3694

2000 INTEGRATED SITE ENVIRONMENTAL REPORT

2000 ENVIRONMENTAL SUMMARY
(Appendices A through E)

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FERNALD, OHIO

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U.S. DEPARTMENT OF ENERGY

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2000 ENVIRONMENTAL SUMMARY

(Appendices A through E)

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LIST OF ACRONYMS

AMSL	above mean sea level
BRSR	Baseline Remedial Strategy Report
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FEMP	Fernald Environmental Management Project
FRL	final remediation level
gpad	gallons per acre per day
gpd	gallons per day
gpm	gallons per minute
IEMP	Integrated Environmental Monitoring Plan
lbs/Mgal	pounds per million gallons
LCS	leachate collection system
LDS	leak detection system
MCL	maximum contaminant level
mg/L	milligrams per liter
NTU	nephelometric turbidity units
OEPA	Ohio Environmental Protection Agency
OMMP	Operations and Maintenance Master Plan
PRRS	Paddys Run Road Site
µg/L	micrograms per liter

APPENDIX A

Appendix A presents additional groundwater data and analysis in support of Chapter 3 of this 2000 Integrated Site Environmental Report. This appendix consists of six attachments as follows:

- Attachment A.1 provides operational data for the South Field (Phase I) Extraction Module, the South Plume Module, and the Re-Injection Module for 2000.
- Attachment A.2 provides total uranium data and plume maps for all four quarters of 2000 with statistical trend results. The summary statistics and Mann-Kendall test for trend are based on unfiltered samples from the Operable Unit 5 remedial investigation/feasibility study data set (1988 through 1993) and 1994 through 2000 groundwater data, except for the newer modules, whose statistics and trends are based on 1998 through 2000 data.
- Attachment A.3 evaluates the capture zone of the Aquifer Restoration System by analyzing groundwater flow directions based on groundwater elevation data. It includes groundwater elevation maps from all four quarters of 2000 and hydrographs for specific wells.
- Attachment A.4 provides an analysis of the 2000 non-uranium final remediation level (FRL) exceedances both inside and outside the 10-year, uranium-based restoration footprint.
- Attachment A.5 provides detailed data from the KC-2 Warehouse Well Monitoring Program.
- Attachment A.6 presents 2000 leak detection and leachate monitoring results associated with the On-Site Disposal Facility Monitoring Program.

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Attachment A.1

ATTACHMENT A.1

OPERATIONAL ASSESSMENT

ATTACHMENT A.1

In 2000 the South Field (Phase I) Extraction, South Plume, and Re-Injection Modules continued to operate. The South Field (Phase I) Extraction Module encompasses Extraction Wells 31550, 31560, 31561, 31562, 31563, 31564, 31565, 31566, 31567 (inactive), 32276, 32446, and 32447. These extraction wells encircle the southern waste unit excavations and the Storm Sewer Outfall Ditch in the South Field area of the Fernald Environmental Management Project (FEMP) from Paddys Run to just west of the South Access Road. The South Plume Module is comprised of Extraction Wells 3924, 3925, 3926, 3927, 32308, and 32309. Extraction Wells 32308 and 32309 were previously part of the South Plume Optimization Module. These wells are located south of Willey Road and north of New Haven Road. The Re-Injection Module is comprised of Re-Injection Wells 22107, 22108, 22109, 22111, and 22240. These wells stretch along the southern border of the FEMP just north of Willey Road between Paddys Run and the South Access Road. Figure A.1-1 depicts the location of the extraction and re-injection wells in these modules and identifies monitoring wells near each module. Table A.1-1 provides a summary of gallons pumped, total uranium removed, and uranium removal indices for 2000 and for August 1993 through December 2000.

South Field (Phase I) Extraction Module

Following the start-up of Extraction Wells 32446 and 32447 in February 2000, the South Field (Phase I) Extraction Module operated at 1,900 gallons per minute (gpm) in 2000, except during maintenance shutdowns and the May 2000 temporary shutdown to investigate the source of the leaking ion exchange resin discussed in the Re-Injection Module section. Tables A.1-2 through A.1-13 provide individual extraction well performance data for the South Field (Phase I) Extraction Module. The footnotes explain individual extraction well or system outages of greater than 24 hours.

During 2000, 957.8 million gallons of groundwater were pumped by the 11 active wells in the South Field (Phase I) Extraction Module and 628.1 pounds of total uranium were removed from the Great Miami Aquifer. The Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration (Task 1) (DOE 1997a) indicated that 788.4 million gallons of water and 643.4 pounds of uranium would be removed by the South Field (Phase I) Extraction Module in 2000. The gallons pumped in 2000 (957.8 million) were 1.21 times the design-specified amount (788.4 million) and the pounds of uranium removed from the aquifer (628.1) were 97.6 percent of the design-predicted amount (643.4) for this module.

Pumping rates were significantly lower in May 2000 at Extraction Wells 31550, 31560, 31561, 31563, and 31567 as a result of decreased groundwater treatment capacity in the advanced wastewater treatment facility 1800 system. The facility was off line a substantial portion of the month while resin leakage from the ion exchange vessels was being investigated (refer to the Re-Injection Module section of this report).

The target pumping rate for Extraction Well 31567 was increased from 100 to 250 gpm in August. This well's target pumping rate was increased in an effort to accelerate remediation of the uranium plume emanating from the former Inactive Flyash Pile area.

Following well screen rehabilitation of Extraction Well 31562, in July and August, the target pumping rate was increased from 200 to 290 gpm in September. The pumping rate was increased because the well appears to be remediating a larger portion of the plume than what was previously thought.

To help compensate for well downtimes (due to maintenance, electrical outages, etc.) pumping rates for the South Field (Phase I) Extraction Module were increased by approximately 10 percent in the latter portions of some months. The opportunity to increase the pumping rates was made available by higher than average groundwater treatment capacity and lower than normal total uranium concentrations in the site effluent (concentrations measured at the Parshall Flume [PF 4001]) to the Great Miami River. Continuation of the pumping rate increases will depend on the available treatment capacity and total uranium concentrations in site effluent.

South Plume Module

The South Plume Module operated at 2,000 gpm in 2000, except during re-injection system shutdowns (prior to October), shutdowns for maintenance events, and rehabilitation activities. Tables A.1-14 through A.1-19 provide individual extraction well performance data for the South Plume Module. The footnotes explain individual extraction well or system outages of greater than 24 hours.

During 2000, 921.23 million gallons of groundwater were pumped by the six wells in the South Plume Module and 226.3 pounds of total uranium were removed from the Great Miami Aquifer. The Baseline Remedial Strategy Report indicated that 998.64 million gallons of water and 170.8 pounds of uranium would be removed by the South Plume Module in 2000. The gallons pumped in 2000 (921.23 million) were 92.2 percent of design-specified amount (998.64 million) and the pounds of uranium removed from the aquifer (226.3) were 1.32 times the design-predicted amount (170.8) for this module.

A proposal to modify the Operations and Maintenance Master Plan, to allow operation of Extraction Wells 32308 and 32309 regardless of the status of the re-injection wells, was approved by the U.S. Environmental Protection Agency (EPA) and the Ohio Environmental Protection Agency (OEPA) in October. This operational modification allows for more continuous operation of Extraction Wells 32308 and 32309, thereby yielding higher monthly average pumping rates. This can be seen in Tables A.1-18 and A.1-19, which show the November and December monthly volume pumped for Extraction Wells 32308 and 32309 was approximately double what they had pumped in September and October.

To help compensate for well downtimes (due to maintenance, electrical outages, etc.), pumping rates of Extraction Wells 32308 and 32309 were increased by approximately 20 percent at the end of some months. The opportunity to increase the pumping rates resulted from average groundwater treatment capacity and lower than normal total uranium concentrations in the site effluent (concentrations measured at the Parshall Flume [PF 4001]). Continuation of the pumping rate increases will depend on the available treatment capacity and total uranium concentrations in site effluent.

The South Plume Module continued to meet the primary objectives of:

- Preventing further southward movement of the total uranium plume while capturing the main lobe of the South Plume without adversely affecting the Paddys Run Road Site (PRRS) plume (Extraction Wells 3924, 3925, 3926, and 3927)
- Actively remediating the higher-concentration region of the off-property plume (Extraction Wells 32308 and 32309).

Attachment A.3 presents additional details concerning the capture zone, along with supporting data. In 2000, as in previous years, PRRS constituents of concern (arsenic, phosphorus, potassium, sodium, and volatile organic compounds) were monitored at 11 monitoring well locations immediately south of the South Plume Module to ensure that the operation of the system does not adversely impact the PRRS plume. The 11 wells monitored were 2128, 2625, 2636, 2898, 2899, 2900, 3128, 3636, 3898, 3899, and 3900 (refer to Figure A.1-1).

Consistent with previous reporting, the Mann-Kendall test for trend was run on PRRS data collected from these wells. As indicated in Table A.1-20, four wells monitored for PRRS constituents of concern had an "up, significant" trend for one constituent based on the Mann-Kendall test for trend:

- Monitoring Wells 2625, 2898, and 2899 had "up, significant" trends for potassium. As discussed below, these increases indicate that PRRS contaminants are not being pulled toward the South

Plume extraction wells. Potassium concentration versus time plots for these three wells are shown on Figures A.1-2, A.1-3, and A.1-4 respectively. As shown on the figures, all three of these wells had new maximum potassium concentrations in 2000. Monitoring Wells 2625 and 2899 were only sampled once in 2000 because they contained an insufficient water column to collect samples during the other three scheduled sampling events. The low water level in the wells was due to low aquifer water levels. The low water levels may have affected the water quality of the samples collected. Also, the quarterly water level maps for 2000 in Appendix A.3 all indicate that the groundwater flow direction was from the northeast to southwest at Monitoring Wells 2898 and 2899. This indicates that the increasing potassium concentrations at these two locations were moving toward the PRRS plume, not away from it. Monitoring Well 2625 is located at or just south (outside) of the capture zones defined on the quarterly water level maps in Appendix A.3. In reviewing the potassium versus time plot for Monitoring Well 2625, as shown in Figure A.1-2, an upward trend is not apparent.

- Monitoring Well 3898 had an "up, significant" trend for sodium. The sodium concentration versus time plot for Monitoring Well 3898 is shown on Figure A.1-5. As indicated above for Monitoring Well 2898, based on the groundwater flow directions derived from the quarterly water level maps, the increasing sodium concentration is moving toward the PRRS plume, not away from it.

The monitoring activity for PRRS constituents of concern also included sampling for volatile organic compounds. These compounds are monitored because they were found to be present in the PRRS plume, which is not of FEMP origin (ERM Midwest Inc. 1994). Volatile organic compounds were detected in low concentrations (1 to 2 orders of magnitude below the contract required detection limits) at three monitoring wells in 2000 as indicated below:

- Monitoring Well 3128 had a toluene detection in the second quarter (May 3, 2000)
- Monitoring Well 2899 had detections of carbon disulfide, ethylbenzene, and toluene in the third quarter (August 15, 2000)
- Monitoring Well 2898 had a toluene detection in the fourth quarter (November 1, 2000).

The levels detected were 0.3 micrograms per liter (μg/L) or below. These concentrations are near method detection limits and may also indicate common laboratory contamination levels. For this reason, these detections are considered false positives, and are being treated as indicators that PRRS contaminants are not being pulled toward the South Plume extraction wells.

Re-Injection Module

The Re-Injection Demonstration Test Report was issued in May of 2000, concluding a one-year re-injection demonstration, and signaling the go-ahead to incorporate re-injection technology into the pump-and-treat aquifer remedy.

During 2000, 299.2 million gallons of groundwater containing 9.58 pounds of uranium were re-injected into the Great Miami Aquifer. The Baseline Remedial Strategy indicated that 525.6 million gallons of water containing 21.9 pounds of uranium would be re-injected by the Re-Injection Module in 2000. The 299.2 million gallons of re-injected water (also called "injectate") were 56.9 percent of the design-specified amount (525.6 million). The gallons re-injected were less than planned because the re-injection system was shut down at various times of the year for reasons indicated in Tables A.1-21 through A.1-25. The 9.58 pounds of uranium re-injected into the aquifer were significantly less than planned (21.9 pounds) due to the successful regeneration of the ion exchange resins and the decreased volume of injectate.

An operational criterion for the re-injection module is to only inject treated groundwater that has a uranium concentration that is less than 20 μg/L. Figure A.1-6 illustrates the total uranium concentrations measured in the injectate for 2000. As noted in the figure, total uranium concentration generally trends upward as uranium loading occurs on the resins in the treatment vessels. After the resin is regenerated, the uranium concentration decreases and the process of increasing concentration begins again. As noted in the figure, during 2000, one 20 μg/L total uranium exceedance was recorded on May 1, 2000, which led to a system shutdown. As reported in the May 2000 Monthly Re-Injection Operating Report, the total uranium composite sample of the injectate for May 1 was 20.3 μg/L. The total uranium grab sample of the injectate from this same date was 22.7 μg/L. On May 2, 2000, the U.S. Department of Energy (DOE) temporarily discontinued re-injection operations and notified the EPA and OEPA verbally of the shutdown due to this total uranium exceedance.

Tables A.1-21 through A.1-25 contain well performance data for individual re-injection wells. The footnotes explain individual re-injection well or system outages of greater than 24 hours. The target re-injection rate for this module, as specified in the Baseline Remedial Strategy Report, is 1,000 gpm. This target re-injection rate was not achieved in 2000 due to:

- System shutdowns to facilitate resin regeneration
- Miscellaneous maintenance problems
- Increased plugging of the re-injection wells
- The discovery of resin within the re-injection wells.

System shutdowns to facilitate resin regeneration and miscellaneous maintenance problems are to be expected and are considered routine aspects of the injection process. Given that these activities are

expected, it is therefore impossible to ever achieve a non-stop 1,000-gallon per minute injection rate given the current system. But when the wells are all operating, this is the operational rate that is targeted.

During 2000, the re-injection wells began to experience deleterious effects from residual plugging outside the well screens. As each re-injection well operates, they slowly begin to plug with bacterial growth. Up until approximately June of 2000, periodic treatment of the re-injection wells with small amounts of sodium hypochlorite was all that was necessary to alleviate the plugging and return the wells to efficient operation. However, beginning in June, the treatments did not appear to be as effective as they once were and operational time between treatments began to decrease. With approval from both the EPA and OEPA, more aggressive treatments were initiated in late 2000 in an attempt to re-establish re-injection efficiency. The aggressive treatments included the use of sodium hypochlorite, calcium hypochlorite, and hydrochloric acid. The more aggressive treatment had mixed results and does not appear to be the solution. This plugging problem resulted in a substantial amount of unplanned downtime in 2000, and is expected to severely hamper efficiency until it is resolved. In 2001, DOE is soliciting the help of recognized experts in the field to determine alternate rehabilitation treatment methods to regain re-injection efficiency.

Another significant operational problem that took place in 2000 was the discovery that treatment resin had leaked out of the treatment vessels and through downstream filters designed to contain the resin. On May 8, 2000, approximately two cups of Dowex 21K ion exchange resin were found in sediments removed from the sump of Re-Injection Well 22107, resulting in the shutdown of the injectate treatment facility and the remaining re-injection wells. On May 17, 2000, tests of the ion exchange vessels were completed that determined which vessel lost the resin. A failure of an effluent strainer in the manifold of ion exchange vessel 3B was determined to be the cause of the resin leakage. Repairs and a modification to the treatment system to more accurately detect resin leakage should it occur again in the future were completed. The injectate treatment system was returned to service on June 2, 2000. The re-injection surge tank was also drained and resin found in the bottom of the tank was removed. Resin cleanout of the remaining re-injection wells was completed in October 2000.

Total Uranium Data

Figures A.1-7 through A.1-24 depict the total uranium concentration data for each of the extraction wells comprising the South Plume and South Field (Phase I) Extraction Modules since start-up through the end of December 2000. Extraction well total uranium concentrations are measured in process control samples that are collected weekly. The weekly total uranium concentrations are used to graphically track

the concentrations over time and to support the statistical trend analysis presented in Attachment A.2. The total uranium concentrations are also used to determine which wells' water needs to be sent to treatment and which wells' water can be bypassed around the treatment facilities. Figure A.1-25 is a graph of the monthly gallons of groundwater extracted versus the monthly gallons of groundwater treated for 2000.

Pumping Rates

Daily pumping rate data for each extraction well were presented in Integrated Environmental Monitoring Plan (IEMP) quarterly status reports for the first three quarters of 2000 and on the IEMP Data Information Site (i.e., the "Extranet Site") for the fourth quarter; therefore, those data have not been repeated here. The footnotes in the well-specific operational tables explain individual well or system outages of greater than 24 hours.

In 2000, as shown in Table A.1-26, the extraction systems were operated at target pumping rates that did not radically differ from those established in the Baseline Remedial Strategy Report. As discussed in the South Field (Phase I) Extraction Module section above, the target pumping rate for Extraction Well 31567 was increased from 100 to 250 gpm in August of 2000. Also, the target pumping rate for Extraction Well 31562 was increased from 200 to 290 gpm in September of 2000. As additional operational experience is gained with the three active restoration modules, additional pumping rate changes are anticipated as efforts to maximize the effectiveness of each module are made.

TABLE A.1-1

AQUIFER RESTORATION SYSTEM OPERATIONAL SUMMARY SHEET

	Reporting Period					
	January 2000 through December 2000			August 1993 through December 2000		
	Gallons Pumped/ Re-Injected (M gal)	Total Uranium Removed/ Re-Injected (lbs)	Uranium Removal Index[a] (lbs/M gal)	Gallons Pumped/ Re-injected (M gal)	Total Uranium Removed/ Re-Injected (lbs)	Uranium Removal Index[a] (lbs/M gal)
South Field (Phase I) Extraction Module	957.8	628.1	0.66	2,064.735	1,332.00	0.65
South Plume Module	921.23	226.3	0.25	5,451.357	1,059.99	0.19
Re-Injection Module	299.2	9.58	NA	858.931	36.22	NA
Aquifer Restoration Systems Totals						
(Extraction Wells)	1,879.069	854.39	0.45	7,516.092	2,391.99	0.32
(Re-Injection Wells)	299.213	9.58	NA	858.931	36.22	NA
(net)	1,579.856	844.81	NA	6,657.161	2,355.77	NA

[a]NA = not applicable

TABLE A.1-2

EXTRACTION WELL 31550
OPERATIONAL SUMMARY SHEET FOR 2000

Reference Elevation (feet AMSL) - 572.11 (top of well)
Northing Coordinate ('83) - 477,018.5
Easting Coordinate ('83) - 1,348,979.8

Hours in reporting period - 8,769 Hours pumped - 8,258 Target pumping rate - 100 gpm
Hours not pumped - 511 Operational percent - 94.2

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/00	101	4.511	57.0	0.48
2/00	105	4.376	56.0	0.47
3/00	105	4.681	56.4	0.47
4/00	100	4.305	56.5	0.47
5/00[a,b]	59	2.569	52.3	0.44
6/00[b]	101	4.352	54.3	0.45
7/00	94	4.192	55.3	0.46
8/00	98	4.379	50.7	0.42
9/00	105	4.547	50.7	0.42
10/00[c]	88	3.903	54.7	0.46
11/00	101	4.358	45.0	0.38
12/00	99	4.411	46.1	0.38
Average	96	Total 50.584	Average 52.9	Average 0.44

[a]Extraction well was out of service for nine days due to failure of final duplex strainer in AWWT Phase III system.
[b]Extraction well was out of service for four days in May and one day in June due to scheduled maintenance activities of treatment facilities.
[c]Extraction well was out of service for three days due to a scheduled power outage.

TABLE A.1-3

EXTRACTION WELL 31560
OPERATIONAL SUMMARY SHEET FOR 2000

Reference Elevation (feet AMSL) - 574.93 (top of well)
Northing Coordinate ('83) - 477,403.1
Easting Coordinate ('83) - 1,349,028.9

Hours in reporting period -8,769 Hours pumped -8,237 Target pumping rate - 100 gpm
Hours not pumped -532 Operational percent - 93.9

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/00	101	4.542	90.0	0.75
2/00	105	4.384	89.9	0.75
3/00	105	4.692	87.2	0.73
4/00[a]	97	4.167	78.7	0.66
5/00[b,c]	58	2.539	64.3	0.54
6/00[c]	100	4.322	74.5	0.62
7/00	96	4.303	75.4	0.63
8/00	98	4.365	70.7	0.59
9/00	105	4.539	70.8	0.59
10/00[d]	91	4.041	72.5	0.60
11/00	97	4.175	64.7	0.54
12/00	100	4.454	67.4	0.56
Average	96	Total 50.523	Average 75.5	Average 0.63

[a]Extraction well was out of service for two days for well screen rehabilitation.
[b]Extraction well was out of service for nine days due to failure of final duplex strainer in AWWT Phase III system.
[c]Extraction well was out of service for four days in May and one day in June due to scheduled maintenance activities of treatment facilities.
[d]Extraction well was out of service for three days due to a scheduled power outage.

TABLE A.1-4

EXTRACTION WELL 31561
OPERATIONAL SUMMARY SHEET FOR 2000

Reference Elevation (feet AMSL) - 578.77 (top of well)
Northing Coordinate ('83) - 477,660.8
Easting Coordinate ('83) - 1,349,254.5

Hours in reporting period - 8,769 Hours pumped - 7,949 Target pumping rate - 100 gpm
Hours not pumped - 820 Operational percent - 90.6

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/00	102	4.559	39.9	0.33
2/00	106	4.406	43.1	0.36
3/00	105	4.668	42.7	0.36
4/00	99	4.271	40.1	0.33
5/00[a,b]	57	2.484	47.2	0.39
6/00[b]	101	4.345	42.2	0.35
7/00	94	4.217	45.3	0.38
8/00[c]	63	2.795	42.4	0.35
9/00[d]	84	3.654	49.5	0.41
10/00[e]	94	4.162	53.2	0.44
11/00[f]	94	4.087	46.7	0.39
12/00	88	3.954	53.7	0.45
Average	91	Total 47.602	Average 45.5	Average 0.38

[a]Extraction well was out of service for nine days due to failure of final duplex strainer in AWWT Phase III system.
[b]Extraction well was out of service for four days in May and one day in June due to scheduled maintenance activities of treatment facilities.
[c]Extraction well was out of service for eight days for well screen rehabilitation.
[d]Extraction well was out of service for five days for preventative maintenance and routine well screen chlorination.
[e]Extraction well was out of service for three days due to a scheduled power outage.
[f]Extraction well was out of service for two days due to well screen chlorination.

TABLE A.1-5

EXTRACTION WELL 31562
OPERATIONAL SUMMARY SHEET FOR 2000

Reference Elevation (feet AMSL) - 576.21 (top of well)
Northing Coordinate ('83) - 477,953.1
Easting Coordinate ('83) - 1,349,499.9

Hours in reporting period - 8,769 Hours pumped - 6,871 Target pumping rate - 200 gpm[a]
Hours not pumped - 1,898 Operational percent - 78.4

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/00	201	8.976	100.1	0.83
2/00	211	8.794	103.9	0.87
3/00	209	9.340	105.0	0.88
4/00[b]	199	8.566	104.7	0.87
5/00[c]	120	5.245	119.7	1.00
6/00[d]	139	6.133	119.2	0.99
7/00[d]	0	0	NS[e]	NA[f]
8/00[d]	52	2.319	179.7[g]	1.50
9/00	247	10.694	138.0	1.15
10/00[h]	240	10.677	127.5	1.06
11/00	276	11.938	114.9	0.96
12/00	291	13.029	117.2	0.98
Average	182	Total 95.711	Average 110.8	Average 0.92

[a]Pumping rate increased to 290 gpm on September 15, 2000.
[b]Extraction well was out of service for nine days due to failure of final duplex strainer in AWWT Phase III system.
[c]Extraction well was out of service for four days in May and three days in June due to scheduled maintenance activities of treatment facilities.
[d]Extraction well was out of service for five days in June, 31 days in July, and 23 days in August for well screen rehabilitation.
[e]NS = not sampled
[f]NA = not applicable
[g]Monthly total uranium concentration consisted of only one sample.
[h]Extraction well was out of service for three days due to a scheduled power outage.

TABLE A.1-6

EXTRACTION WELL 31563
OPERATIONAL SUMMARY SHEET FOR 2000

Reference Elevation (feet AMSL) - 544.36 (top of well)
Northing Coordinate ('83) - 477,066.4
Easting Coordinate ('83) - 1,348,330

Hours in reporting period -8,745 Hours pumped -8,161 Target pumping rate - 200 gpm
Hours not pumped - 584 Operational percent - 93.3

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/00	201	9.012	25.2	0.21
2/00	216	8.710	25.1	0.21
3/00	201	8.941	25.4	0.21
4/00	208	8.987	25.9	0.22
5/00[a,b]	114	4.962	26.9	0.22
6/00[b]	200	8.608	25.6	0.21
7/00[c]	173	7.744	26.8	0.22
8/00	205	9.153	24.2	0.20
9/00	211	9.130	22.3	0.19
10/00[d,e]	182	8.070	22.4	0.19
11/00	204	8.823	22.1	0.18
12/00	200	8.957	22.6	0.19
	Average 193	Total 101.097	Average 24.5	Average 0.20

[a]Extraction well was out of service for nine days due to failure of final duplex strainer in AWWT Phase III system.
[b]Extraction well was out of service for four days in May and one day in June due to scheduled maintenance activities of treatment facilities.
[c]Extraction well was out of service for two days due to an electrical outage.
[d]Extraction well was out of service for two days due to well screen chlorination.
[e]Extraction well was out of service for three days due to a scheduled power outage.

TABLE A.1-7

EXTRACTION WELL 31564
OPERATIONAL SUMMARY SHEET FOR 2000

Reference Elevation (feet AMSL) - 538.65 (top of well)
Northing Coordinate ('83) - 477,124.7
Easting Coordinate ('83) - 1,347,880.4

Hours in reporting period - 8,769 Hours pumped - 8,228 Target pumping rate - 200 gpm
Hours not pumped - 541 Operational percent - 93.8

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/00	202	9.020	14.5	0.12
2/00	209	8.749	14.4	0.12
3/00[a]	195	8.727	14.2	0.12
4/00	201	8.690	13.0	0.11
5/00[b]	173	7.542	13.4	0.11
6/00[b]	202	8.694	12.9	0.11
7/00[c]	173	7.714	13.4	0.11
8/00	206	9.168	12.7	0.11
9/00[d]	181	7.839	12.6	0.11
10/00[e]	180	8.010	11.8	0.10
11/00	203	8.785	12.3	0.10
12/00	200	8.968	12.9	0.11
	Average 194	Total 101.906	Average 13.2	Average 0.11

[a]Extraction well was out of service for two days due to well screen chlorination.
[b]Extraction well was out of service for four days in May and one day in June due to scheduled maintenance activities of treatment facilities.
[c]Extraction well was out of service for two days due to an electrical outage.
[d]Extraction well was out of service for four days due to well screen chlorination.
[e]Extraction well was out of service for three days due to a scheduled power outage.

TABLE A.1-8

EXTRACTION WELL 31565
OPERATIONAL SUMMARY SHEET FOR 2000

Reference Elevation (feet AMSL) - 540.72 (top of well)
Northing Coordinate ('83) - 477,648.3
Easting Coordinate ('83) - 1,347,629.9

Hours in reporting period - 8,769 Hours pumped - 8,408 Target pumping rate - 200 gpm
Hours not pumped - 361 Operational percent - 95.9

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/00	202	9.034	11.8	0.10
2/00	210	8.775	11.2	0.09
3/00[a]	196	8.732	11.2	0.09
4/00	209	9.013	10.1	0.08
5/00[b]	172	7.535	12.2	0.10
6/00[b]	200	8.642	10.5	0.09
7/00[c]	172	7.681	11.0	0.09
8/00	206	9.204	10.0	0.08
9/00	203	8.817	9.4	0.08
10/00[d]	187	8.303	9.4	0.08
11/00	203	8.801	8.9	0.07
12/00	201	9.004	9.0	0.08
Average	197	Total 103.541	Average 10.4	Average 0.09

[a]Extraction well was out of service for two days for well screen chlorination.
[b]Extraction well was out of service for four days in May and one day in June due to scheduled maintenance activities of treatment facilities.
[c]Extraction well was out of service for two days due to an electrical outage.
[d]Extraction well was out of service for three days due to a scheduled power outage.

TABLE A.1-9

EXTRACTION WELL 31566[a]
OPERATIONAL SUMMARY SHEET FOR 2000

Reference Elevation (feet AMSL) – 575.16 (top of well)
Northing Coordinate ('83) - 477,576.1
Easting Coordinate ('83) - 1,348,361.3

Hours in reporting period - NA[b]
Hours not pumped - NA[b]
Hours pumped - NA[b]
Operational percent - NA[b]

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate[b] (gpm)	Million Gallons Pumped[b]	Monthly Total Uranium Concentration[c,d] (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)[b]
1/00	NA	NA	NS	NA
2/00	NA	NA	NS	NA
3/00	NA	NA	NS	NA
4/00	NA	NA	8.4	NA
5/00	NA	NA	7.8	NA
6/00	NA	NA	8.6	NA
7/00	NA	NA	8.2	NA
8/00	NA	NA	2.8	NA
9/00	NA	NA	8.1	NA
10/00	NA	NA	7.6	NA
11/00	NA	NA	8.0	NA
12/00	NA	NA	7.3	NA
Average	NA	Total NA	Average 7.4	Average NA

[a] Extraction well was shut off on August 7, 1998, due to low total uranium recover efficiency, excessive drawdown at the target pumping rate (200 gpm), and concerns regarding the creation of a recalcitrant zone.
[b]NA = not applicable
[c]Monthly sampling of total uranium resumed in April.
[d]NS = not sampled

TABLE A.1-10

EXTRACTION WELL 31567
OPERATIONAL SUMMARY SHEET FOR 2000

Reference Elevation (feet AMSL) - 574.84 (top of well)
Northing Coordinate ('83) - 477,905.5
Easting Coordinate ('83) - 1,348,854.1

Hours in reporting period - 8,768 Hours pumped - 8,185 Target pumping rate[a] - 100/250 gpm
Hours not pumped - 583 Operational percent - 93.4

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/00	128	5.706	34.6	0.29
2/00	152	6.365	35.7	0.30
3/00	105	4.700	36.5	0.30
4/00	99	4.285	34.5	0.29
5/00[b,c]	67	2.931	36.8	0.31
6/00[c]	144	6.225	41.3	0.34
7/00[d]	115	5.132	38.8	0.32
8/00	214	9.545	33.5	0.28
9/00	265	11.484	32.7	0.27
10/00[e]	232	10.298	33.0	0.28
11/00	255	11.048	29.9	0.25
12/00	252	11.260	31.0	0.26
Average	169	Total 88.979	Average 34.9	Average 0.29

[a]Pumping rate increased to 250 gpm on August 8, 2000.
[b]Extraction well was out of service for nine days due to failure of final duplex strainer in AWWT Phase III system.
[c]Extraction well was out of service for four days in May and one day in June due to scheduled maintenance activities of treatment facilities.
[d]Extraction well was out of service for two days due to an electrical outage.
[e]Extraction well was out of service for three days due to a scheduled power outage.

TABLE A.1-11

EXTRACTION WELL 32276
OPERATIONAL SUMMARY SHEET FOR 2000

Reference Elevation (feet AMSL) - 567.14 (top of well)
Northing Coordinate ('83) - 476,447.3
Easting Coordinate ('83) - 1,348,857.3

Hours in reporting period - 8,769 Hours pumped - 8,402 Target pumping rate - 300 gpm
Hours not pumped - 367 Operational percent - 95.8

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/00	302	13.520	163.2	1.36
2/00	316	13.173	160.9	1.34
3/00	313	13.986	154.9	1.29
4/00	288	12.426	140.5	1.17
5/00[a]	230	10.034	136.9	1.14
6/00[a]	299	12.908	139.8	1.17
7/00[b]	252	11.264	145.3	1.21
8/00	298	13.310	134.9	1.13
9/00	315	13.667	136.3	1.14
10/00[c]	262	11.616	136.9	1.14
11/00	279	12.065	128.1	1.07
12/00	301	13.481	135.5	1.13
Average	288	Total 151.450	Average 142.8	Average 1.19

[a]Extraction well was out of service for four days in May and one day in June due to scheduled maintenance activities of treatment facilities.
[b]Extraction well was out of service for two days due to an electrical outage.
[c]Extraction well was out of service for three days due to a scheduled power outage.

TABLE A.1-12

EXTRACTION WELL 32446[a]
OPERATIONAL SUMMARY SHEET FOR 2000

Reference Elevation (feet AMSL) - 578.367 (top of well)
Northing Coordinate ('83) - 476,634.53
Easting Coordinate ('83) - 1,349,312.38

Hours in reporting period - 7,243 Hours pumped - 7,000 Target pumping rate - 200 gpm
Hours not pumped - 473 Operational percent - 93.7

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate(gpm)	Million Gallons Pumped	Monthly Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/00	NA[b]	NA[b]	NS[c]	NA[b]
2/00	41	1.731	166.8	1.39
3/00	199	8.897	137.2	1.14
4/00	200	8.626	122.8	1.02
5/00[d]	179	7.796	105.9	0.88
6/00	201	8.703	113.7	0.95
7/00	189	8.428	90.4	0.75
8/00	191	8.521	88.6	0.74
9/00	197	8.549	82.1	0.68
10/00[e,f]	139	6.185	87.3	0.73
11/00	194	8.377	81.4	0.68
12/00[g]	152	6.787	80.2	0.67
Average	171	Total 82.600	Average 105.1	Average 0.88

[a]Well became operational on February 24, 2000.
[b]NA = not applicable
[c]NS = not sampled
[d]Extraction well was out of service for two days due to scheduled maintenance activities of treatment facilities.
[e]Extraction well was out of service for three days due to a scheduled power outage.
[f]Extraction well was out of service for four days due to repair of well discharge pipe.
[g]Extraction well was out of service for seven days due to well screen chlorination.

TABLE A.1-13

EXTRACTION WELL 32447[a]
OPERATIONAL SUMMARY SHEET FOR 2000

Reference Elevation (feet AMSL) - 574.528 (top of well)
Northing Coordinate ('83) - 477,150.24
Easting Coordinate ('83) - 1,349,421.19

Hours in reporting period - 7,473 Hours pumped - 7,106 Target pumping rate - 200 gpm
Hours not pumped -367 Operational percent - 95.1

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/00	NA[b]	NA[b]	NS[c]	NA[b]
2/00	41	1.732	302.3	2.52
3/00	198	8.862	266.9	2.23
4/00	200	8.617	237.8	1.98
5/00[d]	178	7.771	218.9	1.83
6/00	200	8.666	208.6	1.74
7/00	181	8.096	206.5	1.72
8/00	192	8.540	194.8	1.62
9/00	197	8.527	189.6	1.58
10/00[e,f]	135	5.980	182.7	1.52
11/00	195	8.451	184.1	1.54
12/00	192	8.601	182.7	1.52
Average	174	Total 83.843	Average 215.9	Average 1.80

[a]Well became operational on February 24, 2000.
[b]NA = not applicable
[c]NS = not sampled
[d]Extraction well was out of service for three days due to scheduled maintenance activities of treatment facilities.
[e]Extraction well was out of service for three days due to a scheduled power outage.
[f]Extraction well was out of service for five days due to repair of well discharge pipe.

TABLE A.1-14

EXTRACTION WELL 3924
OPERATIONAL SUMMARY SHEET FOR 2000

Reference Elevation (feet AMSL) - 533.51 (top of well)
Northing Coordinate ('83) - 474,219.7
Easting Coordinate ('83) - 1,348,314.3

Hours in reporting period - 8,767 Hours pumped - 8,408 Target pumping rate - 300 gpm
Hours not pumped - 359 Operational percent - 95.9

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/00	300	13.349	36.5	0.30
2/00	300	12.517	38.6	0.32
3/00	300	13.431	35.8	0.30
4/00	285	12.306	34.3	0.29
5/00	290	12.641	28.6	0.24
6/00	299	12.906	29.2	0.24
7/00	288	12.859	32.5	0.27
8/00	290	12.960	27.4	0.23
9/00	283	12.219	31.7	0.26
10/00[a]	261	11.658	39.4	0.33
11/00	300	12.943	33.1	0.28
12/00	299	13.390	36.0[b]	0.30
Average	291	Total 153.179	Average 33.6	Average 0.28

[a]Extraction well out of service for four days due to a scheduled power outage.
[b]Monthly total uranium concentration consisted of only one sample.

TABLE A.1-15

EXTRACTION WELL 3925
OPERATIONAL SUMMARY SHEET FOR 2000

Reference Elevation (feet AMSL) - 542.01 (top of well)
Northing Coordinate ('83) - 474,319.7
Easting Coordinate ('83) - 1,348,565.4

Hours in reporting period - 8,654 Hours pumped - 8,362 Target pumping rate - 300 gpm
Hours not pumped - 292 Operational percent - 96.6

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/00	293	13.099	26.9	0.22
2/00	293	12.336	28.5	0.24
3/00	292	13.060	32.7	0.27
4/00	298	12.856	33.8	0.28
5/00	278	12.151	33.1	0.28
6/00	320	13.049	29.2	0.24
7/00	285	12.734	30.7	0.26
8/00	289	12.878	27.2	0.23
9/00	279	12.052	30.6	0.26
10/00[a]	262	11.667	32.5	0.27
11/00	274	11.844	27.5	0.23
12/00	254	11.357	28.4[b]	0.24
Average	285	Total 149.083	Average 30.1	Average 0.25

[a]Extraction well was out of service for four days due to a scheduled power outage.
[b]Monthly total uranium concentration consisted of only one sample.

TABLE A.1-16

EXTRACTION WELL 3926
OPERATIONAL SUMMARY SHEET FOR 2000

Reference Elevation (feet AMSL) - 586.73 (top of well)
Northing Coordinate ('83) - 474,428.6
Easting Coordinate ('83) - 1,348,837.5

Hours in reporting period - 8,670 Hours pumped - 8,177 Target pumping rate - 400 gpm
Hours not pumped - 493 Operational percent - 94.3

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/00[a]	314	14.037	19.7	0.16
2/00	379	15.840	25.5	0.21
3/00	378	16.897	23.4	0.20
4/00	382	16.475	25.1	0.21
5/00	359	15.686	26.0	0.22
6/00	402	16.382	23.3	0.19
7/00	368	16.435	27.4	0.23
8/00	361	16.124	26.2	0.22
9/00[b]	308	13.292	30.0	0.25
10/00[c]	306	13.655	34.0	0.28
11/00	346	14.932	29.6	0.25
12/00	360	16.122	30.7	0.26
Average	355	Total 185.877	Average 26.7	Average 0.22

[a]Extraction well was out of service for five days due to well screen rehabilitation.
[b]Extraction well was out of service for three days due to well screen chlorination and an electrical outage.
[c]Extraction well was out of service for four days due to a scheduled power outage.

TABLE A.1-17

EXTRACTION WELL 3927
OPERATIONAL SUMMARY SHEET FOR 2000

Reference Elevation (feet AMSL) - 591.84 (top of well)
Northing Coordinate ('83) - 474,541.8
Easting Coordinate ('83) - 1,349,127.3

Hours in reporting period - 8,654 Hours pumped - 8,290 Target pumping rate - 500 gpm
Hours not pumped - 364 Operational percent - 95.8

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/00	486	21.690	2.0	0.02
2/00	479	20.018	1.9	0.02
3/00	474	21.208	2.0	0.02
4/00	485	20.899	2.1	0.02
5/00	468	20.447	4.0	0.03
6/00	477	19.460	2.1	0.02
7/00	464	20.718	2.2	0.02
8/00	469	20.931	2.0	0.02
9/00[a]	440	19.018	2.2	0.02
10/00[b]	420	18.734	2.0	0.02
11/00	451	19.483	1.9	0.02
12/00	489	21.873	2.1	0.02
Average	467	Total 244.479	Average 2.2	Average 0.02

[a]Extraction well was out of service for two days due to malfunctioning flow meter.
[b]Extraction well was out of service for four days due to a scheduled power outage.

TABLE A.1-18

EXTRACTION WELL 32308
OPERATIONAL SUMMARY SHEET FOR 2000

Reference Elevation (feet AMSL) - 582.05 (top of casing)
Northing Coordinate ('83) - 475,078.83
Easting Coordinate ('83) - 1,348,693.9

Hours in reporting period - 8,671 Hours re-injected - 5,970 Target pumping rate - 250 gpm
Hours not pumped - 2,701 Operational percent - 68.9

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/00	249	11.099	67.0	0.56
2/00	274	11.442	69.3	0.58
3/00	271	12.138	70.0	0.58
4/00[a]	230	9.919	67.3	0.56
5/00[a]	40	1.801	60.5	0.50
6/00[a]	182	7.420	73.1	0.61
7/00[a]	0	0	NS[b]	NA[c]
8/00[a]	184	8.205	77.0	0.64
9/00[a]	109	4.699	68.7	0.57
10/00[a,d]	125	5.591	77.0	0.64
11/00	257	11.114	67.7	0.56
12/00	246	11.004	72.4	0.60
Average	181	Total 94.432	Average 64.2	Average 0.53

[a]Extraction well was out of service for four days in April, 24 days in May, eight days in June, 31 days in July, eight days in August, 17 days in September, and 18 days in October due to inability to inject a sufficient quantity of injectate, per the OMMP.
[b]NS = not sampled
[c]NA = not applicable
[d]On October 12, 2000, EPA granted relief from the OMMP requirement that this well be shutdown when there is insufficient injectate capacity.

TABLE A.1-19

EXTRACTION WELL 32309
OPERATIONAL SUMMARY SHEET FOR 2000

Reference Elevation (feet AMSL) - 582.05 (top of casing)
Northing Coordinate ('83) - 475,109.60
Easting Coordinate ('83) - 1,348,366.34

Hours in reporting period - 8,671 Hours re-injected - 5,925 Target pumping rate - 250 gpm
Hours not pumped - 2,746 Operational percent - 68.3

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/00	249	11.104	71.0	0.59
2/00	273	11.414	69.1	0.58
3/00	271	12.113	65.5	0.55
4/00[a]	230	9.935	59.6	0.50
5/00[a]	40	1.792	50.7	0.42
6/00[a]	182	7.399	64.8	0.54
7/00[a]	0	0	NS[b]	NA[c]
8/00[a]	183	8.186	77.2	0.64
9/00[a]	108	4.651	69.1	0.58
10/00[a,d,e]	126	5.598	76.2	0.64
11/00	257	11.092	66.3	0.55
12/00	246	10.999	70.3	0.59
Average	180	Total 94.283	Average 61.7	Average 0.52

[a]Extraction well was out of service for four days in April, 27 days in May, eight days in June, 31 days in July, eight days in August, 17 days in September, and 18 days in October due to inability to inject a sufficient quantity of injectate, per the OMMP.
[b]NS = not sampled
[c]NA = not applicable
[d]Extraction well was out of service for four days due to a scheduled power outage.
[e]On October 12, 2000, EPA granted relief from the OMMP requirement that this well be shutdown when there is insufficient injectate capacity.

TABLE A.1-20

PADDYS RUN ROAD SITE GROUNDWATER SUMMARY STATISTICS AND TREND ANALYSIS

Constituent	Monitoring Well	Number of Samples[a,b,c]	Min.[a,b,c,d] (mg/L)	Max.[a,b,c,d] (mg/L)	Avg.[a,b,c,d] (mg/L)	SD[a,b,c,d] (mg/L)	Trend[a,b,c,d]
Arsenic	2128	214	0.000195	0.1876	0.0124	0.0219	Down, Significant
	2625	200	0.0048	0.0595	0.012	0.0091	Down, Marginal
	2636	171	0.01	0.0939	0.04	0.02	Down, Significant
	2898	30	0.00035	0.082	0.0049	0.015	No Significant Trend
	2899	26	0.00032	0.0032	0.0013	0.00083	No Significant Trend
	2900	212	0.00032	0.0609	0.0054	0.0064	Down, Significant
	3128	33	0.00085	0.234	0.010	0.040	Up, Marginal
	3636	32	0.0006	0.014	0.002	0.0023	No Significant Trend
	3898	30	0.0006	0.0062	0.0022	0.0011	No Significant Trend
	3899	31	0.00032	0.003	0.0013	0.0008	No Significant Trend
	3900	31	0.000375	0.0045	0.0022	0.0010	Down, Significant
Phosphorus	2128	40	0.025	16.2	1.9	2.9	Down, Significant
	2625	25	0.307	12.3	3.31	3.18	No Significant Trend
	2636	23	9.6	170	95	50	No Significant Trend
	2898	31	0.005	9.95	0.5	1.8	No Significant Trend
	2899	25	0.005	0.831	0.07	0.16	No Significant Trend
	2900	29	0.05	4.74	0.6	0.9	Down, Marginal
	3128	40	0.005	13	0.4	2	No Significant Trend
	3636	31	0.00955	1.1	0.09	0.19	No Significant Trend
	3898	29	0.00955	1.24	0.112	0.229	No Significant Trend
	3899	30	0.00955	0.83	0.11	0.16	Down, Significant
	3900	31	0.005	1.38	0.13	0.3	No Significant Trend
Potassium	2128	32	0.83	18	3.8	4.4	Down, Significant
	2625	25	0.64	9.49	3.7	2.0	**Up, Significant**
	2636	23	8.51	218	82.4	54.7	No Significant Trend
	2898	31	1.11	9.64	4.08	1.53	**Up, Significant**
	2899	26	1.36	8.85	3.78	1.20	**Up, Significant**
	2900	30	0.0095	6	2.1	1.4	No Significant Trend
	3128	33	1.085	3.7	2.3	0.67	Down, Significant
	3636	31	1.09	4.24	2.46	0.603	Down, Significant
	3898	30	0.61	3.93	2.3	0.65	No Significant Trend
	3899	31	0.875	3.22	2.37	0.414	Down, Significant
	3900	31	0.975	3.19	1.84	0.494	Down, Marginal
Sodium	2128	32	18.2	75.2	36.8	12.9	Down, Marginal
	2625	25	16.5	50.7	34.0	7.77	No Significant Trend
	2636	23	23	79.9	47	16	Down, Significant
	2898	31	4.945	29.2	18.0	4.51	Down, Significant
	2899	26	11.2	22.9	16.9	3.14	No Significant Trend
	2900	30	0.01355	43.3	28.3	9.23	No Significant Trend
	3128	33	3.56	13.4	6.26	3.24	Down, Significant
	3636	31	3.71	13	7.4	3.0	Down, Significant
	3898	30	7.29	14.6	9.53	1.89	**Up, Significant**
	3899	31	6.24	12.1	8.52	1.38	Down, Significant
	3900	31	3.51	10.8	5.85	1.97	Down, Significant

[a]The data are based on unfiltered samples from the Operable Unit 5 remedial investigation/feasibility study data set (1988 through 1993) and 1994 through 2000 groundwater data.
[b]If more than one sample is collected per well per day (e.g., duplicate), then only one sample is counted for the total number of samples, and the sample with the maximum concentration is used to determine the summary statistics (minimum, maximum, average, and standard deviation [SD] and Mann-Kendall test for trend).
[c]Rejected data qualified with either a R or Z were not included in this count or the summary statistics.
[d]Where concentrations are below the detection limit, each result used in the summary statistics is set at half the detection limit.

TABLE A.1-21

RE-INJECTION WELL 22107
OPERATIONAL SUMMARY SHEET FOR 2000

Reference Elevation (feet AMSL) - 540.6 (top of well)
Northing Coordinate ('83) - 476,196.2
Easting Coordinate ('83) - 1,347,978.2

Hours in reporting period - 8,783 Hours re-injected - 4,262 Target re-injection rate - 200 gpm
Hours not re-injected - 4,521 Operational percent - 48.5

Monthly Measurements at Wellfield		
Month	Monthly Average Re-Injection Rate (gpm)	Million Gallons Re-Injected
1/00[a]	174	7.740
2/00	212	8.847
3/00	206	9.216
4/00[b,c]	95	4.072
5/00[d,e,f]	0	0
6/00[g,h]	132	5.704
7/00[i,j,k]	55	2.441
8/00[l]	25	1.112
9/00	185	8.004
10/00[m,n]	89	3.985
11/00[o]	0	0
12/00[p]	0	0
Average	98	Total 51.121

[a]Re-injection well was out of service for three days for well screen rehabilitation.
[b]Re-injection well was out of service for four days due to regeneration of treatment plant resin.
[c]Re-injection well was out of service for 11 days for well screen rehabilitation.
[d]Re-injection well was out of service for seven days for well screen rehabilitation.
[e]Re-injection well was out of service for 20 days due to failure of final duplex strainer in AWWT Phase III system.
[f]Re-injection well was out of service for four days due to scheduled maintenance activities of treatment facilities.
[g]Re-injection well was out of service for four days due to scheduled maintenance activities of treatment systems.
[h]Re-injection well was out of service for four days due to evaluation of uranium concentration in injectate.
[i]Re-injection well was out of service for eight days due to evaluation of uranium concentration in injectate.
[j]Re-injection well was out of service for five days due to an electrical outage.
[k]Re-injection well was out of service for eight days due to well screen rehabilitation.
[l]Re-injection well was out of service for 27 days due to well screen rehabilitation.
[m]Re-injection well was out of service for three days due to a scheduled power outage.
[n]Re-injection well was out of service for 13 days due to well screen rehabilitation.
[o]Re-injection well was out of service for 30 days due to well screen rehabilitation.
[p]Re-injection well was out of service for 31 days due to well screen rehabilitation.

TABLE A.1-22

RE-INJECTION WELL 22108
OPERATIONAL SUMMARY SHEET FOR 2000

Reference Elevation (feet AMSL) - 578.56 (top of well)
Northing Coordinate ('83) - 476,255.7
Easting Coordinate ('83) - 1,348,384

Hours in reporting period - 8,761 Hours re-injected - 4,261 Target re-injection rate - 200 gpm
Hours not re-injected - 4,500 Operational percent - 48.6

Monthly Measurements at Wellfield		
Month	Monthly Average Re-Injection Rate (gpm)	Million Gallons Re-Injected
1/00[a]	137	6.118
2/00	210	8.778
3/00	206	9.219
4/00[b]	175	7.542
5/00[c,d]	32	1.422
6/00[d,e]	134	5.753
7/00[f,g]	35	1.566
8/00[h]	153	6.800
9/00[i]	79	3.416
10/00[j]	14	0.868
11/00[k]	0	0
12/00[l]	0	0
Average	98	Total 51.482

[a]Re-injection well was out of service for 10 days for well screen rehabilitation.
[b]Re-injection well was out of service for four days due to regeneration of treatment plant resin.
[c]Re-injection well was out of service for 20 days due to failure of final duplex strainer in AWWT Phase III system.
[d]Re-injection well was out of service for four days in May and June due to scheduled maintenance activities of treatment facilities.
[e]Re-injection well was down for four days due to evaluation of uranium concentration in injectate.
[f]Re-injection well was out of service for eight days due to evaluation of uranium concentration in injectate.
[g]Re-injection well was out of service for 15 days due to well screen rehabilitation.
[h]Re-injection well was out of service for four days due to the source water treatment system being down.
[i]Re-injection well was out of service for 17 days due to well screen rehabilitation.
[j]Re-injection well was out of service for 27 days due to well screen rehabilitation.
[k]Re-injection well was out of service for 30 days due to well screen rehabilitation.
[l]Re-injection well was out of service for 31 days due to well screen rehabilitation.

TABLE A.1-23

RE-INJECTION WELL 22109
OPERATIONAL SUMMARY SHEET FOR 2000

Reference Elevation (feet AMSL) - 577.53 (top of well)
Northing Coordinate ('83) - 476,175.6
Easting Coordinate ('83) - 1,348,861

Hours in reporting period - 8,762 Hours re-injected - 3,926 Target re-injection rate - 200 gpm
Hours not re-injected - 4,836 Operational percent - 44.8

Monthly Measurements at Wellfield		
Month	Monthly Average Re-Injection Rate (gpm)	Million Gallons Re-Injected
1/00[a]	195	8.720
2/00	158	6.607
3/00	204	9.112
4/00[b]	173	7.465
5/00[c,d]	32	1.432
6/00[d,e]	29	1.257
7/00[f,g,h]	60	2.627
8/00[i]	153	6.821
9/00[j]	80	3.442
10/00[k]	0	0
11/00[l]	0	0
12/00[m]	0	0
Average	90	Total 47.483

[a]Re-injection well was out of service for seven days for well screen rehabilitation.
[b]Re-injection well was out of service for four days due to regeneration of treatment plant resin.
[c]Re-injection well was out of service for 20 days due to failure of final duplex strainer in AWWT Phase III system.
[d]Re-injection well was out of service for four days in May and June due to scheduled maintenance activities of treatment facilities.
[e]Re-injection well was out of service for two days due to evaluation of uranium concentration in injectate.
[f]Re-injection well was out of service for eight days due to evaluation of uranium concentration in injectate.
[g]Re-injection well was out of service for five days for well screen rehabilitation.
[h]Re-injection well was out of service for five days due to an electrical outage.
[i]Re-injection well was out of service for four days due to AWWT Phase III treatment system being down.
[j]Re-injection well was out of service for 17 days for well screen rehabilitation.
[k]Re-injection well was out of service for 31 days for well screen rehabilitation.
[l]Re-injection well was out of service for 30 days for well screen rehabilitation.
[m]Re-injection well was out of service for 31 days for well screen rehabilitation.

TABLE A.1-24

RE-INJECTION WELL 22111
OPERATIONAL SUMMARY SHEET FOR 2000

Reference Elevation (feet AMSL) - 583.62 (top of well)
Northing Coordinate ('83) - 476,518.6
Easting Coordinate ('83) - 1,350,105

Hours in reporting period - 8,760 Hours re-injected - 6,077 Target re-injection rate - 200 gpm
Hours not re-injected - 2,683 Operational percent - 69.4

Monthly Measurements at Wellfield		
Month	Monthly Average Re-Injection Rate (gpm)	Million Gallons Re-Injected
1/00	198	8.842
2/00	210	8.766
3/00	206	9.194
4/00[a]	174	7.518
5/00[b,c]	32	1.446
6/00[c,d]	134	5.742
7/00[d,e,f]	31	1.380
8/00[f,g]	129	5.770
9/00	185	8.015
10/00[h]	173	7.679
11/00	191	8.281
12/00[i]	0	0
Average	139	Total 72.633

[a]Re-injection well was out of service for four days due to regeneration of treatment plant resin.
[b]Re-injection well was out of service for 20 days due to failure of final duplex strainer in AWWT Phase III system.
[c]Re-injection well was out of service for four days in May and June due to scheduled maintenance activities of treatment facilities.
[d]Re-injection well was out of service for four days in June and July due to evaluation of uranium concentration in injectate.
[e]Re-injection well was out of service for five days due to an electrical outage.
[f]Re-injection well was out of service for 16 days in July and six days in August for well screen rehabilitation.
[g]Re-injection well was out of service for two days due to AWWT Phase III treatment system being down.
[h]Re-injection well was out of service for three days due to a scheduled power outage.
[i]Re-injection well was out of service for 31 days for well screen rehabilitation.

TABLE A.1-25

RE-INJECTION WELL 22240
OPERATIONAL SUMMARY SHEET FOR 2000

Reference Elevation (feet AMSL) - 577.61 (top of well)
Northing Coordinate ('83) - 476,422.8
Easting Coordinate ('83) - 1,349,387

Hours in reporting period - 8,761 Hours re-injected - 6,114 Target re-injection rate - 200 gpm
Hours not re-injected - 2,647 Operational percent - 69.8

Monthly Measurements at Wellfield		
Month	Monthly Average Re-Injection Rate (gpm)	Million Gallons Re-Injected
1/00	198	8.859
2/00	210	8.756
3/00	206	9.188
4/00[a]	174	7.525
5/00[b,c]	32	1.414
6/00[c,d]	134	5.769
7/00[d,e]	88	3.940
8/00[f,g]	127	5.683
9/00[g]	66	2.863
10/00[h]	172	7.616
11/00	193	8.341
12/00[i,j]	146	6.539
Average	146	Total 76.493

[a]Re-injection well was out of service for four days due to regeneration of treatment plant resin.
[b]Re-injection well was out of service for 20 days due to failure of final duplex strainer in AWWT Phase III System.
[c]Re-injection well was out of service for four days in May and June due to scheduled maintenance activities of treatment facilities.
[d]Re-injection well was out of service for four days in June and eight days in July due to evaluation of uranium concentration in injectate.
[e]Re-injection well was out of service for five days due to an electrical outage.
[f]Re-injection well was out of service for four days due to AWWT Phase III system being down.
[g]Re-injection well was out of service for four days in August and 19 days in September for well screen rehabilitation.
[h]Re-injection well was out of service for three days due to a scheduled power outage.
[i]Re-injection well was out of service for three days due to an evaluation of uranium concentration in injectate.
[j]Re-injection well was out of service for two days due to AWWT Phase III system being down.

TABLE A.1-26

2000 EXTRACTION WELL TARGET PUMPING RATES

Module	Extraction Well	Initial Rates[a] (gpm)	Target Rates[b] (gpm)
South Plume	3924	300	300
	3925	300	300
	3926	400	400
	3927	500	500
	32308	250	250
	32309	250	250
Sub-Total		2000	2000
South Field (Phase I) Extraction	31550	100	100
	31560	100	100
	31561	100	100
	31562[c]	100	290
	31563	200	200
	31564	200	200
	31565	200	200
	31566[d]	200	0
	31567[e]	100	250
	32276	200	300
	32446	200	200
	32447	200	200
Sub-Total		1900	1900
Total Pumping		3900	3900

[a]With the exception of the pumping rate for Extraction Well 3927, these pumping rates are identical to the design pumping rates presented in Table 5-1 of the Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration. The pumping rate for Extraction Well 3927 was increased from 400 to 500 gpm on November 6, 1997 to maximize the extent of the eastern edge of the capture zone in this area.
[b]The target pumping rates for some wells are different from the Baseline Remedial Strategy Report pumping rates shown in the first column and were changed based on operational experience with the extraction system.
[c]The target pumping rate increased from 200 gpm to 290 gpm on September 14, 2000 due to increased total uranium concentrations in well following rehabilitation, and the indications that the well may be remediating a larger portion of the plume than previous projections had indicated.
[d]This well was shut off on August 7, 1998 after operational experience demonstrated its continued operation may have been detrimental in meeting system objectives. Pumping rates for Extraction Wells 31562 and 32276 were increased at that time to compensate for the shut down of Extraction Well 31566.
[e]The target pumping rate increased from 100 gpm to 250 gpm on August 8, 2000 in an effort to accelerate the remediation of the plume emanating from the former inactive flyash pile area.

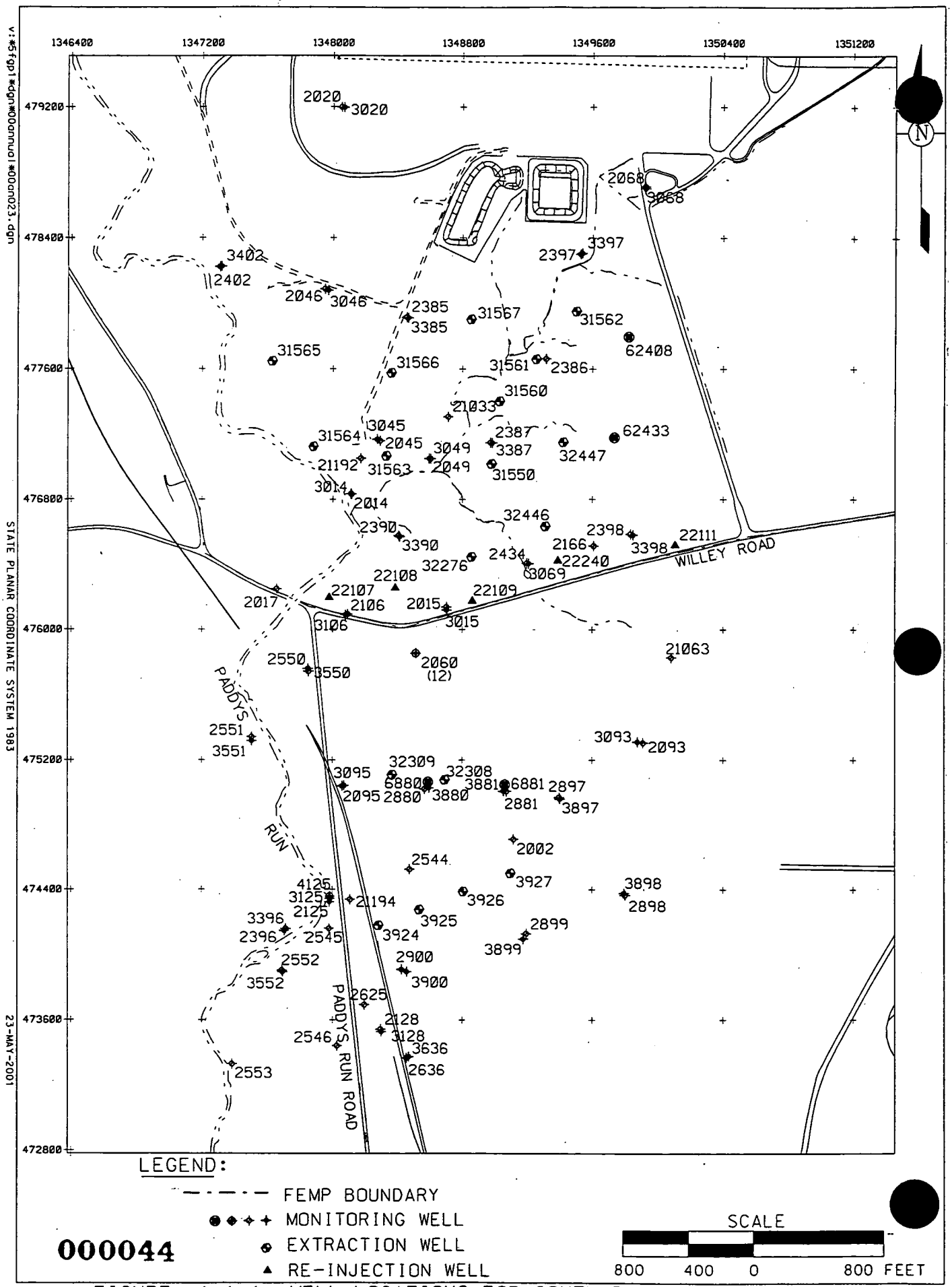

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FIGURE A.1-1. WELL LOCATIONS FOR SOUTH PLUME, SOUTH FIELD, RE-INJECTION AND PADDYS RUN ROAD SITE MONITORING ACTIVITES

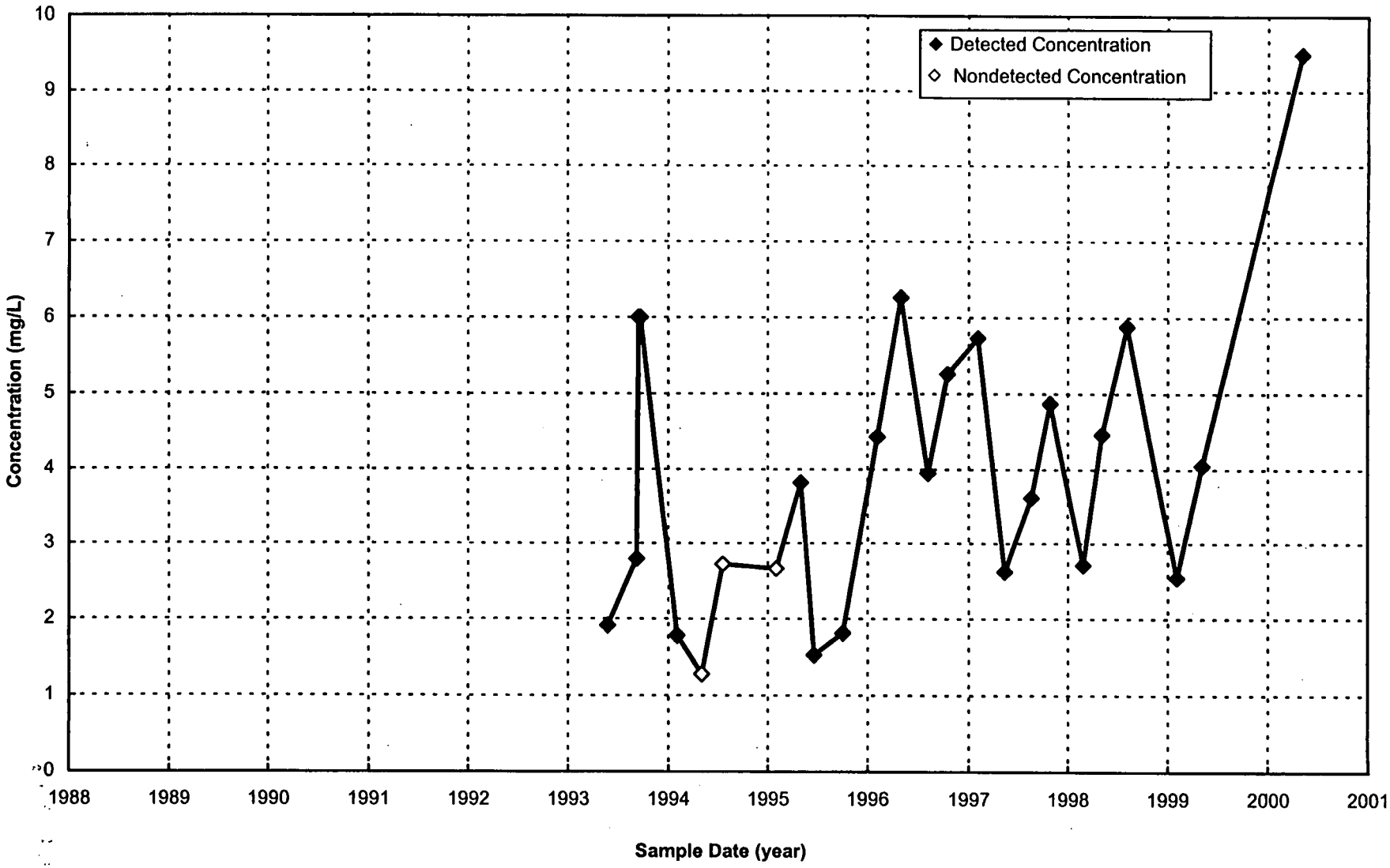


FIGURE A.1-2. POTASSIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2625

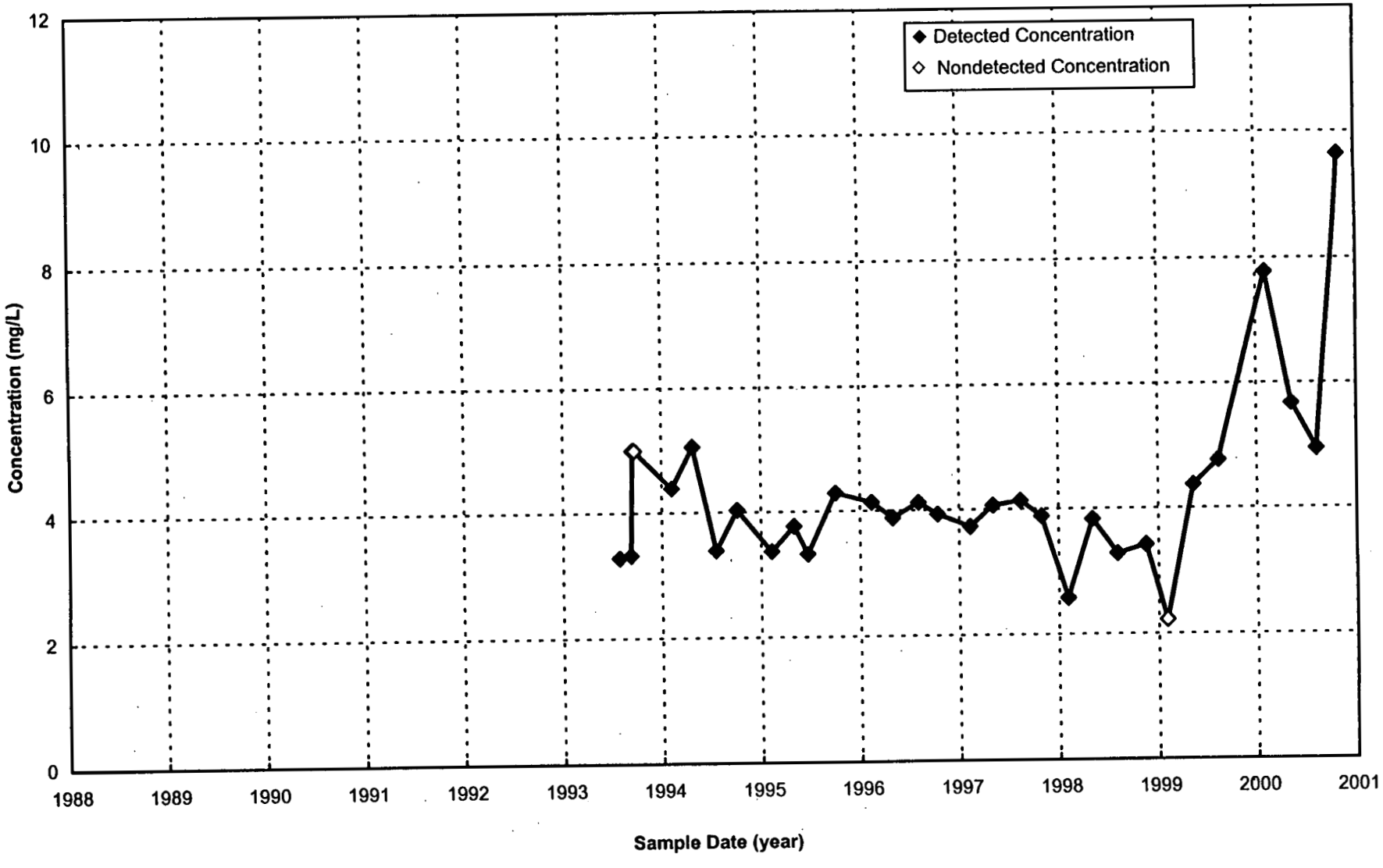


FIGURE A.1-3. POTASSIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2898

000046

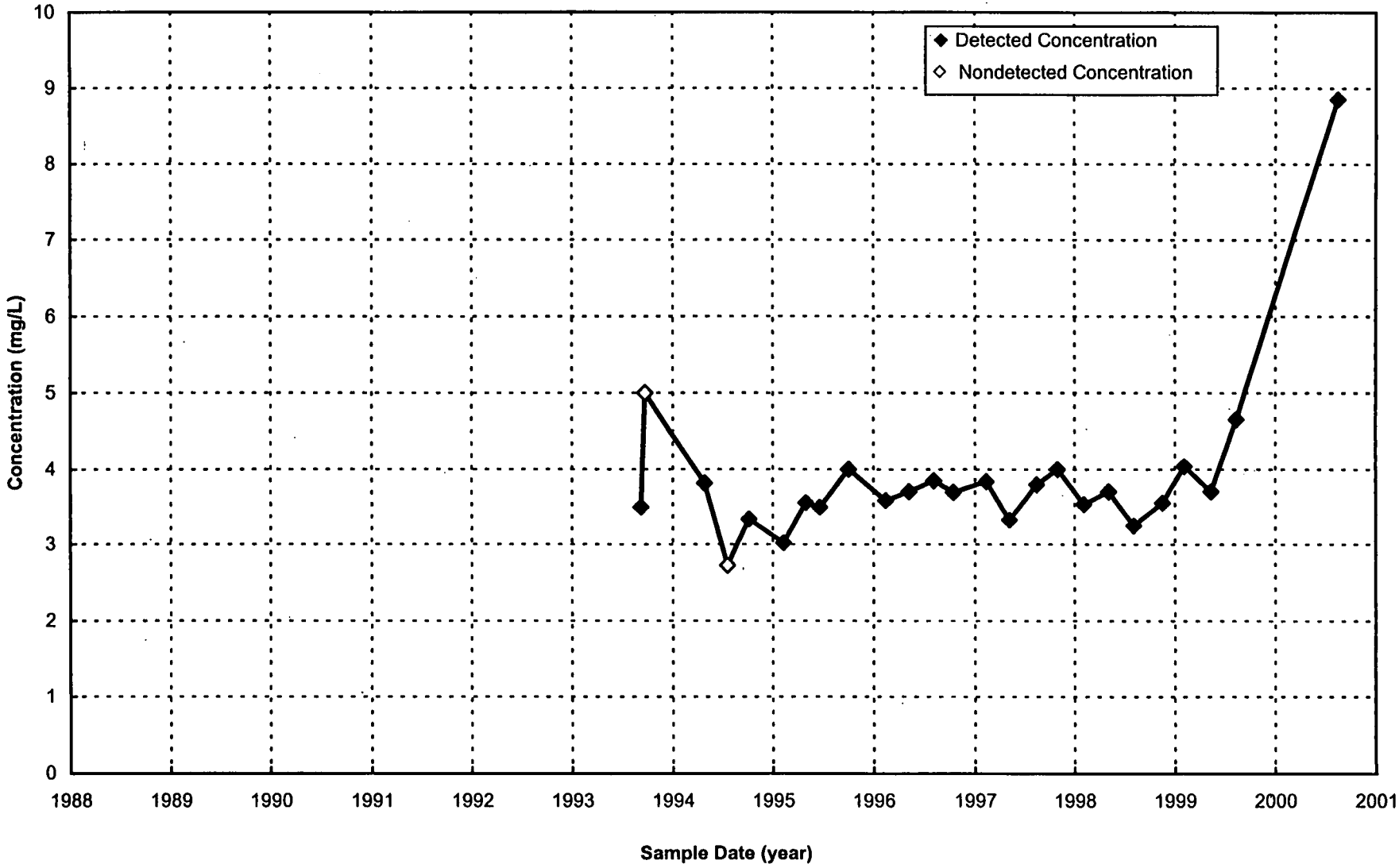


FIGURE A.1-4. POTASSIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2899

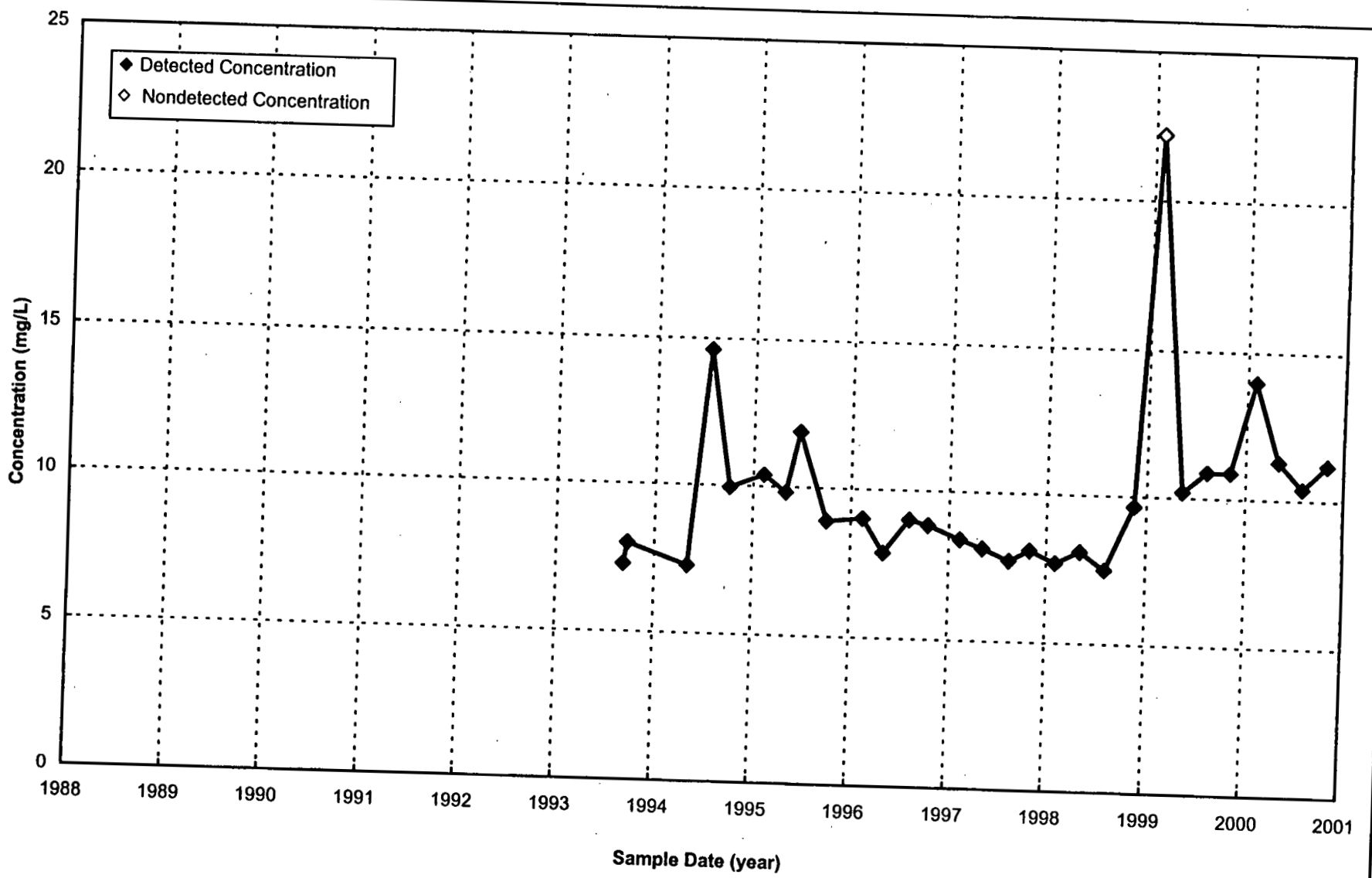
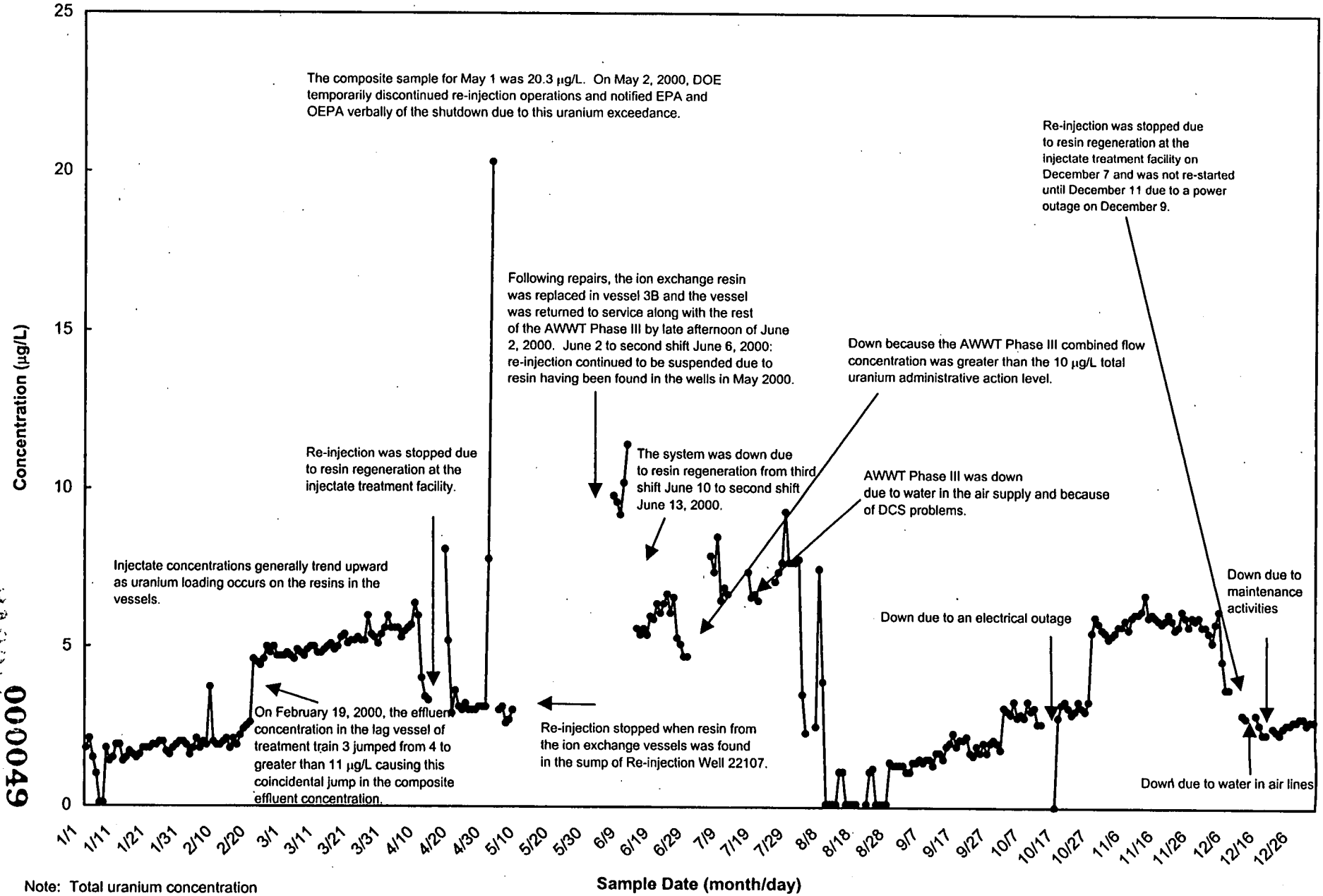


FIGURE A.1-5. SODIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3898

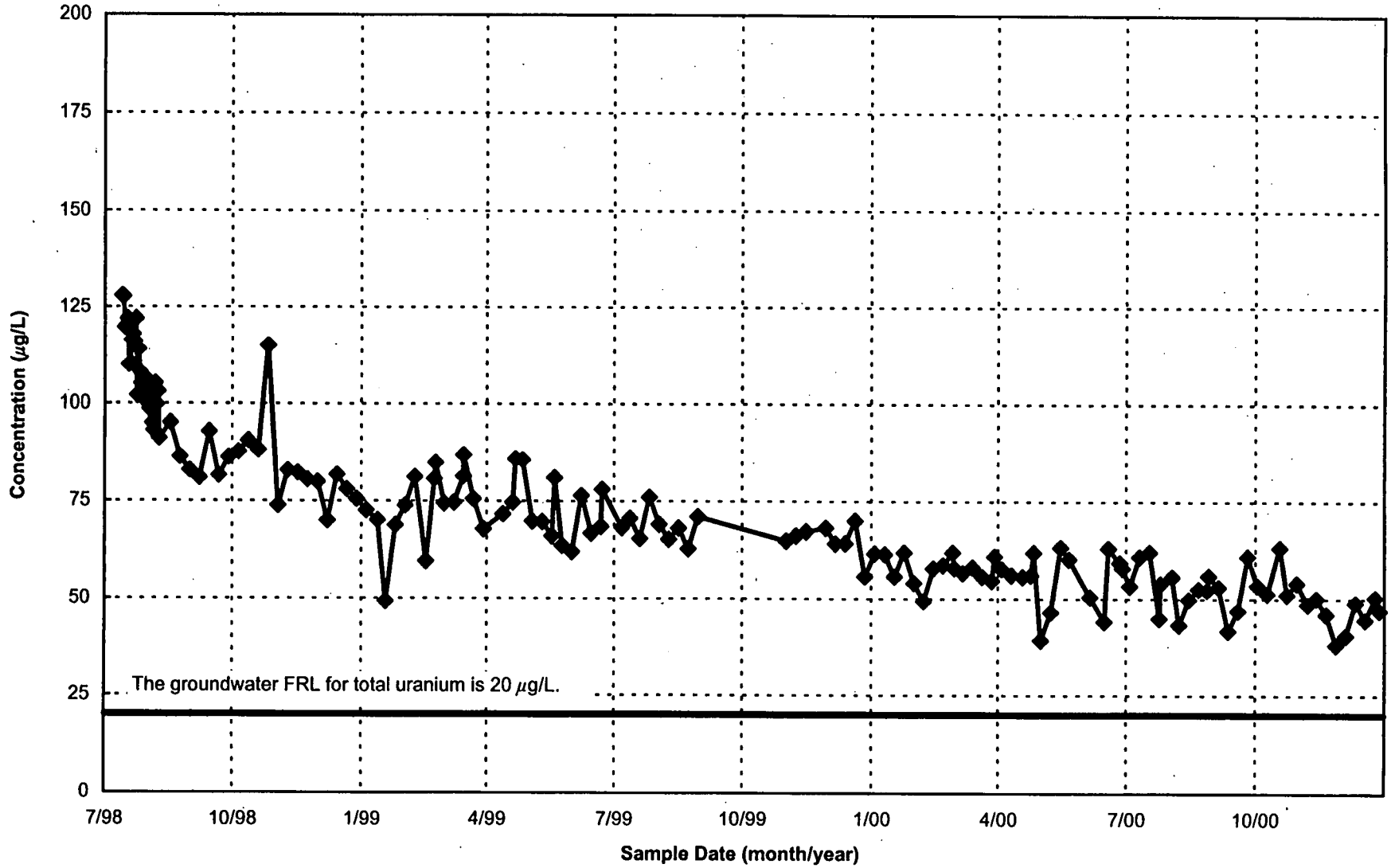
000048



Note: Total uranium concentration required to be less than 20 µg/L.

FIGURE A.1-6. 2000 TOTAL URANIUM CONCENTRATIONS IN INJECTATE

000049



Modeled Concentration = 16.9 µg/L
Developed Concentration = 130 µg/L

FIGURE A.1-7. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 31550

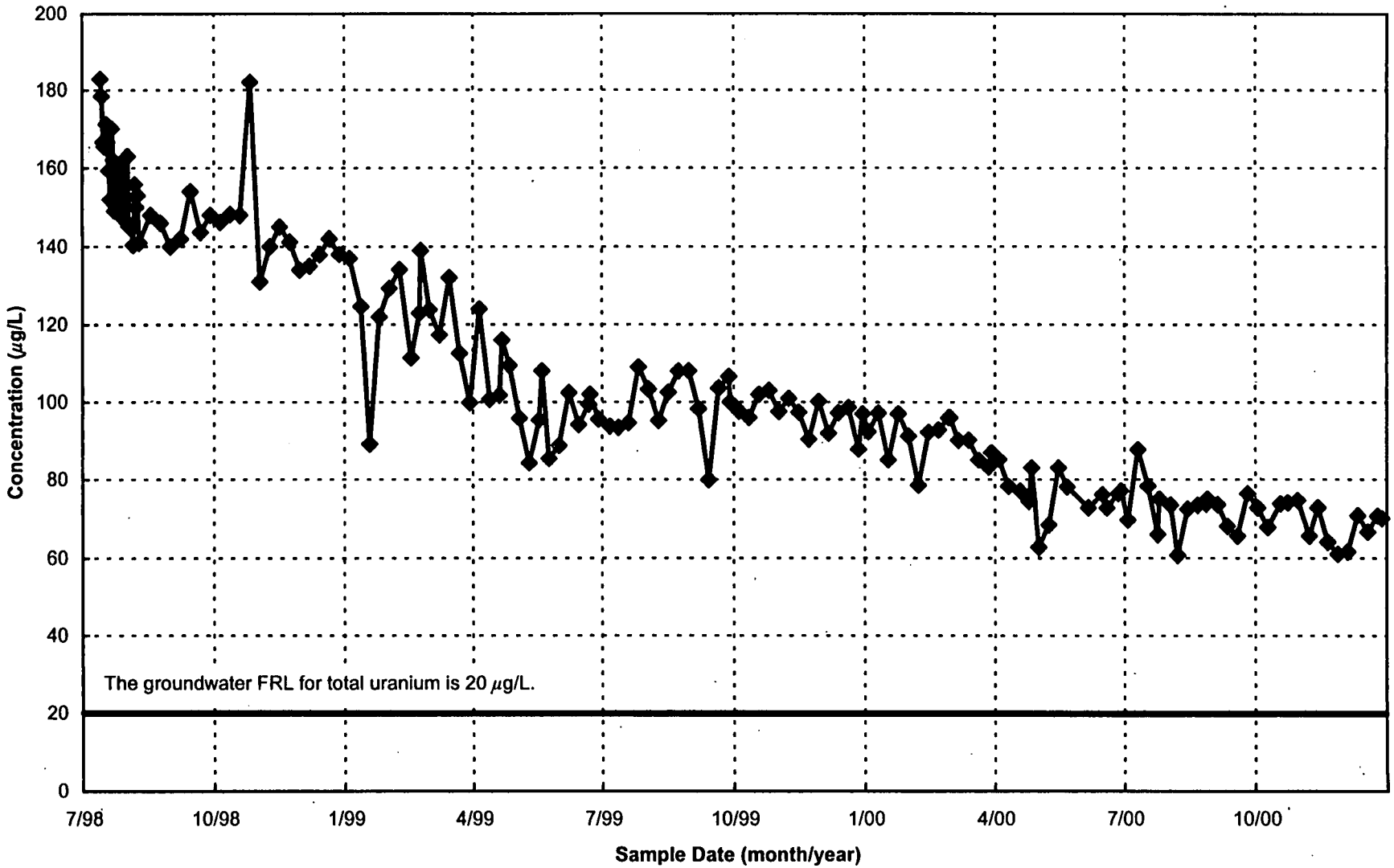
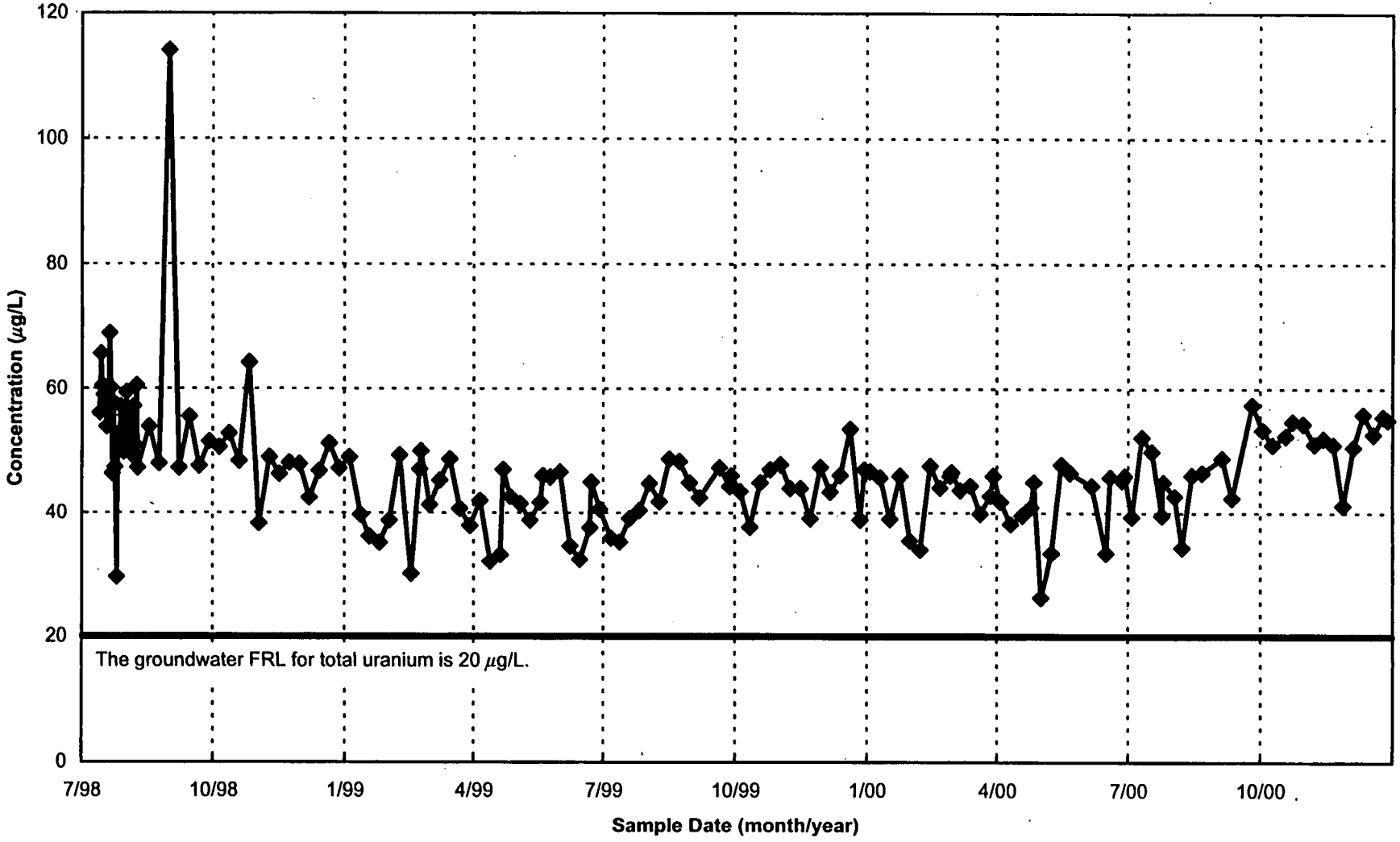


FIGURE A.1-8. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 31560

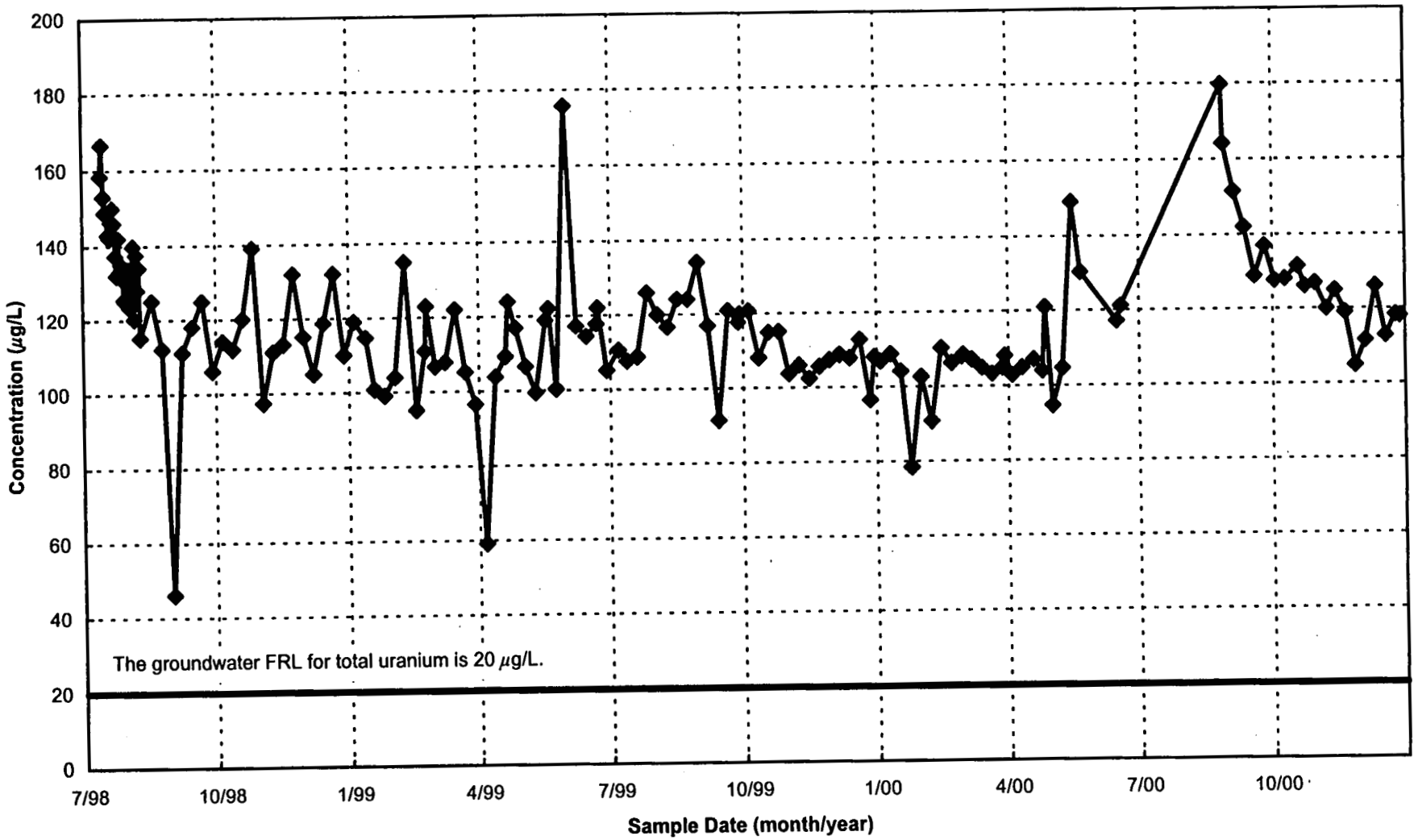
Modeled Concentration = 62.7 µg/L
Developed Concentration = 217 µg/L



Modeled Concentration = 64.8 µg/L
Developed Concentration = 49 µg/L

FIGURE A.1-9. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 31561

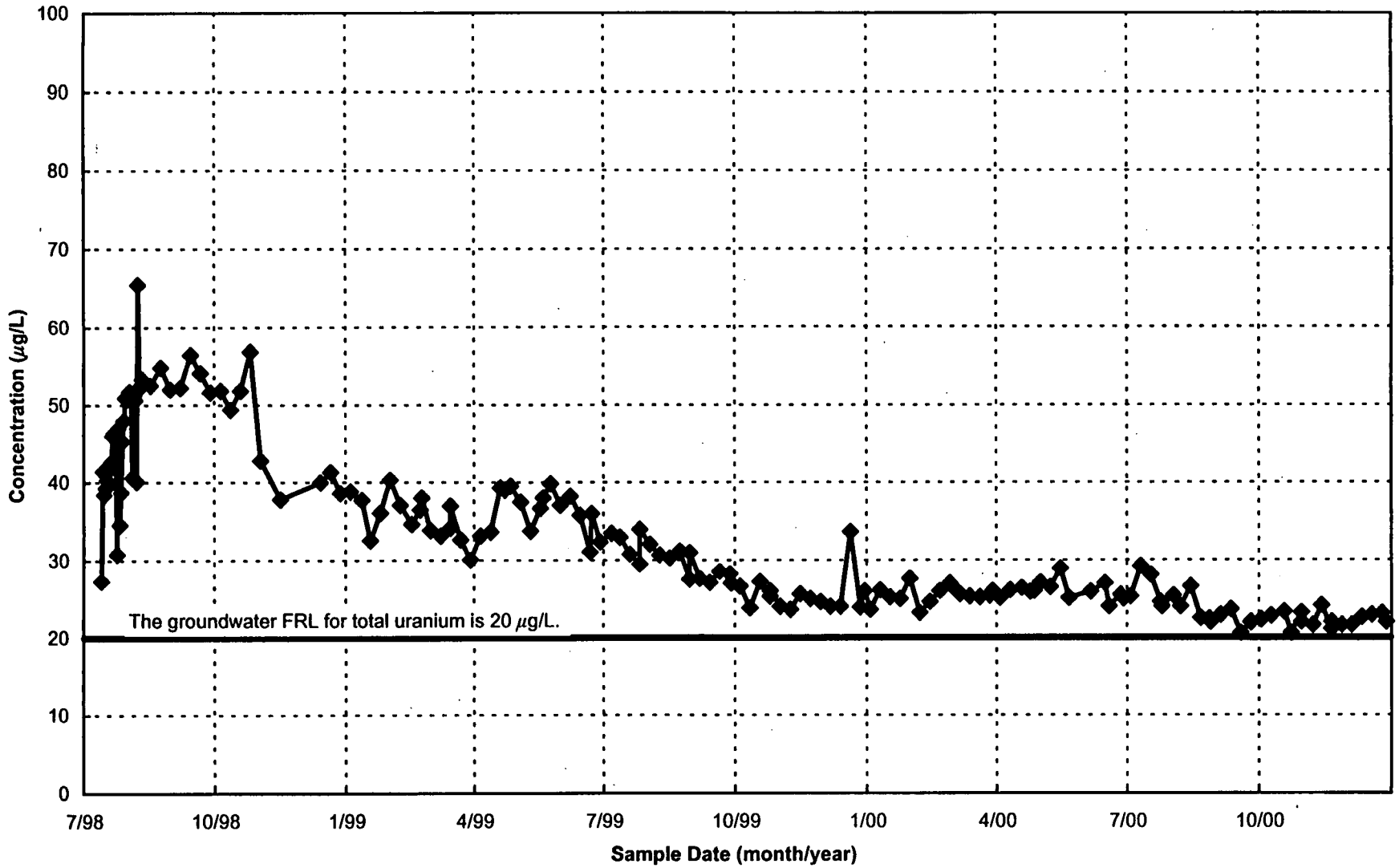
000052



Modeled Concentration = 231.4 µg/L
Developed Concentration = 177 µg/L

FIGURE A.1-10. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 31562

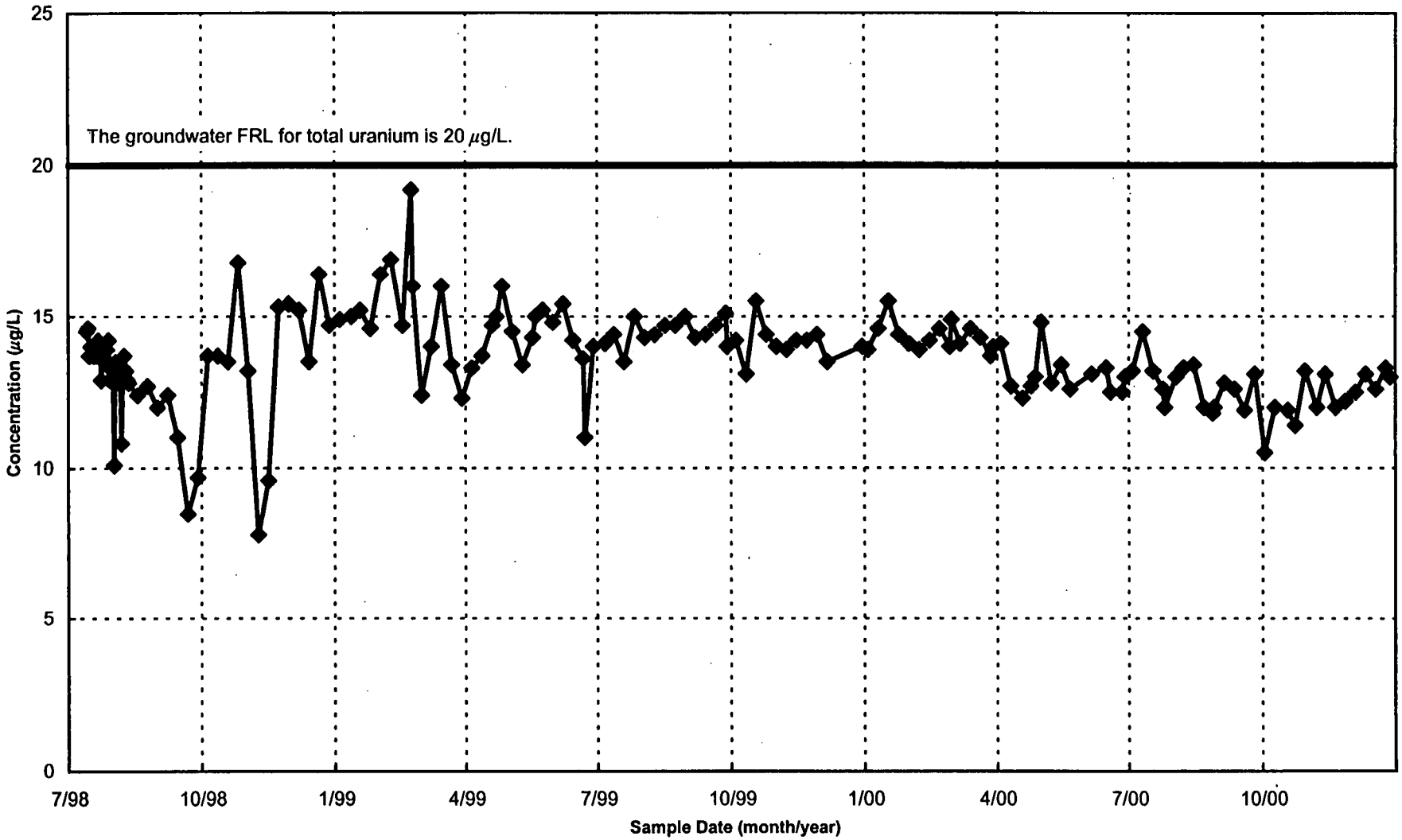
000053



Modeled Concentration = 79.8 µg/L
Developed Concentration = 30 µg/L

FIGURE A.1-11. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 31563

000054

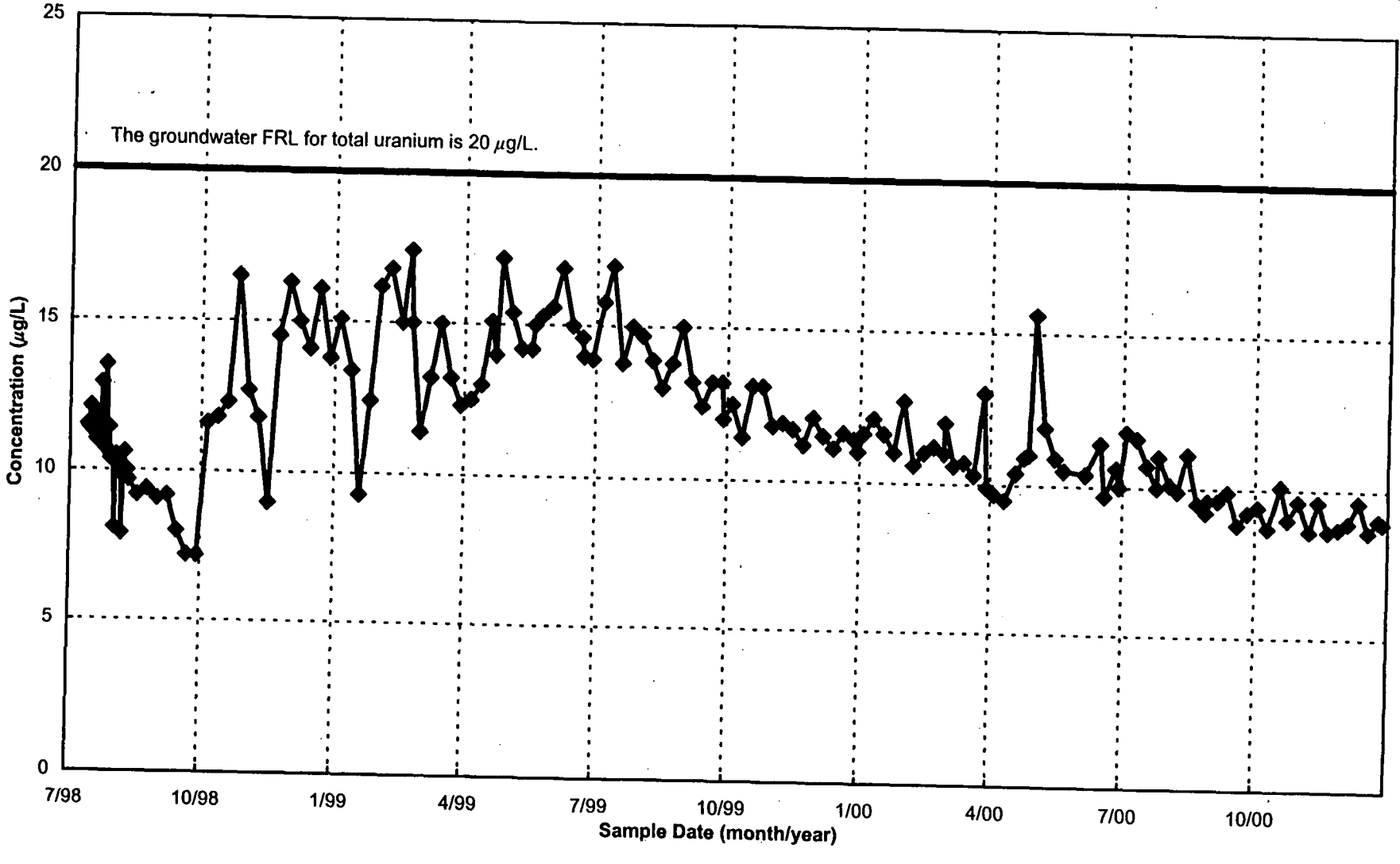


Modeled Concentration = 11.9 μg/L.
Developed Concentration = 18 μg/L

FIGURE A.1-12. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 31564

000055

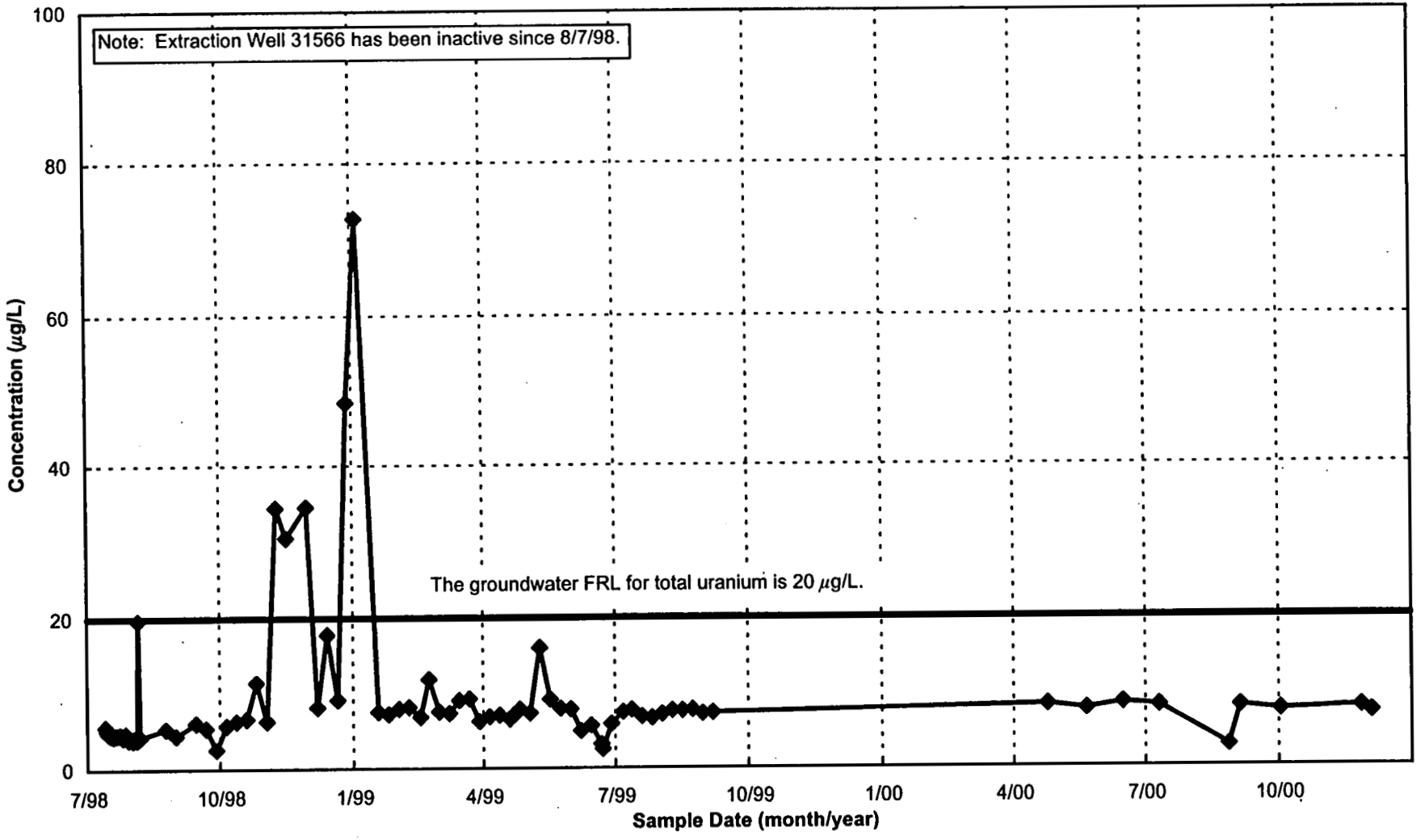
3694



Modeled Concentration = 139.2 μg/L
Developed Concentration = 15 μg/L

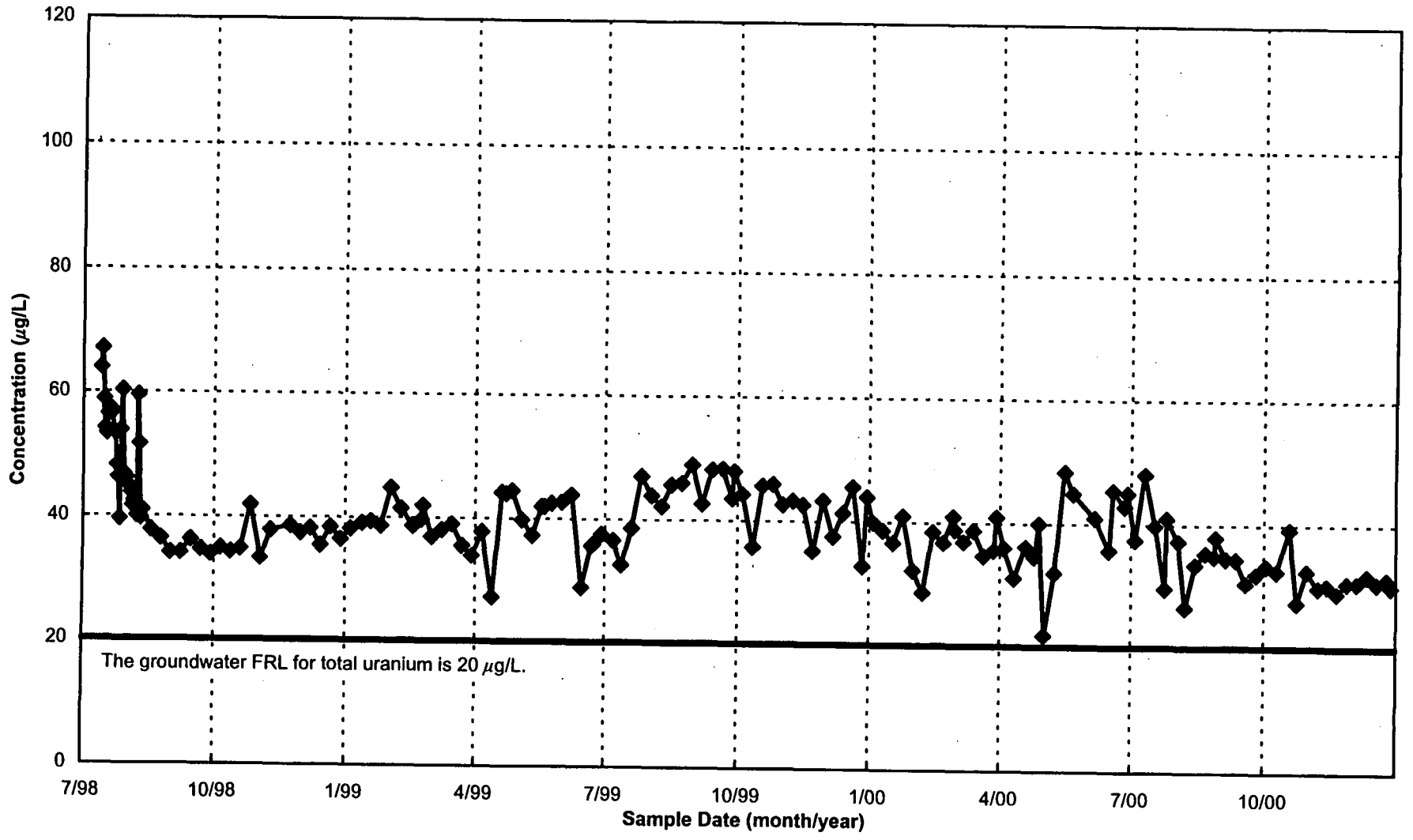
FIGURE A.1-13. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 31565

000056



Modeled Concentration = 63.3 μg/L
Developed Concentration = 4.8 μg/L

FIGURE A.1-14. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 31566



Modeled Concentration = 9.6 µg/L
Developed Concentration = 14 µg/L

FIGURE A.1-15. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 31567

000058

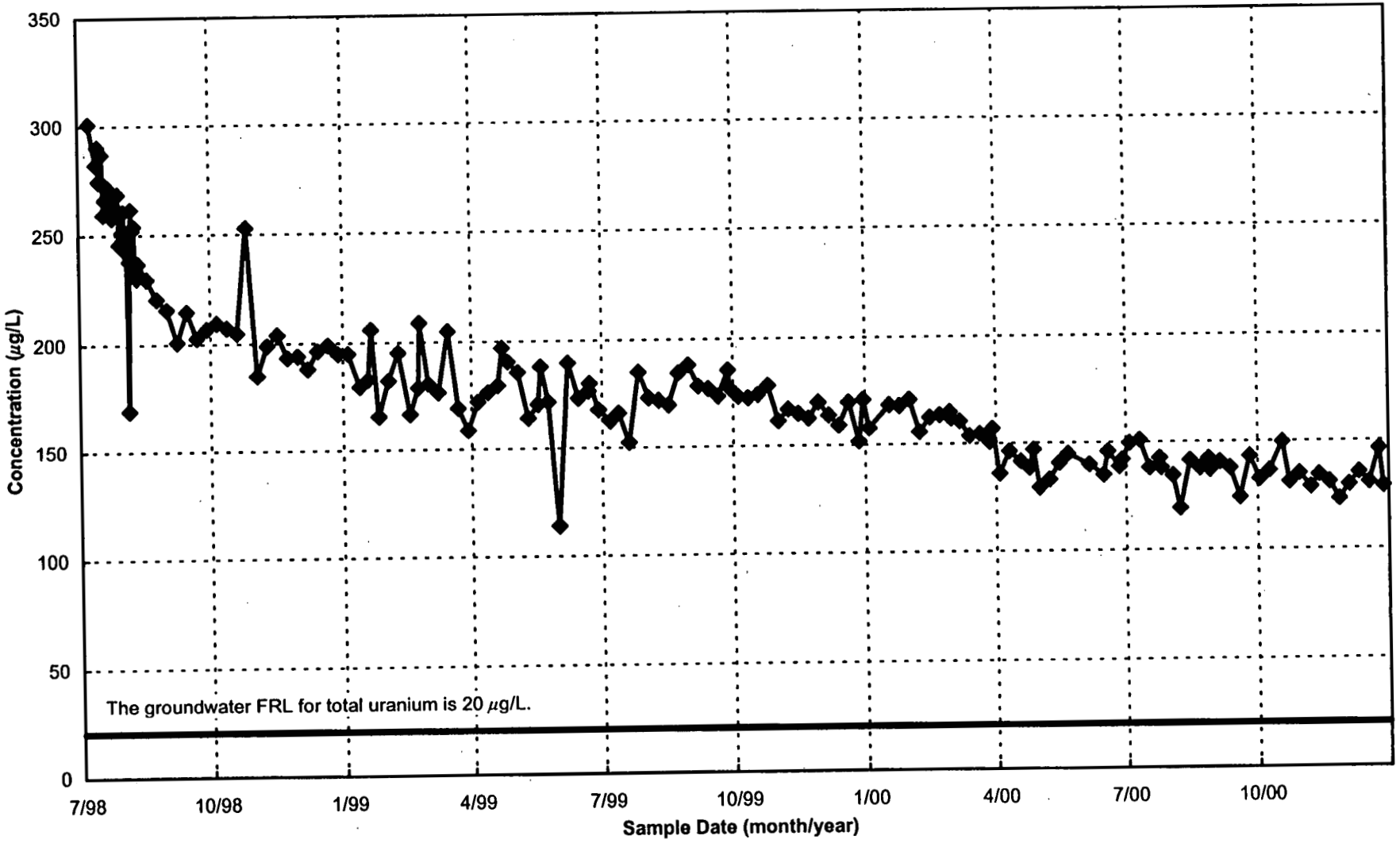


FIGURE A.1-16. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 32276

Modeled Concentration = 239.4 µg/L
Developed Concentration = 400 µg/L

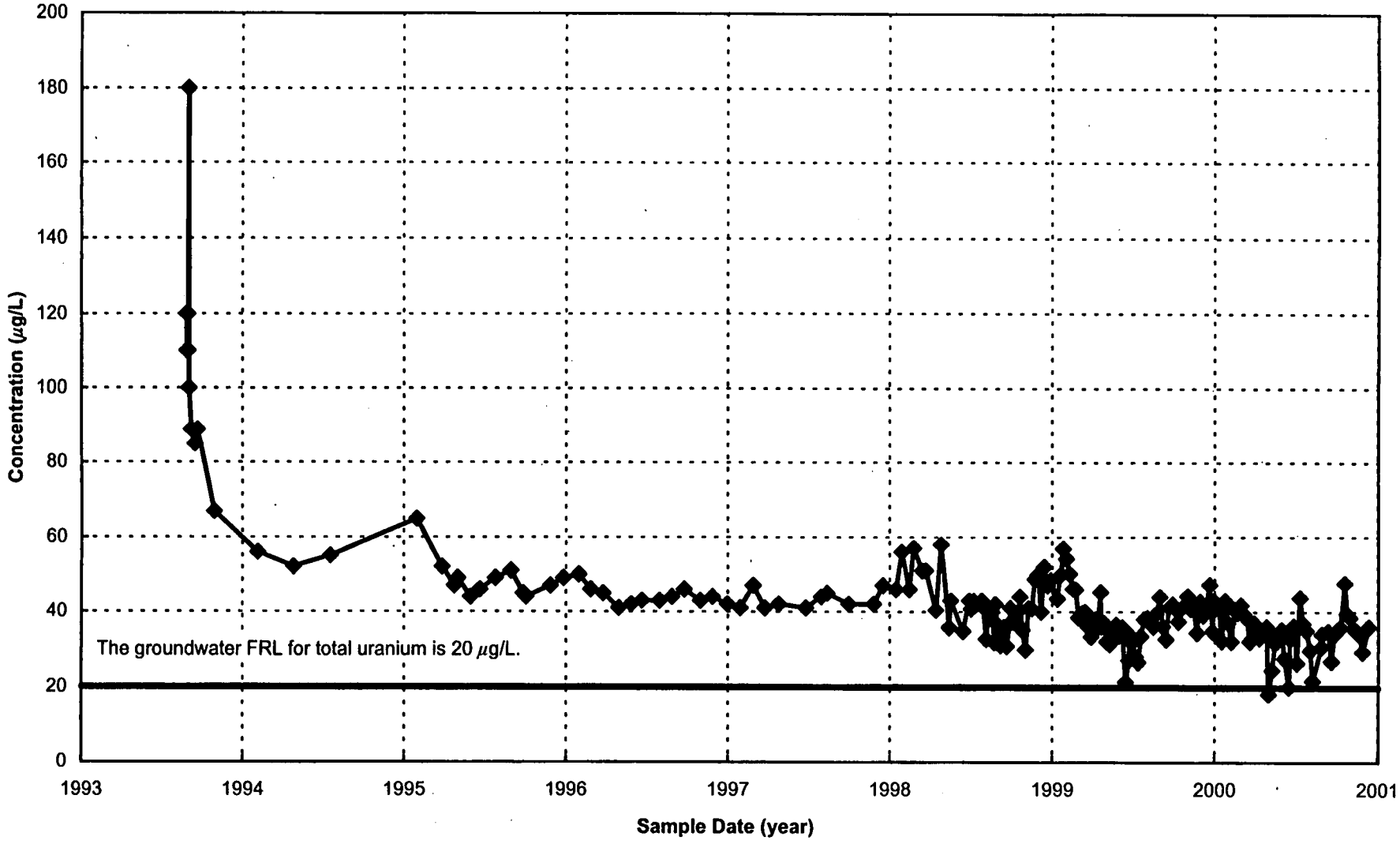


FIGURE A.1-17. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 3924

000060

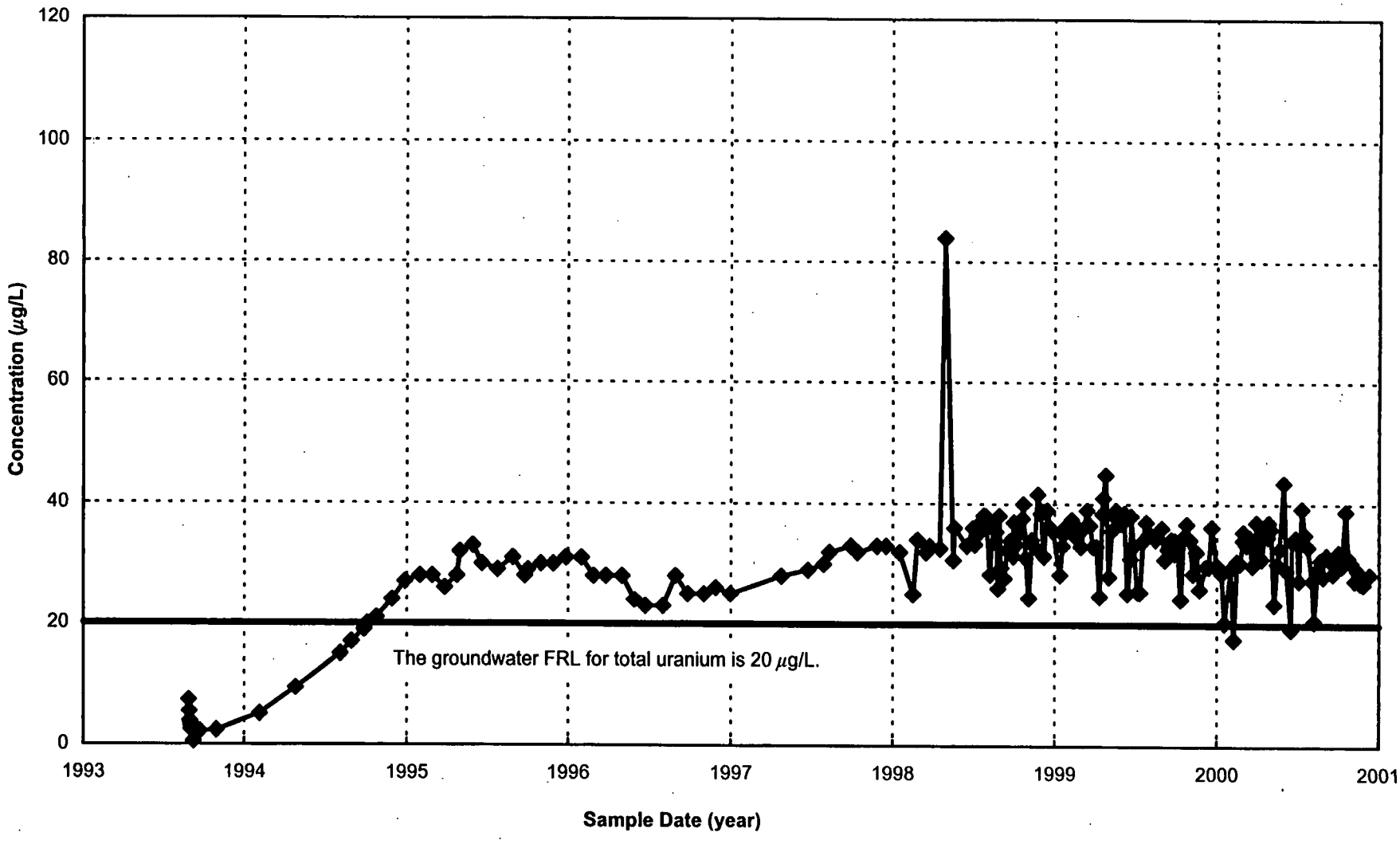


FIGURE A.1-18. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 3925

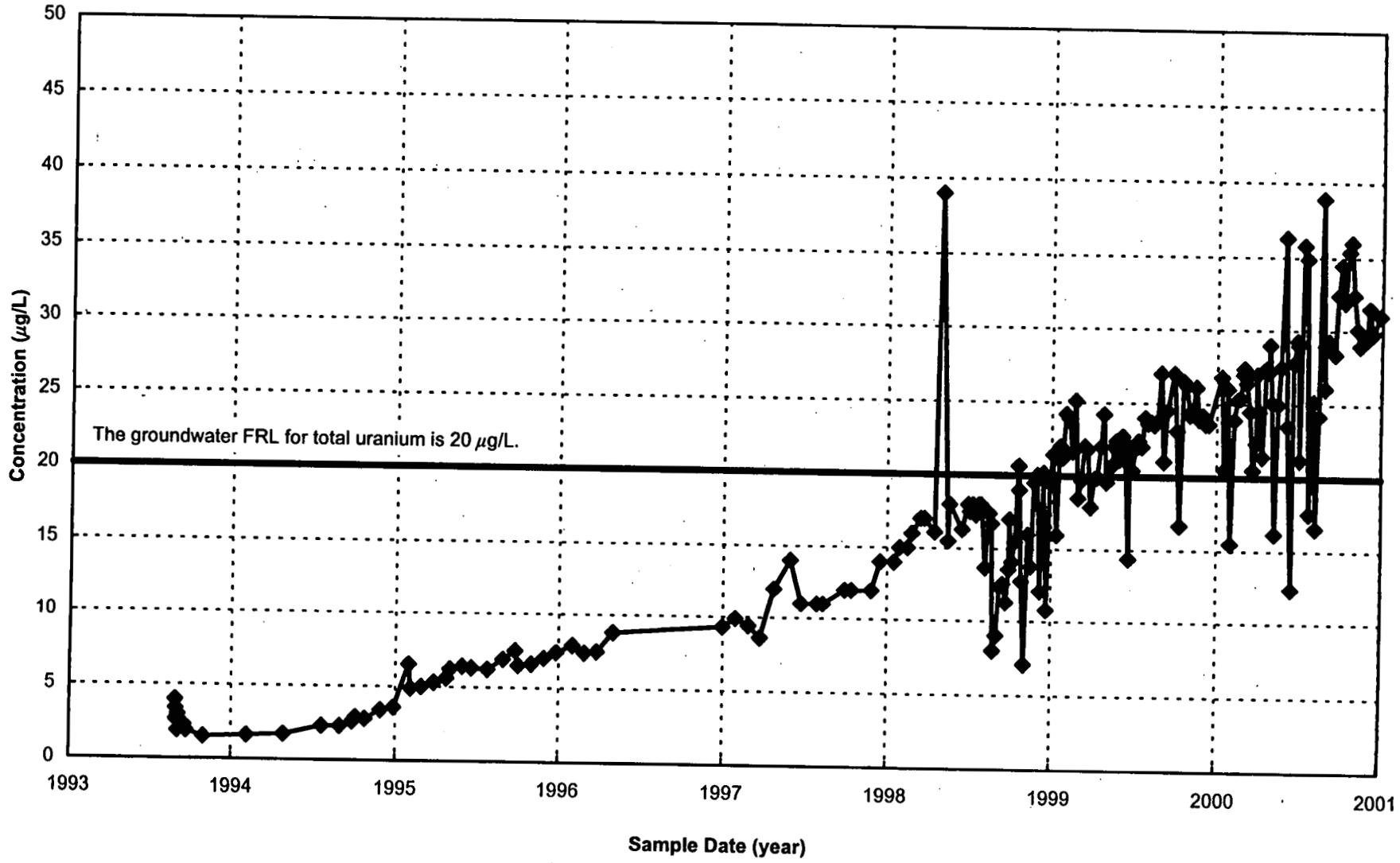


FIGURE A.1-19. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 3926

000062

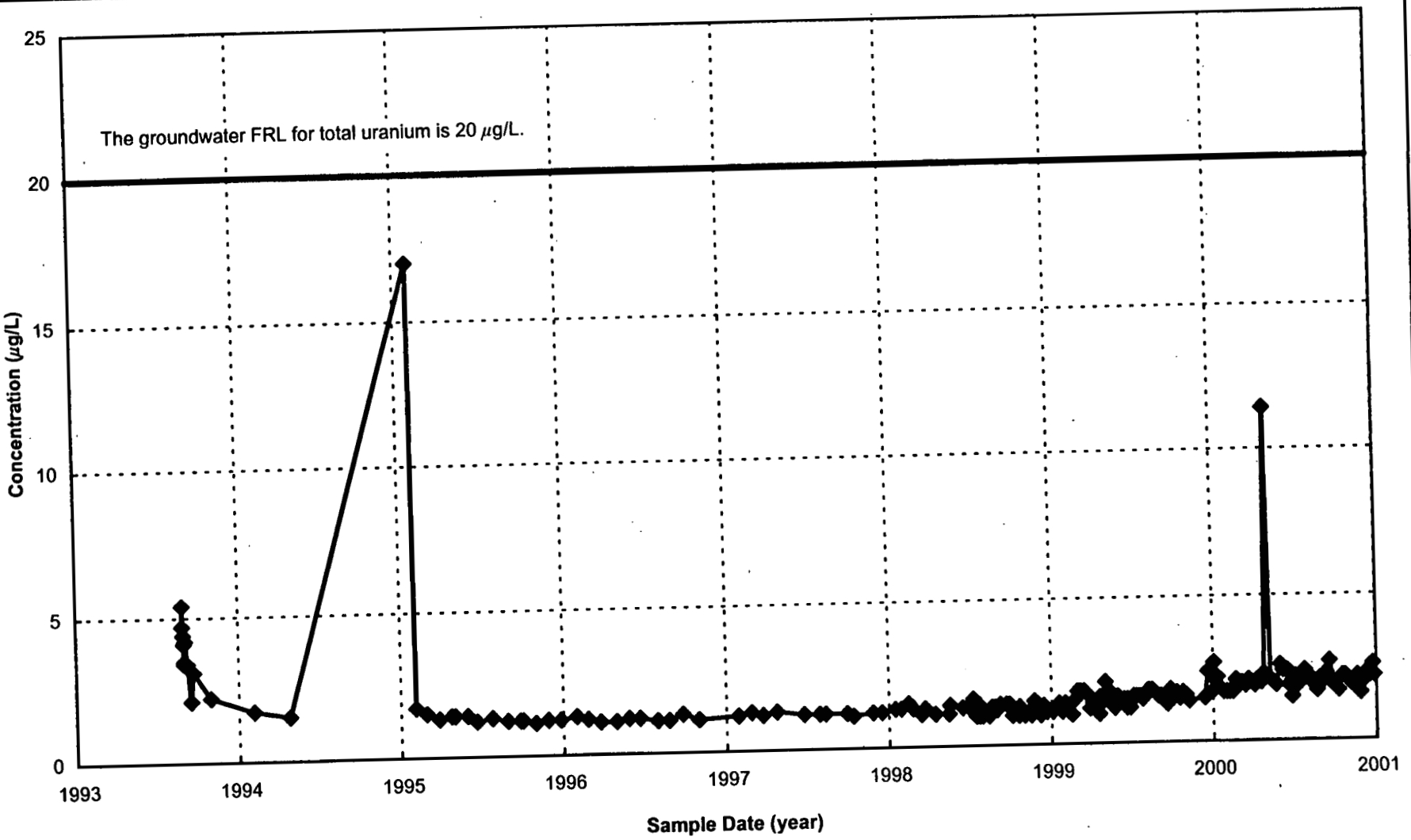
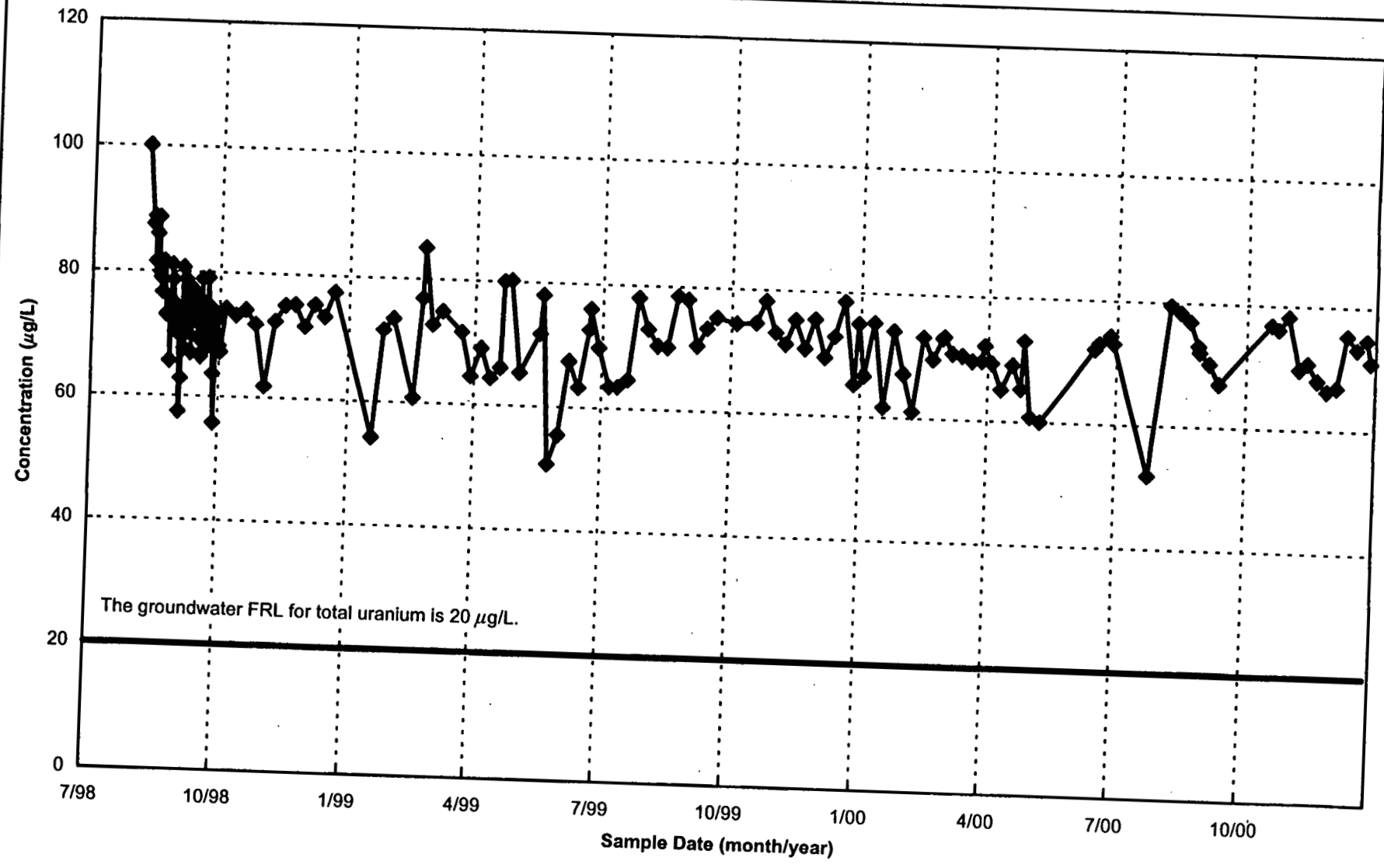
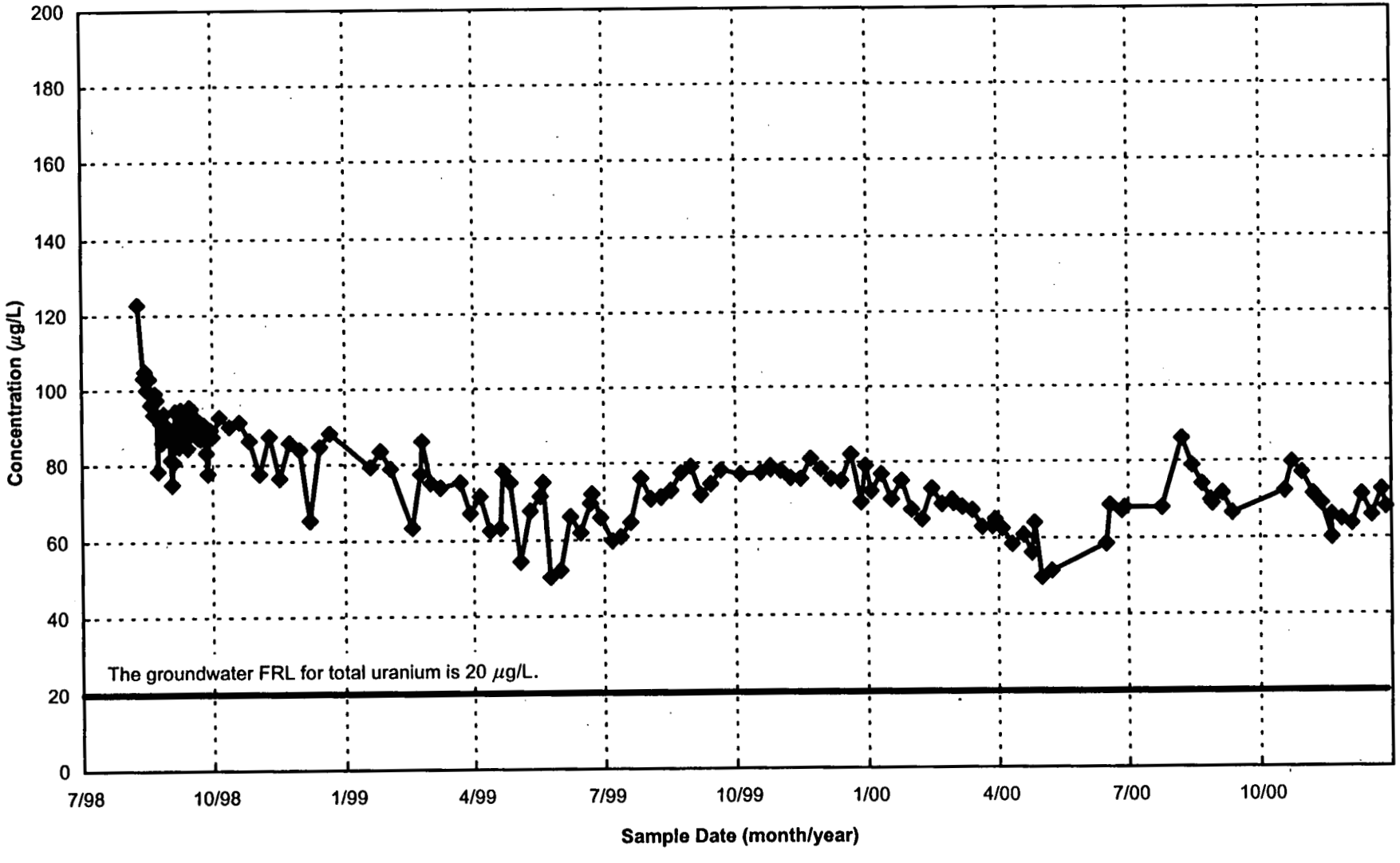


FIGURE A.1-20. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 3927



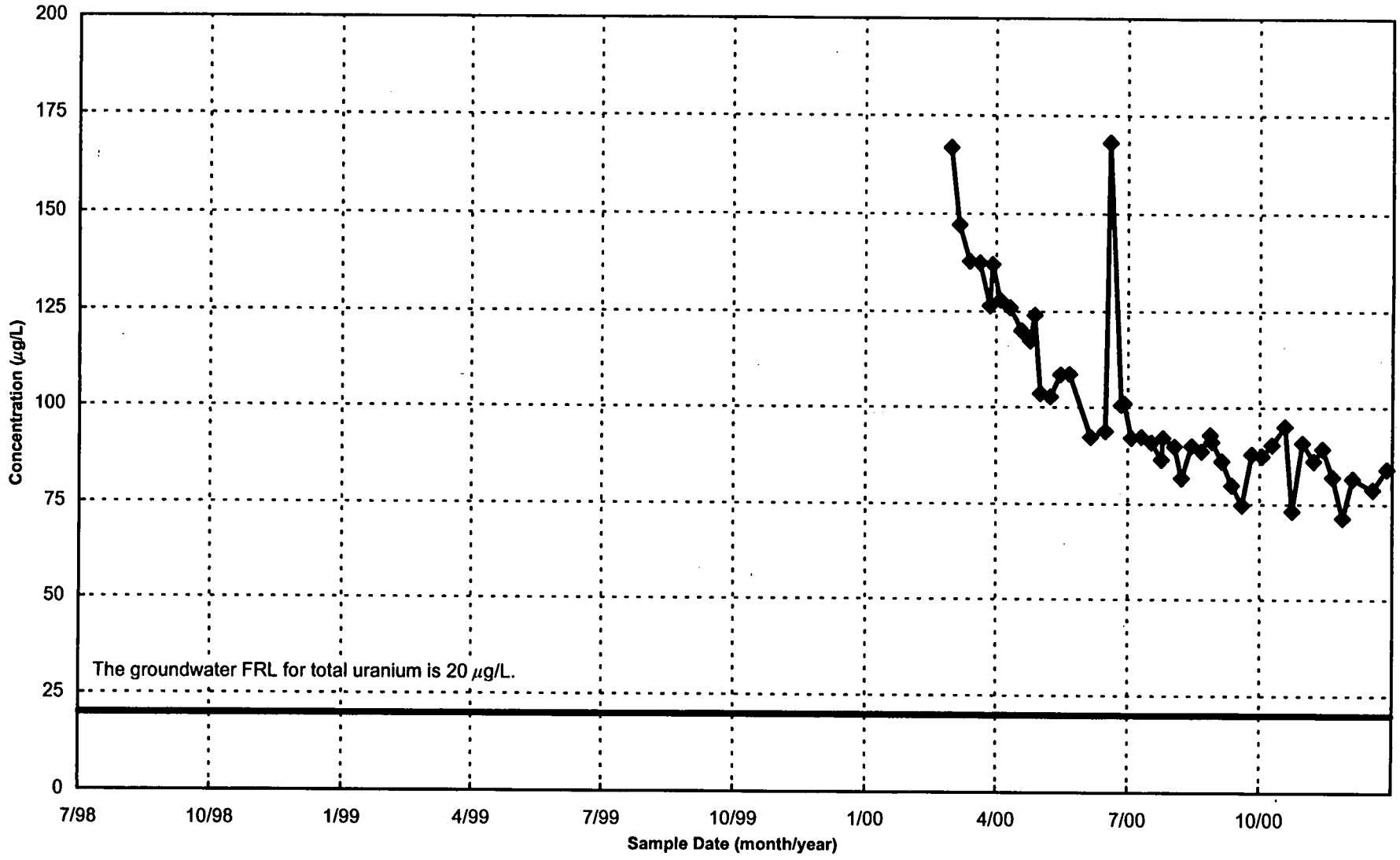
Modeled Concentration = 27.8 µg/L
Developed Concentration = 123 µg/L

FIGURE A.1-21. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 32308



Modeled Concentration = 45.6 µg/L
Developed Concentration = 143 µg/L

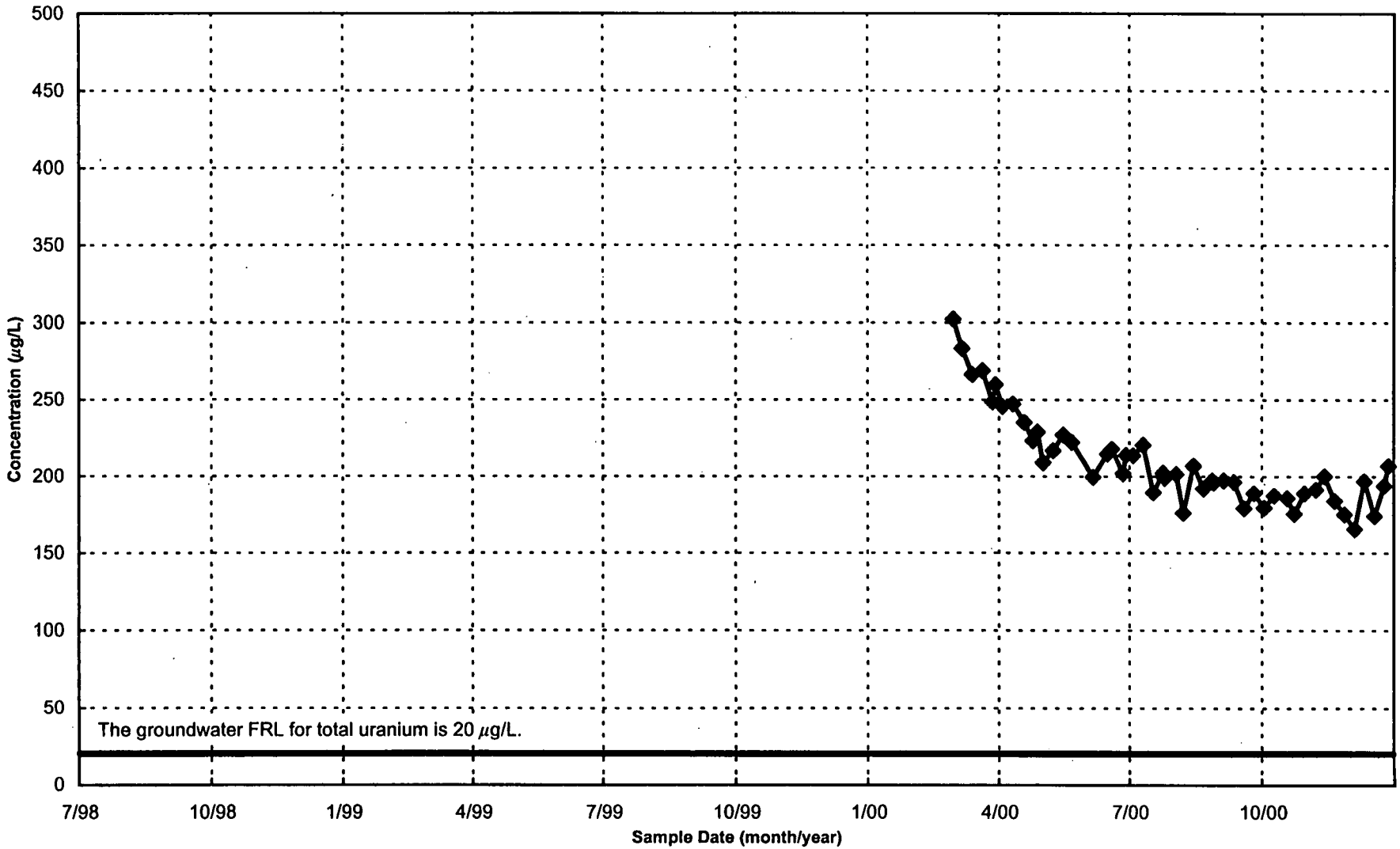
FIGURE A.1-22. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 32309



Modeled Concentration = 239.4 µg/L
Developed Concentration = 400 µg/L

FIGURE A.1-23. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 32446

000066



Modeled Concentration = 239.4 µg/L
Developed Concentration = 400 µg/L

FIGURE A.1-24. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 32447

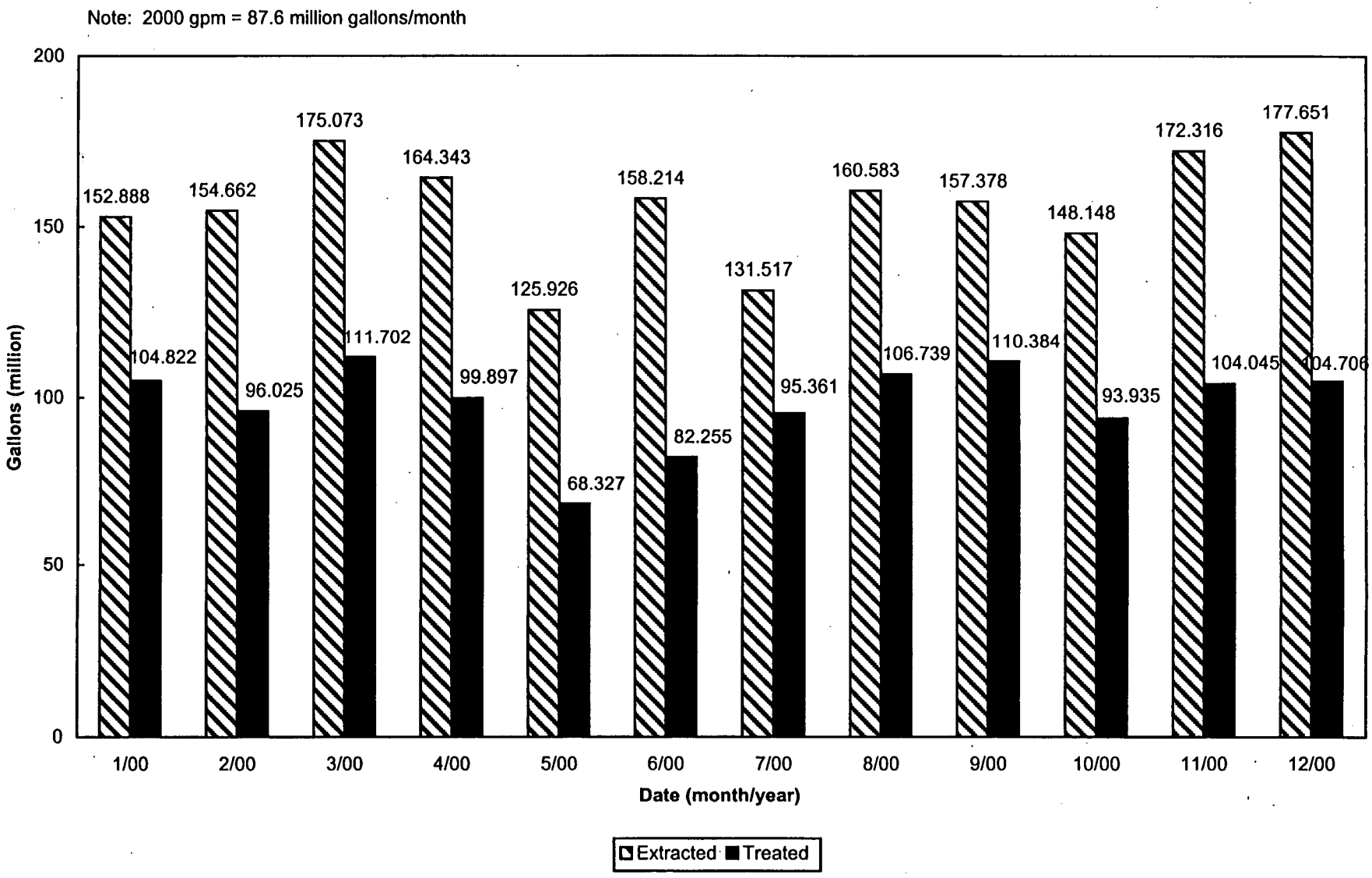


FIGURE A.1-25. TOTAL GROUNDWATER EXTRACTED VS. GROUNDWATER TREATED FOR 2000

000068

Attachment A.2

ATTACHMENT A.2

ASSESSMENT OF TOTAL URANIUM RESULTS

ATTACHMENT A.2

This attachment discusses total uranium results for 2000, in context with uranium data collected prior to 2000. Monitoring and extraction well locations associated with the IEMP are shown in Figure A.2-1 and listed in Table A.2-1. For integration purposes, the on-site disposal facility monitoring well locations are also shown on Figure A.2-1.

Figures A.2-2 through A.2-5 are maximum total uranium plume maps for each sampling quarter of 2000. Data collected quarterly from the aquifer are used to progressively update the total uranium plume maps in the following manner:

- Total uranium concentration data from the most recent quarter are posted on a map with the contours from the previous IEMP quarterly status report. The highest representative total uranium value of Type 2, 3, or 4 wells at a cluster is selected. The highest concentration associated with each Geoprobe® location is also selected.
- If the most recent quarterly concentration from a well is greater than the concentration contour value at that location, then the plume is re-contoured to honor the higher value.
- At some locations, the plume may be migrating between the Type 2 well screen and the Type 3 well screen. Therefore, if the quarterly concentration measurement from a well is less than what is contoured for that location previously, then the new data are posted but the plume contours are not adjusted to honor the new data.
- If direct-push data are available, and a complete vertical profile of an area indicates that the edge of the 20 μg/L plume has contracted, then the map is re-contoured to honor the contracted interpretation.

Tables A.2-2 and A.2-3 list the monitoring wells and extraction wells, respectively, where total uranium concentrations exceeded the 20 μg/L FRL during 2000. Included in the tables are statistical summaries for total uranium concentrations at each well and a calculated statistical trend. Figure A.2-6 illustrates the statistics presented in Tables A.2-2 and A.2-3, where total uranium concentrations are increasing, decreasing, or showing no significant trend. Figure A.2-7 through A.2-136, present total uranium concentration versus time plots for all IEMP and on-site disposal facility monitoring wells.

The topics listed below are deemed to be important based on a review of these total uranium data.

- Changes in the waste storage and Plant 6 areas
  - Revised plume characterization based on pre-design data
  - Plugging and abandonment of Monitoring Well 3027
  - Total uranium increase at Monitoring Well 2648

- Changes in the South Field area
  - Beneath the former Inactive Flyash Pile (direct push sampling, Monitoring Wells 2046 and 2385)
  - Less than expected remediation response along the eastern edge of the South Field plume (Monitoring Wells 62408, 62433, and 2166)
  - Need for an additional extraction well in the South Field (near Monitoring Well 2397)
  - Plugging and abandonment of Monitoring Well 3068
  - Total uranium increase at Monitoring Well 3069
  - Total uranium decrease at Monitoring Well 2049
- Changes near the on-site disposal facility
  - Total uranium increase at Monitoring Well 2426
  - Total uranium increases in monitoring wells
- Changes in the South Plume area
  - Monitoring well "Down, Significant" trends and lack of significant trend in Monitoring Wells 6881 and 2551
  - Up, Significant Trends in Extraction Wells 3925, and 3926, and Monitoring Well 3095
  - Total uranium increases at Monitoring Well 2900
- Biased total uranium results due to high turbidity.

The following subsections present in-depth discussion of the above noted topics.

Changes in the Waste Storage and Plant 6 Areas:

Revised plume characterization based on pre-design data

As identified in the 1999 Integrated Site Environmental Report, early in 2000, additional characterization efforts utilizing 30 direct push sampling locations were conducted in the waste storage and Plant 6 areas to support the engineering design of the aquifer restoration modules planned for those areas. Additionally some wells in these areas, which were not part of the IEMP, were sampled to support the characterization efforts. These design characterization efforts are detailed in the report: Conceptual Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas (DOE 2000a). As discussed below, this characterization effort resulted in changes to the total uranium plume interpretation in both the waste storage and Plant 6 areas.

The uranium plume beneath the waste storage area was depicted in the 1999 Integrated Site Environmental Report as a single large plume. This interpretation dates back to the Remedial Investigation Report for Operable Unit 5 (DOE 1995, Plate E-81). Characterization work conducted in 2000 has resulted in a three-plume interpretation. All of the quarterly total uranium plume maps produced in 2000 (Figures A.2-2 through A.2-5) show this new three-plume interpretation. One plume is

relatively narrow, trends east west, and parallels and extends east of the Pilot Plant Drainage Ditch. Total uranium concentrations in this plume range up to 566 µg/L. The second plume is in the vicinity of the silos and the Bio-Surge Lagoon. The third plume is east of Waste Pit 3 and the Clearwell.

A total uranium plume beneath the Plant 6 area was depicted in the 1999 Integrated Site Environmental Report. This interpretation was also set forth in Plate E-81 of the Remedial Investigation Report for Operable Unit 5. As a result of the additional characterization work conducted in 2000 (DOE 2000a), the total uranium plume no longer appears to be present at concentrations greater than the 20 µg/L uranium FRL. Routine sampling of the Plant 6 area monitoring wells took place during the second and fourth quarters of 2000. During the second quarter of 2000, Monitoring Well 2389 had a total uranium concentration of 22.7 µg/L (refer to Figure A.2-3). During the fourth quarter the uranium concentration at Monitoring Well 2389 was 5.6 µg/L (refer to Figure A.2-5). Figure A.2-38 is a total uranium concentration versus time plot for Monitoring Well 2389. The figure illustrates that the total uranium concentration has historically been below 20 µg/L at this well. Table A.2-2 indicates that total uranium concentrations at Monitoring Well 2389 are not showing a significant trend.

Plugging and Abandonment of Monitoring Well 3027

Beginning in late 1999 and throughout 2000, total uranium concentrations increased at Monitoring Well 3027. This well is located just southeast of Waste Pit 4 in the waste storage area. Monitoring Well 3027 was routinely sampled during the second and fourth quarters in 2000. The FRL exceedance (40.3 µg/L) is noted on the second quarter uranium plume map (refer to Figure A.2-3). Figure A.2-73 is a total uranium concentration versus time plot for Monitoring Well 3027, which illustrates the increase. Direct-push sampling conducted to support design of the aquifer restoration module for the waste storage area indicated that the contamination was not indicative of a plume that was slowly migrating through the area. In fact it was indicative of cross contamination within the well itself, whereby surface or glacial overburden contamination migrates down the well bore.

A small scale pumping operation was conducted in October of 2000 within this localized pocket of contamination. The results of this pumping effort re-inforced the interpretations that the higher levels of contamination detected were due to cross-contamination. At the start of pumping, the total uranium concentration was 259 µg/L. After pumping 5,000 gallons of water from the well, the total uranium concentration decreased to approximately 15 µg/L. After pumping 20,000 gallons from the well, the total uranium concentration decreased to 13 µg/L. On October 27, 2000, the well was plugged and abandoned. However, the well was first pumped immediately prior to being plugged. At the start of that pumping, the

total uranium concentration of the static water in the well was 50 μg/L. After pumping 5,000 gallons from the well, the total uranium concentration of the pumped water decreased to 14 μg/L.

Total Uranium Increase at Monitoring Well 2648

Monitoring Well 2648 is located in the waste storage area, adjacent to Waste Pit 4. This well was sampled during the second and fourth quarters of 2000. As indicated in Table A.2-2, the total uranium concentration at this well has an "up, significant" trend. Figure A.2-61 is the total uranium concentration versus time plot for Monitoring Well 2648. This figure illustrates the increase in total uranium concentration. The second quarter 2000 sample had a total uranium concentration of 74.1 μg/L and a turbidity of 35 nephelometric turbidity units (NTU). The fourth quarter 2000 sample had a total uranium concentration of 54.4 μg/L and a turbidity of 7 NTU. This plume is targeted for remediation after surface contamination sources have been removed from the area.

<u>Changes in the South Field Area:</u>

Beneath the Former Inactive Flyash Pile

In late 2000, direct-push sampling was conducted in the area of the Inactive Flyash Pile to support pre-design of the Phase II South Field Extraction Module. The sampling effort focused on the Inactive Flyash Pile area and the area south and east of the Storm Water Retention Basin. Although most of the direct-push sampling carried over into 2001, five direct-push sample locations were completed in 2000 (12814, 12815, 12816, and 12817, and 12818) and are reported here. Results from three of the locations (12814, 12815 and 12816) along the western edge of the Inactive Flyash Pile indicate that total uranium concentrations have dramatically decreased since the remedial investigation/feasibility study characterization back in 1993.

Results from Monitoring Well 2046 indicate that total uranium concentrations are decreasing as depicted in Figure A.2-21, which is a total uranium concentration versus time plot for Monitoring Well 2046. The graph illustrates how the total uranium concentration in this area has dramatically decreased. Table A.2-2 confirms statistically that the total uranium concentration at this well is showing a "down, significant" trend. Also, concentrations were once as high as 2,070 μg/L at Monitoring Well 2945 (Plate E-81 of the Remedial Investigation Report for Operable Unit 5) and are now approximately 30 μg/L as shown on Figure A.2-5 at direct-push sample location 12814.

As reported in the 1999 Integrated Site Environmental Report, total uranium concentrations at Monitoring Well 2385 were increasing through 1999 as shown in Figure A.2-35. The total uranium concentration

appears to have peaked at about 600 µg/L in the fourth quarter of 1999, held relatively steady at about 400 µg/L through the first three quarters of 2000, then in the fourth quarter of 2000, declined to about 100 µg/L, which is consistent with the concentration seen prior to the increasing trend.

The above noted decreases in total uranium concentrations are attributed to: pumping of the South Field (Phase I) extraction wells, the removal of the source term, and a recharge of fresh water through the base of Paddys Run and the deep excavation area located immediately upgradient of and above the plume respectively. A smaller plume is presented in the fourth quarter plume map (refer to Figure A.2-5). Comparison of uranium plume maps constructed for the first three quarters (Figures A.2-2 through A.2-4) to the map for the fourth quarter (Figure A.2-5) illustrates how the western edge of the uranium plume in the area of the Inactive Flyash Pile has contracted to the east. In 2001 this area will undergo additional delineation, as data from additional direct-push locations become available. The additional data are being collected in support of the design of the South Field (Phase II) Extraction Module. The increase and subsequent decrease in the total uranium concentration at Monitoring Well 2385 from 1998 through 2000 may be due to recharge from the west. Perhaps in 2001, total uranium concentrations will continue to decrease in this well as the recharge front advances further to the east. The last quarter of 2000 may be an indication of this beginning to happen (refer to Figure A.2-35).

Less than Expected Remediation Response along the Eastern Edge of the South Field Plume

Total uranium concentration data collected along the eastern edge of the South Field uranium plume indicate that very few locations are showing decreasing trends (refer to Figure A.2-6).

Monitoring Wells 62408, 62433, and 2166 are all located along the eastern edge of the South Field plume. Monitoring Wells 62408 and 62433 were installed in 1999. As shown in Table A.2-2, six rounds of sampling have been completed at each well. Figures A.2-135 and A.2-136 are total uranium concentration versus time plots for Monitoring Wells 62408 and 62433, respectively. The plots indicate that total uranium concentration levels do not appear to be decreasing. Table A.2-2 indicates that both wells are exhibiting "no significant trend." Monitoring Well 2166 is also exhibiting "no significant trend." Figure A.2-34 is a total uranium concentration versus time plot for Monitoring Well 2166. Data from these three wells (62408, 62433, and 2166) imply that the current extraction system is not actively flushing uranium contamination from the eastern edge of the South Plume. If this continues along the eastern edge of the South Field plume, then pumping and/or system design changes will need to be considered in order to assure that the area is being adequately flushed.

Capture maps presented in Attachment A.3, indicate that the extraction wells appear to be exerting a slight influence over the eastern edge of the South Field plume. This slight influence in conjunction with a natural flow divide appears to be holding the plume in check from further eastward migration, but the pumping influence does not appear to be enough to actively flush the area. Options for increasing the pumping rates of the existing extraction wells in the eastern South Field are scheduled to be evaluated in 2001.

Need for an Additional Extraction Well in the South Field

Monitoring Well 2397 is located just southeast of the Storm Water Retention Basin and north of Extraction Well 31562. Since approximately mid-1998, the total uranium concentrations in this well have been increasing (refer to Figure A.2-41). It appears that Extraction Well 31562 is not providing adequate flushing in the area of Monitoring Well 2397; therefore, the decision has been made to install an additional extraction well in the area of Monitoring Well 2397 in 2001.

Plugging and Abandonment of Monitoring Well 3068

Throughout 2000 a uranium increase was reported for Monitoring Well 3068. This well is located east of the Storm Water Retention Basin and northeast of the South Field plume. Although total uranium concentrations in Monitoring Well 2068 were far below 20 µg/L, it was considered possible that the South Field plume had migrated down to the same depth of as the Type 3 well screen in Monitoring Well 3068. Therefore, the total uranium plume maps for the first, second, and third quarters of 2000 showed the South Field uranium plume expanded into this area based on the concentrations being recorded at Monitoring Well 3068.

In November of 2000, a direct push sample was collected just upgradient of Monitoring Well 3068 at Location 12817. Samples were collected at the water table and every 10 feet below the water table providing a complete vertical profile down through the aquifer. The results were shared with the EPA and OEPA in the weekly report for the week of November 24 to December 1 and they indicated that there was not a uranium plume present. The lack of a plume upgradient of Monitoring Well 3068 indicated a local problem around the well. A camera survey of the well was conducted on November 21, 2000, to look for signs of any problems within the well. The camera survey indicated leakage into the well, as the casing was wet with an abundance of red material on the casing above the water table. The red material was assumed to be iron bacteria residue. Also, as the camera passed casing joints, it was apparent that water was accumulating at the joints. It was therefore concluded that contaminated perched water had been leaking into the well. To determine if this was the case, the well was pumped in December to determine if the uranium concentrations would rapidly decrease.

Prior to being pumped, the total uranium concentration of an unfiltered sample collected from the well was 59.9 µg/L. After pumping three well volumes out, the concentration of an unfiltered sample was 1.9 µg/L. This concentration drop confirmed that the elevated total uranium concentrations being detected in Monitoring Well 3068 were due to cross contamination, and did not represent an extension of the South Field uranium plume. Monitoring Well 3068 was plugged and abandoned on December 15, 2000. The fourth quarter 2000 uranium plume map once again shows that the eastern edge of the South Field plume is located west of where Monitoring Well 3068 had been located.

Total Uranium Increase at Monitoring Well 3069

Monitoring Well 3069 is located in the South Field, just north of Willey Road. The top of the uranium plume in this area is not located at the water table. The top of the plume is located beneath the traditional Type 2 well screen depth. Table A.2-2 indicates that total uranium concentrations at this well have an "up, significant" trend. Figure A.2-83 is the total uranium concentration versus time plot for Monitoring Well 3069 and illustrates the increasing total uranium concentration trend. Notice that in mid 1999, the trend appears to reverse (total uranium concentration decreases). This indicates that pumping in the South Field, which began in 1998, appears to be decreasing the total uranium concentrations in this well.

Total Uranium Decrease at Monitoring Well 2049

Monitoring Well 2049 is located near the geographic center of the South Field (Phase I) Extraction Module. Table A.2-2 indicates this wells has an "up, significant" trend and Figure A.2-22 shows that from late 1997 through late 1999 this well had increasing uranium concentration. However, also shown on Figure A.2-22 is a decreasing trend in uranium concentration from late 1999 through 2000. As noted in the Integrated Site Environmental Report for 1999 (DOE 2000e), the 1997 to 1999 uranium concentration increase might have been due to the pumping of Extraction Well 31563, which could have been drawing the uranium plume back toward it from the east. However, based on the 1999 to 2000 decrease, it appears that the plume may be moving to the east of Monitoring Well 2049 towards Extraction Well 31550. Continued sampling will determine whether the concentration trend continues to decrease.

<u>Changes near the On-Site Disposal Facility:</u>

Total Uranium Increase at Monitoring Well 2426

The second quarter sample for Monitoring Well 2426 showed a total uranium concentration of 24.2 µg/L. The sample was reanalyzed with the second analysis showing a total uranium concentration of 10.0 µg/L. The third and fourth quarter 2000 data indicate that total uranium concentrations were back down below

10 and 5 µg/L, respectively. This well is located on the eastern property boundary just east of the on-site disposal facility footprint (refer to Figure A.2-3). In reviewing the total uranium concentration versus time plot (Figure A.2-46) for this well, it is noted that historical total uranium concentrations have fluctuated between about 2 to 14 µg/L. Therefore, the 24.2 µg/L concentration is considered suspect and was not used in statistics, graphs, or contour maps provided in this attachment. It is also notable that these fluctuations represent baseline pre-on-site disposal facility conditions, and therefore need to be factored into future leak detection interpretations.

Total Uranium Increases in Monitoring Wells

Additionally, the total uranium concentration in several on-site disposal facility monitoring wells increased during 2000. These increases are considered to be representative of baseline conditions and therefore do not represent a release from the cells. New maximum total uranium concentrations were observed in both the upgradient (22201 and 22203) and downgradient (22198 and 22204) wells for Cells 1 and 3, respectively. The 2000 total uranium concentrations at these wells are shown on Figures A.2-2 through A.2-5. The total uranium concentration versus time plots for these four wells are shown in Figures A.2-127 (22198), A.2-130 (22201), A.2-131 (22203), and A.2-132 (22204). These baseline concentrations will be factored into future leak detection interpretations.

Changes in the South Plume Area:

"Down, Significant" Trends and Lack of Significant Trends in Monitoring Wells 6881 and 2551

Most monitoring wells located in the interior of the South Plume indicate that total uranium concentrations are decreasing, but data collected along the edges of the plume at Monitoring Wells 2551 and 6881 indicate that no trend in total uranium concentration is present. Monitoring Well 6881 was installed in 1999 with its screen set across the plume. However, as shown in Figures A.2-56 (2551) and A.2-122 (6881), the total uranium concentration in both these wells have been consistently near or slightly above the uranium FRL of 20 µg/L.

"Up, Significant" Trends in Extraction Wells 3925 and 3926 and Monitoring Well 3095

Extraction Wells 3925 and 3926 are South Plume extraction wells. The "up, significant" trends indicate that contamination was being drawn to the wells from the higher concentrations in the central portion of the plume to the north. The calculated "up, significant" trend for Extraction Well 3925 does not appear to be substantiated by visual observation of the uranium concentration versus time plot for this well shown in Figure A.1-18. However, the plot for Extraction Well 3926 shown in Figure A.1-19 does appear to substantiate the calculated "up, significant" trend. In addition, an "up, significant" trend was calculated

for South Plume Monitoring Well 3095, which is situated north of Extraction Well 3925. However, a slight decreasing trend is shown for Monitoring Well 3095 on Figure A.2-85.

Total Uranium Increases at Monitoring Well 2900

As shown in Table A.2-2, the total uranium concentration trend at Monitoring Well 2900 is "up, significant". Figure A.2-70 is a total uranium concentration versus time plot for Monitoring Well 2900. If the total uranium concentration continues to increase at this location, then pumping and/or system design changes may need to be considered.

Biased Total Uranium Results due to High Turbidity:

During 2000 groundwater samples were sometimes affected by high turbidity. An example is at Monitoring Well 2546. This well is located south of the South Plume Module in the Paddys Run Road site area and south of the South Plume. During the second quarter of 2000, the unfiltered groundwater sample collected from this well had a total uranium concentration of 40.0 μg/L and a turbidity of 999 NTU. Nearly a 100 fold reduction in concentration was observed upon analyzing a filtered sample (0.45 microns); the total uranium result was 0.48 μg/L.

An objective of the IEMP groundwater-monitoring program is to collect and analyze representative groundwater samples. The sample analysis for metals and radionuclides should quantify species that are dissolved, occur as mobile precipitates, or are adsorbed onto mobile particles. If immobile particles to which metals are bound are allowed to remain in field-acidified samples, then the laboratory analysis will overstate the true concentration of mobile species present in the sample because acidification dissolves precipitates or causes adsorbed metals to desorb. Turbidity readings and the use of filtration to obtain a representative sample are therefore important field concerns for collection of groundwater samples. Therefore, sampling procedures in the IEMP have been revised to address this turbidity issue. The revised procedures became effective in 2001.

Consistent with OEPA guidelines, 5 NTU will serve as the cut off for representative groundwater samples and for determining when filtration of the samples to be analyzed for metals/radionuclides is required. Specifics can be found in the Final IEMP, Revision 2, (DOE 2001).

TABLE A.2-1

LISTING OF IEMP GROUNDWATER WELLS

Well ID	Monitoring Activity
13	Private Well Monitoring
14	Private Well Monitoring
67	KC-2 Warehouse
2002	South Plume Module
2008	Waste Storage Area Module
2009	Waste Storage Area Module
2014	South Field Extraction Module
2015	South Plume Module
2017	South Plume Module
2027	Waste Storage Area Module
2032	Waste Storage Area Module
2033	Waste Storage Area Module
2034	Waste Storage Area Module
2045	South Field Extraction Module
2046	South Field Extraction Module
2049	South Field Extraction Module
2051	Property Boundary Monitoring
2054	Plant 6 Area Module
2060 (12)	Private Well Monitoring
2068	South Field Extraction Module
2070	Property Boundary Monitoring
2093	South Plume Module
2095	South Plume Module
2106	South Plume Module and Property Boundary Monitoring
2118	Plant 6 Area Module
2125	South Plume Module
2128	South Plume Module
2166	South Plume Module
2385	South Field Extraction Module
2386	South Field Extraction Module
2387	South Field Extraction Module
2389	Plant 6 Area Module
2390	South Field Extraction Module
2396	South Plume Module
2397	South Field Extraction Module
2398	South Plume Module and Property Boundary Monitoring
2402	South Field Extraction Module
2417	Property Boundary Monitoring
2424	Property Boundary Monitoring
2426	Property Boundary Monitoring
2429	Property Boundary Monitoring
2430	Property Boundary Monitoring
2431	Property Boundary Monitoring
2432	Property Boundary Monitoring
2434	Property Boundary Monitoring
2545	South Plume Module
2546	South Plume Module

TABLE A.2-1
(Continued)

Well ID	Monitoring Activity
2550	South Plume Module
2551	South Plume Module
2552	South Plume Module
2553	South Plume Module
2625	South Plume Module
2636	South Plume Module
2648	Waste Storage Area Module
2649	Waste Storage Area Module
2733	Property Boundary Monitoring
2821	Waste Storage Area Module
2880	South Plume Module
2881	South Plume Module
2897	South Plume Module
2898	South Plume Module
2899	South Plume Module
2900	South Plume Module
3009	Waste Storage Area Module
3014	South Field Extraction Module
3015	South Plume Module
3027	Waste Storage Area Module
3032	Waste Storage Area Module
3034	Waste Storage Area Module
3045	South Field Extraction Module
3046	South Field Extraction Module
3049	South Field Extraction Module
3054	Plant 6 Area Module
3067	Property Boundary Monitoring
3068	South Field Extraction Module
3069	South Plume Module, Property Boundary Monitoring
3070	Property Boundary Monitoring
3093	South Plume Module
3095	South Plume Module
3106	South Plume Module and Property Boundary Monitoring
3125	South Plume Module
3128	South Plume Module
3385	South Field Extraction Module
3387	South Field Extraction Module
3390	South Field Extraction Module
3396	South Plume Module
3397	South Field Extraction Module
3398	Property Boundary Monitoring
3402	South Field Extraction Module
3417	Property Boundary Monitoring
3424	Property Boundary Monitoring
3426	Property Boundary Monitoring
3429	Property Boundary Monitoring
3431	Property Boundary Monitoring
3432	Property Boundary Monitoring
3550	South Plume Module

TABLE A.2-1
(Continued)

Well ID	Monitoring Activity
3551	South Plume Module
3552	South Plume Module
3636	South Plume Module
3733	Property Boundary Monitoring
3821	Waste Storage Area Module
3880	South Plume Module
3881	South Plume Module
3897	South Plume Module
3898	South Plume Module
3899	South Plume Module
3900	South Plume Module
3924	South Plume Module
3925	South Plume Module
3926	South Plume Module
3927	South Plume Module
4067	Property Boundary Monitoring
4125	South Plume Module
4398	Property Boundary Monitoring
4424	Property Boundary Monitoring
4426	Property Boundary Monitoring
4432	Property Boundary Monitoring
6880	South Plume Module
6881	South Plume Module
21033	South Field Extraction Module
21063	South Plume Module
21192	South Field Extraction Module
21194	South Plume Module
22198	Property Boundary Monitoring
31217	Property Boundary Monitoring
32308	South Plume Module
32309	South Plume Module
31550	South Field Extraction (Phase I) Module
31560	South Field Extraction (Phase I) Module
31561	South Field Extraction (Phase I) Module
31562	South Field Extraction (Phase I) Module
31563	South Field Extraction (Phase I) Module
31564	South Field Extraction (Phase I) Module
31565	South Field Extraction (Phase I) Module
31566	South Field Extraction (Phase I) Module
31567	South Field Extraction (Phase I) Module
32276	South Field Extraction (Phase I) Module
32446	South Field Extraction Module
32447	South Field Extraction Module
41217	Property Boundary Monitoring
62408	South Field Extraction Module
62433	South Field Extraction Module

TABLE A.2-2

SUMMARY STATISTICS AND TREND ANALYSIS OF MONITORING WELLS FOR TOTAL URANIUM WITH 2000 RESULTS ABOVE FINAL REMEDIATION LEVEL

Well	No. of Samples Since 1988[a,b,c]	Minimum[a,b,c,d] (µg/L)	Maximum[a,b,c,d] (µg/L)	Average[a,b,c,d] (µg/L)	Standard Deviation[a,b,c,d] (µg/L)	Trend[a,b,c,d]
13	21	21	64	38	12	Down, Significant
2008	18	5	25.4	20	5	No Significant Trend
2009	14	13.6	39.2	25.0	7.69	No Significant Trend
2015	46	1.3	290	150	41	Down, Significant
2033	9	3.3	104.288	67	32	Up, Marginal
2045	26	17.569	462	200	135	Down, Significant
2046	25	31.594	907	314	268	Down, Significant
2049	24	3	177.893	100	50	**Up, Significant**
2060 (12)	50	8.4	332	82	71	Down, Significant
2095	37	27	208	129	41	Down, Significant
2106	42	6.059	88.6	46.9	18.0	Down, Significant
2166	26	48	95.1	69	11	No Significant Trend
2385	18	76.648	592.164	234.54	149.10	**Up, Significant**
2387	18	68.7	492	153	110	Down, Significant
2389	10	1.667	120	21	36	No Significant Trend
2390	17	73.556	163	101	24	No Significant Trend
2397	17	212	580.004	374	100	**Up, Significant**
2545	28	7.6	106	32.5	20.3	Down, Significant
2550	30	3.3	120	71	20	Down, Significant
2551	27	7.5	90	27	17	No Significant Trend
2648	15	9.61	74.053	34.3	21.5	**Up, Significant**
2821	9	9.63	32.6	24.9	6.73	Down, Significant
2900	30	0.4	21	7	6	**Up, Significant**
3014	22	9.914	35.3	19.6	8.01	No Significant Trend
3027[f]	11	0.2	45.151	18	17	**Up, Significant**
3068[f]	20	0.028	100.699	13	28	No Significant Trend
3069	44	0.5	398.33	140	120	**Up, Significant**
3095	38	2	94	20	17	**Up, Significant**
3125	35	19.3	82	47	16	Down, Significant
3387	18	0.71	42	5.7	9.3	No Significant Trend
3390	16	58.608	110	82	15	Down, Significant
3821	10	8.8	30.13	13	6.1	Up, Marginal
62408	6	86.479	157	140	27	No Significant Trend
62433	6	331.94	571.389	431.03	79.150	No Significant Trend
6880	5	110.28	145	126	16.4	Down, Significant
6881	5	30	35	31	2.0	No Significant Trend

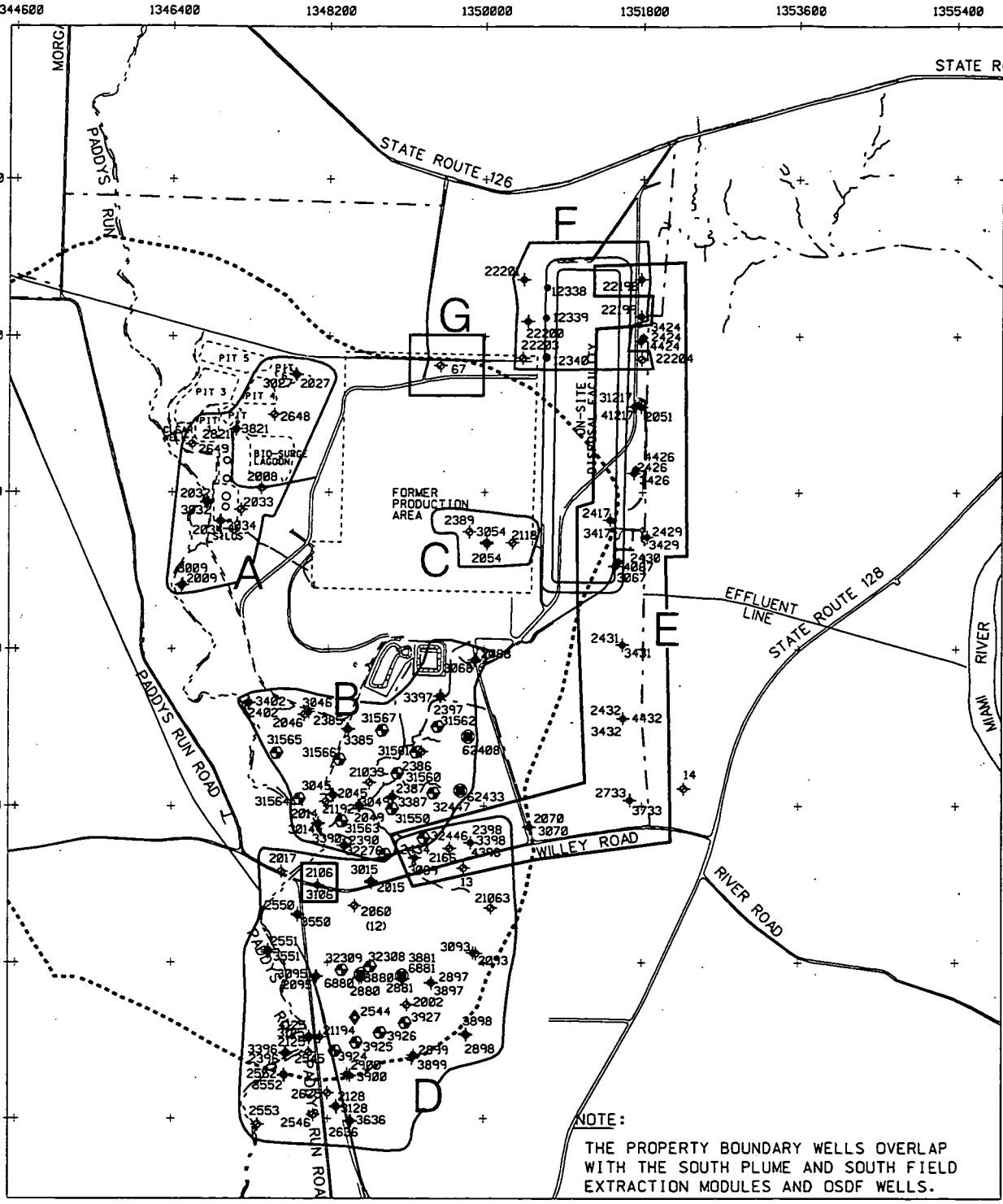
[a]Summary statistics and Mann-Kendall test for trend are primarily based on unfiltered samples with some filtered samples from the Operable Unit 5 remedial investigation/feasibility study data set (1988 through 1993) and 1994 through 2000 groundwater data.
[b]If more than one sample is collected per well per day (e.g., duplicate), then only one sample is counted for the number of samples, and the sample with the maximum representative concentration is used for determining the summary statistics (minimum, maximum, average, and standard deviation [SD]) and Mann-Kendall test for trend.
[c]Rejected data qualified with either a R or Z were not included in this count, the summary statistics, or Mann-Kendall test for trend.
[d]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 detection limit.
[f]Some results from 1999 and 2000 were excluded from summary statistics and trend analysis because of high turbidity.

TABLE A.2-3

SUMMARY STATISTICS AND TREND ANALYSIS OF EXTRACTION WELLS WITH 2000 RESULTS ABOVE TOTAL URANIUM FINAL REMEDIATION LEVEL

Well	No. of Samples Since 1988[a,b]	Minimum[a,b,c] (µg/L)	Maximum[a,b,c] (µg/L)	Average[a,b,c] (µg/L)	Standard Deviation[a,b,c] (µg/L)	Trend[a,b,c]
South Plume Module (August 27, 1993 through December 31, 2000)						
3924	197	18.2	180	44	18	Down, Significant
3925	203	0.5	84	30	9.2	**Up, Significant**
3926	199	1.5	39	18	9.1	**Up, Significant**
South Plume Optimization Module (August 9, 1998 through December 31, 2000)						
32308	159	50.8	100.1	72.1	6.87	Down, Significant
32309	158	49.8	122.8	77.8	12.5	Down, Significant
South Field (Phase I) Extraction Module (July 13, 1998 through December 31, 2000)						
31550	152	38.1	127.9	73.0	21.5	Down, Significant
31560	165	60.7	182.8	109	32.4	Down, Significant
31561	160	26.2	114[d]	46.9	9.08	Down, Significant
31562	152	46.1[e]	179.7	119	18.4	Down, Significant
31563	162	20.6	65.4	33.5	10.2	Down, Significant
31567	165	21.8	67	40	7.6	Down, Significant
32276	166	114	290.2	183	43.2	Down, Significant
32446	47	71.4	168.1	102	23.5	Down, Significant
32447	49	165.5	302.3	210.2	30.0	Down, Significant

[a]If more than one sample is collected per well per day (e.g., duplicate), then only one sample is counted for the number of samples, and the sample with the maximum representative concentration is used for determining the summary statistics (minimum, maximum, average, and standard deviation [SD]) and Mann-Kendall test for trend.
[b]Rejected data qualified with either a R or Z were not included in this count, the summary statistics, or Mann-Kendall test for trend.
[c]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 detection limit.
[d]This result (sampled 8/31/98) appears to be an outlier. It is susupected that the sample for this well was switched with the sample for Extraction Well 31562 (refer to Figures A.1-9 and A.1-10).
[e]This result (sampled 8/31/98) appears to be an outlier. It is susupected that the sample for this well was switched with the sample for Extraction Well 31561 (refer to Figures A.1-9 and A.1-10).



NOTE:
THE PROPERTY BOUNDARY WELLS OVERLAP WITH THE SOUTH PLUME AND SOUTH FIELD EXTRACTION MODULES AND OSDF WELLS.

LEGEND:

A - WASTE STORAGE AREA
B - SOUTH FIELD EXTRACTION AREA
C - PLANT 6 AREA
D - SOUTH PLUME AREA
E - PROPERTY BOUNDARY WELLS
F - OSDF MONITORING WELLS
G - KC-2 WAREHOUSE WELL

— · — · — FEMP BOUNDARY
..... 10-YEAR, URANIUM-BASED RESTORATION FOOTPRINT
MONITORING WELL
EXTRACTION WELL
HORIZONTAL TILL WELL

SCALE
1800 900 0 1800 FEET

V:/SFGP1/DGN/00ANNUAL/00AN001.DGN

STATE PLANAR COORDINATE SYSTEM 1983

12-13-00

FIGURE A.2-1. IEMP WATER QUALITY MONITORING WELLS AND EXTRACTION WELLS

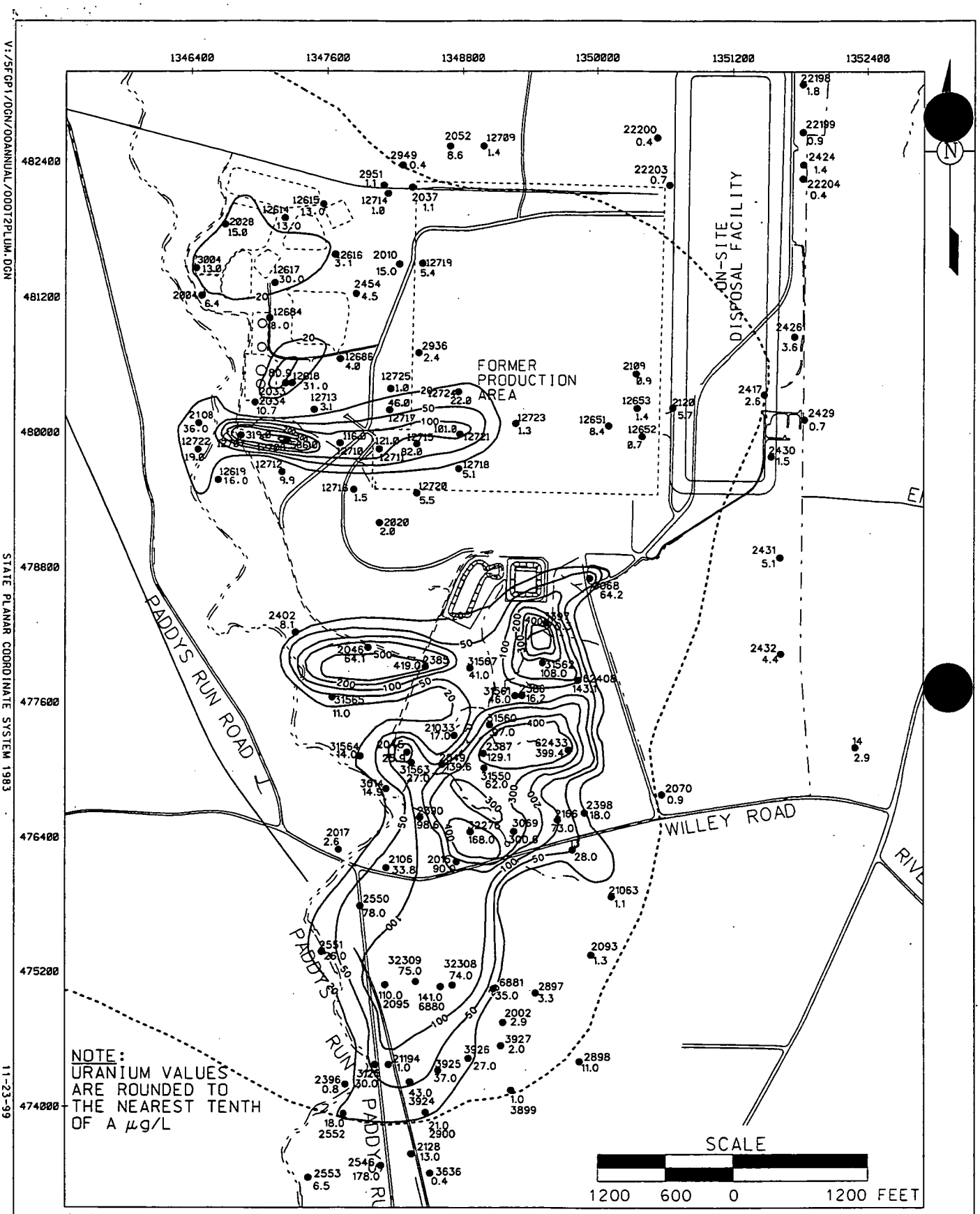
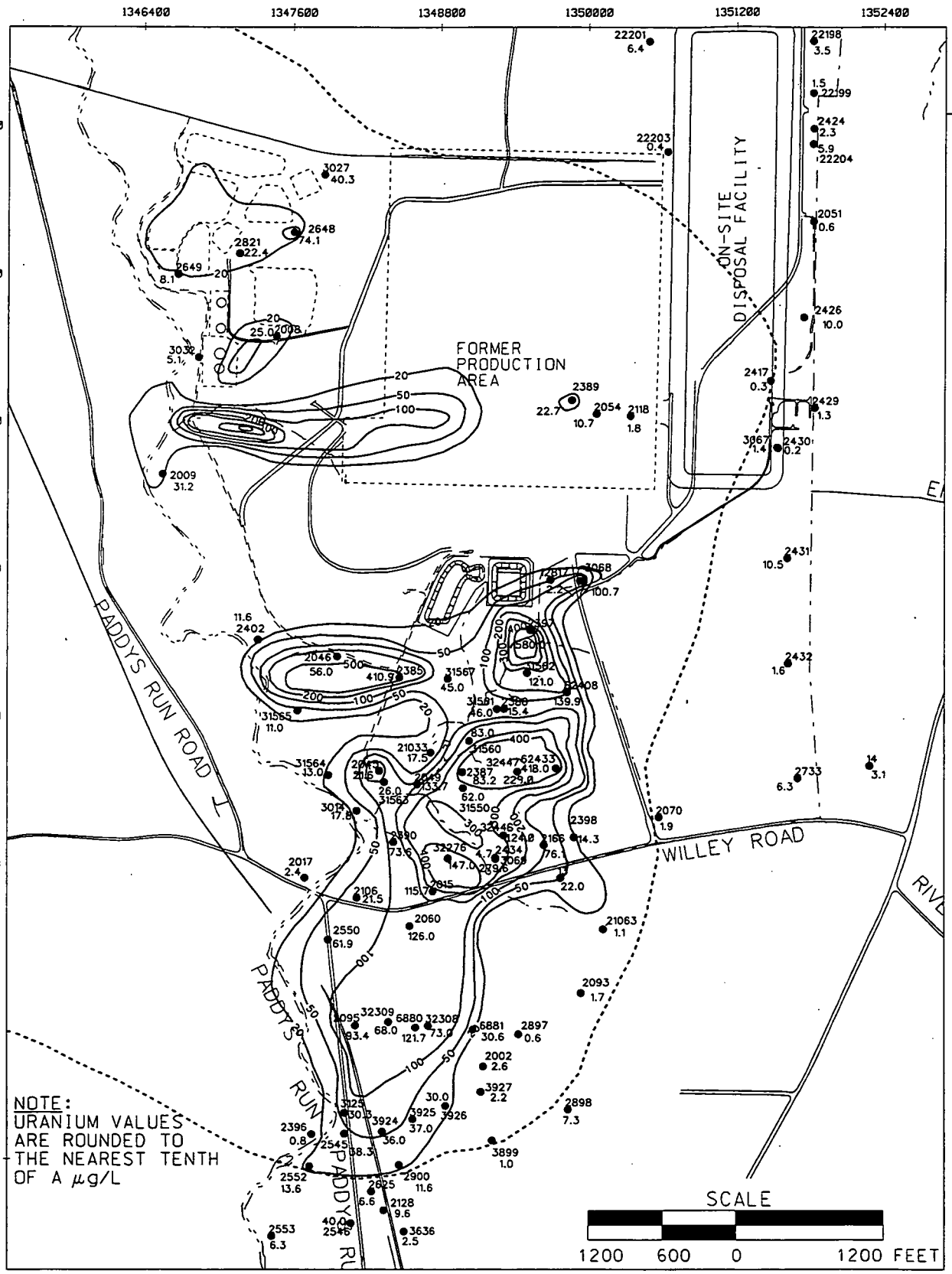


FIGURE A.2-2. TOTAL URANIUM PLUME MAP, FIRST QUARTER 2000



NOTE:
URANIUM VALUES ARE ROUNDED TO THE NEAREST TENTH OF A µg/L

LEGEND:

- 2553● MONITORING WELL OR GEOPROBE LOCATION
- 5.1 TOTAL URANIUM CONCENTRATION MEASURED IN SECOND QUARTER 2000
- CONTOUR CHANGES BASED ON NEW MAXIMUM SECOND QUARTER 2000 DATA
- FEMP BOUNDARY
- 50 MAX TOTAL URANIUM CONTOUR IN µg/L FROM BASELINE MODIFIED QUARTERLY
- 10-YEAR, URANIUM-BASED RESTORATION FOOTPRINT (BRSR 1997)

FIGURE A.2-3. TOTAL URANIUM PLUME MAP, SECOND QUARTER 2000

V:/5FGP1/DGN/ODANNUAL/00QT3PLUM.DGN

STATE PLANAR COORDINATE SYSTEM 1983

12-13-00

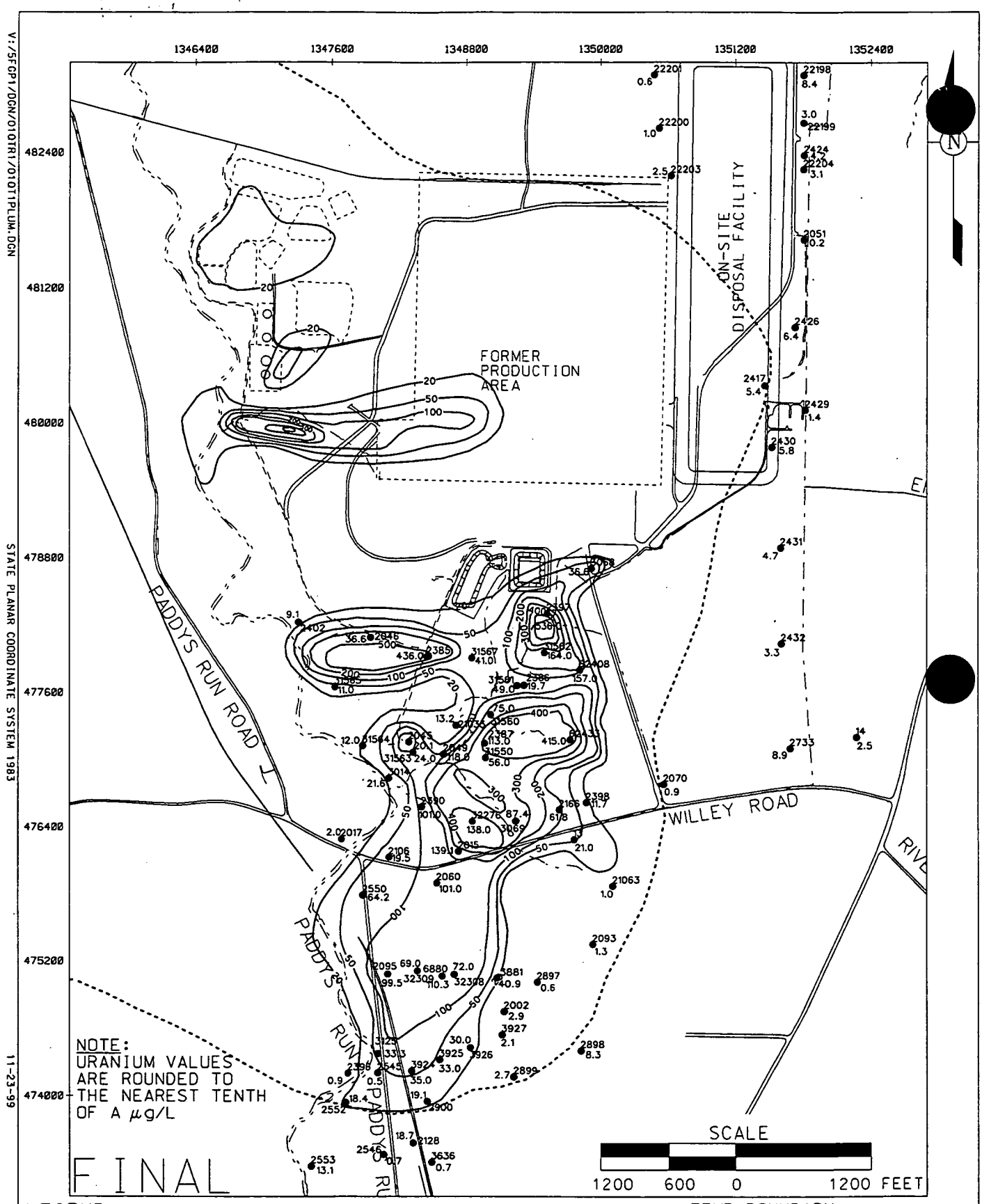
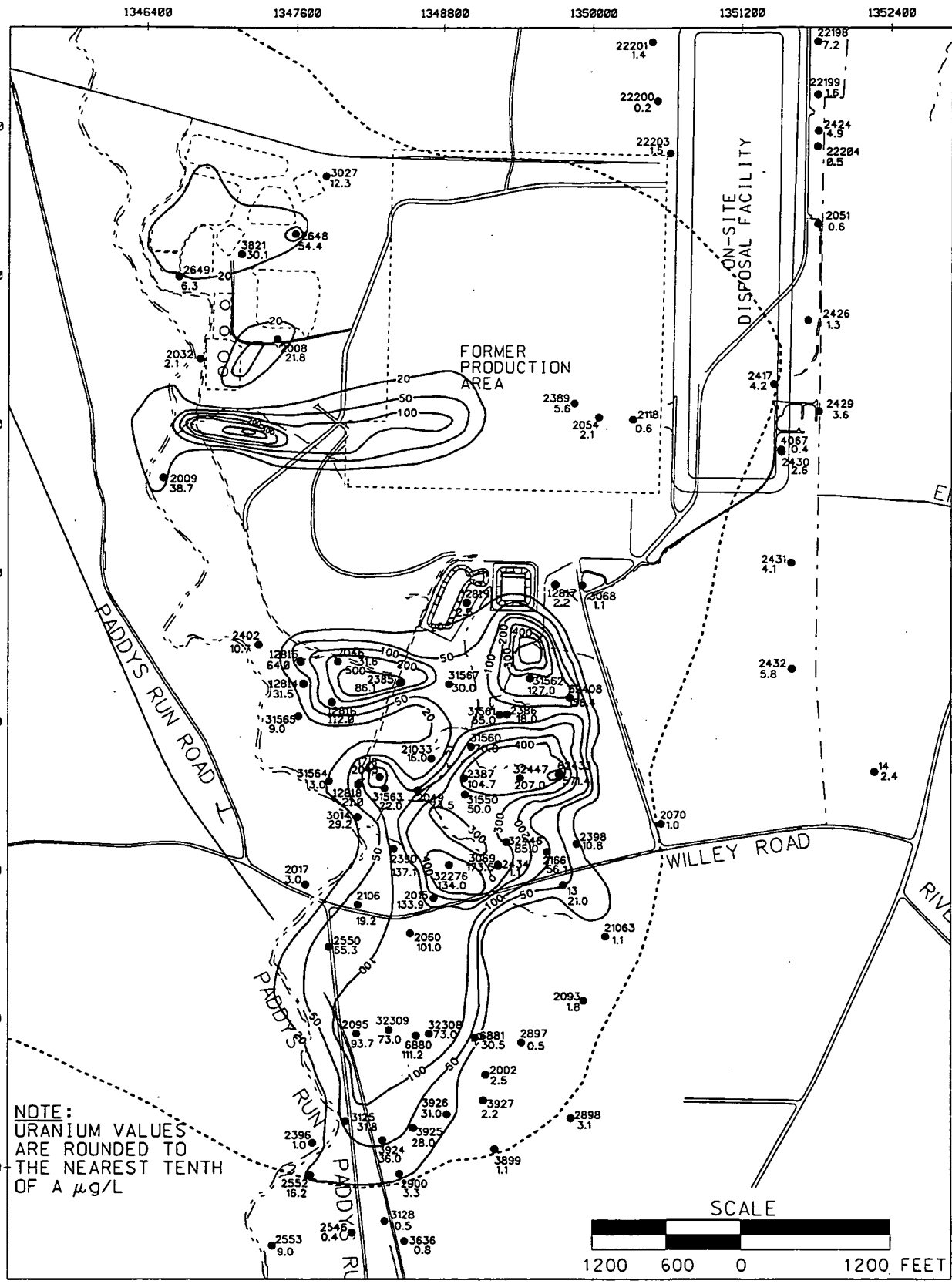


FIGURE A.2-4. TOTAL URANIUM PLUME MAP, THIRD QUARTER 2000

V:/5FCP1/DGN/ODANNUAL/ODANPLUM.DGN

STATE PLANAR COORDINATE SYSTEM 1983

11-23-99



LEGEND:

2553● MONITORING WELL OR GEOPROBE LOCATION

5.1 TOTAL URANIUM CONCENTRATION MEASURED IN FOURTH QUARTER 2000

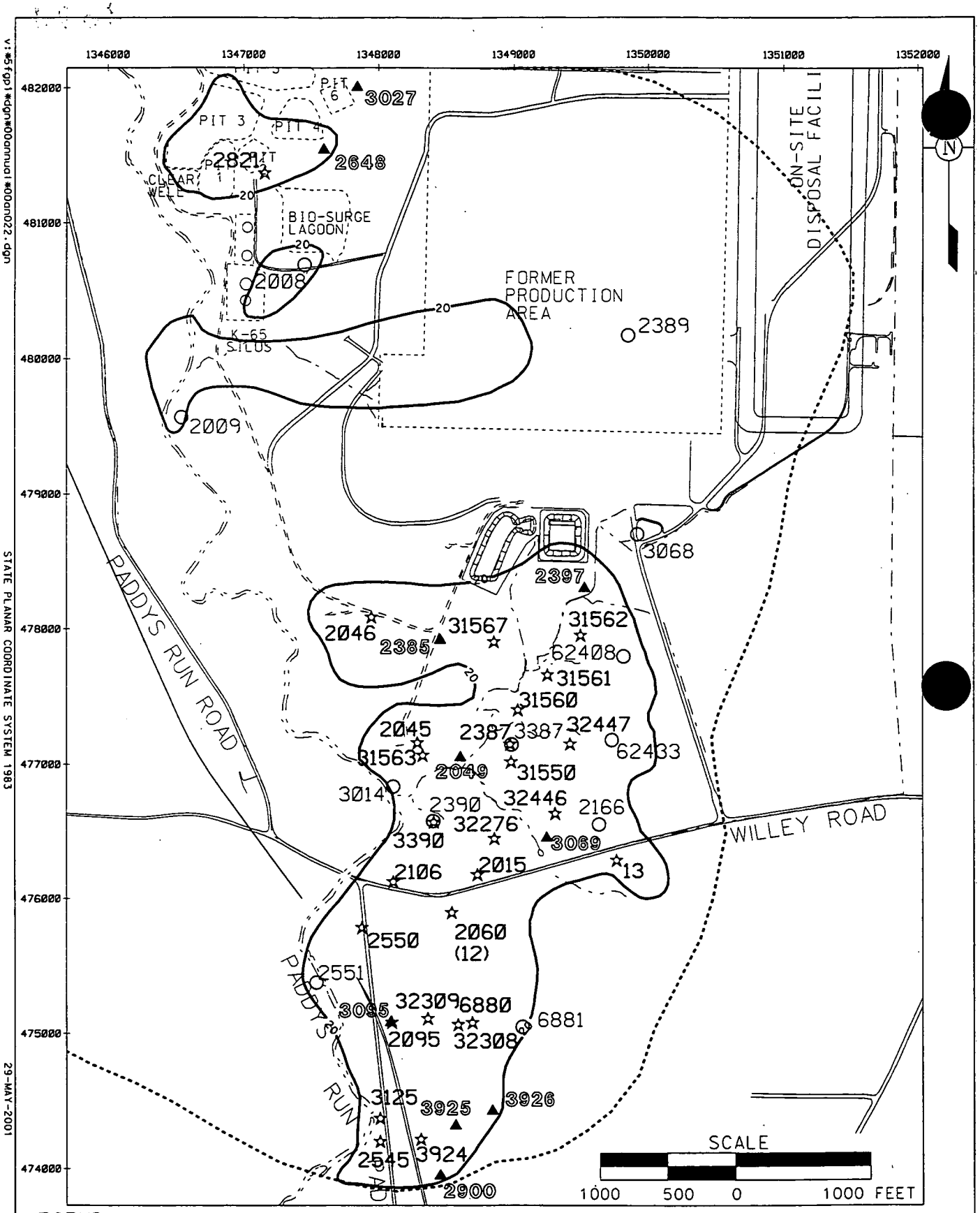
CONTOUR CHANGES BASED ON NEW MAXIMUM FOURTH QUARTER 2000 DATA

FEMP BOUNDARY

MAX TOTAL URANIUM CONTOUR IN µg/L FROM BASELINE MODIFIED QUARTERLY

10-YEAR, URANIUM-BASED RESTORATION FOOTPRINT (BRSR 1997)

FIGURE A.2-5. TOTAL URANIUM PLUME MAP, FOURTH QUARTER 2000



LEGEND:

- FEMP BOUNDARY
- 10-YEAR, URANIUM-BASED RESTORATION FOOTPRINT (BRSR 1997)
- ▲ 2049 UP, SIGNIFICANT TREND
- ☆ 2015 DOWN, SIGNIFICANT TREND
- ○ 2008 NO SIGNIFICANT TREND
- 20 μg/L TOTAL URANIUM PLUME FROM FOURTH QUARTER 2000

v:\5fdp1\dgn\00annual\00an022.dgn

STATE PLANAR COORDINATE SYSTEM 1983

29-MAY-2001

000089

FIGURE A.2-6. WELLS WITH 2000 FRL EXCEEDANCES FOR TOTAL URANIUM WITH UP, DOWN OR NO SIGNIFICANT TRENDS

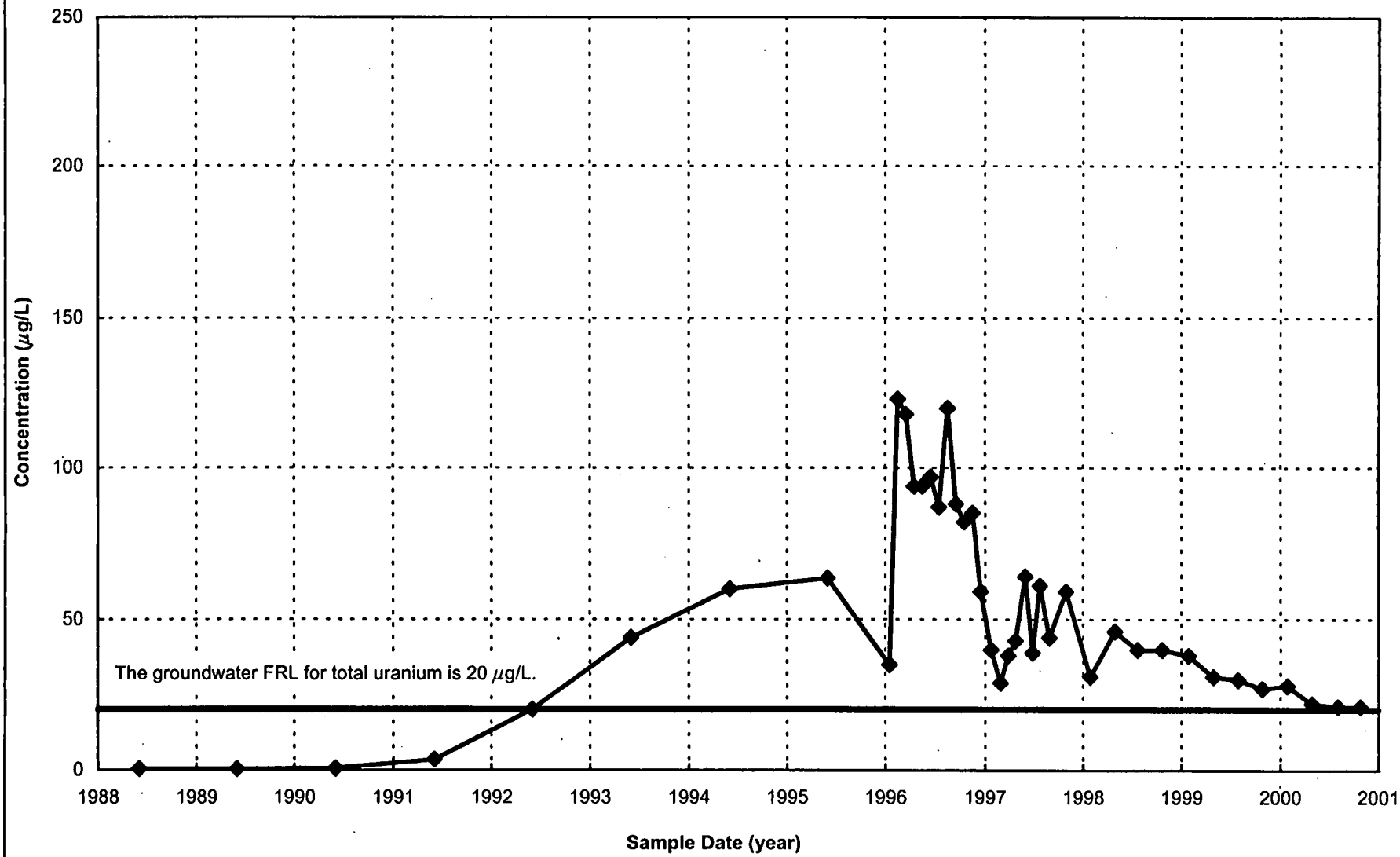


FIGURE A.2-7. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 13

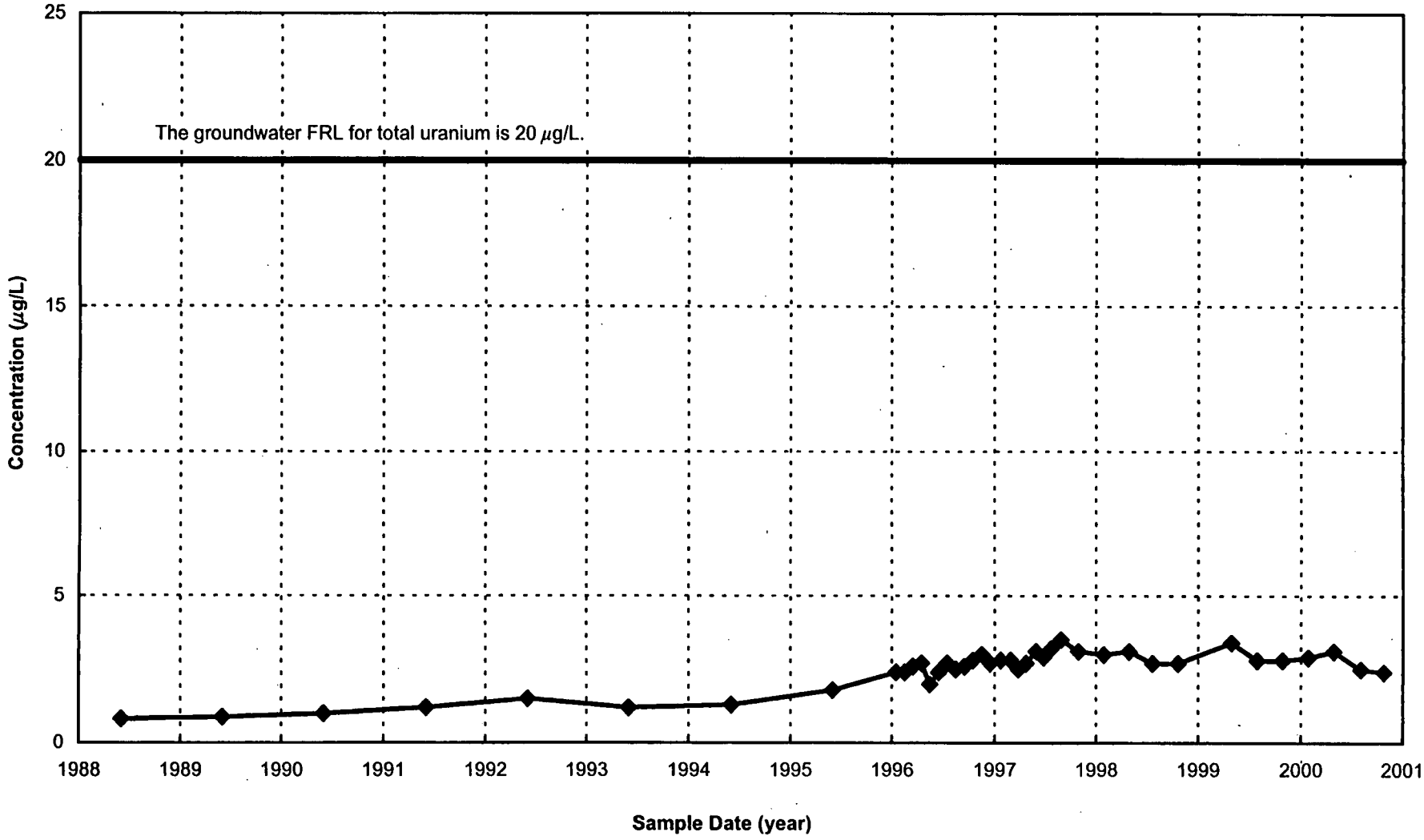


FIGURE A.2-8. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 14

000091

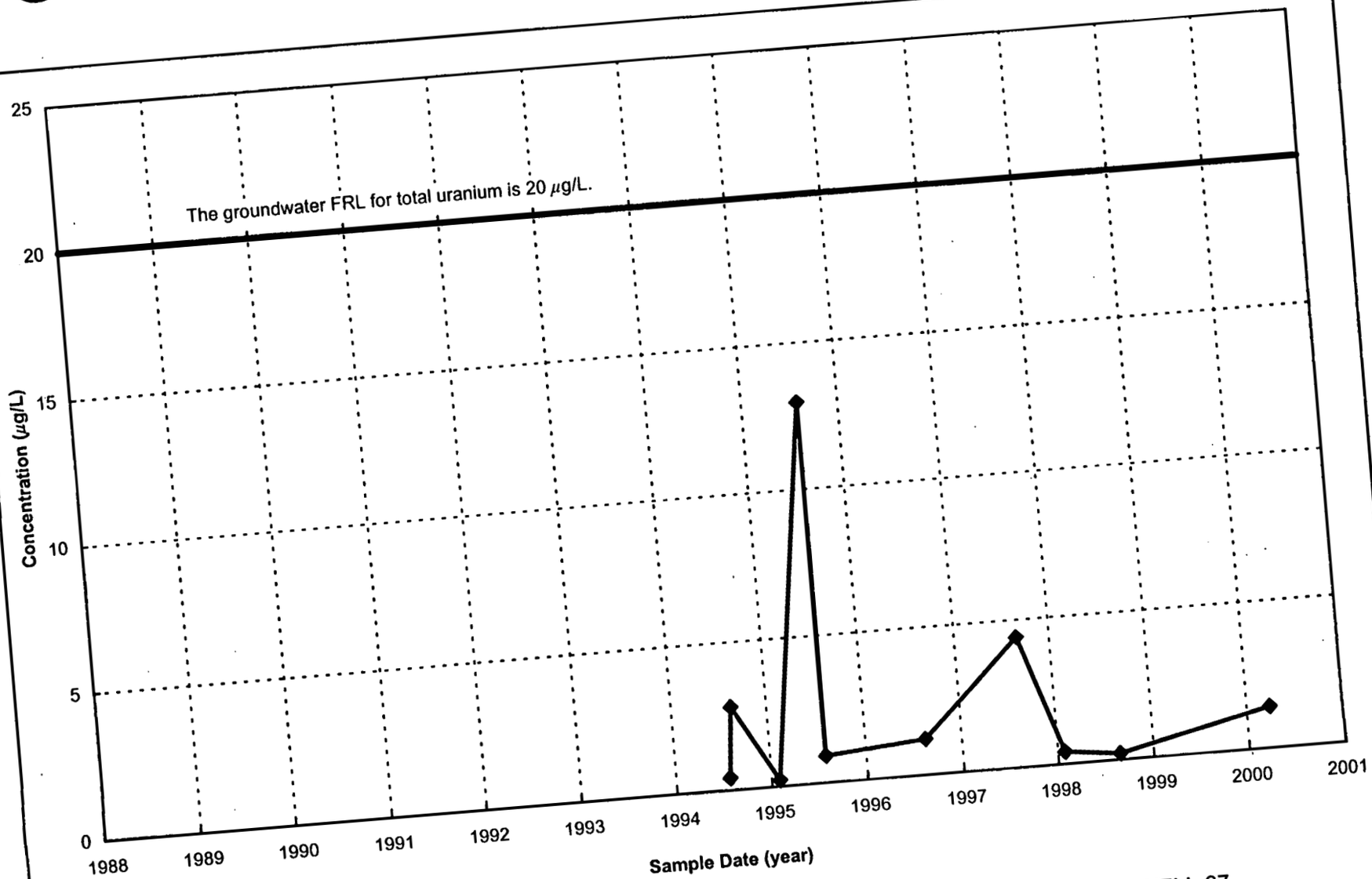


FIGURE A.2-9. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 67

000092

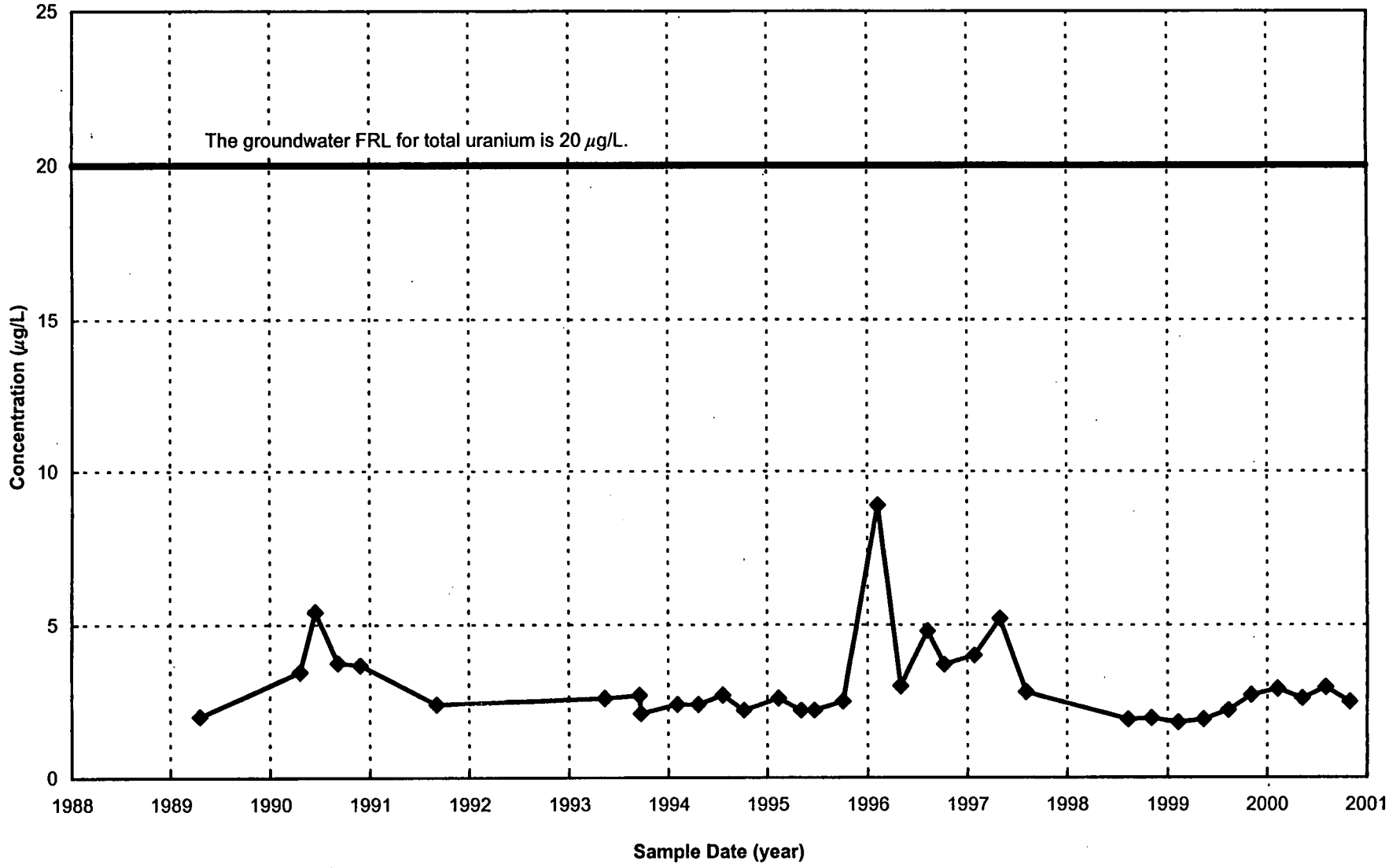


FIGURE A.2-10. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2002

000093

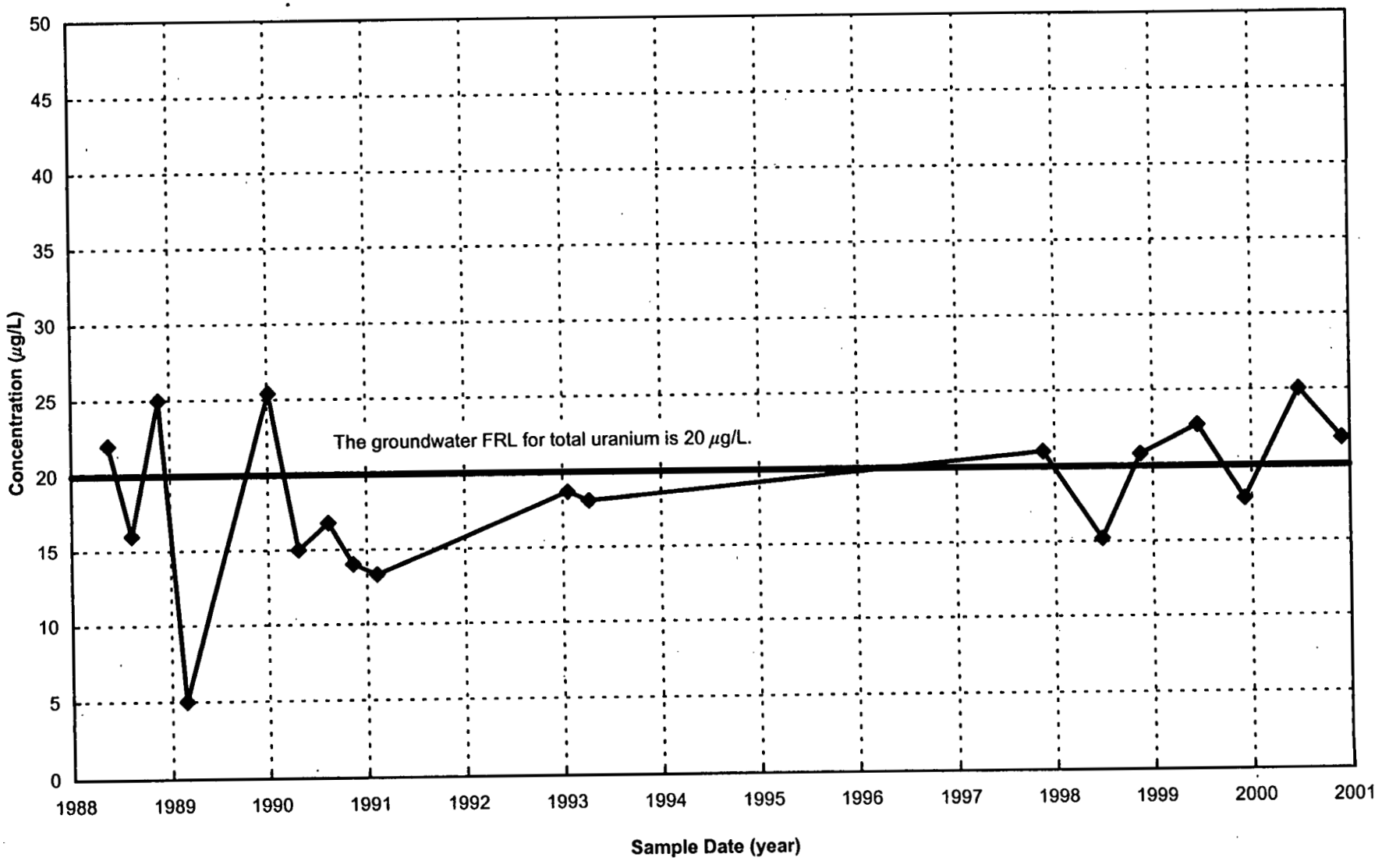


FIGURE A.2-11. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2008

FIGURE A.2-12. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2009

000095

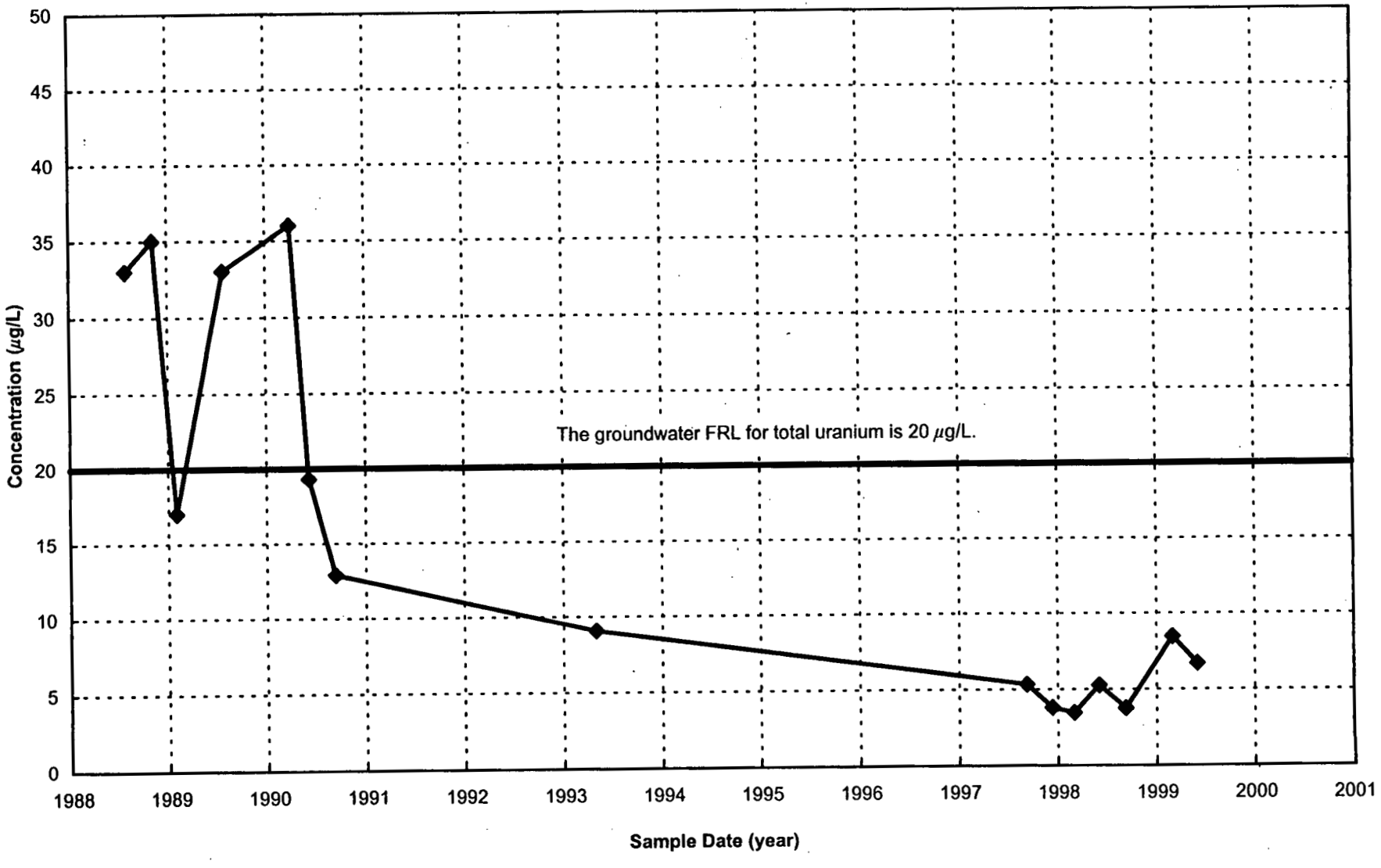


FIGURE A.2-13. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2014

000096

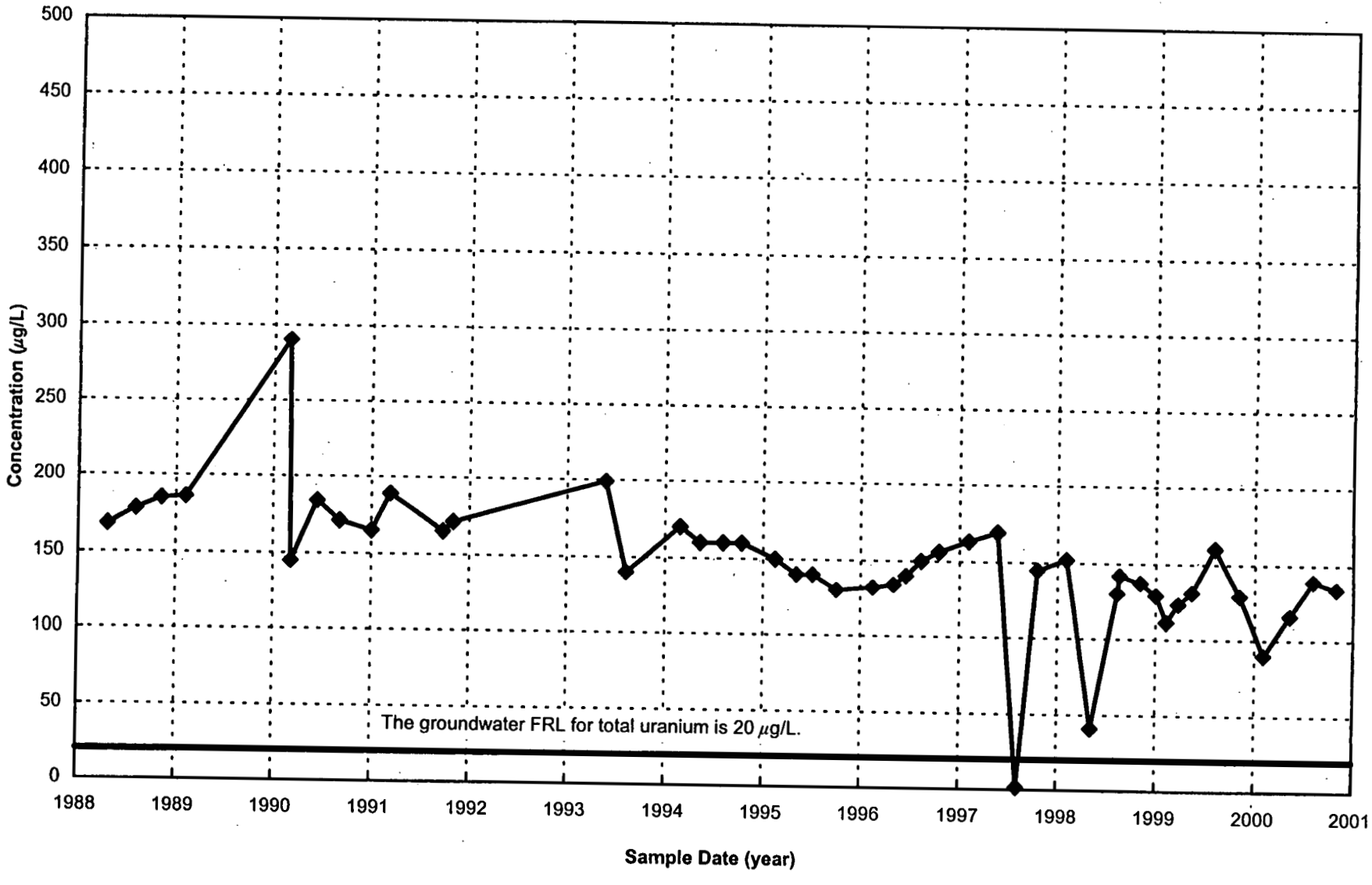


FIGURE A.2-14. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2015

000097

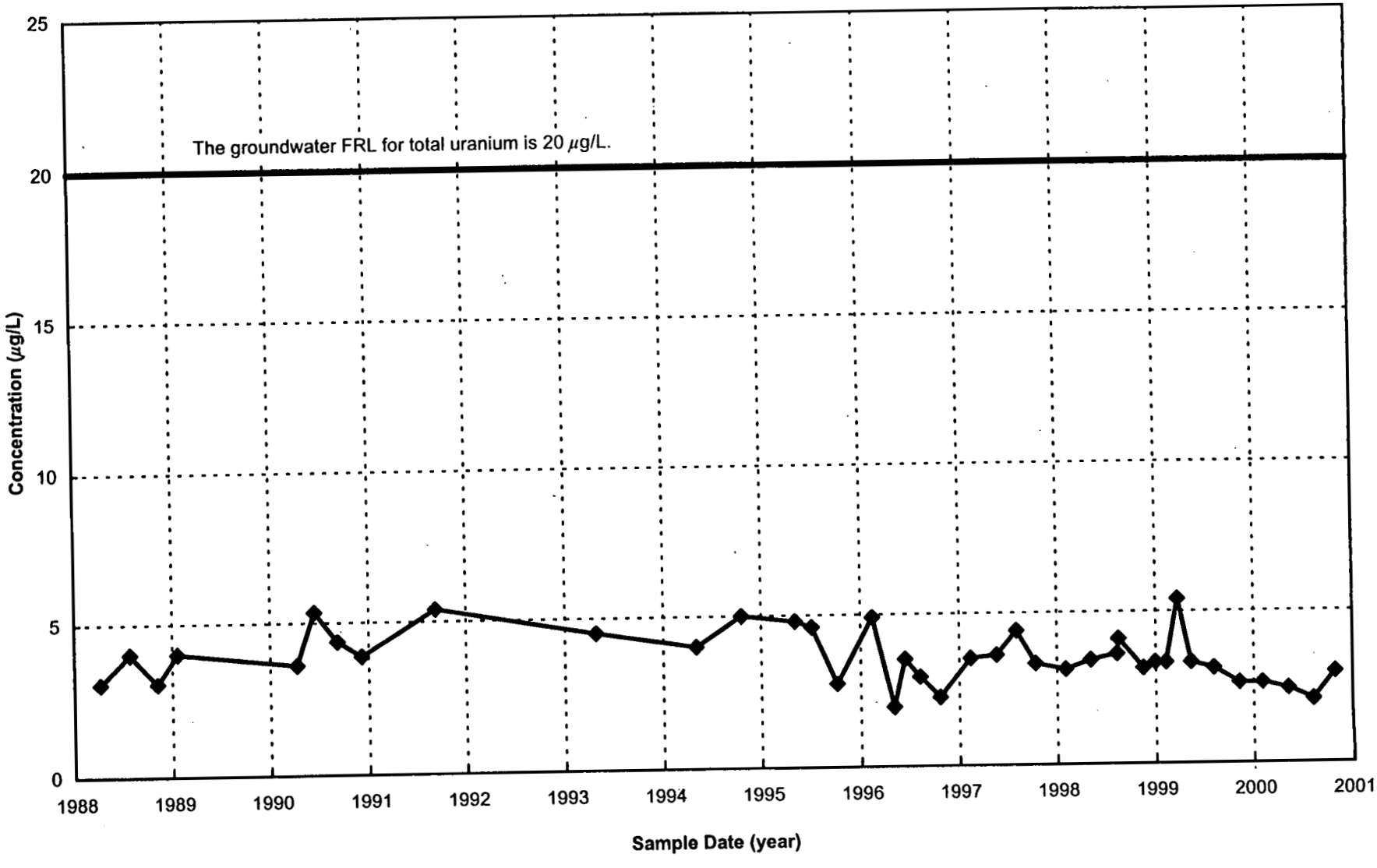


FIGURE A.2-15. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2017

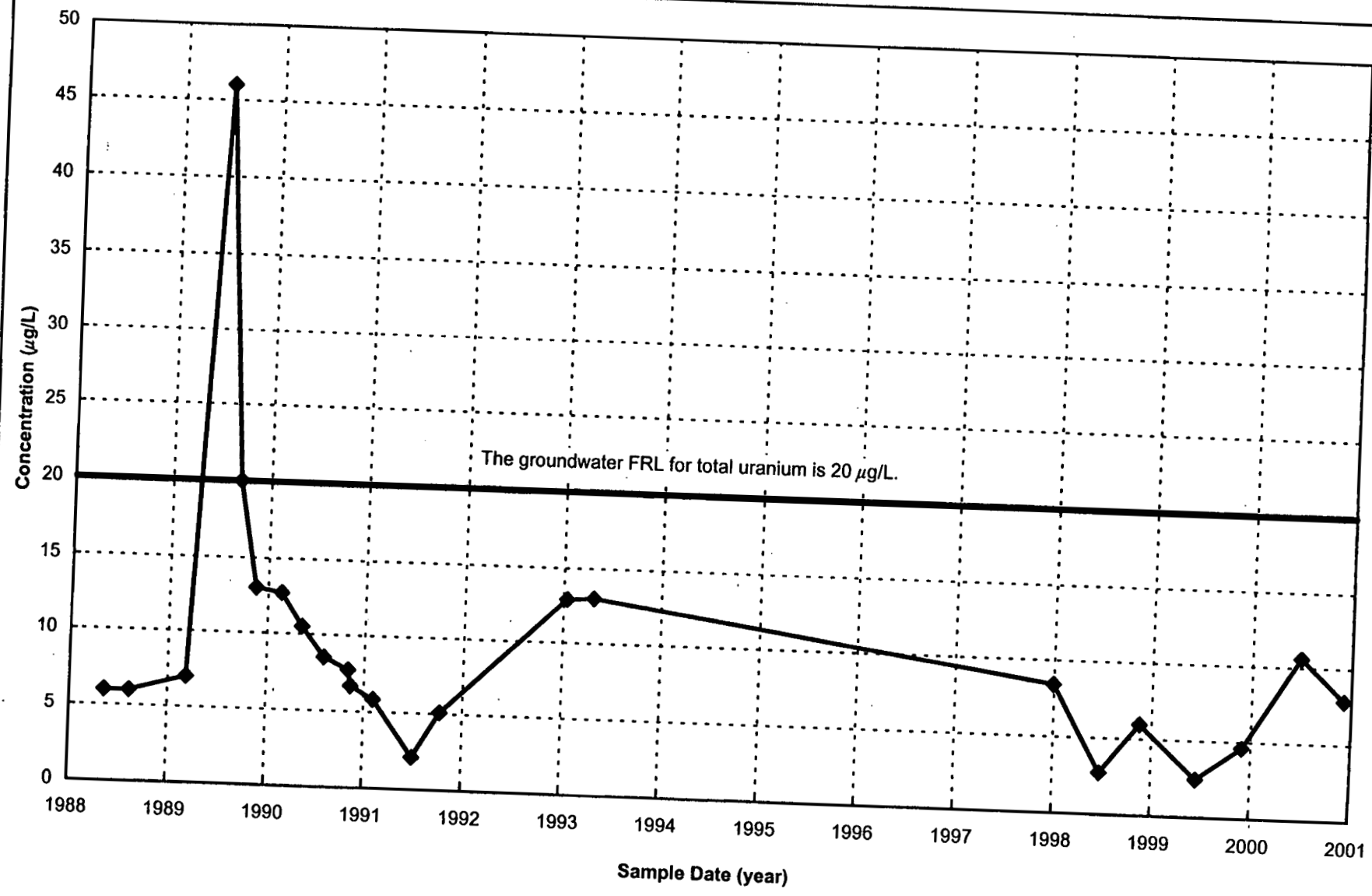


FIGURE A.2-16. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2027

000099

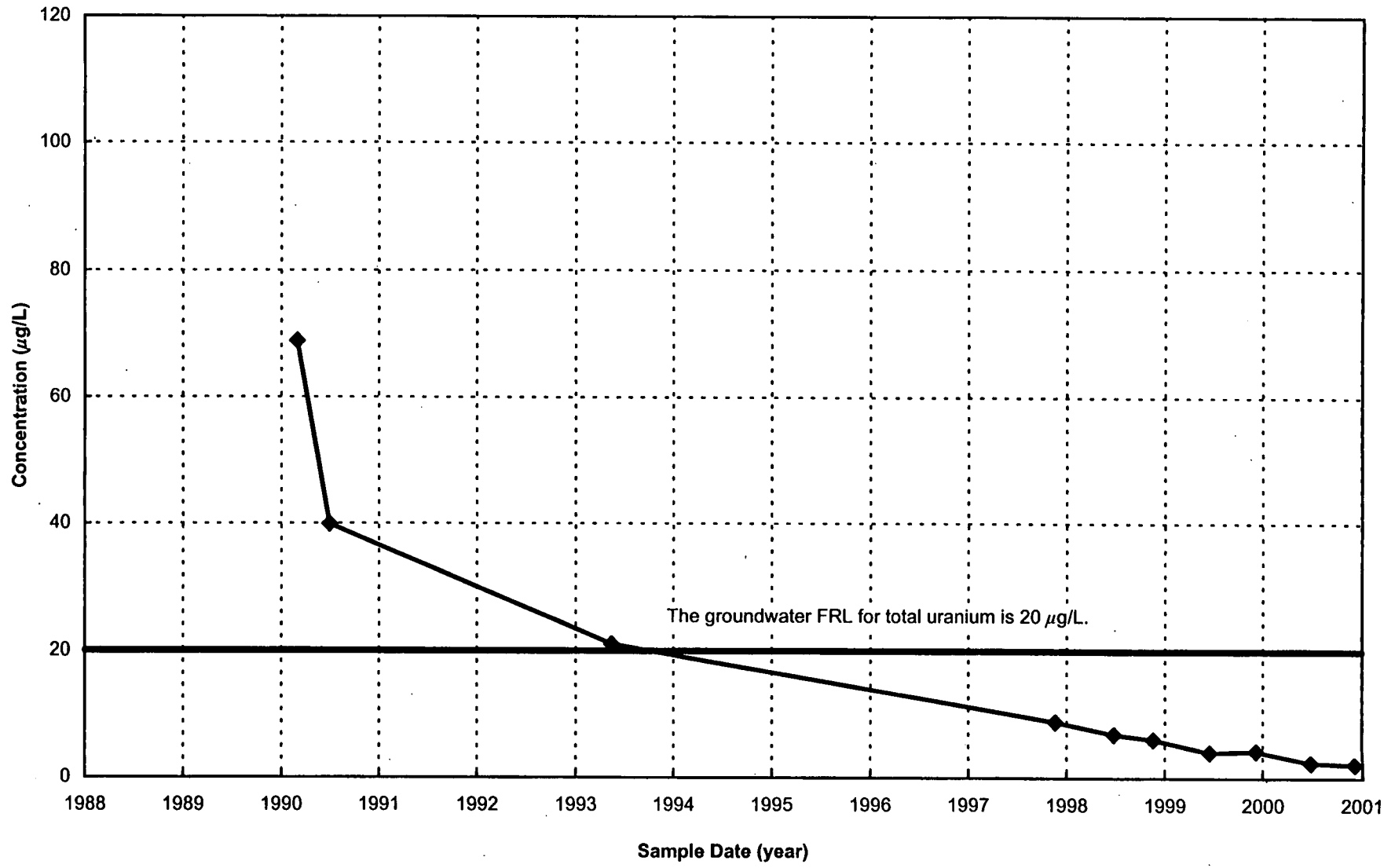


FIGURE A.2-17. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2032

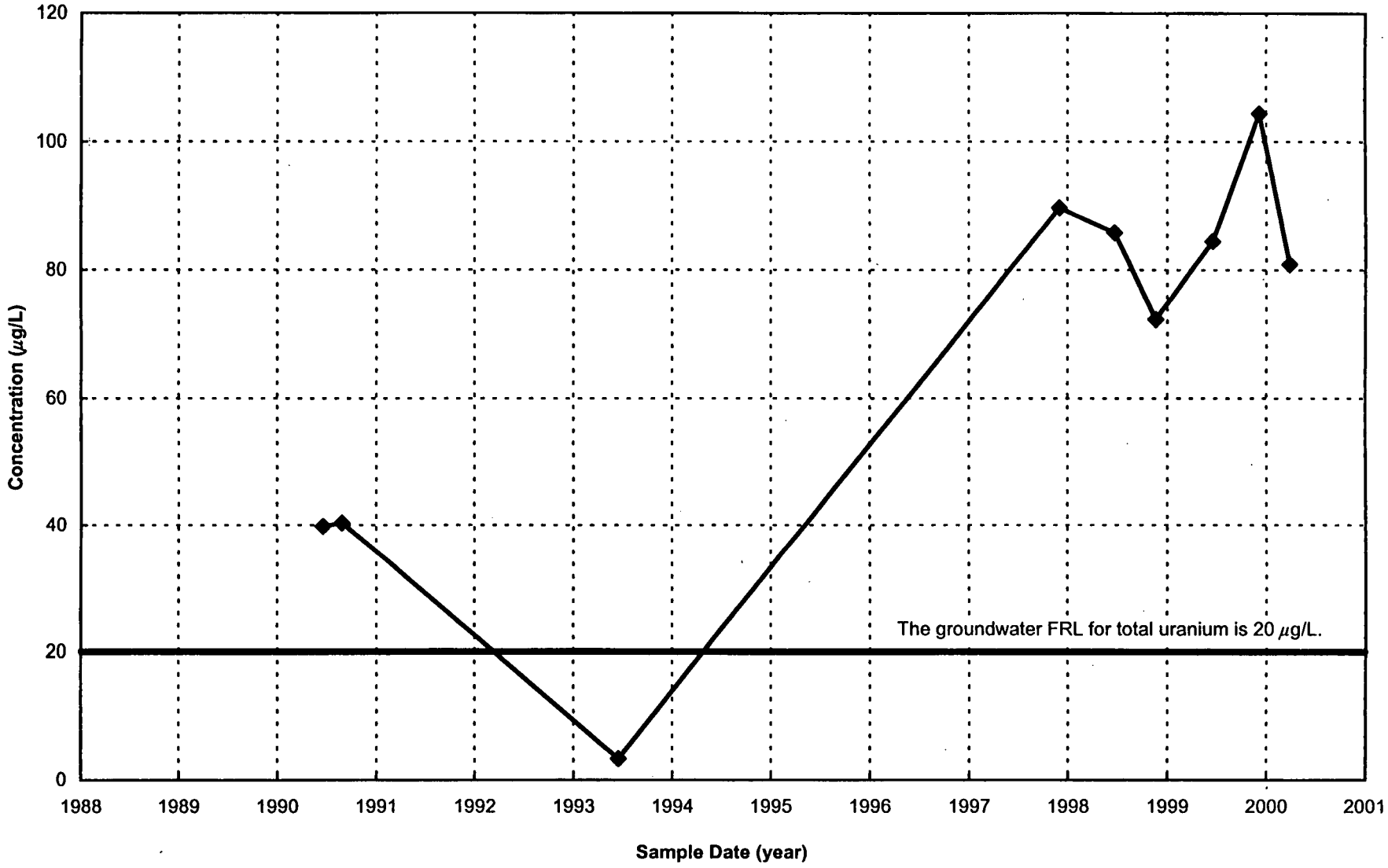


FIGURE A.2-18. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2033

000101

FIGURE A.2-19. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2034

FIGURE A.2-20. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2045

000103

FIGURE A.2-21. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2046

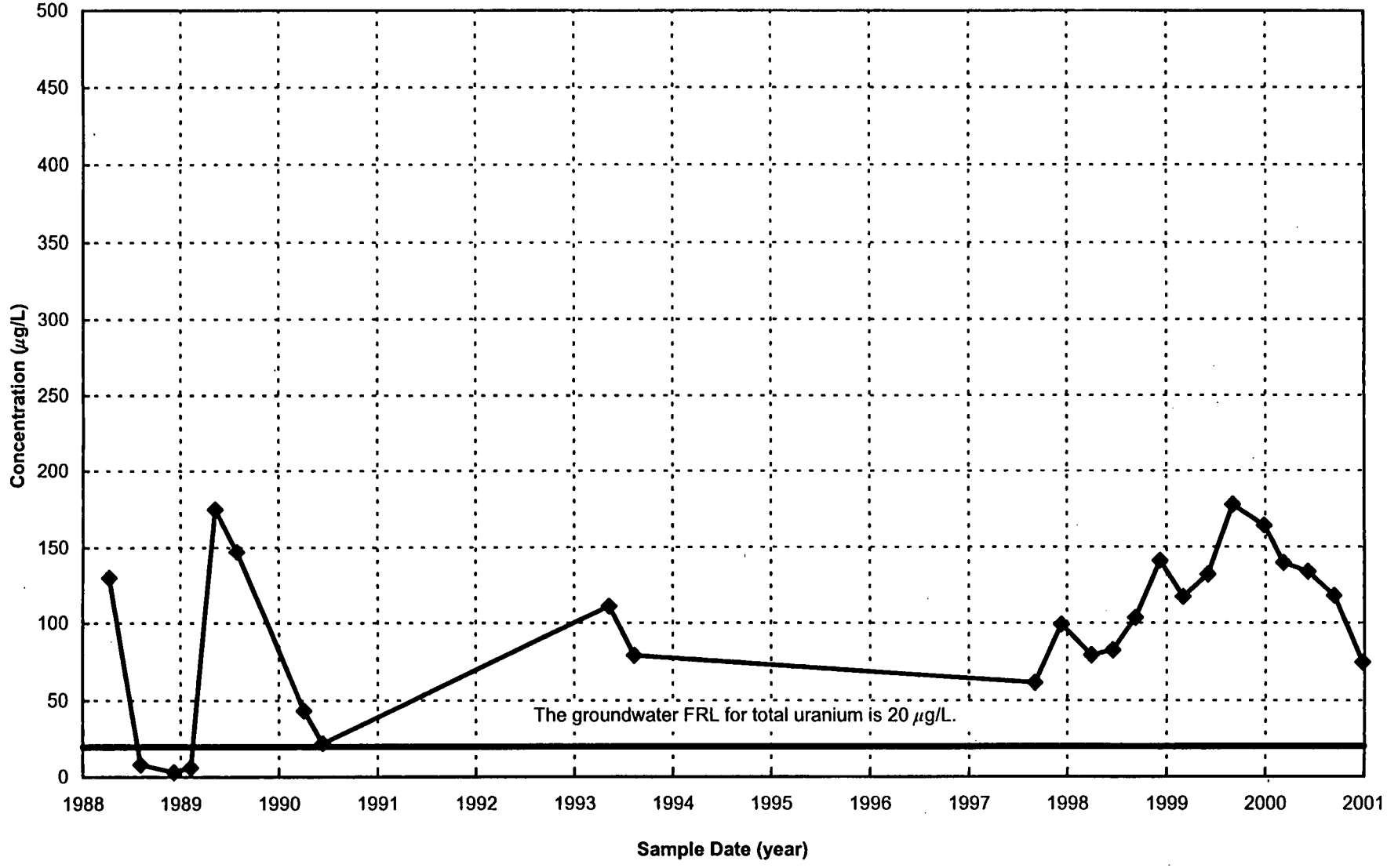


FIGURE A.2-22. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2049

000105

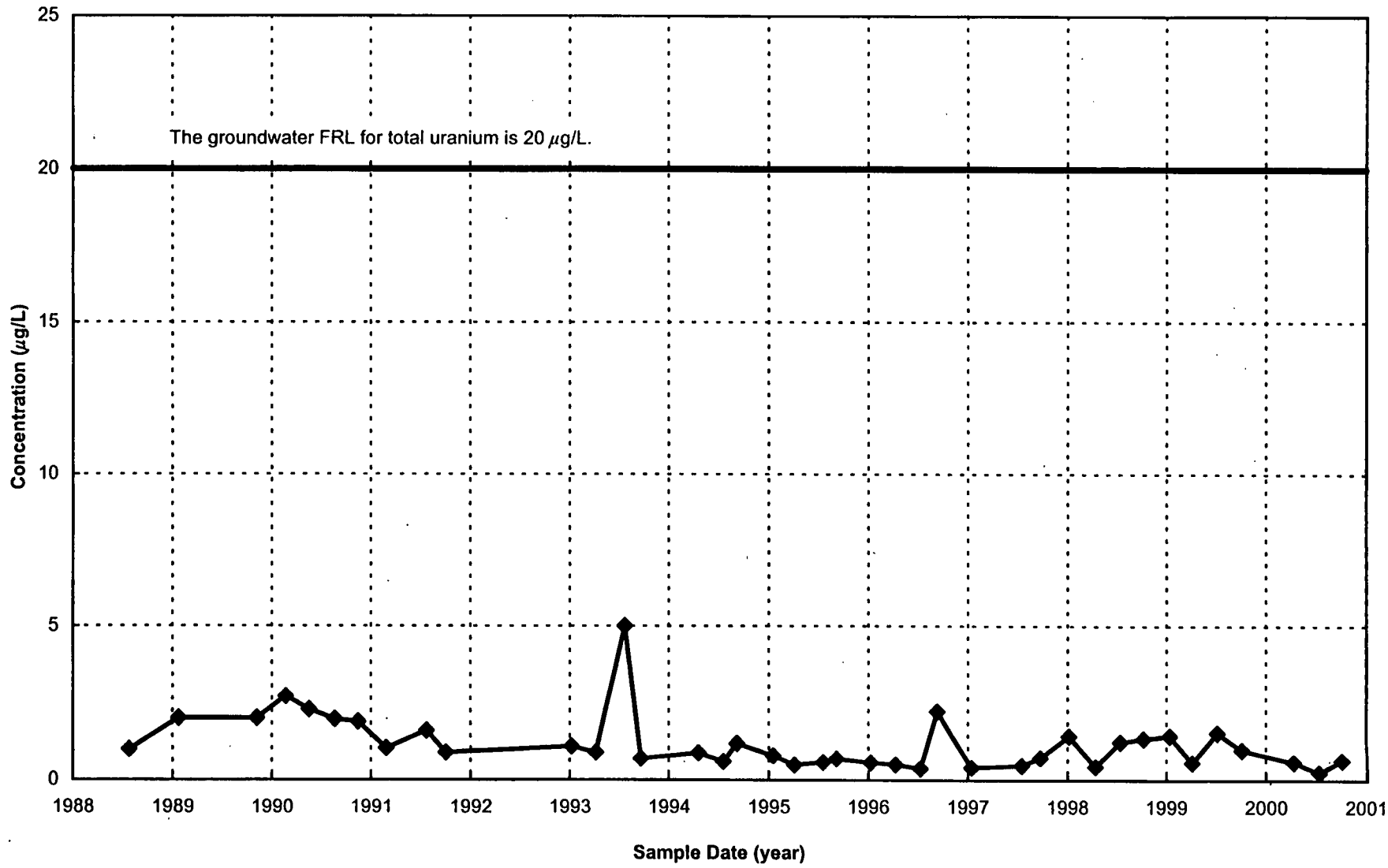


FIGURE A.2-23. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2051

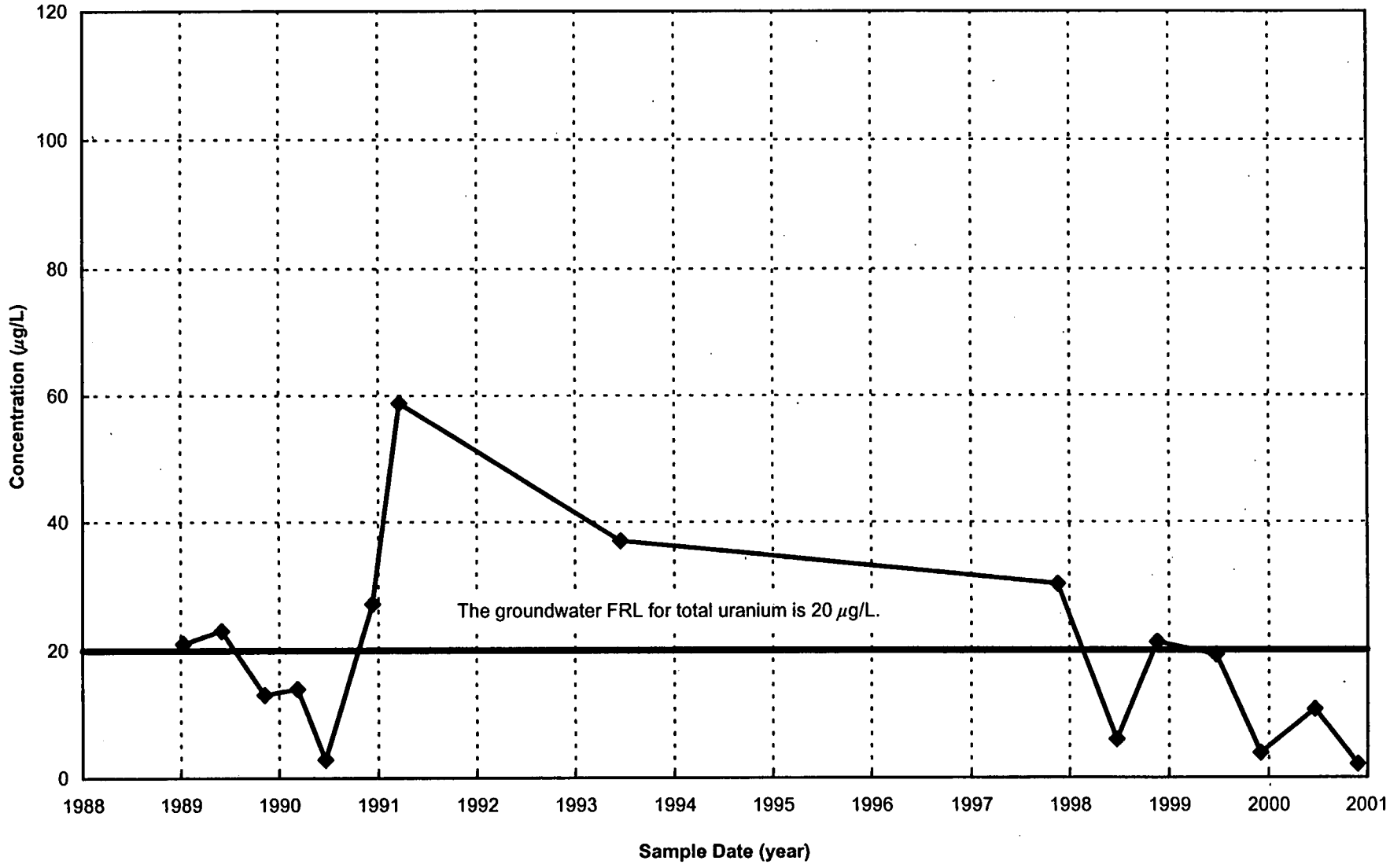


FIGURE A.2-24. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2054

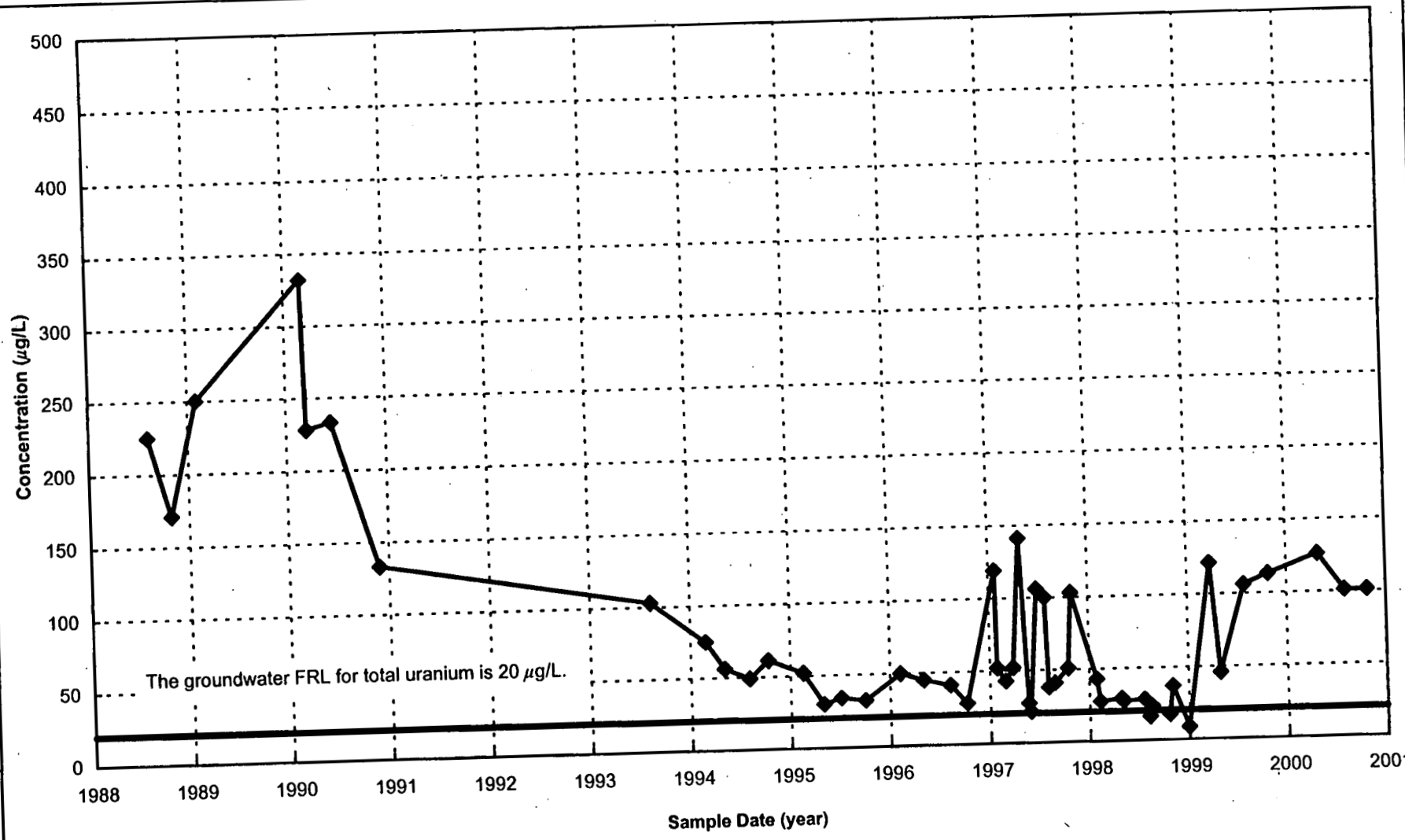


FIGURE A.2-25. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2060 (12)

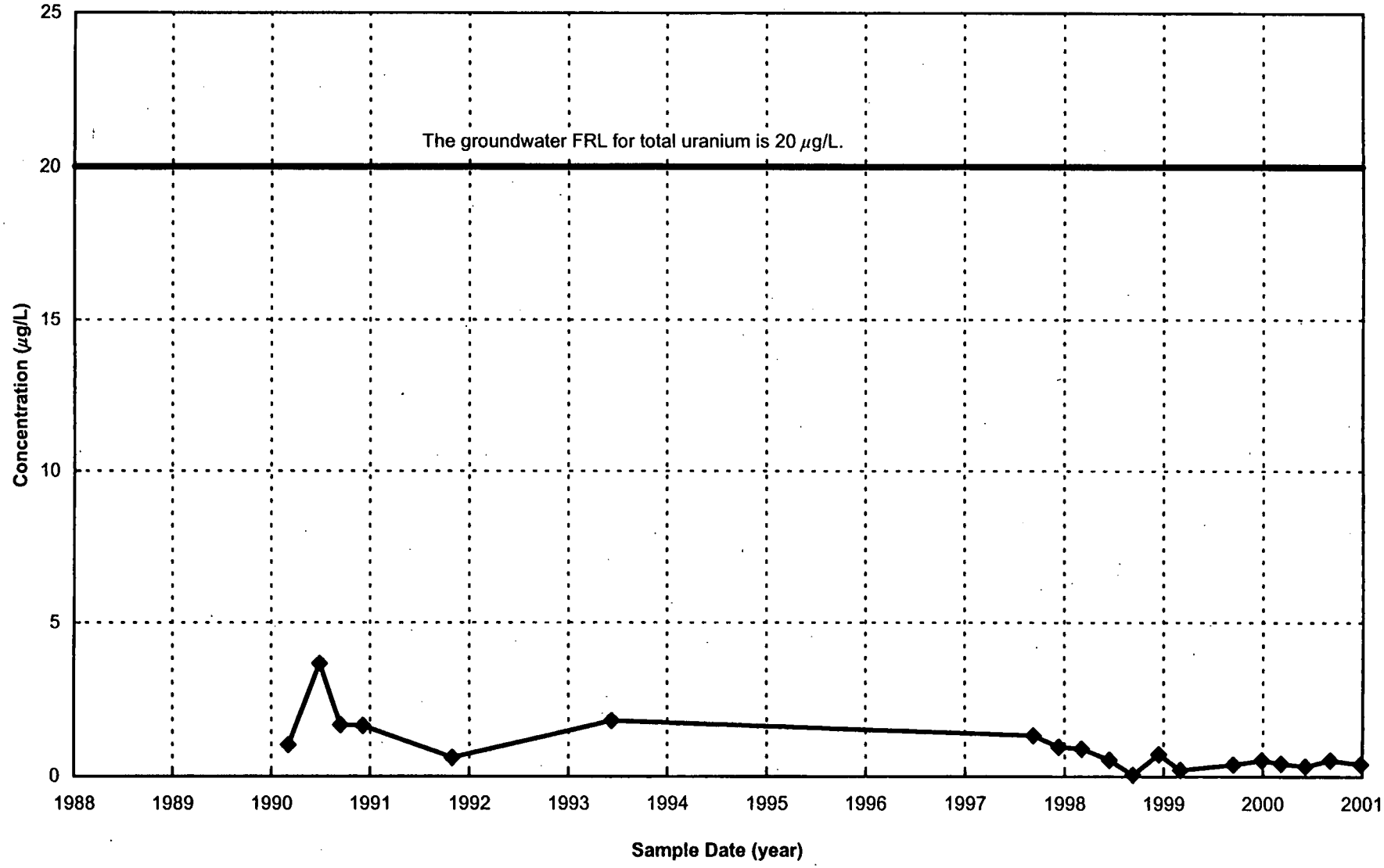


FIGURE A.2-26. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2068

000109

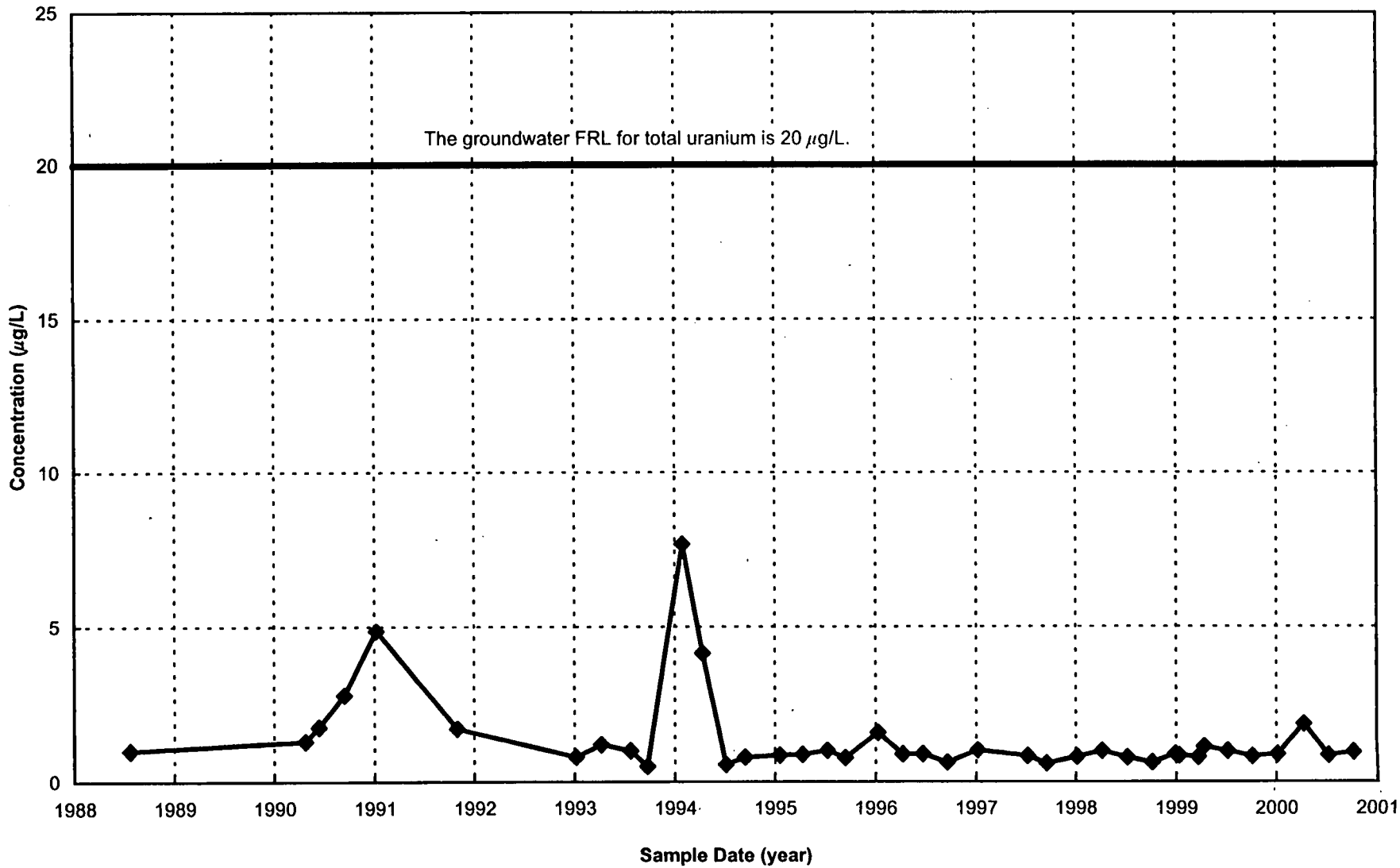


FIGURE A.2-27. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2070

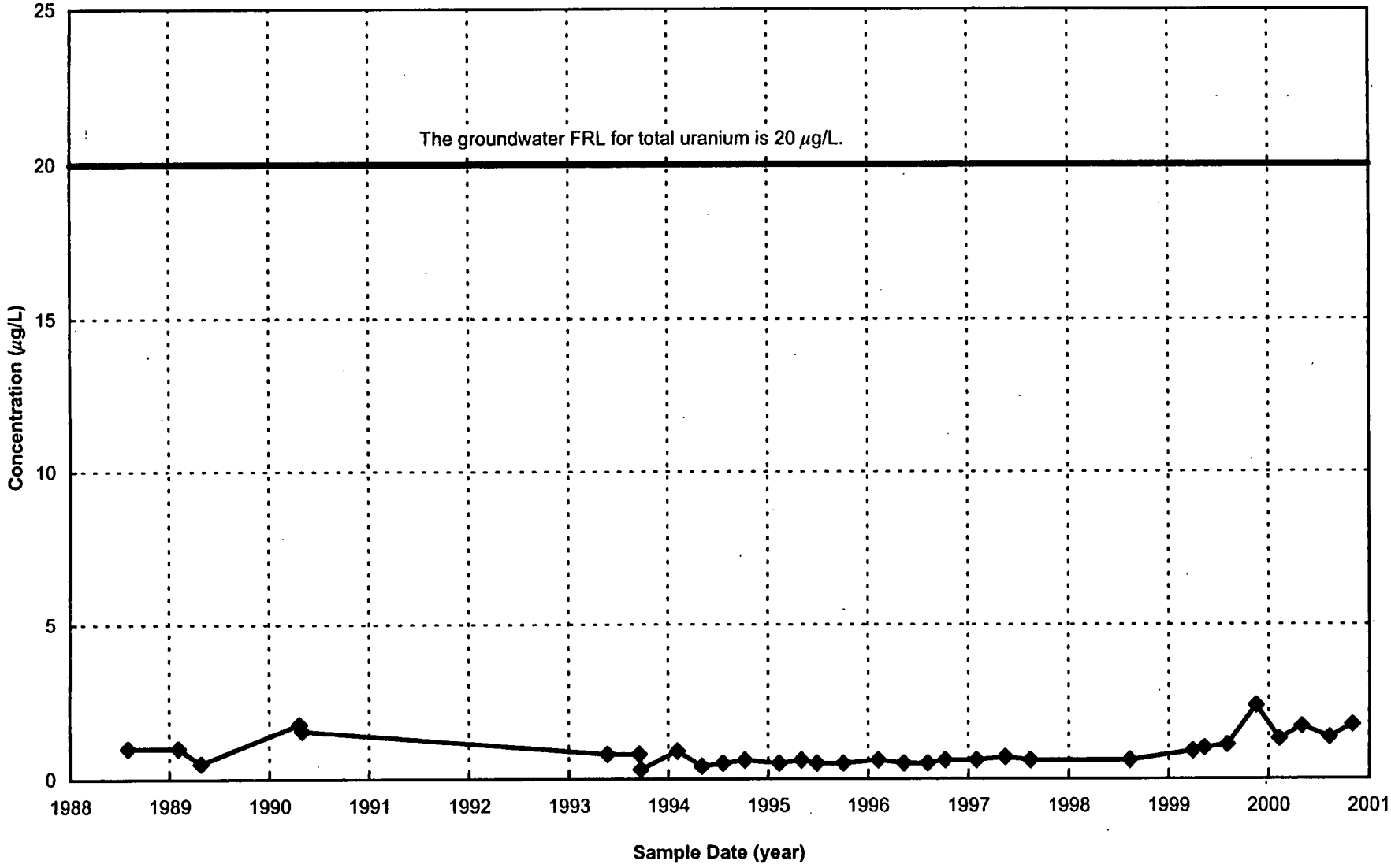


FIGURE A.2-28. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2093

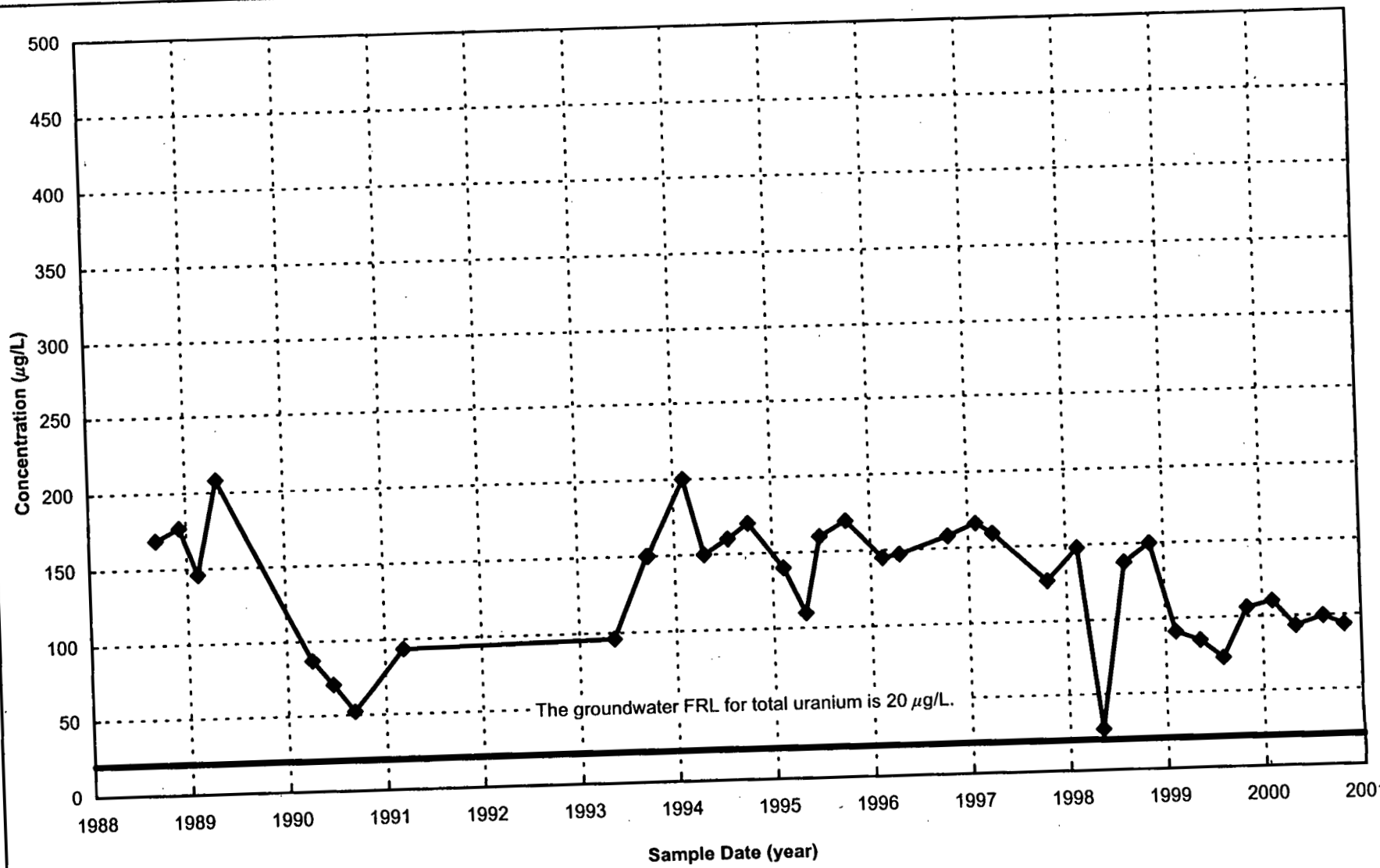


FIGURE A.2-29. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2095

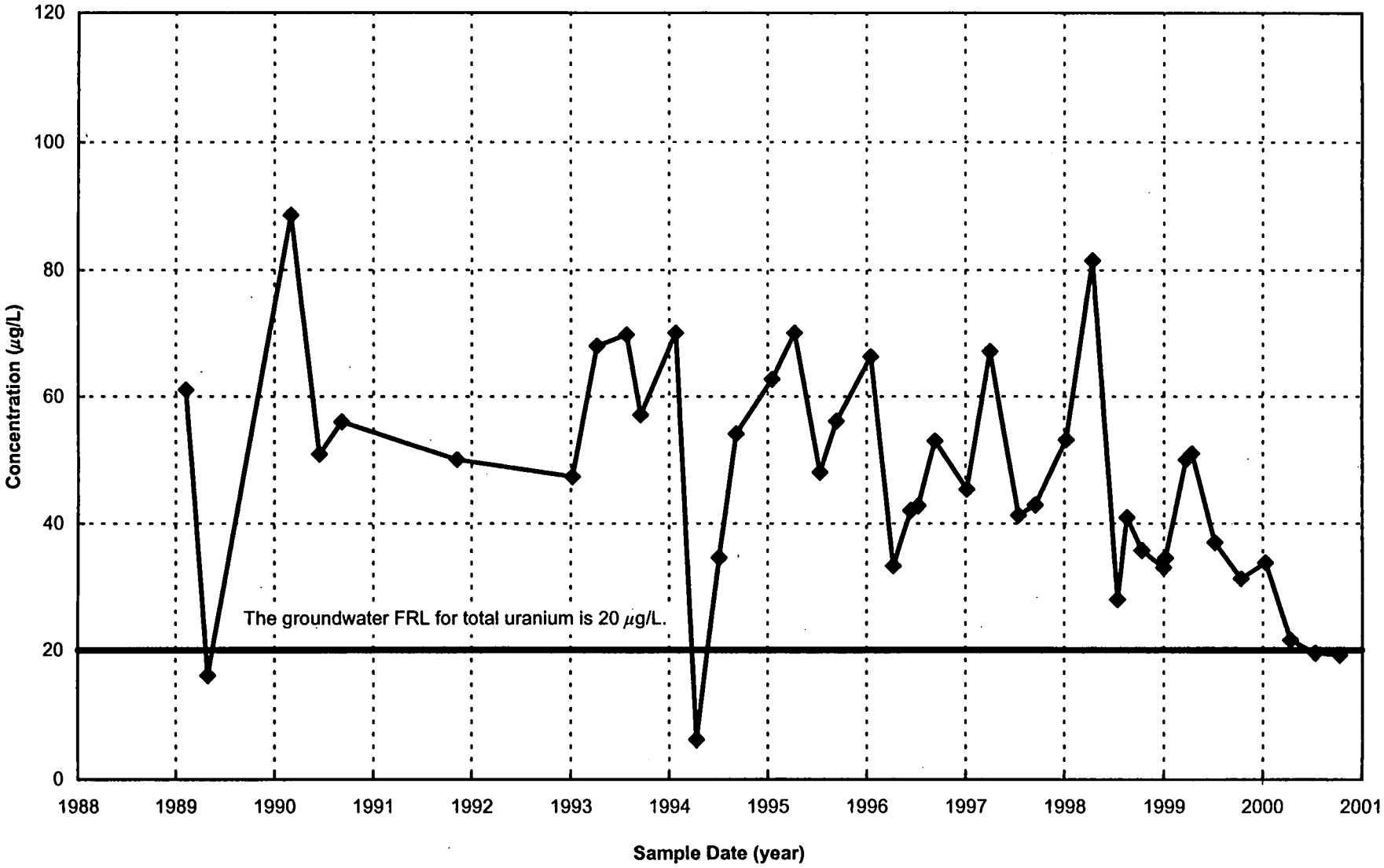


FIGURE A.2-30. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2106

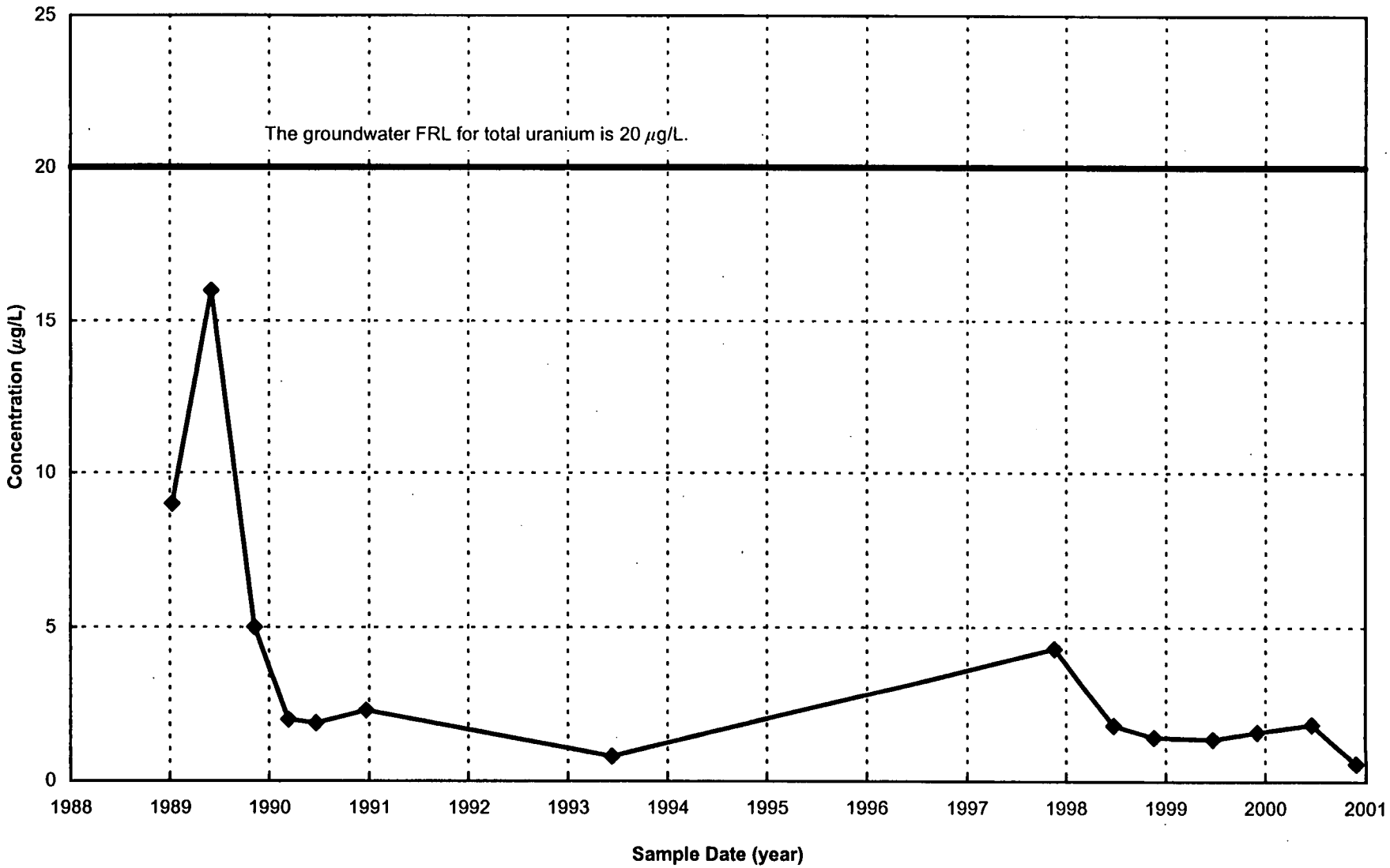


FIGURE A.2-31. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2118

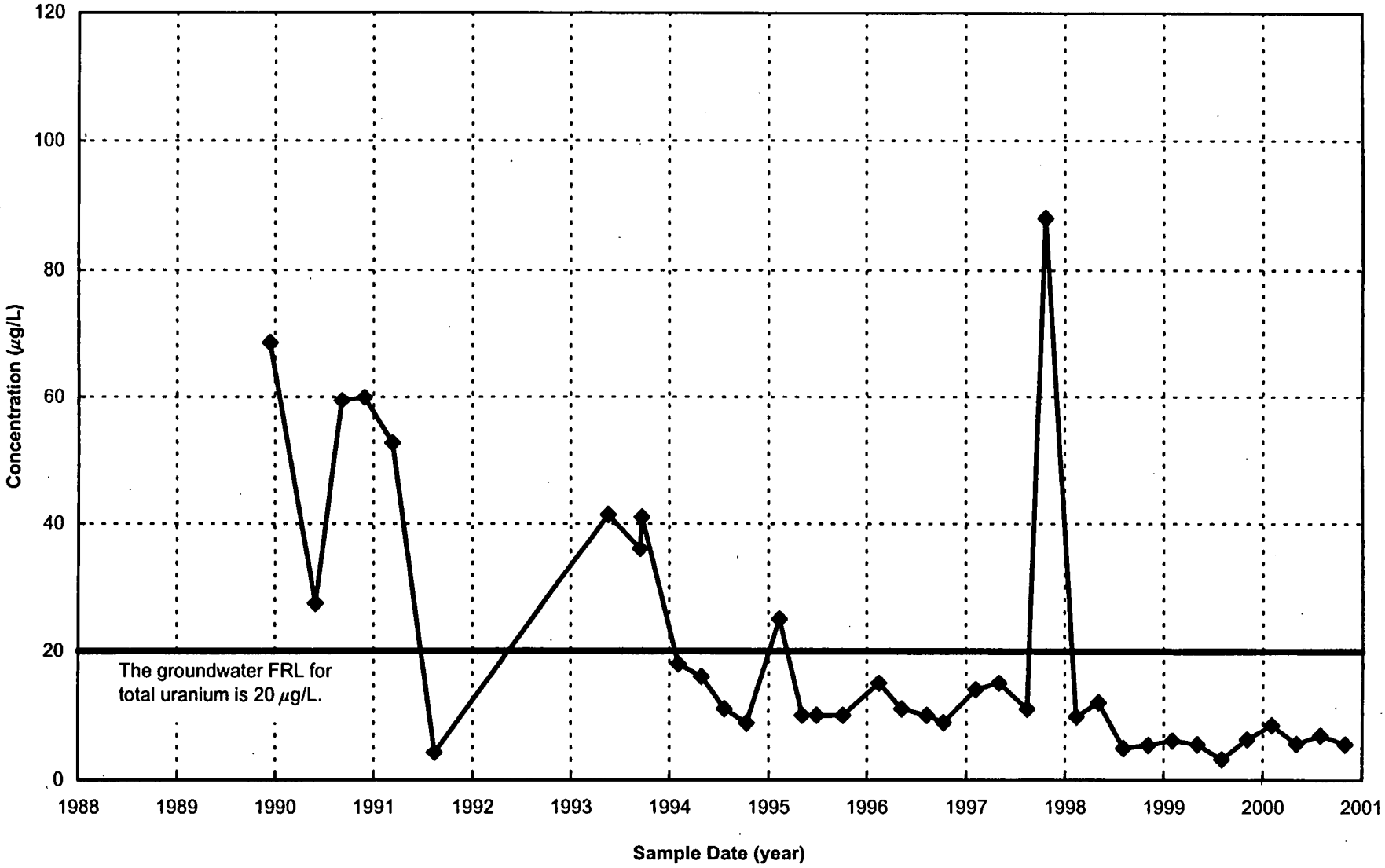


FIGURE A.2-32. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2125

000115

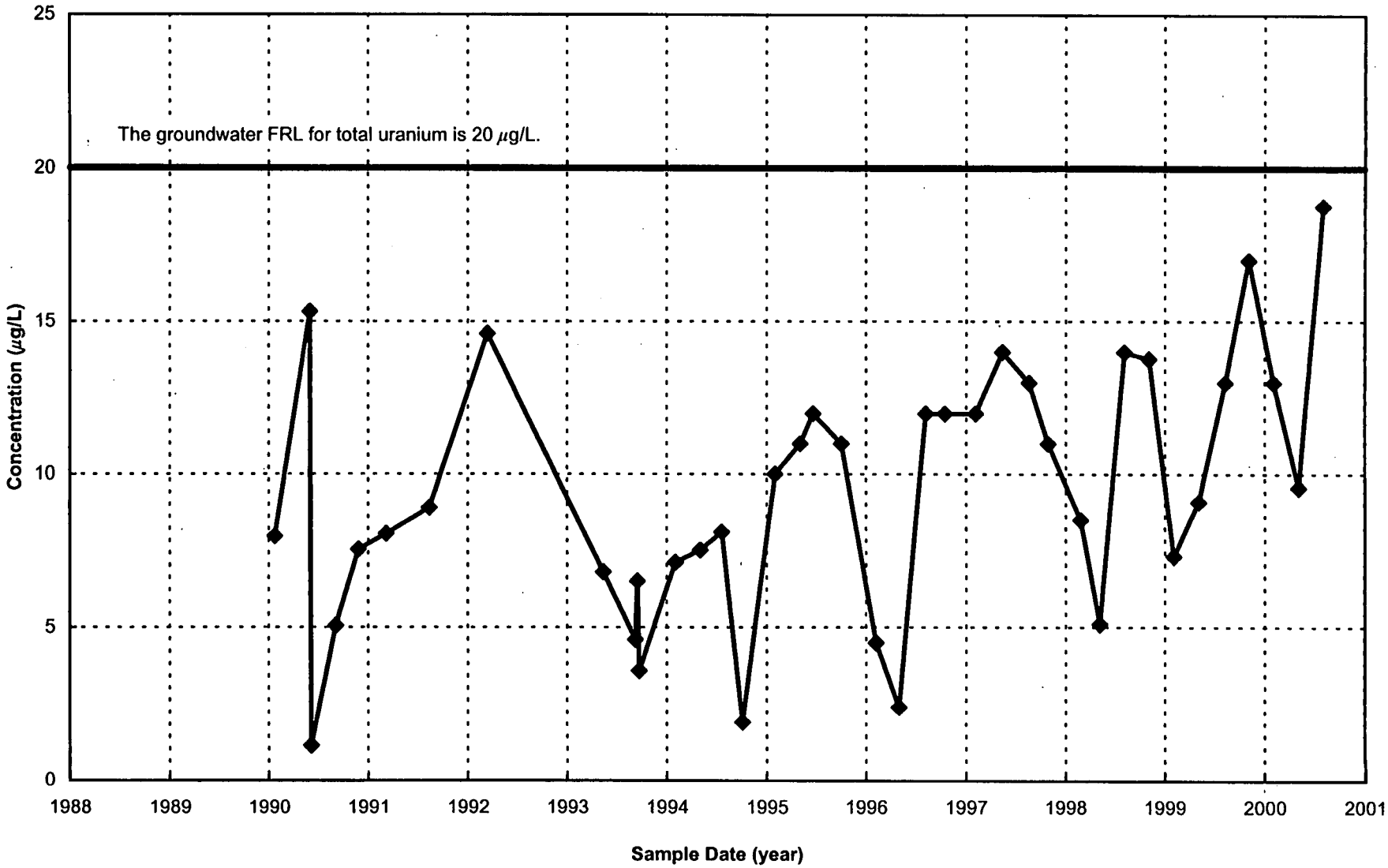


FIGURE A.2-33. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2128

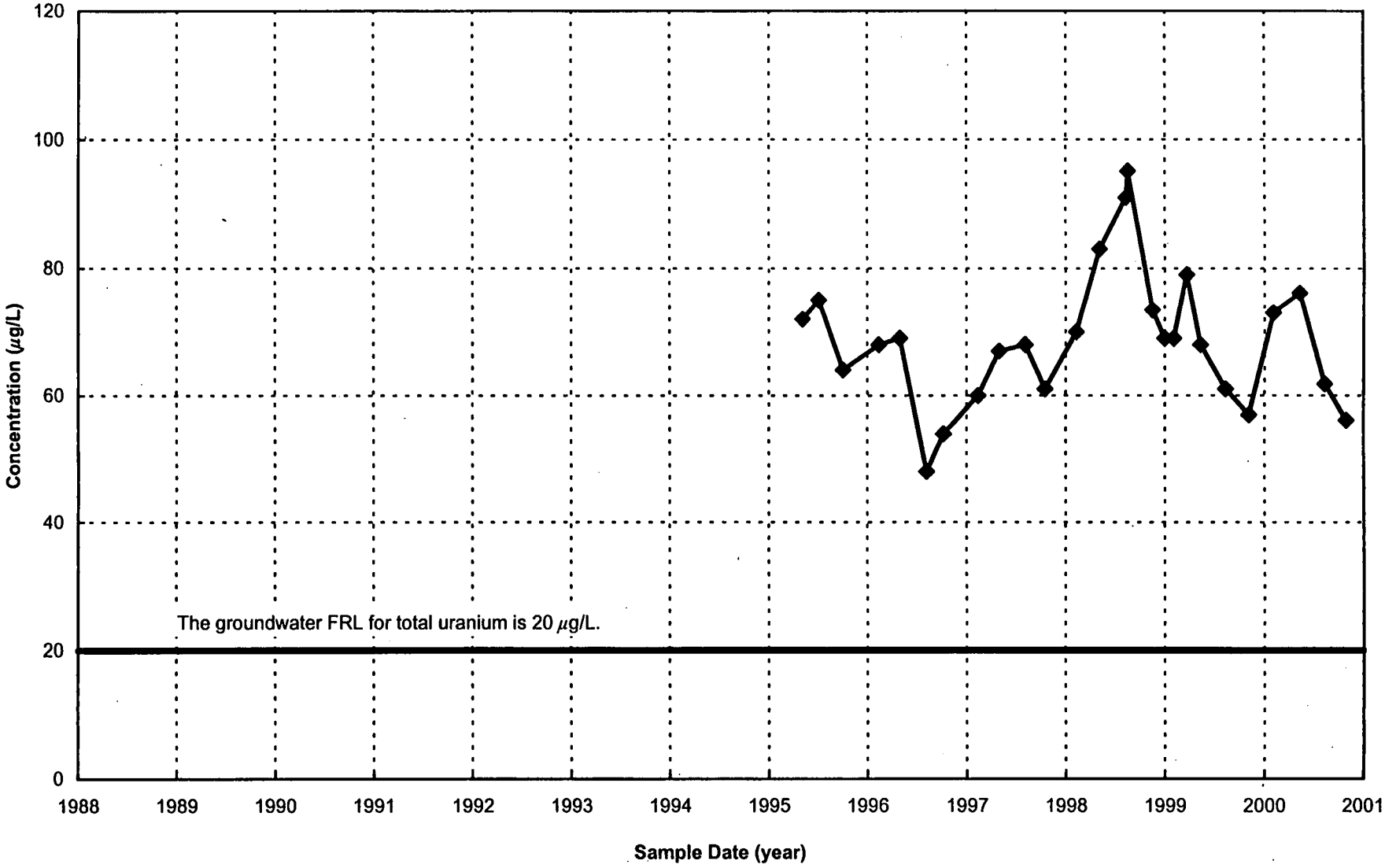


FIGURE A.2-34. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2166

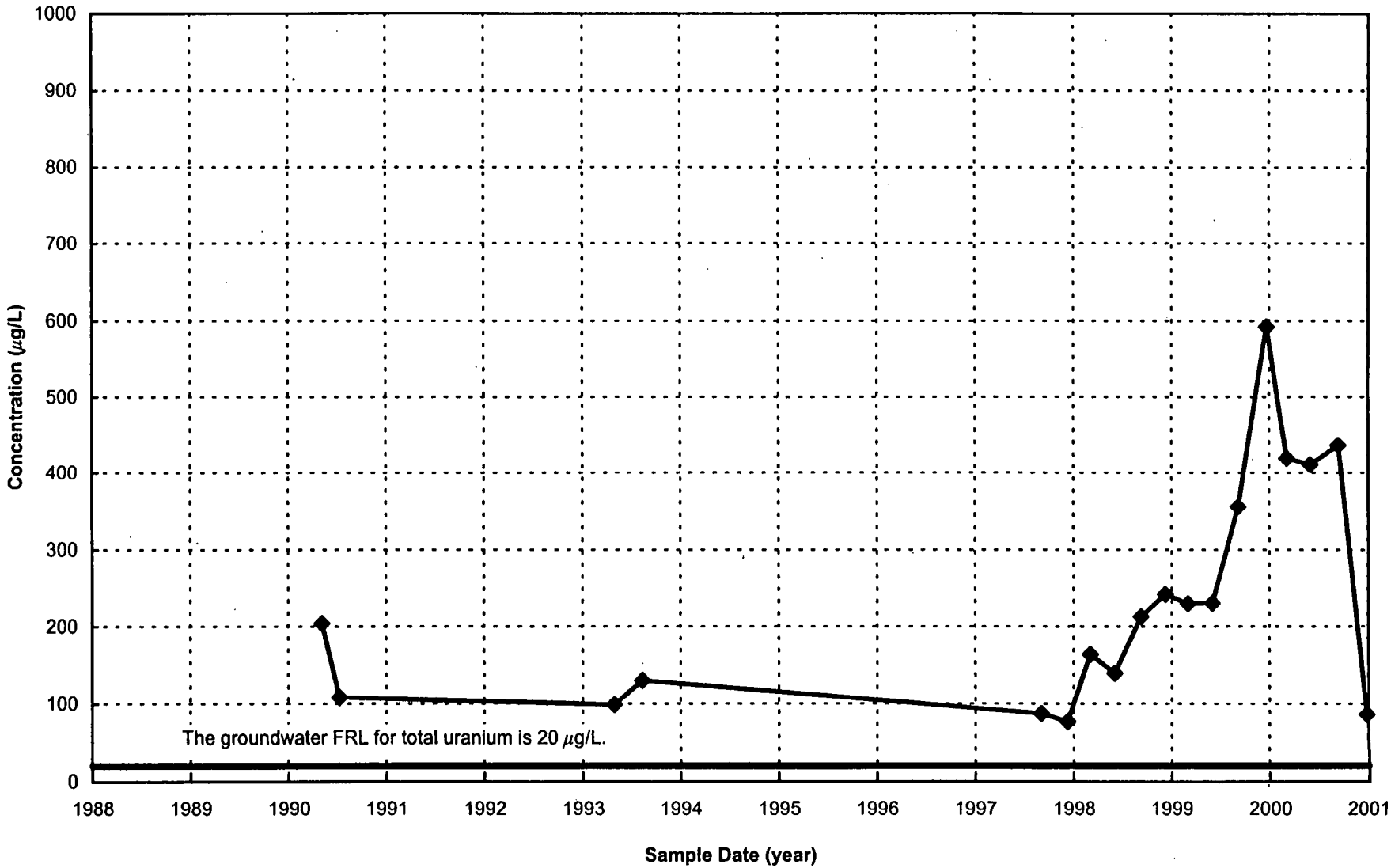


FIGURE A.2-35. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2385

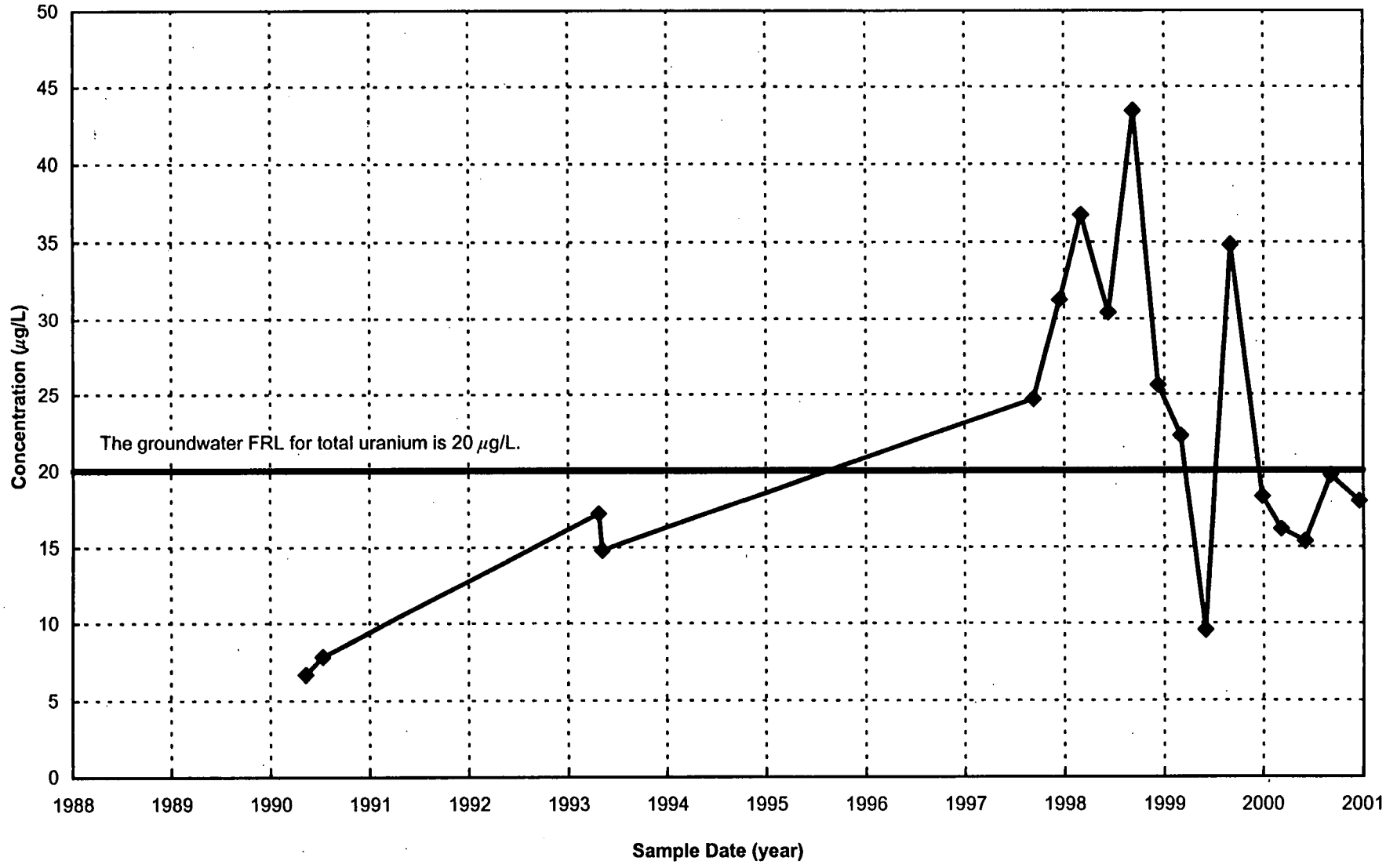


FIGURE A.2-36. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2386

000119

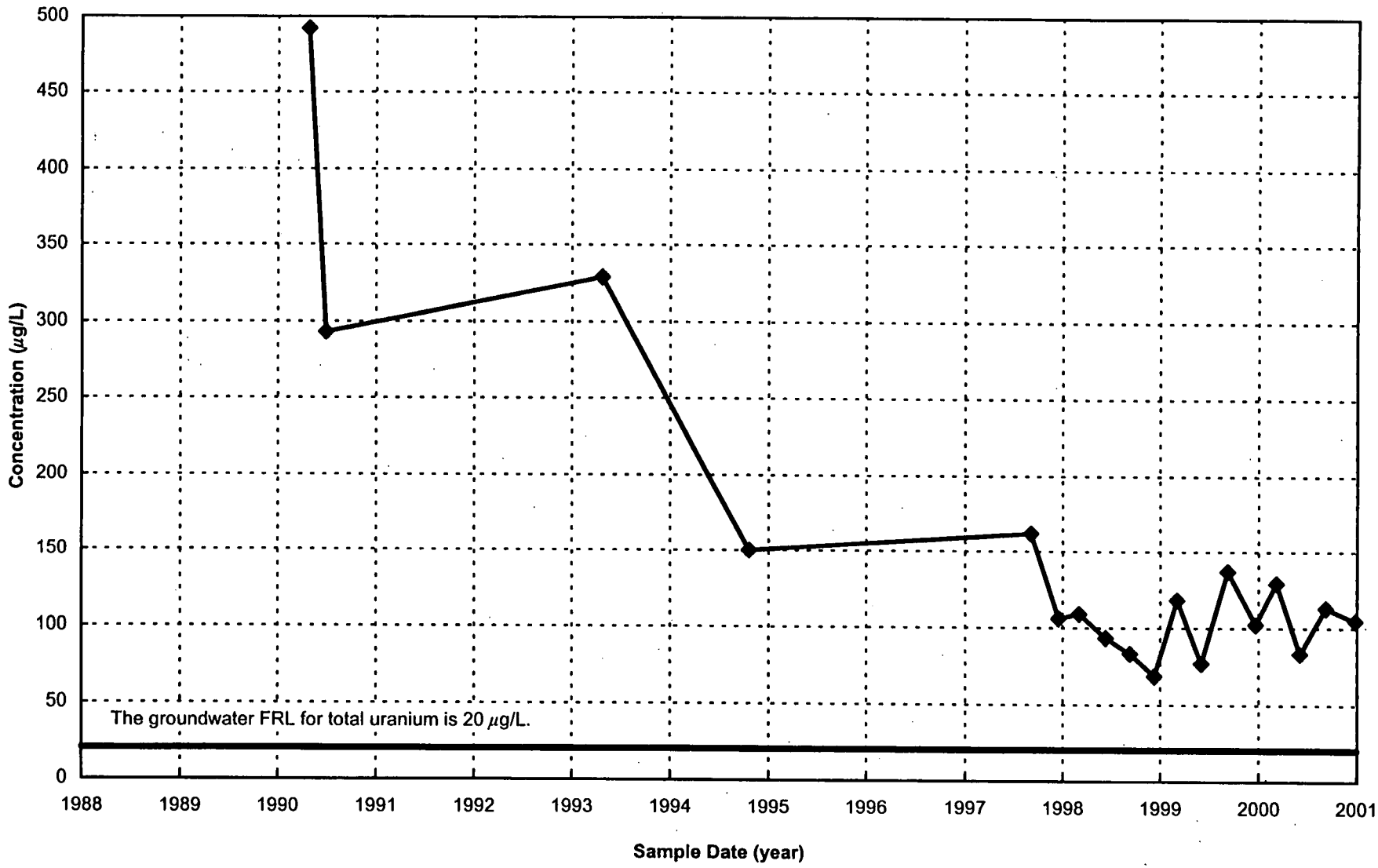


FIGURE A.2-37. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2387

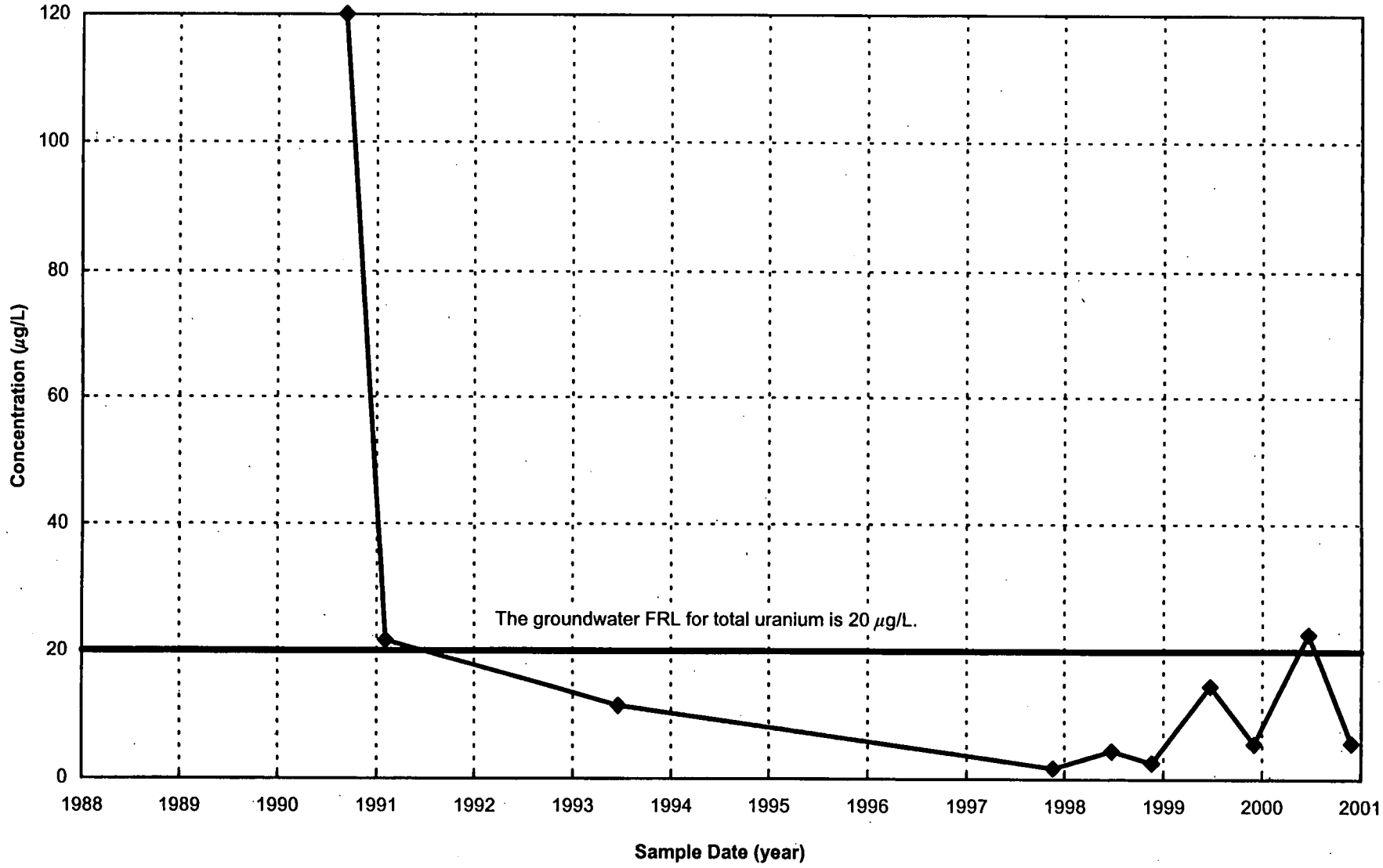


FIGURE A.2-38. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2389

000121

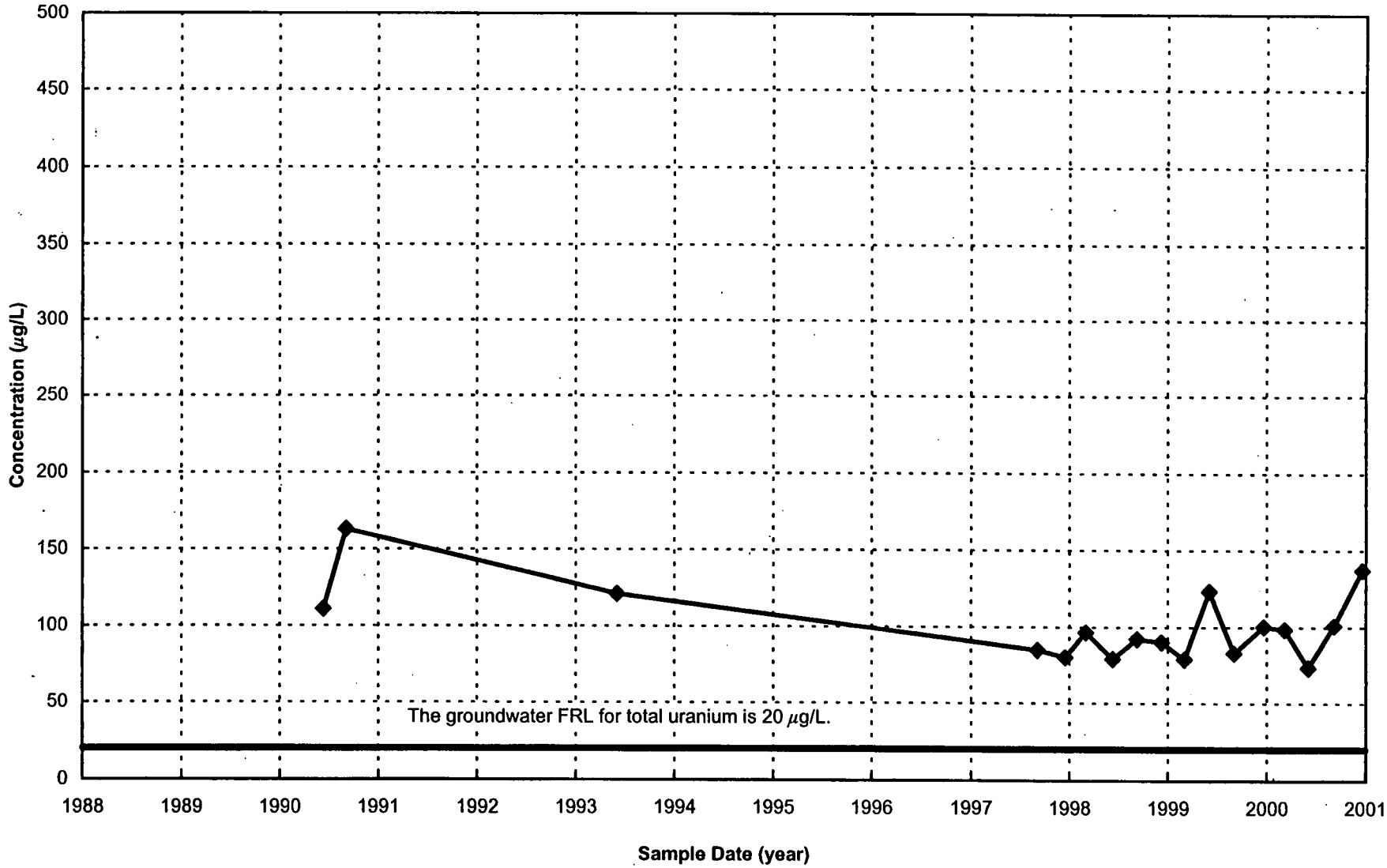


FIGURE A.2-39. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2390

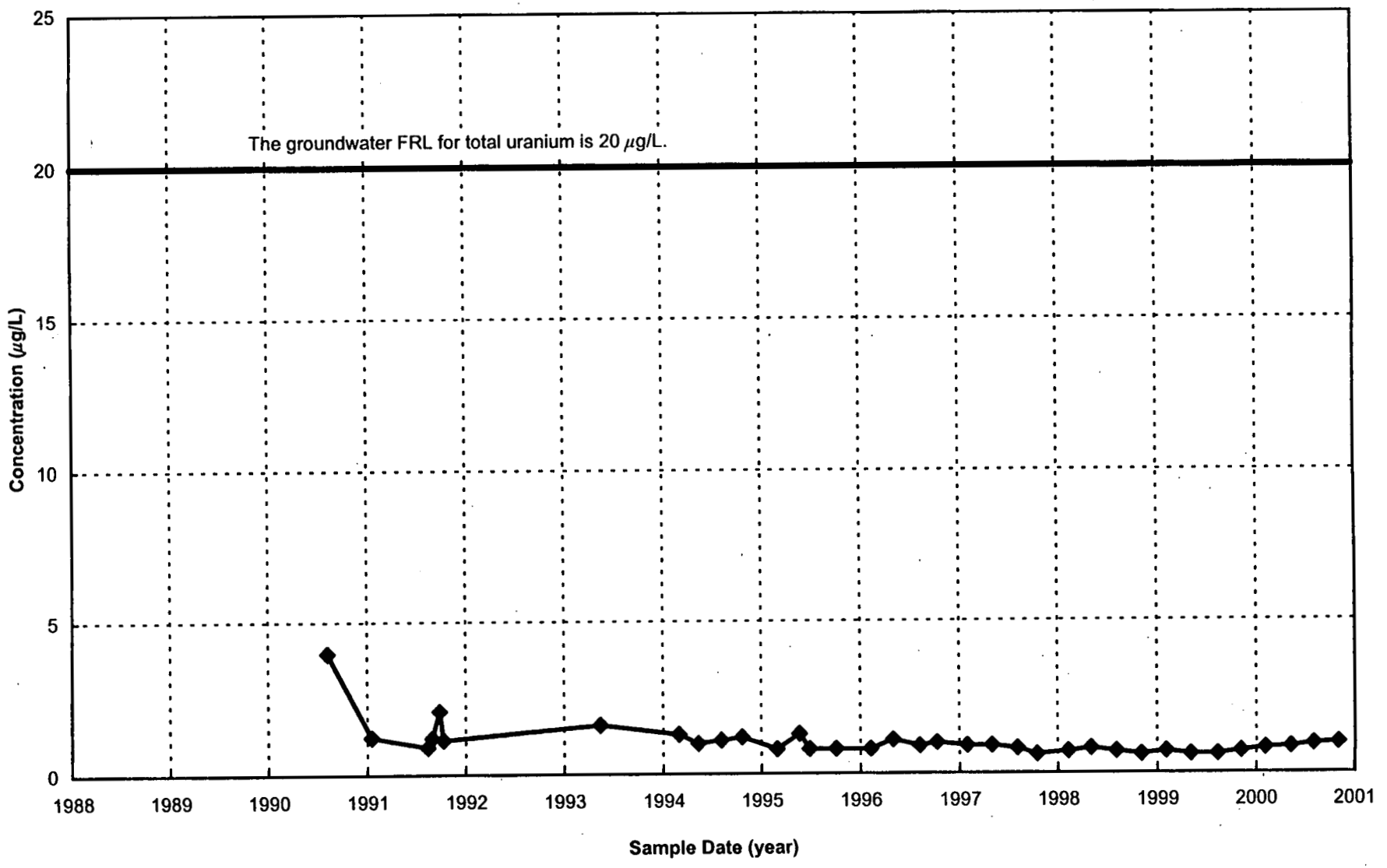


FIGURE A.2-40. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2396

000123

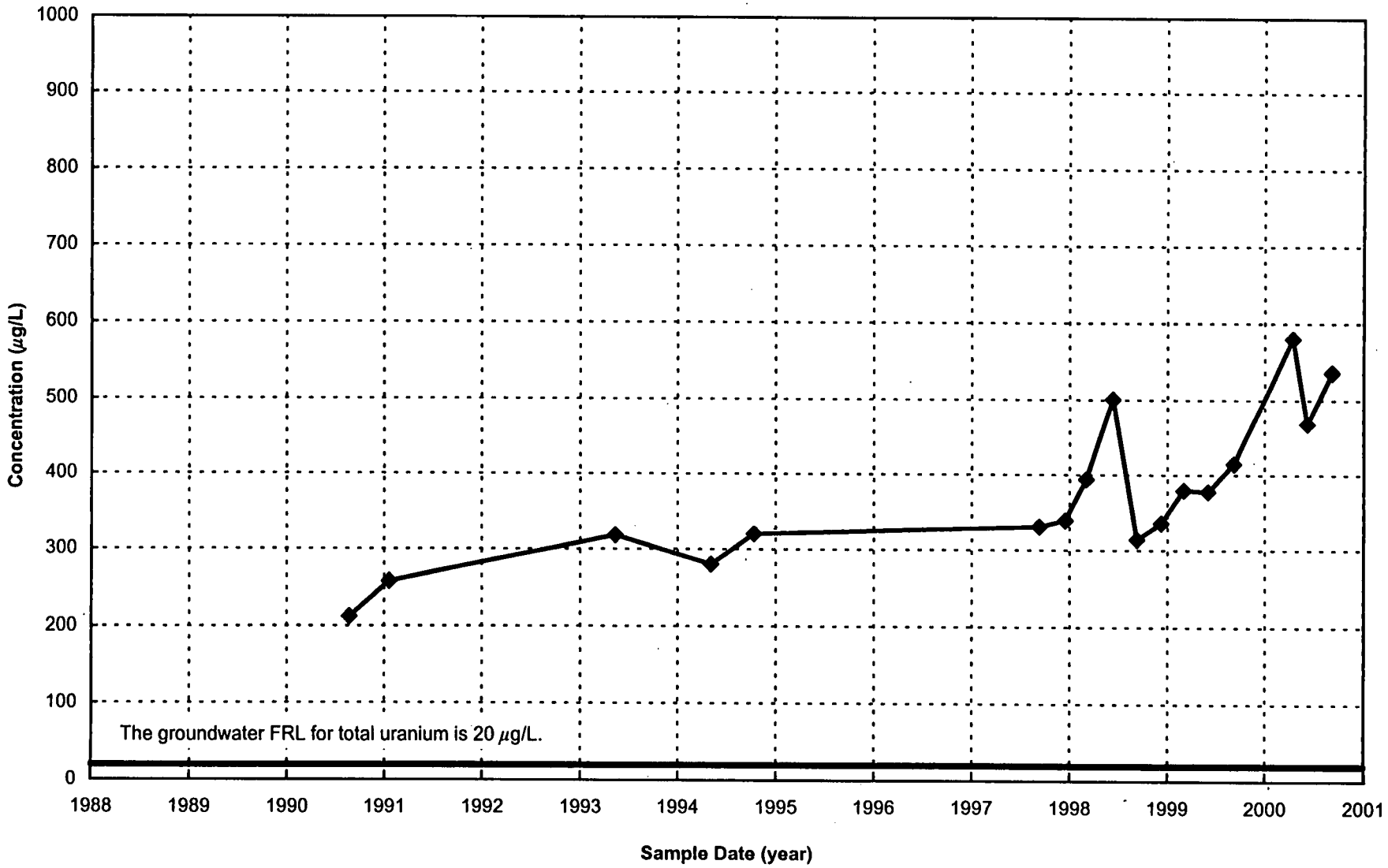


FIGURE A.2-41. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2397

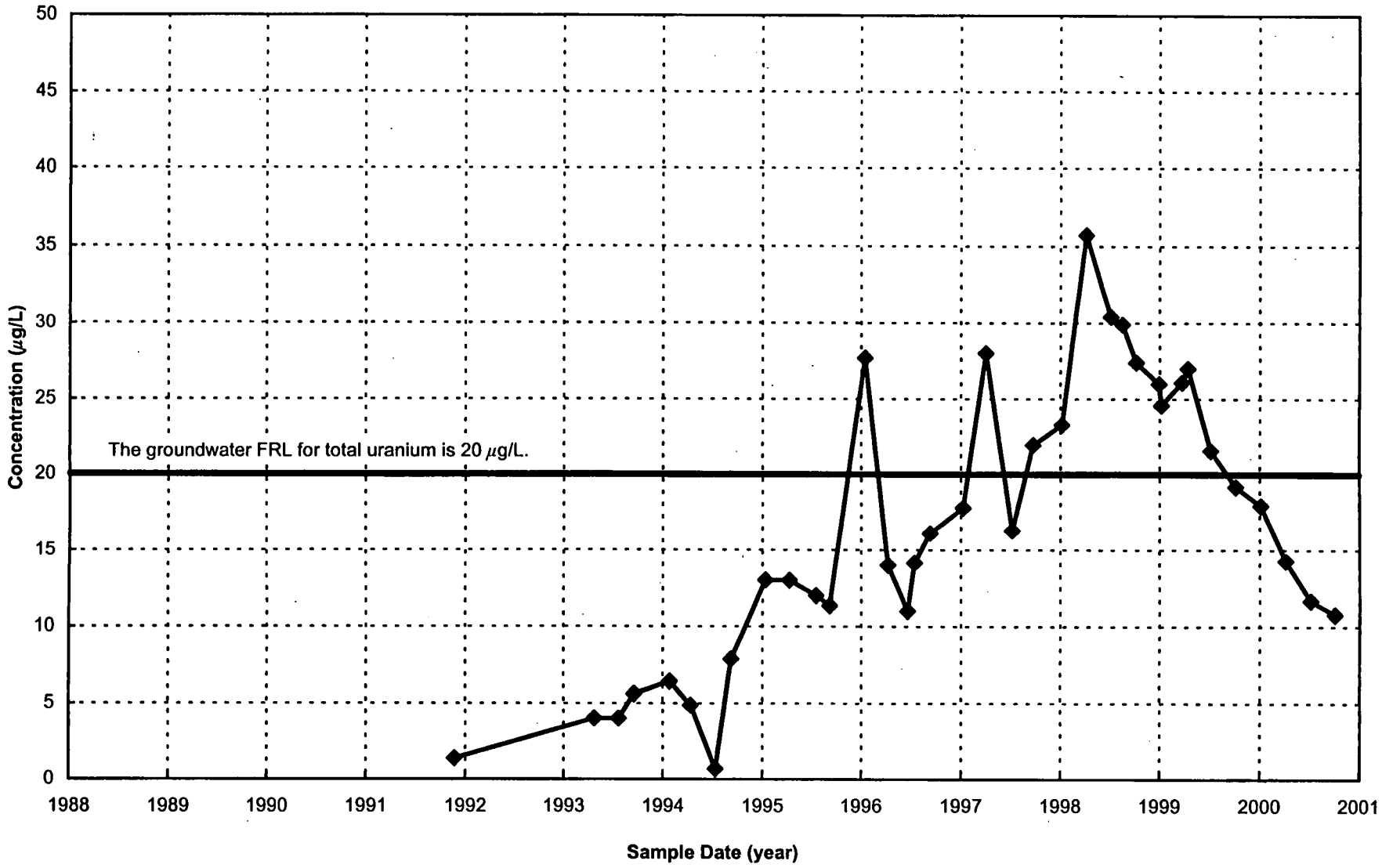


FIGURE A.2-42. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2398

000125

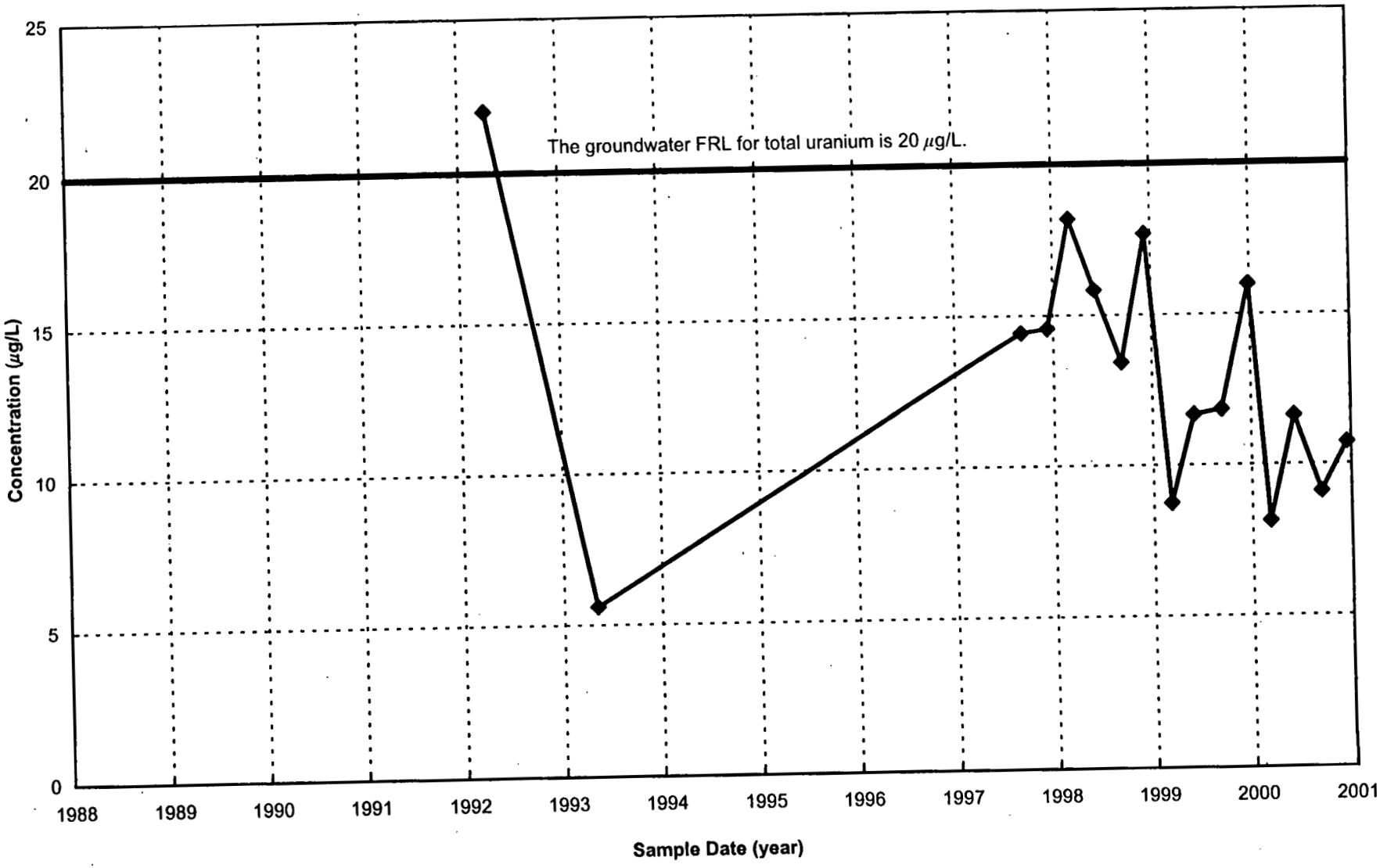


FIGURE A.2-43. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2402

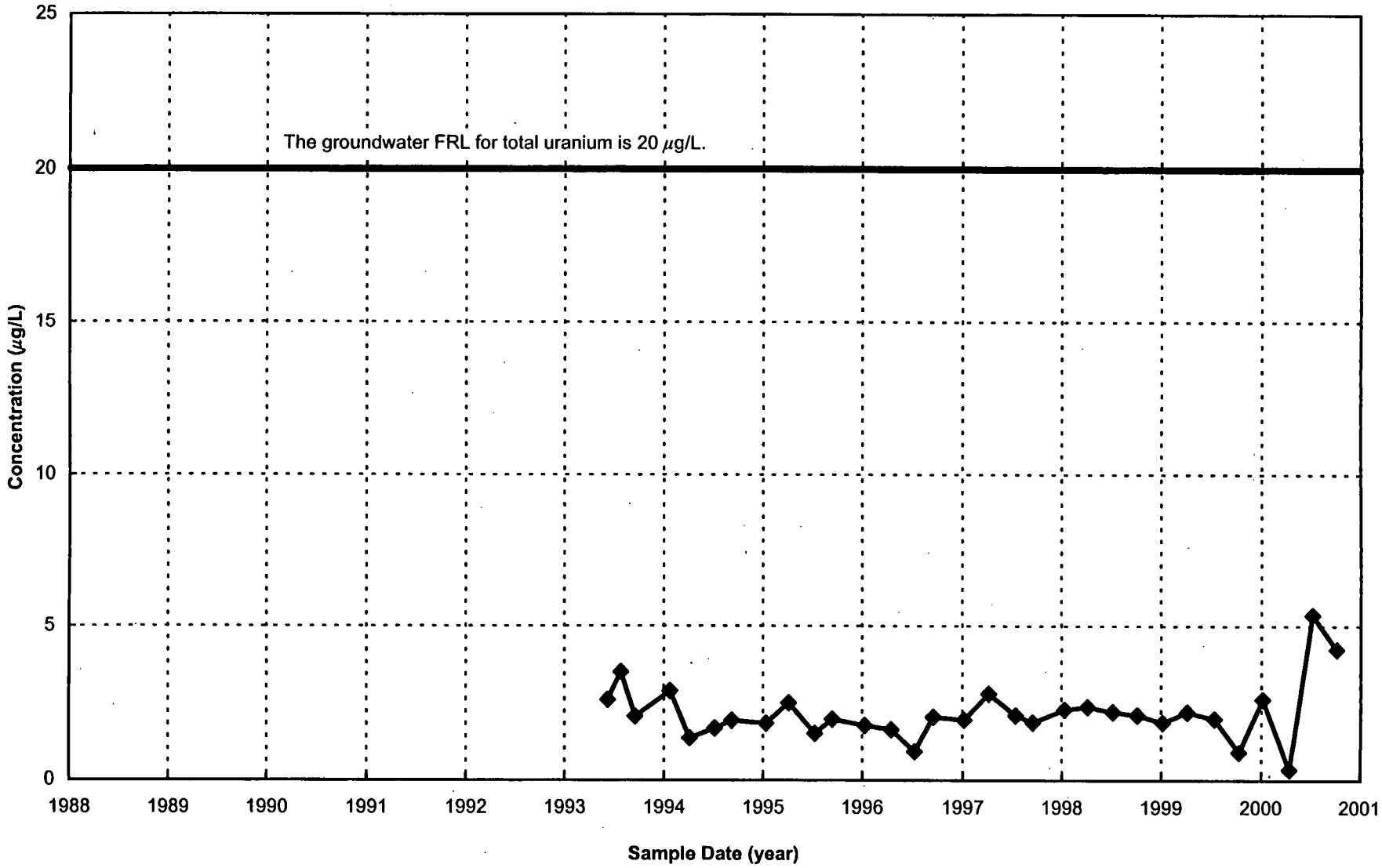


FIGURE A.2-44. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2417

000227

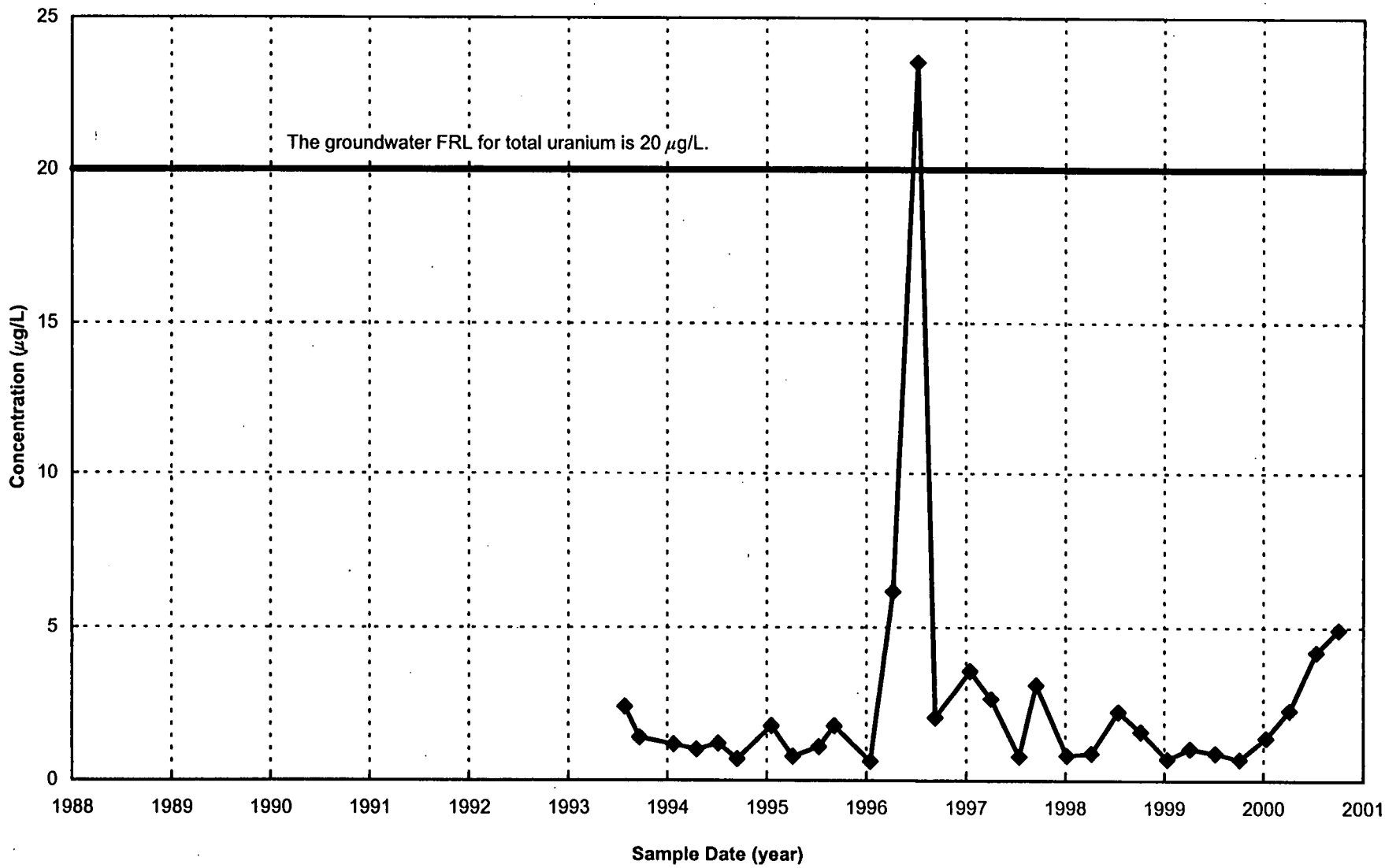


FIGURE A.2-45. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2424

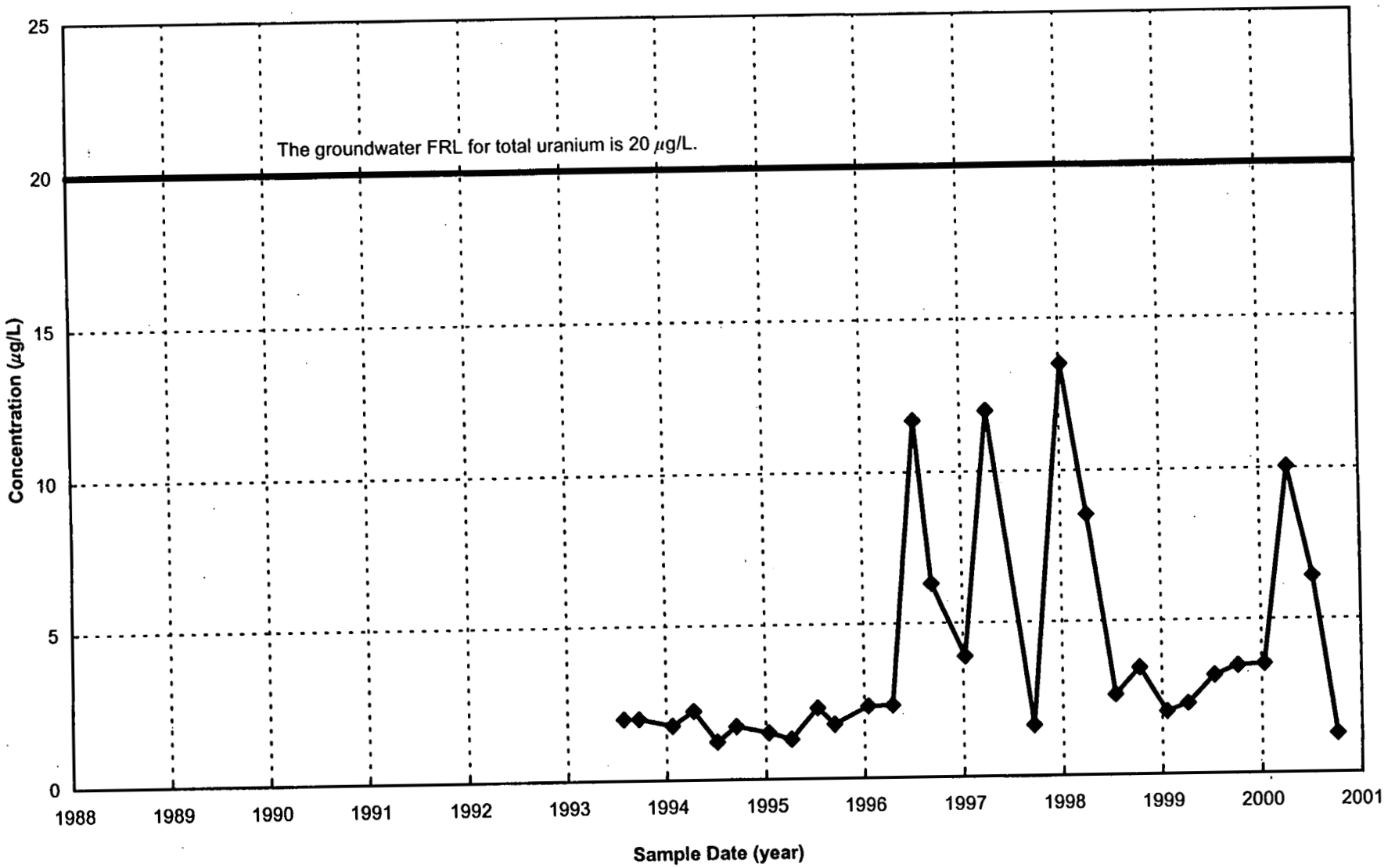


FIGURE A.2-46. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2426

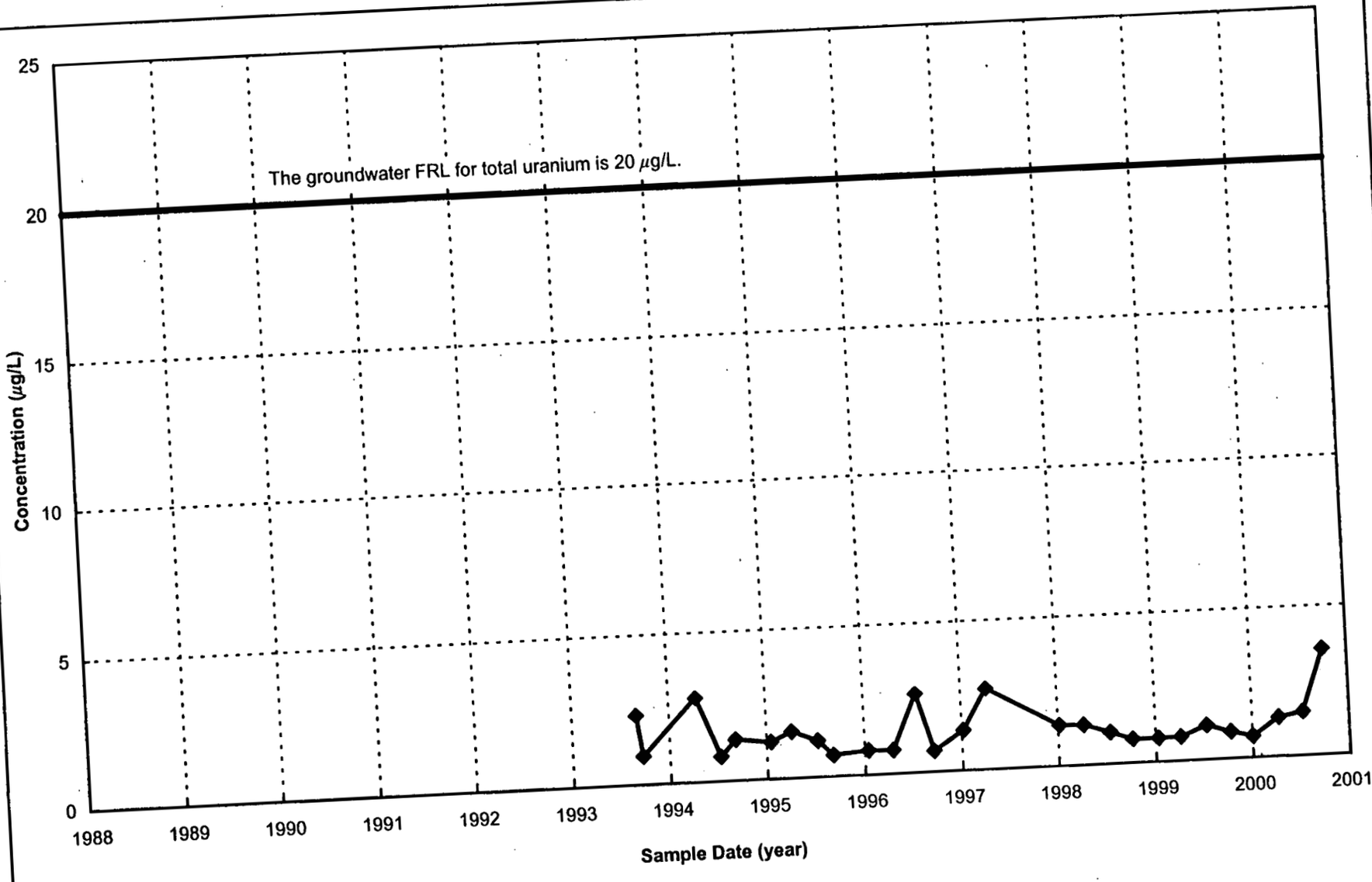


FIGURE A.2-47. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2429

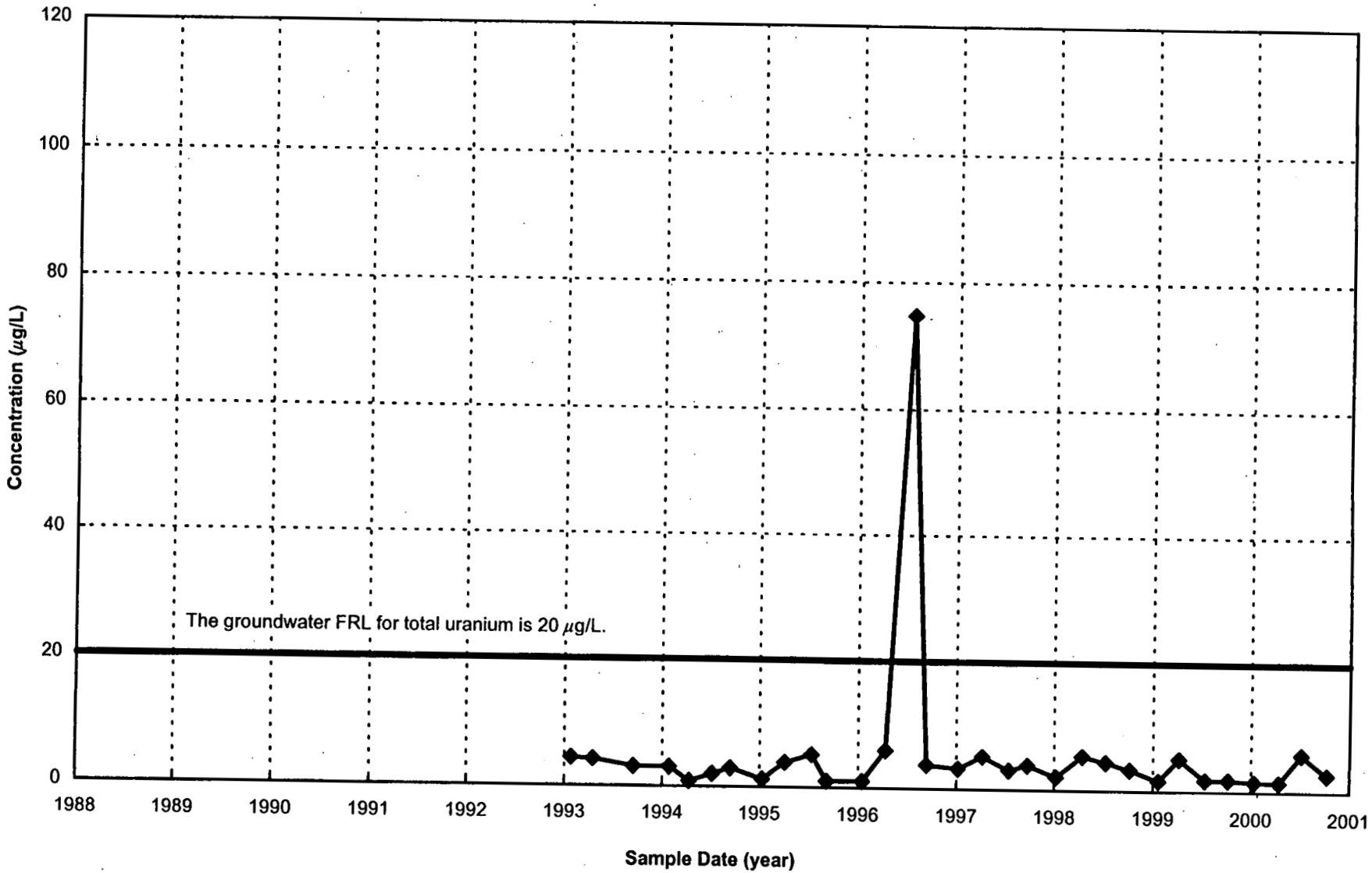


FIGURE A.2-48. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2430

000131

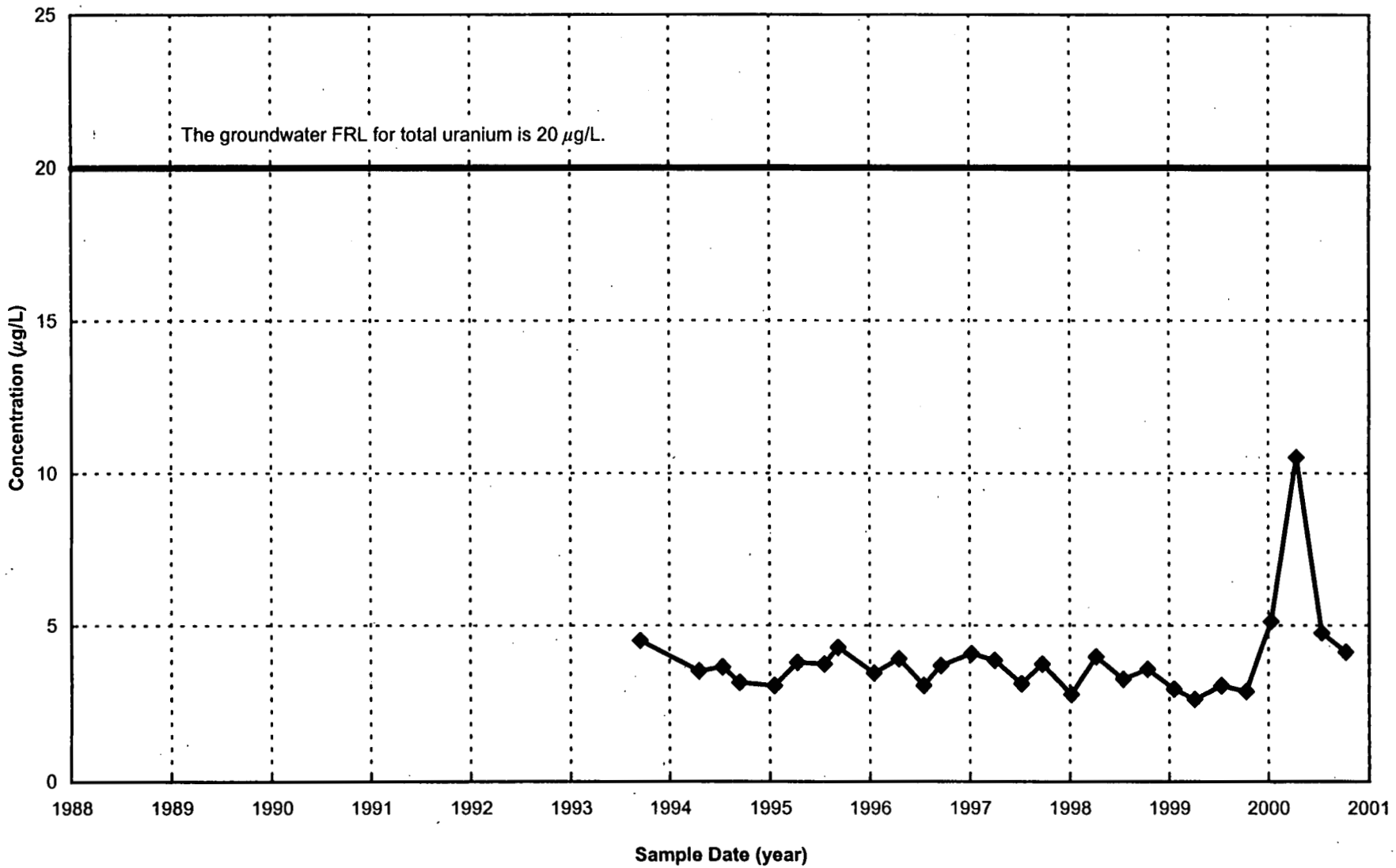


FIGURE A.2-49. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2431

0001133

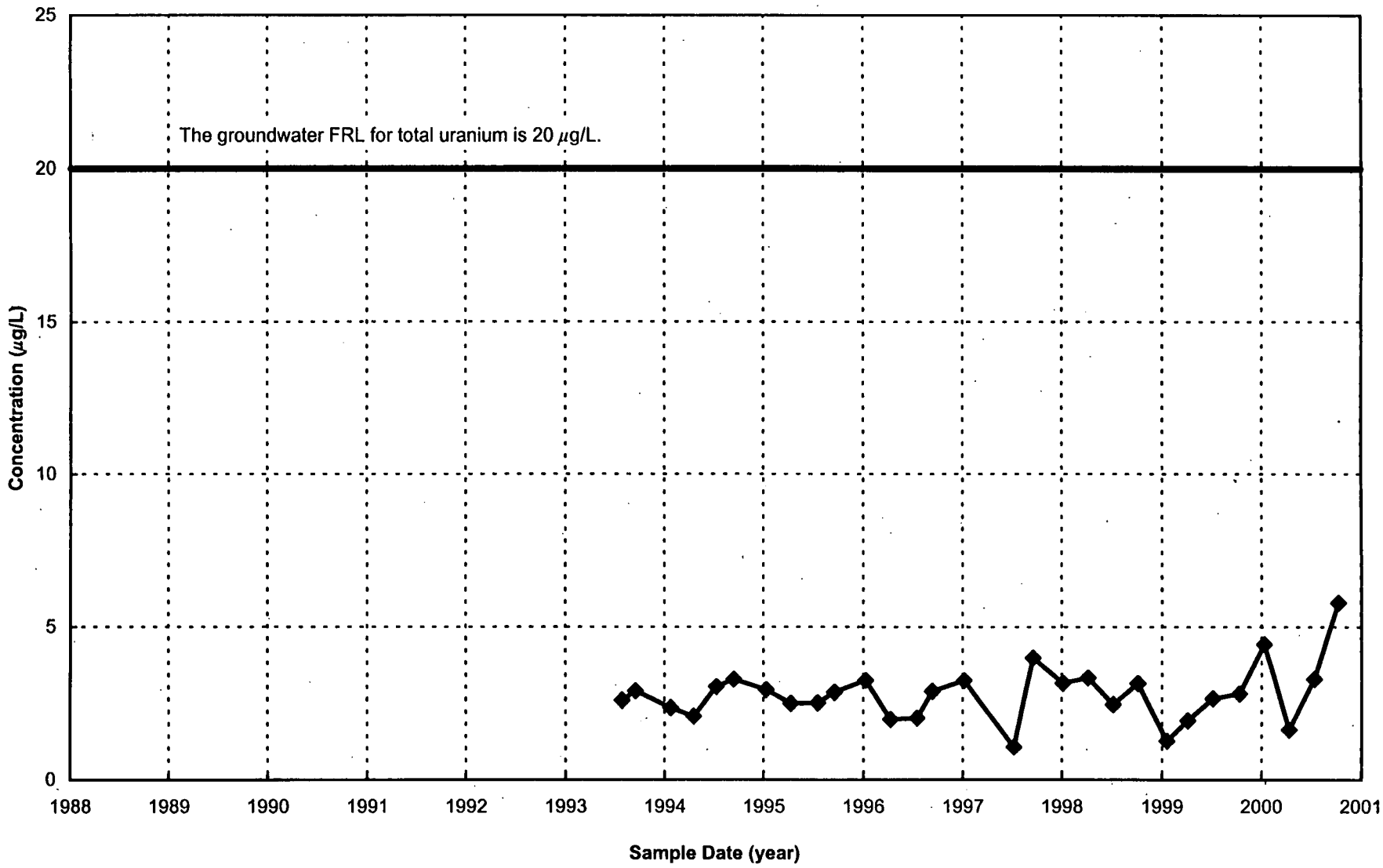


FIGURE A.2-50. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2432

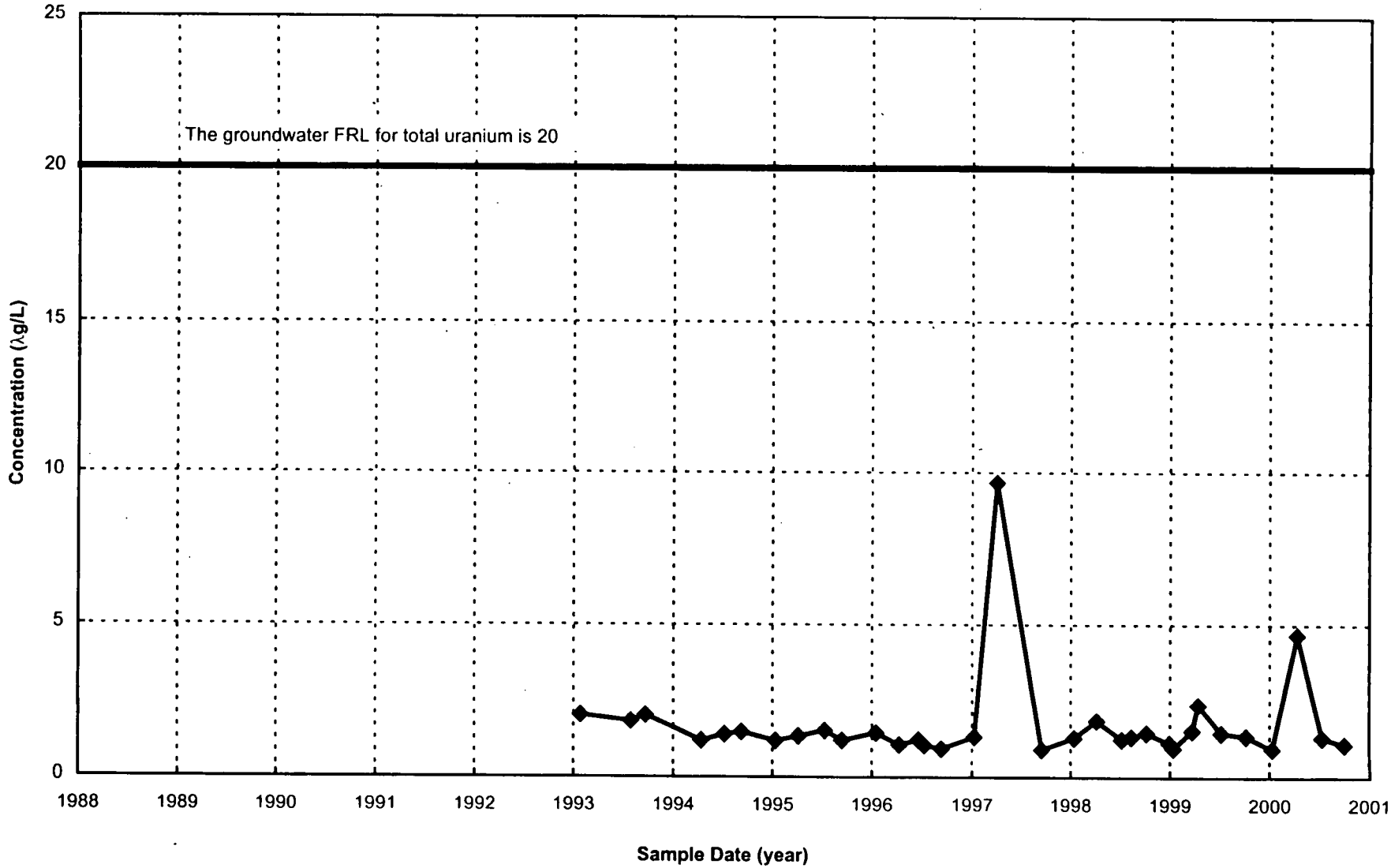


FIGURE A.2-51. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2434

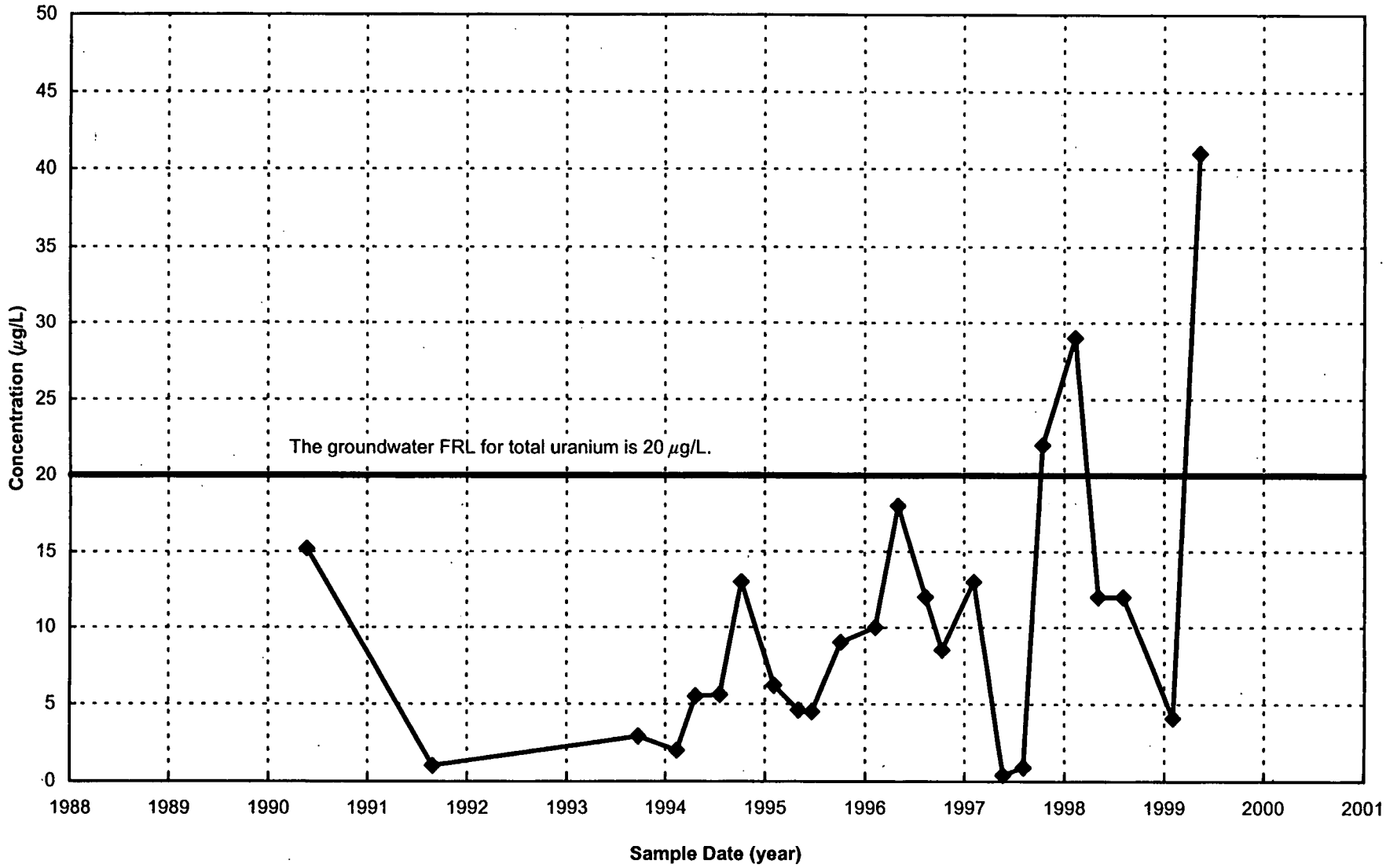


FIGURE A.2-52. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2544

000135

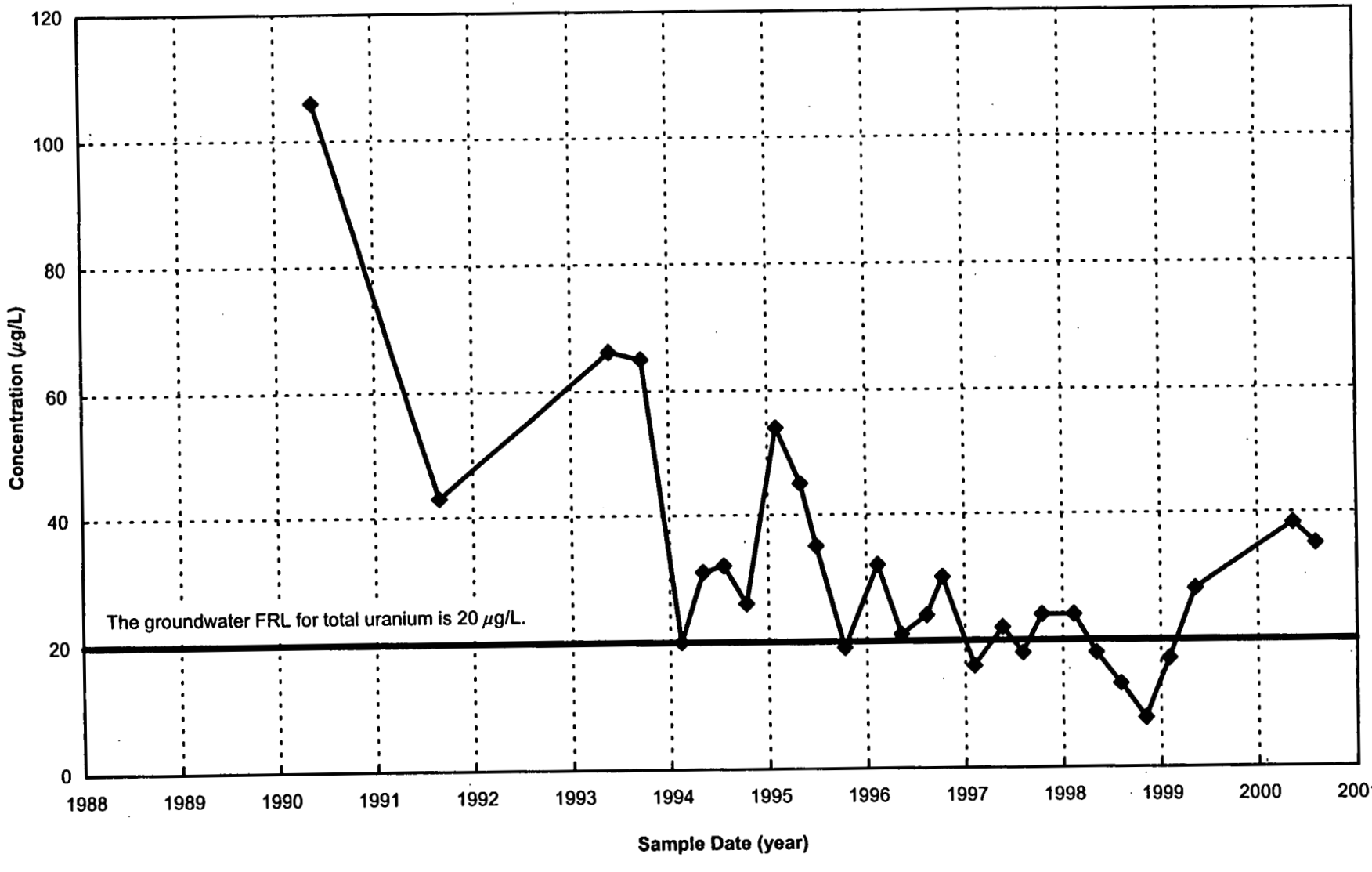


FIGURE A.2-53. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2545

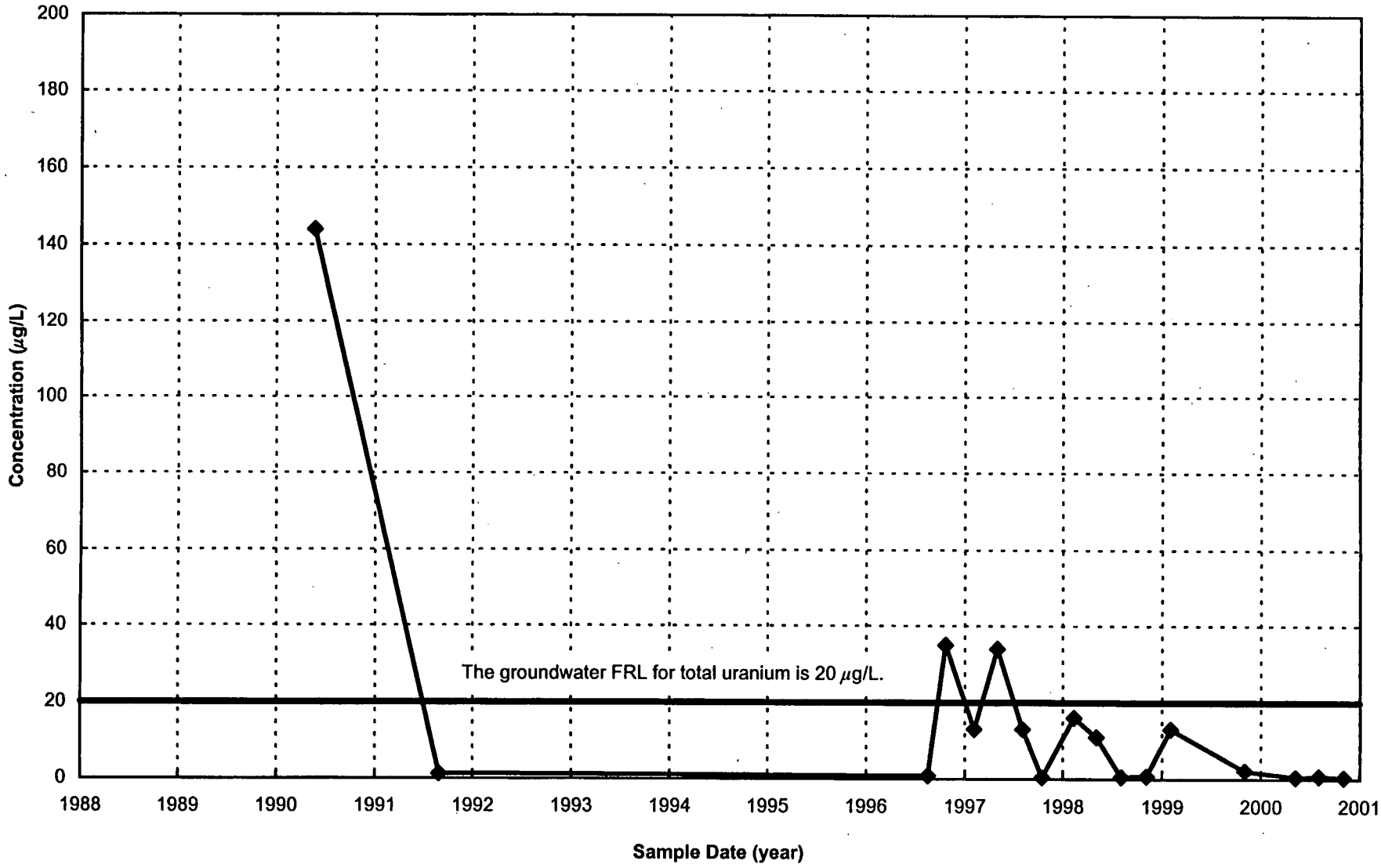


FIGURE A.2-54. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2546

001137

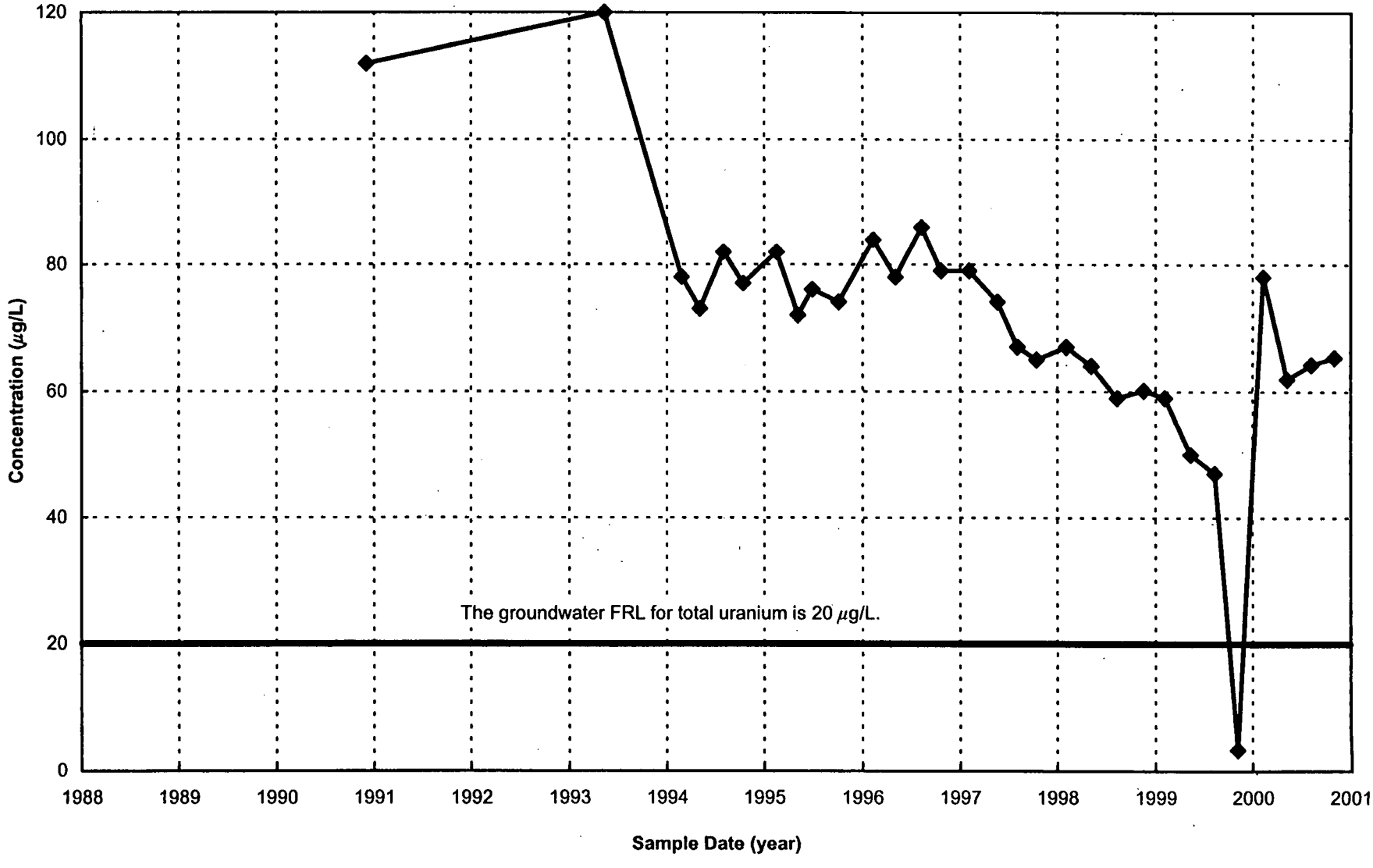


FIGURE A.2-55. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2550

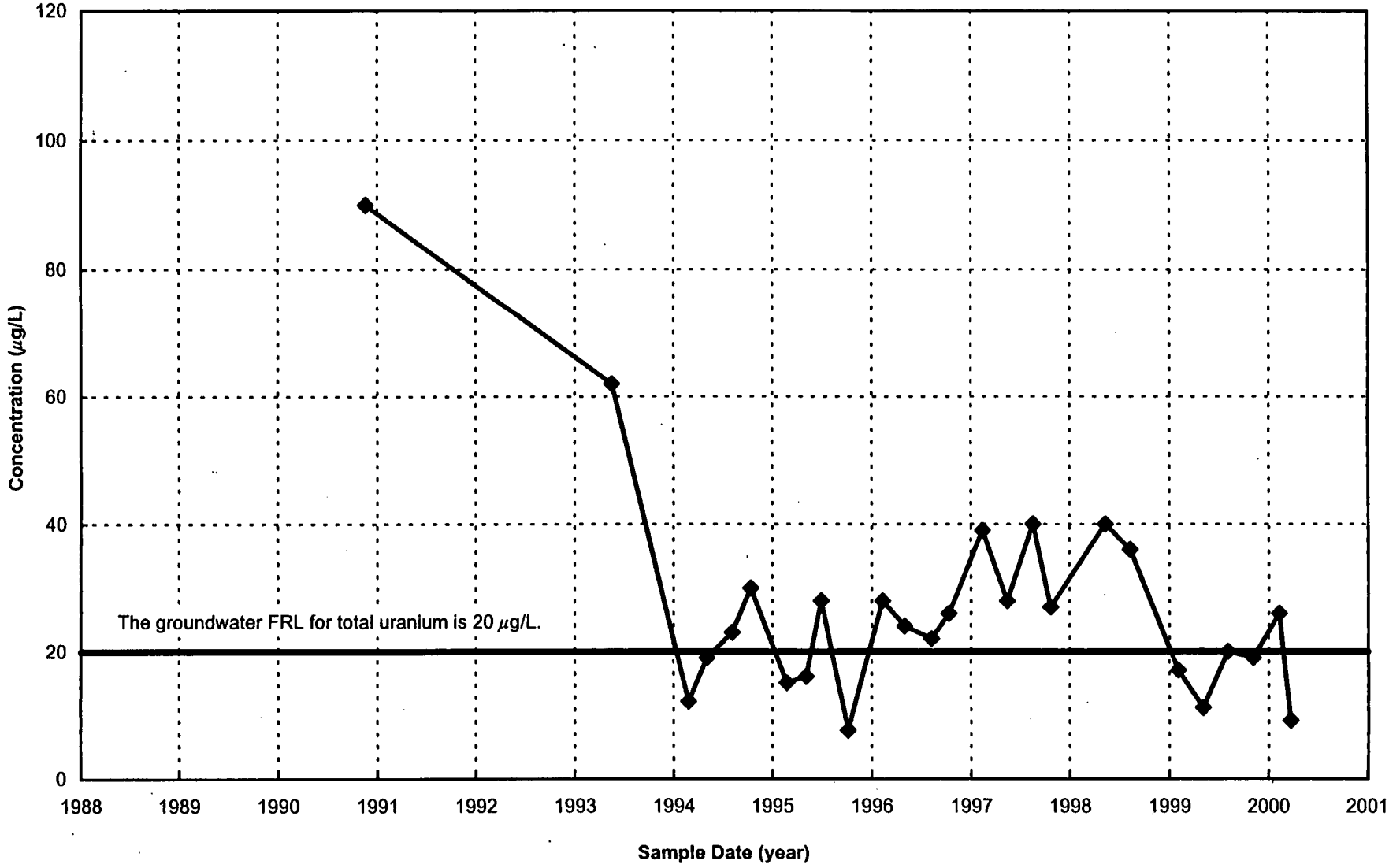


FIGURE A.2-56. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2551

000139

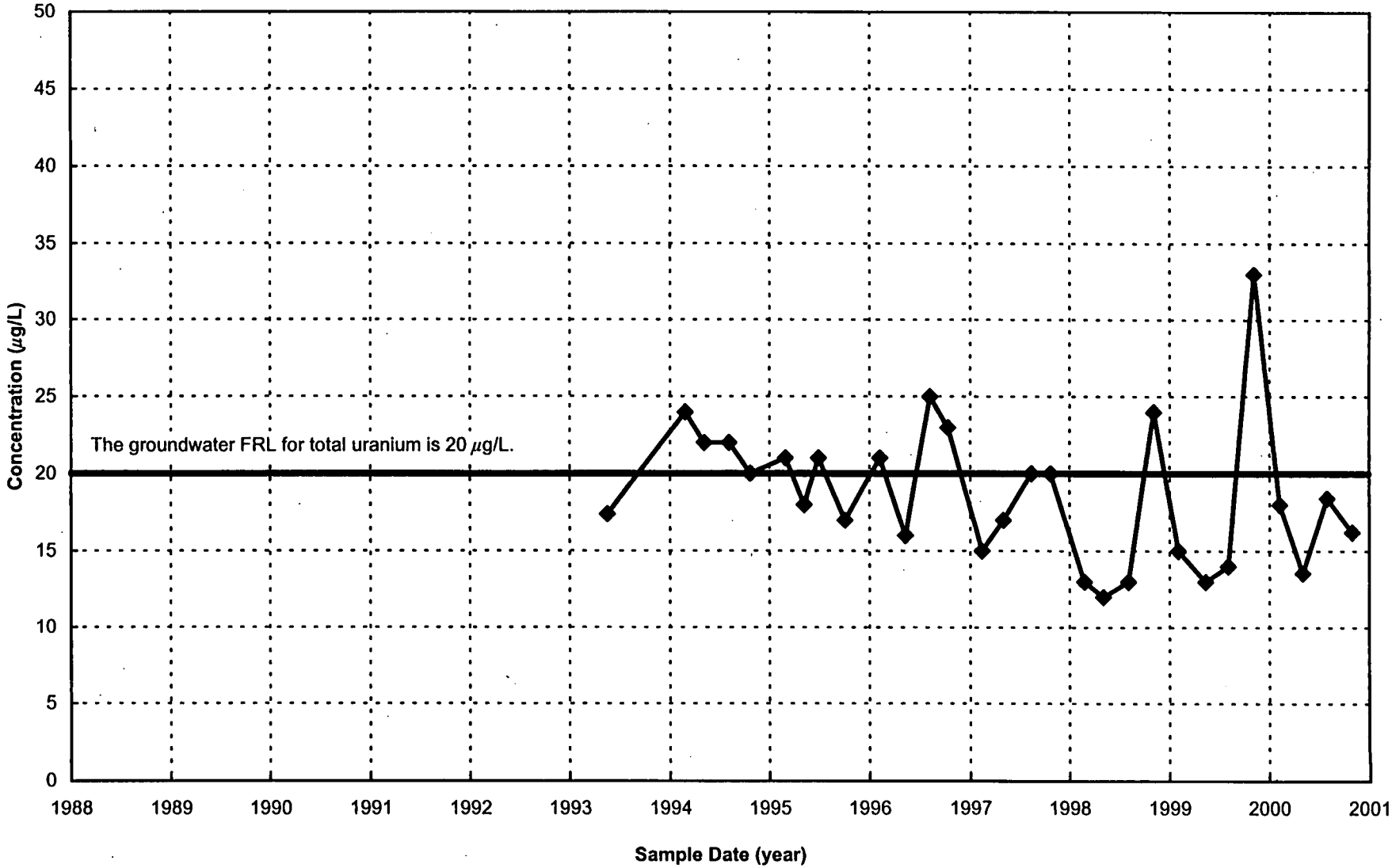


FIGURE A.2-57. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2552

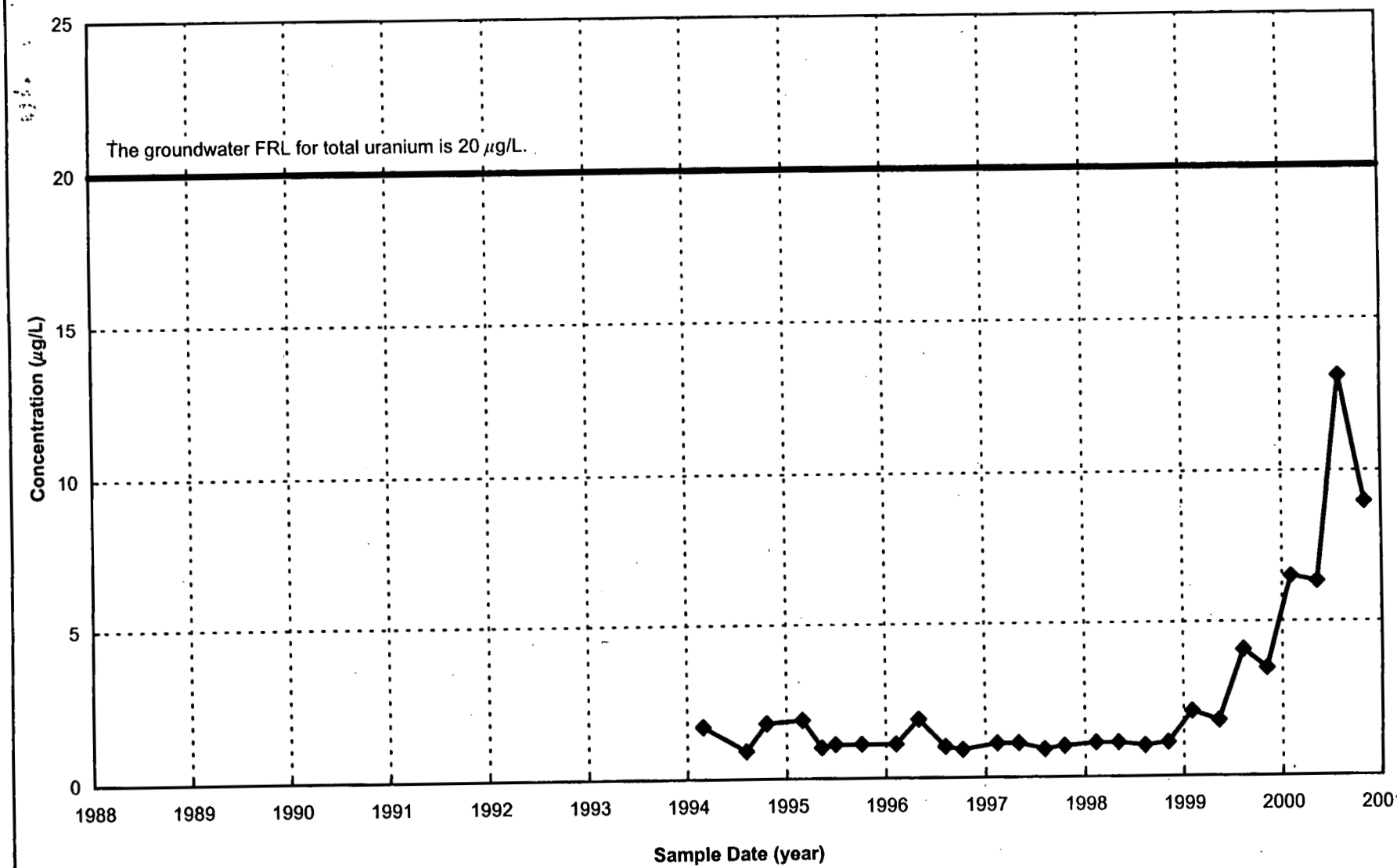


FIGURE A.2-58. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2553

000141

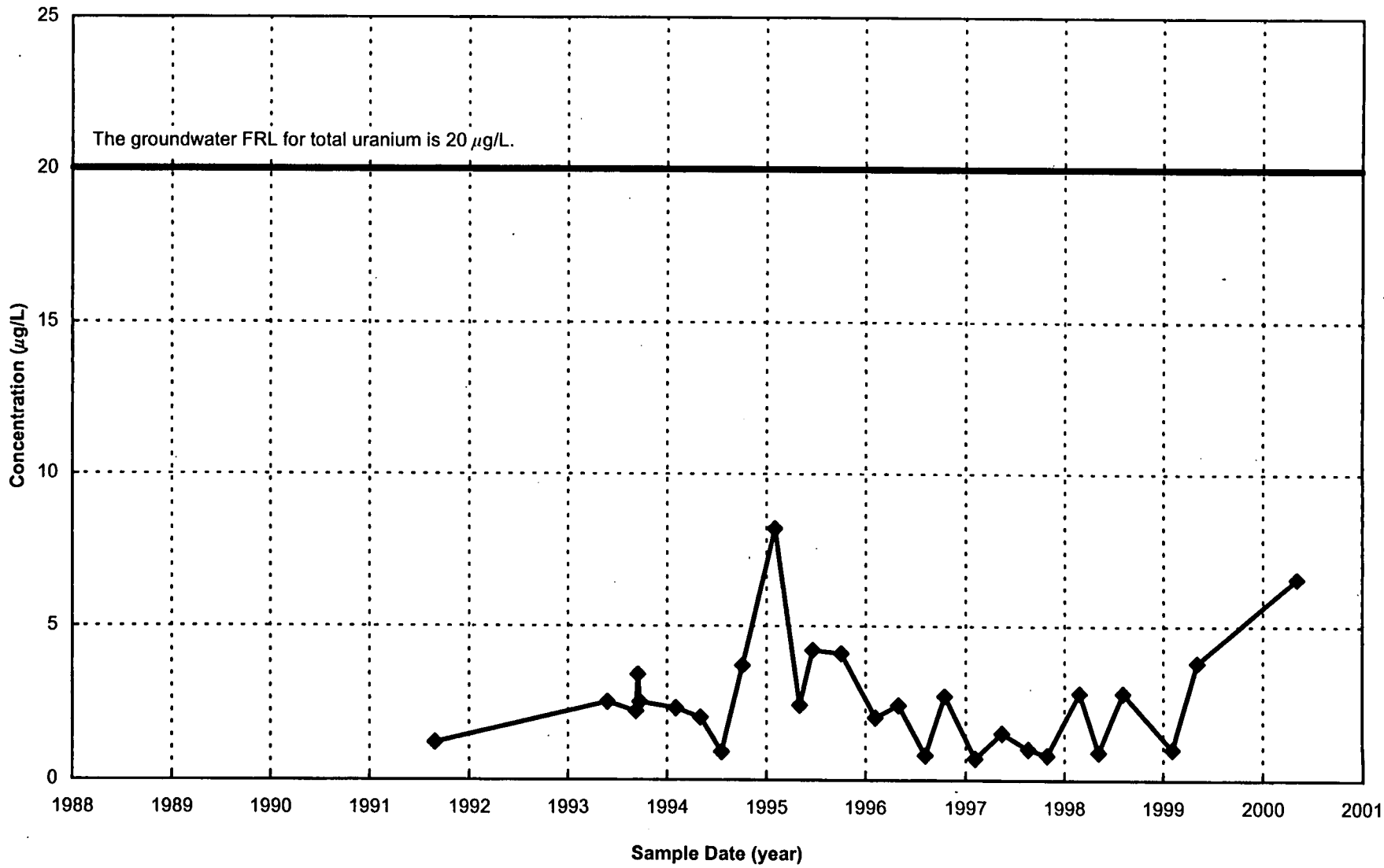


FIGURE A.2-59. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2625

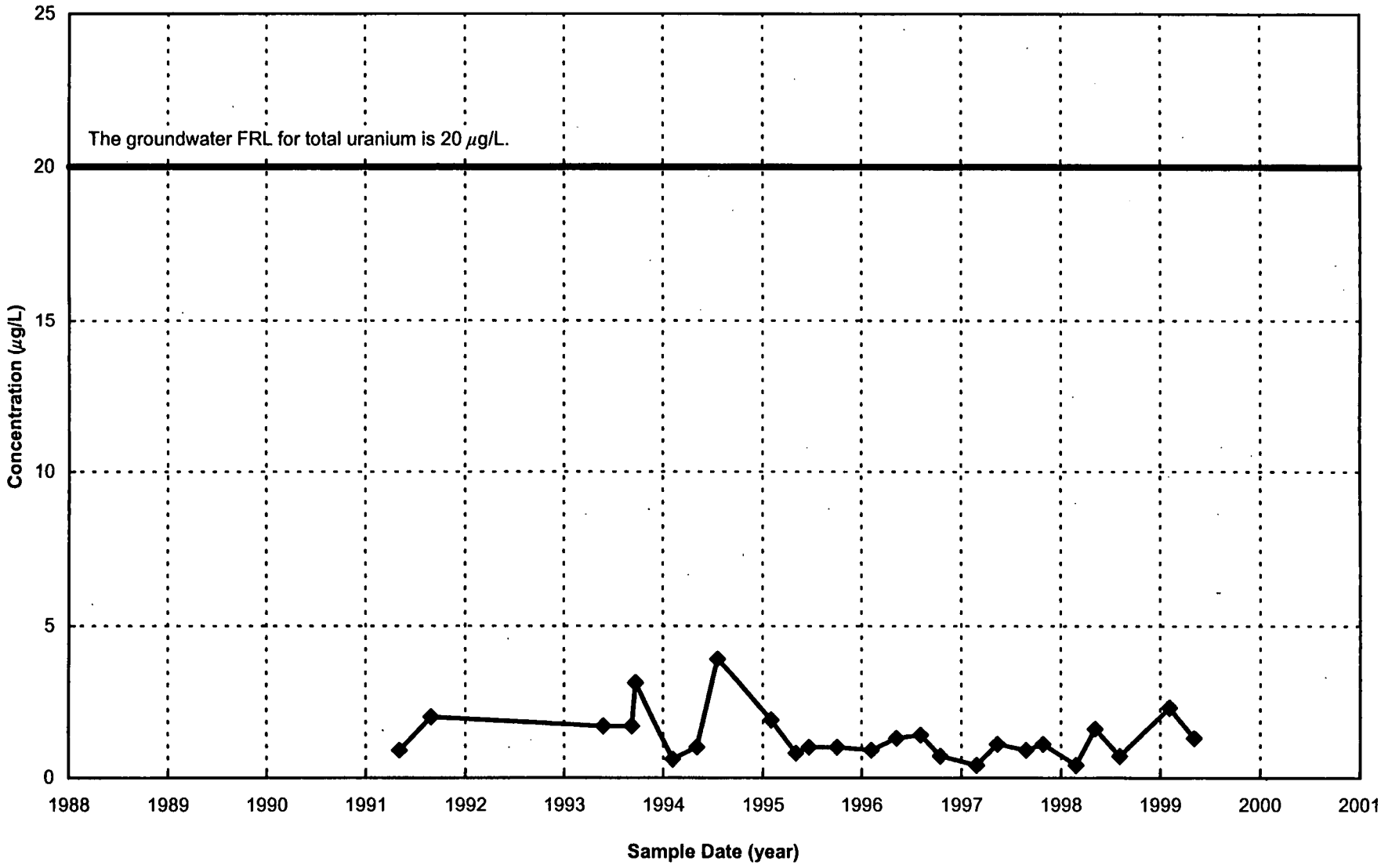


FIGURE A.2-60. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2636

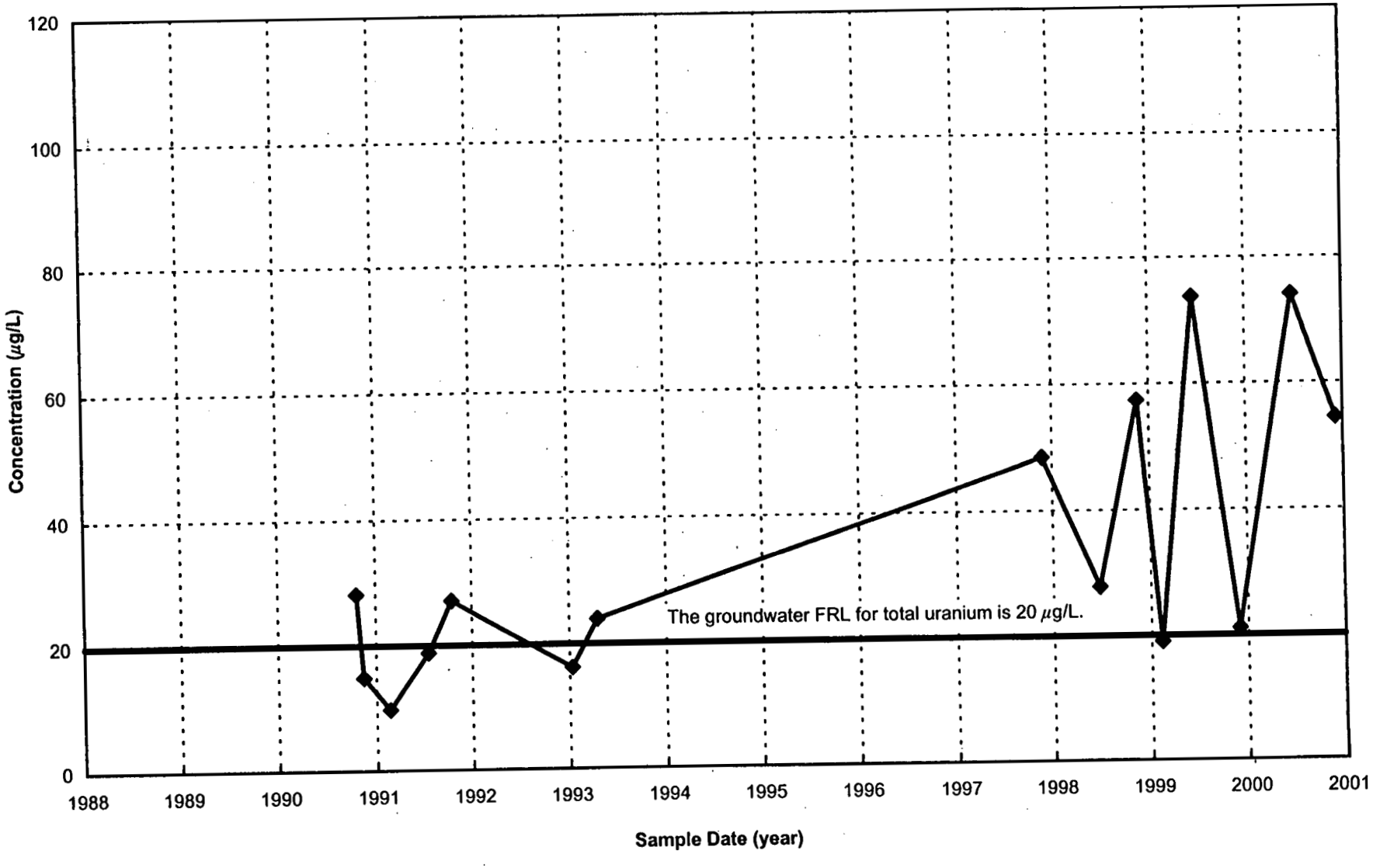


FIGURE A.2-61. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2648

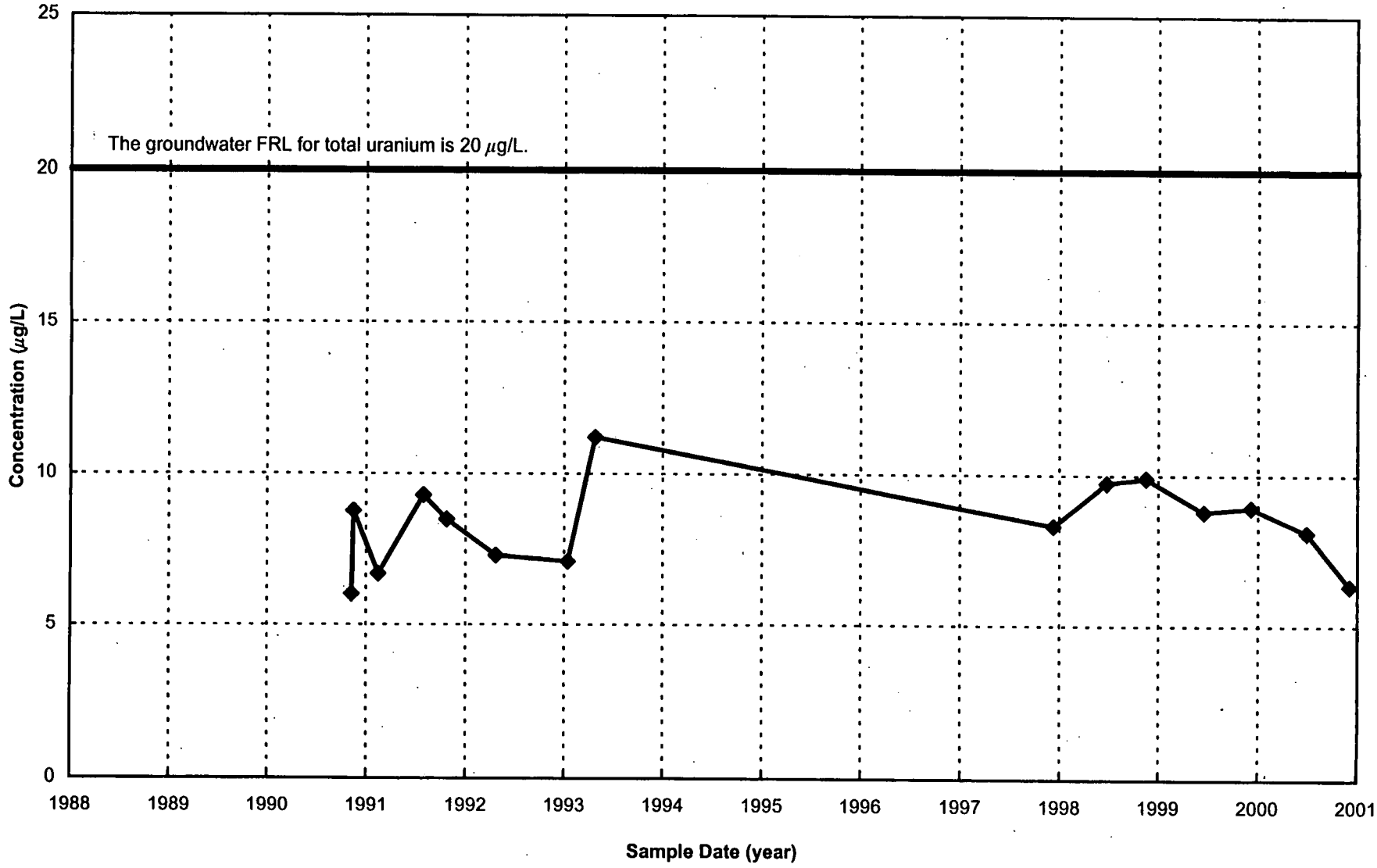


FIGURE A.2-62. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2649

000145

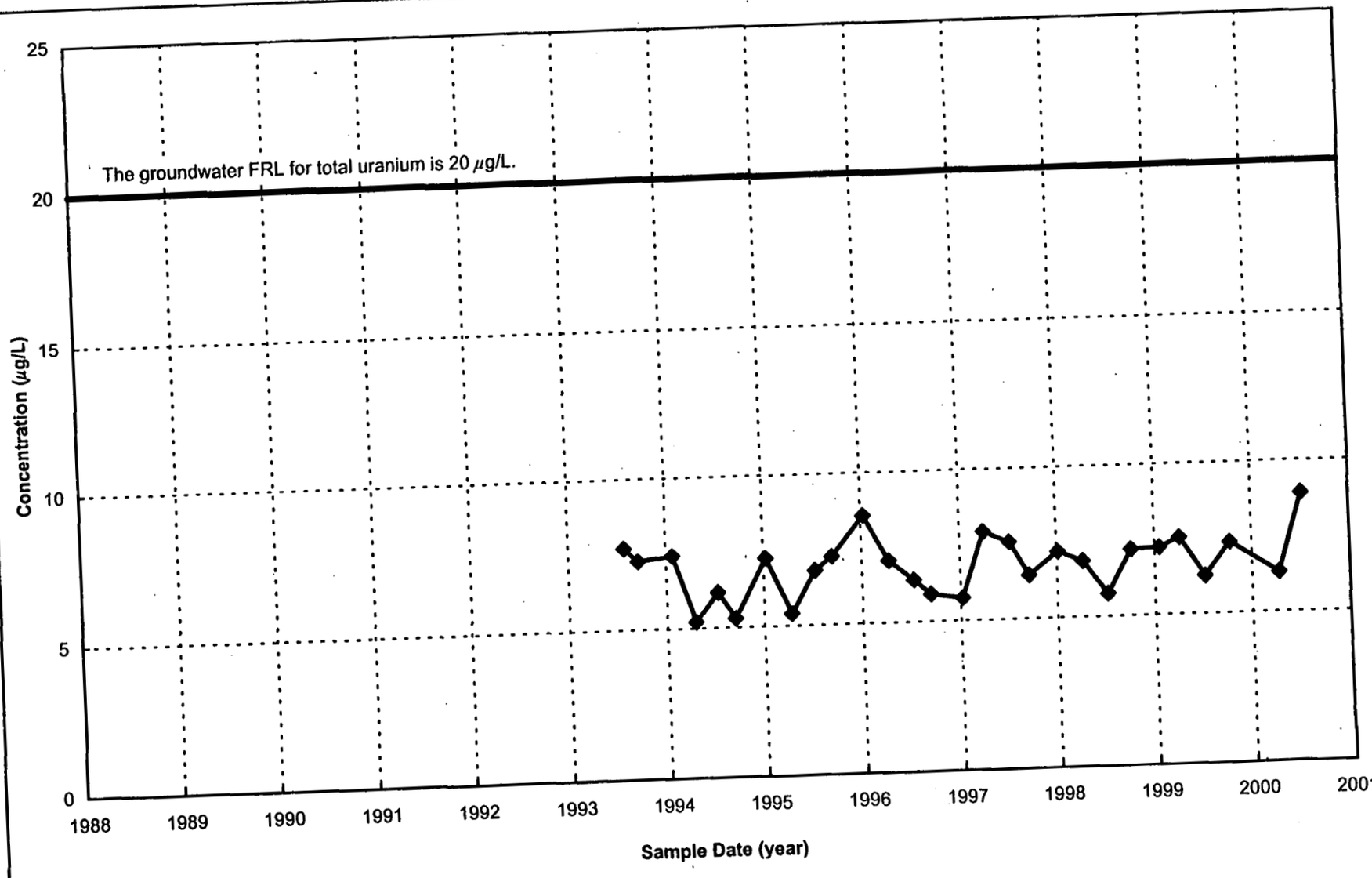


FIGURE A.2-63. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2733

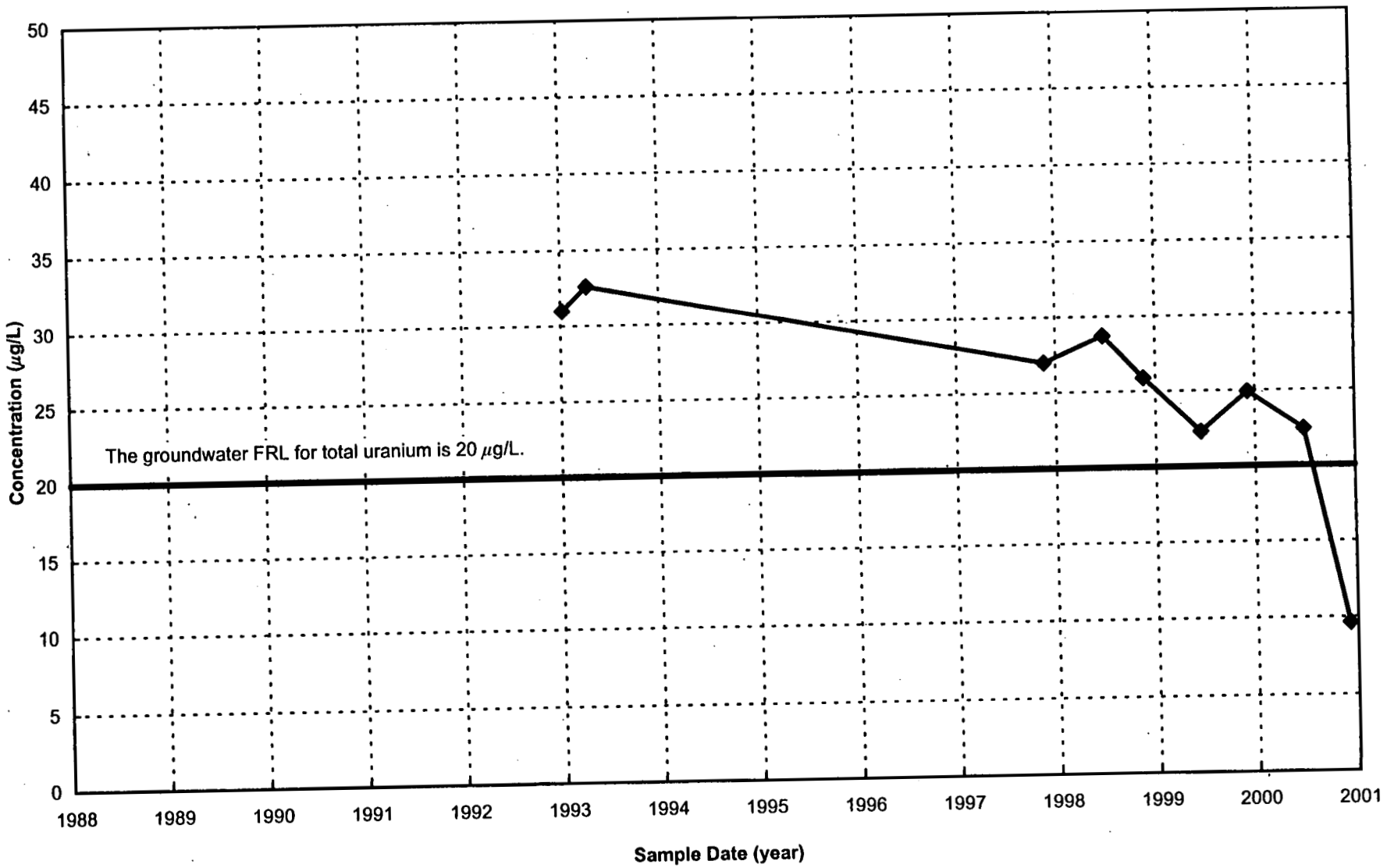


FIGURE A.2-64. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2821

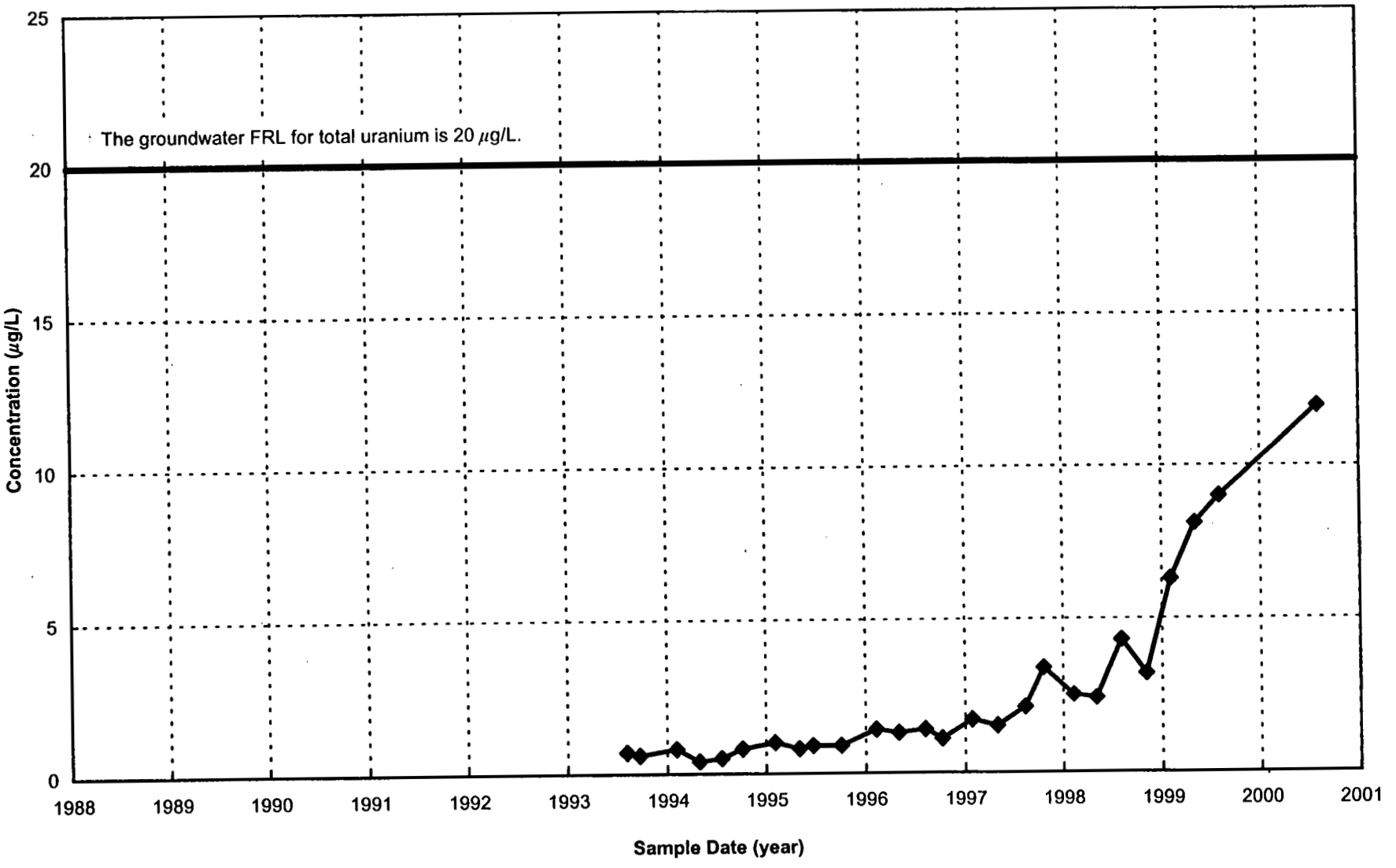


FIGURE A.2-65. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2880

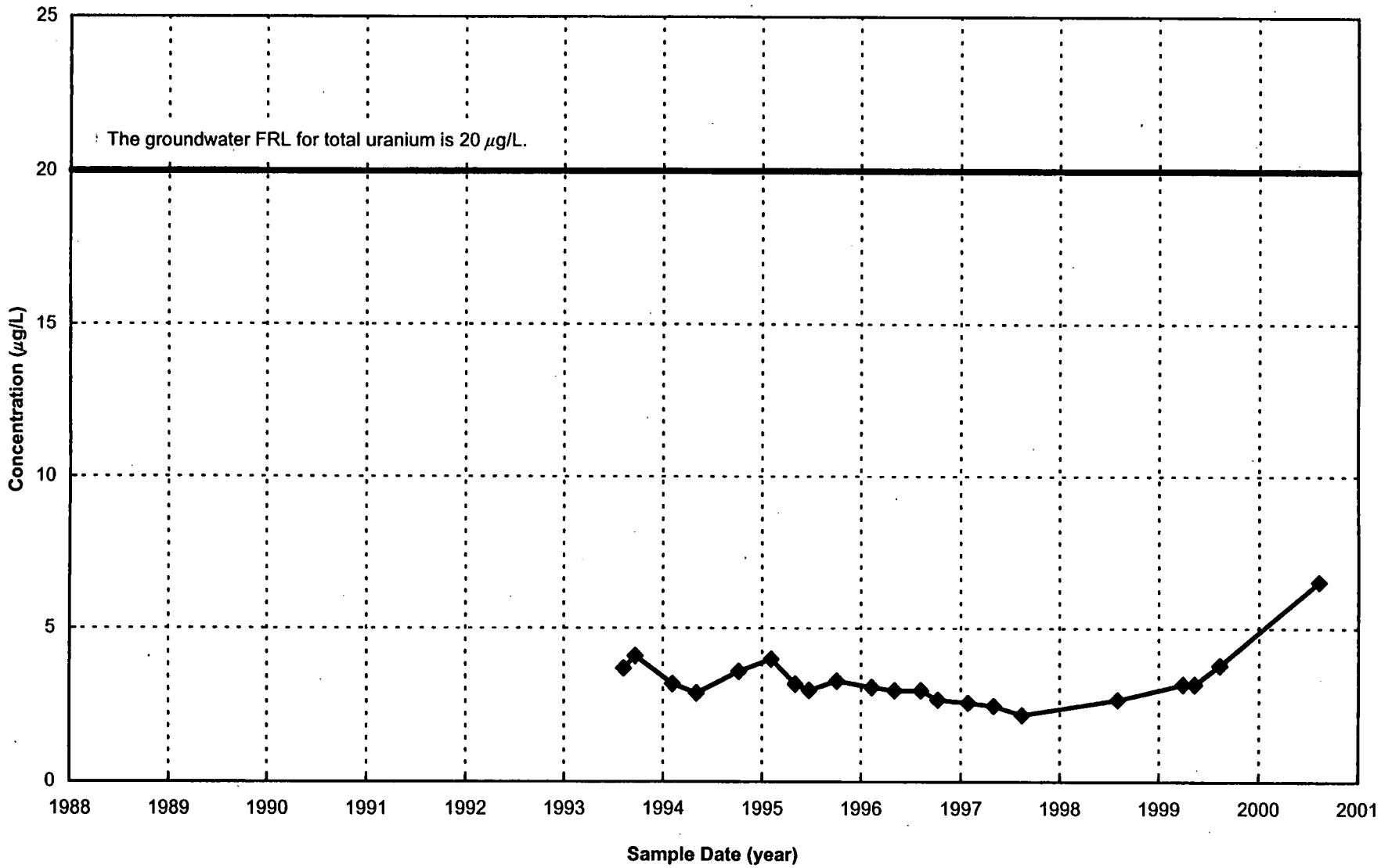


FIGURE A.2-66. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2881

000149

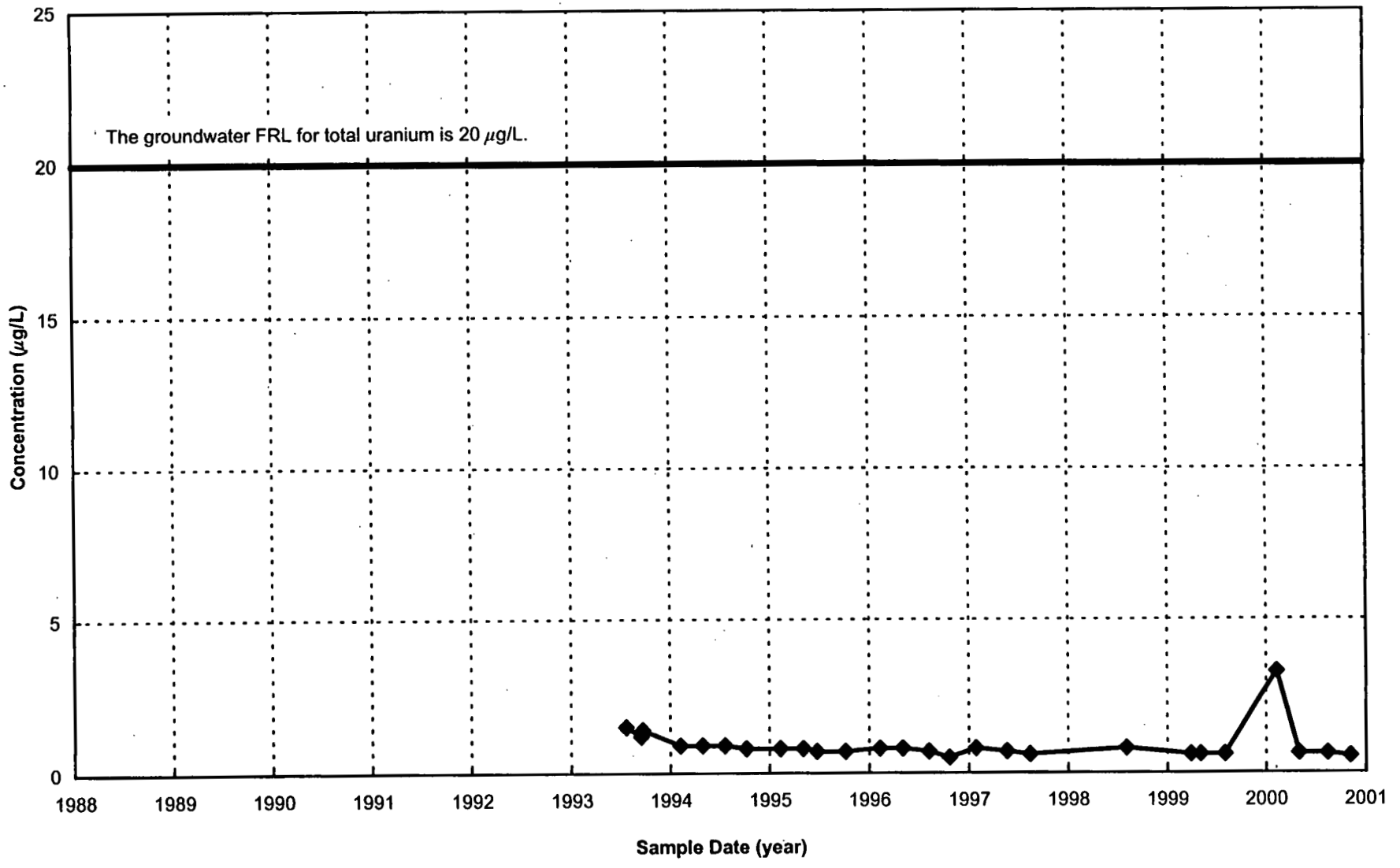


FIGURE A.2-67. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2897

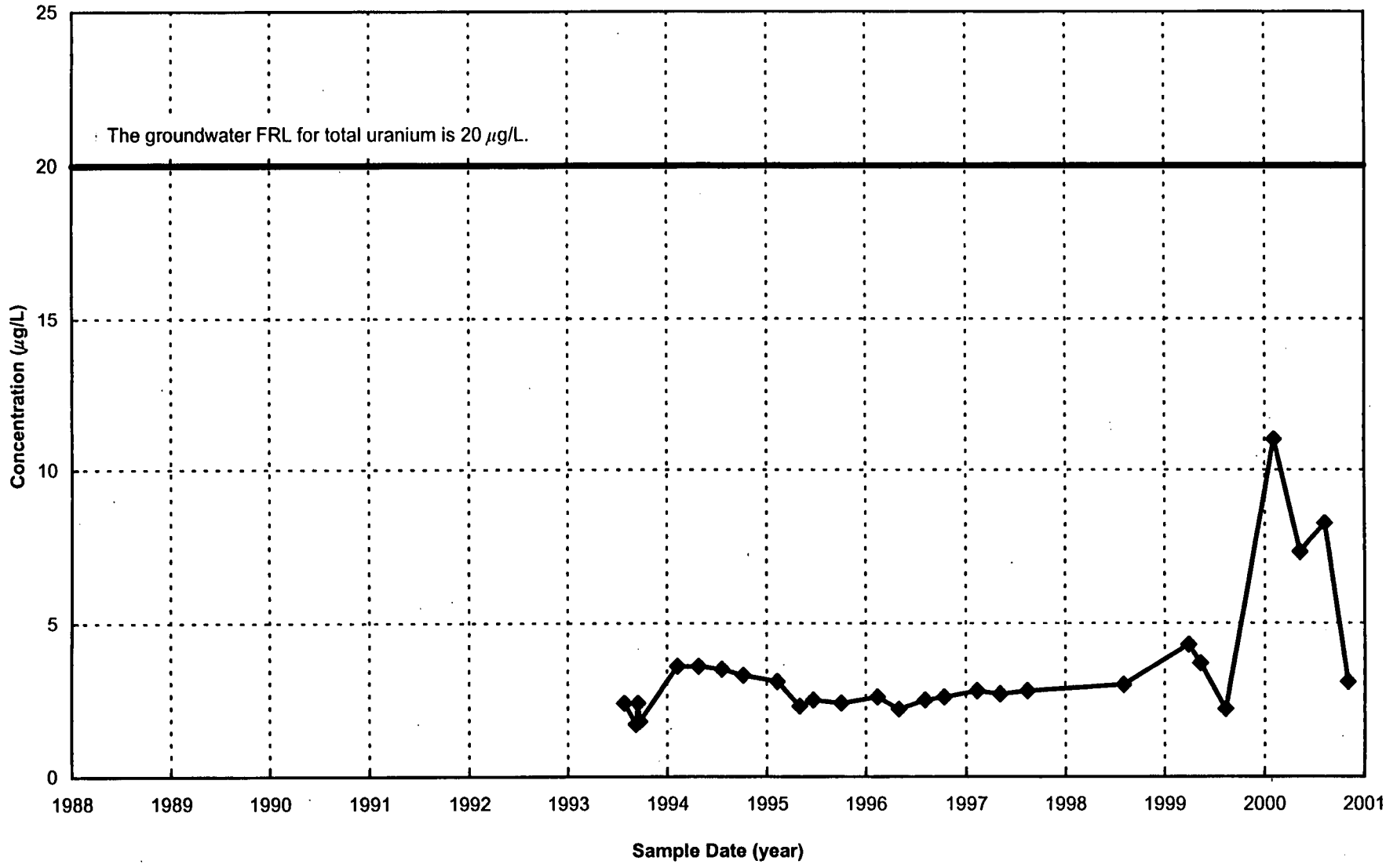


FIGURE A.2-68. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2898

000151

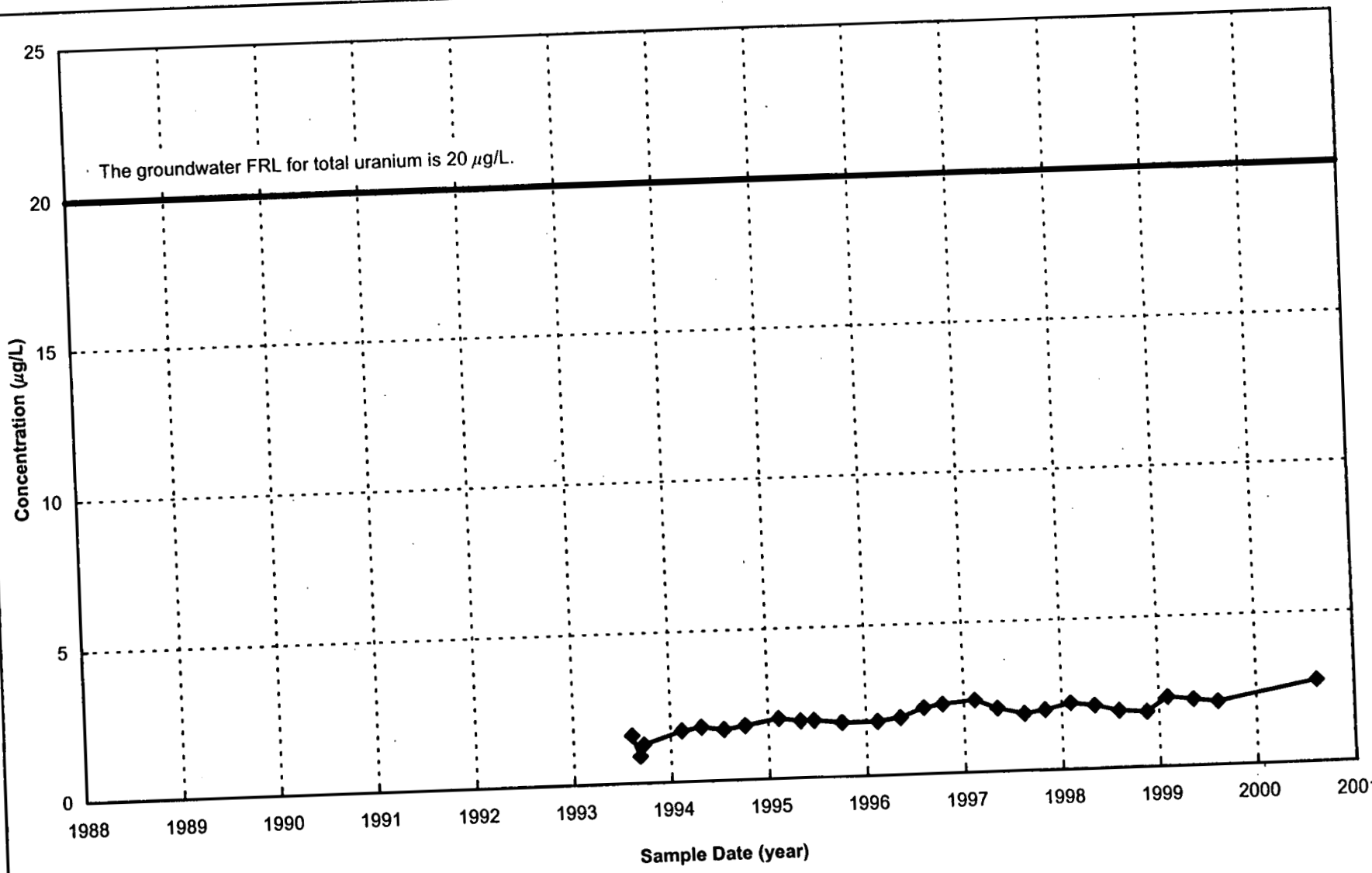


FIGURE A.2-69. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2899

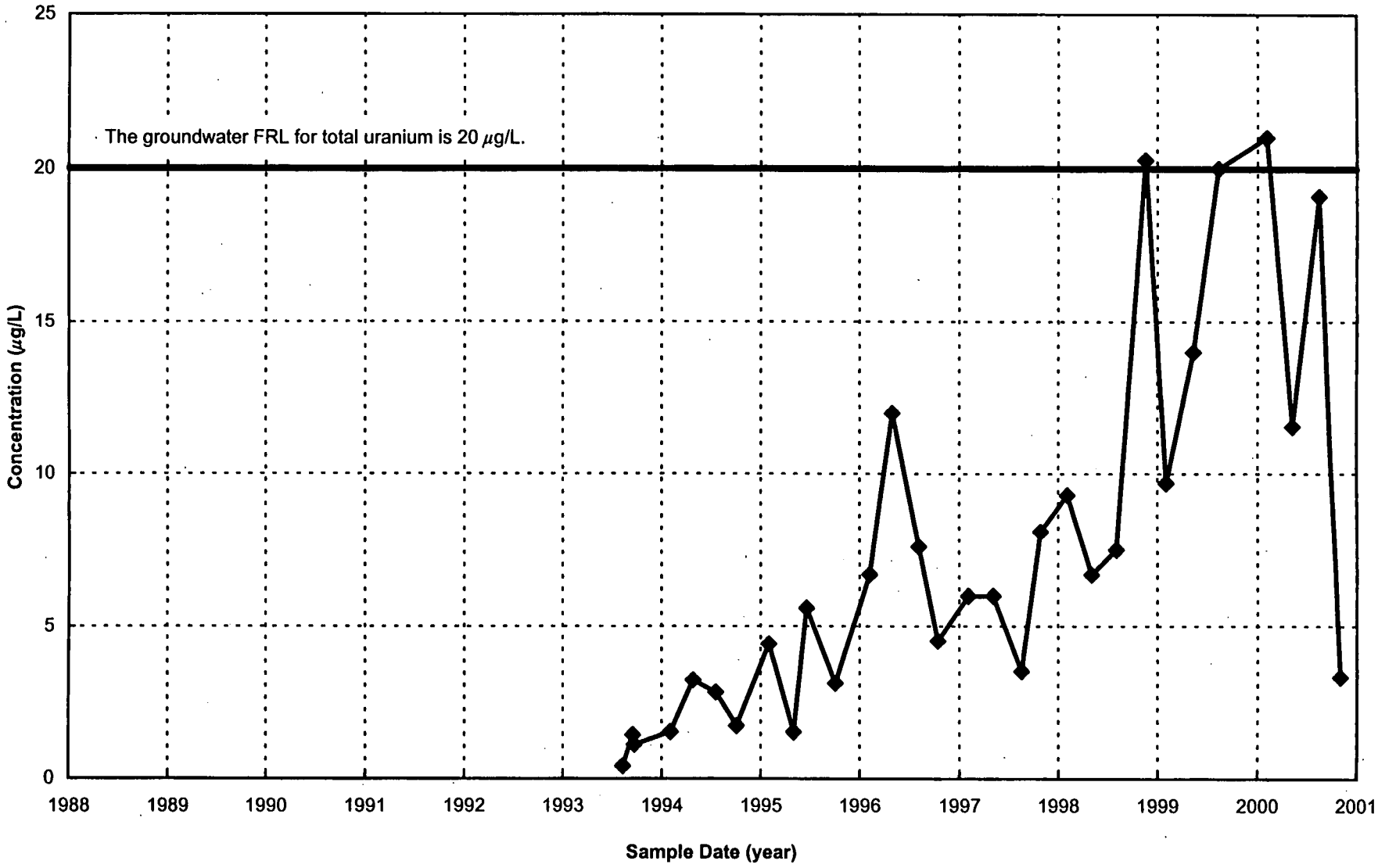


FIGURE A.2-70. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2900

000153

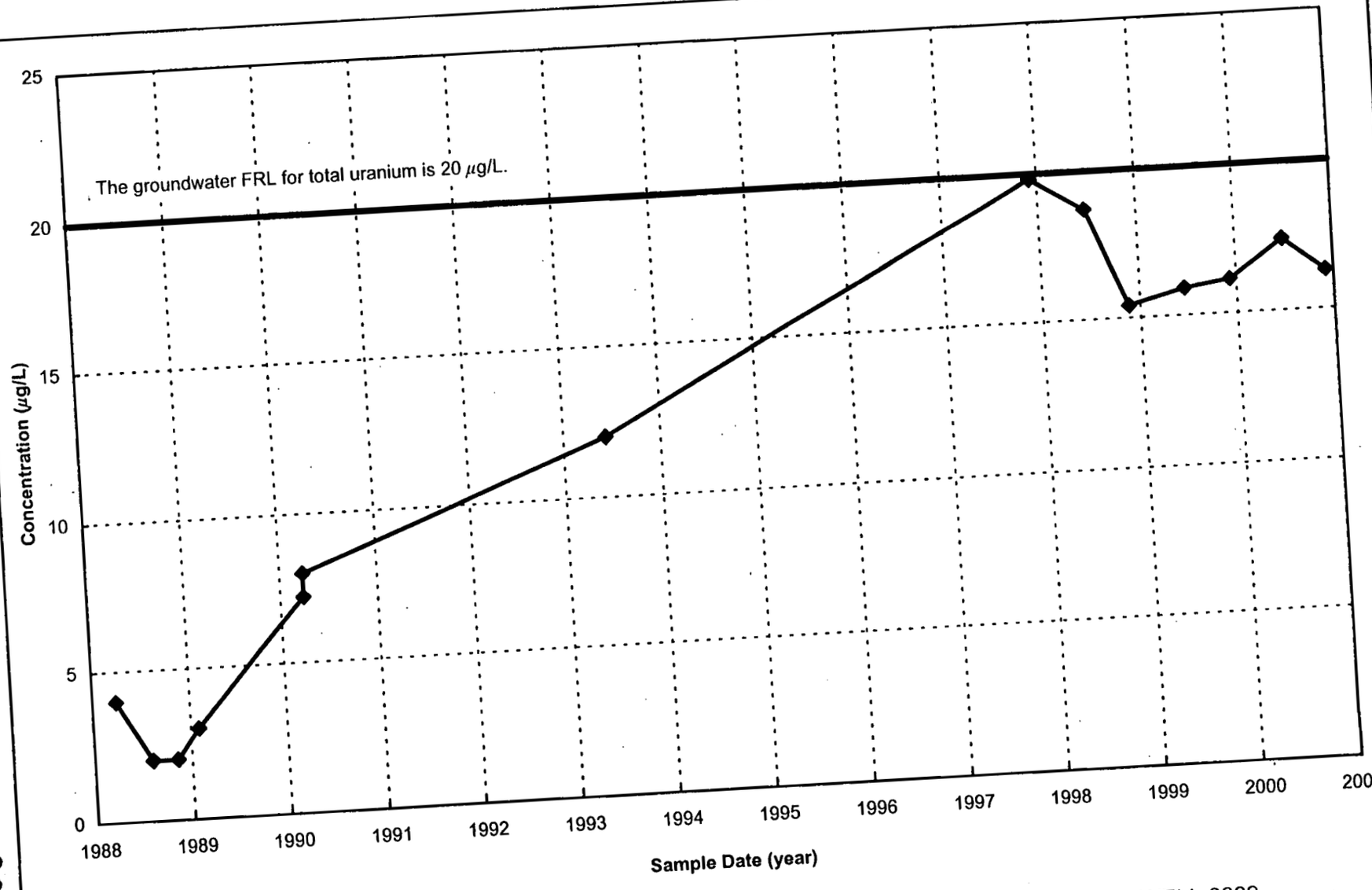


FIGURE A.2-71. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3009

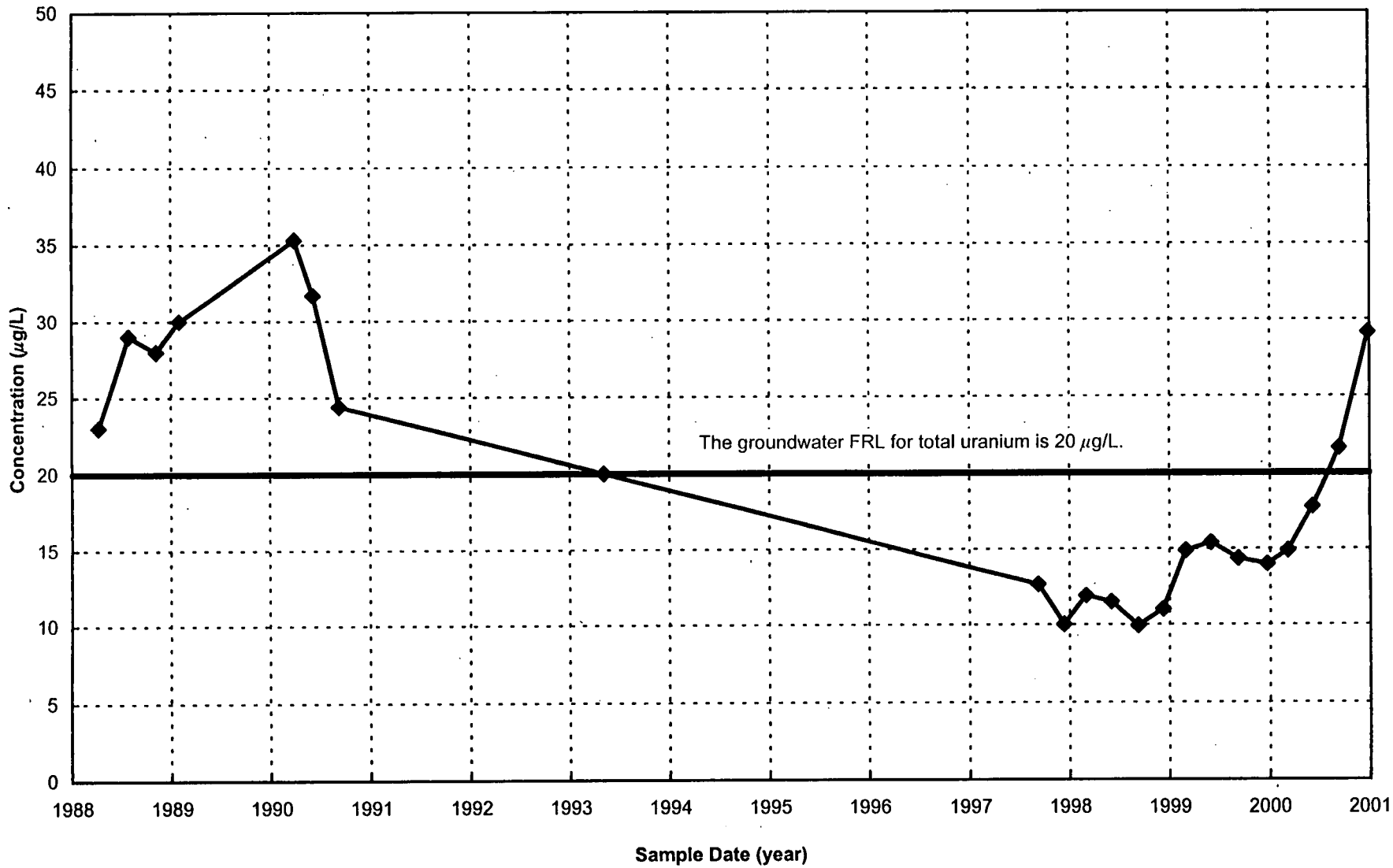


FIGURE A.2-72. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3014

0001155

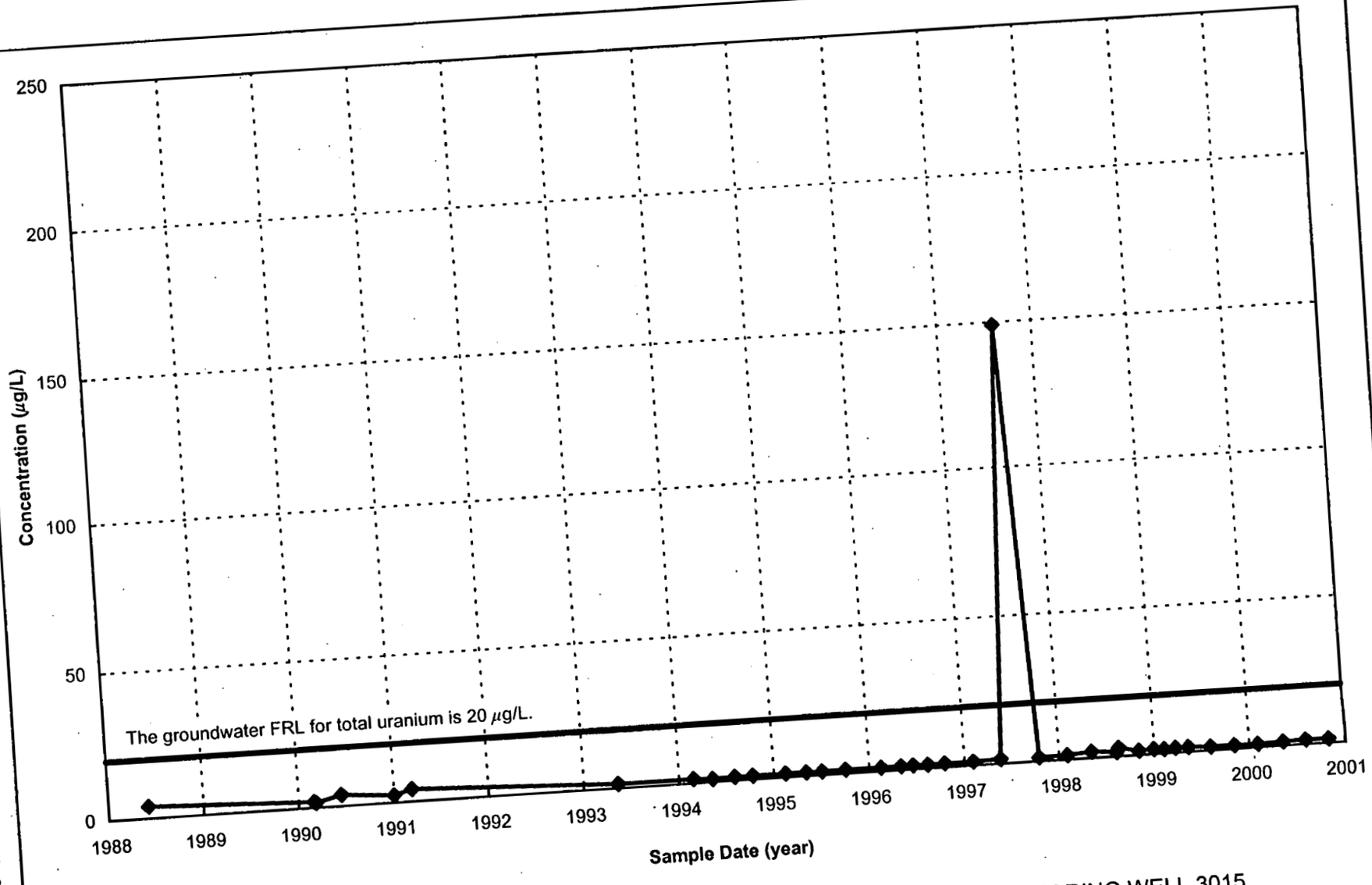


FIGURE A.2-73. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3015

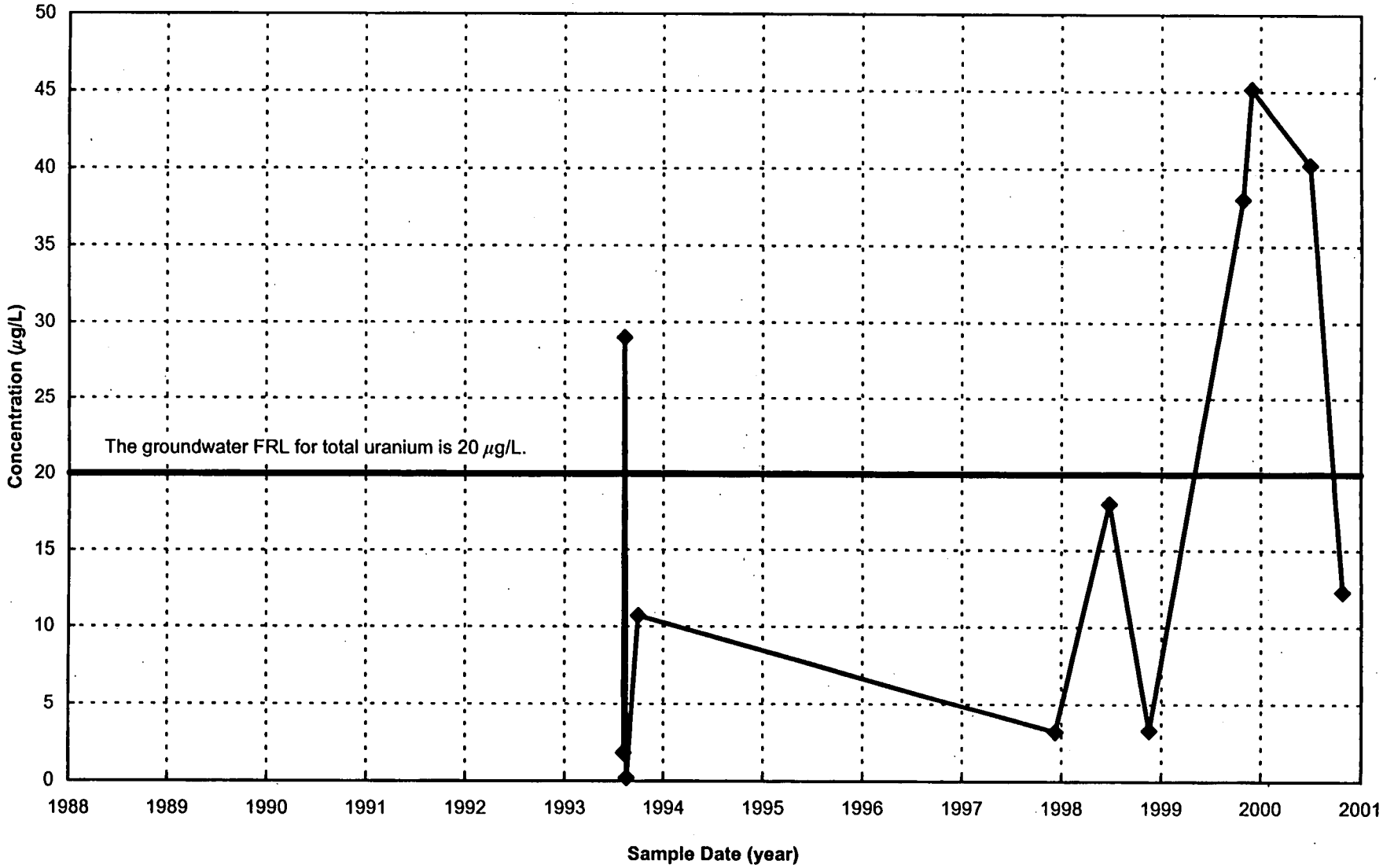


FIGURE A.2-74. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3027

000157

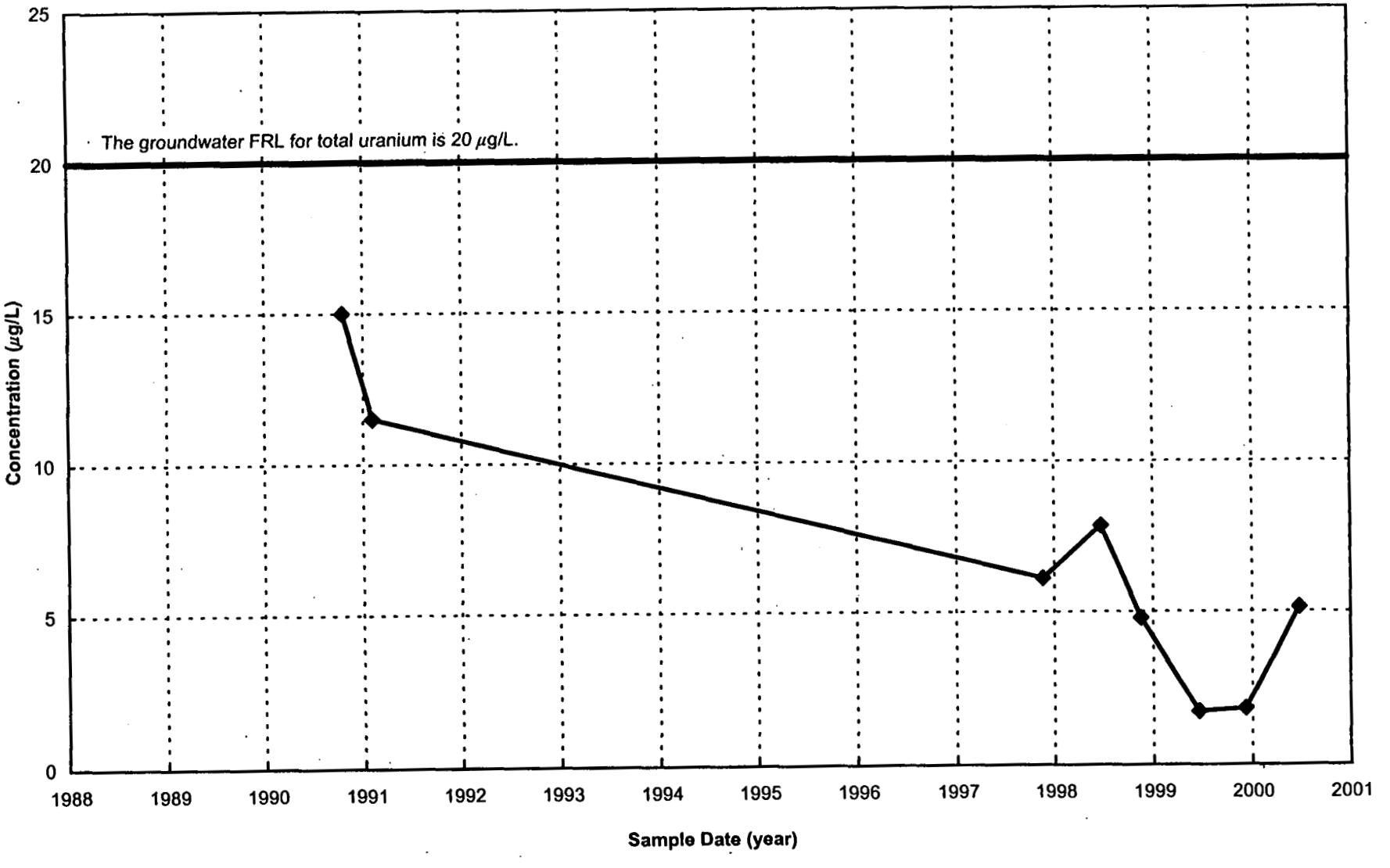


FIGURE A.2-75. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3032

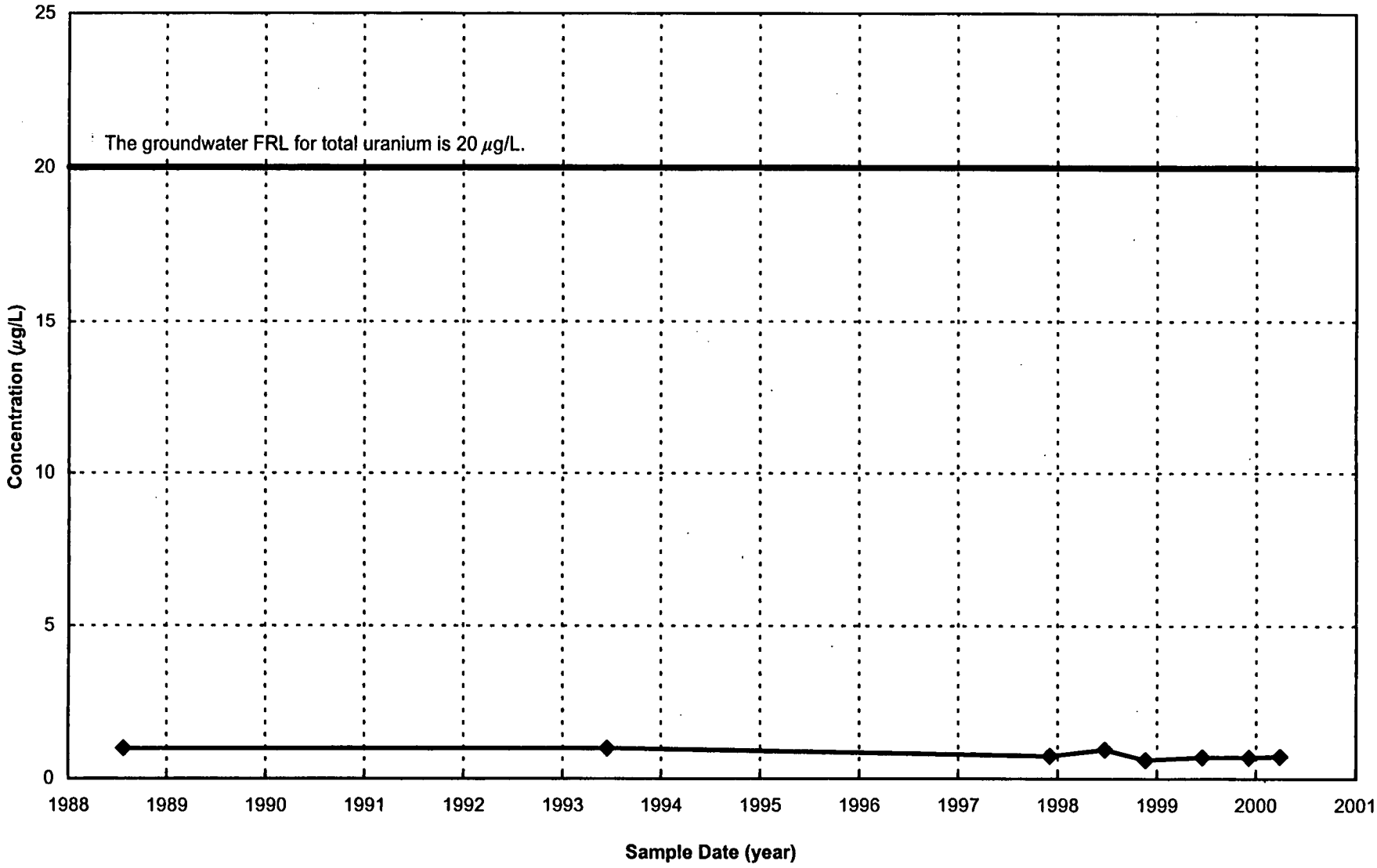


FIGURE A.2-76. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3034

000159

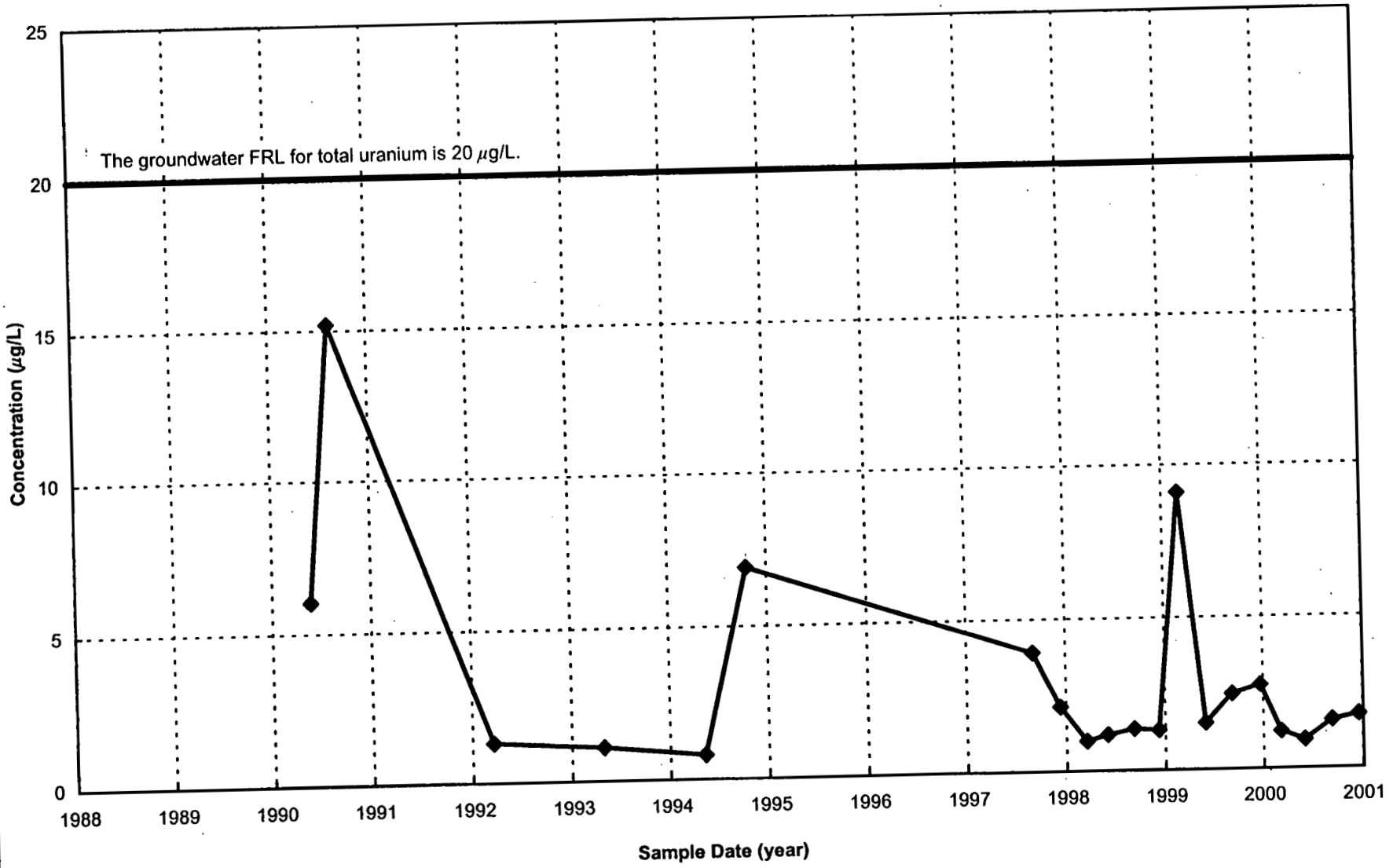


FIGURE A.2-77. TOTAL UANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3045

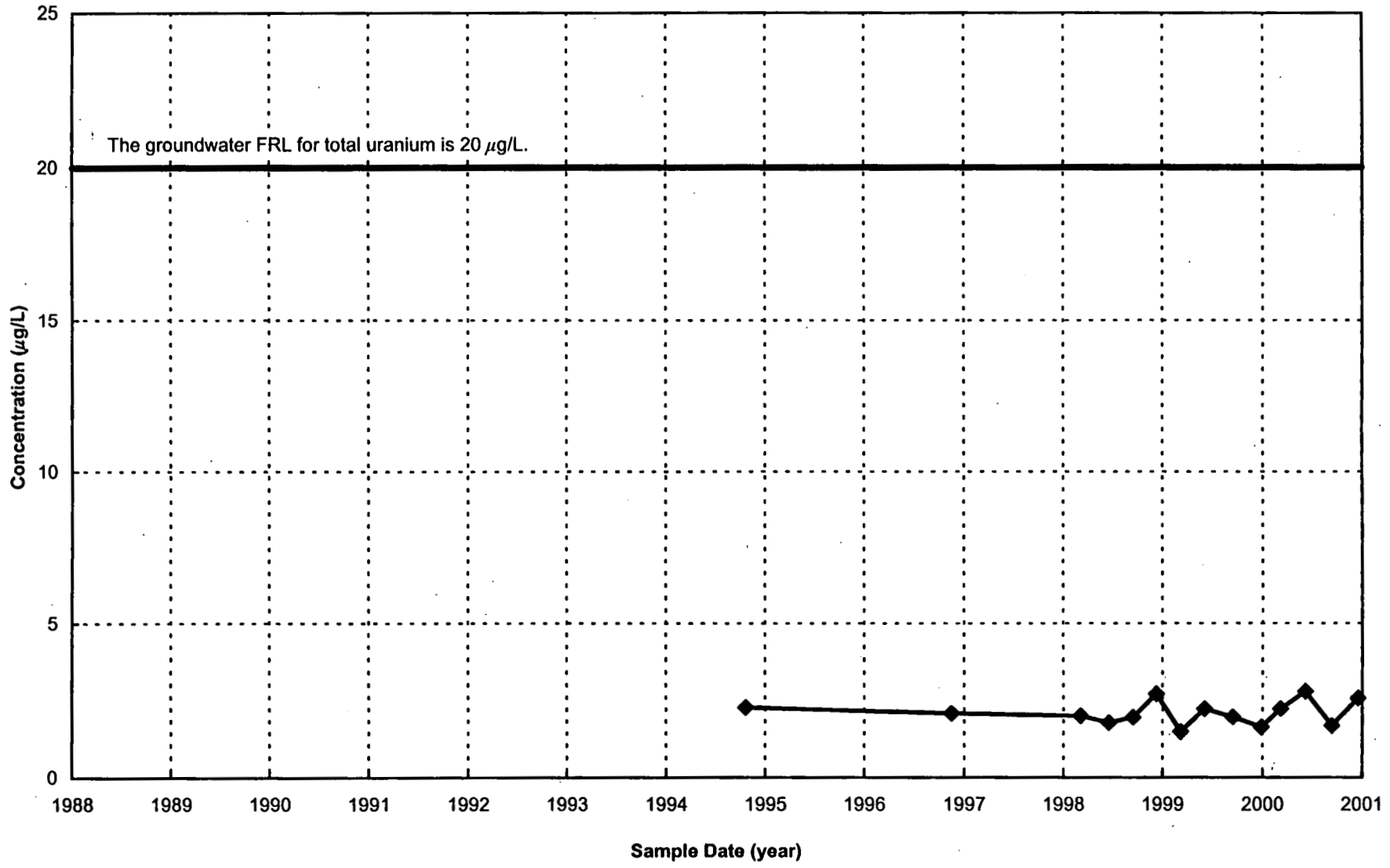


FIGURE A.2-78. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3046

000161

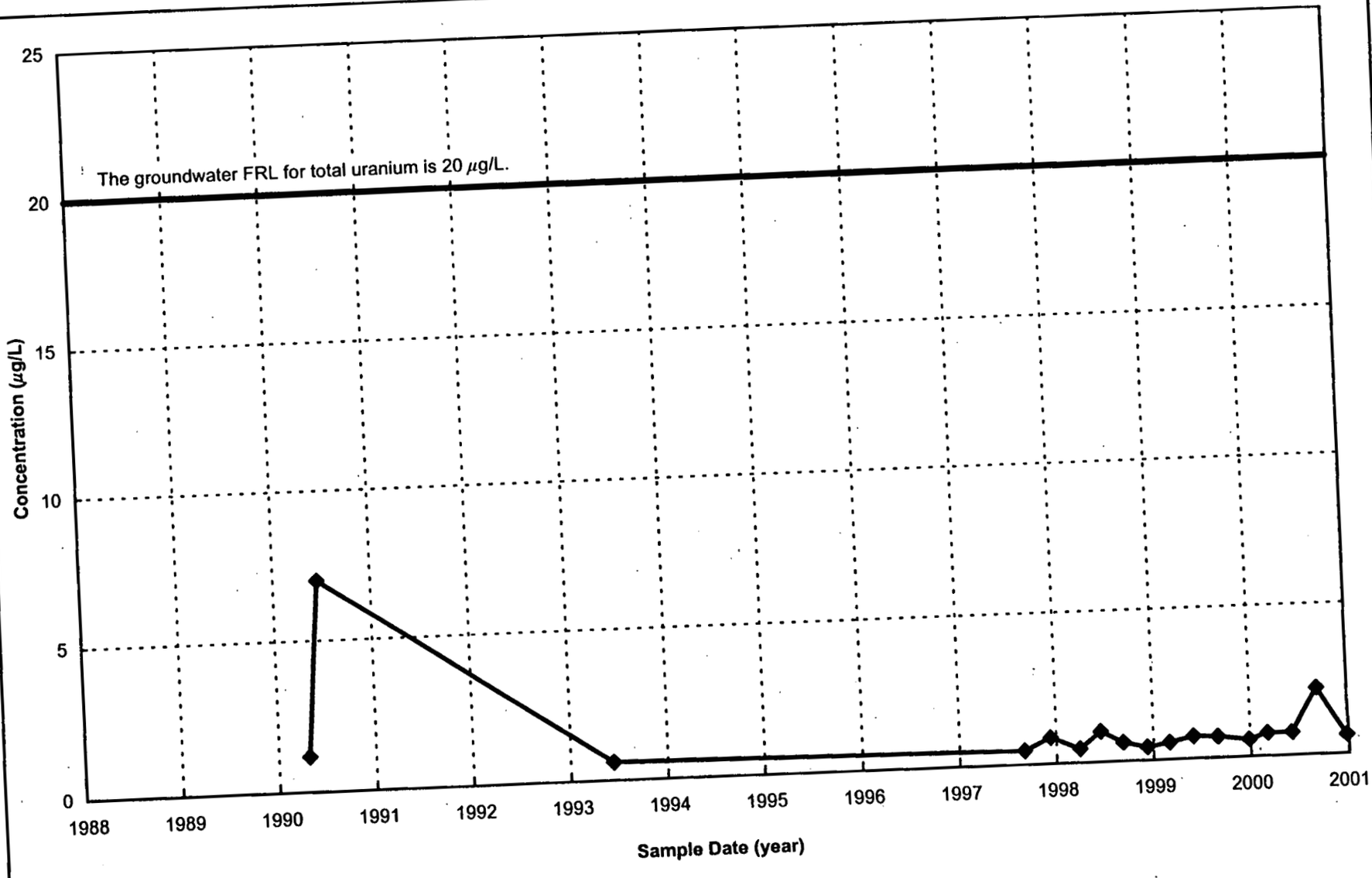


FIGURE A.2-79. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3049

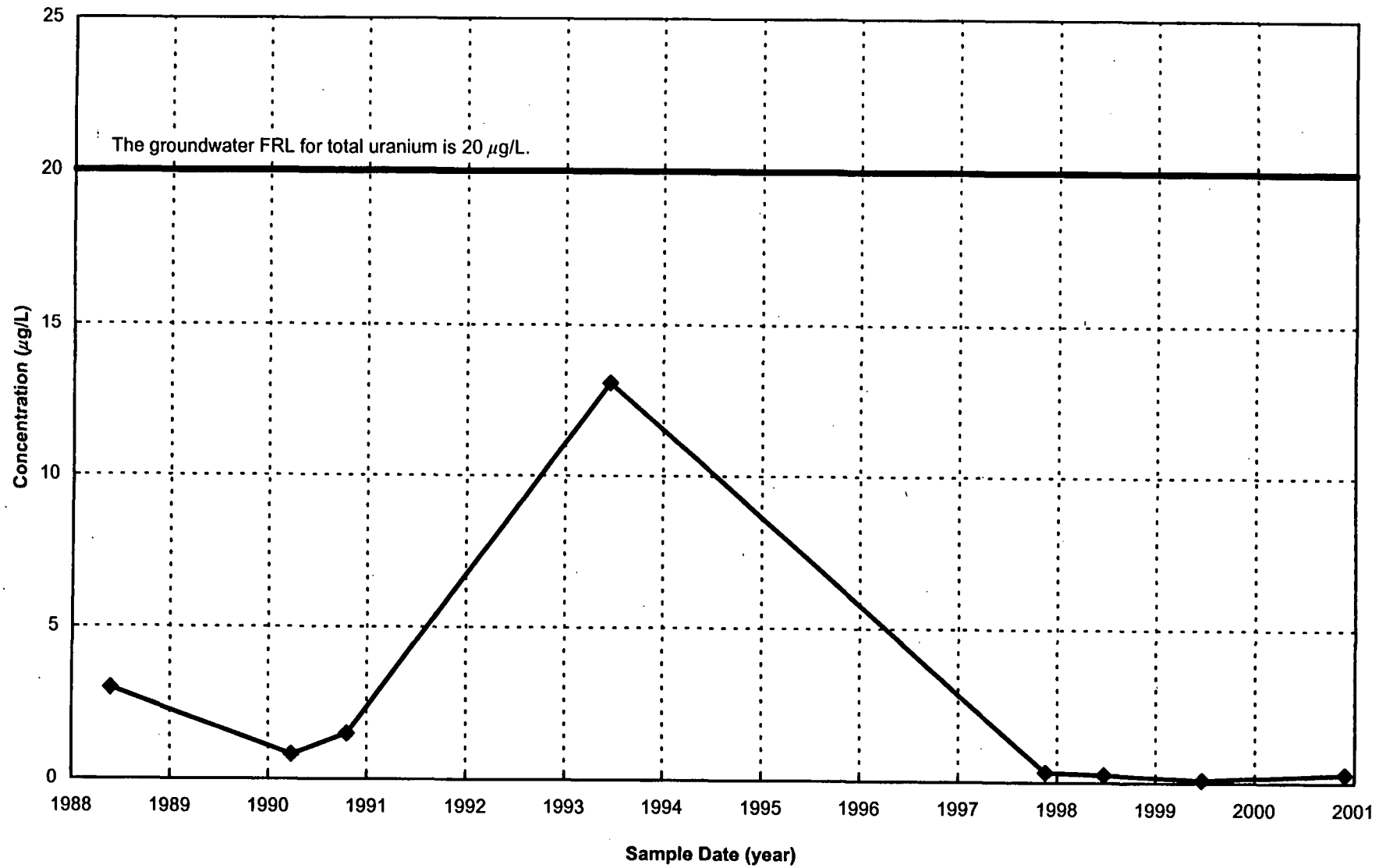


FIGURE A.2-80. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3054

000163

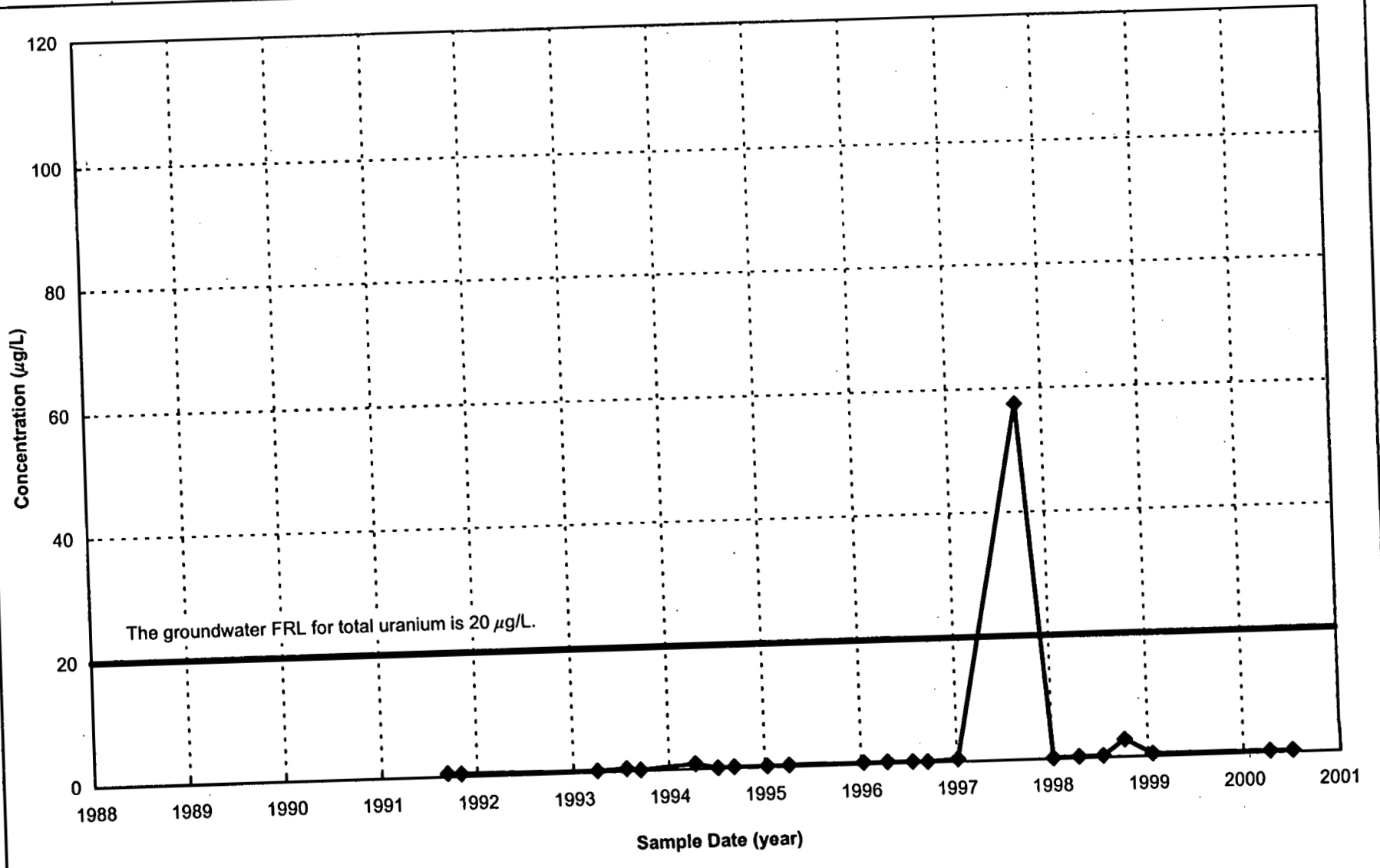


FIGURE A.2-81. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3067

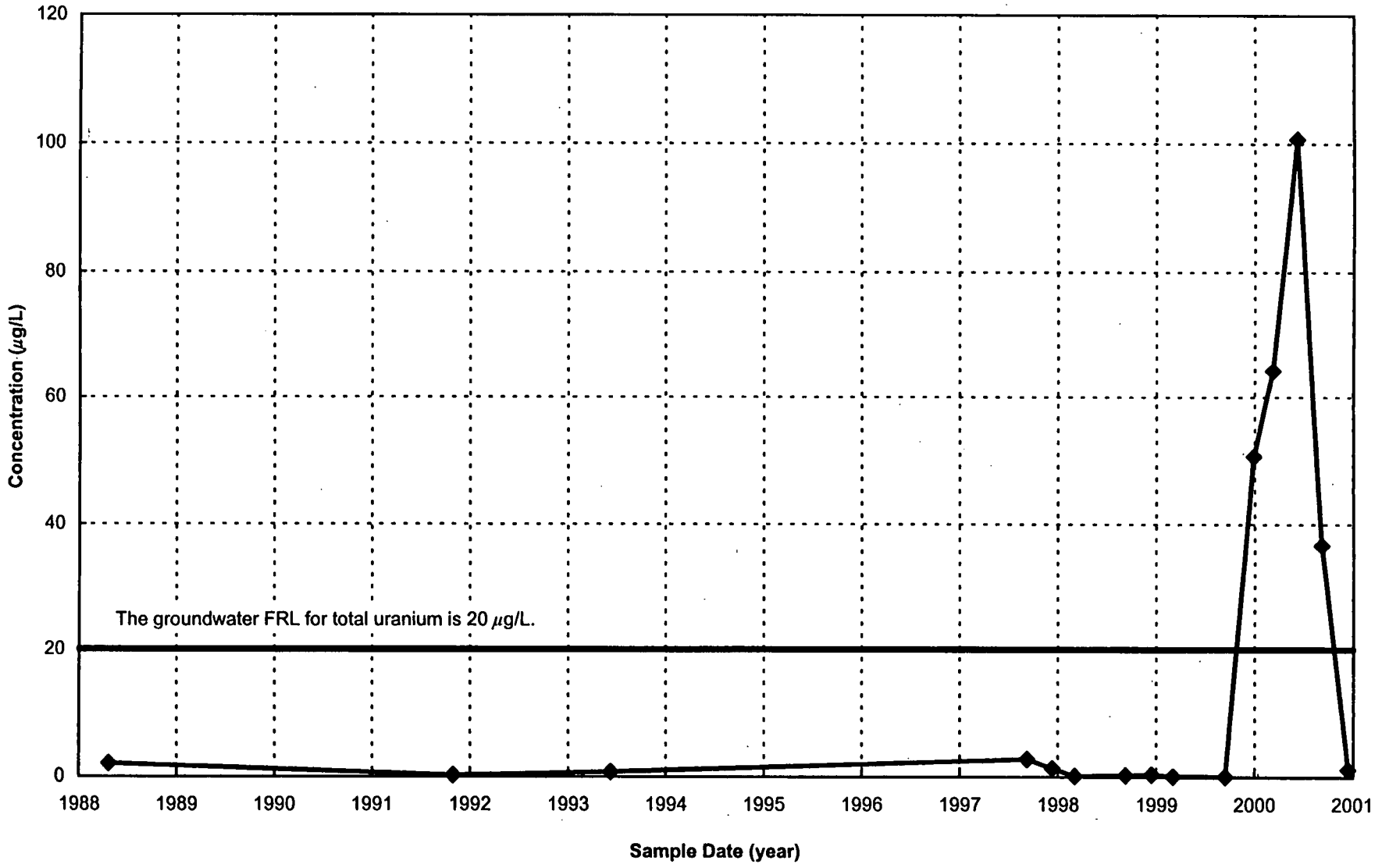


FIGURE A.2-82. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3068

000165

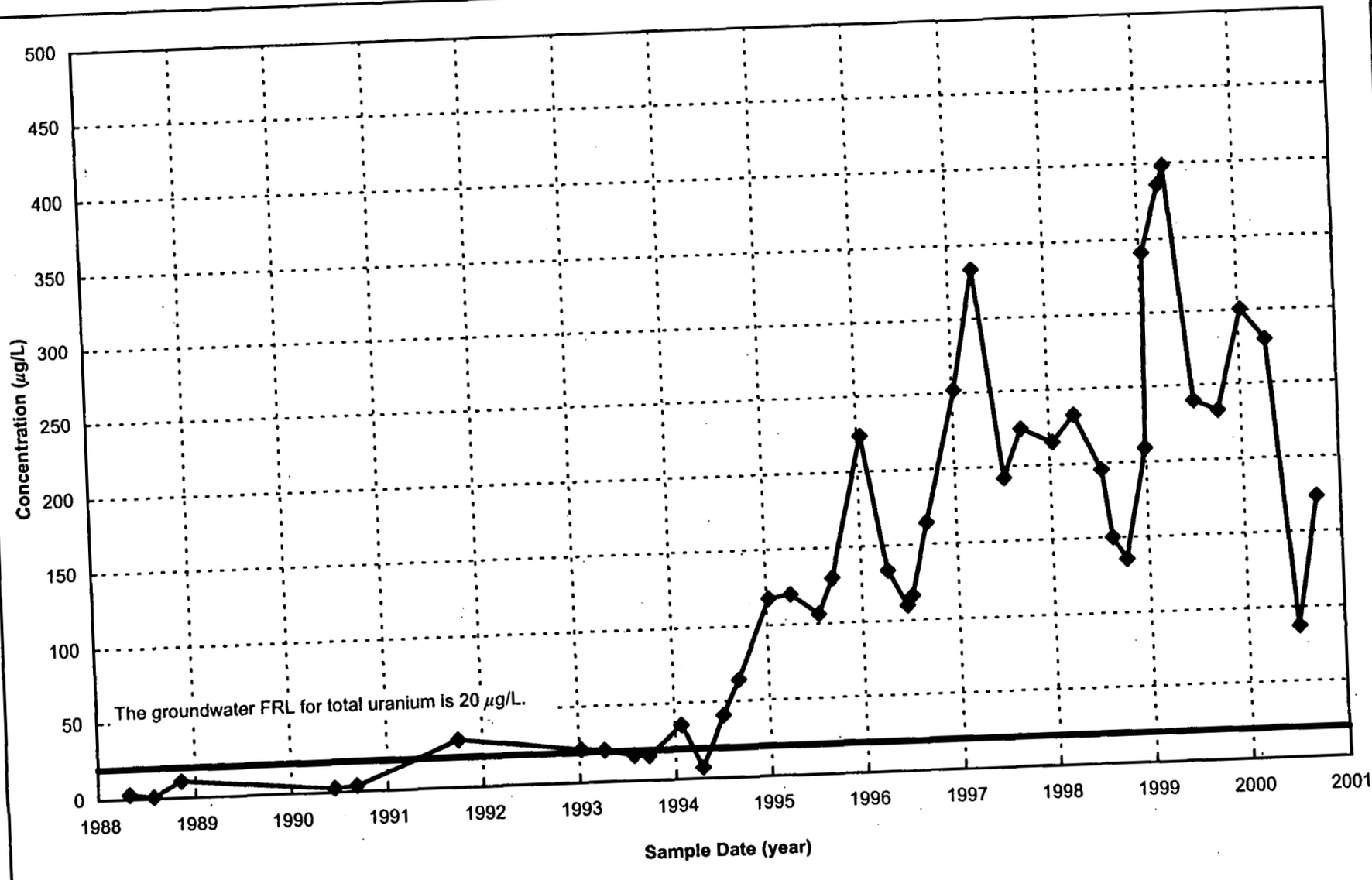


FIGURE A.2-83. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3069

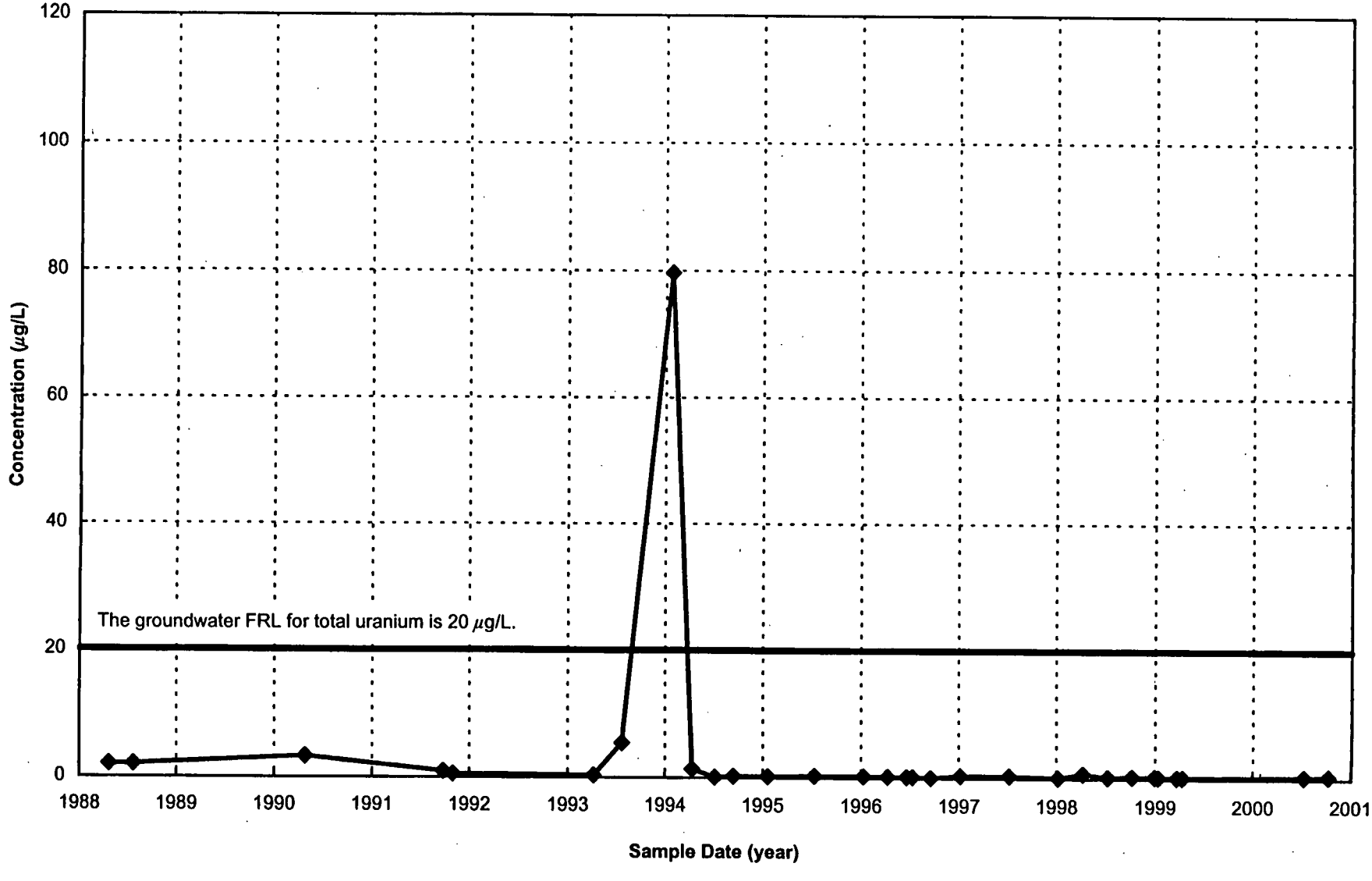


FIGURE A.2-84. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3070

000167

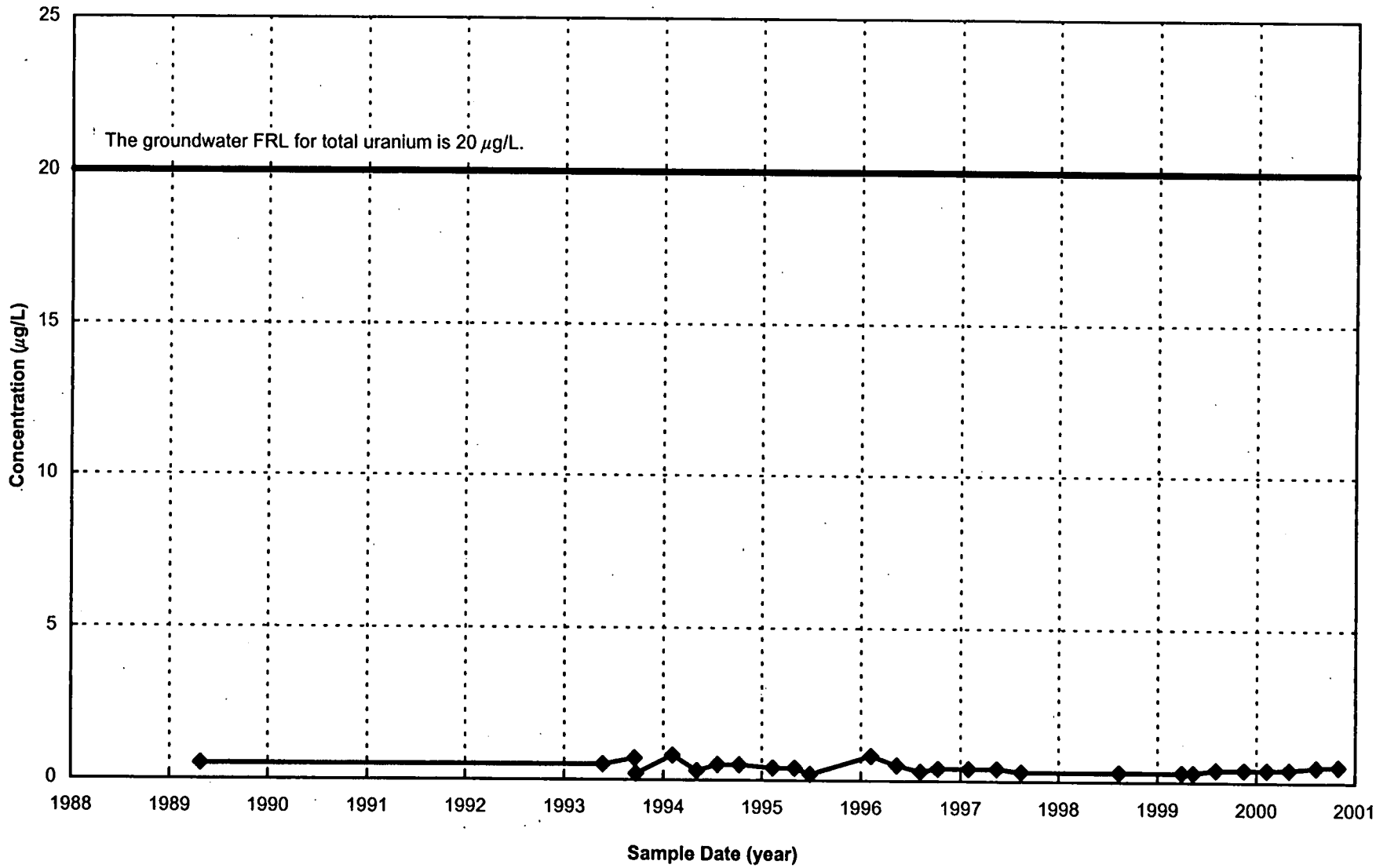


FIGURE A.2-85. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3093

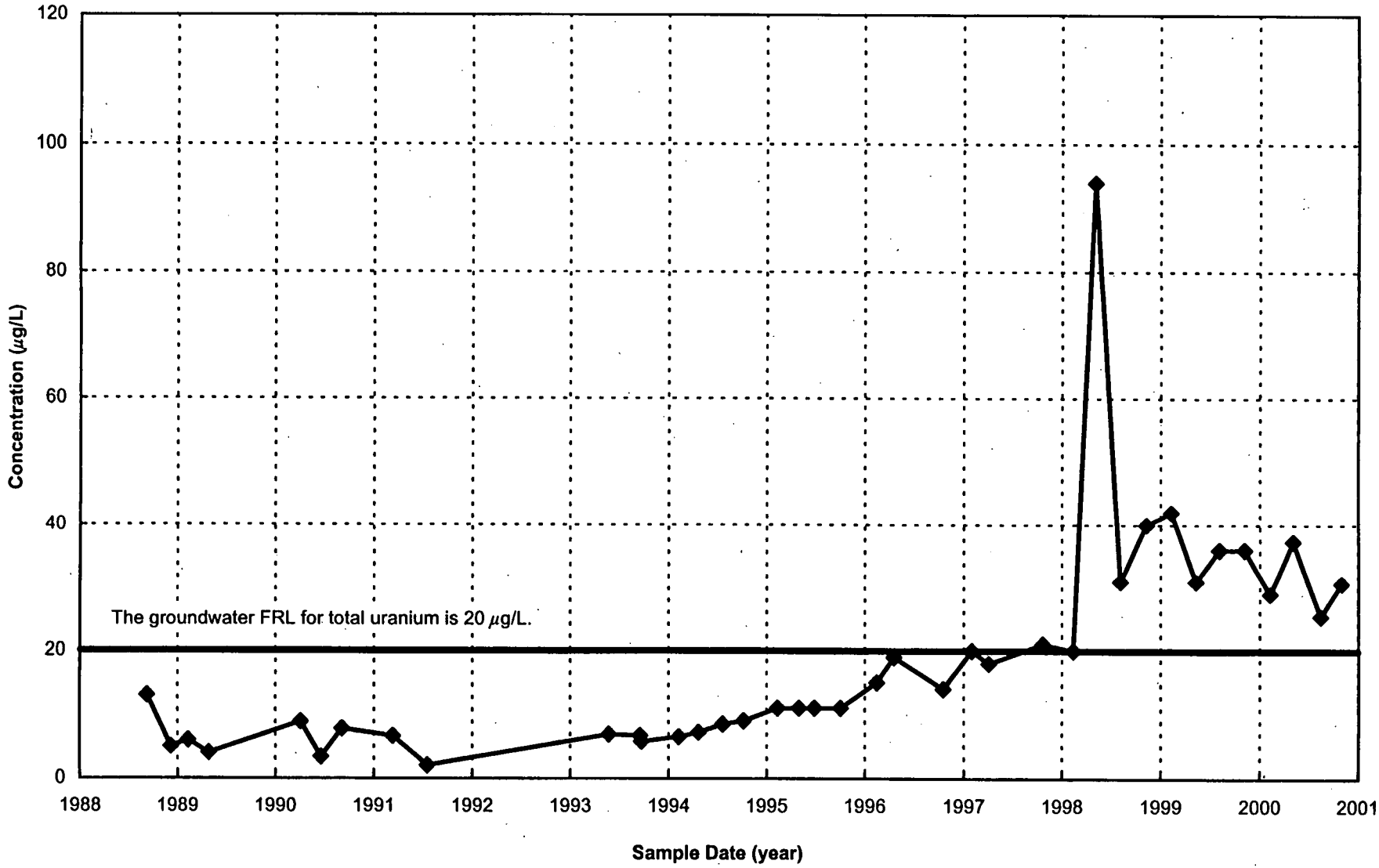


FIGURE A.2-86. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3095

000169

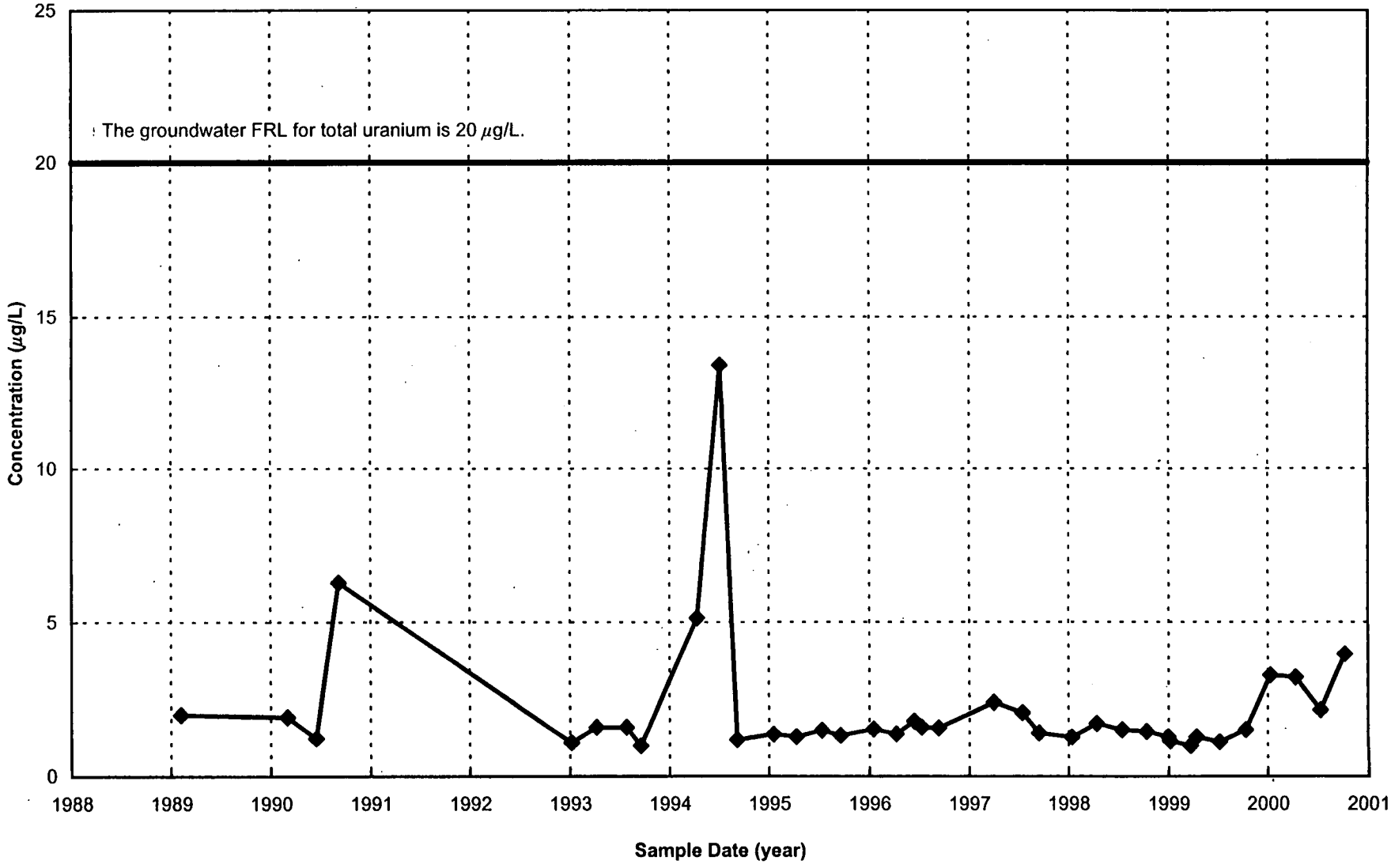


FIGURE A.2-87. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3106

0001170

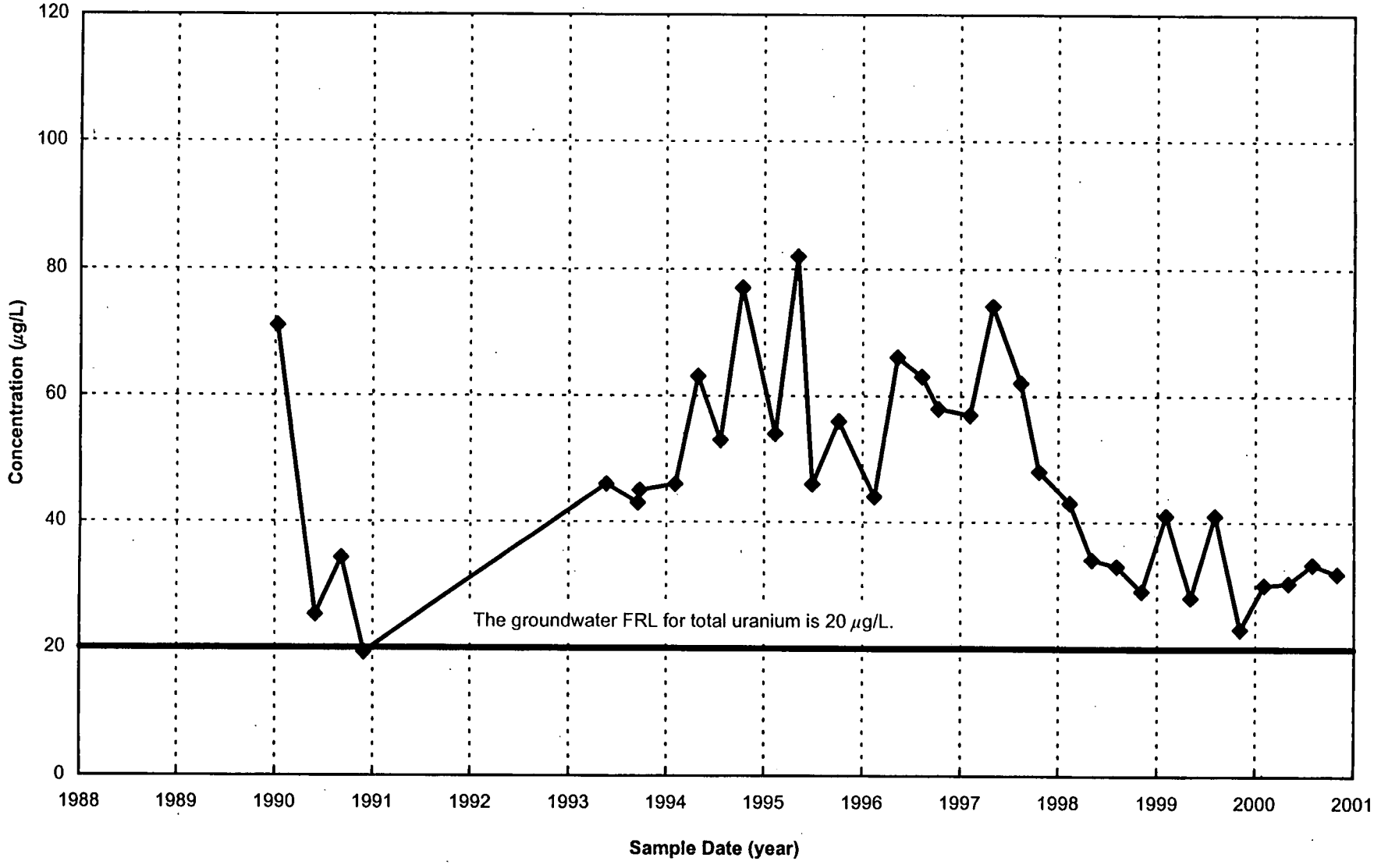


FIGURE A.2-88. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3125

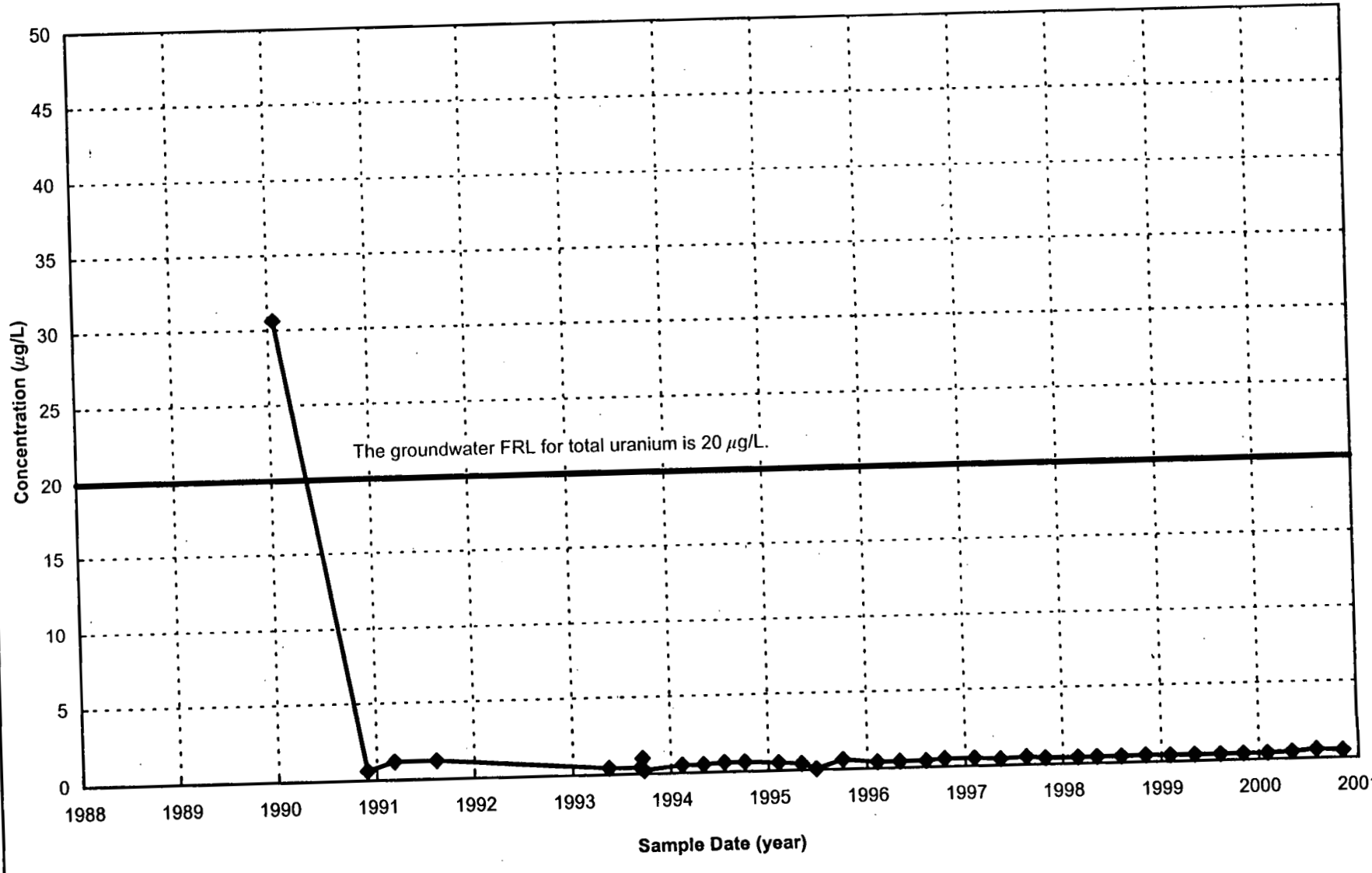


FIGURE A.2-89. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3128

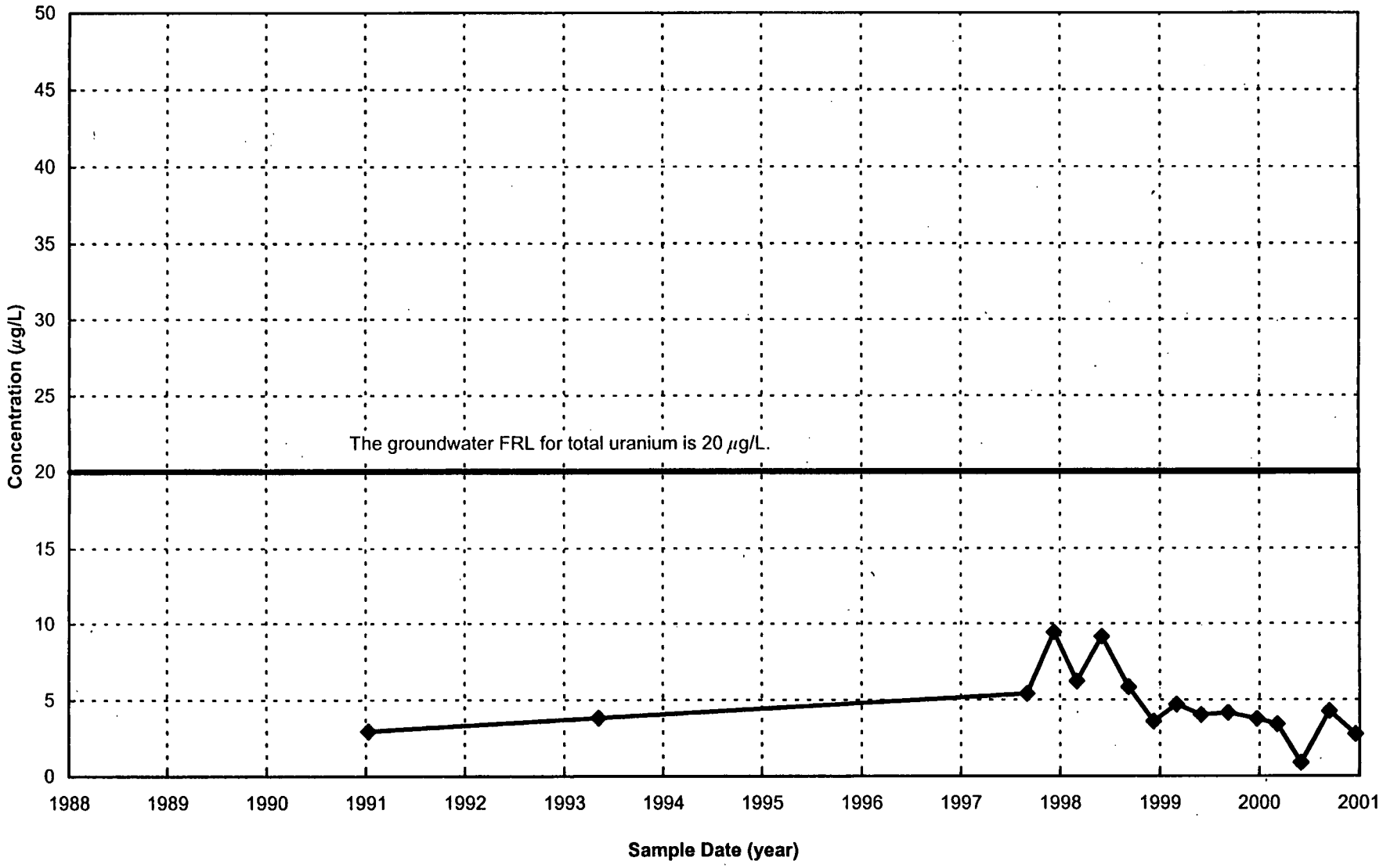


FIGURE A.2-90. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3385

0001173

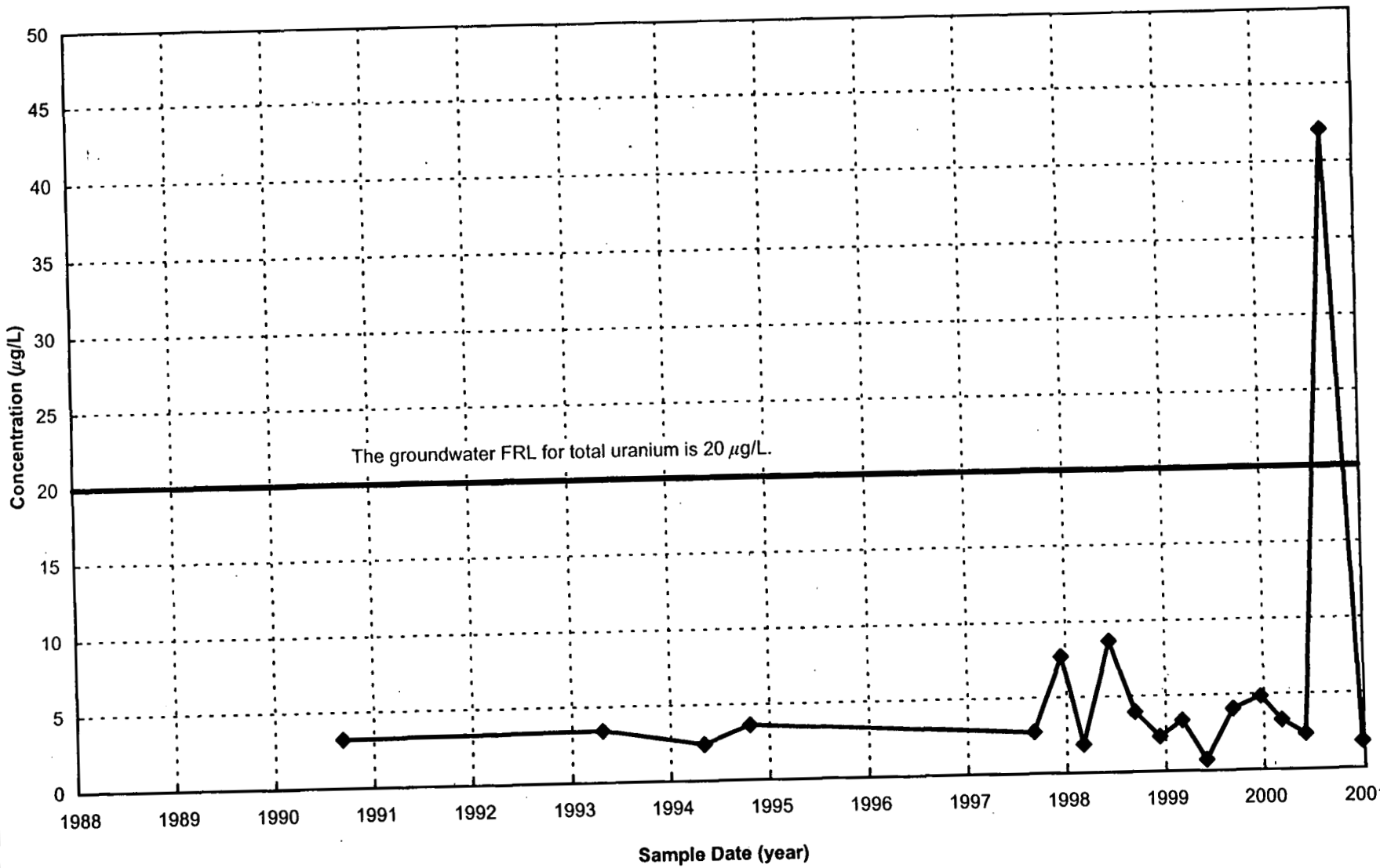


FIGURE A.2-91. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3387

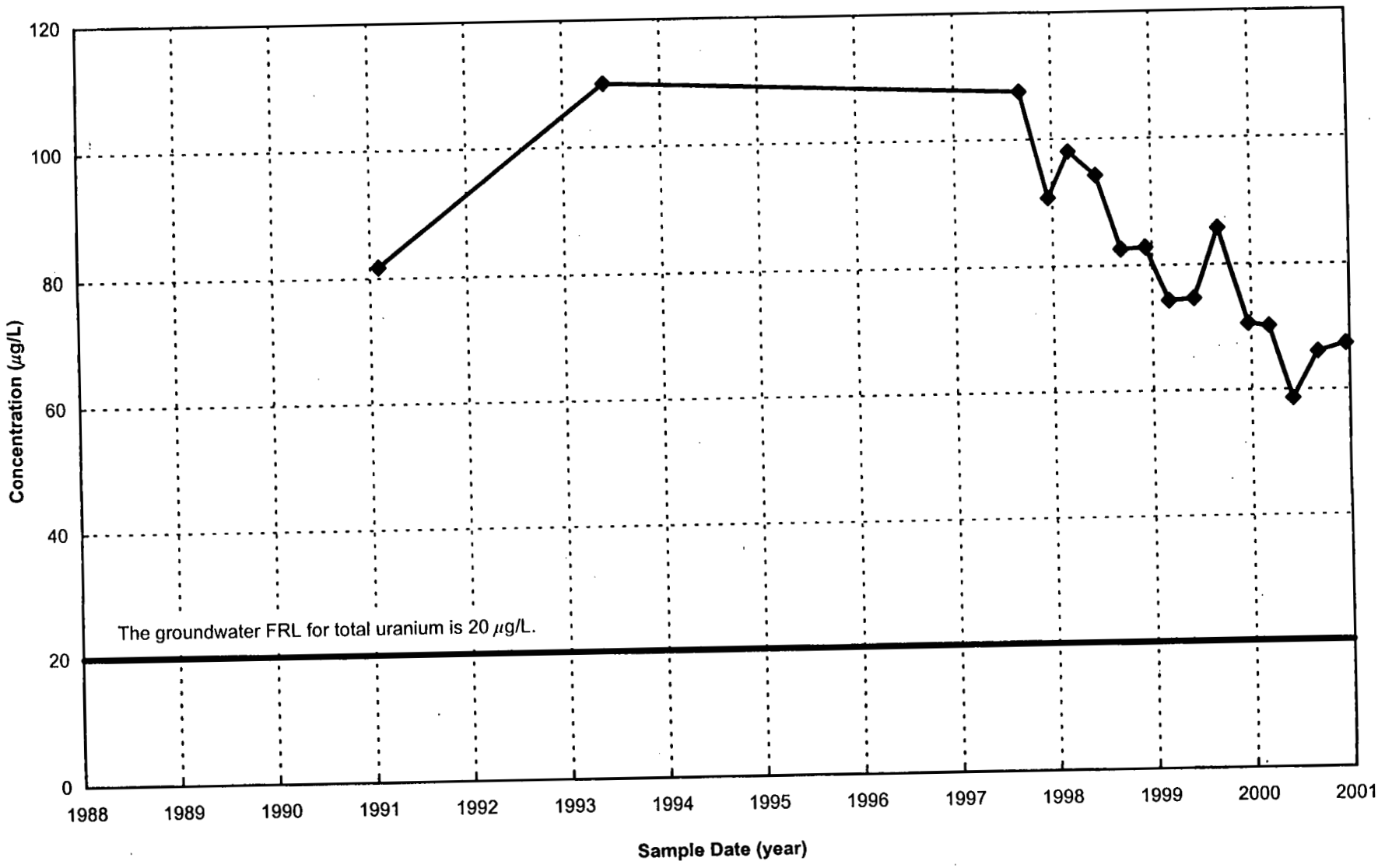


FIGURE A.2-92. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3390

000175

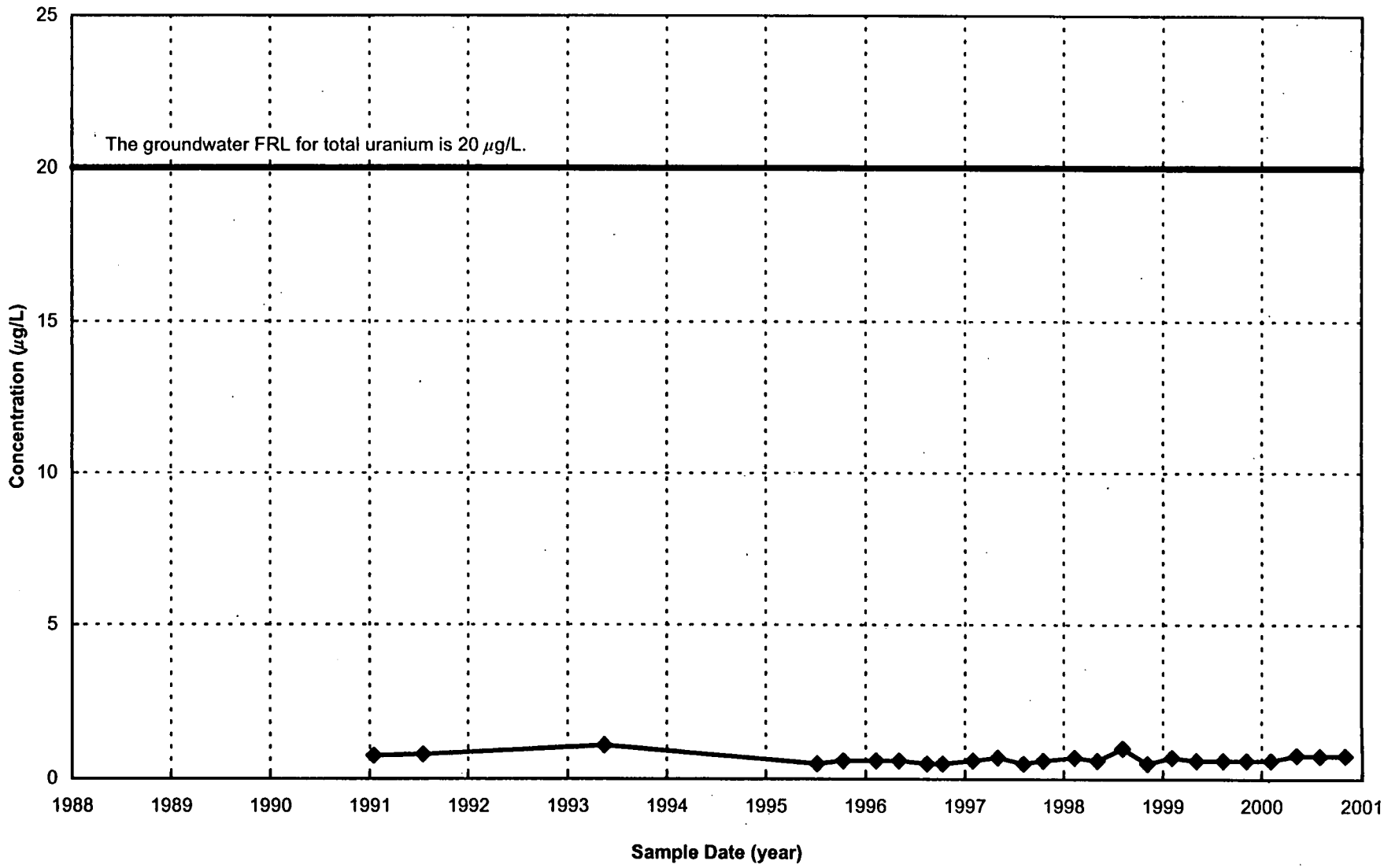


FIGURE A.2-93. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3396

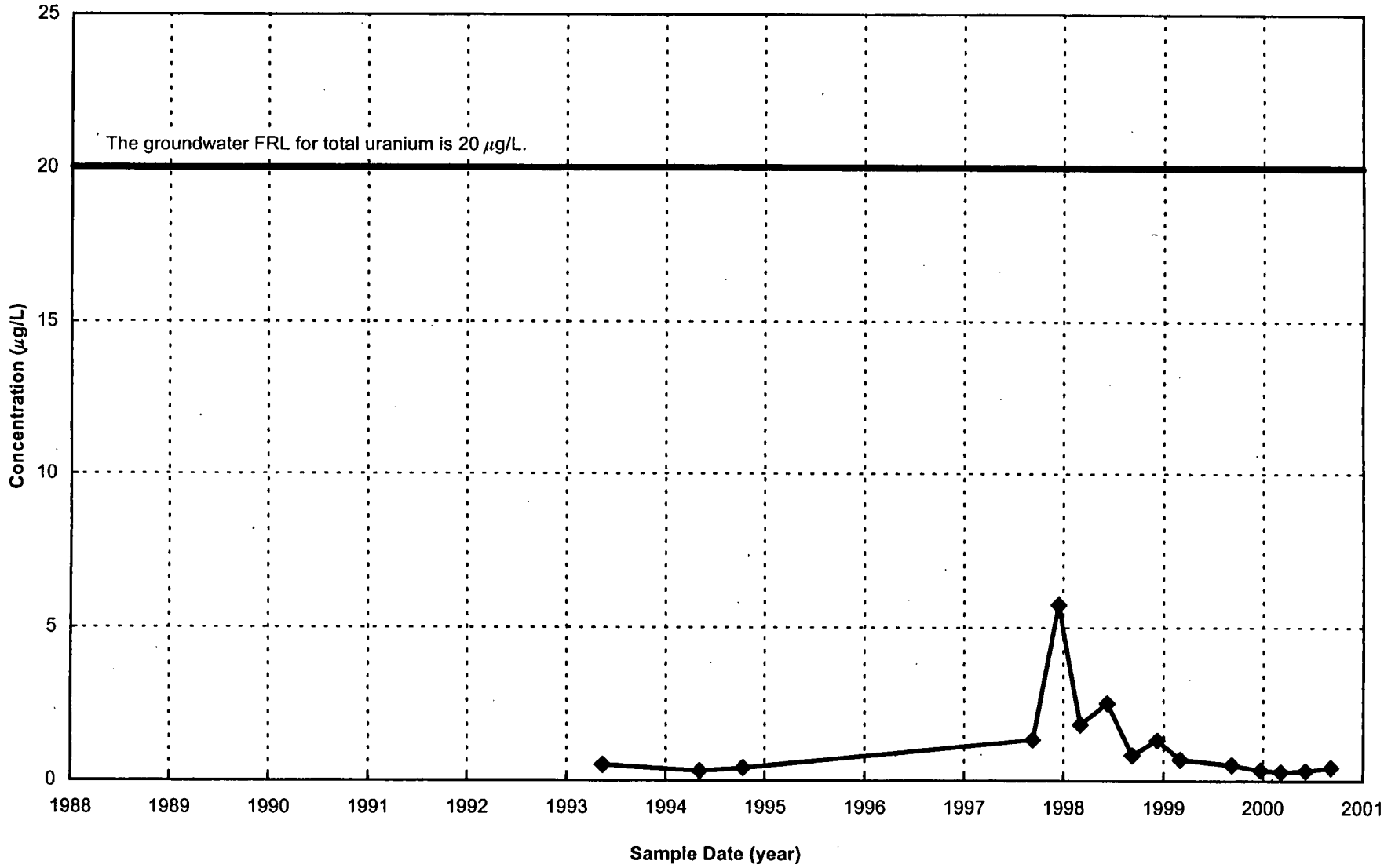


FIGURE A.2-94. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3397

000177

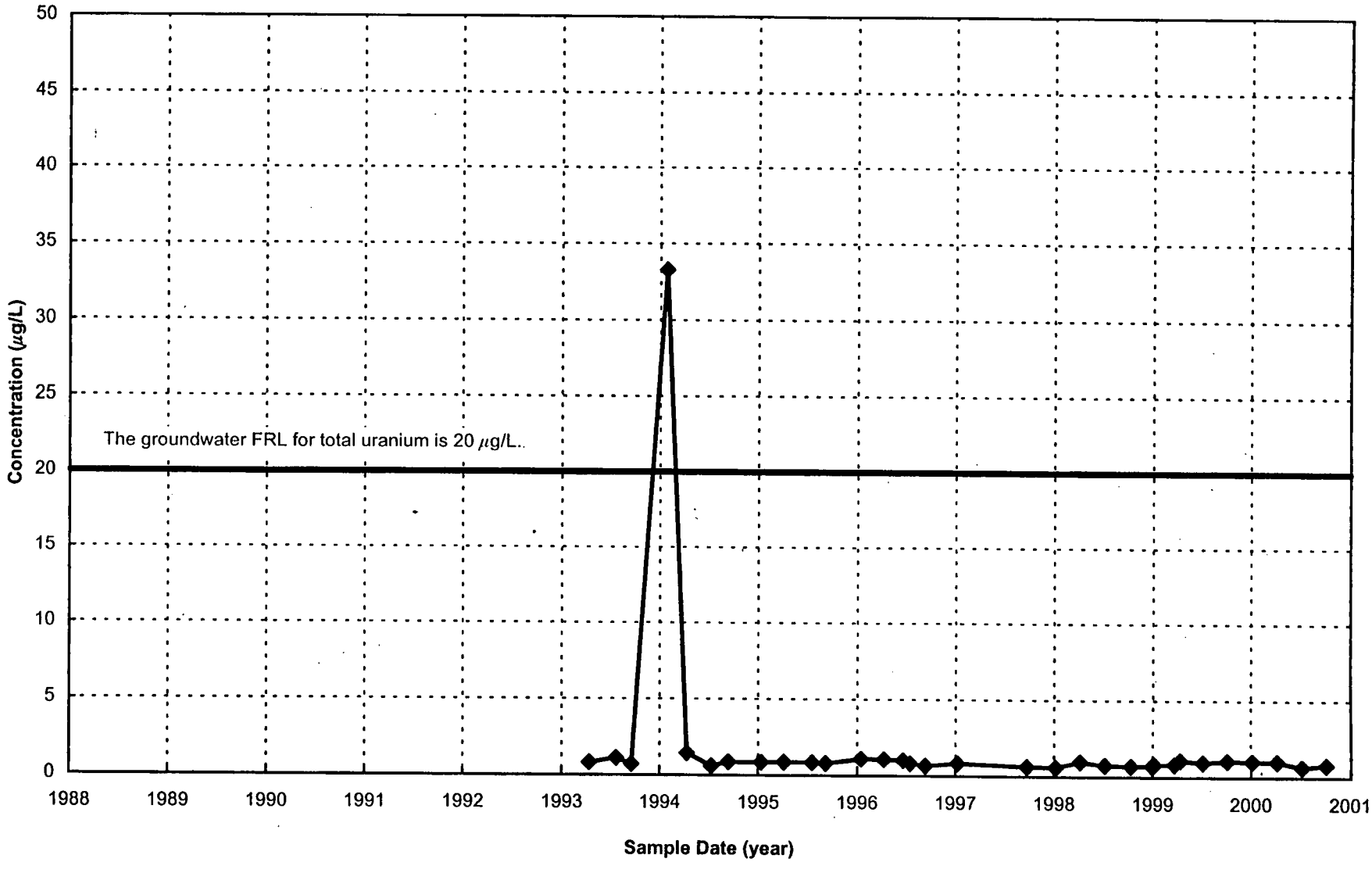


FIGURE A.2-95. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3398

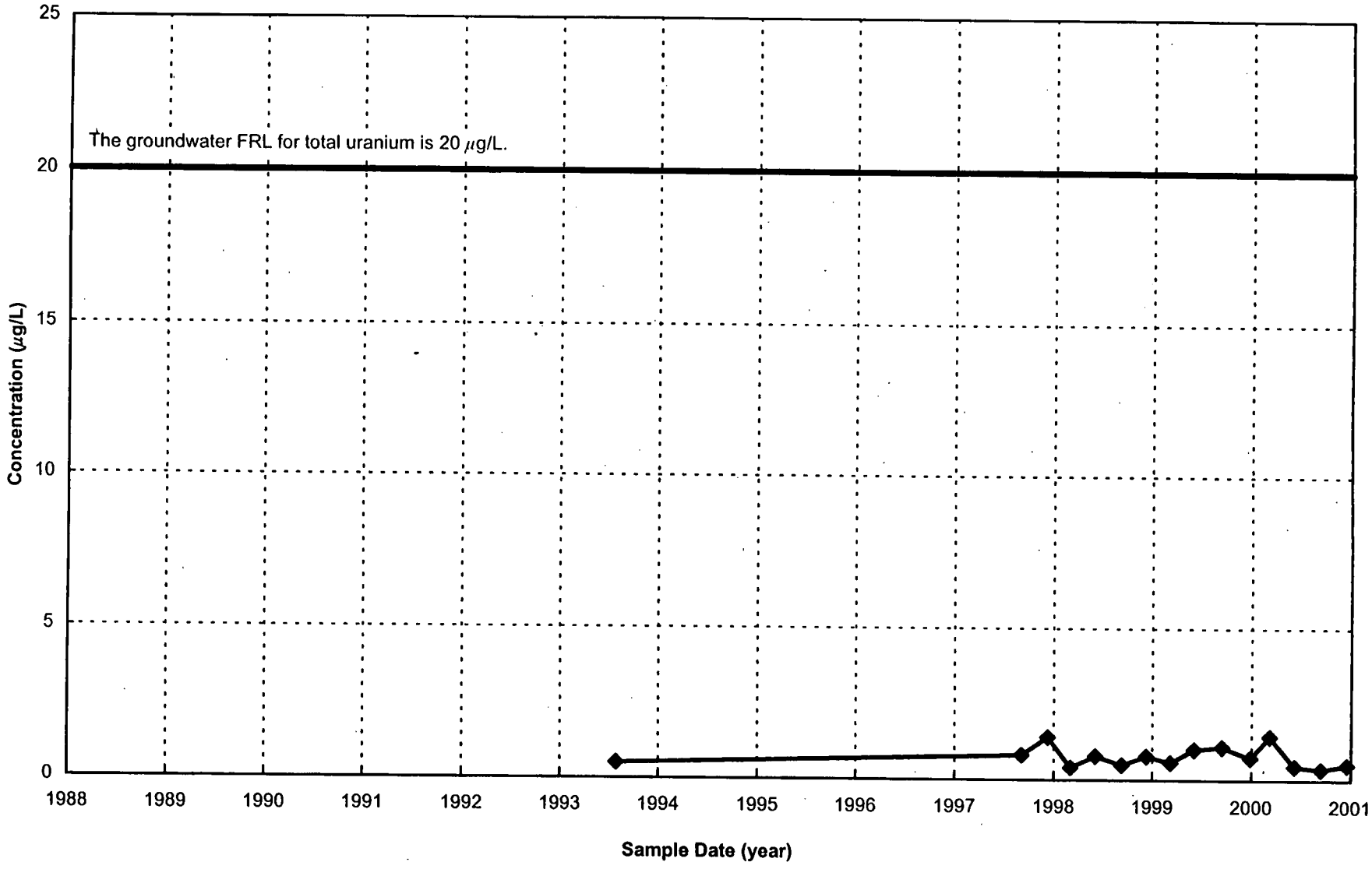


FIGURE A.2-96. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3402

000179

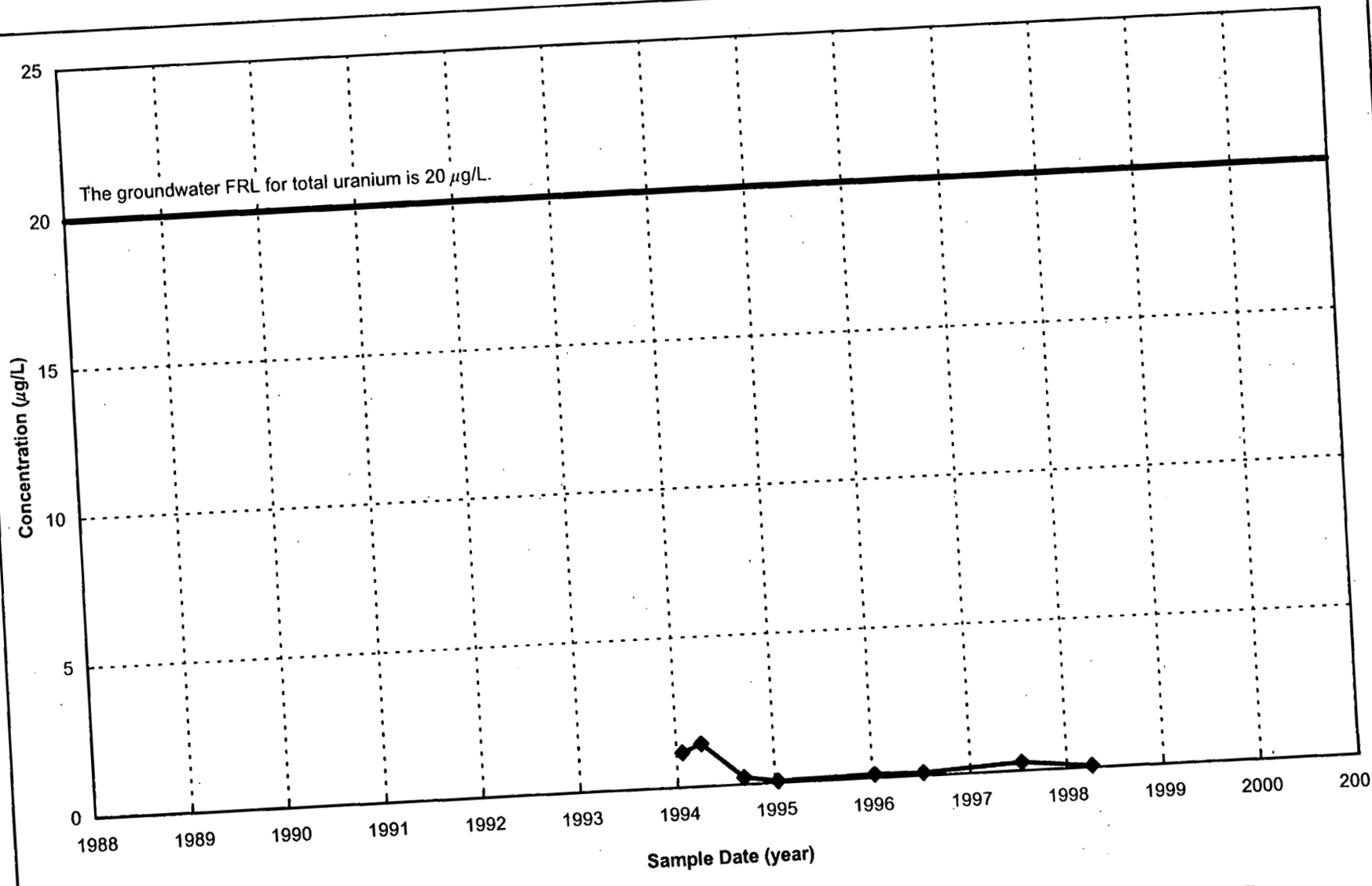


FIGURE A.2-97. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3417

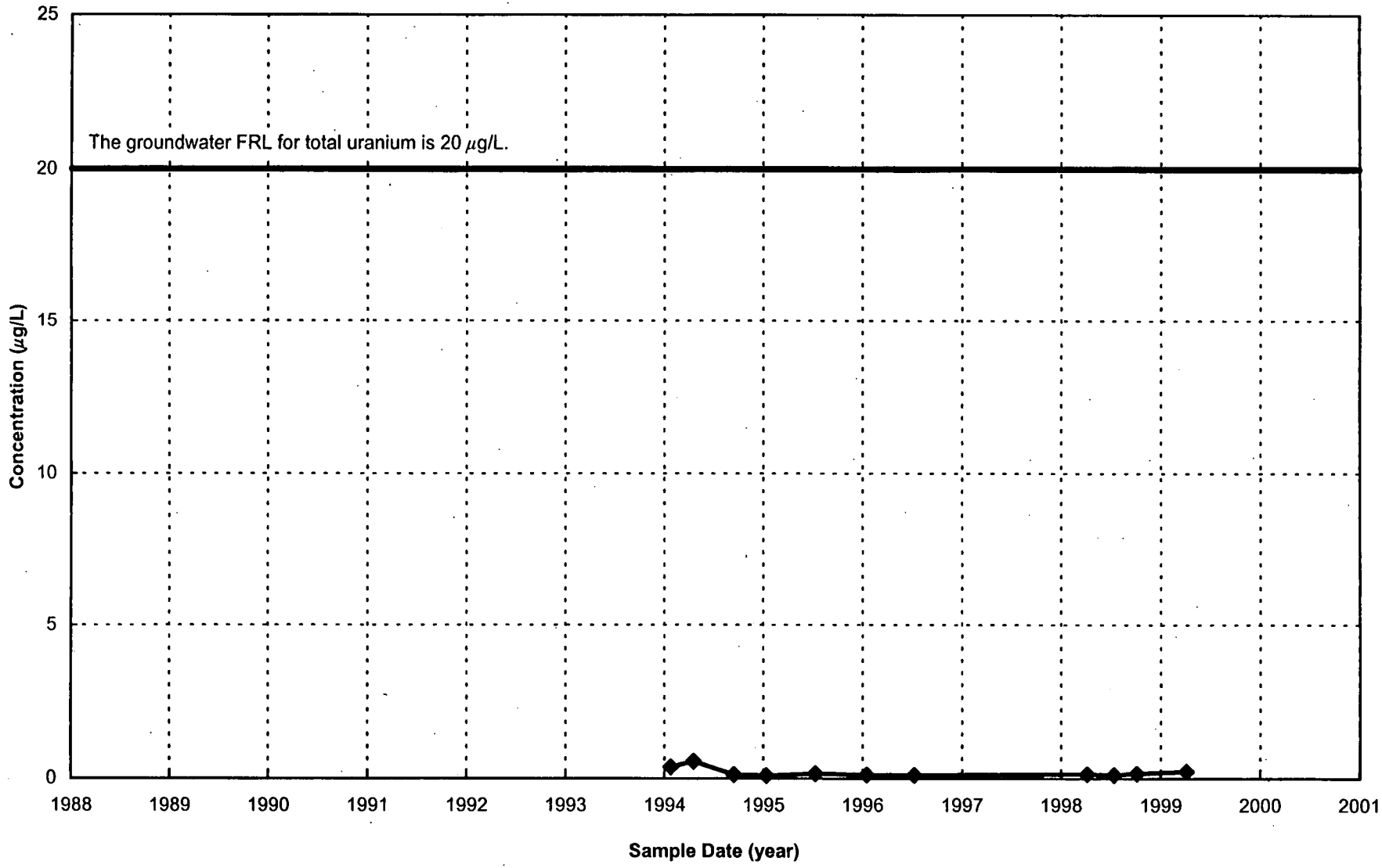


FIGURE A.2-98. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3424

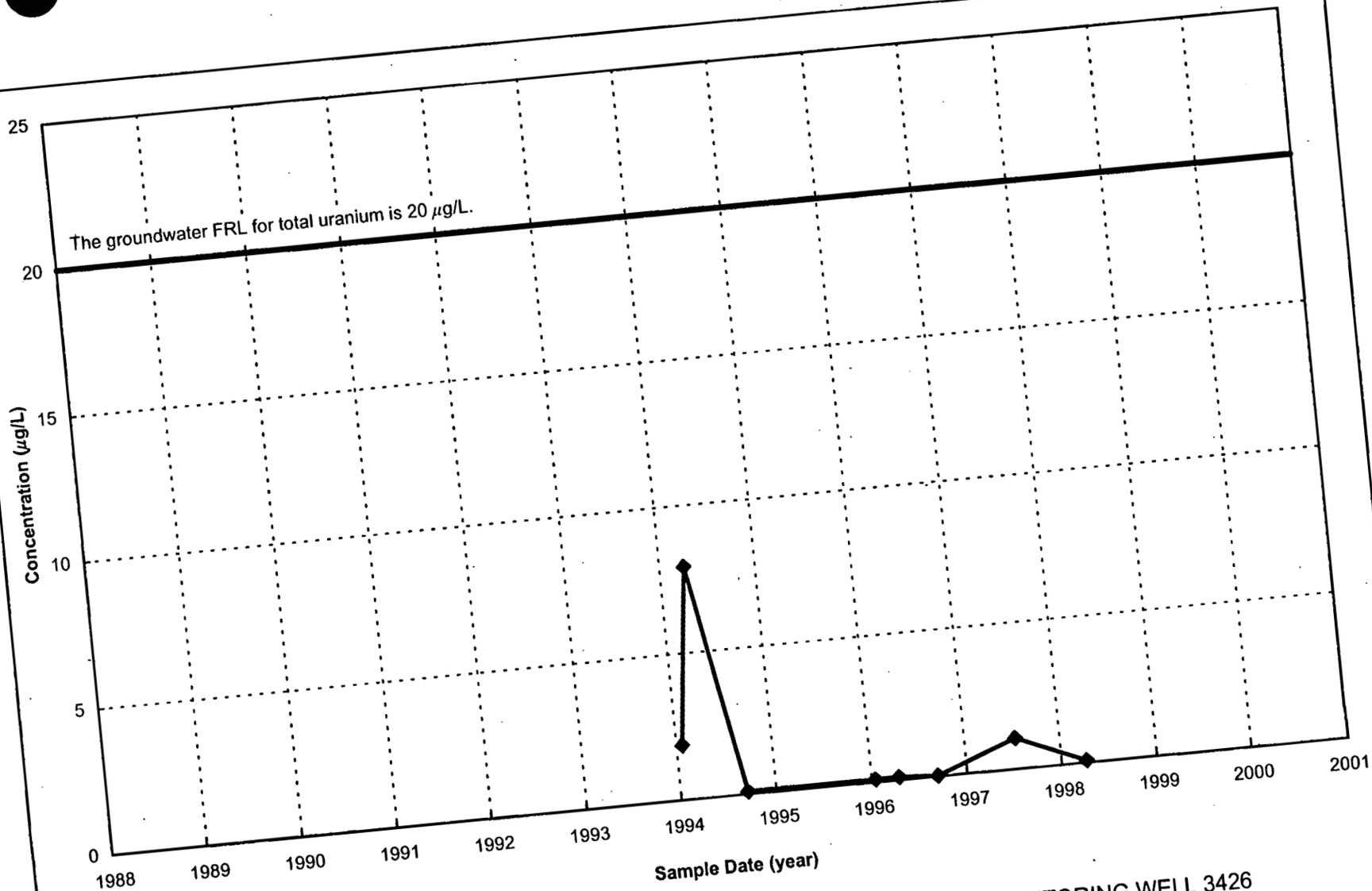


FIGURE A.2-99. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3426

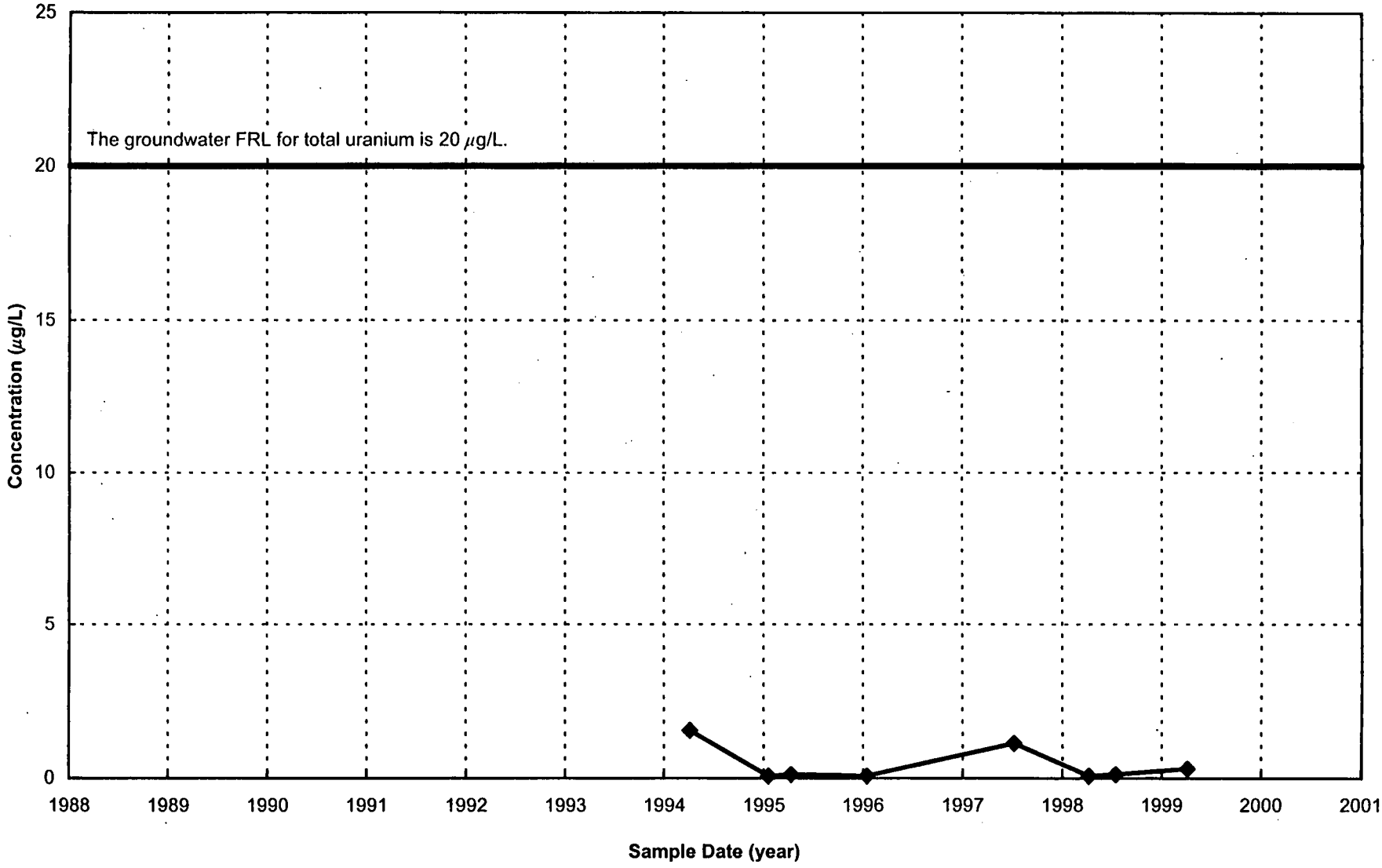


FIGURE A.2-100. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3429

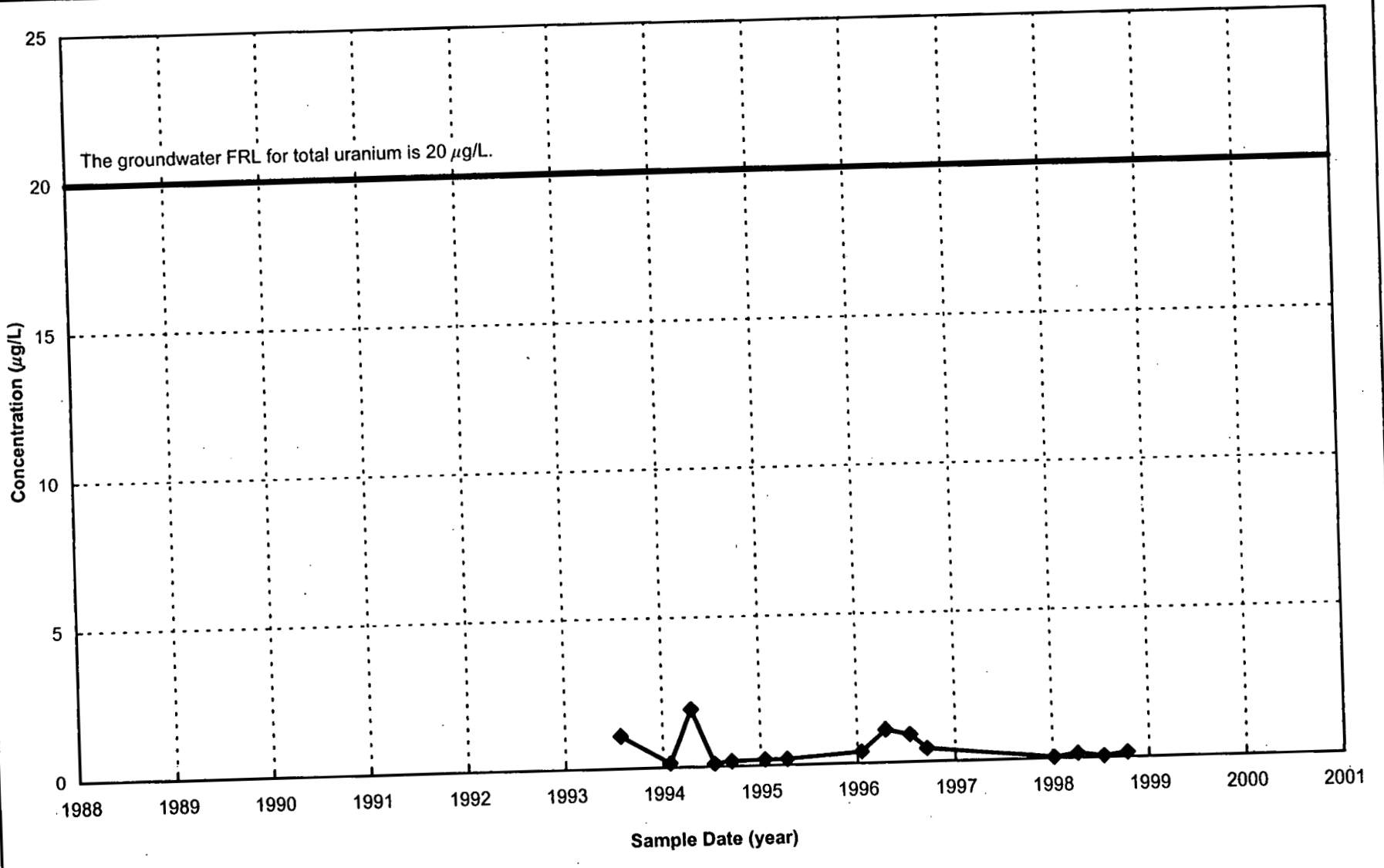


FIGURE A.2-101. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3431

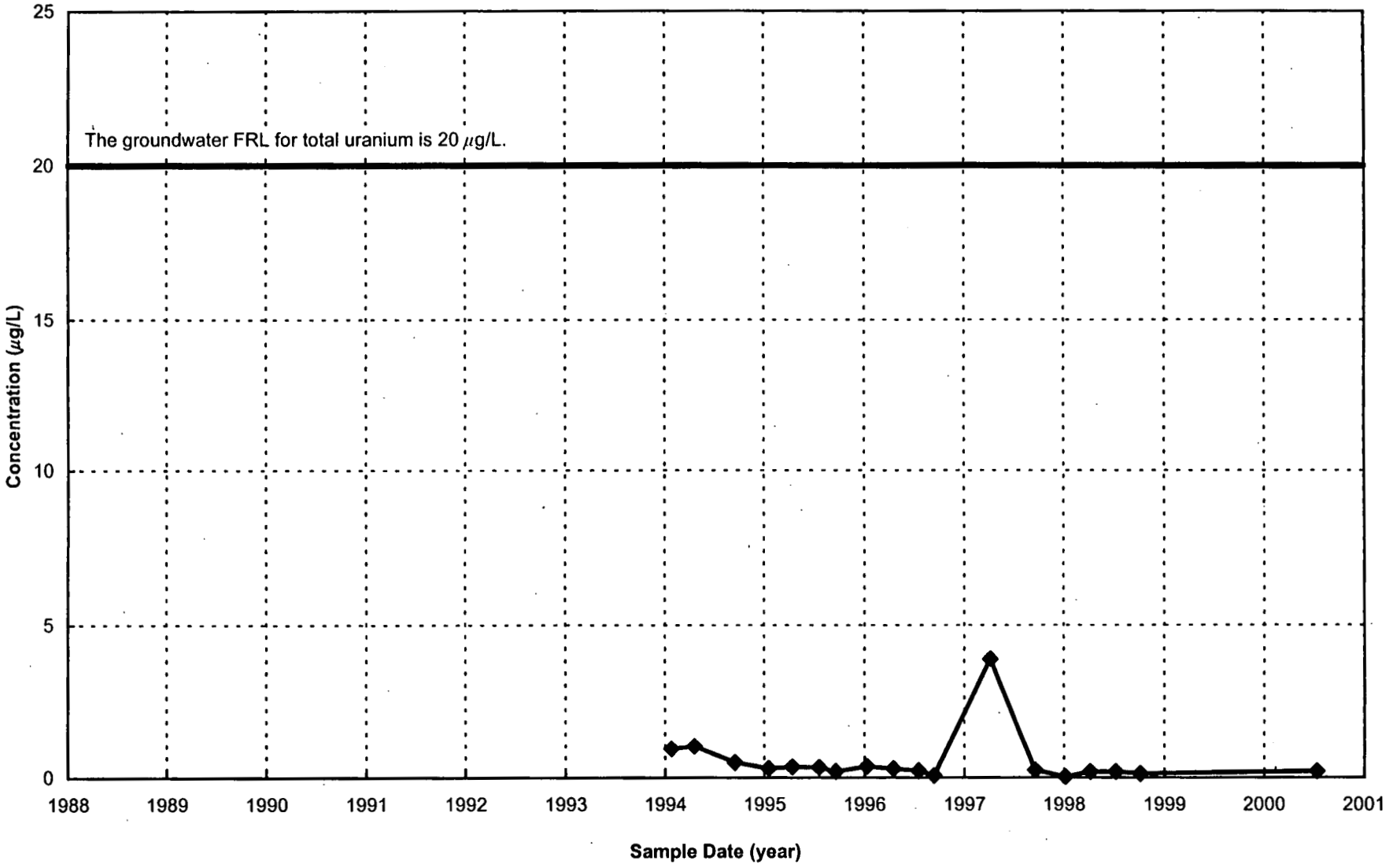


FIGURE A.2-102. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3432

000185

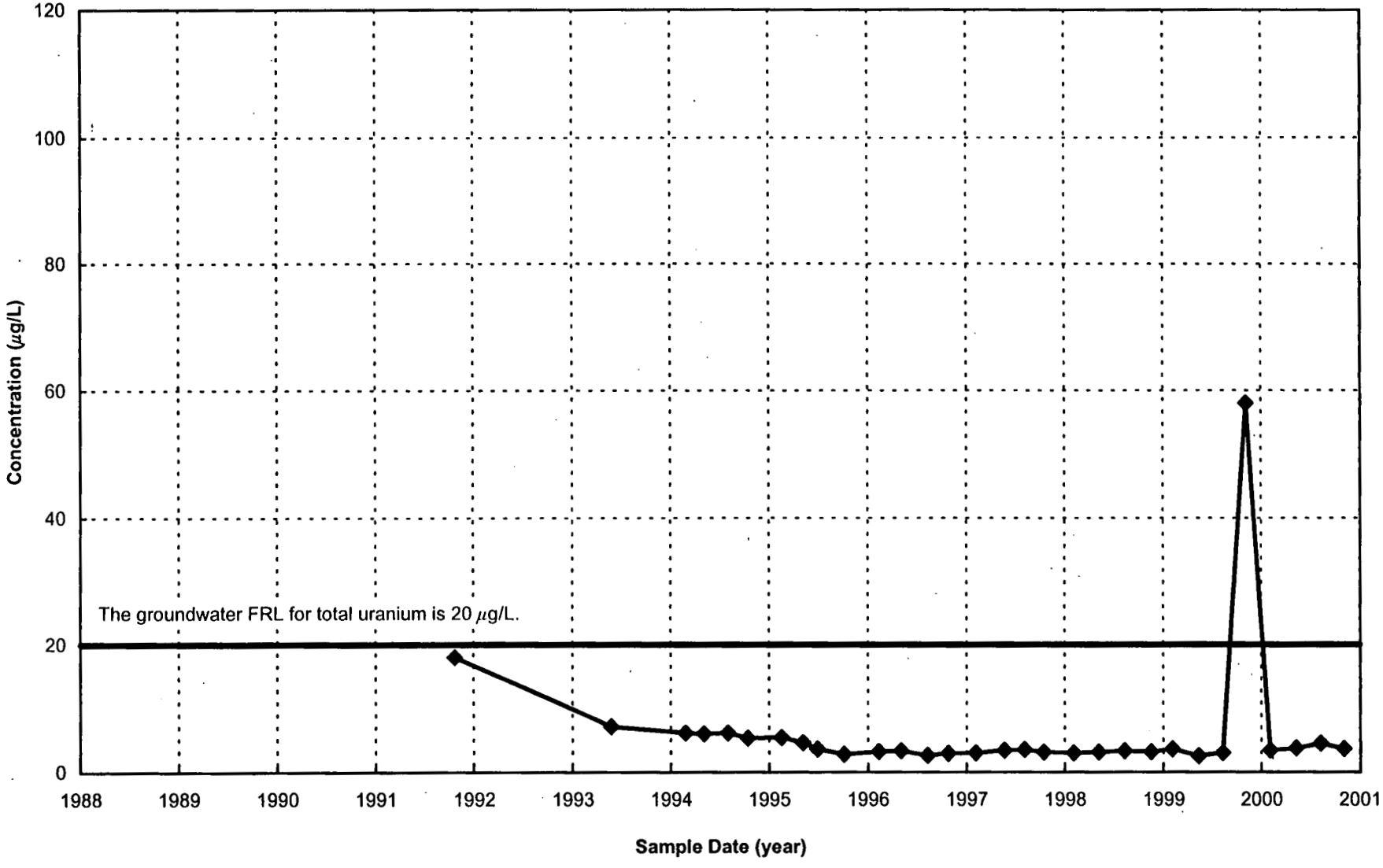


FIGURE A.2-103. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3550

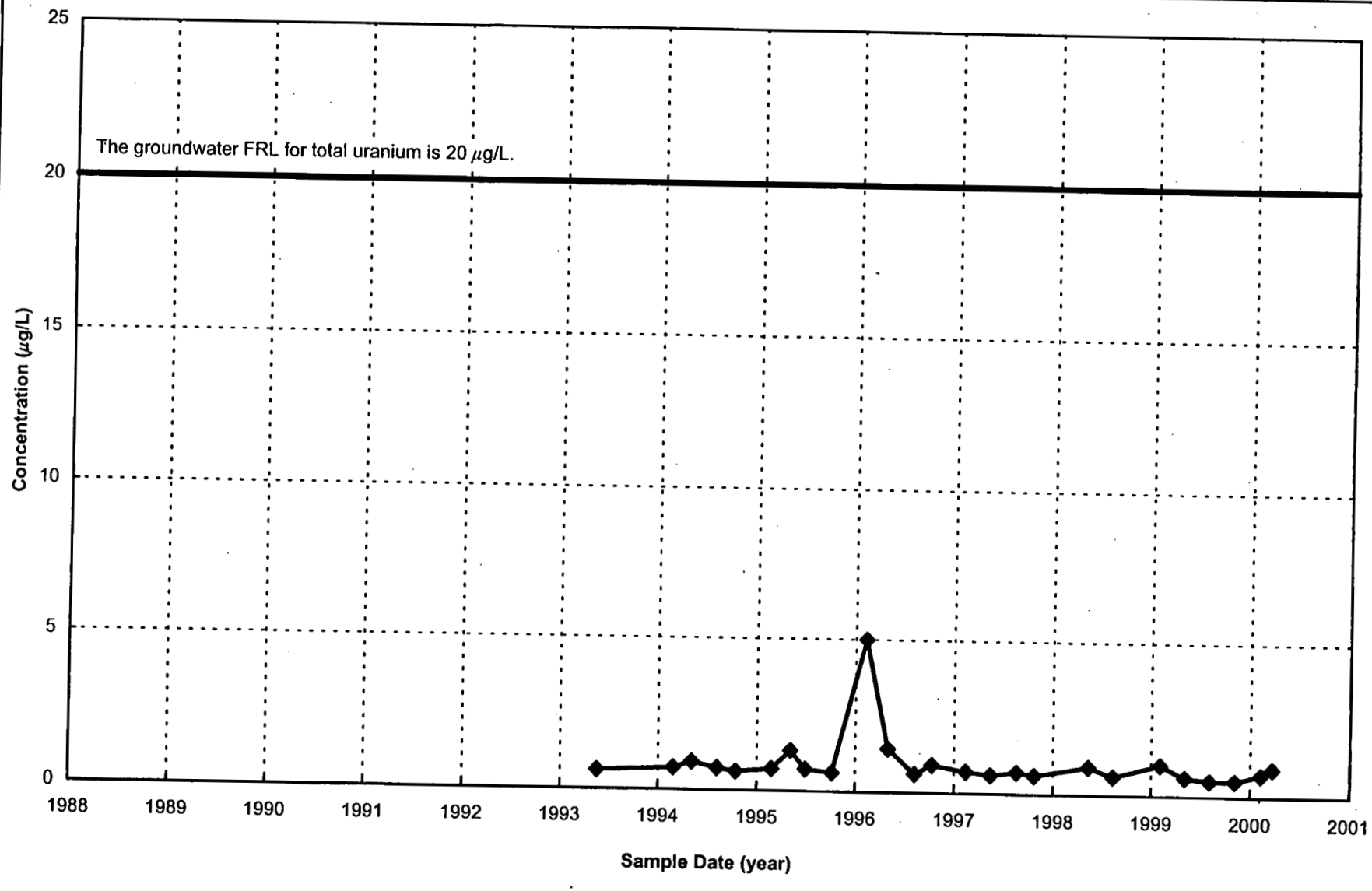


FIGURE A.2-104. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3551

000187

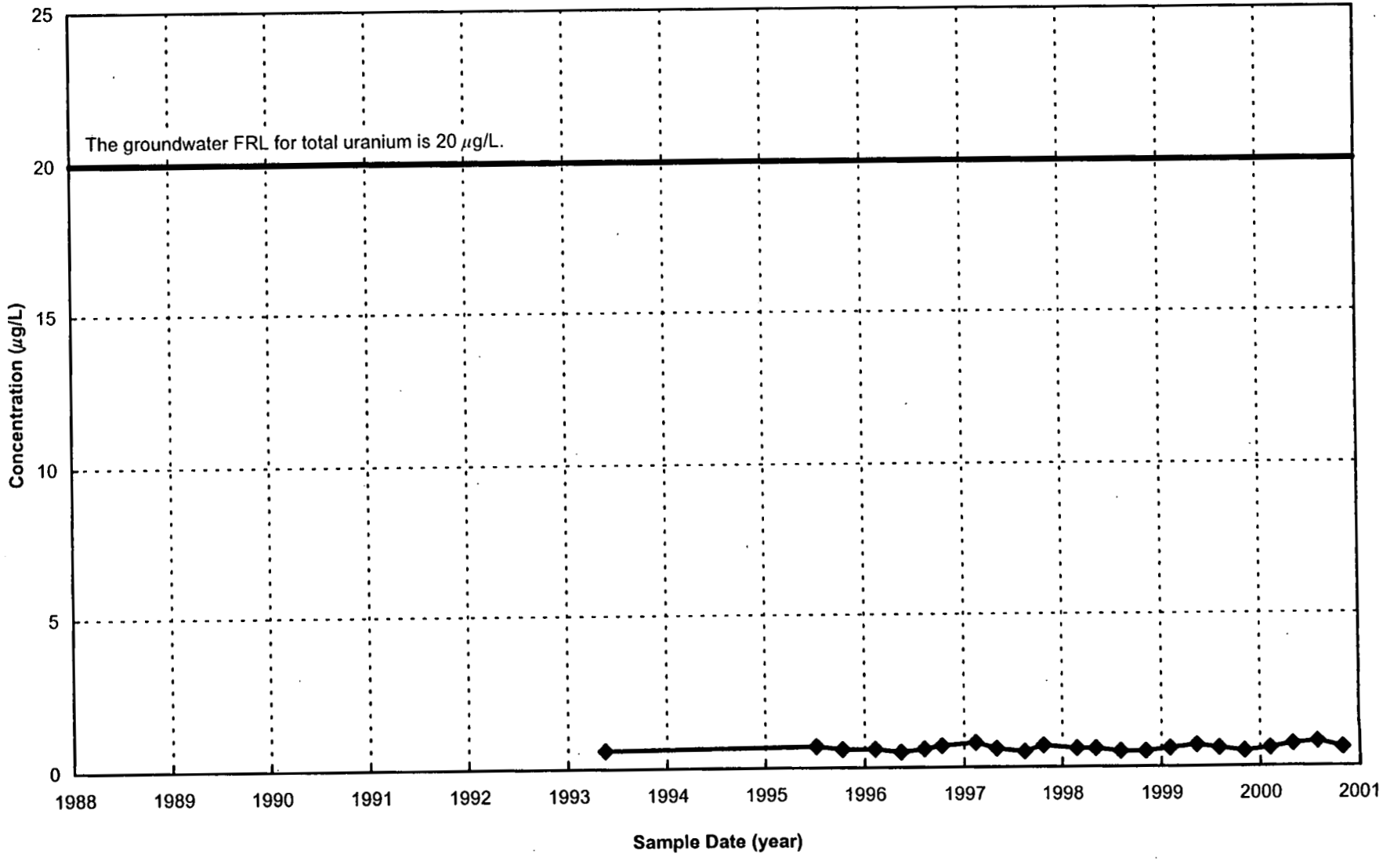


FIGURE A.2-105. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3552

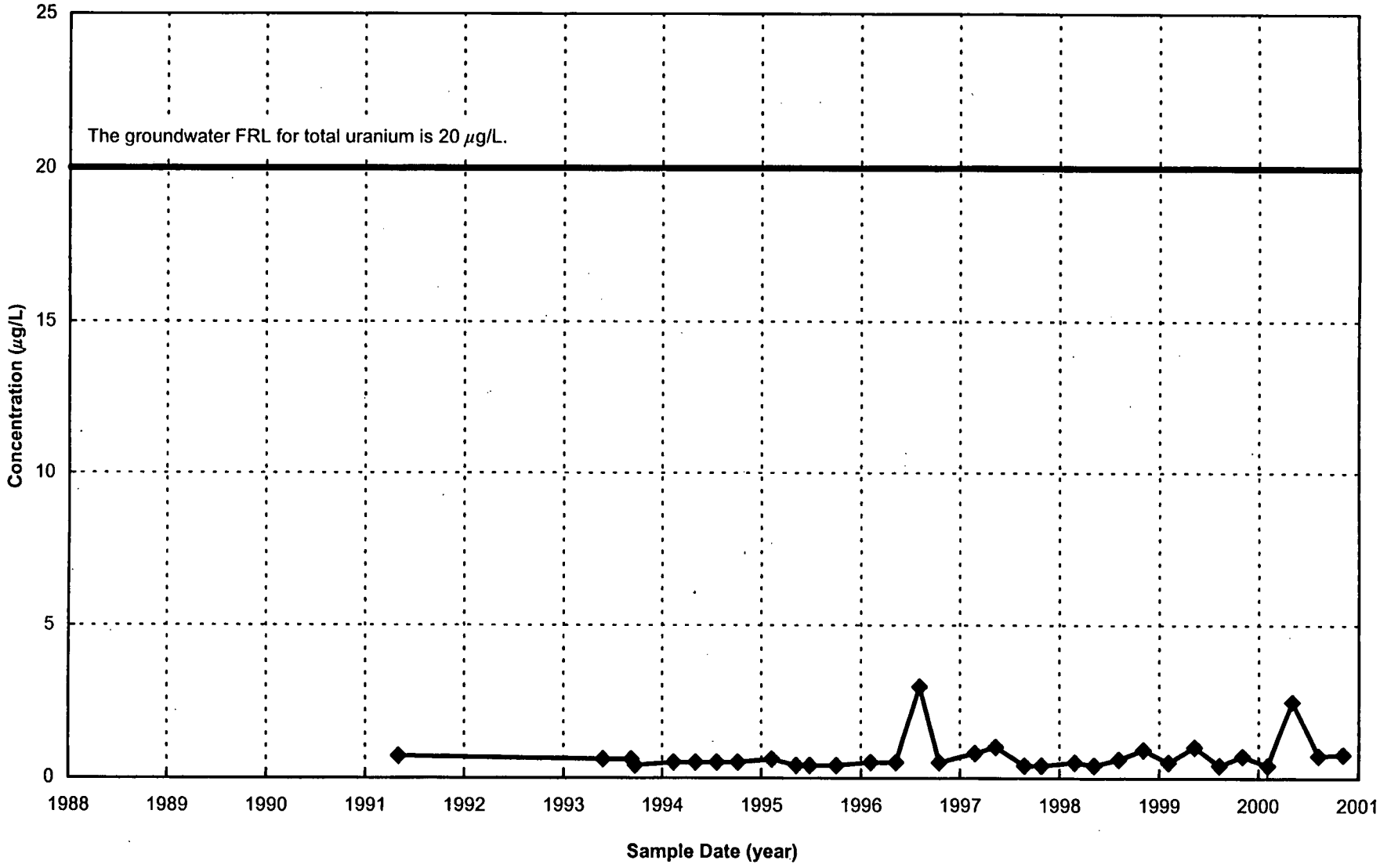


FIGURE A.2-106. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3636

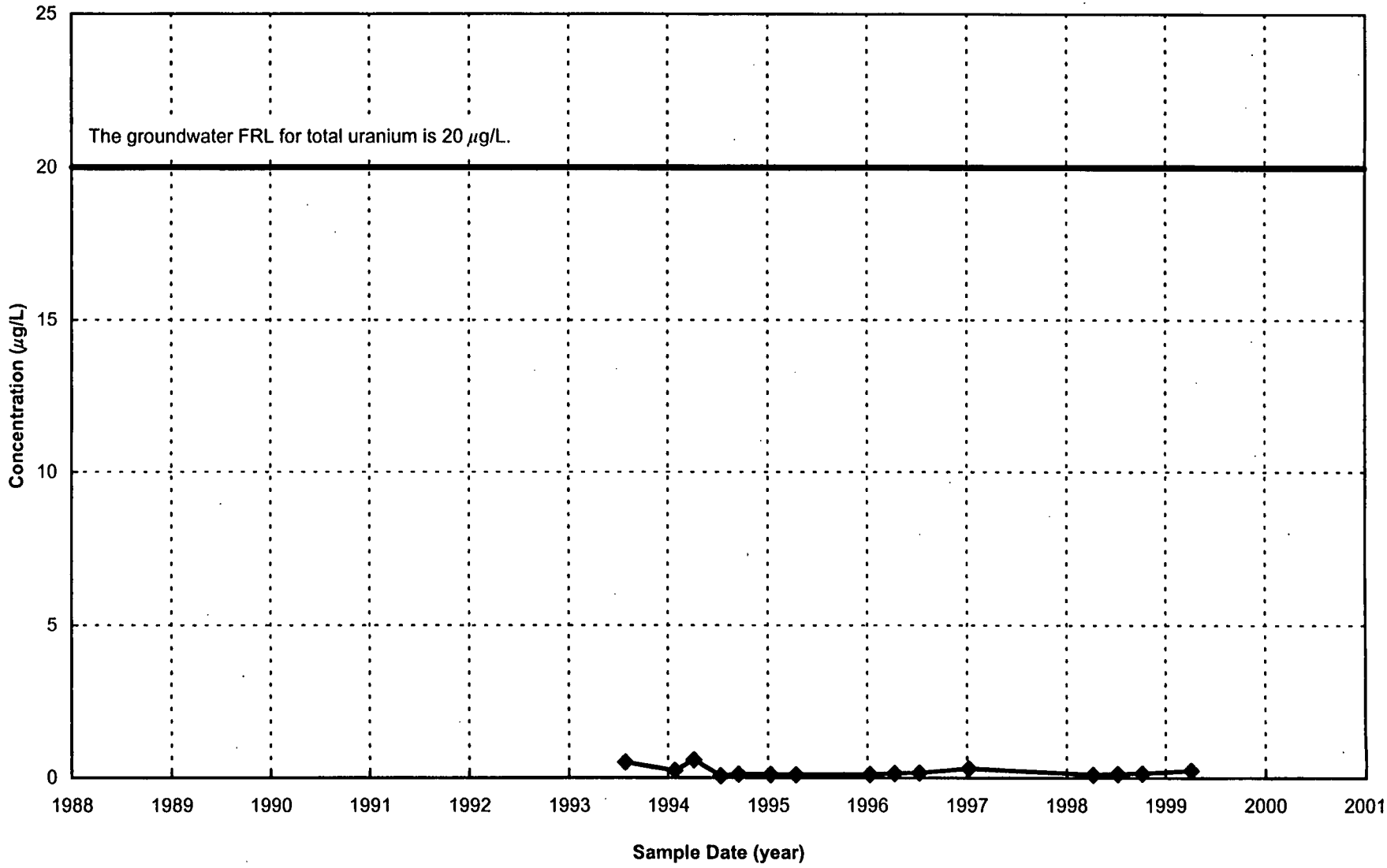


FIGURE A.2-107. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3733

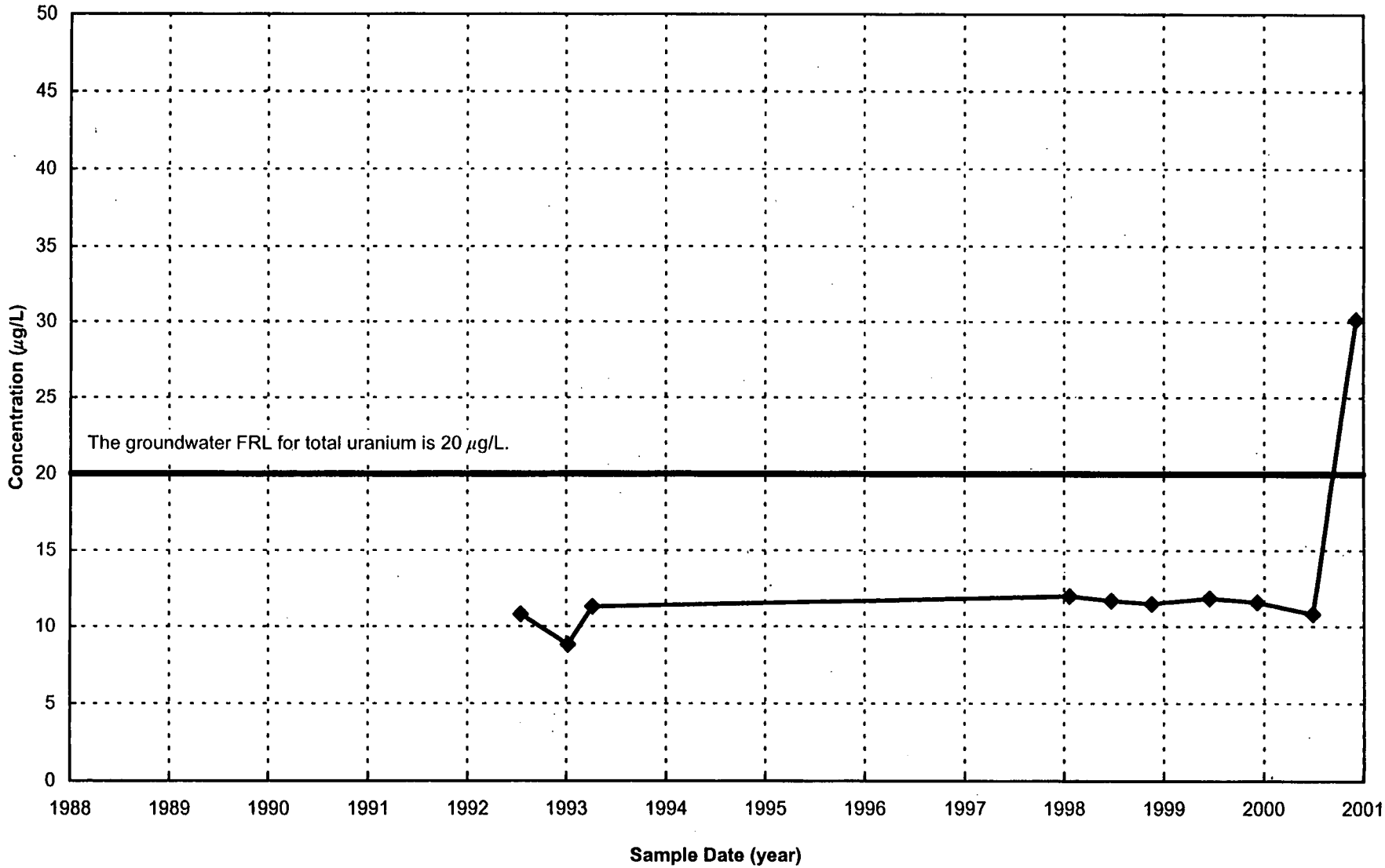


FIGURE A.2-108. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3821

000191

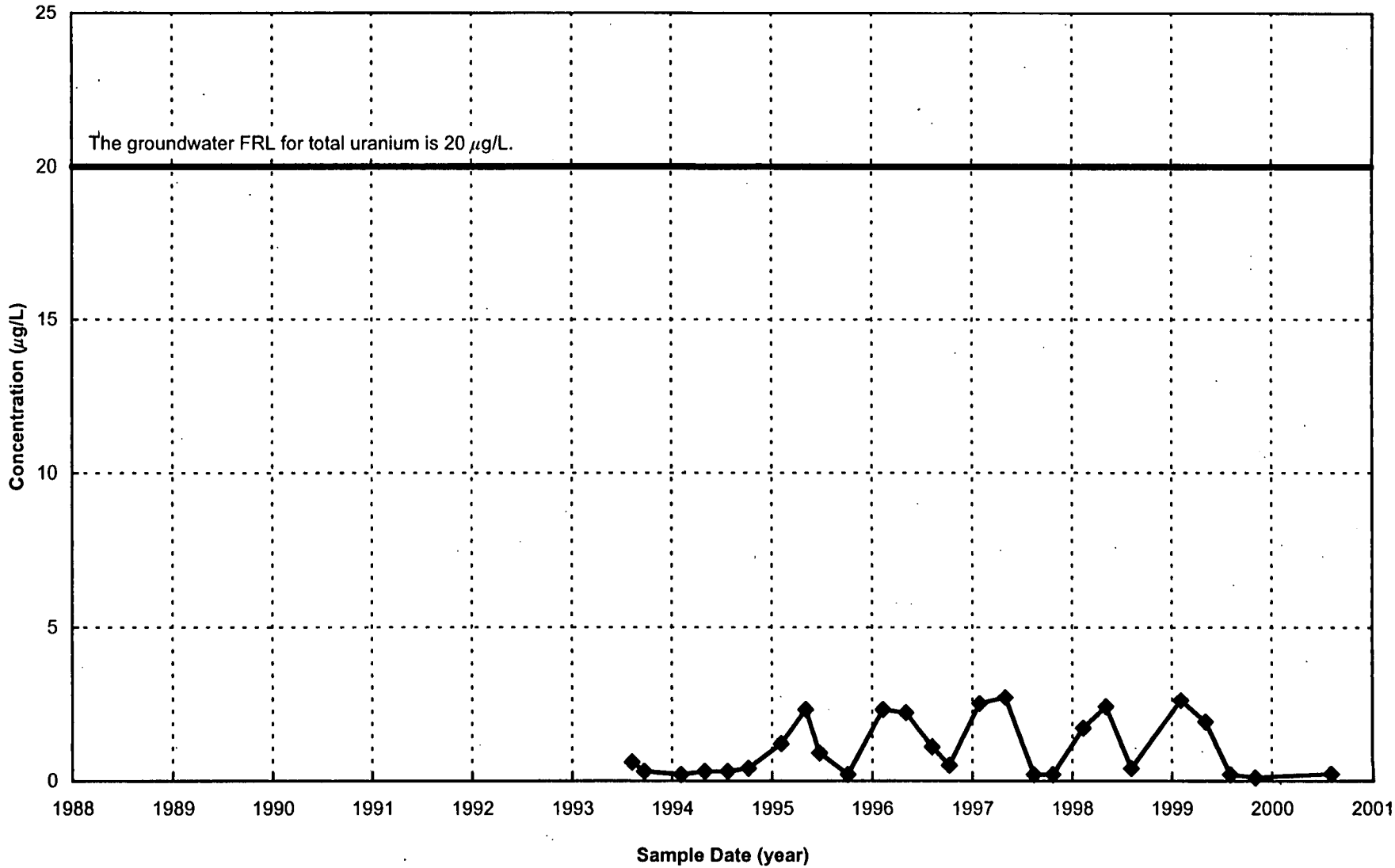


FIGURE A.2-109. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3880

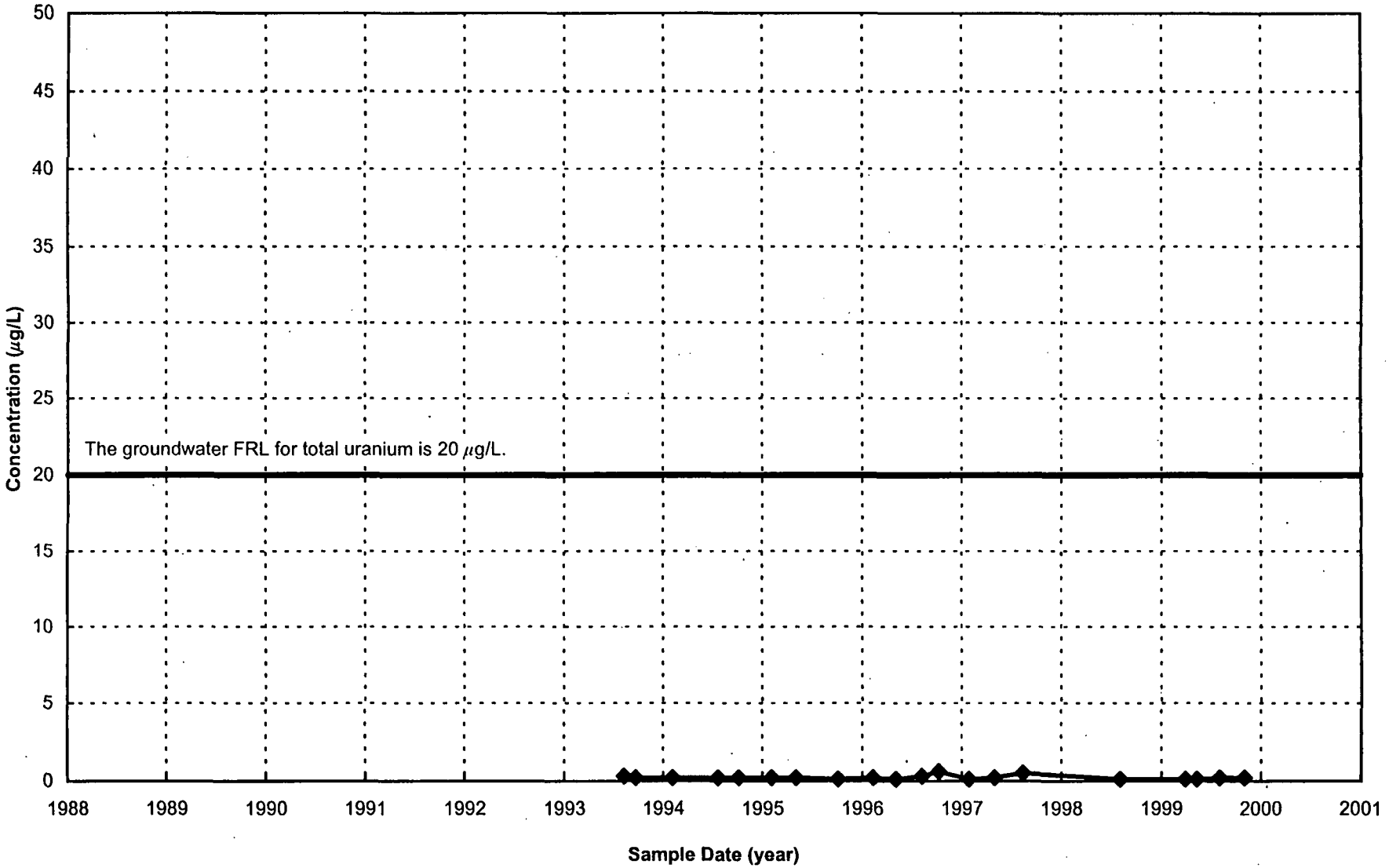


FIGURE A.2-110. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3881

000193

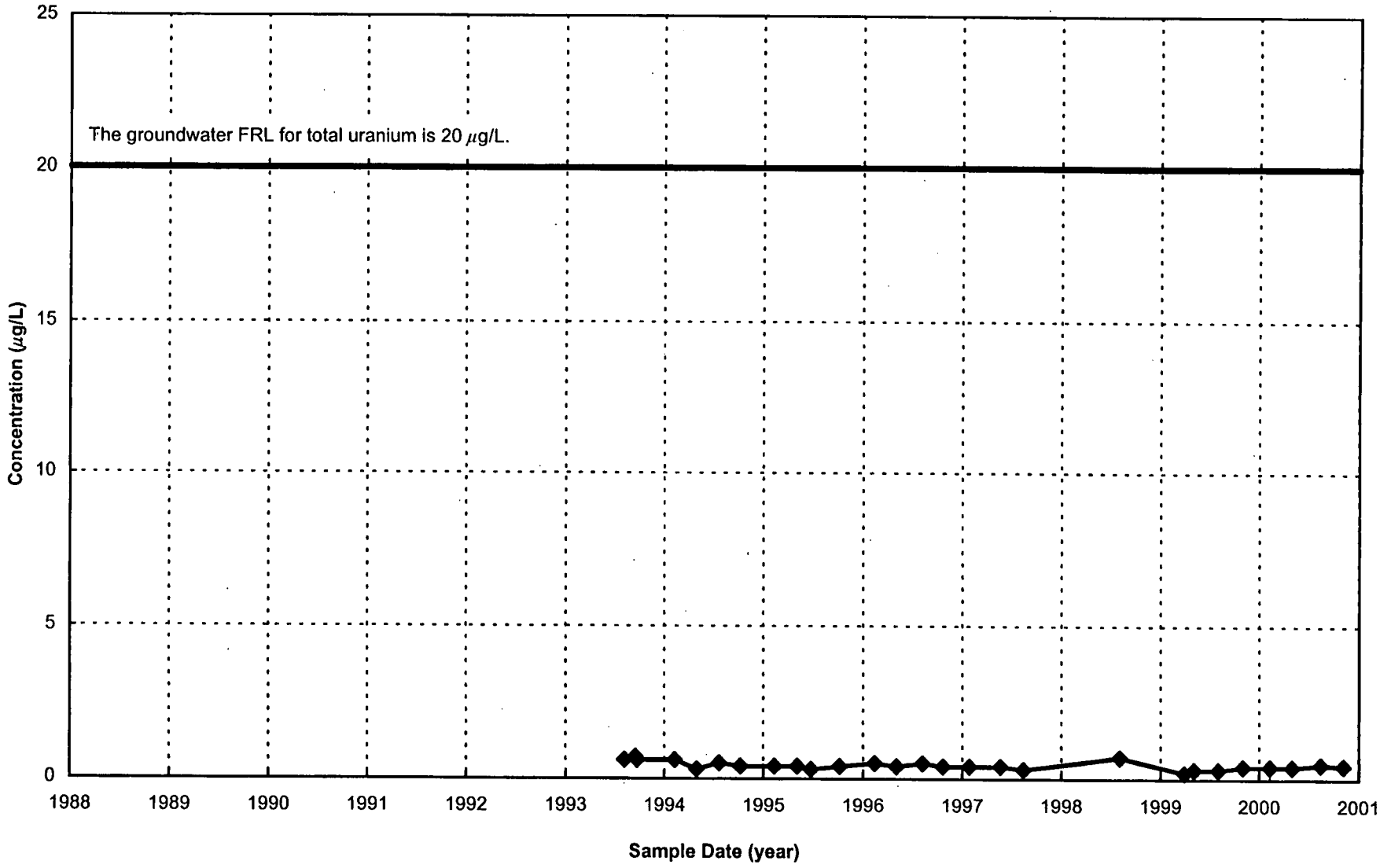


FIGURE A.2-111. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3897

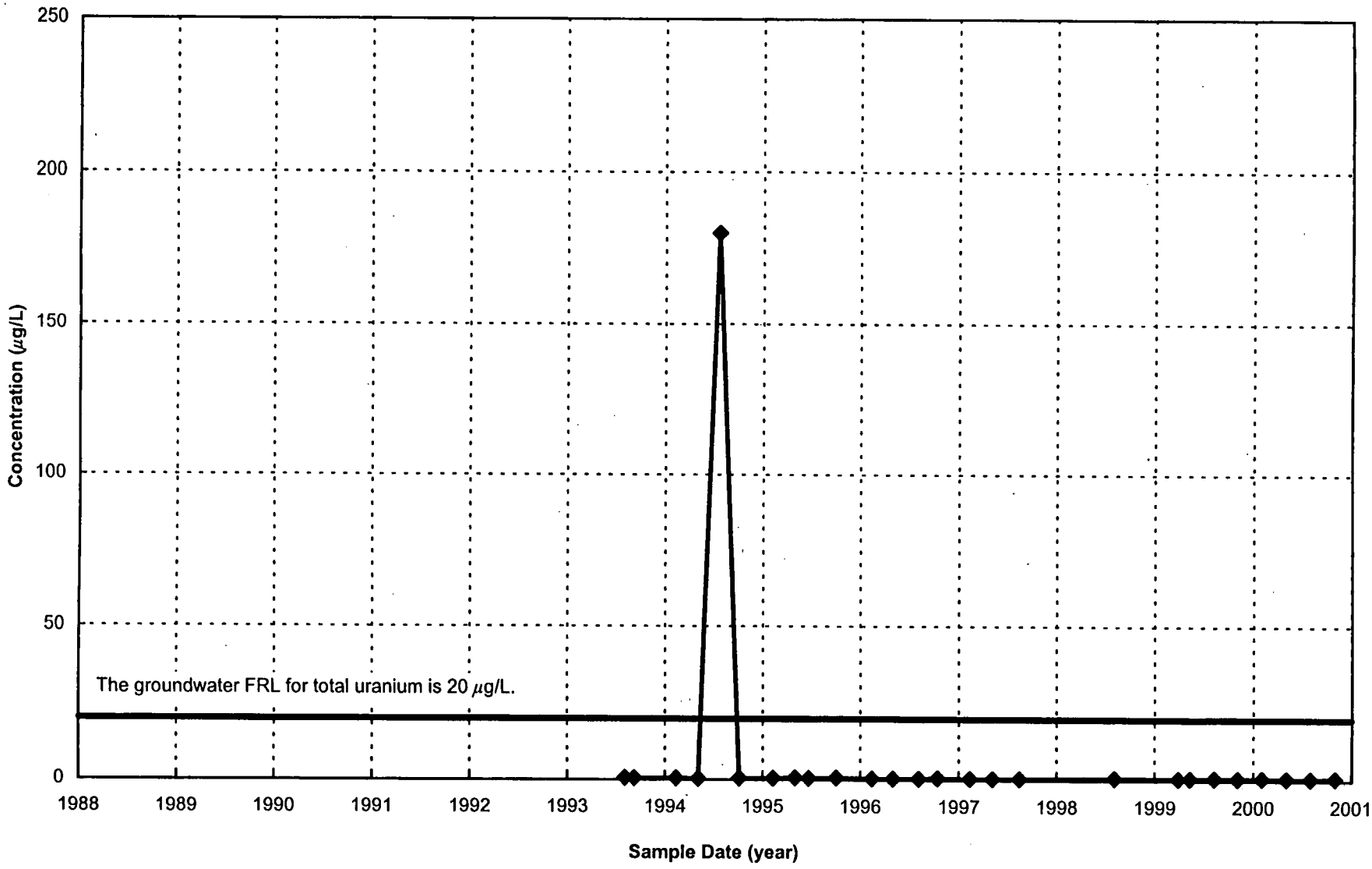


FIGURE A.2-112. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3898

000195

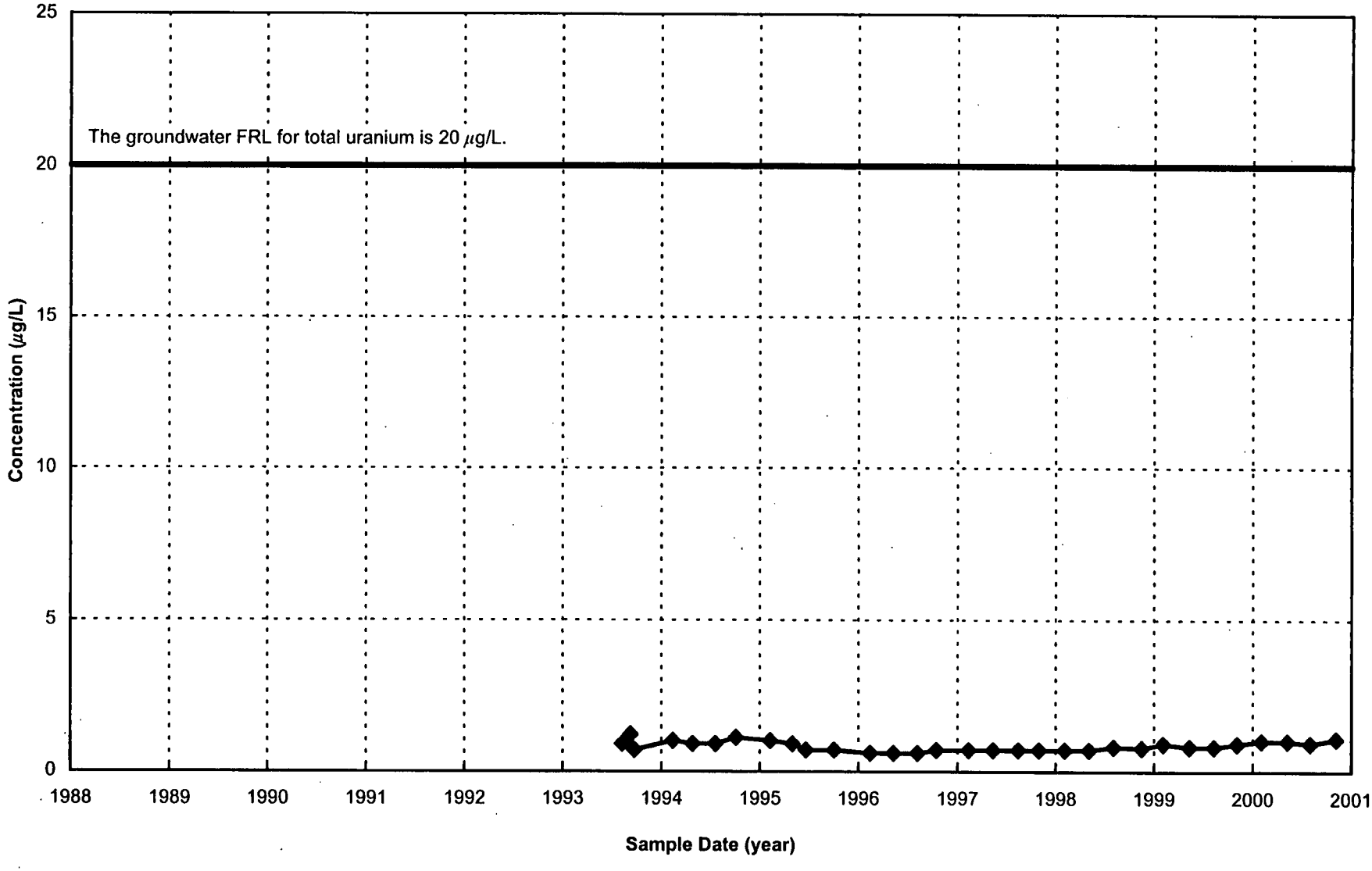


FIGURE A.2-113. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3899

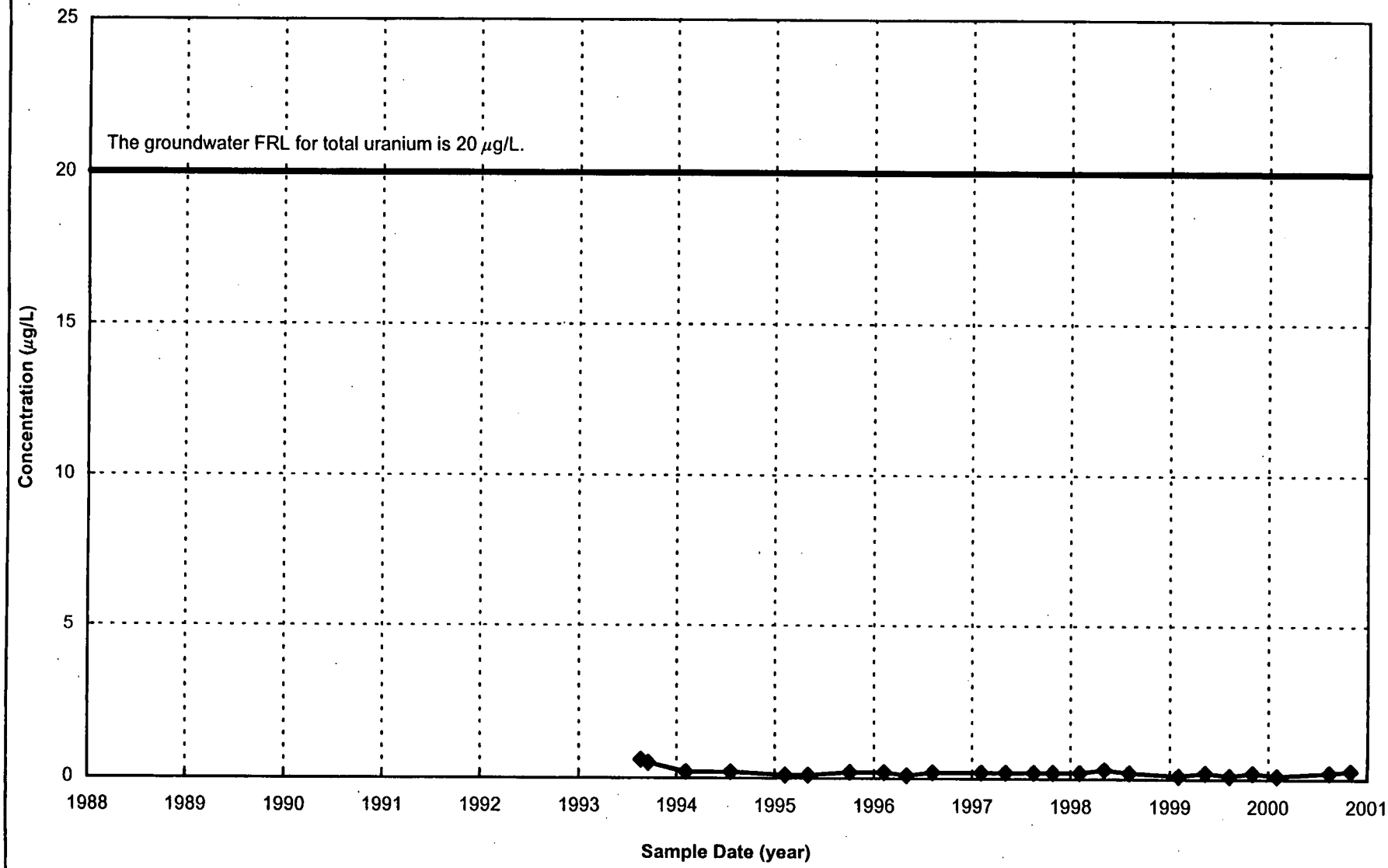


FIGURE A.2-114. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3900

000197

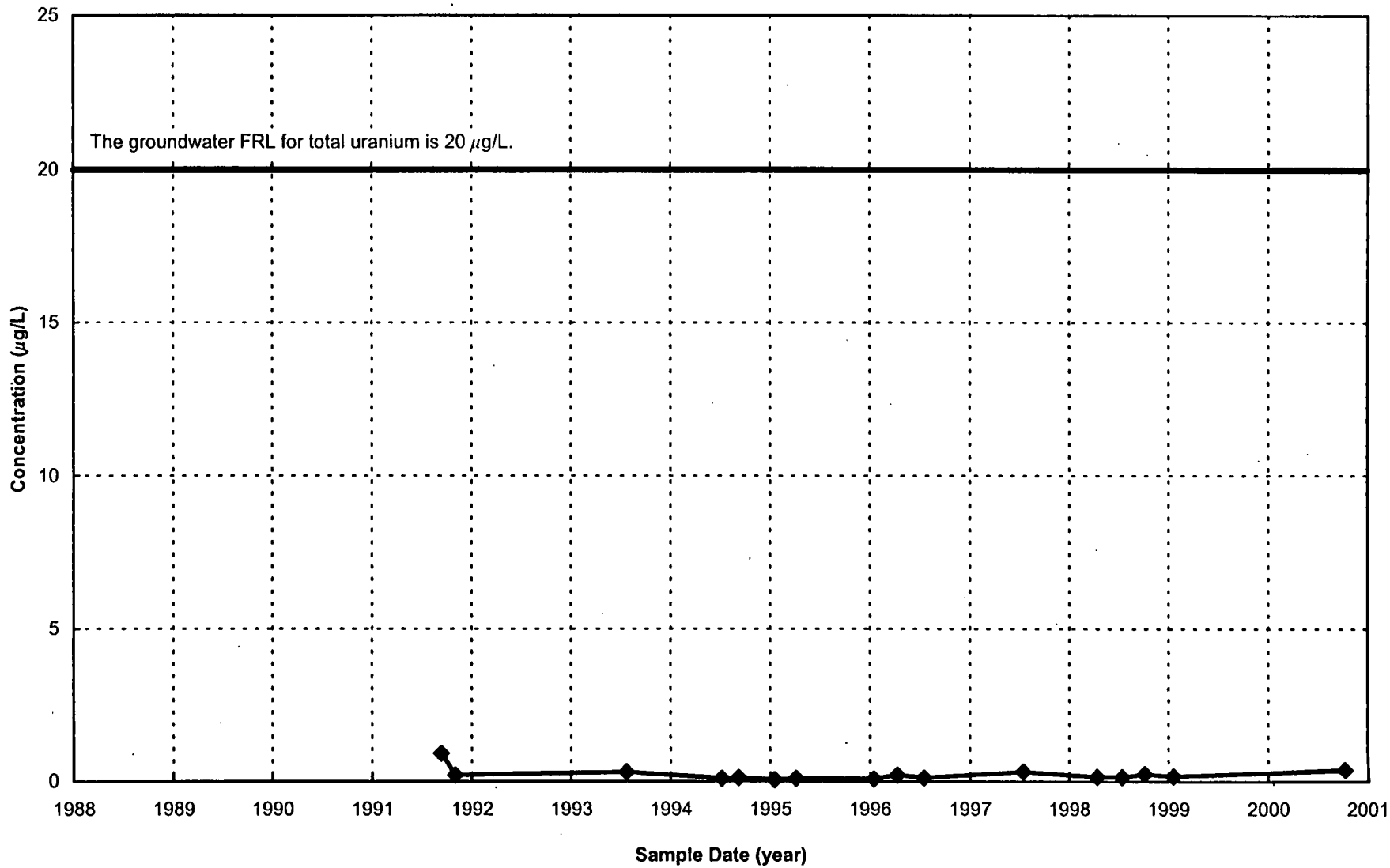


FIGURE A.2-115. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 4067

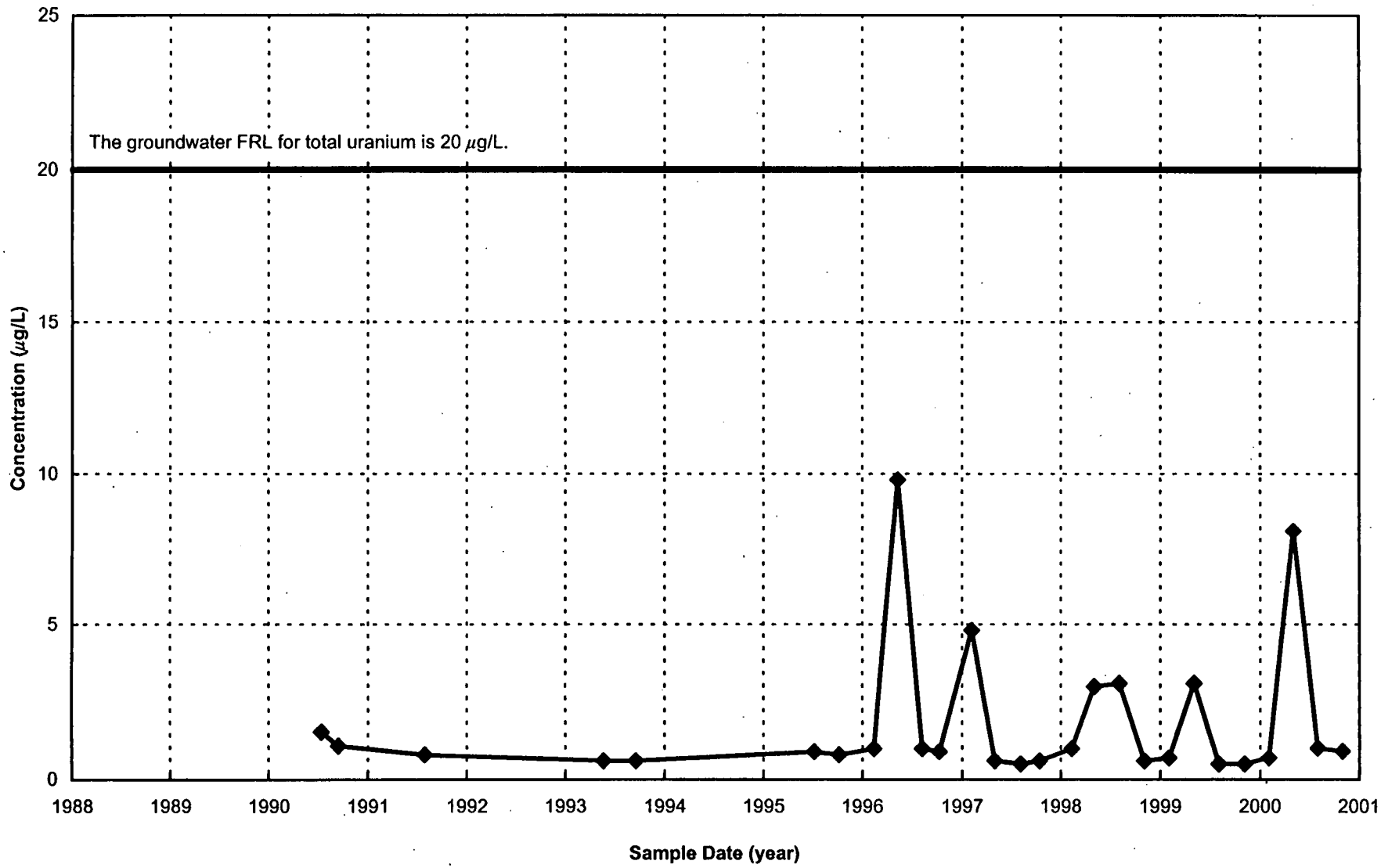


FIGURE A.2-116. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 4125

000199

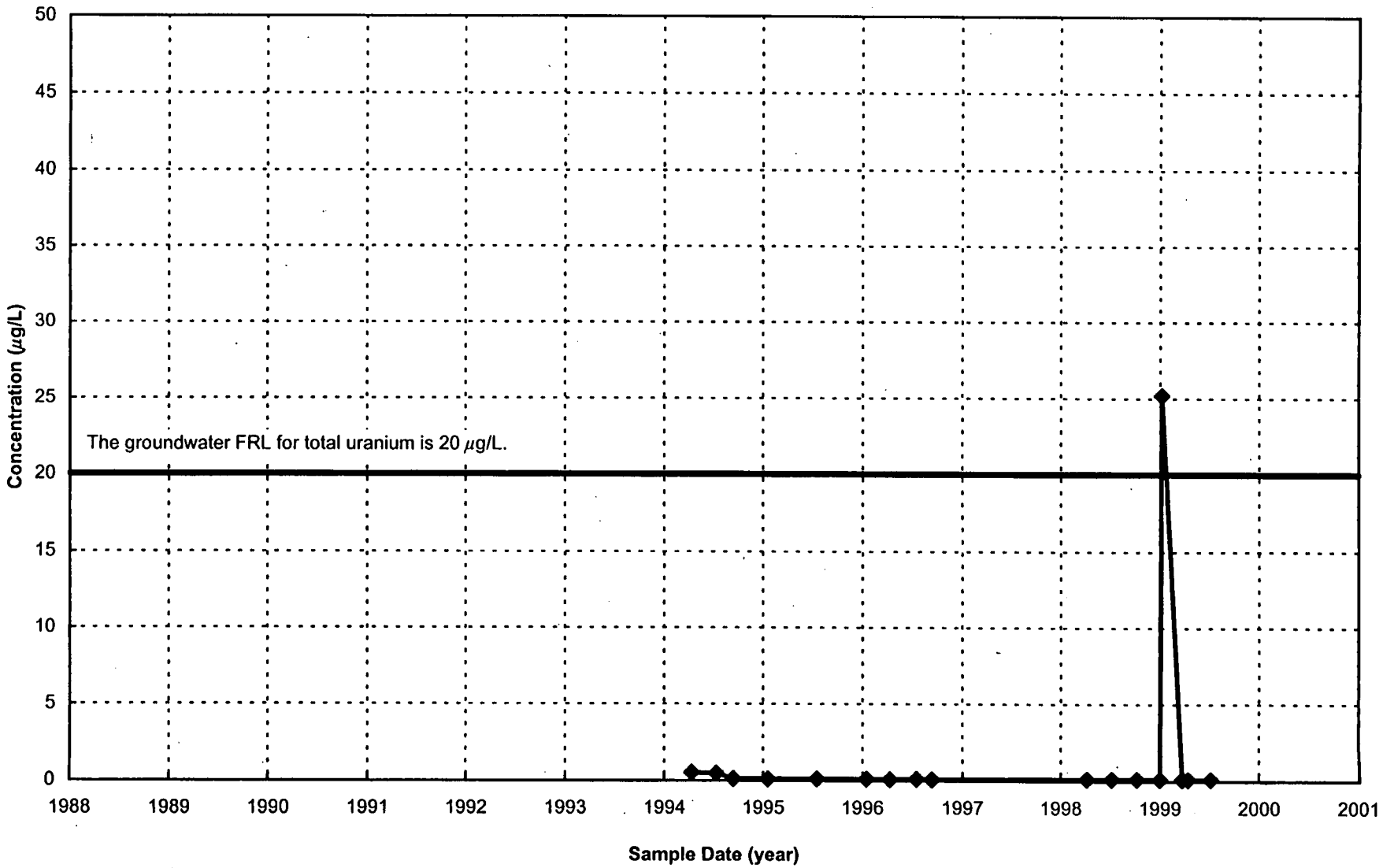


FIGURE A.2-117. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 4398

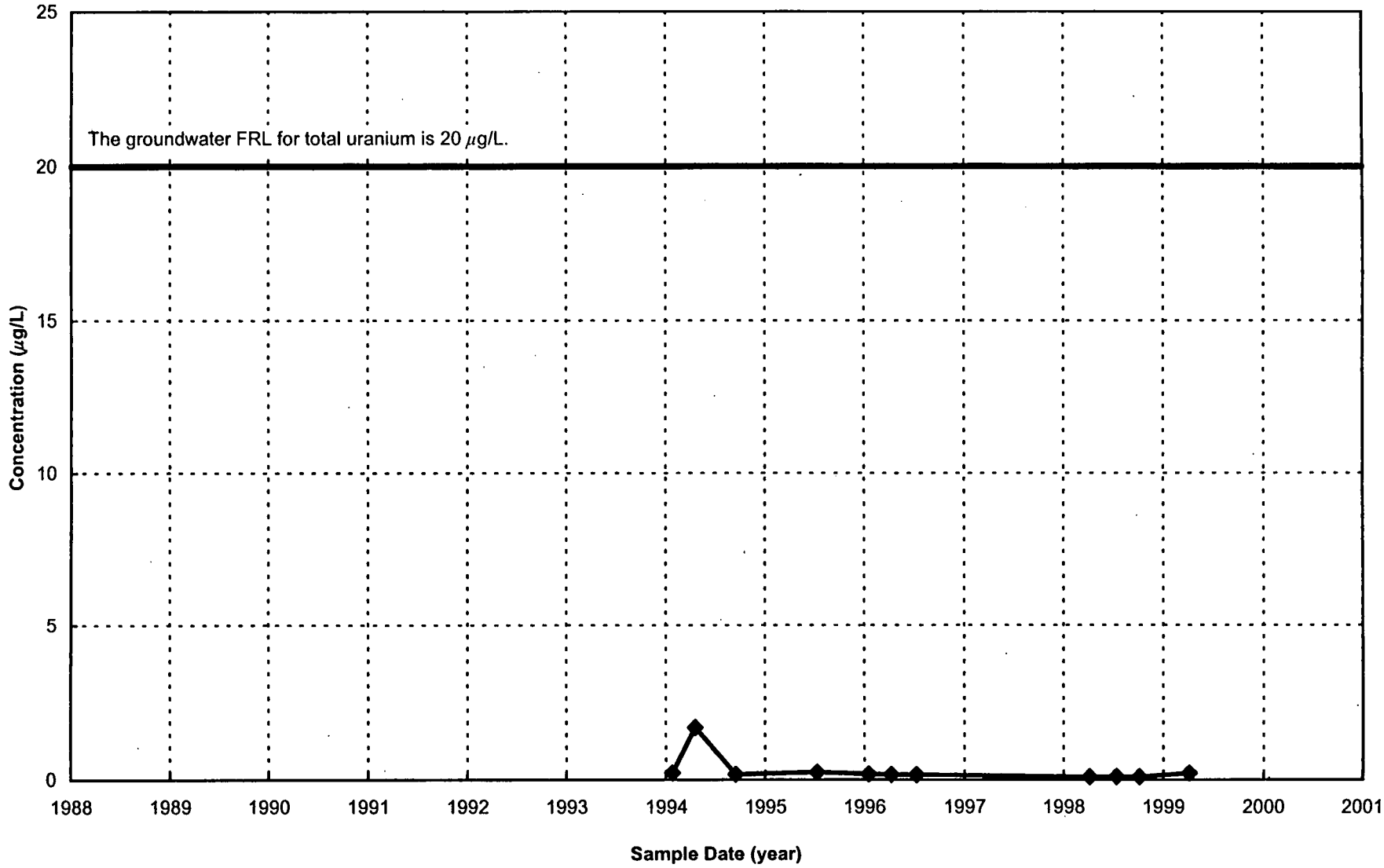


FIGURE A.2-118. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 4424

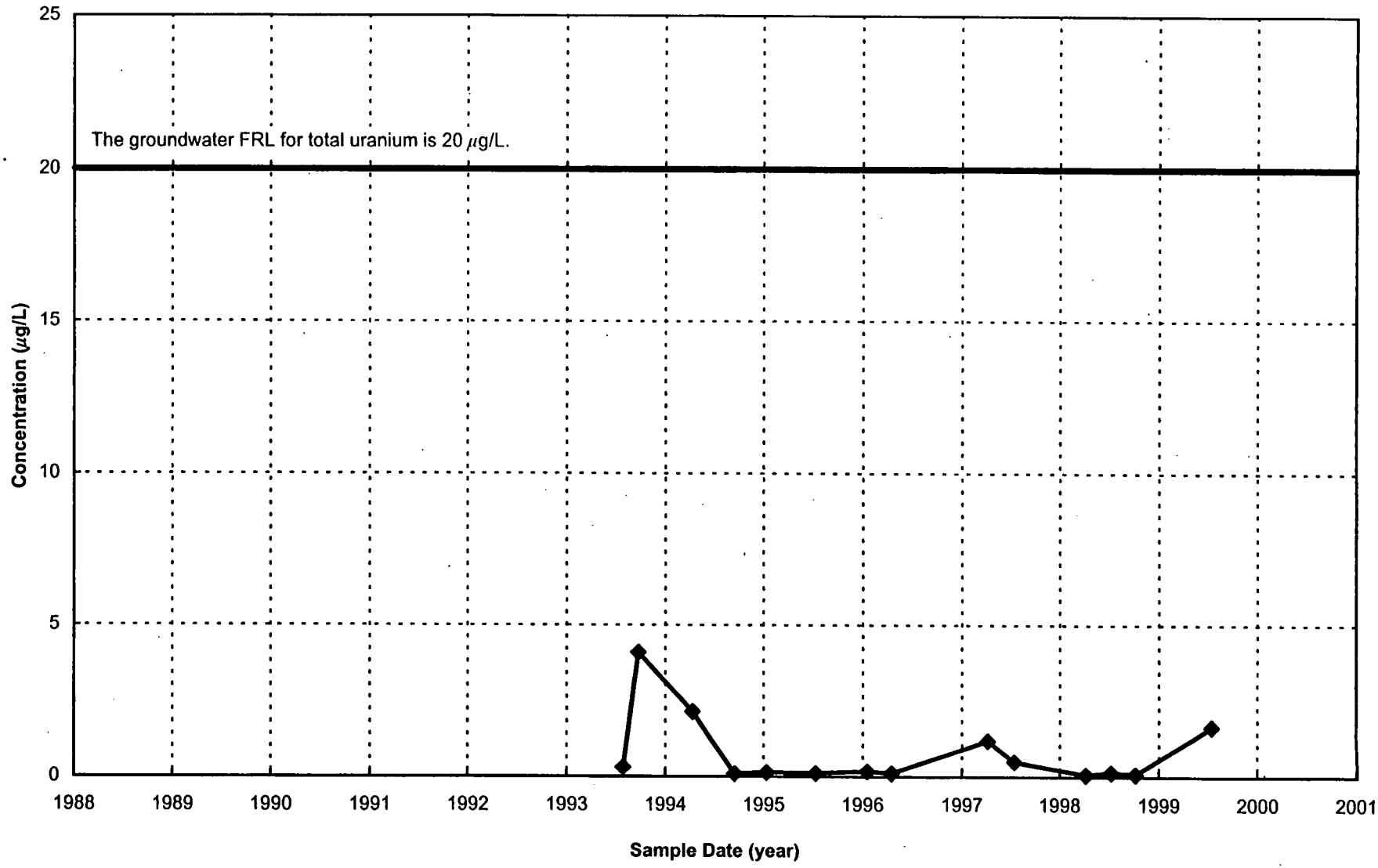


FIGURE A.2-119. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 4426

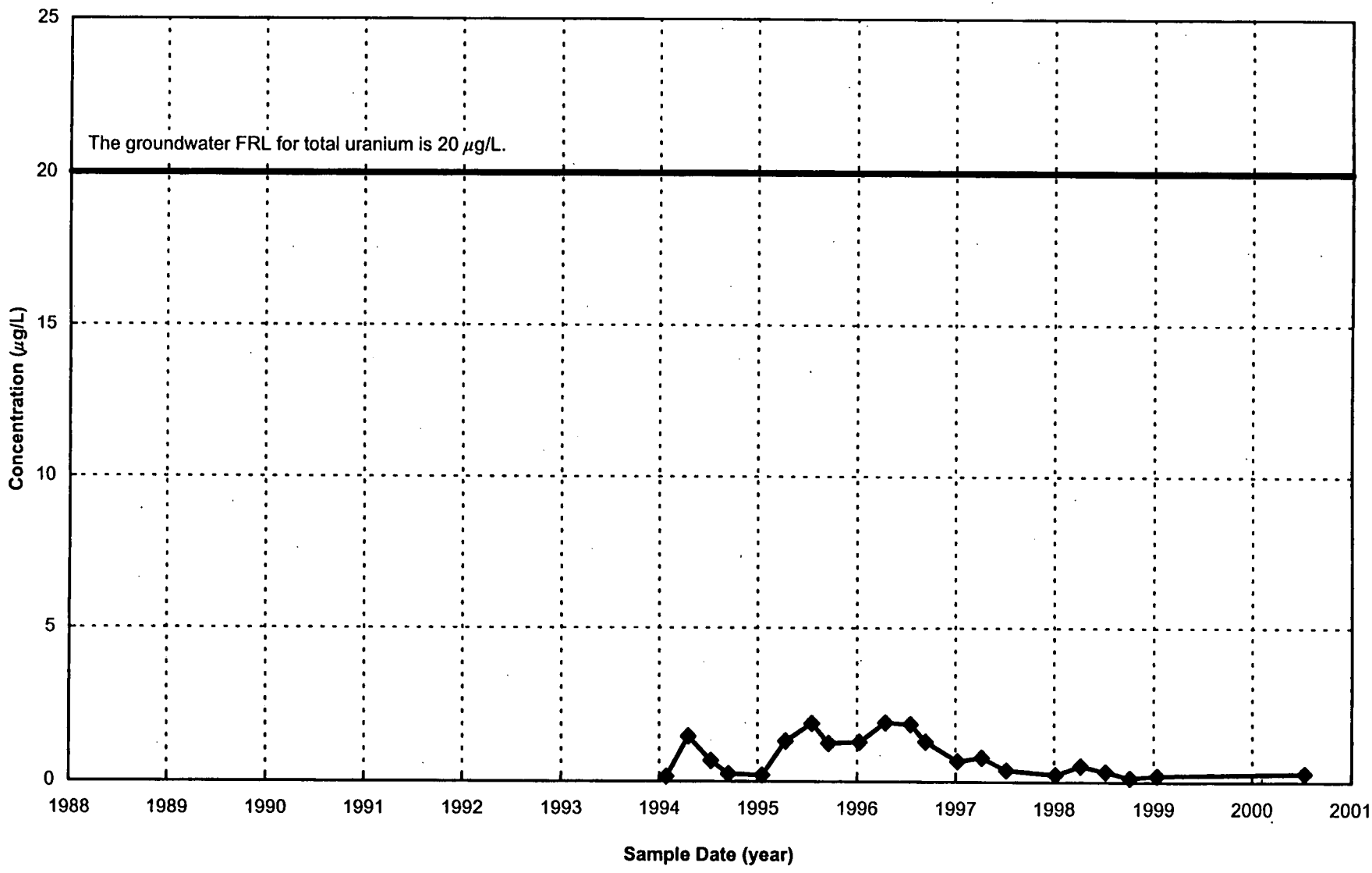


FIGURE A.2-120. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 4432

000203

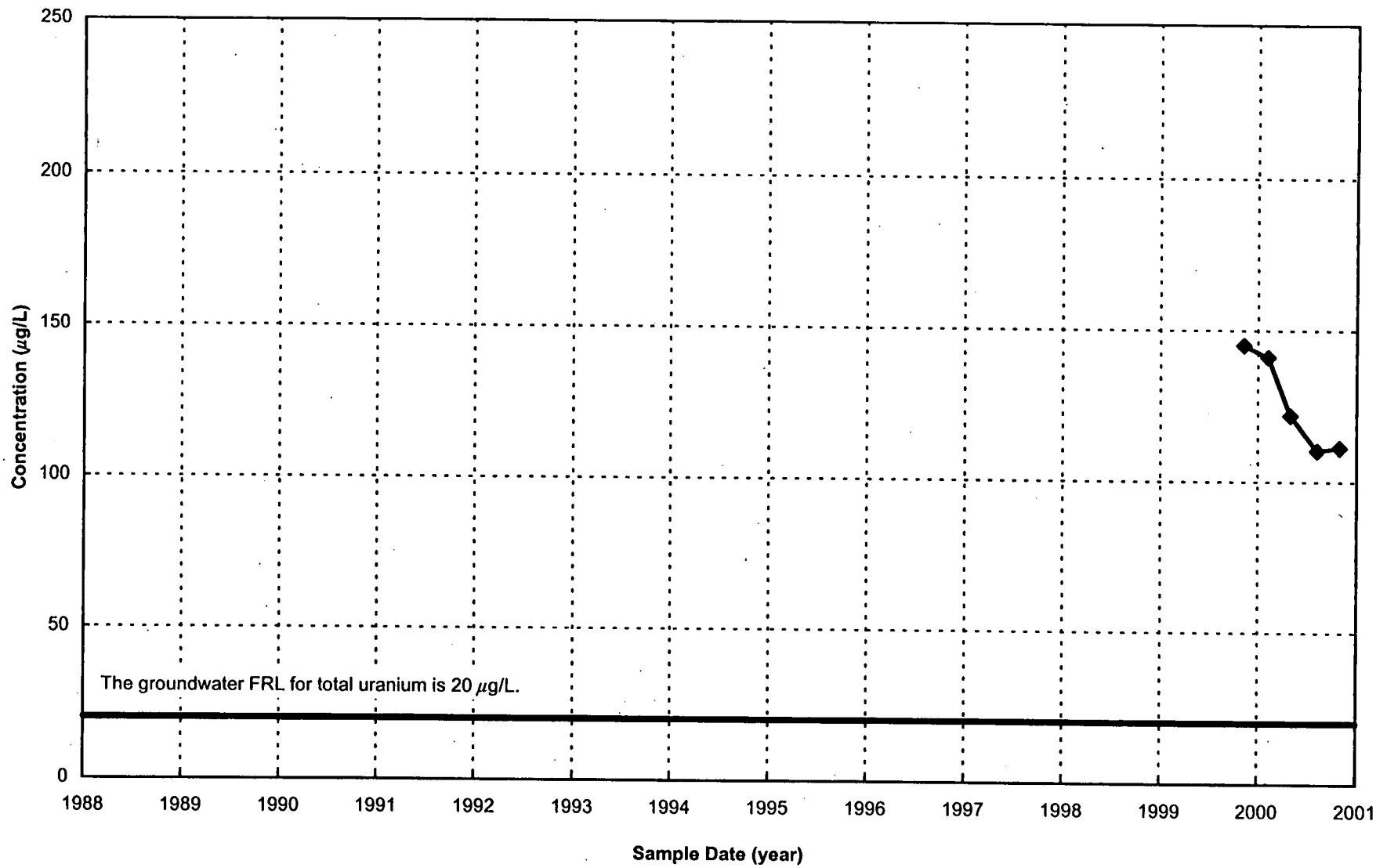


FIGURE A.2-121. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 6880

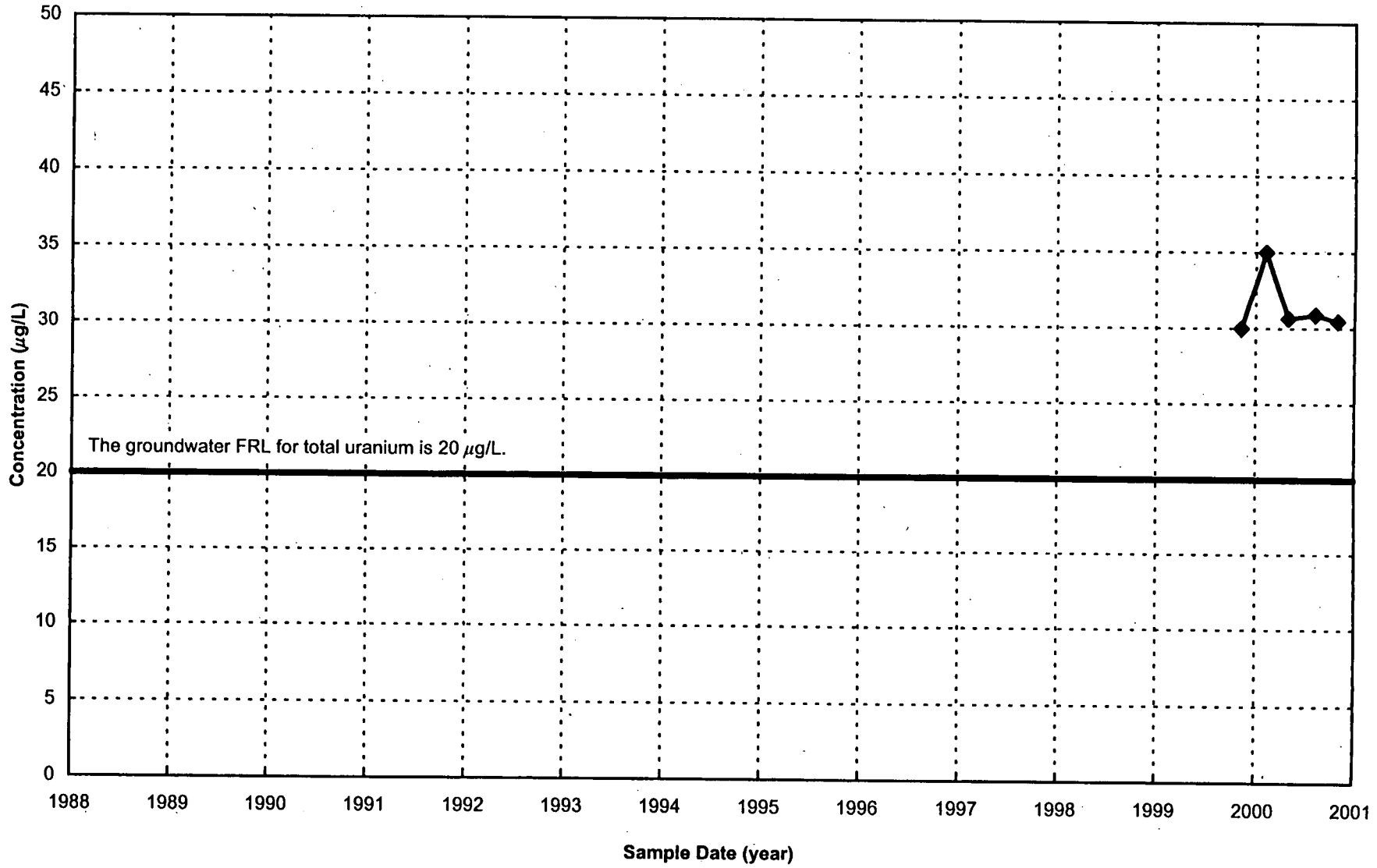


FIGURE A.2-122. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 6881

000205

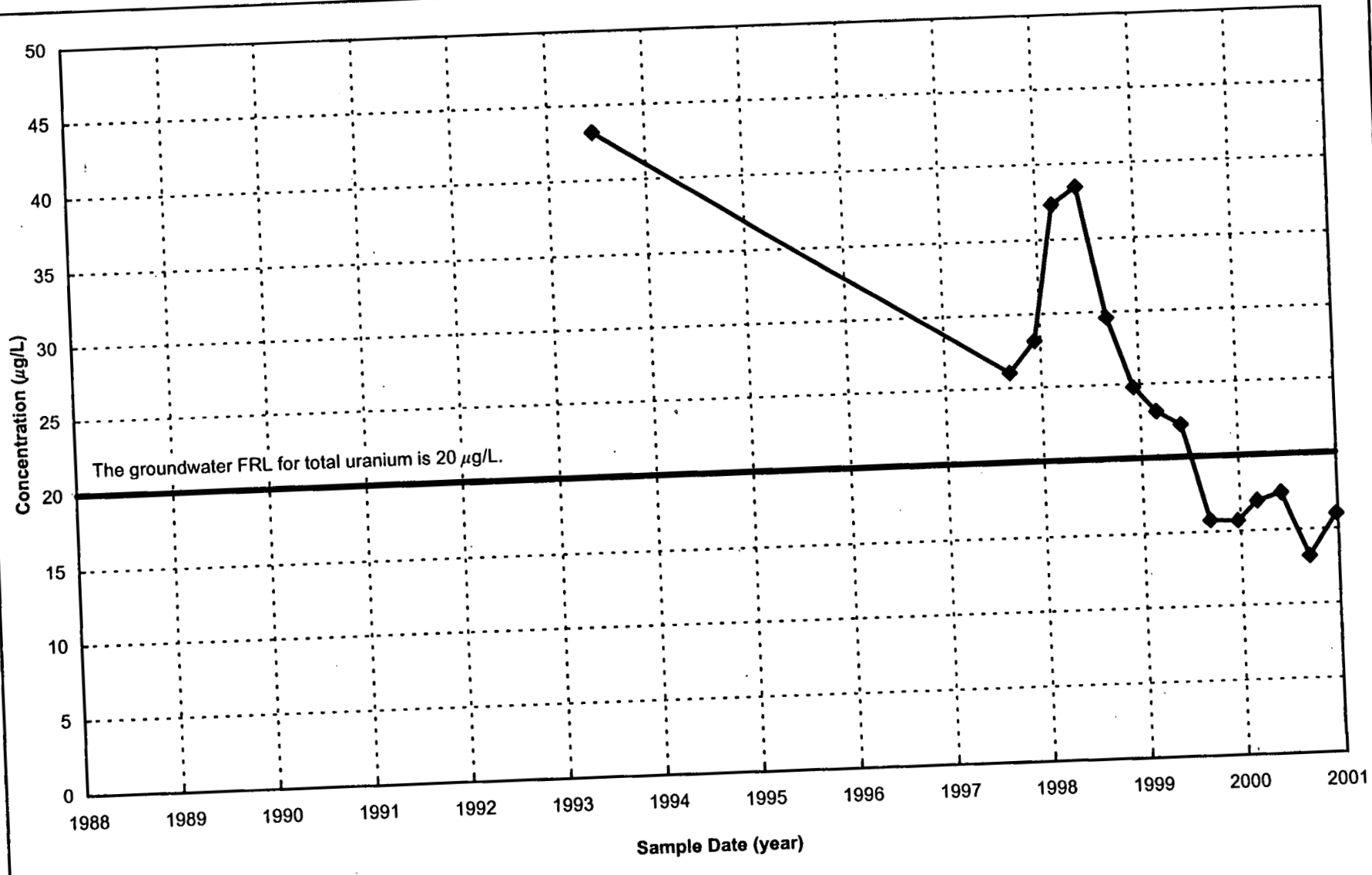


FIGURE A.2-123. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 21033

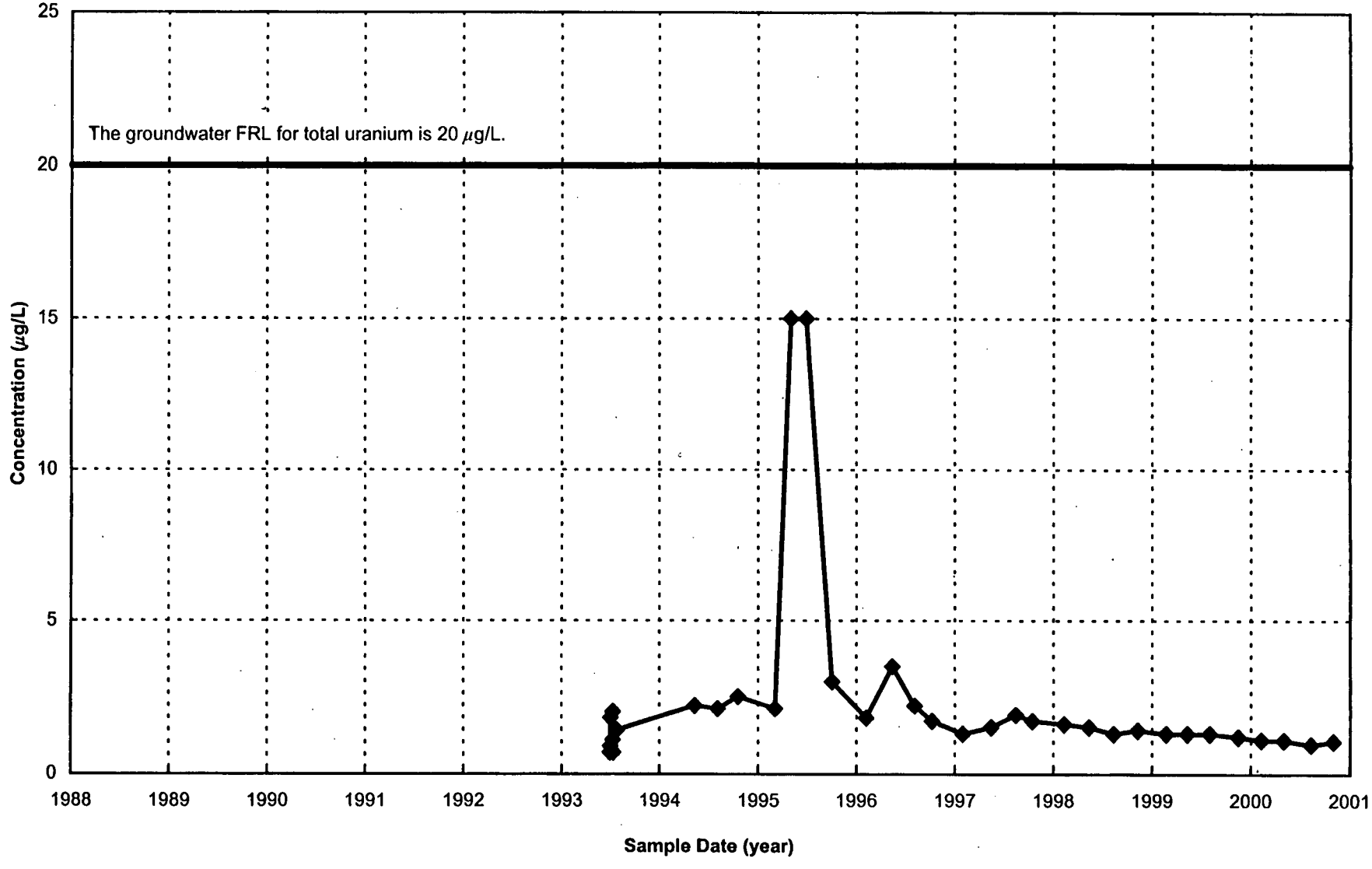


FIGURE A.2-124. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 21063

000207

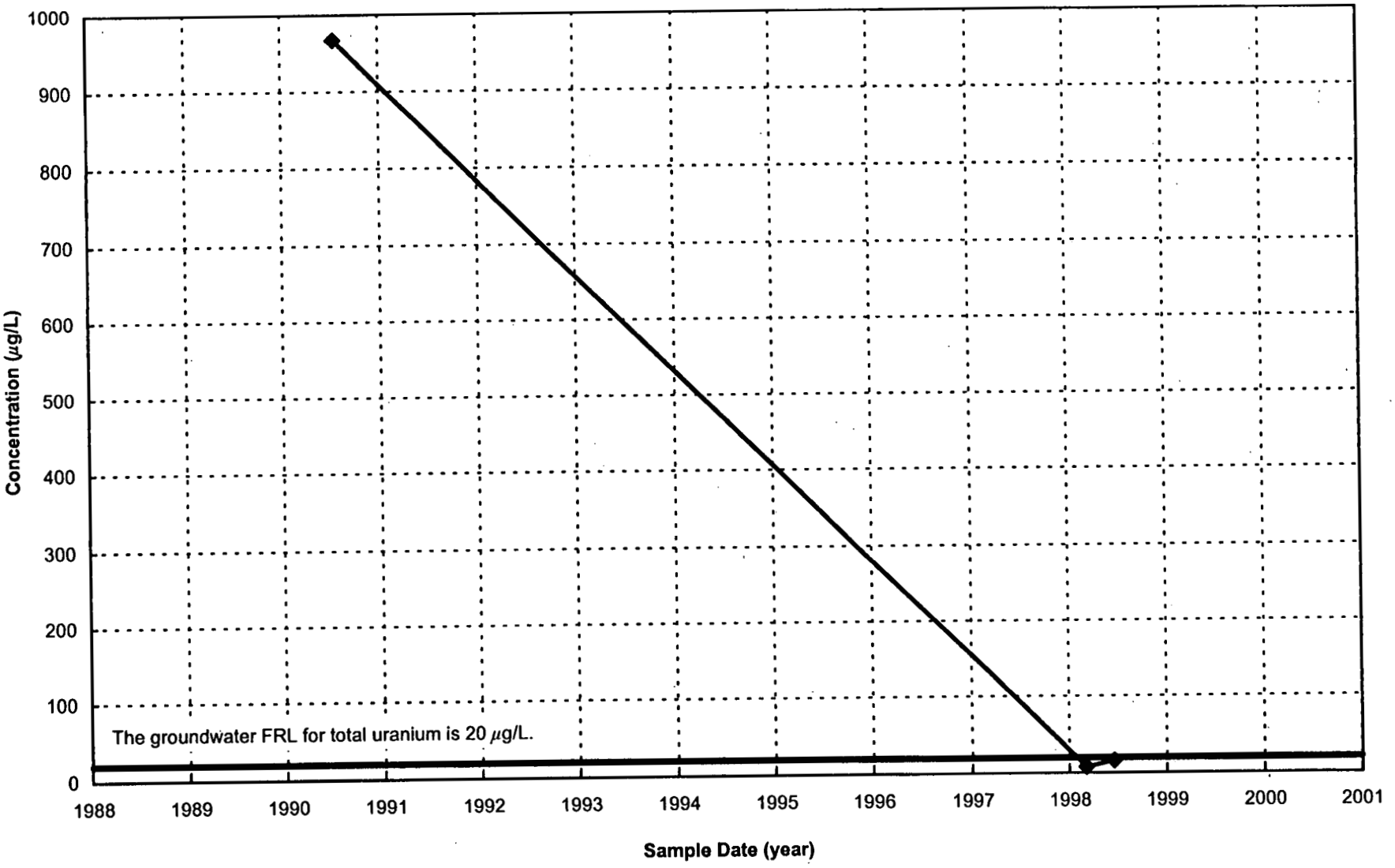


FIGURE A.2-125. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 21192

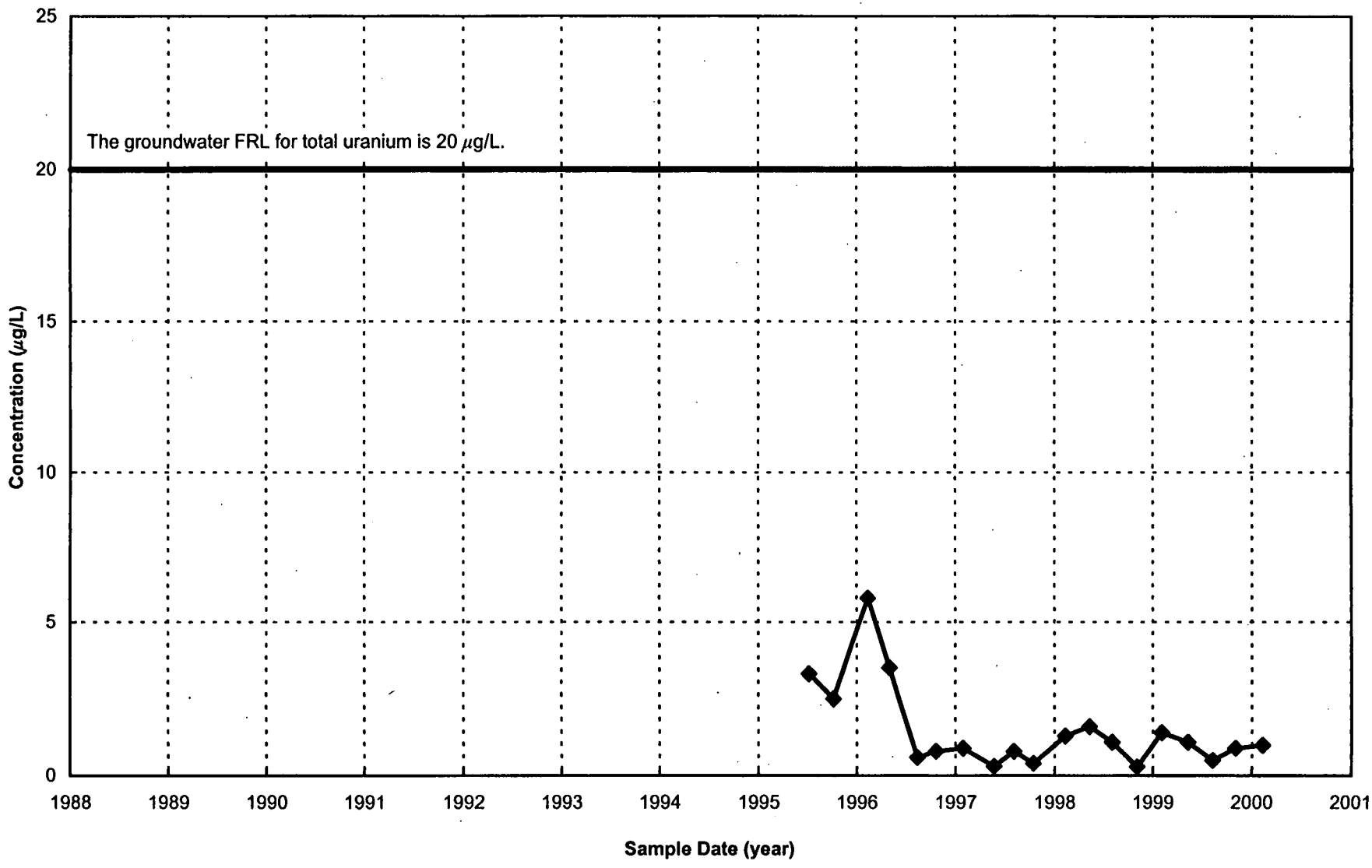


FIGURE A.2-126. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 21194

000209

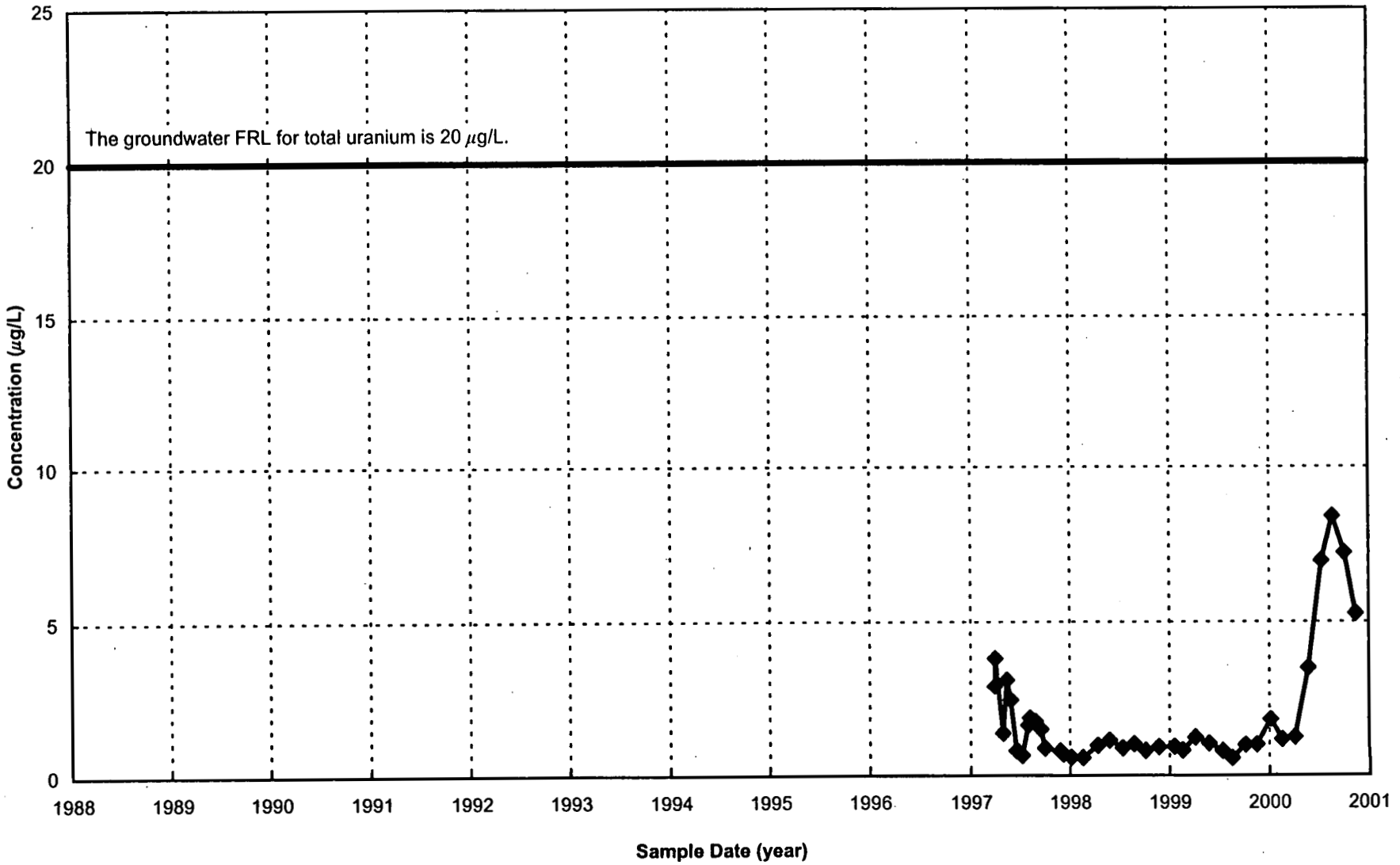


FIGURE A.2-127. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22198

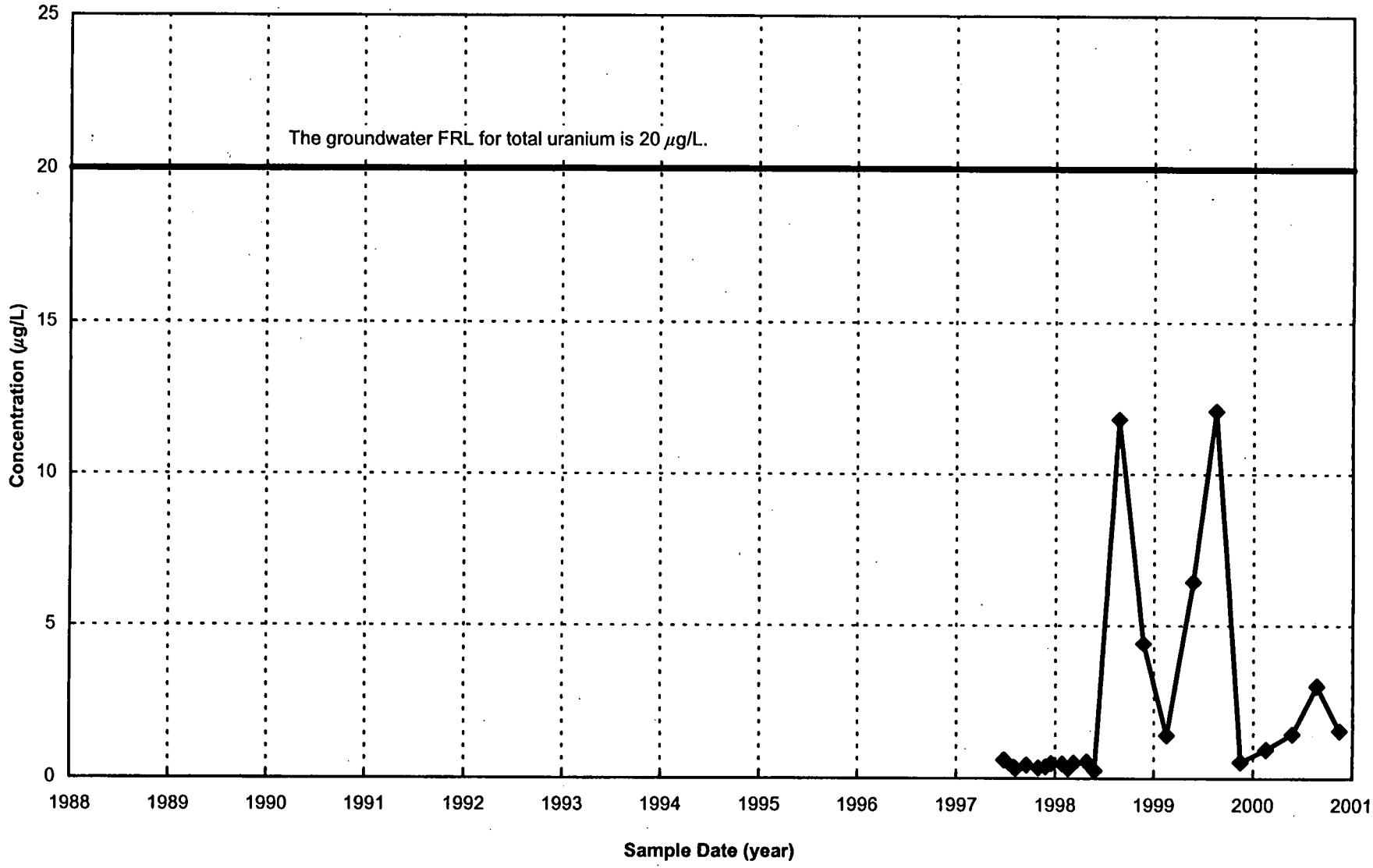


FIGURE A.2-128. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22199

000211

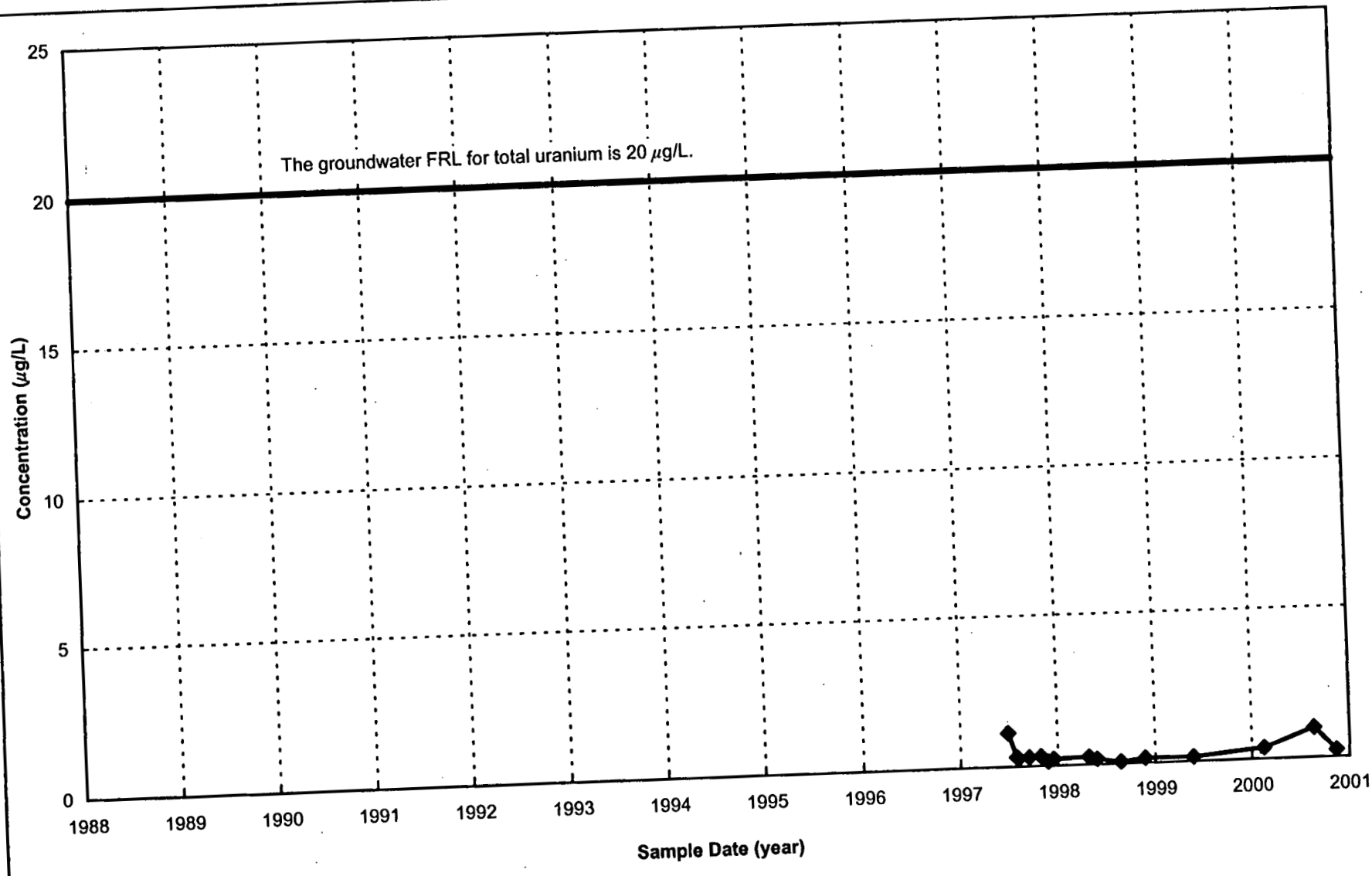


FIGURE A.2-129. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22200

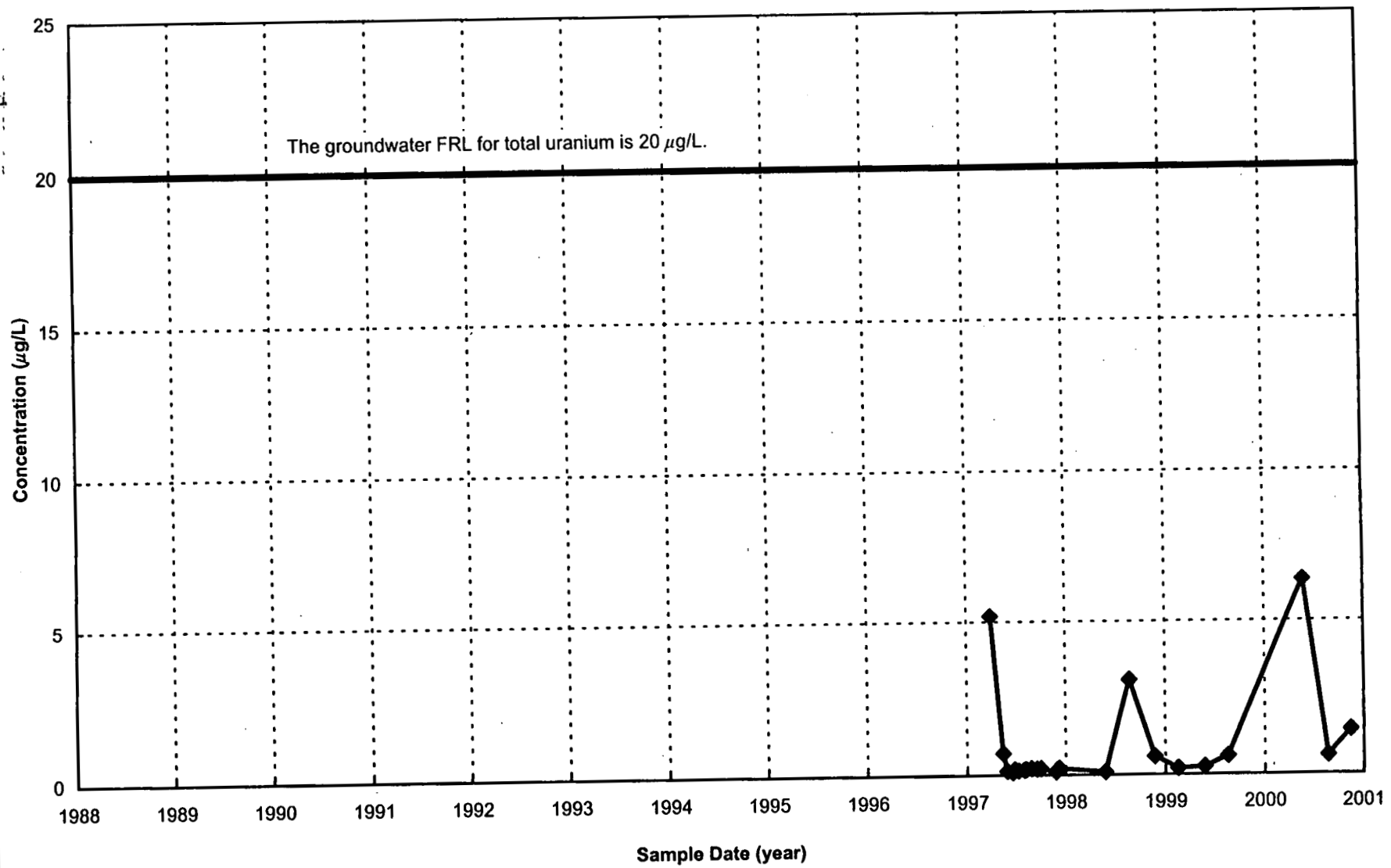


FIGURE A.2-130. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22201

000213

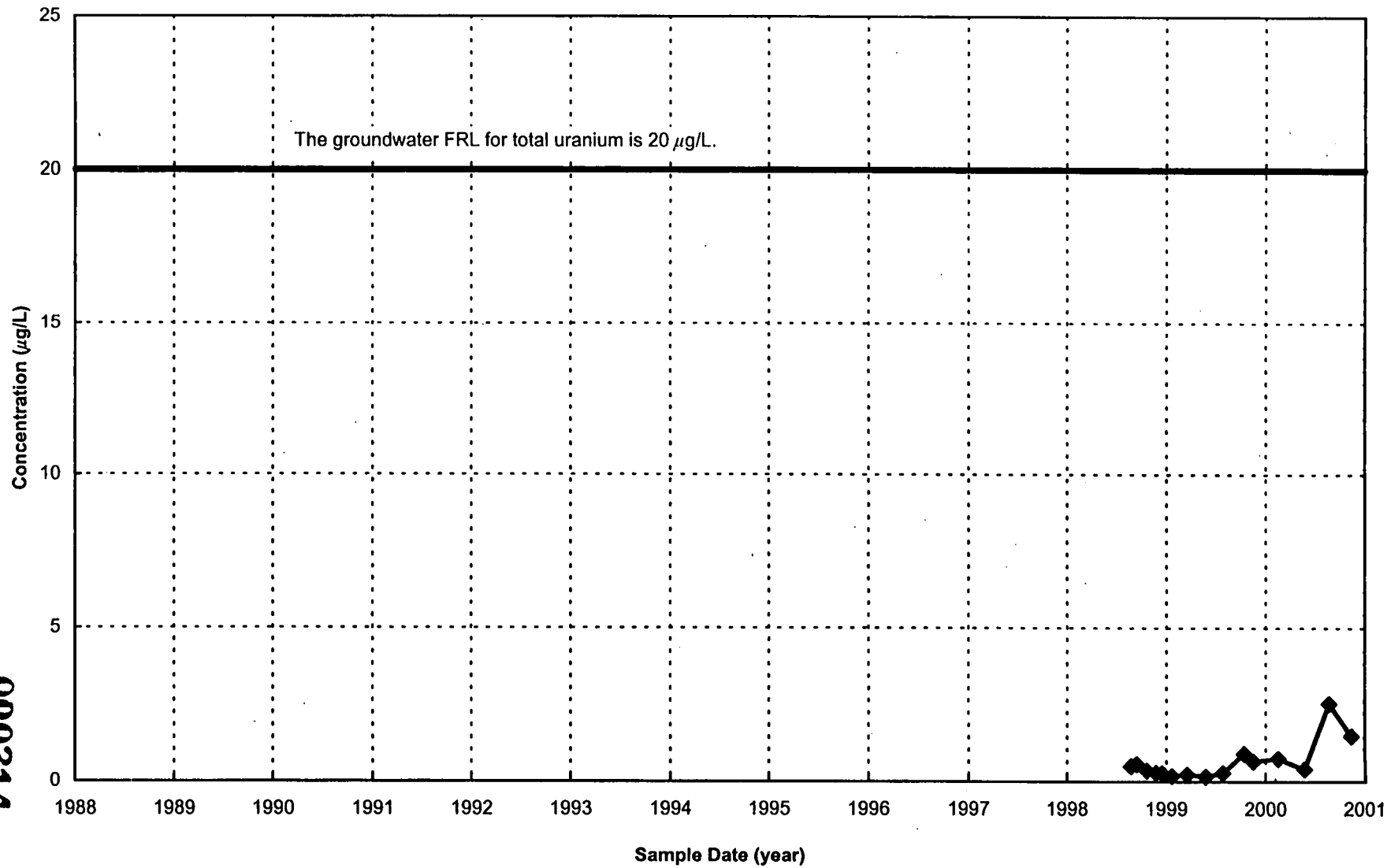


FIGURE A.2-131. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22203

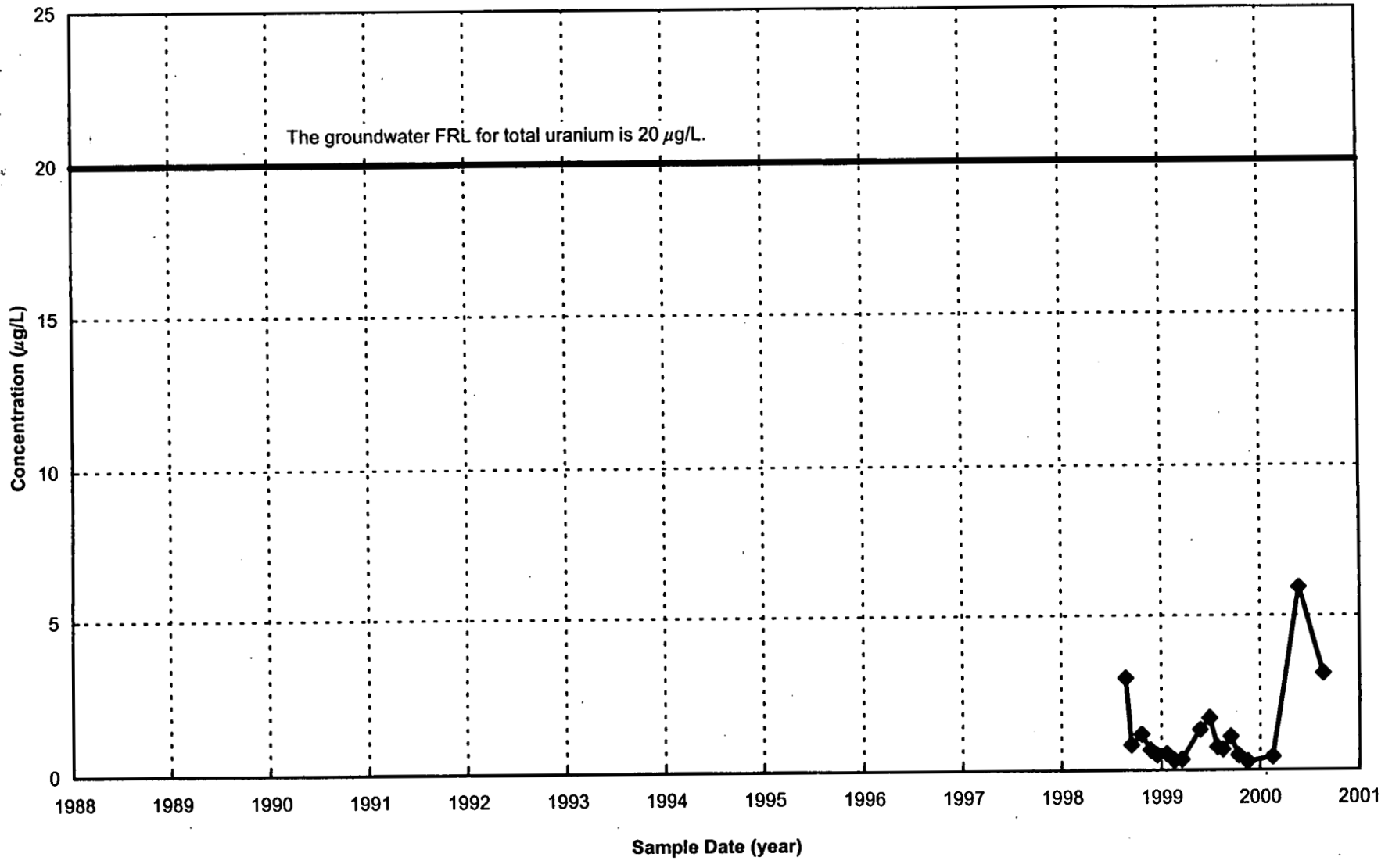


FIGURE A.2-132. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22204

000215

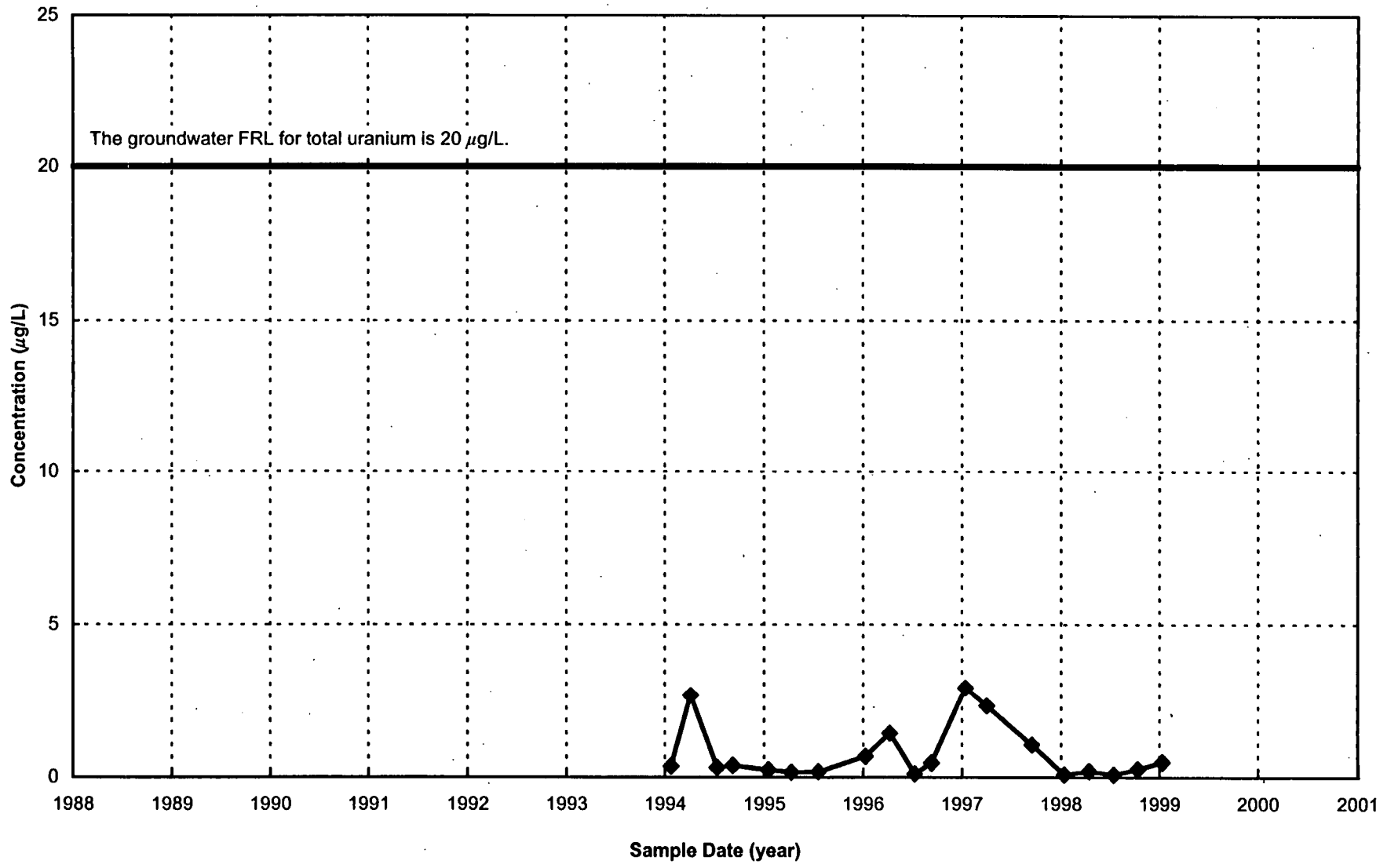


FIGURE A.2-133. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 31217

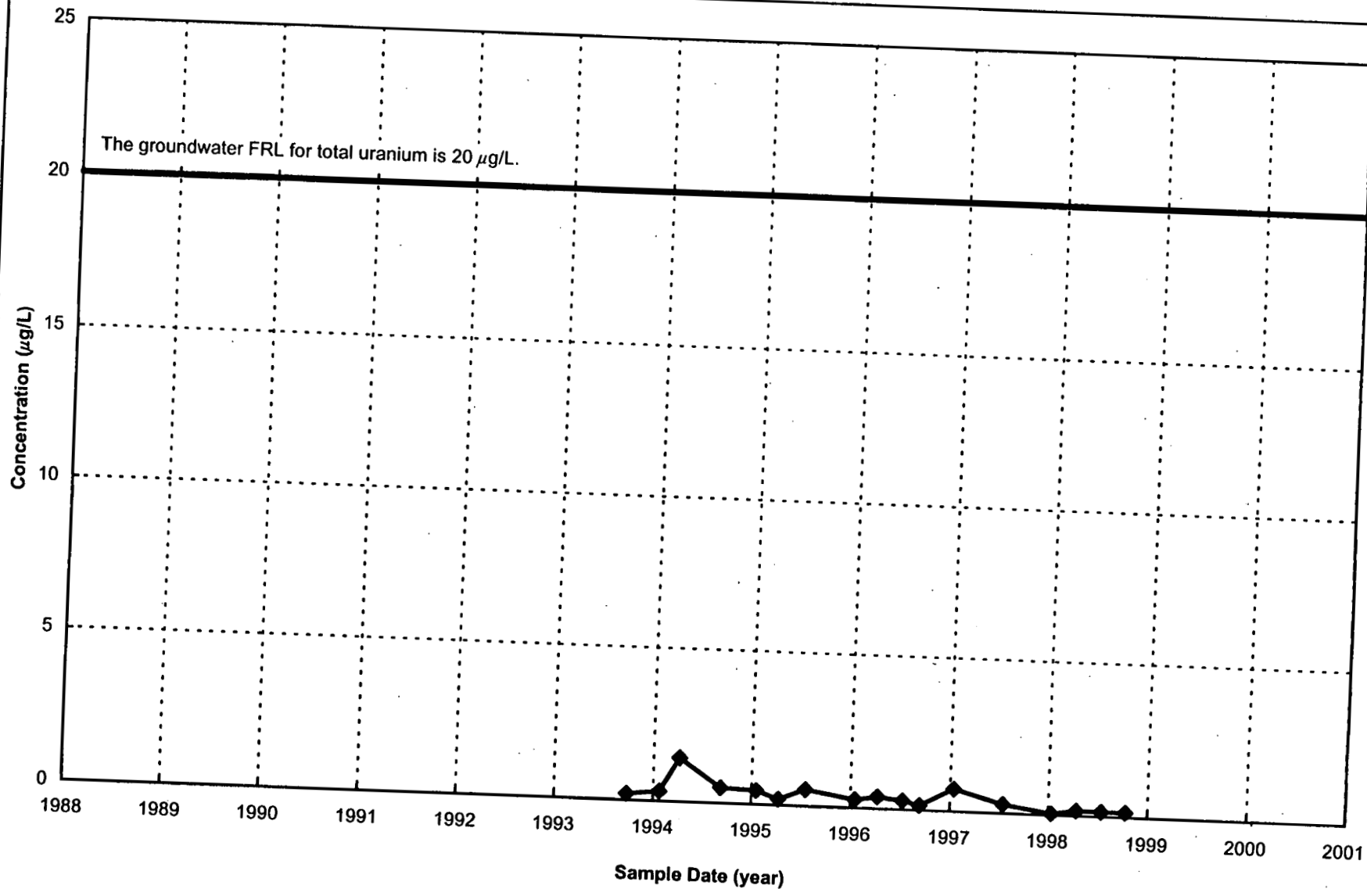


FIGURE A.2-134. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 41217

000217

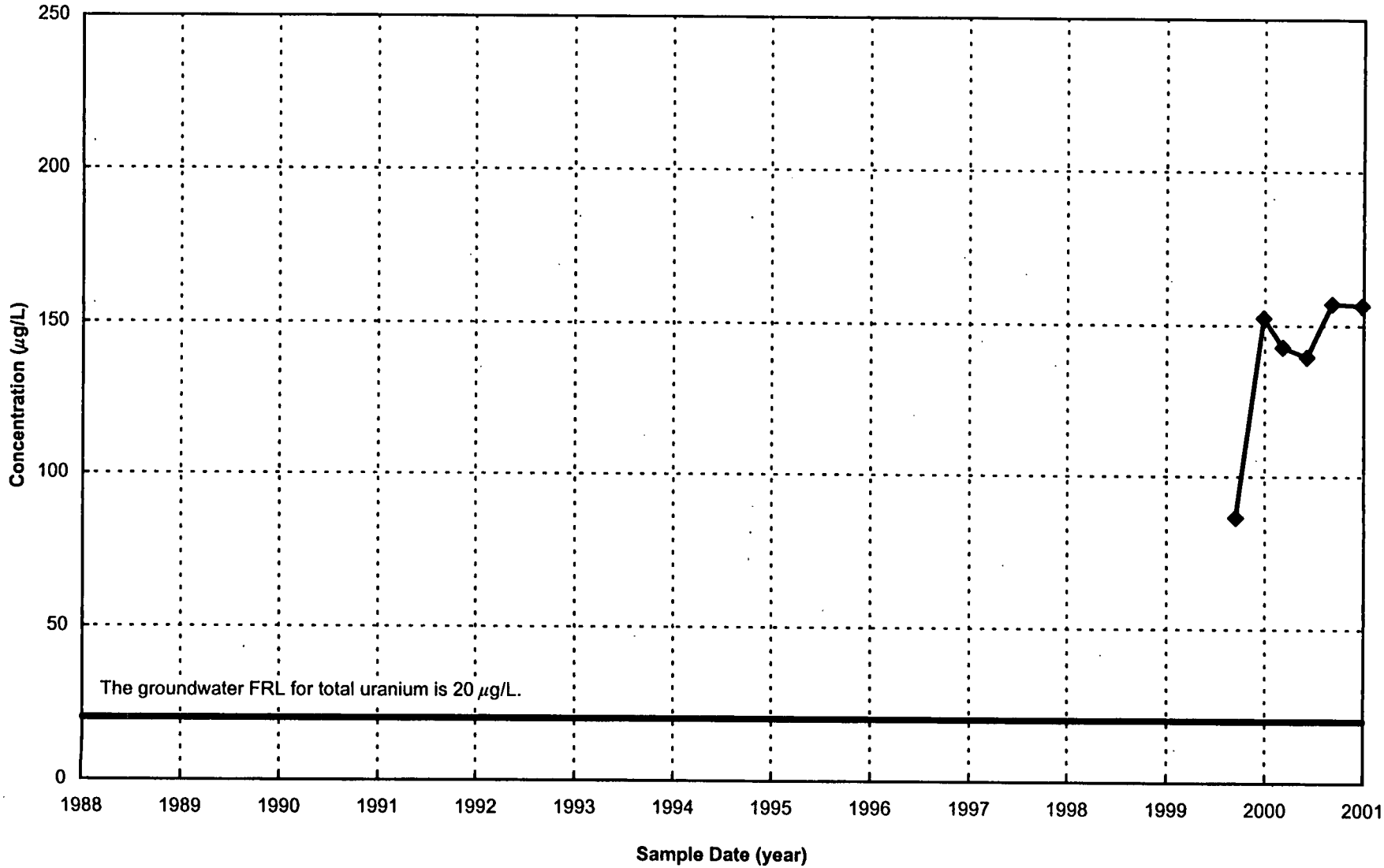


FIGURE A.2-135. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 62408

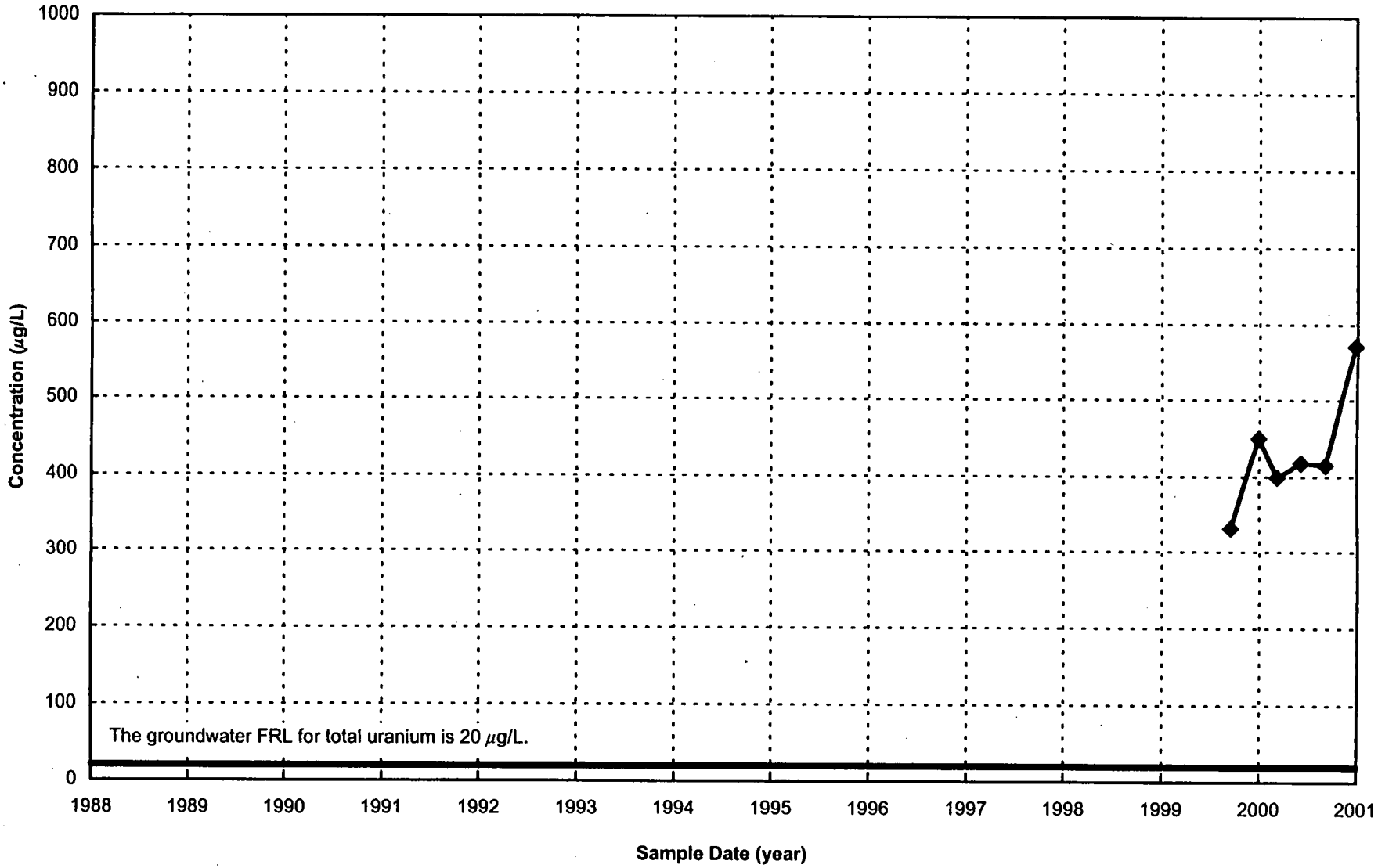


FIGURE A.2-136. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 62433

000219

Attachment A.3

ATTACHMENT A.3

GROUNDWATER ELEVATIONS AND CAPTURE ASSESSMENT

ATTACHMENT A.3

Figures A.3-1 through A.3-4 present groundwater elevation maps for Type 2 groundwater monitoring wells for the four quarters of 2000. In accordance with "Responses to OEPA Comments to Responses to OEPA Comments on Proposed Changes Resulting from the 1999 Annual Review of the Integrated Environmental Monitoring Plan, Revision 1," Comment #5, the water level maps derived from Type 3 well measurements are not provided. Each groundwater elevation map contains the following quarter-specific information:

- Groundwater elevation data and resultant water table contours
- Interpreted capture zones
- Bedrock highs
- 10-year, uranium-based restoration footprint, taken from the Baseline Remedial Strategy Report-Remedial Design For Aquifer Restoration
- Extent of the maximum total uranium plume 20 μg/L contour
- Module-specific pumping rates during the time that the groundwater elevation measurements were collected
- Major groundwater flow divide which separates groundwater exiting the New Haven Trough to the Great Miami River through the Paddys Run Outlet from groundwater exiting the New Haven Trough to the Great Miami River through the New Baltimore Outlet.

These elevation maps were also included in 2000 IEMP quarterly status reports (first three quarters only), but have been updated with the respective quarter's total uranium plume data.

The quarterly groundwater maps shown in Figures A.3-1 through A.3-4 illustrate two capture issues:

1. Actual capture interpreted through collected water level measurements
2. Projected capture over the life of the 10-year remedy, as defined in the Baseline Remedial Strategy Report.

Actual capture during 2000 appears to be adequate. However, based on water level data collected in 2000, the extreme southwest portion of the 20 μg/L total uranium plume (near Monitoring Well 2552, Figure A.2-1) lies very close to the capture zone created by the South Plume wells. At certain times of the year (when water levels are low) the tip of the 20 μg/L total uranium plume appears to be just outside the reach of capture (refer to Figures A.3-1 and A.3-4). Based on several years of monitoring the capture

zone, this fluctuation is seasonal. This seasonal fluctuation of the capture zone in this area is acceptable because as explained below, over the course of the remedy, it is predicted that the southwest tip of the plume will be captured.

Predicted capture over the life of the remedy (the 10-year, uranium-based restoration footprint) is also shown on each quarterly map. This predicted capture zone was modeled in the Baseline Remedial Strategy Report and reflects implementation of the baseline remedy presented in that report. As shown in all of the quarterly maps for 2000, the extreme southwest portion of the plume is within the 10-year, uranium-based restoration footprint. This indicates that even though during certain portions of the year the extreme southwest tip of the plume might be outside of capture, the entire plume will be captured over the course of the remedy.

Monitoring Well 2552 is the well that defines the extent of the southwest tip of the plume and it is notable that during 2000, all the samples from this well indicated total uranium concentrations less than the 20 μg/L FRL. The seasonal capture effect of the southwest tip will become even less significant when the FEMP adopts the new 30 μg/L maximum contaminant level (MCL) for uranium in drinking water as the site's total uranium groundwater FRL. Both the EPA and OEPA support the adoption of the 30 μg/L MCL standard. It is anticipated that the 30 μg/L MCL standard will be adopted as the total uranium groundwater FRL in 2001.

In accordance with "Responses to OEPA Comments to Responses to OEPA Comments on the Integrated Environmental Monitoring Status Report for Second Quarter 1999," Comment #1, well cluster hydrographs are provided a means to assess vertical groundwater gradients. Thus, hydrographs for the following monitoring well clusters (Type 2 and Type 3 wells) appear in Figures A.3-5 through A.3-34: 009, 014, 015, 017, 027, 032, 045, 046, 049, 054, 065, 068, 069 (434), 095, 106, 125,128, 385, 387, 390, 396, 398, 402, 550, 551, 552, 821, 880, 881, and 900. The last three digits of the monitoring wells identify the well clusters (e.g., cluster 552 consists of Monitoring Wells 2552 and 3552). Groundwater elevations available from 1993 through 2000 from Type 2 and Type 3 wells at the same cluster were plotted on the same graph. Figure A.1-1 identifies the well cluster locations.

Analysis of these hydrographs for 2000 indicates that elevations in the Type 2 and Type 3 monitoring wells within the majority of the clusters monitored are almost always identical for each measurement event. An occasional, slight difference can be seen but these differences do not appear to be indicative of vertical hydraulic gradients, rather they are attributed to measurement, transcription, or key-punch error during data collection and processing.

In the fourth quarter of 1999, the groundwater flow model was successfully recalibrated to an October 1998 data set and was validated against three other quarterly elevation data sets (April 1998, July 1998, and October 1999). The Great Miami Aquifer VAM3D Flow Model Recalibration Report was provided to EPA and OEPA in May 2000 (DOE 2000b). Phase II of the groundwater model upgrade project, which incorporates data fusion technology into the groundwater transport model, was completed in fourth quarter 1999. A final report was issued in April 2000 and submitted to EPA and OEPA in May 2000 (HydroGeoLogic, Inc., 2000).

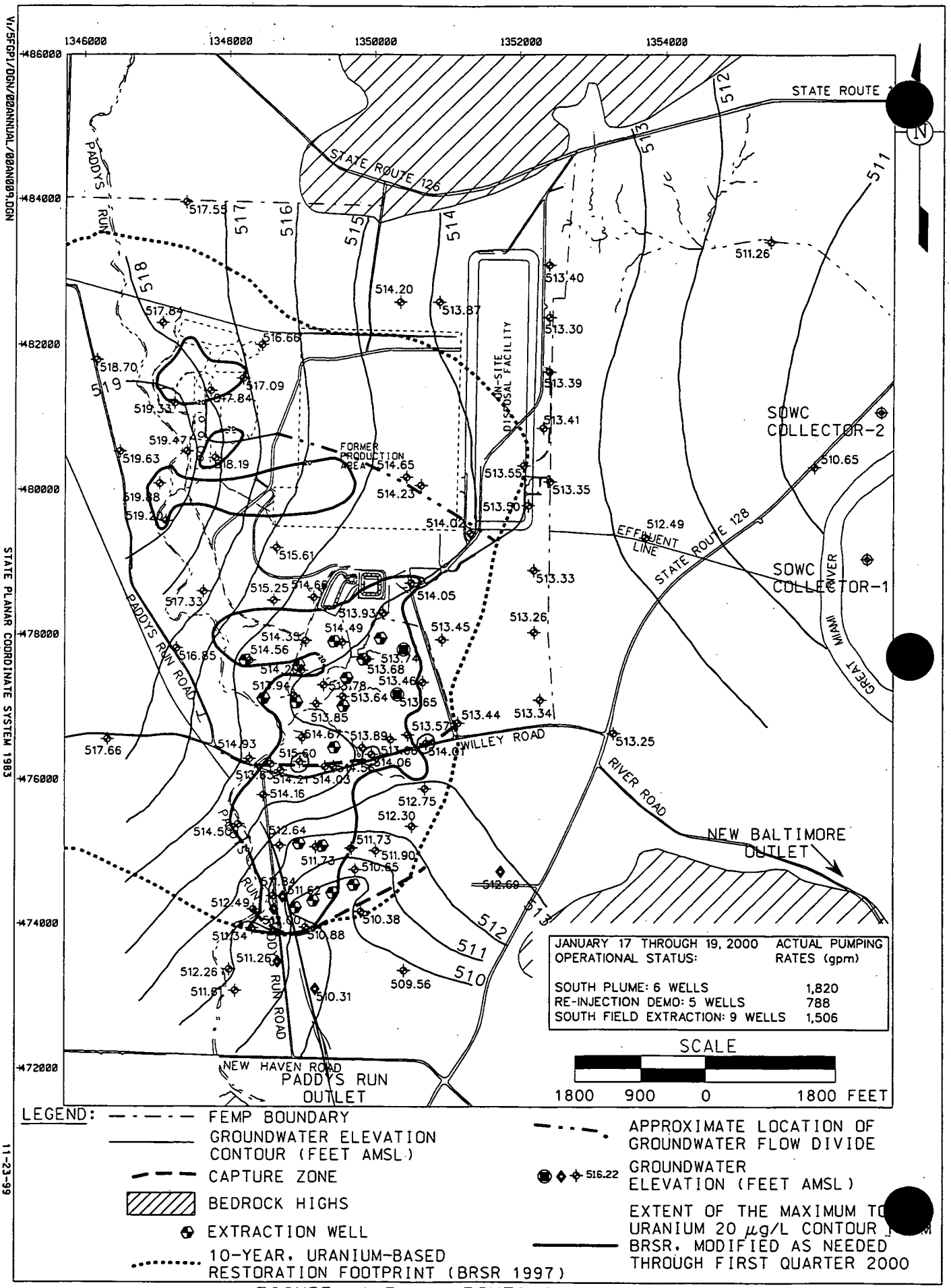
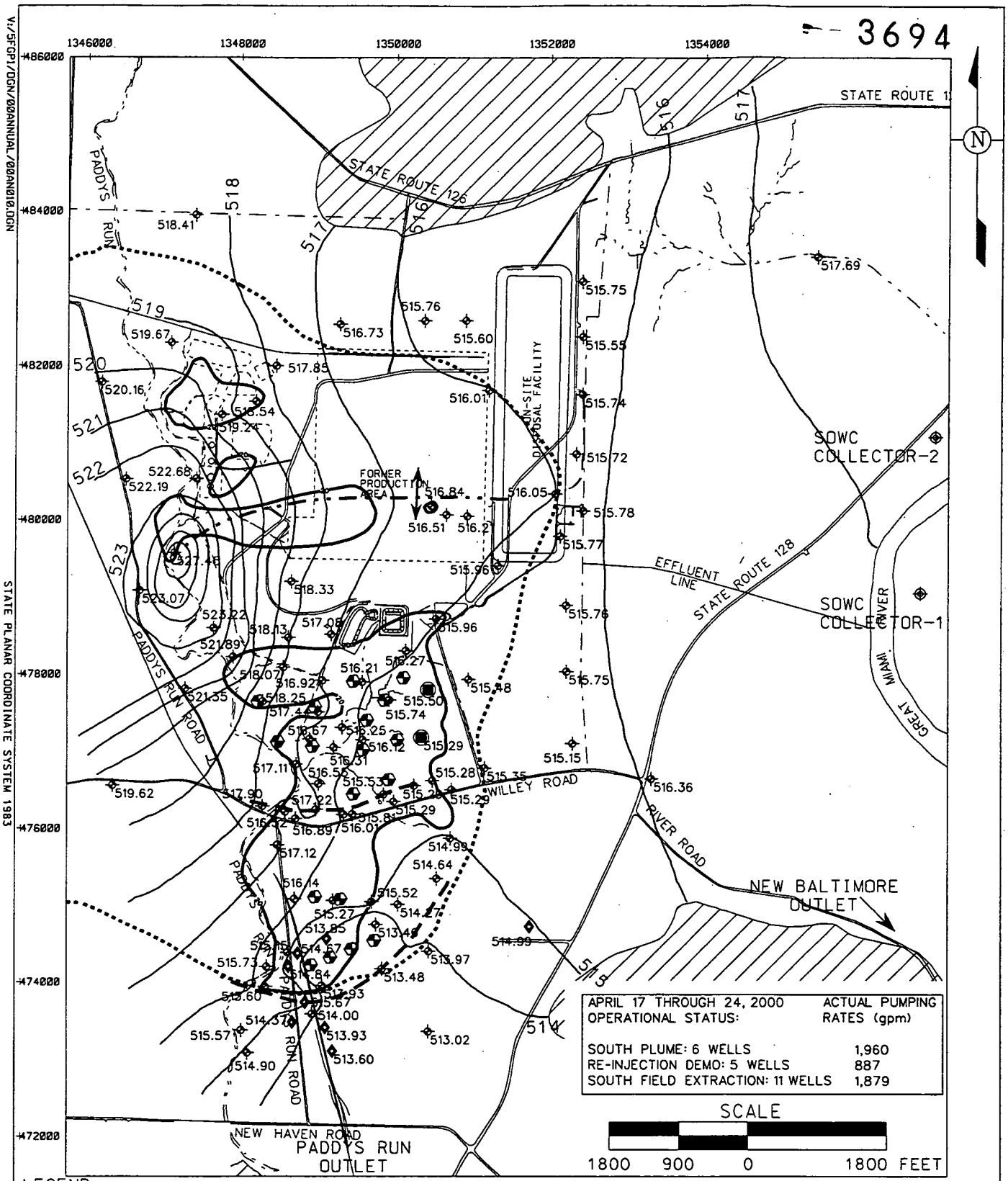


FIGURE A.3-1. ROUTINE GROUNDWATER ELEVATIONS FOR TYPE 2 WELLS, JANUARY 2000



V:/SFGP1/DGN/00ANNUAL/00AN010.DGN

STATE PLANAR COORDINATE SYSTEM 1983

11-23-99

FIGURE A.3-2. ROUTINE GROUNDWATER ELEVATIONS FOR TYPE 2 WELLS, APRIL 2000

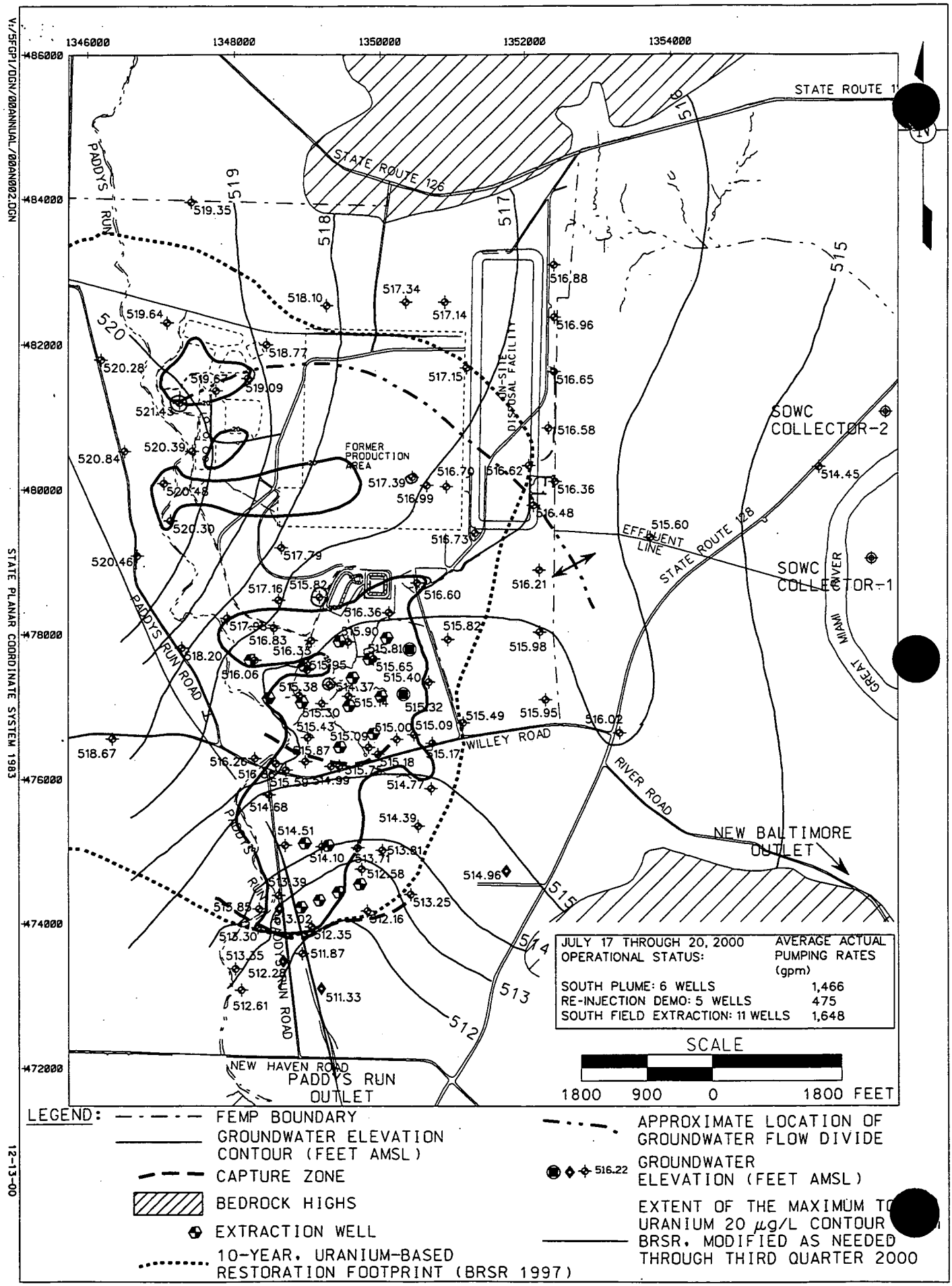
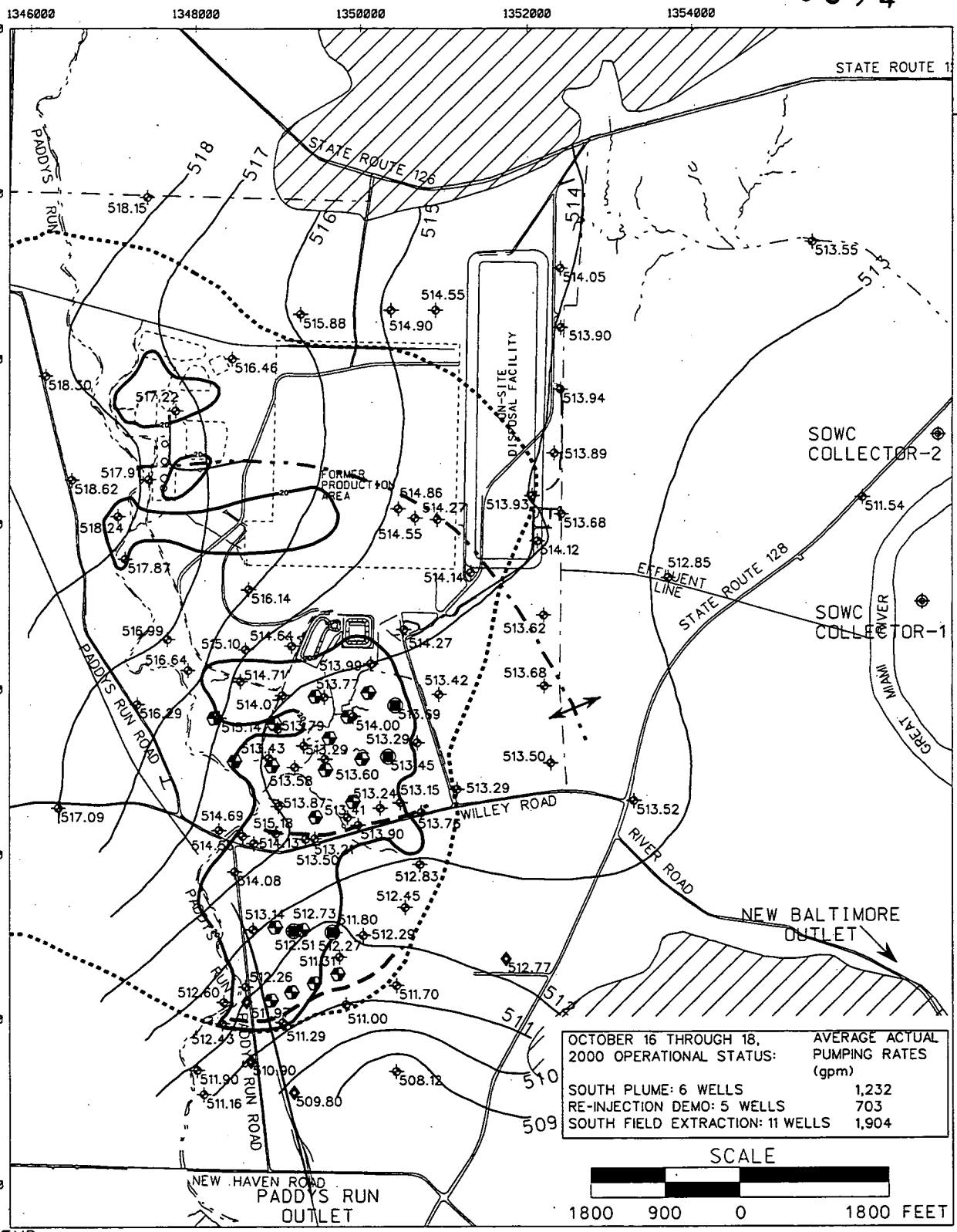


FIGURE A.3-3. ROUTINE GROUNDWATER ELEVATIONS FOR TYPE 2 WELLS, JULY 2000

V:\SFCP1/DGN/00ANNUAL/00AN019.DGN

STATE PLANAR COORDINATE SYSTEM 1983



12-13-00

FIGURE A.3-4. ROUTINE GROUNDWATER ELEVATIONS FOR TYPE 2 WELLS, OCTOBER 2000

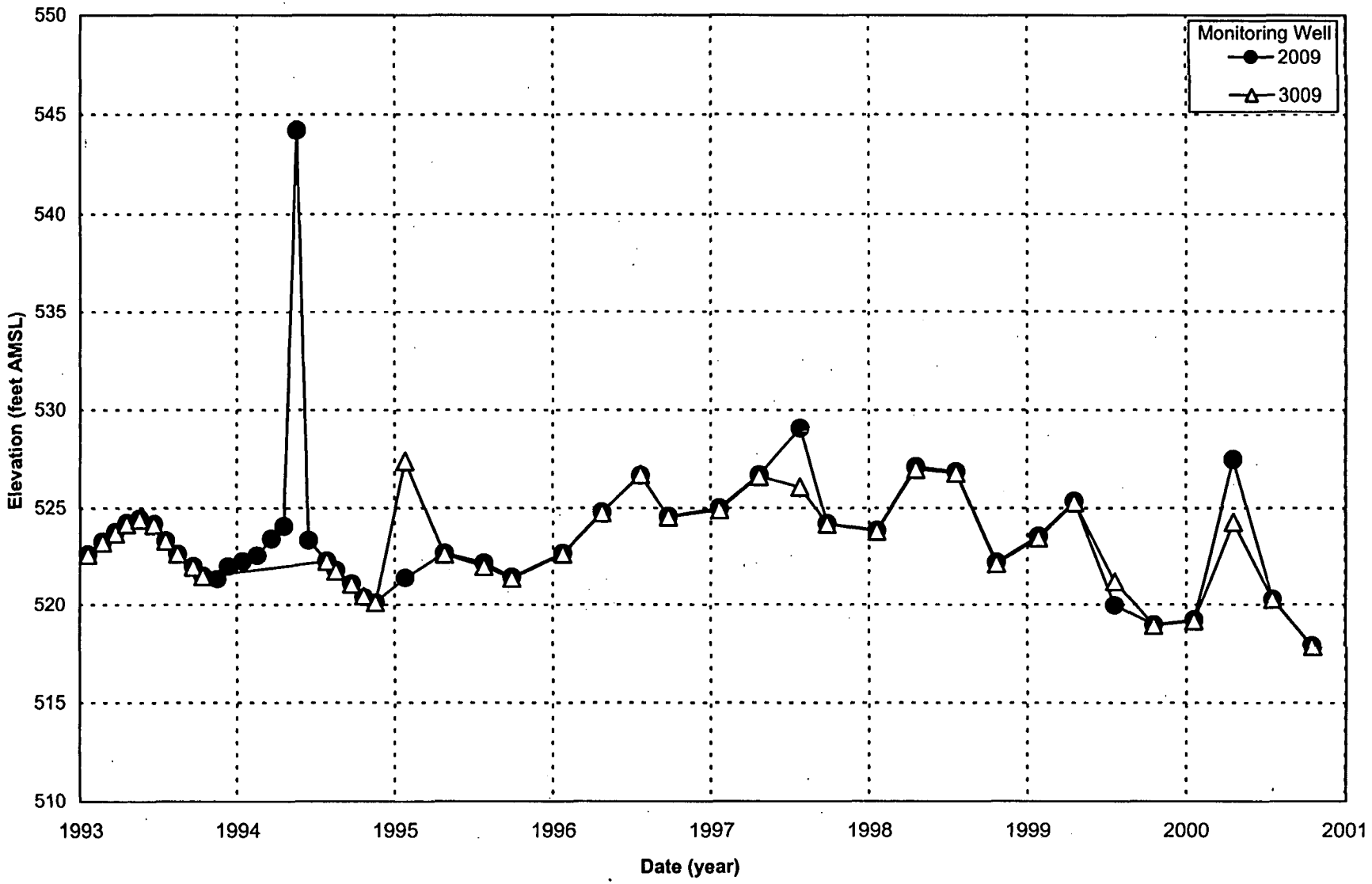


FIGURE A.3-5. HYDROGRAPH FOR WELL CLUSTER 009

0002228

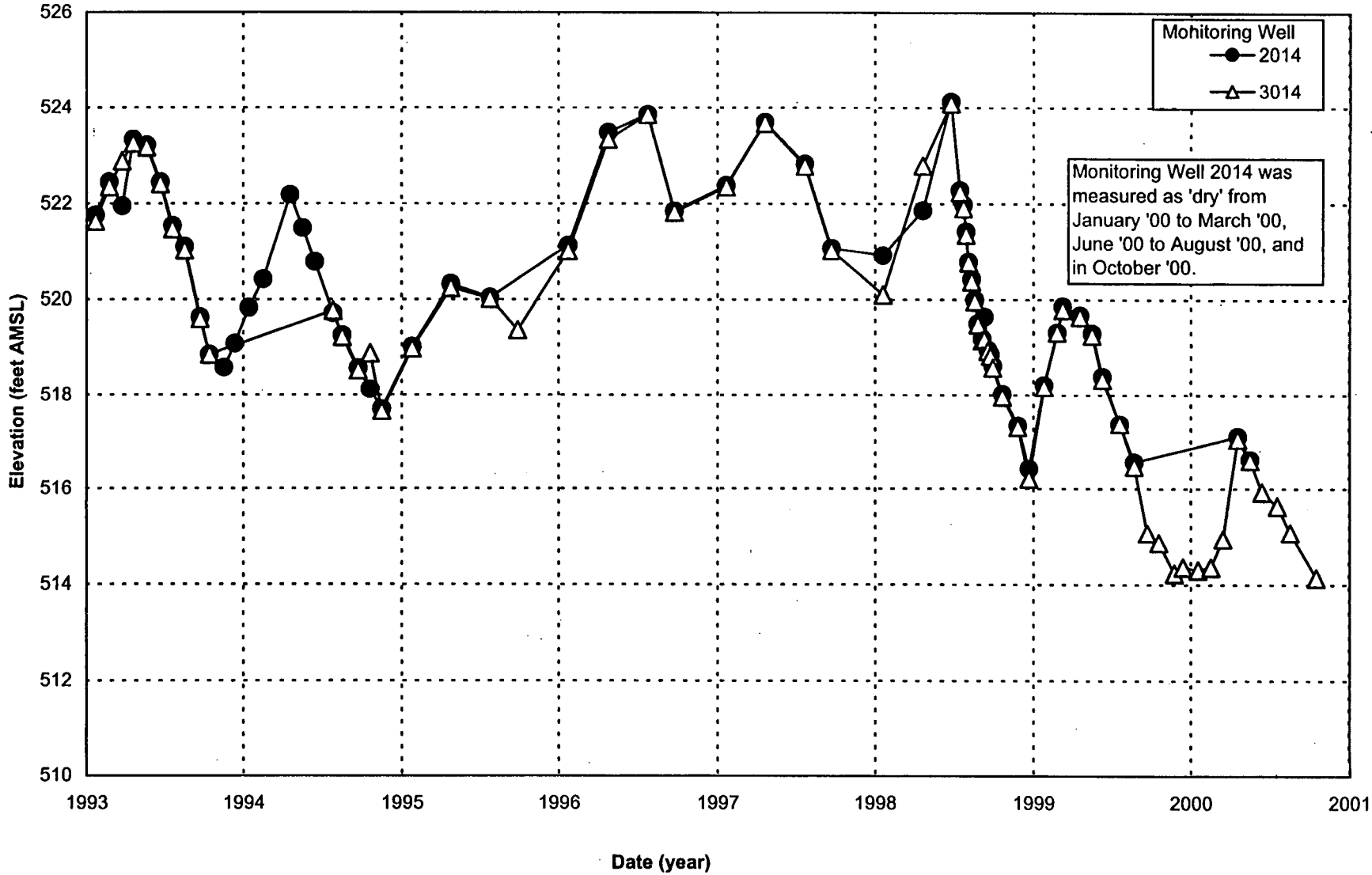


FIGURE A.3-6. HYDROGRAPH FOR WELL CLUSTER 014

000229

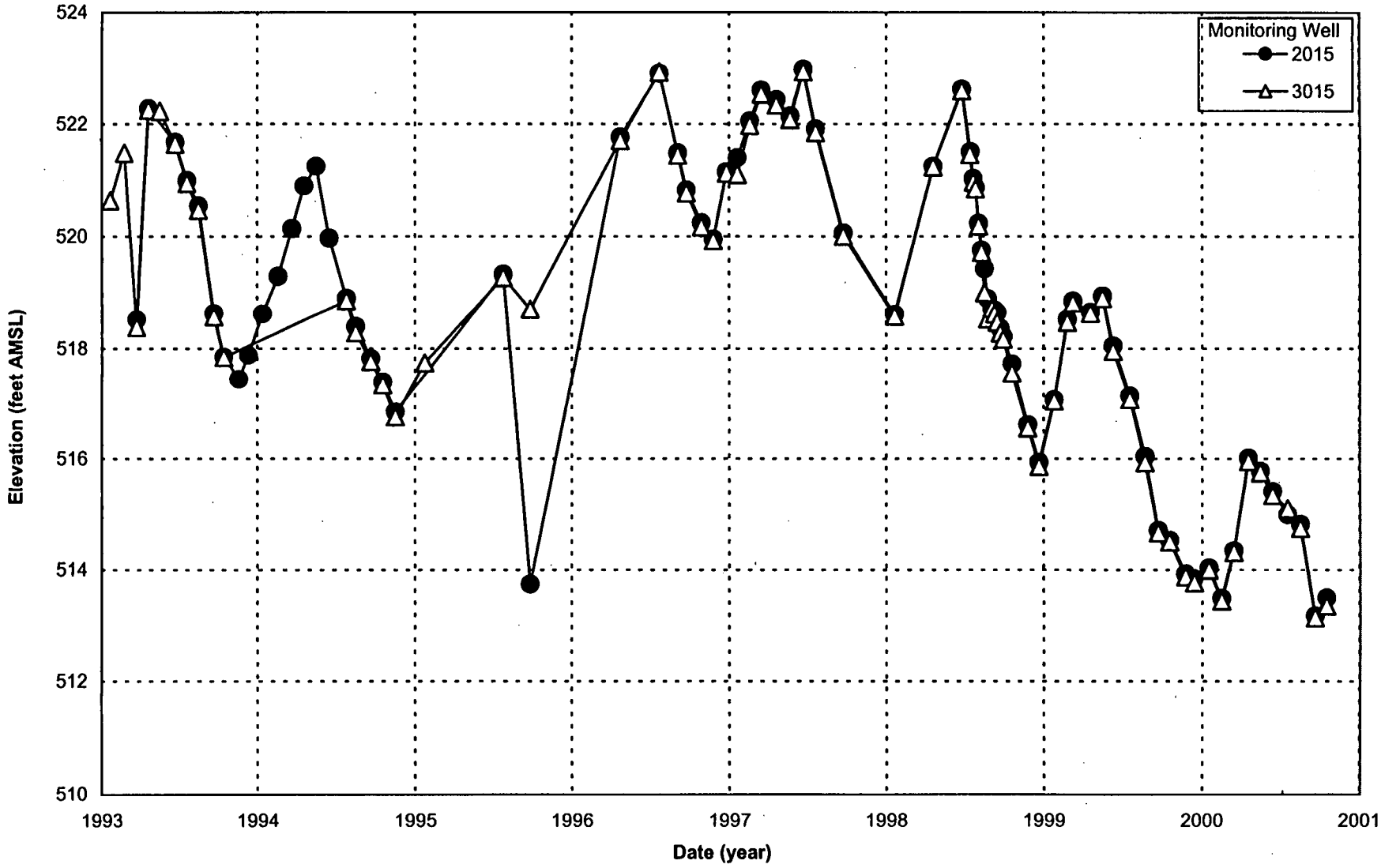


FIGURE A.3-7. HYDROGRAPH FOR WELL CLUSTER 015

000230

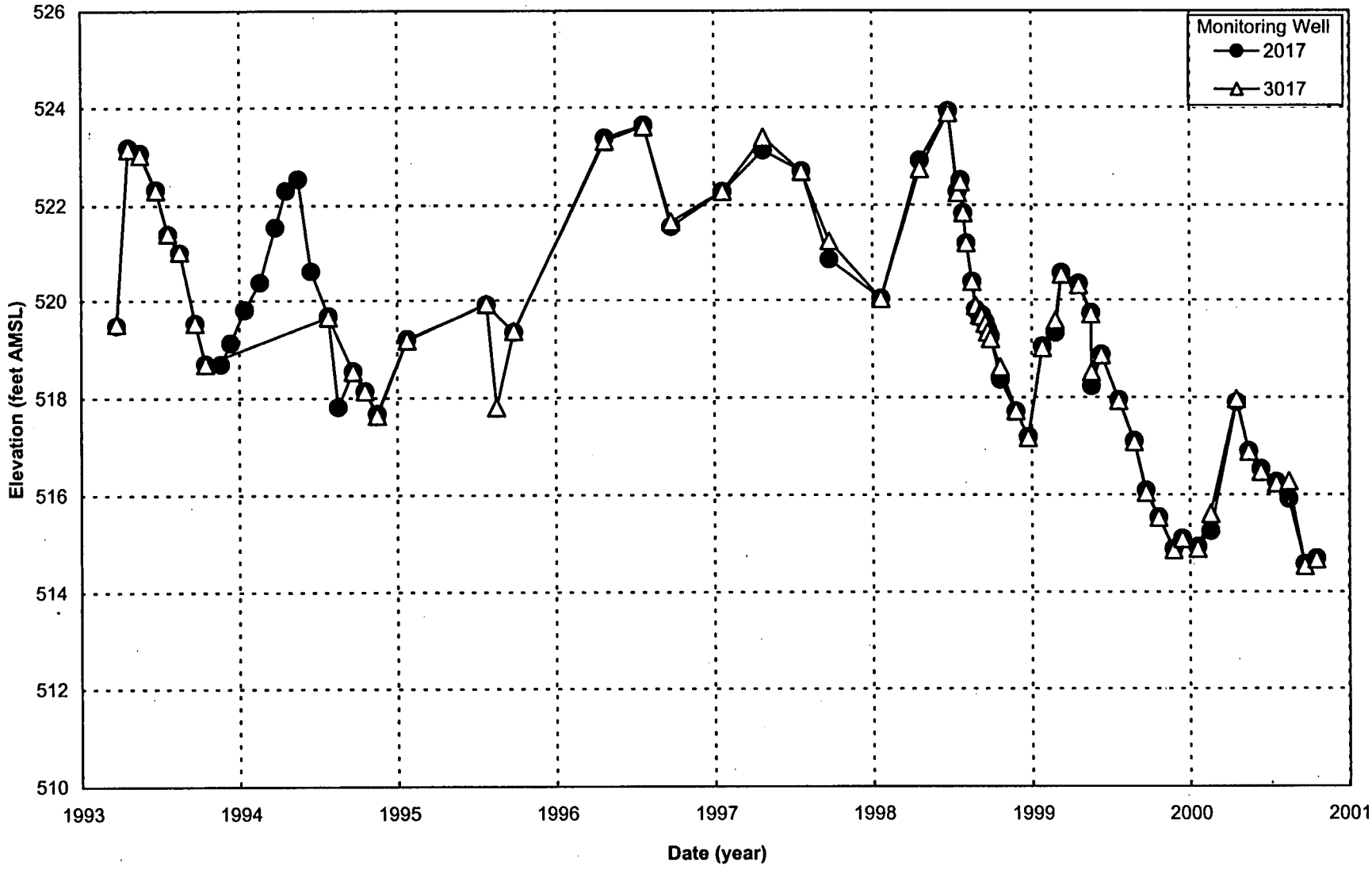


FIGURE A.3-8. HYDROGRAPH FOR WELL CLUSTER 017

000231

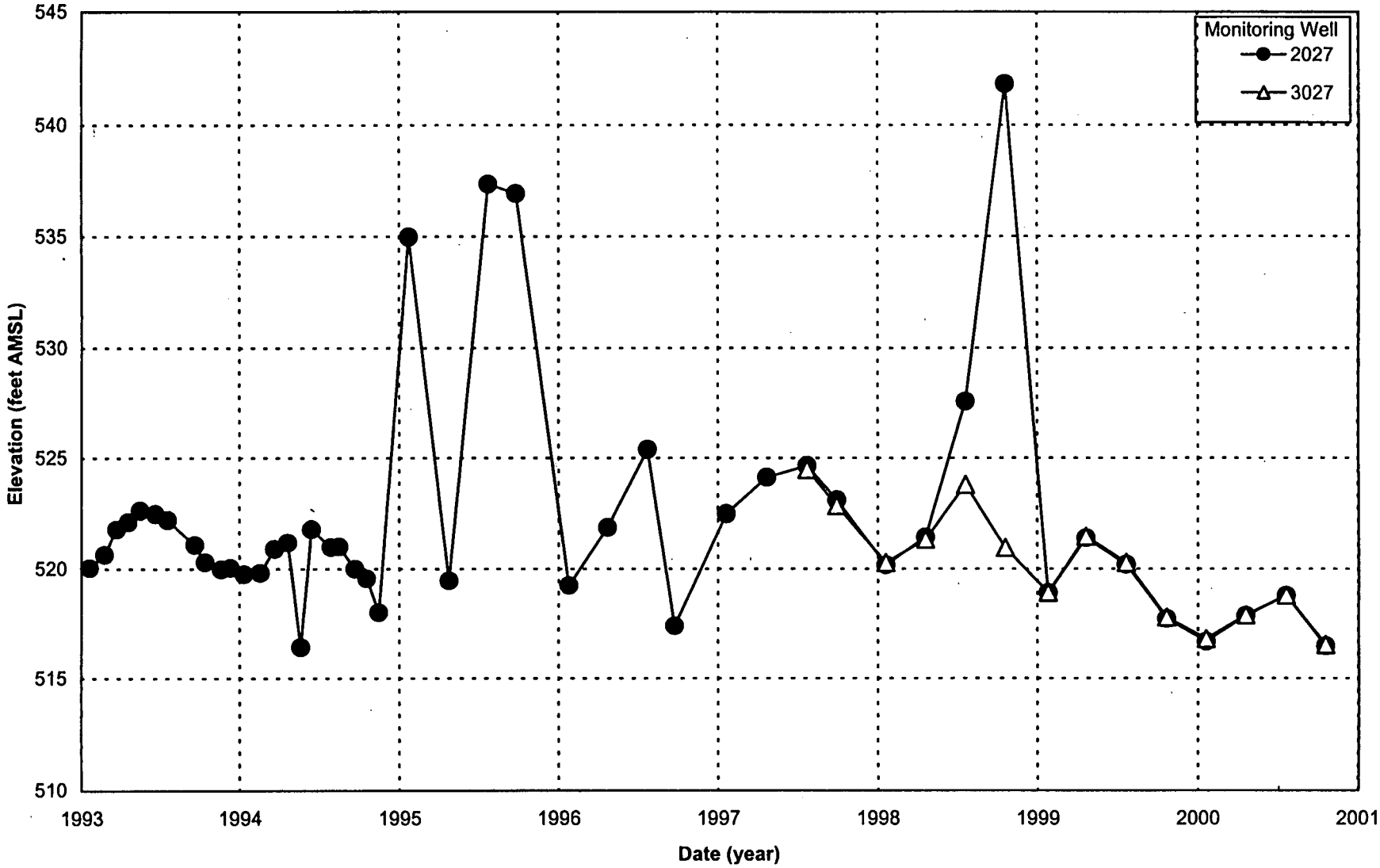


FIGURE A.3-9. HYDROGRAPH FOR WELL CLUSTER 027

000232

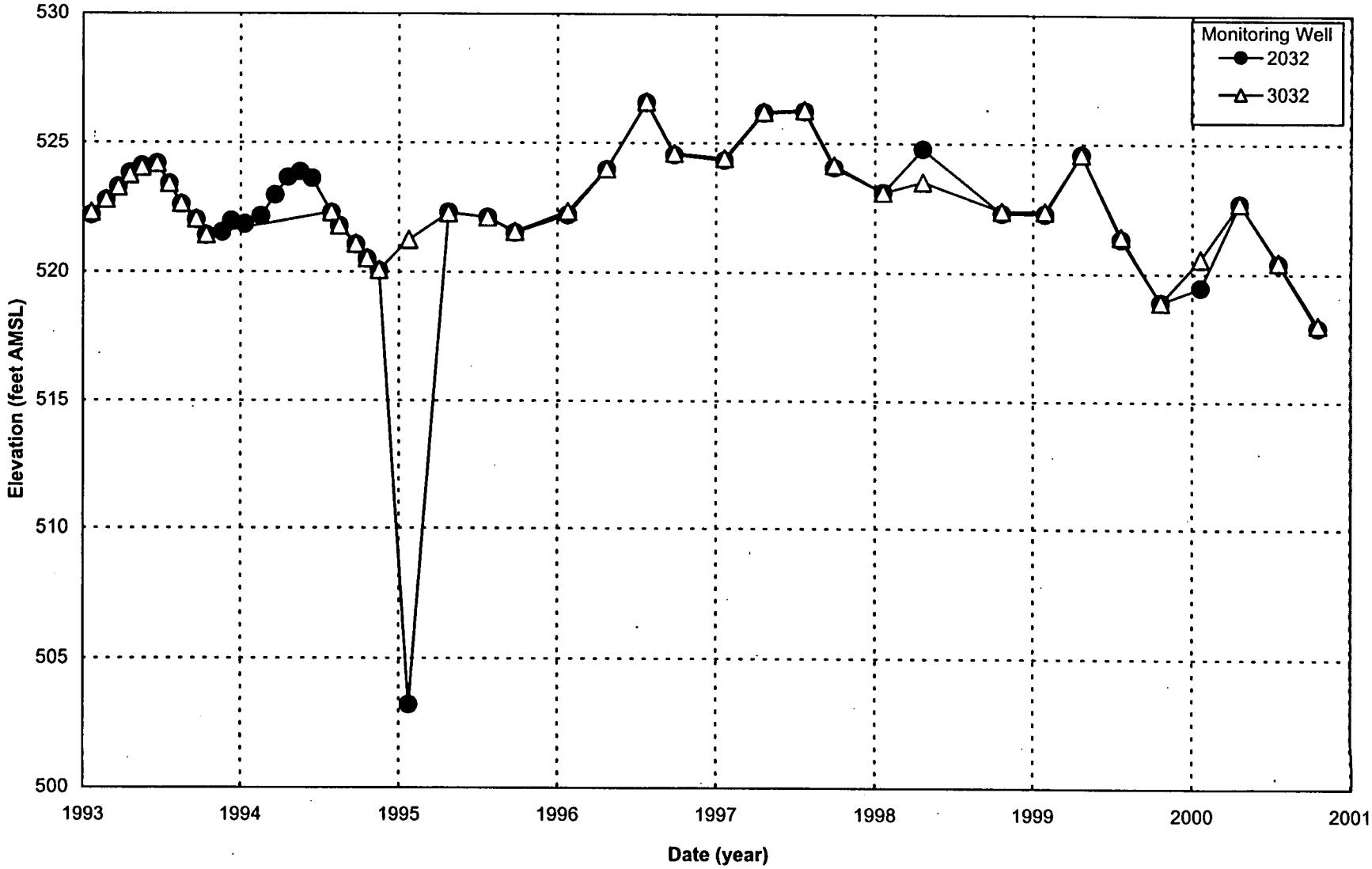


FIGURE A.3-10. HYDROGRAPH FOR WELL CLUSTER 032

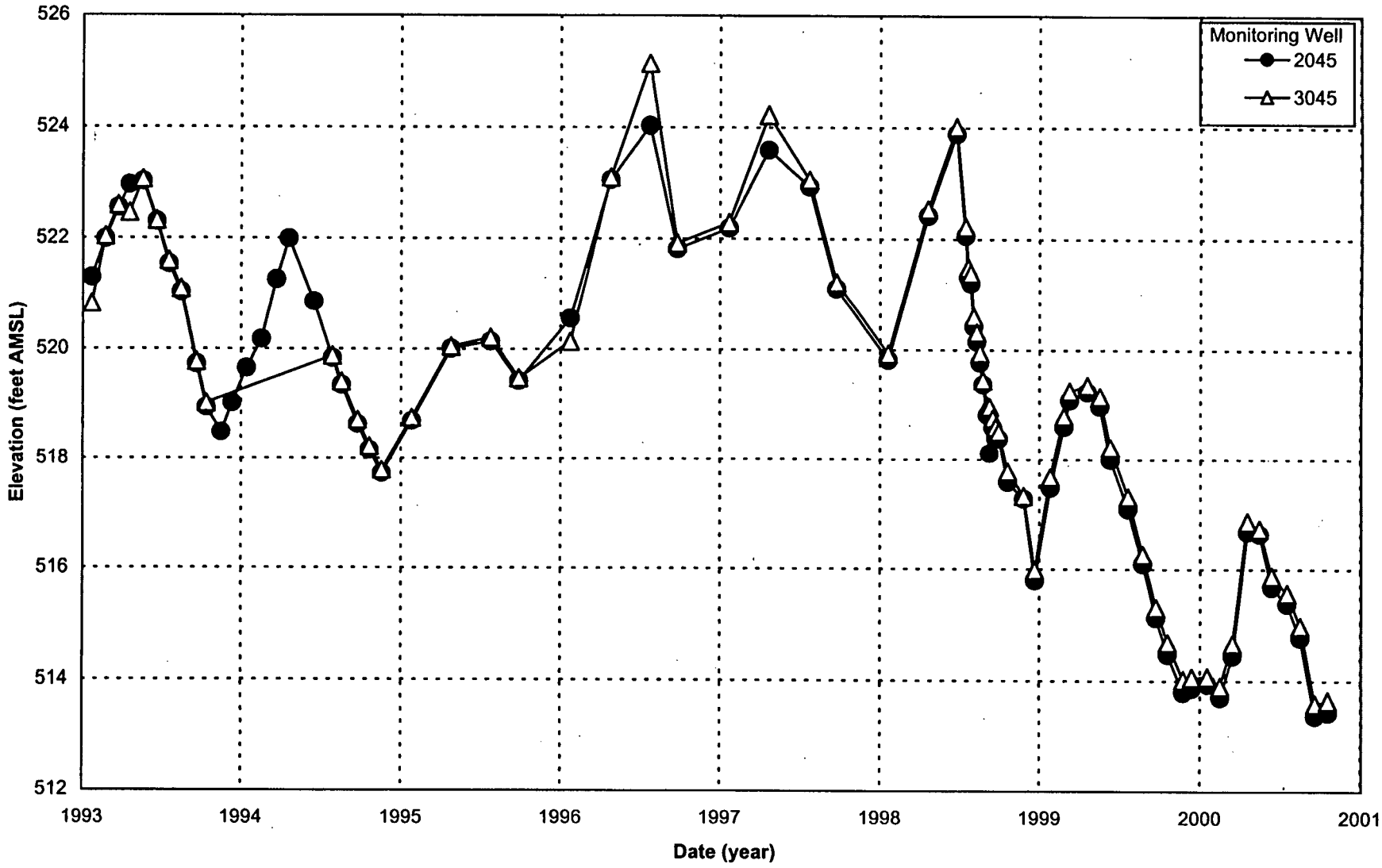


FIGURE A.3-11. HYDROGRAPH FOR WELL CLUSTER 045

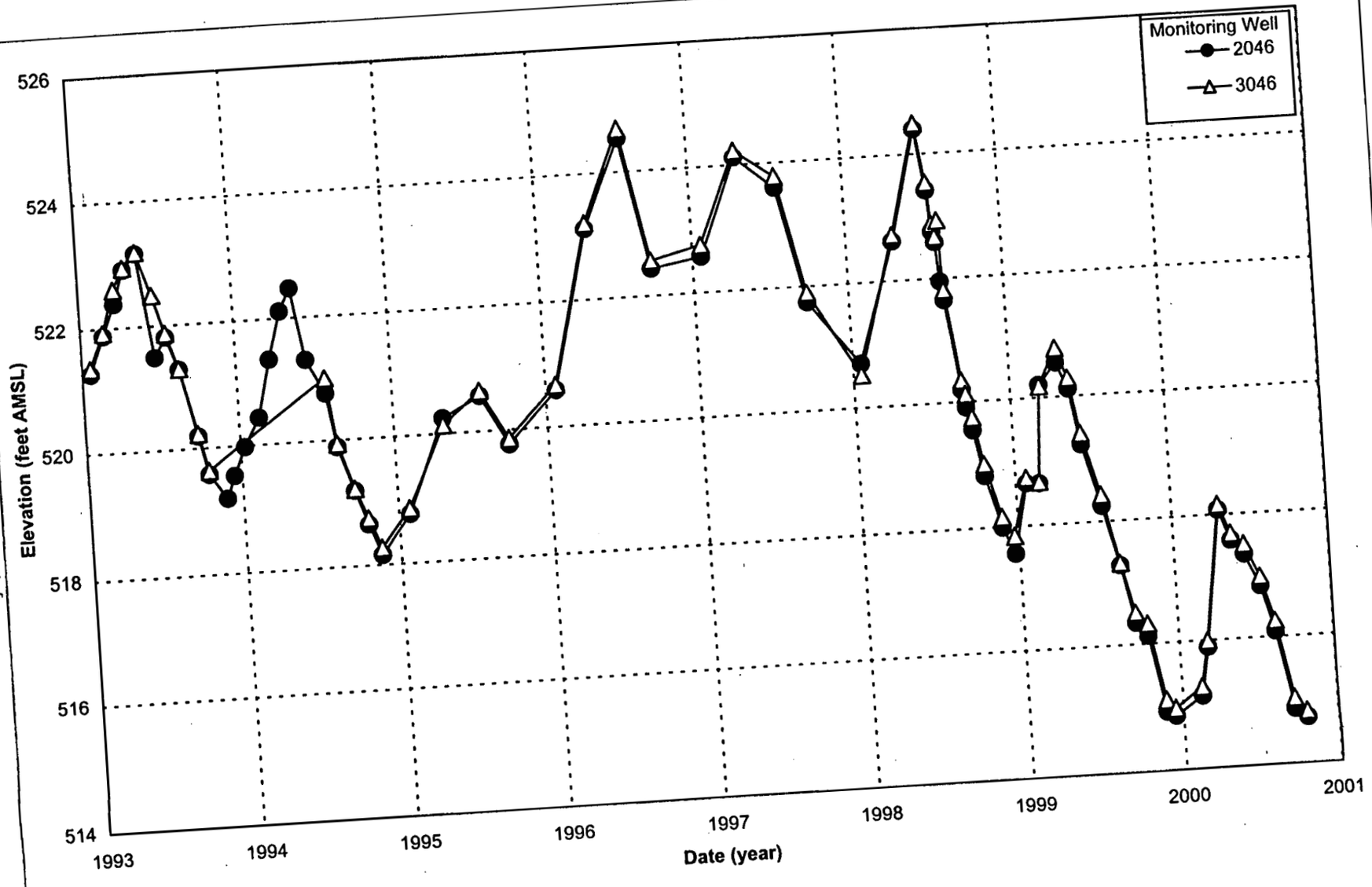


FIGURE A.3-12. HYDROGRAPH FOR WELL CLUSTER 046

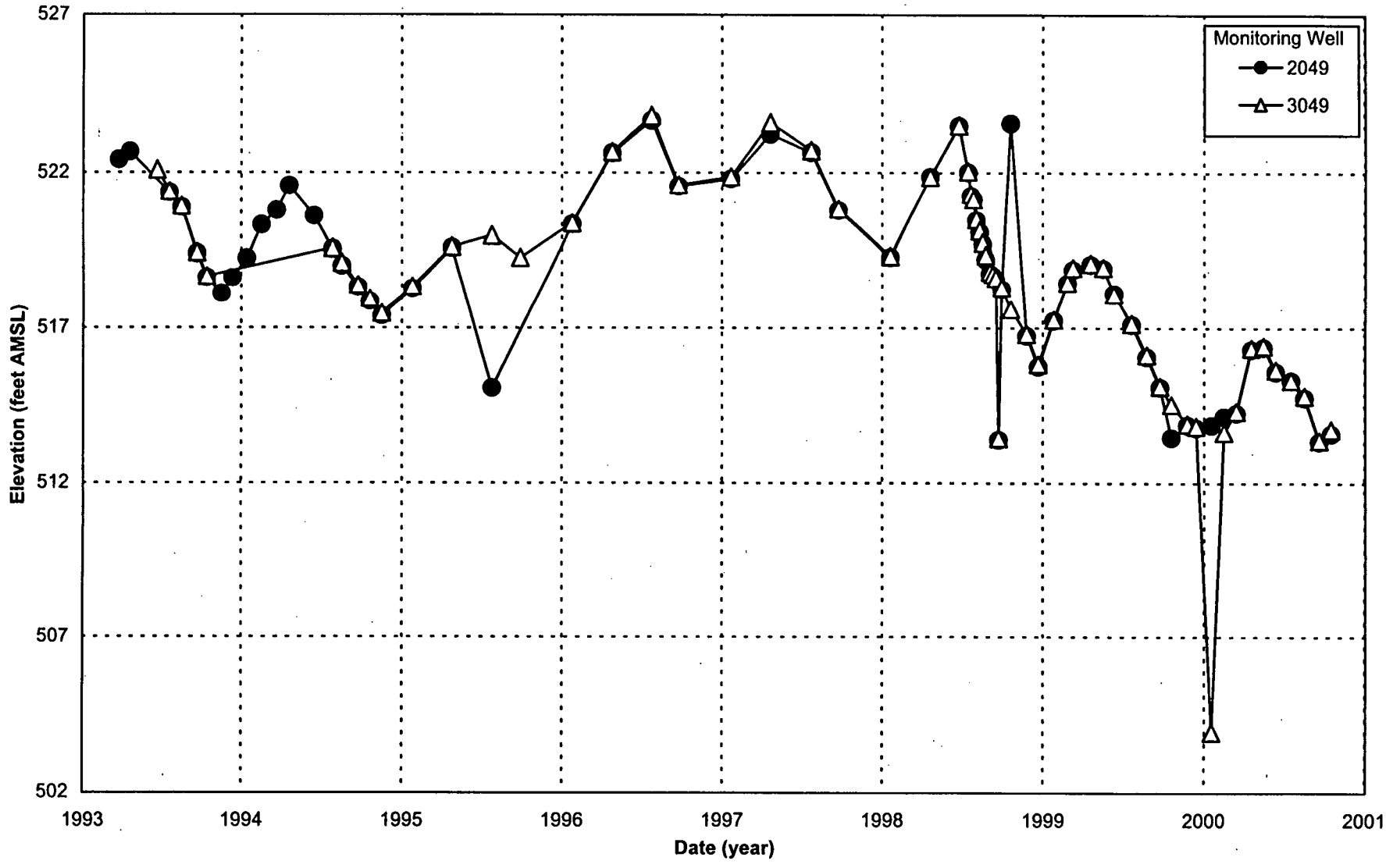


FIGURE A.3-13. HYDROGRAPH FOR WELL CLUSTER 049

0002236

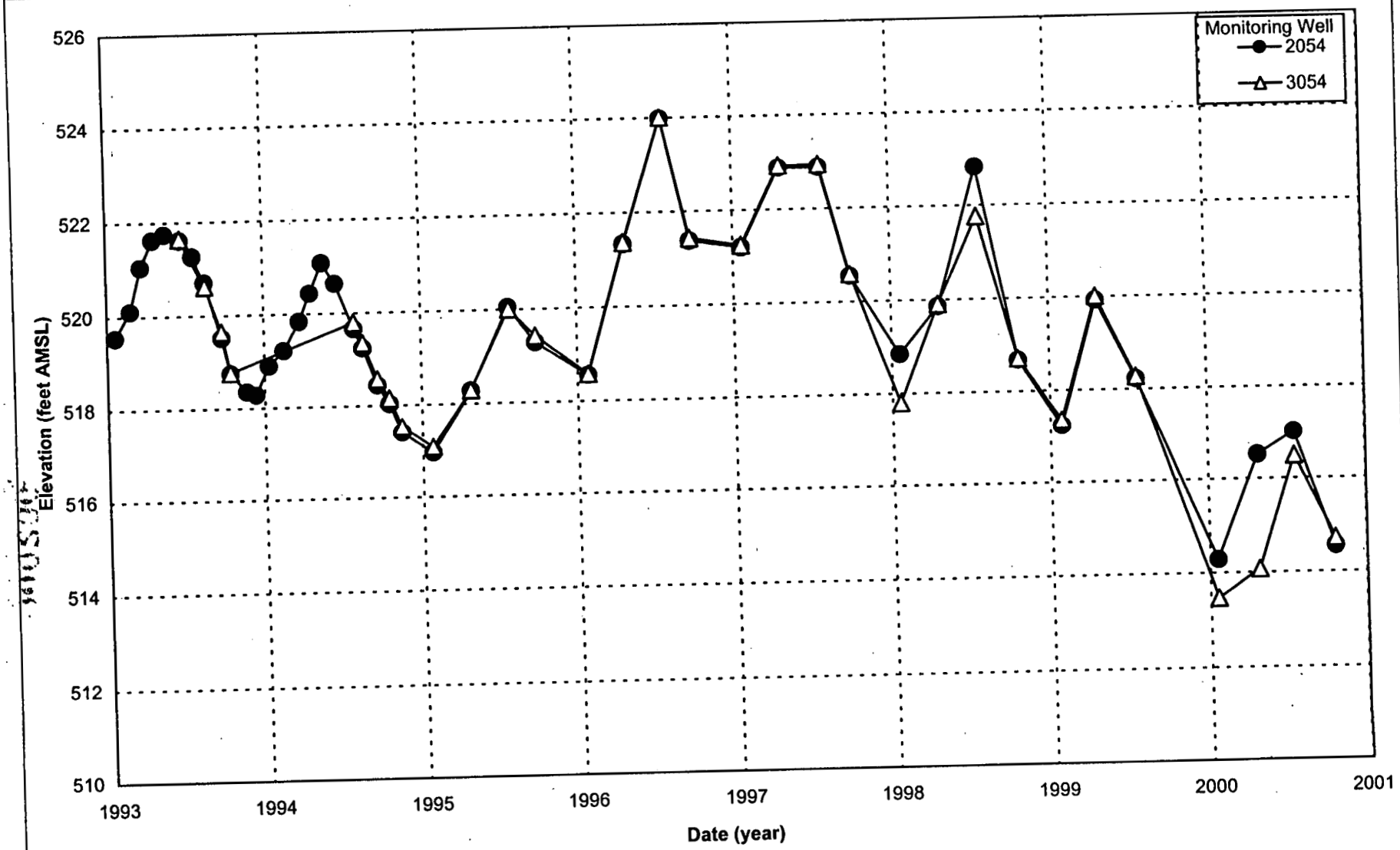


FIGURE A.3-14. HYDROGRAPH FOR WELL CLUSTER 054

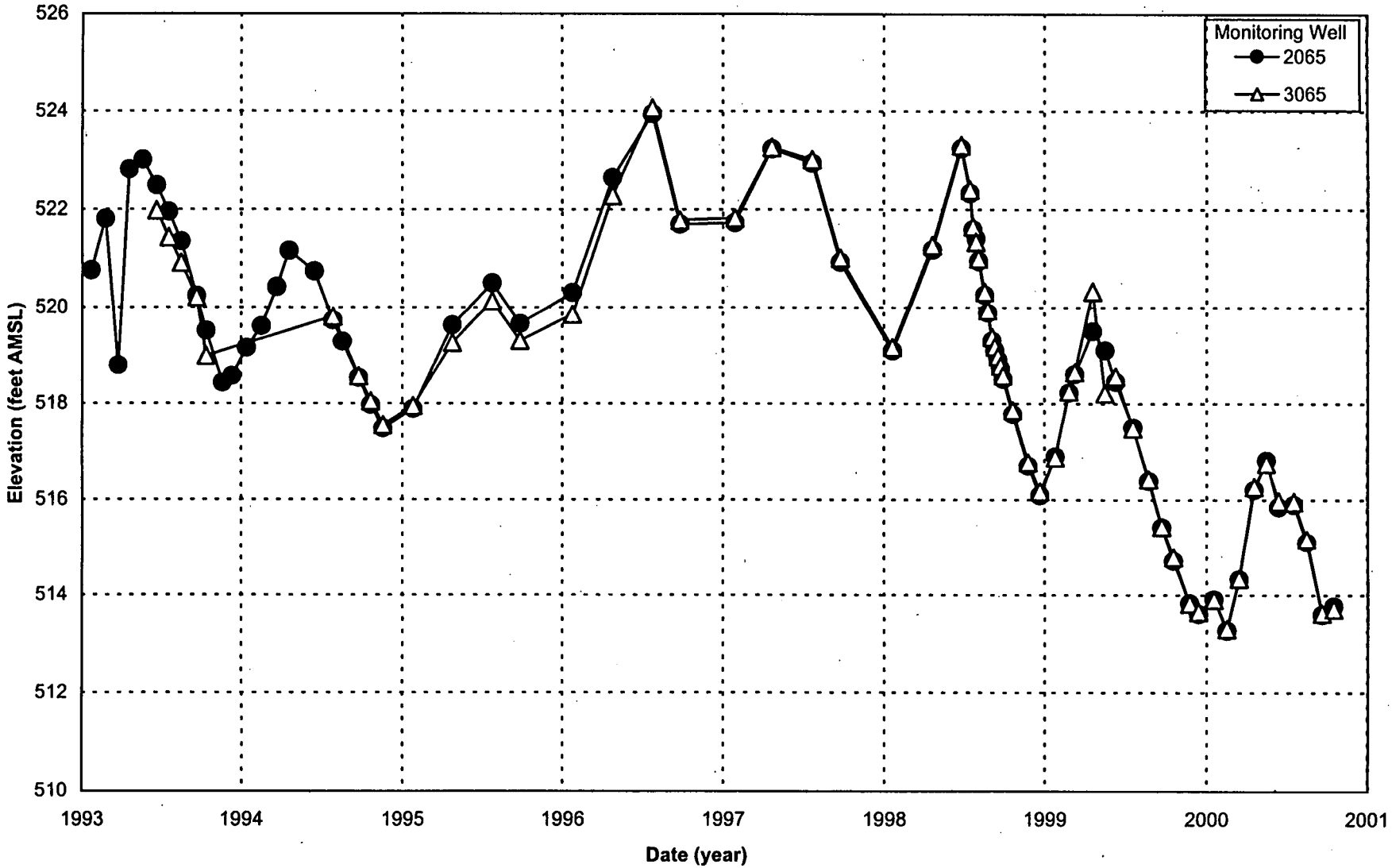


FIGURE A.3-15. HYDROGRAPH FOR WELL CLUSTER 065

000238

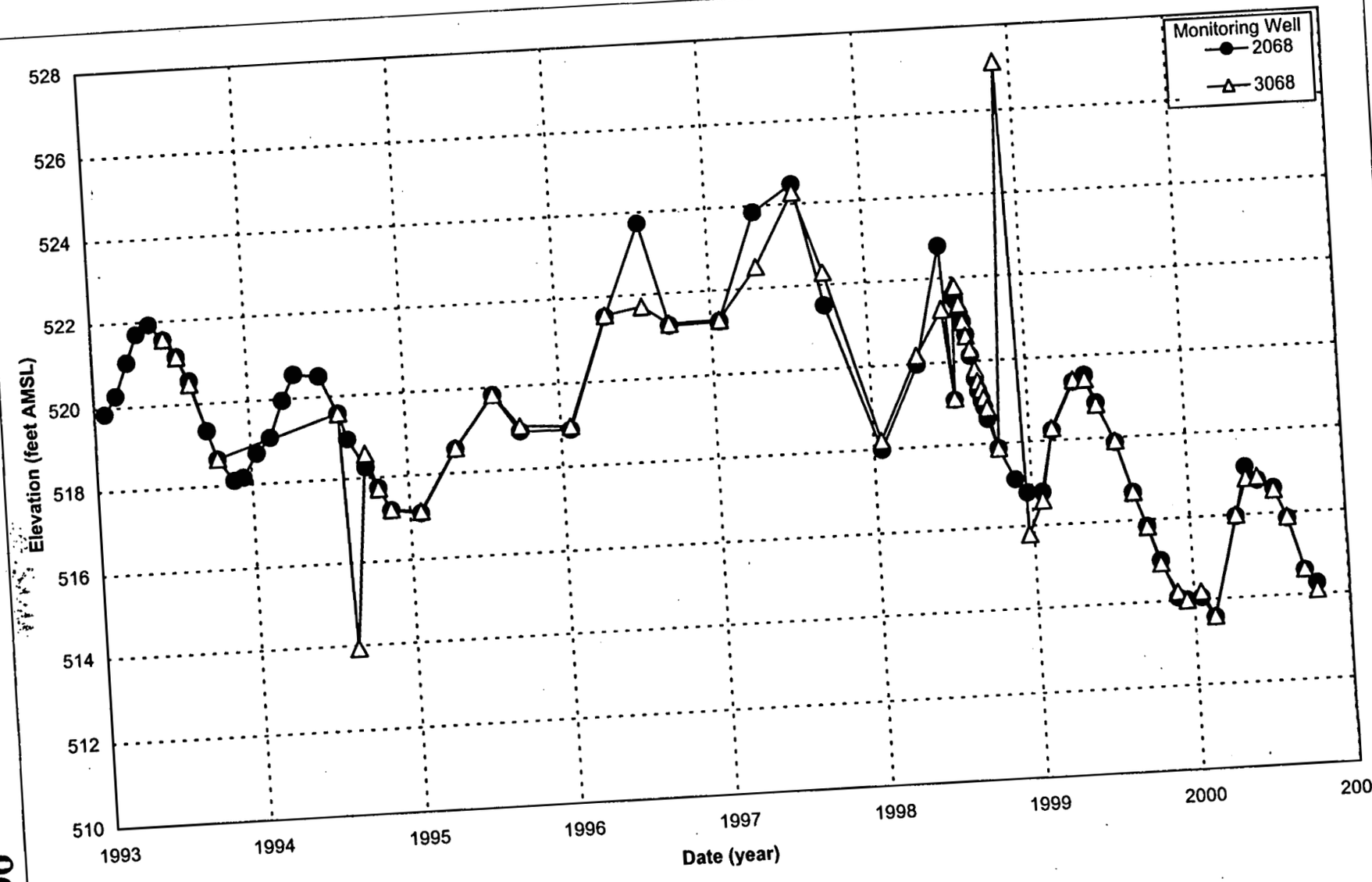


FIGURE A.3-16. HYDROGRAPH FOR WELL CLUSTER 068

000239

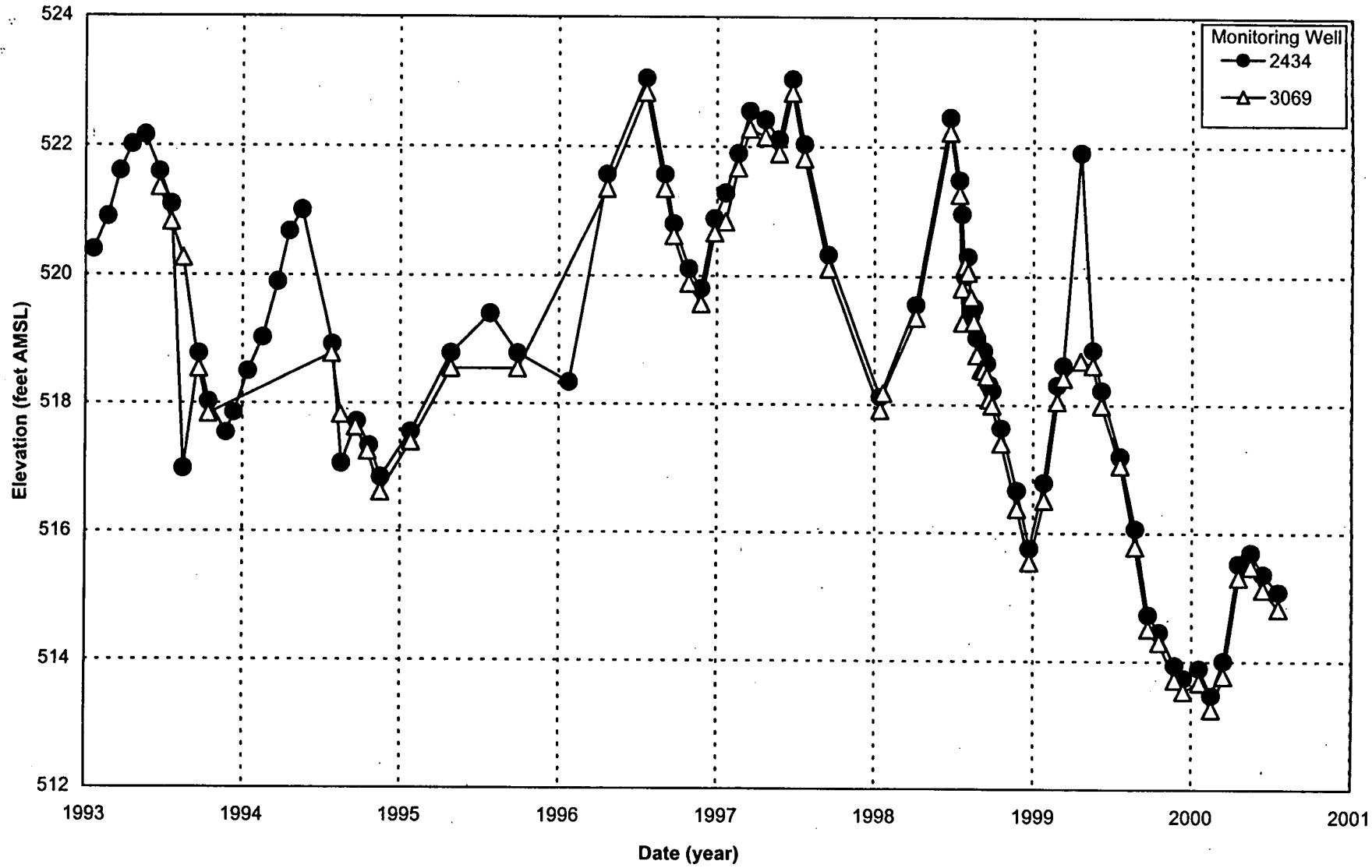


FIGURE A.3-17. HYDROGRAPH FOR WELLS 2434 AND 3069

000240

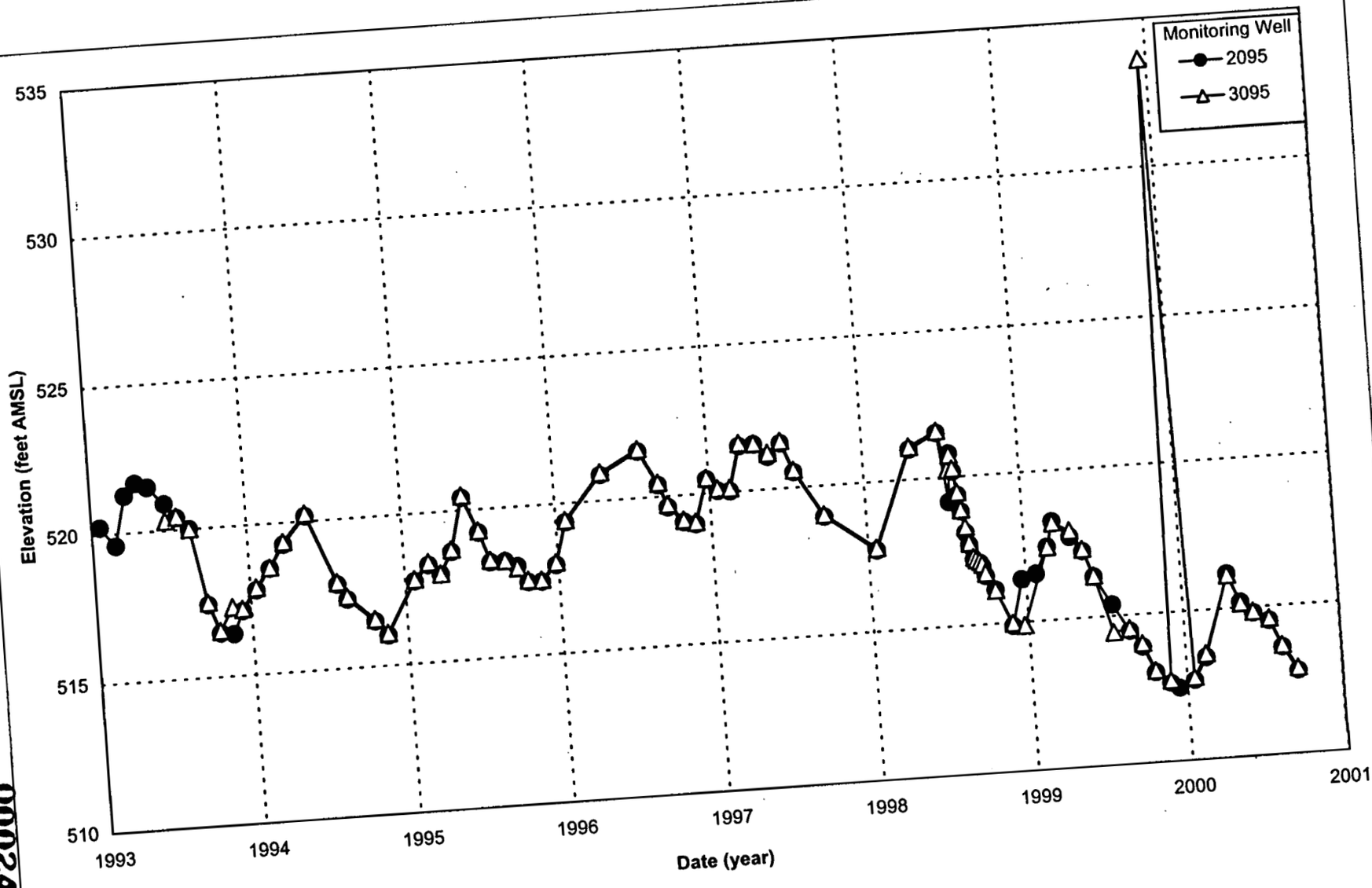


FIGURE A.3-18. HYDROGRAPH FOR WELL CLUSTER 095

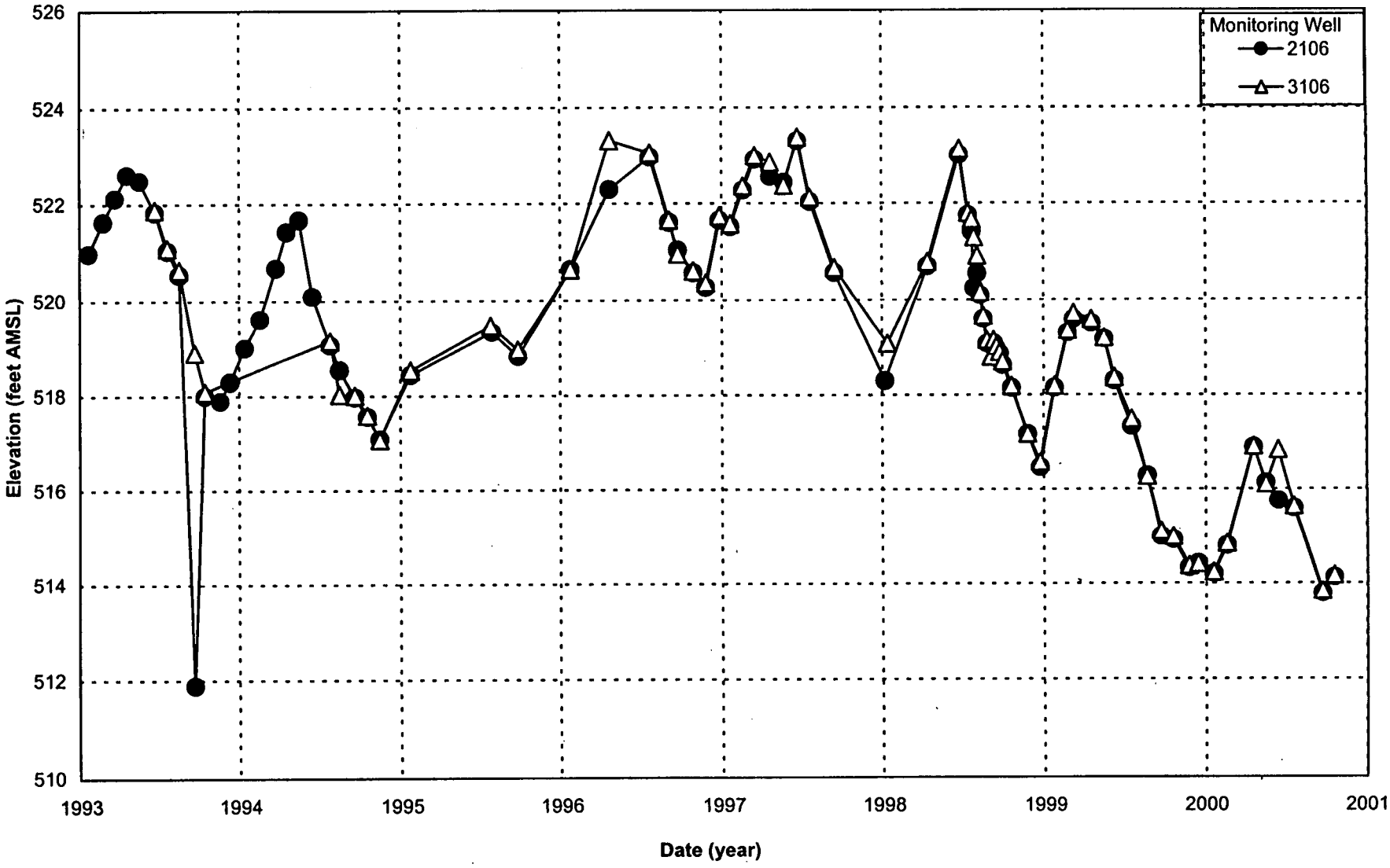


FIGURE A.3-19. HYDROGRAPH FOR WELL CLUSTER 106

000242

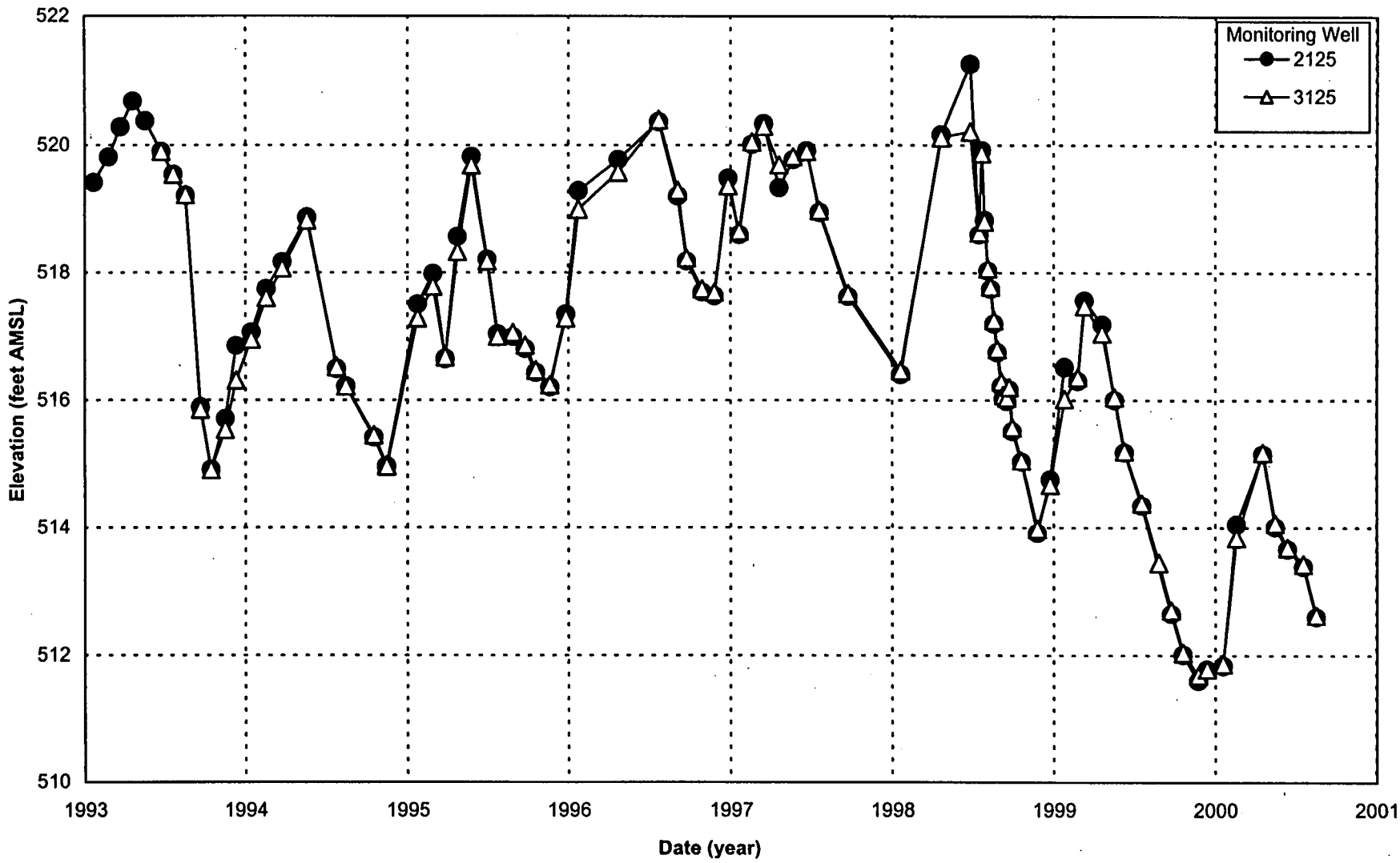


FIGURE A.3-20. HYDROGRAPH FOR WELL CLUSTER 125

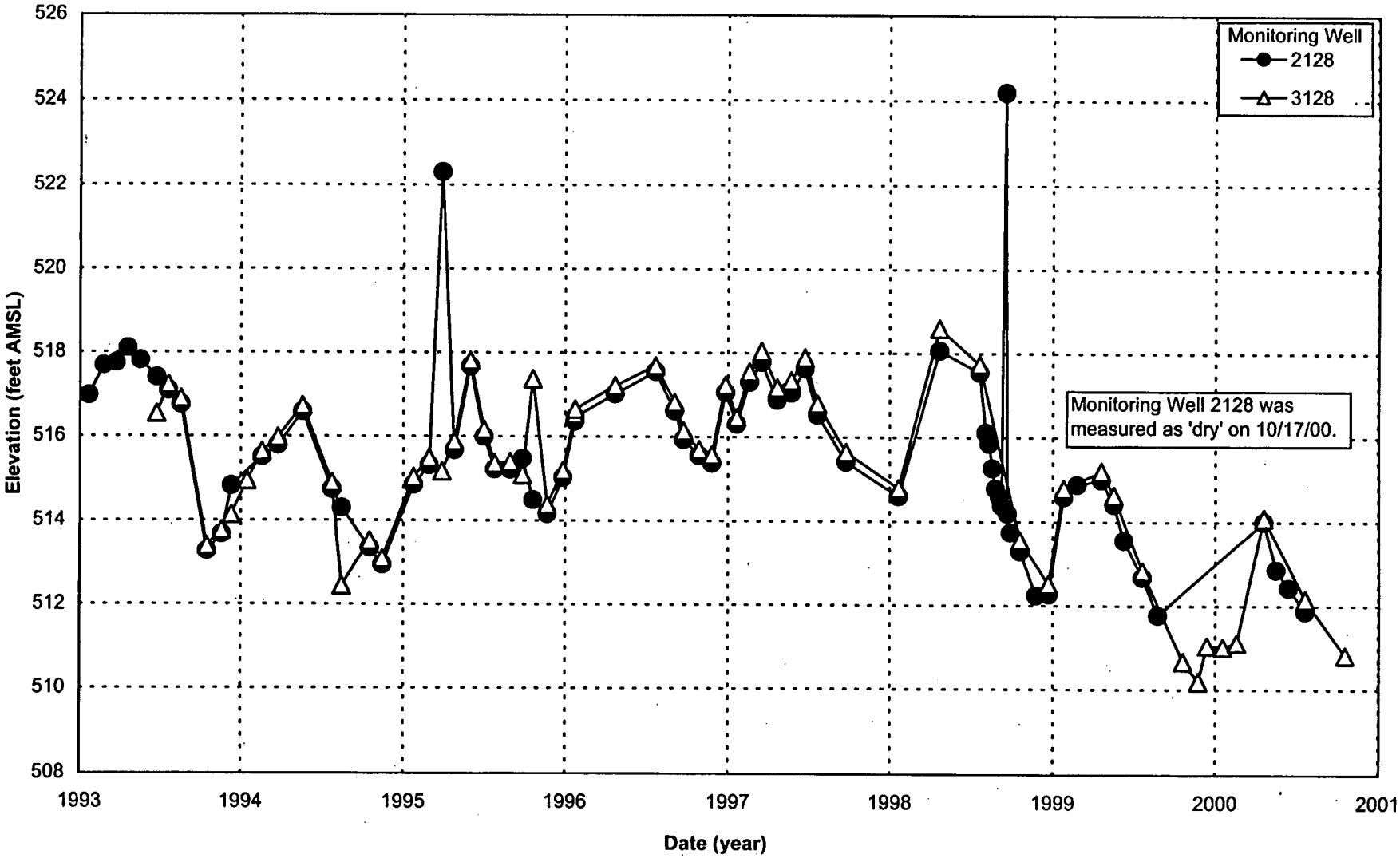


FIGURE A.3-21. HYDROGRAPH FOR WELL CLUSTER 128

000244

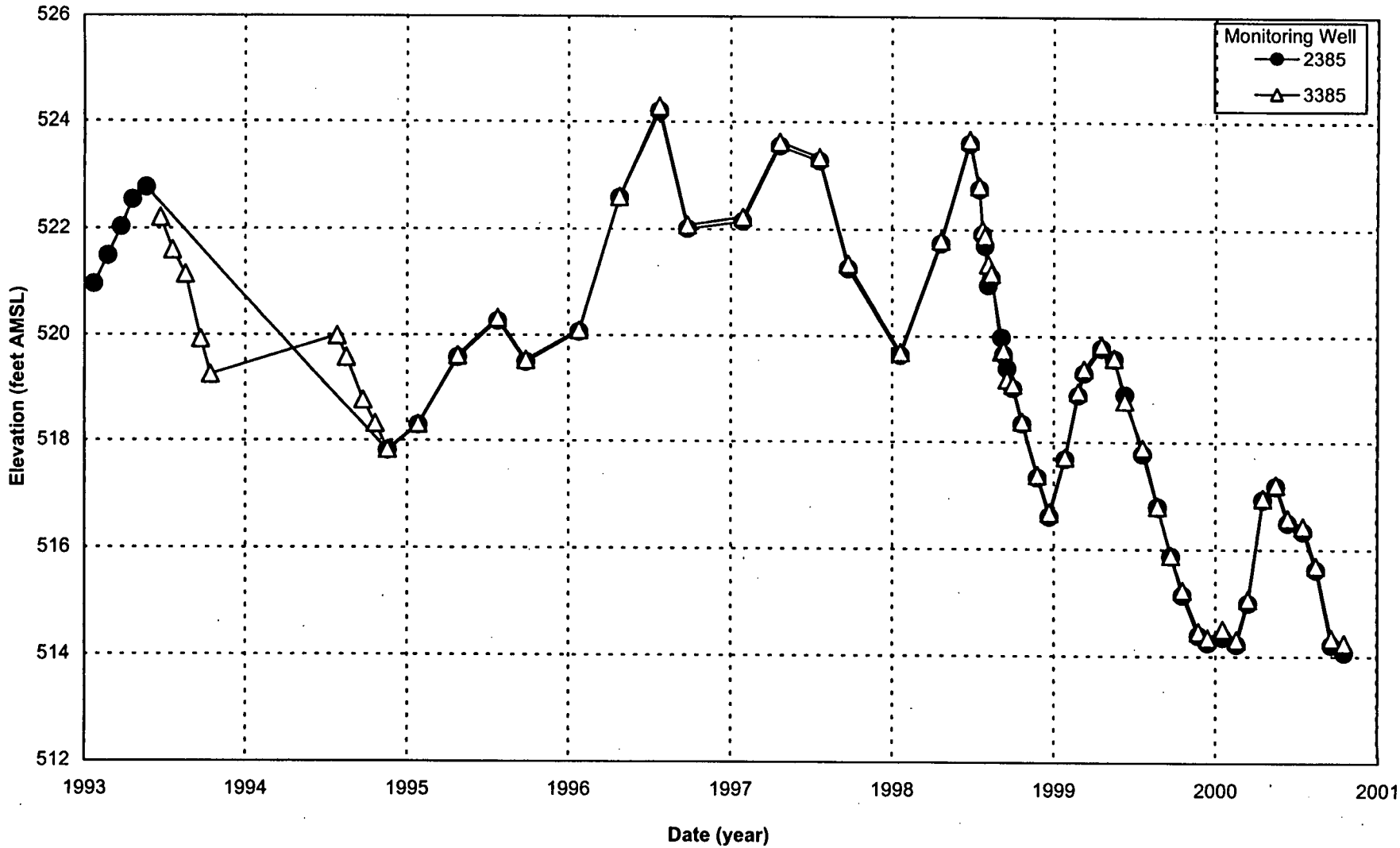


FIGURE A.3-22. HYDROGRAPH FOR WELL CLUSTER 385

000245

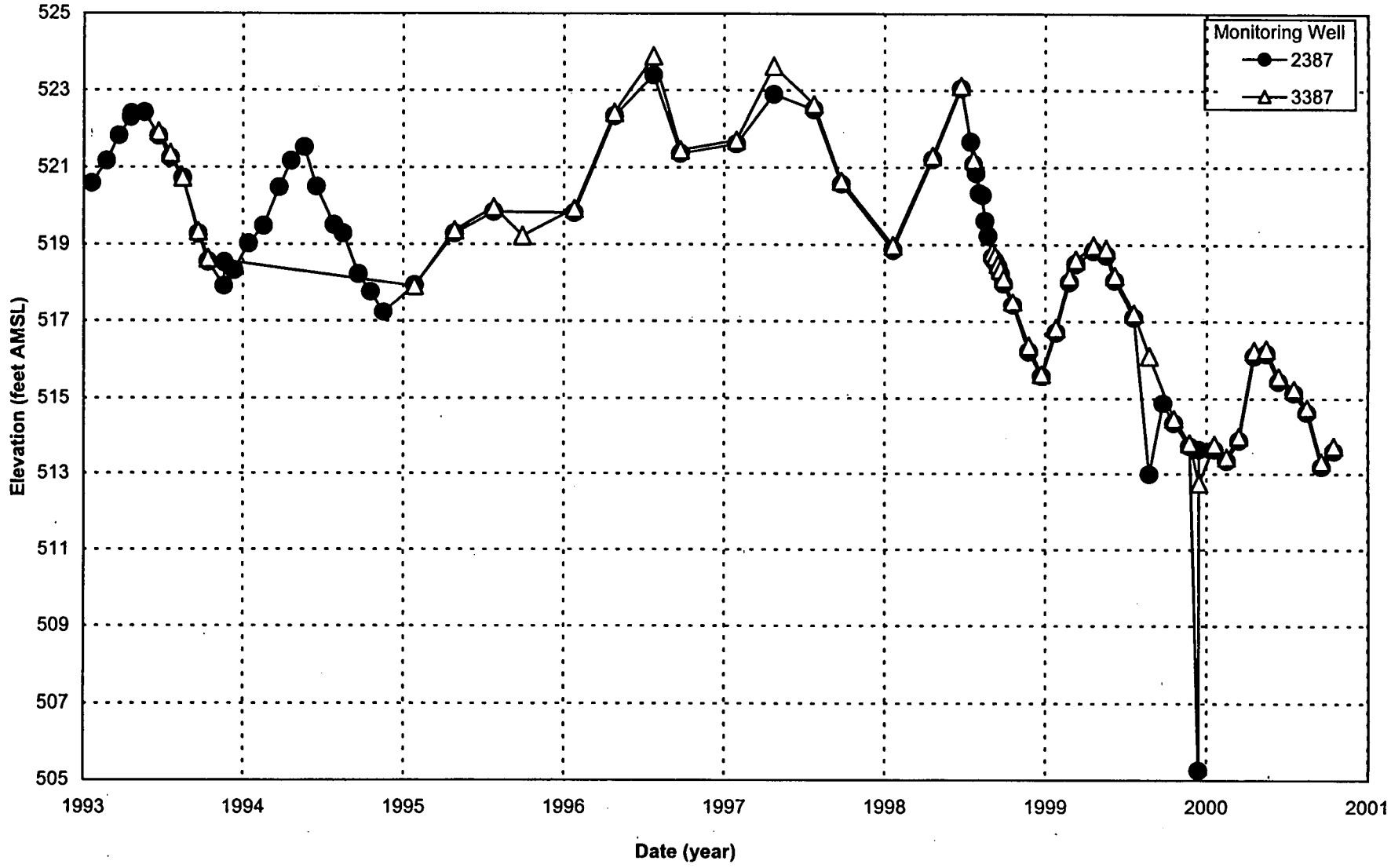


FIGURE A.3-23. HYDROGRAPH FOR WELL CLUSTER 387

000246

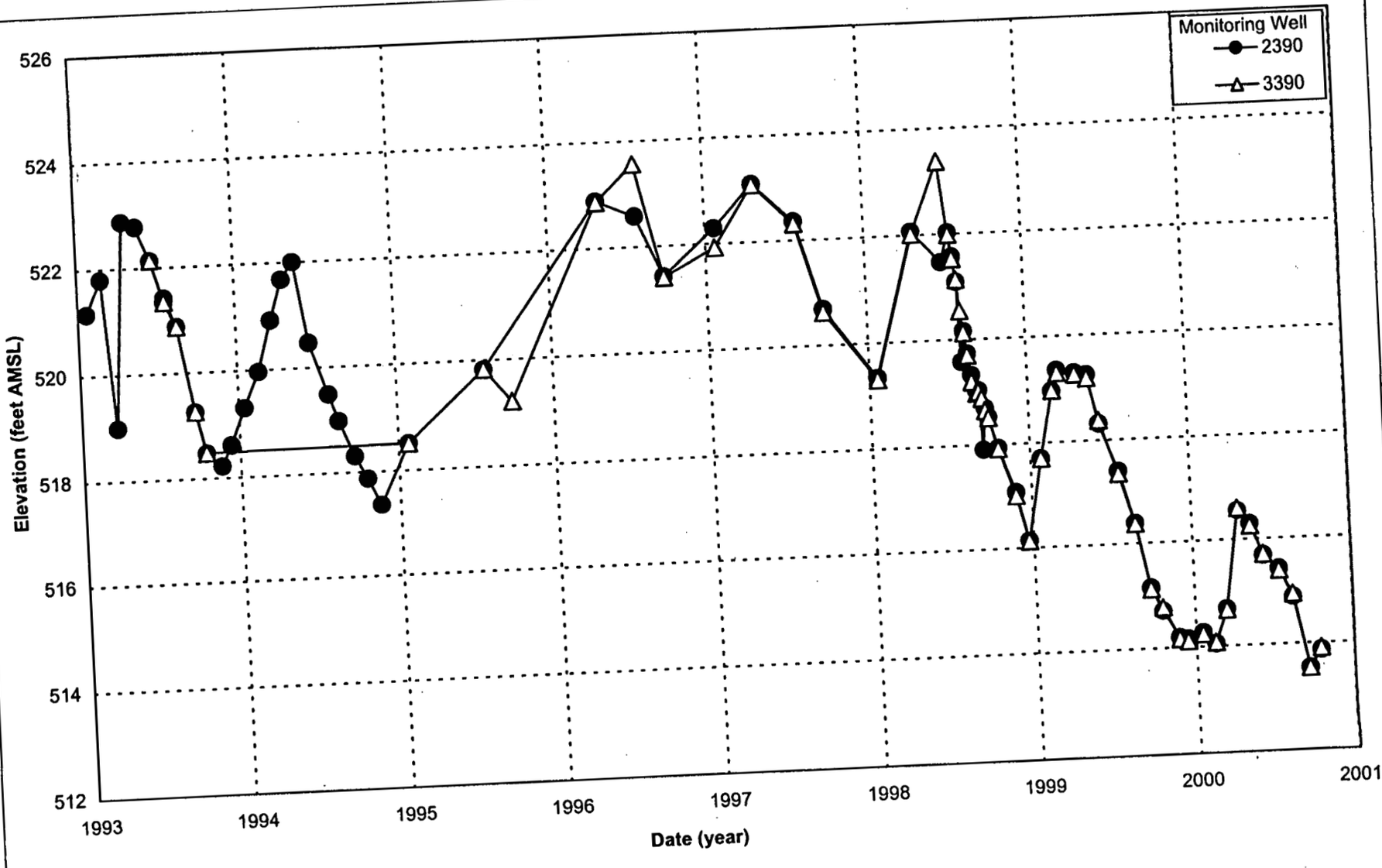


FIGURE A.3-24. HYDROGRAPH FOR WELL CLUSTER 390

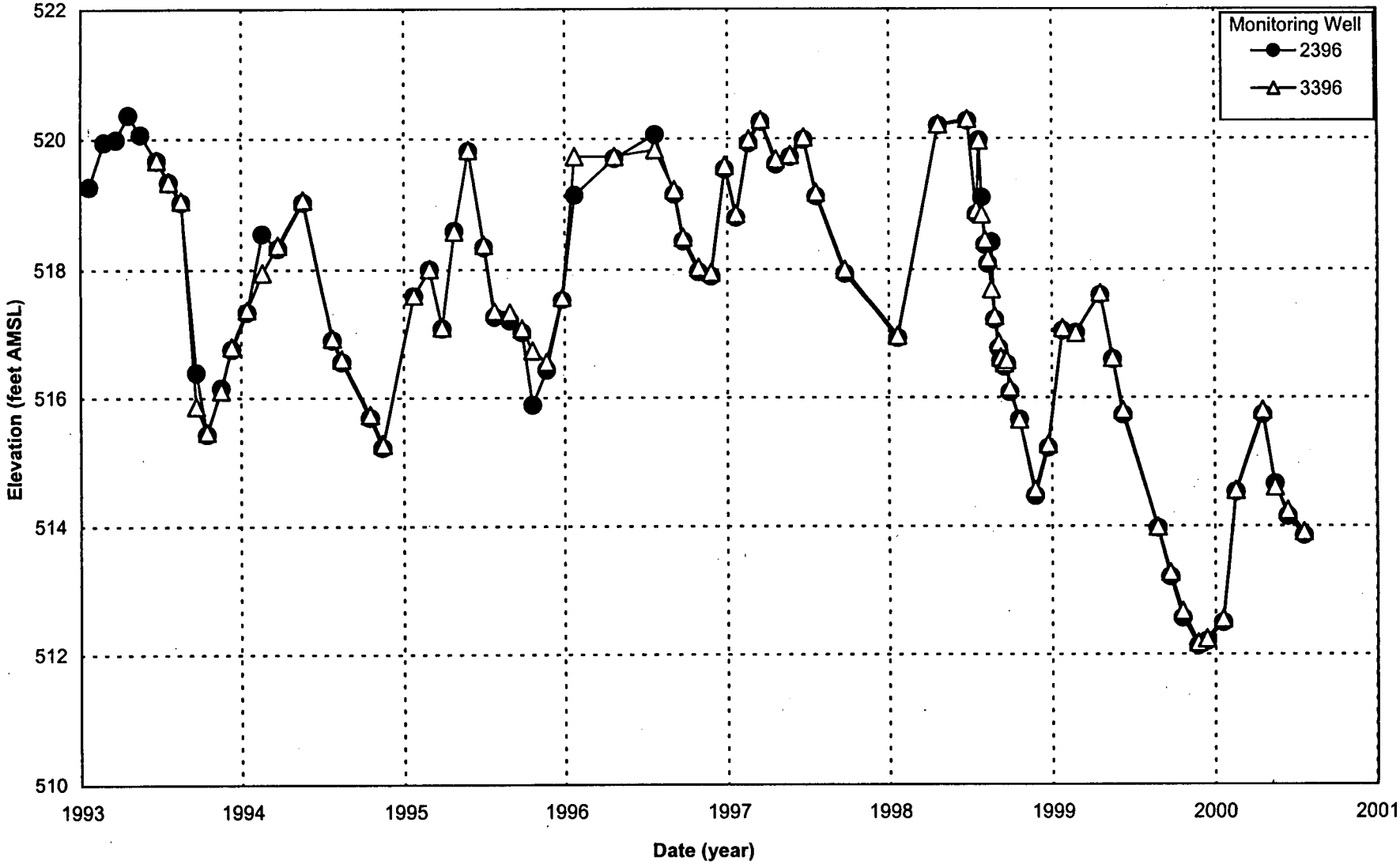


FIGURE A.3-25. HYDROGRAPH FOR WELL CLUSTER 396

000248

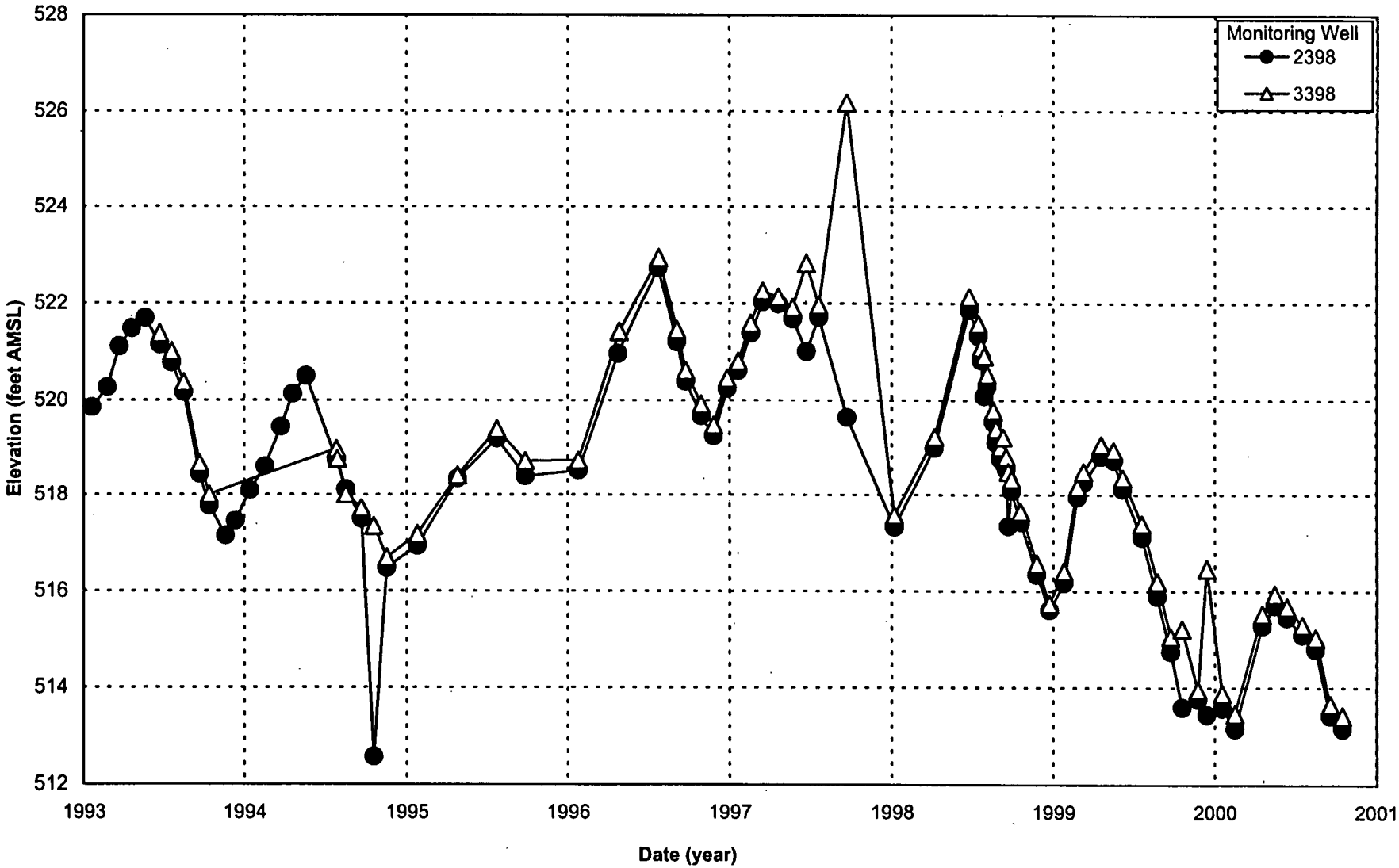


FIGURE A.3-26. HYDROGRAPH FOR WELL CLUSTER 398

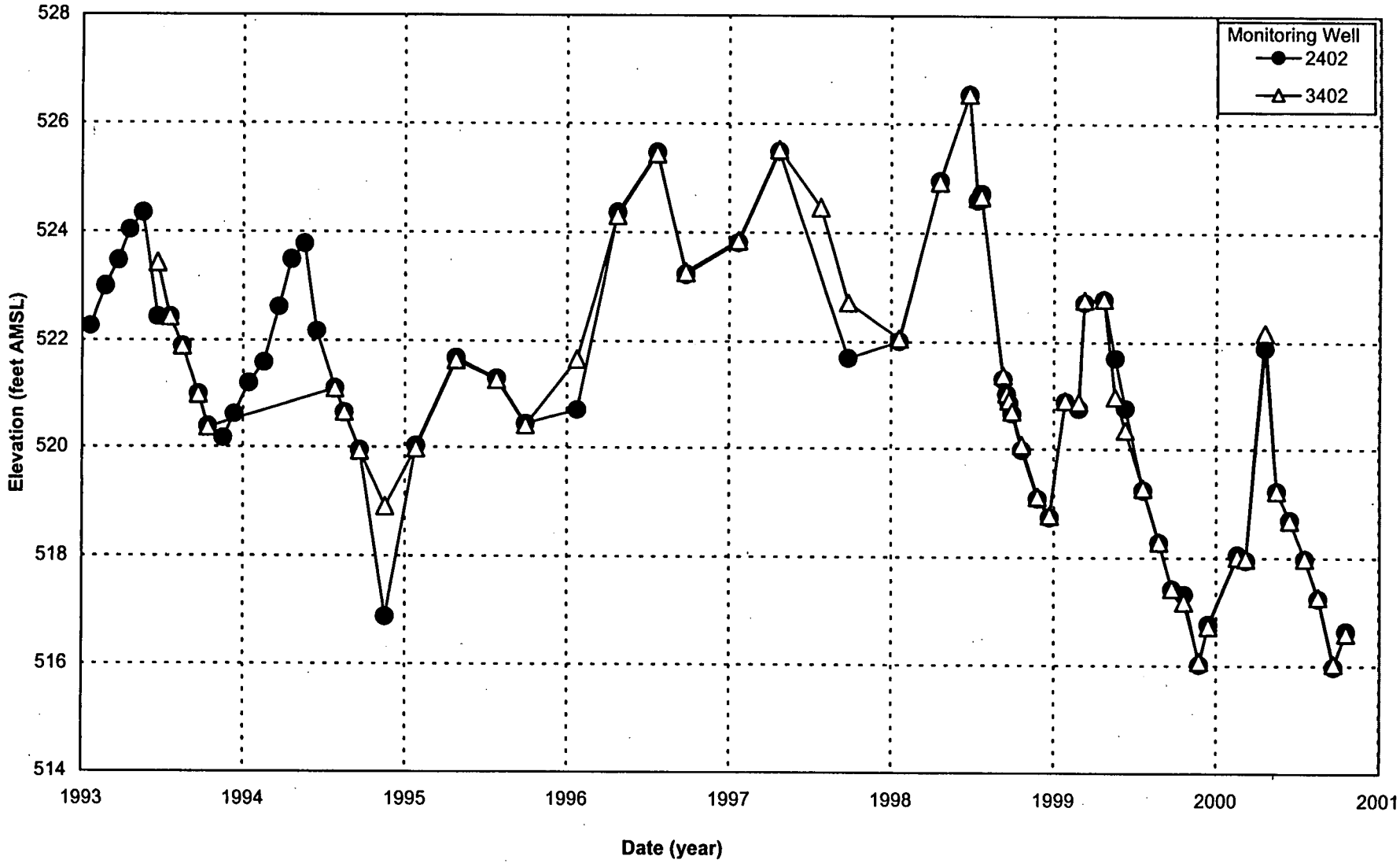


FIGURE A.3-27. HYDROGRAPH FOR WELL CLUSTER 402

000250

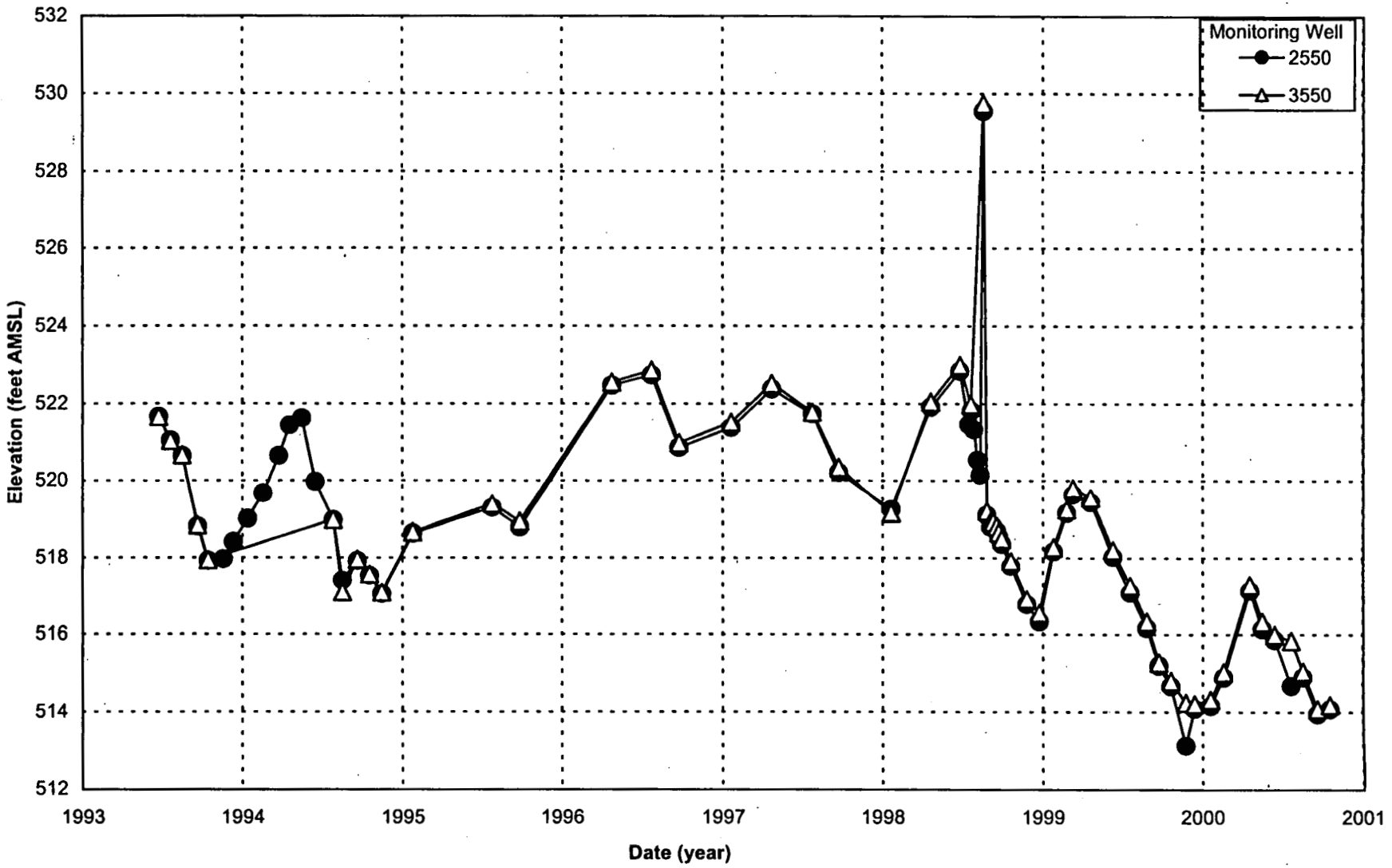


FIGURE A.3-28. HYDROGRAPH FOR WELL CLUSTER 550

FIGURE A.3-29. HYDROGRAPH FOR WELL CLUSTER 551

000252

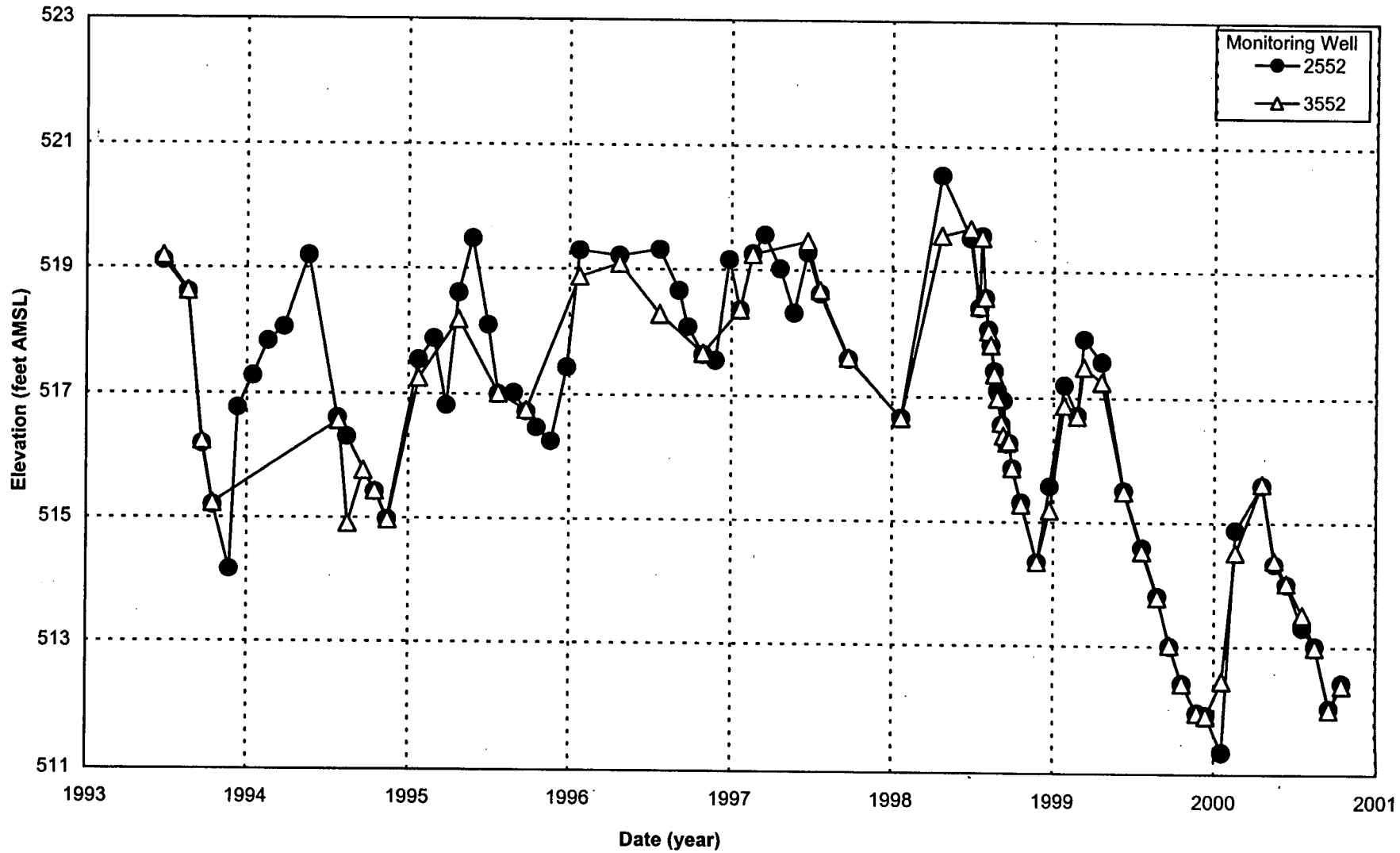


FIGURE A.3-30. HYDROGRAPH FOR WELL CLUSTER 552

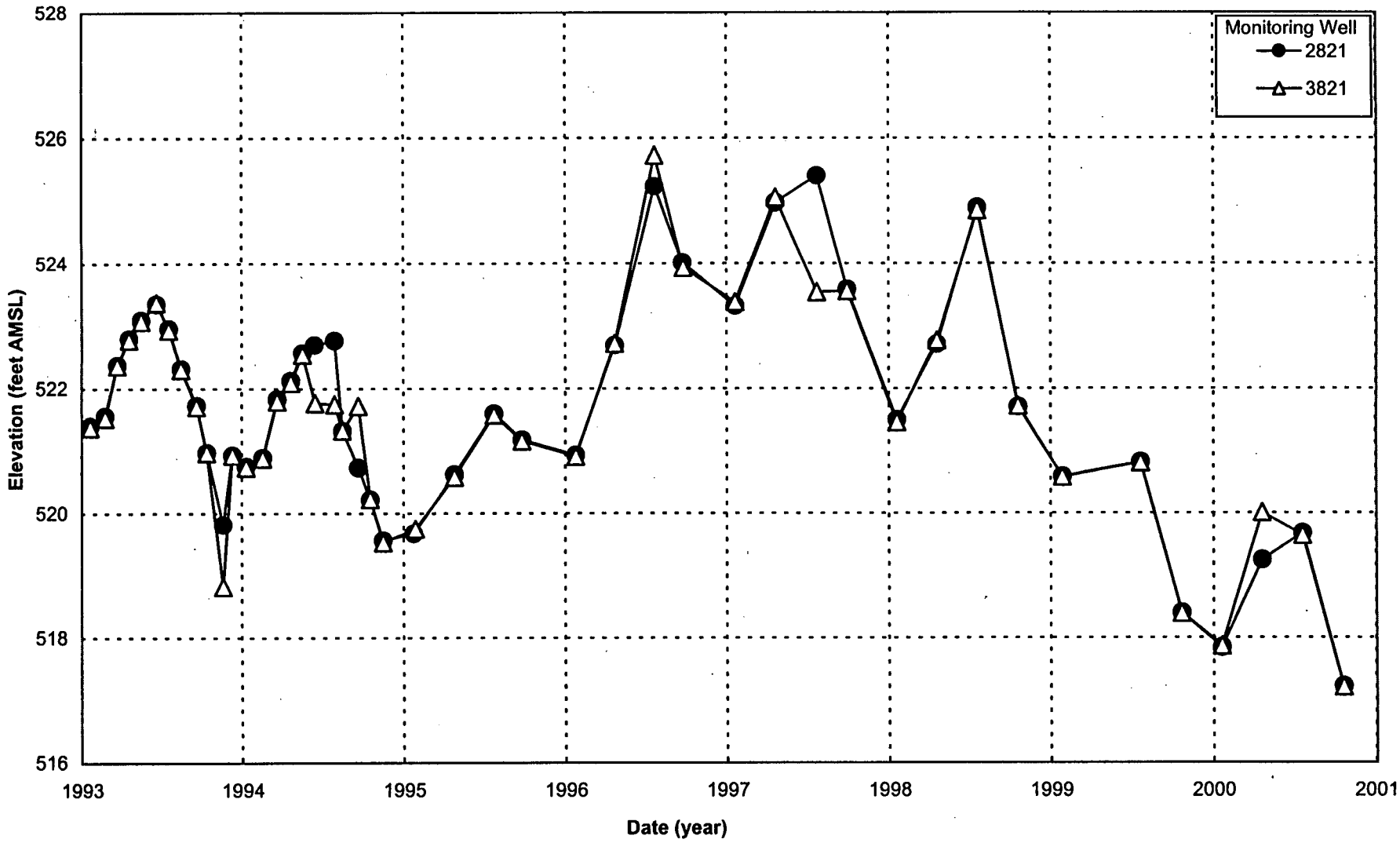


FIGURE A.3-31. HYDROGRAPH FOR WELL CLUSTER 821

000254

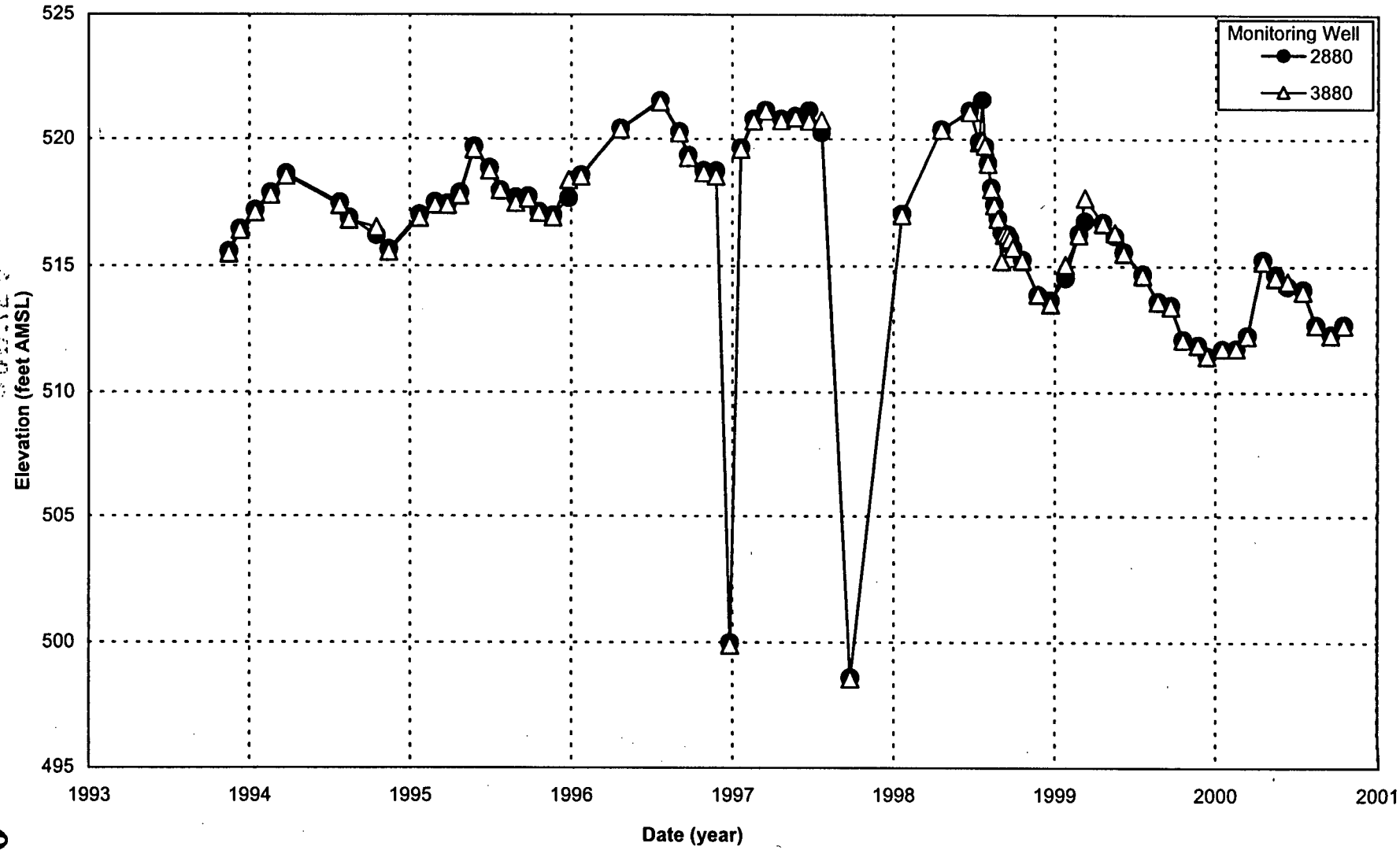


FIGURE A.3-32. HYDROGRAPH FOR WELL CLUSTER 880

000255

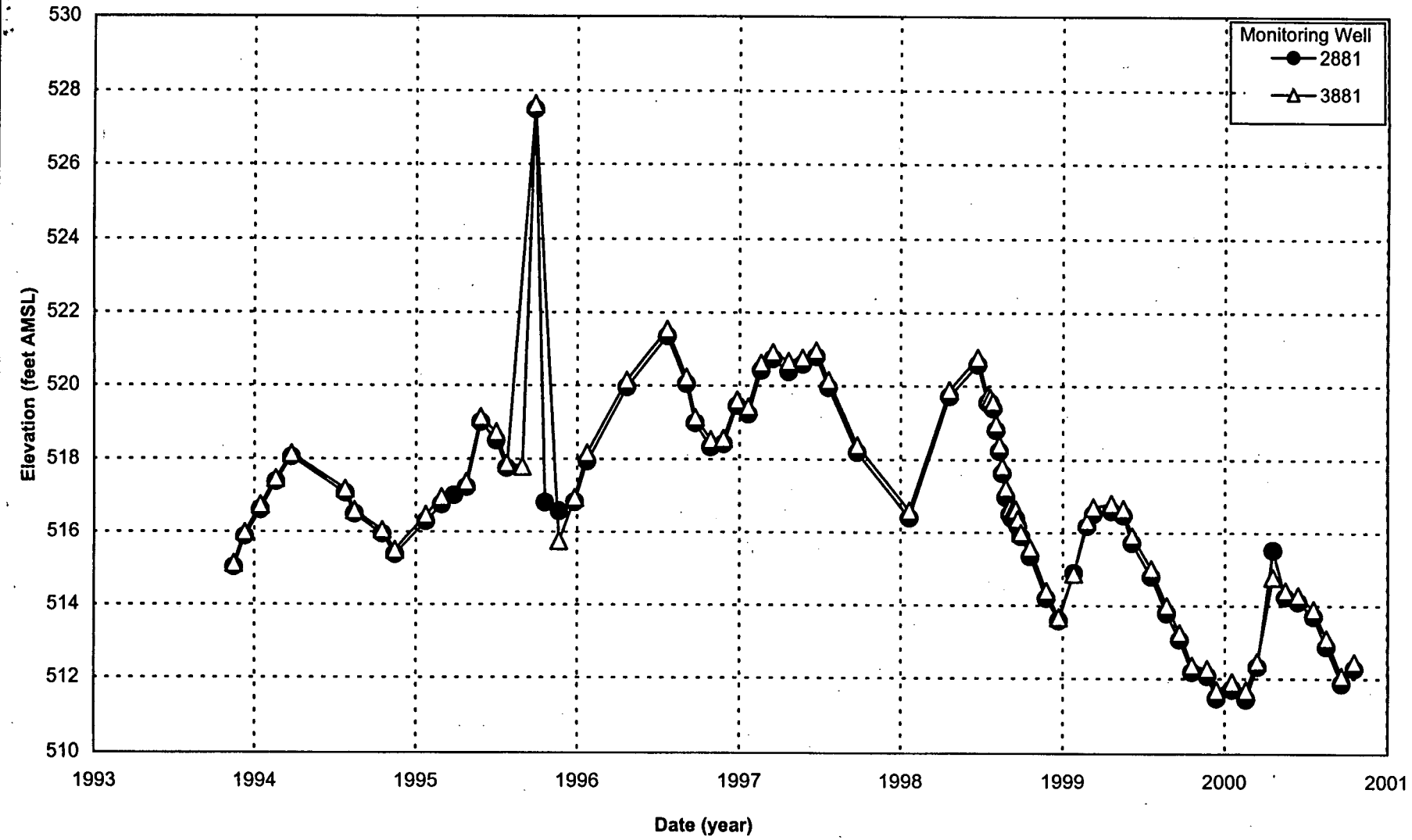


FIGURE A.3-33. HYDROGRAPH FOR WELL CLUSTER 881

000256

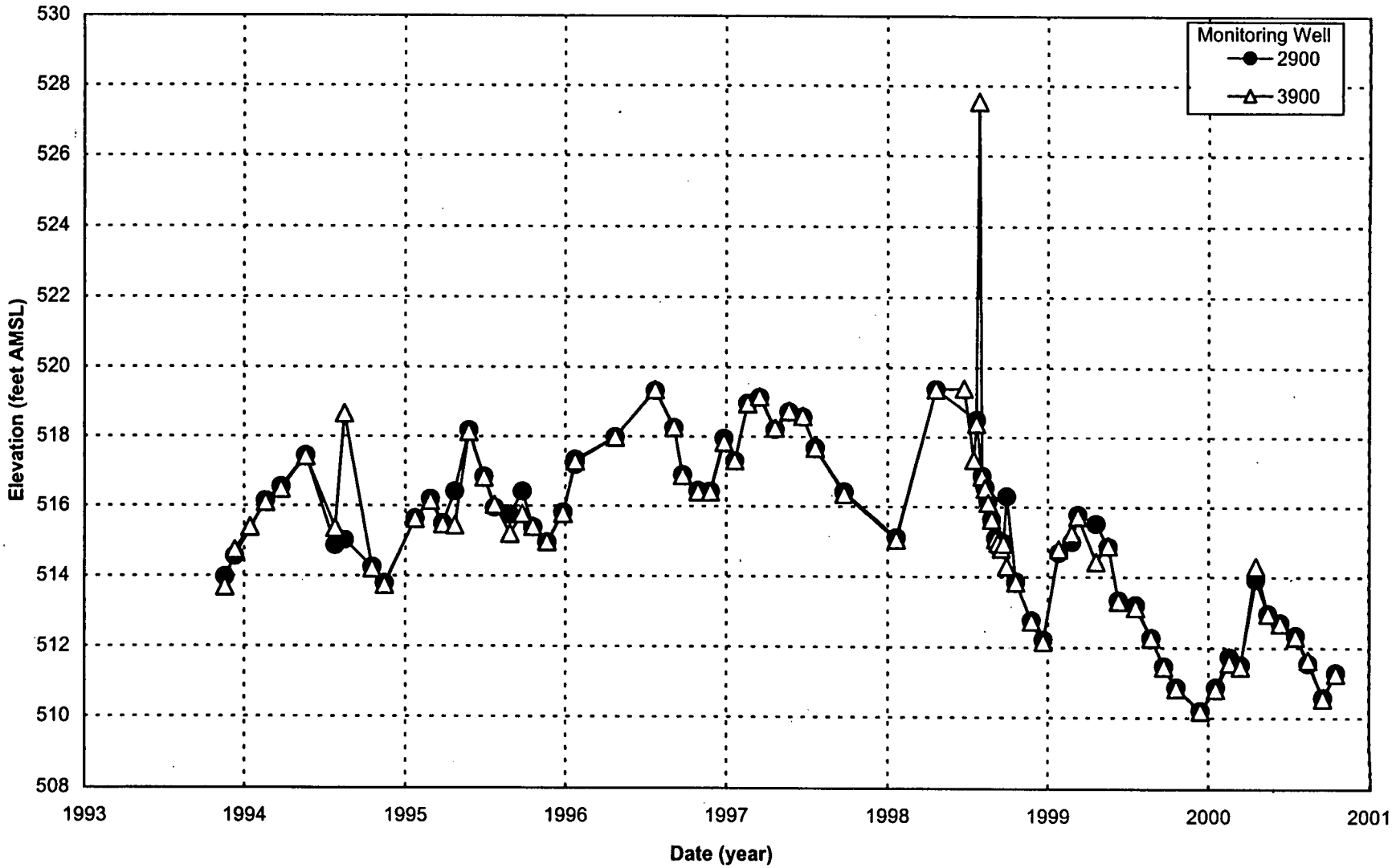


FIGURE A.3-34. HYDROGRAPH FOR WELL CLUSTER 900

ATTACHMENT A.4

NON-URANIUM FRL EXCEEDANCES

ATTACHMENT A.4

3694

This attachment to Appendix A evaluates non-uranium FRL exceedances that occurred in 2000. The purpose of the evaluation is to:

- Determine if 2000 non-uranium FRL exceedances result in the re-categorization of a constituent (Section A.4.1)
- Determine persistence of FRL exceedances outside the 10-year, uranium-based restoration footprint (Section A.4.2)
- Summarize the correlation between iron, manganese, and zinc in Property Boundary wells) (Section A.4.3)
- Identify conclusions (Section A.4.4).

A.4.1 RE-CATEGORIZATION OF NON-URANIUM FRL CONSTITUENTS BASED ON 2000 FRL EXCEEDANCES

Each year groundwater data are reviewed and monitoring constituent lists are evaluated to ensure that the sampling frequency for monitored constituents meets the criteria established for the program. The results of these evaluations are used to determine if the constituents should be re-categorized, which might change the monitoring frequency.

A.4.1.1 Background

Groundwater monitoring under the IEMP focuses on the 50 groundwater FRL constituents listed in the Record of Decision for Remedial Actions at Operable Unit 5 (DOE 1996). A detailed selection process was used to develop lists of constituents for groundwater monitoring of the aquifer restoration remedy. This process is presented in Appendix A of the IEMP, Revision 1.

For the purpose of modeling and monitoring, the aquifer was divided into different zones. A unique monitoring constituent list was initially developed for each zone, based on data collected from the aquifer from 1988 through 1997 and criteria defined in Appendix A of the IEMP, Revision 1.

Constituents were categorized based on whether or not they were mobile and persistent, and whether or not they had been detected above the FRL in the aquifer zone in question. The categories are defined as follows:

- >MP The constituent has been detected in the aquifer at concentrations greater than its established FRL and is considered "Mobile and Persistent". It has been predicted to be able to migrate vertically from the glacial overburden to the aquifer and has already caused an FRL exceedance in the aquifer.

- >N The constituent has been detected in the aquifer at concentrations greater than its established FRL but is "Not considered mobile and persistent". This constituent is not predicted to be able to migrate vertically through the glacial overburden, reach the aquifer, and create an unacceptable risk. Background conditions and/or surface water infiltrations may be the cause of the isolated FRL exceedances noted in the historical record.

- <MP The constituent has not been detected in the aquifer at concentrations greater than its established FRL, but is considered both "Mobile and Persistent". This constituent is predicted to be able to migrate vertically through the glacial overburden to the aquifer (if no source removal/control actions are taken), but as yet has not caused exceedances of its established FRL.

- <N The constituent has not been detected in the aquifer at concentrations greater than its established FRL and is "Not considered mobile and persistent".

If a new exceedance occurs in an aquifer zone for an FRL constituent, then the following criteria would trigger the need to re-categorize the constituent and increase its sampling frequency:

- For a <MP constituent, two consecutive FRL exceedances will result in re-categorization to a >MP constituent for the affected aquifer zone. An evaluation of each specific exceedance will be conducted to determine if re-sampling ahead of schedule is warranted.

- For a <N constituent, two consecutive FRL exceedances will result in re-categorization to a >N constituent for the affected aquifer zone. An evaluation of each specific exceedance will be conducted to determine if re-sampling ahead of schedule is warranted.

A.4.1.2 Evaluation

The criteria presented above were used to evaluate the non-uranium FRL constituents with exceedances in 2000 for re-categorization. Table A.4-1 lists the 2000 non-uranium FRL exceedances both inside and outside the 10-year, uranium-based restoration footprint and Figure A.4-1 identifies the location of these FRL exceedances. In 2000, 10 non-uranium FRL constituents had one or more FRL exceedances (Table A.4-1). As reported in Table A-2 of the IEMP, of the 10 constituents identified in Table A.4-1, five (boron, molybdenum, nitrate/nitrite as nitrogen, technetium-99, and trichloroethene)

have a "<" categorization in one or more aquifer zones. Correlation of the locations where the five constituents had exceedances in 2000 with the aquifer zones defined in the IEMP indicate that all five constituents are already categorized as ">" in all of the affected aquifer zones. Therefore no constituents need to be re-categorized from "<" to ">" based on 2000 monitoring results.

A.4.2 THE PERSISTENCE OF 2000 NON-URANIUM FRL EXCEEDANCES OUTSIDE THE 10-YEAR, URANIUM-BASED RESTORATION FOOTPRINT

The Restoration Area Verification Sampling Program Summary Report (DOE 1998b) states that any FRL exceedance outside the 10-year, uranium-based restoration footprint at the property boundary during routine monitoring would also be evaluated for persistence. This evaluation is to be performed using the same conservative data evaluation method approved for the Restoration Area Verification Sampling Program, Project-Specific Plan (DOE 1997d) to determine if a change in the aquifer restoration remedy is required. This evaluation was expanded for this report to include all non-uranium FRL exceedances detected outside of the 10-year, uranium-based restoration footprint, not just those detected at the property boundary. This section presents an evaluation of the persistence of non-uranium FRL exceedances.

A.4.2.1 Background

Analytical data from samples collected immediately following an FRL exceedance are evaluated to determine if the detected exceedance is persistent. In accordance with the approved Restoration Area Verification Sampling method, if two or more consecutive sampling events following an FRL exceedance indicate that the concentration in question has decreased below the groundwater FRL, then the exceedance is not considered persistent.

If an FRL exceedance detected outside the 10-year, uranium-based restoration footprint is determined to be not persistent, then no additional action is required above and beyond the routine groundwater monitoring specified in the IEMP. If an FRL exceedance is determined to be persistent, then the cause of the persistent exceedance needs to be identified, and its impact on the aquifer remedy design assessed. Ultimately, the cause needs to be addressed either through a modification of the aquifer remedy or by other means as applicable.

Results reported in Appendix A of the Restoration Area Verification Sampling Project-Specific Plan and the Restoration Area Verification Sampling Program Summary Report indicate that no persistent FRL exceedance was identified outside the 10-year, uranium-based restoration footprint. Evaluations for the IEMP began in 1997. In 1997, persistent FRL exceedances for manganese were identified in Monitoring Wells 2426, 2430, and 2431 and reported in the 1997 Integrated Site Environmental Report (DOE 1998a).

For 1998 no persistent FRL exceedances were reported. In 1999 one persistent FRL exceedance for zinc was reported at Monitoring Well 4067 and three possible persistent FRL exceedances were identified, that required additional data to be collected in 2000. The possible persistent FRL exceedances identified in the 1999 Integrated Site Environmental Report are listed below:

- Manganese at Monitoring Well 2426
- Nickel at Monitoring Well 22198
- Zinc at Monitoring Well 3426.

The non-uranium FRL exceedances for 2000 along with the possible persistent exceedances for 1999 are addressed below.

A.4.2.2 Evaluation

Figure A.4-1 and Table A.4-1 identifies the 2000 FRL exceedances. In 2000, four FRL constituents had one or more FRL exceedances at 10 property boundary wells located outside the 10-year, uranium-based restoration footprint, as noted below:

- Arsenic at Monitoring Wells 2625 and 2898
- Lead at Monitoring Wells 2431 and 3733
- Manganese at Monitoring Wells 2424, 2429, 2430, and 2432
- Zinc at Monitoring Wells 2424, 2426, 2430, 2431, 2432, and 3067.

Table A.4-2 provides a summary of the 2000 FRL exceedances that occurred outside the 10-year uranium-based restoration footprint. Table A.4-2 also addresses the possible persistent FRL exceedances identified in the 1999 Integrated Site Environmental Report. If two or more sampling events immediately following an FRL exceedance indicate that the concentration decreased below the FRL, then the exceedance is identified as not persistent in Table A.4-2. As shown in Table A.4-2, two persistent FRL exceedances (manganese and zinc at Monitoring Well 2430) were identified outside the 10-year, uranium-based restoration footprint using groundwater data collected in 2000.

The following is a summary of results presented in Table A.4.2:

- The following FRL exceedances detected in 1999 are not persistent, based on 2000 monitoring data:
  - Manganese at Monitoring Well 2426
  - Nickel at Monitoring Well 22198
  - Zinc at Monitoring Wells 3426 and 4067.

- The following FRL exceedances detected in 2000 are not persistent:

  - Arsenic at Monitoring Wells 2625 and 2898
  - Lead at Monitoring Well 2431
  - Zinc at Monitoring Wells 2424, 2426, and 2431.

- Additional data to be collected in 2001 is necessary to determine the persistence of the following exceedances detected in 2000:

  - Lead at Monitoring Well 3733
  - Manganese at Monitoring Wells 2424, 2429, and 2432
  - Zinc at Monitoring Wells 2432 and 3067.

Figures A.4-2 through A.4-19 present individual concentration versus time graphs for all monitoring wells and constituents identified above.

A.4.2.3 Discussion

The evaluation for persistence of non-uranium FRL exceedances detected in property boundary wells located outside the 10-year, uranium-based restoration footprint in 2000 marks the fourth year that an evaluation has been conducted as part of the IEMP. For this report, the evaluation was expanded to include 2000 data collected at all IEMP wells located outside of the 10-year, uranium-based restoration footprint, not just the property boundary wells. Evaluating the data for persistence appears to be valuable in tracking changing conditions outside the 10-year, uranium-based restoration footprint. As outlined below, over the past four years, persistent exceedances have been identified for manganese and zinc.

- Manganese: There were three persistent manganese FRL exceedances in 1997 at Monitoring Wells 2426, 2430, and 2431. However, the manganese concentrations at all three of these wells in 1998 and 1999 were below the manganese FRL concentration of 0.90 milligrams per liter (mg/L), such that no persistent manganese FRL exceedances were identified for them in either 1998 or 1999. However, in 2000, manganese was once again determined to be persistent at Monitoring Well 2430.

- Zinc: The identification of a single persistent zinc FRL exceedance in 1999 at Monitoring Well 4067. The zinc concentration at this well increased above the zinc FRL concentration of 0.021 mg/L during the third quarter of 1998, and remained above the FRL for six consecutive sampling quarters. However, in 2000, the quarterly monitoring results indicated that the zinc concentration at Monitoring Well 4067 was below the zinc FRL. In 2000 a persistent FRL exceedance for zinc was identified at Monitoring Well 2430.

A.4.3 ADDITIONAL STUDIES

The following subsection provides a discussion on the correlation of iron, manganese, and zinc concentrations in property boundary wells. The commitment to begin this study was identified in the 1997 Integrated Site Environmental Report.

It has been noted in this and in past integrated site environmental reports that exceedances of the groundwater FRL concentration for zinc and manganese have periodically been detected in some of the property boundary wells. Table A.4-3 provides a summary of the detections. As the table illustrates, the detections appear to be sporadic. Some years they meet the requirement for being labeled persistent, but sampling in later years indicates that the concentrations are no longer exceeding the groundwater FRL. Periodic zinc exceedances are more widespread than periodic manganese exceedances. Since 1997 zinc exceedances have been recorded at 15 different property boundary wells, while manganese exceedances have only been recorded at six different property boundary wells. Five of the property boundary wells showing manganese exceedances have also shown zinc exceedances (Monitoring Wells 2424, 2426, 2430, 2431, and 2432).

Biofouling around well screens can lead to bioaccumulation of iron, manganese, and zinc (Cullimore 1993). Therefore, since 1998, groundwater samples collected from the property boundary wells have been sampled for iron, in addition to manganese and zinc to see if there is any correlation between the constituent concentrations over time.

Figures A.4-20 through A.4-52 are concentration versus time plots for iron, manganese, and zinc for each property boundary well. Only three of the 33 property boundary wells monitored (less than 10 percent) showed a visual correlation between iron, manganese, and zinc concentrations (Monitoring Wells 2733, 2432, and 2431). This indicates that biofouling does not appear to be prevalent. Most of the figures indicate that iron and manganese concentrations appear to hold fairly steady while the zinc concentrations fluctuate around the detection limit of 0.015 mg/L. Sampling for iron in the property boundary wells will be discontinued in the third quarter of 2001.

A.4.4 CONCLUSIONS

From the above sections, the following conclusions can be made from review of the 2000 non-uranium FRL exceedance data:

- Re-categorization of FRL constituents is not required, and the sampling frequency used in 2000 to sample FRL constituents do not need to be changed.

- There are two new persistent FRL exceedances outside the 10-year, uranium-based restoration footprint (manganese and zinc in Monitoring Well 2430). A change in the design of the aquifer remedy to address the exceedances is not required at this time.

- Sampling for iron in the property boundary wells will be discontinued beginning in the third quarter of 2001.

TABLE A.4-1

SUMMARY STATISTICS AND TREND ANALYSIS FOR NON-URANIUM CONSTITUENTS WITH 2000 RESULTS ABOVE FINAL REMEDIATION LEVELS

Constituent (FRL)[a]	Monitoring Well	No. of Samples[b,c,d]	No. of Samples Above FRL[b,c,d]	No. of Samples Above FRL for 2000[c,d]	Minimum[b,c,d,e,f]	Maximum[b,c,d,e,f]	Average[b,c,d,e,f]	Standard Deviation[b,c,d,e,f]	Trend[b,c,d,e,f]
Arsenic (0.050 mg/L)					(mg/L)	(mg/L)	(mg/L)	(mg/L)	
	2385	5	1	1	0.0003	0.0633	0.015	0.03	No Significant Trend
	2625	23	1	1	0.0052	0.0595	0.016	0.011	No Significant Trend
	2898	30	1	1	0.00035	0.082	0.0049	0.015	No Significant Trend
	2900	30	2	1	0.00032	0.0609	0.0075	0.015	No Significant Trend
Boron (0.33 mg/L)	2045	14	3	1	0.0434	0.666	0.212	0.170	Up, Marginal
	2049	14	11	3	0.0072	1.16	0.61	0.35	No Significant Trend
Lead (0.015 mg/L)	2054	5	1	1	0.0016	0.0224	0.0087	0.0083	No Significant Trend
	2385	5	1	1	0.000005	0.0191	0.004	0.008	No Significant Trend
	2431	29	1	1	0.000031	0.0157	0.0017	0.0036	Down, Significant
	3733	30	3	1	0.000005	0.201	0.009	0.04	Down, Significant
Manganese (0.90 mg/L)	2027	6	2	1	0.37	1.94	0.85	0.58	No Significant Trenc
	2054	5	2	1	0.303	1.68	0.926	0.491	No Significant Trend
	2118	5	2	1	0.209	1.15	0.776	0.348	**Up, Significant**
	2385	5	4	1	0.384	105	23	46	No Significant Trenc
	2389	5	2	1	0.241	1.88	0.753	0.695	No Significant Trend
	2397	5	1	1	0.324	1.5	0.59	0.51	**Up, Significant**
	2417	31	1	1	0.266	0.953	0.599	0.159	**Up, Significant**
	2424	31	5	1	0.018	2.83	0.62	0.58	**Up, Significant**
	2429	29	1	1	0.281	0.983	0.387	0.149	**Up, Significant**
	2430	30	7	2	0.131	1.69	0.706	0.339	**Up, Significant**
	2432	30	1	1	0.33	0.92	0.48	0.16	**Up, Significant**
	2648	7	5	1	0.566	2.93	1.79	0.962	No Significant Trend
	2899	6	1	1	0.0626	1.72	0.393	0.655	No Significant Trend
	2900	7	1	1	0.017	1.03	0.28	0.35	No Significant Trend
	3027	6	6	2	1.29	2.04	1.58	0.286	No Significant Trend
	3045	6	3	1	0.0257	5.23	1.45	2.01	Up, Marginal
	3821	5	2	1	0.706	5.23	2.06	1.99	**Up, Significant**
Molybdenum (0.10 mg/L)	2649	6	6	1	0.275	0.69	0.48	0.16	No Significant Trend
Nickel (0.10 mg/L)	2054	5	1	1	0.0057	0.104	0.038	0.040	No Significant Trend
	2385	5	1	1	0.0059	0.389	0.092	0.17	No Significant Trend
	2386	6	3	1	0.0095	1.42	0.44	0.59	**Up, Significant**
	2387	5	3	1	0.0095	0.972	0.28	0.40	**Up, Significant**
Nitrate/Nitrite (11 mg/L)[g]	2648	8	4	1	0.15	20	8.6	8.4	No Significant Trend
	2649	8	8	2	29.1	73.6	44.2	13.4	No Significant Trend
	3821	8	1	1	0.01	11.4	1.5	4.0	No Significant Trend
Technetium-99 (94 pCi/L)					(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)	
	2649	1	1	2	130.587	1352.27	718.709	510.910	No Significant Trend

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TABLE A.4-1
(Continued)

Constituent (FRL)[a]	Monitoring Well	No. of Samples[b,c,d]	No. of Samples Above FRL[b,c,d]	No. of Samples Above FRL for 2000[c,d]	Minimum[b,c,d,e,f]	Maximum[b,c,d,e,f]	Average[b,c,d,e,f]	Standard Deviation[b,c,d,e,f]	Trend[b,c,d,e,f]
Trichloroethene (5.0 µg/L)					(µg/L)	(µg/L)	(µg/L)	(µg/L)	
	2649	7	6	1	0.5	150	93	49	Down, Marginal
Zinc (0.021 mg/L)					(mg/L)	(mg/L)	(mg/L)	(mg/L)	
	2054	5	2	1	0.0048	0.0688	0.03	0.03	No Significant Trend
	2068	5	2	1	0.0011	0.071	0.028	0.03	No Significant Trend
	2385	5	2	1	0.0027	0.235	0.06	0.10	No Significant Trend
	2424	31	9	1	0.00065	0.239	0.024	0.045	No Significant Trend
	2426	30	6	1	0.0008	0.0628	0.012	0.016	No Significant Trend
	2430	30	3	3	0.00105	0.0316	0.00750	0.00784	No Significant Trend
	2431	29	4	1	0.00145	0.0917	0.0140	0.0214	No Significant Trend
	2432	30	4	2	0.0008	0.114	0.01	0.02	No Significant Trend
	2434	30	3	1	0.0008	0.0532	0.008	0.01	No Significant Trend
	2551	5	1	1	0.0017	0.1	0.02	0.04	No Significant Trend
	2900	7	1	1	0.0001	0.0216	0.011	0.009	No Significant Trend
	3045	5	3	1	0.0052	0.367	0.10	0.15	No Significant Trend
	3067	31	1	1	0.0005	0.0358	0.006	0.007	No Significant Trend
	3385	5	4	1	0.014	0.0656	0.038	0.022	No Significant Trend
	3387	5	4	1	0.0121	0.162	0.0618	0.0585	No Significant Trend
	3397	5	3	1	0.0034	0.114	0.042	0.045	No Significant Trend
	3402	6	1	1	0.00415	0.115	0.0282	0.0429	Up, Marginal

Note: Highlighting indicates well is outside the 10-year, uranium-based restoration footprint.

[a]From Operable Unit 5 Record of Decision, Table 9-4
[b]Based on unfiltered samples from the Operable Unit 5 remedial investigation/feasibility study data set (1988 through 1993) and 1994 through 2000
[c]If more than one sample is collected per well per day (e.g., duplicate), then only one sample is counted for the total number of samples, and the sample with the maximum representative concentration is used for determining the summary statistics (minimum, maximum, average, and standard deviation [SD]) and Mann-Kendall test for trend.
[d]Rejected data qualified with either a R or Z were not included in the count, the summary statistics, or Mann-Kendall test for trend.
[e]If the number of samples is greater than or equal to four, then the Mann-Kendall test for trend and all of the summary statistics 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.
[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 detection limit.
[g]FRL based on nitrate, from Operable Unit 5 Record of Decision, Table 9-4

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TABLE A.4-2

SUMMARY OF PERSISTENCE EVALUATION OF NON-URANIUM FRL EXCEEDANCES OUTSIDE THE 10-YEAR, URANIUM-BASED RESTORATION FOOTPRINT

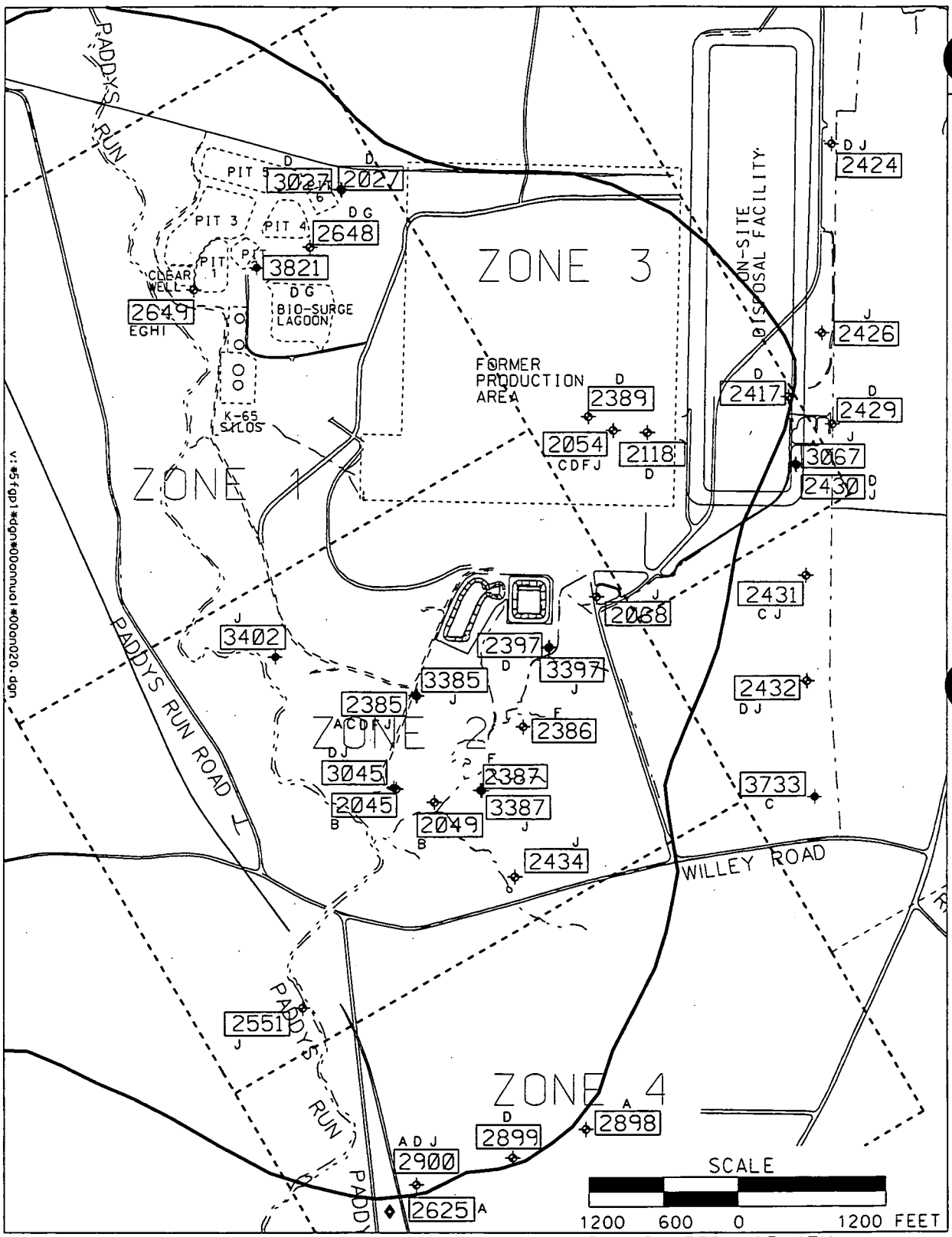
Constituent	Monitoring Well	Pertinent 1999 Results	2000 FRL Exceedance First Qtr	Second Qtr	Third Qtr	Fourth Qtr	Evaluation Results for 2000	Figure No.
Arsenic	2625		No	Yes	No	No	Not persistent	A.4-2
	2898		Yes	No	No	No	Not persistent	A.4-3
Lead	2431		Yes	No	No	No	Not persistent	A.4-4
	3733		No	No	No	Yes	Additional data required	A.4-5
Manganese	2424		No	No	Yes	No	Additional data required	A.4-6
	2426	Third Quarter FRL Exceedance	No	No	No	No	Not persistent	A.4-7
	2429		No	No	No	Yes	Additional data required	A.4-8
	2430		No	No	Yes	Yes	Persistent	A.4-9
	2432		No	No	No	Yes	Additional data required	A.4-10
Nickel	22198	Fourth Quarter FRL Exceedance	No	No	No	No	Not persistent	A.4-11
Zinc	2424		Yes	No	No	No	Not persistent	A.4-12
	2426		Yes	No	No	No	Not persistent	A.4-13
	2430		Yes	No	Yes	Yes	Persistent	A.4-14
	2431		Yes	No	No	No	Not persistent	A.4-15
	2432		Yes	No	No	Yes	Additional data required	A.4-16
	3067		No	No	Yes	No	Additional data required	A.4-17
	3426	First and Third Quarter FRL Exceedances	No	No	No	No	Not persistent	A.4-18
	4067	First, Second, Third, and Fourth Quarter FRL Exceedances	No	No	No	No	Not persistent	A.4-19

TABLE A.4-3

MANGANESE AND ZINC FRL EXCEEDANCES FROM 1997 THROUGH 2000 BY QUARTER

		1997[a,b]				1998[a,b]				1999[a,b]				2000[a,b]			
	Well	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Manganese																	
	2424	Y	N	N	N									N	N	Y	N
	2426	**Y**	**Y**	**Y**	N	Y	Y	N	N	N	N	Y	N	N	N	N	N
	2429													N	N	N	Y
	2430	N	N	**Y**	**Y**	Y	Y	N	N					N	N	**Y**	**Y**
	2431	**Y**	**Y**	**Y**	N	Y	Y	N	N								
	2432													N	N	N	Y
Zinc																	
	2424	N	Y	N	N	N	N	Y	N	Y	Y	N	N	Y	N	N	N
	2426		Y	N	N	Y	Y	N	N					Y	N	N	N
	2430													Y	N	**Y**	**Y**
	2431					N	N	Y	Y	N	N	N	N	Y	N	N	N
	2432									Y	N	N	N	Y	N	N	Y
	2434								Y	N	N	N	N				
	2733									N	Y	N	N				
	22198		Y	N	N												
	3067													N	N	Y	N
	3426	N	N	Y	N	N	N	N	N	N	Y	N	Y	N	N	N	N
	3429									Y	N	N	N				
	4067					N	N	Y	Y	**Y**	**Y**	**Y**	**Y**	N	N	N	N
	4424	N	Y	N	N												
	4426									N	Y	N	N				
	41217					N	N	Y	N	N	N	N	N				

[a]A "Y" indicates an FRL exceedance for that quarter. A"Y" indicates a persistence designation at that well for that year.
[b]A "N" indicates no FRL exceedance for that quarter.



LEGEND:

- FEMP BOUNDARY
- 10-YEAR, URANIUM-BASED RESTORATION FOOTPRINT
- AQUIFER ZONE BOUNDARY
- MONITORING WELL LOCATIONS WITH FRL EXCEEDANCE

FRL EXCEEDANCE KEY:

A ARSENIC	F NICKEL
B BORON	G NITRATE/NITRITE
C LEAD	H TECHNETIUM-99
D MANGANESE	I TRICHLOROETHENE
E MOLYBDENUM	J ZINC

FIGURE A.4-1. NON-URANIUM CONSTITUENTS WITH 2000 RESULTS ABOVE FINAL REMEDIATION LEVELS

v:\5fgp1\dgn\00annual\00an020.dgn
STATE PLANAR COORDINATE SYSTEM 1983
24-MAY-2001

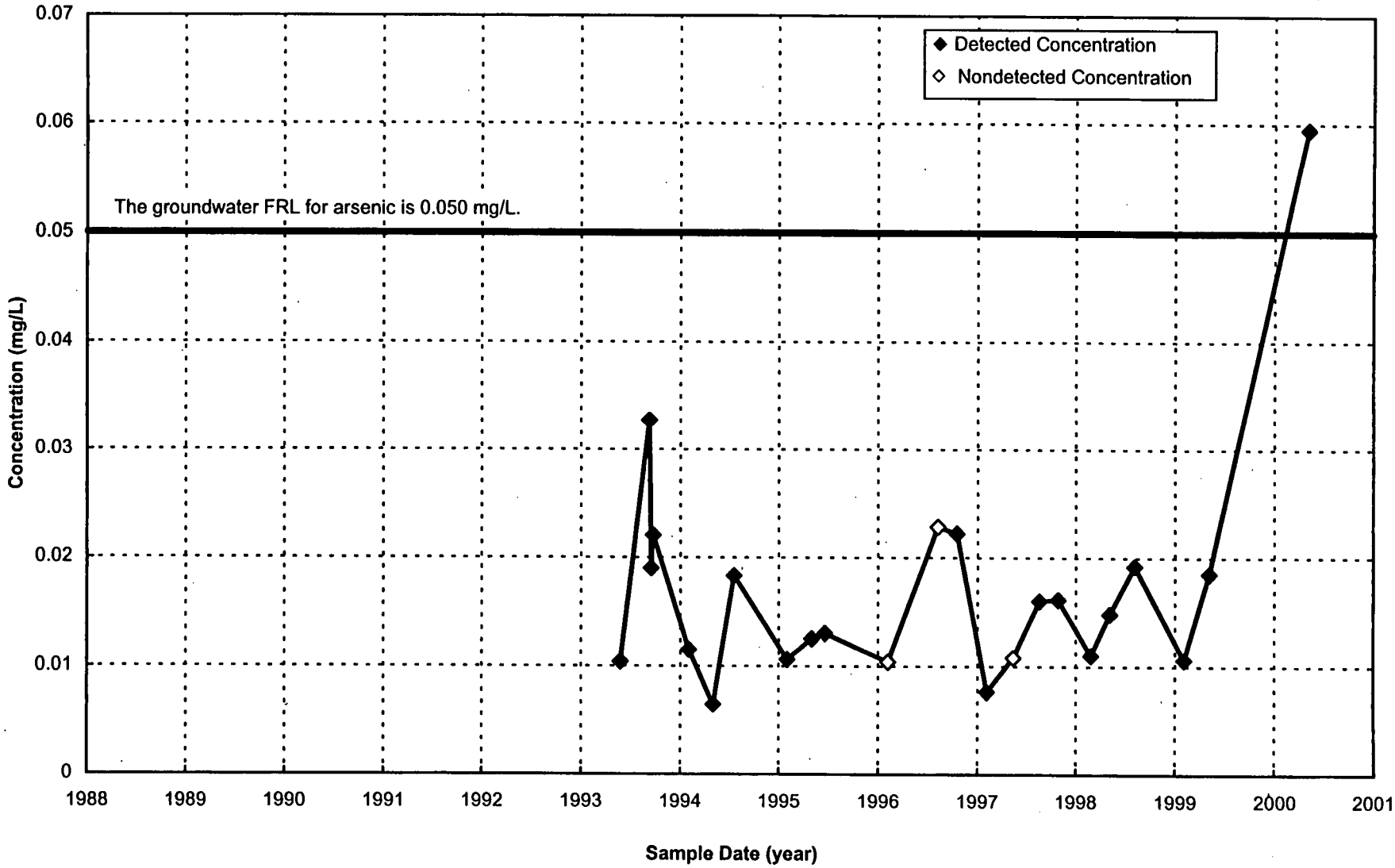


FIGURE A.4-2. ARSENIC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2625

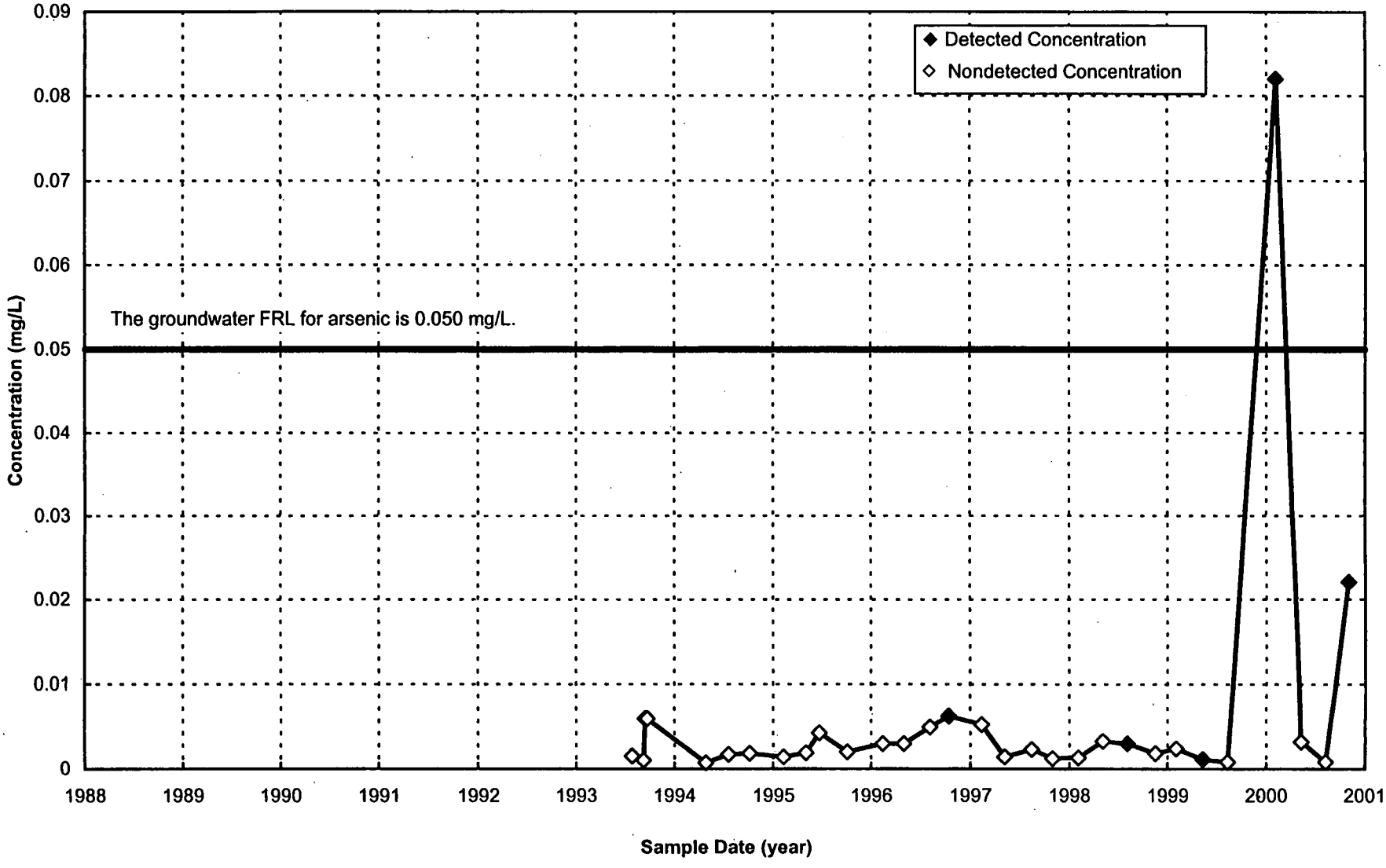


FIGURE A.4-3. ARSENIC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2898

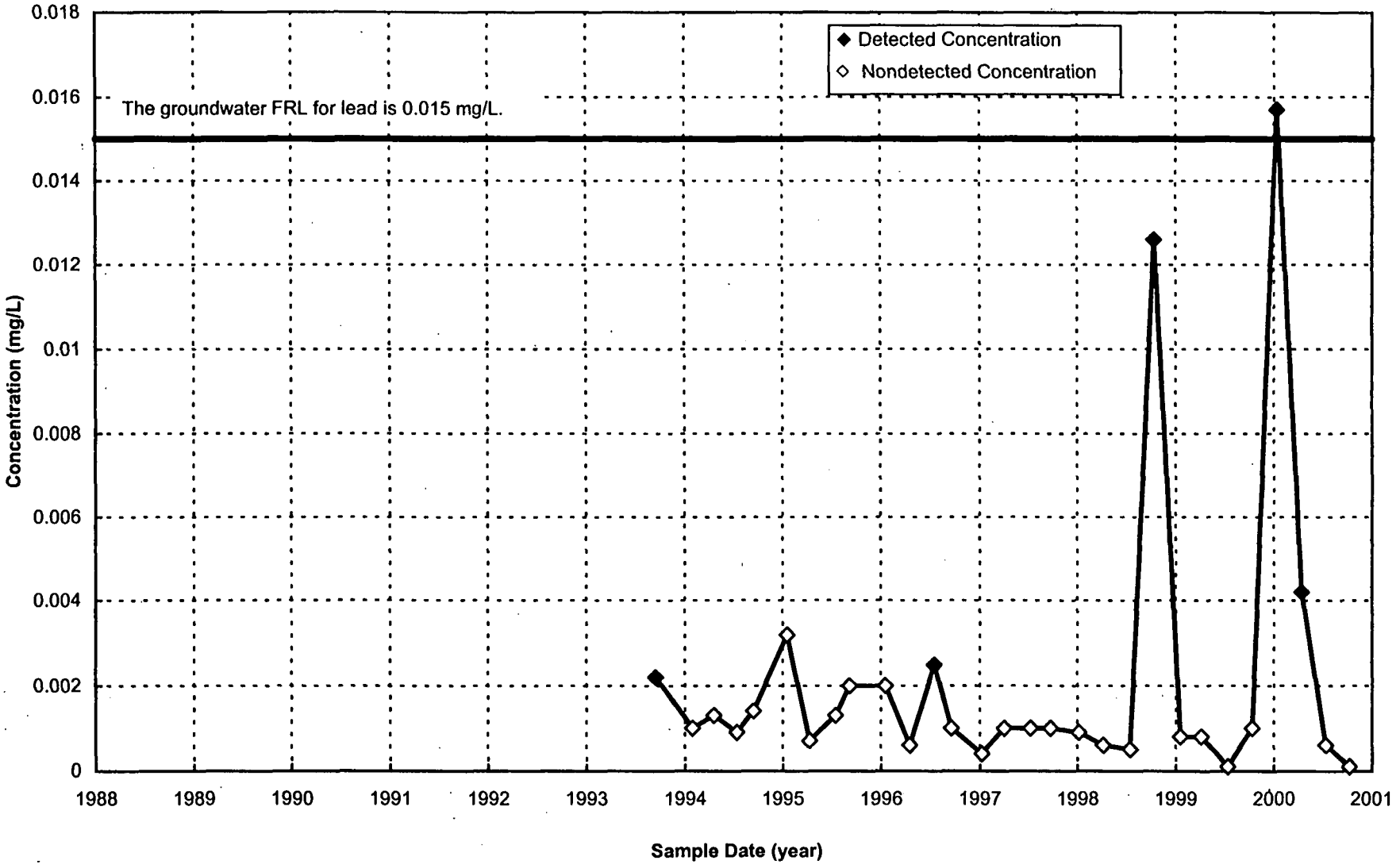


FIGURE A.4-4. LEAD CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2431

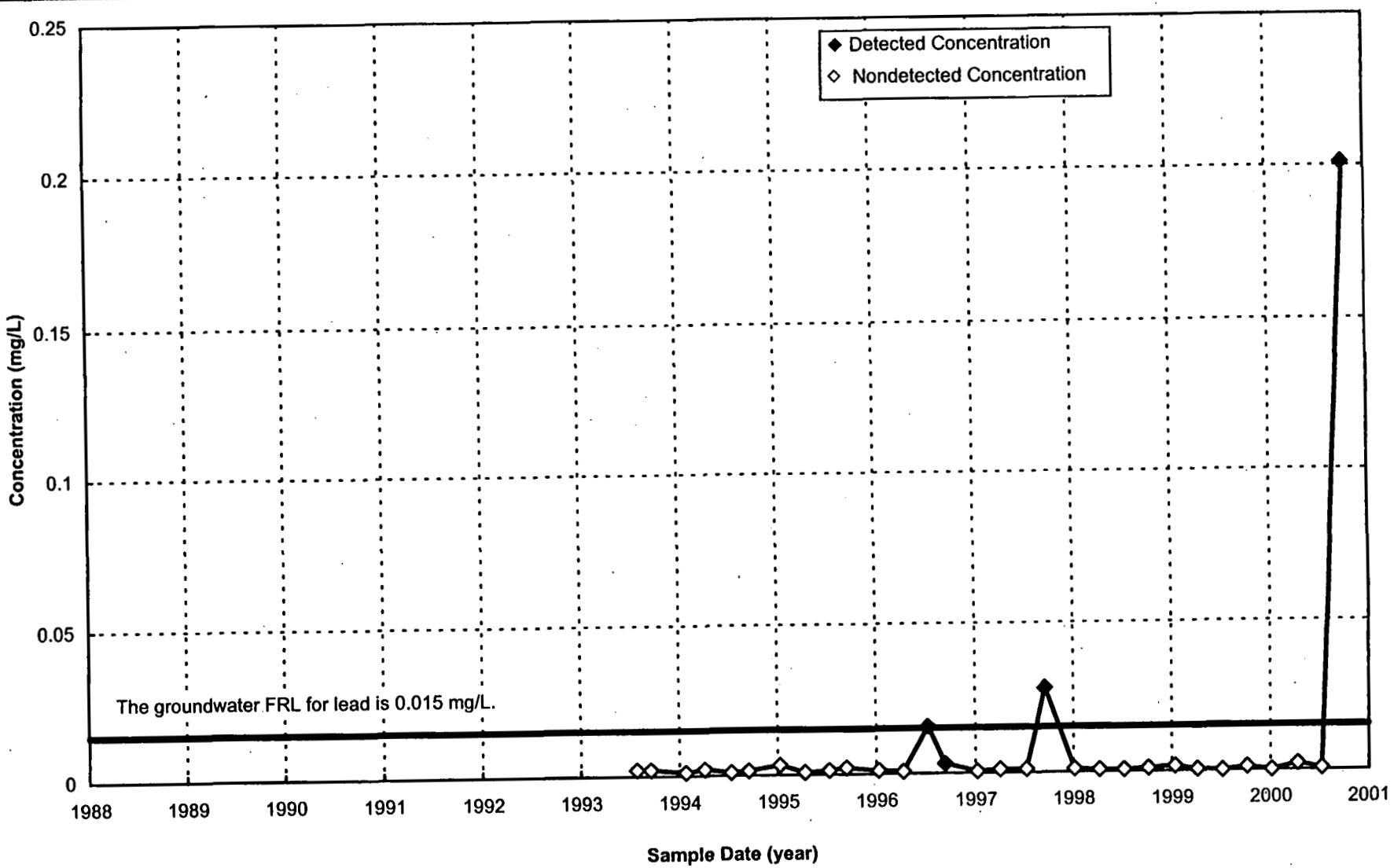


FIGURE A.4-5. LEAD CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3733

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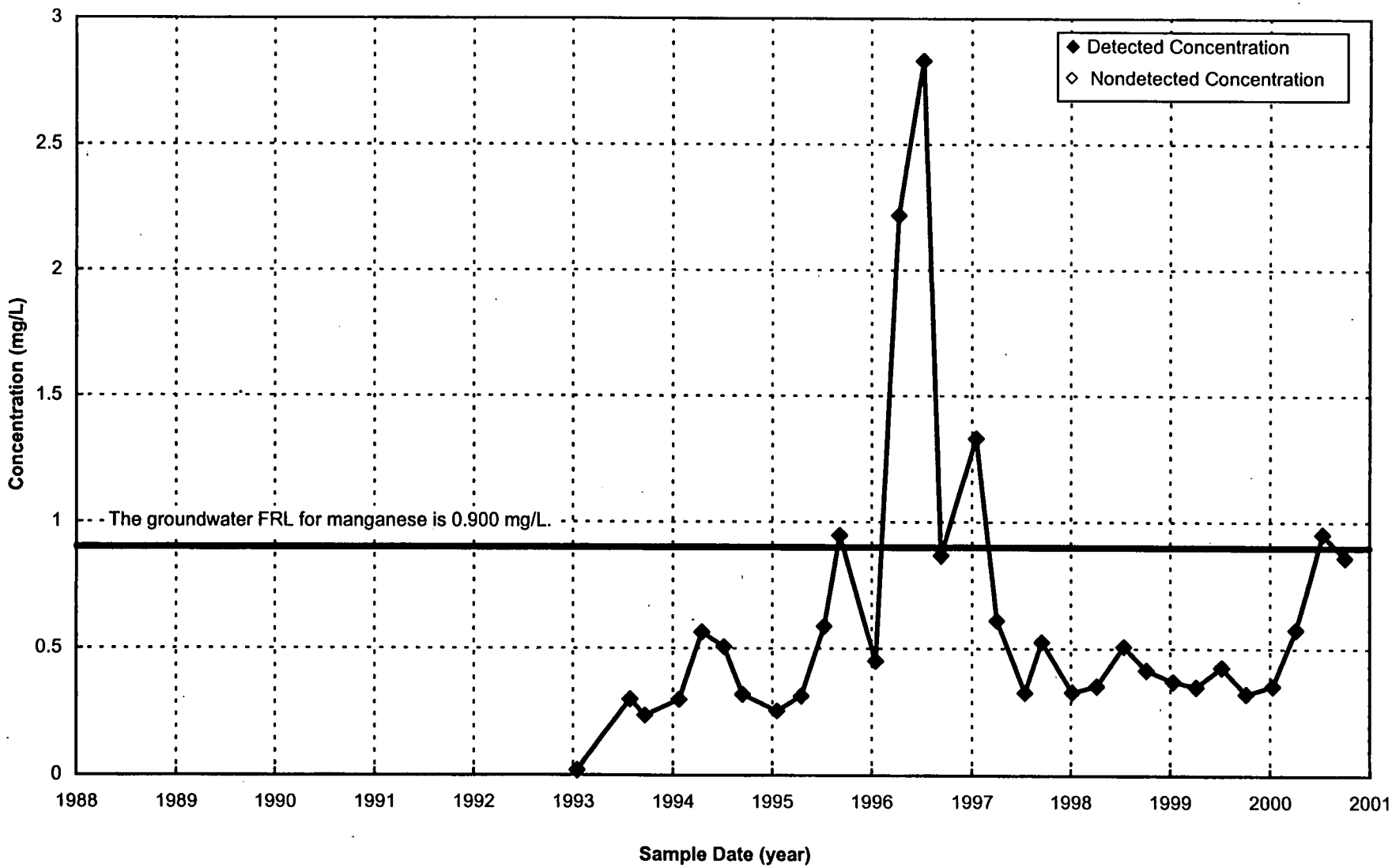

FIGURE A.4-6. MANGANESE CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2424

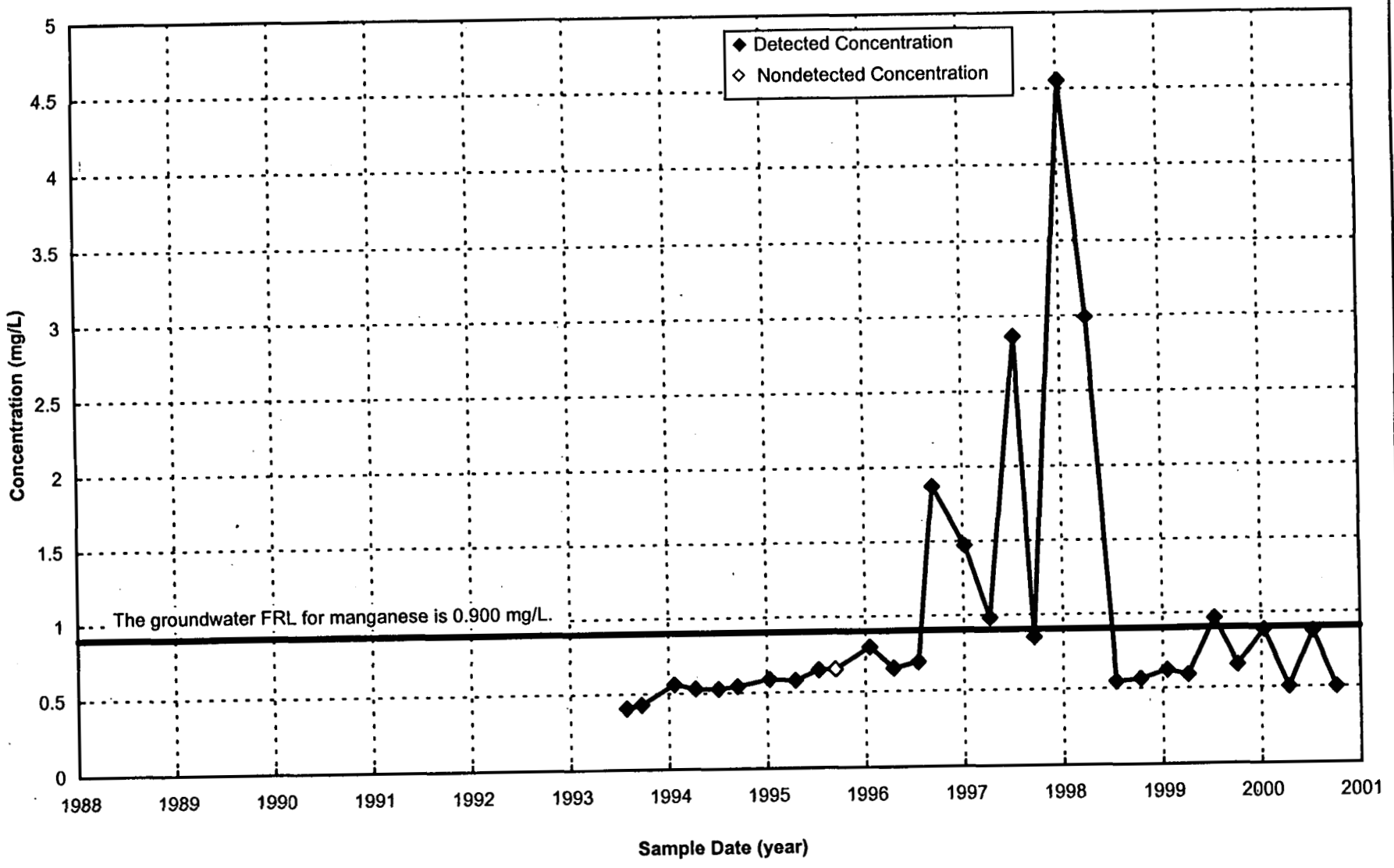

FIGURE A.4-7. MANGANESE CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2426

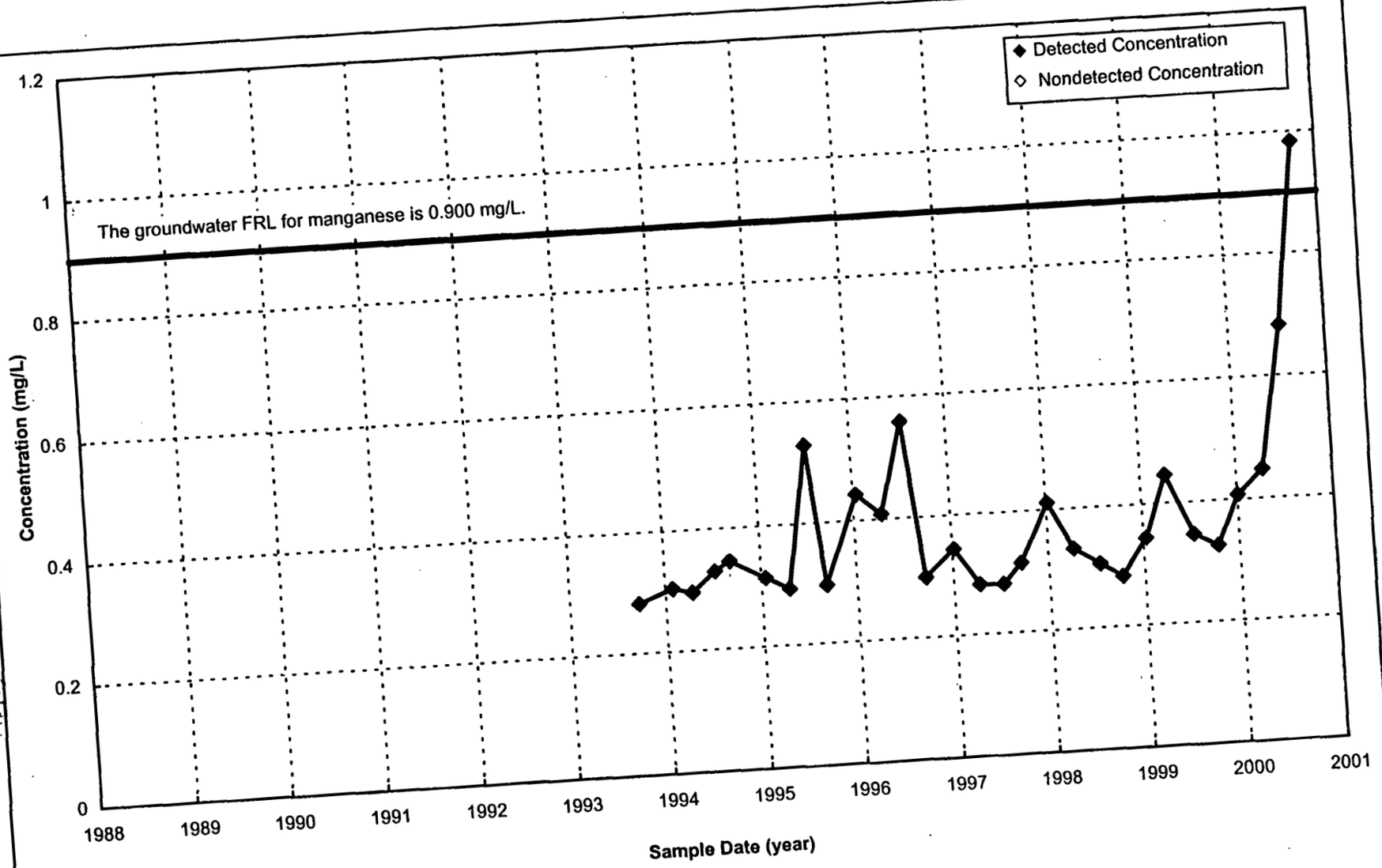

FIGURE A.4-8. MANGANESE CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2429

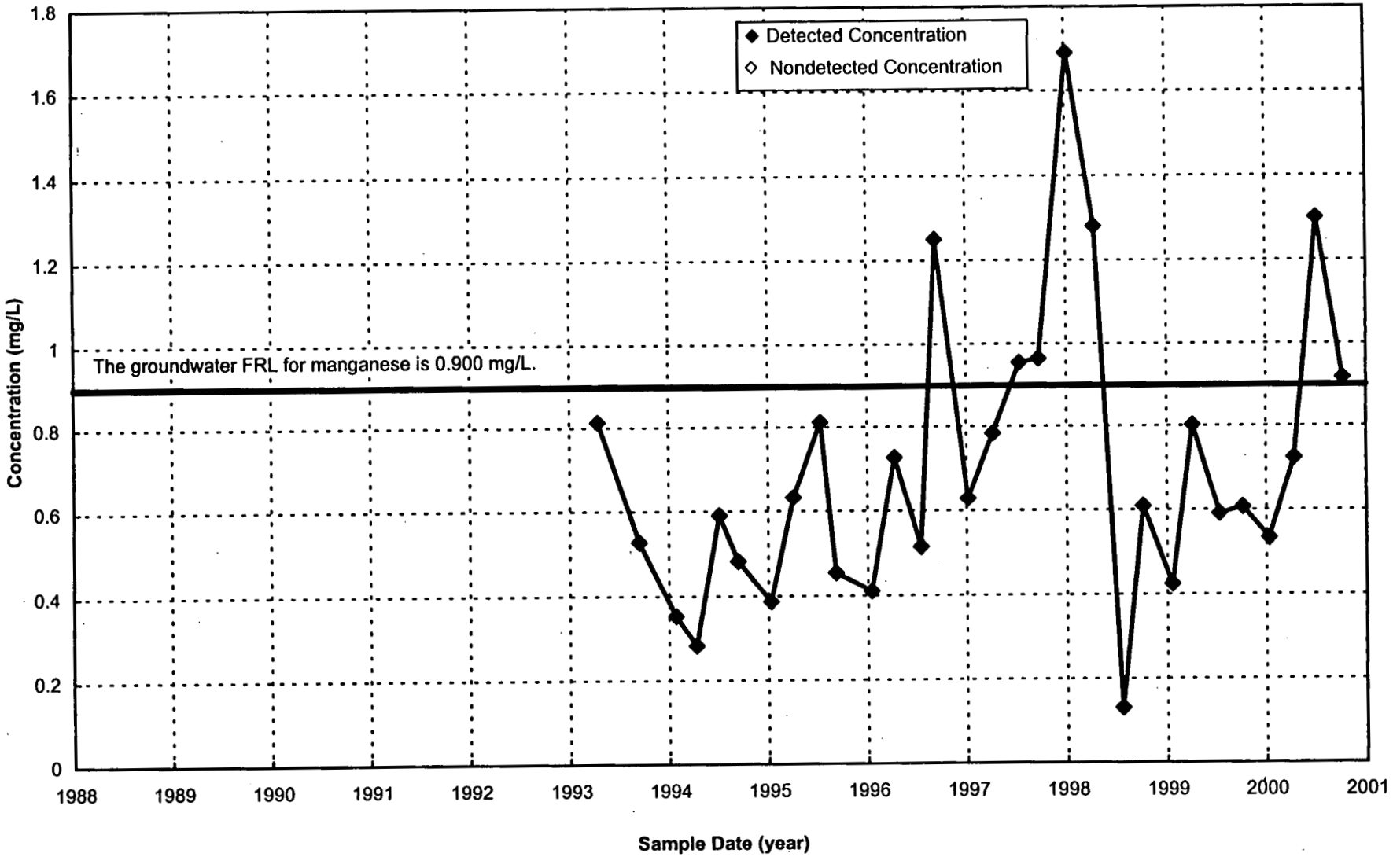

FIGURE A.4-9. MANGANESE CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2430

000278

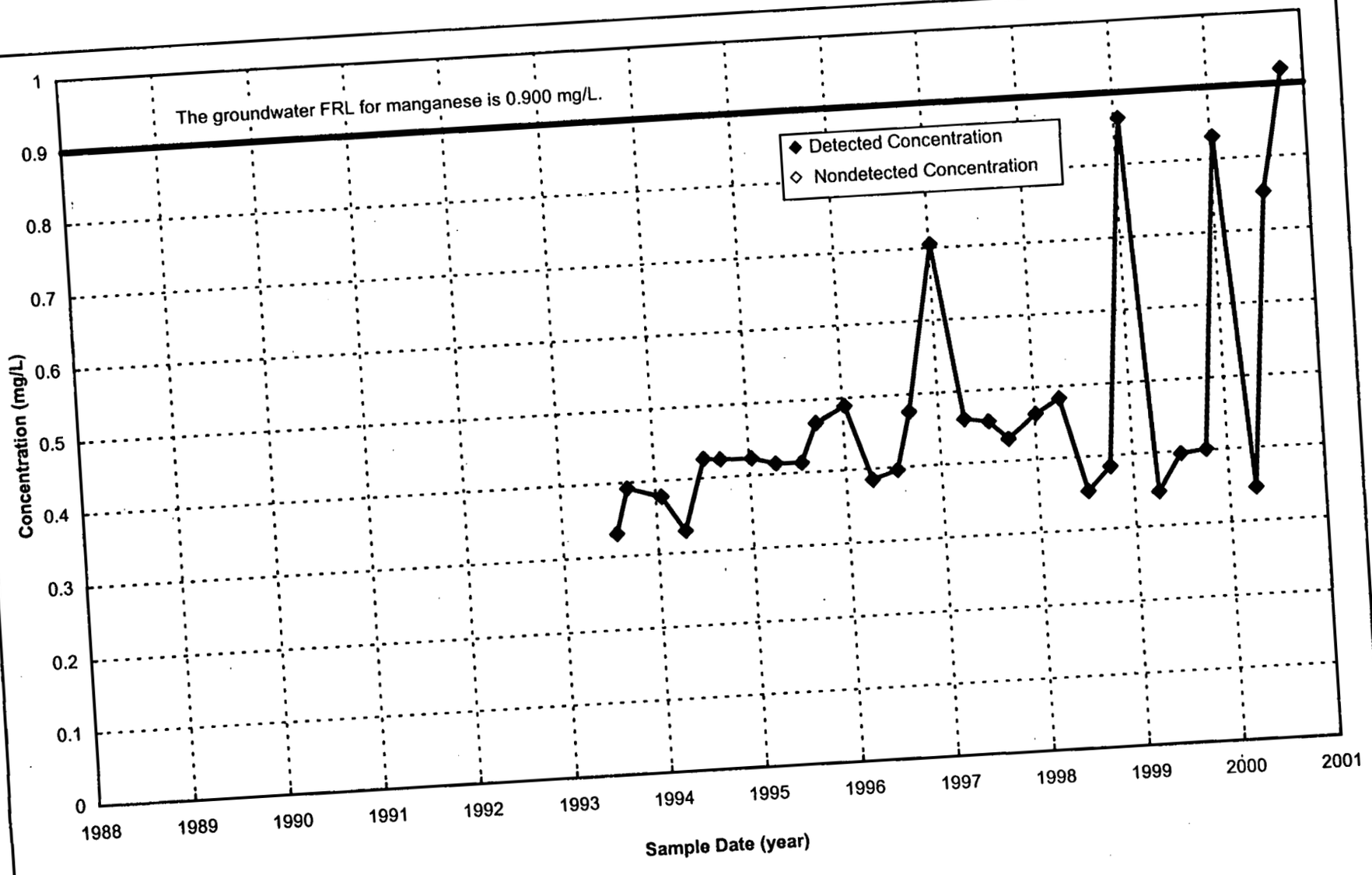

FIGURE A.4-10. MANGANESE CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2432

000279

3694

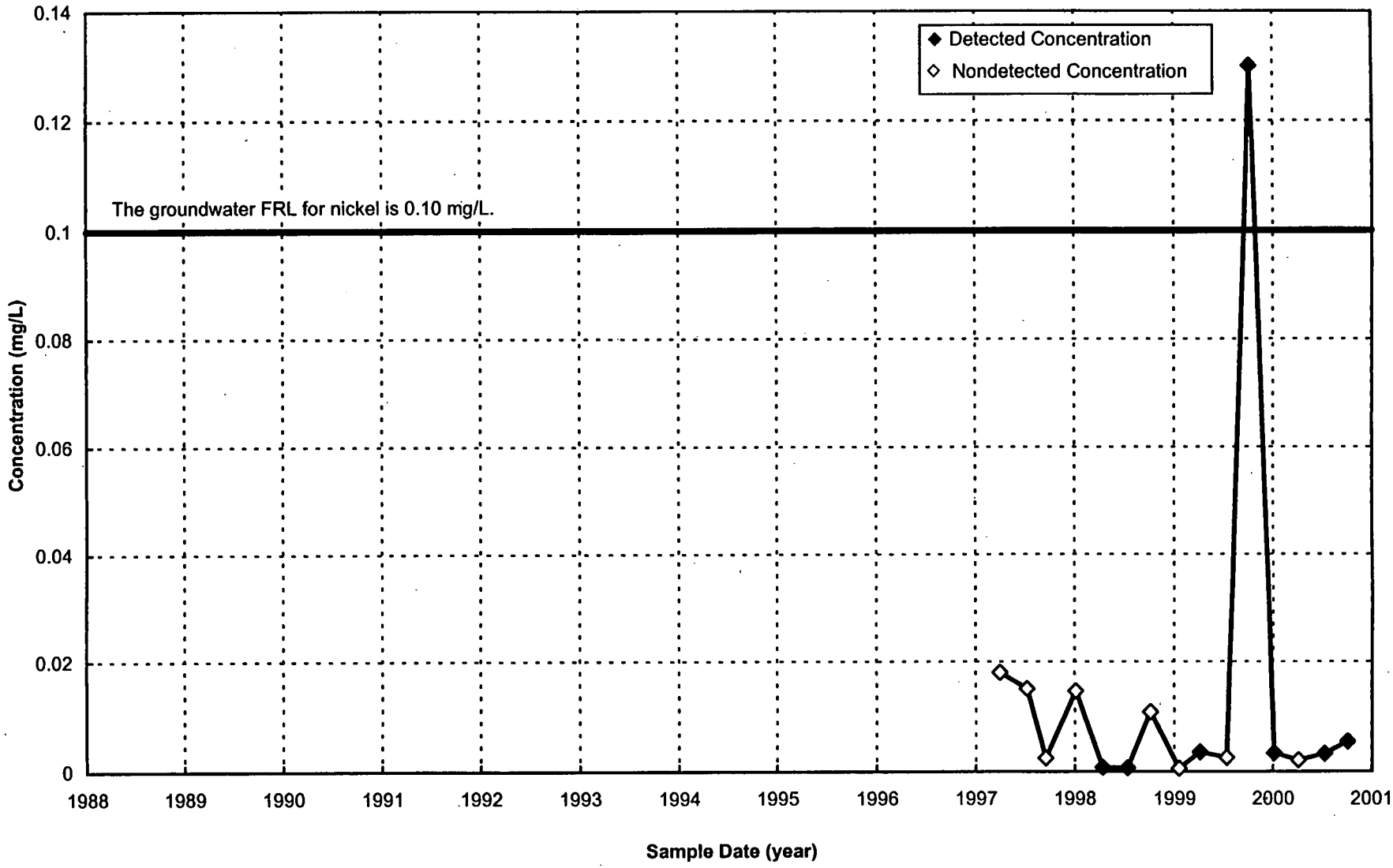

FIGURE A.4-11. NICKEL CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22198

082000

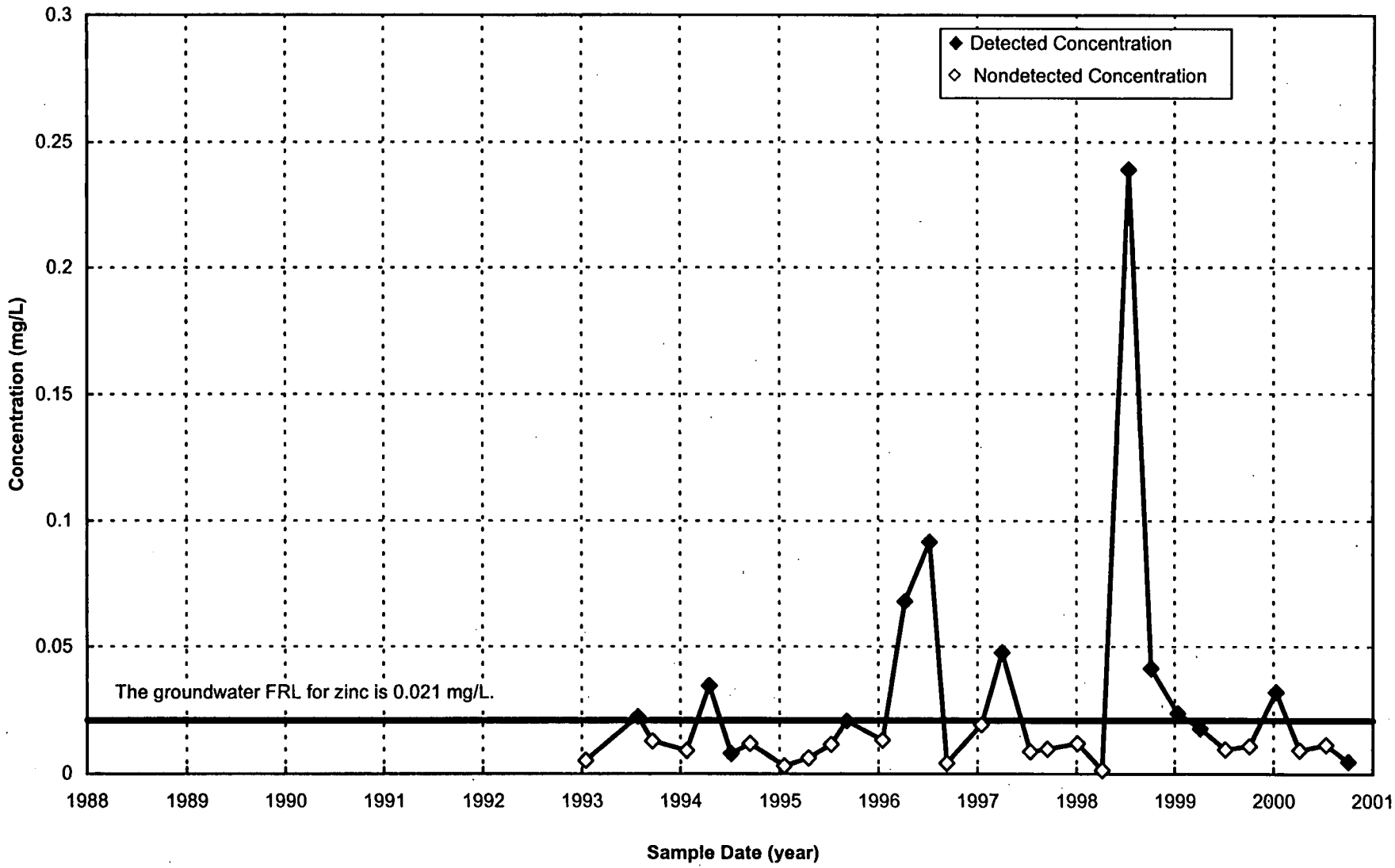

FIGURE A.4-12. ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2424

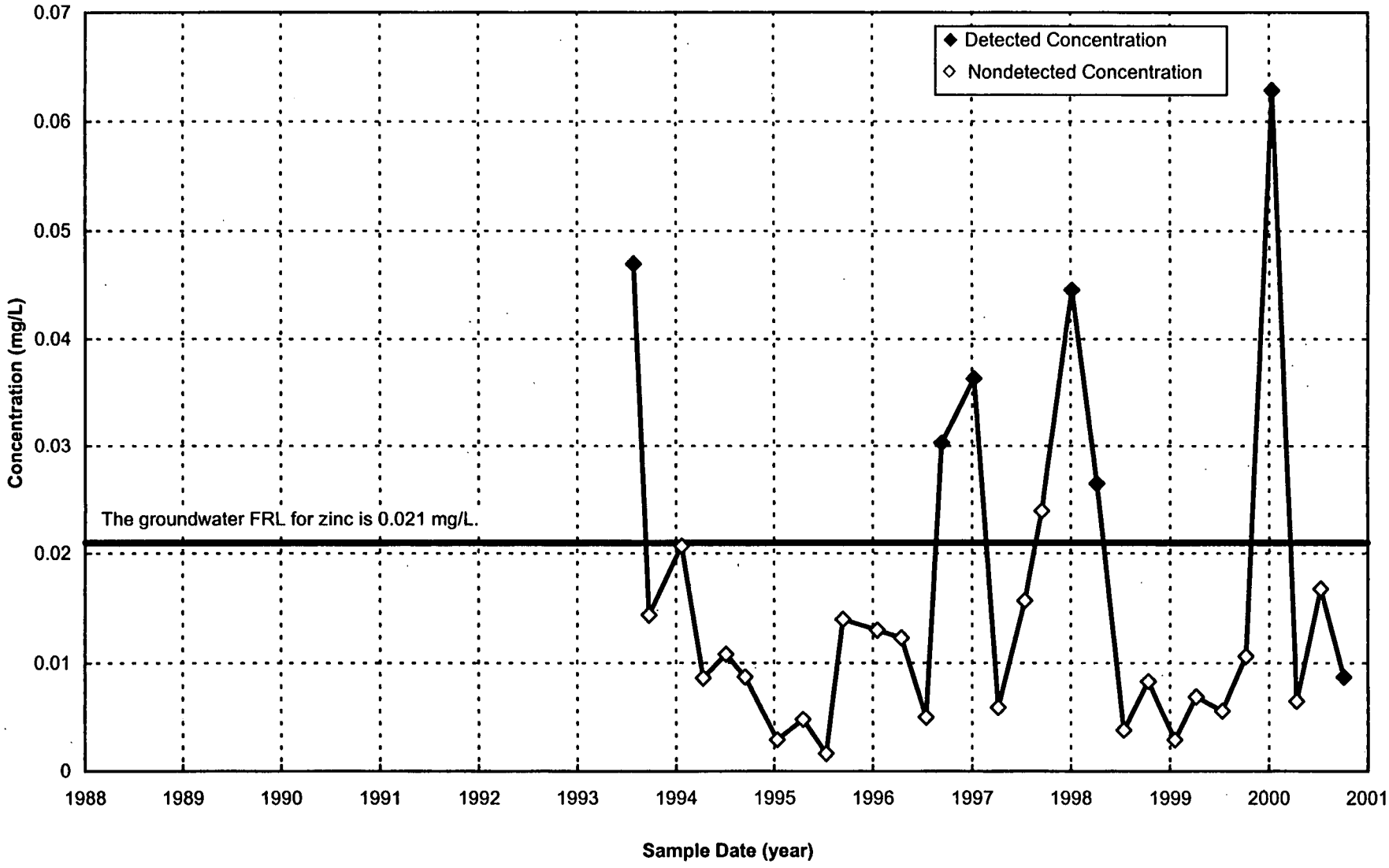

FIGURE A.4-13. ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2426

002282

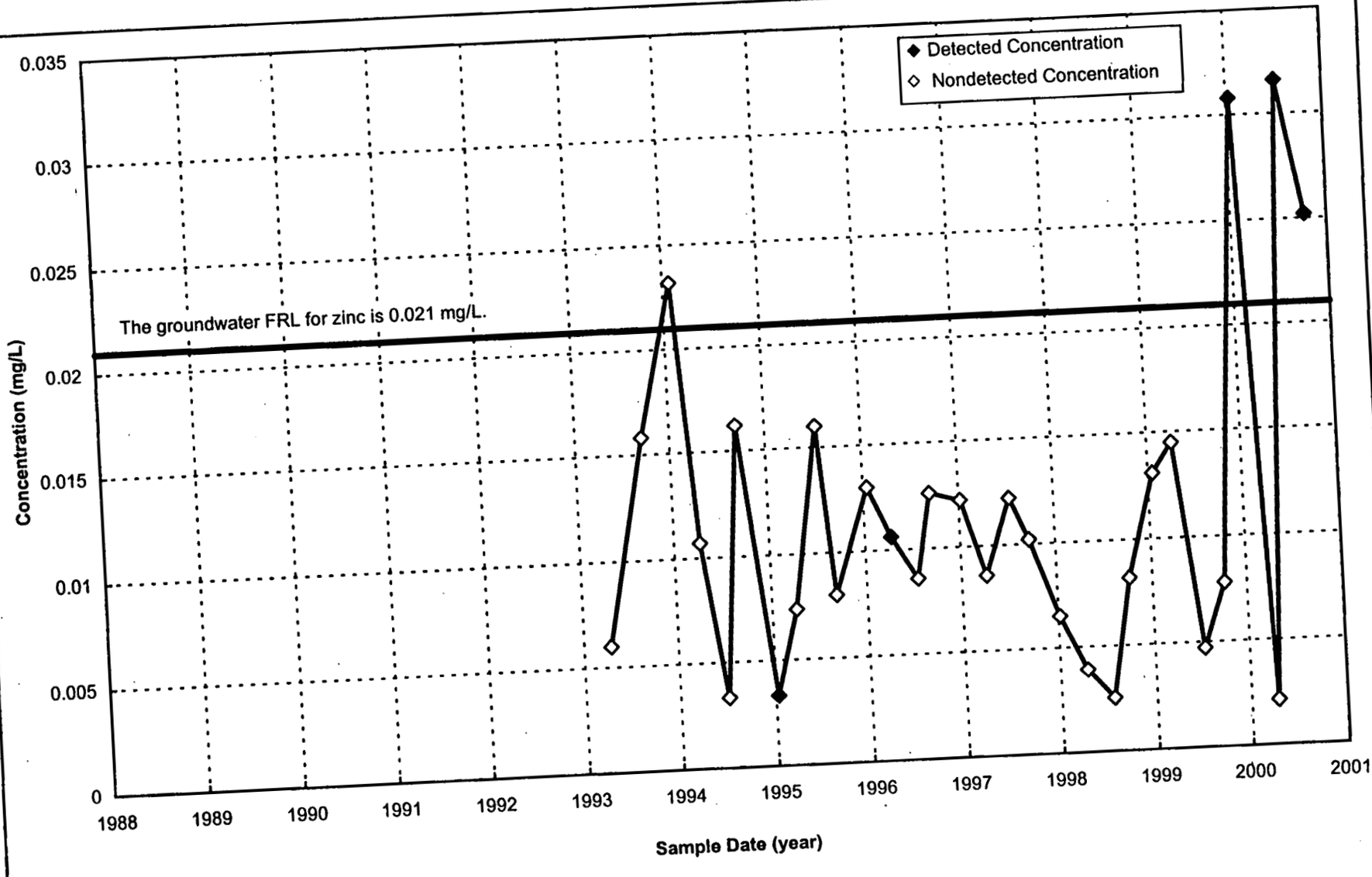

FIGURE A.4-14. ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2430

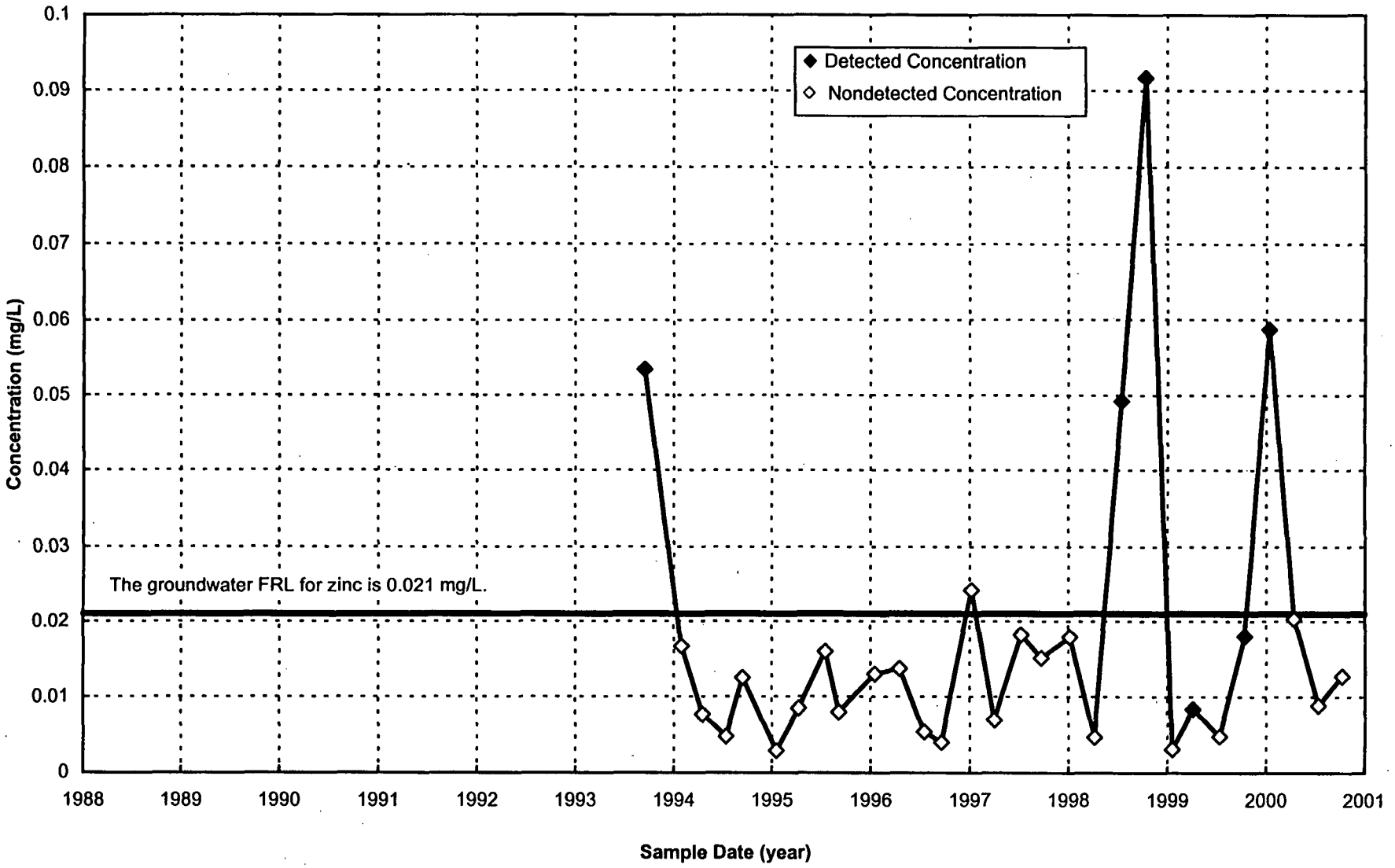

FIGURE A.4-15. ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2431

000284

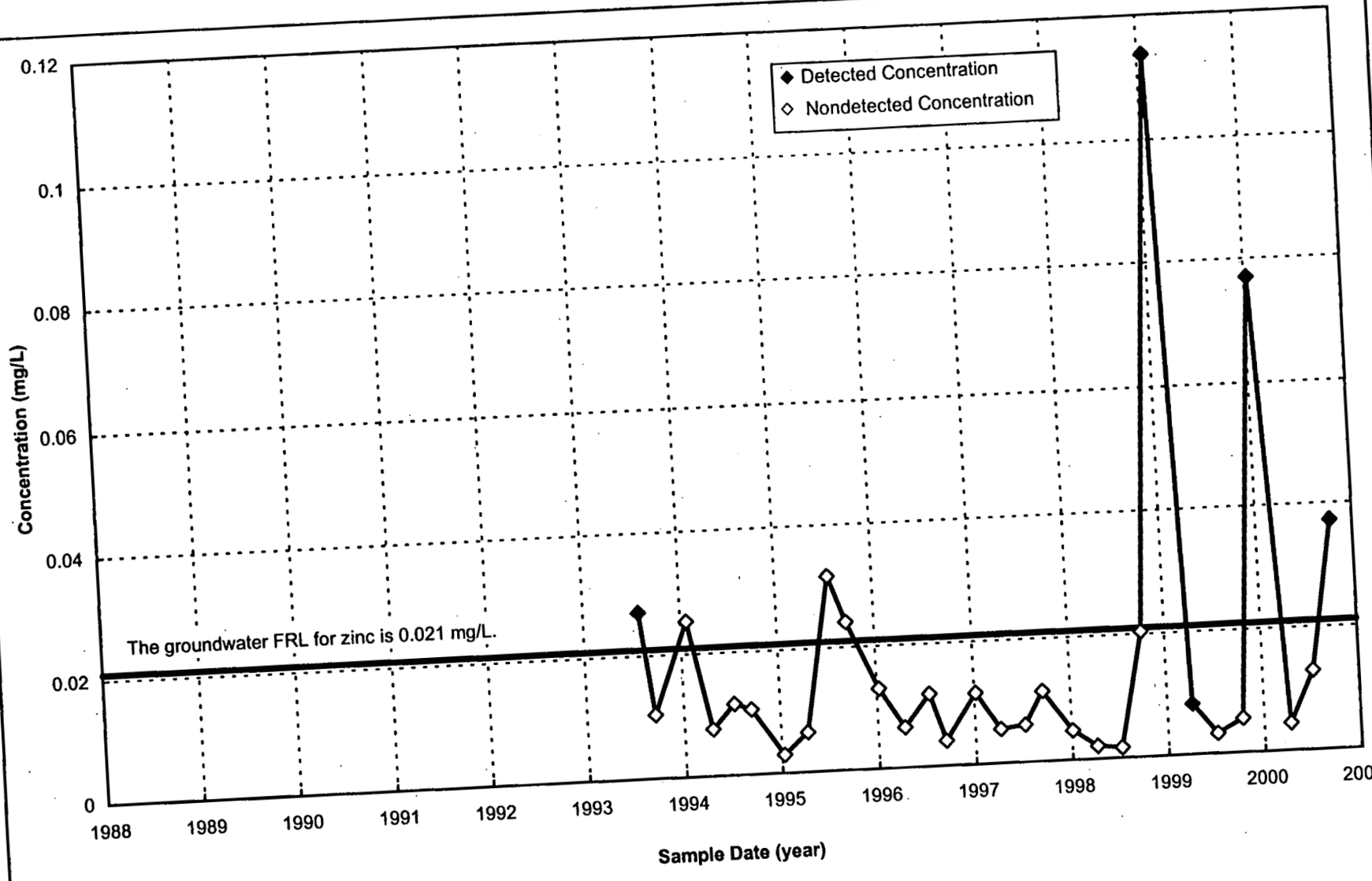

FIGURE A.4-16. ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2432

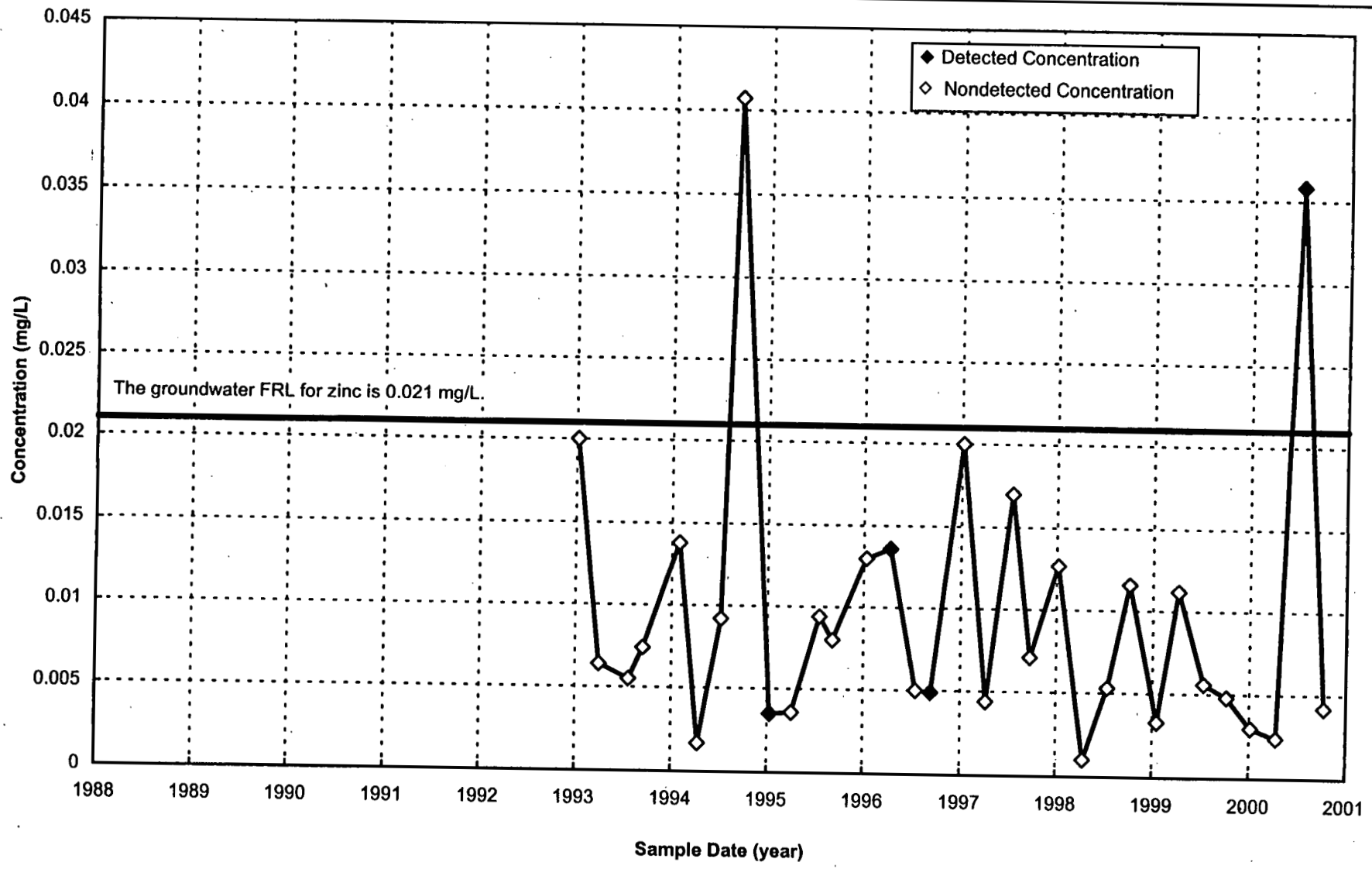

FIGURE A.4-17. ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3067

000286

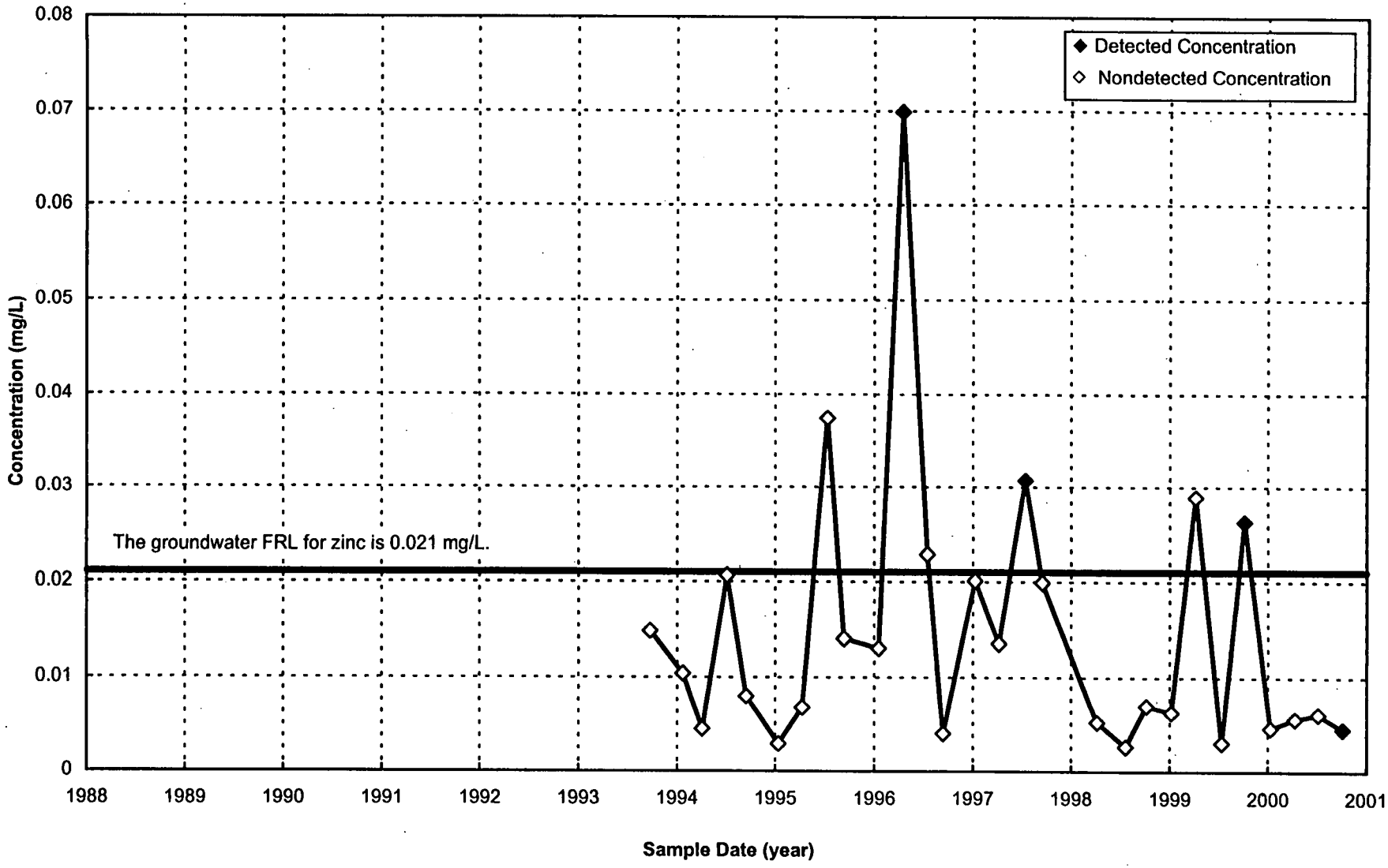

FIGURE A.4-18. ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3426

000287

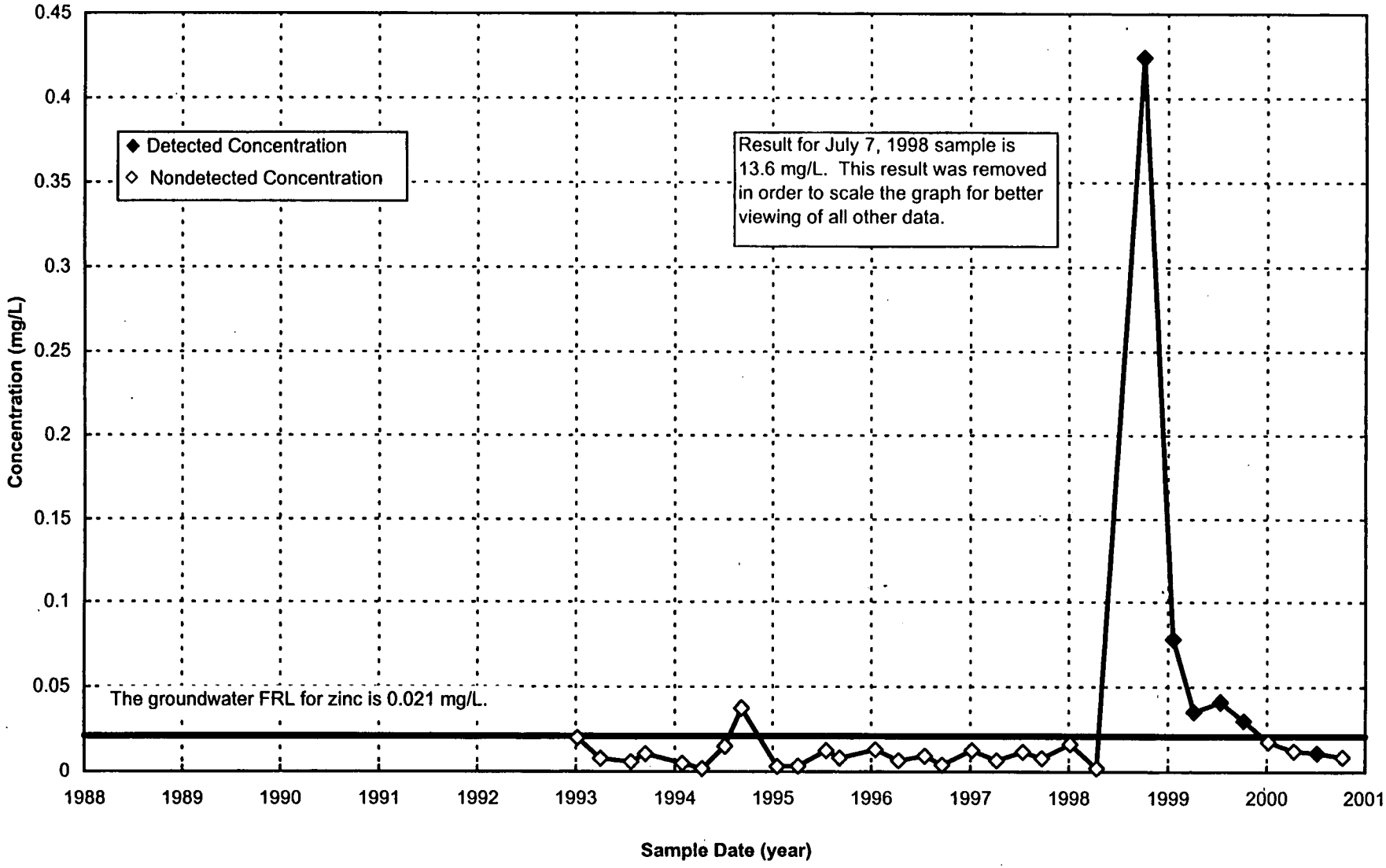

FIGURE A.4-19. ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 4067

000288

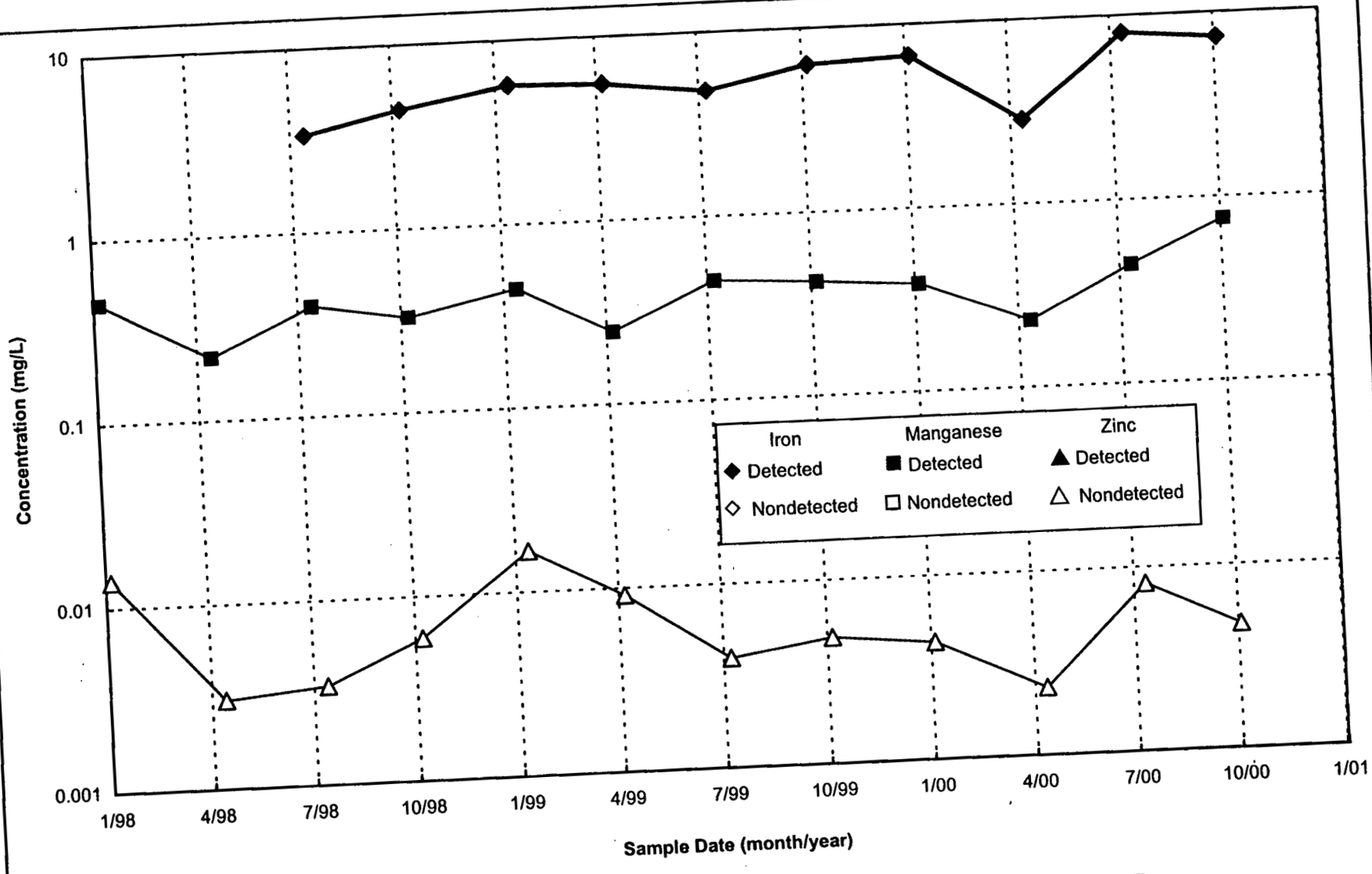

FIGURE A.4-20. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2051

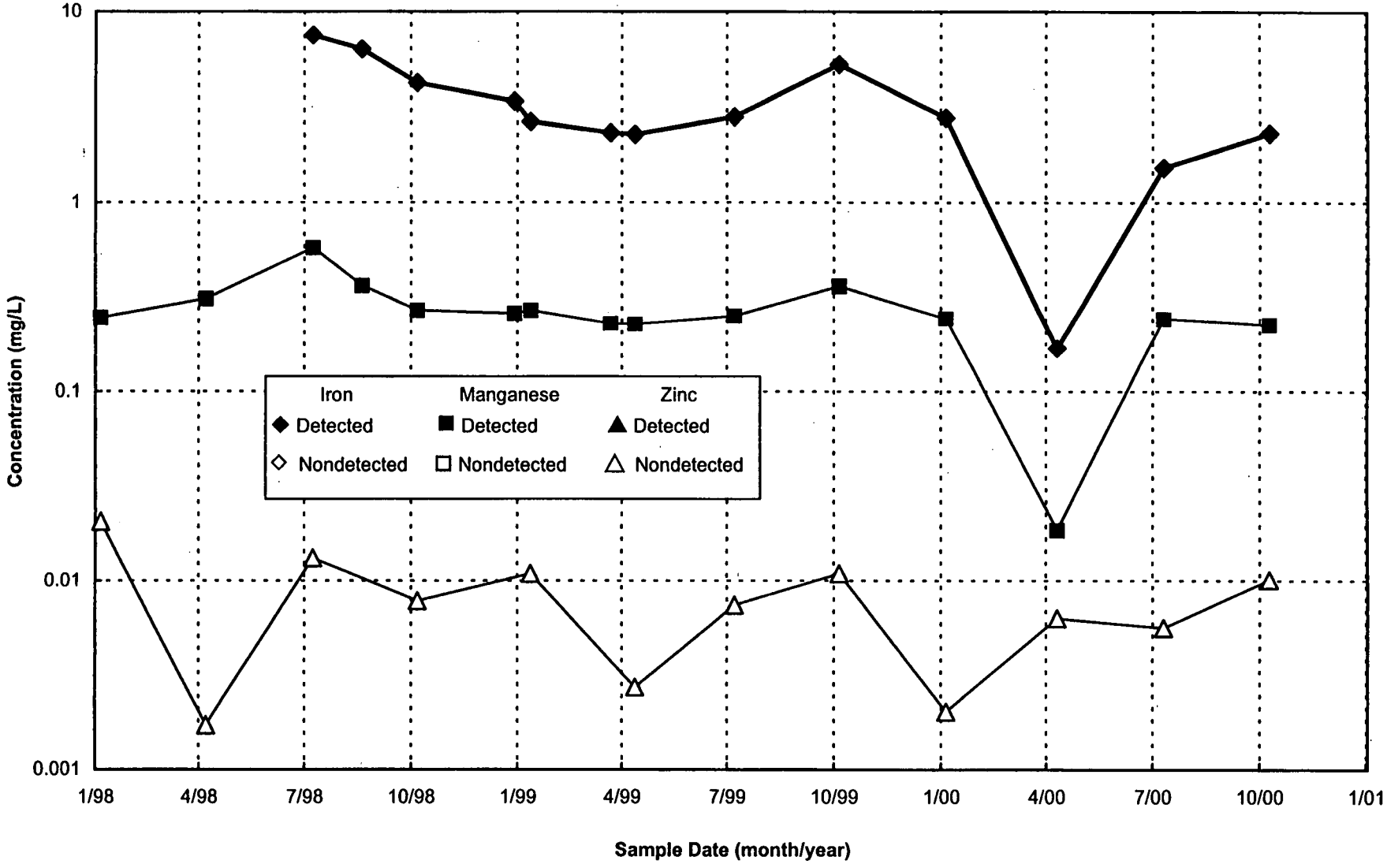

FIGURE A.4-21. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2070

000290

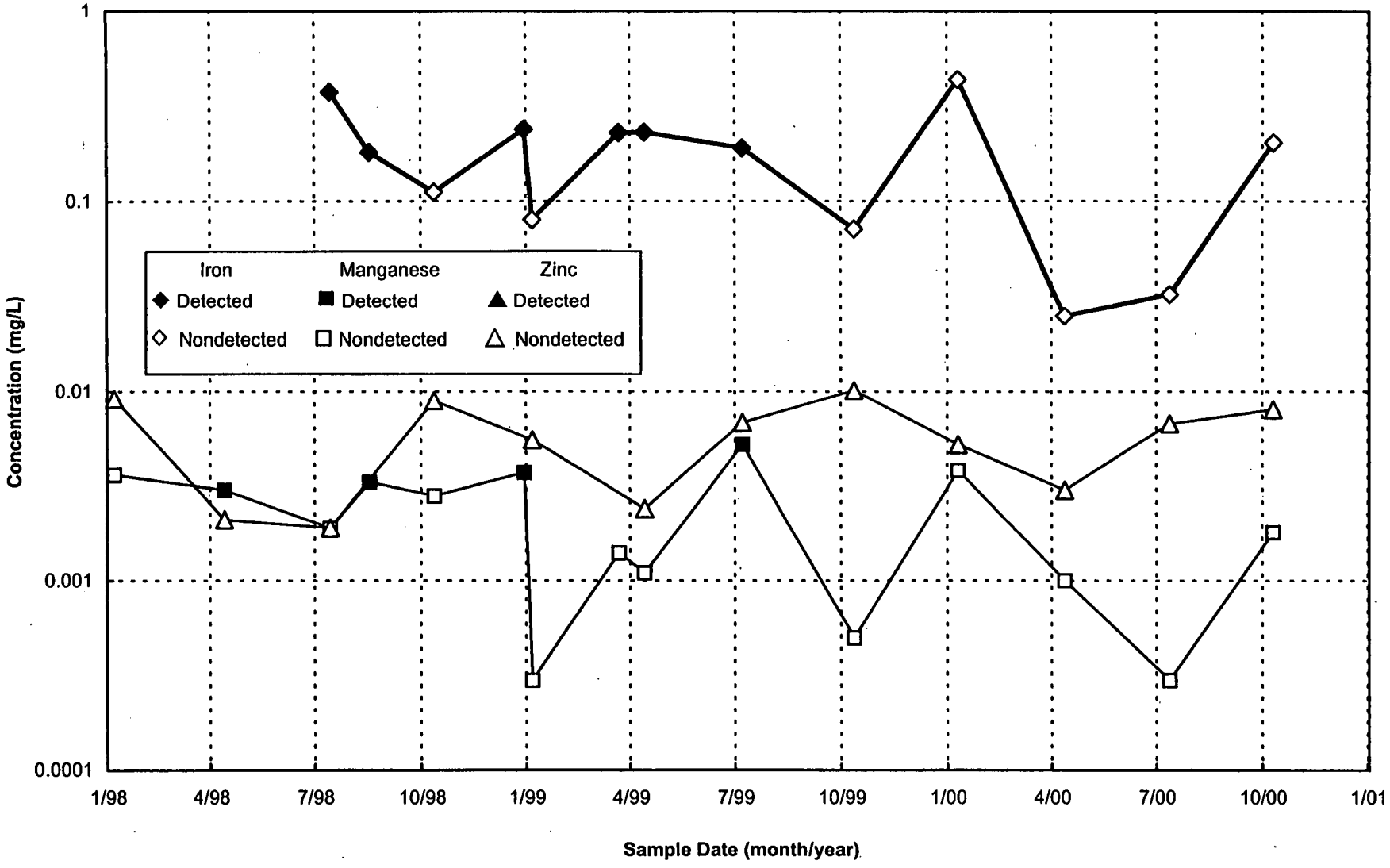

FIGURE A.4-22. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2106

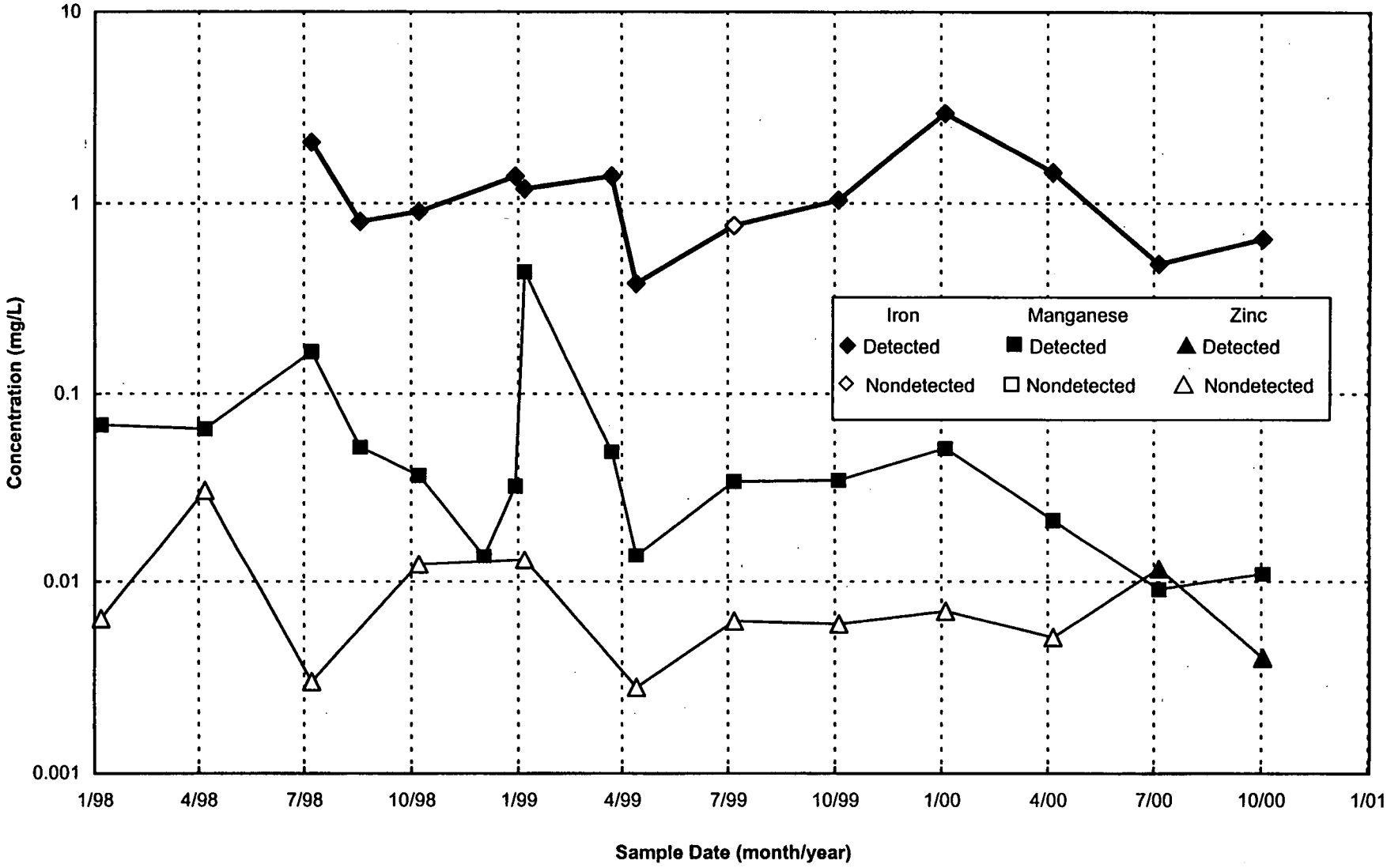

FIGURE A.4-23. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2398

000292

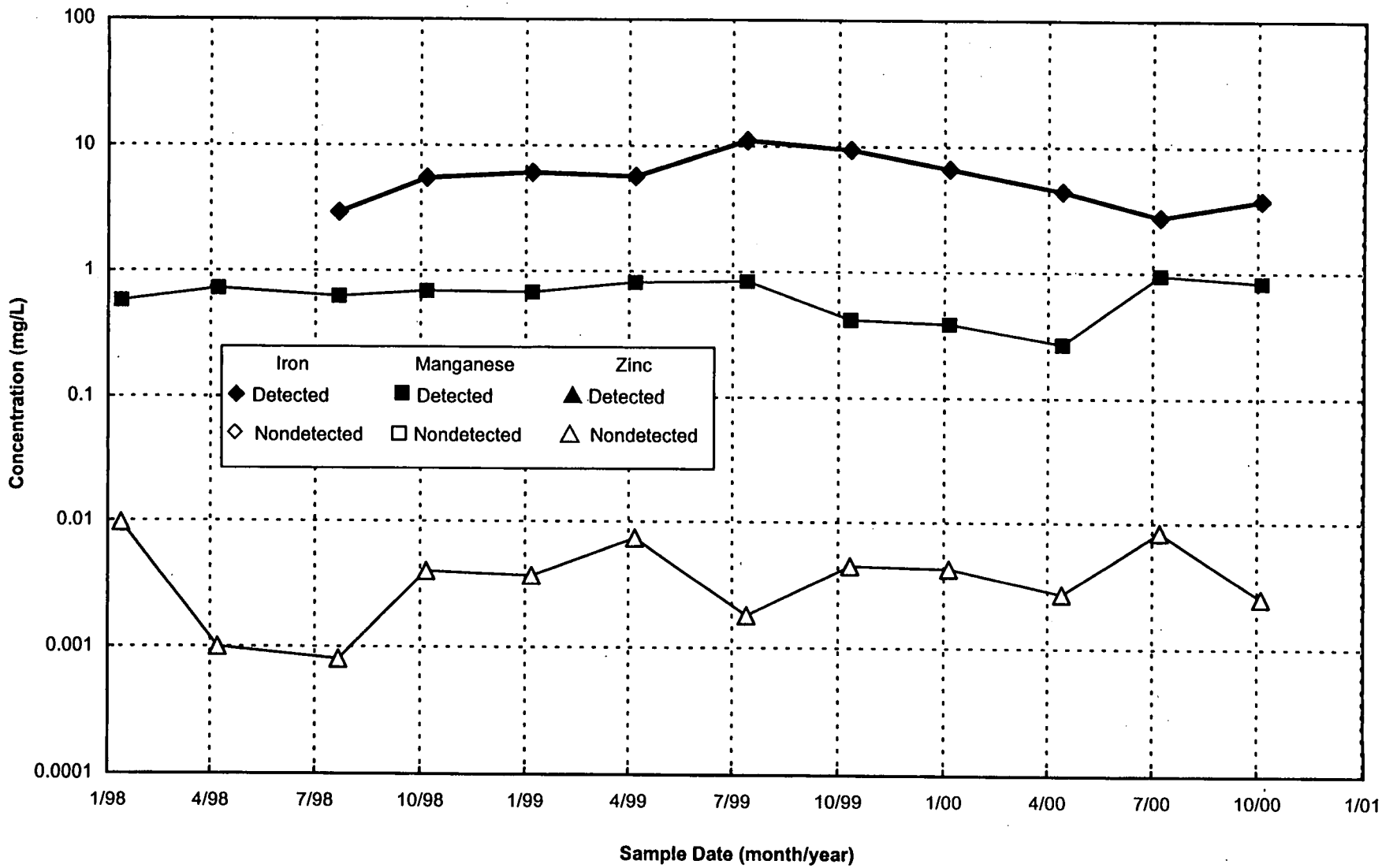

FIGURE A.4-24. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2417

000293

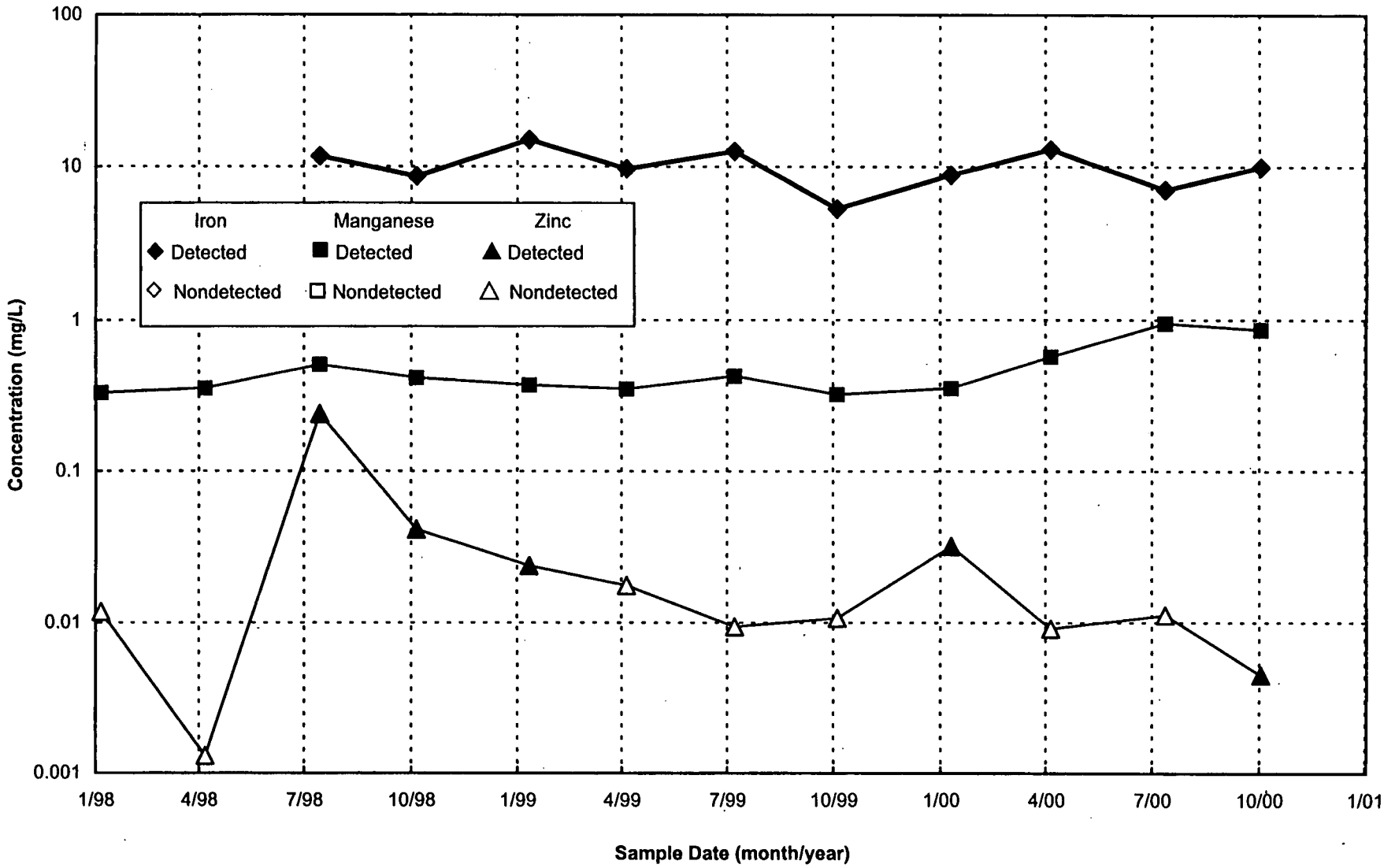

FIGURE A.4-25. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2424

000294

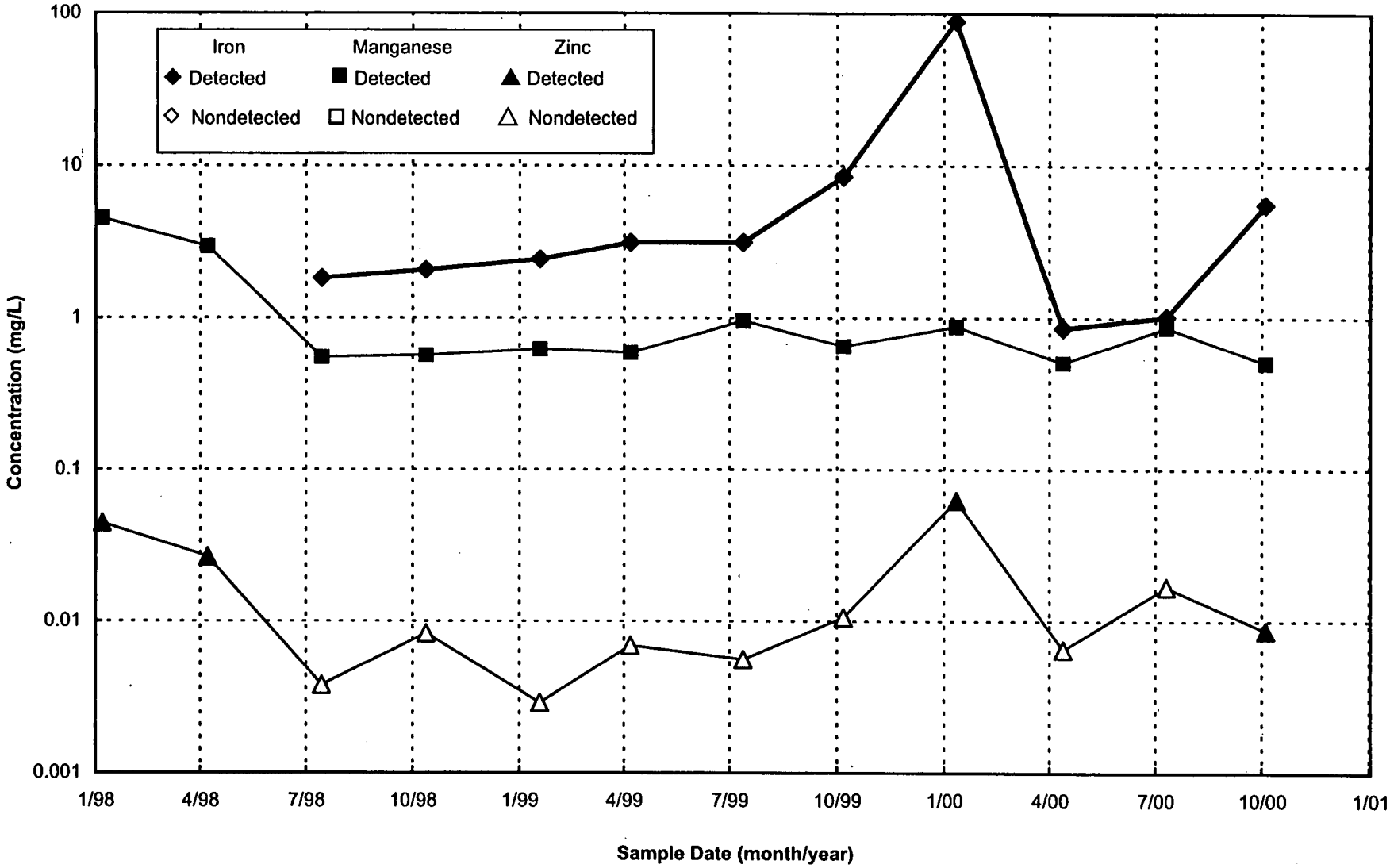

FIGURE A.4-26. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2426

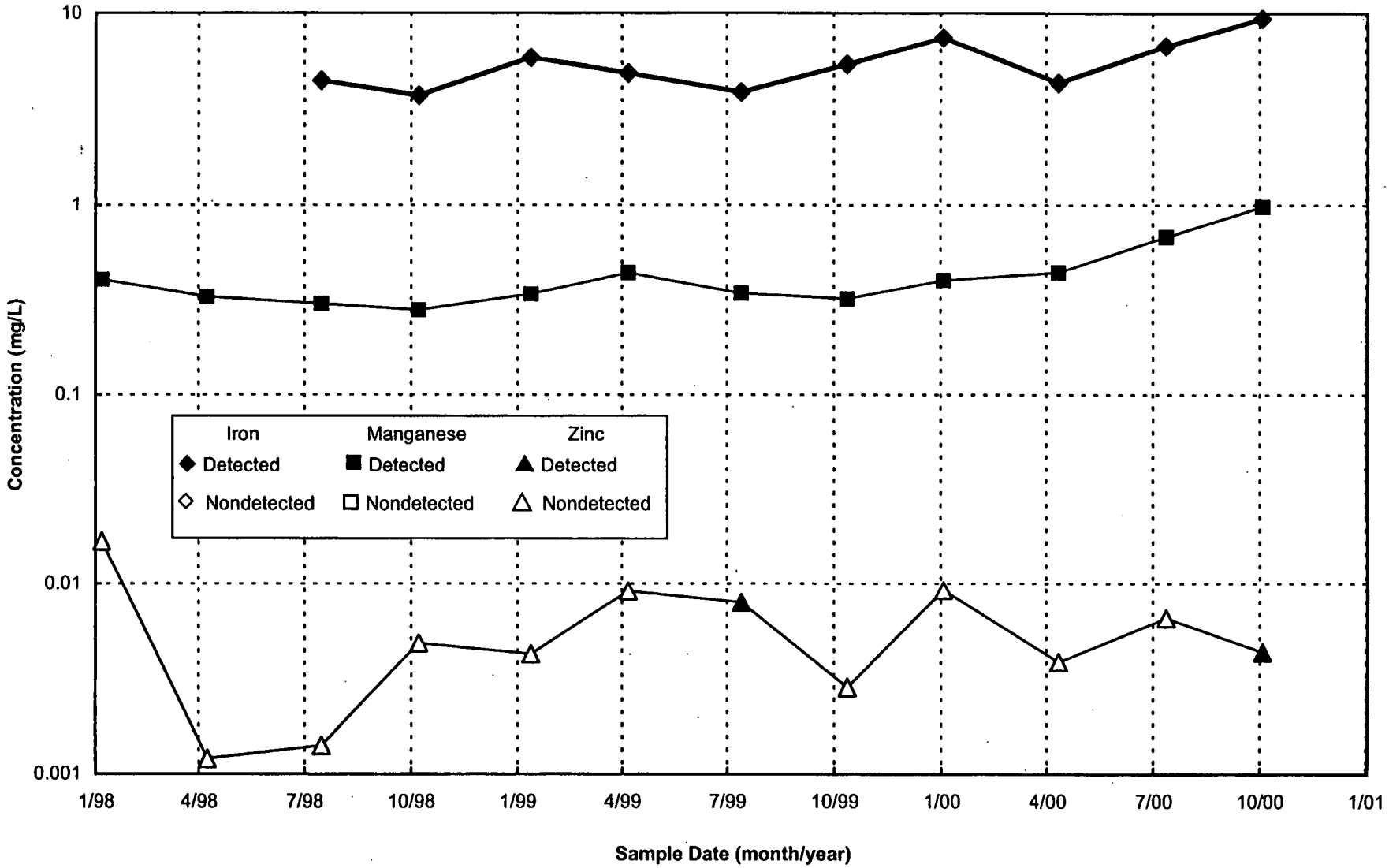

FIGURE A.4-27. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2429

000296

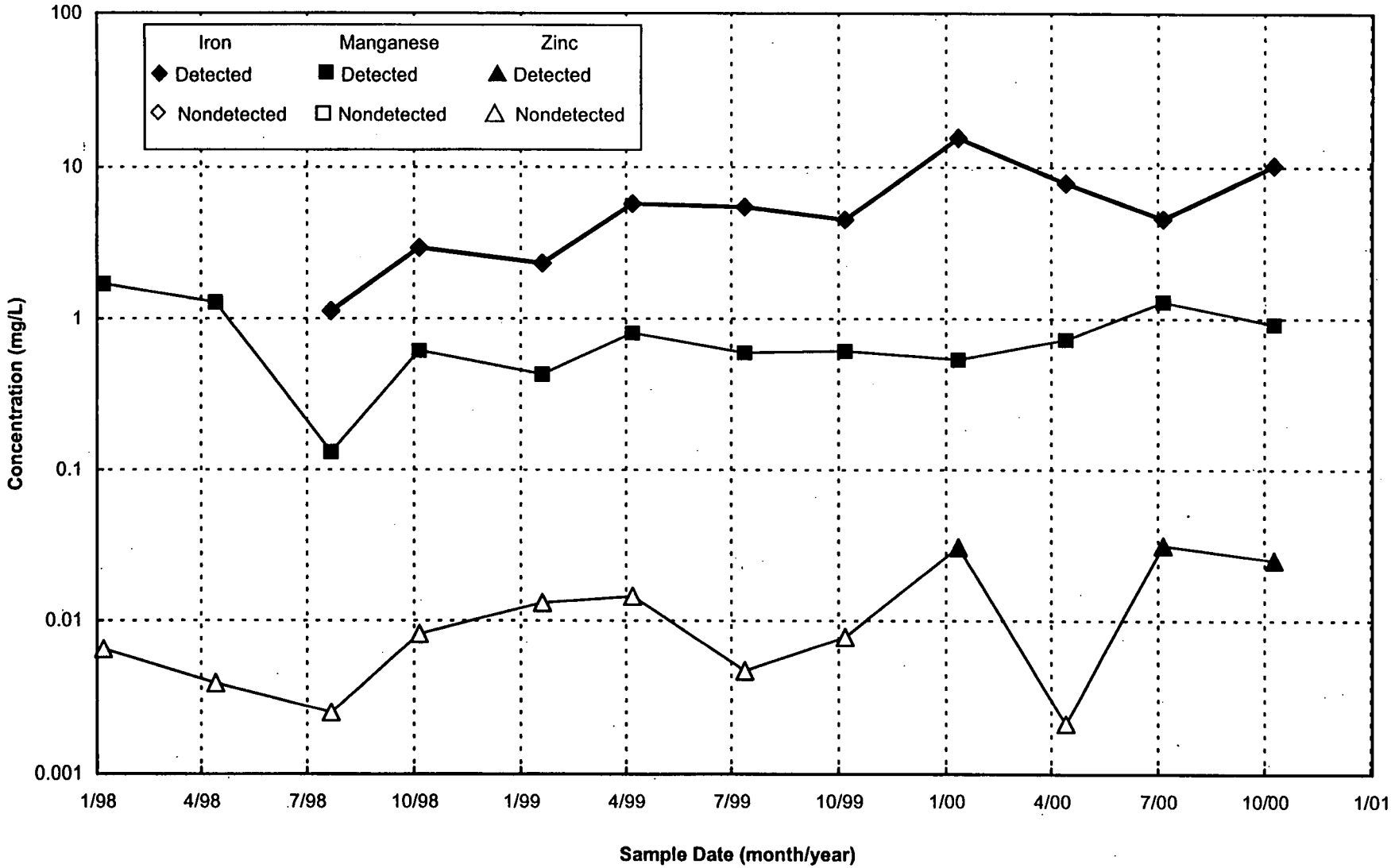

FIGURE A.4-28. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2430

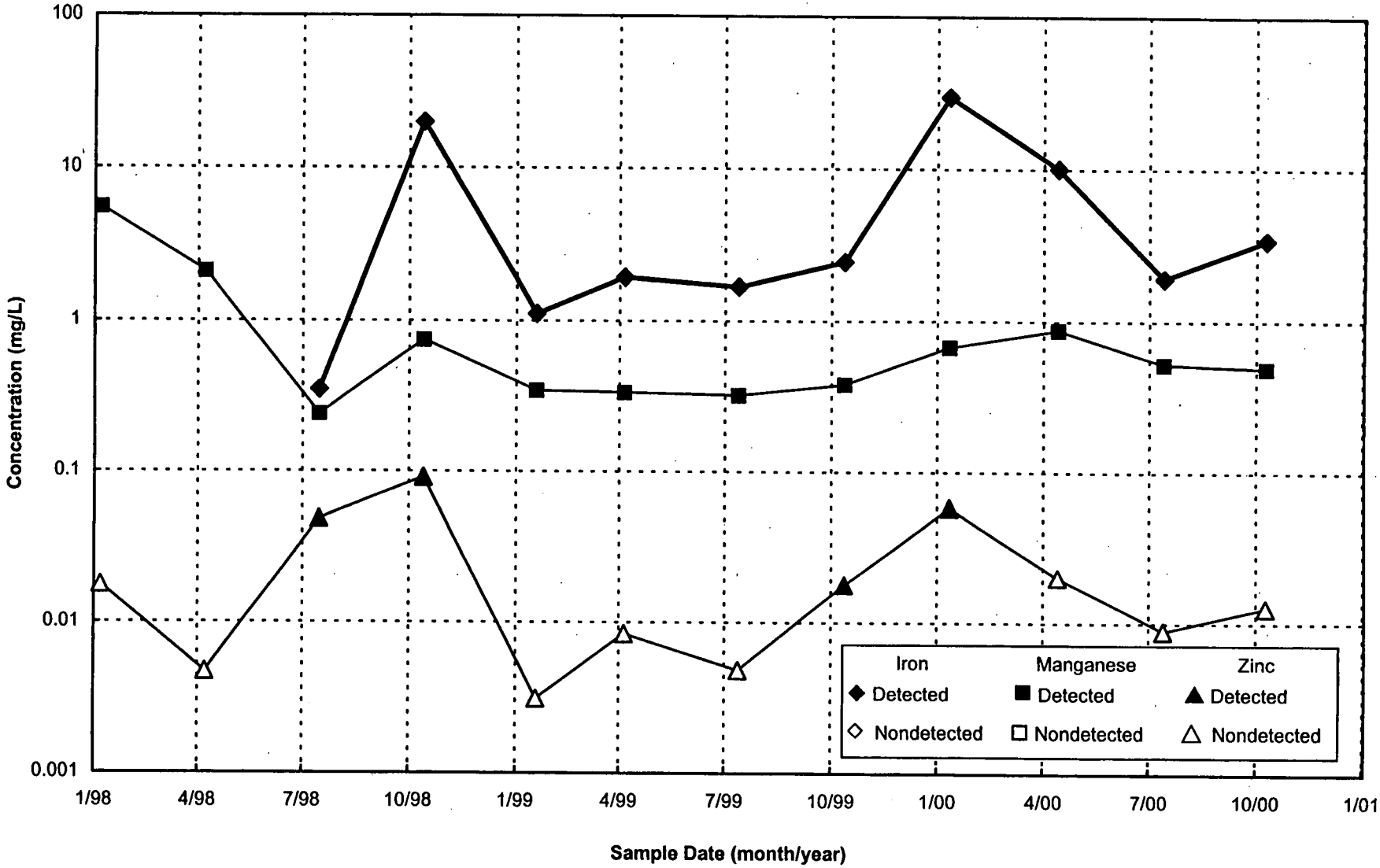

FIGURE A.4-29. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2431

000298

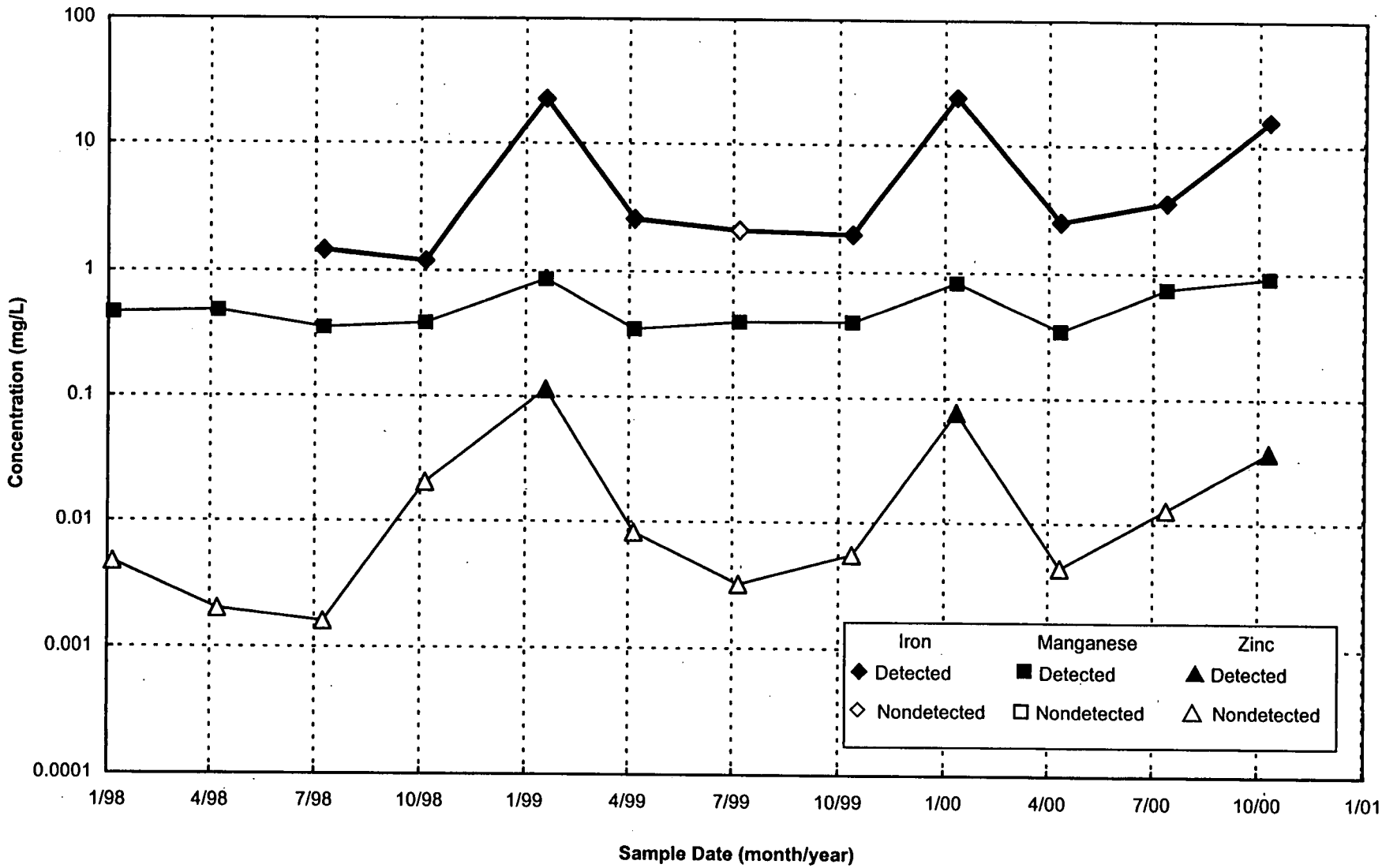

FIGURE A.4-30. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2432

000299

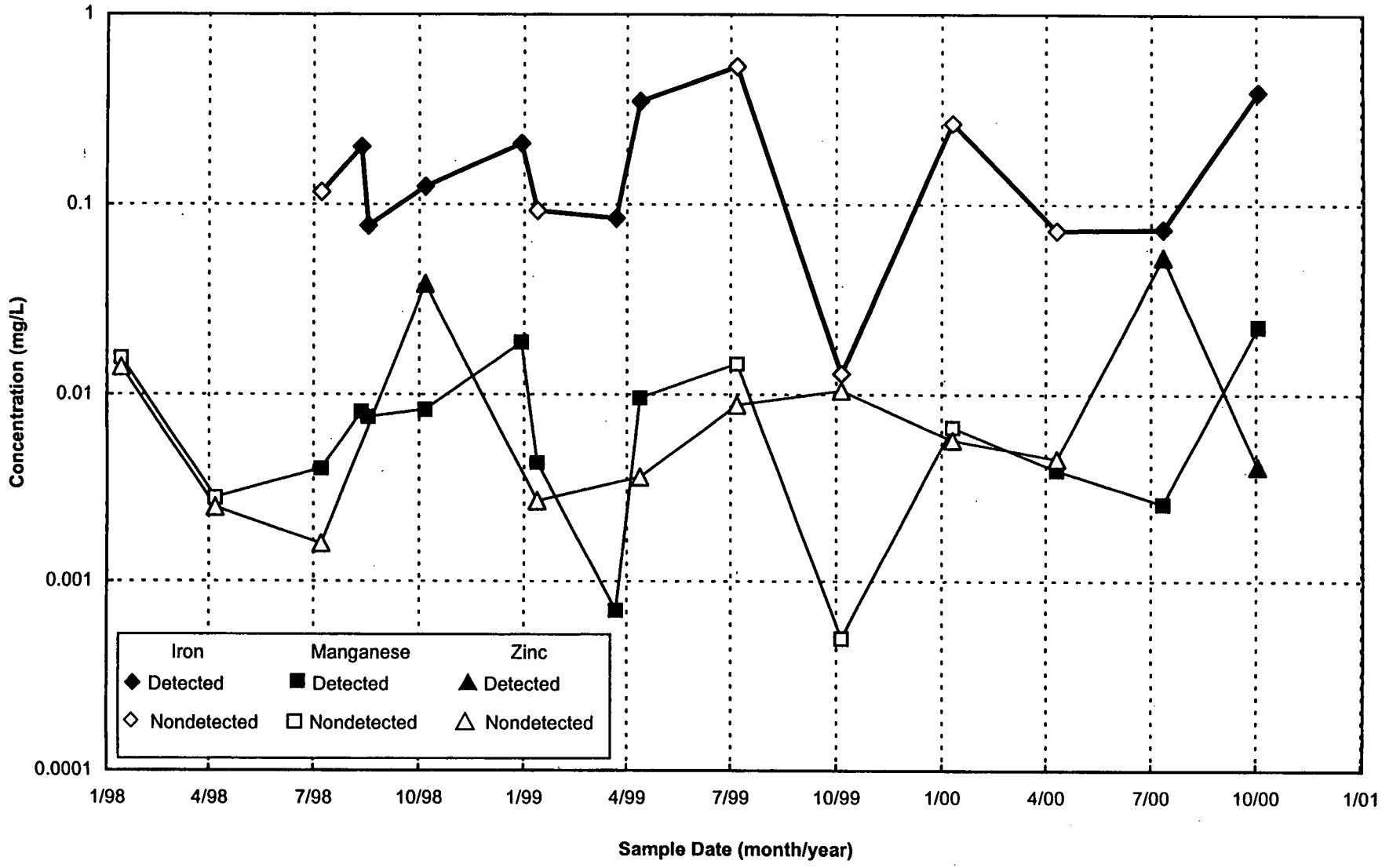

FIGURE A.4-31. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2434

000300

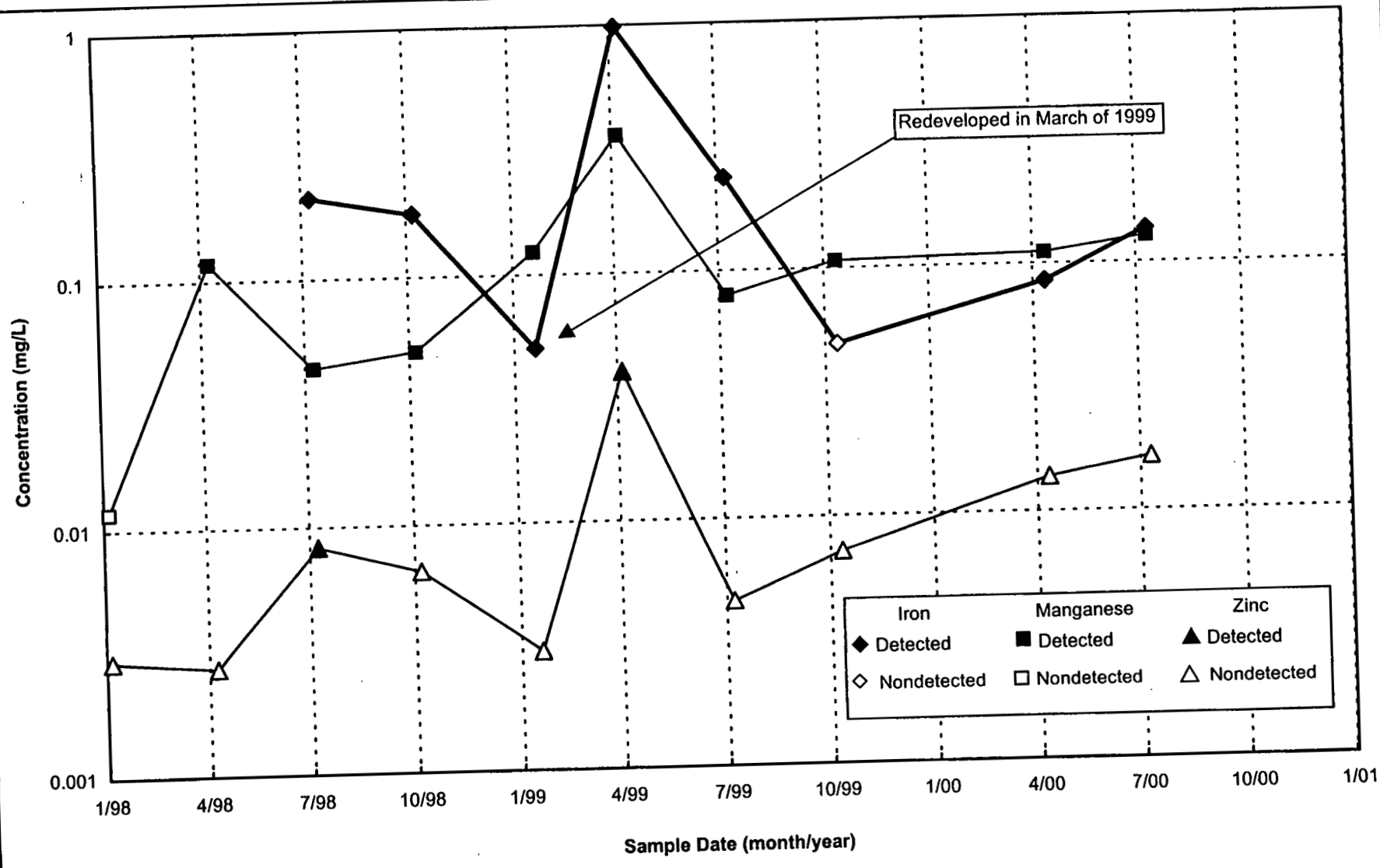

FIGURE A.4-32. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2733

000301

3694

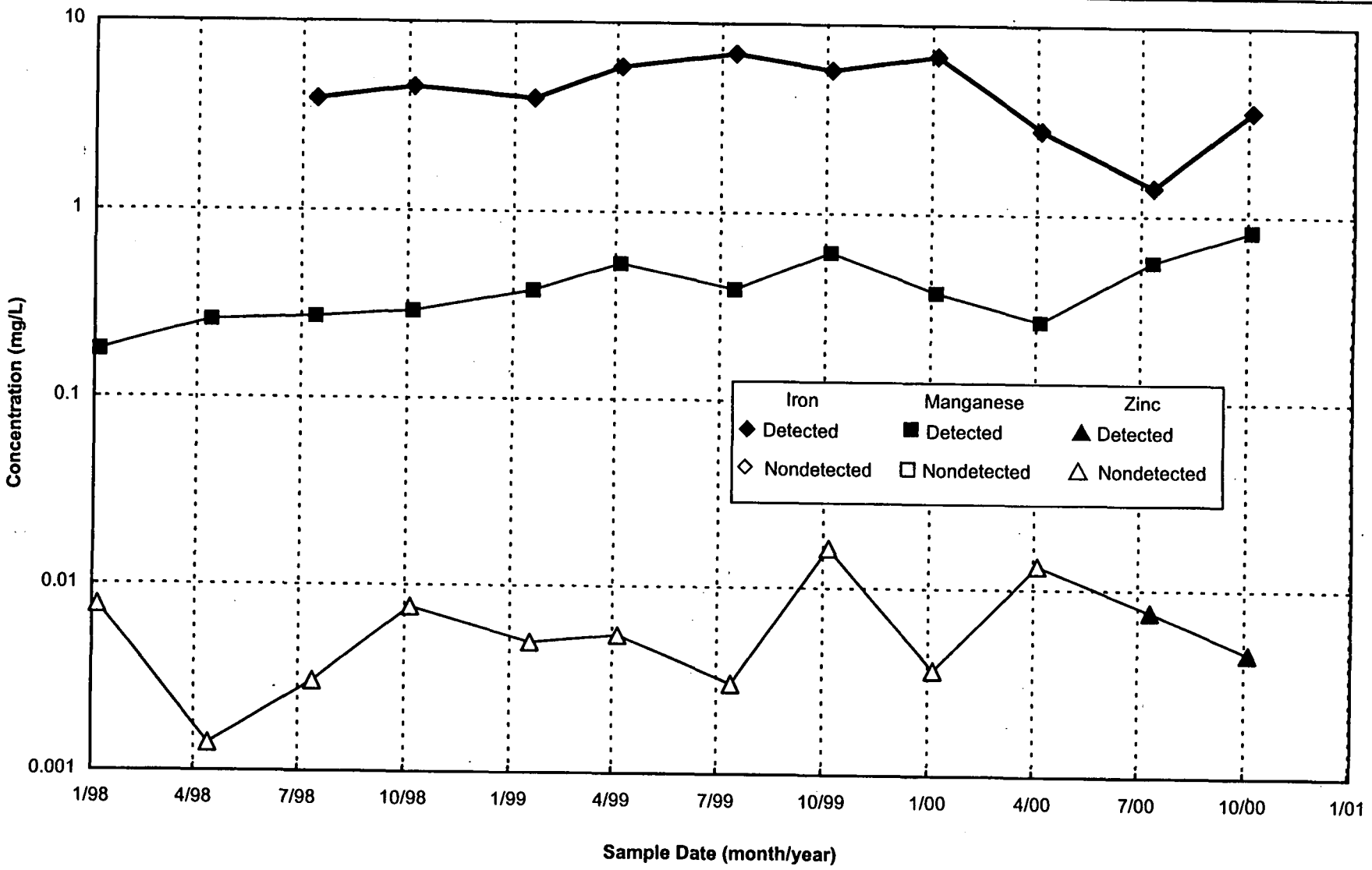

FIGURE A.4-33. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22198

000302

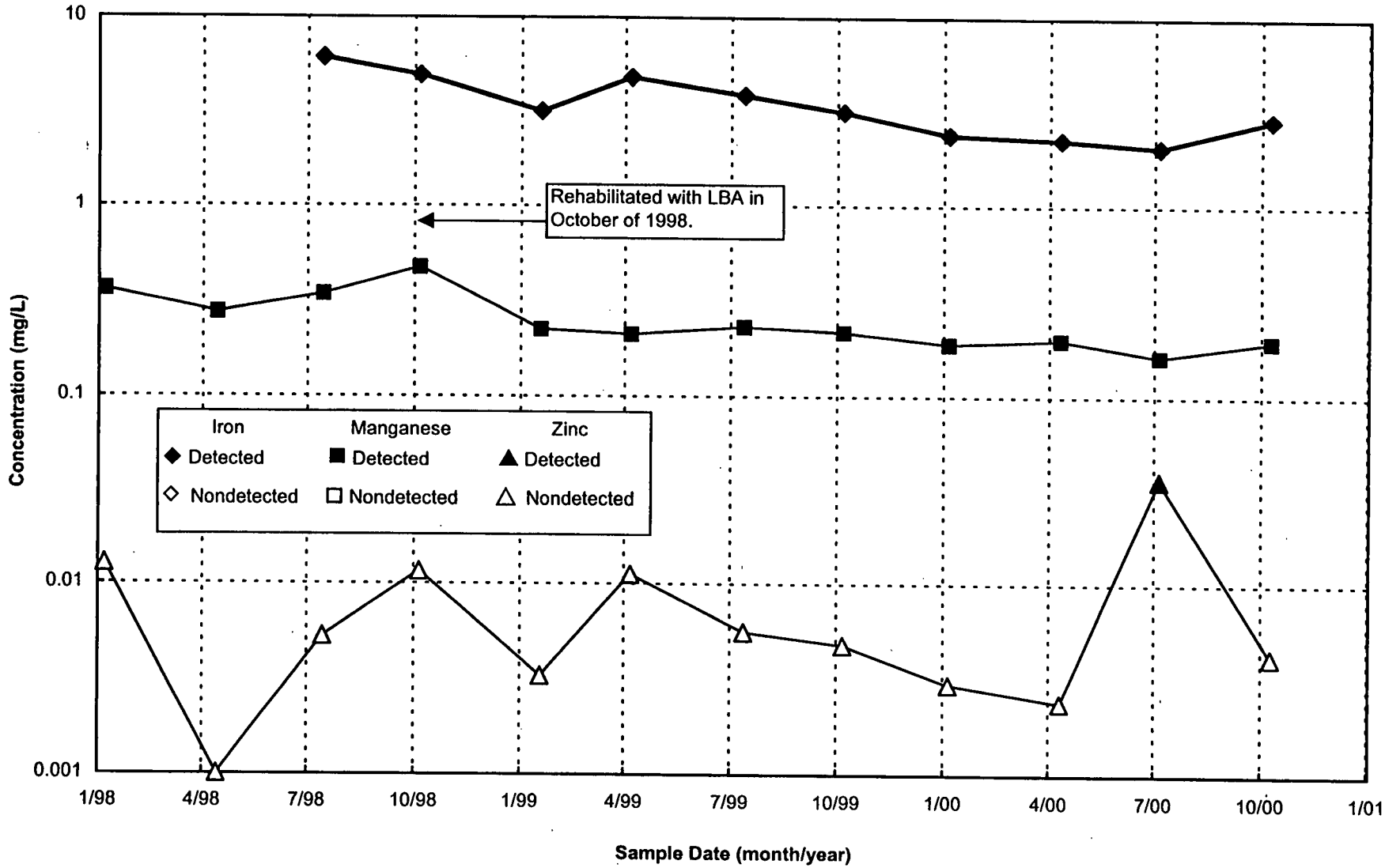

FIGURE A.4-34. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3067

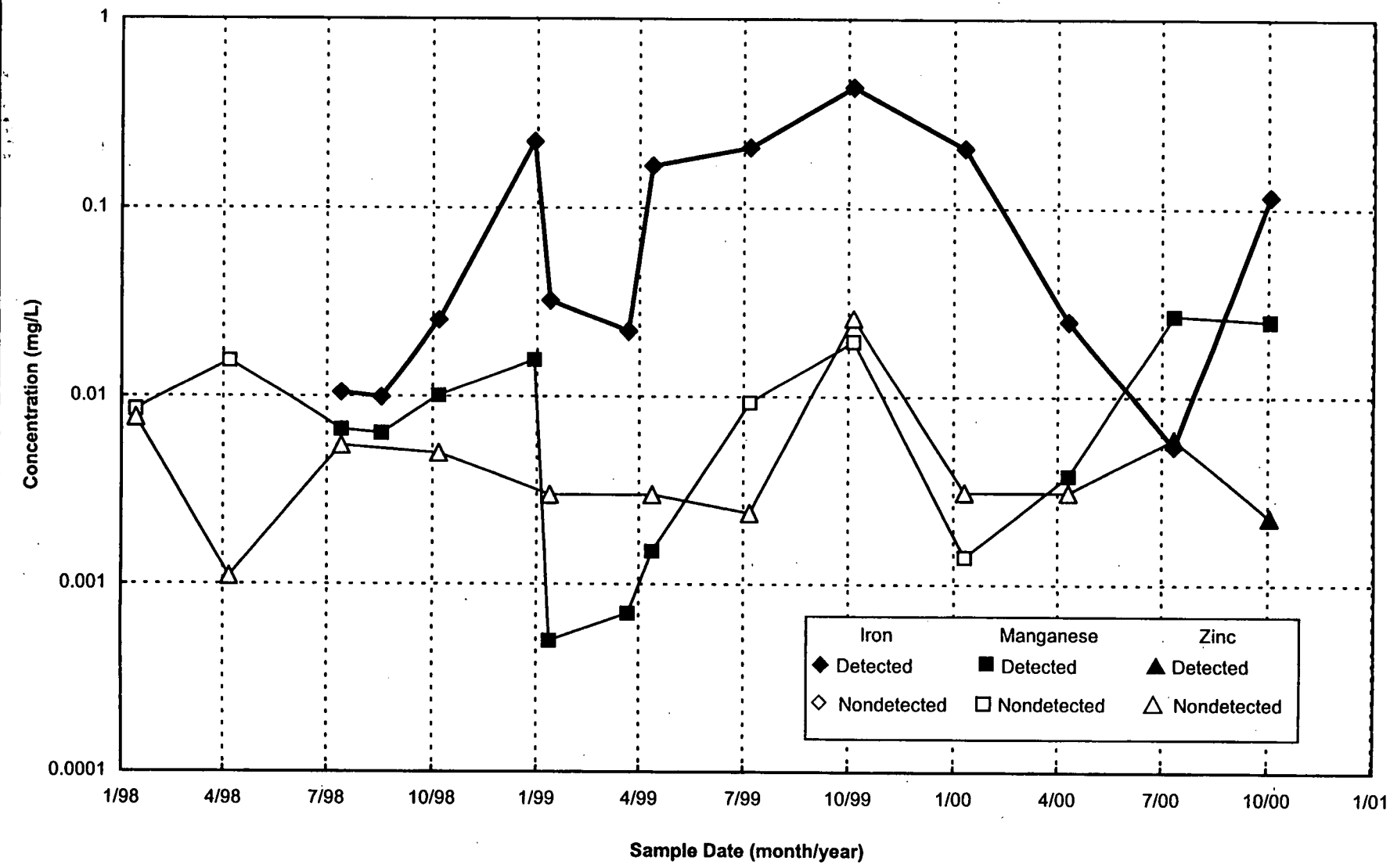

FIGURE A.4-35. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3069

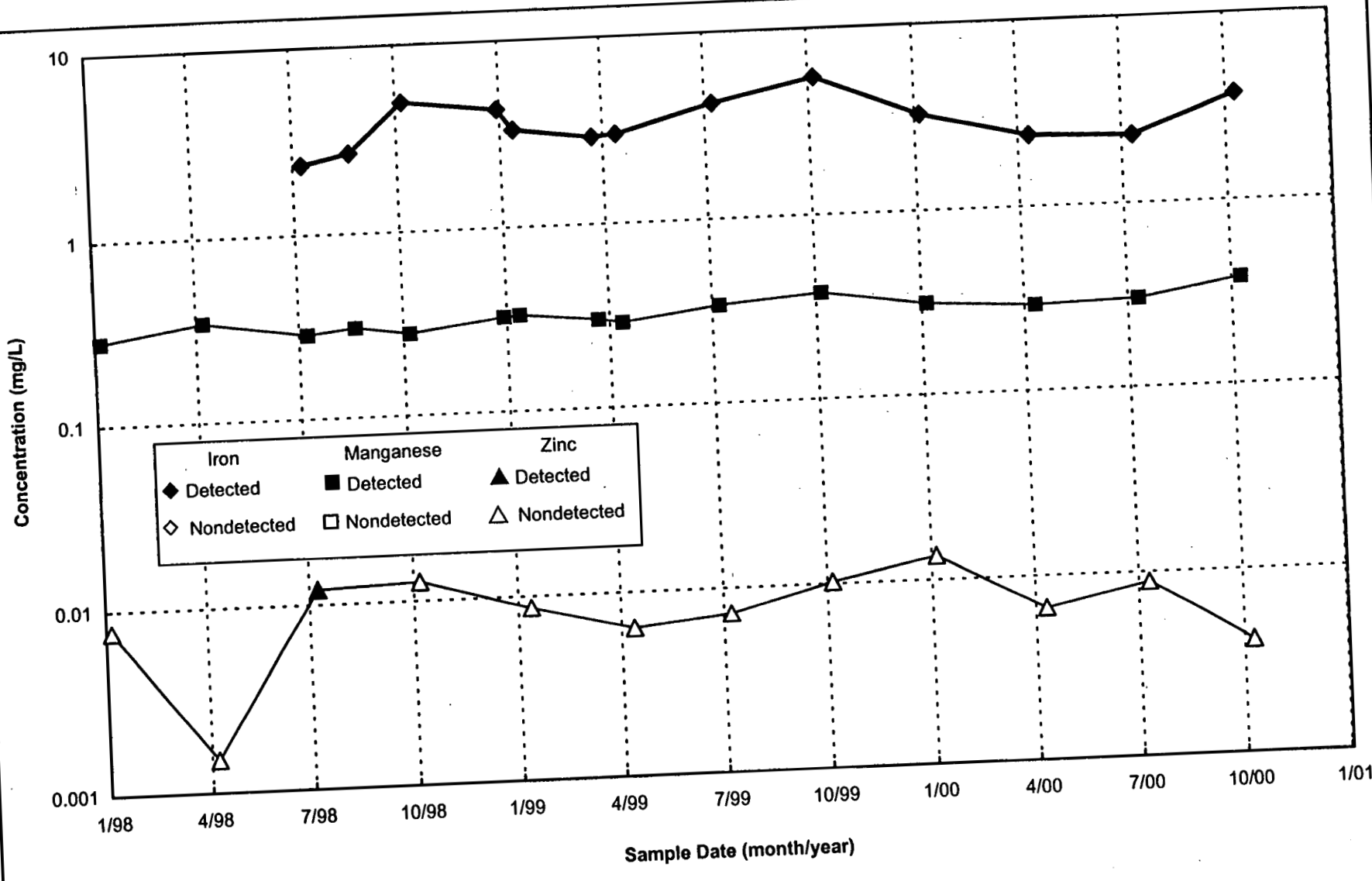

FIGURE A.4-36. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3070

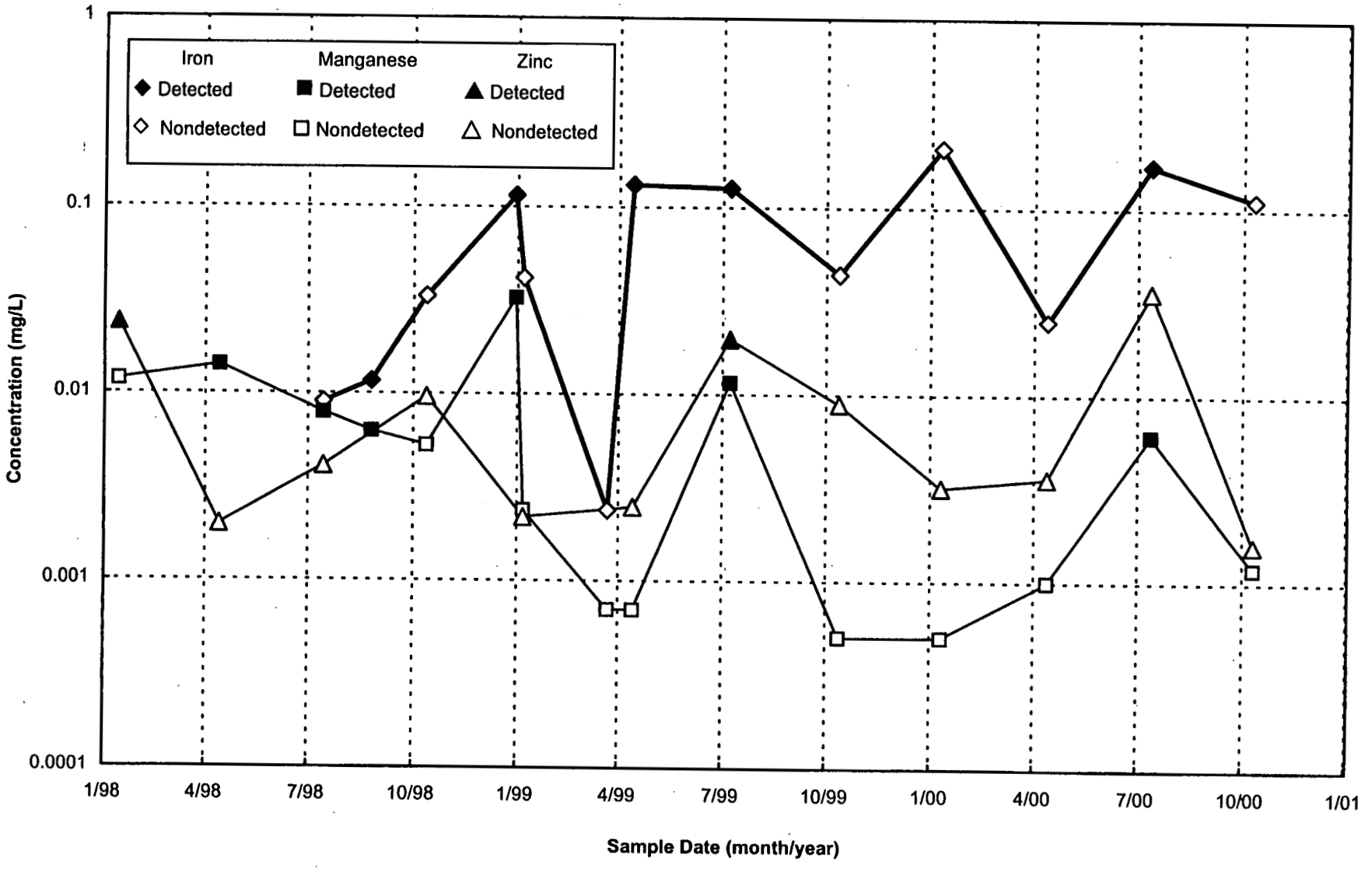

FIGURE A.4-37. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3106

000306

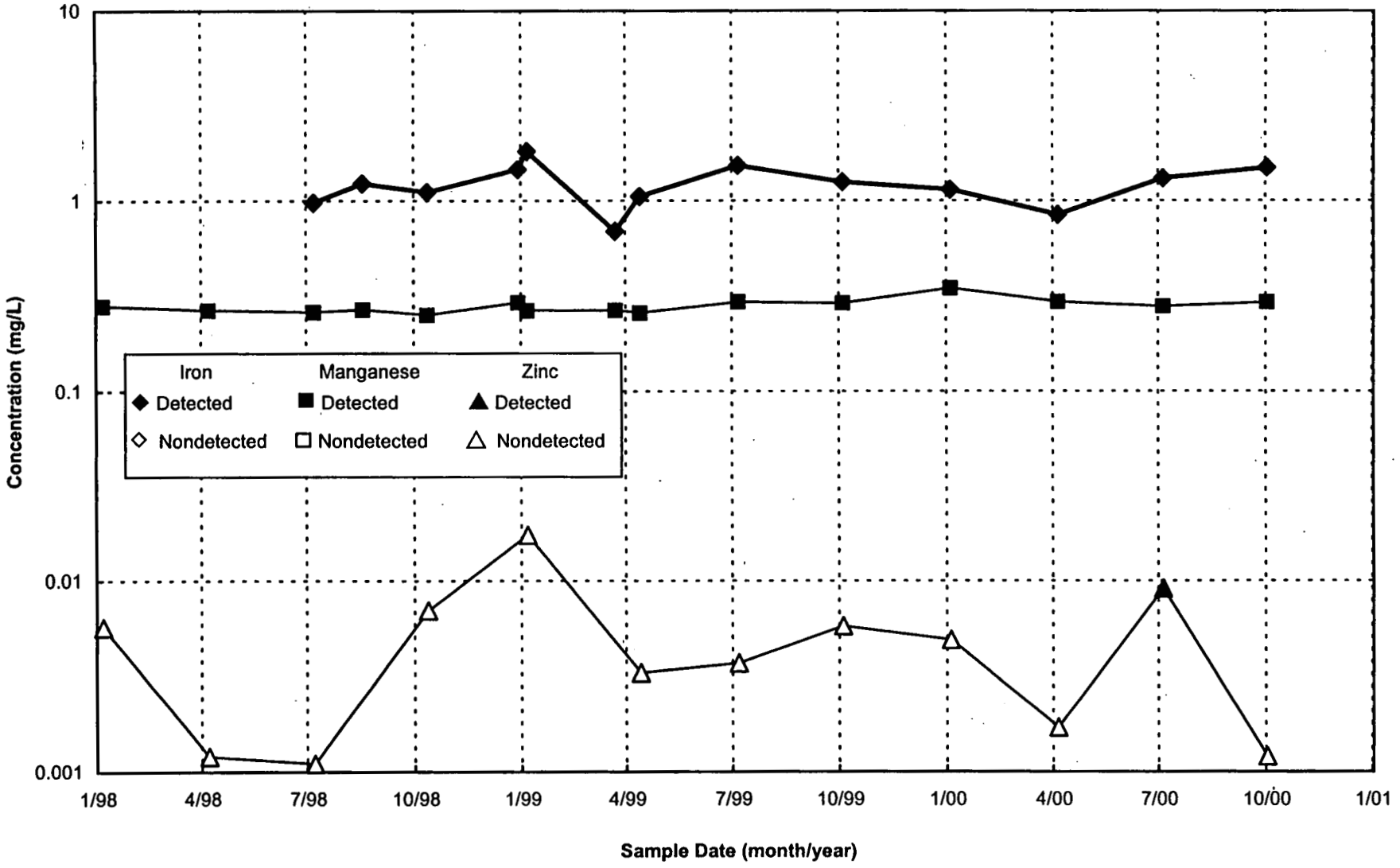

FIGURE A.4-38. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3398

000307

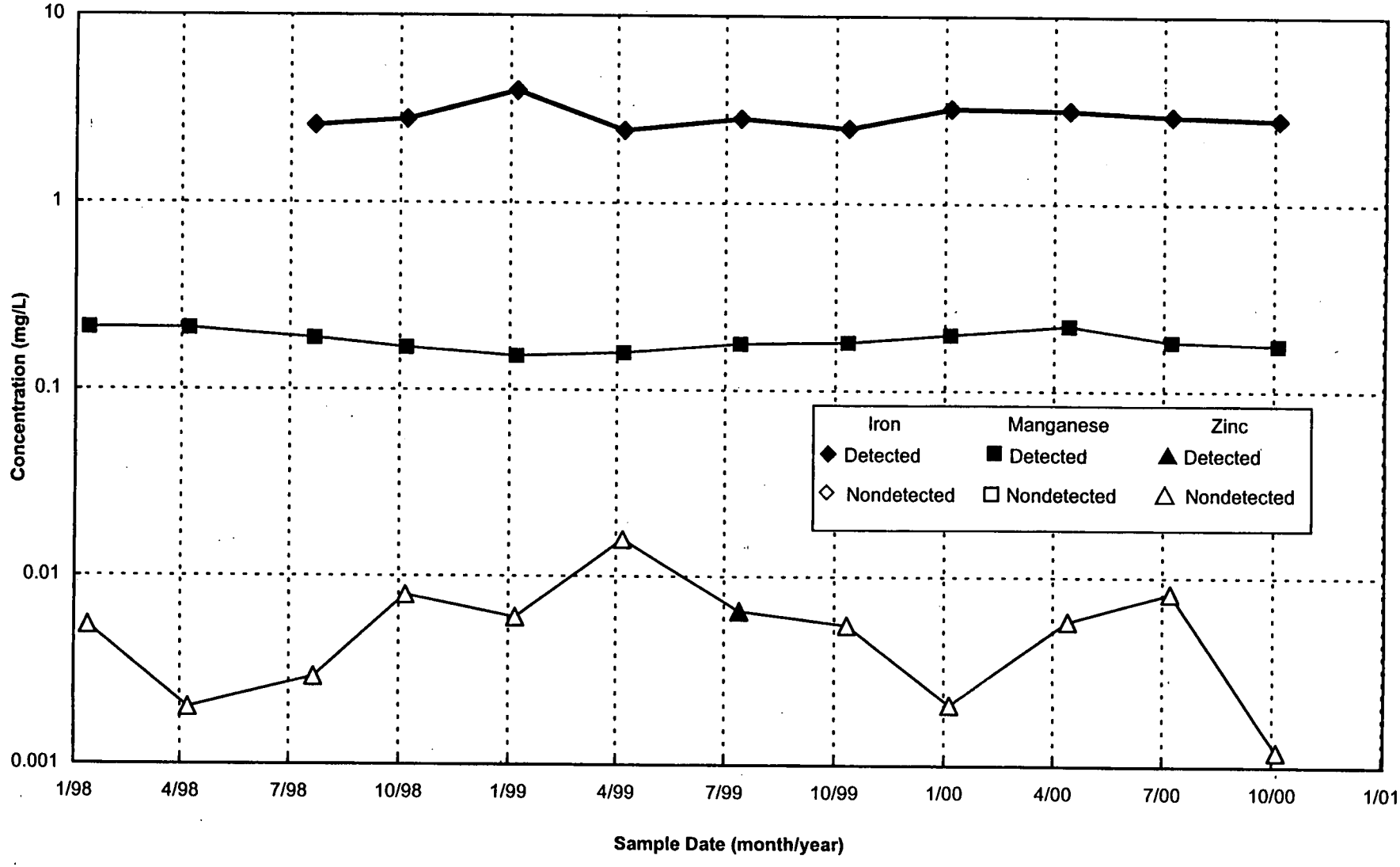

FIGURE A.4-39. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3417

000308

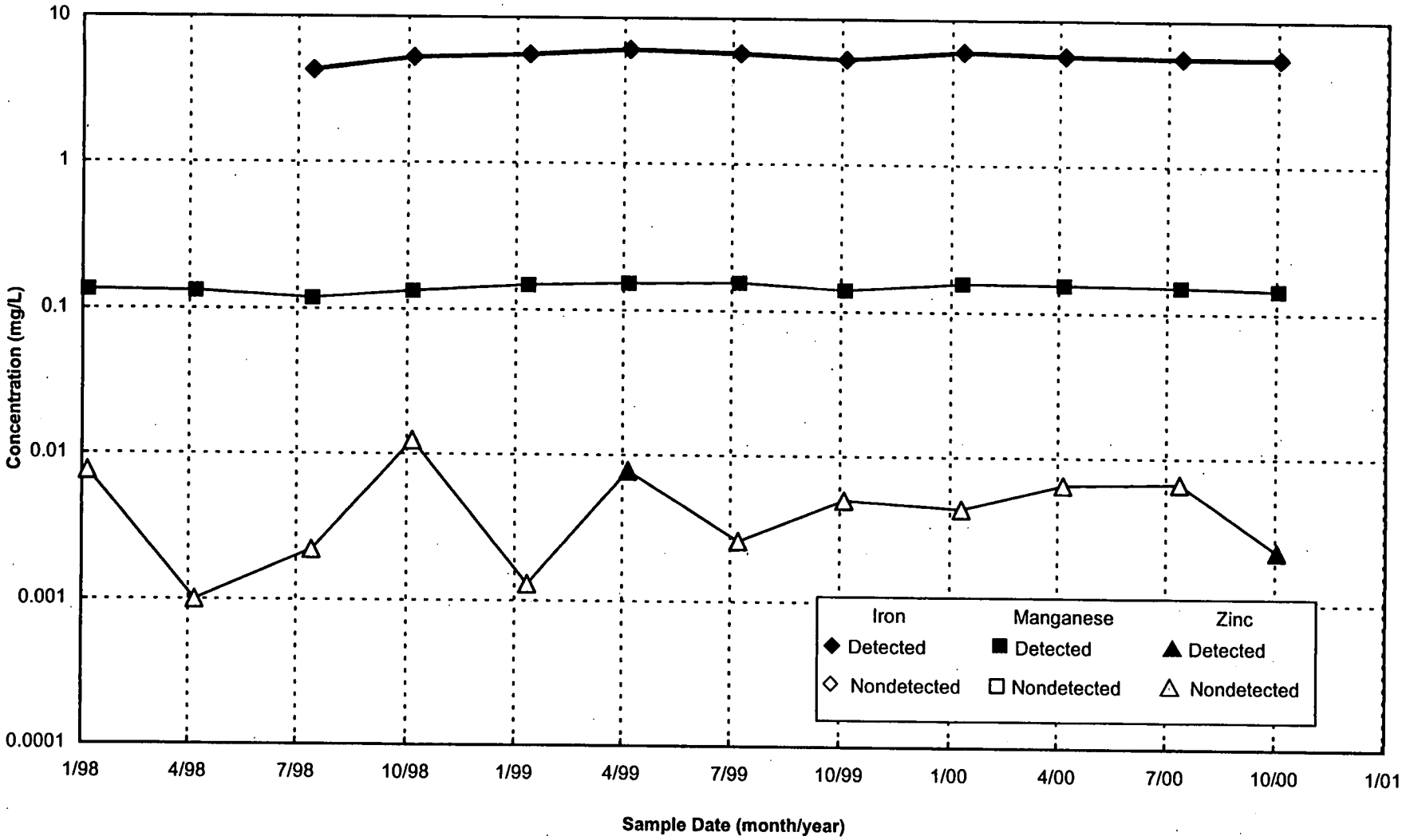

FIGURE A.4-40. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3424

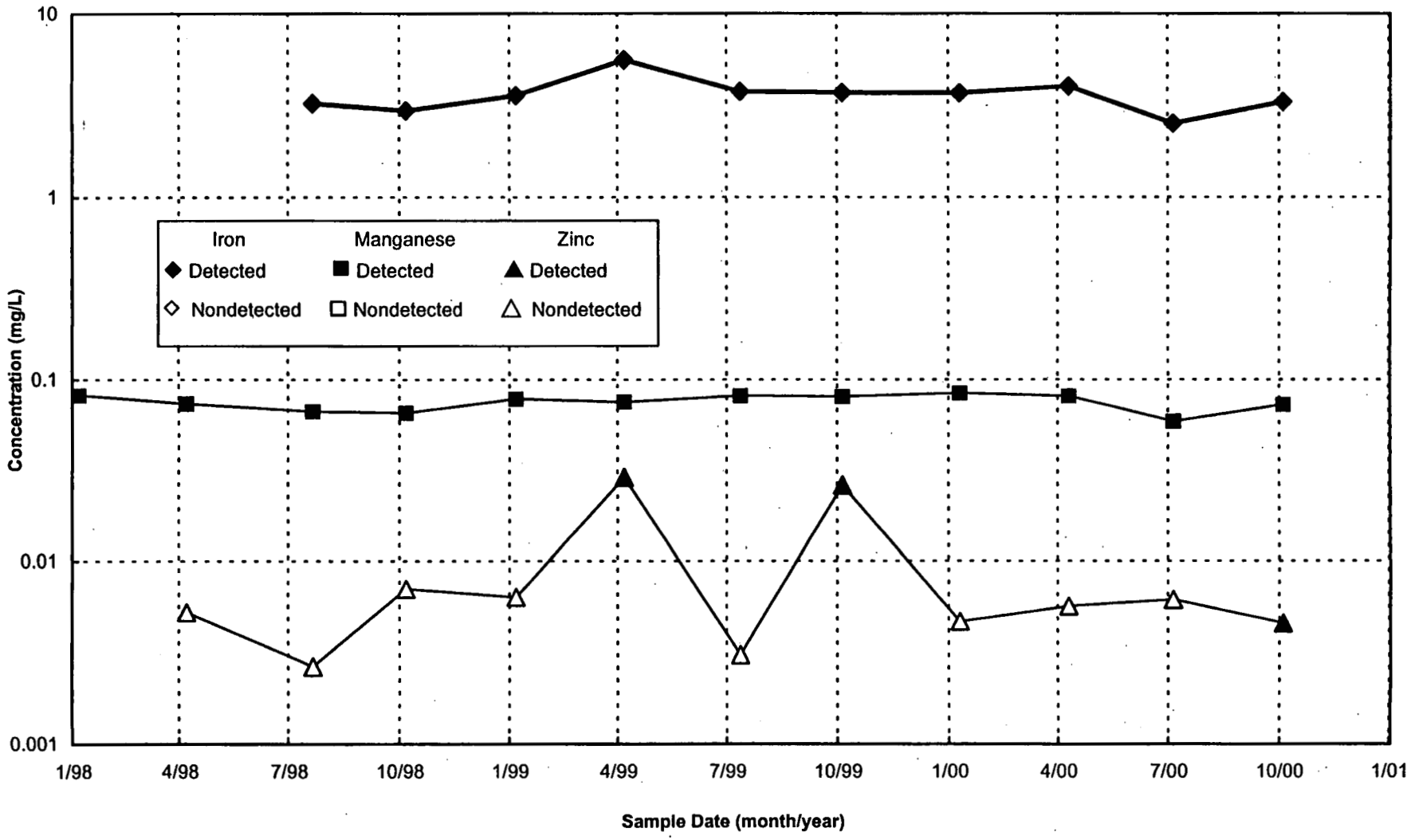

FIGURE A.4-41. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3426

000310

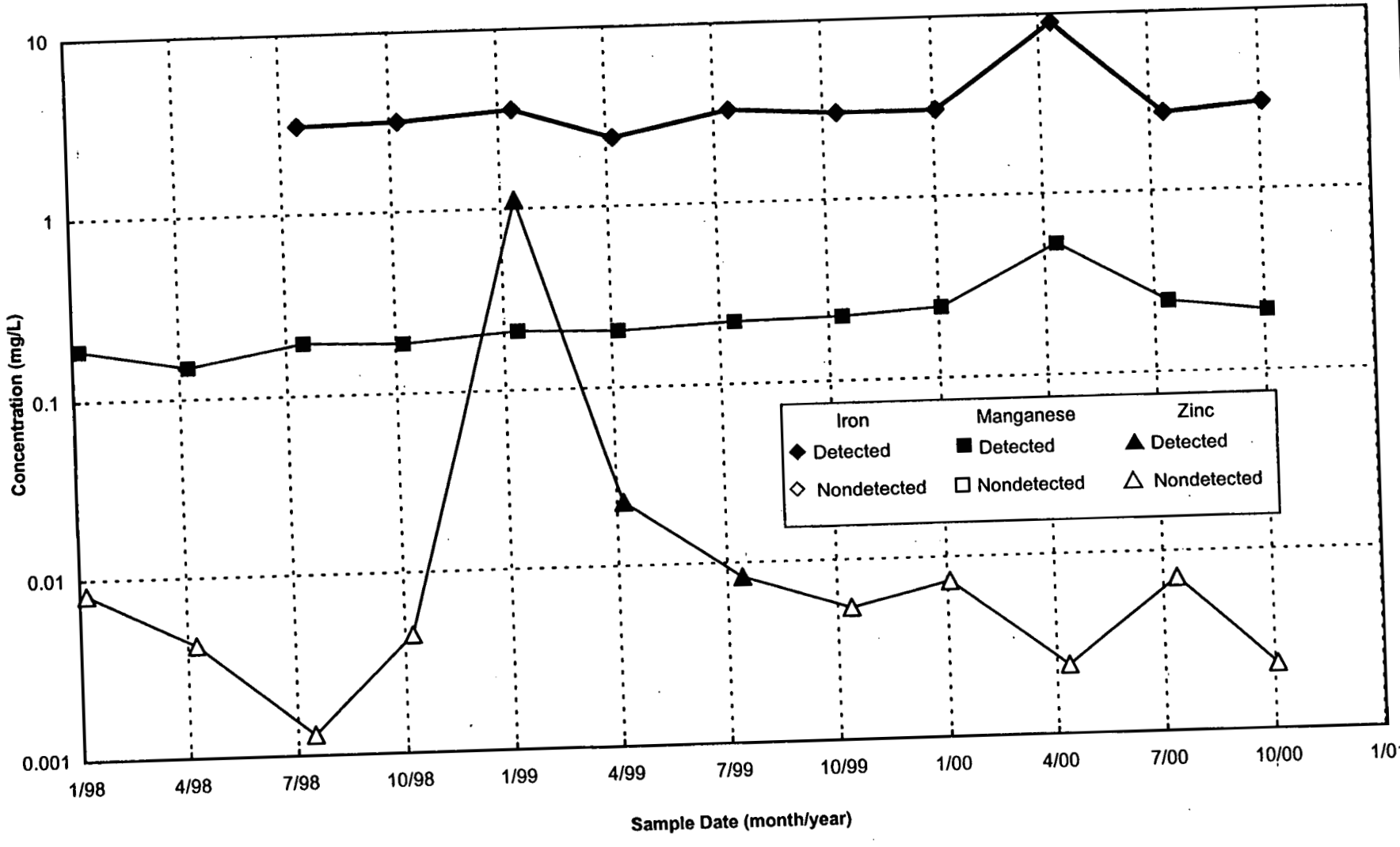

FIGURE A.4-42. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3429

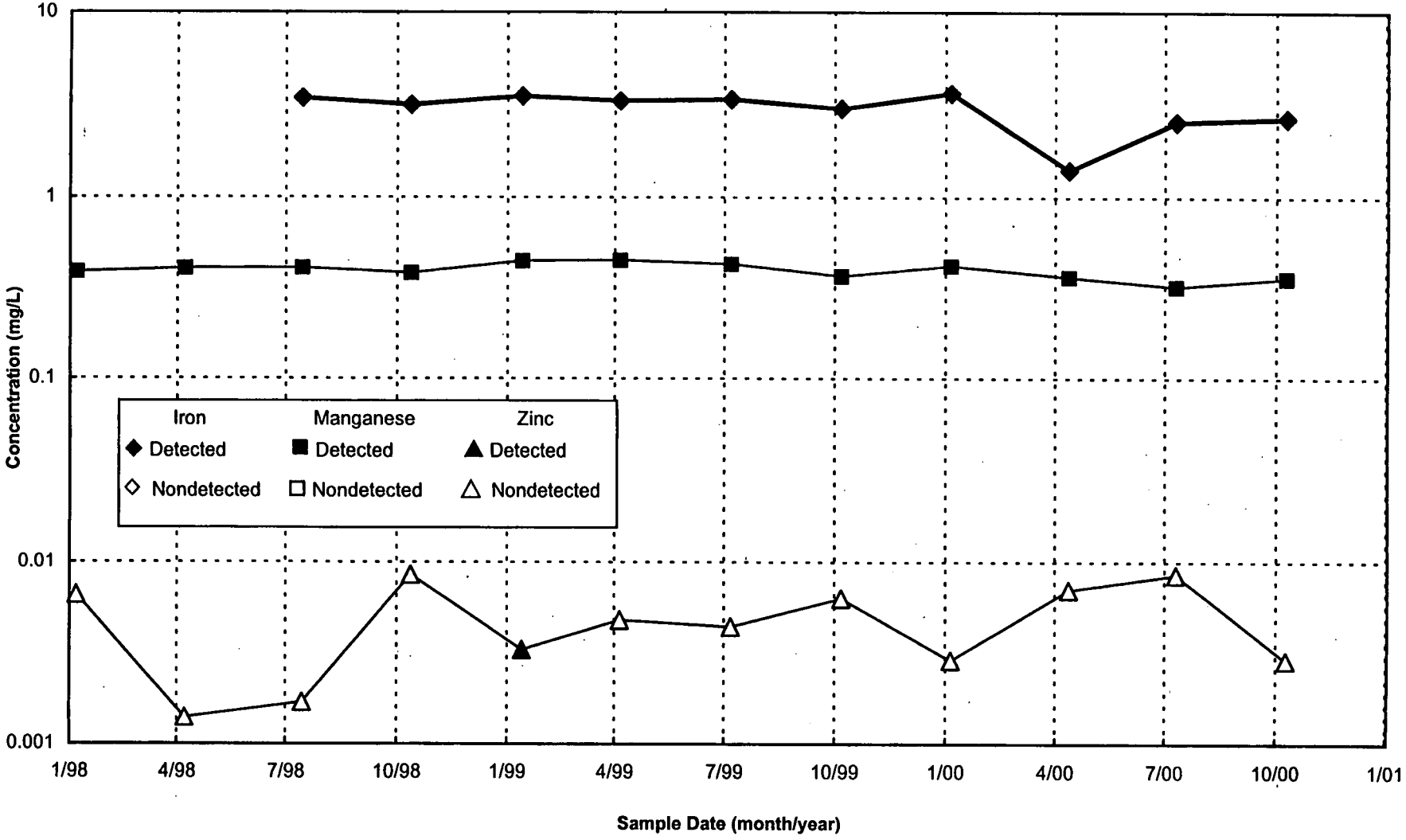

FIGURE A.4-43. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3431

000312

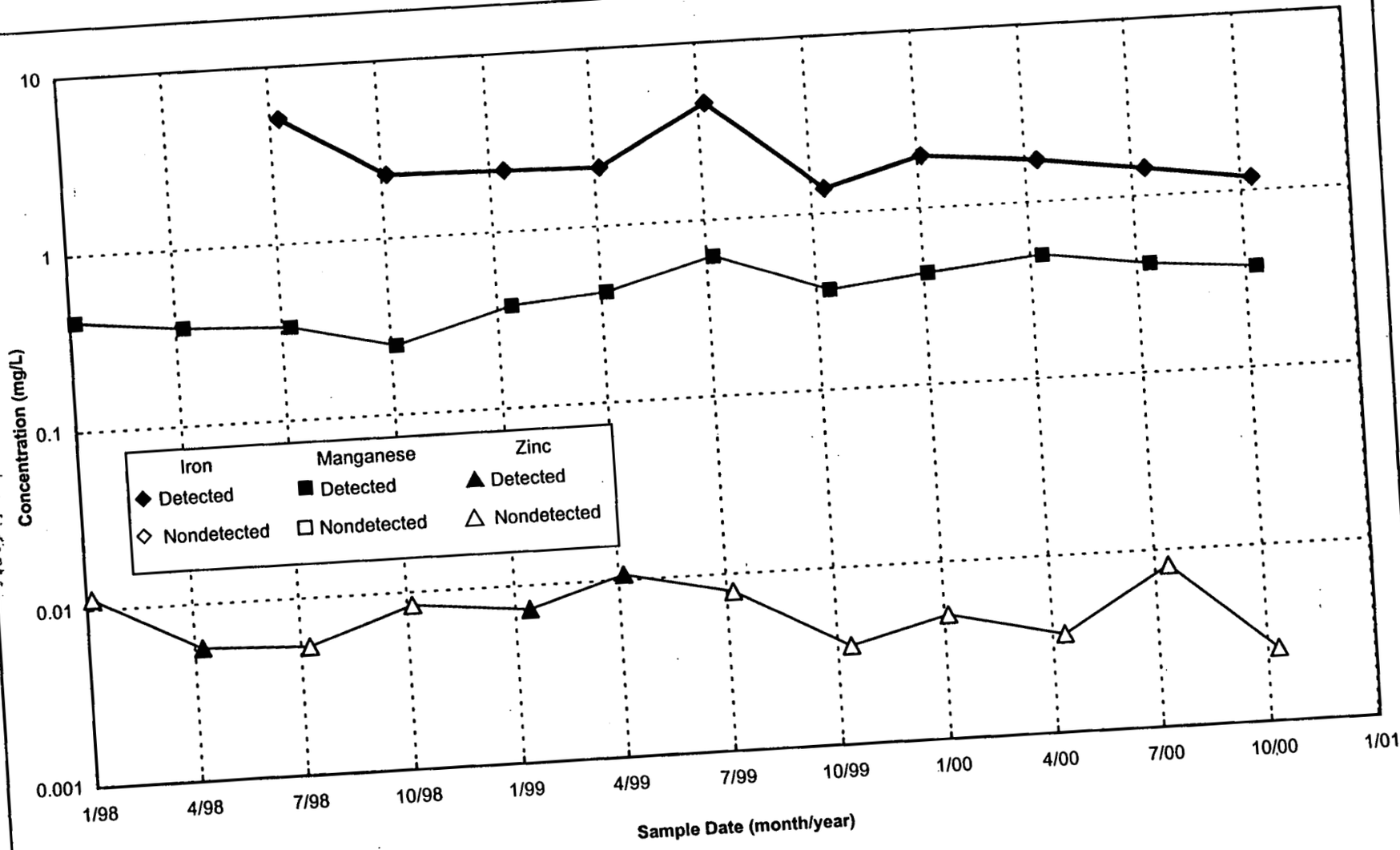

FIGURE A.4-44. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3432

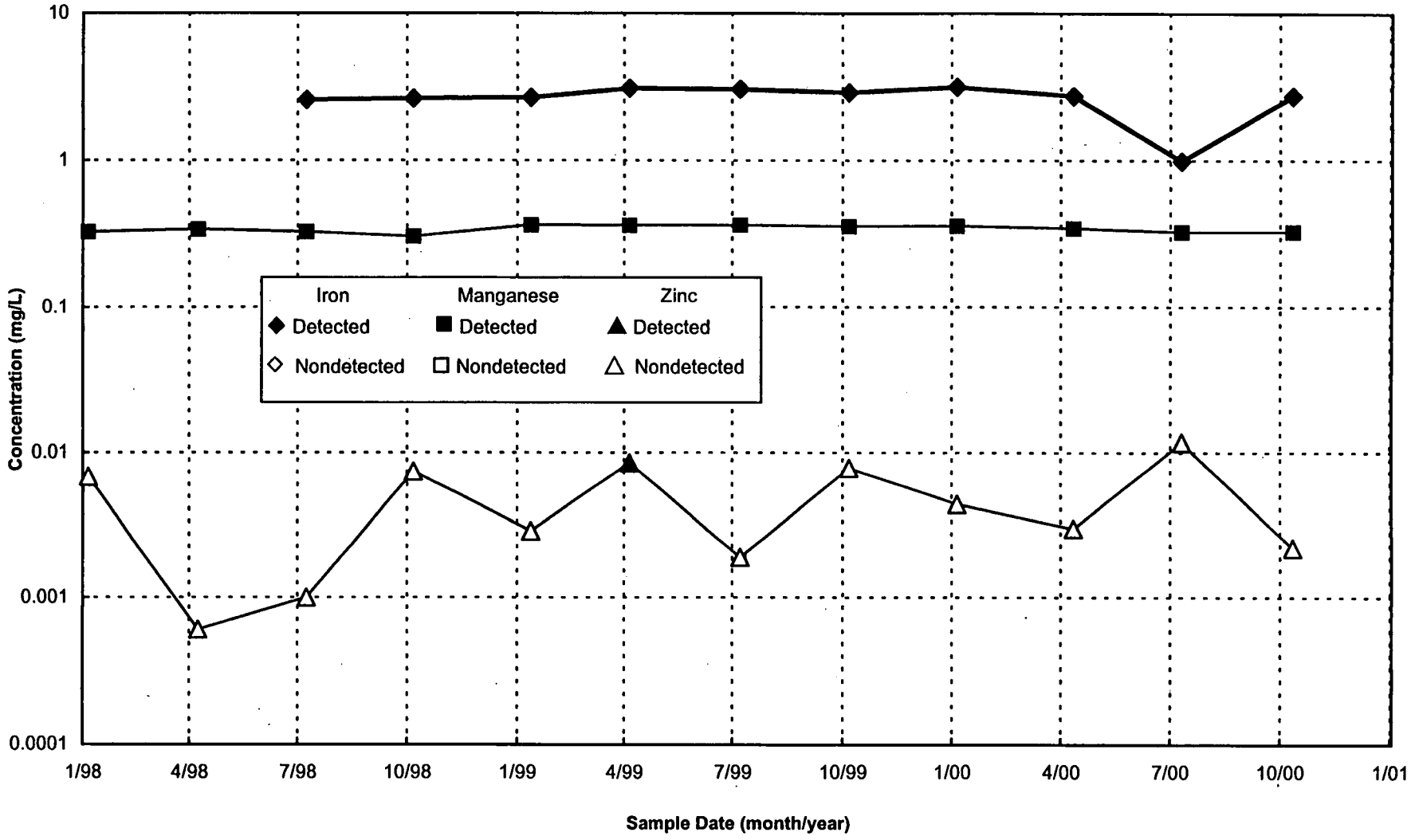

FIGURE A.4-45. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3733

000314

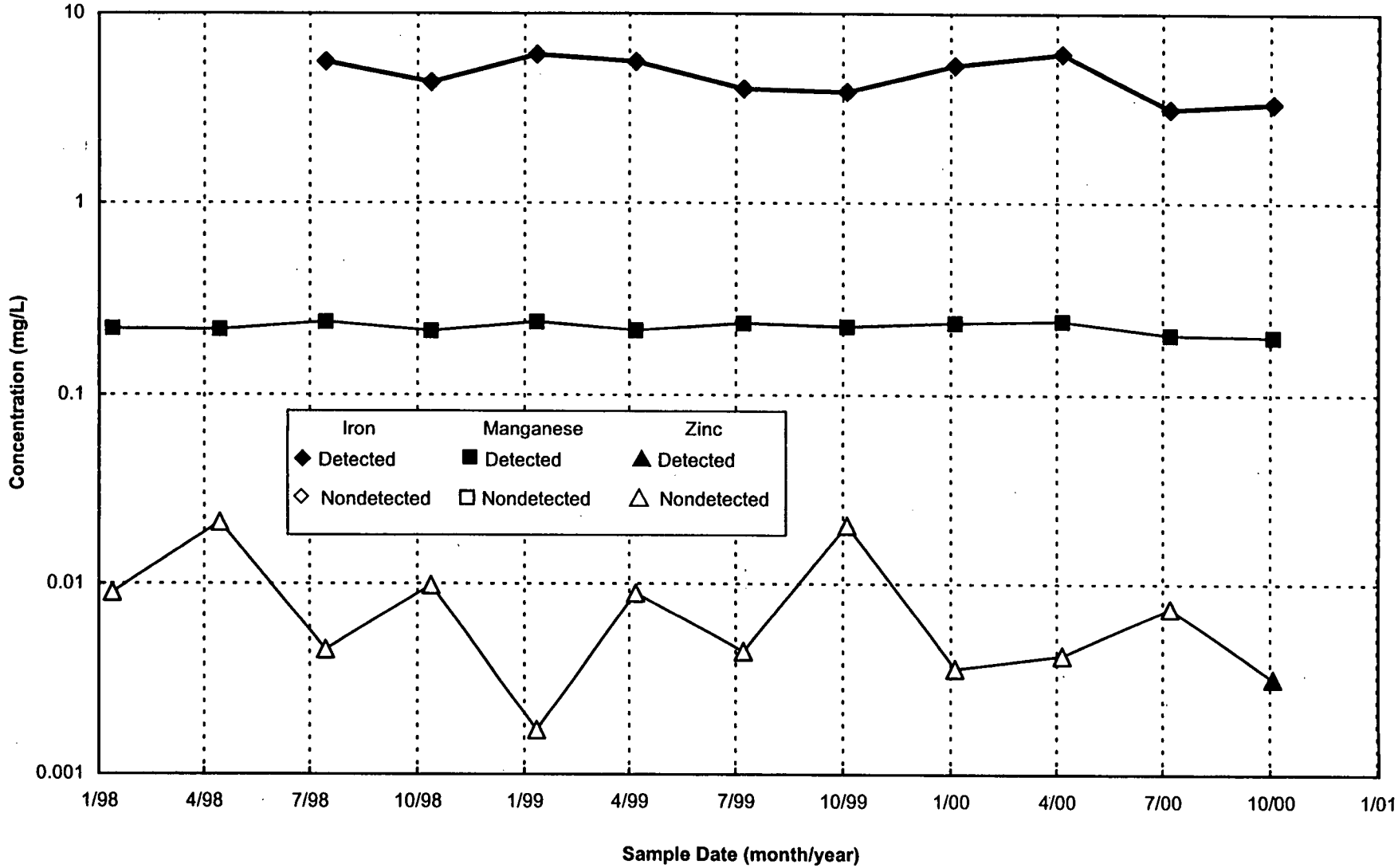

FIGURE A.4-46. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 31217

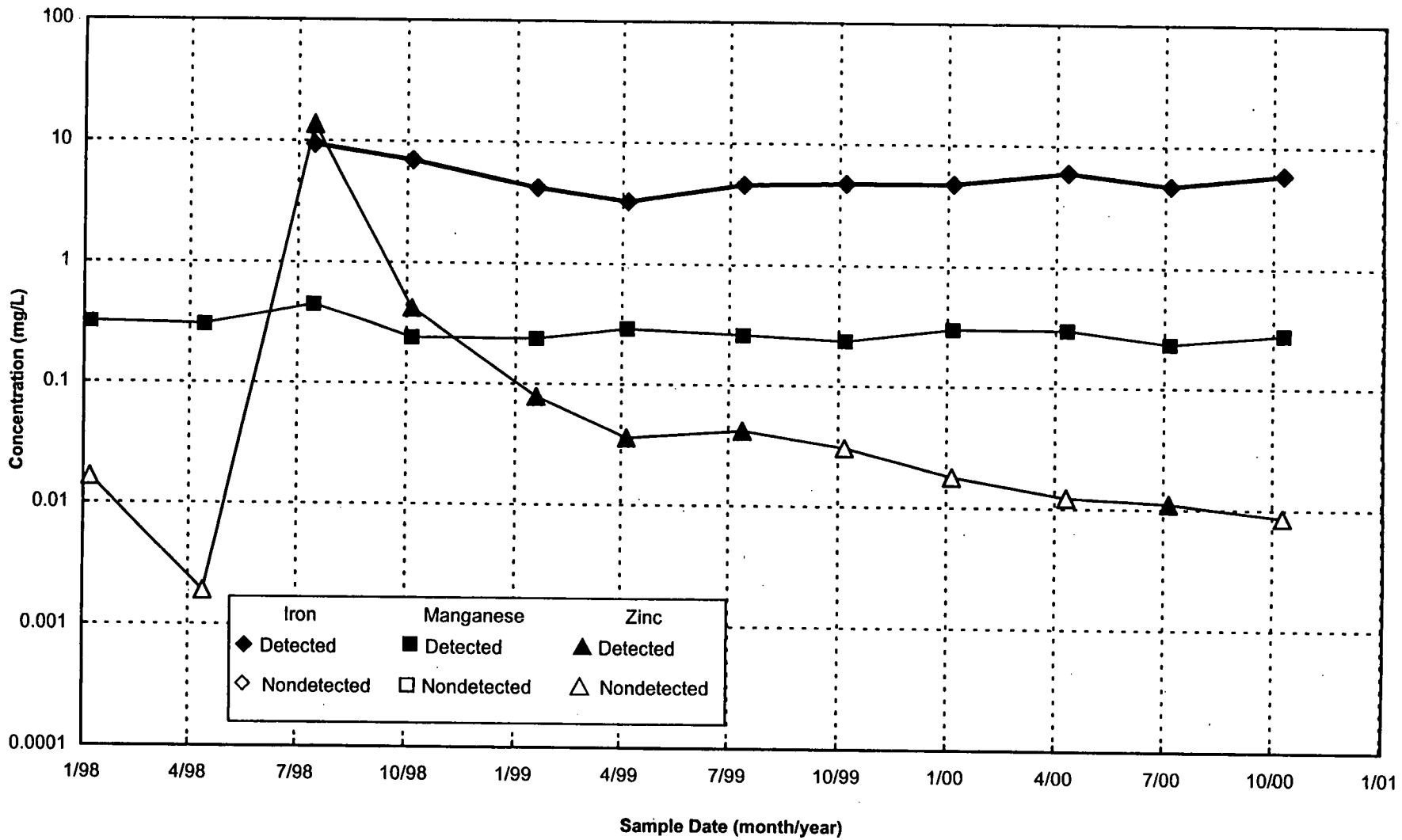

FIGURE A.4-47. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 4067

000316

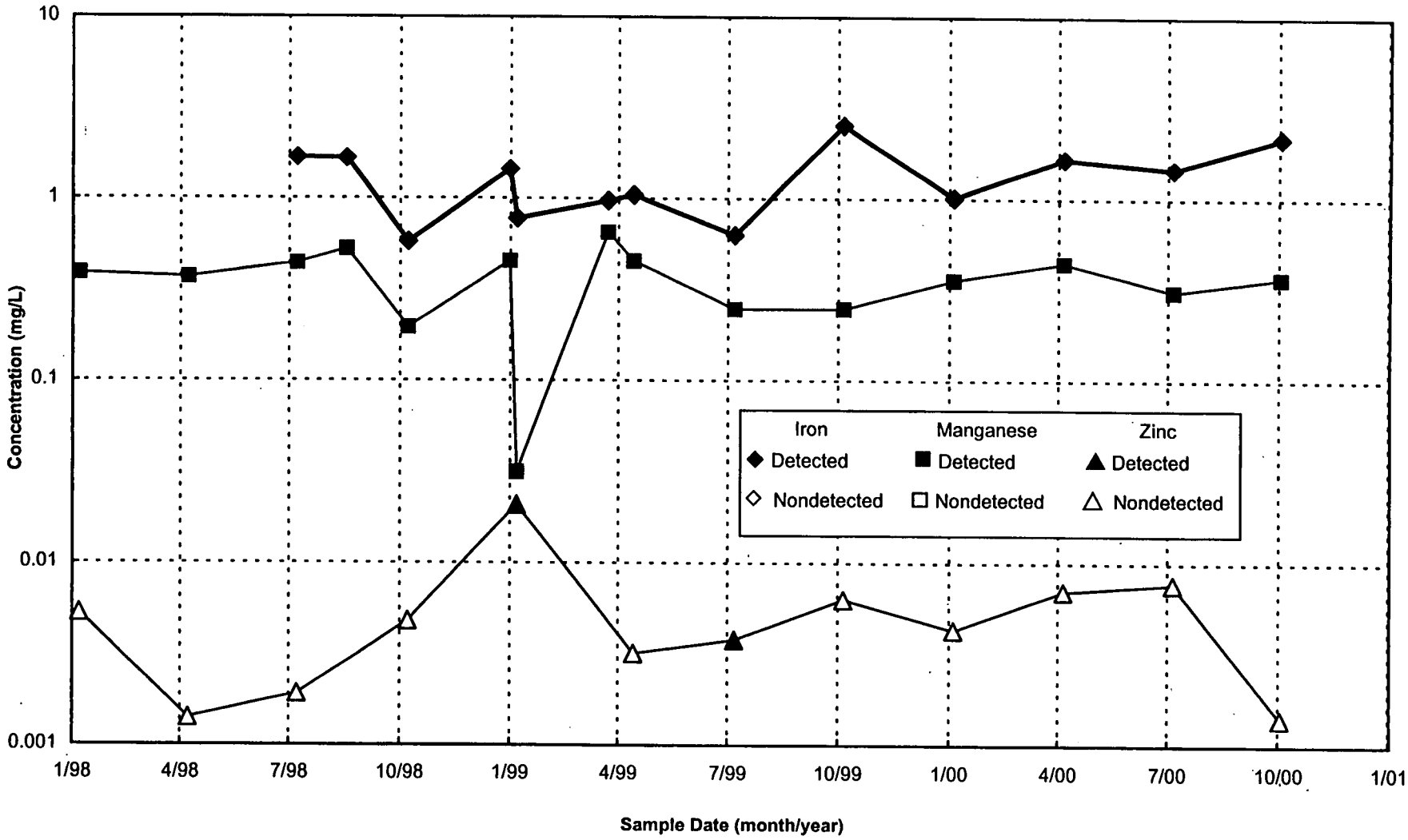

FIGURE A.4-48. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 4398

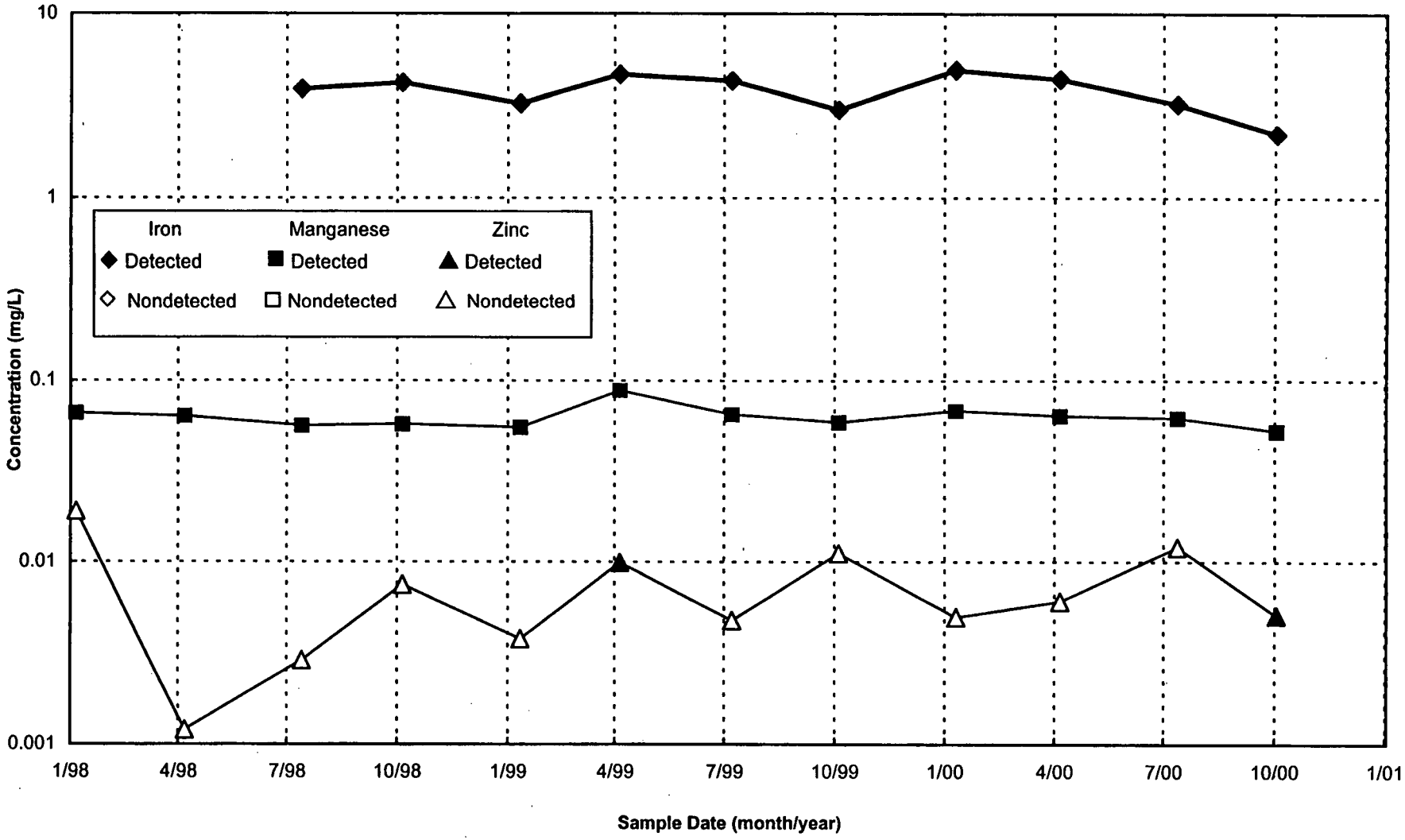

FIGURE A.4-49. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 4424

000318

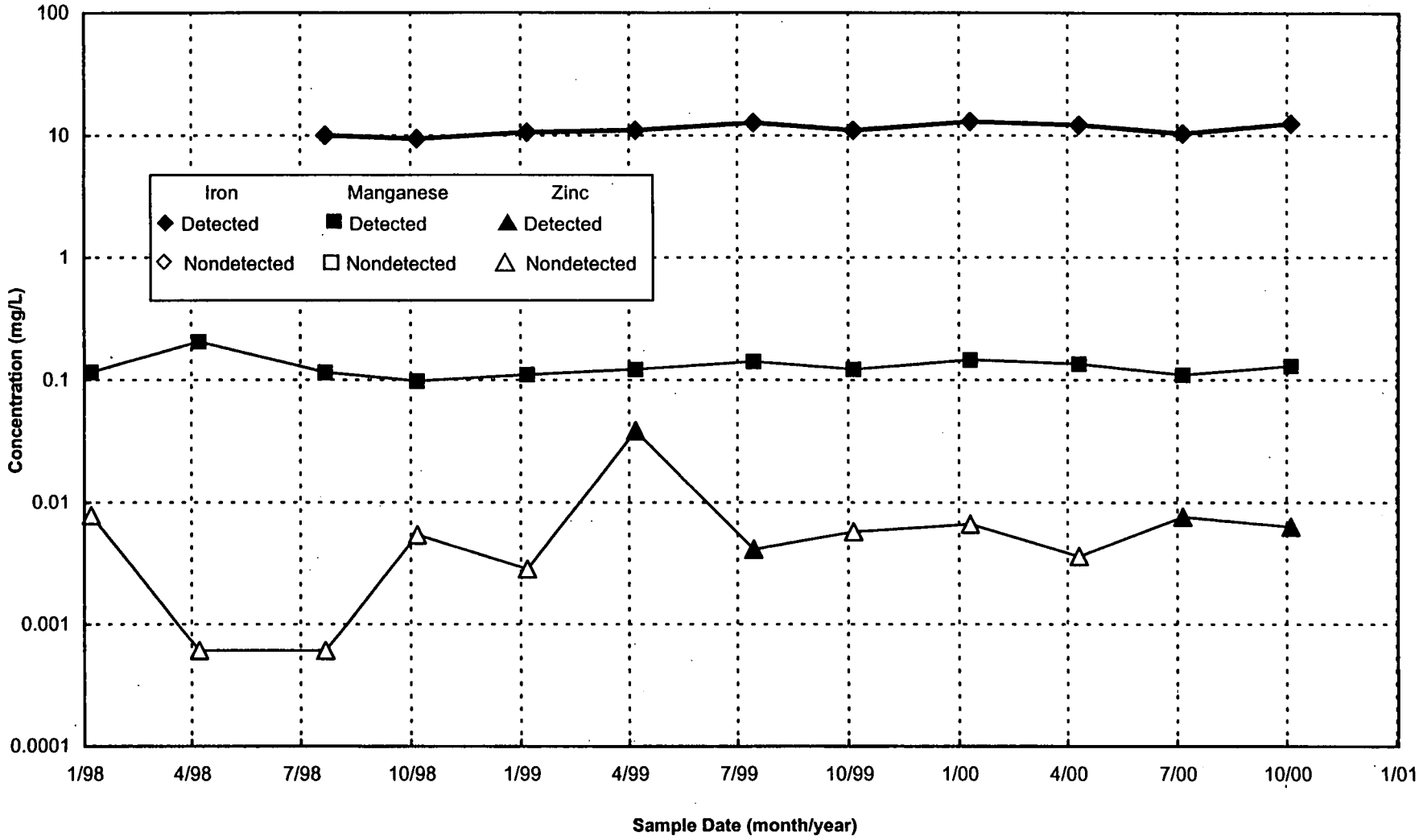

FIGURE A.4-50. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 4426

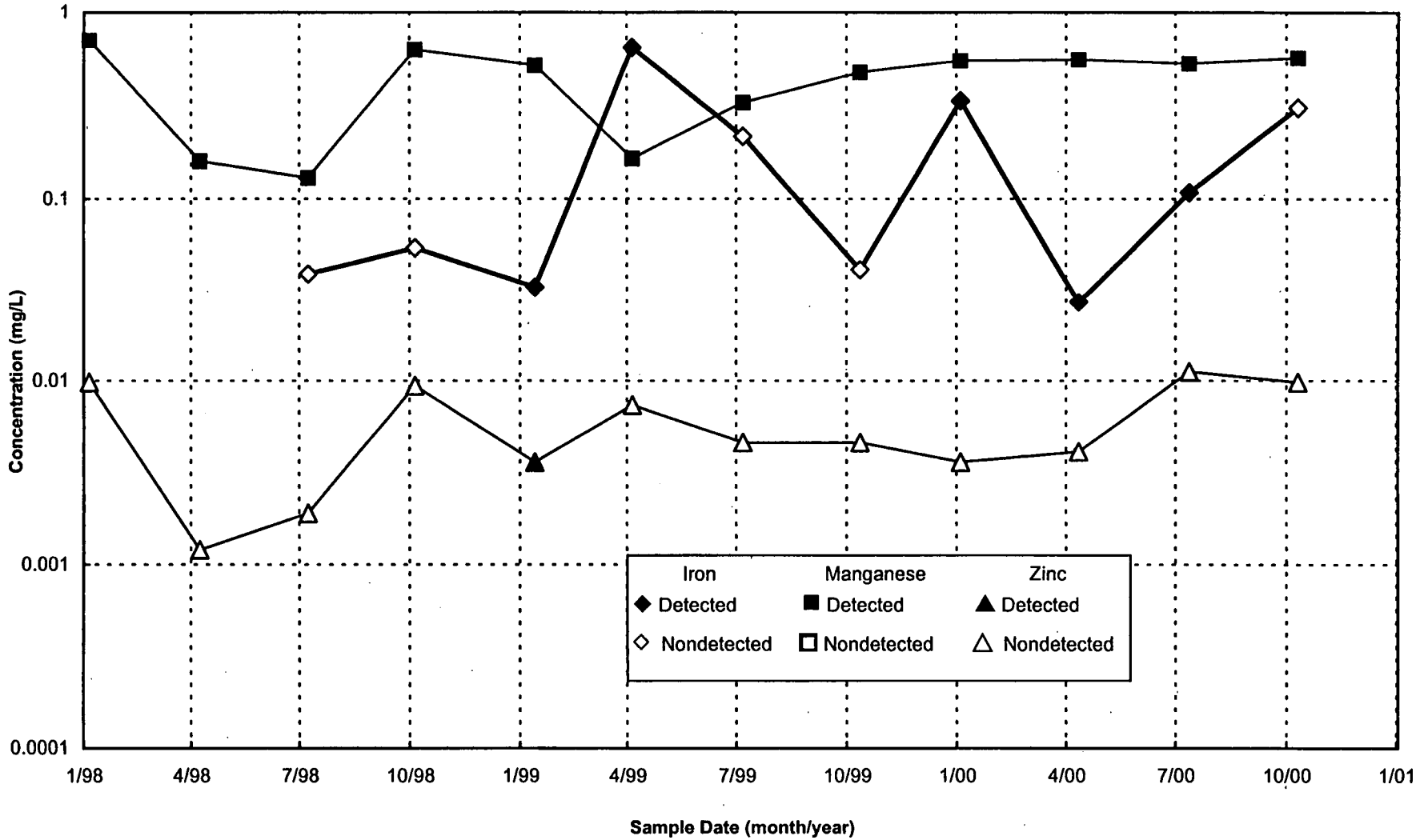

FIGURE A.4-51. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 4432

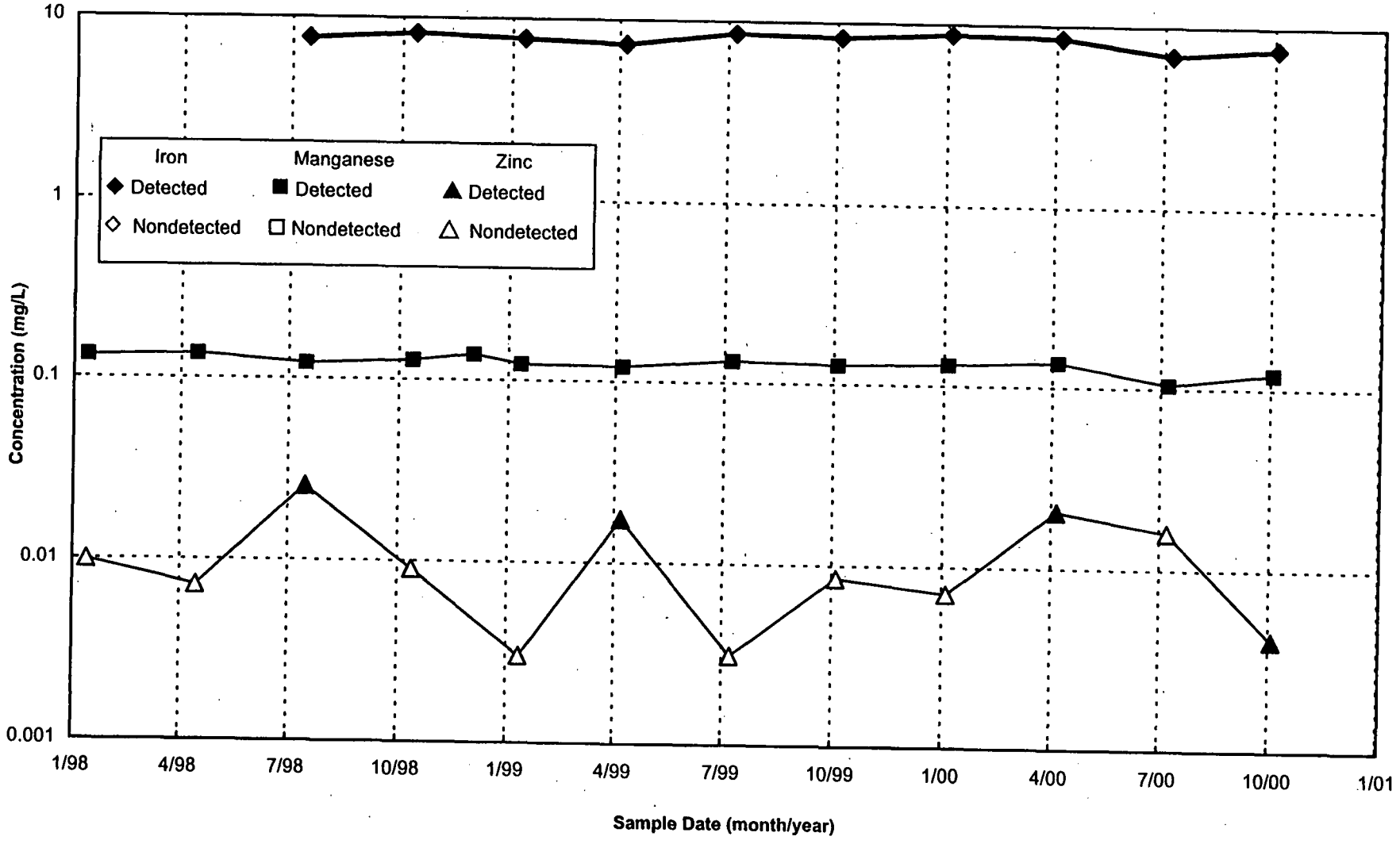

FIGURE A.4-52. IRON, MANGANESE, AND ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 41217

ATTACHMENT A.5

MISCELLANEOUS MONITORING ACTIVITIES

ATTACHMENT A.5

KC-2 Warehouse Well Monitoring Activity

The KC-2 Warehouse well monitoring has also been included as part of the IEMP. Monitoring of this well (Well 67 in Figure A.5-1) was conducted on an annual basis. As reported in the 1999 Integrated Site Environmental Report (DOE 2000f) and as identified in DOE Letter No. 0087-00, dated November 1, 1999, which transmitted IEMP changes to EPA and OEPA, the KC-2 Warehouse well has been removed from the IEMP sampling program. The KC-2 Warehouse well was plugged and abandoned on April 13, 2000. Prior to plugging and abandonment, the well was sampled in March of 2000. Table A.5-1 presents these data. Results were generally lower than the historical averages. Although cyanide and sodium concentrations exceeded the historical average, there is no groundwater FRL for either constituent.

TABLE A.5-1

KC-2 WAREHOUSE GROUNDWATER SUMMARY STATISTICS (January 1993 through First Quarter [March] 2000)

Constituent	Number of Samples[a,b]	FRL[c] (mg/L)	Min.[a,b,d] (mg/L)	Max.[a,b,d] (mg/L)	Avg.[a,b,d] (mg/L)	SD[a,b,d] (mg/L)	2000 Data Sample Result (mg/L); Validation Qualifier[e]
Aluminum	14	NA	0.0104	80	12	24	0.103 -
Antimony	14	0.0060	0.000065	0.22	0.045	0.068	0.00162 -
Arsenic	14	0.050	0.00041	0.0873	0.014	0.029	0.000851 U
Barium	14	2.0	0.103	0.867	0.336	0.246	0.153 -
Beryllium	14	0.0040	0.0000065	0.005	0.0012	0.0016	0.000013 U
Cadmium	14	0.014	0.00003	0.0671	0.01	0.02	0.00013 U
Calcium	14	NA	45.3	1310	300	422	63.4 -
Chromium	14	0.022[g]	0.000415	2.35	0.372	0.720	0.00178 U
Cobalt	14	0.17	0.000065	0.102	0.022	0.036	0.000451 -
Copper	14	1.3	0.000335	0.373	0.0825	0.138	0.00282 U
Cyanide	6	NA	0.000985	0.005	0.003	0.0018	0.01 UJ
Iron	14	NA	1.65	620	130	219	5.99 J
Lead	14	0.015	0.00026	3.8	0.68	1.3	0.00959 -
Magnesium	14	NA	31.4	322	93.6	99.9	31.4 -
Manganese	14	0.900	0.0363	8.52	1.8	2.9	0.16 -
Mercury	14	0.0020	0.00002	0.0022	0.0003	0.0006	0.00004 U
Nickel	14	0.10	0.00039	1.21	0.21	0.38	0.00297 -
Potassium	13	NA	0.922	14.6	3.05	3.83	2.53 -
Selenium	14	0.050	0.00039	0.0099	0.0025	0.0027	0.00121 U
Silver	14	0.050	0.0000505	0.0312	0.00476	0.00853	0.000101 U
Sodium	13	NA	17.5	32	21	3.7	32 -
Thallium	14	NA	0.000025	1.8	0.13	0.48	0.000324 -
Vanadium	14	0.038	0.000075	0.19	0.033	0.053	0.000879 U
Zinc	14	0.021	0.0061	1.79	0.34	0.55	0.0188 -
		(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
Uranium, Total	14	20	0.04	2400	180	600	1.3904 -

[a]If more than one sample is collected per well per day (e.g., duplicate), then only one sample is counted for the total number of samples, and the sample with the maximum concentration is used to determine the summary statistics (minimum, maximum, average, and standard deviation [SD]).
[b]Rejected data qualified with either a R or Z were not included in this count or the summary statistics.
[c]NA = not applicable
[d]Where concentrations are below the detection limit, each result used in the summary statistics is set at half the detection limit.
[e]Validation qualifier codes are provided in Appendix D of the Sitewide CERCLA Quality Assurance Project Plan (DOE 1998c).
[f]The FRL is based on chromium VI, from Operable Unit 5 Record of Decision, Table 9 -4; however, the sampling results are for total chromium.

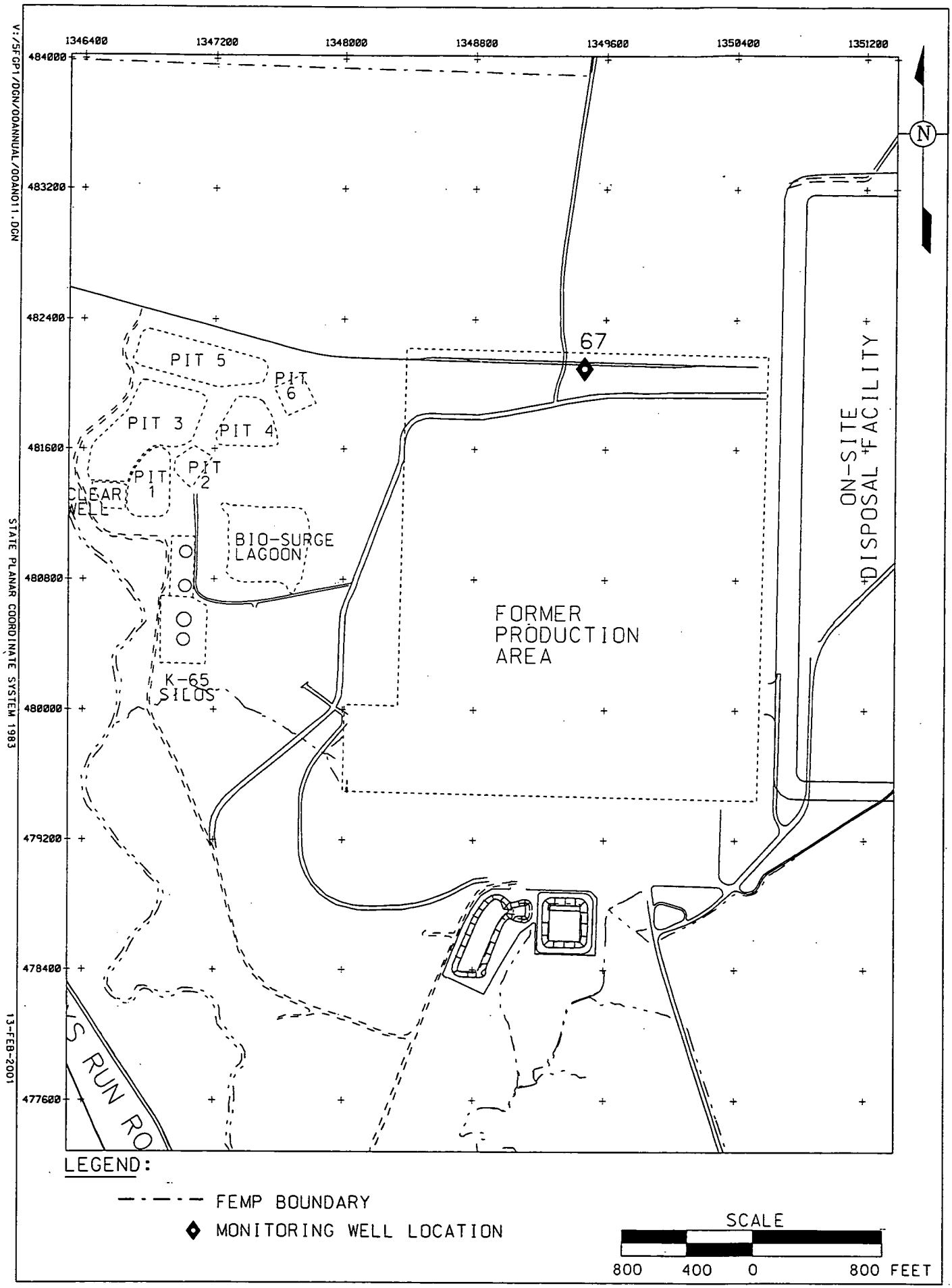

FIGURE A.5-1. KC-2 WAREHOUSE WELL MONITORING LOCATION

Attachment A.6

ATTACHMENT A.6

ON-SITE DISPOSAL FACILITY MONITORING RESULTS

ATTACHMENT A.6

The on-site disposal facility monitoring program fulfills two purposes: leak detection and leachate monitoring. It also meets the regulatory requirements for groundwater detection monitoring in the Great Miami Aquifer and perched groundwater system at the FEMP. The On-Site Disposal Facility Groundwater/Leak Detection and Leachate Monitoring Plan (DOE 1997c) presents the specific on-site disposal facility monitoring strategy for construction, closure, and post closure. The plan represents the first part of a three-tiered detection, assessment, and corrective action monitoring strategy required by EPA.

The final anticipated facility dimensions are: capacity of 2.5 million cubic yards, maximum height of approximately 65 feet, and an estimated areal coverage of 70 acres of the northeastern area of the FEMP. Protection of the Great Miami Aquifer and the overlying perched groundwater system includes the following measures for each of the eight anticipated cells:

- Leachate collection system (LCS)
- Leak detection system (LDS)
- Multi-layer composite liner system
- Multi-layer composite cap system.

The LCS consists of a gravel layer installed beneath the waste to collect rainwater that comes in contact with the waste during cell construction and additional moisture that drains from the waste following capping. The LDS is located beneath both the LCS and the primary geosynthetic liner system and provides a mechanism for collecting and monitoring leakage from the on-site disposal facility prior to any releases to the environment. Both systems drain to the west and extend beyond the synthetic liner systems where they become accessible for monitoring through manholes. Figure A.6-1 depicts a cross section of the liner system. Horizontal till wells are set beneath the compacted clay liner of each cell. These wells provide monitoring of the perched groundwater quality beneath the point where the leachate collection and leak detection system pipes exit the liner system. The Great Miami Aquifer is monitored via both an upgradient and a downgradient monitoring well for each cell.

The following subsections provide information for Cells 1, 2, and 3 where monitoring was conducted during 2000. There is also a subsection describing the Cell 4 monitoring status. Figure A.6-2 identifies the well locations associated with the on-site disposal facility.

A.6.1 CELL 1

A.6.1.1 Construction and Leak Detection System Flow Data

Placement of waste (contaminated soil and debris) in Cell 1, which began in December 1997, continued during 2000. At the end of December 2000, Cell 1 was 100 percent full. Figure A.6-3 shows the monthly volume of water pumped from the Cell 1 LDS for 2000.

Beginning in May 1999 quantitative measurement of the volumes accumulating and pumped from the Cell 1 leak detection monitoring system was initiated. This was accomplished by installing a water level probe (data logger) in the primary containment vessel, which recorded water levels on an hourly basis. On a weekly basis, the water level data collected are downloaded and converted into a volume based on volumetric calibration of the containment vessel. This tracking of the accumulating volume in the primary containment vessel provided the data to determine accumulation rates and the monthly volume pumped. Note that the January 2000 volume is not considered representative of Cell 1's LDS as a malfunctioning valve was discovered to be allowing backflow from the leachate pipeline to enter the primary containment vessel. The malfunctioning valve was replaced with a more reliable valve in the latter portion of the month. The total volume pumped from the Cell 1 LDS primary containment vessel for 2000 was 672 gallons which is less than the volume pumped in 1999 (1,014 gallons).

Figure A.6-4 provides accumulation rates for the Cell 1 LDS for 2000. These LDS accumulation rates were usually calculated weekly. In the 1999 Integrated Site Environmental Report, accumulation rates based on pump outs of the primary containment vessel were provided. The weekly accumulation rates are being provided now as a refinement because of the general decrease in accumulation rates. Figure A.6-4 also provides the weekly precipitation amounts corresponding to each accumulation period. The precipitation data were added in an effort to determine if a correlation exists between precipitation and the LDS accumulation rate. Based on review of Figure A.6-4, it does not appear that there is a strong correlation between precipitation and the Cell 1 LDS accumulation rates. In general the accumulation rate decreased from January through May 2000, then increased through early October, held steady through late December when the peak accumulation rate for the year (0.57 gallons per acre per day [gpad]) was observed. The average LDS accumulation rate for the year was 0.19 gpad, which is, less than half of the 1999 average rate of 0.45 gpad. This overall decreasing trend in LDS accumulation rates is consistent with what is expected as a disposal cell is filled.

The On-site Disposal Facility Final Design Calculation Package (DOE 1997b) concluded that an initial response leakage rate for individual cells would be 20 gpad. The above-noted maximum accumulation rate for Cell 1 in 2000 (0.57 gpad) is about three percent of the initial response leakage rate. This

indicates that the liner system is performing well within the specifications outlined in the approved cell design. Over time, with the capping and closure of the cell, the volume of water removed from the LDS is expected to continue to diminish. The volume of water removed from the LDS will continue to be closely tracked to determine if the primary liner system continues to perform as expected.

A.6.1.2 Analytical Data

Sampling of groundwater, the LCS, and the LDS for Cell 1 continued in 2000. In 1997 groundwater sampling was initiated for Cell 1 in an effort to establish a baseline for the horizontal till well and Great Miami Aquifer wells prior to the initiation of waste placement in December 1997. During 1998 a draft technical memorandum was issued to discuss the baseline results. The regulatory agencies issued comments on this technical memorandum identifying that it would be necessary to extend the baseline sampling period for the existing horizontal till wells in order to better establish baseline conditions. Accordingly, a strategy to extend the baseline sampling period for the horizontal till wells associated with Cells 1, 2, and 3 was approved by the regulatory agencies in 1999. This baseline period extended through the end of 2000. A technical memorandum establishing baseline for Cells 1, 2, and 3 is scheduled to be issued in 2001.

Table A.6-1 presents the constituents detected in 2000 from the monitoring locations (LCS, LDS, horizontal till well, and Great Miami Aquifer) associated with Cell 1. Of the 16 constituents sampled, six (total organic carbon, total organic halogens, boron, mercury, technetium-99, and total uranium) were detected in at least one location. Consistent with the Final On-Site Disposal Facility Groundwater/Leak Detection and Leachate Monitoring Plan, the table also provides the results of the Mann-Kendall statistical trend analysis on data from the LCS and LDS. Monitoring results by location are discussed below.

A.6.1.2.1 Leachate Collection System

All six constituents identified in Table A.6-1 were detected in the LCS. Trend analysis indicates that there was an up, marginal trend for total organic halogens; the remaining constituents had no significant trend.

A sample is collected annually and analyzed for 67 additional constituents (general chemistry, inorganic, and organic) from Ohio Administrative Code 3745-27-10, Appendix I, to determine if the constituents analyzed quarterly are sufficient for leak detection purposes. This monitoring is identified in the On-Site Disposal Facility Groundwater/Leak Detection and Leachate Monitoring Plan. As noted in the plan, new indicator constituents are to be added to the quarterly monitoring list if: 1) concentrations

observed in the annual sample are much higher than the perched water concentrations at the FEMP; and 2) routine analysis of the constituent can significantly enhance the early detection capability.

The annual sample for 2000 was collected on August 21, 2000. All detected constituent concentrations found in the annual leachate sample were within the range of FEMP perched water constituent concentrations as defined in the Operable Unit 5 Remedial Investigation Report, except for chemical oxygen demand, which was not among those sampled for during the remedial investigation. The chemical oxygen demand concentration in the annual sample was 98.6 mg/L, which was higher than the 1999 result of 65 mg/L. Routine analysis of chemical oxygen demand is not believed to be a significant enhancement to early detection capability; therefore, based on the results of the 2000 annual sample, no changes to the quarterly monitoring list are required.

Section A.6.4 discusses the volume of water pumped from the LCS.

A.6.1.2.2 Leak Detection System

Four of the six constituents identified in Table A.6-1 were detected in the LDS (mercury and technetium-99 were not detected). With the exception of total organic halogens, the 2000 maximum concentrations of the constituents detected in the Cell 1 LDS are, as expected, less than the overall maximum concentrations detected in the LCS. The maximum detected total organic halogens concentration was 0.361 mg/L, which was only 0.009 mg/L higher than the maximum LCS result for 2000. Trend analysis indicated no significant trend in any of the detected constituents.

A.6.1.2.3 Horizontal Till Well

Four of the six constituents identified in Table A.6-1 were detected at the horizontal till well. Mercury and technetium-99 were not detected. In 2000 none of the detected constituents had higher maximum concentrations than those found in the overlying LDS. These concentrations are interpreted as being within the range of baseline concentrations in the perched water and therefore do not represent a release from the cell.

A.6.1.2.4 Great Miami Aquifer

Four of the six constituents identified in Table A.6-1 were detected in the Great Miami Aquifer wells. Mercury and technetium-99 were not detected in upgradient Monitoring Well 22201, and total organic halogens, mercury, and technetium-99 were not detected in downgradient Monitoring Well 22198. None of the constituents sampled and analyzed from the aquifer exceeded groundwater FRLs. The maximum overall concentrations for total organic carbon and total uranium are higher in both Great Miami Aquifer

wells than in the horizontal till well. The 2000 maximum total organic halogens concentration in upgradient Monitoring Well 22201 was greater than the 2000 maximum concentration in the horizontal till well. The 2000 total uranium concentrations in both the upgradient and downgradient monitoring wells reached new maximums, as indicated in Table A.6-1. These concentrations are interpreted as being within the range of baseline concentrations in the Great Miami Aquifer and therefore do not represent a release from the cell.

A.6.2 CELL 2

A.6.2.1 Construction and Leak Detection System Flow Data

Placement of waste (contaminated soil and debris) in Cell 2, which began in November 1998, continued during 2000. At the end of December 2000, Cell 2 was approximately 51 percent full. Figure A.6-5 shows the monthly volume of water pumped from the Cell 2 LDS for 2000.

As with Cell 1, in May 1999, quantitative measurement of the volumes accumulating and pumped from the Cell 2 leak detection monitoring system was initiated. Figure A.6-5 depicts the Cell 2 LDS volumes pumped for 2000. The total volume pumped from the Cell 2 LDS primary containment vessel for 2000 was 1,377 gallons, which is less than 25 percent of the volume pumped in 1999 (6,009 gallons).

Figure A.6-6 provides the Cell 2 year 2000 LDS accumulation rates along with weekly precipitation amounts corresponding to each accumulation period. As was the case with Cell 1, these rates were usually calculated weekly and precipitation data were added. Based on review of Figure A.6-6, there appears to be a correlation with precipitation early in the year (January to mid-March); however, this correlation was not apparent throughout the rest of the year. In June, the rate of accumulation peaked at a maximum of about 2.2 gpad, then declined to a rate of 0.0 gpad toward the end of the year. Note that the relatively steady accumulation rate increase from March through June is coincident with the time period when waste placement occurred in Cell 2. After waste placement stopped in July, a relatively steady decline in the accumulation rates was observed for the remainder of the year. This LDS accumulation rate response to waste placement in Cell 2 also occurred in 1999 as reported in Appendix A.6 of the 1999 Integrated Site Environmental Report. The average LDS accumulation rate for the year was 0.60 gpad, which is one sixth of the 1999 average rate of 3.6 gpad. Also notable is the decline in the annual maximum LDS accumulation rate, which in 1999 was 6.8 gpad and 2.2 gpad in 2000. This overall decreasing trend in LDS accumulation rates is consistent with what is expected as a disposal cell is filled.

As noted for Cell 1, the On-site Disposal Facility Final Design Calculation Package specified an initial response leakage rate for individual cells of 20 gpad. The above noted annual maximum accumulation

rate for Cell 2 (2.2 gpad) is 11 percent of the initial response leakage rate. This indicates that the liner system for Cell 2 is performing well within the specifications outlined in the approved cell design. Over time, with the capping and closure of the cell, the volume of water removed from the LDS is expected to continue to diminish. The volume of water removed from the LDS will continue to be closely tracked to determine if the primary liner system continues to perform as expected.

A.6.2.2 Analytical Data

Groundwater sampling was initiated in 1997 for Cell 2 and continued in 2000. Leachate collection and leak detection system monitoring began after waste placement was initiated in November 1998. Table A.6-2 presents the constituents detected in 2000 from the monitoring locations (LCS, LDS, horizontal till well, and Great Miami Aquifer) associated with Cell 2. Of the 16 constituents sampled, four constituents were detected in at least one location (total organic carbon, total organic halogens, boron, and total uranium). Consistent with the Final On-Site Disposal Facility Groundwater/Leak Detection and Leachate Monitoring Plan, the table also provides the results of Mann-Kendall statistical trend analysis on data from the LCS and LDS. Monitoring results by location are discussed below.

A.6.2.2.1 Leachate Collection System

All four constituents identified in Table A.6-2 were detected in the LCS. Trend analysis indicates that there was an up, significant trend for total uranium and an up, marginal trend for total organic halogens. However, there was no significant trend for the remaining two constituents at this monitoring location.

A sample is collected annually and analyzed for 67 additional constituents (general chemistry, inorganic, and organic) at the LCS. In addition, all detected constituent concentrations found in the annual leachate sample were within the range of FEMP perched water constituent concentrations as defined in the Operable Unit 5 Remedial Investigation Report. As was the case for the Cell 1 annual LCS sample, the Cell 2 annual LCS sample had no constituent concentrations that would require a change to the quarterly monitoring list.

Section A.6.4 discusses the volume of water pumped from the LCS.

A.6.2.2.2 Leak Detection System

All four constituents identified in Table A.6-2 were detected in the LDS. Trend analysis indicates that there was a down, significant trend for boron and total uranium. In addition, there was no significant trend for total organic carbon and total organic halogens at this monitoring location. Similar to the 1999 data, the maximum concentration of total organic carbon and boron in the Cell 2 LDS were still

greater than the maximum concentrations observed in the Cell 2 LCS. As noted in the 1999 Integrated Site Environmental Report, these higher concentrations in the LDS were due to the inadvertent mixing of Cell 1 LCS flow with that from the Cell 2 LDS in late 1998 and early 1999. However, consistent with the predictions made in the 1999 Integrated Site Environmental Report, these concentrations are declining. In fact, the 2000 maximum total uranium concentration in the LDS was less than the maximum found in the LCS. The elevated concentrations are expected to continue to decline over time and the analytical results to become more representative of the Cell 2 LDS.

A.6.2.2.3 Horizontal Till Well

All four constituents identified in Table A.6-2 were detected in the horizontal till well. Three of the four constituents showed 2000 maximum concentrations lower than the overall maximum concentration found in the overlying LDS. As indicated in Table A.6-2, the maximum total uranium result for 2000 was 3.35 µg/L, which is less than the previous maximum of 3.6 µg/L. These concentrations are far below the groundwater FRL of 20 µg/L.

A.6.2.2.4 Great Miami Aquifer

All four constituents identified in Table A.6-2 were detected in the Great Miami Aquifer upgradient well. Three of the four constituents were detected in the Great Miami Aquifer downgradient well. Total organic halogens were not detected in downgradient Monitoring Well 22199. None of the constituents sampled and analyzed from the aquifer exceeded groundwater FRLs. In addition, with the exception of total uranium, the downgradient Great Miami Aquifer maximum well concentrations were less than both the upgradient Great Miami Aquifer maximum well concentrations and the horizontal till well maximum concentrations. With the exception of total uranium, the upgradient Great Miami Aquifer maximum well concentrations were greater than those in the horizontal till well. These concentrations are interpreted as being within the range of baseline concentrations in the Great Miami Aquifer and therefore do not represent a release from the cell.

A.6.3 CELL 3

A.6.3.1 Construction and Leak Detection Flow Data

Placement of waste (contaminated soil and debris) in Cell 3, which began in October 1999, continued during 2000. At the end of December 2000, Cell 3 was approximately 24 percent full.

Quantitative measurement of the volumes accumulating and pumped from the Cell 3 LDS began in October 1999. This monitoring is consistent with Cells 1 and 2 that began in May 1999 as described

above. In 2000 no water had accumulated in the primary containment vessel for the Cell 3 LDS. This indicates that the liner system for Cell 3 is performing well within design specifications.

A.6.3.2 Analytical Data

Sampling for Cell 3 was initiated in July 1998, and continued through the end of 2000 to establish baseline groundwater conditions. Sampling of the LCS was initiated in the fourth quarter of 1999. The Cell 3 LDS has not yielded any water, therefore samples have not been collected from this system. Table A.6-3 presents the constituents detected in 2000 from the monitoring locations associated with Cell 3. Of the 16 constituents sampled, six constituents (total organic carbon, total organic halogens, boron, mercury, technetium-99, and total uranium) were detected in at least one location. Consistent with the On-Site Disposal Facility Groundwater/Leak Detection and Leachate Monitoring Plan, the table also provides the results of Mann-Kendall statistical trend analysis for leachate collection data. Monitoring results by location (LCS, LDS, horizontal till well, and Great Miami Aquifer) are discussed below.

A.6.3.2.1 Leachate Collection System

The LCS for Cell 3 was sampled on a quarterly basis in 2000. Four of the six constituents identified in Table A.6-3 were detected in the LCS samples (mercury and technetium-99 were not detected).

A sample is collected annually at the LCS and analyzed for 67 additional constituents (general chemistry, inorganic, and organic). All detected constituent concentrations found in the annual leachate sample were within the range of FEMP perched water constituent concentrations as defined in the Operable Unit 5 Remedial Investigation Report. Like Cells 1 and 2, the Cell 3 annual sample had no constituent concentrations that would require a change to the quarterly monitoring list.

A.6.3.2.2 Leak Detection System

As noted above, due to lack of water accumulation/yield, Cell 3's LDS was not sampled during 2000.

A.6.3.2.3 Horizontal Till Well

Four of the six constituents identified in Table A.6-3 were detected in the horizontal till well (mercury and technetium-99 were not detected). The 2000 data from the horizontal till well will be added to the data set to be used for calculating baseline.

A.6.3.2.4 Great Miami Aquifer

All six constituents identified in Table A.6-3 were detected in the Great Miami Aquifer monitoring wells. Mercury was not detected in the upgradient Great Miami Aquifer well and technetium-99 was not

detected in the downgradient Great Miami Aquifer well. None of the constituents sampled and analyzed from the aquifer exceeded groundwater FRLs. Total organic carbon, total organic halogens, boron, and technetium-99 had higher maximum concentrations in upgradient Monitoring Well 22203 than the downgradient Monitoring Well 22204 for 2000. Mercury and total uranium had higher maximum concentrations at downgradient Monitoring Well 22204 than in the upgradient Monitoring Well 22203 for 2000. The 2000 total uranium concentrations in both the upgradient and downgradient monitoring wells reached new maximums, as indicated in Table A.6-3. These concentrations are interpreted as being within the range of baseline concentrations in the Great Miami Aquifer and therefore do not represent a release from the cell.

A.6.4 CELL 4 ANALYTICAL STATUS

The downgradient Great Miami Aquifer Monitoring Well 22205 for Cell 4 was installed in August 1999. Sampling of this well and installation of a new upgradient well for Cell 4 has been delayed consistent with the delay in the Cell 4 construction schedule. As currently scheduled, it is anticipated that sampling to establish the Great Miami Aquifer baseline for Cell 4 will begin in late 2002.

A.6.5 LEACHATE COLLECTION SYSTEM VOLUMES

Leachate volumes are measured at a meter located within the on-site disposal facility leachate conveyance system at a manhole near the Bio-Surge Lagoon. In addition to leachate from active cells, the volumes measured include water from the following sources: 1) on-site disposal facility heavy equipment wash, 2) water pumped from the LDS of each active cell, and 3) pre-sampling purge volumes from on-site disposal facility Great Miami Aquifer and horizontal till monitoring wells. These three flows are subtracted from the total meter reading at the Bio-Surge Lagoon to obtain a leachate volume measurement representative of the collective leachate volume from all on-site disposal facility cells that contain waste materials.

Leachate from Cells 1, 2, and 3 contributed to the leachate volumes measured during 2000, and was collected from Cells 1, 2, and 3 for the entire year. In 2000 approximately 13,537,512 gallons of leachate were collected and pumped to the Bio-Surge Lagoon for subsequent treatment at Phase II of the advanced wastewater treatment facility. This volume indicates that about 58 percent of the precipitation that fell on the controlled areas of Cells 1, 2, and 3 (23,330,964 gallons) became leachate that was collected. The remaining 42 percent of the precipitation was retained in the waste material or evaporated. The 13.5 million gallons collected is somewhat higher than what were expected based on design calculations (7.03 million gallons). However, the design calculations assumed average precipitation (approximately

40 inches/year) and the actual precipitation at the FEMP in 2000 was 44.75 inches. The design calculations used were:

- For Cell 1, considered to be in the intermediate stage based on 2000 volume in cell (EPA 1996), average annual for the intermediate stage (696 gpad) x (6.45 acres/cell) x (365 days) = 1,638,558 gallons
- For Cell 2 (considered to be in the initial stage based on 2000 volume in cell), average annual for the initial stage (1,145 gpad) x (6.45 acres/cell) x (365 days) = 2,695,616 gallons
- For Cell 3, average annual for the initial stage (1,145 gpad) x (6.45 acres/cell) x (365 days) = 2,695,616 gallons
- Total for Cells 1, 2, and 3 = 7.03 million gallons.

As presented in Figure A.6-7, leachate volumes fluctuated throughout the year but generally correlate to precipitation. These fluctuations are expected during the active waste placement period of the on-site disposal facility, which occurs prior to final capping. The leachate volumes during this period primarily reflect the amount of precipitation that falls on the active cells and is subsequently collected in the leachate collection systems. As the cells are capped, the leachate volume from the capped cells is expected to stabilize and diminish over time. With the completion of the enhanced permanent leachate transmission system in 2001, cell-specific leachate volumes can be quantified. The cell-specific leachate volumes will be useful in tracking liner and cap performance as the on-site disposal facility matures.

TABLE A.6-1

ON-SITE DISPOSAL FACILITY CELL 1 DATA SUMMARY FOR CONSTITUENTS DETECTED DURING 2000

Note: Non-italicized pertains to total number of samples (including 2000 samples).
Italicized pertains to 2000 samples only.

Constituent (FRL)[a]	LCS[b,c,d,e] (12338C)		LDS[b,c,d,e,f] (12338D)		HTW[b,c,d,e,g] (12338)		Great Miami Aquifer: Upgradient[b,c,d,g] (22201)		Great Miami Aquifer: Downgradient[b,c,d,g] (22198)	
	No. of Samples with Detections / No. of Samples	Range	No. of Samples with Detections / No. of Samples	Range	No. of Samples with Detections / No. of Samples	Range	No. of Samples with Detections / No. of Samples	Range	No. of Samples with Detections / No. of Samples	Range
Total Organic Carbon (NA[g] mg/L)	10/12	ND to 123	9/11	ND to 80.9	29/32	ND to 12.2	24/27	ND to 59.7	22/27	ND to 52.5
	4/4	*21.3 to 29.3*	*4/4*	*2.96 to 15.7*	*5/6*	*ND to 7.24*	*4/4*	*2.16 to 12.4*	*3/4*	*ND to 13*
Trend	No Significant Trend		No Significant Trend		NA		NA		NA	
Total Organic Halogens (NA[g] mg/L)	10/12	ND to 0.352	8/11	ND to 0.361	17/31	ND to 0.077	14/27	ND to 0.308	8/27	0.0062 to 0.0526
	3/4	*ND to 0.352*	*2/4*	*ND to 0.361*	*2/6*	*ND to 0.00748*	*2/4*	*ND to 0.308*	*0/4*	*ND*
Trend	Up, Marginal		No Significant Trend		NA		NA		NA	
Boron (0.33 mg/L)	13/13	0.0642 to 2.8	10/11	ND to 0.321	25/32	ND to 0.685	22/27	ND to 0.142	30/40	ND to 0.116
	4/4	*0.768 to 1.72*	*3/4*	*ND to 0.243*	*5/6*	*ND to 0.123*	*4/4*	*0.0692 to 0.125*	*6/8*	*ND to 0.0627*
Trend	No Significant Trend		No Significant Trend		NA		NA		NA	
Mercury (0.0020 mg/L)	2/12	ND to 0.00047	0/11	ND	0/32	ND	0/27	ND	0/39	ND
	2/4	*ND to 0.00047*	*0/4*	*ND*	*0/6*	*ND*	*0/4*	*ND*	*0/7*	*ND*
Trend	No Significant Trend		No Significant Trend		NA		NA		NA	
Technetium-99 (94.0 pCi/L)	4/12	ND to 18.28	1/11	8.92	7/33	8.51 to 21.1	1/27	13.41	2/40	12.18 to 14.8
	2/4	*ND to 12.374*	*0/4*	*ND*	*0/6*	*ND*	*0/4*	*ND*	*0/8*	*ND*
Trend	No Significant Trend		No Significant Trend		NA		NA		NA	
Total Uranium (20 µg/L)	11/12	ND to 119	11/11	1.5 to 20.17	31/32	ND to 19	23/27	ND to 6.384	40/40	0.557 to 8.365
	4/4	*49.85 to 106.4346*	*4/4*	*6.041 to 15.4236*	*6/6*	*1.521 to 1.923*	*3/4*	*ND to 6.384*	*8/8*	*1.1522 to 8.365*
Trend	No Significant Trend		No Significant Trend		NA		NA		NA	

[a]From Operable Unit 5 Record of Decision, Table 9-4
[b]If there was more than one sample result per day (e.g, a duplicate sample), then only the maximum sample concentration was counted and compared to the FRL.
[c]Rejected data qualified with either a R or Z were not used in this comparison.
[d]ND = not detected
[e]LCS = leachate collection system
LDS = leak detection system
HTW = horizontal till well
[f]Data from the Cell 2 LDS is considered suspect due to mixing of flows (refer to Section A.6.2.2.2).
[g]NA = not applicable

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TABLE A.6-2

ON-SITE DISPOSAL FACILITY CELL 2 DATA SUMMARY FOR CONSTITUENTS DETECTED DURING 2000

Note: Non-italicized pertains to total number of samples (including 2000 samples).
Italicized pertains to 2000 samples only.

Constituent (FRL)[a]	LCS[b,c,d,e] (12339C)		LDS[b,c,d,e,f] (12339D)		HTW[b,c,d,e,f] (12339)		Great Miami Aquifer: Upgradient[b,c,d,f] (22200)		Great Miami Aquifer: Downgradient[b,c,d,f] (22199)	
	No. of Samples with Detections / No. of Samples	Range	No. of Samples with Detections / No. of Samples	Range	No. of Samples with Detections / No. of Samples	Range	No. of Samples with Detections / No. of Samples	Range	No. of Samples with Detections / No. of Samples	Range
Total Organic Carbon (NA[f] mg/L)	6/9	ND to 6.25	9/10	ND to 26.1	25/30	ND to 11.1	20/22	ND to 47.6	17/22	ND to 51.8
	3/4	*ND to 6.25*	*4/4*	*1.22 to 11.5*	*5/6*	*ND to 11.1*	*4/4*	*1.06 to 14.4*	*3/4*	*ND to 9.68*
Trend	No Significant Trend		No Significant Trend		NA		NA		NA	
Total Organic Halogens (NA[f] mg/L)	4/9	ND to 0.0576	5/10	ND to 0.0205	20/30	ND to 0.101	10/22	ND to 0.177	9/22	0.0055 to 0.0386
	1/4	*ND to 0.0576*	*1/4*	*ND to 0.0121*	*4/6*	*ND to 0.0373*	*1/4*	*ND to 0.177*	*0/4*	*ND*
Trend	Up, Marginal		No Significant Trend		NA		NA		NA	
Boron (0.33 mg/L)	9/10	ND to 0.915	9/9	0.289 to 2.22	18/30	ND to 0.0829	14/22	ND to 0.158	15/22	ND to 0.0569
	4/4	*0.295 to 0.448*	*4/4*	*0.289 to 0.497*	*4/6*	*ND to 0.0601*	*2/4*	*ND to 0.0606*	*3/4*	*ND to 0.0497*
Trend	No Significant Trend		Down, Significant		NA		NA		NA	
Total Uranium (20 µg/L)	9/9	4.51 to 39.299	9/9	9.334 to 71	30/31	ND to 3.607	15/22	ND to 1.11	22/22	0.259 to 12.1
	4/4	*23.811 to 39.299*	*4/4*	*9.334 to 24.7613*	*6/6*	*2.5603 to 3.351*	*3/4*	*ND to 0.991*	*4/4*	*0.9446 to 3.028*
Trend	Up, Significant		Down, Significant		NA		NA		NA	

[a]From Operable Unit 5 Record of Decision, Table 9-4
[b]If there was more than one sample result per day (e.g., a duplicate sample), then only the maximum sample concentration was counted and compared to the FRL.
[c]Rejected data qualified with either a R or Z were not used in this comparison.
[d]ND = not detected
[e]LCS = leachate collection system
LDS = leak detection system
HTW = horizontal till well
[f]NA = not applicable

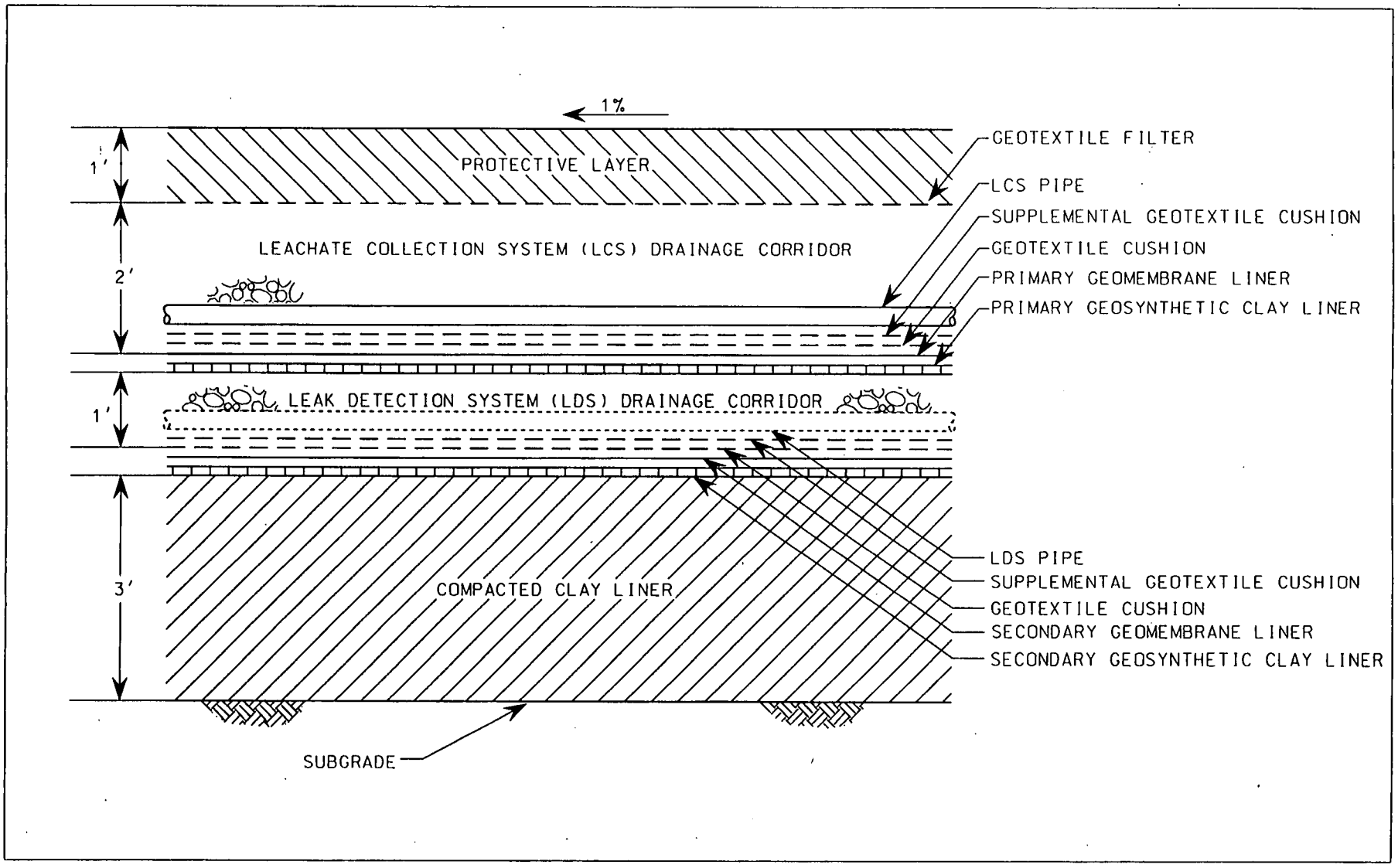
TABLE A.6-3

ON-SITE DISPOSAL FACILITY CELL 3 DATA SUMMARY FOR CONSTITUENTS DETECTED DURING 2000

Note: Non-italicized pertains to total number of samples (including 2000 samples).
Italicized pertains to 2000 samples only.

Constituent (FRL)[a]	LCS[b,c,d,e] (12340C) No. of Samples with Detections / No. of Samples	LCS Range	LDS[b,c,d,e,f,g] (12340D) No. of Samples with Detections / No. of Samples	LDS Range	HTW[b,c,d,e,g] (12340) No. of Samples with Detections / No. of Samples	HTW Range	Great Miami Aquifer: Upgradient[b,c,e,g] (22203) No. of Samples with Detections / No. of Samples	Upgradient Range	Great Miami Aquifer: Downgradient[b,c,e,g] (22204) No. of Samples with Detections / No. of Samples	Downgradient Range
Total Organic Carbon (NA[g] mg/L)	4/6	ND to 34.2	NA	NA	16/26	ND to 9.81	9/20	ND to 14.1	9/20	ND to 8.83
	3/4	*ND to 3.14*	*NA*	*NA*	*6/6*	*1.368 to 9.81*	*4/4*	*0.89 to 14.1*	*3/4*	*ND to 8.83*
Trend	No Significant Trend		NA		NA		NA		NA	
Total Organic Halogens (NA[g] mg/L)	3/6	ND to 0.178	NA	NA	20/26	ND to 0.158	9/20	ND to 0.213	8/21	ND to 0.165
	1/4	*ND to 0.0383*	*NA*	*NA*	*4/6*	*ND to 0.0243*	*1/4*	*ND to 0.213*	*1/5*	*ND to 0.165*
Trend	Down, Significant		NA		NA		NA		NA	
Boron (0.33 mg/L)	6/6	0.202 to 1.51	NA	NA	20/24	ND to 0.24	12/20	ND to 0.0776	13/20	ND to 0.179
	4/4	*0.202 to 1.51*	*NA*	*NA*	*4/5*	*ND to 0.235*	*2/4*	*ND to 0.0494*	*4/4*	*0.0227 to 0.048*
Trend	No Significant Trend		NA		NA		NA		NA	
Mercury (0.0020 mg/L)	0/6	ND	NA	NA	1/24	0.00026	0/19	ND	2/19	ND to 0.00028
	0/4	*ND*	*NA*	*NA*	*0/5*	*ND*	*0/3*	*ND*	*1/3*	*ND to 0.0002*
Trend	No Significant Trend		NA		NA		NA		NA	
Technetium-99 (94.0 pCi/L)	0/6	ND	NA	NA	2/24	13.55 to 38.35	1/20	ND to 8.438	0/20	ND
	0/4	*ND*	*NA*	*NA*	*0/5*	*ND*	*1/4*	*ND to 8.438*	*0/4*	*ND*
Trend	No Significant Trend		NA		NA		NA		NA	
Total Uranium (20 µg/L)	6/6	9.27 to 37.854	NA	NA	22/24	ND to 9.14	15/20	ND to 2.522	19/20	ND to 5.924
	4/4	*9.3481 to 37.854*	*NA*	*NA*	*5/5*	*5.4502 to 8.422*	*4/4*	*0.401 to 2.522*	*4/4*	*0.418 to 5.924*
Trend	Up, Marginal		NA		NA		NA		NA	

[a]From Operable Unit 5 Record of Decision, Table 9-4
[b]If there was more than one sample result per day (e.g., a duplicate sample), then only the maximum sample concentration was counted and compared to the FRL.
[c]Rejected data qualified with either a R or Z were not used in this comparison.
[d]ND = not detected
[e]LCS = leachate collection system
LDS = leak detection system
HTW = horizontal till well
[f]No samples were taken from the LDS because it was dry.
[g]NA = not applicable



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V:/5FGP1/DGN/O[illegible]L/00AN012.DGN
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FIGURE A.6-1. ON-SITE DISPOSAL FACILITY LINER SYSTEM AT THE DRAINAGE CORRIDOR

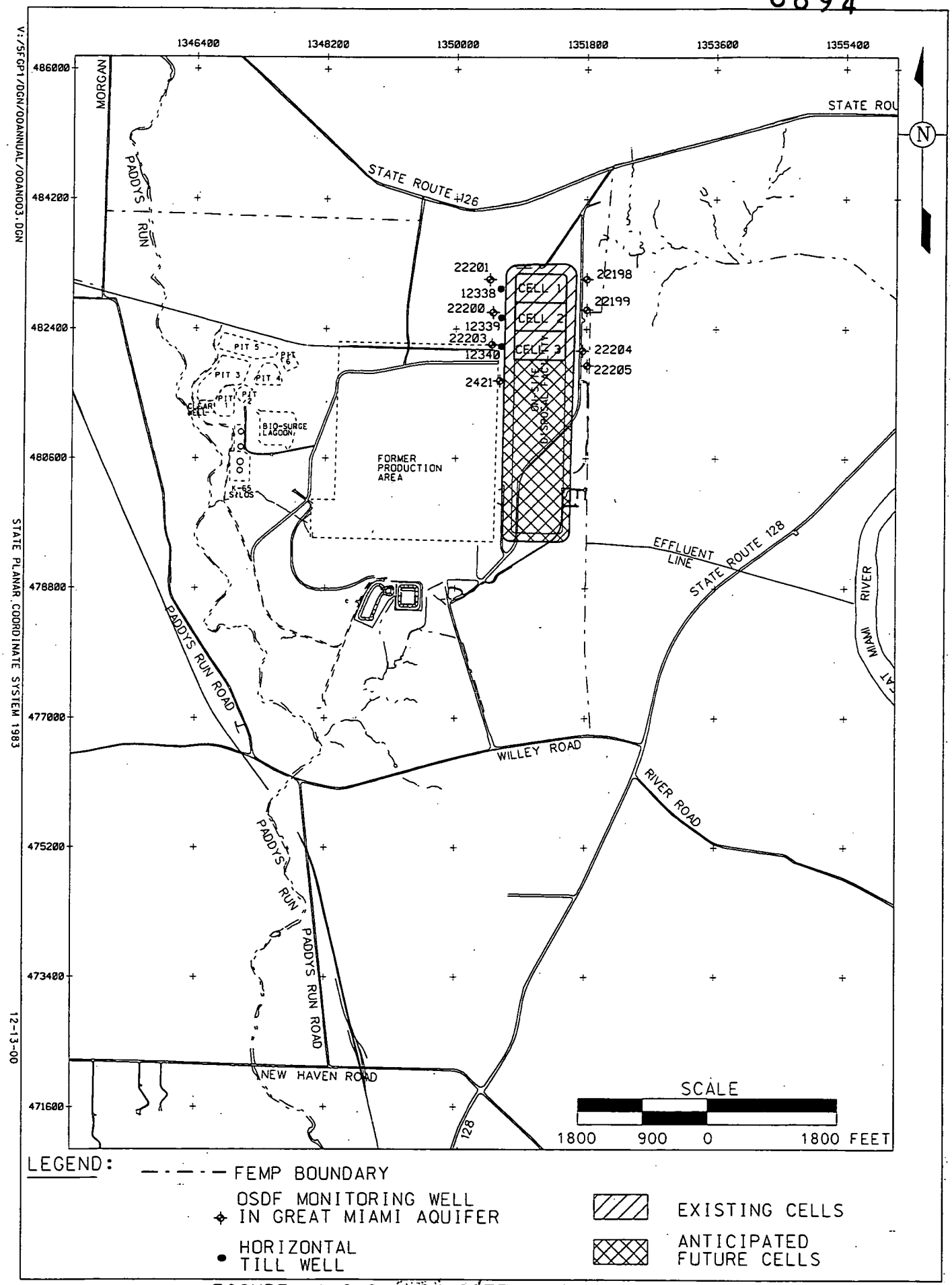

FIGURE A.6-2. ON-SITE DISPOSAL FACILITY FOOTPRINT AND MONITORING WELL LOCATIONS

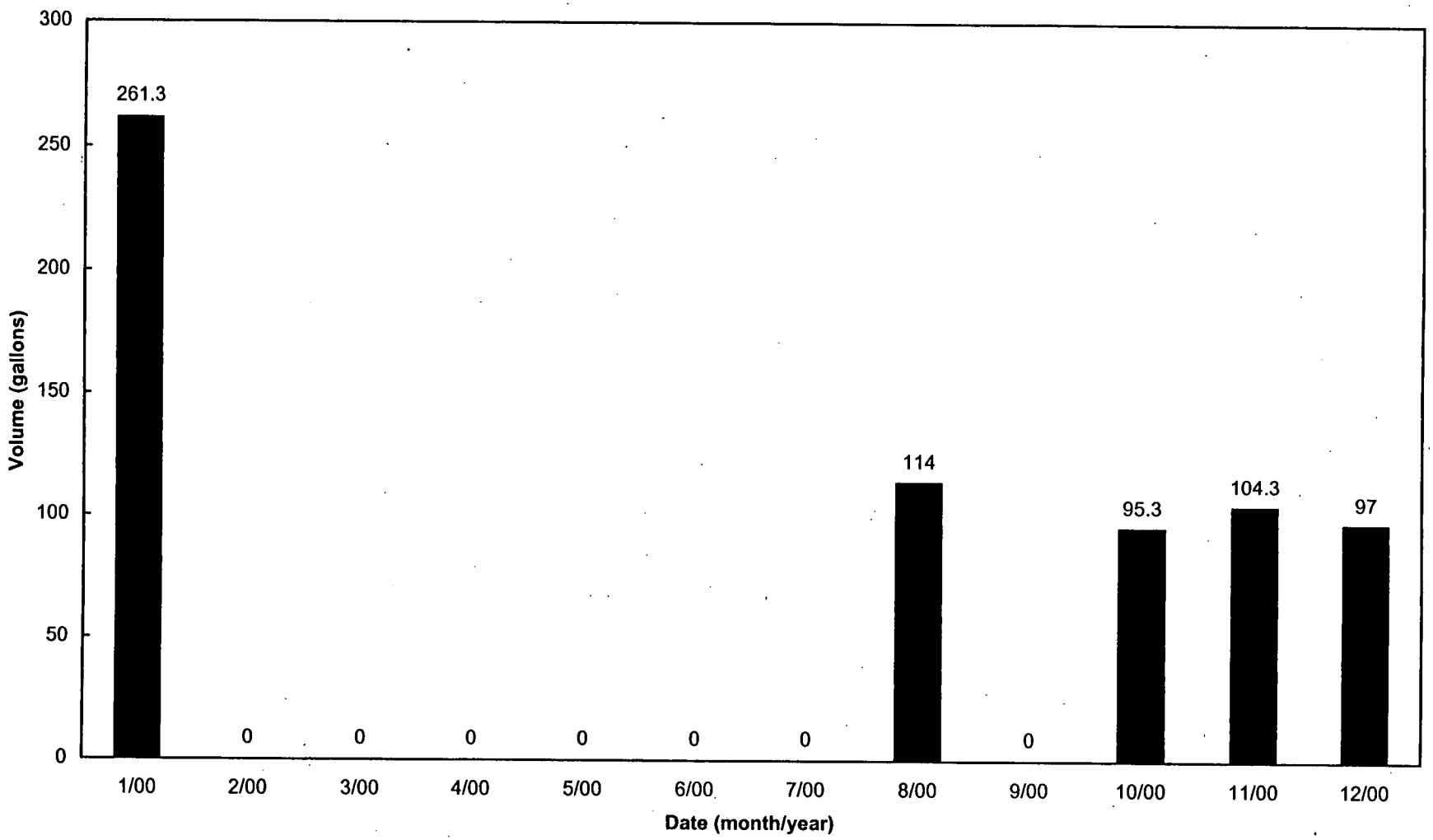

FIGURE A.6-3. 2000 VOLUMES PUMPED FROM THE LEAK DETECTION SYSTEM FOR CELL 1 OF THE ON-SITE DISPOSAL FACILITY

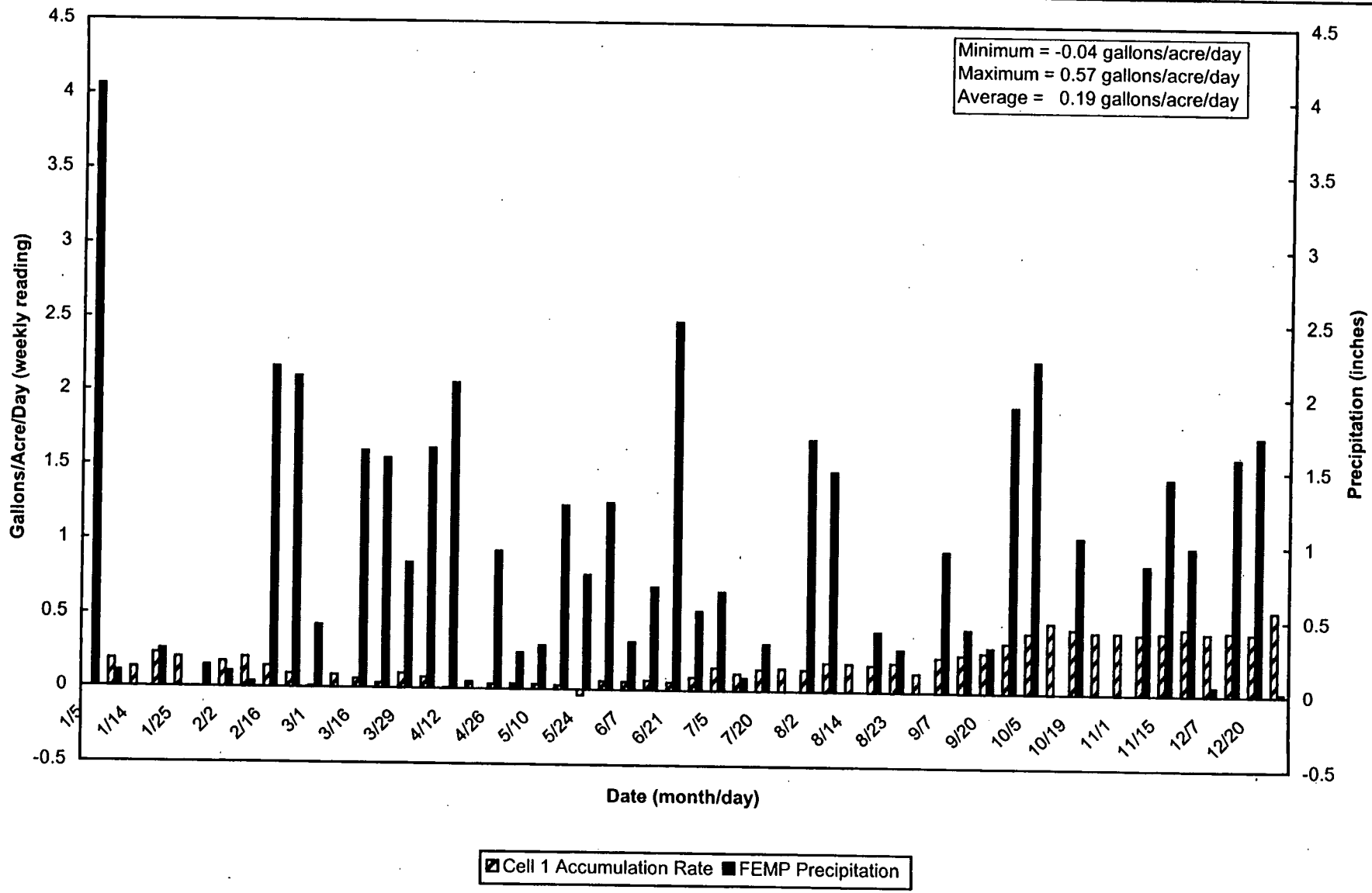

FIGURE A.6-4. ON-SITE DISPOSAL FACILITY LDS ACCUMULATION RATES FOR CELL 1

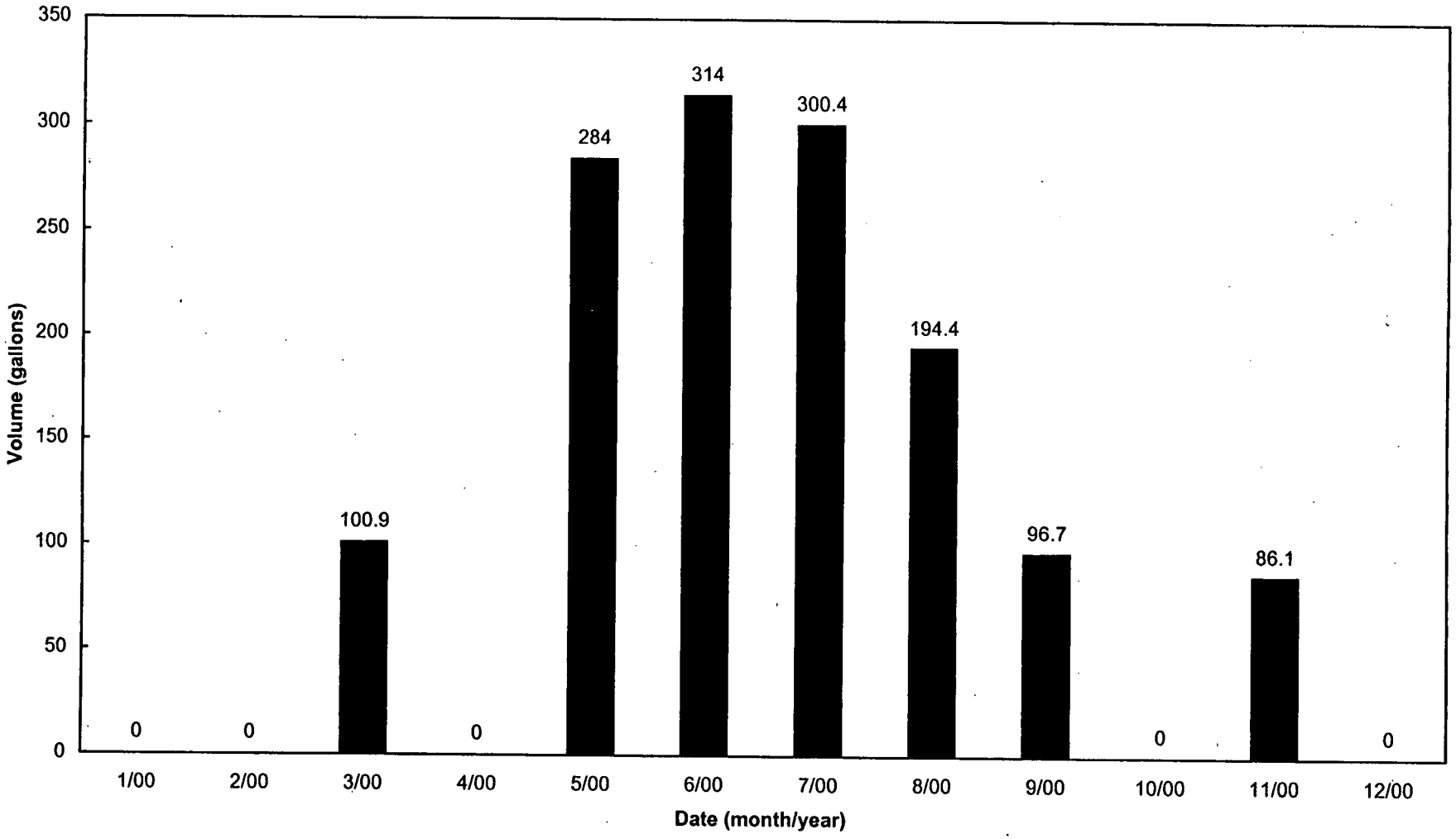

FIGURE A.6-5. 2000 VOLUMES PUMPED FROM THE LEAK DETECTION SYSTEM FOR CELL 2 OF THE ON-SITE DISPOSAL FACILITY

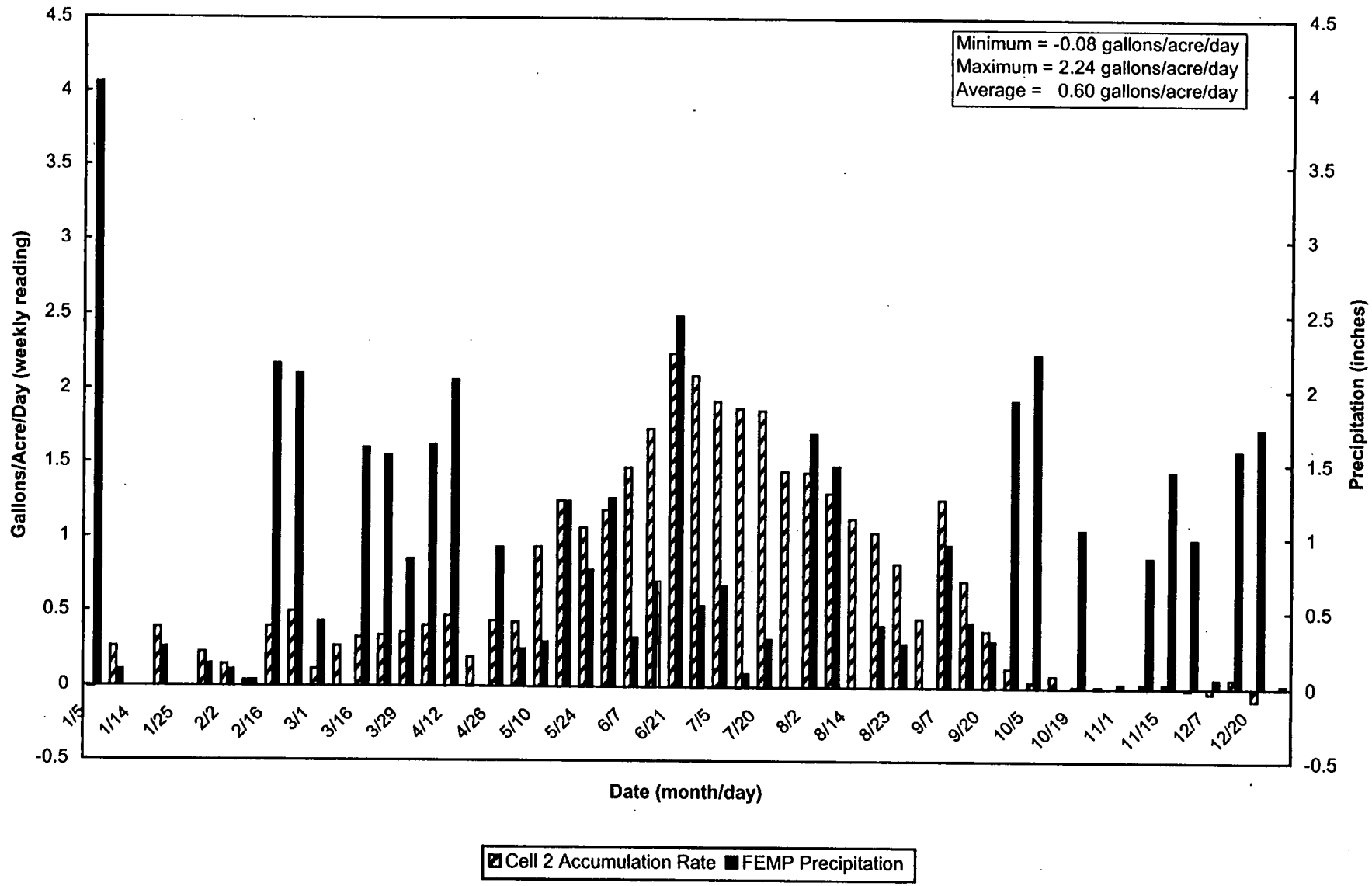

FIGURE A.6-6. ON-SITE DISPOSAL FACILITY LDS ACCUMULATION RATES FOR CELL 2

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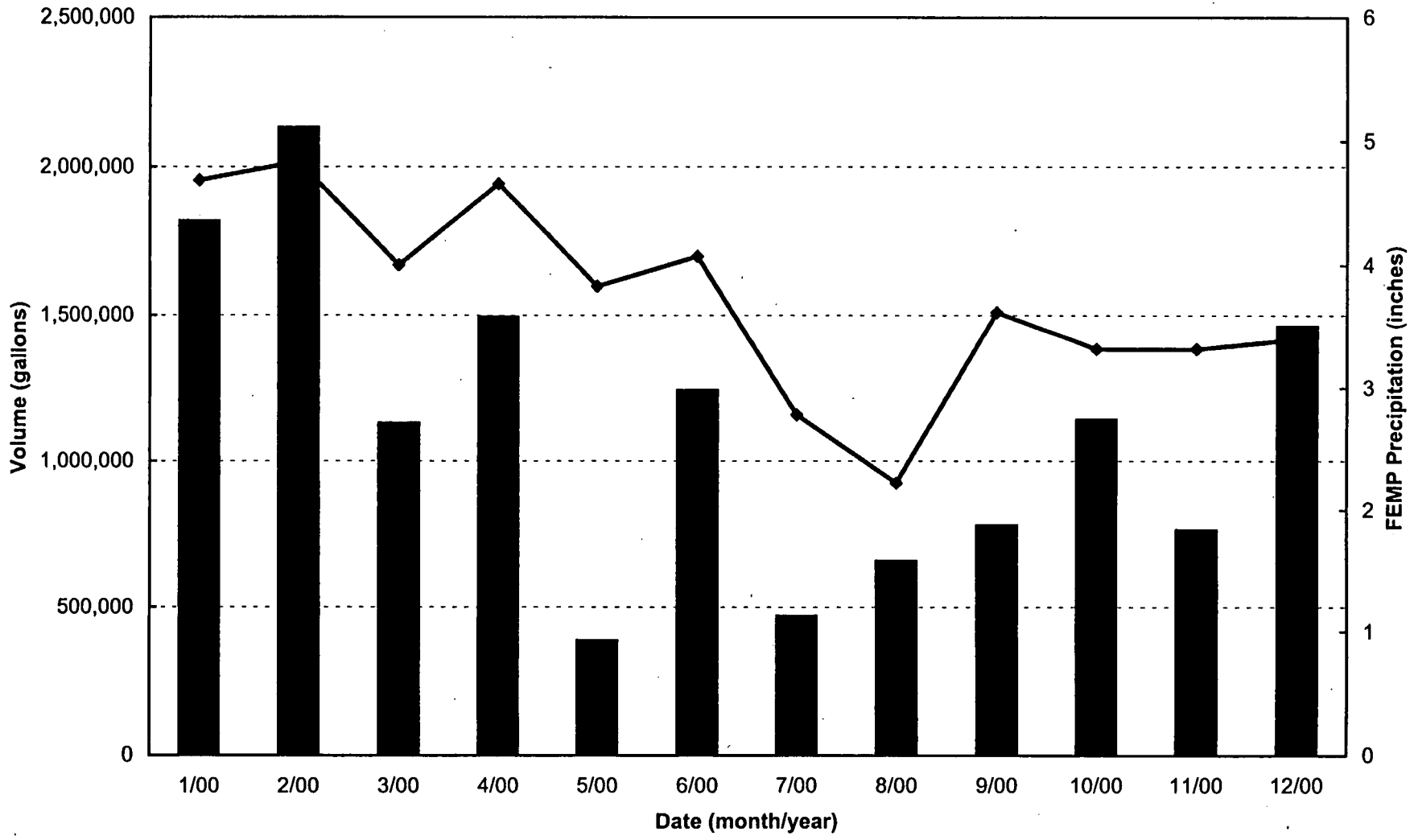

Note: Non-LCS flows such as LDS volumes, truck washes, and purge volumes were subtracted from the 2000 LCS volumes.

FIGURE A.6-7. 2000 LEACHATE COLLECTION SYSTEM VOLUMES

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Appendix B

APPENDIX B

SUPPLEMENTAL SURFACE WATER AND TREATED EFFLUENT INFORMATION

TABLE OF CONTENTS

Appendix B Supplemental Surface Water And Treated Effluent Information B-1

Attachment B.1 Surface Water and Treated Effluent B.1-1

Attachment B.2 Sediment B.2-1

LIST OF ACRONYMS

BTV	benchmark toxicity value
cfs	cubic feet per second
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FEMP	Fernald Environmental Management Project
FFCA	Federal Facilities Compliance Agreement
FRL	final remediation level
IEMP	Integrated Environmental Monitoring Plan
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
NPDES	National Pollutant Discharge Elimination System
OEPA	Ohio Environmental Protection Agency
pCi/g	picoCuries per gram
pCi/L	picoCuries per liter
µg/L	micrograms per liter
WPRAP	Waste Pits Remedial Action Project

APPENDIX B

Appendix B presents additional surface water, treated effluent, and sediment data in support of Chapter 4 of this 2000 Integrated Site Environmental Report. This appendix consists of two attachments as follows:

- Attachment B.1 provides further evaluation of the final remediation levels (FRLs) and benchmark toxicity values (BTVs) exceedances for surface water and treated effluent including an assessment of potential cross-media impacts to the groundwater pathway. This attachment also provides detail on storm water-related bypasses pertaining to compliance with the Record of Decision for Remedial Actions at Operable Unit 5 (DOE 1996) total uranium treated effluent discharge limits.

- Attachment B.2 provides additional details pertaining to the 2000 sediment analytical results and historical results for comparison purposes.

REFERENCES

U.S. Dept. of Energy, 1999a, "Integrated Environmental Monitoring Plan, Revision 1" Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1999b, "Operations and Maintenance Master Plan for Aquifer Restoration and Wastewater Treatment Projects," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1998, "Sitewide Excavation Plan," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1996, "Record of Decision for Remedial Actions at Operable Unit 5," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1995, "Remedial Investigation Report for Operable Unit 5," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

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Attachment B.1

ATTACHMENT B.1

SURFACE WATER AND TREATED EFFLUENT

ATTACHMENT B.1

During 2000 surface water and treated effluent samples were collected under the Integrated Environmental Monitoring Plan (IEMP), Revision 1 (DOE 1999a). Figures B.1-1 and B.1-2 show all surface water monitoring locations. The following information is discussed in this attachment:

- Surveillance monitoring (Section B.1.1)
- Federal Facilities Compliance Agreement (FFCA)/Operable Unit 5 Record of Decision compliance (Section B.1.2)
- Controlled and uncontrolled areas (Section B.1.3).

The National Pollutant Discharge Elimination System (NPDES) Permit sampling is not discussed in this attachment as it is discussed in sufficient detail in Chapter 4 of this report.

B.1.1 SURVEILLANCE MONITORING

Surveillance monitoring is the comparison of surface water and treated effluent analytical results to the surface water FRLs and BTVs in order to determine effects of Fernald Environmental Management Project (FEMP) remediation activities on the surface water 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 2000 data with the exception of the data collected from the sewage treatment plant (STP 4601) were compared to FRLs and BTVs. Results of treated effluent samples collected from the sewage treatment plant (STP 4601) are not used for surveillance monitoring, because these samples are collected at an internal point prior to the sewage treatment plant treated effluent being discharged to the Parshall Flume (PF 4001). Samples collected at the Parshall Flume (PF 4001) are used in the surveillance evaluation because this is the last point treated 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). To make a determination of the concentration of each constituent at this point in the Great Miami River for comparison to the FRLs, the following calculation was applied to data from the Parshall Flume (PF 4001):

$$C_{PF4001} = \frac{[Q_{10}][C_{GMR}] + [Q_{PF}][C_{PF}]}{[Q_{10}] + [Q_{PF}]}$$

where:

C_{PF4001}	=	Flow-weighted average concentration outside the mixing zone in the Great Miami River, picoCuries per liter (pCi/L) or milligrams per liter (mg/L)
Q_{10}	=	7-day, 10-year low flow, 583 cubic feet per second (cfs)
C_{GMR}	=	Background concentration in Great Miami River from the Remedial Investigation Report for Operable Unit 5 (DOE 1995), pCi/L or mg/L (0 was used when no background concentration was available)
Q_{PF}	=	Daily flow at Parshall Flume (PF 4001), cfs
C_{PF}	=	Daily concentration at Parshall Flume (PF 4001), pCi/L or mg/L

Note: In addition, 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 583 cfs. The lowest daily flow measured at the Hamilton Dam gauge (if lower than 583 cfs) is used in the equation to see if an exceedance could potentially occur.

All samples were successfully obtained during 2000 with the exception of the January monthly total uranium sample at locations SWD-02 and SWD-03.

B.1.1.1 Evaluation of Constituents Above FRLs and BTVs for 2000

Tables B.1-1 and B.1-2 list surface water FRL and BTV exceedances, respectively, at corresponding sample locations and Figure B.1-3 shows the locations of these exceedances. The FRL exceedances that occurred in 2000 were generally sporadic. The following are general observations:

- No exceedances occurred in the Great Miami River (using the mixing equation and Parshall Flume [PF 4001] concentrations). The lowest daily flow at the Hamilton Dam gauge during 2000 was 501 cfs. There were also no exceedances identified using this low flow value in the mixing equation.
- Three exceedances occurred at the point where Paddys Run flows off property (SWP-03), two for chromium, and one for copper.

- No exceedances of the surface water FRL for total uranium occurred at any surface water sample location. Figures B.1-4 through B.1-10 are total uranium concentration versus time plots for the surface water sample locations.

- There were a total of nine FRL exceedances: the three above mentioned exceedances at SWP-03; three at the Great Miami River background location SWR-01; one at the overflow from the Storm Water Retention Basin (SWRB 4002O) and two at SWD-03. One of the FRL exceedances at SWD-03 was also a BTV exceedance (silver).

The following provides a discussion, by constituent, on these exceedances.

Chromium

The FRL (0.010 mg/L) for chromium was exceeded at location SWP-03. The FRL for chromium is actually associated with hexavalent chromium; however, due to the short laboratory holding times for hexavalent chromium, total chromium is analyzed instead. Comparing total chromium concentrations against the hexavalent chromium FRL is conservative, because hexavalent chromium is a component of total chromium.

On September 25 and October 5, 2000, there were two chromium exceedances at location SWP-03. Investigation of these exceedances has revealed no discernable cause. The September 25, 2000 sampling round included no other drainages to Paddys Run. With no upstream results and no specific activity identified that would cause these exceedances, it is not possible to pinpoint a causal relationship. There were other drainages sampled during the sampling round on October 5, 2000. The chromium result at the Paddys Run background location (SWP-01) was in fact elevated (8.53 micrograms per liter [μg/L]). The other drainage location sampled on October 5 was SWD-03 with a chromium result of 4.9 μg/L. These results do not establish a causal relationship for the October 5, 2000 chromium exceedance. There is no significant trend associated with the chromium exceedances.

Copper

Exceedances for copper occurred at locations Storm Water Retention Basin overflow (SWRB 4002O) and SWP-03. The single exceedance at SWRB 4002O occurred during the January 3, 2000 overflow event. Although copper is a common site contaminant, a specific activity that would have caused the exceedance at SWRB 4002O has not been established.

Given the data available and the field activities that occurred in 2000, no specific circumstance can be discerned that would explain the copper exceedance at SWP-03 on September 25, 2000.

Lead and Mercury

There was one exceedance for lead and one exceedance for mercury at location SWR-01. Location SWR-01 is a background location upstream of the FEMP effluent line in the Great Miami River. Background monitoring locations are located upstream and outside the influence of FEMP discharges. The background data are used to distinguish impacts from FEMP activities against upstream water quality conditions. Therefore, concentrations at the background locations (both in Paddys Run [SWP-01] and in the Great Miami River [SWR-01]) are not attributable to the FEMP.

Silver

On April 4, 2000, the one exceedance for silver occurred at location SWD-03. The analytical result of 0.0106 mg/L exceeded both the FRL (0.005 mg/L) and the BTV (0.0013 mg/L). This is the first exceedance of silver at this location. A definitive cause has not been established. There was no discharge of storm water from the Waste Pits Remedial Action Project (WPRAP) Storm Water Management Pond to Paddys Run on that day and no unusual occurrences logged in the Assistant Emergency Duty Officer's daily log that may have contributed to this exceedance. The FEMP received 1.62 inches of rain over a four-day period beginning April 1, 2000; however, only 0.08 inches of rain was recorded on April 4, 2000. Construction activity was occurring in the area of the silos, but silver is not a contaminant of concern within this drainage area (Area 7).

Zinc

On February 15, 2000, an exceedance occurred for zinc at location SWD-03. The result of 0.126 mg/L was above the established FRL of 0.11 mg/L. This is the first exceedance identified for zinc at this location. While a definitive cause has not been established, there was a discharge of storm water from the WPRAP Storm Water Management Pond to Paddys Run on this day. However, data submitted to characterize the Storm Water Management Pond in April 1999, in support of the NPDES Permit, show a low concentration of zinc (0.008 mg/L) (reference Letter No. DOE-0613-99 from the U.S. Department of Energy [DOE] to Ohio Environmental Protection Agency [OEPA], dated April 23, 1999).

There was one exceedance for zinc at location SWR-01. As discussed for lead and mercury, this is a Great Miami River background sample location and is not under the influence of FEMP operations.

B.1.1.2 Evaluation of Cross-Media Impacts for 2000

Another objective 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. To conduct this assessment, sample 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 (i.e., 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.

Total uranium is used as an indicator to evaluate the impact of surface water on the Great Miami Aquifer, because it is the primary contaminant at the site. 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 Great Miami Aquifer through infiltration. However, the most likely scenario is that the total uranium concentration (and all other constituent concentrations) would decrease, because dilution and adsorption occur as the water infiltrates through the ground and is mixed with the groundwater in the Great Miami Aquifer.

As shown in Table B.1-3, the results of the cross-media impact assessment for 2000 indicate occasional exceedances of the groundwater total uranium FRL of 20 µg/L in the areas where surface water is directly infiltrating into the Great Miami Aquifer. Key sample locations associated with these areas of direct infiltration are SWP-02, SWD-02, STRM 4005, SWD-03, and the Storm Water Retention Basin overflow (SWRB 4002O). Figures B.1-11 through B.1-15 present the total uranium concentrations for these cross-media impact sample locations. The design of the groundwater restoration systems has accounted for this potential contaminant pathway by installing extraction wells down gradient of these areas where direct infiltration can occur. Only one of the locations (SWD-03) exceeded non-uranium FRLs. The technetium-99 result of 113 pCi/L exceeded its groundwater FRL of 94 pCi/L while two results for zinc (0.126 mg/L and 0.0469 mg/L) exceeded its respective FRL of 0.02 mg/L.

B.1.1.3 Evaluation of Constituents Above BTVs for 2000

Based on the results of the BTV screening process presented in the approved Sitewide Excavation Plan (DOE 1998), three constituents (barium, cadmium, and silver) are evaluated against surface water BTVs. One BTV exceedance (silver at location SWD-03) occurred during 2000 as was explained above.

B.1.1.4 Conclusions

Based on the sporadic nature of these FRL and BTV exceedances, continued monitoring is recommended to determine their significance. The data will continue to be used to document exceedances, provide statistical trend analysis, assess the cross-media impacts, and determine if additional administrative or engineered controls are required to protect the surface water pathway. At this time no additional controls or changes in the surface water monitoring program are warranted.

B.1.2 FFCA/OPERABLE UNIT 5 RECORD OF DECISION COMPLIANCE

The Operable Unit 5 Record of Decision stipulates compliance with a monthly flow-weighted average total uranium concentration of 20 µg/L at the Great Miami River via the Parshall Flume (PF 4001) beginning on January 1, 1998. Additionally, the Operable Unit 5 Record of Decision stipulates that the total mass discharged during a year is limited to 600 pounds beginning January 1996. During 2000 the FEMP monitored total uranium concentrations at the Parshall Flume (PF 4001) daily to demonstrate compliance with these limitations.

The FEMP was in compliance with the total mass limitation as uranium discharges totaled 252 pounds, which is well below the 600 pound limitation. The FEMP was in compliance with the 20 µg/L limitation every month during 2000 as identified on Figure B.1-16.

B.1.2.1 Storm Water-Related Bypasses

The Operable Unit 5 Record of Decision allows the FEMP to directly discharge water collected in the Storm Water Retention Basin to the Great Miami River during periods of "significant precipitation." These are referred to as bypass events (storm water bypassing treatment directly to the Great Miami River). The Operable Unit 5 Record of Decision allows the FEMP to eliminate the flow-weighted concentration for these bypass days due to "significant precipitation" (up to 10 days each year) in order to comply with the 20 µg/L total uranium limit. "Significant precipitation" and the manner in which these days are accounted for in the calculation demonstrating compliance with the 20 µg/L limitation is defined in the Operations and Maintenance Master Plan for Aquifer Restoration and Wastewater Treatment Project (Section 3.6.2) (DOE 1999b). The Operations and Maintenance Master Plan was revised in 1999 and approved by the U.S. Environmental Protection Agency (EPA) and OEPA in December 1999. In summary, "significant precipitation" bypass days are to be accounted for as follows:

- Each day the system is bypassed for less than 12 hours is to be counted only as necessary to achieve the 20 µg/L monthly average total uranium limit.
- Each day the system is bypassed for 12 or more hours is to be counted as a full bypass day.

The flow-weighted concentration and flow rate for each bypass day is eliminated from the calculation for the month. Based on the approved definition, there were two such days in 2000 as identified in Table B.1-4.

B.1.2.2 Maintenance Related Bypasses

Bypassing during scheduled treatment plant maintenance is permissible under the Operable Unit 5 Record of Decision provided prior notice is given to EPA and OEPA. The uranium concentration, for those days when a maintenance activity was performed, can be eliminated from the monthly uranium concentration calculation. There were no maintenance-related bypasses during 2000.

B.1.3 CONTROLLED AND UNCONTROLLED STORM WATER RUNOFF AREAS

There were no previously uncontrolled areas that were added to the FEMP controlled storm water system in 2000 (Figure B.1-17). The following identifies areas where storm water runoff is collected due to specific remediation objectives, how it is controlled, the reason why the area is now controlled, and the amount of area controlled:

- On-Site Disposal Facility: Storm water runoff associated with Cells 1, 2, and 3 is collected by the leachate collection system. This storm water runoff is pumped to the Bio-Surge Lagoon and then to the advanced wastewater treatment facility. This area is controlled because waste placement is occurring within all three cells. Each individual cell is approximately seven acres; therefore, the total controlled area associated with the on-site disposal facility is 21 acres at the end of 2000.

- Southern Waste Units: Storm water runoff associated with the southern waste units is collected by three engineered basins which became operational in July 1998. They continued to be operated in 2000. The water from these basins is transferred to the Storm Water Retention Basin and then to the advanced wastewater treatment facility. This area is controlled due to the excavation of contaminated soil and waste material. The area controlled is 26 acres.

- Waste Pits Remedial Action Project area: The WPRAP facility area is designed so that storm water runoff associated with this project is collected in the Storm Water Management Pond. Collected storm water requiring treatment (>20 μg/L) is pumped to the Bio-Surge Lagoon and then to the advanced wastewater treatment facility. Runoff from this area (10.5 acres) is controlled due to past construction and current excavation activities in the Operable Unit 1 area. DOE has received approval to discharge storm water from this Storm Water Management Pond, which is determined to be uncontaminated, directly to Paddys Run upon the following two conditions:

  1) Prior to discharging water to Paddys Run, a sample is collected from the Storm Water Management Pond and analyzed for total uranium. If the total uranium result is below 20 μg/L, then the water is discharged to Paddys Run.

  2) As the water is being discharged to Paddys Run, a total suspended solids sample is collected.

The areas from which storm water runoff must be controlled will continue to change throughout remediation. Potentially contaminated areas associated with remediation may be added to the controlled system and areas that have been remediated will be removed from the system. This information will continue to be provided in IEMP quarterly summaries.

TABLE B.1-1

SUMMARY STATISTICS AND TREND ANALYSIS FOR CONSTITUENTS WITH 2000 RESULTS ABOVE FINAL REMEDIATION LEVELS

Location[a]	Constituent	No. of Samples[b,c,d]	No. of Samples Above FRL[b,c,d]	No. of Samples Above FRL for 2000[c,d]	FRL[e] (mg/L)	Min.[b,c,d,f] (mg/L)	Max.[b,c,d,f] (mg/L)	Avg.[b,c,d,f] (mg/L)	SD[b,c,d,f] (mg/L)	Trend[b,c,d,f]
SWD-03 (Waste Storage Area)	Silver	12	1	1	0.005	0.000046	0.0106	0.0011	0.0030	No Significant Trend
	Zinc	12	1	1	0.11	0.0033	0.126	0.029	0.035	No Significant Trend
SWP-03 (Paddys Run at Downstream Property Boundary)	Chromium	18	3	2	0.01[g]	0.00024	0.0153	0.0035	0.0047	No Significant Trend
	Copper	18	1	1	0.012	0.0005	0.0159	0.0042	0.0043	No Significant Trend
SWR-01 (Great Miami River Background)	Lead	18	2	1	0.01	0.0008	0.0222	0.0040	0.0056	No Significant Trend
	Mercury	17	1	1	0.0002	1.69E-06	0.00021	0.0001	0.0000	No Significant Trend
	Zinc	18	1	1	0.11	0.0101	0.114	0.033	0.032	No Significant Trend
SWRB 4002O (Storm Water Retention Basin Overflow)	Copper	4	3	1	0.012	0.0116	0.016	0.014	0.0023	No Significant Trend

[a]Refer to Figure B.1-3
[b]Based on samples collected from 1997 through 2000
[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 [SD]), Mann-Kendall test for trend, and in determining FRL exceedances.
[d]Rejected data qualified with either a R or Z were not included in the count, the summary statistics, or Mann-Kendall test for trend.
[e]From Operable Unit 5 Record of Decision, 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 detection limit.
[g]FRL based on hexavalent chromium, from Operable Unit 5 Record of Decision, Table 9-5; however, the sampling results are for total chromium.

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TABLE B.1-2

SUMMARY STATISTICS AND TREND ANALYSIS FOR CONSTITUENTS WITH 2000 RESULTS ABOVE BENCHMARK TOXICITY VALUE

Location[a]	Constituent	No. of Samples[b,c]	No. of Samples Above BTV[b,c]	No. of Samples Above BTV for 2000[b,c]	BTV (mg/L)	Min.[b,c,d] (mg/L)	Max.[b,c,d] (mg/L)	Avg.[b,c,d] (mg/L)	SD[b,c,d] (mg/L)	Trend[b,c,d]
SWD-03 (Waste Storage Area)	Silver	12	1	1	0.0013	0.000046	0.0106	0.0011	0.0030	No Significant Trend

[a]Refer to Figure B.1-3
[b]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 [SD]), Mann-Kendall test for trend, and in determining BTV exceedances.
[c]Rejected data qualified with either a R or Z were not included in the count, the summary statistics, or Mann-Kendall test for trend.
[d]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 detection limit.

TABLE B.1-3

SUMMARY STATISTICS AND TREND ANALYSIS FOR SURFACE WATER TOTAL URANIUM RESULTS EXCEEDING GROUNDWATER FRL AT CROSS-MEDIA IMPACT LOCATIONS DURING 2000[a]

Location[b]	No. of Samples[c,d,e]	No. of Samples Above FRL[c,d,e]	No. of Samples Above FRL for 2000[d,e]	Min.[c,d,e,f] (µg/L)	Max.[c,d,e,f] (µg/L)	Avg.[c,d,e,f] (µg/L)	SD[c,d,e,f] (µg/L)	Trend[c,d,e,f]
STRM 4005 (Drainages to Paddys Run)	38	34	3	0.004	374	66.1	56.8	Down, Significant
SWD-02 (Storm Sewer Outfall Ditch)	38	11	2	0.599	73	19	15	Down, Significant
SWD-03 (Waste Storage Area)	35	30	9	0	173	67	40	No Significant Trend
SWRB 4002O (Storm Water Retention Basin Overflow)	4	4	1	104	314	211	92.1	No Significant Trend

[a]Groundwater total uranium FRL is 20 µg/L.
[b]Refer to Figure B.1-1 for sample locations
[c]Based on samples collected from 1997 through 2000
[d]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 [SD]) and in determining FRL exceedances.
[e]Rejected data qualified with either a R or Z were not included in the count, the summary statistics, or Mann-Kendall test for trend.
[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 detection limit.

TABLE B.1-4

2000 STORM WATER RETENTION BASIN OVERFLOWS AND TREATMENT BYPASS EVENTS

Event	Duration (hours)	Number of Bypass Days[a]	Cumulative Number of Bypass Days[a]	Total Uranium Discharged (pounds)	Total Water Discharged (millions of gallons)
Overflows				(to Paddys Run)	(to Paddys Run)
January 3	16.16	1	1	8.53	4.041
Significant Precipitation Bypasses				(to Great Miami River)	(to Great Miami River)
January 3 through January 5	39.67	1	1	4.19	2.455
February 18 through February 19	30.50	1	2	5.87	2.064

[a]Days are counted according to the definition provided in the Operations and Maintenance Master Plan for the Aquifer Restoration and Wastewater Project.

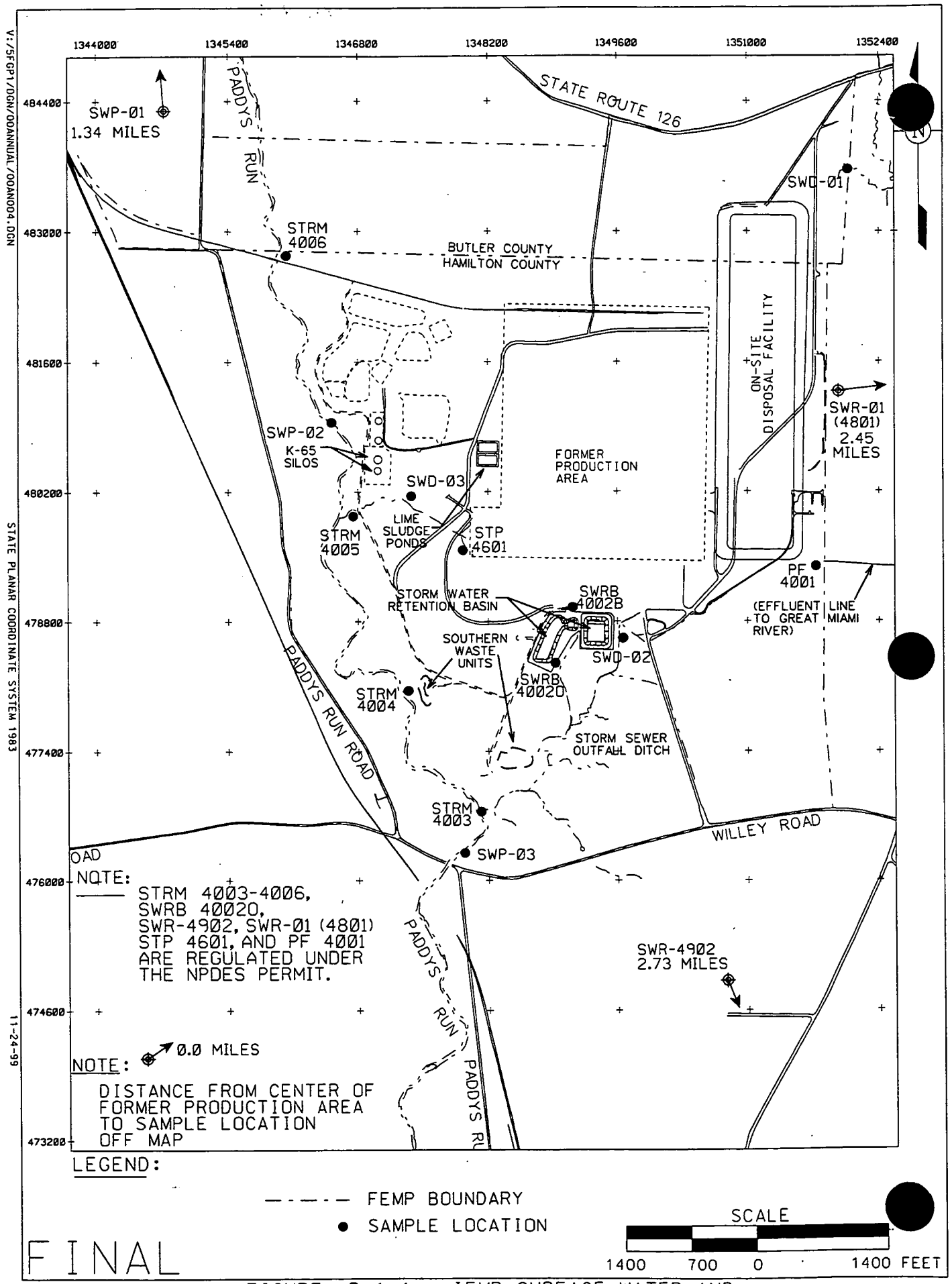
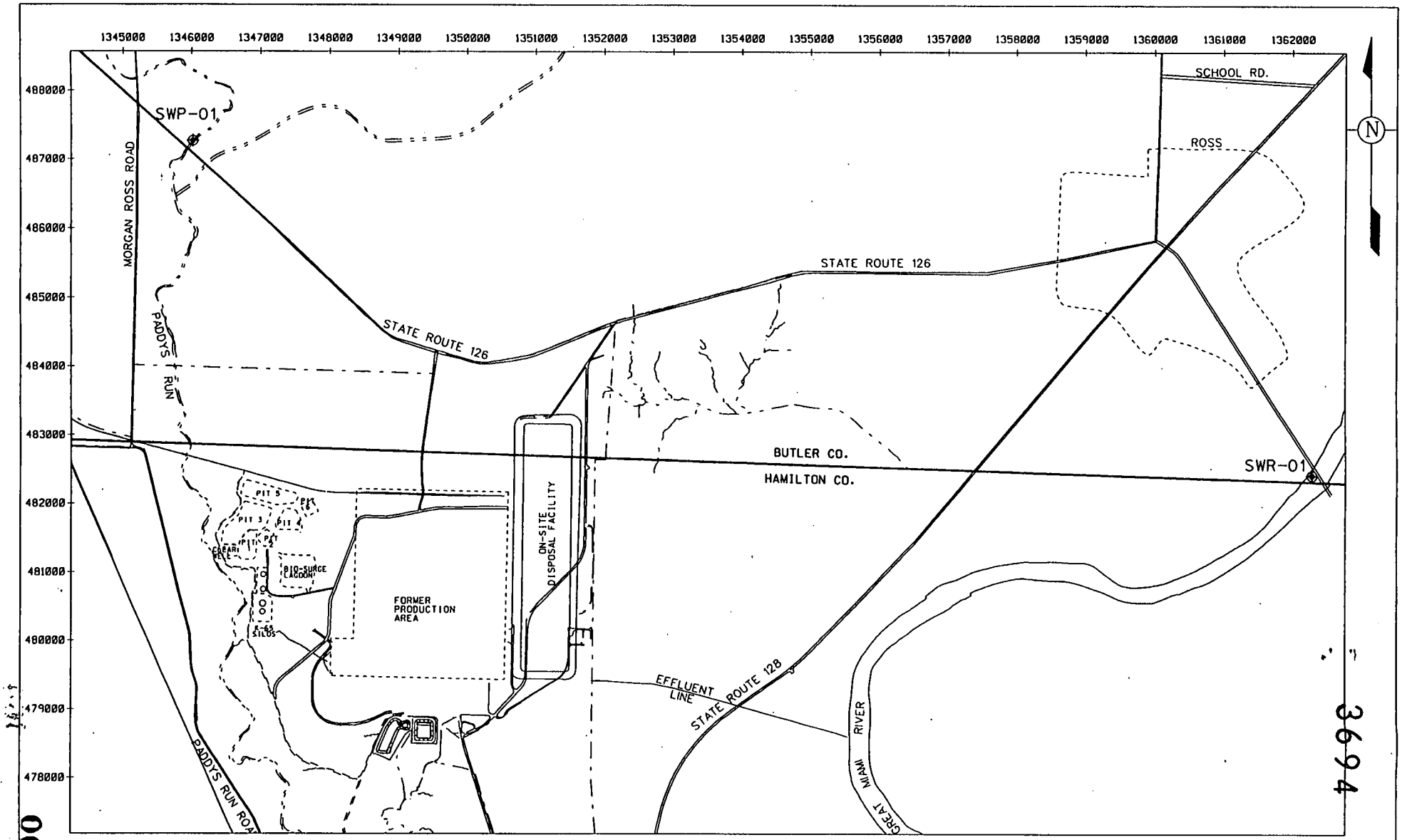


FIGURE B.1-1. IEMP SURFACE WATER AND TREATED EFFLUENT SAMPLE LOCATIONS



LEGEND:

FEMP BOUNDARY

SWR-01 ◈ SAMPLE LOCATION

SCALE

1000 500 0 1000 FEET

V:/5FGP1/DGN/00ANNUAL/00AN013.DGN 13-FEB-2001
STATE PLANAR COORDINATE SYSTEM 1983

FIGURE B.1-2. IEMP BACKGROUND SURFACE WATER SAMPLE LOCATIONS

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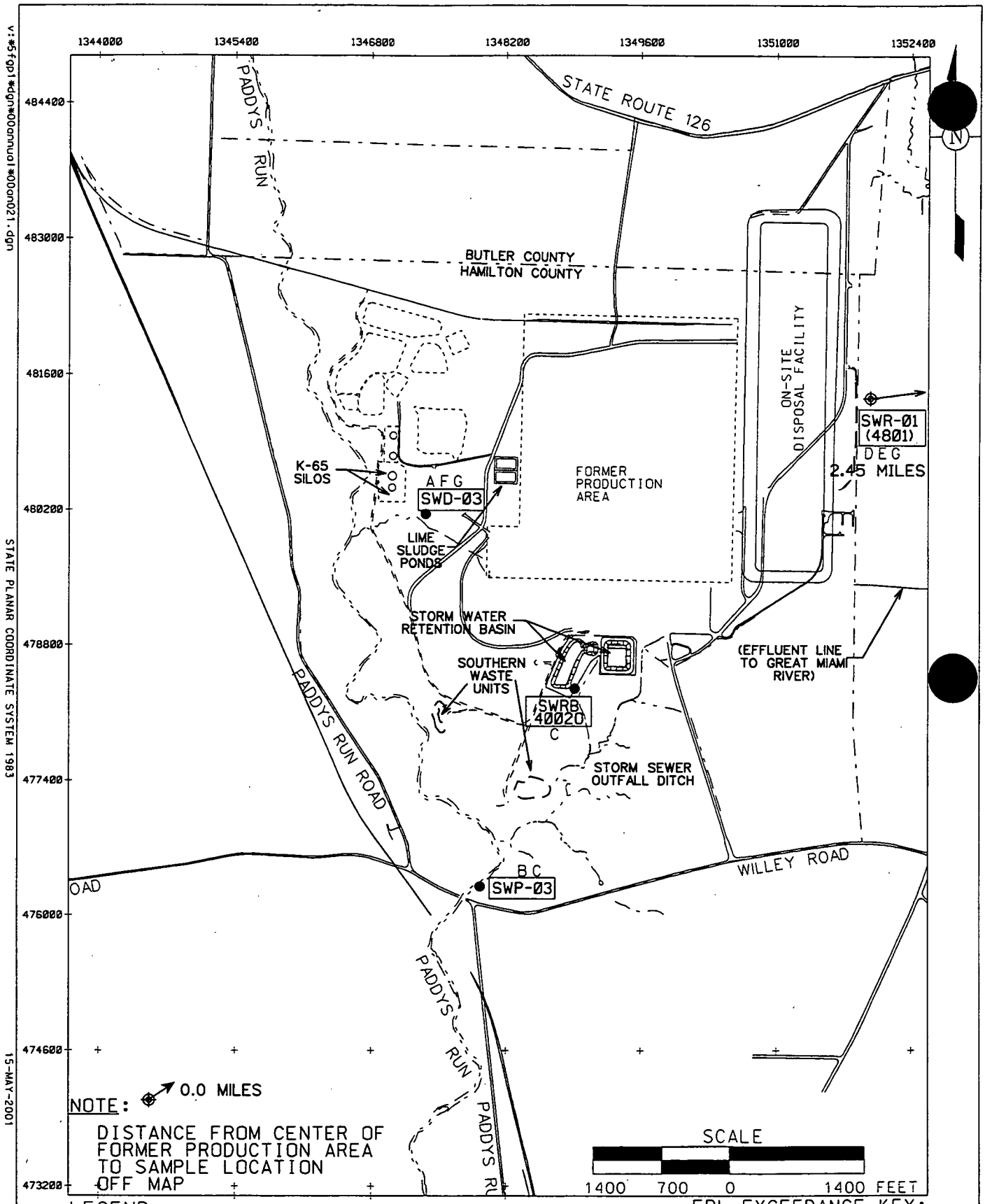
000365



LEGEND:

FEMP BOUNDARY

SAMPLE LOCATION

BTV EXCEEDANCE KEY:

A SILVER

FRL EXCEEDANCE KEY:

B CHROMIUM
C COPPER
D LEAD
E MERCURY
F SILVER
G ZINC

FINAL

000366

FIGURE B.1-3: CONSTITUENTS WITH 2000 RESULTS ABOVE FINAL REMEDIATION LEVELS AND/OR BENCHMARK TOXICITY VALUES

Note: The surface water FRL for total uranium is 530 μg/L.

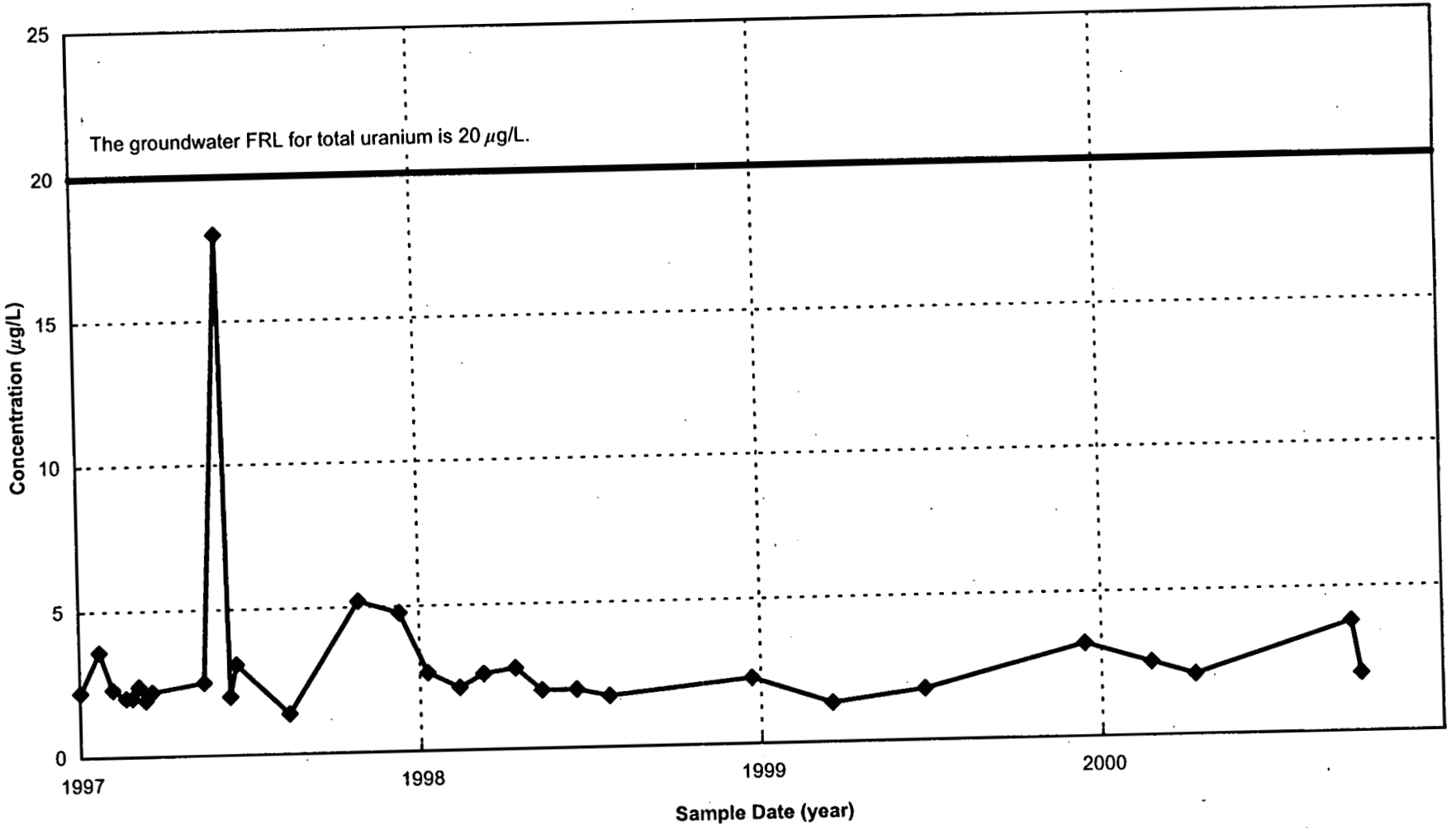


FIGURE B.1-4. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR LOCATION SWP-03 (PADDYS RUN AT DOWNSTREAM PROPERTY BOUNDARY)

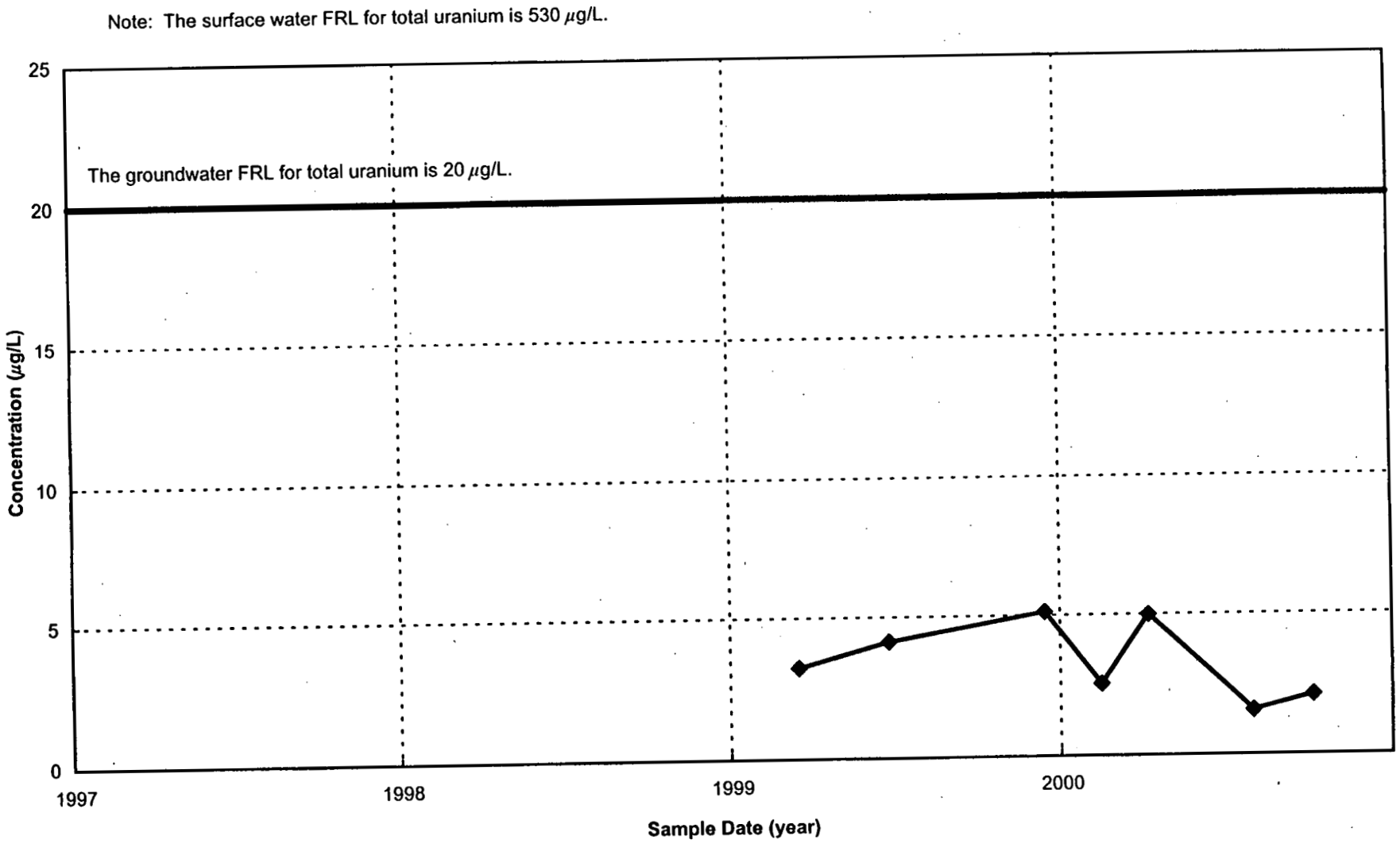


FIGURE B.1-5. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR LOCATION SWD-01 (NORTHEAST DRAINAGE)

000368

Note: The surface water FRL for total uranium is 530 μg/L.

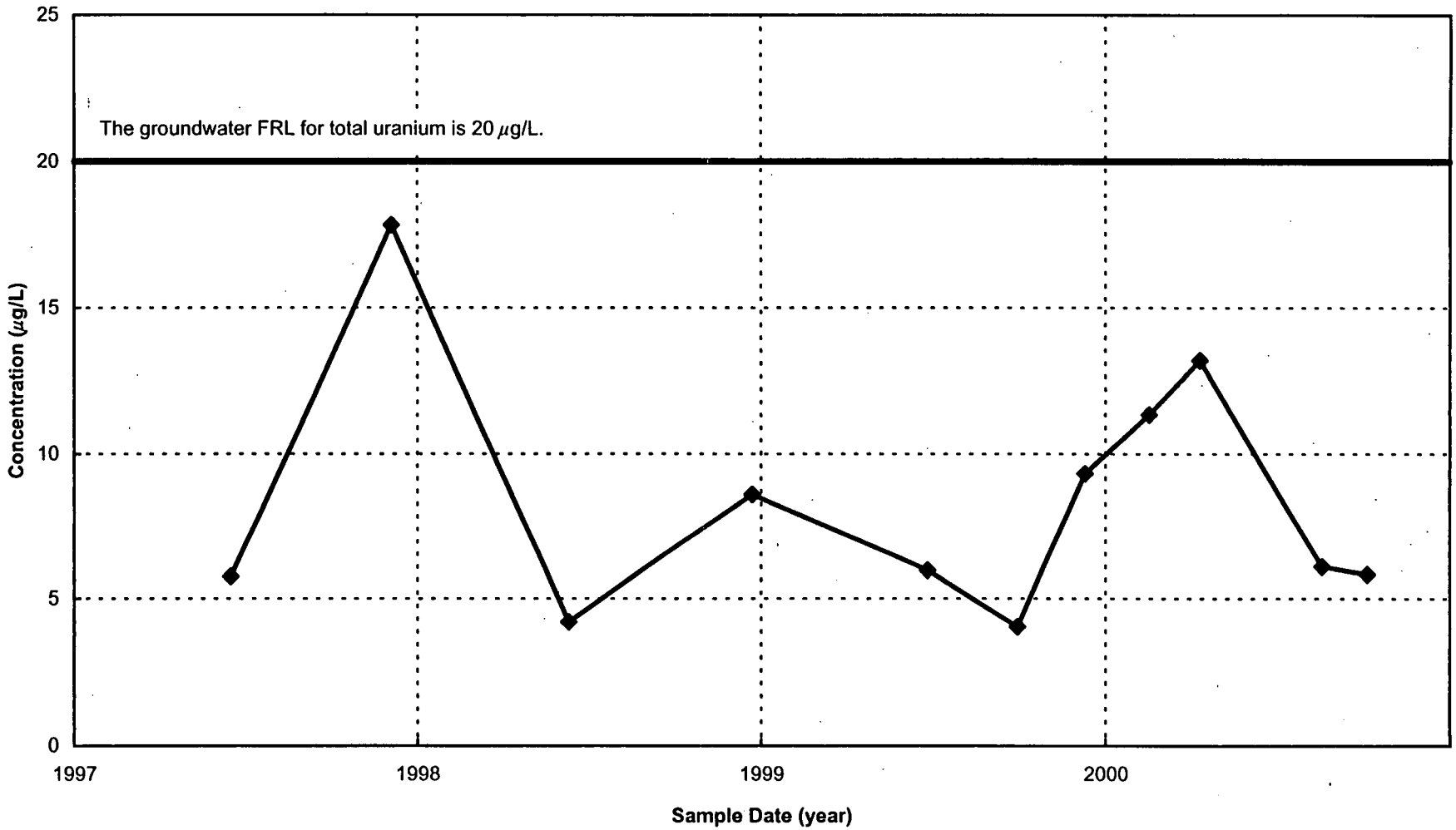


FIGURE B.1-6. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR LOCATION STRM 4003 (DRAINAGE TO PADDYS RUN)

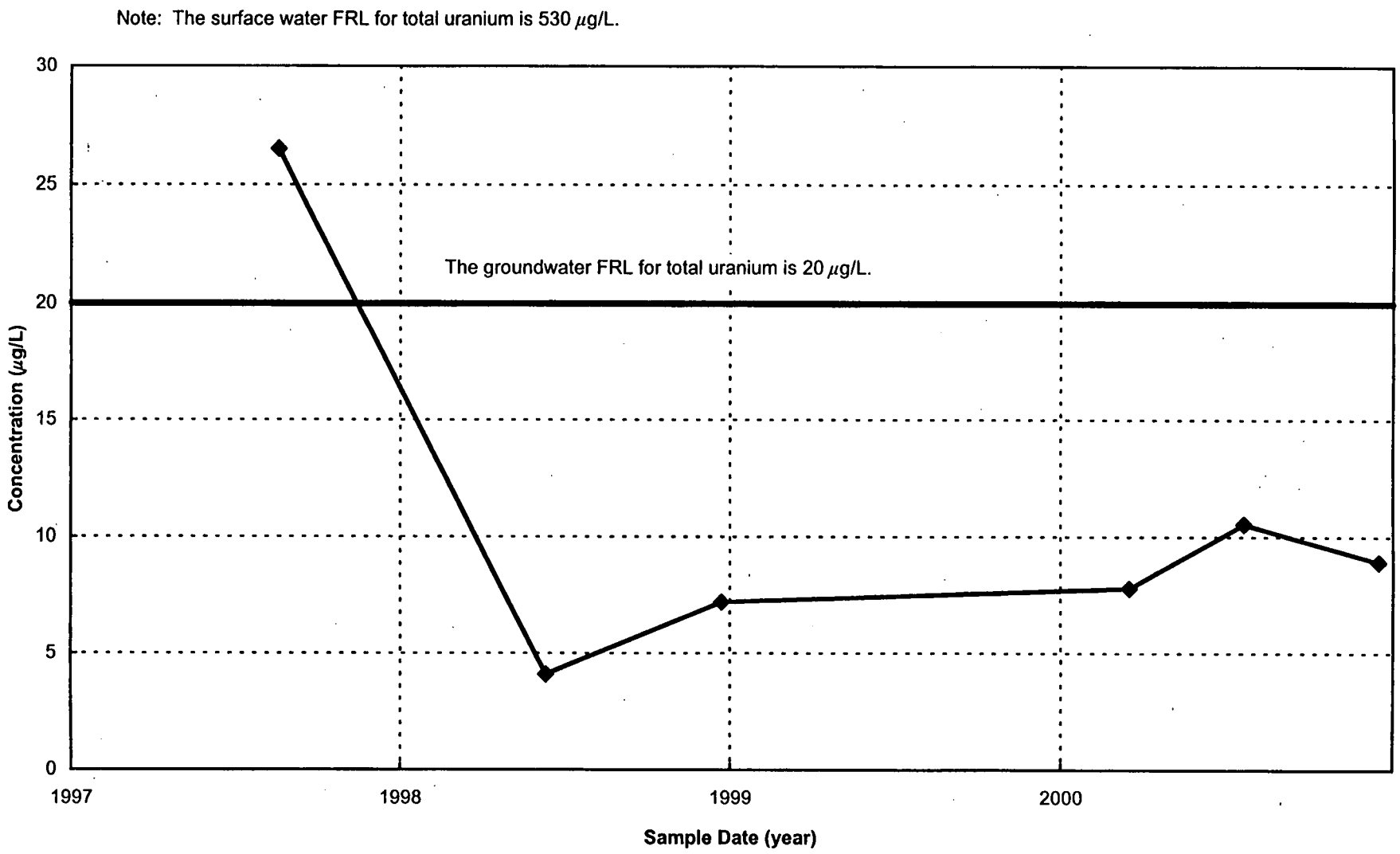


FIGURE B.1-7. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR LOCATION STRM 4004 (DRAINAGE TO PADDYS RUN)

000370

Note: The surface water FRL for total uranium is 530 μg/L.

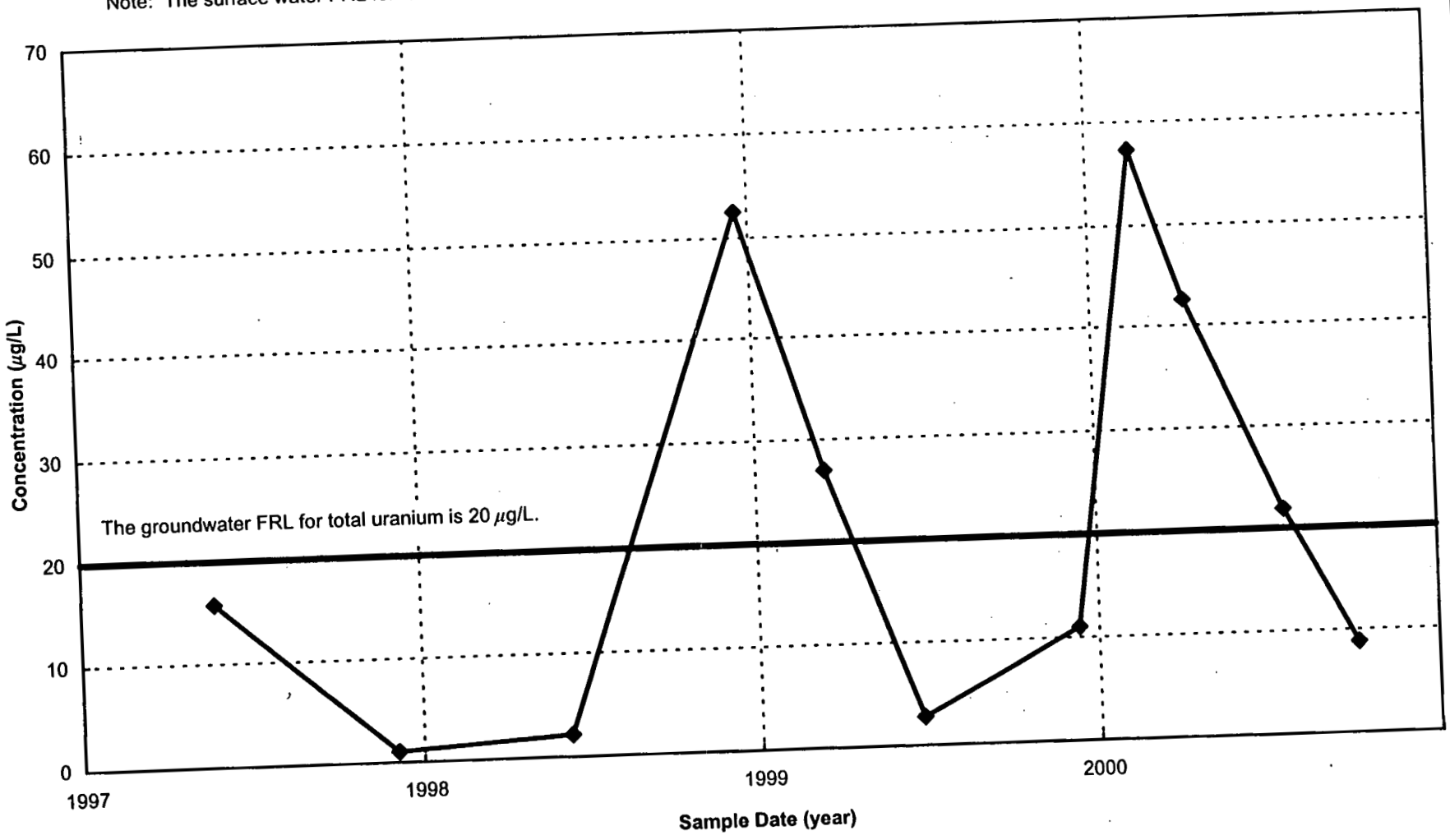


FIGURE B.1-8. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR LOCATION STRM 4006 (DRAINAGE TO PADDYS RUN)

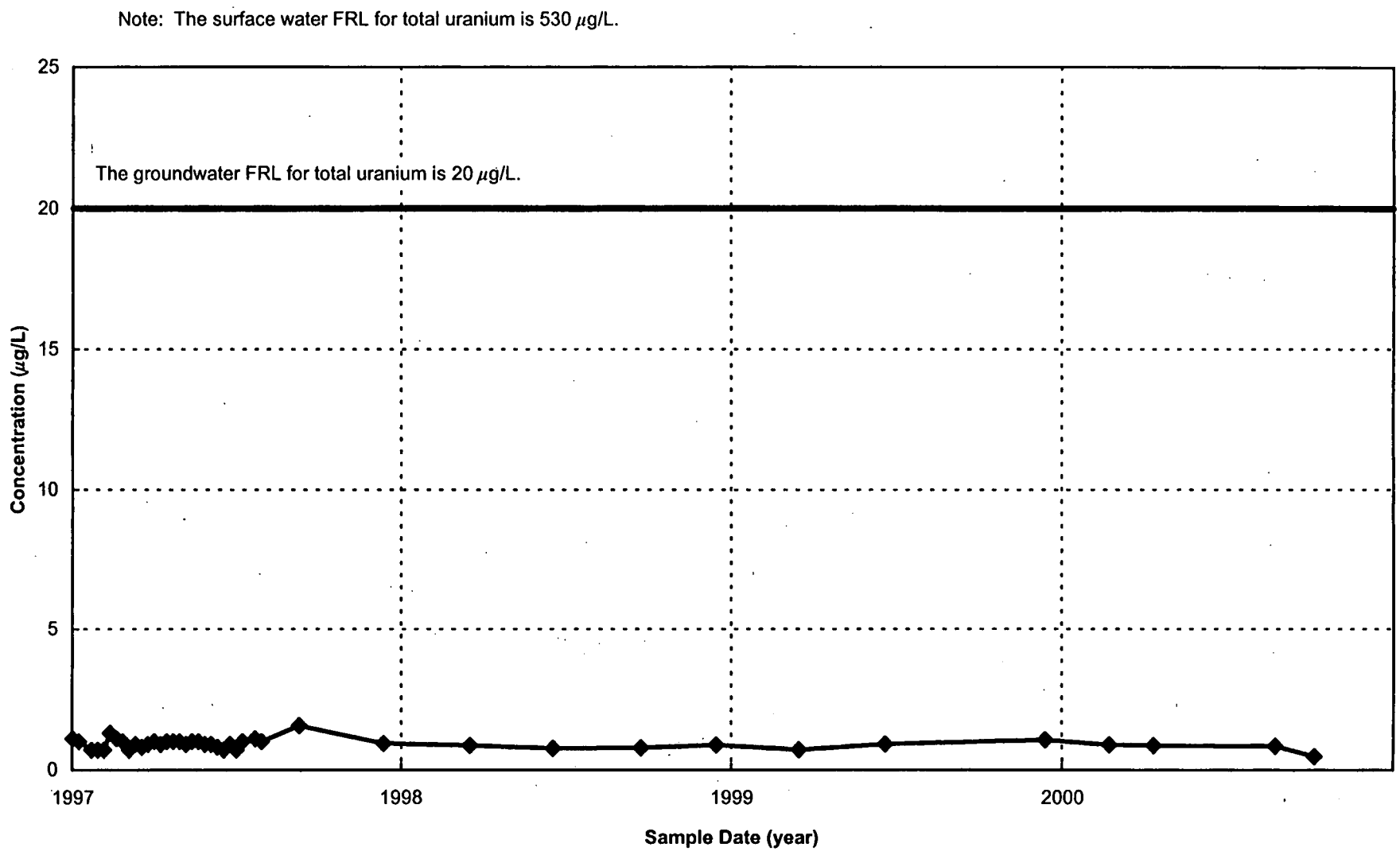


FIGURE B.1-9. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR LOCATION SWP-01 (PADDYS RUN BACKGROUND)

000372

Note: The surface water FRL for total uranium is 530 μg/L.

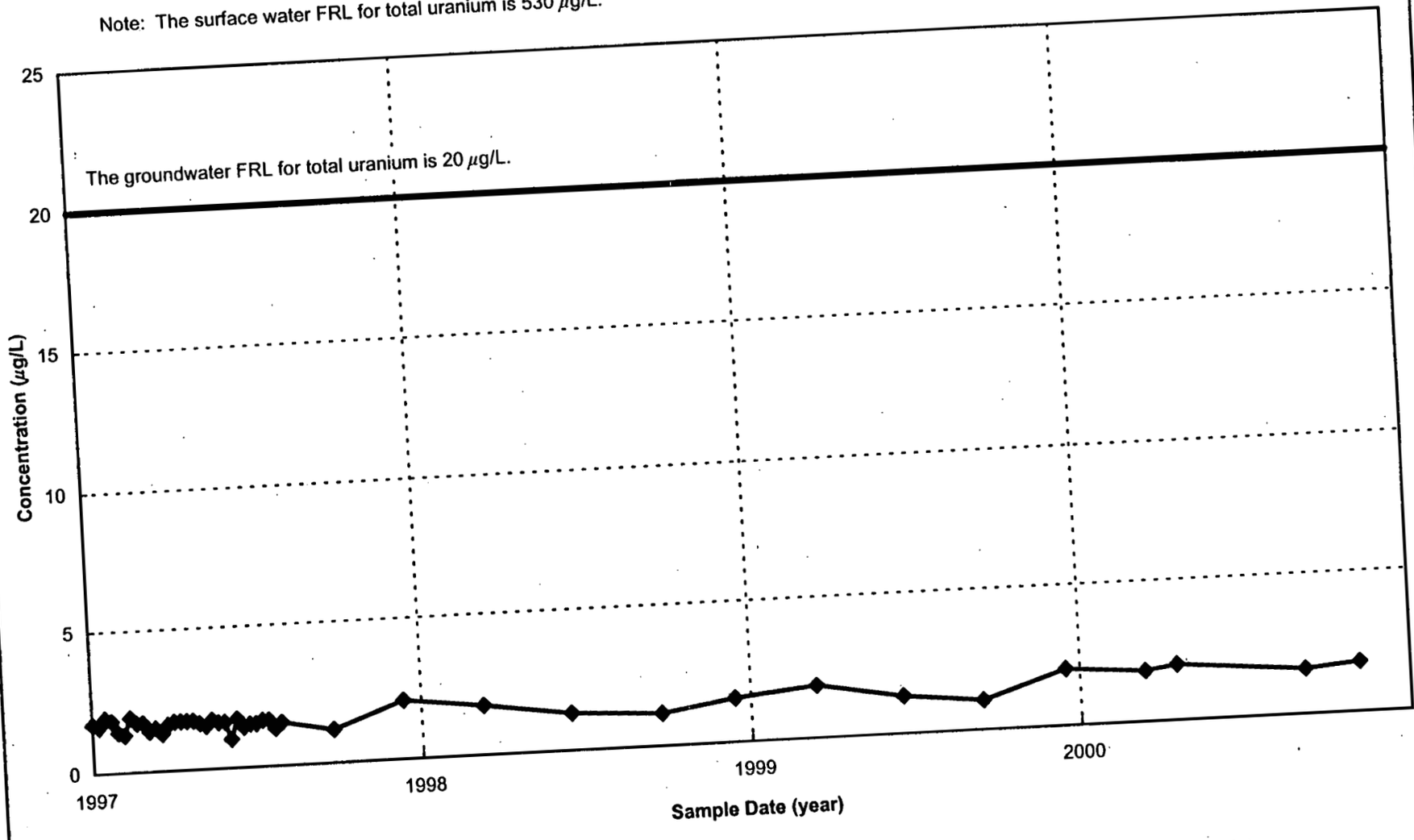


FIGURE B.1-10. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR LOCATION SWR-01 (GREAT MIAMI RIVER BACKGROUND)

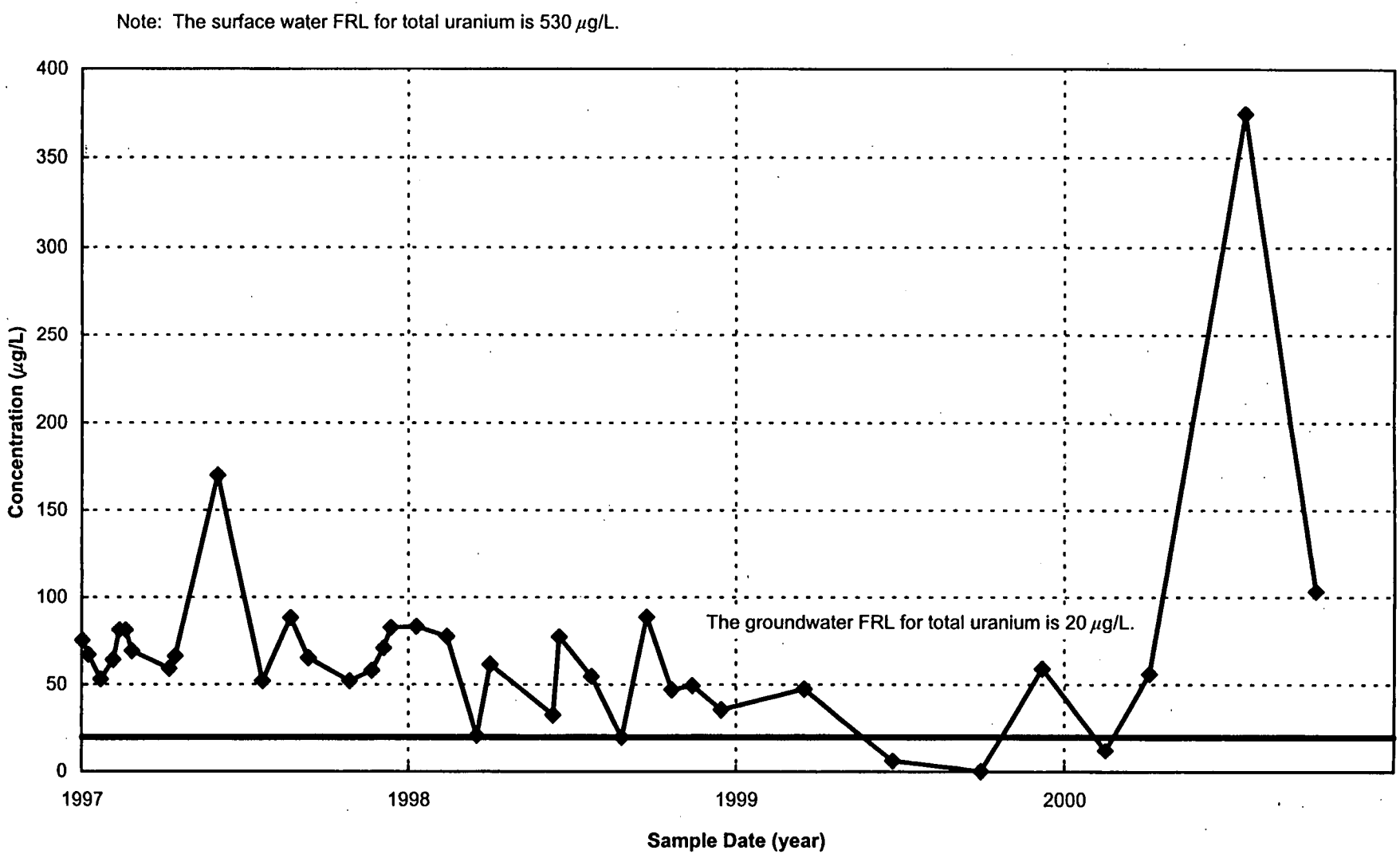


FIGURE B.1-11. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR LOCATION STRM 4005 (DRAINAGE TO PADDYS RUN) FOR CROSS-MEDIA IMPACT EVALUATION

000374

Note: The surface water FRL for total uranium is 530 μg/L.

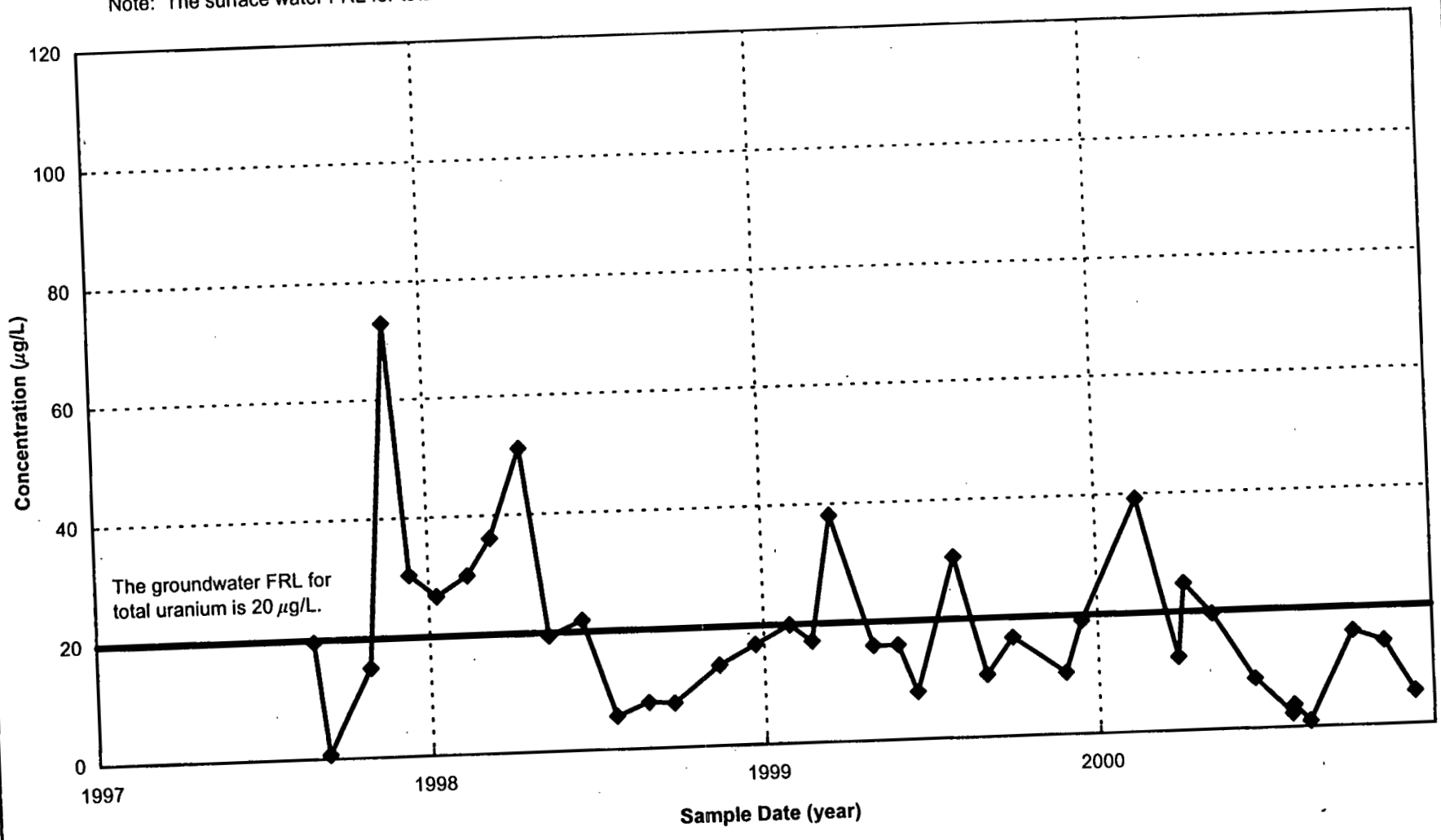


FIGURE B.1-12. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR LOCATION SWD-02 (STORM SEWER OUFALL DITCH) FOR CROSS-MEDIA IMPACT EVALUATION

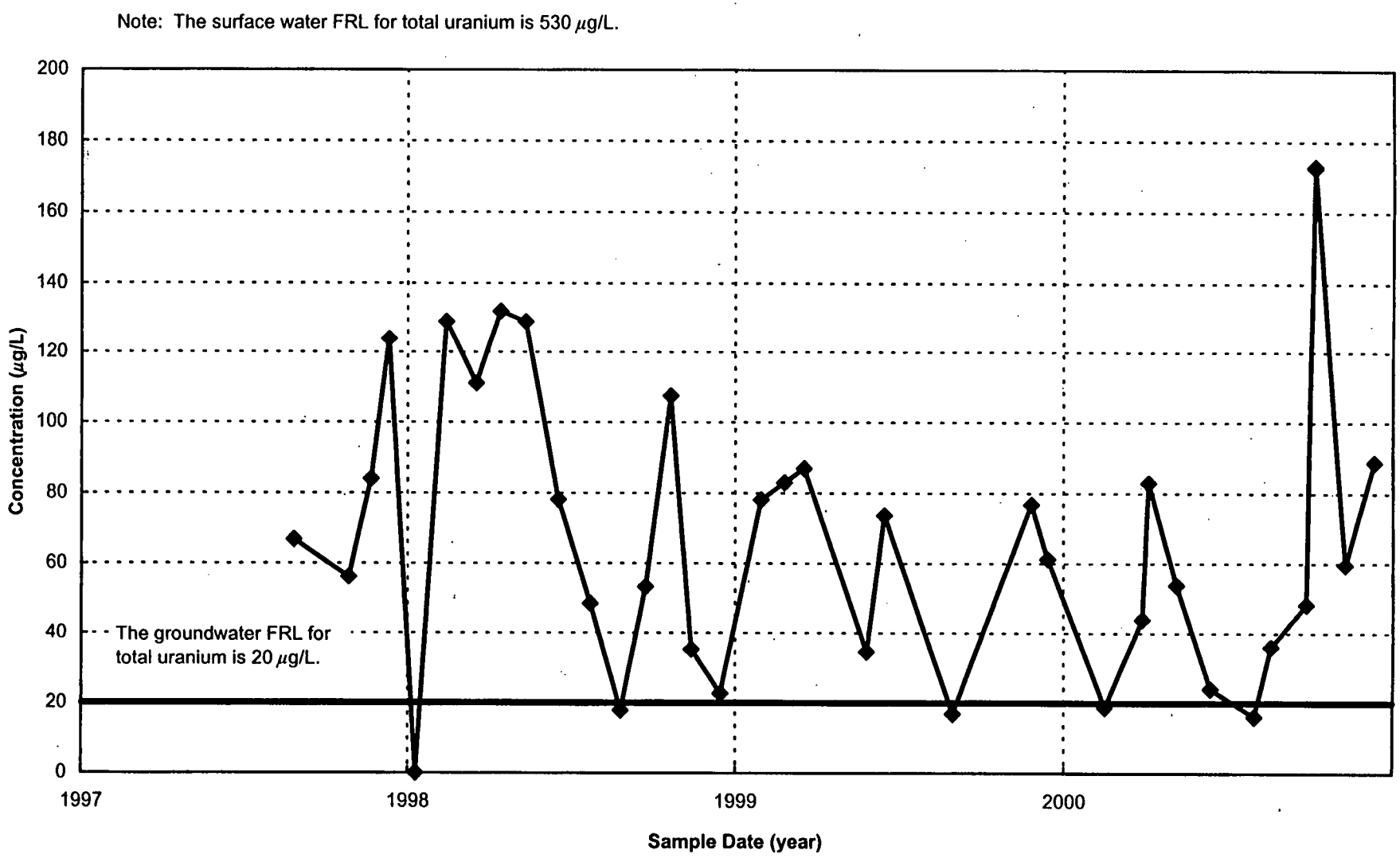


FIGURE B.1-13. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR LOCATION SWD-03 (WASTE STORAGE AREA) FOR CROSS-MEDIA IMPACT EVALUATION

000376

Note: The surface water FRL for total uranium is 530 μg/L.

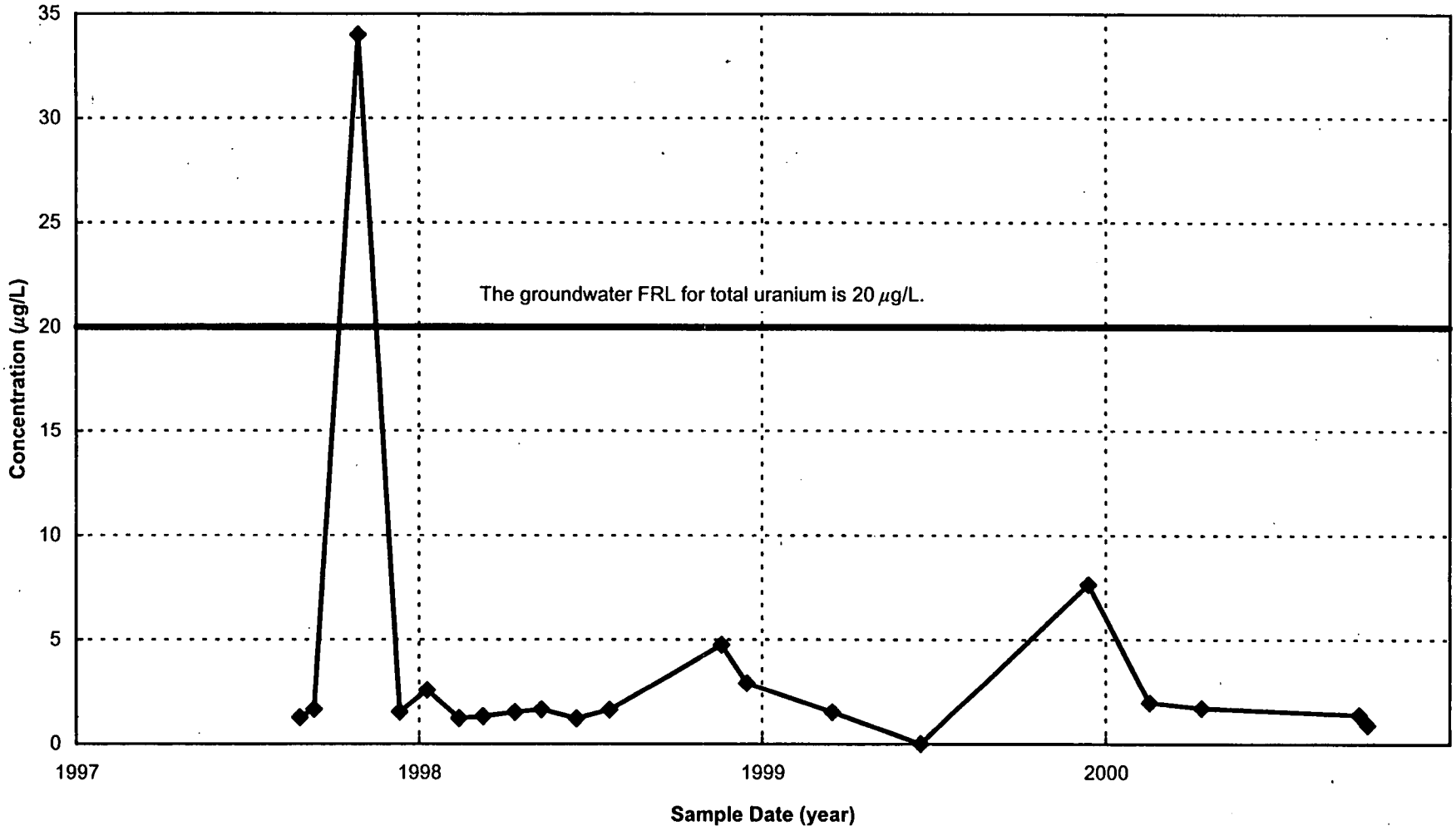


FIGURE B.1-14. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR LOCATION SWP-02 (PADDYS RUN) FOR CROSS-MEDIA IMPACT EVALUATION

000377

F-3694

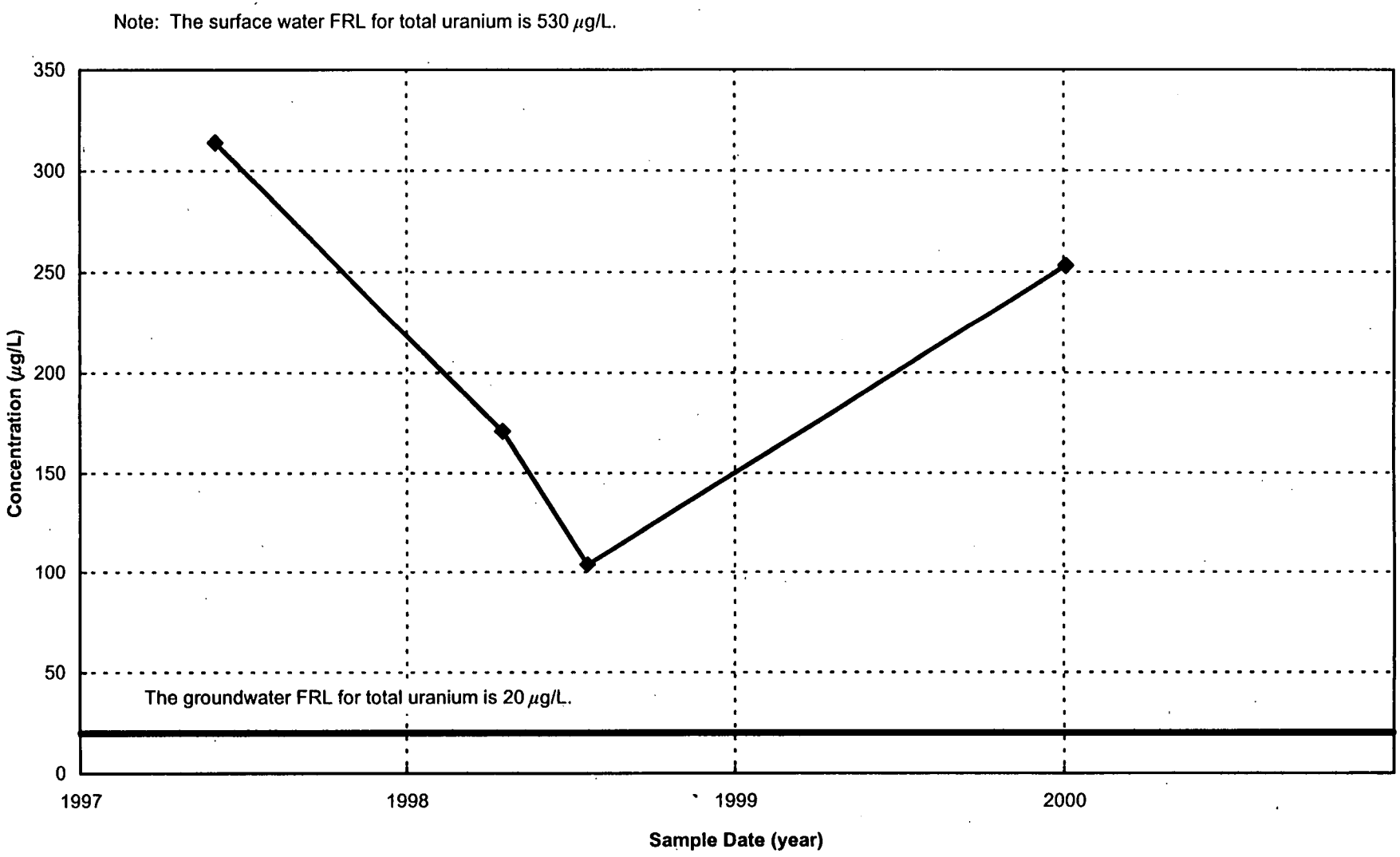
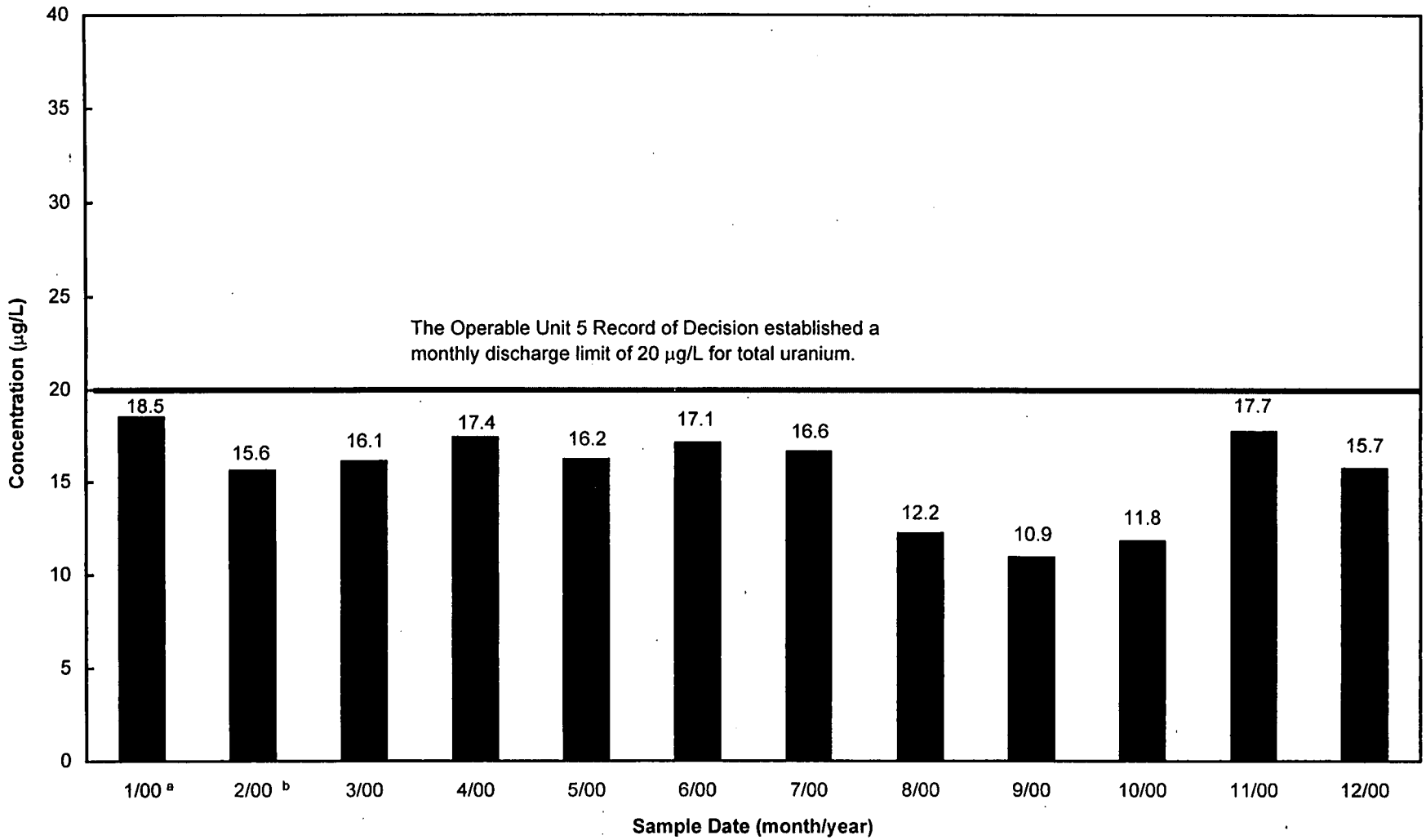


FIGURE B.1-15. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR LOCATION STORM WATER RETENTION BASIN OVERFLOW (SWRB 4002O) FOR CROSS-MEDIA IMPACT EVALUATION

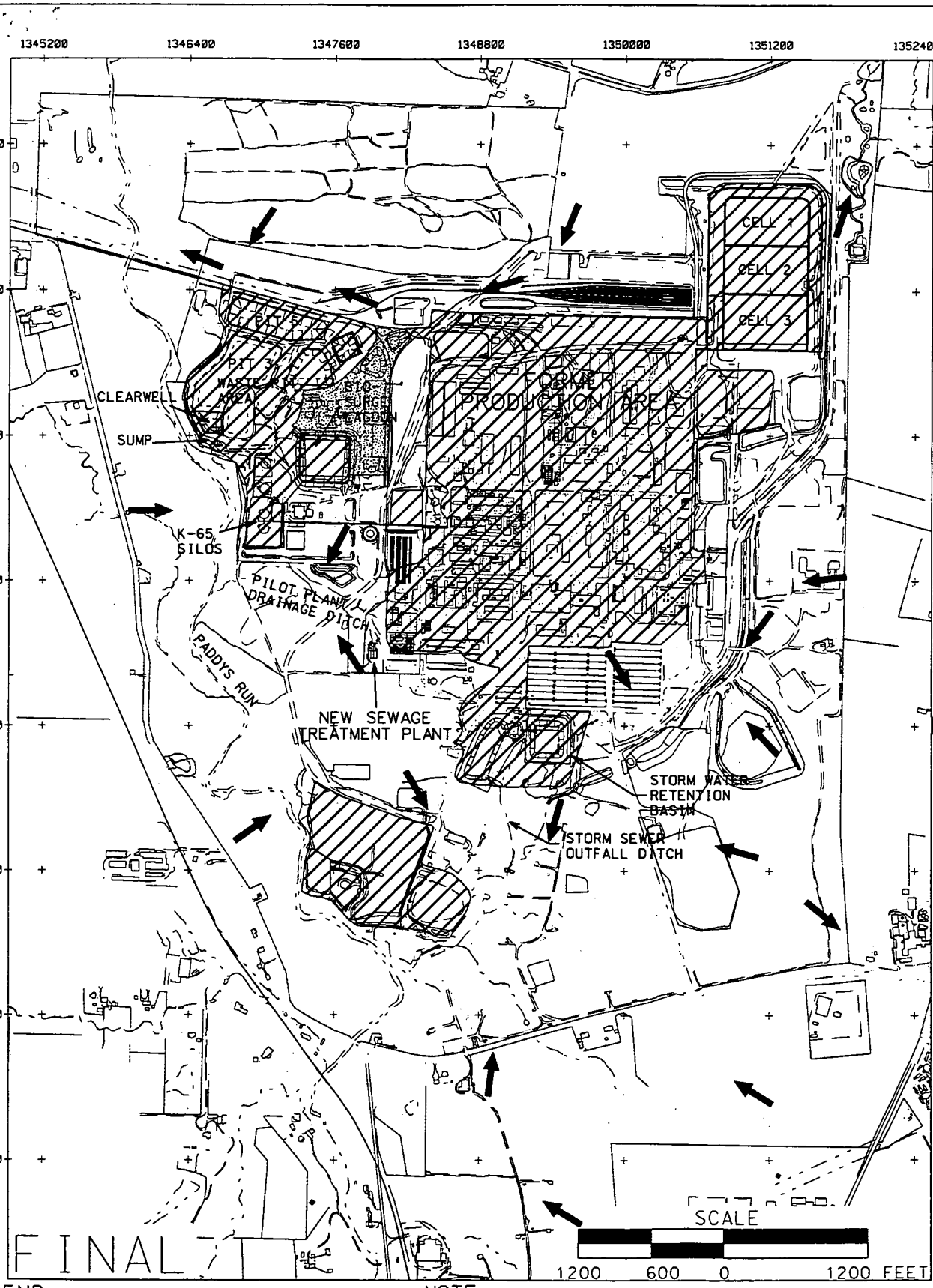
000378



[a] Actual concentration was 20.9 µg/L. Eliminating one "significant precipitation" bypass day reduces average to 18.5 µg/L.

[b] Actual concentration was 18.7 µg/L. Eliminating one "significant precipitation" bypass day reduces average to 15.6 µg/L.

FIGURE B.1-16. 2000 MONTHLY AVERAGE TOTAL URANIUM CONCENTRATION IN WATER DISCHARGED FROM THE PARSHALL FLUME (PF 4001) TO THE GREAT MIAMI RIVER



LEGEND:

- FEMP BOUNDARY
- CONTROLLED AREA
- UNCONTROLLED RUNOFF FLOW DIRECTION

NOTE:

CONTROLLED MEANS WATER IS COLLECTED AND SENT FOR TREATMENT AT THE AWW

WATER TREATED IF TOTAL URANIUM RESULT IS >20 μg/L

V:/SFGP1/DGN/00ANNUAL/00AN005.DGN

STATE PLANAR COORDINATE SYSTEM 1983

12-13-00

000380

FIGURE B.1-17. CONTROLLED SURFACE WATER AREAS AND UNCONTROLLED FLOW DIRECTIONS FOR FOURTH QUARTER 2000

ATTACHMENT B.2

SEDIMENT

ATTACHMENT B.2

Sediment is a secondary exposure pathway and is monitored annually to assess the impact of remediation activities on sediments deposited along surface water drainages. Sediment is collected at strategic locations to ensure that the most recently deposited sediment is collected. Sediment collected in 2000 marked the third year for implementing the sediment monitoring program contained in the IEMP.

Sediment samples were collected in August of 2000 at 16 locations along Paddys Run, the Storm Sewer Outfall Ditch, and the Great Miami River (refer to Figure B.2-1). Samples collected at each location were analyzed for total uranium. All samples collected from the Storm Sewer Outfall Ditch, Paddys Run (north and south of the outfall ditch), and from the Paddys Run background location were also analyzed for radium-226, radium-228, and isotopic thorium.

Table B.2-1 summarizes the results of the 2000 sediment monitoring program. Analytical results of samples collected from the Storm Sewer Outfall Ditch, Paddys Run, and the Great Miami River from 2000 were below the FRL for all of the constituents (radium-226, radium-228, isotopic thorium, and total uranium). In comparison to 1999 data, there was a slight increase in average concentrations of thorium-228, thorium-230, thorium-232, and total uranium at the Paddys Run north locations. However, there was also an increase in radium-226, thorium-230, and thorium-232 at the Paddys Run background location. Of the five samples collected from northern portion of Paddys Run (PN1-PN5), the maximum total uranium concentration for 2000 was 11.9 milligrams per kilogram (mg/kg) compared to a maximum of 2.98 mg/kg in 1999. However, all results are within the range of historical background levels.

Figures B.2-2 through B.2-6 present sediment data trends for the period 1990 through 2000. Monitoring of sediment will continue to determine the effectiveness of the engineered controls designed to reduce erosion from the FEMP and sedimentation of Paddys Run and its tributaries.

TABLE B.2-1

SUMMARY STATISTICS FOR SEDIMENT MONITORING PROGRAM

		2000 Results – Concentration (dry weight)							1999 Results						1990 - 1998 Results			
	No. of	Minimum[a,b,c,d]		Maximum[a,b,c]		Average[a,b,c,d]		No. of	Minimum[a,b,c]		Maximum[a,b,c]		Average[a,b,c]		Minimum[a,b,c]		Maximum[a,b,c]	
Radionuclide	Samples[a]	pCi/g	(mg/kg)	pCi/g	(mg/kg)	pCi/g	(mg/kg)	Samples[a]	pCi/g	(mg/kg)	pCi/g	(mg/kg)	pCi/g	(mg/kg)	pCi/g	(mg/kg)	pCi/g	(mg/kg)
Great Miami River, North of the Effluent Line (G2)																		
Uranium, Total	1	1.353	(2.002)	NA	NA	NA	NA	1	1.30	(1.92)	NA	NA	NA	NA	0.50	(0.74)	1.8	(2.7)
Great Miami River, South of the Effluent Line (G4)																		
Uranium, Total	1	0.909	(1.34)	NA	NA	NA	NA	1	2.51	(3.72)	1.13	(1.7)	0.83	(1.2)	0.30	(0.44)	2.6	(3.8)
Paddys Run Background, North of S.R. 126 (P1)																		
Radium-226	1	0.504	NA	NA	NA	NA	NA	1	0.494	NA	NA	NA	NA	NA	0.00	NA	1.4	NA
Radium-228	1	0.373	NA	NA	NA	NA	NA	1	0.416	NA	NA	NA	NA	NA	NS	NS	NS	NS
Thorium-228	1	0.383	NA	NA	NA	NA	NA	1	0.426	NA	NA	NA	NA	NA	0.15	NA	1.2	NA
Thorium-230	1	0.930	NA	NA	NA	NA	NA	1	0.461	NA	NA	NA	NA	NA	0.22	NA	1.9	NA
Thorium-232	1	0.381	NA	NA	NA	NA	NA	1	0.364	NA	NA	NA	NA	NA	0.15	NA	1.1	NA
Uranium, Total	1	0.944	(1.40)	NA	NA	NA	NA	1	0.824	(1.22)	NA	NA	NA	NA	0.41	(0.61)	2.8	(4.1)
Paddys Run, North of the Storm Sewer Outfall Ditch (PN1-PN5)																		
Radium-226	5	0.523	NA	0.786	NA	0.6704	NA	5	0.612	NA	0.889	NA	0.745	NA	0.00	NA	3.7	NA
Radium-228	5	0.289	NA	0.745	NA	0.5004	NA	5	0.478	NA	0.655	NA	0.602	NA	NS	NS	NS	NS
Thorium-228	5	0.344	NA	0.999	NA	0.5288	NA	5	0.295	NA	0.704	NA	0.511	NA	0.25	NA	5.1	NA
Thorium-230	5	0.637	NA	1.12	NA	0.9242	NA	5	0.548	NA	1.22	NA	0.842	NA	0.08	NA	9.8	NA
Thorium-232	5	0.214	NA	1.06	NA	0.538	NA	5	0.277	NA	0.604	NA	0.458	NA	0.19	NA	5.4	NA
Uranium, Total	5	1.043	(1.544)	8.056	(11.92)	2.651	(3.923)	5	0.939	(1.39)	2.01	(2.98)	1.48	(2.19)	0.55	(0.81)	8.7	(13)
Storm Sewer Outfall Ditch (D1-D5)																		
Radium-226	5	0.498	NA	0.924	NA	0.6302	NA	5	0.538	NA	0.932	NA	0.755	NA	0.00	NA	1.4	NA
Radium-228	5	0.271	NA	0.769	NA	0.4416	NA	5	0.339	NA	0.813	NA	0.614	NA	NS	NS	NS	NS
Thorium-228	5	0.114	NA	0.585	NA	0.3524	NA	5	0.426	NA	0.773	NA	0.615	NA	0.05	NA	1.9	NA
Thorium-230	5	0.621	NA	1.38	NA	0.912	NA	5	0.595	NA	0.959	NA	0.929	NA	0.02	NA	4.0	NA
Thorium-232	5	0.154	NA	0.688	NA	0.3204	NA	5	0.294	NA	0.674	NA	0.479	NA	0.01	NA	2.1	NA
Uranium, Total	5	1.086	(1.607)	5.035	(7.452)	2.090	(3.093)	5	1.51	(2.24)	4.49	(6.65)	2.75	(4.07)	0.41	(0.61)	16	(23)
Paddys Run, South of the Storm Sewer Outfall Ditch (PS1-PS3)																		
Radium-226	1	0.538	NA	NA	NA	NA	NA	1	0.645	NA	NA	NA	NA	NA	NA	NA	NA	NA
Radium-228	1	0.317	NA	NA	NA	NA	NA	1	0.582	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thorium-228	1	0.263	NA	NA	NA	NA	NA	1	0.347	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thorium-230	1	0.933	NA	NA	NA	NA	NA	1	0.675	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thorium-232	1	0.325	NA	NA	NA	NA	NA	1	0.352	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium, Total	3	0.982	(1.45)	1.055	(1.562)	1.024	(1.515)	3	1.03	(1.53)	1.45	(2.15)	1.26	(1.87)	0.55	(0.81)	30	(44)

FRLs	mg/kg	pCi/g
Radium-226	-	2.9
Radium-228	-	4.8
Thorium-228	-	3.2
Thorium-230	-	18,000
Thorium-232	-	1.6
Uranium, Total	210	-

[a]If more than one sample is collected per sample location (e.g., split or duplicate), 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, and average).
[b]If the number of samples is greater than or equal to three, then the minimum, maximum, and average are reported. If the number of samples is equal to two, then the minimum and maximum are reported. If the number of samples is equal to one, then the result is reported as the minimum.
[c]NA = not applicable; NS = not sampled
[d]Where conditions are below the detection limit, each result used in the summary statistics is set at half the detection limit.

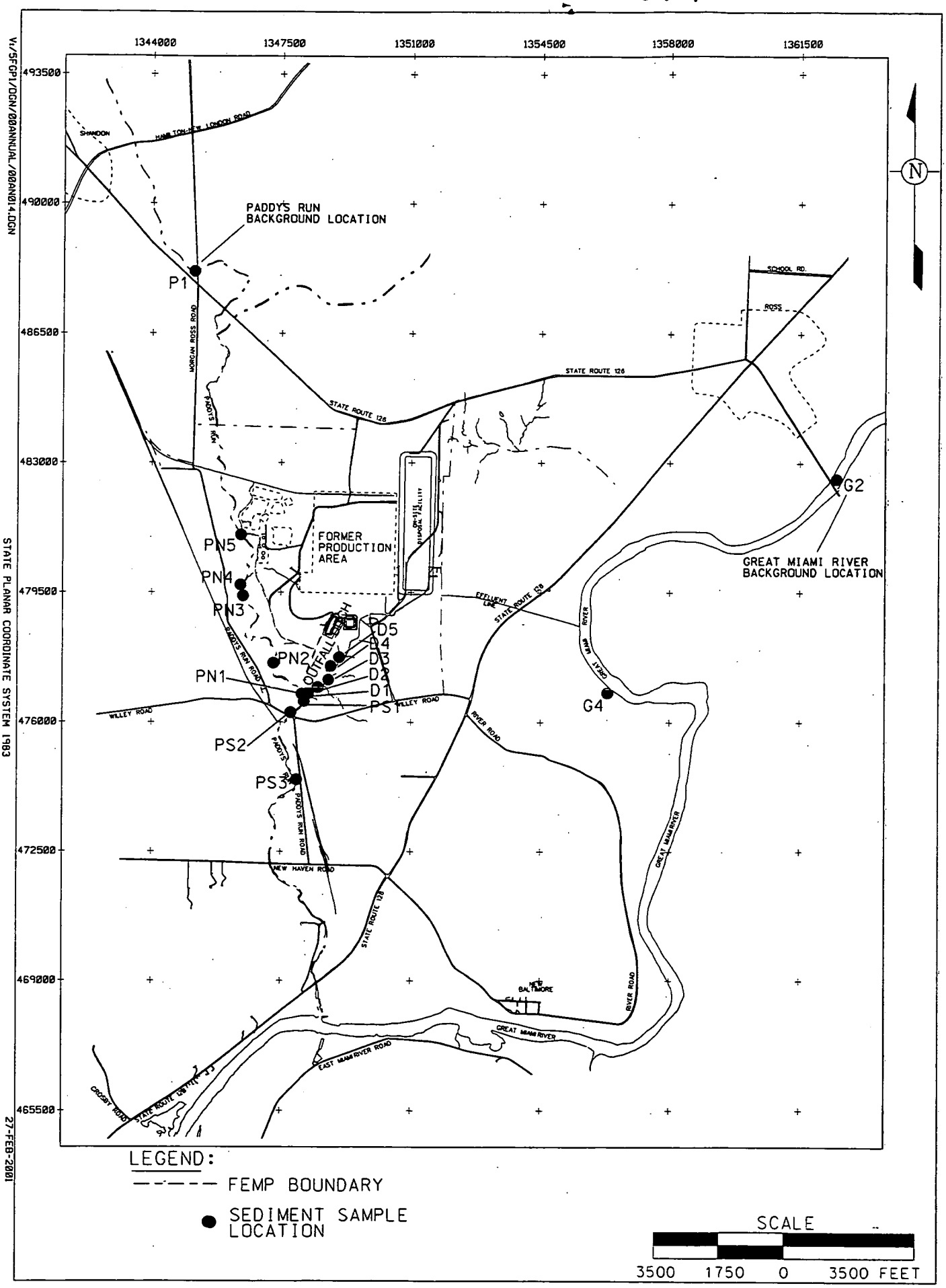


FIGURE B.2-1. 2000 SEDIMENT SAMPLE LOCATIONS

Note: The sediment BTV for radium-226 is 580,000 pCi/g.

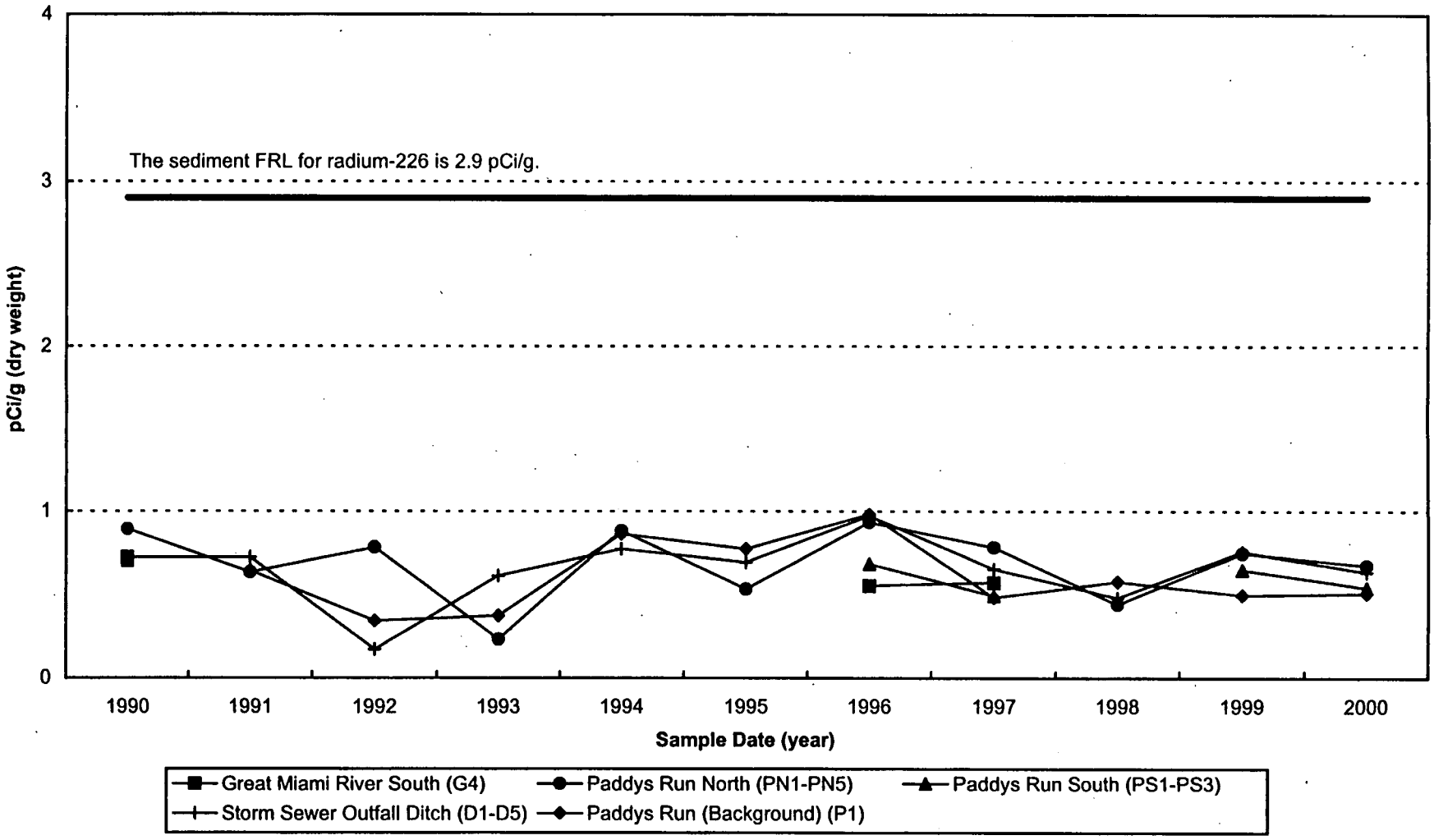


FIGURE B.2-2. RADIUM-226 CONCENTRATION VS. TIME PLOT FOR SEDIMENT

000385

Note: The sediment BTV for thorium-228 is 4,900,000 pCi/g.

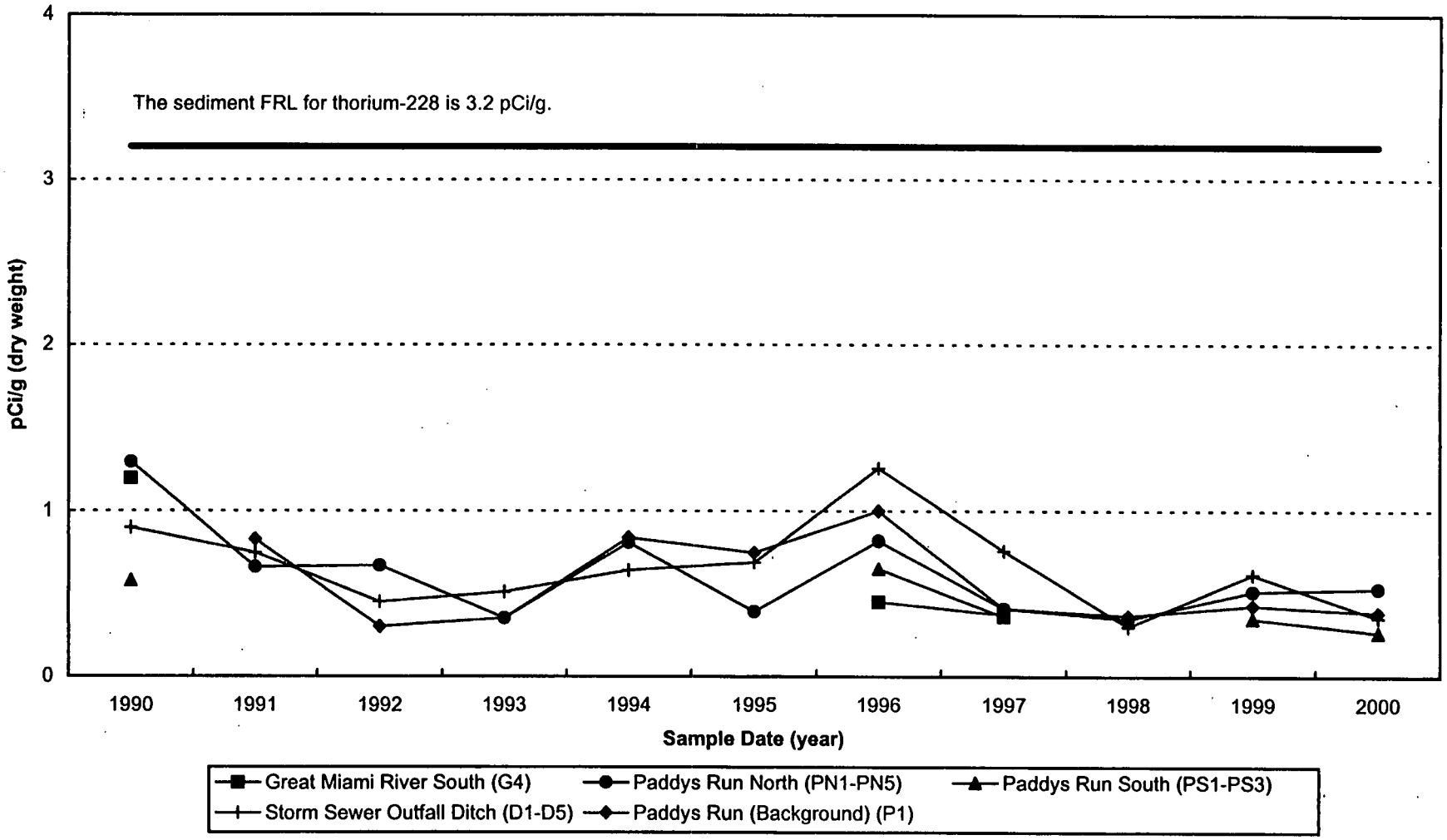


FIGURE B.2-3. THORIUM-228 CONCENTRATION VS. TIME PLOT FOR SEDIMENT

000386

Note: The sediment FRL for thorium-230 is 18,000 pCi/g and the BTV is 29,000,000 pCi/g.

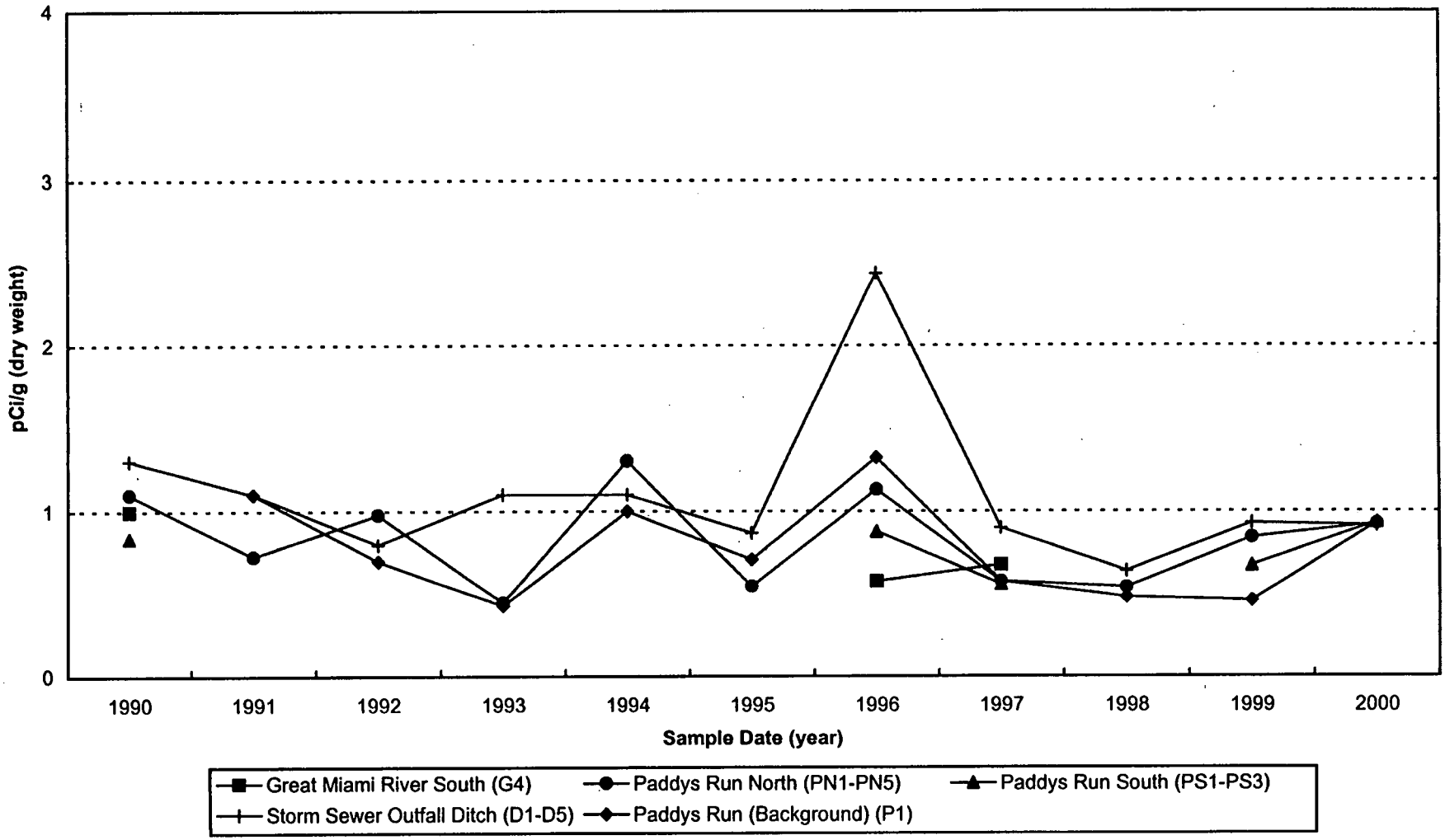


FIGURE B.2-4. THORIUM-230 CONCENTRATION VS. TIME PLOT FOR SEDIMENT

000387

Note: The sediment BTV for thorium-232 is 8,000,000 pCi/g.

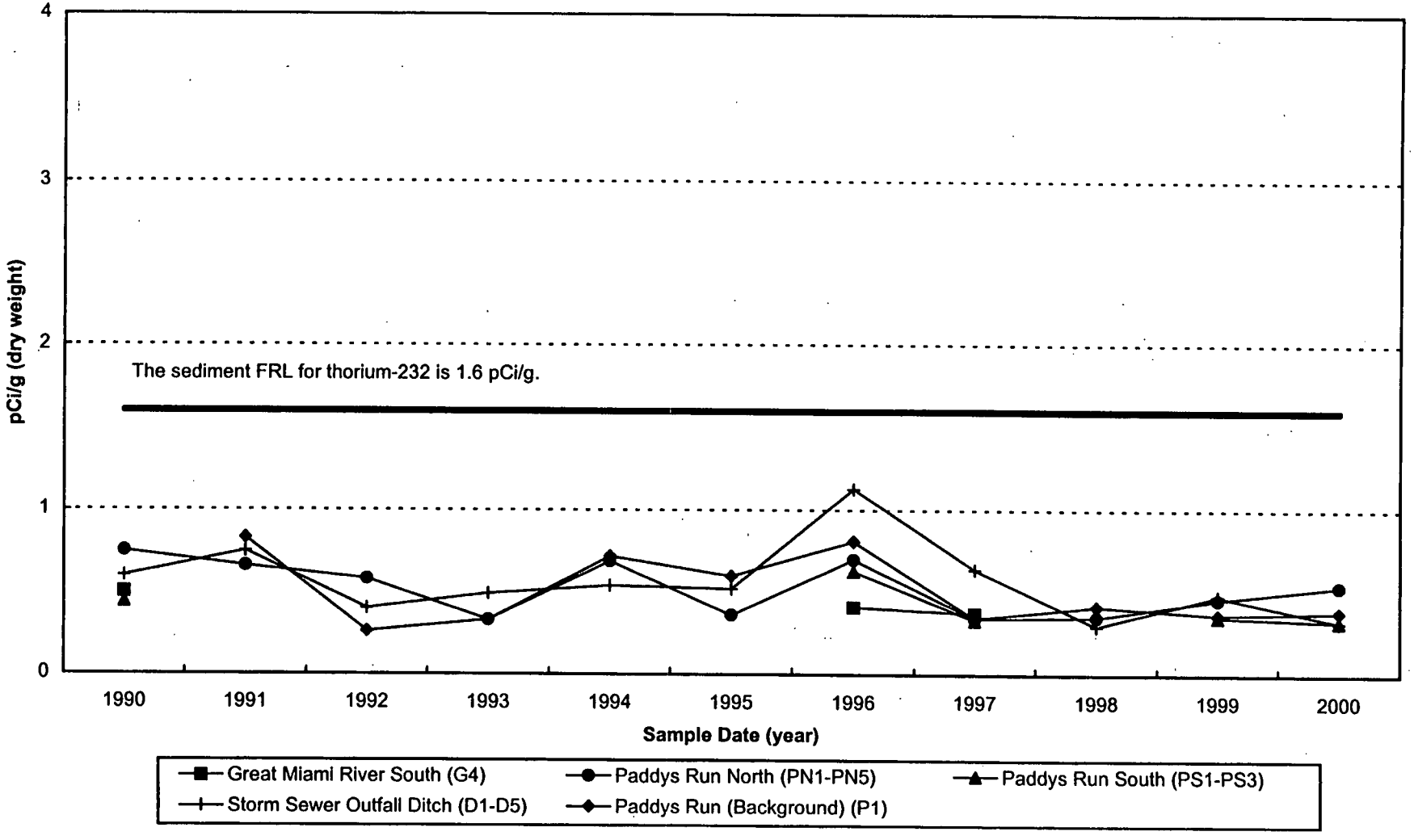


FIGURE B.2-5. THORIUM-232 CONCENTRATION VS. TIME PLOT FOR SEDIMENT

Note: The sediment BTV for total uranium is 210 mg/kg.

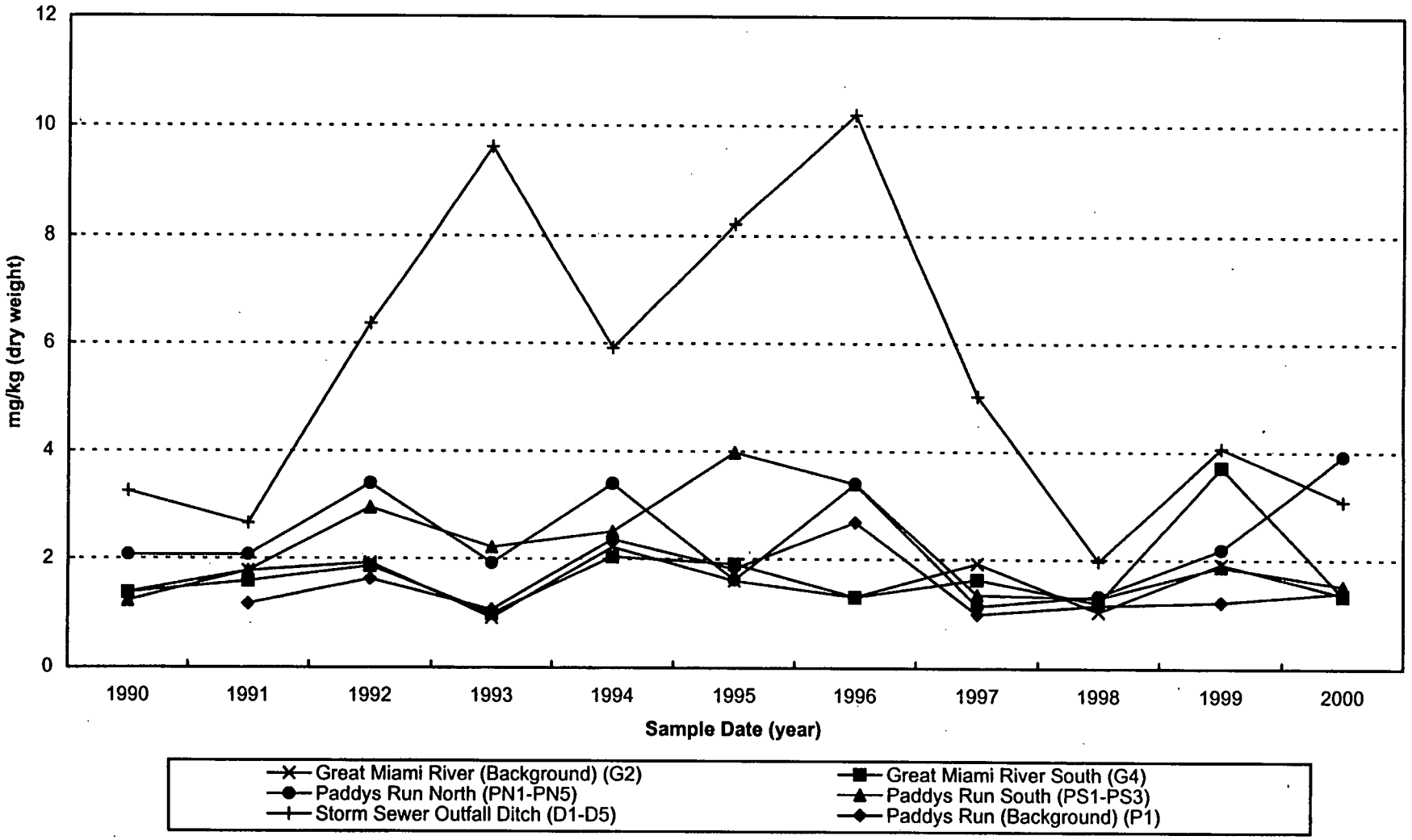


FIGURE B.2-6. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR SEDIMENT

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APPENDIX C

SUPPLEMENTAL AIR INFORMATION

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LIST OF ACRONYMS

AMS	air monitoring station
°C	Degrees Centigrade
cm	centimeters
DOE	U.S. Department of Energy
°F	Degrees Fahrenheit
FEMP	Fernald Environmental Management Project
IEMP	Integrated Environmental Monitoring Plan
in	inches
kph	kilometers per hour
mph	miles per hour
mrem	millirem
pCi/L	picoCuries per liter
pCi/m^3	picoCuries per cubic meter
TLD	thermoluminescent dosimeter
$\mu g/m^3$	micrograms per cubic meter

APPENDIX C

Appendix C presents additional air monitoring data and analysis in support of Chapter 5 of the 2000 Integrated Site Environmental Report. This appendix consists of five attachments as follows:

- Attachment C.1 provides the results of the radiological air particulate monitoring program, including an assessment of 2000 results with respect to historical data, and provides concentration versus time plots of the total uranium, total particulate, and thorium data for 2000.
- Attachment C.2 provides the results of the radon monitoring program, including an assessment of radon data relative to continuous radon monitors. This discussion focuses on the U.S. Department of Energy (DOE) standards contained in DOE Order 5400.5 and an evaluation of trends observed in the 2000 data.
- Attachment C.3 provides the results of the direct radiation monitoring program including an assessment of 2000 results with respect to historical data.
- Attachment C.4 provides the results of the biota (produce) monitoring program including an assessment of the 2000 results with respect to historical data.
- Attachment C.5 provides a summary of the meteorological data measured at the site during 2000.

REFERENCES

U.S. Dept. of Energy, 2001, "Integrated Environmental Monitoring Plan, Revision 2," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Cincinnati, OH.

Attachment C.1

ATTACHMENT C.1

RADIOLOGICAL AIR PARTICULATE

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ATTACHMENT C.1

Appendix C.1 provides a detailed discussion of the radiological air particulate data for 2000. This information is used to measure the emissions of uranium, thorium, and radium from the Fernald Environmental Monitoring Project (FEMP).

In 2000 the FEMP operated 19 air monitoring stations (AMS) 24 hours per day, seven days a week, as part of the Integrated Environmental Monitoring Plan (IEMP) Radiological Air Particulate Monitoring Program. The data from 16 fenceline monitoring stations and two background monitoring stations are used to demonstrate compliance with the National Emissions Standards for Hazardous Air Pollutants Subpart H. Data from the project-specific air monitoring station (WPTH-2) is used to supplement the fenceline monitoring of thorium emissions from the excavation of the waste pits. With the inclusion of isotopic thorium sampling at the fenceline monitors, beginning in the fourth quarter of 2000, one thorium monitor (WPTH-1) became redundant, therefore it was removed from service. Figure C.1-1 provides the location of IEMP air particulate monitoring stations during 2000.

Table C.1-1 provides an operational summary for the IEMP air monitoring stations in 2000. On average, the fenceline air monitors operated 99.2 percent of the time, and all monitors exceeded 95 percent operational time for the year. Routine maintenance and filter exchange combined with periodic electrical outages and equipment malfunctions create short periods of down time for each monitor throughout the year that result in operation times of less than 100 percent.

Biweekly Air Particulate Monitoring Results

Air filters were exchanged every two weeks at all the monitoring locations during 2000. The biweekly filters from the 16 fenceline monitors and two background monitors were analyzed for total uranium and total particulate, and beginning in the fourth quarter of 2000, all monitors were also analyzed for isotopic thorium. Table C.1-2 summarizes the results of the biweekly total uranium analyses. Table C.1-3 summarizes results from the biweekly total particulate monitoring. Figures C.1-2 through C.1-39 provide graphical information on the total uranium, total particulate, and isotopic thorium concentrations measured at each monitor during 2000.

The total uranium and particulate results for air monitoring in 2000 were generally consistent with the 1999 data and historical ranges. Temporary increases in total uranium and total particulate concentrations were observed along the eastern fenceline during the summer and fourth quarter of 2000. These temporary increases, which are particularly evident at AMS-3, AMS-8A, and AMS-9C, are attributable to the remediation

activities associated with the Waste Pits Remedial Action Project, on-site disposal facility and its associated material transfer area, and the Plant 5 Decontamination and Dismantlement Project.

Starting in the fourth quarter, all monitor filters were analyzed for isotopic thorium (thorium-228, thorium-230, and thorium-232). Tables C.1-4 through C.1-6 summarize the results of the biweekly isotopic thorium analyses and Figures C.1-21 through C.1-39 provide graphical information on the measured isotopic thorium concentrations. During 2000, the thorium-230 concentrations measured at AMS-28 (WPTH-1) and WPTH-2 increased with the start of waste pit excavation. As previously mentioned, thorium analysis was initiated in the fourth quarter in response to evolving work activities and dose contributions from thorium isotopes. Increases in thorium-230, the primary thorium isotope of concern, were also noted at the eastern fenceline, particularly at AMS-3, AMS-8A, and AMS-9C.

Slightly elevated levels of thorium-230 can be expected when large-scale remediation projects such as the excavation of the waste pits begin operations. Although the higher thorium-230 concentrations were measurable at the site fenceline, the annual average thorium-230 concentrations remain below one percent of the DOE-derived concentration guide value for thorium-230. During the course of the waste pit excavation, thorium-230 concentrations continue to be monitored and the data provided to the remediation projects to ensure that emission controls are operating as expected.

Airborne concentrations of thorium-228 and thorium-232 measured at WPTH-1 and WPTH-2 were comparable to background concentrations throughout 2000. This fenceline data reflect the fact that, in comparison to thorium-230, the concentrations of thorium-228 and thorium-232 in the waste pit material are relatively low thus far into the excavation of waste. The Waste Pits Remedial Action Project operations are not expected to significantly impact the fenceline concentrations of thorium-228 and thorium-232. With the initiation of biweekly thorium measurements at all fenceline monitors in October 2000, the WPTH-1 monitor was removed since biweekly thorium measurements were started at AMS-28, which was adjacent to WPTH-1.

Quarterly Composite Air Particulate Monitoring Results

An aliquot of the 16 fenceline and two background filters was maintained to provide a quarterly composite sample to be analyzed for isotopes of uranium, thorium, and radium-226. Table C.1-7 presents the annual average radionuclide concentrations calculated from the quarterly composite sample data. The results indicate the radionuclide concentrations are well below the DOE guidelines.

All air monitoring data are reviewed and evaluated according to criteria established in the IEMP. The data review focuses on tracking and trending data compared with historical data. Data evaluation includes a review

of the quality control measures utilized in the analysis of the samples. As a result of this data evaluation process, some 2000 quarterly composite data were rejected or unavailable as explained below:

- During both the first and fourth quarters of 2000, the radium-226 results at AMS-2 were rejected due to failure of multiple quality control checks by the contract laboratory. Sample re-analysis was not possible due to consumption of the sample. The loss of radium-226 data from AMS-2 during the first and fourth quarters does not significantly affect the compliance demonstration because radium-226 has not historically contributed the major dose fraction from FEMP emissions and AMS-2 has not historically been the maximum fenceline indicator sample location.

- During the second quarter of 2000, the results at AMS-16, one of the background monitors indicated elevated levels. Isotopic thorium levels were approximately six times those of AMS-12, the other background monitor; while isotopic uranium and radium-226 levels reflected values of three times those of AMS-12. An examination of the control checks indicated valid results. Because the background concentrations are subtracted from each fenceline monitor's concentrations in order to determine net FEMP emissions, any bias in background levels would carry through to the indicator results. The AMS-16 samples were reanalyzed which confirmed elevated background concentrations. Even though the results were confirmed valid, incorporating them might have produced artificially lower net fenceline concentrations. Therefore, the second quarter AMS-16 results were rejected as not representative of FEMP background concentrations. The rejection of the background data from AMS-16 during the second quarter does not significantly affect the compliance demonstration because of the conservative nature, insofar as this affect overestimates the FEMP air inhalation dose.

Evaluation of Isotopic Dose Contributions from FEMP Airborne Emissions

Historically, uranium has been the major contributor to the air inhalation dose from FEMP emissions. Uranium typically contributed greater than 62 percent of the effective dose equivalent based on an evaluation of monitoring results from 1990 through 1998 (post production era). In 2000 uranium isotopes (uranium-234, uranium-235/236, and uranium-238) contributed an average of 25 percent of the dose at the fenceline, while radium-226 contributed an average of 22 percent, and thorium isotopes (thorium-228, thorium-230, and thorium-232) contributed an average of 52 percent. Figures C.1-40 through C.1-42 illustrate the percentage contribution to dose from uranium, thorium, and radium-226 at each fenceline and background monitor. In order to improve the presentation of information and to focus on the primary contributors (uranium, thorium, and radium) to dose, only these contributions are shown on these figures. Contributions from radionuclides, which are assumed to be in equilibrium with their parent radionuclides, were not included in the figures. At all fenceline locations, the contribution from radionuclides assumed to be in equilibrium with their parent radionuclides was less than 10 percent of the dose from airborne emissions. In 1998 uranium isotopes contributed on average 76 percent of dose at the fenceline. The average percentage contribution from uranium isotopes in 1999 and 2000 (45 and 25 percent, respectfully) are significantly lower.

The decrease in the percentage of dose from uranium is a result of thorium-230 becoming the major dose contributor through fugitive emissions from the Waste Pits Remedial Action Project operations. Given the

methods required to excavate, transport, and process waste pit material, fugitive emissions were expected to increase the average concentration of thorium-230 at the fenceline. Although the project employs several environmental compliance-based dust abatement practices and controls, some fugitive emissions are expected to be generated from the project based on the large-scale waste handling operations.

TABLE C.1-1

OPERATIONAL SUMMARY FOR AIR PARTICULATE MONITORING STATIONS IN 2000

Location	Number of Samples	Sample Start Date	Last Sample Collection Date	Operating Time (hours)[a]	Percent Of Operation
Fenceline					
AMS-2	26	12/28/99	12/26/00	8706.8	99.7
AMS-3	26	12/28/99	12/26/00	8622.4	98.7
AMS-4	26	12/28/99	12/26/00	8549.5	97.9
AMS-5	26	12/28/99	12/26/00	8601.7	98.5
AMS-6	26	12/29/99	12/26/00	8616.6	98.9
AMS-7	26	12/28/99	12/26/00	8649.7	99.0
AMS-8A	26	12/28/99	12/26/00	8591.1	98.3
AMS-9C	26	12/28/99	12/26/00	8731.2	99.9
AMS-22	26	12/28/99	12/26/00	8699.4	99.6
AMS-23	26	12/28/99	12/26/00	8689.8	99.5
AMS-24	26	12/29/99	12/26/00	8644.8	99.2
AMS-25	26	12/29/99	12/26/00	8667.6	99.5
AMS-26	26	12/29/99	12/26/00	8670.0	99.5
AMS-27	26	12/29/99	12/26/00	8644.5	99.2
AMS-28	26	12/28/99	12/26/00	8717.2	99.8
AMS-29	26	12/28/99	12/26/00	8679.1	99.3
Background					
AMS-12	26	12/28/99	12/26/00	8680.8	99.4
AMS-16	26	12/28/99	12/26/00	8649.7	99.0
Project-Specific					
WPTH-1[b]	20	12/28/99	10/3/00	6551.2	97.5
WPTH-2	26	12/28/99	12/26/00	8683.7	99.4

[a]8736 available operating hours from December 28, 1999 through December 26, 2000; 8712 available operating hours from December 29, 1999 through December 26, 2000; 6720 available operating hours from December 28, 1999 through October 3, 2000
[b]Operation of WPTH-1 monitor was suspended in October of 2000. Biweekly thorium analysis at AMS-28, which was adjacent to WPTH-1, made the WPTH-1 monitor redundant.

TABLE C.1-2
TOTAL URANIUM PARTICULATE CONCENTRATIONS IN AIR

	Summary of 2000 Results[b] (pCi/m^3 x 1E-06)				Summary of 1999 Results[b] (pCi/m^3 x 1E-06)				1990 through 1998 Summary Results[b] (pCi/m^3 x 1E-06)	
Location[a]	No. of Samples	Min.	Max.	Avg.	No. of Samples	Min.	Max.	Avg.	Min.	Max.
Fenceline										
AMS-2	26	18	264	89	25	9.5	269	57	0	3500
AMS-3	26	34	988	223	26	12	585	146	0	17000
AMS-4	26	10	185	45	26	0	109	29	0	2300
AMS-5	26	0	203	41	26	0	72	25	0	4400
AMS-6	26	0	259	87	26	3.2	453	55	0	3200
AMS-7	26	2.7	101	35	26	0	83	24	0	7800
AMS-8A	26	25	841	191	26	0	1135	130	0	900
AMS-9C[c]	26	26	545	187	26	9.2	409	102	0	562
AMS-22	26	0.52	238	73	26	0	89	35	0	101
AMS-23	26	10	191	68	26	0	202	49	9	194
AMS-24	26	0	207	43	26	0	112	24	0	65
AMS-25	26	0	215	35	26	0	402	33	0	79
AMS-26	26	9.4	267	50	26	0	171	31	0	98
AMS-27	26	0	170	54	26	0	101	30	0	64
AMS-28	26	2.2	153	63	26	0	445	40	0	216
AMS-29	26	10	326	76	26	0	199	41	0	121
Background										
AMS-12	26	0	43	13	26	0	45	8.1	0	107
AMS-16	26	2.6	143	19	26	0	37	16	0	106

[a]Refer to Figure C.1-1 for sample locations
[b]For blank corrected concentrations less than or equal to 0.0 pCi/m^3, the concentration is set at 0.0 pCi/m^3.
[c]Summary results for 1990 through 1998 include AMS-9B/C data.

TABLE C.1-3
TOTAL PARTICULATE CONCENTRATIONS IN AIR

	Summary of 2000 Results (µg/m³)				Summary of 1999 Results[b] (µg/m³)				1990 through 1998 Summary Results[b] (µg/m³)	
Location[a]	No. of Samples	Min.	Max.	Avg.	No. of Samples	Min.	Max.	Avg.	Min.	Max.
Fenceline										
AMS-2	26	17	39	29	26	11	69	34	7	77
AMS-3	26	17	44	30	26	19	83	37	8	159
AMS-4	26	19	55	31	26	18	74	38	13	79
AMS-5	26	20	44	28	26	18	45	29	9.6	62
AMS-6	26	20	45	30	26	19	48	32	8	69
AMS-7	26	20	52	32	26	20	84	34	13	76
AMS-8A	26	20	67	33	26	20	63	37	18	89
AMS-9C[c]	26	19	46	31	26	19	66	38	7.1	136
AMS-22	26	21	45	31	26	16	53	37	13	57
AMS-23	26	11	45	27	26	18	57	30	15	51
AMS-24	26	5	54	32	26	13	57	38	18	79
AMS-25	26	23	47	32	26	17	45	31	21	40
AMS-26	26	20	40	28	26	19	52	31	15	51
AMS-27	26	30	72	47	26	16	92	50	24	86
AMS-28	26	16	68	27	26	15	51	28	12	49
AMS-29	26	18	45	30	26	18	52	33	11	62
Background										
AMS-12[d]	26	17	39	26	26	16	48	29	6	416
AMS-16[d]	26	27	52	39	26	26	61	44	18	84
Project-Specific[e]										
WPTH-2	26	25	46	33	NS	NA	NA	NA	NA	NA

[a]Refer to Figure C.1-1 for sample locations
[b]NA = not applicable
NS = not sampled
[c]Summary results for 1990 through 1998 include AMS-9B/C data.
[d]Total particulate analysis was discontinued during 1994 and was reinstated in 1997 for AMS-12 and AMS-16.
[e]Total particulate analysis began in 2000 at project-specific monitor.

TABLE C.1-4

THORIUM-228 PARTICULATE CONCENTRATIONS IN AIR

	Summary of 2000 Results (pCi/m^3 x 1E-06)				Summary of 1999 Results[c] (pCi/m^3 x 1E-06)				1990 through 1998 Summary Results[c] (pCi/m^3 x 1E-06)	
Location[a]	No. of Samples[b]	Min.	Max.	Avg.	No. of Samples	Min.	Max.	Avg.	Min.	Max.
Fenceline										
AMS-2	6	0.8	10	5.0	NS	NA	NA	NA	NA	NA
AMS-3	6	1.1	10	4.5	NS	NA	NA	NA	NA	NA
AMS-4	6	0.0	8.6	4.2	NS	NA	NA	NA	NA	NA
AMS-5	6	0.0	6.1	3.6	NS	NA	NA	NA	NA	NA
AMS-6	6	0.0	8.1	5.5	NS	NA	NA	NA	NA	NA
AMS-7	6	4.4	11	7.1	NS	NA	NA	NA	NA	NA
AMS-8A	6	1.2	13	5.6	NS	NA	NA	NA	NA	NA
AMS-9C	6	3.0	13	6.1	NS	NA	NA	NA	NA	NA
AMS-22	6	1.4	8.6	5.7	NS	NA	NA	NA	NA	NA
AMS-23	6	0.0	7.6	3.0	NS	NA	NA	NA	NA	NA
AMS-24	6	0.38	7.5	5.2	NS	NA	NA	NA	NA	NA
AMS-25	6	0.0	6.7	3.2	NS	NA	NA	NA	NA	NA
AMS-26	6	2.6	14	6.0	NS	NA	NA	NA	NA	NA
AMS-27	6	0.37	7.4	3.4	NS	NA	NA	NA	NA	NA
AMS-28[d]	6	1.1	14	5.7	25	0	14	5.3	8.4	9.4
AMS-29	6	0.0	7.1	3.2	NS	NA	NA	NA	NA	NA
Background										
AMS-12	6	0.0	6.7	1.9	NS	NA	NA	NA	NA	NA
AMS-16	6	0.0	17	7.1	NS	NA	NA	NA	NA	NA
Project-Specific[e]										
WPTH-2	26	0.0	13	6.5	26	0	17	8.4	3.5	7.9

[a]Refer to Figure C.1-1 for sample locations
[b]Sampling began during the fourth quarter of 2000.
[c]NA = not applicable
NS = not sampled
[d]Summary results for AMS-28 include WPTH-1; these monitors are adjacent.
[e]Project-specific monitor began operation on November 3, 1998.

TABLE C.1-5

THORIUM-230 PARTICULATE CONCENTRATIONS IN AIR

	Summary of 2000 Results (pCi/m^3 x 1E-06)				Summary of 1999 Results[c] (pCi/m^3 x 1E-06)				1990 through 1998 Summary Results[c] (pCi/m^3 x 1E-06)	
Location[a]	No. of Samples[b]	Min.	Max.	Avg.	No. of Samples	Min.	Max.	Avg.	Min.	Max.
Fenceline										
AMS-2	6	3.1	27	13	NS	NA	NA	NA	NA	NA
AMS-3	6	3.4	63	28	NS	NA	NA	NA	NA	NA
AMS-4	6	0.0	23	11	NS	NA	NA	NA	NA	NA
AMS-5	6	0.0	43	14	NS	NA	NA	NA	NA	NA
AMS-6	6	0.0	74	36	NS	NA	NA	NA	NA	NA
AMS-7	6	0.0	44	21	NS	NA	NA	NA	NA	NA
AMS-8A	6	6.3	71	29	NS	NA	NA	NA	NA	NA
AMS-9C	6	12	78	38	NS	NA	NA	NA	NA	NA
AMS-22	6	12	46	24	NS	NA	NA	NA	NA	NA
AMS-23	6	1.5	19	9.5	NS	NA	NA	NA	NA	NA
AMS-24	6	3.4	24	12	NS	NA	NA	NA	NA	NA
AMS-25	6	0.37	23	11	NS	NA	NA	NA	NA	NA
AMS-26	6	2.6	37	15	NS	NA	NA	NA	NA	NA
AMS-27	6	0.0	99	27	NS	NA	NA	NA	NA	NA
AMS-28[d]	6	7.5	357	94	25	0	83	19	11	20
AMS-29	6	6.1	45	18	NS	NA	NA	NA	NA	NA
Background										
AMS-12	6	0.0	9.3	3.3	NS	NA	NA	NA	NA	NA
AMS-16	6	0.0	18	9.2	NS	NA	NA	NA	NA	NA
Project-Specific[e]										
WPTH-2	26	0.73	557	96	26	1.2	116	24	11	18

[a]Refer to Figure C.1-1 for sample locations
[b]Sampling began during the fourth quarter of 2000.
[c]NA = not applicable
NS = not sampled
[d]Summary results for AMS-28 include WPTH-1; these monitors are adjacent.
[e]Project-specific monitor began operation on November 3, 1998.

TABLE C.1-6

THORIUM-232 PARTICULATE CONCENTRATIONS IN AIR

	Summary of 2000 Results (pCi/m^3 x 1E-06)				Summary of 1999 Results[c] (pCi/m^3 x 1E-06)				1990 through 1998 Summary Results[c] (pCi/m^3 x 1E-06)	
Location[a]	No. of Samples[b]	Min.	Max.	Avg.	No. of Samples	Min.	Max.	Avg.	Min.	Max.
Fenceline										
AMS-2	6	0.0	8.6	3.7	NS	NA	NA	NA	NA	NA
AMS-3	6	0.0	9.8	5.3	NS	NA	NA	NA	NA	NA
AMS-4	6	0.0	9.3	3.9	NS	NA	NA	NA	NA	NA
AMS-5	6	0.0	9.1	3.3	NS	NA	NA	NA	NA	NA
AMS-6	6	0.0	8.1	3.9	NS	NA	NA	NA	NA	NA
AMS-7	6	0.38	12	5.0	NS	NA	NA	NA	NA	NA
AMS-8A	6	0.0	8.4	5.1	NS	NA	NA	NA	NA	NA
AMS-9C	6	1.8	11	5.5	NS	NA	NA	NA	NA	NA
AMS-22	6	0.0	6.5	3.8	NS	NA	NA	NA	NA	NA
AMS-23	6	0.0	5.2	3.1	NS	NA	NA	NA	NA	NA
AMS-24	6	0.0	9.1	5.0	NS	NA	NA	NA	NA	NA
AMS-25	6	1.1	10	3.8	NS	NA	NA	NA	NA	NA
AMS-26	6	0.38	14	4.0	NS	NA	NA	NA	NA	NA
AMS-27	6	0.0	7.8	4.0	NS	NA	NA	NA	NA	NA
AMS-28[d]	6	0.0	17	6.0	25	0	12	5.2	6.5	12
AMS-29	6	0.0	13	4.5	NS	NA	NA	NA	NA	NA
Background										
AMS-12	6	0.0	9.3	4.8	NS	NA	NA	NA	NA	NA
AMS-16	6	0.0	14	6.0	NS	NA	NA	NA	NA	NA
Project-Specific[e]										
WPTH-2	26	0.0	13	6.4	26	0	17	7.8	2.7	13

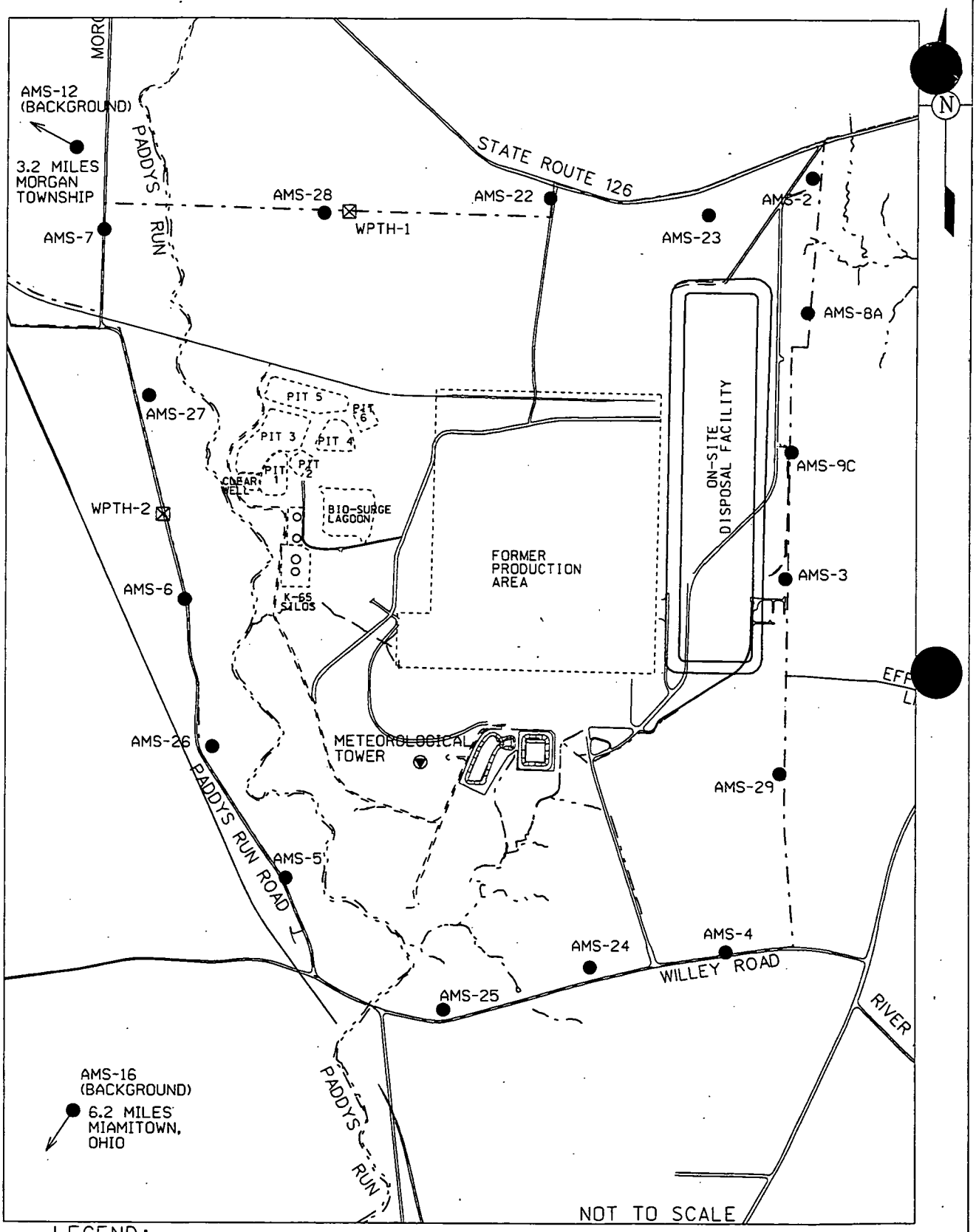
[a]Refer to Figure C.1-1 for sample locations
[b]Sampling began during the fourth quarter of 2000.
[c]NA = not applicable
NS = not sampled
[d]Summary results for AMS-28 include WPTH-1; these monitors are adjacent.
[e]Project-specific monitor began operation on November 3, 1998.

TABLE C.1-7

RADIONUCLIDE PARTICULATE CONCENTRATIONS IN AIR DURING 2000

	Gross Concentrations (pCi/m³)[a]											
Location[b]	Uranium-238	Uranium-234	Uranium-235/ Uranium-236	Thorium-228	Thorium-230	Thorium-232	Radium-226	Thorium-234[c]	Radium-228[c]	Actinium-228[c]	Radium-224[c]	Thorium-231[c]
Fenceline												
AMS-2	5.1E-03	3.7E-03	2.3E-04	8.6E-05	1.0E-02	1.0E-03	0.0E+00	1.9E-05	1.1E-04	1.8E-07	4.3E-06	5.8E-09
AMS-3	1.5E-02	1.1E-02	9.3E-04	1.1E-03	5.5E-02	6.9E-03	1.6E-02	5.6E-05	7.3E-04	1.2E-06	2.9E-05	2.4E-08
AMS-4	2.1E-03	1.7E-03	2.1E-04	1.8E-04	8.2E-03	2.4E-03	4.2E-03	7.9E-06	2.5E-04	4.0E-07	9.8E-06	5.4E-09
AMS-5	2.5E-03	1.5E-03	9.7E-05	1.2E-04	8.8E-03	5.9E-04	7.2E-03	9.3E-06	6.2E-05	9.8E-08	2.4E-06	2.5E-09
AMS-6	4.8E-03	2.8E-03	1.7E-04	0.0E+00	1.7E-02	1.6E-03	1.6E-03	1.8E-05	1.6E-04	2.6E-07	6.4E-06	4.5E-09
AMS-7	1.8E-03	1.3E-03	9.1E-05	8.9E-06	5.0E-03	6.1E-04	5.5E-03	7.0E-06	6.4E-05	1.0E-07	2.5E-06	2.3E-09
AMS-8A	1.1E-02	9.1E-03	6.2E-04	5.6E-04	2.3E-02	3.2E-03	6.2E-03	4.3E-05	3.4E-04	5.4E-07	1.3E-05	1.6E-08
AMS-9C	9.5E-03	7.1E-03	5.0E-04	5.6E-04	3.0E-02	6.8E-03	1.1E-02	3.6E-05	7.1E-04	1.1E-06	2.8E-05	1.3E-08
AMS-22	3.6E-03	2.2E-03	1.1E-04	3.4E-04	1.2E-02	1.3E-03	2.4E-03	1.4E-05	1.4E-04	2.2E-07	5.3E-06	2.9E-09
AMS-23	3.4E-03	2.0E-03	9.6E-05	3.7E-04	1.0E-02	2.2E-03	4.7E-03	1.3E-05	2.3E-04	3.7E-07	9.0E-06	2.4E-09
AMS-24	3.7E-03	2.9E-03	2.1E-04	5.3E-04	1.6E-02	2.8E-03	3.6E-03	1.4E-05	2.9E-04	4.7E-07	1.1E-05	5.4E-09
AMS-25	2.1E-03	1.5E-03	9.4E-05	4.0E-04	9.3E-03	1.9E-03	1.3E-02	8.0E-06	2.0E-04	3.2E-07	8.0E-06	2.4E-09
AMS-26	3.0E-03	1.9E-03	1.5E-04	2.0E-04	8.3E-03	0.0E+00	5.6E-03	1.1E-05	0.0E+00	0.0E+00	0.0E+00	3.9E-09
AMS-27	2.8E-03	1.8E-03	8.1E-05	8.7E-04	1.0E-02	2.2E-03	1.2E-02	1.1E-05	2.4E-04	3.8E-07	9.3E-06	2.1E-09
AMS-28	4.3E-03	1.9E-03	2.4E-04	0.0E+00	1.5E-02	0.0E+00	5.9E-03	1.6E-05	0.0E+00	0.0E+00	0.0E+00	6.0E-09
AMS-29	4.8E-03	3.5E-03	3.3E-04	4.7E-04	1.3E-02	2.4E-03	1.2E-02	1.8E-05	2.5E-04	4.0E-07	9.8E-06	8.5E-09
Background												
AMS-12	7.8E-04	7.7E-04	2.6E-05	1.8E-03	1.8E-03	5.8E-03	2.1E-02	2.9E-06	6.1E-04	9.8E-07	2.4E-05	6.7E-10
AMS-16[d]	8.9E-04	9.3E-04	0.0E+00	2.5E-03	2.6E-03	9.9E-03	2.4E-02	3.4E-06	1.0E-03	1.7E-06	4.1E-05	0.0E+00
DCG[e]	1.0E-01	9.0E-02	1.0E-01	4.0E-02	4.0E-02	7.0E-03	1.0E+00	4.0E+02	3.0E+00	4.0E+01	4.0E+00	1.0E+04

[a]A ratio of 0.0 indicates the filter results were less than or equal to the blank results, and/or the indicator concentrations were less than or equal to the average net background concentrations.
[b]Refer to Figure C.1-1 for sample locations
[c]Isotopes assumed to be in equilibrium with their parents
[d]Second quarter AMS-16 background sample results were rejected because not representative of historical background levels.
[e]Derived concentration guidelines (DCG) for air (Ci/mL · 1.0E+12 pCi/m³) from DOE Order 5400.5., Radiation Protection of the Public and the Environment, February 1990. Continuous inhalation of this concentration for one year will result in a committed effective dose equivalent of 100 mrem (1mSv).



LEGEND:

FEMP BOUNDARY

AMS LOCATION

DISTANCE FROM CENTER OF FORMER PRODUCTION AREA TO AMS LOCATION OFF MAP

THORIUM MONITOR LOCATI

FIGURE C.1-1. IEMP AIR MONITORING LOCATIONS

V:/5FGP1/DGN/00ANNUAL/00AN006.DGN

12-13-00

000407

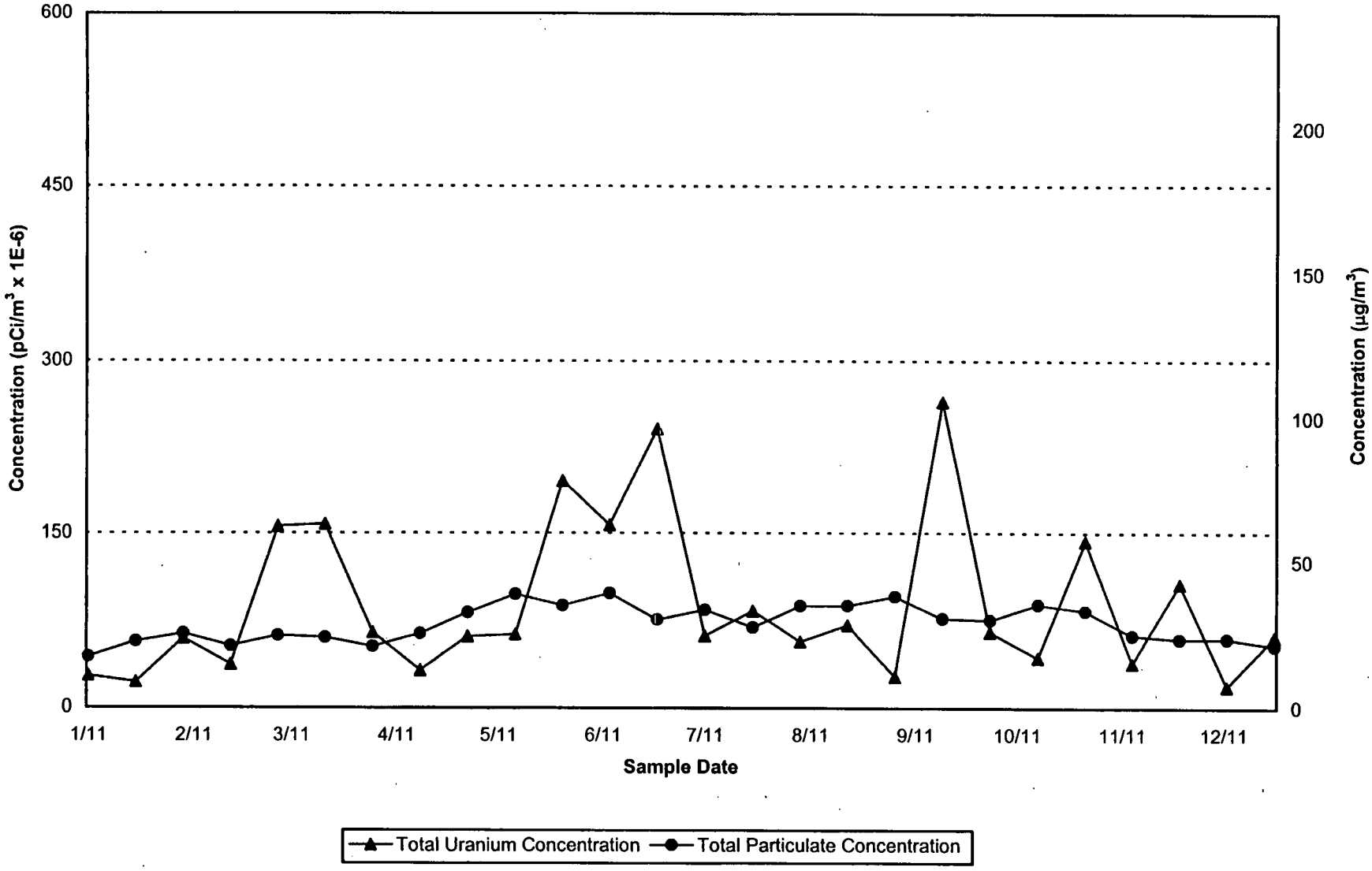


FIGURE C.1-2. 2000 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-2)

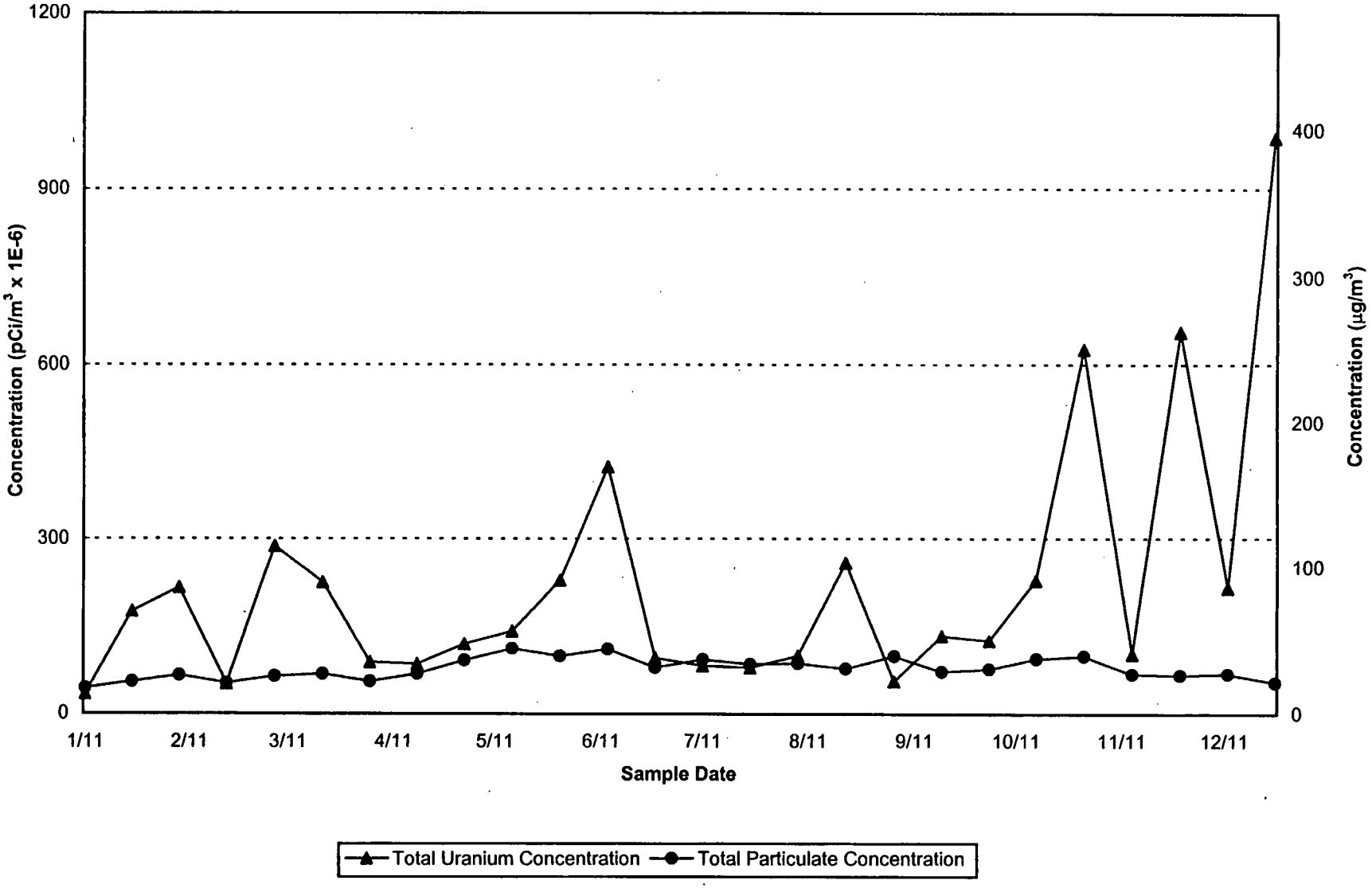


FIGURE C.1-3. 2000 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-3)

000409

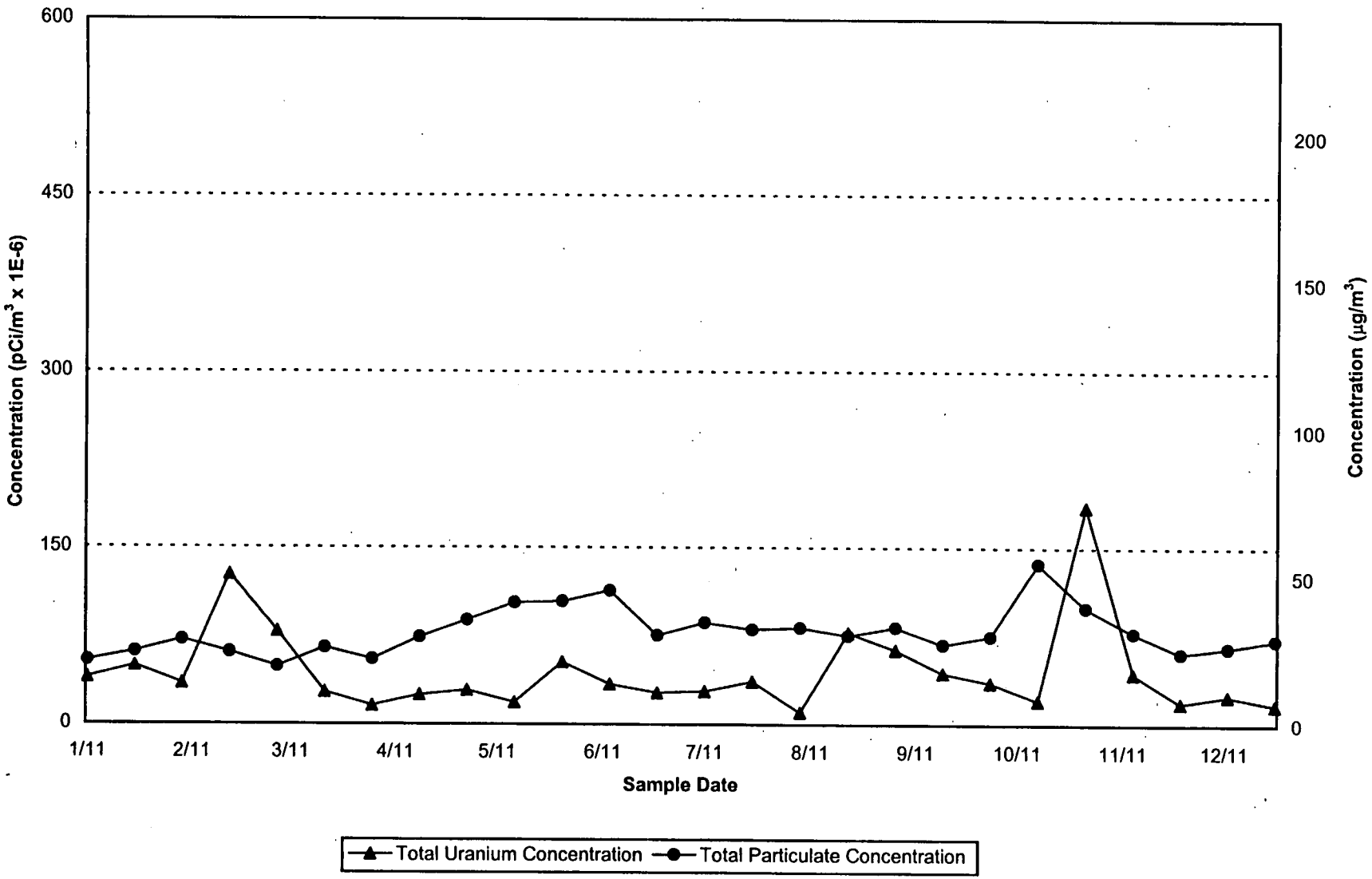


FIGURE C.1-4. 2000 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-4)

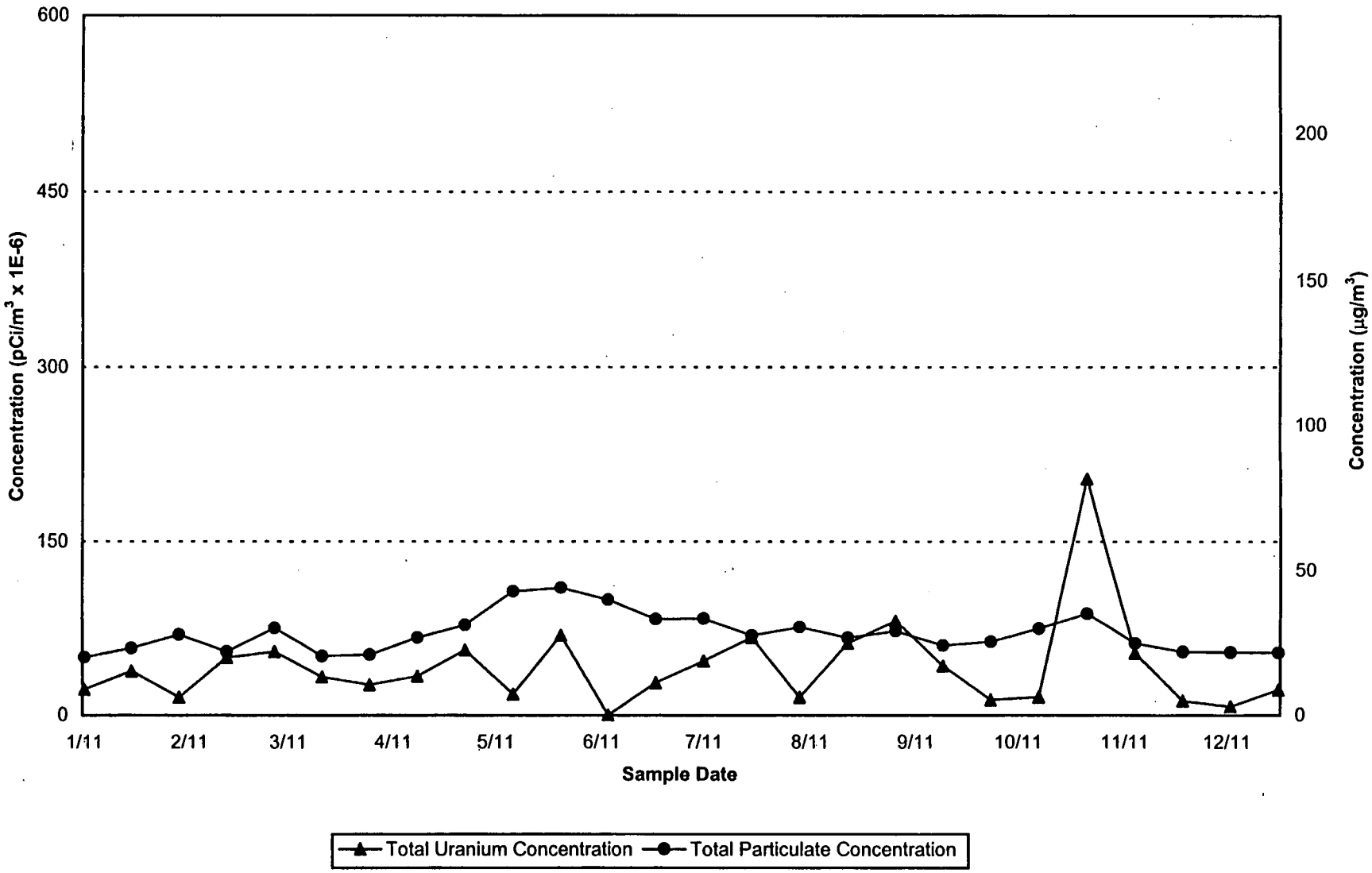


FIGURE C.1-5. 2000 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-5)

000411

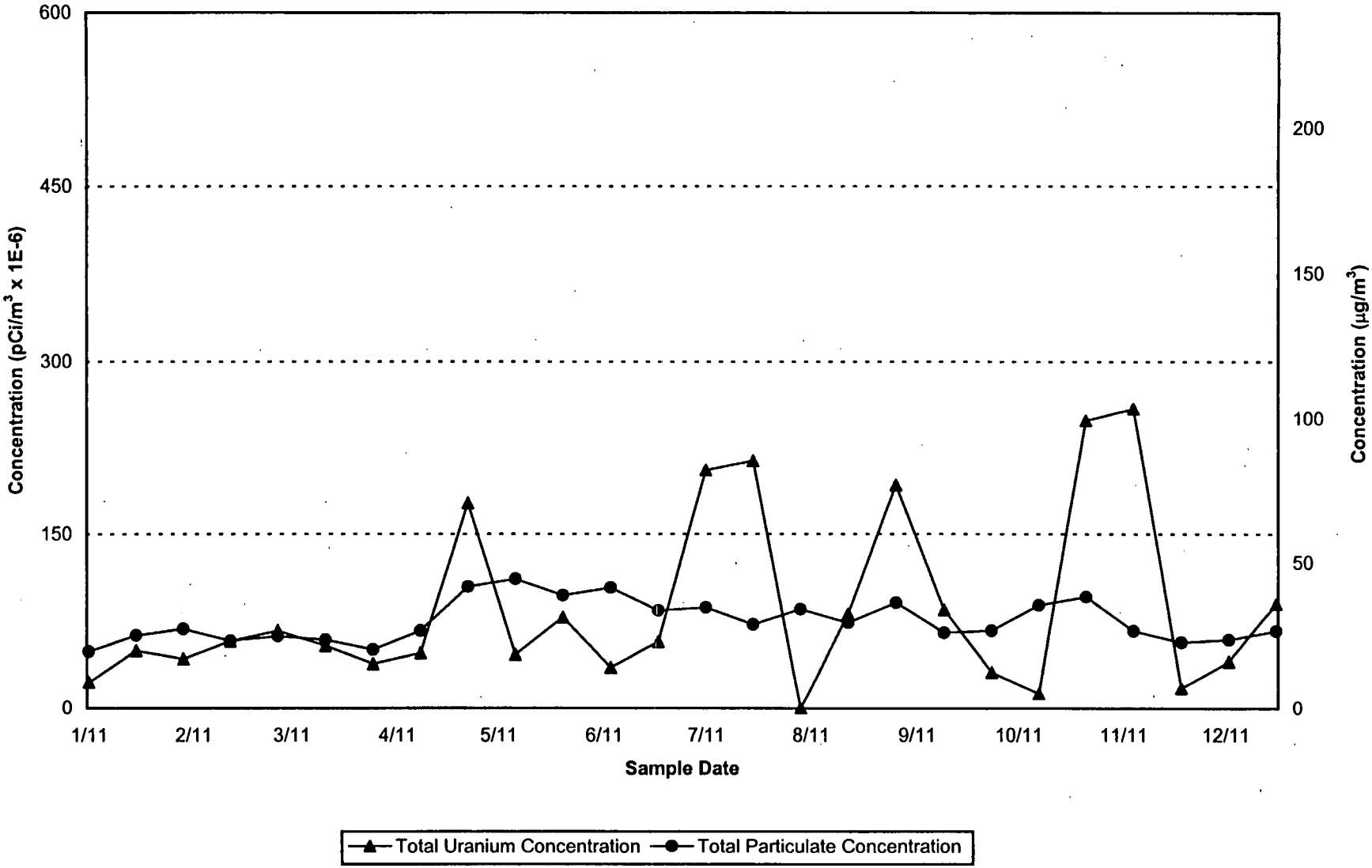


FIGURE C.1-6. 2000 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-6)

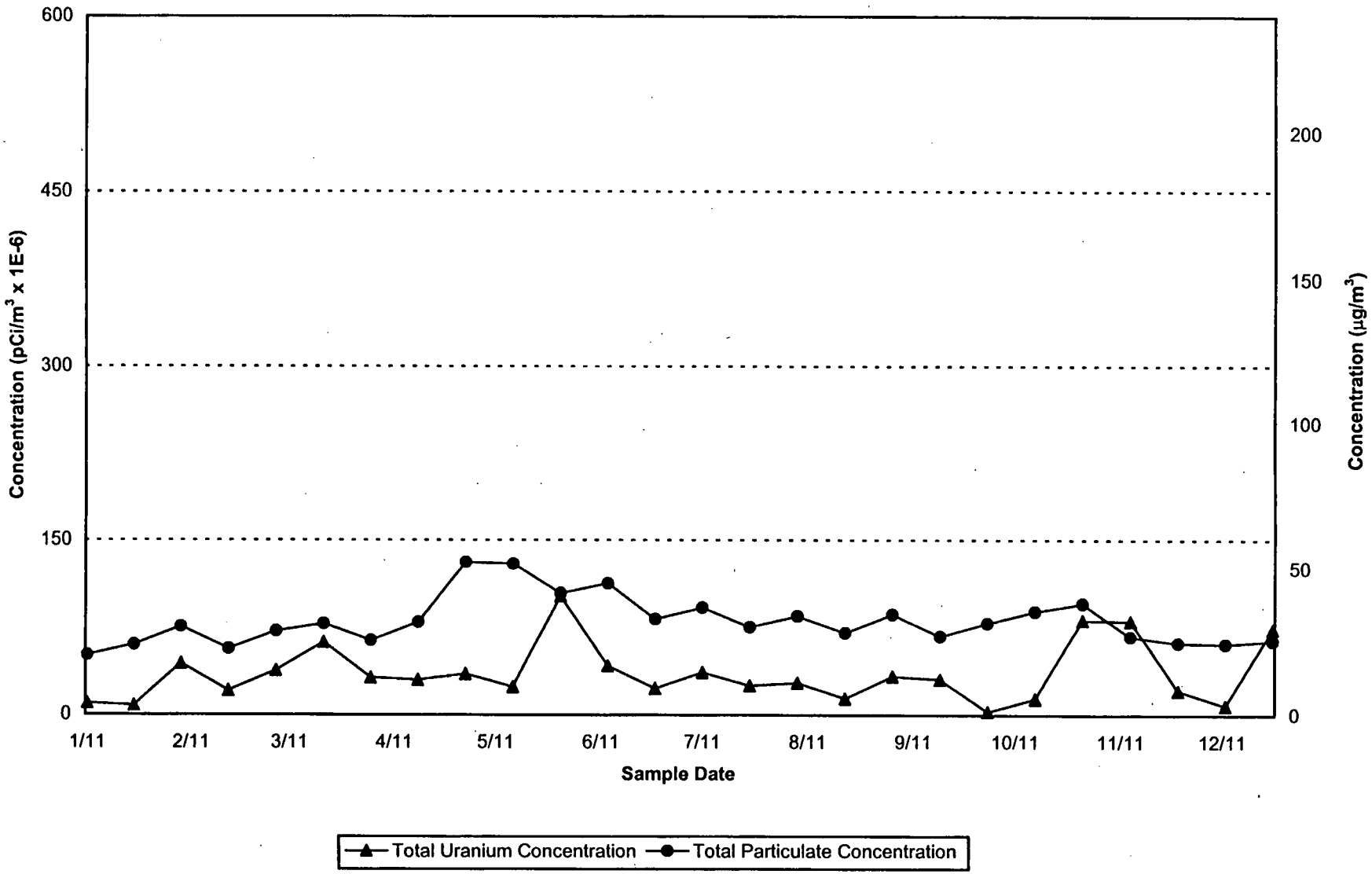


FIGURE C.1-7. 2000 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-7)

000413

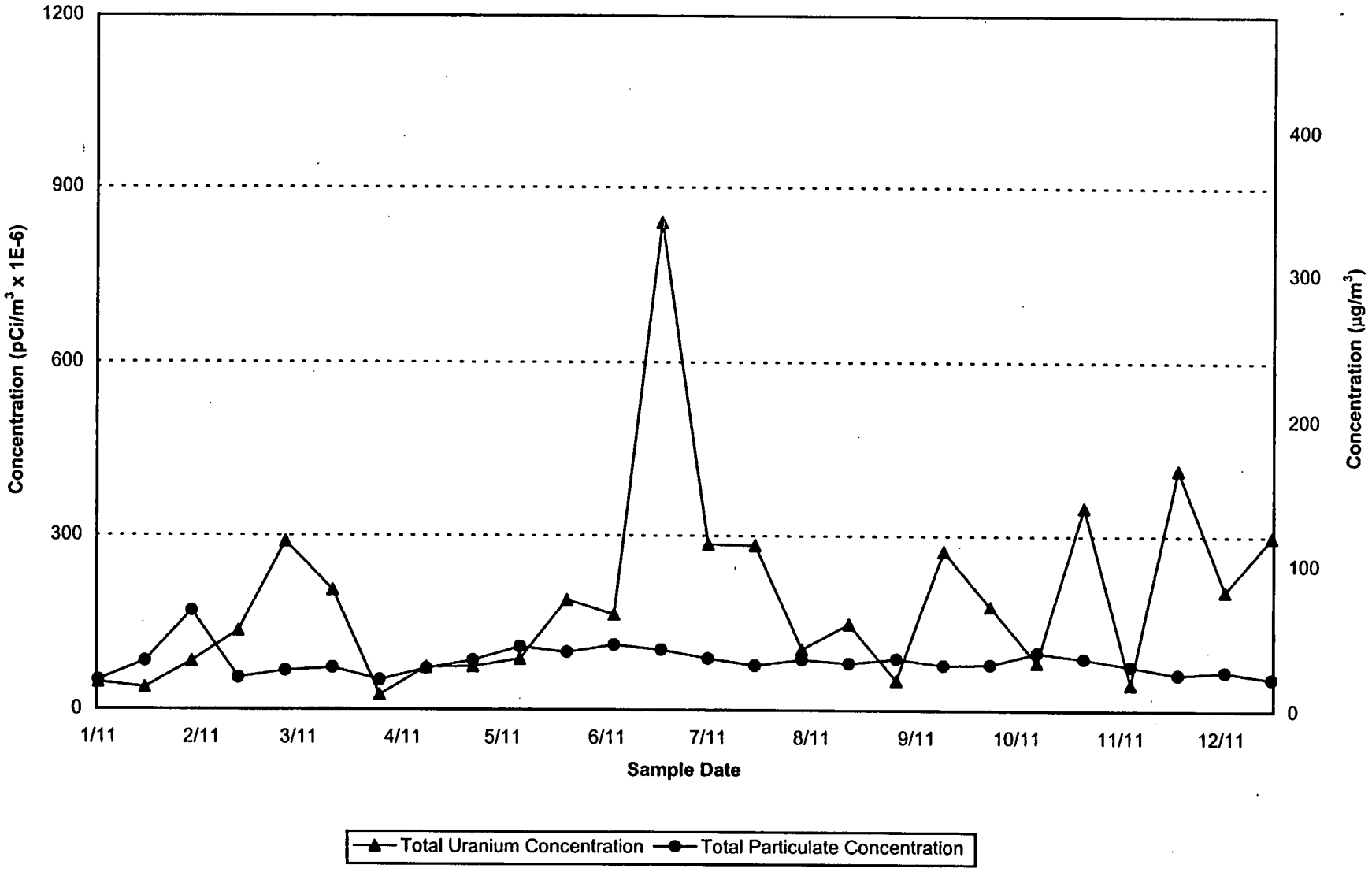


FIGURE C.1-8. 2000 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-8A)

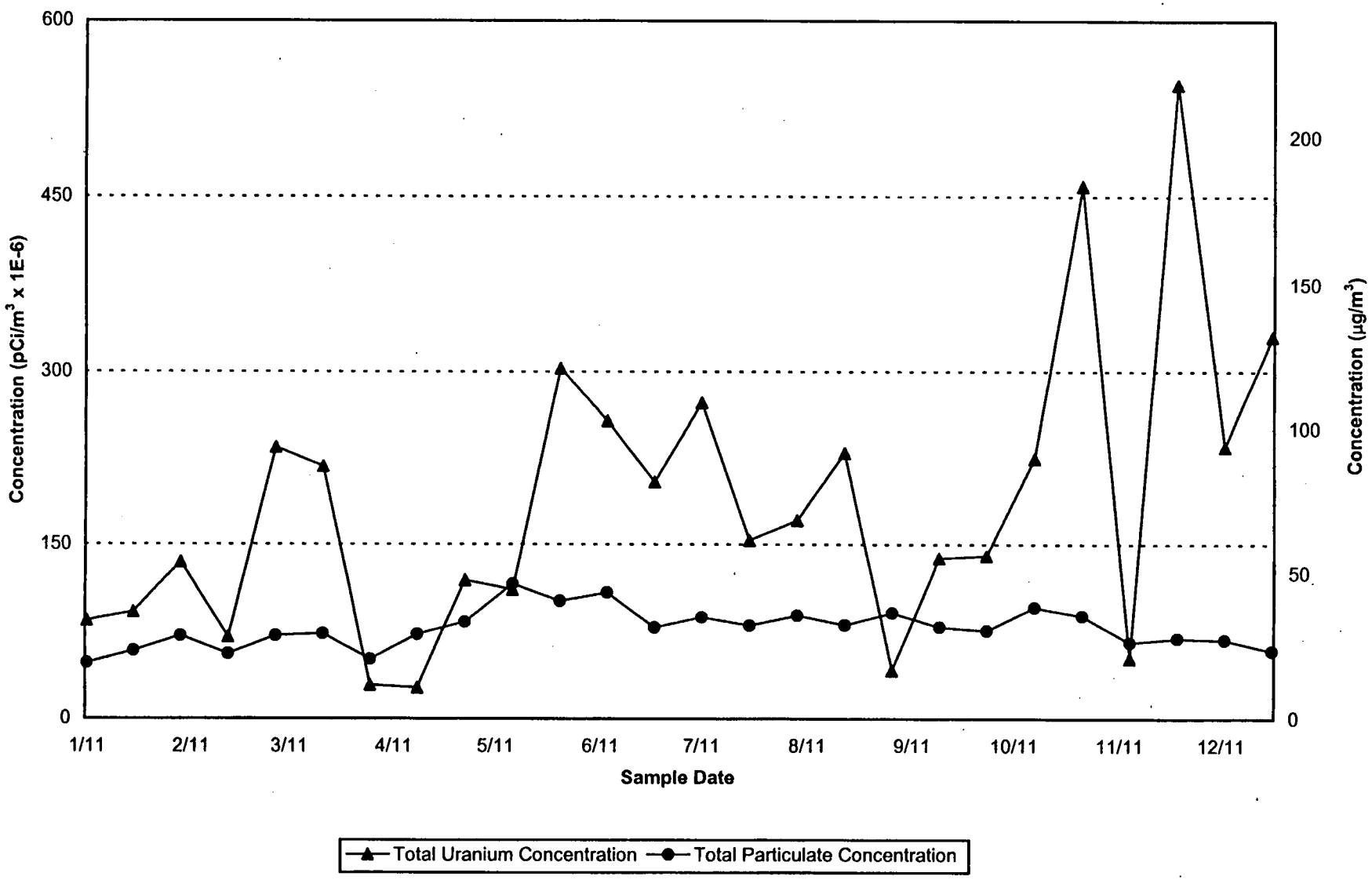


FIGURE C.1-9. 2000 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-9C)

000415

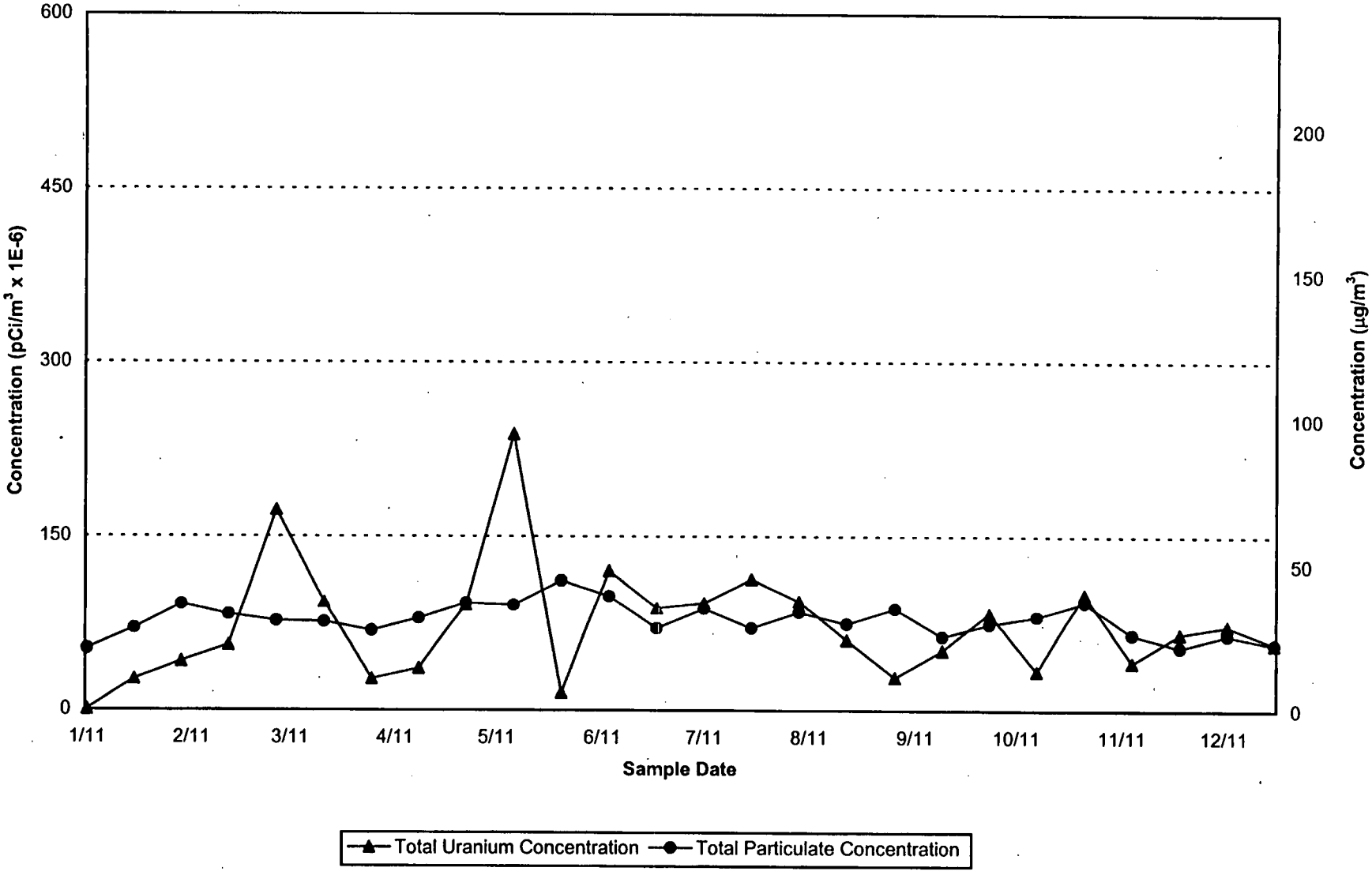


FIGURE C.1-10. 2000 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-22)

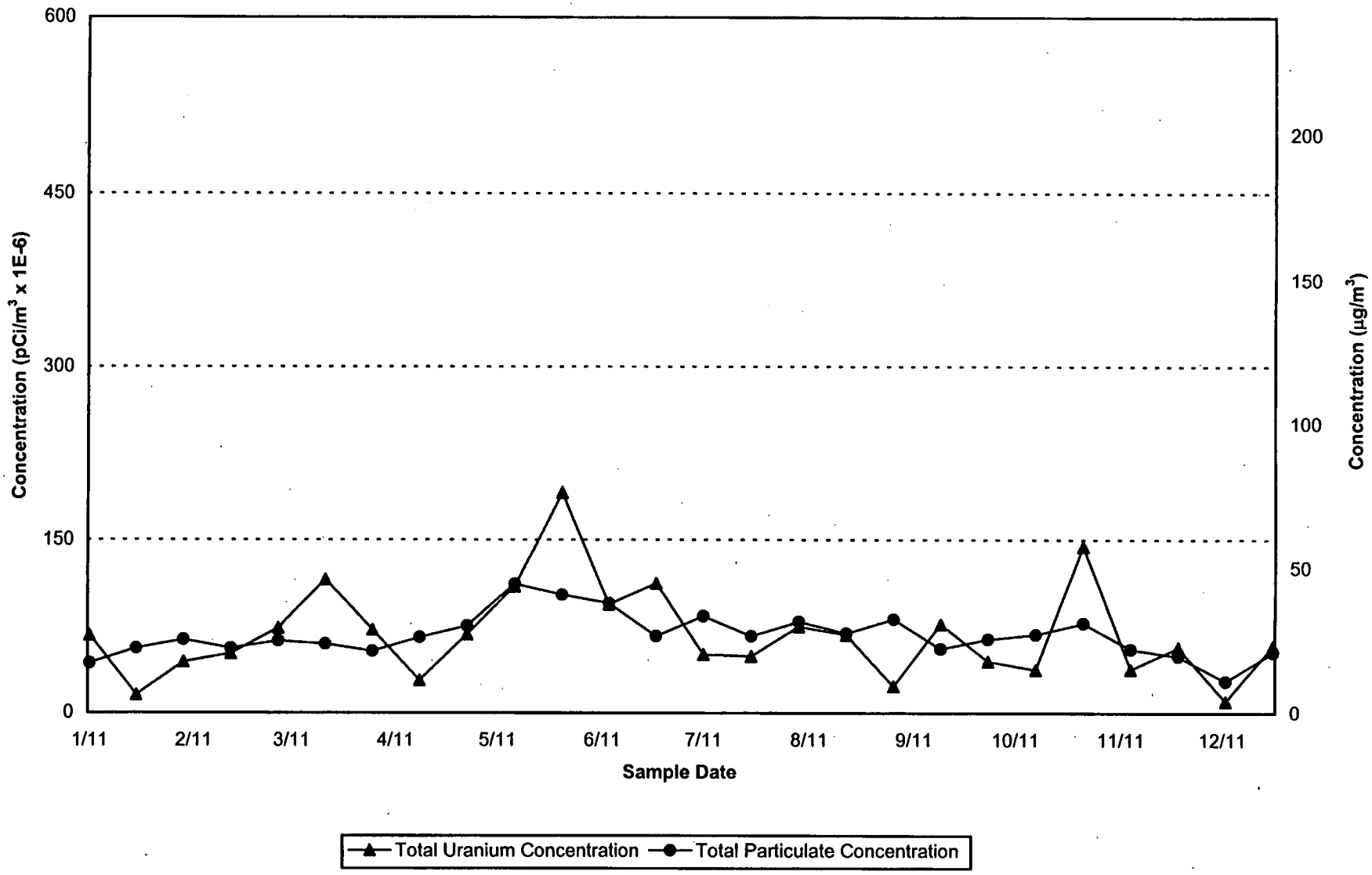


FIGURE C.1-11. 2000 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-23)

000417

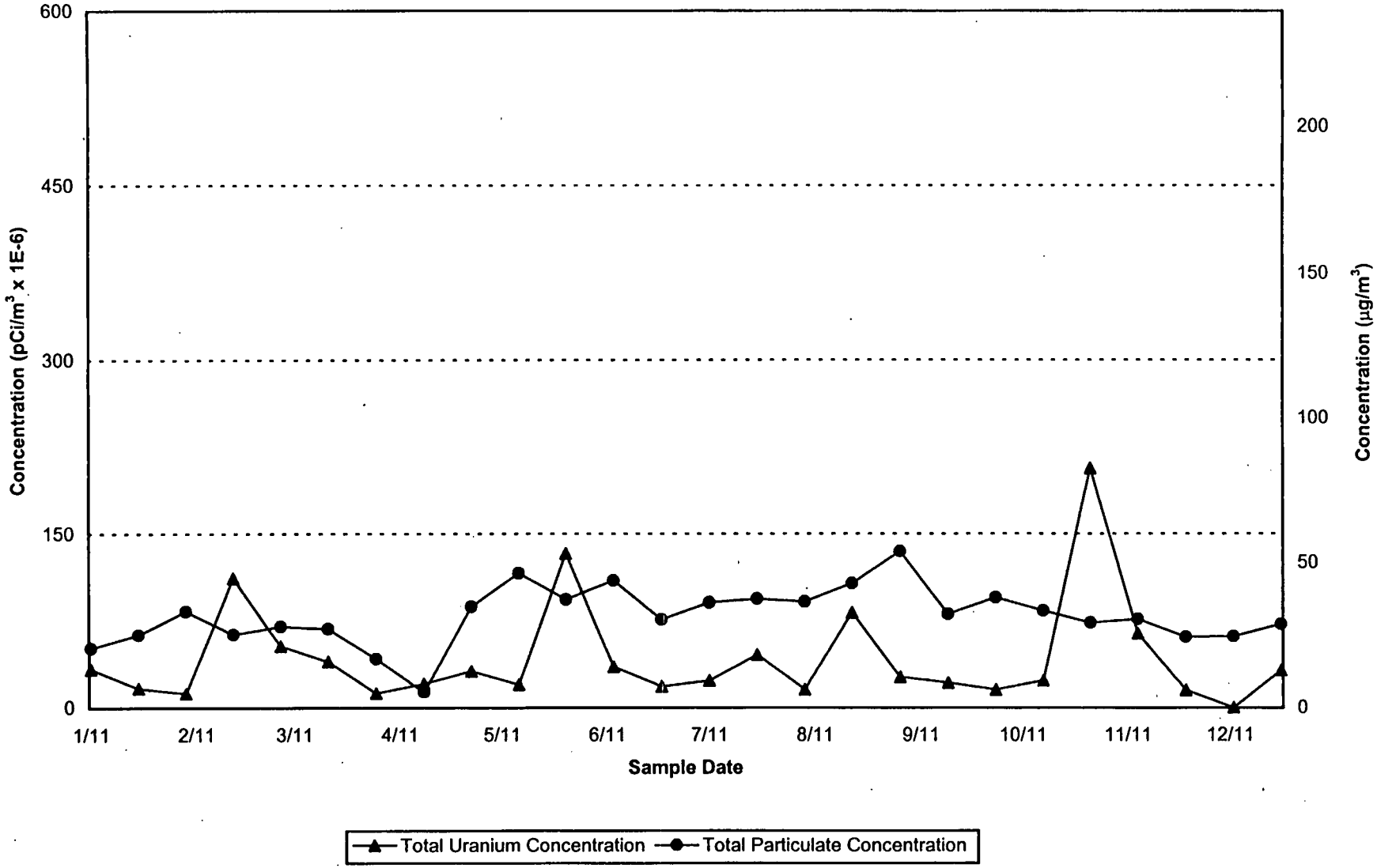


FIGURE C.1-12. 2000 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-24)

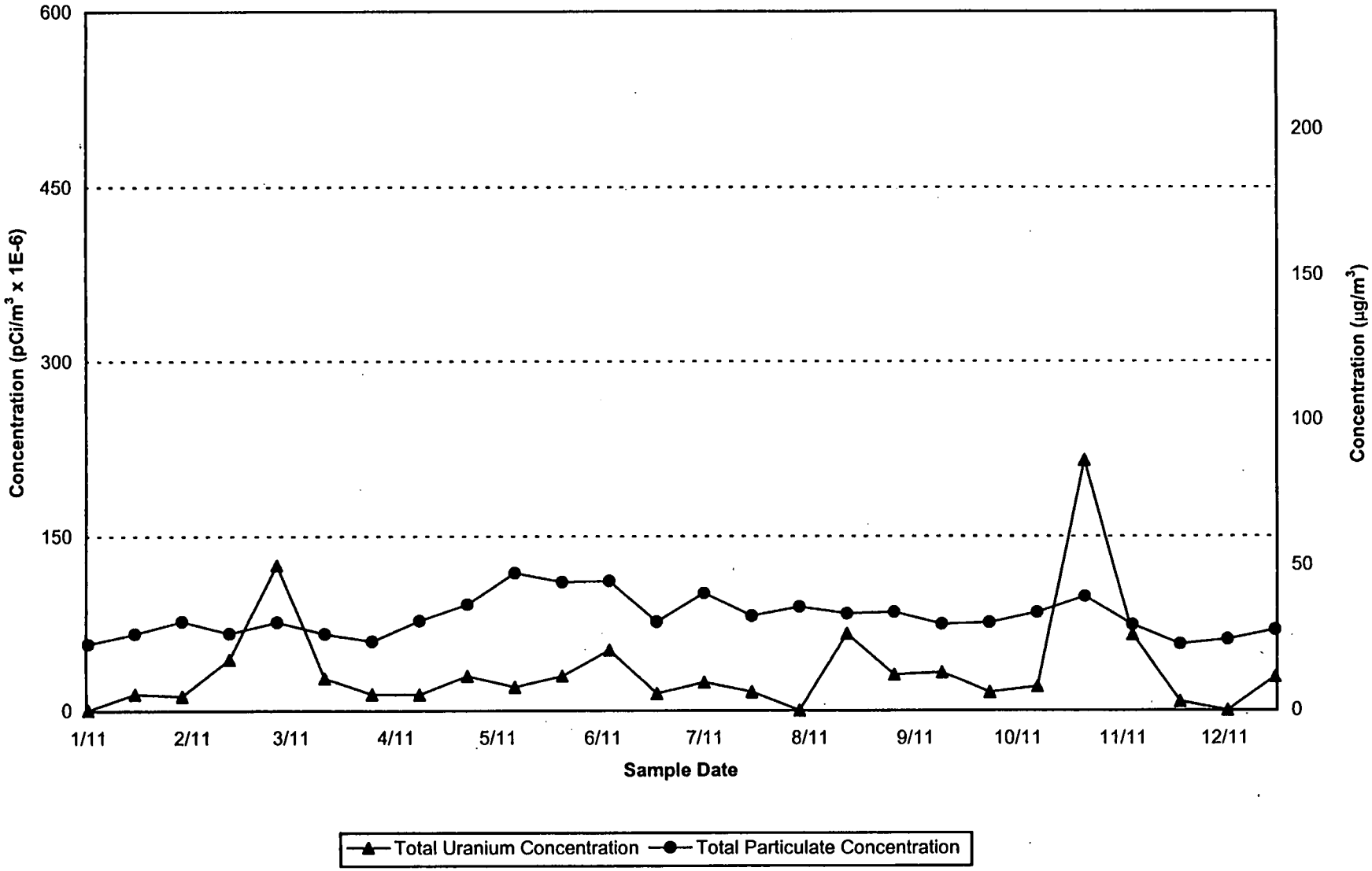


FIGURE C.1-13. 2000 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-25)

000419

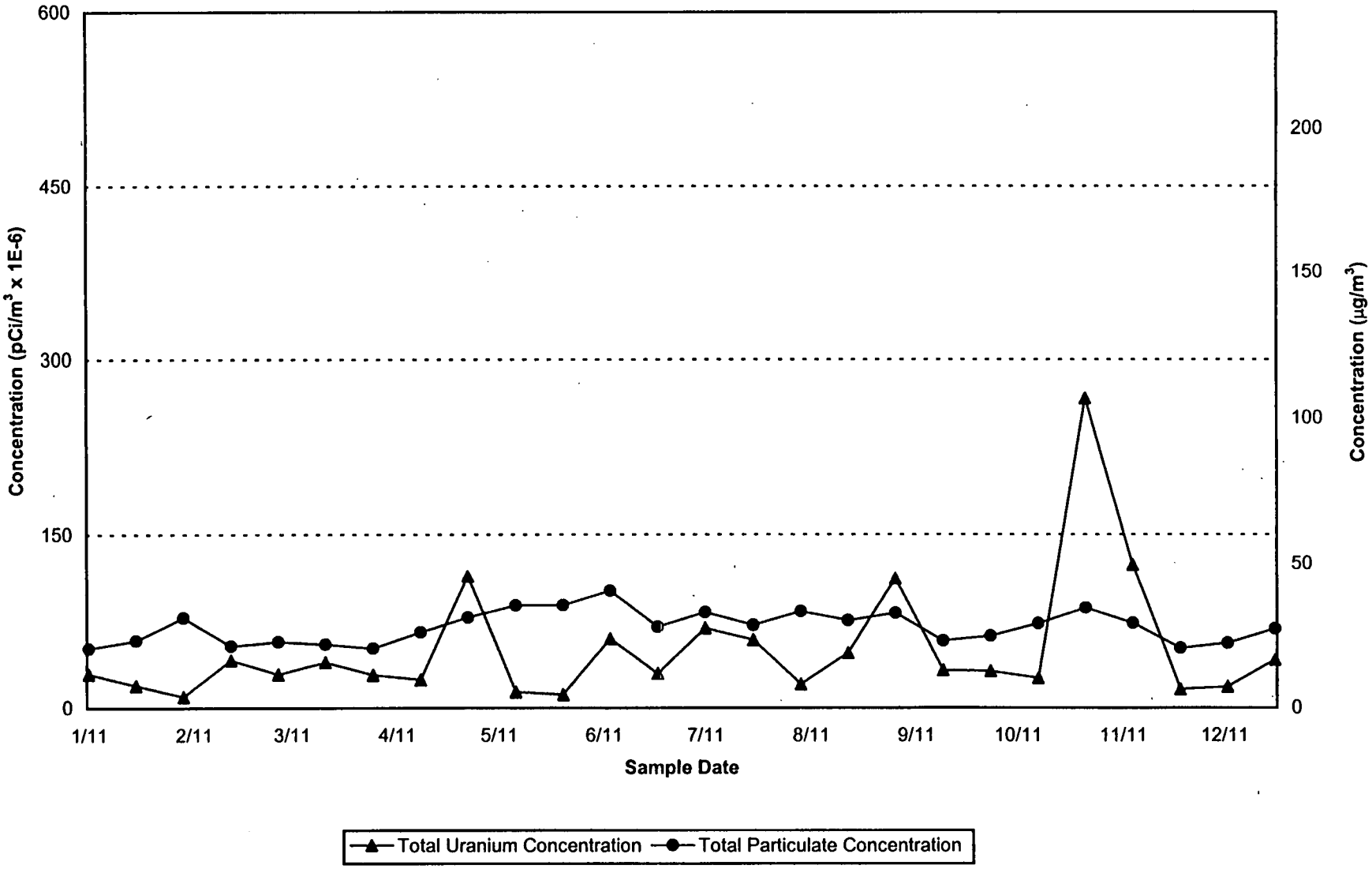


FIGURE C.1-14. 2000 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-26)

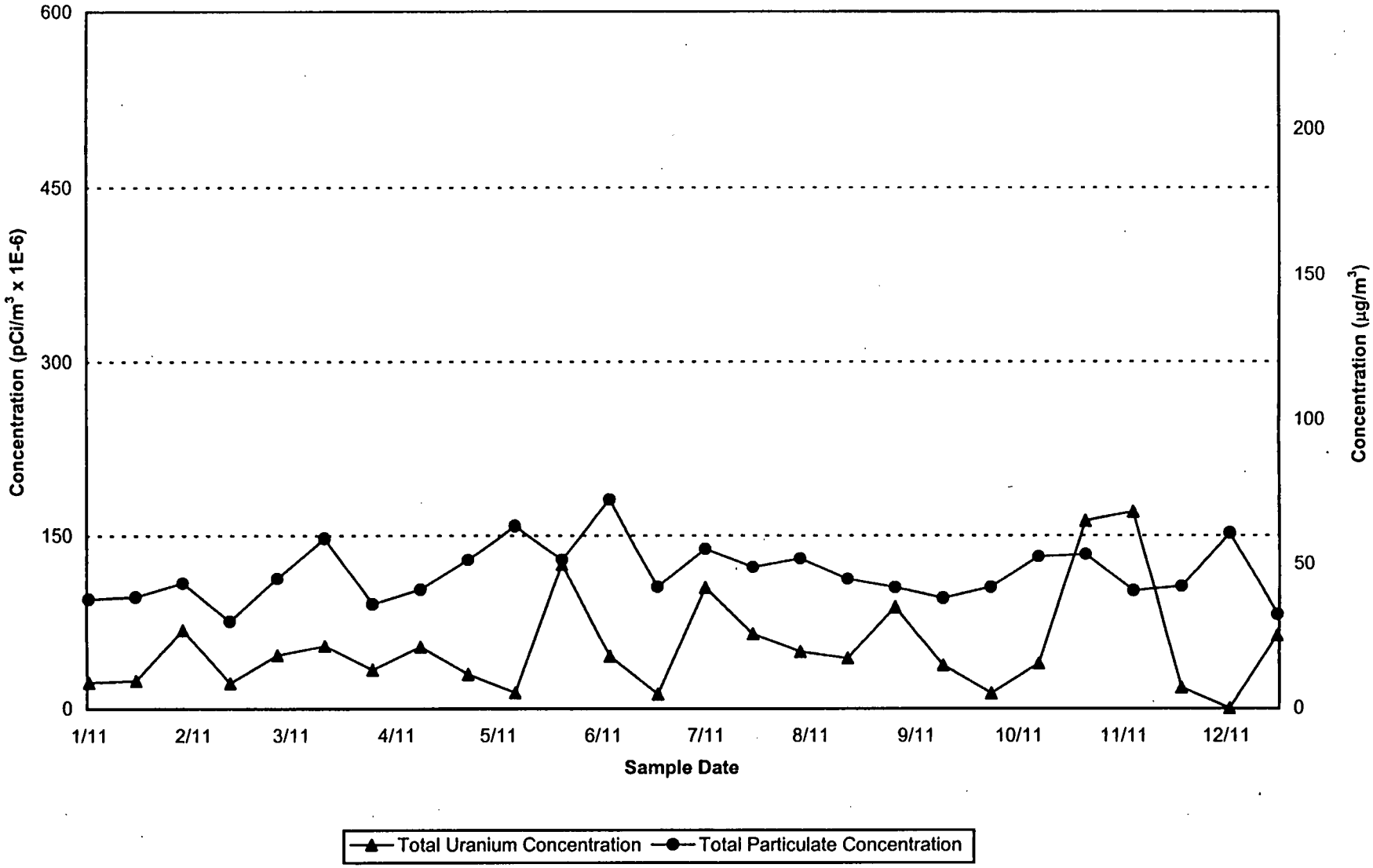


FIGURE C.1-15. 2000 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-27)

000421

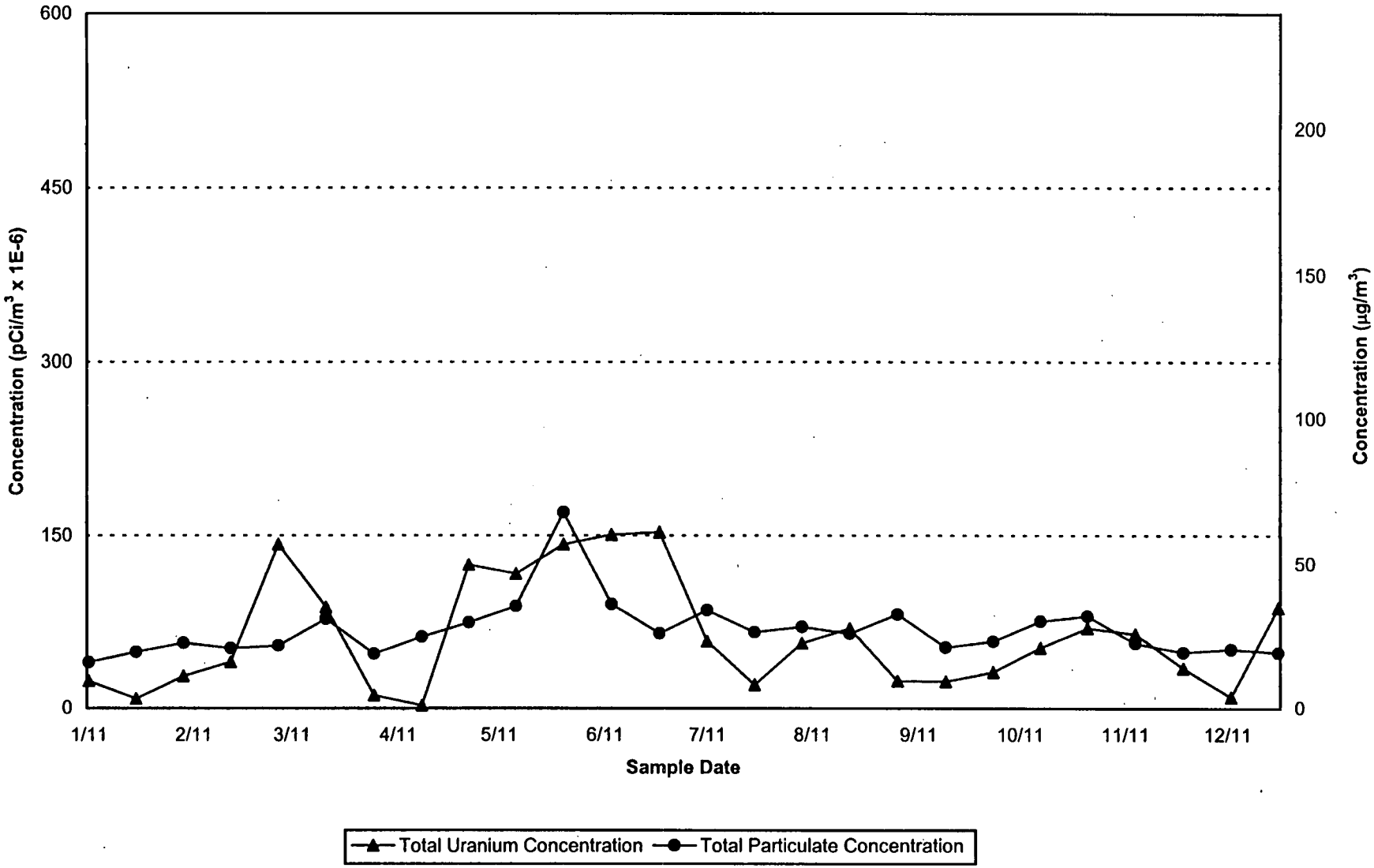


FIGURE C.1-16. 2000 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-28)

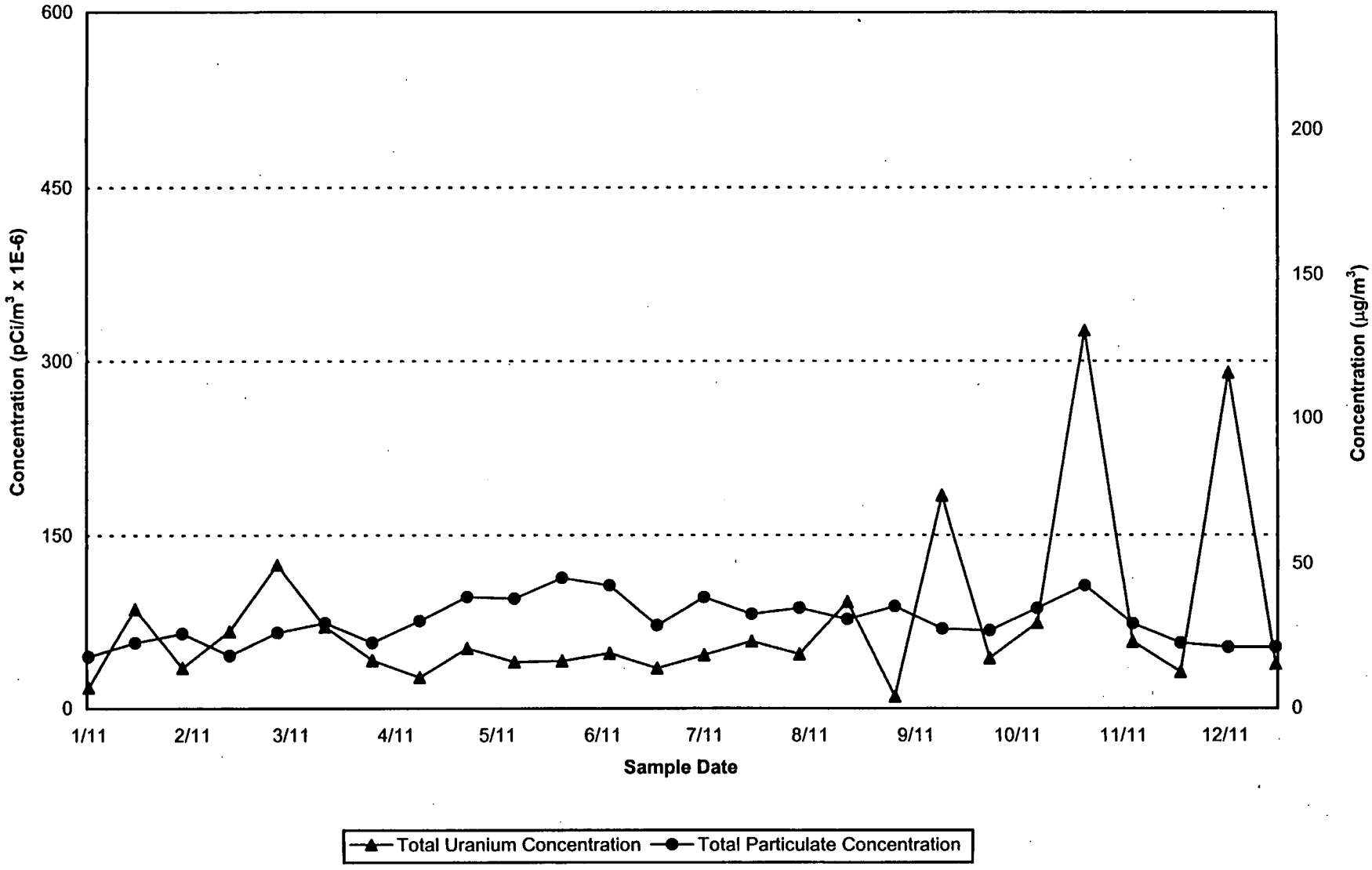


FIGURE C.1-17. 2000 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-29)

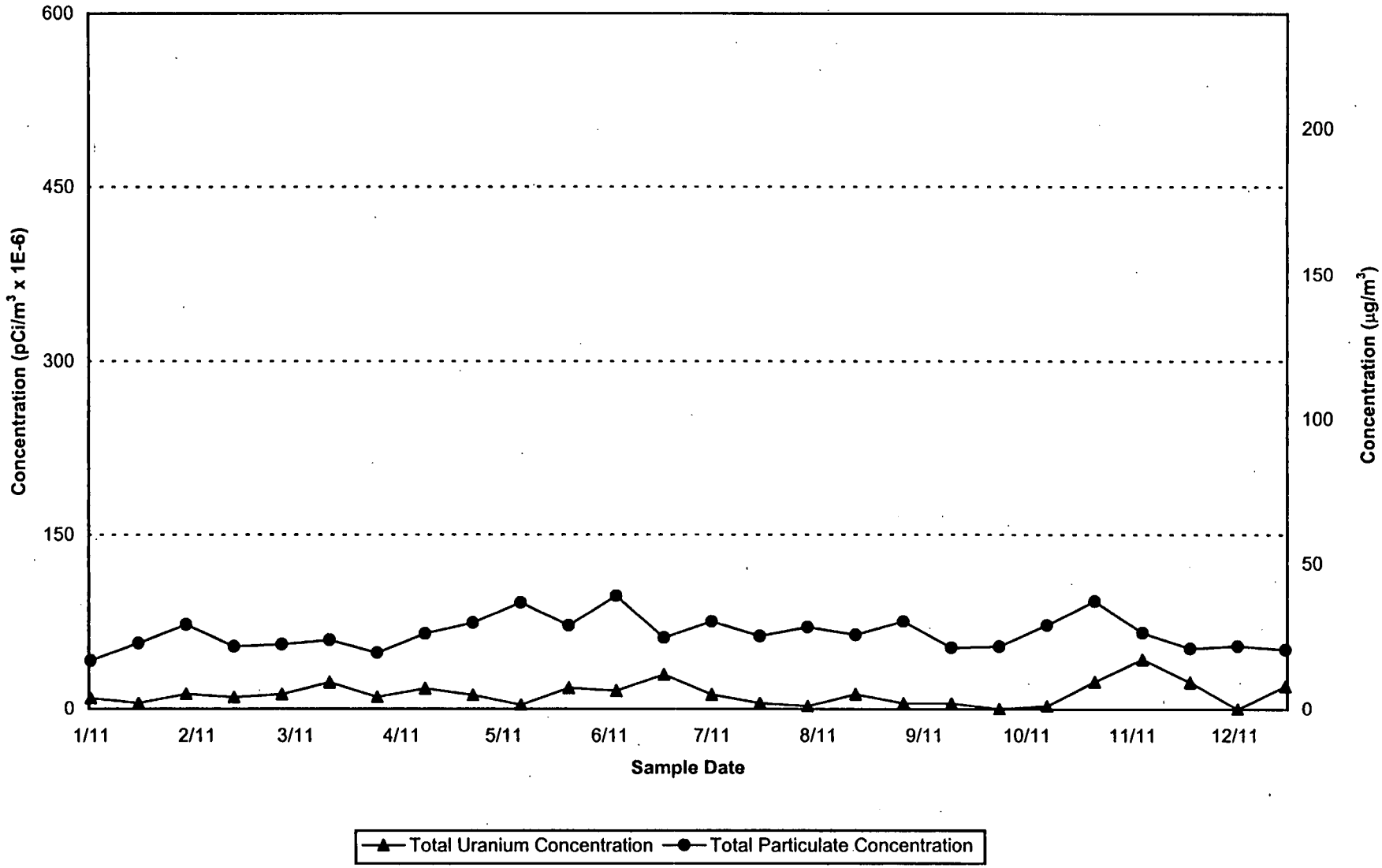


FIGURE C.1-18. 2000 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-12)

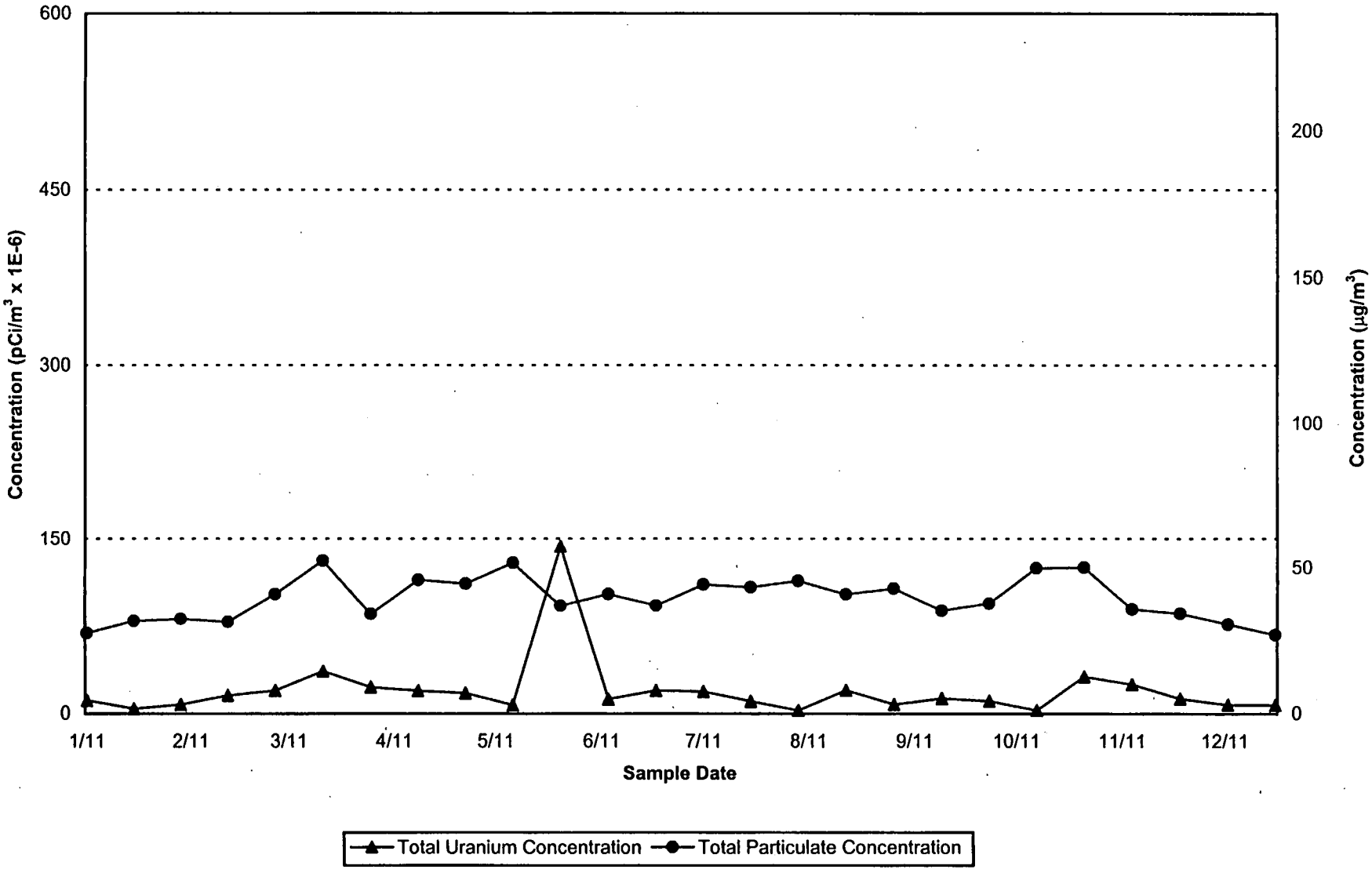


FIGURE C.1-19. 2000 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-16)

000425

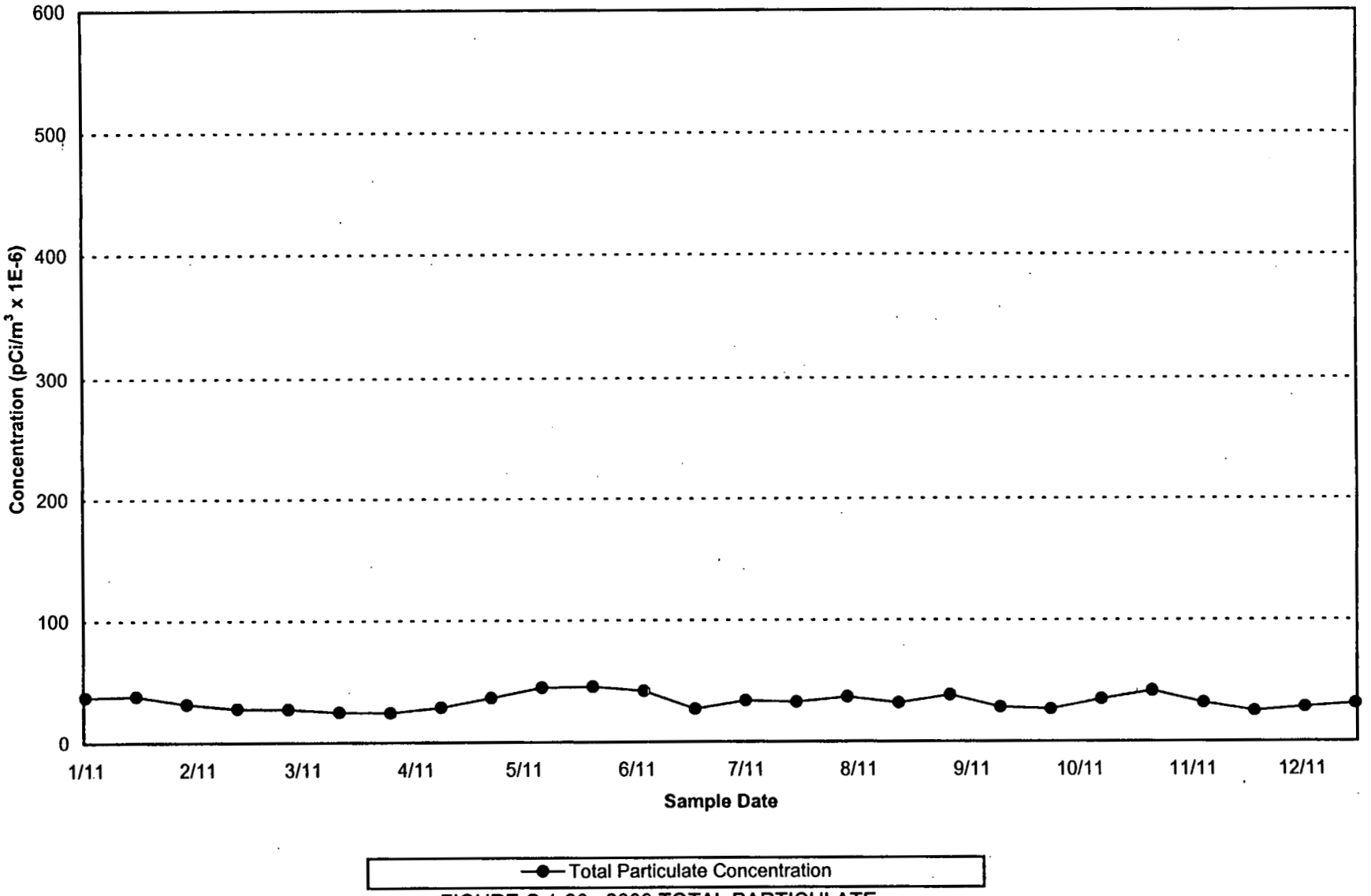


FIGURE C.1-20. 2000 TOTAL PARTICULATE CONCENTRATIONS IN AIR (WPTH-2)

000426

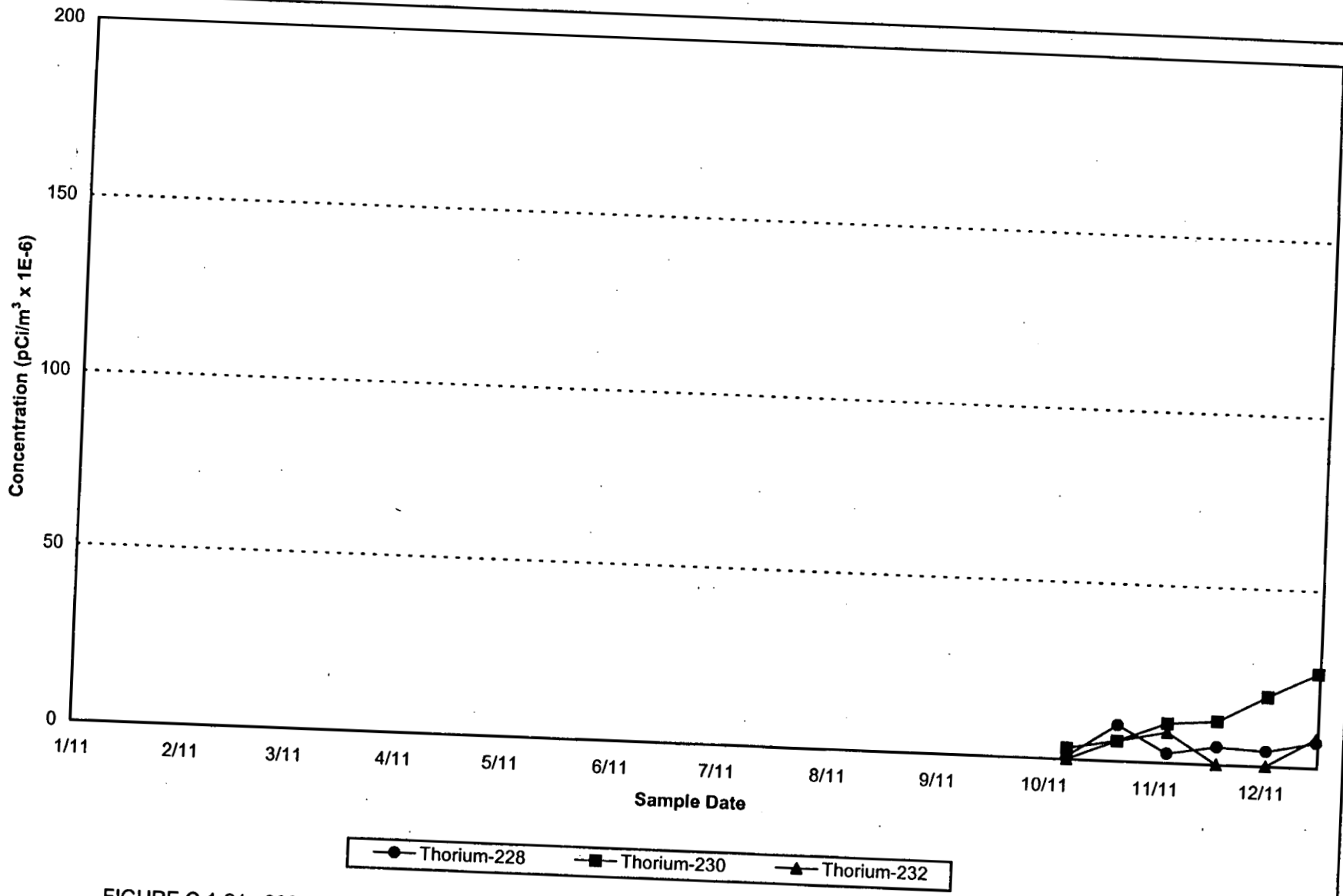


FIGURE C.1-21. 2000 THORIUM-228, THORIUM-230, AND THORIUM-232 CONCENTRATIONS IN AIR (AMS-2)

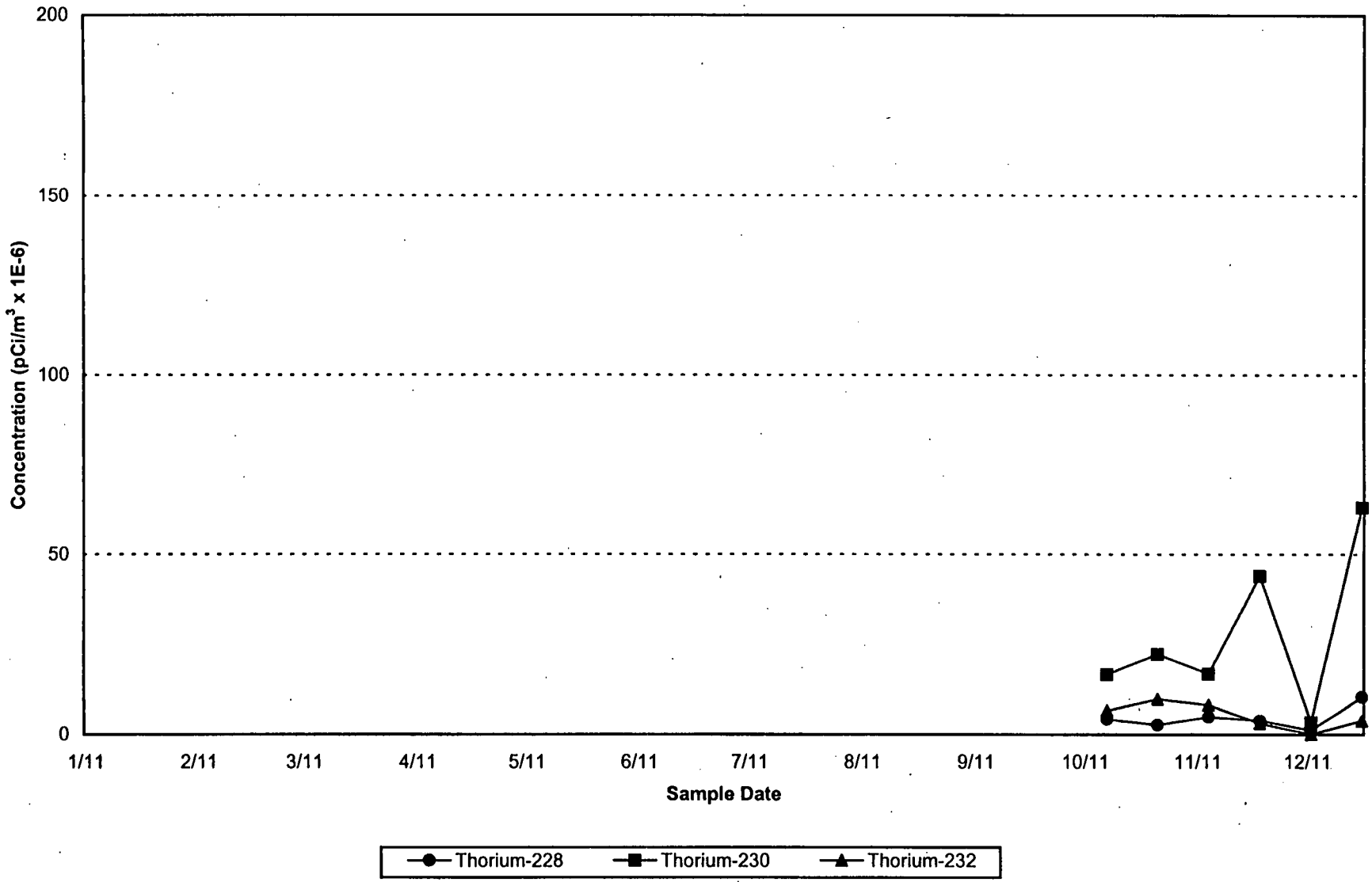


FIGURE C.1-22. 2000 THORIUM-228, THORIUM-230, AND THORIUM-232 CONCENTRATIONS IN AIR (AMS-3)

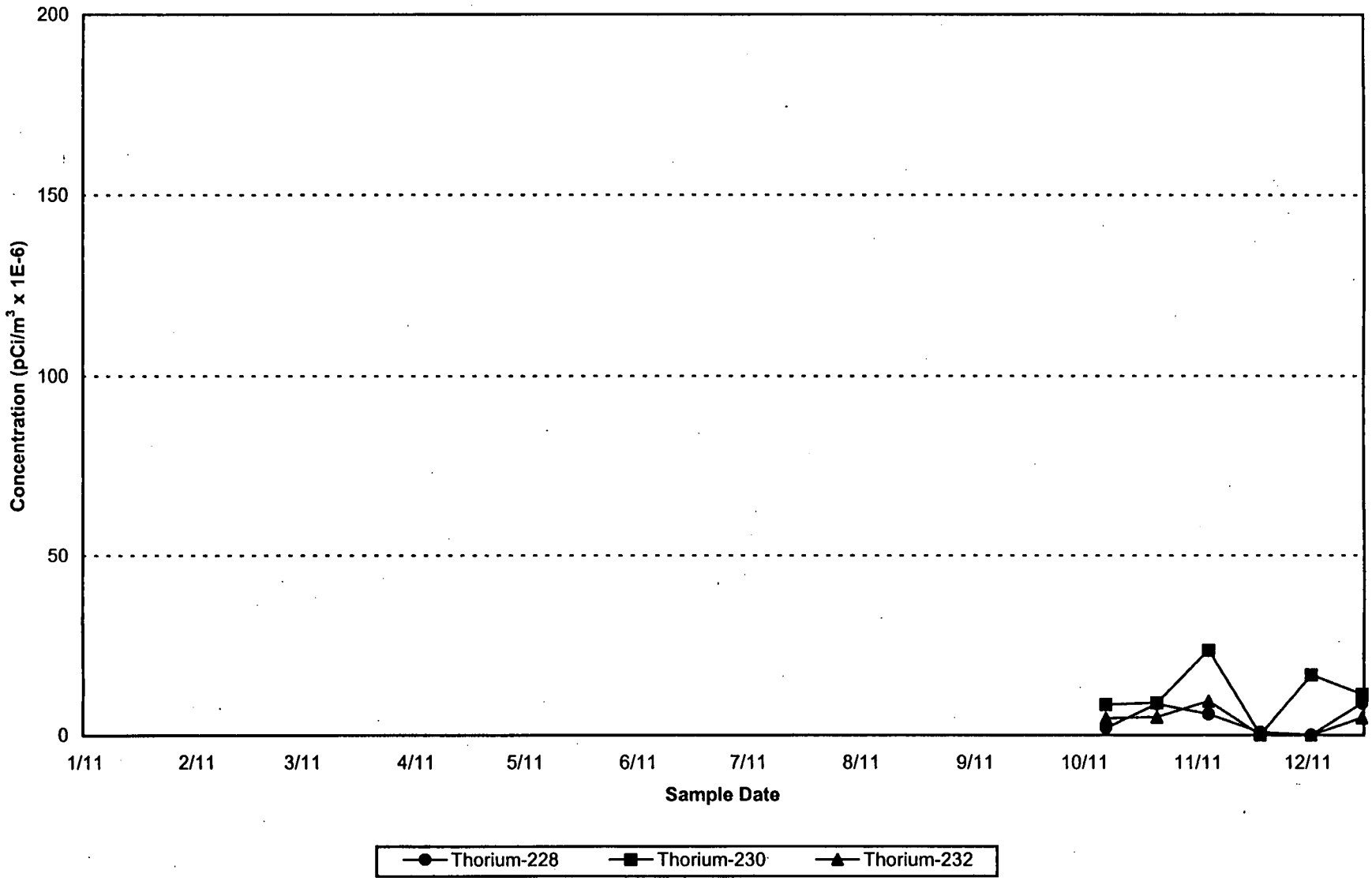


FIGURE C.1-23. 2000 THORIUM-228, THORIUM-230, AND THORIUM-232 CONCENTRATIONS IN AIR (AMS-4)

000429

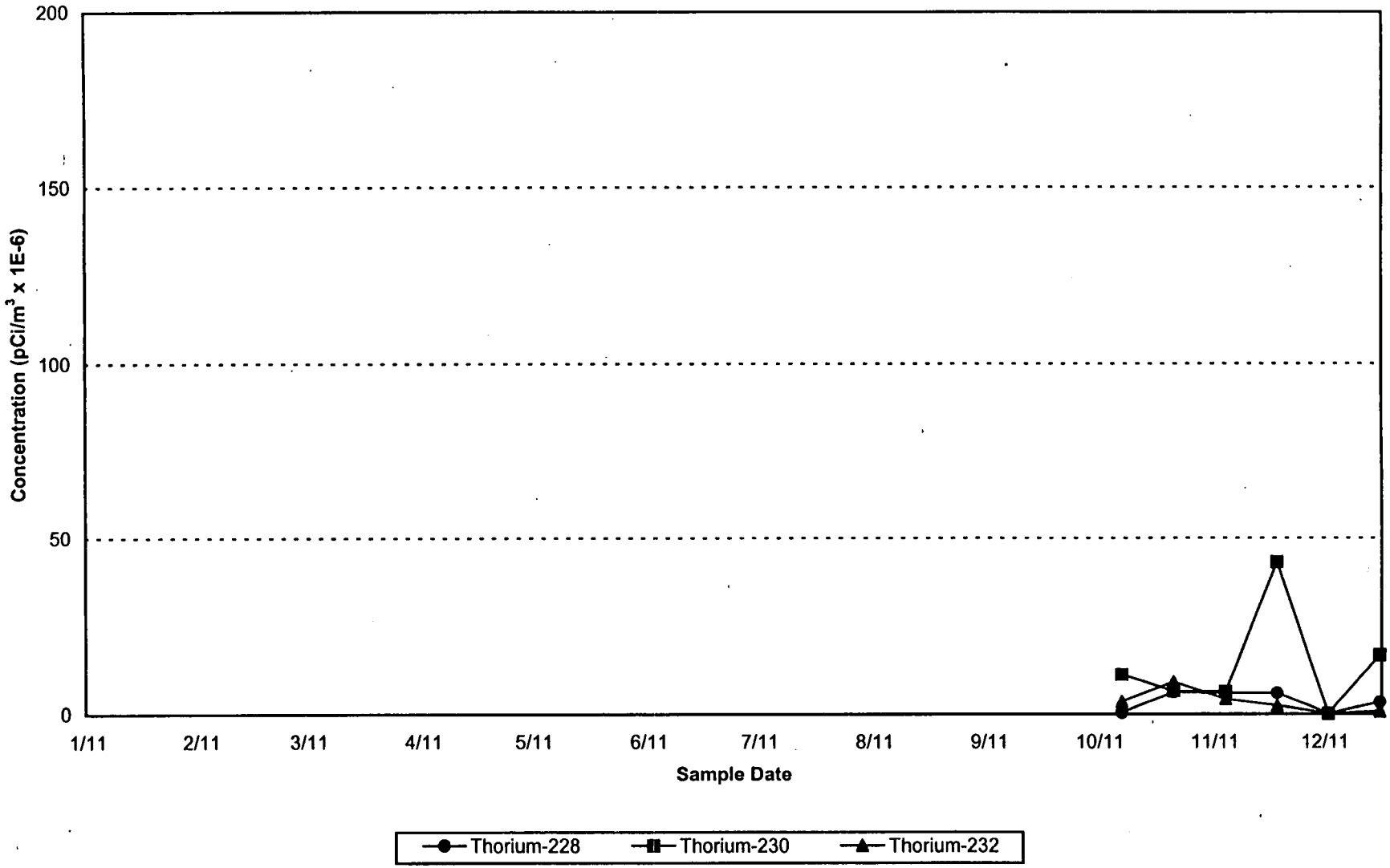


FIGURE C.1-24. 2000 THORIUM-228, THORIUM-230, AND THORIUM-232 CONCENTRATIONS IN AIR (AMS-5)

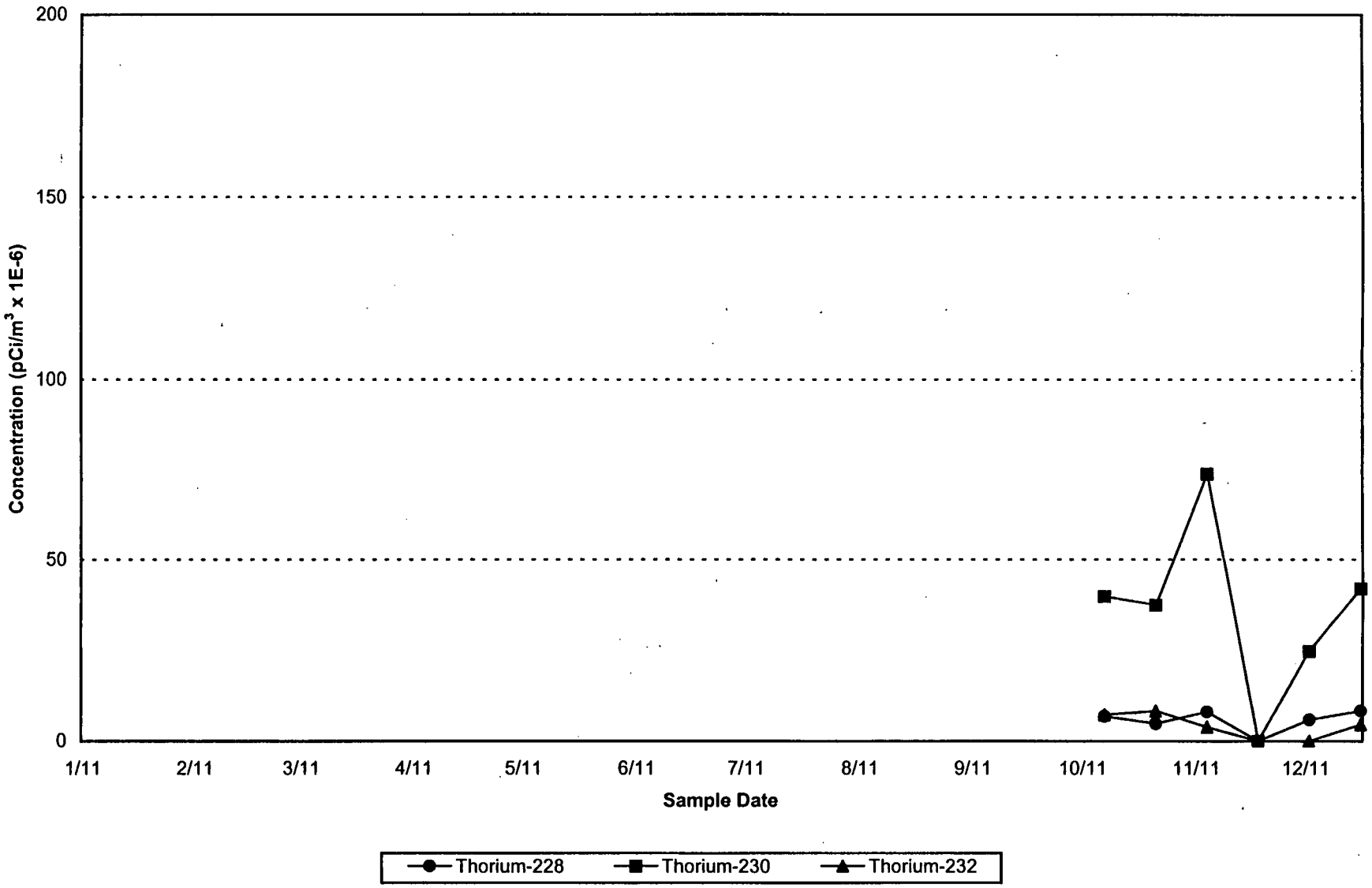


FIGURE C.1-25. 2000 THORIUM-228, THORIUM-230, AND THORIUM-232 CONCENTRATIONS IN AIR (AMS-6)

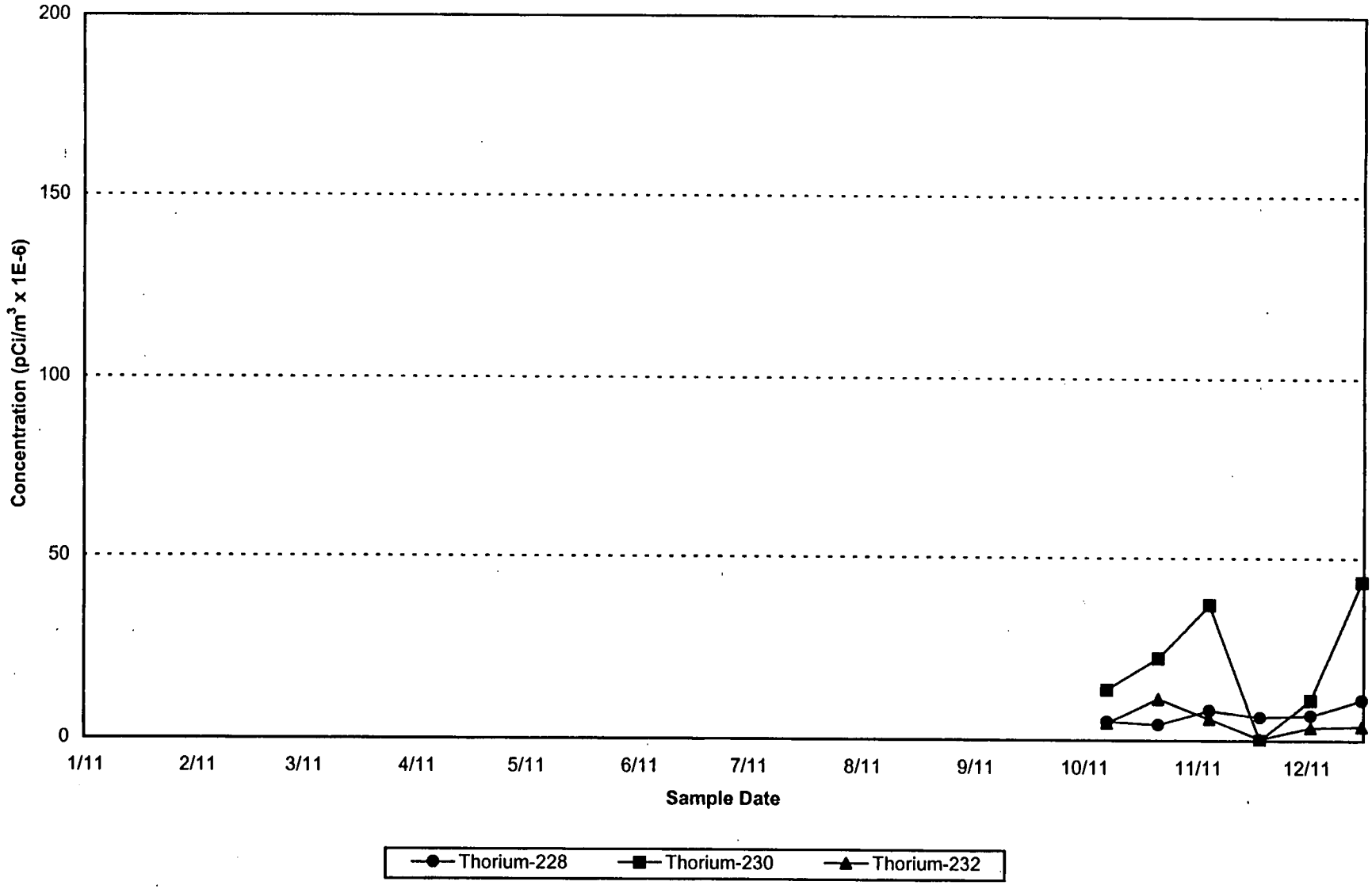


FIGURE C.1-26. 2000 THORIUM-228, THORIUM-230, AND THORIUM-232 CONCENTRATIONS IN AIR (AMS-7)

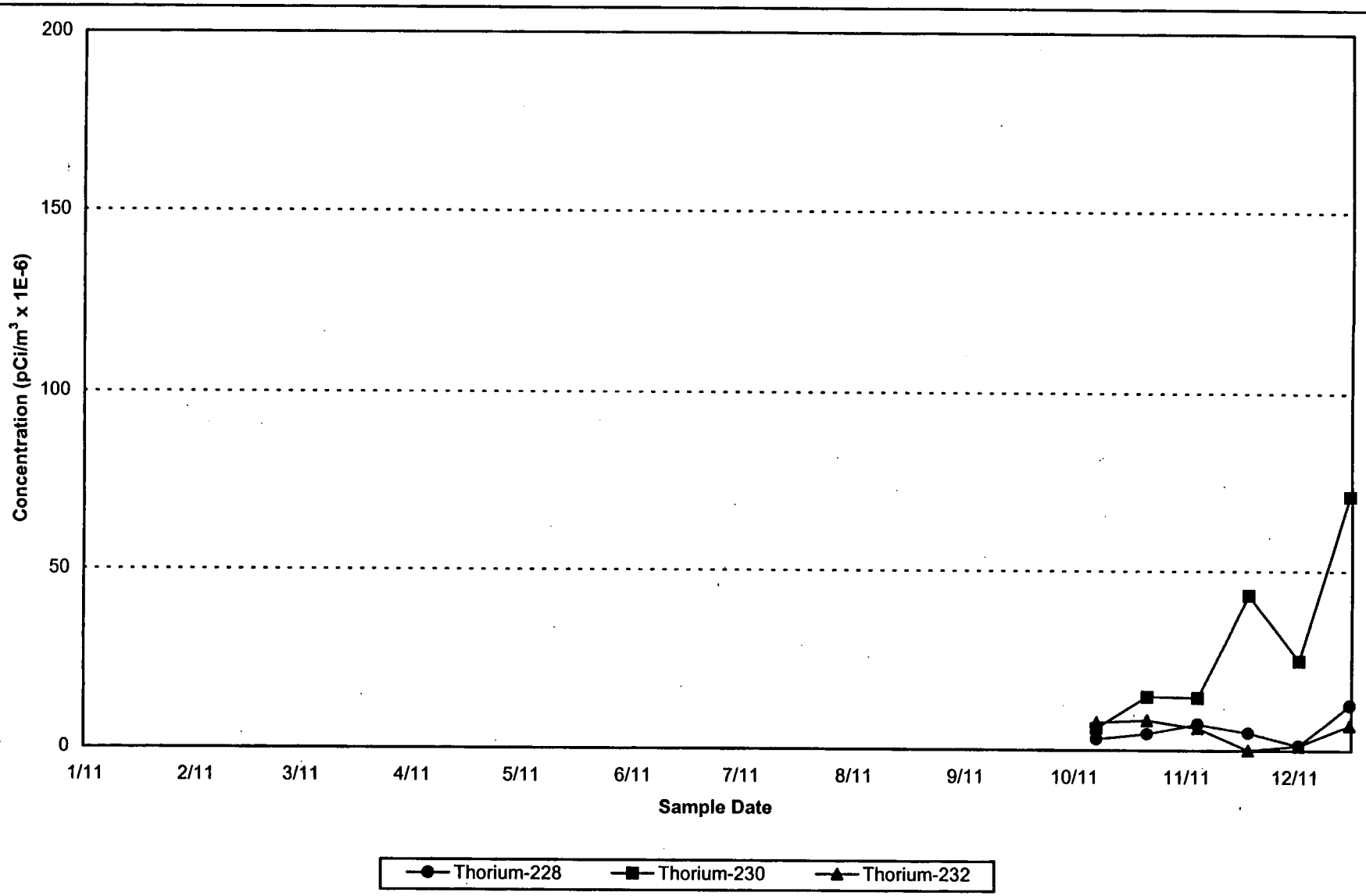


FIGURE C.1-27. 2000 THORIUM-228, THORIUM-230, AND THORIUM-232 CONCENTRATIONS IN AIR (AMS-8A)

000433

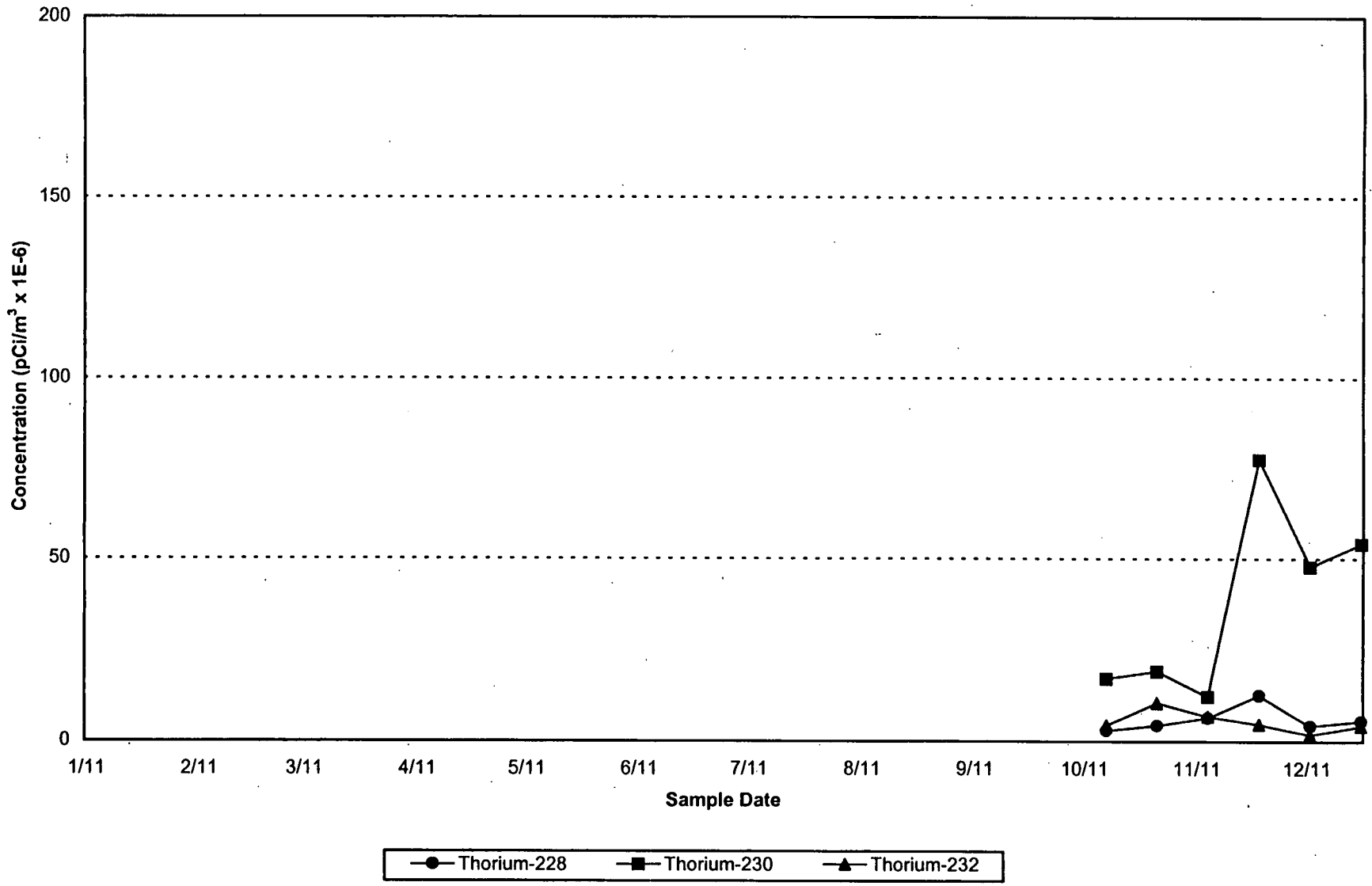


FIGURE C.1-28. 2000 THORIUM-228, THORIUM-230, AND THORIUM-232 CONCENTRATIONS IN AIR (AMS-9C)

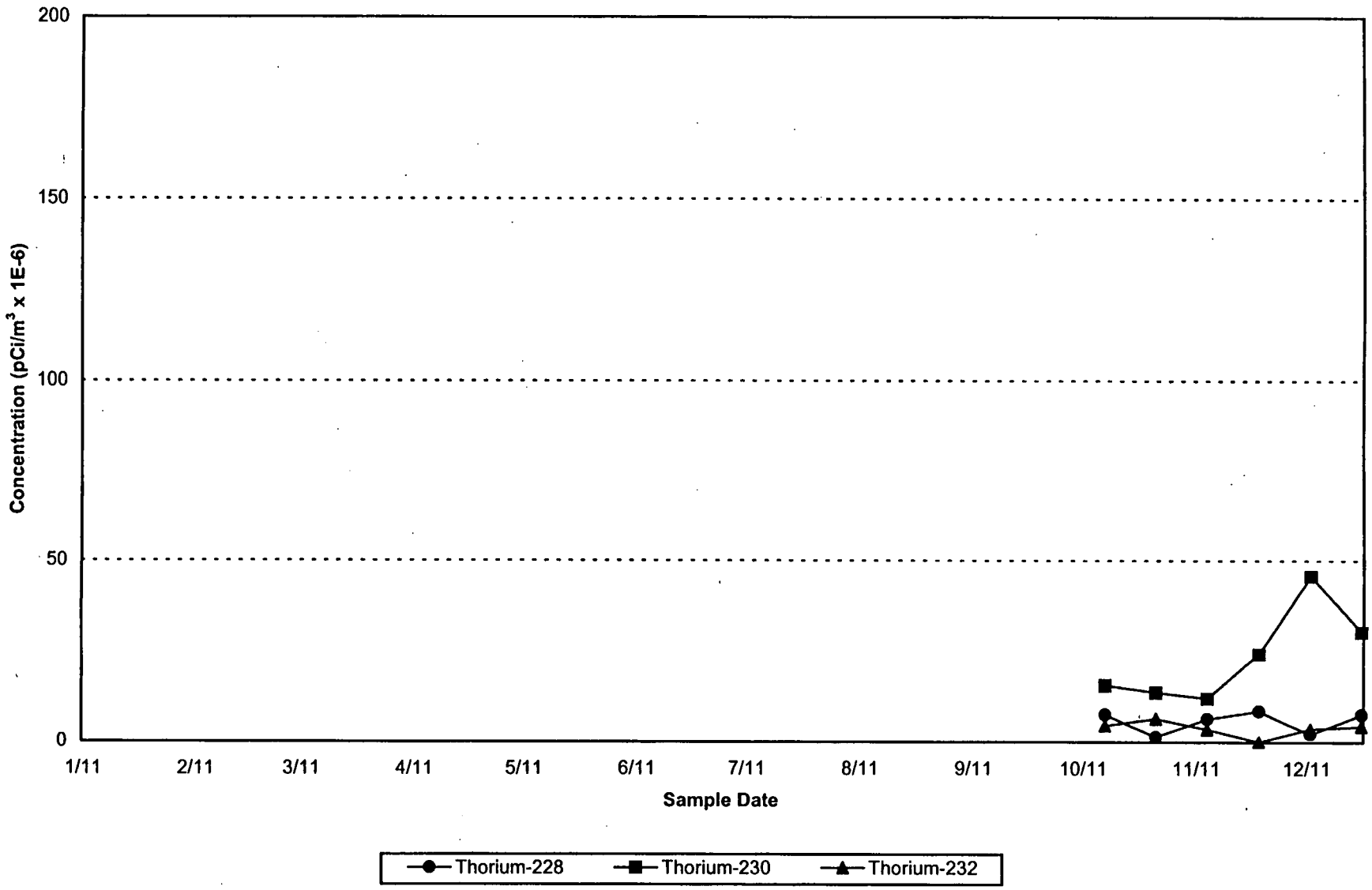


FIGURE C.1-29. 2000 THORIUM-228, THORIUM-230, AND THORIUM-232 CONCENTRATIONS IN AIR (AMS-22)

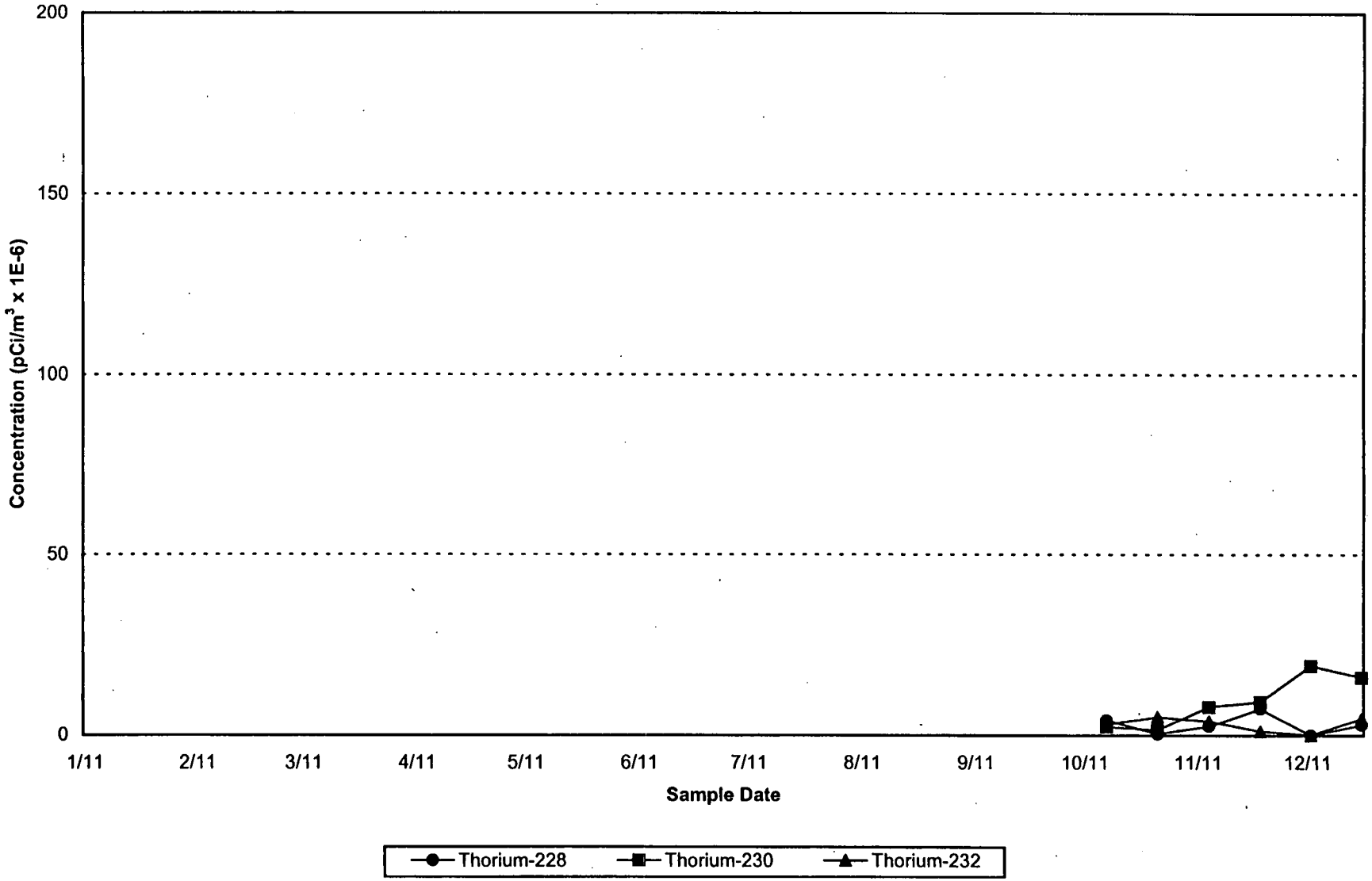


FIGURE C.1-30. 2000 THORIUM-228, THORIUM-230, AND THORIUM-232 CONCENTRATIONS IN AIR (AMS-23)

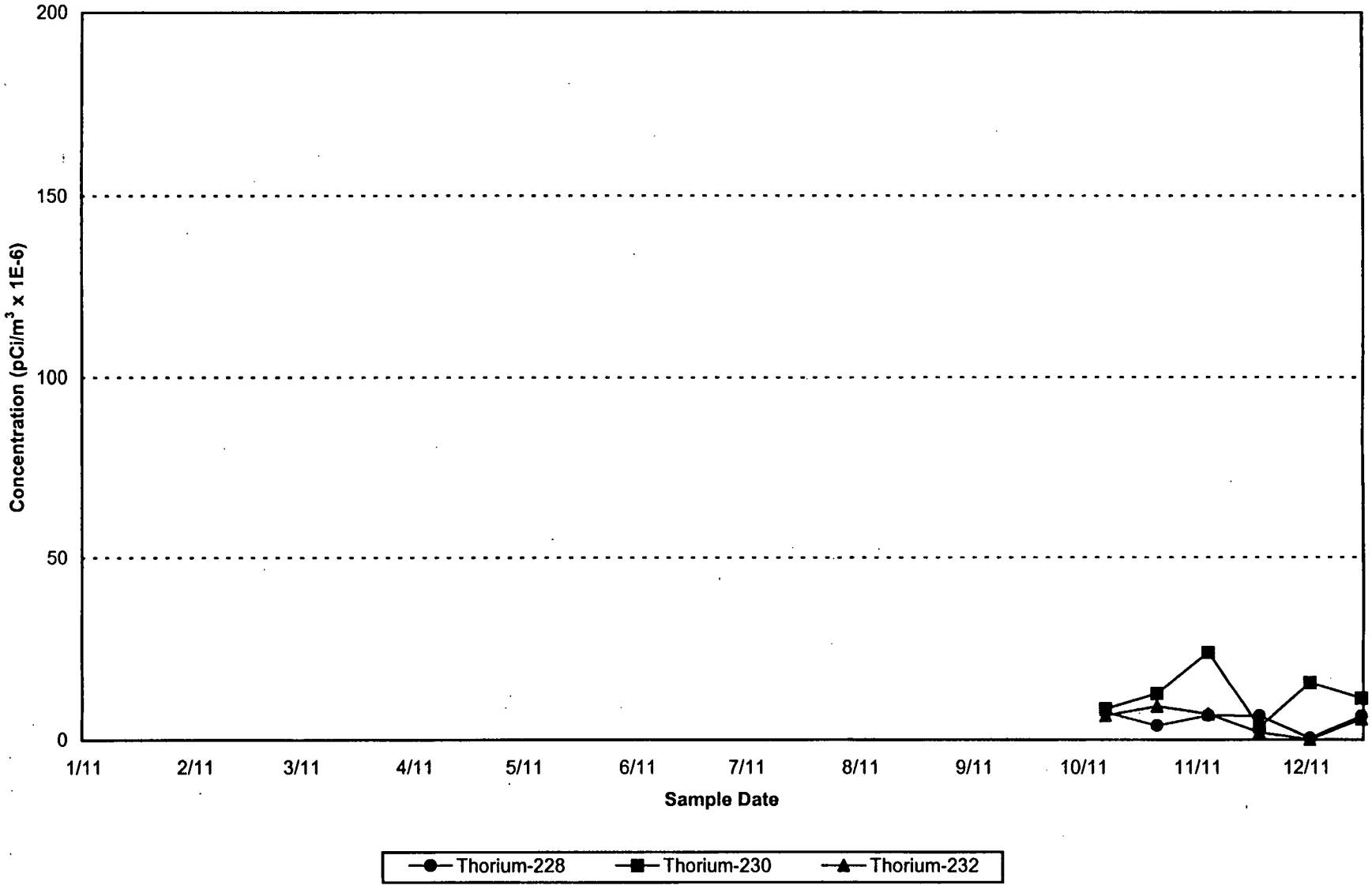


FIGURE C.1-31. 2000 THORIUM-228, THORIUM-230, AND THORIUM-232 CONCENTRATIONS IN AIR (AMS-24)

000437

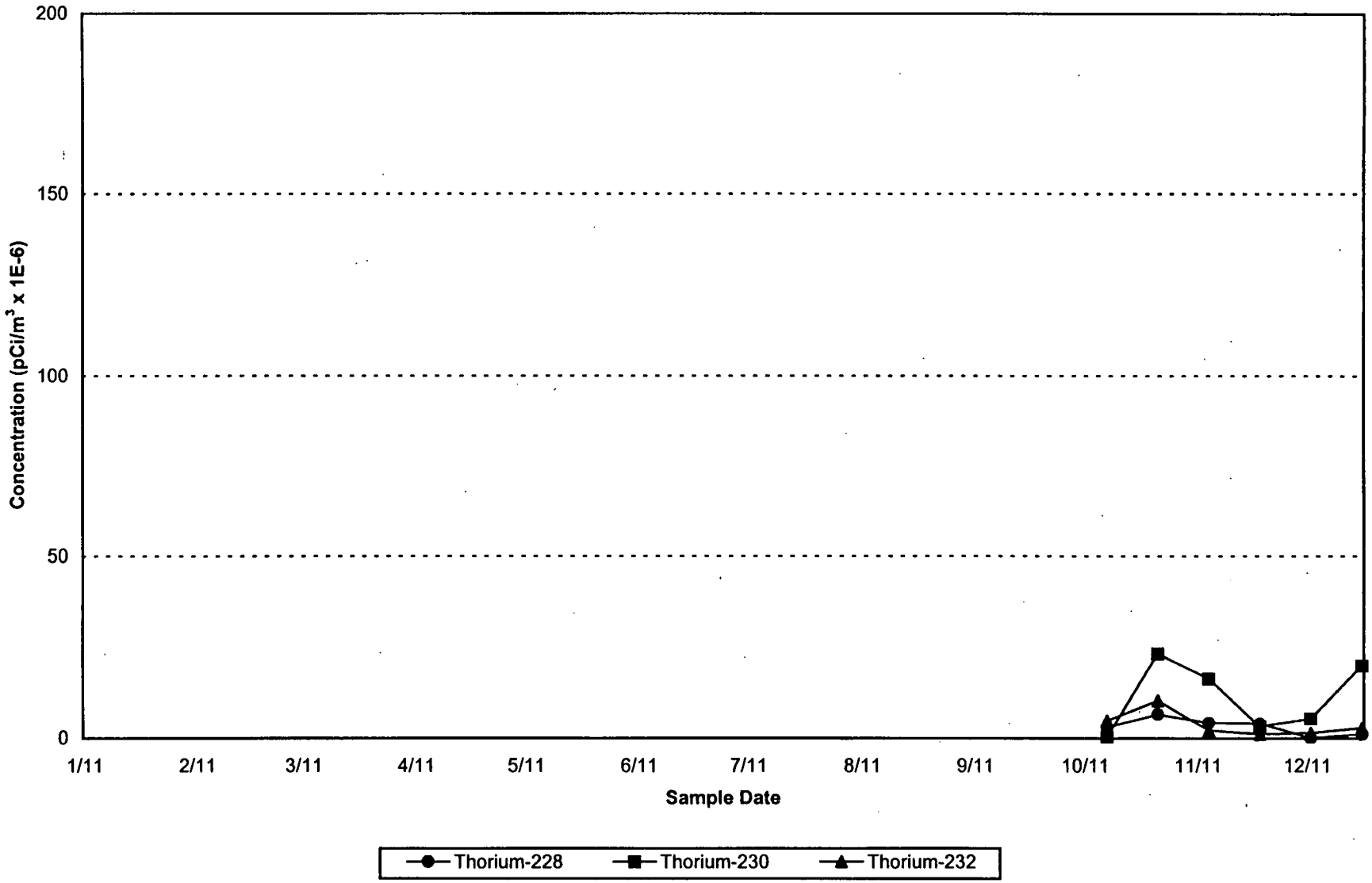


FIGURE C.1-32. 2000 THORIUM-228, THORIUM-230, AND THORIUM-232 CONCENTRATIONS IN AIR (AMS-25)

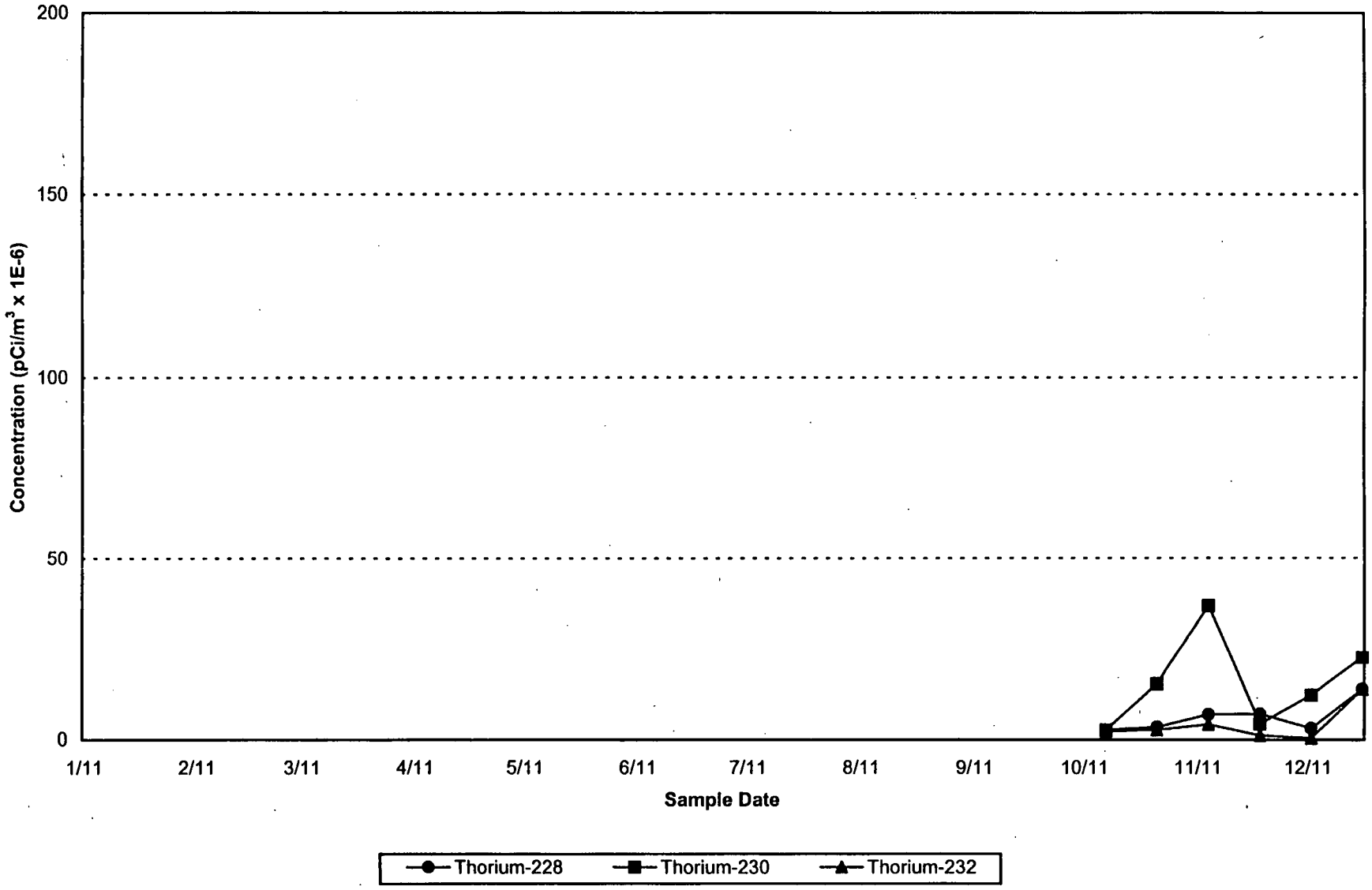


FIGURE C.1-33. 2000 THORIUM-228, THORIUM-230, AND THORIUM-232 CONCENTRATIONS IN AIR (AMS-26)

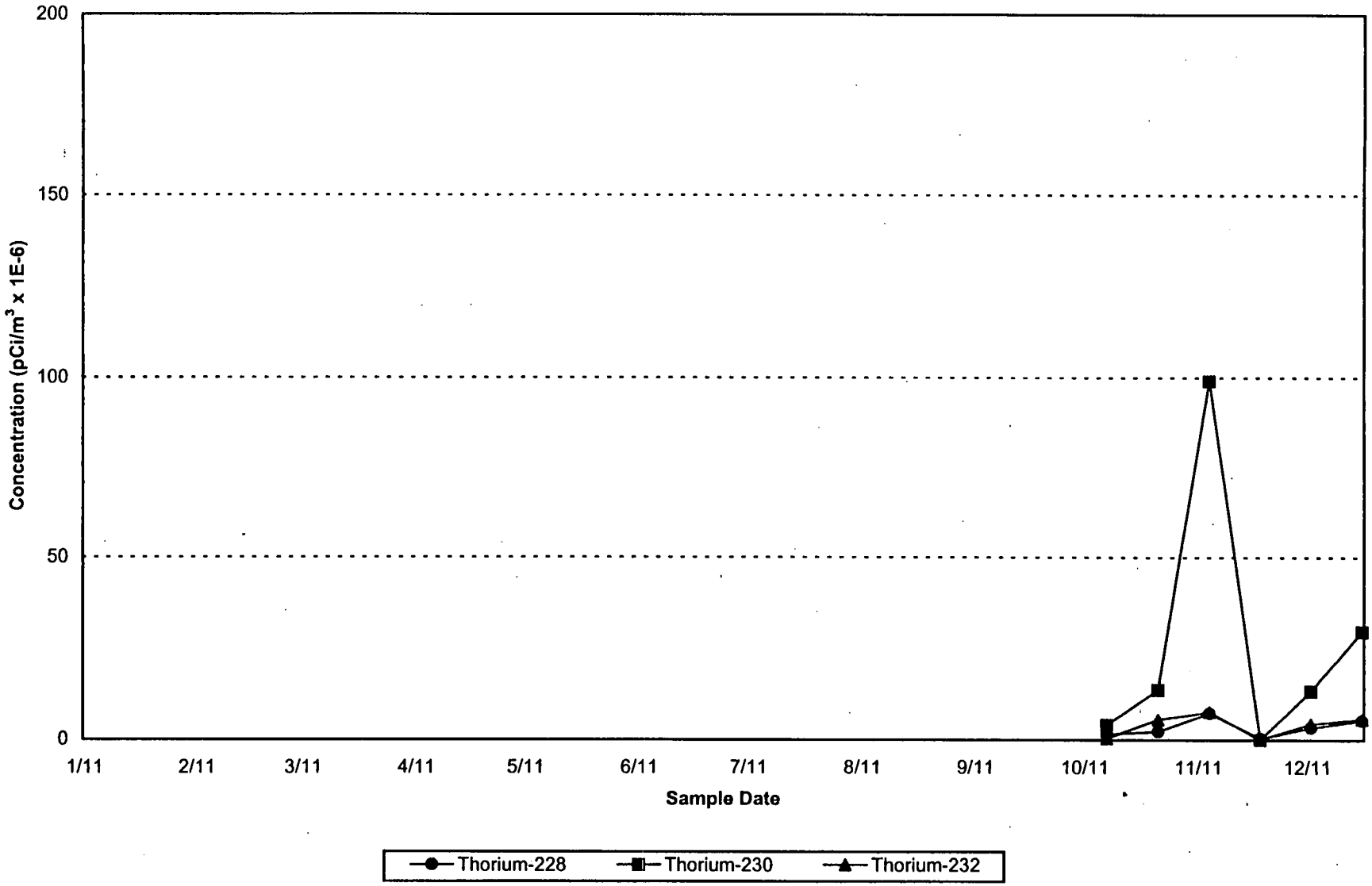


FIGURE C.1-34. 2000 THORIUM-228, THORIUM-230, AND THORIUM-232 CONCENTRATIONS IN AIR (AMS-27)

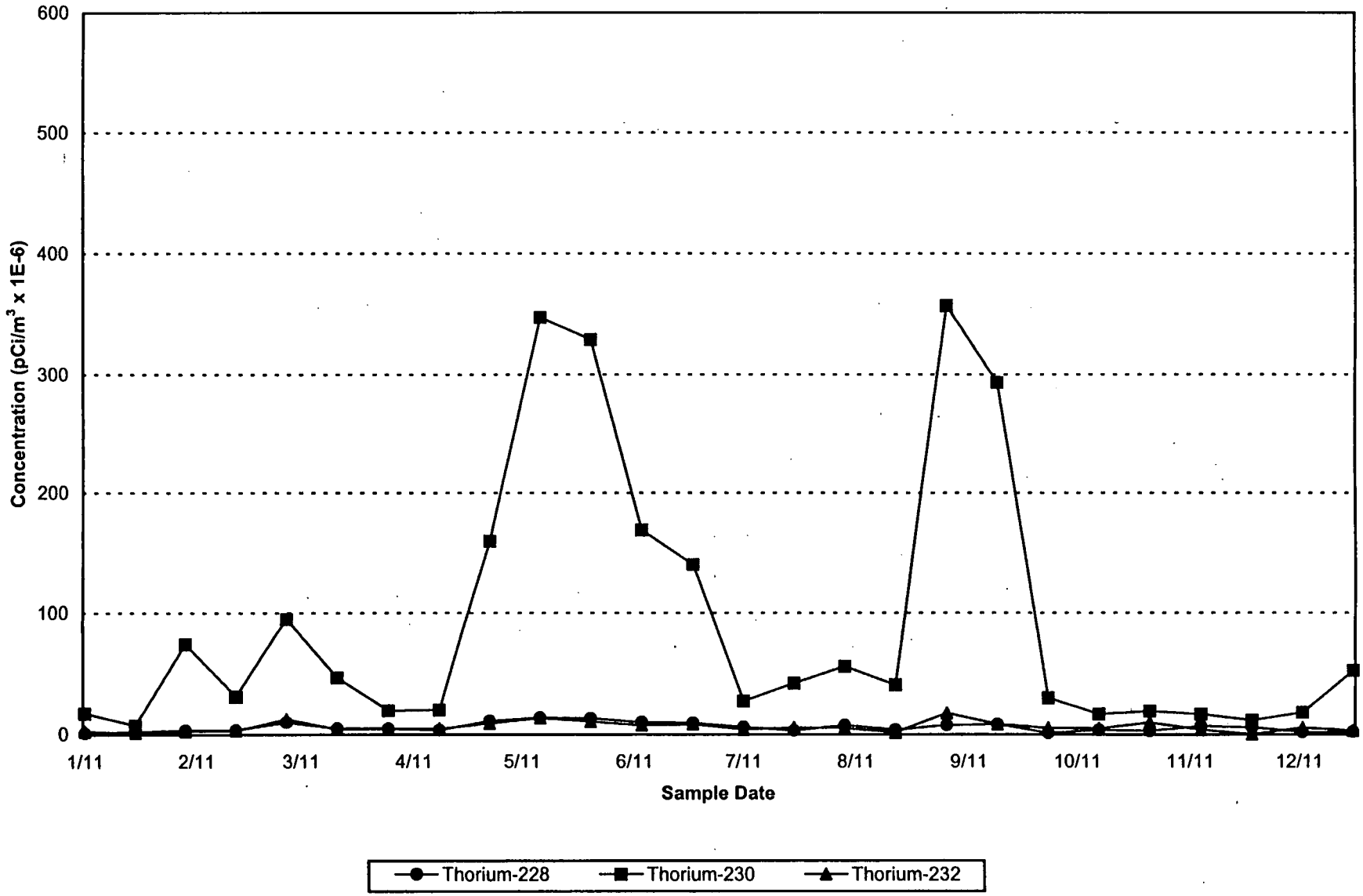


FIGURE C.1-35. 2000 THORIUM-228, THORIUM-230, AND THORIUM-232 CONCENTRATIONS IN AIR (AMS-28)

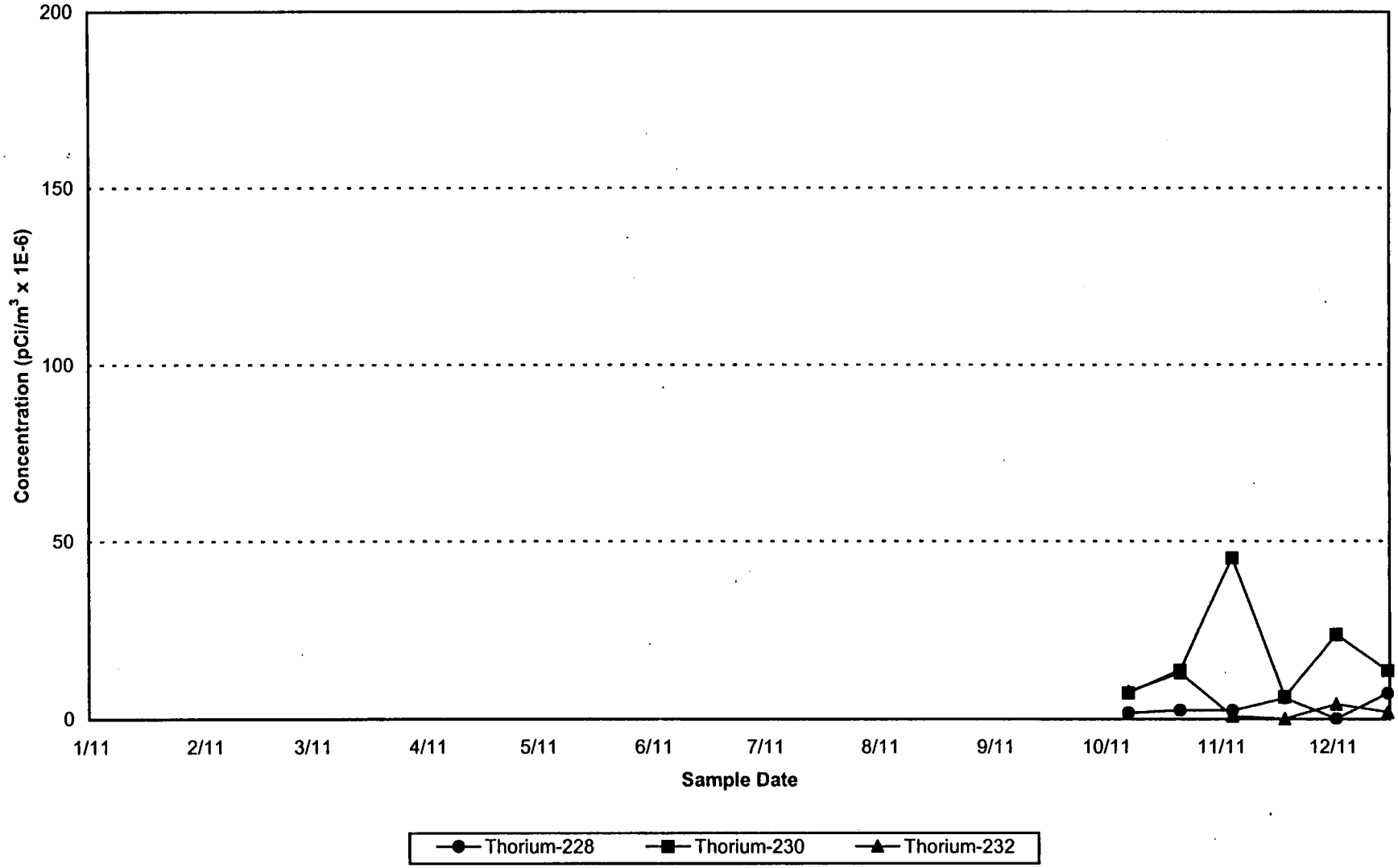


FIGURE C.1-36. 2000 THORIUM-228, THORIUM-230, AND THORIUM-232 CONCENTRATIONS IN AIR (AMS-29)

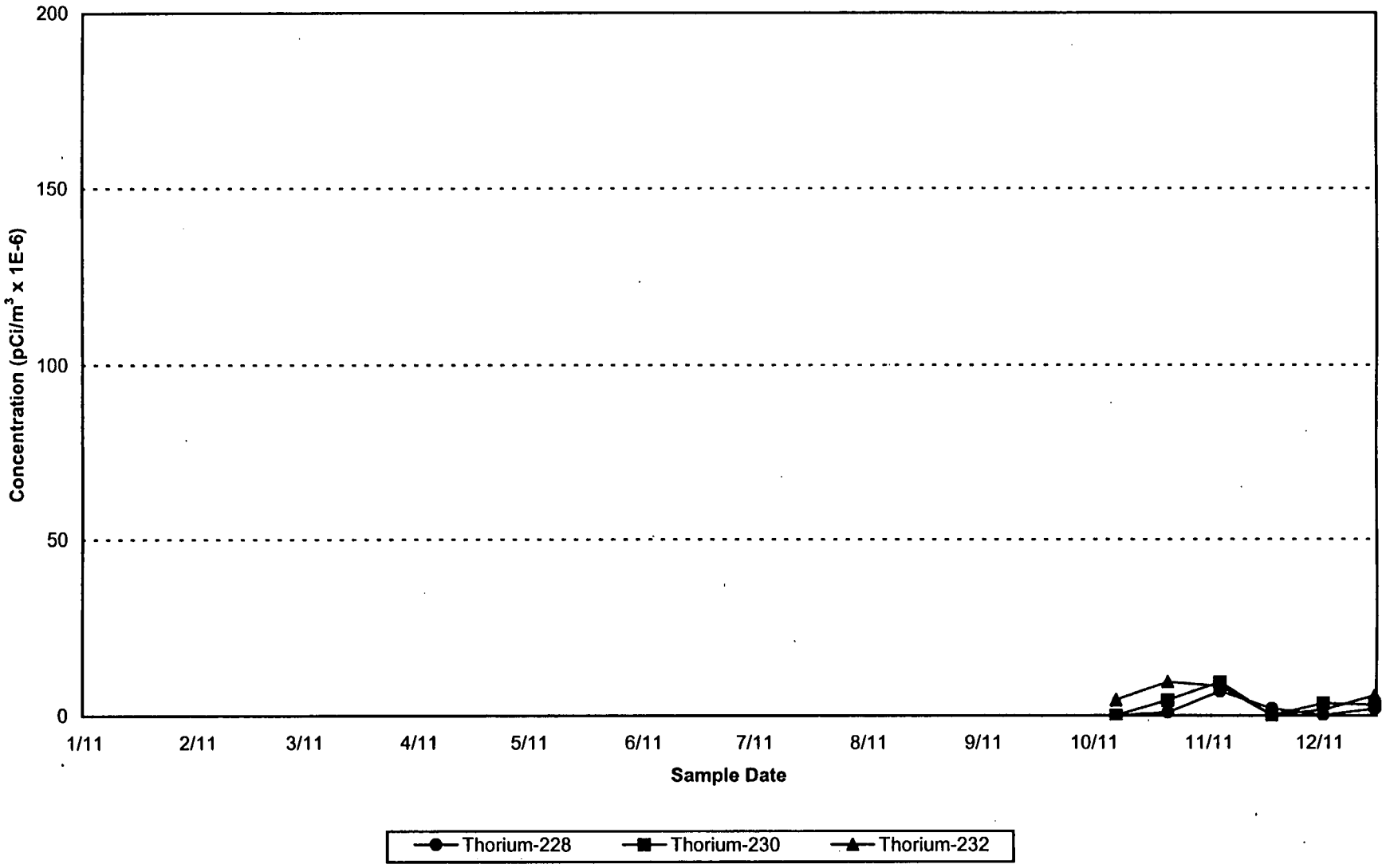


FIGURE C.1-37. 2000 THORIUM-228, THORIUM-230, AND THORIUM-232 CONCENTRATIONS IN AIR (AMS-12)

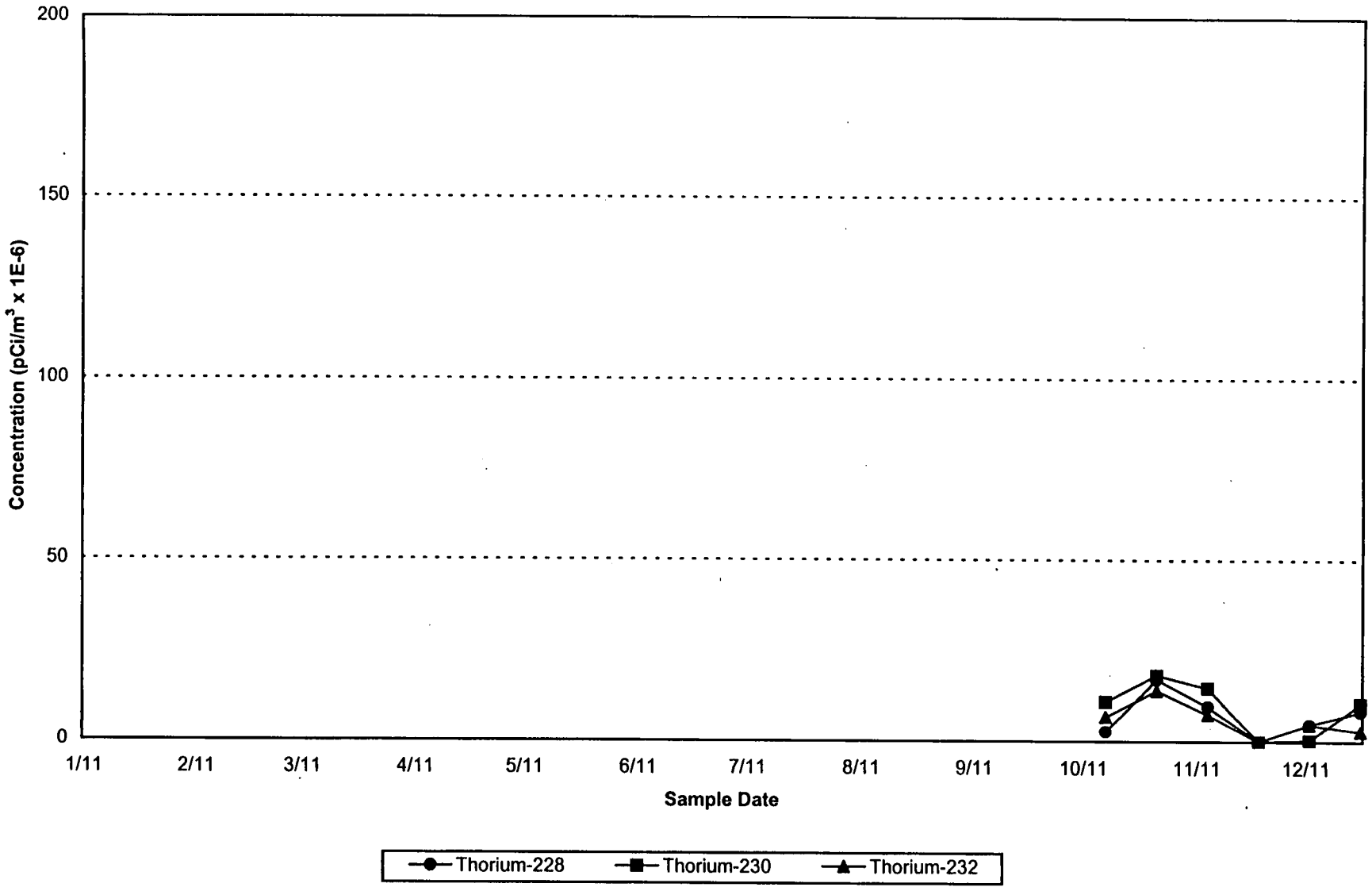


FIGURE C.1-38. 2000 THORIUM-228, THORIUM-230, AND THORIUM-232 CONCENTRATIONS IN AIR (AMS-16)

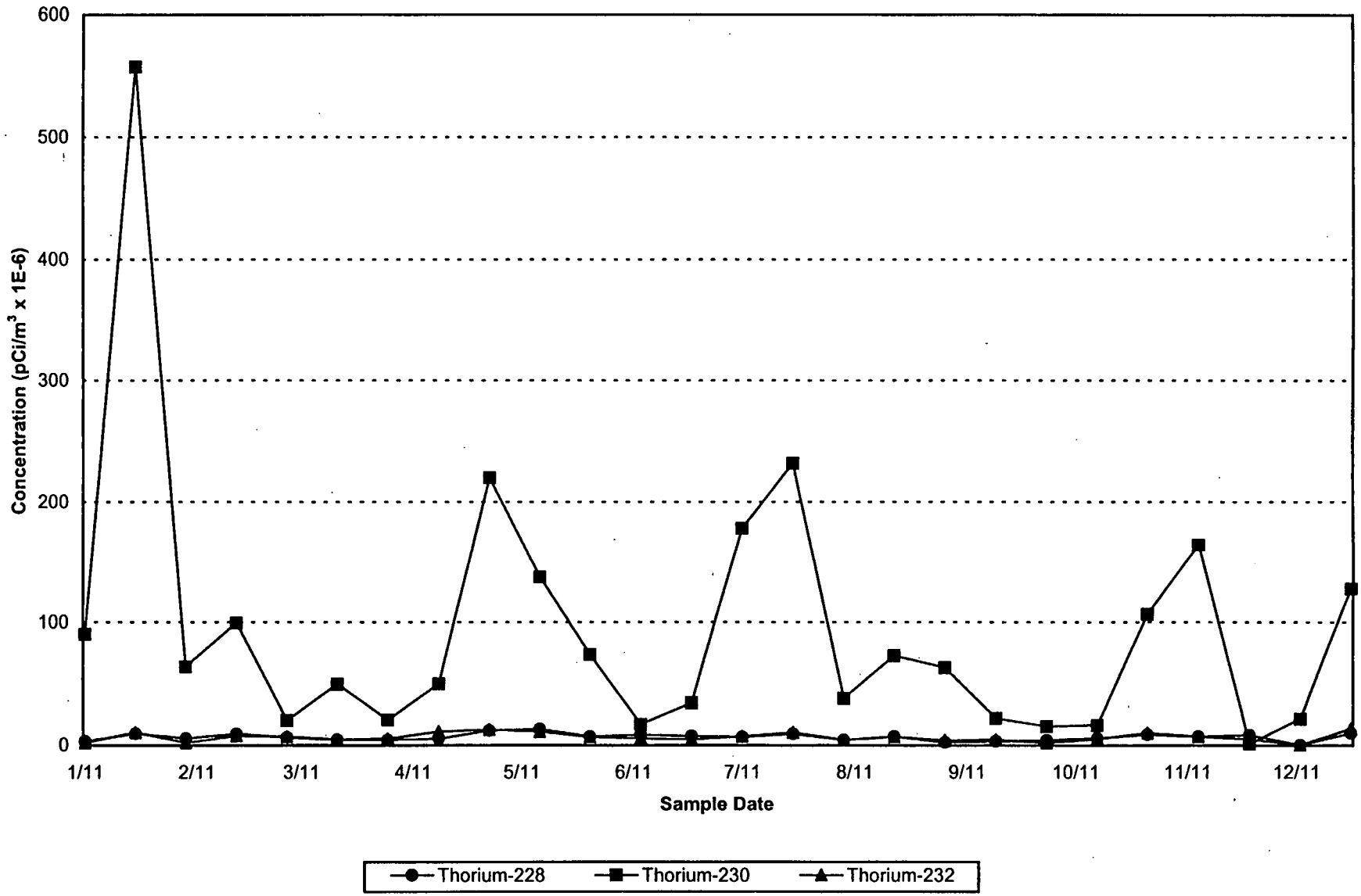


FIGURE C.1-39. 2000 THORIUM-228, THORIUM-230, AND THORIUM-232 CONCENTRATIONS IN AIR (WPTH-2)

000445

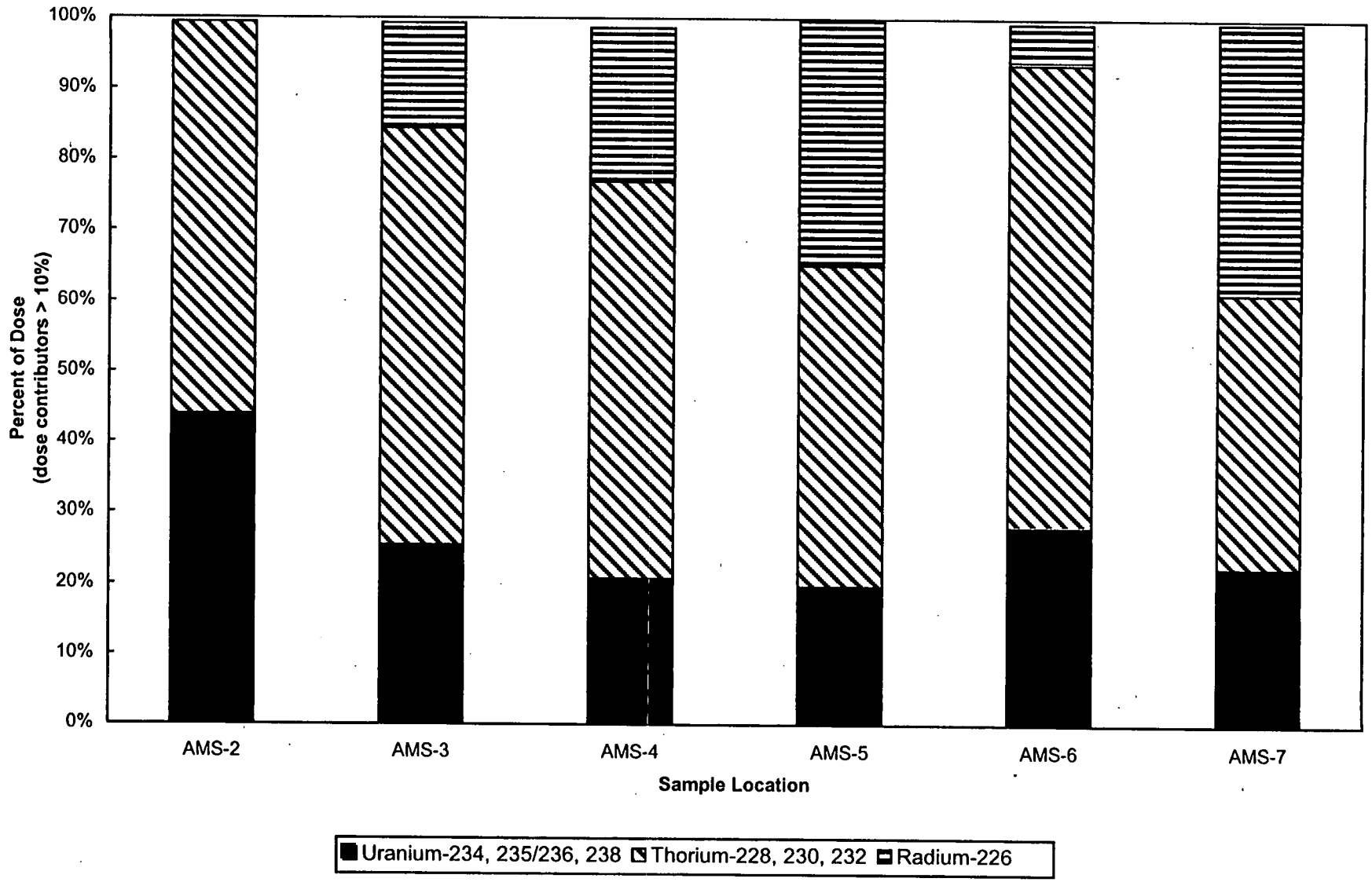


FIGURE C.1-40. 2000 DOSE CONTRIBUTIONS PER AMS LOCATION

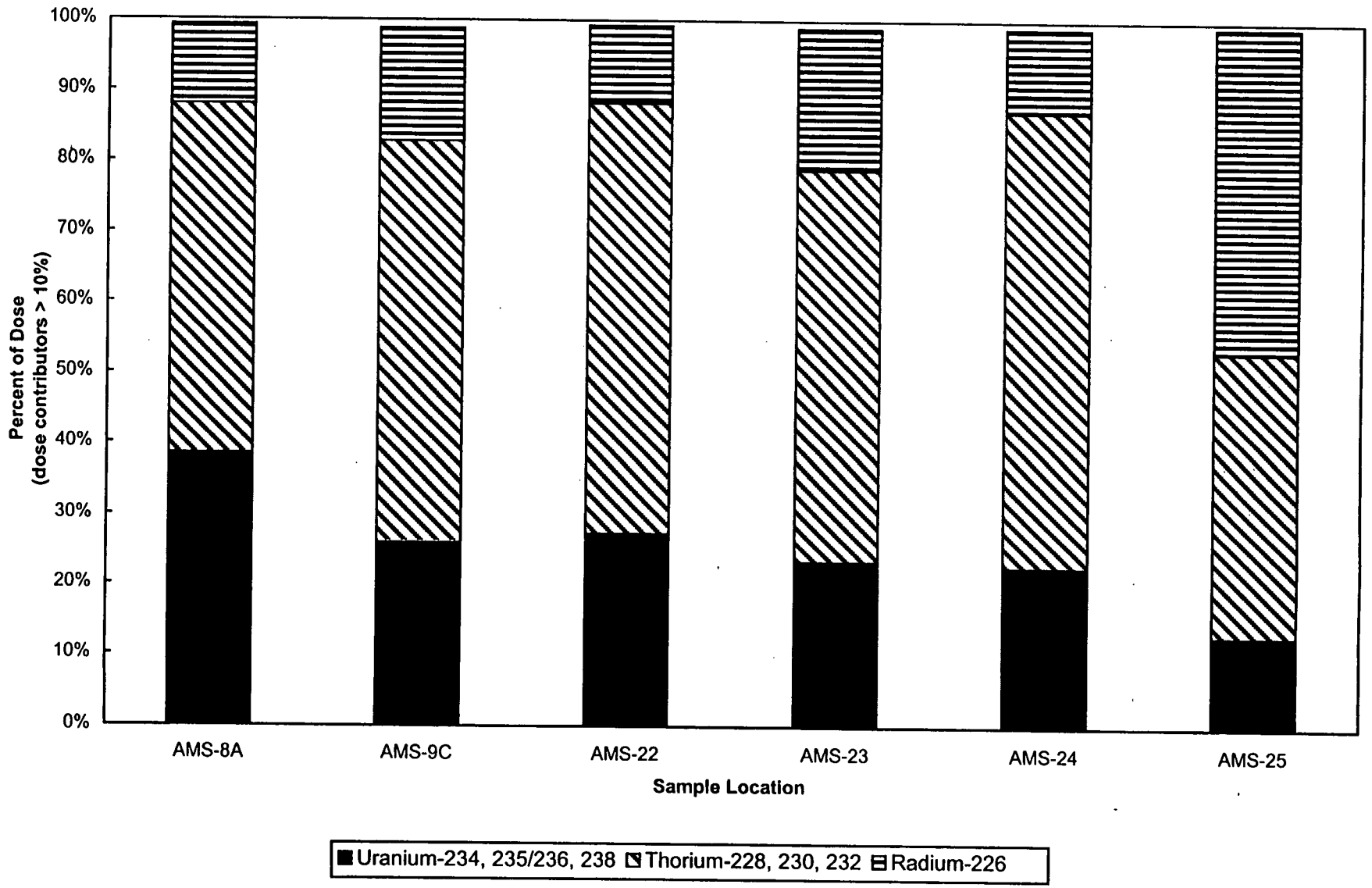


FIGURE C.1-41. 2000 DOSE CONTRIBUTIONS PER AMS LOCATION

000447

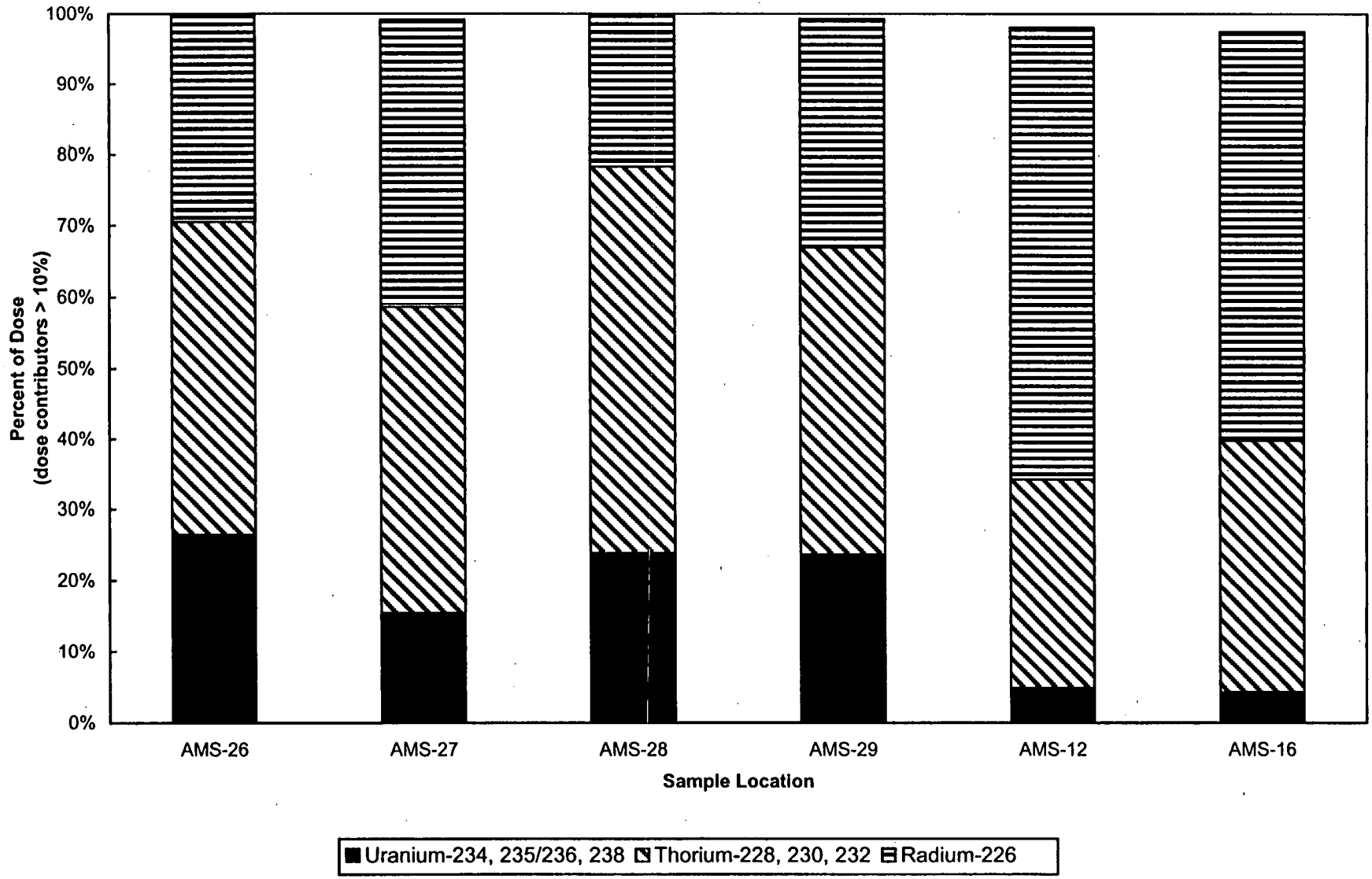


FIGURE C.1-42. 2000 DOSE CONTRIBUTIONS PER AMS LOCATION

Attachment C.2

ATTACHMENT C.2

RADON

ATTACHMENT C.2

As discussed in Chapter 5 of the 2000 Integrated Site Environmental Report, the FEMP's radon monitoring program primarily focuses on assessing the effects of radon emissions from the K-65 Silos 1 and 2 on the surrounding environment. The radon data collected under the program are compared to the radon concentration standards contained in DOE Order 5400.5, Radiation Protection of the Public and the Environment. The pertinent standards and associated 2000 compliance status are provided below:

- The DOE annual average limit at and beyond the facility fenceline is 3 picoCuries per liter (pCi/L) above background; there were no exceedances in 2000.
- The DOE annual average limit over the facility is 30 pCi/L above background; this limit was not exceeded in 2000.
- The DOE limit measured at any point over the facility is 100 pCi/L; there were six exceedances during 2000.

Continuous monitors are used at the FEMP to determine compliance with these limits and track changes in radon concentrations. The following section summarizes the findings from the radon monitoring program for 2000.

Continuous Monitoring Results

For 2000, the radon monitoring program operated 34 continuous environmental radon monitors during the year. The operational radon monitor run-time averaged approximately 95 percent for the 34 monitors. The five percent down-time was associated with downloading of instrument data, interruptions due to extreme cold temperatures, power interruptions, and/or an increase in routine maintenance or project activities.

Data from the continuous environmental radon monitors are provided in this attachment in the following two formats:

- Table C.2-1 provides a detailed summary of 100 pCi/L exceedances. During 2000 there were six exceedances of the 100 pCi/L DOE limit.
- Figure C.2-1 identifies the location of continuous environmental radon monitoring locations in 2000. Figures C.2-2 through C.2-35 present the monthly average radon concentrations plotted over time for the 34 continuous environmental radon monitoring stations which operated during 2000. The 3 pCi/L (fenceline and off site) and 30 pCi/L limits (on site) have been added as reference points to the appropriate graphs to assist in evaluating the data.

- Table C.2-2 provides a summary of monthly average radon concentrations for the continuous environmental radon monitoring stations.

Following the re-sealing activities on the silo domes initiated in late May 1999 and completed on June 4, 1999, radon data from the K-65 Silo area has been closely monitored in order to gauge the effectiveness in reducing radon emissions. During 2000 only six exceedances of the 100 pCi/L DOE radon limit were observed as compared to 47 exceedances in 1999. The significant decrease in the number of exceedances indicates that the silo domes have retained their integrity after the resealing activities. As in past years, the exceedances were observed at monitoring locations adjacent to the K-65 Silos and occurred during periods of atmospheric inversions.

- In order to better monitor radon levels in the K-65 Silos area during the Accelerated Waste Retrieval Project, five radon monitoring locations were added to the existing IEMP radon network in 2000 with the last monitors being placed in the field during November. Four of the monitors were located in the immediate vicinity of the silos (KNO, KSO, LP2, and T117) and the fifth monitor (PR1) was located along the western fenceline of the FEMP near AMS-6. The T-28 radon monitor was also relocated to a new location, designated as T-28A, in order to remove the monitor from an active construction area. The new monitoring locations are documented in the IEMP, Rev. 2 (DOE 2001).

- Additionally, the KNW and KSW radon monitors were relocated approximately 35 feet to the west of their former locations on October 24, 2000 to remove them from the Accelerated Waste Retrieval Project construction area. The new locations (KNW-A and KSW-A) are expected to show lower average radon concentrations due to the increased distance from the silos but still serve the purpose of monitoring Silo 1 and Silo 2 radon emissions.

TABLE C.2-1

2000 RADON CONCENTRATIONS
100 pCi/L EXCEEDANCES AT THE K-65 SILOS 1 AND 2 EXCLUSION FENCE

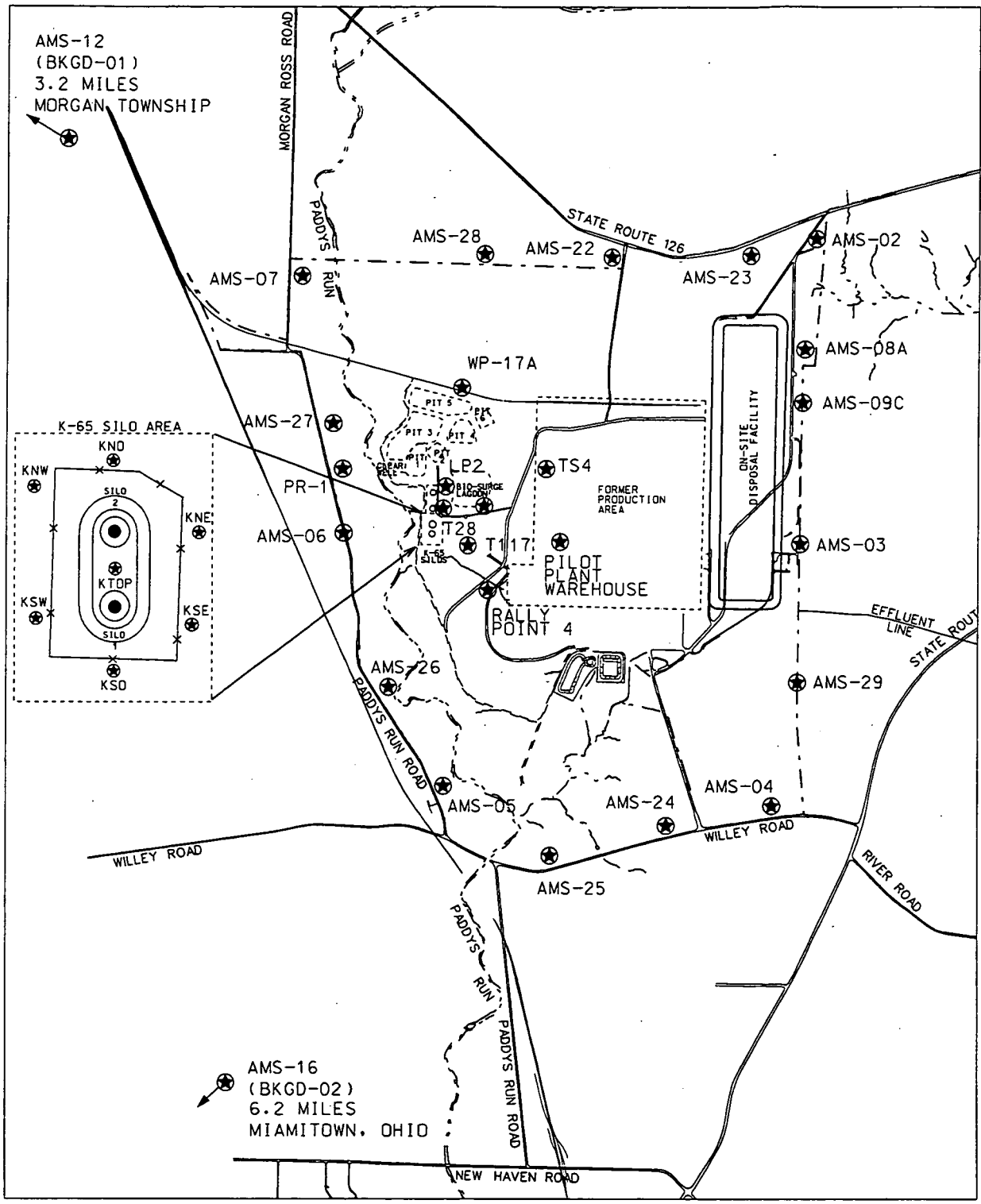
Exceedance Event Date	Duration of Exceedance (hours)	Maximum Recorded Hourly Radon Concentration (pCi/L)	Monitoring Locations
3/27	1	131	KNW
4/16	3	165	KNW
4/27	1	114	KSE
5/1	1	140	KNW
5/5	1	130	KNW
6/12	3	219	KSE

TABLE C.2-2

CONTINUOUS ENVIRONMENTAL RADON MONITORING MONTHLY AVERAGE CONCENTRATIONS[a]

Location[b]	2000 Summary Results (Instrument Background Corrected)[c] (pCi/L)			1999 Summary Results (Instrument Background Corrected)[c,d] (pCi/L)		
	Min.	Max.	Avg.	Min.	Max.	Avg.
Fenceline						
AMS-02	0.2	0.6	0.4	0.2	1.0	0.5
AMS-03	0.3	1.0	0.6	0.1	1.0	0.5
AMS-04	0.2	0.8	0.4	0.1	0.8	0.4
AMS-05	0.2	0.7	0.4	0.2	1.4	0.7
AMS-06	0.2	0.7	0.4	0.2	0.8	0.5
AMS-07	0.3	0.9	0.5	0.3	1.5	0.8
AMS-08A	0.2	0.6	0.4	0.1	0.8	0.4
AMS-09C	0.1	0.8	0.4	0.2	0.8	0.5
AMS-22	0.1	0.5	0.3	0.1	0.5	0.3
AMS-23	0.1	0.3	0.2	0.1	0.6	0.3
AMS-24	0.2	0.8	0.4	0.2	1.1	0.6
AMS-25	0.2	0.6	0.3	0.2	0.8	0.5
AMS-26	0.2	0.7	0.4	0.2	0.8	0.5
AMS-27	0.2	0.8	0.4	0.2	1.1	0.6
AMS-28	0.2	0.6	0.3	0.1	0.8	0.4
AMS-29	0.2	0.7	0.4	0.1	0.8	0.4
Background						
AMS-12	0.1	0.5	0.3	0.1	0.5	0.2
AMS-16	0.1	0.4	0.2	0.1	0.5	0.3
On Site						
KNE	1.5	3.6	2.2	1.7	18.3	9.6
KNO[e]	1.3	3.7	2.7	NA	NA	NA
KNW	1.0	4.2	1.9	2.1	8.2	3.8
KSE	1.3	4.7	2.8	1.2	9.9	4.9
KSO[e]	0.3	0.9	0.5	NA	NA	NA
KSW	1.0	2.4	1.6	1.7	4.8	3.1
KTOP	1.8	11.8	4.7	3.4	15.8	8.4
LP2[f]	0.4	0.5	0.4	NA	NA	NA
Pilot Plant Warehouse	0.1	1.1	0.4	0.3	0.8	0.4
PR-1[g]	0.3	1.0	0.6	NA	NA	NA
Rally Point 4	0.3	0.8	0.4	0.5	1.3	0.8
Surge Lagoon	0.2	0.6	0.4	0.4	1.0	0.7
T117[f]	0.2	0.4	0.3	NA	NA	NA
T28	0.7	1.2	1.0	1.1	3.8	2.2
TS4	0.1	0.7	0.3	0.2	0.9	0.5
WP-17A	0.2	1.0	0.4	0.1	1.1	0.6

[a]Monthly average radon concentrations are calculated from daily average concentrations. Daily average concentrations are calculated by summing all hourly count data, treating the sum as a single daily measurement, and then converting the sum to a (daily average) concentration.
[b]Refer to Figure C.2-1 for sample locations
[c]Instrument background changes as monitors are replaced.
[d]NA = not applicable
[e]Unit was placed in service in April 2000.
[f]Unit was placed in service in November 2000.
[g]Unit was placed in service in March 2000.



LEGEND:

— · — · — FEMP BOUNDARY

ENVIRONMENTAL RADON MONITORING - CONTINUOUS ALPHA SCINTILLATION LOCATION

DISTANCE FROM CENTER OF FORMER PRODUCTION AREA TO LOCATION OFF MAP

SILO HEAD SPACE RADON MONITORING - CONTINUOUS ALPHA SCINTILLATION LOCATION

SCALE

2000 1000 0 2000 FEET

FIGURE C.2-1. RADON MONITORING - CONTINUOUS ALPHA SCINTILLATION LOCATIONS

V:/5FGP1/DGN/00ANNUAL/00AN007.DGN
STATE PLANAR COORDINATE SYSTEM 1983
12-13-00

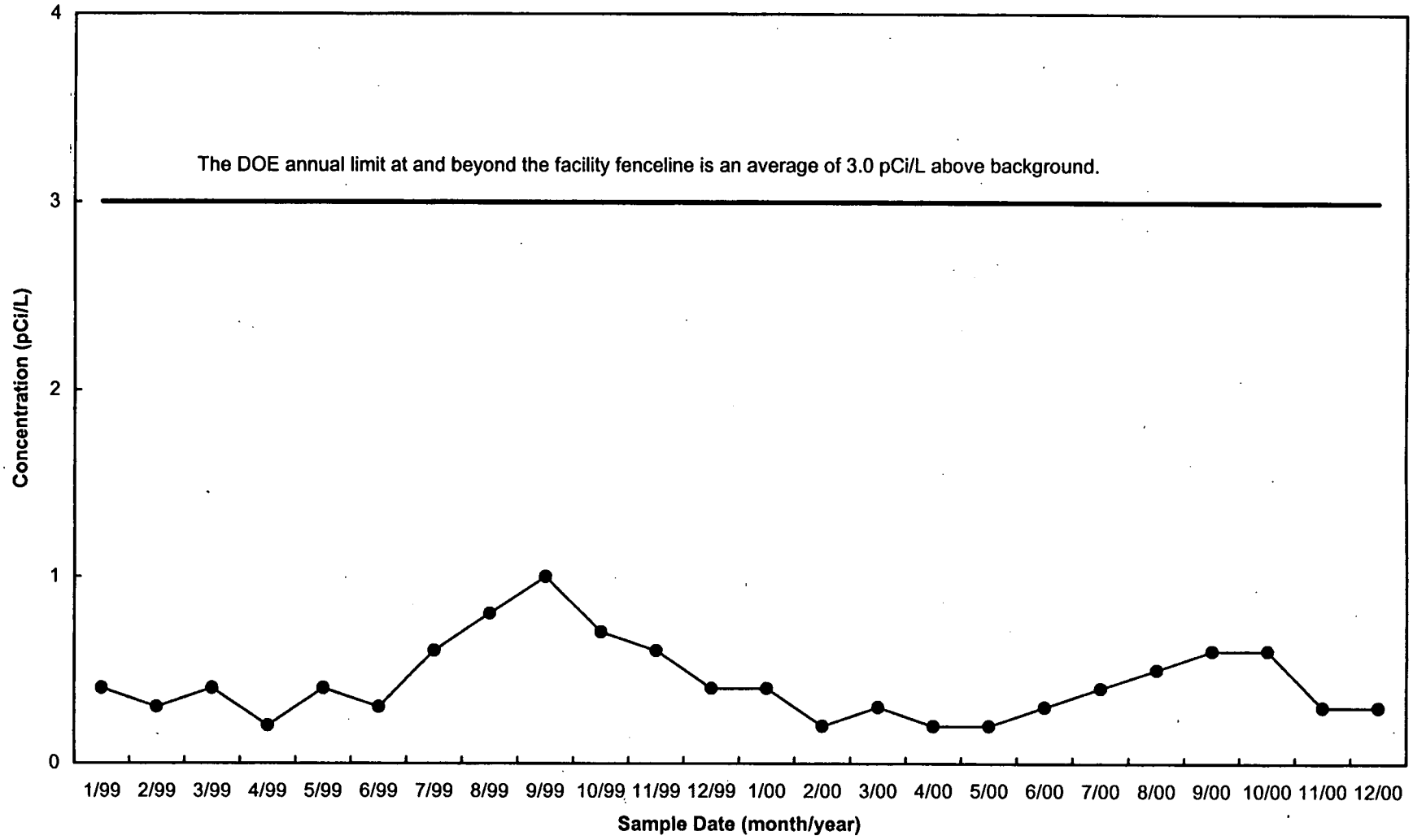


FIGURE C.2-2. 1999 AND 2000 MONTHLY AVERAGE
RADON CONCENTRATION FOR AMS-02

000455

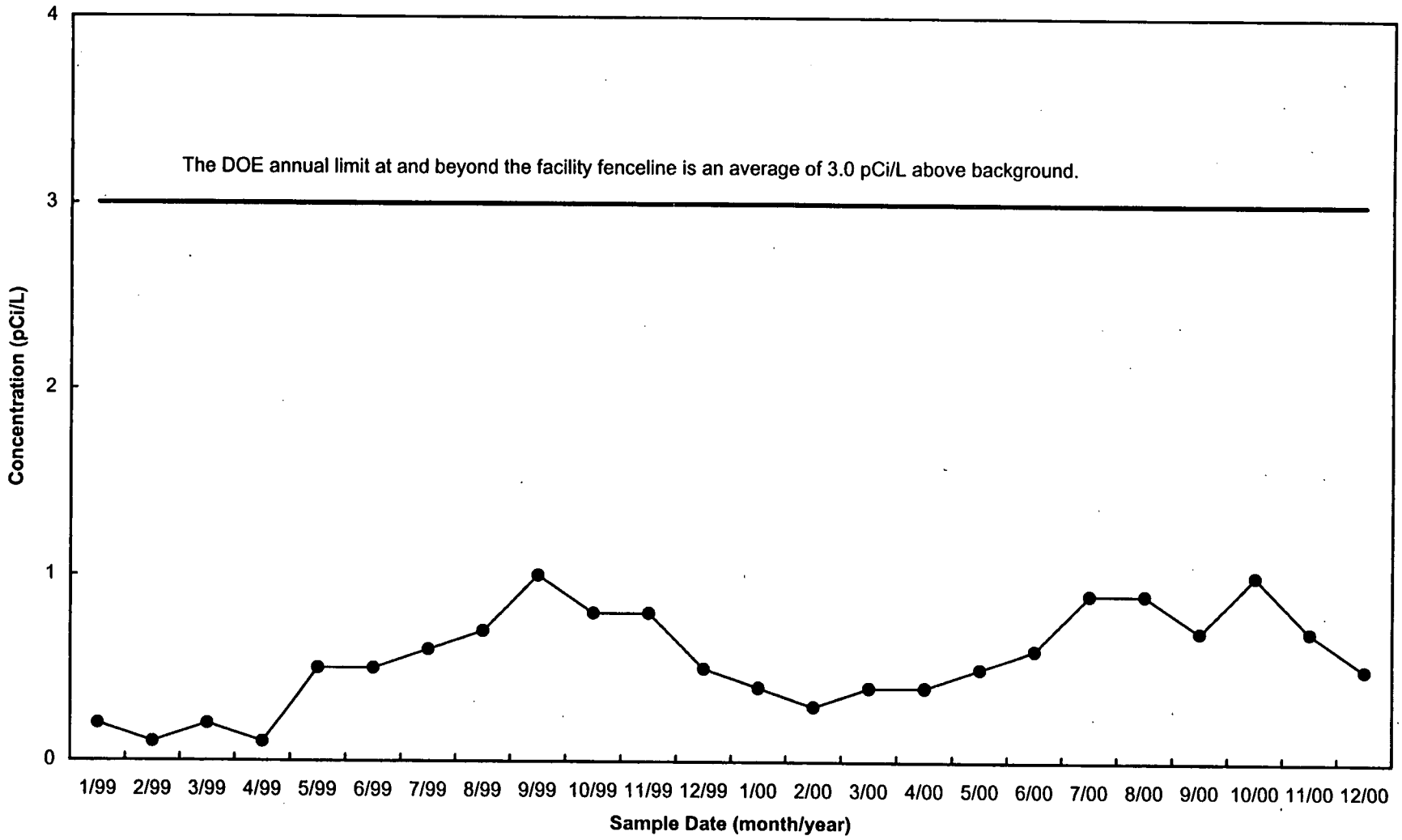


FIGURE C.2-3. 1999 AND 2000 MONTHLY AVERAGE
RADON CONCENTRATION FOR AMS-03

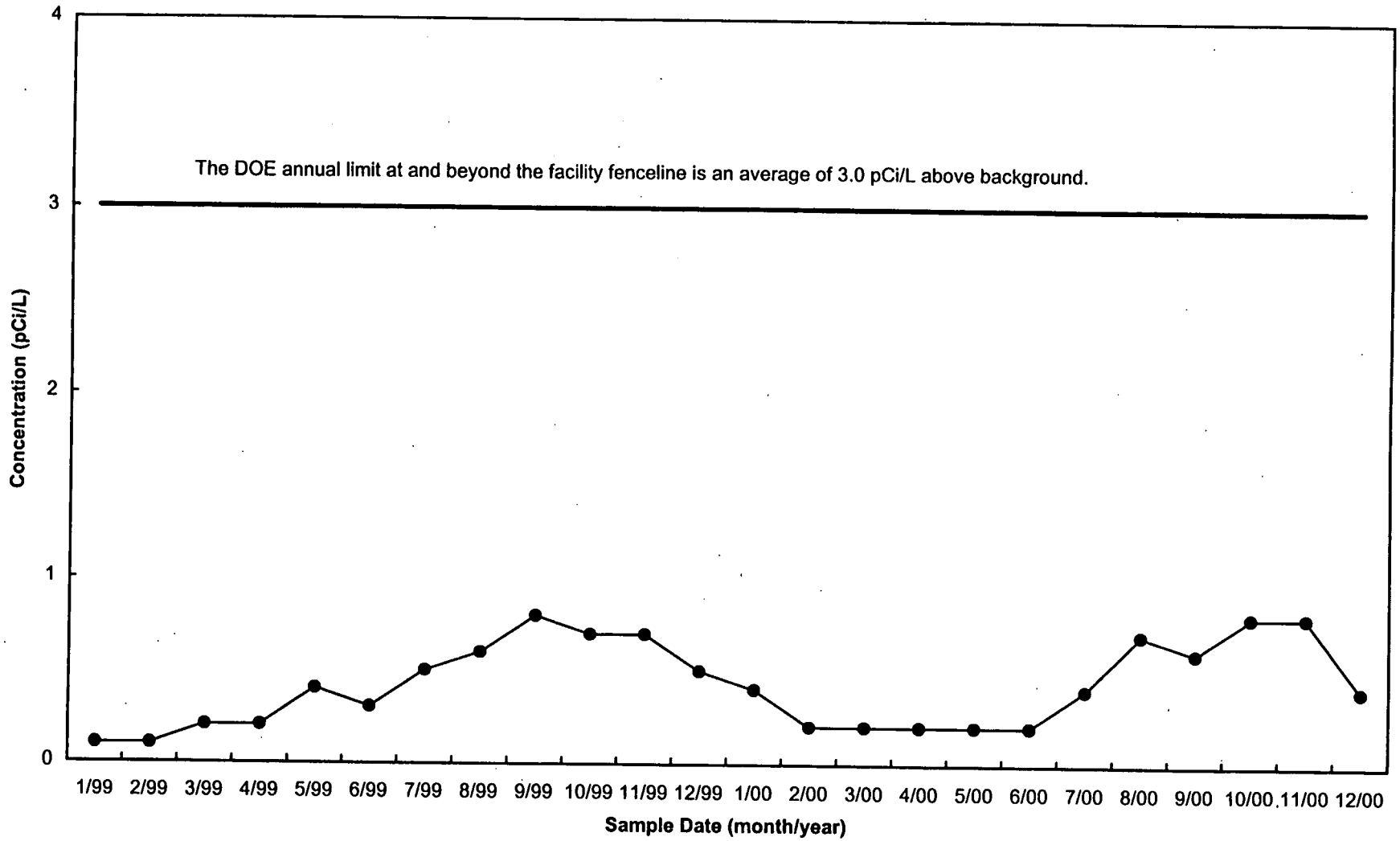


FIGURE C.2-4. 1999 AND 2000 MONTHLY AVERAGE RADON CONCENTRATION FOR AMS-04

000457

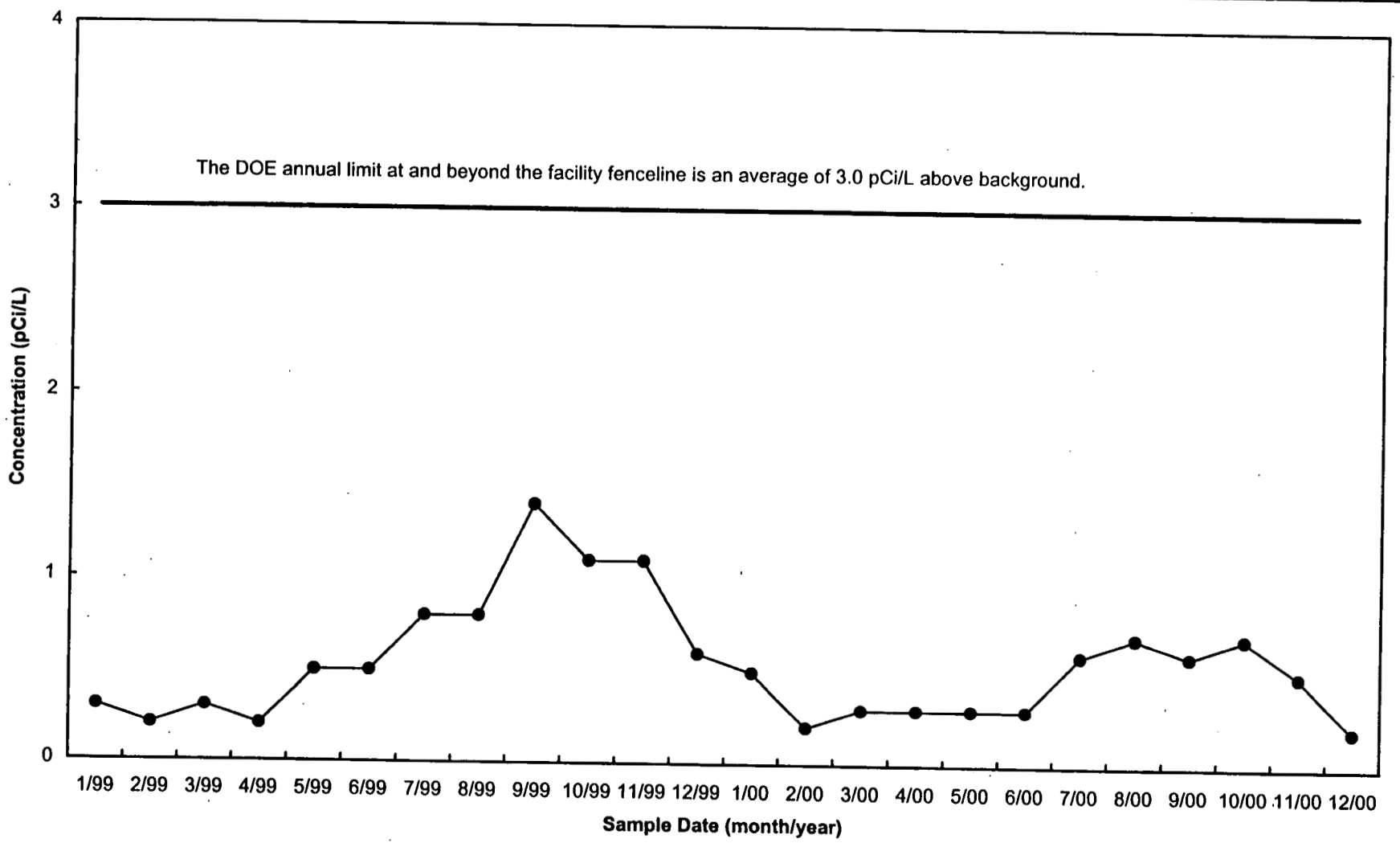


FIGURE C.2-5. 1999 AND 2000 MONTHLY AVERAGE RADON CONCENTRATION FOR AMS-05

000458

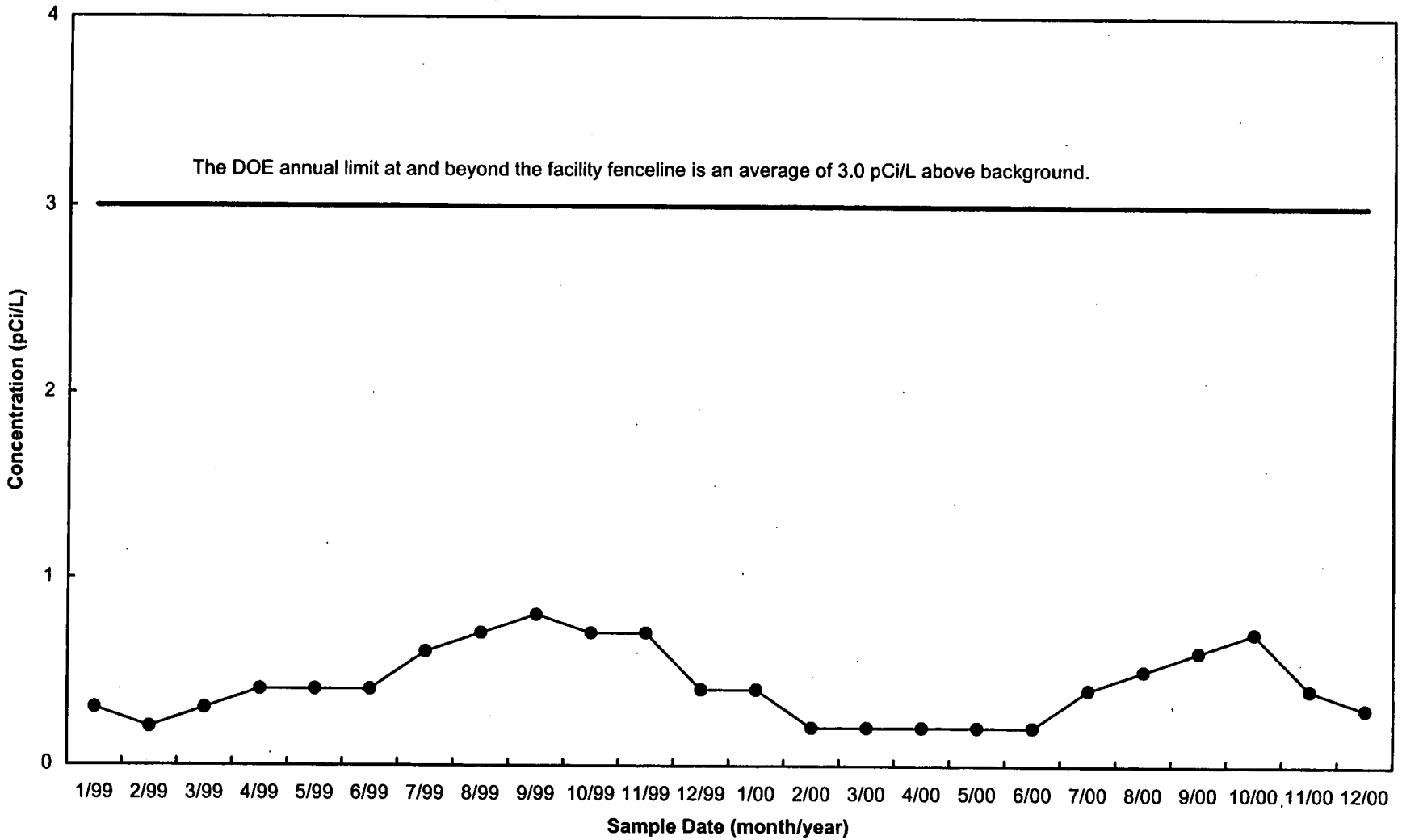


FIGURE C.2-6. 1999 AND 2000 MONTHLY AVERAGE
RADON CONCENTRATION FOR AMS-06

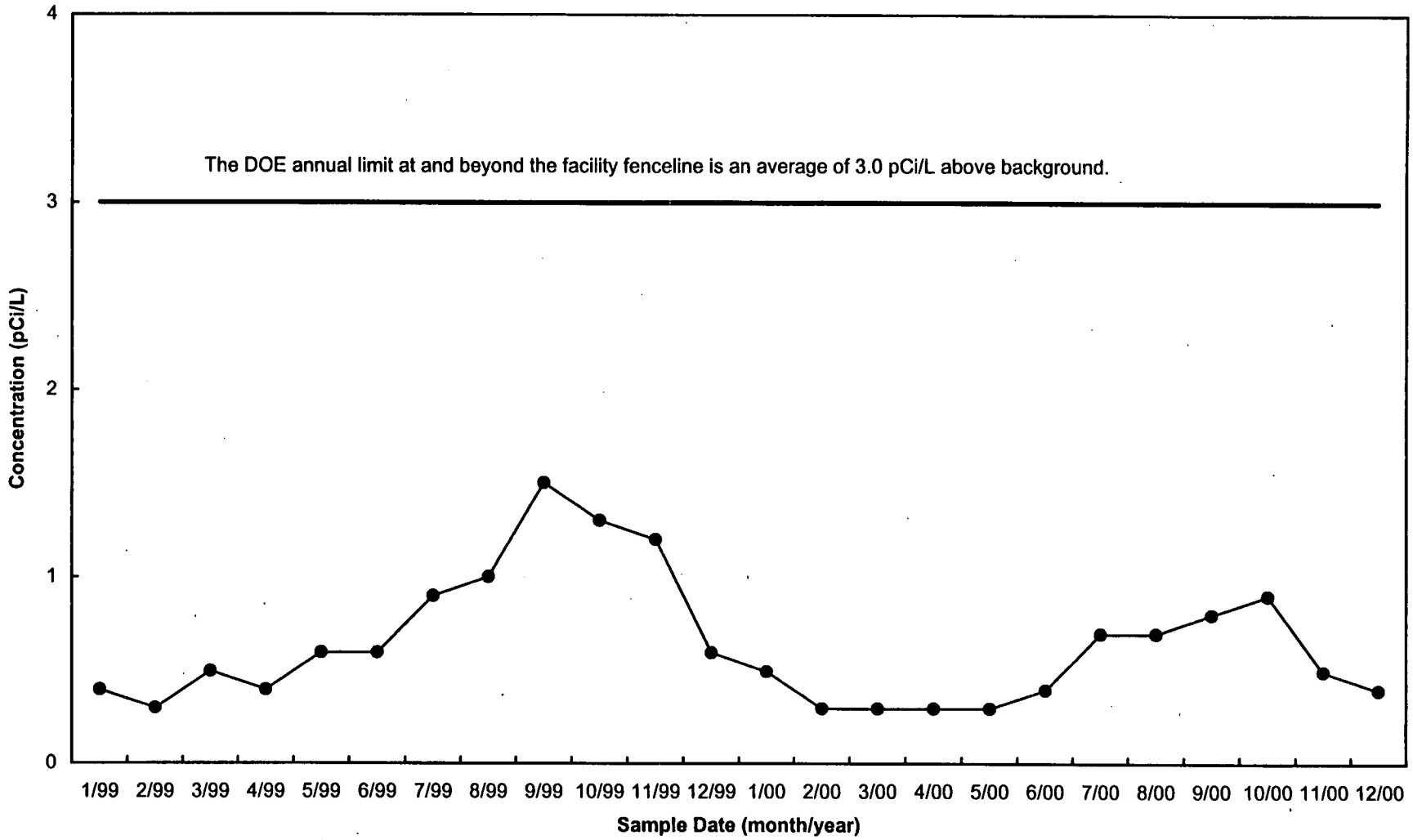


FIGURE C.2-7. 1999 AND 2000 MONTHLY AVERAGE
RADON CONCENTRATION FOR AMS-07

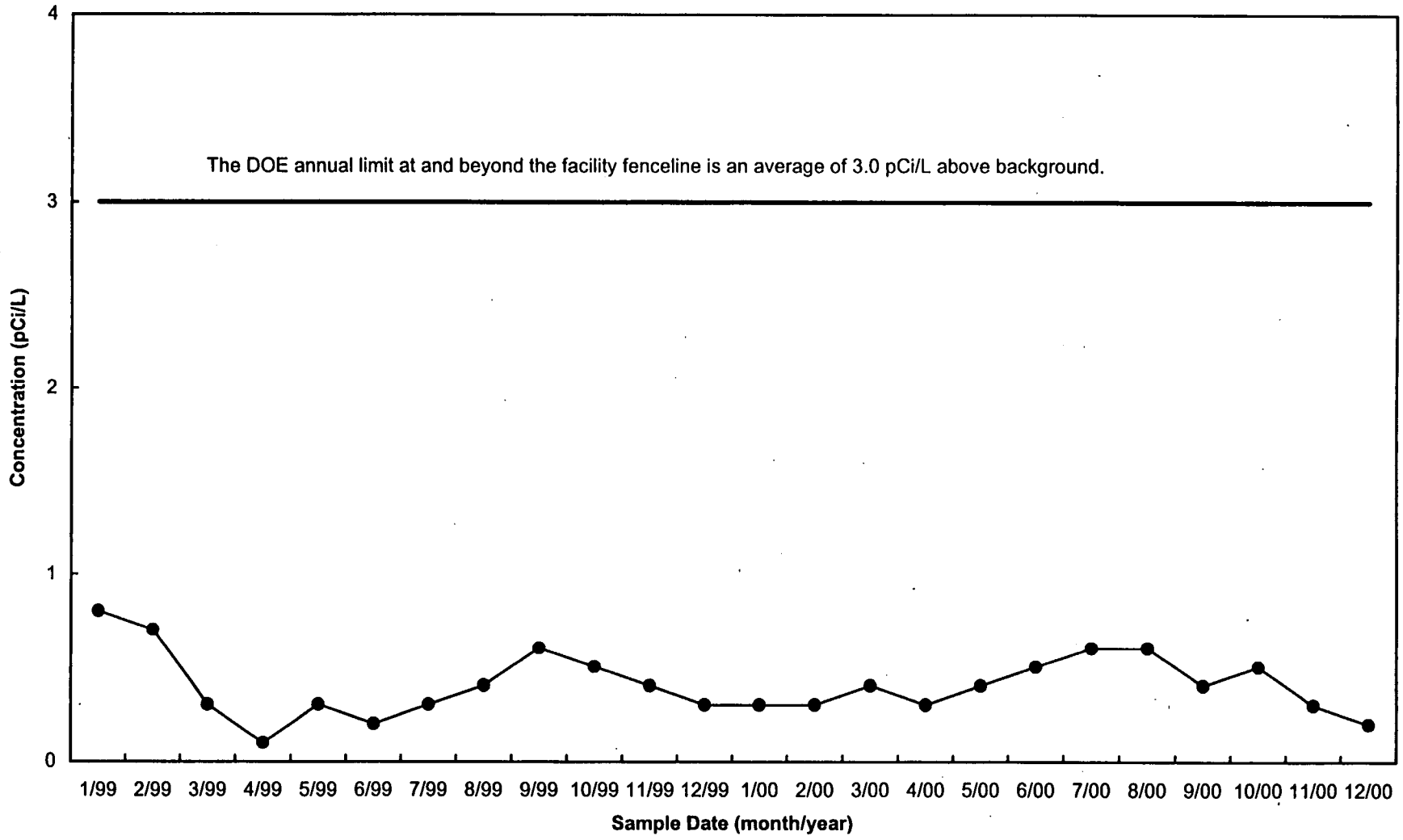


FIGURE C.2-8. 1999 AND 2000 MONTHLY AVERAGE
RADON CONCENTRATION FOR AMS-08A

000461

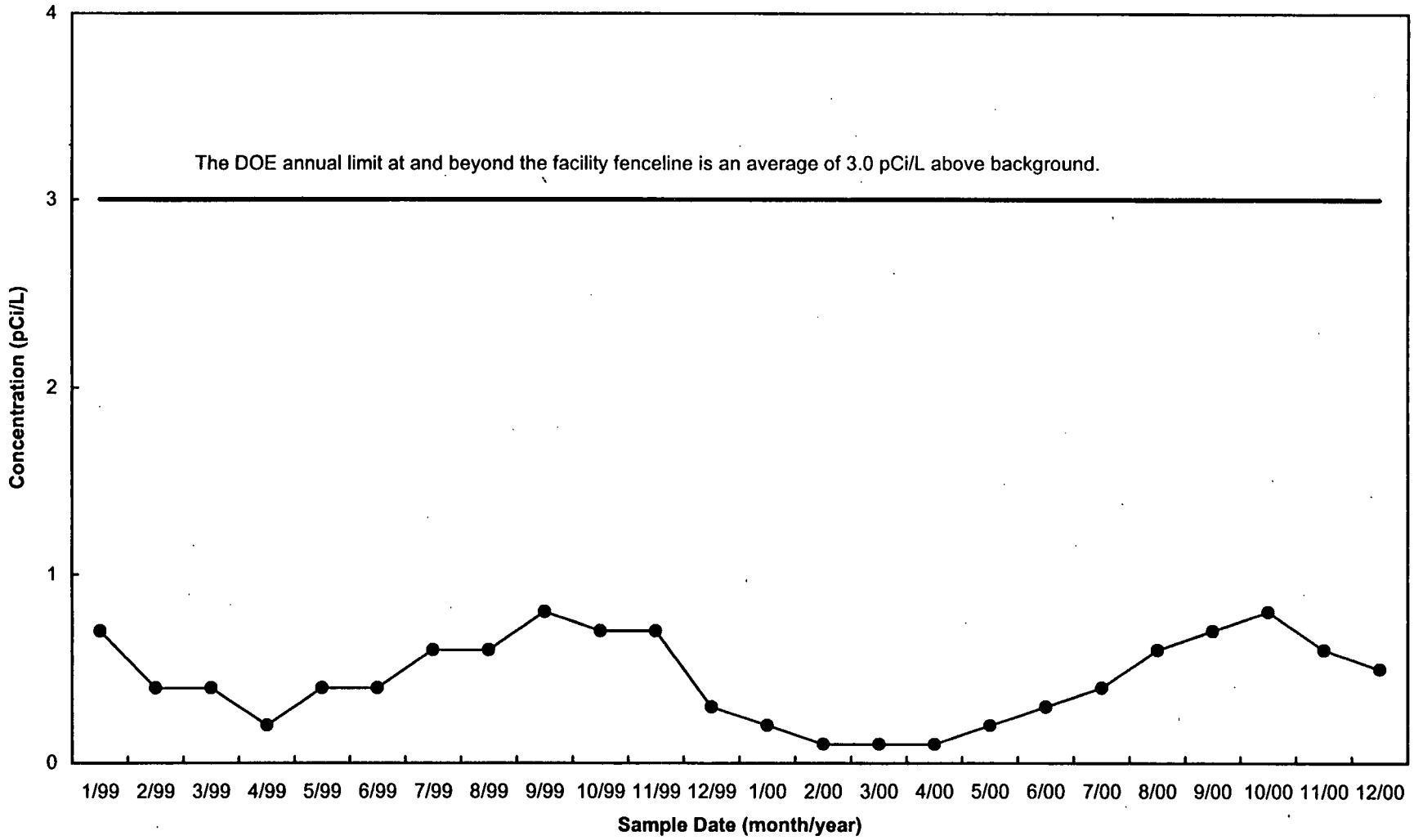


FIGURE C.2-9. 1999 AND 2000 MONTHLY AVERAGE
RADON CONCENTRATION FOR AMS-09C

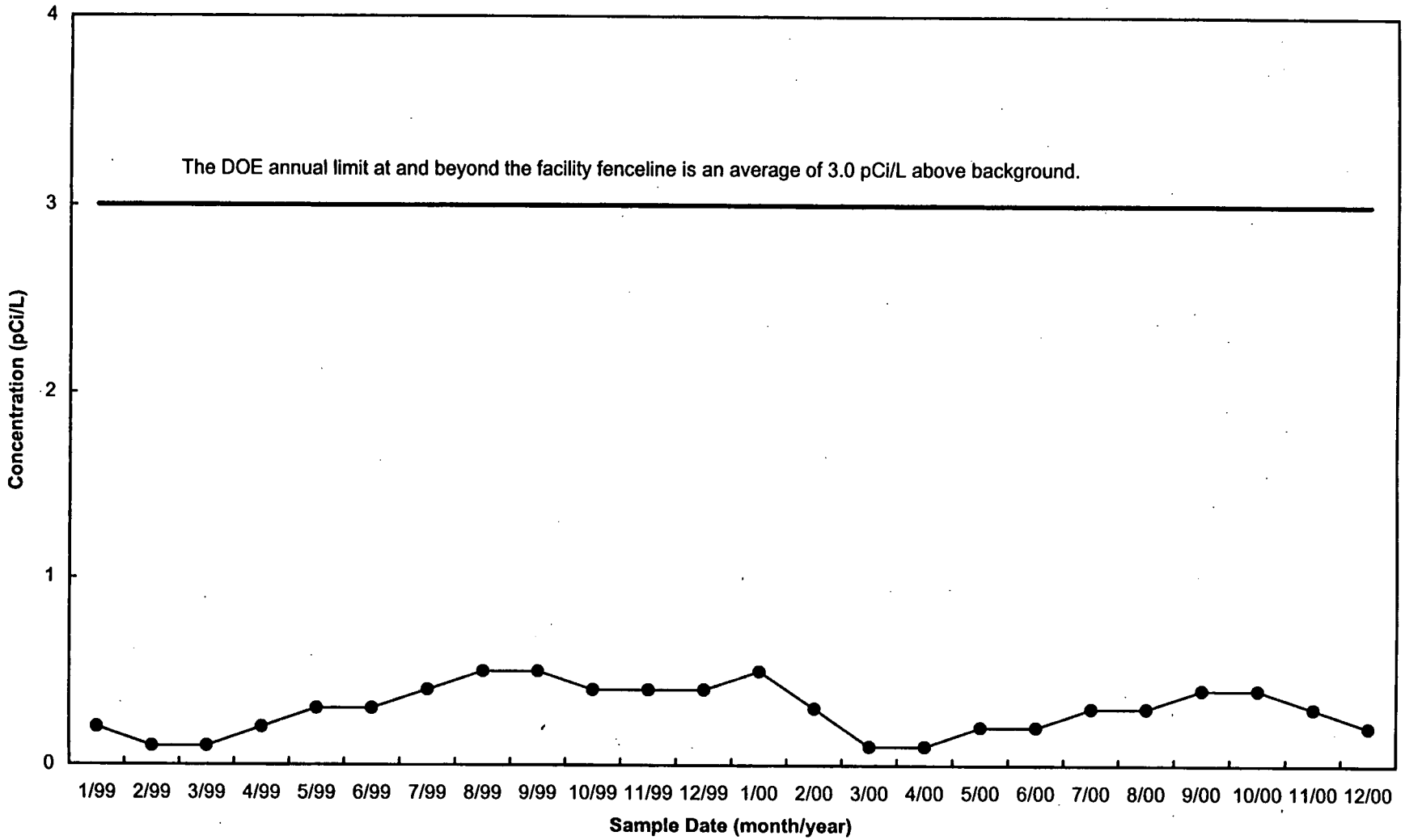


FIGURE C.2-10. 1999 AND 2000 MONTHLY AVERAGE RADON CONCENTRATION FOR AMS-22

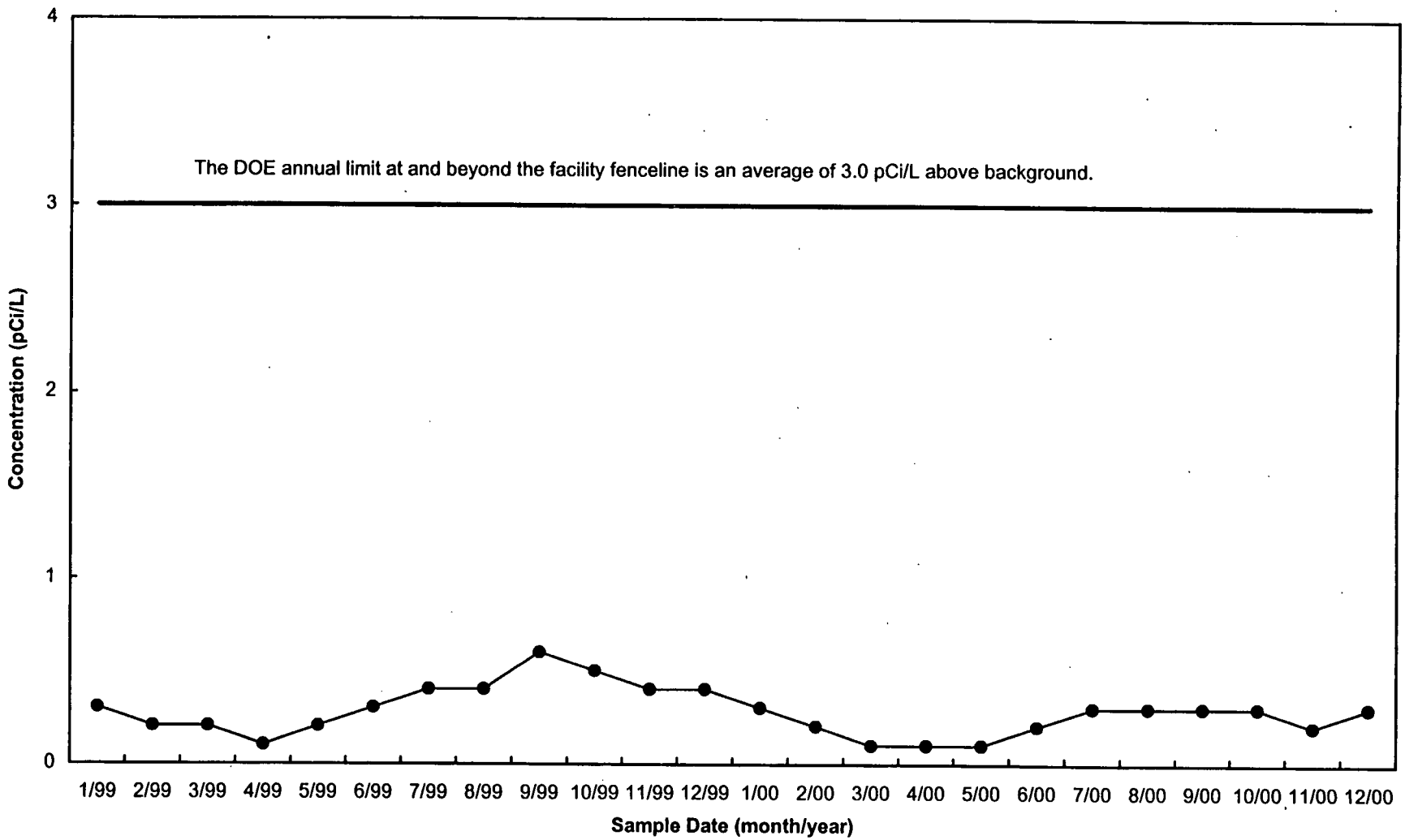


FIGURE C.2-11. 1999 AND 2000 MONTHLY AVERAGE
RADON CONCENTRATION FOR AMS-23

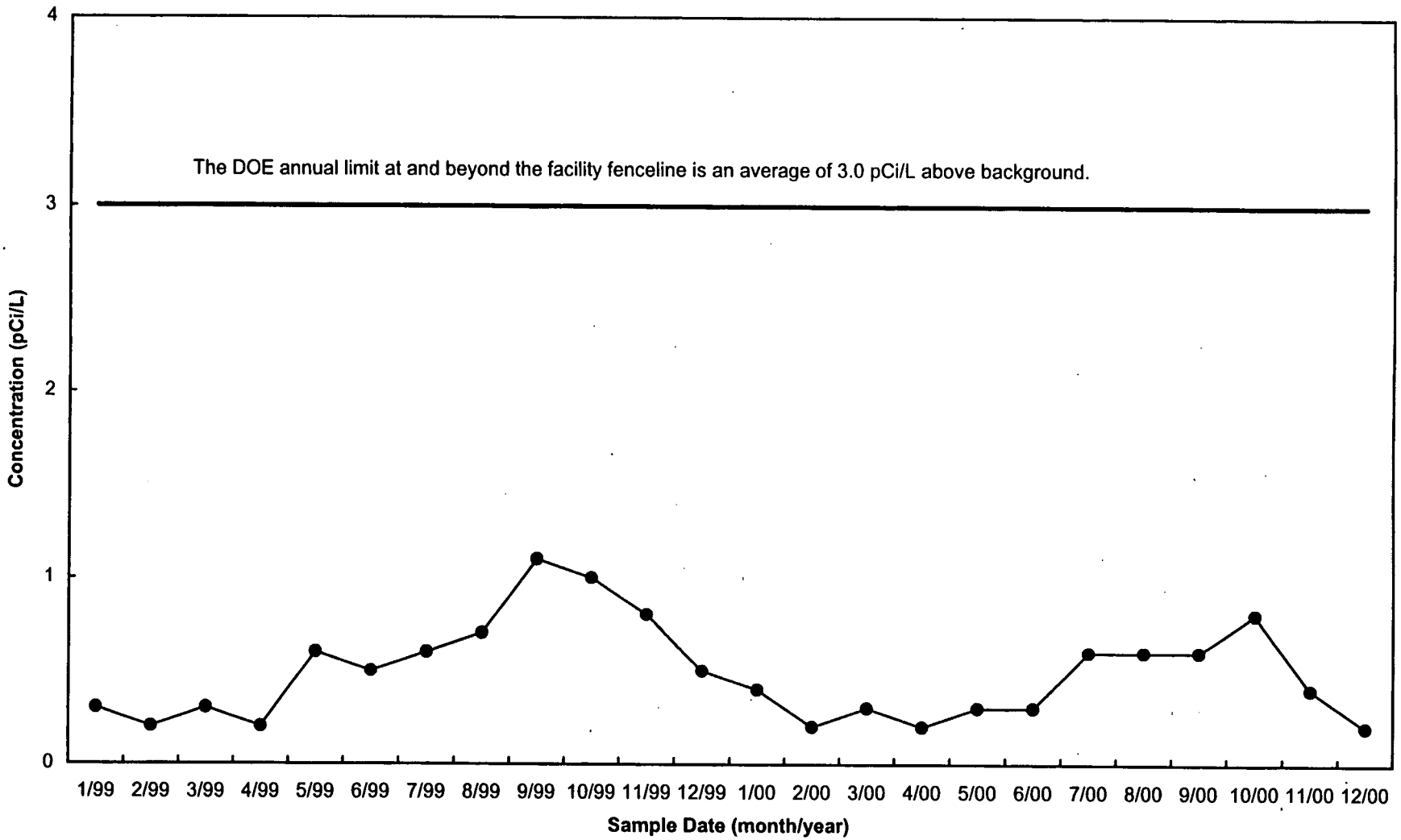


FIGURE C.2-12. 1999 AND 2000 MONTHLY AVERAGE RADON CONCENTRATION FOR AMS-24

000465

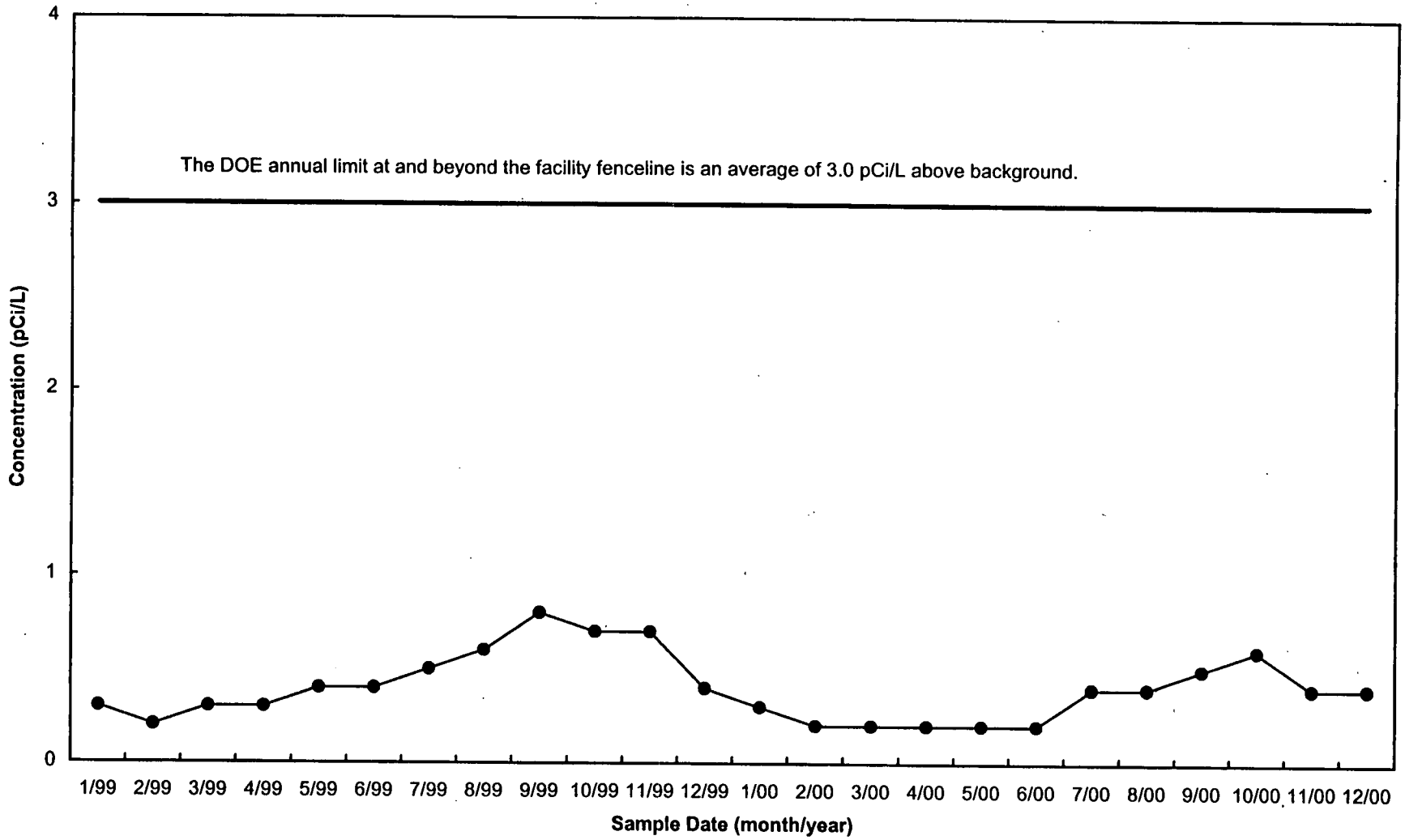


FIGURE C.2-13. 1999 AND 2000 MONTHLY AVERAGE RADON CONCENTRATION FOR AMS-25

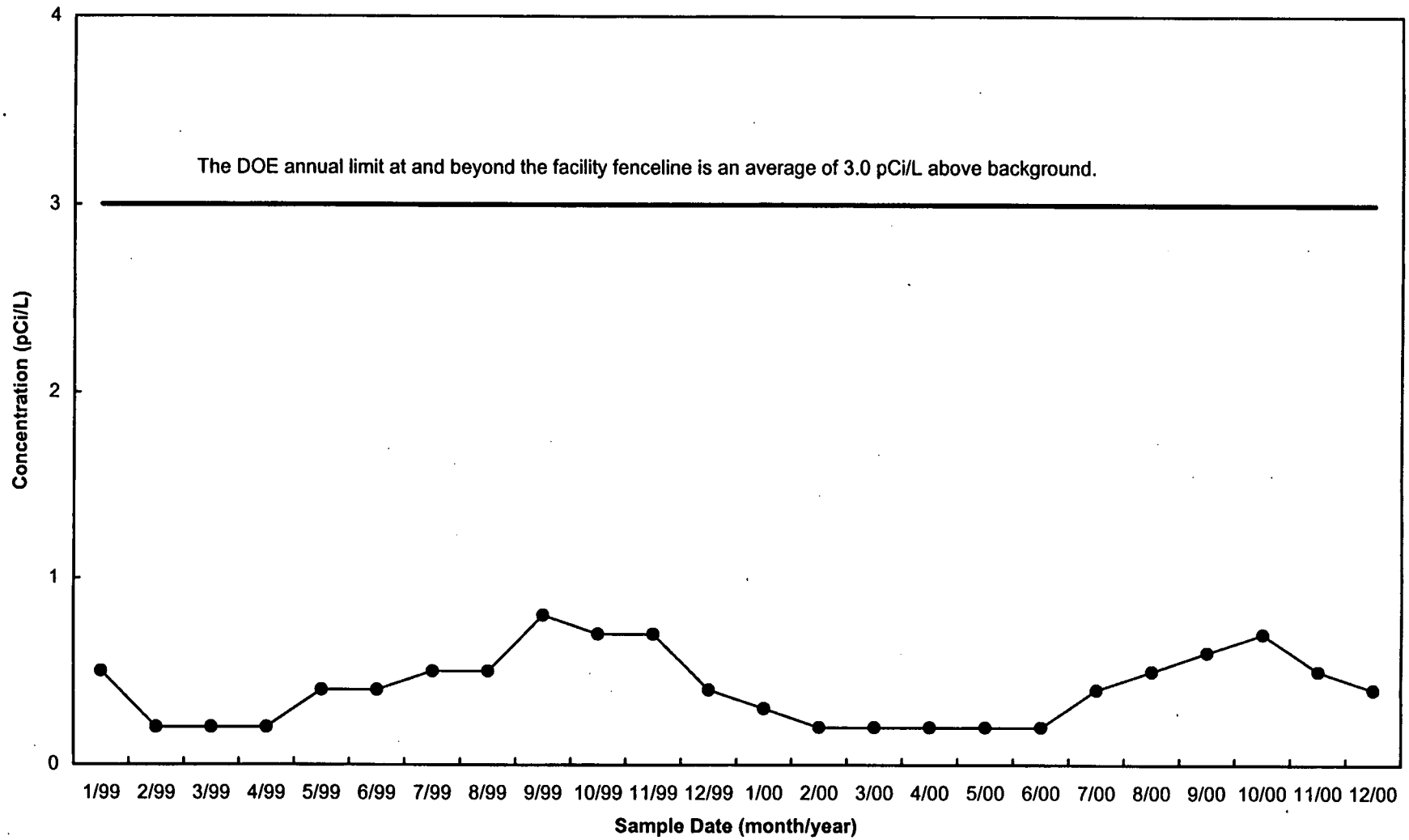


FIGURE C.2-14. 1999 AND 2000 MONTHLY AVERAGE RADON CONCENTRATION FOR AMS-26

000467

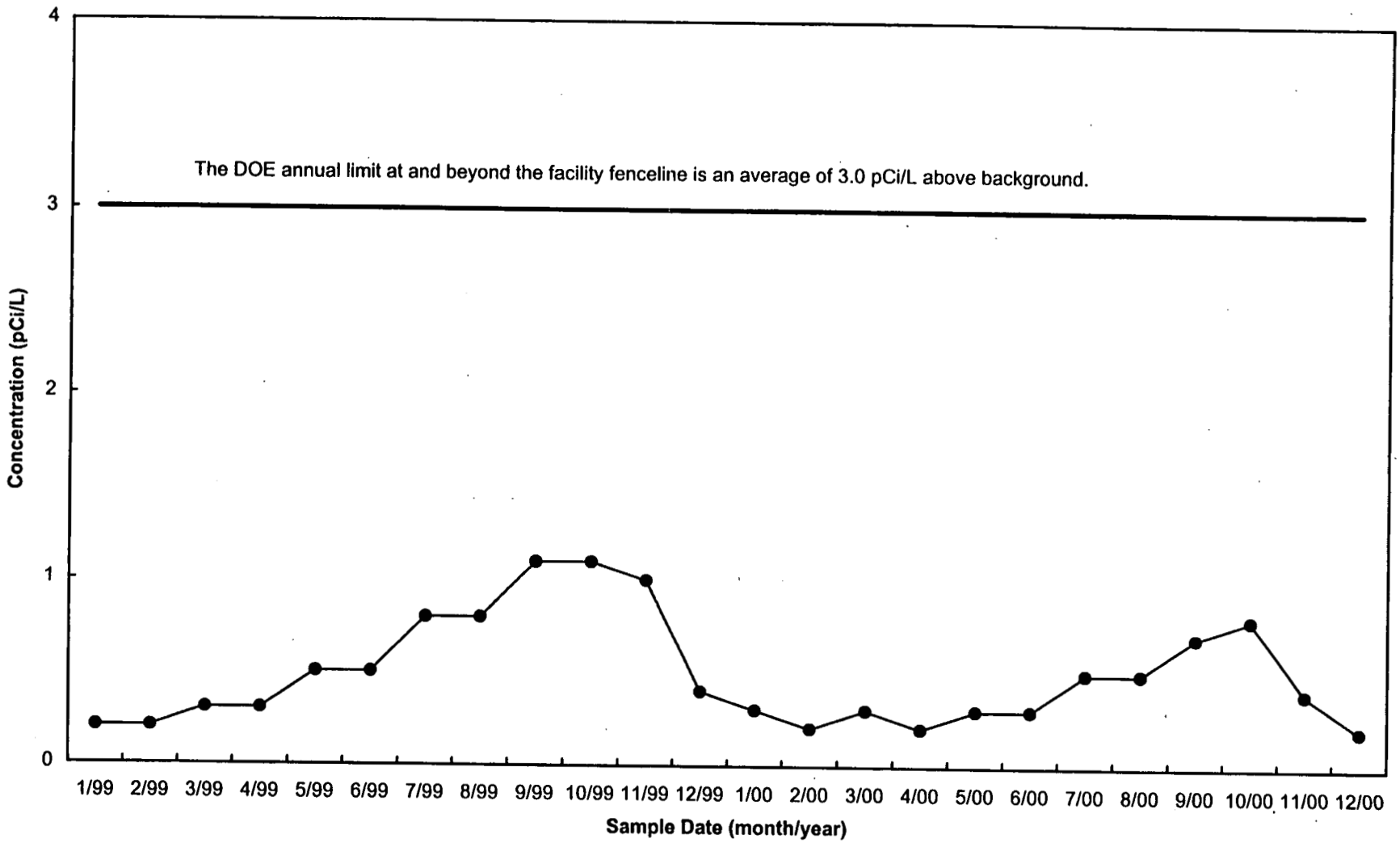


FIGURE C.2-15. 1999 AND 2000 MONTHLY AVERAGE RADON CONCENTRATION FOR AMS-27

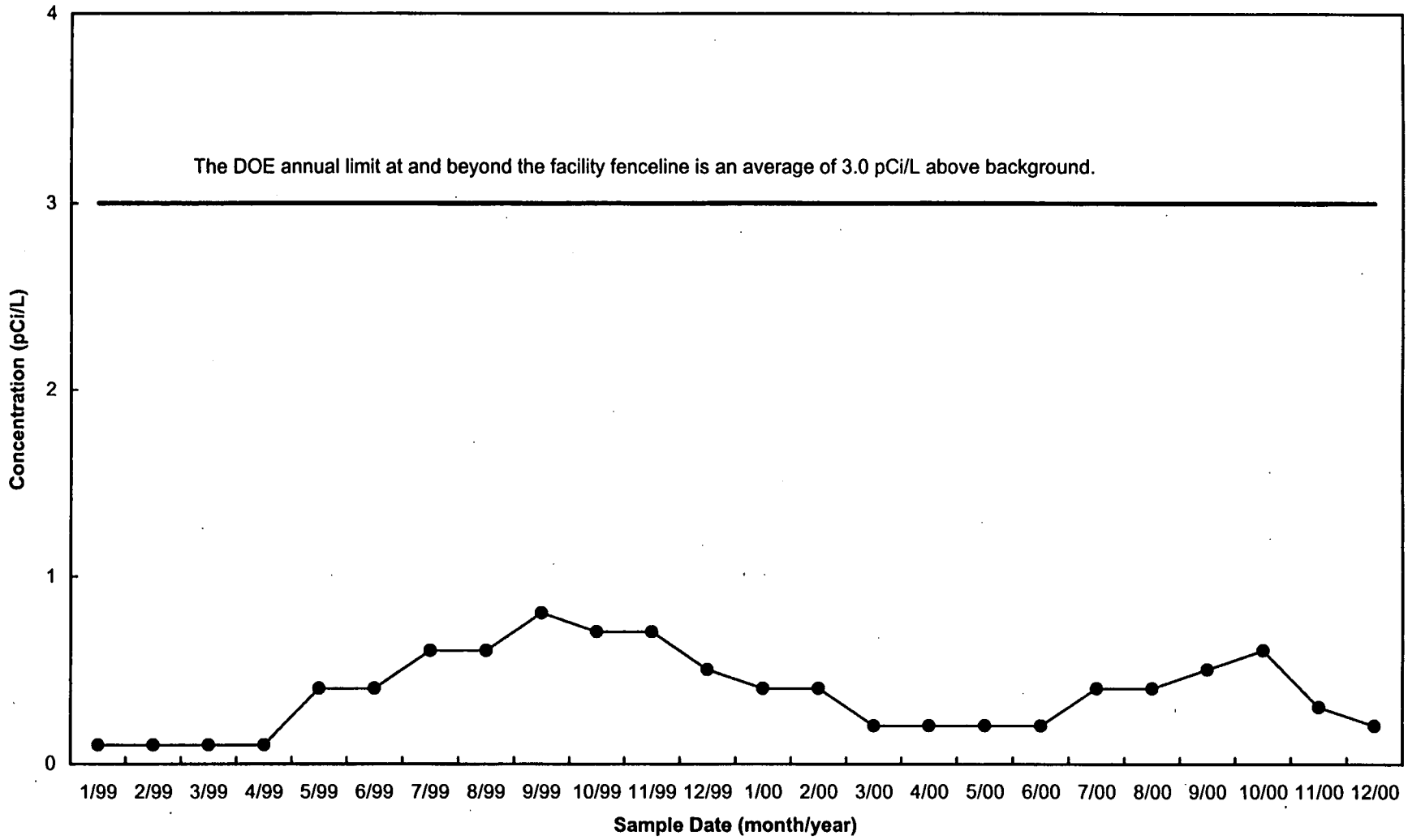


FIGURE C.2-16. 1999 AND 2000 MONTHLY AVERAGE
RADON CONCENTRATION FOR AMS-28

000469

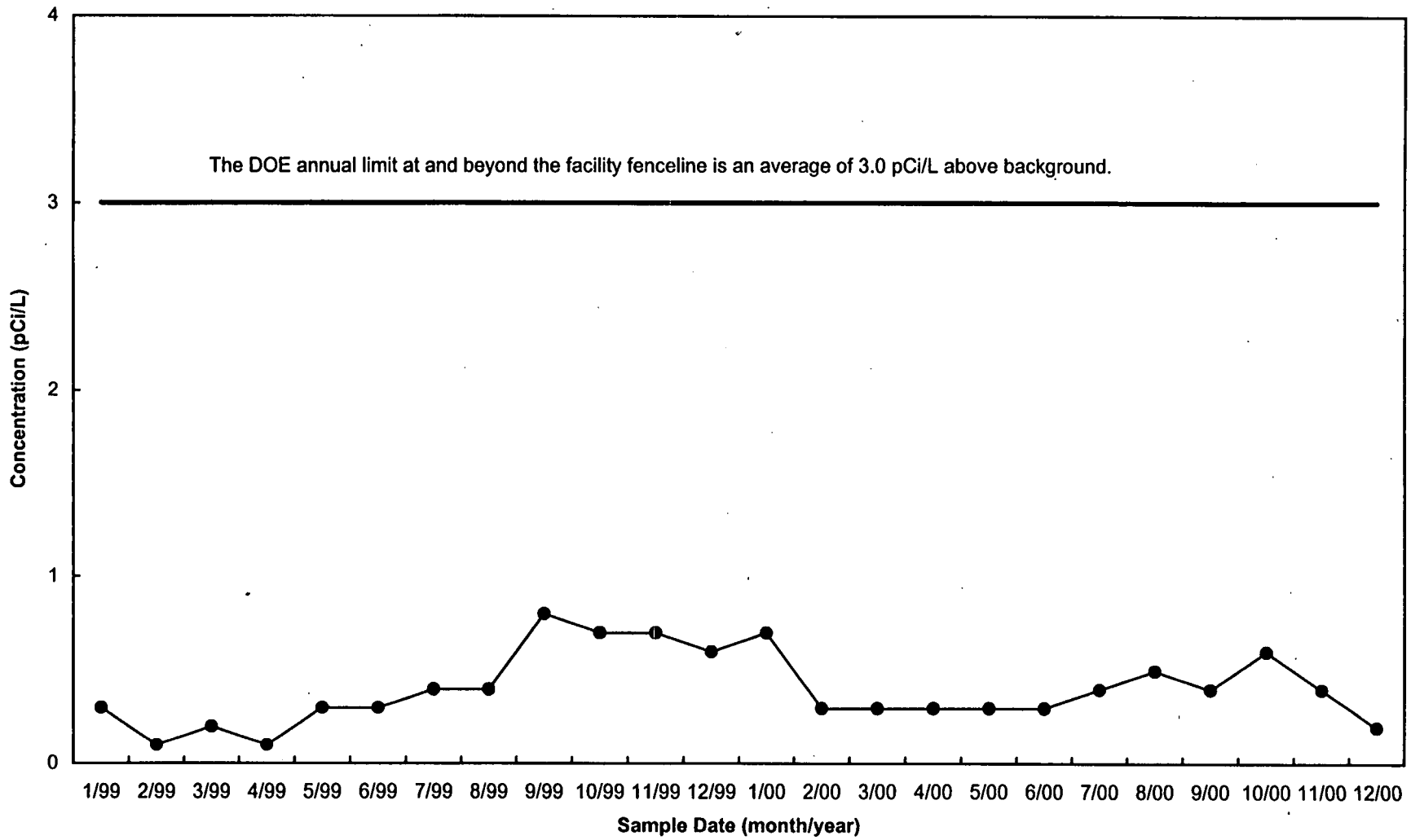


FIGURE C.2-17. 1999 AND 2000 MONTHLY AVERAGE RADON CONCENTRATION FOR AMS-29

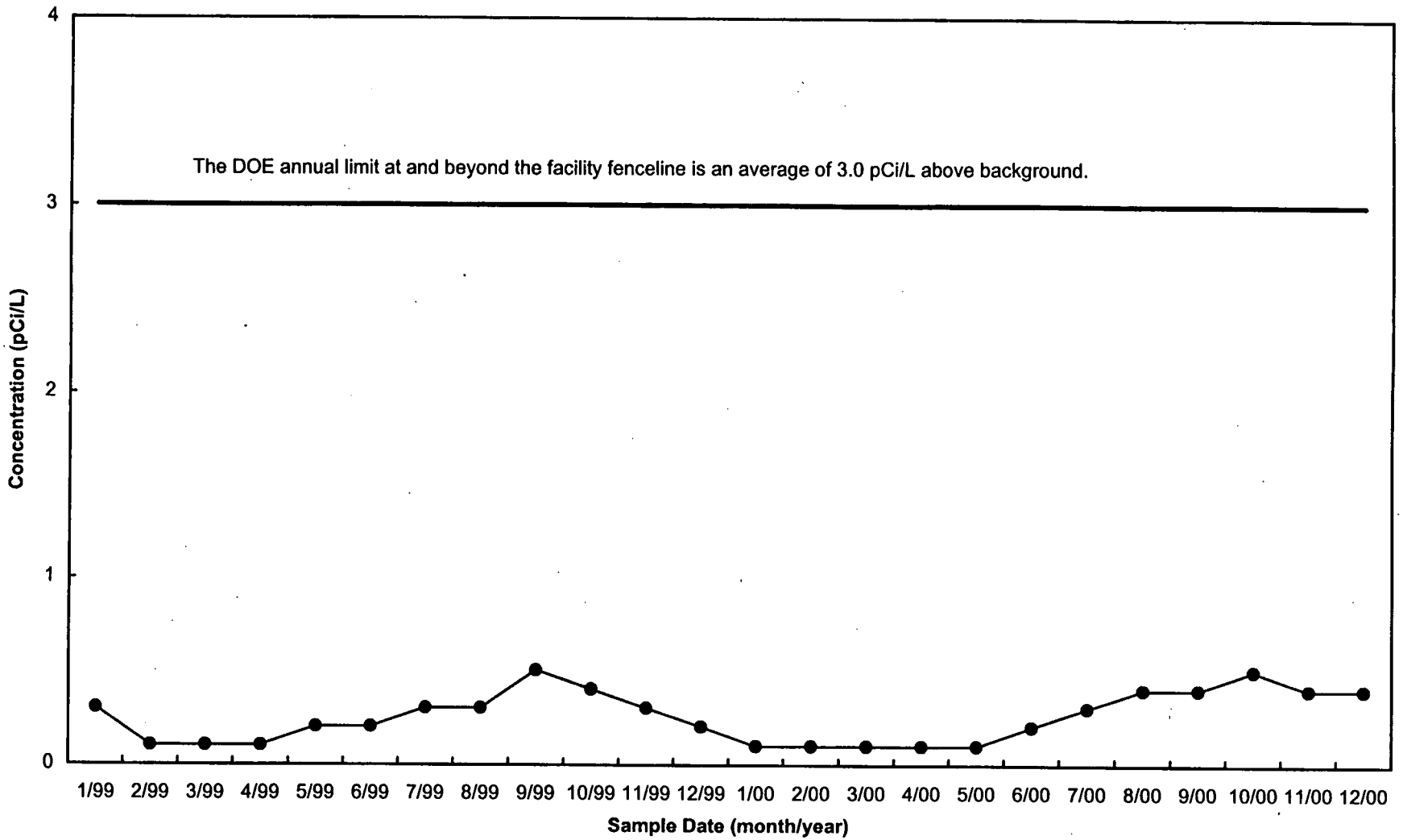


FIGURE C.2-18. 1999 AND 2000 MONTHLY AVERAGE RADON CONCENTRATION FOR AMS-12

000471

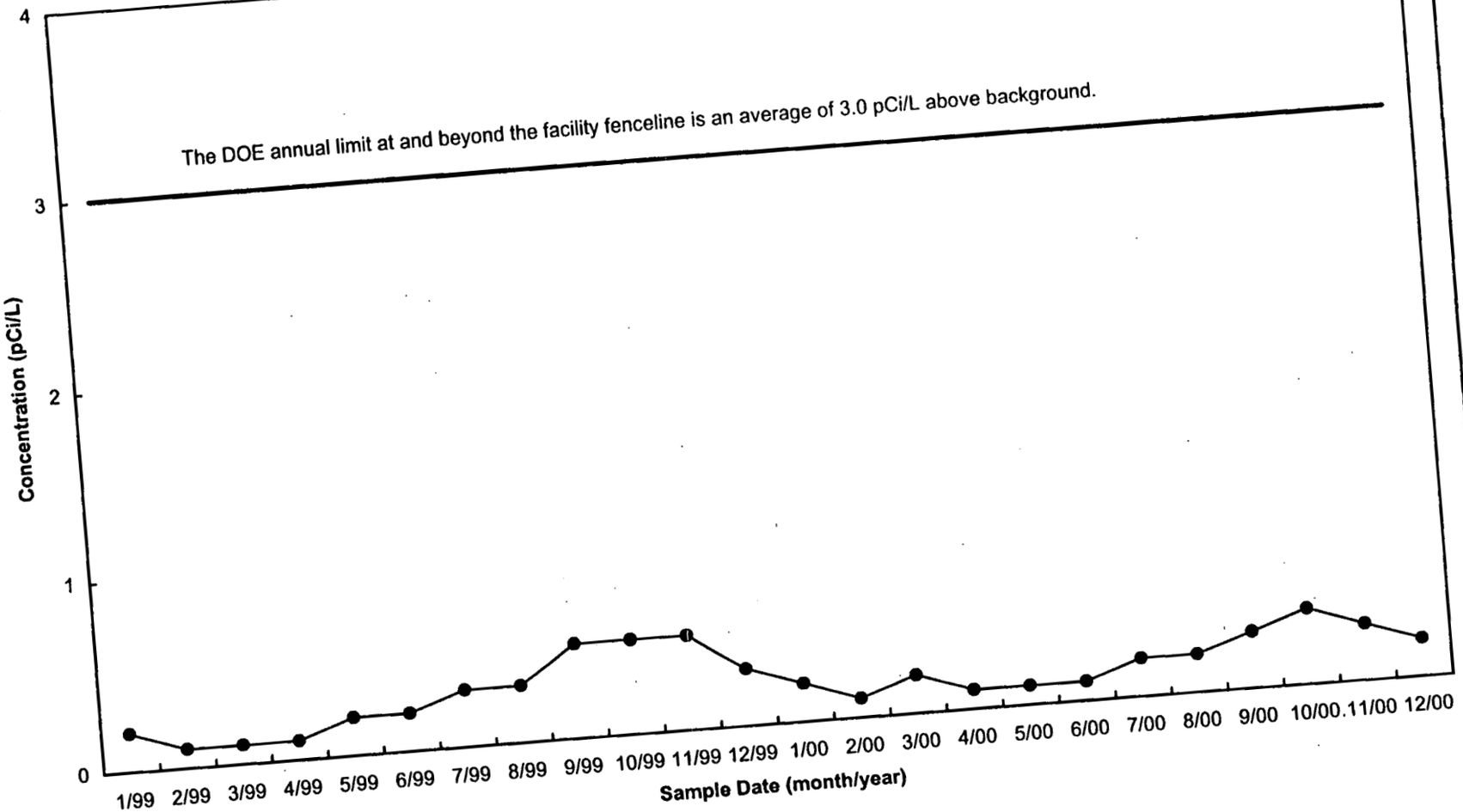


FIGURE C.2-19. 1999 AND 2000 MONTHLY AVERAGE RADON CONCENTRATION FOR AMS-16

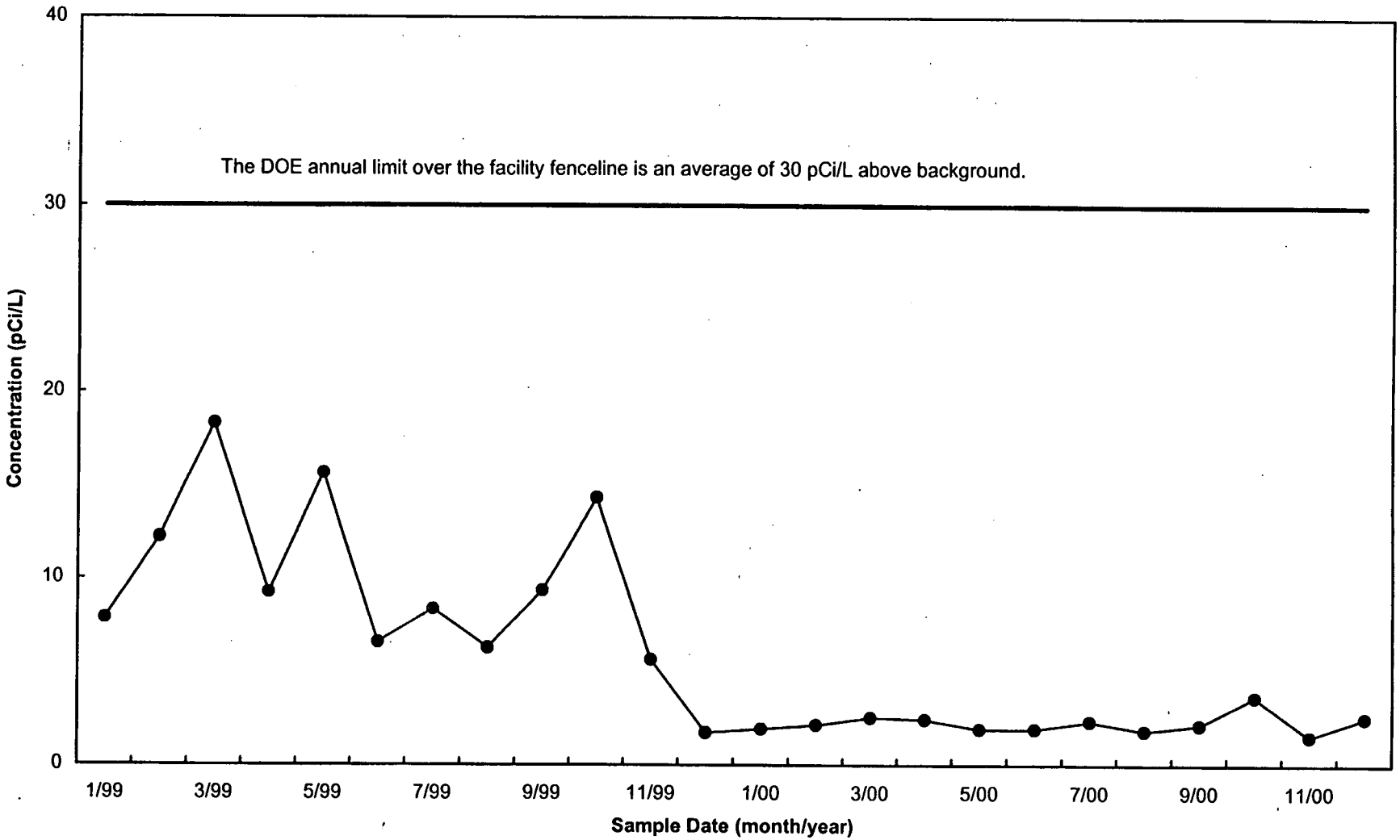


FIGURE C.2-20. 1999 AND 2000 MONTHLY AVERAGE RADON CONCENTRATION FOR KNE

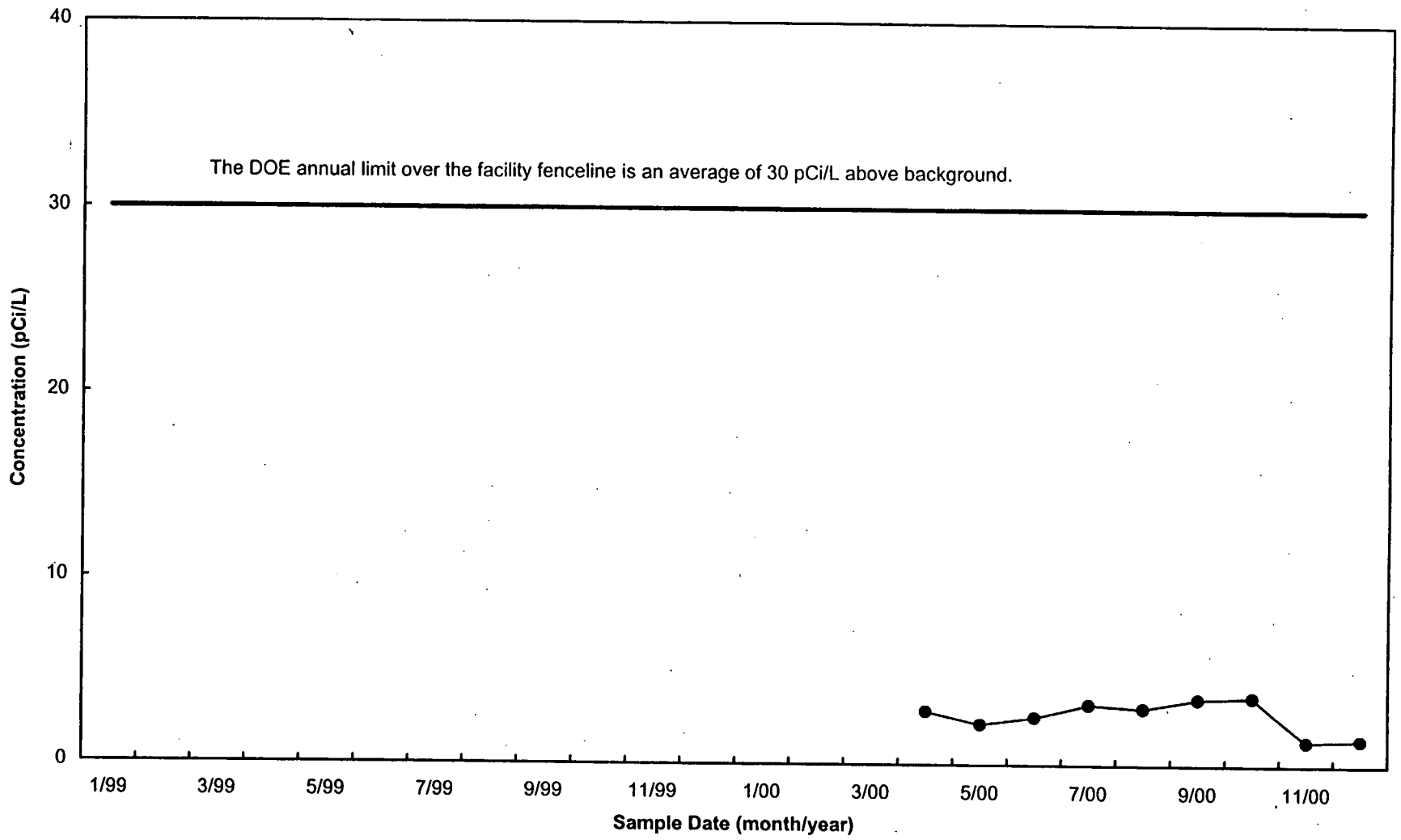


FIGURE C.2-21. 1999 AND 2000 MONTHLY AVERAGE RADON CONCENTRATION FOR KNO

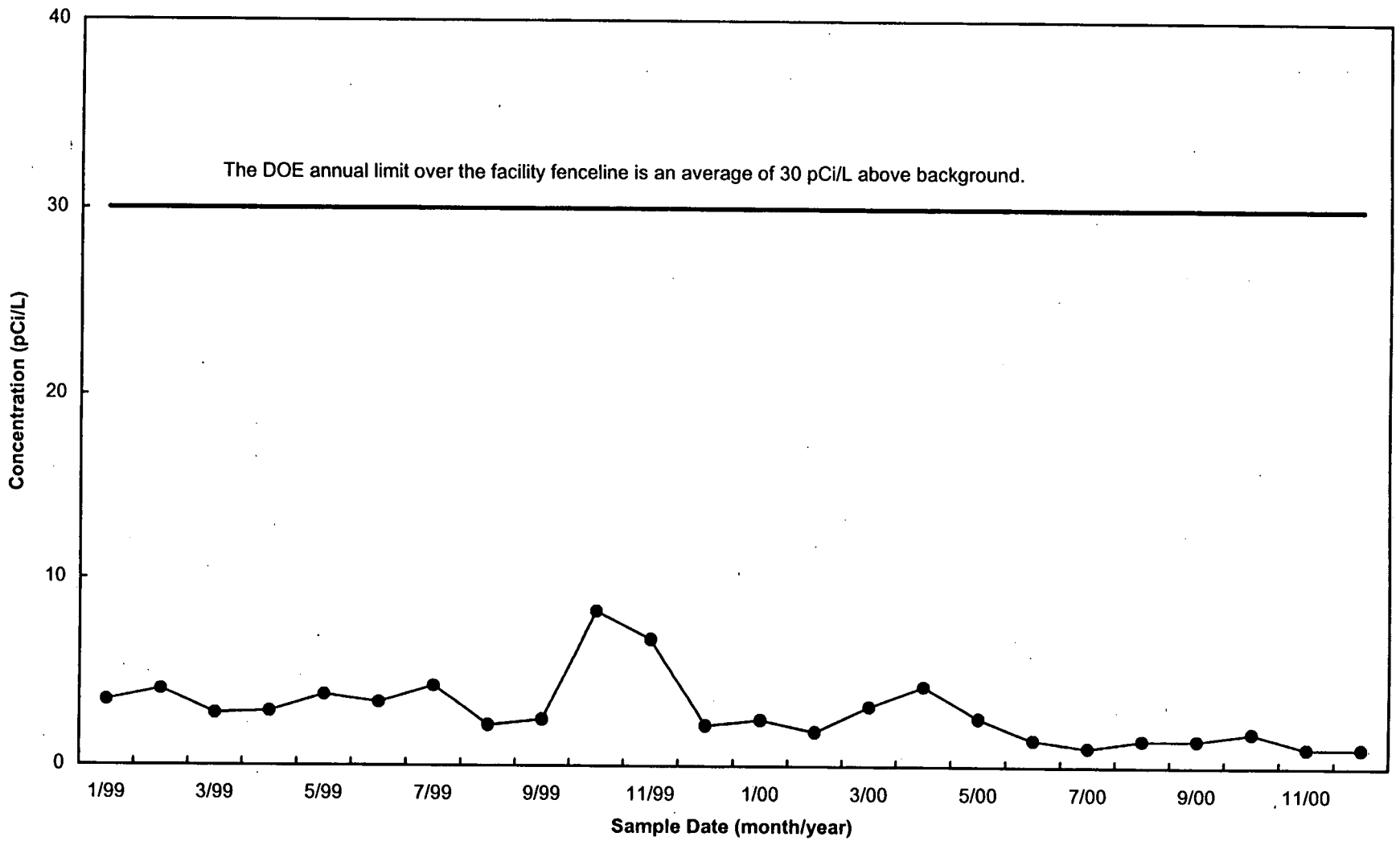


FIGURE C.2-22. 1999 AND 2000 MONTHLY AVERAGE RADON CONCENTRATION FOR KNW

000475

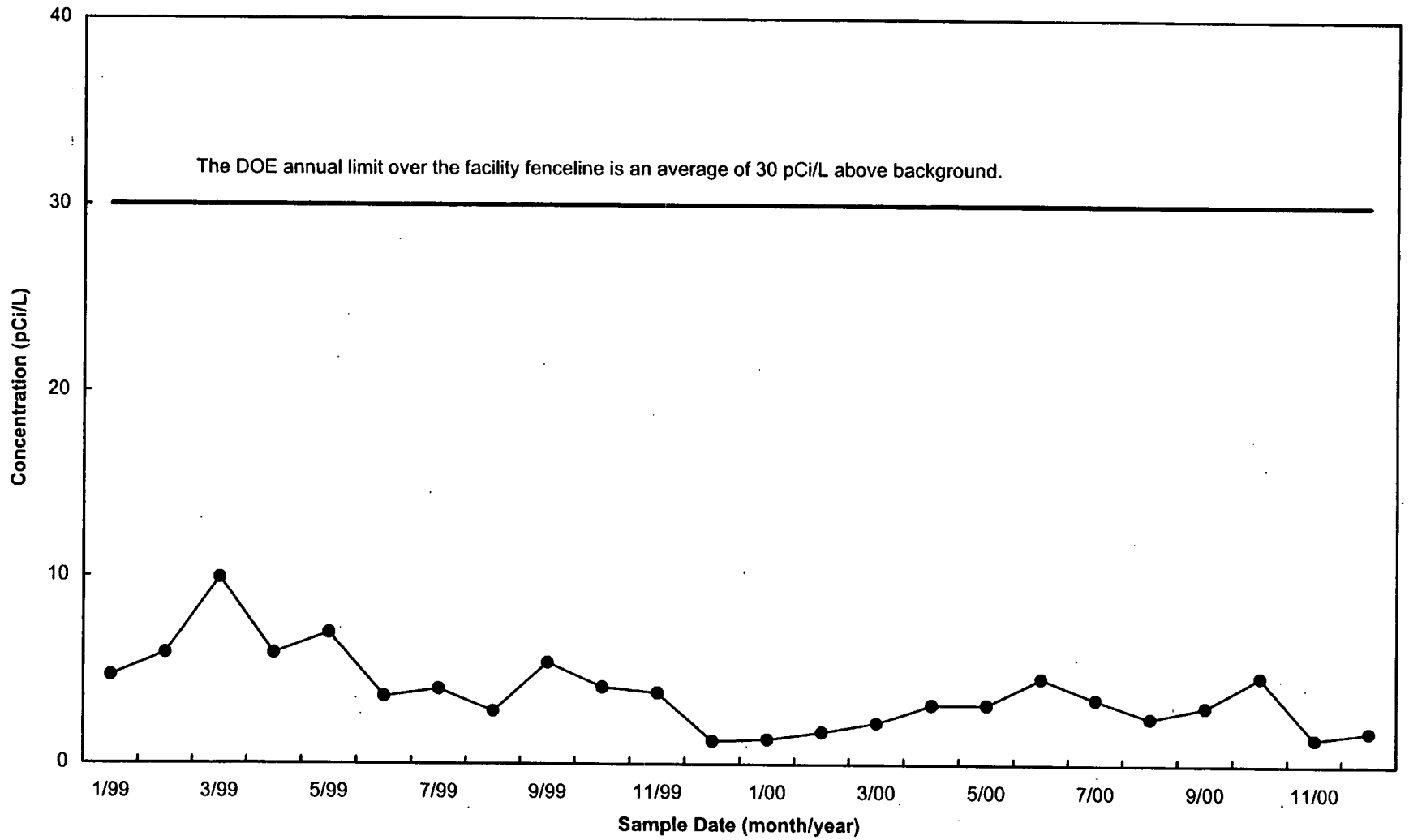


FIGURE C.2-23. 1999 AND 2000 MONTHLY AVERAGE RADON CONCENTRATION FOR KSE

Note: The DOE annual limit over the facility fenceline is an average of 30 pCi/L above background.

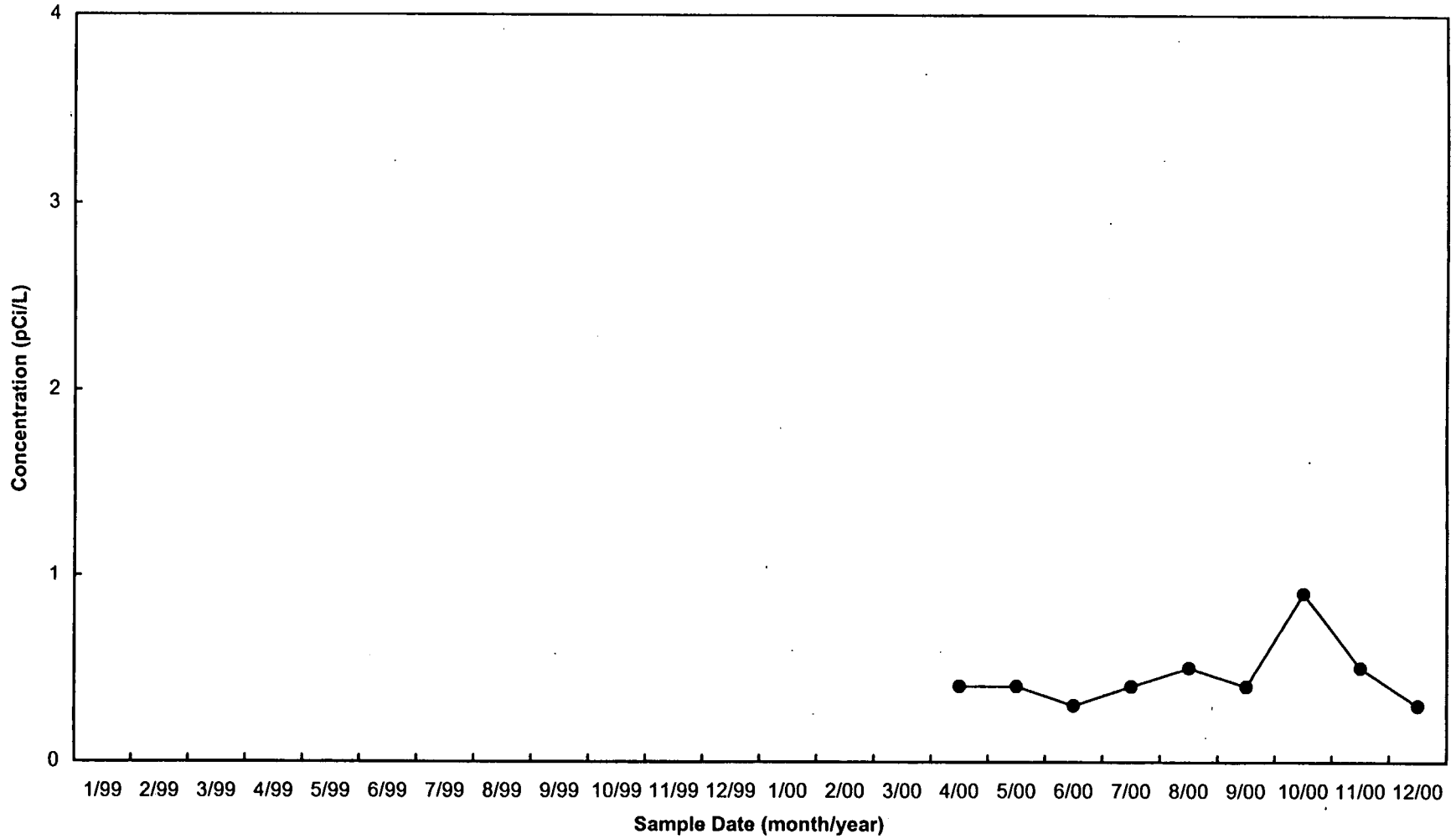


FIGURE C.2-24. 1999 AND 2000 MONTHLY AVERAGE
RADON CONCENTRATION FOR KSO

000477

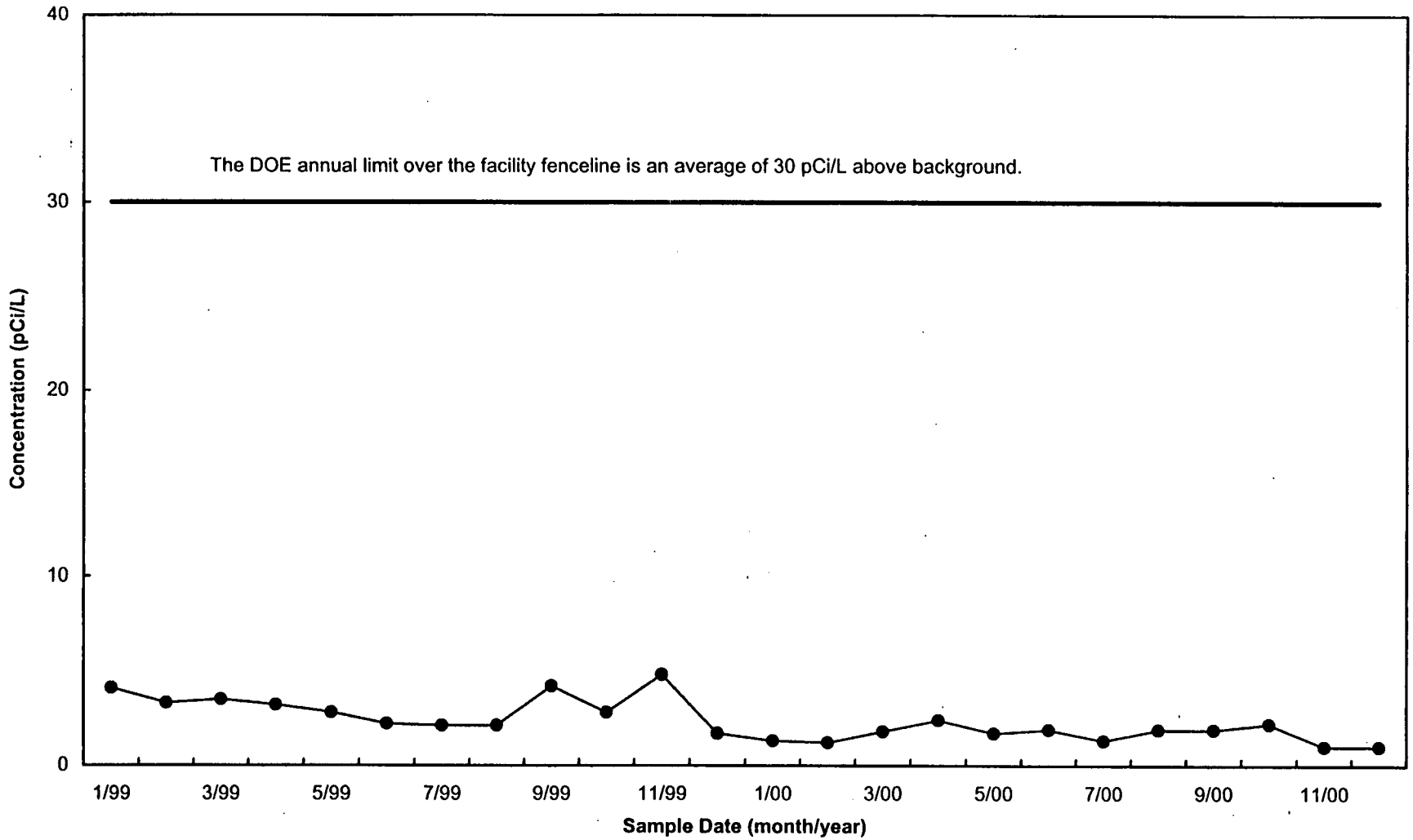


FIGURE C.2-25. 1999 AND 2000 MONTHLY AVERAGE RADON CONCENTRATION FOR KSW

000478

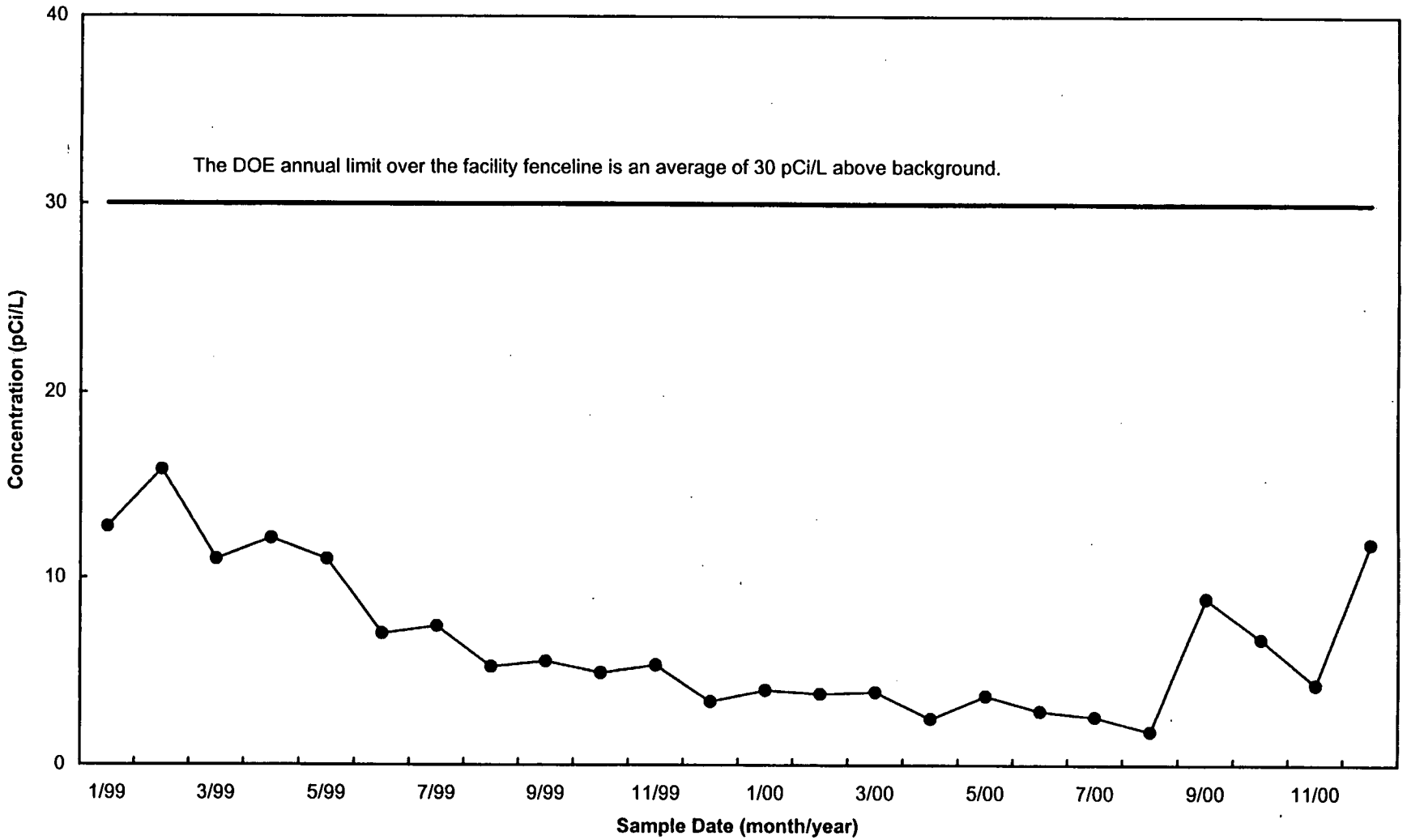


FIGURE C.2-26. 1999 AND 2000 MONTHLY AVERAGE RADON CONCENTRATION FOR KTOP

Note: The DOE annual limit over the facility fenceline is an average of 30 pCi/L above background.

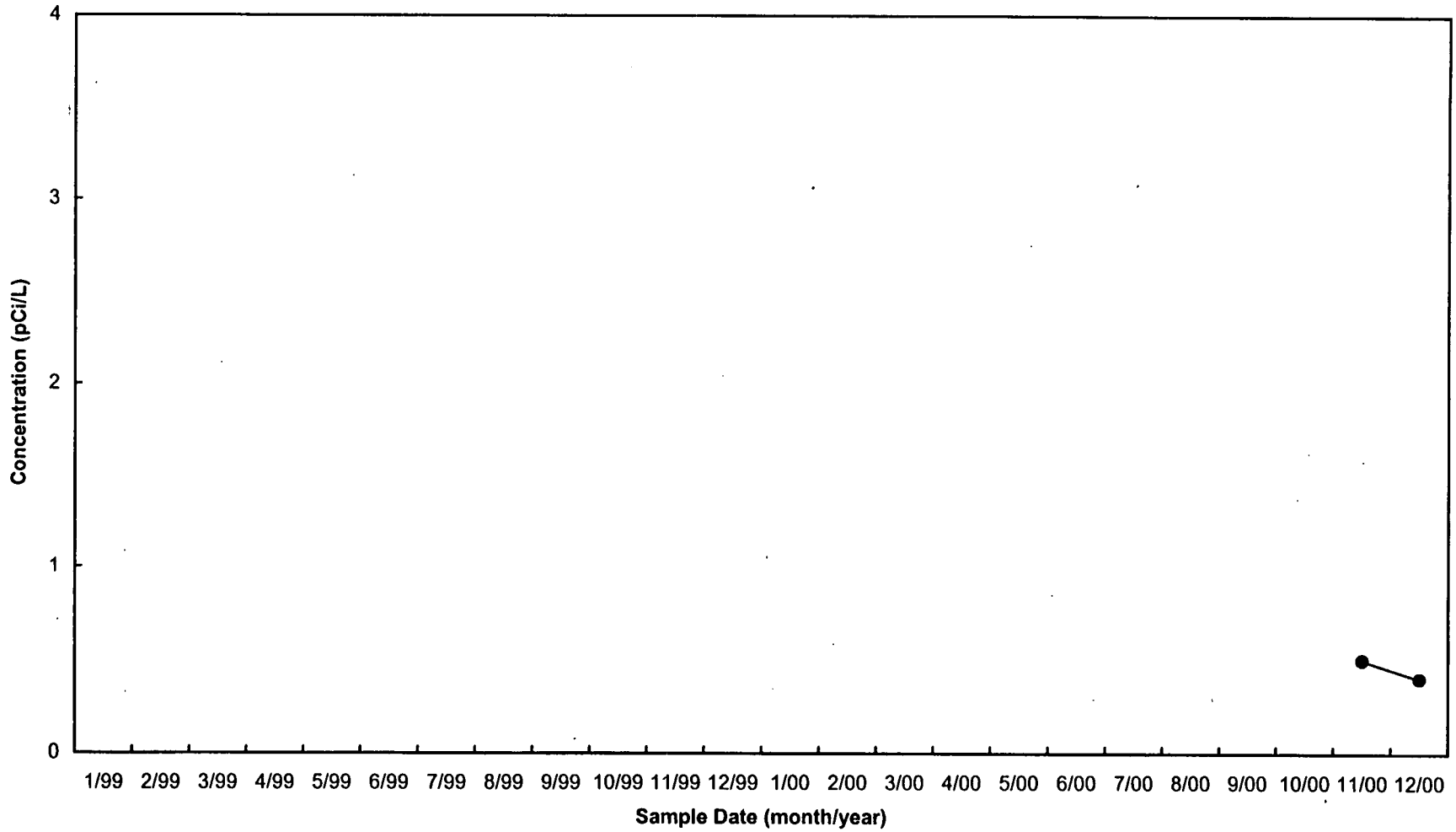


FIGURE C.2-27. 1999 AND 2000 MONTHLY AVERAGE RADON CONCENTRATION FOR LP2

Note: The DOE annual limit over the facility fenceline is an average of 30 pCi/L above background.

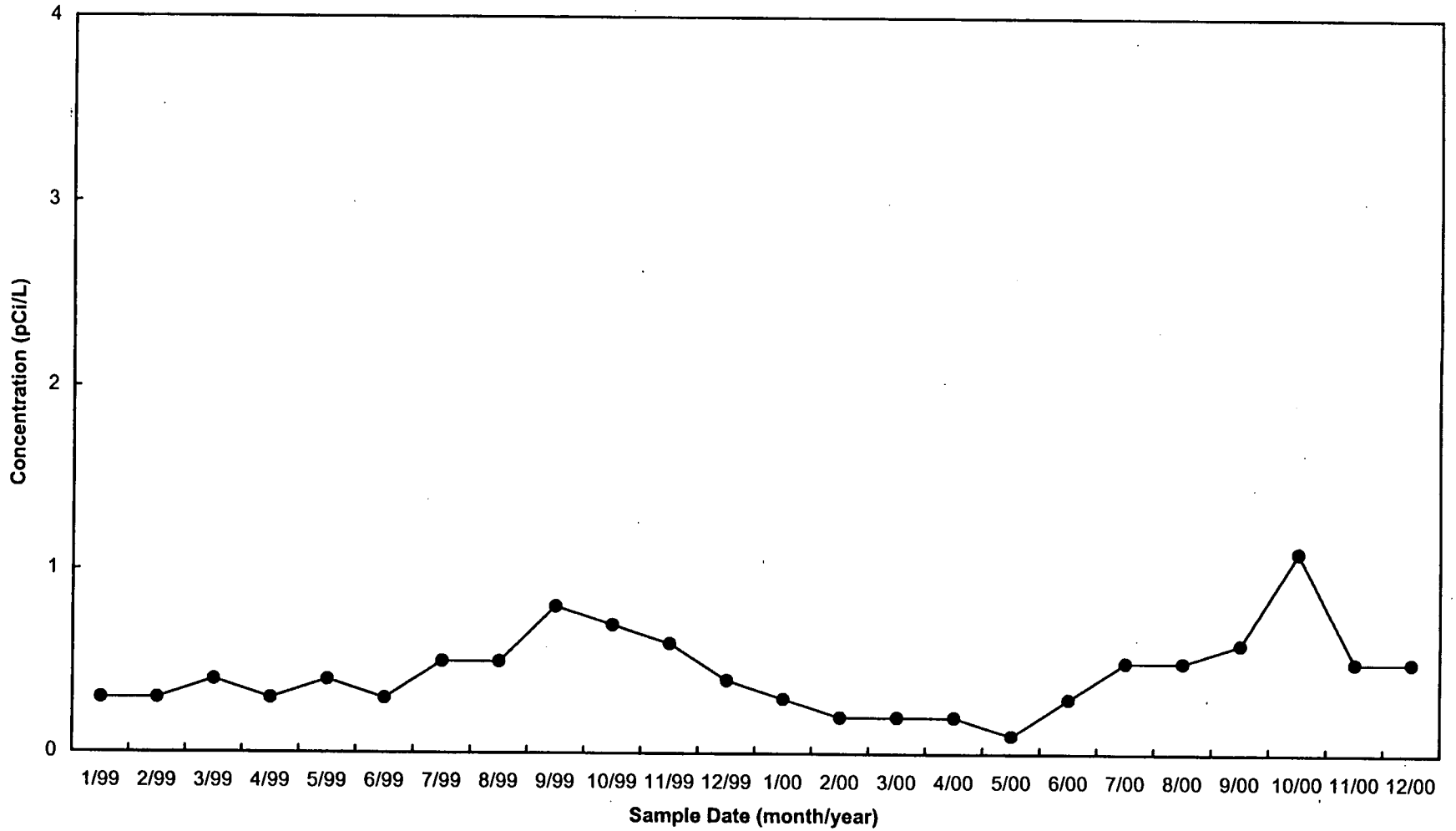


FIGURE C.2-28. 1999 AND 2000 MONTHLY AVERAGE
RADON CONCENTRATION FOR PILOT PLANT WAREHOUSE

Note: The DOE annual limit over the facility fenceline is an average of 30 pCi/L above background.

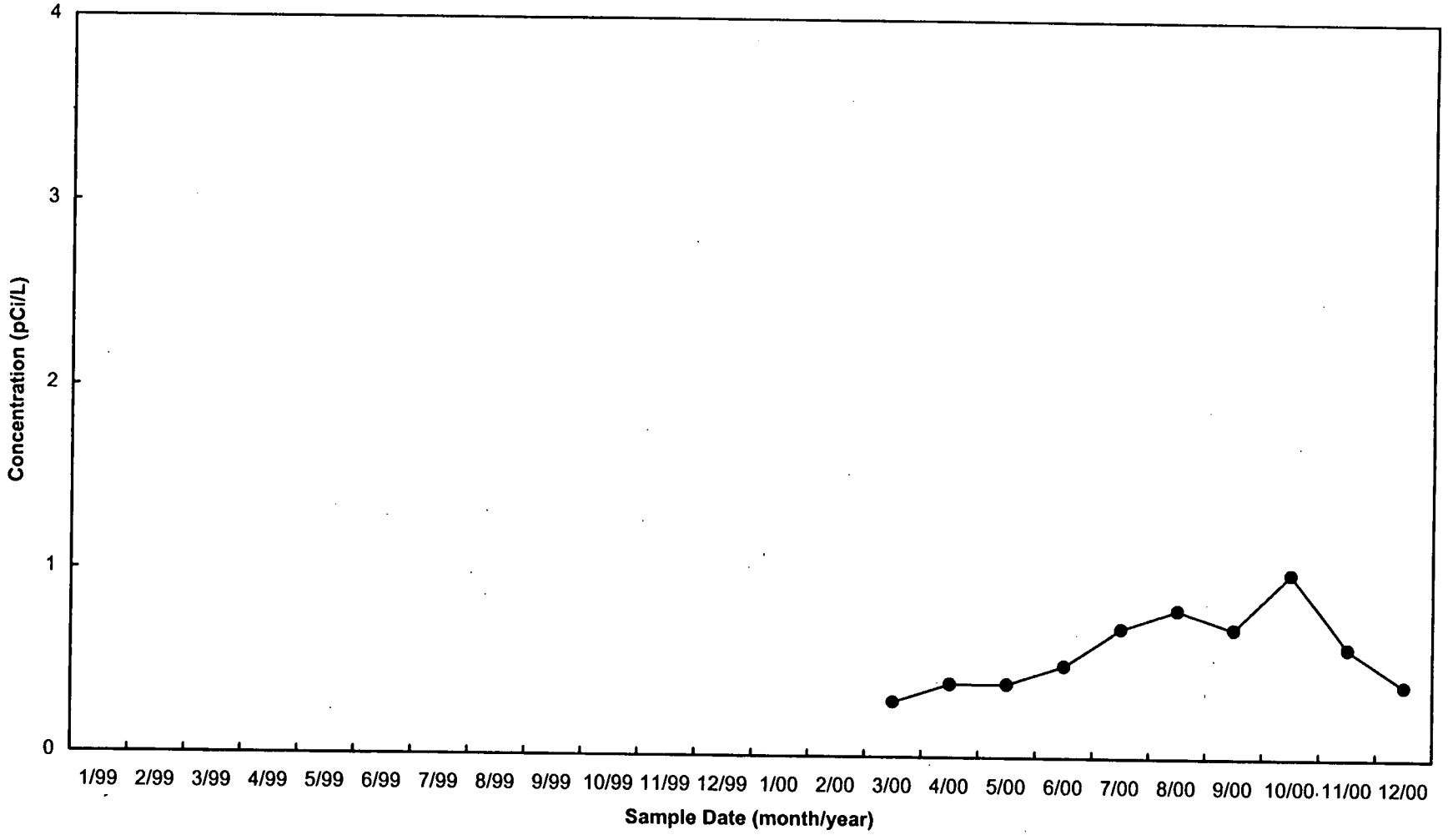


FIGURE C.2-29. 1999 AND 2000 MONTHLY AVERAGE RADON CONCENTRATION FOR PR-1

Note: The DOE annual limit over the facility fenceline is an average of 30 pCi/L above background.

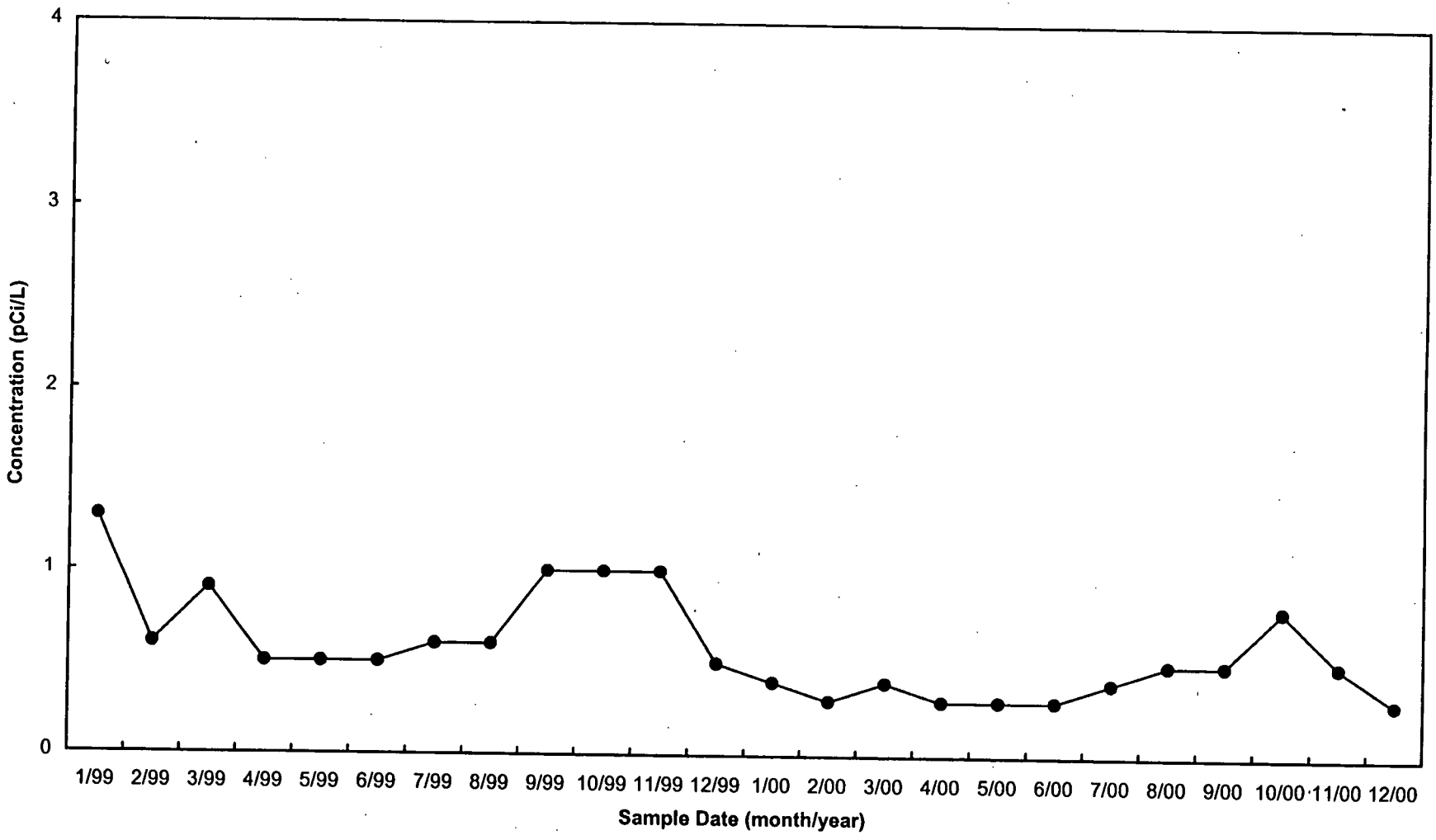


FIGURE C.2-30. 1999 AND 2000 MONTHLY AVERAGE RADON CONCENTRATION FOR RALLY POINT 4

000483

Note: The DOE annual limit over the facility fenceline is an average of 30 pCi/L above background.

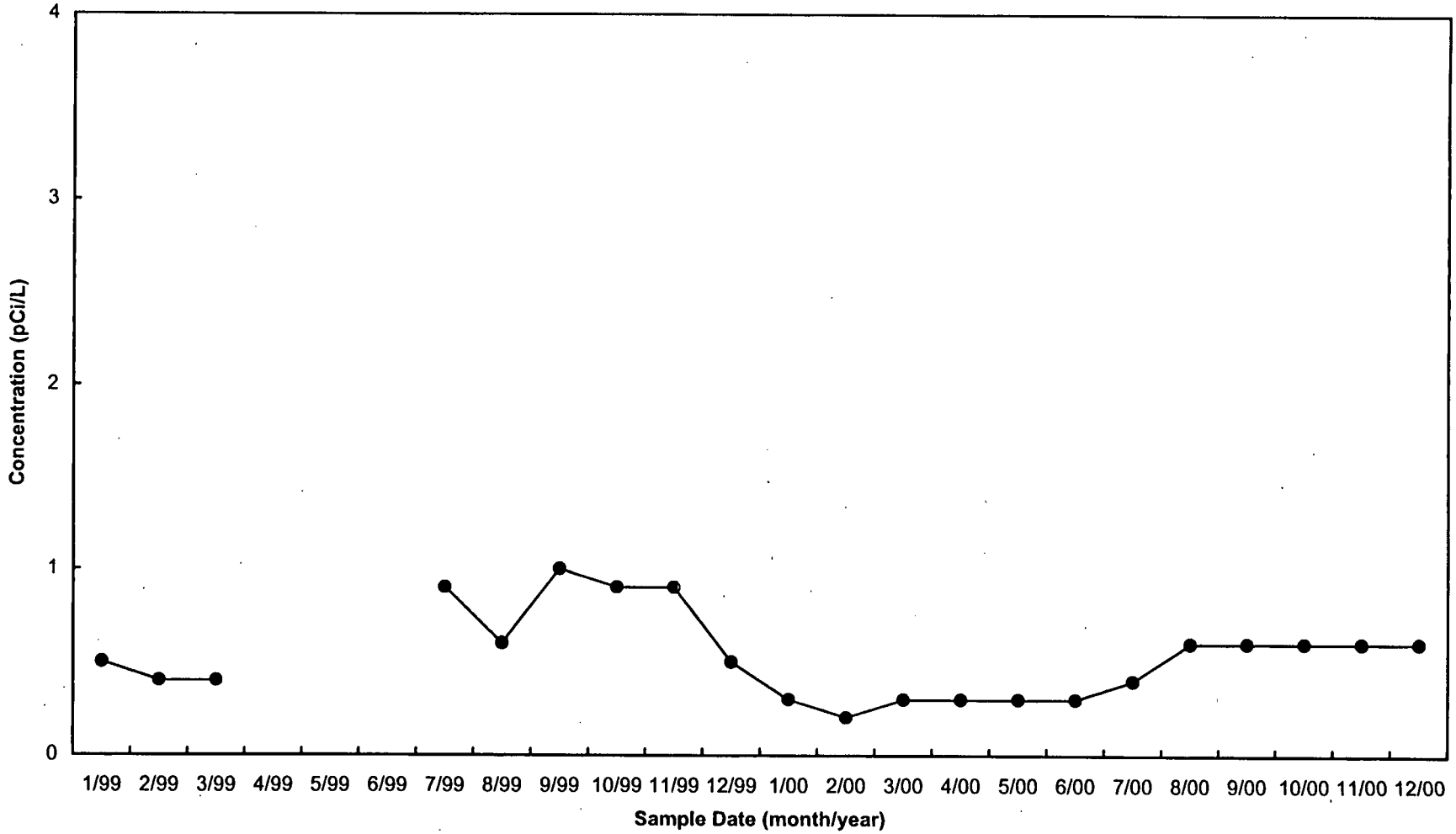


FIGURE C.2-31. 1999 AND 2000 MONTHLY AVERAGE RADON CONCENTRATION FOR SURGE LAGOON

Note: The DOE annual limit over the facility fenceline is an average of 30 pCi/L above background.

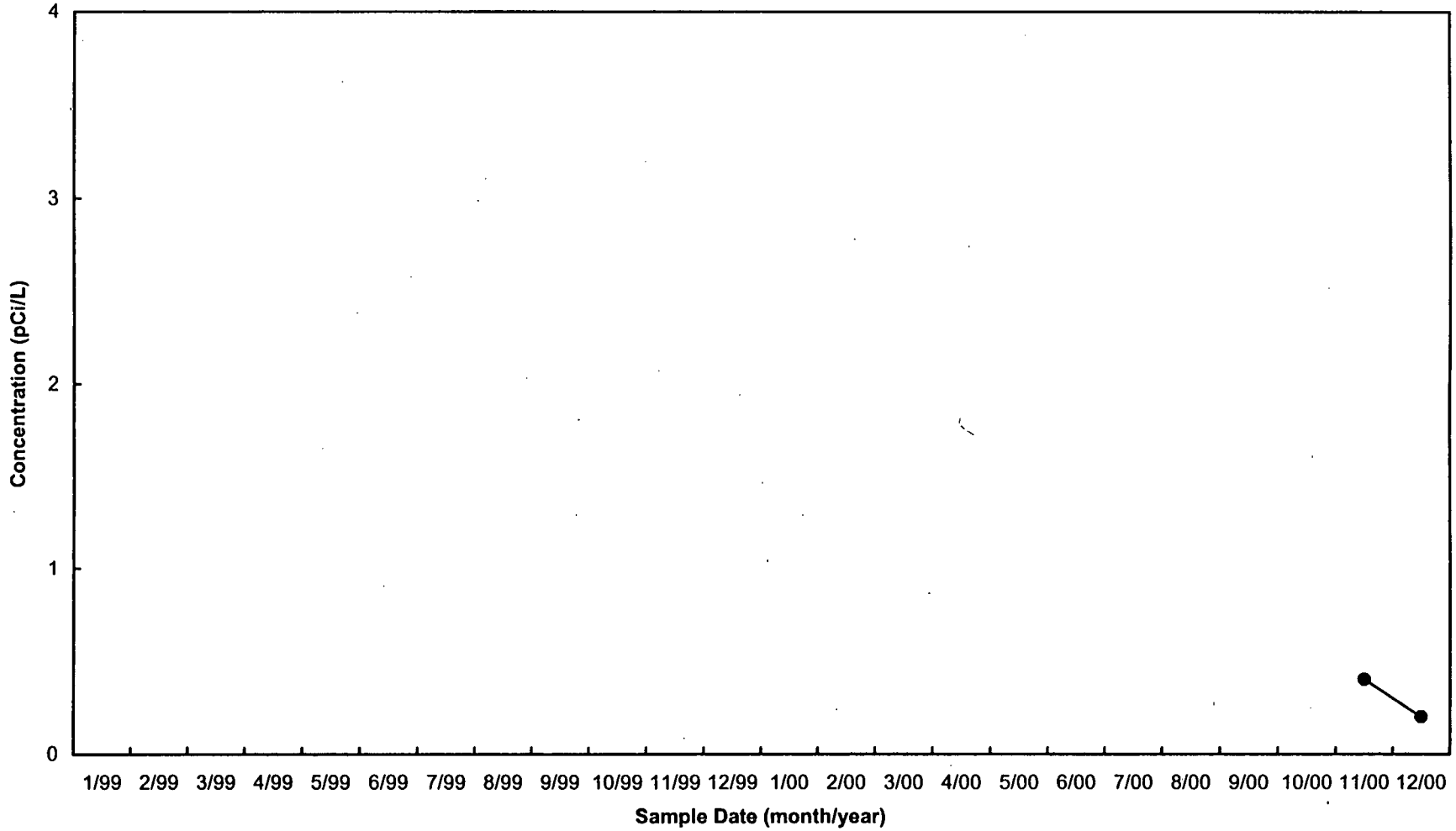


FIGURE C.2-32. 1999 AND 2000 MONTHLY AVERAGE
RADON CONCENTRATION FOR T117

000485

Note: The DOE annual limit over the facility fenceline is an average of 30 pCi/L above background.

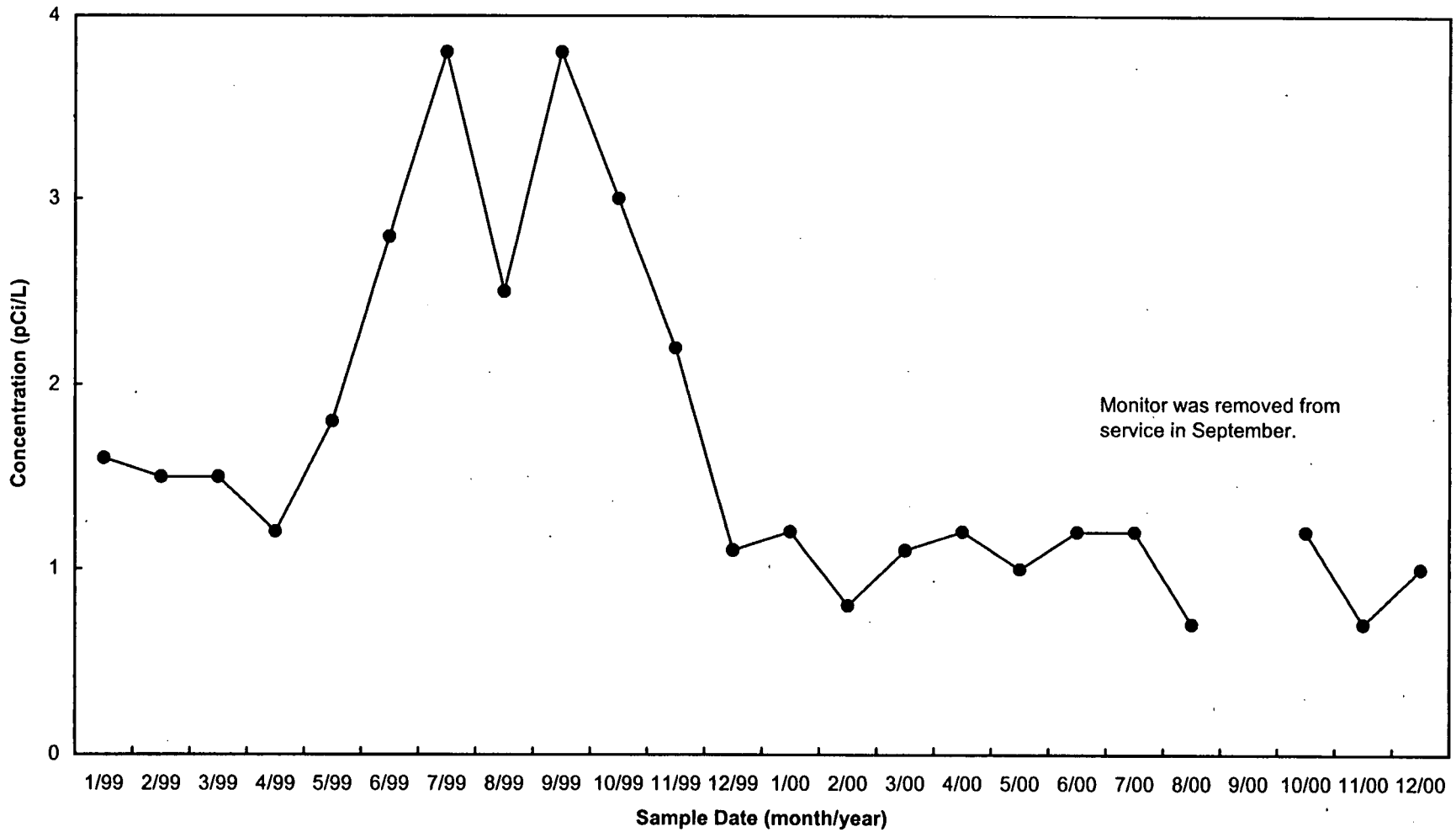


FIGURE C.2-33. 1999 AND 2000 MONTHLY AVERAGE RADON CONCENTRATION FOR T28

Note: The DOE annual limit over the facility fenceline is an average of 30 pCi/L above background.

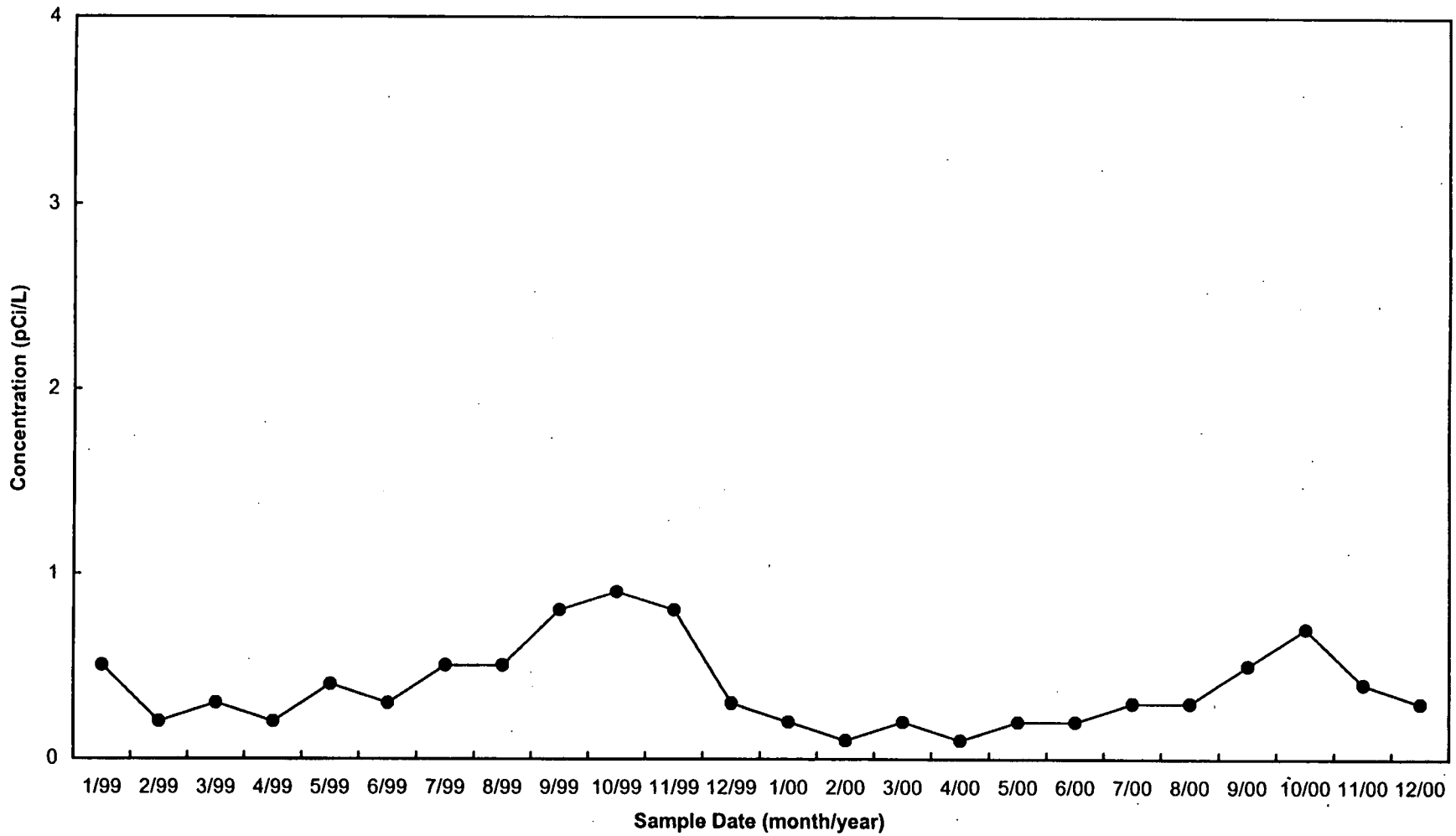


FIGURE C.2-34. 1999 AND 2000 MONTHLY AVERAGE
RADON CONCENTRATION FOR TS4

000487

Note: The DOE annual limit over the facility fenceline is an average of 30 pCi/L above background.

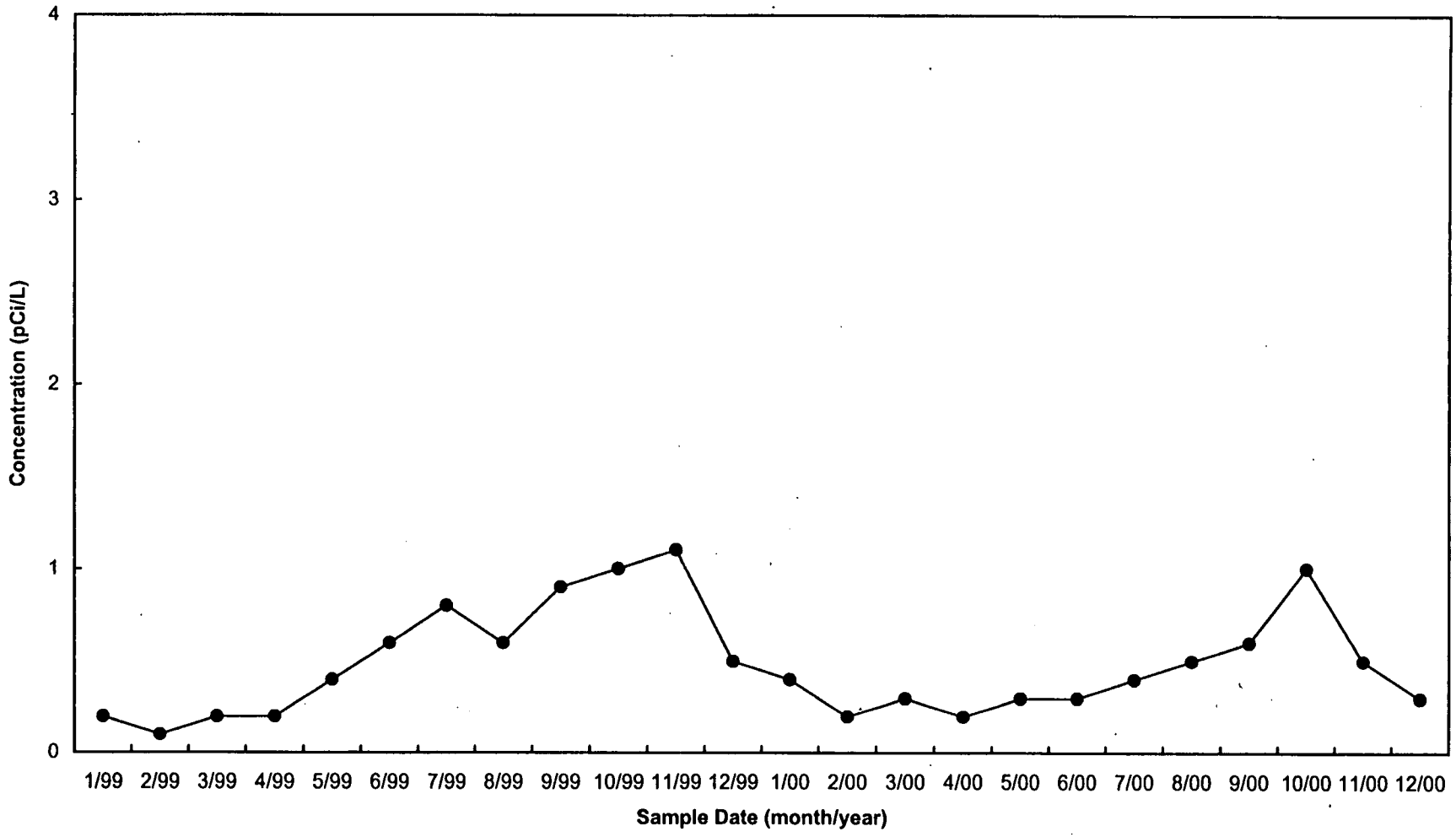


FIGURE C.2-35. 1999 AND 2000 MONTHLY AVERAGE
RADON CONCENTRATION FOR WP-17A

Attachment C.3

ATTACHMENT C.3

DIRECT RADIATION

ATTACHMENT C.3

Direct radiation measurements were conducted at 32 locations using thermoluminescent dosimeters (TLDs) during 2000. Figure C.3-1 identifies all TLD locations for 2000. Three TLDs are deployed at each location and the measurements from each TLD are averaged on a quarterly basis. These measurements are used to track and evaluate environmental direct radiation levels. Five locations are near the K-65 Silos, one additional on site location near the TLD processing center, 21 are located at the site fenceline, and five locations are also placed off site to measure background in areas unaffected by site activities. During the third quarter 2000, one of the background TLDs (location 18) was lost when the homeowner sold the property. An alternate background location was quickly identified and placed in service (location 42) shortly after the fourth quarter 2000 began, maintaining five background locations.

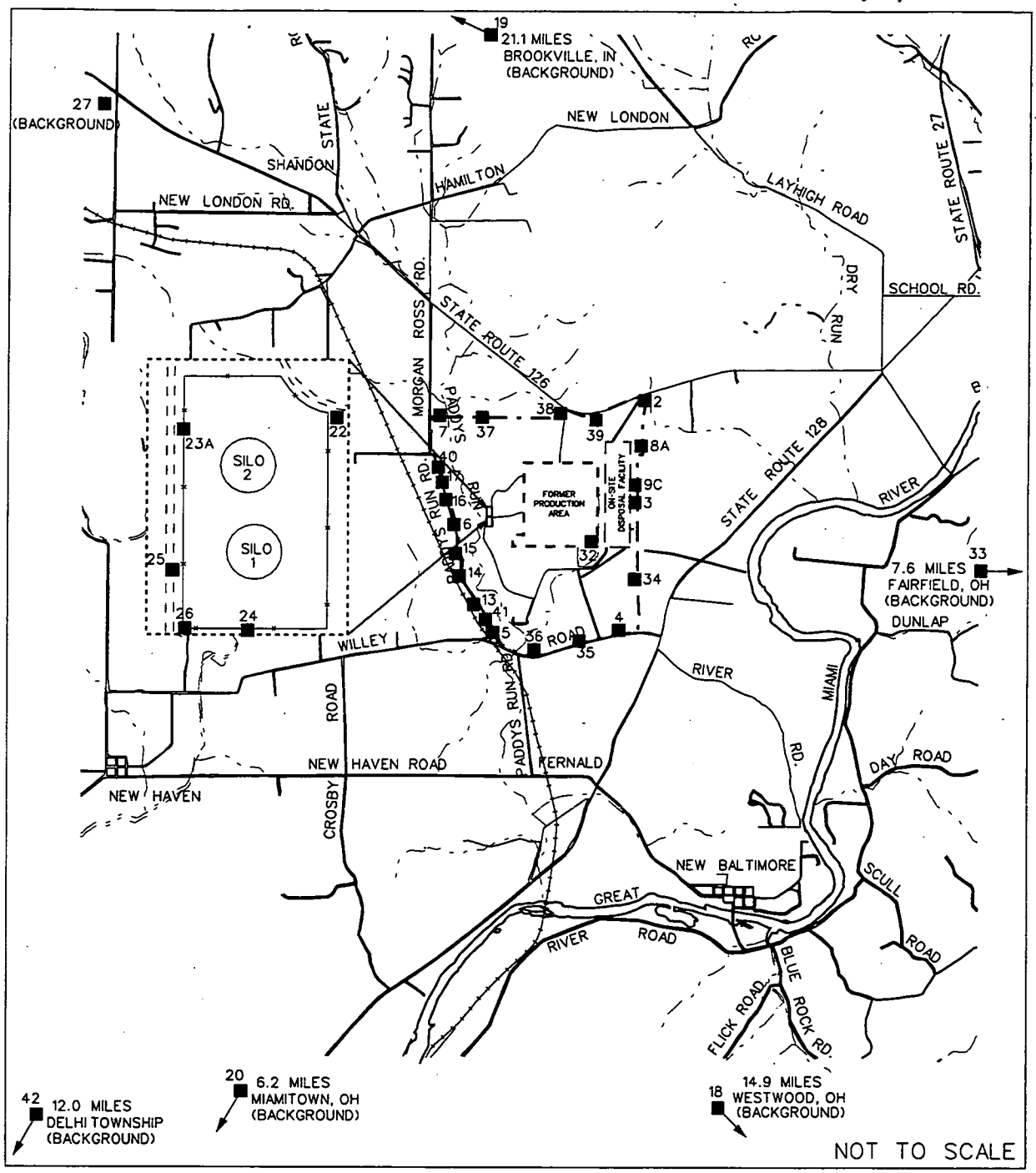
Table C.3-1 provides the data collected and averaged for four quarters in 2000. For comparison, annual average data collected during 1999 has been included. As discussed in Chapter 5 of this report, an increasing trend has been identified at the locations around the K-65 Silos 1 and 2 exclusion fence (locations 22 through 26). To a lesser degree, an increase in direct radiation levels has also been measured at the site boundary west of the K-65 Silos (Location 6). The relatively small increases in direct radiation at the fenceline are difficult to measure consistently because of variations in the sensitivity and accuracy of the environmental TLDs. The increasing direct radiation levels in these areas are the result of the increasing radon (and associated decay products) concentrations in the headspace of the K-65 Silos 1 and 2. While an increasing trend is evident, the 2000 results are still less than the levels observed prior to the addition of bentonite to the silos in 1991. These data are being considered in the design of the Advanced Waste Retrieval Project for K-65 Silos 1 and 2 which will address both radon and direct radiation concerns associated with the K-65 waste materials. Monitoring for direct radiation will continue until completion of remediation at the K-65 Silos.

TABLE C.3-1

DIRECT RADIATION (TLD) MEASUREMENTS

Location[a]	Direct Radiation (mrem)	
	2000 Summary Results[b]	1999 Summary Results
Fenceline		
2	76	75
3	74	72
4	69	68
5	69	70
6	85	81
7	69	68
8A	74	74
9C	79	76
13	74	74
14	75	71
15	82	79
16	85	81
17	75	70[c]
34	76	75
35	72	71
36	66	64
37	78	76
38	65	63
39	81	79
40	69	68
41	75	72
Min.	**65**	**63**
Max.	**85**	**81**
On Site (K-65 area)		
22	1084	904
23A[d]	1048	866[e]
24	793	707
25	989	881
26	646	547
32 (Bldg. 53A Dosimetry Lab)	58	55
Min. (K-65 area)	**646**	**547**
Max. (K-65 area)	**1084**	**904**
Background		
18	76[f]	77
19	65	63
20	62	62
27	64	62
33	70	67
42	77[g]	Not Applicable
Min.	**62**	**62**
Max.	**77**	**77**

[a]Refer to Figure C.3-1 for sample locations
[b]2000 summary result value may not always agree with quarterly results due to rounding differences.
[c]Value includes estimated second quarter results which were based on first quarter results.
[d]TLD location 23 was relocated to TLD location 23A on May 26, 1999.
[e]Direct radiation levels for TLD locations 23 and 23A were extrapolated due to relocation of TLD.
[f]Value includes extrapolated results, TLD location was not in use the full year.
[g]TLD location 42 was not in operation prior to the fourth quarter. Year-end result is extrapolated from fourth quarter result of 21.



LEGEND:

DISTANCE FROM CENTER OF FORMER PRODUCTION AREA TO SAMPLE LOCATIONS OFF MAP

FEMP BOUNDARY

DIRECT RADIATION (TLD) MONITORING LOCATION

FIGURE C.3-1. DIRECT RADIATION (THERMOLUMINESCENT DOSIMETER) MONITORING LOCATIONS

V:/5FGP1/DGN/00ANNUAL/00AN008.DGN
12-13-00

ATTACHMENT C.4

BIOTA (PRODUCE)

ATTACHMENT C.4

Biota (produce) were collected at 15 locations as identified on Figure C.4-1 during 2000. Produce is sampled once every three years to ensure that airborne emission from the remediation of the site are not adversely affecting the produce grown near the FEMP. Historically, produce samples have only been analyzed for uranium because it has been the major contributor to dose from airborne emissions at the FEMP. With the start of the Waste Pits Remedial Action Project in late 1999, thorium and more specifically thorium-230, has become the major contributor to dose via the air inhalation pathway. Therefore, thorium-230 analysis of produce samples was initiated in 2000. Radium analysis of produce samples was also initiated in 2000 in response to a study conducted by the Agency for Toxic Substances and Disease Registry (ATSDR 2000) which suggested that radium may be a potentially significant contributor to dose based on their review of historical environmental monitoring data. The uranium, thorium, or radium detected in produce may be radiological contaminants that are deposited from the air pathway, naturally occurring in the soil, or added by fertilizers.

Table C.4-1 presents the results of the produce-sampling program. The initial laboratory results of the produce samples indicated that sample cross contamination or instrumentation errors may have occurred at the contract laboratory. Re-analysis of several produce samples was necessary in order to address concerns with the analytical methods and quality control at the contract laboratory. The results in Table C.4-1 are footnoted if sample re-analysis was performed.

As indicated in Table C.4-1, concentrations of uranium were less than detectable in 24 of the 27 samples analyzed. Radium-226 and radium-228 were less than detectable in all samples. Thorium-230 concentrations were less than detectable in 16 of the 27 samples analyzed. The large percentage of less than detectable concentrations, lack of historical thorium data for produce, and a limited number of background produce sample results makes it difficult to rigorously compare and evaluate the produce data with a high degree of confidence. However, the uranium results, which remained within the range of historical background concentrations from produce samples collected from 1990 to 1997, suggest that there is currently no substantial impact from past or current FEMP emissions on produce grown in the area.

Estimated Dose from Consumption of Locally Grown Produce

The average total uranium and thorium-230 concentrations measured in locally produce was used to estimate dose. In cases where the uranium and thorium-230 sample results were less than detectable, one half of the detection limit was used for the calculation of an average uranium and thorium-230 concentration. Due to the limited number of produce samples from background locations (beyond 3 miles of the FEMP), for particular types of produce, no correction for the naturally occurring concentrations of uranium or thorium-230 in produce were made. Radium-226 and radium-228 were not detected in locally grown produce; therefore these isotopes were not included in the calculation of estimated dose from produce. The average concentrations in each type of produce were multiplied by annual consumption rates and appropriate dose conversion factors in order to determine dose.

For 2000 the estimated dose from the consumption of locally grown produce was 0.9 millirem (mrem). Of this 0.9 mrem, total uranium contributed 0.46 mrem and thorium-230 contributed 0.44 mrem. For comparison, in 1997 when produce was analyzed for only total uranium, the estimated dose from the consumption of locally grown produce was 0.1 mrem. The increase in the produce dose for 2000 is attributable to several factors;

- The limited number of background samples in 2000 and the lack of historical data on thorium-230 concentrations in produce did not permit the average uranium and thorium-230 concentrations in locally grown produce to be background-corrected. Not correcting for the naturally occurring concentrations of radionuclides in produce leads to an overestimation of dose that is attributable to FEMP emissions.

- The inclusion of thorium-230 data in the calculation of the 2000 produce dose represents a change from past methods for estimating dose. The addition of the thorium-230 component will tend to cause doses due to the consumption of produce to be higher than historical values.

- The method of using one half of the detection limit for uranium and thorium-230 sample results that were less than detectable may increase the average concentration of uranium and thorium-230 in produce. This, in turn, may conservatively overestimate the dose from produce.

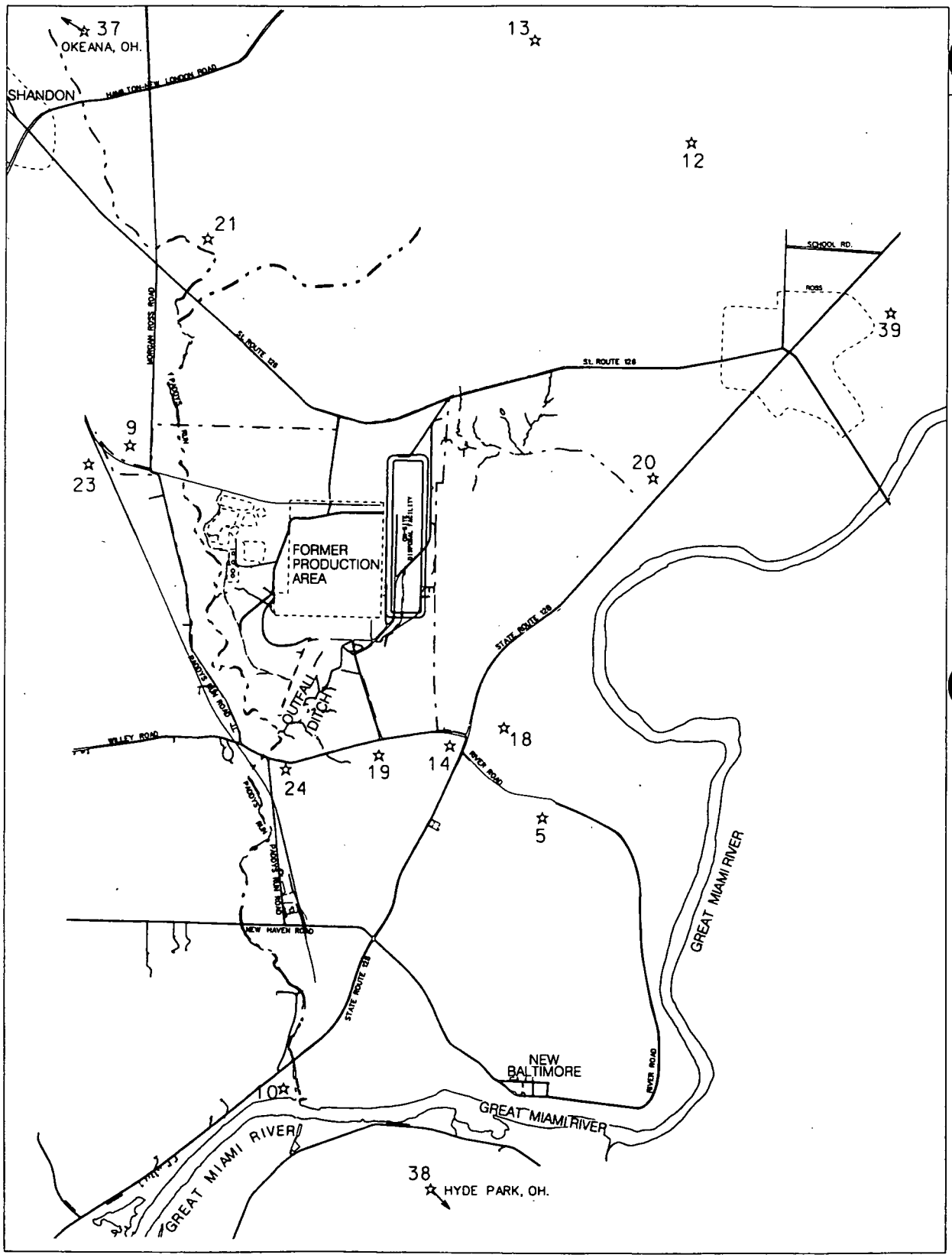
Although higher than previous years' produce dose estimates, the 2000 produce dose represents less than one percent of the DOE all-pathways dose limit of 100 mrem per year. Furthermore, the 2000 produce dose, in conjunction with the produce sample results, confirms that past and current emissions from the FEMP do not substantially impact produce grown in the area. Under the IEMP, produce will continue to be sampled once every three years. The next sampling round is scheduled for 2003.

TABLE C.4-1

2000 RESULTS FROM THE BIOTA (PRODUCE) MONITORING PROGRAM

Sample Location[a]	Distance from Center of the FEMP (km)	Total Uranium[b]	Th-230[b]	Ra-226[b]	Ra-228[b]	1990 - 1997 Total Uranium Historical Range Minimum	Maximum
		(All Concentrations in pCi/g [dry weight])				pCi/g (dry weight)	
Corn[c]						ND	0.2
14	1.6	0.144[d]	ND	ND	ND		
23	1.6	ND	0.045[d]	ND	ND		
18	1.9	0.067[d]	ND	ND	ND		
18	1.9	ND	ND	ND	ND		
20	2.1	ND	0.015[d]	ND	ND		
21	2.4	ND	ND	ND	ND		
Zucchini (Squash)[e]							
10	4.0	ND	ND	ND	ND	ND	0.34
Soybeans						ND	1.2
19	1.4	0.197[d]	ND	ND	ND		
23	1.6	ND	0.041[d]	ND	ND		
24	1.6	ND	ND	ND	ND		
18	1.9	ND	0.05[d]	ND	ND		
18	1.9	ND	ND	ND	ND		
20	2.1	ND	ND	ND	ND		
21	2.4	ND	0.066[d]	ND	ND		
Cucumbers						0.00026	0.021
9	1.6	ND	0.054[d]	ND	ND		
5	2.9	ND	0.035[d]	ND	ND		
12	3.6	ND	ND	ND	ND		
13	3.8	ND	0.019	ND	ND		
37 (Background)	9.3	ND	ND	ND	ND		
Tomatoes						0.00018	0.61
9	1.6	ND	0.042[d]	ND	ND		
5	2.9	ND	0.03	ND	ND		
12	3.6	ND	ND	ND	ND		
13	3.8	ND	ND	ND	ND		
10	4.0	ND	ND	ND	ND		
39	4.4	ND	0.062[d]	ND	ND		
37 (Background)	9.3	ND	ND	ND	ND		
38 (Background)	31	ND	ND	ND	ND		

[a]Refer to Figure C.4-1 for produce sample locations
[b]ND = non-detectable; NA = not applicable
[c]The corn family includes sweet corn for human consumption and field corn for livestock feed.
[d]Value is averaged from multiple analyses of sample.
[e]The term squash includes squash, zucchini, and eggplant.



LEGEND:

- FEMP BOUNDARY
- ☆ SINGLE MONITORING LOCATION
- ☆ DISTANCE FROM FORMER PRODUCTION AREA TO MONITORING LOCATIONS OFF MAP

SCALE

3500 1750 0 3500 FEET

000497

FIGURE C.4-1. AVAILABLE PRODUCE MONITORING LOCATIONS

v:#5fgp1#dgn#00annual#00an018.dgn

STATE PLANAR COORDINATE SYSTEM 1983

30-MAY-2001

ATTACHMENT C.5

METEOROLOGICAL DATA

ATTACHMENT C.5

Meteorological data were recorded at the site meteorological station during 2000. Meteorological data recovery for 2000 was 95 percent. As shown in Table C.5-1, data from the 10-meter and 60-meter elevations are reported as a monthly maximum hourly average and a monthly minimum hourly average. Ambient air temperature is provided which includes monthly average temperature, and daily maximum and minimum values per month. The precipitation totals include the monthly total and daily maximum values recorded during 2000. Table C.5-2 presents the 2000 average wind speed and percent of time from direction at the 10-meter and 60-meter elevations.

For 2000 the highest hourly average wind speed at the 10-meter elevation was measured at 23.4 miles per hour during August while the lowest hourly average wind speed was measured at 0.4 in February, March, May, and June. At the 60-meter elevation, the highest hourly average wind speed was measured at 38.2 miles per hour during December while the lowest hourly average wind speed was measured at 0.2 in April. The prevailing winds were from directions west through south-southwest approximately 40 percent of the time at both elevations. The winds out of the east-southeast and southeast were least predominant, occurring less than three percent of the time.

The monthly average temperatures during 2000 ranged from 28.9 degrees Fahrenheit (°F) in January to 72.9 °F in July. The coldest day was –9.2 °F recorded in January and the warmest day was 88.6 °F recorded in June and August.

Total precipitation for 2000 measured 44.75 inches, which is 3.67 inches above the annual average precipitation of 41.08 inches for the period 1950 through 1999. For comparison, the total annual precipitation in 1999 was 34.39 inches. The highest amount of precipitation was measured during February (4.84 inches) and the lowest amount was measured during August (2.22).

TABLE C.5-1

2000 METEOROLOGICAL DATA

	Units	January	February	March	April	May	June	July	August	September	October	November	December
10-Meter Wind Speed													
Maximum hourly average	mph	18.6	15.9	16.8	18.2	16.7	15.6	11.6	23.4	17.2	12.7	17.3	19.1
	kph	29.9	25.6	27	29.3	26.9	25.1	18.7	37.7	27.7	20.4	27.8	30.7
Minimum hourly average	mph	0.5	0.4	0.4	0.5	0.4	0.4	0.7	0.7	0.6	0.6	0.7	0.8
	kph	0.8	0.6	0.6	0.8	0.6	0.6	1.1	1.1	1.0	1.0	1.1	1.3
60-Meter Wind Speed													
Maximum hourly average	mph	31.4	21.7	33.8	26.5	25.3	21.8	18.5	13.2	25.3	22.1	31.8	38.2
	kph	50.5	34.9	54.4	42.6	40.7	35.1	29.8	21.2	40.7	35.6	51.2	61.5
Minimum hourly average	mph	0.4	0.8	0.3	0.2	0.5	0.5	0.5	0.5	0.3	0.3	1.2	0.6
	kph	0.6	1.3	0.5	0.3	0.8	0.8	0.8	0.8	0.5	0.5	1.9	1.0
Ambient Air Temperature													
Average	°F	28.9	39.5	47	49.6	65.4	70.9	72.9	72	63.9	56.4	41.8	23.5
	°C	-1.7	4.2	8.3	9.8	18.6	21.6	22.7	22.2	17.7	13.6	5.4	-4.7
Daily maximum	°F	62.9	73.9	77.9	77.2	85.5	88.6	87.4	88.6	88.2	81.1	77.6	52.6
	°C	17.2	23.3	25.5	25.1	29.7	31.4	30.8	31.4	31.2	27.3	25.3	11.4
Daily minimum	°F	-9.2	11.7	23	27.6	39.1	43.6	54.3	54.1	39.7	31.4	14.2	-2.9
	°C	-22.9	-11.3	-5.0	-2.4	3.9	6.4	12.4	12.3	4.3	-0.3	-9.9	-19.4
Precipitation													
Total	in	4.69	4.84	4.0	4.66	3.83	4.07	2.78	2.22	3.62	3.32	3.32	3.4
	cm	11.9	12.3	10.2	11.8	9.7	10.3	7.1	5.6	9.2	8.4	8.4	8.6
Daily maximum	in	3.56	2.07	1.15	1.94	1.18	1.08	0.97	0.72	1.45	1.51	1.32	1.67
	cm	9.0	5.3	2.9	4.9	3.0	2.7	2.5	1.8	3.7	3.8	3.4	4.2

TABLE C.5-2

2000 AVERAGE WIND SPEED AND PERCENT OF TIME FROM DIRECTION AT TEN AND SIXTY METERS ABOVE GROUND LEVEL

Direction	Average 10-meter Wind Speed (mph)	Average 10-meter Wind Speed (kph)	Percent of Time from Direction	Average 60-meter Wind Speed (mph)	Average 60-meter Wind Speed (kph)	Percent of Time from Direction
N	5.5	8.8	3.8	7.6	12.2	4.3
NNE	6.2	10.0	4.4	7.7	12.4	5.2
NE	5.3	8.5	6.0	7.1	11.4	11.2
ENE	4.6	7.4	6.5	6.5	10.5	5.9
E	3.7	6.0	4.1	6.4	10.3	3.4
ESE	3.0	4.8	2.1	5.5	8.8	2.0
SE	3.2	5.1	2.1	6.3	10.1	2.4
SSE	4.0	6.4	3.1	7.1	11.4	3.4
S	5.5	8.8	6.5	9.0	14.5	8.7
SSW	6.6	10.6	12.4	9.7	15.6	13.6
SW	4.6	7.4	12.8	9.4	15.1	11.5
WSW	4.0	6.4	10.8	9.7	15.6	9.6
W	4.7	7.6	10.2	10.0	16.1	7.8
WNW	4.5	7.2	7.8	9.0	14.5	5.8
NW	4.8	7.7	6.8	8.7	14.0	5.2
NNW	5.1	8.2	4.1	7.2	11.6	4.1

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Appendix D

APPENDIX D

CY 2000 NATIONAL EMISSIONS STANDARDS FOR HAZARDOUS AIR POLLUTANTS (NESHAP)

ANNUAL REPORT FOR THE

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

3694

2000 NATIONAL EMISSIONS STANDARDS FOR HAZARDOUS AIR POLLUTANTS (NESHAP) ANNUAL REPORT

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FERNALD, OHIO

MAY 2001

U.S. DEPARTMENT OF ENERGY

60200-RP-0004
REV. 0
FINAL

000503

U.S. Department of Energy
Radionuclide Air Emissions Annual Report
(under Subpart H of 40 CFR Part 61)
Calendar Year 2000

Site Name: Fernald Environmental Management Project (FEMP), Fernald, Ohio

Field Office Information:

Office: Fernald Area Office (FN), U.S. Department of Energy (DOE)

Address: Post Office Box 538705
Mail Stop 45
Cincinnati, Ohio 45253-8705

Contact: Ed Skintik Phone: (513) 648-3050

Site Information

Operating Contractor: Fluor Fernald, Inc.

Address: 7400 Willey Road
Fernald, Ohio 45030 (Site Location)

Post Office Box 538704
Cincinnati, Ohio 45253-8704 (mailing address)

Contact: John Byrne Phone: (513) 648-7517

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ATTACHMENT D.1

CAP88-PC Computer Model Runs as Supporting Documentation for 40 CFR 61.96

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Figure D-2 CY 2000 Wind Rose Data, 10-Meter Height

LIST OF ACRONYMS

AMS	air monitoring station
CFR	Code of Federal Regulations
CY	calendar year
D&D	decontamination and dismantling
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FEMP	Fernald Environmental Management Project
HEPA	high-efficiency particulate air
IEMP	Integrated Environmental Monitoring Plan
mrem	millirem
mSv	millisieverts
NESHAP	National Emission Standards for Hazardous Air Pollutants
OEPA	Ohio Environmental Protection Agency
WPRAP	Waste Pits Remedial Action Project

PREAMBLE

On May 23, 1997, the U.S. Department of Energy (DOE) Fernald Environmental Management Project (FEMP) submitted a written request to the U.S. Environmental Protection Agency (EPA) for approval to use an alternate approach for demonstrating compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP), Subpart H requirements (DOE 1997). The alternate approach utilizes environmental measurements of airborne radionuclide concentrations (as provided for under 40 Code of Federal Regulations [CFR] 61.93[b][5]) rather than air dispersion modeling to demonstrate that radionuclide emissions resulting from FEMP operations remain below the annual NESHAP Subpart H standard. The request for approval of the alternative approach was driven by the recognition that the dominant sources of radiological emissions at the FEMP had changed as the mission of the FEMP changed from uranium metal production (which ended in 1989) to environmental remediation. During production, the primary emission sources from the facility were point sources (stacks and vents). However, under the current mission of full scale environmental remediation, the dominant emission sources are fugitive emissions from diffuse sources (i.e., large scale excavations, wind erosion from stockpiled materials, decontamination and dismantling projects, etc.). Because there is a high degree of uncertainty associated with modeling fugitive emissions, environmental measurements were proposed as an alternative to provide a more accurate assessment of FEMP emissions.

On August 11, 1997, the EPA granted approval to use environmental measurements as an alternative methodology for demonstrating NESHAP compliance (EPA 1997). The FEMP began utilizing environmental measurements for NESHAP compliance purposes in 1998.

SUMMARY

For CY 2000 the maximum effective dose equivalent from emissions of radionuclides to the ambient air, based on radionuclide measurements at the FEMP fenceline, is estimated to be 1.1 millirem (mrem) (1.1E-02 millisieverts [mSv]), which is in compliance with the Subpart H standard of 10 mrem. This estimation is based on the FEMP's radiological air particulate monitoring program which consists of a network of high-volume air monitoring stations (AMS) operated continuously during the year at the FEMP facility fenceline and background locations.

SECTION I: FACILITY INFORMATION

A. Site Description

The FEMP is located on a 1,050 acre (425 hectare) area approximately 18 miles (29 km) northwest of downtown Cincinnati, Ohio. The former production area covers approximately 136 acres (55 hectares) in the center of the FEMP. The facility is sited just north of the small farming community of Fernald, Ohio.

The area immediately surrounding the FEMP is primarily rural in nature, characterized by the predominance of agriculture, with some light industry and private residences. The FEMP is located on a relatively level plain, outside of the 500-year flood plain of the Great Miami River, in an ancestral river valley known as the New Haven Trough.

The climate is characterized as continental, with CY 2000 average temperatures ranging from approximately 29°F (-1.7°C) in January to 73°F (23°C) in July. Average annual precipitation is approximately 41 inches (104 centimeters) per year. Prevailing wind flow is from the south-southwest.

For 37 years, the former Feed Materials Production Center (Fernald site) produced uranium metals for DOE and its predecessors. On July 10, 1989, uranium metals production was suspended. Management responsibilities of the Fernald site were transferred from the Defense Programs organization to the DOE's Office of Environmental Restoration and Waste Management.

Currently, most activities at the FEMP are conducted under the Comprehensive Environmental Response, Compensation, and Liability Act. These activities include sample analysis; waste characterization; the management, treatment, storage and disposal of hazardous, mixed, low-level and solid wastes; and the decontamination and cleanup of radioactively contaminated buildings, equipment, soils, and waters. The site also manages thorium wastes and K-65 Silos waste material which contains radium and produces radon gas.

B. Source Descriptions

The majority of the radioactive airborne contaminants at the FEMP consist of thorium and uranium isotopes. Additional radioactive airborne contaminants consist of daughter products from the uranium, actinium, and thorium series decay chains.

For CY 2000, potential radionuclide emissions sources at the FEMP included:

- Building 11*, emissions from the laundry facilities resulting from the processing of contaminated clothing used at the FEMP and from the respirator washing facility located in the building
- Building 12, fugitive emissions from Tank Farm/Maintenance Decontamination and Dismantling (D&D) Project
- Building 15, emissions from laboratory operations
- Building 51, emissions from the advanced wastewater treatment facility
- Building 53, emissions from laboratory operations
- Building 56, fugitive emissions from packaging of enriched ingots and derbies
- Building 65, emissions from thorium repackaging operations
- Building 71*, emissions from material sorting and repackaging operations
- Building 80, fugitive emissions from metal fuel-core repackaging operations
- Plant 5, fugitive emissions generated from the Metals Production Plant D&D Project
- Plant 6, fugitive emissions from covered storage area D&D
- Waste Pits Remedial Action Project* (WPRAP) dryer stack operations
- Other sources include fugitive emissions from WPRAP excavations of waste pits 1 and 3, on-site disposal facility excavations, construction, and debris placement, various borrow area excavations (i.e., Area 1, Phase II, Area 1, Phase III, Area 2, Phase I, Area 2, Phase III, Part 2, etc.), wind erosion of stockpiles (i.e., Soil Pile 3, Soil Pile 7, South Field, Active Flyash Pile, southern waste units, etc.), and earth moving equipment, material handling and storage operations.

Note: *Indicates point sources were continuously monitored during process operations. Table D-1 provides a summary of data from point source monitors, and is included as supporting documentation but is not used to demonstrate 40 CFR 61.92 compliance.

All monitored stacks are equipped with a high-efficiency particulate air (HEPA) filter used for effluent controls. HEPA filters are 99.97 percent efficient for particles of 0.3 microns or larger. Additionally, HEPA filtration systems are utilized throughout the FEMP in adhering to the As Low As Reasonably Achievable philosophy. In accordance with 40 CFR 61.94(b)(5), some examples of HEPA filters used at the FEMP include vacuum cleaner exhaust controls, negative pressure ventilation controls, venting glove bags and glove boxes, and general decontamination efforts. Table D-2 is provided to comply with 40 CFR 61.94 (b)(6), which requires reporting the distances from the points of release to the nearest residence, school, business, etc. This table is not used to demonstrate compliance with 40 CFR 61.92.

C. Radiological Air Particulate Monitoring Program Description

The FEMP's radiological air monitoring program is defined in the Integrated Environmental Monitoring Plan (IEMP) (DOE 1999). The program design, as approved by the EPA, is summarized below:

Monitoring Equipment and Locations

- A network of 18 high-volume environmental AMS comprise the FEMP's radiological air particulate monitoring program for NESHAP compliance (refer to Figure D-1 for monitoring locations). The monitors draw air continuously through 8-inch by 10-inch filters at a rate of 40-50 cubic feet per minute. Each AMS contains a flow-rate chart recorder and an hour-meter that provides a record of the monitors' operational run-time over the sampling period. Additionally, each AMS is equipped with flow controllers that maintain a constant air flow through the monitor automatically adjusting blower/motor speed to correct for variations in line voltage, temperature, pressure, or filter loading.

- The 18 AMS are divided among on-site and background monitoring locations. Sixteen monitors are located on the FEMP fenceline corresponding to the 16 windrose sectors. Two monitors collect background data and are located in the predominant upwind directions of northwest (3.2 miles) and southwest (6.2 miles) from the center of the FEMP. The EPA siting criteria (40 CFR 58, Appendix E) were considered when selecting these locations.

Analytical Regime and Sampling Frequency

The analytical regime and sampling frequency for this program was designed to account for the major contributors to dose as defined in 40 CFR 61.93(b)(5)(ii) for the purpose of demonstrating NESHAP Subpart H compliance.

- Filters are exchanged on a biweekly basis and analyzed for total uranium, isotopic thorium, and total particulates. These data are used to track site emissions routinely throughout the year to ensure emission controls at the FEMP are operating effectively.

- A portion of each biweekly filter is retained and is used to form a quarterly composite sample. The composite sample is analyzed for the radionuclides expected to be the major contributors to dose from site emissions. The results of the quarterly data are used to track compliance against the NESHAP Subpart H standard during the year and for demonstrating compliance at the end of the year.

Isotopes that comprise the quarterly composite analysis were selected based on the following considerations:

- Radionuclides which are stored in large quantities at the FEMP and which will be handled or processed during the remediation effort (uranium, thorium-230, thorium-232, and radium-226)

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- Radionuclides which have been the major contributors to dose based on environmental and stack filter measurements (uranium)

- Radionuclides which, due to their concentrations in waste and contaminated soil, will be the major contributors to dose (uranium, thorium-228, and thorium-230).

Uranium-238, thorium-232, and uranium-235 are initial radionuclides in the uranium, thorium, and actinide decay chains, respectively. The majority of uranium and thorium received and processed during the production era of the FEMP had been separated from its decay chain progeny prior to shipment to the FEMP. As a result, decay chain progeny products were not in equilibrium with the parent concentrations, but may have grown into equilibrium with their parents during the history of operations at the FEMP. In addition to the potential in-growth of decay chain progeny, some of the progeny are difficult to quantify using standard radiochemistry analytical techniques. Analysis is particularly difficult given the limited sample volume and low environmental concentrations of all radionuclides in the quarterly composite samples. In order to account for the progeny's contribution to dose (while avoiding analytical difficulties), a number of progeny radionuclides can conservatively be considered to be present in equilibrium with their parents. These radionuclides (thorium-234, radium-228, actinium-228, radium-224, and thorium-231) are assumed to be in equilibrium with their parent concentrations as measured in the quarterly composites. Table D-3 summaries measured net air concentrations.

Air Emission Data Reporting

In addition to this report, the biweekly and quarterly composite data associated with this program were tracked and reported to the EPA and Ohio Environmental Protection Agency (OEPA) through IEMP quarterly status reports during CY 2000. In conjunction with the quarterly reports, all monitoring data were provided to the EPA and OEPA via electronic media (data diskettes or CD-ROM) on a quarterly basis.

SECTION II: AIR EMISSIONS DATA

A. Air Monitoring Data Completeness Status

During CY 2000 there were two types of concerns about data completeness of the quarterly composite results that led to the loss or rejection of the data for purposes of demonstrating NESHAP compliance. In each case where data were lost or rejected, an evaluation was performed in order to determine the impacts with respect to demonstrating NESHAP compliance. On an individual basis, each case of lost or rejected data had minimal influence on the compliance demonstration. A summary of each case is provided below:

- During both the first and fourth quarters of CY 2000, the radium-226 results at AMS-2 were rejected due to failure of multiple quality control checks by the contract laboratory. Sample reanalysis was not possible due to consumption of the sample. The loss of radium-226 data from AMS-2 during the first and fourth quarters does not significantly affect the compliance demonstration because radium-226 has not historically contributed the major dose fraction from FEMP emissions and AMS-2 has not historically been the maximum fenceline indicator sample location.

- During the second quarter of CY 2000, the results at AMS-16, one of the background monitors indicated elevated levels. Isotopic thorium levels were approximately six times those of AMS-12, the other background monitor; while isotopic uranium and radium-226 levels reflected values of three times those of AMS-12. An examination of the control checks indicated valid results. Because the background concentrations are subtracted from each fenceline monitor's concentrations in order to determine net FEMP emissions, any bias in background levels would carry through to the indicator results. The AMS-16 samples were reanalyzed which confirmed elevated background concentrations. Even though the results were confirmed valid, incorporating them might have produced artificially lower net fenceline concentrations. Therefore, the second quarter AMS-16 results were rejected as not representative of FEMP background concentrations. The rejection of the background data from AMS-16 during the second quarter does not significantly affect the compliance demonstration because of the conservative nature, insofar as this affect overestimates the FEMP air inhalation dose.

B. Air Monitoring Station Operational Performance

During CY 2000, operational run-times for the 18 NESHAP air monitoring stations averaged 99.2 percent, with all monitors operating in excess of the 95 percent minimum expectation. In general, interruptions in monitor operations that were encountered during CY 2000 were the result of power failures and/or equipment failures (refer to Table D-4).

SECTION III: DOSE ASSESSMENT

Based on the sum of the quarterly isotopic results and annual air volumes, the net measured concentrations for each radionuclide were calculated at each fenceline air monitor to determine annual

average concentrations. The annual average concentrations at each fenceline air monitor are divided by the corresponding values listed in Subpart H of 40 CFR 61, Appendix E, Table 2 to form a radionuclide-specific compliance ratio. At each fenceline air monitor, the sum of the radionuclide-specific compliance ratios was determined. Refer to Table D-5 for the NESHAP compliance ratios at each air monitor. The maximum value of the sum of the ratios was 0.11 and occurred at AMS-3. AMS-3 operated 98.7 percent of the time during 2000.

In accordance with 40 CFR 61.107, compliance with the NESHAP standard is demonstrated when the sum of the ratios is less than 1. Based on this approach for demonstrating compliance, the 40 CFR 61, Appendix E, Table 2 values can be assumed to represent the annual average radionuclide concentrations that correspond to a 10 mrem annual effective dose equivalent. It follows that a fraction of the 40 CFR 61, Appendix E, Table 2 values would correspond to an equivalent fraction of a 10 mrem annual effective dose equivalent.

Based on the assumption above, the sum of the radionuclide-specific compliance ratios can be converted to a dose by multiplying the ratio by 10. The maximum value of the sum of the ratios (0.11) converts to a maximum effective dose equivalent of 1.1 mrem (1.1E-02 mSv) at the fenceline (AMS-3). Because the nearest residence is located approximately 1,555 feet (474 meters) downwind (east-southeast) from AMS-3, the actual dose received by this receptor would be substantially lower than 1.1 mrem.

SECTION IV: COMPLIANCE ASSESSMENT

For CY 2000, the maximum effective dose equivalent from emissions of radionuclides to the ambient air, based on radionuclide measurements at the FEMP fenceline, is estimated to be 1.1 mrem (1.1E-02 mSv), which is in compliance with the Subpart H standard of 10 mrem.

SECTION V: ADDITIONAL INFORMATION

A. Meteorological Data

Refer to Figure D-2 for the CY 2000 wind rose data.

B. Construction/Modifications at the FEMP

There were two projects completed in CY 2000 for which the requirements to apply to the EPA for approval to construct or modify were waived due to the provisions of 40 CFR 61.96. These projects were:

- Building 30 Sampling Line HEPA Exhaust
- WPRAP Laundry Dryer Exhaust.

Attachment D.1 contains CAP88-PC computer model runs as supporting documentation for the waivers.

C. Unplanned Releases of Radionuclides

There were 338 potential release notifications received by the site's release evaluators during CY 2000. The notifications included all spills and/or releases of chemicals, oils, radiological material, or other hazardous materials. Of the 338 notifications, eight were identified as outside releases with a potential for radionuclide emissions. For CY 2000 no significant unplanned releases of radionuclides were identified in a review of the 338 notifications received by the site's release evaluators.

TABLE D-1

NESHAP STACK EMISSIONS MONITORING RESULTS

	CY 2000 Annual Results	
Stack Location/ Analysis Performed	Number of Samples (including rinsate)[a,b]	Total Pounds[a,c]
Building 71 Stack		
Uranium, Total	5	1.8E-05
Thorium-232	5	3.4E-05
Thorium-230	5	8.2E-10
Total Particulate	4	4.6E-02
Laundry Stack		
Uranium, Total	3	1.9E-05
Thorium-232	3	1.5E-04
Thorium-230	3	3.0E-09
Total Particulate	3	1.1E-01
WPRAP Dryer Stack		
Uranium-238	11	4.2E-05
Uranium-235/236	11	2.5E-07
Uranium-234	11	2.1E-09
Thorium-232	11	1.0E-05
Thorium-230	11	1.1E-09
Thorium-228	11	1.3E-15
Radium-226	11	3.3E-11
Total Particulate	NS	NS
Total Radon[d]	NA	507[e] (µCi/day)

[a]NS = not sampled; NA = not applicable
[b]WPRAP samples consist of 32 composited filters.
[c]Total pounds are only determined from detected results.
[d]Sample results are continuously collected and recorded.
[e]Value represents a daily average.

TABLE D-2[a]

DISTANCE AND DIRECTION FROM POINTS OF RELEASE TO RECEPTORS

Source	Type of Control	Percent Efficiency[b]	Distance and Direction to Nearest Off Site Receptor
Plant 5	None	NA	1023m ESE
Plant 6	None	NA	799m ESE
Building 11			
Laundry Dryer Exhaust	HEPA	99.97	1016m WSW
Respirator Washing Facility	HEPA	99.97	1017m WSW
Building 12	None	NA	959m NNE
Building 15			
Perchloric Stacks	None	NA	921m WSW
HEPA Exhaust	HEPA	99.97	921m WSW
General Exhaust	None	NA	921m WSW
Building 51	None	NA	671m W
Building 53	None	NA	939m ESE
Building 56	None	NA	750m N
Building 65	HEPA	99.97	844m N
Building 71	HEPA	99.97	944m N
Building 78	HEPA	99.97	833m N
Building 80	None	NA	869m WSW
WPRAP Dryer	HEPA	99.97	904m NNE

[a]Table D-2 is included to comply with 40 CFR 61.94 (b)(6) and not used to demonstrate compliance with 40 CFR 61.92.
[b]NA = not applicable

TABLE D-3

NET AIR CONCENTRATIONS[a]

Location	Uranium (pCi/m^3)[b]			Thorium (pCi/m^3)[b]			Radium (pCi/m^3)[b,c]
	234	235/236	238	228	230	232	226
Fenceline							
AMS-2	2.9E-05	1.7E-06	4.2E-05	2.7E-07	3.5E-05	6.5E-07	0.0E+00
AMS-3	8.8E-05	6.9E-06	1.2E-04	3.3E-06	1.9E-04	4.3E-06	5.3E-05
AMS-4	1.3E-05	1.6E-06	1.7E-05	5.6E-07	2.8E-05	1.5E-06	1.4E-05
AMS-5	1.2E-05	7.1E-07	2.0E-05	3.6E-07	3.0E-05	3.6E-07	2.4E-05
AMS-6	2.1E-05	1.3E-06	4.0E-05	0.0E+00	5.7E-05	9.6E-07	5.2E-06
AMS-7	9.9E-06	6.8E-07	1.5E-05	2.8E-08	1.7E-05	3.8E-07	1.8E-05
AMS-8A	7.0E-05	4.6E-06	9.4E-05	1.7E-06	8.0E-05	2.0E-06	2.0E-05
AMS-9C	5.5E-05	3.7E-06	7.8E-05	1.7E-06	1.0E-04	4.2E-06	3.5E-05
AMS-22	1.7E-05	8.4E-07	3.0E-05	1.1E-06	3.9E-05	8.0E-07	7.9E-06
AMS-23	1.5E-05	7.1E-07	2.8E-05	1.1E-06	3.5E-05	1.4E-06	1.6E-05
AMS-24	2.3E-05	1.6E-06	3.1E-05	1.6E-06	5.6E-05	1.7E-06	1.2E-05
AMS-25	1.1E-05	7.0E-07	1.8E-05	1.2E-06	3.2E-05	1.2E-06	4.4E-05
AMS-26	1.5E-05	1.1E-06	2.5E-05	6.3E-07	2.8E-05	0.0E+00	1.9E-05
AMS-27	1.4E-05	6.0E-07	2.3E-05	2.7E-06	3.4E-05	1.4E-06	4.1E-05
AMS-28	1.5E-05	1.7E-06	3.6E-05	0.0E+00	5.0E-05	0.0E+00	1.9E-05
AMS-29	2.7E-05	2.5E-06	4.0E-05	1.5E-06	4.4E-05	1.5E-06	3.9E-05
Background							
AMS-12	5.9E-06	1.9E-07	6.4E-06	5.5E-06	6.1E-06	3.6E-06	6.8E-05
AMS-16	7.2E-06	0.0E+00	7.4E-06	7.7E-06	8.9E-06	6.1E-06	8.0E-05

[a]Thorium-234, radium-228, actinium-228, radium-224, and thorium-231 are considered to be in equilibrium with their parent of the primordial decay chain (i.e., uranium-238 pCi/m^3 = thorium-234 pCi/m^3, thorium-232 pCi/m^3 = radium-228, actinium-228, and radium-224 pCi/m^3, uranium-235 pCi/m^3 = thorium-231 pCi/m^3).
[b]AMS-16 second quarter CY 2000 data were rejected because not representative of background levels.
[c]AMS-2 first and fourth quarter CY 2000 radium-226 data were rejected due to failure of multiple quality control checks.

TABLE D-4

CY 2000 OPERATIONAL SUMMARY FOR AIR PARTICULATE MONITORING STATIONS

Location	Number of Samples	Sample Start Date	Last Sample Collection Date	Operating Time (hours)[a]	Percent of Operation
Fenceline					
AMS-2	26	12/28/99	12/26/00	8706.8	99.7
AMS-3	26	12/28/99	12/26/00	8622.4	98.7
AMS-4	26	12/28/99	12/26/00	8549.5	97.9
AMS-5	26	12/28/99	12/26/00	8601.7	98.5
AMS-6	26	12/29/99	12/26/00	8616.6	98.9
AMS-7	26	12/28/99	12/26/00	8649.7	99.0
AMS-8A	26	12/28/99	12/26/00	8591.1	98.3
AMS-9C	26	12/28/99	12/26/00	8731.2	99.9
AMS-22	26	12/28/99	12/26/00	8699.4	99.6
AMS-23	26	12/28/99	12/26/00	8689.8	99.5
AMS-24	26	12/29/99	12/26/00	8644.8	99.2
AMS-25	26	12/29/99	12/26/00	8667.6	99.5
AMS-26	26	12/29/99	12/26/00	8670	99.5
AMS-27	26	12/29/99	12/26/00	8644.5	99.2
AMS-28	26	12/28/99	12/26/00	8717.2	99.8
AMS-29	26	12/28/99	12/26/00	8679.1	99.3
Background					
AMS-12	26	12/28/99	12/26/00	8680.9	99.4
AMS-16	26	12/28/99	12/26/00	8649.7	99.0

[a]8736 available operating hours from December 28, 1999 through December 26, 2000, and 8712 available operating hours from December 29, 1999 through December 26, 2000.

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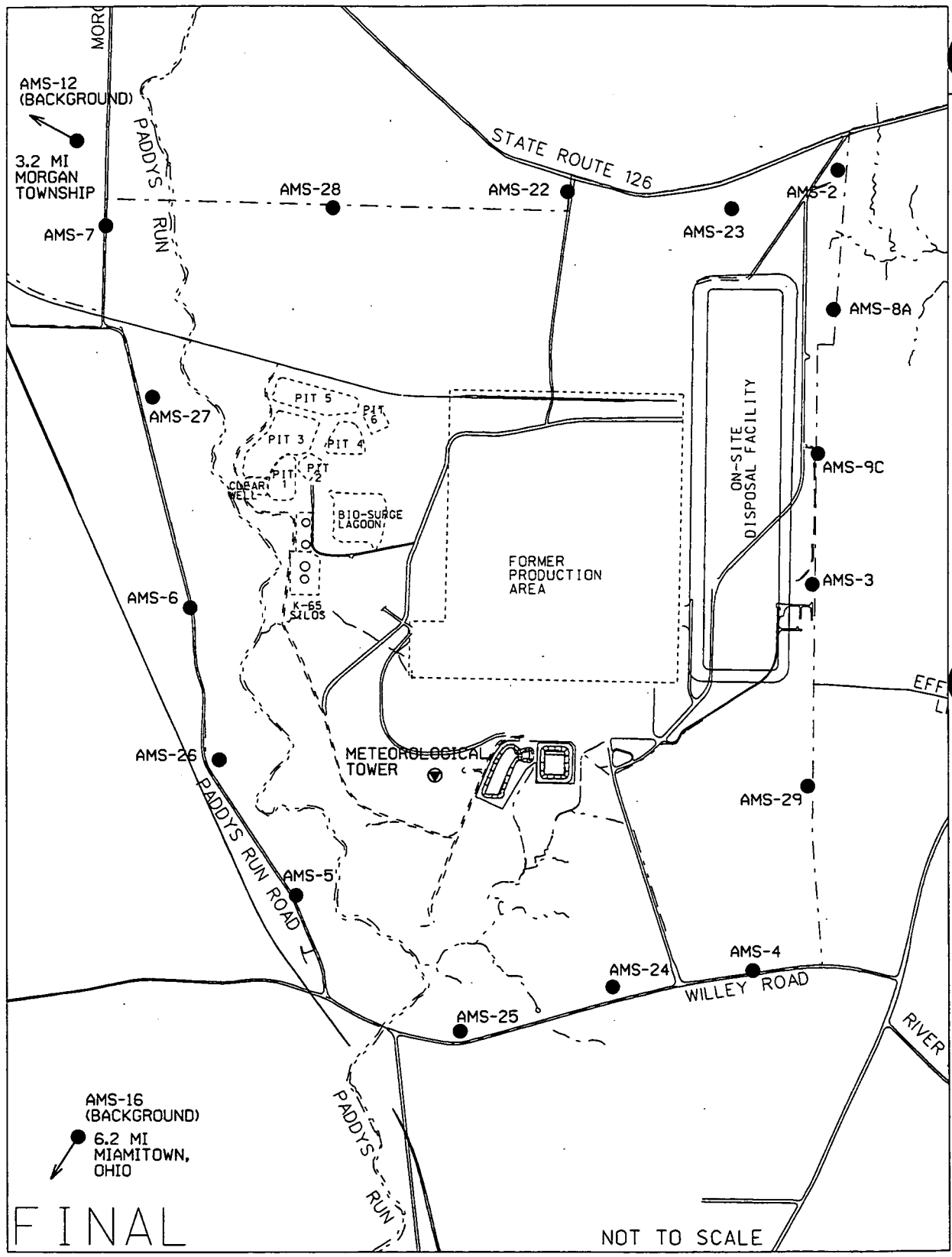
TABLE D-5

ANNUAL NESHAP COMPLIANCE RATIO REPORT

	40 CFR 61 (NESHAP) Subpart H Appendix E, Table 2; Net Ratios[a]													
Location	Actinium-228[b]	Radium-224[b]	Radium-226[c]	Radium-228[b]	Thorium-228	Thorium-230	Thorium-231[b]	Thorium-232	Thorium-234[b]	Uranium-234	Uranium-235 Uranium-236	Uranium-238	Ratio Totals	Dose[d] (mrem)
Fenceline														
AMS-2	1.8E-007	4.3E-006	-	1.1E-004	8.6E-005	1.0E-002	5.8E-009	1.0E-003	1.9E-005	3.7E-003	2.3E-004	5.1E-003	0.021	0.205
AMS-3	1.2E-006	2.9E-005	1.6E-002	7.3E-004	1.1E-003	5.5E-002	2.4E-008	6.9E-003	5.6E-005	1.1E-002	9.3E-004	1.5E-002	0.107	1.069
AMS-4	4.0E-007	9.8E-006	4.2E-003	2.5E-004	1.8E-004	8.2E-003	5.4E-009	2.4E-003	7.9E-006	1.7E-003	2.1E-004	2.1E-003	0.019	0.191
AMS-5	9.8E-008	2.4E-006	7.2E-003	6.2E-005	1.2E-004	8.8E-003	2.5E-009	5.9E-004	9.3E-006	1.5E-003	9.7E-005	2.5E-003	0.021	0.208
AMS-6	2.6E-007	6.4E-006	1.6E-003	1.6E-004	-	1.7E-002	4.5E-009	1.6E-003	1.8E-005	2.8E-003	1.7E-004	4.8E-003	0.028	0.277
AMS-7	1.0E-007	2.5E-006	5.5E-003	6.4E-005	8.9E-006	5.0E-003	2.3E-009	6.1E-004	7.0E-006	1.3E-003	9.1E-005	1.8E-003	0.014	0.144
AMS-8A	5.4E-007	1.3E-005	6.2E-003	3.4E-004	5.6E-004	2.3E-002	1.6E-008	3.2E-003	4.3E-005	9.1E-003	6.2E-004	1.1E-002	0.055	0.549
AMS-9C	1.1E-006	2.8E-005	1.1E-002	7.1E-004	5.6E-004	3.0E-002	1.3E-008	6.8E-003	3.6E-005	7.1E-003	5.0E-004	9.5E-003	0.066	0.656
AMS-22	2.2E-007	5.3E-006	2.4E-003	1.4E-004	3.4E-004	1.2E-002	2.9E-009	1.3E-003	1.4E-005	2.2E-003	1.1E-004	3.6E-003	0.022	0.217
AMS-23	3.7E-007	9.0E-006	4.7E-003	2.3E-004	3.7E-004	1.0E-002	2.4E-009	2.2E-003	1.3E-005	2.0E-003	9.6E-005	3.4E-003	0.023	0.234
AMS-24	4.7E-007	1.1E-005	3.6E-003	2.9E-004	5.3E-004	1.6E-002	5.4E-009	2.8E-003	1.4E-005	2.9E-003	2.1E-004	3.7E-003	0.030	0.305
AMS-25	3.2E-007	8.0E-006	1.3E-002	2.0E-004	4.0E-004	9.3E-003	2.4E-009	1.9E-003	8.0E-006	1.5E-003	9.4E-005	2.1E-003	0.029	0.287
AMS-26	-	-	5.6E-003	-	2.0E-004	8.3E-003	3.9E-009	-	1.1E-005	1.9E-003	1.5E-004	3.0E-003	0.019	0.192
AMS-27	3.8E-007	9.3E-006	1.2E-002	2.4E-004	8.7E-004	1.0E-002	2.1E-009	2.2E-003	1.1E-005	1.8E-003	8.1E-005	2.8E-003	0.031	0.307
AMS-28	-	-	5.9E-003	-	-	1.5E-002	6.0E-009	-	1.6E-005	1.9E-003	2.4E-004	4.3E-003	0.027	0.272
AMS-29	4.0E-007	9.8E-006	1.2E-002	2.5E-004	4.7E-004	1.3E-002	8.5E-009	2.4E-003	1.8E-005	3.5E-003	3.3E-004	4.8E-003	0.037	0.366
Background														
AMS-12	9.8E-007	2.4E-005	2.1E-002	6.1E-004	1.8E-003	1.8E-003	6.7E-010	5.8E-003	2.9E-006	7.7E-004	2.6E-005	7.8E-004	NA[f]	
AMS-16[e]	1.7E-006	4.1E-005	2.4E-002	1.0E-003	2.5E-003	2.6E-003	-	9.9E-003	3.4E-006	9.3E-004	-	8.9E-004	NA[f]	

Maximum Year-to-Date Ratio: 0.107
Maximum Year-to-Date Dose (mrem): 1.1

[a]A "-" indicates the filter results were less than or equal to the blank results, and/or the indicator concentrations were less than or equal to the average net background concentrations.
[b]Isotopes are assumed to be in equilibrium with their primordial decay chain parent.
[c]AMS-2 first and fourth quarter CY 2000 radium-226 data were rejected due to failure of multiple quality control checks.
[d]Dose conversions are based on the NESHAP standard of 10 mrem per year.
[e]AMS-19 second quarter CY 2000 background results were rejected because not representative of background levels.
[f]NA = not applicable



LEGEND:

FEMP BOUNDARY

AMS LOCATION

DISTANCE FROM CENTER OF FORMER PRODUCTION AREA TO AMS LOCATION OFF MAP

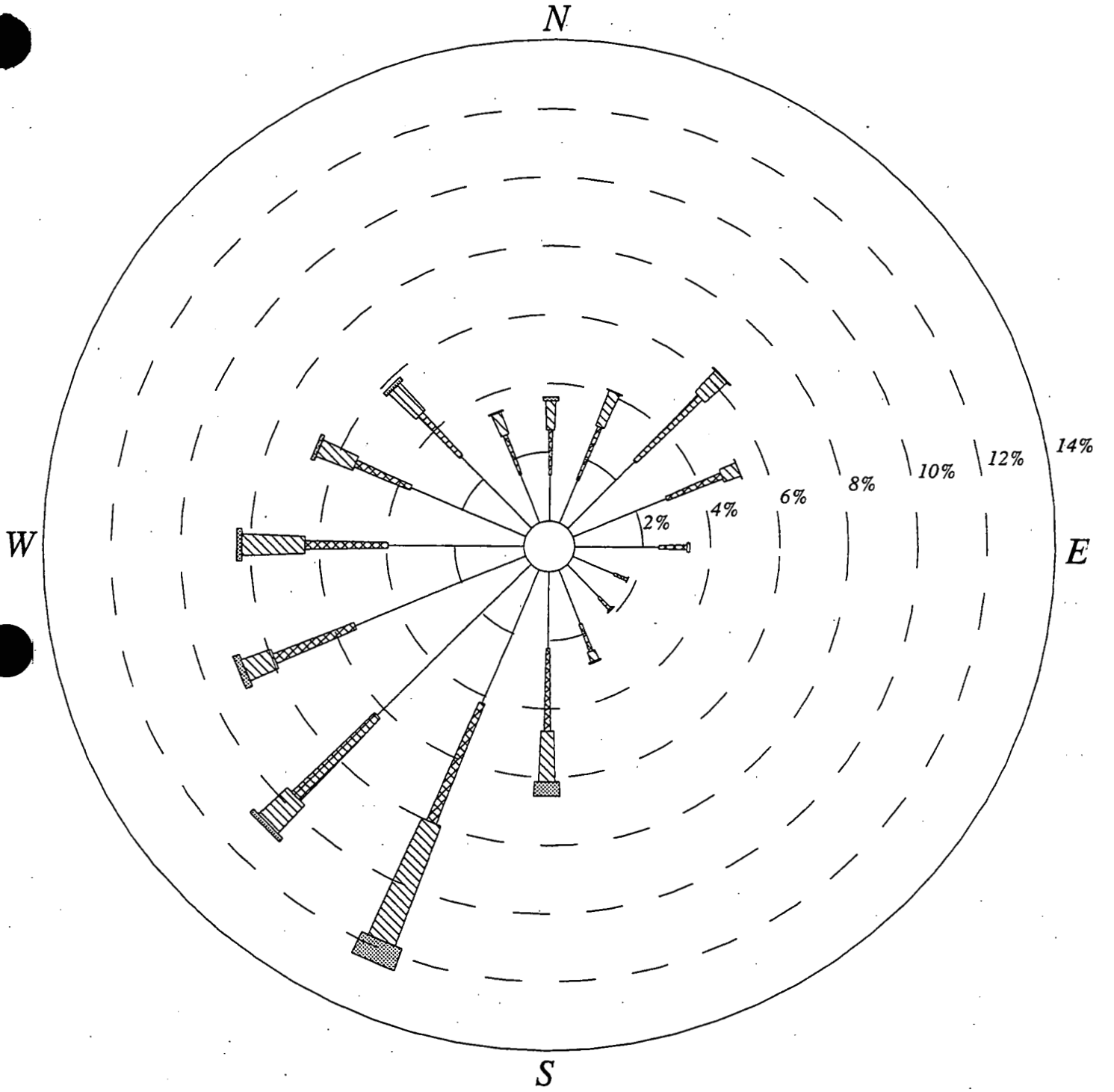
000521

FIGURE D-1. RADIOLOGICAL AIR MONITORING STATION LOCATIONS

v:\5fgp1\dgn\00annual\00an024.dgn

STATE PLANAR COORDINATE SYSTEM 1927

15-MAY-2001



CALM WINDS 7.42%

WIND SPEED (KNOTS)

NOTE: Frequencies indicate direction from which the wind is blowing.

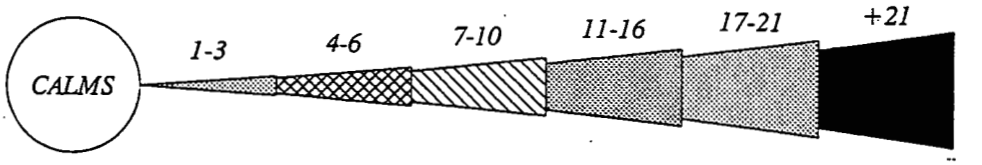


FIGURE D-2. CY 2000 WIND ROSE DATA, 10-METER HEIGHT

REFERENCES

U.S. Dept. of Energy, 1999, "Integrated Environmental Monitoring Plan, Revision 1," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1997, DOE-0980-97, Johnny Reising to James Saric and Michael Murphy, "Application for Approval to Use Environmental Measurements to Demonstrate Compliance with the National Emission Standards for Hazardous Air Pollutants Subpart H," dated May 23, 1997.

U.S. Environmental Protection Agency, 1997, Jack Barnett to Johnny Reising, "Application for Approval to Use Environmental Measurements to Demonstrate Compliance with the National Emission Standards for Hazardous Air Pollutants Subpart H," dated August 11, 1997.

SECTION VI: CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment (see 18 U.S.C. 1001).

Name: STEPHEN H. MCCRACKEN

Signature: S H McCracken

Date: 5/31/01

3694

Attachment D.1

ATTACHMENT D.1

CAP88-PC COMPUTER MODEL RUNS AS SUPPORTING DOCUMENTATION FOR 40 CFR 61.96

ATTACHMENT D.1-1

BUILDING 30 SAMPLING LINE HEPA EXHAUST

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment
Oct 5, 1999 3:31 pm

Facility: FERNALD ENVIRONMENT MANAGEMENT PROJECT
Address: P. O. BOX 538704
7400 WILLEY ROAD
City: CINCINNATI
State: OH Zip: 45253-8704

Effective Dose Equivalent (mrem/year)
8.14E-02

At This Location: 919 Meters North Northeast

Source Category: POINT SOURCE
Source Type: Stack
Emission Year: 1999

Comments: OFFSITE EDE FOR SAMPLING LINE INSIDE BLDG 30A
Part 1

Dataset Name: BLDG30A
Dataset Date: Oct 5, 1999 3:31 pm
Wind File: WNDFILES\FEMPSTD.WND

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 919 Meters North Northeast
Lifetime Fatal Cancer Risk: 1.04E-06

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Dose Equivalent (mrem/y)
GONADS	2.57E-04
BREAST	2.92E-04
R MAR	1.11E-02
LUNGS	6.14E-01
THYROID	3.33E-04
ENDOST	1.46E-01
RMNDR	6.42E-03
EFFEC	8.14E-02

RADIONUCLIDE EMISSIONS DURING THE YEAR 1999

Nuclide	Class	Size	Source #1 Ci/y	TOTAL Ci/y
U-234	Y	1.00	9.5E-04	9.5E-04
U-235	Y	1.00	5.0E-05	5.0E-05
U-236	Y	1.00	3.7E-05	3.7E-05
U-238	Y	1.00	1.1E-03	1.1E-03
RA-226	W	1.00	6.7E-07	6.7E-07
RA-228	W	1.00	2.7E-06	2.7E-06
TH-228	Y	1.00	2.9E-05	2.9E-05
TH-230	Y	1.00	8.4E-05	8.4E-05
TH-232	Y	1.00	4.5E-06	4.5E-06
TH-234	Y	1.00	4.2E-03	4.2E-03
SR-90	D	1.00	5.6E-06	5.6E-06
TC-99	W	1.00	1.2E-04	1.2E-04
RU-106	Y	1.00	2.2E-05	2.2E-05
CS-137	D	1.00	1.6E-05	1.6E-05

SITE INFORMATION

Temperature: 10 degrees C
Precipitation: 100 cm/y
Mixing Height: 1000 m

SOURCE INFORMATION

Source Number:	1
Stack Height (m):	4.60
Diameter (m):	0.20
Plume Rise Momentum (m/s): (Exit Velocity)	2.18E+01

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.700	0.399	0.442
Fraction From Assessment Area:	0.300	0.601	0.558
Fraction Imported:	0.000	0.000	0.000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

959	919	1720	1439	1197	1133	1323	1410	1446	1599
1597	1611	1519	1512	2096	1583	1266	1242	1547	1439

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

D O S E A N D R I S K E Q U I V A L E N T S U M M A R I E S

Non-Radon Individual Assessment
Oct 5, 1999 3:31 pm

Facility: FERNALD ENVIRONMENT MANAGEMENT PROJECT
Address: P. O. BOX 538704
7400 WILLEY ROAD
City: CINCINNATI
State: OH Zip: 45253-8704

Source Category: POINT SOURCE
Source Type: Stack
Emission Year: 1999

Comments: OFFSITE EDE FOR SAMPLING LINE INSIDE BLDG 30A
Part 1

Dataset Name: BLDG30A
Dataset Date: Oct 5, 1999 3:31 pm
Wind File: WNDFILES\FEMPSTD.WND

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem/y)
GONADS	2.57E-04
BREAST	2.92E-04
R MAR	1.11E-02
LUNGS	6.14E-01
THYROID	3.33E-04
ENDOST	1.46E-01
RMNDR	6.42E-03
EFFEC	8.14E-02

PATHWAY EFFECTIVE DOSE EQUIVALENT SUMMARY

Pathway	Selected Individual (mrem/y)
INGESTION	4.59E-03
INHALATION	7.67E-02
AIR IMMERSION	6.42E-09
GROUND SURFACE	4.96E-05
INTERNAL	8.13E-02
EXTERNAL	4.96E-05
TOTAL	8.14E-02

NUCLIDE EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclide	Selected Individual (mrem/y)
U-234	3.52E-02
U-235	1.77E-03
U-236	1.29E-03
U-238	3.50E-02
RA-226	3.37E-06
RA-228	5.45E-06
TH-228	1.92E-03
TH-230	5.66E-03
TH-232	4.33E-04
TH-234	9.15E-05
SR-90	5.42E-06
TC-99	2.09E-05
RU-106	3.96E-06
CS-137	4.82E-06
TOTAL	8.14E-02

CANCER RISK SUMMARY

Cancer	Selected Individual Total Lifetime Fatal Cancer Risk
LEUKEMIA	1.09E-08
BONE	7.16E-09
THYROID	9.71E-11
BREAST	6.65E-10
LUNG	1.00E-06
STOMACH	1.02E-09
BOWEL	1.17E-09
LIVER	5.45E-10
PANCREAS	2.64E-10
URINARY	1.32E-08
OTHER	3.23E-10
TOTAL	1.04E-06

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk
INGESTION	2.52E-08
INHALATION	1.01E-06
AIR IMMERSION	1.43E-13
GROUND SURFACE	1.14E-09
INTERNAL	1.03E-06
EXTERNAL	1.14E-09
TOTAL	1.04E-06

NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk
U-234	4.52E-07
U-235	2.32E-08
U-236	1.66E-08
U-238	4.53E-07
RA-226	4.46E-11
RA-228	5.55E-11
TH-228	3.86E-08
TH-230	4.64E-08
TH-232	2.44E-09
TH-234	2.89E-09
SR-90	9.13E-11
TC-99	7.65E-10
RU-106	1.85E-10
CS-137	1.26E-10
TOTAL	1.04E-06

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	959	919	1720	1439	1197	1133	1323
N	3.9E-02	4.2E-02	1.5E-02	2.0E-02	2.7E-02	2.9E-02	2.3E-02
NNW	1.7E-02	1.8E-02	6.7E-03	8.8E-03	1.2E-02	1.3E-02	1.0E-02
NW	1.4E-02	1.5E-02	5.7E-03	7.4E-03	9.8E-03	1.1E-02	8.4E-03
WNW	1.2E-02	1.3E-02	5.0E-03	6.5E-03	8.5E-03	9.2E-03	7.3E-03
W	1.7E-02	1.8E-02	7.2E-03	9.3E-03	1.2E-02	1.3E-02	1.1E-02
WSW	4.8E-02	5.1E-02	1.9E-02	2.5E-02	3.3E-02	3.6E-02	2.8E-02
SW	3.1E-02	3.3E-02	1.2E-02	1.6E-02	2.2E-02	2.4E-02	1.9E-02
SSW	4.2E-02	4.6E-02	1.6E-02	2.2E-02	2.9E-02	3.2E-02	2.5E-02
S	3.9E-02	4.2E-02	1.5E-02	2.0E-02	2.7E-02	3.0E-02	2.3E-02
SSE	3.8E-02	4.1E-02	1.5E-02	1.9E-02	2.6E-02	2.9E-02	2.2E-02
SE	3.3E-02	3.5E-02	1.4E-02	1.8E-02	2.3E-02	2.5E-02	2.0E-02
ESE	4.8E-02	5.2E-02	1.9E-02	2.5E-02	3.4E-02	3.7E-02	2.9E-02
E	3.3E-02	3.6E-02	1.3E-02	1.8E-02	2.4E-02	2.6E-02	2.0E-02
ENE	3.8E-02	4.0E-02	1.5E-02	2.0E-02	2.6E-02	2.9E-02	2.2E-02
NE	4.2E-02	4.5E-02	1.6E-02	2.2E-02	2.9E-02	3.2E-02	2.5E-02
NNE	7.6E-02	8.1E-02	3.0E-02	4.0E-02	5.3E-02	5.8E-02	4.6E-02

	Distance (m)						
Direction	1410	1446	1599	1597	1611	1519	1512
N	2.1E-02	2.0E-02	1.7E-02	1.7E-02	1.7E-02	1.9E-02	1.9E-02
NNW	9.0E-03	8.7E-03	7.4E-03	7.5E-03	7.4E-03	8.1E-03	8.1E-03
NW	7.7E-03	7.4E-03	6.4E-03	6.4E-03	6.3E-03	6.9E-03	6.9E-03
WNW	6.6E-03	6.4E-03	5.5E-03	5.5E-03	5.5E-03	6.0E-03	6.0E-03
W	9.6E-03	9.3E-03	8.0E-03	8.0E-03	7.9E-03	8.6E-03	8.7E-03
WSW	2.6E-02	2.5E-02	2.1E-02	2.1E-02	2.1E-02	2.3E-02	2.3E-02
SW	1.7E-02	1.6E-02	1.4E-02	1.4E-02	1.4E-02	1.5E-02	1.5E-02
SSW	2.2E-02	2.2E-02	1.8E-02	1.8E-02	1.8E-02	2.0E-02	2.0E-02
S	2.1E-02	2.0E-02	1.7E-02	1.7E-02	1.7E-02	1.9E-02	1.9E-02
SSE	2.0E-02	1.9E-02	1.6E-02	1.6E-02	1.6E-02	1.8E-02	1.8E-02
SE	1.8E-02	1.8E-02	1.5E-02	1.5E-02	1.5E-02	1.6E-02	1.7E-02
ESE	2.6E-02	2.5E-02	2.1E-02	2.1E-02	2.1E-02	2.3E-02	2.3E-02
E	1.8E-02	1.8E-02	1.5E-02	1.5E-02	1.5E-02	1.6E-02	1.6E-02
ENE	2.0E-02	1.9E-02	1.7E-02	1.7E-02	1.6E-02	1.8E-02	1.8E-02
NE	2.2E-02	2.1E-02	1.8E-02	1.8E-02	1.8E-02	2.0E-02	2.0E-02
NNE	4.1E-02	4.0E-02	3.4E-02	3.4E-02	3.4E-02	3.7E-02	3.7E-02

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)					
Direction	2096	1583	1266	1242	1547	1439
N	1.1E-02	1.7E-02	2.5E-02	2.5E-02	1.8E-02	2.0E-02
NNW	5.0E-03	7.6E-03	1.1E-02	1.1E-02	7.8E-03	8.8E-03
NW	4.3E-03	6.5E-03	9.0E-03	9.3E-03	6.7E-03	7.4E-03
WNW	3.7E-03	5.6E-03	7.8E-03	8.0E-03	5.8E-03	6.5E-03
W	5.4E-03	8.1E-03	1.1E-02	1.2E-02	8.4E-03	9.3E-03
WSW	1.4E-02	2.1E-02	3.0E-02	3.1E-02	2.2E-02	2.5E-02
SW	9.1E-03	1.4E-02	2.0E-02	2.0E-02	1.5E-02	1.6E-02
SSW	1.2E-02	1.9E-02	2.7E-02	2.8E-02	1.9E-02	2.2E-02
S	1.1E-02	1.7E-02	2.5E-02	2.6E-02	1.8E-02	2.0E-02
SSE	1.1E-02	1.7E-02	2.4E-02	2.5E-02	1.7E-02	1.9E-02
SE	1.0E-02	1.5E-02	2.2E-02	2.2E-02	1.6E-02	1.8E-02
ESE	1.4E-02	2.2E-02	3.1E-02	3.2E-02	2.3E-02	2.5E-02
E	9.9E-03	1.5E-02	2.2E-02	2.2E-02	1.6E-02	1.8E-02
ENE	1.1E-02	1.7E-02	2.4E-02	2.5E-02	1.7E-02	2.0E-02
NE	1.2E-02	1.8E-02	2.6E-02	2.7E-02	1.9E-02	2.2E-02
NNE	2.2E-02	3.4E-02	4.9E-02	5.0E-02	3.6E-02	4.0E-02

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	959	919	1720	1439	1197	1133	1323
N	4.9E-07	5.3E-07	1.9E-07	2.5E-07	3.4E-07	3.7E-07	2.9E-07
NNW	2.1E-07	2.2E-07	8.1E-08	1.1E-07	1.5E-07	1.6E-07	1.2E-07
NW	1.7E-07	1.8E-07	6.9E-08	9.1E-08	1.2E-07	1.3E-07	1.0E-07
WNW	1.5E-07	1.6E-07	6.0E-08	7.9E-08	1.0E-07	1.1E-07	9.0E-08
W	2.2E-07	2.3E-07	8.8E-08	1.2E-07	1.5E-07	1.7E-07	1.3E-07
WSW	6.1E-07	6.5E-07	2.3E-07	3.1E-07	4.2E-07	4.6E-07	3.6E-07
SW	3.9E-07	4.2E-07	1.5E-07	2.0E-07	2.7E-07	3.0E-07	2.3E-07
SSW	5.4E-07	5.8E-07	2.0E-07	2.7E-07	3.7E-07	4.1E-07	3.1E-07
S	4.9E-07	5.3E-07	1.9E-07	2.6E-07	3.4E-07	3.8E-07	2.9E-07
SSE	4.8E-07	5.2E-07	1.8E-07	2.4E-07	3.3E-07	3.6E-07	2.8E-07
SE	4.1E-07	4.4E-07	1.7E-07	2.2E-07	3.0E-07	3.2E-07	2.5E-07
ESE	6.1E-07	6.6E-07	2.4E-07	3.2E-07	4.3E-07	4.7E-07	3.6E-07
E	4.2E-07	4.5E-07	1.7E-07	2.2E-07	3.0E-07	3.2E-07	2.5E-07
ENE	4.8E-07	5.1E-07	1.8E-07	2.4E-07	3.3E-07	3.6E-07	2.8E-07
NE	5.3E-07	5.7E-07	2.0E-07	2.7E-07	3.7E-07	4.0E-07	3.1E-07
NNE	9.6E-07	1.0E-06	3.8E-07	5.1E-07	6.8E-07	7.4E-07	5.8E-07

	Distance (m)						
Direction	1410	1446	1599	1597	1611	1519	1512
N	2.6E-07	2.5E-07	2.1E-07	2.1E-07	2.1E-07	2.3E-07	2.3E-07
NNW	1.1E-07	1.1E-07	9.1E-08	9.1E-08	9.0E-08	9.9E-08	1.0E-07
NW	9.4E-08	9.1E-08	7.8E-08	7.8E-08	7.7E-08	8.4E-08	8.5E-08
WNW	8.1E-08	7.8E-08	6.7E-08	6.7E-08	6.6E-08	7.2E-08	7.3E-08
W	1.2E-07	1.1E-07	9.8E-08	9.8E-08	9.7E-08	1.1E-07	1.1E-07
WSW	3.2E-07	3.1E-07	2.6E-07	2.6E-07	2.6E-07	2.9E-07	2.9E-07
SW	2.1E-07	2.0E-07	1.7E-07	1.7E-07	1.7E-07	1.9E-07	1.9E-07
SSW	2.8E-07	2.7E-07	2.3E-07	2.3E-07	2.3E-07	2.5E-07	2.5E-07
S	2.6E-07	2.5E-07	2.2E-07	2.2E-07	2.1E-07	2.3E-07	2.4E-07
SSE	2.5E-07	2.4E-07	2.0E-07	2.0E-07	2.0E-07	2.2E-07	2.2E-07
SE	2.3E-07	2.2E-07	1.9E-07	1.9E-07	1.9E-07	2.1E-07	2.1E-07
ESE	3.3E-07	3.2E-07	2.7E-07	2.7E-07	2.7E-07	2.9E-07	2.9E-07
E	2.3E-07	2.2E-07	1.9E-07	1.9E-07	1.9E-07	2.0E-07	2.0E-07
ENE	2.5E-07	2.4E-07	2.1E-07	2.1E-07	2.0E-07	2.2E-07	2.3E-07
NE	2.8E-07	2.7E-07	2.3E-07	2.3E-07	2.2E-07	2.5E-07	2.5E-07
NNE	5.2E-07	5.0E-07	4.3E-07	4.3E-07	4.2E-07	4.7E-07	4.7E-07

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)					
Direction	2096	1583	1266	1242	1547	1439
N	1.4E-07	2.2E-07	3.1E-07	3.2E-07	2.3E-07	2.5E-07
NNW	5.9E-08	9.3E-08	1.3E-07	1.4E-07	9.6E-08	1.1E-07
NW	5.1E-08	7.9E-08	1.1E-07	1.1E-07	8.2E-08	9.1E-08
WNW	4.4E-08	6.8E-08	9.6E-08	9.9E-08	7.0E-08	7.9E-08
W	6.5E-08	1.0E-07	1.4E-07	1.4E-07	1.0E-07	1.2E-07
WSW	1.7E-07	2.7E-07	3.9E-07	4.0E-07	2.8E-07	3.1E-07
SW	1.1E-07	1.7E-07	2.5E-07	2.6E-07	1.8E-07	2.0E-07
SSW	1.5E-07	2.3E-07	3.4E-07	3.5E-07	2.4E-07	2.7E-07
S	1.4E-07	2.2E-07	3.1E-07	3.2E-07	2.3E-07	2.6E-07
SSE	1.3E-07	2.1E-07	3.0E-07	3.1E-07	2.2E-07	2.4E-07
SE	1.2E-07	1.9E-07	2.7E-07	2.8E-07	2.0E-07	2.2E-07
ESE	1.7E-07	2.7E-07	3.9E-07	4.0E-07	2.8E-07	3.2E-07
E	1.2E-07	1.9E-07	2.7E-07	2.8E-07	2.0E-07	2.2E-07
ENE	1.3E-07	2.1E-07	3.0E-07	3.1E-07	2.2E-07	2.4E-07
NE	1.5E-07	2.3E-07	3.3E-07	3.4E-07	2.4E-07	2.7E-07
NNE	2.8E-07	4.4E-07	6.2E-07	6.4E-07	4.5E-07	5.1E-07

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment
Oct 6, 1999 8:47 am

Facility: FERNALD ENVIRONMENT MANAGEMENT PROJECT
Address: P. O. BOX 538704
7400 WILLEY ROAD
City: CINCINNATI
State: OH Zip: 45253-8704

Effective Dose Equivalent
(mrem/year)

7.31E-02

At This Location: 978 Meters North Northeast

Source Category: POINT SOURCE
Source Type: Stack
Emission Year: 1999

Comments: OFFSITE EDE FOR SAMPLING LINE INSIDE BLDG 30A-
PART 2

Dataset Name: bldg30a2
Dataset Date: Oct 6, 1999 8:47 am
Wind File: WNDFILES\FEMPSTD.WND

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 978 Meters North Northeast
Lifetime Fatal Cancer Risk: 9.31E-07

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Dose Equivalent (mrem/y)
GONADS	2.29E-04
BREAST	2.60E-04
R MAR	9.88E-03
LUNGS	5.52E-01
THYROID	2.94E-04
ENDOST	1.30E-01
RMNDR	5.68E-03
EFFEC	7.31E-02

RADIONUCLIDE EMISSIONS DURING THE YEAR 1999

Nuclide	Class	Size	Source #1 Ci/y	TOTAL Ci/y
U-234	Y	1.00	9.5E-04	9.5E-04
U-235	Y	1.00	5.0E-05	5.0E-05
U-236	Y	1.00	3.7E-05	3.7E-05
U-238	Y	1.00	1.1E-03	1.1E-03
RA-226	W	1.00	6.7E-07	6.7E-07
RA-228	W	1.00	2.7E-06	2.7E-06
TH-228	Y	1.00	2.9E-05	2.9E-05
TH-230	Y	1.00	8.4E-05	8.4E-05
TH-232	Y	1.00	4.5E-06	4.5E-06
TH-234	Y	1.00	4.2E-03	4.2E-03
SR-90	D	1.00	5.6E-06	5.6E-06
TC-99	W	1.00	1.2E-04	1.2E-04
RU-106	Y	1.00	2.2E-05	2.2E-05
CS-137	D	1.00	1.6E-05	1.6E-05

SITE INFORMATION

Temperature: 10 degrees C
Precipitation: 100 cm/y
Mixing Height: 1000 m

SOURCE INFORMATION

Source Number:	1
Stack Height (m):	4.60
Diameter (m):	0.20
Plume Rise Momentum (m/s): (Exit Velocity)	2.18E+01

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.700	0.399	0.442
Fraction From Assessment Area:	0.300	0.601	0.558
Fraction Imported:	0.000	0.000	0.000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

978	1260	1994	1883	2470	2360	2475	1360	1649	2227
2286	1431	2418	1465	1715	1809	1768	2042	2071	1545

CAP88-PC

Version 1.00

Clean Air Act Assessment Package - 1988

DOSE AND RISK EQUIVALENT SUMMARIES

Non-Radon Individual Assessment
Oct 6, 1999 8:47 am

Facility: FERNALD ENVIRONMENT MANAGEMENT PROJECT
Address: P. O. BOX 538704
7400 WILLEY ROAD
City: CINCINNATI
State: OH Zip: 45253-8704

Source Category: POINT SOURCE
Source Type: Stack
Emission Year: 1999

Comments: OFFSITE EDE FOR SAMPLING LINE INSIDE BLDG 30A-
PART 2

Dataset Name: bldg30a2
Dataset Date: Oct 6, 1999 8:47 am
Wind File: WNDFILES\FEMPSTD.WND

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem/y)
GONADS	2.29E-04
BREAST	2.60E-04
R MAR	9.88E-03
LUNGS	5.52E-01
THYROID	2.94E-04
ENDOST	1.30E-01
RMNDR	5.68E-03
EFFEC	7.31E-02

PATHWAY EFFECTIVE DOSE EQUIVALENT SUMMARY

Pathway	Selected Individual (mrem/y)
INGESTION	4.06E-03
INHALATION	6.90E-02
AIR IMMERSION	5.78E-09
GROUND SURFACE	4.50E-05
INTERNAL	7.31E-02
EXTERNAL	4.50E-05
TOTAL	7.31E-02

NUCLIDE EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclide	Selected Individual (mrem/y)
U-234	3.16E-02
U-235	1.59E-03
U-236	1.16E-03
U-238	3.14E-02
RA-226	3.01E-06
RA-228	4.84E-06
TH-228	1.73E-03
TH-230	5.09E-03
TH-232	3.89E-04
TH-234	8.17E-05
SR-90	4.78E-06
TC-99	1.81E-05
RU-106	3.54E-06
CS-137	4.18E-06
TOTAL	7.31E-02

CANCER RISK SUMMARY

Cancer	Selected Individual Total Lifetime Fatal Cancer Risk
LEUKEMIA	9.73E-09
BONE	6.39E-09
THYROID	8.57E-11
BREAST	5.96E-10
LUNG	9.00E-07
STOMACH	8.90E-10
BOWEL	1.04E-09
LIVER	4.87E-10
PANCREAS	2.35E-10
URINARY	1.17E-08
OTHER	2.88E-10
TOTAL	9.31E-07

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk
INGESTION	2.23E-08
INHALATION	9.08E-07
AIR IMMERSION	1.29E-13
GROUND SURFACE	1.03E-09
INTERNAL	9.30E-07
EXTERNAL	1.03E-09
TOTAL	9.31E-07

NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk
U-234	4.06E-07
U-235	2.08E-08
U-236	1.49E-08
U-238	4.07E-07
RA-226	4.00E-11
RA-228	4.96E-11
TH-228	3.47E-08
TH-230	4.17E-08
TH-232	2.19E-09
TH-234	2.59E-09
SR-90	8.04E-11
TC-99	6.63E-10
RU-106	1.66E-10
CS-137	1.09E-10
TOTAL	9.31E-07

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	978	1260	1994	1883	2470	2360	2475
N	3.7E-02	2.5E-02	1.2E-02	1.3E-02	8.5E-03	9.1E-03	8.4E-03
NNW	1.6E-02	1.1E-02	5.2E-03	5.7E-03	3.8E-03	4.0E-03	3.7E-03
NW	1.3E-02	8.9E-03	4.5E-03	4.9E-03	3.3E-03	3.5E-03	3.3E-03
WNW	1.1E-02	7.7E-03	3.9E-03	4.2E-03	2.8E-03	3.0E-03	2.8E-03
W	1.6E-02	1.1E-02	5.6E-03	6.1E-03	4.1E-03	4.4E-03	4.1E-03
WSW	4.6E-02	3.1E-02	1.5E-02	1.6E-02	1.0E-02	1.1E-02	1.0E-02
SW	2.9E-02	2.0E-02	9.7E-03	1.1E-02	6.9E-03	7.4E-03	6.9E-03
SSW	4.1E-02	2.7E-02	1.3E-02	1.4E-02	9.0E-03	9.7E-03	8.9E-03
S	3.8E-02	2.5E-02	1.2E-02	1.3E-02	8.5E-03	9.2E-03	8.5E-03
SSE	3.6E-02	2.4E-02	1.1E-02	1.2E-02	8.0E-03	8.6E-03	8.0E-03
SE	3.1E-02	2.2E-02	1.1E-02	1.2E-02	7.7E-03	8.3E-03	7.7E-03
ESE	4.7E-02	3.1E-02	1.5E-02	1.6E-02	1.1E-02	1.1E-02	1.1E-02
E	3.2E-02	2.2E-02	1.1E-02	1.1E-02	7.5E-03	8.1E-03	7.5E-03
ENE	3.6E-02	2.4E-02	1.1E-02	1.3E-02	8.2E-03	8.8E-03	8.2E-03
NE	4.0E-02	2.6E-02	1.3E-02	1.4E-02	9.0E-03	9.7E-03	9.0E-03
NNE	7.3E-02	4.9E-02	2.4E-02	2.6E-02	1.7E-02	1.8E-02	1.7E-02

	Distance (m)						
Direction	1360	1649	2227	2286	1431	2418	1465
N	2.2E-02	1.6E-02	1.0E-02	9.6E-03	2.0E-02	8.8E-03	1.9E-02
NNW	9.4E-03	7.0E-03	4.4E-03	4.2E-03	8.7E-03	3.9E-03	8.4E-03
NW	7.9E-03	5.9E-03	3.8E-03	3.7E-03	7.4E-03	3.4E-03	7.1E-03
WNW	6.9E-03	5.1E-03	3.3E-03	3.2E-03	6.4E-03	2.9E-03	6.1E-03
W	1.0E-02	7.5E-03	4.8E-03	4.6E-03	9.3E-03	4.2E-03	8.9E-03
WSW	2.7E-02	2.0E-02	1.2E-02	1.2E-02	2.5E-02	1.1E-02	2.4E-02
SW	1.8E-02	1.3E-02	8.1E-03	7.8E-03	1.6E-02	7.2E-03	1.6E-02
SSW	2.4E-02	1.7E-02	1.1E-02	1.0E-02	2.2E-02	9.3E-03	2.1E-02
S	2.2E-02	1.6E-02	1.0E-02	9.6E-03	2.0E-02	8.8E-03	2.0E-02
SSE	2.1E-02	1.5E-02	9.5E-03	9.1E-03	1.9E-02	8.3E-03	1.9E-02
SE	1.9E-02	1.4E-02	9.1E-03	8.7E-03	1.8E-02	8.0E-03	1.7E-02
ESE	2.8E-02	2.0E-02	1.3E-02	1.2E-02	2.5E-02	1.1E-02	2.4E-02
E	1.9E-02	1.4E-02	8.8E-03	8.5E-03	1.8E-02	7.8E-03	1.7E-02
ENE	2.1E-02	1.6E-02	9.6E-03	9.2E-03	2.0E-02	8.5E-03	1.9E-02
NE	2.3E-02	1.7E-02	1.1E-02	1.0E-02	2.2E-02	9.3E-03	2.1E-02
NNE	4.4E-02	3.2E-02	2.0E-02	1.9E-02	4.0E-02	1.8E-02	3.9E-02

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)					
Direction	1715	1809	1768	2042	2071	1545
N	1.5E-02	1.4E-02	1.4E-02	1.1E-02	1.1E-02	1.8E-02
NNW	6.5E-03	6.0E-03	6.2E-03	5.0E-03	4.9E-03	7.7E-03
NW	5.6E-03	5.2E-03	5.4E-03	4.3E-03	4.2E-03	6.6E-03
WNW	4.8E-03	4.5E-03	4.6E-03	3.7E-03	3.7E-03	5.7E-03
W	7.1E-03	6.5E-03	6.7E-03	5.4E-03	5.3E-03	8.3E-03
WSW	1.9E-02	1.7E-02	1.8E-02	1.4E-02	1.4E-02	2.2E-02
SW	1.2E-02	1.1E-02	1.2E-02	9.3E-03	9.1E-03	1.4E-02
SSW	1.6E-02	1.5E-02	1.5E-02	1.2E-02	1.2E-02	1.9E-02
S	1.5E-02	1.4E-02	1.5E-02	1.2E-02	1.1E-02	1.8E-02
SSE	1.4E-02	1.3E-02	1.4E-02	1.1E-02	1.1E-02	1.7E-02
SE	1.4E-02	1.2E-02	1.3E-02	1.0E-02	1.0E-02	1.6E-02
ESE	1.9E-02	1.7E-02	1.8E-02	1.4E-02	1.4E-02	2.2E-02
E	1.3E-02	1.2E-02	1.3E-02	1.0E-02	9.9E-03	1.6E-02
ENE	1.5E-02	1.3E-02	1.4E-02	1.1E-02	1.1E-02	1.7E-02
NE	1.6E-02	1.5E-02	1.5E-02	1.2E-02	1.2E-02	1.9E-02
NNE	3.0E-02	2.8E-02	2.9E-02	2.3E-02	2.2E-02	3.6E-02

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

Direction	Distance (m) 978	1260	1994	1883	2470	2360	2475
N	4.7E-07	3.1E-07	1.5E-07	1.6E-07	1.0E-07	1.1E-07	1.0E-07
NNW	2.0E-07	1.3E-07	6.3E-08	6.9E-08	4.5E-08	4.8E-08	4.5E-08
NW	1.6E-07	1.1E-07	5.5E-08	6.0E-08	3.9E-08	4.2E-08	3.9E-08
WNW	1.4E-07	9.6E-08	4.7E-08	5.1E-08	3.3E-08	3.6E-08	3.3E-08
W	2.1E-07	1.4E-07	6.9E-08	7.5E-08	4.9E-08	5.3E-08	4.9E-08
WSW	5.8E-07	3.9E-07	1.8E-07	2.0E-07	1.3E-07	1.4E-07	1.3E-07
SW	3.7E-07	2.5E-07	1.2E-07	1.3E-07	8.5E-08	9.2E-08	8.5E-08
SSW	5.2E-07	3.4E-07	1.6E-07	1.7E-07	1.1E-07	1.2E-07	1.1E-07
S	4.8E-07	3.2E-07	1.5E-07	1.6E-07	1.1E-07	1.1E-07	1.1E-07
SSE	4.6E-07	3.0E-07	1.4E-07	1.6E-07	9.9E-08	1.1E-07	9.9E-08
SE	4.0E-07	2.7E-07	1.3E-07	1.5E-07	9.6E-08	1.0E-07	9.6E-08
ESE	5.9E-07	3.9E-07	1.9E-07	2.1E-07	1.3E-07	1.4E-07	1.3E-07
E	4.1E-07	2.7E-07	1.3E-07	1.4E-07	9.3E-08	1.0E-07	9.2E-08
ENE	4.6E-07	3.0E-07	1.4E-07	1.6E-07	1.0E-07	1.1E-07	1.0E-07
NE	5.1E-07	3.3E-07	1.6E-07	1.7E-07	1.1E-07	1.2E-07	1.1E-07
NNE	9.3E-07	6.2E-07	3.0E-07	3.3E-07	2.1E-07	2.3E-07	2.1E-07

Direction	Distance (m) 1360	1649	2227	2286	1431	2418	1465
N	2.8E-07	2.0E-07	1.2E-07	1.2E-07	2.5E-07	1.1E-07	2.5E-07
NNW	1.2E-07	8.6E-08	5.3E-08	5.1E-08	1.1E-07	4.7E-08	1.0E-07
NW	9.9E-08	7.3E-08	4.6E-08	4.4E-08	9.1E-08	4.0E-08	8.8E-08
WNW	8.5E-08	6.3E-08	3.9E-08	3.8E-08	7.8E-08	3.5E-08	7.6E-08
W	1.3E-07	9.3E-08	5.8E-08	5.6E-08	1.2E-07	5.1E-08	1.1E-07
WSW	3.4E-07	2.5E-07	1.5E-07	1.5E-07	3.2E-07	1.3E-07	3.0E-07
SW	2.2E-07	1.6E-07	1.0E-07	9.7E-08	2.0E-07	8.8E-08	2.0E-07
SSW	3.0E-07	2.2E-07	1.3E-07	1.3E-07	2.7E-07	1.2E-07	2.6E-07
S	2.8E-07	2.0E-07	1.3E-07	1.2E-07	2.6E-07	1.1E-07	2.5E-07
SSE	2.7E-07	1.9E-07	1.2E-07	1.1E-07	2.4E-07	1.0E-07	2.4E-07
SE	2.4E-07	1.8E-07	1.1E-07	1.1E-07	2.2E-07	9.9E-08	2.2E-07
ESE	3.5E-07	2.6E-07	1.6E-07	1.5E-07	3.2E-07	1.4E-07	3.1E-07
E	2.4E-07	1.8E-07	1.1E-07	1.1E-07	2.2E-07	9.6E-08	2.1E-07
ENE	2.7E-07	2.0E-07	1.2E-07	1.1E-07	2.5E-07	1.0E-07	2.4E-07
NE	3.0E-07	2.2E-07	1.3E-07	1.3E-07	2.7E-07	1.2E-07	2.6E-07
NNE	5.5E-07	4.1E-07	2.5E-07	2.4E-07	5.1E-07	2.2E-07	4.9E-07

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)					
Direction	1715	1809	1768	2042	2071	1545
N	1.9E-07	1.7E-07	1.8E-07	1.4E-07	1.4E-07	2.2E-07
NNW	8.1E-08	7.4E-08	7.7E-08	6.1E-08	6.0E-08	9.6E-08
NW	6.9E-08	6.3E-08	6.6E-08	5.3E-08	5.1E-08	8.1E-08
WNW	5.9E-08	5.4E-08	5.6E-08	4.5E-08	4.4E-08	7.0E-08
W	8.7E-08	8.0E-08	8.3E-08	6.6E-08	6.5E-08	1.0E-07
WSW	2.3E-07	2.2E-07	2.2E-07	1.8E-07	1.7E-07	2.8E-07
SW	1.5E-07	1.4E-07	1.5E-07	1.2E-07	1.1E-07	1.8E-07
SSW	2.0E-07	1.9E-07	1.9E-07	1.5E-07	1.5E-07	2.4E-07
S	1.9E-07	1.8E-07	1.8E-07	1.4E-07	1.4E-07	2.3E-07
SSE	1.8E-07	1.7E-07	1.7E-07	1.4E-07	1.3E-07	2.2E-07
SE	1.7E-07	1.6E-07	1.6E-07	1.3E-07	1.3E-07	2.0E-07
ESE	2.4E-07	2.2E-07	2.3E-07	1.8E-07	1.8E-07	2.8E-07
E	1.7E-07	1.5E-07	1.6E-07	1.3E-07	1.2E-07	2.0E-07
ENE	1.8E-07	1.7E-07	1.7E-07	1.4E-07	1.3E-07	2.2E-07
NE	2.0E-07	1.9E-07	1.9E-07	1.5E-07	1.5E-07	2.4E-07
NNE	3.8E-07	3.5E-07	3.6E-07	2.9E-07	2.8E-07	4.5E-07

ATTACHMENT D.1-2

WPRAP LAUNDRY DRYER EXHAUST

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment
Jul 18, 2000 12:14 am

Facility: FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
Address: P. O. BOX 538704
7400 WILLEY ROAD
City: CINCINNATI
State: OH Zip: 45253-8704

Effective Dose Equivalent
(mrem/year)

1.73E-06

At This Location: 749 Meters North Northeast

Source Category: STACK
Source Type: Stack
Emission Year: 2000

Comments: OFFSITE EDE FOR RADIONUCLIDE EMISSIONS FROM IT LAUNDRY FACILITY REVISION A- PART 1

Dataset Name: ITLAUND1REV1
Dataset Date: Jul 18, 2000 12:14 am
Wind File: WNDFILES\FEMPSTD.WND

MAXIMALLY EXPOSED INDIVIDUAL
(RN-222 Working Level Calculations Excluded)

Location Of The Individual: 749 Meters North Northeast
Lifetime Fatal Cancer Risk: 2.02E-11

ORGAN DOSE EQUIVALENT SUMMARY
(RN-222 Working Level Calculations Excluded)

Organ	Dose Equivalent (mrem/y)
GONADS	8.79E-09
BREAST	8.15E-09
R MAR	6.11E-07
LUNGS	1.16E-05
THYROID	8.71E-09
ENDOST	7.67E-06
RMNDR	1.03E-07
EFFEC	1.73E-06

RADIONUCLIDE EMISSIONS DURING THE YEAR 2000

Nuclide	Class	Size	Source #1 Ci/y	TOTAL Ci/y
CS-137	D	1.00	1.1E-10	1.1E-10
BA-137M	D	1.00	1.1E-10	1.1E-10
NP-237	W	1.00	2.6E-11	2.6E-11
PU-238	Y	1.00	8.7E-13	8.7E-13
PU-239	Y	1.00	9.0E-12	9.0E-12
PU-240	Y	1.00	9.0E-12	9.0E-12
RA-226	W	1.00	4.9E-10	4.9E-10
RA-228	W	1.00	2.0E-10	2.0E-10
RU-106	Y	1.00	1.6E-12	1.6E-12
SR-90	D	1.00	2.9E-11	2.9E-11
TC-99	W	1.00	1.6E-09	1.6E-09
TH-228	Y	1.00	5.9E-10	5.9E-10
TH-230	Y	1.00	5.3E-09	5.3E-09
TH-232	Y	1.00	1.5E-10	1.5E-10
U-234	Y	1.00	3.4E-09	3.4E-09
U-235	Y	1.00	1.5E-09	1.5E-09
U-236	Y	1.00	1.5E-09	1.5E-09
U-238	Y	1.00	1.7E-08	1.7E-08
K-40	D	1.00	1.2E-11	1.2E-11
RN-222	*	0.00	3.7E-08	3.7E-08

SITE INFORMATION

Temperature: 10 degrees C
Precipitation: 100 cm/y
Mixing Height: 1000 m

SOURCE INFORMATION

Source Number:	1
Stack Height (m):	5.11
Diameter (m):	0.30
Plume Rise Momentum (m/s): (Exit Velocity)	6.79E+00

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.700	0.399	0.442
Fraction From Assessment Area:	0.300	0.601	0.558
Fraction Imported:	0.000	0.000	0.000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

1011	904	1390	1013	749	871	1218	1362	1406	1604
1619	1717	1715	1729	2381	1934	1700	1682	1919	1699

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

D O S E A N D R I S K E Q U I V A L E N T S U M M A R I E S

Non-Radon Individual Assessment
Jul 18, 2000 12:14 am

Facility: FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
Address: P. O. BOX 538704
7400 WILLEY ROAD
City: CINCINNATI
State: OH Zip: 45253-8704

Source Category: STACK
Source Type: Stack
Emission Year: 2000

Comments: OFFSITE EDE FOR RADIONUCLIDE EMISSIONS FROM IT LAUNDRY FACILITY REVISION A- PART 1

Dataset Name: ITLAUND1REV1
Dataset Date: Jul 18, 2000 12:14 am
Wind File: WNDFILES\FEMPSTD.WND

ORGAN DOSE EQUIVALENT SUMMARY
(RN-222 Working Level Calculations Excluded)

Organ	Selected Individual (mrem/y)
GONADS	8.79E-09
BREAST	8.15E-09
R MAR	6.11E-07
LUNGS	1.16E-05
THYROID	8.71E-09
ENDOST	7.67E-06
RMNDR	1.03E-07
EFFEC	1.73E-06

Radon Decay Product Concentration (working level)

0.00E+00

PATHWAY EFFECTIVE DOSE EQUIVALENT SUMMARY
(RN-222 Working Level Calculations Excluded)

Pathway	Selected Individual (mrem/y)
INGESTION	7.57E-08
INHALATION	1.65E-06
AIR IMMERSION	6.35E-14
GROUND SURFACE	2.07E-09
INTERNAL	1.72E-06
EXTERNAL	2.07E-09
TOTAL	1.73E-06

Radon Decay Product Concentration (working level)

0.00E+00

NUCLIDE EFFECTIVE DOSE EQUIVALENT SUMMARY
(RN-222 Working Level Calculations Excluded)

Nuclide	Selected Individual (mrem/y)
CS-137	4.44E-11
BA-137M	2.40E-10
NP-237	5.14E-09
PU-238	1.11E-10
PU-239	1.24E-09
PU-240	1.24E-09
RA-226	3.37E-09
RA-228	5.42E-10
RU-106	4.03E-13
SR-90	3.83E-11
TC-99	3.64E-10
TH-228	5.64E-08
TH-230	5.05E-07
TH-232	2.06E-08
U-234	1.76E-07
U-235	7.18E-08
U-236	7.16E-08
U-238	8.13E-07
K-40	2.08E-11
RN-222	0.00E+00
TOTAL	1.73E-06

Radon Decay Product Concentration (working level)

0.00E+00

CANCER RISK SUMMARY

Cancer	Selected Individual Total Lifetime Fatal Cancer Risk
LEUKEMIA	5.48E-13
BONE	3.53E-13
THYROID	2.54E-15
BREAST	1.94E-14
LUNG	1.90E-11
STOMACH	2.14E-14
BOWEL	1.29E-14
LIVER	4.10E-14
PANCREAS	7.72E-15
URINARY	1.98E-13
OTHER	9.45E-15
TOTAL	2.02E-11

	Selected Individual Cancer Risk
Radon Decay Product Lung Exposure	0.00E+00
Total Fatal Risk All Exposures	2.02E-11

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk
INGESTION	4.05E-13
INHALATION	1.97E-11
AIR IMMERSION	1.49E-18
GROUND SURFACE	4.81E-14
INTERNAL	2.01E-11
EXTERNAL	4.81E-14
TOTAL	2.02E-11

	Selected Individual Cancer Risk
Radon Decay Product Lung Exposure	0.00E+00
Total Fatal Risk All Exposures	2.02E-11

NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk
CS-137	1.16E-15
BA-137M	5.75E-15
NP-237	2.60E-14
PU-238	9.47E-16
PU-239	9.73E-15
PU-240	9.73E-15
RA-226	4.52E-14
RA-228	5.59E-15
RU-106	1.90E-17
SR-90	6.45E-16
TC-99	1.34E-14
TH-228	1.13E-12
TH-230	4.14E-12
TH-232	1.16E-13
U-234	2.26E-12
U-235	9.43E-13
U-236	9.21E-13
U-238	1.05E-11
K-40	5.22E-16
RN-222	0.00E+00
TOTAL	2.02E-11

	Selected Individual Cancer Risk
Radon Decay Product Lung Exposure	0.00E+00
Total Fatal Risk All Exposures	2.02E-11

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	1011	904	1390	1013	749	871	1218
N	5.3E-07	6.5E-07	3.2E-07	5.3E-07	9.0E-07	6.9E-07	4.0E-07
NNW	2.3E-07	2.8E-07	1.4E-07	2.3E-07	3.8E-07	3.0E-07	1.7E-07
NW	1.9E-07	2.3E-07	1.2E-07	1.9E-07	3.1E-07	2.4E-07	1.4E-07
WNW	1.7E-07	2.0E-07	1.0E-07	1.7E-07	2.7E-07	2.1E-07	1.2E-07
W	2.4E-07	2.9E-07	1.5E-07	2.4E-07	3.9E-07	3.0E-07	1.8E-07
WSW	6.6E-07	8.0E-07	4.0E-07	6.6E-07	1.1E-06	8.5E-07	4.9E-07
SW	4.3E-07	5.1E-07	2.6E-07	4.2E-07	7.0E-07	5.5E-07	3.2E-07
SSW	5.8E-07	7.1E-07	3.5E-07	5.8E-07	1.0E-06	7.6E-07	4.3E-07
S	5.4E-07	6.5E-07	3.2E-07	5.4E-07	9.1E-07	7.0E-07	4.0E-07
SSE	5.2E-07	6.3E-07	3.1E-07	5.2E-07	8.8E-07	6.8E-07	3.8E-07
SE	4.6E-07	5.5E-07	2.8E-07	4.6E-07	7.3E-07	5.8E-07	3.5E-07
ESE	6.7E-07	8.1E-07	4.0E-07	6.7E-07	1.1E-06	8.6E-07	5.0E-07
E	4.6E-07	5.6E-07	2.8E-07	4.6E-07	7.6E-07	5.9E-07	3.5E-07
ENE	5.2E-07	6.3E-07	3.1E-07	5.2E-07	8.7E-07	6.7E-07	3.8E-07
NE	5.7E-07	7.0E-07	3.4E-07	5.7E-07	9.7E-07	7.4E-07	4.2E-07
NNE	1.0E-06	1.3E-06	6.4E-07	1.0E-06	1.7E-06	1.3E-06	7.8E-07

	Distance (m)						
Direction	1362	1406	1604	1619	1717	1715	1729
N	3.3E-07	3.1E-07	2.6E-07	2.5E-07	2.3E-07	2.3E-07	2.3E-07
NNW	1.4E-07	1.4E-07	1.1E-07	1.1E-07	1.0E-07	1.0E-07	9.9E-08
NW	1.2E-07	1.2E-07	9.5E-08	9.4E-08	8.6E-08	8.6E-08	8.5E-08
WNW	1.1E-07	1.0E-07	8.2E-08	8.1E-08	7.4E-08	7.5E-08	7.4E-08
W	1.5E-07	1.5E-07	1.2E-07	1.2E-07	1.1E-07	1.1E-07	1.1E-07
WSW	4.1E-07	3.9E-07	3.1E-07	3.1E-07	2.8E-07	2.8E-07	2.8E-07
SW	2.7E-07	2.5E-07	2.1E-07	2.0E-07	1.9E-07	1.9E-07	1.8E-07
SSW	3.6E-07	3.4E-07	2.7E-07	2.7E-07	2.4E-07	2.5E-07	2.4E-07
S	3.3E-07	3.2E-07	2.6E-07	2.5E-07	2.3E-07	2.3E-07	2.3E-07
SSE	3.2E-07	3.0E-07	2.4E-07	2.4E-07	2.2E-07	2.2E-07	2.2E-07
SE	2.9E-07	2.8E-07	2.3E-07	2.3E-07	2.1E-07	2.1E-07	2.0E-07
ESE	4.2E-07	4.0E-07	3.2E-07	3.2E-07	2.9E-07	2.9E-07	2.9E-07
E	2.9E-07	2.8E-07	2.3E-07	2.2E-07	2.0E-07	2.0E-07	2.0E-07
ENE	3.2E-07	3.0E-07	2.5E-07	2.4E-07	2.2E-07	2.2E-07	2.2E-07
NE	3.5E-07	3.4E-07	2.7E-07	2.7E-07	2.4E-07	2.4E-07	2.4E-07
NNE	6.6E-07	6.2E-07	5.1E-07	5.0E-07	4.6E-07	4.6E-07	4.5E-07

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)					
Direction	2381	1934	1700	1682	1919	1699
N	1.4E-07	1.9E-07	2.3E-07	2.4E-07	1.9E-07	2.3E-07
NNW	6.1E-08	8.3E-08	1.0E-07	1.0E-07	8.4E-08	1.0E-07
NW	5.3E-08	7.2E-08	8.7E-08	8.9E-08	7.3E-08	8.7E-08
WNW	4.6E-08	6.2E-08	7.6E-08	7.7E-08	6.3E-08	7.6E-08
W	6.6E-08	9.0E-08	1.1E-07	1.1E-07	9.1E-08	1.1E-07
WSW	1.7E-07	2.3E-07	2.9E-07	2.9E-07	2.4E-07	2.9E-07
SW	1.1E-07	1.5E-07	1.9E-07	1.9E-07	1.6E-07	1.9E-07
SSW	1.4E-07	2.0E-07	2.5E-07	2.5E-07	2.0E-07	2.5E-07
S	1.4E-07	1.9E-07	2.3E-07	2.4E-07	1.9E-07	2.3E-07
SSE	1.3E-07	1.8E-07	2.2E-07	2.3E-07	1.8E-07	2.2E-07
SE	1.3E-07	1.7E-07	2.1E-07	2.1E-07	1.7E-07	2.1E-07
ESE	1.7E-07	2.4E-07	2.9E-07	3.0E-07	2.4E-07	2.9E-07
E	1.2E-07	1.7E-07	2.1E-07	2.1E-07	1.7E-07	2.1E-07
ENE	1.3E-07	1.8E-07	2.2E-07	2.3E-07	1.9E-07	2.3E-07
NE	1.4E-07	2.0E-07	2.5E-07	2.5E-07	2.0E-07	2.5E-07
NNE	2.7E-07	3.8E-07	4.6E-07	4.7E-07	3.8E-07	4.6E-07

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	1011	904	1390	1013	749	871	1218
N	6.2E-12	7.5E-12	3.7E-12	6.2E-12	1.0E-11	8.0E-12	4.6E-12
NNW	2.6E-12	3.2E-12	1.6E-12	2.6E-12	4.5E-12	3.4E-12	1.9E-12
NW	2.2E-12	2.6E-12	1.3E-12	2.2E-12	3.6E-12	2.8E-12	1.6E-12
WNW	1.9E-12	2.3E-12	1.2E-12	1.9E-12	3.2E-12	2.4E-12	1.4E-12
W	2.8E-12	3.3E-12	1.7E-12	2.8E-12	4.5E-12	3.5E-12	2.1E-12
WSW	7.7E-12	9.3E-12	4.6E-12	7.7E-12	1.3E-11	9.9E-12	5.7E-12
SW	4.9E-12	6.0E-12	3.0E-12	4.9E-12	8.2E-12	6.4E-12	3.7E-12
SSW	6.8E-12	8.3E-12	4.0E-12	6.7E-12	1.2E-11	8.8E-12	5.0E-12
S	6.3E-12	7.6E-12	3.7E-12	6.2E-12	1.1E-11	8.1E-12	4.6E-12
SSE	6.1E-12	7.4E-12	3.6E-12	6.0E-12	1.0E-11	7.9E-12	4.4E-12
SE	5.3E-12	6.3E-12	3.3E-12	5.3E-12	8.5E-12	6.7E-12	4.0E-12
ESE	7.8E-12	9.4E-12	4.7E-12	7.8E-12	1.3E-11	1.0E-11	5.8E-12
E	5.4E-12	6.5E-12	3.3E-12	5.4E-12	8.9E-12	6.9E-12	4.0E-12
ENE	6.0E-12	7.3E-12	3.6E-12	6.0E-12	1.0E-11	7.8E-12	4.4E-12
NE	6.7E-12	8.1E-12	4.0E-12	6.6E-12	1.1E-11	8.6E-12	4.9E-12
NNE	1.2E-11	1.5E-11	7.4E-12	1.2E-11	2.0E-11	1.6E-11	9.1E-12

	Distance (m)						
Direction	1362	1406	1604	1619	1717	1715	1729
N	3.8E-12	3.6E-12	2.9E-12	2.9E-12	2.6E-12	2.6E-12	2.6E-12
NNW	1.6E-12	1.5E-12	1.3E-12	1.2E-12	1.1E-12	1.1E-12	1.1E-12
NW	1.4E-12	1.3E-12	1.1E-12	1.1E-12	9.6E-13	9.7E-13	9.5E-13
WNW	1.2E-12	1.1E-12	9.2E-13	9.1E-13	8.3E-13	8.3E-13	8.2E-13
W	1.7E-12	1.7E-12	1.4E-12	1.3E-12	1.2E-12	1.2E-12	1.2E-12
WSW	4.7E-12	4.5E-12	3.6E-12	3.6E-12	3.3E-12	3.3E-12	3.2E-12
SW	3.1E-12	2.9E-12	2.4E-12	2.3E-12	2.1E-12	2.1E-12	2.1E-12
SSW	4.1E-12	3.9E-12	3.1E-12	3.1E-12	2.8E-12	2.8E-12	2.8E-12
S	3.9E-12	3.7E-12	3.0E-12	2.9E-12	2.7E-12	2.7E-12	2.6E-12
SSE	3.7E-12	3.5E-12	2.8E-12	2.8E-12	2.5E-12	2.5E-12	2.5E-12
SE	3.4E-12	3.2E-12	2.6E-12	2.6E-12	2.4E-12	2.4E-12	2.3E-12
ESE	4.8E-12	4.6E-12	3.7E-12	3.7E-12	3.3E-12	3.3E-12	3.3E-12
E	3.4E-12	3.2E-12	2.6E-12	2.5E-12	2.3E-12	2.3E-12	2.3E-12
ENE	3.7E-12	3.5E-12	2.8E-12	2.8E-12	2.5E-12	2.5E-12	2.5E-12
NE	4.1E-12	3.9E-12	3.1E-12	3.1E-12	2.8E-12	2.8E-12	2.8E-12
NNE	7.6E-12	7.3E-12	5.9E-12	5.8E-12	5.3E-12	5.3E-12	5.2E-12

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)					
Direction	2381	1934	1700	1682	1919	1699
N	1.5E-12	2.2E-12	2.7E-12	2.7E-12	2.2E-12	2.7E-12
NNW	6.7E-13	9.3E-13	1.1E-12	1.2E-12	9.4E-13	1.1E-12
NW	5.8E-13	8.0E-13	9.8E-13	1.0E-12	8.1E-13	9.8E-13
WNW	5.0E-13	6.9E-13	8.4E-13	8.6E-13	7.0E-13	8.4E-13
W	7.3E-13	1.0E-12	1.2E-12	1.3E-12	1.0E-12	1.2E-12
WSW	1.9E-12	2.7E-12	3.3E-12	3.4E-12	2.7E-12	3.3E-12
SW	1.3E-12	1.8E-12	2.2E-12	2.2E-12	1.8E-12	2.2E-12
SSW	1.6E-12	2.3E-12	2.9E-12	2.9E-12	2.3E-12	2.9E-12
S	1.6E-12	2.2E-12	2.7E-12	2.7E-12	2.2E-12	2.7E-12
SSE	1.5E-12	2.1E-12	2.6E-12	2.6E-12	2.1E-12	2.6E-12
SE	1.4E-12	2.0E-12	2.4E-12	2.4E-12	2.0E-12	2.4E-12
ESE	2.0E-12	2.7E-12	3.4E-12	3.4E-12	2.8E-12	3.4E-12
E	1.4E-12	1.9E-12	2.4E-12	2.4E-12	1.9E-12	2.4E-12
ENE	1.5E-12	2.1E-12	2.6E-12	2.6E-12	2.1E-12	2.6E-12
NE	1.6E-12	2.3E-12	2.8E-12	2.9E-12	2.3E-12	2.9E-12
NNE	3.1E-12	4.4E-12	5.4E-12	5.5E-12	4.4E-12	5.4E-12

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment
Jul 18, 2000 12:17 am

Facility: FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
Address: P. O. BOX 538704
7400 WILLEY ROAD
City: CINCINNATI
State: OH Zip: 45253-8704

Effective Dose Equivalent
(mrem/year)

9.90E-07

At This Location: 1046 Meters North Northeast

Source Category: STACK
Source Type: Stack
Emission Year: 2000

Comments: OFFSITE EDE FOR RADIONUCLIDE EMISSIONS FROM IT LAUNDRY FACILITY REVISION A- PART 2

Dataset Name: ITLAUND2REV1
Dataset Date: Jul 18, 2000 12:17 am
Wind File: WNDFILES\FEMPSTD.WND

MAXIMALLY EXPOSED INDIVIDUAL
(RN-222 Working Level Calculations Excluded)

Location Of The Individual: 1046 Meters North Northeast
Lifetime Fatal Cancer Risk: 1.16E-11

ORGAN DOSE EQUIVALENT SUMMARY
(RN-222 Working Level Calculations Excluded)

Organ	Dose Equivalent (mrem/y)
GONADS	5.20E-09
BREAST	4.85E-09
R MAR	3.53E-07
LUNGS	6.61E-06
THYROID	5.22E-09
ENDOST	4.43E-06
RMNDR	6.22E-08
EFFEC	9.90E-07

RADIONUCLIDE EMISSIONS DURING THE YEAR 2000

Nuclide	Class	Size	Source #1 Ci/y	TOTAL Ci/y
CS-137	D	1.00	1.1E-10	1.1E-10
BA-137M	D	1.00	1.1E-10	1.1E-10
NP-237	W	1.00	2.6E-11	2.6E-11
PU-238	Y	1.00	8.7E-13	8.7E-13
PU-239	Y	1.00	9.0E-12	9.0E-12
PU-240	Y	1.00	9.0E-12	9.0E-12
RA-226	W	1.00	4.9E-10	4.9E-10
RA-228	W	1.00	2.0E-10	2.0E-10
RU-106	Y	1.00	1.6E-12	1.6E-12
SR-90	D	1.00	2.9E-11	2.9E-11
TC-99	W	1.00	1.6E-09	1.6E-09
TH-228	Y	1.00	5.9E-10	5.9E-10
TH-230	Y	1.00	5.3E-09	5.3E-09
TH-232	Y	1.00	1.5E-10	1.5E-10
U-234	Y	1.00	3.4E-09	3.4E-09
U-235	Y	1.00	1.5E-09	1.5E-09
U-236	Y	1.00	1.5E-09	1.5E-09
U-238	Y	1.00	1.7E-08	1.7E-08
K-40	D	1.00	1.2E-11	1.2E-11
RN-222	*	0.00	3.7E-08	3.7E-08

SITE INFORMATION

Temperature: 10 degrees C
Precipitation: 100 cm/y
Mixing Height: 1000 m

SOURCE INFORMATION

Source Number:	1
Stack Height (m):	5.11
Diameter (m):	0.30
Plume Rise Momentum (m/s): (Exit Velocity)	6.79E+00

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.700	0.399	0.442
Fraction From Assessment Area:	0.300	0.601	0.558
Fraction Imported:	0.000	0.000	0.000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

1142	1147	1548	2333	2894	1959	2851	1212	2021	2663
2719	1268	2016	1046	1372	1462	1413	1792	1816	1776

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

D O S E A N D R I S K E Q U I V A L E N T S U M M A R I E S

Non-Radon Individual Assessment
Jul 18, 2000 12:17 am

Facility: FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
Address: P. O. BOX 538704
7400 WILLEY ROAD
City: CINCINNATI
State: OH Zip: 45253-8704

Source Category: STACK
Source Type: Stack
Emission Year: 2000

Comments: OFFSITE EDE FOR RADIONUCLIDE EMISSIONS FROM IT LAUNDRY FACILITY REVISION A- PART 2

Dataset Name: ITLAUND2REV1
Dataset Date: Jul 18, 2000 12:17 am
Wind File: WNDFILES\FEMPSTD.WND

ORGAN DOSE EQUIVALENT SUMMARY
(RN-222 Working Level Calculations Excluded)

Organ	Selected Individual (mrem/y)
GONADS	5.20E-09
BREAST	4.85E-09
R MAR	3.53E-07
LUNGS	6.61E-06
THYROID	5.22E-09
ENDOST	4.43E-06
RMNDR	6.22E-08
EFFEC	9.90E-07

Radon Decay Product Concentration (working level)

0.00E+00

PATHWAY EFFECTIVE DOSE EQUIVALENT SUMMARY
(RN-222 Working Level Calculations Excluded)

Pathway	Selected Individual (mrem/y)
INGESTION	4.61E-08
INHALATION	9.43E-07
AIR IMMERSION	3.54E-14
GROUND SURFACE	1.23E-09
INTERNAL	9.89E-07
EXTERNAL	1.23E-09
TOTAL	9.90E-07

Radon Decay Product Concentration (working level)

0.00E+00

NUCLIDE EFFECTIVE DOSE EQUIVALENT SUMMARY
(RN-222 Working Level Calculations Excluded)

Nuclide	Selected Individual (mrem/y)
CS-137	2.74E-11
BA-137M	1.43E-10
NP-237	2.95E-09
PU-238	6.38E-11
PU-239	7.12E-10
PU-240	7.12E-10
RA-226	1.99E-09
RA-228	3.23E-10
RU-106	2.35E-13
SR-90	2.33E-11
TC-99	2.26E-10
TH-228	3.23E-08
TH-230	2.89E-07
TH-232	1.18E-08
U-234	1.01E-07
U-235	4.13E-08
U-236	4.11E-08
U-238	4.67E-07
K-40	1.26E-11
RN-222	0.00E+00
TOTAL	9.90E-07

Radon Decay Product Concentration (working level)

0.00E+00

CANCER RISK SUMMARY

Cancer	Selected Individual Total Lifetime Fatal Cancer Risk
LEUKEMIA	3.17E-13
BONE	2.04E-13
THYROID	1.53E-15
BREAST	1.15E-14
LUNG	1.08E-11
STOMACH	1.30E-14
BOWEL	7.73E-15
LIVER	2.38E-14
PANCREAS	4.61E-15
URINARY	1.20E-13
OTHER	5.63E-15
TOTAL	1.16E-11

	Selected Individual Cancer Risk
Radon Decay Product Lung Exposure	0.00E+00
Total Fatal Risk All Exposures	1.16E-11

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk
INGESTION	2.46E-13
INHALATION	1.13E-11
AIR IMMERSION	8.27E-19
GROUND SURFACE	2.86E-14
INTERNAL	1.15E-11
EXTERNAL	2.86E-14
TOTAL	1.16E-11

	Selected Individual Cancer Risk
Radon Decay Product Lung Exposure	0.00E+00
Total Fatal Risk All Exposures	1.16E-11

NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk
CS-137	7.17E-16
BA-137M	3.42E-15
NP-237	1.49E-14
PU-238	5.43E-16
PU-239	5.58E-15
PU-240	5.58E-15
RA-226	2.62E-14
RA-228	3.29E-15
RU-106	1.09E-17
SR-90	3.93E-16
TC-99	8.27E-15
TH-228	6.47E-13
TH-230	2.37E-12
TH-232	6.63E-14
U-234	1.30E-12
U-235	5.41E-13
U-236	5.28E-13
U-238	6.04E-12
K-40	3.16E-16
RN-222	0.00E+00
TOTAL	1.16E-11

	Selected Individual Cancer Risk
Radon Decay Product Lung Exposure	0.00E+00
Total Fatal Risk All Exposures	1.16E-11

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

Direction	Distance (m) 1142	1147	1548	2333	2894	1959	2851
N	4.4E-07	4.3E-07	2.7E-07	1.4E-07	9.9E-08	1.8E-07	1.0E-07
NNW	1.9E-07	1.9E-07	1.2E-07	6.1E-08	4.4E-08	8.0E-08	4.5E-08
NW	1.6E-07	1.6E-07	9.9E-08	5.3E-08	3.9E-08	6.9E-08	4.0E-08
WNW	1.4E-07	1.4E-07	8.5E-08	4.6E-08	3.4E-08	6.0E-08	3.4E-08
W	2.0E-07	2.0E-07	1.2E-07	6.7E-08	4.8E-08	8.7E-08	4.9E-08
WSW	5.4E-07	5.4E-07	3.3E-07	1.7E-07	1.2E-07	2.3E-07	1.2E-07
SW	3.5E-07	3.5E-07	2.2E-07	1.1E-07	8.1E-08	1.5E-07	8.3E-08
SSW	4.8E-07	4.7E-07	2.9E-07	1.5E-07	1.0E-07	2.0E-07	1.1E-07
S	4.4E-07	4.4E-07	2.7E-07	1.4E-07	1.0E-07	1.9E-07	1.0E-07
SSE	4.3E-07	4.2E-07	2.6E-07	1.3E-07	9.3E-08	1.7E-07	9.5E-08
SE	3.8E-07	3.8E-07	2.4E-07	1.3E-07	9.1E-08	1.7E-07	9.3E-08
ESE	5.5E-07	5.5E-07	3.4E-07	1.8E-07	1.2E-07	2.3E-07	1.3E-07
E	3.8E-07	3.8E-07	2.4E-07	1.2E-07	8.8E-08	1.6E-07	9.0E-08
ENE	4.2E-07	4.2E-07	2.6E-07	1.3E-07	9.5E-08	1.8E-07	9.8E-08
NE	4.7E-07	4.7E-07	2.9E-07	1.5E-07	1.0E-07	2.0E-07	1.1E-07
NNE	8.6E-07	8.6E-07	5.3E-07	2.8E-07	2.0E-07	3.7E-07	2.0E-07

Direction	Distance (m) 1212	2021	2663	2719	1268	2016	1046
N	4.0E-07	1.7E-07	1.1E-07	1.1E-07	3.7E-07	1.8E-07	5.0E-07
NNW	1.7E-07	7.6E-08	5.0E-08	4.8E-08	1.6E-07	7.6E-08	2.1E-07
NW	1.4E-07	6.6E-08	4.4E-08	4.3E-08	1.3E-07	6.6E-08	1.8E-07
WNW	1.2E-07	5.7E-08	3.8E-08	3.7E-08	1.2E-07	5.7E-08	1.6E-07
W	1.8E-07	8.3E-08	5.5E-08	5.3E-08	1.7E-07	8.3E-08	2.3E-07
WSW	4.9E-07	2.2E-07	1.4E-07	1.3E-07	4.6E-07	2.2E-07	6.2E-07
SW	3.2E-07	1.4E-07	9.2E-08	8.9E-08	3.0E-07	1.4E-07	4.0E-07
SSW	4.3E-07	1.9E-07	1.2E-07	1.2E-07	4.0E-07	1.9E-07	5.5E-07
S	4.0E-07	1.8E-07	1.1E-07	1.1E-07	3.7E-07	1.8E-07	5.1E-07
SSE	3.9E-07	1.7E-07	1.1E-07	1.0E-07	3.6E-07	1.7E-07	4.9E-07
SE	3.5E-07	1.6E-07	1.0E-07	1.0E-07	3.2E-07	1.6E-07	4.3E-07
ESE	5.0E-07	2.2E-07	1.4E-07	1.4E-07	4.7E-07	2.2E-07	6.3E-07
E	3.5E-07	1.5E-07	1.0E-07	9.7E-08	3.2E-07	1.6E-07	4.4E-07
ENE	3.9E-07	1.7E-07	1.1E-07	1.1E-07	3.6E-07	1.7E-07	4.9E-07
NE	4.3E-07	1.9E-07	1.2E-07	1.2E-07	4.0E-07	1.9E-07	5.4E-07
NNE	7.9E-07	3.5E-07	2.3E-07	2.2E-07	7.3E-07	3.5E-07	9.9E-07

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)					
Direction	1372	1462	1413	1792	1816	1776
N	3.3E-07	2.9E-07	3.1E-07	2.1E-07	2.1E-07	2.2E-07
NNW	1.4E-07	1.3E-07	1.3E-07	9.2E-08	9.0E-08	9.3E-08
NW	1.2E-07	1.1E-07	1.1E-07	7.9E-08	7.7E-08	8.0E-08
WNW	1.0E-07	9.3E-08	9.8E-08	6.8E-08	6.7E-08	6.9E-08
W	1.5E-07	1.4E-07	1.4E-07	9.9E-08	9.7E-08	1.0E-07
WSW	4.0E-07	3.6E-07	3.8E-07	2.6E-07	2.6E-07	2.7E-07
SW	2.6E-07	2.4E-07	2.5E-07	1.7E-07	1.7E-07	1.7E-07
SSW	3.5E-07	3.2E-07	3.3E-07	2.3E-07	2.2E-07	2.3E-07
S	3.3E-07	3.0E-07	3.1E-07	2.1E-07	2.1E-07	2.2E-07
SSE	3.1E-07	2.8E-07	3.0E-07	2.0E-07	2.0E-07	2.1E-07
SE	2.9E-07	2.6E-07	2.8E-07	1.9E-07	1.9E-07	1.9E-07
ESE	4.1E-07	3.7E-07	3.9E-07	2.7E-07	2.6E-07	2.7E-07
E	2.9E-07	2.6E-07	2.7E-07	1.9E-07	1.8E-07	1.9E-07
ENE	3.2E-07	2.8E-07	3.0E-07	2.1E-07	2.0E-07	2.1E-07
NE	3.5E-07	3.1E-07	3.3E-07	2.3E-07	2.2E-07	2.3E-07
NNE	6.5E-07	5.9E-07	6.2E-07	4.2E-07	4.2E-07	4.3E-07

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	1142	1147	1548	2333	2894	1959	2851
N	5.1E-12	5.1E-12	3.1E-12	1.6E-12	1.1E-12	2.1E-12	1.1E-12
NNW	2.2E-12	2.1E-12	1.3E-12	6.8E-13	4.8E-13	9.0E-13	5.0E-13
NW	1.8E-12	1.8E-12	1.1E-12	5.9E-13	4.2E-13	7.8E-13	4.3E-13
WNW	1.6E-12	1.5E-12	9.6E-13	5.1E-13	3.6E-13	6.7E-13	3.7E-13
W	2.3E-12	2.3E-12	1.4E-12	7.5E-13	5.3E-13	9.8E-13	5.4E-13
WSW	6.3E-12	6.3E-12	3.8E-12	2.0E-12	1.4E-12	2.6E-12	1.4E-12
SW	4.1E-12	4.0E-12	2.5E-12	1.3E-12	9.2E-13	1.7E-12	9.4E-13
SSW	5.5E-12	5.5E-12	3.3E-12	1.7E-12	1.2E-12	2.3E-12	1.2E-12
S	5.1E-12	5.1E-12	3.1E-12	1.6E-12	1.1E-12	2.1E-12	1.2E-12
SSE	4.9E-12	4.9E-12	3.0E-12	1.5E-12	1.1E-12	2.0E-12	1.1E-12
SE	4.4E-12	4.4E-12	2.8E-12	1.5E-12	1.0E-12	1.9E-12	1.1E-12
ESE	6.4E-12	6.4E-12	3.9E-12	2.0E-12	1.4E-12	2.7E-12	1.5E-12
E	4.4E-12	4.4E-12	2.7E-12	1.4E-12	9.9E-13	1.9E-12	1.0E-12
ENE	4.9E-12	4.9E-12	3.0E-12	1.5E-12	1.1E-12	2.0E-12	1.1E-12
NE	5.4E-12	5.4E-12	3.3E-12	1.7E-12	1.2E-12	2.2E-12	1.2E-12
NNE	1.0E-11	1.0E-11	6.2E-12	3.2E-12	2.3E-12	4.3E-12	2.3E-12

	Distance (m)						
Direction	1212	2021	2663	2719	1268	2016	1046
N	4.6E-12	2.0E-12	1.3E-12	1.2E-12	4.3E-12	2.0E-12	5.9E-12
NNW	2.0E-12	8.6E-13	5.5E-13	5.3E-13	1.8E-12	8.6E-13	2.5E-12
NW	1.6E-12	7.4E-13	4.8E-13	4.7E-13	1.5E-12	7.4E-13	2.1E-12
WNW	1.4E-12	6.3E-13	4.1E-13	4.0E-13	1.3E-12	6.4E-13	1.8E-12
W	2.1E-12	9.3E-13	6.1E-13	5.9E-13	1.9E-12	9.4E-13	2.6E-12
WSW	5.7E-12	2.5E-12	1.6E-12	1.5E-12	5.3E-12	2.5E-12	7.3E-12
SW	3.7E-12	1.6E-12	1.0E-12	1.0E-12	3.4E-12	1.6E-12	4.7E-12
SSW	5.0E-12	2.1E-12	1.4E-12	1.3E-12	4.6E-12	2.1E-12	6.4E-12
S	4.7E-12	2.0E-12	1.3E-12	1.2E-12	4.3E-12	2.0E-12	5.9E-12
SSE	4.5E-12	1.9E-12	1.2E-12	1.2E-12	4.1E-12	1.9E-12	5.7E-12
SE	4.0E-12	1.8E-12	1.2E-12	1.1E-12	3.8E-12	1.8E-12	5.0E-12
ESE	5.8E-12	2.5E-12	1.6E-12	1.6E-12	5.4E-12	2.6E-12	7.4E-12
E	4.0E-12	1.8E-12	1.1E-12	1.1E-12	3.8E-12	1.8E-12	5.1E-12
ENE	4.5E-12	1.9E-12	1.2E-12	1.2E-12	4.2E-12	1.9E-12	5.7E-12
NE	4.9E-12	2.1E-12	1.4E-12	1.3E-12	4.6E-12	2.1E-12	6.3E-12
NNE	9.2E-12	4.1E-12	2.6E-12	2.5E-12	8.5E-12	4.1E-12	1.2E-11

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)					
Direction	1372	1462	1413	1792	1816	1776
N	3.8E-12	3.4E-12	3.6E-12	2.4E-12	2.4E-12	2.5E-12
NNW	1.6E-12	1.4E-12	1.5E-12	1.0E-12	1.0E-12	1.1E-12
NW	1.4E-12	1.2E-12	1.3E-12	8.9E-13	8.7E-13	9.1E-13
WNW	1.2E-12	1.1E-12	1.1E-12	7.7E-13	7.5E-13	7.8E-13
W	1.7E-12	1.6E-12	1.6E-12	1.1E-12	1.1E-12	1.1E-12
WSW	4.7E-12	4.2E-12	4.5E-12	3.0E-12	3.0E-12	3.1E-12
SW	3.0E-12	2.7E-12	2.9E-12	2.0E-12	1.9E-12	2.0E-12
SSW	4.1E-12	3.7E-12	3.9E-12	2.6E-12	2.6E-12	2.7E-12
S	3.8E-12	3.4E-12	3.6E-12	2.5E-12	2.4E-12	2.5E-12
SSE	3.6E-12	3.3E-12	3.5E-12	2.3E-12	2.3E-12	2.4E-12
SE	3.3E-12	3.0E-12	3.2E-12	2.2E-12	2.2E-12	2.2E-12
ESE	4.8E-12	4.3E-12	4.5E-12	3.1E-12	3.0E-12	3.1E-12
E	3.3E-12	3.0E-12	3.2E-12	2.2E-12	2.1E-12	2.2E-12
ENE	3.7E-12	3.3E-12	3.5E-12	2.4E-12	2.3E-12	2.4E-12
NE	4.0E-12	3.6E-12	3.8E-12	2.6E-12	2.5E-12	2.6E-12
NNE	7.5E-12	6.8E-12	7.2E-12	4.9E-12	4.8E-12	5.0E-12

Appendix E

APPENDIX E

SPLIT/CO-LOCATED SAMPLING COMPARISON WITH OEPA

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List of Acronyms ..... E-ii

Appendix E E-1

LIST OF ACRONYMS

DOE	U.S. Department of Energy
OEPA	Ohio Environmental Protection Agency
mg/kg	milligrams per kilogram
pCi/g	picoCuries per grams
pCi/L	picoCuries per liter
µg/L	micrograms per liter

APPENDIX E

Appendix E presents split/co-located sample data, as mentioned in Chapter 2 of this 2000 Integrated Site Environmental Report. The data reflect results from split/co-located samples for analysis between the U.S. Department of Energy (DOE) and the Ohio Environmental Protection Agency (OEPA) for groundwater, surface water, and sediment. The results are provided in Table E-1 and the sample locations for groundwater, surface water, and sediment are depicted in Figures E-1, E-2, and E-3, respectively.

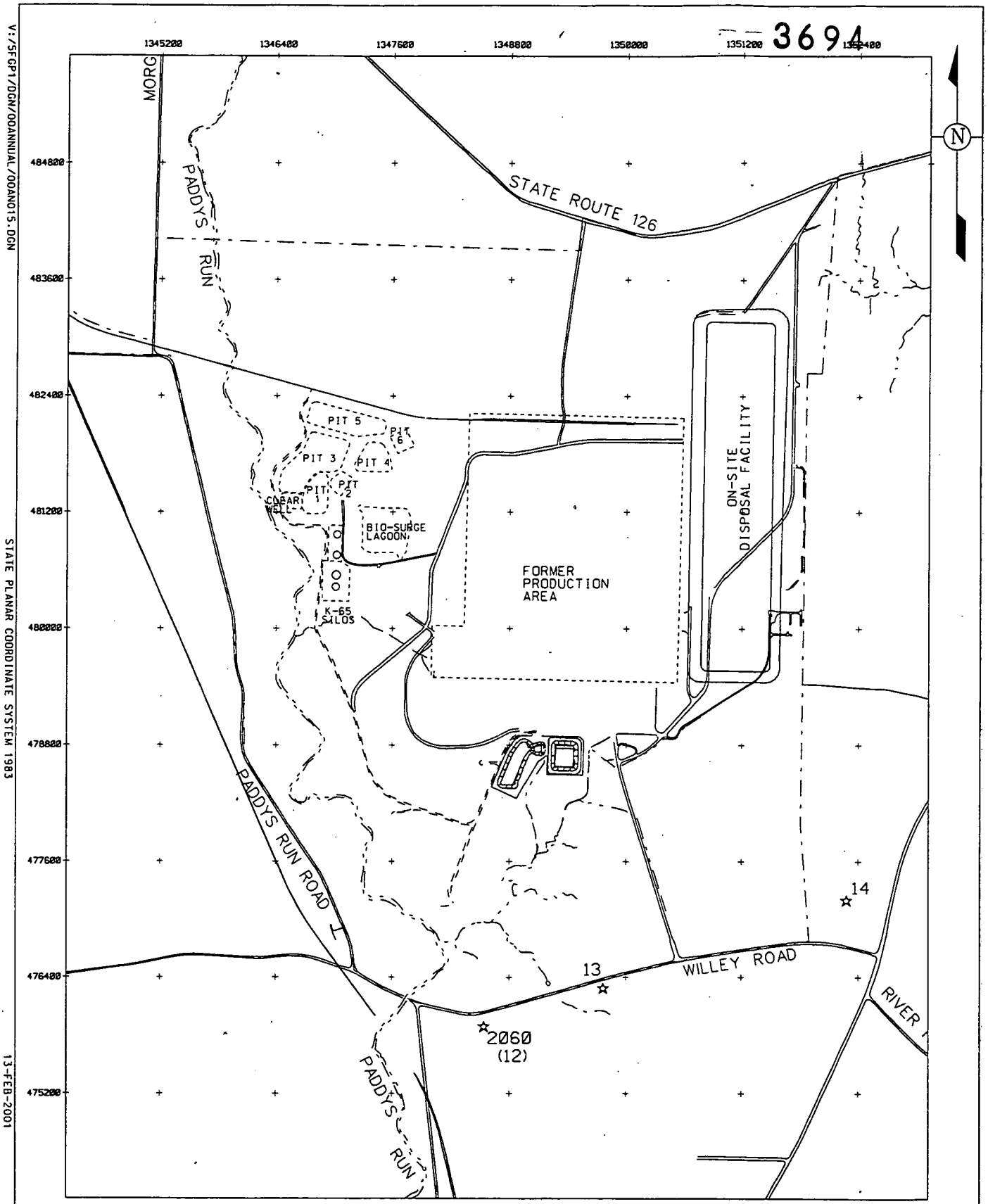
The data from the split/co-located sampling program show reasonable agreement between DOE and OEPA results for all media, with some exceptions. This includes the groundwater sample collected in October at Monitoring Well 13, where the OEPA result was notably lower than the DOE result and historical ranges for this well. Also, several of the DOE surface water radium-228 results were considerably lower than the OEPA results. These differences, as well as the slight variability observed for other results, are likely due to laboratory variability, actual sampling date differences, and sampling methodology differences. The slight differences in DOE and OEPA sample results presented for 2000 do not impact compliance with federal or state regulations.

TABLE E-1

2000 FEMP DOE-OEPA SPLIT/CO-LOCATED SAMPLING COMPARISON

Media	Sample Location	Sample Date	Constituent	DOE Result	OEPA Result[a]	FRL
Groundwater[b]				(µg/L)	(µg/L)	(µg/L)
	2060 (12)	January	Total Uranium	Not Sampled	Not Sampled	20
	2060 (12)	April	Total Uranium	126	-	20
	2060 (12)	August	Total Uranium	101	110	20
	2060 (12)	October	Total Uranium	101	107	20
	13	January	Total Uranium	28	30	20
	13	April	Total Uranium	22	-	20
	13	August	Total Uranium	21	24	20
	13	October	Total Uranium	21	3.06	20
	14	January	Total Uranium	2.9	3.1	20
	14	April	Total Uranium	3.1	-	20
	14	August	Total Uranium	2.5	2.8	20
	14	October	Total Uranium	2.4	2.47	20
Surface Water[c,d]				(pCi/L)	(pCi/L)	(pCi/L)
	SWR-01	First Quarter	Radium-226	0.73	0.14	38
	SWR-01	First Quarter	Radium-228	0.22	4.7	47
	SWR-01	First Quarter	Total Uranium (µg/L)	1.62	0.78	530
	SWR-01	Second Quarter	Radium-226	0.61	0.33	38
	SWR-01	Second Quarter	Radium-228	0.68	3.6	47
	SWR-01	Second Quarter	Total Uranium (µg/L)	1.94	2	530
	SWR-01	Third Quarter	Radium-226	0.66	-0.1	38
	SWR-01	Third Quarter	Radium-228	0.52	11	47
	SWR-01	Third Quarter	Total Uranium (µg/L)	1.58	1.5	530
	SWR-01	Fourth Quarter	Radium-226	0.80	0.457	38
	SWR-01	Fourth Quarter	Radium-228	-1.08	13.1	47
	SWR-01	Fourth Quarter	Total Uranium (µg/L)	1.74	2.25	530
	SWP-03	First Quarter	Radium-226	0.18	0.15	38
	SWP-03	First Quarter	Total Uranium (µg/L)	2.53	3.2	530
	SWP-03	Second Quarter	Radium-226	0.28	-0.063	38
	SWP-03	Second Quarter	Total Uranium (µg/L)	2.08	2.4	530
	SWP-03	Third Quarter	Radium-226	1.92	Not Sampled	38
	SWP-03	Third Quarter	Total Uranium (µg/L)	3.81	Not Sampled	530
	SWP-03	Fourth Quarter	Radium-226	0.9	0.032	38
	SWP-03	Fourth Quarter	Total Uranium (µg/L)	2.01	1.97	530
Sediment[c,e,f]				(pCi/g)	(pCi/g)	(pCi/g)
	P1	August/June	Radium-226	0.504	0.56	2.9
	P1	August/June	Thorium-228	0.383	0.36	3.2
	P1	August/June	Thorium-230	0.93	0.57	18,000
	P1	August/June	Thorium-232	0.381	0.36	1.6
	P1	August/June	Total Uranium (mg/kg)	1.397	1.3	210
	PS2	August/June	Total Uranium (mg/kg)	1.45	1.3	210

[a]OEPA results from the April groundwater sampling event are not reported due to suspected data problems.
[b]Refer to Figure E-1 for groundwater sample locations (splits)
[c]Refer to Figure E-2 for surface water sample location (co-located)
[d]DOE samples were collected quarterly while OEPA samples were collected bi-monthly; the highest DOE and OEPA result for a quarter is being reported.
[e]The DOE sample was collected in August while the OEPA sample was collected in June. OEPA's sediment data that are not co-located with DOE's sediment sample locations are not included.
[f]Refer to Figure E-3 for sediment sample location (co-located)



LEGEND:

FEMP BOUNDARY

SAMPLE LOCATION

SCALE

1200 600 0 1200 FEET

FIGURE E-1. 2000 OEPA AND FEMP SPLIT GROUNDWATER SAMPLE LOCATIONS

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STATE PLANAR COORDINATE SYSTEM 1983

13-FEB-2001

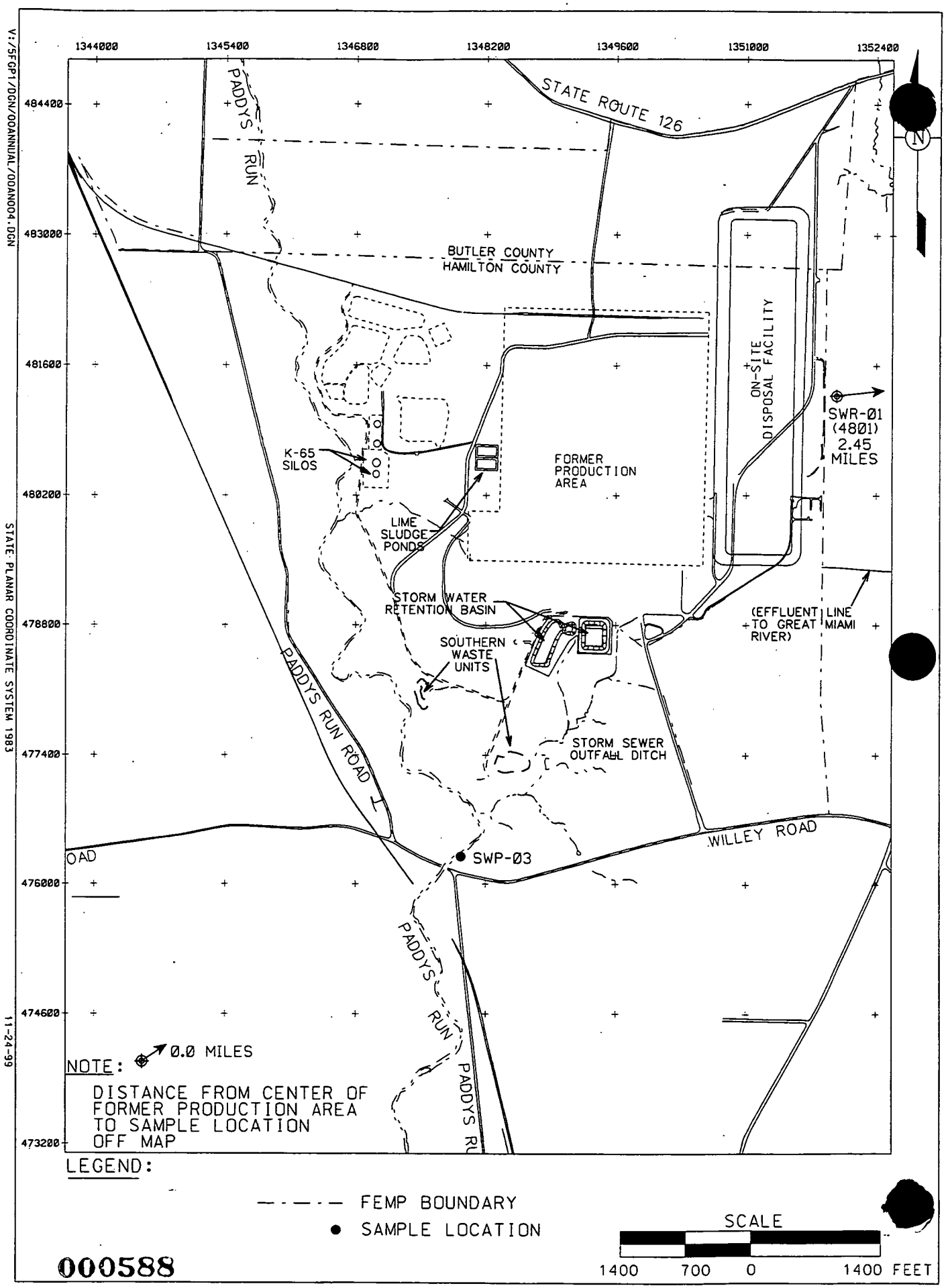

FIGURE E-2. 2000 OEPA AND FEMP CO-LOCATED SURFACE WATER SAMPLE LOCATIONS

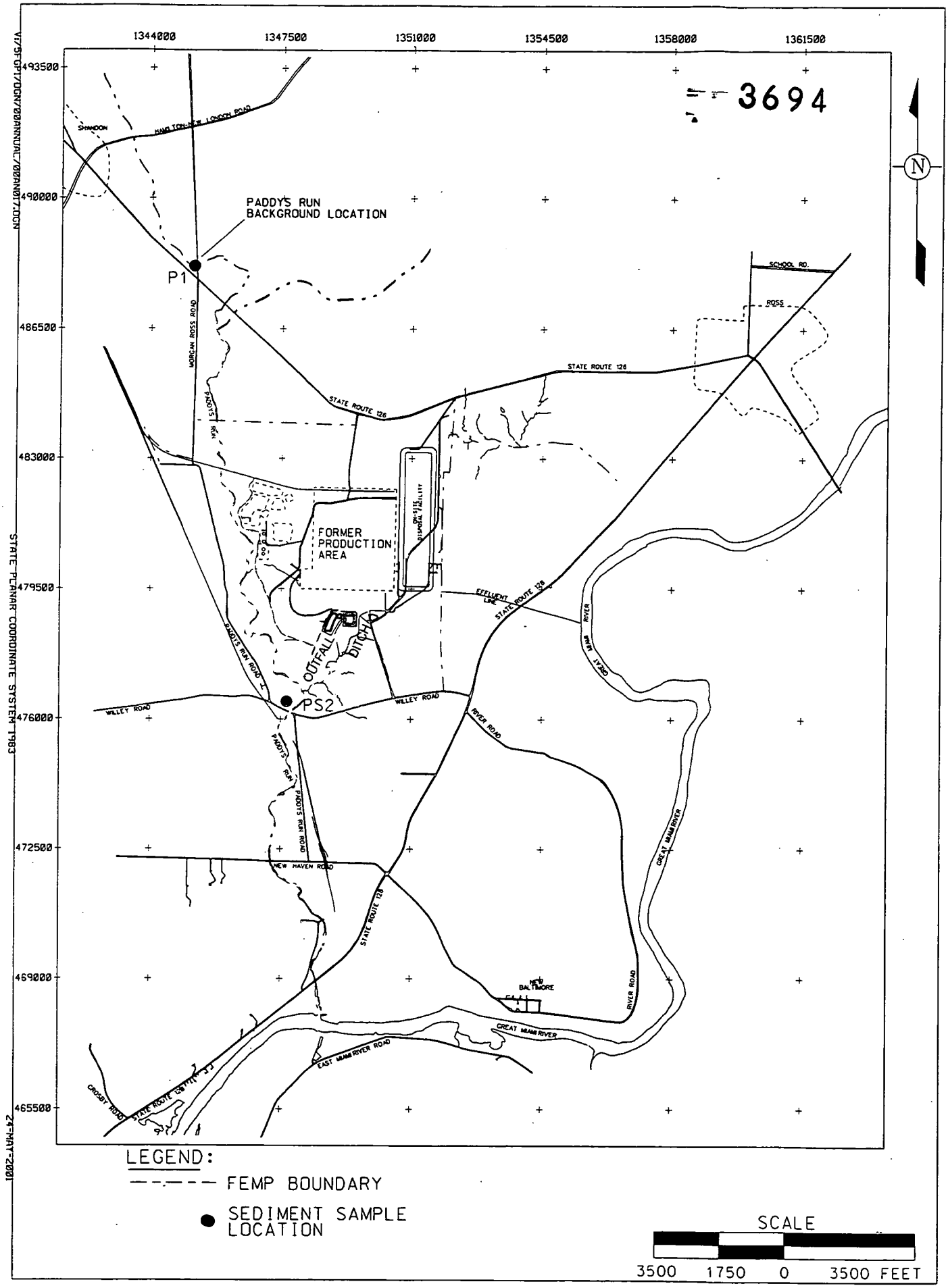

FIGURE E-3. 2000 OEPA AND FEMP CO-LOCATED SEDIMENT SAMPLE LOCATIONS