

**Annual Report of  
Site Surveillance and  
Maintenance Activities at the  
Rocky Flats, Colorado, Site**

**Calendar Year 2013**

**April 2014**



U.S. DEPARTMENT OF  
**ENERGY**

Legacy  
Management

This page intentionally left blank

**Annual Report of Site Surveillance and Maintenance Activities  
at the Rocky Flats, Colorado, Site**

**Calendar Year 2013**

**April 2014**

This page intentionally left blank

# Contents

Abbreviations.....	xvi
Executive Summary.....	xxi
1.0 Introduction.....	1
1.1 Purpose and Scope.....	2
1.2 Background.....	3
1.3 RFLMA Contact Records.....	3
1.4 RFLMA Modifications.....	4
1.4.1 Attachment 1 “Site Map”.....	4
1.4.2 Attachment 2 “Legacy Management Requirements”.....	5
1.4.2.1 Monitoring Requirements.....	5
1.4.2.2 Reporting Requirements.....	5
1.4.2.3 Table 1 “Surface Water Standards”.....	6
1.4.2.4 Table 3, “Present and Original Landfill Inspection and Maintenance Requirements”.....	6
2.0 Site Operations and Maintenance.....	9
2.1 Annual Site Inspection.....	9
2.2 Pond Operations.....	9
2.3 Landfills.....	10
2.3.1 Present Landfill.....	10
2.3.1.1 Inspection Results.....	11
2.3.1.2 Slumps.....	11
2.3.1.3 Settlement Monuments.....	11
2.3.2 Original Landfill.....	11
2.3.2.1 Inspection Results.....	11
2.3.2.2 Settlement Monuments.....	12
2.3.2.3 Geotechnical Investigation and Repairs.....	12
2.3.2.4 Precipitation Response Repairs.....	12
2.3.2.5 Inclinometers.....	15
2.3.2.6 Berm Height Evaluation.....	15
2.4 Groundwater Plume Treatment Systems Maintenance.....	16
2.4.1 Mound Site Plume Treatment System.....	16
2.4.1.1 Flow.....	16
2.4.1.2 Upgrades.....	17
2.4.1.3 Maintenance.....	17
2.4.1.4 Operation.....	18
2.4.2 East Trenches Plume Treatment System.....	18
2.4.2.1 Flow.....	18
2.4.2.2 Upgrades.....	19
2.4.2.3 Maintenance.....	20
2.4.2.4 Operation.....	20
2.4.3 Solar Ponds Plume Treatment System.....	21
2.4.3.1 Flows.....	21
2.4.3.2 Upgrades.....	22
2.4.3.3 Maintenance.....	22
2.4.3.4 Operation.....	23
2.5 Sign Inspection.....	23

2.6	Erosion Control and Revegetation.....	23
2.6.1	Erosion Control.....	23
2.7	General Site Maintenance and Operations .....	24
2.7.1	Site Road Upgrades.....	24
2.7.1.1	Site Road Upgrades 2013.....	24
2.7.2	Site Security .....	24
3.0	Environmental Monitoring.....	25
3.1	Water Monitoring.....	25
3.1.1	Introduction.....	25
3.1.1.1	Water Monitoring Highlights: CY 2013 .....	25
3.1.1.2	Use of Analytical Data.....	29
3.1.2	Routine Monitoring.....	33
3.1.2.1	POC Monitoring.....	33
3.1.2.2	POE Monitoring.....	54
3.1.2.3	AOC Wells and SW018 .....	89
3.1.2.4	Sentinel Wells .....	93
3.1.2.5	Evaluation Wells .....	96
3.1.2.6	PLF Monitoring.....	99
3.1.2.7	OLF Monitoring.....	106
3.1.2.8	Groundwater Treatment System Monitoring .....	113
3.1.2.9	Predischarge Monitoring.....	120
3.1.3	Rocky Flats Hydrology.....	121
3.1.3.1	General Hydrologic Setting.....	121
3.1.3.2	Surface-Water Hydrologic Data Presentation.....	126
3.1.3.3	Surface-Water Discharge Data Summaries.....	128
3.1.3.4	Precipitation Data.....	170
3.1.3.5	Groundwater Flow .....	174
3.1.3.6	Seeps .....	188
3.1.4	Surface-Water Data Interpretation and Evaluation.....	191
3.1.4.1	Surface-Water Quality Summaries .....	191
3.1.4.2	Surface-Water Loading Analysis.....	207
3.1.5	Groundwater Data Interpretation and Evaluation.....	265
3.1.5.1	RFLMA Groundwater Monitoring Activities of 2013.....	265
3.1.5.2	Additional Groundwater Monitoring Activities of 2013 .....	267
3.1.5.3	Groundwater at the Rocky Flats Site: Discussion and Interpretations .....	268
3.1.6	High-Resolution Uranium Isotopic Analyses .....	377
3.2	Ecological Monitoring at RFS.....	380
3.2.1	Introduction.....	380
3.2.2	Vegetation Monitoring.....	381
3.2.3	Site Flora.....	381
3.2.4	Weed Mapping and Weed Control .....	381
3.2.5	Revegetation Activities.....	385
3.2.5.1	Interseeding/Revegetation Activities .....	385
3.2.5.2	Habitat Enhancement Project Evaluations.....	386
3.2.5.3	Volunteer Seed Collections/Forb Nursery Evaluations .....	391
3.2.6	Revegetation Monitoring .....	392
3.2.7	Photopoint Monitoring Results.....	398

3.2.8	Wildlife Monitoring.....	401
3.2.8.1	Prairie Dog Monitoring.....	401
3.2.8.2	Nest Box Monitoring.....	401
3.2.8.3	Raptor Nesting Observations.....	401
3.2.8.4	Video of RFS Wildlife.....	401
3.2.9	Preble’s Meadow Jumping Mouse Mitigation Monitoring.....	402
3.2.10	Wetland Monitoring.....	405
3.2.10.1	Wetland Mitigation Closeouts.....	405
3.2.10.2	Interim Wetland Monitoring.....	409
3.2.11	Summary.....	410
3.3	<b>Data Management.....</b>	<b>410</b>
3.3.1	Water Data.....	410
3.3.2	Ecology Data.....	413
3.4	<b>Validation and Data Quality Assessment.....</b>	<b>414</b>
3.4.1	General Discussion.....	414
3.4.2	PARCC Parameters.....	415
3.4.2.1	Criteria for Precision.....	415
3.4.2.2	Criteria for Accuracy.....	416
3.4.2.3	Criteria for Representativeness.....	417
3.4.2.4	Criteria for Completeness.....	417
3.4.2.5	Criteria for Comparability.....	418
3.4.3	Water DQA Results for CY 2013.....	418
3.4.3.1	Precision During CY 2013.....	419
3.4.3.2	Accuracy During CY 2013.....	419
3.4.3.3	Representativeness During CY 2013.....	420
3.4.3.4	Completeness During CY 2013.....	421
3.4.3.5	Comparability During CY 2013.....	423
4.0	<b>References.....</b>	<b>425</b>

## Figures

Figure 1.	Original Landfill Previously Observed Surface Cracking Location and Inclinometer Locations.....	13
Figure 2.	MSPTS Air Stripper Components Showing Typical Clogging.....	17
Figure 3.	ETPTS Air Stripper Components Showing Typical Scaling.....	20
Figure 4.	Rocky Flats Site Water Monitoring Locations and Precipitation Gages in CY 2013.....	27
Figure 5.	Vinyl Chloride Results from Evaluation Well 07391, Illustrating Variations in Detection Limits.....	31
Figure 6.	Effects of Data Replacement on Statistical Trends Calculated for Cr in 2011 at PLF Well 73005.....	31
Figure 7.	POC Monitoring Locations.....	34
Figure 8.	Volume-Weighted 30-Day Average Pu and Am Activities at GS01: CY 2013 Through September 8, 2013.....	37
Figure 9.	Volume-Weighted 30-Day Average Total U Concentrations at GS01: CY 2013 Through September 8, 2013.....	37

Figure 10.	Volume-Weighted 30-Day Average Pu and Am Activities at GS01: Post-Closure Period Through September 8, 2013.....	38
Figure 11.	Volume-Weighted 30-Day Average Total U Concentrations at GS01: Post-Closure Period Through September 8, 2013.....	38
Figure 12.	Volume-Weighted 30-Day Average Pu and Am Activities at GS03: CY 2013 Through September 27, 2013 .....	41
Figure 13.	Volume-Weighted 30-Day Average Total U Concentrations at GS03: CY 2013 Through September 27, 2013 .....	41
Figure 14.	Volume-Weighted 30-Day Average Nitrate+Nitrite as N Concentrations at GS03: CY 2013 Through September 27, 2013.....	42
Figure 15.	Volume-Weighted 30-Day Average Pu and Am Activities at GS03: Post-Closure Period Through September 27, 2013.....	42
Figure 16.	Volume-Weighted 30-Day Average Total U Concentrations at GS03: Post Closure-Period Through September 27, 2013 .....	43
Figure 17.	Volume-Weighted 30-Day Average Nitrate+Nitrite as N Concentrations at GS03: Post-Closure Period Through September 27, 2013 .....	43
Figure 18.	Volume-Weighted 30-Day Average Pu and Am Activities at WOMPOC: Year Ending Fourth Quarter CY 2013 .....	45
Figure 19.	Volume-Weighted 12-Month Rolling Average Pu and Am Activities at WOMPOC: Year Ending Fourth Quarter CY 2013 .....	46
Figure 20.	Volume-Weighted 30-Day Average Total U Concentrations at WOMPOC: Year Ending Fourth Quarter CY 2013 .....	46
Figure 21.	Volume-Weighted 12-Month Rolling Average Total U Concentrations at WOMPOC: Year Ending Fourth Quarter CY 2013 .....	47
Figure 22.	Volume-Weighted 30-Day Average Pu and Am Activities at WALPOC: Year Ending Fourth Quarter CY 2013 .....	49
Figure 23.	Volume-Weighted 12-Month Rolling Average Pu and Am Activities at WALPOC: Year Ending Fourth Quarter CY 2013 .....	49
Figure 24.	Volume-Weighted 30-Day Average Nitrate+Nitrite as N Concentrations at WALPOC: Year Ending Fourth Quarter CY 2013 .....	50
Figure 25.	Volume-Weighted 12-Month Rolling Average Nitrate+Nitrite as N Concentrations at WALPOC: Year Ending Fourth Quarter CY 2013 .....	50
Figure 26.	Volume-Weighted 30-Day Average Total U Concentrations at WALPOC: Year Ending Fourth Quarter CY 2013 .....	51
Figure 27.	Volume-Weighted 12-Month Rolling Average Total U Concentrations at WALPOC: Year Ending Fourth Quarter CY 2013 .....	51
Figure 28.	POE Monitoring Locations .....	55
Figure 29.	Volume-Weighted 12-Month Rolling Average Pu and Am Activities at GS10: Year Ending Fourth Quarter CY 2013 .....	58
Figure 30.	Volume-Weighted 12-Month Rolling Average Pu and Am Activities at GS10: Post-Closure Period.....	58
Figure 31.	Volume-Weighted 12-Month Rolling Average Total U Concentrations at GS10: Year Ending Fourth Quarter CY 2013 .....	59
Figure 32.	Volume-Weighted 12-Month Rolling Average Total U Concentrations at GS10: Post-Closure Period.....	59
Figure 33.	Volume-Weighted Average Metals Compliance Values at GS10: Year Ending Fourth Quarter CY 2013.....	63
Figure 34.	Average Plutonium Activities at Locations Downstream of GS10.....	65

Figure 35.	Average Americium Activities at Locations Downstream of GS10 .....	65
Figure 36.	Evaluation Sampling Location Map for GS10 Drainage Area.....	66
Figure 37.	Location Map for Evaluation Sampling GS10 Drainage Area.....	74
Figure 38.	Average Uranium Concentrations at Locations Downstream of GS10 .....	76
Figure 39.	Volume-Weighted 12-Month Rolling Average Pu and Am Activities at SW027: Year Ending Fourth Quarter CY 2013 .....	81
Figure 40.	Volume-Weighted 12-Month Rolling Average Total U Concentrations at SW027: Year Ending Fourth Quarter CY 2013 .....	81
Figure 41.	Volume-Weighted 12-Month Rolling Average Pu and Am Activities at SW027: Post-Closure Period.....	82
Figure 42.	Volume-Weighted 12-Month Rolling Average Total U Concentrations at SW027: Post-Closure Period.....	82
Figure 43.	Volume-Weighted Average Metals Compliance Values at SW027: Year Ending Fourth Quarter CY 2013.....	83
Figure 44.	Volume-Weighted 12-Month Rolling Average Pu and Am Activities at SW093: Year Ending Fourth Quarter CY 2013 .....	87
Figure 45.	Volume-Weighted 12-Month Rolling Average Total U Concentrations at SW093: Year Ending Fourth Quarter CY 2013 .....	87
Figure 46.	Volume-Weighted 12-Month Rolling Average Pu and Am Activities at SW093: Post-Closure Period.....	88
Figure 47.	Volume-Weighted 12-Month Rolling Average Total U Concentrations at SW093: Post-Closure Period.....	88
Figure 48.	Volume-Weighted Average Metals Compliance Values at SW093: Year Ending Fourth Quarter CY 2013.....	91
Figure 49.	AOC Wells and SW018 Locations.....	93
Figure 50.	Sentinel Well Locations .....	96
Figure 51.	Evaluation Well Locations .....	99
Figure 52.	PLF Monitoring Locations .....	100
Figure 53.	Consistently Detected Constituents Meeting Both ANOVA and Trending Decision Criteria at the PLF Through 2013 .....	104
Figure 54.	OLF Monitoring Locations .....	106
Figure 55.	B and U in Downgradient Groundwater from OLF RCRA Wells Identified in 2013 ANOVA Data Evaluations .....	111
Figure 56.	Calculated S-K Trend Plot for Boron at Downgradient OLF Well 80205.....	111
Figure 57.	RFLMA MSPTS Monitoring Locations.....	114
Figure 58.	RFLMA ETPTS Monitoring Locations .....	115
Figure 59.	RFLMA SPPTS Monitoring Locations .....	117
Figure 60.	PLFTS Monitoring Locations .....	118
Figure 61.	Predischarge Sampling Locations .....	120
Figure 62.	Major Site Drainage Areas—Walnut Creek, Woman Creek, and Rock Creek: End of CY 2013.....	123
Figure 63.	Rocky Flats Site Water Routing Schematic: End of CY 2013.....	124
Figure 64.	Annual Discharge Summary from Major Site Drainages: CY 1997–2013.....	129
Figure 65.	Relative Total Discharge Summary from Major Site Drainages: Pre- and Post-Closure Periods .....	129
Figure 66.	Annual Discharge Summary from COU Drainages: CY 2011–2013 .....	130
Figure 67.	Relative Total Discharge Summary from COU Drainages: CY 2011–2013 .....	130
Figure 68.	Pond Inflows: CY 1997–2013 .....	131

Figure 69.	Pond Outflows: CY 1997–2013 .....	131
Figure 70.	Relative Total Inflow Volumes for Site Ponds: Pre- and Post-Closure Periods .....	132
Figure 71.	Relative Total Outflow Volumes for Site Ponds: Pre- and Post-Closure Periods....	133
Figure 72.	GS01 Drainage Area .....	134
Figure 73.	CY 2013 Mean Daily Hydrograph at GS01: Woman Creek at Indiana Street.....	135
Figure 74.	CY 1997–2013 Mean Daily Hydrograph at GS01: Woman Creek at Indiana Street.....	135
Figure 75.	GS03 Drainage Area .....	136
Figure 76.	CY 2013 Mean Daily Hydrograph at GS03: Walnut Creek at Indiana Street.....	137
Figure 77.	CY 1997–2013 Mean Daily Hydrograph at GS03: Walnut Creek at Indiana Street.....	137
Figure 78.	WOMPOC Drainage Area.....	138
Figure 79.	CY 2013 Mean Daily Hydrograph at WOMPOC: Woman Creek at Eastern COU Boundary.....	139
Figure 80.	CY 2011–2013 Mean Daily Hydrograph at WOMPOC: Woman Creek at Eastern COU Boundary.....	139
Figure 81.	WALPOC Drainage Area.....	140
Figure 82.	CY 2013 Mean Daily Hydrograph at WALPOC: Walnut Creek at Eastern COU Boundary.....	141
Figure 83.	CY 2011–2013 Mean Daily Hydrograph at WALPOC: Walnut Creek at Eastern COU Boundary.....	141
Figure 84.	GS05 Drainage Area .....	142
Figure 85.	CY 2013 Mean Daily Hydrograph at GS05: North Woman Creek at West Fence Line .....	143
Figure 86.	CY 1997–2013 Mean Daily Hydrograph at GS05: North Woman Creek at West Fence Line.....	143
Figure 87.	GS08 Drainage Area .....	144
Figure 88.	CY 2013 Mean Daily Hydrograph at GS08: South Walnut Creek at Pond B-5 Outlet.....	145
Figure 89.	CY 1997–2013 Mean Daily Hydrograph at GS08: South Walnut Creek at Pond B-5 Outlet.....	145
Figure 90.	GS10 Drainage Area .....	146
Figure 91.	CY 2013 Mean Daily Hydrograph at GS10: South Walnut Creek at Former Pond B-1 .....	147
Figure 92.	CY 1997–2013 Mean Daily Hydrograph at GS10: South Walnut Creek at Former Pond B-1 .....	147
Figure 93.	GS11 Drainage Area .....	148
Figure 94.	CY 2013 Mean Daily Hydrograph at GS11: North Walnut Creek at Pond A-4 Outlet.....	149
Figure 95.	CY 1997–2013 Mean Daily Hydrograph at GS11: North Walnut Creek at Pond A-4 Outlet.....	149
Figure 96.	GS12 Drainage Area .....	150
Figure 97.	CY 2013 Mean Daily Hydrograph at GS12: North Walnut Creek at Former Pond A-3 Outlet.....	151
Figure 98.	CY 1997–2013 Mean Daily Hydrograph at GS12: North Walnut Creek at Former Pond A-3 Outlet.....	151
Figure 99.	GS13 Drainage Area .....	152

Figure 100. CY 2013 Mean Daily Hydrograph at GS13: North Walnut Creek at Former Pond A-1.....	153
Figure 101. CY 2005–2013 Mean Daily Hydrograph at GS13: North Walnut Creek at Former Pond A-1.....	153
Figure 102. GS31 Drainage Area.....	154
Figure 103. CY 2013 Mean Daily Hydrograph at GS31: Woman Creek at Pond C-2 Outlet.....	155
Figure 104. CY 1997–2013 Mean Daily Hydrograph at GS31: Woman Creek at Pond C-2 Outlet.....	155
Figure 105. GS33 Drainage Area.....	156
Figure 106. CY 2013 Mean Daily Hydrograph at GS33: No Name Gulch at Walnut Creek.....	157
Figure 107. CY 1997–2013 Mean Daily Hydrograph at GS33: No Name Gulch at Walnut Creek.....	157
Figure 108. GS51 Drainage Area.....	158
Figure 109. CY 2013 Mean Daily Hydrograph at GS51: Ditch South of 903 Pad.....	159
Figure 110. CY 2001–2013 Mean Daily Hydrograph at GS51: Ditch South of 903 Pad.....	159
Figure 111. GS59 Drainage Area.....	160
Figure 112. CY 2013 Mean Daily Hydrograph at GS59: Woman Creek Upstream of Antelope Springs Confluence.....	161
Figure 113. CY 2002–2013 Mean Daily Hydrograph at GS59: Woman Creek Upstream of Antelope Springs Confluence.....	161
Figure 114. B5INFLOW Drainage Area.....	162
Figure 115. CY 2013 Mean Daily Hydrograph at B5INFLOW: South Walnut Creek Above Pond B-5.....	163
Figure 116. CY 2010–2013 Mean Daily Hydrograph at B5INFLOW: South Walnut Creek Above Pond B-5.....	163
Figure 117. SW018 Drainage Area.....	164
Figure 118. CY 2013 Mean Daily Hydrograph at SW018: FC-2 at FC-2 Wetland.....	165
Figure 119. CY 2003–2013 Mean Daily Hydrograph at SW018: FC-2 at FC-2 Wetland.....	165
Figure 120. SW027 Drainage Area.....	166
Figure 121. CY 2013 Mean Daily Hydrograph at SW027: SID at Pond C-2.....	167
Figure 122. CY 1997–2013 Mean Daily Hydrograph at SW027: SID at Pond C-2.....	167
Figure 123. SW093 Drainage Area.....	168
Figure 124. CY 2013 Mean Daily Hydrograph at SW093: North Walnut Creek Upstream of former Pond A-1 Bypass.....	169
Figure 125. CY 1997–2013 Mean Daily Hydrograph at SW093: North Walnut Creek Upstream of former Pond A-1 Bypass.....	169
Figure 126. Site Precipitation Gages: CY 2013.....	170
Figure 127. Annual Total Precipitation for CY 1997–2013.....	171
Figure 128. Average Monthly Precipitation for CY 1997–2013.....	171
Figure 129. Relative Monthly Precipitation Totals for CY 1997–2013.....	172
Figure 130. Monthly Precipitation for CY 2013.....	172
Figure 131. Relative Monthly Precipitation Volumes for CY 2013.....	173
Figure 132. Daily Precipitation Totals for CY 2013.....	173
Figure 133. UHSU Potentiometric Contours: Second Quarter CY 2013.....	177
Figure 134. UHSU Potentiometric Contours: Fourth Quarter CY 2013.....	178
Figure 135. Example Hydrographs Showing Strong Response to September, 2013 Rains.....	180
Figure 136. Example Hydrographs Showing Minimal Response to September, 2013 Rains.....	180
Figure 137. Example Hydrographs Showing Seasonal Patterns.....	181

Figure 138. Seeps and Wet Areas Observed in 2013 .....	189
Figure 139. Median Pu-239, 240 Activities for CY 1997—October 13, 2005.....	193
Figure 140. Post-Closure Median Pu-239, 240 Activities .....	194
Figure 141. Median Am-241 Activities for CY 1997—October 13, 2005.....	196
Figure 142. Post-Closure Median Am-241 Activities .....	197
Figure 143. Median Total U Concentrations for CY 1997—October 13, 2005 .....	199
Figure 144. Post-Closure Median Total U Concentrations.....	200
Figure 145. Post-Closure Median Nitrate+Nitrite as Nitrogen Concentrations.....	202
Figure 146. Average Pu/Am Ratios for CY 1997—October 13, 2005 .....	204
Figure 147. Post-Closure Average Pu/Am Ratios .....	205
Figure 148. Relative Average Annual Pu Loading Schematic: CY 1997–2005 .....	210
Figure 149. Relative Average Annual Pu Loading Schematic: CY 2006–2013 .....	211
Figure 150. Relative Average Annual Am Loading Schematic: CY 1997–2005.....	212
Figure 151. Relative Average Annual Am Loading Schematic: CY 2006–2013.....	213
Figure 152. Relative Average Annual Total U Loading Schematic: CY 2003–2005 .....	214
Figure 153. Relative Average Annual Total U Loading Schematic: CY 2006–2013 .....	215
Figure 154. Combined Annual Pu and Am Loads from Walnut and Woman Creeks at Indiana Street: CY 1997–2013 .....	216
Figure 155. Annual Pu Loads from Walnut and Woman Creeks at Indiana Street: CY 1997–2013 .....	217
Figure 156. Relative Average Annual Pu Load Totals from Walnut and Woman Creeks at Indiana Street.....	217
Figure 157. Annual Am Loads from Walnut and Woman Creeks at Indiana Street: CY 1997–2013 .....	218
Figure 158. Relative Average Annual Am Load Totals from Walnut and Woman Creeks at Indiana Street.....	218
Figure 159. Annual Total U Loads from Walnut and Woman Creeks at Indiana Street: CY 2003–2013 .....	219
Figure 160. Relative Average Annual Total U Load Totals from Walnut and Woman Creeks at Indiana Street.....	220
Figure 161. Combined Annual Pu and Am Loads from Walnut and Woman Creeks at Site Boundary: CY 2011–2013.....	221
Figure 162. Annual Pu Loads from Walnut and Woman Creeks at Site Boundary: CY 2011–2013 .....	221
Figure 163. Annual Am Loads from Walnut and Woman Creeks at Site Boundary: CY 2011–2013 .....	222
Figure 164. Annual Total U Loads from Walnut and Woman Creeks at Site Boundary: CY 2011–2013 .....	222
Figure 165. Annual Pu and Am Loads at GS03: CY 1997–2013.....	225
Figure 166. Annual Pu Loads at GS03, GS08, and GS11: CY 1997–2013.....	225
Figure 167. Annual Pu Loads at GS03, WALPOC, GS08, and GS11: CY 2011–2013.....	226
Figure 168. Relative Average Annual Pu Load Totals at GS03, GS08, and GS11 .....	227
Figure 169. Annual Am Loads at GS03, GS08, and GS11: CY 1997–2013.....	228
Figure 170. Annual Am Loads at GS03, WALPOC, GS08, and GS11: CY 2011–2013 .....	228
Figure 171. Relative Average Annual Am Load Totals at GS03, GS08, and GS11 .....	229
Figure 172. Annual Total U Loads at GS03, GS08, and GS11: CY 2003–2013 .....	230
Figure 173. Annual Total U Loads at GS03, WALPOC, GS08, and GS11: CY 2011–2013.....	231
Figure 174. Relative Average Annual Total U Load Totals at GS03, GS08, and GS11 .....	232

Figure 175. Annual Pu and Am Loads at GS01: CY 1997–2013.....	234
Figure 176. Annual Pu Loads at GS01 and GS31: CY 1997–2013.....	235
Figure 177. Annual Pu Loads at GS01, WOMPOC, and GS31: CY 2011–2013.....	235
Figure 178. Relative Average Annual Pu Load Totals at GS01 and GS31.....	236
Figure 179. Annual Am Loads at GS01 and GS31: CY 1997–2013.....	237
Figure 180. Annual Am Loads at GS01, WOMPOC, and GS31: CY 2011–2013.....	237
Figure 181. Relative Average Annual Am Load Totals at GS01 and GS31.....	238
Figure 182. Annual Total U Loads at GS01 and GS31: CY 2003–2013.....	239
Figure 183. Annual Total U Loads at GS01, WOMPOC, and GS31: CY 2011–2013.....	239
Figure 184. Relative Average Annual Total U Load Totals at GS01 and GS31.....	240
Figure 185. Annual Pu Loads for the A- and B-Series Ponds: CY 1997–2013.....	242
Figure 186. Relative Average Annual Pu Load Totals for the A- and B-Series Ponds.....	243
Figure 187. Annual Am Loads for the A- and B-Series Ponds: CY 1997–2013.....	244
Figure 188. Relative Average Annual Am Load Totals for the A- and B-Series Ponds.....	245
Figure 189. Relative Average Annual Total U Loading Schematic for the A- and B-Series Ponds: CY 1997–2005.....	246
Figure 190. Relative Average Annual Total U Loading Schematic for the A- and B-Series Ponds: CY 2006–2013.....	247
Figure 191. Annual Total U Loads for the A- and B-Series Ponds: CY 1997–2013.....	248
Figure 192. Relative Average× Annual Total U Load Totals for the A- and B-Series Ponds.....	249
Figure 193. Annual Pu Loads for Pond C-2: CY 1997–2013.....	251
Figure 194. Relative Average Annual Pu Load Totals for Pond C-2.....	251
Figure 195. Annual Am Loads for Pond C-2: CY 1997–2013.....	252
Figure 196. Relative Average Annual Am Load Totals for Pond C-2.....	253
Figure 197. Relative Average Annual U Loading Schematic for Pond C-2: CY 1997–2005.....	255
Figure 198. Relative Average Annual U Loading Schematic for Pond C-2: CY 2006–2013.....	256
Figure 199. Annual Total U Loads for Pond C-2: CY 1997–2013.....	257
Figure 200. Relative Average Annual Total U Load Totals for Pond C-2.....	257
Figure 201. Combined Annual Pu Loads from Former IA Drainages: CY 1997–2013.....	259
Figure 202. Relative Average Annual Pu Load Totals from Former IA Drainages and WWTP.....	260
Figure 203. Annual Am Loads from Former IA Drainages and WWTP: CY 1997–2013.....	260
Figure 204. Relative Average Annual Am Load Totals from Former IA Drainages and WWTP.....	261
Figure 205. Annual Pu and Am Loads at GS10: CY 1997–2013.....	261
Figure 206. Annual Pu and Am Loads at the WWTP: CY 1997–2013.....	262
Figure 207. Annual Pu and Am Loads at SW027: CY 1997–2013.....	262
Figure 208. Annual Pu and Am Loads at SW093: CY 1997–2013.....	263
Figure 209. Annual Total U Loads from Former IA Drainages and WWTP: CY 1997–2013.....	264
Figure 210. Relative Average Annual Total U Loads from Former IA Drainages and WWTP.....	264
Figure 211. Primary VOCs in OBP #2 Source Area Well 91105 (and Predecessors).....	281
Figure 212. Selected VOCs at Mound/OBP #2 Area Wells 91105 and 91203 and MSPTS Influent.....	283
Figure 213. Selected VOCs at Sentinel Well 91203.....	284
Figure 214. Concentrations of Selected VOCs in Samples from Sentinel Well 15699 and MSPTS Influent.....	285
Figure 215. Hydrograph for MSPTS from 2000 Through 2013.....	288
Figure 216. Hydrograph for MSPTS for CY 2013.....	288

Figure 217. Total VOCs in MSPTS Influent and Effluent, 2000 Through 2013 .....	289
Figure 218. Concentrations of Primary VOCs in MSPTS Influent .....	293
Figure 219. Photographs of MSPTS Air Stripper Upgrades Completed in 2013 .....	297
Figure 220. Concentrations of Total Detected VOCs at MSPTS Locations .....	298
Figure 221. Most Commonly Detected VOCs in Sentinel Wells Downgradient of the ETPTS .....	302
Figure 222. Water Levels in Ponds B-1, B-2, and B-3, 1992 Through 2013 .....	304
Figure 223. Concentrations of Uranium in Samples from Well 23296 .....	304
Figure 224. Hydrograph for ETPTS from 2000 Through 2013 .....	307
Figure 225. Hydrograph for ETPTS for CY 2013 .....	307
Figure 226. TCE in ETPTS Influent and Effluent .....	312
Figure 227. Total VOCs in ETPTS Influent and Effluent .....	314
Figure 228. Cis-1,2-DCE in ETPTS Influent and Effluent .....	315
Figure 229. Photographs of ETPTS Air Stripper Features .....	319
Figure 230. Effect of ETPTS Air Stripper on VOC Concentrations .....	320
Figure 231. Effect of ETPTS Air Stripper and Related Optimizations on VOC Concentrations .....	321
Figure 232. Concentrations of Nitrate in SPP Source-Area Evaluation Wells .....	326
Figure 233. Concentrations of Uranium in SPP Source-Area Evaluation Wells .....	328
Figure 234. Nitrate and Uranium Concentrations in Wells Downgradient of the Former SEPs .....	330
Figure 235. Primary VOCs in SEP VOC Plume Wells .....	332
Figure 236. Hydrograph for SPPTS from 2000 Through 2013 .....	335
Figure 237. Hydrograph for SPPTS for CY 2013 .....	335
Figure 238. Concentrations of Nitrate at Selected SPPTS Monitoring Locations .....	338
Figure 239. Concentrations of Uranium at Selected SPPTS Monitoring Locations .....	339
Figure 240. Overview of Microcell Design Components .....	341
Figure 241. Example Microcell Uranium Treatment Performance Charts .....	345
Figure 242. Overall Treatment Performance of SPPTS Phase III Pilot-Scale Lagoons .....	347
Figure 243. Charts of Various Parameters in SPPTS Phase III Lagoons .....	348
Figure 244. Primary VOCs in Ryan’s Pit Plume Source Area Well 07391 .....	352
Figure 245. Concentrations of Uranium at Ryan’s Pit Evaluation Well 07391 .....	353
Figure 246. Primary VOCs in 903 Pad/Ryan’s Pit Plume Sentinel Well 90399 .....	354
Figure 247. Concentrations of VOCs in South IA Plume Evaluation Well 40005 .....	356
Figure 248. Primary VOCs in the VC Plume Evaluation and Sentinel Wells .....	359
Figure 249. Chlorinated Benzene Compounds in Samples from VC Plume Evaluation Wells .....	360
Figure 250. Chlorinated Compounds in Samples from VC Plume Sentinel Well 33711 .....	361
Figure 251. Concentrations of VOCs in the IHSS 118.1 Plume .....	363
Figure 252. U in Groundwater Along North Side of Former B771 .....	365
Figure 253. Concentrations of Primary PU&D Yard Plume VOCs in Upgradient PLF RCRA Wells .....	366
Figure 254. Concentrations of Nitrate and U in Groundwater Samples from AOC Well B206989 .....	368
Figure 255. Concentrations of Primary VOCs in B991-Area Groundwater .....	370
Figure 256. Concentrations of U in B991 Sentinel Wells .....	371
Figure 257. Concentrations of VOCs in Sentinel Well 45608, South of Former B991 .....	374
Figure 258. Concentrations of Uranium in Samples from Sentinel Well 91305 .....	375
Figure 259. 2013 Diffuse Knapweed ( <i>Centaurea diffusa</i> ) Distribution at Rocky Flats .....	383
Figure 260. 2013 Dalmation Toadflax ( <i>Linaria dalmatica</i> ) Distribution at Rocky Flats .....	384

Figure 261. 2013 Herbicide Application Locations at the Rocky Flats Site .....	387
Figure 262. 2013 Revegetation, Interseeding, and Planting Locations .....	388
Figure 263. D-2 Parcel Road Revegetation Project.....	389
Figure 264. Forb Nursery Monitoring Locations.....	393
Figure 265. 2013 Revegetation Monitoring Locations.....	395
Figure 266. Prairie Dog Town Locations Within or Near the Central Operable Unit at Rocky Flats.....	403
Figure 267. Rocky Flats Site Nest Box Locations.....	404
Figure 268. Rocky Flats Site 2013 Wetland Mitigation Monitoring Locations .....	411

## Tables

Table 1. Status of RFLMA Contact Records.....	7
Table 2. Hypothetical Example Illustrating Effects of Detection Limits and Data Replacement on Statistical Calculations .....	32
Table 3. U Isotope Conversion Factors Used in Groundwater Evaluations.....	32
Table 4. Sampling and Data Evaluation Protocols at POCs.....	34
Table 5. September 2013 Composite Sampling Detail for POC GS03 .....	35
Table 6. Annual Volume-Weighted Average Radionuclide Activities at GS01 for 1997–2013 .....	36
Table 7. September 2013 Composite Sampling Detail for POC GS03.....	39
Table 8. Annual Volume-Weighted Average Radionuclide Activities and Nitrate+Nitrite as Nitrogen Concentrations at GS03 for 1997–2013.....	40
Table 9. September 2013 Composite Sampling Detail for POC WOMPOC.....	44
Table 10. Annual Volume-Weighted Average Radionuclide Activities at WOMPOC for 2011–2013 .....	45
Table 11. September 2013 Composite Sampling Detail for POC WALPOC .....	48
Table 12. Annual Volume-Weighted Average Radionuclide Activities and Nitrate+Nitrite as Nitrogen Concentrations at WALPOC for 2011–2013.....	48
Table 13. CYs 2013–2014 Composite Sampling Results at WALPOC.....	54
Table 14. Sampling and Data Evaluation Protocols at POEs.....	55
Table 15. September 2013 Composite Sampling Detail for POE GS10 .....	56
Table 16. Annual Volume-Weighted Average Radionuclide Activities at GS10 for 1997–2013 .....	57
Table 17. CY 2012–2014 Composite Sampling Results at GS10.....	60
Table 18. Annual Volume-Weighted Average Hardness and Metals Concentrations at GS10 for 1997–2013 .....	61
Table 19. Recent Plutonium and Americium Flow-Paced Composite Sample Results .....	62
Table 20. Grab Sampling Results Upstream of GS10: November 25, 2011 .....	67
Table 21. Americium Grab Sampling Results for SEEP995 Locations (pCi/L).....	68
Table 22. Plutonium Grab Sampling Results for SEEP995 Locations (pCi/L) .....	69
Table 23. Uranium Grab Sampling Results for SEEP995 Locations (µg/L) .....	69
Table 24. Filtered Results for SEEP995A.....	70
Table 25. Grab Sampling Results in FC-4 Upstream of GS10: March 6, 2012 .....	70
Table 26. Americium, Plutonium, and Uranium Grab Sampling Results for FC-4 Locations (pCi/L).....	71
Table 27. Results for Filtered and Unfiltered Composite Sample Pairs at GS10.....	72

Table 28.	Results for Time-Paced Composites at GS10 and FC4997: May 22–28, 2012 .....	73
Table 29.	Results for Time-Paced Composites at GS10, FC4997, and FC4991: April 22–25, 2013.....	73
Table 30.	Recent Uranium Flow-Paced Composite Sample Results .....	75
Table 31.	Summary of Biweekly Uranium Grab Sampling in South Walnut Creek .....	77
Table 32.	Summary of High-Resolution Isotopic Uranium Results for Locations Related to GS10.....	77
Table 33.	September 2013 Composite Sampling Detail for POE SW027 .....	79
Table 34.	Annual Volume-Weighted Average Radionuclide Activities at SW027 for 1997–2013 .....	80
Table 35.	Annual Volume-Weighted Average Hardness and Metals Concentrations at SW027 for 1997–2013 .....	85
Table 36.	September 2013 Composite Sampling Detail for POE SW093 .....	86
Table 37.	Annual Volume-Weighted Average Radionuclide Activities at SW093 for 1997–2013 .....	86
Table 38.	Annual Volume-Weighted Average Hardness and Metals Concentrations at SW093 for 1997–2013 .....	89
Table 39.	Sampling and Data Evaluation Protocols at AOC Wells and SW018 .....	90
Table 40.	Sampling and Data Evaluation Protocols at Sentinel Wells.....	94
Table 41.	Sampling and Data Evaluation Protocols at Evaluation Wells .....	97
Table 42.	Sampling and Data Evaluation Protocols at PLF RCRA Monitoring Wells.....	100
Table 43.	RCRA Groundwater Sampling Performed in 2013 at the PLF .....	101
Table 44.	Results of Groundwater ANOVA Evaluation for 2013 at the PLF.....	102
Table 45.	Results of Groundwater S-K Trend Testing for 2013 at the PLF Downgradient Wells.....	103
Table 46.	Sampling and Data Evaluation Protocols at OLF Surface-Water Monitoring Locations .....	107
Table 47.	Sampling and Data Evaluation Protocols at OLF RCRA Monitoring Wells .....	107
Table 48.	RCRA Groundwater Sampling Performed in 2013 at the OLF .....	108
Table 49.	Results of Groundwater ANOVA Evaluation for 2013 at the OLF .....	109
Table 50.	Results of Groundwater S-K Trend Testing for 2013 at OLF Downgradient Wells .....	109
Table 51.	VOCs and SVOCs Detected in 2013 at Downgradient Wells at the OLF .....	112
Table 52.	RFLMA Sampling and Data Evaluation Protocols at MSPTS Monitoring Locations .....	114
Table 53.	RFLMA Sampling and Data Evaluation Protocols at ETPTS Monitoring Locations .....	115
Table 54.	RFLMA Sampling and Data Evaluation Protocols at SPPTS Monitoring Locations .....	116
Table 55.	Sampling and Data Evaluation Protocols at PLFPTS Monitoring Locations .....	119
Table 56.	Sampling and Data Evaluation Protocols at Predischarge Monitoring Locations ...	120
Table 57.	Monitoring Network Precipitation Gage Information.....	170
Table 58.	Total CY 2013 Monthly Precipitation Data for the Site .....	179
Table 59.	Precipitation in CY 2013 by Quarter, Compared with Average Precipitation by Quarter.....	179
Table 60.	Calculated Flow Velocities for 2013.....	183
Table 61.	Pre-Closure Summary Statistics for Pu-239, 240 Analytical Results (January 1, 1997– October 13, 2005).....	192

Table 62.	Post-Closure Summary Statistics for Pu-239, 240 Analytical Results (October 13, 2005–December 31, 2013).....	192
Table 63.	Pre-Closure Summary Statistics for Am-241 Analytical Results (January 1, 1997–October 13, 2005).....	195
Table 64.	Post-Closure Summary Statistics for Am-241 Analytical Results (October 13, 2005–December 31, 2013).....	195
Table 65.	Pre-Closure Summary Statistics for Total U Analytical Results (January 1, 1997–October 13, 2005).....	198
Table 66.	Post-Closure Summary Statistics for Total U Analytical Results (October 13, 2005–December 31, 2013).....	198
Table 67.	Post-Closure Summary Statistics for Nitrate+Nitrite as Nitrogen Analytical Results (October 13, 2005–December 31, 2013).....	201
Table 68.	Pre-Closure Average Pu/Am Ratios for Analytical Results (January 1, 1997–October 13, 2005).....	201
Table 69.	Post-Closure Average Pu/Am Ratios for Analytical Results (October 13, 2005– December 31, 2013).....	203
Table 70.	Pre-Closure Summary Statistics for POE Metals Results from GS10 (January 1, 1997–October 13, 2005).....	203
Table 71.	Post-Closure Summary Statistics for POE Metals Results from GS10 (October 13, 2005–December 31, 2013).....	206
Table 72.	Pre-Closure Summary Statistics for POE Metals Results from SW027 (January 1, 1997–October 13, 2005).....	206
Table 73.	Post-Closure Summary Statistics for POE Metals Results from SW027 (October 13, 2005–December 31, 2013).....	206
Table 74.	Pre-Closure Summary Statistics for POE Metals Results from SW093 (January 1, 1997–October 13, 2005).....	206
Table 75.	Post-Closure Summary Statistics for POE Metals Results from SW093 (October 13, 2005–December 31, 2012).....	206
Table 76.	Activity to Mass Conversion Factors for Pu, Am, and U Isotopes.....	208
Table 77.	Pu and Am Loads from Walnut and Woman Creeks at Indiana Street: CY 1997–2013.....	216
Table 78.	Total U Loads from Walnut and Woman Creeks at Indiana Street: CY 2003–2013.....	219
Table 79.	Offsite Pu and Am Loads from Walnut and Woman Creeks at Site Boundary: CY 2011–2013.....	220
Table 80.	Total U Loads from Walnut and Woman Creeks at Site Boundary: CY 2011–2013.....	222
Table 81.	Pu Loads at GS03, GS08, and GS11: CY 1997–2013.....	224
Table 82.	Am Loads at GS03, GS08, and GS11: CY 1997–2013.....	224
Table 83.	Total U Loads at GS03, GS08, and GS11: CY 2003–2013.....	230
Table 84.	Pu Loads at GS01, WOMPOC, and GS31: CY 1997–2013.....	233
Table 85.	Am Loads at GS01, WOMPOC, and GS31: CY 1997–2013.....	234
Table 86.	Total U Loads at GS01, WOMPOC, and GS31: CY 2003–2013.....	238
Table 87.	Pu Load Summary for the A- and B-Series Ponds: CY 1997–2013.....	242
Table 88.	Am Load Summary for the A- and B-Series Ponds: CY 1997–2013.....	244
Table 89.	Total U Load Summary for the A- and B-Series Ponds: CY 1997–2013.....	248
Table 90.	Pu Load Summary for Terminal Pond C-2: CY 1997–2013.....	250
Table 91.	Am Load Summary for Terminal Pond C-2: CY 1997–2013.....	252

Table 92.	Total U Load Summary for Terminal Pond C-2: CY 1997–2013.....	254
Table 93.	Former IA Drainage Pu and Am Loads: CY 1997–2013.....	259
Table 94.	Former IA Total U Loads: CY 1997–2013.....	263
Table 95.	RFLMA Monitoring Classifications for the Groundwater Monitoring Network.....	265
Table 96.	Summary of Scheduled RFLMA-Required Groundwater Sampling in CY 2013 (by Quarter).....	266
Table 97.	Summary of RFLMA-Required Groundwater Samples Not Successfully Collected in 2013 (by Quarter).....	267
Table 98.	Summary of Non-RFLMA-Required Groundwater Samples Collected in CY 2013 (by Quarter).....	269
Table 99.	Summary of Statistical Trend Calculations Through 2013 by Location.....	273
Table 100.	Estimated Volumes of Water Treated by the MSPTS.....	287
Table 101.	Average Volumes Treated by the MSPTS.....	287
Table 102.	Summary of VOC Data (µg/L) for MSPTS Influent and Effluent.....	291
Table 103.	Average Contaminant Concentrations in MSPTS Influent, Pre- vs. Post-Closure, in µg/L.....	294
Table 104.	Summary of VOCs Detected in 2013 at GS10.....	295
Table 105.	Estimated Volumes of Water Treated by the ETPTS.....	306
Table 106.	Average Volumes Treated by the ETPTS.....	306
Table 107.	Summary of VOC Data (µg/L) for ETPTS Influent and Effluent.....	309
Table 108.	Estimated Volumes of Water Treated by the SPPTS.....	334
Table 109.	Average Volumes Treated by the SPPTS.....	336
Table 110.	Summary of SPPTS Construction and Upgrades.....	337
Table 111.	Summary of Microcell Designs Tested in 2013.....	342
Table 112.	Summary of LBNL High-Resolution Uranium Isotopic Results for Samples Collected in 2011–Spring 2013.....	378
Table 113.	Summary of LBNL High-Resolution Uranium Isotopic Results for Samples Collected Later in 2013.....	379
Table 114.	COU Noxious Weed Acreage Summary (2007–2013).....	382
Table 115.	FY 2013 Herbicide Application Summary.....	385
Table 116.	2013 Revegetation Location Summary.....	386
Table 117.	Forb Nursery Abundance Summary 2010–2013.....	394
Table 118.	Evaluation of Successional Changes in Plant Community Composition at Revegetation Locations.....	399
Table 119.	Bluebird Nest Box Summary 2013.....	402
Table 120.	Wetland Impacts From CERCLA Projects at Rocky Flats.....	406
Table 121.	Engineered Mitigation Wetlands at Rocky Flats Used for CERCLA Mitigation.....	406
Table 122.	Wetland Impacts From USACE Permitted Projects At Rocky Flats.....	407
Table 123.	Engineered Mitigation Wetlands at Rocky Flats used for USACE Permitted Project Mitigation.....	408
Table 124.	Naturally Occurring (Non-Engineered) Wetlands in the COU at Rocky Flats.....	409
Table 125.	CY 2013 Sample Type Breakdown.....	418
Table 126.	Summary of DER Values.....	419
Table 127.	Summary of RPD Values.....	419
Table 128.	Summary of MS and MSD Recovery Data.....	420
Table 129.	Summary of V&V Data Completeness.....	422
Table 130.	Summary of Field QC Samples (DUPs) and Data Records.....	422
Table 131.	Summary of Field QC Samples (RNSs) and Data Records.....	423

## Appendixes

- Appendix A Hydrologic Data
- Appendix B Water-Quality Data
- Appendix C Landfill Inspection Forms—Fourth Quarter CY 2013
- Appendix D Data Evaluation Flowcharts Reproduced from RFLMA and the RFSOG
- Appendix E *Technical Memorandum Regarding Instrumentation and Monitoring at the Rocky Flats OLF*
- Appendix F *Technical Memorandum on OLF Berm Height Evaluation Using Site-Specific Data*
- Appendix G U Isotopic Compositions and Concentrations of Rocky Flats Water Samples Submitted to LBNL
- Appendix H 2013 RFLMA Contact Records

### **Available on DVD:**

Ecology DVD: 2013 Annual RFS Ecology Reports

## Abbreviations

Ag	silver
Am	americium
ANOVA	Analysis of Variance
AOC	Area of Concern
B	boron
Be	beryllium
BMP	best management practice
Ca	calcium
CAD/ROD	Corrective Action Decision/Record of Decision
Cd	cadmium
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (also known as “Superfund”)
CFR	<i>Code of Federal Regulations</i>
cfs	cubic feet per second
COU	Central Operable Unit
Cr	chromium
Cu	copper
CY	calendar year
DCB	dichlorobenzene
DCE	dichloroethene
DER	duplicate error ratio
DNAPL	dense nonaqueous-phase liquid
DO	dissolved oxygen
DOC	dissolved organic carbon
DOE	U.S. Department of Energy
DQA	data quality assessment
DUP	duplicate sample
EPA	U.S. Environmental Protection Agency
ERP	<i>Emergency Response Plan for Rocky Flats Site Dams</i>
ESL	Environmental Sciences Laboratory
ET	evapotranspiration
ETPTS	East Trenches Plume Treatment System
FC	Functional Channel
FR	<i>Federal Register</i>
ft/yr	feet per year
GIS	geographic information system
gpd	gallons per day

gpm	gallons per minute
GWIS	Groundwater Intercept System
HRC	Hydrogen Release Compound
HRT	hydraulic residence time
IA	Industrial Area
IC	institutional control
IHSS	Individual Hazardous Substance Site
IMP	Integrated Monitoring Plan
ITSS	Intercept Trench System Sump
J	For sampling data, a laboratory and/or validation qualifier that indicates an estimated value.
K-H	Kaiser-Hill Company LLC
L	liters
LANL	Los Alamos National Laboratory
LBNL	Lawrence Berkeley National Laboratory
LCS	laboratory control sample
LM	Office of Legacy Management
M&M	monitoring and maintenance
M-K	Mann-Kendall
MCL	maximum contaminant level
µg	micrograms
µg/L	micrograms per liter (sometimes expressed as ug/L)
mg/L	milligrams per liter
MS	matrix spike
MSD	matrix spike duplicate
MSPTS	Mound Site Plume Treatment System
N	nitrogen
Ni	nickel
NOIPD	Notice of Intent for Partial Deletion
NPL	National Priorities List
OBP	Oil Burn Pit
OLF	Original Landfill
OU	Operable Unit
PARCC	precision, accuracy, representativeness, completeness, and comparability
PBA	Programmatic Biological Assessment
PCE	tetrachloroethene
pCi	picocuries
pCi/L	picocuries per liter
PIP	Public Involvement Plan
PLF	Present Landfill

PLFTS	Present Landfill Treatment System
POC	Point of Compliance
POE	Point of Evaluation
POU	Peripheral Operable Unit
PQL	practical quantitation limit
Pu	plutonium
PU&D	Property Utilization and Disposal
QA	quality assurance
QC	quality control
R	For sampling data, a laboratory and/or validation qualifier that indicates a value rejected as unusable.
RCRA	Resource Conservation and Recovery Act
Refuge	Rocky Flats National Wildlife Refuge
RER	relative error ratio
RFCA	<i>Rocky Flats Cleanup Agreement</i>
RFETS	Rocky Flats Environmental Technology Site
RFLMA	<i>Rocky Flats Legacy Management Agreement</i>
RFSOG	<i>Rocky Flats, Colorado, Site, Site Operations Guide</i>
RNS	rinsate sample
RPD	relative percent difference
S-K	Seasonal-Kendall
Se	selenium
SED	Sitewide Ecological Database
SEEP	Site Environmental Evaluation for Projects
SEP	Solar Evaporation Pond
SID	South Interceptor Ditch
SPP	Solar Ponds Plume
SPPTS	Solar Ponds Plume Treatment System
STP	Sewage Treatment Plant
SVOC	semivolatile organic compound
TCA	trichloroethane
TCB	trichlorobenzene
TCE	trichloroethene
TOC	total organic carbon
U	uranium
U	For sampling data, a laboratory and/or validation qualifier that indicates an analyte not detected at the indicated concentration.
UHSU	upper hydrostratigraphic unit
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service

V&V	validation and verification
VC	vinyl chloride
VOC	volatile organic compound
WQP	water quality parameter
WWTP	Wastewater Treatment Plant
Zn	zinc
ZVI	zero-valent iron

This page intentionally left blank

## Executive Summary

The U.S. Department of Energy (DOE) Office of Legacy Management (LM) is responsible for implementing the final response action selected in the *Final Corrective Action Decision/Record of Decision for Rocky Flats Plant (USDOE) Peripheral Operable Unit and Central Operable Unit (CAD/ROD)* issued September 29, 2006, for the Rocky Flats, Colorado, Site (Site).

Under the CAD/ROD, two Operable Units were established within the boundaries of the Rocky Flats property: the Peripheral Operable Unit (POU) and the Central Operable Unit (COU). The COU consolidates all areas of the Site that require additional remedial or corrective actions while also considering practicalities of future land management. The POU includes the remaining, generally unimpacted portions of the Site and surrounds the COU. The response action in the Final CAD/ROD is no action for the POU and institutional and physical controls with continued monitoring for the COU. The CAD/ROD determined that conditions in the POU were suitable for unrestricted use. The U.S. Environmental Protection Agency (EPA) subsequently published a Notice of Partial Deletion from the National Priorities List for the POU on May 25, 2007.

DOE, EPA, and the Colorado Department of Public Health and Environment (CDPHE) have chosen to implement the monitoring and maintenance requirements of the CAD/ROD under, and as described in, the *Rocky Flats Legacy Management Agreement (RFLMA)*, executed March 14, 2007. RFLMA Attachment 2 defines the COU remedy surveillance and maintenance requirements. The requirements include environmental monitoring; maintenance of the erosion controls, access controls (signs), landfill covers, and groundwater treatment systems; and operation of the groundwater treatment systems.

LM prepared and continually updates the *Rocky Flats, Colorado, Site, Site Operations Guide* (DOE 2013e). It is the primary document to guide work performed to satisfy the requirements of RFLMA and to implement best management practices at the Site.

This report addresses all surveillance and maintenance activities conducted at the Site during calendar year (CY) 2013 (January 1 through December 31, 2013). Highlights of the surveillance and maintenance activities are as follows:

- RFLMA references the use of contact records to document CDPHE approvals of field modifications to implement approved response actions. RFLMA Attachment 2 references the use of contact records to document the outcome of consultation related to addressing any reportable conditions. This report discusses the three RFLMA contact records issued in 2013 and the contact record status as of December 31, 2013.
- Inclinometers were installed at the Original Landfill (OLF) as part of the 2008 geotechnical investigation to address localized slumping and settling of the OLF cover observed in 2007. The localized instability is caused by the weakening of one or more soil layers in the shallow subsurface due to moisture in these layers. To address these conditions, filling and grading to recontour some sideslopes and to minimize and remove subsurface moisture was completed in 2009. This annual report includes the annual review of the inclinometer data by a qualified geotechnical engineer. The data indicate that movement at the OLF is exacerbated by precipitation events and elevated water levels, as seen in September due to the heavy precipitation. While the large-scale, overall OLF slope is stable, localized failures have occurred on the landfill under elevated water level conditions. Continued monitoring

and routine maintenance of the OLF cover are recommended. Localized cracking and subsidence in the northeast portion of the OLF were observed after the September heavy precipitation event. Cracks were filled to minimize infiltration of additional precipitation and a temporary drain was installed to reduce ponding in the new subsidence area. The displaced section of berm 4 will be repaired in summer 2014. Design has been completed for a 2014 project to recontour sideslopes in the East Perimeter Channel to increase slope stability in that area. Berm-height criteria were re-defined based on the observed performance of the berm channels during the September heavy precipitation event.

- Reportable 30-day average uranium concentrations were observed starting on December 18, 2013, in surface water at RFLMA Point of Compliance (POC) monitoring station WALPOC, which is located on Walnut Creek at the eastern COU boundary. Validated results were received on February 3, 2014, and notification to the regulatory agencies and the public—in accordance with RFLMA Attachment 2, Figure 6—was made by e-mail on February 13, 2014. Representatives of the regulatory agencies and DOE met on February 18, 2014, to discuss the observations and develop a path forward.

RFLMA Contact Record 2014-05, “Reportable condition for evaluation purposes for uranium at point of compliance WALPOC,” provides a discussion of the monitoring results and recaps the outcome of the RFLMA Parties consultation regarding the evaluation steps to be taken. This contact record is available on the Rocky Flats website, [http://www.lm.doe.gov/Rocky\\_Flats/ContactRecords.aspx](http://www.lm.doe.gov/Rocky_Flats/ContactRecords.aspx).

- All other POC analyte concentrations/activities remained below reporting levels throughout CY 2013.
- Reportable 12-month rolling average uranium concentrations continued to be observed periodically in CY 2013, in surface water at RFLMA Point of Evaluation (POE) monitoring station GS10, which is located on South Walnut Creek upstream of former Pond B-1. Reportable 12-month rolling average americium (Am) and plutonium (Pu) activities also continued to be observed periodically during CY 2013. However, all sampling results since August 2013 show Am and Pu activities well below the 0.15 picocurie per liter surface water standard. The evaluation of these reportable conditions is ongoing.
- All other POE analyte concentrations/activities remained below reporting levels throughout CY 2013.
- As with many locations on the Front Range, the Site experienced very high water flows due to heavy precipitation during the second week of September 2013. In some cases the high flows and debris caused damage to the automated sampling equipment, resulting in temporary interruptions in composite sampling. At almost all Site locations, the unanticipated runoff volumes caused flow-paced composite bottles to fill before personnel could safely replace them with empty bottles. Access to various areas of the Site was unsafe and restricted by local authorities during certain periods.

Due to the interruptions in automated sampling at RFLMA POCs and POEs, tables have been added to this report (see Sections 3.1.2.1 and 3.1.2.2 below) detailing automated composite sample collection during September 2013. That said, the automated surface-water monitoring network performed as well as could be expected. During September 2013, composite samples collected at RFLMA POCs and POEs included more than 2,000 individual grabs.

- The results of statistical evaluations of groundwater quality at the OLF and Present Landfill (PLF) were largely identical to the results of these evaluations performed in 2012.
- Water monitoring at the Present Landfill Treatment System during CY 2013 showed three analytes detected above the applicable standards for individual sample results. The observed concentrations did not recur and RFLMA consultation was not required during CY 2013. Groundwater samples collected from the three downgradient PLF Resource Conservation and Recovery Act (RCRA) wells indicated notable concentrations of boron in one well; boron and nickel in another; and boron, chromium, and selenium in a third well. These concentrations were statistically higher than in upgradient groundwater and were on increasing trends, although only the selenium results exceeded corresponding RFLMA levels. These conditions are generally consistent with those reported for earlier years. After reviewing the results of statistical evaluation of the 2013 groundwater data presented in this Annual report, the RFLMA Parties may decide that subsequent consultation regarding the appropriate response is required. Such consultation, if it occurs, will be documented in a new contact record (in accordance with guidelines described in Contact Record 2011-03). Surface-water monitoring for the OLF during CY 2013 showed one analyte detected above the applicable standards for individual sample results. The observed concentrations did not recur and RFLMA consultation was not required. Boron was determined to be present at higher concentrations in groundwater at all three downgradient OLF RCRA wells than in upgradient wells. This condition also applied to uranium in two of these wells and nickel in one downgradient well. An increasing trend in downgradient concentrations was only calculated for boron in one downgradient well. These conditions are generally consistent with those reported for earlier years. In all cases, the concentrations of these constituents in downgradient groundwater were below the associated RFLMA limits. After reviewing the results of statistical evaluation of the 2013 groundwater data presented in this Annual report, the RFLMA Parties may decide that subsequent consultation regarding the appropriate response is required. Such consultation, if it occurs, will be documented in a new contact record (in accordance with guidelines described in Contact Record 2011-03). Analytical results for effluent from the Mound Site Plume Treatment System (MSPTS) and East Trenches Plume Treatment System (ETPTS) continued to demonstrate that the vast majority of contaminants have been removed. However, concentrations of some volatile organic compounds (VOCs) in system effluent exceeded target concentrations. Both of these treatment systems received new, larger air strippers in early 2013 that were modeled after the unit installed in the existing effluent manhole at the MSPTS in 2011. The air stripper installed in 2013 at the MSPTS was placed in the effluent manhole, while that at the ETPTS was installed in the influent manhole. Both operated continuously and acted to remove additional VOCs.
- The Solar Ponds Plume Treatment System (SPPTS) was the focus of continued study in an effort to improve cost and treatment effectiveness. Building on results obtained in 2012, pilot-scale lagoons are being tested to treat nitrate. An approach using small containers of treatment media—on the order of 1 to 2 gallons—is being tested to treat uranium. Both of these approaches are being optimized for potential full-scale implementation.
- Groundwater quality and flow at the Site were generally consistent with previous years. No reportable conditions were indicated. Statistical trending calculations indicated numerous significant concentration trends. Conditions observed at some locations, particularly with respect to groundwater elevations, suggested climatic causes (i.e., the extremely heavy precipitation received in September 2013).

- Wetlands constructed to mitigate the impacts to wetlands caused by both Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and non-CERCLA related projects have been managed and monitored in accordance with the *Rocky Flats, Colorado, Site Wetland Mitigation Monitoring and Management Plan* (Plan) (DOE 2006b). That Plan states “The annual report for the fifth year will contain the wetland delineation data and will serve as the final wetland mitigation report (unless further monitoring is required by the regulatory agencies).” This annual report serves as that final wetland mitigation report for those projects that disturbed wetlands in 2009 or earlier and closes out the Plan. In summary, the CERCLA and non-CERCLA wetland impacts were mitigated onsite in a one-to-one ratio. A detail accounting for the impacted and compensatory mitigation wetland acreage is provided in this annual report.

Although the Plan is closed out (with the delivery of this report), projects with wetland impacts after 2009 will continue to be monitored following the same basic methodology as outlined in the Plan. The methodology and process will be documented in the *Rocky Flats, Colorado, Site, Site Operations Guide*. CERCLA-related projects that impact wetlands will have their compensatory wetlands delineated in the fifth year and closed out. Non-CERCLA projects that impact wetlands subject to the U.S. Army Corps of Engineers Clean Water Act Section 404 permitting process will be closed out as required by the permit issued for the project. The status of any CERCLA-related impacted/mitigated wetlands will be reported in future annual reports.

- All RFLMA-required ecological data collection, analysis, and reporting were completed as scheduled.
- Revegetation monitoring data continued to demonstrate the establishment and sustainability of desirable grassland species at the Site.
- The annual data quality assessment showed that the Site continues to collect high-quality data sufficient for decision making.