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ACRONYMS

ALARA	as low as reasonably achievable
ASTM	American Society for Testing and Materials
BWIP	Basalt Waste Isolation Project
CERCLA	<i>Comprehensive Environmental Response Compensation and Liability Act of 1980</i>
DOW	description of work
Ecology	Washington State Department of Ecology
EFS	Environmental Field Services
EPA	U.S. Environmental Protection Agency
HEIS	Hanford Environmental Information System
PID	photoionization detector
RCRA	<i>Resource Conservation and Recovery Act of 1976</i>
RWP	radiation work permit
VOA	volatile organic analysis

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1.0 SCOPE OF WORK

This description of work (DOW) details the field activities associated with the vadose zone drilling and soil sampling in the 200-UP-2 Operable Unit (Task 2, 3, and 5) and will serve as a field guide for those performing the work. It will be used in conjunction with the *200-UP-2 RCRA Facility Investigation/Corrective Measures Study* (DOE-RL 1993a,[LFI]) and *Site Characterization Manual* (WHC 1988a). Vadose zone borings are being constructed to characterize the vertical and horizontal extent of contaminants in sediments within and beneath the cribs. The locations for the proposed borings are presented in Figure 1. The contaminants of concern for the project are presented in Table 1.

1.1 SITE BACKGROUND AND PROPOSED ACTIVITIES

The following section supplies general information for each site. Specific data on waste volumes, contaminants, and system history are contained in Section 2.0 of the *U Plant Aggregate Area Management Study Report* (U Plant AAMS, [DOE/RL 1992]).

1.1.1 216-U-1 and 216-U-2 Cribs

The 216-U-1 (U-1) and 216-U-2 (U-2) Cribs are underground timbered structures measuring 3.6 x 3.6 x 1.2 m (12 x 12 x 4 ft). Each crib is set in its own excavation, which is 6 m (20 ft) deep and was backfilled with native soil. The two cribs are connected by a stainless steel pipe and were constructed so that the U-2 Crib received overflow from the U-1 Crib. The cribs operated from 1951 to 1967 and received uranium waste from U Plant Operations. The highly sorptive characteristics of the soil allowed the majority of the uranium waste to be retained in the sediments beneath the cribs. The uranium was remobilized in 1985 by an acid waste stream from the newly constructed 216-U-16 (U-16) Crib and was transported downward through the caliche layer and improperly sealed monitoring wells to groundwater.

To characterize the vertical extent of uranium contamination beneath the cribs, soil boring 299-W19-96 will be drilled next to the U-1 Crib (299-W19-96) to the top of the caliche layer (Figure 2a). The U-1/2 Cribs have a low potential for collapse because of the small size of the cribs and their depth.

To delineate the lateral extent of contamination beneath the cribs, two additional borings are planned in the vicinity of the U-1/U-2 Cribs (Figure 2a). Dependent upon the presence of perched water, these borings will be drilled to the top or through the caliche layer. If sufficient perched water occurs on top of the caliche layer, the borings will be completed as perched monitoring wells. Boring 299-W19-95 will be located midway between the U-1/U-2 and U-16 Cribs. The purpose of this boring is to determine if the hydrologic head created from the discharges at the U-16 Crib carried uranium upslope on the caliche layer. Boring 299-W19-97 will be drilled adjacent to the W-5 tile fields and will be used to characterize the northern extent of

contamination from the U-1/U-2 Cribs and to determine if perched water zones are forming beneath the active W-5 drain field.

1.1.2 216-U-8 Crib

The 216-U-8 Crib consists of three underground timber structures within a trench that measures 49 x 15.2 x 9.2 m (160 x 50 x 30 ft). Each crib is a 4.9 x 4.9 x 3 m (16 x 16 x 10 ft) box resting on a 0.9 m (3 ft) gravel bed and backfilled with gravel. The crib operated from 1952 to 1960 and received acidic process condensate from the 221-U and 224-U Buildings and the 291-U Stack.

Boring 299-W19-94 will be drilled near the center of the U-8 Crib to the top of the caliche layer (Figure 2b). This boring will be used to characterize the vertical extent of contamination beneath the U-8 Crib. An evaluation will also be performed to determine what impact the acidic waste from the crib has had upon the calcium carbonate cement of the caliche layer. The perching capacity of the caliche layer may be diminished due to decreased calcium carbonate. The U-8 Crib has a higher potential for collapse because of the large size and structure of the trench and crib.

1.1.3 216-U-12 Crib

The 216-U-12 Crib (U-12 Crib) is a 46-m (150-ft) -long, gravel-filled drain field with no internal structure. The crib operated from 1960 to 1988 and received waste from the 291-U Stack Drainage System, the UO3 Process Condensate System, the C-5 and C-7 Tank, and acidic process condensate from the 221-U and 224-U Building. The crib was constructed to replace the U-8 Crib.

Boring 299-W22-78 will be drilled adjacent to the U-12 Crib and, dependent upon the presence of perched water, will be drilled to the top or through the caliche layer (Figure 2c). This boring was selected to collect data supporting integration of *Resource Conservation and Recovery Act of 1976* (RCRA) closure and *Comprehensive Environmental Response Compensation and Liability Act of 1980* (CERCLA) activities at this site. The objective is to collect information concerning the impact of acidic waste on the soils beneath the crib, not the maximum levels of contamination. Samples will be collected for uranium, nitrate, calcium carbonate, and pH analysis. An evaluation will also be performed to determine what impact the acidic waste from the crib has had upon the calcium carbonate cement of the caliche layer. The perching capacity of the caliche layer may be diminished because of the decreased calcium carbonate. Placement of the boring at the crib edge allows collection of this data while reducing the exposure of personnel. It is included in the work plan as Subtask 5b, Table 5.5, to distinguish it from investigations at analogue sites.

1.1.4 216-U-4 Reverse Well/216-U-4A French Drain

The 216-U-4 Reverse Well (U-4 Reverse Well) is a injection facility constructed of a 7.6-cm (3-in.) -diameter steel pipe extending to 23 m (75 ft) beneath the surface. The bottom 2.4 m (8 ft) is perforated. The U-4 Reverse

well operated from 1947 to 1955 and received acidic plutonium and fission product waste from the 222-U Laboratory. The U-4 Reverse Well became plugged in 1955 and was replaced with the 216-U-4A French Drain.

The 216-U-4A French Drain (U-4A French Drain) is a 130-cm (51-in.) diameter concrete pipe extending to a depth of 1.2 m (4 ft). The drain rests on undisturbed soil and is not gravel filled. The drain operated from 1955 to 1970.

Boring 299-W19-98 will be placed between the U-4 Reverse Well and the U-4A French Drain and drilled to the top of the caliche layer (Figure 2d). The discharge points for these two waste units are separated vertically by 21 m (64 ft). This boring will be used to characterize the vertical concentration of contaminants between the two waste management units. Elevated levels of contamination are expected in the near surface below the U-4A French Drain and should decrease in concentration with depth. Contaminant concentrations should increase again near the depth of the discharge point for the U-4 Reverse Well and then should decrease with depth. The final location for the boring is contingent upon the proximity of buried and overhead utilities.

1.2 GENERAL SITE GEOLOGY AND HYDROLOGY

The central UP-2 Area is underlain from the surface downwards by Holocene eolian sands, the Hanford formation, the early Palouse/Plio-Pleistocene interval, and the Ringold Formation. These strata overlie basalts of the Columbia River Basalt Group. The geology of this area is outlined in the following text. More detailed discussions of Hanford Site and 200 West Area geology can be found in Myers et al. (1979), Tallman et al. (1979, 1981), Reidel and Fecht (1981), DOE (1988), Delaney et al. (1991), Lindsey (1991), Lindsey et al. (1992), and Connelly et al. (1992). A generalized stratigraphic column for the 200-UP-2 Operable Unit is presented in Figure 3.

Holocene-aged deposits form the uppermost unit in the area. These deposits consist of eolian silt and sand that forms a thin (<10 ft), discontinuous sheet across the site.

The uppermost laterally continuous unit in the area is the Hanford formation. The Hanford formation consists of an upper, gravelly interval (25 to 100 ft thick) and a lower, finer interval (10 to 100 ft thick). Stratified, open-framework, and largely uncemented granule to cobble gravel deposits typical of the gravel-dominated facies (see Lindsey et al. 1992) dominate the upper interval. Localized interbeds of the sand- and silt-dominated facies also may be present in the upper interval. Interstratified strata typical of both the sand-dominated and silt-dominated facies form the Touchet bed-like strata of the lower interval. Silt-rich horizons within the lower interval may be well compacted and partially cemented by calcium carbonate. The lower interval also may contain pebbly horizons up to 5 ft thick. Examination of recently drilled (FY 1993), closely spaced borehole geologic logs in the U-14 Ditch area and outcrops of analogous strata indicate that individual beds may be very discontinuous, commonly pinching out over a distance of a few hundred feet.

The Plio-Pleistocene/early Palouse interval consists of locally derived basaltic detritus, deposits reworked from the Ringold Formation, and calcium carbonate-rich paleosols ranging from 1 to 25 ft thick. In the central UP-2 area the interval appears to be dominated by a mix of silt, sand, and gravel containing thin (<1-in thick), calcium carbonate horizons, (caliche) coated clasts, and nodules. Examination of borehole geologic logs, split-tube samples, and Basalt Waste Isolation Project (BWIP) cores suggests that the well-cemented carbonate horizons may be discontinuous and highly fractured.

Recent drilling at the U-14 Ditch reveals that the lower interval of the Hanford formation and the Plio-Pleistocene/early Palouse carbonate horizons are commonly cross-cut by clastic dikes. Clastic dikes, described in detail by Black (1979), most commonly consist of vertical to subvertical layers of silt and sand that cut across bedding planes. The presence of these dikes coupled with the abundance of laterally discontinuous beds in the Plio-Pleistocene/early Palouse and lower Hanford intervals suggests perched groundwater intervals may be of limited lateral extent. Again, recent observations in the area of the U-14 Ditch indicate this is the case; boreholes spaced less than 300 ft apart never reported perched water twice in the same horizon. In addition, where perched water was reported, it was found above fine-grained partially cemented zones within the lower Hanford interval (Touchet-like beds), and not at the top of the Plio-Pleistocene. The lack of laterally extensive perched waters is inferred to be directly related to the absence of laterally extensive fine-grained horizons within the Hanford formation, the absence of laterally extensive and unfractured calcium carbonate horizons in the Plio-Pleistocene/early Palouse, and the presence of clastic dikes that potentially acted as vertical pathways for the downward movement of water within the vadose zone. The presence of the perching intervals as described above will define the methods for drilling boreholes as described in Section 3.3, General Drilling Activities.

Ringold Formation strata above the water table in the central UP-2 area consist largely of the partially cemented fluvial gravels and minor sands and silts of unit E. Interbedded fluvial sands and paleosols of the Ringold Formation upper unit also may be present in the area of the U-17 Crib. Cemented zones and silt layers within these units may cause perched conditions, although this has never been documented. However, with current data it is not clear if horizons such as these are continuous or discontinuous.

2.0 GENERAL REQUIREMENTS

2.1 HEALTH AND SAFETY

All personnel working to this DOW will have completed the 40-Hour Hazardous Waste Site Worker Training Program and will perform all work in accordance with the following:

WHC-CM-7-7, *Environmental Investigations and Site Characterization Manual* (EII) (WHC 1988a).

- . WHC-CM-7-5, *Environmental Compliance Manual* (WHC 1988b)
- . WHC-CM-1-6, *Radiological Control Manual* (WHC 1993c)
- . WHC-IP-0692, *Health Physics Procedures Manual* (WHC 1991)
- . WHC-CM-4-11, *ALARA Program* (WHC 1988d)
- . WHC-EP-0383, *Environmental Engineering, Technology, and Permitting Function Quality Assurance Program Plan* (WHC 1990)
- . WHC-CM-4-3, *Industrial Safety Manual*, Vol. 1 through 4 (WHC 1987)
- . Site-specific health and safety plan/radiation work permits/job safety analysis

2.2 PREREQUISITES

The requirements and procedures applicable to the 200-UP-2 Operable Unit field activities are specified in the *Environmental Investigations and Site Characterization Manual* (WHC 1988a). Applicable EIIs include the following:

- EII 1.1 "Hazardous Waste Site Entrance Requirements"
- EII 1.5 "Field Logbooks"
- EII 1.13 "Readiness Review"
- EII 2.1 "Preparation of Hazardous Waste Operations" Permit
- EII 3.2 "Calibration and Control of Monitoring Instruments"
- EII 3.4 "Field Screening"
- EII 4.3 "Control of CERCLA and Other Past-Practice Investigation Derived Waste"
- EII 5.1 "Chain of Custody"
- EII 5.2 "Soil and Sediment Sampling"
- App. B "Split-Spoon Sampling"
- EII 5.4 "Field Decontamination of Drilling, Well Development, and Sampling Equipment"
- EII 5.5 "1706 KE Laboratory Decontamination of RCRA/CERCLA Sampling Equipment"
- EII 5.7A "Hanford Geotechnical Sample Library Control"
- EII 5.10 "Obtaining Sample Identification Numbers and Accessing HEIS Data"
- EII 5.11 "Sample Packaging and Shipping"
- EII 6.1 "Activity Reports of Field Operations"

- EII 6.7 "Resource Protection Well and Test Borehole Drilling"
- EII 9.1 "Geologic Logging"

Each item on the checklist for tasks requiring no readiness review (EII 1.13, "Engineering and Geotechnology Readiness Review" [WHC 1988a]) will be signed and dated by the cognizant engineer or field team leader (FTL) prior to the start of work.

3.0 FIELD ACTIVITIES

The following sections detail the activities to be conducted for the drilling and sampling and analysis of boreholes in the UP-2 Operable Unit. Background information applicable to these activities is presented in DOE-RL (1993a) Section 5.3, Field Activities, and its subsections. Information from these subsections has been excerpted and is attached as Appendix A to this document.

3.1 SCREENING, BACKGROUND AND BASELINE ACTIVITIES

All samples and cuttings will be field screened for radionuclides and for evidence of carbon tetrachloride, which is the indicator species for organics (LFI, DOE-RL 1993a), Section 5.3.2.3). Soil screening for carbon tetrachloride will be conducted using a photoionization detector (PID) equipped with an 11.7 eV lamp. Radionuclides will be screened by alpha and Beta-gamma counting instruments. Field screening will be performed in accordance with EII 3.4, "Field Screening." The action level is twice background, as specified in DOE/RL (1993a), and is based on 95% confidence that anthropogenic species are identified. The action level for carbon tetrachloride screening is 5 ppm. All instruments will be used, maintained, and calibrated consistent with EII 3.2, "Calibration and Control of Monitoring Instruments," and EII 3.4, "Field Screening." The field geologist will record screening results on the borehole log (EII 9.1, "Geologic Logging" [WHC 1988a]).

Prior to start of drilling, a one-time background level for radiation will be established outside each drill site. The health physics technician (HPT) will select the appropriate location for the background survey. Instrument background will be measured holding the device less than 2.54 cm (1 in.) from soil excavated from a depth of 15.24 cm (6 in.). The field geologist will record the background levels on a field activity report per EII 6.1, "Activity Reports of Field Operations" (WHC 1988a).

A radiological baseline will be established at each drill site before drilling and after each borehole is completed. This activity will be performed to ensure that instrument background is defined at each site and that the drill pads are restored to pre-drilling radiological levels. Screening results will be recorded on the field activity report per EII 6.1 "Activity Reports of Field Operations" (WHC 1988a).

3.2 GENERAL DRILLING ACTIVITIES

The following sections describe the general drilling activities that will be conducted at each drill site. All drilling will be conducted utilizing the specifications and guidance presented in the *Washington Administrative Code* (WAC) 173-160 Part Three--"Resource Protection Wells," the "Generic Well Specification," WHC-S-014, and the "Drilling Geotechnical Test Borings Specification," WHC-S-0105. It should be noted that the requirements presented in the WAC in Section 173-160-500, Item 2 (No resource protection well shall interconnect saturated formations or aquifers) are not being violated when casing is carried through perching layers above the caliche layer. Previous drilling conducted in the area and the site conceptual model have shown that perching layers above the caliche layer are discontinuous and the water reported can be treated as a single hydrologic unit. No technical purpose would be served by attempting to seal individual silt or clay beds that occur in the lower fine-grained units of the Hanford formation (Touchet-like beds) (Attachment 1). The perching units expected are typically several centimeters to no more than 0.305 m (1 ft) thick and are laterally discontinuous (see Appendix B for cross sections). Layers thicker than 1.5 m (5 ft) are not expected; however, if they occur and perched water is reported, the Washington State Department of Ecology (Ecology) will be informed and an evaluation will be performed to determine if casing will be downsized.

In support of the 200-UP-2 Operable Unit field investigations, six borings will be constructed and sampled. The borings will be drilled using the cable-tool method. The drilling operations will be conducted according to EII 6.7, "Resource Protection Well and Test Borehole Drilling," and EII 5.4, "Field Decontamination of Drilling, Well Development, and Sampling Equipment" (WHC 1988a). All waste will be handled according to EII 4.3, "Control of CERCLA and other Past-Practice Investigation Derived Waste" (WHC 1988a). A temporary casing will be used to minimize slough in the borehole and limit transport of gross contamination within the vadose zone; it will be telescoped as contaminant concentrations decrease.

Borings 299-W19-94, 299-W19-96, 299-W19-98, and 299-W22-78 will be constructed in areas where contamination is expected in the near surface and again in the lower fine unit of the Hanford formation. These boreholes will be drilled in the following manner (Figure 4):

- Casing string #1. Large-diameter casing will be run to a minimum of 2.1 m (7 ft) below the bottom of the crib or french drain and will not be carried deeper than 12.2 m (40 ft) below ground surface. If radiological contamination drops below 5000 cpm before the 12.2 m (40 ft) maximum, casing string #2 can then be installed.
- Casing string #2. Smaller diameter secondary casing will be telescoped through casing string #1 and carried to a total depth of no greater than 30.5 m (100 ft), below ground surface. If radiological contamination drops below the established background level for the site prior to the 30.5 m (100 ft) maximum, casing string #3 can be installed.

- Casing string #3. Smaller diameter intermediate casing will be telescoped through casing string #2 and carried to the top of the caliche layer or to the depth that the caliche layer is estimated to occur.
- Drilling will stop at the caliche layer if perched water is reported. If perched water is not reported, the regulatory agencies will be notified before further drilling. With regulator approval, the casing string will be set in the caliche layer and the boring will be drilled open hole no farther than 3 m (10 ft) and a soil sample will be obtained.

Borings 299-W19-97 and 299-W19-95 are being constructed in areas where contamination is expected to occur in the lower fine units of the Hanford formation above the caliche layer. These borings will be drilled in the following manner (Figure 5):

- Casing string #1. Large-diameter casing will be carried to 30.5 m (100 ft).
- Casing string #2. Secondary smaller casing will be telescoped through casing string #2 and carried to the top of caliche layer or to the depth that the caliche layer is estimated to occur.
- Drilling will stop at the caliche layer if perched water is reported. If perched water is not reported, the regulatory agencies will be notified before further drilling. With regulator approval, the casing string will be set in the caliche layer and the boring will be drilled open hole no farther than 3 m (10 ft), and a soil sample will be obtained.

When perched water is reported above the caliche layer in all boreholes, drilling will stop and an initial baseline water level will be established with an electronic water tape. The amount of water in the borehole will be recorded on the borehole log and the field activity report. A water sample will then be obtained using the rigs bailer. At least 0.305 m (1 ft) of water is required for water sampling. A water sample will not be obtained if less than 0.305 m (1 ft) of water is present. When taking a perched water sample, an attempt will be made to fill all the bottles specified on Table 2. If sufficient water cannot be obtained to fill the bottle requirements specified within 1 hour of the start of the sampling event, sampling will stop and drilling will continue. Casing would not be downsized at the perching layer and drilling would continue to the next casing point.

When perched water is reported at the top of the caliche layer, drilling will stop and the amount of perched water will be determined using an electronic measuring tape. If water is present, the temporary casing should be back pulled from the top of the caliche layer at least 0.305 m (1 ft) to ensure that water can enter the casing. The borehole will then be allowed to equilibrate for 4 hours and a baseline water level will be established. A water sample will then be obtained.

RLS gamma spectrometer and gamma logging will be conducted for all boreholes on each string of casing prior to downsizing and after reaching total depth (EII 11.1, "Geophysical Logging") (WHC 1988a). Gross gamma logging should be performed first to target possible zones of contamination that may require additional screening by the RLS gamma logging tool.

All boreholes not converted to perched monitoring wells will be abandoned per the WAC.

The site geologist will record all activities on the field activity report per EII 6.1 "Activity Reports of Field Operations" (WHC 1988a). Items for entry will include borehole numbers, site location drawings, the names of site personnel, sampling types, and sampling intervals.

All boreholes will be logged according to EII 9.1, "Geologic Logging," (WHC 1988a). The geologic log will include the lithologic description, sample code, and depth; Hanford Environmental Information System (HEIS) numbers for each sample interval; borehole construction characteristics; screening results; and any general information the site geologist believes is pertinent to the characterization of the subsurface lithology. Each log sheet should contain no more than 20 ft of stratigraphic information.

3.3 PERCHED MONITORING WELLS

Perched monitoring wells may be constructed at the top of the caliche layer in borings 299-W19-97, 299-W19-95 and 299-W22-78 utilizing the guidance presented in "Generic Specification," WHC-S-014. When perched water is encountered at the top of the caliche layer, the amount of water and the estimated recovery rate will be determined. A water sample will also be obtained and analyzed at the 222-S Laboratory. The Remedial Investigation Coordinator will then convene a meeting with the regulatory agencies and an evaluation will be performed to determine if a perched monitoring well will be constructed.

3.4 PERCHED WATER AND SOIL SAMPLING

3.4.1 Perched Water Sampling

Perched water samples will be collected from the applicable boreholes and target horizons per EII 5.8, "Groundwater Sampling" (WHC 1988c) and will be analyzed for the analytes presented on Table 2.

3.4.2 General Sampling Requirements

Chemical, physical, and archive samples will be collected from each borehole using the split-spoon sampler in accordance with EII 5.2, Appendix B. If insufficient samples are obtained to satisfy the required analysis, the split spoon can be redriven. The chemical portion of the sample will take precedence over physical samples, which take precedence over archive samples. The drive barrel can be used to obtain physical and archive samples when

insufficient samples are obtained with the split spoon. An entry will be made in the borehole log identifying the sampling method using codes presented in Table 3.

3.4.3 Geologic and Archive Sampling

All material removed from a borehole will be identified and described by the geologist and summarized on the Borehole Log. Geologic samples for archive will be collected and described every 5 ft, at significant changes of lithology as determined by the field geologist, and from all other sampling points. Proposed sampling intervals and expected subsurface lithology are presented in Table 4 and in Appendix B.

The archive sample is to provide the geotechnical library with material from sampling intervals and to supply a representative physical record of the lithologies encountered during excavation activities. The field geologist shall archive only nonradioactive material. The field geologist will submit archive samples per EII 5.7A, "Hanford Geotechnical Sample Library Control" (WHC 1988d). Each archive sample will be labeled with the appropriate sample depth interval (to the nearest foot), date, and time the sample was obtained. Chain of Custody documentation as detailed in EII 5.1, "Chain of Custody" (WHC 1988d) will be prepared by the site geologist. Splits of samples will be labeled, placed in a plastic bag, and given to the HPT for survey and release evaluation. Each archive interval will be logged in the field logbook and the borehole log. Container requirements for archive samples are presented in Table 5.

3.4.4 Analytical Soil Sampling

Soil samples for chemical, physical, and radiological analysis will be collected as specified in the LFI (DOE-RL 1993a), section 5.3.2.3, Source Area Borings (Appendix A), EII 5.2, Appendix B, "Soil and Sediment Sampling" (WHC 1988a) and as described below. Packaging and shipping requirements for samples transported offsite shall be selected on the basis of total activity values and the preservation requirements applicable to the parameters of interest, as described in EII 5.11, "Sampling Packaging and Shipping" (WHC 1988a).

This DOW presents only general guidance for obtaining samples. Because of the unexpected variations occurring in the field, the site geologist will need to use professional judgment to determine the appropriate intervals for obtaining samples. The approximate sampling depths for each borehole are presented on Table 4 and Appendix B. Field screening will be used to ensure that the most contaminated material from each sampling interval is submitted for analysis. This will involve screening the ends of the split spoon after the drive head and shoe are removed. If radiological contamination does not exceed the criteria established in the Radiation Work Permit (RWP) for placement in the glove box, the split spoon will be opened and the liners surveyed. If an interval is identified (i.e., silt layer in a predominantly gravel unit) that is more contaminated than surrounding material, it will be separated from adjacent liners and a sample will be obtained. If insufficient material is present to satisfy all the bottle requirements for analysis, a composite sample will be obtained by mixing material from above and below the

contaminated interval. If radiological contamination exceeds the criteria established in the RWP, the split spoon will be opened in the glove box. Accurate screening of the sample cannot be performed outside the glovebox because of shielding.

Field screening will also be used to monitor drill cuttings obtained with the drive barrel and to identify alternate sampling points not presented in this DOW. For example, if a contaminate zone occurs (i.e., silt layer in a predominately gravel unit) before a designated sampling point, a sample will be obtained. When the designated sampling point is encountered, if screening indicates lower contamination than at the previous sampling point, no sample will be obtained. If screening indicates contamination is greater than the previous sampling point, a sample will be obtained.

All samples shall have a representative portion submitted to the 222-S Laboratory for total activity analysis. This will be utilized for sample pre-shipment characterization. Chemical and radiological samples with a total activity of less than the established lab criteria will be analyzed at an offsite laboratory. Those samples exceeding the lab criteria will be routed to a designated onsite laboratory for analysis. Onsite and offsite laboratories will be identified prior to initiating field activities and will be mutually acceptable to Hanford Analytical Services Management (HASM) and the cognizant engineer.

Samples collected for physical analysis and unconditionally released by the HPT as nonradioactive will be submitted to the Geotechnical Engineering Cold Laboratory. Radioactive physical samples that do not exceed 25 mrem will be submitted to the Geotechnical Engineering Hot Laboratory. Samples exceeding 25 mrem will be stored at a temporary radioactive storage area until a determination is made if they will be analyzed. Physical samples not tested will be disposed of as waste. All sample containers will be labeled with applicable borehole number, sampling date, time, depth interval to the nearest foot (physical samples only), HEIS number, requested analysis, and the sampler's initials.

Sample splits of intervals may be obtained for Ecology from each boring identified before the start of drilling. Ecology will be present and work in conjunction with the field team leader and the samplers to obtain sample splits. Ecology will assume responsibility that the samples are properly collected. Shipping requirements will be determined based on the total activities (i.e. if the samples are <50 pCi/g total activity, Ecology will ship; if >50 pCi/g, Westinghouse Hanford Company (WHC) will ship.

3.4.4.1 Physical Property Analysis. Samples for determining the physical parameters of crib material and the underlying sediments will be collected at each boring at the intervals presented in Table 4 and Appendix B. Chain of Custody documentation will be prepared by the site geologist for each day's sampling. The project geologist will supply HEIS numbers for physical samples to the site geologist at the beginning of borehole activities. Container requirements for physical samples are contingent on the size of material being sampled. Sample container requirements are presented in Table 5. Material larger than 7.62 (3 in.) will be removed from cuttings collected with the drive barrel before placing in the sample container. Analyses requested for samples collected with the drive barrel will be limited to tests that can be

performed on disturbed material (see Table 5). The applicable WHC Geotechnical Engineering Lab Gel numbers will be requested on the sampling and analysis request form. The following parameters using the American Society for Testing and Materials (ASTM) methods (LFI, DOE/RL-91-19) will be used on physical samples:

- Bulk density
- Particle size distribution (ASTM D422-63) (Gel-07)
- Moisture content (ASTM D2216) (Gel-14)
- CaCO₃ Content (Gel-19).

3.4.4.2 Chemical and Radiological Analysis. Soil samples for characterizing chemical and radiological contaminants will be collected from each boring at the intervals presented in Table 4 and Appendix B. Chain of custody documentation will be prepared by the Environmental Field Services (EFS) sampling scientist. Container and volume requirements for chemical and radiological samples are presented in Table 6. The laboratory will use existing Level IV CLP methods and methods approved under their contract for radiological analyses (Level V; Level III for anions). Samples will be analyzed for the constituents as specified in Table 6.

If full sample volume requirements cannot be met, the volume obtained will be recorded in the sampling scientist's logbook per EII 1.5, "Field Logbook" (WHC 1988a) and analyzed in the following order:

1. Radionuclides
2. Volatiles
3. Semivolatiles/PCB/pesticides
4. Target analyte list
5. Anions.

4.0 QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS

Internal quality control samples shall be collected at each facility by the sampling scientist as specified in *Quality Assurance Project Plan*, (DOE-RL 1993, Appendix A) with the revisions as outlined below. The sampling shall be documented in the sampling logbook per EII 1.5, "Field Logbooks" (WHC 1988a).

- Field Duplicate Samples. A minimum of one duplicate per borehole or one duplicate for every 20 samples shall be collected, whichever is greater. Duplicate samples shall be retrieved from the same sampling location using the same equipment and sampling technique and shall be placed in two sets of identically prepared and preserved containers. All field duplicates shall be analyzed independently to provide an indication of the reproducibility of sampling and/or analysis techniques.

- Split samples. At the direction of the cognizant engineer, and if a laboratory is designated, split samples shall be collected at the same frequency as duplicate samples.
- Field Blanks. Field blanks shall consist of silica sand transferred into clean sample containers at the site. Field blanks are used as a check on environmental contamination and shall be collected for each borehole, or one for every 20 samples, whichever is greater.
- Equipment Rinsate Blanks. Equipment rinsate blanks consist of pure deionized distilled water or silica sand (depending on the media being collected) that is run through decontaminated sampling equipment and placed in clean sample containers. Equipment blanks are used to verify the adequacy of sampling equipment decontamination procedures and shall be collected at the same frequency as field duplicate samples where applicable.
- Volatile organic analysis (VOA) trip blanks. The VOA trip blanks consist of silica sand added to clean sample containers accompanying each batch of coolers shipped to the analytical facility. Trip blanks shall be returned unopened to the laboratory and are prepared as a check on possible contamination originating from container preparation methods, shipment, handling, storage, or site conditions. The trip blank shall be analyzed for volatile organic compounds (EPA's target compound list).

5.0 SCHEDULE

The following schedule is for drilling in the 200-UP-2 Operable Unit for 1993 to 1994. This schedule is subject to change and the operable unit coordinator should be contacted for the current status. An agreement Activity Notification form will be issued at least 5 days before the start of field work.

Well Number	Drilling Dates
299-W19-95 (N. of U-16 Crib)	Late Aug. 1993 - Late Oct. 1993
299-W19-97 (W-5 Tile Field)	Mid Sep. 1993 - Mid Nov. 1993
299-W22-78 (U-12 Crib)	Mid Nov. 1993 - Late Dec. 1993
299-W19-96 (U-1/2 Crib)	Early Nov. 1993 - Late Dec. 1993
299-W19-98 (U-4/4A)	Late Dec. 1993 - Late Feb. 1994
299-W19-94 (U-8 Crib)	Mid Jan. 1994 - Early Mar. 1994

6.0 ALARA CONSIDERATIONS AND CHANGES TO THE DESCRIPTION OF WORK

All boreholes will be drilled utilizing the guidance of the As Low As Reasonably Achievable (ALARA) program. Boreholes will be located as close as possible to the crib structure to meet the data quality objectives for the project and avoid the potential of crib collapse.

Field changes to this DOW, such as a changing sampling methods, analyzing different parameters, using different analytical methods, or significantly changing the sampling interval, will be submitted on the attached form (Attachment 2) and kept on file with the operable unit coordinator. Copies will be submitted to the regulatory agencies and the appropriate field personnel within 10 working days of the occurrence.

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Figure 1. Proposed Borehole Site Location Map.

GEOSCI\061893C1

Figure 2a. Proposed Borehole Location Map (299-W19-96).

200UP2C3

Figure 2b. Proposed Borehole Location Map (299-W19-94).

200UP2H1

Figure 2c. Proposed Borehole Location Map (299-W22-78).

200UP2A1

Figure 2d. Proposed Borehole Location Map (299-W19-98).

200UP2G1

Figure 3. General Stratigraphic Column for 200-UP-2 Operable Unit.

GEOSCI\081293-B

Figure 4. Drilling with Three Strings of Casing.

GEDSCA\081203-C

Figure 5. Drilling with Two Strings of Casing.

Table 1. 200-UP-2 Contaminants of Concern. Sheet 1 of 2.

Contaminants of Concern	Direct Analysis	Indirect Analysis	Contaminants of Concern	Direct Analysis	Indirect Analysis
Gross Alpha	X		Gross Beta	X	
THORIUM/ URANIUM					
Th-230		NOTE 1	U-234	X	NOTE 10
Th-231		NOTE 2	U-235	X	NOTE 9
			U-238	X	NOTE 10
TRANSURANICS					
Np-237	X		Pu-241		NOTE 11
Np-239		NOTE 3	Am-241	X	
Pu-238	X		Am-243	X	NOTE 3
Pu-239/240	X		Cm-244	X	
FISSION/ ACTIVATION PRODUCTS					
H-3 (Note 12)	X		Tc-99	X	
C-14 (Note 12)	X		Ru-106		NOTE 6
Na-22	X		I-129	X	
Co-60	X		Cs-134	X	
Se-79	X		Cs-137	X	NOTE 7
Sr-90	X	NOTE 4	Ba-137m		NOTE 7
Y-90		NOTE 4	Sm-151	X	
Zr-93	X		Eu-152	X	
Nb-93m		NOTE 5	Eu-154	X	
			Eu-155	X	
OTHER RADIONUCLIDES					
K-40	X				
Tl-207		NOTE 2	Bi-214		NOTE 1
Pb-211		NOTE 2	Po-214		NOTE 1
Pb-214		NOTE 2	Po-218		NOTE 1
Bi-210		NOTE 1	Pa-231		NOTE 9
Bi-211		NOTE 2	Pa-234m		NOTE 10
HEAVY METALS					
Arsenic	X		Manganese	X	
Barium	X		Mercury	X	
Beryllium (Note 8)	X		Nickel	X	
Cadmium	X		Selenium	X	
Chromium	X		Silver	X	

Table 1. 200-UP-2 Contaminants of Concern. Sheet 2 of 2.

Copper	X		Titanium	X	
Iron	X		Vanadium	X	
Lead	X		Zinc	X	
OTHER INORGANICS					
Boron	X		Fluoride	X	
Cyanide	X		Nitrate	X	
Nitrite	X				
VOLATILE ORGANICS					
Acetone	X		MIBK ("hexone")	X	
Carbon tetrachloride	X		Toluene	X	
Chloroform	X		1,1,1-Trichlorethane	X	
Methylene chloride	X				
SEMIVOLATILE ORGANICS					
Kerosene	X		Tributyl phosphate	X	

NOTES:

- 1 This radionuclide is a decay progeny of uranium-238 and will be analyzed based on the concentration of uranium-238 determined through direct analysis.
- 2 This radionuclide is a decay progeny of uranium-235 and will be analyzed based on the concentration of uranium-235 determined through direct analysis.
- 3 The analysis of americium-243 is accomplished through analysis of its short-lived progeny neptunium-239.
- 4 The analysis of strontium-90 is accomplished through analysis of its short-lived decay progeny yttrium-90.
- 5 This radionuclide is a decay progeny of zirconium-93 and will be analyzed based on the concentration of zirconium-93 determined through direct analysis.
- 6 The analysis of ruthenium-106 is accomplished through analysis of its short-lived decay progeny rhodium-106.
- 7 The analysis of cesium-137 is accomplished through analysis of its short-lived decay progeny barium-137m.
- 8 Beryllium is being added to the list of contaminants of potential concern because it is a suspected human carcinogen, it is known to be common in Hanford Waste streams, and it is detected in environmental samples from other Hanford studies.
- 9 The analysis of uranium-235 can involve either direct measurement or is accomplished by analysis of its short-lived decay progeny protactinium-231.
- 10 The analysis of uranium-234 and uranium-238 can involved either direct measurement or is accomplished by analysis of the short-lived decay progeny protactinium-234m.
- 11 Plutonium-241 concentrations are inferred from the concentrations of plutonium-238, plutonium-239, and plutonium-240.
- 12 The Constituent is analyzed for only in water samples.

Table 2. Analytical Methods for Target Analytes (Perched Water).
(sheet 1 of 4)

Analyte ^{a/}	General Analytical Technique ^{b/}	Perched Water Analysis Method ^{c/}	Container and Volume ^{d/}	Comments
Gross Alpha	Gas proportional	h	f	-
Gross Beta				-
Acetone	Volatile Organic Analysis	CLP-VOAs	Gs 3 x 40 mL	-
Carbon Tetrachloride				-
Chloroform				Gs 2 x 40 mL
Methylene Chloride				-
MIBK (hexone)				-
1,1,1 Trichloroethane				-
Toluene				-
Americium-243 (NP-239)	Gamma Spectrometry	h	f	Am-243 measured by counting NP-239
Cesium-134				-
Cesium-137 (Ba-137m)				Cs-137 measured by counting Ba-137m
Cobalt-60				-
Europium-152				-
Europium-154				-
Europium-155				-
Potassium-40				-
Ruthenium-106				Ru-106 measured by counting Rh-106
Sodium-22				-
Uranium-235 (PA-231)	Alpha Spectrometry	h	f	For most samples U-235 measured by counting Pa-231
Uranium-234/238 (Pa-234m)				For most samples U-234/238 measured by counting Pa-234m

Table 2. Analytical Methods for Target Analytes (Perched Water).
(sheet 2 of 4)

Analyte ^a	General Analytical Technique ^b	Perched Water Analysis Method ^c	Container and Volume ^d	Comments
Americium-241	Alpha Spectrometry	h	f	May also use gamma spectrometry
Curium-244				-
Neptunium-237				-
Plutonium-238				-
Plutonium-239/240				-
Uranium-234 ^e	Alpha Spectrometry	h	f	-
Uranium-235 ^e				-
Uranium-238 ^e				-
Iodine-129	Beta Counting ^c	h	f	-
Strontium-90 (Y-90)				Sr-90 measured by counting Y-90
Technetium-99				-
Barium	ICP Analysis	CLP-Metals	g	-
Beryllium				-
Boron				-
Cadmium				-
Chromium				P 500 mL Weston
Copper				-
Iron				-
Lead				-
Manganese				-

Table 2. Analytical Methods for Target Analytes (Perched Water).
(sheet 3 of 4)

Analyte ^{d/}	General Analytical Technique ^{b/}	Perched Water Analysis Method ^{c/}	Container and Volume ^{d/}	Comments
Nickel	ICP Analysis	CLP-Metals	g	-
Silver				-
Titanium				P 500 mL Weston
Vanadium				-
Zinc				-
Arsenic	GFAA	CLP-Metals	g	-
Selenium	GFAA	CLP-Metals	g	-
Cyanide	Colorimetric	CLP-TAL	p 1000 mL	G 1000 mL
Tributyl Phosphate	GC	CLP-Semi-VOAs	3 x 1000 mL	aG 21 x 1000 mL
Selenium-79	Beta Counting ^{e/}	h	f	-
Samarium-151				-
Zirconium-93				-
Mercury	Atomic Adsorption	CLP-Metals	g	-
Kerosene	GCFID	8015 ⁱ	Gs 3 x 1000 mL	-
Nitrate	Colorimetric	353.2	P/G 300 mL	P/B 500 mL
Nitrite		353.2		-
Additional Analyses for Water Samples Only				
Fluoride	Ion Chromatography	300	300 mL	G 500 mL

Table 2. Analytical Methods for Target Analytes (Perched Water).
(sheet 4 of 4)

Analyte ^{a/}	General Analytical Technique ^{b/}	Perched Water Analysis Method ^{c/}	Container and Volume ^{d/}	Comments
Carbon-14	Beta Counting ^{e/}	h	G/P 1L	Not applicable for soil samples
Tritium	Scintillation	h	Gs 250 mL	Not applicable for soil samples

G = Glass; P = Plastic; Gs = Glass septum w/zero headspace; aG = amber Glass
TBD = To Be Determined

M = method modified to include extraction from the solid medium, extraction method is matrix and laboratory-specific

Prescribed Procedures for Measurement of Radioactivity in Drinking Water (EPA 1980a)

Test Methods for Evaluating Solid Waste (SW 846) Third Edition (EPA 1986)

Methods for Chemical Analysis of Water and Waste (EPA 1983)

Radionuclide Method for the Determination of Uranium in Soil and Air (EPA 1980b)

EML Procedures Manual (DOE/EML 1990)

Eastern Environmental Radiation Facility Radiochemistry Procedures Manual (EPA 1984)

High-Resolution Gamma-Ray Spectrometry of Water (ASTM 1985)

^{a/} In addition to the analytes listed in this table, there are many progeny isotopes whose concentrations may be derived from known parent concentrations. Radionuclides related to U-238 include: Th-230, Bi-210, Po-214, and Po-218. Radionuclides related to U-235 include: Th-231, Th-207, Pb-214, and Bi-211. Nb-93m is related to Zr-93. Pu-241 concentrations are inferred from Pu-238, Pu-239, and Pu-240. The radionuclides listed in parenthesis under the analyte column are measured as part of the analysis of the adjacent radionuclide.

^{b/} The analytical techniques are listed in the order that they should be performed. Gross alpha, gross beta, and VOA analyses will always be done first. Gamma Spectrometry will be done next because it generally does not require destruction of any sample. Alpha spectrometry, Sr-90 and Tc-99 analyses will next be done if sufficient sample exists. The next priority is to perform ICP analyses. Approximately 2 lbs (1 kg) of material will be required to perform these primary analyses. If more sample exists, then several additional, secondary analyses may be performed. These are shown on the table below the ICP analysis. In borings, additional drive samples should be collected, if possible, to insure that all analyses can be run.

^{c/} These analytical methods should be considered examples of possible analytical techniques to use. Individual labs may have other techniques developed for some analytes.

^{d/} The uranium analyses will be conducted periodically to confirm the uranium concentrations calculated from the Pa-234m or Pa-231 analyses. Two samples from each deep boring and one sample from each test pit or shallow boring will undergo this confirmatory analysis. No uranium analyses will be done on surface soil or sediment samples.

^{e/} Analytes that will be studied by beta counting are listed in the order that they should be analyzed. For instance, the Sr-90 analysis should be made first, followed by the Tc-99 analysis.

^{f/} All samples submitted for radionuclide analysis will be placed in 9 P/G 1000 mL bottles.

^{g/} All samples submitted for CLP-Metals analysis will be placed in a P 1000 mL bottle.

^{h/} Analytical methods for radionuclide analysis are laboratory specific and by contract with WHC, must meet analytical requirements for level IV. (Examples of standard methods include ASTM D3549, ASTM D3865, ASTM D3972, ASTM D2334.)

^{i/} Samples collected for the 200-UP-2 Limited Field Investigation (LFI) activities that require analysis for kerosene will be analyzed at TMA by SW-846 method 8015. Kerosene is not listed in the SW-846 reference procedure as a compound that is included on the target list for 8015, Non-Halogenated Volatile Organics. Through its contract with WHC, TMA has adapted method 8015 to include kerosene as a target compound using its characteristic "fingerprint."

^{j/} Volumes listed are for TMA except where noted in comment column for split analysis where bottle size differs.

Table 3. Sampling Codes.

Sample Type	Sample Type Designation	Purpose of Sample
Archive	AR	Provide samples for future data needs.
Physical	PH	Provide material for determination of physical characteristics of vadose zone.
Chemical	CH	Provide material for chemical analysis to determine contaminant inventory and extent of contamination in the vadose zone.

Table 4. Proposed Sampling Intervals. (sheet 1 of 2)

Borehole Location 299-W19-96 216-U-1 Crib		Borehole Location 299-W19-95 S. OF 216-U-1 Crib		Borehole Location 299-W19-97 N. OF 216-U-1 Crib	
Chemical Sample Depth (Ft)	Physical Sample Depth (Ft)	Chemical Sample Depth (Ft)	Physical Sample Depth (Ft)	Chemical Sample Depth (Ft)	Physical Sample Depth (Ft)
15	NA	15	NA	5	NA
20	NA	NA	17	10	NA
22	NA	30	NA	NA	12
24	NA	NA	32	20	NA
30	NA	45	NA	30	NA
NA	32	NA	47	NA	32
35	NA	60	NA	50	NA
40	NA	NA	62	NA	52
NA	42	75	NA	70	NA
45	NA	NA	77	NA	72
50	NA	90	NA	100	NA
NA	52	NA	92	NA	102
60	NA	105	NA	130	NA
NA	62	NA	107	NA	132
80	NA	120	NA	146	NA
NA	82	NA	122	NA	148
100	NA	140	NA	156	NA
NA	102	NA	142	NA	158
120	NA	165	NA	164	NA
NA	122	NA	167	NA	166
140	NA	180	NA		
NA	142	NA	182		
164	NA	190	NA		
NA	166	NA	192		
177	NA				
NA	179				
Total: 16	Total: 10	Total: 12	Total: 12	Total: 12	Total: 9
Caliche layer at ~ 169-176 ft		Caliche layer at ~ 168-178 ft		Caliche layer at ~ 149-165 ft	

Table 4. Proposed Sampling Intervals. (sheet 2 of 2)

Borehole Location 299-W19-94 216-U-8 Crib		Borehole Location 299-W19-98 U-4/U4A Reverse Well, French Drain		Borehole Location 299-W22-78 216-U-12 Crib	
Chemical Sample Depth (ft)	Physical Sample Depth (ft)	Chemical Sample Depth (ft)	Physical Sample Depth (ft)	Chemical Sample Depth (ft)	Physical Sample Depth (ft)
15	NA	5	NA	10	NA
28	NA	NA	7	NA	12
30	NA	10	NA	30	NA
32	NA	NA	12	NA	32
38	NA	15	NA	50	NA
NA	40	25	NA	NA	52
43	NA	NA	27	70	NA
48	NA	40	NA	NA	72
NA	50	NA	42	90	NA
53	NA	60	NA	NA	92
58	NA	NA	62	110	NA
NA	60	75	NA	NA	112
68	NA	80	NA	130	NA
NA	70	NA	82	NA	132
88	NA	85	NA	150	NA
NA	90	90	NA	NA	152
108	NA	100	NA	170	NA
NA	110	NA	102	NA	172
128	NA	120	NA	183	NA
NA	130	NA	122	NA	185
148	NA	140	NA	194	NA
NA	150	NA	142	NA	196
168	NA	160	NA		
NA	170	NA	162		
197	NA	180	NA		
NA	199	NA	182		
207	NA	195	NA		
NA	209	NA	197		
		205	NA		
		NA	207		
Total: 17	Total: 11	Total: 17	Total: 13	Total: 11	Total: 11
Caliche layer at ~190-200 ft		Caliche layer at ~183-205 ft		Caliche layer at ~185-195 ft	

Table 5. Container Sampling Requirements.

Analyses	Drive Barrel	Split Spoon
Archive	2 mason jars or 1 bag+	1-2 liners
Sieving* (Gel-07)	1 moisture tin or 1 mason jar or 1 bag+	1 liner
Moisture content* (Gel-14)	1 moisture tin or 1 mason jar or 1 bag+	Combine analyses with above liner
Calcium carbonate* (Gel-19)	Combine analyses with above samples	Combine analyses with above liner
Bulk mass* density	Not taken	Combine analyses with above liner
HPT release	1 plastic bag	1 plastic bag

*=Westinghouse Hanford Company Geotechnical Engineering Lab method procedure number (Gel-#)

+ = Container type dependent upon size of material sampled.

Table 6. Analytical Methods for Target Analytes (Soils).
(sheet 1 of 4)

Analyte "	General Analytical Technique ^{a/}	Soil and Sediment Analysis Method ^{c/}	Container and Volume	Comments
Gross Alpha Gross Beta	Gas proportional	h	f	-- --
Acetone Carbon Tetrachloride Chloroform Methylene Chloride MIBK (hexone) 1,1,1 Trichloroethane Toluene	Volatile Organic Analysis	CLP-VOAs	GS 250 ml	-- -- -- -- -- --
Americium-243 (NP-239) Cesium-134 Cesium-137 (Ba-137m) Cobalt-60 Europium-152 Europium-154 Europium-155 Potassium-40 Ruthenium-106 Sodium-22 Uranium-235 (PA-231)	Gamma Spectrometry	h	f	Am-243 measured by counting NP-239 -- Cs-137 measured by counting Ba-137m -- -- -- -- -- Ru-106 measured by counting Rh-106 -- For most samples U-235 measured by counting Pa-231
Uranium-234/238 (Pa-234m)	Alpha Spectrometry	h	f	For most samples U-234/238 measured by counting Pa-234m

Table 6. Analytical Methods for Target Analytes (Soils).
(sheet 2 of 4)

Analyte ^{a/}	General Analytical Technique ^{b/}	Soil and Sediment Analysis Method ^{c/}	Container and Volume	Comments
Americium-241 Curium-244 Neptunium-237 Plutonium-238 Plutonium-239/240 Uranium-234 ^{d/}	Alpha Spectrometry	h	f	May also use gamma spectrometry -- -- -- -- --
Uranium-234 ^{d/} Uranium-238 ^{d/}	Alpha Spectrometry	h	f	-- --
Iodine-129 Strontium-90 (Y-90) Technetium-99	Beta Counting ^{c/}	h	f	Sr-90 measured by counting Y-90 --
Barium Beryllium Boron Cadmium Chromium Copper Iron Lead Manganese	ICP Analysis	CLP-Metals	g	-- -- -- -- -- -- -- --

Table 6. Analytical Methods for Target Analytes (Soils).
(sheet 3 of 4)

Analyte ^{a/}	General Analytical Technique ^{b/}	Soil and Sediment Analysis Method ^{c/}	Container and Volume	Comments
Nickel	ICP Analysis	CLP-Metals	g	--
Silver				--
Titanium				--
Vanadium				--
Zinc				--
Arsenic	GFAA	CLP-Metals	g	--
Selenium	GFAA	CLP-Metals	g	--
Cyanide	Colorimetric	CLP-TAL	G 125 ml	--
Tributyl Phosphate	GC	CLP-Semi-VOAs	ag 250 ml	--
Selenium-79	Beta Counting	h	f	--
Samarium-151				--
Zirconium-93				--
Mercury	Atomic Adsorption	CLP-Metals	g	--
Kerosene	GCFID	8015'	Gs 125 ml	--
Nitrate	Ion Chromatography	300	Gs 125 ml	--
Nitrite		300		--
Additional Analyses for Water Samples Only				
Fluoride		300	G 125 ml	--

Table 6. Analytical Methods for Target Analytes (Soils).
(sheet 4 of 4)

Analyte ^a	General Analytical Technique ^b	Soil and Sediment Analysis Method ^c	Container and Volume	Comments
Carbon-14	Beta Counting	--	--	Not applicable for soil samples
Tritium		--	--	Not applicable for soil samples

G = Glass; P = Plastic; Gs = Glass septum w/zero headspace; aG = amber Glass
TBD = To Be Determined
M = method modified to include extraction from the solid medium, extraction method is matrix and laboratory-specific

Prescribed Procedures for Measurement of Radioactivity in Drinking Water (EPA 1980a)

Test Methods for Evaluating Solid Waste (SW 846) Third Edition (EPA 1986)

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High-Resolution Gamma-Ray Spectrometry of Water (ASTM 1985)

^a In addition to the analytes listed in this table, there are many progeny isotopes whose concentrations may be derived from known parent concentrations.

Radionuclides related to U-238 include: Th-230, Bi-210, Po-214, and Po-218. Radionuclides related to U-235 include: Th-231, Ti-207, Pb-214, and Bi-211. Nb-93m is related to Zr-93. Pu-241 concentrations are inferred from Pu-238, Pu-239, and Pu-240. The radionuclides listed in parenthesis under the analyte column are measured as part of the analysis of the adjacent radionuclide.

^b The analytical techniques are listed in the order that they should be performed. Gross alpha, gross beta, and VOA analyses will always be done first. Gamma Spectrometry will be done next because it generally does not require destruction of any sample. Alpha spectrometry, Sr-90 and Tc-99 analyses will next be done if sufficient sample exists. The next priority is to perform ICP analyses. Approximately 2 lbs (1 kg) of material will be required to perform these primary analyses. If more sample exists, then several additional, secondary analyses may be performed. These are shown on the table below the ICP analysis. In borings, additional drive samples should be collected, if possible, to insure that all analyses can be run.

^c These analytical methods should be considered examples of possible analytical techniques to use. Individual labs may have other techniques developed for some analytes.

^d The uranium analyses will be conducted periodically to confirm the uranium concentrations calculated from the Pa-234m or Pa-231 analyses. Two samples from each deep boring and one sample from each test pit or shallow boring will undergo this confirmatory analysis. No uranium analyses will be done on surface soil or sediment samples.

^e Analytes that will be studied by beta counting are listed in the order that they should be analyzed. For instance, the Sr-90 analysis should be made first, followed by the Tc-99 analysis.

^f All samples submitted for radionuclide analysis will be placed in a P/G 750 ml bottle.

^g All samples submitted for CLP-Metals analysis will be placed in a P 250 ml bottle.

^h Analytical methods for radionuclide analysis are laboratory specific and by contract with WHC, must meet analytical requirements for level IV. (Examples of standard methods include ASTM D3549, ASTM D3865, ASTM D3972, ASTM D2334.)

ⁱ Samples collected for the 200-UP-2 Limited Field Investigation (LFI) activities that require analysis for kerosene will be analyzed at TMA by SW-846 method 8015. Kerosene is not listed in the SW-846 reference procedure as a compound that is included on the target list for 8015, Non-Halogenated Volatile Organics. Through its contract with WHC, TMA has adapted method 8015 to include kerosene as a target compound using its characteristic "fingerprint."

TELEPHONE CONFERENCE MEMORANDUM

Company: WHC

Address:

[] INCOMING [X] OUTGOING

DATE: April 9, 1993

TIME: 9:00 a.m.

WITH: K. Kowalik *K.K. 4.14.93*

OF: Ecology

PHONE: 206-438-7525

WITH: Marty Gardner

OF: Environmental Field Services PHONE: 376-2908

Copies to:

Name

Address

M. G. Gardner

N3-06

R. L. Jackson *RJ*

H6-06

J. F. Keller

L4-33

K. D. Reynolds

H6-06

R. R. Thompson

L4-36

Subject: Discussion of: 1) Remediation of Z-20 wells - 299-W18 - 17, 18, 19 and 20
 2) Geohydrologic conditions at U-14 Ditch

Geosciences Function

 K. D. Reynolds

372-0540

Department

Telephone #

Summary of Conference

- 1) A detailed discussion of cementing plans for the four wells along the Z-20 Ditch was held. K. D. Reynolds explained the reasoning and data used to define the intervals selected for cementing. M. D. Gardner explained the techniques that will be employed. After discussion, K. Kowalik gave verbal approval to proceed with the planned remediation.
- 2) A brief discussion of the current knowledge of the perching conditions being encountered at the U-14 Ditch drilling project was held. Based on information gathered from 299-W18-250 and 251 and from wells in the area WHC Geosciences and K. Kowalik of State of Washington Department of Ecology agreed that the Touchet facies of the Hanford formation should be treated as a single hydrologic unit and no technical purpose would be served by attempting to seal individual silt/clay beds within the Touchet member.

Attachment 2

200-UP-2 DESCRIPTION OF WORK

PROJECT CHANGE FORM

Date:

Person Initiating Change:

Change:

Reason for Change:

APPROVAL:

Field Team Leader:

Operable Unit Coordinator:

Quality Assurance:

APPENDIX A

FIELD ACTIVITIES -

5.3 FIELD ACTIVITIES (TASKS 2 TO 6)

This section describes the field activities to be performed for the LFI. The field activities are designed to accomplish the following tasks: source characterization (Task 2), geologic investigation (Task 3), surface water sediment investigation (Task 4), vadose zone investigation (Task 5), and air investigation (Task 6). These tasks are described in Section 5.1. Section 5.3 is intended to provide sufficient detail for field data gathering activities to prepare specific DOWs for these tasks.

Table 5-7 summarizes the field activities that are planned at each waste management unit and unplanned release site. Several activities that are not associated with individual waste management units are listed on the table under their own headings. In addition, the table has been divided between primary field activities and supporting field activities. Supporting field activities must generally be conducted along with each of the primary field activities. The subsections of this work plan describing each field activity and waste management unit are also listed on the table.

Section 5.3.1 discusses the locations and frequencies of each activity, and is subdivided by waste management unit and unplanned release. The protocols and procedures for each type of field activity are described in Section 5.3.2. Section 5.3.3 describes the laboratory analyses that each sample will undergo.

5.3.1 Sampling Locations and Frequencies

The sampling locations and frequencies of many of the later activities are contingent upon the results of the initial activities. The general order of activities at each waste management unit will include the following:

- (1) Surface radiation surveys
- (2) Subsurface spectral geophysics on appropriate existing wells
- (3) Electromagnetic (EM) surveys
- (4) Ground penetrating radar (GPR) surveys
- (5) Surface soil and surface water sediment sampling
- (6) Test pits
- (7) Borings with spectral geophysics as casing is telescoped
- (8) Perched water sampling.

Surface radiation surveys are run for both health and safety reasons and to identify surface soil or sediment sampling locations. If no surface contamination is detected during the initial surface radiation survey and no surface contamination is expected, as at surface stabilized areas, then no surface soil or sediment sampling will occur at that waste management unit. Subsurface investigation such as borings and test pits will proceed whether or not surface contamination is detected. Surface geophysics and surface radiation survey results will be used to locate subsurface soil sampling (boring) locations in cases where no engineering drawings are available for the facility.

Subsurface spectral gamma logging will also be used to refine the sampling intervals in nearby proposed borings.

The proposed field activities at each waste management unit are described below.

5.3.1.2 Cribs. Field activities are planned at the 216-U-1/216-U-2 and 216-U-8 Cribs. The 216-U-12, 216-U-16 and 216-U-17 Cribs are considered analogous to these facilities and will not undergo field investigations of their own (see Section 4.2.3). The 216-U-3 French Drain is also considered analogous to these cribs.

216-U-1 and 216-U-2 Cribs. A surface radiation survey will be run over and adjacent to the cribs. This survey will be run in conjunction with surveys of the 2607-W-5 Septic Tank and Drain Field, the 241-U-361 Settling Tank, and Unplanned Release UN-200-W-19 and will cover an area of approximately 7,500 m² (80,730 ft²) (Figure 5-1). The entire area surrounding the cribs was interim stabilized in December 1991, so no surface contamination is expected. If surface contamination is detected, up to five soil samples may be collected from the area covered by the unified survey. Two of the five samples may be collected in the vicinity of the cribs. Nearby existing monitoring wells, 299-W19-3 and 299-W19-9, will undergo RLS gamma spectrometer surveys. Well 299-W19-11 has already undergone RLS gamma logging (Section 3.1). An inventory of the actual daily discharge to the 2607-W5 Drain Field will be made to help predict the likelihood of perched water formation.

One soil boring will be made through the 216-U-1 Crib (Figure 5-1). The crib has collapse potential so an evaluation must be completed to determine whether a special drilling platform will be required for the drill rig (Section 5.3.2.1). The boring will extend to the caliche layer (about 50 m [160 ft]) and at least one physical and chemical sample will be collected in the caliche. Figure 5-2 depicts a cross-sectional view of the boring and its relationship to the cribs. Figure 5-3 is a schematic diagram of the boring showing the sample locations for the chemical and physical samples.

The sampling protocol for the boring through the 216-U-1 Crib will be:

- **Chemical Samples**—Collect one sample from 4.6 m (15 ft) below the surface, immediately above the open crib structure. Measuring from the base of the open crib structure (approximately 6 m [20 ft] deep) collect chemical samples beginning at the following depths: 0, 0.6, 1.2, 3, 4.6, 6, 8, 9, 12, 18, 24, 30, 37, and 43 m (0, 2, 4, 10, 15, 20, 25, 30, 40, 60, 80, 100, 120, 140, and 160 ft). The actual number of samples sent for analysis may be reduced based on field screening results (Section 5.3.2.3). The sample intervals may be modified based on the results of spectral gamma logging at nearby existing wells (5.3.2.5).
- **Physical Samples**—Physical samples will be collected beginning at the following depths from below the base of the crib: 4, 7, 10, 13, 19, 25, 31, 37, and 43 m (12, 22, 32, 42, 62, 82, 102, 122, 142, and 162 ft). Additional samples may be collected at major changes of stratigraphy or water content. A portion of each nonradioactive sample will be archived.

A second boring will be located midway between the 216-U-1/216-U-2, and 216-U-16 Cribs (Plate 1). This boring is placed here to characterize the extent of remobilization of 216-U-1/216-U-2 Cribs contaminants by 216-U-16 Crib wastewater. This boring will extend to the groundwater (about 62 m [203 ft]) unless perched water is encountered, in which case it will extend to the caliche layer (about 50 m [160 ft]). Figure 5-3 is a schematic diagram of this boring showing the location of chemical and physical samples.

The sampling protocol for the boring between the three cribs will be:

- **Chemical Samples**—Collect samples beginning at the following depths below the surface: 4.6, 9, 14, 18, 23, 27, 32, 37, 43, 49, 55, and 61 m (15, 30, 45, 60, 75, 90, 105, 120, 140, 160, 180, and 200 ft). Each sample will undergo immediate field screening (Section 5.3.2.3). If it does not exceed contaminant action levels, it will not be sent to the laboratory for further analysis. Regardless of the field screening results, the two samples collected immediately above the caliche layer (43 and 49 m [140 and 160 ft]) will be sent to the laboratory for analysis, and at least one sample from below the caliche layer (or in the caliche should perched water be encountered) will be sent for analysis.
- **Physical Samples**—Collect samples beginning at the following depths below the surface: 5, 10, 14, 19, 23, 28, 33, 37, 43, 49, 51, and 61 m (17, 32, 47, 62, 77, 92, 107, 122, 142, 162, 182, and 202 ft). Additional samples may be collected at major changes of stratigraphy or water content. A portion of each nonradioactive sample will be archived.

A third boring will be placed north of the 216-U-1 and 216-U-2 Cribs, adjacent to the 2607-W-5 Septic Tank and Drain Field. This boring is shown on Figure 5-1. This boring will help characterize the northern extent of contamination from the cribs and determine if perched water zones are forming beneath the active 2607-W-5 Drain Field. The boring will extend to groundwater (about 62 m [203 ft]) unless perched water is encountered in which case it will extend to the caliche layer (about 50 m [165 ft]). Figure 5-3 is a schematic diagram of this boring showing the location of chemical and physical samples.

The sampling protocol for this boring will be:

- **Chemical Samples**—Collect samples beginning from the following depths below the surface: 2, 3, 5, 9, 15, 20, 30, 40, 49, 55, and 61 m (5, 10, 20, 30, 50, 70, 100, 130, 160, 180, and 200 ft). Each sample will undergo immediate field screening if it does not exceed contaminant action levels (Section 5.3.2.3), then it will not be sent to the laboratory for further analysis. Regardless of the field screening results, the two samples collected immediately above the caliche layer (40 and 49 m [130 and 160 ft]) will be sent to the laboratory for analysis, and at least one sample from below the caliche layer (or in the caliche should perched water be encountered) will be sent for analysis.
- **Physical Samples**—Collect samples beginning from the following depths below the surface: 3.5, 9.5, 16, 22, 31, 40, 49, 55, and 61 m (12, 32, 52, 72, 102, 132, 162, 182, and 202 ft). Additional samples may be collected at major changes of stratigraphy or water content.

Both holes will undergo RLS spectral gamma logging.

216-U-8 Crib. A surface radiation survey will be run over the crib (approximately 75 x 75 m [250 x 250 ft]) (Figure 5-4). This area has not been surface stabilized so at least one and up to two surface soil samples may be collected from the most highly contaminated areas. The RLS gamma spectrometer surveys will be run at nearby existing Wells 299-W19-69, 299-W19-70, 299-W19-71, and 299-W22-62.

One soil boring will be made through the middle open wood structure in the crib (Figure 5-4). The crib has collapse potential so an evaluation must be completed to determine whether a special drilling platform will be required for the drill rig. The boring will extend to the caliche layer (about 61 m [200 ft]) and at least one physical and chemical sample will be collected from the caliche. Figure 5-5 is a cross-sectional view of the boring and its relationship to the crib. Figure 5-6 is a schematic diagram of the boring showing the locations of chemical and physical samples. An RLS gamma spectrometer survey will be conducted as the boring is being made.

The sampling protocol for this boring will be:

- **Chemical Samples**—Collect one sample about 4.6 m (15 ft) below the surface, immediately above the open wood structure. Measuring from the base of the open crib structure (about 8.5 m [28 ft]) collect samples beginning at: 0, 0.6, 1, 3, 4.6, 6, 7.6, 9, 10, 20, 25, 30, 40, 43, and 50 m (0, 2, 4, 10, 15, 20, 25, 30, 40, 60, 80, 100, 120, 140, and 160 ft). The actual number of samples sent for analysis may be reduced based on field screening results (Section 5.3.2.3). The sample intervals may be modified based upon the results of spectral gamma logging at nearby existing wells (5.3.2.5).
- **Physical Samples**—Collect samples beginning at the following intervals beneath the open crib structure: 4, 7, 10, 13, 19, 25, 31, 37, 43, and 49 m (12, 22, 32, 42, 62, 82, 102, 122, 142, and 162 ft). Additional samples may be collected at major changes of stratigraphy or water content. A portion of each nonradioactive sample will be archived.

5.3.1.3 Drains and Reverse Wells. Field activities are planned at the 216-U-4 Reverse Well and 216-U-4A French Drain. The 216-U-4B and 216-U-7 French Drains are considered analogous to these units. The 216-U-3 French Drain is considered analogous to the cribs that were selected for study.

216-U-4 Reverse Well/216-U-4A French Drain. The 216-U-4 Reverse Well and the 216-U-4A French Drain are only 2.4 m (8 ft) apart and are being studied together. A surface radiation survey will be conducted over a 4.6 x 4.6 m (15 x 15 ft) area on the ground surrounding the two units (Figure 5-7). One surface soil sample will be collected from the most contaminated area or from between the two units if no radionuclide contamination is detected. A soil boring to the caliche layer (about 61 m [200 ft]) will be collared as close as possible to midway between the two units. At least one physical and chemical sample will be collected in the caliche. Figure 5-8 is a schematic diagram showing the chemical and physical sample intervals in the boring.

The sampling protocol for this boring will be:

- **Chemical Samples**—Collect samples beginning at the following depths below the surface: 2, 3, 4.6, 7.6, 12, 20, 24, 26, 27, 30, 33, 37, 43, 49, and 55 m (5, 10, 15, 25, 40, 60, 75, 80, 85, 90, 100, 120, 140, 160, and 180 ft). The actual number of samples sent for analysis may be reduced based on field screening results (Section 5.3.2.3).
- **Physical Samples**—Collect samples beginning at the following depths below the surface: 4, 8, 13, 19, 25, 31, 37, 43, 49, and 55 m (12, 27, 42, 62, 82, 102, 122, 142, 162, and 182 ft). Additional samples may be collected at major changes of stratigraphy or water

content. A portion of each nonradioactive sample will be archived.

216-U-10 Pond System Sampling. A unified surface radiation survey will be run over the 216-U-10 Pond, the 216-U-11 Trench, the 216-U-14 Ditch, the 216-Z-1D Ditch, the 216-Z-11 Ditch and the 216-Z-19 Ditch (Figure 5-9). This survey will cover an approximate area of 372,000 m² (4,000,000 ft²). If contamination is detected, up to ten surface soil samples may be collected from the most contaminated areas. This area has been surface stabilized, so if no radionuclide contamination is detected during the survey no samples need to be collected.

One test pit to an approximate depth of 11 m (35 ft) will be excavated in the center of the 216-U-10 Pond delta area (Figure 5-9). Chemical samples will be collected at the base of the clean fill cover (about 1 m [3 ft] below the surface) and at 1.5, 3, 6, and 11 m (5, 10, 20, and 35 ft) below the surface. A physical sample representative of the material underlying the pond fill (below 1 m [3 ft]) will also be taken.

One test pit will also be dug through the center of the 216-U-10 Pond to an approximate depth of 11 m (35 ft). Chemical samples will be collected at the base of the clean fill (about 1.5 m, 5 ft from the surface), and at 3, 4.5, 7.5, and 11 m (10, 15, 25, and 35 ft) below the surface. These depths are approximate, and the excavated material should be screened in the field so that the most contaminated soils are sampled. A physical sample representative of the material underlying the old pond (below 2 m [6 ft]) will also be taken.

5.3.1.6 Nonsite-Specific Activities. Nonsite-specific activities include perched water sampling, air sampling, and a pipeline integrity assessment.

5.3.1.6.1 Perched Water Sampling. Six deep borings are planned for the 200-UP-2 Operable Unit investigation. If perched water is encountered in any of these borings then a perched water well will be installed against the water-bearing interval. The proposed locations of these borings are three at the 216-U-1/216-U-2 Cribs, and one at the 216-U-4 Reverse Well/216-U-4A French Drain, the 216-U-8 Crib, and the 216-U-12 Crib. One perched water sample will be collected from each of these wells. In addition, four existing wells, 299-W-19-22, 299-W-19-91, 299-W-19-92, and 299-W-19-93 will be sampled if they are found to contain perched water. The locations of the existing wells and the new borings are shown on Plate 1.

5.3.1.6.4 216-U-12 pH Boring. A boring is planned immediately adjacent to the 216-U-12 Crib (Figure 5-12). The boring will extend to the caliche layer and laboratory samples will be collected at approximate 6 m (20 ft) intervals (Figure 5-13) and at significant changes in lithology or CaCO₃ content. At least one sample will be collected from the caliche. A perched water well will be installed in the boring if water is encountered above the caliche layer. The boring will undergo spectral gamma logging as described in Section 5.3.2.5. The samples will only be analyzed for pH, CaCO₃ content, total uranium, and nitrate. At least one sample will be collected from the upper part of the caliche layer.

5.3.2 Protocols and Procedures

5.3.2.3 Source Area Borings. Six deep borings will be made during the 200-UP-2 Operable Unit field investigations (Table 5-7). Additional shallow

borings may be required if conditions prevent test pits to be excavated at one of the proposed sites or if a test pit reaches its maximum depth and still is in contaminated material (Section 5.3.2.5). Each deep boring will extend to the caliche layer, which is generally between 46 and 60 m (150 and 200 ft) deep. If perched water is encountered in the boring, a well will be installed that is screened against the water-bearing interval.

Drilling. The borings will be sited to avoid buried obstructions and to target areas that appear most contaminated. Before drilling commences, an onsite and offsite utility check should be performed and the area checked with a pipe and cable locator. In all cases, drilling will also be preceded by a surface radiation survey of the area and at some locations (Table 5-1) surface geophysics and oil gas surveys. If a boring through a crib encounters contamination at such high levels that it cannot be continued as determined by health physics personnel, it should be abandoned and a new boring begun immediately outside the crib. Also, if a boring does not encounter a caliche layer or another significant aquitard at the same approximate depth, it will extend to the groundwater (unconfined aquifer).

The drilling technique used on the boreholes will be the cable-tool method or one of other acceptable technologies. Drilling operations will be conducted according to EII 6.7, "Resource Protection Well and Test Borehole Drilling," and EII 5.4, "Field Decontamination of Drilling, Well Development and Sampling Equipment" (WHC 1988a). A short drive barrel or split-spoon sampler (0.6 m [2 ft] maximum length) will be used to remove soils (slough and/or pristine material) from the borehole between sampling intervals. Hard tool drilling will only be initiated as a last resort when drilling conditions are not conducive to the use of the drive barrel or split-spoon sampler. The decision to drill with the hard tool will be made by the drilling field team leader only after consultation with the well-site geologist and/or the project coordinator.

Temporary casing will be driven frequently to minimize the slough in the borehole. Casings will be telescoped through intervals of contamination to limit the driving of contaminants deeper into the vadose zone. The approximate casing sizes to be used will be 15, 20, and 25 cm (6, 8, and 10 in.) casings. The casings will be telescoped as contaminant concentrations decrease. The 25 cm (10 in.) casing will be run to at least 2 m (7 ft) below the crib or french drain and will be telescoped when grab samples from the boring are less than 5,000 ct/min according to field screening. The 20 cm (8 in.) casing will be used to control gross contamination from 500 to 5,000 ct/min. The 15 cm (6 in.) casing will be used to control gross contamination below 500 ct/min. For borings at which little or no contamination is expected, such as at the 2607-W-5 Septic Tank and Drain Field or at the boring between the 216-U-1/216-U-2 and 216-U-16 Cribs, only 15 and 20 cm (6 and 8 in.) casings need be used. For the shallow boring at the 216-U-10 Pond, only 15 cm (6 in.) casings will be used. Whenever the casing is telescoped, an RLS gamma spectrometer survey will be run on the hole. The survey procedures are outlined in Section 5.3.2.6.

As drilling proceeds, the well-site geologist will be responsible for completing the borehole geologic log. The borehole geologic log will be completed according to EII 9.1, "Geologic Logging" (WHC 1988a). The geologic log will contain sample type and depth, lithologic description, crib construction characteristics, and any other geologic information the well-site geologist believes is pertinent to the characterization of the subsurface stratigraphy. Each log sheet should contain no more than 3 m (10 ft) of stratigraphic information.

If perched water is encountered in a boring, a perched water well will be installed that is screened against the water-bearing interval. Each telescoped casing will be cut and left in place so that it extends about 1 m (3 ft) in the larger-diameter casing above. Any hole that does not encounter perched water will be abandoned. Holes will be abandoned according to the procedures outlined in EII 6.10, "Abandoning/Decommissioning Ground Water Wells" (WHC 1988a).

Perched water wells will be installed after the boreholes have been advanced to the proper depth. The design and specification of these wells will be according to the information presented in WHC-S-014 (Hodge 1990). In general, the wells will be constructed of 0.1 m (4 in.) inner diameter 304 stainless steel, joint-threaded casing, and wire-wrapped well screen. The screen slot and pack sand size will be determined from the results of sieve analyses. The wells will be installed according to procedures outlined in EII 6.8, "Well Completion" (WHC 1988a).

Sampling. Chemical, physical, and archive samples will be collected from each borehole. The split-spoon sampler will be the primary device for collecting these samples. If an insufficient sample is collected with the split-spoon, an alternative sampling method may be used, such as repeating the sampling at the same interval. All split-spoon sampling depths will be recorded to the nearest 0.025 m (0.10 of a foot). All depths will be recorded to the nearest 0.025 m (0.10 of a foot). The chemical, physical, and archive sampling intervals are unit- and depth-specific and are described along with the individual borings in Section 5.3.1. The sampling intervals are only approximate depths and may be modified at the discretion of the onsite geologist. If perched water is encountered in a boring the sampling interval should be modified such that at least one chemical and physical sample is collected in the saturated zone. Physical and chemical samples are generally grouped together so that the two sets of data may be compared. Chemical samples always take precedence over physical samples, which take precedence over archive samples. Sample intervals may be extended by driving the split-spoon sampler a second time if an insufficient sample is collected during the first attempt. It should be noted that some borings will require continuous sampling over part of their length to meet these sampling requirements. This is particularly true of the first 4.5 m (15 ft) drilled beneath each of the cribs.

Chemical samples will be collected in accordance with EII 5.2, "Soil and Sediment Sampling" (WHC 1988a). Chemical samples will be collected with a split-spoon sampler with stainless steel liners. Drilling personnel will not overdrive the sampling device. The split-spoon and liners will be decontaminated before use according to EII 5.5, "1706 KE Laboratory Decontamination of Resource Conservation and Recovery Act/Comprehensive Environmental Response, Compensation, and Liability Act (RCRA/CERCLA) Sampling Equipment" (WHC 1988a). Prior to sampling, slough in the borehole will be removed to the greatest extent possible. Sampling personnel will transfer samples from the split-spoon liners to the appropriate sample containers and preserve them in accordance with the EPA guidelines set forth in *Test Methods for Evaluating Solid Wastes* (EPA 1986). All chemical samples will be geologically logged by the well-site geologist. Chemical samples will be labeled with the appropriate Hanford Environmental Information System (HEIS) number to accommodate sample tracking and data entry into the HEIS system.

All samples and cuttings will be field screened for evidence of volatile organics and radionuclides. Volatiles will be screened by the field geologist or other qualified personnel using an organic vapor monitor. Radionuclides will be screened by alpha and gamma counting instruments. All instruments

will be used, maintained, and calibrated consistent with EII 3.2, "Calibration and Control of Monitoring Instruments" (WHC 1988a), and EII 3.4, "Field Screening" (WHC 1988a). Radionuclides will be screened according to EII 3.4, "Field Screening" (WHC 1988a). The field geologist will record screening results in the borehole log (EII 9.1, "Geologic Logging" [WHC 1988a]). For two of the proposed borings (at the 2607-W-5 Septic Tank and Drain Field, and at the boring between the 216-U-1/216-U-2 and 216-U-16 Cribs), the decision to analyze a chemical sample from one of the designated intervals is dependent upon the results of the field screening. If a sample from either of these two borings does not contain radionuclide or volatile organic contamination above the set action levels, it should not be sent for analysis.

For the other three borings, the number of chemical samples that are sent to the lab may also be reduced by field screening. If two or more chemical samples in a row are found to be below action levels, then only every second sample will be sent to the lab for analysis. If later field screening identifies contamination deeper in the boring, then material from every designated sampling interval will be sent to the lab until two or more chemical samples in a row are below action levels.

The action level for radionuclide screening is twice background. Readings of less than twice the average background are within the normal background variability for the site and so are not indicative of the presence of anthropogenic radionuclide. The action level for volatile organic screening is 5 ppm above background. The 5 ppm limit is based on the total volatile organic compounds detected as either benzene or methane equivalents. Either a FID (flame ionization detector) or PID (photoionization detector) can be used to detect the volatile organics found within the 200-UP-2 Operable Unit. The relative response ratios of the chlorine based compounds for either the FID or PID range from 10% for carbon tetrachloride (FID) to 105% for 1,1,1-trichloroethane (FID). In order to detect the chlorinated compounds using survey type instruments under ambient, uncontrolled conditions the 5 ppm action level provides reasonable confidence in detection of these compounds. Prior to initiating drilling, determine a one-time instrument background reading using the above instruments at a background site to be determined in the field. Instrument background will be measured on freshly disturbed surface soil, holding the instruments less than 2 cm (1 in.) from the soil. The field geologist will record the background levels in the borehole log according to EII 9.1, "Geologic Logging" (WHC 1988a), prior to the start of drilling.

Physical samples will be collected by the same procedures as for chemical samples. Most of the physical samples will undergo a limited set of physical analyses (Type A samples), but two samples from each borehole will undergo a much larger set of physical analyses (Type B samples). Both suites of physical analyses are described in Section 5.3.3. The samples to undergo the additional analyses will be selected by the field geologist on site. Portions of physical samples that have been unconditionally radiologically released will be sent to an existing storage facility to be archived. Contaminated samples will be sent to a long-term storage facility if one is available. If one is not available, such samples will not be collected. The nonradioactive samples will be archived according to EII 5.7A, "Hanford Geotechnical Sample Library Control" (WHC 1988a).

The samples must be collected and transported in a manner that preserves the original moisture content and soil structure. Type A samples will be collected in sample sleeves and/or "moisture tins." The sample in the sleeve must be in an undisturbed state and the sleeve must be as full as possible.

5.3.2.5 Subsurface Geophysics. Subsurface geophysics will be run on the new boreholes as each casing string reaches its maximum depth. Boreholes will be logged according to EII 11.1, "Geophysical Survey Work" (WHC 1988a). A description of the typical equipment configuration, calibration, and acquisition parameters for this technique is presented in Appendix A. Spectral gamma logs will also be done on eight existing monitoring wells that includes the following:

- 299-W19-3
- 299-W19-9
- 299-W19-11
- 299-W19-69
- 299-W19-70
- 299-W19-71
- 299-W22-62
- 299-W22-75.

These wells were selected for logging because they are located within or adjacent to waste management units that will undergo LFIs, and because recent gross gamma logging suggest that they intersect radionuclide contaminated intervals. If analysis of data from these eight wells indicate that spectral gamma logging provides useful information, then a second round of spectral logging may be instituted. Wells designated during this second round will be near waste management units that will undergo LFIs but at which previous gross gamma logging did not suggest the presence of radionuclide contaminated intervals. Data from these existing wells may also be used to refine the sampling intervals at nearby proposed wells.

The RLS spectral gamma logs will be run on each new hole to provide an in situ spectral analysis. Gamma-gamma and neutron-epithermal-neutron logs will also be run if the technology is available at the time of the field work. These two techniques can give valuable information on the stratigraphy and water content of the units adjacent to the borehole.

Spectral gamma logging was conducted during 1992 at Wells 299-W19-9, 299-W19-11, and 299-W22-75 as part of the 200 Area AAMSR screening study (WHC 1991). Logging should be conducted at the other wells in the future.

5.3.2.8 Perched Water Sampling. Perched water samples will be collected from up to ten wells: six from new wells (if perched water is encountered), and four from existing wells (where perched water has been observed in the past). No other existing wells in the area are screened against potential perched water zones and have been noted to contain perched water (Section 5.3.1.6.2). The actual number may be less depending upon how many of these wells are found to contain perched water. Perched water sampling will be conducted according to the protocols listed in EII 5.8, "Groundwater Sampling" (WHC 1988a). Temperature, pH, turbidity, and electrical conductivity will be monitored during the purging of each well. Wells will be purged until a minimum of three well and sand pack pore space volumes have been removed, all parameters have stabilized, or the well is dry. Purged groundwater will be collected and properly disposed of depending upon its quality as described in EII 10.3 "Purgewater Management" (WHC 1988a). For all analyses except for volatile organics, tributyl phosphate and kerosene, two samples will be collected per well instead of one; one will be unfiltered, and a second will be filtered through a 0.45 micron filter onsite before being bottled and preserved. Only an unfiltered sample will be required for organic analyses. Samples will be labeled with the well designation, an indication of the filtration, and the date of collection.

Perched water level measurements will be taken monthly and before the wells are purged and sampled. These data will be used to evaluate water level fluctuations and to establish horizontal perched water gradients. The vertical gradients within the perched water zone will not be studied. These data will also be used to determine the amount of water that needs to be purged from each well before it is sampled. All measurements will be conducted according to EII 10.2, "Measurement of Groundwater Levels" (WHC 1988a).

5.3.2.11 216-U-12 pH Boring. This boring will be conducted according to the protocols and procedures outlined in Section 5.3.2.3, Source Area Borings. The boring will extend to the caliche layer [about 55 m (180 ft)]. Laboratory samples will be collected every 6 m (20 ft) or at significant changes in lithology or CaCO_3 content (Figure 5-13). In addition, the geologist will field check samples every 1 m (3 ft) or at changes in lithology to qualitatively log the CaCO_3 content of the soil. A perched water well will be installed in the boring if water is encountered above the caliche layer. The boring will undergo spectral gamma logging according to the protocols described in Section 5.3.2.5. The laboratory samples will only be analyzed for pH and CaCO_3 content, total uranium, and nitrates.

5.3.2.12 Sample Designation and Handling. Field logs will be maintained to record all field observations and activities according to EII 1.5, "Field Logbooks" (WHC 1988a). Samples for laboratory analysis will be taken at 11 waste management units and along 2 pipelines within the 200-UP-2 Operable Unit as indicated in Tables 5-7 and 5-8. These will be placed in containers and properly preserved. All samples for laboratory analysis will be transported under chain of custody in accordance with EII 5.1, "Chain of Custody" (WHC 1988a), and EII 5.11, "Sample Packaging and Shipping" (WHC 1988a). Laboratory analysis will be conducted on designated samples. The analysis of the soil and source samples will include determination of physical, chemical, and radiological characteristics.

The HEIS is used to track the sample and laboratory data obtained during these investigations. Each sample will be identified and labeled with a unique HEIS sample number. The HEIS numbers will be assigned in the field according to EII 5.10, "Obtaining Sample Identification Numbers and Assessing HEIS Data" (WHC 1988a). The sample location and corresponding HEIS numbers will be documented in the field logbook.

5.3.2.13 Decontamination Equipment and Procedures. Equipment decontamination will occur in conjunction with most of the sampling activities planned at the 200-UP-2 Operable Unit. The methods will generally consist of washing or steam cleaning with a detergent/water or other decontamination solution. Rinsing with a diluted nitric acid solution may be necessary to remove metal oxides and hydroxides. Field decontamination of drilling equipment, where applicable, shall be performed within impoundments in the decontamination zone to ensure that all wash liquids are captured. All wash liquids used for decontamination purposes must be properly disposed of according to applicable state/federal regulations. Drilling and backhoe equipment will be decontaminated before use on another borehole as required to ensure the safety of personnel and prevent cross-contamination of samples.

Decontamination procedures have been established for the Hanford Site by Westinghouse Hanford and are provided in the *Environmental Investigations and Site Characterization Manual*, which includes decontamination requirements and specific methods for radiological and nonradiological contamination. The EII 5.4, "Field Decontamination of Drill, Well Development and Sampling Equipment" (WHC 1988a), establishes methods and equipment for decontaminating drilling equipment to mitigate cross contamination during drilling and samples

collected for physical analysis only. The EII 5.5, "1706 KE Laboratory Decontamination of Equipment for RCRA/CERCLA Sampling" (WHC 1988a), establishes methods and equipment for decontaminating sampling equipment that is used for both physical and analytical testing.

5.3.2.14 Investigation Derived Waste. Investigation derived waste generated by LFI/FFS activities will be managed according to EII 4.3, "Control of CERCLA and Other Past-Practice Investigation Derived Waste" (WHC 1988a), or as agreed upon by the cognizant regulators (DOE, EPA, Ecology). If investigation derived waste is managed according to EII 4.3, the following exception to the procedure applies: Because of excessive turnaround times between sample submittal to the labs and receipt of sample analysis, if the 90 day clock (waste generation to disposal) is determined by the cognizant regulators to be appropriate for the RI/FS, the clock will not begin until generator receipt of the sample analyses results used for waste designation purposes. The samples collected for the LFI study will be sufficient for waste designation and waste management unit characterization.

5.3.2.15 Geodetic Surveys. Surveying applies to almost all the tasks required to complete the operable unit characterization and will occur at most of the waste management units within the operable unit (see Table 5-7). Surveys are to be completed by a licensed surveyor, registered in Washington State. Surveyors will be accompanied, at least initially, by the Field Team Leader (or designee) to familiarize the surveyors with specific locations. At least two vertical controls will be referenced to a U.S. Geological Survey datum obtained from a permanent bench mark. The NAD83 datum (Lambert Projection) will be used for horizontal control and the NGVD 1929 datum will be used for vertical control.

Horizontal (x,y coordinates) locations of surface soil samples; surface water sediment samples; and the corners of surface geophysical, surface radiation, and soil gas survey grids will be professionally surveyed. Horizontal and vertical locations (x, y, z coordinates) will be professionally surveyed for those soil borings that have a well screen installed. Abandoned borings and test pits will also be surveyed.

5.3.3 Laboratory Analysis

Surface soil samples, vadose zone soil samples (from borings and test pits), sediment samples, and perched water samples will be sent for chemical analysis. Air monitoring samples collected from the high volume samplers are controlled under a separate program and are typically analyzed for ^{60}Co , ^{90}Sr , ^{238}Pu , ^{239}Pu , ^{240}Pu , uranium, gross alpha, and gross beta. Only vadose zone soil samples will be sent to the laboratory for physical analyses. Table 5-8 summarizes the types of samples that will be collected from each of the waste management units. The table also lists the general chemical and physical analyses that will be required. These analyses are described in greater detail in Sections 5.3.3.1 and 5.3.3.2.

5.3.3.1 Chemical Analyses. Table 5-9 lists the contaminants of concern for the 200-UP-2 Operable Unit and specifies the suggested method of analysis. For some of the analytes, the contract laboratory may have to use a different analytical method than the suggested one. If an insufficient sample exists to perform all of the analyses, the analyses should be prioritized in the order they are listed on the table (Table 5-9, footnotes b,e). The concentrations of many of the radionuclide contaminants of concern (Table 3-2) will be calculated from parent or daughter relationships. The radionuclides whose

concentrations will be calculated in this way are listed in Table 3-2 and on the bottom of Table 5-9 (footnote a).

For the reasons listed below, the list of contaminants of concern may be modified for some samples.

- (1) Surface soil samples will not be analyzed for volatile organics. These compounds are unlikely to persist in near-surface conditions.
- (2) Perched water samples will be analyzed for three additional analytes: fluoride, ^{14}C , and tritium. In addition, each water sample will undergo radionuclide and inorganic analyses on both filtered and unfiltered samples.
- (3) Only two samples from each deep boring, and one sample from each test pit through the 216-U-10 Pond will be run for the full list of target analytes. The first samples collected beneath the assumed waste inflow point into the soil column or the samples that appear most contaminated by field screening, whichever is most appropriate, should undergo the full suite of analyses. The other samples from the boring or test pit should be saved until after the initial analytical results have been reviewed. Gamma spectrometry will be run on all samples whatever the results from the first samples. However, for other analyses, only those analytes that had positive detections in the first samples will be analyzed for in the other samples from that boring or test pit.

Uranium isotopic analyses will only be made on the one or two samples from each boring or test pit that undergoes the full suite of target analyses (Table 5-9, footnote d). Whatever the results from these initial samples, the subsequent samples will not undergo uranium isotopic analyses because uranium concentrations will be calculated from ^{231}Pa and ^{234m}Pa concentrations (measured via gamma spectrometry). Uranium isotopic analyses will not be run on any surface soil or sediment samples for the same reason.

Samples from the pH boring at the 216-U-12 Crib will be analyzed for total uranium and nitrates.

5.3.3.2 Physical Analyses. There are two suites of physical analyses. Type A physical analyses involve a limited suite of physical analyses and will be done on all samples from test pits and on most of the samples from deep borings. Type B physical samples involve additional physical analyses and will be done on two samples from each deep boring. The samples will be analyzed using American Society for Testing and Materials methods.

The following physical analyses will be run on Type A samples:

- Bulk density
- Particle size distribution
- Moisture content
- CaCO_3 content.

The following physical analyses will be run on Type B samples:

- The four Type A analyses listed above
- Saturated hydraulic conductivity
- Unsaturated hydraulic conductivity
- Matric potential and soil moisture retention curves
- Particle density
- Cation exchange capacity

- Organic carbon content
- pH and, if possible, Eh
- Mineralogy.

Samples from the pH boring at the 216-U-12 Crib will undergo a very limited suite of analyses:

- pH
- CaCO_3 content.

APPENDIX B

Borehole 299-W19--94, (216-U-8 Crib)

Borehole 299-W19-96, (216-U-1 Crib)

Borehole 299-W19-97, (2607-W-5 Drain Field)

Borehole 299-W19-98, (216-U-4/4A)

Borehole 299-W22-78, (216-U-12 Crib)

Borehole 299-W19-95, (South of 216-U-1 Crib)

Cross Section Location Map

GEOSCI 081893-B

Cross Section A - A'

GEOSCI\081393-A

GEOSCI\081393-C

Cross Section B - B'

Cross Section C - C'

END

**DATE
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11/26/93