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Description of Work for the Installation of Groundwater Well (299-E29-54) at the 200-BP-5 Operable Unit

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

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Description of Work for the Installation of Groundwater Well (299-E29-54) at the 200-BP-5 Operable Unit

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Fluor Government Group

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ACRONYMS

bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CFR	*Code of Federal Regulations*
DOW	Description of Work
ERDF	Environmental Restoration Disposal Facility
FH	Fluor Hanford, Inc.
FY	Fiscal Year
MSW	Miscellaneous Solid Waste
NTU	Nephelometric Turbidity Units
OU	Operable Unit
P&T	Pump and Treat
QA	Quality Assurance
RTE	Returned to the Environment
TCE	Trichloroethene
WAC	*Washington Administrative Code*
WIDS	Waste Information Data System
WPLIS	Waste Packaging/Labeling Instruction Sheet

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METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
If You Know	*Multiply By*	*To Get*	*If You Know*	*Multiply By*	*To Get*
Length			**Length**		
Inches	25.4	millimeters	millimeters	0.039	inches
Inches	2.54	centimeters	centimeters	0.394	inches
Feet	0.305	meters	Meters	3.281	feet
Yards	0.914	meters	Meters	1.094	yards
Miles	1.609	kilometers	kilometers	0.621	miles
Area			**Area**		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.093	sq. meters	sq. meters	10.76	sq. feet
sq. yards	0.0836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.6	sq. kilometers	sq. kilometers	0.4	sq. miles
Acres	0.405	hectares	Hectares	2.47	acres
Mass (weight)			**Mass (weight)**		
Ounces	28.35	grams	Grams	0.035	ounces
Pounds	0.454	kilograms	Kilograms	2.205	pounds
Ton	0.907	metric ton	metric ton	1.102	ton
Volume			**Volume**		
Teaspoons	5	milliliters	Milliliters	0.033	fluid ounces
Tablespoons	15	milliliters	Liters	2.1	pints
fluid ounces	30	milliliters	Liters	1.057	quarts
Cups	0.24	liters	Liters	0.264	gallons
Pints	0.47	liters	cubic meters	35.315	cubic feet
Quarts	0.95	liters	cubic meters	1.308	cubic yards
Gallons	3.8	liters			
cubic feet	0.028	cubic meters			
cubic yards	0.765	cubic meters			
Temperature			**Temperature**		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius	Celsius	multiply by 9/5, then add 32	Fahrenheit
Radioactivity			**Radioactivity**		
Picocuries	37	millibecquerel	millibecquerel	0.027	picocuries

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1.0 SCOPE OF WORK

This description of work (DOW) describes the drilling and construction of a single well in the 200-BP-5 operable unit (OU) during fiscal year (FY) 2008. The 200-BP-5 OU is located in the 200 East Area of the Hanford Site and is divided into nine sub-areas (see figure 1-1). The purpose of this project is to determine the extent of contamination in the deep vadose zone and groundwater near the 216-B-6 reverse well which is located in sub-area 5. The well will be drilled as a *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) activity and all waste generated during drilling will be managed as CERCLA waste.

The scope of the planned work activities includes the drilling and construction of a single unconfined aquifer monitoring well. As part of this activity, soil and groundwater samples will be collected with the objective to identify contaminants that may affect waste disposition and have impacted groundwater.

The well identification number is C5860 and the well name is 299-E29-54, the location map of the new well is shown in Figure 1-2. All drilling and well construction will be self performed.

Figure 1-1. Map of Operable Unit Sub-Areas for 200-BP-5 Groundwater Operable Unit

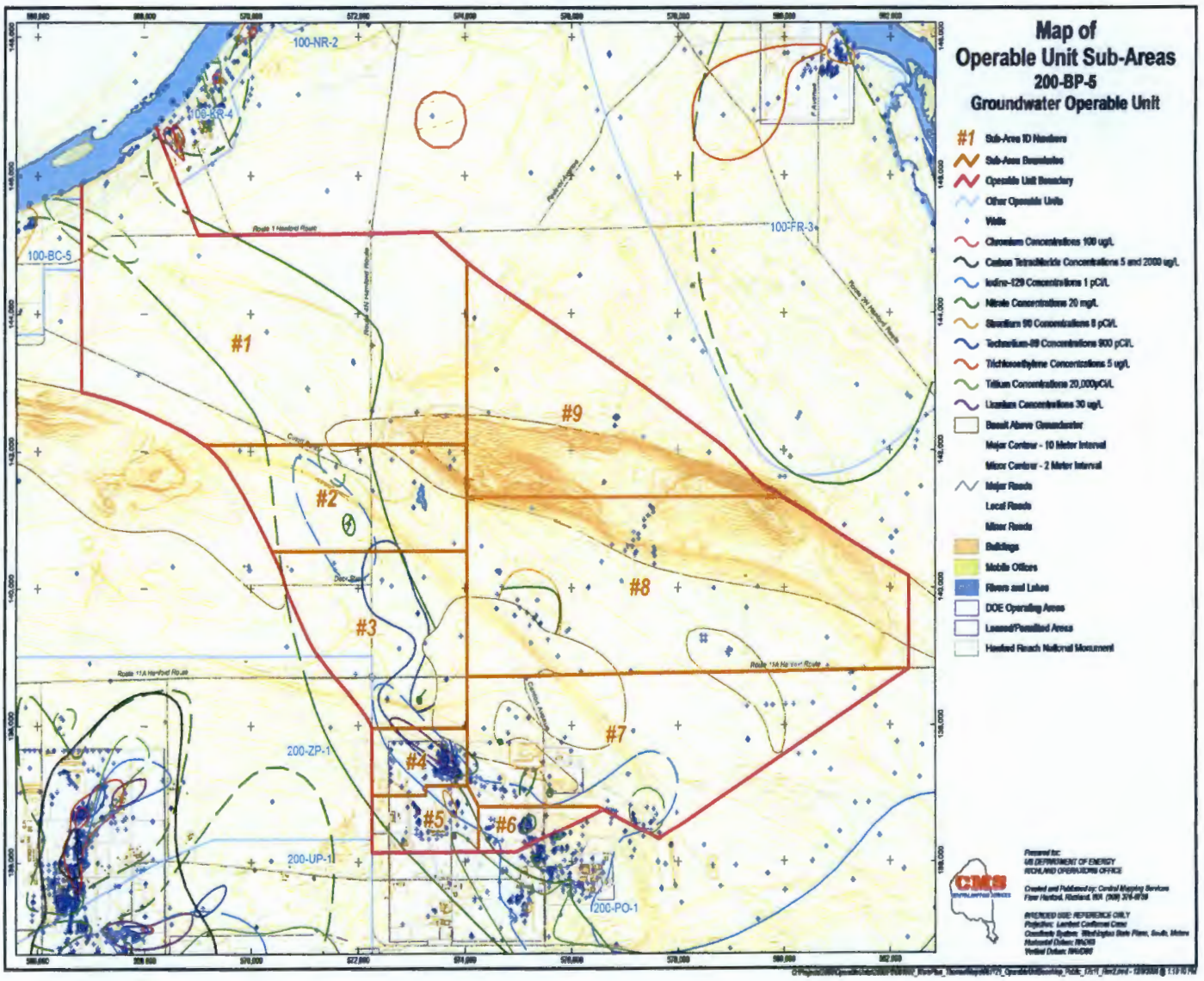
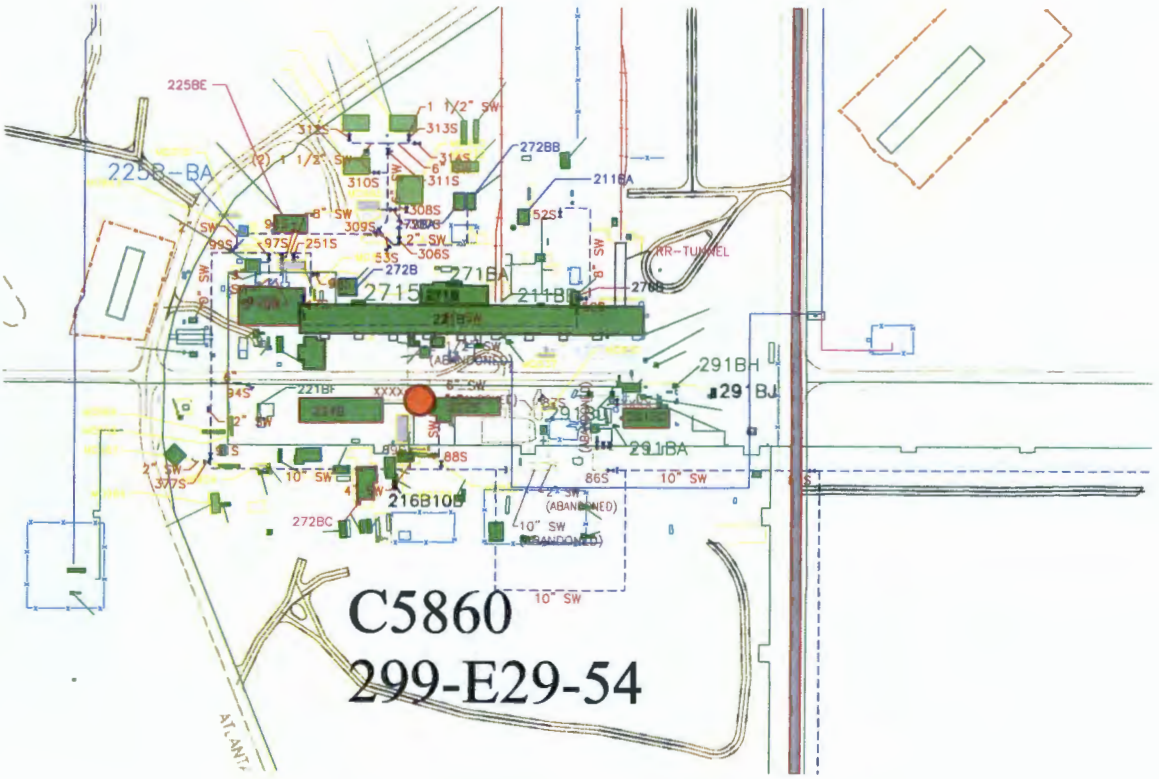


Figure 1-2. Map for New Well "K" in 200 East Area

(Red dot below shows location west of building 222-B)



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2.0 BACKGROUND

This section discusses previous work activities and regulatory decisions associated with the 200-BP-5 Operable Unit (OU). General summaries of hydrogeology, contaminants of interest, and conceptual models of relevant factors associated with the planned work activities are presented.

Figure 2-1 shows the location of the 200-BP-5 OU at the Hanford Site, located in the state of Washington. The 200-BP-5 extends from the 200 East Area to the Columbia River to the north and to the east flank of the Gable Mountain to the east. The boundaries of the 200-BP-5 OU encompass an approximate area of 32.6 mi^2 (84.5 km^2).

In 1989, the Hanford Site was listed on the National Priorities List pursuant to CERCLA. To address groundwater issues in the 200 East Area, the 200-BP-5 OU, and 200-PO-1 OU Areas were established. The 200-BP-5 OU is located within the Hanford Site and includes the groundwater beneath the northern part of the 200 East Area and north to the Columbia River. The 200-BP-5 OU groundwater flow appears bifurcated and may posses both a northward component and a southeastern component of flow (PNNL-15070-SUM) and is impacted by wastes disposed during the operation of B Plant and PUREX. The OU includes 51 CERCLA liquid effluent waste sites and five facilities that have groundwater monitoring requirements under RCRA and *Atomic Energy Act of 1954* (AEA):

- Waste Management Area (WMA) B-BX-BY
- 216-B-63 Trench
- Low-Level WMA (LLWMA)-1 and -2
- Liquid Effluent Retention Facility (LERF)
- WMA C

Fifteen new wells will be installed to support the 200-BP-5 OU Remedial Investigation. Of these fifteen well only well "K" (C5860/299-E29-54) is addressed in this DOW. As mentioned above, this borehole/well is planned to determine the nature and extent of contamination in the deep vadose zone and groundwater associated with the 216-B-6 reverse well.

This reverse well was used from 1945 to 1949 (HW-43121) and was associated with lab waste generated during refining the plutonium separation process. Wastewater was injected into this well and entered the surrounding vadose zone soils at an uncertain depth. The uncertainty is associated with various drawings and reports that indicate different well construction. The most plausible design was used for this investigation. The reverse well design indicates that the well is 160 feet deep and that perforations within the well casing exist from 75 to 160 feet below ground surface. However, other possible designs include no perforation or the well extending to groundwater (e.g. approximately 302 ft bgs).

The Recent Soil Inventory Model (SIM) estimates the median inventory for chromium is nearly 2,500 kg. The highest mobile radionuclide curie content according to the SIM was associated with tritium and technetium (both less the 1 Curie). Nitrate, chloride, and sodium concentrations were significant (58,373 kg, 675 kg, 26,954 kg, respectively). Currently, there are no groundwater monitoring wells within the vicinity or down gradient of this well. Thus, it is

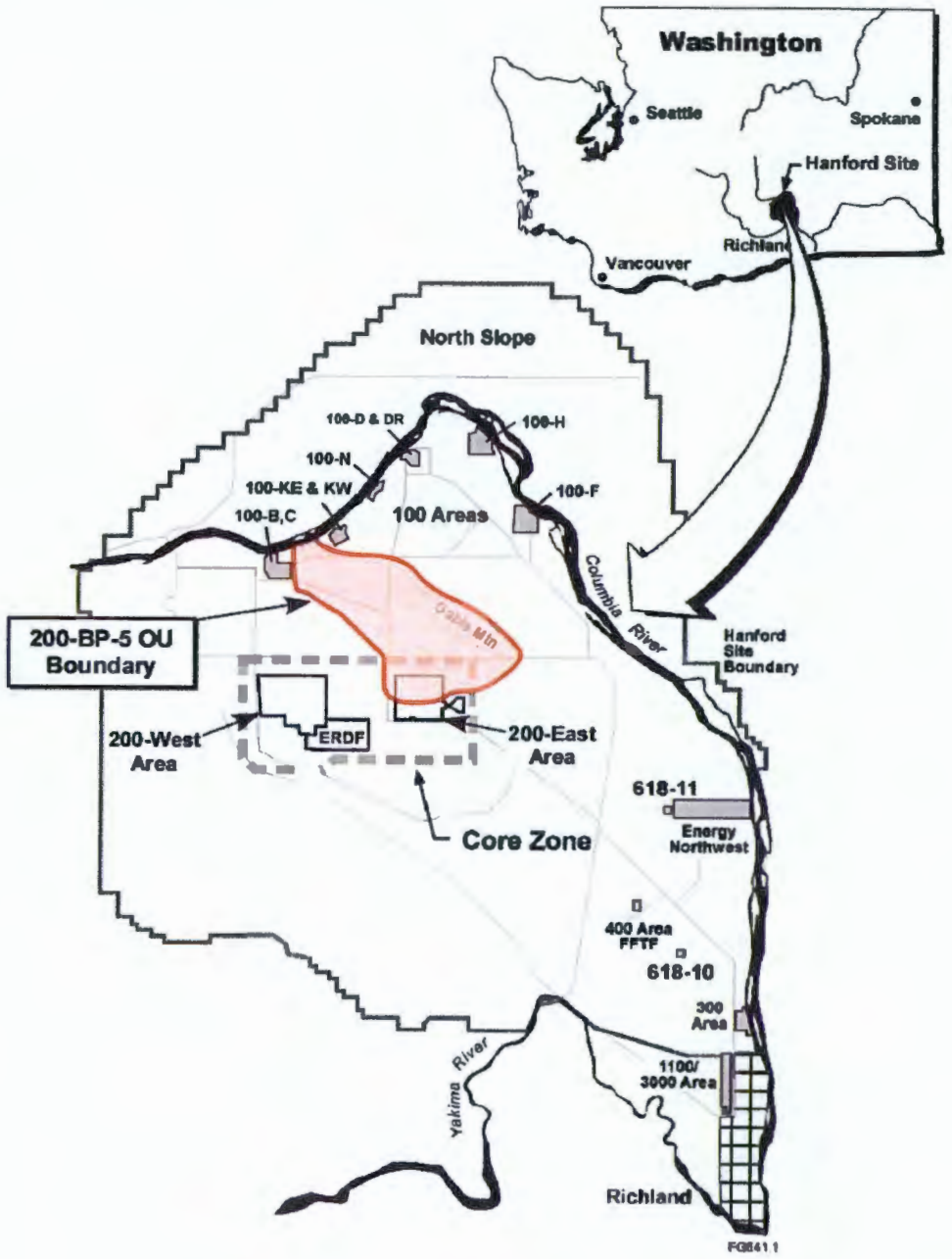
uncertain what fraction of the inventory is still present in the vadose zone and what has if any migrated into the groundwater.

2.1 REMEDIAL ACTION GOALS

A number of studies were conducted related to liquid waste disposal associated with B Plant past operations. These investigations are described in the *Data Quality Objectives Summary Report in Support of the 200-BP-5 Groundwater Operable Unit Remedial Investigation/Feasibility Study Process* (WMP-28945).

This DOW describes the sample collection associated with the installation of well C5860. The vadose zone data will be collected to provide input for modeling and possible future risk of groundwater impact for contamination in the vadose zone. This information will support the baseline risk assessment and the feasibility study. In addition, several samples will be collected and analyzed from the unconfined aquifer to determine the nature and extent of contamination within the unconfined aquifer.

Figure 2-1. Location of the 200-BP-5 Operable Unit within the Hanford Site.



2.1.1 Site Geology

The following section summarizes the structural geology and general stratigraphy in the vicinity of the 200-BP-5 OU.

Structural Setting

The Central Pasco Basin and the Hanford Site are structurally dominated by sub-parallel, west-to-northwest-trending folds of the Yakima Fold Belt. The Yakima Fold Belt consists of a series of segmented, narrow, asymmetric anticlines whose ridges are separated by broad synclines or basins that, in many cases, contain thick accumulations of Neogene- to Quaternary-age sediments. The Pasco Basin is divided into the Wahluke and Cold Creek synclines, which are separated by the Gable Mountain anticline.

The principal structural feature found in the basalts beneath the 200-BP-5 OU is the subsurface extension of the Umtanum Ridge anticline. Umtanum Ridge is an asymmetrical, north-vergent to locally-overturned anticline with a major thrust to high-angle reverse fault on the north side. Gable Mountain and Gable Butte are two topographically isolated, anticlinal ridges that are composed of a series of northwest trending, doubly-plunging, en echelon anticlines, synclines, and associated faults (RPP-23748, *Geology, Hydrogeology, Geochemistry, and Mineralogy Data Package for the Single-Shell Tank Waste Management Areas at the Hanford Site*). This structure consists of five segments. These and other significant structural features are illustrated in Fig.2-2.

The east-west-trending axis of this anticline coincides with the location of Gable Mountain and Gable Butte. These anticlinal features are important from a groundwater perspective, where these basalt features occur above the water table. The south limb of the basalt and overlying sediments dip approximately 5 degrees to the south toward the Cold Creek syncline, which is a broad structural depression associated with regional uplift (RPP-23748). The 200 East Area (including OU Sub-Area 5) lie on the northern flank of the Cold Creek syncline, so bedrock in this area is generally described as dipping gently to the south.

Stratigraphic Setting

The stratigraphy of the 200-BP-5 OU consists of unconsolidated sedimentary deposits which overlie older Columbia River flood basalt and associated sedimentary interbeds. The principal stratigraphic units that are found in the 200-BP-5 OU are listed and described below (listed oldest to youngest) and shown in Figure 2-3.:

- Elephant Mountain Member basalt (CRBG)
- Miocene-Pliocene Ringold Formation sediments
- Post-Ringold/Pre-Hanford deposits (Cold Creek Unit)
- Pleistocene Hanford formation sediments
- Holocene surficial deposits (fill and eolian deposits)

Figure 2-2. Geomorphic Map Showing Selected Geologic Structures in Vicinity of 200-BP-5 Operable Unit (after Reidel et al. 2006)

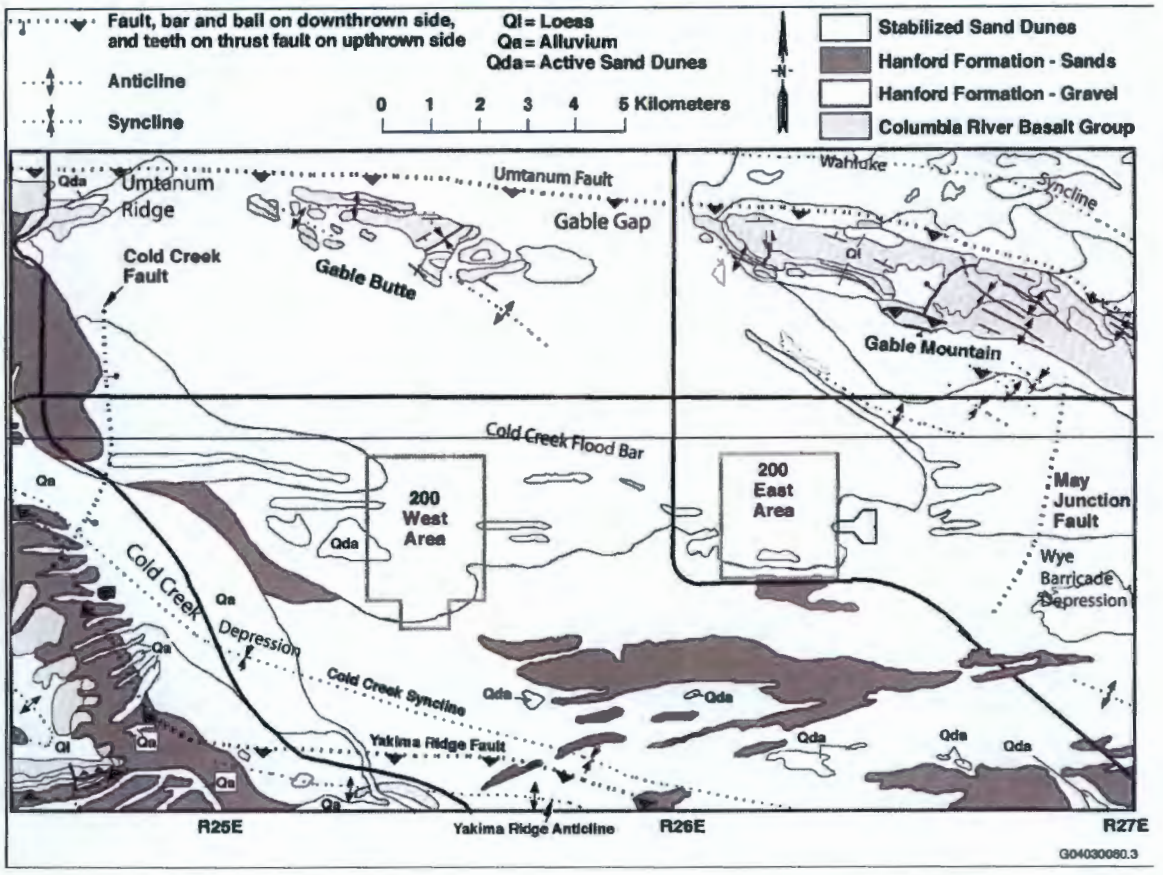
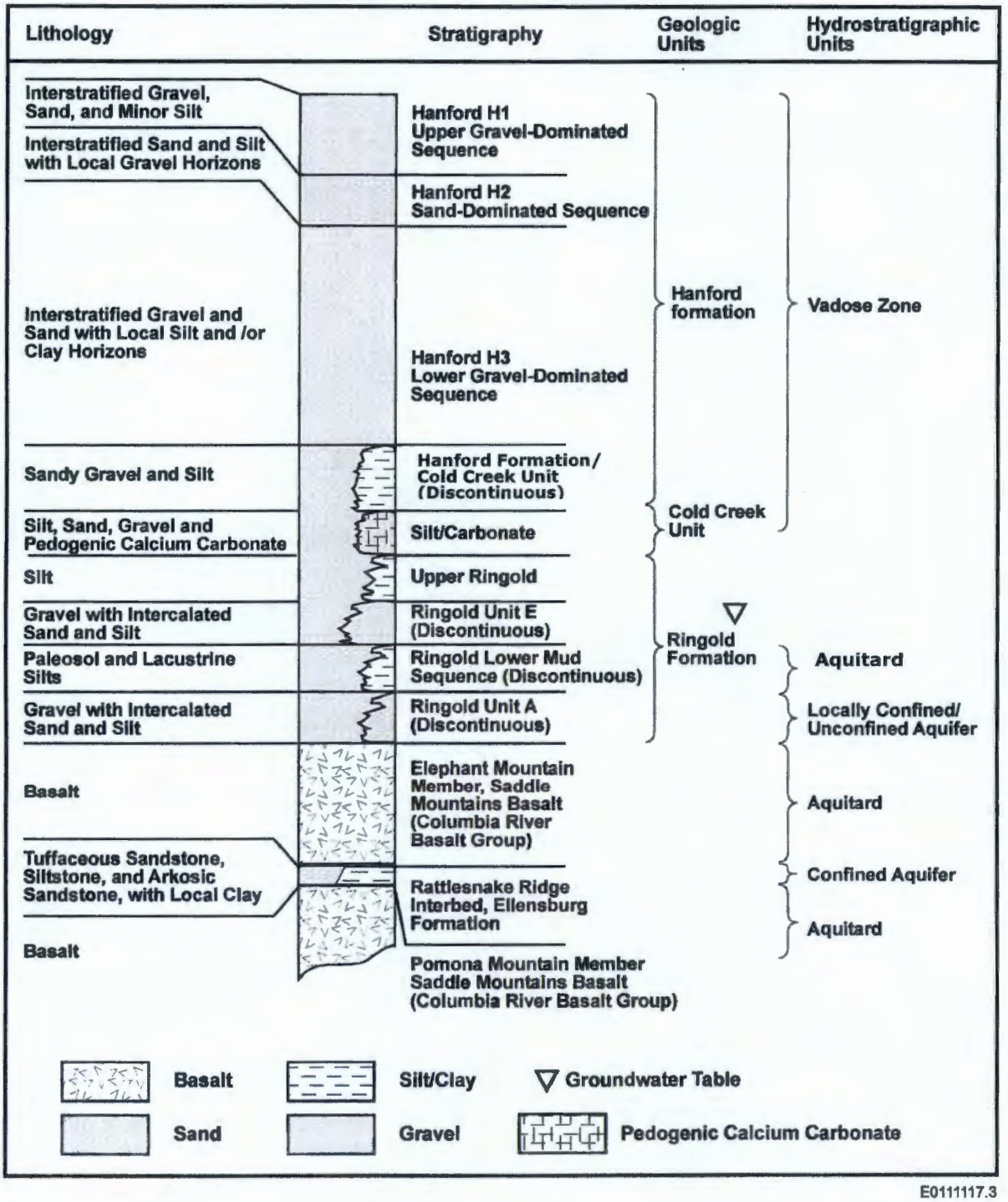


Figure 2-3. Generalized Geologic and Hydrogeologic Column for 200-BP-5 Groundwater Operable Unit.



Columbia River Basalt Group (CRBG)

The basalt bedrock underlying the 200-BP-5 OU is the CRBG. This bedrock strikes northwest-southeast with a southwest dip into the Cold Creek syncline.

Elephant Mountain Member Basalt

The uppermost basalt unit beneath the 200-BP-5 is the Elephant Mountain Member of the Saddle Mountain Basalt which consists of two flows (RPP-23748). In most of the OU this basalt unit is the base of the unconfined aquifer. The Elephant Mountain Member is about 100 to 116 m (320 to 380 ft.) below ground surface (bgs) in Sub-Area 5.

The Elephant Mountain Member of Saddle Mountain Basalt is anticipated at a depth of approximately 320-380' bgs. The basalt surface dips gently to the south southwest into the Cold Creek Syncline beneath Sub-Area 5 (PNNL-12261).

Ringold Formation

The Ringold Formation is a regionally extensive sedimentary sequence filling the Pasco Basin, and the unit unconformably overlies the basalt under the southern part of the 200-BP-5 OU. It consists of river channel sand and gravel deposits, along with overbank sand and silt deposits. Fresh-water lake mud deposits were deposited in between the channel deposits, and the muds form less permeable layers for groundwater movement (DOE/RL-95-59, *200-BP-5 Operable Unit Treatability Test Report*). Ringold thins to the North and is absent in North Eastern 200E, and its disappearance north toward Gable Mountain is attributed to erosion by the Missoula Floods and the ancestral Columbia River. Ringold maybe present in structure lows South of the Gable Gap Area where high energy floods may have been diverted and its disappearance within and north of Gable Gap is attributed to erosion by the Missoula Floods and the ancestral Columbia River.

Ringold deposits present at the Hanford Site consist of five separate units dominated by fluvial gravels. The gravels are designated from bottom to top as units A, B/D, C, and E and are separated by fine-grained deposits typical of overbank and lacustrine environments. The lowermost of the fine-grained sequences is designated the lower mud unit. Only gravel units A and E and lower mud unit are present beneath the 200 East Area. However, as mentioned above the Ringold Formation is absent beneath the north and northeast parts of the 200 East Area (Lindsey et al. 1992, PNNL-12261).

The Ringold Formation gravels are clast and matrix-supported, pebble to cobble conglomerates with a fine to coarse sand matrix (Lindsey 1996). Cemented zones within the conglomerates are discontinuous and of variable thickness. In several places, reworked ringold sediments occur above the Ringold Formation. If these sediments were laid down by fluvial and eolian processes prior to ice-age flooding, they are Plio-Pleistocene unit. Those re-worked gravels attributed to Pleistocene floods are considered part of the lower Hanford formation gravels (H3).

Important units of the Ringold formation in the Southern portion of the OU are as follows (listed oldest to youngest):

- Ringold Unit A (gravels)
- Ringold Lower Mud
- Ringold Unit E (gravels).

Pleistocene/Pliocene Units (Cold Creek Unit)

Various reports have reported on the Hanford formation/Cold Creek Unit or "Pre-Missoula Gravels" which occur below the Hanford formation but above Ringold Formation and the basalt flows of the Columbia River Basalt Group. This unit will be difficult to characterize due to lack of available subsurface data in sub-area 5. This description of work refers to these units as they are described in RPP-23748. In many cases these units are indistinguishable from the Hanford H3 unit described above, so consequently, are lumped together with that unit. Lindsey (1996) described these units as Hanford/Cold Creek Unit/Ringold.

Silt-Dominated Facies (Hanford formation/Upper Cold Creek Unit)

This unit is a locally thick layer of silt locally overlies the gravelly sediments of the Hanford formation/upper Cold Creek unit. The silt facies of the Hanford formation/Cold Creek Unit has an irregular surface and is divided into two distinctive beds. The upper bed consists of a light olive-brown to tan colored, massive, well-sorted fine calcareous silt to sand. Root casts occur locally. The other distinctive bed is not defined.

Hanford formation H3/Cold Creek Upper Unit

This unit has also been described as Hanford formation/Cold Creek Unit/Ringold Formation (WHC-SD-EN-EE-004, *Revised Stratigraphy for the Ringold Formation, Hanford Site, South-Central Washington*). The thick silt-rich interval is believed to be a pre-Ice Age flood deposit, since silty layers associated with Pleistocene flood deposits of the Hanford formation in this area are generally much thinner (i.e., a few centimeters or less) (HNF-5507).

Sandy Gravel to Gravelly Sand-Dominated Facies.

A sequence of sandy gravel to gravelly sand occurs beneath the silt-dominated facies and above the top of basalt that either represents cataclysmic flood deposits or ancestral Columbia River deposits. In core, this sediment occurs as muddy sandy gravel to sandy gravel, consisting of approximately 30 to 80% gravel, 15 to 65% sand, and up to 15% mud (PNNL-14121, *Characterization of Vadose Zone Sediment: RCRA Borehole 299-E33-338 Located near the B-BX-BY Waste Management Area*).

Hanford formation

The Hanford formation is the result of sediment deposition associated with glaciofluvial sediments deposited by cataclysmic floods from glacial Lake Missoula, pluvial Lake Bonneville, and other ice-margin dams (PNNL-13024). The Hanford formation is present throughout the Hanford Site and is up to 370 ft (113 m) thick (PNNL-12261). The Hanford formation consists of pebble to boulder gravel, fine- to coarse-grained sand and silt. These deposits are divided into three facies: 1) gravel dominated facies, 2) sand dominated facies, and 3) silt-dominated facies (WHC-SD-EN-TI-012).

Holocene Deposits

Holocene deposits include eolian (wind-blown) sands and backfill. The backfill is poorly-sorted, gravelly sand to sandy gravel (ARH-LD-129, *Geology of the 241-B Tank Farm;* ARH-LD-130, *Geology of the 241-BX Tank Farm;* ARH-LD-131, *Geology of the 241-BY Tank Farm*) and is derived generally from gravel-dominated Hanford formation.

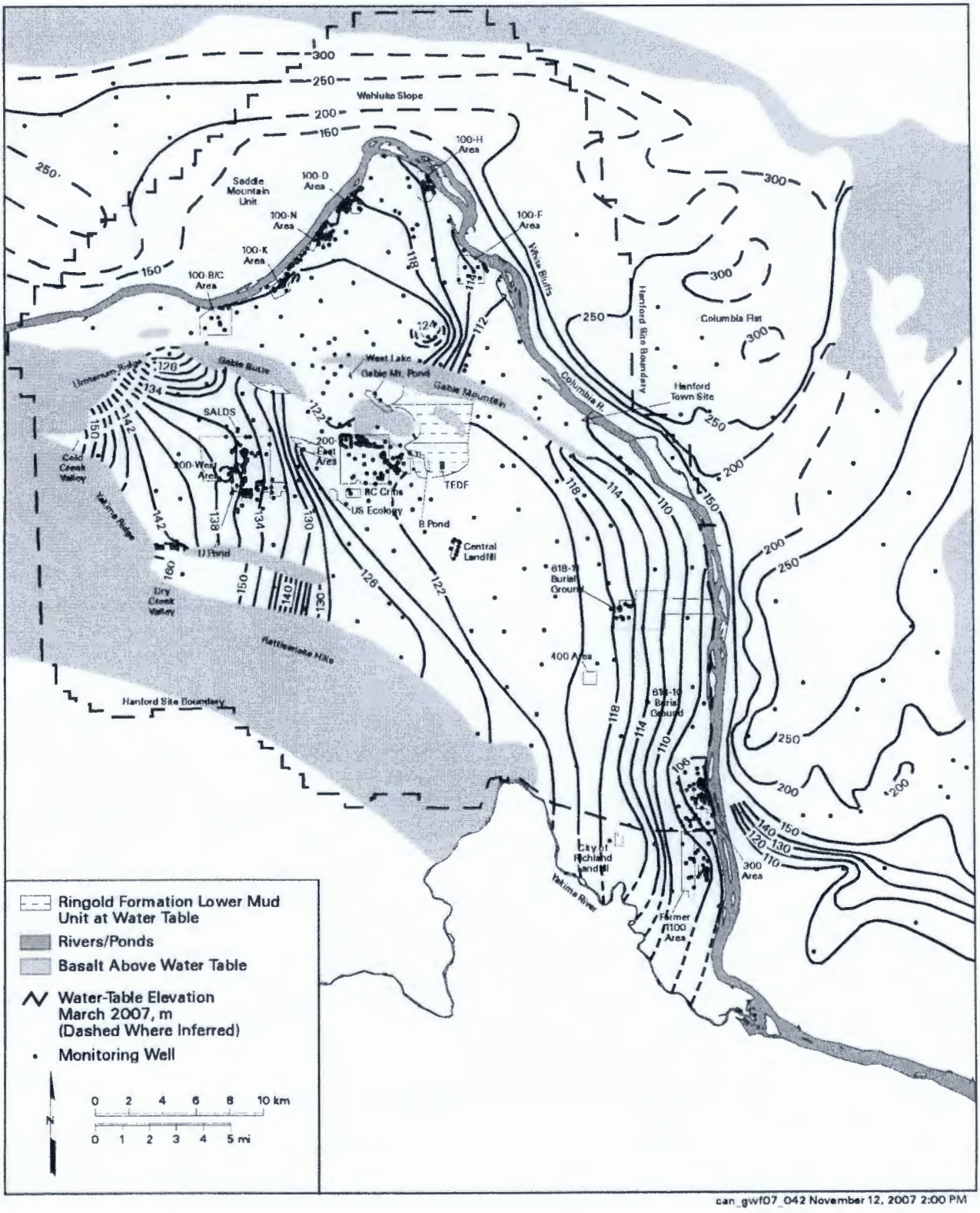
2.1.2 Hydrogeology

The aquifer system in the northern portion of the 200 East Area and 600 Area (north of the 200 East Area) constitutes the 200-BP-5 OU. The uppermost aquifer beneath most of the Hanford Site is generally unconfined within the sands and gravels that overlie the basalt bedrock. In some areas, layers of silt and clay confine portions of the aquifer. Confined aquifer's also occur within the ballast flows themselves and in thin sedimentary intervals between basalt flows.

Groundwater beneath the Hanford site flows primarily from recharge areas along the western parts of the site, to the east and north toward the Columbia River (figure 2-4). Groundwater flows historically have been modified by the formation of groundwater mounds created by the discharge of large volumes of process waste water from site activities. The elimination of most liquid waste discharge to ground over the last 10 to 20 years has resulted in changes to local groundwater flow patterns and a continuing decline in the water table and hydraulic conditions resulting in an eventual return to pre-Hanford groundwater conditions (DOE/RL-2007-18). Figure 2-4 shows the water table elevation in 2003. The uppermost aquifer beneath sub-area 5 within the 200-BP-5 OU is unconfined and consists primarily of saturated Hanford formation and Ringold Formation Units E or Unit A sediments. Much of the area has been eroded to various degrees by the paleo-floods which removed much of the Ringold Formation sediment. In the southern-most areas where the Ringold Formation Lower Mud Sequence (paleosol/overbank facies and lucstrine fine-grained facies) is still present it will isolate and confine the lower Ringold Formation Unit A from the overlying, younger Ringold Unit E and/or Hanford sediments (PNNL-12261). Confined aquifers also occur deeper beneath the Elephant Mountain basalt in various basalt sedimentary interbeds.

In this sub-area, the unconfined aquifer thickens to the south as the saturated suprabasalt sediments thicken in response to the southerly dipping basalt surface. The unconfined aquifer occurs at a depth of between 100 and 116 m (320 to 380 ft) below ground surface (depending on topography) and ranges in thickness from approximately 9 m (30 ft) to over 18 m (60 ft) north to south.

Figure 2-4. Contour Map of Hanford Site Water Table.



2.2 CONCEPTUAL MODEL

The B-Plant support building, 222-B Laboratory, was used from 1945 until 1952 for small scale experiments in support of the B Plant Bismuth Phosphate Fuel Processing. The 216-B-6 reverse well operated from 1945 to 1949, receiving mixed liquid waste from the 222-B Laboratory. The laboratory was used to develop plutonium separation processes which generated less high level waste due to the limited high level waste storage capacity.

B Plant was constructed in 1944 and brought on line in 1945 to extract plutonium from fuel rods using the bismuth phosphate fuels-separation process. The following description of the separation process for B Plant shows possible waste streams that may have been disposed of at the 216-B-6 Reverse Well. Plutonium separation began with the dissolution of the aluminum-jacketed fuel rods in a sodium hydroxide solution to which sodium nitrate was added to avoid formation of too much hydrogen. The resulting sodium aluminate-sodium nitrate solution was a component of the first cycle waste stream sent to underground tanks. The remaining uranium metal slugs were rinsed in water and dissolved in 50 to 60% nitric acid. Sodium and bismuth nitrate and phosphoric acid were added to the dissolver solution to precipitate bismuth phosphate, which carried the plutonium. The solution comprises a portion of the metal waste stream, which contains all of the uranium, approximately 90% of the original fission products activity, and about 1% of the product. The byproduct of the dichromate solution that was added as the next step in the plutonium separation process was added to metal waste stream following its dissolution in nitric acid. The metal waste was neutralized with 50% caustic and treated with sodium carbonate, then sent to the underground tanks in tank farms.

The product solution was again treated to precipitate bismuth phosphate and the plutonium carrier, completing the first decontamination cycle. The waste from this treatment was combined with coating removal waste, and contained about 10% of the original fission activity and 1% of the plutonium. The entire process was repeated, and the second decontamination cycle waste contained less that 1% of the fission product activity and about 1% of the plutonium.

2.3 CONTAMINANTS OF CONCERN

The waste inventory for the 216-B-6 reverse well indicates that this waste site received 6,000,000 L of effluent. As mentioned in Section 2.0 several metals, anions and radionuclides were determined to be part of the inventory sent to this waste site. The Waste Information Data System (WIDS) database indicated that this waste site was similar to the discharges associated with 222-T Laboratory, with 2.6 Ci of fission products and 600 mg of plutonium received per month. It should be noted that the WIDS information is much higher than the SIM information for fission products and plutonium. Since this site was associated with laboratory waste generated in refining the plutonium extraction process and that REDOX followed the Bismuth-Phosphate process it is believed that all types of constituents (e.g. acid/base to organics) are possible with this waste site.

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3.0 DESCRIPTION OF WORK ACTIVITIES

The planning and construction of C5860 (the new well "K") will be conducted under this DOW and will adhere to the guidelines and requirements presented in FH procedure GRP-EE-02-14.1, *"Drilling, Remediating, and Decommissioning Resource Protection Wells, and Geotechnical Soil Borings."* A completed drilling planning form will be submitted to FH Geoscience Support prior to initiation of field activities. The well will conform to resource protection well standards as defined in Washington Administrative Code 173-160, *"Minimum Standards for Construction and Maintenance of Wells"* (WAC 173-160).

3.1 WELL SITE PREPARATION

The well site is serviced by an existing access road. Well leveling using compacted gravel may be required.

3.2 DRILLING

Well K (C5860) will be drilled and constructed as a monitoring well as defined in WAC 173-160. The new well is to be installed at the location illustrated in Figure 1-2. The well shall be drilled as close to vertical as possible using cable tool drilling technology. A straightness test prior to installing the permanent well screen is required. The test shall be conducted by running a 20-ft-long section of pipe that is a diameter 2 in. smaller than the inner diameter of the temporary casing to the bottom of the boring. The 20-ft pipe must freely pass to the TD of the boring. The Project Manager shall be notified of all major drilling activities, (such as when the water table is encountered and when the borehole achieves total depth, sampling intervals, etc). Perched water is not expected in this area or at these locations; however if perched water is encountered, the Project Manager will be immediately notified, and a sample of the perched water will be taken as soon as possible.

During the drilling and/or completion/development activities, the quantity of potable water, foaming agents, or other fluids used shall be recorded and if at all possible kept to an absolute minimum. Intact core (splitspoon) samples (6" minimum split spoon inner diameter casing) will be collected in order to provide samples to test for physical characteristics and sediment chemistry. In addition, depth discrete groundwater samples and hydrologic slug testing will be carried out during drilling in the borehole. The sampling will be determined based on actual conditions encountered during drilling. Because of uncertainties associated with drilling in this area, the depth specific sampling depths will be determined/confirmed in the field by the responsible Hydrogeologist. A general sampling plan is outlined in Table 3.2

Drilling activities at the well site will be documented by the field geologist on field activity report (FAR) sheets. The field geologist will examine material from the borehole and prepare borehole logs as specified in the FH procedure GRP-EE-01-7.0, *"Geologic Logging."*

Drilling activities are currently evaluated as high radiological and chemical risk. The level of radiological and industrial hygiene protection support is anticipated to consist of daily am/pm checks for low risk zones. Should a higher radiological or chemical risk be encountered during drilling, radiological and industrial protection support will be re-evaluated and increased. An Environmental Radiological Survey Task Instruction will be prepared by FH to cover working with radiologically contaminated sediment and material for this well. In the event radiological contamination or perched water is encountered, reduction of drill well casing diameter (i.e., telescoping) will be evaluated to prevent drag-down of contamination down the hole into a low-risk zone. If at any time there is a reduction of drill well casing diameter, geophysical logging shall be performed on the well. If field instrumentation indicates that chemical or radiological contamination is encountered, work shall be stopped immediately, the FH Buyer's Technical Representative shall be contacted, and an appropriate monitoring plan will be followed.

All down-hole equipment (including submersible sampling pumps and core samplers) shall be steam-cleaned (i.e., high pressure and temperature) or decontaminated to minimize contaminants.

3.3 WELL CONSTRUCTION

Well completion will not begin until the screen slot size and filter pack size are confirmed by the field samples. If field sieve analyses dictate a screen slot and filter pack of different size than that specified, the Project Manage shall confirm the alternative screen and filter pack specification.

The well shall be constructed in accordance with the WAC 173-160 requirements and consistent with Hanford Site well construction standards. The well shall be constructed with stainless steel casing and stainless steel screen with appropriate sand pack (100% silica sand) as specified in this DOW. The placement of well seals and riser casings is at the discretion of FH. The well construction diagram for the new well and approximate location are shown in Figure 3-1. The BTR shall contact the Project Manager to resolve any unrecognized or unanticipated well design discrepancies prior to drilling the well.

The design of the new well must meet the minimum standards required in WAC 173-160 for construction of resource protection wells. The monitoring well will be constructed using Schedule 10 4-inch Type 304 or 316 stainless steel flush-threaded riser casing and a 3-ft. long Schedule 10 stainless steel sump with end cap. If the well screen location is determined to be along the bottom of the aquifer drilling 3 ft into bedrock so that the full 3 ft sump is placed below the aquifer bottom will be required. An environmentally compatible non-petroleum lubricant, such as Jet-Lube Well Guard thread compound or equivalent, may be used for lubricating the threads of the stainless steel while installing the casing.

The well screens will be 4-inch Type 304 or 316 stainless steel, V-wire, continuous wire-wrap screen, and up to 35 feet in length (at a depth to be determined based on the measured depth to water) based on sample results provided by others. The screen slot size will be 0.010 or 0.020 inches unless otherwise determined based upon sieve analysis results. The filter pack will consist of 10-20 mesh Colorado silica sand unless otherwise determined based upon sieve

analysis results. Final placement of the well screen will be at the direction of the Project Manager based on field-screening results. Table 3-2 provides a general summary of estimated well construction parameters, including the estimated water level, well depth, screen interval, sand pack interval, bentonite seal intervals, and cement seal interval.

The actual completed screened length and depth intervals for the well, as well as the associated filter pack configuration, will be determined in the field based on conditions observed during drilling. The well casing/screen string must be maintained in tension (i.e., the weight of the string is suspended from the top and not allowed to rest on the bottom of the borehole) in order to maintain straightness of the completed well. The final well stickup (protective casing) should not be more than 3 ft above ground to accommodate future sampling crews. The permanent stainless steel casing shall have a stickup of between 1.75 and 2 ft above ground surface.

The monitoring well will be constructed with a 5 foot-thick bentonite pellet seal extending from the top of the filter pack sand at the time of construction. Care must be used to ensure correct placement of the bentonite pellet seal to prevent bridging of the bentonite. Granular bentonite will be used to seal the remaining portion of the annulus to within 10 feet of ground surface. Neat Portland cement grout will be used to seal the remaining portion of the annulus to ground surface. The cement grout seal will consist of Portland cement mixed with water (in accordance with the instructions provided by the cement manufacturer), with not more than 5% bentonite by weight.

Surface protection for the well will be installed in accordance with WAC 173-160-420 (13) and GRP-EE-02-14.1, *"Drilling, Remediating, and Decommissioning Resource Protection Wells and Geotechnical Soil Borings"* with the following modifications:

- The protective casing shall be a minimum of 2 inches larger in diameter than the permanent casing. This protective casing shall be made of Type 304 (or higher grade e.g., 304L, 316, or 316L) stainless steel.
- The protective casing shall rise approximately 3 feet above ground surface for the groundwater monitoring well. The protective casing for the groundwater monitoring well will be capped with a 15-inch lockable cap above the top of the protective casing and have inner tabs to fit plumb.
- The permanent casing shall rise to approximately 2 feet above ground surface and shall be approximately 1 foot below the top of the protective casing in the groundwater monitoring well.
- Concrete pads shall be 4 feet by 4 feet square by 6 inches thick, reinforced with 6 inch by 6 inch W1.4 by W1.4 (metric wire gage, approximately equivalent to 166 gage) welded steel wire fabric as a minimum.
- A brass survey marker with the well identification number, well name, and completion date inscribed shall be installed on the north side of the pad.

Four protective posts shall be placed around the concrete pad. The posts shall be at least 3 inches in diameter. Three of the posts shall extend at least 3 feet above and below ground and shall be cemented at least 3 feet into the ground. The fourth post shall be removable for well

access. Posts shall be located no more than 1 foot from the corner of the concrete pad and painted yellow (ANSI Standard Z535.1 [ANSI 1991]). This surface protection shall meet the standards of WAC173-160-420 (12) (a).

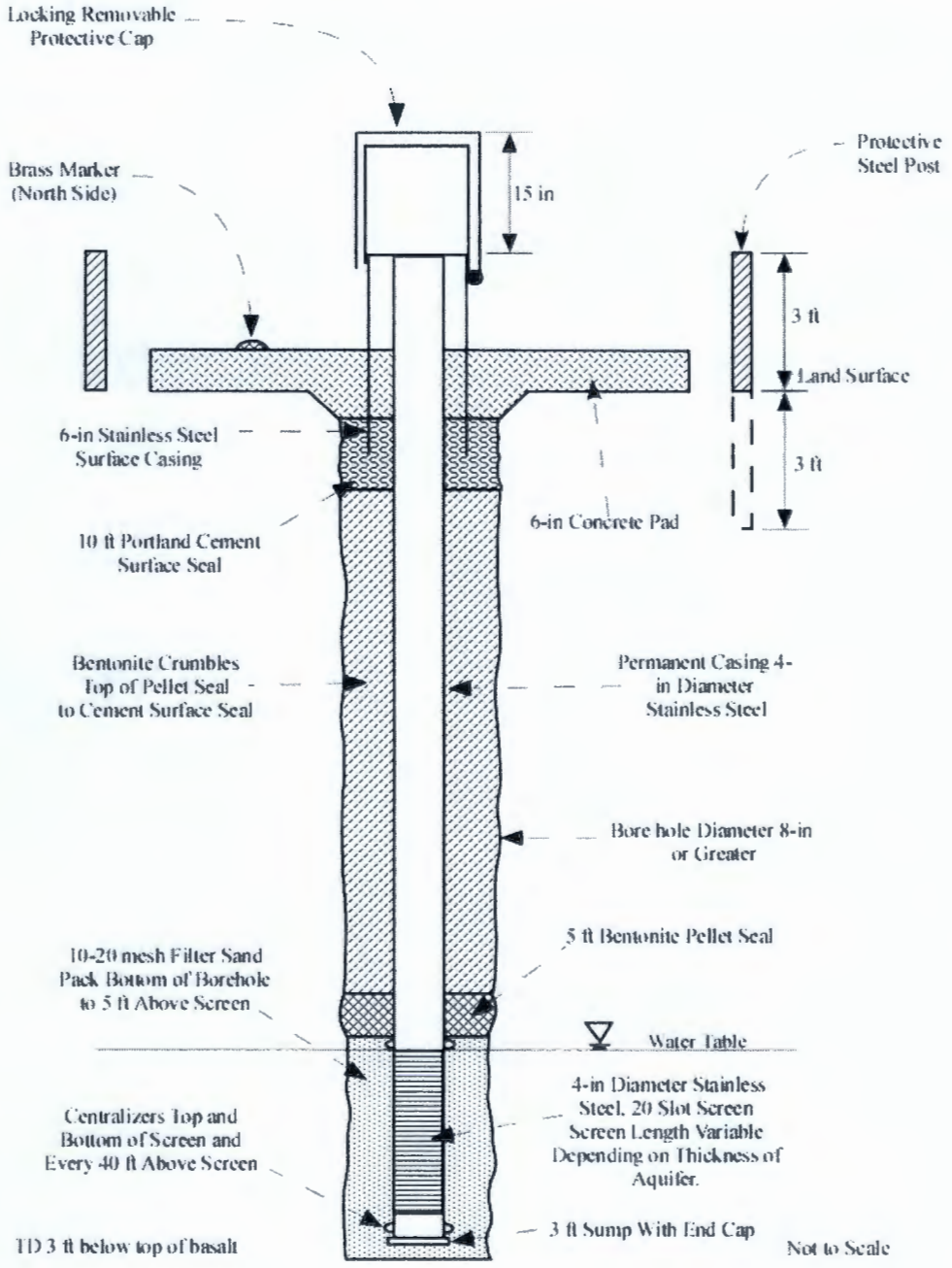
Table 3-1. Summary of Well Installation, 200-BP-5 OU Monitoring Well C5860 ("K")

Summary of Well Installation, 200-BP-5 OU Monitoring Well C5860 ("K")

Well Name	Estimated Depth to Water (ft)[1]	Estimated Drill Depth (ft)	Screen and Casing Diameter (in)	Screen Slot Size	Screen Length / Interval (ft)	Filter Pack Mesh / Interval (ft)	Bentonite Pellet Seal Interval (ft)	Bentonite Crumble Seal Interval (ft)	Cement Seal Interval (ft)
Monitoring Well Design									
299-E29-54 (C5860)	302.5 ± 5	380 ± 5	4	20 or TBD[2]	35 / TBD[4]	10-20 or TBD[2] / TBD[3]	TBD[3]	TBD[3]	0 – 10

Notes:
[1] Estimated depth to water estimated from data from previously drilled wells in the 200 Area.
[2] Screen slot size and filter-pack mesh size will be determined after evaluation of sample data.
[3] Screened interval, filter pack interval, and bentonite seal intervals will be determined based upon field-screening results.
ft = foot (feet).
in = inch (inches).
TBD = to be determined.

Figure 3-1. Well Design for 200-BP-5 OU Monitoring Well C5860 (well K.)



3.4 SAMPLING AND DATA COLLECTION

The primary objective for the new well is to provide the nature and extent of contamination in the vadose zone and groundwater for understanding the current and potential future risks associated with the groundwater at this location. The field geologist will document drilling activities at the well sites on field activity report sheets. The field geologist will examine and characterize borehole cuttings and prepare borehole logs as specified in the FH procedure GRP-EE-01-7.0.

Grab Samples - Sampling requirements for the borehole include collecting routine grab archive samples (stored in one-pint jars) at 5-ft intervals and at changes in lithology. In addition to the archived samples, small volume samples for chip trays are to be collected. These samples are to be made available to the project scientist to corroborate the field geologist descriptions and aid in the hydrogeologic interpretation for use in constructing maps and cross-sections for conceptual models. The field geologist will examine the cuttings generated during drilling and shall prepare a borehole log in accordance with FH procedure GRP-EE-01-7.0.

Additional sampling requirements include the collection of a single one quart jar grab samples at 2.5 foot intervals from the ground surface to the total depth of drilling as stated in Table 3-2. The quart-size sediment samples are intended to support various geochemical and physical soil analyses in the development of modeling parameters for the 200-BP-5 remedial investigation and feasibility study. The samplers will collect soil samples, and complete sample labels and chain of custody forms in accordance with FH procedure GRP-EE-01-4.6. The Pacific Northwest National Laboratory will provide the testing of the quart jar samples. All sediment samples are to be labeled with the borehole number, sample depth, and date of sample and documented on the geologist log.

Split-spoon samples will be collected from the borehole at depths and intervals listed within Table 3-2. These samples will be collected in 4-in diameter split-spoon sampler(s) containing four 6-in long Lexan liners. The length of the split spoon sampler shall be 2.5 ft (including shoe) and the sampling device shall be driven the full 2.5 ft, or until refusal, whichever comes first. Split-spoon samplers used for collecting samples for chemical and physical property analyses and will be decontaminated prior to sample collection. The samplers will collect soil samples, and complete sample labels and chain of custody forms in accordance with FH procedure GRP-EE-01-4.6.

Groundwater samples will be collected from the borehole at depths and intervals listed within Table 3-2. The borehole shall be bailed to remove cuttings. All pumped groundwater sampling shall occur after a minimum of three casing volumes of water have been purged from the borehole, and the pH, conductivity, temperature, and dissolved-oxygen readings have stabilized. These samples should be collected with a submersible pump in accordance with FH procedure GRP-EE-01-4.1. A KABIS sampler may be used if water level is not sufficient to support a submersible pump. The samplers will collect groundwater samples, and complete sample labels and chain of custody forms in accordance with FH procedure GRP-EE-01-4.1.

Borehole Geophysical logging will be performed to assess potential for future groundwater impacts from vadose zone contaminants by defining the extent and distribution of subsurface contaminants adjacent to known surface discharges or inadvertent releases. The borehole will be logged using spectral gamma and neutron (moisture) instrumentation. Borehole logging will be performed through a single string of casing (i.e., from surface to prior to telescoping and from the top of basalt to TD) to produce a geophysical log of the entire length of borehole.

Water levels will be monitored during well construction and development activities.

A summary of the data collection requirements is found in Table 3-2.

Figure 3-2. Sediment and Groundwater Samples for Borehole K. (2 sheets)

Sediment and Groundwater Samples for Borehole K. (2 sheets)

Sample Location	Sample Collection Method	Sample Collection Interval	Analyte List
Lithologic Archive Samples			
Borehole K	Grab Pint Jar	Every 5 ft and at major changes in lithology	Samples for archive storage – no analysis required beyond geologist's sample description.
Unsaturated Zone Sediment Samples			
Borehole K	Split-spoon	Split-spoon samples will be collected at a minimum of 30 foot intervals from 30 to 160 bgs. In addition, samples will be collected every 10 feet from 160 to groundwater. Finally samples will be collected continuously every 2.5 ft over intervals (ft bgs): 195-225 and 295-302.5.	Analyses are associated with geophysical, geochemical and contaminant parameters. -
Borehole K	Grab Quart Jar	Grab samples collected every 2.5 ft over the interval (ft bgs): ground surface -302.5.	Model Development parameters
Saturated Zone Sediment Samples			
Borehole K	Split-spoon	Split-spoon samples collected continuously over intervals (ft bgs): 302.5-305, 315-317.5, 341-343.5, and 377.5-380	Analyses are associated with geophysical, geochemical and contaminant parameters. -
Borehole K	Grab, Quart Jar	Grab samples collected over the interval (ft bgs): 302.5-total depth (estimated 380 bgs)	Model Development parameters
Groundwater Samples			
Borehole K	Pump or KABIS	One sample will be collected at each of the following intervals (ft bgs): 302.5-305, 315-317.5, 341-343.5, and 377.5-380	Contaminant parameters.

Notes:
bgs = below ground surface
TBD = to be determined
WSCF = Waste Sampling and Characterization Facility

3.5 WELL DEVELOPMENT

The objectives of well development for the new monitoring well is to settle the filter pack, prevent uncontrolled infiltration of fines and ensure communication of the well with the surrounding formation. Well development will be conducted in two stages with initial

development performed during well construction and final development performed after the well is completed. Well development activities are directed toward ensuring adequate aquifer communication without causing excessive agitation of the aquifer to avoid potential aeration of the formation. To this end, a variety of well development tools and capabilities are required.

Well development shall consist of surging and pumping to clean the disturbed zone surrounding the well, recover drilling fluids and cuttings, and maximize well production. Well development shall be conducted in two steps: 1) predevelopment during well construction to settle the sand pack behind the screen and flush the surrounding formation of fines and cuttings; and 2) final development after the well is constructed, to improve aquifer communication between the surrounding aquifer and the well and remove residual fines and drill cuttings.

To settle the sand pack during predevelopment, a dual flange surge block will be used to aggressively surge the well. As needed, a submersible pump may also be used as an effective surge block that pumps during the surging action, thus effectively working as a vacuum to remove the fine sediments immediately, which facilitates a more uniform development along the well screen and improves the effectiveness of the final well development. Predevelopment criteria are defined as follows:

- Following placement of the screen and final casing and addition of an appropriate amount of filter pack sand, the temporary casing is withdrawn no more than 10 feet.

- Surging is carried out with a dual flange surge block over intervals not to exceed more than 10 feet of filter sand placement at one time. Surging will be considered complete when the filter pack sand level settles no more than 0.1 feet in 15 minutes. Each interval must be surged for a minimum of one hour.

- Surging continues until the field geologist confirms completion of the initial development.

- Fines will be removed from the well as necessary.

Final development is performed after well completion and within two weeks of installation of the well screen/casing. Fines are removed from the well by bailing and/or pumping in preparation for final development. Final development consists of gently surging the well and bailing to remove residual fines. The well will be surged gently and bailed to remove fines until minimal fines are recovered. Final well development with a submersible pump will occur after the fines are removed. The development pump shall be capable of pumping over a minimum range of 5 to 20 gallons per minute (gpm) with the pump intake placed at mid-depth along the length of the screen to adequately develop the screened interval. During the duration of final well development the pumping rate shall be incrementally increased up to 20 gpm, assuming excessive drawdown does not become a problem. After installation of the development pump, water samples will be collected for analysis of turbidity, temperature, dissolved oxygen, pH, and conductivity using field instruments. Development will continue until the well produces clear water (<5 nephelometric turbidity units) and the temperature, pH, and conductivity have stabilized (at least three consecutive measurements within 10% of each other). The field geologist will monitor aquifer response and record recovery time with a pressure transducer and

data logger. The recovery test should be performed without removing the development equipment and shall last a minimum of 30 minutes.

The field geologist will determine when the final development is completed per criteria in FH procedure GRP-EE-01-6.3, "*Well Development and Testing*." After final well development has been determined to be complete, the depth to bottom of the permanent casing shall be checked, and, if necessary, excess sediment will be removed by bailing.

Water samples will be collected for field analysis of turbidity, temperature, pH, dissolved oxygen, and conductivity using field instruments. Well development activities will be conducted in accordance with GRP-EE-01-6.3, "Well Development and Testing." Typically, well development is considered complete when groundwater turbidity samples are measured at or below 5 NTU. Because the well is designed for groundwater monitoring the well development standards may be modified at the discretion of the FH Project Manager. The field geologist will monitor aquifer response and record the groundwater field parameters and recovery time during development.

3.6 SAMPLE PUMPS

Following final well development, a dedicated Grundfos RediFlo-3, stainless steel sampling pump shall be installed in the monitoring well with the pump intake located within the screen interval as directed by the Project Manager. The pump will be decontaminated and tested prior to installation. The check valves will be removed prior to pump installation.

3.7 FINAL REPORT

A borehole summary report will be prepared after well completion to document well construction. The purpose of this document is to compile and archive records, observations, and measurements associated with the drilling and well construction. The borehole summary report includes the field notes and forms prepared during the drilling and construction of each well, well construction details, and well development data. Additional information described in the report includes subsurface geologic descriptions, civil survey results and elevation corrections, management of drilling-derived waste, and well acceptance.

4.0 WASTE MANAGEMENT

The following are the major assumptions for handling and management of wastes derived during the drilling and construction of the well in the 200-BP-5 OU. These wastes may include drill cuttings, purgewater, decontamination waste, personal protective equipment, and miscellaneous solid waste (MSW). Waste generated by installation of the well will be managed according to the *Waste Control Plan for the 200-BP-5 Operable Unit* (DOE/RL-2003-30), SGW-34748, and a Waste Management Specialist-approved Waste Packaging/Labeling Instruction Sheet (WP/LIS). The FH Waste Management Specialist will provide final waste management instructions for the project.

4.1 VADOSE ZONE WASTE

Vadose zone drill cuttings from ground surface to approximately 75 feet bgs may be placed on plastic sheeting near the point of generation and periodically (twice daily) surveyed. If no elevated contaminant levels are detected by field instrument monitoring during drilling in the vadose zone, the drill cuttings will not be considered contaminated and will be returned to the well site or treated as solid waste (e.g., at the Waste Management Specialist's directive, waste will either be return-to-earth, disposed to municipal trash, or stored at Environmental Restoration Disposal Facility (ERDF), as applicable). Vadose zone sediment will be initially stockpiled and a formal review and approval will be obtained prior to final disposition as per GRP-EE-02-14, "Returning Vadose Zone Drill Cuttings/Soils to the Environment."

Vadose zone drill cuttings from below 75 feet bgs to the historical high water mark (saturated zone), shall be contained in drums at the point of generation. These drill cuttings are expected to be chemically and radiologically contaminated. The soils should be scanned using appropriate radiological and volatile organic field screening instruments. Theses soils will be characterized using analysis from soil samples collected during this investigation. The sample will be analyzed for the contaminants of potential concern identified in SGW-34748 and WMP-28945 Free liquids are not expected, however, if present in the top of the drum after settling will be dewatered (eliminated by evaporation and/or by the addition of sorbent material) and managed as purge water. Dewatered drums containing saturated cuttings will be stored and managed as stated in the WP/LIS. These soils will be disposed at the Environmental Restoration Disposal Facility if waste acceptance criteria can be met.

4.2 GROUNDWATER-CONTACTED WASTE

All drill cuttings from below the historical high water mark (saturated zone) to the TD drilled, shall be contained in drums at the point of generation. These drill cuttings are not expected to be chemically or radiologically contaminated (e.g., elevated field readings) but should be scanned periodically using appropriate radiological and volatile organic field screening instruments. The saturated zone waste will be characterized using analysis from a single soil sample collected from 10 ft below the groundwater table or from drill cuttings with the highest field screen reading. The sample will be analyzed for the contaminants of potential concern identified in

SGW-36277 and DOE/RL-2007-18, Rev. 0. Free liquids occurring in the top of the drum after settling, will be dewatered (eliminated by evaporation and/or by the addition of sorbent material) and managed as purge water. Dewatered drums containing saturated cuttings will be stored and managed as stated in the WP/LIS. These soils will be disposed at the Environmental Restoration Disposal Facility if waste acceptance criteria can be met.

Groundwater-contacted wastes will not be designated as "ignitable, corrosive, or reactive" based on historic Hanford Site groundwater *Hanford Environmental Information System* database data.

4.3 PURGEWATER

Purgewater will be generated during well installation, development, testing, monitoring, sampling, maintenance, and dewatered of saturated drill cuttings. Purgewater shall be temporarily collected and contained at the well head until it is either transported to the Purgewater Storage and Treatment Facility or, if waste acceptance criteria can be met, the Effluent Treatment Facility. Purgewater, groundwater samples, and decontamination fluids generated during well drilling, sample screening, and analysis shall be managed as purgewater in accordance with purgewater guidance provided in "Strategy for Handling and Disposing of Purgewater at the Hanford Site, Washington" (Izatt 1990).

4.4 MISCELLANEOUS SOLID WASTE

Miscellaneous Solid Waste generated during work in the vadose and saturated zone will be temporarily stored and managed as outlined in the WP/LIS. MSW will be surveyed by the Industrial Health and Radiation Control technicians during their scheduled site surveillance in accordance with HNF-13536, Section 4.1.1 "Standard Radiological Release Surveys for Materials and Equipment" the site specific Health and Safety Plan and Radiological Work Permit. All MSW collected from 75 feet bgs shall be designated using the vadose zone and saturated drill-cuttings contaminant profiles, respectively. If elevated readings are detected, the MSW from ground surface to 75 feet bgs then the MSW shall be designated using the vadose zone drill-cuttings contaminant profile. The profile will be generated from analysis defined in the data quality objective summary report.

5.0 QUALITY ASSURANCE

FH issued document "Quality Assurance Program Description" (HNF-MP-599), describes how FH implements the quality assurance (QA) requirements conveyed in U.S. Department of Energy Order 414.1C (*Quality Assurance*) and "Nuclear Safety Management" (10 *Code of Federal Regulations* [CFR] 830.121). HNF-MP-599 also shows how the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989) and *Hanford Analytical Services Quality Assurance Requirements Document (HASQARD)* (DOE/RL-96-68) apply to Environmental QA Program Plans. FH has also issued *Fluor Hanford Environmental Quality Assurance Program Plan* (HNF-23333). All FH employees and subcontractors performing environmental cleanup activities are responsible for performing work in accordance with the requirements set forth in HNF-23333. Project management requirements are also detailed in "Project Management Requirements" (HNF-RD-14988).

All work performed under this DOW will be performed in compliance with Project Hanford Management System overall QA program design (HNF-MP-599). A project specific QA Program plan for the Groundwater Remediation Project scope is presented in *Groundwater Remediation Project Quality Assurance Project Plan (GRP-QA-001)* (HNF-20635) or subsequent and equivalent FH quality program plans.

All operations including drilling, sampling and well completion/decommissioning, testing and associated documentation are subject to surveillance by FH, FH's authorizing agent and/or owner. This surveillance shall in no way relieve the contractor of any contractual responsibilities. Note the term "surveillance" as used here may include inspection, survey, and/or assessment. The drilling contractor will implement a QA program as submitted and approved under the drilling master agreement.

Technical procedures are listed in Section 7.2 "Technical Procedures/Specifications."

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6.0 SCHEDULE

Drilling and completion operations for the new well is scheduled to begin after February 1, 2008. The well shall be completed no later than September 30th, 2008.

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7.0 GENERAL REQUIREMENTS

Well construction activities will be conducted in accordance with existing FH procedures and protocols and the specifications of this DOW. The applicable procedures are discussed in the following sections.

7.1 SAFETY AND HEALTH

All personnel working at the drilling sites addressed by this plan will have completed, at a minimum:

- Occupational Safety and Health Administration Act 40-hour Hazardous Waste Site Worker training program (29 CFR 1910.120).
- Hanford General Employee Training (HGET).
- Hanford Radiation Worker II training.

Work will be performed in accordance with the following procedures:

- *PHMC Radiological Control Manual* (HNF-5173)
- Site-specific plans, as applicable:
  - Health and safety plans
  - Radiological Work Permit, as applicable
  - Activity hazard analysis/job safety analysis
  - Site-specific Waste Packaging Instruction
- FH Environmental Procedures
- Soil and Groundwater Remediation Project Radiological Control Procedures.

7.2 TECHNICAL PROCEDURES/SPECIFICATIONS

This section identifies technical procedures/specifications applicable to field activities performed under this DOW. Activities associated with the drilling and installation of this well and management of waste generated by these activities will adhere to, at a minimum, the following FH procedures and requirements:

- HNF-PRO-10863, "Notebooks and Logbooks"
- GRP-EE-01-1.11, "Purgewater Management"
- GRP-EE-01-3.0, "Chain of Custody"

- GRP-EE-01-3.1, "Sample Packaging and Shipping"
- GRP-EE-01-4.0, "Soil and Sediment Sampling"
- GRP-EE-01-6.2, "Field Cleaning and/or Decontamination of GeoProbe® and Drilling Equipment"
- GRP-EE-01-6.3, "Well Development and Testing"
- GRP-EE-01-7.0, "Geologic Logging"
- GRP-EE-02-14.1, "Drilling, Remediating, and Decommissioning Resource Protection Wells, and Geotechnical Soil Borings"
- GRP-EE-02-14.5, "Returning Vadose Zone Drill Cuttings/Soils to the Environment"
- GRP-EE-05-1.17, "Determination of Hexavalent Chromium in Water, Wastewater, and Soils Utilizing the Hach DR/2000 and DR/2010 Spectrophotometers"
- HNF-RD-15332, "Environmental Protection Requirements"
- HNF-PRO-15333, "Environmental Protection Processes"
- HNF-PRO-15334, "Effluent and Environmental Monitoring"
- HNF-PRO-15335, "Environmental Permitting and Document Preparation"
- HNF-EP-0063, "Hanford Site Solid Waste Acceptance Criteria"
- 0000X-DC-W0001, Rev. 6, "Supplemental Waste Acceptance Criteria for Disposal at Environmental Restoration Disposal Facility"

8.0 PROJECT DOCUMENTATION

Documentation requirements for these activities are separated into scoping documents, field activity documents, and reporting documents. The following documents will be prepared to support the well drilling activity:

- Scoping Documents
  - DOW (this document)
  - Data quality objective summary report
  - Sampling and analysis instruction
  - Excavation permit
  - Additional waste management documents, as required
  - Health & Safety Plan
  - Job Hazard/Safety Analysis (prepared by FH or Contractor)

- Field Documentation
  - Well drilling/decommissioning planning form
  - Daily field activity reports
  - Sample collection, custody, and shipment documentation for waste samples
  - Well logs (borehole, lithologic, and completion)
  - Field logbook
  - Well construction summary report
  - Well summary sheet
  - Field cleaning and/or decontamination sheets
  - Well development and test data sheets
  - Sieve analysis sheets
  - Well survey data report
  - Well acceptance report
- Reporting Documents
  - Field documentation will be transmitted to FH Geoscience Support for incorporation into the well database
  - Borehole summary report
  - State of Washington Resource Protection Well Report.

Field documentation will be transmitted to the FH Groundwater Remediation Project lead for incorporation into the well database. The records produced for this project will undergo technical and management review in accordance with FH practices and procedures. The required reviewers will be identified prior to document completion, and the review time will be established as soon as practical.

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9.0 REFERENCES

Groundwater Protection Program Procedures:

HNF-PRO-10863, "*Notebooks and Logbooks*"

GRP-EE-01-1.11, "*Purgewater Management*"

GRP-EE-01-3.0, "*Chain of Custody*"

GRP-EE-01-3.1, "*Sample Packaging and Shipping*"

GRP-EE-01-4.0, "*Soil and Sediment Sampling*"

GRP-EE-01-4.1, "*Groundwater Sampling*"

GRP-EE-01-6.2, "*Field Cleaning and/or Decontamination of GeoProbe® and Drilling Equipment*"

GRP-EE-01-6.3, "*Well Development and Testing*"

GRP-EE-01-7.0, "*Geologic Logging*"

GRP-EE-02-14.1, "*Drilling, Remediating, and Decommissioning Resource Protection Wells, and Geotechnical Soil Borings*"

HNF-RD-15332, "*Environmental Protection Requirements*"

HNF-PRO-15333, "*Environmental Protection Processes*"

HNF-PRO-15334, "*Effluent and Environmental Monitoring*"

HNF-PRO-15335, "*Environmental Permitting and Document Preparation*"

HNF-EP-0063, "*Hanford Site Solid Waste Acceptance Criteria*"

HNF-RD-14988, "*Project Management Requirements*"

HNF-MP-599, "*Quality Assurance Program Description*"

HNF-13536, Section 4.1.1, "Standard Radiological Release Surveys for Material and Equipment"

HNF-23333, "*Fluor Hanford Environmental Quality Assurance Program Plan*"

HNF-20635, "*Groundwater Remediation Project Quality Assurance Project Plan" (GRP-QA-001)*

HW-43121, "*Tabulation of Radioactive Liquid Waste Disposal Facilities"*

10 CFR 830.120. *"Nuclear Safety Management, Quality Assurance Requirements."* U.S. Department of Energy, *U.S. Code of Federal Regulations*.

10 CFR 830.121, *Quality Assurance Program*, U.S. Department of Energy, *U.S. Code of Federal Regulations*.

29 CFR 1910.120, *Hazardous Waste Operations and Emergency Response*, Code of Federal Regulations, as amended.

ANSI, 1991, *ANSI Standard Z535.1*, American National Standards Institute, New York, New York.

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DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document (HASQARD)*

DOE-RL, 1996, *Hanford Analytical Services Quality Assurance Requirements Document*, DOE/RL-96-68, Rev 2. U.S. Department of Energy, Richland, Washington

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