435.36
04/03/2017
Rev. 15
Use with MCP-3480

FEDERAL FACILITY AGREEMENT AND CONSENT ORDER (FFA/CO)
NEW SITE IDENTIFICATION (NSI)

Site Title (must include Site Code in title): CFA-56—CFA Storm Water Injection Well, CFA Disposal Well	**Site Code: CFA-56** **Document Number: NSI-26022**

PART B

1. **Data Analysis and Risk Assessment:** See attachment

2. **OU 10-08 Recommendation** ☒ **Yes** ☐ **No**

   ☒ No Action
   ☐ No Further Action with Institutional Controls
   ☐ Removal and Disposal Plug-in Remedy (meets remedy profile)

3. **Assignment to Operable Unit Recommendation**

   Assign waste area group (WAG) and operable unit (OU):

   WAG: _____ OU: _____

   ☐ Explanation of Significant Differences
   ☐ Record of Decision Amendment
   ☐ Remedial Investigation/Feasibility Study → Record of Decision
   ☐ Removal Action → Action Memorandum
   ☐ Plug-in Remedy Memorandum
   ☐ Minor Change Memorandum
   ☐ Memorandum to File
   ☐ NSI Only (i.e., no change to previous decision for an existing site)

4. **Prepared By:**

Valerie M. Kimbro	Valerie M Kimbro	8/23/17
Name (printed)	Signature	Date

5. **Idaho Cleanup Project Core Environmental Restoration Director Concurrence:**

Marc Jewett	Marc Jewett	8/28/17
Name (printed)	Signature	Date

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FEDERAL FACILITY AGREEMENT AND CONSENT ORDER (FFA/CO)
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CFA-56—CFA Storm Water Injection Well, CFA Disposal Well	Document Number: NSI-26022

PART B

6. **FFA/CO Remedial Project Manager (RPM) Concurrence:**

DOE-ID FFA/CO RPM: ☑ Concur with recommendation. ☐ Do not concur with recommendation.

Nicole Badrov (Name printed) | Nicole Badrov (Signature) | 8/24/17 (Date)

Explanation:

EPA FFA/CO RPM: Rod Lobos ☑ Concur with recommendation. ☐ Do not concur with recommendation.

~~Dennis Faulk~~ (Name printed) | (Signature) | 8/28/17 (Date)

Explanation:

DEQ FFA/CO RPM: ☑ Concur with recommendation. ☐ Do not concur with recommendation.

Daryl Koch (Name printed) | Daryl F. Koch (Signature) | 08/25/2017 (Date)

Explanation:

CFA-56–Storm Water Injection Well, CFA Disposal Well
NSI-26022 Part B Attachment
Data Analysis and Risk Assessment

SAMPLING SUMMARY

In 1992, the Central Facilities Area (CFA) Disposal Well retention basin soil was sampled to provide chemical and radiological data in support of Idaho Department of Water Resources (IDWR) permitting of the CFA Disposal Well for storm water injection. Data from the sampling effort was used in assessing whether or not chemical or radiological contaminants had been discharged to the injection well retention basin, potentially contaminating the subsurface.

Analytical results from soil samples collected from the CFA Disposal Well retention basin were summarized in Pole (1992). Soil samples were collected from three intervals (i.e., 0 to 6 in., 6 to 12 in., and 12 to 18 in.) at three borehole locations. All samples were grab samples and boreholes were biased locations that were selected to provide the most accurate representation of potential contaminants. Samples were collected from the northwest corner near the culvert (CFA34W34001, CFA34W34002, and CFA34W34003), in front of the injection well (CFA34W34004, CFA34W34005, and CFA34W34006), and from the center of the retention basin (CFA34W34007, CFA34W34008, and CFA34W34009). All samples were analyzed for total metals (i.e.., arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) and radionuclides (e.g., gross alpha/beta and gamma isotopic spectrometry). One sample (CFA34W34009) was selected as a worst-case condition (i.e., low-point depression) and analyzed for volatile organic compounds (VOCs) to determine whether additional sampling of VOCs was warranted. Target analytes included vinyl chloride; 2-butanone; 1, 1-dichloroethene; chloroform; 1, 2-dichloroethane; carbon tetrachloride; trichloroethene; benzene; tetrachloroethene; and chlorobenzene. Analytes were selected and analyzed in accordance with U.S. Environmental Protection Agency (EPA) SW-846 guidelines to assess whether chemical or radiological contaminants may have been discharged to the retention basin or connecting ditches and, thereby, potentially to the subsurface via the injection well. Total metals and VOCs were selected as target analytes based on the presence of these analytes in other locations of the Idaho National Laboratory (INL) Site due to historical activities. All VOC results—which were reported in µg/L for toxicity characteristic leaching procedure (TCLP) analysis—were nondetect or below detection limits. Table 1 summarizes analytical results of soil samples collected from the retention basin. Data were validated to Level C. Reporting by Pole (1992) showed that target analytes were either nondetect or below INL Site background levels. Subsequently, the IDWR approved the deep injection well permit and required an automatic sampling device to be installed at the inlet pipe for future monitoring.

While the CFA Disposal Well operated under the IDWR deep injection well permit (1993 to present), only two measurable storm events (1995 and 1996) partially filled the settling pond where storm water samples could be collected from the retention basin. At that time, monitoring was managed under the Site-wide Storm Water Pollution Prevention Program. The purpose of the storm water monitoring program was to demonstrate compliance with Federal Clean Water Act regulatory requirements. Samples were analyzed for Resource Conservation and Recovery Act-regulated metals, copper, nickel, and zinc and radionuclides (i.e., gamma isotopic spectrometry and gross alpha/beta). Results were compared to Safe Drinking Water Act maximum contaminant levels, not as regulatory requirements, but to evaluate the quality of storm water in the event of a discharge to the well. In 1996, VOCs were added to the list of target analytes; all results were nondetect.

Grab samples collected from the retention basin in January 1995 were from snow melt as it entered into the retention basin—storm water did not discharge to the deep injection well during this weather event. Samples collected in February 1996 were from standing water in the basin, 2 to 3 ft below the injection well inlet. Storm water sample results are summarized in Table 2.

Table 1. CFA disposal well retention basin soil sample results.

Sample ID	CFA34W34001	CFA34W34002	CFA34W34003	CFA34W34004	CFA34W34005	CFA34W34006	CFA34W34007	CFA34W34008	CFA34W34009
Depth (ft)	0–0.5	0.5–1	1–1.5	0–0.5	0.5–1	1–1.5	0–0.5	0.5–1	1–1.5
Metals (mg/kg)									
Arsenic	14.0	5.90	6.00	6.60	6.30	5.90	7.50	7.80	7.60
Barium	230.0	210.0	240.0	220.0	140.0	100.0	240.0	170.0	180.0
Cadmium	1.0 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.10	1.00 U	1.00 U
Chromium	26.0	24.0	24.0	26.00	25.0	20.0	27.0	27.0	31.0
Lead	13.0	13.0	14.0	19.00	10.0	11.0	27.0	20.0	13.0
Mercury	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U
Selenium	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Silver	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U
Volatile organic compounds[a] (ug/L)									
Vinyl chloride	NA	NA	NA	NA	NA	NA	NA	NA	20.0 U
Methylethylketone (2-butanone)	NA	NA	NA	NA	NA	NA	NA	NA	20000 U
1, 1-dichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	70.0 U
Chloroform	NA	NA	NA	NA	NA	NA	NA	NA	600 U
1, 2-dichloroethane	NA	NA	NA	NA	NA	NA	NA	NA	50.0 U
Carbon tetrachloride	NA	NA	NA	NA	NA	NA	NA	NA	50.0 U
Trichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	50.0 U
Benzene	NA	NA	NA	NA	NA	NA	NA	NA	50.0 U
Tetrachloroethene	NA	NA	NA	NA	NA	NA	NA	NA	70.0 U
Chlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	10000 U
Radionuclides (piC/g)									
Gross alpha	1.52E+01 ± 9.00E+00	1.16E+01 ± 6.80E+00	9.50E+00 ± 7.00E+00	7.60E+00 ± 6.90E+00	1.39E+01 ± 8.60E+00	3.10E+01 ± 1.30E+01	1.70E+01 ± 1.10E+01	1.67E+01 ± 9.10E+00	1.99E+01 ± 9.80E+00
Gross beta	2.65E+01 ± 6.90E+00	1.73E+01 ± 5.20E+00	2.30E+01 ± 5.70E+00	2.50E+01 ± 6.80E+00	2.75E+01 ± 6.50E+00	3.46E+01 ± 7.10E+00	3.04E+01 ± 6.70E+00	2.70E+01 ± 6.90E+00	3.08E+01 ± 6.90E+00
Ra-226	1.51E+00 ± 3.40E-01	1.52E+00 ± 3.50E-01	1.02E+00 ± 3.20E-01	1.17E+00 ± 2.45E-01	1.04E+00 ± 3.50E-01	1.53E+00 ± 3.45E-01	1.27E+00 ± 3.60E-01	1.50E+00 ± 2.65E-01	1.52E+00 ± 3.70E-01
U-235	5.16E-02 ± 2.00E-01	7.98E-02 ± 2.00E-01	6.75E-02 ± 2.00E-01	6.15E-02 ± 1.50E-02	9.73E-02 ± 2.00E-01	4.72E-02 ± 2.00E-01	8.30E-02 ± 2.00E-01	5.70E-02 ± 1.50E-02	9.05E-02 ± 2.50E-02
Ac-228 (thorium decay)	1.30E+00 ± 9.50E-02	1.51E+00 ± 1.05E-01	1.44E+00 ± 1.25E-01	1.35E+00 ± 8.00E-02	1.45E+00 ± 1.45E-01	1.39E+00 ± 9.50E-02	1.48E+00 ± 1.35E-01	1.50E+00 ± 9.00E-02	1.52E+00 ± 1.00E-01
Sb-125	—	—	—	—	—	—	—	—	—
Bi-214 (radium decay)	1.18E+00 ± 8.00E-02	1.28E+00 ± 8.50E-02	1.21E+00 ± 8.00E-02	1.13E+00 ± 6.00E-02	1.18E+00 ± 7.50E-02	1.19E+00 ± 7.50E-02	1.33E+00 ± 8.50E-02	1.15E+00 ± 6.50E-02	1.46E+00 ± 8.50E-02
Bi-212 (thorium decay)	1.81E+00 ± 3.50E-01	2.01E+00 ± 3.00E-01	1.86E+00 ± 2.70E-01	1.64E+00 ± 1.65E-01	1.70E+00 ± 2.90E-01	1.31E+00 ± 2.60E-01	1.75E+00 ± 3.20E-01	1.91E+00 ± 1.95E-01	1.44E+00 ± 3.00E-01
Cs-137	7.30E-02 ± 2.00E-01	1.10E-01 ± 2.00E-01	—	2.87E-01 ± 2.00E-01	—	—	1.21E+00 ± 6.50E-02	3.53E-01 ± 2.00E-01	6.67E-02 ± 1.50E-02
Co-60	—	—	—	—	—	—	—	—	—
Eu-155	—	—	—	2.05E-01 ± 5.50E-02	—	—	—	—	—
Pb-214 (radium decay)	1.26E+00 ± 8.00E-02	1.44E+00 ± 9.00E-02	1.21E+00 ± 7.50E-02	1.17E+00 ± 6.50E-02	1.38E+00 ± 8.50E-02	1.25E+00 ± 7.50E-02	1.38E+00 ± 8.50E-02	1.32E+00 ± 7.50E-02	1.47E+00 ± 8.50E-02
Pb-212 (thorium decay)	1.43E+00 ± 7.50E-02	1.46E+00 ± 8.00E-02	1.45E+00 ± 7.50E-02	1.24E+00 ± 6.50E-02	1.45E+00 ± 8.00E-02	1.43E+00 ± 7.50E-02	1.42E+00 ± 8.00E-02	1.34E+00 ± 7.00E-02	1.47E+00 ± 8.00E-02
Pb-210 (radium decay)	—	1.16E+00 ± 3.65E-01	1.17E+00 ± 3.45E-01	—	8.72E-01 ± 4.10E-01	1.11E+00 ± 3.50E-01	1.28E+00 ± 3.90E-01	—	1.09E+00 ± 3.45E-01
Mn-54	—	4.87E-02 ± 2.00E-01	—	—	—	—	—	—	
K-40	2.01E+01 ± 9.90E-01	2.07E+01 ± 1.01E+00	2.06E+01 ± 1.01E+00	2.04E+01 ± 9.10E-01	2.05E+01 ± 1.01E+00	2.03E+01 ± 9.90E-01	1.84E+01 ± 9.35E-01	2.05E+01 ± 9.20E-01	1.80E+01 ± 9.05E-01
Ru-106	—	—	—	—	—	—	—	—	—
Tl-208 (thorium decay)	4.53E-01 ± 3.50E-02	4.38E-01 ± 3.50E-02	4.67E-01 ± 3.50E-02	3.94E-01 ± 2.50E-02	4.71E-01 ± 4.00E-02	4.43E-01 ± 3.50E-02	5.15E-01 ± 3.50E-02	5.04E-01 ± 3.00E-02	4.81E-01 ± 4.00E-02
Th-234	1.53E+00 ± 3.20E-01	1.89E+00 ± 3.65E-01	1.67E+00 ± 3.45E-01	—	2.01E+00 ± 3.65E-01	2.11E+00 ± 3.65E-01	1.75E+00 ± 3.60E-01	1.89E+00 ± 3.15E-01	2.26E+00 ± 3.70E-01

Table 1. (continued).

a. All VOC results were reported in µg/L for TCLP analysis. Pole (1992) stated soil samples were to be analyzed using SW-846 TCLP Method 1311 followed by Method 8240; however, results from Method 8240 were not provided in the summary report. Method detection limits for VOCs are:

Vinyl chloride	20 ug/L
Methylethylketone (2-butanone)	20000 ug/L
1,1-Dichloroethene	70 ug/L
Chloroform	600 ug/L
1,2-Dichloroethane	50 ug/L
Carbon tetrachloride	50 ug/L
Trichloroethene	50 ug/L
Benzene	50 ug/L
Tetrachloroethene	70 ug/L
Chlorobenzene	10000 ug/L

—	sample results not reported
NA	sample not analyzed
TCLP	toxicity characteristic leaching procedure
U	constituent was analyzed for but not detected
VOC	volatile organic compound

Table 2. Central Facilities Area Disposal Well storm water sample results for metals and radionuclides.

Analyte	Sample ID# SWCFA32011295G January 1995	Sample ID# SWCFA32021396G February 1996	Residential Risk-Based Screening Levels[a]
Metals (ug/L)			
Antimony	—	**60.00**	7.8
Arsenic	10.00 U	**54.00**	5.2
Barium	200.00 U	3200.00	3,800
Cadmium	5.00 U	**13.00**	9.2[b]
Chromium	10.00 U	210.00	3.5[c]
Copper	25.00 U	260.00	800
Lead	10.60	**480.00**	15[d]
Manganese	—	**3700.00**	430[e]
Mercury	0.20 U	0.80	5.7[f]
Nickel	40.00 U	280.00	390[g]
Selenium	5.00 U	5.00 U	100
Silver	10.00 U	7.00	94
Titanium	—	5300.00	—
Zinc	68.70	1800.00	6,000[h]
Radionuclides (pCi/L)			
Gamma spectrometry	ND	—	—
Gross alpha	ND	140±38 B	—
Gross beta	0.0086±0.002 (pCi/mL)	230±50 B	—
Potassium-40	—	**98±70** B	12.6
Radium-226	—	**11±0.9** B	0.397
Radium-228	—	**11±1.6** B	0.0966
Strontium-89/90	—	2.8±6.4 BJ	6.46
Tritium	—	-0.07±0.22 (pCi/mL) BU	484

a. Screening level sources: EPA Regional Screening Levels for Resident Tapwater (EPA 2017a) and EPA Radionuclide PRGs for Resident Tapwater (EPA 2014), based on 1E-04 risk or 1.0 hazard index.
b. 2017 EPA Regional Screening Level for cadmium (water).
c. 2017 EPA Regional Screening Level for chromium (IV).
d. 2017 EPA Regional Screening Level for lead and compounds.
e. 2017 EPA Regional Screening Level for manganese (non-diet).
f. 2017 EPA Regional Screening Level for mercuric chloride (and other mercury salts).
g. 2017 EPA Regional Screening Level for nickel soluble salts.
h. 2017 EPA Regional Screening Level for zinc and compounds.

EPA Environmental Protection Agency
ND non detect
PRG preliminary remediation goal
— sample results not reported
bold indicates concentration exceeds risk-based levels for residential tapwater

Laboratory qualifier:
B Value less than the contract required detection limit but greater than or equal to the instrument detection limit

Validation qualifiers:
J Results is an estimate and may be inaccurate or imprecise
U Analyte not detected

HUMAN HEALTH RISK ASSESSMENT

The Operable Unit (OU) 10-08 risk evaluation for the new site identification process follows the approach described in the OU 10-08 Remedial Investigation/Baseline Risk Assessment (DOE-ID 2008). Conceptual site models were developed for the current occupational scenario and future residential scenario. This risk evaluation evaluates risk to a future resident. An initial soil screening for human health includes three steps: (1) background comparison, (2) essential nutrient identification, and (3) comparison against EPA risk-based soil screening levels for nonradionuclides and EPA and INL Site-specific risk-based screening levels for radionuclides.[a]

Inorganic compounds presented in Table 1 were screened as follows:

- Eliminate all nondetects
- Eliminate metals that are less than or equal to representative INL Site background levels established by Rood, Harris, and White (1996)
- Eliminate essential nutrients (aluminum, calcium, iron, magnesium, potassium, and sodium) as identified in DOE-ID (2008)
- Eliminate contaminants that are less than or equal to EPA risk-based preliminary remediation goals (PRGs).

Table 3 summarizes screening results for metals detected in CFA-56 retention basin soil. The maximum concentration for each contaminant detected was used for the initial screening. Nondetects cadmium, mercury, selenium, and silver were eliminated. Arsenic, barium, chromium, and lead maximum concentrations were compared to INL Site background levels. Arsenic and lead were retained for additional screening, and barium and chromium were eliminated because concentrations were below INL Site background levels. Arsenic and lead are not essential nutrients and, thus, were carried forward for comparison against EPA PRGs for unrestricted use. Both arsenic and lead are below risk-based PRGs for the residential risk scenario. This initial screening eliminated all inorganic compounds from the human health risk evaluation. Detected metals in the CFA-56 retention basin do not present a risk to human health.

Radionuclides presented in Table 1 were screened by eliminating nondetects, comparing maximum detections to INL Site background concentrations, and then comparing to EPA or INL Site-specific risk-based screening levels for unrestricted use (DOE-ID 2015, 2016). Gross alpha and gross beta were excluded because they cannot be used in risk assessment. Table 4 presents the initial screening of radionuclides detected in CFA-56 retention basin soil. Cs-137 and K-40 are the only radionuclides with background concentrations calculated for the INL Site. Both radionuclide concentrations are below background concentrations and were eliminated from further screening. Remaining radionuclides were compared to EPA and INL Site-specific risk-based screening levels for the residential risk scenario. Screening results for Ra-226 and Pb-210 are greater than risk-based PRGs.

Ra-226 and Pb-210 have been further evaluated to determine whether they pose actual risk to human health. Pb-210 has a half-life of 22.3 years and was detected at CFA-56 at a maximum concentration of 1.28 pCi/g. Since Pb-210 is a daughter product of Ra-226, the concentration of Pb-210 will not decrease, and instead will continue to exist in a state of equilibrium with Ra-226. Ra-226 exists as part of the natural uranium decay series, and because no anthropogenic sources of radium exist, its activity is expected to remain relatively stable and in equilibrium with U-238. The maximum concentration detected at CFA-56 for Ra-226 was 1.53 pCi/g and, after natural decay, the resulting soil concentration of 1.46 pCi/g still exceeds the 1.40 pCi/g risk-based level in 2095. As such, Ra-226 contamination poses a current risk to human health via soil exposure and may pose an unacceptable risk in the year 2095.

a. The post-Site-wide Five-Year Review Explanation of Significant Differences (DOE-ID 2016) implements EPA default values for the new site identification process when evaluating nonradionuclide contaminants and INL Site-specific calculated risk-based values for radionuclides (DOE-ID 2015).

Table 3. Initial screening of CFA-56 retention basin soil for metals.

Detected Contaminants	Sample ID	Sample Depth (ft)	Maximum Concentration (mg/kg)	INL Site Background Concentration[a] (mg/kg)	Maximum Concentration >INL Site Background?	Residential Risk-based Screening Level (mg/kg)	Maximum Concentration > Residential Risk-based Screening Level?
Arsenic	CFA34W34001	0–0.5	14.0	7.4	Yes	34.9[b]	No
Barium	CFA34W34003 CFA34W34007	1–1.5 0–0.5	240.0	440	No	—	—
Chromium	CFA34W34009	1–1.5	31.0	50	No	—	—
Lead	CFA34W34007	0–0.5	27.0	23	Yes	400[c]	No

a. Rood, Harris, and White (1996).

b. EPA (2017a).

c. Lead screening level identified in DOE-ID (2010) is the same as EPA risk-based screening level (EPA 2017a).

— Contaminant eliminated from further screening
EPA Environmental Protection Agency

Table 4. Initial screening of CFA-56 retention basin soil for radionuclides.

Detected Contaminants	Sample ID	Sample Depth (ft)	Maximum Concentration (pCi/g)	INL Site Background Concentration[a] (pCi/g)	Maximum Concentration >Background?	Residential Risk-based Screening Level (pCi/g)	Maximum Concentration $>10^{-04}$ Residential Risk-based Screening Level?
Ra-226	CFA34W34006	1–1.5	1.53E+00 ± 3.45E-01	NA	NA	1.40E+00[b]	**Yes**
U-235	CFA34W34005	0.5–1	9.73E-02 ± 2.00E-01	NA	NA	1.90E+01[b]	No
Ac-228	CFA34W34009	1–1.5	1.52E+00 ± 1.00E-01	NA	NA	7.30E+04[c]	No
Bi-214	CFA34W34009	1–1.5	1.46E+00 ± 8.50E-02	NA	NA	7.50E+05[c]	No
Bi-212	CFA34W34002	0.5–1	2.01E+00 ± 3.00E-01	NA	NA	3.50E+04[c]	No
Cs-137	CFA34W34007	0–0.5	1.21E+00 ± 6.50E-02	1.28E+00	No	—	—
Eu-155	CFA34W34004	0–0.5	2.05E-01 ± 5.50E-02	NA	NA	3.60E+02[b]	No
Pb-214	CFA34W34009	1–1.5	1.47E+00 ± 8.50E-02	NA	NA	4.10E+06[c]	No
Pb-212	CFA34W34009	1–1.5	1.47E+00 ± 8.00E-02	NA	NA	1.50E+05[c]	No
Pb-210	CFA34W34007	0–0.5	1.28E+00 ± 3.90E-01	NA	NA	7.70E-01[c]	**Yes**
Mn-54	CFA34W34002	0.5–1	4.87E-02 ± 2.00E-01	NA	NA	6.10E+01[c]	No
K-40	CFA34W34002	0.5–1	2.07E+01 ± 1.01E+00	3.20E+01	No	—	—
Tl-208	CFA34W34007	0–0.5	5.15E-01 ± 3.50E-02	NA	NA	2.00E+06[c]	No
Th-234	CFA34W34009	1–1.5	2.26E+00 ± 3.70E-01	NA	NA	5.00E+03[c]	No

a. Rood, Harris, and White (1996).

b. Site-specific risk-based screening levels (RBSLs) using EPA default ingestion, inhalation, and external radiation exposure combined with site-specific homegrown produce ingestion RBSLs (DOE-ID 2015, 2016).

c. EPA (2014).

— Contaminant eliminated from further screening
EPA Environmental Protection Agency
NA not applicable

Ra-226 has a half-life of 1,600 years, so natural radioactive decay processes will not result in acceptable concentrations by the year 2095. A site-specific PRG was developed to determine whether Ra-226 and the daughter product Pb-210 (i.e., secular equilibrium) truly pose a risk to human health at this site. The methodology is outlined below. It should be noted that the remainder of the discussion regarding Ra-226 also includes the daughter activity of Pb-210. Thus, the PRG includes the dose contribution from Pb-210 in the Ra-226 calculation, and, therefore, only the Ra-226 soil values need to be compared to the PRG.

The INL Site-specific risk-based screening levels for radionuclides (DOE-ID 2015) were used as the basis for evaluating Ra-226 contamination at CFA-56. These values incorporate EPA default PRGs for ingestion, inhalation, and external exposure, along with site-specific PRGs for ingestion of homegrown produce to determine the total PRG for exposure across all pathways. The basis for this approach is discussed in detail in the *Five-Year Review of CERCLA Response Actions at the Idaho National Laboratory Site—Fiscal Years 2010-2014* (DOE-ID 2015). The Five-Year Review also stated the following with regard to external radiation exposure:

> Risk estimates from external exposure to radiation via soil exposure include a gamma shield factor (GSF) and an area correction factor (ACF). The GSF accounts for shielding from clean cover soil over buried contamination, and the ACF accounts for the area and thickness of the contaminated source area and is radionuclide-specific. Both these factors were recently updated to allow for more site-specific information to be factored into calculating cleanup levels (Bellamy et al. 2014a, 2014b). Default values used in the EPA PRG calculator represent the worst-case scenario in order to be conservative; the GSF is set to 1, which assumes no shielding, and the ACF is the highest value available for each radionuclide and assumes an infinite volume of contaminated soil. Using the default values for these two factors results in potentially overly conservative external exposure PRGs, depending on the specific characteristics of the site.

A site-specific external exposure PRG was calculated for Ra-226 by adjusting the ACF to represent site-specific conditions for CFA-56. EPA's online PRG Calculator (EPA 2017b) was used to calculate the external exposure PRG for Ra-226. CFA-56 has an area of approximately 0.75 acres, equivalent to approximately 3,000 m^2. However, the PRG Calculator does not include an ACF of 3,000 m^2; options are either 2,000 m^2 or 5,000 m^2. In order to be conservative in PRG calculations, an ACF of 5,000 m^2 was selected. In addition, there was assumed to be no gamma shielding from clean cover soil (i.e., the gamma shielding factors, GSF_o and GSF_b, were set to 0 cm to calculate the site-specific external exposure PRG. The remaining default values for calculating the external exposure PRG for Ra-226 were used. The resulting external exposure PRG is 1.6E+00 pCi/g.

The external exposure PRG was then utilized to calculate the total PRG for Ra-226. The ingestion, inhalation, and home-grown produce PRGs identified in Appendix B of DOE-ID (2015) were combined with the site-specific external exposure PRG to calculate the total PRG. The calculation for combining pathway-specific PRGs is shown in Equation (1) (EPA 2014):

$$PRG_{total} = \frac{1}{\frac{1}{PRG_{ingestion}} + \frac{1}{PRG_{inhalation}} + \frac{1}{PRG_{external\ exposure}} + \frac{1}{PRG_{homegrown\ produce}}} \quad (1)$$

Where

$PRG_{ingestion}$	=	PRG for soil exposure via ingestion
$PRG_{inhalation}$	=	PRG for soil exposure via inhalation
$PRG_{external\ exposure}$	=	PRG for soil exposure via external exposure
$PRG_{homegrown\ produce}$	=	PRG for soil exposure via homegrown produce ingestion.

Using the PRGs identified in DOE-ID (2015) for ingestion (1.3E+02 pCi/g), inhalation (3.0E+04 pCi/g), and homegrown produce (2.9E+02 pCi/g) and the site-specific PRG for external exposure (1.6E+00 pCi/g), the resulting total PRG for Ra-226 is 1.6E+00 pCi/g.

The site-specific PRG for Ra-226 is greater than the maximum concentration for Ra-226 of 1.53 pCi/g at CFA-56. Therefore, Ra-226 does not pose an unacceptable risk to human health at this site.

ECOLOGICAL RISK ASSESSMENT

Ecological screening uses a similar approach to that of human health but with comparison against ecologically based screening levels or EPA ecological-soil screening levels (Eco-SSL). The OU 10-08 remedial action objective is to inhibit unacceptable exposure to populations of flora and fauna and individual threatened and/or endangered species (DOE-ID 2009). Table 5 summarizes initial ecological screening of CFA-56 retention basin soil for metals. Arsenic and barium concentrations are below EPA Eco-SSL. Chromium and lead concentrations exceeded EPA Eco-SSL; thus, they were retained for further evaluation. Contaminants that do not screen are assessed by calculating hazard quotients for INL Site-selected ecological receptors using the method described in the OU 10-04 Remedial Investigation/Feasibility Study, as updated by the OU 10-08 Remedial Investigation/Baseline Risk Assessment (DOE-ID 2008) and the Refined Waste Area Group Ecological Risk Assessments (VanHorn 2013). A hazard quotient is calculated by dividing the calculated dose from the contaminant by its toxicity reference value. The maximum concentration for chromium and lead were used to calculate the dose. Further evaluation determined chromium and lead hazard quotients are less than 1 (see Table 6), where hazard quotients greater than 10 for flora and fauna populations and 1 for individual flora and fauna listed as threatened and/or endangered indicate potential unacceptable ecological risk (DOE-ID 2010).

Table 5. Initial ecological screening of CFA-56 retention basin soil for metals.

Detected Contaminants	Sample ID	Sample Depth (ft)	Maximum Concentration (mg/k g)	Eco-SSL[a] (mg/kg)	Maximum Concentration > Eco-SSL?
Arsenic	CFA34W34001	0–0.5	14.0	18.0	No
Barium	CFA34W34007	0–0.5	240.0	330.0	No
Chromium	CFA34W34009	1–1.5	31.0	26	**Yes**
Lead	CFA34W34007	0–0.5	27.0	11.0	**Yes**

a. Eco-SSLs identified in DOE-ID (2010) are the lowest EPA value for groups of ecological receptors (i.e., plants, soil invertebrates, birds, and mammals).

Eco-SSL ecological-soil screening level
EPA Environmental Protection Agency

Table 6. Results of ecological risk evaluation for CFA-56 basin soils for metals.

Functional groups	Hazard Quotient (unitless)		Maximum Hazard Quotient
	Chromium	Lead	
Great Basin spadefoot toad	NA	NA	NA
Mourning dove	NA	4.63E-03	4.63E-03
Blue-winged teal	NA	0.00E+00	0.00E+00
Sage sparrow	NA	2.70E-02	2.70E-02
Ferruginous hawk	NA	4.64E-06	4.64E-06
Loggerhead shrike	NA	1.77E-03	1.77E-03
Burrowing owl	NA	3.37E-04	3.37E-04
Black-billed magpie	NA	2.24E-03	2.24E-03
Mule deer	3.13E-04	4.77E-04	4.77E-04
Pygmy rabbit	3.22E-02	4.90E-02	4.90E-02
Townsend's western big-eared bat	9.73E-03	2.33E-03	9.73E-03
Coyote	6.65E-07	1.60E-07	6.65E-07
Deer mouse	5.23E-02	4.32E-02	5.23E-02
Sagebrush lizard	NA	NA	NA
Plants	NA	1.80E-02	1.80E-02
Grasshoppers, beetles	NA	NA	NA
Maximum Hazard Quotient	5.23E-02	4.90E-02	4.90E-02

NA toxicity reference value not available to calculate hazard quotient

Radionuclides with half-lives less than 1 year were eliminated from further evaluation (i.e., Mn-54). Other nuclides removed from consideration (i.e., Ac-228, Bi-214, Pb-212, Pb-214, Tl-208, and Th-234) are radioactive progeny of longer-lived parents (i.e., uranium and thorium natural decay series) and exist in secular equilibrium with the parent (i.e., same activity as the parent). Pb-210 also was removed from further evaluation because, as described in the human health risk analysis, it is a Ra-226 daughter product that ingrows to secular equilibrium with Ra-226. Remaining radionuclides retained for initial screening include U-235, Cs-137, Eu-155, and K-40. All the radionuclides screened and, thus, do not pose an unacceptable risk to ecological receptors (see Table 7).

Table 7. Initial ecological screening of CFA-56 retention basin soil for radionuclides.

Detected Contaminants	Sample ID	Sample Depth (ft)	Maximum Concentration (pCi/g)	INL Site Background Concentration (pCi/g)	Maximum Concentration >Background?	Eco-SSL (pCi/g)	Maximum Concentration >Eco-SSL?
Ra-226	CFA34W34006	1–1.5	1.53E+00 ± 3.45E-01	NA	NA	2.04E+01[a]	No
U-235	CFA34W34005	0.5–1	9.73E-02 ± 2.00E-01	NA	NA	2.27E+01[a]	No
Cs-137	CFA34W34007	0–0.5	1.21E+00 ± 6.50E-02	1.28E+00	No	—	—
Eu-155	CFA34W34004	0–0.5	2.05E-01 ± 5.50E-02	NA	NA	3.25E+04[a]	No
K-40	CFA34W34002	0.5–1	2.07E+01 ± 1.01E+00	3.20E+01	No	—	—

a. DOE-ID (2010).

— contaminant eliminated from further screening
Eco-SSL ecological-soil screening level
NA toxicity not available

STORM WATER EVALUATION

The storm water data presented in Table 2 was collected in 1995 and 1996, when measurable precipitation events partially filled the settling pond. Water levels remained below the well inlet and did not discharge to the well during the 1995 and 1996 precipitation events. All storm water collected in the pond either evaporated or infiltrated the soil. The only discharge to the well was in 1969, when a major flood event filled the pond. Historical records indicate very little water has been observed in the settling pond since the 1969 event.

There is not currently a complete exposure pathway to residential receptors through drinking water that would potentially be contaminated with storm water at CFA-56, and the likelihood of exposure to future residents at the site is low. Current land use at the INL Site is industrial with access restrictions, and the 100-year land-use projection is the INL Site will remain industrial while under U.S. Department of Energy (DOE) control (INL 2016). Future land use likely will be similar to current uses, and DOE expects some facilities at the INL Site will remain under DOE control beyond the 100-year scenario. Institutional controls will remain in place at the INL Site until at least 2095, a measure which prevents potential residential exposure to drinking water drawn from the Snake River Aquifer at CFA-56, and DOE will continue to manage portions of the INL Site that cannot be released for unrestricted land use beyond 2095. Drinking water that is drawn from the aquifer at downgradient locations is monitored and will continue to be monitored according to drinking water standards to ensure that contamination is not occurring and that current and future residents at downgradient locations are not exposed to potential contaminants at CFA-56.

As mentioned above, the settling pond does not typically contain water and the small amount of water that intermittently collects in the pond either evaporates or infiltrates the soil. Human health risk at CFA-56 has been quantitatively assessed using the soil data collected within the footprint of the settling pond as presented in this document, since any contaminants in storm water would likely deposit in the surface soil during infiltration. Further, the depth to the Snake River Plain Aquifer at CFA-56 is approximately 490 ft, making it unlikely that discharges to the settling pond or to the injection well would result in contamination to the aquifer and contaminate drinking water at downgradient locations. A qualitative discussion of storm water contaminants is presented here to aid in decision-making process regarding potential action at CFA-56.

The storm water results from the 1995 and 1996 are shown in Table 2. Risk-based screening levels (RBSLs) for tap water are also presented in the table for informational purposes only. As shown, antimony, arsenic, cadmium, lead, manganese, K-40, Ra-226, and Ra-228 results from the 1996 sampling event exceed RBSLs. However, none of these contaminants are highly mobile in the environment and would therefore not be likely to reach the aquifer. Based on the quantitative risk evaluation for soil presented in this document, the main contaminant of concern at CFA-56 is Ra-226. The travel time for Ra-226 to travel from the bottom of the injection well is presented below. Based on this information, current and future exposure to a resident as a result of storm water infiltration to the aquifer at CFA-56 is unlikely.

The velocity of leaching of a contaminant and the time it takes for the contaminant to move from the soil to the groundwater can be calculated using Darcy's equation (Adams and Jovanovic 2005):

$$q = -K(\theta)\frac{\Delta H}{\Delta z} \quad (2)$$

Where

q = volumetric flux (L/T)

K = hydraulic conductivity under the degree of saturation (L/T)

Θ = volumetric water content (L^3/L^3)

$\Delta H/\Delta z$ = average hydraulic gradient in the downward direction (assumed to be unit gradient conditions).

The velocity of flow (v) (L/T) in unsaturated soil is calculated by dividing the volumetric flux with the volumetric water content (Adams and Jovanovic 2005):

$$v = \frac{q}{\theta} \tag{3}$$

RF is the retardation factor. The RF index is given as (NRC 1993):

$$R_d = 1 + \left(\frac{\rho_b}{\theta}\right)(K_d) \tag{4}$$

Where

ρ_b = soil bulk density (M/L^3)

K_d = sorption coefficient (L^3/M)

Θ = soil water content (volume fraction).

If a solute is reactive, it will travel slower than the water, owing to adsorption. The rate of solute movement can be determined from the retardation factor (Adams and Jovanovic 2005):

$$v_s = \frac{v}{R_d} \tag{5}$$

Thus, the time taken for a contaminant to travel a distance (L) is estimated by (Adams and Jovanovic 2005):

$$t = \frac{L}{v_s} \tag{6}$$

The parameter values for the calculations were taken from DOE-ID (1994), as shown in Table 8.

Table 8. Travel time parameter values (DOE-ID 1994).

Parameter	Description	Value
$\frac{\Delta H}{\Delta z}$	Average hydraulic gradient in the downward direction	1.0 (assumed to be a unit gradient)
$K(\theta)$	Hydraulic conductivity under the degree of saturation	0.1 m/yr (based on infiltration rate)
θ	Soil water content	0.07 (basalt)
ρ_b	Soil bulk density	1.9 g/cm^3 (basalt)
K_d	Sorption coefficient	100 mL/g (radium and lead)
L	Distance to the aquifer	128.63 m (bottom of borehole to aquifer)

Using the parameter values in Table 8, the Ra-226 travel time to the aquifer is 244,487 years. Thus, Ra-226 does not pose a risk to groundwater.

RISK EVALUATION SUMMARY

The CFA-56 risk evaluation determined that contaminants detected in the CFA Disposal Well retention basin soil do not pose an unacceptable risk to human health or ecological receptors. All detected metals screened and Ra-226 concentrations (i.e., 1.53E+00 pCi/g) were below the site-specific cleanup level (i.e., 1.6E+00 pCi/g). All radionuclide contaminants screened for the ecological evaluation, and the hazard quotients for chromium and lead were less than 1, indicating no risk to ecological receptors. The qualitative storm water evaluation examined the lack of complete exposure pathways to a current or future resident. The travel time of Ra-226 to the aquifer was determined to be 244,487 years; as such, contamination in storm water does not pose a risk to groundwater at the site.

Based on the health and ecological risk evaluation, there is acceptable human health, ecological, and groundwater risk. Thus, it is recommended that CFA-56 is included under OU 10-08 as a no action site.

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