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16. KEY

Impact Level (F)	Reason for Transmittal (G)		Disposition (H) & (I)	
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7. Abstract

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1.0 INTRODUCTION

Aquifer testing will be conducted at groundwater monitoring well #3 at the proposed State-Approved Land Disposal Site (SALDS) north of the 200 West Area (Figure 1). Hydrologic testing will consist of instantaneous slug tests and constant rate discharge tests in a "drill-and-test" type sequence. Well #2 will be installed as a shallow groundwater monitoring well prior to testing and used as an observation well during the constant rate discharge tests at well #3. Pumping tests will be performed at two to three intervals during the drilling process at well #3.

The SALDS will be an infiltration disposal site for treated waste water originating at the proposed Effluent Treatment Facility (ETF) located just east of the 200 East Area. Initially the ETF will be treating a liquid stream containing hazardous and radiological constituents from the 242-A Evaporator. These constituents will be removed from the waste stream at the ETF, with the exception of tritium (no reasonable technology exists at this present time for the extraction of tritium). The U.S. Department of Energy, Richland Operations Office, is in the process of applying for a WAC 173-216 State-Waste Discharge Permit for operating the SALDS.

Aquifer test results (hydraulic conductivities) will be used to refine estimates of groundwater travel time from the SALDS to the Columbia River about 5 mi to the north/northeast. The SALDS location was selected because it provides the longest travel time to the Columbia River, allowing sufficient time for the tritium to decay to acceptable levels before entering the river. For this reason, it is important to make good estimates of the aquifer hydraulic conductivity, since this is the key factor for estimating groundwater travel times. Only one previous aquifer test was conducted at the SALDS: an instantaneous test at upgradient well 699-48-77A in 1992 (Figure 1). The current proposed testing program should provide an areally extensive estimate of hydraulic conductivity without the limitations of slug tests.

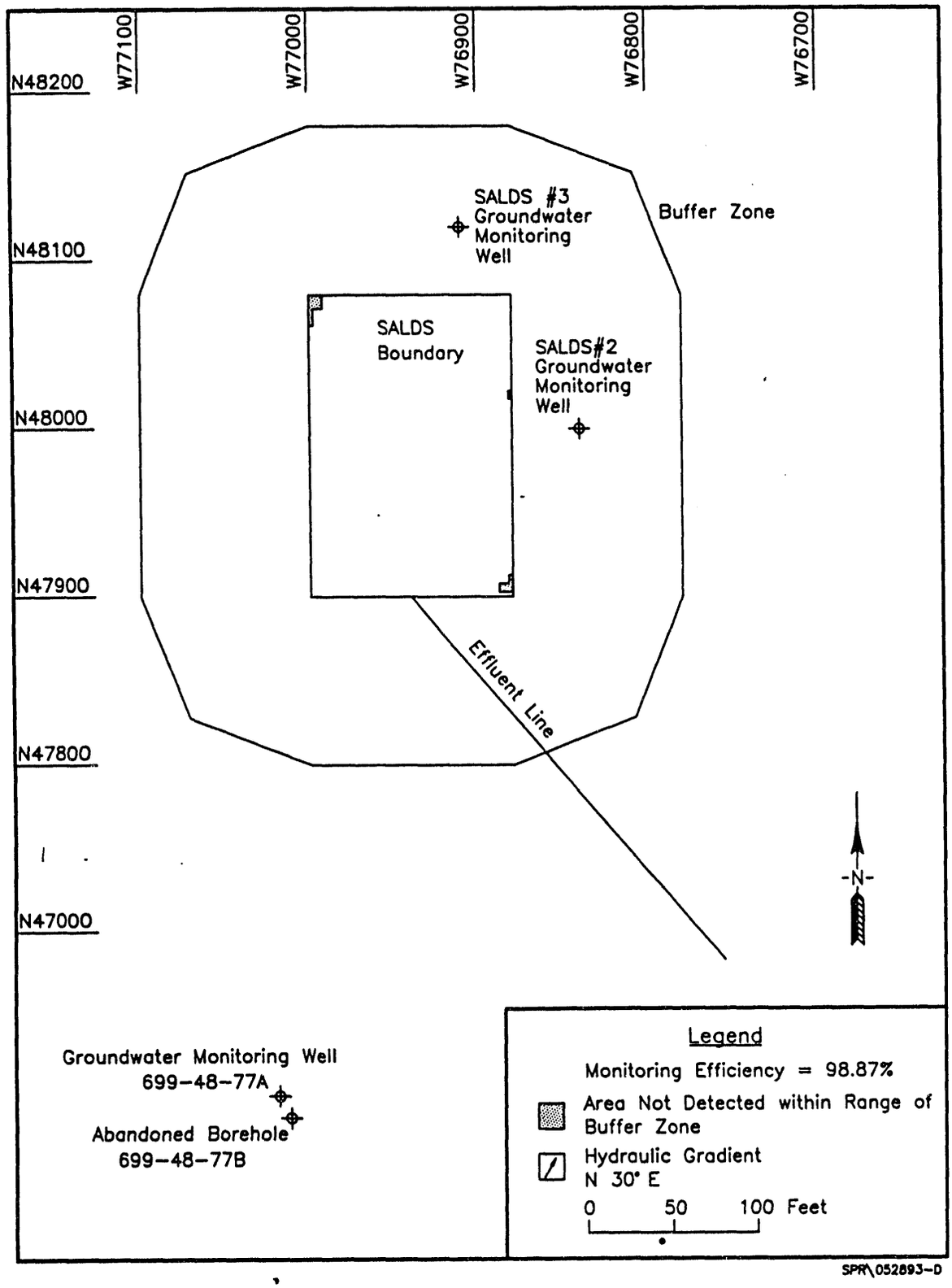
1.1 SCOPE

This test plan provides technical guidance for performing hydrologic tests at well #3 at the proposed SALDS facility, in accordance with the site groundwater monitoring plan (Reidel 1993b). Specific items included in this test plan are test design requirements, equipment requirements, field operational requirements, implementation requirements, and data collection guidelines for the aquifer testing. This test plan was prepared in accordance with Environmental Investigations Instruction (EII) 10.1, "Aquifer Testing" (WHC 1988a).

Field testing will occur during well drilling and after the monitoring well is completed. The first aquifer test is expected to commence in February 1994. Hazardous and radioactive groundwater and sediments are not expected. After field testing a report will be issued summarizing the test results. Field testing will consist of the following types of tests:

- Instantaneous slug injection and withdrawal tests (Papadopulos and Cooper 1967, Bouwer and Rice 1976)

Figure 1. Well Location Map for the Proposed State-Approved Land Disposal Facility.



- Constant rate discharge drawdown and recovery tests (Neuman 1975, Cooper and Jacob 1946).

1.2 PURPOSE AND OBJECTIVES

The primary purpose of these aquifer tests is to characterize the hydrology beneath the proposed SALDS. Aquifer testing is expected to provide estimates of hydraulic conductivity for the single-well tests (slug tests), and additionally specific yield, possibly the elastic storage coefficient, and the vertical hydraulic conductivity for the multiple-well constant rate discharge tests. Constant discharge tests will be conducted at two or three depth intervals in well #3.

The general objective of this test plan is to provide administrative and technical guidance for the field testing. Specific information contained in this test plan includes:

(1) The expected hydrogeology at the test wells
(2) A discussion about the types of tests that will be performed
(3) The test well configuration and test equipment requirements
(4) The general sequence of field testing activities
(5) Specific test design and data collection requirements
(6) The handling of purgewater produced during testing
(7) Applicable procedures and quality assurance guidelines.

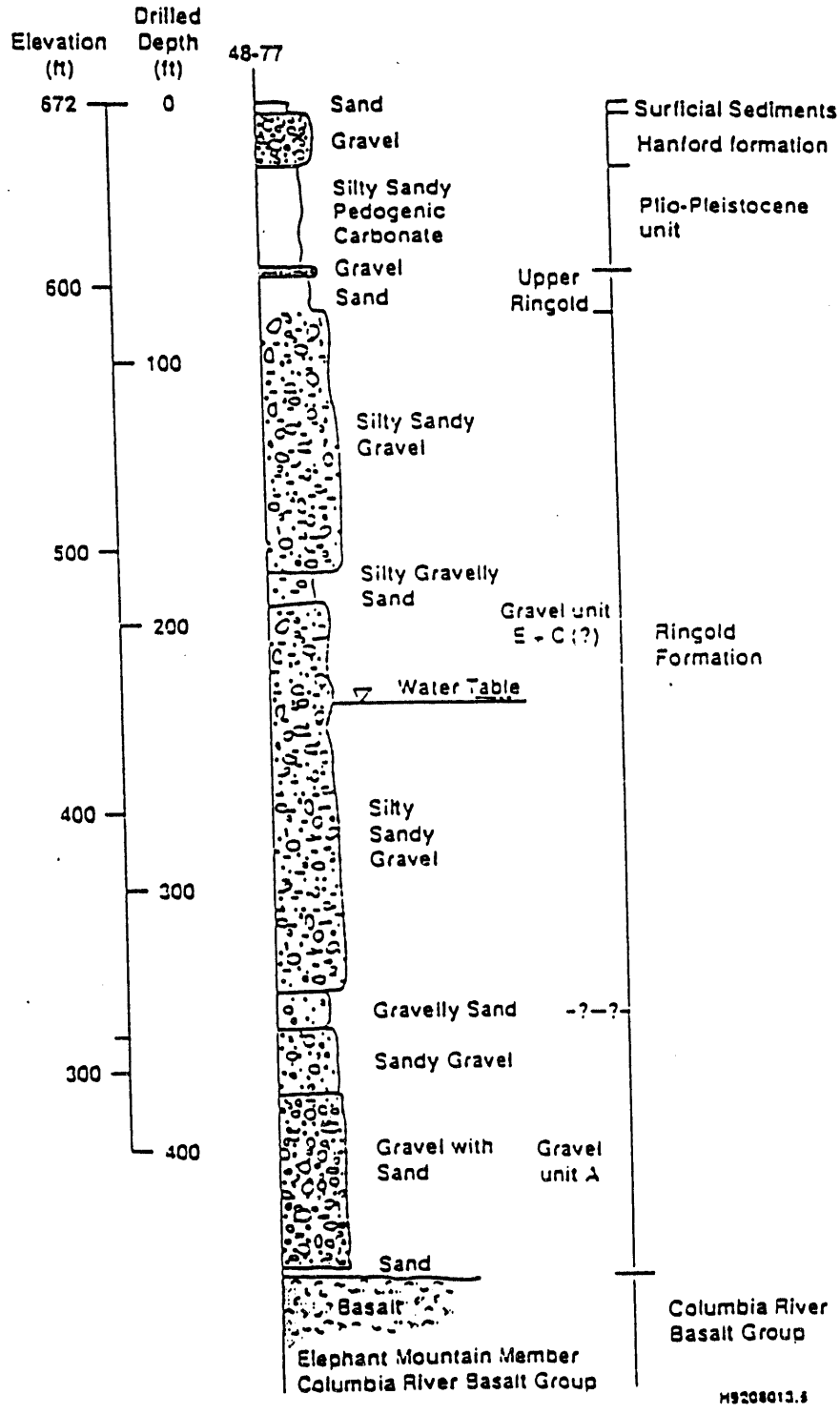
2.0 SITE HYDROGEOLOGY

A brief description of the expected hydrogeology for the test sites is presented below. For greater detail refer to the characterization report (Reidel 1993a) and groundwater monitoring plan (Reidel 1993b). The hydrogeology described below is based on two upgradient characterization boreholes drilled in 1992, 699-48-77A and 699-48-77B.

The top of the unconfined aquifer at the proposed test site is situated within Ringold Formation unit E at a depth of about 219 ft below land surface. The Ringold Formation is dominated by gravel sequences with a matrix of sands and increasing silt content below 170 ft. A major cataclysmic flood channelway incised into the Ringold Formation occurs approximately 1 km north of the site. This channelway is filled with Hanford formation gravel-dominated deposits. The position of the erosional channelway edge is inexact because of poor well control in the area.

The bottom of the unconfined aquifer is marked by the top of the Elephant basalt. The lower mud unit common to the Ringold Formation was not present in the upgradient borehole and will probably not be encountered in well #3. As interpreted by Lindsey and Gaylord (1991), the lower mud pinches out moving north from the 200 West Area toward the SALDS. The expected general sequence of stratigraphic units from ground surface to total depth for well #3 is shown in Figure 2.

Figure 2. Stratigraphic Units and Lithology Penetrated at the Preferred Soil Column Disposal Site by Borehole 699-48-77A.



Movement of groundwater in the unconfined aquifer occurs primarily in the Ringold Formation. Groundwater flow direction is to the northeast from the SALDS toward Gable Gap. A hydraulic conductivity of 20 ft/d was estimated at well 699-48-77A from slug test data (Appendix A).

3.0 WELL CONSTRUCTION AND CONFIGURATION

Both wells will be completed as groundwater monitoring wells, screened in the silty sandy gravels of the Ringold Formation unit E at the top of the unconfined aquifer. Well #3 is a deep characterization borehole that will follow a drill-and-test sequence to the top of basalt (estimated at 445 to 455 ft below ground surface). This well will then be backfilled and completed at the top of the uppermost aquifer. During drilling of well #3, pumping tests will be performed at specific intervals: (1) the top of the unconfined aquifer, (2) the bottom of the unconfined aquifer, and (3) below the lower mud (if present). After completion, these wells will be used to collect groundwater chemistry samples and water-level data.

Both wells will be constructed according to RCRA standards as outlined in WAC-173-160, and implemented by the Hanford Site Generic Well Specification for groundwater monitoring wells (Reynolds 1992). Final well materials will consist of 4-in.-diameter stainless steel casing and a 20-ft stainless steel continuous wire-wrap 10 or 20 slot (0.010-0.020 in.) screen. The screen slot size and filter pack will be based on the geologic data from the completion interval.

Aquifer testing will commence after completing well #2 and drilling well #3 to the first test interval (top of the unconfined aquifer). Testing is expected to take 5 days at each test interval. A 10- to 20-ft 6- to 8-in. telescoping screen will be temporarily installed in well #3. Screen slot sizes will be either 0.010 or 0.020 in. depending on information from the geologic log. The well will be developed using surge blocks and/or by pumping to remove formational fines. The Geosciences Aquifer Test Lead will give final approval that the well is sufficiently developed for testing. The screen will be removed before drilling to the next test interval. Up to three intervals will be screened and tested in this manner. If the lower mud is not present, the third test will not be conducted.

4.0 DESCRIPTION OF TEST ACTIVITIES

The hydrologic testing sequence for each test interval consists of the following: an instantaneous slug injection and withdrawal test, step-drawdown pumping, a constant rate discharge test, and a final slug test. Step-drawdown pumping will be used to determine an optimum discharge rate for the constant rate discharge tests. A final slug test may be conducted at each test site to determine if additional development occurred during the discharge test.

4.1 TEST DESCRIPTION

The primary objective for the aquifer tests is to determine aquifer hydraulic parameters. For single-well instantaneous slug tests, only the hydraulic conductivity can be estimated. Use of the observation well during the pumping tests should provide the additional estimates of the vertical hydraulic conductivity, the specific yield, and possibly the elastic storage coefficient.

During step-drawdown pumping and constant rate discharge tests, water will be removed from the aquifer at a constant rate. Step-drawdown pumping will consist of discharging groundwater at a constant rate for 60 to 90 min, then increasing the discharge rate for another 60 to 90 min. This "step" increase in pumping may be repeated two to five times.

Slug tests stress the aquifer by "instantaneously" changing the level of the water within the well with the use of a slugging rod, or by some other volumetric means. The slug tests provide an estimate of the aquifer hydraulic conductivity near the borehole, whereas the constant rate discharge test provides estimates of aquifer properties integrated over the volume of the drawdown cone. Slug test results will be compared to the hydraulic conductivities estimated from the constant rate discharge tests.

Slug tests are affected by local, small-scale aquifer heterogeneities and near borehole formational disturbances (e.g., from the drilling operation). The test results generally apply only to the part of the aquifer being stressed and should not be considered representative of the entire saturated thickness. Given these limitations, slug test results should be interpreted with caution.

Aquifer testing will be initiated only after several administrative tasks are completed. These tasks include:

- A groundwater chemistry evaluation to determine if purgewater produced from testing needs to be contained. If purgewater must be contained, constant rate discharge testing will only proceed if a purgewater truck (or other containment vessel) can be used for collecting the water (i.e., very large volumes of purgewater will not be produced).

- An assessment of the impact of purgewater on endangered, threatened, or sensitive plant and animal species if water is to be disposed to the ground. If purgewater must be contained, the same criteria apply as described under bullet one above.

5.0 DESCRIPTION OF TEST REQUIREMENTS

The following sections describe pre- and post-test monitoring, equipment requirements, and test design and data collection requirements for the aquifer tests.

5.1 GENERAL EQUIPMENT REQUIREMENTS

A calibrated transducer should be used in the pumping and observation wells for the baseline monitoring, pre-test water-level monitoring, and during the aquifer tests. Calibrated equipment other than flow measurement devices shall be controlled as described in EII 3.2 of WHC-CM-7-7 (WHC 1988a). The transducer should be located in the well as stated in EII 10.1, "Aquifer Testing." Steel tapes and electric tapes used for measuring water levels must meet the calibration and standardization requirements in EII 10.2.

The transducers must record at a log-scale frequency at the start of the slug tests, step-drawdown pumping, constant rate discharge tests, and the beginning of recovery monitoring, with a maximum recording frequency not to exceed 1 h. Recording frequencies for baseline monitoring and pre-test monitoring should be set at a maximum interval of 1 h.

For step-drawdown pumping and the constant rate discharge tests, the pump should be installed within 5 ft of the bottom of the screen or at a depth that is at least 3 to 5 ft below the level of maximum expected drawdown. This setting should provide an adequate buffer to prevent cavitation during pump operation.

5.2 PRE- AND POST-TEST MONITORING

Barometric pressures must be recorded at 1-h intervals at least 2 days before testing is initiated, throughout the testing activities, and for 1 to 2 weeks after all testing is completed (or after the well itself is finally completed). If barometric measurements are taken at either of the test wells, the recording rate must be set at the same recording frequency as the water-level transducer frequencies and times.

Prior to step-drawdown pumping and the constant rate discharge tests, water levels should also be monitored from 1 to 5 days. In general, pre-test monitoring should exceed the expected length of the test by a factor of about 2 or 3. If time for testing is limited, this period may be reduced to 1 day. However, the longer monitoring period is preferred. The maximum measurement interval is 1 h.

Water levels must be monitored just prior to initiation of the test to establish any short-term trends or disturbances from recent operational activities. The time of monitoring could range from 30 min to 1 day, or until stable conditions are evident (water level is at "static").

After pumping is terminated for the step-drawdown and constant rate discharge testing, water-level data collection will continue throughout the recovery period until a dynamic equilibrium is re-established or the recovery trend is clearly defined. In most cases full recovery is expected to occur in about 2 or 3 days. A final slug test may then be performed at the well.

5.3 SLUG TESTS

Instantaneous slug tests will be conducted in all wells following the procedure contained in the Environmental Investigation Instruction Manual (WHC-CM-7-7, Section 10.1, "Aquifer Testing").

5.4 STEP-DRAWDOWN AND CONSTANT DISCHARGE TESTS

Step-drawdown pumping will be used to determine the optimum pumping rate for the constant rate discharge test. Two to five steps at 60 to 90 min in length will be necessary to make this determination, unless diagnostic development data are available from the development work. A reasonable drawdown for the long-term test would be at least 5 to 10 ft in the pumping well, not exceeding 25% of the aquifer thickness. A pump capable of discharging 10 to 90 gal/min at a total dynamic head of 250 to 500 ft or more will probably be required.

A constant rate discharge test will be conducted at each of the test intervals after the step-drawdown pumping. Well #2 will be used as an observation well during all of the pumping tests at well #3. During these tests, the riser pipe from the pump must have a backflow valve or a surface valve installed to prevent water in the pipe from draining back into the aquifer after the pump is shut off. At a minimum, a valve should be installed at ground surface that can be closed at the end of the pumping period.

5.4.1 Discharge Rates

A calibrated flow measurement device (which includes orifice-type devices) must be used to monitor the discharge rates. The orifice device is considered calibrated if it was constructed according to standard industry specifications (e.g., Driscoll 1986). The discharge rate will be confirmed during the test using, for example, a stop watch and container of known volume. The error of the flow measurement device should not exceed $\pm$10% of the total flow. This confirmation testing will be adequate in itself if the test has started and the flow measurement device fails.

Flow measurement devices must be installed with the correct length of straight run pipe upstream and downstream from the device per the manufacturer's recommendations or standard industry practice (e.g., Driscoll 1986). If a rotor meter type flow meter is used for low flow rates (<20 gal/min), the factory calibration is acceptable, provided the flow rate is also confirmed while running the test. Expected flow rates may range from 5 to 90 gal/min based on previously estimated hydraulic conductivities.

Flow rates should be recorded at least every 5 min at the start of the test, and at a maximum of 30- to 60-min intervals after the first 30 min. If a transducer can be used for recording flow rates, the rate should be set to a logarithmic recording frequency at the start of the test with a maximum rate of every 30 to 60 min.

The discharge rate for the pumping test will depend on the results of the step-drawdown pumping or the development data. The Aquifer Test Lead will make the final determination of the flow rate. A pump capable of discharging

10 to 90 gal/min at a total dynamic head of 250 to 500 ft will probably be required.

The entrance velocities of groundwater into the wells are not expected to produce significant turbulence at an estimated maximum flow rate of 90 gal/min. For an 8-in. 10 slot continuous wire-wrap screen 10 ft long, the entrance velocity at 90 gal/min is about 0.1 ft/s. This velocity meets the criteria specified by Driscoll (1986), is significantly below the upper limit of 2 to 4 ft/s given by Roscoe Moss Company (1990), and lower than that recommended by the American Water Well Association (A 100-84) of 1.5 ft/s (for long-term production wells). Assuming that 50% of the screen area is blocked, the entrance velocity will still be below the later two standards.

5.5.2 Length of Test

The constant rate discharge test should run until the effects of delayed yield have dissipated, and/or a straight line is well developed on a semi-log plot of drawdown versus time. It is anticipated that the test will run 8 to 24 h. Final determination on the length of the test is at the discretion of the Aquifer Test Lead. The rationale for stopping the test will be recorded on the field activity report.

6.0 PURGEWATER REQUIREMENTS

If the groundwater at the test well is designated as uncontaminated, the water can be released to ground surface at least 200 ft away from both the stress and observation well in a topographically low area, or where the slope if away from the wells. From a preliminary examination of the groundwater data at well 699-48-77A (upgradient from the SALDS), the quality of the groundwater appears to be acceptable. Purgewater is not expected to recharge the aquifer during the test, because of the depth of the water table (220 ft below land surface). Geosciences will document the quality of the groundwater in the wells prior to testing following procedure EII 10.3 (WHC-CM-7-7, 1988a). EII 10.3 satisfies the requirements of the purgewater strategy document (WHC 1990b). The volume of purgewater for one test is estimated at 129,600 gal, assuming a discharge rate of 90 gal/min for 1 day.

The collection of three purgewater samples is recommended during the constant discharge test for screening level information. The samples could be collected at the beginning of the test, near the middle, and one before the pump is shut off. Recommended analyses include tritium and nitrate since these are the nearest contaminant plumes. The Field Team Leader will collect the groundwater samples or assign field support personnel to do so. Nitrate samples will be analyzed in the field after collection using any standard field chemistry analysis kit. Tritium samples will be transported to the 222-S laboratory for analysis per standard WHC laboratory procedures (LA-218-111, Liquid Scintillation Method). No special handling is required. All bottles should be labeled with the date, collection time, sample type, and sample number. One-liter bottles will be used for sample collection. Detection limits of 500 pCi/L and 1 ppm are suggested for the tritium and nitrate samples.

7.0 PROCEDURES AND DOCUMENTATION

Testing documentation and procedural control is covered by EII 10.1, 10.2, and 10.3 (WHC-CM-7-7). Field activity reports will be used to record daily field activities during aquifer testing per EII 6.7. Standard activities and any unusual observations should be recorded on a daily activity log. Data collected during the testing will be stored according to EII 1.6 and incorporated into the project file after testing is completed. The wells will be installed using the Generic Well Specification (Reynolds 1992). This specification meets the requirements of WAC-173-160 (Ecology 1990).

8.0 QUALITY ASSURANCE

Data quality is controlled by this test plan and EII 10.1, "Aquifer Testing." The data at the test wells can be reproduced if the initial test fails by re-running the test. The quality assurance documents that cover the test activities are the *Quality Assurance Manual* (WHC 1988b) and the *Environmental Engineering, Technology, and Permitting Function Quality Assurance Program Plan* (WHC 1990a). A quality assurance surveillance will be performed during testing to determine if the aquifer testing and sampling activities meet the requirements of this test plan and relevant procedures. This aquifer test plan and the aquifer testing is assigned an impact level of 3Q.

9.0 RESPONSIBILITIES

Specific responsibilities for the testing activities are contained in EII 10.1. Personnel performing individual test activities will be identified in the daily field activity log. Geosciences personnel will be the primary lead for aquifer testing and will direct and schedule field activities. Geosciences is responsible for evaluating the quality of groundwater that will be produced from each well.

Environmental Field Services and/or a drilling subcontractor may support the testing by conducting camera surveys, operating the slugging rod during slug testing, setting and removing pumps, and providing certain equipment required during testing (such as pump generators, outdoor lighting, discharge pipe).

10.0 HEALTH AND SAFETY

Site safety will be controlled by the applicable site safety plan, prepared by either Westinghouse Hanford Company and its subcontractors or the drilling contractor on the test site. No impact to safety is anticipated.

11.0 REFERENCES

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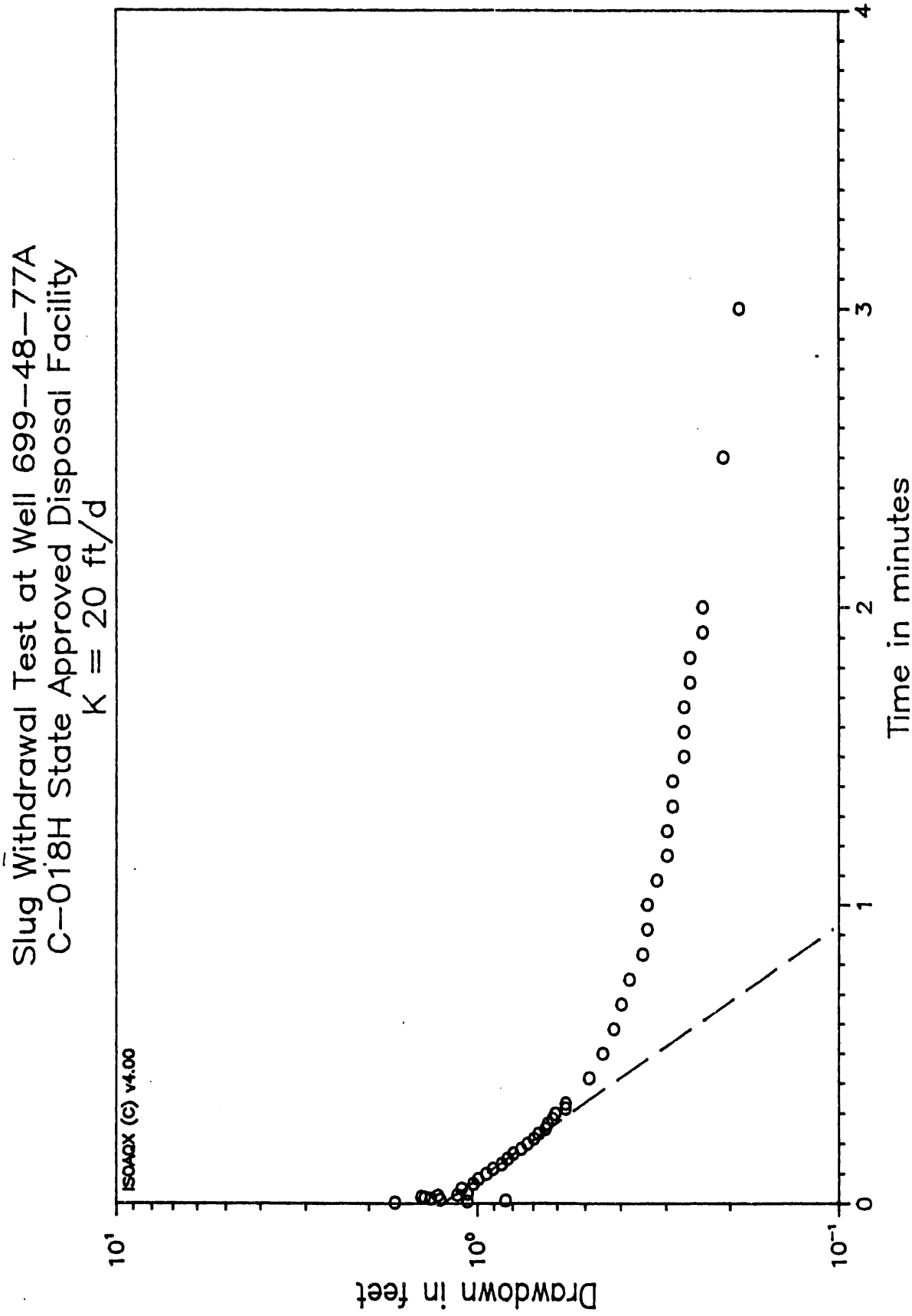
APPENDIX A

SLUG TEST ANALYSIS FOR WELL 699-48-77A

Figure A-1. Slug Test Analysis for Well 699-48-77A.



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