Appendix B

Supplemental Surface Water and Effluent Information

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Abbreviations

DOE	U.S. Department of Energy
FFCA	Federal Facility Compliance Agreement
FRL	final remediation level
GMA	Great Miami Aquifer
IEMP	Integrated Environmental Monitoring Plan
LMICP	*Comprehensive Legacy Management and Institutional Controls Plan*
NPDES	National Pollutant Discharge Elimination System
Ohio EPA	Ohio Environmental Protection Agency
OU5 ROD	*Final Record of Decision for Remedial Actions at Operable Unit 5*

Measurement Abbreviations

cfs	cubic feet per second
mg/L	milligrams per liter
µg/L	micrograms per liter
pCi/L	picocuries per liter

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B.1.0 Surface Water and Effluent

This appendix presents additional surface water and effluent data in support of Section 4.0 of this *Fernald Preserve 2021 Site Environmental Report* and provides an evaluation of the final remediation level (FRL) exceedances for surface water and effluent at the Fernald Preserve, Ohio, Site, including an assessment of potential cross-media impacts to the groundwater exposure pathway. Surface water data are available through the U.S. Department of Energy (DOE) Office of Legacy Management's Geospatial Environmental Mapping System (GEMS) database at https://gems.lm.doe.gov/#.

Surface water and effluent samples are collected as required by the Integrated Environmental Monitoring Plan (IEMP), which is Attachment D of the *Comprehensive Legacy Management and Institutional Controls Plan* (LMICP) (DOE 2019). Figure B-1 shows all IEMP surface water monitoring locations. The following information is discussed in this appendix:

- Surveillance monitoring (see Section B.1.1)
- Federal Facility Compliance Agreement (FFCA)/*Final Record of Decision for Remedial Actions at Operable Unit 5* (OU5 ROD) (DOE 1996) compliance (see Section B.1.2)
- Controlled and uncontrolled areas (see Section B.1.3)
- Proposed Surface Water Monitoring Reduction (see Section B.1.4)

Routine National Pollutant Discharge Elimination System (NPDES) permit sampling is not discussed in this appendix because it is discussed in detail in Section 4.0, "Surface Water and Effluent Pathway," of this 2021 Site Environmental Report.

B.1.1 Surveillance Monitoring

Surveillance monitoring is the comparison of surface water and effluent analytical results to the surface water FRLs to determine the effects of remediation activities on the surface water exposure pathway. Surveillance monitoring also includes an assessment of the effects surface water may have on the groundwater pathway (referred to as cross-media impacts).

All 2021 data were compared to surface water FRLs. Concentration versus time plots are presented in Figures B-2 through B-25. Samples collected at the Parshall Flume (PF 4001) are used in the surveillance evaluation because this is the last point effluent is sampled prior to discharge to the Great Miami River.

Water discharges to the Great Miami River are required to be below the FRLs at the point where discharged water is completely mixed with water in the Great Miami River (i.e., outside the mixing zone). In cases where the Parshall Flume data are already below the FRLs, no further action is taken. When the Parshall Flume data are above the FRLs, to make a determination of each constituent's concentration at this point in the Great Miami River, the following calculation is applied. No samples collected at PF 4001 exceeded the surface water FRLs in 2021.

$$C_{PF\,4001} = \frac{[Q_{10}][C_{GMR}] + [Q_{PF}][C_{PF}]}{[Q_{10}] + [Q_{PF}]}$$

where:

C_{PF4001} = Flow-weighted average concentration outside the mixing zone in the Great Miami River, picocuries per liter (pCi/L), micrograms per liter (µg/L), or milligrams per liter (mg/L)

Q_{10} = 7-day, 10-year low flow, 280.58 cubic feet per second (cfs)

C_{GMR} = Background concentration in the Great Miami River from Table 11 in Attachment D of the LMICP, pCi/L, µg/L, or mg/L; (zero was used when no background concentration was available)

Q_{PF} = Daily flow at PF 4001, cfs

C_{PF} = Daily concentration at PF 4001, pCi/L, µg/L, or mg/L

Note: Flow conditions at the Hamilton Dam gauge are periodically reviewed to determine if there is a lower flow than the 7-day, 10-year low flow of 280.58 cfs. The low flow of 280.58 cfs went into effect during the NPDES permit renewal process using information provided in the NPDES permit fact sheet finalized in early 2015. The lowest daily flow measured at the Hamilton Dam gauge (if lower than 280.58 cfs) is used in the equation to see if an exceedance could potentially occur. The lowest daily flow recorded during 2021 was 764 cfs, which occurred on September 14.

B.1.1.1 Evaluation of Constituents Above FRLs for 2021

As shown in Table B-1, there were 18 exceedances of the total uranium surface water in 2021. Figures B-2 through B-14 are plots of the total uranium concentration versus time for all surface water sampling locations. All eighteen of the total uranium surface water FRL exceedances (530 µg/L) occurred at sampling location SWD-09. Figure B-2 is a plot of the total uranium concentration versus time for sampling location SWD-09. Concentrations display a cycle of high to low each year. The historical high was 2,087 µg/L, measured in December 2016. The highest total uranium concentration in 2021, 1,201 µg/L, was at this location. The overall statistical trends (Mann-Kendall) with a 95% confidence interval at SWD-09 is "Down."

As discussed in Section 4.0 of this Site Environmental Report, surface water monitoring currently conducted in a small swale area west of the former waste pits continues to show elevated but slowly diminishing uranium concentrations. After a limited maintenance activity was completed in the fall of 2007, DOE committed to continued monitoring of the swale area. Two monitoring points (SWD-05 and SWD-09) were added to the surface water program to fulfill this monitoring commitment. These two locations are sampled weekly, when water is present.

Location SWD-05 has been sampled 265 times and location SWD-09 has been sampled 454 times between January 2007 and December 2021. As shown in Table B-1, 16 of the 265 samples collected at SWD-05 (6.0%) and 277 of the 454 samples collected at SWD-09 (61%) have exceeded the total uranium surface water FRL. As discussed in Attachment A.2, the swale is isolated from surface drainage features, so water entering the swale either evaporates or infiltrates into the ground. If the surface water with elevated total uranium concentration infiltrates into the aquifer beneath the swale, it is quickly captured by nearby extraction

well 33347 and poses no threat to human health or the environment. Additional information concerning the impact to groundwater is provided in Section A.2.1.1.4.

B.1.1.2 Evaluation of Cross-Media Impacts for 2021

One of the objectives of the IEMP surveillance monitoring program is to provide an ongoing assessment of the potential for cross-media impacts from surface water to the underlying Great Miami Aquifer (GMA). To conduct this assessment, sampling locations were selected to evaluate contaminant concentrations in surface water just upstream from those areas where site drainages have eroded through the protective glacial overburden (e.g., the Storm Sewer Outfall Ditch, Pilot Plant Drainage Ditch, and certain reaches of Paddys Run). In areas where the glacial overburden is absent, a direct pathway exists for contaminants to reach the aquifer. Key sampling locations associated with these areas of direct infiltration are SWD-03, SWD-04, SWD-05, SWD-07, SWD-08, and STRM 4005 (Figures B-3 through B-8).

Because it is the primary contaminant at the site, total uranium is used as an indicator to evaluate the impact of surface water on the GMA. A conservative assumption is used in this assessment, which considers the total uranium concentration (and all other constituent concentrations) in the surface water to be at the same concentration when the water reaches the GMA through infiltration. However, the more likely scenario is that the total uranium concentration (and all other constituent concentrations) would decrease through dilution and adsorption to sediment particles as the water infiltrates through the ground and mixes with the groundwater in the GMA. The groundwater total uranium FRL of 30 µg/L is used in this cross-media impact assessment.

The results of the cross-media impact assessment for 2021 indicate that three of the six surface water locations evaluated (SWD-04, SWD-05, and SWD-08) had results that exceeded the total uranium groundwater FRL of 30 µg/L. Location SWD-05 also had a thorium-232 groundwater FRL exceedance of 2.59 pCi/L (Figure B-20). The groundwater FRL is 1.2 pCi/L for thorium-232. The impact SWD-04, SWD-05, and SWD-08 have on the aquifer is similar to SWD-09's impact discussed in Section B.1.1.1 above. All locations are within capture of the groundwater remediation system. Sampling at these locations will continue, and results of these samples will continue to provide an assessment of the cross-media impacts.

B.1.2 FFCA/OU5 ROD Compliance

The OU5 ROD and subsequent *Explanation of Significant Differences for Operable Unit 5* (DOE 2001) stipulate compliance with a monthly flow-weighted average total uranium concentration discharge limit of 30 µg/L at the Great Miami River via PF 4001. In addition to the concentration limitation, the OU5 ROD stipulated that the total mass discharged during a year not exceed 600 pounds.

During 2021, the total uranium concentrations were monitored daily at PF 4001 to demonstrate compliance with these limitations. The Fernald Preserve was in compliance with the total mass limitation, as uranium discharges totaled 330 pounds, which is below the 600-pound limit. The Fernald Preserve was in compliance with the monthly flow-weighted concentration limit every month in 2021, as identified in Figure B-26.

B.1.3 Controlled and Uncontrolled Storm Water Runoff Areas

In 2021, there were no previously uncontrolled areas that were added to the Fernald Preserve controlled storm water system (refer to Figure B-27). At the conclusion of remediation in October 2006, control of storm water runoff was no longer required. The only storm water collected for treatment is that which falls on the controlled pad of the Converted Advanced Wastewater Treatment facility.

B.1.4 Proposed Surface Water Monitoring Reduction

As stated in the Fifth CERCLA Five Year Review Report (DOE 2021), based on an initial review of the surface water results, it may be appropriate to stop monitoring several locations where FRLs have not been exceeded during the five-year period. This review, which was to also take into account cross-media impact issues, was proposed to be discussed in the 2021 Site Environmental Report.

The most recent reductions in the surface water monitoring program were documented in the 2015 and 2017 Site Environmental Reports (DOE 2016 and DOE 2018, respectively). The assessment was completed due to the number of years of data that had been collected without FRL exceedances at many locations. Concentration versus time graphs were reviewed for each location and evaluated against the following criteria:

- The surface water location has never had a surface water FRL exceedance
- The cross-media impact surface water location has never had a groundwater FRL exceedance
- It has been at least 10 years since the surface water (all locations) or groundwater (cross-media impact locations) FRL exceedance has occurred

Table B-2 provides a list of surface water locations that meet these criteria. The first column identifies the location number and general location. General locations indicate whether the location is in Paddys Run, a drainage to Paddys Run, or a water body internal to the site. The second column identifies the monitored analyte. The third column identifies the current sample collection frequency. The fourth column identifies the figure that presents the concentration versus time graph. The fifth column presents the number of years that the location has been sampled. The sixth column provides the criteria met, as defined above. The last column of the table provides a recommendation.

As shown in Table B-2, it has been determined that reductions in surface water monitoring are warranted. Although total uranium collected at SWP-03 (the point where Paddys Run flows off the Fernald Preserve property) meets the criteria listed above, collection of total uranium at SWP-03 will not be eliminated.

DOE proposes to update the IEMP surface water monitoring program based on the conclusions presented above and document these changes in the 2023 LMICP. If approved by the U.S. Environmental Protection Agency, the Ohio Environmental Protection Agency (Ohio EPA), and stakeholders during the LMICP revision process, the monitoring changes would take effect January 1, 2023, and will be reflected in the 2023 LMICP.

B.2.0 References

DOE (U.S. Department of Energy), 1996. *Final Record of Decision for Remedial Actions at Operable Unit 5*, 7478 U-007-501.4, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio, January.

DOE (U.S. Department of Energy), 2001. *Explanation of Significant Differences for Operable Unit 5*, FEMP-OU5-ESD-FINAL, Final, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio, October.

DOE (U.S. Department of Energy), 2016. *Fernald Preserve 2015 Site Environmental Report*, LMS/FER/S13591, Office of Legacy Management, May.

DOE (U.S. Department of Energy), 2018. *Fernald Preserve 2017 Site Environmental Report*, LMS/FER/S17983, Office of Legacy Management, May.

DOE (U.S. Department of Energy), 2019. *Comprehensive Legacy Management and Institutional Controls Plan*, LMS/FER/S03496, Revision 12, Office of Legacy Management, Fernald Area Office, Cincinnati, Ohio, January.

DOE (U.S. Department of Energy), 2021. *Fifth Five-Year Review Report for the Fernald Preserve*, LMS/FER/S33442, Office of Legacy Management, September.

Table B-1. Summary Statistics and Trend Analysis for Constituents with 2021 Results Above Surface Water FRLs

Location[a]	Constituent	Number of Samples[b,c,d]	Number of Samples Above FRL[b,c,d]	Number of Samples Above FRL for 2021[c,d]	FRL[e] (µg/L)	Maximum FRL Exceedance 2021 (µg/L)	Min[b,c,d,f,g] (µg/L)	Max.[b,c,d,f,g] (µg/L)	Average[b,c,d,f,g] (µg/L)	SD[b,c,d,f,g] (µg/L)	Trend[b,c,d,f,g] (µg/L)
SWD-05	Uranium	265	16	0	530	Not Applicable	4.4	988	229	185	Down
SWD-09	Uranium	454	277	18	530	1,201	16.4	2,087	665	368	Down

[a] Refer to Figure B-1.
[b] Based on samples collected from January 3, 2007, through December 31, 2021.
[c] If more than one sample is collected per surface water location per day (e.g., duplicate, grab, composite), then only one sample is counted for the number of samples, and the sample with the maximum concentration is used for determining the summary statistics (minimum, maximum, average, and standard deviation), the Mann-Kendall test for trend with a 95% confidence interval, and in determining FRL exceedances.
[d] Rejected data qualified with laboratory qualifiers R or Z were not included in the count, the summary statistics, or Mann-Kendall test for trend.
[e] FRL = Final Remediation Level. From OU5 ROD, Table 9−5.
[f] For results where the concentrations are below the detection limit, the results used in the summary statistics and Mann-Kendall test for trend are each set at half the method detection limit.
[g] If the number of samples is greater than or equal to four, then all of the summary statistics and the Mann-Kendall test for trend are reported. If the total number of samples is equal to three, then the minimum, maximum, and average are reported. If the total number of samples is equal to two, then the minimum and maximum are reported. If the total number of samples is equal to one, then the data point is reported as the minimum.

Table B-2. Proposed Surface Water Monitoring Reductions

Location	Constituent	IEMP Requirements (Reason for Selection)[a]	Figure Number	Years of Data	Criteria[b]	Recommendation
SWD-03 (Waste Storage Area)[c]	Uranium, Total	Semiannual (PC)	B-3	25	3	Stop Monitoring
SWD-07 (Storm Sewer Outfall Ditch)[c]	Uranium, Total	Semiannual (PC)	B-6	15	3	Stop Monitoring
SWD-08 (Former Southern Waste Units Area)[c]	Radium-226	Annual (C)	B-21	14	1, 2	Stop Monitoring
	Radium-228	Annual (C)	B-22	14	1, 2	Stop Monitoring
	Thorium-228	Annual (C)	B-23	14	1, 2	Stop Monitoring
	Thorium-230	Annual (C)	B-24	14	1, 2	Stop Monitoring
SWD-06 (Former Pilot Plant)	Uranium, Total	Semiannual (PC)	B-9	15	1	Stop Monitoring
SWD-10 (Lodge Pond)	Uranium, Total	Annual (PC)	B-10	13	1	Stop Monitoring
SWD-11 (Former Lime Sludge Pond)	Uranium, Total	Annual (PC)	B-11	13	1	Stop Monitoring
SWD-12 (Former Area 4B)	Uranium, Total	Annual (PC)	B-12	13	1	Stop Monitoring
SWD-13 (Former Silos Area)	Uranium, Total	Annual (PC)	B-13	13	1	Stop Monitoring
SWP-03 (Paddys Run at Downstream Property Boundary)	Uranium, Total	Annual (PC)	B-14	25	1	No Change
SWD-04 (Former Waste Pit 3)[c]	Radium-226	Annual (C)	B-15	14	1, 2	Stop Monitoring
SWD-05 (Former Waste Storage Area)[c]	Radium-226	Annual (C)	B-16	14	1, 2	Stop Monitoring
	Radium-228	Annual (C)	B-17	14	1, 2	Stop Monitoring
	Thorium-230	Annual (C)	B-19	14	1,2	Stop Monitoring

[a] C = DOE response to Ohio EPA comment, 2008 LMICP; PC = primary constituent of concern.
[b] 1 = Surface water location — no surface water FRL exceedance.
2 = Cross-media impact location — no groundwater FRL exceedance.
3 = Surface water location — minimum of 10 years since surface water or groundwater FRL exceedance.
[c] Cross-media impact location.

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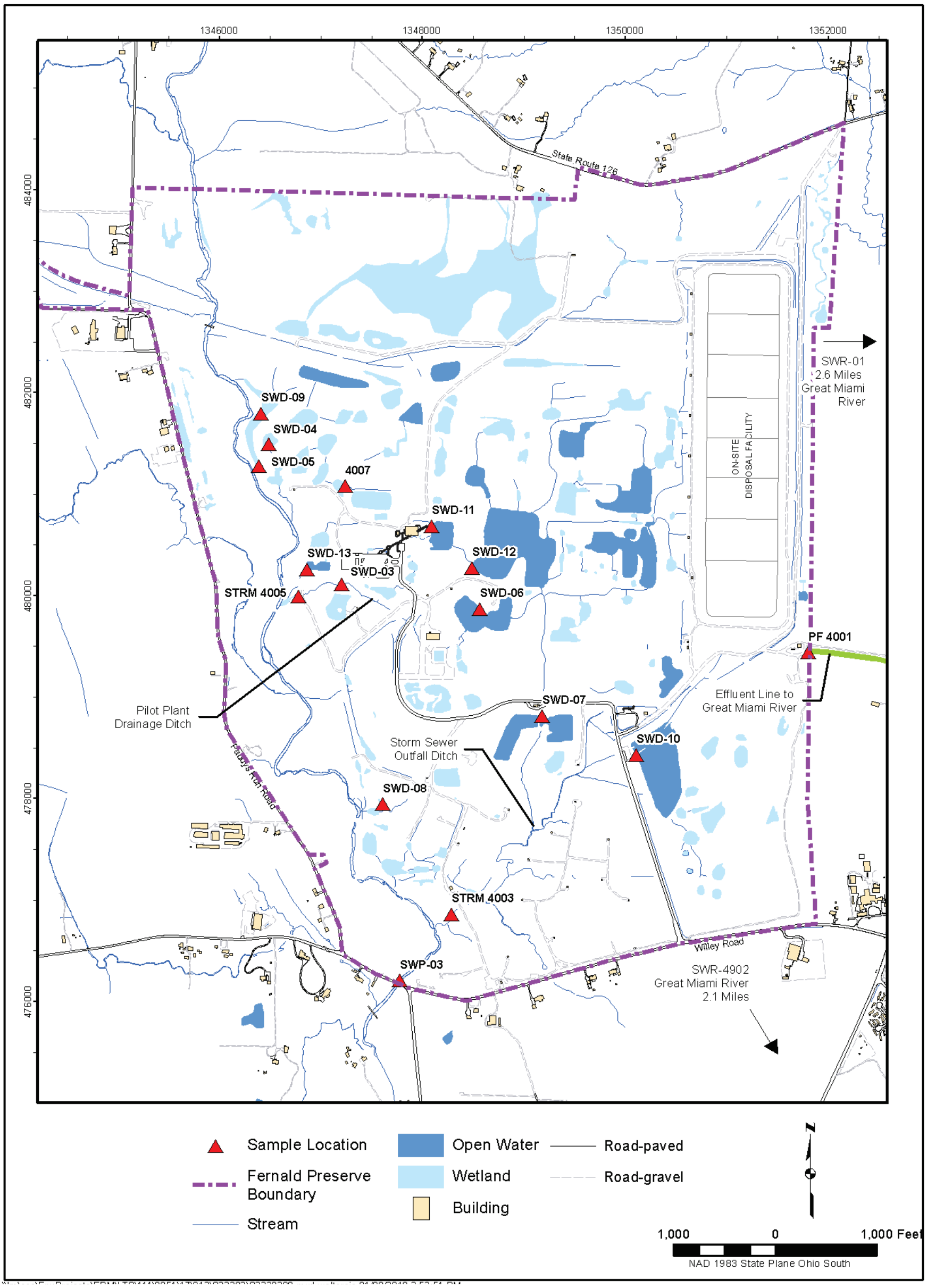

Figure B-1. IEMP/NPDES Surface Water and Effluent Sample Locations

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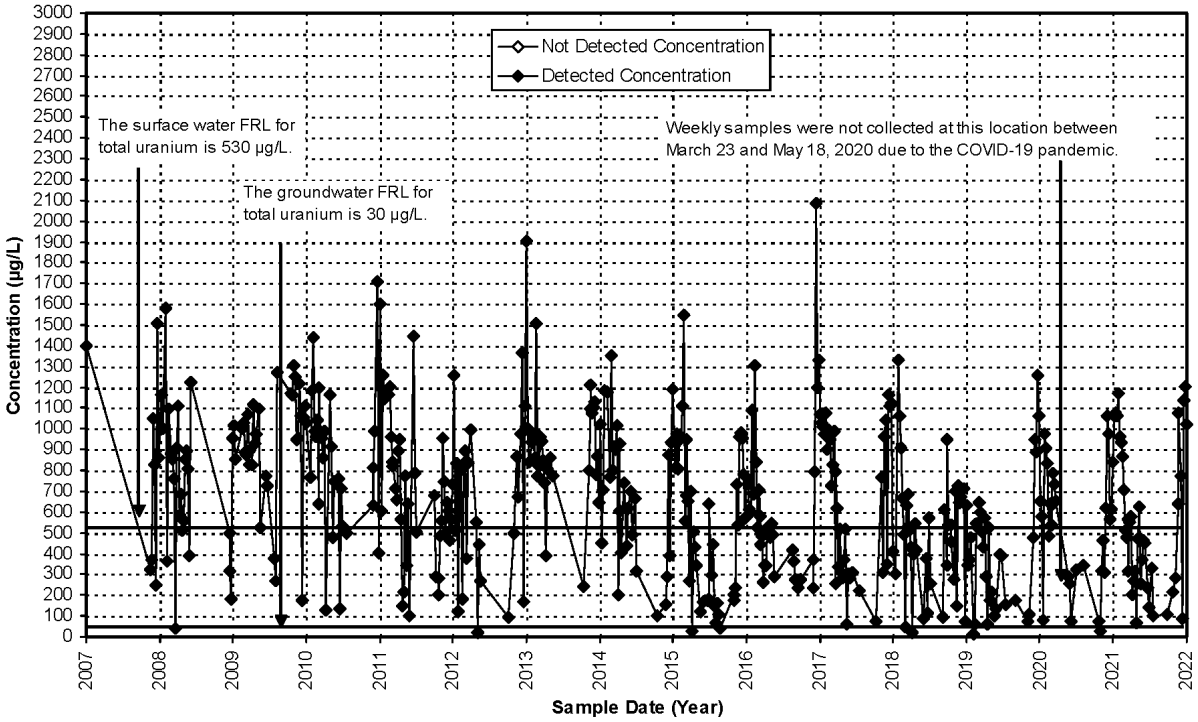

Figure B-2. Total Uranium Concentration Versus Time Plot for Location SWD-09 (Former Waste Storage Area)

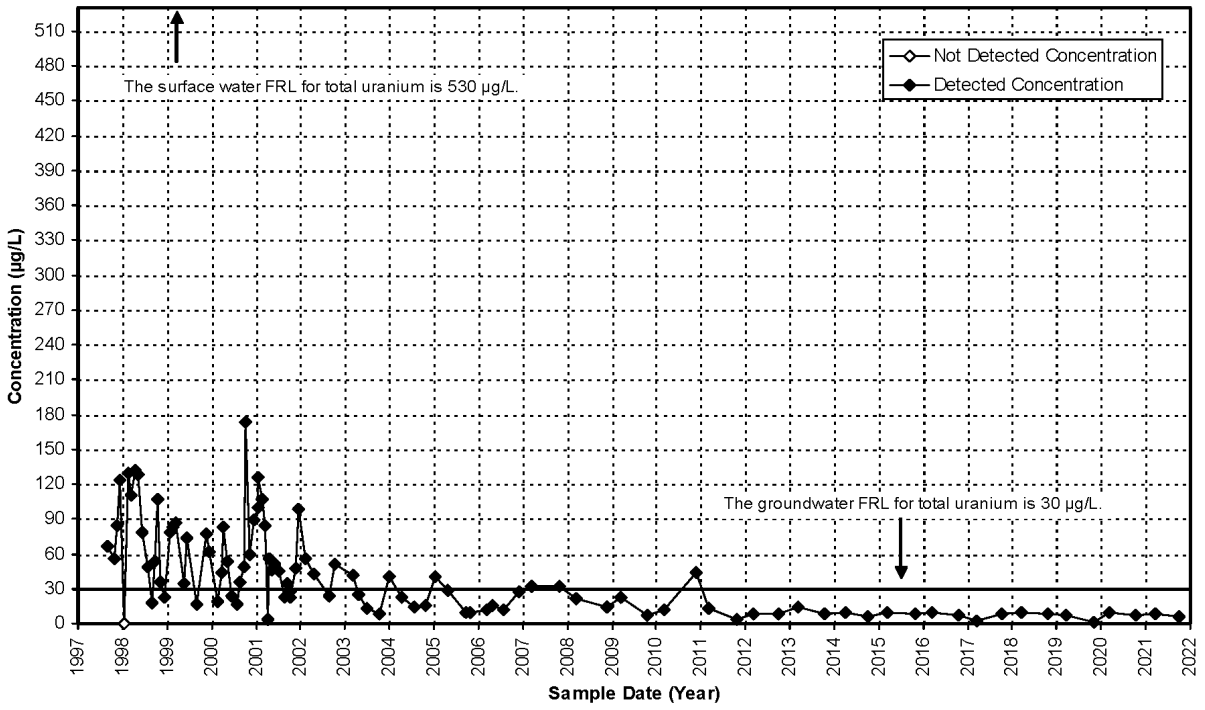

Figure B-3. Total Uranium Concentration Versus Time Plot for Location SWD-03 (Former Waste Storage Area) for Cross-Media Impact Evaluation

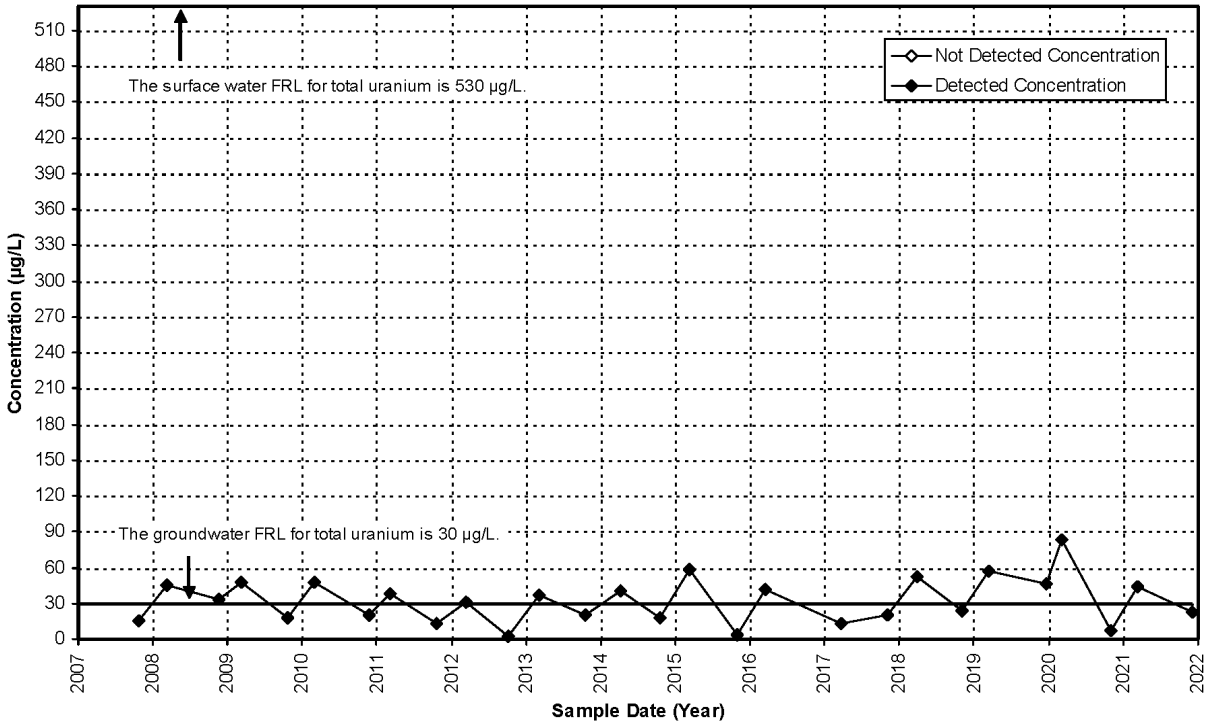

Figure B-4. Total Uranium Concentration Versus Time Plot for Location SWD-04 (Former Waste Pit 3) for Cross-Media Impact Evaluation

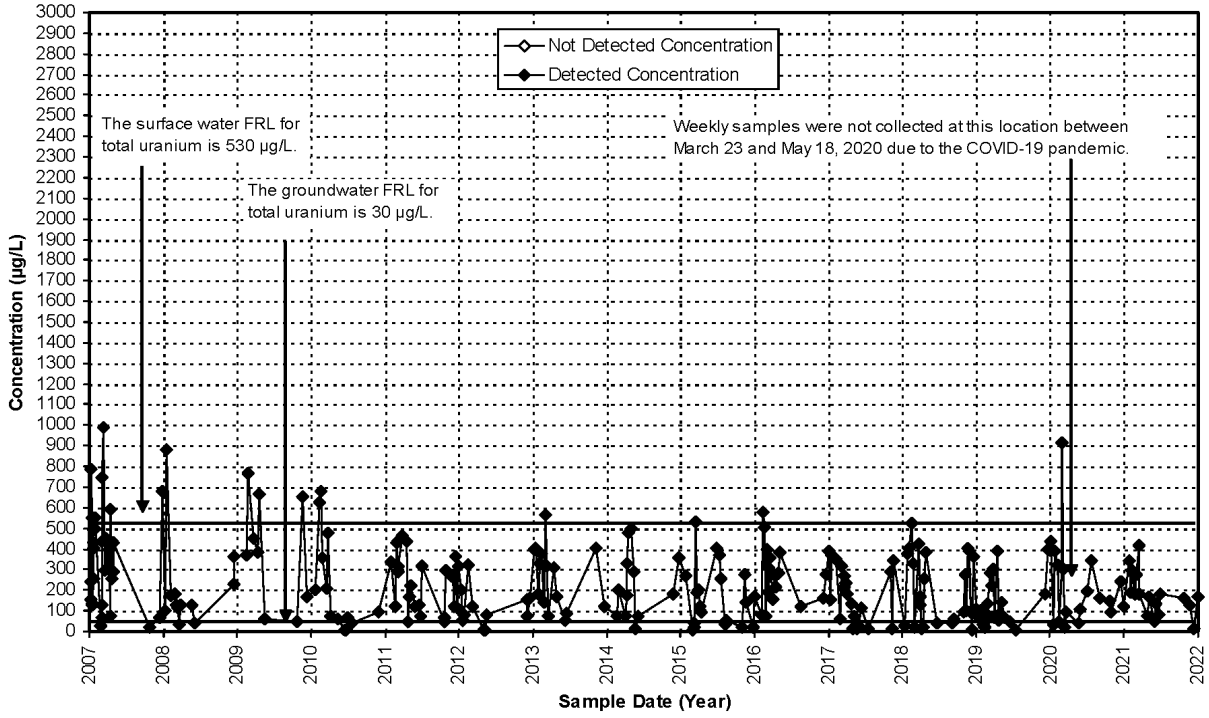

Figure B-5. Total Uranium Concentration Versus Time Plot for Location SWD-05 (Former Waste Storage Area) for Cross-Media Impact Evaluation

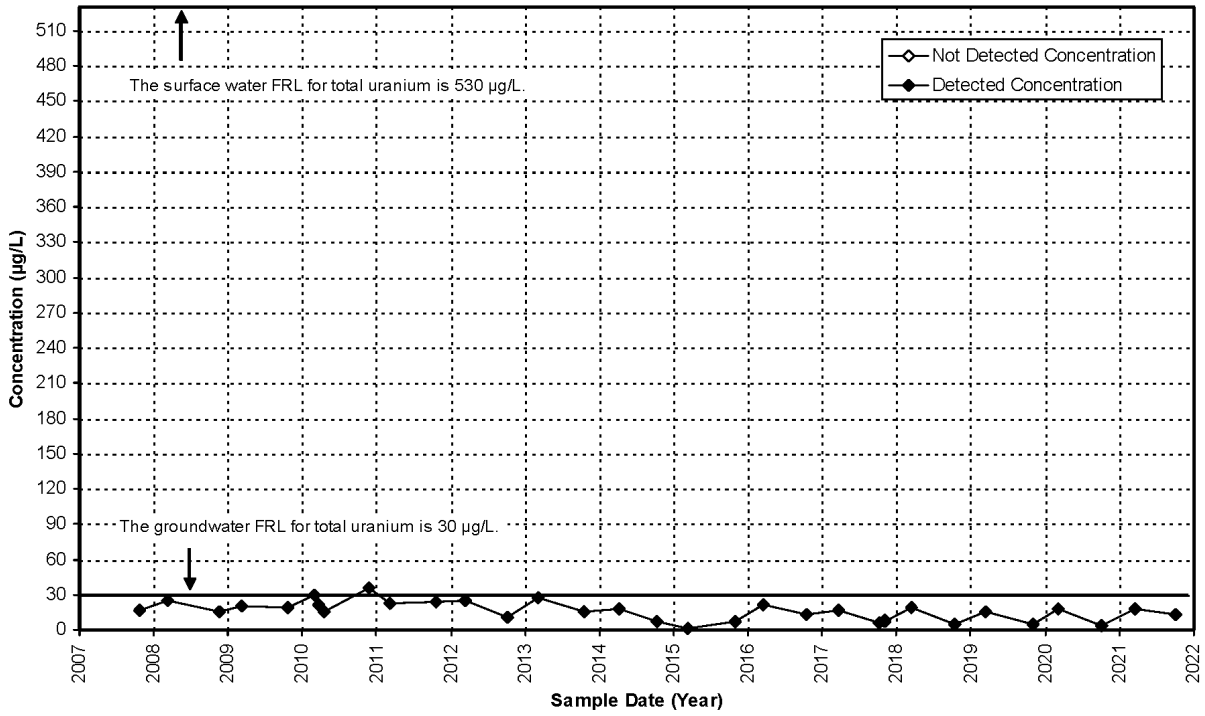

Figure B-6. Total Uranium Concentration Versus Time Plot for Location SWD-07 (Former Production Area Drainage) for Cross-Media Impact Evaluation

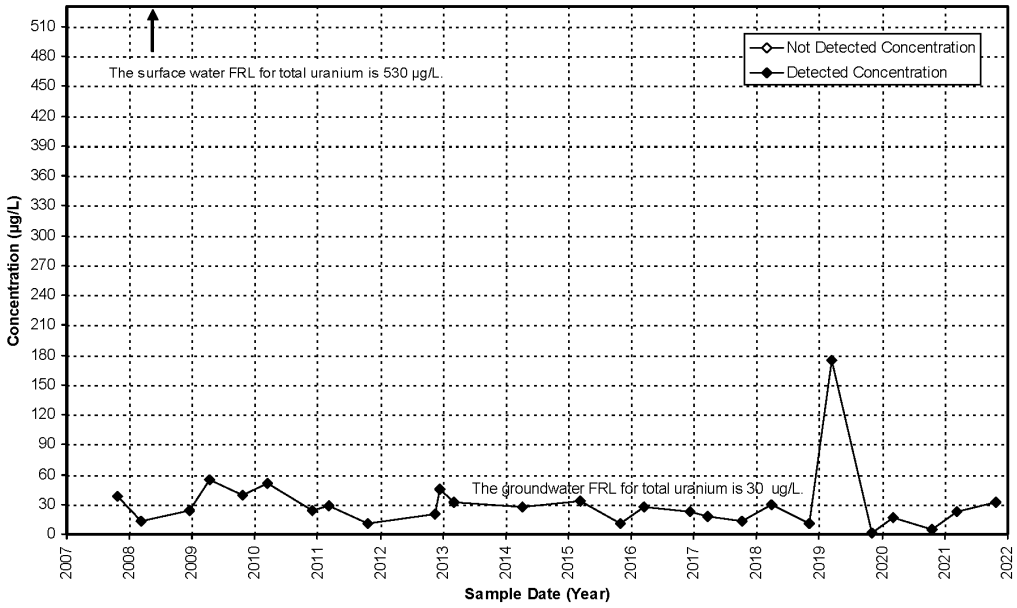

Figure B-7. Total Uranium Concentration Versus Time Plot for Location SWD-08 (Former Southern Waste Units) for Cross-Media Impact Evaluation

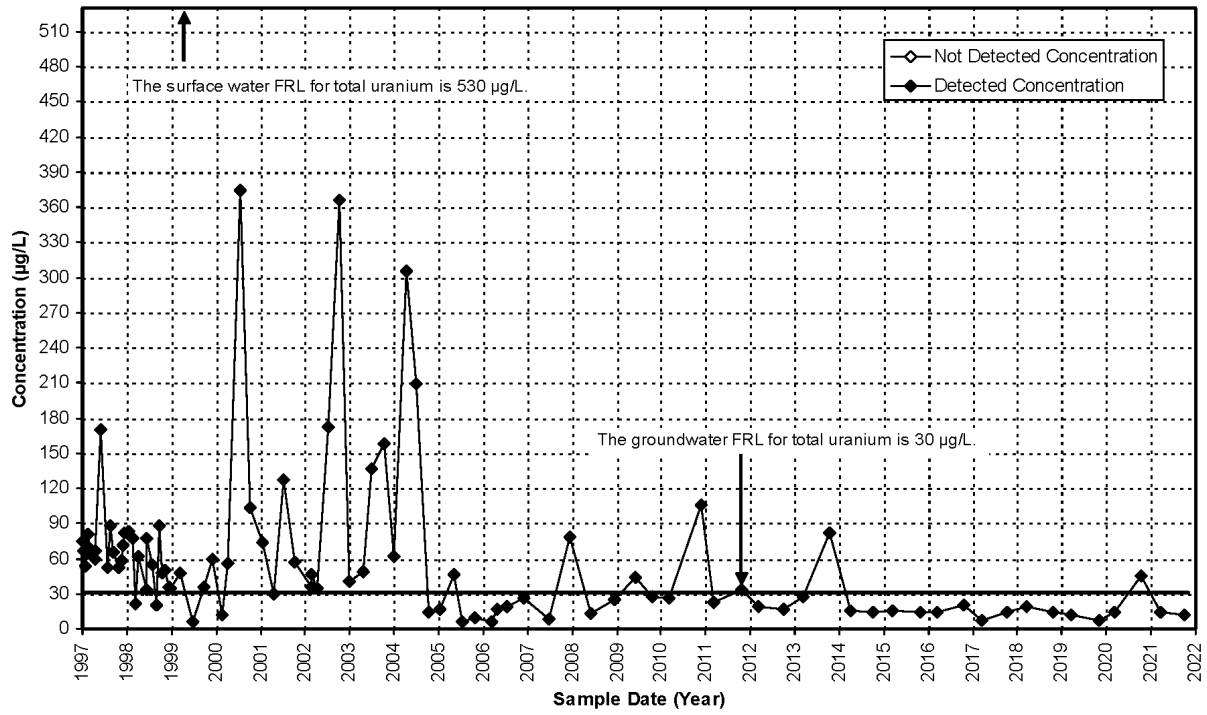

Figure B-8. Total Uranium Concentration Versus Time Plot for Location STRM 4005 (Drainage to Paddys Run) for Cross-Media Impact Evaluation

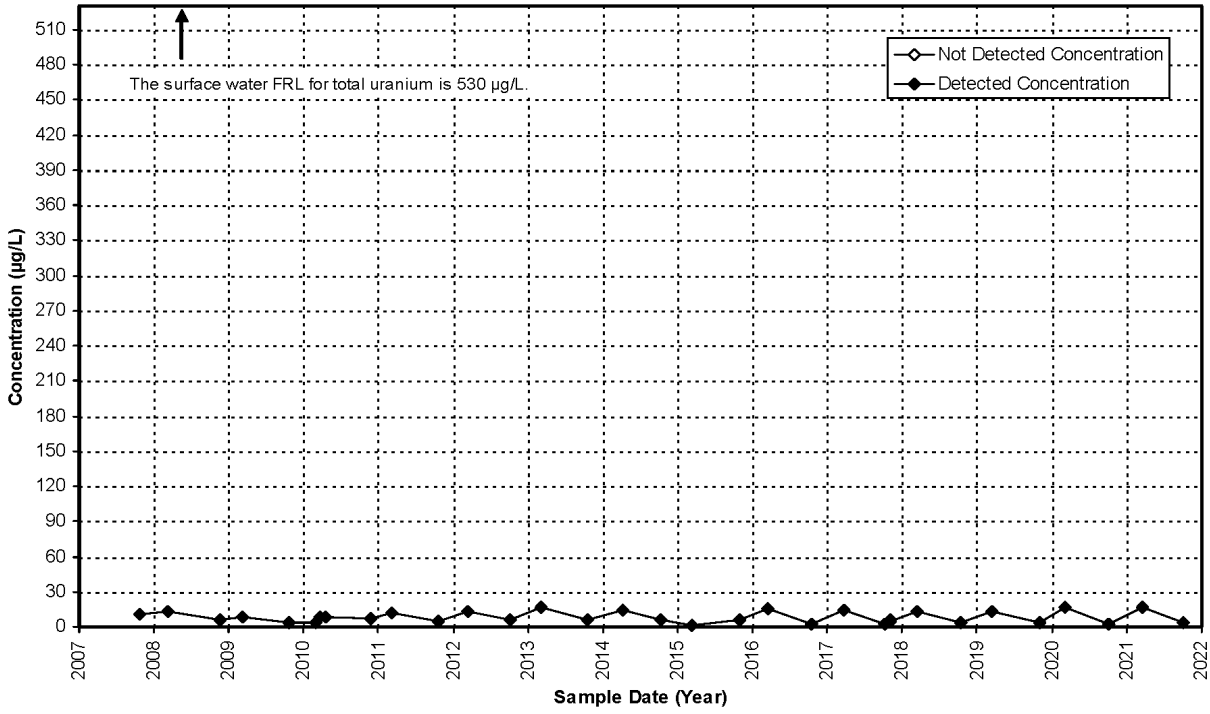

Figure B-9. Total Uranium Concentration Versus Time Plot for Location SWD-06 (Former Pilot Plant)

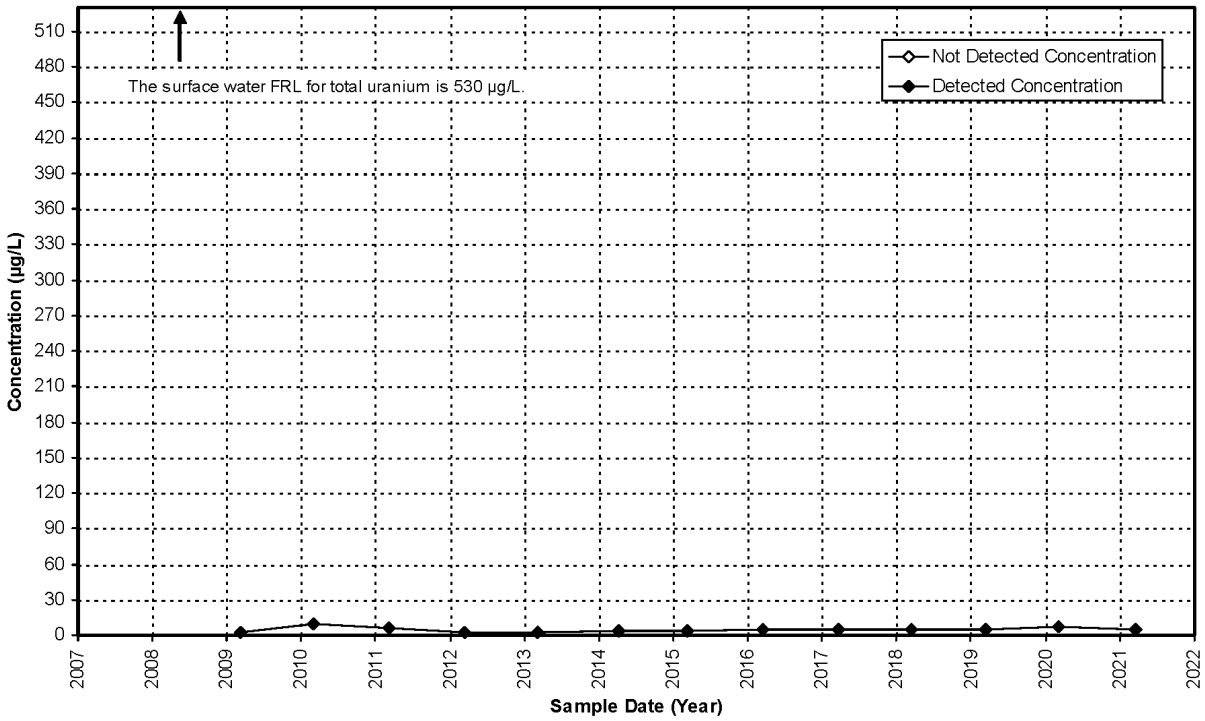

Figure B-10. Total Uranium Concentration Versus Time Plot for Location SWD-10 (Lodge Pond)

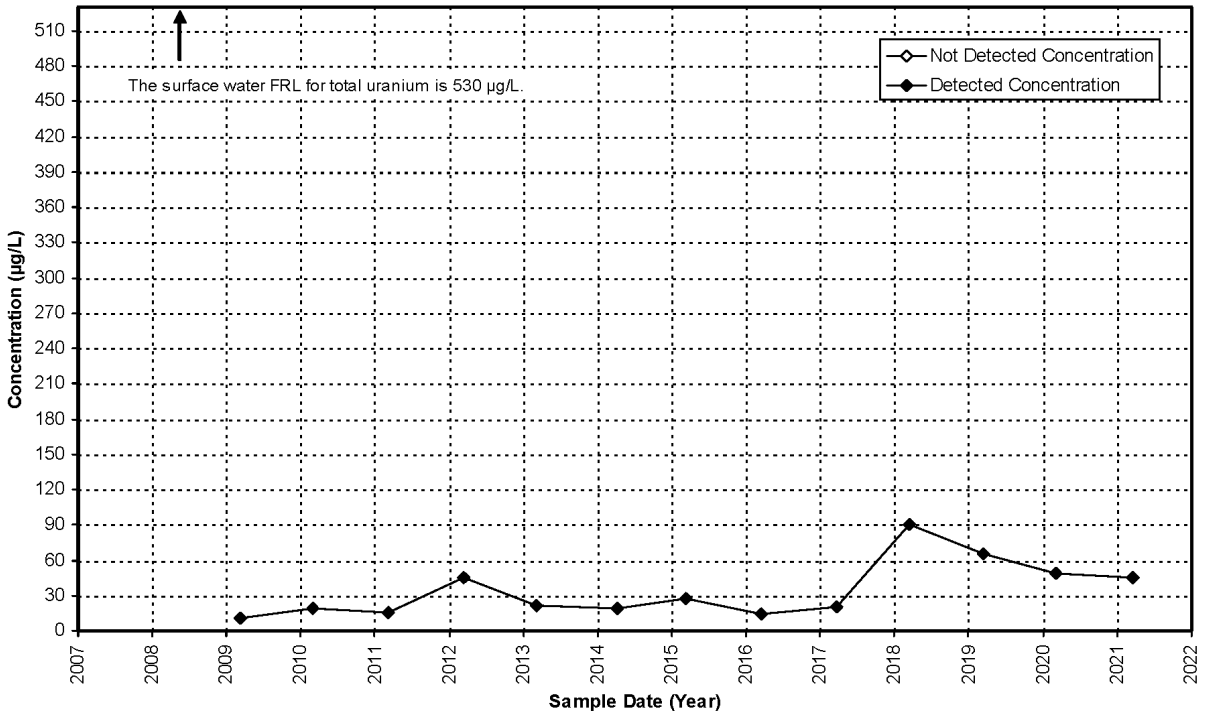

Figure B-11. Total Uranium Concentration Versus Time Plot for Location SWD-11 (Former Lime Sludge Pond)

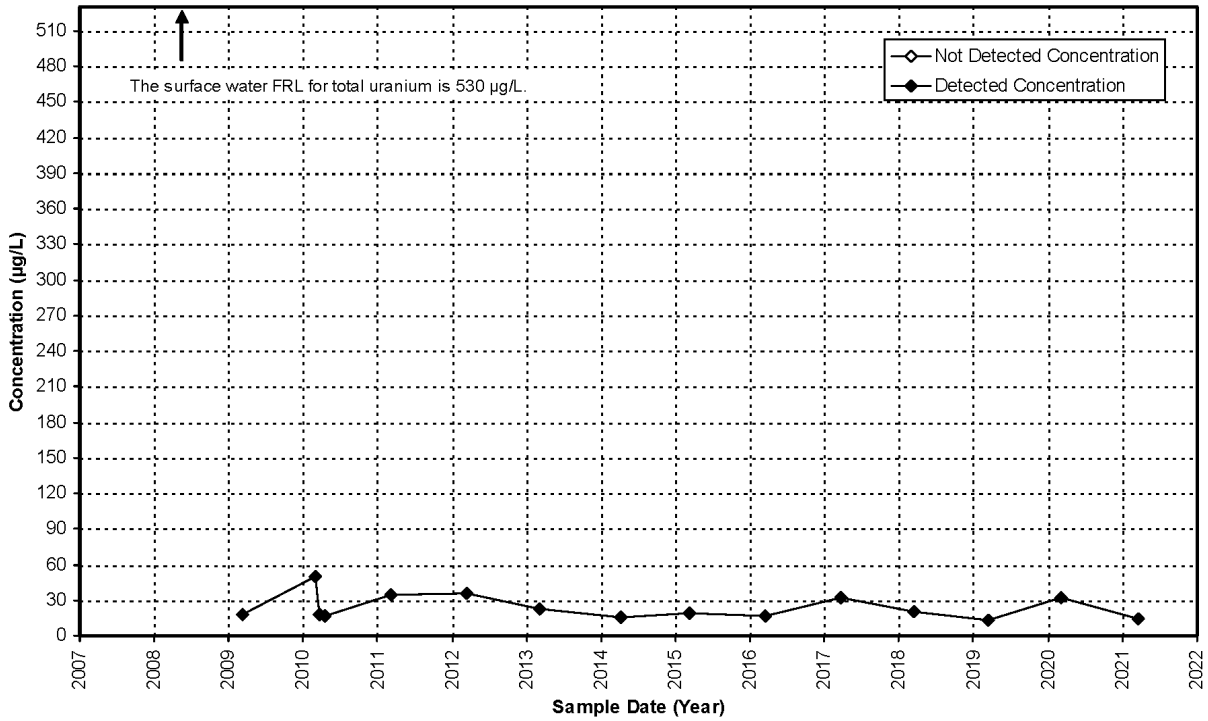

Figure B-12. Total Uranium Concentration Versus Time Plot for Location SWD-12 (Former Area 4B)

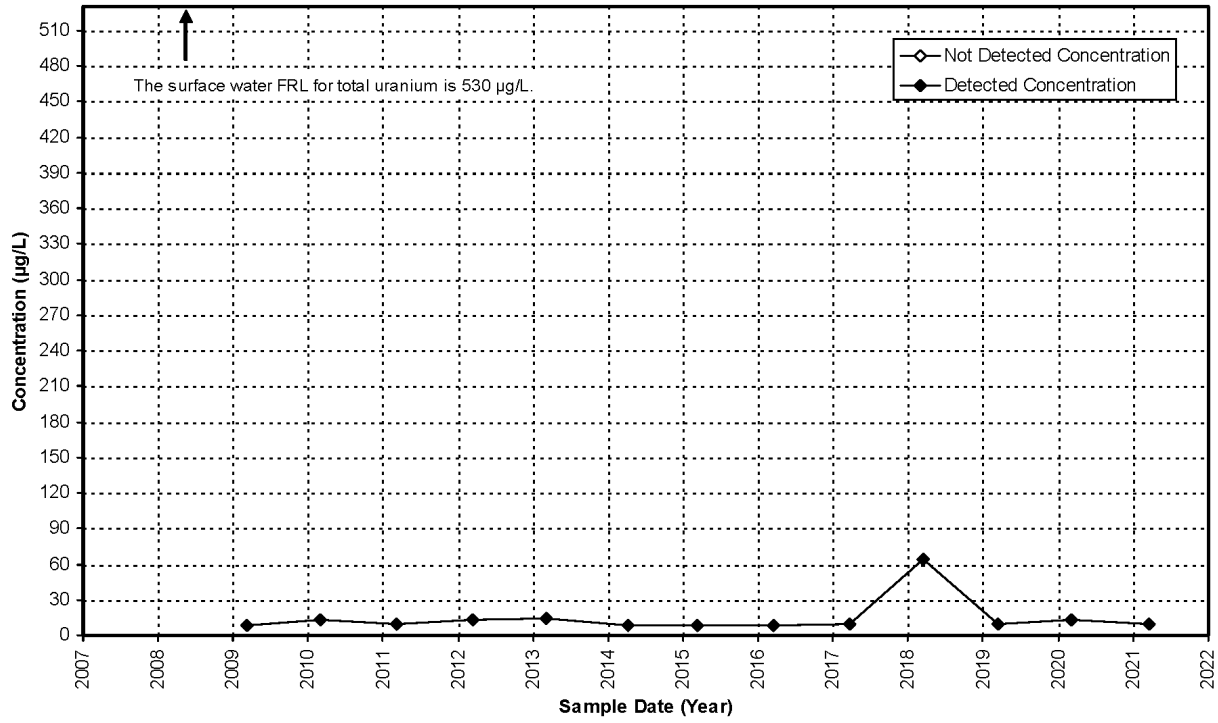

Figure B-13. Total Uranium Concentration Versus Time Plot for Location SWD-13 (Former Silos Area)

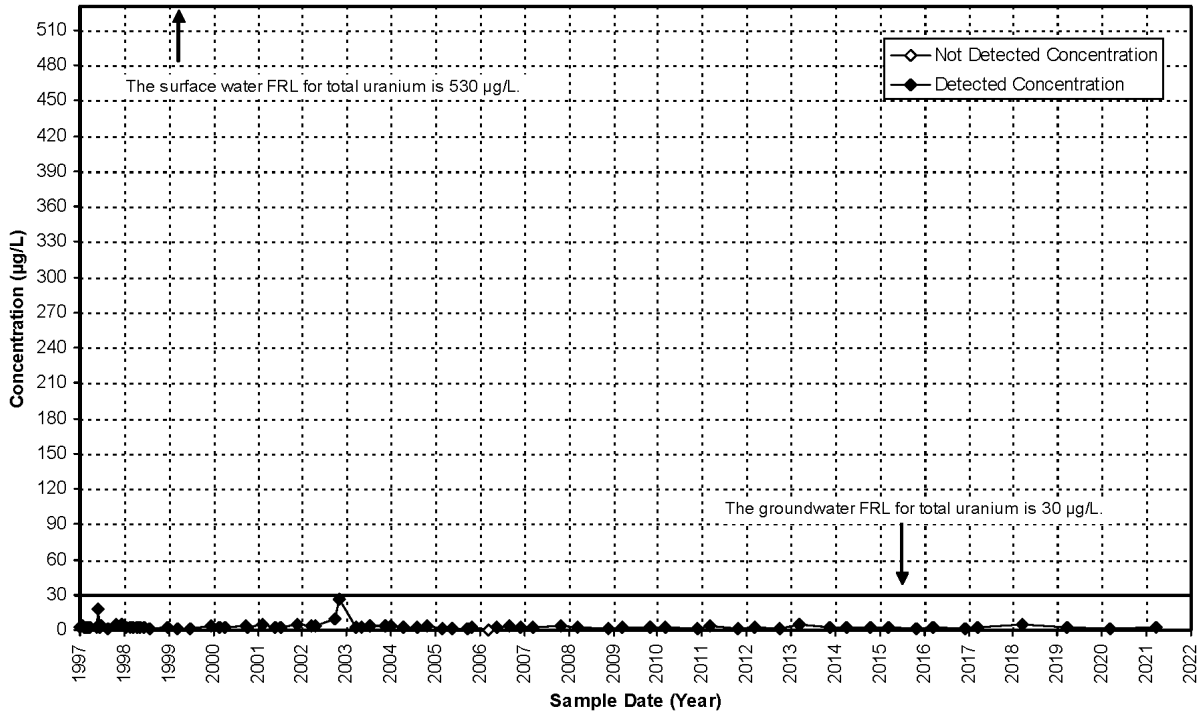

Figure B-14. Total Uranium Concentration Versus Time Plot for Location SWP-03 (Paddys Run at Downstream Property Boundary)

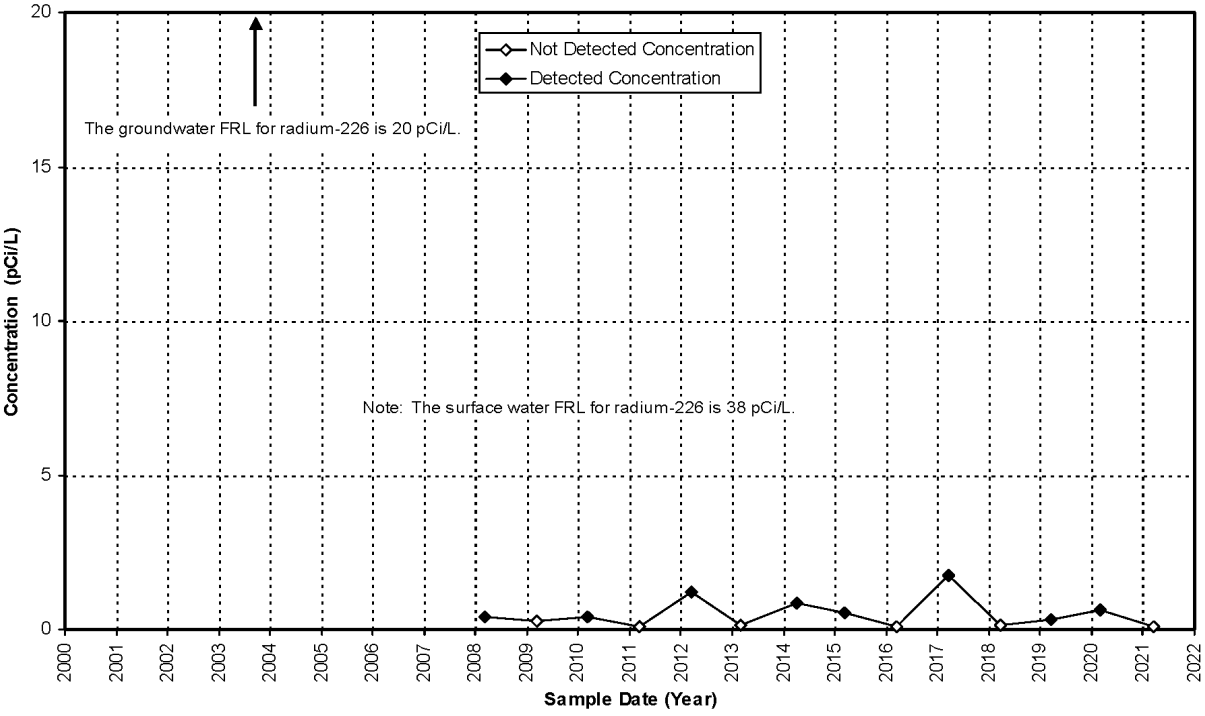

Figure B-15. Radium-226 Concentration Versus Time Plot for Location SWD-04 (Former Waste Pit 3) for Cross-Media Impact Evaluation

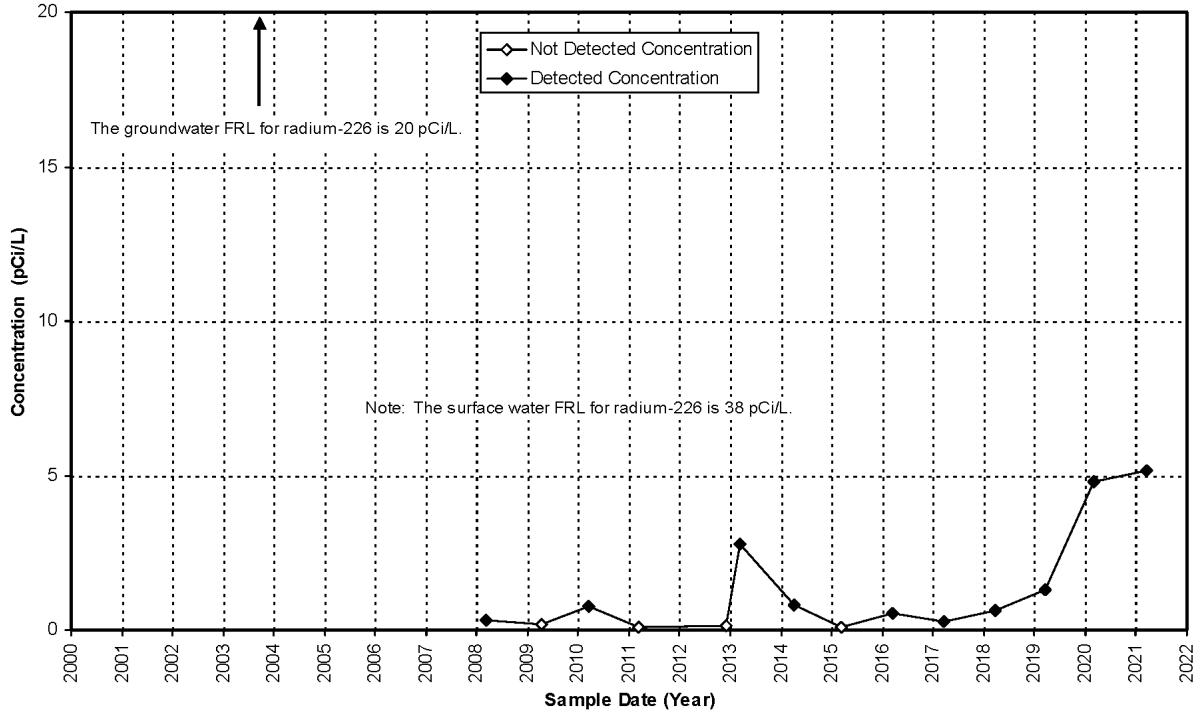

Figure B-16. Radium-226 Concentration Versus Time Plot for Location SWD-05 (Former Waste Storage Area) for Cross-Media Impact Evaluation

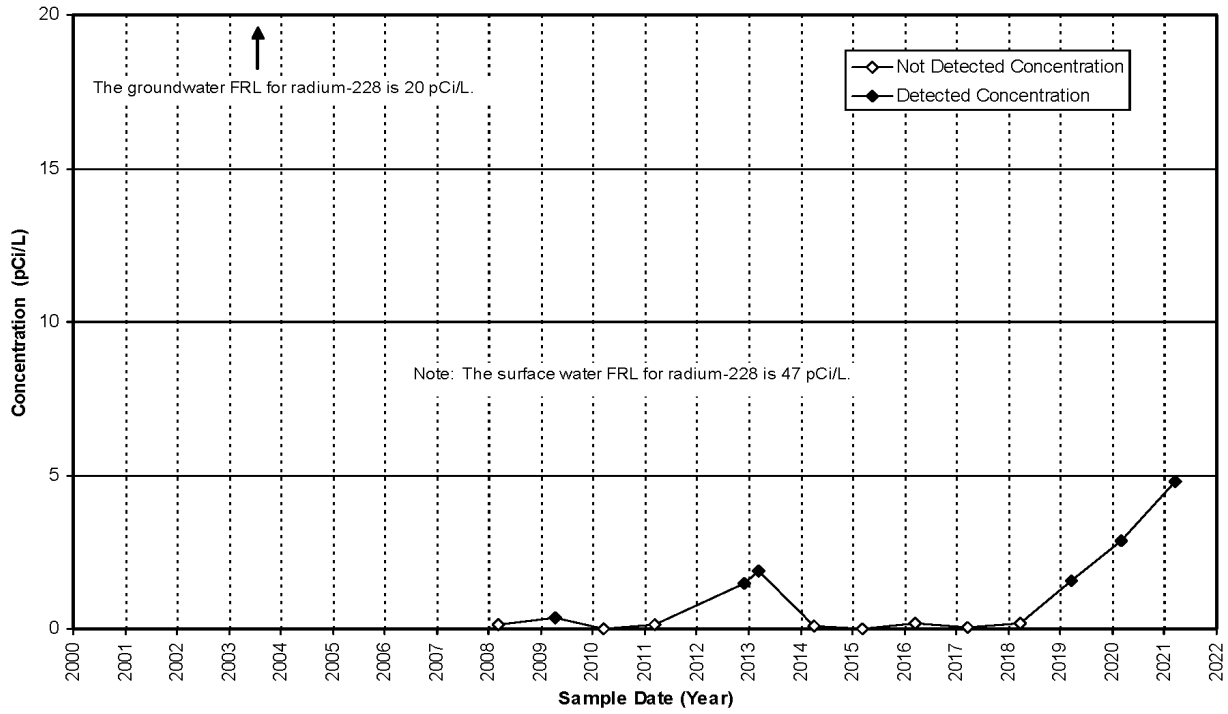

Figure B-17. Radium-228 Concentration Versus Time Plot for Location SWD-05 (Former Waste Storage Area) for Cross-Media Impact Evaluation

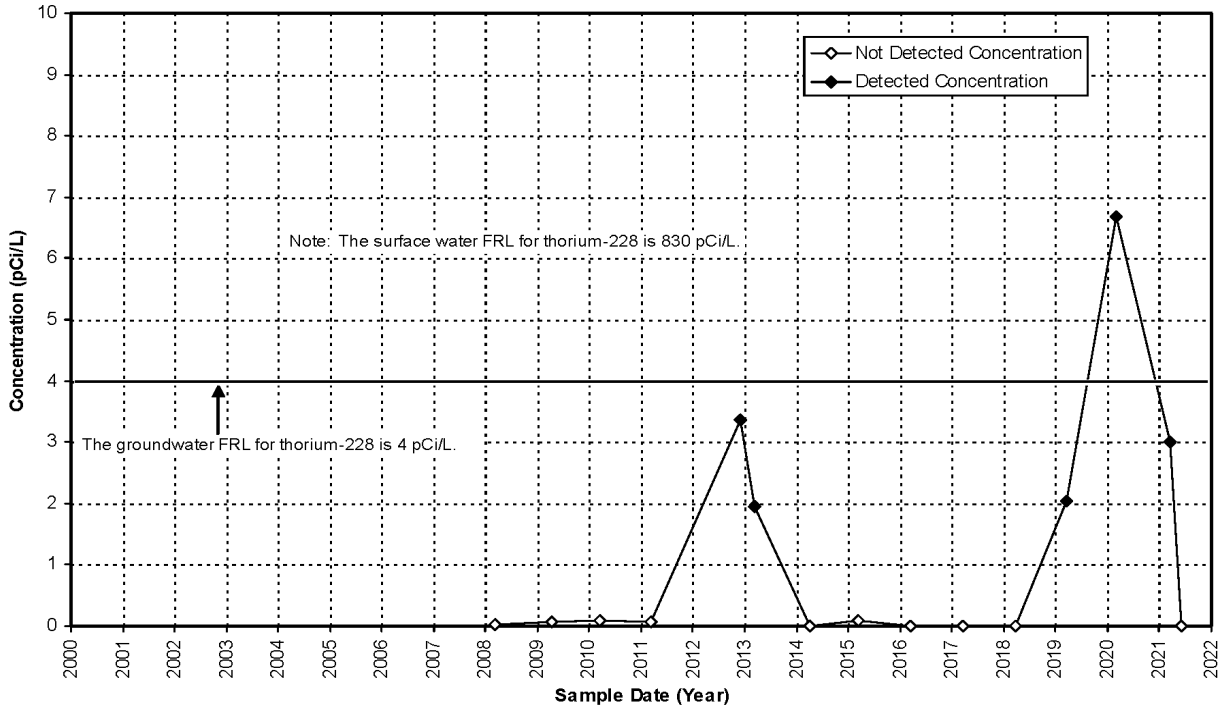

Figure B-18. Thorium-228 Concentration Versus Time Plot for Location SWD-05 (Former Waste Storage Area) for Cross-Media Impact Evaluation

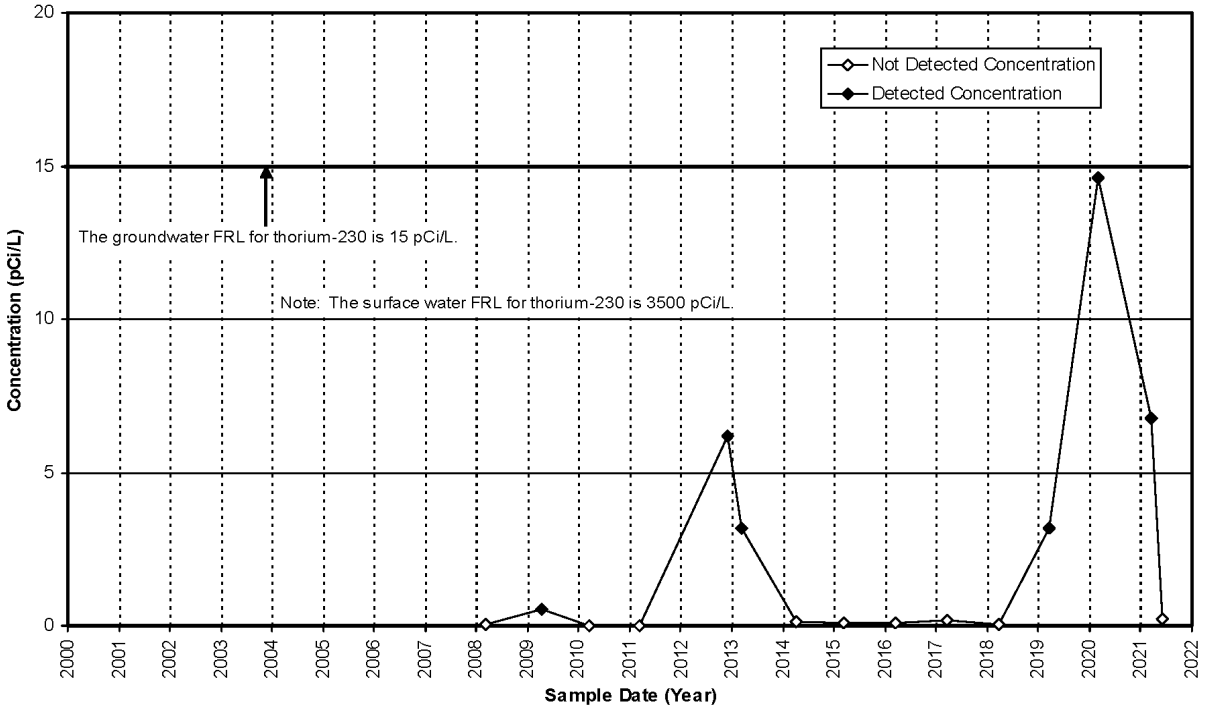

Figure B-19. Thorium-230 Concentration Versus Time Plot for Location SWD-05 (Former Waste Storage Area) for Cross-Media Impact Evaluation

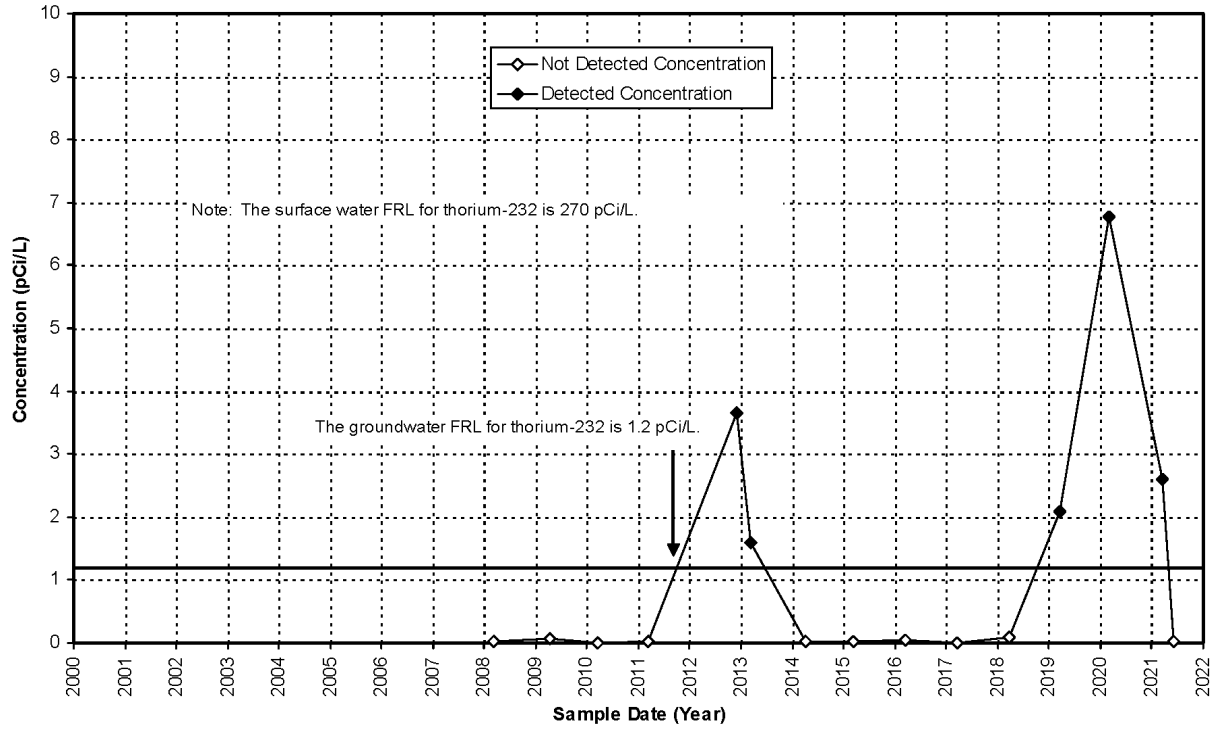

Figure B-20. Thorium-232 Concentration Versus Time Plot for Location SWD-05 (Former Waste Storage Area) for Cross-Media Impact Evaluation

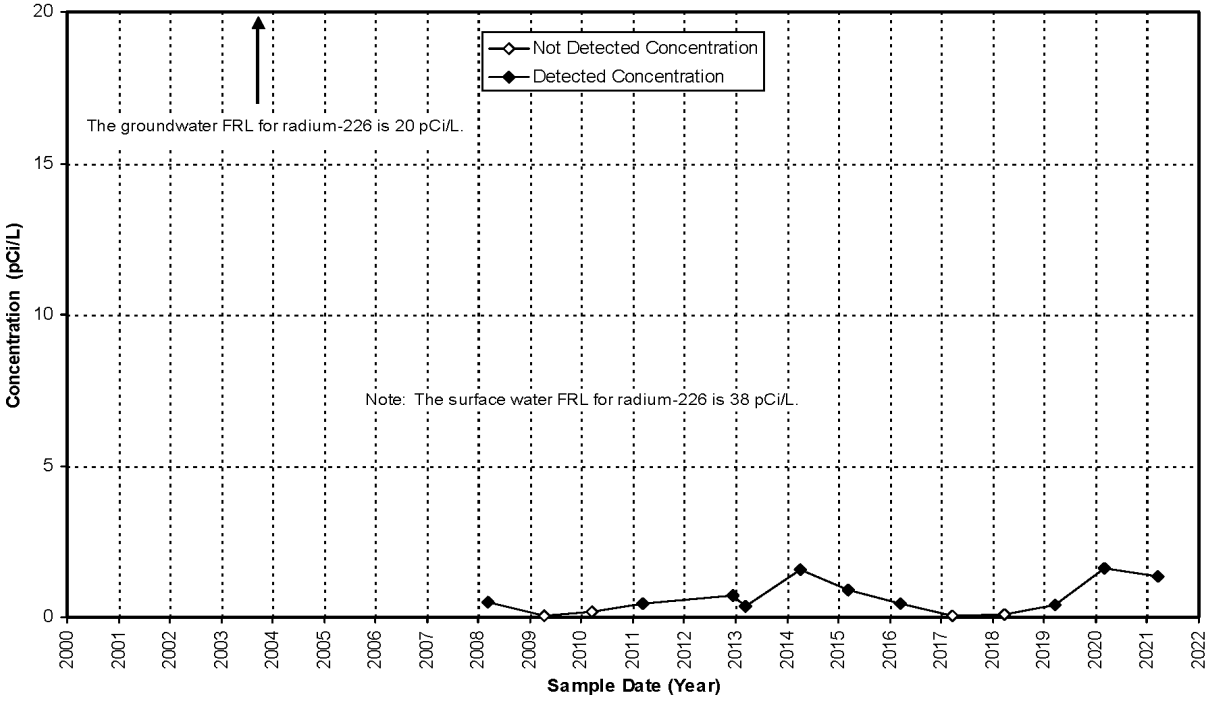

Figure B-21. Radium-226 Concentration Versus Time Plot for Location SWD-08 (Former Southern Waste Units) for Cross-Media Impact Evaluation

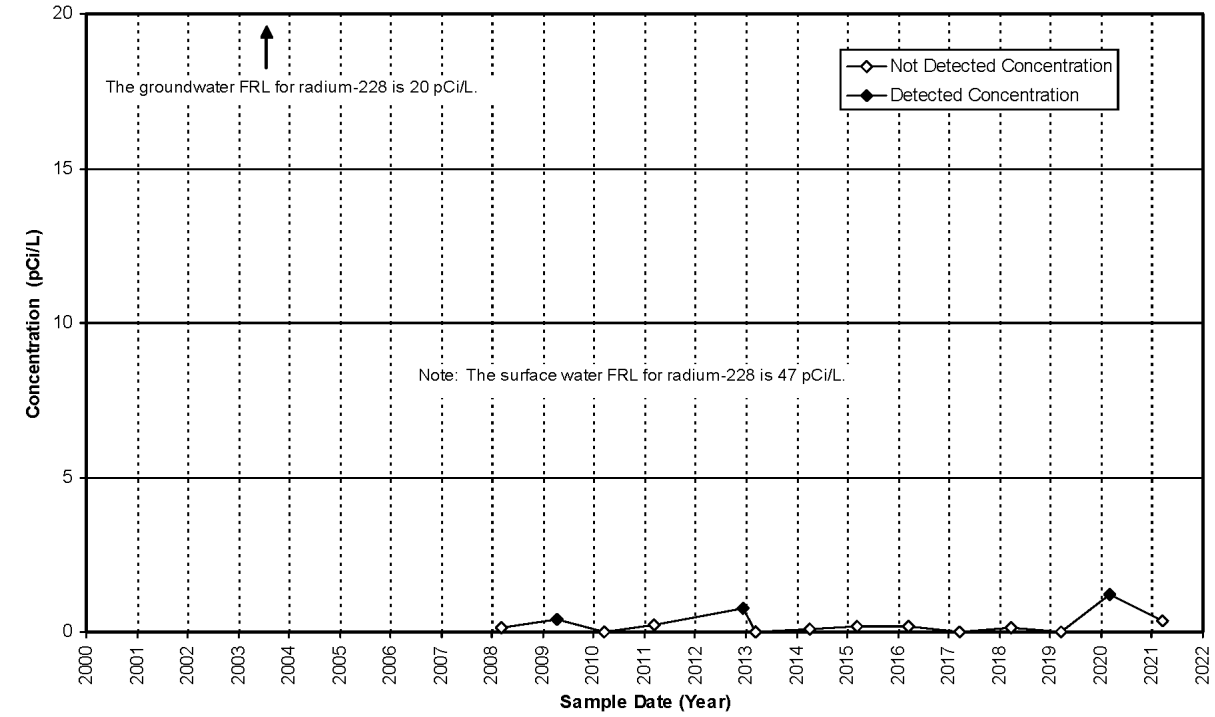

Figure B-22. Radium-228 Concentration Versus Time Plot for Location SWD-08 (Former Southern Waste Units) for Cross-Media Impact Evaluation

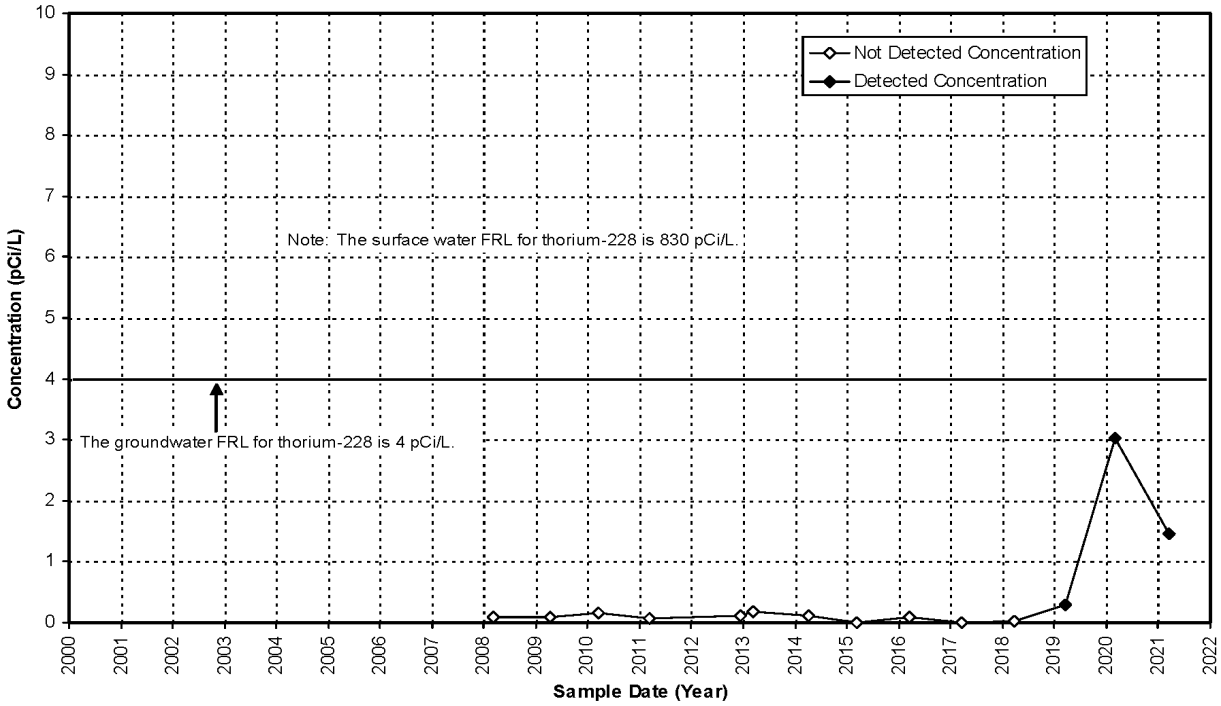

Figure B-23. Thorium-228 Concentration Versus Time Plot for Location SWD-08 (Former Southern Waste Units) for Cross-Media Impact Evaluation

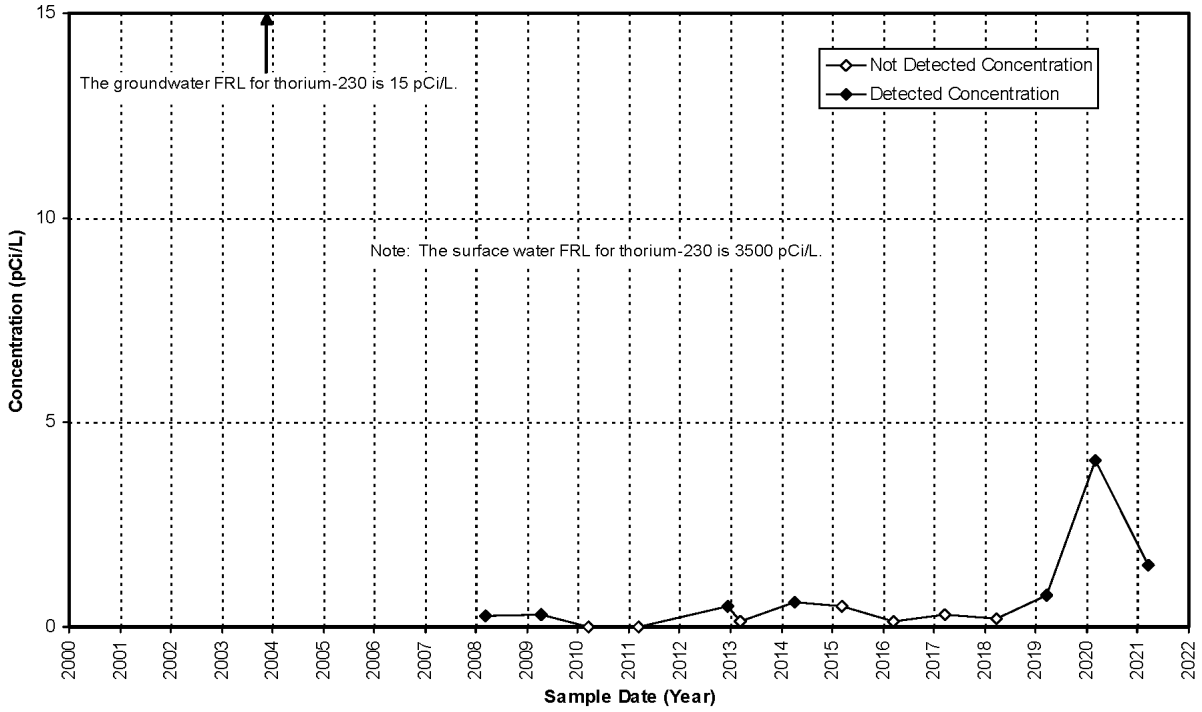

Figure B-24. Thorium-230 Concentration Versus Time Plot for Location SWD-08 (Former Southern Waste Units) for Cross-Media Impact Evaluation

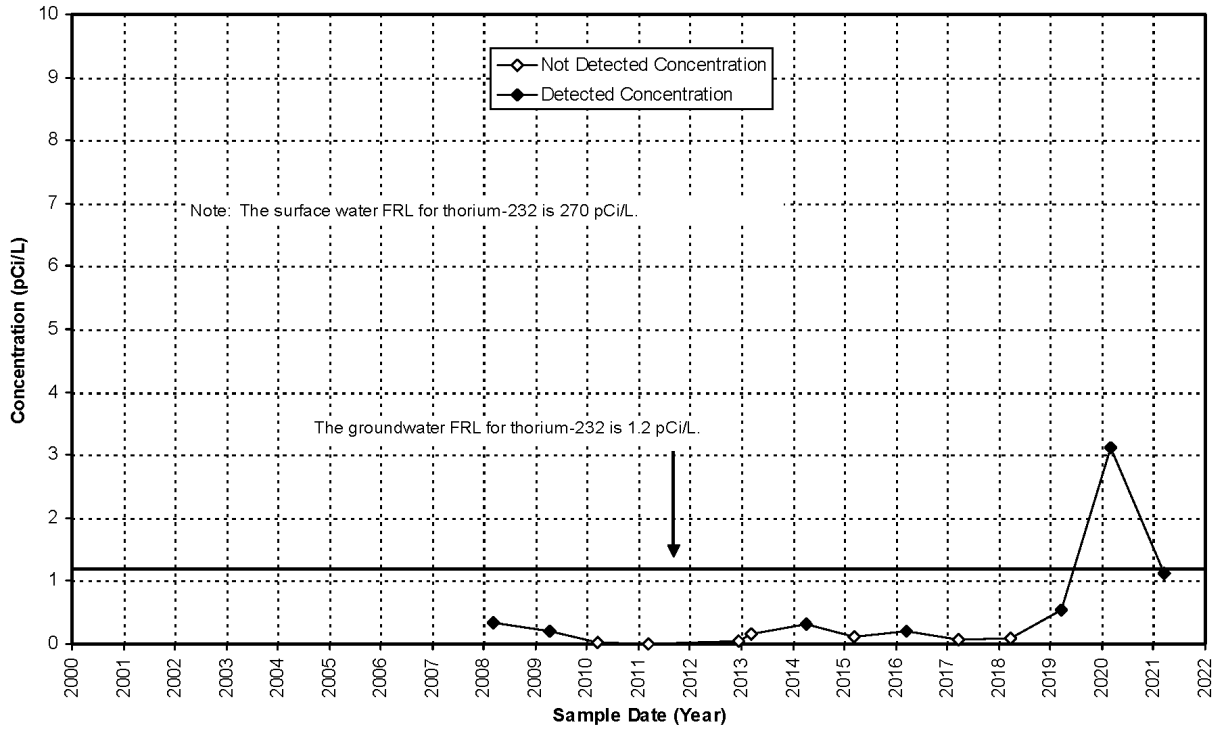

Figure B-25. Thorium-232 Concentration Versus Time Plot for Location SWD-08 (Former Southern Waste Units) for Cross-Media Impact Evaluation

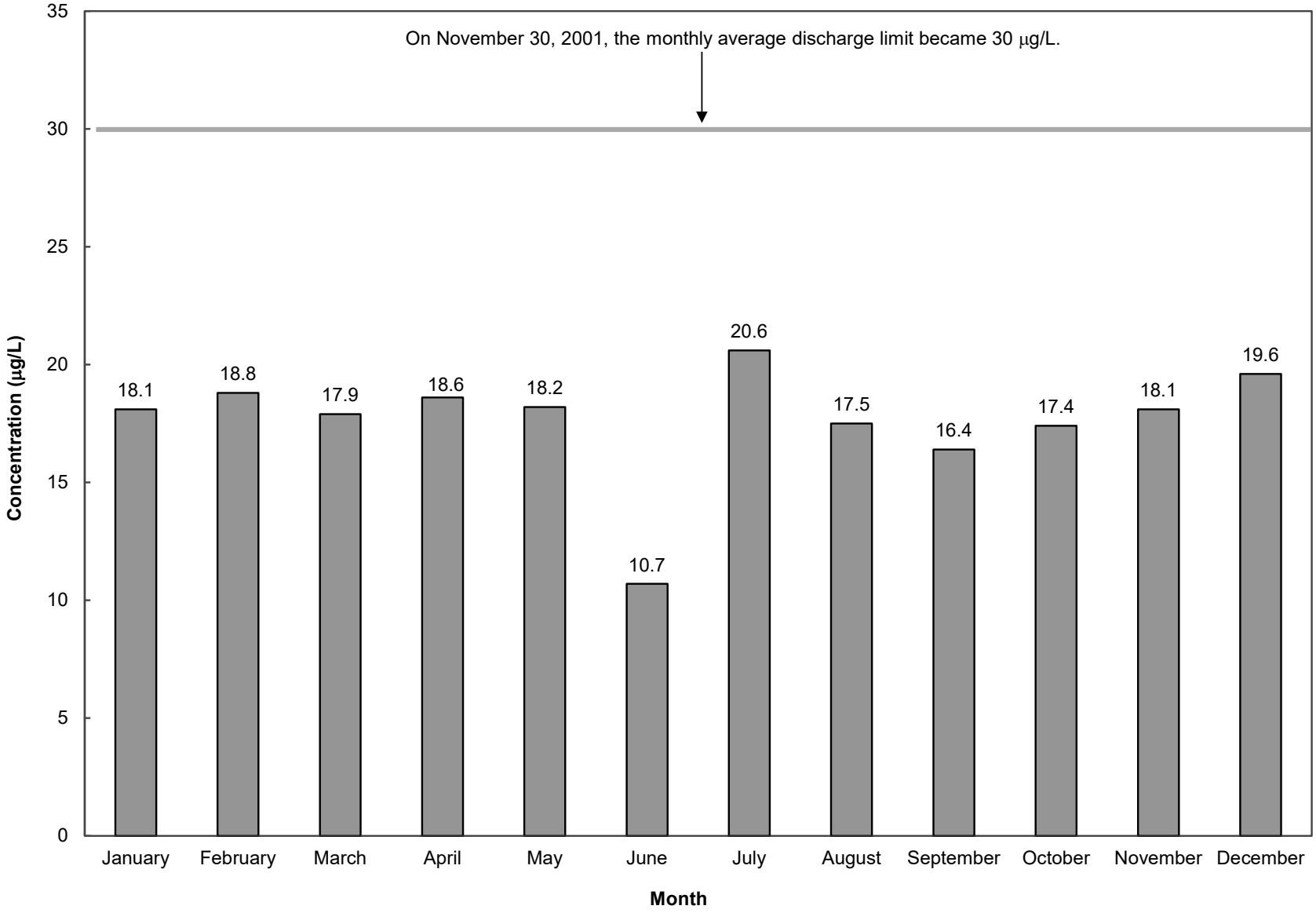

Figure B-26. 2021 Monthly Average Total Uranium Concentration in Water Discharged from PF 4001 to the Great Miami River

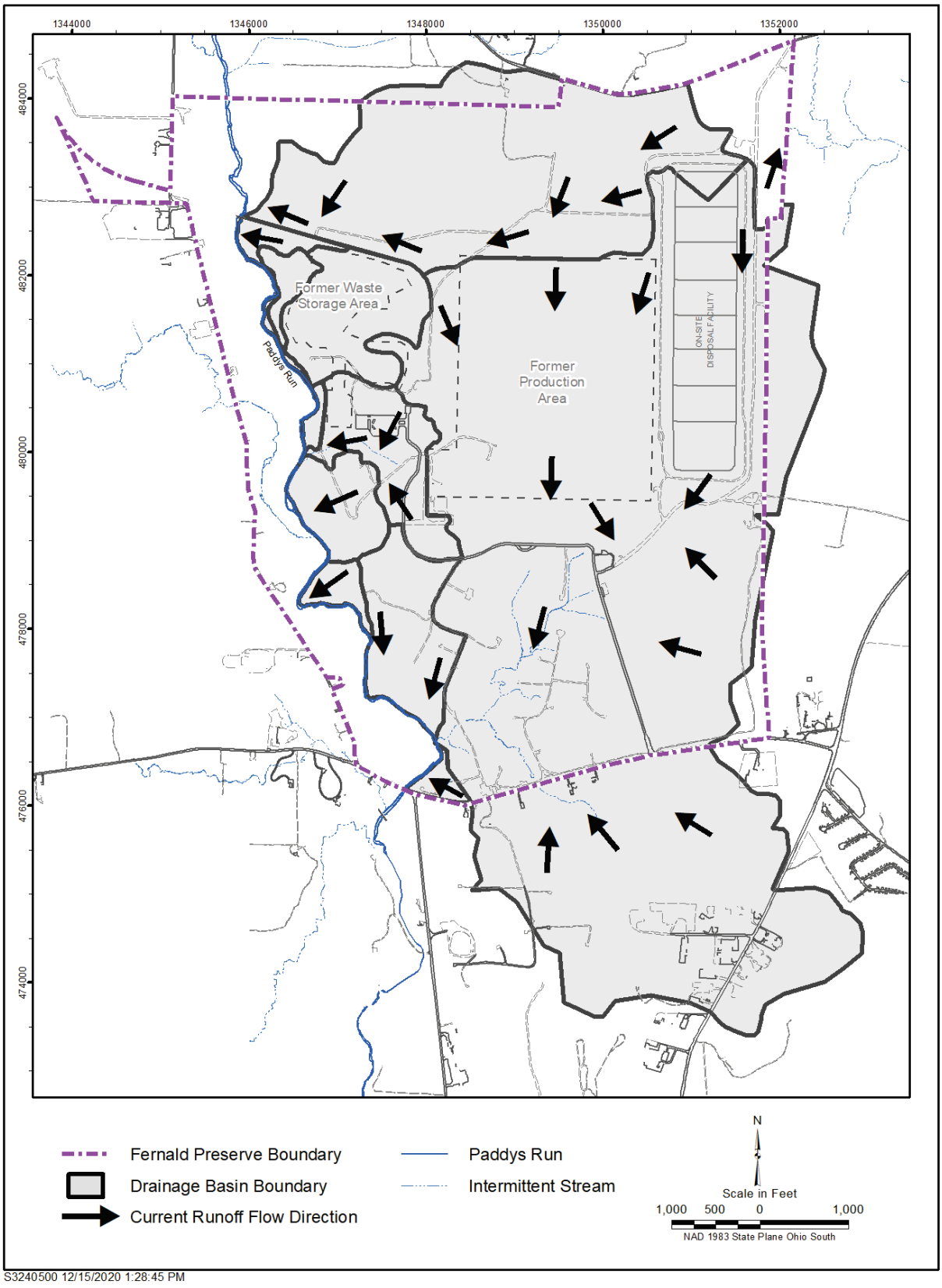

Figure B-27. Current Surface Water Basins and Runoff Flow Direction