Chapter 5: Environmental Monitoring Programs – Liquid Effluents Monitoring

CHAPTER 5

Wastewater discharged to land surfaces and infiltration basins (percolation ponds) at the Idaho National Laboratory (INL) Site is regulated by the state of Idaho groundwater quality and recycled water rules and requires a reuse permit. Liquid effluents and surface water runoff were monitored in 2022 by the INL contractor and the Idaho Cleanup Project (ICP) contractor for compliance with permit requirements and applicable Department of Energy (DOE) orders established to protect human health and the environment.

During 2022, permitted reuse facilities included the Advanced Test Reactor Complex Cold Waste Ponds, Idaho Nuclear Technology and Engineering Center New Percolation Ponds and Sewage Treatment Plant, and Materials and Fuels Complex Industrial Waste Pond. Liquid effluent and groundwater at these facilities were sampled for parameters required by their facility-specific permits. No permit limits were exceeded in 2022.

Additional liquid effluent and groundwater monitoring was performed in 2022 at the Advanced Test Reactor Complex, Idaho Nuclear Technology and Engineering Center, and Materials and Fuels Complex to comply with environmental protection objectives of DOE. All parameters were below applicable health-based standards in 2022.

Surface water that runs off the Subsurface Disposal Area at the Radioactive Waste Management Complex during periods of rapid snowmelt or heavy precipitation was sampled and analyzed for radionuclides. Additionally, water sheet flowed across asphalt surfaces and infiltrated around/under door seals at Waste Management Facility-636 at the Advanced Mixed Waste Treatment Project and collected in catch tanks. Specific human-made gamma-emitting radionuclides were not detected. Detected concentrations of americium-241, plutonium-239/240, and uranium isotopes did not exceed DOE Derived Concentration Standards.

5. ENVIRONMENTAL MONITORING PROGRAMS – LIQUID EFFLUENTS MONITORING

Some INL Site operations retain wastewater in lined, total containment evaporative ponds constructed to eliminate liquid effluent discharges to the environment. Other INL Site operations discharge liquid effluents to unlined infiltration basins or ponds that may potentially contain nonhazardous levels of radioactive, or nonradioactive, contaminants. Effluent discharges are subject to specified discharge limits, permit limits, or maximum contaminant levels. INL and ICP personnel conduct liquid effluent monitoring through liquid effluent and surface water runoff sampling and surveillance programs to ensure compliance with applicable permits, limits, and maximum contaminant levels. These programs also sample groundwater related to liquid effluent.

Table 5-1 presents the requirements for liquid effluent monitoring performed at the INL Site. Maps and a comprehensive discussion of environmental monitoring, including liquid effluent monitoring and surveillance programs performed by various organizations within and around the INL Site can be found in the *INL Environmental Monitoring Plan* (DOE-ID 2021). To improve the readability of this chapter, data tables are only included when monitoring results exceed specified discharge limits, permit limits, or maximum contaminant levels. Data tables for other monitoring results are provided in Appendix A.

Table 5-1. Liquid effluent monitoring at the INL Site.

MONITORING REQUIREMENTS			
AREA/FACILITY	IDAHO REUSE PERMIT[a]	DOE O 458.1[b] LIQUID EFFLUENT MONITORING	DOE O 435.1[c] SURFACE RUNOFF SURVEILLANCE
INL CONTRACTOR			
ATR[d] Complex Cold Waste Ponds	●	●	
MFC[d] Industrial Waste Pond	●	●	
ICP CONTRACTOR			
INTEC[d] New Percolation Ponds and Sewage Treatment Plant	●	●	
RWMC[d] SDA[d] surface water runoff		●	●

a. Required by permits issued according to the Idaho Department of Environmental Quality Rules, IDAPA 58.01.17, "Recycled Water Rules." This includes wastewater effluent monitoring and related groundwater monitoring.

b. Paragraph 4(g) of DOE Order 458.1, "Radiation Protection of the Public and the Environment," establishes specific requirements related to control and management of radionuclides from DOE activities in liquid discharges. Radiological liquid effluent monitoring recommendations in DOE Handbook Environmental Radiological Effluent Monitoring and Environmental Surveillance (DOE-HDBK-1216-2015) (DOE 2015) are followed to ensure quality. DOE Standard DOE-STD-1196-2021, "Derived Concentration Technical Standard," (DOE 2021) supports the implementation of DOE O 458.1 and provides Derived Concentration Standards as reference values to control effluent releases from DOE facilities.

c. The objective of DOE O 435.1, "Radioactive Waste Management," is to ensure that all DOE radioactive waste is managed in a manner that is protective of worker and public health and safety and the environment. This order requires that radioactive waste management facilities, operations, and activities meet the environmental monitoring requirements of DOE O 458.1. DOE Handbook DOE-HDBK-1216-2015 suggests that potential impacts of stormwater runoff as a pathway to humans or biota should be evaluated.

d. Advanced Test Reactor (ATR), Materials and Fuels Complex (MFC), Idaho Nuclear Technology and Engineering Center (INTEC), and Radioactive Waste Management Complex (RWMC), Subsurface Disposal Area (SDA).

5.1 Liquid Effluent and Related Groundwater Compliance Monitoring

Discharge of liquid effluent to the land surface for treatment or disposal is known as "reuse" in the state of Idaho and is regulated by the Recycled Water Rules (IDAPA 58.01.17), Wastewater Rules (IDAPA 58.01.16), and Ground Water Quality Rule (IDAPA 58.01.11) promulgated according to the Idaho Administrative Procedures Act. The Idaho Department of Environmental Quality (DEQ) issues reuse permits for operation of the reuse systems. Reuse permits may require monitoring of nonradioactive constituents in the effluent and groundwater in accordance with the monitoring requirements specified within each permit. Some facilities may have specified radiological constituents monitored for surveillance purposes (but are not required by regulations). The permits may specify annual discharge volumes, application rates, and effluent quality limits. Annual reports (ICP 2023a and 2023b; INL 2023a, 2023b, 2023c, and 2023d) were prepared and submitted to the Idaho DEQ.

During 2022, the INL and ICP contractors monitored, as required by the permits, the following reuse facilities shown in Table 5-2:

- ATR Complex Cold Waste Ponds (Section 5.1.1)
- INTEC New Percolation Ponds and Sewage Treatment Plant (STP) (Section 5.1.2)
- MFC Industrial Waste Pond (Section 5.1.3).

Table 5-2. 2022 status of reuse permits.

FACILITY	PERMIT STATUS AT END OF 2022	PERMIT EXPIRATION DATE	EXPLANATION
ATR Complex Cold Waste Ponds	Active	October 29, 2029	Idaho DEQ issued Reuse Permit I-161-03 on October 30, 2019 (DEQ 2019), with Modification 1 issued May 23, 2022 (DEQ 2022a).
INTEC New Percolation Ponds	Active	June 1, 2024	Idaho DEQ issued Permit M-130-06 on June 1, 2017 (DEQ 2017).
MFC Industrial Waste Pond	Active	January 25, 2027	Idaho DEQ issued Reuse Permit I-160-02 on January 26, 2017, with modifications issued March 7, 2017; May 8, 2019; May 21, 2020[a] (DEQ 2020); and May 23, 2022 (DEQ 2022b).

a. MFC Modification 3, issued May 21, 2020, removed the Industrial Waste Ditch as a permit Management Unit, resulting in changes to monitoring and reporting requirements. Idaho DEQ re-issued Modification 3 on September 15, 2020, to correct administrative matters.

Additional effluent constituents are monitored at these facilities to comply with environmental protection objectives of DOE O 458.1 and are discussed in Section 5.2. Surface water monitoring at the RWMC is presented in Section 5.3.

5.1.1 Advanced Test Reactor Complex Cold Waste Ponds

Description. The Cold Waste Ponds (CWP) are located approximately 137 m (450 ft) from the southeast corner of the ATR Complex compound and approximately 1.2 km (0.75 mi) northwest of the Big Lost River channel, as shown in Figure 5-1. The CWP was excavated in 1982 and consist of two unlined cells, each with dimensions of 55 × 131 m (180 × 430 ft) across the top of the berms and with a depth of 3 m (10 ft). Total surface area for the two cells at the top of the berms is approximately 1.44 ha (3.55 acres). Maximum capacity is approximately 38.69 ML (10.22 MG).

The CWP function as percolation basins for the infiltration of nonhazardous industrial liquid effluent consisting primarily of noncontact cooling tower blowdown, once-through cooling water for air conditioning units, coolant water from air compressors, and wastewater from secondary system drains and other nonradioactive drains throughout the ATR Complex. Chemicals used in the cooling tower and other effluent streams discharged to the CWP include commercial biocides and corrosion inhibitors. The cold waste effluent reports through collection piping to a monitoring location where flow rates to the CWP are measured using a v-notch weir and effluent samples are collected using an automated composite sampler.

Effluent Monitoring Results for the Reuse Permit. Reuse Permit I-161-03 Modification 1 requires monthly sampling of the effluent to the CWP (DEQ 2022a). The 2022 permit reporting year monitoring results are presented in the 2022 annual reuse report (INL, 2023c) and the 2022 calendar year monitoring results are summarized in Table A-1 in Appendix A. The total dissolved solids concentrations ranged from 204–266 mg/L. Sulfate ranged from 21.1 mg/L to 30.1 mg/L. Concentrations of sulfate and total dissolved solids are higher during reactor operation because of the evaporative concentration of the corrosion inhibitors and biocides added to the reactor cooling water. Due to the composition and characteristics of the effluent, the reuse permit does not require pre-treatment or specify maximum constituent loading limits or concentration limits for the cold waste effluent discharged to the CWP. The 2022 constituent concentrations continue to remain consistent with historical results.

The permit specifies the maximum annual and five-year moving average hydraulic loading rate limits of 300 MG/yr and 375 MG/yr, respectively, based on the annual reporting year of the permits. As shown in Table A-2, the 2022 annual reporting year flow of 279.21 MG did not exceed either of these hydraulic loading limits.

Groundwater Monitoring Results for the Reuse Permit. The permit requires groundwater monitoring twice annually in April/May and September/October, at seven groundwater wells (see Figure 5-1), to measure potential impacts from the CWP. In 2022, none of the constituents exceeded their respective primary or secondary constituent standards. The constituents are presented in Table A-3a and Table A-3b. The metals concentrations continue to remain at low levels and are consistent with historical ranges.

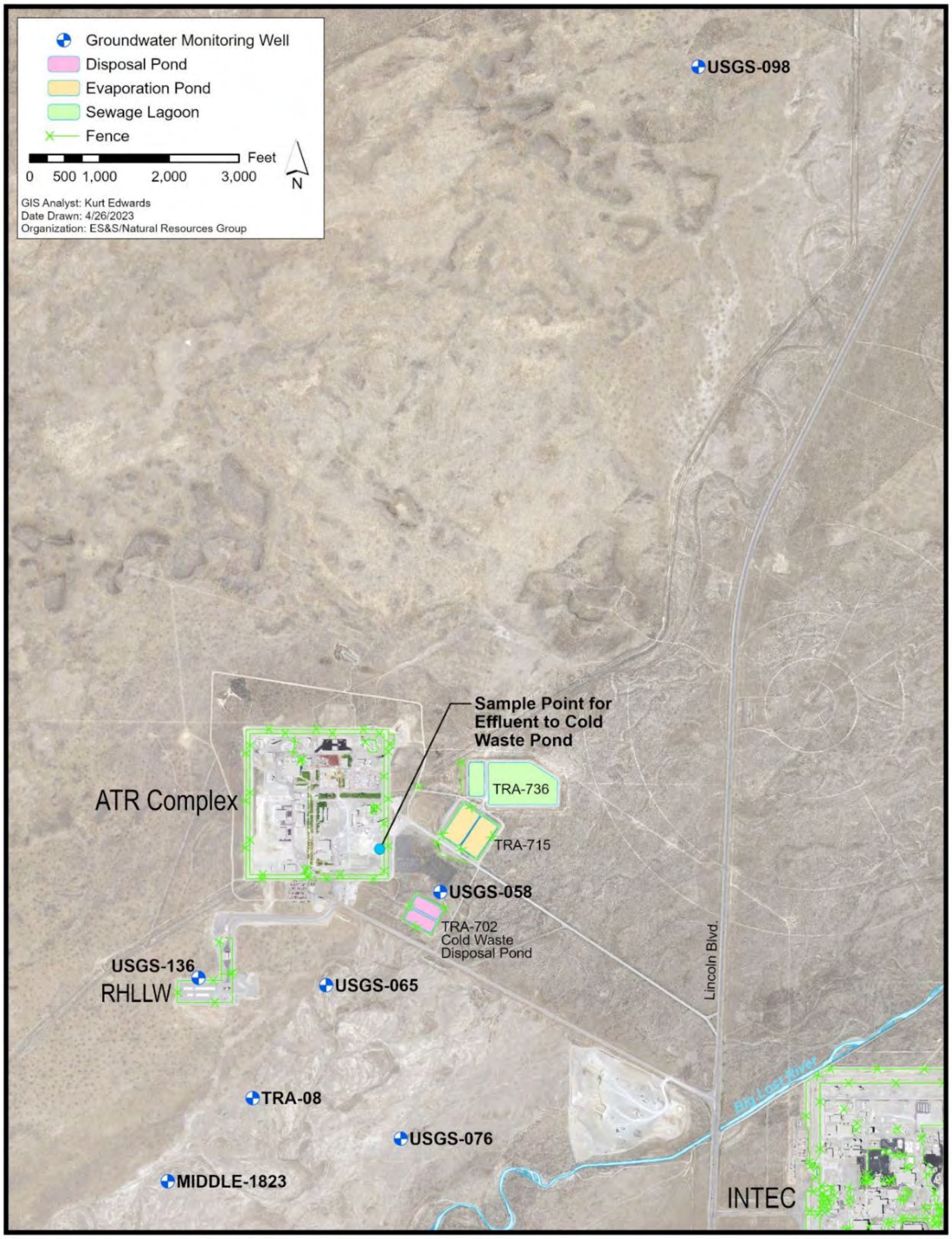

Figure 5-1. Permit monitoring locations for the ATR Complex Cold Waste Pond.

5.1.2 Idaho Nuclear Technology and Engineering Center New Percolation Ponds and Sewage Treatment Plant

Description. The INTEC New Percolation Ponds are composed of two rapid infiltration ponds excavated into the surficial alluvium and surrounded by bermed alluvial material, as observed in Figure 5-2. The rapid infiltration system uses the soil ecosystem to treat wastewater. Each pond is 93 m × 93 m (305 ft × 305 ft) at the top of the berm and is approximately 3 m (10 ft) deep. Each pond is designed to accommodate a continuous wastewater discharge rate of 11.36 ML (3 MG) per day.

The INTEC New Percolation Ponds receive discharge of only industrial and municipal wastewater. Industrial wastewater (i.e., service waste) from INTEC operations consists of steam condensates, noncontact cooling water, water treatment effluent, boiler blowdown wastewater, stormwater, and small volumes of other nonhazardous/nonradiological liquids. Municipal wastewater (i.e., sanitary waste) is treated at the INTEC STP.

The STP is located east of INTEC, outside the INTEC security fence, and treats and disposes of sewage, septage, and other nonhazardous industrial wastewater at INTEC. The sanitary waste is treated by natural biological and physical processes (e.g., digestion, oxidation, photosynthesis, respiration, aeration, and evaporation) in four lagoons. After treatment in the lagoons, the effluent is combined with the service waste and discharged to the INTEC New Percolation Ponds.

The INTEC New Percolation Ponds were permitted by Idaho DEQ to operate as a reuse facility under Reuse Permit M-130-06 (DEQ 2017).

Wastewater Monitoring Results for the Reuse Permit. Monthly samples were collected from CPP-769 (influent to STP), CPP-773 (effluent from STP), and CPP-797 (effluent to the INTEC New Percolation Ponds), as shown in Figure 5-3. As required by the permit, all samples are collected as 24-hour composites, except pH, fecal coliform, and total coliform, which are collected as grab samples. The permit specifies the constituents that must be monitored at each location. The permit does not specify any wastewater discharge limits at these three locations. The 2022 reporting year monitoring results for CPP-769, CPP-773, and CPP-797 are provided in the 2022 Wastewater Reuse Report (ICP 2023a), and the 2022 calendar year monitoring results are summarized in Tables B-4, B-5, and B-6 (in Appendix B).

The permit specifies maximum daily and yearly hydraulic loading rates for the INTEC New Percolation Ponds. As shown in Table A-7, the maximum daily flow and yearly total flow to the INTEC New Percolation Ponds were below the permit limits in 2022.

Groundwater Monitoring Results for the Reuse Permit. To measure the potential impact on groundwater from wastewater discharges to the INTEC New Percolation Ponds, the permit requires that groundwater samples are collected from six monitoring wells, as shown in Figure 5-2.

The permit requires that groundwater samples are collected semiannually during April/May and September/October and lists which constituents must be analyzed. Contaminant concentrations in the monitoring wells are limited by primary constituent standards and secondary constituent standards specified in IDAPA 58.01.11, "Ground Water Quality Rules."

Table A-8 shows the 2022 water table elevations and depth-to-water table, determined prior to purging and sampling, and the analytical results for all constituents specified by the permit for the aquifer wells. Table A-9 presents similar information for the perched water wells.

Tables B-8 and B-9 show all permit-required constituents associated with the aquifer monitoring wells were below their respective primary constituent standards and secondary constituent standards in 2022. The pH values in perched water well ICPP-MON-V-212 were elevated in both April and September. The pH values associated with this well are consistently higher in the spring versus the fall, indicative of surface water recharge. Historically, each recharge of this perched water well results in decreasing pH values. Purge times are being evaluated to ensure that pH values have stabilized prior to sampling.

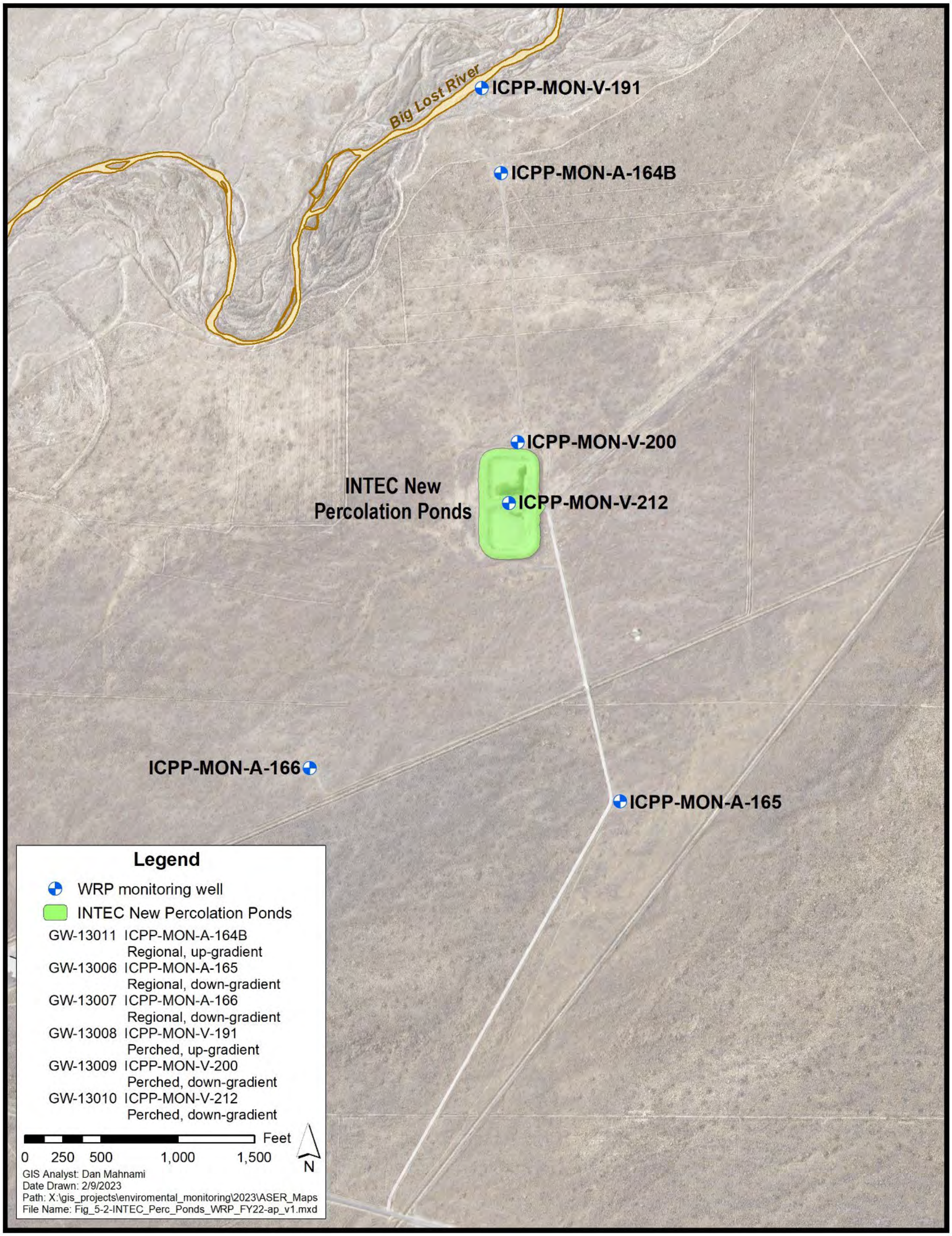

Figure 5-2. Reuse permit groundwater monitoring locations for INTEC New Percolation Ponds.

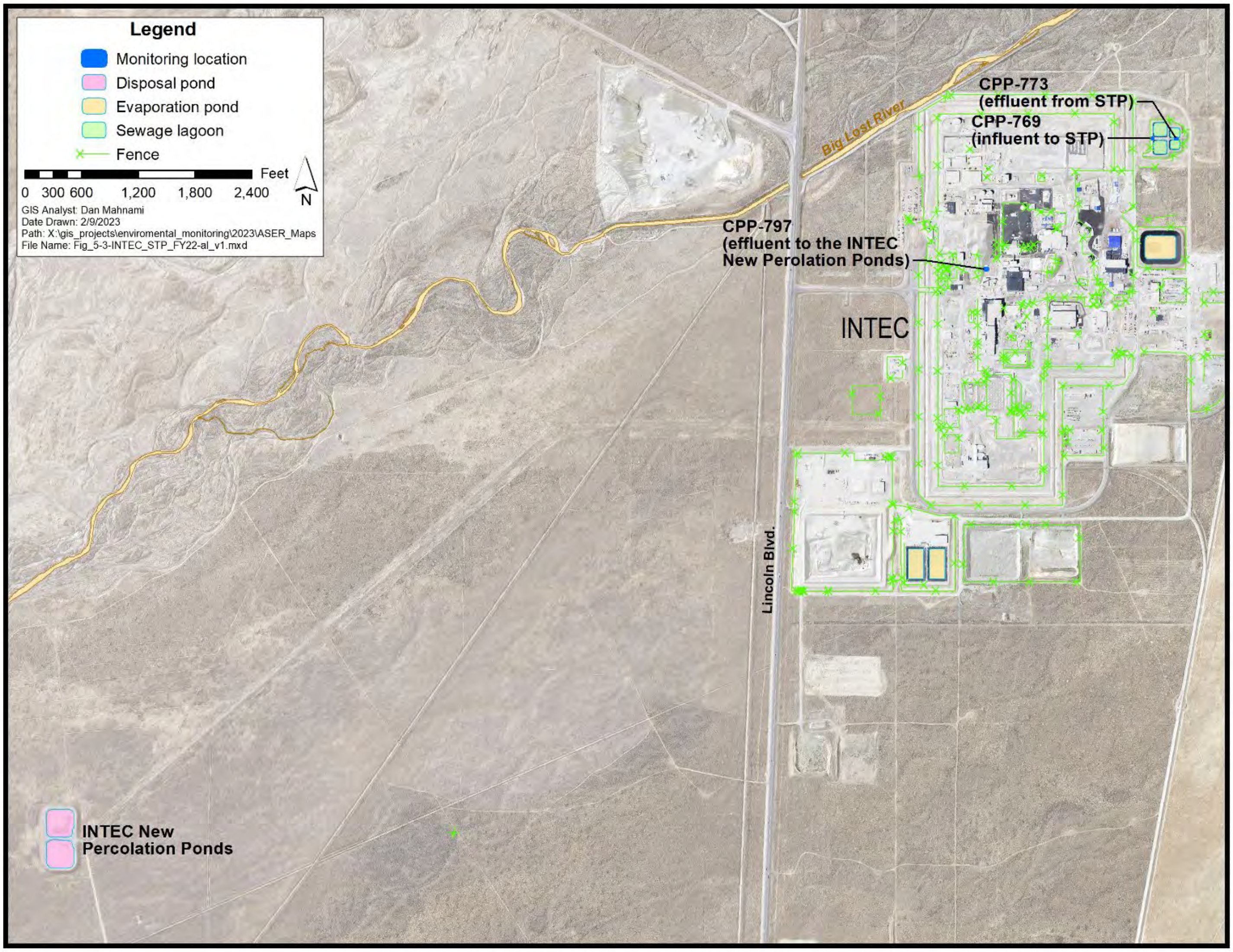

Figure 5-3. INTEC wastewater monitoring for reuse permit.

5.1.3 Materials and Fuels Complex Industrial Waste Pond

Description. The MFC Industrial Waste Pond is an unlined basin that was first excavated in 1959 and has a design capacity of 1,078.84 ML (285 MG) at a maximum water depth of 3.96 m (13 ft) identified in Figure 5-4. In previous years the pond received industrial wastewater from the stormwater runoff from the nearby areas and industrial wastewater from the Industrial Waste Ditch (IWD) (Ditch C).

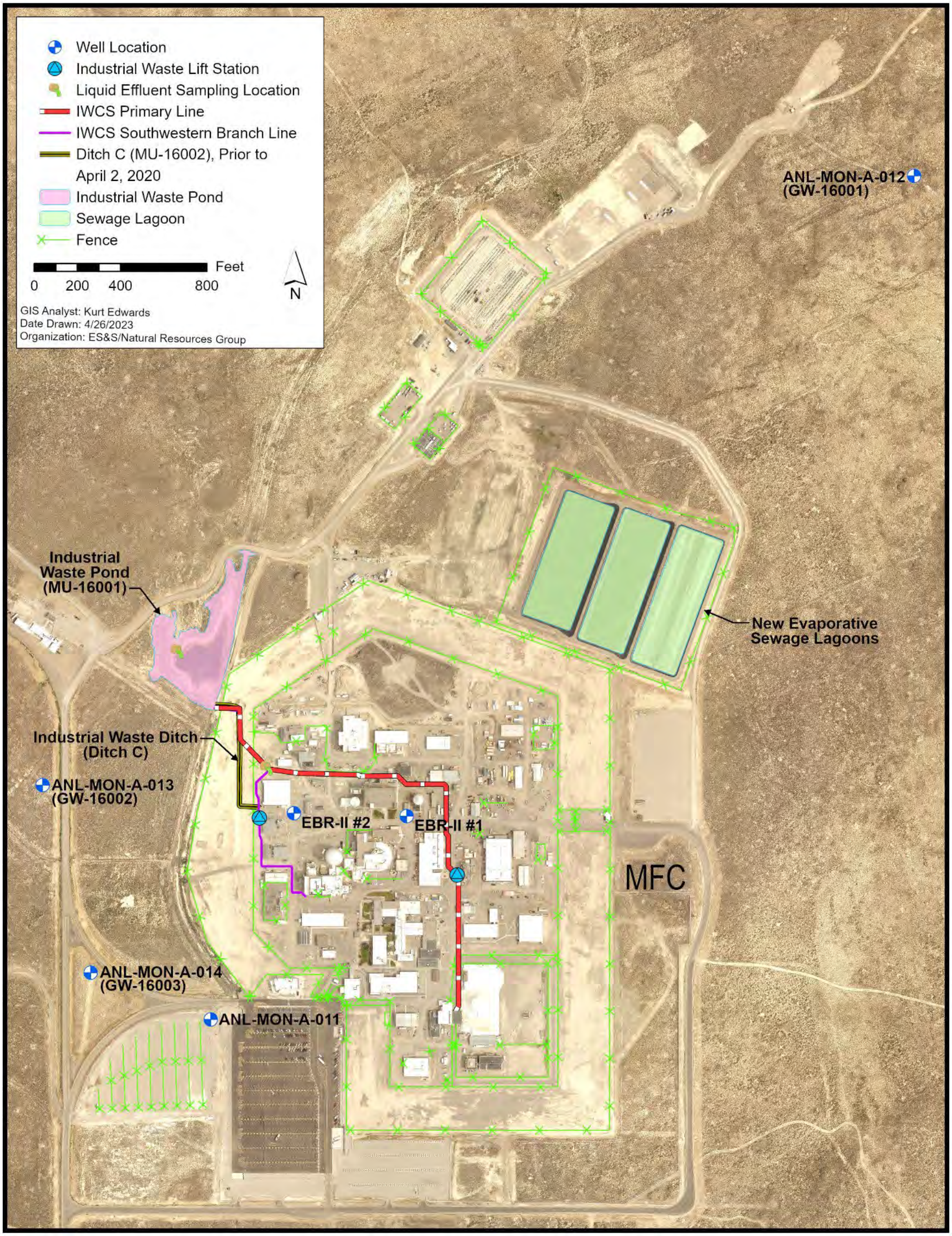

Figure 5-4. Wastewater and groundwater sampling locations MFC.

As part of the MFC Utility Corridor Upgrade Project completed in 2020, industrial wastewater discharges into the IWD (Ditch C) were eliminated. The Ditch C industrial wastewater is now collected in a new lift station and rerouted into the primary industrial waste pipeline via a new connecting pipeline. Reuse Permit I-160-02 Modification 3 issued May 21, 2020 (DEQ 2020) removed the IWD (Ditch C) Management Unit and associated monitoring from the permit as a result of INL permanently joining the industrial wastewater collection system (IWCS) pipelines together, upstream of the existing flow monitoring and sampling station, prior to discharging the combined effluent into the Industrial Waste Pond.

Now that the two MFC IWCS pipelines are joined together and have one flow/sample monitoring location, the system has been given more descriptive, common names. The combination of industrial wastewater pipelines/branches, lift stations, flow meter, sampling station, and associated components are now designated as the industrial wastewater collection system (IWCS). The pipeline, previously known as the industrial waste pipeline, that captures the majority of industrial wastewater and eventually discharges into the pond is referred to as the IWCS Primary Line (PL) since it is the pipeline that collects wastewater from all sources and on which the flow meter and sampling station are located. The pipeline that collected small amounts of industrial wastewater, which previously discharged into the IWD (Ditch C) but now discharges into the PL upstream of the existing sampling station via the new lift station and connecting pipeline, is referred to as the IWCS Southwestern Branch Line.

The Industrial Waste Pond functions as a percolation basin for the infiltration of nonhazardous industrial effluent. Industrial wastewater, which is discharged to the pond via the IWCS PL, consists primarily of noncontact cooling water, boiler blowdown, cooling tower blowdown and drain, air wash flows, and steam condensate. A small amount of wastewater collected within the IWCS Southwestern Branch Line (that now discharges into the PL via a new lift station) consists of intermittent reverse osmosis effluent and laboratory sink discharge from the MFC-768 Power Plant.

Wastewater Monitoring Results for the Reuse Permit. Reuse Permit I-160-02 Modification 4 requires monthly sampling of effluent discharging from the IWCS PL into the Industrial Waste Pond. The 2022 permit reporting year monitoring results are presented in the 2022 annual reuse report (INL 2023d), and the calendar year results are summarized in Table A-10. Based on the composition of the industrial effluent, the reuse permit does not require pre-treatment or specify maximum constituent loading limits or concentration limits. In 2022, concentrations of iron and manganese continued to be at or near the laboratory instruments' minimum detection levels. Total dissolved solids ranged from 204–356 mg/L. The 2022 constituent concentrations continue to be within historical ranges.

The permit specifies an annual reporting year hydraulic loading limit of 17 MG/yr. As shown in Table A-11, the 2022 reporting year flow of 10.188 MG/yr was well below the permit limit.

Groundwater Monitoring Results for the Reuse Permit. The reuse permit requires groundwater monitoring twice annually, in April/May and September/October, at one upgradient well and two downgradient wells (Figure 5-4) to measure potential impacts from the pond. The analytical results are summarized in Table A-12. In 2022, none of the constituents exceeded their respective primary or secondary constituent standards, and the analyte concentrations in the downgradient wells remained consistent with background levels in the upgradient well.

5.2 Liquid Effluent Surveillance Monitoring

The following sections discuss the results of liquid effluent surveillance monitoring performed at each wastewater reuse permitted facility.

5.2.1 Advanced Test Reactor Complex

The effluent to the CWP receives a combination of process water from various ATR Complex facilities. Table A-13 lists wastewater effluent surveillance monitoring results for those constituents with at least one detected result. In 2022, gross alpha and gross beta were the only constituents detected in the CWP effluent. Groundwater radionuclide surveillance monitoring results are summarized in Table A-14. All detected constituents, including strontium-90, tritium, gross alpha, and gross beta, were well below the Idaho groundwater primary constituent standards, IDAPA 58.01.11.

5.2.2 Idaho Nuclear Technology and Engineering Center

In addition to the permit-required monitoring summarized in Section 5.1.3, surveillance monitoring was conducted at CPP-797 (effluent to the INTEC New Percolation Ponds), and the groundwater monitoring was conducted at the INTEC New Percolation Ponds. Table A-15 summarizes the results of radiological monitoring at CPP-797, while Table A-16 summarizes the results of radiological monitoring at groundwater Wells ICPP-MON-A-165, ICPP-MON-A-166, ICPP-MON-V-200, and ICPP-MON-V-212.

Twenty-four-hour flow proportional samples were collected from the CPP-797 wastewater effluent and composited daily into a monthly sample. Each collected monthly composite sample was analyzed for specific gamma-emitting radionuclides, gross alpha, gross beta, and total strontium activity. As shown in Table A-15, no total strontium activity was detected in any of the samples collected at CPP-797 in 2022. Gross alpha was not detected, while gross beta was detected in all 12 samples collected in 2022.

Groundwater samples were collected from aquifer Wells ICPP-MON-A-165 and ICPP-MON-A-166 and perched water Wells ICPP-MON-V-200 and ICPP-MON-V-212 in April 2022 and September 2022 and were analyzed for gross alpha and gross beta. As shown in Table A-16, gross alpha was detected in one of the four monitoring wells in September 2022. Gross beta was detected in all the monitoring wells in April 2022 and in three of the monitoring wells in September 2022. All detected constituents, including strontium-90, tritium, gross alpha, and gross beta, were below the Idaho groundwater primary constituent standards, IDAPA 58.01.11.

5.2.3 Materials and Fuels Complex

The Industrial Waste Pond is sampled quarterly and analyzed for gross alpha, gross beta, gamma spectrometry, and tritium, as shown in Figure 5-4. Annual samples are collected and analyzed for selected isotopes of americium, strontium, plutonium, and uranium. Gross alpha, gross beta, and uranium isotopes were detected in 2022, as summarized in Table A-17, and are below applicable Derived Concentration Standards (DCS) (DOE 2022).

Additionally, five ground water monitoring wells are sampled twice per year for select radionuclides, metals, anions, cations, and other water quality parameters as surveillance monitoring under the WAG 9 Record of Decision. The 2022 groundwater surveillance monitoring results are discussed in Chapter 6, Section 6.5.6, and summarized in Table 6-11. Overall, the detected results were below the Idaho groundwater primary constituent standards, IDAPA 58.01.11, and show no discernable impact from activities at the MFC.

5.3 Waste Management Surveillance Surface Water Sampling

Radionuclides could be transported outside the RWMC boundaries via surface water runoff. Surface water runs off the SDA only during periods of rapid snowmelt or heavy precipitation. At these times, water may be pumped out of the SDA retention basin into a drainage canal, which directs the flow outside the RWMC. The canal also carries runoff from outside the RWMC that has been diverted around the SDA.

Additionally, water sheet flows across asphalt surfaces and infiltrates around/under door seals at Waste Management Facility (WMF)-636 at the Advanced Mixed Waste Treatment Project. The resulting surface water inflow accumulates in the WMF-636 Fire Water Catch Tanks (Tanks A, B, C, and D). If the level of surface water in the Fire Water Catch Tanks reaches a predetermined level, the water is pumped into aboveground holding tanks, where it can be sampled, prior to discharge into the drainage canal surrounding the SDA.

In compliance with DOE O 435.1, the ICP contractor collects surface water runoff samples at the RWMC SDA from the location shown in Figure 5-5. The WMF-636 Fire Water Catch Tanks are also shown in Figure 5-5. Surface water is collected to determine if radionuclide concentrations exceed administrative control levels or if concentrations have increased significantly, as compared to historical data. A field blank is also collected for comparison. Samples from the WMF-636 Fire Water Catch Tanks were not collected during 2022 as periodic measurements of tank levels did not indicate pumping to be necessary.

Two samples were collected from the SDA Lift Station in 2022. These samples were analyzed for a suite of radionuclides that includes americium-241 and strontium-90 and plutonium and uranium isotopes. There were positive detections (three sigma [3σ]) of americium-241, plutonium-238, plutonium-239/240, and strontium-90 in samples taken in 2022. The maximum concentration detected for americium-241 was 0.95 (± 0.09) pCi/L, which is well below the 740 pCi/L DCS for americium-241. The maximum concentration detected for plutonium-238 was 0.04 (± 0.01) pCi/L, which is well below the 430 pCi/L DCS. The maximum concentration detected for plutonium-239/240 was 0.17 (± 0.02) pCi/L, which is well below the applicable DCS (400 pCi/L). Finally, the maximum concentration detected for strontium-90 was 0.68 (± 0.17) pCi/L, which is also well below the applicable DCS (1,700 pCi/L). In addition to these nuclides, uranium isotopes were detected at levels consistent with historical results, which are below any applicable DCS.

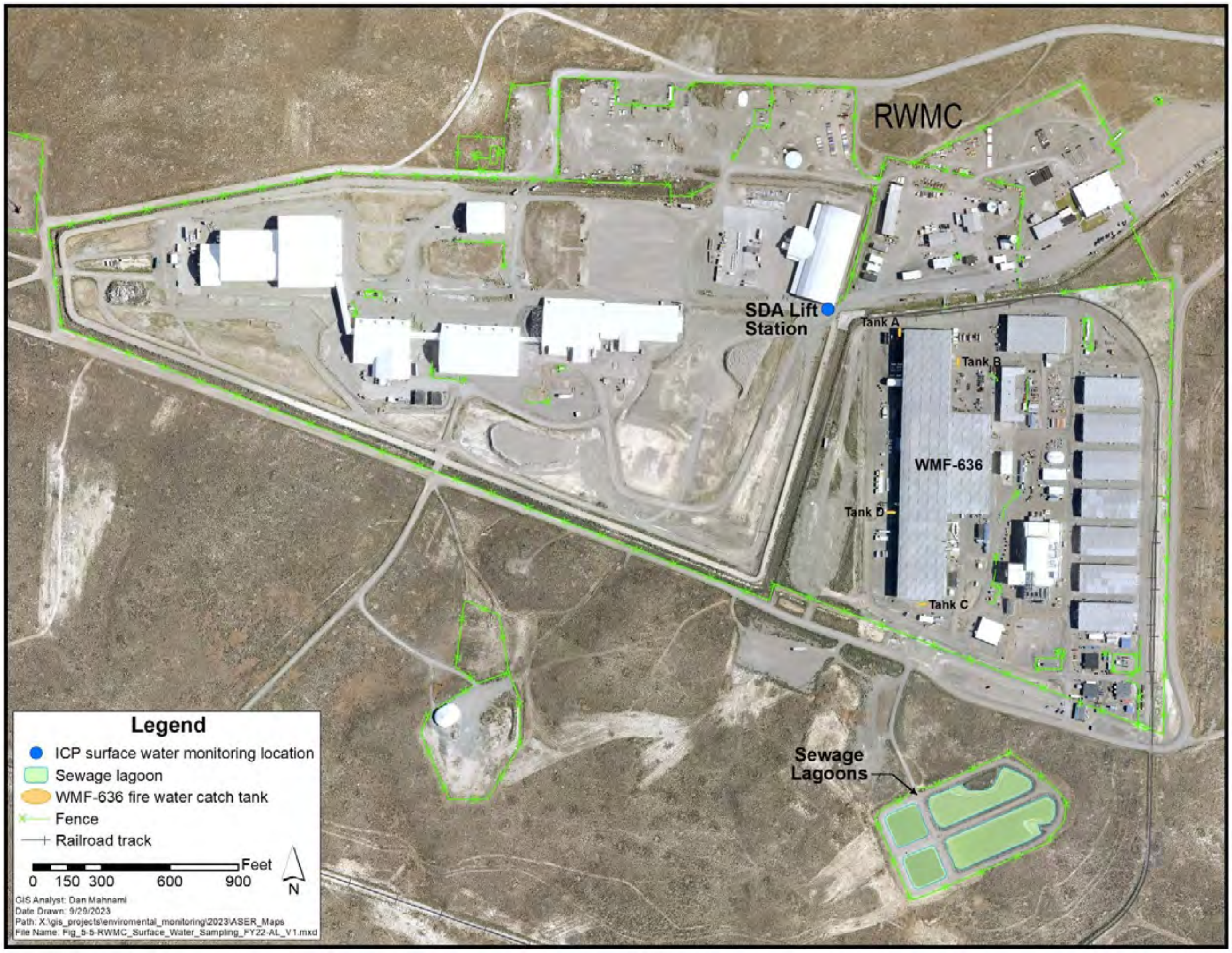

Figure 5-5. Surface water sampling location at the RWMC SDA.

Table 5-3 summarizes the specific alpha and beta results of human-made radionuclides. No human-made gamma-emitting radionuclides were detected. The ICP contractor took samples from the SDA Lift Station twice during 2022 at times when water was available and evaluated the results to identify any potential abnormal trends or results that would warrant further investigation. ICP will also continue to collect samples as necessary for the discharge of accumulated water run-in contained in the WMF-636 Fire Water Catch Tanks.

Table 5-3. Radionuclides detected in surface water runoff at the RWMC SDA (2022).

LOCATION	PARAMETER	MAXIMUM CONCENTRATION[a] (pCi/L)	% DERIVED CONCENTRATION STANDARD[b]
SDA Lift Station	Americium-241	0.95 ± 0.09	0.13
	Plutonium-238	0.04 ± 0.01	0.01
	Plutonium-239/240	0.17 ± 0.02	0.04
	Strontium-90	0.68 ± 0.17	0.04
	Uranium-234	0.46 ± 0.03	0.04
	Uranium-235	0.03 ± 0.01	0.00
	Uranium-238	0.36 ± 0.03	0.03

a. Result ±1s. Results shown are greater than 3σ.
b. See DOE-STD-1196-2021, Table A-6 (DOE 2022).

5.4 References

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Smoke on Middle Butte