SGW-60568
Revision 1

Description of Work for the Installation of Four Monitoring Wells Near the Southeastern Portion of the 200-UP-1 Operable Unit, FY 2017

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

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

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TERMS

bgs	below ground surface
BTR	Buyer's Technical Representative
CFR	*Code of Federal Regulations*
CHPRC	CH2M Hill Plateau Remediation Company
Cr(VI)	Hexavalent chromium
DOE	U.S. Department of Energy
DOW	Description of Work
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ft	foot/feet
gpm	gallons per minute
IH	Industrial Hygiene
OU	Operable Unit
QA	quality assurance
RLM	Ringold Formation lower mud unit
SAP	sampling and analysis plan
SGRP	Soil and Groundwater Remediation Project
TD	total depth
VOA	volatile organic analysis
WAC	*Washington Administrative Code*
WDOH	Washington Department of Health
WMA	Waste Management Area

1. Introduction/Scope of Work

This description of work (DOW) describes the drilling, construction, development, and sampling activities associated with the installation of five 200-UP-1 groundwater Operable Unit (OU) chrome monitoring wells. The work associated with this DOW is planned for fiscal years 2017 and 2018. These monitoring wells are being installed to support the southeast chromium plume characterization.

The installation of these new wells supports Ecology et al., (1989), *Hanford Federal Facility Agreement and Consent Order*, and will be in compliance with requirements of the *Resource Conservation and Recovery Act of 1976* as well as the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*. Activities to be carried out during the installation of the new wells will include well drilling, soil and groundwater sampling, borehole geophysical logging, and well-construction and development in accordance with DOE/RL-2014-27, *Sampling and Analysis Plan for Remediation Wells in the 200-UP-1 Operable Unit* (SAP), Rev. 2, as amended by applicable change notices.

A project site map with locations of the five wells is presented in Figure 1. Wells 699-27-68 (C9632), 699-29-55 (C9634), 699-30-70 (C9635), 699-30-73 (C9636) and 699-31-50 (C9737) are located in the 600 Area of the Hanford Site, between 200 West and 200 East Areas, and adjacent to the southeastern portion of the 200-UP-1 OU boundary, and located south and southeast of the Environmental Restoration Disposal Facility.

Drilling activities will consist of advancing the wells between approximately 358 and 433 feet (ft) below ground surface (bgs), depending on well location and depth to the Ringold Formation lower mud (RLM). All boreholes will be drilled 10 ft into the RLM geologic unit to support soil and groundwater characterization efforts. Wells are planned to be constructed in the upper aquifer. The abandoned section of the well below the screen will be backfilled with bentonite.

Sampling activities will include the following: 1) collection of soil grab samples for archive purposes; 2) collection of soil grab samples in the saturated zone for sediment grain size (sieve) analysis; 3) split spoon soil samples in the saturated zone for physical properties, chemical properties, and microbiological characterization; 4) water samples during drilling for contaminant analysis; 5) borehole geophysical logging of the entire borehole for subsurface characterization; and 6) a baseline water sample to be collected at the end of well development.

Well completion activities for the wells consist of installing 4-in diameter stainless steel monitoring wells with one 35 ft screened interval. Well development will be conducted for each well. Development will include surging in the well screen during sand pack installation, and over-pumping after the well has been built.

All drilling, decommissioning, and well construction activities will be performed by a drilling subcontractor using air rotary drilling method to help maintain oxygenated conditions in the subsurface. Sampling and testing will be performed by CH2M Hill Plateau Remediation Company (CHPRC) and affiliates. Table 1 lists the wells' construction identification numbers, names, and type, and provides location information.

Table 1. Well Identification and Location Summary

Well ID	Well Name	Type	Northing (m)	Easting (m)	Elevation (m)
C9632	699-27-68	Monitoring	131670.00	569350.00	197.8
C9634	699-29-55	Monitoring	132232.40	573241.04	211.1
C9635	699-30-70	Monitoring	132581.36	568429.06	197.0
C9636	699-30-73	Monitoring	132789.36	567781.87	200.9
C9737	699-31-50	Monitoring	132960.00	574750.00	215.5

m = meters

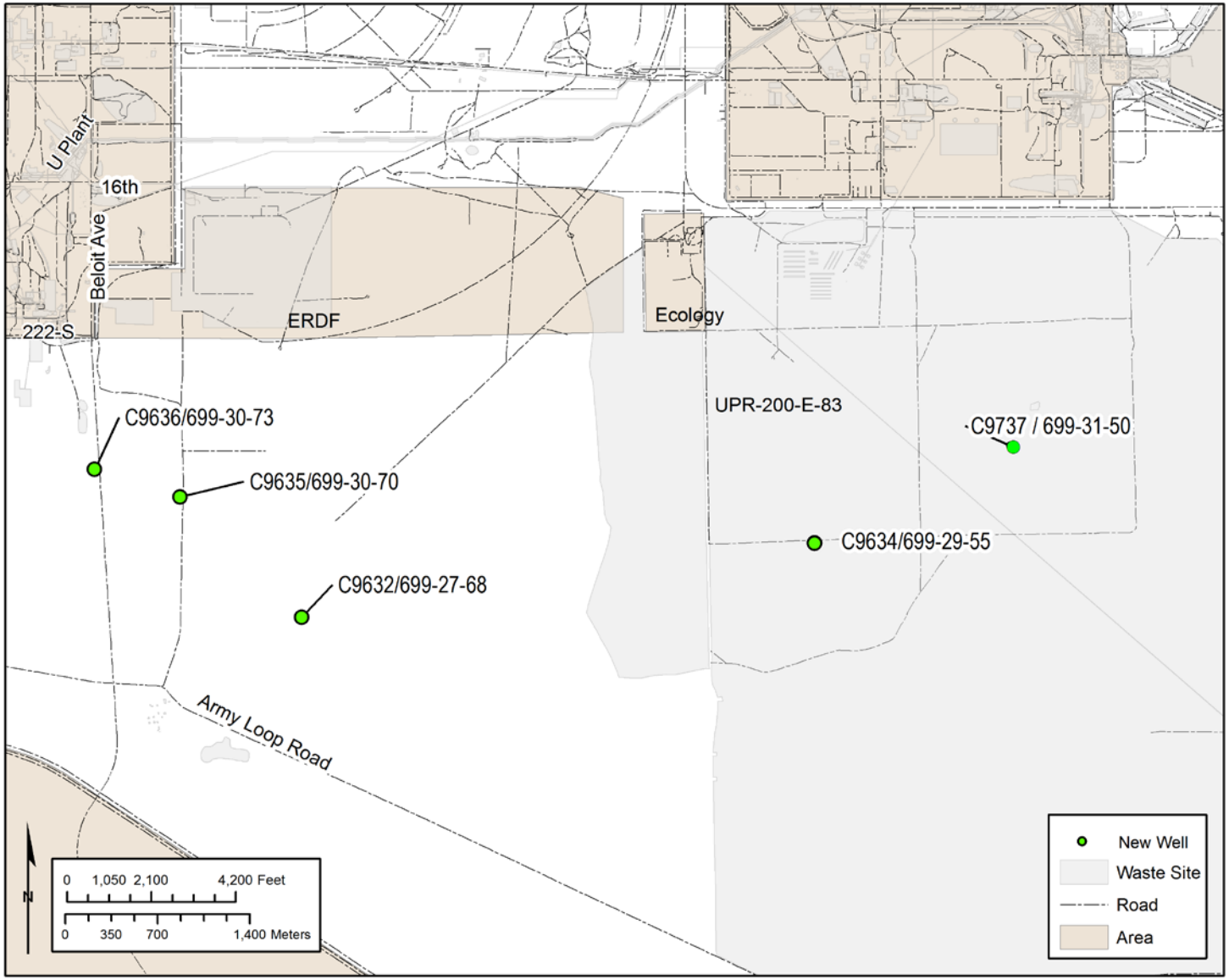

Figure 1. Locations for Five New 200-UP-1 OU Monitoring Wells

2. Background

The following section discusses previous work activities and regulatory decisions associated with the 200-UP-1 groundwater OU. General summaries of the site geology and hydrogeology and contaminants of concern relevant to the planned wells are presented.

All measurements in this document will be listed in English standard notation.

2.1 Historic Site Operations and Resulting Contamination

The Hanford Site covers approximately 586 square miles. Past nuclear weapon production activities at the Site resulted in approximately 450 billion gallons of liquid waste being released to the ground. Some of the associated contaminants remain in the vadose zone, between the top of the water table and the surface of the ground, but some have reached the groundwater. Hazardous chemical contaminants include various organics, chromium, and nitrate. Radioactive contaminants typically include iodine-129, cobalt-60, cesium-137, nickel-63, carbon-14, strontium-90, technetium-99, tritium, and uranium. The U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the Washington State Department of Ecology (Ecology) have developed a remediation plan for protecting the Columbia River Corridor. The Soil and Groundwater Remediation Project (SGRP) is largely responsible for ensuring the plan is implemented.

The 200 West Area contains waste management facilities and former irradiated fuel reprocessing facilities grouped into four process areas: U Plant, Z Plant, S Plant (Reduction-Oxidation Plant), and T Plant. The major waste streams that contributed to 200-UP-1 OU groundwater contamination were associated with the plutonium-separation and uranium recovery operations at the S Plant and U Plant facilities, where liquid wastes were disposed to the ground via ponds, cribs, ditches, and trenches. As effluent was discharged to these sites in the past, the more mobile contaminants migrated through the vadose zone to the groundwater. Some groundwater contamination also resulted from single-shell tank leaks or unplanned releases, particularly associated with Waste Management Area (WMA) S-SX. In addition, groundwater contamination has migrated from the adjacent 200-ZP-1 OU into the 200-UP-1 OU that originated from liquid waste disposed to the ground at Z Plant plutonium concentration and recovery facilities.

In the 200-UP-1 OU, the contaminants of concern are carbon tetrachloride, uranium, nitrate, chromium (total and hexavalent), iodine-129, technetium-99, and tritium. More than 90 groundwater monitoring wells were used to assess the nature and extent of these contaminants within and surrounding the 200-UP-1 OU. The plumes originating within the 200-UP-1 OU include the following:

- A uranium plume originating from the U Plant cribs
- A nitrate plume, originating from U Plant and S Plant cribs and WMA S-SX, and a small plume at WMA U
- Two chromium (total and hexavalent) plumes associated with WMA S-SX, and a dispersed chromium (total and hexavalent) plume in the southeast corner of the OU that originated from an S Plant crib
- An iodine-129 plume originating from U Plant and S Plant cribs
- Four separate technetium-99 plumes associated with WMA U, U Plant cribs, and WMA S-SX
- A tritium plume originating from S Plant cribs.

In addition to the plumes formed within the 200-UP-1 OU, a carbon tetrachloride plume exists over a large portion of the 200 West Area. This plume originated from operation of the Plutonium Finishing Plant (Z Plant) facilities and has spread south and east from the 200-ZP-1 OU and into the 200-UP-1 OU.

Most recently, EPA et al. (2012), *Record of Decision for Interim Remedial Action, Hanford 200 Area Superfund Site, 200-UP-1 Operable Unit,* was signed by EPA, DOE, and Ecology on September 27, 2012, to address these plumes. The selected interim remedy for the 200-UP-1 OU is a combination of groundwater extraction and treatment using pump-and-treat, monitored natural attenuation, hydraulic containment of the iodine-129 plume, an iodine-129 treatment technology evaluation, remedy performance monitoring, and institutional controls.

The five new wells in this DOW are being installed to monitor the dispersed chromium plume in the southeast corner of the 200-UP-1 OU that originated from the S Plant crib. These wells will be constructed to support future extraction use, if applicable.

2.2 Site Stratigraphy and Hydrogeology

The following section summarizes the stratigraphic setting and hydrogeologic conditions in the vicinity of the new wells. Table 2 provides a listing of estimated contact depths for each borehole planned in this document, based on contour maps developed from the nearest available well logs.

Table 2. Estimated Geologic Contacts and Depth to Water for 200-UP-1 OU Dual-Purpose Wells

Well ID	Depth to Water (ft bgs)	Hanford and Surficial Deposits	Ringold Formation, unit E (Rwie) (ft bgs)	Ringold Formation Lower Mud (RLM) (ft bgs)	Ringold Formation, unit A (Rwia) (ft bgs)	Columbia River Basalt (ft bgs)
C9632	221	Ground surface to top of Rwie.	201	348	399	515
C9634	289		270	395	474	669
C9635	216		209	372	424	554
C9636	220		187	397	449	562
C9737	307		292	423	515	663

Depths are estimated based on geology at nearby wells and intervals may be subject to change (±5 ft) based on geologic conditions.
ft bgs = feet below ground surface
Rwie = Ringold Formation, member of Wooded Island unit E

2.2.1 Stratigraphic Setting

The following section summarizes the general stratigraphy in the areas surrounding the new wells.

The Hanford Site lies within the semiarid, shrub-steppe Pasco Basin of the Columbia Plateau in southeastern Washington State. The 200 Areas are located on a broad, relatively flat area that constitutes a local topographic high near the center of the Hanford Site. The 200-UP-1 OU underlies the southern portion of the 200 West Area and all of Environmental Restoration Disposal Facility, which is on the western end of the Central Plateau. Surface elevations above the OU range from approximately 600 ft to more than 700 ft above mean sea level.

Basalt of the Columbia River Basalt Group and a sequence of overlying sedimentary deposits comprise the local geology. Within the 200 West Area, the overlying sediments range between 580 to 612 ft thick

and primarily consist of the Ringold Formation and Hanford formation, which are composed of sand and gravel with some silt layers. Geologic units above the basalt bedrock consist of the following sedimentary units; not all of these may be present at any one location (in descending sequence):

- Eolian (Holocene) deposits/disturbed sediments/recent sand and gravel backfill
- Sand and gravel of the Hanford formation
- Sand and gravel Ringold Formation member of Wooded Island unit E (Rwie)
- Fine-grained Ringold Formation lower mud unit (RLM)
- Sand and gravel of Ringold Formation member of Wooded Island unit A (Rwia – which overlies the Columbia River Basalt Group)

Depending on proximity to former facilities and/or remediation sites, the ground surface of the 200 Areas has been extensively disturbed by grading, construction, and demolition work. Disturbed sediments can extend more deeply, but in general range from 1 to 15 ft bgs in disturbed areas. However, this does not apply to the five wells being drilled per this DOW because these are located south outside of the 200 West Separations area.

Underlying any recent Holocene deposits, the Hanford formation is a Pleistocene, cataclysmic flood and inter-flood deposit resulting from the Missoula Floods 15,000 to 12,000 years ago. The Hanford formation can be loosely divided into three facies: gravel-dominated, sand-dominated, and slackwater (WHC-SD-EN-TI-011, *Geology of the Northern Part of the Hanford Site: An outline of Data Sources and the Geologic Setting of the 100 Areas*). The gravel-dominated Hanford formation is highly basaltic, ranging from approximately 50% to 80% basalt (WHC-SD-EN-TI-011). The sand-dominated facies of the Hanford formation consist of relatively thick, predominantly horizontally laminated, loose, basalt-rich, fine- to coarse-grained sand, with an average of about 50% mafic and 50% quartz-feldspar composition. This gives the Hanford formation its characteristic "salt and pepper" appearance (DOE/RL-2002-39, *Standardized Stratigraphic Nomenclature for the Post-Ringold-Formation Sediments Within the Central Pasco Basin*).

The Ringold Formation, in the project area, comprises the deepest portion of the sedimentary sequence, disconformably underlies the Hanford formation or cold creek unit (not expected to be present in the project area), and consists of (in descending order): semi-consolidated fluvial silt, sand, and mostly gravels (of the Rwie); paleosol and lacustrine clay and silt of the RLM; and quartz-feldspar-lithic gravel, sand, and paleosols of the basal unit (Rwia). The Ringold Formation extends down to the basalt bedrock (BHI-00184, *Miocene- to Pliocene-Aged Suprabasalt Sediments of the Hanford Site, South-Central Washington*).

2.2.2 Hydrogeology

The vadose zone at the project location is generally composed of Holocene material and the silts, sands, gravels and of the Hanford formation and upper Ringold Formation.

Groundwater beneath the Hanford Site is found in an upper, primarily-unconfined aquifer system and also in deeper, confined aquifers within the lower Ringold Formation and the basalt. The unconfined aquifer beneath the project area wells is found within the Rwie. The lower boundary of the unconfined aquifer is silt and silty clay of the RLM, which acts as a hydraulic barrier over the majority of the OU and limits groundwater flow from moving into the confined aquifer system below.

Depths to groundwater for the new well locations are specified in Table 2 and are expected to be approximately 216 to 307 ft bgs, depending on well location. Groundwater contamination is largely

contained within the uppermost unconfined aquifer, which ranges in thickness from 106 to 177 ft in these wells.

2.3 Contaminants of Potential Concern

Recent groundwater plume maps for the vicinity are provided in DOE/RL-2016-09, *Hanford Site Groundwater Monitoring Report for 2016*, as well as in this project's associated SAP. Table 3 presents the contaminants of concern for the 200-UP-1 OU.

Table 3. 200-UP-1 OU Contaminants of Concern

Contaminant	CAS Number
Carbon Tetrachloride	56-23-5
Chromium, Total*	7440-47-3
Chromium, Hexavalent*	18540-29-9
Iodine-129	15046-84-1
Nitrate	14797-55-8
Technetium-99	14133-76-7
Tritium	10028-17-8
Uranium	7440-61-1

* Chromium is aqueous in Hanford groundwater only in the hexavalent form. Thus, analyses for total chromium and hexavalent chromium essentially measure the same constituent in groundwater, hexavalent chromium.

CAS = Chemical Abstracts Service

3. Description of Work Activities

Activities to be conducted at each well site include site preparation, drilling, sampling, well construction, and well development. All activities described in this document will be conducted in accordance with the guidelines and requirements set forth in SGRP-PRO-EN-50030 (GRP-EE-02-14.1), *Drilling, Remediating, and Decommissioning Resource Protection Wells, and Geotechnical Soil Borings* and shall conform to minimum resource protection well standards as defined in WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells." The WDOH (2012), *The Department of Energy Hanford Site Radioactive Air Emissions License #FF-01*, Enclosure 3, "ALARACT Agreements," ALARACT 18, "Environmental Restoration Program ALARACT Demonstration for Drilling," shall also apply. A legal record of well site activities will be maintained by a third-party field geologist and recorded in daily field activity reports.

3.1 Well Site Preparation

Drilling sites will be accessed by existing roads wherever possible and wherever limited access roads have been constructed as necessary. A drill pad of sufficient size for operations and limited access roads will be constructed for each well. Grub surveys will be performed by radiation control technicians for each site prior to the drill pad and access road construction. Ground penetrating radar surveys will also be conducted as necessary and excavation permits obtained as part of site preparation prior to drilling.

3.2 Drilling

The drilling contractor shall be responsible for complying with well drilling and construction standards defined in WAC 173-160 and applicable CHPRC procedures. The drill rig and all down-hole equipment shall be high temperature and pressure washed prior to use between wells, including all wells located within the same OU, to minimize potential for cross-contamination. An environmentally-compatible non-petroleum lubricant, such as Jet-Lube Well-Guard[1] thread compound or equivalent, may be used for lubricating the threads of the stainless steel and temporary casing during installation activities. Hydrocarbon-based lubricants are not acceptable.

The new monitoring wells will be drilled to support soil and groundwater characterization efforts in the southeast chromium plume and will be completed with one screened interval planned for the top of the unconfined aquifer. The screen could be moved deeper depending on the vertical distribution of chromium in the aquifer. The total screen length is estimated to be 35 ft in length for wells 699-27-68 (C9632), 699-29-55 (C9634), 699-30-70 (C9635), 699-30-73 (C9636) and 699-31-50 (C9737). Estimated well construction parameters are presented in Table 4.

The actual TD of the wells will be determined by CHPRC's field geologist or hydrogeologist and may vary from anticipated depths depending on the varying geologic conditions encountered. The nominal casing diameter for the borehole at TD for all wells shall be no less than 8-in to allow completion of a 4-in diameter well. This assures that the wells retain a minimum 2-in annulus called for under WAC 173-160.

Drilling aids such as bentonite, other clay-based agents, water, or any foreign matter capable of affecting the characteristics of the sediment samples or ground water will not be placed in the wells without prior approval of CHPRC.

During drilling and sampling, all reasonable efforts shall be made to minimize, or eliminate, the addition of water to the borehole. If water addition is necessary, the volume added should be kept to the smallest volume required and only added with the approval of the buyer's technical representative (BTR) or OU Project Technical Lead. Only potable water shall be added during drilling. Added water volumes will be accurately recorded in the geologist and drilling log, including volume added and depth interval.

The drilling contractor will be responsible for performing a straightness test prior to beginning well completion as required by WAC 173-160. The pipe must freely pass without binding to declare the well straight. The test for straightness shall be made in the presence of the CHPRC BTR or delegate.

Drilling activities for all wells have been evaluated as low radiological hazard with specific controls based on the site histories, sampling of nearby waste sites and existing wells. A grub survey is required prior to surface disturbance while preparing drilling pads for the three new wells. Radiological-control support is anticipated to consist of daily "AM/PM" surveys as long as current radiological hazards remain unchanged for wells C9632, C9365, and C9636. Wells C9634 and C9637 are located within a posted contamination area. Fulltime radiological surveying coverage will be required for the first 10 feet of drilling. Beyond 10 ft, only AM/PM surveys are required. Any other work will be identified and incorporated into applicable work instructions.

The planned frequency for Industrial Hygiene (IH) monitoring is AM/PM during drilling activities for volatile organic contaminants. Continuous IH support will not be required for water sampling unless requested by the groundwater samplers. Continued IH support for well construction/development activities will be contingent upon data obtained during drilling. Additional sampling/monitoring may be

[1] Jet-Lube Well-Guard® is a registered trademark of Jet-Lube, Inc. of Houston, Texas.

required by the Industrial Hygienist based on monitoring results, work activities conducted, and environmental conditions.

Table 4. Well Construction Parameters

Well ID / Well Name	Estimated Depth to Water (ft bgs)	Estimated Drill Depth (ft bgs)	Perm. Well diameter (in)	Bentonite Backfill (ft bgs)	Screened Intervals (ft bgs)[a]	Filter Pack Interval (ft bgs)	Bentonite Pellet Seal (ft bgs)	Bentonite Crumble/ Granule Seal (ft bgs)	Cement Bentonite Grout Seal (ft bgs)
C9632 699-27-68	221	358	4	358 - 259	256 - 221	259 - 216	216 - 213	213 - 10	10 - 0
C9634 699-29-55	289	405	4	405 - 327	324 - 289	327 - 284	284 - 281	281 - 10	10 - 0
C9635 699-30-70	216	382	4	382 - 254	251 – 216	254 - 211	211- 208	208 - 10	10 - 0
C9636 699-30-73	220	407	4	407 - 258	255 - 220	258 - 215	215 - 212	212 - 10	10 - 0
C9737 699-31-50	307	433	4	433 - 345	342 - 307	345 - 302	302 - 299	299 - 10	10 - 0

Note: Information and depths presented on table are estimates and may vary. Final drill depth, position of well screen, backfill interval, filter pack interval, and bentonite seal intervals will be determined based upon actual borehole conditions and sieve analysis; intervals may be subject to change (± 5 ft) based on geologic conditions.

a. Assume a 3 ft sump with end cap on the bottom of each screen.

ft bgs = feet below ground surface
in = inches

3.3 Sampling Requirements

All data collection requirements for this project meet the requirements established by the SAP.
A sampling summary of planned collection activities is found in Table 5. Additional samples may also be collected if unusual or unexpected conditions are encountered in the field. If the RLM is not encountered within 20 ft below the last specified sample depth, water samples will continue to be collected every 20 ft until reaching the RLM.

Table 5. Summary of Well Sampling for 200-UP-1 OU Wells

Well ID / Well Name	Geologic Grab Sample	Sieve Analysis Grab	Split Spoon Sample[a] (ft BWT [ft bgs])	Groundwater Sample[b,c] (ft BWT [ft bgs])
C9632 699-27-68	Every 5 ft or where lithologic changes occur; in one pint jar and a chip tray from drill cuttings.	Sediment grab samples at 5 ft intervals from 0 to 125 ft BWT Composite grab samples every 20 ft for sieve analysis.	10 (231) 50 (271) 90 (311)	10 (231) 30 (251) 50 (271) 70 (291) 90 (311) 110 (331) Post-Development
C9634 699-29-55		Sediment grab samples at 5 ft intervals from 0 to 105 ft BWT Composite grab samples every 20 ft for sieve analysis	10 (299) 50 (339) 90 (379)	10 (299) 30 (319) 50 (339) 70 (359) 90 (379) Post-Development
C9635 699-30-70		Sediment grab samples at 5 ft intervals from 0 to 155 ft BWT Composite grab samples every 20 ft for sieve analysis	10 (226) 70 (286) 130 (346)	10 (226) 30 (246) 50 (266) 70 (286) 90 (306) 110 (326) 130 (346) 150 (366) Post-Development
C9636 699-30-73		Sediment grab samples at 5 ft intervals from 0 to 177 ft BWT Composite grab samples every 20 ft for sieve analysis	10 (231) 70 (291) 130 (350)	10 (231) 30 (251) 50 (271) 70 (291) 90 (311) 110 (331) 130 (350) 150 (370) 170 (390) Post-Development
C9737 699-31-50		Sediment grab samples at 5 ft intervals from 0 to 115 ft BWT Composite grab samples every 20 ft for sieve analysis	10 (317) 50 (357) 90 (397)	10 (317) 30 (337) 50 (357) 70 (377) 90 (397) 110 (417) Post-Development

NOTE: Refer to DOE/RL-2014-27, Rev 2 , as amended by applicable change notice. Sample depths are estimated based on geology at nearby wells and intervals may be subject to change (±5 ft) based on geologic conditions.

a. To be collected at upper, middle, and lower portions of unconfined aquifer.
b. If the Ringold Formation Lower Mud unit is not encountered within 20 ft below the last specified sample depth, water samples will continue to be collected every 20 ft until reaching the mud.
c. An additional 1 L unfiltered sample to be collected for PNNL at all groundwater locations.

bgs = below ground surface
BWT = below water table
ft = feet

3.3.1 Grab Samples

Grab soil samples for archive purposes will be collected from drill cuttings every 5 ft and at other changes in lithology or at depths where unusual conditions are encountered (as determined by the field geologist) for lithologic descriptions, from ground surface to TD. Archive grab samples will be collected in one-pint glass jars and chip trays. Archive samples will not be collected if contamination is encountered. The field geologist will collect grab samples for archives, examine material from the boreholes, and prepare borehole logs as specified in SGRP-PRO-EN-50025 (GRP-EE-01-7.0), *Geologic Logging*.

In addition to lithologic archive samples, grab samples will be collected at 5 ft intervals per well, by the field geologist, in the screened interval of the saturated zone (top of groundwater to top of RLM) for soil particle size (sieve) analysis. These grab samples will be composited over 20 ft intervals for sieve analysis (5 to 6 sieve analysis per well). Results of the sieve analysis, together with the field geologist's borehole log, will be used to select the final filter pack and well screen slot size. The field geologist will collect grab samples and conduct sieve analyses in accordance with SGRP-PRO-OP-50037 (GRP-EE-05-1.21), *Particle Size Distribution of Sediment-Wet Sieve Analysis*.

3.3.2 Split Spoon Samples

Split spoon soil samples will be analyzed to characterize the geochemistry of the sediments and associated pore water. Planned analyses include determination of physical properties (bulk density, particle density, particle size, moisture content, and permeability), determination of chemical properties (specific conductance, alkalinity, pH, metals, anions, uranium, and other radioisotopes), and microbiological characterization (quantitative polymerase chain reaction, terminal restriction fragment length polymorphism, enzyme activity probes, fluorescent in situ hybridization, and construction of clone libraries and enrichment for groundwater and soil microbes). In addition, analyses for contaminant leaching characteristics and transport/attenuation assessment may be performed for samples from the wells.

The split spoon samplers will be equipped with four separate polycarbonate liners. Immediately after recovery, the core barrel liners will be wrapped in aluminum foil and plastic to preserve water content. Samples are to be delivered to the Pacific Northwest National Laboratory. The percent recovery for each split spoon will be recorded. If insufficient material is recovered, a second split spoon will be collected prior to advancing the borehole. If there is not enough sample volume recovered during split spoon sampling for the entire planned analysis, the OU Project Technical Lead will be consulted.

For all new 200-UP-1 OU wells, split spoon samples will be collected at the upper, middle, and lower aquifer portions of the unconfined aquifer, starting at approximately 10 ft below static water table, at depths indicated in Table 5.

3.3.3 Groundwater Samples

Depth-discrete groundwater samples will be collected during drilling for laboratory analysis to determine the vertical profile of groundwater contamination and subsequent plume characterization. The groundwater samples are planned at specific depths in the unconfined aquifer provided in Table 5, starting at approximately 10 ft below static water table. A baseline water sample will be collected from each well

at the end of well development, and the samples will be analyzed for the same constituents as the water samples collected during drilling.

Groundwater samples will be pumped from selected intervals. The groundwater samples may not be collected before a minimum of one borehole volume has been purged and water chemistry (e.g., temperature, pH, and conductivity) has stabilized within 10% variance over three consecutive measurements (SGRP-PRO-SMP-50060 [GRP-FS-04-G-028] *Field Characterization and Treatment Monitoring Activities Groundwater Sampling*).

The drilling process typically causes localized reducing conditions which affects hexavalent chromium (Cr[VI]) concentrations indicating lower than actual concentrations. When collecting water samples during drilling for Cr(VI), extra measures will be required to ensure that representative samples are collected to assure the well screen is placed at the interval with the highest Cr(VI) concentration. During the purge, dissolved oxygen and oxidation-reduction potential will be measured as additional field readings. The borehole will be purged until dissolved oxygen has stabilized at or above 7 mg/L and oxidation-reduction potential is at least 200 mV. Once these parameters have been achieved field Cr(VI) readings will be collected until values stabilize within 10% variance over three consecutive measurements collected in approximately 15 minute intervals.

Turbidity is expected to remain elevated, so samples for all analytes except volatile organic analysis (VOA) should be filtered through a 0.45-micron filter in the field. Samples for VOAs and all water samples collected for Pacific Northwest National Laboratory delivery will be unfiltered.

During groundwater sampling, if the borehole cannot sustain sufficient water production in the open hole to collect a sample, or excessive sediment is damaging the pump, the OU Project Technical Lead will be contacted for consultation and direction. The Contractor will provide low-flow pumps for groundwater sampling to facilitate collection of quality groundwater samples during the "drill-and-test" portion of the field activities.

3.3.4 Geophysical Logging

The planned groundwater wells will be geophysically logged with a high-resolution, spectral gamma-ray logging system to support determination of the depth and extent of the upper unconfined aquifer boundaries, provide information supporting well completion, and screen for gamma-emitting radionuclides (but none are expected at these locations). The boreholes will be logged before the temporary casing is telescoped (if applicable) and/or at the point of TD.

3.4 Well Construction

Well construction shall meet the minimum standards required by WAC 173-160, Part II, for construction of resource protection wells, unless a state approved variance is utilized. Table 4 provides a summary of estimated well construction parameters, including estimated water levels, well depths, screen intervals, filter-pack intervals, bentonite-seal intervals, and cement-seal intervals. The generalized well design is illustrated in Figure 2.

3.4.1 Screen Riser and Sump

Well depths will be determined based on the TD of the boreholes and sieve analysis results from each well. All wells shall be constructed using a sump, screen, and riser/couplings composed of 4-in diameter, Schedule 10, Type 304/304L or 316/316L stainless steel with flush-joint design and O-rings, and will extend to the surface. The wells will be constructed using a 3-ft long sump with end cap. All wells will be constructed using a V-Slot continuous wire-wrap well screen.

Well designs will be dependent on the sieve analysis results for all wells, determined by CHPRC's OU Project Technical Lead. Anticipated screen length is 35 ft (Figure 2). The screened interval is planned to

be located in the upper most 35 ft of the aquifer unless higher concentrations of chromium or other key constituents have higher concentrations at a deeper location. Screen lengths are subject to change depending on the vertical distribution of contaminants. Final screen length and placement will be determined by CHPRC's OU Project Technical Lead in consultation with drilling BTR and/or CHPRC's field geologist/hydrogeologist. The Contractor will obtain CHPRC approval before purchasing anticipated well screens and filter pack materials for the three 200-UP-1 OU wells.

Stainless steel centering guides (centralizers) shall be placed both above and below the well screen. If well screen lengths exceed 40 ft, centralizers shall be placed at 40 ft intervals throughout the length of the screen. Centralizers shall also be placed at 40 ft intervals above the top of the screen.

Well construction will not be carried out until the filter pack mesh size, screen length, and slot size are confirmed by standard sieve analyses and sediment examination. Contractors are required to use clean gloves when handling well materials to be placed below groundwater.

3.4.2 Annular Seal and Filter Pack

Boreholes extending below the designed well depth shall be decommissioned from TD to 5 ft below the depth equivalent to the bottom of the sump with bentonite, and to the depth of the bottom of the sump with a bentonite pellet seal. The filter pack will extend from the base of the well sump to up to 10 ft above the top of the screen. Screen size will correspond to the chosen mesh size (i.e. filter pack mesh size is chosen based on formation sieve analysis results; screen slot size is based on the mesh size where up to 10% of the filter pack is capable of passing into the screen). The Contractor shall place and develop the filter pack in no greater than 3 ft intervals using a dual surge block method. As a general guide, if the filter pack in the annulus drops out at a rate of less than 0.1 ft in 15 minutes, the interval is considered sufficiently settled (Section 3.5.1).

A minimum 3 ft layer of bentonite pellets will be placed directly on top of the filter pack. Bentonite granules or crumbles will be used to seal the annulus from the top of the pellet seal to approximately 10 ft bgs. Non-shrinking, neat cement grout, containing no more than 5% bentonite gel powder by dry weight and no more than 6 gallons of water per 94 pounds of grout, will be used to seal the remaining borehole annulus from 10 ft bgs to 0.5 ft bgs. The cement seal shall be emplaced using tremie pipe while maintaining the tremie nozzle inside the cement to prevent dilution of the cement. The cement must be allowed to cure for a minimum of 8 hours before additional well construction activities take place.

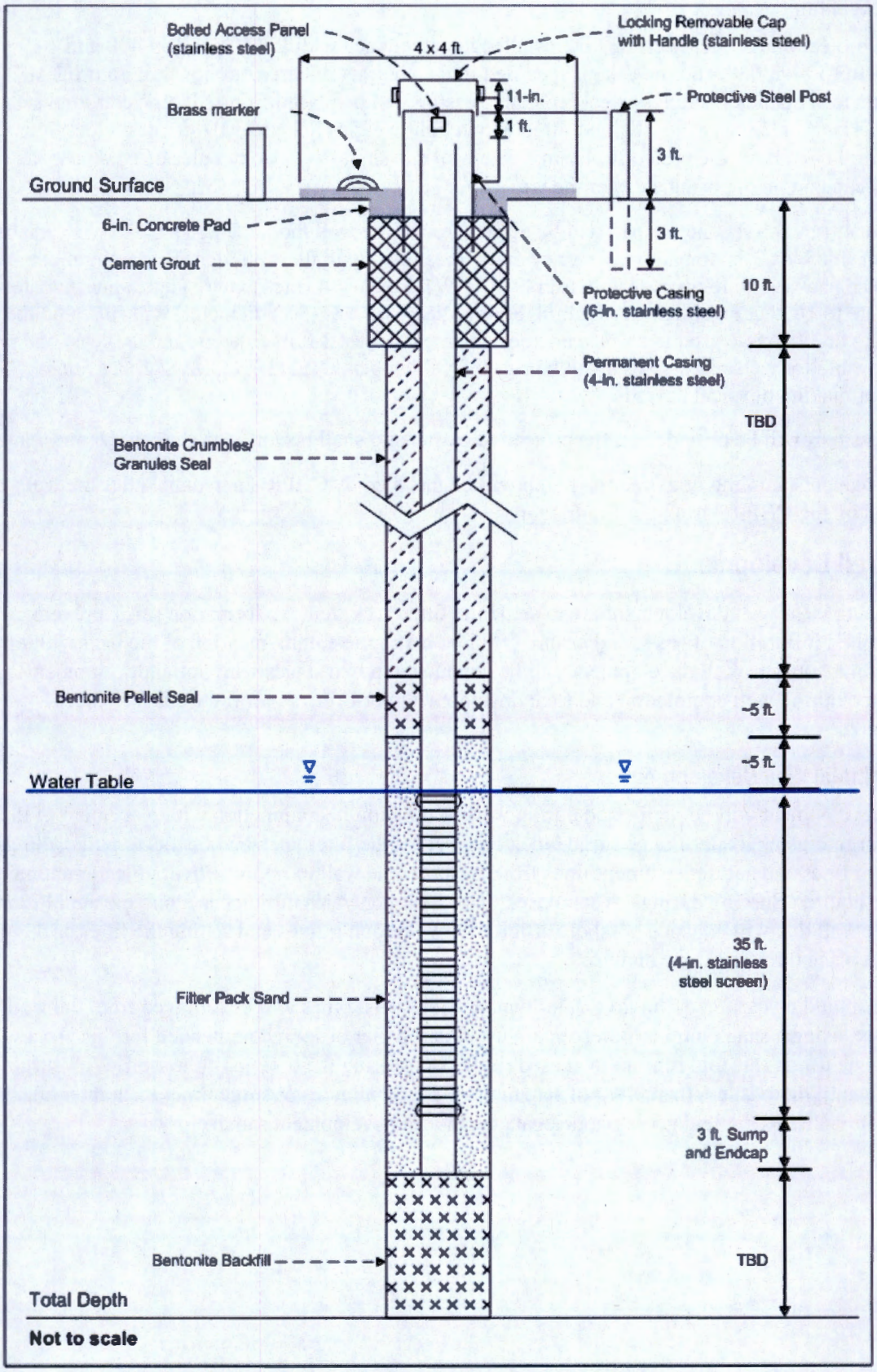

Figure 2. General Well Construction Diagram for 200-UP-1 OU Monitoring Wells

3.4.3 Wellhead

Surface protection for each well will be installed in accordance with WAC 173-160-420 and SGRP-PRO-EN-50030, and the design specified in the contract release. As shown in Figure 2, a minimum 6-in diameter stainless steel protective casing will be placed from 3 ft above ground surface to 2 ft bgs. The protective casing shall be fitted with a light weight (Schedule 10 stainless steel) lockable cap extending 11-in above the protective casing. The well cap shall have two handles affixed near the top of the well cap and on opposing sides of the well cap.

A 4 ft by 4 ft by 0.5 ft concrete pad will be placed around the well monument. This pad will be labeled on the north side by a 3-in domed brass survey marker stamped with the well identification number and well name. The pad will be reinforced with 6-in by 6-in W1.4 by W1.4 (metric wire gage, approximately equivalent to 16 gage) welded wired fabric. Four protective posts (3-in diameter) will surround the pad, extending to 3 ft above ground surface and be cemented at least 3 ft into the ground. At least one post will be removable for well access. Posts will be painted yellow per ANSI (1991), *ANSI Z53.1 Safety Color Code,* for making physical hazards.

An access port will be provided on the protective casing and shall be configured as shown in Figure 3.

The permanent sampling or extraction pump will be installed by CHPRC personnel after the wells are accepted by the CHPRC from the Contractor.

3.5 Well Development

The objectives of well development are to settle the filter pack, remove formation fines, prevent uncontrolled infiltration of fines, and ensure efficient hydraulic communication of the well with the surrounding aquifer. Well development will be conducted in two stages with initial development performed during well completion and final development performed after the wells have been constructed.

3.5.1 Initial Well Development

Initial development will be performed during well completion in conjunction with placement of the filter pack. Surging using a dual-flange surge block both settles the filter pack and begins to pull drilling-generated fines and aquifer sediment fines from the borehole wall to improve hydraulic communication with the aquifer. Surging during the sand pack placement generates turbulence along the annulus and borehole wall that will enhance borehole efficiency by removing fines and setting the filter pack grains firmly in place throughout the annulus.

Surging should be carried out in no greater than 3 ft intervals. Fines will be removed from the well, as necessary, using a sand pump or other apparatus. A dart bailer is not recommended for this process because the use of this tool runs an increased risk of puncturing the bottom of the well. Well surging will continue until there is less than 0.1 ft of screen infill per 15 minutes of surge time. Each interval shall be surged until CHPRC's field geologist delegate deems the development satisfactory.

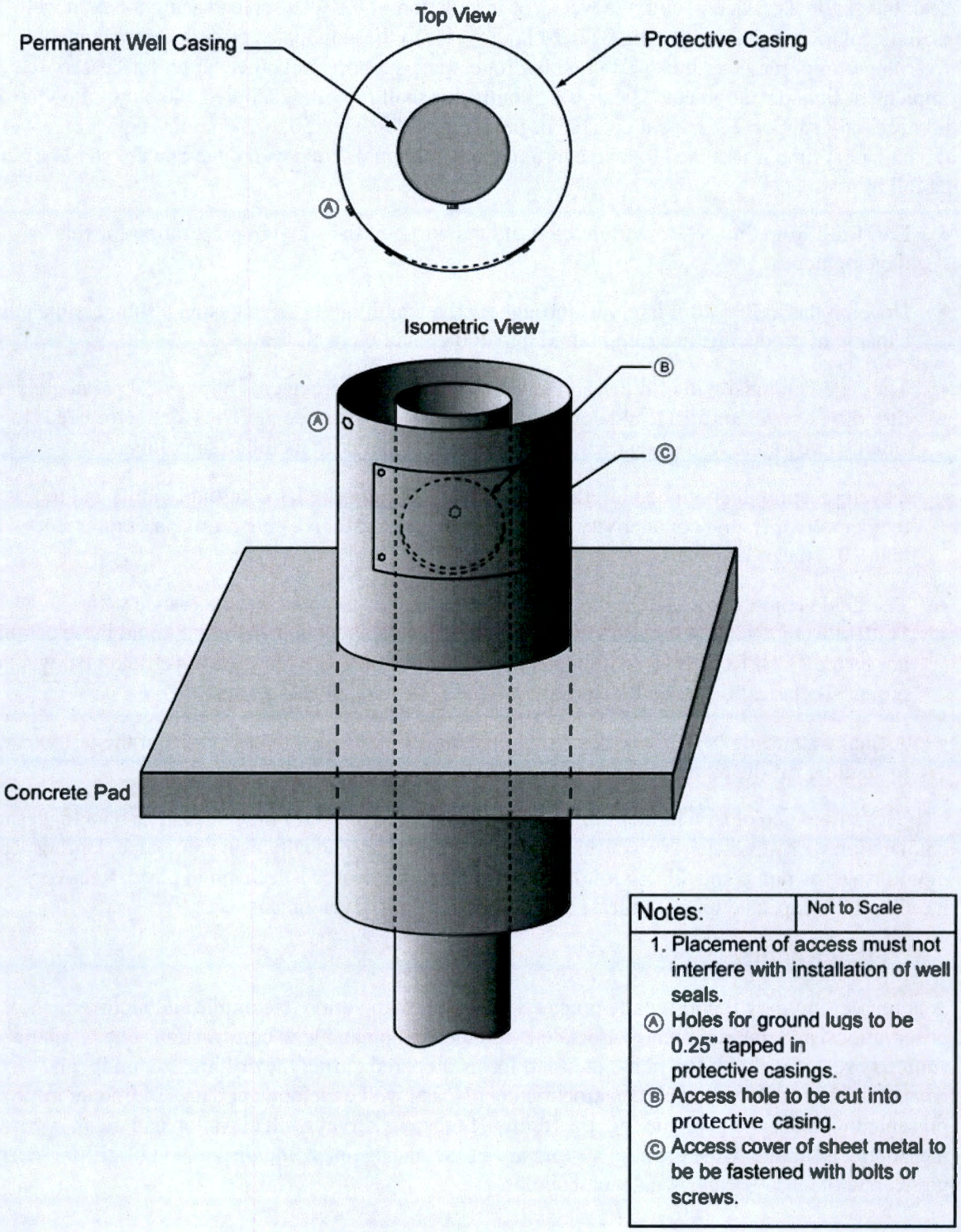

Figure 3. Diagram Showing Configuration of Access Port in Protective Casing

3.5.2 Final Well Development

Final well development may be conducted prior to the placement of the final grout seal. If sealed, then development shall not be started sooner than 12 hours following placement of the annular cement grout seal, but shall take place within two weeks of installation of the well screen/casing for each well. The drilling contractor shall notify the BTR 24 hours prior to the anticipated final development time in order to arrange for purgewater transportation, hydrogeologic support, and other support necessary to implement final development. The drilling contractor shall provide a submersible pump, flow meter, and all necessary support equipment capable of pumping no less than 50 to 200 gpm. The average well development time is assumed to take approximately 12 hours. Final well development shall be performed as follows:

- Bail fines from the well to within 0.5 ft of the bottom of the sump in preparation for final development.
- Develop the well at 20 ft intervals throughout the length of the screen using a submersible pump capable of producing, at a minimum, 50 to 200 gpm at the well head.
- The field geologist will also periodically collect water measurements of physical parameters, such as turbidity, temperature, pH, and conductivity using field instruments. The Contractor needs to place a small valve on the restricting manifold with the flow meter to facilitate sampling.
- Development will continue until the well water is <5 nephelometric turbidity units and the temperature, pH, and conductivity have stabilized (at least three consecutive measurements with less than 10% mean variance).
- The field geologist will determine when development is complete in accordance with SGRP-PRO-OP-50024 (GRP-EE-01-6.3), *Well Development and Testing*. Should these conditions not be met, CHPRC's BTR, with the concurrence of CHPRC's representative field geologist, and the project Technical Lead, shall determine when the development is adequate.
- A final water sample will be collected upon completion of final development of the last interval, prior to shutting off the pump.

CHPRC's field geologist will monitor aquifer response and recovery time utilizing a data logger in conjunction with a pressure transducer (or similar device) or manually using an e-tape. During recovery monitoring, the pump and all down-hole monitoring equipment must remain in place. Recovery monitoring is expected to take at least 60 minutes per final development stage.

3.6 Final Report

A borehole summary report will be prepared after well completion 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, sampling, and construction of each well, well construction details, and well development data. Additional information presented includes the geologic log, the results of the civil survey with elevation and depth corrections to measurements made while drilling, a summary of the management and disposition of drilling-derived waste, and the well acceptance documentation.

4. Waste Management

Waste generated during the activities described in this document will be managed according to DOE/RL-2016-13, *Waste Management Plan for the 200-UP-1 Groundwater Operable Unit* as amended by applicable chance notices. This waste management plan establishes the requirements for the management and disposal of waste associated with groundwater wells in the 200-UP-1 OU. Waste from these sampling activities will be handled in accordance with *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*. Ultimate disposal of supplemental samples collected for other organizations (i.e., Pacific Northwest National Laboratory) will be the responsibility of those organizations.

Vadose and saturated zone soil cuttings and miscellaneous solid waste will be stored and managed as investigation-derived waste and surveyed by the Industrial Health and Radiation Control technicians in accordance with the site-specific Health and Safety Plan. The contractor shall be responsible for packaging and handling all wastes generated during construction, testing, decontamination, and demobilization. The SGRP Waste Management Specialist will provide final waste management instructions for the project.

Wells 699-29-55 (C9634) and 699-31-50 (C9737) are located within the BC Controlled Area. This is an area of sporadically distributed contamination in biologic vectors (vegetation and wildlife droppings and remains). Although significant contamination is not expected at the well location, a complete lack of contamination cannot be assumed. Therefore, vadose zone soils will be containerized with saturated zone cuttings at this well for subsequent disposal at Environmental Restoration Disposal Facility. If elevated readings are detected by routine surveys during drilling, a sample will be collected from the depth of highest readings and analyzed for suite-type analyses (i.e., metals, VOAs, semi-VOAs, and gamma energy analysis, as well as technetium-99, iodine-129, and isotopic uranium), per the SAP.

Purgewater will be collected and contained at the well head until it is transported to the Modular Storage Unit. 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 DOE/RL-2009-80, *Investigation Derived Waste Purgewater Management Work Plan,* and DOE/RL-2011-41, *Hanford Site Strategy for the Management of Investigation Derived Waste.*

5. Quality Assurance

CHPRC-issued document PRC-MP-QA-599, *Quality Assurance Program*, describes how CHPRC implements the quality assurance (QA) requirements conveyed in DOE O 414.1D, *Quality Assurance,* and 10 CFR 830.121, "Nuclear Safety Management," also shows how Ecology et al. (1989) and DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document (HASQARD)*, apply to Environmental QA Program Plans. CHPRC has also issued CHPRC-00189, *Environmental Quality Assurance Plan*. All CHPRC employees and subcontractors performing environmental cleanup activities are responsible for performing work in accordance with the requirements set forth in CHPRC-00189.

All work performed under this DOW will be performed in compliance with Project Hanford Management System overall QA program design (PRC-MP-QA-599). A project specific QA Program plan for the SGRP scope is presented in Appendix B of CHPRC-00189.

All operations including drilling, sampling and well completion/decommissioning, testing and associated documentation are subject to surveillance by CHPRC, CHPRC'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 surface of the ground adjacent to the borehole will be used as the "ground surface" reference for depth measurements. The elevation of the brass marker on the concrete well pad and the top of the protective casing will be surveyed after the well has been completed. A correlation of the measurements made while drilling to the surveyed elevation will be included in the final report.

Technical procedures to be followed are listed in Section 6.2 of this document.

6. General Requirements

Field work for the wells will be conducted in accordance with existing CHPRC procedures and protocols and the specifications set forth in this DOW. The applicable procedures are discussed in the following sections.

6.1 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).
- CHPRC General Employee Training (CGET).
- Hanford Radiation Worker II training.

Work will be performed in accordance with the following procedures:

- CHPRC-00073, *CH2M Hill Plateau Remediation Company Radiological Control Manual*
- Site specific plans, as applicable:
  - Health and safety plans
  - Radiological evaluation/radiation work permits
  - Activity hazard analysis/job safety analysis
  - Site-specific Waste Packaging Instruction
- Hanford Site procedures
- CHPRC procedures
- Soil and Groundwater Remediation Project Radiological Control Procedures
- CHPRC Environmental Procedures

6.2 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 these wells and management of waste generated by these activities will adhere to, at a minimum, the following procedures and requirements:

- PRC-PRO-EP-15333, *Environmental Protection Processes*
- PRC-PRO-EP-15334, *Effluent and Environmental Monitoring for Radionuclide Airborne Emissions*
- PRC-PRO-EP-15335, *Environmental Permitting and Document Preparation*
- PRC-PRO-IRM-8310, *Document Control Processes*
- PRC-RD-EP-15332, *Environmental Protection Requirements*
- SGRP-PRO-EN-50025 (GRP-EE-01-7.0), *Geologic Logging*
- SGRP-PRO-EN-50030 (GRP-EE-02-14.1), *Drilling, Remediating, and Decommissioning Resource Protection Wells, and Geotechnical Soil Borings*

- SGRP-PRO-EP-50026 (GRP-EE-01-7.4), *Requirements for Use of Hydrogeologic Field Measurement & Monitoring Equipment*
- SGRP-PRO-OP-50004 (GRP-EE-01-1.11), *Purgewater Management*
- SGRP-PRO-OP-50120, *Waste Packaging and Handling at S&GRP*
- SGRP-PRO-OP-50021 (GRP-EE-01-3.1), *Environmental and IH Sample Preparation and Shipping Authorization*
- SGRP-PRO-OP-50024 (GRP-EE-01-6.3), *Well Development and Testing*
- SGRP-PRO-OP-50037 (GRP-EE-05-1.21), *Particle Size Distribution of Sediment - Wet Sieve Analysis*
- SGRP-PRO-RP-50023 (GRP-EE-01-6.2), *Field Cleaning and/or Decontamination of GeoProbe® and Drilling Equipment*
- SGRP-PRO-SMP-50015 (GRP-EE-01-2.7), *Sample Management and Reporting Sample Issue Resolution*
- SGRP-PRO-SMP-50043 (GRP-FS-04-G-004), *Operational Monitoring Groundwater Sampling*
- SGRP-PRO-SMP-50060 (GRP-FS-04-G-028), *Field Characterization and Treatment Monitoring Activities Groundwater Sampling*
- SGRP-PRO-SMP-50061 (GRP-FS-04-G-029), *Non-VOC Soil and Sediment Sampling*
- SGRP-PRO-SMP-50062 (GRP-FS-04-G-030), *VOC Soil and Sediment Sampling*
- WAC 173-160, *Minimum Standards for Construction and Maintenance of Wells*

7. 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)
  - Drilling specifications/subcontractor scope of work (procurement package)
  - Excavation permit
  - SGRP-PRO-OP-50120
  - Additional waste management documents, as required
- 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
  - Borehole geophysical log data report
  - 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
- The WDOH (2012) ALARACT Agreements(s)
- Reporting Documents
  - Field documentation will be transmitted to Drilling Operations for incorporation into the well database
  - Borehole Summary Report
  - State of Washington Resource Protection Well Report (generated by driller)

The records produced for this project will undergo technical and management review in accordance with CHPRC practices and procedures. The required reviewers will be identified prior to document completion, and the review time will be established as soon as practical.

8. References

CH2M Hill Plateau Remediation Company Soil and Groundwater Remediation Project Procedures:

PRC-MP-QA-599, *Quality Assurance Program*

PRC-PRO-EP-15333, *Environmental Protection Processes*

PRC-PRO-EP-15334, *Effluent and Environmental Monitoring for Radionuclide Airborne Emissions*

PRC-PRO-EP-15335, *Environmental Permitting and Document Preparation*

PRC-PRO-IRM-8310, *Document Control Processes*

PRC-RD-EP-15332, *Environmental Protection Requirements*

SGRP-PRO-EN-50025 (GRP-EE-01-7.0), *Geologic Logging*

SGRP-PRO-EN-50030 (GRP-EE-02-14.1), *Drilling, Remediating, and Decommissioning Resource Protection Wells, and Geotechnical Soil Borings*

SGRP-PRO-EP-50026 (GRP-EE-01-7.4), *Requirements for Use of Hydrogeologic Field Measurement & Monitoring Equipment*

SGRP-PRO-OP-50004 (GRP-EE-01-1.11), *Purgewater Management*

SGRP-PRO-OP-50021 (GRP-EE-01-3.1), *Environmental Sample and IH Preparation and Shipping Authorization*

SGRP-PRO-OP-50024 (GRP-EE-01-6.3), *Well Development and Testing*

SGRP-PRO-OP-50037 (GRP-EE-05-1.21), *Particle Size Distribution of Sediment - Wet Sieve Analysis*

SGRP-PRO-OP-50120, *Waste Packaging and Handling at S&GRP*

SGRP-PRO-RP-50023 (GRP-EE-01-6.2), *Field Cleaning and/or Decontamination of GeoProbe® and Drilling Equipment*

SGRP-PRO-SMP-50015 (GRP-EE-01-2.7), *Sample Management and Reporting Sample Issue Resolution*

SGRP-PRO-SMP-50043 (GRP-FS-04-G-004), *Operational Monitoring Groundwater Sampling*

SGRP-PRO-SMP-50060 (GRP-FS-04-G-028), *Field Characterization and Treatment Monitoring Activities Groundwater Sampling*

SGRP-PRO-SMP-50061 (GRP-FS-04-G-029), *Non-VOC Soil and Sediment Sampling*

SGRP-PRO-SMP-50062 (GRP-FS-04-G-030), *VOC Soil and Sediment Sampling*

Other References:

10 CFR 830.121, "Nuclear Safety Management," *Code of Federal Regulations*, as amended

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

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CHPRC-00189, 2017, *CH2M Hill Plateau Remediation Company Environmental Quality Assurance Program Plan*, Rev 13, CH2M Hill Plateau Remediation Company, Richland, Washington

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WAC 173-160-420, "General Construction Requirements for Resource Protection Wells," *Washington Administrative Code*, as amended

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