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Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area U at the Hanford Site

F. N. Hodges
C. J. Chou

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Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

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Pacific Northwest National Laboratory
Richland, Washington 99352

Summary

Waste Management Area U (WMA U), located in the 200 West Area of the Hanford Site, includes the U Tank Farm, which contains 16 single-shell tanks and their ancillary equipment and waste systems. WMA U is regulated under the *Resource Conservation and Recovery Act of 1976* (RCRA) as stipulated in 40 CFR Part 265, Subpart F, which is incorporated into the Washington State dangerous waste regulations (Washington Administrative Code 173-303-400) by reference.

Groundwater monitoring has been under an interim-status indicator evaluation program. One of the indicator parameters, specific conductance, exceeded its background value in one downgradient well, triggering a change from detection monitoring to a groundwater quality assessment program. The major contributors to the higher specific conductance are nonhazardous constituents (i.e., sodium, calcium, magnesium, chloride, sulfate, and bicarbonate). Concentrations of nitrate (~14,500 as NO_3^-) and chromium (38 µg/L) are increasing. However, the elevated nitrate and chromium concentrations are still significantly below the drinking water standard.

Groundwater flow directions at WMA U have been in constant flux since the initiation of RCRA groundwater monitoring as a result of changing effluent discharge patterns within the 200 West Area. Changes in site conditions (e.g., reversal of flow direction, discharge practice) have necessitated the revision of background values to be used in the statistical evaluation. The most recent revision of background values was conducted during fiscal year 1999. The combination of lower average specific conductance values, together with a much smaller degree of variation in the upgradient wells, resulted in an ~50% reduction in the critical mean value (from ~533 to ~273 µS/cm).

This plan presents the approach to be used for the groundwater quality assessment program. Based on the results of this investigation, if WMA U is not the source of groundwater contamination, the site will revert to detection monitoring. If WMA U is the source, then a second part of the groundwater quality assessment plan will be prepared to define the rate and extent of migration of contaminants in the groundwater and their concentrations. Information gathered will enhance the understanding of subsurface conditions and processes to support tank waste remediation and cleanup decisions and/or complement near-term corrective actions to protect groundwater and the Columbia River.

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1.0 Introduction

1.1 Background

The Hanford Federal Facility Agreement and Consent Order (commonly known as the Tri-Party Agreement; Ecology et al. 1989) placed the single-shell tank farms under *Resource Conservation and Recovery Act of 1976* (RCRA) interim-status regulation. This agreement also placed the interim-status sites under the supervision of the Washington State Department of Ecology (Ecology).

Waste Management Area U (WMA U) includes the U Tank Farm, which contains 16 single-shell tanks (constructed in 1943-1944) and their ancillary equipment and waste systems (e.g., transfer lines, diversion boxes). WMA U is located in the 200 West Area (Figure 1.1) and is currently regulated under RCRA interim-status regulations as stipulated in 40 CFR Part 265, Subpart F, which is incorporated into the Washington State dangerous waste regulations (Washington Administrative Code [WAC] 173-303-400) by reference.

A RCRA Part A (interim-status) permit application and closure/work plan was submitted in 1989 (DOE 1989). Under the Tri-Party Agreement, as amended, the single-shell tank farm WMAs are scheduled for closure under Washington State final-status regulations (WAC 173-303-610). The time and method of closure are uncertain, but closure will probably be post-2030.

Groundwater monitoring has been under an interim-status indicator evaluation program that compared general contaminant indicator parameters from downgradient wells to background values established from upgradient wells. One of the indicator parameters, specific conductance, exceeded its background value in one downgradient well, 299-W19-41, triggering a change from detection monitoring to a groundwater quality assessment program.

Major contributors to the higher specific conductance are nonhazardous constituents (i.e., sodium, calcium, magnesium, chloride, sulfate, and bicarbonate). Their elevated concentrations may be related to enhanced water infiltration along the southern boundary of the WMA. However, additional information is needed to confirm or refute this hypothesis. This plan presents the investigatory approach used by Pacific Northwest National Laboratory[(a)] for the assessment program.

1.2 Objective

The objective of the first phase of this assessment program is to determine, as allowed under 40 CFR 265.93(d)(5), whether the increased concentrations of nitrate and chromium in groundwater are from WMA U or from an upgradient source. Based on the results of the first determination, if WMA U is not the source of groundwater contamination, then the site will revert to detection monitoring. If WMA U is

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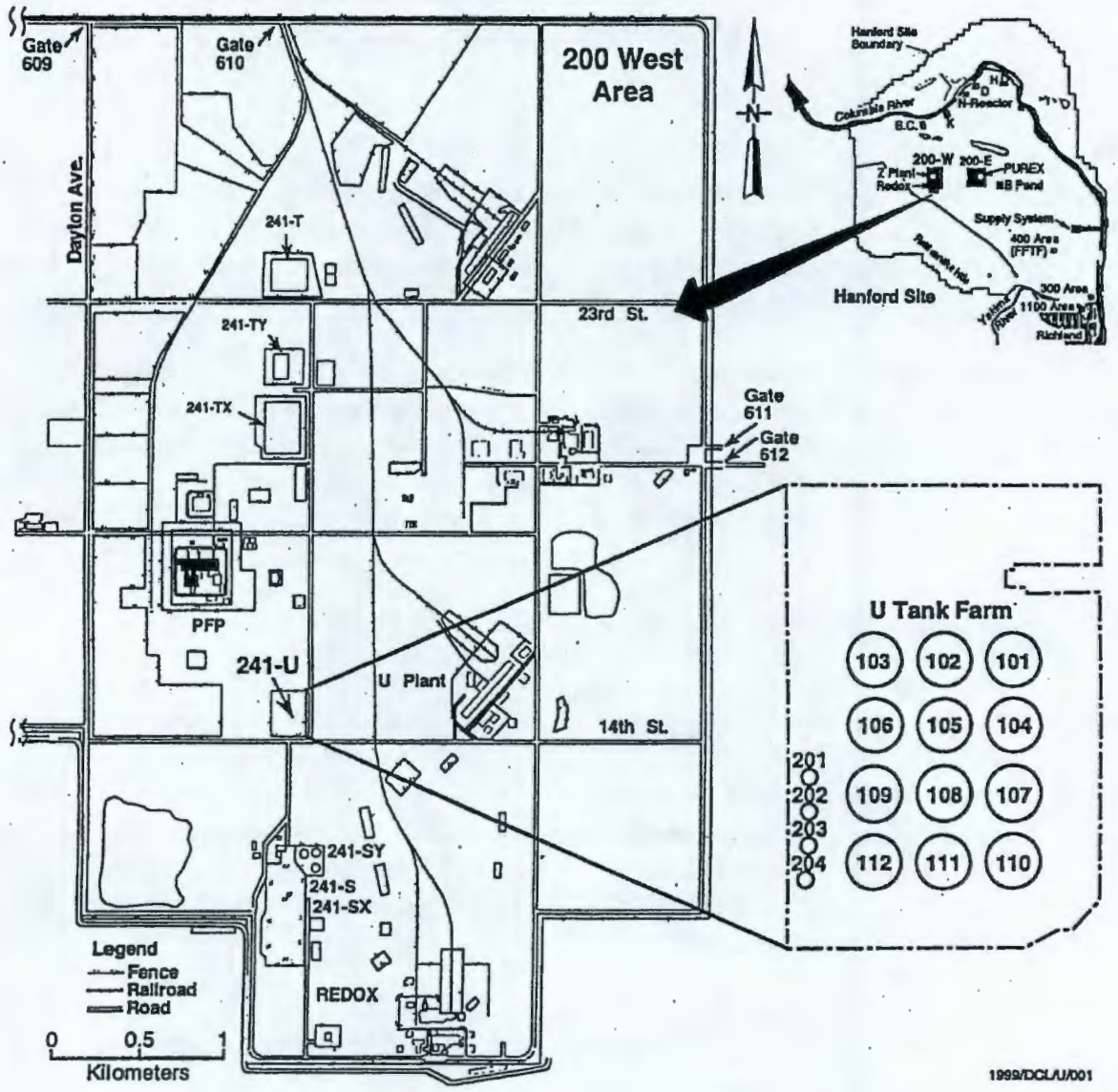

Figure 1.1. Map Showing Location of Waste Management Area U in the 200 West Area of the Hanford Site

the source, then a second part of the groundwater quality assessment plan will be prepared to define the rate and extent of migration of contaminants in the groundwater and their concentrations (40 CFR 265.93[d][4]).

1.3 Report Organization

In addition to this introduction, this report consists of a description of the facility and the wastes disposed therein (Chapter 2.0), the hydrogeology of the area (Chapter 3.0), an evaluation of the indicator parameter that caused this assessment program (Chapter 4.0), and a description of the ensuing quality

assessment program for this WMA (Chapter 5.0). How the data gathered from the monitoring of this area is treated is given in Chapter 6.0, and the references cited in the text are given in Chapter 7.0. An appendix provides the as-built drawings of the wells used for monitoring this WMA.

2.0 Facility Description and Waste Characteristics

2.1 Physical Structure

WMA U is located in the south-central portion of the Hanford Site's 200 West Area (see Figure 1.1). The WMA, with an area of ~30,000 m^2 (323,000 ft^2), contains 16 single-shell carbon steel tanks constructed between 1943 and 1944 (Figure 2.1). Twelve of the tanks (U-101 through U-112) have capacities of 2,017,000 L (533,000 gal) and four (U-201 through U-204) have capacities of 208,000 L (55,000 gal).

The tanks are constructed with a concrete shell and a single-walled liner of carbon steel. The tanks are 22.9 m (75 ft) in diameter and are ~9 m (29.5 ft) in height. The tanks are set with the bottoms ~11 m (37 ft) below grade with ~2 m (7 ft) of fill over the top. Various ports in the tank tops are available for waste transfer and monitoring. In addition, vadose zone monitoring wells (dry wells) are located in the fill material around the tanks to allow monitoring of radionuclide migration around the tanks. The smaller (208,000-L [55,000-gal]) tanks are 6.1 m (20 ft) in diameter and ~7.8 m (25.5 ft) in height. The bottoms are at ~11.3 m (37.25 ft) below grade and ~3.6 m (11.75 ft) of fill cover the tanks. Additional details on tank construction are available in Anderson (1990).

2.2 Operational History

The tanks began receiving waste in 1946 (Anderson 1990) and were in more-or-less continual use from that time until 1980. The first waste sent to the U Tank Farm was "metal waste" resulting from the bismuth phosphate process at B and T Plants. Most of the metal waste was subsequently removed from the tanks and recycled through U Plant to remove uranium. The metal waste was replaced by waste from the Reduction Oxidation (REDOX) Plant and from other waste operations. Wastes were transferred between tanks and tank farms throughout the operational history, and, as a result, there is considerable uncertainty about the exact compositions of waste in the tanks at any particular time. Anderson (1990) provides information on tank histories, and historical information on the chemistry of waste disposed to the tanks is provided by Kupfer et al. 1999. Agnew (1997) provides an estimate of current tank waste compositions based on their mixing histories.

Waste was cascaded between tanks at WMA U; however, apparently none was cascaded to cribs or ditches. Four of the tanks in the WMA (U-101, U-104, U-110, and U-112) have been declared leakers (Anderson 1990, DOE 1992, Hanlon 1996). There is considerable uncertainty in reported leak volumes; however, the two most serious leaks involved tanks U-101 and U-104. Tank U-101, declared a leaker in 1959, apparently leaked ~114,000 L (~30,000 gal) of waste. Tank U-104, declared a leaker in 1956, apparently leaked ~208,000 L (55,000 gal) of waste. Tank U-110, declared a leaker in 1975, leaked ~31,000 L (~8,200) of waste. Tank U-112 was declared a leaker in 1969. There is considerable uncertainty concerning the volume leaked from tank U-112, which may have been as high as 32,000 L (8,400 gal). All four leakers have been stabilized and contain little or no pumpable liquid.

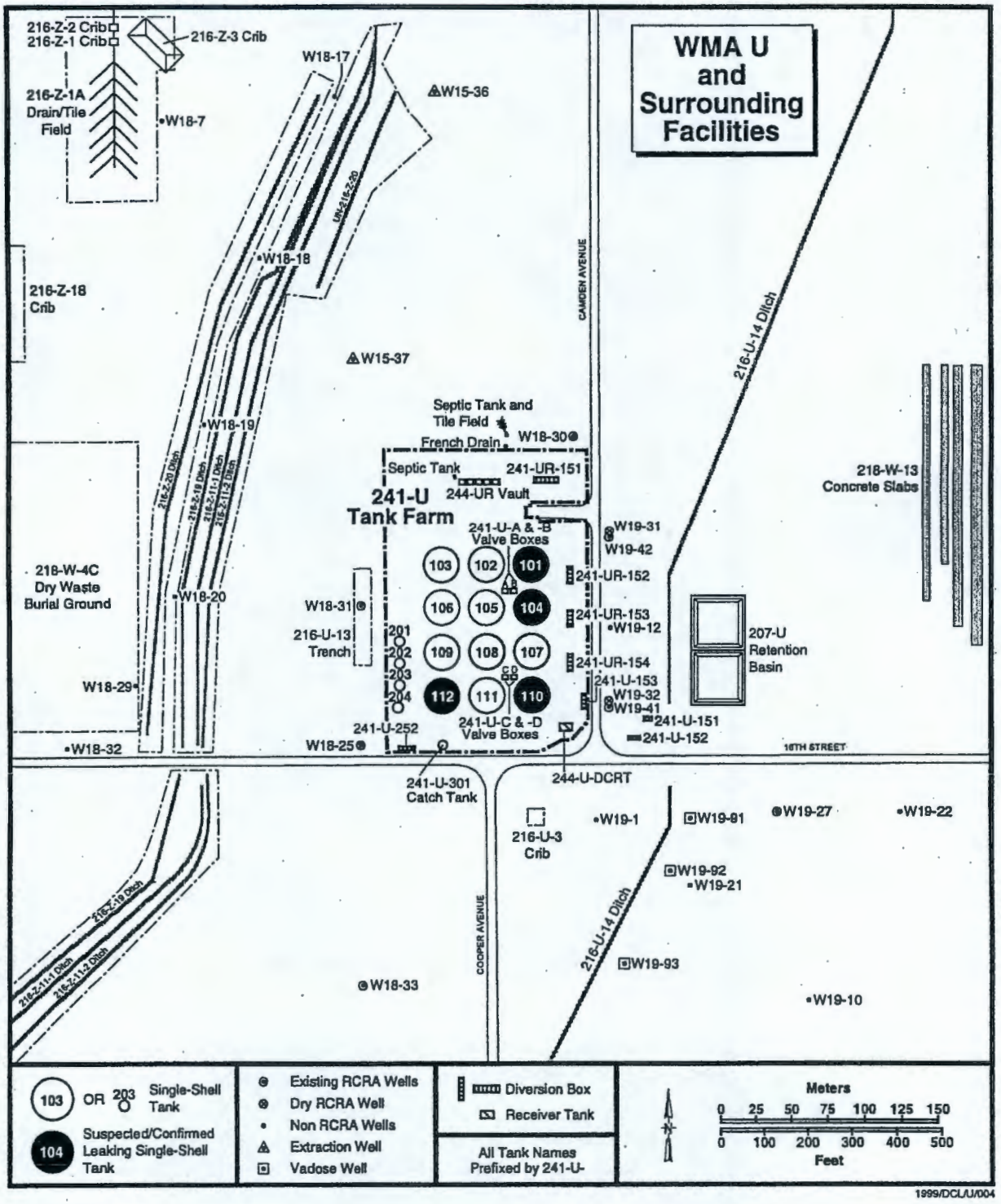

Figure 2.1. Map of Waste Management Area U, Showing Locations of Waste Tanks, Monitoring Wells, and Miscellaneous Structures. RCRA downgradient wells 299-W19-31 and 299-W19-32 are no longer sampleable and are included for historical reasons.

Four unplanned releases have been documented (DOE 1992). The waste volumes associated with these unplanned releases are unknown. The three releases that may have had significant impact were a beta contamination in the vicinity of the 241-U-151 and 241-U-152 diversion boxes east of the WMA (20 mr/h at surface), a "violent chemical reaction" in a vat at the 244-UR vault that spread first-cycle metal waste contamination over an unspecified area, and a ruptured waste line at tank U-103. DOE (1997) reported significant surface contamination within the tank farm and evidence for several unreported releases.

The 216-U-13 trench, located immediately east of the tank farm fence (see Figure 2.1), was a facility for steam cleaning and decontaminating vehicles and never received tank waste. The trench was stabilized by removal of contaminated soil and backfilling with clean fill (DOE 1992).

2.3 Waste Characteristics

The principal waste sent to the U Tank Farm, both from the bismuth phosphate process at B and T Plants and from the REDOX process, consisted of nitric acid waste solution from the plutonium removal process that was subsequently over-neutralized with sodium hydroxide and sodium carbonate. The result was a high-pH sodium nitrate solution and contained other process chemicals, fission products, and residual actinides. Early bismuth phosphate waste contained large quantities of uranium that was subsequently removed by secondary processing at U Plant. Average total concentrations and activities, as well as ratios in the tanks in relation to the drinking water standard or maximum contaminant level for selected components in the waste at WMA U, are presented in Table 2.1. Values used in arriving at these unweighted averages are from Agnew (1997). The values represent bulk tank concentrations and do not distinguish between liquid and solid phases within the tanks.

As shown in Table 2.1, the tank waste is a mixed waste with a wide range of chemical and radiological constituents. In terms of chemical constituents, however, only a few are RCRA regulated and have sufficient concentration and mobility to present a potential for groundwater contamination at this time. Principal among these are nitrate, chromium (hexavalent), and fluoride. Nitrite and ammonium are present in significant quantities; however, they are rarely detected in Hanford Site groundwater and are probably converted to nitrate by bacterial action within the vadose zone.

A number of the tanks also contain significant concentrations of organic chemicals, principally complexants used during plutonium removal. These are not listed hazardous wastes but are mobile and, through elevated total organic carbon (TOC), should aid in identifying contaminants originating from the tanks. There is no evidence for significant quantities of chlorinated hydrocarbons in tank waste at WMA U; thus, total organic halides (TOX) are of little or no use in indicating contamination from tank waste within the WMA.

In addition to the chemical constituents, the tank waste contains a wide variety of radioactive constituents, including cesium-137, strontium-90, cobalt-60, tritium, technetium-99, iodine-129, selenium-79, and neptunium-237, along with several isotopes of uranium and plutonium (see Table 2.1). From the perspective of transport, the most important indicators are tritium, technetium-99, and iodine-129.

Table 2.1. Selected Waste Constituents and Average Compositions in the Tanks for Waste Management Area U (calculated from values for individual tanks in Agnew 1997)

Waste Component	Average Concentration or Activity in the Tanks	Concentration or Activity Divided by DWS or MCL
Sodium	1.5×10^8 µg/L	(a)
Calcium	1.6×10^6 µg/L	(a)
Chromium	2.6×10^6 µg/L	26,000
Nitrate	1.4×10^8 µg/L	3,111
Nitrite	4.46×10^7 µg/L	13,500
Ammonium	6.68×10^5 µg/L	(a)
Sulfate	1.7×10^7 µg/L	34
Chloride	3.0×10^6 µg/L	(a)
Fluoride	6.2×10^5 µg/L	155
Phosphate	1.3×10^7 µg/L	(a)
Carbon-14	2.02×10^7 pCi/L	10,100
Cesium-137	1.59×10^{11} pCi/L	795,000,000
Strontium-90	7.83×10^{10} pCi/L	9,790,000,000
Tritium	1.4×10^8 pCi/L	7,000
Cobalt-60	2.2×10^7 pCi/L	220,000
Technetium-99	1.4×10^8 pCi/L	155,555
Selenium-79	2.01×10^6 pCi/L	(a)
Iodine-129	2.7×10^5 pCi/L	270,000
Uranium-232	4.15×10^5 pCi/L	(a)
Uranium-233	1.59×10^6 pCi/L	(a)
Uranium-234	2.05×10^7 pCi/L	(a)
Uranium-235	9.1×10^5 pCi/L	(a)
Uranium-236	2.02×10^5 pCi/L	(a)
Uranium-238	2.06×10^7 pCi/L	(a)
Uranium	2.52×10^5 µg/L	12,600
Neptunium-237	5.19×10^5 pCi/L	34,600
Plutonium-238	6.71×10^6 pCi/L	44,700
Plutonium-239	3.85×10^8 pCi/L	25,700,000
Plutonium-240	5.52×10^7 pCi/L	3,680,000
Plutonium-241	3.72×10^8 pCi/L	24,800,000
Plutonium-242	1.6×10^3 pCi/L	107
Americium-241	3.4×10^6 pCi/L	227,000
Americium-243	3.92×10^3 pCi/L	261
Curium-242	3.14×10^5 pCi/L	20,900
Curium-243	1.33×10^4 pCi/L	887
Curium-244	1.78×10^5 pCi/L	11,900
(a) No applicable drinking water standard (DWS) or maximum contaminant level (MCL).		

3.0 Hydrogeology

3.1 Stratigraphy

WMA U is underlain by ~150 m (490 ft) of suprabasalt sediments. The major sedimentary units underlying the WMA are the Ringold Formation and the Hanford formation. The Pliocene-Pleistocene unit occurs between the Ringold Formation and the Hanford formation. A generalized stratigraphic column is presented in Figure 3.1.

The Ringold Formation consists of Miocene-Pliocene fluvial and lacustrine clastic sediments deposited by the ancestral Columbia River system. The sediments rest unconformably on the Miocene-age Columbia River Basalt Group. Lindsey (1995), using a depositional environment approach, identified a number of facies within the Ringold Formation. Using facies associations, Lindsey divided the Ringold Formation into three informal members. The Ringold Formation underlying WMA U belongs entirely to the Member of Wooded Island, the lowest member of the formation. Lindsey divided the Member of Wooded Island into five gravel-dominated fluvial depositional units, separated by widespread overbank, paleosol, and lacustrine deposits. The lower mud unit, a thick lacustrine deposit, separates gravel unit A from the overlying deposits.

The Plio-Pleistocene unit, which separates the Ringold Formation from the Hanford formation, was divided into two distinct sequences by Singleton and Lindsey (1994). The upper sequence of thinly laminated silts was identified as lacustrine deposits. Calcium carbonate-rich strata characterize the lower sequence. This lower interval consists of locally derived basaltic detritus, silt-rich eolian deposits, reworked Ringold material, and calcium carbonate-rich paleosols. The calcium carbonate occurs as thin (<2.5-cm [<1-ft]) layers, nodules, and coatings on clasts. Singleton and Lindsay also state that examination of geologic logs, split-tube samples, and cores "suggest that the well-cemented carbonate horizons may be discontinuous and highly fractured." This latter observation is important in assessing the role of the Plio-Pleistocene unit in retarding water flow through the vadose zone in this area.

The Hanford formation is an informal stratigraphic unit made up of uncemented gravel, sand, and silt deposited by the late Pleistocene Missoula glacial floods (Fecht et al. 1987, DOE 1988, Baker et al. 1991). Singleton and Lindsey (1994) described the Hanford formation in terms of three gradational facies: gravel dominated, sand dominated, and silt dominated. At both the 216-U-14 ditch (Singleton and Lindsey 1994) and at WMA U (Horton and Hodges 1999), the upper portion of the Hanford formation is gravel dominated and the lower portion is sand and silt dominated. At WMA U, the upper, gravel-dominated unit is ~16 m (53 ft) thick, and the Hanford formation has a total thickness of ~35 m (115 ft).

The entire suprabasalt sequence is penetrated in well 299-W19-10 (also known as DH-7), located ~275 m (900 ft) southeast of the southeastern corner of WMA U (see Figure 2.1). In this well, the top of basalt occurs at a depth of 170 m (557 ft). Interpretation of core from well 299-W19-10 (Lindsay 1995) indicates that Ringold unit A, below the lower mud unit, is ~23 m (75 ft thick). The lower mud

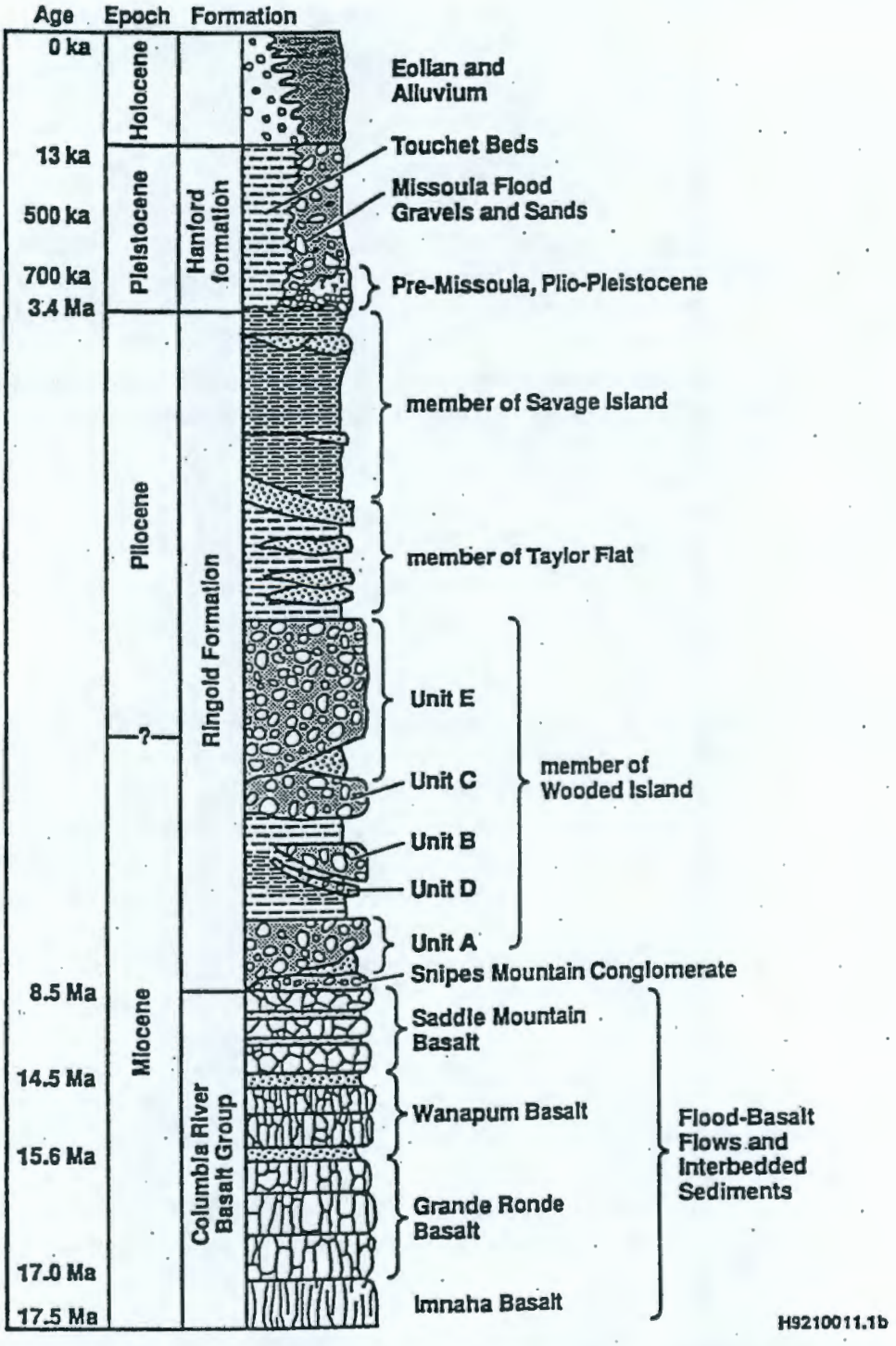

Figure 3.1. Generalized Stratigraphic Column for the Suprabasalt Sediments Beneath the 200 West Area (Lindsey 1995)

unit, a prominent lacustrine deposit near the base of the Ringold Formation is ~10 m (33 ft thick). Ringold unit E, between the lower mud and the Plio-Pleistocene unit, has a thickness of ~90 m (295 ft). The upper ~50 m (164 ft) of core were not recovered in well 299-W19-10; thus, the thickness of the Plio-Pleistocene unit is not available from this well. However, geologic and geophysical logs for the two wells drilled at WMA U in 1998 (Horton and Hodges 1999) indicate a thickness of ~7.3 m (24 ft). The thickness of the Hanford formation beneath the WMA is ~35 m (116 ft).

3.2 Physical Hydrogeology

The water table beneath WMA U occurred at an elevation of ~137 m (450 ft) in December 1998. Thus, the depth to water at that time was 69 m (226 ft), and the thickness of the saturated suprabasalt sediments was ~101 m (331 ft). The lower mud unit is at least partly confining and is generally considered the base of the unconfined aquifer in this area. On this basis, the thickness of the unconfined aquifer is ~68 m (223 ft). Singleton and Lindsey (1994) reported perched water beneath the 216-U-14 ditch as a result of disposal of large quantities of water to that facility; however, no evidence for perched water has been reported during drilling at WMA U.

Slug tests in RCRA monitoring wells have yielded a range of values for hydraulic conductivity from 1.1 to 11.2 m/d (3.5 to 36.6 ft/d). Caggiano (1994) reported hydraulic conductivity values of 1.9 m/d (6.1 ft/d) for upgradient well 299-W18-25 and 11.2 m/d (36.6 ft/d) for downgradient well 299-W19-31. Slug tests carried out in wells drilled in 1998 exhibited a similar range of values. Tests carried out in well 299-W19-41 yielded hydraulic conductivity values between 1.1 and 1.5 m/d (3.5 and 5 ft/d), and tests in well 299-W19-42, adjacent to well 299-W19-31, yielded hydraulic conductivity values between 7.3 and 10.7 m/d (24 and 35 ft/d). The variability between wells indicates differing degrees of cementation, compaction, and/or sorting within the Ringold Formation and indicates the potential for preferred flow zones within the upper portion of the unconfined aquifer. The current data indicate horizontal variability; however, data from other sites in the 200 West Area indicate that vertical variability is also present.

The rate of groundwater flow, v, within the unconfined aquifer beneath WMA U is highly uncertain. The equation

$$v = Ki/n_e$$

where K = hydraulic conductivity
i = hydraulic gradient
n_e = effective porosity

can be used to estimate the so-called "Darcy velocity;" however, this equation requires a value for effective porosity, a largely unknown parameter. Graham et al. (1981) estimated that the effective porosity for the Ringold Formation is somewhere in the range 0.1 to 0.3, which is still the best available estimate. The hydraulic gradient in December 1998 was ~0.002. Using the measured range of hydraulic conductivities, the estimated range of effective porosities, and the December 1998 hydraulic gradient yields estimated

groundwater flow rates ranging from 0.007 to 0.22 m/d (0.02 to 0.74 ft/d). It should be noted, however, that during much of the RCRA monitoring period the hydraulic gradient was less than the current (i.e., December 1998) value.

Historically, water levels and flow directions at WMA U have been dominated by discharges to the 216-U-10 pond, located ~450 m (1475 ft) southeast of WMA U. Effluent discharge to U Pond resulted in a 26-m (85-ft) mound on the water table (Graham et al. 1981) and a northeasterly flow direction at WMA U. U Pond was decommissioned in 1984 and, as a result, water levels dropped rapidly across a significant portion of the 200 West Area. Figure 3.2, a hydrograph for well 299-W19-1 (see Figure 2.1 for location), illustrates the effect of U Pond on water-table elevations in the vicinity of WMA U. Between June 1984 and July 1995, the water-table elevation in well 299-W19-1 dropped 7.5 m (24.6 ft). Figure 3.3, hydrographs for the RCRA monitoring wells at WMA U, shows the further decline of the water table.

A water-table map for the vicinity of WMA U is presented in Figure 3.4. This water-table map, based on March 1999 data, indicates an east or northeast groundwater flow direction. The flow directions indicated in Figure 3.4 represent the latest in a series of groundwater flow directions at the WMA that resulted from changing effluent discharge patterns in the 200 West Area through the 1980s and 1990s. These changes and their causes are discussed below.

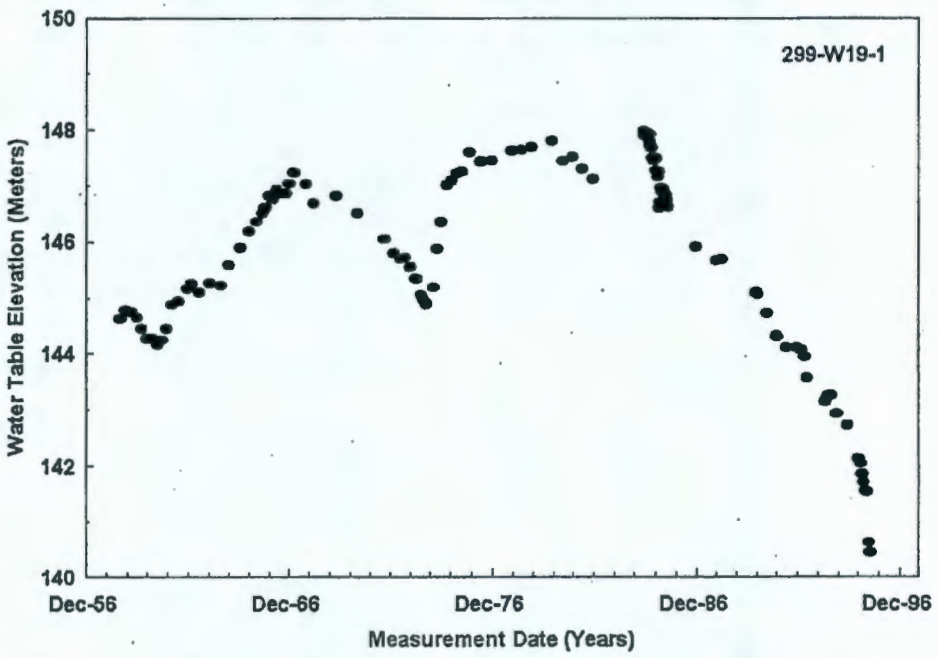

Figure 3.2. Hydrograph for Well 299-W19-1 (elevations in meters above mean sea level)

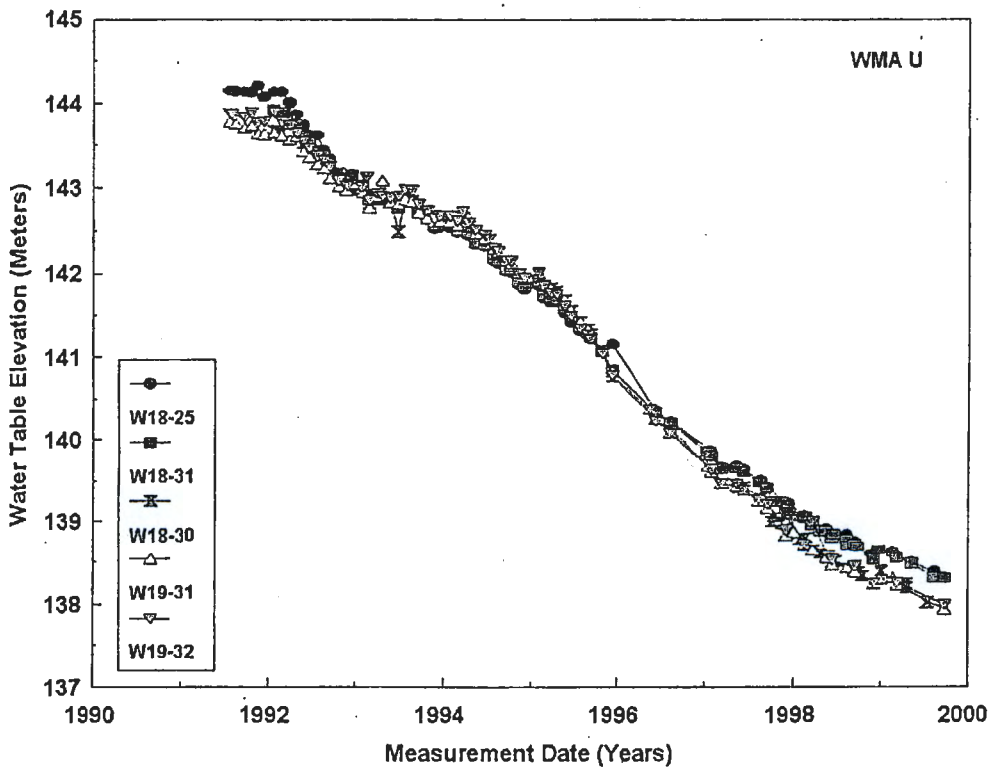

Figure 3.3. Hydrographs for RCRA Monitoring Wells at Waste Management Area U (elevations in meters above mean sea level)

After cessation of discharge to U Pond in 1984, discharge continued at the Plutonium Finishing Plant. Because of this discharge, the U Pond mound declined more slowly in the vicinity of the Plutonium Finishing Plant, resulting in a northward migration of the high point of the mound as the mound decreased. This northward migration of the high point of the groundwater mound resulted in a shift in groundwater flow direction, first to the east and then to the southeast.

In the 1991-1993 time period, two major effluent discharges to the 216-U-14 ditch, southeast of WMA U, resulted in a temporary reversal of flow directions at the WMA. This reversal is apparent in the hydrographs in Figure 3.3, with upgradient wells 299-W18-25 and 299-W18-31 becoming downgradient wells in early 1993 and then resuming their upgradient identities in 1996 as groundwater flow swung back around toward the east.

The discharges to the 216-U-14 ditch described by Singleton and Lindsey (1994) peaked in 1991 and 1993, producing at least a 15-m (50-ft) increase in the perched water table beneath the ditch. The 1991 discharge was the larger of the two, and the effects on the water table are apparent in the earliest monitoring data for the WMA. However, given the uncertainty in paths to groundwater and in travel times through the vadose zone, it is not possible to separate the effects of the two events.

Phase 3 of the 200-ZP-1 Operable Unit pump-and-treat operation started in August 1997 (DOE 1998). This pump-and-treat operation, designed to stabilize the carbon tetrachloride plume that results from

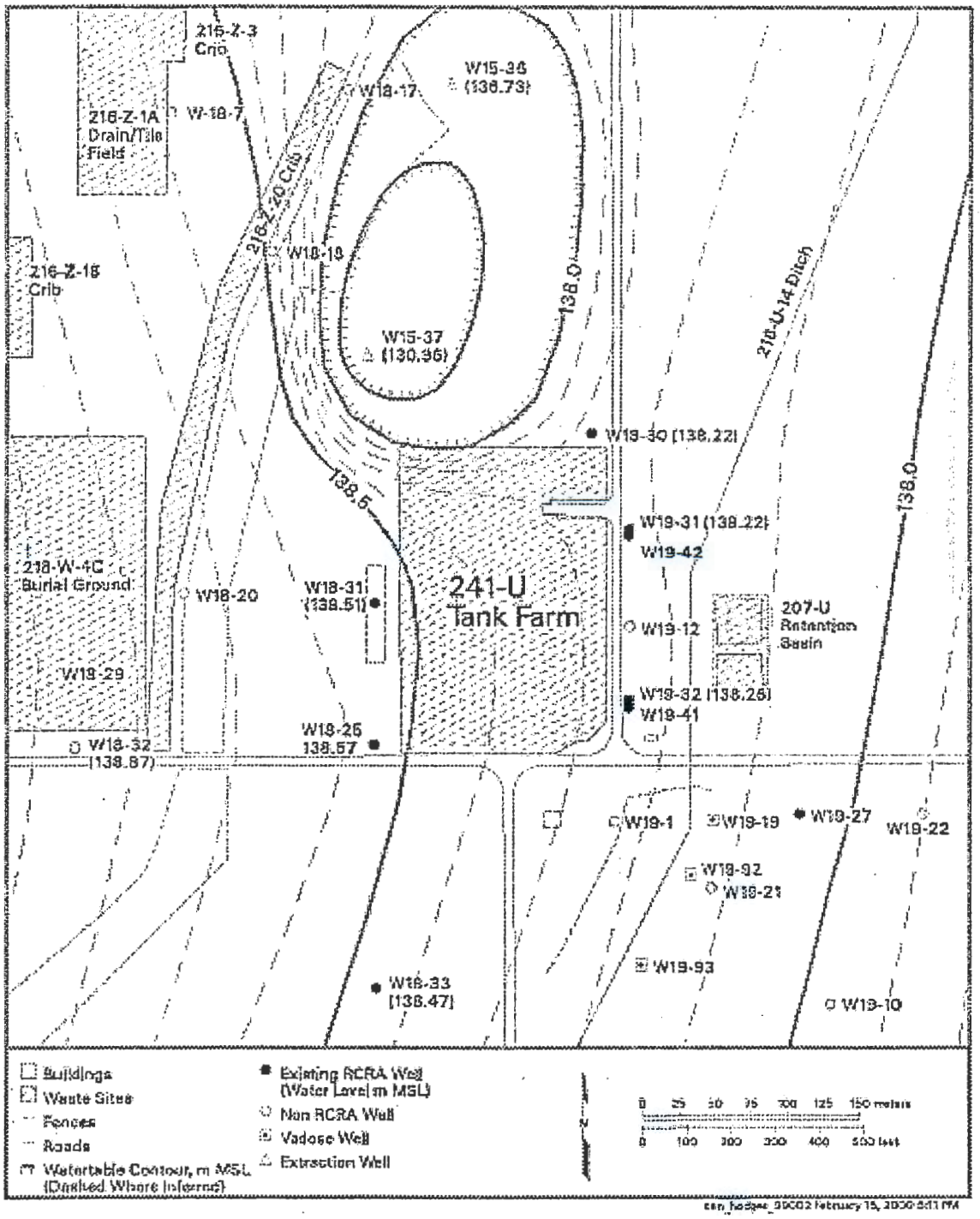

Figure 3.4. Water-Table Map (March 1999 data) for Vicinity of Waste Management Area U (elevations in meters above mean sea level)

disposal to cribs near the Plutonium Finishing Plant, extracts contaminated groundwater from a series of wells east of the Plutonium Finishing Plant, between WMAs U and TX-TY to the north. The nearest of the extraction wells for the pump-and-treat operation is 299-W15-37, located ~100 m (330 ft) northwest of the WMA (see Figure 3.4). After removal of carbon tetrachloride, the water is reinjected into the aquifer in several wells immediately west of the 200 West Area boundary. As a result of the pump-and-treat activities, groundwater at the WMA may flow more toward the northeast direction some time in the future. This condition may represent relative stability, as there are no plans to halt the pump-and-treat operations in the foreseeable future. However, there is also a chance that changing flow directions, and potential injection of contaminants upgradient to the WMA, may result in changes in upgradient contaminant chemistry.

4.0 Evaluation of Specific Conductance Data

The general contamination indicator data were statistically evaluated by comparing concentrations obtained from downgradient wells with those obtained from upgradient wells. One of the indicator parameters, specific conductance, exceeded its background values in one downgradient well, 299-W19-41, during the fourth quarter of fiscal year 1999 sampling. The elevation of specific conductance triggers a shift from detection monitoring to a groundwater assessment program. A general description of the statistical method is presented first. Evaluation of the specific conductance data is presented next.

4.1 Statistical Evaluation Method

The goal of RCRA detection monitoring is to determine if WMA U has affected groundwater quality. This is determined based on the results of a statistical test. According to 40 CFR 265.92 (and by reference in WAC 173-303-400[3]), the owner/operator of an interim-status hazardous waste facility must establish initial background concentrations for the contamination indicator parameters: specific conductance, pH, TOC, and TOX. This has been done for WMA U by obtaining at least four replicate measurements for each parameter from each well quarterly for 1 year. Data from the upgradient well(s) were used to determine the initial background arithmetic mean and variance.

Monitoring data collected after the first year are compared with the initial background data to determine if there is an indication that contamination may have occurred. A t-test is required to make this determination (40 CFR 265.93[b]). A recommended method is the averaged replicate t-test method described in Appendix B of the *RCRA Groundwater Monitoring Technical Enforcement Guidance Document* (EPA 1986ba). The averaged replicate t-test method for each contamination indicator parameter is calculated as follows:

$$t = \left(\bar{x}_i - \bar{x}_b\right) / S_b * \sqrt{1 + 1/n_b}$$

where t = test statistic

$\bar{x}_i$ = average of replicates from the ith monitoring well
$\bar{x}_b$ = background average
S_b = background standard deviation
n_b = number of background replicate averages.

A test statistic larger than the Bonferroni critical value, t_c (i.e., $t > t_c$), indicates a statistically significant probability of contamination. These Bonferroni critical values depend on the overall false-positive rate required for each sampling period (i.e., 1% for interim status), the total number of wells in the monitoring network, and the number of degrees of freedom (n_b - 1) associated with the background standard deviation. Because of the nature of the test statistic in the above equation, results to be compared to background do not contribute to the estimate of the variance. The test can be reformulated, without prior knowledge of the results of the sample to be compared to background (i.e., $\bar{x}_i$), in such a way that a critical mean, CM, can be obtained:

$$CM = \bar{x}_b + t_c * S_b * \sqrt{(1+1/n_b)} \quad \text{(one tailed)}$$

$$CM = \bar{x}_b \pm t_c * S_b * \sqrt{(1+1/n_b)} \quad \text{(two tailed)}$$

If downgradient data exceed the critical means, they are determined to be statistically different from background. For pH, a two-tailed critical mean (or critical range) is calculated, and downgradient data beyond the range are considered to be statistically different from background. If a statistical exceedance is detected, the well will be resampled to determine if the originally detected increase (or pH decrease) was a result of laboratory or measurement error (verification sampling). If verification sampling confirms the exceedance, the owner/operator must notify Ecology within 7 days and submit a groundwater quality assessment plan within 15 days following the notification (40 CFR 265.93[d]). The goal of the assessment monitoring program is to determine if dangerous waste or dangerous waste constituents from the facility have entered the groundwater and, if so, to determine their concentration and the rate and extent of migration in groundwater (40 CFR 265.93[d]).

4.2 Evaluation of Specific Conductance Data

Groundwater flow directions at WMA U have been in constant flux since the initiation of RCRA groundwater monitoring as a result of changing effluent discharge patterns within the 200 West Area (see Section 3.2). Changes in site conditions (e.g., reversal of flow direction, discharge practice) have necessitated the revision of background values (critical means) to be used in the statistical evaluation. Specific conductance data from the WMA U monitoring wells is presented in Figure 4.1. Wells 299-W18-25 and 299-W18-31 were the upgradient wells when groundwater monitoring was first initiated at WMA U (October 1991). Original background values were established using quarterly monitoring data collected from April 1992 to March 1993 (Table 4.1). The critical mean for specific conductance was 407 µS/cm.

In the 1991-1993 time period, two major effluent discharges to the 216-U-14 ditch, southeast of WMA U, resulted in a temporary reversal of flow directions at WMA U. From early 1993 until 1995, upgradient wells 299-W18-25 and 299-W18-31 became downgradient wells, resuming their upgradient identities in 1996 as groundwater flow swung back around toward the east (see Section 3.2). Because of the changes in groundwater flow direction, background values were recalculated in 1996. The results are presented in Table 4.2. The average specific conductance concentration was increased from ~240 ± 29 µS/cm (see Table 4.1) to ~309 ± 39 µS/cm (see Table 4.2). As a result, the critical mean was increased from ~407 to ~533 µS/cm.

Since the 1996 revision, specific conductance from upgradient wells 299-W18-25 and 299-W18-31 showed lower but steady concentrations (see Figure 4.1). Background concentrations were recalculated in fiscal year 1999 and are presented in Table 4.3. The combination of lower average specific conductance values, together with a much smaller variation in the upgradient wells, resulted in a near 50% reduction in the critical mean value (from ~533 to ~273 µS/cm; see Figure 4.1).

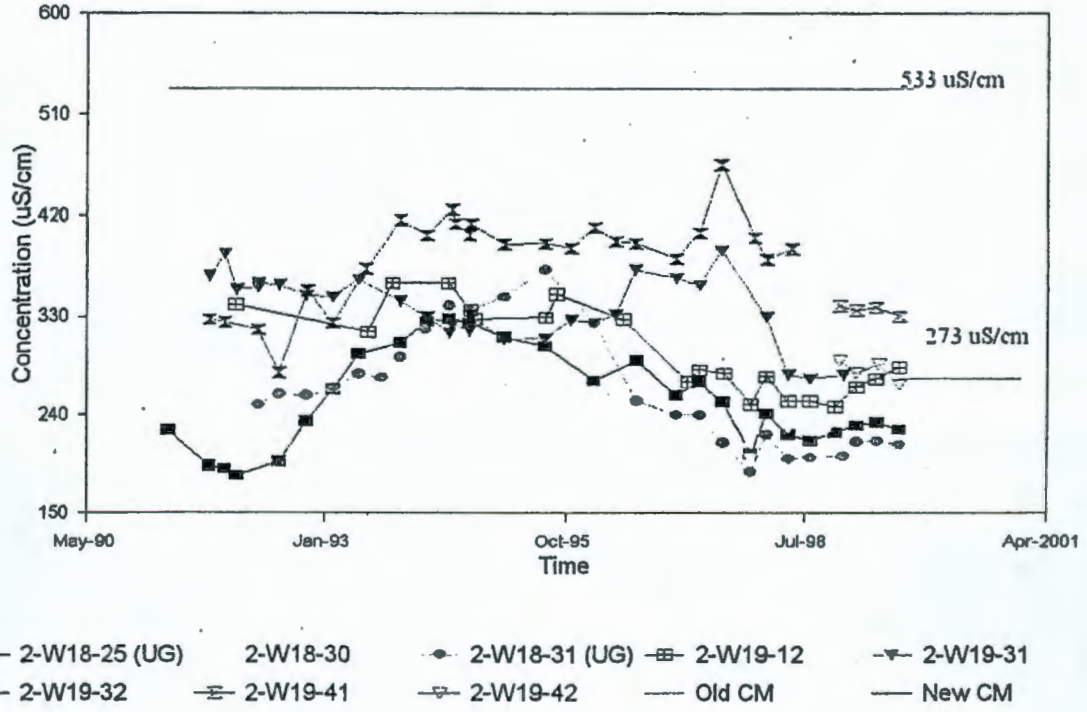

Figure 4.1. Specific Conductance Concentration Versus Time at Monitoring Wells for Waste Management Area U

Table 4.1.[a] Critical Means for 20 Comparisons–Background Contamination Indicator Parameter Data for Waste Management Area U[b]

Constituent, unit	n	df	t_c	Average Background	Standard Deviation	Critical Mean	Upgradient/ Downgradient Comparison Value
Specific conductance, µS/cm	8	7	5.4079	239.562	29.216	407.1	407.1
Field pH	7[c]	6	6.7883	7.909	0.328	[5.53, 10.29]	[5.53, 10.29]
Total organic carbon,[d] µg/L	7[c]	6	5.9588	500	NC	NC	800
Total organic halides,[e] µg/L	NC	NC	NC	NC	NC	NC	NC

(a) Source: Caggiano (1994) Table 4.13-8.
(b) Data collected from April 1992 to March 1993 for upgradient wells 299-W18-25 and 299-W18-31.
(c) Excluding outliers.
(d) Upgradient/downgradient comparison value is the limit of quantitation based on 1993 field blanks data.
(e) Critical mean cannot be calculated because of problems associated with data quality.
df = Degrees of freedom (n-1).
n = Number of background replicate averages.
t_c = Bonferroni critical t-value for appropriate df and 20 comparisons.
NC = Not calculated.

Table 4.2.[a] Critical Means for 20 Comparisons--Background Contamination Indicator Parameter Data for Waste Management Area U[b]

Constituent, unit	n	df	t_c	Average Background	Standard Deviation	Critical Mean	Upgradient/ Downgradient Comparison Value
Specific conductance, µS/cm	8	7	5.4079	308.875	39.032	532.8	532.8
Field pH	8	7	6.0818	8.008	0.091	[7.42, 8.59]	[7.42, 8.59]
Total organic carbon,[c] µg/L	8	7	5.4079	275.031	82.580	748.7	1,140
Total organic halides, µg/L	8	7	5.4079	102.994	24.120	241.3	241.3

a) Source: Hartman (1999), Table B.20.
(b) Data collected based on semiannual sampling events from February 1995 to August 1996 for upgradient wells 299-W18-25 and 299-W18-31.
(c) Upgradient/downgradient comparison value is the limit of quantitation.
df = Degrees of freedom (n-1).
n = Number of background replicate averages.
t_c = Bonferroni critical t-value for appropriate df and 20 comparisons.

Table 4.3. Critical Means for 20 Comparisons--Background Contamination Indicator Parameter Data for Waste Management Area U[a]

Constituent, unit	n	df	t_c	Average Background	Standard Deviation	Critical Mean	Upgradient/ Downgradient Comparison Value
Specific conductance, µS/cm	10	9	4.7815	218.175	10.870	272.7	272.7
Field pH	10	9	5.2912	8.088	0.112	[7.46, 8.71]	[7.46, 8.71]
Total organic carbon,[b] µg/L	10	9	4.7815	465.250	125.069	1,092.5	1,153.7
Total organic halides, µg/L	10	9	4.7815	32.938	25.438	160.5	160.5

(a) Data collected from August 1998 to August 1999 for upgradient wells 299-W18-25 and 299-W18-31.
(b) Upgradient/downgradient comparison value is the limit of quantitation.
df = Degrees of freedom (n-1).
n = Number of background replicate averages.
t_c = Bonferroni critical t-value for appropriate df and 20 comparisons.

The clearest link between specific conductance and groundwater chemistry is through the equivalents of dissolved ionic solids present in the groundwater. The major element chemistries of recent groundwater samples from WMA U, in terms of milliequivalents, are presented in Table 4.4. All major components, with the exception of potassium, are higher in well 299-W19-41 than in the downgradient wells; however, the major contributors to the higher specific conductance are naturally occurring constituents: chloride, sulfate, calcium, and magnesium. Nitrate, chromium, and technetium-99 are increasing in well 299-W19-41; however, they are well below their respective drinking water standards. If nitrate were completely removed, groundwater in this well would still exceed the critical mean for specific conductance.

Table 4.4. Milliequivalents in Recent Waste Management Area U Groundwater Samples

Well	299-W19-41	299-W19-41	299-W19-32	299-W19-42	299-W18-30	299-W18-25	299-W18-31
Date	8/17/99	1/26/00	5/28/98[a]	8/17/99	10/7/99	8/18/99	8/17/99
Cations (meq)							
Sodium	0.88 (24.9%)[b]	0.83 (24.5%)	0.91 (22.8%)	0.81 (27.5%)	0.80 (30.1%)	0.66 (27.0%)	0.60 (26.1%)
Potassium	0.12 (3.3%)	0.10 (2.9%)	0.13 (3.3%)	0.08 (2.7%)	0.10 (3.8%)	0.07 (2.9%)	0.11 (4.8%)
Calcium	1.64 (46.5%)	1.59 (47.1%)	2.00 (50.0%)	1.33 (45.1%)	1.16 (62.4%)	1.09 (44.7%)	1.03 (44.8%)
Magnesium	0.89 (25.2%)	0.86 (25.5%)	0.96 (24.0%)	0.73 (24.7%)	0.60 (25.4%)	0.62 (25.4%)	0.56 (24.3%)
Sum	3.53	3.37	4.00	2.95	2.66	2.44	2.30
Anions (meq)							
Chloride	0.40 (12.3%)	0.45 (12.3%)	0.83 (22.0%)	0.20 (7.5%)	0.17 (6.3%)	0.16 (6.6%)	0.11 (5.0%)
Sulfate	0.59 (18.1%)	0.71 (19.5%)	0.71 (18.8%)	0.44 (16.4%)	0.43 (15.8%)	0.40 (16.5%)	0.33 (15.1%)
Alkalinity	2.04 (62.6%)	2.18 (60.0%)	2.20 (58.4%)	1.80 (67.2%)	1.92 (70.6%)	1.76 (78.7%)	1.70 (77.6%)
Nitrate	0.23 (7.0%)	0.30 (8.2%)	0.03 (0.8%)	0.24 (9.0%)	0.20 (7.4%)	0.10 (4.1%)	0.05 (2.3%)
Sum	3.26	3.63	3.77	2.68	2.72	2.42	2.19
Specific Conductance	331 µS/cm	355 µS/cm[c] 343 µS/cm[d]	390 µS/cm	270 µS/cm	269 µS/cm	227 µS/cm	214 µS/cm

(a) Last available sample from well.
(b) Percentage of total cations or anions.
(c) Field measurement.
(d) Laboratory measurement.

5.0 Groundwater Quality Assessment Program

The monitoring program was set up to meet the requirements of RCRA regulations (40 CFR 265, Subpart F). The overriding objective of the RCRA regulations is the protection of human health and the environment. The protection of human health and the environment under RCRA is accomplished through monitoring for releases of hazardous chemicals to the environment, in this case groundwater, and carrying out the appropriate assessment and possible corrective actions if a release of contaminants has been determined to exist.

5.1 Summary of Approach

As discussed in Section 4.2, the average result of quadruplicate samples from downgradient well 299-W19-41 exceeded the recalculated critical mean for specific conductance. There has been a significant decrease (~50%) in the critical mean for WMA U as a result of lower average background concentrations and a lower degree of variability in recent samplings. The higher specific conductance observed in well 299-W19-41 is a result of nonhazardous constituents (sodium, calcium, magnesium, chloride, sulfate, and bicarbonate). However, nitrate, chromium, and technetium-99 are increasing in well 299-W19-41. Therefore, the objective of the first phase of the assessment program is to determine, as allowed under 40 CFR 265.93(d)(5), whether the increasing concentrations of nitrate and chromium are originating from the WMA or an upgradient source. The approach includes the following steps:

- review waste site information for potential contaminant sources
- evaluate existing and future water-level data from WMA U monitoring wells and other wells in the 200 West Area to assess the groundwater flow directions
- evaluate chemistry data from WMA U monitoring wells
- develop a conceptual model of hypothetical sources, constituents of interest, driving forces, and pathway to groundwater
- evaluate monitoring network to identify data gaps.

Based on the results of the first determination, if WMA U is not the source of groundwater contamination, then the site will revert to detection monitoring. If WMA U is the source, then a second part of the groundwater quality assessment plan will be prepared to define the rate and extent of migration of contaminants in the groundwater and their concentrations, as required under 40 CFR 265.93(d)(4).

5.2 Special Conditions at WMA U

Groundwater flow directions at WMA U have been in constant flux since the initiation of RCRA groundwater monitoring as a result of changing effluent discharge patterns within the 200 West Area (see Section 3.2). More recently, the 200-ZP-1 Operable Unit pump-and-treat operations have influenced groundwater flow directions at the WMA. Prior to the reversal in groundwater flow direction, resulting from discharge to the 216-U-14 ditch, groundwater flow was toward the southeast. As the effects of the discharge waned, groundwater flow began to swing around to a west-to-east orientation; however, groundwater at the WMA may flow more toward the northeast direction sometime in the future. The southernmost well of the pump-and-treat extraction network (299-W15-37) is located ~150 m (490 ft) northwest of the WMA. WMA U is apparently just outside of the capture zone of well 299-W15-37; however, it is near enough to impose a northerly component on groundwater flow direction at the WMA, particularly in the northern part (see Figure 3.4). The adequacy of the monitoring network will be reevaluated.

5.3 Sampling and Analysis Program

5.3.1 Monitoring Well Network

The current groundwater monitoring network at WMA U consists of five RCRA-compliant wells and one pre-RCRA well used for information only (Table 5.1). Two of the wells (299-W18-25 and 299-W18-31) are upgradient wells. Three RCRA-compliant wells (299-W18-30, 299-W19-41, and 299-W19-42) as well as pre-RCRA well 299-W19-12 are downgradient. The construction drawings or as-built diagrams for wells listed in Table 5.1 are presented in the Appendix.

Three of the original RCRA wells were constructed prior to Ecology approval of the 10.7-m (35-ft) screened intervals and were completed with 4.6-m (15-ft) screened intervals. The last two of the original five RCRA wells, drilled in 1991, were completed with 10.7-m (35-ft) screened intervals. Subsequently, two of the original RCRA wells (299-W19-31 and 299-W19-32) cannot be sampled because of the decline in the water table. Also, upgradient well 299-W18-25 is expected to go dry in early 2000.

Two replacement wells were drilled in 1998. Well 299-W19-42 was drilled as a replacement for downgradient well 299-W19-31 and well 299-W19-41 was drilled as a replacement for downgradient well 299-W19-32. Both wells 299-W19-41 and 299-W19-42 were completed with 10.7-m (35-ft) screened intervals to extend the operational lives of the wells. Upgradient well 299-W18-25 will probably become unsampleable in early calendar year 2000; however, upgradient well 299-W18-31 should be able to be sampled until at least 2004. There are no immediate plans to replace well 299-W18-25.

Table 5.1. Wells in Monitoring Network

Well	Depth to Bottom of Borehole (m)	Depth to Water (m)	Screen Length (m)	Construction Casing/Screen	Monitoring Interval
299-W18-25[90]	65.7	65.7	4.6	SS/SS[(a)]	Top of unconfined
299-W18-30[91]	71.8	68.2	10.7	SS/SS	Top of unconfined
299-W18-31[91]	69.4	65.2	10.7	SS/SS	Top of unconfined
299-W19-12[83(b)]	76.2	68.2	12.2	CS[(c)]/SS(?)	Top of unconfined
299-W19-31[90(d)]	68.7	68.6	4.6	SS/SS	Dry
299-W19-32[91(d)]	68.0	68.8	4.6	SS/SS	Dry
299-W19-41[98]	80.6	68.5	10.7	SS/SS	Top of unconfined
299-W19-42[98]	80.8	68.3	10.7	SS/SS	Top of unconfined

Note: Superscript following well number denotes year of installation.
(a) Stainless steel.
(b) Pre-RCRA.
(c) Carbon steel.
(d) Unsampleable.

Pre-RCRA well 299-W19-12 is sampled to fill a gap in the downgradient network and to provide continuity with pre-RCRA monitoring. Because of uncertainties about the construction, well 299-W19-12 is currently used for indication only, and indicator parameters for this well were not included in statistical analysis for WMA U.

5.3.2 Constituent List and Sampling Frequency

The groundwater at WMA U will continue to be sampled on a quarterly schedule for the key tank waste constituents and/or indicators. The more frequent sampling is required under a groundwater quality assessment program. The sampling constituent list is presented in Table 5.2. The constituent list and/or sample frequency shown in Table 5.2 may be revised as more information becomes available.

TOX has been dropped from the list of RCRA indicator parameters measured at WMA U. Although tank waste at WMA U contains organic constituents, most of these are complexants used during processing, and chlorinated hydrocarbons are insignificant. In addition, encroachment of the Plutonium Finishing Plant carbon tetrachloride plume has resulted in a number of TOX exceedances that were unrelated to WMA U. Carbon tetrachloride will be monitored on an annual basis to allow an evaluation of this important groundwater contaminant in the vicinity of the WMA.

Table 5.2. Constituent List

Contamination Indicator Parameters		
Specific conductance	Total organic carbon	pH
Groundwater Quality Parameters		
Chloride	Manganese	Sodium
Iron	Phenols[a]	Sulfate
Site-Specific Constituents		
Chromium	Gross alpha	Technetium-99
Nitrate	Gross beta	Tritium
Cobalt-60	Iodine-129	
Other Constituents		
Carbon Tetrachloride[b]		

(a) Not analyzed.
(b) Annually.

The groundwater quality parameters, with the exception of phenols, will be analyzed on a quarterly basis. Phenols, which are not constituents of tank waste, will be not be analyzed.

Chromium, nitrate, technetium-99, cobalt-60 (from gamma scan), iodine-129, and tritium will be analyzed quarterly because they are significant mobile constituents of tank waste. Technetium-99, cobalt-60, iodine-129, and tritium (non-RCRA co-contaminants) will be used as tracers. Gross alpha and gross beta will be analyzed quarterly as screening tools for other potential radionuclide contamination. If reported gross alpha exceeds the expected alpha activity as a result of the presence of uranium, transuranics analyses will be requested. Likewise, if the reported gross beta exceeds the expected gross beta level based on the technetium-99 present, more specific isotopic analyses will be requested (e.g., strontium-90).

5.3.3 Determination of Groundwater Flow Directions

Water levels will be measured in monitoring wells at the time of sampling and additional wells in the 200 West Area may be measured independently to provide a firmer basis for determination of groundwater flow directions. Water-table elevations will be used to determine groundwater flow directions at the site. Results of these determinations will be discussed in the annual Hanford Site Groundwater Monitoring Report and in the groundwater quality assessment report.

5.3.4 Sampling and Analysis Protocol

Monitoring for WMA U is part of the Hanford Groundwater Monitoring Project. Procedures for groundwater sampling, documentation, sample preservation, shipment, and chain-of-custody

requirements are described in Pacific Northwest National Laboratory or subcontractor manuals (e.g., currently Waste Management Federal Services, Inc., Northwest Operations' procedures manual ES-SSPM-001) and in the quality assurance plan (PNNL 1998). Samples generally are collected after three casing volumes of water have been purged from the well or after field parameters (pH, temperature, and specific conductance) have stabilized, and turbidity is 25 NTU or less. For routine groundwater samples, preservatives are added to the collection bottles before their use in the field. Samples to be analyzed for metals are usually filtered in the field so that results represent dissolved metals.

Procedures for field measurements are specified in the subcontractor's or manufacturer's manuals. Analytical methods are specified in contracts with laboratories, and most are standard methods from *Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods* (EPA 1986b). Alternative procedures meet the guidelines of SW-846, Chapter 10 (EPA 1986b). Analytical methods are described in Gillespie (1999).

5.3.5 Data Evaluation

The primary mobile constituents associated with a tank or related source should co-vary in groundwater at a specific well or wells if a WMA source is responsible for the observed change in groundwater quality by comparing the concentrations in relation to background concentrations. Accordingly, the quarterly results for technetium-99, chromate, and nitrate for the upgradient well and downgradient wells monitoring the U Tank Farm will be plotted to identify any abrupt changes or trends. Interpretive techniques include hydrographs, water-table maps, trend plots, plume maps, and contaminant ratios (Section 6.2).

5.3.6 Quality Assurance and Quality Control

The Hanford Groundwater Monitoring Project's quality assurance/quality control program is designed to assess and enhance the reliability and validity of groundwater data. The primary quantitative measures or parameters used to assess data quality are accuracy, precision, completeness, and method detection limit. Qualitative measures include representativeness and comparability. Goals for data representativeness for groundwater monitoring projects are addressed qualitatively by the specification of well locations, well construction, sampling intervals, and sampling and analysis techniques in the groundwater monitoring plan for each RCRA facility. Comparability is the confidence with which one data set can be compared to another. The quality control parameters are evaluated through laboratory checks (e.g., matrix spikes, laboratory blanks), replicate sampling and analysis, analysis of blind standards and blanks, and interlaboratory comparisons. Acceptance criteria have been established for each of these parameters (PNNL 1998), based on guidance from the U.S. Environmental Protection Agency (OSWER-9950.1, EPA 1986a). When a parameter is outside the criteria, corrective actions are taken to prevent a future occurrence and affected data are flagged in the database.

5.3.7 Schedule of Implementation

Monitoring wells in the existing network will be sampled quarterly (February, May, August, and November) for the constituents specified in Table 5.1, with the exception of carbon tetrachloride that will

be sampled semiannually for tracking the movement of the plume originated from the Plutonium Finishing Plant. Specific isotopic analyses will be requested if reported elevated gross alpha or gross beta values exceed the expected activity as a result of the presence of uranium or technetium-99, respectively. Results of the sampling and analysis for WMA U will be submitted to the U.S. Department of Energy and Ecology in the form of quarterly status reports (April, July, October, January) and groundwater annual reports (March). Results of the first determination will be due to the U.S. Department of Energy on September 30, 2000 and to Ecology shortly thereafter.

6.0 Data Management, Evaluation, and Reporting

This chapter describes how groundwater data are stored, retrieved, evaluated, and interpreted. Reporting requirements are also described.

6.1 Data Management

The contract laboratories report analytical results electronically. The results are loaded into the Hanford Environmental Information System (HEIS) database. Field-measured parameters are entered manually or through electronic transfer. Data from HEIS may be downloaded to smaller databases, such as the Geosciences Data Analysis Toolkit (GeoDAT) for data validation, reduction, and trend analysis. Paper data reports and field records are considered to be the record copies and are stored at Pacific Northwest National Laboratory.

The data undergo a validation/verification process according to a documented procedure, as indicated in the project quality assurance plan. Quality control data are evaluated against the criteria listed in the project quality assurance plan, and data flags are assigned when appropriate. In addition, data are screened by scientists familiar with the hydrogeology of the unit, compared to historical trends or spatial patterns, and flagged if they are not representative. Other checks on data may include comparison of general parameters to their specific counterparts (e.g., conductivity to ions; gross alpha to uranium), calculation of charge balances, and comparison of calculated versus measured conductance. If necessary, the laboratory may be asked to check calculations or reanalyze the sample, or the well may be resampled.

6.2 Interpretation

After data are validated and verified, the acceptable data are used to interpret groundwater conditions at the site. Interpretive techniques include the following:

- **Hydrographs**: graph water levels versus time to determine decreases, increases, seasonal, or man-made fluctuations in groundwater levels.

- **Water-table maps**: use water-table elevations from multiple wells to construct contour maps to estimate flow directions. Groundwater flow is assumed to be perpendicular to lines of equal potential.

- **Trend plots**: graph concentrations of chemical or radiological constituents versus time to determine increases, decreases, and fluctuations. May be used in tandem with hydrographs and/or water-table maps to determine if concentrations relate to changes in water level or in groundwater flow directions.

- **Plume maps**: map distributions of chemical or radiological constituents in the aquifer to determine extent of contamination. Changes in plume distribution over time aid in determining movement of plumes and direction of flow.

- **Contaminant ratios**: sometimes used to distinguish between different sources of contamination.

6.3 Reporting

Chemistry and water-level data are reviewed at least quarterly and are available in HEIS. Interpretive reports are issued annually in March (e.g., Hartman 1999). Reporting requirements are listed in Table 6.1.

Table 6.1. Reports Required for Compliance with 40 CFR 265, Subpart F, for Groundwater Monitoring

Submittal	Submittal Period	Reporting Vehicle (applicable date)	Regulatory Requirement
First year of sampling: concentrations of interim primary drinking water constituents, identifying those that exceed limits	Quarterly	Complete[a] (4/92 – 3/93)	40 CFR 265.94(a)(2)(i)
Concentration and statistical analyses of groundwater contamination indicator parameters, noting significant differences in upgradient wells	Annually, by March 1 of following year	Annual Hanford Groundwater Monitoring Report (e.g., Hartman 1999)	40 CFR 265.94(a)(2)(ii)
Results of groundwater surface elevation evaluation and description of response if appropriate	Annually, by March 1 of following year	Annual Hanford Groundwater Monitoring Report	40 CFR 265.94(a)(2)(iii)
Notification of statistical exceedance[b]	Within 7 days of verification	Letter to Ecology (2/14/2000)	40 CFR 265.93(c)
Assessment plan[b]	Within 15 days of notification	PNNL document (2/28/2000)	40 CFR 265.93(d)
First determinations under assessment program[b]	As soon as technically feasible; annually thereafter	PNNL document (9/30/2000)	40 CFR 265.93(d)(5) and 265.94(b)

(a) Requirement was fulfilled during first year of sampling via published reports. Quarterly submittal of data continues via HEIS.
(b) Required if exceedance occurs and is verified.

7.0 References

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Appendix

Well Construction and Completion Summaries

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: 200E Raw Water
Driller's Name: Multiple drillers
Drilling Company: Kaiser Engineers
Date Started: 08Nov90

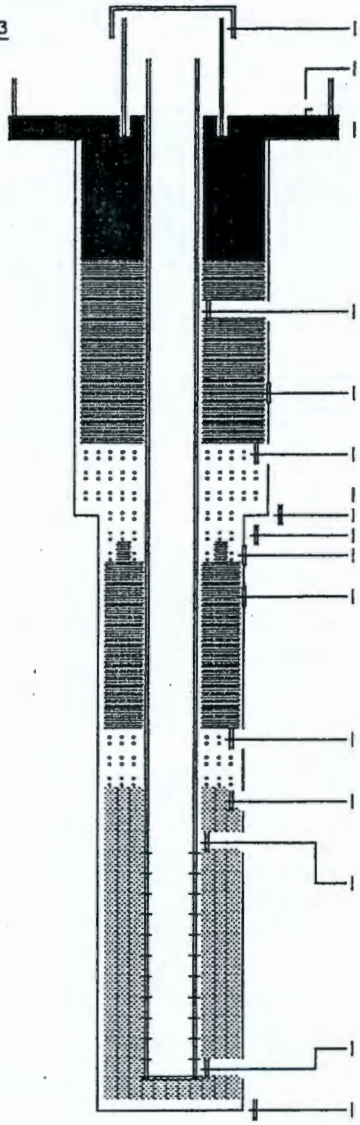
Sample Method: Hard tool
Drilling Additives Used: None
WA State Lic Nr: Not documented
Company Location: Hanford
Date Complete: 11Dec90

WELL NUMBER: 299-W18-25
TEMPORARY WELL NO: None
Hanford Coordinates: N/S N 37,786 E/W W 76,034
State NAD83 134,978.22m 566,721.48m
Coordinates: N 442,893 E 2,219,194
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 663.03 Brass cap

Depth to water: 193.8-ft Dec90
(Ground surface) 197.7-ft 26Mar93

GENERALIZED Geologist's STRATIGRAPHY Log
Sl=slightly

0-5: (Not documented)
5-10: SAND
10-15: Sl gravelly SAND
15-25: Sandy GRAVEL
25-120: SAND
120-130: Silty SAND
130-135: Sandy SILT
135-140: SILT to sandy SILT (CALICHE @ 136-ft)
140-185: Silty sandy GRAVEL
185-195: Sandy GRAVEL
195-215.4: Silty sandy GRAVEL



Elevation of reference point: [666.04-ft] (top of casing)
Height of reference point above ground surface [3.01-ft]
Depth of surface seal [0-19.9-ft]
Type of surface seal: Pre-mix concrete 4x4-ft x 6-in surface pad to 2.2-ft
4 equidistant protective posts
Cement grout, 2.2-19.9-ft
I.D. of riser pipe: [4-in]
Type of riser pipe: Stainless steel
8-20-mesh bentonite crumbles 19.9-127.9-ft
Hole plug bentonite chunks, 127.9-143.0-ft
Diameter of borehole,
0-137.0-ft, 11-in nominal
137.0-215.4-ft, 9-in nominal
Pure Gold bentonite grout, 143.0-143.4-ft
8-20 mesh bentonite crumbles 143.4-185.8-ft
Depth top of seal: [185.8-ft]
Type of seal: Bentonite pellets
Depth top of sand pack: [189.6-ft]
8-12-mesh silica sand
Depth top of screen: [193.5-ft]
4-in, #10-slot, stainless steel with channel pack
Depth bottom of screen [214.8-ft]
Depth to bottom of borehole: [215.4-ft]

Drawing By: RKL/2W18-25.ASB Date: 19Apr93
Reference: WHC-SD-EN-DP-041

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W18-25

WELL DESIGNATION	:	299-W18-25
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Single Shell Tanks
HANFORD COORDINATES	:	N 37,786 W 76,034 [200W-01Apr91]
LAMBERT COORDINATES	:	N 442,893 E 2,219,194 [HANCONV]
	:	N 134,978.22m E 566,721.48m [NAD83-01Apr91]
DATE DRILLED	:	Dec90
DEPTH DRILLED (GS)	:	215.4-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	193.8-ft, 12Dec90; 197.7-ft, 26Mar93
CASING DIAMETER	:	4-in stainless steel, +1.0-193.5-ft; 6-in stainless steel, +3.0--0.5-ft
ELEV TOP CASING	:	666.04-ft, [NGVD'29-01Apr91]
ELEV GROUND SURFACE	:	663.03-ft, Brass cap [NGVD'29-01Apr91]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	193.5-214.8-ft, 4-in #10-slot stainless steel, with channel pack
COMMENTS	:	FIELD INSPECTION, OTHER:
AVAILABLE LOGS	:	Geologist, driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	SST Monthly water level measurement, 01Jul91-26Mar93,
PUMP TYPE	:	Hydrostar
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: 200 W Water Supply
Driller's Name: D. Kruger
Drilling Company: Kaiser Engineers
Date Started: 11Sep91

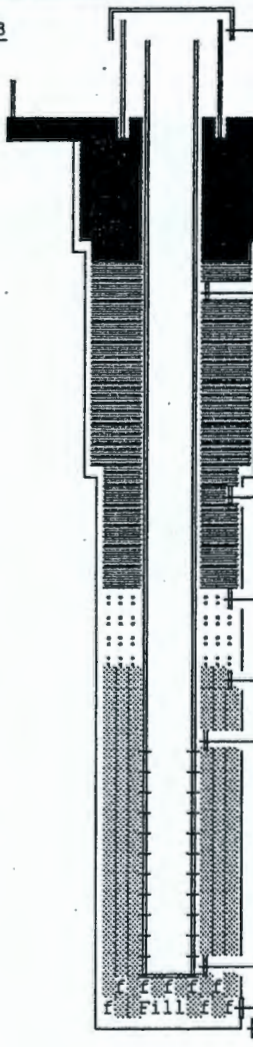
Sample Method: Drive barrel Hard tool
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Hanford
Date Complete: 14Nov91

WELL NUMBER: 299-W18-30
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 38,492.8 E/W W 75,541.4
State NAD83 Coordinates: N 135,193.95m E 566,871.07m
Start Card #: Not documented T R S
Elevation Ground surface (ft): 669.44 (Brass cap)

Depth to water: 201.2-ft Nov91
(Ground surface) 204.1-ft 26Mar93

GENERALIZED STRATIGRAPHY Log
Geologist's
Sl=slightly

0-2: GRAVEL
2-10: GRAVEL
10-12: Sl sandy GRAVEL
12-15: GRAVEL
15-25: GRAVEL, tr. SAND
25-35: Sl sandy GRAVEL
35-40: Sandy GRAVEL
40-50: Sl sandy GRAVEL
50-55: Sl gravelly SAND
55-60: Gravelly SAND
60-65: SAND w/trace GRAVEL
65-70: Sl silty SAND
70-75: SAND, w/trace SILT
75-79.4: SAND
79.4-80.7: Silty SAND
80.7-89.2: SAND, w/trace SILT
89.2-100: Silty SAND
100-110: Sl silty SAND
110-119.4: SAND
119.4-120.7: Silty SAND
120.7-123.7: SAND
123.7-129.6: SILT, w/trace SAND
129.6-131: CALICHE
131-140: Sandy GRAVEL
140-150: Sl silty sandy GRAVEL
150-170: Silty sandy GRAVEL
170-175: Sandy GRAVEL
175-205: Sl sandy GRAVEL
205-210: Sl silty sandy GRAVEL
210-225: Sandy GRAVEL
225-230: Sl sandy GRAVEL
230-233.3: Sandy GRAVEL
233.3-235.5: Silty sandy GRAVEL



Elevation of reference point: [672.84-ft]
(top of casing)
Height of reference point above ground surface [3.40-ft]
Depth of surface seal [1.5-18.0-ft]
Type of surface seal: Pre-mix concrete
4x4-ft x 6-in surface pad
4 equidistant protective posts
Cement grout 1.5-18.0-ft
I.D. of riser pipe: [4-in]
Type of riser pipe:
Stainless steel
Diameter of borehole,
0-19.2-ft, 13-in nominal
19.2-131.4-ft, 11-in nominal
131.4-235.5-ft, 9-in nominal
Type of filler, 18.0-188.0-ft
Bentonite crumbles
Depth top of seal: [188.0-ft]
Type of seal:
Bentonite pellets
Depth top of sand pack: [193.3-ft]
10-20-mesh silica sand
Depth top of screen: [197.5-ft]
4-in, #20-slot, continous wrap
T304 stainless steel with
filter pack
Depth bottom of screen: [234.3-ft]
Fill, 233.7-235.5-ft
Depth to bottom of borehole: [235.5-ft]

Drawing By: RKL/2W18-30.ASB Date: 19Apr93
Reference:

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W18-30

WELL DESIGNATION	:	299-W18-30
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	SST, 241-U Farm
HANFORD COORDINATES	:	N 38,492.8 W 75,541.4 [200W-13Dec91]
LAMBERT COORDINATES	:	N 443,601 E 2,219,685 [HANCONV]
		N 135,193.95m E 566,871.07m [NAD83-13Dec91]
DATE DRILLED	:	Nov91
DEPTH DRILLED (GS)	:	235.5-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	201.2-ft, Nov91;
		204.1-ft, 22Oct92
CASING DIAMETER	:	4-in stainless steel, +0.9-197.5-ft;
		6-in stainless steel, +3.40-ft--0.5-ft
ELEV TOP CASING	:	672.84-ft, [NGVD'29-13Dec91]
ELEV GROUND SURFACE	:	669.44-ft, Brass cap [NGVD'29-13Dec91]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	197.5-234.3-ft, 4-in #20-slot stainless steel;
COMMENTS	:	FIELD INSPECTION,
		OTHER:
AVAILABLE LOGS	:	Geologist
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	SST Monthly water level measurement, 23Jan92-26Mar93;
		Not on water sample schedule
PUMP TYPE	:	Hydrostar, intake at 226.2-ft (GS).
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: 200 W Water Supply
Driller's Name: H. Baker
Drilling Company: Kaiser Engineers
Date Started: 06Sep91

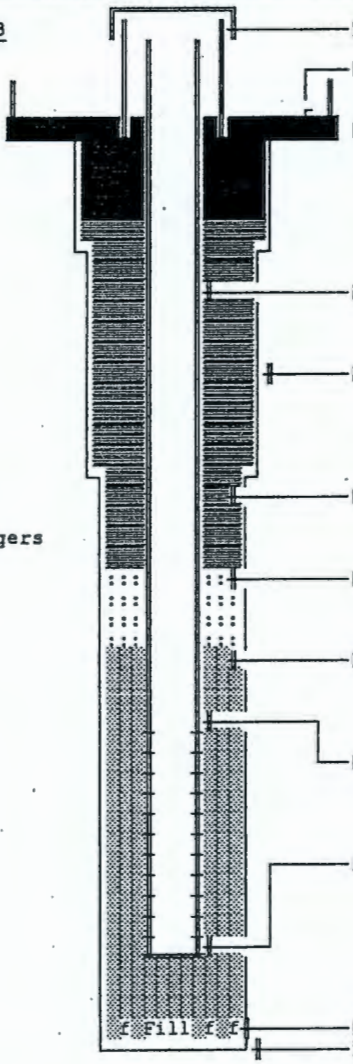
Sample Method: Drive barrel
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Hanford
Date Complete: 11Dec91

WELL NUMBER: 299-W18-31 TEMPORARY WELL NO:
Hanford Coordinates: N/S N 38,105.3 E/W W 76,032.1
State NAD83 N 135,075.47m E 566,721.83m
Coordinates: N 443,212 E 2,219,195
Start Card #: Not documented T R S
Elevation Ground surface (ft): 660.73 (Brass cap)

Depth to water: 191.2-ft Dec91
(Ground surface) 195.4-ft 26Mar93

GENERALIZED Geologist's STRATIGRAPHY Log
Sl=slightly

0-5: Gravelly silty SAND
5-10: Sl silty SAND
10-20: Gravelly silty SAND
20-25: Silty sandy GRAVEL
25-30: Sl silty SAND
30-35: Silty SAND
35-45: Sl silty SAND
45-50: SAND
50-55: Silty SAND
55-60: Sl silty gravelly SAND
60-65: SAND
65-70: Sl silty SAND
70-75: Silty SAND
75-80: SAND
80-85: Silty SAND
85-95: Sl silty SAND
95-110: Silty SAND
110-118: Sl silty SAND
118-119: CLAY, calcareous
119-130: Silty SAND w/CLAY stringers
130-131: CALICHE
131-132: Silty GRAVEL
132-140: Silty gravelly SAND
140-155: Silty sandy GRAVEL
155-160: GRAVEL
160-180: Sandy GRAVEL
180-200: Silty sandy GRAVEL
200-210: GRAVEL
210-220: Silty sandy GRAVEL
220-227.6: Sandy GRAVEL



Elevation of reference point: [664.16-ft] (top of casing)
Height of reference point above ground surface [3.43-ft]
Depth of surface seal [2.0-18.0-ft]
Type of surface seal: Pre-mix concrete 4x4-ft x 6-in surface pad 4 equidistant protective posts Cement grout 2.0-18.0-ft
I.D. of riser pipe: [4-in]
Type of riser pipe: Stainless steel
Diameter of borehole, 0-19.0-ft, 13-in nominal 19.0-127.4-ft, 11-in nominal 127.4-227.6-ft, 9-in nominal
Type of filler, 18.0-178.8-ft 8-20-mesh bentonite crumbles
Depth top of seal: [178.8-ft]
Type of seal: 3/8-in bentonite pellets
Depth top of sand pack: [181.5-ft]
20-40-mesh silica sand
Depth top of screen: [187.3-ft]
4-in, #10-slot, continous wrap T304 stainless steel with filter pack
Depth bottom of screen: [222.3-ft]
Fill, 226.0-227.6-ft
Depth to bottom of borehole: [227.6-ft]

Drawing By: RKL/2W18-31.ASB Date: 19Apr93
Reference:

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W18-31

WELL DESIGNATION	:	299-W18-31
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	SST, 241-U Farm
HANFORD COORDINATES	:	N 38,105.3 W 76,032.1 [200W-20May92]
LAMBERT COORDINATES	:	N 443,212 E 2,219,195 [HANCONV]
		N 135,075.47m E 566,721.83m [NAD83-20May92]
DATE DRILLED	:	Dec91
DEPTH DRILLED (GS)	:	227.6-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	191.2-ft, Dec91;
		194.8-ft, 22Oct92
CASING DIAMETER	:	4-in stainless steel, +1.5-187.3-ft;
		6-in stainless steel, +3.43-ft--0.5-ft
ELEV TOP CASING	:	664.16-ft, [NGVD'29-20May92]
ELEV GROUND SURFACE	:	660.73-ft, Brass cap [NGVD'29-20May92]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	187.3-222.3-ft, 4-in #10-slot stainless steel;
COMMENTS	:	FIELD INSPECTION,
		OTHER:
AVAILABLE LOGS	:	Geologist
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	SST Monthly water level measurement, 23Jan92-22Oct92;
		Not on water sample schedule
PUMP TYPE	:	Hydrostar, intake at 222.3-ft (TOC)
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

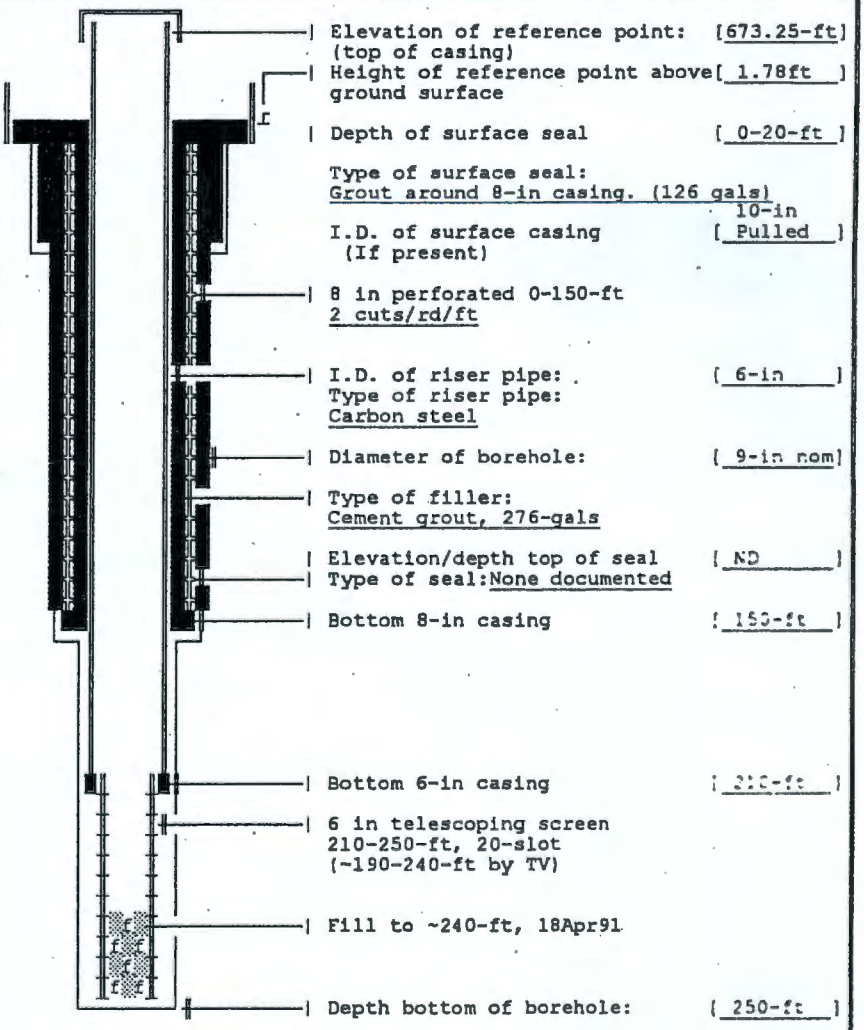
Drilling Method: Cable tool	Sample Method: Hard tool (nom)
Drilling Fluid Used: Water	Additives Used: Not documented
Driller's Name: Garcia/Bultena	WA State Lic Nr:1143/ND
Drilling Company: Not documented	Company Location:Not documented
Date Started: 01Dec82	Date Complete: 24Jan83

WELL NUMBER: 299-W19-12	TEMPORARY WELL NO:
Hanford Coordinates: N/S N 38,052	E/W W 75,456
State NAD83 N 135,059.75m	E 566,897.42m
Coordinates: N 443,160	E 2,219,771
Start Card #:Not documented	T R S
Elevation Ground surface (ft): 671.47 Brass cap	

Depth to water: 192-ft Jan83
(Ground surface) 206.1-ft 26Mar93

GENERALIZED STRATIGRAPHY — Driller's Log

0-4: SAND & SILT
4-15: COBBLES, PEBBLES & SAND
15-20: SAND, GRAVEL & COBBLES
20-25: GRAVEL, SAND & SILT
25-35: GRAVEL, SAND, SILT & CLAY
35-40: GRAVEL, SAND & SILT
40-45: COBBLES, GRAVEL, SAND, SILT & CLAY
45-50: COBBLES, GRAVEL, SAND & SILT
50-75: GRAVEL, SAND & SILT
75-85: SAND, SILT & CLAY
85-95: SAND & SILT
95-105: SAND, SILT & CLAY
105-120: SAND & SILT
120-140: SAND, SILT & CLAY
140-155: SAND, SILT, CLAY & GRAVEL
155-160: GRAVEL, COBBLE, SAND & SILT
160-165: RINGOLD
165-188: RINGOLD & COBBLE/ROCK
188-200: RINGOLD & SAND
200-202: SAND & ROCK
202-237: RINGOLD & SAND
237-239: SAND
239-250: RINGOLD & SAND



- Elevation of reference point: [673.25-ft] (top of casing)
- Height of reference point above ground surface [1.78ft]
- Depth of surface seal [0-20-ft]
- Type of surface seal: Grout around 8-in casing. (126 gals)
- I.D. of surface casing (If present) [10-in Pulled]
- 8 in perforated 0-150-ft, 2 cuts/rd/ft
- I.D. of riser pipe: [6-in]
- Type of riser pipe: Carbon steel
- Diameter of borehole: [9-in nom]
- Type of filler: Cement grout, 276-gals
- Elevation/depth top of seal [ND]
- Type of seal:None documented
- Bottom 8-in casing [150-ft]
- Bottom 6-in casing [210-ft]
- 6 in telescoping screen 210-250-ft, 20-slot (~190-240-ft by TV)
- Fill to ~240-ft, 18Apr91
- Depth bottom of borehole: [250-ft]

Drawing By: RKL/2W19-12.ASB Date: 19Apr93

Reference:

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W19-12

WELL DESIGNATION	:	299-W19-12
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 38,052 W 75,456 [200W-06May91]
LAMBERT COORDINATES	:	N 443,160 E 2,219,771 [HANCONV]
		N 135,059.75m E 566,897.42m [NAD83-06May91]
DATE DRILLED	:	Jan83
DEPTH DRILLED (GS)	:	250-ft
MEASURED DEPTH (GS)	:	239.7-ft, 18Apr91
DEPTH TO WATER (GS)	:	192-ft, Jan83;
		206.1-ft, 26Mar93
CASING DIAMETER	:	8-in carbon steel, 0-150-ft;
		6-in carbon steel, +1.78-210-ft;
ELEV TOP CASING	:	673.25-ft, [NGVD'29-06May91]
ELEV GROUND SURFACE	:	671.47, Brass cap [NGVD'29-06May91]
PERFORATED INTERVAL	:	8-in casing 0-150-ft
SCREENED INTERVAL	:	6-in telescoping 210-250-ft
COMMENTS	:	FIELD INSPECTION, 18Apr91,
		6-in carbon steel casing.
		2-ft cement pad. Four posts, capped and locked.
		Identification stamped on brass marker in pad.
		Not in radiation zone.
		OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	SST Monthly water level measurement, 02Apr90-26Mar93;
		Not on water sample schedule,
PUMP TYPE	:	Electric submersible
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: 200E Raw Water
Driller's Name: G Thomas/B Strode
Drilling Company: Kaiser Engineers
Date Started: 08Aug89
Date Complete: 18Dec90

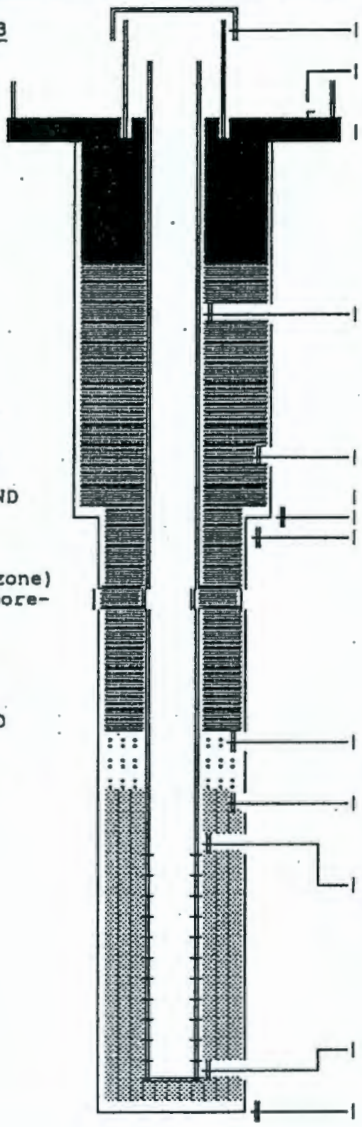
Sample Method: Drive barrel
Additives Used: None
WA State Lic Nr: Not documented
Company Location: Hanford

WELL NUMBER: 299-W19-31
TEMPORARY WELL NO: None
Hanford Coordinates: N/S N 38,275 E/W W 75,457
State NAD83 135,127.48m 566,897.00m
Coordinates: N 443,383 E 2,218,770
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 671.06 Brass cap

Depth to water: 202.3-ft Dec90
(Ground surface) 205.8-ft 26Mar93

GENERALIZED Geologist's STRATIGRAPHY Log
Sl=slightly

0-5: (Not documented)
5-10: SAND
10-28: Sandy GRAVEL
(Drilling stopped 10Nov89)
(Drilling resumed, 09Oct90)
28-35: Silty sandy GRAVEL
35-50: Sl silty gravelly SAND
50-53: Sl gravelly SAND
53-55: Sl silty SAND
55-60: Sl gravelly SAND
60-65: Sl silty SAND
65-70: SAND
70-75: Sl silty SAND
75-80: Sl gravelly sl silty SAND
80-85: Sl silty SAND
85-90: Sl gravelly sl silty SAND
90-110: Sl silty SAND
110-115: Sl gravelly sl silty SAND
115-120: Sl gravelly SAND
120-130: Silty-sl silty SAND
130-135: Sandy SILT
135-140: Gravelly SAND (CALICHE zone)
(CCL, detected in well bore- reduced casing size)
140-160: Gravelly SAND
160-170: Sl silty gravelly SAND
170-190: Sl silty sandy GRAVEL
190-195: Sandy GRAVEL
195-200: SAND-gravelly silty SAND
200-205: Sl silty sandy GRAVEL
205-215: Sandy GRAVEL
215-225.3: Sl silty sandy GRAVEL



Elevation of reference point: [674.19-ft] (top of casing)
Height of reference point above ground surface [3.13-ft]
Depth of surface seal [0-19.8-ft]
Type of surface seal: Pre-mix concrete 4x4-ft x 6-in surface pad to 2.1-ft
4 equidistant protective posts
Cement grout, 2.1-19.8-ft
I.D. of riser pipe: [4-in]
Type of riser pipe: Stainless steel
Bentonite crumbles, 19.9-183.7-ft
Diameter of borehole,
0-135.9-ft, 11-in nominal
135.9-225.3-ft, 9-in nominal
Depth top of seal: [191.1-ft]
Type of seal: Bentonite pellets
Depth top of sand pack: [196.1-ft]
20-40-mesh silica sand
Depth top of screen: [201.3-ft]
4-in, #10-slot, stainless steel with channel pack
Depth bottom of screen [222.6-ft]
Depth to bottom of borehole: [225.3-ft]

Drawing By: RKL/2W19-31.ASB Date: 20Apr93

Reference: WHC-SD-EN-DP-041

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W19-31

WELL DESIGNATION	:	299-W19-31
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Single Shell Tanks
HANFORD COORDINATES	:	N 38,275 W 75,457 [200W-01Apr91]
LAMBERT COORDINATES	:	N 443,383 E 2,218,770 [HANCONV]
	:	N 135,127.48m E 566,970.00m [NAD83-01Apr91]
DATE DRILLED	:	Dec90
DEPTH DRILLED (GS)	:	225.3-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	202.3-ft, 12Dec90; 205.8-ft, 26Mar93
CASING DIAMETER	:	4-in stainless steel, +1.0-201.3-ft; 6-in stainless steel, +3.1--0.5-ft
ELEV TOP CASING	:	674.19-ft, [NGVD'29-01Apr91]
ELEV GROUND SURFACE	:	671.06-ft, Brass cap [NGVD'29-01Apr91]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	201.3-222.6-ft, 4-in #10-slot stainless steel, with channel pack
COMMENTS	:	FIELD INSPECTION, OTHER:
AVAILABLE LOGS	:	Geologist, driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	SST Monthly water level measurement, 01Jul91-26Mar93,
PUMP TYPE	:	Hydrostar
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Raw water
Driller's Name: D Ludtke/M Thoresen
Drilling Company: Kaiser Engineers
Date Started: 08Nov89

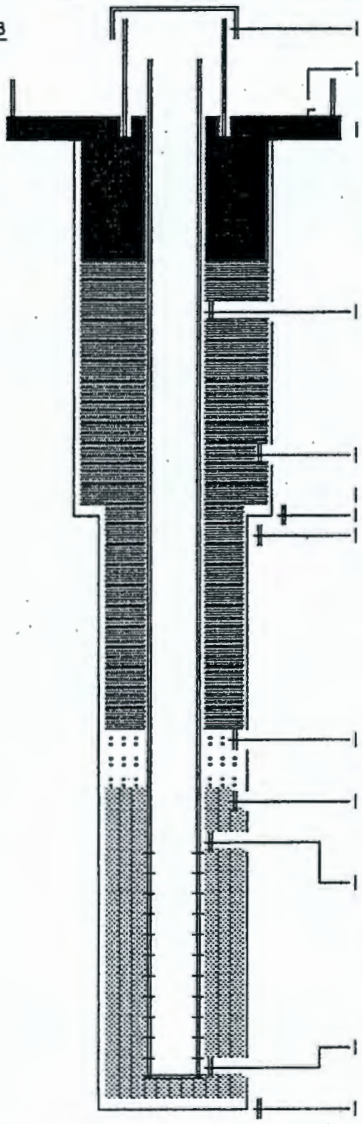
Sample Method: Drive barrel
Hard tool
Drilling Additives Used: None
WA State Lic Nr: Not documented
Company Location: Hanford
Date Complete: 03Jan91

WELL NUMBER: 299-W19-32
TEMPORARY WELL NO: None
Hanford Coordinates: N/S N 37,887 E/W W 75,459
State NAD83 135,009.29m 566,896.55m
Coordinates: N 442,995 E 2,219,769
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 671.92 Brass cap

Depth to water: 202.4-ft Nov90
(Ground surface) 206.5-ft 26Mar93

GENERALIZED Geologist's STRATIGRAPHY Log
Sl=slightly

0-5: (Not documented)
5-15: Sandy GRAVEL
15-17.5: Gravelly SAND
(Drilling stopped 10Nov89)
(Drilling resumed, 22Oct90)
17.5-22.5: Gravelly SAND
22.5-23: Sandy SILT
23-41: Sandy GRAVEL
41-43: Gravelly SAND
43-47: Sandy GRAVEL
47-65: Sl gravelly SAND
65-80: SAND
80-85: Sl gravelly SAND
85-90: SAND
90-95: Sl silty SAND
95-110: Sl gravelly SAND
110-132: SAND
132-133: SILT
133-140: Sandy SILT
140-145: SAND
145-150: Sl silty SAND
(CALICHE @ 145-ft)
150-200: Sandy GRAVEL
200-223.1: Silty sandy GRAVEL



Elevation of reference point: [674.90-ft] (top of casing)
Height of reference point above ground surface [2.98-ft]
Depth of surface seal [0-20.3-ft]
Type of surface seal: Pre-mix concrete 4x4-ft x 6-in surface pad to 3.1-ft 4 equidistant protective posts Cement grout, 3.1-20.3-ft
I.D. of riser pipe: [4-in]
Type of riser pipe: Stainless steel
8-20-mesh Bentonite crumbles, 20.3-190.0-ft
Diameter of borehole, 0-140.3-ft, 11-in nominal
135.9-223.1-ft, 9-in nominal
Depth top of seal: [190.0-ft]
Type of seal: 3/8-1/2-in bentonite pellets
Depth top of sand pack: [195.4-ft]
20-40-mesh silica sand
Depth top of screen: [201.7-ft]
4-in, #10-slot, stainless steel with channel pack
Depth bottom of screen [222.4-ft]
Depth to bottom of borehole: [223.1-ft]

Drawing By: RKL/2W19-32.ASB Date: 20Apr93

Reference: WHC-SD-EN-DP-041

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W19-32

WELL DESIGNATION	:	299-W19-32
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Single Shell Tanks
HANFORD COORDINATES	:	N 37,887 W 75,459 [200W-01Apr91]
LAMBERT COORDINATES	:	N 442, 995 E 2,219,769 [HANCONV]
	:	N 135,009.29m E 566,896.55m [NAD83-01Apr92]
DATE DRILLED	:	Jan91
DEPTH DRILLED (GS)	:	223.1-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	202.4-ft, 13Nov90; 206.5-ft, 26Mar93
CASING DIAMETER	:	4-in stainless steel, +1.0-201.7-ft; 6-in stainless steel, +3.0--0.5-ft
ELEV TOP CASING	:	674.90-ft, [NGVD'29-01Apr91]
ELEV GROUND SURFACE	:	671.92-ft, Brass cap [NGVD'29-01Apr91]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	201.7-222.4-ft, 4-in #10-slot stainless steel, with channel pack
COMMENTS	:	FIELD INSPECTION, OTHER:
AVAILABLE LOGS	:	Geologist, driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	SST Monthly water level measurement, 01Jul91-25Mar93,
PUMP TYPE	:	Hydrostar
MAINTENANCE	:	

0502374

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method:	Air Rotary - TUBEX	Sample Method:	Grab/Split Spoon
Drilling Fluid Used:	Reverse Air	Additives Used:	None
Driller's Name:	Willie Franklin	WA State Lic Nr:	Not Available
Drilling Company:	Layne Christensen	Company Location:	Salt Lake City, Ut
Date Started:	17Sep98	Date Completed:	23Sep98

WELL NUMBER: 299-W19-41 TEMPORARY B8551 WELL NO: Not Allowed

Coordinates: N Not documented

Coordinates: E Not documented

Start Card #: Not Available

Elevation Ground Surface: Brass Marker

Depth to Water: 220.35 ft 23Sep98
(Ground surface)

GENERALIZED STRATIGRAPHY Geologist's Log & Geophysical Logs

0 - 0.1 ft : Asphalt
0.1 - 14 ft : Silty sandy gravel
14 - 22 ft : Sand
22 - 39 ft : Sandy gravel

39 - 43 ft : Gravelly sand
43 - 47 ft : Sandy gravel
47 - 54 ft : Gravelly sand
54 - 81 ft : Sand

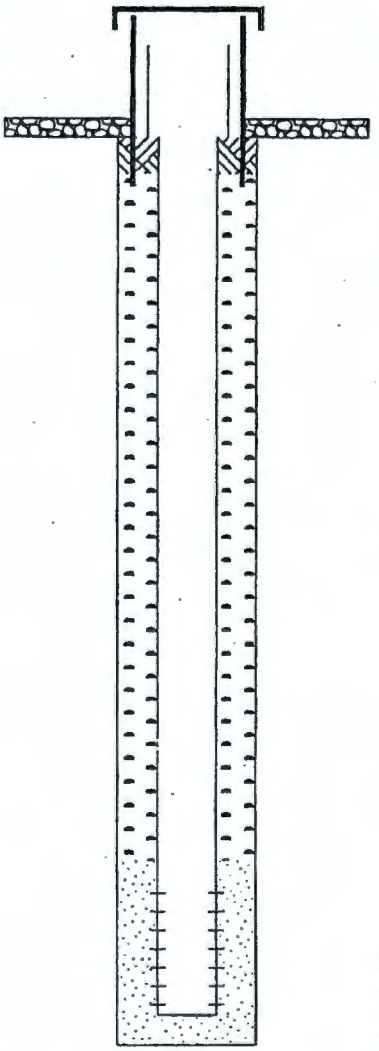
81 - 84 ft : Sand (Fn)
84 - 88 ft : Sand (Cse)
88 - 91 ft : Sand (Fu)
91 - 127 ft : Sand

127 - 136 ft : Silty sand
136 - 144 ft : Sandy silt - calcareous
144 - 168 ft : Silty sandy gravel

168 - 188 ft : Sandy gravel

188 - 249 ft : Silty sandy gravel
(Water Level = 220.35')

249 - 253 ft : Silty sandy gravel - Fe staining
253 - 264.5 ft : Silty sandy gravel



Elevation of Reference Point: m

Height of Reference Point Above Ground Surface:

Depth of Surface Seal: 10.5 ft

Type of Surface Seal: 4x4 Concrete Pad

Fill	*Casing*	*Screen*
0 - 10.5 ft : 9.125-inch hole Cement Seal	0 - 220.05 ft : 4 inch 4" Sch.5 SS Csg.	
10.5 - 210.4 ft : 9.125-inch hole Bentonite Chips		
		220.05 - 255.14 ft : 4 inch 4" Wire Wrap SS Screen .010 Slot
210.4 - 255.47 ft : 9.125-inch hole 20/40 Silica Sand		
255.47 - 264.5 ft : 9.125-inch hole 20/40 Silica Sand	255.14 - 255.47 ft : 4 inch 4" SS End Cap	

264.5 ft : Borehole drilled depth

0 - 264.5 ft : 9.125-in. 8-5/8" CS Temp. Csg. set with TUBEX reverse air rotary

Drawing By:	TGB
Reference:	Hanford Wells
Revision:	0
Revision Date:	25Sep98
Print Date:	28Dec98

Report Form: WELLS Project File: WELLS.GPJ

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W19-41

WELL DESIGNATION	:	299-W19-41
CERCLA UNIT	:	
RCRA FACILITY	:	
DEPTH DRILLED (GS)	:	264.5 ft
MEASURED DEPTH (GS)	:	255.47
AVAILABLE LOGS	:	Geologist & Geophysical Logs
DATE EVALUATED	:	Data not available
EVAL RECOMMENDATION	:	Data not available
LISTED USE	:	Data not available
CURRENT USER	:	RCRA & Operations
PUMP TYPE	:	Data not available
MAINTENANCE	:	Data not available
COMMENTS	:	8-5/8" TUBEX Sys. 4-1/2" Reverse Cir. Drl. Pipe with Interchange
TV SCAN COMMENTS	:	

Report Form: WELLS Project File: WELLS.GPJ

Drawing By:	TGB
Reference:	Hanford Wells
Revision:	0
Revision Date:	25Sep98
Print Date:	28Dec98

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method:	Air Rotary - TUBEX	Sample Method:	Grab/Split Spoon	WELL NUMBER:	299-W19-42	TEMPORARY WELL NO:	B8553 Not Allowed
Drilling Fluid Used:	Reverse Air	Additives Used:	None	Coordinates: N	Not documented		
Driller's Name:	Willie Franklin	WA State Lic Nr:	Not Available	Coordinates: E	Not documented		
Drilling Company:	Layne Christensen	Company Location:	Salt Lake City, Ut	Start Card #:	Not Available		
Date Started:	31Aug98	Date Completed:	16Sep98	Elevation Ground Surface:	Brass Marker		

Depth to Water: 219.56 ft 16Sep98
(Ground surface)

GENERALIZED STRATIGRAPHY — Geologist's Log & Geophysical Logs

0 - 0.7 ft : Backfill (gm 5)
0.7 - 7 ft : Sand
7 - 15 ft : Sandy gravel
15 - 119.5 ft : Silty sand
15 - 16 ft : Sand
16 - 32.5 ft : Sandy gravel
32.5 - 39 ft : Sandy gravel
39 - 43.5 ft : Sandy gravel
43.5 - 52 ft : Slightly silty gravelly sand
52 - 53 ft : Sandy gravel
53 - 71 ft : Sand

71 - 79 ft : Sand
79 - 84 ft : Slightly silty sand
84 - 89 ft : Sand
89 - 105 ft : Slightly silty sand

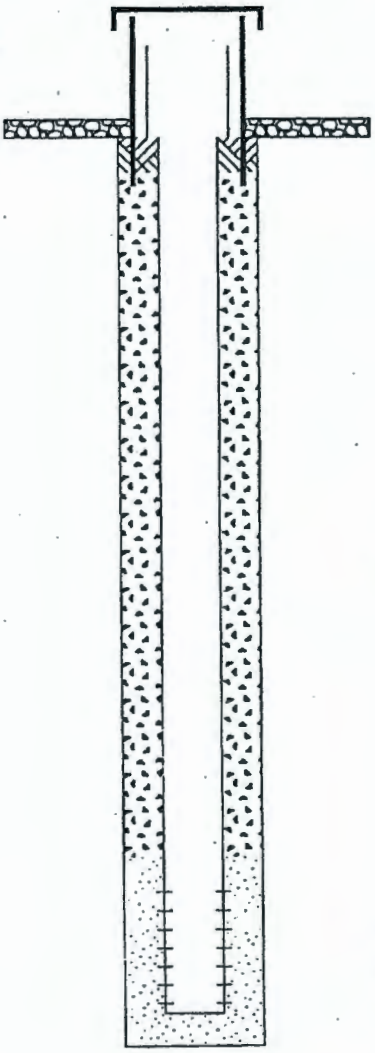
119.5 - 138.5 ft : Silt

138.5 - 141 ft : Caliche
141 - 170 ft : Silty sandy gravel

170 - 189 ft : Silty sandy gravel

189 - 196 ft : Gravelly sand
196 - 222 ft : Sandy gravel

222 - 265.2 ft : Silty sandy gravel



Elevation of Reference Point: m

Height of Reference Point Above Ground Surface:

Depth of Surface Seal: 10.2 ft

Type of Surface Seal: 4x4 Concrete Pad

Fill	*Casing*	*Screen*
0 - 10.2 ft : 9.125-inch hole Cement Seal	0 - 220.28 ft : 4 inch 4" Sch 5 SS Csg.	
10.2 - 210.2 ft : 9.125-inch hole Bentonite Chips		
		220.28 - 255.37 ft : 4 inch 4" Wire Wrap SS Screen .010 Slot
210.2 - 255.7 ft : 9.125-inch hole 20-40 Silica Sand		
255.7 - 265.2 ft : 9.125-inch hole 20-40 Silica Sand	255.37 - 255.7 ft : 4 inch 4" SS End Cap	

265.2 ft : Borehole drilled depth

0 - 265.2 ft : 9.125-in. 8-5/8" CS Temp. Csg.

Drawing By:	TGB
Reference:	Hanford Wells
Revision:	0
Revision Date:	21Sep98
Print Date:	28Dec98

Report Form: WELLS Project File: WELLS.GPJ

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W19-42

WELL DESIGNATION	:	299-W19-42
CERCLA UNIT	:	
RCRA FACILITY	:	
DEPTH DRILLED (GS)	:	265.2 ft
MEASURED DEPTH (GS)	:	
AVAILABLE LOGS	:	Data not available
DATE EVALUATED	:	Data not available
EVAL RECOMMENDATION	:	Data not available
LISTED USE	:	Data not available
CURRENT USER	:	RCRA & Operations
PUMP TYPE	:	Data not available
MAINTENANCE	:	Data not available
COMMENTS	:	8-5/8" TUBEX Sys. 4-1/2" Reverse Cir. Drl. Pipe with Interchange
TV SCAN COMMENTS	:	

Report Form: WELLS Project File: WELLS.GPJ

Drawing By:	TGB
Reference:	Hanford Wells
Revision:	0
Revision Date:	21Sep98
Print Date:	28Dec98

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