

USEcology

an American Ecology company

May 1, 1986

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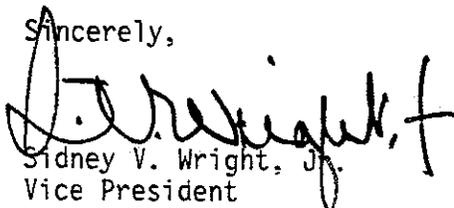
Dear Mrs. Kirner:

Attached please find two (2) copies of a report describing the subsurface investigation and monitoring well installation recently completed at our Richland, Washington low-level radioactive waste disposal facility. Five monitoring wells have now been installed at the site and a sampling program has begun. Copies of laboratory analyses will continue to be transmitted to you in accordance with license requirements.

As you are aware, our license will require the completion of a dose model and radionuclide pathway analysis for the Richland facility. We are in the process of developing a work plan to identify the tasks required prior to commencing of the actual study. Since this study will identify potential pathways for migration into the groundwater, we are proposing to delay installation of any additional wells until completion of this study. At the completion of this study, we would also have several sets of monitoring data from the existing wells which will provide additional information to be used in locating any additional wells.

If you have any questions regarding this submittal, please contact R. E. Sauer.

Sincerely,


Sidney V. Wright, J.
Vice President
Radiological Division

SVW/jn
Attachments

R125-2

REPORT OF HYDROGEOLOGIC INVESTIGATION
AND MONITORING WELL INSTALLATION
AT THE RICHLAND, WASHINGTON
LOW-LEVEL RADIOACTIVE WASTE DISPOSAL FACILITY

US ECOLOGY, INC.

April 21, 1986

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1.0 INTRODUCTION

US Ecology, Inc., operates a low-level radioactive waste (LLRW) disposal facility near Richland, Washington. This facility operates under license WN-I019-2 issued by the state of Washington, Department of Social and Health Services, and under a license issued by the U.S. Nuclear Regulatory Commission (NRC), No. 16-19204-01.

Beginning in June 1985, a hydrogeologic investigation was conducted to characterize the geology and groundwater regime beneath the site. Work was concluded in December 1985, with the installation of four groundwater monitoring wells along the eastern perimeter of the disposal area, and one background well 600 feet west of the site. Each well was constructed to intercept and sample the uppermost aquifer, which was encountered over 300 feet beneath the ground surface. This construction involved the use of 40 feet of well screen and a dedicated (permanently installed) two pump purging and sampling system. Water level data collected since December confirm that the monitoring wells are located hydraulically downgradient of the disposal area and that the background well is upgradient. The system is shown, therefore, to be fully capable of monitoring groundwater quality beneath the Richland LLRW facility.

Prior to the installation of this monitoring network, groundwater quality data for the aquifer beneath the Richland area was obtained from the U.S. Department of Energy (DOE) and Rockwell Hanford Operations, who monitor their various facilities in the vicinity. US Ecology's groundwater monitoring system will augment the data collected by these agencies and may also help define contamination from their sources.

The following report summarizes and discusses the data collected during the hydrogeologic investigation and well installation. Reference is made to reports prepared by CH2M-Hill, Inc., and Benjamin F. Hajek Consulting Services who supervised well installation and performed laboratory analyses of the samples taken during drilling. These reports are included as Attachments I and II, respectively.

2.0 BACKGROUND

2.1 Facility Location

The Richland LLRW disposal facility is located on 100 acres within the boundaries of the DOE's Hanford Reservation. To date, the LLRW disposal operations have utilized only 24 acres of the 100 permitted. The Hanford Reservation began operation in the 1940's as a repository for waste generated by the Manhattan Project. The Hanford Reservation is the site of several nuclear reactors as well as research on nuclear energy and waste disposal.

The US Ecology LLRW facility is located adjacent to the 200 East Area of the Hanford Reservation. The 200 East and 200 West Areas are located near the center of the reservation and are utilized for fuel separations and waste disposal. Figure 1 illustrates the location of the Hanford Reservation and the LLRW facility.

The Hanford Reservation is located within the Pasco Basin area of southern Washington, near the confluence of the Columbia and Yakima Rivers. The nearest population center is Richland, Washington, which is located about three miles from the southernmost boundary of the reservation. The reservation is surrounded by the Rocky Mountains to the east and the Cascade Mountains to the west and south. Locally, several basalt ridges provide natural boundaries within the basin, further subdividing the area.

The LLRW facility is located between Gable Mountain and Gable Butte to the north, Yakima Ridge to the west, and Rattlesnake Hills and Red Mountain to the south. The Columbia River is the nearest natural surface water body to the facility and is located about twelve miles to the east.

2.2 Climatology

The Pasco basin is located in the rain shadow of the Cascade Mountains and receives an average annual rainfall of about 6.3 inches. Most of this occurs during the winter. The area is

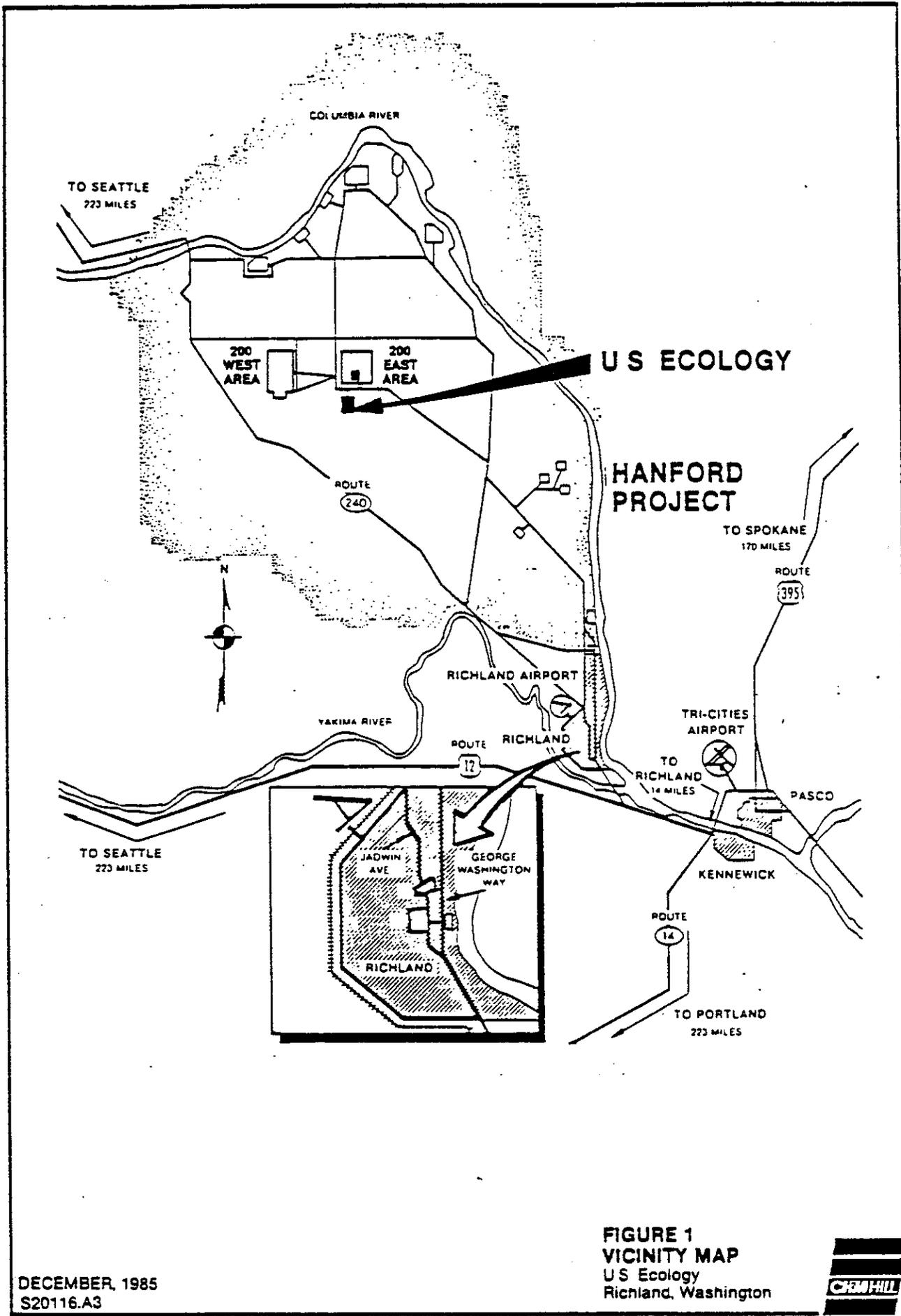


FIGURE 1
VICINITY MAP
 U.S. Ecology
 Richland, Washington



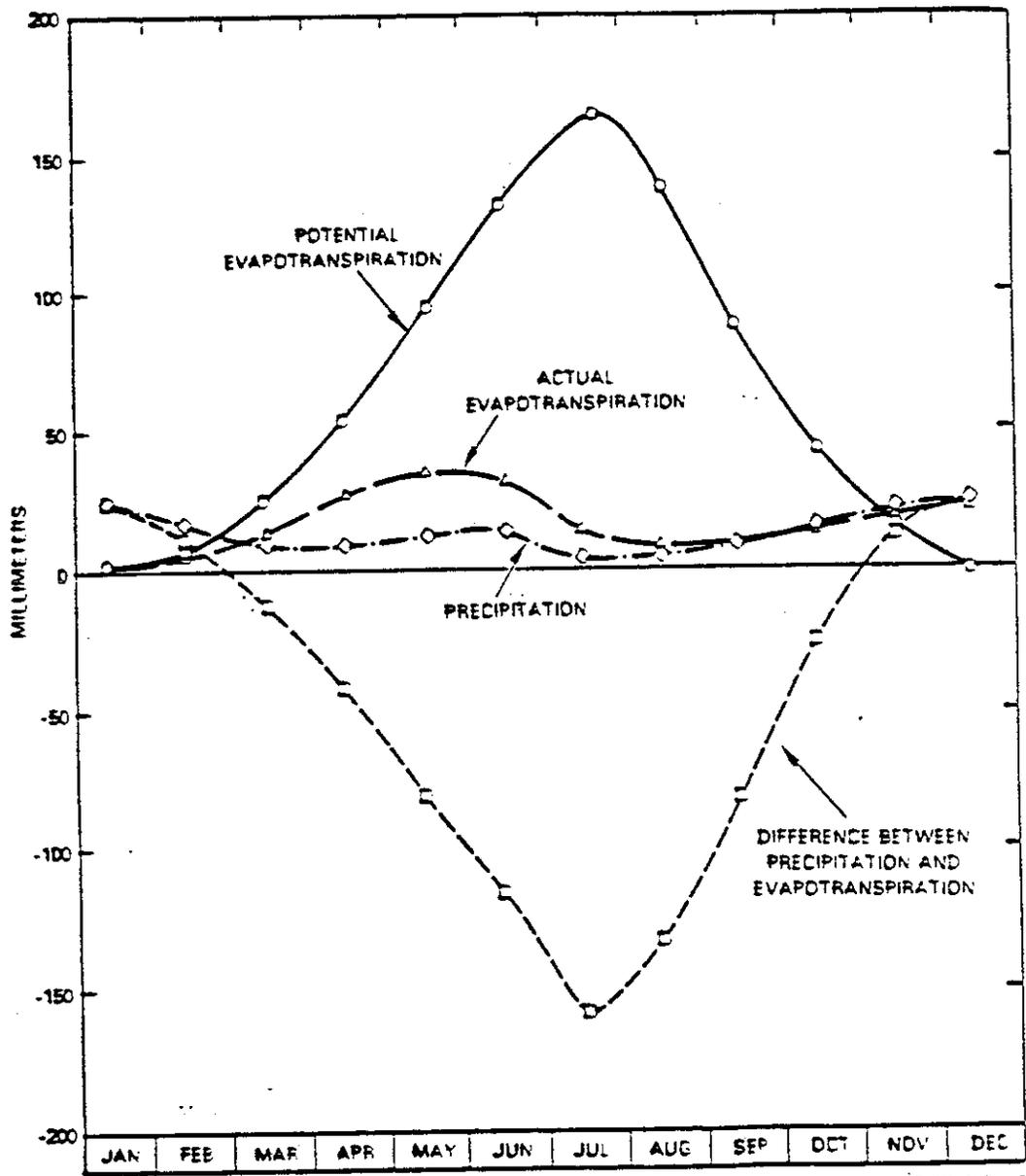
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classified as a midlatitude semiarid desert. The potential evapotranspiration (PET) is between 28 and 33 inches per year. Water balance computations, performed as part of the Basalt Waste Isolation Project (BWIP), indicate the annual PET to be about 29.4 inches. Figure 2 is a graphical representation of the computed water balance and shows that precipitation is exceeded by evapotranspiration during nine months of the year. Infiltration can occur only during the period between November and January, when precipitation exceeds evapotranspiration. The net moisture deficit is found by subtracting the annual average rainfall from PET. Based on PET value of 29.4 inches, the net deficit for the LLRW facility is 23.1 inches annually.

2.3 Geology

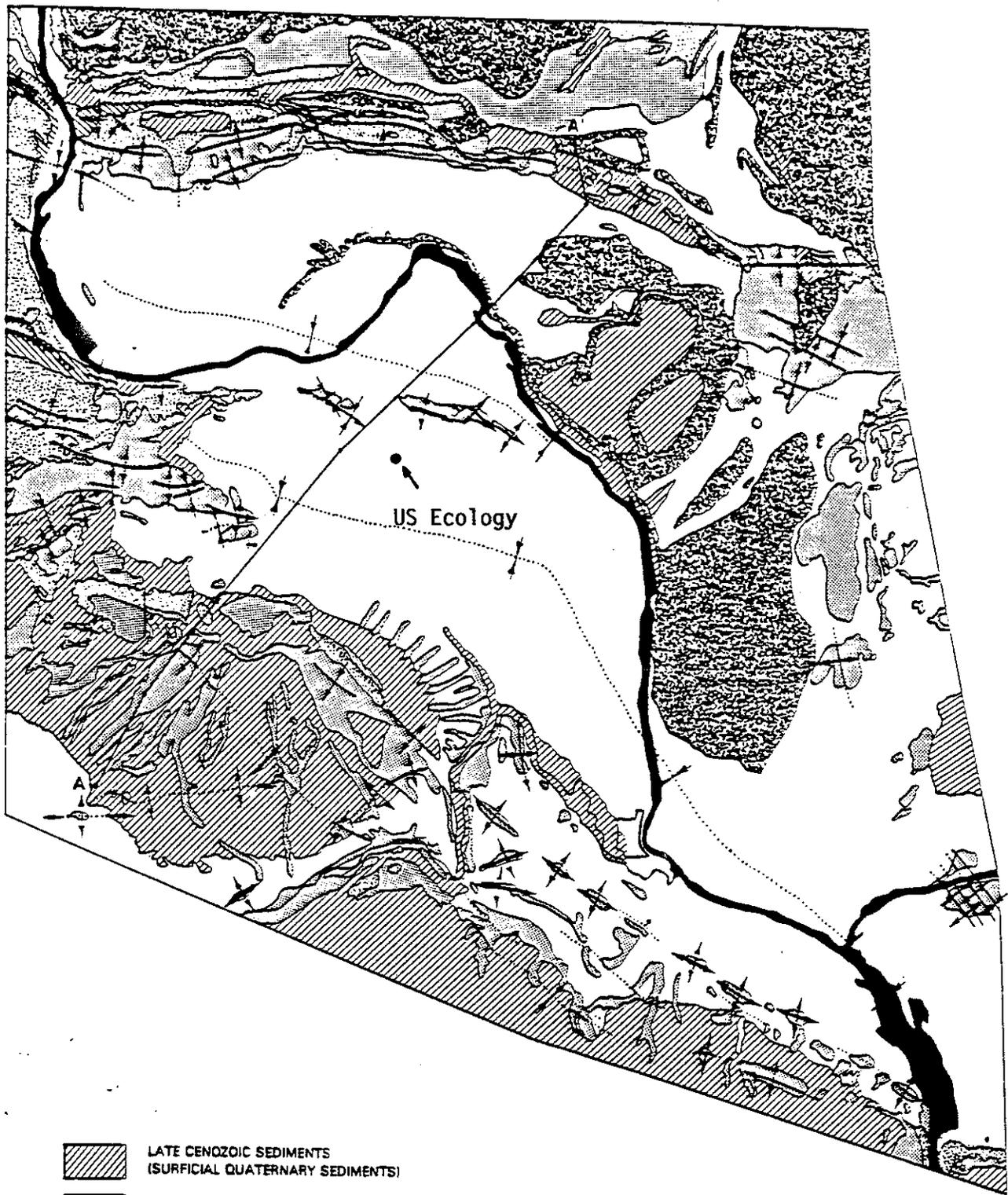
The Pasco basin is underlain by basalt flows of the Columbia River Basalt Group. The basalt sequences are interbedded with erosional sediments, and are in excess of 700 feet in thickness. The basalt outcrops within the Hanford Reservation and near the facility. Figure 3 is a geologic map showing the surficial geology and general structural geology of the area. Figure 4 is a cross-section showing the relationships of the various units, and Figure 5 is a stratigraphic column for the area. The upper unconsolidated sediments are contained in the Ringold and Hanford formations which are alluvial and colluvial in origin. The Hanford formation consists of sands, silts, clays and some gravels, which were deposited in alluvial fans. The Ringold formation is mostly sands, silts and clays, with some gravels and cobbles, and is either partially cemented or cemented. The Hanford and Ringold formations extend from the surface to a depth of about 510 feet near the LLRW facility (Rockwell, 1982).

The upper 50 to 100 feet of material consists of fine sand to silt and is uncemented. Several distinct zones of volcanic ash are reported within the upper 50 feet (Rockwell, 1982). One prominent ash layer was encountered during drilling and is described in Section 4.1.



RCP8112-116

FIGURE 2 Water Balance at Hanford.



 LATE CENOZOIC SEDIMENTS
(SURFICIAL QUATERNARY SEDIMENTS)

 HANFORD FORMATION

 RINGOLD FORMATION

 SADDLE MOUNTAINS BASALT

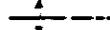
 WANAPUM BASALT

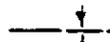
 GRANDE RONDE BASALT

0 5 10 KILOMETERS

0 5 MILES

 FAULT

 ANTICLINE

 SYNCLINE

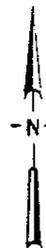


FIGURE 3

RCPE202-51

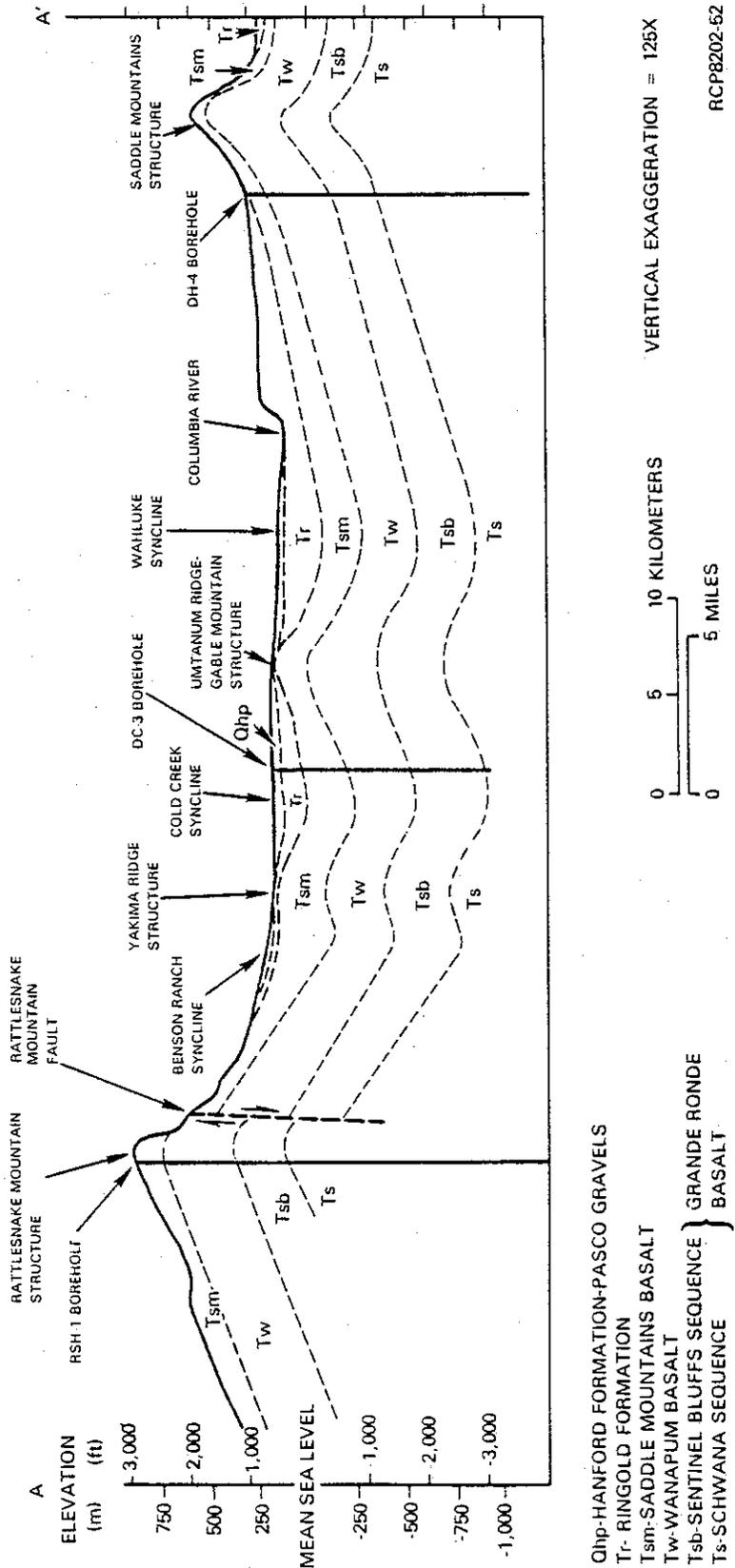


FIGURE 4 Generalized Structure Cross Section. (See Fig. 3 for location.)

PERIOD	EPOCH	GROUP	SUBGROUP	FORMATION	K-Ar AGE YEARS ± 106	MEMBER OR SEQUENCE	SEDIMENT STRATIGRAPHY OR BASALT FLOWS
QUATERNARY	Pleistocene/Holocene					SURFICIAL UNITS	LOESS DUNE SAND ALLUVIUM LANDSLIDES TALUS COLLUVIUM
						TOUCHET BEDS	PASCO GRAVELS
QUATERNARY	Pleistocene			Ringold		UPPER RINGOLD	RINGOLD FANGLOMERATE TRANSGRESSES RINGOLD TIME ANGULAR TO SUB ANGULAR BASALT FRAGMENTS IN THE SAND AND SILT
						MIDDLE RINGOLD	
LOWER RINGOLD	SAND AND GRAVEL VARIABLY WELL SORTED COMPACT BUT VARIABLY CEMENTED						
BASAL RINGOLD	SAND SILT AND CLAY INTERBEDDED GRAVEL AND SAND						
TERTIARY	Miocene	Columbia River Basalt Group	Yakima Basalt Subgroup	Saddle Mountains Basalt	8.5	ICE HARBOR MEMBER	GOOSE ISLAND FLOW MARTINDALE FLOW BASIN CITY FLOW LEVEY INTERBED
						ELEPHANT MOUNTAIN MEMBER	UPPER ELEPHANT MOUNTAIN FLOW LOWER ELEPHANT MOUNTAIN FLOW RATTLESNAKE RIDGE INTERBED
					10.5	POMONA MEMBER	UPPER POMONA FLOW LOWER POMONA FLOW SELAH INTERBED
					12.0	ESQUATZEL MEMBER	UPPER GABLE MOUNTAIN FLOW GABLE MOUNTAIN INTERBED LOWER GABLE MOUNTAIN FLOW COLD CREEK INTERBED
						ASOTIN MEMBER	HUNTZINGER FLOW
						WILBUR CREEK MEMBER	WAHLUKE FLOW
						UMATILLA MEMBER	SILLUSI FLOW UMATILLA FLOW
			Wanapum Basalt		13.6	PRIEST RAPIDS MEMBER	MABTON INTERBED LOLO FLOW ROSALIA FLOW QUINCY INTERBED
		ROZA MEMBER				UPPER ROZA FLOW LOWER ROZA FLOW SQUAW CREEK INTERBED	
			Grande Ronde Basalt		14.5	FRENCHMAN SPRINGS MEMBER	APHYRIC FLOWS PHYRIC FLOWS
		SENTINEL BLUFFS SEQUENCE				VANTAGE INTERBED UPPER FLOWS MIDDLE SENTINEL BLUFFS FLOW LOWER FLOWS McCOY CANYON FLOW	
					16.5	SCHWANA SEQUENCE	INTERMEDIATE-Mg FLOW LOW-Mg FLOW ABOVE UMTANUM UMTANUM FLOW HIGH-Mg FLOW BELOW UMTANUM VERY HIGH-Mg FLOWS AT LEAST 30 LOW-Mg FLOWS

ELLENSBURG FORMATION

RCP8204-1A

FIGURE 5 Stratigraphic Nomenclature, Pasco Basin, Cold Creek Syncline.

2.4 Hydrology

The groundwater at the Hanford site occurs under both confined and unconfined conditions. The confined aquifers consist of sedimentary interbeds between basalt units. The basalts and some clay-rich interbeds serve as aquitards. The unconfined aquifer is contained within the Hanford and Ringold formations. The water table at the facility was expected at a depth of 320 to 330 feet below the ground surface or at an elevation 403 to 410 feet [referenced to mean sea level (MSL)].

The aquifer characteristics for the unconfined aquifer have been developed by pump tests, conducted by Battelle and Rockwell, in a number of monitoring wells. The unconfined aquifer ranges in thickness from 0 to 230 feet, and the depth to water ranges from one foot, near the Columbia River, to 350 feet near the center of the reservation. Figure 6 is a water table map for the unconfined aquifer. Figure 7 is a comparison of hydraulic heads in the confined aquifer and the unconfined aquifer above it. This figure shows that the heads are nearly the same in the area of the Richland facility, indicating a very low potential for migration of groundwater from one aquifer to the next.

The unconfined aquifer is recharged by the infiltration of precipitation along the flanks of the basalt ridges. The thickness, low moisture content, low precipitation and high evapotranspiration reduces or eliminates any natural infiltration through the unsaturated sediments in the basin.

In 1971, an ongoing project was begun by Rockwell to assess the movement of moisture through the unsaturated zone. Using weighing lysimeters and neutron moisture probes, the moisture content variation over time was measured for the upper 55 feet of the unsaturated zone. The moisture content was found to fluctuate only in the upper six to seven feet of the material. Below 40 feet, the moisture content remained constant, varying by less than 0.25 percent over the year (Jones, 1978).

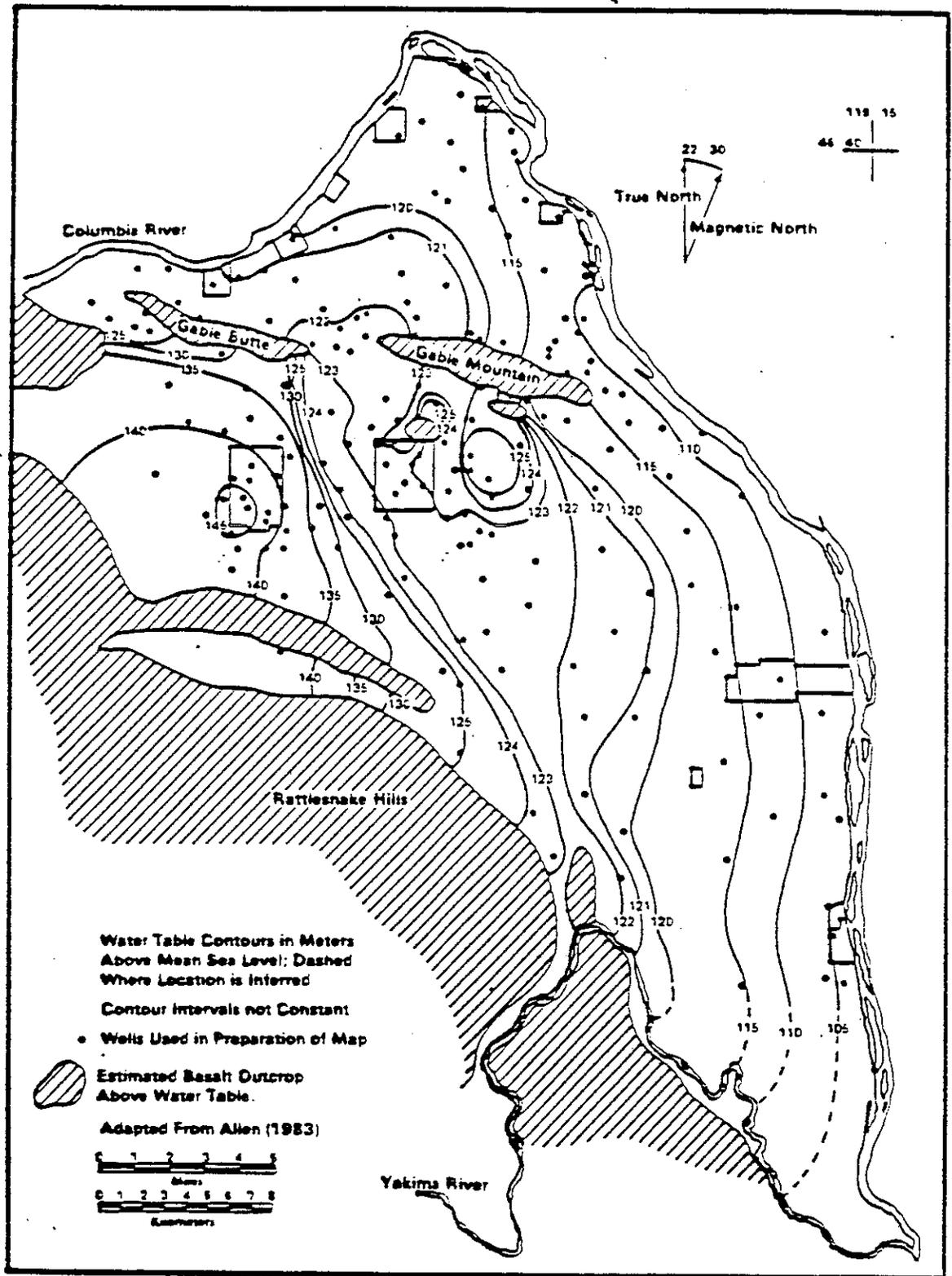


FIGURE 6 Water Table Elevations - December, 1983

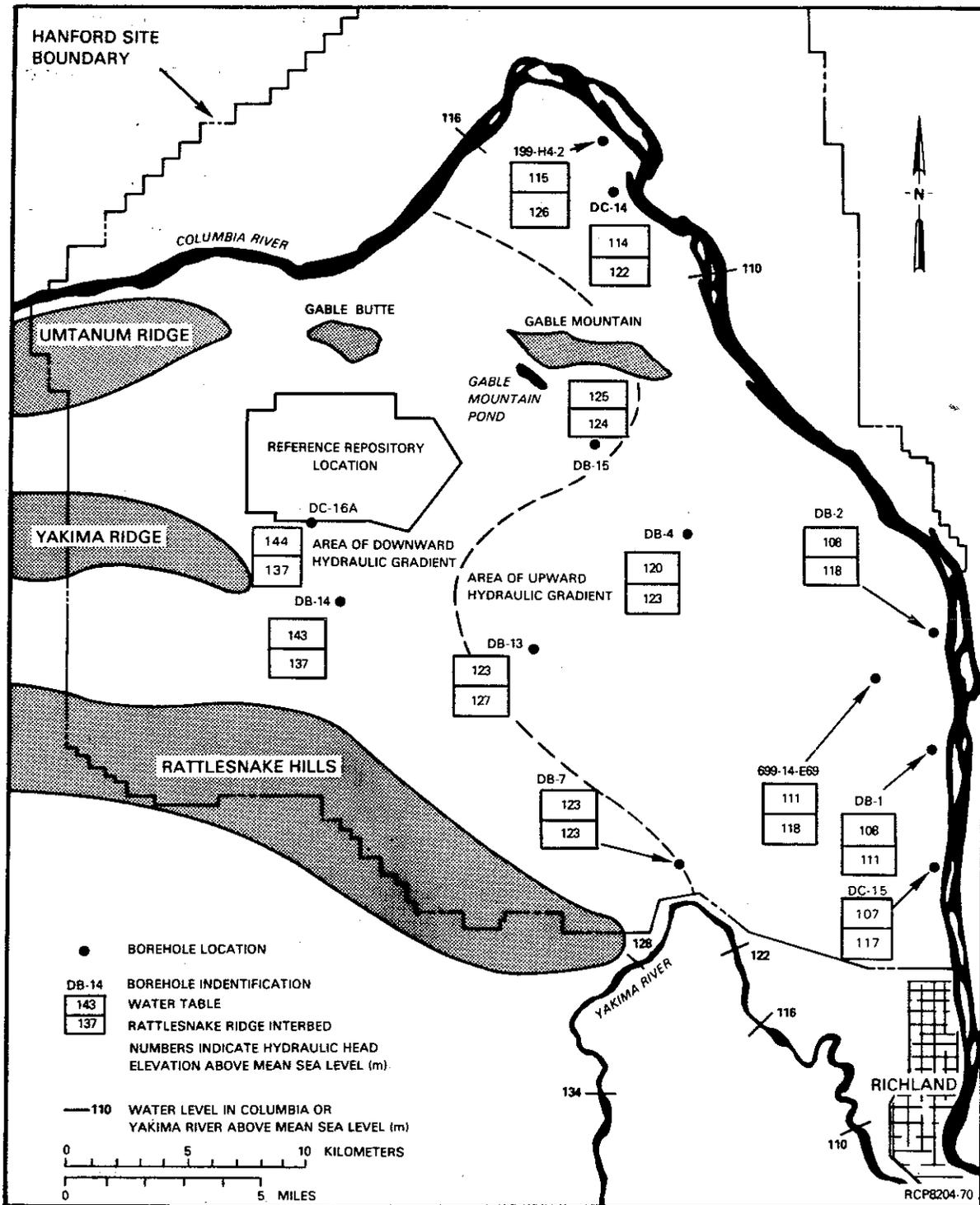


FIGURE 7 Comparison of Hydraulic Heads in the Rattlesnake Ridge Interbed to Water-Table Elevation.

The unconfined aquifer is also subject to recharge from man-made sources. The major source of artificial recharge is from the disposal of liquid wastes by the DOE. This liquid waste is generated by fuel reprocessing activities in the 200-East and 200-West areas. The waste generated in these areas is disposed of in infiltration basins. The two groundwater mounds shown in Figure 6 were created by the infiltration of liquid from DOE activities in the 200-areas. Figures 8, 9 and 10 show the tritium, nitrate and gross beta plumes, respectively, which are present in the unconfined aquifer as a result of DOE disposal activities in the 200-areas. The nitrate plume may be assumed to show the extent of the plume, as nitrate is not adsorbed by the natural media.

The second type of artificial recharge is from the infiltration of irrigation water. The irrigation occurs on property outside the boundaries of the Hanford Reservation, and does not affect the water levels at the facility.

Groundwater in the unconfined aquifer moves from west to east and discharges at perennial springs along the Columbia and Yakima Rivers, except during periods of high river stage. During periods of high river stage, water enters the aquifer from the rivers and is held as bank storage until the rivers return to normal pool elevations. Effects of this process would not be expected to be seen at the Richland facility.

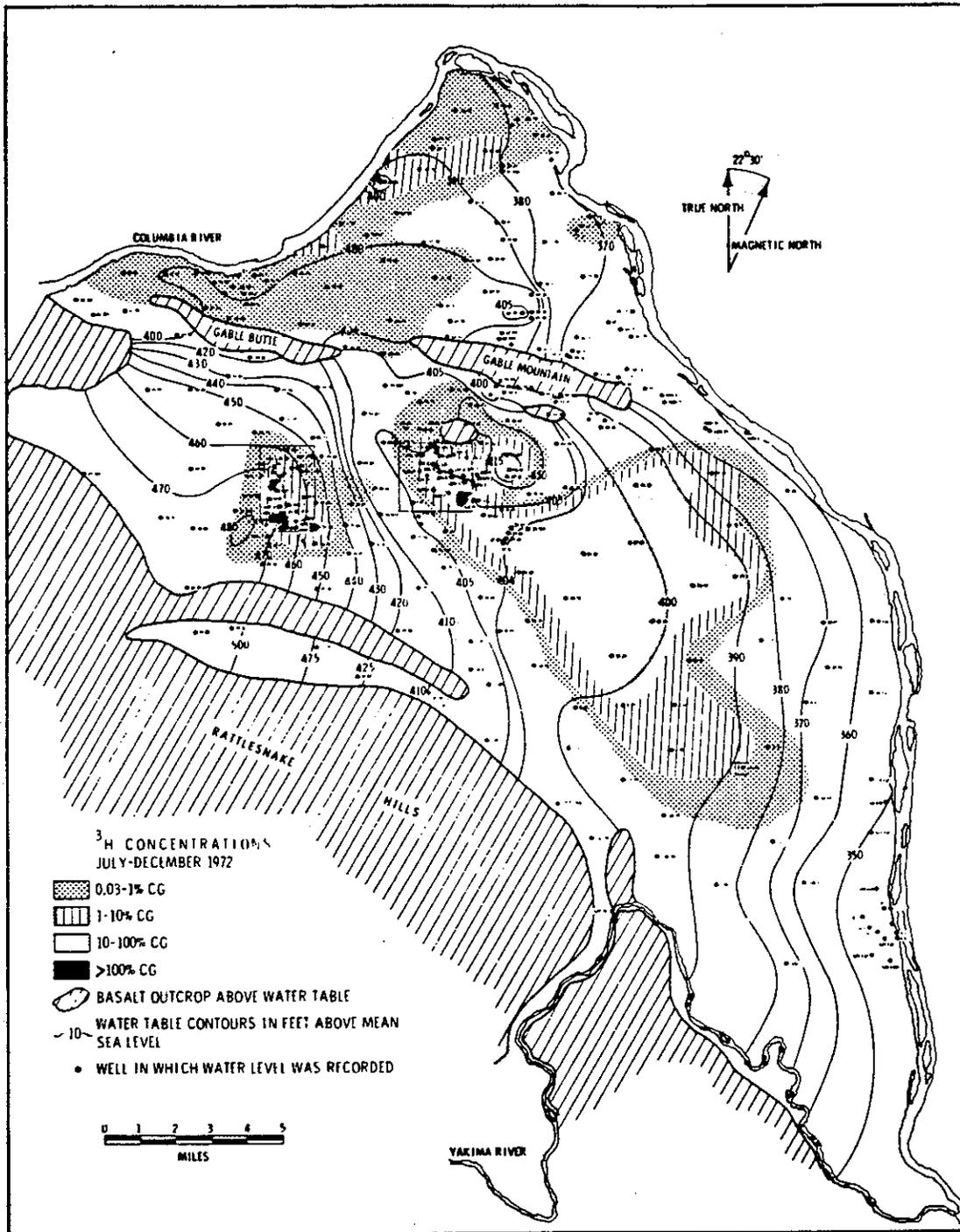
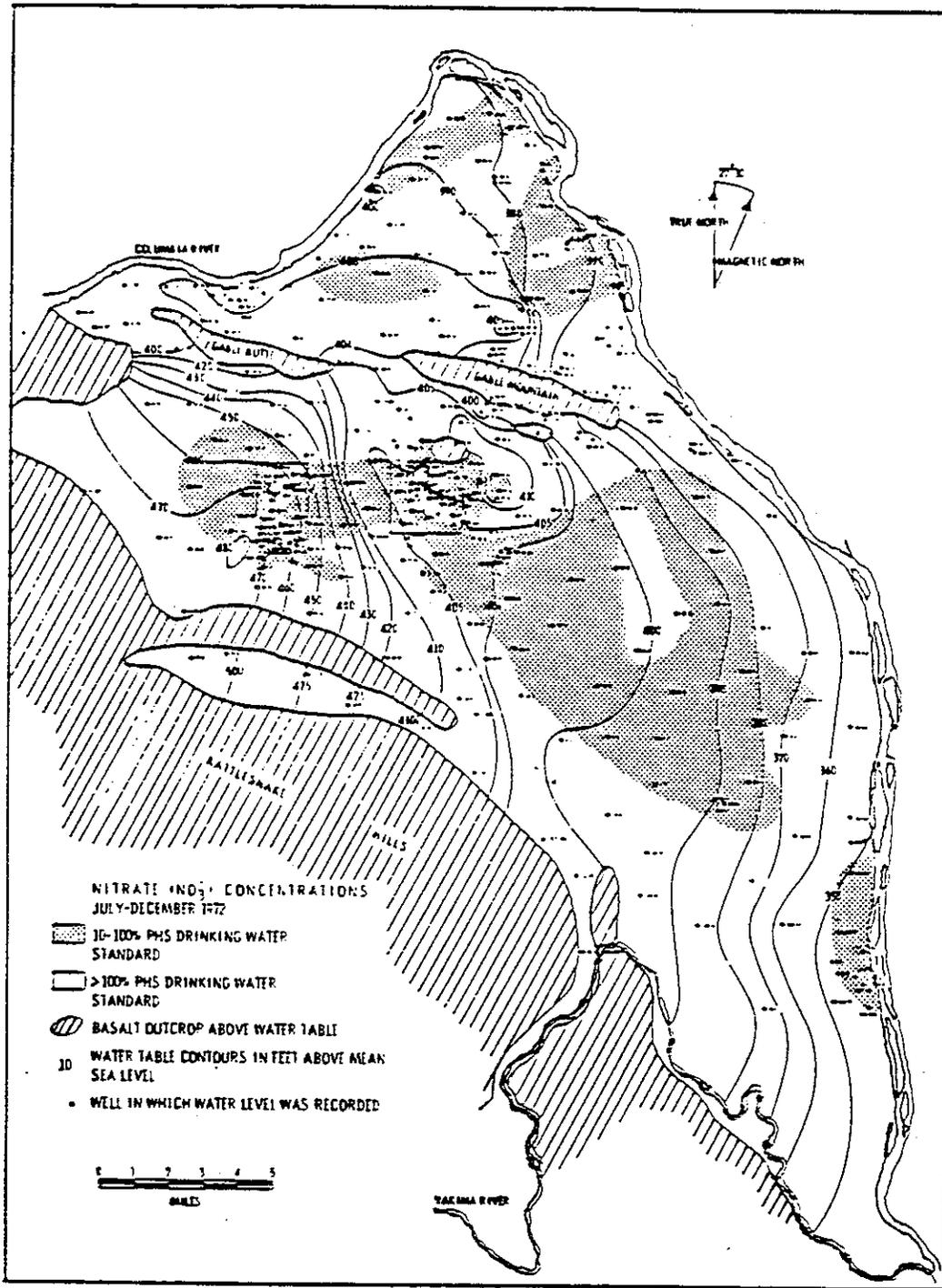


FIGURE 8

AVERAGE TRITIUM (³H) CONCENTRATIONS
July-December 1972 (Concentration Guide -
3000 pCi/ml)



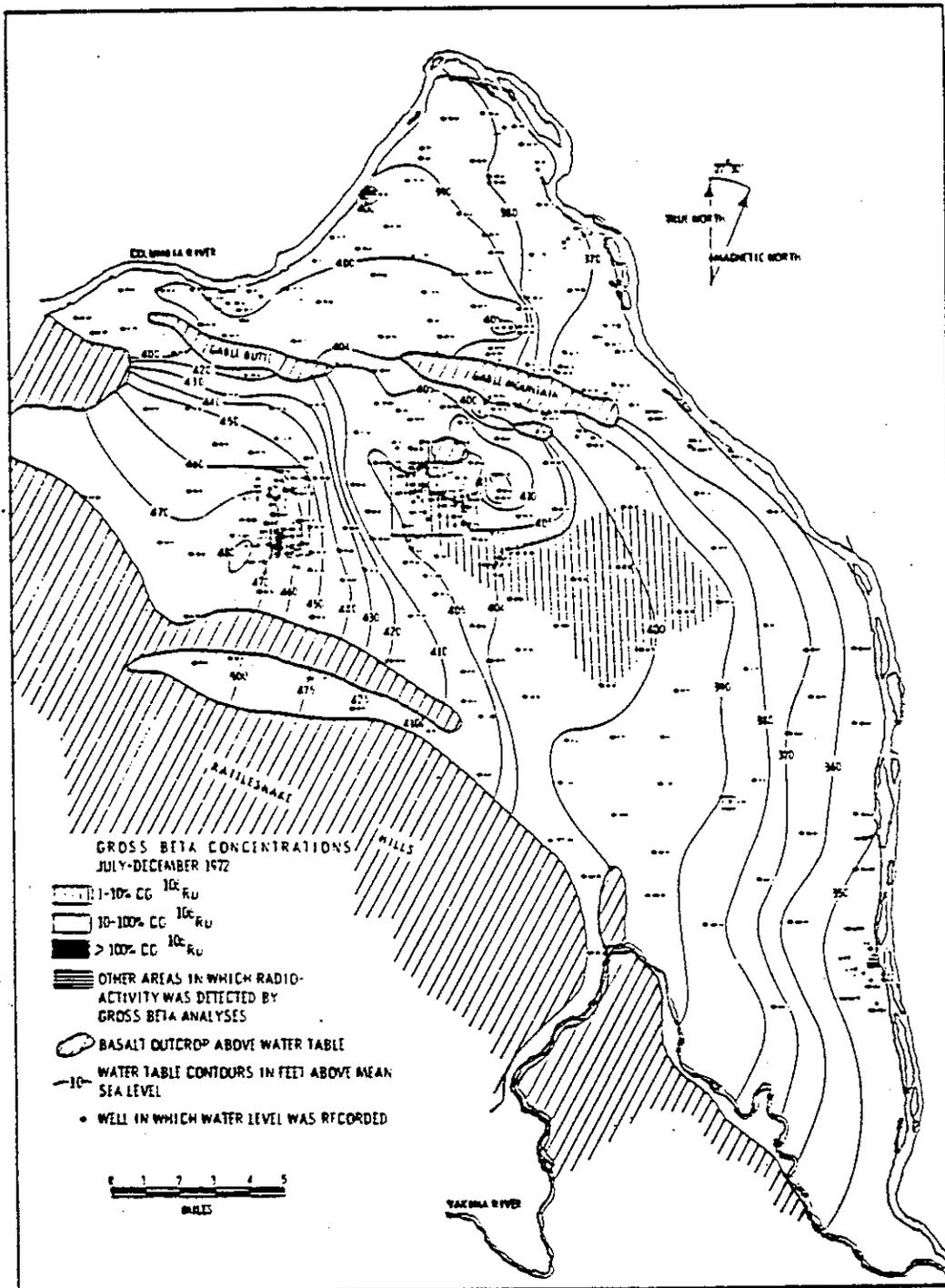


FIGURE 10

AVERAGE GROSS BETA (AS ^{106}Ru) CONCENTRATIONS
 July-December 1972 (Concentration Guide -
 10 pCi/ml)

2.5 Existing Monitoring Data

US Ecology's LLRW disposal facility monitors for radioactivity by collecting soil, vegetation, air and groundwater samples. The first quarter of groundwater sampling at the five monitoring wells has been completed and the analyses are contained in Attachment V.

Groundwater has also been monitored for radiological parameters at five off-site wells maintained by the DOE. That monitoring has defined the tritium, nitrate, and ruthenium-106 plumes described in Section 2.4. These plumes lie east and west of the facility and are the result of wastewater disposal practices in the 200-areas.

Additionally, a number of wells around the DOE Hanford site are being sampled for organic compounds under a program begun in 1983 by Battelle. No data from this program has been published to date.

3.0 GROUNDWATER MODELING

The following subsections describe the data and methods which were used to attempt to model groundwater flow beneath US Ecology's facility. The purpose of the modeling was to assist in the design and placement of the monitoring well network.

3.1 Site-Specific Parameters

The geology and hydrogeology of the Hanford Reservation has been studied by a number of researchers since the 1940's. Based on the over 1000 wells installed by the DOE, the groundwater flow on the water table aquifer has been well characterized, and has been shown to flow in an easterly to northeasterly direction in the area of the LLRW disposal facility. Regional hydraulic gradients calculated from Figure 6 and from 1980 data are 0.0015 and 0.0026, respectively. These large-scale values are presumed to be influenced by the disposal of liquid wastes in the separations areas and actual gradients across the Richland site may be lower (Graham, 1981).

Hydraulic conductivities reportedly range between 2,000 and 10,000 ft./day in the Hanford formation and between 10 and 230 ft./day in the middle Ringold formation (Graham, 1981). With an estimated average porosity of 35%, the groundwater flow velocities beneath the facility would fall between 0.043 and 75 ft./day. Since the water table has been determined to lie in the less transmissive Ringold formation, the actual velocities should tend toward the lower end of this calculated range.

The various parameter values chosen for use in the groundwater model are shown in Table 1. The dispersion coefficients in the longitudinal and transverse directions were selected after a review of pertinent literature (Gilliam, et al. 1982). The final dispersivities were chosen after matching the computer-generated plume to an existing tritium plume from the 200-East area. Values ranged from 10 to 200 feet for longitudinal and 3 to 100

TABLE 1

SITE-SPECIFIC PARAMETERS

Hydraulic Conductivity	13,300 gpd/ft ² (1778 ft./day)
Gradient	0.002 ft/ft
Aquifer Thickness	230 feet
Porosity	35%
Transmissivity	305,670 gpd/ft
Velocity	75 ft/day
Longitudinal Dispersivity	30 to 70 feet
Transverse Dispersivity	15 to 60 feet
Storativity	0.07
Retardation Coefficient	2

for transverse dispersivity (Gilliam, et al. 1982). The transverse dispersivity was always the lesser of the two values. In each case, the parameter value chosen was felt to be conservative and was designed to maximize contaminant migration.

3.2 The Random-Walk Model

This model used a finite-difference computer code developed by Prickett, et al. 1981, which simulates the movement of a solute in the groundwater. The model was verified using the examples given in Bulletin 65 of the Illinois State Water Survey.

The random-walk model simulation is limited to the two-dimensional non-steady flow of a solute in a homogeneous aquifer. The model uses the particle-in-a-cell method to determine convective transport and a random-walk method to produce the effects of large-scale dispersion. The basis for the random-walk code is that the distribution of a concentration for a solute may be represented by the distribution of a finite number of discrete particles. Each particle is moved by the groundwater flow and is then dispersed according to the dispersion coefficients.

3.3 Model Calibration

The model used in this study was modified from the original random-walk model to run on a microcomputer, with the output directed to both a line printer and a graphics plotter. The model was calibrated using the site-specific data given in Section 3.1. The model was then given additional data to allow for discharge to the Columbia River. The discharge was modeled as a well along the extreme northeastern and eastern boundary of the finite-difference grid, with a discharge rate of 100 gpm.

The source of contamination was chosen to be a line extending northward for 200 feet from E440,000 to E440,200, along N2,237,800. The length and orientation of this line represents the eastern-most boundary of Trench 10. The effective width of the source (perpendicular to groundwater flow) is actually 142 feet,

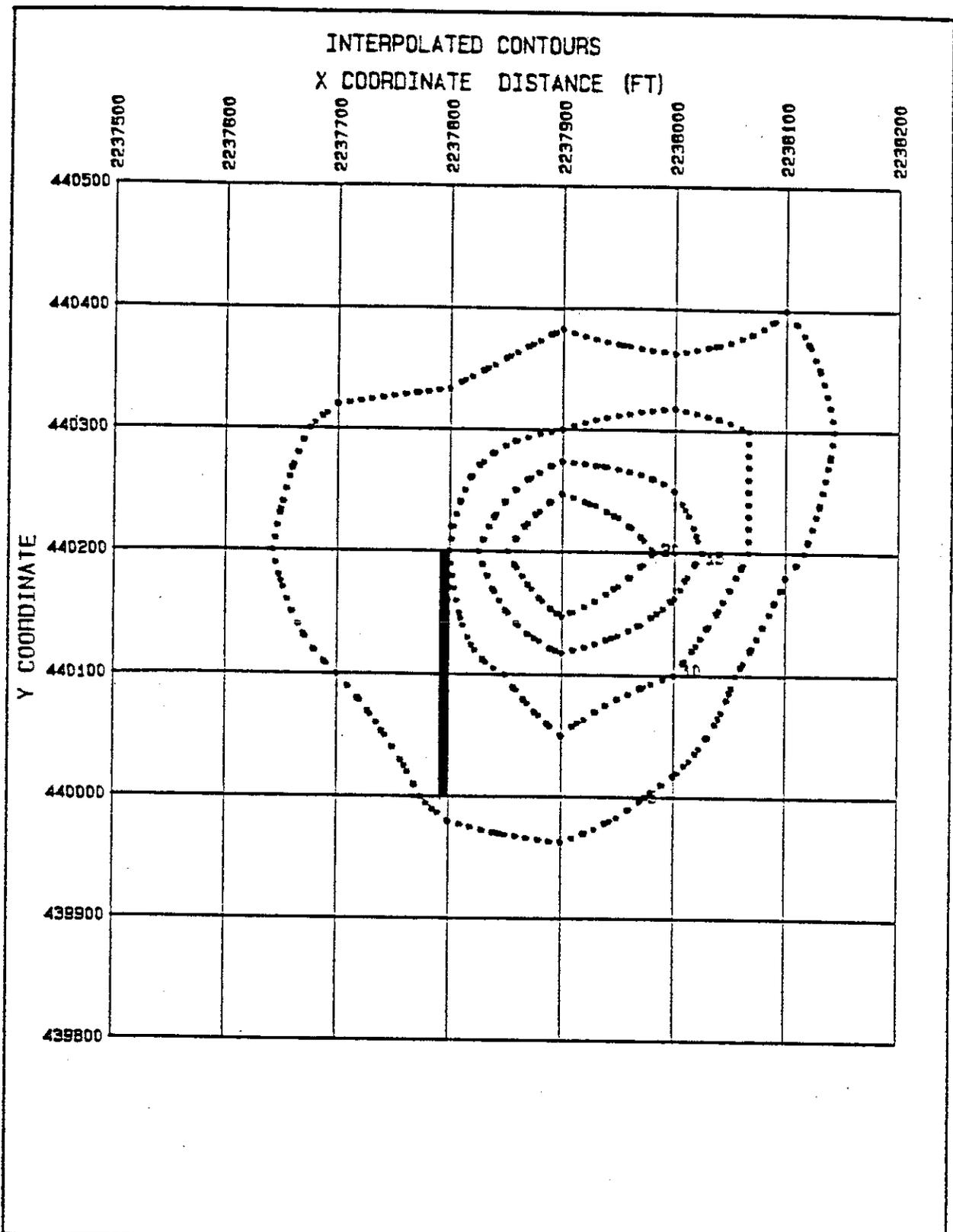
which was considered to be reasonably conservative given the overall extent of the disposal area.

The dispersivities were varied within the ranges shown in Table 1, with the transverse dispersivity being less than the longitudinal. As stated before, the model was calibrated by varying the dispersion and matching the resulting plume with the existing tritium plume. The final dispersivity values which produced the best fit were 70 feet longitudinal and 40 feet transverse.

3.4 Modeling Results

Figure 11 shows the contaminant plume after five days of simulation using the dispersivity values discussed in the previous subsection. The plume has migrated 426 feet downgradient and has spread to 395 feet along a line 50 feet east of the source line. This figure suggested that monitoring wells spaced less than 395 feet apart and 50 feet east of the trench boundaries would be capable of detecting any releases of the type modeled.

In reality, any contaminant release would first travel downward, independent of the groundwater flow direction, through approximately 315 feet of unsaturated deposits. During this downward migration, dispersion would spread the plume uniformly and its shape as it entered the water table would be much broader and less concentrated. The plume width as it reached the monitoring wells would therefore be greater than that shown by the model. This allows greater confidence in the ability of the monitoring wells to detect any contamination from the facility, even with much wider downgradient spacing.



PROJECT: RICHLAND MONITORING FILE: 11 LOCATION: WASHINGTON	PARTICLE DENSITY CONTOURS AFTER 5 DAYS OF SIMULATION
US ECOLOGY, INC.	FIGURE 11

4.0 RESULTS OF SUBSURFACE INVESTIGATION

4.1 Boring Logs

Based on preliminary information generated from the groundwater flow model, five borings were made at the Richland LLRW disposal facility under the direction of CH2M-Hill, Inc. Drilling and subsequent monitoring well installation were completed by Onwego Drilling Company of Kennewick, Washington. Work was conducted between September 3, 1985 and December 10, 1985. The location of each boring is shown on Figure 12. Attachment I is the report prepared by CH2M-Hill.

All borings were completed using the cable-tool percussion method. The cable-tool percussion drilling method advances the well by regularly lifting and dropping a heavy string of drilling tools in the borehole. When working in soft, unconsolidated material, a 6-3/4-inch-diameter dry barrel sampler was advanced to remove the material in borings 3, 8, and 13. A 9-3/4-inch-diameter dry barrel sampler was used in MW-5. When harder consolidated material was encountered, a drill bit along with water was used. The bit breaks the hard rock into small fragments and mixes it with the water to form a slurry. The necessary water for slurry formation was placed in the borehole if no water was present in the formation being penetrated. The resulting slurry was removed at intervals from the borehole by means of a bailer.

The unconsolidated materials encountered during drilling were classified visually by CH2M-Hill geotechnical personnel, and grouped into the following two general types:

0 ~ 300 feet

Sand and Silty Sand (SP-SM). The fluvial deposits of sand and silty sand are generally poorly graded fine to medium sand. The sand contains 0 to 25 percent intermixed and inter-layered silt and less than 5 percent occasional pebbly gravel. The sand is dry except in the top 20 feet, where it is damp to moist, light

brown in color, and loose. Some calcium carbonate is present throughout the deposit.

300 + feet

Sandy Gravel (GW). The gravel layer of the Ringold formation is well graded and contains less than 5 percent material by weight smaller than a U.S. Standard No. 200 sieve. The gravel ranges in size from 1/4 inch to 3 inches in diameter, and contains occasional cobbles. The gravel is well-rounded and contains 5 to 15 percent fine to medium sand which is generally found in lenses. The gravel layer is wet, gray in color, and is very dense.

Samples were collected at regular intervals from each boring, and laboratory tests were performed for grain size distribution, moisture content, bulk density, specific gravity of solids, porosity, and moisture-density relationships. This information is used to characterize the unsaturated zone and in particular to examine the potential for surface water movement through it. A detailed log of each boring is found in Appendix B of the CH2M-Hill report (Attachment I). A summary of the laboratory test data for each sample is found in Appendix D of that report.

In addition to these analyses, several samples from each boring, 22 in all, were sent to Benjamin F. Hajek Consulting Services at Auburn University for further laboratory testing. Detailed particle size distributions, cation exchange capacities, soil mineralogy, and soil water tension were determined for each sample. Attachment II is a copy of this report

In general, the subsurface data collected confirms the presence of the unconsolidated Hanford and Ringold Formations beneath the Richland site. The Hanford Formation occurs as rhythmically bedded sands with varying silt content and occasional gravel. Grain-size analyses from each boring exhibit an overall fining-upward sequence

typical of fluvial deposition. Statistical analysis of the detailed grain-size distribution data clearly shows the relative uniformity of the sand-sized fraction compared to the variability of the silt content. For particles smaller than 2mm in all samples taken above the 425 foot elevation (Hanford Formation), the coefficients of variation for sand and silt are 14.5 and 85.7 respectively. Clay content averages 2.3%, and with a standard deviation of 1.2 is not a significant volumetric component of any sample.

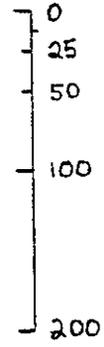
Near elevation 710, a persistent layer of white volcanic ash is found in four of the borings, and is evidenced in the fifth by a small carbonate concretion. This deposit was identified as the Mount Mazama Ash, which has a reported age of 6600 years b.p. (Rockwell Hanford Operations, 1982). It proved to be useful as a marker bed to help correlate information from each boring.

At an elevation of 425 feet is an abrupt contact with the gravel deposits of the Ringold Formation. These gravels are well graded and contain up to 40% sand in the first 30 feet below the formational contact. The sand content then grades to less than 5% with depth in each boring. Apart from this variation, the deposit appears very uniform over the 50-foot interval penetrated. Each boring was terminated at elevation 375.

Figure 13 presents graphically the subsurface description from each boring and projects a correlation between them. The scale of this diagram required that the different Hanford units be divided roughly into two types. Contacts between deposits identified as sand and silty sand are more gradational than shown, and the actual clay and silt content within the silty sands ranges from 5% to 25%.

Comparison of the moisture content values given in the CH2M-Hill report with the soil water tension data from Hajek Consulting resulted in the graphs shown on Figure 14. Actual moisture content was plotted versus depth for wells 003, 010, and 013.

MW 013



MW 003

MW 005

MW 010

MW 008

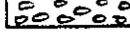
-  ASH BED
-  SILTY SAND
-  SAND
-  GRAVEL

FIGURE 13

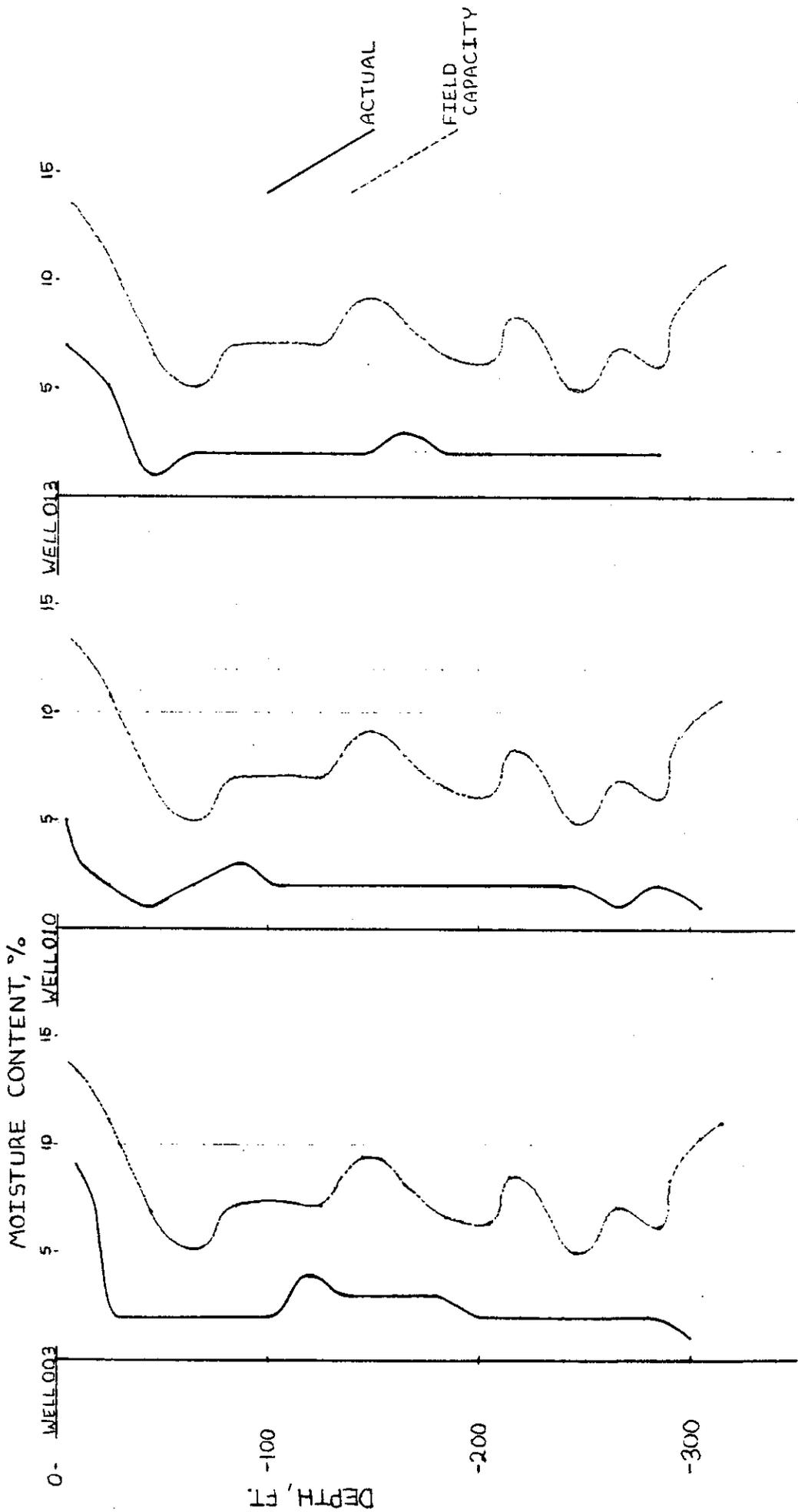


FIGURE 14

Extrapolating the soil water retained at one-third atmosphere of soil tension (344 cm H₂O) gave an estimated value for the field capacity of each sample (Linsley, 1982). The minimum field capacity value at each depth was then plotted adjacent to the three measured curves.

The field capacity of a material is the moisture content above which water would begin to drain from the material by the force of gravity. At a moisture content below field capacity no downward movement of liquid water can take place. A comparison of actual moisture content data determined from field samples with laboratory determinations of field capacity is very valuable in describing the potential for surface water or contaminant migration to the water table.

At a depth of ten feet in well 003 the moisture content reaches 79% of field capacity. At 120 feet in well 003 it reaches 55%. Apart from these two points, actual soil moisture remains below 50% of its field capacity in the borings shown on Figure 14. It is clear from this that no downward percolation of surface water was occurring through the 300-foot vadose zone at the time of this investigation. Further, the borings were made during months of highest precipitation and lowest evapotranspiration, which should have maximized any surface water infiltration. Therefore, it seems extremely unlikely based on this data, that surface water ever penetrates the unsaturated zone to the depth of the water table.

Geophysical logging of the completed monitoring wells was conducted by Battelle's Pacific Northwest Laboratory. Neutron, natural gamma, and gamma-gamma logs were run and will be integrated into Battelle's data base for the Hanford Reservation.

These logs have not yet been formally interpreted by Pacific Northwest Laboratory, but should ultimately yield porosity data which will be useful in determining groundwater movement through the Ringold Formation. Preliminary calculations have shown the

porosity in the Ringold gravel to be in the 20% - 40% range in well 8. This corresponds favorably with the 35% estimate used in the groundwater model. Copies of the geophysical logs are attached (Attachment III).

4.2 Water Level Data

Monitoring well water levels were recorded during and after well installation and are summarized on page 11 of the CH2M-Hill report. The first round of sampling by US Ecology was completed in February 1986, and the water levels recorded at that time as well as a second set of water level measurements made on April 30, 1986, are listed in Table 2.

Figure 15 is a groundwater table contour map based on the data collected in February. Groundwater flow directions range from N43⁰E to N100⁰E with gradients between 0.0025 ft./ft. and 0.0031 ft./ft. Flow velocity in the Ringold Formation may be roughly calculated at 2 ft./day using the previously assumed 35% porosity and the highest reported hydraulic conductivity value in the middle Ringold of 230 ft./day (Graham, 1981).

The divergent groundwater flow directions shown on Figure 15 are the result of elevation data from well 005, which was sampled five days after the other four wells. Figure 16 is a second contour map using the April measurements. As these levels were all recorded within a 24 hour period it is reasonable to expect this map to represent the groundwater condition more accurately. The Groundwater flow directions based on these contours are not divergent and are predominantly N60⁰E. Future sampling intervals will include the measurement of water levels in all wells within a 24 hour period. This should eliminate any uncertainty regarding fluctuations in an individual well.

TABLE 2

DATE	WELL	DEPTH TO WATER LEVEL FROM TOP OF CASING	WATER LEVEL ELEVATION
2-18-86	013	315.96	409.65
2-18-86	008	320.75	406.01
2-19-86	010	330.63	405.81
2-19-86	003	320.75	404.98
2-24-86	005	317.21	406.49
4-30-86	003	318.92	406.81
4-30-86	005	317.04	406.66
4-30-86	008	320.42	406.34
4-30-86	010	330.17	406.27
4-30-86	013	315.83	409.78

GROUNDWATER CONTOURS

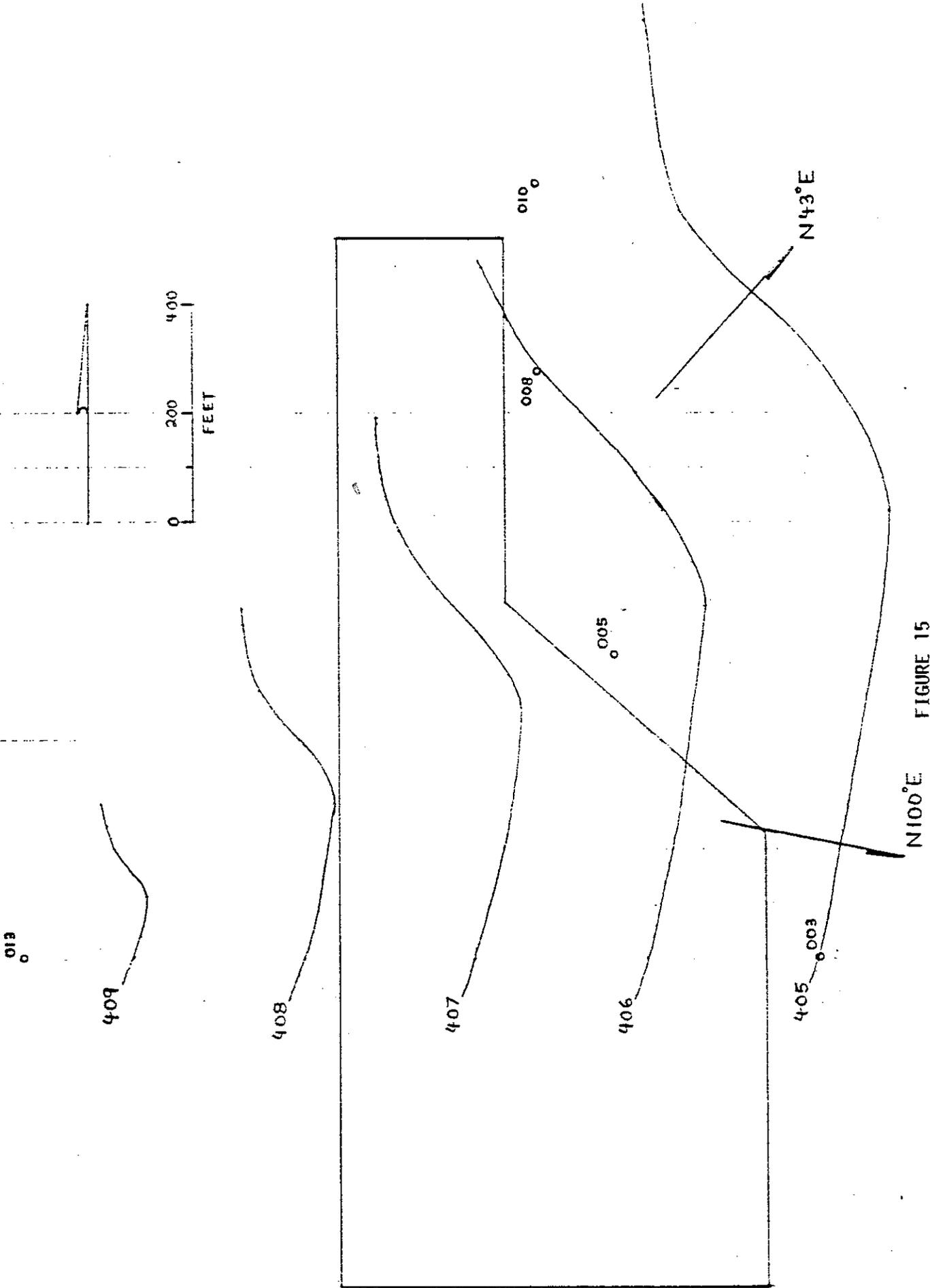


FIGURE 15

GROUNDWATER CONTOURS

013

409

408

407

010

008

005

003

506
906

N 60° E

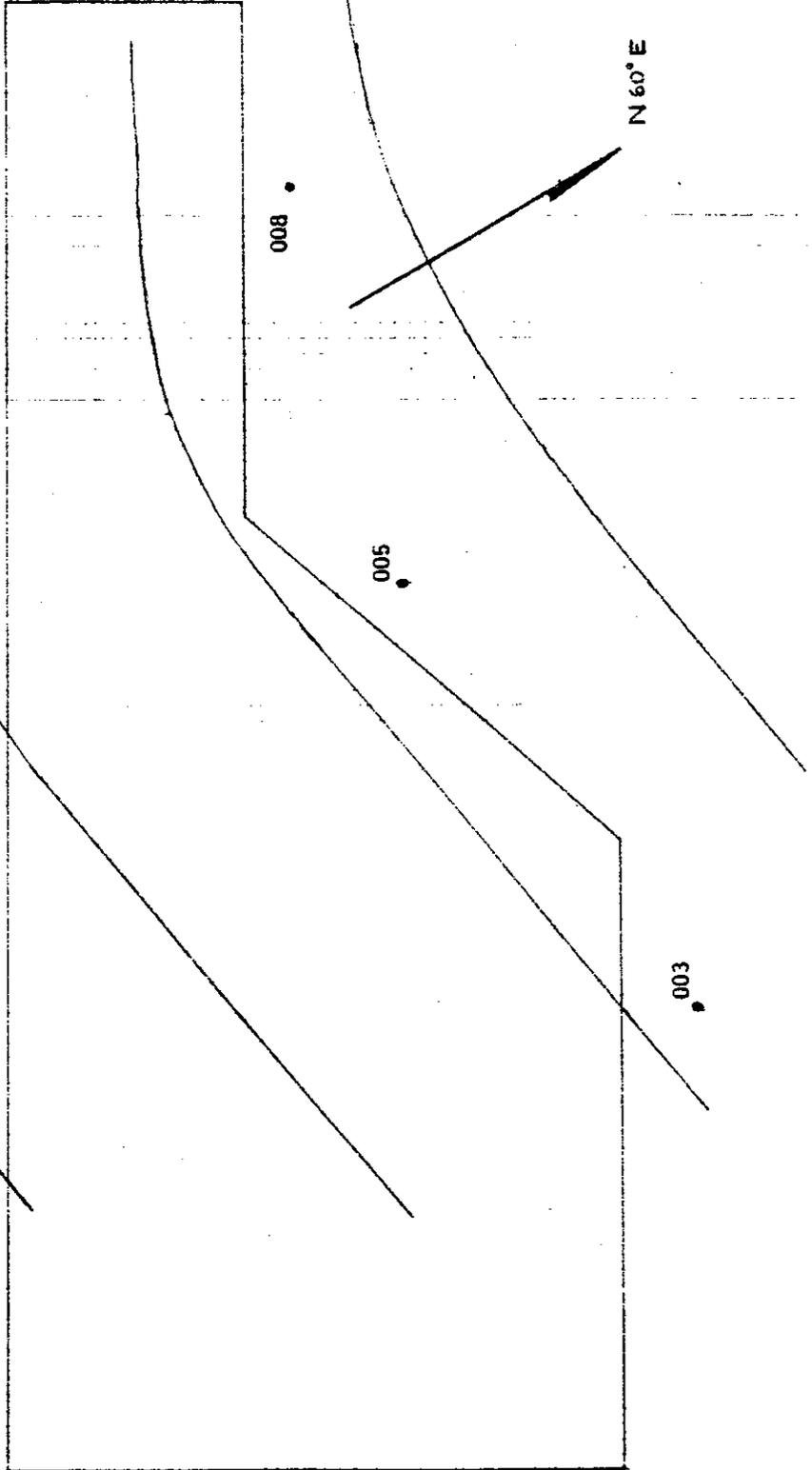


FIGURE 16

5.0 GROUNDWATER MONITORING SYSTEM

Each of the five borings were completed as groundwater monitoring wells. Their locations are shown on Figure 12. The installation and construction of these wells is described on pages 6 and 7 of the CH2M-Hill report. Diagrams of each well are contained in Appendix A of that report (Attachment I).

A dedicated dual pump system was installed in each well for purging and sampling. Purging is accomplished by a 3/4-horsepower Grundfos submersible pump (model SP-122). Mounted one foot above this pump is a 1.66-inch diameter Well Wizard teflon bladder pump for sampling. Figure 17 is a diagram of the dual pump installation.

Finally, a 3/4-inch stainless steel access pipe was installed in each well to allow water level measurements to be made. This pipe will accommodate the electric water level probe used for making those measurements. Attachment IV shows the installation depths for the two pumps and access pipe at each well.

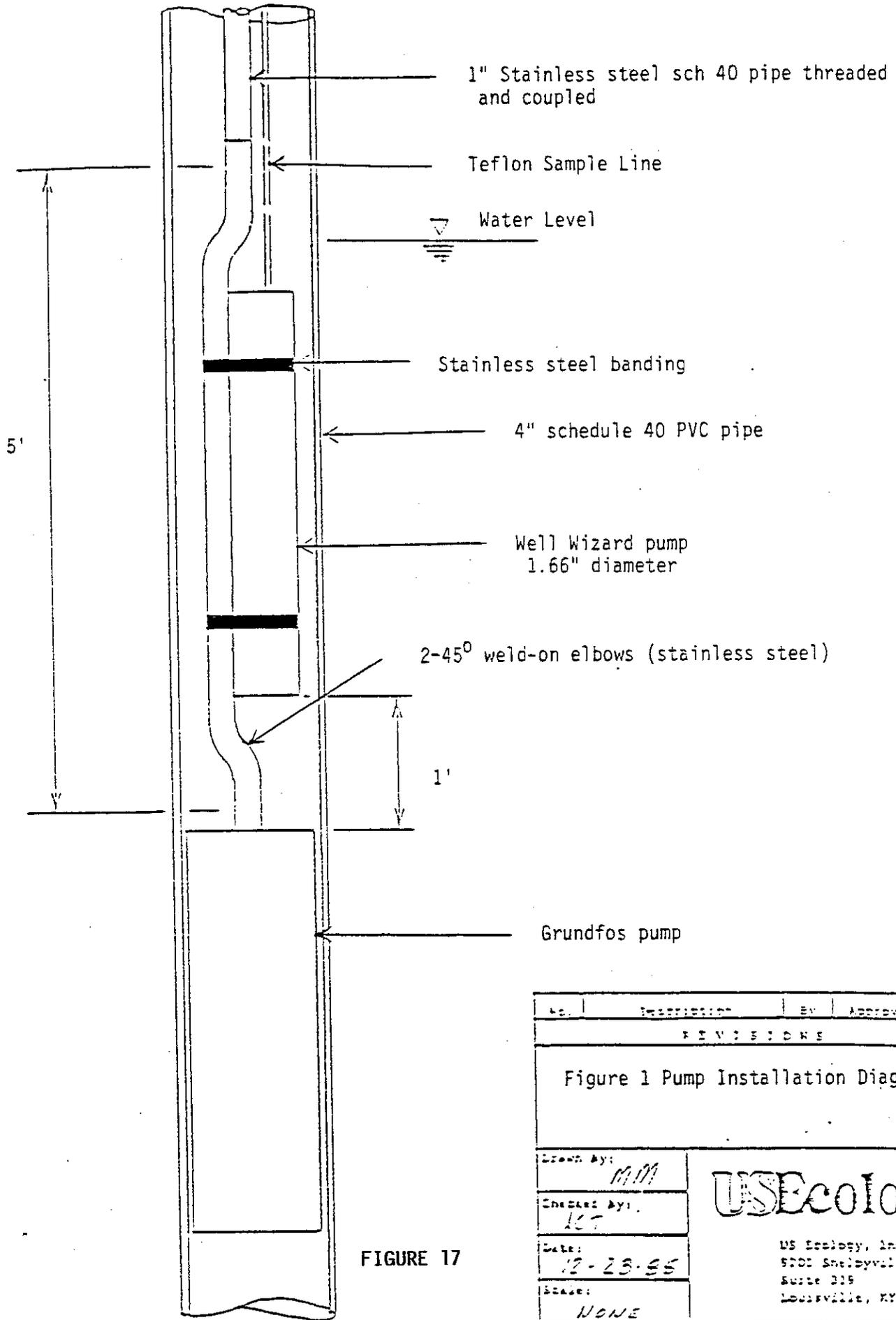


FIGURE 17

No.	Description	By	Approval	Date
REVISED				
Figure 1 Pump Installation Diagram				
Drawn By:	MAM			
Checked By:	JCT			
Date:	12-23-95			
Scale:	NONE			
Sheet	/	of	/	Drawing No.

USECOLOGY

US Ecology, Inc.
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6.0 CONCLUSIONS

The groundwater monitoring system installed at the Richland LLRW disposal facility will effectively monitor groundwater quality in the uppermost aquifer beneath the site. Both predictive modeling and the analysis of collected site-specific data indicate that the positioning of the five monitoring wells is correct.

Our preliminary study had indicated that additional monitoring points could be necessary in the future based on data from the system just installed. To increase our understanding of what this might involve, a work plan for a pathways analysis of radionuclide migration is currently being developed by Battelle Pacific Northwest Laboratories for the Richland facility. This study will examine in detail the concentrations and characteristics of each waste as well as the mechanisms for its migration off-site, including vadose zone migration. It is expected that such a comprehensive analysis will enhance this study and help identify areas where additional groundwater monitoring would be most valuable. The analysis will be more detailed than the groundwater flow model presented in this report and will provide additional justification for the present system as installed and any necessary modification to it. The pathways analysis will be completed in April 1987.

For this reason, a more logical and comprehensive proposal for the installation of additional groundwater monitoring wells could be developed after the Battelle study and several rounds of monitoring data become available. US Ecology is therefore proposing to delay installation of any additional wells until completion of the pathways analysis.

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ATTACHMENT I

CH₂M-HILL REPORT

ATTACHMENT IV

WELL PUMP INSTALLATION SCHEMATICS

A cross-sectional diagram of a well. It features two vertical stainless steel pipes. The outer pipe is 1 inch in diameter and 331 feet 7 inches long. The inner pipe is 3/4 inch in diameter and 341 feet 5 inches long. Two pumps are located at the bottom of the well. The upper pump is a sample pump, and the lower pump is a submersible pump. The ground level is indicated by a horizontal line at the top of the diagram.

1' STAINLESS STEEL
331' - 7'

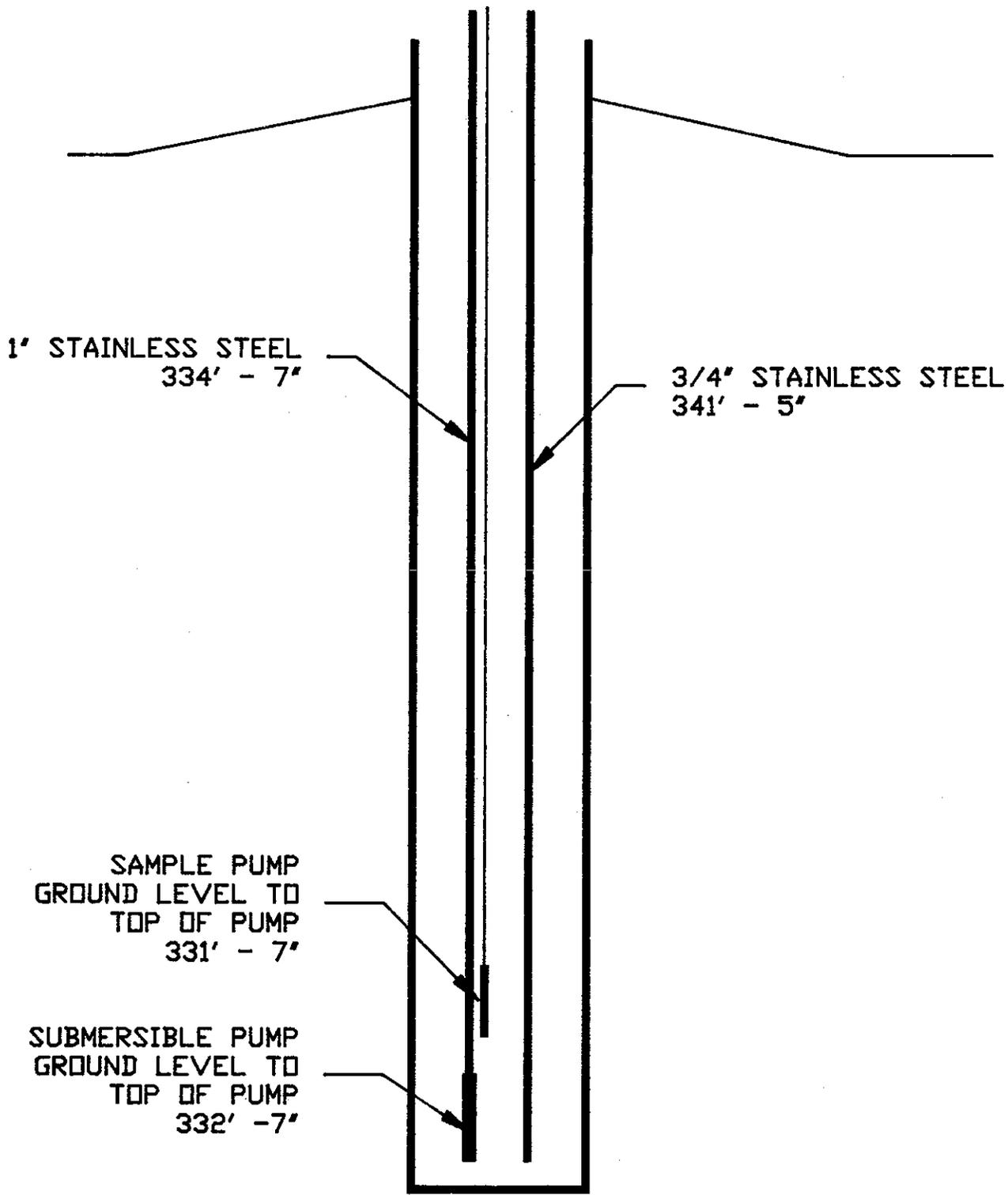
3/4" STAINLESS STEEL
341' - 5'

SAMPLE PUMP
GROUND LEVEL TO
TOP OF PUMP
328' - 7'

SUBMERSIBLE PUMP
GROUND LEVEL TO
TOP OF PUMP
329' - 7'

WELL NUMBER 3

US Ecology Inc.



WELL NUMBER 5

US Ecology Inc.

1' STAINLESS STEEL
334' - 7"

The diagram shows a vertical well casing with two inner tubes. The outer casing is 1' stainless steel, 334' - 7" long. The inner casing is 3/4" stainless steel, 341' - 5" long. A sample pump is located at a depth of 331' - 7" from the ground level to the top of the pump. A submersible pump is located at a depth of 332' - 7" from the ground level to the top of the pump. The well is labeled as Well Number 8.

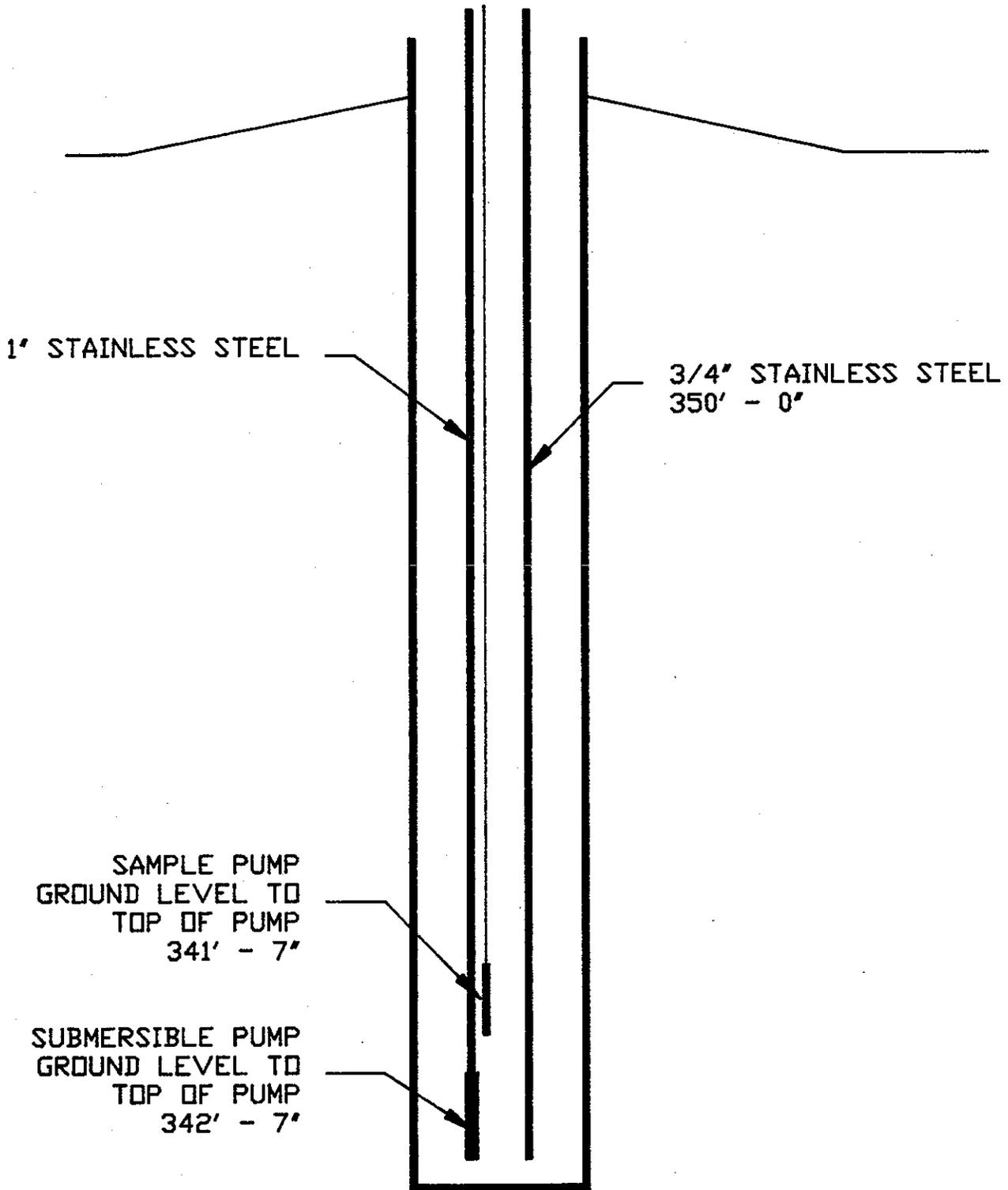
3/4" STAINLESS STEEL
341' - 5"

SAMPLE PUMP
GROUND LEVEL TO
TOP OF PUMP
331' - 7"

SUBMERSIBLE PUMP
GROUND LEVEL TO
TOP OF PUMP
332' - 7"

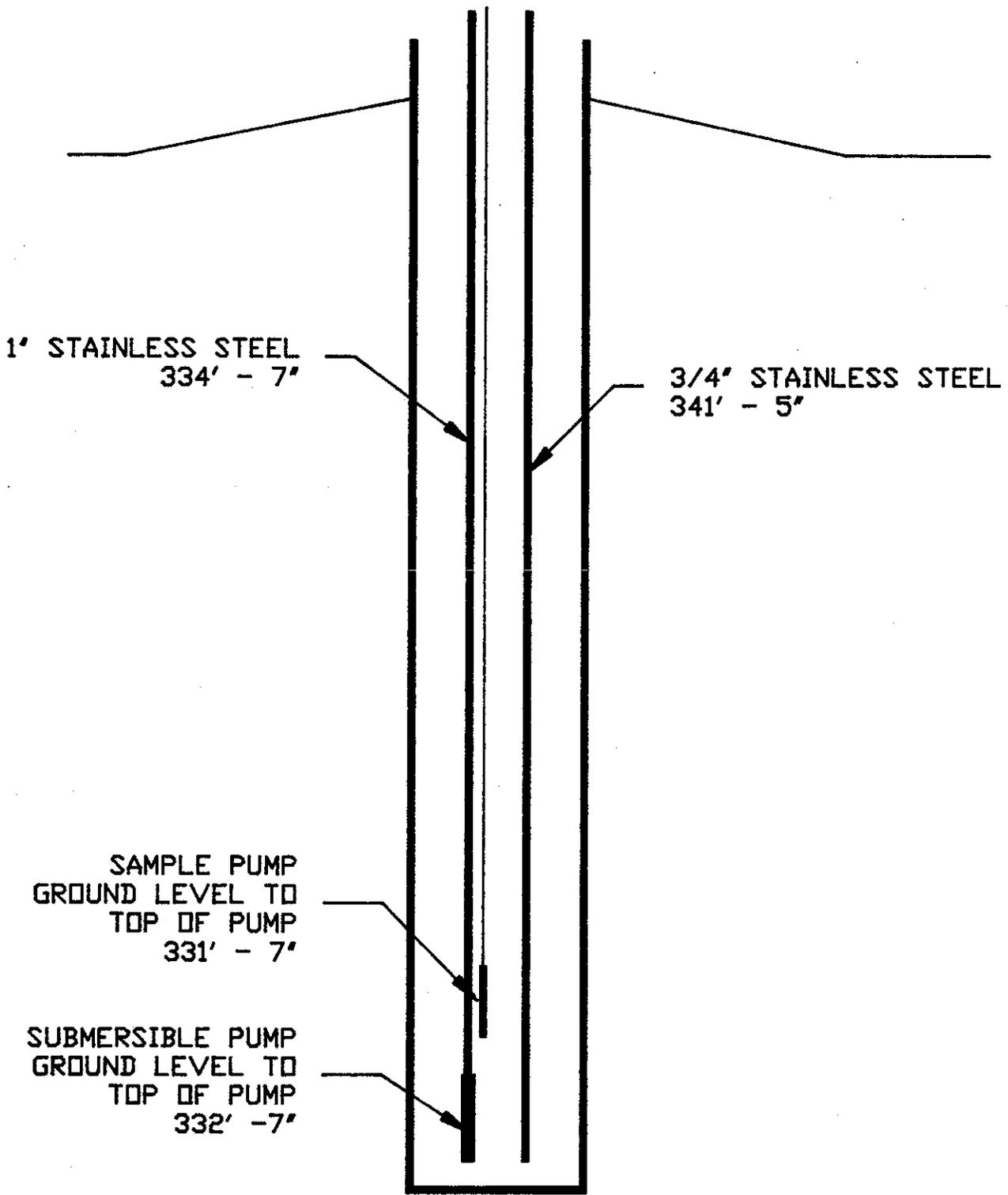
WELL NUMBER 8

US Ecology Inc.



WELL NUMBER 10

US Ecology Inc.



WELL NUMBER 13

US Ecology Inc.

ATTACHMENT V
GROUNDWATER ANALYSES

Introduction:

The attached tables present the radioanalytical results for the First Quarter 1986 Groundwater Samples collected by US Ecology. These monitoring wells are located within US Ecology Inc.'s sublease hold.

Sample Identification:

The samples are identified with the following number code X-XX-X. The first digit represents the quarter in which the samples are taken, the second and third digits the well number and the fourth digit represents the split sample sequential number.

The samples were collected on the following dates: 2/18/86 - Wells 13 & 8; 2/19/86 - Wells 10 & 3; 2/24/86 - Well 5. Well 13 is the upgradient well.

VOLATILE ORGANIC COMPOUND (VOC) REPORT

US ECOLOGY I.D.: 1-13-7

COMPOUND	DETECTION LIMIT (PPB)	RESULT (PPB)
TETRACHLOROMETHANE	10	Less than 10
BENZENE	10	Less than 10
DIOXANE	500	Less than 500
METHYLETHYL KETONE	10	Less than 10
PYRIDINE	500	Less than 500
TOLUENE	10	Less than 10
1,1,1-TRICHLOROETHANE	10	Less than 10
1,1,2-TRICHLOROETHANE	10	Less than 10
1,1,2-TRICHLOROETHENE	10	Less than 10
TETRACHLOROETHENE	10	Less than 10
XYLENE (O, P)	10	Less than 10
XYLENE (M)	10	Less than 10
FORMALDEHYDE	500	Less than 500

VOLATILE ORGANIC COMPOUND (VOC) REPORT

US ECOLOGY I.D.: 1-8-8

COMPOUND	DETECTION LIMIT (PPB)	RESULT (PPB)
TETRACHLOROMETHANE	10	Less than 10
BENZENE	10	Less than 10
DIOXANE	500	Less than 500
METHYLETHYL KETONE	10	Less than 10
PYRIDINE	500	Less than 500
TOLUENE	10	Less than 10
1,1,1-TRICHLOROETHANE	10	Less than 10
1,1,2-TRICHLOROETHANE	10	Less than 10
1,1,2-TRICHLOROETHENE	10	Less than 10
TETRACHLOROETHENE	10	Less than 10
XYLENE (O, P)	10	Less than 10
XYLENE (M)	10	Less than 10
FORMALDEHYDE	500	Less than 500

VOLATILE ORGANIC COMPOUND (VOC) REPORT

US ECOLOGY I.D.: 1-10-7

COMPOUND	DETECTION LIMIT (PPB)	RESULT (PPB)
TETRACHLOROMETHANE	10	Less than 10
BENZENE	10	Less than 10
DIOXANE	500	Less than 500
METHYLETHYL KETONE	10	Less than 10
PYRIDINE	500	Less than 500
TOLUENE	10	Less than 10
1,1,1-TRICHLOROETHANE	10	Less than 10
1,1,2-TRICHLOROETHANE	10	Less than 10
1,1,2-TRICHLOROETHENE	10	Less than 10
TETRACHLOROETHENE	10	Less than 10
XYLENE (O, P)	10	Less than 10
XYLENE (M)	10	Less than 10
FORMALDEHYDE	500	Less than 500

VOLATILE ORGANIC COMPOUND (VOC) REPORT

US ECOLOGY I.D.: 1-3-7

COMPOUND	DETECTION LIMIT (PPB)	RESULT (PPB)
TETRACHLOROMETHANE	10	Less than 10
BENZENE	10	Less than 10
DIOXANE	500	Less than 500
METHYLETHYL KETONE	10	Less than 10
PYRIDINE	500	Less than 500
TOLUENE	10	Less than 10
1,1,1-TRICHLOROETHANE	10	Less than 10
1,1,2-TRICHLOROETHANE	10	Less than 10
1,1,2-TRICHLOROETHENE	10	Less than 10
TETRACHLOROETHENE	10	Less than 10
XYLENE (O, P)	10	Less than 10
XYLENE (M)	10	Less than 10
FORMALDEHYDE	500	Less than 500

VOLATILE ORGANIC COMPOUND (VOC) REPORT

US ECOLOGY I.D.: 1-5-9

COMPOUND	DETECTION LIMIT (PPB)	RESULT (PPB)
TETRACHLOROMETHANE	10	Less than 10
BENZENE	10	Less than 10
DIOXANE	500	Less than 500
METHYLETHYL KETONE	10	Less than 10
PYRIDINE	500	Less than 500
TOLUENE	10	Less than 10
1,1,1-TRICHLOROETHANE	10	Less than 10
1,1,2-TRICHLOROETHANE	10	Less than 10
1,1,2-TRICHLOROETHENE	10	Less than 10
TETRACHLOROETHENE	10	Less than 10
XYLENE (O, P)	10	Less than 10
XYLENE (M)	10	Less than 10
FORMALDEHYDE	500	Less than 500

PH AND SPECIFIC CONDUCTIVITY REPORT

<u>US ECOLOGY</u> <u>#</u>	<u>ANALYSIS</u> <u>DATE</u>	<u>RESULT</u> <u>pH</u>	<u>CONDUCTIVITY</u> <u>umhos/cm</u>
1-13	2-19-86	7.94	370
1-8	2-19-86	7.99	365
1-10	2-24-86	7.86	390
1-3	2-24-86	7.87	395
1-5	2-25-86	7.89	415

NITRATE REPORT ¹

<u>US ECOLOGY</u> <u>#</u>	<u>ANALYSIS</u> <u>DATE</u>	<u>RESULT</u> <u>(PPM)</u>	<u>COMMENTS</u>
1-13-7	2-25-86	17.47	2,3
1-8-8	2-25-86	16.55	2,3
1-10-7	2-25-86	14.37	2,3
1-3-7	2-25-86	18.72	2,3
1-5-9	2-25-86	17.36	2,3

1. Detection limit is 0.1 ppm.
2. Initial analyses of the samples yielded a result that exceeded the calibration range and instrumental capability. Therefore, the samples were diluted by a factor of 10 and reanalyzed. The reported results have been corrected for the dilution factor.
3. The samples were taken from the VOA sample bottles.

TOC REPORT ¹

<u>US ECOLOGY</u> <u>#</u>	<u>ANALYSIS</u> <u>DATE</u>	<u>RESULT</u> <u>(PPB)</u>	<u>COMMENTS</u>
1-13-3	2-21-86	Less than 1000	2
1-8-3	2-21-86	Less than 1000	2
1-10-4	2-21-86	Less than 1000	2
1-3-4	2-21-86	Less than 1000	2
1-5-5	3-11-86	Less than 1000	2

1. Detection limit is 1000 PPB.
2. Result is the average of at least 2 measurements.

TOX REPORT ¹

<u>US ECOLOGY</u> <u>#</u>	<u>ANALYSIS</u> <u>DATE</u>	<u>RESULT</u> <u>(PPB)</u>	<u>COMMENTS</u>
1-13-8	2-24-86	Less than 20	
1-8-6	2-24-86	Less than 20	
1-10-9	2-24-86	Less than 20	
1-3-8	2-25-86	Less than 20	
1-5-6	2-25-86	Less than 20	

1. Detection limit is 20 PPB.

Groundwater Data
Radiological Results
(All data is in pCi/l)

<u>Sample Identification</u>	<u>Analysis</u>	<u>Results</u>	
1-13-2	Plutonium 239/240	0.00 E+00 + 1.35 E-02*	
	Plutonium 238	-4.49 E-03 + 8.99 E-03*	
	Tritium	7.06 E+02 + 3.00 E+02	
	Strontium-90	6.07 E-01 + 6.66 E-01*	
	Carbon-14	1.11 E+03 + 3.20 E+03*	
	Gamma Spectral:		
	Cobalt-60	-2.81 E+00 + 6.56 E+00*	
	Cesium-137	1.72 E+00 + 5.06 E+00*	
	Ruthenium-106	3.43 E+01 + 2.81 E+01	
	Dissolved Gross Beta	7.82 E+00 + 2.29 E+00	
	Suspended Gross Beta	7.30 E-01 + 9.44 E-01*	
	Dissolved Gross Alpha	1.15 E+01 + 4.62 E+00	
	Suspended Gross Beta	5.08 E-02 + 1.29 E-01*	
	1-8-2	Plutonium 239/240	0.00 E+00 + 1.77 E-02*
		Plutonium 238	1.18 E-02 + 1.67 E-02*
Tritium		3.63 E+02 + 2.86 E+02	
Strontium-90		8.09 E-01 + 7.25 E-01*	
Carbon-14		1.20 E+03 + 3.20 E-03*	
Gamma Spectral:			
Cobalt-60		-6.75 E+00 + 9.01 E+00*	
Cesium-137		-5.85 E+00 + 9.38 E+00*	
Ruthenium-106		2.00 E+01 + 4.05 E+01*	
Dissolved Gross Beta		8.80 E+00 + 2.06 E+00	
Suspended Gross Beta		6.87 E-01 + 8.97 E-01*	
Dissolved Gross Alpha		9.55 E+00 + 4.11 E+00	

1-10-1

Suspended Gross Alpha	4.14 E-02 \pm 1.05 E-01*
Plutonium 239/240	7.64 E-03 \pm 1.53 E-02*
Plutonium 238	3.06 E-02 \pm 3.07 E-02*
Tritium	4.65 E+02 \pm 2.90 E+02
Strontium-90	4.28 E-01 \pm 4.83 E-01*
Carbon-14	5.19 E+01 \pm 3.16 E+03
Gamma Spectral:	
Cobalt-60	0.00 E+00 \pm 0.00 E+00
Cesium-137	4.13 E+00 \pm 3.37 E+00
Ruthenium-106	-3.16 E+01 \pm 5.33 E+01*
Dissolved Gross Beta	7.33 E+00 \pm 2.19 E+00
Suspended Gross Beta	1.23 E+00 \pm 9.82 E-01
Dissolved Gross Alpha	3.49 E+00 \pm 2.32 E+00
Suspended Gross Alpha	4.73 E-02 \pm 1.06 E-01*
Plutonium-239/240	0.00 E+00 \pm 1.48 E-02*
Plutonium-238	4.92 E-03 \pm 9.85 E-03*
Tritium	9.90 E+02 \pm 3.12 E+02
Strontium-90	2.33 E-01 \pm 4.98 E-01*
Carbon-14	1.77 E+03 \pm 3.22 E+03*
Gamma Spectral:	
Cobalt-60	3.03 E+00 \pm 3.50 E+00*
Cesium-137	-2.56 E+00 \pm 5.42 E+00*
Ruthenium-106	-5.29 E+01 \pm 6.17 E+01*
Dissolved Gross Beta	9.36 E+00 \pm 2.47 E+00
Suspended Gross Beta	1.27 E+00 \pm 1.02 E+00
Dissolved Gross Alpha	3.49 E+00 \pm 2.37 E+00
Suspended Gross Alpha	1.94 E-01 \pm 2.09 E-01*
Plutonium 239/240	-1.22 E-02 \pm 2.44 E-02*
Plutonium 238	1.22 E-02 \pm 5.44 E-02*

1-3-2

1-5-1

Tritium	5.96 E+02 \pm 2.45 E+02
Strontium-90	4.55 E-01 \pm 5.31 E-01*
Carbon-14	5.78 E+02 \pm 3.18 E+03*
Gamma Spectral:	.
Cobalt-60	-1.11 E+1 \pm 7.81 E+00*
Cesium-137	3.19 E-01 \pm 4.33 E+00*
Ruthenium-106	2.89 E+01 \pm 4.26 E+01*
Dissolved Gross Beta	9.33 E+00 \pm 2.43 E+00
Suspended Gross Beta	9.32 E-01 \pm 9.24 E-01
Dissolved Gross Alpha	3.72 E+00 \pm 2.29 E+00
Suspended Gross Alpha	3.95 E-01 \pm 3.00 E-01

Notes for Radioanalytical Results:

1. An asterisk's (*) after the result denotes that the overall error at two sigma is greater than the result.
2. The theoretical lower limits of detection used by the analytical laboratory are as follows:

<u>Parameter</u>	<u>Detection Limit</u>
Gross Alpha suspended	5 pCi/l
Gross Alpha dissolved	5 pCi/l
Gross Beta suspended	5 pCi/l
Gross Beta dissolved	5 pCi/l
Gamma Spectral Analysis	10 pCi/l*
Isotopic Plutonium	0.1 pCi/l
Strontium-90	2 pCi/l
Tritium	300 pCi/l
Carbon-14	200 pCi/l**

* based on cesium-137

** based on analysis by liquid scintillation direct counting



Engineers
Planners
Economists
Scientists

January 16, 1985

S20116.A3

US Ecology
9200 Shelbyville Road
Suite 526
P.O. Box 7246
Louisville, Kentucky 40207

Attention: Mr. Joseph C. Thornton, C.P.G.S.

Gentlemen:

Subject: Monitoring Well Installation Report and Laboratory
Testing Program Results for US Ecology, Inc.,
Richland, Washington

CH2M HILL is pleased to present this report summarizing our observations of monitoring well installations at your Richland, Washington, facility and the results of laboratory testing as requested by you.

We appreciate the opportunity to work with you on this project. If you have any questions concerning this report or if we may be of further service, please do not hesitate to call.

Sincerely,

CH2M HILL NORTHWEST, INC.

Dorinda Himes
Dorinda S. Himes
Hydrogeologist

Richard G. Crim
Richard G. Crim, P.E.
Geotechnical Engineer



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INTRODUCTION

US Ecology's Richland, Washington, site is a low-level radioactive waste disposal facility. Five monitoring wells were installed in the vicinity of trenches used for disposal of low-level radioactive waste.

This report presents the results of CH2M HILL's field observation of well drilling, monitoring well construction procedures, and soil conditions at the US Ecology facility in Richland, Washington. The report also contains the results of our laboratory testing program which consisted of grain size distribution, moisture content, moisture-density relationships, and porosity determinations. The purpose of CH2M HILL's services was to provide quality control for well drilling, well installation, soil sampling, and laboratory testing of selected samples. Our scope of work included:

- Reviewing available soil and geologic literature
- Observing well drilling and well construction procedures for five monitoring wells
- Conducting a field soil sampling program
- Visual classification of soil sampled and observed in the field
- Conducting laboratory tests on selected soil samples
- Preparing this report summarizing our findings

LIMITATIONS

This report has been prepared for the exclusive use of US Ecology, Inc., for specific application to the subject site, in accordance with generally accepted geotechnical engineering practices. No other warranty, express or implied, is made.

The soil boring logs indicate subsurface conditions only at specific locations and times, and only to the depths drilled. They do not necessarily reflect soil, strata, or water level variations that may exist between soil boring location or throughout the site.

CH2M HILL is not responsible for any claims, damages, or liabilities associated with interpretation of subsurface data or reuse of the subsurface data without the express written authorization of CH2M HILL.

SITE DESCRIPTION

The US Ecology Richland site is centrally located on the Hanford Nuclear Reservation, 25 miles northwest of Richland, Washington. A vicinity map locating the site is shown in Figure 1. The site is about 100 acres in size, is semi-arid, and is generally flat except where construction of manmade dunes has taken place. Several trenches were open for burial of the low-level radioactive wastes during the course of our field work.

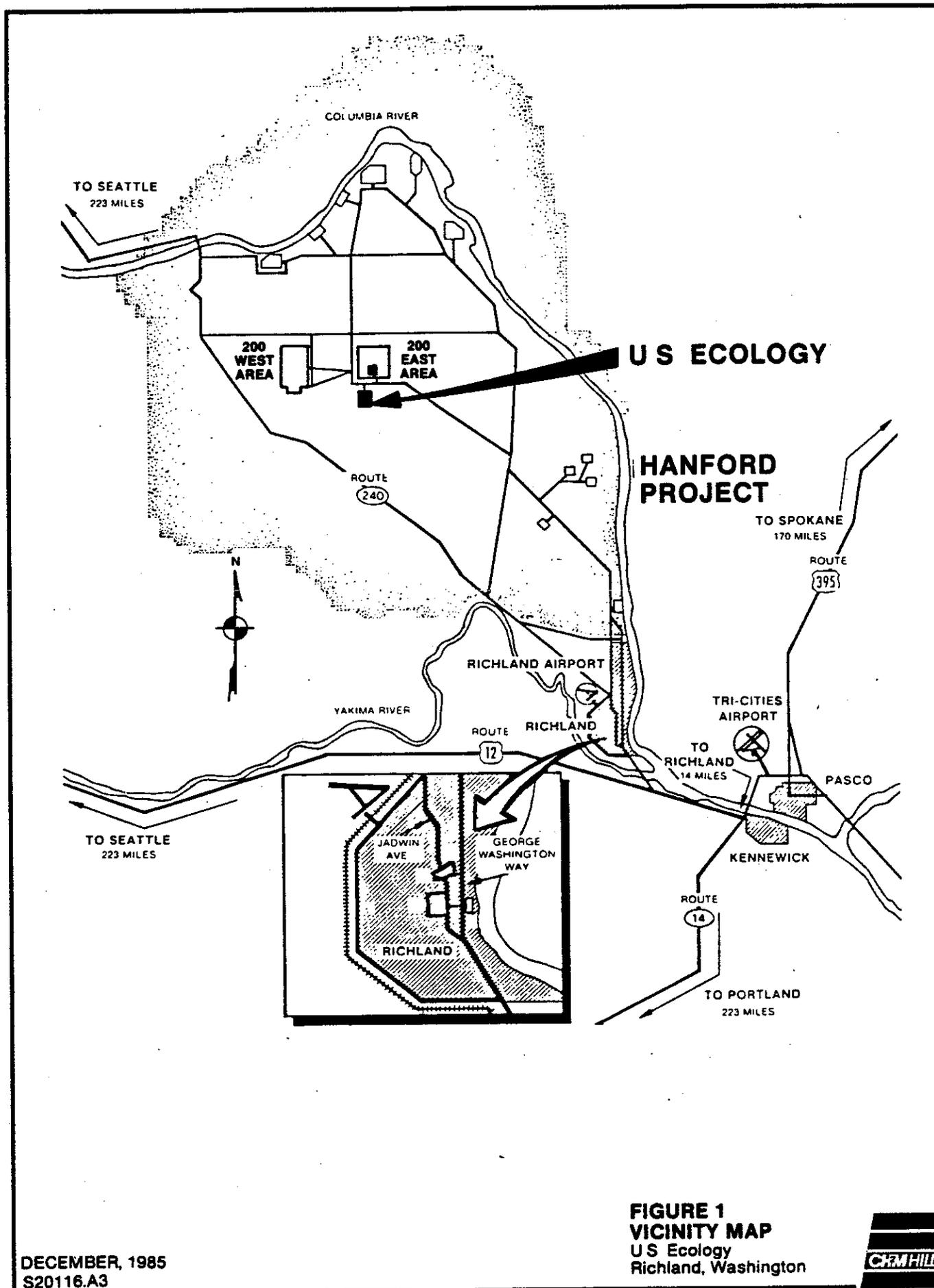
The ground surface elevation generally varies from 720 feet to 740 feet NGVD (National Geodetic Vertical Datum). The ground surface is partially covered by sagebrush and other desert vegetation except where the vegetation has been stripped due to construction activities.

REGIONAL GEOLOGY

The Hanford Reservation contains approximately 350 square miles of land located on the broad sandy terraces along the Columbia River in south central Washington. The broad Pasco and Cold Creek synclines form the saucer-shaped bedrock structure of the Pasco Basin. The wind-scarred terrace lands of the reservation terminate on the west against the Yakima Ridges. Rattlesnake Mountain is located southwest of the reservation, and a few bedrock outliers, such as Gable Mountain, protrude above the terraces of the reservation. Elevations range from 340 feet to about 800 feet NGVD on the terraces.

The thick basalt of the Columbia River group of Miocene and early Pliocene time is the bedrock of the region. The basalt in the Hanford area is generally 3,500 to 5,000 feet thick. Its top lies within 100 to 200 feet of mean sea level below broad areas of sedimentary deposits. The Ringold Formation, of middle to late Pleistocene age, overlies the basalt and consists of up to 1,200 feet of bedded silts and fine sands containing some gravel and volcanic ash. The Ringold formation was deposited in a current-carrying part of a lake. The upper portion of the Ringold formation is a water-bearing sandy gravel layer. This sand and gravel deposit is locally termed "conglomerate," though it is best termed semiconsolidated gravel. At the Hanford Reservation, the elevation of the top of the Ringold formation varies generally between 285 and 450 feet NGVD.

The Ringold formation has been partly eroded from the southwestern part of the Pasco basin in the Hanford Reservation. On top of this erosional surface are glaciofluvial and fluvial deposits that were water laid by the ancestral Columbia River and in part by glacial melt waters. The glaciofluvial and fluvial deposits consist of pebble gravel and sand with some intermixed and interlayered silt



U S ECOLOGY

HANFORD PROJECT

**FIGURE 1
VICINITY MAP
U S Ecology
Richland, Washington**



as well as a few scattered cobbles and boulders. These soils were deposited during Pleistocene time and are known to be several hundred feet thick (Newcomb, et al., 1972).

REGIONAL HYDROLOGY

The Columbia and Yakima Rivers are the base level drainages for the Hanford area. The natural groundwater gradient beneath most of the terraced plains of the reservation is about 5 feet per mile toward the Columbia River.

The principal water-bearing units at the Hanford site are the basalt of the Columbia River group, and the sandy gravel stratum of the Ringold formation. The regional water table generally lies in the Ringold formation at the US Ecology site. Most of the Ringold formation is sufficiently sandy to transmit water vertically. The Ringold beds transmit water more readily in a horizontal direction than they do in the vertical direction. The sandy gravel stratum of the Ringold formation provides a path of relatively uniform permeability for the lateral movement of groundwater beneath the reservation.

The glaciofluvial and fluvial deposits overlying the Ringold formation are sufficiently permeable to permit water to infiltrate readily downward. However, little, if any, water moves downward through the soil to the water table in broad areas of the desert terrain (Newcomb et al., 1972). This is evidently because the zone of aeration effectively separates the low precipitation (average 8 inches per year) on the surface from the water table.

The principal natural recharge to the unconfined groundwater occurs in the upper and middle parts of the Cold Creek Valley, at places where the discharge from upper Cold Creek and Dry Creek Valleys spread onto the valley plains along the Yakima River and along the Columbia River during its annual high stages.

MONITORING WELL INSTALLATION METHODS

Five monitoring wells were installed by Onwego Drilling Company of Kennewick, Washington, using cable tool drilling methods. The drilling program was observed in the field by a CH2M HILL hydrogeologist or geotechnical engineering staff member. Field work was performed between September 4 and December 10, 1985. The locations of the wells are shown in Figure 2. Monitoring wells MW-3, MW-8, MW-10, and MW-13 were constructed using steel casing. Monitoring well MW-5 was constructed using polyvinyl chloride (PVC) casing. General well construction methods are briefly discussed within the following text. Individual well construction details are presented in Appendix A.



NOTE:

- 1. PHOTOGRAPH PROVIDED BY U.S. ECOLOGY, OBLIQUE #4, NO. 3899-001, TAKEN JUNE 24, 1983.
- 2. MONITORING WELL LOCATIONS ARE APPROXIMATE.
- 3. SEE FIGURES 3 AND 4 FOR CROSS SECTIONS A-A' AND B-B'.

MW-3 ● = MONITORING WELL LOCATION
NOT TO SCALE

FIGURE 2
MONITORING WELL AND CROSS SECTION LOCATIONS
U.S. Ecology
Richland, Washington



CABLE TOOL DRILLING

The cable-tool percussion drilling method advances the well by regularly lifting and dropping a heavy string of drilling tools in the borehole. When working in soft, unconsolidated material, a 6-3/4-inch-diameter dry barrel sampler was advanced to remove the material in MW-3, MW-8, MW-10, and MW-13. A 9-3/4-inch-diameter dry barrel sampler was used in MW-5. When harder consolidated material was encountered, a drill bit along with water was used. The bit breaks the hard rock into small fragments and mixes it with the water to form a slurry. The necessary water to form the slurry was put into the borehole if no water was present in the formation being penetrated. The resulting slurry was removed at intervals from the borehole by means of a bailer.

The hole was kept open by means of a casing. When using the dry barrel sampler, the casing generally followed the sampler down the hole without driving. In the consolidated material, or when the casing did not advance under its own weight, the casing was driven. A hardened steel drive shoe was attached to the lower end of the casing for protection.

CASING INSTALLATION

Four of the five monitoring wells (MW-3, MW-8, MW-10, and MW-13) were installed using similar materials and construction methods. Initially, a temporary 12-inch-diameter casing was installed to approximately a 20-foot depth. The permanent, 8-inch-diameter, Schedule 40 mild steel casing was installed inside the temporary casing to a total depth of 350 feet in MW-3, MW-8, and MW-13 and 360 feet in MW-10. The 8-inch-diameter casing was furnished in 21-foot sections. Casing joints were welded.

WELL SCREEN INSTALLATION

When the casing installation was completed to the full depth required in MW-3, MW-8, MW-10, and MW-13, a screen assembly was lowered to the bottom of the hole. The screen assembly consisted of two 20-foot-long, 6-inch-diameter stainless steel screens which were welded together. The slot size was No. 20 (0.020 inches wide). A stainless steel plate was welded onto the bottom of the screen, and a 2-foot-long, 6½-inch-diameter blank pipe extension was welded to the top of the screen. A 1.3-foot-long neoprene self-sealing packer assembly was welded to the blank pipe.

After lowering the screen into place, the casing was pulled up 41 feet using a pipe spear, to expose the screen in the water-bearing layer. The excess casing was cut off. About 24 to 30 inches of casing was left sticking up above the ground surface at each well.

MONITORING WELL COMPLETION

At the completion of the screen installation, the annular space between the permanent 8-inch-diameter casing and the temporary 12-inch-diameter casing was filled to the ground surface with a cement-bentonite grout. The 12-inch diameter casing was then removed. A concrete pad was placed around the top of wells MW-8 and MW-13 and sloped to drain surface water away from the well. (Monitoring wells MW-3, MW-5, and MW-10 do not have concrete pads at this time because of the freezing weather conditions.) An 8-inch steel cap was placed on each well. Each well was developed for a period of 4 to 5 hours using a bailer to remove sand and/or silt material. All drilling and sampling equipment was cleaned with either high-pressure hot or cold water after each monitoring well was constructed.

MONITORING WELL MW-5

One of the five monitoring wells (MW-5) differed from the other monitoring wells in that it was constructed using 6-inch-diameter Schedule 80 PVC flush-threaded pipe as the permanent well casing. A temporary casing was installed, which enabled the borehole to stay open to a total depth of 350 feet. The upper 200 feet of the temporary casing consisted of 12-inch-diameter Schedule 40 mild steel pipe. Then, 10-inch-diameter Schedule 40 mild steel pipe was telescoped down the borehole to a total depth of 350 feet below the ground surface. When the temporary casing installation was completed, 350 feet of PVC pipe, including 40 feet of flush-threaded 304 stainless steel screen with 0.010-inch-wide slots, was installed using centralizers at 60-foot intervals. The annular space around the PVC pipe was filled with a sand pack at the well screen, followed by a bentonite seal and cement-bentonite grout up to the ground surface. During the insertion of these materials, the temporary casing was removed using the pullback method.

SUBSURFACE CONDITIONS

Based on our field observations, the soils at the US Ecology site consist of approximately 250 feet of fluviatile deposits which overly the water-bearing gravel layer of the Ringold formation. The fluviatile deposits consist predominately of fine to medium sand with some intermixed and interlayered silt as well as a few scattered cobbles and pebbly gravel. A distinct thin volcanic ash layer was found in all of the wells, except for MW-13, at an elevation of approximately 710 feet.

The top of the Ringold formation is at an elevation of approximately 425 feet NGVD. The Ringold formation consists predominately of well-graded gravel with sand. The sand

tends to be concentrated in thin seams. The subsurface conditions at the US Ecology site are depicted on cross section A-A' and B-B' in Figures 3 and 4, respectively. Detailed soil descriptions of materials encountered during the drilling operation are contained on the soil boring logs presented in Appendix B. The driller's logs of materials encountered are presented in Appendix C.

The following is a generalized description of the two different types of soil materials encountered during the drilling operation:

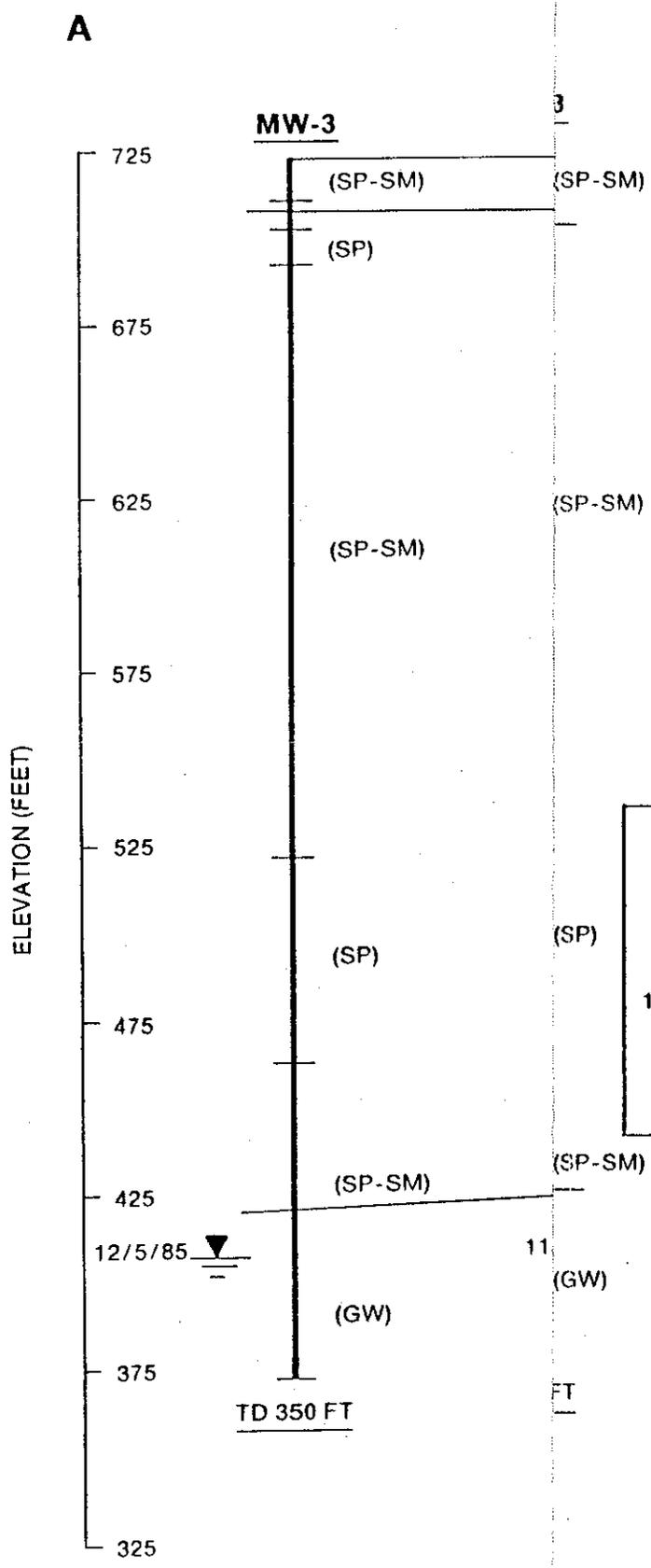
- Sand and Silty Sand (SP-SM). The fluviatile deposits of sand and silty sand are generally poorly graded fine to medium sand. The sand contains 0 to 25 percent intermixed and interlayered silt and less than 5 percent occasional pebbly gravel. The sand is dry except in the top 20 feet, where it is damp to moist, light brown in color, and loose. Some calcium carbonate is present throughout the deposit.
- Sandy Gravel (GW). The gravel layer of the Ringold formation is well graded and contains less than 5 percent material by weight smaller than a U.S. Standard No. 200 sieve. The gravel ranges in size from ¼ inch to 3 inches in diameter, and contains occasional cobbles. The gravel is well-rounded and contains 5 to 15 percent fine to medium sand which is generally found in lenses. The gravel layer is wet, gray in color, and is very dense.

WATER LEVELS

Water levels were measured in each of the five monitoring wells prior to and after installation of the well screen. Measured depths to water beneath the US Ecology site are shown in Table 1. The reported water levels are representative for only the specific locations explored and dates measured, and can be expected to change with time and season.

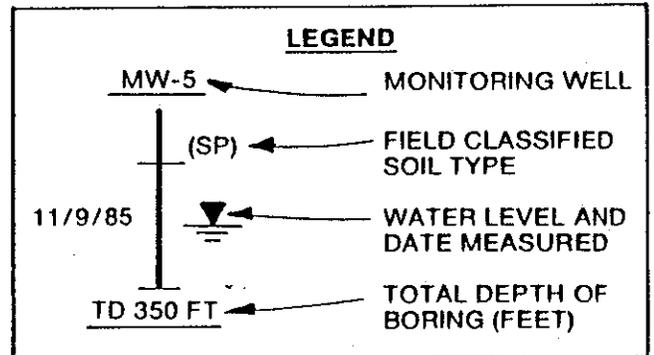
LABORATORY TESTING

The laboratory testing program consisted of performing grain size analyses, moisture content determinations, moisture-density relationships, and porosity determinations. All samples were analyzed for moisture content except those that had water added to them to aid in retrieving the sample from the borehole. Two soil samples from each monitoring well were tested for grain size analysis, bulk density, specific gravity of solids, and moisture-density relationships.



NOTES:

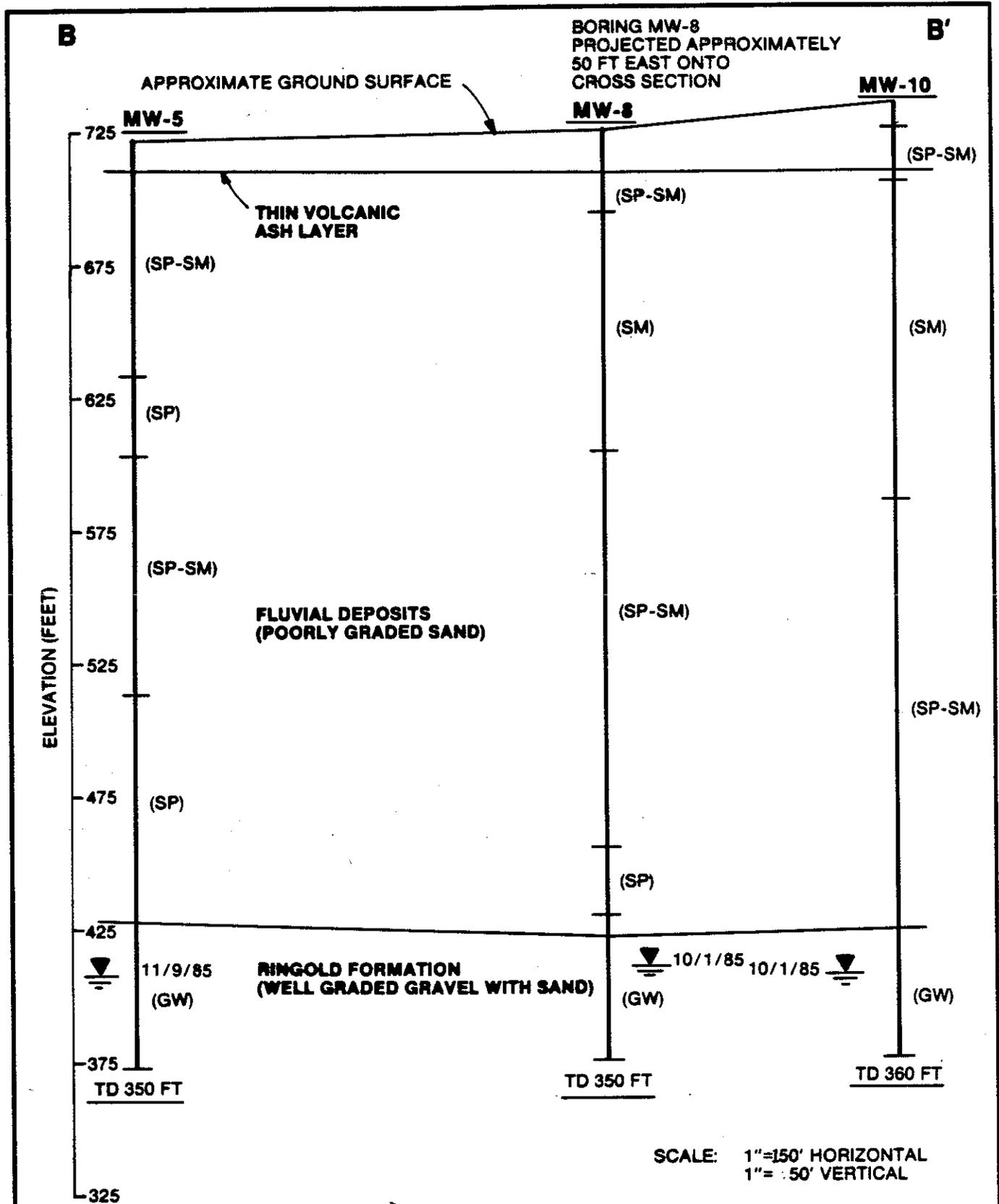
1. SEE FIGURE 2 FOR LOCATIONS OF MONITORING WELLS.
2. SUBSURFACE CONDITIONS DEPICTED ON CROSS SECTIONS ARE INTERPRETATIONS AND REPRESENT THE OPINION OF THE CH2M HILL HYDROGEOLOGIST. ACTUAL SUBSURFACE CONDITIONS MAY DIFFER.
3. SOIL TYPES SHOWN ON CROSS SECTIONS ARE OBTAINED FROM SOIL BORING LOGS FOUND IN APPENDIX B. SEE SOIL BORING LOGS FOR DETAILED SOIL DESCRIPTION.
4. ELEVATIONS ARE TAKEN FROM A TOPOGRAPHY MAP SURVEYED FOR U.S. ECOLOGY, BY WALKER AND ASSOCIATES OF SEATTLE, DATED 10/24/28.



SCALE: 1"=150' HORIZONTAL
1"= 50' VERTICAL

FIGURE 3
CROSS SECTION A-A'
U.S. Ecology
Richland, Washington





*SEE NOTES AND
LEGEND ON FIGURE 3
FOR EXPLANATION

DECEMBER, 1985
S20116.A3

**FIGURE 4
CROSS SECTION B-B'**
U.S. Ecology
Richland, Washington



Table 1
MEASURED WATER DEPTHS BENEATH THE
US ECOLOGY SITE

<u>Well No.</u>	<u>Date Measured</u>	<u>Water Depth measured from ground surface (feet)</u>
MW-3	12-5-85	316.2
MW-5	10-29-85	316.5
	11-9-85	315.4
	11-20-85	316.0
MW-8	10-1-85	318.9
	10-18-85	319.2
	11-13-85	319.4
MW-10	10-1-85	328.8
	11-13-85	329.3
MW-13	10-31-85	315.5
	11-9-85	314.9
	11-20-85	315.7

Porosity estimates were made based on bulk density of disturbed samples, specific gravity of solids, and moisture content. Monitoring wells MW-3, MW-5, and MW-13 also had one sample each tested for grain size distribution from the sandy gravel layer. Results of the laboratory testing program are presented in Appendix D.

REFERENCES

Newcomb, R. C.; J. R. Strand; and F. J. Frank. 1972.
Geology and Groundwater Characteristics of the Hanford
Reservation of the US Atomic Energy Commission,
Washington. US Geological Survey Prof. Paper 717, 78
pp.

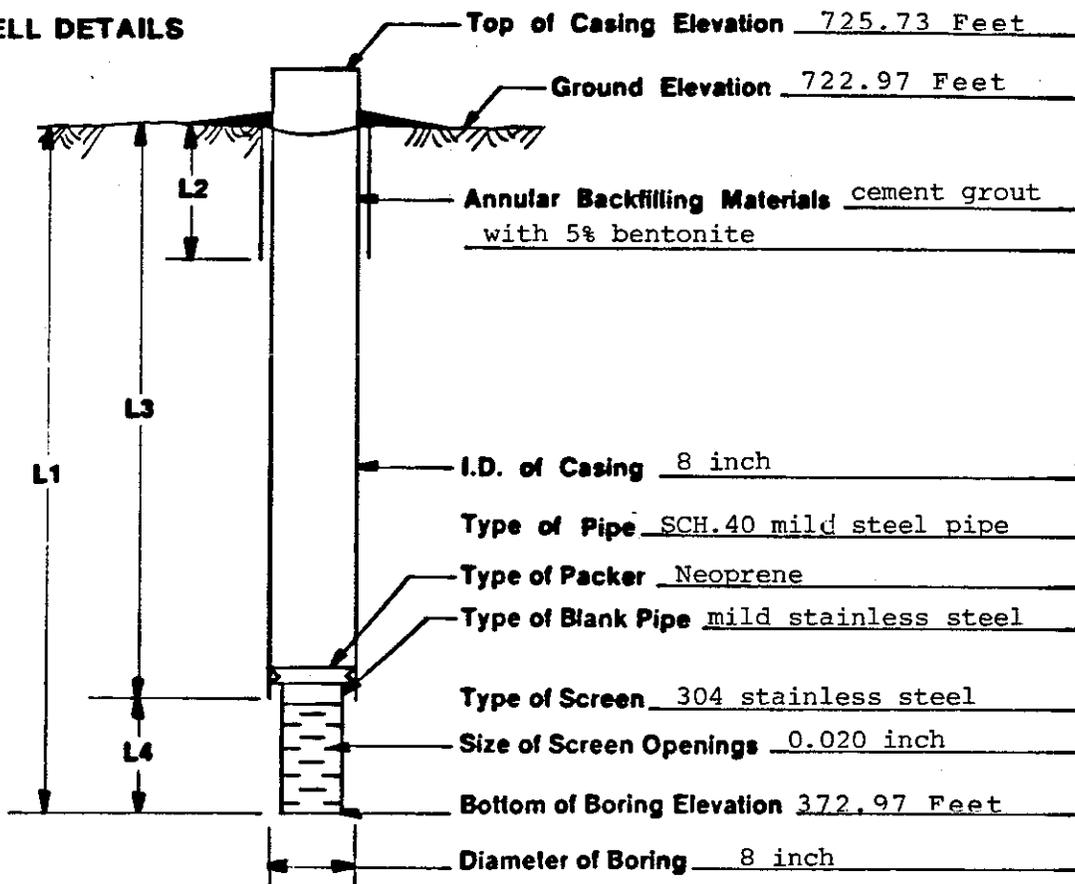
Appendix A
MONITORING WELL DIAGRAMS

MONITOR WELL INSTALLATION REPORT

Project: US Ecology Inc. Monitor Well No. MW-3
 Project No. S20116.A3 Installed By: Onwego Drilling Co. Date: 11/8-12/10/85
 Location: Hanford Reservation, Richland, Washington
 Method of Installation: Cable Tool, 22W Bucyrus Erie Mobile/Drill Rig

Type of Monitoring Well 8 inch steel casing

MONITOR WELL DETAILS



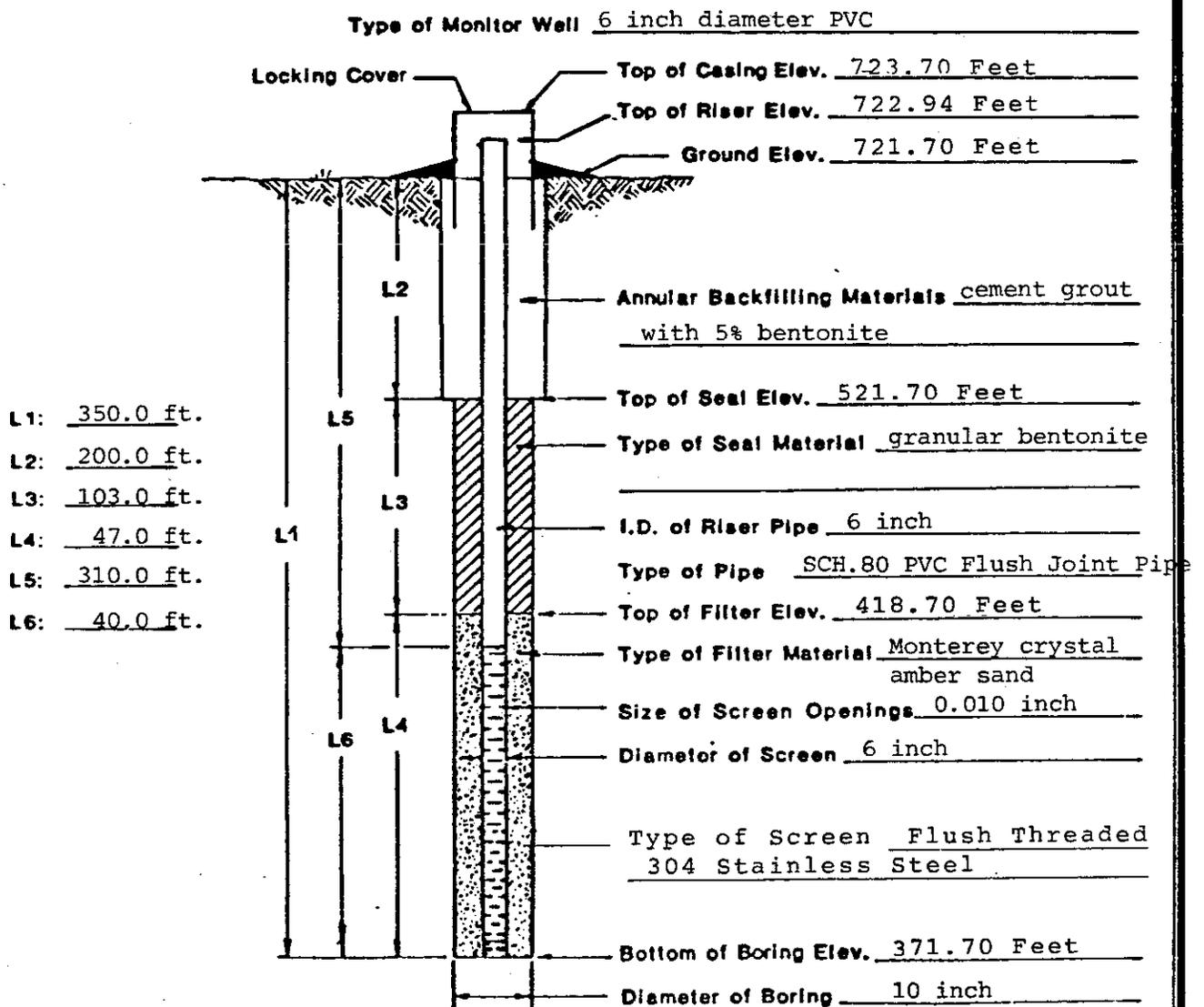
- L1: 350.0 ft.
- L2: 20.0 ft.
- L3: 310.0 ft.
- L4: 40.0 ft.



MONITOR WELL INSTALLATION REPORT

Project: US Ecology Inc. Monitor Well No. MW-5
 Project No. S20116.A3 Installed By: Onwego Drilling Co. Date: 10/3/85-10/31/85
 Location: Hanford Reservation, Richland, Washington
 Method of Installation: Cable Tool, 22W Bucyrus Erie Mobil/Drill Rig

MONITOR WELL DETAILS



MONITOR WELL INSTALLATION REPORT

Project: US Ecology Inc. Monitor Well No. MW-8

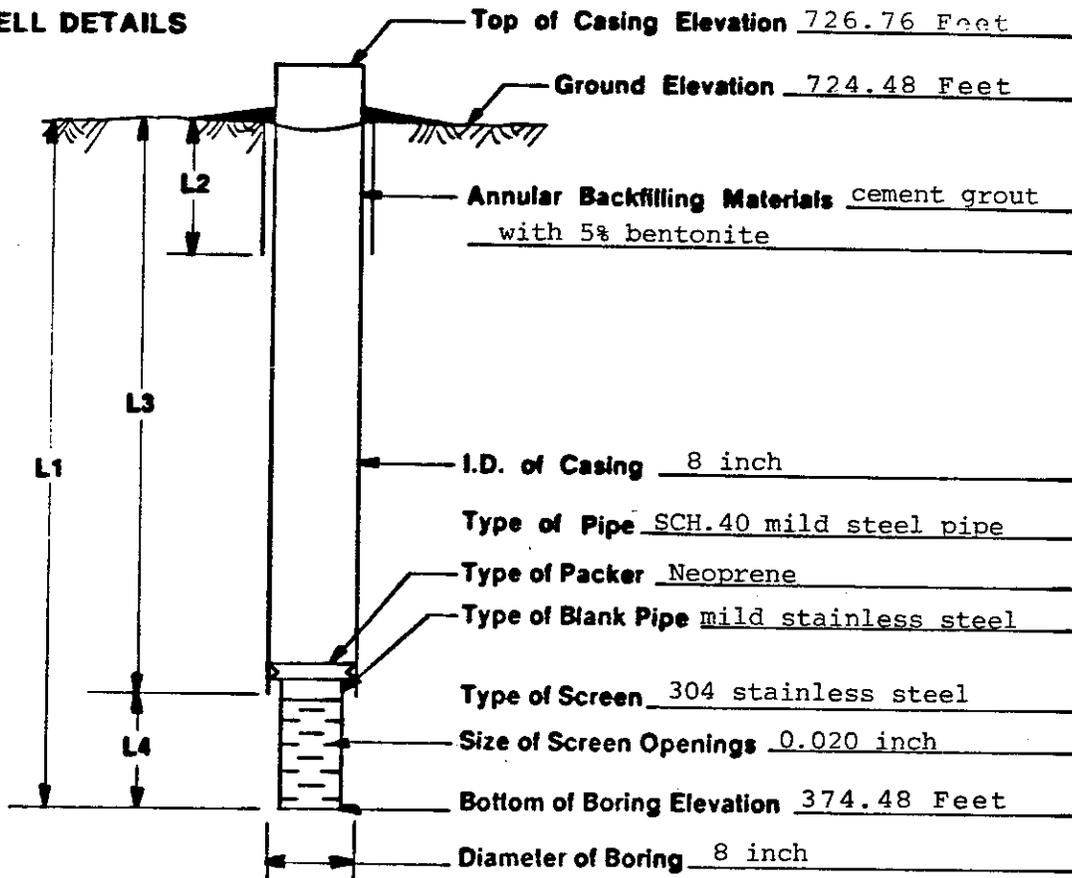
Project No. S20116.A3 Installed By: Onwego Drilling Co. Date: 9/4-9/27/85

Location: Hanford Reservation, Richland, Washington

Method of Installation: Cable Tool, 22W bucyrus erie Mobil/Drill Rig

MONITOR WELL DETAILS

Type of Monitoring Well 8 inch steel casing



- L1: 350.0 ft.
- L2: 19.0 ft.
- L3: 310.0 ft.
- L4: 40.0 ft.



MONITOR WELL INSTALLATION REPORT

Project: US Ecology Inc. Monitor Well No. MW-10

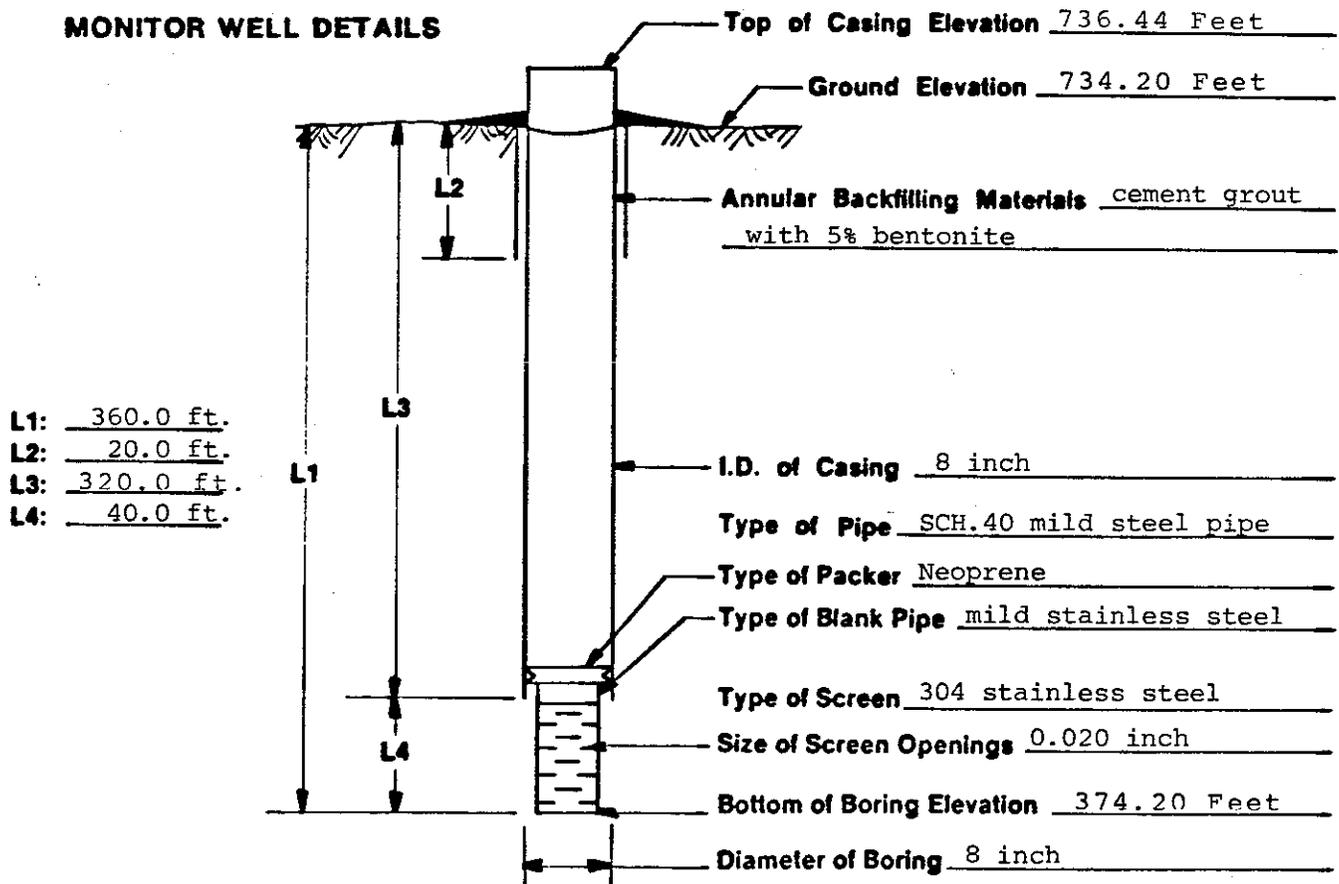
Project No. S20116.A3 Installed By: Onwego Drilling Co. Date: 9/4-9/23/85

Location: Hanford Reservation, Richland, Washington

Method of Installation: Cable Tool, 22W Bucyrus Erie Mobil/Drill Rig

Type of Monitoring Well 8 inch steel casing

MONITOR WELL DETAILS

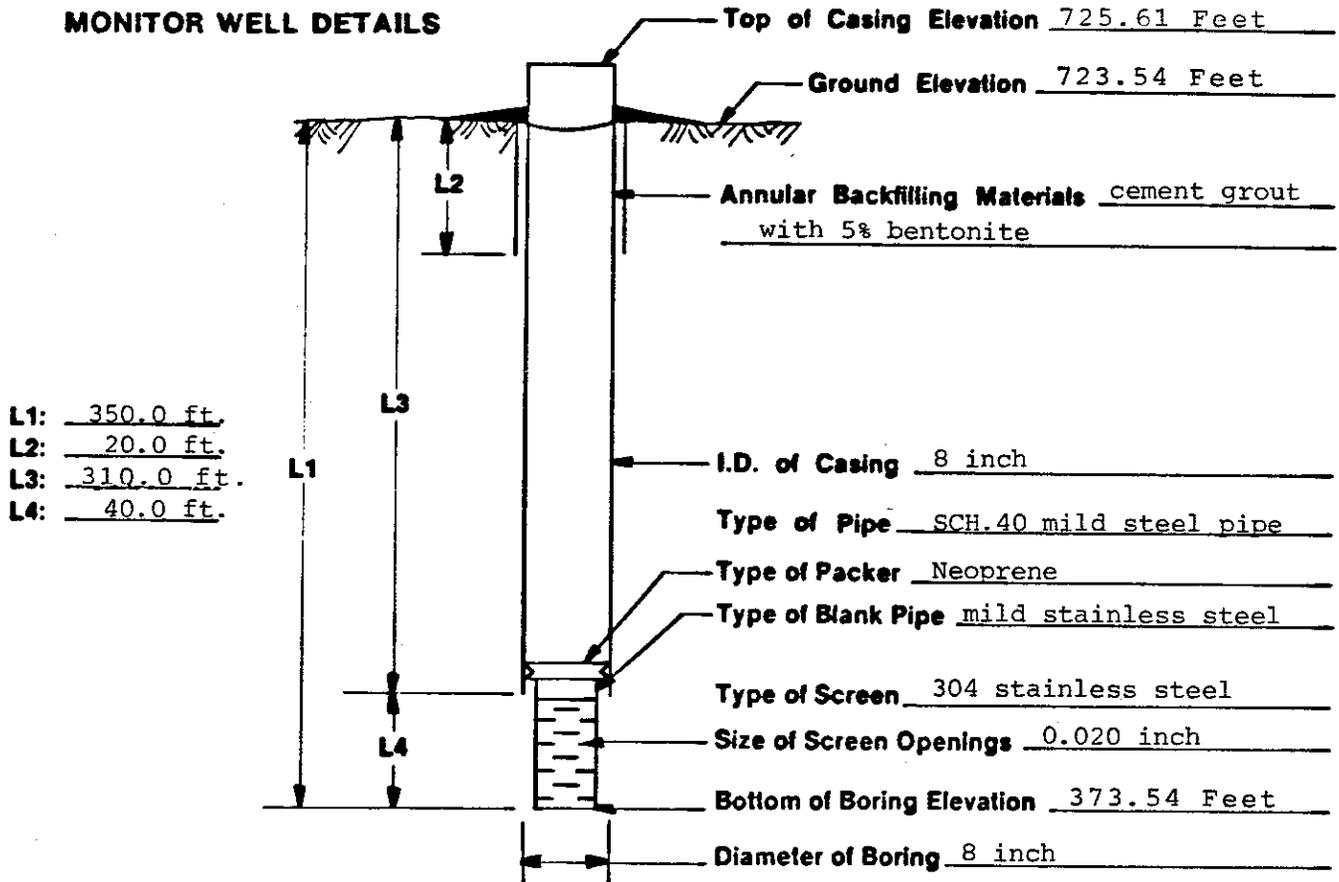


MONITOR WELL INSTALLATION REPORT

Project: US Ecology Inc. Monitor Well No. MW-13
 Project No. S20116.A3 Installed By: Onwego Drilling Co. Date: 10/8-10/31/85
 Location: Hanford Reservation, Richland, Washington
 Method of Installation: Cable Tool, 22W Bucyrus Erie Mobil/Drill Rig

Type of Monitoring Well 8 inch steel casing

MONITOR WELL DETAILS



Appendix B
SOIL BORING LOGS

BORING LOG LEGEND:

SAMPLE TYPE:

- B - BAG SAMPLE**
- J - JAR SAMPLE**
- S - SPLIT BARREL (ASTM D1586
UNLESS OTHERWISE NOTED)**
- W - WASH SAMPLE**
- ST - SHELBY TUBE**
- OT - OSTERBERG TUBE**
- NX - DIAMOND CORE BARREL**

SYMBOLIC LOG:

SEE SYMBOLIC LOG LEGEND FOR KEY TO GRAPHIC PATTERN

NOTES:

- 1. THE BORING LOGS AND RELATED INFORMATION DEPICT SUBSURFACE CONDITIONS ONLY AT THE SPECIFIC LOCATIONS AND DATES INDICATED. SOIL CONDITIONS AND WATER LEVELS AT OTHER LOCATIONS MAY DIFFER FROM CONDITIONS OCCURRING AT THESE BORING LOCATIONS. ALSO, THE PASSAGE OF TIME MAY RESULT IN A CHANGE IN THE CONDITIONS AT THESE LOCATIONS.**
- 2. BORINGS WERE LOGGED IN THE FIELD BY A CH2M HILL HYDROGEOLOGIST OR GEOTECHNICAL ENGINEERING STAFF MEMBER. SAMPLES WERE EXAMINED AND VISUALLY CLASSIFIED IN APPROXIMATE ACCORDANCE WITH ASTM D2488.**
- 3. BORINGS MW-3, MW-5, MW-8, MW-10 and MW-13 WERE DRILLED BY ONWEGO DRILLING COMPANY OF KENNEWICK, WASHINGTON. THE MONITORING WELLS WERE DRILLED AND INSTALLED BETWEEN SEPTEMBER 3, 1985 AND DECEMBER 10, 1985, USING A TRUCK-MOUNTED 22W BUCYRUS ERIE CABLE TOOL DRILLING RIG.**

**BORING
LOG LEGEND**





GRAVEL, GRAVEL-SAND MIXTURES (GW, GP)



PEAT, OTHER HIGHLY ORGANIC SOILS (PT)



SILTY GRAVEL, GRAVEL-SAND-SILT MIXTURES (GM)



CLAYEY GRAVEL, GRAVEL-SAND-CLAY MIXTURES (GC)



SAND, WELL TO POORLY GRADED (SW, SP)



SAND, WITH SOME SILT (SP-SM)



SILTY SAND, SAND-SILT MIXTURES (SM)



CLAYEY SAND, SAND-CLAY MIXTURES (SC)



SILT, INORGANIC, LOW PLASTICITY (ML)



SILT, INORGANIC, HIGH PLASTICITY (MH)



ORGANIC SILT, LOW PLASTICITY (OL)



CLAY, INORGANIC, LOW TO MOD. PLASTICITY (CL)



CLAY, INORGANIC, HIGH PLASTICITY (CH)



ORGANIC CLAY AND SILT, MOD. TO HIGH PLASTICITY (OH)

NOTE: Standard symbolic log legend, All symbols may not be used.

SYMBOLIC LOG LEGEND





PROJECT NUMBER 520116, A3	BORING NUMBER MW-3	SHEET 1 OF 12
SOIL BORING LOG		

PROJECT **US ECOLOGY, HANFORD SITE** LOCATION **RICHLAND, WASHINGTON**
 ELEVATION **APPROX 723.5 FT** DRILLING CONTRACTOR **ONWEGO DRILLING CO. KENNEWICK**
 DRILLING METHOD AND EQUIPMENT **TRUCK MOUNTED CAB & TOOL, 22-W BUCKYUS ERIE**
 WATER LEVEL AND DATE **316.2 FT, 12/5/85** START **11/8/85** FINISH **12/10/85** LOGGER **DSHINGS**

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (%)				
	0							Top soil was watered down to enable access. using 6" φ dry barrel sampler.
	5							MW-3 IS LOCATED 10 FT EAST OF ORIGINAL MARK.
	9.0							
	10.0	S-1	3	—				moisture content 9.0%
	10							
	15							ASH AT 15.0 FT
	19.0							
	20.0	S-2	3	—				Raining when we recovered S-2, may affect the moisture content. moisture content 6.2%
	20							
	25							
	30							between 25.0 and 30.0 FT occasional large gravel. 2-3" φ subrounded, lt colored



PROJECT NUMBER S20116.A3	BORING NUMBER MW-3	SHEET 2 OF 12
SOIL BORING LOG		

PROJECT US ECOLOGY, HANFORD SITE LOCATION RICHLAND, WASHINGTON
 ELEVATION approx 723.5 FT DRILLING CONTRACTOR DWDEGO DRILLING CO. KEMEWICK
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 22-W BUCURUS CRE
 WATER LEVEL AND DATE 316.2 FT, 12/5/85 START 11/8/85 FINISH 12/10/85 LOGGER DSHIMS

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION <small>NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL</small>	SYMBOLIC LOG	COMMENTS <small>DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION</small>
		INTERVAL	TYPE AND NUMBER	RECOVERY (FT/MS)	6"-6"-6" (N)			
30	30.0 31.0	S-3	3	—	SILTY SAND - poorly graded, 10-20% fines, fine to med sand, lt brown, dry, loose. fluvial (SP-sm)	[Symbolic Log]	moisture content 2.0%	
35							smooth drilling	
40	39.0 40.0	S-4	3	—	SILTY SAND - poorly graded 10-20% fines, fine to med sand, lt brown, dry, loose. fluvial (SP-sm) silty seams		moisture content 2.0%	
45								
50	49.0 50.0	S-5	3	—	SILTY SAND - similar to S-4		moisture content 1.7% finished drilling at 520 FT on 11/9/85	
55								
60								



PROJECT NUMBER S20116.A3	BORING NUMBER MW-3	SHEET 3 OF 12
SOIL BORING LOG		

PROJECT USECOLOGY HANFORD SITE LOCATION RICHLAND, WASHINGTON
 ELEVATION APPROX 723.5 FT DRILLING CONTRACTOR DNWEGO DRILLING CO. KENNEWICK
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 22W BUCYRUS ERIE
 WATER LEVEL AND DATE 316.2 FT, 12/5/85 START 11/8/85 FINISH 12/10/85 LOGGER KREKOS

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (%)				
60	60.0 61.0	S-6	3	—	SILTY SAND - POORLY GRADED, 5-15% FINES, FINE TO MED. SAND, DRY, LT. BROWN, FLUVIAL (SP-SM)	SYMBOLIC LOG	LOGGED SAMPLE AT 10:00 AM - moisture content 2.0%	
65								
70								
75								
80	79.0 80.0	S-7	2	—	SILTY SAND - POORLY GRADED, 5-15% FINES, FINE TO MED. SAND, DRY, LT. BROWN, (SP-SM) FLUVIAL	SYMBOLIC LOG	1257 11/11/85 NO APPROVAL ON MW-3 DRILLING STOPPED FOR AWHILE	
85								0900 11/12/85 RELIEVED OK TO DILL ON MW-3
90								



PROJECT NUMBER 520116.A3	BORING NUMBER MW-3	SHEET 4 OF 12
SOIL BORING LOG		

PROJECT USECOLOGY HANFORD SITE LOCATION RICHLAND, WASHINGTON
 ELEVATION APPROX 723.5 FT DRILLING CONTRACTOR ONWEGO DRILLING CO. KEENEWICK
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABIE TOOL, 22-W BUCYFUS ERIE
 WATER LEVEL AND DATE 316.2 FT, 12/5/85 START 11/8/85 FINISH 12/10/85 LOGGER KREKOS

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (%)				
90								
95								
100		100						
		101	S-8	2	—	SILTY-SAND, POOR GRADED, 5-15% FINES, FINE TO MED SAND, LT. BROWN, DRY, FLUVIAL (SP-SM)	moisture content 2.1%	
105								
110								
115								
120								



PROJECT NUMBER 520116.A3	BORING NUMBER MW-3	SHEET 5 of 12
SOIL BORING LOG		

PROJECT US ECOLOGY INC. HANFORD SITE LOCATION RICHLAND, WASHINGTON
 ELEVATION approx 723.5 FT DRILLING CONTRACTOR ONWEGO DRILLING CO. KENNEWICK
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 22-W BUCYRUS ERIE
 WATER LEVEL AND DATE 316.2 FT, 12/5/85 START 11/8/85 FINISH 12/10/85 LOGGER KREKOS

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (# JARS)	6"-6"-6" (N)			
120		121	5-9	2	—	SILTY-SAND, POORLY GRADED, LESS THAN 10% FINES, FINE TO MOD. SAND, SILTY LAYER, LT. BROWN, DAMP, FLUVIAL, (SP-SM)	[Symbolic Log Column]	moisture content 3.5%
125								
130								
135								
140		141	5-10	2	—	SILTY-SAND, POORLY GRADED, LESS THAN 10% FINES, FINE SAND, LT BROWN, DAMP FLUVIAL (SP-SM)	[Symbolic Log Column]	LOGGED AT 1200 11/13/85 moisture content 3.2%
145								
150								



PROJECT NUMBER

S20116.A3

BORING NUMBER

MW-3

SHEET 6 OF 12

SOIL BORING LOG

PROJECT USECOLOGY INC. HANFORD SITE LOCATION RICHLAND, WASHINGTON
 ELEVATION APPROX 723.5 FT DRILLING CONTRACTOR ON WEGO DRILLING CO. KENNEWICK
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 22W BUCYRUS ERIE
 WATER LEVEL AND DATE 316.2 FT, 12/5/85 START 11/8/85 FINISH 12/10/85 LOGGER KREKOS

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (#FARS)				
150								
155								
160		160	S-11	2	—	SILTY SAND, POORLY GRADED, LESS THAN 10% FINES, FINE TO MED. SAND., MOIST, LT. BROWN FLUVIAL (SP SM)	LOGGED AT 0830 11/14/85. MOISTURE CONTENT 26%.	
165								
170								
175								
180								



PROJECT NUMBER S20116. A3	BORING NUMBER MW-3	SHEET 7 OF 12
SOIL BORING LOG		

PROJECT US EKOLOGY INC. HANFORD SITE LOCATION RICHMOND, WASHINGTON
 ELEVATION APPROX 723.5 FT. DRILLING CONTRACTOR ONWEGO DRILLING CO KENNEWICK
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 22-W BUCYRUS ERIE
 WATER LEVEL AND DATE 316.2 FT, 12/5/85 START 11/8/85 FINISH 12/10/85 LOGGER KREKOS

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	SYMBOLIC LOG	COMMENTS
		INTERVAL	TYPE AND NUMBER	RECOVERY (# JARS)	6"-6"-6" (N)			
180	180-181	S-12	2	-	-	SILTY SAND, POORLY GRADED, LESS THAN 10% FINES, MED TO COARSE SAND. LT. BROWN DAMP, FLUVIAL (SP-SM).	LOGGED AT 1200 11/14/85.	182' RECOVERING COARSE SAND SMALL GRAVEL. moisture content 2.9%
185								
190								
195								
200	200-201	S-13	2	-	-	SAND, POORLY GRADED LESS THAN 5% FINES MED TO COARSE SAND, SMALL GRAVEL LT. BROWN DAMP, FLUVIAL (SP)	LOGGED AT 0830 11/15/85	moisture content 2.2%
205								
210								



PROJECT NUMBER 320116.A3	BORING NUMBER MW-3	SHEET 8 OF 12
SOIL BORING LOG		

PROJECT USECOLOGY INC. HANFORD SITE LOCATION RICHMOND, WASHINGTON
 ELEVATION APPROX. 723.5 FT DRILLING CONTRACTOR ONWEGIO DRILLING CO, KENNEWICK
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 22W BUCYRUS ERIG
 WATER LEVEL AND DATE 316.2 FT, 12/5/85 START 1/8/85 FINISH 12/10/85 LOGGER KREKOS

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (#FT/PS)				
210								
215								
220		220						
		221	5-14	2	—	SAND, POBBY GRADED LESS THAN 5% FINES, MED TO COARSE SAND, SMALL GRAVEL, PRY, FLUVIAL (SP)		SAMPLED AT 1545 11/15/85 MOISTURE content 2.0%
225								
230								11/16/85 WATER WAS ADDED TO PICK UP SAMPLE.
235								
240								



PROJECT NUMBER S20116 . A3	BORING NUMBER MW-3	SHEET 9 OF 12
SOIL BORING LOG		

PROJECT USECOLOGY INC, HANFORD SITE LOCATION RICHLAND, WASHINGTON
 ELEVATION APPROX 723.5 FT DRILLING CONTRACTOR ONWEGO DRILLING CO, KENNEWICK
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 22W BUCYRUS ERIE
 WATER LEVEL AND DATE 316.2 FT, 12/5/85 START 11/8/85 FINISH 12/10/85 LOGGER KIRKOS

ELEVATION	DEPTH (FT) BELOW SURFACE	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (%TARS)				
240	240 241	S-15	2	-	SAND, POORLY GRADED, LESS THAN 5% FINES, COARSE SAND, LT. BROWN DRY, FLUVIAL, (SP) WATER WAS NOT NOTICED IN THIS SAMPLE, BUT WAS ADDED AT 230'.		WATER WAS ADDED AT 230' TO RETRIEVE SAMPLE Moisture content 1.7%	
245								
250							WATER WAS ADDED AT 250' TO PICK UP MATERIAL NO SAMPLE S-16	
255								
260	260 261	S-17	2	-	SILTY SAND, POORLY GRADED LESS THAN 10% FINES, MED. TO COARSE SAND, LT. BROWN, DRY, FLUVIAL, (SP-SM) H2O WAS ADDED AT 250' BUT NOT NOTICED IN THIS SAMPLE.			
265								
270								



PROJECT NUMBER S20116. A3	BORING NUMBER MW-3	SHEET 10 OF 12
SOIL BORING LOG		

PROJECT US ECOLOGY INC. HANFORD SITE LOCATION RICHLAND, WASHINGTON
 ELEVATION approx 723.5 FT DRILLING CONTRACTOR ONWEGO DRILLING CO. KENNEWICK
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 22W BUCYRUS ERIE
 WATER LEVEL AND DATE 316.2 FT, 12/5/85 START 11/8/85 FINISH 12/10/85 LOGGER KREKOS

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (FJARS)				
270								
275								
280		280-281	S-1B	2	-	SILTY-SAND, POORLY GRADED, LESS THAN 10% FINES, FINE MED SAND; Lt BROWN; DAMP, FLUVIAL, (SP SM)	LOGGED SAMPLE 11/8/85 0840. MOISTURE content 22%	
285								
290								
295								
300								



PROJECT NUMBER S20116.A3	BORING NUMBER MW-3	SHEET 11 OF 12
SOIL BORING LOG		

PROJECT US ECOLOGY INC. HANFORD SITE LOCATION RICHLAND WASHINGTON
 ELEVATION APPROX 723.5 FT DRILLING CONTRACTOR OMWEGO DRILLING CO KENNEWICK
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CAB TOOL 22W BUCHNUS ERIE
 WATER LEVEL AND DATE 316.2 FT 12/5/85 START 11/8/85 FINISH 12/10/85 LOGGER KREKOS

ELEVATION	DEPTH (FT) BELOW SURFACE	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (%)(#)				
300	300	S-19	3	—	SILTY-SAND, POORLY GRADED, LESS THAN 10% FINES, MED TO COARSE SAND, LT. BROWN, SAND FLUVIAL, (FSH)		LOGGED AT 0900 11/20/85 MOISTURE CONTENT 1.4% 30' ENTERED THE RINGOLD FORMATION	
310	300-311	S-20	3	—	SANDY GRAVEL, WELL GRADED, LESS THAN 10% FINES, 20-40% FINE TO MED. SAND, GRAY, VERY DENSE (GW) RINGOLD FORMATION		LOGGED AT 1330 11/25/85	
315							DRILLING HAS PICKED UP CASING DRIVES 1-2 FEET EACH TIME.	
320	320	S-21	3	—	SANDY-GRAVEL, WELL GRADED, LESS THAN 10% FINES, 20-30% FINE TO MED. SAND, GRAY, VERY DENSE, RINGOLD FORMATION (GW).		LOGGED AT 1500 11/26/85 DRILLER NOTES: STATIC WATER LEVEL IS ABOUT 318'.	
325								
330								



PROJECT NUMBER 520116.A3	BORING NUMBER MW-3	SHEET 12 OF 12
SOIL BORING LOG		

PROJECT USECOLOGY INC. HANFORD SITE LOCATION RICHLAND WASHINGTON
 ELEVATION approx. 723.5 FT DRILLING CONTRACTOR ONEGO DRILLING CO. KENNEWICK
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 22W BUCYRUS ERIE
 WATER LEVEL AND DATE 316.2 FT, 12/15/85 START 11/8/85 FINISH 12/10/85 LOGGER KREKOS

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-8"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (#FARS)				
330	330-331	S-22	3	—	SANDY-GRAVEL, WELL GRADED, LESS THAN 5% FINES, 30-50% FINE TO MED. SAND, GRAY, VERY DENSE, (GW) RINGOLD FORMATION.		SAMPLE CONSIST OF CRUSHED ROCK FRAGMENTS LOGGED SAMPLE 12:30 11/27/85	
340	341	S-23	3	—	GRAVEL WITH SAND, WELL GRADED, LESS THAN 5% FINES, 20-30% ROUNDED GRAVEL, GRAY, VERY DENSE, RINGOLD FORMATION (GW).		LOGGED SAMPLE 1530 12/2/85	
350	350	S-24	3	—	GRAVEL WITH SAND, WELL GRADED, LESS THAN 5% FINES, 30-40% ROUNDED GRAVEL, GRAY, VERY DENSE RINGOLD FM. (GW).		FINISHED DRILLING AT 12:30 ON 12/4/85. WASHED SCREEN AND WILL INSTALL IT ON 12/5.	
END OF BORING AT 350'								



PROJECT NUMBER 520116, A 3	BORING NUMBER MW-5	SHEET 1 OF 12
SOIL BORING LOG		

PROJECT USECOLOGY, HANFORD RESERVATION LOCATION Richland, Washington
 ELEVATION approx 723.5 FT DRILLING CONTRACTOR Onwego Drilling of Kennewick wa
 DRILLING METHOD AND EQUIPMENT TRUCKMOUNTED CABIG TOOL, 22W BUCYRUS GLIS
 WATER LEVEL AND DATE 315.4 FT, 11/9/85 START 10/3/85 FINISH 10/31/85 LOGGER DS HINES

ELEVATION	DEPTH (FT) BELOW SURFACE	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (#/JAR)				
0							begin drilling at 8:10	
5						SILTY SAND - poorly graded, 15-30% fines, some fine mostly medium sand, less than 5% small gravels, few randomly scattered cobbles up to 6" ϕ subrounded, brown, dry, fluvial (SM) efferv. w/HCL	using AT 10 inch ϕ dry barrel sampler	
							INSTALLING 200 FT OF 12 inch diameter casing	
10	9.0						moisture content 12.2%	
	10.0	S-1	2	—		SILTY SAND - poorly graded, 15-25% fines, mostly medium sand, brown, moist, medium density, fluvial (SM) efferv. w/HCL		
	11.0						moisture content 3.8%	
	12.0	S-2	2	—		SAND - poorly graded, less than 5% fines, medium sand, dk gray, moist, loose (SP) fluvial 20% dark grains and 40% light colored grains of sand, efferv. w/HCL		
						AT 14.0 FT: A 2"-3" thick clean white ash layer, moist	ASH AT 14.0 FT	
15						DOWN TO 21.0 FT: ALTERNATING SAND AND SILTY SAND LAYER SIMILAR TO SAMPLE S-1 and S-2. Layers are 1/4" to 1" thick	easy recovering of samples.	
20						AT 21.0 FT: SAND - poorly graded, less than 10% fines, medium sand, dk gray, little moist, loose, 20% dark colored grains, fluvial (SP-SM)	AT 21.0 FT change in color of soil	
25						AT 25.0 FT: SAND - poorly graded, less than 10% fines, fine sand, dk brown, dry, loose (SP-SM)	soil is becoming dryer with depth.	
30						AT 29.0 FT: med to coarse SAND - 35% angular basalt grains		



PROJECT NUMBER S20116.A3	BORING NUMBER MW-5	SHEET 2 OF 12
SOIL BORING LOG		

PROJECT US ECOLOGY INC. HAMFORD RES LOCATION Richland, Washington
 ELEVATION Approx 723.5 FT DRILLING CONTRACTOR Onweep drilling Co. Kennewick Wa.
 DRILLING METHOD AND EQUIPMENT Truck mounted cable tool, 22W BUCKEYS ER16
 WATER LEVEL AND DATE 315.4 FT, 11/9/85 START 10/3/85 FINISH 10/31/85 LOGGER D SHIMS

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (#/JAR)				
	30	30.0 31.0	S-3	2	—	<p><u>SILTY SAND</u> - alternating layers of fine and coarse sand with few very thin silt seams. poorly graded, 10-20% fines, lt brown, dry, loose, Fluvial (SP-SM) efferv. w/HCL</p>	<p>TRIED 4 TIMES TO RECOVER SAMPLE AT 30.0 FT, TOO DRY AND LOOSE. MOISTURE CONTENT 3.8%</p>	
	35							<p>driller advanced 18 FT in front of the casing</p>
	40						<p>begin drilling at 40.0 FT on 10/14/85</p>	
	45							
	50	49.0 50.0	S-4	2	—	<p><u>SILTY SAND</u> - poorly graded, 10-15% fines. lt brown, fine to medium sands, dry, loose, few compacted pieces, Fluvial (SP-SM) efferv. w/HCL fines are concentrated in stringers.</p>	<p>driller is having difficulty recovering sample, keeps falling out of the barrel. MOISTURE CONTENT 1.3%</p>	
	55							
	60							



PROJECT NUMBER S20116.A3	BORING NUMBER MW-5	SHEET 3 OF 12
SOIL BORING LOG		

PROJECT US ECOLOGY INC. HANFORD RES. LOCATION RICHLAND, WASHINGTON
 ELEVATION approx 723.5 FT DRILLING CONTRACTOR ONNEGO DRILLING CO. KENNEWICK, WA.
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 22W BUCYRUS ERIE
 WATER LEVEL AND DATE 315.4 FT, 11/9/85 START 10/3/85 FINISH 10/31/85 LOGGER D SHIMES

ELEVATION	DEPTH (FT) BELOW SURFACE	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	SYMBOLIC LOG	COMMENTS
		INTERVAL	TYPE AND NUMBER	RECOVERY (# OF PCS)	6"-8"-6" (N)	NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL		DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
60								
65								
	69.0							
	70.0	S-5	2	—				begin drilling at 63.0 FT on 10/7/85
70						SAND - poorly graded, less than 10% fines, mostly fine sand 10-15% coarse angular sand in stringers, lt brown, dry, loose, few compact pieces efferv w/HCL, some muscovite and old colored biotite(?) fluidal (SP-SM)		moisture content 1.9%
75								driller is losing the sample often out of the barrel. yet able to advance 10-14 FT below the casing
						AT 78.0 FT: 1-2" thick coarse sand layers, black		
80								
85								
90								



PROJECT NUMBER S20116.A3	BORING NUMBER MW-5	SHEET 4 OF 12
SOIL BORING LOG		

PROJECT US ECOLOGY INC. HANFORD RES. LOCATION RICHLAND, WASHINGTON
 ELEVATION approx 723.5 FT DRILLING CONTRACTOR CANNON DRILLING CO. KENNEWICK, WA.
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 22W BICYRUS ERIE
 WATER LEVEL AND DATE 315.4 FT, 11/9/85 START 10/3/85 FINISH 10/31/85 LOGGER D SHIMES

ELEVATION DEPTH BELOW SURFACE	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	SYMBOLIC LOG	COMMENTS
	INTERVAL	TYPE AND NUMBER	RECOVERY (#JARS)	6"-6"-6" (N)			
90	90.0 91.0	S-6	2	—	SAND - poorly graded, less than 5% fines, mostly medium sand, lt. brown, dry, loose, Fluvial efferv. w/HCL (SP)	[Symbolic Log: Dotted pattern]	moisture content 1.4% began drilling at 92.0 FT on 10/8/85
95					ALTERNATING FINE AND MEDIUM SAND LAYERS. less than 2% occasional gravel.		
100							
105							
110	109.0 110.0	S-7	2	—	SAND - poorly graded, less than 15% fines, fine sand, lt brown, dry, loose, efferv. with HCL, Fluvial (SP)	[Symbolic Log: Dotted pattern]	moisture content 2.3% begin drilling at 110.0 FT on 10/9/85
115							
120							



PROJECT NUMBER 520116. A3	BORING NUMBER MW-5	SHEET 5 OF 12
SOIL BORING LOG		

PROJECT USECOLOGY INC. HANFORD RES. LOCATION RICHLAND, WASHINGTON
 ELEVATION approx 723.5 FT DRILLING CONTRACTOR OMEGIO DRILLING CO. KENNEWICK WA.
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 22W BILLYS ERIE
 WATER LEVEL AND DATE 315.4 FT 11/9/85 START 10/3/85 FINISH 10/31/85 LOGGER DSHINES

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY *% # JACS				
120								driller is able to advance 10 FT in front of the casing.
125								
	129.0							
	130.0	S-8	2					moisture content 1.2%
130								
135								material is the same down to 150.0 feet
140								begin drilling at 140 FT on 10/10/85
145								
150								



PROJECT NUMBER S20116. A3	BORING NUMBER MW-5	SHEET 6 OF 12
SOIL BORING LOG		

PROJECT US ECOLOGY INC. HAMFORD SITE LOCATION RICHLAND, WASHINGTON
 ELEVATION approx 723.5 FT DRILLING CONTRACTOR ONWEGO DRILLING, INC. KENNEWICK WA
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 2.2W BUCYRUS ERIE
 WATER LEVEL AND DATE 315.4 FT, 11/19/85 START 10/3/85 FINISH 10/31/85 LOGGER D SHIMES

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (% FACES)				
150	150.0 151.6	S-9	2	—	SAND - poorly graded, less than 10% fines, mostly medium sand, lt brown, dry, loose, efferv. w/HCl, fluvial (SP-SM)	[Symbolic Log Column]	moisture content 1.6%	
155								
160								
165								
170	169.0 170.0	S-10	2	—	SAND - poorly graded, less than 10% fines, fine to med um sand, lt brown, dry, loose efferv. w/HCl, some white and gold mica, fluvial (SP-SM)	[Symbolic Log Column]	moisture content 2.4%	
175								
180					AT 178 FT: SAND with increased amount of CaCO ₃ partially cementing			



PROJECT NUMBER 520116, A3	BORING NUMBER MW-5	SHEET 7 OF 12
SOIL BORING LOG		

PROJECT USECOLOGY INC. HANFORD SITE LOCATION RICHLAND, WASHINGTON
 ELEVATION APPROX 723.5 FT DRILLING CONTRACTOR ONWEGO DRILLING CO. KENNEWICK WA.
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL - 22W BUCYRUS ERIE
 WATER LEVEL AND DATE 315.4 FT, 11/9/85 START 10/3/85 FINISH 10/31/85 LOGGER SM KREKOS

ELEVATION (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS
	INTERVAL	TYPE AND NUMBER	RECOVERY (%/AES)				DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
80						SYMBOLIC LOG	
85							
189							
190	189-190	S-11	2	—	SAND POORLY GRADED, LESS THAN 10% FINES. MEDIUM TO COARSE, L. BROWN, MOIST EFFERV W/HCL (SP-SM)		MOISTURE CONTENT 1.6%
195							
200							begin installing 10 inch ϕ casing at 200 feet.
205							
209							
210	209-210	S-12	2	—	SAND, POORLY GRADED, LESS THAN 5% FINES, FINE TO MEDIUM SAND, L. BROWN, DRY (SP)		moisture content 2.0%



PROJECT NUMBER 520116, A3	BORING NUMBER MW-5	SHEET 8 OF 12
SOIL BORING LOG		

PROJECT USECOLOGY INC. HANFORD SITE LOCATION RICHLANDS, WASHINGTON
 ELEVATION approx 723.5 FT DRILLING CONTRACTOR ONWEGO DRILLING CO. KENNEWICK, WA.
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL - 22W BUCHFUS GRIE
 WATER LEVEL AND DATE 315.4 FT, 11/9/85 START 10/3/85 FINISH 10/31/85 LOGGER SMKREKAS

ELEVATION (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	INTERVAL	TYPE AND NUMBER	RECOVERY (#JARS)				
210							
215							
220							
225							
229							
230	230	5-13	2	—	SAND, POORLY GRADED, LESS THAN 6% FINES, FINE TO MEDIUM SAND, DAMP, (SP) LT. BROWN.		MOISTURE CONTENT 1.8%
235							
240							



PROJECT NUMBER 520116.A3	BORING NUMBER MW-5	SHEET 9 OF 12
SOIL BORING LOG		

PROJECT US ECOLOGY INC. HANFORD SITE LOCATION RICHLAND, WASHINGTON
 ELEVATION APPROX 723.5 FT DRILLING CONTRACTOR DNWEGO DRILLING CO. KENNEWICK WA.
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL - 22W BUCYFUS ERIE
 WATER LEVEL AND DATE 315.4 FT 11/9/85 START 10/3/85 FINISH 10/31/85 LOGGER DS HIMES

ELEVATION	DEPTH (FT) BELOW SURFACE	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (# OF TMS)				
240								
245								
250	249-256	S-14	2	—	SAND, POORLY GRADED, LESS THAN 5% FINES, VERY MOIST, LT BROWN (SP)		THIS SAMPLE HAD TO HAVE WATER ADDED TO IT SO IT COULD BE RETRIEVED. ALL SAMPLES AFTER AND INCLUDING S-14 HAVE WATER ADDED TO SAMPLE AND REMOVED USING A BAILEY.	
255								
260								
265								
0FT								



PROJECT NUMBER S20116.A3	BORING NUMBER MW-5	SHEET 10 OF 12
SOIL BORING LOG		

PROJECT USECOLOGY INC. HANFORD SITE LOCATION RICHLAND, WASHINGTON
 ELEVATION approx 723.5 FT DRILLING CONTRACTOR DNWEGO DRILLING CO. KENNEWICK
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CASING TOOL, 22-W BUCYRUS ERIE
 WATER LEVEL AND DATE 315.4 FT 11/9/85 START 10/3/85 FINISH 10/31/85 LOGGER DSHIMES

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (RTARS)				
270	270	S-15	2	—	SAND - poorly graded, less than 5% fines, fine to medium SAND, lt brown, some mica Fluvial (SP)	[Symbolic Log: Dotted pattern]		
	271							
275							using drill bit and water to retrieve sample with bailer	
280								
285								
290	289 290	S-16	2	—	SAND with gravel - poorly graded, less than 10% fines 10-15% gravel, lt brown, (SP) Ringold Formation (?)	[Symbolic Log: Dotted pattern]	driller notes gravel at 290 FT. may be 10-15%.	
295							harder drilling with depth increase in gravel at 295 FT. gradual contact with gravels	
300								



PROJECT NUMBER S20116, A3	BORING NUMBER MW-5	SHEET 11 OF 12
SOIL BORING LOG		

PROJECT U.S. ECOLOGY INC. HANFORD SITE LOCATION RICHLAND, WASHINGTON
 ELEVATION APPROX. 723.5 FT DRILLING CONTRACTOR ONWEGO DRILLING CO., KENNEWICK
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 22-W RUCYRUS FRIG
 WATER LEVEL AND DATE 315.4 FT, 11/9/85 START 10/9/85 FINISH 10/31/85 LOGGER DS HINES

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (# JARS)				
300	300	S-17	3	—	SANDY GRAVEL - well graded, less than 5% fines, 15-25% fine to medium sand, rounded gravel, gray, very dense (GW) RINGOLD FORMATION		sample as slurry	
	301						1 jar sample is for the Dept of Ecology.	
305								
310	310	S-18	3	—	SANDY GRAVEL - well graded, less than 5% fines, 20-30% fine to medium sand, gray, very dense (GW) RINGOLD FORMATION		very slow drilling	
	311							
315								
320	319	S-19	3	—	SANDY GRAVEL - similar to S-18		drilling is a little faster at 320-350'	
	320							
325								
330								



PROJECT NUMBER 320116, A3	BORING NUMBER MW-5	SHEET 12 OF 12
SOIL BORING LOG		

PROJECT U.S. ECOLOGY INC. HANFORD SITE LOCATION RICHLAND, WASHINGTON
 ELEVATION approx 723.5 FT DRILLING CONTRACTOR DWEGO DRILLING CO. KENNEWICK, WA.
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 22-W BUCHRUS ERIE
 WATER LEVEL AND DATE 315.4 FT, 11/9/85 START 10/3/85 FINISH 10/31/85 LOGGER DSTHIMS

ELEVATION	DEPTH (FT) BELOW SURFACE	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	SYMBOLIC LOG	COMMENTS
		INTERVAL	TYPE AND NUMBER	RECOVERY (#SPLS)	6"-8"-6" (N)	NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL		DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
330	330-331	S-20	3	—	—	SANDY GRAVEL - well graded, less than 5% fines, 20-35% FINE TO MEDIUM SAND, gray, very dense (GW) RINGOLD FORMATION		sample consists of crushed rock fragments
335								
340	339-340	S-21	3	—	—	GRAVEL with sand - well graded less than 5% fines, 10-20% rounded gravel, gray, very dense (GW) Ringold FM.		
345								Finished drilling at 12:30 on 10/31/85 installed 6" PVC pipe and steel screen 40' menpack annulus with sand, bent, grout.
350	349-350	S-22	3	—	—	GRAVEL with sand - well graded, less than 5% fines 10-20% fine sand probably in pockets, rounded gravel of varying sizes, 60% light and 40% dark clasts, gray, very hard, probably some cobbles, Ringold form. (GW)		
355						END BORING AT 350 FT.		
360								



PROJECT NUMBER S20116.A3	BORING NUMBER MW-8	SHEET 1 OF 12
SOIL BORING LOG		

PROJECT USECOLOGY INC. HANFORDS RES. LOCATION Richland, Washington
 ELEVATION approx 729.5 FT DRILLING CONTRACTOR Onwego Drilling Co. Kennewick WA
 DRILLING METHOD AND EQUIPMENT Truck mounted cable tool, 22 w Bucyrus Erie
 WATER LEVEL AND DATE 318.9 FT, 10/1/85 START 9/4/85 FINISH 9/27/85 LOGGER DS HIMES

ELEVATION	DEPTH (FT) BELOW SURFACE	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (%)				
0						Top 1 FT has occasional gravel 1/4" - 1" φ		Begin drilling at 9:35
	4.0					SILTY SAND - poorly graded, loose, 15-25% fines, below 3 FT. is more compacted medium sand with some coarse angular basalt chips, dark gray, little moist, few laminations 1/8" - 1/8" thick, efferv. w/HCL, Fluvial (SP-SM) AT 6.5-7.0 FT is a coarse black sand lens, loose,	[Symbolic Log Pattern]	Sampling with a 6" φ, 2 1/2 FT length dry barrel sampler
5	5.0	S-1	2	—				
						then a fine to medium sand with 5-15% fines		10:30 drillers are installing the 12" φ casing to 20 FT depth
15						AT 15.0 FT: 0.5 FT thick Ash layer, white, clean, moist		TOOK 1 JAR SAMPLE OF THE ASH.
						AT 18.0 FT: Alternating sand (60%) and Sandy Silt (40%) layers		Silt lenses at 17.0 FT
20						SAND - poorly graded, less than 5% fines, medium to coarse sand, gray, little moist dense (SP)		
	24.0					SANDY SILT - nonplastic, varying amounts of sand 5-15% fine to coarse sand, brown, moist, firm (ML)		Color change of soil at 24.0 FT
25	25.0	S-2	2	—		SAND - poorly graded, less than 5% fines, medium sand, lt. gray, dry, dense, Fluvial (SP) efferv w/HCL. few 1" φ silt lenses.		
30								Begin drilling at 28.5 FT on 9/5/85



PROJECT NUMBER 520116, A3	BORING NUMBER MW-8	SHEET 2 OF 12
SOIL BORING LOG		

PROJECT U.S. ECOLOGY Inc. LOCATION Hanford Res. Richland, Wa.
 ELEVATION approx 724.5 FT DRILLING CONTRACTOR Onwego Drilling Co. Kennewick, Wa.
 DRILLING METHOD AND EQUIPMENT Truck mounted cable tool, 22W Bucyrus Erie
 WATER LEVEL AND DATE 318.9 FT, 10/1/85 START 9/4/85 FINISH 9/23/85 LOGGER DSTimes

ELEVATION (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	INTERVAL	TYPE AND NUMBER	RECOVERY (%/TR)				
30					<u>SILTY SAND - poorly graded, 5-20% fines, fine to medium sand, lt brown, dry, loose. Fluvial (sm) silt is probably concentrated in seams. no str med or sand</u>		<u>due to type of sampling - difficult to see any structure of the soil.</u>
35							
40							
44.0							
45	<u>45.0</u>	<u>S-3</u>	<u>2</u>	<u>—</u>	<u>SILTY SAND - poorly graded, 5-20% fines, fine to med sand, lt brown, dry, loose, little white (calc) cementation of sand. Fluvial (sm) efferv w/HCl</u>		
50							<u>unable to keep hole open without casing</u>
55							
60							



PROJECT NUMBER 820116.A3	BORING NUMBER mw-8	SHEET 3 OF 12
SOIL BORING LOG		

PROJECT U S Ecology Inc. LOCATION Hanford Res. Richland Wa.
 ELEVATION approx 724.5 FT DRILLING CONTRACTOR Onwego Drilling Co. Kennewick Wa.
 DRILLING METHOD AND EQUIPMENT Truck mounted cable tool, 22w Bucyrus Erie
 WATER LEVEL AND DATE 318.9 FT, 10/1/85 START 9/4/85 FINISH 9/27/85 LOGGER DS HINES

ELEVATION	DEPTH (FT) BELOW SURFACE	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (% JAR)				
60								
	61.0							
65	65.0	S-4	2	—	SILTY SAND - poorly graded, 5-20% fine, fine to med sand, lt brown, dry, loose Fluvial (sm) efferv. w/HCL		casing at 50 FT depth begin drilling @ 68.0 FT - 9/6/85	
70							driller checking depth with 5 foot measuring rod.	
75							casing is following the sampler down the hole	
80								
	84.0							
85	85.0	S-5	2	—	SILTY SAND - poorly graded 5-20% fines, fine to medium sand, lt brown, dry, loose Fluvial (sm) few compacted pieces slightly cemented but easy to break apart. efferv/ with HCL		begin drilling at 88.8" on 9/9/85	
90								



PROJECT NUMBER J20116.A3	BORING NUMBER MW-8	SHEET 4 OF 12
SOIL BORING LOG		

PROJECT US Ecology, Inc. LOCATION Hampden Res. Richmond, Va
 ELEVATION approx 724.5 FT DRILLING CONTRACTOR Onwego Drilling Co. Kennewick, WA
 DRILLING METHOD AND EQUIPMENT Truck mounted cable tool, 22W Bucyrus Erie
 WATER LEVEL AND DATE 318.9 FT, 10/1/85 START 9/4/85 FINISH 9/27/85 LOGGER DSTHIMS

ELEVATION	DEPTH BELOW SURFACE (ft)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (%)				
90								
95						<p>AT 91.0 FT: 2 inch thick SANDY SILT layer, non plastic, 10-20% mostly medium sand, lt brown, dry. Fluvial (ML) 3" thick silty sand layer at 94.0 FT, alternating sand and silt layers</p>		
100							SILTier material down to approx 96.0 FT SANDier at 99.0 FT	
105	104.0 105.0	S-6	2	—		<p>SILTY SAND - poorly graded, 10-25% fines, mostly fine sand, lt brown, dry base, some compacted pieces Fluvial (sm) effervesces w/HCL</p>		
110						<p>AT 110 FT: SILTY SAND - 30-40% FINES, lt brown dry</p>	begin drilling at 110 FT on 9/10/85 first few soil sample are moist to wet probably due to rain last night.	
115								
120								



PROJECT NUMBER 520116. A3	BORING NUMBER B-8	SHEET 5 OF 12
SOIL BORING LOG		

PROJECT US ECOLOGY INC. LOCATION Hanford Res. Richland Wa.
 ELEVATION approx. 724.5 FT DRILLING CONTRACTOR Onwego Drilling Co. Kennewick Wa.
 DRILLING METHOD AND EQUIPMENT Truck mounted cable tool, 22w Bucyrus Erie
 WATER LEVEL AND DATE 318.9 FT, 10/1/85 START 9/4/85 FINISH 9/27/85 LOGGER DSH/MES

ELEVATION	DEPTH (FT) BELOW SURFACE	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (% STAR)				
	120							
	124.0							
	125.0	S-7	2	—	SAND - poorly graded, less than 5% fines, fine sand, lt brown, dry, loose, some mica, Fluvial (SP) effervesces w/HCL		Casing is at 121.4" Alternating sand and silty sand layers.	
	130							
	135				AT 135.0 FT: silty SAND - similar to S-7 except 15-25% fines. (SM) slightly moist			
	140				clean sand at 140. FT (SP)			
	144.0							
	145.0	S-8	2	—	SAND - poorly graded, 0-15% fines as silty seams, fine sand, lt. brown, damp, loose (SP-SM) Fluvial effervesces w/HCL			
	150							



PROJECT NUMBER S20116.A3	BORING NUMBER MW-8	SHEET 6 OF 12
SOIL BORING LOG		

PROJECT US ECOLOGY INC. LOCATION HANFORD RES. RICHLAND, Wa.
 ELEVATION approx 729.5 FT DRILLING CONTRACTOR Onweap Drilling Co. Kennewick, Wa
 DRILLING METHOD AND EQUIPMENT Truck mounted cable tool, 22w Bucyrus Erie
 WATER LEVEL AND DATE 318.9 FT, 10/1/85 START 9/4/85 FINISH 9/27/85 LOGGER DS HINES

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-8"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (% JARS)				
150						[Symbolic Log]	begin drilling at 153.0 FT on 9/11/85	
155					<p>SAND WITH OCCASIONAL SILTY SEAMS. <u>SAND</u>-poorly graded, less than 10% fines, lt brown, dry, loose (SP) <u>SILT</u>-non plastic, 5-15% medium sand, lt brown dry, 1/2"-1" thick, some minor oxidation, Fluvial (ML)</p>			
160						[Symbolic Log]	able to sample 13.0' ahead of the casing	
165	164.0 - 165.0	S-9	2	—	<p><u>SILTY SAND</u>-poorly graded, 5-25% fines mostly as silty seams, fine sand, lt brown, little moist, sand is loose and silty material tend to be compacted, Fluvial (SP-SM) MP/VEGLES w/HCL</p>			
170						[Symbolic Log]	begin drilling at 179.0' on 9/12/85	
175					At 175 FT: some coarse sand stringers and some compacted layers with poor cementation.			
180						[Symbolic Log]		



PROJECT NUMBER
320116, A3

BORING NUMBER
MW-8

SHEET 7 OF 12

SOIL BORING LOG

PROJECT US ECOLOGY INC. LOCATION Hanford Res. Richland, Wa.
 ELEVATION approx 724.5 FT DRILLING CONTRACTOR Onwego Drilling Co. Kennewick, Wa
 DRILLING METHOD AND EQUIPMENT Truck mounted cable tool, 22w Bucyrus Erie
 WATER LEVEL AND DATE 318.9 FT, 10/1/85 START 9/4/85 FINISH 9/27/85 LOGGER DSTHMS

ELEVATION	DEPTH BELOW SURFACE	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (SP-SM)				
180								
	184.6							driller notes hard material at 184.0'
185	185.0	S-10	2	—	SILTY SAND - moderately graded, 15-30% coarse sand to 3/4" φ black subangular gravel, 5-15% fines, brown, damp, Fluvial (SP-SM) coarse material of quartz and basalt. SILTY MATERIAL AS lenses increases at 189.0 FT effervesces w/HCL			driller checks depth with 5 Foot rod.
190								at 190': Sand is fine to medium grain size.
195								
200								
	204.0							
205	205.0	S-11	2	—	SILTY SAND - poorly graded, 5-15% fines, fine to med Sand, brown, dry, some compacted sections with CaCO ₃ poor cementing, efferv. w/HCL, Fluvial (SP-SM)			begin drilling at 205' on 9/13/85
210								



PROJECT NUMBER 520116.A3	BORING NUMBER mw-8	SHEET 8 OF 12
SOIL BORING LOG		

PROJECT USECOLOGY, Hanford Res. LOCATION Richland, Washington
 ELEVATION approx. 724.5 FT DRILLING CONTRACTOR Onwego Drilling Co. Kennewick wa.
 DRILLING METHOD AND EQUIPMENT Truck mounted cable tool, 22W Bucyrus Erie
 WATER LEVEL AND DATE 318.9 FT, 10/1/85 START 9/4/85 FINISH 9/27/85 LOGGER DShimes

ELEVATION	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	SYMBOLIC LOG	COMMENTS
	INTERVAL	TYPE AND NUMBER	RECOVERY (%)	6"-6"-6" (N)			
210					<u>SILTY SAND - poorly graded less than 15% fines, CaCO₃ white powder, lt brown, dry, Fluvial (SP-SM)</u>	SYMBOLIC LOG	
215							begin drilling at 218.0' on 9/16/85
220							sampler is getting wedged between the casing and the loose sand.
225	<u>224.0</u> <u>225.0</u>	<u>S12</u>	<u>2</u>	<u>—</u>	<u>SILTY SAND - poorly graded, 5-15% fines, fine to medium sand, lt brown, dry, few poorly cemented CaCO₃ pieces. after vesicles w/ HCl (SP-SM) Fluvial</u>		
230							
235					<u>at 235.0 FT: SAND - poorly graded less than 5% fines, mostly medium sand brown-black, damp, loose (SP)</u>		
240							begin drilling at 240.0 FT on 9/17/85



PROJECT NUMBER 520116.A3	BORING NUMBER MW-8	SHEET 9 OF 12
SOIL BORING LOG		

PROJECT US Ecology, Hanford Res. LOCATION Richland, Washington
 ELEVATION approx. 724.5 FT DRILLING CONTRACTOR Onwego Drilling Co. Kennewick, WA
 DRILLING METHOD AND EQUIPMENT Truck mounted cable tool, 22W Bucyrus Erie
 WATER LEVEL AND DATE 318.9 FT, 10/1/85 START 9/4/85 FINISH 9/27/85 LOGGER DS HINES

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (#/JAR)				
240								
	241.0							
245	245.0	S-13	2	—	SAND - poorly graded, less than 10% fine, fine to med sand, lt. brown, dry, loose, efferv. w/HCL (SP)			
250								driller is unable to drill more than 3 FT in front of the casing.
255					AT 255.0 FT: ALTERNATING SILT and medium clean sand laminations in predominant fine sand, few clay stringers			2"-4" thick laminations
260								
	261.0							
265	265.0	S-14	2	—	SAND - poorly graded, less than 10% fines, fine to med sand, lt brown, dry, loose Fluvial, slight effervesces with HCL (SP)			begin drilling at 267.0 FT on 9/18/85
					AT 267.0': SILTY SAND - 4" thick, poorly graded, 15-25% fines, brown, moist, Fluvial (SM)			
270								



PROJECT NUMBER S20116, A3	BORING NUMBER MW-8	SHEET 10 OF 12
SOIL BORING LOG		

PROJECT USECOLOGY, HANFORD RESERVOIR LOCATION Richland, Washington
 ELEVATION approx 72A.5 FT DRILLING CONTRACTOR Onwego drilling Co, Kennewick Wa
 DRILLING METHOD AND EQUIPMENT Truck mounted cable tool, 22w Bucyrus Erie
 WATER LEVEL AND DATE 318.9 FT, 10/1/85 START 9/4/85 FINISH 9/27/85 LOGGER D. SHINGS

ELEVATION	DEPTH (FT) BELOW SURFACE	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (# JARS)				
	270					[Symbolic Log: Dotted pattern]	hole continues to collapse when trying to advance beyond the casing.	
	275							
	280					[Symbolic Log: Dotted pattern]		
	284.0				AT 282.0; one 7" ϕ granitic subrounded cobble			
	285	285.0	S-15	2	—	[Symbolic Log: Dotted pattern]		
	285				SAND - poorly graded, 5-10% fines, mostly medium sand, et brown, damp, loose (SP) / Fluvial			
	290					[Symbolic Log: Dotted pattern]	START drilling at 290 FT on 9/19/85 drillers switched from using a dry barrel to using water with bailer.	
	295							
	295					[Symbolic Log: Horizontal line pattern]	a thick brown sandy slurry. START drilling at 295 FT on 9/20/85	
	300				SILTY SAND - similar to S-15 except 15-20% fines.			



PROJECT NUMBER
520116.A3

BORING NUMBER
MW-8

SHEET 11 OF 12

SOIL BORING LOG

PROJECT US ECOLOGY INC, HANFORD RES LOCATION Richland, Washington
 ELEVATION approx. 724.5 FT DRILLING CONTRACTOR Onwego Drilling Co, Kennewick, Wa
 DRILLING METHOD AND EQUIPMENT truck mounted cable tool, 22w Bucyrus Erie
 WATER LEVEL AND DATE 318.9 FT, 10/1/85 START 9/9/85 FINISH 9/27/85 LOGGER DS HINES

ELEVATION	DEPTH (FT) BELOW SURFACE	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (%)				
300								driller is having a difficult time bailing out alot, of sand - may be settling out to quickly.
	304.0							
	305.0	S-16	2	—		SANDY GRAVEL - well graded, less than 5% fines 10-20φ.		
305						fine to medium sand, wide range of sizes of well rounded gravel, possibly some cobbles, gray, dry, very dense (GW) 40% basalt clasts and 60% igneous (quartz) and metamorphic rocks some gold flecks of phlogopite; RINGOLD FM.		very hard drilling at 302.0 FT alot of broken pieces of gravel. driller notes probably cobbles.
310								
315								
320								
	324.0							
	325.0	S-17	2	—		SANDY GRAVEL - well graded less than 5% fines, 15-25φ		sample S-17 field sieve = 2% > #4 95% > #200 but many crushed pieces.
325						fine to medium sand, well rounded gravel, gray, wet, very dense (GW) some mica RINGOLD FM.		
330								



PROJECT NUMBER S20116.A3	BORING NUMBER MW-8	SHEET 12 OF 12
SOIL BORING LOG		

PROJECT USECOLOGY, HANFORD RES LOCATION Richland, Washington
 ELEVATION approx 724.5 FT DRILLING CONTRACTOR Onwego Drilling Co. Kennewick, WA
 DRILLING METHOD AND EQUIPMENT Truck mounted cable tool, 22W Bucyrus Erie
 WATER LEVEL AND DATE 318.9 FT, 10/1/85 START 9/4/85 FINISH 9/27/85 LOGGER DSHIMES

ELEVATION	DEPTH (FT) BELOW SURFACE	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	SYMBOLIC LOG	COMMENTS
		INTERVAL	TYPE AND NUMBER	RECOVERY (%)	6"-6"-6" (N)			
330								
335								
340								
		344.0						
345		345.0	S-18	2	—			
350								
355								
360								

SANDY GRAVEL - well graded, less than 5% fines, 15-20% sand - some sandier lenses, well rounded gravel, gray, wet, very dense RINGOLD FORMATION (GW)

driller is having problems with the rig - jamming

driller notes some sand heaving up the casing

GRAVEL with SAND -

begin drilling at 345 FT on 9/27/85.

well graded, less than 5% fine 5-15% fine to medium sand, well rounded gravel of all sizes, 65% basalt clasts and 35% igneous and metamorphic some mica, gray, wet, very dense (GW) RINGOLD FM.

350 FT of 8-inch ϕ casing installed prior to telescope-screen and pull-back method. 40 FT well screen

END OF BORING AT 350 FT



PROJECT NUMBER

S20116.A3

BORING NUMBER

MW-10

SHEET 1 OF 12

SOIL BORING LOG

PROJECT US ECOLOGY INC. HANFORD RES. LOCATION Richland, Washington
 ELEVATION approx. 735.0 FT DRILLING CONTRACTOR Druego Drilling Co. Kennewick, Waw.
 DRILLING METHOD AND EQUIPMENT Truck mounted cable tool, 22w Bucyrus Erie
 WATER LEVEL AND DATE 328.8 FT, 10/1/85 START 9/4/85 FINISH 9/23/85 LOGGER DSTHMS

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (# TRIES)				
	0							begin drilling @ 9:30
	4.0							using a dry barrel sampler 6" d
	5.0	S-1	2	—				hole is caving
	5							
	11.0							
	12.0	S-2	2	—				AT 12.0 FT change to a loose coarse sand. driller is driving 12" φ casing down
	15							
	20							will leave 19.0 FT of 12" φ casing down the hole until well is completed.
	24.0							
	25.0	S-3	2	—				
	25							
	30							



PROJECT NUMBER 520116. A3	BORING NUMBER MW-10	SHEET 2 OF 12
SOIL BORING LOG		

PROJECT U S ECOLOGY INC. LOCATION Hanford Res. Richland Wa.
 ELEVATION approx. 735.0 FT DRILLING CONTRACTOR Onwego Drilling Co. Kennewick wa.
 DRILLING METHOD AND EQUIPMENT Truck mounted cable tool, 22w Bucyrus Erie
 WATER LEVEL AND DATE 328.8 FT, 10/1/85 START 9/4/85 FINISH 9/23/85 LOGGER DSTHIMES

ELEVATION (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	INTERVAL	TYPE AND NUMBER	RECOVERY (# JAR)				
30					<u>SILTY SAND - poorly graded, 10-25% fines, mostly med sand, lt. brown, dry, loose Fluvial (sm)</u>		<u>The sampler is approx 2 FT long and 6" dia no water is being used to remove the sample</u>
35							
40							<u>Some sand heaving in the casing at 40.0 FT</u>
45	<u>44.0 45.0</u>	<u>S-9</u>	<u>2</u>	<u>—</u>	<u>SILTY SAND - poorly graded, 5-20% fines, less than 5% gravel 1/8"-1/4" dia, fine to medium sand, lt. brown, dry, loose, little-poor cementation, white efferv w/ HCL, Fluvial (sm)</u>		
50							
55							
60							



PROJECT NUMBER S20116.A3	BORING NUMBER MW-10	SHEET 3 OF 12
SOIL BORING LOG		

PROJECT US ECOLOGY INC. LOCATION Hanford Res. Richland, Wa.
 ELEVATION approx 735.0 FT DRILLING CONTRACTOR Onwego Drilling Co. Kennewick, Wa.
 DRILLING METHOD AND EQUIPMENT Truck mounted cable tool. 22w Bucyrus Erie
 WATER LEVEL AND DATE 328.8 FT, 10/1/85 START 9/4/85 FINISH 9/23/85 LOGGER DShimes

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (% STARS)				
80								
65	69.0 65.0	S-5	2	—	SILTY SAND - poorly graded, 5-20% fines, fine to med sand, lt. brown, dry, loose, Fluvial (sm) efferv. w/HCL		casing depth at 69.5 FT	
70								
75								
80								
85	85.0 86.0	S-6	2	—	SILTY SAND - similar to S-5		begin drilling at 84.0 FT - 9/16/85	
90								



PROJECT NUMBER 520116, A3	BORING NUMBER MW-10	SHEET 4 OF 12
SOIL BORING LOG		

PROJECT US Ecology, Inc. LOCATION HANFORD RES. Richland, Wa
 ELEVATION approx. 735.0 FT DRILLING CONTRACTOR Onweep Drilling Co. Kennewick wa.
 DRILLING METHOD AND EQUIPMENT Truck mounted Cable tool, 22W Bucyrus Erie
 WATER LEVEL AND DATE 328.8 FT, 10/1/85 START 9/4/85 FINISH 9/23/85 LOGGER DSH/TMG

ELEVATION	DEPTH BELOW SURFACE (ft)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (%-TARS)				
90						[Symbolic Log Pattern]		
95								
100								
105		104.0 105.0	S-7	2	—	<p>SILTY SAND - poorly graded, 5-20% fines, fine to medium sand, et brown, dry, loose Fluvial (sm) 1/2 light quartz sand grains And 1/2 dark-basalt sand grains efferv/w HCL</p>	hole caves in ahead of casing at 105.5 FT	
110								
115								
120							AT 120 FT: FINE SAND SEAM about 6" thick.	



PROJECT NUMBER 520116.A3	BORING NUMBER MW-10	SHEET 5 OF 12
SOIL BORING LOG		

PROJECT US Ecology INC LOCATION Hanford Res. Richland Wa.
 ELEVATION approx 735.0 FT DRILLING CONTRACTOR Onwego Drilling Co, Kennewick, Wa
 DRILLING METHOD AND EQUIPMENT Truck mounted cable tool, 22w Bucyrus Erie
 WATER LEVEL AND DATE 328.8 FT, 10/1/85 START 9/4/85 FINISH 9/23/85 LOGGER DSTHMS

ELEVATION	DEPTH BELOW SURFACE	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY				
120								
	124.0							
125	125.0	S-8	2	—	SILTY SAND - poorly graded 5-20% fines, med and fine sand with some fine sand stringers, lt brown, dry loose, fluvial (sw) fine sand tends to be slightly compacted. effervesces w/HCl.		consistent drilling	
130							driller checks depth with 5 foot rod.	
135							begin drilling at 135.0 FT on 9/19/85	
140								
	144.0							
145	145.0	S-9	2	—	SILTY SAND - similar to S-8		casing is following the sampler down the hole	
150								



PROJECT NUMBER 52016, A3	BORING NUMBER mw-10	SHEET 6 OF 12
SOIL BORING LOG		

PROJECT U S ECOLOGY INC. LOCATION HANFORD RES. RICHLAND, WA
 ELEVATION approx 735.0 FT DRILLING CONTRACTOR Onwego Drilling Co. Kennewick WA
 DRILLING METHOD AND EQUIPMENT Truck mounted Cable tool, 22w Bucyrus Erie
 WATER LEVEL AND DATE 328.8 FT, 10/1/85 START 9/4/85 FINISH 9/23/85 LOGGER Dsthines

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (#JAB)				
150								
155								
160								
165	164.0 165.0	S-10	2	—	<p>SILTY SAND - poorly graded, 10-25% fines, mostly fine sand, lt brown, dry, loose, some compacted material (SP-sm) effervesces with HCL, Fluvial</p>		able to drill 6 FT in front of casing to sample S-10.	
170								
175								
180								



PROJECT NUMBER 520116.A3	BORING NUMBER MW-10	SHEET 7 OF 12
SOIL BORING LOG		

PROJECT US ECOLOGY INC. LOCATION Hanford Res. Richland Wa
 ELEVATION approx 735.0 FT DRILLING CONTRACTOR Onwego Drilling Co. Kennewick Wa
 DRILLING METHOD AND EQUIPMENT truck mounted cable tool, 22w Bucyrus Erie
 WATER LEVEL AND DATE 328.8 FT, 10/1/85 START 9/4/85 FINISH 9/23/85 LOGGER DSHIMES

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (%)				
180								
	181.0							
185	185.0	S-11	2	—	ALTERNATING layers of Silty sand (60%) and sand (40%)		able to see fine lamination and alternating layers of fine and medium sand probably due to higher moisture content which is holding material together	
					SILTY SAND - poorly graded, 10-20% fines, fine sand, lt brown, damp, some oxidized siltier stringers in the fine sand layers, some mica (sm) eff w/ HCL			
190					SAND - poorly graded, less than 10% fines, medium sand with 50% dark colored grains (basalt), med brown, damp, loose (SP) effereces w/ HCL			
	195.0							
195	196.0	S-12	2	—	SILTY SAND - moderately graded, 15-30% coarse sand to 3/4" φ black subangular gravel of quartz and lesser amount of basalt, 10-20% fines, brown, dry, Fluvial (sm) eff w/ HCL		begin drilling at 190 FT on 9/10/85 drill notes harder drilling at 195.0 FT	
							begin drilling at 195 FT on 9/11/85	
200								
	204.0							
205	205.0	S-13	2	—	SAND - poorly graded, 5-15% fines, medium to coarse sand, brown, dry, Fluvial (sp-sm) effereces w/ HCL			
210					AT 210.0 FT: ALTERNATING fine sand and coarse sand layers			



PROJECT NUMBER 520116.A3	BORING NUMBER MW-10	SHEET 8 OF 12
SOIL BORING LOG		

PROJECT US ECOLOGY INC. LOCATION HANFORD RES Richland, Wa.
 ELEVATION approx 735.0 FT DRILLING CONTRACTOR Onwego Drilling Co, Kennewick, Wa.
 DRILLING METHOD AND EQUIPMENT truck mounted cable tool, 22w BUCYUS
 WATER LEVEL AND DATE 328.8 FT, 10/1/85 START 9/4/85 FINISH 9/23/85 LOGGER DSHINES

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (# TAPS)				
210						[Symbolic Log Column]		
215					ALTERNATING Sand (70%) and Silt (30%) layers AT 210' SAND - poorly graded 5-10% fines, alternating fine-medium and coarse sand, brown, dry, loose (SP) Silt - nonplastic, 5-15% sand, brown, dry, some compacted pieces, Fluvial (ML)		hole is collapsing very dry soil, occasionally losing sample.	
220							begin drilling at 221.0 FT on 9/12/85	
225	224.0 - 225.0	S-14	2	—	SILTY SAND - poorly graded, 5-25% fines mostly in silty seams, fine to medium sand, brown, dry, few compacted pieces, Fluvial (SM) effervesces w/ HCL little white SP and gold flecks of musc. and phloppite AT 228: clean med grained sand.			
230								
235								
240								



PROJECT NUMBER S20116.A3	BORING NUMBER MW-10	SHEET 9 OF 12
SOIL BORING LOG		

PROJECT USECOLOGY INC. HANFORD RES. LOCATION Richland, Washington
 ELEVATION approx 735.0 FT DRILLING CONTRACTOR Onwego Drilling Co. Kennewick, Wa.
 DRILLING METHOD AND EQUIPMENT Truck mounted cable tool, 22w Bucyrus Erie
 WATER LEVEL AND DATE 328.8 FT, 10/1/85 START 9/4/85 FINISH 9/23/85 LOGGER DSHIMS

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (#TAR)				
240								
	244.0							
245	245.0	S-15	2	—	SILTY SAND - poorly graded, 5-15% fines, some stringers, mostly medium sand, brown, dry, some compacted sections. Fluvial (SP-SM) some micaceous w/HCL			
250							fine sandy material at 250'	
255							begin drilling at 255.0' on 9/13/85	
260								
	264.0							
265	265.0	S-16	2	—	Silty Sand - poorly graded, 5-15% fines, fine sand, lt brown, dry, loose. Fluvial (SM-SP) micaceous w/HCL		only recovering half amount of sample from the dry barrel - loose	
270								



PROJECT NUMBER 620116.A3	BORING NUMBER mw-10	SHEET 10 OF 12
SOIL BORING LOG		

PROJECT U.S. ECOLOGY INC HANFORD RES LOCATION Richland, Washington
 ELEVATION approx 735.0 FT DRILLING CONTRACTOR Onwego Drilling Co. Kennewick wa
 DRILLING METHOD AND EQUIPMENT Truck mounted cable tool, 22w Bucyrus Erie
 WATER LEVEL AND DATE 328.8 FT, 10/1/85 START 9/1/85 FINISH 9/23/85 LOGGER DSHIMES

ELEVATION	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	DEPTH BELOW SURFACE (FT)	INTERVAL	TYPE AND NUMBER				
270					Sand - poorly graded, less than 10% fines, fine sand dry, loose, Fluvial (SP-SM)	SYMBOLIC LOG	
275							casing at 284.0' hole is collapsing, unable to drive sample very far ahead of casing.
280							
285	284.0 285.0	S-17	2	—	Silty Sand - poorly graded, 5-15% fines, fine sand, Lt brown, dry loose effervesces w/HCL (SP-SM) some white flecks of muscovite and prominent old flecks of phlogopite (?) or biotite		
290							
295							begin drilling at 295.0' on 9/16/85
300							



PROJECT NUMBER 320116, A3	BORING NUMBER mw-10	SHEET 11 OF 12
SOIL BORING LOG		

PROJECT U.S. ECOLOGY, Hanford Res. LOCATION Richland, Washington
 ELEVATION approx 735.0 FT DRILLING CONTRACTOR Onwego Drilling Co, Kennewick Wa
 DRILLING METHOD AND EQUIPMENT Truck mounted cable tool, 22 w Bucyrus Erie
 WATER LEVEL AND DATE 328.8 FT, 10/1/85 START 9/4/85 FINISH 9/23/85 LOGGER DSHIMES

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (# TARS)				
	300						AT 300.0 FT driller is unable to advance dry barrel sampler ahead of the casing without the hole collapsing	
	304.0							
	305.0	S-18	2	—	<u>SILTY SAND - poorly graded</u> 5-15% fines, fine to medium sand, lt brown, dry, loose effervesces w/HCL (SP-SM) less than 5% rounded gravel 1/2"-3" φ AT 310.0 FT some mica		begin drilling at 305 FT on 9/17/85	
	310						driller notes header drilling at 312.0'	
	311.0							
	312.0	S-19	1	—	<u>Gravelly sand - poorly graded</u> 5-10% fines, 25-30% rounded gravel 1/4"-3" φ, lt brown, dry, some clasts of basalt, effervesces w/HCL (SP) 2 cobbles, 3-5" φ RINGOLD FM.		cannot pick up sample with dry barrel at 315' begin drilling at 315' on 9/18/85 AT 315' switched over to using an 8" φ drill bit with water and 4" φ bailer that is 16 FT long.	
	315							
	320							
	322.0						AT 322.0 FT <u>SANDY GRAVEL</u> well graded, some med-coarse sand, 1/4"-3" φ well rounded gravel, probably some cobbles. Brown (GW)	sample comes out of bailer as thick slurry.
	324.0							
	325.0	S-20	2	—	<u>SANDY GRAVEL</u> - well graded 15-20% med sand, less than 10% fines, brown, dry (GW) well rounded gravel clasts of 30% basalt + 70% igneous exs. fewer fines at 328. RINGOLD FM			
	328							
	330							



PROJECT NUMBER 520116.A3	BORING NUMBER MW-10	SHEET 12 OF 12
SOIL BORING LOG		

PROJECT USECOLOGY, Hanford Res. LOCATION Richland, Washington
 ELEVATION approx 735.0 FT DRILLING CONTRACTOR Onweg Drilling Co, Kennewick wa.
 DRILLING METHOD AND EQUIPMENT Truck mounted cable tool, 22w Bucyrus Erie
 WATER LEVEL AND DATE 328.8 FT, 10/1/85 START 9/4/85 FINISH 9/23/85 LOGGER D.S. HIMES

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (#TACS)				
	330					GRAVEL with sand - well graded, less than 5% fines, 10-15% SAND, well rounded gravel, gray, wet, very dense (RINGOLD FM (GW))	[Symbolic Log: Gravel with sand]	bailer slurry gray at 330 FT compared to brown slurry at 325 FT
	335							
	340							
	344.0							sample S-21 was a gray slurry
	345.0	S-21	2	—		GRAVEL with sand - well graded less than 5% fines, 5-15% SAND, variety of sizes of well rounded gravel, gray, wet, very dense, 40% casts of basalt and 60% a variety of ign. and metamorphic EX RINGOLD FM. (GW) some minor gissing with HCL. some sandy lenses, some muscovite and phlogopite flakes.	[Symbolic Log: Gravel with sand]	begin drilling at 347.0 FT on 9/23/85
	350							
	355							360 FT of 8-inch ϕ casing installed prior to telescope - screen 40 FT length
	359.0							
	360	S-22	2	—		GRAVEL with sand - similar to S-21	[Symbolic Log: Gravel with sand]	END BORING AT 360.0 FT on 9/23/85



PROJECT NUMBER S 20116, A3	BORING NUMBER MW-13	SHEET 1 OF 2
SOIL BORING LOG		

PROJECT WS ECOLOGY INC., HANFORD SITE LOCATION RICHLAND, WASHINGTON
 ELEVATION approx 723.5 FT DRILLING CONTRACTOR ONWEGO DRILLING INC. KENNEWICK WA
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 22W BUCYRUS ERIE
 WATER LEVEL AND DATE 314.9 FT 11/9/85 START 10/8/85 FINISH 10/31/85 LOGGER DSHIMES

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (%-SPMS)				
0						[Symbolic Log: Dotted pattern]	begin drilling at 8:53 on 10/8/85 using 6 inch ϕ dry barrel sampler.	
5	5.0				<u>SAND - poorly graded, less than 5% fines, fine to medium sand, lt brown, dry, loose (SP)</u> Soil is moist and siltier at 3.5' organic odor, few root hairs		MOISTURE CONTENT 7.4%	
	6.0	S-1	2	—	<u>SILTY SAND - poorly graded, 10-20% fines, fine to medium sand, less than 2% gravels, dk brown, moist, some compacted pieces, organic odor, efferv. w/HCL, Fluvial (SP-SM)</u> AT 8.0 FT: coarse black sand seam occasional thin silty seams below 8.0 FT to 20.0 FT		hole is staying open down to 10.0 FT. driller is installing 19 FT of 12" ϕ temporary casing.	
10								
15							driller was able to advance 25.0 FT ahead of the casing	
20							less silt below 20.0 FT	
	22.0						AT 22.0 FT: A 1-inch diameter concretion, cemented by CaCO ₃ - strong efferv. w/HCL possibly contains ash, beige	
25	24.0						NO DISTINCT ASH LAYER present except for concretion at 22.0 FT	
	25.0	S-2	2	—			MOISTURE CONTENT 4.9%	
30							AT 29.0 FT: 6-inch thick alternating fine sand-silt, partly indurated paper thin, lt gray, strong efferv. w/HCL	



PROJECT NUMBER 520116, A3	BORING NUMBER MW-13	SHEET 2 OF 12
SOIL BORING LOG		

PROJECT US ECOLOGY INC., HANFORD SITE LOCATION RICHLAND, WASHINGTON
 ELEVATION APPROX 723.5 FT DRILLING CONTRACTOR ONWEGO DRILLING INC. KENNEWICK, WA.
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 22 W BILLYRUS ERIE
 WATER LEVEL AND DATE 314.9 FT, 11/9/85 START 10/8/85 FINISH 10/31/85 LOGGER DSHIMS

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (%)(#TALS)				
30						[Symbolic Log]	begin drilling at 30.0 FT on 10/9/85	
35					SAND with some silt, poorly graded, less than 10% fines in stringers, lt brown dry, loose, fluvial (SP-SM)		driller is having difficulty advancing ahead of the casing.	
44.0						[Symbolic Log]		
45.0	S-3	2		—	SAND with some silt, poorly graded, 5-15% fines, fine to medium sand, lt brown, dry, loose, 70% light colored angular grains, some mica, fluvial (SP-SM) efferv. w/HCL		MOISTURE CONTENT 1.4%	
50						[Symbolic Log]		
55								
60						[Symbolic Log]		



PROJECT NUMBER 520116 A3	BORING NUMBER MW-13	SHEET 3 OF 12
SOIL BORING LOG		

PROJECT U.S. ECOLOGY INC. HANFORD SITE LOCATION RICHLAND, WASHINGTON
 ELEVATION APPROX 723.5 FT DRILLING CONTRACTOR OWEGO DRILLING INC. KENNEWICK, WA
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 22W BUCKEYS ERIE
 WATER LEVEL AND DATE 314.9 FT 11/9/85 START 10/8/85 FINISH 10/31/85 LOGGER D. SHINES

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (IN)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (FEET)				
60								
		60.0						
65		65.0	S-4	2	—	SAND with some silt, poorly graded, 5-15% fines, fine to medium sand, lt brown, dry, loose, some compacted pieces cemented with CaCO ₃ , caliche efferv. w/HCL Fluvial (SP-SM)	moisture content 1.5%	
70								
75								
80								
		84.0						
85		85.0	S-5	2	—	SAND with some silt, poorly graded, less than 10% fines, fine to medium sand, lt brown, dry, loose, efferv. w/HCL, Fluvial (SP-SM)	unable to advance ahead of the casing moisture content 1.6%	
90						damp soil at 88 FT with some coarser sand down to 92 FT. at 90.0 FT: 2-3" thick fine sand seam.		



PROJECT NUMBER S20116.A3	BORING NUMBER MW-13	SHEET 4 OF 12
SOIL BORING LOG		

PROJECT US ECOLOGY INC., HANFORD SITE LOCATION RICHLAND, WASHINGTON.
 ELEVATION APPROX 723.5 FT DRILLING CONTRACTOR ORWEGO DRILLING INC. KENNEWICK WA.
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 22W BUCHERUS ERIE
 WATER LEVEL AND DATE 314.9 11/9/85 START 10/8/85 FINISH 10/31/85 LOGGER SM KREKOS

ELEVATION	DEPTH (FT) BELOW SURFACE	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (AS PER)	6"-6"-6" (N)			
90								
95								
100								
104								
105		5-6	2	—		SILTY SAND - POORLY GRADED, 10-15% FINES, MOSTLY FINE SAND, LT. BROWN, MOIST, SOME COMPACTED PIECES (SP/SM)	MOISTURE CONTENT 1.7%	
110								
115								
120								



PROJECT NUMBER 020116.A3	BORING NUMBER MW-13	SHEET 5 OF 12
SOIL BORING LOG		

PROJECT U.S. ECOLOGY INC., HANFORD SITE LOCATION RICHLAND, WASHINGTON
 ELEVATION approx 723.5 FT DRILLING CONTRACTOR DNWEGO DRILLING INC, KENNEWICK, WA.
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 22W BUCYRUS GRIP
 WATER LEVEL AND DATE 319.9 FT, 11/9/85 START 10/18/85 FINISH 10/31/85 LOGGER SM KREKOS

ELEVATION	DEPTH (FT) BELOW SURFACE	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (FEET)	6"-6"-6" (N)			
120								
	124							
125	125	5-7	2	—	SAND - POORLY GRADED, LESS THAN 10% FINES, FINE TO MEDIUM SAND, MOIST, LT. BROWN (SP, SM)		MOISTURE CONTENT 1.7%	
130								
							132' 3" LAYER OF POORLY GRADED SAND 15% FINES MOIST, COMPACTED PIECES.	
135								
140								
	144							
145	145	5-8	2	—	SILTY SAND, POORLY GRADED, 10-15% FINES, FINE TO MEDIUM SAND, MOIST, LT. BROWN, SOME COMPACTED PIECES, EFFERV W/HCL FLUVIAL. (SP, SM)		MOISTURE CONTENT 3.2%	
							DRILLER WELDS ON MORE CASING TO 147' 10"	
150								



PROJECT NUMBER S20116 A3	BORING NUMBER MW-13	SHEET 6 OF 12
SOIL BORING LOG		

PROJECT U.S. ECOLOGY INC., HANFORD SITE LOCATION RICHLAND, WASHINGTON
 ELEVATION APPROX 723.5 FT DRILLING CONTRACTOR OWEGO DRILLING CO., KENNEWICK, WA
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 2.2W BUCYRUS ERIE
 WATER LEVEL AND DATE 314.9 FT, 11/9/85 START 10/6/85 FINISH 10/31/85 LOGGER SM KREKOS

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (%/FT)				
150								
155								
160								
164								
165		164-165	S-9	2	—	SILTY SAND, POORLY GRADED, 15-20% FINES, FINE SAND, MOSTLY AS SILT SEEDS, LT. BROWN, LITTLE MOIST, LARGE AMOUNT COMPACTED, EFFERV/HCL FLUVIAL (SP-SH)	MOISTURE CONTENT 3.1%	
170						169' SILT SECT, POORLY GRADED, 15-25% FINES, SLIGHTLY MOIST, LT. BROWN, COMPACTED (SH)		
175						173 FT: LAYER OF COARSE SAND, LESS THAN 5% FINES, (POORLY) GRADED SAND.		
180								



PROJECT NUMBER 520116 A3	BORING NUMBER MW-13	SHEET 7 OF 12
SOIL BORING LOG		

PROJECT US ECOLOGY INC., HANFORD SITE LOCATION RICHLAND, WASHINGTON
 ELEVATION APPROX 923.5 FT DRILLING CONTRACTOR ONWEGO DRILLING CO. KENNEWICK, WA
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 22W BUCHSUS ERIE
 WATER LEVEL AND DATE 314.9 FT 11/9/85 START 10/8/85 FINISH 10/31/85 LOGGER SMKREKOS

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	SYMBOLIC LOG	COMMENTS
		INTERVAL	TYPE AND NUMBER	RECOVERY (FEET)	6"-6"-6" (N)			
180								
	184							
185	185	S-10	2	—		SAND, POORLY GRADED, LESS THAN 6% FINES, FINE TO MEDM SAND, LT. BROWN, SLIGHTLY MOIST (SP) FLUVIAL		MOISTURE CONTENT 1.7%
190								
195						195 (4): SILTY SAND, POORLY GRADED, 5-15% FINES, FINE TO MEDIUM SAND, LT. BROWN, DRY SOME COMPACTED PIECES. (SP-SM)		
200								
	204							
205	205	S-11	2	—		SAND, POORLY GRADED, LESS THAN 6% FINES, FINE TO MEDIUM SAND, LT. BROWN, DRY (SP) FLUVIAL		MOISTURE CONTENT 1.7%
210								



PROJECT NUMBER 520116.A3	BORING NUMBER MW-13	SHEET 8 OF 12
SOIL BORING LOG		

PROJECT ULS ECOLOGY INC, HANFORD SITE LOCATION RICHMOND, WASHINGTON
 ELEVATION APPROX 723.5 FT DRILLING CONTRACTOR ONWEGO DRILLING CO, KENNEWICK
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 22W BUCYRUS ERIE
 WATER LEVEL AND DATE 314.9 FT 11/9/85 START 10/8/85 FINISH 10/31/85 LOGGER SMKREKOS

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-8"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (WT%)				
210								
215								
220								
224								
225		224-225	S-12	2	—	SAND, POORLY GRADED, LESS THAN 5% FINES, FINE TO MEDIUM SAND, VERY CLEAN, (SP) FLUVID	Moisture content 1.7%	
230								
235								
240								



PROJECT NUMBER 520116.A3	BORING NUMBER MW-13	SHEET 9 OF 12
SOIL BORING LOG		

PROJECT US ECOLOGY INC. HANFORD SITE LOCATION RICHLAND, WASHINGTON
 ELEVATION APPROX 723.5 FT DRILLING CONTRACTOR ONWEGO DRILLING CO. KENNEWICK
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 22W BUCHFUS GRIE
 WATER LEVEL AND DATE 314.9 FT, 11/9/85 START 10/8/85 FINISH 10/31/85 LOGGER SMKREKOS

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	SYMBOLIC LOG	COMMENTS
		INTERVAL	TYPE AND NUMBER	RECOVERY (S-JARS)	6"-6"-6" (N)			
240								
	244							
245	245	S-13	2	—		SAND, POORLY GRADED, LESS THAN 5% FINES, FINE TO MED		1125 SAMPLE TAKEN
						MEDIUM SAND, DRY, LT BROWN (SP)		MOISTURE CONTENT 1.69%
250								
255								
260								
	264.0							
265	265.0	S-1A	2	—		SAND, poorly graded, less than 10% FINES, FINE TO MED SAND, lt brown, slight moist efferv. w/HCL, Fluvial (SP)		moisture content 1.6%
270								



PROJECT NUMBER 520116.A3	BORING NUMBER MW-13	SHEET 10 OF 12
SOIL BORING LOG		

PROJECT US ECOLOGY INC. HANFORD SITE LOCATION RICHLAND, WASHINGTON
 ELEVATION APPROX 723.5 FT. DRILLING CONTRACTOR OWEGO DRILLING CO. KENNEWICK
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 22-W BUCYRUS ERIG
 WATER LEVEL AND DATE 319.9 FT, 11/9/85 START 10/8/85 FINISH 10/31/85 LOGGER DS HINES

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (%)				
270						SAND - loose, dry, et brown		
275								driller notes occasional gravels up to 2" φ between 265 FT and 285 FT
280								driller is having difficulty picking up the sample.
285	284-285	S-15	2	—	—	SILTY SAND - poorly graded, 5-15% fines, mostly fine sand, lt brown, dry, loose efferv. w/HCL, 2 pieces of rounded gravel, 2" φ of granite fluvial (sp-sm) Between 285-290 FT few pieces of 2 1/2" φ sub rounded gravel mostly quartzite. very hard		moisture content 1.5%
290								AFTER sample S-15, water is being poured down the hole to help pick up the samples.
295								
300	299-300	S-16	1	—	—	SAND - poorly graded, less than 5% fines, et brown, dry		S-16 water was poured down the hole



PROJECT NUMBER 520116.A3	BORING NUMBER MW-13	SHEET 11 OF 12
SOIL BORING LOG		

PROJECT US ECOLOGY INC. HANFORD SITE LOCATION RICHLAND, WASHINGTON
 ELEVATION APPROX 723.5 FT DRILLING CONTRACTOR ONWEGO DRILLING CO. KENNEWICK
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CABLE TOOL, 22W BOLYFUS ERIE
 WATER LEVEL AND DATE 314.9 FT, 11/9/85 START 10/8/85 FINISH 10/31/85 LOGGER DSHINES

ELEVATION	DEPTH (FT) BELOW SURFACE	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (#JARS)				
	300							
	305					GRAVELLY SAND - well graded, less than 5% fines, 30-50% subrounded and rounded gravel, 1/4" - 3/4" φ, occasional cobble, gray, dry (?) Ringold Formation (sw-gw)		driller notes very hard material at 302', recovered 2 samples of gravel + sand with a few cobbles
	310	309	S-17	3	—	SANDY GRAVEL - well graded, less than 5% fines, 30-40% fine to medium sand, rounded gravel, gray, very dense Ringold Formation (aw)		AT 308' switched over to using a drill bit and water to remove the material w/bailer very slow drilling
	315							
	320	319	S-18	3	—	SANDY GRAVEL - similar to S-17		
	325							
	330							



PROJECT NUMBER 520116.A3	BORING NUMBER MW-13	SHEET 12 OF 12
SOIL BORING LOG		

PROJECT US ECOLOGY INC, HANFORD SITE LOCATION RICHLAND, WASHINGTON
 ELEVATION APPROX 723.5 FT DRILLING CONTRACTOR ONWEGO DRILLING CO, KENNEWICK
 DRILLING METHOD AND EQUIPMENT TRUCK MOUNTED CASE TOOL, 22-W BUCYRUS FRIE
 WATER LEVEL AND DATE 314.9 FT 11/9/85 START 10/8/85 FINISH 10/31/85 LOGGER DBHIMES

ELEVATION	DEPTH (FT) BELOW SURFACE	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		INTERVAL	TYPE AND NUMBER	RECOVERY (%/FT)				
330	330-331	S-19	3	—	SANDY GRAVEL - well graded, less than 5% fines, 20-30% fine to medium sand, gray, very dense (Gw) Ringold formation	[Symbolic Log: Sandy Gravel]	very hard slow drilling	
335	339-340	S-20	3	—	SANDY GRAVEL - well graded, less than 5% fines, 15-20% fine sand, rounded gravel variety of sizes of mostly light colored ex, gray, very dense (Gw) Ringold formation			
340	349-350	S-21	3	—	SANDY GRAVEL - well graded, less than 5% fines, 15-25% fine to medium sand, gray, very dense, Ringold formation (Gw)		end boring at 350 Ft will install telescoping screen and then pull back casing.	
350					END BORING AT 350 FT.			
355								
360								

Appendix C
DRILLERS LOGS

DRILL LOG		BY	Rig	Well Num.	Computer Number	Project or Work Order No.
		K. Olson	blue	# 3		782a
		Date	1118	Depth		Subcontract No.
				0		
				To		
				30'		
Total Casing	Depth	Drill Method	Wet/Dry Sample	LITHOLOGIC DESCRIPTION % Each Grain Size, Color, Roundness, Caliche, Etc.		Drilling Comments
20'	30'	D	Dry	'got rig un-stuck with Lenny & Parcel, set up rig, picked up spear, short 12" casing at #13 site with Ford truck, moved Ford to #3 site, re-built drive- barrel, changed battery in welder, made up tools, cut surface pipe, drilled 12' hole from 0' to 13', welded surface pipe, drilled from 13' to 30', 0-9- Brown sand & silt 9-10- Black sand 10-25 Brown sand & silt layers, (some gravel) 25-30- Brown sand with gravel & cobbles		
REMARKS:						
Item #1 - 5 hrs						10 hrs total
M15 - 5 hrs						

