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ERDF Leachate Sampling Strategy

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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Contents

Tables

Terms

ERDF	Environmental Restoration Disposal Facility
FBR	fluidized bed reactor
gpm	gallons per minute
IX	ion exchange
Tc-99	technetium-99

1 ERDF Leachate Sampling Strategy

The purpose of this document is to present the sampling strategy and actions to ensure that leachate from the Environmental Restoration Disposal Facility (ERDF) does not hinder treatment at the 200 West Pump and Treat. This document includes the following information:

- Key contaminants of concern from ERDF leachate
- Recommendations from SGW-57790, *Characterization data for New Waste Streams (200-UP-1, ERDF Leachate, 200-BP-5, and Perched Water) for 200 West Pump-and-Treat Facility*
- Approach to balance the flows, concentrations, and mass loadings to maintain smooth operation
- Sample strategy including process and laboratory samples and sample locations

ERDF leachate has been characterized with the results documented in SGW-57790. An overview is presented in Table 1.

Table 1. Concentrations of Constituents in ERDF Leachate for Planning Purposes and Hazard Categorization

Contaminant	Units	95th Percentile Concentration	Average Concentration	Typical 200-ZP-1 Concentrations (Unless Noted)
Technetium-99	pCi/L	413	356	1,500 to 2,500
Total Uranium	µg/L	1,519	1,157	50 to 80[a]
Carbon-14	pCi/L	246	87	Below detection
Cesium-137	pCi/L	7.3	4.3	Below detection
Hexavalent Chromium	µg/L	71	49	20
Strontium	µg/L	1,485	1,214	150 to 350
Nitrate (as N)	mg/L	96	59	30[b]
Cyanide	µg/L	2.5	1.3	Below detection
Sulfate (as SO_4)	mg/L	612	546	40 to 50

Source: WCH-590, *Groundwater, Leachate, and Lysimeter Monitoring and Sampling at the Environmental Restoration Disposal Facility, Calendar Year 2013.*

a. For water from 200-BP-5 and 200-UP-1 based on plant experience through April 13, 2016.

b. Blend of waters from 200-ZP-1, 200-BP-5, and 200-UP-1.

2 Recommendations from SGW-57790

The following recommendations are applicable to ERDF flow from SGW-57790:

- Nitrate concentrations to the plant should be consistent.
  - Avoid concentration changes greater than 10 percent in any one 24-hour period.
  - Likewise, avoid mass nitrate loading (e.g., kg nitrate/day) change greater than 10 percent in any one 24-hour period.
- Avoid large sulfate changes in uranium or technetium-99 (Tc-99) ion exchange (IX) systems, especially once the bed has become loaded with anions.
  - IX reactions are reversible, and sudden increases in competing ions (e.g., sulfate) will displace previously adsorbed uranium or Tc-99.
  - Although firm guidelines are highly site specific, avoid concentration changes greater than 30 percent in any one 24-hour period until the system has shown an ability to handle more.
- Avoid large changes in uranium or Tc-99 concentrations and mass loading, particularly after the bed has been loaded.
  - Large swings in uranium or Tc-99 mass loading can lead to premature breakthrough of the IX bed.
  - Tc-99 will initially accumulate on the uranium IX resin, then it will be released at concentrations exceeding those coming in. This release could compromise the efficiency of downstream Tc-99 IX resin (Purolite® A530E) to remove Tc-99.
- Avoid introducing cyanide concentrations greater than 25 µg/L without further evaluation of the capacity of the biological system to acclimate to cyanide.
- Develop an approach to balance the flows, concentrations of key contaminants, and mass loadings under expected operating scenarios (e.g., with and without ERDF).
- Develop a sampling program for the IX systems. The program should include target anions (uranium and Tc-99), as well as chromate, to provide an early warning of breakthrough, track the contaminants through the bed, and provide improved guidance for allowable swings in anion concentration.

2.1 Approach to Balancing Flows

First, an integrated mass balance calculation was used to determine the impact of ERDF leachate along with perched water (200-UP-1 and 200-BP-5). The results are summarized in Table 2. Perched water is highlighted in Table 2 along, with ERDF flow, because it is an exceptionally high strength waste stream. This calculation resulted in the following conclusions:

1. ERDF leachate should be pumped at approximately 20 gallons per minute (gpm) or less to minimize impacts to the 200 West Pump and Treat.

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2. An ERDF leachate flow of approximately 20 gpm results in a blended waste stream that is within the stated design limits associated with the facility. The calculation indicates that no additional treatment processes are needed to treat ERDF leachate.
3. ERDF leachate will not degrade the quality of the plant effluent.

These conclusions are based on calculations, and a sampling program is required for verification.

Table 2. Impact of ERDF Leachate on Concentrations of Contaminants of Concern in Treated Water Based on Integrated Mass Balance Model

Contaminant	Units	No ERDF Flow; No Perched Water Flow	ERDF at 20 gpm and No Perched Water Flow	ERDF at 20 gpm and Perched Water at 2 gpm
Technetium-99	pCi/L	7.0	7.0	6.9
Total Uranium	pCi/L	<1	<1	<1
Carbon-14	pCi/L	Below detection	1.3E-07	2.1E-07
Cesium-137	pCi/L	Below detection	7.4E-07	7.4E-07
Hexavalent Chromium	µg/L	2	2	2
Strontium	µg/L	241	250	248
Nitrate (as N)	mg/L	2	2	2
Cyanide	µg/L	21	21	21
Sulfate (as SO_4)	mg/L	44	47	47

Note: 200-UP-1 flow is set to 155 gpm, 200-BP-5 flow is at 150 gpm, 200-ZP-1 nonradioactive wells are at 1,353 gpm, and 200-ZP-1 radioactive wells are at 425 gpm.

ERDF = Environmental Restoration Disposal Facility

To provide a good flow balance, ERDF leachate was added to the recipe calculation used to provide a stable supply of water to the plant. The recipe approach was developed to stabilize nitrate loading and the biomass population in the treatment process. Engineering defines 10 plant flow rates from which operations staff can choose. Each of these process flow rates has a specific set of well flows associated with it that sum to the process flow. Utilizing the most recent laboratory well sample results, the well flows are calculated by engineering to provide the desired water quality in the plant influent. These flow rates are programmed into the supervisory control and data acquisition system, so the operations staff may change the plant flow rate by selecting a recipe rather than turning individual well flows up or down. ERDF leachate will be added to the recipe mix to maintain smooth operation.

Target an ERDF flow of 20 gpm. If the flow must be greater than 20 gpm, engineering staff shall take the following precaution. When the uranium IX resin is within 80 percent of exhaustion, avoid pumping ERDF leachate (greater than approximately 20 gpm) and perched water simultaneously. Pumping ERDF leachate greater than approximately 20 gpm and perched water together will hasten breakthrough triggering early resin change out. If both waste streams must be treated at the same time (with ERDF leachate greater than approximately 20 gpm), temporarily reduce or suspend flow from the high uranium wells.

2.2 Production

The amount of contaminant removed will not need to include removals from ERDF leachate. The leachate does not represent removal from the groundwater.

2.3 Sampling Strategy

The sampling strategy is composed of two components: process sampling and laboratory samples. The process sampling allows rapid decision making by providing contaminant removal and treatment efficiency information within hours of sample collection. Laboratory samples provide high quality data subject to stringent quality assurance with lower detection limits; however, the laboratory data are not available until days after sampling. The two sources work in concert. Process sampling provides near immediate feedback. Laboratory samples provide validation of the process monitoring data. As data are collected, the constituents and sampling locations may be adjusted.

2.3.1 Process Sampling Specifics

Process sampling includes nitrate and uranium because these two are key contaminants that can provide fast feedback on system performance. Timing is important for tracking the nitrate and uranium through the facility and verifying that uranium and nitrate concentrations have been removed and will not exceed the limitation for treatment in the fluidized bed reactors. Process sample locations and the timing and dilution recommendations are listed in Table 3.

2.3.2 Laboratory Sampling Specifics

Laboratory sampling shall be performed within a day of initial delivery and at the end of the delivery. The constituents to be sampled are listed in Table 4, and sampling locations are listed in Table 5.

3 References

SGW-57790, 2015, *Characterization data for New Waste Streams (200-UP-1, ERDF Leachate, 200-BP-5 and Perched Water) for the 200 West Pump-and-Treat Facility*, Rev. 2, CH2M HILL Plateau Remediation Company, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0078453H.

WCH-590, 2014, *Groundwater, Leachate, and Lysimeter Monitoring and Sampling at the Environmental Restoration Disposal Facility, Calendar Year 2013*, Rev. 0, Washington Closure Hanford, Richland, Washington.

Table 3. Process Sample Schedule to Determine Impact of New Stream on Treatment

Unit	Valve Number	Minimum Time from Start of Pumping to Allow for Travel Time and Mixing	Expected Dilution Needed						
			Nitrate				Uranium		
			Sample	Dilution Water	Multiplication Factor	Comments	Sample	Dilution Water	Multiplication Factor
Uranium IX Inlet	V05-Y10	1 hour after pumping starts	20 ml	20 ml	2	High Range	20 ml	20 ml	2
Uranium IX Vessel 3	V03-Y11A3	1.5 hours after pumping starts					40 ml	0 ml	1
Tc-99 Inlet	V05-Y20	2 hours after pumping starts	20 ml	20 ml	2	High Range	40 ml	0 ml	1
Post Tc-99 Resin	V06-Y22	3 hours after pumping starts					40 ml	0 ml	1
Recycle Tank/FBR Influent	V05-Y40A1 or B1	8 hours after pumping starts	40 ml	0 ml	1	High Range			
FBRs	V17-Y40A and B	8 hours after pumping starts	40 ml	0 ml	1	Low Range			
Effluent Tank	V07-Y80	8 hours after pumping starts	40 ml	0 ml	1	Low Range			

FBR = fluidized bed reactor
IX = ion exchange
Tc-99 = technetium-99

Table 4. Analytical Constituents

Constituent	Constituent
Carbon-14	Cadmium
Cesium-137	Calcium
Chromium (Total)	Chloride
Hexavalent Chromium	Fluoride
Iodine-129	Iron
Nitrate as Nitrogen	Magnesium
Strontium	Manganese
Technetium-99	Nitrite as Nitrogen
Tritium	Sodium
Uranium	Sulfate
Arsenic	Total Inorganic Carbon
Bicarbonate Alkalinity	Total Organic Carbon
Carbonate Alkalinity	Total Dissolved Solids

Table 5. 200 West Pump and Treat Sample Locations

Location	Valve Number
Uranium IX Inlet	V05-Y10
Uranium IX Vessel 3	V03-Y11A3
Technetium-99 Inlet	V05-Y20
Post Technetium-99 Resin	V06-Y22
Recycle Tank/Fluidized Bed Reactor Influent	V05-Y40A1 or B1
Effluent Tank	V07-Y80