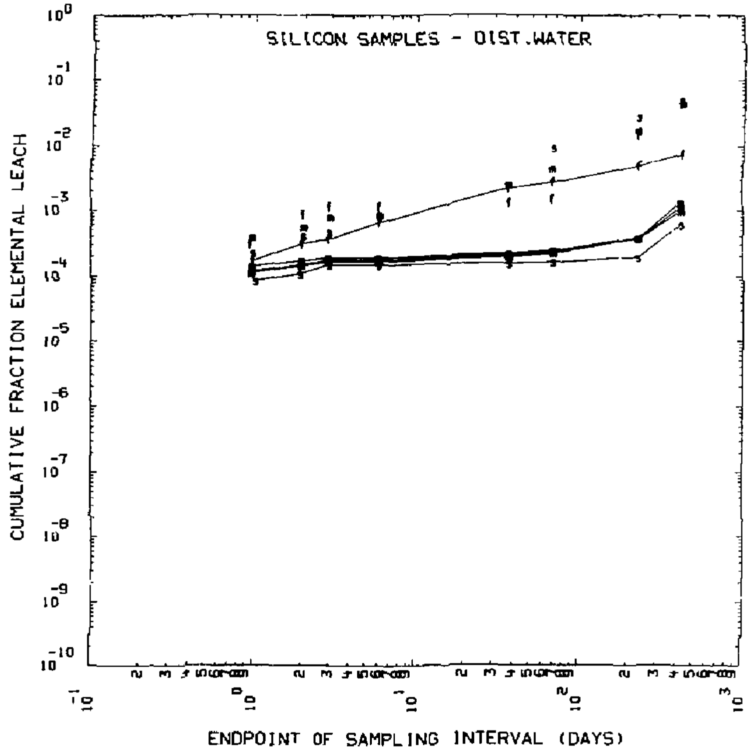
MOLLY SAMPLES - DIST.WATER
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)



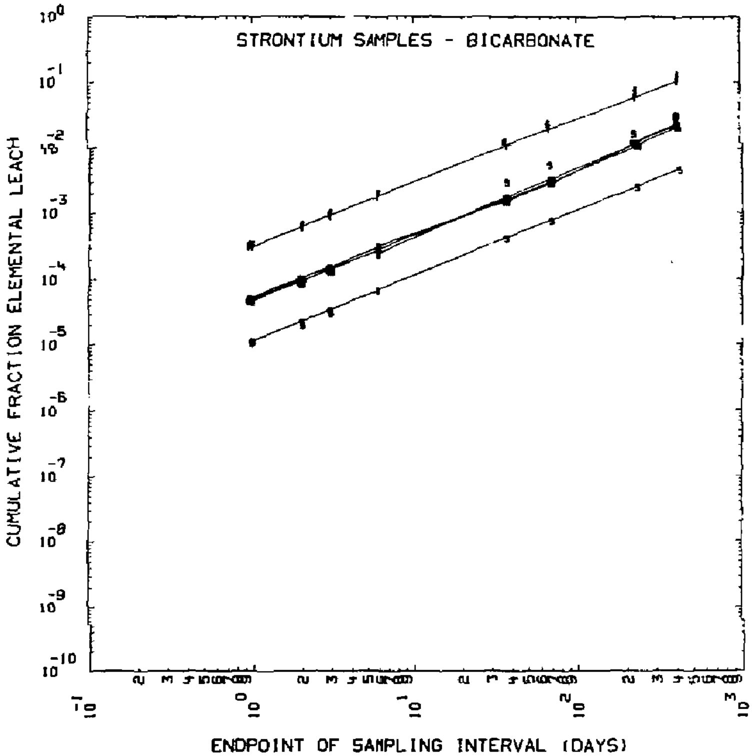
NICKEL SAMPLES - BICARBONATE
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)


NICKEL SAMFLES - DIST.WATER
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)

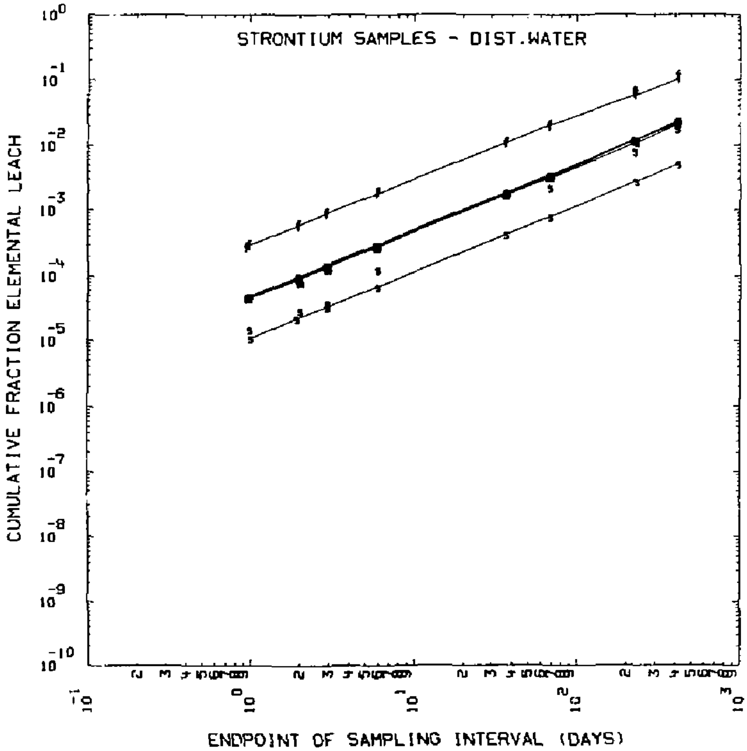

SILICON SAMPLES - BICARBONATE
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)

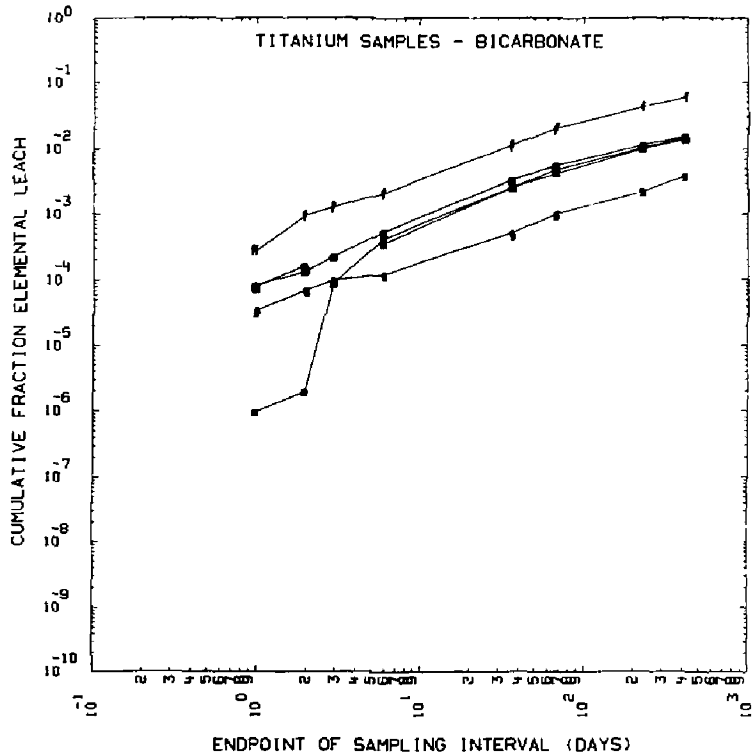


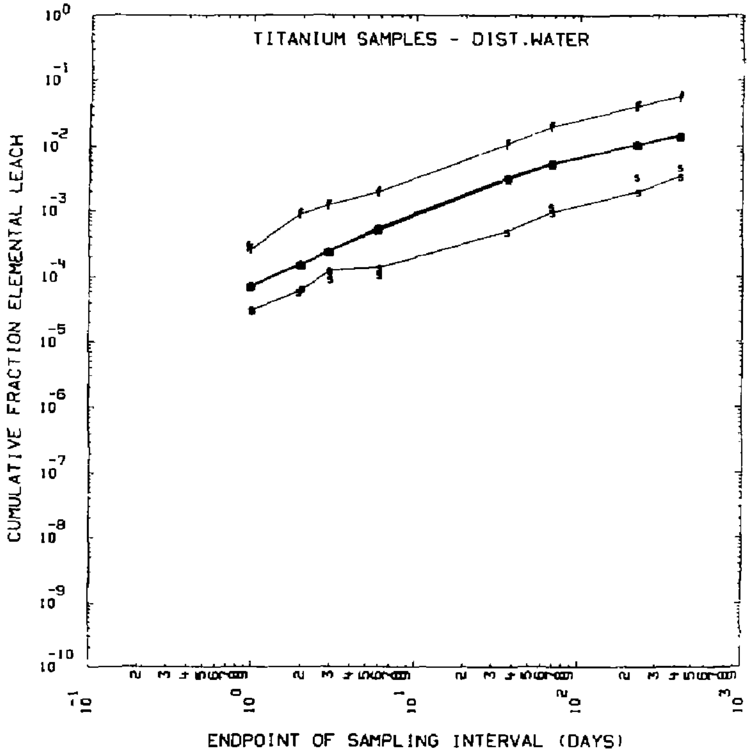
SILICON SAMPLES - DIST.WATER
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)



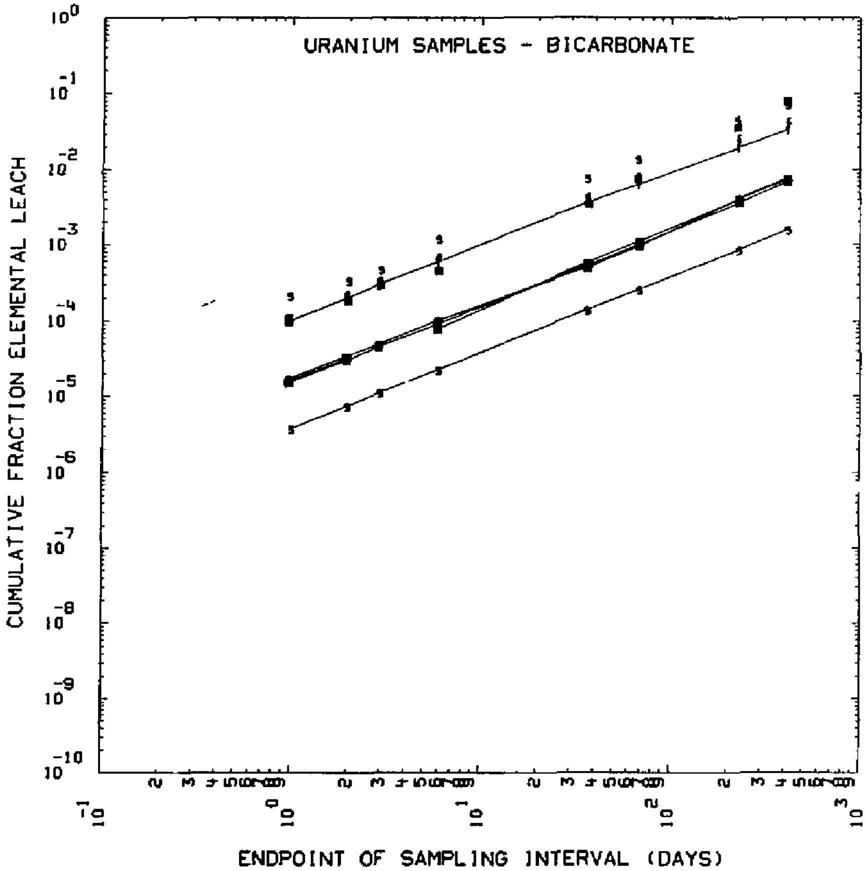
STRONTIUM SAMPLES - BICARBONATE
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)


STRONTIUM SAMPLES - DIST.WATER
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)

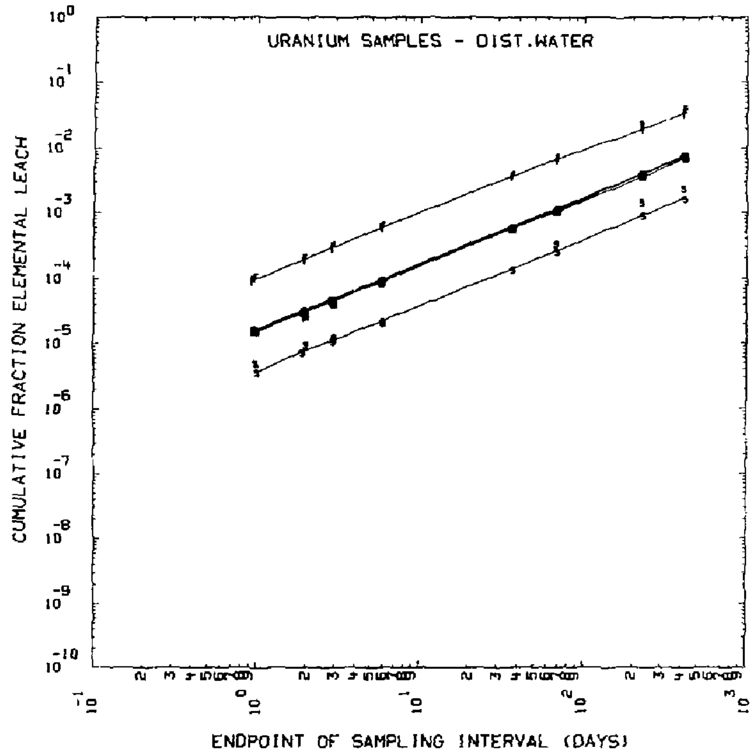

TITANIUM SAMPLES - BICARBONATE
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)

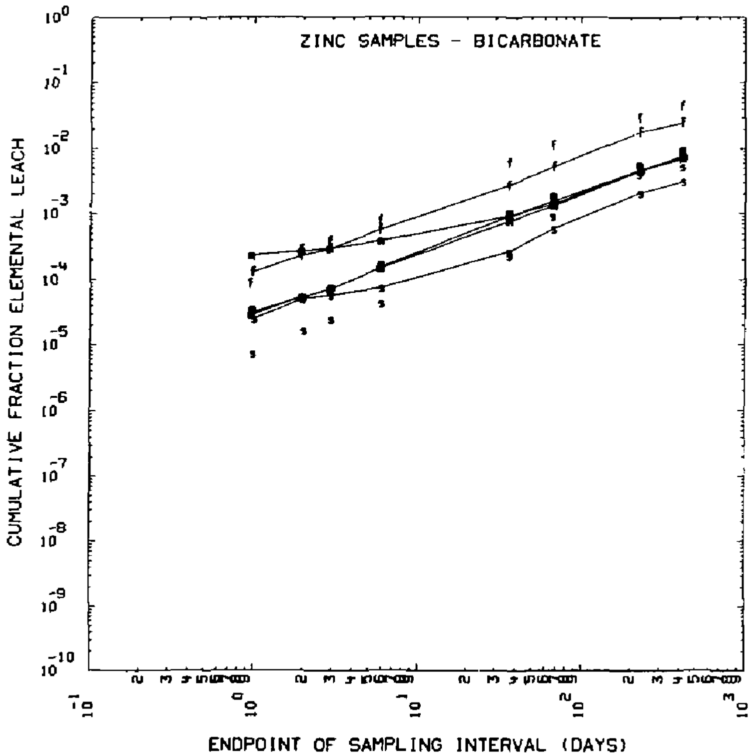


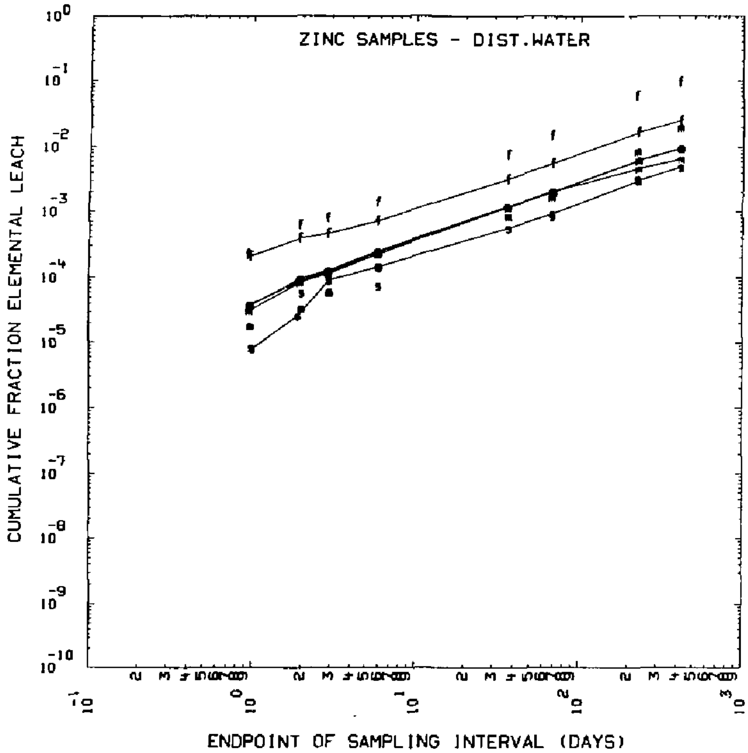
TITANIUM SAMPLES - DIST.WATER
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)



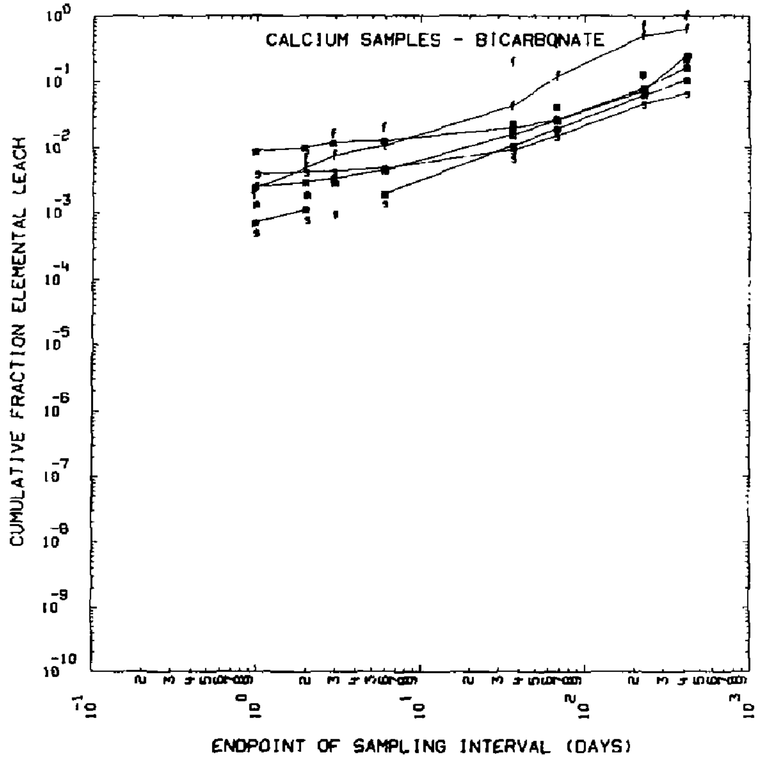
URANIUM SAMPLES - BICARBONATE
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)


URANIUM SAMPLES - DIST.WATER
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)

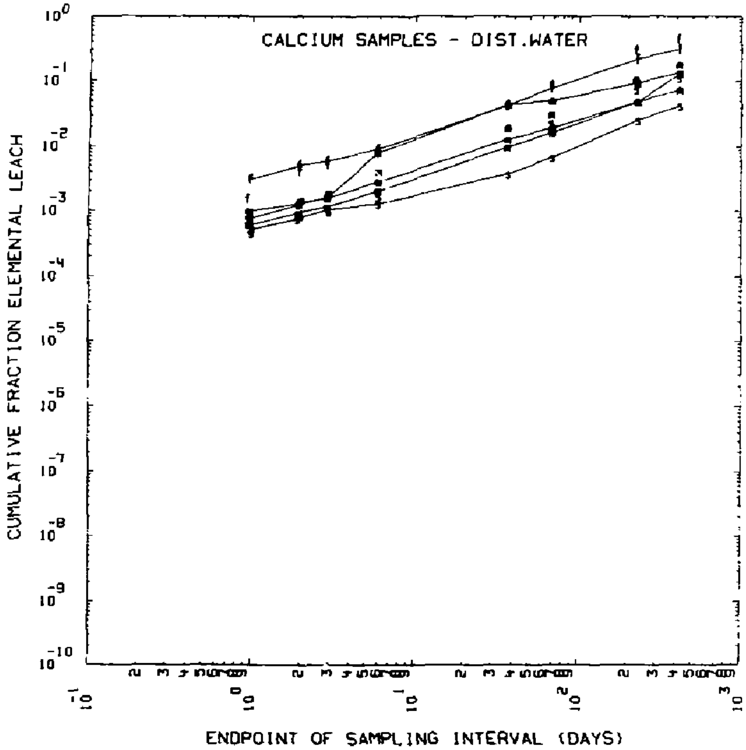

ZINC SAMPLES - BICARBONATE
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)

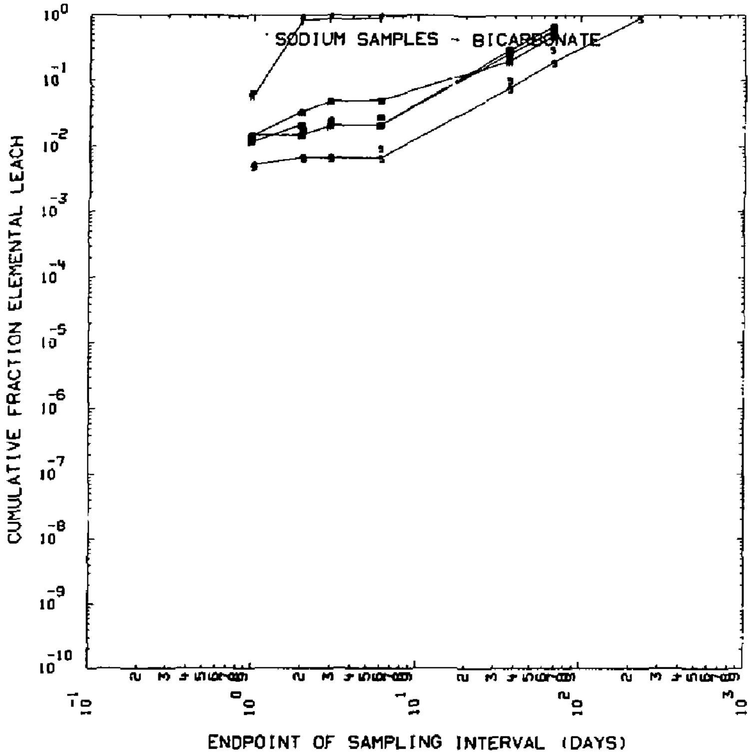


ZINC SAMPLES - DIST.WATER
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)

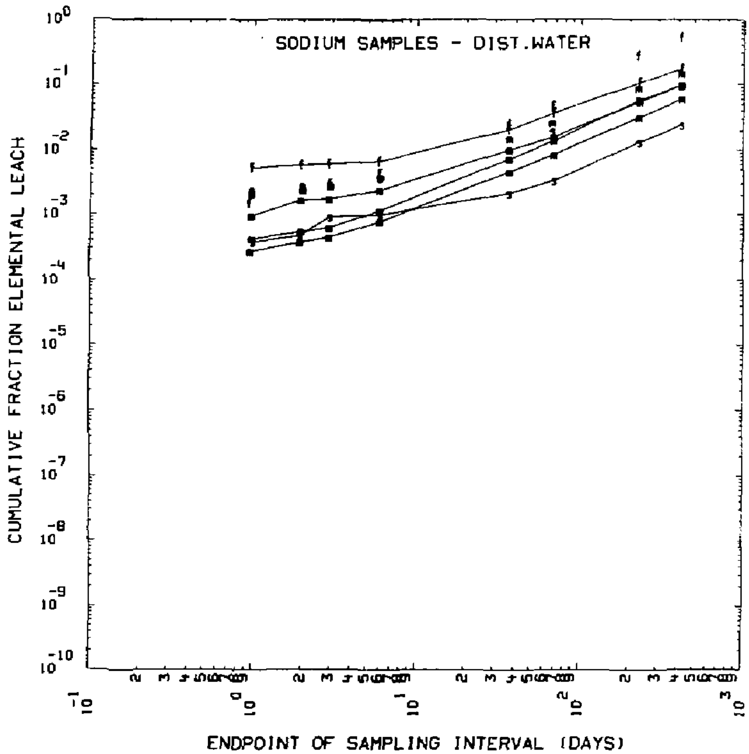


CALCIUM SAMPLES - BICARBONATE
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)


CALCIUM SAMPLES - DIST.WATER
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)

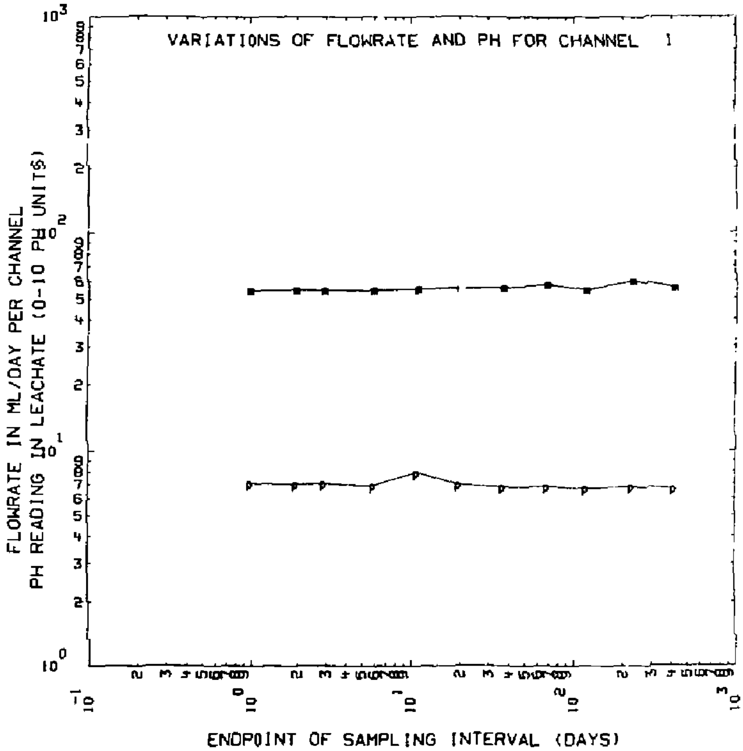


SODIUM SAMPLES - BICARBONATE
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)

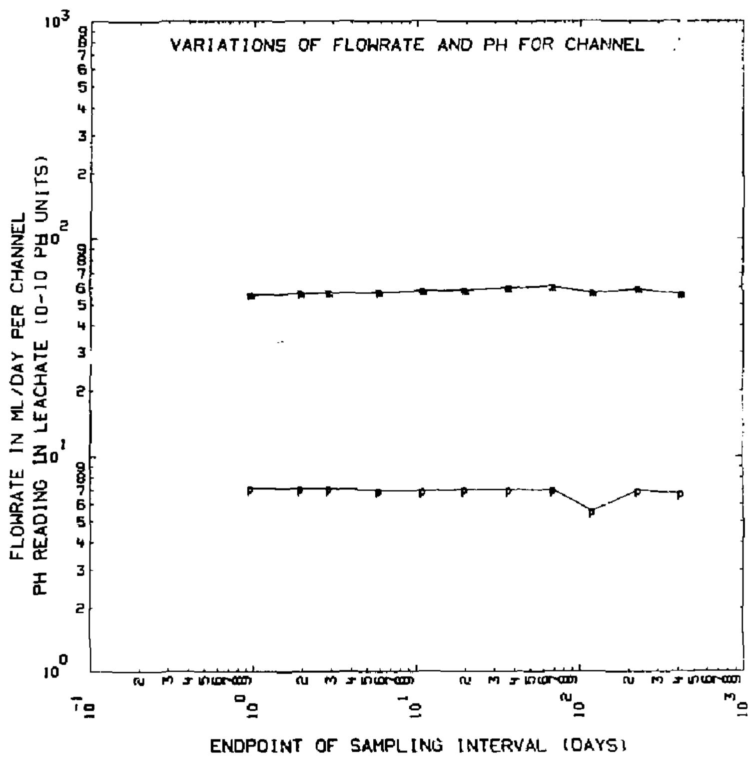

SODIUM SAMPLES - DIST.WATER
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)

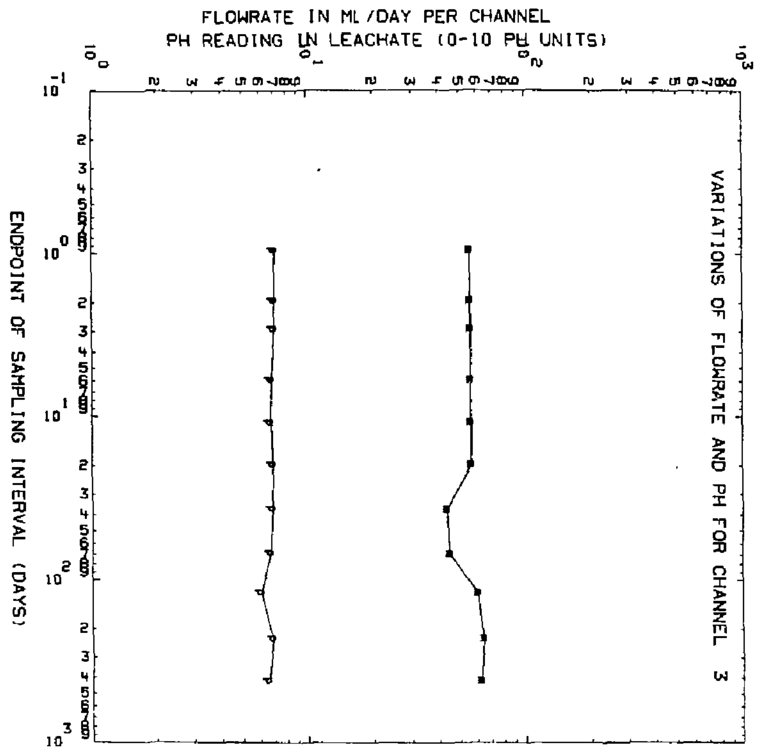
APPENDIX 14

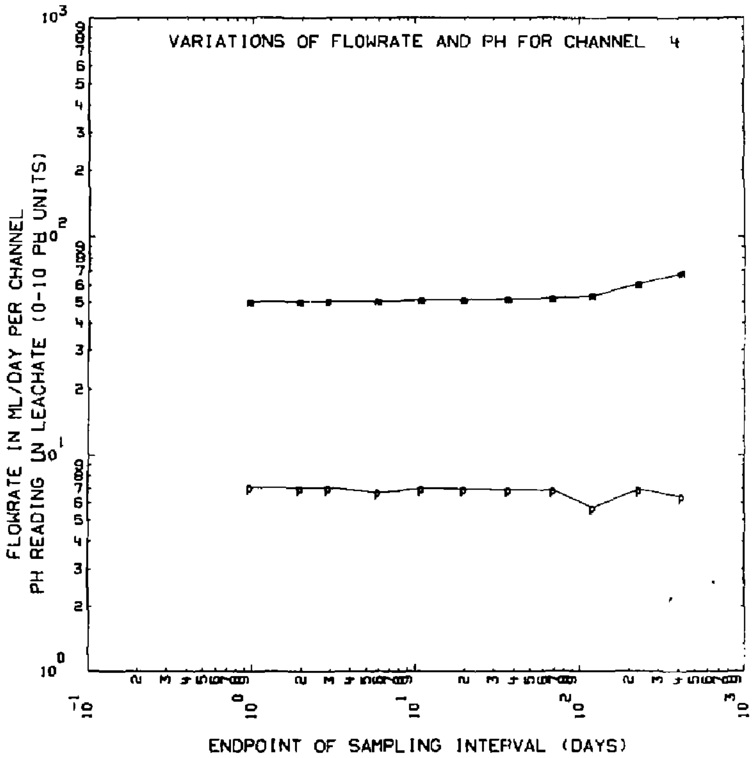
Graphs of Log Flow Rate and Log pH Against Log Time for all 28 Channels.



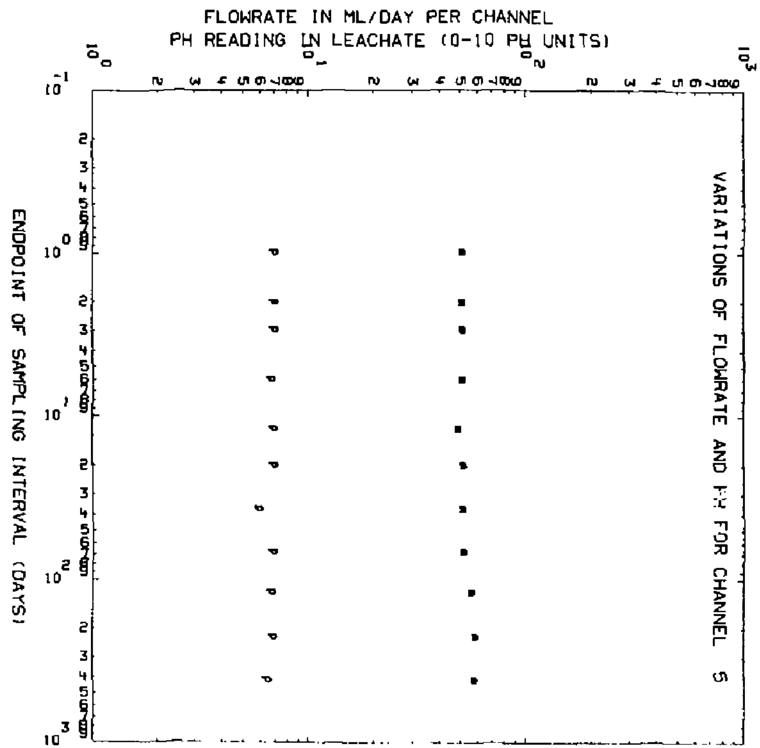
VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 1
FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

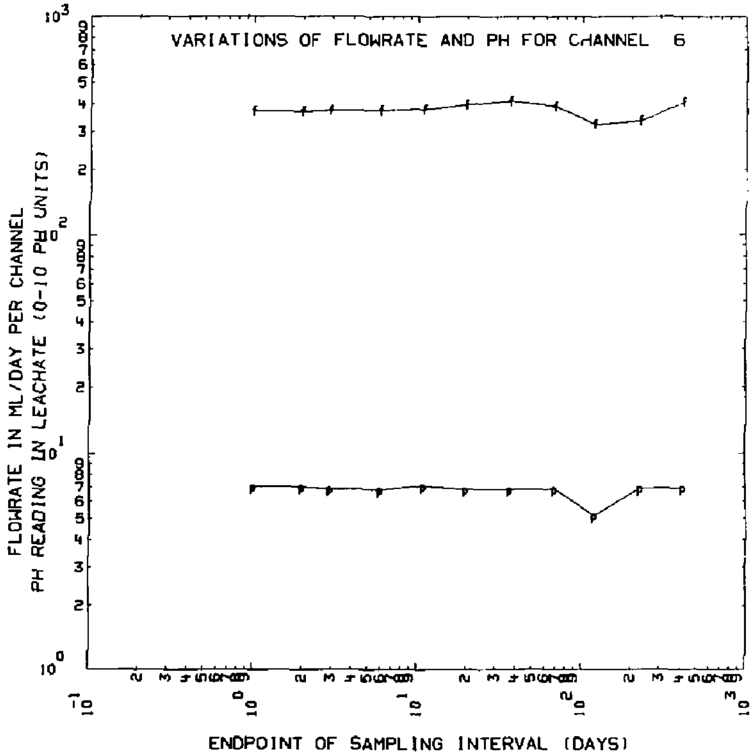

VARIATIONS OF FLOWRATE AND PH FOR CHANNEL
FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

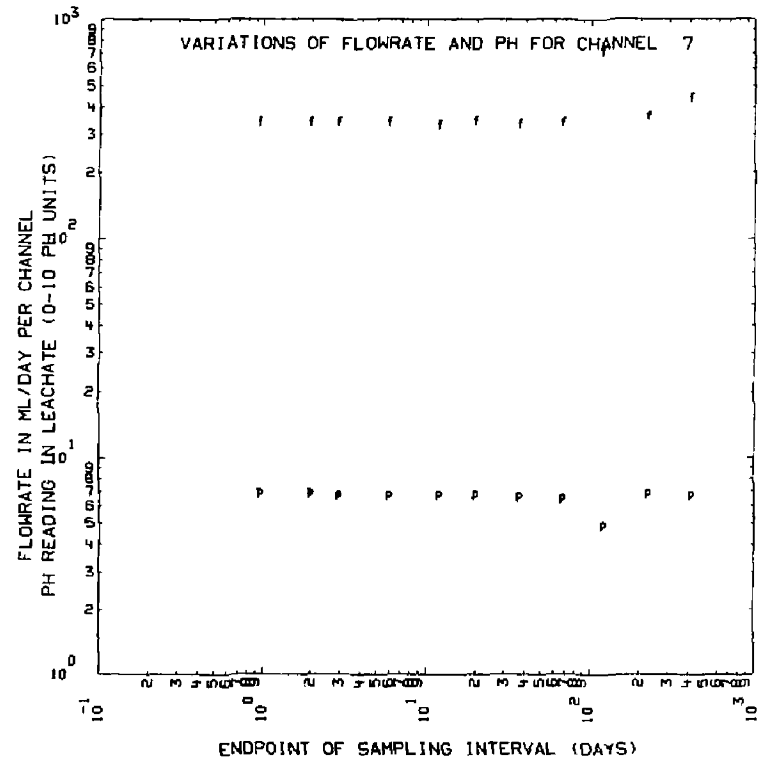

FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 3
ENDPOINT OF SAMPLING INTERVAL (DAYS)

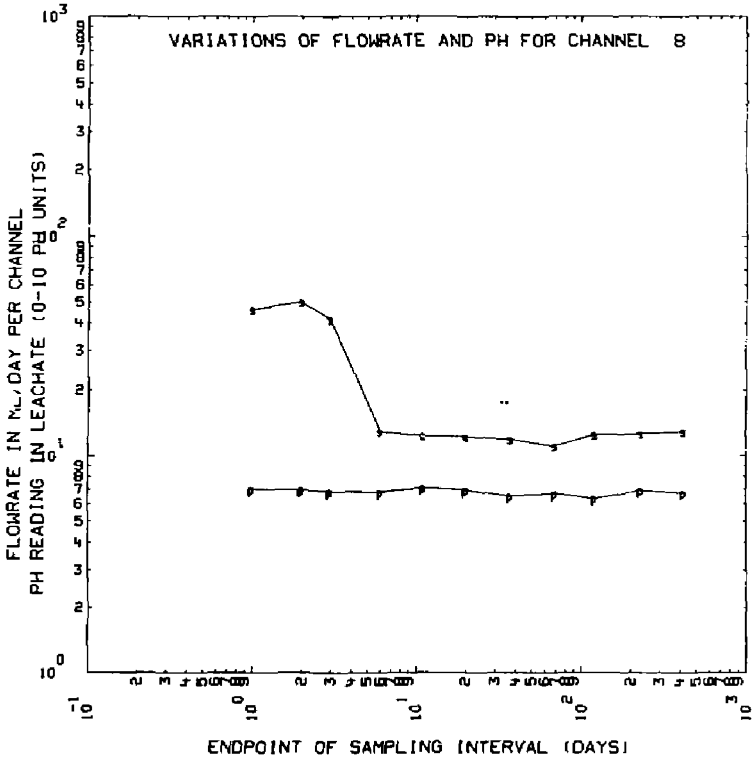


VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 4
FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

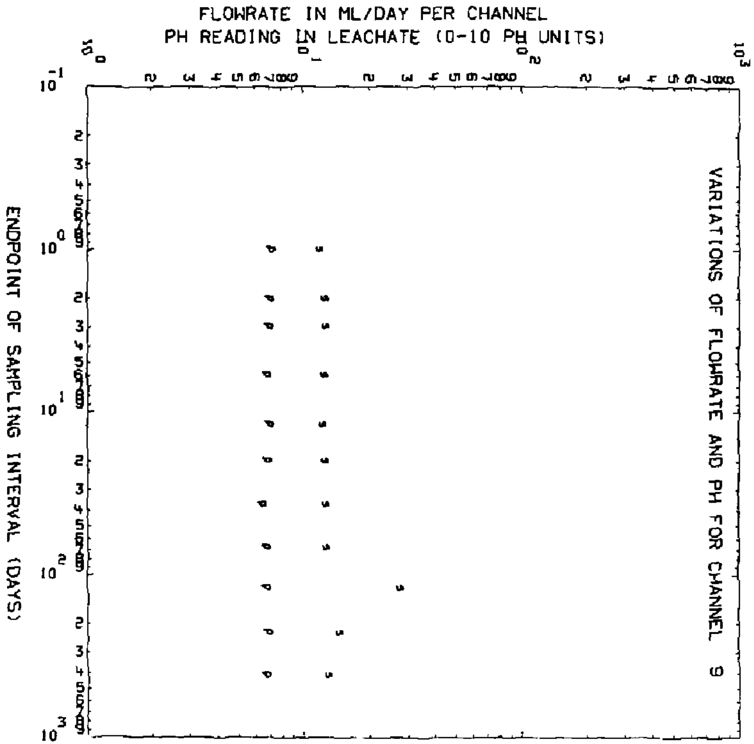

FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 5
ENDPOINT OF SAMPLING INTERVAL (DAYS)

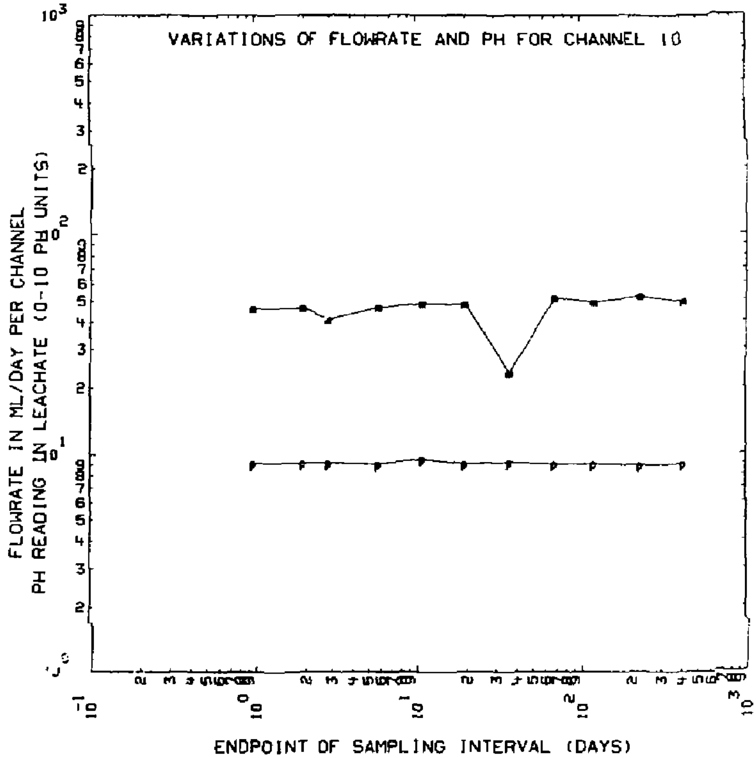

VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 6
FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

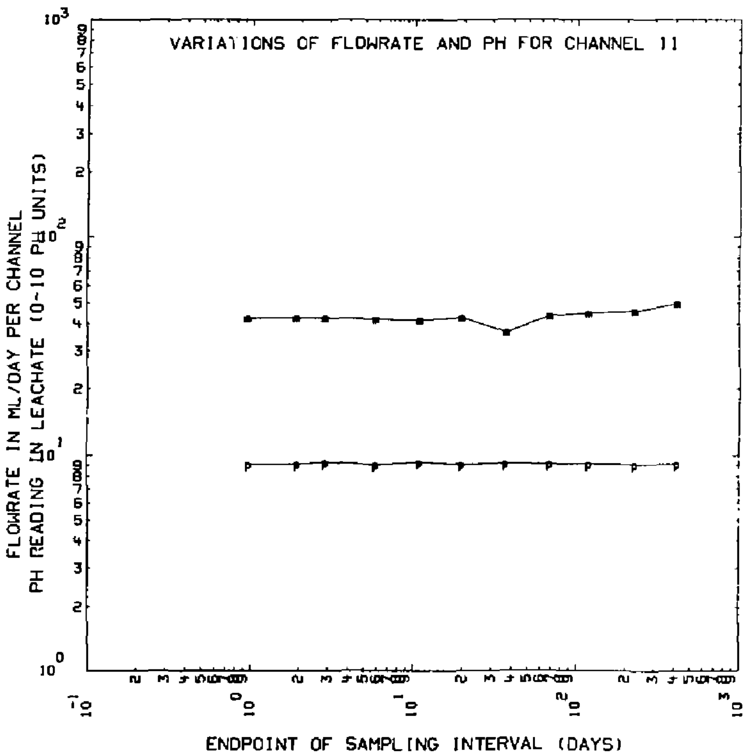

VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 7
FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)



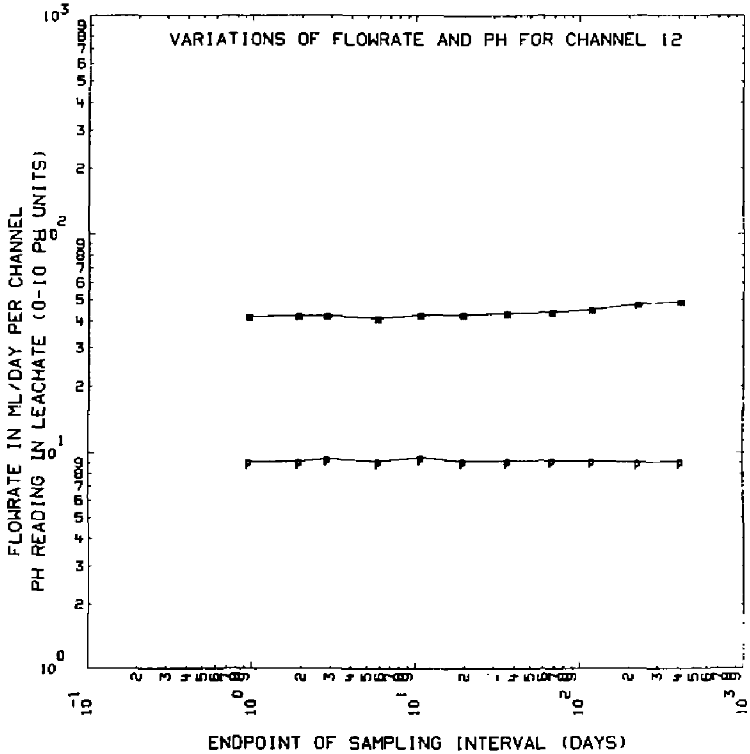
VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 8
FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

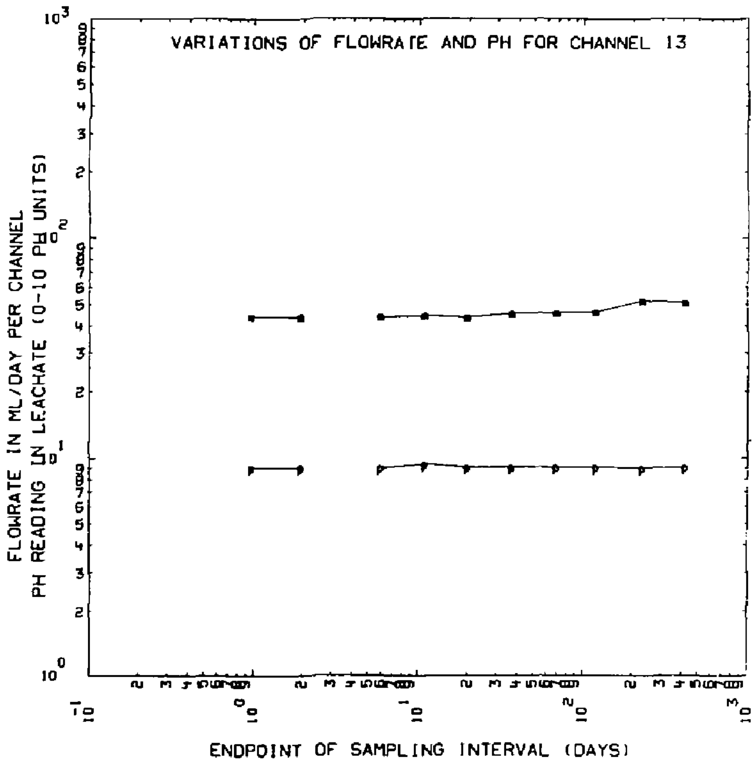

FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)
VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 9

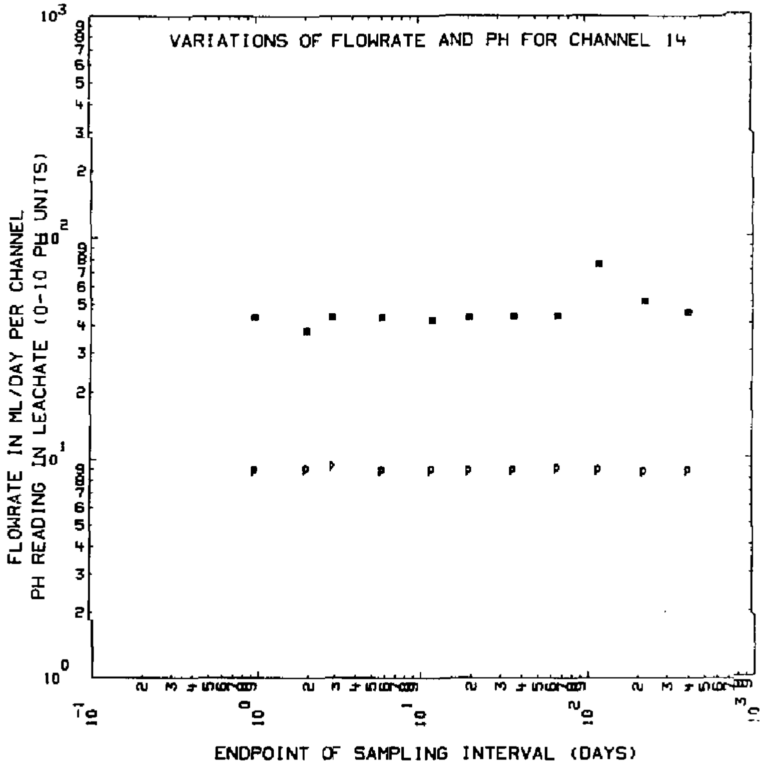

VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 10
FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

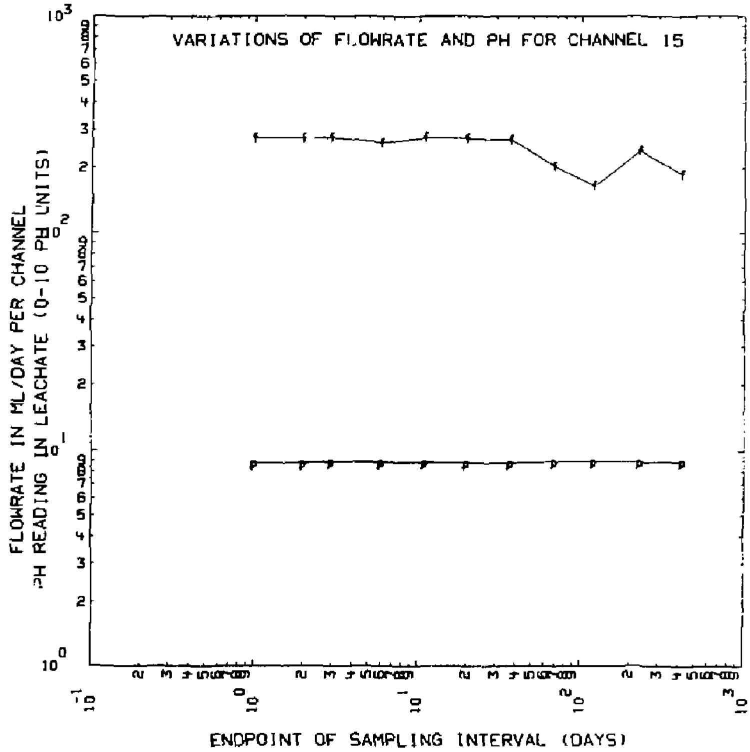


VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 11
FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

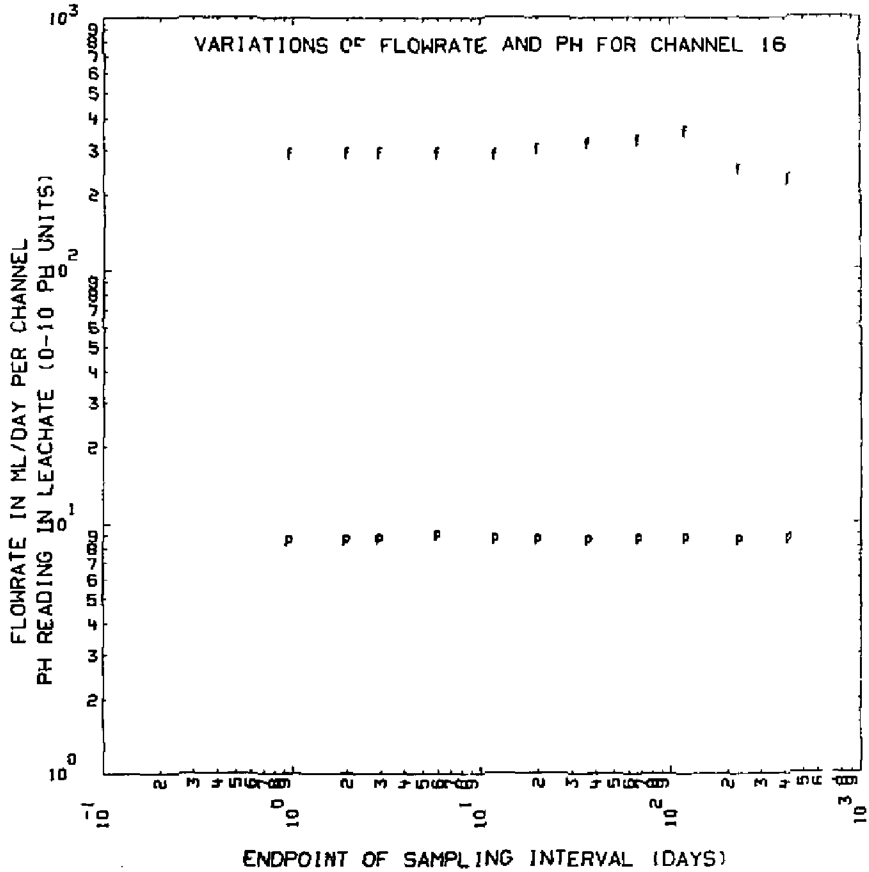

VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 12
FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

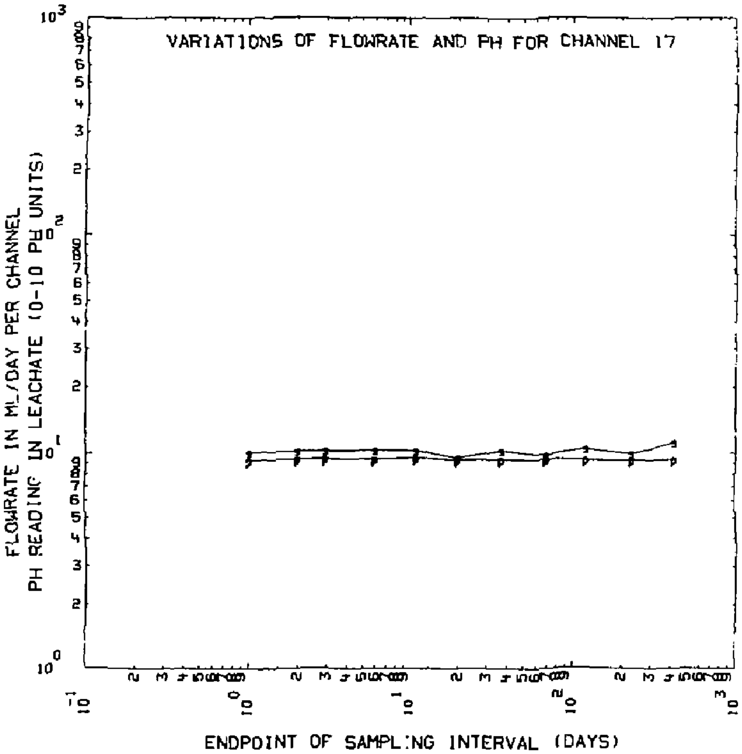

VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 13
FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

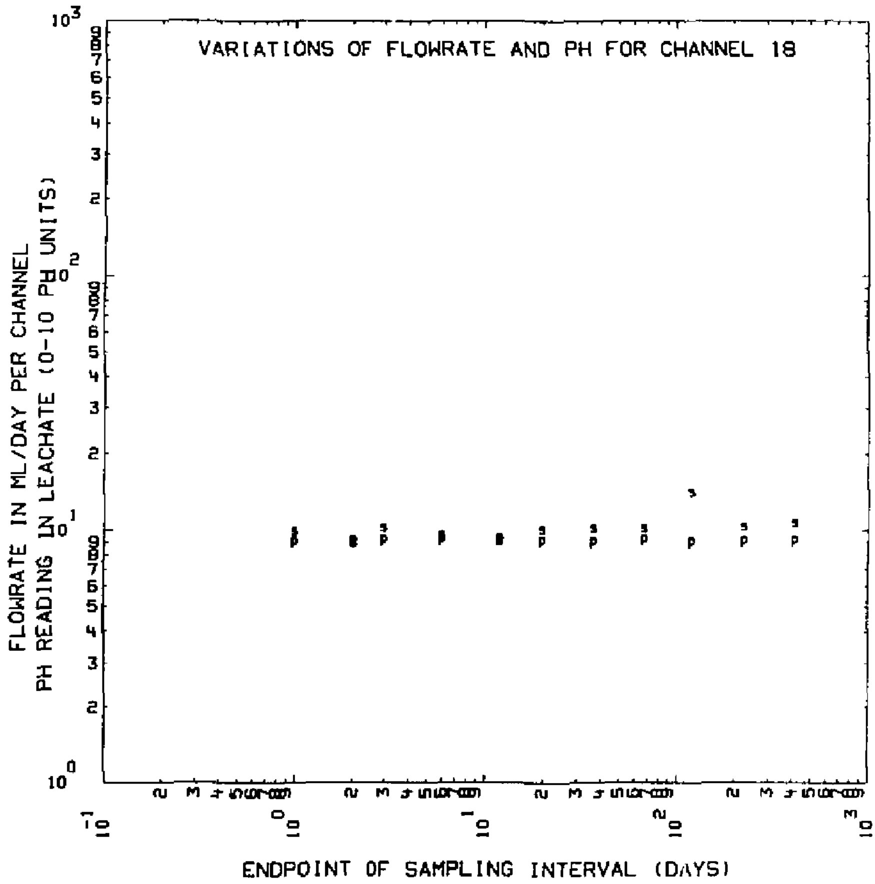

VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 14
FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

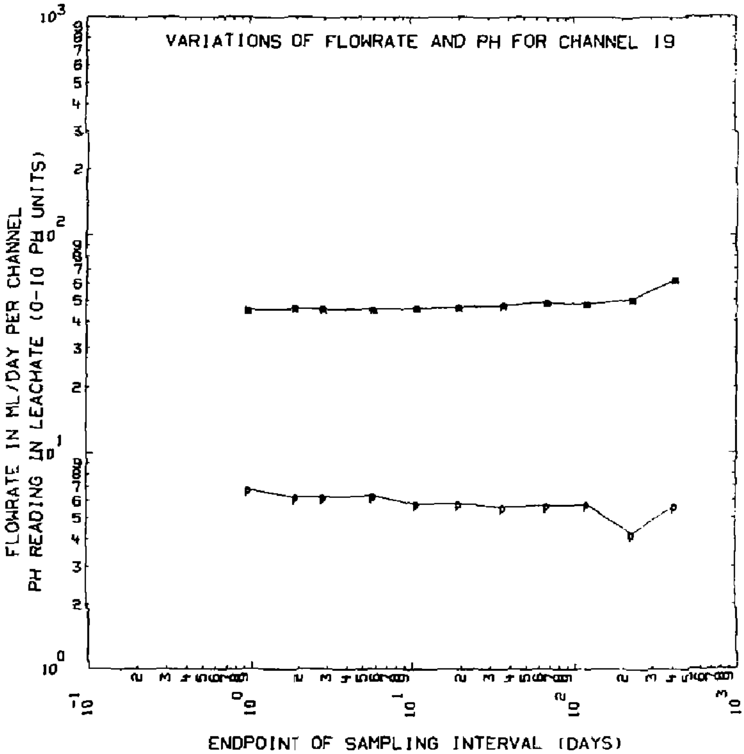


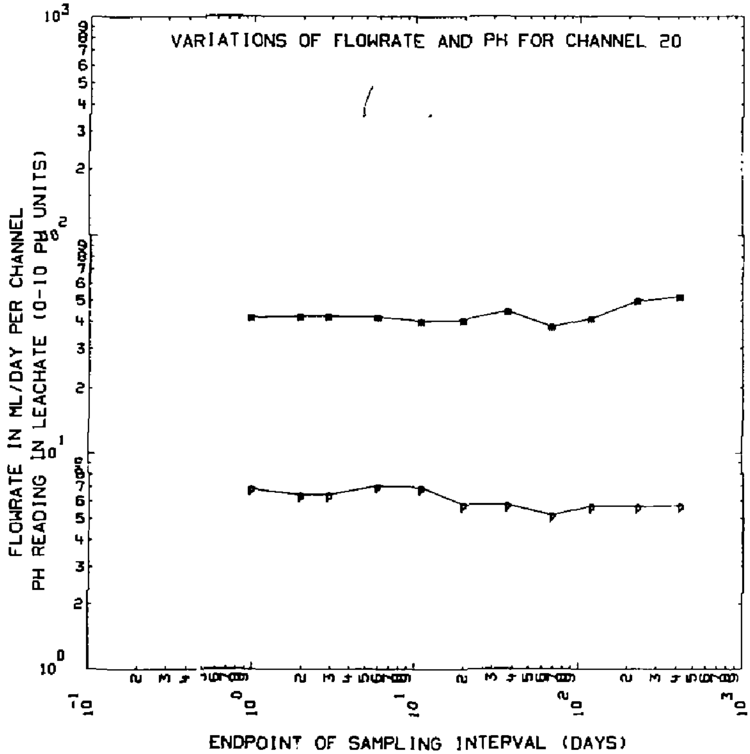
VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 15
FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)


VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 16
FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

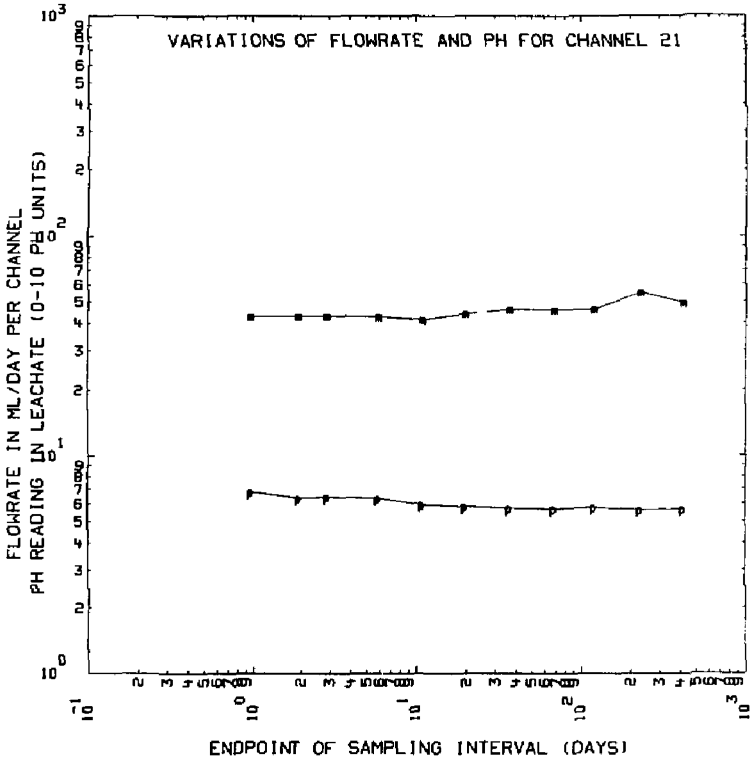

VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 17
FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

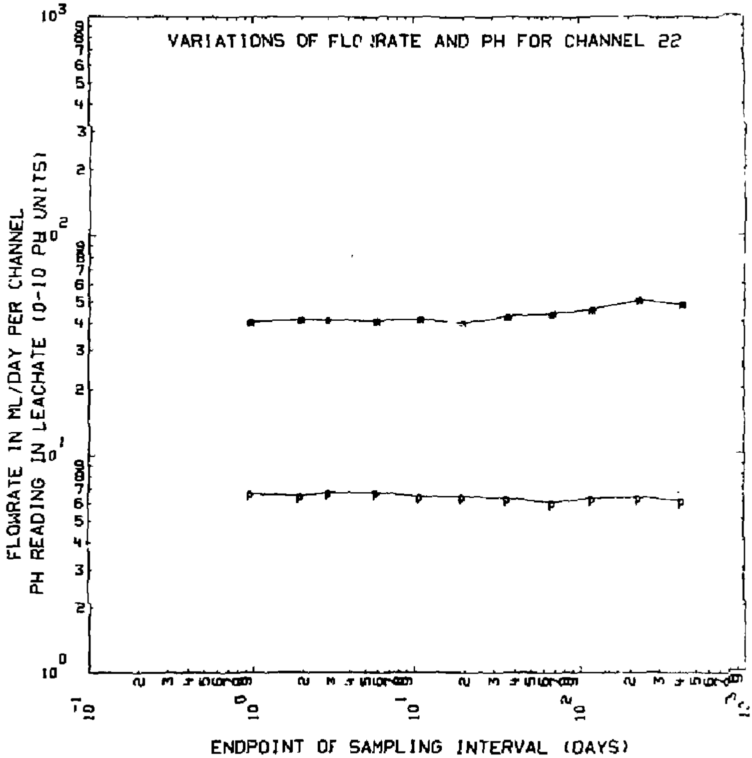

VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 18
FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)


VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 19
FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

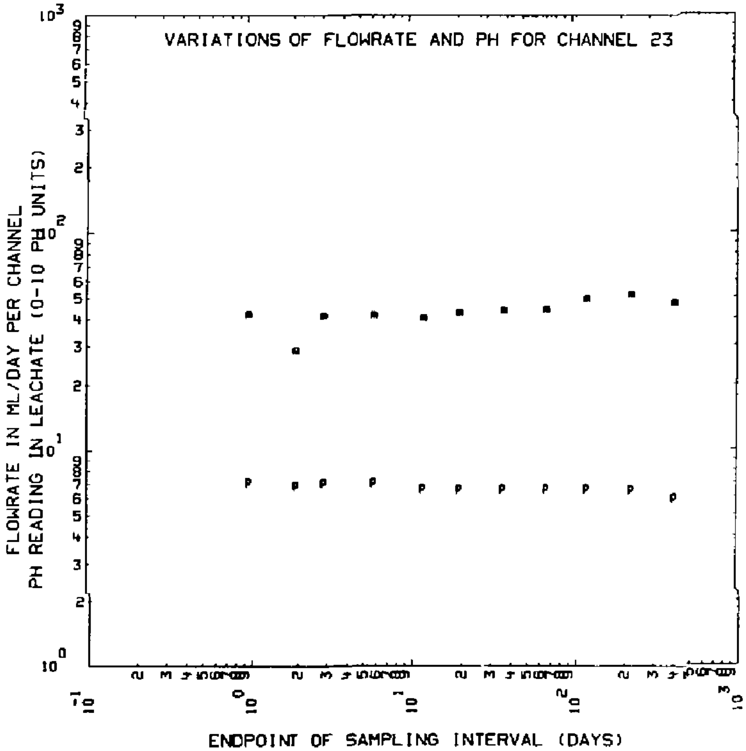


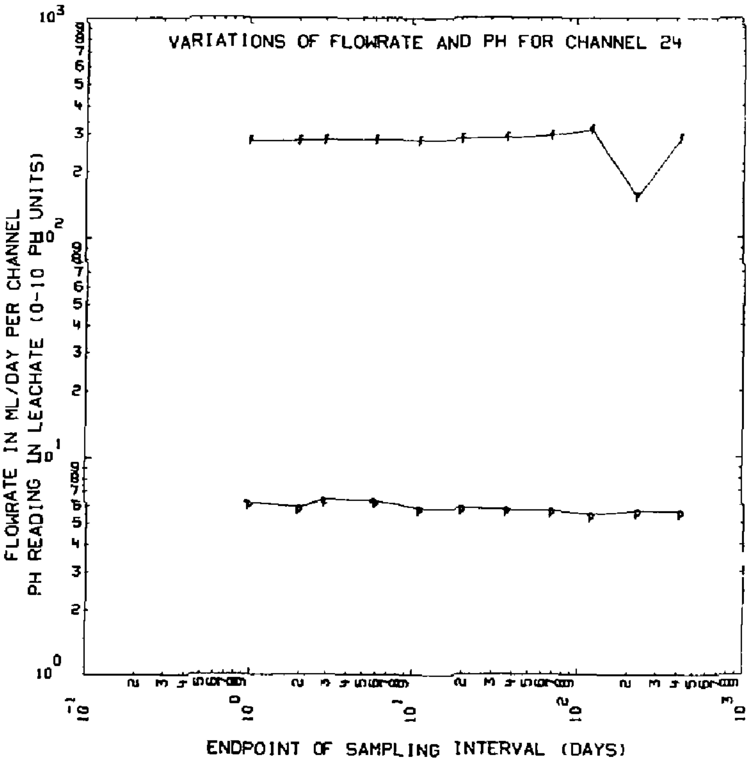
VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 20
FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)


VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 21
FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

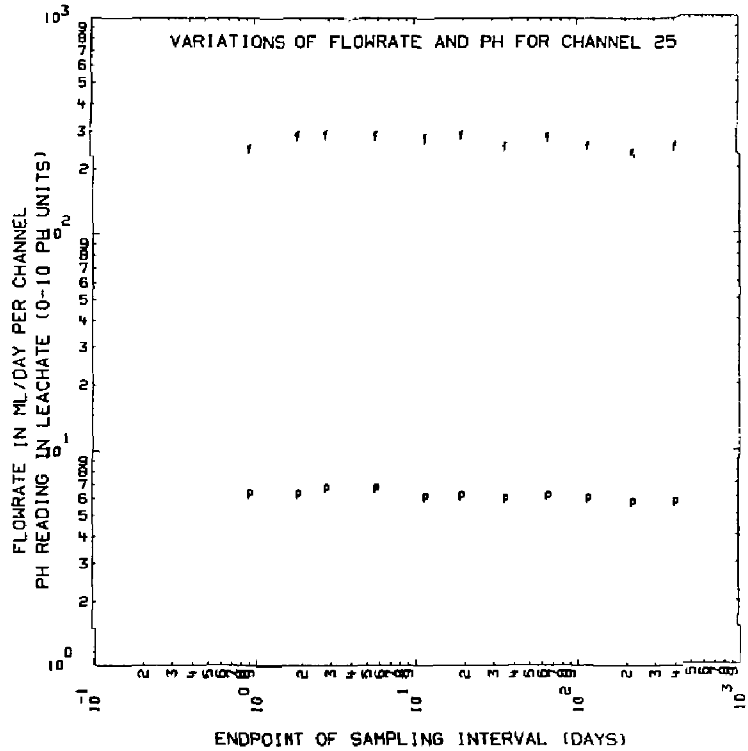


VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 22
FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

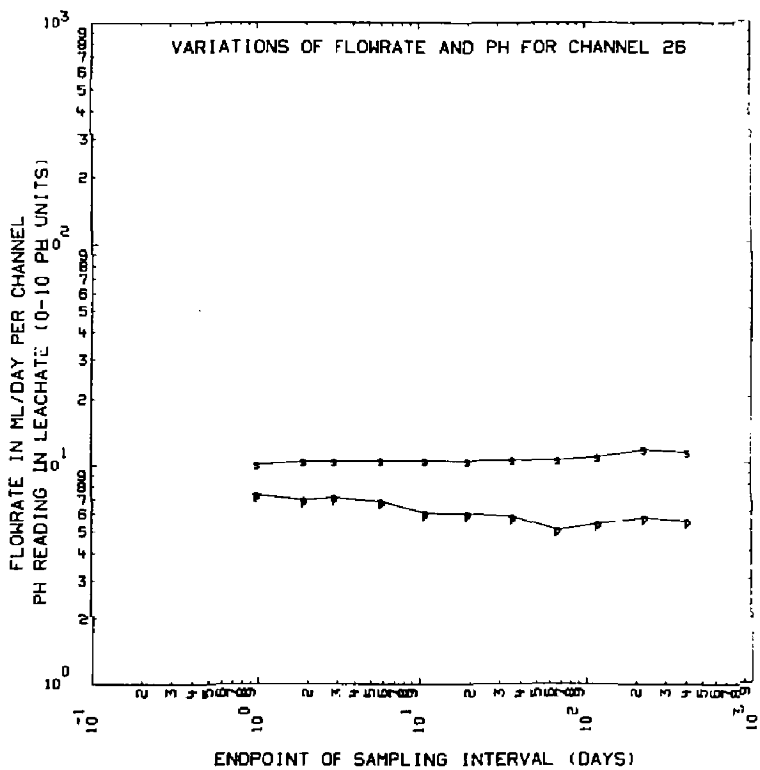

VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 23
FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

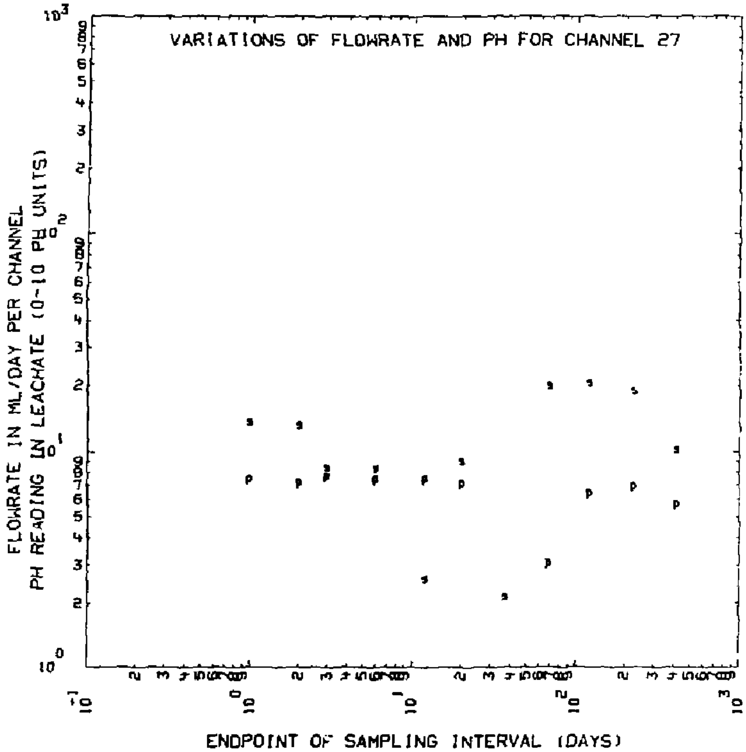


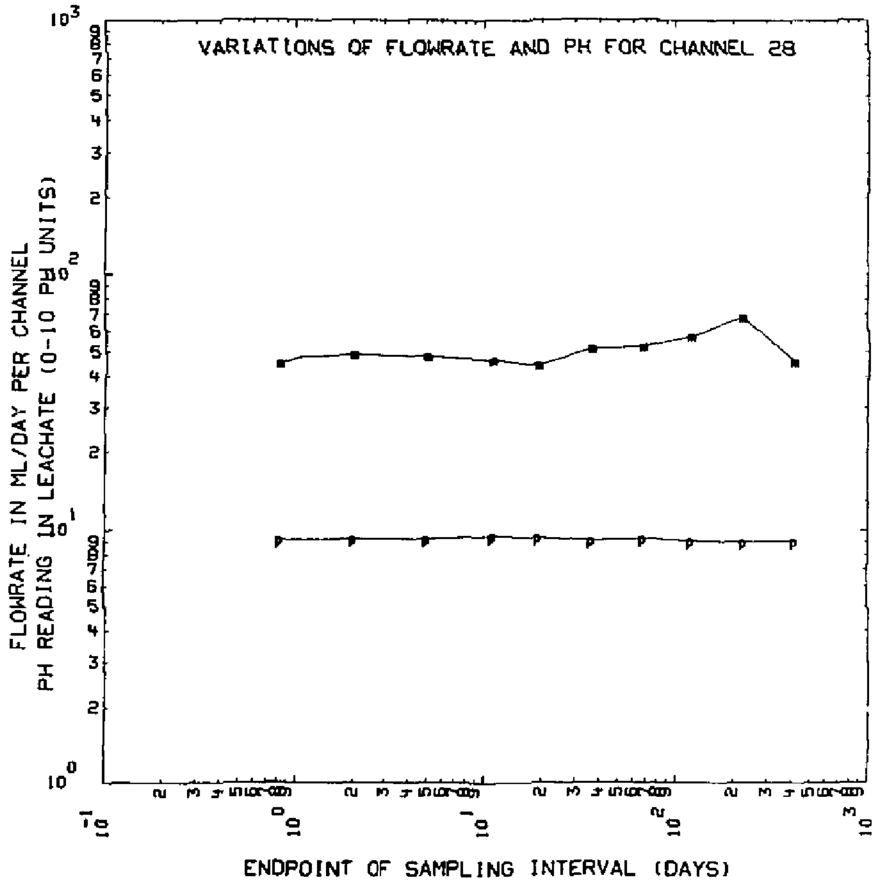
VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 24
FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)



VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 25
FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)


VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 26
FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)


VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 27
FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)



VARIATIONS OF FLOWRATE AND PH FOR CHANNEL 28
FLOWRATE IN ML/DAY PER CHANNEL
PH READING IN LEACHATE (0-10 PH UNITS)
ENDPOINT OF SAMPLING INTERVAL (DAYS)