5. INORGANIC CONTAMINANTS

Numerous anion and metal analyses results were significantly above soil-moisture (lysimeter) background concentrations in FY 2003, and a few results exceeded MCLs. None of the perched water sample results exceeded the MCL of 10 mg/L; however, a few analytes in the aquifer exceeded MCLs. Nitrates, which are discussed in Section 5.1, are one of the COCs for OU 7-13/14. Other inorganic contaminants are described in Section 5.2.

5.1 Nitrates

5.1.1 Waste Zone

No waste zone soil-moisture samples were collected and analyzed for nitrates in FY 2003.

5.1.2 Vadose Zone

5.1.2.1 ***Lysimeter Samples at Depths of 0 to 35 ft.*** Eighteen nitrate (as nitrogen) analyses were performed on samples collected from 14 lysimeter wells in and around the SDA in FY 2003, with 15 detections above local soil-moisture background (see Table 5-1). Of the 15 detections, eight exceeded the drinking water MCL of 10 mg/L. The primary drinking water MCL is not applicable to soil-moisture samples, but it is used as a basis for comparison.

Nitrate concentrations in the shallow region of the vadose zone show wide variations, ranging from 0.4 mg/L in Well W23 to 91 mg/L in Well PA02. Background levels of nitrate in the vadose zone outside the SDA typically range from 0.1 to 6 mg/L. Water from Well W-08 exceeded the MCL of 10 mg/L, but the level has been stable since monitoring began in the mid-1990s. The highest nitrate concentrations were measured in Well PA02, which is adjacent to Pad A where nitrate-laden waste is disposed of. Nitrate concentrations have been fairly stable in this well at about 45–55 mg/L; however, data from the last two samples indicate increases above this baseline level (see Figure 5-1). Nitrates in this location appear to have migrated to a depth of about 100 ft, as nitrate concentrations at this 100-ft depth also are above background (see results of Lysimeter I4S-DL11 in Table 5-2). Another area where elevated nitrate levels are measured is west of Pit 4 in two adjacent wells (i.e., 98-4 and W-25). Data have indicated a gradual upward trend in nitrate in Well W-25 since 1997 (see Figure 5-1).

5.1.2.2 ***Lysimeter Samples at Depths of 35 to 140 ft.*** Twenty-two nitrate (as nitrogen) analyses were performed on samples collected from 13 lysimeter wells in and around the SDA in FY 2003, with nine detections above local soil-moisture background (see Table 5-2). Of the nine detections, six exceeded the drinking water MCL. The primary drinking water MCL is not applicable to soil-moisture samples, but is used as a basis for comparison. Nitrate concentrations in the intermediate vadose zone also show wide variations, ranging from 0.3 mg/L in Well O2S to 110 mg/L in Well I2S. Wells completed in this depth interval around Pad A (i.e., D06, TW1, and I4S) generally have nitrate concentrations in the range of 12–15 mg/L. Nitrate concentrations in Well I4S show nitrate contamination has migrated to about the 100-ft depth around Pad A. This lysimeter well is located in the same vicinity as the high and trending nitrate concentrations observed in PA02. Well I2S has the highest nitrate concentration observed in the 35–140-ft depth interval, and the concentration is increasing a fairly significant rate (see Figure 5-1).

Table 5-1. Positive detections of nitrate concentrations above local soil-moisture background in the 0- to 35-ft depth interval of the Subsurface Disposal Area vadose zone soil moisture (lysimeter).

Lysimeter	Depth (ft)	Sample Date	Analyte	Sample Result (mg/L)	Local Soil-Moisture Background[a] (mg/L)	MCL[b] (mg/L)
98-1L35	16.5	04/30/03	Nitrate-N	**10**[c]	6.0	10
98-4L38	17.0	04/30/03	Nitrate-N	**43**[d]	6.0	10
98-5L39	10.5	04/30/03	Nitrate-N	**7.8**[c]	6.0	10
D15-DL07	32	05/01/03	Nitrate-N	**27**[d]	6.0	10
PA01-L15	14.3	04/30/03	Nitrate-N	**9.2**[c]	6.0	10
PA02-L16	8.7	04/30/03	Nitrate-N	**89**[d]	6.0	10
W05-L24	16	04/29/03	Nitrate-N	**7**[c]	6.0	10
W08-L13	11.3	04/30/03	Nitrate-N	**36**[d]	6.0	10
W08-L14	6.2	04/29/03	Nitrate-N	**13**[d]	6.0	10
W09-L23	14.8	04/30/03	Nitrate-N	**8.4**[c]	6.0	10
W23-L09	7.7	04/28/03	Nitrate-N	**6.8**[c]	6.0	10
W25-L28	15.5	04/30/03	Nitrate-N	**32**[d]	6.0	10
PA01-L15	14.3	7/21/03	Nitrate-N	**9.3**$_J$[c,e]	6.0	10
PA02-L16	8.7	7/21/03	Nitrate-N	**91**$_J$[d,e]	6.0	10
W23-L09	7.7	7/21/03	Nitrate-N	**8.4**$_J$[d,e]	6.0	10

a. Local soil-moisture background values are the upper concentration ranges obtained from up to 30 soil-moisture samples collected between 1997 and 2003 from the D15 and O-series lysimeter wells located outside of the SDA.
b. The MCLs are from the "National Primary Drinking Water Regulations" (40 CFR 141) established by the U.S. Environmental Protection Agency. The MCLs for vadose zone water samples are applicable to perched water, but not to soil-moisture (lysimeter) samples. The MCLs for lysimeter sample results are provided here only as a basis of comparison.
c. **Black bold font** indicates sample concentrations less than the MCL, but exceeding local soil-moisture background concentrations (see footnote a).
d. **Red bold font** indicates sample concentrations that exceed the MCL (see footnote b).
e. Concentration values with a "J" subscript denote that "J" data validation qualifier flags were assigned. The "J" flags were assigned to the results because of high matrix spike recoveries. The results are usable, but should only be used as estimated quantities.
CFR = *Code of Federal Regulations*
MCL = maximum contaminant level
SDA = Subsurface Disposal Area

Table 5-2. Positive detections of nitrate concentrations above local soil-moisture background in the 35-to 140-ft depth interval of the Subsurface Disposal Area vadose zone soil moisture (lysimeter).

Lysimeter	Depth (ft)	Sample Date	Analyte	Sample Result (mg/L)	Local Soil-Moisture Background[a] (mg/L)	MCL[b] (mg/L)
D06-DL01	88	04/29/03	Nitrate-N	**8.9**[c]	5.3	10
D06-DL02	44	04/29/03	Nitrate-N	**14**[e]	5.3	10
I1S-DL09	101	04/29/03	Nitrate-N	**6.5**[c]	5.3	10
I2S-DL11	92	04/29/03	Nitrate-N	**97**[e]	5.3	10
I4S-DL15	97	04/29/03	Nitrate-N	**14**[e]	5.3	10
TW1-DL04	102	04/28/03	Nitrate-N	**12**[e]	5.3	10
I1S:DL09	101	7/22/03	Nitrate-N	**10**[c]	5.3	10
I2S:DL11	92	7/21/03	Nitrate-N	**110_J**[d,e]	5.3	10
I4S:DL15	97	7/21/03	Nitrate-N	**15_J**[d,e]	5.3	10

a. Local soil-moisture background values are the upper concentration ranges obtained from up to 30 soil-moisture samples collected between 1997 and 2003 from the D15 and O-series lysimeter wells located outside of the SDA.
b. The MCLs are from the "National Primary Drinking Water Regulations" (40 CFR 141) established by the U.S. Environmental Protection Agency. The MCLs for vadose zone water samples are applicable to perched water, but not to soil-moisture (lysimeter) samples. The MCLs for lysimeter sample results are provided here only as a basis of comparison.
c. **Black bold font** indicates sample concentrations less than the MCL, but exceeding local soil-moisture background concentrations (see footnote a).
d. **Red bold font** indicates sample concentrations that exceed the MCL (see footnote b).
e. Concentration values with a "J" subscript denote that "J" data validation qualifier flags were assigned. The "J" flags were assigned to the results because of high matrix spike recoveries. The results are usable, but should only be used as estimated quantities.
CFR = *Code of Federal Regulations*
MCL = maximum contaminant level
SDA = Subsurface Disposal Area

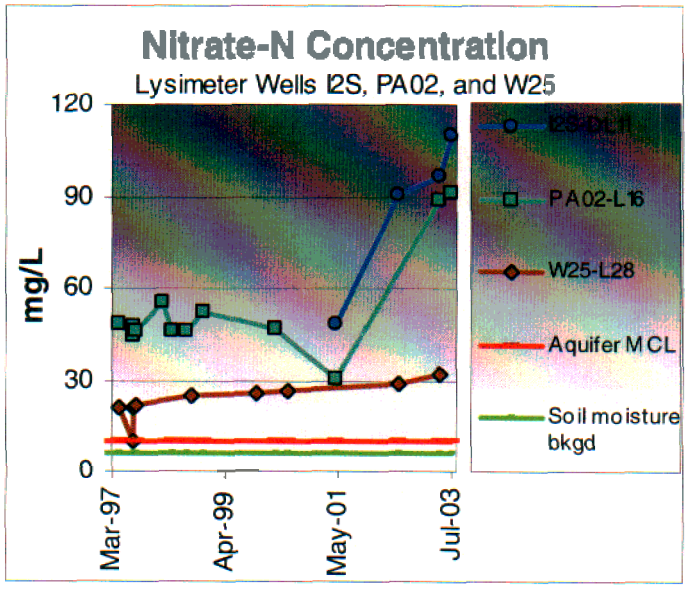

Figure 5-1. Lysimeters in the Subsurface Disposal Area vadose zone exhibiting concentration trends.

5.1.2.3 Lysimeter Samples at Depths of 140 to 250 ft. Ten nitrate (as nitrogen) analyses were performed on samples collected from six lysimeter and two perched water wells in and around the SDA in FY 2003, with one detection above local soil-moisture background (see Table 5-3). The concentration did not exceed the drinking water MCL. The primary drinking water MCL is not applicable to soil-moisture samples, but is used as a basis for comparison. Nitrate concentrations detected in the deep vadose zone are near background levels and indicate much less variation than do nitrate concentrations in the shallow and intermediate vadose zone. Nitrate concentrations in this depth interval range from 0.13 to 7.7 mg/L. It should be noted that the concentration of 7.7 mg/L is associated with Well I2D and is located in the same vicinity as Well I2S, which shows a nitrate trend.

Table 5-3. Positive detections of nitrate concentrations above local soil-moisture background in the 140- to 250-ft depth interval of the Subsurface Disposal Area vadose zone soil moisture (lysimeter).

Lysimeter	Depth (ft)	Sample Date	Analyte	Sample Result (mg/L)	Local Soil-Moisture Background[a] (mg/L)	MCL[b] (mg/L)
I2D-DL10	196	04/29/03	Nitrate-N	**7.7**[c]	5.3	10

a. Local soil-moisture background values are the upper concentration ranges obtained from up to 30 soil-moisture samples collected between 1997 and 2003 from the D15 and O-series lysimeter wells located outside of the SDA.
b. The MCLs are from the "National Primary Drinking Water Regulations" (40 CFR 141) established by the U.S. Environmental Protection Agency. The MCLs for vadose zone water samples are applicable to perched water, but not to soil-moisture (lysimeter) samples. The MCLs for lysimeter sample results are provided here only as a basis of comparison.
c. **Black bold font** indicates sample concentrations less than the MCL, but exceeding local soil-moisture background concentrations (see footnote a).
CFR = *Code of Federal Regulations*
MCL = maximum contaminant level
SDA = Subsurface Disposal Area

5.1.3 Aquifer

Sixty-two nitrate (as nitrogen) analyses were performed on samples collected from 15 RWMC monitoring wells around the RWMC in FY 2003, with three detections slightly above the SRPA background concentration of 1 to 2 mg/L established by Knobel, Orr, and Cecil (1992). Samples were collected in November 2002 and February, April, May, and August 2003 from Monitoring Wells AllA31, M1S, M3S, M4D, M6S, M7S, M11S, M12S, M13S, M14S, M15S, M16S, M17S, OW2, and USGS-127. Low levels of nitrates were detected in all RWMC aquifer samples at concentrations characteristic of SRPA background levels, except for Well M6S. Nitrate concentrations in FY 2003 ranged from 0.4 mg/L in Well M13S to 3.4 mg/L in M6S. All results were below the primary drinking water MCL of 10 mg/L. The nitrate concentrations above aquifer background were collected from Monitoring Well M6S. Nitrate levels from Aquifer Well M6S continue to exhibit an increasing trend that appears to be stabilizing at concentrations near the SRPA background (see Figure 5-2). The results above background are summarized in Table 5-4.

5.1.4 Summary of Nitrates

Low levels of nitrates were detected in all aquifer-monitoring wells in the vicinity of the RWMC in FY 2003 at concentrations characteristic of background levels typically found in the SRPA, with the exception of Well M6S. Nitrate concentrations in Well M6S are slightly above SRPA background and have a long-term trend that appears to be stabilizing at concentrations near the SRPA background level (see Figure 5-2).

Table 5-4. Nitrate (as nitrogen) aquifer concentrations detected above background at the Radioactive Waste Management Complex in Fiscal Year 2003.

Well	Sample Date	Sample Result (mg/L)	Aquifer Background[a] (mg/L)	Maximum Contaminant Level[b] (mg/L)
M6S	11/11/02	**3.4**[c]	1–2	10
M6S	04/28/03	**2.1**[c]	1–2	10
M6S	8/4/2003	**2.1**[c]	1–2	10

a. The USGS established SRPA background levels in 1992 from samples collected upgradient (i.e., Mud Lake area) and downgradient (i.e., Magic Valley area) of the INEEL (Knobel, Orr, and Cecil 1992).
b. The MCL is from the "National Primary Drinking Water Regulations" (40 CFR 141) established by the U.S. Environmental Protection Agency.
c. **Black bold font** indicates sample concentrations less than the MCL, but exceeding SRPA background concentrations (see footnote a).
CFR = *Code of Federal Regulations*
INEEL = Idaho National Engineering and Environmental Laboratory
MCL = maximum contaminant level
SRPA = Snake River Plain Aquifer
USGS = United Stated Geological Survey

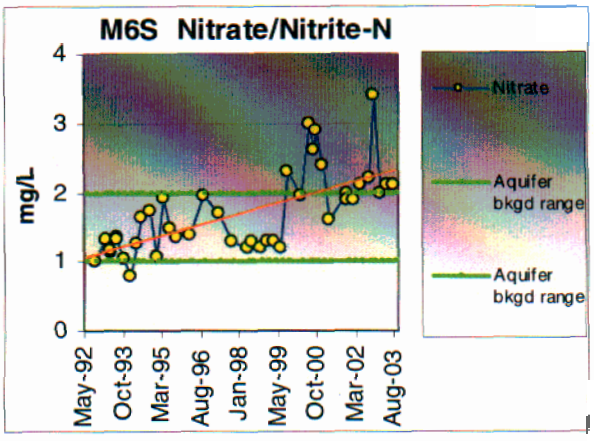

Figure 5-2. Concentration of nitrates (as nitrogen) in Radioactive Waste Management Complex Aquifer Monitoring Well M6S from 1992 to August 2003.

Of the 50 vadose zone soil-moisture and perched water samples collected and analyzed for nitrates in FY 2003, 25 results were above background levels and 14 of those 25 exceeded the primary drinking water MCL. Significant concentration trends were associated with Lysimeters PA02-L16 and I2S-DL11, providing evidence that nitrates have migrated to about 100 ft in the vadose zone. Nitrate concentrations are highest in the 0- to 35-ft and 35- to 140-ft regions of the vadose zone and most prevalent in lysimeter wells located around the Pit 5 and Pad A area (i.e., Wells D06, I4S, PA01, PA02, and TW1), the west end of the SDA (i.e., Wells I2S, W23, and 98-5), the east end of Pit 4 (i.e., Wells 98-4 and W25), and the acid pit (Well W08).

5.2 Other Inorganic Contaminants

Numerous anions and metals analysis results were above background in samples collected from RWMC aquifer-monitoring wells and vadose zone soil moisture in FY 2003. Many of these anions and metals have high concentrations that exceed aquifer MCLs. Anion and metal contaminants detected in the vadose zone have relatively high concentrations, and many are attributed to dust-suppression activities at the SDA up to 20 years ago. In 1984, 1985, 1992, and 1993, magnesium chloride brine was applied to

roads in the SDA to suppress dust. The chemical constituents of the brine are now widely distributed in the vadose zone at the SDA, and most of the elevated concentrations of cations and anions can be related to the brine application. The primary anion in brine is chloride, but bromide and sulfate also are present at high concentrations. Magnesium from the brine exchanges for cations on clay minerals; therefore, elevated calcium, sodium, potassium, and magnesium are related to the brine application. Lysimeter and aquifer results for other inorganic contaminants are addressed in the following sections.

5.2.1 Vadose Zone

In FY 2003, lysimeter wells with evidence of brine contamination were consistent with wells where brine was previously identified (Hull and Bishop 2003), namely 8802D, 98-1, 98-4, 98-5, D06, LYS-1, I1S, I4S, I4D, O-4S, PA01, PA02, TW1, W05, and W23. Wells 98-1, LYS-1, and PA02 have the highest measured chloride concentrations in the shallow vadose zone with up to 11,000 mg/L. Wells 98-1 and LYS-1 are located in the southeast corner of the SDA, and PA02 is located adjacent to Pad A. In the intermediate vadose zone, chloride levels have reached 5,300 mg/L in Well I1S. Two wells in the deep region of the vadose zone, 8802D and I4D, show chloride levels about 800 mg/L, which are slightly above soil-moisture background. Evidence indicates that brine has migrated to a depth of 240 ft at the SDA. Elevated concentrations of anions and cations associated with brine contamination are not reported in Table 5-5, because they are not contaminants of concern and detract from emphasizing important waste constituents that are migrating.

Metals that are not associated with brine appear in a few samples at concentrations above local soil-moisture backgrounds (see Table 5-5). These elevated concentrations may be sampling artifacts, natural elevated concentrations, or related to contaminant migration. Based on the association of metals and the similarities and differences in the geochemistry of the metals, an evaluation can be made as to which possibility is most likely.

Selenium is frequently detected in numerous lysimeter samples at concentrations near the MCL, although one well (D15_DL07) exceeded the MCL. The source of the low-level selenium has yet to be identified, but an evaluation is ongoing.

Aluminum and iron are elevated in the sample from Well USGS-92, which is sampled by bailing. When the bailer is lowered to the bottom of the well, the sediment in the well is disturbed and becomes suspended in the water sample. These suspended solids then become part of the water sample brought to the surface in the bailer. Both aluminum and iron are common elements in sedimentary interbed minerals and are likely from suspended solids as artifacts of the sampling process.

Elevated concentrations of chromium, iron, and nickel were found in the lysimeter sample from Well O7-DL28. Nickel and chromium are not abundant rock-forming elements, and other rock-forming species (e.g., aluminum) are low in this sample; therefore, the metals in Lysimeter O7-DL28 do not appear to be suspended solids from natural rock materials. The geochemical behavior of iron, chromium, and nickel are very different. Iron is higher in solubility at low redox potential, chromium is higher in solubility at high redox potential, and nickel is not affected by redox potential. Therefore, the metals do not appear to be related to geochemical conditions in the vadose zone. The ratio of iron to chromium to nickel in this water sample is typical of the ratio of the same metals in stainless steel. Conjecture is that elevated metals in the sample from Lysimeter O7-DL28 are likely the result of stainless steel from lysimeter materials suspended in the sample that were dissolved during sample digestion.

Table 5-5. Positive detections of anions and metals above local soil-moisture background in Subsurface Disposal Area vadose zone soil-moisture (lysimeter) samples, excluding brine contaminants.

Lysimeter	Depth (ft)	Sample Date	Analyte	Sample Result (mg/L)	Local Soil-Moisture Background[a] (mg/L)	MCL[b] (mg/L)
D06-DL01	88	04/29/03	Selenium	**0.04**[c]	0.014	0.05
			Zinc	**0.61**[c]	0.47	NA
		07/15/03	Selenium	**0.034**[c]	0.014	0.05
D06-DL02	44	04/29/03	Selenium	**0.05**[c]	0.014	0.05
			Zinc	**2.4**[c]	0.47	NA
D15-DL07	32	05/01/03	Selenium	**0.09**[d]	0.014	0.05
I2D-DL10	196	04/29/03	Iron	**0.97**[c]	0.20	NA
			Selenium	**0.05**[c]	0.014	0.05
O7-DL27	240	05/01/03	Chromium	**1.3**[d]	0.013	0.10
			Iron	**22**[d]	0.20	NA
			Nickel	**12**[d]	0.71	0.10
O7-DL28	119	07/23/03	Selenium	**0.018**[c]	0.014	0.05
PA01-L15	14.3	04/30/03	Fluoride	**5.7**[d]	1.2	4.0
			Selenium	**0.05**[c]	0.014	0.05
		07/21/03	Fluoride	**5.6_J**[d,e]	1.2	4.0
			Selenium	**0.042**[c]	0.014	0.05
USGS-92	214	05/01/03	Aluminum	**11**[c]	0.14	NA
			Iron	**11**[c]	0.20	NA
W23-L09	7.7	04/28/03	Selenium	**0.02**[c]	0.014	0.05
		07/21/03	Fluoride	**1.7_J**[c,e]	1.2	4.0

a. Local soil-moisture background values are the upper concentration ranges obtained from up to 49 soil-moisture samples collected between 1987 and 2003 from the C01, C02, D15, and O-series lysimeter wells located outside of the SDA.
b. The MCLs are from the "National Primary Drinking Water Regulations" (40 CFR 141) established by the U.S. Environmental Protection Agency. The MCLs for vadose zone water samples are applicable to perched water, but not to soil-moisture (lysimeter) samples. The MCLs for lysimeter sample results are provided here only as a basis of comparison.
c. **Black bold font** indicates sample concentrations less than the MCL, but exceeding local soil-moisture background concentrations (see footnote a).
d. **Red bold font** indicates sample concentrations that exceed the MCL (see footnote b).
e. Concentration values with a "J" subscript denote that "J" data validation qualifier flags were assigned. The "J" flags were assigned to the results because of high matrix spike recoveries. The results are usable, but should only be used as estimated quantities.
CFR = *Code of Federal Regulations*
MCL = maximum contaminant level
SDA = Subsurface Disposal Area

5.2.2 Aquifer

Several anions and metals have been detected in concentrations greater than aquifer background values in FY 2003, and a few exceeded drinking water MCLs (see Table 5-5). Antimony and lead analysis results of samples from Well A11A31 exceeded MCLs. Historically lead has been detected sporadically in this well; however, the frequency of lead detections increased in FY 2003. Lead is likely associated with corrosion of the well casing, which is constructed of galvanized steel. Corrosion of the galvanized steel casing also explains why concentrations of aluminum, iron, and zinc also are elevated in this well, as they are all components of galvanized steel. Antimony was detected above the MCL in February 2003, and all previous and subsequent analysis results have been nondetections. Table 5-6 lists anions and metals detected in concentrations that exceed background values or MCLs.

Table 5-6. Anions and metals concentrations in excess of aquifer background levels or maximum contaminant levels.

Well	Sample Date	Analyte	Sample Result[a] (µg/L)	Aquifer Background Range (µg/L)	MCL[b] (µg/L)
M1S	11/05/02	Aluminum	**1,[redacted]$_J$[c,d]**	<10–10[e]	—
		Chromium	**70**	1–22[e]	100
		Copper	**15$_J$[c,d]**	<10[e]	1,300
		Iron	**970[c]**	4–85[e]	—
		Nickel	**27[c]**	<10[e]	100
	02/05/03	Chromium	**34[c]**	1–22[e]	100
	05/06/03	Chromium	**33$_U$[c,g]**	1–22[e]	100
	08/06/03	Chromium	**32[c]**	1–22[e]	100
			31[c] filtered	1–22[e]	100
		Vanadium	**15[c]**	<6–14[e]	—
			15[c] filtered	<6–14[e]	—
M3S	08/06/03	Calcium	**48,000[c]**	35,000–46,000[e]	—
			48,000[c] filtered	35,000–46,000[e]	—
M4D	11/12/02	Arsenic	**6.8[c]**	1–5[f]	10
		Potassium	**22,000[c]**	1,000–6,000[e]	—
	02/03/03	Arsenic	**6.2[c]**	1–5[f]	10
		Potassium	**23,000[c]**	1,000–6,000[e]	—
		Sodium	**43,000[c]**	5,400–28,000[e]	—
	05/05/03	Aluminum	**20[c]**	<10–10[e]	—
		Potassium	**22,000[c]**	1,000–6,000[e]	—
		Sodium	**42,000[c]**	5,400–28,000[e]	—
	08/05/03	Arsenic	**6.6[c]**	1–5[f]	50
			7.2[c] filtered	1–5[f]	50
		Fluoride	**810[c]**	100–500[f]	4,000
		Potassium	**22,000[c]**	1,000–6,000[e]	—
		Sodium	**41,000[c]**	5,400–28,000[e]	—
			41,000[c] filtered	5,400–28,000[e]	—
M6S	11/11/02	Chromium	**37[c]**	1–22[e]	100
		Iron	**4,500$_J$[c,d]**	4–85[e]	—
		Nickel	**15[c]**	<10[e]	100
	02/03/03	Chromium	**32[c]**	1–22[e]	100
		Iron	**1,500[c]**	4–85[e]	—
		Nickel	**12[c]**	<10[e]	100
	04/28/03	Aluminum	**91[c]**	<10–10[e]	—
		Chloride	**25,200[c]**	**8,000–20,000[e]**	
		Chromium	**36$_U$[c,g]**	1–22[e]	100
		Iron	**3,200[c]**	4–85[e]	—

Table 5-6. (continued).

Well	Sample Date	Analyte	Sample Result[a] (µg/L)	Aquifer Background Range (µg/L)	MCL[b] (µg/L)
		Nickel	**12**[c]	<10[e]	100
		Sulfate	**65,400**[c]	23,000–30,000[e]	—
	08/04/03	Chloride	**29,000**[c]	8,000–20,000[e]	—
		Chromium	**36**[c]	1–22[e]	100
			30[c] filtered	1–22[e]	100
		Iron	**3,800**[c]	4–85[e]	—
		Nickel	**11**[c]	<10[e]	100
		Selenium	**3.7**[c]	<1[f]	50
			4.5[c] filtered	<1[f]	50
		Sulfate	**71,000**[c]	23,000–30,000[e]	—
M11S	11/12/02	Chromium	**30**[c]	1–22[e]	100
		Nickel	**51**[c]	<10[e]	100
	08/04/03	Chloride	**32,000**[c]	8,000–20,000[e]	—
		Chromium	**27**[c]	1–22[e]	100
			6.7[b]$_J$ filtered	1–22[e]	100
		Iron	**180**[c]	4–85[e]	—
		Nickel	**73**[c]	<10[e]	100
			75[c] filtered	<10[e]	100
M12S	02/03/03	Aluminum	**25**	<10–10[e]	—
		Chromium	**26**[c]	1–22[e]	100
		Iron	**700**[c]	4–85[e]	—
		Lead	**8.6**	<5[f]	15
	04/29/03	Aluminum	**57**[c]	<10–10[e]	—
		Iron	**260**[c]	4–85[e]	—
	08/04/03	Iron	**110**[c]	4–85[e]	—
M13S	11/12/02	Vanadium	**15**[c]	<6–14[e]	—
	02/03/03	Vanadium	**15**[c]	<6–14[e]	—
	08/04/03	Vanadium	**15**[c]	<6–14[e]	—
M14S	11/05/02	Aluminum	**2,800**$_J$[c]	<10–40[e]	—
		Chromium	**34**[c]	1–22[e]	100
		Iron	**3,200**[c]	4–85[e]	—
		Manganese	**52**[c]	<1–15[e]	—
		Nickel	**18**	<10[e]	100
	02/03/03	Aluminum	**180**[c]	<10–10[d]	—
			99[c] duplicate	<10–10[d]	—
	04/28/03	Aluminum	**300**[c]	≤10–10[e]	—
		Iron	**600**[c]	4–85[e]	—
	08/05/03	Calcium	**47,000**[c]	35,000–46,000[e]	—
			47,000[c] filtered	35,000–46,000[e]	—

Table 5-6. (continued).

Well	Sample Date	Analyte	Sample Result[a] (µg/L)	Aquifer Background Range (µg/L)	MCL[b] (µg/L)
		Iron	**280**[c]	4–85[d]	—
M15S	11/06/02	Chromium	**35**[c]	1–22[e]	100
	02/03/03	Chromium	**29**[c]	1–22[e]	100
	05/06/03	Chloride	**35.1**[c]	8,000–20,000[e]	—
			35.2[c] duplicate	8,000–20,000[e]	—
		Chromium	**32**$_U$[c,g]	1–22[e]	100
			duplicate	1–22[e]	
		Sulfate	**36.9**[c,d]	23,000–30,000[e]	—
			37.6[c,d]	23,000–30,000[e]	—
	08/05/03	Chloride	**41,000**[c]	8,000–20,000[e]	—
			40,000[c] duplicate	8,000–20,000[e]	—
		Chromium	**33**[c]	1–22[e]	100
			27[c] filtered	1–22[e]	100
		Chromium duplicate	**34**[c]	1–22[e]	100
			27[c] filtered	1–22[e]	100
		Iron	**120**[c]	4–85[e]	—
			120[c] duplicate	4–85[e]	—
		Sulfate	**36,000**[c]	23,000–30,000[e]	—
			36,000[c] duplicate	23,000–30,000[e]	—
M17S	11/06/02	Aluminum	**560**$_J$[c,d]	<10–40[e]	—
		Iron	**540**[c]	4–85[e]	—
	02/04/03	Aluminum	**65**[c]	<10–10[e]	—
	05/07/03	Iron	**210**[c]	4–85[e]	—
	08/06/03	Iron	**280**[c]	4–85[e]	—
OW-2	05/05/03	Sulfate	**38,600**[c]	23,000–30,000[e]	—
	08/05/03	Iron	**200**[c]	4–85[e]	—
		Sulfate	**36,000**[c]	23,000–30,000[e]	—
USGS-127	11/11/02	Iron	**830**$_J$[c,d]	4–85[e]	—
	02/04/03	Aluminum	**31**[c]	<10–10[e]	—
		Iron	**240**[c]	4–85[e]	—
	05/05/03	Aluminum	**60**[c]	<10–10[e]	—
		Iron	**260**[c]	4–85[e]	—
	08/04/03	Iron	**360**[c]	4–85[e]	—
A11A31	11/05/02	Potassium	**6,100**[c]	1,000–6,000[e]	—
		Sodium	**39,000**[c]	5,400–28,000[e]	—
		Zinc	**290**$_J$[d,i]	3–210[e]	—

Table 5-6. (continued).

Well	Sample Date	Analyte	Sample Result[a] (µg/L)	Aquifer Background Range (µg/L)	MCL[b] (µg/L)
	02/03/03	Aluminum	**700**[c,i]	<10–10[e]	—
		Antimony	**6.7**[h]	—	6
		Chromium	**25**[c]	1–22[e]	100
		Iron	**1,300**[c,j]	4–85[e]	—
		Lead	**66**[h,j]	<5[f]	15
		Manganese	**26**[c]	<1–15[e]	—
		Sodium	**39,000**[c]	5,400–28,000	—
		Zinc	**4,700**[c,j]	3–210[e]	—
	04/30/03	Aluminum	**310**[c,j]	<10–10[e]	—
		Chloride	**35,400**[c]	8,000–20,000[e]	—
		Iron	**490**[c,i]	4–85[e]	—
		Lead	**29**[h,i]	<5[f]	15
		Sodium	**38,000**[c]	5,400–28,000[e]	—
		Sulfate	**64,500**[c]	23,000–30,000[e]	—
		Zinc	**2,300**[c,j]	3–210[e]	—
	08/04/03	Aluminum	**690**[c,j]	<10–10[e]	—
		Chloride	**40,000**[c]	8,000–20,000[e]	—
		Chromium	**27**[c]	1–22[e]	100
		Iron	**1,100**[c,j]	4–85[e]	—
		Lead	**38**[h,j]	<5[f]	15
		Manganese	**20**[c]	<1–15[e]	—
		Sodium	**38,000**[c]	5,400–28,000[e]	—
			37,000[c] filtered	5,400–28,000[e]	—
		Sulfate	**66,000**[c]	23,000–30,000[e]	—
		Zinc	**3,000**[c,j]	<3–210[e]	—
South-1835	8/7/03	Aluminum	**5,400**[c]	<10–10[e]	—
			300[c] filtered	<10–10[e]	—
		Barium	**140**[c]	<2–110[e]	—
		Bicarbonate	**400,000**[c]	228,000[e]	—
		Cadmium	**2.3**[c]	<1–2[e]	5
		Calcium	**66,000**[c]	35,000–46,000[e]	—
			66,000[c] filtered	35,000–46,000[e]	—
		Chloride	**73,000**[c]	8,000–20,000[e]	—
		Chromium	**60**[c]	1–22[e]	100
		Cobalt	**8.5**[c]	<3–3[e]	—
			4.9[c] filtered	<3–3[e]	—
		Copper	**33**[c]	<10–10[e]	1,300
		Iron	**7,800**[c]	4–85[e]	—
		Lead	**10**[c]	<5[f]	15
		Manganese	**1,500**[c]	<1–15[e]	—

Table 5-6. (continued).

Well	Sample Date	Analyte	Sample Result[a] (µg/L)	Aquifer Background Range (µg/L)	MCL[b] (µg/L)
			1,600[c] filtered	<1–15[e]	—
		Nickel	**67[c]**	<10[e]	100
			32[c] filtered	<10[e]	100
		Potassium	**7,100[c]**	1,000–6,000[e]	—
		Sodium	**180,000[c]**	5,400–28,000[e]	—
			190,000[c] filtered	5,400–28,000[e]	—
		Sulfate	**75,000[c]**	23,000–30,000[e]	—
		Vanadium	**29[c]**	<6–14[e]	—
		Zinc	**610[c]**	<3–210[e]	—

a. Reported results are unfiltered, unless otherwise indicated.

b. The MCLs are from the "National Primary Drinking Water Regulations" (40 CFR 141) established by the U.S. Environmental Protection Agency.

c. **Black bold font** indicates sample concentrations less than the MCL, but exceeding aquifer background concentrations (see footnote f).

d. November 2002 sample results with a "J" subscript were positively identified in the sample and assigned a "J" data qualifier flag, because one of the laboratory's internal quality control test results (i.e., serial dilution sample percent difference) was above the acceptance criteria of ±10%. The difference may be because of chemical or physical interferences, which could influence the accuracy of the measurement. Therefore, the reported concentrations should be used only as estimated quantities.

e. The USGS established concentration ranges of various analytes in the SRPA at or near the INEEL in 1999 from samples collected from 39 locations at or near the vicinity of the INEEL and Eastern Snake River Plain (Knobel et al. 1999). The aquifer concentration range shown for chromium, iron, sulfate, and zinc does not include atypical concentrations measured near the Test Reactor Area (i.e., 210, 210, 150, and 420 µg/L, respectively). In addition, chloride and sodium concentration ranges do not include atypical concentrations measured near the Idaho Nuclear Technology and Engineering Center. Furthermore, most analyte concentrations associated with Lidy Hot Springs were excluded, because they are not representative of the aquifer at or near the INEEL.

f. The USGS established the SRPA background ranges in 1992 from samples collected upgradient (i.e., Mud Lake area) and downgradient (i.e., Magic Valley area) of the INEEL (Knobel, Orr, and Cecil 1992). If a background concentration has not been established for a particular analyte, then sample results are compared to concentration ranges typically observed in the aquifer at or near the INEEL (see footnote e).

g. April and May 2003 concentration values with a "U" subscript denote that "U" data validation qualifier flags were assigned. The "U" flags were assigned to the chromium results because chromium contamination was detected in the laboratory batch blank (i.e., continuing calibration blank). The field sample chromium results are not considered reliable or defensible, but are reported herein because the measured concentrations are typical of historical concentrations, are above INEEL aquifer background levels, and chromium was not detected in any other associated blank samples (i.e., preparation blank and field blank). These data are usable, even though their defensibility is limited.

h. **Red bold font** indicates sample concentrations that exceed the MCL.

i. Well A11A31 casing is constructed of galvanized steel, which is the likely cause of the elevated concentration of zinc and other metals.
CFR = *Code of Federal Regulations*
INEEL = Idaho National Engineering and Environmental Laboratory
MCL = maximum contaminant level
SRPA = Snake River Plain Aquifer
USGS = United States Geological Survey
— = not established or not applicable

Some analytes reported in Table 5-6 have historical concentrations above aquifer background levels, but concentrations of these analytes consistently remain below drinking water MCLs and show no observable concentration trends. Only the RWMC monitoring wells exhibiting concentration trends or sudden increases in FY 2003 are discussed below.

Many chromium concentrations in the aquifer beneath the RWMC are significantly above INEEL aquifer background levels. Total chromium concentrations in FY 2003 ranged from 5 pCi/L in Well M4D to 70 pCi/L in Well M1S. Total chromium includes contributions from dissolved and solid chromium as well as chromium in various oxidation states (e.g., Cr^{3+} and Cr^{6+}). Total chromium concentrations in four RWMC monitoring wells (i.e., M1SA, M6S, M11S, and M15S) exceed levels typically detected in the

SRPA around the INEEL (1 to 22 µg/L), as determined from data published by Knobel et al. (1999), which excludes high total chromium concentrations measured around the TRA. Chromium concentrations measured in these four RWMC wells are considerably above aquifer background levels and show increasing trends (see Figure 5-3). Potential sources of chromium include the basalt, well-construction materials, well pumps, buried waste, and upgradient facilities. The following USGS aquifer monitoring wells also have chromium concentrations above 22 µg/L: USGS-088, USGS-089, and USGS-119. Figure 5-4 shows locations of wells with relatively high chromium concentrations.

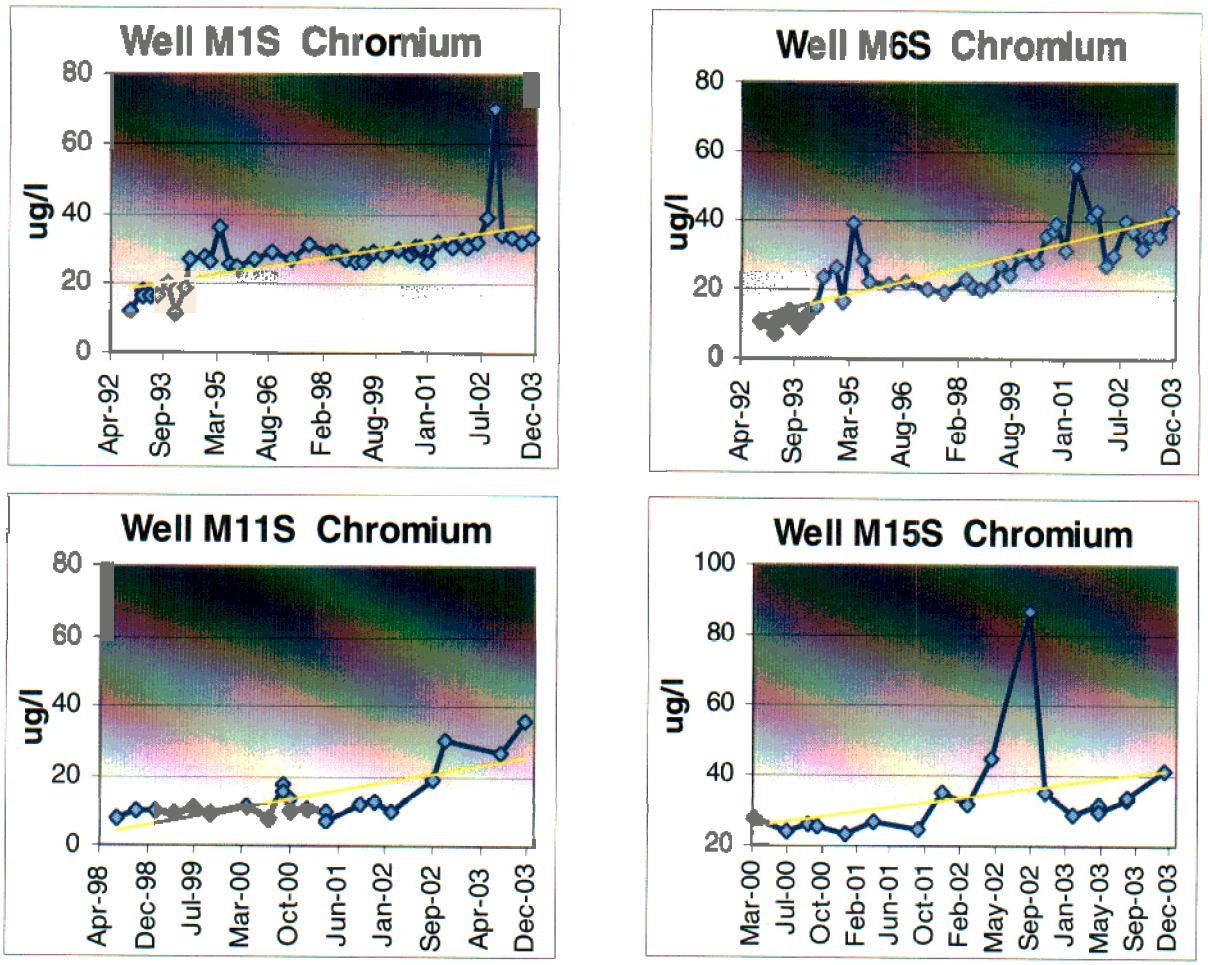

Figure 5-3. Radioactive Waste Management Complex aquifer-monitoring wells exhibiting increasing concentrations of chromium.

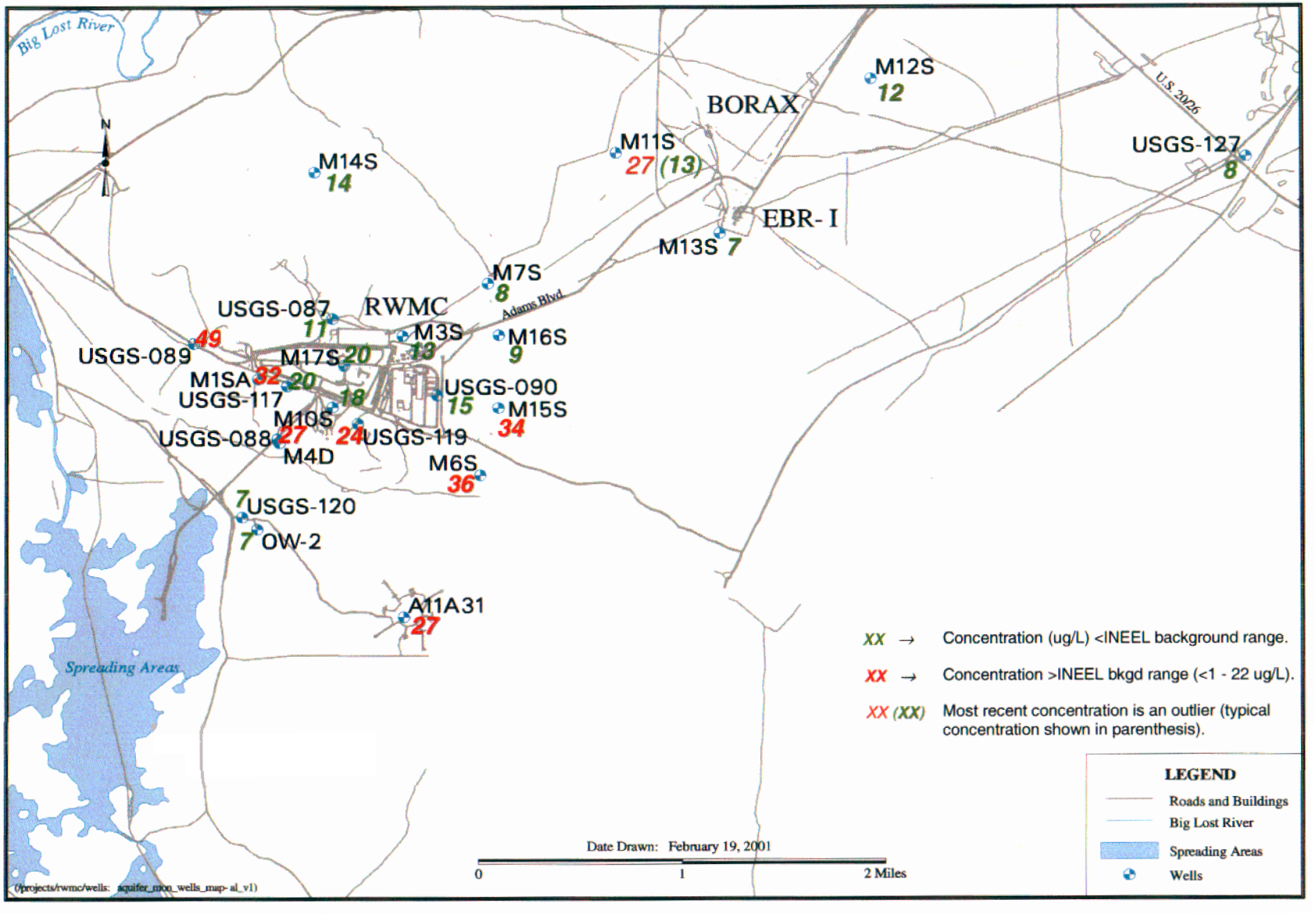

Figure 5-4. Total chromium concentrations in aquifer wells near the Radioactive Waste Management Complex.

Both filtered and unfiltered samples were collected in August 2003 to determine whether chromium is in the dissolved phase, from suspended solids in clays and precipitates in the aquifer, or from well-construction material. It was determined from filtered and unfiltered sample results that chromium in the aquifer around the RWMC exists mainly in the dissolved phase, except for the M11S upgradient well, where it is present mostly as a suspended solid. Wells M6S and M15S, on the east side of the SDA, also have a significant fraction of suspended chromium.

Dissolved chromium is commonly found in groundwater systems where water interacts with basaltic rock. Concentrations of dissolved chromium in the SRPA upgradient and downgradient of the INEEL range from 1 to 50 μg/L (Knobel, Orr, and Cecil 1992), whereas concentrations on or near the INEEL range from 1 to 190 μg/L, with the highest concentrations near TRA (Knobel et al. 1999). It has yet to be determined whether elevated levels of chromium in wells located at the south-southeast side of the RWMC are from the SDA, TRA, or natural occurrences.

Anion and metal concentrations in Well M4D are unlike all other RWMC aquifer-monitoring wells. Potassium and sodium concentrations are about six times higher than other wells and arsenic is about two times higher, whereas calcium and magnesium are about five times lower, and naturally occurring uranium concentrations are about two times lower than other RWMC wells. The difference in chemistry between Well M4D and the other RWMC wells suggests that this well is isolated from the shallower wells. Well M4D is much deeper than other RWMC aquifer-monitoring wells (i.e., 838 ft versus about 650 ft); the atypical concentrations might be related to low flow at this greater depth.

Magnesium chloride brine was historically used on SDA roads for dust suppression, and elevated concentrations of some of the anionic components have been detected in some of the RWMC area wells: M6S, M15S, and A11A31. Elevated chloride is detected in Well M11S and sulfate in OW2. It has been shown that brine contaminants have migrated to the 240-ft level, but it has yet to be established that brine has moved through the vadose zone to the aquifer. It will require continued sampling of the vadose zone and aquifer to identify the source(s) of chloride and sulfate in the RWMC aquifer. Meanwhile, the pattern of the chloride and sulfate detections suggests that there might be input from an upgradient source such as INTEC or TRA.

Most of the anions and metals measured in Well South-1835 were above background. Well South-1835 was a replacement well for M10S. Following well construction, Well South-1835 was determined to have a very low yield with highly turbid water containing suspended solids. X-ray diffraction patterns of the filtered solids were compared to x-ray diffraction patterns of well-construction materials and natural interbed material. The x-ray patterns suggest that the suspended solids are natural silts and clays similar to sedimentary interbed or fracture fill material. During well development, several chemicals were used to break down the drilling mud assumed to remain in the well. Because the well has a low yield, it was not possible to purge and remove all of the added chemicals,[g] as is evident from the analytical results shown in Table 3. Joel Hubbell and Larry Hull[h] conclude that the problems with Well South-1835 occurred mainly from attempts to develop the well after drilling rather than from the drilling itself. Because of its high turbidity and organic carbon, Hubbell and Hull also recommend that water samples from Well S-1835 not be used for groundwater contamination monitoring.

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g. Joel Hubbell Informal Report to T. J. Meyer, et al., 2003, "Well South 1835," Idaho National Engineering and Environmental Laboratory, July 22, 2003.

h. Joel Hubbell and Larry Hull Interoffice Correspondence to T. J. Meyer, 2003, "Evidence for Unsuitability of Using Well S1835 for Groundwater Contaminant Monitoring (Draft)," Idaho National Engineering and Environmental Laboratory, August 26, 2003.

5.2.3 Summary of Other Inorganic Contaminants

Chromium concentrations in most RWMC monitoring wells are consistent with levels typically observed around the INEEL (i.e., 1-22 μg/L). Nonetheless, the RWMC-INEEL chromium concentrations are above SRPA background at the INEEL. The chromium trend for Wells M1S, M6S, M11S, and M15S as well as elevated chloride and sulfate in Wells M6S, M11S, M15S, and A11A31 continue to be of concern.

6. SUMMARY

Soil moisture, soil gas, perched water, and the aquifer are measured around the RWMC to meet a variety of INEEL needs. Monitoring data were summarized for radionuclide and nonradionuclide contaminants for the shallow (0 to 35 ft), intermediate (35 to 140 ft), and deep (greater than 140 ft) vadose zone and for the perched water and the aquifer. Aquifer samples are collected on a quarterly basis.

The Environmental Monitoring Program at the RWMC serves multiple needs. This report is focused on the needs of two specific activities: (1) continued operation of the low-level waste disposal facility and (2) efforts associated with the CERCLA evaluation. Although many objectives are similar for the two projects, there are a number of differences in COCs and other specific needs. Thus, separate summaries of the data presented in the report are provided in the following two sections in the context of the different needs.

6.1 Summary in the Context of Low-Level Waste Disposal

Chapter IV of DOE Order 435.1, "Radionuclide Waste Management," requires that the results of PA/CA modeling be used to design an environmental monitoring program for the disposal facility. The monitoring results are to be used to verify modeling assumptions, confirm that the model adequately represents actual conditions, and demonstrate compliance with the RWMC performance objectives. The required data streams for the RWMC PA/CA monitoring program are identified in the PA/CA monitoring program description (McCarthy, Seitz, and Ritter 2001). Most of the required information can be gathered from results of the ongoing INEEL monitoring programs, but several new monitoring efforts have been initiated to characterize the migration of radionuclides in surface sediment near specific types of waste. Results of the monitoring are discussed in the following sections.

The FY 2003 monitoring results will be compared with FY 2003 action levels developed based on the modeling conducted for the performance assessment. This comparison is made in the annual PA/CA review (Parsons and Seitz 2004). The action levels are concentrations predicted at different locations in the vadose zone and aquifer based on modeling conducted for the existing PA/CA. Thus, if measured concentrations are below the action levels, then the model conclusions about compliance remain valid. The summary information in this report (see Tables 3-5, 3-6, 3-9, 3-10, 3-11, 3-14, 3-15, 3-23, and 3-24) is presented in a manner that facilitates identifying the maximum measured concentration at different depths to make the comparison with the action levels.

6.1.1 Performance Assessment and Composite Analysis Source Monitoring Summary

The Beryllium Source Monitoring Project has produced a useful record of H-3 concentrations in the subsurface and atmosphere. Some of the results and methods developed for beryllium source monitoring may be used to find other beryllium disposal locations for the early risk-reduction project. It is evident that long-term monitoring is required to adequately represent the conditions around the buried beryllium. Air-concentration data show consistent annual fluctuations, yet there is no obvious long-term trend in air concentrations. The H-3 concentration in soil gas has increased at an accelerating rate, and although the concentration must reach a peak and eventually decline, there is no evidence of a peak yet.

Other source-monitoring projects were established to characterize C-14 releases from activated stainless steel and the subsurface conditions in typical disposal pits. The first sampling for the Activated Steel-Monitoring Project was conducted in FY 2002, and it is evident that the C-14 concentrations are substantially lower than the concentrations found around the beryllium blocks, as expected. Sampling equipment and instrumentation are being installed in the active pit, but no data will be available until the equipment and waste have been covered.

6.1.2 Performance Assessment and Composite Analysis Vadose Zone Monitoring Summary

The vadose zone in the vicinity of the RWMC contains a network of suction lysimeters that allow repeated soil-moisture sampling from soil surrounding the waste and from interbeds in the vadose zone. Data were summarized for the PA/CA radionuclides of concern (i.e., C-14, Cl-36, H-3, I-129, Np-237, U-233/234, and U-238). Tritium also was included, because it is a good early indicator for contaminant movement. Maximum concentrations detected were presented for each FY since 1997 and for each depth interval within the vadose zone: shallow (0 to 35 ft), intermediate (35 to 140 ft), and deep (greater than 140 ft). As shown in Table 6-1, data for C-14, H-3, I-129, and uranium are available starting in FY 1997, whereas data for Cl-36 and Np-237 were not collected until years later. Vadose zone analyses for Np-237 began in FY 2000, and Cl-36 was just added to the lysimeter analyte list in FY 2002. The first Cl-36 samples from the vadose zone were analyzed in FY 2003.

In FY 2003, lysimeter sampling results were obtained for all of the PA/CA radionuclides of concern. Iodine-129 and Np-237 were not detected in any of the samples. The maximum concentration of C-14 was found in the intermediate vadose zone (46 pCi/L), two orders of magnitude less than the aquifer MCL (2,000 pCi/L). Chlorine-36 was detected at low levels throughout the vadose zone with maximum concentrations (up to 32.3 pCi/L) much less than the 700-pCi/L aquifer MCL. Tritium was expected in samples from the shallow and intermediate vadose zone. Maximum concentrations of H-3 were one to two orders of magnitude smaller than the MCL of 20,000. Uranium concentrations have been, and continue to be, detected above background for U-233/234 (3 pCi/L) and U-238 (1.5 pCi/L) in several lysimeters in the shallow and intermediate vadose zone. In the deep vadose zone, the maximum concentrations of uranium are at background levels.

Table 6-1. Summary of radionuclide detections in vadose zone soil-moisture and perched water samples from the Radioactive Waste Management Complex from Fiscal Year 1997 through 2003.

Sampling Range (feet below land surface)	Fiscal Year [a]	C-14	Cl-36	H-3	I-129	Np-237	U-233/234	U-238
		Number of Detection Results/Total Environmental Samples						
Lysimeters 0 to 35 ft	1997	4/17	NA[b]	13/29	0/20	NA	2/2	2/2
	1998	1/9	NA	3/8	0/7	NA	23/24	24/24
	1999	2/11	NA	3/7	2/9	NA	25/25	25/25
	2000	0/21	NA	3/12	1/18	0/20	62/62	63/63
	2001	NA	NA	NA	NA	0/8	8/8	7/7
	2002	NA	NA	NA	NA	0/5	5/5	5/5
	2003	0/15	3/22	2/7	0/3	0/10	24/24	22/24
Lysimeters 35 to 140 ft	1997	0/1	NA	0/1	0/1	NA	3/3	3/3
	1998	0/5	NA	2/6	0/4	NA	11/11	8/8
	1999	NA	NA	1/1	NA	NA	2/2	5/5
	2000	NA	NA	NA	NA	0/11	18/21	19/20
	2001	NA	NA	NA	NA	0/5	5/5	3
	2002	0/1	NA	NA	NA	0/3	2/3	2/3
	2003	1/15	2/36	4/11	0/4	0/23	33/40	30/40

Table 6-1. (continued).

Sampling Range (feet below land surface)	Fiscal Year [a]	C-14	Cl-36	H-3	I-129	Np-237	U-233/234	U-238
Lysimeters >140 ft	1997	NA	NA	NA	NA	NA	NA	NA
	1998	NA	NA	NA	NA	NA	NA	NA
	1999	NA	NA	NA	NA	NA	NA	NA
	2000	NA	NA	NA	NA	0/2	0/1	0/1
	2001	NA	NA	NA	NA	0/1	0/1	0/1
	2002	NA	NA	NA	NA	0/4	3/3	0/3
	2003	0/6	0/12	0/2	0/1	0/10	6/17	3/17
Perched water wells >140 ft	1997	2/2	NA	3/5	0/2	NA	NA	NA
	1998	3/4	NA	3/3	0/3	NA	1/2	1/2
	1999	0/2	NA	0/2	0/3	NA	4/6	2/7
	2000	NA	NA	0/1	0/1	0/1	4/6	4/6
	2001	1/1	NA	NA	NA	0/1	0/1	0/1
	2002	NA	NA	0/1	0/1	0/1	1/1	1/2
	2003	0/2	1/5	0/1	0/1	0/3	5/5	4/5

a. Fiscal year spans from October 1 to September (e.g., Fiscal Year 1997 is October 1, 1996, to September 30, 1997).
b. NA = not analyzed

6.1.3 Performance Assessment and Composite Analysis Aquifer Monitoring Summary

Groundwater monitoring has been ongoing from the network of monitoring wells located around the RWMC for many years. Groundwater samples are collected on a quarterly basis as required for the OU 7-13/14 routine monitoring program. Data for H-3, C-14, and I-129 were summarized beginning in FY 1997 (see Table 6-2). Aquifer sampling for uranium was conducted from FY 1998 through the present, while Np-237 data were not collected until FY 1999. Aquifer sampling for Cl-36 began in FY 2001 in the vicinity of the RWMC.

Aquifer sampling results in FY 2003 were obtained for all of the PA/CA COCs (i.e., C-14, I-129, Np-237, U-233/234, and U-238) as well as H-3. No samples were analyzed for Cl-36. Furthermore, C-14, I-129, and Np-237 were not detected in the aquifer (see Table 6-1). Tritium was found in about one-half of the samples collected in FY 2003. The maximum H-3 concentration was 1,690 pCi/L, which is below the aquifer MCL of 20,000 pCi/L. Uranium-233/234 and U-238 were detected in all aquifer samples at levels at or below the normal background concentrations at the RWMC. Typical aquifer background concentrations for U-233/234 and U-238 are 1.1 pCi/L (Holdren et al. 2002).

6.2 Summary in the Context of the Comprehensive Environmental Response, Compensation, and Liability Act

Results from the waste zone, vadose zone, and aquifer monitoring indicate that some contaminants are migrating out of the waste zone and into the vadose zone; however, the data about the aquifer are inconclusive. Tritium is detected in the aquifer beneath the RWMC, but significant detections also are occurring upgradient of the RWMC. It is speculated that H-3 is from upgradient facilities, primarily TRA; however, it is also likely that the some H-3 beneath the RWMC is from sources in the SDA. Uranium is regularly detectable above background concentrations in the shallow- and intermediate-depth lysimeters around Pad A, Pit 5, and the western end of SDA; uranium is sporadically detected in the vadose zone

Table 6-2. Summary of aquifer sampling results for radionuclides at the Radioactive Waste Management Complex from Fiscal Year 1997 through 2003.

Fiscal Year[a]	C-14	C1-36	H-3	I-129	Np-237	U-233/234	U-238
	Number of Detection Results/Total Environmental Samples						
1997	0/7	NA[b]	10/24	1/8	NA	NA	NA
1998	2/23	NA	18/52	2/24	NA	18/18	18/18
1999	3/31	NA	29/73	1/39	0/47	22/44	33/44
2000	9/46	NA	34/79	0/53	0/55	52/53	53/53
2001	5/49	0/15	23/65	0/54	0/62	62/63	63/63
2002	3/45	0/9	20/43	0/53	3/48	46/46	46/46
2003	0/63	NA	28/64	0/78	0/63	63/63	63/63

a. Fiscal year spans from October 1 to September (e.g., Fiscal Year 1997 is October 1, 1996, to September 30, 1997).
b. NA = not analyzed

over 140 ft deep. Detections in the aquifer are representative of natural uranium. Thus, the uranium trend data appear to warrant further investigation for use as a modeling calibration target or model validation. Other results are provided below:

- Low concentrations of CCl_4 and nitrates are affecting the aquifer beneath the RWMC.
- Carbon tetrachloride and nitrates are exhibiting concentration trends.
- Chromium concentrations in Wells M1S, M6S, M11S, and M15S are significantly above aquifer background levels and have evident concentration trends. Chromium levels in all RWMC aquifer wells, including the trending wells, remain below the MCL.
- Nitrates, H-3, Tc-99, and uranium were detected in soil-moisture samples from the vadose zone. There are significant concentration trends associated with nitrates around Pad A and the west end of the SDA.
- Uranium concentrations in a few isolated areas of the SDA, between the 0- and 140-ft depth interval, are significantly elevated and continue to show both concentration trends and isotopic ratio trends. Some lysimeters have isotopic ratios and ratio trends indicative of anthropogenic uranium that is slightly enriched in U-235.
- Technetium-99 was consistently detected in soil moisture from Lysimeter Well D06 and W23 in FY 2003. These lysimeter wells have exhibited many Tc-99 detections, suggesting the presence and migration of Tc-99 in areas of the SDA.
- Plutonium isotopes were not detected in any samples in FY 2003.
- Air concentration data from beryllium-block monitoring show consistent annual fluctuations of H-3 and a total release for FY 2003 of 5 Ci, but with no obvious long-term trend in air concentrations.
- Carbon-14 concentrations around the beryllium blocks are substantially higher than C-14 concentrations near the activated steel or low-level waste disposals, as expected.

7. REFERENCES

40 CFR 61, 2004, "National Emission Standards for Hazardous Pollutants," *Code of Federal Regulations*, Office of the Federal Register, February 2004.

40 CFR 61, Subpart H, 2004, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities," *Code of Federal Regulations*, Office of the Federal Register, February 2004.

40 CFR 141, 2004, "National Primary Drinking Water Regulations," *Code of Federal Regulations*, Office of the Federal Register, February 2004.

42 USC § 9601 et seq., 1980, "Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA/Superfund)," *United States Code.*

Becker, B. H., J. D. Burgess, K. J. Holdren, D. K. Jorgensen, S. O. Magnuson, and A. J. Sondrup, 1998, *Interim Risk Assessment and Contaminant Screening for the Waste Area Group 7 Remedial Investigation*, DOE/ID-10569, Rev. 0, U.S. Department of Energy Idaho Operations Office, August 1998.

DOE O 435.1, 2001, "Radioactive Waste Management," Change 1, U.S. Department of Energy.

DOE-ID, 1991, *Federal Facility Agreement and Consent Order for the Idaho National Engineering Laboratory,* Administrative Record No. 1088-06-29-120, U.S. Department of Energy Operations Office; U.S. Environmental Protection Agency, Region 10; Idaho Department of Health and Welfare.

EPA, 1999, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air,* EPA/625/R-96/010b, Second Edition, "Determination of Volatile Organic Compounds (VOCs) in Ambient Air Using Specially Prepared Canisters with Subsequent Analysis by Gas Chromatography," Compendium Method TO-14A, U.S. Environmental Protection Agency, January 1999.

Holdren, K. Jean, Bruce H. Becker, Nancy L. Hampton, L. Don Koeppen, Swen O. Magnuson, T. J. Meyer, Gail L. Olson, and A. Jeffrey Sondrup, 2002, *Ancillary Basis for Risk Analysis of the Subsurface Disposal Area,* INEEL/EXT-02-01125, Rev. 0, Idaho National Engineering and Environmental Laboratory, September 2002.

Housley, L. Todd, 2003, *Environmental and Operational Mid-Year Data Report for the OU 7-08 Organic Contamination in the Vadose Zone Project—2003*, INEEL/EXT-03-00917, Rev. 0, Idaho National Engineering and Environmental Laboratory, September 2003.

Housley, L. Todd, 2004, Environmental and Operational End-Year Data Report for the OU 7-08 Organic Contamination in the Vadose Zone Project—2003, ICP/EXT-04-00188, Idaho Completion Project, March 2004.

Hull, Larry C. and Carolyn W. Bishop, 2003, *Fate of Magnesium Chloride Brine Applied to Suppress Dust from Unpaved Roads at the INEEL Subsurface Disposal Area*, INEEL/EXT-01-01173, Rev. 0, Idaho National Engineering and Environmental Laboratory, June 2003.

Knobel, L. L., B. R. Orr, and L. D. Cecil, 1992, "Summary of Background Concentrations of Selected Radiochemical and Chemical Constituents in Groundwater from the Snake River Plain Aquifer, Idaho: Estimated from an Analysis of Previously Published Data," *Journal of the Idaho Academy of Science*, Vol. 28, X10.1, p. 48.

Knobel, L. L., R. C. Bartholomay, B. J. Tucker, L. M. Williams, and L. D. Cecil, 1999, *Chemical Constituents in Ground Water from 39 Selected Sites with an Evaluation of Associated Quality Assurance Data, Idaho National Engineering and Environmental Laboratory and Vicinity, Idaho,* DOE/ID-22159, U.S. Geological Survey, Open-File Report 99-246, August 1999.

Leecaster, Molly K., L. Don Koeppen, Gail L. Olson, 2003, *Determination of Background Uranium Concentration in the Snake River Plain Aquifer under the Idaho National Engineering and Environmental Laboratory's Radioactive Waste Management Complex*, INEEL/EXT-03-00367, Rev. 0, Idaho National Engineering and Environmental Laboratory, June 2003.

Magnuson, S. O. and A. J. Sondrup, 1998, *Development, Calibration, and Predictive Results of a Simulator for Subsurface Pathway Fate and Transport of Aqueous- and Gaseous-Phase Contaminants in the Subsurface Disposal Area at the Idaho National Engineering and Environmental Laboratory*, INEEL/EXT-97-00609, Rev. 0, Idaho National Engineering and Environmental Laboratory, July 1998.

Maheras, Steven J., Arthur S. Rood, Swen O. Magnuson, Mary E. Sussman, and Rajiv N. Bhatt, 1994, *Radioactive Waste Management Complex Low-Level Waste Performance Assessment*, INEEL/EXT-97-00462, Idaho National Engineering and Environmental Laboratory.

McCarthy, James M., Roger R. Seitz, and Paul D. Ritter, 2001, *Performance Assessment and Composite Analysis Monitoring Program*, INEEL/EXT-01-00449, Idaho National Engineering and Environmental Laboratory.

Miller, Eric C. and Mark D. Varvel, 2001, *Reconstructing the Past Disposal of 743-Series Waste in the Subsurface Disposal Area for Operable Unit 7-08, Organic Contamination in the Vadose Zone*, INEEL/EXT-01-00034, Rev. 0, Idaho National Engineering and Environmental Laboratory, May 2001.

Mullen, Carlan K., Glen R. Longhurst, Michael L. Carboneau, and James W. Sterbentz, 2003, *Beryllium Waste Transuranic Inventory in the Subsurface Disposal Area, Operable Unit 4-13/14,* INEEL/EXT-01-01678, Rev. 2, Idaho National Engineering and Environmental Laboratory, March 2003.

Myers, Dennis R., Joel M. Hubbell, Nicholas Josten, Don L. Koeppen, Peter Martian, Paul D. Ritter, Michael S. Roddy, Hopi Salomon, Jeffrey A. Sondrup, 2003, *Fiscal Year 2002 Report for the OU 7-13/14 Probing Project*, INEEL/EXT-03-00001, Rev. 0, Idaho National Engineering and Environmental Laboratory, April 2003.

Parsons, A. M., J. M. McCarthy, and R. R. Seitz, 2003, *Annual Performance Assessment and Composite Analysis Review for the RWMC Low-Level Waste Disposal Facility—FY 2002,* INEEL/EXT-03-00247, Rev. 0, Idaho National Engineering and Environmental Laboratory Environmental, March 2003.

Parsons, Alva M. and Roger R. Seitz, 2004, *Annual Performance Assessment and Composite Analysis Review for the RWMC Low-Level Waste Disposal Facility—FY 2003,* ICP/EXT-04-00280, Rev. 0, Idaho Completion Project, March 2004.

Salomon, Hopi, 2003, *Field Sampling Plan for Monitoring Type B Probes for the Operable Unit 7-13/14 Integrated Probing Project*, INEEL/EXT-2000-01435, Rev. 1, Idaho National Engineering and Environmental Laboratory, July 2003.

Varvel, M. D., 2001, "Mass Estimates of Organic Compounds Buried in the Subsurface Disposal Area for Operable Units 7-08 and 7-13/14," INEEL/EXT-01-00277, EDF-ER-301, Rev. 0, Idaho National Engineering and Environmental Laboratory, May 2001.

Wood, M. J. and W. J. G. Workman, 1992, "Environmental Monitoring of Tritium in Air with Passive Diffusion Samplers," *Fusion Technology*, Vol. 21, pp. 529–535.

Wood, M. J., 1996, "Outdoor Field Evaluation of Passive Tritiated Water Vapor Samplers at Canadian Power Reactor Sites," *Health Physics*, Vol. 70, pp. 258–267.