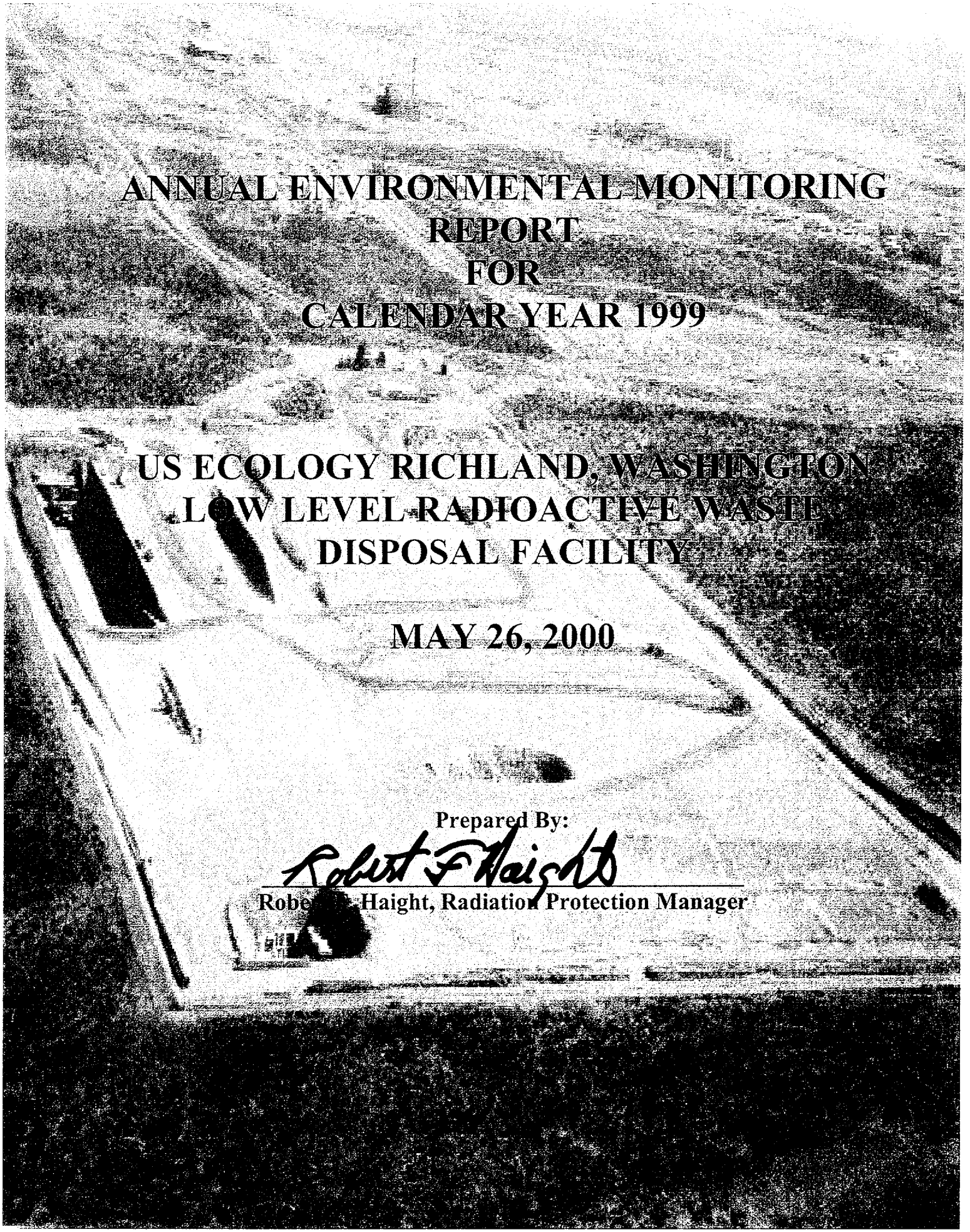

ANNUAL ENVIRONMENTAL MONITORING REPORT FOR CALENDAR YEAR 1999

US ECOLOGY RICHLAND, WASHINGTON LOW LEVEL RADIOACTIVE WASTE DISPOSAL FACILITY

MAY 26, 2000

Prepared By:

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27-48

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June 9, 2000

Distribution

Dear Sir or Madam:

Enclosed is a copy of the US Ecology's Richland Washington Low Level Radwaste Waste Facility Environmental Report. Also enclosed is an errata to the 1998 Environmental Report. Please call me on 509-377-244 if you have any questions or comments.

Sincerely,

Robert F. Haight

Robert F. Haight
Radiation Protection Manager

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ATTACHMENT 1
ERRATA to US ECOLOGY 1998 ENVIRONMENTAL REPORT

LOCATION	CHANGE	EXPLANATION
Page 3-2, Section 3.3 " 2nd paragraph,.	Change third line change ... "fourth quarter" .... to "first quarter " Change last line ... "first quarter." to ... "fourth quarter."	Two samples obtained in the 1st quarter and only one sample in the 4th quarter
Page 3-2, Section 3.3, 3rd paragraph, second sentence Section 3.3, Page , 3rd paragraph, 3 rd sentence	Second sentence delete "6". Sentence should read "There was that adequate vegetation for sampling in trench 1,2,3,4,5,7, 9 and 13." Third sentence add "6". Sentence should read "Insufficient vegetation occurred at Trench 4a, 4b, 6, 7a, 8,10,11a, the Reactor head trench and Tank Farms trench caps."	No sample could be obtained from Trench 6 in 1998.
Page 4-1, Section 4.2 paragraph 1 fourth line Section 4.2, paragraph 2, second line.	Change "1997" to "1998." Change "1997" to "1998."	
Page 5-11 Section 5.5, Table 5-7	Table 5-7 change average value of 4.5 to 4.6	The table inadvertently truncated 4.56 pCi/l as 4.5 instead of rounding up to 4.6.
Page 6- 27,	Replace Figure 6.21 with attached.	Graph omitted 1998 data.
Page 8-7 and 8-8 , Table 8-1	Table 8-1 Change trench distances to the following , AM029 should be 450', AM030 should be 650', and AM031 should be 850'.	Table 8.1 copied from EXCEL into MSWord, which resulted in some distance information being incorrectly transposed.
Page 9.6, Section 9.5, last paragraph	.Delete solar still from the last sentence of the 3rd paragraph.	Solar still measurements are limited to tritium. Although, tritium data appears similar to radon, linking tritium and radon may not be correct.
Page 10-3, Table 10.2	Table 10.2, Well 13's 1st quarter gross beta, change 14.6 pCi/l to 10.7 pCi/l.	This sample was recounted and recount value was 10.7 pCi/l.
Page 10- Section 10-7, first sentence.	Change "Table 10.8 " to "Table 10.9"	Section 10 table numeration changed.

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TABLE OF CONTENTS

PAGE

1.0 INTRODUCTION 1-1

2.0 SUMMARY 2-1

2.1 Air Monitoring Program 2-1

2.2 Soil Monitoring Program 2-3

2.3 Vegetation Monitoring Program 2-4

2.4 Penetrating Radiation Monitoring 2-4

2.5 Vadose Zone Monitoring 2-5

2.6 Groundwater Monitoring 2-5

2.7 Special Programs 2-7

3.0 COMPLIANCE SUMMARY 3-1

3.1 Air Sampling Program Compliance 3-1

3.2 Soil Compliance Summary 3-2

3.3 Vegetation Compliance Summary 3-2

3.4 Groundwater Compliance Summary 3-3

3.5 Penetrating Radiation Monitoring Compliance Summary 3-3

4.0 ENVIRONMENTAL PROGRAM INFORMATION 4-1

4.1 Description of the Environmental Program 4-1

4.2 Environmental Monitoring Program Changes 4-1

5.0 ENVIRONMENTAL AIRBORNE MONITORING 5-1

5.1 Gross Beta Activity 5-1

5.2 Gross Alpha Activity 5-5

5.3 Gamma Analysis of Airborne Particulates 5-8

5.4 Iodine in Air 5-8

5.5 Tritium in Air 5-11

5.6 Radon Air Monitoring 5-12

5.7 Air Emission from Package Inspection Facility 5-12

6.0 RADIOACTIVITY IN SOIL 6- 1

6.1 Gross Beta Activity in Soil 6-1

6.2 Total Uranium in Soil 6-2

6.3 Isotopic Plutonium in Soil 6-3

6.4 Gamma Emitters in Soil 6-4

7.0 VEGETATION SAMPLING 7-1
7.1 Gross Beta Activity in Vegetation 7-1
7.2 Total Uranium in Vegetation 7-3
7.3 Plutonium in Vegetation 7-4
7.4 Gamma Emitters in Vegetation 7-4
7.5 Tritium in Trench Cap Vegetation 7-5
8.0 PENETRATING RADIATION MONITORING 8-1
8.1 Monthly TLD Data 8-2
8.2 Quarterly TLD Data 8-2
8.3 Analysis of Environmental TLD Response 8-12
9.0 VADOSE AND SOLAR STILL SAMPLING 9-1
9.1 Vadose Zone Organic Vapor Monitoring 9-1
9.2 Vadose Zone Radon 9-2
9.3 Vadose Zone Tritium 9-3
9.4 Solar Still Tritium 9-4
9.5 Trench Cap Gas Radon Monitoring 9-6
10.0 RADIOANALYTICAL ANALYSES OF WELL WATER SAMPLES 10-1
10.1 Gross Alpha and Beta Activity 10-1
10.2 Tritium and Carbon-14 10-4
10.3 Gamma Emitting Radioisotopes in Groundwater 10-5
10.4 Plutonium in Groundwater 10-6
10.5 Uranium in Groundwater 10-8
10.6 Non-radiological Analysis 10-8
10.7 DOE 200 Area Groundwater Summary 10-10
10.8 Groundwater Elevations 10-11
11.0 QUALITY ASSURANCE 11-1
12.0 REFERENCES 12-1
13.0 DISTRIBUTION LIST 13-1

APPENDIX A - ASSESSMENT OF US ECOLOGY, RICHLAND, WASHINGTON INSPECTION FACILITY VENTILATION EXHAUST A-1

APPENDIX B – CLIMATOLOGICAL SUMMARY AND WIND ROSE FOR 1998 ..... B-1

TABLES

PAGE

4.1 Environmental & Occupational Monitoring Requirements....4-3
4.2 Action Categories....4-7
4.3 Required Minimum Detectable Concentration (MDCs) for Gamma Spectroscopy Analysis of Environmental Samples....4-8
5.1 Gross Beta Comparisons Environmental Particulate Air Samples....5-2
5.2 Gross Beta Analysis of Environmental Particulate Air Samples....5-3
5.3 Gross Alpha Environmental Particulate Air Comparisons....5-5
5.4 Gross Alpha Environmental Particulate Air Measurements....5-6
5.5 Required Minimum Detectable Concentrations (MDCs) for Selected Gamma Emitters in....5-8
5.6 Environmental Air Samples Iodine 125 Measurements....5-9
5.7 - Air Tritium Air Moisture Concentration Comparisons....5-11
5.8 Tritium Air Moisture Concentrations at Environmental Monitoring Stations 1, 2, and 5....5-11
5.9 Radon in Air Measurements....5-12
6.1 Gross Beta in Soil Comparisons....6-1
6.2 Gross Beta Measurements in Soil at the Eleven Environmental Monitoring Stations....6-2
6.3 Total Uranium in Soil Comparisons....6-2
6.4 Total Uranium Measured in Soil at the Eleven Environmental Monitoring Stations....6-3
6.5 Plutonium(Pu238, Pu239/240) Measured in Soil at the Eleven Environmental Monitoring Stations....6-4
6.6 Required Minimum Detectable Concentrations for Gamma Spectroscopy Analysis of Soil Samples....6-5
6.7 Gamma Spectrometry Analysis of Soil Samples....6-6
7.1 Locations with Sufficient Vegetation....7-1
7.2 Comparison Gross Beta in Vegetation....7-2
7.3 Gross Beta Analysis of Vegetation at Eleven Environmental Monitoring Stations....7-2
7.4 Comparison of Total Uranium in Vegetation....7-3
7.5 Total Uranium in Vegetation at Eleven Environmental Monitoring Stations....7-3
7.6 Plutonium Concentrations in Vegetation at 11 Environmental Monitoring Stations....7-4
7.7 Required Minimum Detectable Concentrations for Gamma Spectrometry Analysis of Vegetation....7-5
7.8 Radioanalytical Measurements of Trench Vegetation....7-5
7.9 Comparison of Trench Cap Tritium....7-6
8.1 Monthly Fenceline Environmental TLD Summary....8-4
8.2 Quarterly Environmental TLD Summary....8-10
8.3 WDOH/US Ecology Quarterly Environmental TLD Results....8-11
8.4 Comparision of WDOH, RDC and ICN Quarterly Environmental TLDs....8-12

TABLES

PAGE

9.1 Quarterly Vadose Zone Organic Vapor Results 9-2
9.2 VADOSE Zone Radon Measurements 9-3
9.3 VADOSE Zone Radon Comparisons 9-3
9.4 VADOSE Zone Tritium Measurements 9-4
9.5 VADOSE Zone Tritium Comparisons 9-4
9.6 Monthly Solar Still Tritium Measurements 9-5
9.6 Monthly Solar Still Tritium Measurements 9-5
9.5 Solar Still Tritium Comparisons 9-5
10.1 Gross Alpha, Gross Beta Comparisons 10-2
10.2 Gross Alpha, Gross Beta, Tritium, and Carbon-14 Analytical Results 10-3
10.3 Comparison of Ground Water Tritium by Year 10-5
10.4 Minimum Detectable Concentrations for Low Level Gamma Spectroscopy of Groundwater 10-5
10.5 Isotopic Plutonium in Groundwater 10-7
10.6 Total Uranium Concentration in Groundwater 10-8
10.7 Summary of Non-radiological Groundwater Analysis 10-9
10.8 Chemical Analysis of Well samples 10-10
10.9 40 CFR 264, Appendix IX Metals : 10-11
10.10 Groundwater Elevations 10-11

FIGURES

PAGE

1.1 DOE's Hanford Site 1-3
4.1 Environmental Monitoring Stations 4-9
5.1 Gross Beta Activity in Air at Station 1 - Richland, WA 5-14
5.2 Gross Beta Activity in Air at Station 2 - Richland, WA 5-15
5.3 Gross Beta Activity in Air at Station 3 - Richland, WA 5-16
5.4 Gross Beta Activity in Air at Station 4 - Richland, WA 5-17
5.5 Gross Beta Activity in Air at Station 5 - Richland, WA 5-18
5.6 Gross Beta Activity in Air at Station 6 - Richland, WA 5-19
5.7 Gross Beta Activity in Air at Station 7 - Richland, WA 5-20
5.8 Gross Beta Activity in Air at Station 8 - Richland, WA 5-21

FIGURES

PAGE

5.9 Gross Beta Activity in Air at Station 9 - Richland, WA 5-22
5.10 Monthly Average Gross Beta Activity in Air - Station 1 5-23
5.11 Monthly Average Gross Beta Activity in Air - Station 2 5-24
5.12 Monthly Average Gross Beta Activity in Air - Station 3 5-25
5.13 Monthly Average Gross Beta Activity in Air - Station 4 5-26
5.14 Monthly Average Gross Beta Activity in Air - Station 5 5-27
5.15 Monthly Average Gross Beta Activity in Air - Station 6 5-28
5.16 Monthly Average Gross Beta Activity in Air - Station 7 5-29
5.17 Monthly Average Gross Beta Activity in Air - Station 8 5-30
5.18 Monthly Average Gross Beta Activity in Air - Station 9 - 5-31
5.19 Gross Alpha Activity in Air Station 1 - Richland, WA 5-32
5.20 Gross Alpha Activity in Air Station 2 - Richland, WA 5-33
5.21 Gross Alpha Activity in Air Station 3 - Richland, WA 5-34
5.22 Gross Alpha Activity in Air Station 4 - Richland, WA 5-35
5.23 Gross Alpha Activity in Air Station 5 - Richland, WA 5-36
5.24 Gross Alpha Activity in Air Station 6 - Richland, WA 5-37
5.25 Gross Alpha Activity in Air Station 7 - Richland, WA 5-38
5.26 Gross Alpha Activity in Air Station 8 - Richland, WA 5-39
5.27 Gross Alpha Activity in Air Station 9 - Richland, WA 5-40
5.28 Monthly Average Gross Alpha Activity in Air - Station 1 5-41
5.29 Monthly Average Gross Alpha Activity in Air - Station 2 5-42
5.30 Monthly Average Gross Alpha Activity in Air - Station 3 - 5-43
5.31 Monthly Average Gross Alpha Activity in Air - Station 4 5-44
5.32 Monthly Average Gross Alpha Activity in Air - Station 5 5-45
5.33 Monthly Average Gross Alpha Activity in Air - Station 6 5-46
5.34 Monthly Average Gross Alpha Activity in Air - Station 7 - 5-47
5.35 Monthly Average Gross Alpha Activity in Air - Station 8 5-48
5.36 Monthly Average Gross Alpha Activity in Air - Station 9 5-49
5.37 I-125 Activity in Air Station 1 - Richland, Washington 5-50
5.38 I-125 Activity in Air Station 2 - Richland, Washington 5-51
5.39 I-125 Activity in Air Station 3 - Richland, Washington 5-52
5.40 I-125 Activity in Air Station 4 - Richland, Washington 5-53
5.41 I-125 Activity in Air Station 5 - Richland, Washington 5-54
5.42 I-125 Activity in Air Station 6 - Richland, Washington 5-55

FIGURES

PAGE

5.43 I-125 Activity in Air Station 7 - Richland, Washington 5-56
5.44 I-125 Activity in Air Station 8 - Richland, Washington 5-57
5.45 I-125 Activity in Air Station 9 - Richland, Washington 5-58
5.46 Monthly Average Iodine -125 Activity in Air - Station 1 - 5-59
5.47 Monthly Average Iodine -125 Activity in Air - Station 2 5-60
5.48 Monthly Average Iodine -125 Activity in Air - Station 3 5-61
5.49 Monthly Average Iodine -125 Activity in Air - Station 4 5-62
5.50 Monthly Average Iodine -125 Activity in Air - Station 5 5-63
5.51 Monthly Average Iodine -125 Activity in Air - Station 6 5-64
5.52 Monthly Average Iodine -125 Activity in Air - Station 7 5-65
5.53 Monthly Average Iodine -125 Activity in Air - Station 8 5-66
5.54 Monthly Average Iodine -125 Activity in Air - Station 9 5-67
5.55 Tritium in Air Moisture - Stations 1 5-68
5.56 Tritium in Air Moisture - Stations 2 5-69
5.57 Tritium in Air Moisture - Stations 5 5-70
5.58 Radon in Air - Stations 1 5-71
5.59 Radon in Air - Stations 2 5-72
5.60 Radon in Air - Stations 5 5-72
5.61 Vent Exhaust Monthly Average Alpha Activity in Air 5-74
5.62 Vent Exhaust Monthly Average BETA Activity in Air 5-75
5.63 Vent Exhaust Monthly Average Iodine -125 Activity in Air 5-76
6.1 Gross Beta in Soil Station 1 - Richland, Washington 6-7
6.2 Gross Beta in Soil Station 2 - Richland, Washington 6-8
6.3 Gross Beta in Soil Station 3 - Richland, Washington 6-9
6.4 Gross Beta in Soil Station 4 - Richland, Washington 6-10
6.5 Gross Beta in Soil Station 5 - Richland, Washington 6-11
6.6 Gross Beta in Soil Station 6 - Richland, Washington 6-12
6.7 Gross Beta in Soil Station 7 - Richland, Washington 6-13
6.8 Gross Beta in Soil Station 8 - Richland, Washington 6-14
6.9 Gross Beta in Soil Station 9 - Richland, Washington 6-15
6.10 Gross Beta in Soil NE Station - Richland, Washington 6-16
6.11 Gross Beta in Soil NW Station - Richland, Washington 6-17
6.12 Total Uranium in Soil Station 1 - Richland, Washington 6-18
6.13 Total Uranium in Soil Station 2 - Richland, Washington 6-19

FIGURES

PAGE

6.14 Total Uranium in Soil Station 3 - Richland, Washington 6-20
6.15 Total Uranium in Soil Station 4 - Richland, Washington 6-21
6.16 Total Uranium in Soil Station 5 - Richland, Washington 6-22
6.17 Total Uranium in Soil Station 6 - Richland, Washington 6-23
6.18 Total Uranium in Soil Station 7 - Richland, Washington 6-24
6.19 Total Uranium in Soil Station 8 - Richland, Washington 6-25
6.20 Total Uranium in Soil Station 9 - Richland, Washington 6-26
6.21 Total Uranium in Soil NE Station - Richland, Washington 6-27
6.22 Total Uranium in Soil NW Station - Richland, Washington 6-28
7.1 Gross Beta in Vegetation Station 1 - Richland, WA 7-7
7.2 Gross Beta in Vegetation Station 2 - Richland, WA 7-8
7.3 Gross Beta in Vegetation Station 3 - Richland, WA 7-9
7.4 Gross Beta in Vegetation Station 4 - Richland, WA 7-10
7.5 Gross Beta in Vegetation Station 5 - Richland, WA 7-11
7.6 Gross Beta in Vegetation Station 6 - Richland, WA 7-12
7.7 Gross Beta in Vegetation Station 7 - Richland, WA 7-13
7.8 Gross Beta in Vegetation Station 8 - Richland, WA 7-14
7.9 Gross Beta in Vegetation Station 9 - Richland, WA 7-15
7.10 Gross Beta in Vegetation NE Station - Richland, WA 7-16
7.11 Gross Beta in Vegetation NW Station -Richland, WA 7-17
7.12 Annual Gross Beta Trench Cap Vegetation Trench 1 - 7-18
7.13 Annual Gross Beta Trench Cap Vegetation Trench 2 - 7-19
7.14 Annual Gross Beta Trench Cap Vegetation Trench 3 - 7-20
7.15 Annual Gross Beta Trench Cap Vegetation Trench 4 7-21
7.16 Annual Gross Beta Trench Cap Vegetation Trench 4A- 7-22
7.17 Annual Gross Beta Trench Cap Vegetation Trench 4B 7-23
7.18 Annual Gross Beta Trench Cap Vegetation Trench 5 7-24
7.19 Annual Gross Beta Trench Cap Vegetation Trench 6 7-25
7.20 Annual Gross Beta Trench Cap Vegetation Trench 7 7-26
7.21 Annual Gross Beta Trench Cap Vegetation Trench 7A 7-27
7.22 Annual Gross Beta Trench Cap Vegetation Trench 8 7-28
7.23 Annual Gross Beta Trench Cap Vegetation Trench 9 7-29
7.24 Annual Gross Beta Trench Cap Vegetation Trench 10 7-30
7.25 Annual Gross Beta Trench Cap Vegetation Trench 11A 7-31

FIGURES

PAGE

7.26 Annual Gross Beta Trench Cap Vegetation Trench 13 7-32
7.27 Annual Gross Beta Trench Cap Vegetation Tank Farm 7.33
7.28 Annual Gross Beta Trench Cap Vegetation RX Head 7.34
8.1 WDOH, RDC, ICN Environmental TLD Results 8-13
9.1 VW 100 Radon 9-7
9.2 VW 101 Radon 9-8
9.3 VW 102 Radon 9-8
9.4 VW 100 Tritium 9-10
9.5 VW 101 Tritium 9-11
9.6 VW 102 Tritium 9-12
9.7 SS 100 Tritium 9-13
9.8 SS 101 Tritium 9-14
9.9 SS 102 Tritium 9-15
9.10 SS 103 Tritium 9-17
10.1 Gross Beta in Groundwater Well 3 10-12
10.2 Gross Beta in Groundwater Well 5 10-13
10.3 Gross Beta in Groundwater Well 8 10-14
10.4 Gross Beta in Groundwater Well 9 10-15
10.5 Gross Beta in Groundwater Well 9a 10-16
10.6 Gross Beta in Groundwater Well 10 10-17
10.7 Gross Beta in Groundwater Well 13 10-18
10.8 Tritium in Groundwater Well 3 10-19
10.9 Tritium in Groundwater Well 5 10-20
10.10 Tritium in Groundwater Well 8 10-21
10.11 Tritium in Groundwater Well 9 10-22
10.12 Tritium in Groundwater Well 9a 10-23
10.13 Tritium in Groundwater Well 10 10-24
10.14 Tritium in Groundwater Well 13 10-25
10.15 Total Uranium in Groundwater Well 3 10-26
10.16 Total Uranium in Groundwater Well 5 10-27
10.17 Total Uranium in Groundwater Well 8 10-28
10.18 Total Uranium in Groundwater Well 9 10-29
10.19 Total Uranium in Groundwater Well 9a 10-30
10.20 Total Uranium in Groundwater Well 10 10-31

FIGURES

PAGE

10.21 Total Uranium in Groundwater Well 13 10-32
10.22 Elevation of Groundwater Well 3 - Richland, WA 10-33
10.23 Elevation of Groundwater Well 5 - Richland, WA 10-34
10.24 Elevation of Groundwater Well 8 - Richland, WA 10-35
10.25 Elevation of Groundwater Well 9 - Richland, WA 10-36
10.26 Elevation of Groundwater Well 9a - Richland, WA 10-37
10.27 Elevation of Groundwater Well 10 - Richland, WA 10-38
10.28 Elevation of Groundwater Well 13 - Richland, WA 10-39
10.29 Ground Water Chlorine 10-40
10.30 Groundwater Nitrates 10-41
10.31 Groundwater Sulfates 10-42
10.32 Groundwater Total Dissolved Solids 10-43
10.33 Groundwater Conductance 10-44

1.0 INTRODUCTION

The US Ecology Low Level Radioactive Waste Disposal Facility (LLRWDF) is located in north-central Benton County, about 20 miles northwest of the city of Richland Washington (Figure 1.1). The facility is situated within the US Department of Energy (DOE) Hanford Site on 100 acres of land (see Figure 1.1). The DOE leases the site to the State of Washington, and the State subleases to US Ecology. The LLRWDF is entirely within the Hanford separations area, which covers approximately 82 square miles in the center of the Hanford Site. The US Ecology facility is located just southwest of the 200-East and about 2.5 miles east of the 200-West. The Hanford 200 Areas contain irradiated uranium fuel processing facilities, plutonium separation facilities and the major radioactive waste storage and disposal facilities.

The LLRWDF began operating in 1965. Approximately 13.7 million cubic feet of low-level waste has been received through December 31, 1999. This waste contains solid or solidified materials, contaminated equipment, cleaning wastes, tools, protective clothing, gloves, laboratory wastes and naturally occurring or accelerator produced radioactive material (NARM). The manifested activity of the buried waste is approximately 3.9 million curies (Ci). The total radioactivity actually contained on site is considerably less than the manifested activity due to radioactive decay and conservatism of manifested quantities.

All waste is contained in trenches that are excavated into the surficial sediments. When completely filled, each trench is covered with at least eight feet of soil and capped with a layer of gravel. Older trenches were covered with three feet of soil before gravel placement. At present, the waste is contained in 20 separate trenches located on about 32 acres in the southeast and east-central part of the facilities. Trench size is variable but the larger trenches are up to 150 feet wide, 1300 feet long and 45 feet deep. Figure 4.1 depicts the site, fences and trench locations.

The potential exposure pathways for radiation or radioactive materials released from the site are direct exposure, airborne radionuclides, biotic transfer, and radionuclide releases into the groundwater. The environmental monitoring program includes nine fixed environmental air stations, routine monitoring of both soil and live vegetation(when available), environmental thermoluminescent dosimeters and seven groundwater wells.

Environmental monitoring stations are placed around the disposal facility. These stations are located to optimize the detection of radioactive materials released to the environs. US Ecology environmental monitoring locations for all media are provided Figure 4.1. The Facility Standards Manual and Section 4 of this report describe the specific requirements for environmental monitoring. The LLRW facility's proximity to Hanford effluents and environmental radioactivity tends to complicate the assessment process. The presence of Hanford environmental radioactivity make it difficult to determine if US Ecology is or is not the source of occasional environmental parameter increase. Therefore, US Ecology also evaluates environmental monitoring trends to determine the need for additional sampling or specific actions to prevent the release of radioactivity.

The 1999 environmental monitoring program did not detect any increase in environmental radioactivity. There were no samples or trends that indicated the need for additional sampling or specific actions. The data and dose calculation demonstrate that 1999 disposal operations have not resulted in measurable increase in environmental concentrations of radioactivity in air, soil, vegetation or groundwater.

Direct radiation exposure rate measurements at all site fence line monitoring locations were within allowed limits and below investigation levels. Potential exposure to non-occupational personnel was minimal, since access to the areas near the site is controlled. Exposures from the direct radiation pathway would be immeasurably low at other Hanford facilities or at the nearest residence, which is outside the Hanford Reservation.

In addition, effluent release data from the package inspection facility is used to calculate doses from site airborne releases to the general public. These calculations show that doses from site airborne releases are extremely low, and indistinguishable from normal environmental background levels.

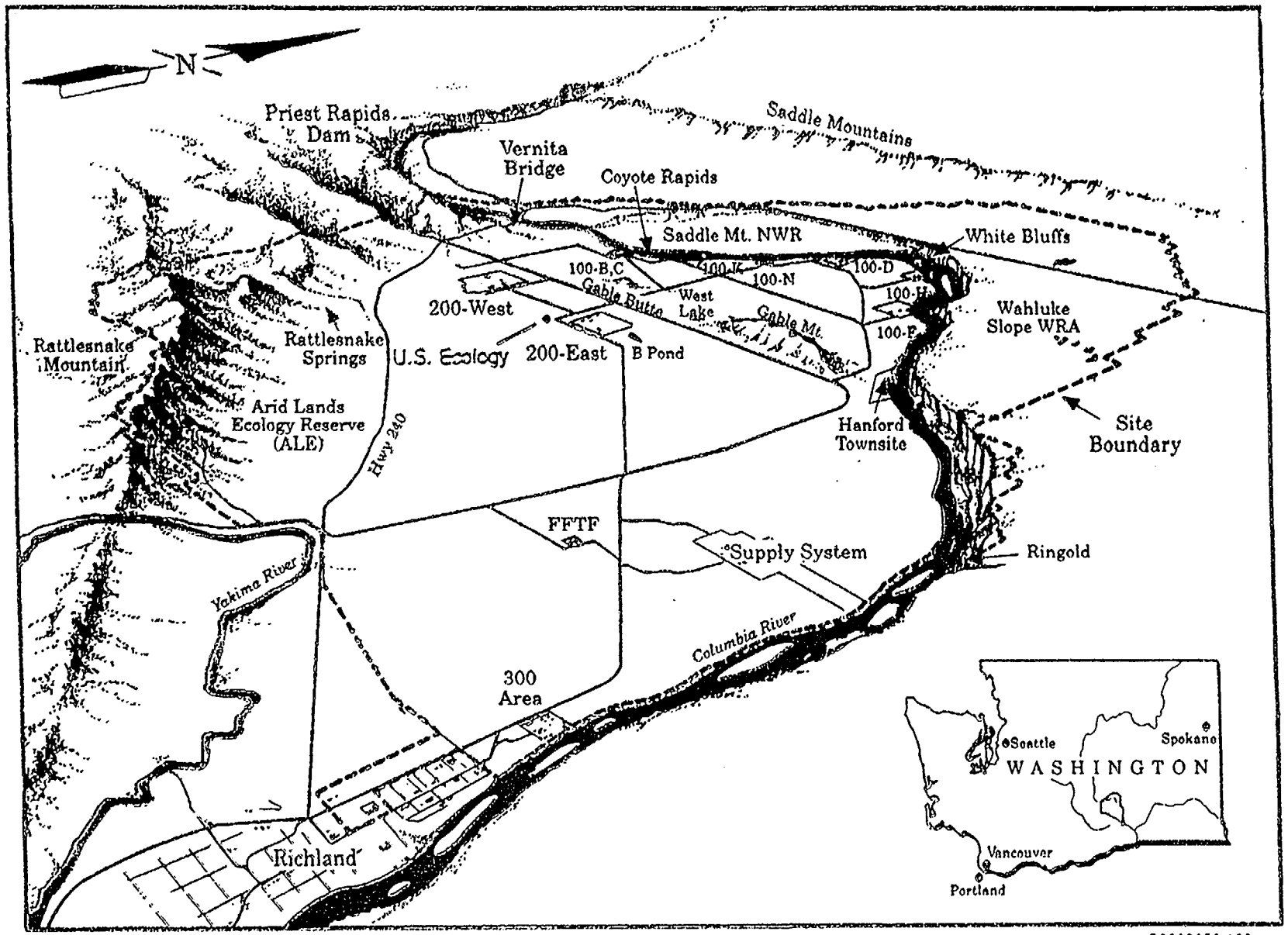


Figure 1.1. DOE's Hanford Site

Source: Ha rd Site Environmental Report 1991.

2.0 SUMMARY

This section summarizes the environmental monitoring information presented in Section 4 and the environmental data results and evaluation presented in Sections 5 through 10. In addition sampling and surveys information that are not part of the site's routine environmental monitoring program, but may contain information that relates to or supplements environmental monitoring program data are also summarized in this section.

There are no liquid effluent releases and airborne releases are undetectable. Therefore, the facility has negligible impact on individual and population doses.

2.1 Air Monitoring Program

The environmental air monitoring program involves continuous sampling of airborne particulate, airborne iodine (I-125), airborne tritium, and radon. Nine environmental stations surrounding the facility continuously sample particulate and iodine. Facility personnel collect weekly airborne particulate filters and charcoal canister samples. The weekly filters are analyzed for gross beta, and gross alpha radioactivity. The weekly charcoal canisters are analyzed for I-125. Each of the air monitoring stations weekly air filters are composited monthly and analyzed by gamma spectroscopy. Investigation levels and reporting levels are established for all air sample analytes. Investigation levels are based measurement statistics and provide prompt detection of potential increasing trends. Reporting levels are based on allowed annual concentrations and assure that a regulatory limit will not be exceeded.

Environmental air sample measurements for gross alpha, gross beta, I-125, tritium and gamma spectroscopy were all within the normal historical ranges during 1999. Gross alpha, gross beta, I-125, and gamma spectroscopy measurements were within or below the current (1998) DOE Hanford 200 Area concentrations. All site airborne emissions are below levels that would be detectable at offsite locations, and offsite doses from site operations are indistinguishable from background.

Gross beta in air samples were all less than the investigation level of 1 E-13 μCi/cc. The maximum gross beta value was 4.9 E-14 μCi/cc. This is 49 % of the investigation level and less than 0.2 % of the site Reporting Level. Comparison with data from surrounding airborne gross beta monitoring programs indicates results were consistent with prior annual results and within or below the DOE Hanford 200 Area concentrations and within the range found throughout the region. Further, there are no increasing trends in airborne gross beta concentrations. Therefore, the dose from gross beta is essentially zero.

Gross alpha in air did not exceed the site investigation level of 1 E-14 μCi/cc. The maximum gross alpha value was 5.5 E-15 μCi/cc. This value is 55 % of the investigation and is less than 35 % of the site Reporting Level. Comparison with data from surrounding airborne gross alpha monitoring programs indicates results were consistent with prior annual results, within or below the DOE Hanford 200 Area concentrations, and within the range found throughout the region. Further, there are no increasing trends in airborne gross alpha concentrations. Therefore, the dose from gross alpha is essentially zero.

The 1999 annual mean I-125 was 2.1 E-14 uCi/cc (2.1 E-2 pCi/m^3). This concentration is less than 0.01 percent of the effluent air limit for unrestricted areas (3.0 E-10 uCi/cc), referenced in WAC 246-221-290, Appendix A, Table II, Column 1. The maximum weekly concentration was 1.1 E-13 uCi/cc and the minimum weekly concentration was - 2.8 E-14 uCi/cc. Comparison of 1999 and 1998 data shows a slight difference for Iodine 125. However, this difference is due to changing the counting efficiency to model a conservative distribution of iodine throughout the canister. Consequently, the calculated concentrations increased. However, background counts and sample counts for 1999 and 1998 are indistinguishable from each other. Analysis of I-125 charcoal cartridges by gamma spectroscopy could not detect I-125 and indicated that the reported activity is probably not any isotope of iodine. In addition, minimal I-125 was received onsite in 1999, and I-125's 60-day half-life eliminates waste received before 1999 as a I-125 source. I-125 in air data are not reported for Hanford or Energy Northwest locations.

Three stations continuously sample tritium using silica gel columns. The silica gel columns are collected and analyzed for tritium monthly. Site airborne tritium concentrations were similar to DOE Hanford 200 Area 1998 levels and 1998 site concentrations. Station 1, the control station, is upwind and the greatest distance from disposal operations. The maximum Station 1 tritium concentration was 3.3 E-12 uCi/cc. The mean Station 1 concentration was 1.2 E-12 uCi/cc. Station No. 5 had the highest tritium concentration of 5.4 E-12 uCi/cc. The mean Station 5 concentration was 3.0 E-12. No tritium air sample exceed the site investigation level of 2 E-11 μCi/cc The maximum location Station 5 averages less than 0.0001 of the reporting level. Airborne tritium quickly disperses and general public exposure to tritium are insignificantly low (<0.001 mrem). Therefore, airborne tritium does not have a significant impact on the environment.

Three stations are monitored for radon using track-etch detectors. Station 1, the control station, is the greatest distance from disposal operations. The maximum Station 1 radon concentration was 3.8 pCi/l. The mean Station 1 concentration was 1.5 pCi/L. Station No. 5 had the highest radon concentration of 4.5 pCi/l The mean Station 5 concentration was 1.8 pCi/l. There are no investigation or reporting levels for radon, and radon data is not reported for DOE or Energy Northwest locations. Comparison with data from previous years indicates airborne radon levels are consistent with previous years.

US Ecology also samples the ventilation exhaust from the package inspection facility. Samples are analyzed for gross beta, gross alpha and I-125 concentrations. All ventilation exhaust air samples were below reporting levels during 1999. Ventilation exhaust air sample results are used to calculate the facilities annual airborne releases using the EPA COMPLY computer program (see Appendix A). Results from COMPLY indicate negligible on site and offsite doses from this facility, using conservative assumptions and atmospheric diffusion parameters.

In summary, environmental air and ventilation exhaust samples are the same as background air samples. Thus the dose from site operations due to airborne radiological releases is not statistically greater than zero. Section 5 contains a more in depth evaluation and discussion of the 1999 air monitoring program data. Appendix A provides the package inspection facility dose assessment.

2.2 Soil Monitoring Program

During 1999, all required soil samples were collected and analyzed. Samples were collected from Stations 1 through 9 and at the northeast and northwest corners of the site. Analysis was performed for gross beta, total uranium, isotopic plutonium (Pu-238 and Pu-239/240) and gamma emitters. All Samples were below investigation levels for all parameters. Section 6 contains detailed information on the soil-monitoring program.

All soil concentrations are consistent with previous years results. Gross beta and total uranium in the soils were within normal background levels. Plutonium was not detected in site soil samples. Sample Location #2, has preexisting slightly elevated levels of Co-60, Cs-137, Eu-155. However, Co-60 was not detected in Station 2 soil samples in 1999. This may indicate that Co-60's has decayed to below detectable levels. Cs-137 from fallout and DOE Hanford activities is frequently found in soil samples at all sample locations. Eu-155 from DOE Hanford operations is occasionally found in soil samples. All concentrations are very low ($\cong$ 0.05 pCi/g) and do not measurably contribute to on-site radiation exposure. No other man made gamma emitters were detected.

Man-made isotopes found in soil were not detected in environmental air-samples. The US Ecology site is remote from populated areas, and doses to the public via the soil pathway are very unlikely. These factors allow the conclusion that the concentrations of radionuclides in soil samples are not significant with respect to radiation exposure to the general population or site workers.

2.3 Vegetation Monitoring Program

Vegetation is sampled quarterly at the nine environmental air-monitoring stations and at the northeast and northwest corners of the site, provided there is sufficient vegetation. Vegetation samples are also collected annually from trench caps when sufficient vegetation is available. Collection procedures require the collection of live deep rooted vegetation whenever greater than 300 grams is available. Vegetation samples are analyzed for gross beta activity, total uranium, isotopic plutonium (Pu-238 and Pu-239/240), gamma emitters and tritium (trench cap only). Section 7 contains a detailed discussion of the vegetation monitoring program.

Vegetation samples were collected at all locations during the third quarters of the year. A few locations were sampled during the first, second and fourth quarters of the year when sufficient live vegetation was present.

Gross beta concentrations ranged from 11 to 77 pCi/g. Total uranium ranged from less than detectable to 0.12 in 1999 compared to less than detectable to 0.10 pCi/g in 1998. These levels are below investigation levels and consistent with historical concentrations.

Plutonium and gamma emitters were not detected in site vegetation samples. All U, Pu and gamma emitter concentrations were less than the required laboratory minimum detectable concentration.

Tritium concentrations in trench cap vegetation ranged from 0.1 to 30 pCi/g in 1999. This compares to 0.1 to 74 pCi/g in 1998. Tritium concentrations in trench cap vegetation are monitored annually for trending purposes. Since trench cap vegetation tritium is an experimental program, there are no applicable environmental standards or limits for tritium in vegetation.

2.4 Penetrating Radiation Monitoring

Thermoluminescent dosimeters (TLDs) are placed around the facility perimeter to monitor external radiation. TLDs are changed monthly at locations on the north, south, east and west fence lines and at fenceline positions nearest each active disposal trench. Quarterly dosimeters are placed at the north, south, east and west fence lines (same as monthly) and at the northeast, northwest, southeast and southwest corners of the facility.

Penetrating gamma readings did not exceed Facility Standards Manual (FSM) investigation levels of 30 millirem per month and 90 millirem per quarter at any locations in 1999. The highest annual total occurred at the west fence adjacent to the open area of Trench 14. The net annual exposure for this location was 77 millirem. This value is 19 percent of the site boundary limit as specified in the FSM. Section 8 provides detailed evaluation of the Environmental TLD program.

2.5 Vadose and Solar Still Monitoring

Vadose monitoring samples for soil gas and vapors. This includes oxygen, nitrogen, carbon dioxide, carbon, monoxide, tritium, radon, organic vapors, and methane/combustible gasses. Vadose monitoring is an experimental program and does not have applicable environmental standards or action levels.

In 1999, vadose radon ranged from less than detectable to 1949 pCi/l. This represents a significant decrease in the maximum concentration observed in VW-101 in 1998. VW 100 and VW 102 results are similar for 1999 and 1998.

Vadose tritium 1999 ranged from less than 100 pCi/l to 5.7 E+5 pCi/l. This is similar to 1998 vadose tritium, which ranged from 441 pCi/l to 5.8 E+5 pCi/l.

Near surface soil vapor tritium is measured using a solar still, consisting of a partially buried 55-gallon drum with a desiccant column that collects the tritium water vapor. Solar still 1999 tritium concentration ranged from less than detectable to 3.1 E+4 pCi/l. In comparison, 1998 solar still tritium concentration ranged from less than detectable to 2.3 E+4 pCi/l. Solar still tritium appears slightly elevated in 1999 compared to 1998. However, all locations, including background, increased, and the observed change may be due to a different meteorological profiles in 1999. As with vadose samples, there are no applicable environmental standards or limits for solar stills.

Non radiological vadose samples were taken in the first and second quarter of 1999. Non-radiological vadose samples were discontinued in the third and fourth quarter of 1999. This change was due the analytical lab discontinuing their services for potentially radioactive soil vapor samples. The first two quarters of 1999 showed that VW-101 and VW-102 had elevated carbon dioxide and lower oxygen levels, which might be indicative of organic material breaking down. However, methane and carbon monoxide were non-detectable. Organic vapors were below detection levels in all vadose wells for the first, and second quarters. This is consistent with 1998 and 1997 results.

2.6 Groundwater Monitoring

US Ecology collects quarterly groundwater samples from wells 3, 5, 8, 9, 9a, 10, and 13. Well 13 is the upgradient control well. Wells 9 and 9a are new upgradient wells that were installed in the second quarter of 1997 to provide additional data on tritium in ground water that is present from past DOE operations.

Groundwater samples are analyzed for radiological as well as nonradiological constituents. Radiological analyses include gross alpha, gross beta, tritium, C-14, gamma emitters, isotopic Pu (Pu-238 and Pu-239/240), and total uranium (U-234, U-235 and U-238). Nonradiological parameters include temperature, specific conductivity, total organic carbon (TOC), nitrates and total dissolved solids (TDS).

Gross beta concentrations in 1999 ranged from 6.0 to 10 pCi/l. All 1999 ground water samples were less than gross beta investigation of 12 pCi/l. In comparison, 1998 gross beta ranged from 4.6 pCi/l to 14.6 pCi/l. The maximum 1998 value of 14.6 pCi/l occurred in the upgradient Well 13, which also exceeded the gross beta investigation level in 1997. All down gradient ground water samples were less than the gross beta investigation and within normal background concentrations throughout 1999, 1998 and 1997.

Gross alpha concentrations ranged from 0.7 pCi/l to 4.0 pCi/l in 1999. In 1998 gross alpha ranged from 1.1 pCi/l to 3.3 pCi/l in 1998. All ground water samples were less than the gross alpha investigation level of 12 pCi/l. All 1999 and 1998 ground water gross alpha results were within normal background levels.

The 1999 total uranium in well water ranged from 1.0 to 2.9 pCi/l. No uranium samples reached the investigation level of 4.5 pCi/l. Groundwater uranium concentrations were all within the normal range in 1999. These results are similar to 1998 where total uranium in well water ranged from 2.0 to 2.9 pCi/l, with all 1998 samples being within normal range,

Tritium in groundwater is present from past Department of Energy operations. The highest groundwater tritium concentrations are found in the upgradient Well 13. The maximum 1999 Well 13 concentration increased to 5591 pCi/l compared to 5062 pCi/l in 1998. The average 1999 Well 13 tritium concentration increased to 5355 pCi/l versus 4846 in 1998. Three out of four Well 13 samples exceeded their tritium investigation level of 5000 pCi/l. The next highest levels were in Well 9, which is also an upgradient. The maximum Well 9 tritium concentration was 3385 pCi/l. This compares to 3038 pCi/l in 1998. The observed increases in ground water tritium are likely due to the continued migration of the 200 Area tritium plumes.

The highest down gradient well is Well 3. The maximum tritium concentration in Well 3 decreased slightly to 3352 pCi/l compared to 3444 pCi/l in 1998. No down gradient water sample exceeded their tritium reporting level of 3600 pCi/g

All groundwater Carbon-14 results were below the minimum detectable concentration of 200 pCi/l throughout 1999. All gamma spectroscopy groundwater results were less than detectable for man-made gamma emitters. All isotopic plutonium results were less than the detectable level (0.01 pCi/l). These results are consistent with ground water data from previous years.

Based upon the above measurements there was no facility impact on ground water in 1999. Offsite doses due to the groundwater pathway are nonexistent. In addition, non-radiological parameters were within expected values, which supports

Based upon the above measurements there was no facility impact on ground water in 1999. Offsite doses due to the groundwater pathway are nonexistent. In addition, non-radiological parameters were within expected values, which supports the above conclusion. Section 10 provides additional information on groundwater monitoring.

2.7 Special Programs

This section describe sampling and surveys information that are not part of the site's routine environmental monitoring program, but may contain information that relates to or supplements environmental monitoring program data.

2.7.1 Investigative Drilling Project

The information contained in this section is summarized from the US Ecology Inc report, "Comprehensive Facility Investigation, Richland LLRW Disposal Facility, Richland Washington, Phase 1 and 2 Report", dated August 1999.

A special project was conducted to investigate if contaminants may have migrated from the trench confines. Angled boreholes located at the north and south end of the Chem trench and the east and west end of trench 5 were drilled without penetrating the trenches. Soil samples were taken from underneath the trenches and vadose wells were constructed. Special water samples were collected in conjunction with this program. All of these activities and sample analysis were independent from the site's environmental monitoring program.

Soil samples did not detect chemicals or radionuclides that indicate migration from the trenches. Water sample results were consistent with routine quarterly ground water samples. The investigative water samples utilized expanded analytes and lower minimum detectable concentrations (MDC). Sample results indicated possible low levels of ground water contaminants known to exist in the 200 West area. Carbon 14 below the routine environmental monitoring programs MDC and Tc-99, which is not analyzed for in quarterly water samples, were reported. However, the low concentrations, the small number of samples, and lack of spikes/splits limits the data's statistical confidence level. Additional analysis of Tc-99 and C-14 in ground water is currently ongoing.

Vadose gas samples including the existing background vadose well, were evaluated by Lawrence Livermore National Laboratory. Although at low levels, several volatile organic compounds were detected in vadose samples. These included benzene, toluene, and the xylenes, which are known scintillation-vial ingredients. Freon compounds, commonly used as degreasing agents in the nuclear industry, were also detected.. The west side of Trench 5 had highest vadose concentrations. However, detection of these compounds also occurred in the background vadose well.

Oxygen and CO2 data indicate possible organic decomposition at the west end of Trench 5. Oxygen and CO2 at the other wells resembled normal air , but oxygen concentrations in the west side Trench 5 were depressed at 11.7% at the shallow well and 14.7 % at the deep wells. This depression of oxygen coincided with the elevated carbon dioxide.

Vadose samples were decayed for 30 days and counted for gross activity. All soil gas samples contained detectable gross activity. Depth variation was not apparent. The concentration of ranges from 0.8 dpm/ to 16.6 dpm/cc. Samples from the west side of Trench 5 had the highest concentrations of 16.6 dpm/cc and 15.2 dpm/cc. Background well VW-100's concentration was 5.1 dpm/cc. No sample contained sufficient water vapor for tritium analysis. The samples from the west end of Trench 5, were chemically separated for CO2 and krypton and counted for the beta activities of krypton-85 and carbon-14 with a gas proportional counter . The krypton-85 fraction read 1.7 dpm/cc and 1.6 dpm/cc, respectively, while the carbon-14 activity in the carbon dioxide fraction was 5.7 dpm/cc and 4.9 dpm/cc.

2.7.2 Contaminated Fruit Fly Surveys

This section summarizes the contaminated fruit fly event that took place in the fall of 1998. The contaminated flies originated from the DOE Hanford 200 Area, and US Ecology actions were limited to the precautionary measures taken on the US Ecology Site. Except for the description of US Ecology actions all of the information contained is section was obtained from the Flour Daniel Hanford report " Fall 1998 200 East Biological vector Contamination Report", dated March 1999.

On September 28 and 29, 1998, fruit flies spread contamination at the Hanford Site, Richland, Washington. The contamination spread was found to have originated in the 200 East Area, located in the center of the Hanford Site. The fruit flies were attracted to a sucrose-based fixative applied to the inside of a contaminated concrete diversion pit to control radiological contamination initiated inside the pit. Eggs are thought to have been laid in the fixative, which then hatched. The flies then matured and spread contamination to other areas. The majority of the contamination was spread to nearby lunchrooms, refuse and dumpsters. This contaminated refuse was picked up during normal disposal activities and hauled to the Richland Landfill.

On September 28, 1998, routine survey in the 200 East Area, discovered low levels of contamination in the MO-967 Mobile Office. Most of the contamination was found around a construction yard adjacent to B Plant. Contamination was not detected when the same locations were surveyed on September 25. The dumpster near the MO-967 Mobile Office had been emptied before the September 28 routine survey. The dumpster had been picked up earlier than scheduled, and the radiation control technicians were unaware that the dumpster had already been emptied and the contents hauled to the City of Richland Landfill.

On discovery of the contamination, radiological controls were implemented and the area encompassing the MO-967 Mobile Office, lay-down yard, other structures, and storage areas were cordoned off. Over the next several weeks, the 241-ER-152 Diversion Pit was confirmed as the source of the contamination was confirmed. Other nearby sources of contamination considered were the B Plant filter housing, the 241-ER- 151 Diversion Pit, and the 2247-B Ironworker's Shop, but these were eliminated because of lack of removable contamination and contaminated fruit flies were not trapped in their immediate vicinity.

On September 30, it was discovered that the dumpster was emptied one day early, and that potentially contaminated refuse possibly had gone to the Richland landfill. The City of Richland was notified and Hanford solid-waste refuse shipments to the City landfill were stopped. Surveys were initiated at the landfill. Contamination was detected on October 7, 1998.

Ninety-five flying-insect traps were placed at strategic locations on and off site. Four traps were placed at the Richland landfill. Ten traps were placed at Hanford Site locations outside the 200 Areas, 3 were placed at the U.S. Ecology site, and six traps were placed at the refuse transfer station in the 400 Area.

US Ecology was notified of the problem on October 7, 1999, and implemented the following precautionary measure. All eating areas, trash cans, empty pop can storage areas, and windowsills were surveyed. Personnel were instructed to wash food and keep food covered. All surveys performed by US Ecology on October 7 and October 8 found no indication of contamination at the US Ecology site.

Upon discovering the contaminated flies both Hanford and US Ecology radiation control technicians surveyed the dumpster, trashcans and lunchroom areas. In addition, US Ecology technicians also surveyed all onsite personnel. No contamination was found except for the flies in the flytrap. Flytraps were then placed near the dumpster and in lunchroom areas. No additional contamination was detected.

On the afternoon of October 30, 1998, a contaminated fly was found in a flytrap placed near the waste dumpster in front of the US Ecology maintenance shop. The U.S. Ecology site is located about 2 kilometers (1.2 miles) south-southwest of the 241 -ER-152 Diversion Pit. A review of the wind patterns that occurred before the contaminated fly was captured at U.S. Ecology showed winds out of the north-northeast for durations of up to 8 hours and speeds from 10 to 24 kilometers per hour (6 to 15 miles per hour). The wind's direction, duration, and speeds are consistent with the fly originating from area south of B Plant.

The fly found on October 30, 1998 at the US Ecology Site read 100,000 disintegrations per minute and was mostly Strontium 90 with a little Cesium 137. This is similar to the contamination found on the flies in the 200 area. The fly's beta to gamma ratio "foot print" of 30 to 1 matches the Hanford waste stream. This footprint is very different from US Ecology waste, which contains more Co60 and Cs 137 than Sr 90 and has a beta to gamma foot print closer to 1 to 1.

Fly traps and dumpster were added to US Ecology's weekly routine survey schedule. These surveys have continued through 1998 and 1999. One weekly routine survey identified possible low level contamination (≈100 cpm) inside the dumpster fly trap. Flour Daniel's radiation control was contacted, but no activity could be found on the insects contained in the fly trap. Except for the fly found on October 30 1998, there have been no contaminated insects found on the US Ecology Site.

3.0 COMPLIANCE SUMMARY

US Ecology submits this environmental monitoring report each year in accordance with the Washington Administrative Code (WAC 246-250-600 (7)) and the Code of Federal Regulations 10 CFR 61.80. Regulations in WAC 246-250-340 and 10 CFR 61.53 (c) also require environmental monitoring. These regulations require "...measurements and observations be made and recorded to evaluate the potential health and environmental impact during construction and operation of the facility and to enable the evaluation of long-term effects and the need for mitigation measures. The monitoring system must be capable of providing early warning of a radiological release before it reaches the site boundary". The US Ecology radioactive materials license, State of Washington (WN-IO19-2), requires implementation of an environmental monitoring program through US Ecology's Facility Standards Manual (FSM) and Richland Operational Procedures (ROPS). The environmental monitoring program complies with the requirements in the Washington Administrative Code, the Code of Federal Regulations, and US Ecology's radioactive materials license.

The content of this environmental report comply with the requirements prescribed by the Washington Department of Health in the document titled "Recommended Content and Format for Environmental Reports," dated January 9, 1992.

3.1 Air Sampling Program Compliance

All 1999 environmental air samples were collected as required. Compliance with the program also requires that samples exceeding action levels be evaluated and that telephone and written notification be provided to the Washington Department of Health.

All gross beta results were below the investigation level of 1.0 E-13 μCi/cc. Table 5.2 provides the gross beta measurements for environmental air samples.

All gross alpha results were below the investigation level of 1.0 E-14 μCi/cc Table 5.4 provides gross alpha measurements for environmental air samples.

All required I-125 environmental air samples were collected in 1999. Several iodine cartridges slightly exceeded their investigation level of 3.5 E-14 μCi/cc. These samples were taken after the counting efficiency was changed to represent a more conservative distribution inside the charcoal canister. These samples were verified to be statistically the same as previous samples and none of the samples would have exceeded the investigation level using the old efficiency. Comparison of background counts and sample counts for samples shows that the 1999 and 1998 charcoal canister results are indistinguishable from each other. Table 5.6 list Iodine-125 environmental air sample results.

All required tritium samples from environmental monitoring stations were collected in 1999. All tritium results were less than the investigation level of 2.0 E-11 μCi/cc. Table 5.7 provides monthly tritium in air results. Tritium sample results were similar to other tritium in air monitoring programs and previous years' results.

Weekly environmental air samples are composited monthly and analyzed by gamma spectroscopy. All air sample composites were below the minimum detectable concentrations (MDC) for the selected gamma emitters. Tables 4.3 and 5.5 list the required MDC values. The Facility Standards Manual specifies environmental air sample investigation/reporting levels of 5 E-14 uCi/cc for Cs-137 and Co-60, and five times the MDC for all other gamma emitters.

Ventilation exhaust samples from the package inspection facility did not exceed any applicable action level in 1999. Exhaust vent air samples are subject to the following action levels: 3.0 E-13 μCi/cc (gross alpha), 1.0 E-12 μCi/cc (gross beta), and 5.0 E-10 μCi/cc (I-125). Exhaust vent air sample results can be found in Appendix A, Table 1

3.2 Soil Compliance Summary

Soil samples were collected at all required locations in 1998. All 1998 soil samples were below action levels. Section 6 of this report provides soil sample results. Gross beta results were less than the action level of 35 pCi/g. No soil samples exceeded the action level of 1.0 pCi/g for total uranium or 0.03 pCi/g for plutonium. All Pu soil samples were below the detection level of 0.01 pCi/g for isotopic plutonium.

Photon emitting radionuclides in soil have an action level of five times their MDC with the exception of Cs-137 and Co-60 that are set at 0.25 pCi/g and 0.3 pCi/g, respectively. All soil samples were below their action levels

3.3 Vegetation Compliance Summary

The Facility Standards Manual requires quarterly vegetation sampling (if sufficient vegetation is available) at the environmental monitoring stations and the NE and NW site corners. In addition, annual sampling is required for capped trenches. Insufficient live deep-rooted vegetation occurred at several locations in 1999. All quarterly samples were collected during the third quarter of 1999. However, insufficient vegetation occurred at most locations in the first, second and fourth quarter of 1999. Vegetation sample availability is listed in Table 7.1.

All 1999 vegetation samples were below their specified action levels. Action levels are 100 pCi/g for gross beta, 0.25 pCi/g for total uranium, 0.02 pCi/g for isotopic plutonium, 0.3 pCi/g Co-60, 0.25 pCi/g Cs-137 and 5 times the MDC for other gamma spectroscopy analysis. Quarterly vegetation results are provided in Tables 7.3, 7.5 and 7.6 Table 7.8 contains the annual trench cap vegetation results.

Capped trench vegetation was sampled in the third quarter of 1999. There was adequate vegetation for sampling of Trench 1, 2, 3, 4, 4B, 5, 6, 7, 8, 9, 10, 13 and the Reactor Head trench caps. Insufficient vegetation occurred at Trench 4A, 7A, 11A, and the Tank Farm trench caps. In accordance with WDOH[1], the Tank Farm trench cap is bladed or graded on a quarterly basis to prevent the growth of deep-rooted vegetation, which absorb and concentrate the buried Tank Farm radionuclides.

3.4 Groundwater Compliance Summary

Quarterly radiological ground water samples are required at seven monitoring locations. All required samples were collected in 1998. Gross alpha, gross beta, C-14, Pu-238, Pu-239/240, total uranium and gamma emitting radioisotopes were all below action levels. Section 10 of this report contains a detailed discussion of the ground water monitoring.

The investigation level for tritium in groundwater is 3,600 pCi/l, except for Well 13 which has an investigation level of 5000 pCi/l. The reporting level is 20,000 pCi/l for all wells. All ground water samples were below the reporting level, and no down gradient ground water sample exceeded their investigation level. However, Well 13 samples, the upgradient background location, exceeded the investigation level for three out of four quarters. Well 13's results ranged from 4990 pCi/l to 5591 pCi/l. As presented in DOE's Hanford Site Environmental Report 1997, tritium concentrations in the unconfined aquifer, surrounding the 200 East and 200 West areas, exceed 2 E+5 pCi/l. These plumes are affecting US Ecology monitoring wells. Well 13 frequently usually exceeds its 5000 pCi/l tritium investigation level, and several other wells have tritium concentrations that are approaching the 3600 pCi/l investigation level.

Non-radiological groundwater samples were taken and analyzed as required. There are no action levels for these parameters, and results were consistent with prior years. There were slight indications of total organics (TOCs) in several first quarter samples. However, TOC results were below detection levels for remainder of the year. The lack of TOC reoccurrence suggests that contamination from vehicle and/or generator emissions may be the cause of the TOC.

3.5 Penetrating Radiation Monitoring Compliance Summary

All 1999 monthly and quarterly environmental dosimeters were placed as required by the Facility Standards Manual. Penetrating gamma radiation levels were below the FSM limit of 400 millirem per year at all fence-line locations. In addition, no TLD exceeded its investigation level of 30 millirem per month or 90 millirem per quarter. Penetrating radiation monitoring is discussed further in Section 8.

[1]Ledoux, M. 1995. Oak Ridge, TN. Letter from M. Ledoux (Action Plan for Vegetation Removal and Sampling) to J. Erickson, WDOH, Environmental Radiation, WA. January 27,1995.

4.0 ENVIRONMENTAL PROGRAM INFORMATION

4.1 Description of the Environmental Program

The Richland facility is required to perform environmental monitoring to show that it is in compliance with the Washington Administrative Code WAC 246-250-170 and the Code of Federal Regulations, 10 CFR 61.41. These regulations require that that annual doses due to effluents do not exceed 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public. In addition effluents release must be maintained "As Low As is Reasonably Achievable" (ALARA) and the 10 CFR 20.1101(d) ALARA criterion of 10 millirem per year from airborne emissions must also verified.

The environmental monitoring program at the Richland facility monitors all pathways, which could result in offsite dose. These include environmental air, soil, vegetation, ground water and direct radiation. Vadose zone monitoring for tritium and radon is also performed. Since the facility is located within the Hanford Reservation, the probability of any effluent reaching the general population is very low. Monitoring of food pathways is not possible, since there are no farms or cattle near the facility. Wildlife is not monitored as hunting or trapping is prohibited on the Hanford Reservation. Vegetation samples provide some indication of radionuclides that could be found in the diet of wildlife.

Table 4.1 describes the environmental monitoring program and action levels as required by operating licenses. The actions required whenever environmental action levels are exceeded are given in Table 4.2. Table 4.3 summarizes the requirements for minimum detectable concentrations for gamma spectroscopy of environmental samples. Figure 4.1 shows all environmental monitoring stations and locations, which are described in Table 4.1. Sections 5 through 10 of this report present the results and evaluation of the environmental program at the facility.

4.2 Environmental Monitoring Program Changes

All aspects of air monitoring, ground water monitoring, soil monitoring, vegetation monitoring, and external exposure monitoring continued through 1999. Radiological monitoring of soil vapors also continued through 1999. However, the analytical laboratory providing non-radiological soil vapor analysis, discontinued their service after the second quarter of 1999. US Ecology is currently searching for another vendor to provide soil vapor non-radiological analysis.

In October 1994, US Ecology initiated near surface tritium vapor concentration measurements using in-ground solar stills. A new upgradient solar still was installed in July, 1997. This solar still is located near groundwater monitoring well 13. The location of the new solar still is away from active trenches and in the suspected direction of the groundwater tritium plume.

Two new groundwater monitoring wells (Wells 9 and 9a) were installed and completed in December, 1996 at the Richland facility. This location is east of environmental air monitoring station No. 8. These wells sample the same location except that Well 9 draws a sample near the top of the aquifer, while 9a samples deeper in the aquifer. Routine monitoring of Wells 9 and 9a started the second quarter of 1997.

Vadose zone monitoring frequencies for radon and tritium increased from quarterly to monthly in the third quarter of 1997. Vadose zone radon monitoring detectors require shorter detection periods to accommodate radon levels that exceed maximum detectable limits on a quarterly basis. The tritium monitoring frequency was increased to maintain an undisturbed monitoring environment, and match solar still tritium samples, which are collected on a monthly basis.

In 1999, one monthly environmental TLD (AM025) was temporarily moved from the mid point of the closed Trench 16 to the mid point of the open Trojan reactor vessel trench. The Trojan reactor vessel trench was open August and September 1999. The TLD was returned to its original Trench 16 location in November 1999, after it was confirmed that exposure levels at the closed reactor vessel trench had returned to background levels.

TABLE 4.1

Environmental/Occupational Monitoring Requirements

Medium	Location	Type, Frequency	Analysis	Investigation Level	Reporting Level	Action Category[1]
Environmental Air	Envir. Monitoring Stations 1-9	Continuous, Changed weekly	Gross Alpha Gross Beta I-125	1×10^{-14} µCi /cc 1×10^{-13} µCi/cc 3.5×10^{-14} µCi/cc	1.7×10^{-14} µCi/cc 2.6×10^{-11} µCi/cc 2.3×10^{-10} µCi/cc	3 , 4 3, 4 3, 4
	Envir. Monitoring Stations 1-9	Continuous, Monthly Composite of weekly samples	Co-60 Cs-137 Gamma Spec	5×10^{-14} µCi/cc 5×10^{-14} µCi/cc 5 X MDC[3]	2.6×10^{-11} µCi/cc 1.9×10^{-10} µCi/cc 5 X MDC[3]	3, 4 3, 4 3, 4
	Envir. Monitoring Stations 1, 2, 5	Continuous, Changed monthly	H-3	2×10^{-11} µCi/cc	6.1×10^{-8} µCi/cc	3, 4
Occupational Air	One downwind plus one at each location of potential exposure	Continuous during operations or 1 hour/day; whichever is greater	Gross Alpha Gross Beta I-125	NA[4] NA[4] NA[4]	3×10^{-13} µCi/cc 1×10^{-12} µCi/cc[2] 5×10^{-10} µCi/cc	1 1 1

TABLE 4.1

Environmental/Occupational Monitoring Requirements

Medium	Location	Type, Frequency	Analysis	Investigation Level	Reporting Level	Action Category[1]
Groundwater	Wells	Grab, Quarterly	Gross Alpha	12 pCi/L	15 pCi/L	3,4
	#013 (upgradient)		Gross Beta	12 pCi/L	50 pCi/L	3,4
	#010		H-3	3,600 pCi/L	20,000 pCi/L	3,4
	#008		C-14	250 pCi/L	2,000 pCi/L	3,4
	#005		Total Uranium[6]	4.5 pCi/L	30 pCi/L	3,4
	#003		Pu-238	0.03 pCi/L	See Pu-239/240	3,4
	#009 (upgradient)		Pu-239/240	0.03 pCi/L	40 pCi/L (Total Pu)	3,4
	#009a (upgradient)		Co-60	6 pCi/L	100 pCi/L	3,4
			Cs-137	7 pCi/L	200 pCi/L	3,4
			Gamma Spec	5 X MDC[3]	5 X MDC[3,7]	3,4
			Specific Conductance	NA[4,8]	NA[4,8]	NA[4]
			TDS	NA[4,8]	NA[4,8]	NA[4]
			TOC	NA[4,8]	NA[4,8]	NA[4]
			Nitrates	NA[4,8]	NA[4,8]	NA[4]
			Temperature	NA[4,8]	NA[4,8]	NA[4]
Field Blank		1 blank per 10 samples collected	Note[9]	NA[4,10]	NA[4,10]	NA[4]

TABLE 4.1

Medium	Location	Type, Frequency	Analysis	Investigation Level	Reporting Level	Action Category[1]
Soil[5]	Envir. Monitoring Stations 1-9 and NE, NW Corners	Grab, Quarterly	Gross Beta	35 pCi/g (dry)	35 pCi/g (dry)[7]	3, 4
			Total Uranium[6]	1 pCi/g (dry)	1 pCi/g (dry)[7]	3, 4
			Pu-238	0.03 pCi/g (dry)	0.03 pCi/g (dry)[7]	3, 4
			Pu-239/240	0.03 pCi/g (dry)	0.03 pCi/g (dry)[7]	3, 4
			Co-60	0.3 pCi/g (dry)	0.3 pCi/g (dry)[7]	3, 4
			Cs-137	0.25 pCi/g (dry)	0.25 pCi/g (dry)[7]	3, 4
			Gamma Spec	5 X MDC[3]	5 X MDC[3,7]	3, 4
Vegetation[5]	Envir. Monitoring Stations 1-9 and NE, NW Corners	Grab, Quarterly for deep rooted	Gross Beta	100 pCi/g (dry)	100 pCi/g (dry)[7]	3, 4
			Total Uranium[6]	0.25 pCi/g (dry)	0.25 pCi/g (dry)[7]	3, 4
			Pu-238	0.02 pCi/g (dry)	0.02 pCi/g (dry)[7]	3, 4
			Pu-239/240	0.02 pCi/g (dry)	0.02 pCi/g (dry)[7]	3, 4
			Co-60	0.1 pCi/g (dry)	0.1 pCi/g (dry)[7]	3, 4
			Cs-137	0.2 pCi/g (dry)	0.2 pCi/g (dry)[7]	3, 4
			Gamma Spec	5 X MDC[3]	5 X MDC[3,7]	3, 4

Table 4.1

Medium	Location	Type, Frequency	Analysis	Investigation Level	Reporting Level	Action Category[1]
Vegetation[5] Continued	Filled and capped trenches	Grab, Annually	Gross Beta	100 pCi/g (dry)	100 pCi/g (dry)[7]	3, 4
			Total Uranium[6]	0.25 pCi/g (dry)	0.25 pCi/g (dry)[7]	3, 4
			Pu-238	0.02 pCi/g (dry)	0.02 pCi/g (dry)[7]	3, 4
			Pu-239/240	0.02 pCi/g (dry)	0.02 pCi/g (dry)[7]	3, 4
			Co-60	0.1 pCi/g (dry)	0.1 pCi/g (dry)[7]	3, 4
			Cs-137	0.2 pCi/g (dry)	0.2 pCi/g (dry)[7]	3, 4
			Gamma Spec	5 X MDC[3]	5 X MDC[3,7]	3, 4
			H-3	NA[4,8]	NA[4,8]	3, 4
Direct Gamma Dose (TLD)	NW, NE, SW, SE Corners and N, S, E, W Fencelines	Continuous, Quarterly	Tissue dose using thermoluminescent dosimeter	90 mrem/qtr	400 mrem/year	3, 4
	N, S, E, W Fencelines and Fenceline position(s) nearest each active disposal trench	Continuous, Monthly	Tissue dose using thermoluminescent dosimeters	30 mrem/month	400 mrem/year	3, 4

NOTES:

1. Table 4.2 presents the action required based upon action categories.
2. If Ac-227 is listed on manifest or known to be present, the reporting level is 2.0×10^{-13} µCi/cc.
3. The required minimum detection concentrations (MDCs) are listed in Table 4.3.
4. NA = Not applicable or none established.
5. Dry to wet ratio will be obtained.
6. Total uranium analysis is defined as the sum of the concentrations of uranium isotopes reported.
7. These are interim reporting levels.
8. Concentrations will be evaluated and reported annually in the environmental report.
9. Field blank analysis is the same as well sample analysis.
10. Used for QA sample.

TABLE 4.2

Action Categories

Actions Required When Action Level Met or Exceeded

1. Type 1 Event
   Follow Reporting Level requirements
   Potential for bioassay examined by RPM.

2. Type 2 Event
   Immediate notification of on-site inspector
   Take corrective action

3. Investigation Level
   Notify the RPM
   Take corrective actions described in FSM 6.1.5

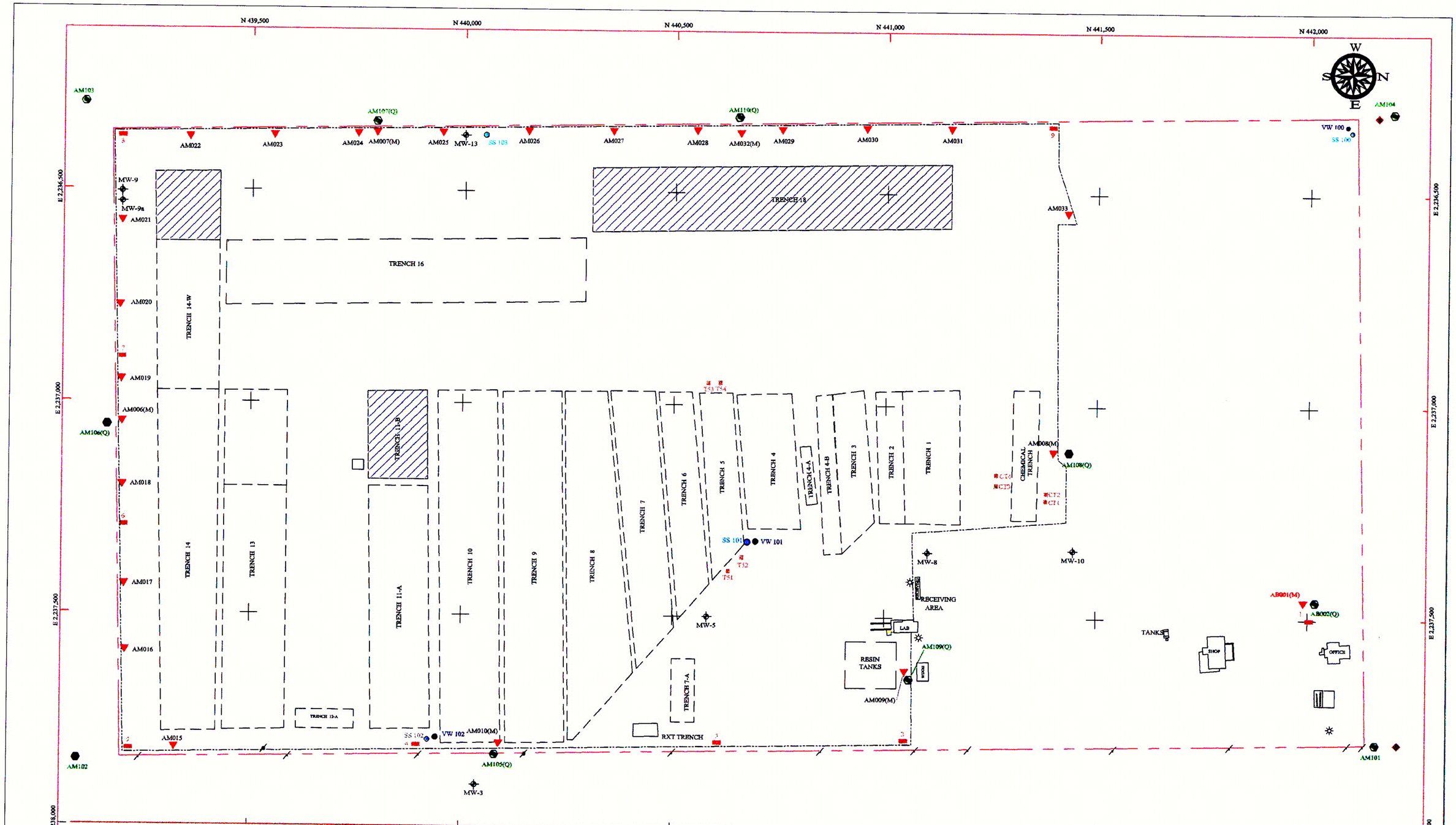
4. Reporting Level
   Notify the RPM and the Department.
   Take corrective actions described in FSM 6.1.5
   Make reports in accordance with FSM 6.1.4.C

TABLE 4.3

Required Minimum Detectable Concentration (MDCs) for Gamma Spectroscopy Analyses of Environmental Samples

Radionuclide	Water (pCi/l)	Airborne Activity (pCi/m^3)	Soil (pCi/g – dry)	Vegetation (pCi/g - dry)
Ba/La-140	24	0.02	0.05	0.21
Ce-141	10	0.01	0.02	0.09
Ce/Pr-144	92	0.09	0.18	0.30
Co-58	10	0.01	0.02	0.09
Co-60	6	0.01	0.02	0.09
Cs-134	11	0.01	0.02	0.09
Cs-137	7	0.01	0.02	0.09
Eu-152	56	0.06	0.11	0.51
Eu-154	27	0.03	0.05	0.24
Eu-155	24	0.02	0.05	0.21
Fe-59	17	0.02	0.03	0.15
Mn-54	10	0.01	0.02	0.09
Na-22	10	0.01	0.02	0.09
Ru-103	10	0.01	0.02	0.09
Ru-106	85	0.09	0.17	0.78
Sb-124	10	0.01	0.02	0.09
Sb-125	24	0.02	0.05	0.21
Zn-65	21	0.02	0.04	0.18
Zr/Nb-95	17	0.02	0.03	0.15

NOTE: The gamma nuclide library used by the analytical laboratory will contain additional radionuclides as specified by US Ecology. Naturally occurring gamma ray emitters, that are also monitored and reported in the annual environmental report, are not included in this listing.



LEGEND

- PROPERTY LINE
- FENCE LINE
- ACTIVE DISPOSAL AREA
- CLOSED DISPOSAL AREA
- EXISTING MONITOR WELL LOCATION AND NUMBER (MW-3)
- SS 100 / VW 102 — SOLAR STILL LOCATION AND NUMBER / VADOSE ZONE LOCATION AND NUMBER (UNSATURATED)
- POWER POLE
- LIGHT
- SOIL, VEGETATION, AIR MONITOR STATION LOCATION AND NUMBER
- ANGLE BORING
- SOIL AND VEGETATION MONITOR STATION
- AM010(M) — MONTHLY TLD LOCATION AND NUMBER
- AM105(Q) — QUARTERLY TLD LOCATION AND NUMBER
- ACTIVE DISPOSAL AREA

SCALE: 100 50 0 100 FEET

Rev	Drawn	Check	Appr	Date	Description
7	CNB	D.G.	D.G.	5/19/00	Added Angle Borings and Gate at Northwest Corner.
6	DWP	M.L.	M.L.	6/16/97	Added AM107, AM108, AM109, AM110, added AM009, MW-9 and MW-9A
5	JMT	M.L.	M.L.	5/15/96	Added Trench 18
4	DKK	M.L.	M.L.	10/95	Added TLD's AM033
3	DKK	M.L.	M.L.		Added TLD's AM027 thru AM032
2	DKK	M.L.	M.L.	4/95	Moved AM009/AM109 Approx. 50' East
1	DKK	M.L.	M.L.	1/95	Removed Tank

REVISIONS

American Ecology
805 W. Idaho
Suite 200
Boise, ID 83702

Reference Drawings: WN-200-TOP-000-R2

Drawn By: GKB
Checked By: ML
Appr. By: ML
Date: 5/94
Scale: AS NOTED
Project No.: WA-125

ENVIRONMENTAL MONITORING STATIONS

LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT FACILITY
US Ecology, Inc.
RICHLAND, WASHINGTON

Drawing No. WA-125-TOP-003

Figure 4.1

5.0 ENVIRONMENTAL AIRBORNE RADIOLOGICAL MONITORING

This section discusses the US Ecology environmental air monitoring program. Where possible, 1999 results are compared with previously reported data contained in previous US Ecology Annual Environmental Monitoring Reports, the Washington Public Power System Annual Environmental Monitoring Report for 1995, and the Hanford Site Environmental Reports for 1998.

Air was sampled continuously during 1999 to determine airborne radionuclide concentrations and to detect trends in concentrations. Nine low-volume air samplers, operating at approximately 1.5 cfm (7.1 E-4 m^3/s) are located around the perimeter of the facility. Particulate air filters and charcoal canisters were collected weekly such that a minimum of six days and a maximum of eight days collection time have accumulated. US Ecology uses in house analysis for gross alpha, gross beta, and I-125 (charcoal cartridge low energy gamma). Particulate filters are composited monthly and sent to Teledyne Isotopes Midwest Laboratories for gamma spectroscopy. Air moisture is collected continuously for a month in desiccant cartridges operating at 150 cc/min. The desiccant cartridges are sent to Teledyne Midwest Laboratory for tritium analysis.

Station 1, located approximately 1000 feet north of the receiving area, is the control station for the facility. Station 1's location also makes it an indicator location for DOE activities that are not attributable to US Ecology. Therefore, Station 1 background concentrations can be higher than US Ecology locations that are less affected by DOE Hanford operations.

Sampling locations are depicted on Figure 4.1 in Section 4 of this report.

5.1 Gross Beta In Air Particulate Samples

Gross beta analysis is a relatively quick, inexpensive and sensitive screening tool that provides indication of sample radioactivity that may require more in-depth analysis by gamma spectroscopy or radiochemical analysis. Gross beta is useful to detect trends in environmental airborne radioactivity.

Weekly average, maximum and minimum gross beta airborne concentrations are given in Table 5.1. Weekly gross beta concentrations in airborne particulates for each environmental air station are presented in Table 5.2. Table 5.2 also provides the mean, maximum, and minimum for each station and the site. Air sample weekly gross beta results are plotted in Figures 5.1 through 5.9. Error bars for weekly plotted data represent the counting error at the 95 percent confidence interval.

Figures 5.10 through 5.18 compare monthly averages for 1994 through 1999. Error bars for monthly plotted data represent the standard deviation of the weekly results. The figures allow one to make a historical comparison of results. Results from year-to-year are similar and do not indicate any trends toward increasing concentrations. It should be noted that pre-count decay times were decreased in 1996 from ten days to three days. Therefore, a slight increase may be indicated on some monthly average charts during this

period. These increases are not due to actual changes in environmental airborne radioactivity.

There are no significant differences in the data from background concentrations at locations surrounding the facility. Station 1, the background location, airborne beta concentrations are statistically the same as all other site locations. In addition, there are no trends indicating a contribution from the site, and routine occupational monitoring of work activities did not detect elevated beta levels attributable to site activities. Therefore, no detectable airborne beta emitters were released from site activities and the dose contribution from airborne beta emitters is essentially zero.

No trends are evident upon inspection of the graphical presentations in Figures 5.1 through 5.9. However, seasonal fluctuations that are normally present due to atmospheric conditions (e.g. temperature inversions), are evident. These inversions usually occur during the fall and winter months and result in increased airborne activity from naturally occurring radon and progeny.

Comparisons of 1999 results with data from previous years and non US Ecology locations are presented in Table 5.1.

Table 5.1 Gross Beta In Air Particulate Samples Comparison (uCi/cc)

	Weekly Minimum	Weekly Maximum	Average
1999 Annual Report	8.8 E-15	4.9 E-14	1.8 E-14 to 2.1 E-14
1998 Annual Report	2.9 E-15	5.1 E-14	2.0 E-14 to 2.1 E-14
1997 Annual Report	8.7 E-15	5.9 E-14	2.2 E-14 to 2.4 E-14
1996 Annual Report	1.6 E-15	7.1 E-14	2.4 E-14 to 2.7 E-14
1995 Annual Report	6.3 E-15	8.7 E-14	
1994 Annual Report	8.8 E-15	8.2 E-14	
Historical Report	3.0 E-15	2.1 E-10	
1998 Hanford Onsite	ND	3.5 E-14	1.5E-14
1998 Hanford perimeter	ND	3.7 E-14	1.5 E-14
1995 Energy North West	3.0 E-15	9.1 E-14	
1995 Hanford Onsite	ND	5.0 E-14	1.5E-14

The range and average values of the 1999 concentrations are consistent with the historical data presented above. The investigation level for gross beta activity is 1.0 E-13 uCi/cc (1.0 E-1 pCi/m^3). There were no air samples, which exceeded the beta action level in 1999.

Table 5.2

Gross Beta Measurements of Environmental Air Samples - 1999 (x 10^{-14} uCi/cc)

Date	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9
1/4/99	1.20 +/- 0.30	1.15 +/- 0.30	0.96 +/- 0.29	0.88 +/- 0.28	1.06 +/- 0.30	1.04 +/- 0.29	1.12 +/- 0.30	1.07 +/- 0.30	1.07 +/- 0.30
1/11/99	3.06 +/- 0.36	3.07 +/- 0.36	2.70 +/- 0.35	3.22 +/- 0.37	2.96 +/- 0.36	3.23 +/- 0.37	3.01 +/- 0.36	3.39 +/- 0.38	2.78 +/- 0.35
1/18/99	0.95 +/- 0.23	1.51 +/- 0.27	1.42 +/- 0.26	1.43 +/- 0.26	1.09 +/- 0.24	1.02 +/- 0.24	1.14 +/- 0.24	1.08 +/- 0.24	1.34 +/- 0.26
1/25/99	1.61 +/- 0.28	1.24 +/- 0.26	1.28 +/- 0.26	1.38 +/- 0.26	1.44 +/- 0.27	1.49 +/- 0.27	1.28 +/- 0.26	1.22 +/- 0.25	1.54 +/- 0.27
2/1/99	2.41 +/- 0.33	2.55 +/- 0.34	2.51 +/- 0.33	2.16 +/- 0.32	2.23 +/- 0.32	1.92 +/- 0.30	1.83 +/- 0.30	2.14 +/- 0.32	2.67 +/- 0.34
2/8/99	2.57 +/- 0.32	1.93 +/- 0.28	2.15 +/- 0.30	2.00 +/- 0.29	1.24 +/- 0.24	1.28 +/- 0.24	1.19 +/- 0.24	1.30 +/- 0.24	1.28 +/- 0.24
2/16/99	1.43 +/- 0.24	1.32 +/- 0.24	1.58 +/- 0.25	1.72 +/- 0.26	1.66 +/- 0.26	1.35 +/- 0.24	1.55 +/- 0.25	1.41 +/- 0.24	1.31 +/- 0.24
2/22/99	1.22 +/- 0.27	1.57 +/- 0.30	1.30 +/- 0.28	1.15 +/- 0.27	1.04 +/- 0.26	1.19 +/- 0.27	1.20 +/- 0.27	1.11 +/- 0.26	0.91 +/- 0.25
3/1/99	1.64 +/- 0.28	1.72 +/- 0.28	1.68 +/- 0.28	1.69 +/- 0.28	1.18 +/- 0.25	1.04 +/- 0.24	1.18 +/- 0.25	1.11 +/- 0.24	1.50 +/- 0.27
3/8/99	0.88 +/- 0.24	1.37 +/- 0.27	2.10 +/- 0.31	1.88 +/- 0.30	1.63 +/- 0.28	1.53 +/- 0.28	1.19 +/- 0.26	1.69 +/- 0.29	1.35 +/- 0.27
3/15/99	1.75 +/- 0.28	1.69 +/- 0.28	1.54 +/- 0.27	1.78 +/- 0.29	1.75 +/- 0.28	1.96 +/- 0.30	1.63 +/- 0.28	1.75 +/- 0.28	1.66 +/- 0.28
3/22/99	2.20 +/- 0.31	2.06 +/- 0.30	2.48 +/- 0.32	2.22 +/- 0.31	2.24 +/- 0.31	1.97 +/- 0.29	1.95 +/- 0.29	2.25 +/- 0.31	2.15 +/- 0.30
3/29/99	1.46 +/- 0.27	1.96 +/- 0.30	1.46 +/- 0.27	1.42 +/- 0.27	1.19 +/- 0.26	1.27 +/- 0.26	1.07 +/- 0.25	1.09 +/- 0.25	1.15 +/- 0.25
4/5/99	1.91 +/- 0.30	1.89 +/- 0.30	1.67 +/- 0.28	1.38 +/- 0.27	1.32 +/- 0.26	1.09 +/- 0.25	1.33 +/- 0.26	1.24 +/- 0.26	1.09 +/- 0.25
4/12/99	1.65 +/- 0.26	1.77 +/- 0.27	1.73 +/- 0.27	1.95 +/- 0.28	1.88 +/- 0.28	1.58 +/- 0.26	1.96 +/- 0.28	2.01 +/- 0.29	1.65 +/- 0.26
4/19/99	2.56 +/- 0.33	2.58 +/- 0.33	2.37 +/- 0.32	2.78 +/- 0.34	2.76 +/- 0.34	2.79 +/- 0.34	2.70 +/- 0.34	2.38 +/- 0.32	2.42 +/- 0.33
4/26/99	1.51 +/- 0.26	1.59 +/- 0.27	1.80 +/- 0.28	2.22 +/- 0.31	1.56 +/- 0.27	1.72 +/- 0.28	2.08 +/- 0.30	1.54 +/- 0.27	1.81 +/- 0.28
5/3/99	1.40 +/- 0.26	1.63 +/- 0.27	1.75 +/- 0.28	1.68 +/- 0.28	1.46 +/- 0.26	1.42 +/- 0.26	1.36 +/- 0.26	1.38 +/- 0.26	1.41 +/- 0.26
5/10/99	1.45 +/- 0.27	1.50 +/- 0.27	1.29 +/- 0.26	1.25 +/- 0.26	1.40 +/- 0.27	1.29 +/- 0.26	1.45 +/- 0.27	1.27 +/- 0.26	1.58 +/- 0.28
5/17/99	1.23 +/- 0.25	1.51 +/- 0.27	1.48 +/- 0.27	1.57 +/- 0.28	1.75 +/- 0.29	1.62 +/- 0.28	1.46 +/- 0.27	1.17 +/- 0.25	1.43 +/- 0.27
5/24/99	1.79 +/- 0.29	1.79 +/- 0.29	1.29 +/- 0.26	2.07 +/- 0.31	2.00 +/- 0.31	1.79 +/- 0.29	1.44 +/- 0.27	1.61 +/- 0.28	1.79 +/- 0.29
6/1/99	1.73 +/- 0.26	1.81 +/- 0.27	1.58 +/- 0.25	1.77 +/- 0.26	2.23 +/- 0.29	1.57 +/- 0.25	1.52 +/- 0.25	1.66 +/- 0.26	1.45 +/- 0.25
6/7/99	1.38 +/- 0.29	1.47 +/- 0.30	1.73 +/- 0.32	2.21 +/- 0.34	1.70 +/- 0.31	1.57 +/- 0.31	1.41 +/- 0.30	1.44 +/- 0.30	1.44 +/- 0.30
6/14/99	0.96 +/- 0.25	0.93 +/- 0.25	1.27 +/- 0.27	2.07 +/- 0.32	1.36 +/- 0.28	1.46 +/- 0.28	1.21 +/- 0.27	0.93 +/- 0.25	1.01 +/- 0.25
6/21/99	1.96 +/- 0.31	1.71 +/- 0.29	1.76 +/- 0.30	2.20 +/- 0.32	1.98 +/- 0.31	1.83 +/- 0.30	2.21 +/- 0.32	1.65 +/- 0.29	1.67 +/- 0.29
6/28/99	1.55 +/- 0.27	1.43 +/- 0.26	1.65 +/- 0.28	1.74 +/- 0.28	1.79 +/- 0.28	1.69 +/- 0.28	1.43 +/- 0.26	1.73 +/- 0.28	1.67 +/- 0.28
7/5/99	0.95 +/- 0.24	1.11 +/- 0.25	1.06 +/- 0.24	1.51 +/- 0.27	1.29 +/- 0.26	1.11 +/- 0.25	1.06 +/- 0.24	1.02 +/- 0.24	0.93 +/- 0.24
7/12/99	1.76 +/- 0.34	2.02 +/- 0.36	2.34 +/- 0.37	2.80 +/- 0.40	2.15 +/- 0.36	2.39 +/- 0.38	1.71 +/- 0.34	1.97 +/- 0.35	1.93 +/- 0.35
7/19/99	1.55 +/- 0.27	1.52 +/- 0.27	1.73 +/- 0.28	2.06 +/- 0.30	1.93 +/- 0.29	1.92 +/- 0.29	1.81 +/- 0.28	1.38 +/- 0.26	1.58 +/- 0.27
7/26/99	1.88 +/- 0.30	2.24 +/- 0.32	2.26 +/- 0.32	2.40 +/- 0.33	2.19 +/- 0.32	1.92 +/- 0.30	2.22 +/- 0.32	2.06 +/- 0.31	1.94 +/- 0.30
8/2/99	1.96 +/- 0.31	2.46 +/- 0.34	2.27 +/- 0.33	2.71 +/- 0.35	2.04 +/- 0.32	2.34 +/- 0.33	2.24 +/- 0.33	2.38 +/- 0.33	2.33 +/- 0.33
8/9/99	1.95 +/- 0.32	2.68 +/- 0.35	2.61 +/- 0.35	2.40 +/- 0.34	2.57 +/- 0.35	2.11 +/- 0.33	2.29 +/- 0.33	2.29 +/- 0.33	2.29 +/- 0.33
8/16/99	1.68 +/- 0.31	1.53 +/- 0.30	1.37 +/- 0.29	1.37 +/- 0.29	1.37 +/- 0.29	1.34 +/- 0.29	1.18 +/- 0.28	1.16 +/- 0.28	1.27 +/- 0.29
8/23/99	1.70 +/- 0.29	1.99 +/- 0.31	2.18 +/- 0.32	2.37 +/- 0.33	2.40 +/- 0.33	2.20 +/- 0.32	1.97 +/- 0.31	2.13 +/- 0.31	1.62 +/- 0.29
8/30/99	2.03 +/- 0.31	2.22 +/- 0.32	2.03 +/- 0.31	2.96 +/- 0.36	2.58 +/- 0.34	2.20 +/- 0.32	2.10 +/- 0.32	2.11 +/- 0.32	1.95 +/- 0.31
9/7/99	2.19 +/- 0.29	2.48 +/- 0.30	2.39 +/- 0.30	2.45 +/- 0.30	2.49 +/- 0.30	2.19 +/- 0.29	1.93 +/- 0.27	1.94 +/- 0.27	1.90 +/- 0.27

Beta Investigation Level =1 E-13 uCi/ml
Beta Reporting Level =2.6 E-11 uCi/ml

Table 5.2

Gross Beta Measurements of Environmental Air Samples - 1999 (x 10^{-14} uCi/cc)

Date	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9
9/13/99	2.00 +/- 0.34	1.63 +/- 0.32	1.91 +/- 0.34	1.78 +/- 0.33	1.74 +/- 0.33	2.13 +/- 0.35	2.04 +/- 0.34	2.15 +/- 0.35	1.76 +/- 0.33
9/20/99	3.07 +/- 0.36	3.01 +/- 0.36	3.41 +/- 0.38	3.08 +/- 0.36	2.84 +/- 0.35	2.67 +/- 0.35	2.95 +/- 0.36	2.87 +/- 0.35	2.96 +/- 0.36
9/27/99	2.24 +/- 0.33	2.89 +/- 0.36	2.57 +/- 0.34	2.50 +/- 0.34	2.58 +/- 0.34	2.11 +/- 0.32	2.40 +/- 0.34	2.12 +/- 0.32	2.34 +/- 0.33
10/4/99	2.33 +/- 0.32	2.82 +/- 0.35	2.73 +/- 0.34	2.50 +/- 0.33	2.47 +/- 0.33	2.13 +/- 0.31	2.81 +/- 0.35	2.77 +/- 0.34	2.67 +/- 0.34
10/11/99	1.95 +/- 0.29	2.10 +/- 0.30	1.64 +/- 0.27	2.01 +/- 0.29	2.22 +/- 0.31	1.87 +/- 0.29	2.15 +/- 0.30	1.87 +/- 0.29	1.80 +/- 0.28
10/18/99	2.02 +/- 0.31	2.70 +/- 0.34	2.61 +/- 0.34	2.75 +/- 0.35	2.29 +/- 0.32	2.32 +/- 0.32	2.87 +/- 0.35	2.44 +/- 0.33	2.17 +/- 0.32
10/25/99	3.67 +/- 0.40	4.27 +/- 0.42	3.71 +/- 0.40	3.94 +/- 0.41	2.88 +/- 0.37	3.78 +/- 0.40	3.80 +/- 0.41	3.78 +/- 0.40	3.46 +/- 0.39
11/1/99	1.63 +/- 0.29	1.89 +/- 0.30	2.28 +/- 0.32	2.11 +/- 0.31	1.76 +/- 0.29	2.11 +/- 0.31	1.96 +/- 0.30	1.91 +/- 0.30	1.72 +/- 0.29
11/8/99	2.52 +/- 0.33	2.90 +/- 0.35	2.72 +/- 0.34	2.76 +/- 0.34	2.24 +/- 0.32	2.44 +/- 0.33	2.76 +/- 0.34	2.33 +/- 0.32	2.50 +/- 0.33
11/15/99	2.03 +/- 0.31	2.05 +/- 0.31	2.07 +/- 0.31	1.59 +/- 0.29	1.69 +/- 0.29	1.75 +/- 0.30	2.04 +/- 0.31	1.88 +/- 0.30	1.76 +/- 0.30
11/22/99	1.53 +/- 0.28	1.75 +/- 0.30	1.89 +/- 0.30	2.02 +/- 0.34	1.85 +/- 0.30	1.67 +/- 0.29	1.68 +/- 0.29	1.71 +/- 0.29	2.00 +/- 0.31
11/29/99	2.08 +/- 0.33	2.36 +/- 0.34	2.47 +/- 0.35	2.33 +/- 0.34	1.99 +/- 0.32	2.11 +/- 0.33	1.80 +/- 0.31	1.94 +/- 0.32	1.89 +/- 0.32
12/6/99	1.69 +/- 0.29	1.79 +/- 0.30	2.19 +/- 0.32	2.33 +/- 0.33	1.84 +/- 0.30	1.74 +/- 0.30	1.25 +/- 0.27	1.70 +/- 0.29	1.69 +/- 0.29
12/13/99	2.44 +/- 0.32	1.55 +/- 0.27	1.67 +/- 0.28	1.59 +/- 0.27	1.05 +/- 0.24	1.04 +/- 0.24	1.05 +/- 0.24	1.11 +/- 0.24	0.98 +/- 0.23
12/20/99	4.91 +/- 0.43	2.51 +/- 0.33	1.61 +/- 0.27	2.20 +/- 0.31	1.50 +/- 0.27	1.35 +/- 0.26	1.53 +/- 0.27	1.31 +/- 0.26	1.50 +/- 0.27
12/27/99	3.05 +/- 0.33	3.05 +/- 0.33	3.40 +/- 0.34	3.17 +/- 0.33	3.26 +/- 0.34	3.24 +/- 0.33	3.39 +/- 0.34	3.32 +/- 0.34	3.40 +/- 0.34
1/3/00	2.42 +/- 0.36	2.22 +/- 0.35	2.52 +/- 0.36	2.82 +/- 0.38	2.42 +/- 0.36	2.11 +/- 0.34	2.09 +/- 0.34	2.64 +/- 0.37	2.22 +/- 0.35
Station Mean	1.94	2.01	2.00	2.12	1.92	1.85	1.85	1.83	1.81
Station Max	4.91	4.27	3.71	3.94	3.26	3.78	3.80	3.78	3.46
Station Min	0.88	0.93	0.96	0.88	1.04	1.02	1.05	0.93	0.91
Site Mean	1.92								
Site Max	4.91								
Site Min	0.88								

Beta Investigation Level =1 E-13 uCi/ml
Beta Reporting Level =2.6 E-11 uCi/ml

5.2 Gross Alpha Particulate Activity

Airborne Gross alpha particulate activity is a sensitive and quick screening tool, and provides trend indication. It should be noted that pre-count decay times were decreased in 1996 from ten days to three days. Therefore, slight increases may be indicated on some monthly average charts during this time. However, these increases are not due to actual changes in environmental airborne radioactivity.

Comparisons of results from 1999 were made with data available from previous years and non US Ecology locations.

Table 5.3 Gross Alpha in Air Samples Comparison (uCi/cc)

	Minimum	Maximum	Average
1999 Annual Report	-5.8 E-15	5.5 E-15	1.6 E-15 to 2.4 E-15
1998 Annual Report	-1.3 E-15	6.7 E-15	1.5 E-15 to 2.4 E-15
1997 Annual Report	2.2 E-16	6.7 E-15	1.2 E-15 to 2.6 E-15
1996 Annual Report	-8.0 E-15	5.4 E-15	2.1 E-15 to 2.5 E-15
1995 Annual Report	-0.21 E-15	4.5 E-15	
1994 Annual Report	-1.9 E-15	1.6 E-15	
Historical Report	background	6.5 E-13	
1998 Hanford Onsite	ND	3.1 E-15	6.8 E-16
1998 Hanford Perimeter	ND	2.0 E-15	7.0 E-16
1997 Hanford Onsite	ND	5.5 E-15	5.2 E-16

(Notes: Multiply values by E+12 to obtain pCi/m^3)

The gross alpha concentrations measured at the US Ecology facility are similar to and consistent with, previous year's measurements. The mean, maximum and minimum gross alpha concentration for each air sampling station and site are presented in Table 5.4.

Weekly airborne gross alpha concentrations are plotted in Figures 5.19 through 5.27. Monthly average airborne alpha concentrations for the current year and previous years are plotted in Figures 5.28 through 5.36 Error bars for weekly plotted data represent the counting error at the 95 percent confidence interval. Error bars for monthly average plots represent the standard deviation of the weekly counts.

No differences from normal background concentrations in previous reports are apparent during 1999. Station 1, the background location, airborne alpha concentrations are statistically the same as all other site locations. In addition, there are no trends indicating a contribution from the site, and routine occupational monitoring of work activities did not detect elevated alpha levels attributable to site activities. Therefore, no significant airborne alpha emitters were released from site activities and the dose contribution due to airborne alpha emitters released from the facility is essentially zero.

TABLE 5.4

GROSS ALPHA MEASUREMENTS OF ENVIRONMENTAL AIR SAMPLES (XE-15 uCi/cc)

Date	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9
1/4/99	0.81 +/ 1.35	1.63 +/ 1.48	-0.58 +/ 1.09	-0.12 +/ 1.18	0.70 +/ 1.33	0.23 +/ 1.25	1.05 +/ 1.39	0.12 +/ 1.23	-0.12 +/ 1.18
1/11/99	3.31 +/ 1.25	1.83 +/ 0.95	2.06 +/ 1.00	4.68 +/ 1.47	2.40 +/ 1.07	2.17 +/ 1.03	3.31 +/ 1.25	2.97 +/ 1.18	2.51 +/ 1.10
1/18/99	0.80 +/ 0.80	1.36 +/ 0.94	1.48 +/ 0.97	0.80 +/ 0.80	1.14 +/ 0.89	0.80 +/ 0.80	0.45 +/ 0.70	1.02 +/ 0.86	0.45 +/ 0.70
1/25/99	0.80 +/ 0.92	1.48 +/ 1.07	1.14 +/ 1.00	1.02 +/ 0.97	0.80 +/ 0.92	1.02 +/ 0.97	0.68 +/ 0.89	0.57 +/ 0.86	1.14 +/ 1.00
2/1/99	1.73 +/ 0.98	1.15 +/ 0.84	2.65 +/ 1.17	1.61 +/ 0.96	1.73 +/ 0.98	2.07 +/ 1.06	1.27 +/ 0.87	1.04 +/ 0.81	0.92 +/ 0.78
2/8/99	1.37 +/ 0.89	1.71 +/ 0.97	2.05 +/ 1.05	0.91 +/ 0.77	0.91 +/ 0.77	0.80 +/ 0.74	0.46 +/ 0.63	1.02 +/ 0.80	1.37 +/ 0.89
2/16/99	1.10 +/ 0.85	1.40 +/ 0.92	1.90 +/ 1.02	1.99 +/ 1.03	1.20 +/ 0.87	1.10 +/ 0.85	1.50 +/ 0.94	1.80 +/ 1.00	1.20 +/ 0.87
2/22/99	0.40 +/ 0.78	1.33 +/ 1.04	1.60 +/ 1.11	1.86 +/ 1.17	1.46 +/ 1.07	1.46 +/ 1.07	1.46 +/ 1.07	1.33 +/ 1.04	1.60 +/ 1.11
3/1/99	1.14 +/ 0.71	1.25 +/ 0.74	2.39 +/ 1.02	2.74 +/ 1.09	1.48 +/ 0.81	1.25 +/ 0.74	0.57 +/ 0.50	0.80 +/ 0.59	1.48 +/ 0.81
3/8/99	0.91 +/ 0.95	2.85 +/ 1.32	2.62 +/ 1.28	3.31 +/ 1.40	2.97 +/ 1.34	2.85 +/ 1.32	1.48 +/ 1.07	1.82 +/ 1.14	2.62 +/ 1.28
3/15/99	1.46 +/ 1.14	2.02 +/ 1.25	1.46 +/ 1.14	2.13 +/ 1.26	2.13 +/ 1.26	2.02 +/ 1.25	1.35 +/ 1.12	1.24 +/ 1.10	1.68 +/ 1.19
3/22/99	2.76 +/ 1.10	3.57 +/ 1.26	2.76 +/ 1.10	4.49 +/ 1.41	2.53 +/ 1.06	1.96 +/ 0.93	2.30 +/ 1.01	2.30 +/ 1.01	2.19 +/ 0.98
3/29/99	1.03 +/ 0.93	1.26 +/ 0.98	0.92 +/ 0.90	1.83 +/ 1.10	0.69 +/ 0.84	0.69 +/ 0.84	1.37 +/ 1.00	0.80 +/ 0.87	0.69 +/ 0.84
4/5/99	1.83 +/ 0.95	2.98 +/ 1.19	2.17 +/ 1.03	1.95 +/ 0.98	2.40 +/ 1.08	1.03 +/ 0.74	0.92 +/ 0.71	1.14 +/ 0.78	2.86 +/ 1.17
4/12/99	2.51 +/ 1.05	2.40 +/ 1.02	2.51 +/ 1.05	2.17 +/ 0.98	2.40 +/ 1.02	1.71 +/ 0.87	2.17 +/ 0.98	3.42 +/ 1.22	2.28 +/ 1.00
4/19/99	2.37 +/ 1.11	3.50 +/ 1.31	2.94 +/ 1.21	5.42 +/ 1.60	2.71 +/ 1.17	4.41 +/ 1.45	4.75 +/ 1.50	3.84 +/ 1.37	1.92 +/ 1.01
4/26/99	1.27 +/ 0.98	1.61 +/ 1.06	1.96 +/ 1.13	3.57 +/ 1.41	1.61 +/ 1.06	1.84 +/ 1.11	2.42 +/ 1.22	2.42 +/ 1.22	1.73 +/ 1.08
5/3/99	1.83 +/ 0.95	2.98 +/ 1.19	1.60 +/ 0.90	2.52 +/ 1.10	1.83 +/ 0.95	1.26 +/ 0.81	1.83 +/ 0.95	1.49 +/ 0.87	2.29 +/ 1.05
5/10/99	1.55 +/ 0.91	2.15 +/ 1.05	2.39 +/ 1.10	2.51 +/ 1.12	1.79 +/ 0.96	2.39 +/ 1.10	2.27 +/ 1.07	1.67 +/ 0.94	2.03 +/ 1.02
5/17/99	2.50 +/ 1.18	2.20 +/ 1.13	2.29 +/ 1.15	1.95 +/ 1.08	3.31 +/ 1.32	3.31 +/ 1.32	2.51 +/ 1.18	2.28 +/ 1.14	1.48 +/ 0.97
5/24/99	2.17 +/ 1.20	0.68 +/ 0.89	2.05 +/ 1.18	2.05 +/ 1.18	2.96 +/ 1.34	2.51 +/ 1.26	1.48 +/ 1.07	1.60 +/ 1.09	1.82 +/ 1.14
6/1/99	0.20 +/ 0.73	1.79 +/ 1.07	1.09 +/ 0.94	0.70 +/ 0.85	0.50 +/ 0.80	1.89 +/ 1.09	1.59 +/ 1.03	1.09 +/ 0.94	0.50 +/ 0.80
6/7/99	1.46 +/ 1.19	1.86 +/ 1.28	1.73 +/ 1.25	1.99 +/ 1.30	1.33 +/ 1.17	1.33 +/ 1.17	0.80 +/ 1.04	1.20 +/ 1.14	1.06 +/ 1.11
6/14/99	1.94 +/ 1.02	1.60 +/ 0.95	3.76 +/ 1.36	2.51 +/ 1.14	2.39 +/ 1.12	2.51 +/ 1.14	1.94 +/ 1.02	0.68 +/ 0.71	1.48 +/ 0.92
6/21/99	1.40 +/ 1.02	2.09 +/ 1.16	2.21 +/ 1.18	1.98 +/ 1.14	2.56 +/ 1.25	1.40 +/ 1.02	1.86 +/ 1.12	1.40 +/ 1.02	1.28 +/ 0.99
6/28/99	1.68 +/ 1.05	0.90 +/ 0.88	1.34 +/ 0.98	2.46 +/ 1.20	1.57 +/ 1.03	2.80 +/ 1.26	1.23 +/ 0.96	1.46 +/ 1.01	0.67 +/ 0.82
7/5/99	0.99 +/ 1.07	1.09 +/ 1.08	1.89 +/ 1.22	0.00 +/ 0.87	1.79 +/ 1.20	0.99 +/ 1.07	1.39 +/ 1.13	0.70 +/ 1.01	0.20 +/ 0.91
7/12/99	0.00 +/ 1.29	0.00 +/ 1.29	1.08 +/ 1.49	1.34 +/ 1.54	0.81 +/ 1.44	1.21 +/ 1.51	0.81 +/ 1.44	0.54 +/ 1.39	-0.27 +/ 1.24
7/19/99	0.46 +/ 1.00	1.14 +/ 1.14	2.27 +/ 1.34	1.70 +/ 1.24	1.14 +/ 1.14	2.61 +/ 1.39	1.02 +/ 1.11	0.68 +/ 1.04	1.82 +/ 1.26
7/26/99	0.79 +/ 0.74	1.92 +/ 1.02	3.05 +/ 1.23	3.73 +/ 1.35	3.51 +/ 1.31	4.41 +/ 1.45	2.15 +/ 1.06	2.60 +/ 1.15	2.15 +/ 1.06
8/2/99	1.38 +/ 1.01	1.61 +/ 1.06	2.30 +/ 1.19	4.25 +/ 1.51	2.18 +/ 1.17	1.84 +/ 1.10	2.18 +/ 1.17	1.61 +/ 1.06	1.49 +/ 1.03
8/9/99	2.63 +/ 1.16	2.74 +/ 1.18	1.83 +/ 1.00	3.20 +/ 1.27	2.97 +/ 1.23	2.28 +/ 1.10	3.08 +/ 1.25	2.17 +/ 1.07	2.17 +/ 1.07
8/16/99	0.68 +/ 1.36	0.34 +/ 1.31	0.34 +/ 1.31	0.00 +/ 1.25	1.24 +/ 1.45	-0.34 +/ 1.19	0.11 +/ 1.27	-0.23 +/ 1.21	-0.11 +/ 1.23
8/23/99	1.37 +/ 1.05	2.74 +/ 1.30	2.40 +/ 1.25	2.17 +/ 1.20	1.03 +/ 0.98	2.51 +/ 1.27	1.60 +/ 1.10	1.48 +/ 1.07	3.20 +/ 1.38
8/30/99	1.04 +/ 0.98	0.35 +/ 0.81	1.04 +/ 0.98	1.96 +/ 1.17	1.84 +/ 1.15	1.84 +/ 1.15	0.81 +/ 0.93	0.69 +/ 0.90	0.69 +/ 0.90
9/7/99	2.09 +/ 1.01	3.98 +/ 1.32	4.18 +/ 1.35	3.19 +/ 1.20	2.69 +/ 1.12	2.99 +/ 1.17	2.39 +/ 1.07	1.69 +/ 0.94	2.39 +/ 1.07
9/13/99	1.99 +/ 1.30	1.86 +/ 1.28	1.73 +/ 1.25	2.26 +/ 1.35	1.33 +/ 1.17	2.26 +/ 1.35	3.06 +/ 1.50	1.46 +/ 1.19	0.93 +/ 1.07

Gross Alpha Investigation Level = 1E-14 uCi/cc
Gross Alpha Reporting Level = 1.7 E-14 uCi/cc

TABLE 5.4

GROSS ALPHA MEASUREMENTS OF ENVIRONMENTAL AIR SAMPLES (XE-15 uCi/cc)

Date	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9
9/20/99	2.25 +/ 1.21	3.15 +/ 1.36	3.60 +/ 1.43	4.17 +/ 1.51	3.15 +/ 1.36	2.59 +/ 1.27	4.73 +/ 1.59	1.58 +/ 1.08	2.37 +/ 1.23
9/27/99	1.38 +/ 1.19	1.15 +/ 1.15	1.04 +/ 1.13	1.73 +/ 1.26	0.69 +/ 1.06	0.69 +/ 1.06	0.46 +/ 1.01	1.38 +/ 1.19	0.35 +/ 0.98
10/4/99	1.36 +/ 1.04	1.36 +/ 1.04	1.25 +/ 1.02	3.18 +/ 1.37	2.04 +/ 1.18	1.93 +/ 1.16	2.61 +/ 1.28	2.27 +/ 1.22	2.61 +/ 1.28
10/11/999	1.91 +/ 1.01	2.14 +/ 1.06	1.46 +/ 0.91	2.14 +/ 1.06	2.25 +/ 1.08	1.69 +/ 0.96	2.36 +/ 1.10	3.60 +/ 1.32	1.80 +/ 0.99
10/18/99	1.84 +/ 0.95	3.10 +/ 1.21	2.75 +/ 1.15	5.16 +/ 1.54	3.10 +/ 1.21	2.98 +/ 1.19	4.36 +/ 1.42	2.87 +/ 1.17	2.64 +/ 1.12
10/25/99	2.76 +/ 1.24	2.65 +/ 1.22	2.88 +/ 1.26	3.92 +/ 1.43	2.07 +/ 1.11	3.57 +/ 1.37	2.07 +/ 1.11	2.65 +/ 1.22	2.07 +/ 1.11
11/1/99	1.13 +/ 0.77	2.24 +/ 1.03	2.24 +/ 1.03	0.90 +/ 0.69	0.90 +/ 0.69	2.69 +/ 1.12	1.90 +/ 0.96	1.57 +/ 0.88	1.79 +/ 0.93
11/8/99	1.73 +/ 1.17	2.88 +/ 1.37	2.19 +/ 1.26	2.30 +/ 1.28	2.30 +/ 1.28	1.27 +/ 1.08	2.99 +/ 1.39	2.30 +/ 1.28	2.65 +/ 1.34
11/15/99	1.60 +/ 1.05	3.08 +/ 1.32	2.74 +/ 1.26	2.05 +/ 1.14	2.62 +/ 1.24	1.37 +/ 1.00	1.14 +/ 0.95	1.37 +/ 1.00	0.80 +/ 0.87
11/22/99	1.03 +/ 0.74	1.03 +/ 0.74	1.60 +/ 0.89	1.32 +/ 0.90	0.68 +/ 0.63	1.14 +/ 0.77	0.68 +/ 0.63	1.94 +/ 0.97	2.17 +/ 1.02
11/29/99	1.36 +/ 0.94	3.29 +/ 1.31	3.29 +/ 1.31	5.44 +/ 1.63	3.29 +/ 1.31	2.95 +/ 1.26	2.95 +/ 1.26	2.72 +/ 1.22	2.38 +/ 1.15
12/6/99	1.38 +/ 1.06	1.72 +/ 1.13	1.38 +/ 1.06	1.61 +/ 1.10	1.49 +/ 1.08	2.30 +/ 1.23	1.38 +/ 1.06	2.18 +/ 1.21	1.38 +/ 1.06
12/13/99	0.79 +/ 0.80	1.47 +/ 0.97	2.03 +/ 1.09	2.26 +/ 1.13	0.79 +/ 0.80	0.00 +/ 0.54	1.58 +/ 0.99	0.79 +/ 0.80	1.02 +/ 0.86
12/20/99	2.41 +/ 1.25	1.95 +/ 1.17	2.41 +/ 1.25	2.18 +/ 1.21	2.87 +/ 1.33	2.06 +/ 1.19	3.21 +/ 1.39	2.18 +/ 1.21	1.95 +/ 1.17
12/27/99	4.61 +/ 1.42	3.91 +/ 1.32	4.21 +/ 1.36	3.70 +/ 1.29	5.51 +/ 1.53	3.30 +/ 1.23	4.11 +/ 1.35	4.81 +/ 1.44	3.20 +/ 1.21
1/3/00	1.85 +/ 1.03	1.85 +/ 1.03	2.11 +/ 1.10	1.98 +/ 1.07	2.11 +/ 1.10	1.71 +/ 1.00	2.90 +/ 1.27	3.03 +/ 1.29	2.64 +/ 1.21
Station Mea	1.57	1.97	2.07	2.39	1.96	1.92	1.91	1.72	1.62
Station Max	4.61	3.98	4.21	5.44	5.51	4.41	4.75	4.81	3.20
Station Min	0.00	0.00	-0.58	-0.12	0.50	-0.34	0.11	-0.23	-0.27
Site Mean	1.90								
Site Max	5.51								
Site Min	-0.58								

Gross Alpha Investigation Level = 1E-14 uCi/cc
Gross Alpha Reporting Level = 1.7 E-14 uCi/cc

5.3 Gamma Analysis of Airborne Particulate Filters

Weekly environmental air filters are composited monthly and sent to Teledyne Isotopes for gamma spectrum analysis. Man made gamma emitters were not detected on any monthly air filter composite for 1999. The required minimum detectable concentrations for gamma isotope analysis are given in Table 5.5.

TABLE 5.5
Required Minimum Detectable Concentration (MDCs)
for Selected Gamma Emitters in Air.

Nuclide	uCi/cc	Nuclide	uCi/cc	Nuclide	uCi/cc
Na-22	1.0 E-14	Mn-54	1.0 E-14	Co-58	1.0 E-14
Co-60	1.0 E-14	Fe-59	2.0 E-14	Zn-65	2.0 E-14
Zr/Nb-95	2.0 E-14	Ru-103	1.0 E-14	Ru-106	9.0 E-14
Sb-124	1.0 E-14	Sb-125	2.0 E-14	Cs-134	1.0 E-14
Cs-137	1.0 E-14	Ba/La140	2.0 E-14	Ce-141	1.0 E-14
Ce/Pr144	9.0 E-14	Eu-152	6.0 E-14	Eu-154	3.0 E-14
Eu-155	2.0 E-14				

NOTES:

1. The Minimum Detectable Concentration (MDC) is defined as the concentration at which a 5% risk of false detection and false non-detection exists.
2. Multiple uCi/cc by 1 E+12 to obtain pCi/m3

5.4 Iodine 125 Airborne Concentrations

Charcoal canister air samples are analyzed weekly for I-125 by low energy gamma counting. Table 5.6 provides the weekly I-125 concentrations along with the mean, maximum and minimum for each station and the site. Figures 5.37 through 5.45 plot the weekly I-125 results. Figures 5.46 through 5.54 plot I-125 data for the last five years. Error bars for weekly data represent the counting error at the 95 percent confidence interval. Error bars for monthly data represents the standard deviation of the monthly readings.

The 1999 annual mean I-125 was 2.1 E-14 uCi/cc (2.1 E-2 pCi/m^3). This concentration is less than 0.01 percent of the effluent air limit for unrestricted areas (3.0 E-10 uCi/cc), referenced in WAC 246-221-290, Appendix A, Table II, Column 1. The maximum weekly concentration was 1.1 E-13 uCi/cc and the minimum weekly concentration was –2.8 E-14 uCi/cc. The 1998 mean annual concentration of I-125 varied from 2.0 E-14 uCi/cc to 2.4 E-14 uCi/cc with a mean of 1.4 E-14 uCi/cc (1.4 E-2 pCi/m^3).

Comparison of 1999 and 1998 data shows a slight difference for Iodine 125. However, this difference is due to decreasing the counting efficiency, and is not indicative of a change in iodine levels. The 1999 counting efficiency was changed to represent a more conservative distribution inside the charcoal canister. Consequently, the calculated iodine concentrations and errors increased. However, comparison of background counts and sample counts shows that the 1999 and 1998 charcoal canister results are indistinguishable from each other. I-125 in air data are not reported in the Hanford or Energy Northwest, and I-125 comparisons are not possible.

Table 5.6

Environmental Air Sample Measurements -1999

Iodine Catridge Gross Gamma ($X10^{-14}$ uCi/cc)

Date	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9
1/4/99	2.30 +/- 1.46	0.82 +/- 0.97	1.86 +/- 1.45	0.77 +/- 0.97	3.02 +/- 0.28	0.48 +/- 0.96	2.35 +/- 1.46	1.18 +/- 0.98	1.33 +/- 1.44
1/11/99	0.31 +/- 0.93	-0.86 +/- 1.46	1.34 +/- 0.96	0.19 +/- 1.49	0.82 +/- 0.28	0.29 +/- 1.49	0.11 +/- 0.93	-0.21 +/- 1.48	1.17 +/- 0.95
1/18/99	2.12 +/- 1.48	0.75 +/- 0.92	-0.60 +/- 1.42	2.03 +/- 0.95	0.88 +/- 0.42	0.74 +/- 0.92	0.00 +/- 1.43	0.65 +/- 0.92	1.20 +/- 1.46
1/25/99	1.13 +/- 1.46	0.79 +/- 0.95	0.86 +/- 1.46	0.88 +/- 0.95	0.88 +/- 0.3	0.38 +/- 0.94	-0.38 +/- 1.43	0.69 +/- 0.95	1.06 +/- 1.46
2/1/99	1.72 +/- 0.98	1.03 +/- 1.49	1.14 +/- 0.96	0.18 +/- 1.47	1.54 +/- 0.37	0.89 +/- 1.49	1.60 +/- 0.97	0.63 +/- 1.48	0.59 +/- 0.95
2/8/99	1.24 +/- 0.96	-0.10 +/- 1.42	1.44 +/- 0.97	1.06 +/- 1.45	0.76 +/- 0.41	0.11 +/- 1.43	1.20 +/- 0.96	1.37 +/- 1.46	1.00 +/- 0.96
2/16/99	1.79 +/- 1.24	1.65 +/- 0.84	1.26 +/- 1.23	0.74 +/- 0.82	0.75 +/- 0.31	1.42 +/- 0.84	2.60 +/- 1.26	1.69 +/- 0.84	1.97 +/- 1.24
2/22/99	-0.04 +/- 1.64	0.41 +/- 1.24	0.69 +/- 1.66	0.00 +/- 1.23	0.35 +/- 0.34	0.26 +/- 1.24	1.21 +/- 1.67	0.68 +/- 1.25	0.14 +/- 1.64
3/1/99	1.15 +/- 1.44	0.09 +/- 1.00	0.16 +/- 1.42	0.36 +/- 1.01	1.01 +/- 0.31	0.52 +/- 1.01	0.34 +/- 1.42	0.22 +/- 1.01	0.14 +/- 1.42
3/8/99	0.69 +/- 1.04	1.29 +/- 1.42	0.52 +/- 1.04	1.53 +/- 1.43	0.73 +/- 0.27	0.93 +/- 1.41	-0.48 +/- 1.01	-0.16 +/- 1.39	-0.12 +/- 1.02
3/15/99	2.44 +/- 1.38	1.20 +/- 1.00	1.96 +/- 1.37	0.68 +/- 0.99	2.11 +/- 0.26	1.47 +/- 1.01	1.81 +/- 1.37	0.03 +/- 0.97	2.03 +/- 1.37
3/22/99	1.25 +/- 1.42	0.43 +/- 0.97	1.72 +/- 1.43	1.13 +/- 0.98	2.46 +/- 0.29	1.30 +/- 0.99	1.20 +/- 1.42	1.56 +/- 1.00	1.49 +/- 1.43
3/29/99	0.97 +/- 1.43	1.16 +/- 1.00	1.99 +/- 1.45	1.25 +/- 1.00	0.42 +/- 0.28	0.78 +/- 0.99	0.02 +/- 1.40	0.96 +/- 0.99	0.52 +/- 1.42
4/5/99	0.90 +/- 0.98	0.98 +/- 0.98	1.11 +/- 0.98	0.34 +/- 0.96	0.63 +/- 0.31	0.81 +/- 0.97	0.85 +/- 0.98	1.11 +/- 0.98	1.73 +/- 1.00
4/12/99	0.29 +/- 0.94	0.09 +/- 0.93	1.00 +/- 0.96	0.73 +/- 0.95	1.10 +/- 0.32	0.23 +/- 0.94	0.53 +/- 0.94	1.17 +/- 0.96	1.68 +/- 0.97
4/19/99	2.04 +/- 0.99	0.74 +/- 0.96	1.54 +/- 0.98	1.60 +/- 0.98	1.55 +/- 0.3	1.76 +/- 0.99	1.90 +/- 0.99	1.54 +/- 0.98	1.78 +/- 0.99
4/26/99	0.79 +/- 0.99	2.37 +/- 1.42	0.59 +/- 0.98	1.76 +/- 1.41	0.46 +/- 0.27	1.61 +/- 1.40	0.43 +/- 0.98	1.15 +/- 1.39	0.66 +/- 0.98
5/3/99	0.85 +/- 0.98	2.17 +/- 1.42	2.18 +/- 1.01	1.52 +/- 1.41	0.74 +/- 0.28	0.52 +/- 1.38	1.08 +/- 0.98	0.69 +/- 1.39	1.63 +/- 1.00
5/10/99	0.75 +/- 1.01	2.35 +/- 1.47	0.56 +/- 1.01	0.84 +/- 1.43	0.94 +/- 0.33	0.88 +/- 1.43	1.52 +/- 1.03	1.02 +/- 1.43	1.37 +/- 1.03
5/17/99	1.54 +/- 1.37	-0.07 +/- 1.02	1.17 +/- 1.37	0.21 +/- 1.02	0.37 +/- 0.67	-0.17 +/- 1.00	0.67 +/- 1.35	0.13 +/- 1.01	1.71 +/- 1.37
5/24/99	2.14 +/- 1.04	1.00 +/- 1.41	1.78 +/- 1.02	1.02 +/- 1.41	1.84 +/- 0.46	1.02 +/- 1.41	1.86 +/- 1.02	0.75 +/- 1.40	1.12 +/- 1.01
6/1/99	1.08 +/- 1.23	0.32 +/- 1.21	0.88 +/- 1.22	1.08 +/- 1.23	0.88 +/- 0.27	0.72 +/- 1.22	1.45 +/- 1.23	0.89 +/- 1.22	0.53 +/- 1.21
6/7/99	1.95 +/- 1.61	1.45 +/- 1.60	1.94 +/- 1.61	1.45 +/- 1.60	1.88 +/- 0.31	1.23 +/- 1.59	1.86 +/- 1.61	0.29 +/- 1.57	2.40 +/- 1.62
6/14/99	1.74 +/- 1.37	0.51 +/- 1.34	1.07 +/- 1.35	1.37 +/- 1.36	0.25 +/- 0.3	1.37 +/- 1.36	0.51 +/- 1.34	0.38 +/- 1.34	0.95 +/- 1.35
6/21/99	1.17 +/- 1.40	1.06 +/- 1.40	0.72 +/- 1.39	0.77 +/- 1.39	0.96 +/- 0.29	0.65 +/- 1.39	1.46 +/- 1.41	1.01 +/- 1.40	0.86 +/- 1.40
6/28/99	2.20 +/- 1.41	2.30 +/- 1.42	2.07 +/- 1.41	2.02 +/- 1.41	0.91 +/- 0.27	2.49 +/- 1.42	0.39 +/- 1.37	1.36 +/- 1.39	1.81 +/- 1.41
7/5/99	1.24 +/- 1.19	2.06 +/- 1.21	1.78 +/- 1.21	1.40 +/- 1.20	3.17 +/- 0.28	1.43 +/- 1.20	1.68 +/- 1.21	2.31 +/- 1.22	1.42 +/- 1.20
7/12/99	1.29 +/- 1.61	2.02 +/- 1.63	0.60 +/- 1.59	1.11 +/- 1.61	1.35 +/- 0.3	1.68 +/- 1.62	1.23 +/- 1.61	1.72 +/- 1.62	2.12 +/- 1.63
7/19/99	0.32 +/- 1.34	1.44 +/- 1.36	1.52 +/- 1.37	1.19 +/- 1.36	1.42 +/- 0.28	1.27 +/- 1.36	0.27 +/- 1.34	0.97 +/- 1.35	0.68 +/- 1.35
7/26/99	3.92 +/- 4.05	2.89 +/- 3.22	4.38 +/- 4.06	2.30 +/- 3.21	3.56 +/- 0.33	4.14 +/- 3.25	5.57 +/- 4.08	4.22 +/- 3.25	1.37 +/- 3.99
8/2/99	-0.41 +/- 4.03	2.49 +/- 3.16	2.51 +/- 4.09	4.83 +/- 3.21	3.66 +/- 0.31	2.34 +/- 3.15	0.84 +/- 4.05	3.13 +/- 3.17	3.53 +/- 4.11
8/9/99	4.30 +/- 3.23	0.64 +/- 4.02	0.94 +/- 3.15	-1.01 +/- 3.98	6.27 +/- 0.33	2.94 +/- 4.07	0.75 +/- 3.14	0.05 +/- 4.00	4.97 +/- 3.24
8/16/99	4.49 +/- 3.93	4.71 +/- 3.16	3.59 +/- 3.91	3.42 +/- 3.13	3.54 +/- 0.35	5.80 +/- 3.18	3.95 +/- 3.92	6.23 +/- 3.19	3.68 +/- 3.91
8/23/99	4.50 +/- 3.18	4.38 +/- 3.18	2.96 +/- 3.15	4.38 +/- 3.18	3.71 +/- 0.33	4.78 +/- 3.19	3.75 +/- 3.16	2.65 +/- 3.14	2.21 +/- 3.13
8/30/99	5.01 +/- 4.03	3.90 +/- 3.35	8.03 +/- 4.10	2.70 +/- 3.32	5.89 +/- 0.3	3.98 +/- 3.35	4.64 +/- 4.03	4.02 +/- 3.35	8.40 +/- 4.11
9/7/99	4.41 +/- 3.45	1.66 +/- 2.92	2.48 +/- 3.41	4.24 +/- 2.97	3.64 +/- 0.32	3.07 +/- 2.95	4.89 +/- 3.46	4.55 +/- 2.98	5.01 +/- 3.46
9/13/99	6.71 +/- 3.77	3.27 +/- 4.67	2.21 +/- 3.66	1.12 +/- 4.62	3.35 +/- 0.35	0.75 +/- 4.61	5.74 +/- 3.74	2.25 +/- 4.65	4.64 +/- 3.72

Investigation Level 3.5E-14 uCi/cc
Reporting Level = 2.3 E-10 uCi/cc

Table 5.6

Environmental Air Sample Measurements -1999

Iodine Catridge Gross Gamma ($X10^{-14}$ uCi/cc)

Date	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9
9/20/99	5.80 +/- 3.37	7.25 +/- 3.95	3.39 +/- 3.32	4.49 +/- 3.88	2.81 +/- 0.3	10.70 +/- 4.02	4.29 +/- 3.34	3.76 +/- 3.87	1.76 +/- 3.28
9/27/99	2.28 +/- 3.93	5.61 +/- 3.34	5.06 +/- 4.00	4.62 +/- 3.32	1.21 +/- 0.33	0.28 +/- 3.22	4.13 +/- 3.98	3.82 +/- 3.30	4.08 +/- 3.98
10/4/99	1.65 +/- 3.32	-0.37 +/- 3.76	-2.31 +/- 3.23	6.08 +/- 3.90	0.48 +/- 0.37	5.49 +/- 3.89	3.03 +/- 3.36	4.07 +/- 3.86	1.38 +/- 3.32
10/11/99	3.58 +/- 3.80	3.00 +/- 3.21	2.81 +/- 3.79	3.31 +/- 3.22	3.62 +/- 0.28	5.21 +/- 3.26	2.13 +/- 3.77	4.70 +/- 3.25	6.29 +/- 3.86
10/18/99	6.19 +/- 3.92	4.30 +/- 3.88	4.21 +/- 3.87	3.93 +/- 3.87	3.47 +/- 0.29	5.50 +/- 3.90	5.59 +/- 3.91	4.99 +/- 3.89	7.39 +/- 3.95
10/25/99	6.40 +/- 3.92	2.60 +/- 3.83	3.76 +/- 3.86	4.78 +/- 3.88	2.78 +/- 0.35	3.38 +/- 3.85	3.38 +/- 3.85	5.66 +/- 3.90	5.42 +/- 3.90
11/1/99	4.72 +/- 3.78	5.45 +/- 3.77	5.59 +/- 3.77	5.36 +/- 3.77	1.93 +/- 0.36	4.14 +/- 3.74	5.86 +/- 3.78	5.41 +/- 3.77	3.47 +/- 3.72
11/8/99	-2.79 +/- 3.43	1.30 +/- 3.95	0.20 +/- 3.49	4.22 +/- 4.01	-1.19 +/- 0.33	2.13 +/- 3.97	0.44 +/- 3.50	4.73 +/- 4.03	0.68 +/- 3.50
11/15/99	7.12 +/- 3.79	3.33 +/- 3.46	2.89 +/- 3.69	3.77 +/- 3.47	3.03 +/- 0.36	3.49 +/- 3.46	1.15 +/- 3.65	0.79 +/- 3.40	5.19 +/- 3.75
11/22/99	2.67 +/- 3.68	0.98 +/- 3.42	4.73 +/- 3.73	3.59 +/- 4.02	5.14 +/- 0.44	0.86 +/- 3.41	2.67 +/- 3.68	-1.65 +/- 3.36	6.61 +/- 3.77
11/29/99	1.77 +/- 3.42	0.35 +/- 3.40	0.22 +/- 3.38	0.59 +/- 3.40	4.15 +/- 0.28	0.43 +/- 3.40	4.15 +/- 3.48	-0.97 +/- 3.37	2.28 +/- 3.43
12/6/99	3.91 +/- 3.40	2.45 +/- 3.54	2.06 +/- 3.36	-0.93 +/- 3.46	6.21 +/- 0.3	0.69 +/- 3.50	5.06 +/- 3.43	4.02 +/- 3.58	5.10 +/- 3.43
12/13/99	7.43 +/- 3.46	3.43 +/- 3.38	5.33 +/- 3.42	4.09 +/- 3.39	4.51 +/- 0.39	5.37 +/- 3.42	3.08 +/- 3.37	5.06 +/- 3.41	4.94 +/- 3.41
12/20/99	1.19 +/- 3.52	4.18 +/- 3.59	2.09 +/- 3.54	0.52 +/- 3.51	2.17 +/- 0.34	1.98 +/- 3.54	-0.90 +/- 3.48	0.28 +/- 3.50	-1.02 +/- 3.48
12/27/99	2.46 +/- 2.80	3.41 +/- 2.98	0.82 +/- 2.76	2.31 +/- 2.96	3.01 +/- 0.28	3.03 +/- 2.97	1.68 +/- 2.78	3.10 +/- 2.98	2.15 +/- 2.79
1/3/00	2.73 +/- 3.97	3.55 +/- 3.65	3.68 +/- 3.99	2.67 +/- 3.63	0.69 +/- 0.36	3.14 +/- 3.64	3.27 +/- 3.98	1.95 +/- 3.61	1.59 +/- 3.95

	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9
Station Mean	2.40	1.97	2.01	1.97	2.11	2.09	2.05	1.94	2.38
Station Max	7.43	7.25	8.03	6.08	6.27	10.70	5.86	6.23	8.40
Station Min	-2.79	-0.86	-2.31	-1.01	-1.19	-0.17	-0.90	-1.65	-1.02

Site Mean	2.1
Site Max	10.7
Site Min	-2.79

Investigation Level 3.5E-14 uCi/cc
Reporting Level = 2.3 E-10 uCi/cc

5.5 Tritium Airborne Activity

Silica gel cartridges are used to collect tritium in air. Tritium concentrations for the three sampling locations are provided in Table 5-7. Figure 5.55 – 5.57 plot the monthly tritium in air concentrations. Comparisons of the minimum, maximum and average 1999 tritium concentrations were made with data available from previous years and the 1995, and 1997 Hanford reports. Results of this comparison are provided in Table 5-8.

Table 5-7 Monthly Tritium Concentrations (x1 E-12 uCi/cc or 1 pCi/m^3)
1999

		Station 1		Station 2		Station 5	
		Tritium	Error	Tritium	Error	Tritium	Error
Year	Month	uCi/cc	uCi/cc	uCi/cc	uCi/cc	uCi/cc	uCi/cc
1999	January	1.28	0.51	0.85	0.46	3.28	0.59
1999	February	0.43	0.47	0.44	0.69	1.94	0.48
1999	March	0.68	0.77	2.26	0.54	3.39	0.65
1999	April	1.45	0.75	0.67	0.50	1.24	0.42
1999	May	1.19	0.55	0.92	0.60	1.71	0.96
1999	June	3.34	1.14	1.48	1.08	3.76	1.09
1999	July	1.25	0.62	1.39	0.62	1.11	0.61
1999	August	1.22	1.12	1.31	1.31	5.44	1.10
1999	Sept.	1.40	0.79	0.52	0.76	4.72	0.68
1999	Oct.	0.99	0.56	1.19	0.60	3.18	0.75
1999	Nov.	0.32	1.05	2.28	1.21	3.15	1.26
1999	Dec.	0.92	0.53	1.49	0.58	3.40	0.63

Table 5-8 Air Moisture Tritium Comparison (uCi/cc or x1 E+12 pCi/m^3)

	Minimum	**Maximum**	**Average**
1999 Annual Report	3.2 E-13	5.4 E-12	1.2 E-12 to 3.0 E-12
1998 Annual Report	7.1 E-13	1.1 E-11	1.2 E-12 to 4.5 E-12
1997 Annual Report	2.6 E-13	1.7 E-11	1.3 E-12 to 5.0 E-12
1996 Annual Report	-6.7 E-13	1.1 E-11	1.2 E-12 to 5.1 E-12
1995 Annual Report	7.0 E-13	1.4 E-11	
1998 Hanford Onsite		7.9 E-12	1.7 E-12
1998 Hanford Perimeter		6.1 E-12	1.4 E-12
1997 Hanford Onsite	ND	4.9 E-12	6.8 E-13
1995 Hanford Onsite	1.6 E-12	2.4 E-11	

The data shows tritium concentrations are essentially the same as the Hanford Site. One location, Station 5, may be slightly higher than offsite locations. However, even Station 5 averages less than 0.0001 of the Table II effluent limit (1.0 E-7 uCi/cc) listed in Appendix A of the Washington Administrative Code 246-221-290. Airborne tritium quickly disperses and general public exposure to tritium involves significant dilution and limited occupancy. Resultant doses from airborne tritium would be very low (<0.001 mrem). Therefore, airborne tritium does not have a significant impact on the environment.

5.6 Radon Air Monitoring

Beginning in May 1993, US Ecology monitored radon gas concentration monthly. Three gas track etch detectors are located at air environmental Stations 1, 2 and 5. Table 5.9 presents monthly radon in air measurements for 1999. Figures 5-58 through 5-60 plot the monthly radon in air concentrations.

TABLE 5.9
Radon Air Measurements, 1999

	Station 1		Station 2		Station 5	
1999 Date	Radon pCi/L	Error pCi/L	Radon pCi/L	Error pCi/L	Radon pCi/L	Error pCi/L
January	1.6	0.7	1.4	0.7	1.3	0.7
February	3.8	0.5	2.5	0.5	1.6	0.6
March	2.1	0.6	2.0	0.6	4.5	0.9
April	1.1	0.6	1.1	0.6	2.7	0.4
May	1.1	0.7	1.2	0.7	1.0	0.5
June	1.1	0.6	1.1	0..6	1.1	0.6
July	0.9	0.6	1.0	0.6	1.4	0.5
August	1.1	0.6	1.1	0.6	1.1	0.6
September	0.9	0.5	1.1	0.6	1.5	0.6
October	1.1	0.6	1.1	0.6	1.1	0.6
November	1.3	0.8	1.7	0.7	2.8	0.6
December	1.7	0.5	1.7	0.5	1.0	0.6

Station 1 serves as the background location.
<LLD values are presented at the LLD

5.7 Air Emissions from Package Inspection Facility

US Ecology's package confirmation program verifies the contents of at least one shipment per week or one out of every 10 shipments (whichever is more frequent). All confirmation shipment packages are inspected non-intrusively and at least one package is opened or evaluated destructively. Packages are opened in the package inspection facility tent whenever possible. If required, waste repackaging is also done inside the inspection tent. The inspection facility exhaust is filtered by a high efficiency filter and sampled for radioactive particulates and Iodine 125 (charcoal filter). There are no non-radiological emissions from the Package Inspection Facility.

Facility emissions were evaluated using the US Environmental Protection Agency (EPA) "Comply" Code and National Council on Radiation Protection and Measurements (NCRP) Commentary 3, "Screening Techniques for Determining Compliance with Environmental Standards". The "Comply" Code uses conservative models and assumptions to calculate the radiation dose from facility emissions. Calculated doses were insignificantly small (<0.01 mrem) and demonstrate compliance with environmental standards. A brief description of the facility and emissions are presented below. More detailed facility descriptions along with the dose assessment details are provided in Appendix A.

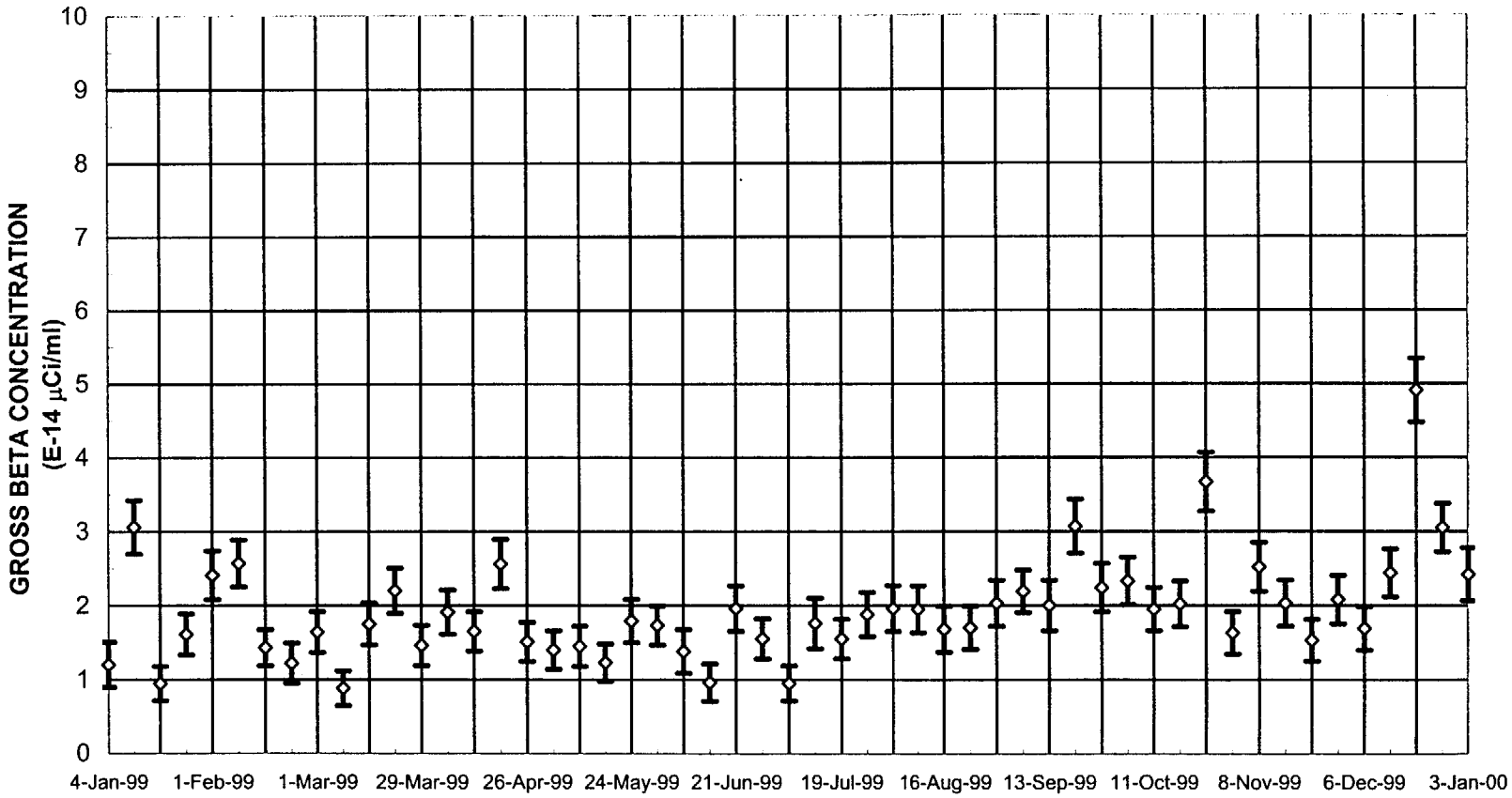
The vent exhaust and air sampler only operate during use of the package inspection facility. Samples are processed as occupational air samples. The typical collection time is one hour, the flow rate is 2.5 cfm, and the usual pre-count decay times is less than a day. In contrast, environmental air samples are collected for 168 hours, with a 1.5 cfm flow rate and a pre count decay time of 72 hours. Consequently vent exhaust samples have higher minimum detectable concentrations and contain a higher level of radon/thoron daughters than environmental air samples. Vent exhaust sample data shows little correlation between the isotopic content and level of activity in the inspected wastes. However, radon/thoron can not be separated from actual releases, and all of the measured vent exhaust activity is evaluated as a vent exhaust release.

All 1999 vent exhaust concentrations were below the occupational air action levels for gross beta, gross alpha and iodine. Attachment 1 of Appendix A provides the individual air sample results for the inspection facility. Figure 5.61 plots monthly average measured gross alpha concentration for the Inspection Facility. The average vent exhaust gross alpha concentration in 1999 was 7.7 E-14 uCi/cc. This is less than 20 percent of the Derived Air Concentration (DAC) for restricted areas for Th-232, the most restrictive alpha emitter present in inspected or remediated packages. Since air emissions from the facility only occur during package inspections, time weighted averages are much less than the measured values.

Figure 5.62 plots the monthly gross beta concentration for the Inspection Facility. The facility's average gross beta concentration was 4.8 E-13 uCi/cc in 1999. This is less than 0.01 percent of the DAC for restricted areas for Sr-90, which is the most restrictive beta emitting isotope present in inspected/remediated waste packages.

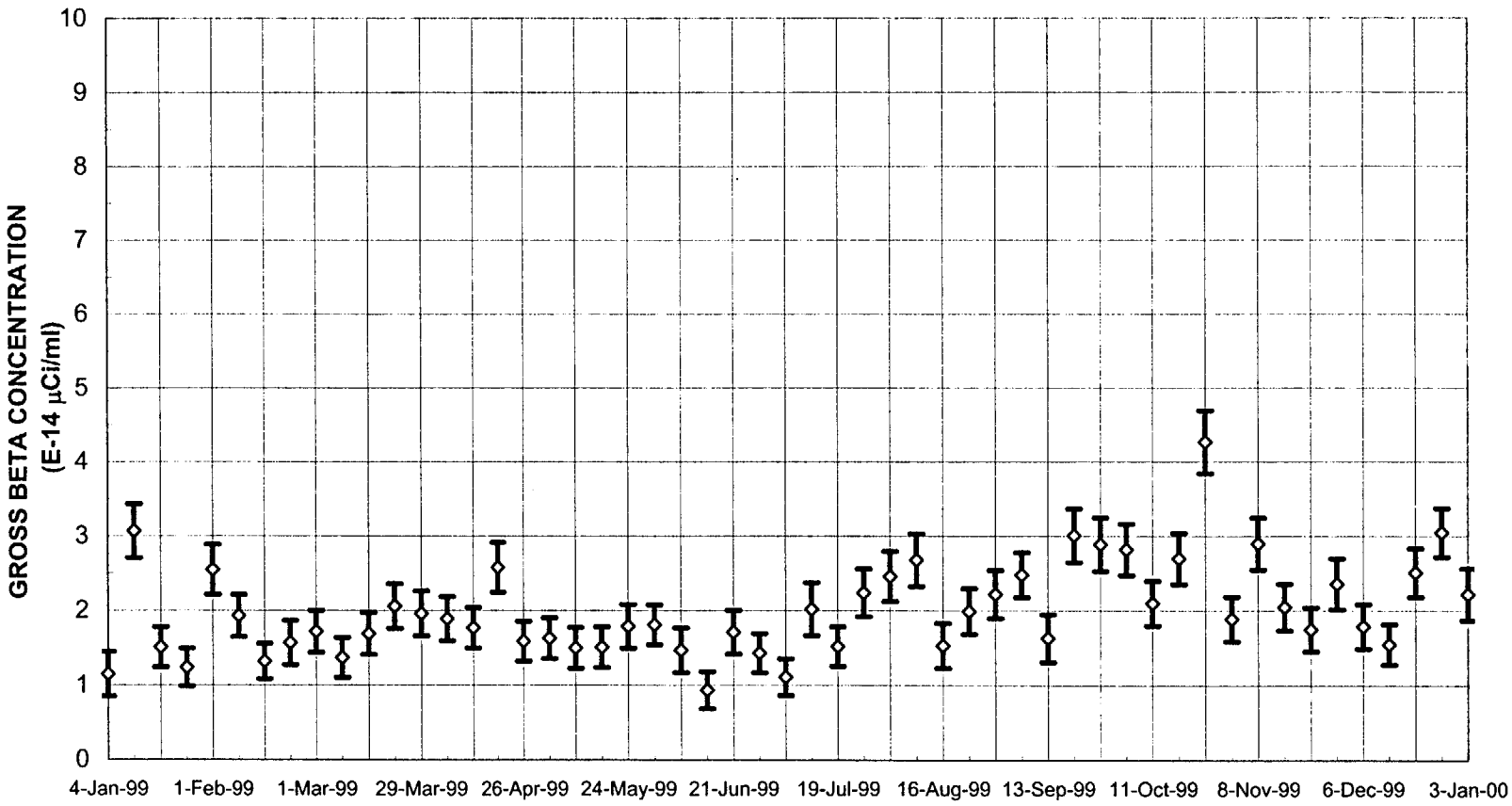
Figure 5.63 plots monthly Iodine 125 concentration for the Inspection Facility. The average I-125 monthly concentration was 2.7 E-12 uCi/cc in 1999. This is less than 0.01 percent of the DAC for I-125 in restricted areas. Based on the radionuclide inventories of inspected wastes and spectrum analysis of selected charcoal cartridges, the charcoal cartridge probably contained naturally occurring radionuclides not iodine.

FIGURE 5.1
WEEKLY GROSS BETA ACTIVITY IN AIR
AT STATION 1 -- RICHLAND, WASHINGTON



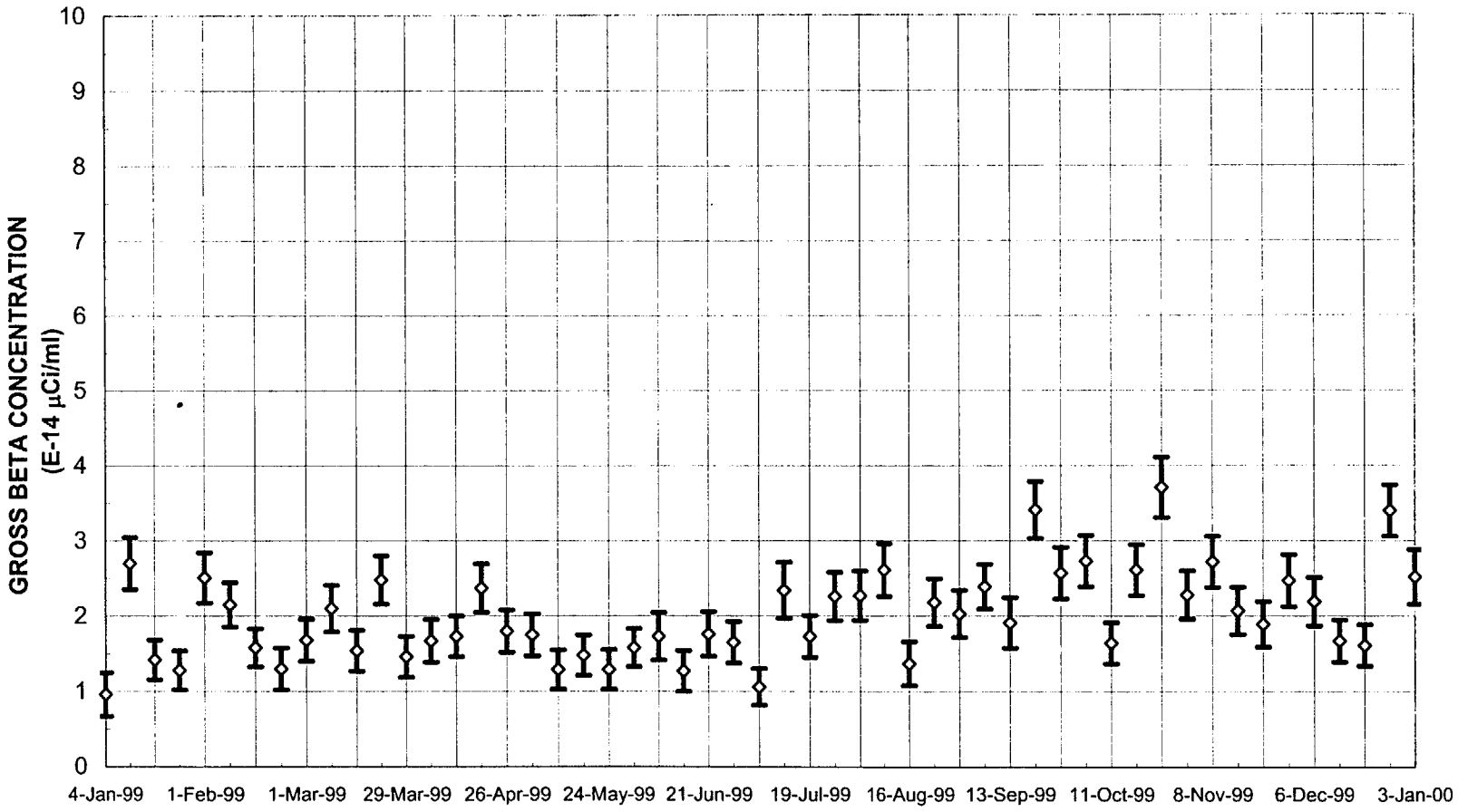
Gross Beta Investigation Level = 1 E-13 uCi/cc
Gross Beta Reporting Level =2.6 E-11 uCi/cc

FIGURE 5.2
WEEKLY GROSS BETA ACTIVITY IN AIR
AT STATION 2 -- RICHLAND, WASHINGTON



Gross Beta Investigation Level = 1 E-13 uCi/cc
Gross Beta Reporting Level =2.6 E-11 uCi/cc

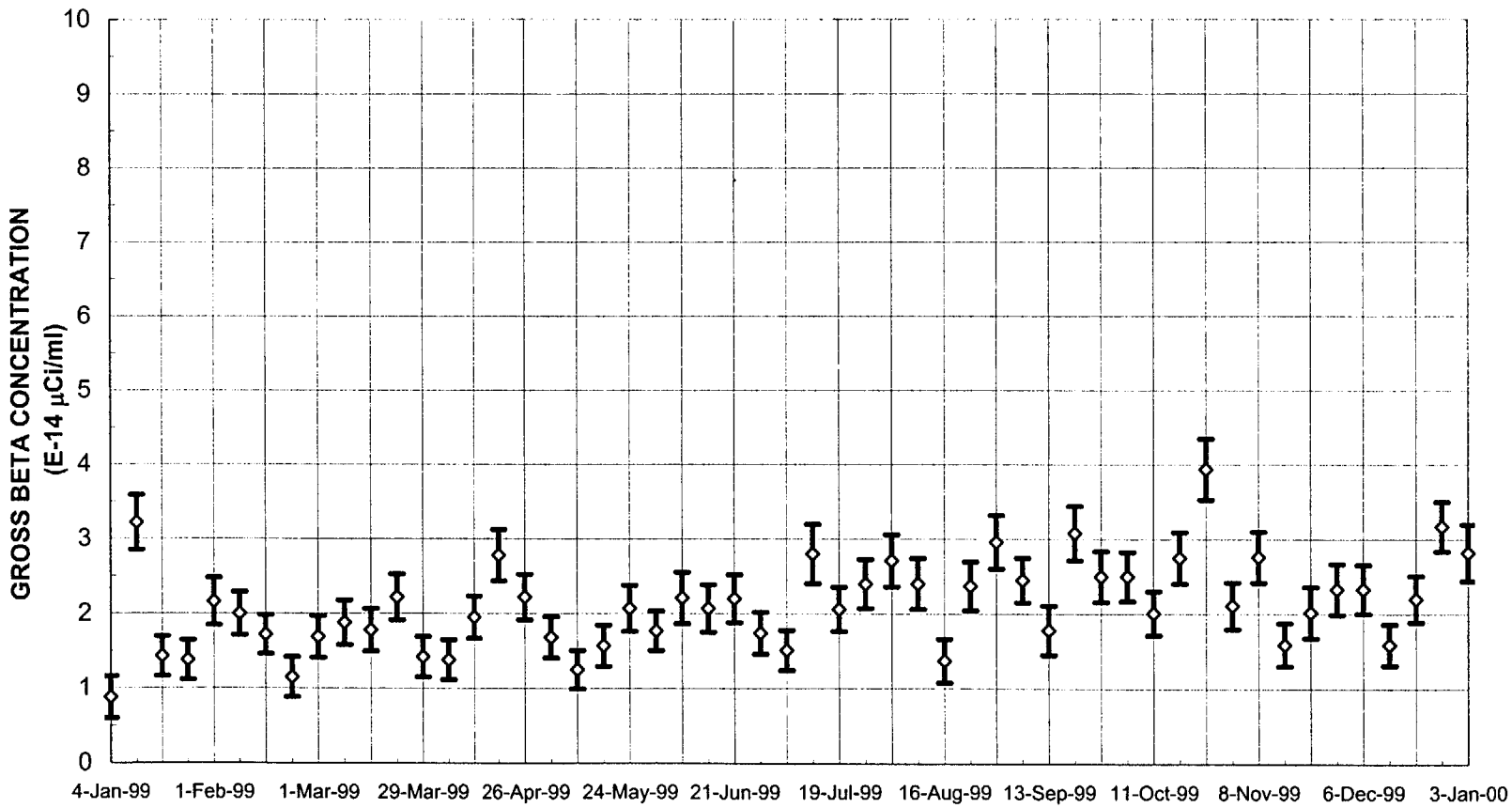
FIGURE 5.3
WEEKLY GROSS BETA ACTIVITY IN AIR
AT STATION 3 -- RICHLAND, WASHINGTON



Gross Beta Investigation Level = 1 E-13 uCi/cc
Gross Beta Reporting Level = 2.6 E-111 uCi/cc

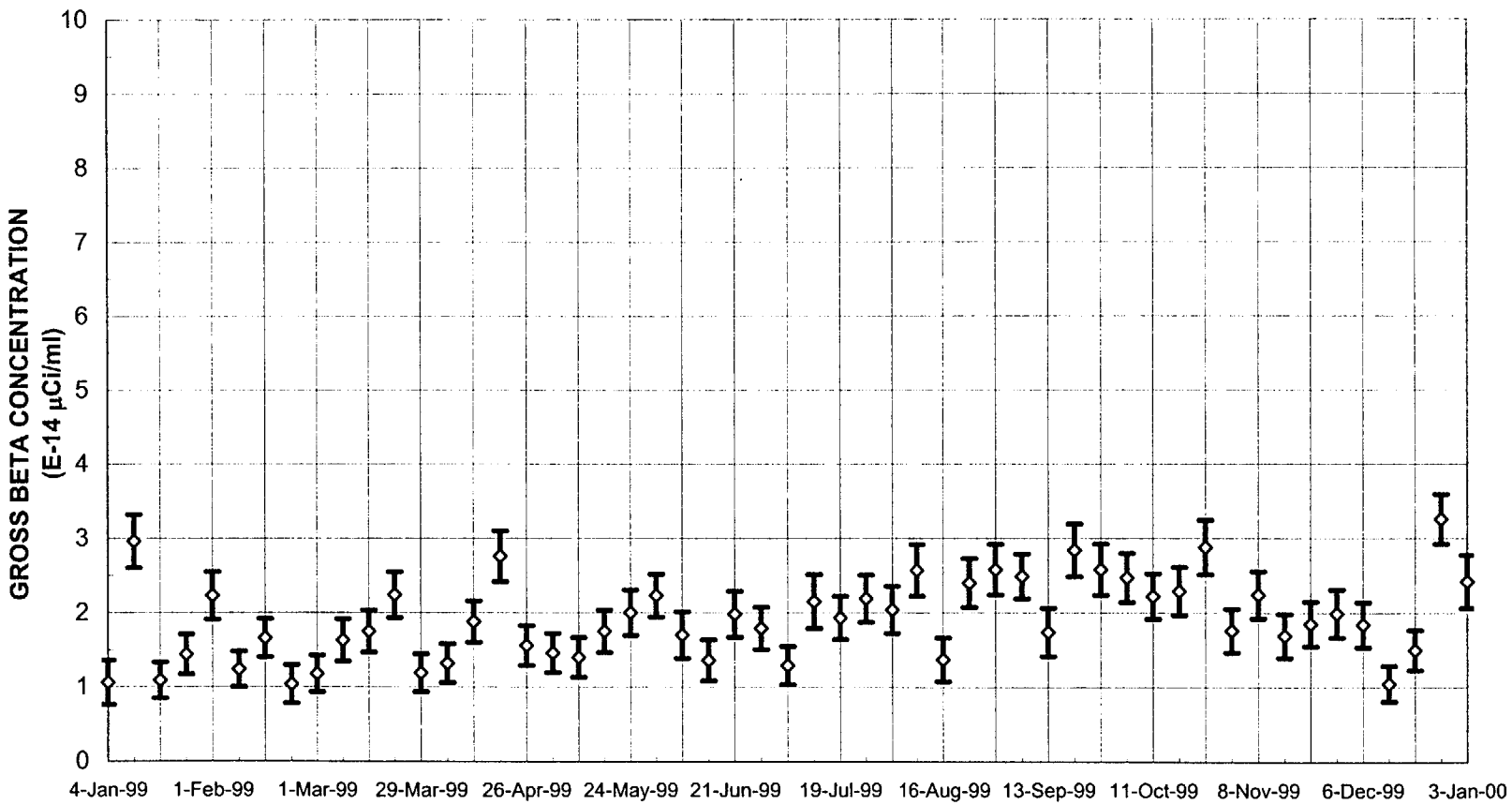
FIGURE 5.4

WEEKLY GROSS BETA ACTIVITY IN AIR
AT STATION 4 -- RICHLAND, WASHINGTON



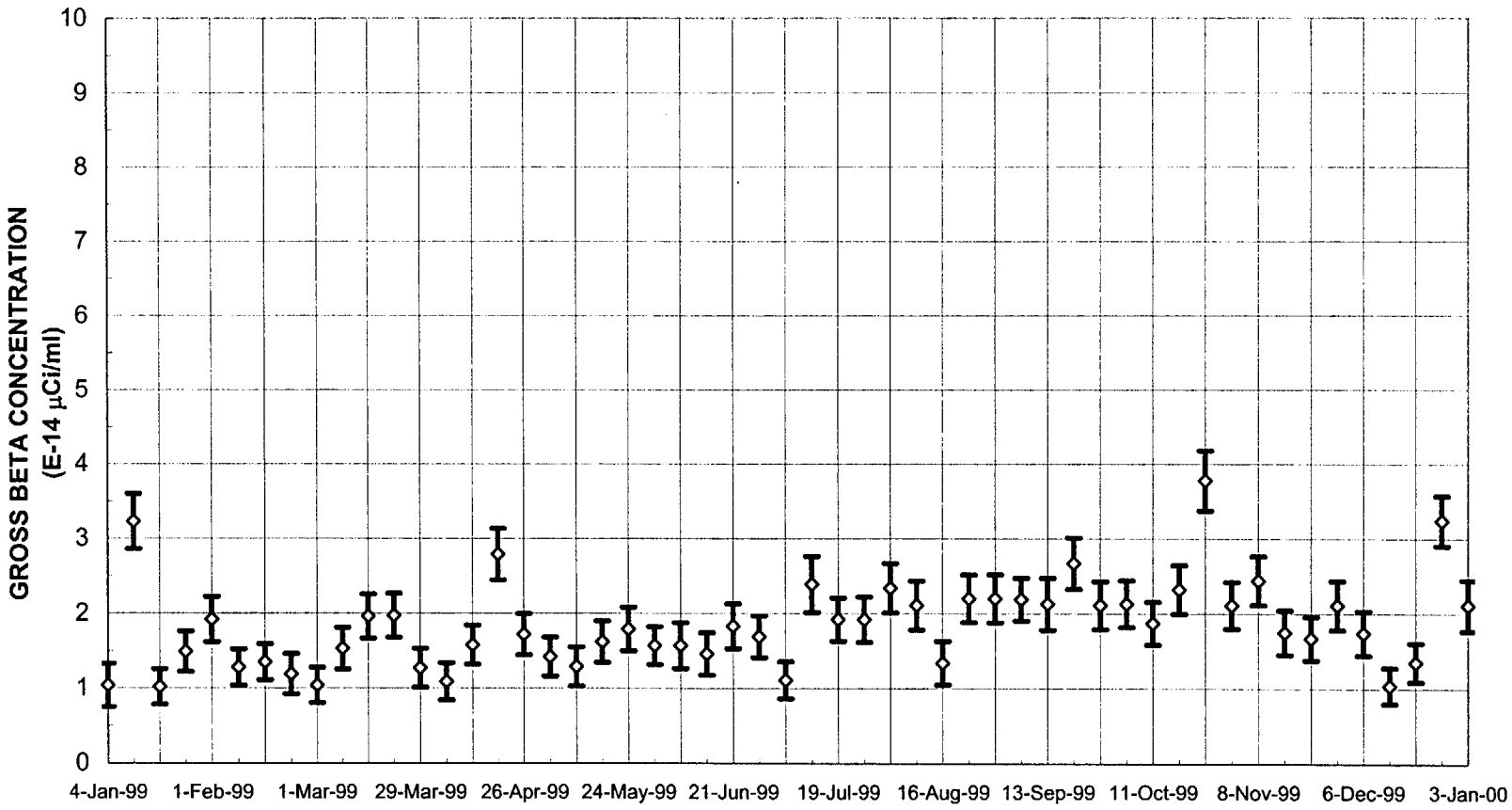
Gross Beta Investigation Level = 1 E-13 uCi/cc
Gros Beta Reporting Level = 2.6 E-11 uCi/cc

FIGURE 5.5
WEEKLY GROSS BETA ACTIVITY IN AIR
AT STATION 5 -- RICHLAND, WASHINGTON



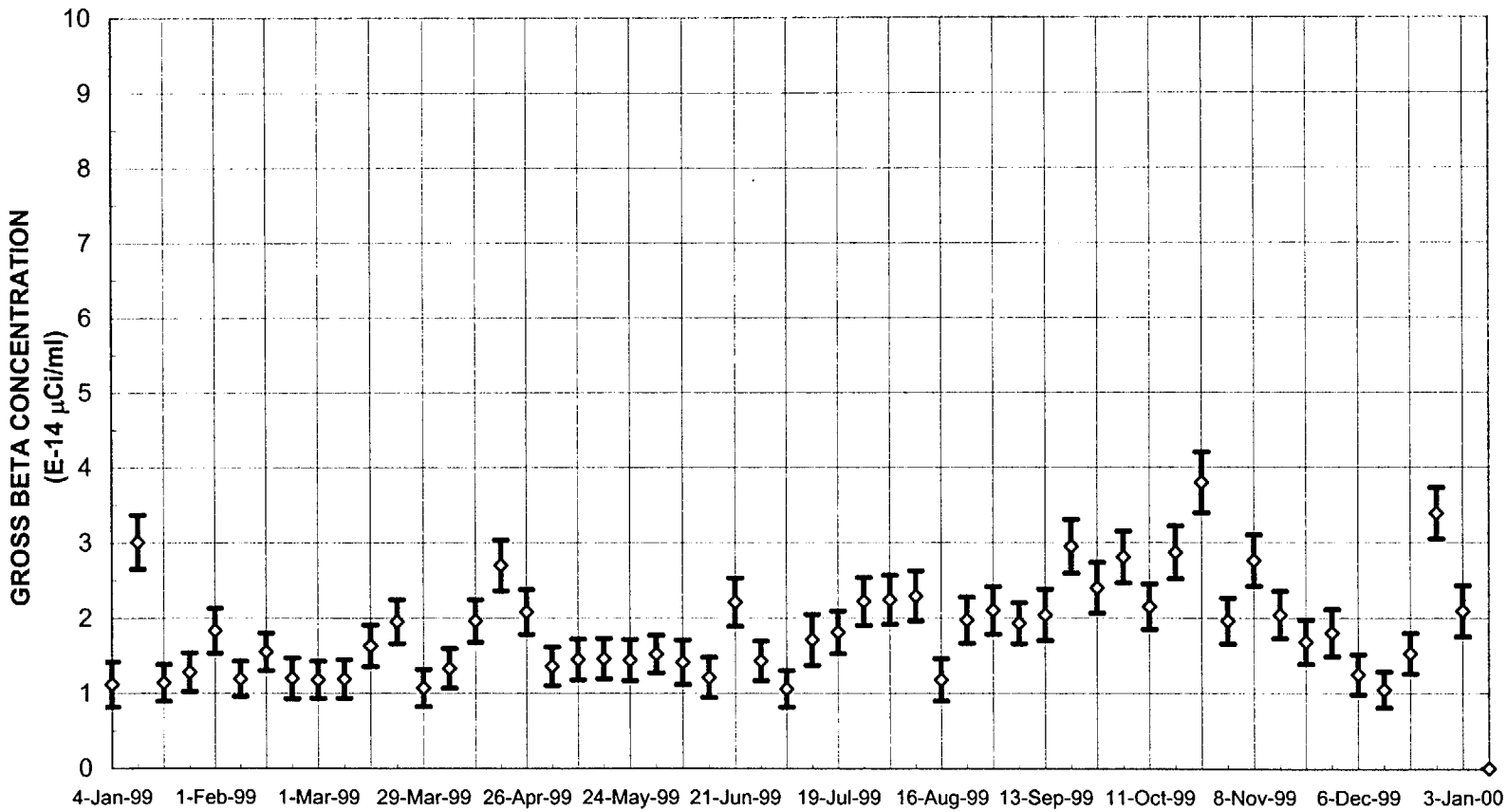
Gross Beta Investigation Level = 1 E-11 uCi/cc
Gross Beta Reporting Level = 2.6 E-11 uCi/cc

FIGURE 5.6
WEEKLY GROSS BETA ACTIVITY IN AIR
AT STATION 6 -- RICHLAND, WASHINGTON



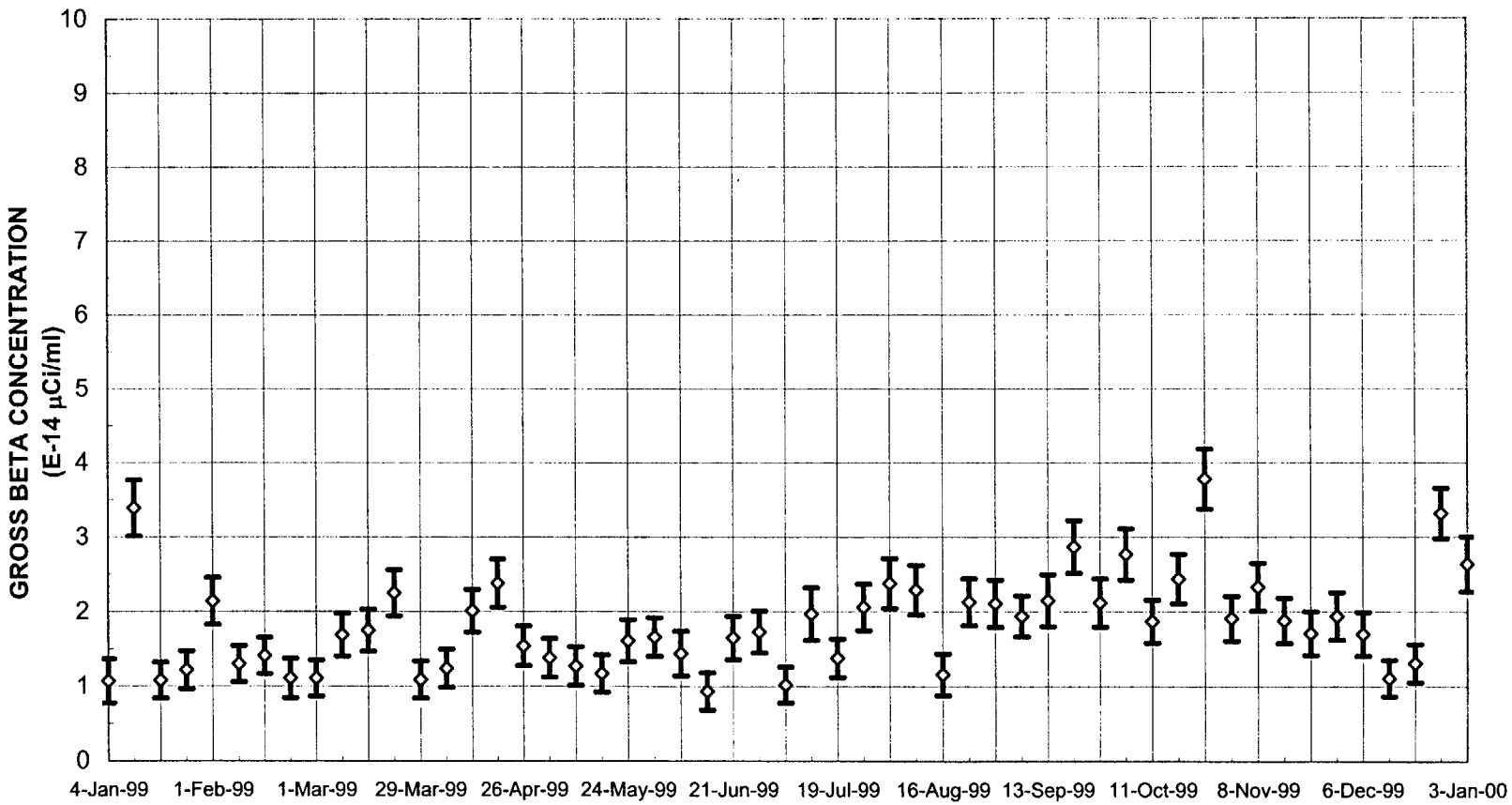
Gross Beta Investigation Level = 1 E-11 uCi/cc
Gross Beta Reporting Level =2,6 E-11 uCi/cc

FIGURE 5.7
WEEKLY GROSS BETA ACTIVITY IN AIR
AT STATION 7 -- RICHLAND, WASHINGTON



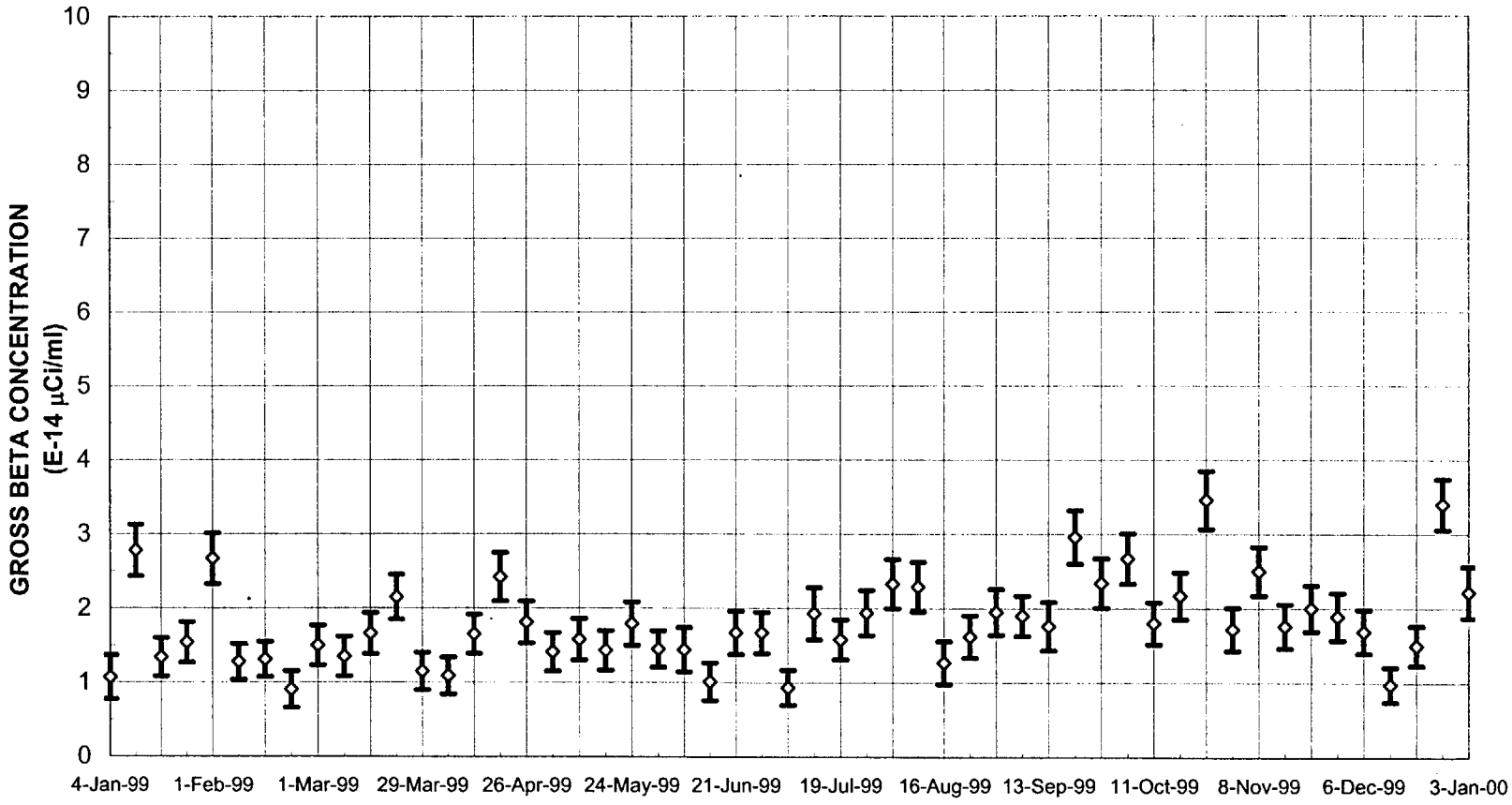
Gross Beta Investigation Level = 1 E-13 uCi/cc]
Gross Beta Reporting Level = 2.6 E-11 uCi/cc

FIGURE 5.8
WEEKLY GROSS BETA ACTIVITY IN AIR
AT STATION 8 -- RICHLAND, WASHINGTON



Gross Beta Investigation Level = 1 E-13 uCi/cc
Gross Beta Reporting Level = 2.6 E-13 uCi/cc

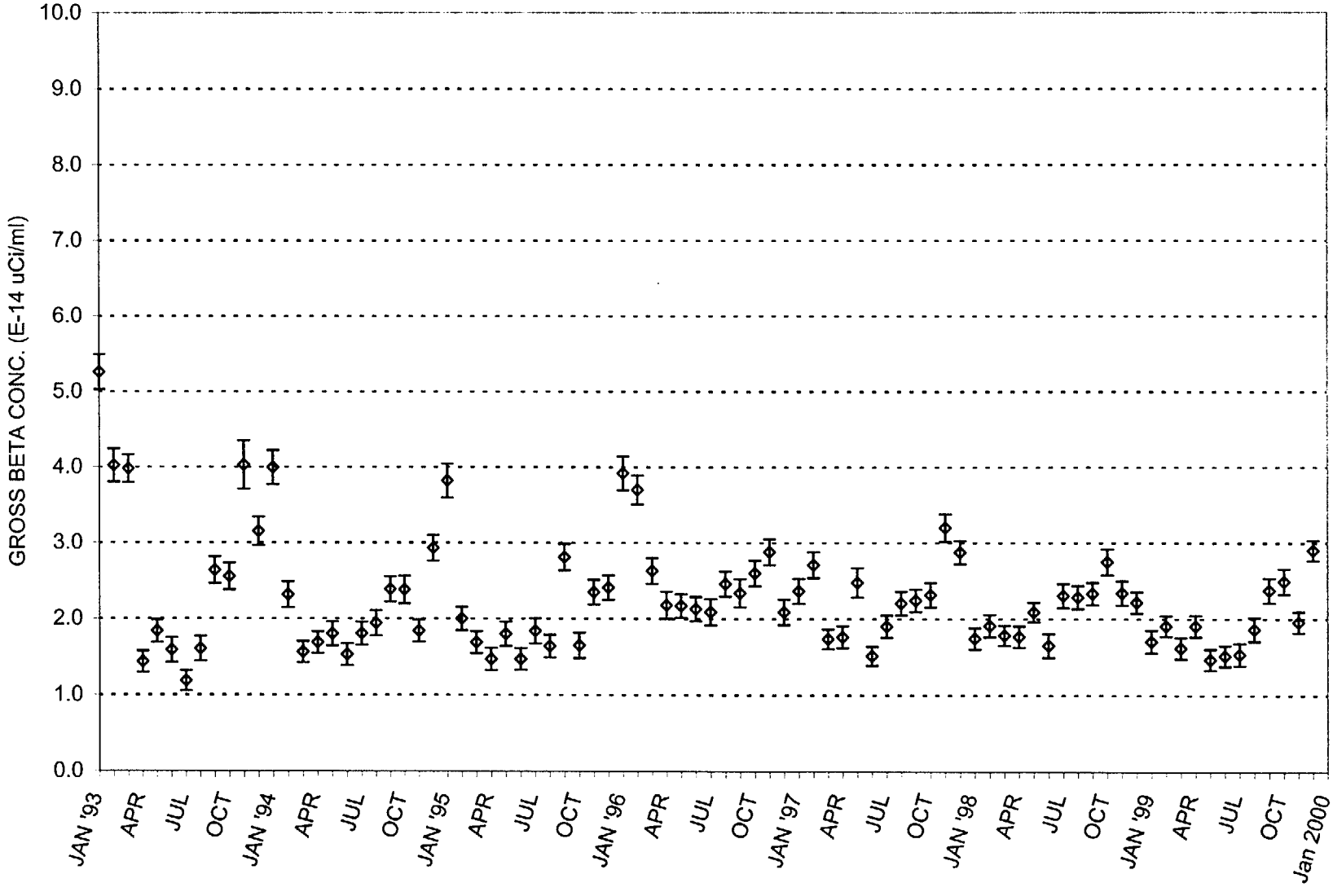
FIGURE 5.9
WEEKLY GROSS BETA ACTIVITY IN AIR
AT STATION 9 - RICHLAND, WASHINGTON



Gross Beta Investigation Level = 1 E-13 uCi/cc
Gross Beta Reporting Level = 2.6 E-11 uCi/cc

FIGURE 5.10
MONTHLY AVERAGE GROSS BETA ACTIVITY IN AIR

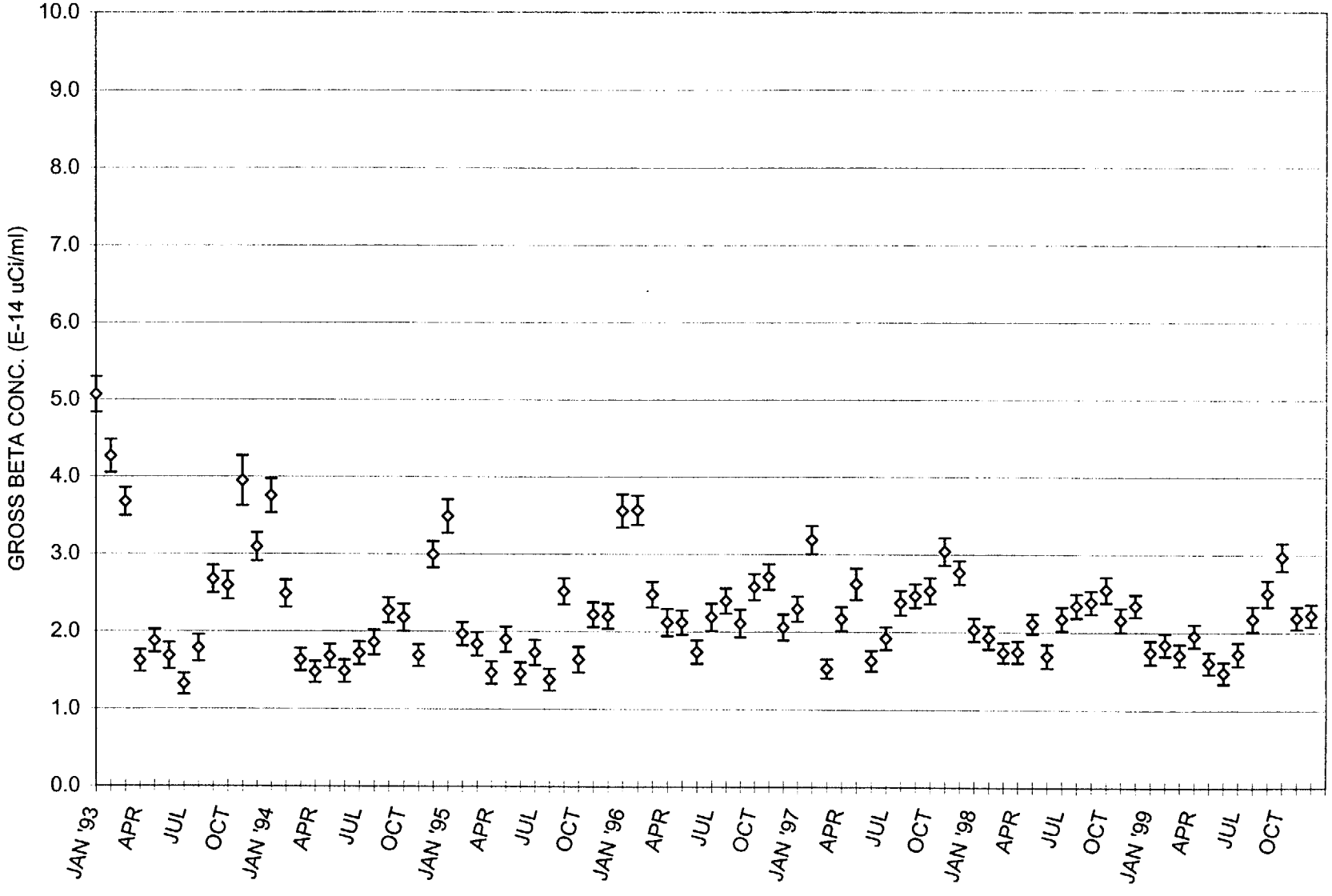
STATION 1



Gross Beta Investigation level = 1 E-13 uCi/cc
Gross Beta Reporting Level = 2.6 E-11 uCi/cc

FIGURE 5.11
MONTHLY AVERAGE GROSS BETA ACTIVITY IN AIR

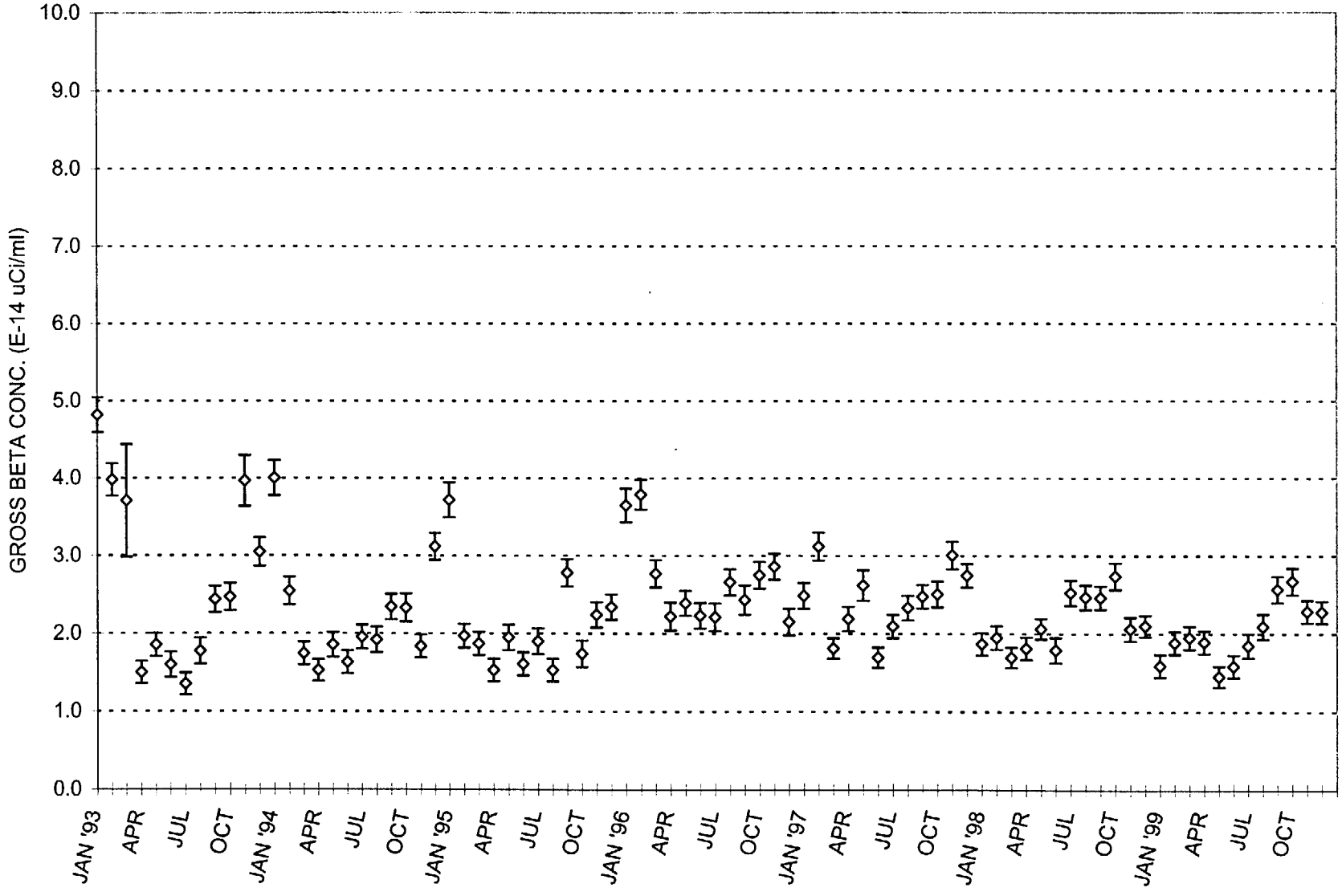
STATION 2



Gross Beta Investigation Level = 1 E-13 uCi/cc
Gross Beta Reporting Level = 2.6 E-11 uCi/cc

FIGURE 5.12
MONTHLY AVERAGE GROSS BETA ACTIVITY IN AIR

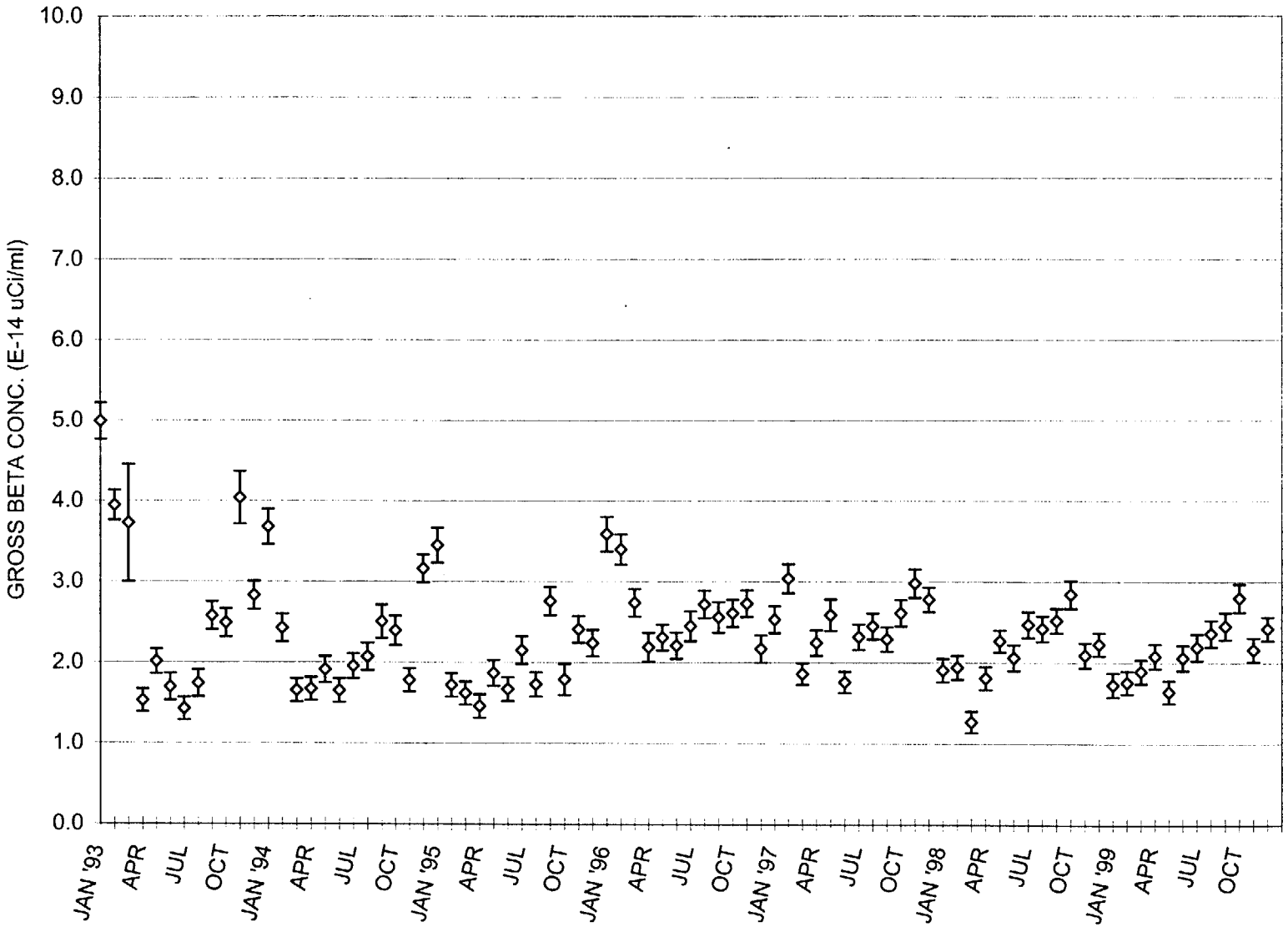
STATION 3



Gross Beta Investigation Level = 1E-13 uCi/cc
Gross Beta Reporting Level = 2.6 E-11 UCi/cc

FIGURE 5.13
MONTHLY AVERAGE GROSS BETA ACTIVITY IN AIR

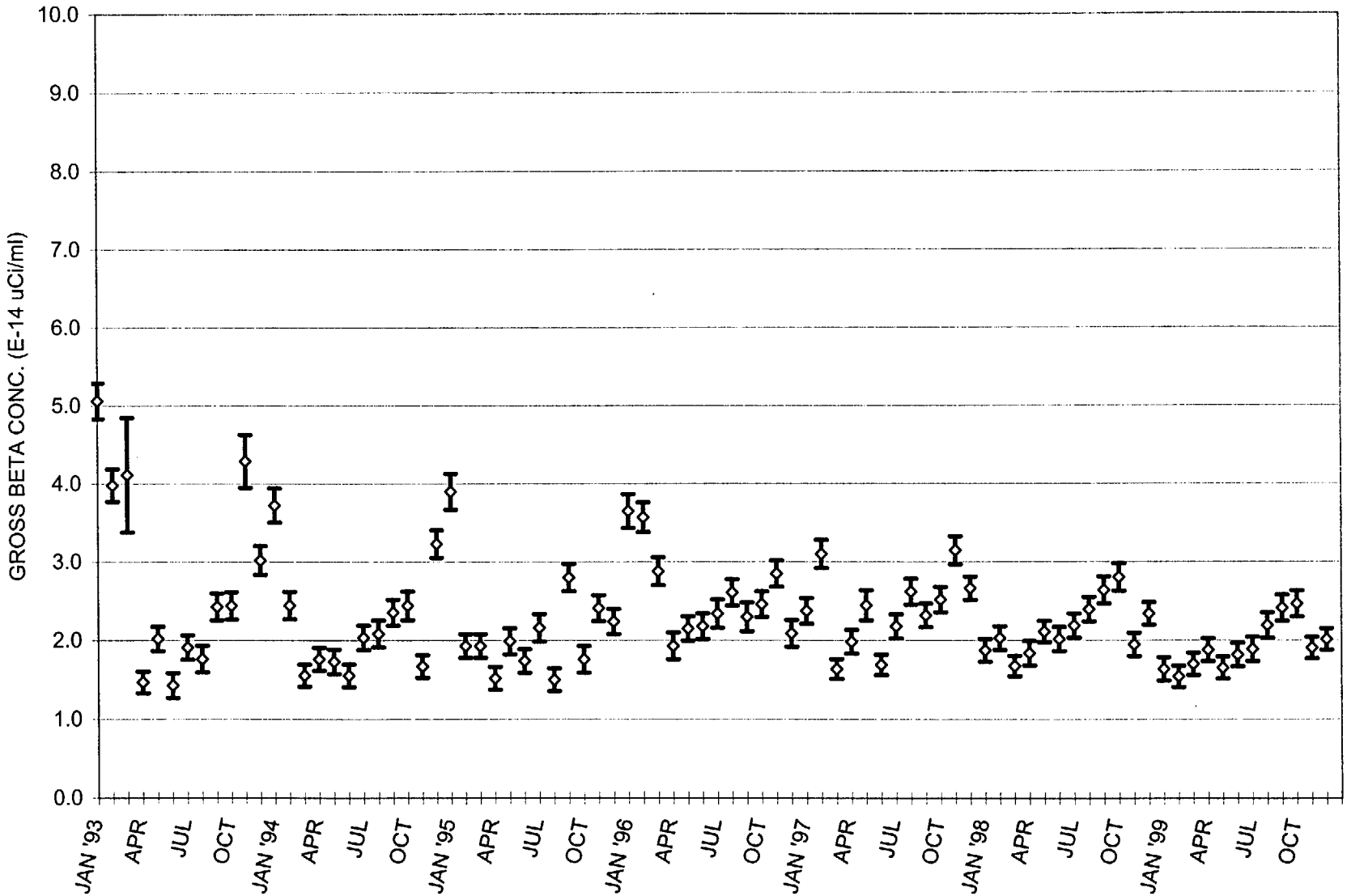
STATION 4



Gross Beta Investigation Level = 1 E-13 uCi/cc
Gross Beta Reporting Level = 2.6 E-11 uCi/cc

FIGURE 5.14

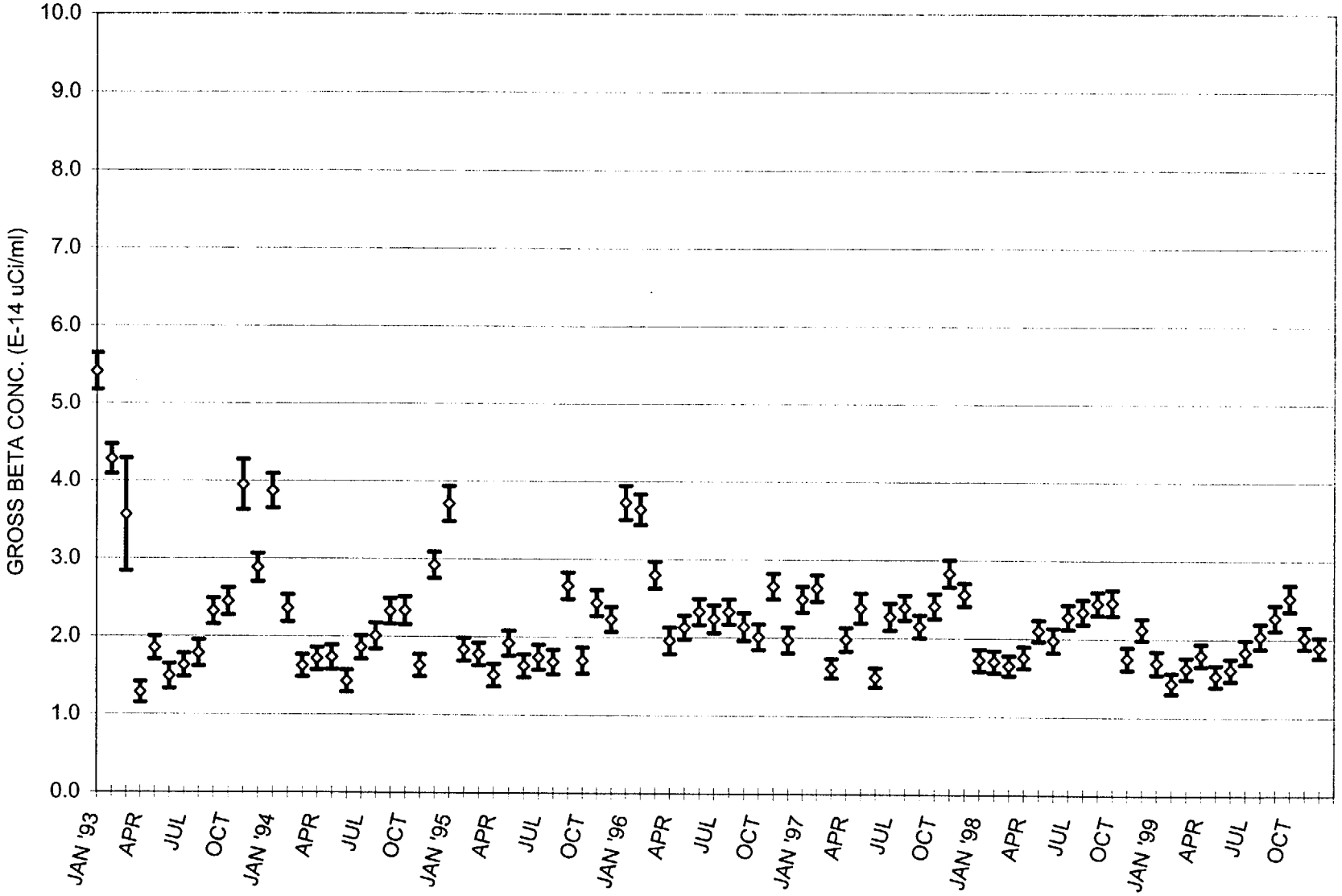
MONTHLY AVERAGE GROSS BETA ACTIVITY IN AIR
STATION 5



Gross Beta Investigation Level = 1 E-13 uCi/cc
Gross Beta Reporting Level = 2.6 E-11 uCi/cc

FIGURE 5.15

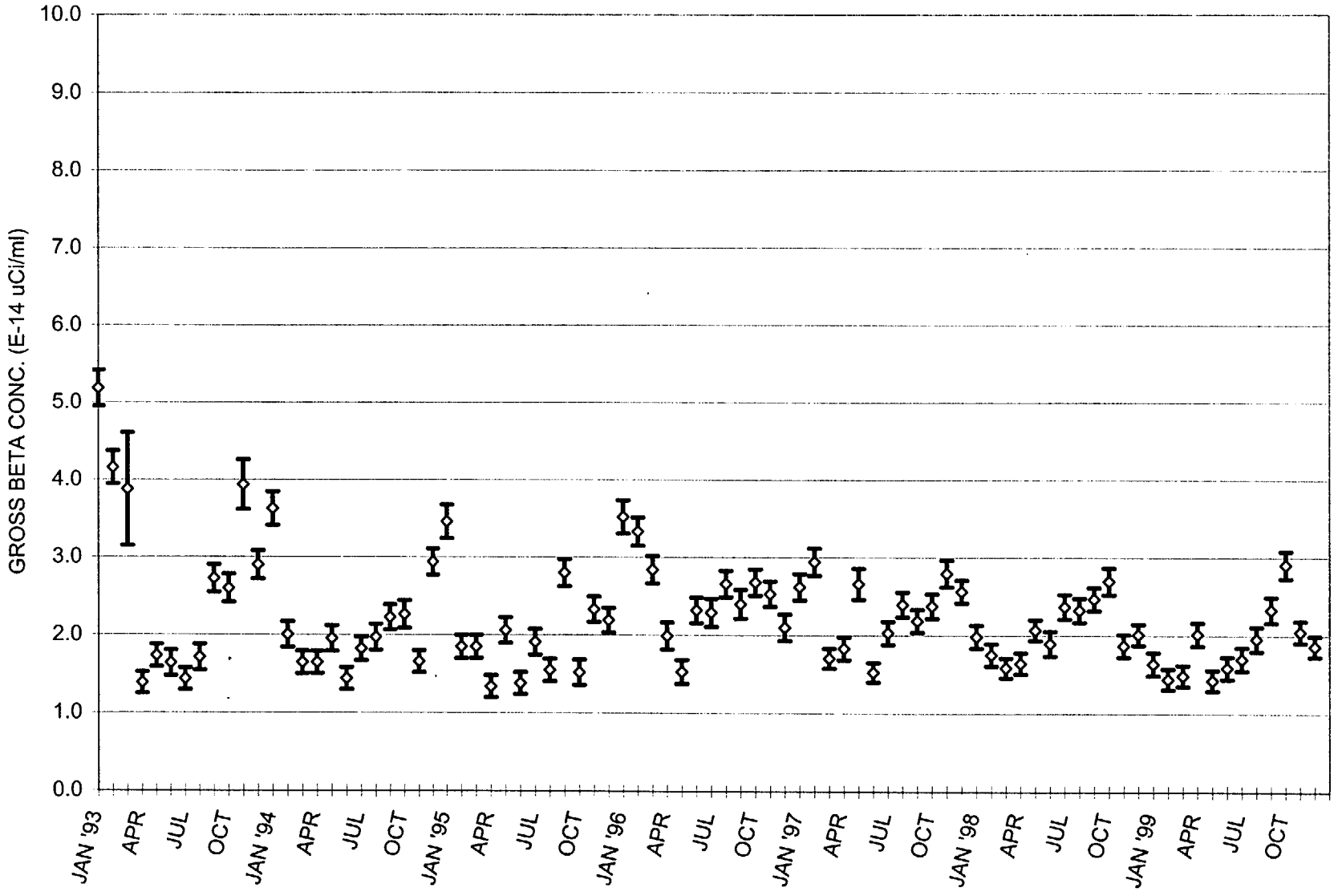
MONTHLY AVERAGE GROSS BETA ACTIVITY IN AIR
STATION 6



Gross Beta Investigation Level = 1 E-13 uCi/cc
Gross Beta Reporting Level = 2.6 E-11 uCi/cc

FIGURE 5.16
MONTHLY AVERAGE GROSS BETA ACTIVITY IN AIR

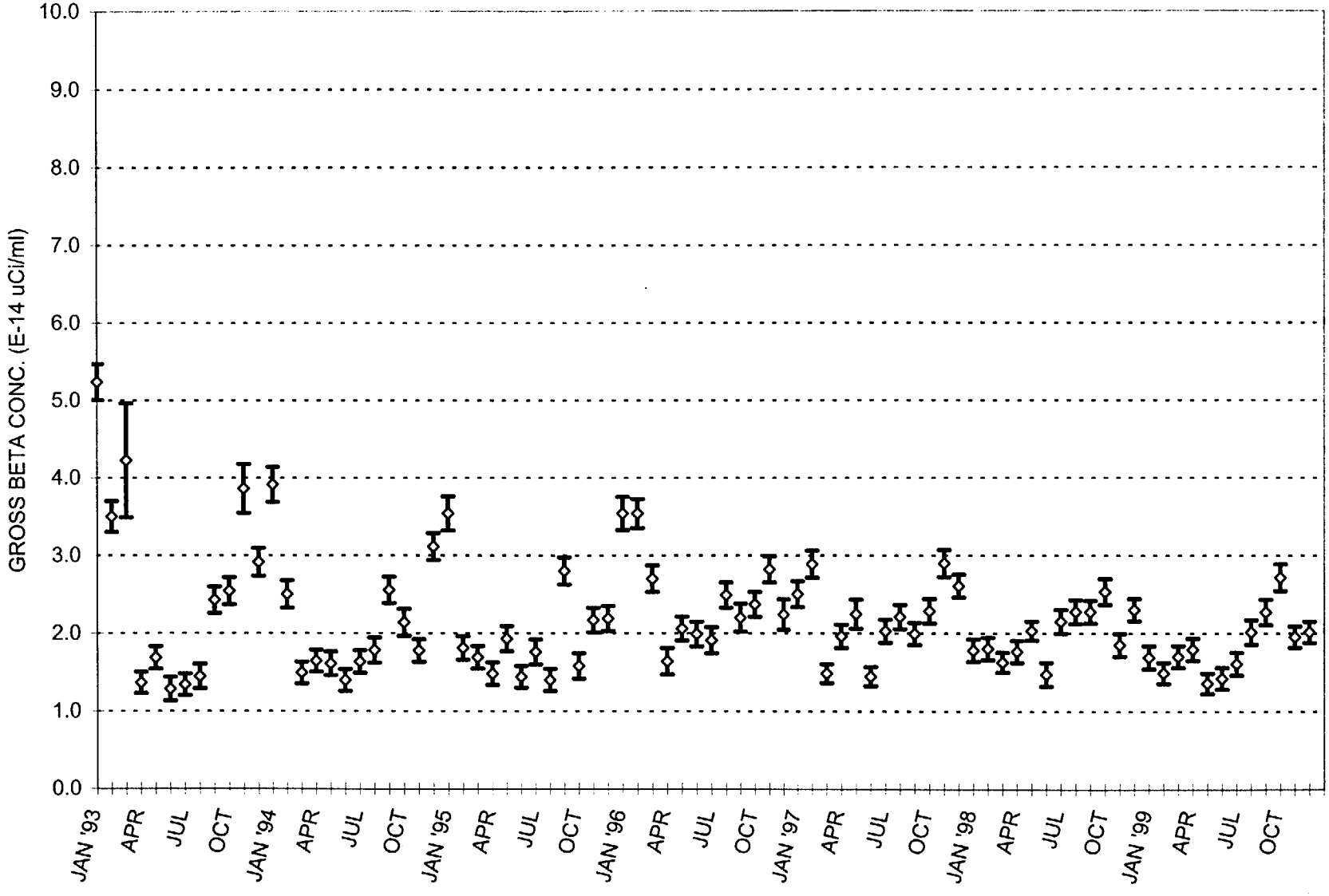
STATION 7



Gross beta Investigation Level = 1 E-13 uCi/cc
Gross Beta Action Level = 2.6 E-11 uCi/cc

FIGURE 5.17

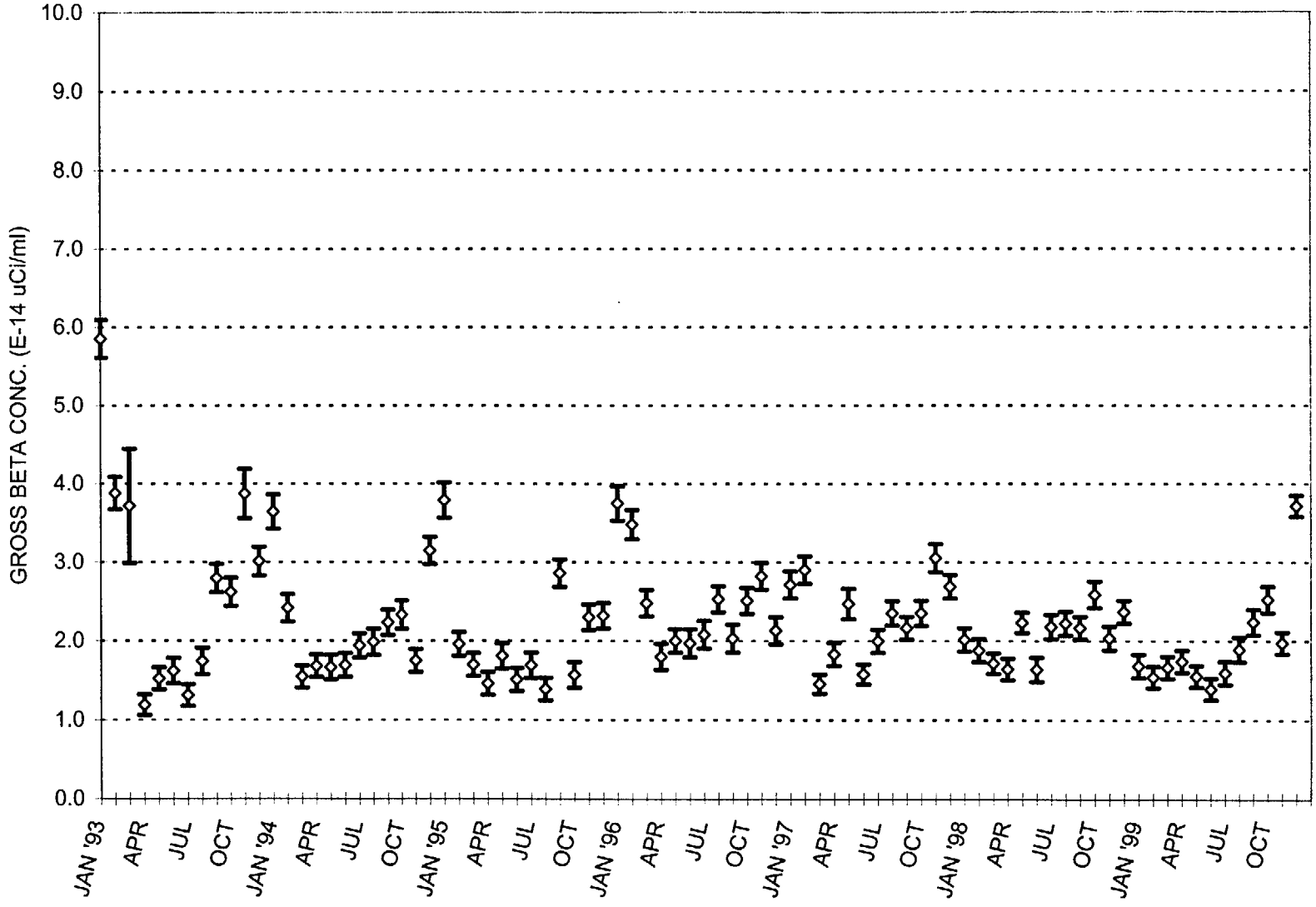
MONTHLY AVERAGE GROSS BETA ACTIVITY IN AIR
STATION 8



Gross Beta Investigation Level = 1 E-11 uCi/cc
Gross Beta Reporting Level = 2.6 E-11 uCi/cc

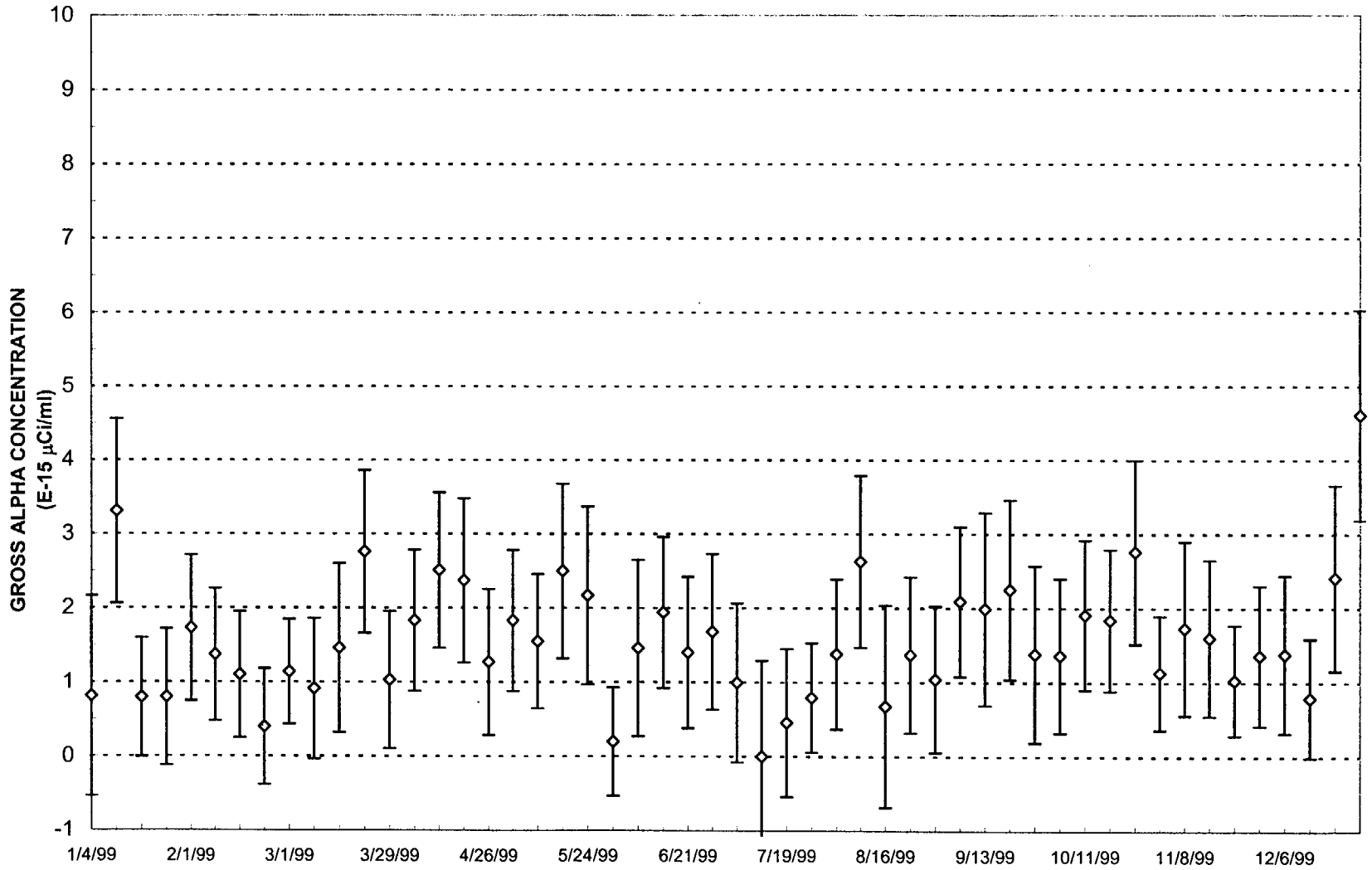
FIGURE 5.18

MONTHLY AVERAGE GROSS BETA ACTIVITY IN AIR
STATION 9



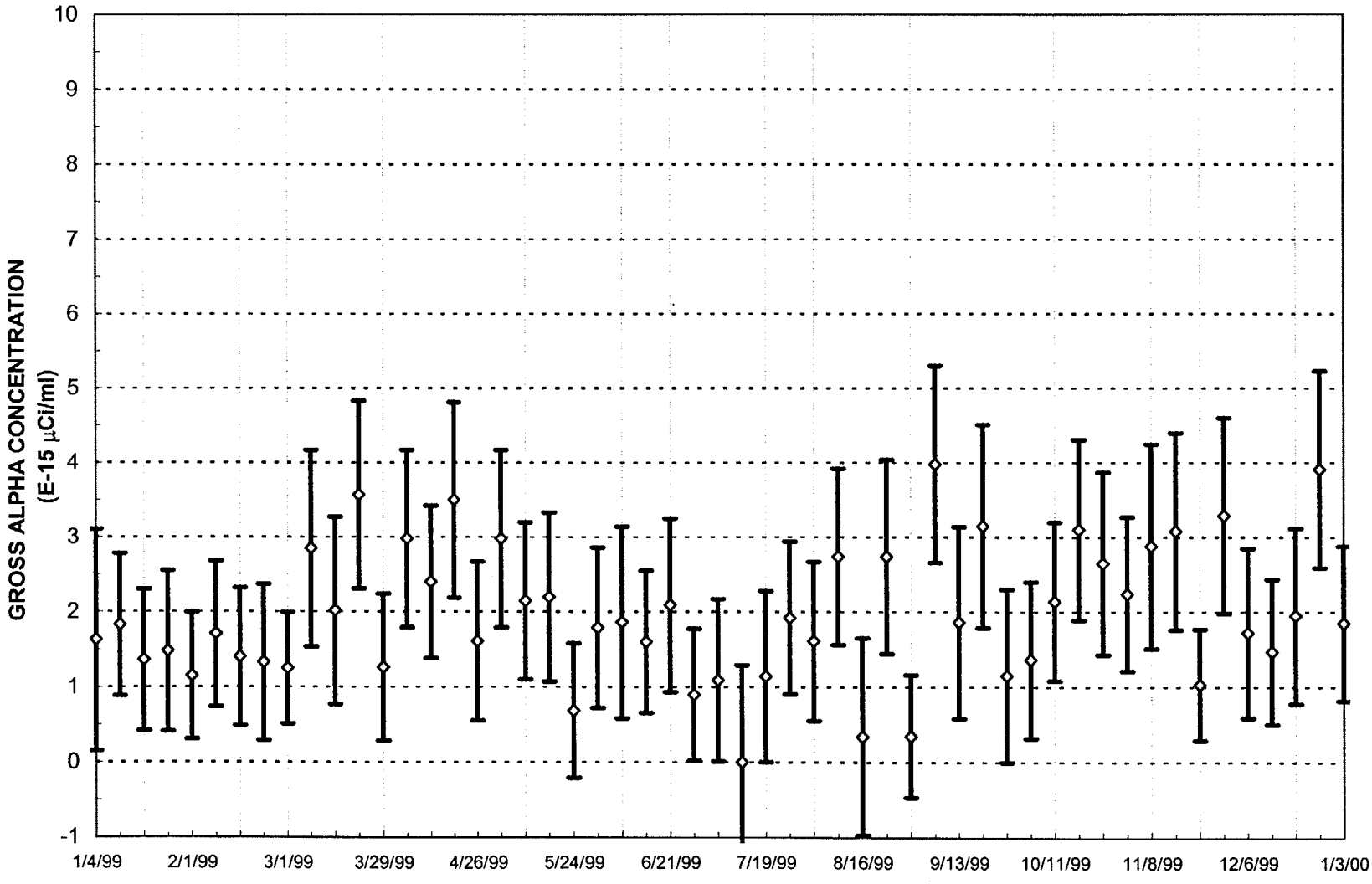
Gross Beta Investigation Level = 1 E-13 uCi/cc
Bross Beta Reporting Level = 2.6 E-11 uCi/cc

FIGURE 5.19
WEEKLY GROSS ALPHA ACTIVITY IN AIR
STATION 1 - RICHLAND, WASHINGTON



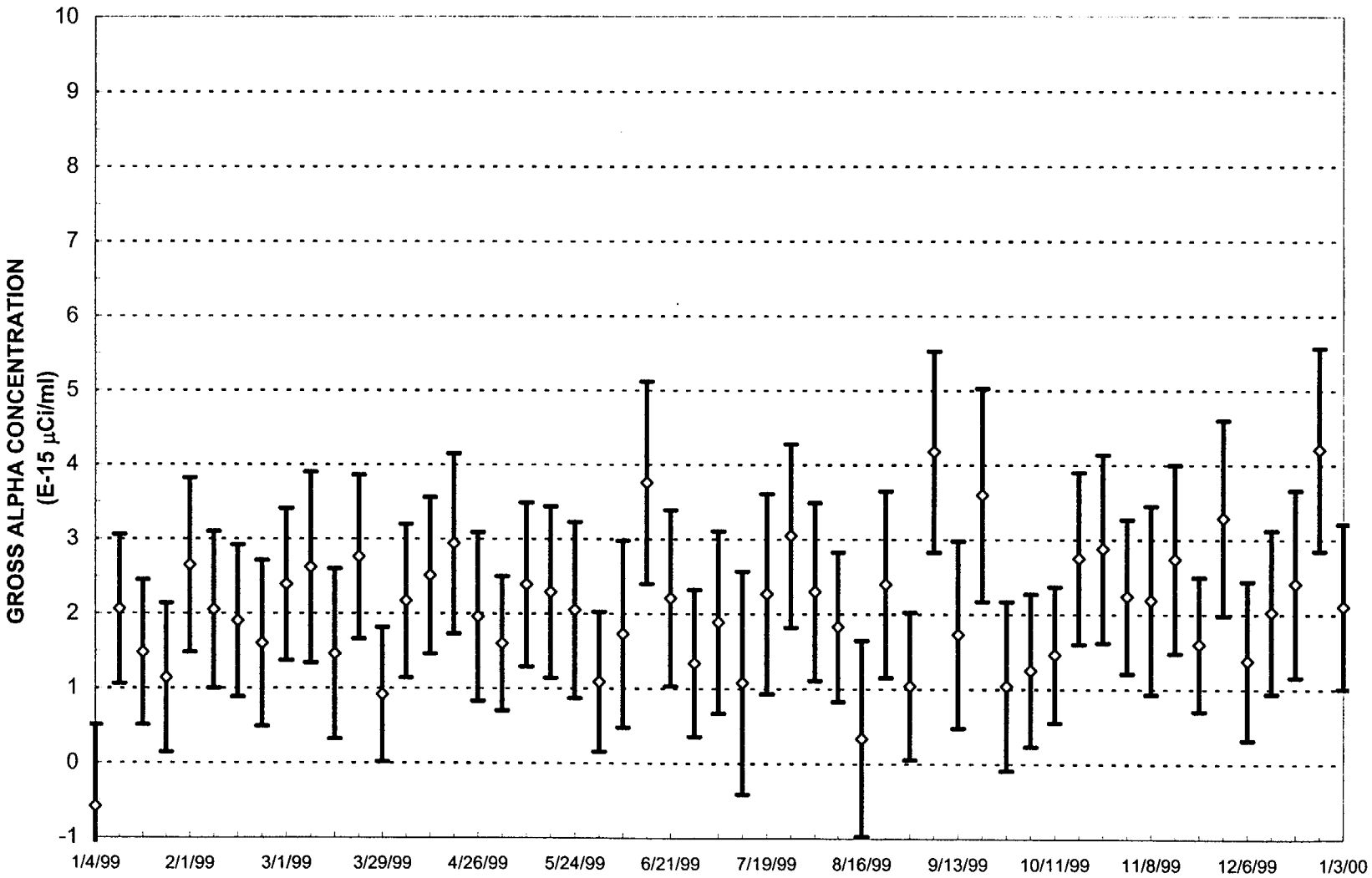
Gross Alpha Investigation Level = 1E-14 uCi/cc
Gross Alpha Reporting Level =1.7 E-14 uCi/cc

FIGURE 5.20
WEEKLY GROSS ALPHA ACTIVITY IN AIR
STATION 2 - RICHLAND, WASHINGTON



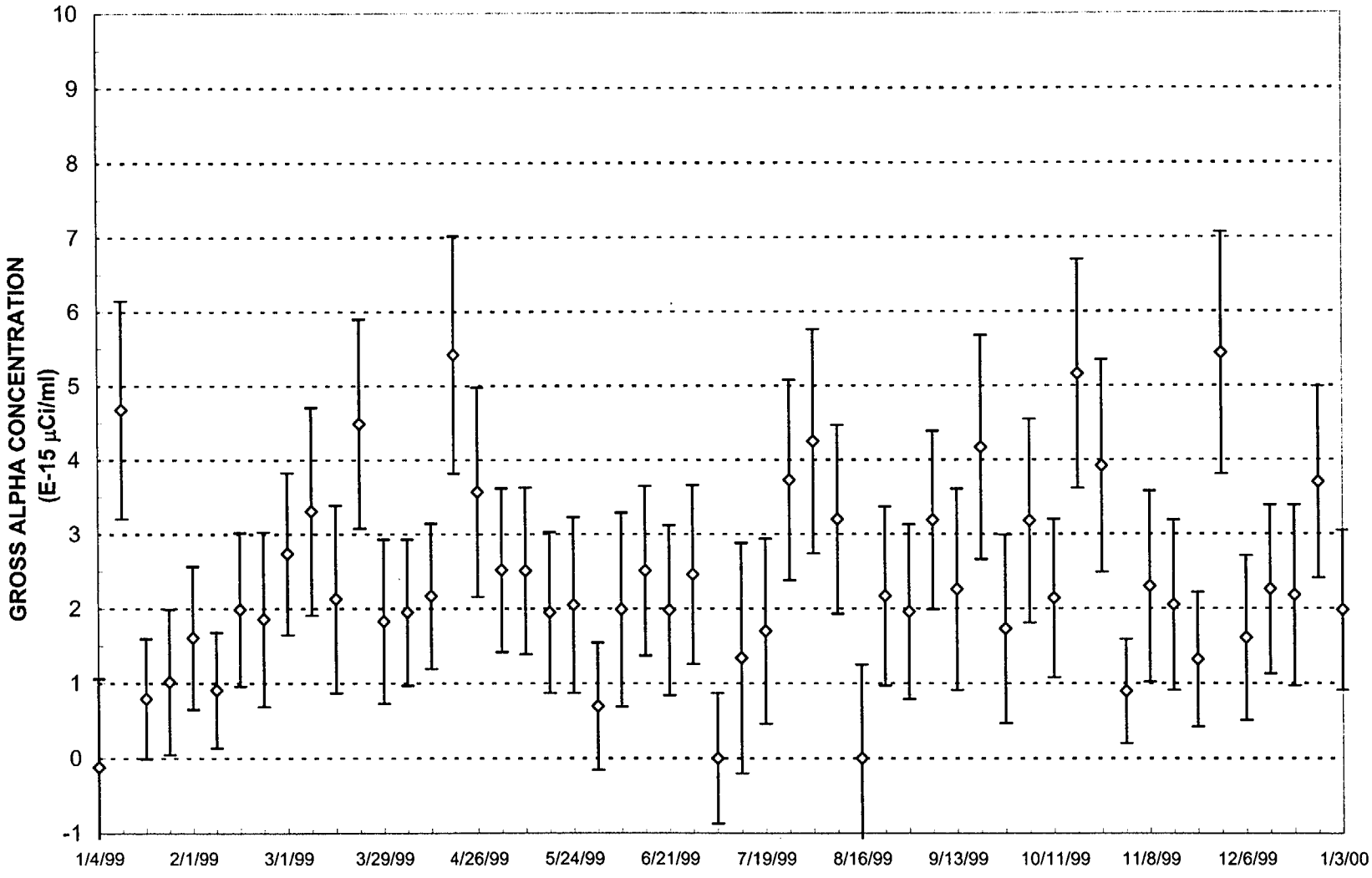
Gross Alpha Investigation Level = 1 E-14 uCi/cc
Gross Alpha Reporting Level = 1.7 E-14 uCi/cc

FIGURE 5.21
WEEKLY GROSS ALPHA ACTIVITY IN AIR
STATION 3 - RICHLAND, WASHINGTON



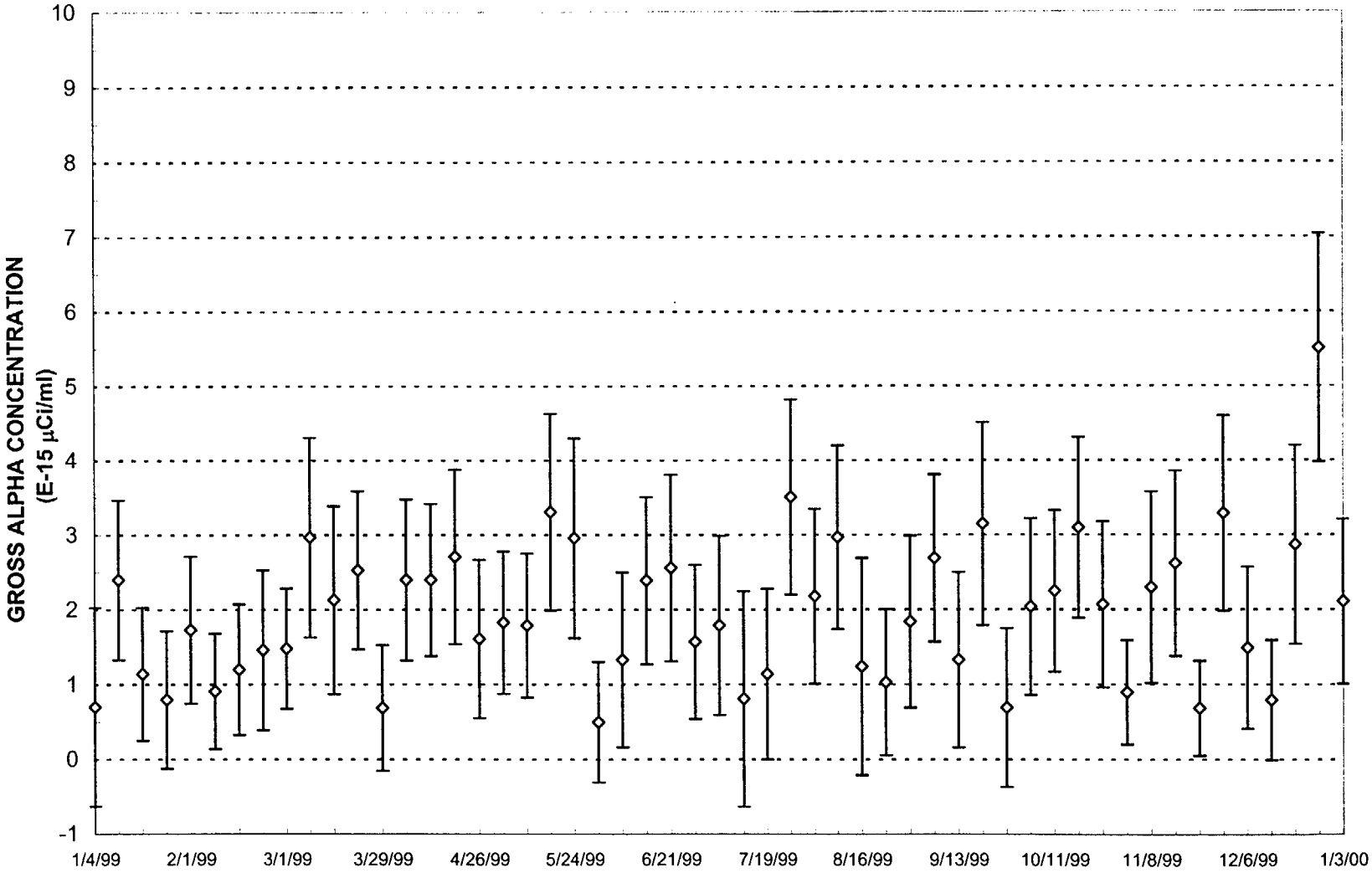
Gross Alpha Investigation Level = 1E-14 uCi/cc
Gross Alpha Reporting Level = 1.7 E-14 uCi/cc

FIGURE 5.22
WEEKLY GROSS ALPHA ACTIVITY IN AIR
STATION 4 - RICHLAND, WASHINGTON



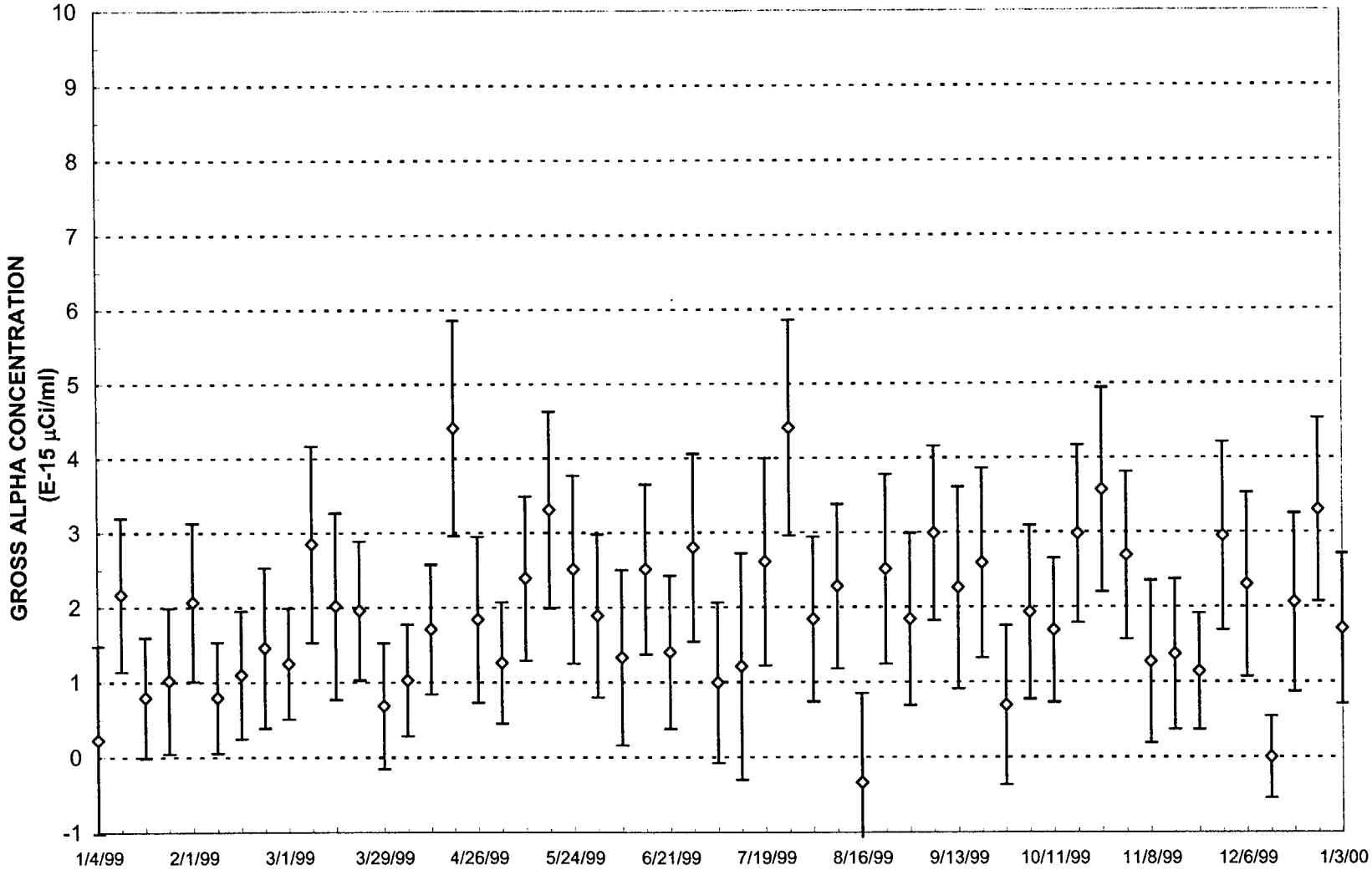
Gross Alpha Investigation Level = 1 E-14 uCi/cc
Gross Alpha Reporting Level =1.7 E-14 uCi/cc

FIGURE 5.23
WEEKLY GROSS ALPHA ACTIVITY IN AIR
STATION 5 - RICHLAND, WASHINGTON



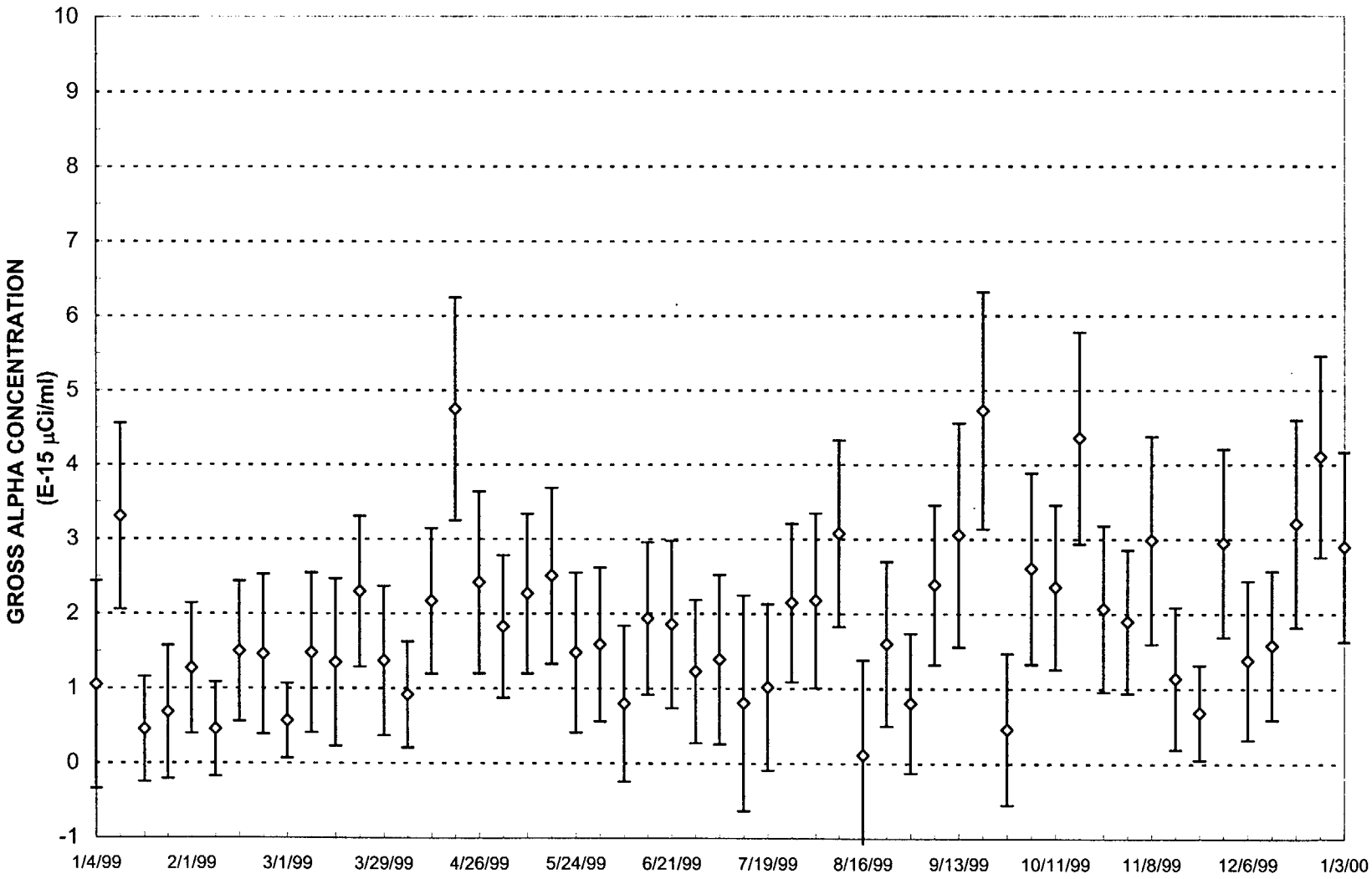
Gross Alpha Investigation Level = 1E-14 uCi/cc
Gross Alpha Reporting Level = 1.7 E-14 uCi/cc

FIGURE 5.24
WEEKLY GROSS ALPHA ACTIVITY IN AIR
STATION 6 - RICHLAND, WASHINGTON



Gross Alpha Investigation Level = 1E-14 uCi/cc
Gross Alpha Reporting Level = 1.7 E-14 uCi/cc

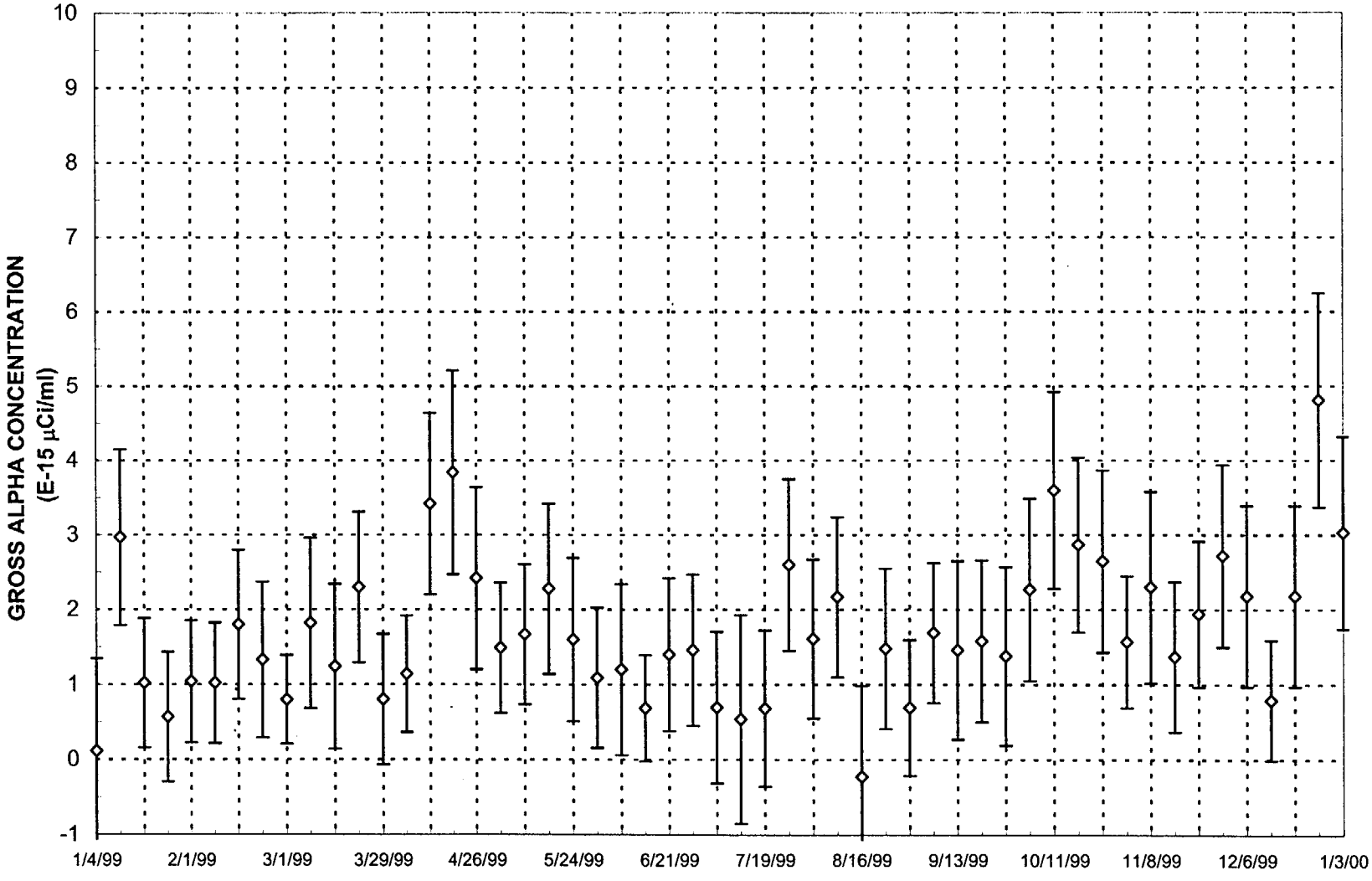
FIGURE 5.25
WEEKLY GROSS ALPHA ACTIVITY IN AIR
STATION 7 - RICHLAND, WASHINGTON



Gross Alpha Investigation Level = 1E-14 uCi/cc
Gross Alpha Reporting Level = 1.7 E-14 uCi/cc

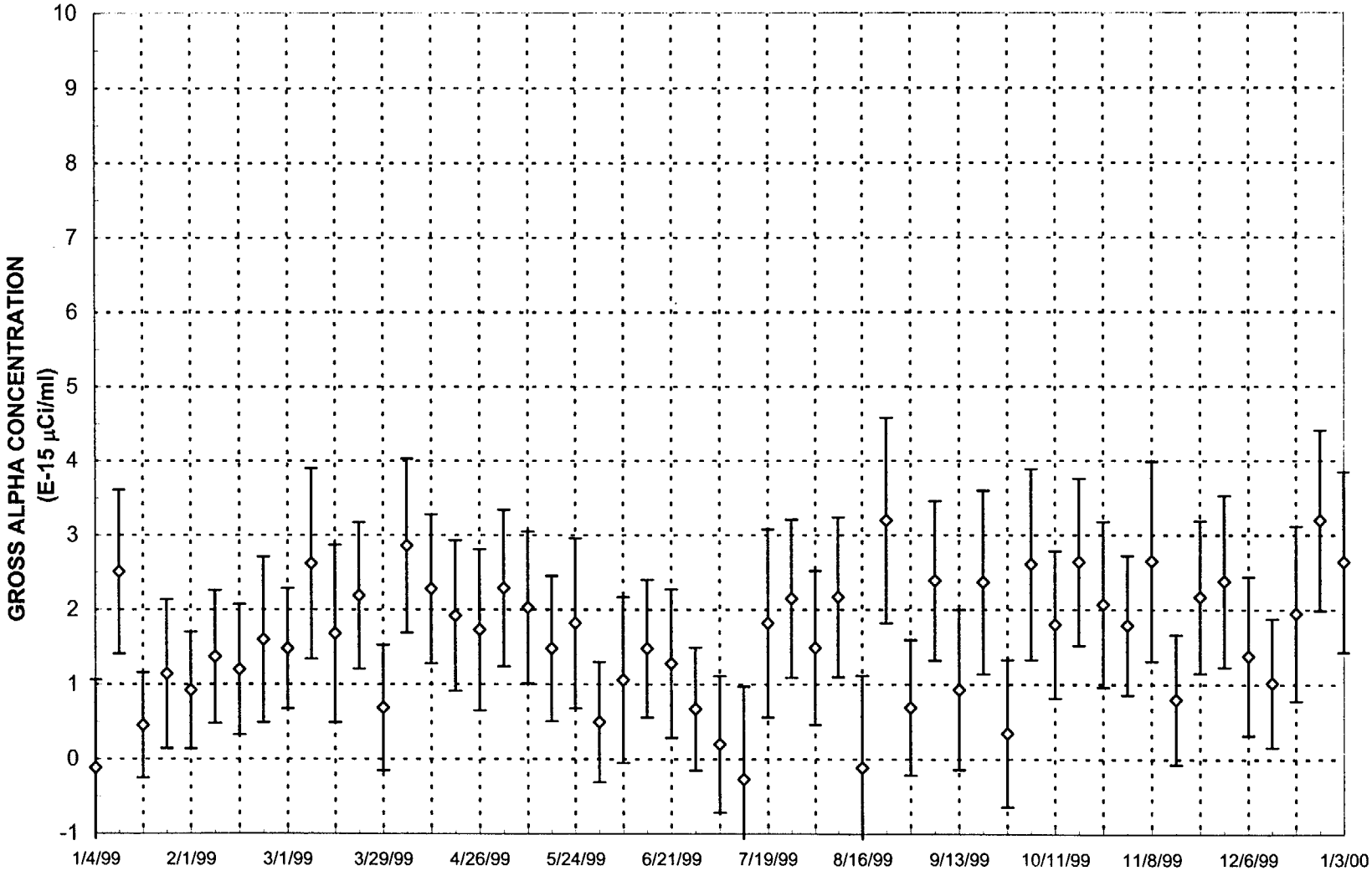
FIGURE 5.26

WEEKLY GROSS ALPHA ACTIVITY IN AIR
STATION 8 - RICHLAND, WASHINGTON



Gross Alpha Investigation Level = 1 E-14 uCi/cc
Gross Alpha Reporting Level = 1.4 E-14 uCi/cc

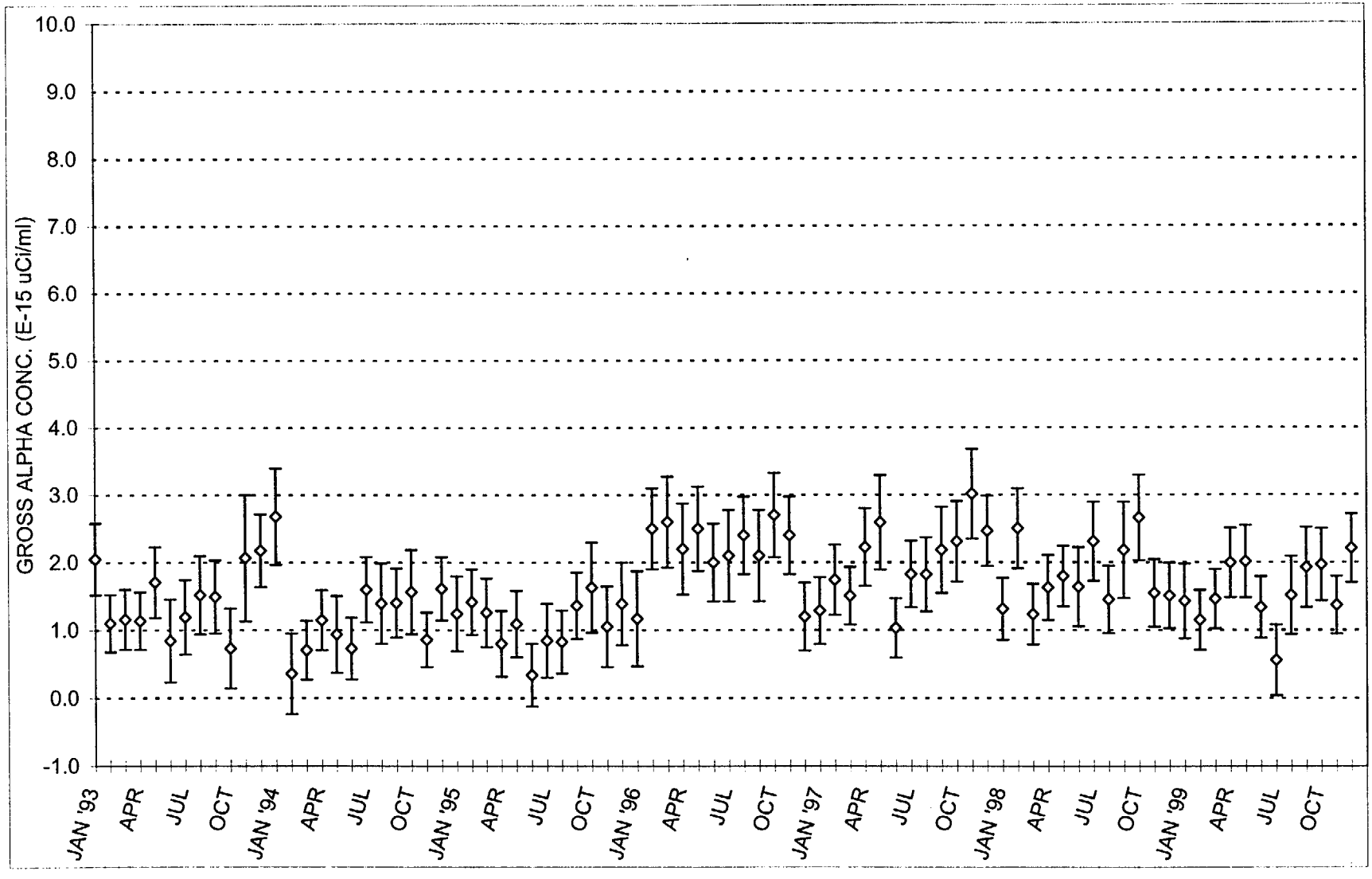
FIGURE 5.27
WEEKLY GROSS ALPHA ACTIVITY IN AIR
STATION 9 - RICHLAND, WASHINGTON



Gross Alpha Investigation Level = 1E-14 uCi/cc
Gross Alpha Reporting level = 1.7E-14 uCi/cc

FIGURE 5.28
MONTHLY AVERAGE GROSS ALPHA ACTIVITY IN AIR

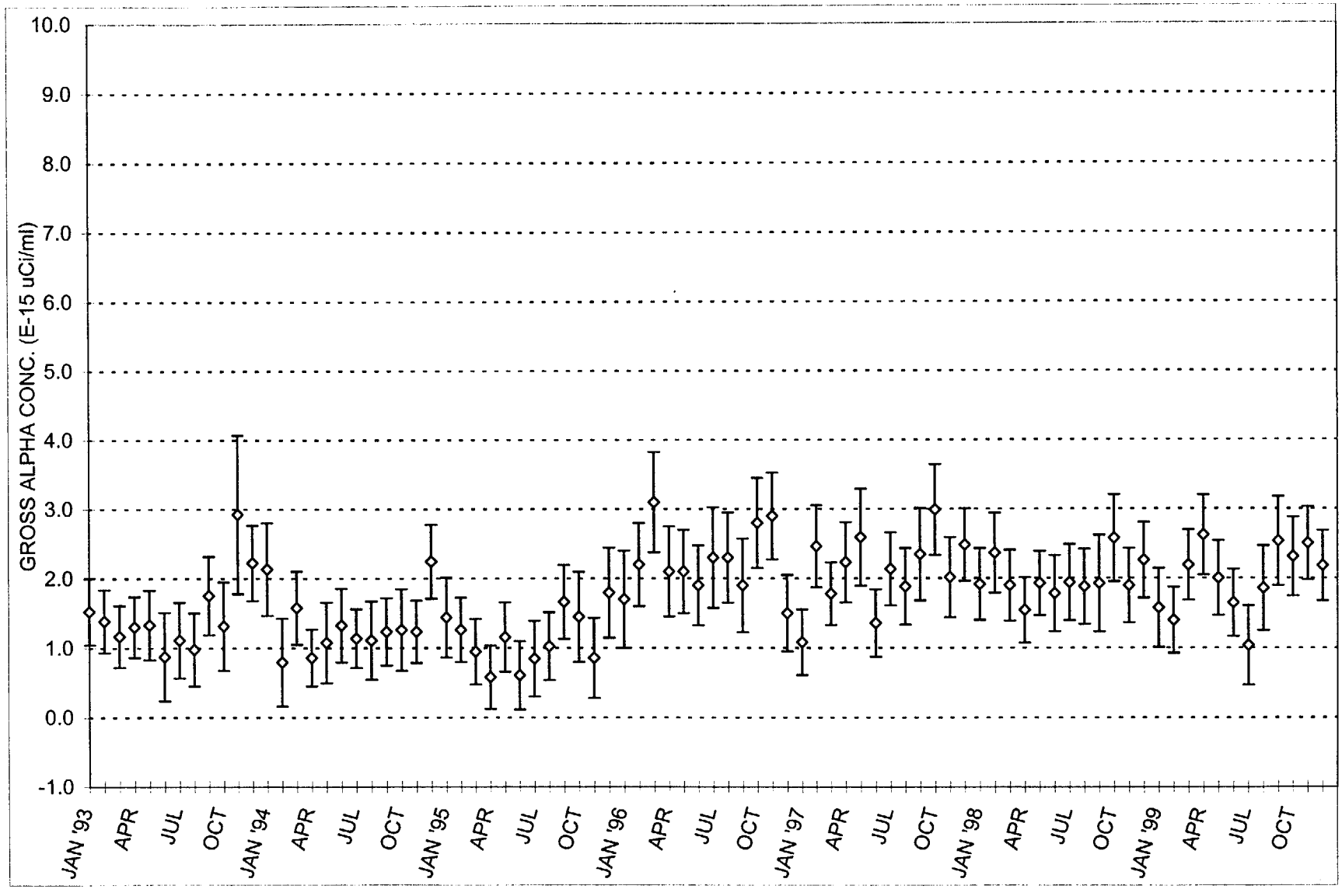
STATION 1



Gross Alpha Investigation Level = 1 E-14 uCi/cc
Gross Alpha Reporting Level = 1.4 E-14 uCi/cc

FIGURE 5.29
MONTHLY AVERAGE GROSS ALPHA ACTIVITY IN AIR

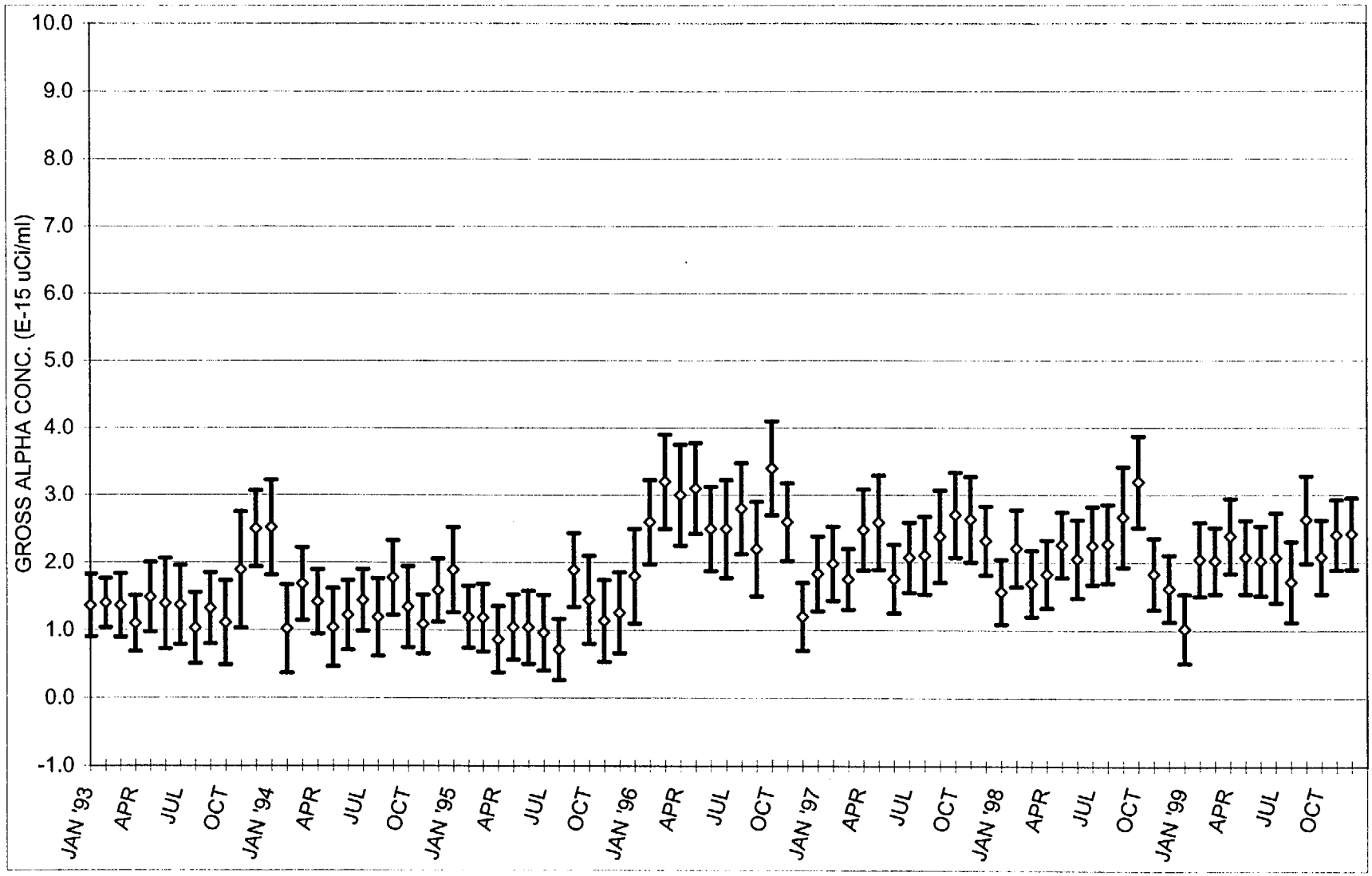
STATION 2



Gross Alpha Investigation level = 1 E-14 uCi/cc
Gross A ^ Alpha Reporting level = 1.4 E-14 uCi/cc

FIGURE 5.30
MONTHLY AVERAGE GROSS ALPHA ACTIVITY IN AIR

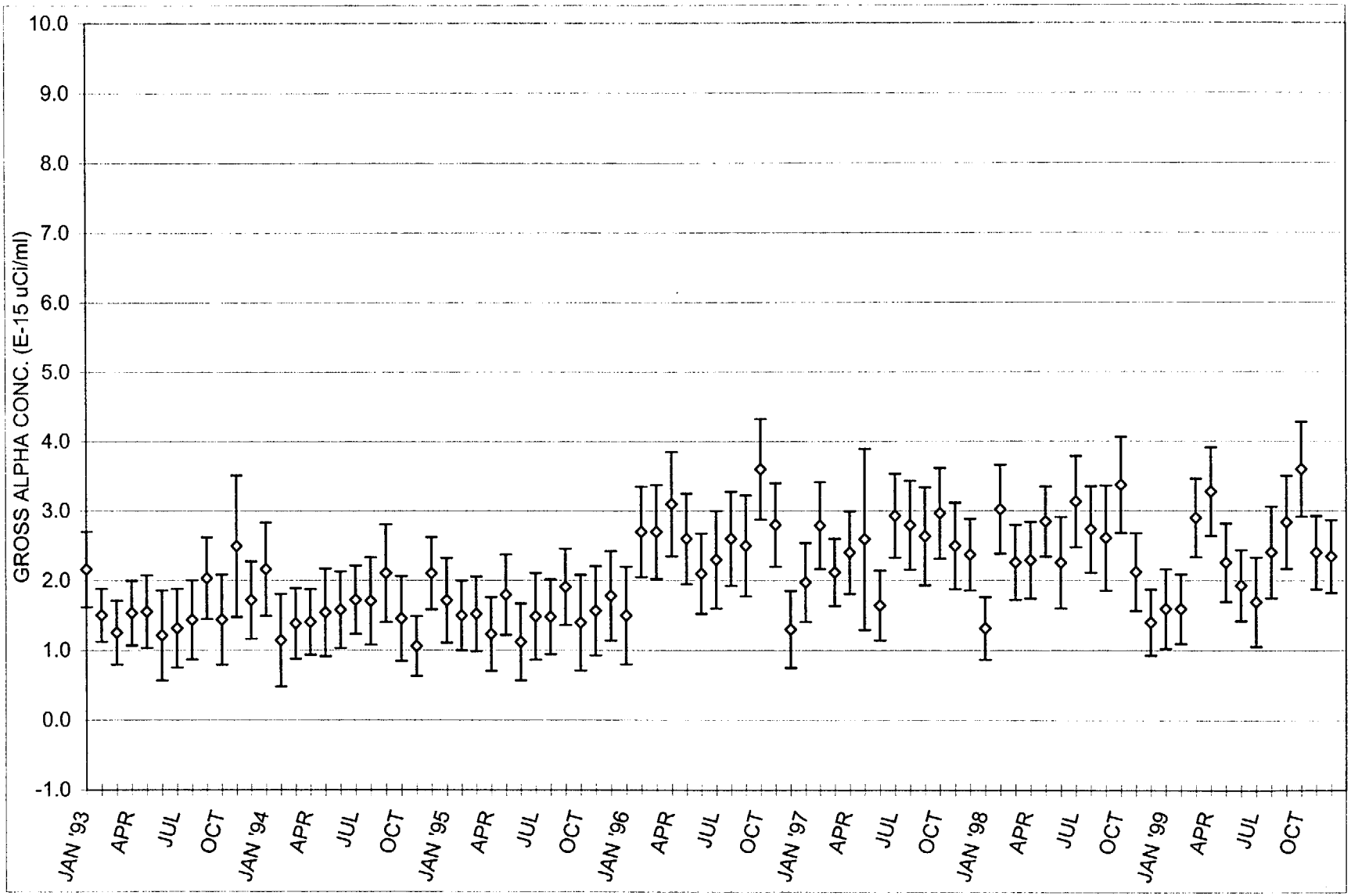
STATION 3



Gross Alpha Investigation Level = 1 E-14 uCi/cc
Gross Alpha Reporting Level = 1.4 E-14 uCi/cc

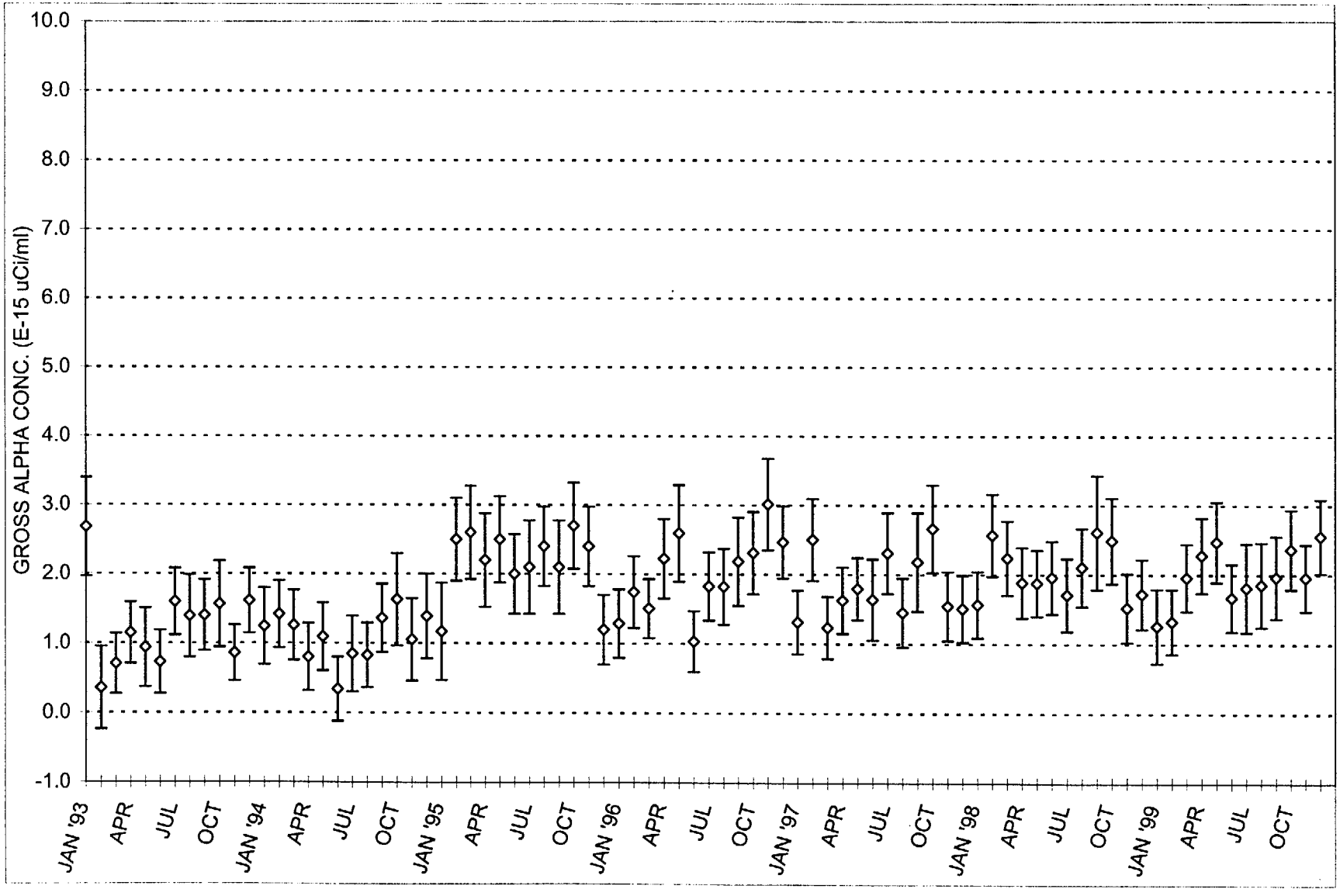
FIGURE 5.31
MONTHLY AVERAGE GROSS ALPHA ACTIVITY IN AIR

STATION 4



Gross Alpha Investigation Level = 1 E-14 uCi/cc
Gross Alpha Reporting Level = 1.4 E-14 uCi/cc

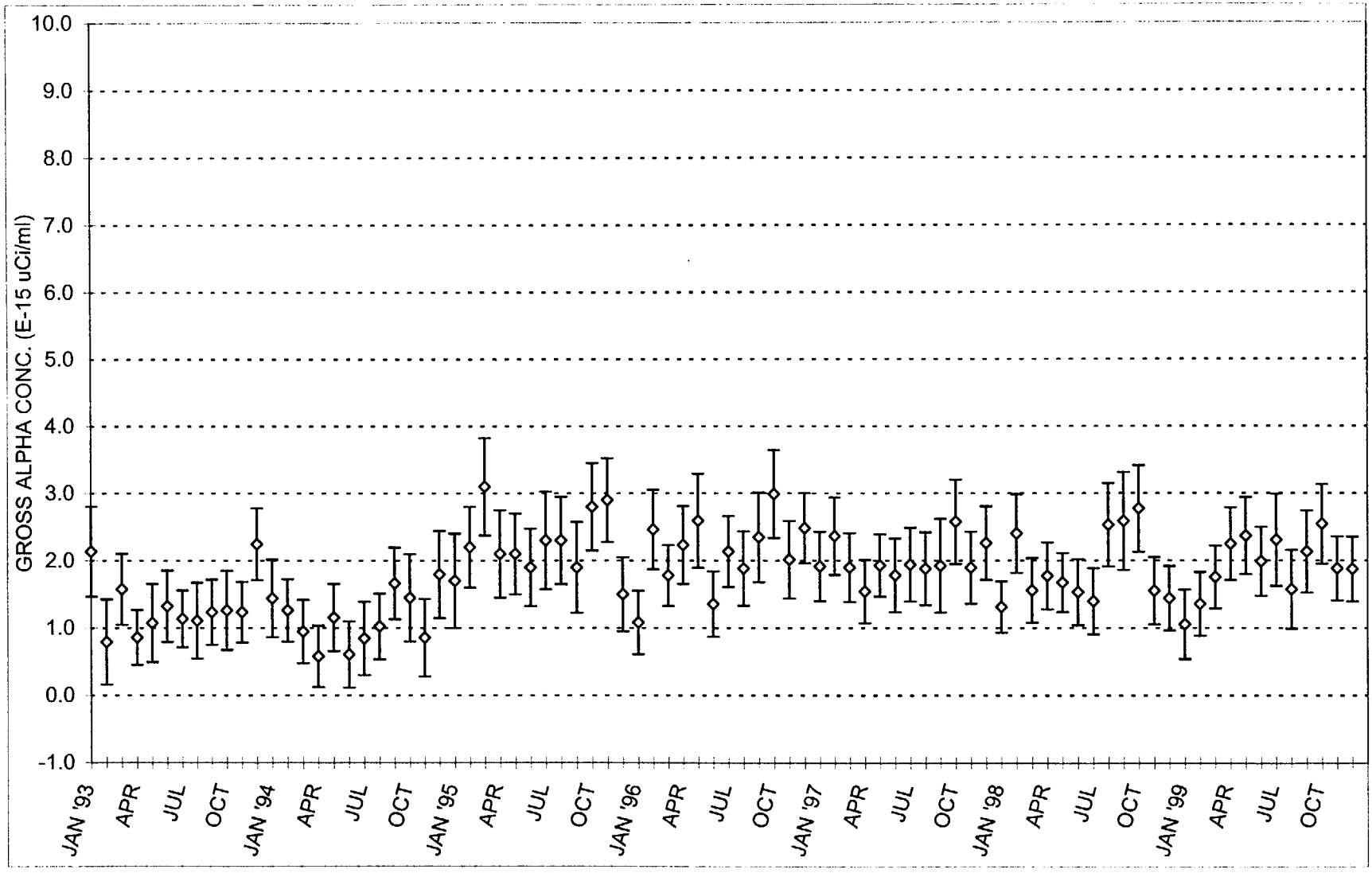
FIGURE 5.32
MONTHLY AVERAGE GROSS ALPHA ACTIVITY IN AIR
STATION 5



Gross Alpha Investigation Level = 1 E-14 uCi/cc
Gross Alpha Reporting Level = 1.4 E-14 uCi/cc

FIGURE 5.33
MONTHLY AVERAGE GROSS ALPHA ACTIVITY IN AIR

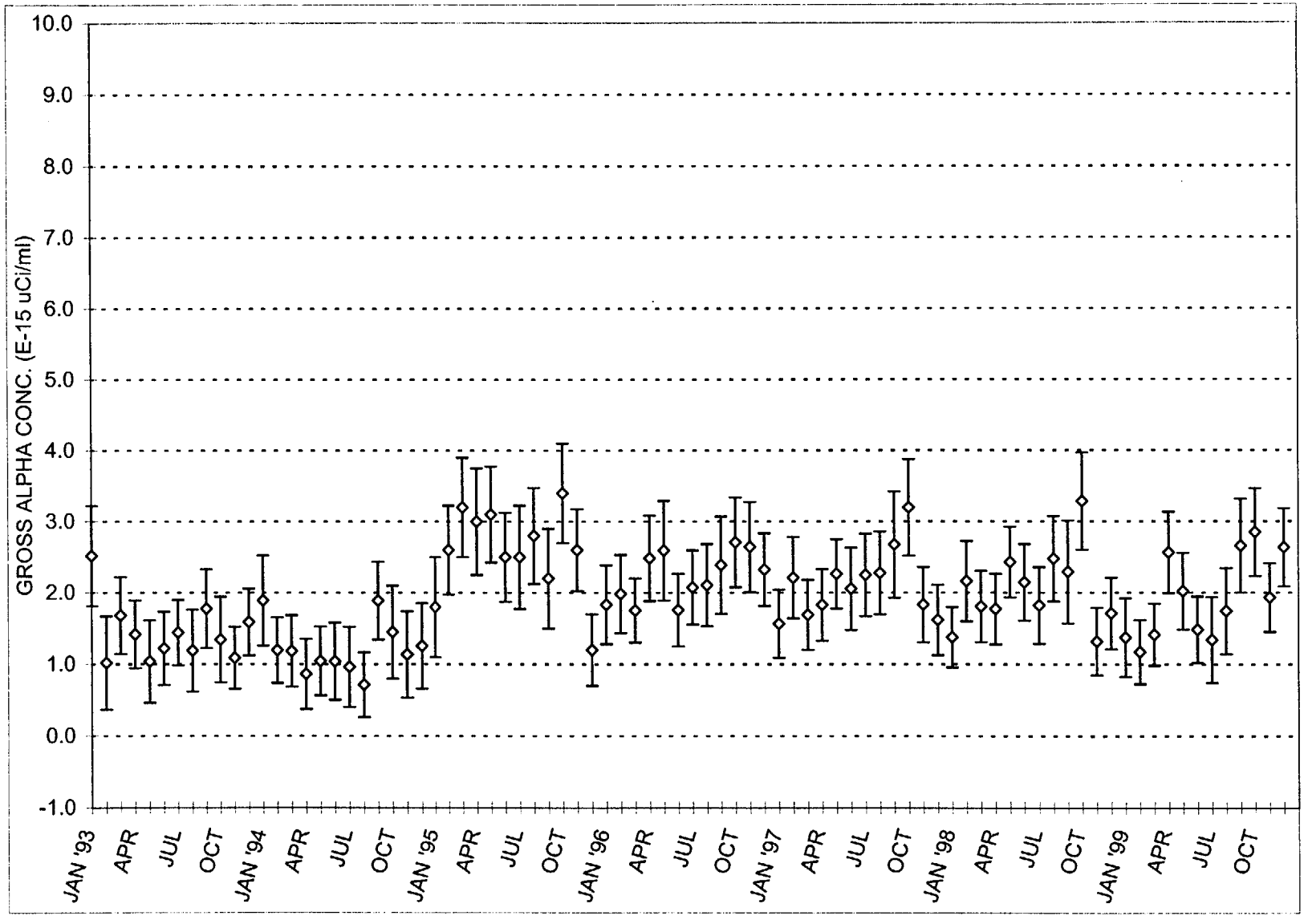
STATION 6



Gross Alpha Investigation Level = 1 E-14 uCi/cc
Gros Alpha Reporting Level = 1.4 E-14 uCi/cc

FIGURE 5.34
MONTHLY AVERAGE GROSS ALPHA ACTIVITY IN AIR

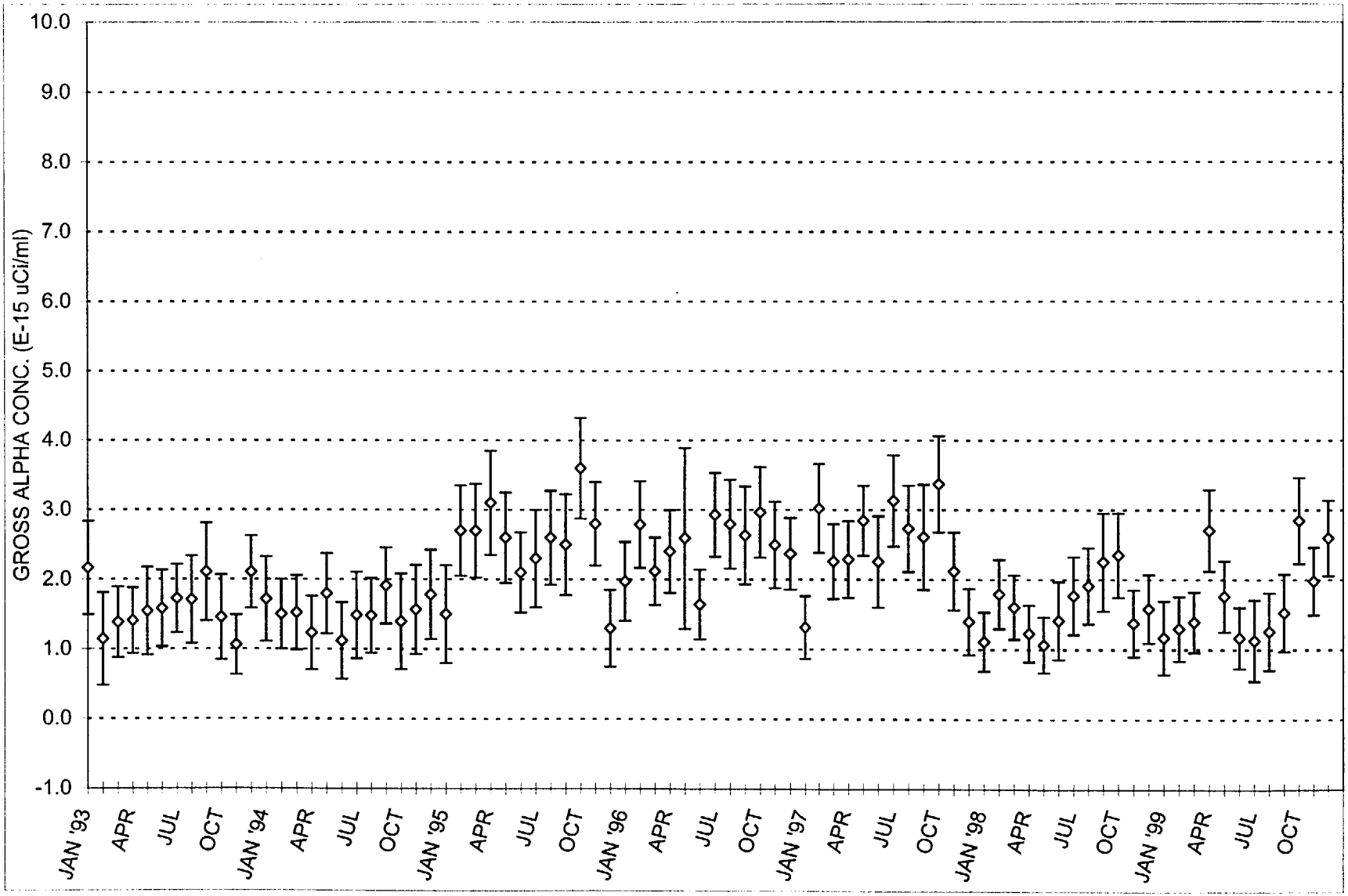
STATION 7



Gross Alpha Investigation Level = 1 E-14 uCi/cc
Gross Alpha Reporting Level = 1.4 E-14 uCi/cc

FIGURE 5.35
MONTHLY AVERAGE GROSS ALPHA ACTIVITY IN AIR

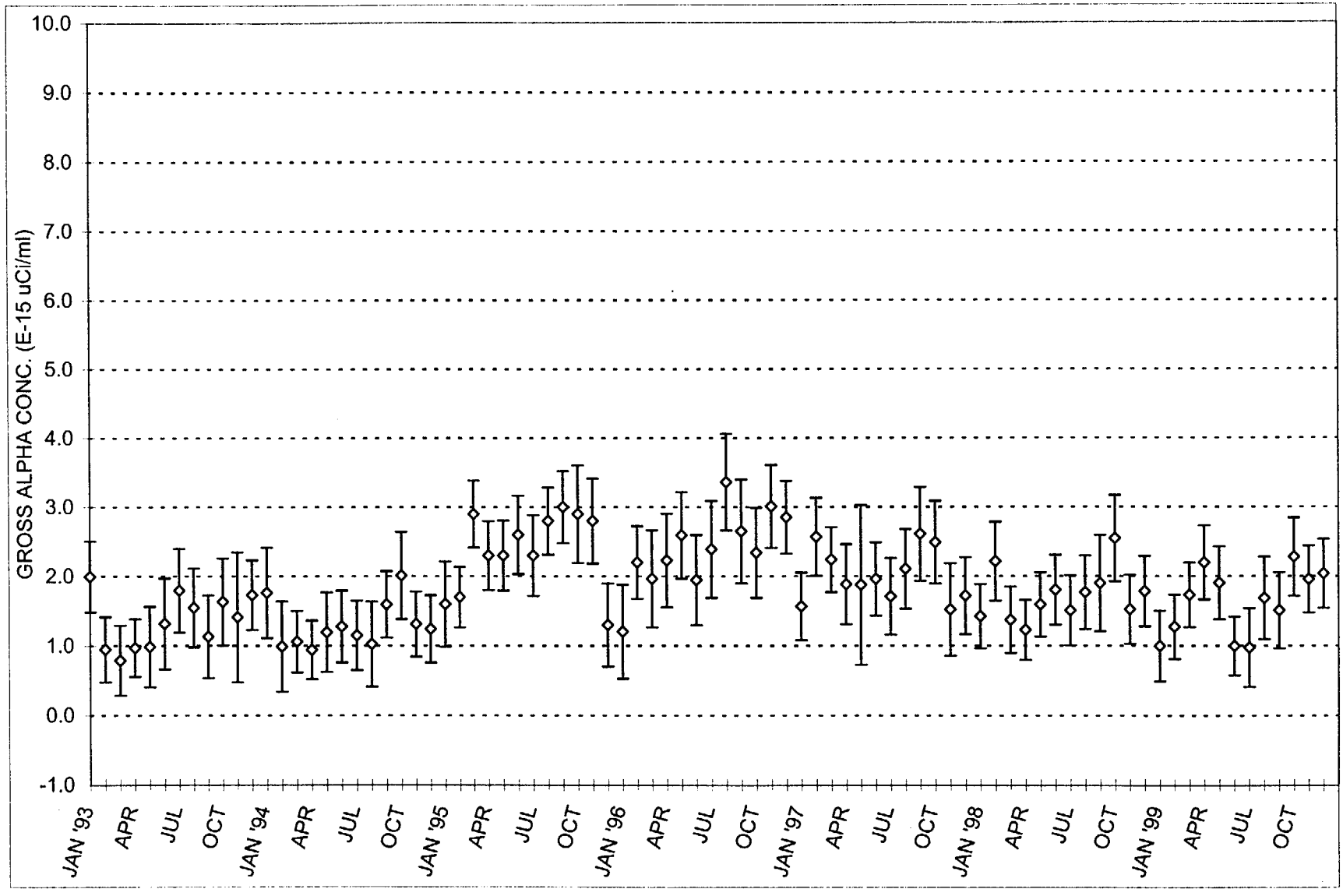
STATION 8



Gross Alpha Investigation Level = 1 E-14 uCi/cc
Gross Alpha Reporting Level = 1.4 E-14 uCi/cc

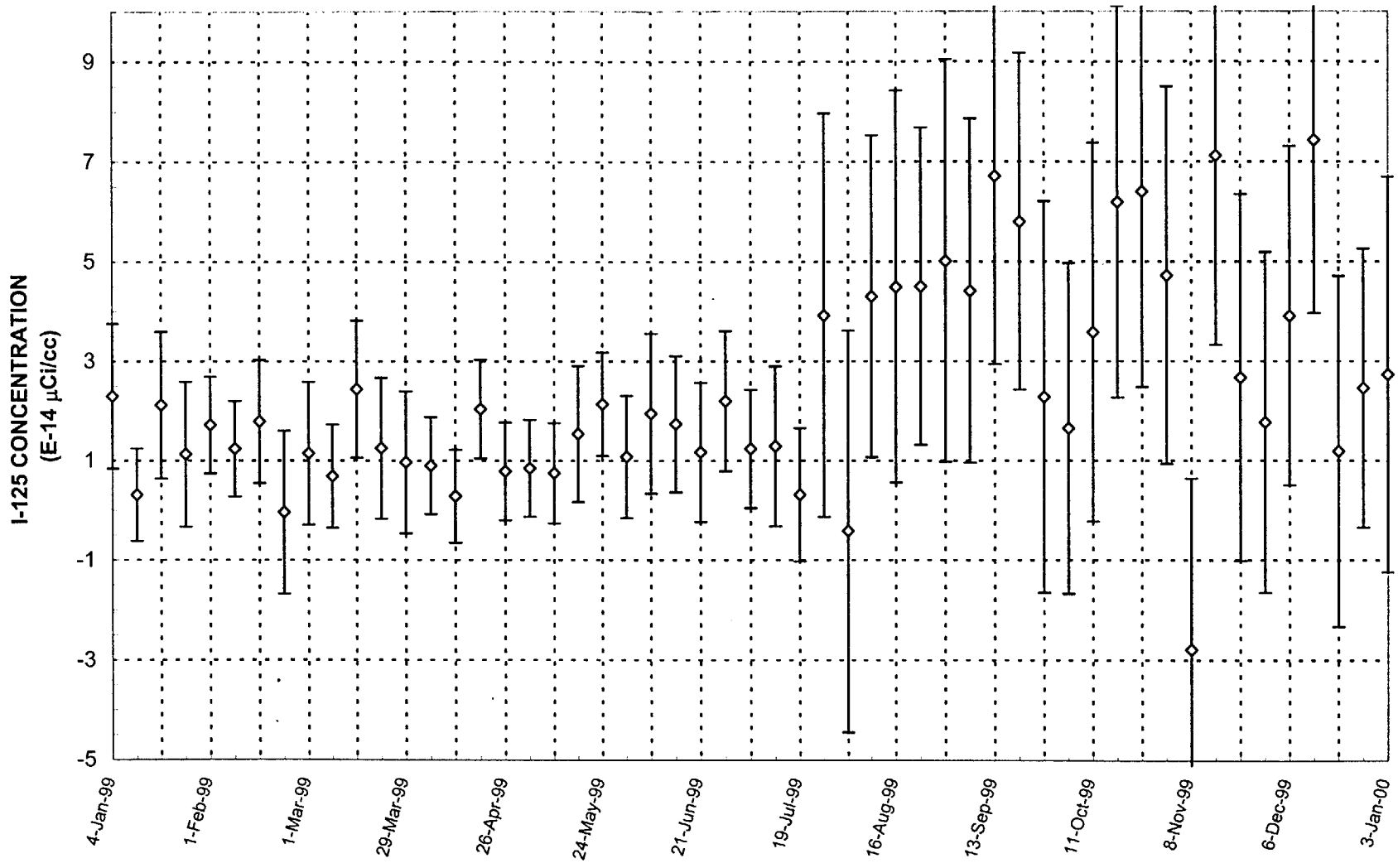
FIGURE 5.36
MONTHLY AVERAGE GROSS ALPHA ACTIVITY IN AIR

STATION 9



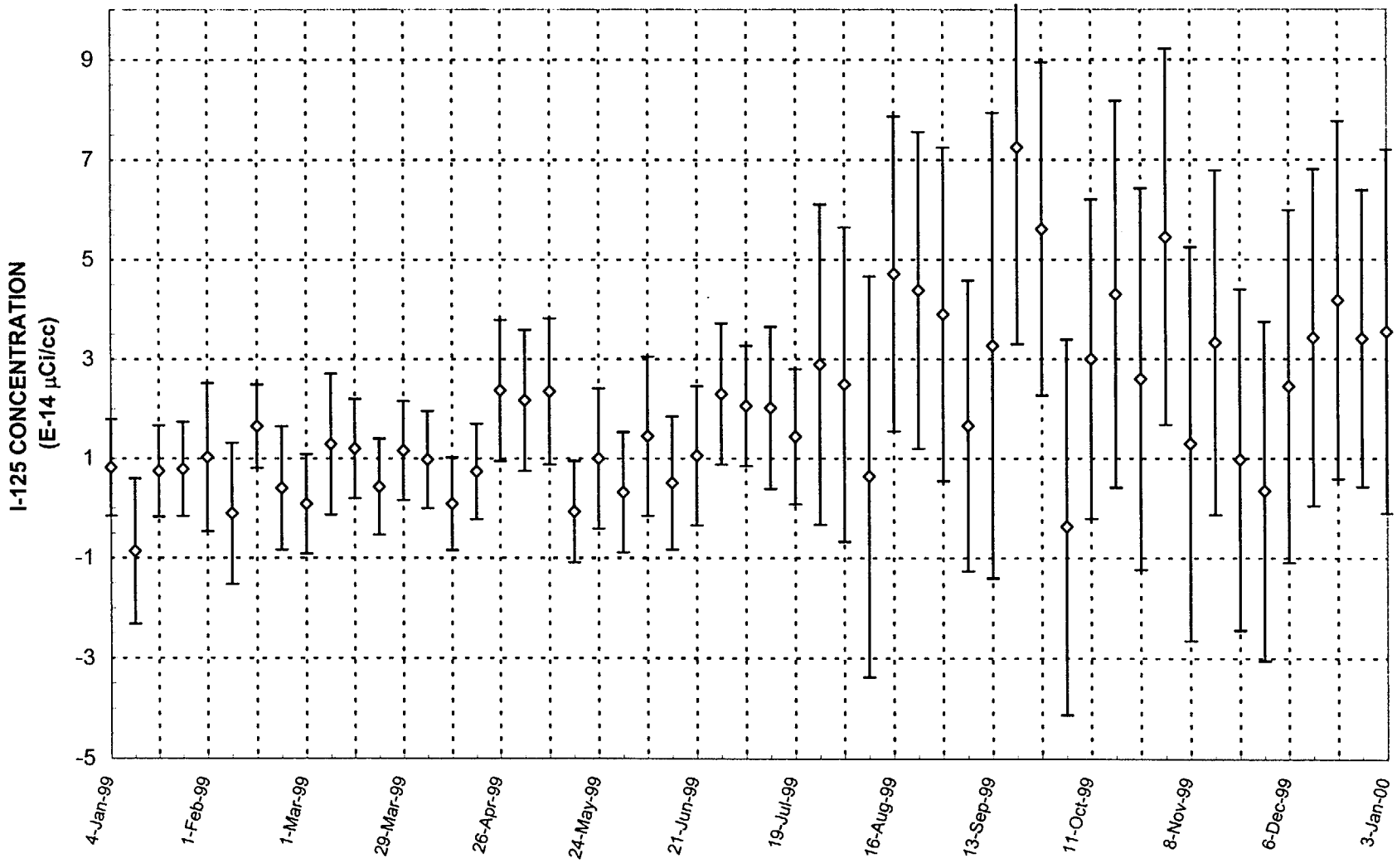
Gross Alpha Investigation Level = 1 E-14 uCi/cc
Gross Alpha Reporting Level = 1.4 E-14 uCi/cc

FIGURE 5.37
WEEKLY I-125 ACTIVITY IN AIR
STATION 1 -- RICHLAND, WASHINGTON



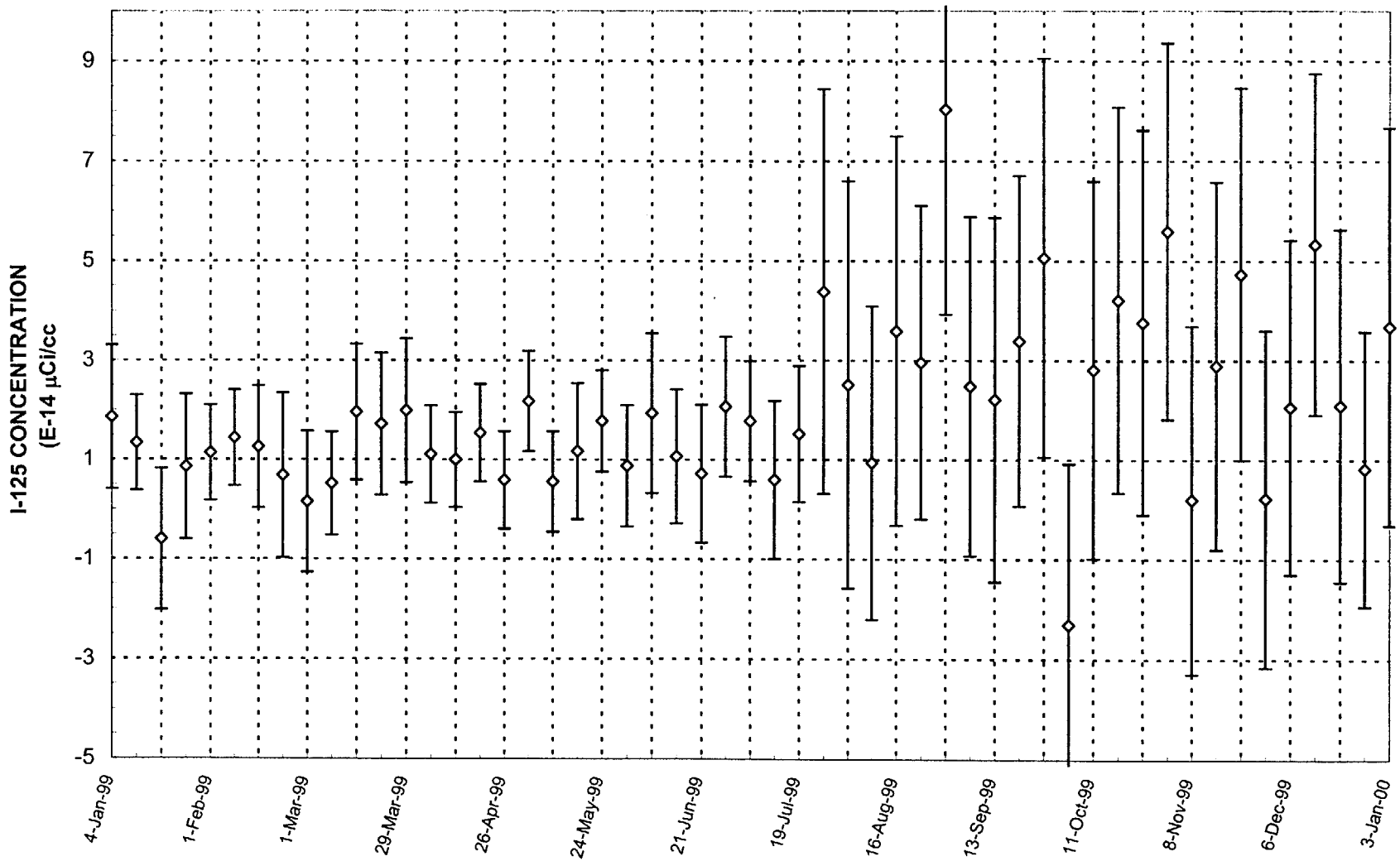
I-125 Investigation level = 3.5 E-14 uCi/cc
I-125 Reporting Level = 2.3 E-10 uCi/cc

FIGURE 5.38
WEEKLY I-125 ACTIVITY IN AIR
STATION 2 -- RICHLAND, WASHINGTON



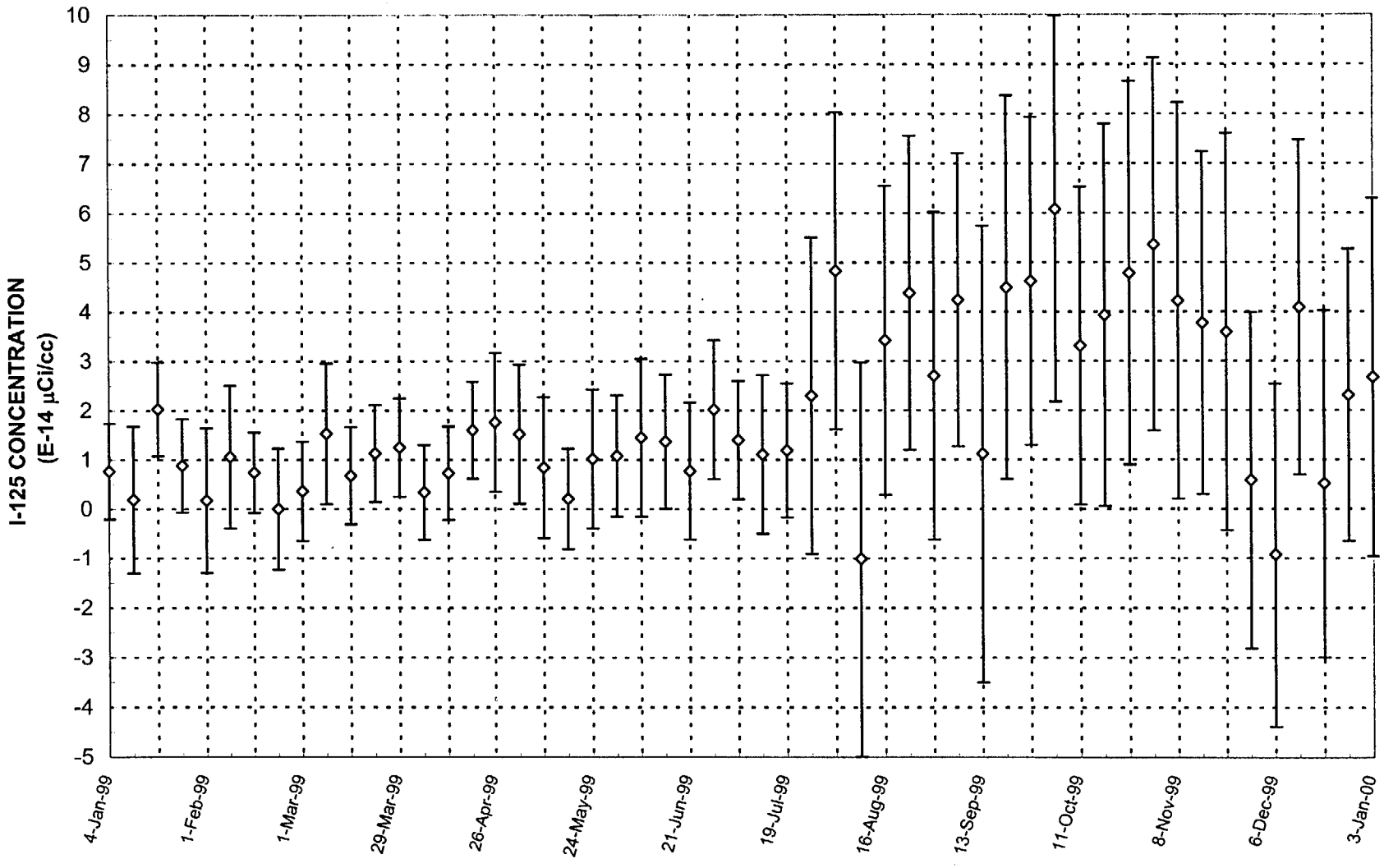
I-125 Investigation Level = 3.5 E-14 uCi/cc
I-125 Reporting level = 2.3 E-10 uCi/cc

FIGURE 5.39
WEEKLY I-125 ACTIVITY IN AIR
STATION 3 -- RICHLAND, WASHINGTON



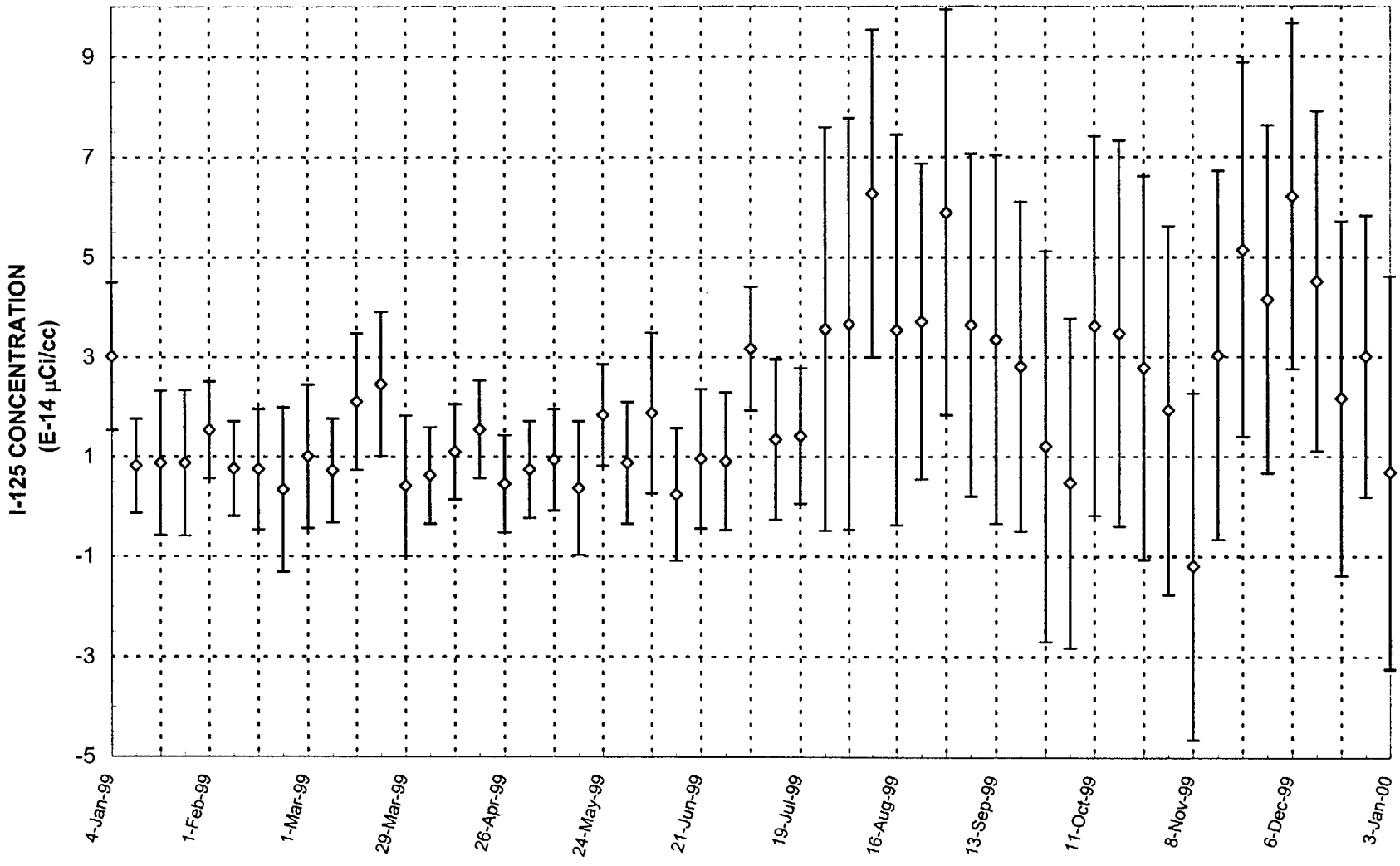
I-125 Investigation Level = 3.5 E-14 uCi/cc
I-125 Reporting Level = 2.3 E-10 uCi/cc

FIGURE 5.40
WEEKLY I-125 ACTIVITY IN AIR
STATION 4 -- RICHLAND, WASHINGTON



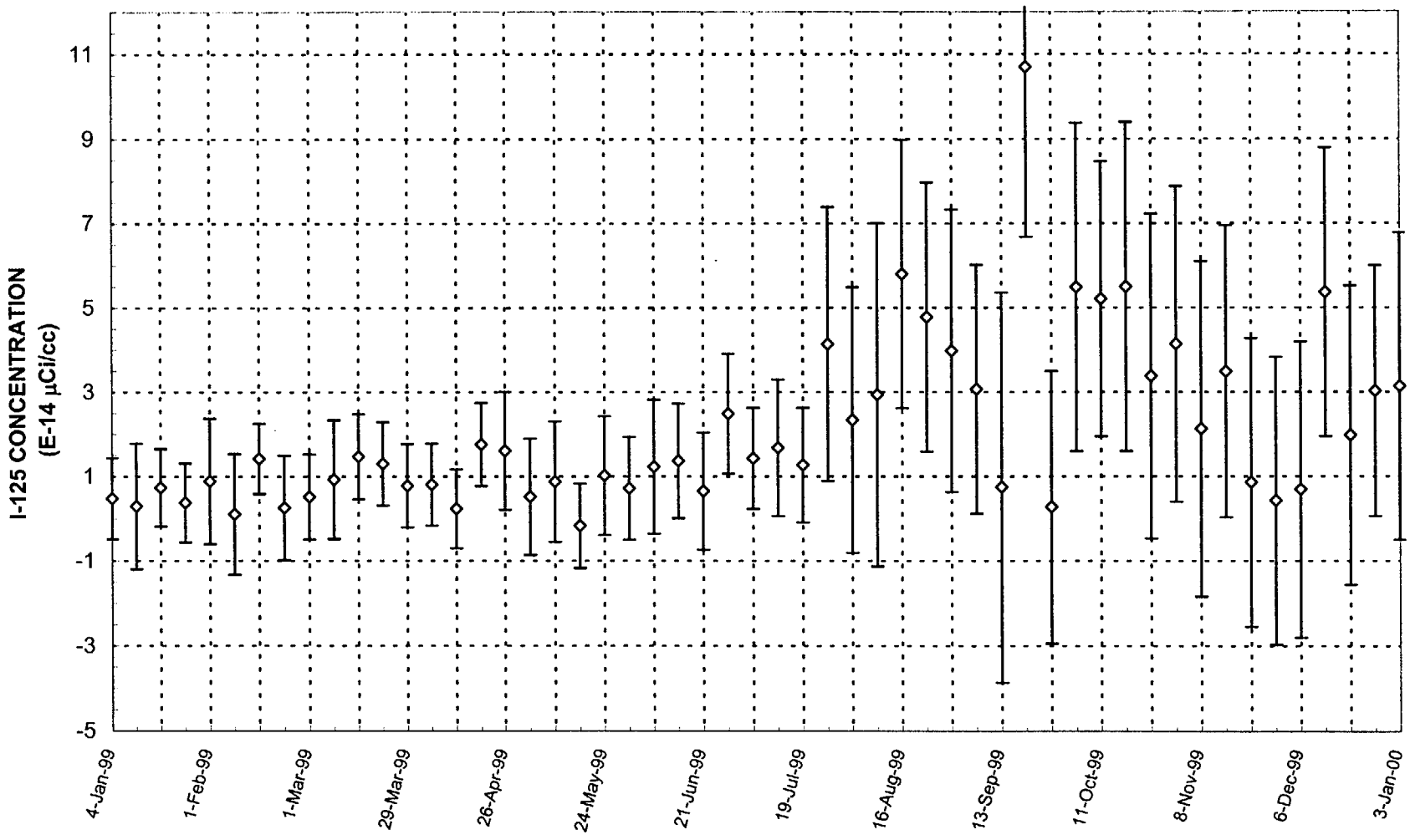
I-125 Investigation Level = 3.5 E-14 uCi/cc
I-125 Reporting Level = 2.3 E-10 uC/cc

FIGURE 5.41
WEEKLY I-125 ACTIVITY IN AIR
STATION 5 -- RICHLAND, WASHINGTON



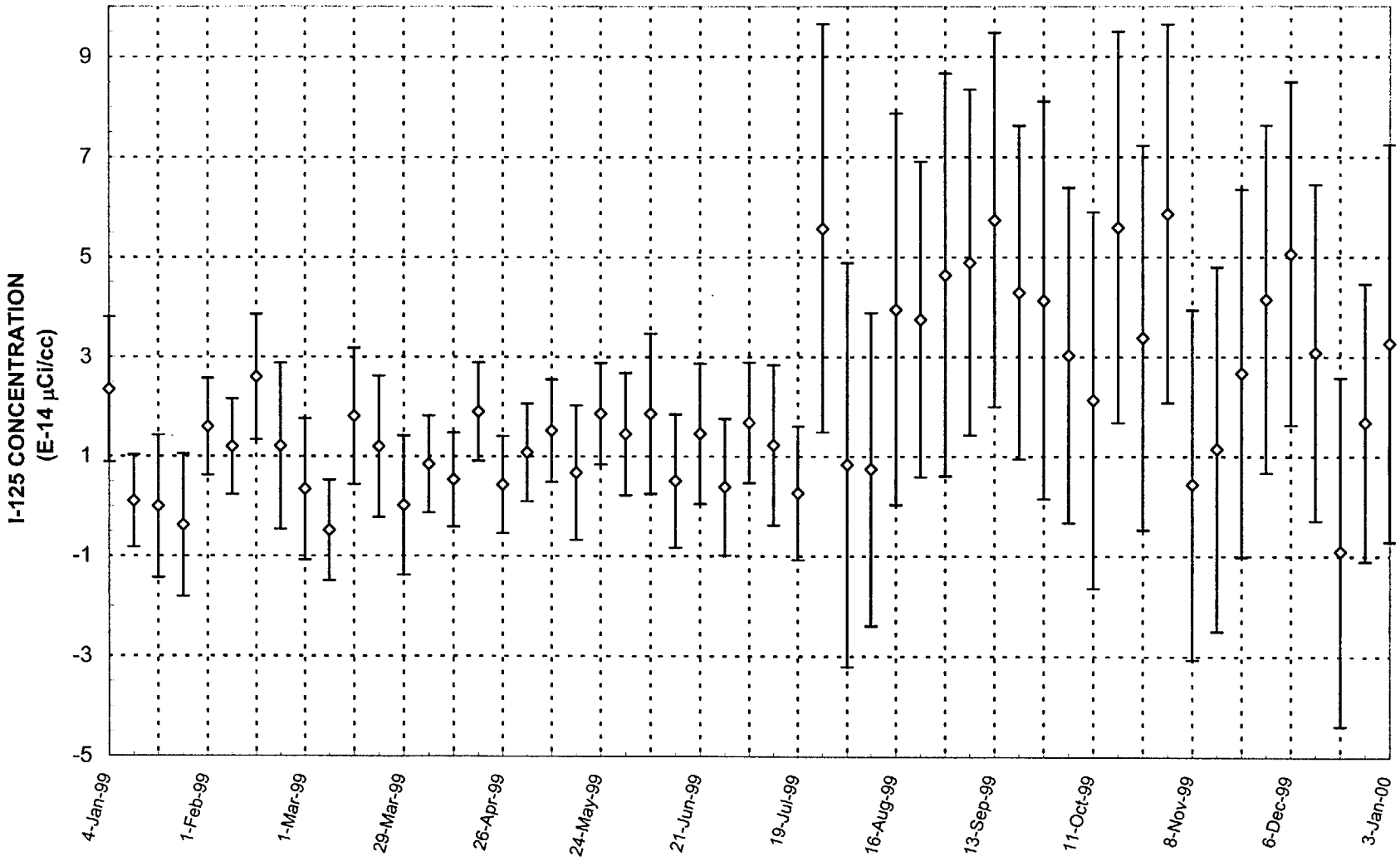
I-125 Investigation level = 3.5 E-14 uCi/cc
I-125 Reporting level =2.3 E-10 uCi/cc

FIGURE 5.42
WEEKLY I-125 ACTIVITY IN AIR
STATION 6 -- RICHLAND, WASHINGTON



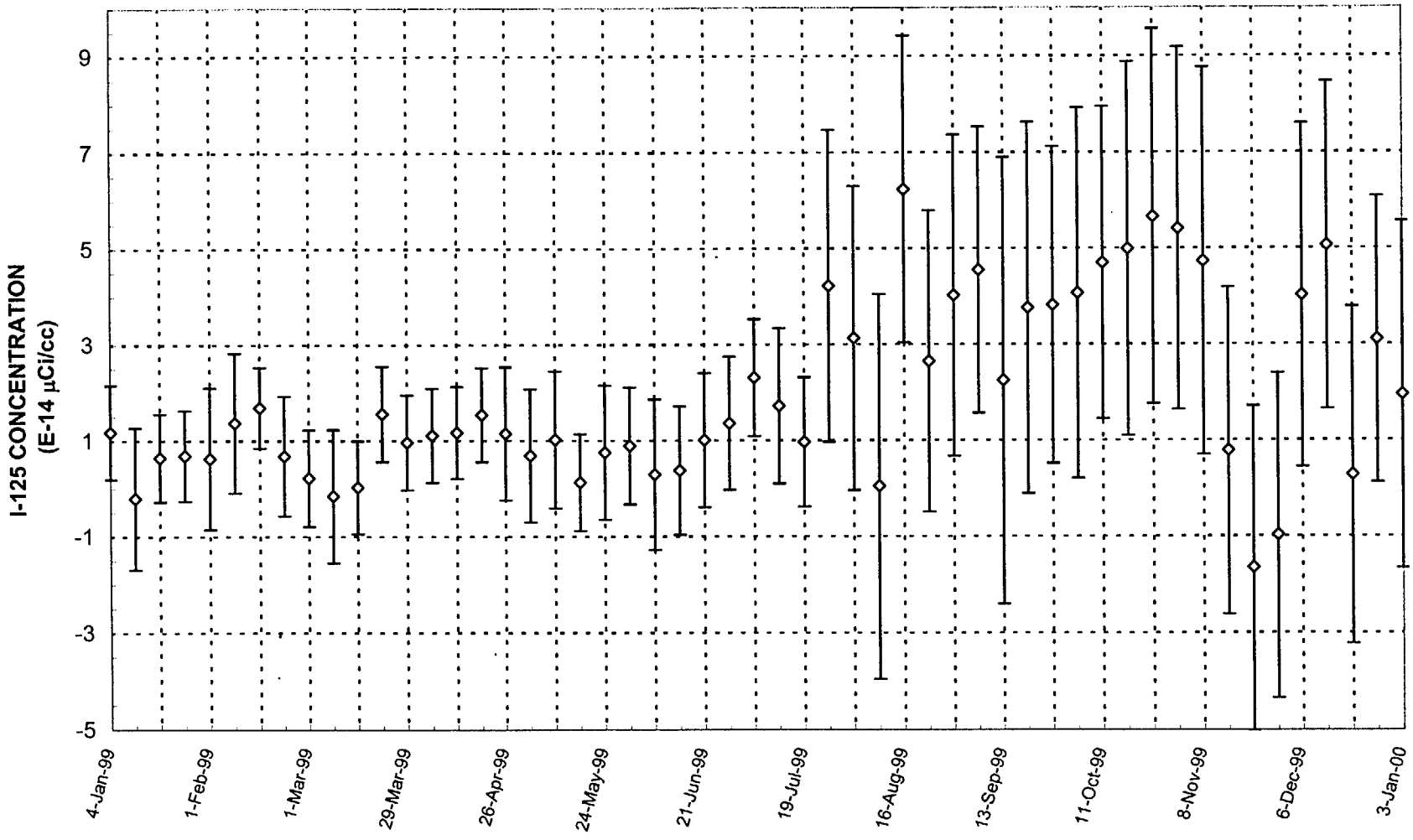
I-125 Investigation Level = 3.5 E-14 uCi/cc
I-125 reporting level = 2.3 E-10 uCi/cc

FIGURE 5.43
WEEKLY I-125 ACTIVITY IN AIR
STATION 7 -- RICHLAND, WASHINGTON



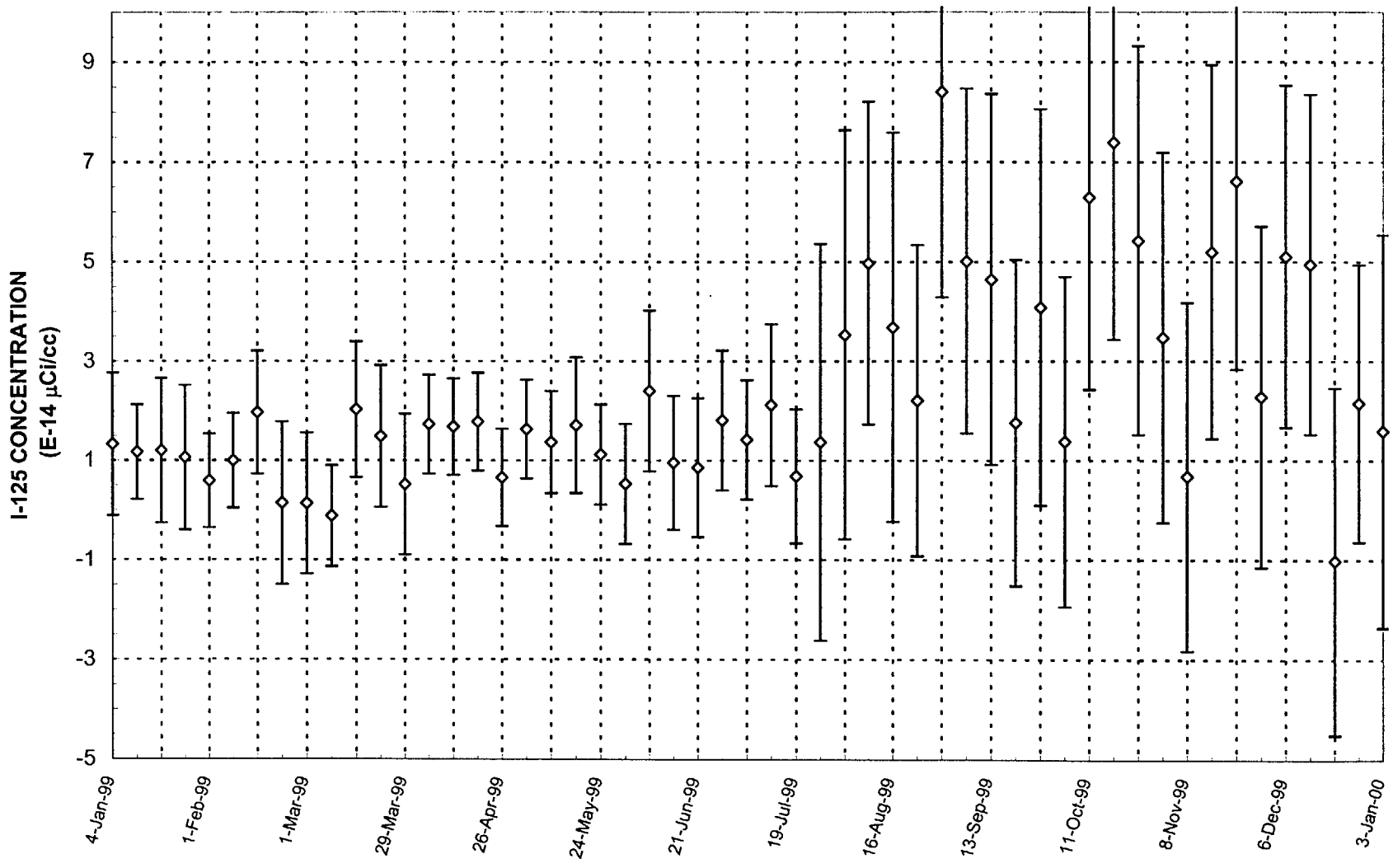
I-125 Investigation Level = 3.5 E-14 uCi/cc
I-125 Reporting Level = 2.3 E-10 uCi/cc

FIGURE 5.44
WEEKLY I-125 ACTIVITY IN AIR
STATION 8 -- RICHLAND, WASHINGTON



I-125 Investigation Level = 3.5 E-14 uCi/cc
I-125 Reporting Level = 2.3 E-10 uCi/cc

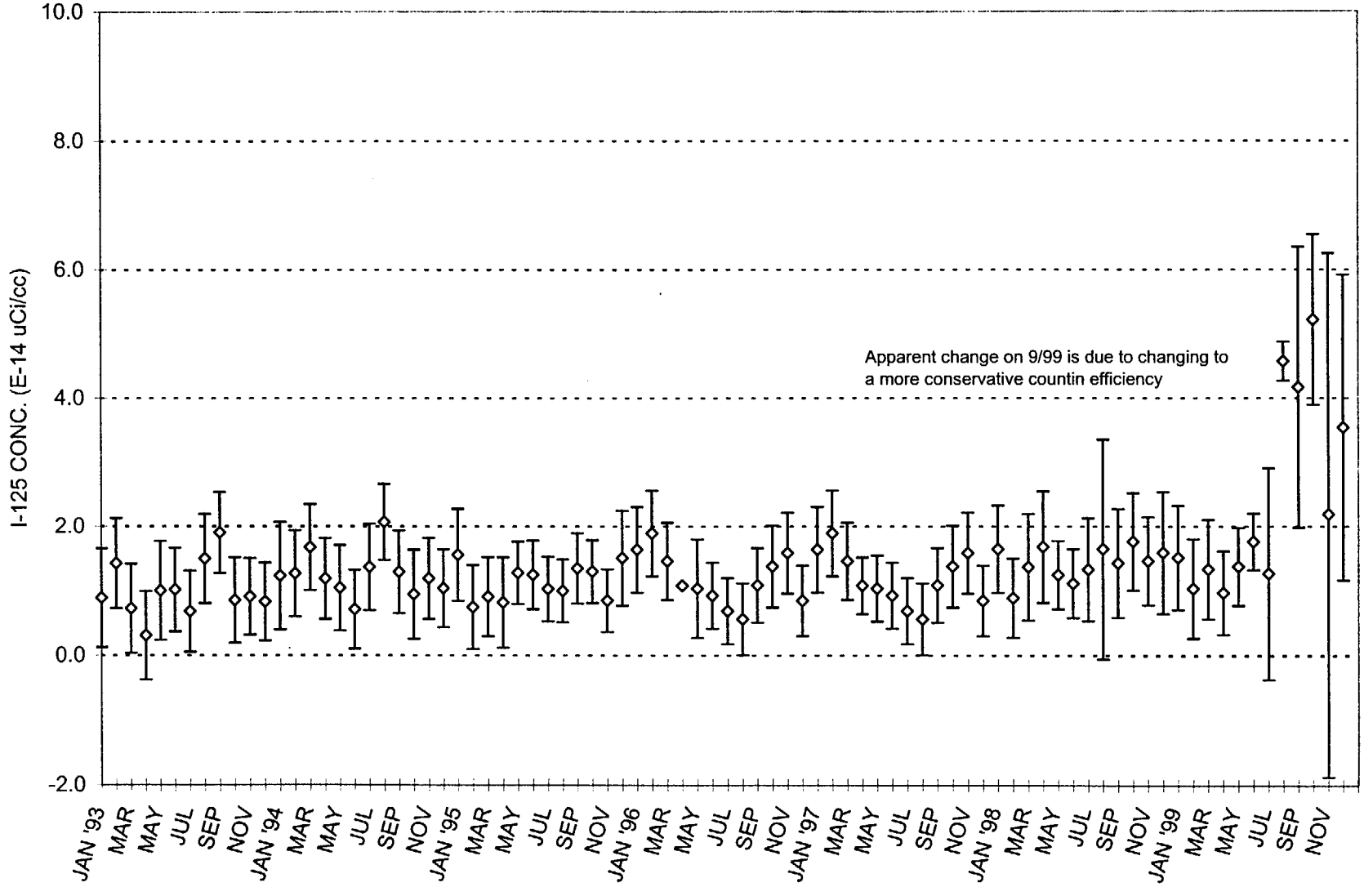
FIGURE 5.45
WEEKLY I-125 ACTIVITY IN AIR
STATION 9 - RICHLAND, WASHINGTON



I-125 Investigation level = 3.5 E-14 uCi/cc
I-125 Reprting Level = 2.3 E-10 uCi/cc

FIGURE 5.46

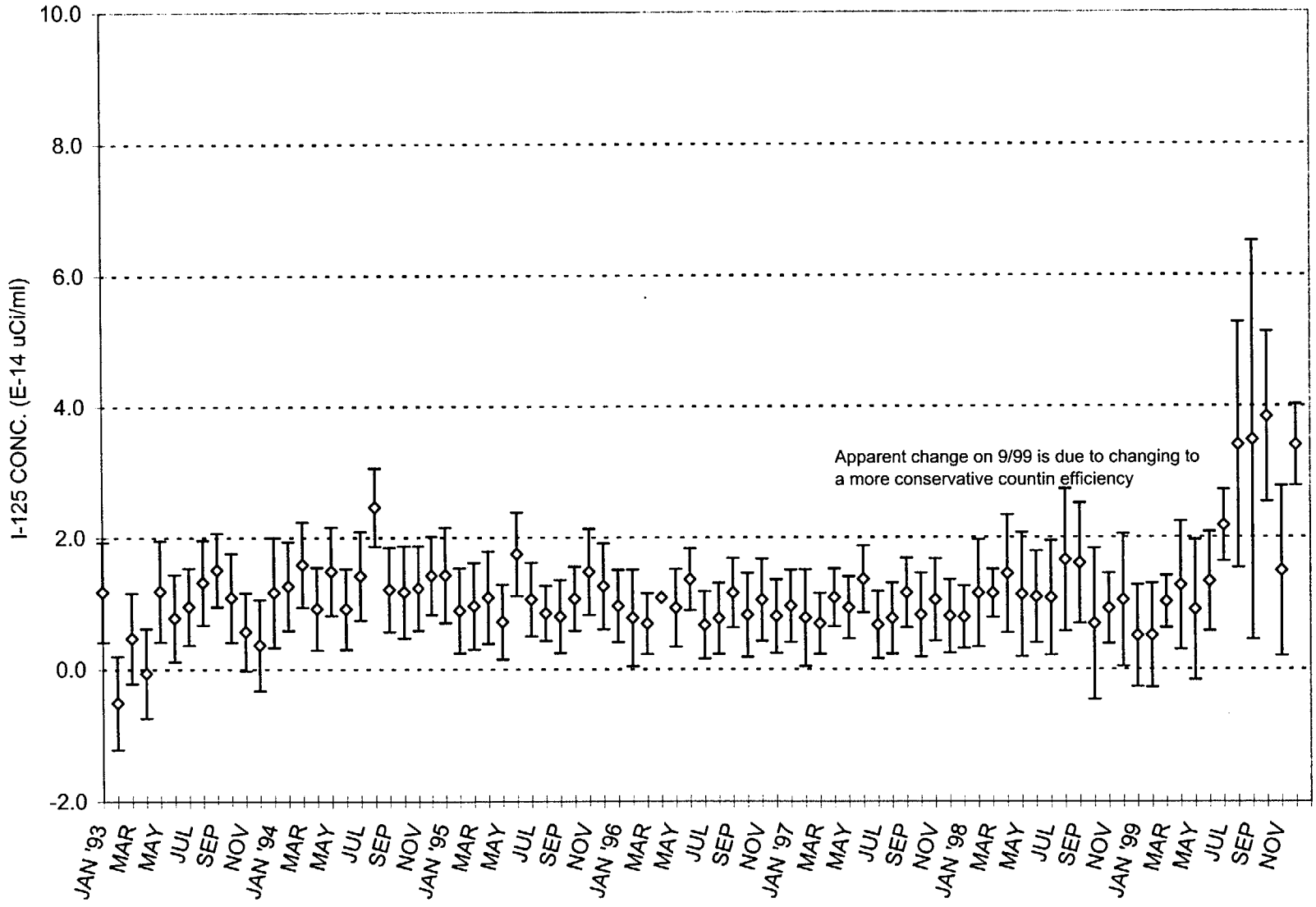
MONTHLY AVERAGE IODINE-125 ACTIVITY IN AIR
STATION 1



I-125 Investigation Level = 3.5 E-14 uCi/cc
I-125 Reporting level = 2.3 E-10 uCi/cc

FIGURE 5.47

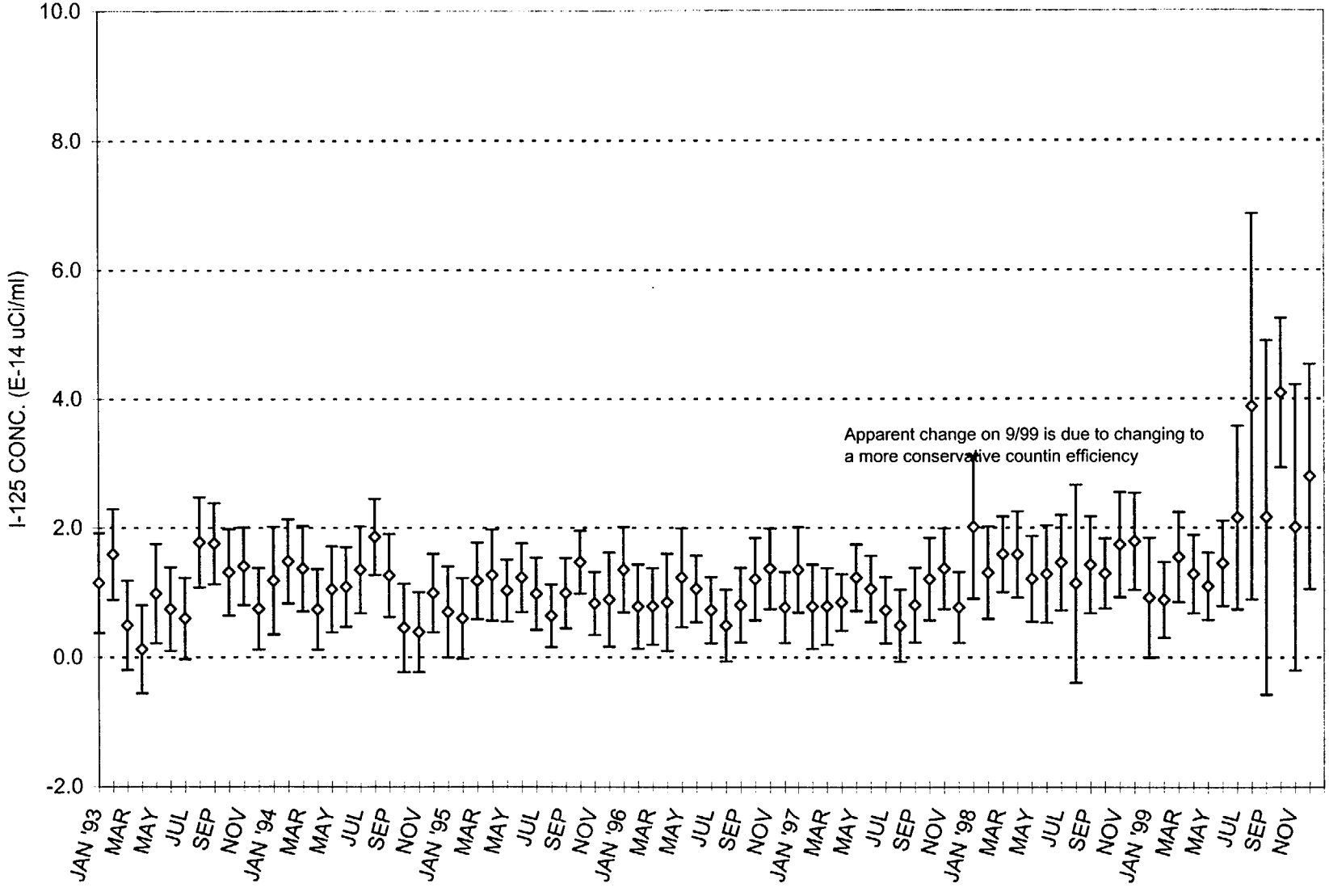
MONTHLY AVERAGE IODINE-125 ACTIVITY IN AIR
STATION 2



I-125 Investigation Level = 3.5 E-14 uCi/cc
I-125 Reporting level = 2.3 E-10 uCi/cc

FIGURE 5.48

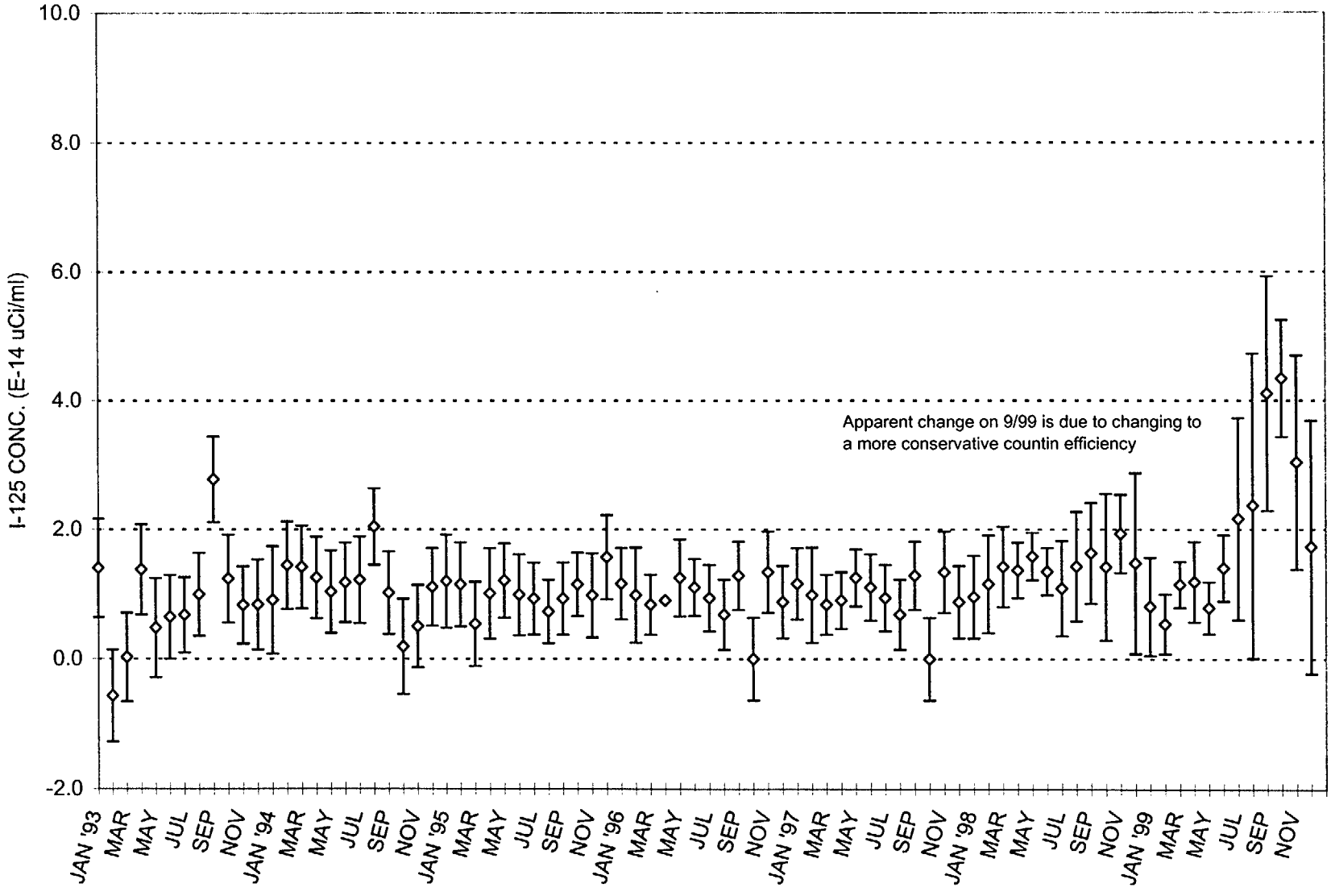
MONTHLY AVERAGE IODINE-125 ACTIVITY IN AIR
STATION 3



I-125 Investigation Level =3.5 E-14 uCi/cc
I-125 Reporting Level = 2.3 E-10 uCi/cc

FIGURE 5.49

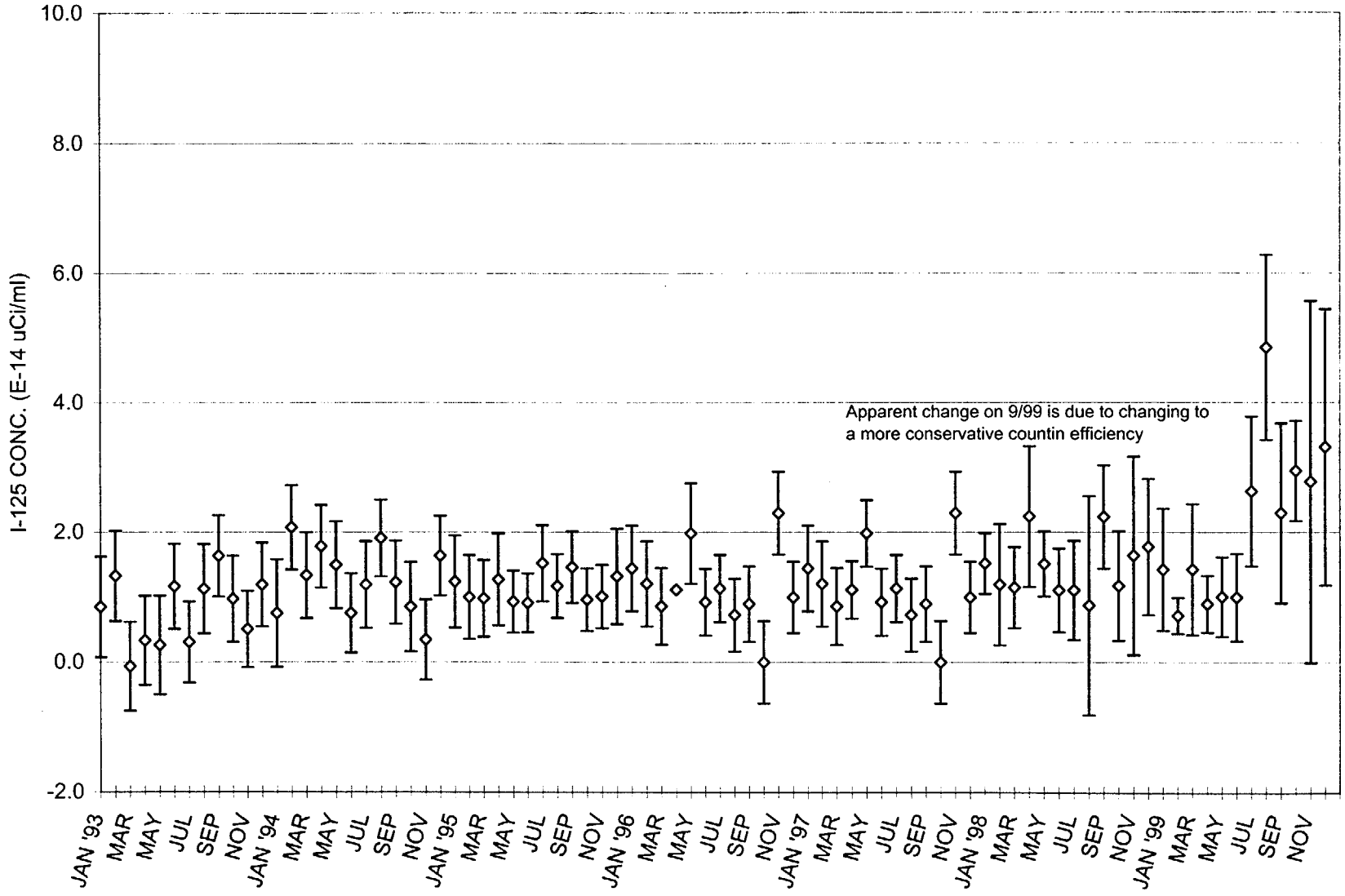
MONTHLY AVERAGE IODINE-125 ACTIVITY IN AIR
STATION 4



I-125 Investigation Level =3.5 E-14 uCi/cc
I-125 Reporting Level = 2.3 E-10 uCi/cc

FIGURE 5.50

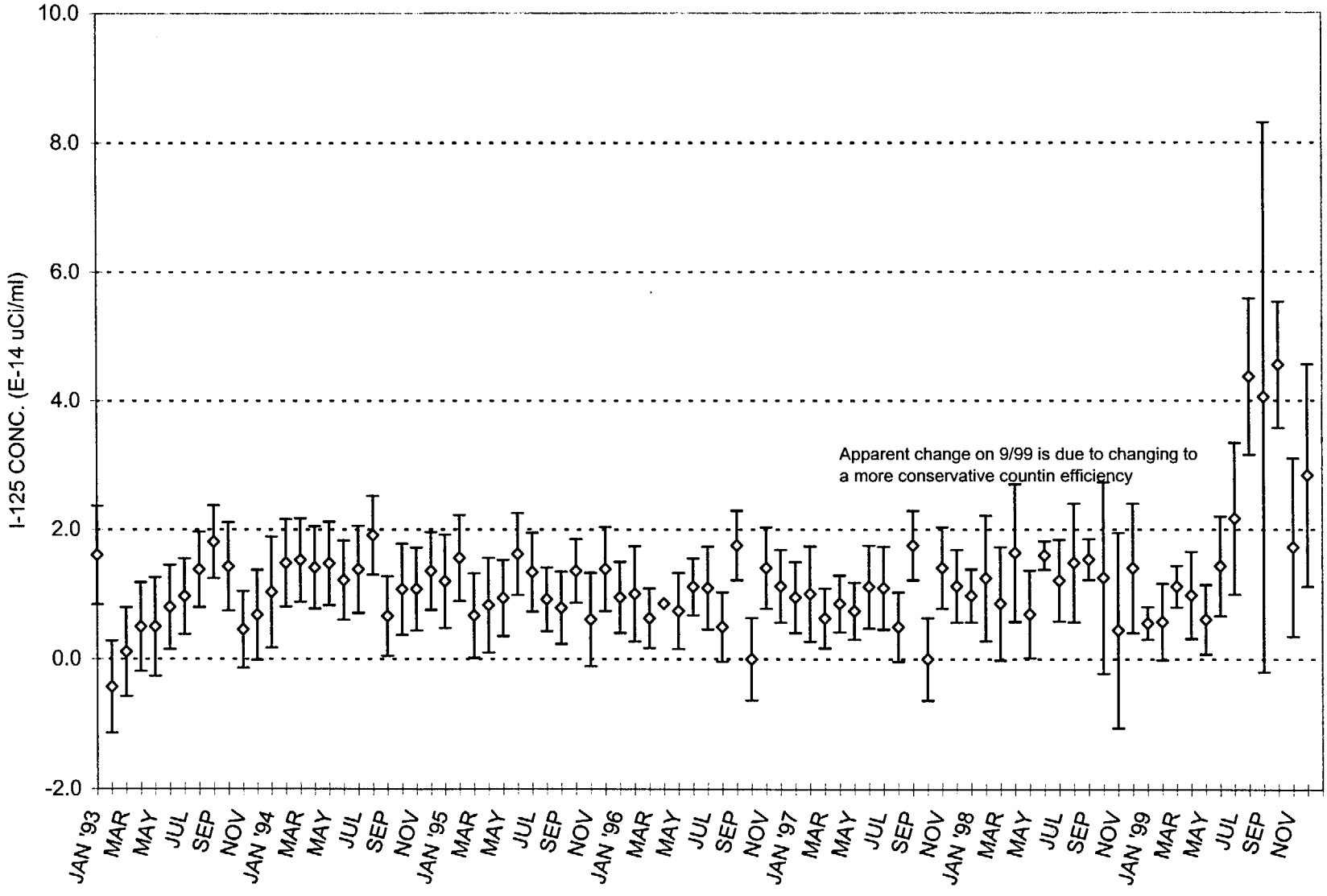
MONTHLY AVERAGE IODINE-125 ACTIVITY IN AIR
STATION 5



I-125 InvestigationLevel = 3.5 E-14 uCi/cc
I-125 Reporting Level = 2.3 E-10 uCi/cc

FIGURE 5.51

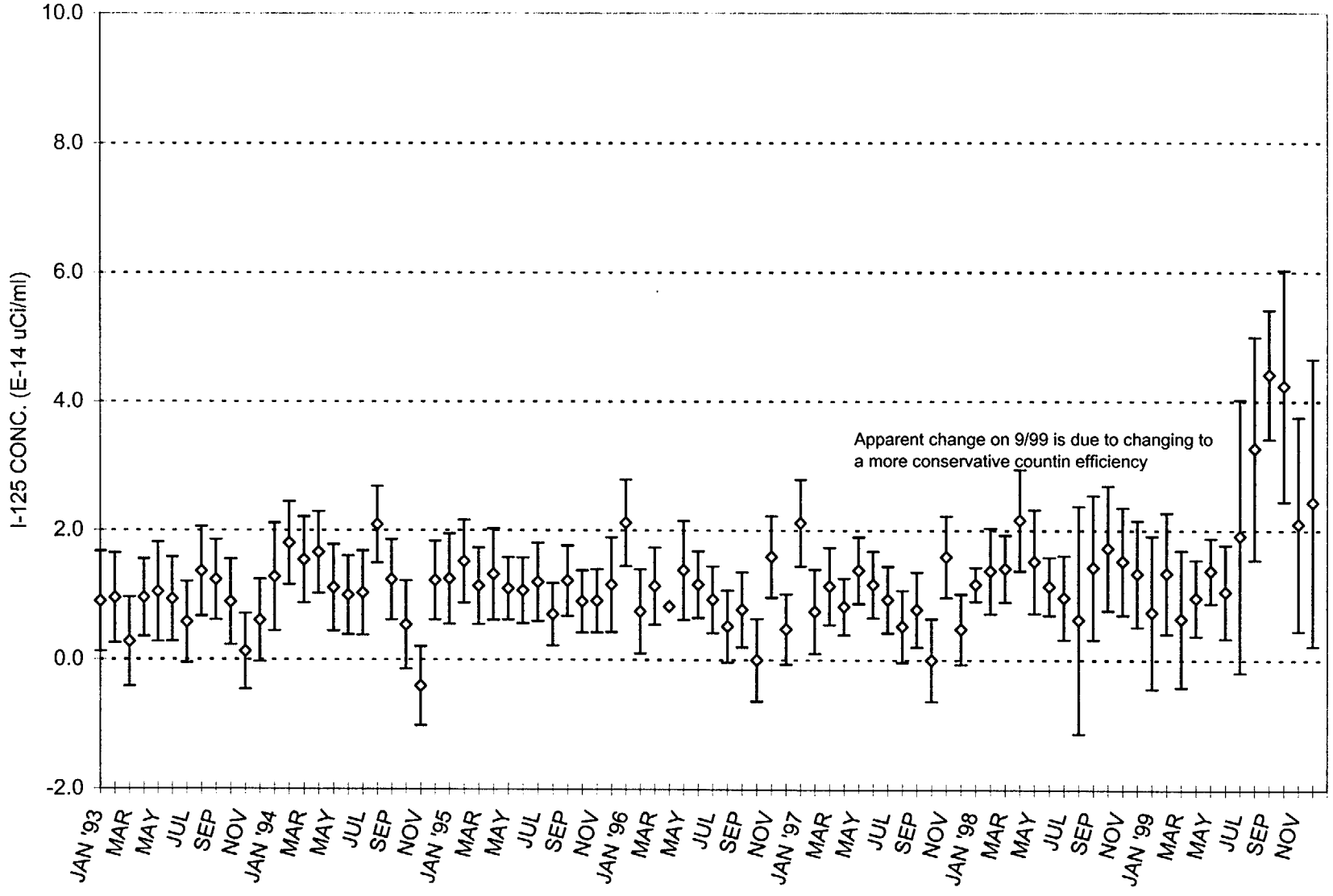
MONTHLY AVERAGE IODINE-125 ACTIVITY IN AIR
STATION 6



I-125 Investigation Level = 3.5 E-14 uCi/cc
I-125 Reporting Level = 2.3 E-10 uCi/cc

FIGURE 5.52

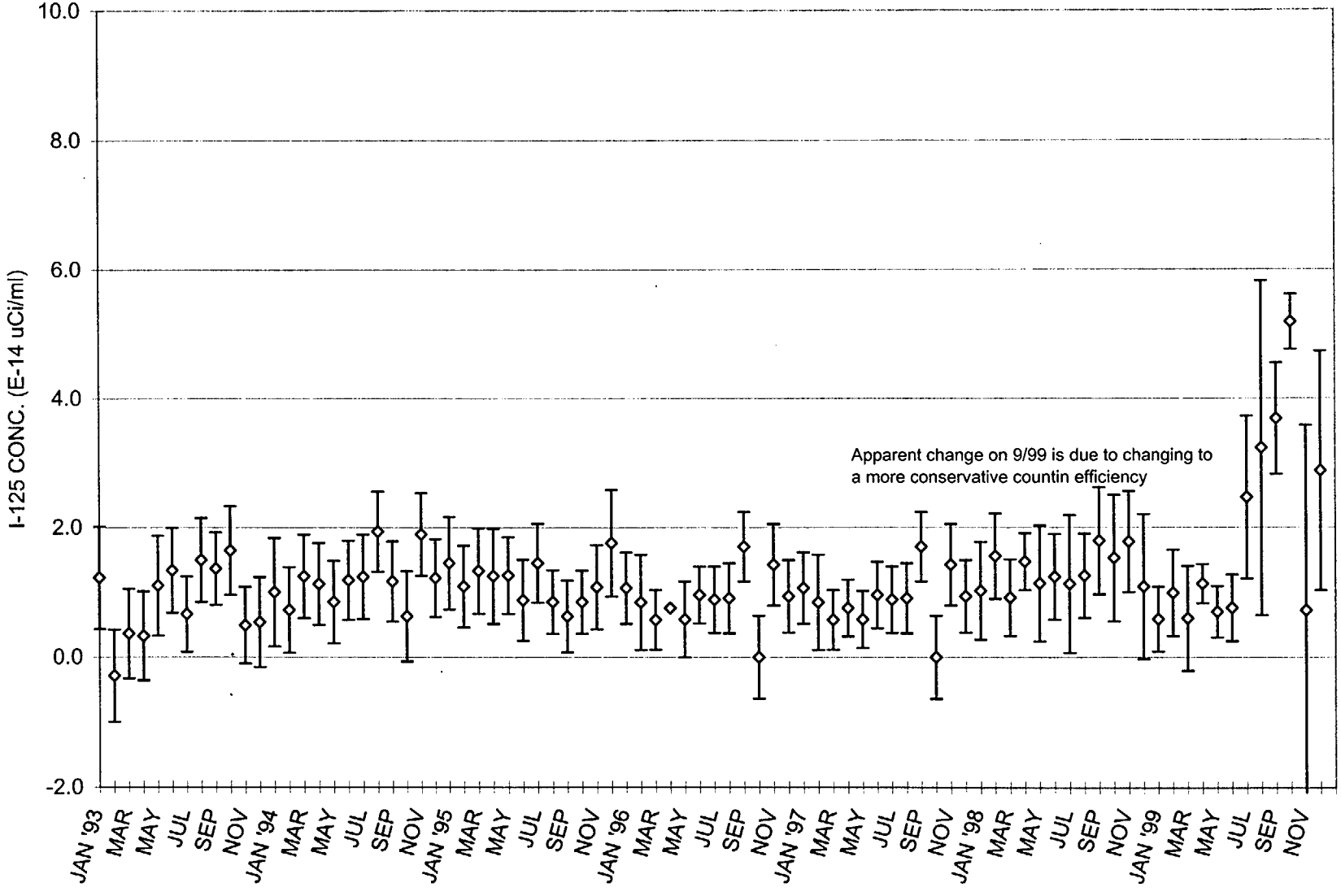
MONTHLY AVERAGE IODINE-125 ACTIVITY IN AIR
STATION 7



I-125 Investigation level = 3.5 E-14 uCi/cc
I-125 Reportinig Level = 2.3 E-10 uCi/cc

FIGURE 5.53

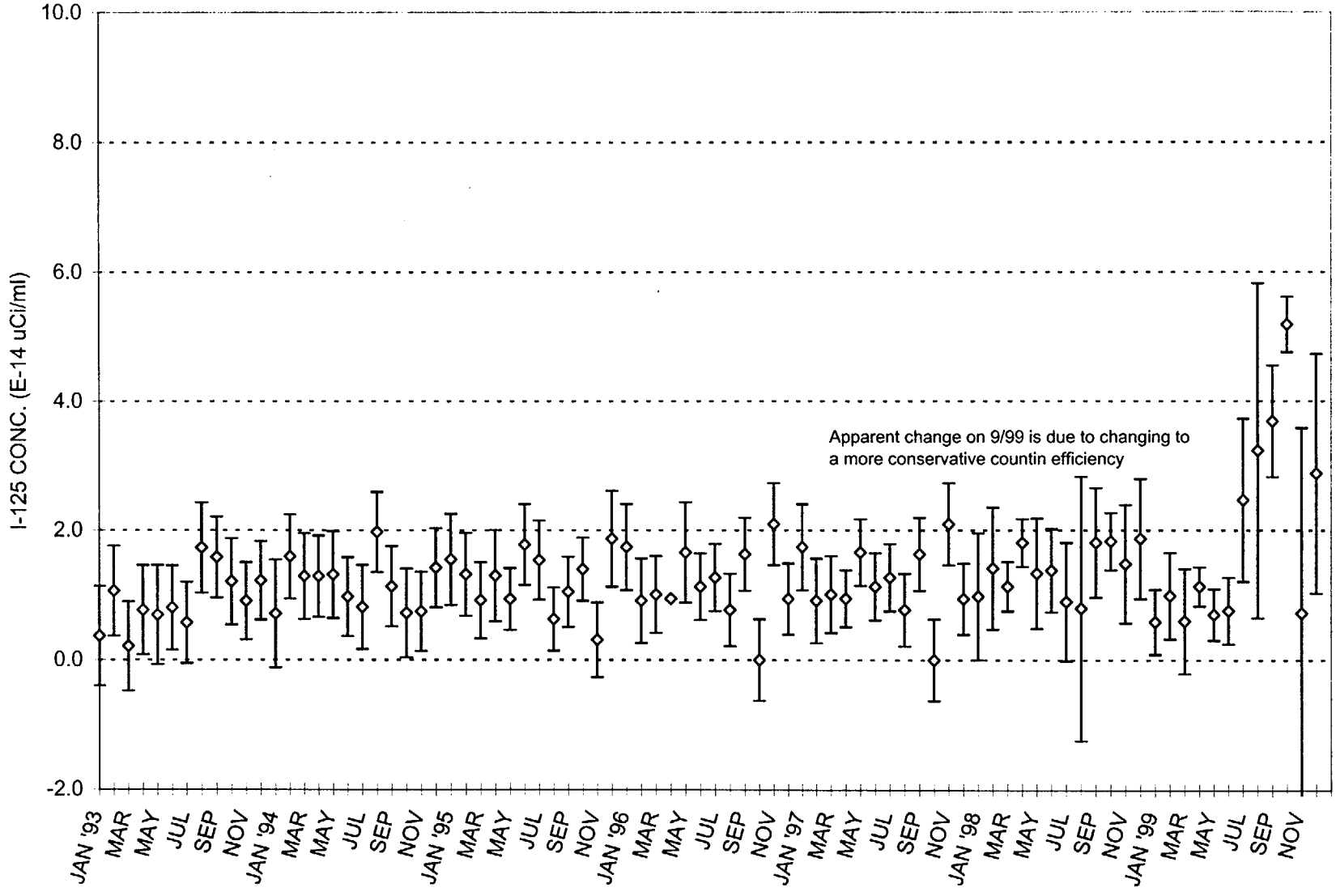
MONTHLY AVERAGE IODINE-125 ACTIVITY IN AIR
STATION 8



I-125 Investigation Level = 3.5 E-14 uCi/cc
I-125 reporting level =2.3 E-10 uCi/cc

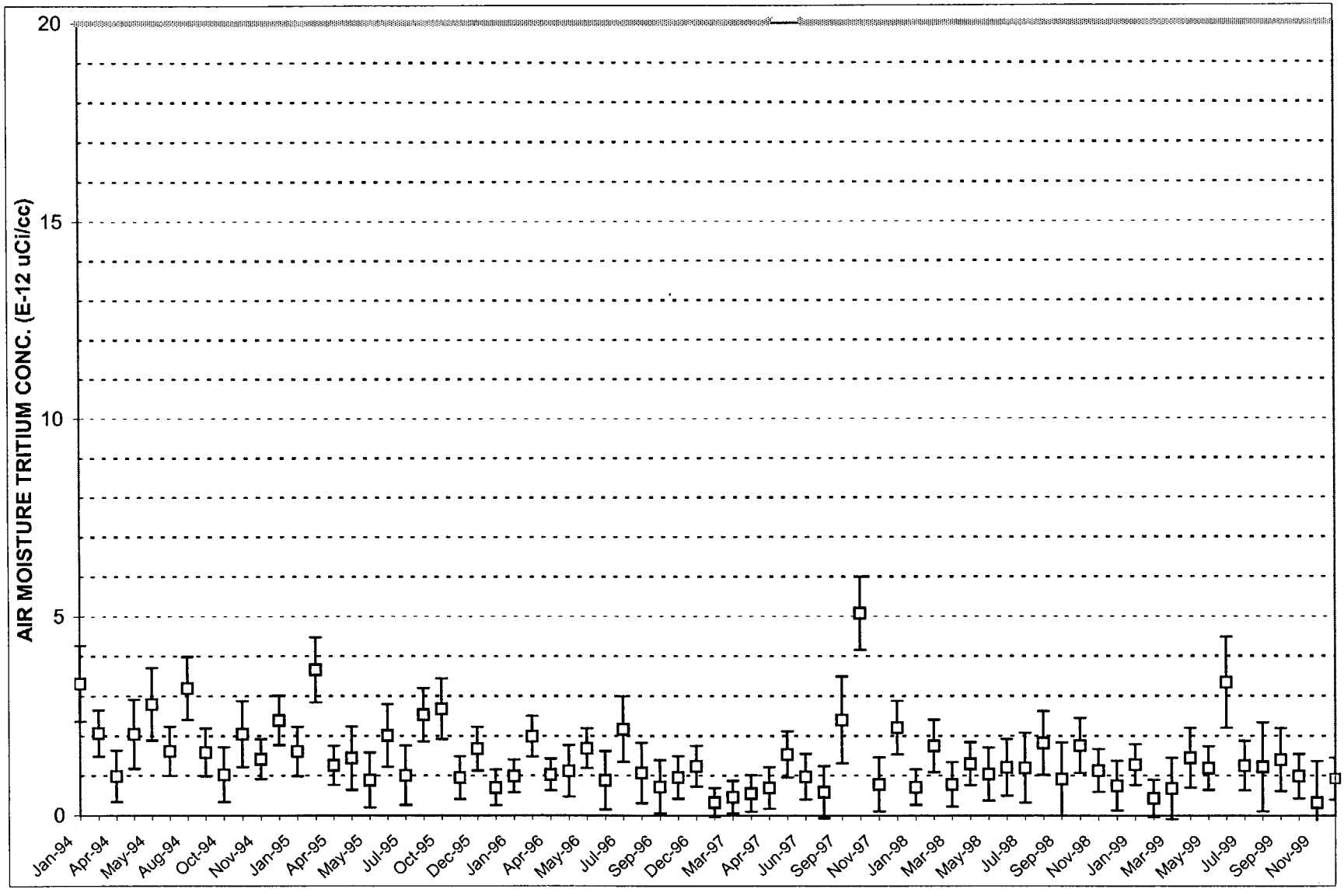
FIGURE 5.54

MONTHLY AVERAGE IODINE-125 ACTIVITY IN AIR
STATION 9



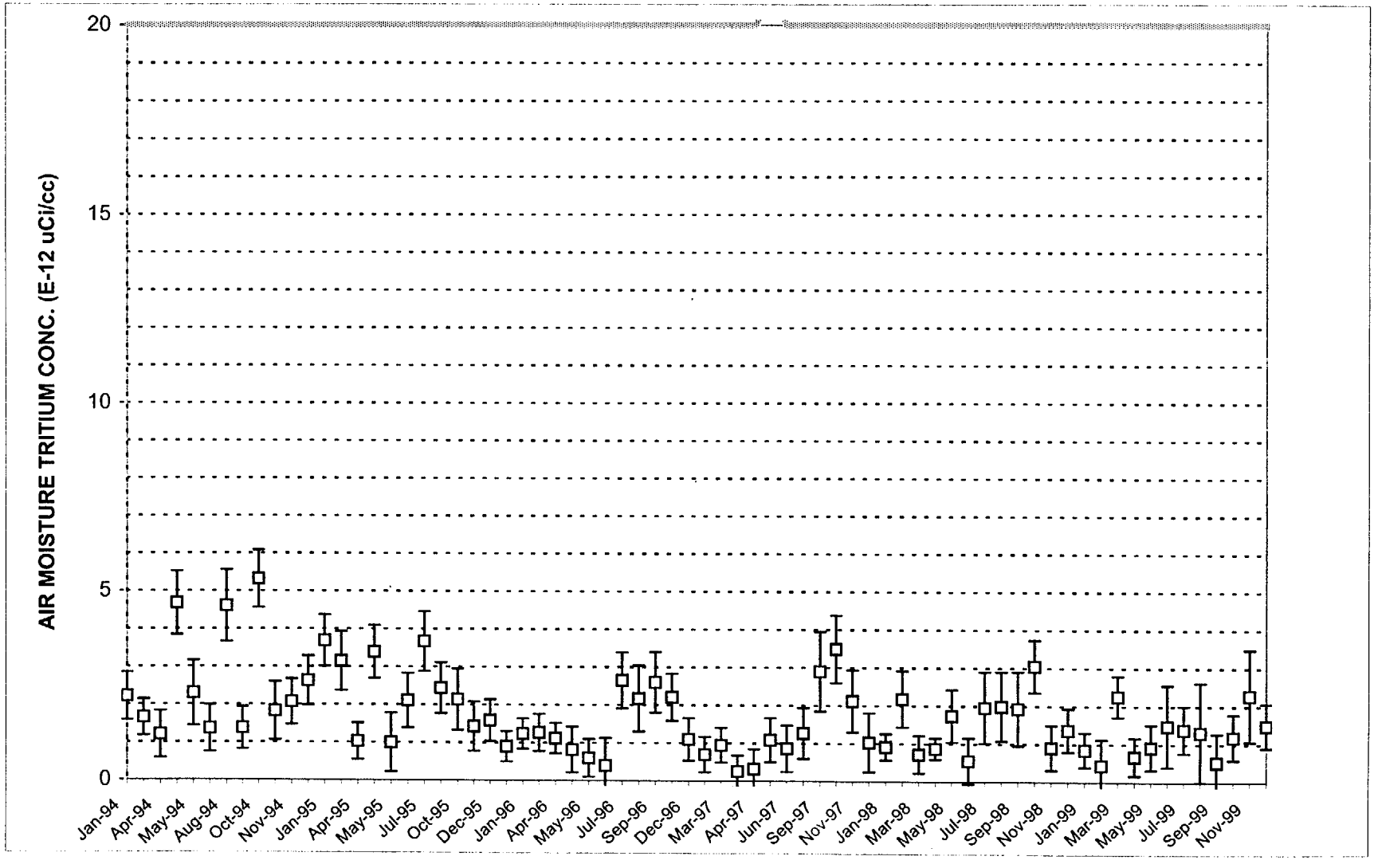
I-125 Investigation Level = 3.5 E-14 uCi/cc
I-125 Reporting Level = 2.3 E-10 uCi/cc

FIGURE 5.55
TRITIUM IN AIR
STATION 1



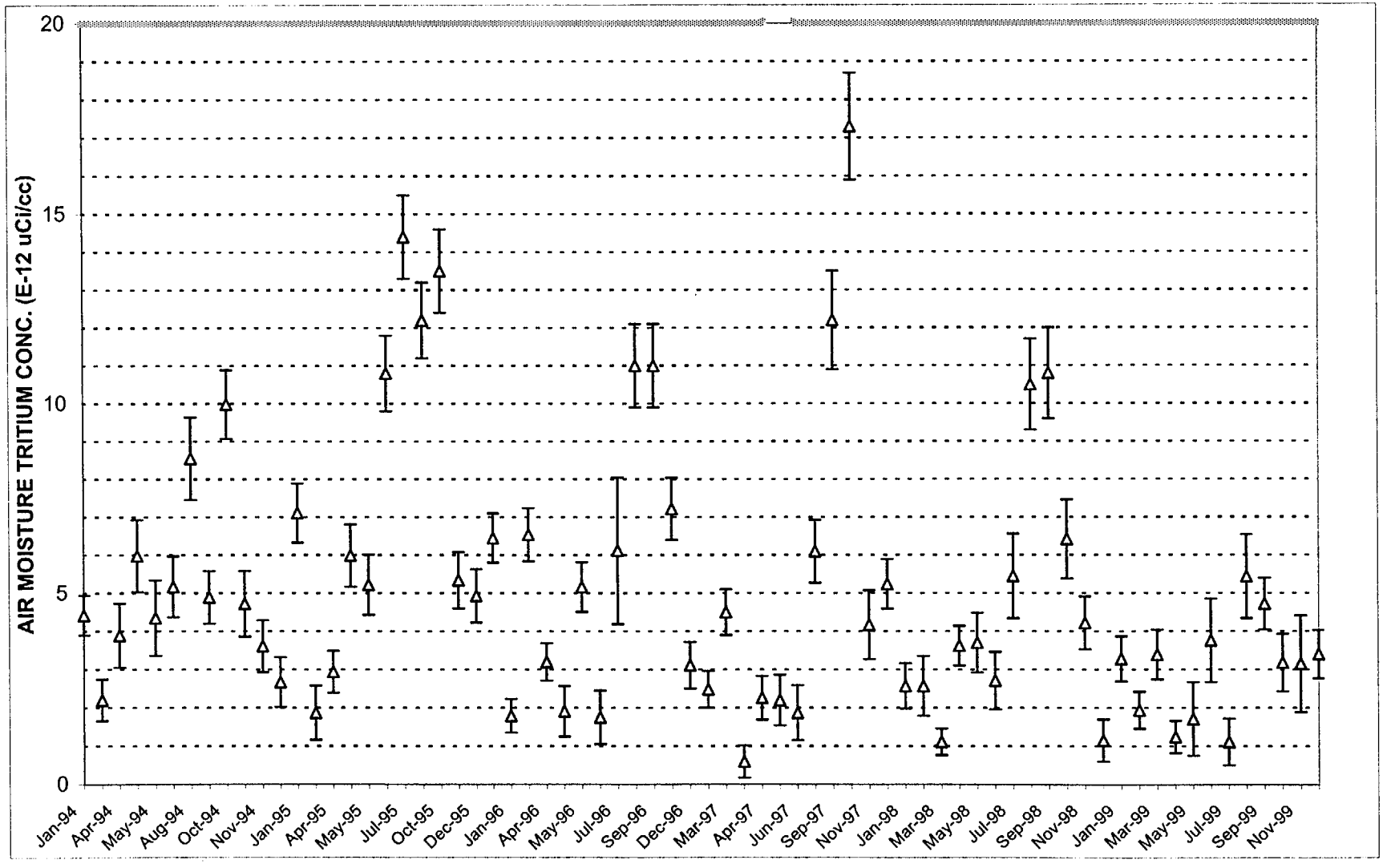
Tritium Investigation Level = 2 E-11 uCi/cc
Tritium Reporting Level = 6.1 E-8 uCi/cc

FIGURE 5.56
TRITIUM IN AIR
STATION 2



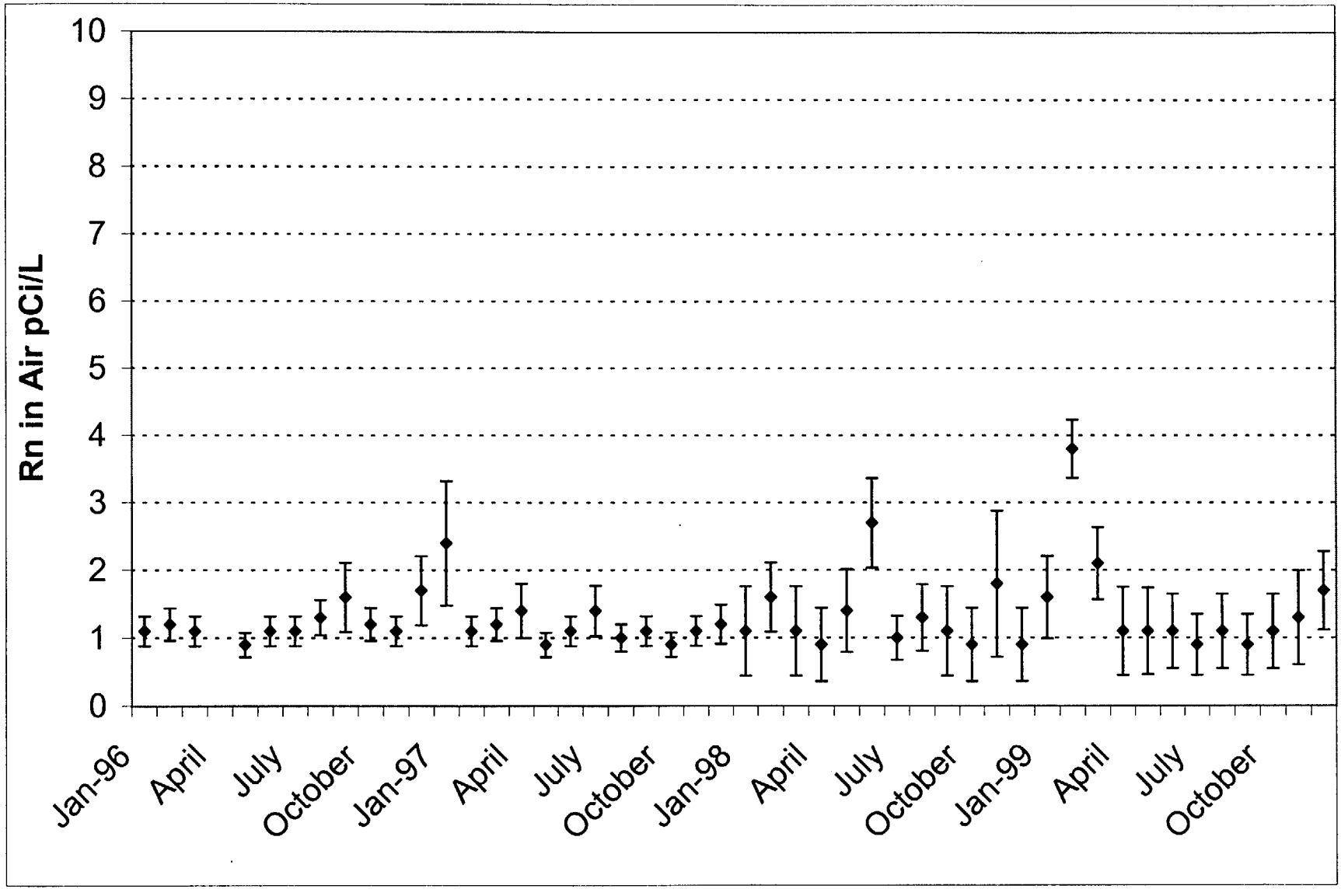
Tritium Investigation Level = 2 E-11 uCi/cc
Tritium Reporting Level = 6.1 E-8 uCi/cc

FIGURE 5.57
TRITIUM IN AIR
STATION 5



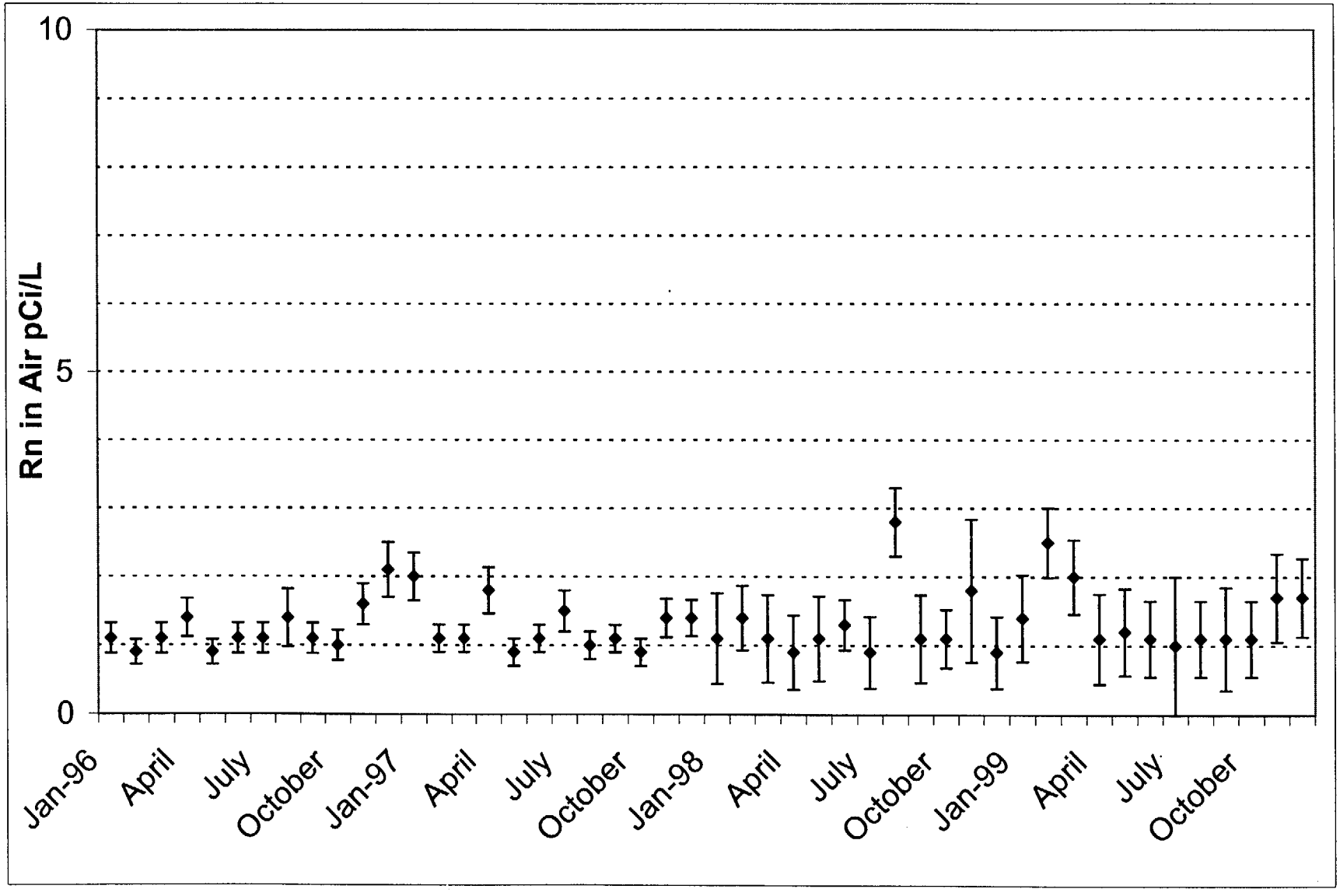
Tritium Investigation Level = 2 E-11 uCi/cc
Tritium Reporting Level = 6.1 E-8 uCi/cc

FIGURE 5 - 58
RADON IN AIR
STATION 1



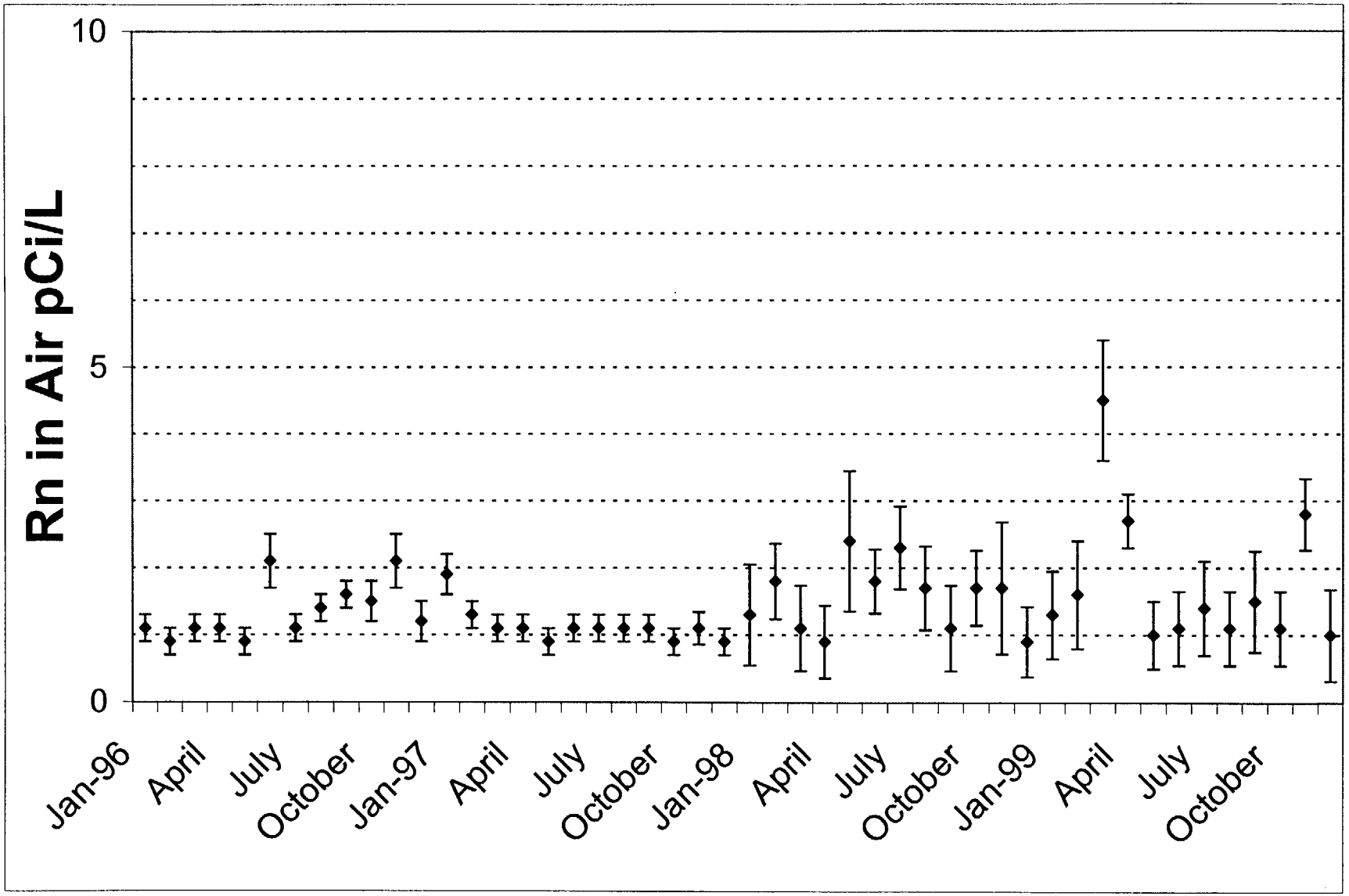
April 1996 Sample read 31.6 +/- 6 pCi/L.
There are no investigation and reporting levels for Rn in Air

Figure 5 - 59
RADON IN AIR
STATION 2



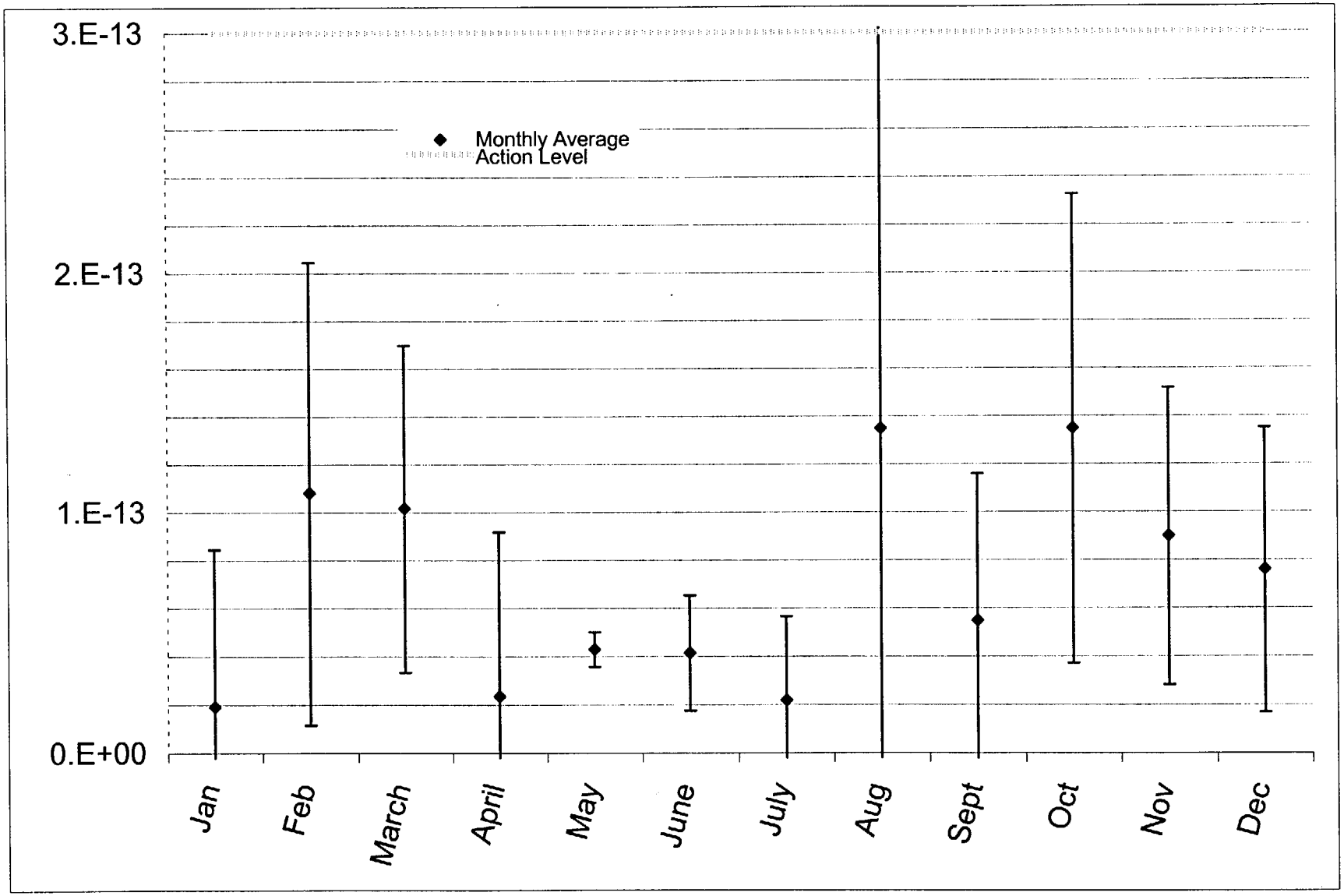
Thre are no investigation or reproting levels for Rn in air

FIGURE 5 - 60
RADON IN AIR
STATION 5



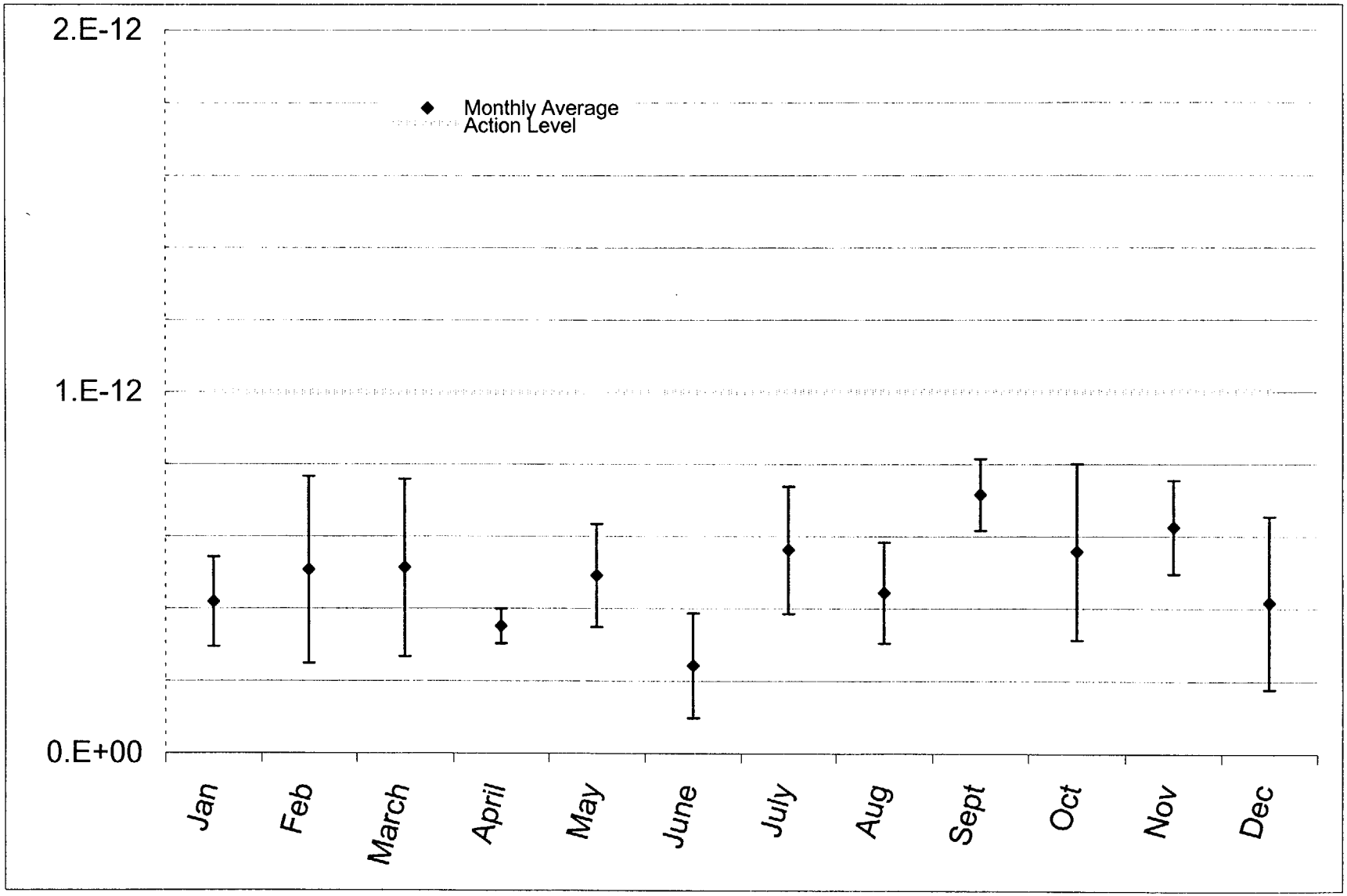
There are no investigation and reporting levels for Rn in air.

FIGURE 5 - 61
VENT EXHAUST ALPHA CONCENTRATION(uCi/cc)
MONTHLY AVERAGE



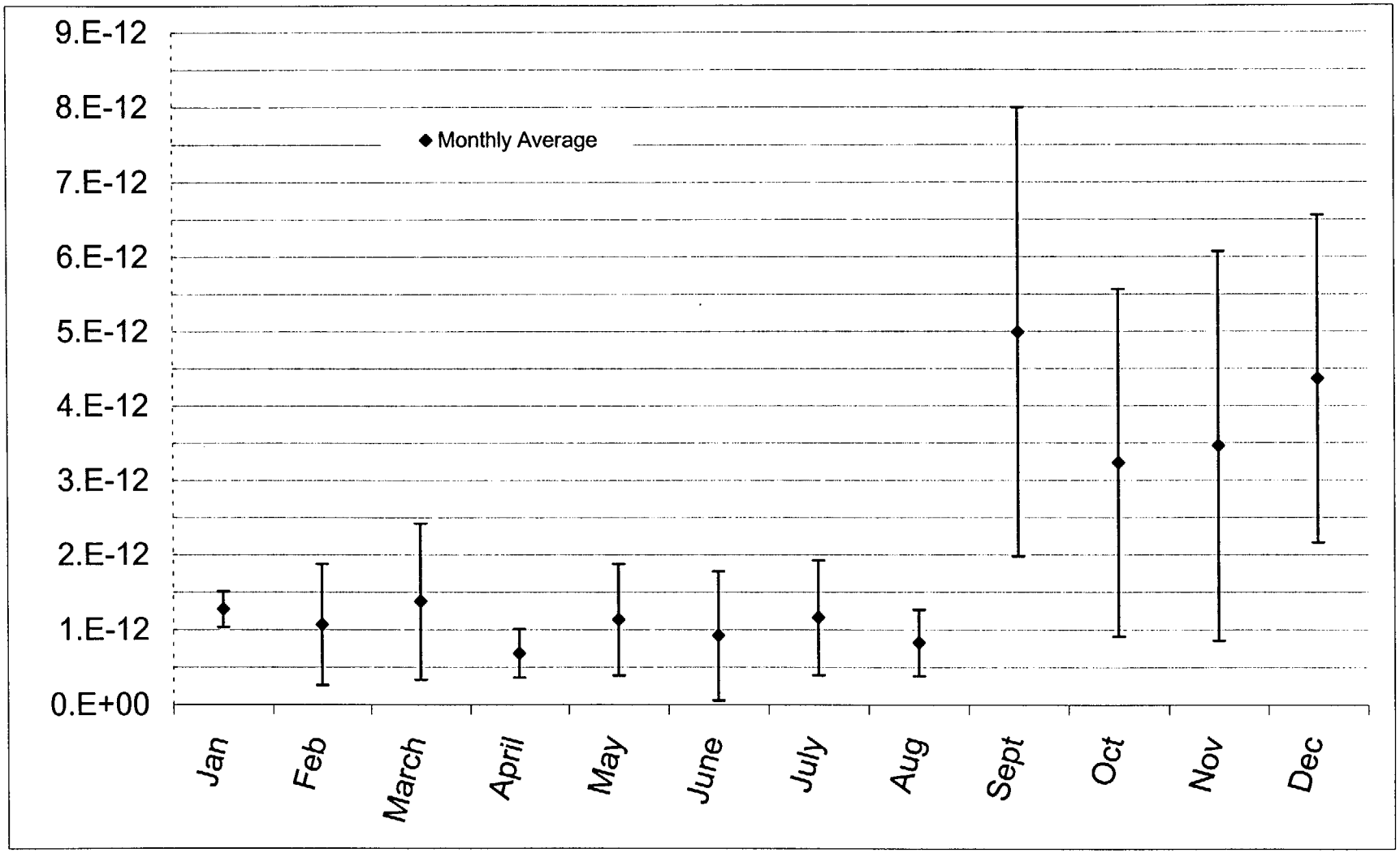
Vent Exhaust Alpha Reporting Level = 3 E-13 uCi/cc
Error Bars Show Standard Deviation for Month

Figure 5 - 62
VENT EXHAUST BETA CONCENTRATION (uCi/cc)
MONTHLY AVERAGE



Vent Exhaust Beta Reporting Level = 1 E-12 uCi/cc
Error Bars Show Standard Deviation for the Month

FIGURE 5 - 63
VENT EXHAUST IODINE CONCENTRATION (uCi/cc)
MONTHLY AVERAGE



Vent Exhaust Iodine Reporting Level = 5 E-10 uCi/cc
Error Bars Show Standard Deviation for the Month
Counting efficiency decreased to more conservatively model cartridge Distribution.

6.0 RADIOACTIVITY IN SOIL

Soil samples are collected quarterly at the nine environmental air monitoring stations and at the northeast and northwest site corners. The samples are collected from undisturbed soil from an area of 12 inches by 12 inches by one inch deep. Analyses include gross beta, total uranium, isotopic plutonium, and gamma emitting radionuclides.

6.1 Gross Beta Analysis

All 1999 soil samples were within the gross beta action level of 35 pCi/g (dry) as defined in Table 6.1 of the Facility Standards Manual. Comparisons of results from 1999 were made with data available from previous years and presented in Table 6.1 Hanford 200 Area gross beta soil results were not provided in recent Hanford Environmental Reports.

Table 6.1
Gross Beta in Soil Samples Comparison (pCi/g)

	Minimum	Maximum	Average
1999 Annual Report	1.60 E+1	2.78 E+1	1.95 E+1
1998 Annual Report	1.20 E+1	2.16 E+1	1.79 E+1
1997 Annual Report	1.60 E+1	2.87 E+1	1.93 E+1
1996 Annual Report	1.45 E+1	2.30 E+1	1.87 E+1
1995 Annual Report	1.36 E+1	2.13 E+1	
Historical Report	1.16 E+1	1.06 E+2	

Table 6.2 presents the results of the quarterly soil analysis for gross beta activity. Figures 6-1 through 6-11 compare the 1993 through 1999 results and indicate no increasing trend. The values reported for gross beta activity are consistent with typical values found in the region; therefore, no contribution from the site is apparent for gross beta in the soil.

TABLE 6.2
Gross Beta Measurements in Soil During 1999.
GROSS BETA CONCENTRATION (pCi/g, dry)

Station Number	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1	18.8 +/- 1.8	19.2 +/- 1.92	22.1 +/ -2.6	18.0 +/-2.5
2	16.8 +/- 1.8	18.1 +/- 1.8	19.9 +/- 2.7	19.6 +/- 2.7
3	21.4 +/- 2.0	27.8 +/- 2.2	19.3 +/- 2.7	21.4 +/- 2.8
4	19.8 +/- 1.9	16.9 +/- 1.8	19.8 +/- 2.5	19.6 +/- 2.5
5	16.0 +/- 1.8	16.0 +/- 1.8	18.7 +/- 2.7	22.7 +/- 2.9
6	17.4 +/- 1.9	20.2 +/- 2.0	23.1 +/- 2.8	21.2 +/- 2.6
7	19.0 +/- 1.9	19.2 +/- 1.8	19.2 +/- 2.6	19.8 +/- 2.7
8	15.6 +/- 1.7	20.1 +/- 2.0	18.9 +/- 2.6	18.6 +/- 2.5
9	19.0 +/- 2.0	18.2 +/- 2.4	16.8 +/- 2.4	22.6 +/- 2.8
NE	17.9 +/- 1.8	18.5 +/- 1.9	19.8 +/- 2.6	21.3 +/- 2.7
NW	19.5 +/- 2.0	18.7 +/- 1.8	22.4 +/- 2.9	21.1 +/- 2.8

NOTE: Minimum Detectable Concentration = 0.1 pCi/g-dry.
Investigation Level = 35 pCi/g (dry)
Reporting Level = 35 pCi/g (dry)

6.2 Total Uranium

The uranium concentration in soil is measured using alpha spectroscopy. None of the soil samples taken during 1999 exceeded the action level of 1 pCi/g (dry) for total uranium in soil, as defined in the Facility Standards Manual Table 6.1. Table 6.3 compares 1999 results with data available from previous years and the 1998 Hanford Report for 200 Area and offsite soils samples.

Table 6.3
Total Uranium in Soil Samples Comparison (pCi/g)

	Minimum	Maximum	Average
1999 Annual Report	1.7 E-1	6.5 E-1	3.7 E-1
1998 Annual Report	3.0 E-2	8.0 E-1	3.6 E-1
1997 Annual Report	9.0 E-2	9.3 E-1	3.5 E-1
1996 Annual Report	2.1 E-1	8.2 E-1	3.8 E-1
1995 Annual Report	2.5 E-1	9.0 E-1	
1998 Hanford 200 Area	ND	6.2 E-1	4.0 E-1
1998 Hanford Offsite	ND	ND	6.0 E-1

Table 6.4 presents the quarterly analysis results for uranium activity in soil. Figures 6.12 through 6.22 compare the 1993 through 1999 uranium in soil results. The data do not indicate any increasing trends. Further, the concentrations of uranium measured in US Ecology's samples are consistent with regional area and distant community samples, as depicted in the 1995 Hanford Report for the years

1990 through 1994. Consequently, no contribution from site activities is apparent for uranium in soil.

TABLE 6.4
Total Uranium in Soil During 1999
TOTAL URANIUM (pCi/g-dry)

Station ID	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1	0.30 +/- 0.04	0.39 +/- 0.06	0.35 +/- 0.05	0.21 +/- 0.08
2	0.43 +/- 0.06	0.43 +/- 0.06	0.48 +/- 0.09	0.33 +/- 0.09
3	0.49 +/- 0.06	0.44 +/- 0.06	0.34 +/- 0.08	0.33 +/- 0.06
4	0.38 +/- 0.05	0.65 +/- 0.14	0.26 +/- 0.06	0.28 +/- 0.15
5	0.33 +/- 0.05	0.28 +/- 0.07	0.43 +/- 0.09	0.23 +/- 0.08
6	0.30 +/- 0.04	0.46 +/- 0.08	0.36 +/- 0.09	0.17 +/- 0.14
7	0.30 +/- 0.04	0.35 +/- 0.09	0.62 +/- 0.12	0.35 +/- 0.11
8	0.29 +/- 0.04	0.41 +/- 0.09	0.53 +/- 0.14	0.31 +/- 0.09
9	0.24 +/- 0.04	0.32 +/- 0.07	0.38 +/- 0.07	0.54 +/- 0.17
NE	0.29 +/- 0.04	0.34 +/- 0.06	0.45 +/- 0.08	0.31 +/- 0.09
NW	0.34 +/- 0.04	0.45 +/- 0.07	0.49 +/- 0.07	0.40 +/- 0.09

NOTE: Minimum detectable concentration: 0.2 pCi/g-dry.
Investigation Level 1 pCi/g (dry)
Reporting Level 1 pCi/g (dry)

6.3 Isotopic Plutonium

Table 6.5 present the results of soil sample analysis for total Plutonium (Pu-238 + Pu-239/240). 1999 soil samples from the US Ecology Low level Radioactive Waste Site for Pu 238 and Pu-239/240 concentrations were all less than the minimum detectable concentration of 1.0 E-2 pCi/g-dry. This is the same as in 1998. In comparison, the 1998 Hanford Report reports a maximum 200 Area Pu-239/240 concentrations of 1.4 pCi/g. The average 200 Area concentration was 0.13 pCi/g. The average 1998 Hanford offsite Pu 239/240 soil concentration averaged 0.011 pCi/g.

TABLE 6.5

Total Plutonium (Pu238, Pu239/240) in Soil During 1999

TOTAL PLUTONIUM CONCENTRATION (pCi/g, dry)

Station ID	1st Quarter	2 nd Quarter	3rd Quarter	4th Quarter
1	0.000 +/- 0.001	0.001 +/- 0.002	0.000 +/- 0.001	0.000 +/- 0.003
2	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.003	0.001 +/- 0.002
3	0.001 +/- 0.002	0.000 +/- 0.001	0.000 +/- 0.001	0.001 +/- 0.005
4	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001
5	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.002
6	0.001 +/- 0.001	0.001 +/- 0.001	0.000 +/- 0.001	0.000 +/- 0.001
7	0.000 +/- 0.001	0.002 +/- 0.003	0.001 +/- 0.001	0.000 +/- 0.001
8	0.000 +/- 0.001	0.000 +/- 0.001	0.001 +/- 0.001	0.001 +/- 0.001
9	0.000 +/- 0.001	0.001 +/- 0.002	0.003 +/- 0.002	0.000 +/- 0.001
NE	0.000 +/- 0.001	0.001 +/- 0.003	0.000 +/- 0.001	0.001 +/- 0.001
NW	0.001 +/- 0.002	0.003 +/- 0.002	0.000 +/- 0.001	0.001 +/- 0.003

NOTE: All Pu soil samples were the minimum detectable concentration of 0.01 pCi/g-dry.
Investigation Level 0.03 pCi/g (dry)
Reporting Level 0.03 pCi/g (dry)

All 1999 US Ecology Pu results were below the minimum detectable concentration. These levels are consistent with Pu-238 and Pu-239/240 concentrations for soil in regional area and Hanford Offsite, as presented in the 1998 and 1995 Hanford Report. This demonstrates that site operations do not affect isotopic plutonium concentrations in soil.

6.4 Spectrometry Analysis of Gamma Emitters in Soil

Table 6.6 presents minimum detectable concentration (MDC) for various radionuclides in soil. Action levels in the US Ecology Facility Standard Manual (FSM) are set at five times the theoretical MDC with the exception of Cs-137 and Co-60. None of the soil samples exceeded the Richland Facility Standards Manual (FSM) action levels for gamma emitters.

Cs-137 and Eu-155 were identified at concentrations in soil that were less than action level. Co-60 was not detected in site soils in 1999, which is different from previous years when several soil samples contained Co-60. Co-60, Cs-137 and Eu-155 are known to be present in Hanford soils, and US Ecology results are consistent with radionuclides identified in the 1998, 1997, 1996 and 1995 Annual Environmental reports. Probable sources of Cs-137 and Eu-155 contamination include worldwide Cs-137 fallout and past US DOE operations. Table 6.7 presents the concentration Cs-137, and Eu-155 measured in site soils in 1999.

Cs-137 was detected at or slightly above the detection limit in the majority of samples. The required minimum detection concentration (MDC) for Cs-137 is 0.02 pCi/g. The mean Cs-137 concentration in 1999 was 0.02 pCi/g. The maximum was 0.11 pCi/g and minimum was below the MDC at <0.01 pCi/g. There are no increasing trends for Cs-137 in soil. In comparison, the 1998 Hanford Environmental Report, listed a maximum 200 Area Cs137 concentration of 10 pCi/g and an average Cs-137 concentration of 0.5 pCi/g. The average Hanford offsite Cs 137 soil concentrations was 0.3 pCi/g.

Eu-155 was detected at or slightly above the minimum detectable concentration in several soil samples. The required MDC for Eu-155 is 0.05 pCi/g. The mean Eu-155 concentration in 1999 was 0.04 pCi/g. The maximum was Eu 155 soil concentration was 0.05 pCi/g, and minimum was below the MDC at <0.02 pCi/g. There are no increasing trends for Eu-155 in soil. The 1998 Hanford Environmental report did not list Eu-155 soil concentrations.

Considering the infrequent occurrences of positive values together with their small magnitude, soil concentrations contribute negligible radiation exposure to any individual.

TABLE 6.6
Required Minimum Detectable Concentrations for Soil Sample Gamma Spectroscopy Analysis

Nuclide	Limit(pCi/g, dry)	Nuclide	Limit(pCi/g, dry)
Na-22	0.02	Mn-54	0.02
Co-58	0.02	Co-60	0.02
Fe-59	0.03	Zn-65	0.04
Zr/Nb-95	0.03	Ru-103	0.02
Ru-106	0.17	Sb-124	0.02
Sb-125	0.05	Cs-134	0.02
Cs-137	0.02	Ba/La-140	0.05
Ce-141	0.02	Ce/Pr-144	0.18
Eu-152	0.11	Eu-154	0.05
Eu-155	0.05		

TABLE 6.7
Gamma Spectrometry Analysis of 1999 Soil Samples (pCi/g, dry)

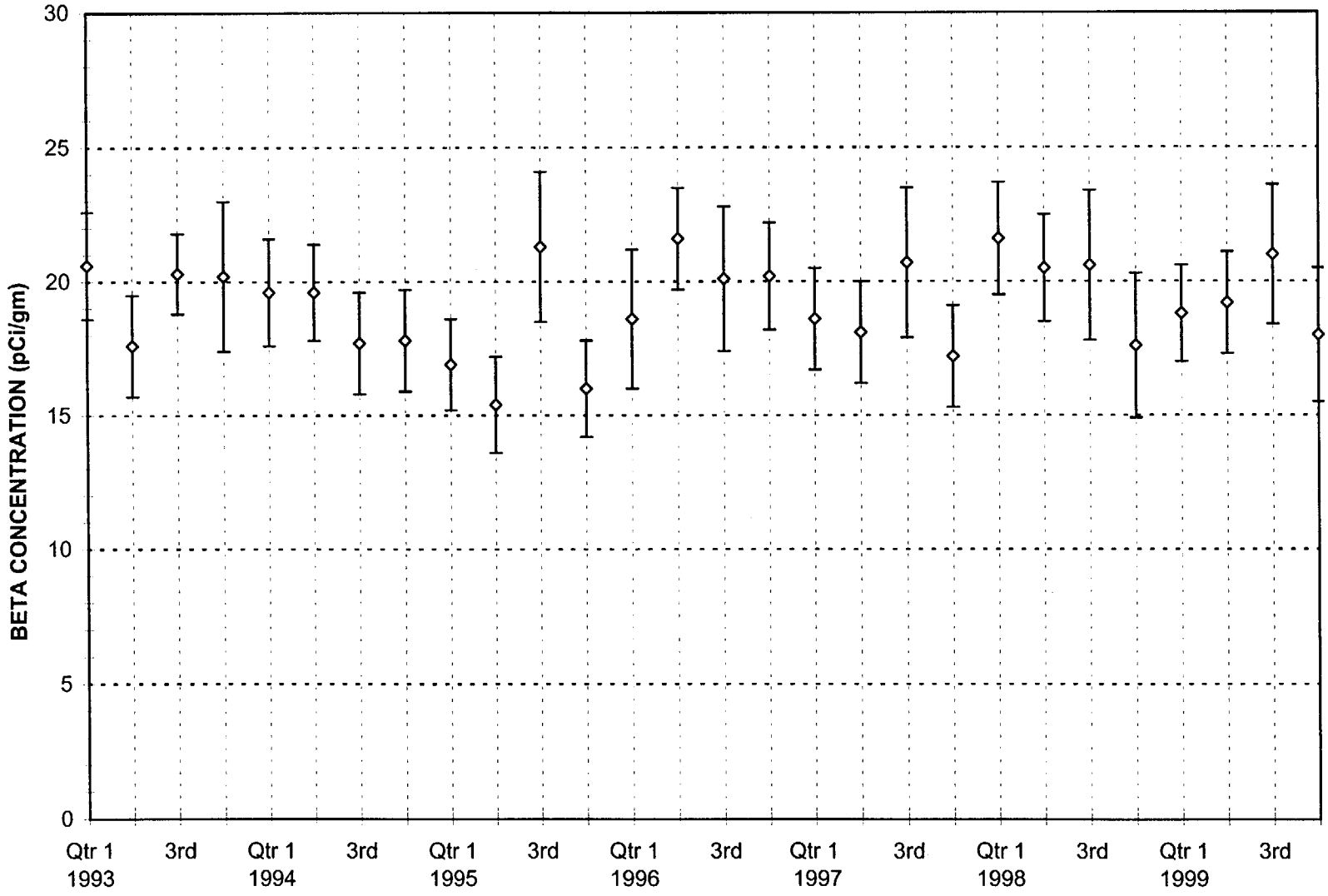
	Activity Cs-137 uCi/g	Error Cs-137 uCi/g	Activity Eu-155 uCi/g	Error Eu-155 uCi/g		Activity Cs-137 uCi/g	Error Cs-137 uCi/g	Activity Eu-155 uCi/g	Error Eu-155 uCi/g
Station 1					Station 2				
Qtr 1	0.02	0.01	<.04			0.01	0.01	0.03	0.02
Qtr 2	0.04	0.01	0.04	0.01		0.01	0.01	0.03	0.02
Qtr 3	>06	0.01	0.04	0.02		0.03	0.01	0.03	0.01
Qtr 4	0.01	0.01	0.04	0.02		0.02	0.01	<.03	0.01
Station 3					Station 4				
Qtr 1	0.01	0.01	0.03	0.02		<.01		0.05	0.03
Qtr 2	<.01		0.06	0.02		<.01		<.04	
Qtr 3	<.01		<.02			<.01		<.04	
Qtr 4	0.01	0.01	0.02	0.01		<.01		<.02	
Station 5					Station 6				
Qtr 1	<.01		<.04			0.02	0.01	<.04	
Qtr 2	<.01		<.04			0.03	0.02	0.06	0.02
Qtr 3	<.01		<.03			0.02	0.01	0.04	0.02
Qtr 4	<.01		<.03			0.01	0.01	0.04	0.02
Station 7					Station 8				
Qtr 1	0.01	0.01	<.06			0.02	0.01	<.04	
Qtr 2	0.01	0.01	<.04			0.06	0.01	0.03	0.02
Qtr 3	0.01	0.01	0.05	0.02		0.02	0.01	<.03	
Qtr 4	0.03	0.01	0.03	0.02		0.01	0.01	<.03	
Station 9					Northeast Corner				
Qtr 1	0.02	0.01	<03	0.02		0.06	0.01	<.04	
Qtr 2	0.02	0.01	0.03	0.02		0.04	0.01	0.06	0.03
Qtr 3	0.01	0.01	<.02			0.06	0.01	<.03	
Qtr 4	0.01	0.01	<.03			0.04	0.01	0.03	0.01
Northwest Corner									
Qtr 1	0.11	0.03	0.03	0.02					
Qtr 2	0.11	0.01	<.04						
Qtr 3	0.08	0.01	<.03						

Notes: Only Cs-137 and Eu-155 had positive results in 1999. This is different from previous years when Co-60 was also detected in several soil samples.

6.5 **Nonradiological Soil Analysis**

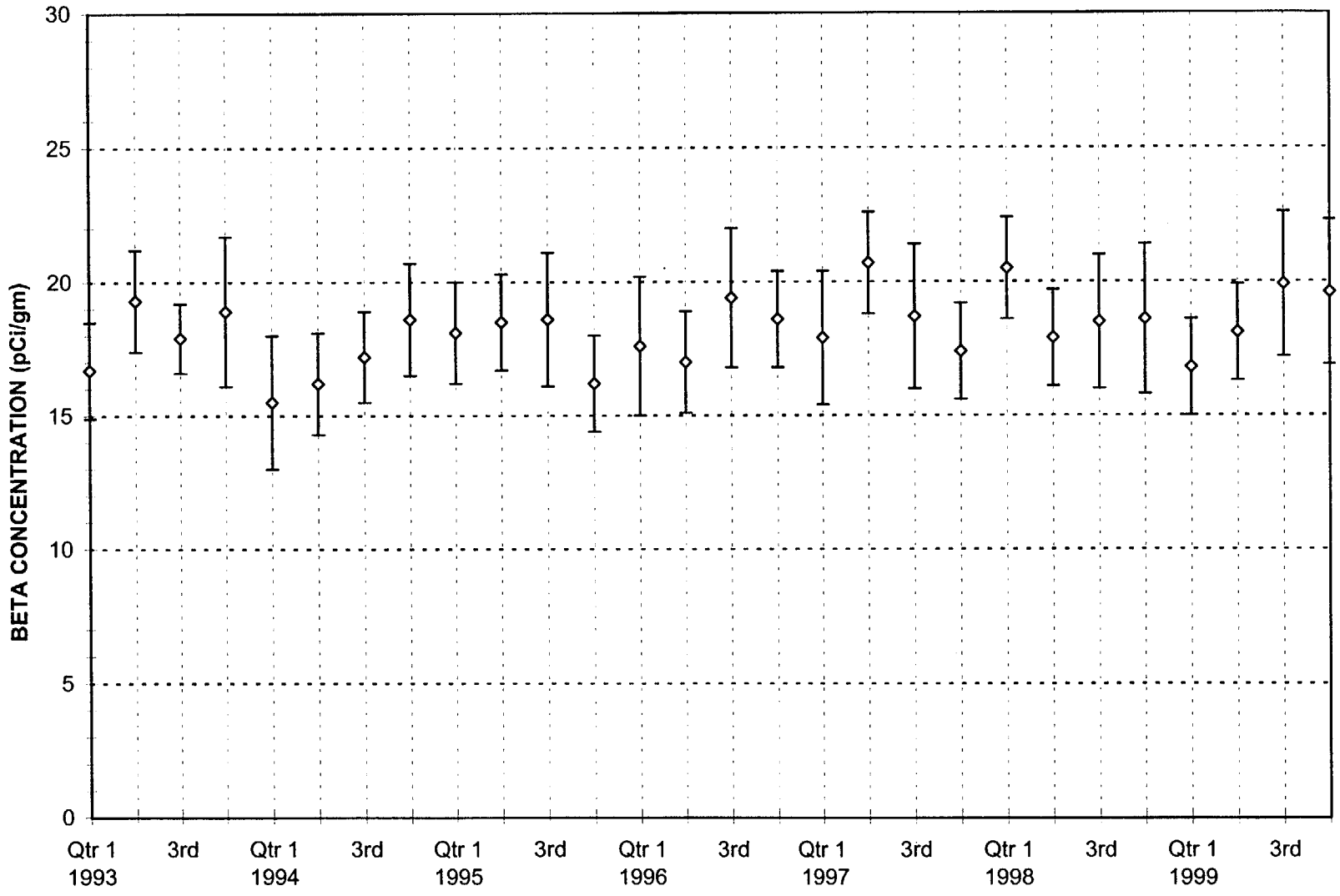
There are no nonradiological analysis performed on soil samples.

FIGURE 6.1
GROSS BETA IN SOIL
STATION 1



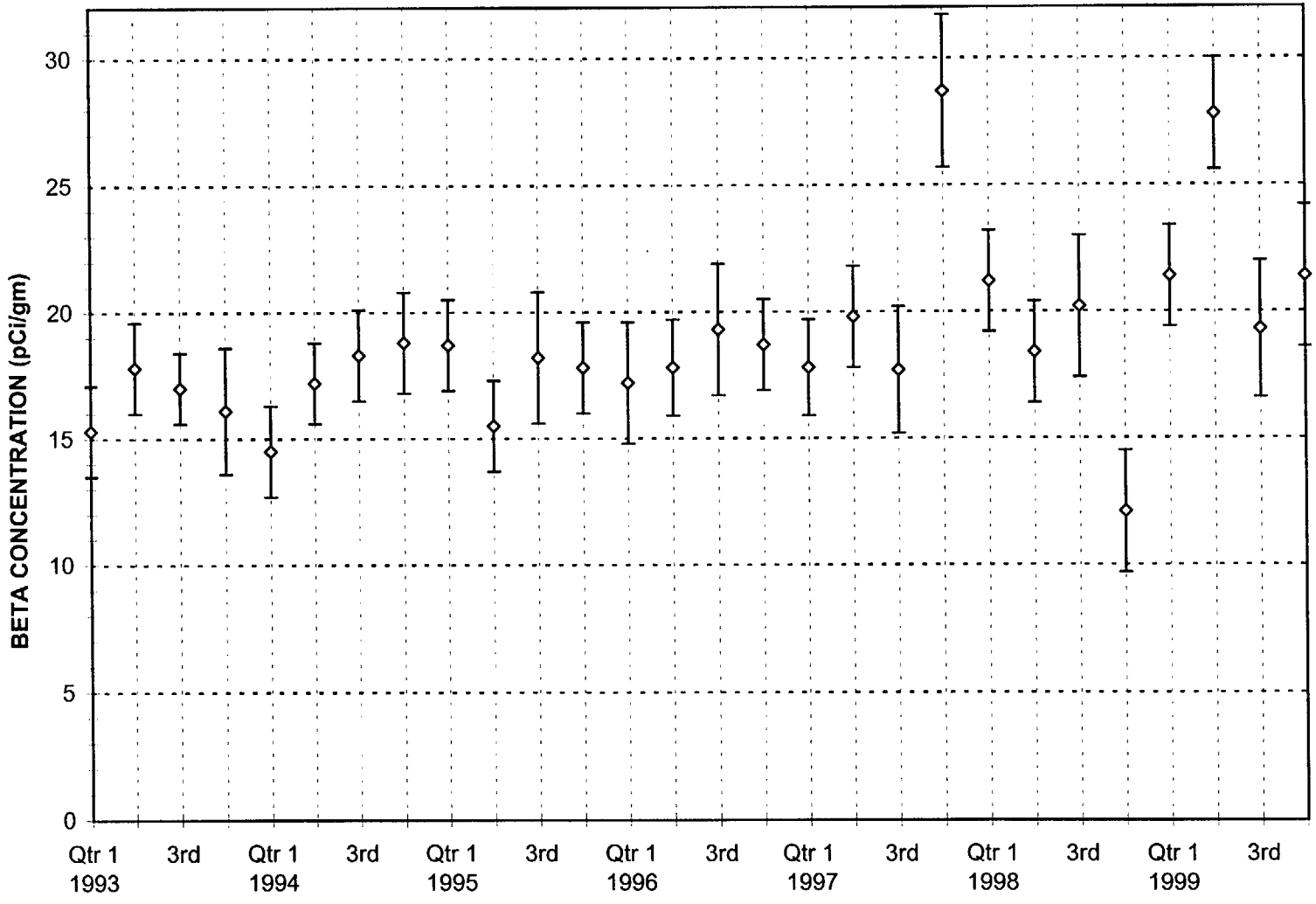
Soil Beta Action level = 35pCi/g(dry)

FIGURE 6.2
GROSS BETA IN SOIL
STATION 2



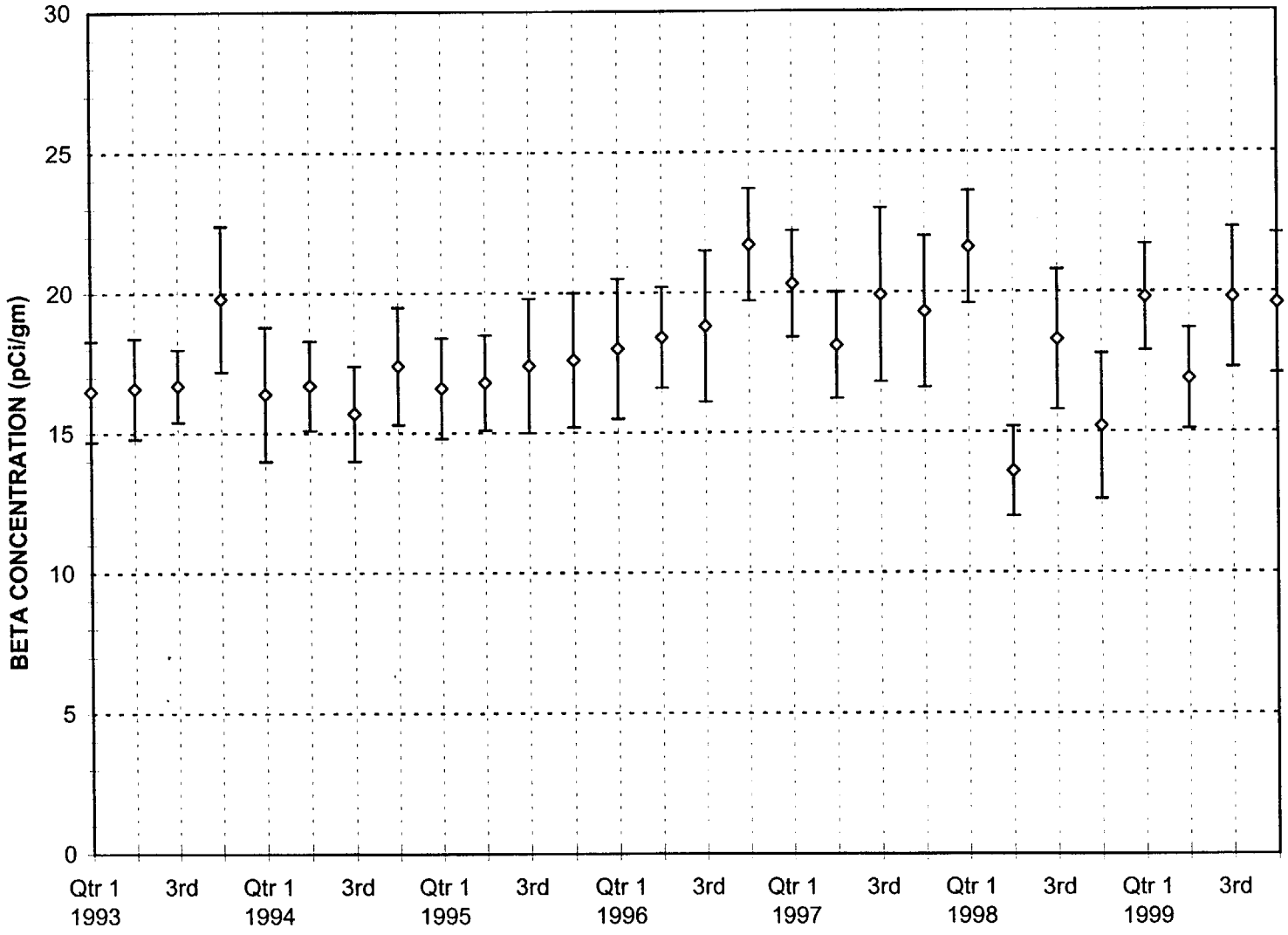
Soil Beta Action Level = 35 pCi/g (dry)

FIGURE 6.3
GROSS BETA IN SOIL
STATION 3



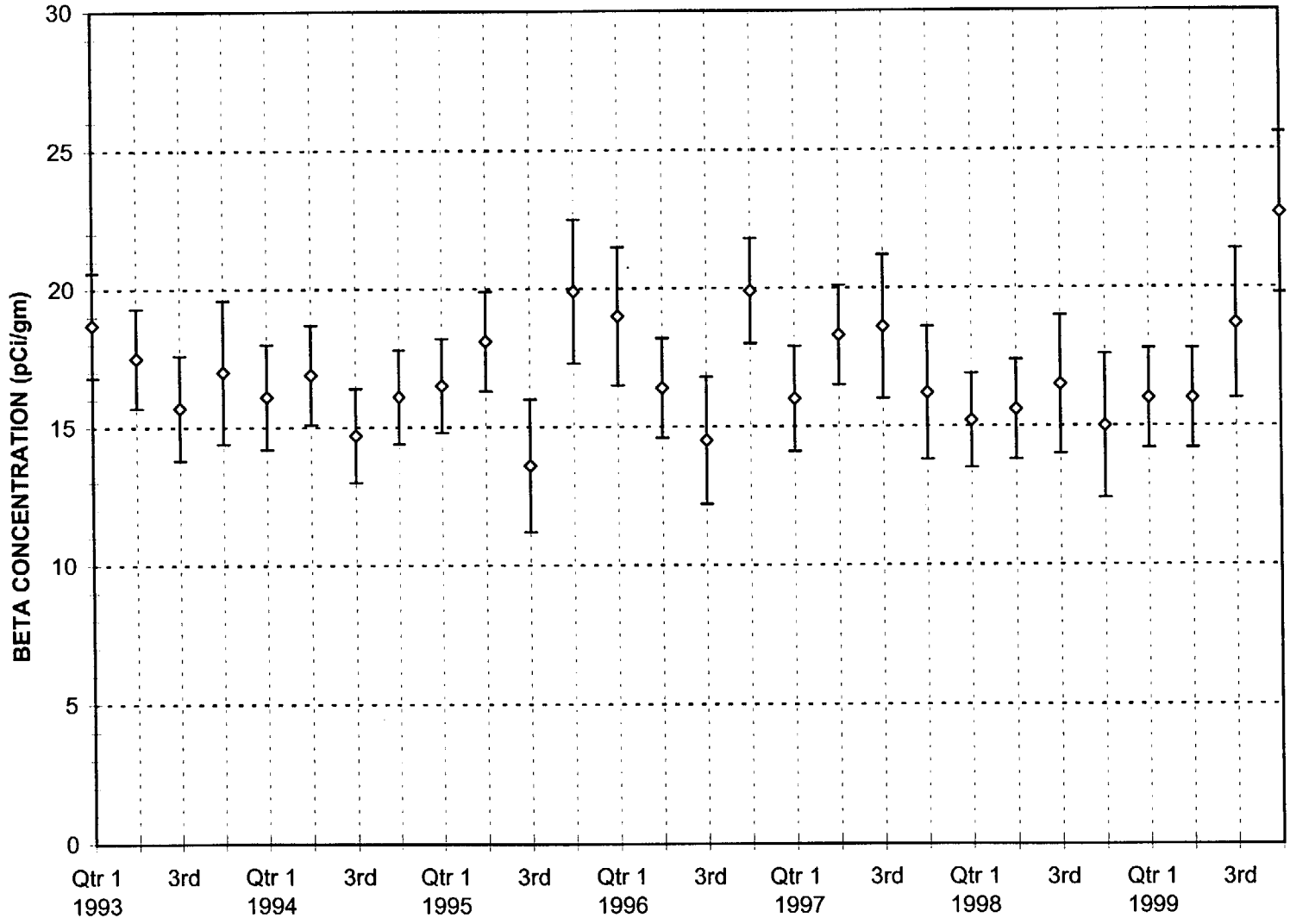
Soil Beta Action Level = 35 pCi/g (dry)

FIGURE 6.4
GROSS BETA IN SOIL
STATION 4



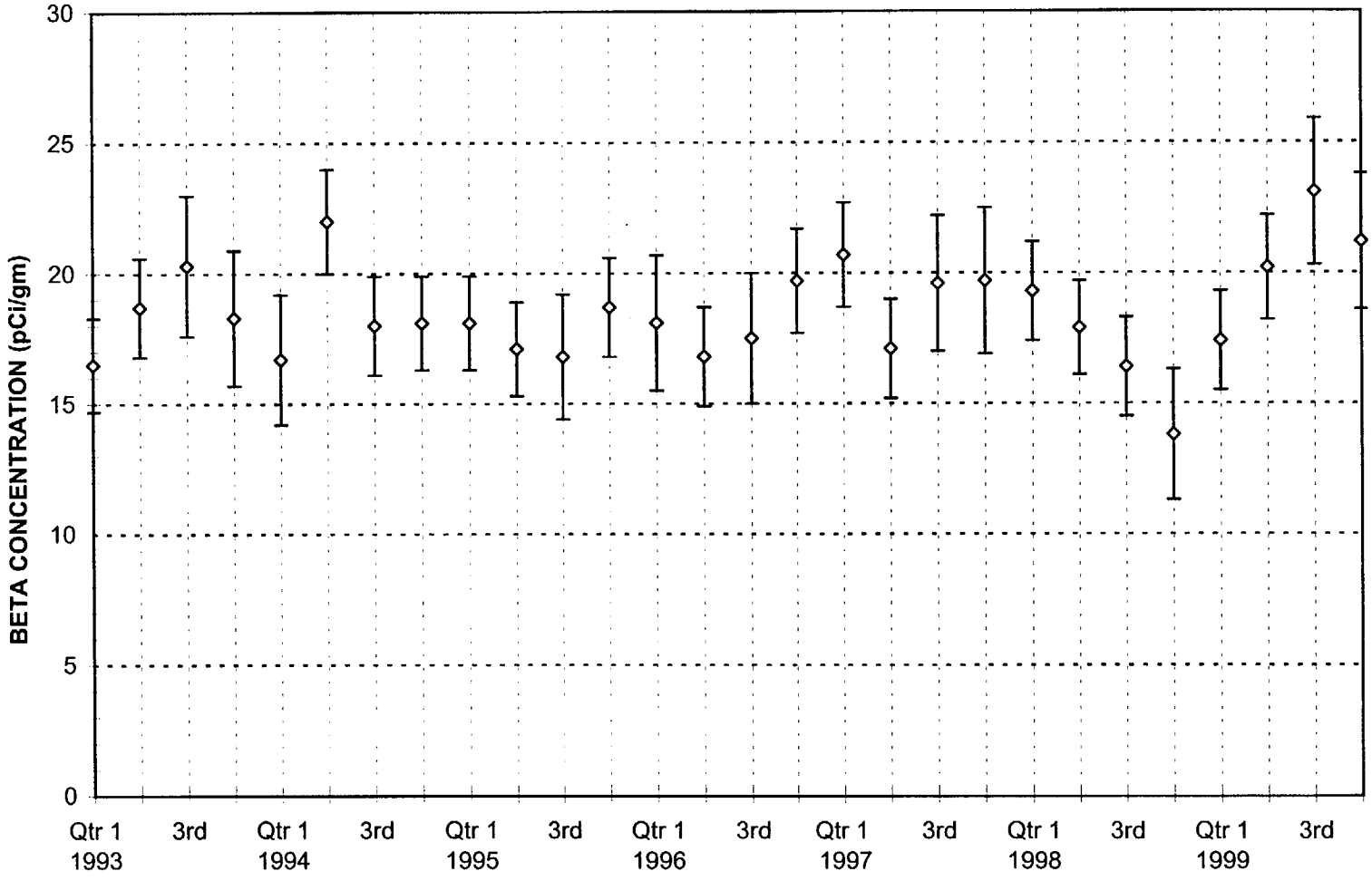
Soil Beta Action Level = 35 pCi/g (dry)

FIGURE 6.5
GROSS BETA IN SOIL
STATION 5



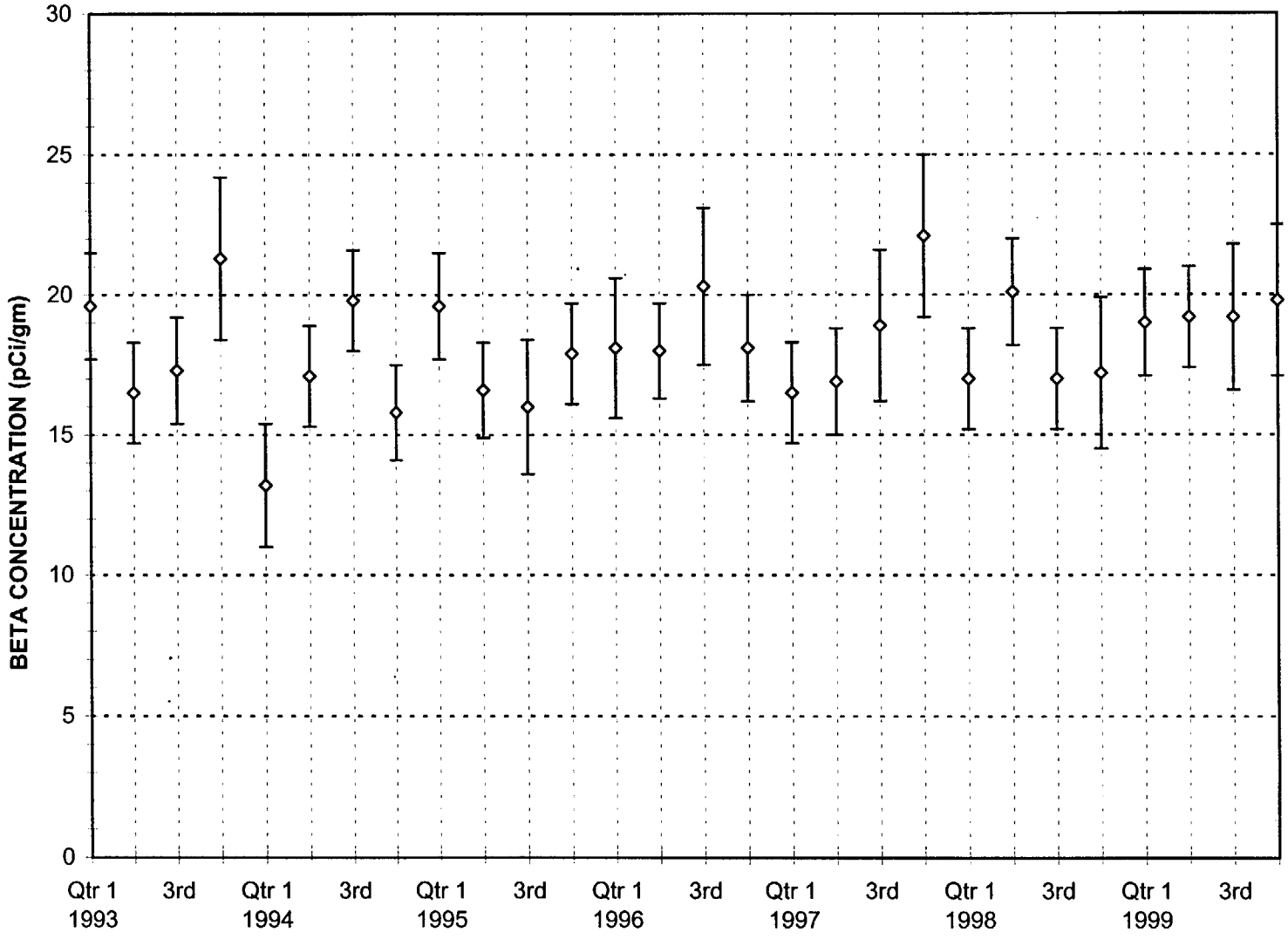
Soil Beta Action Level = 35 pCi/g (dry)

FIGURE 6.6
GROSS BETA IN SOIL
STATION 6



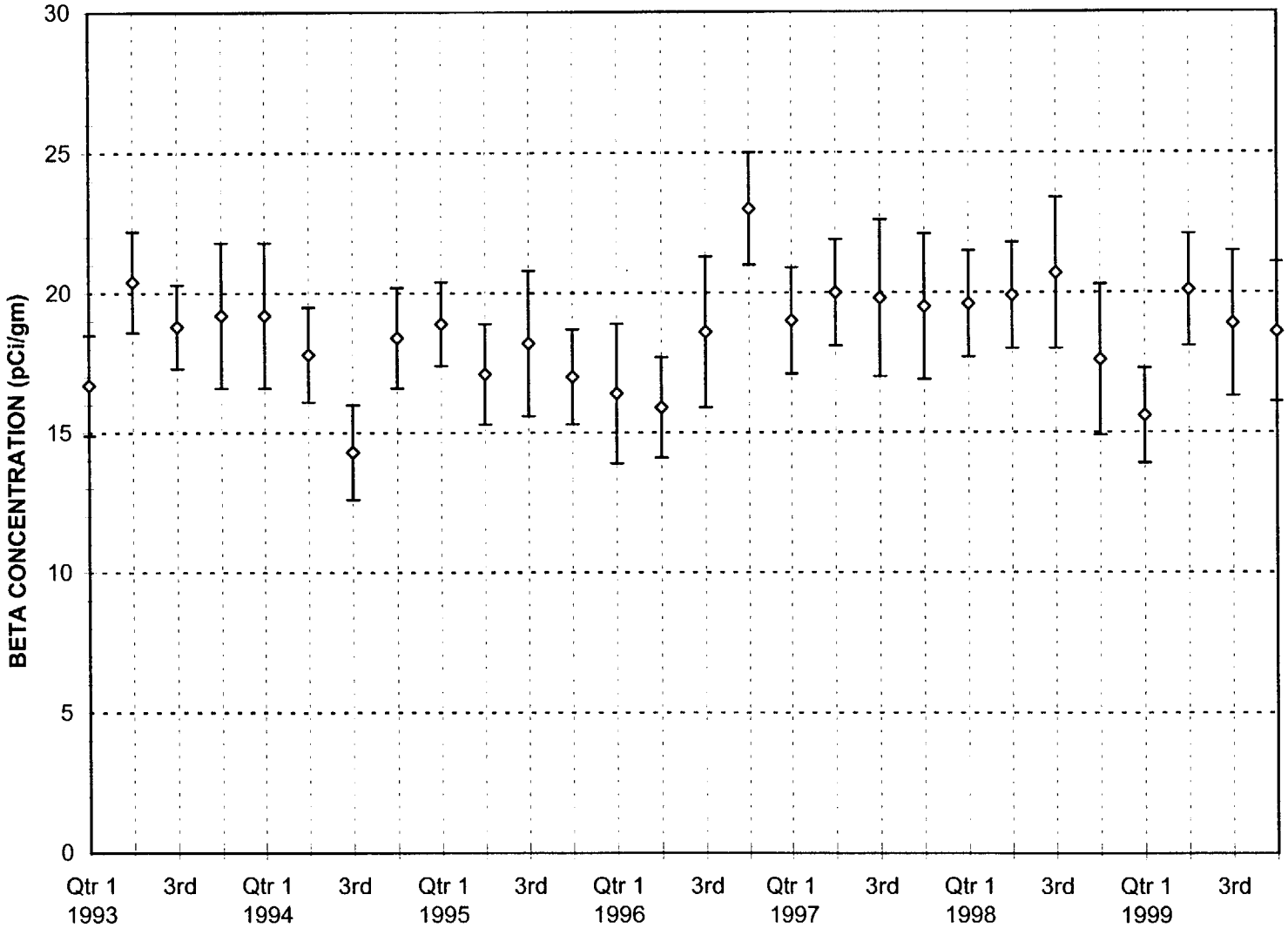
Soil Beta Action Level = 35 pCi/g (dry)

FIGURE 6.7
GROSS BETA IN SOIL
STATION 7



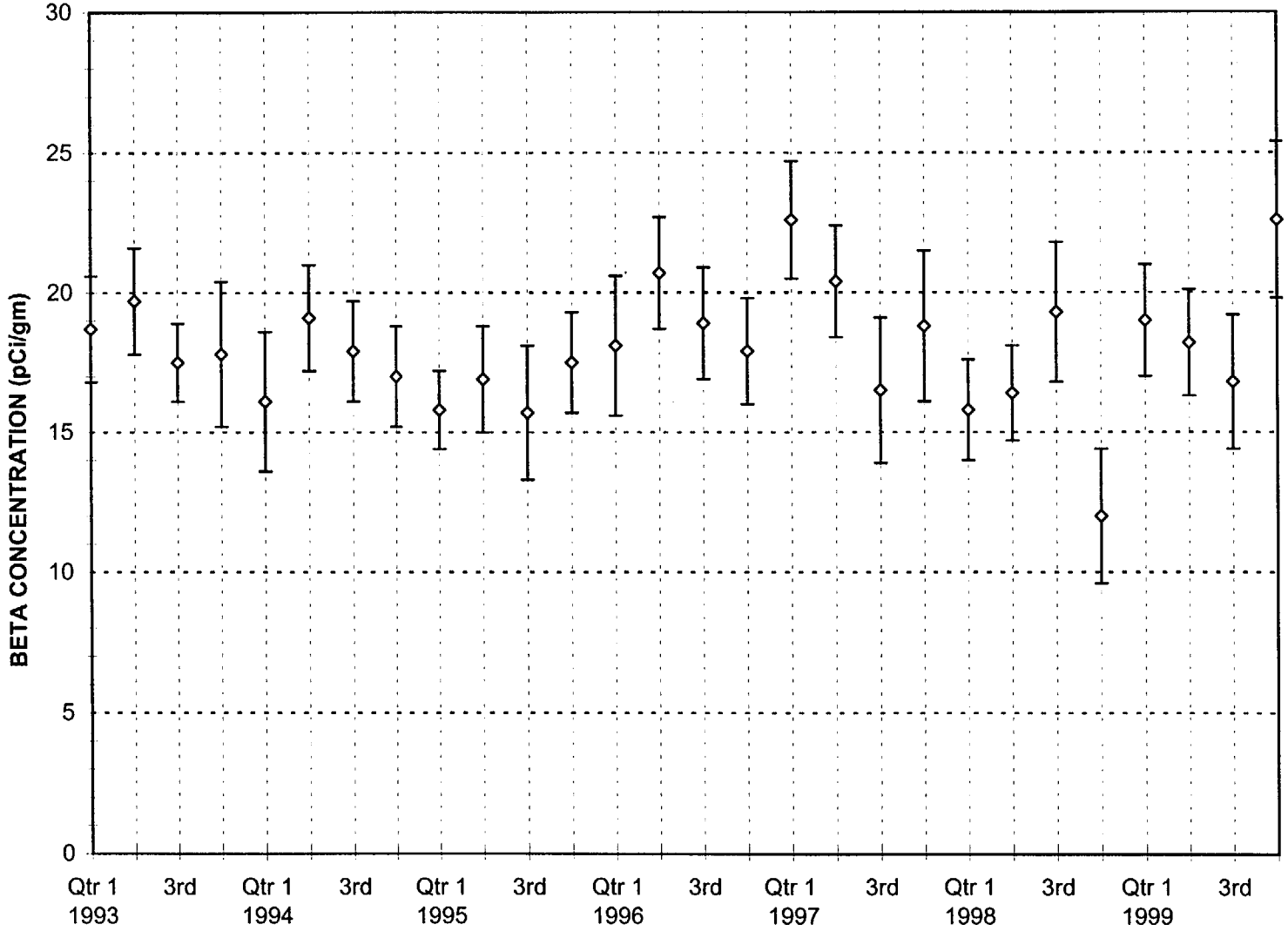
Soil Beta Action Level = 35 pCi/g (dry)

FIGURE 6.8
GROSS BETA IN SOIL
STATION 8



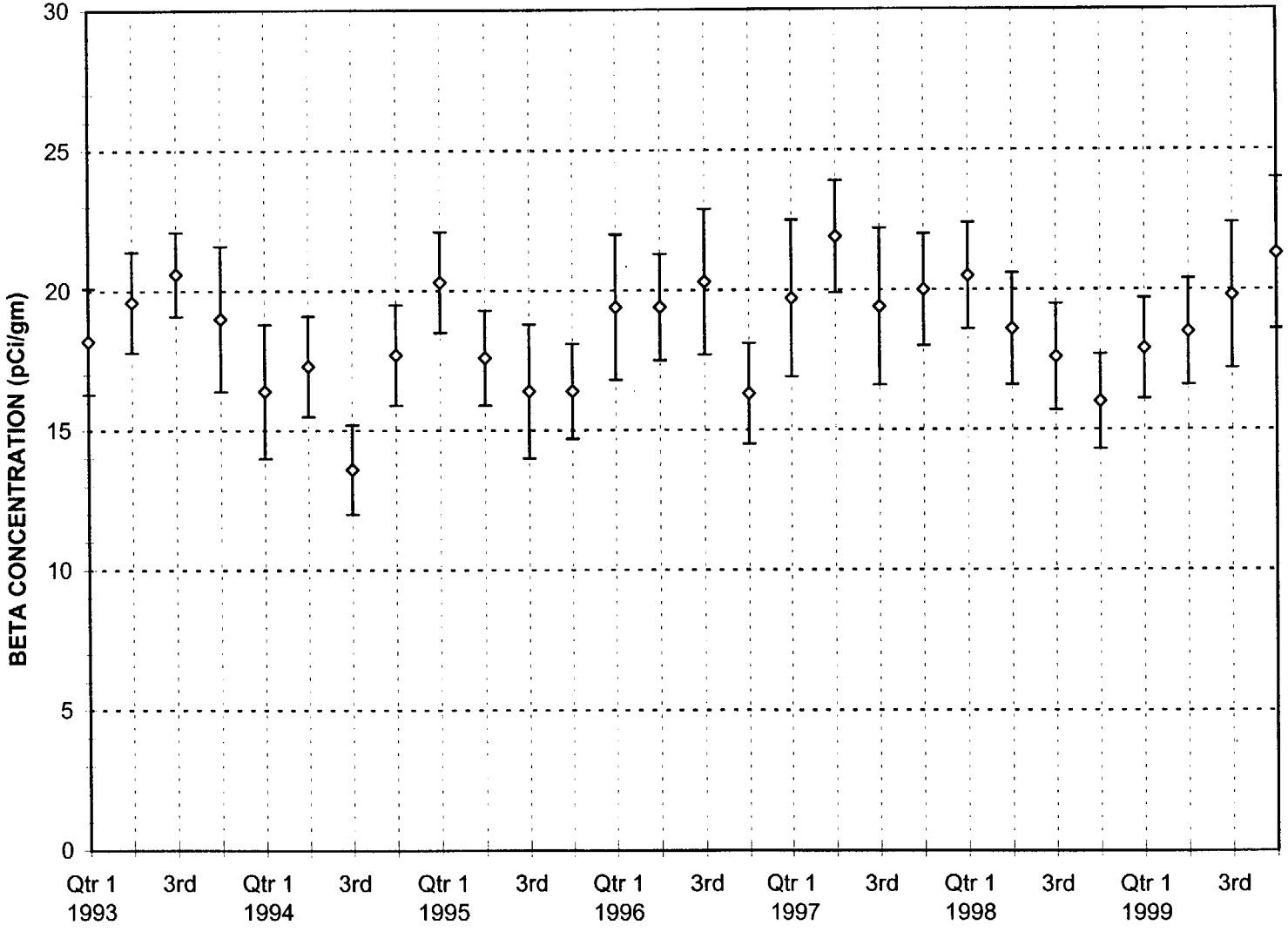
Soil Beta Action Level = 35 pCi/g (dry)

FIGURE 6.9
GROSS BETA IN SOIL
STATION 9



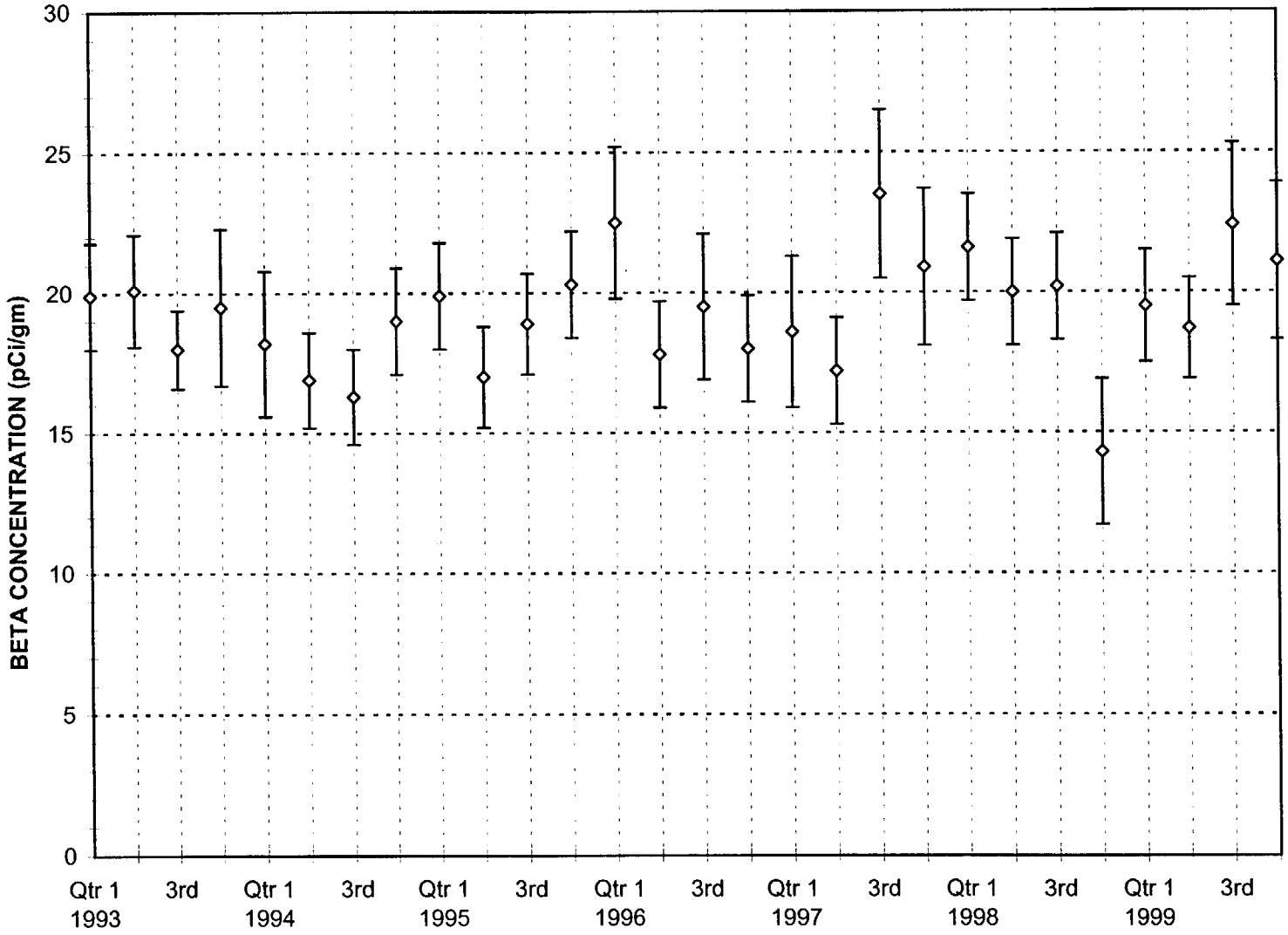
Soil Beta Action Level = 35 pCi/g (dry)

FIGURE 6.10
GROSS BETA IN SOIL
NORTHEAST STATION



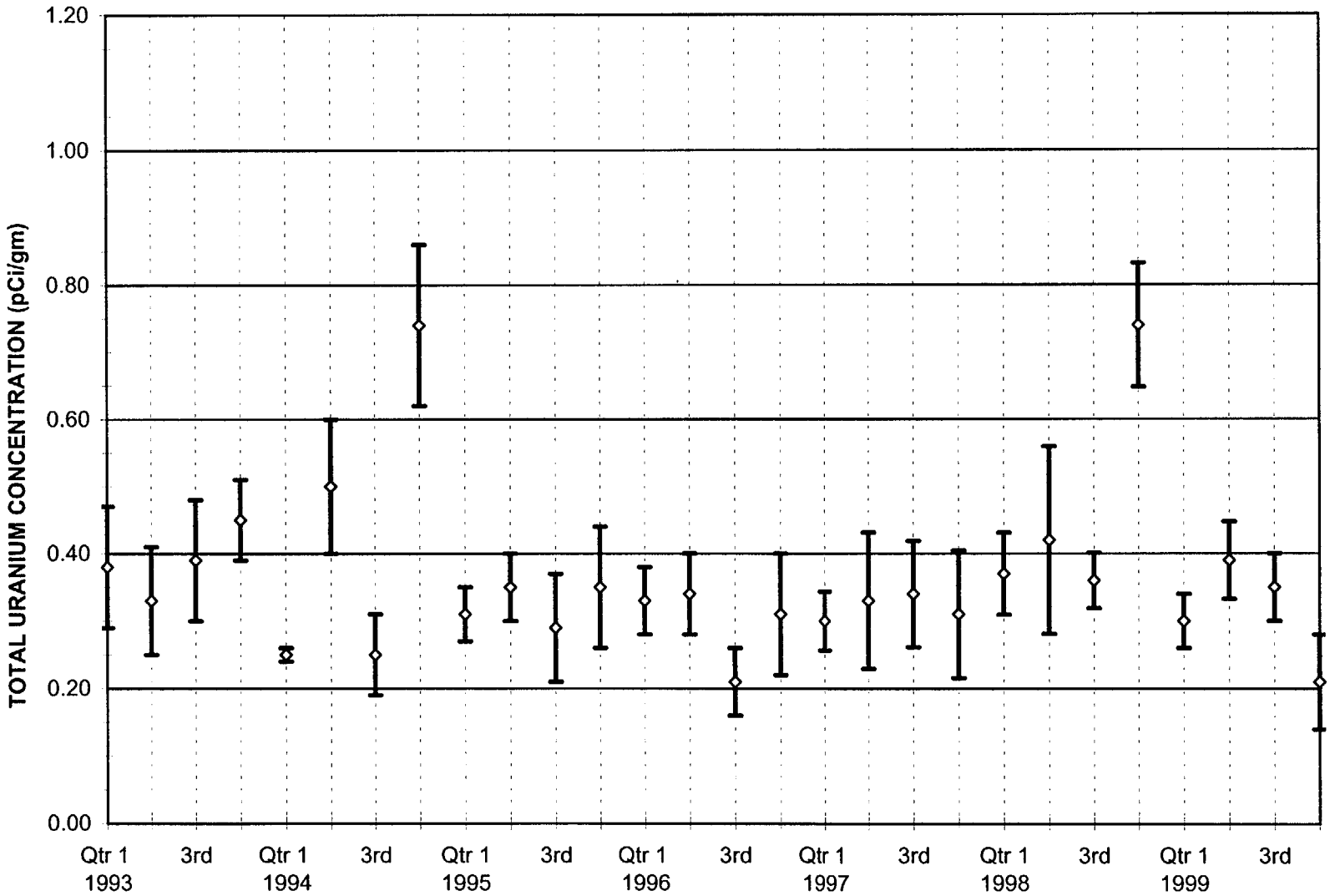
Soil Beta Action level = 35 pCi/g (dry)

FIGURE 6.11
GROSS BETA IN SOIL
NORTHWEST STATION



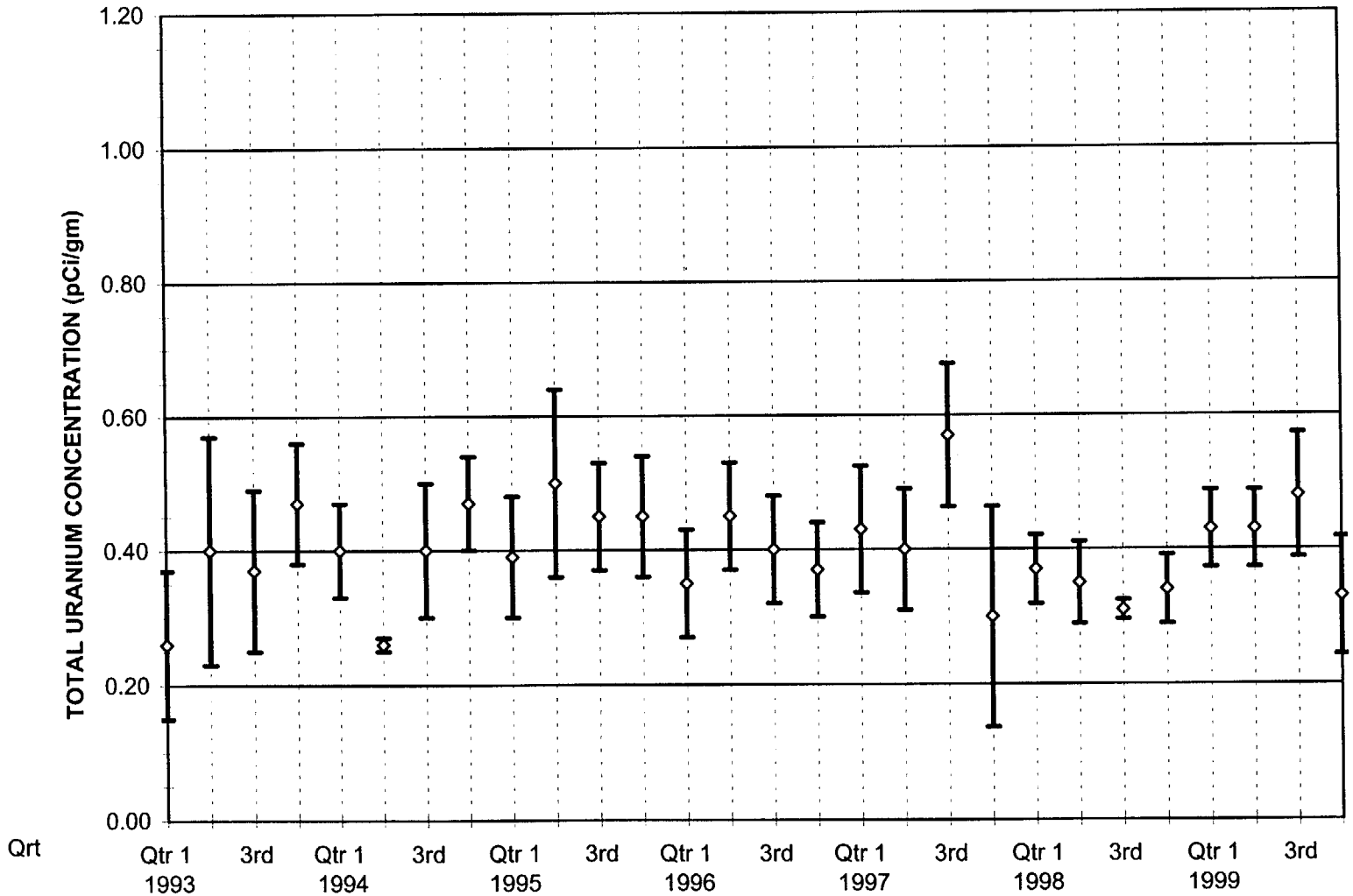
Soil Beta Action level = 35 pCi/g (dry)

FIGURE 6.12
TOTAL URANIUM IN SOIL
STATION 1



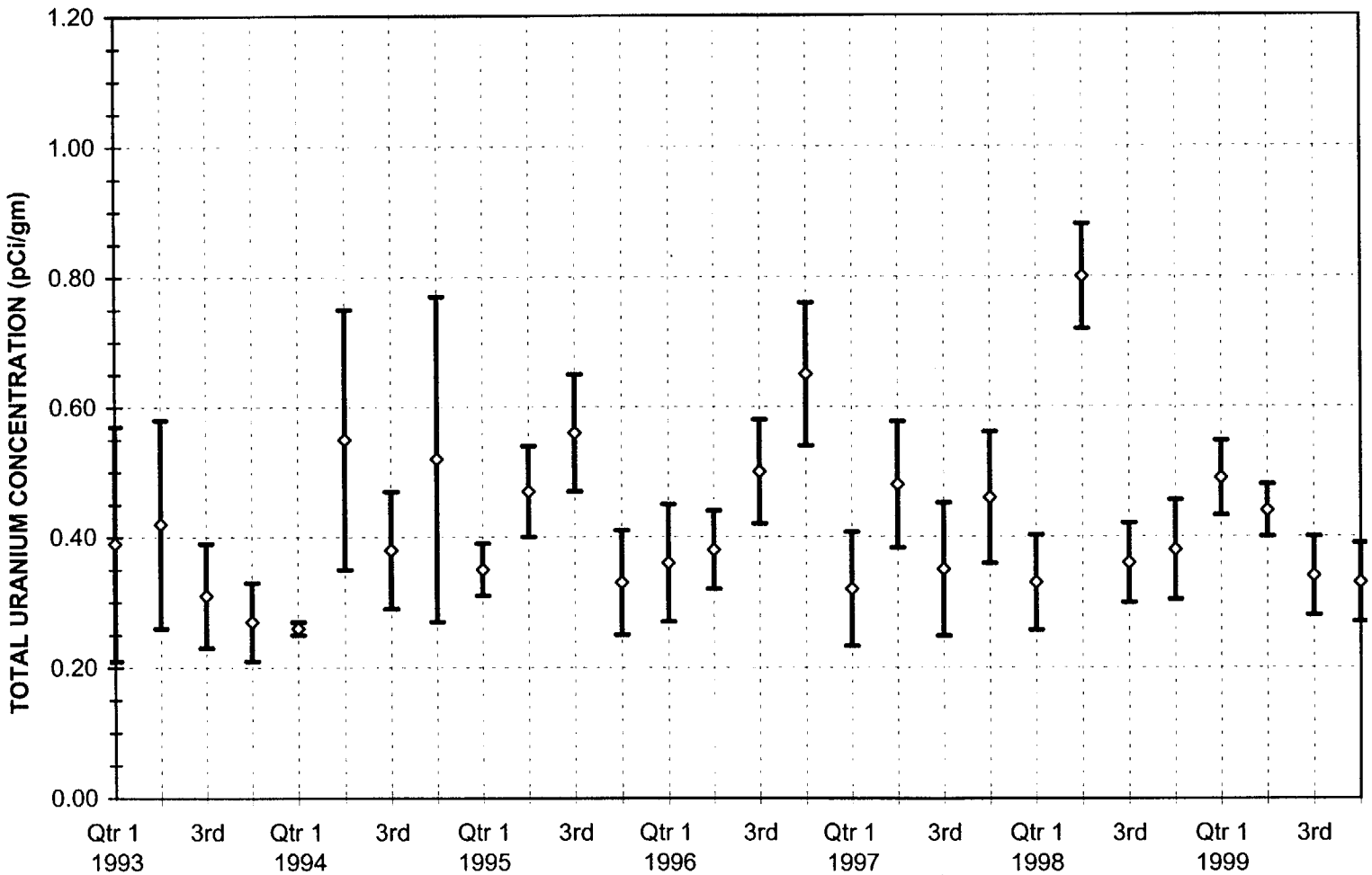
Total Uranium Action level = 1 pCi/g

FIGURE 6.13
TOTAL URANIUM IN SOIL
STATION 2



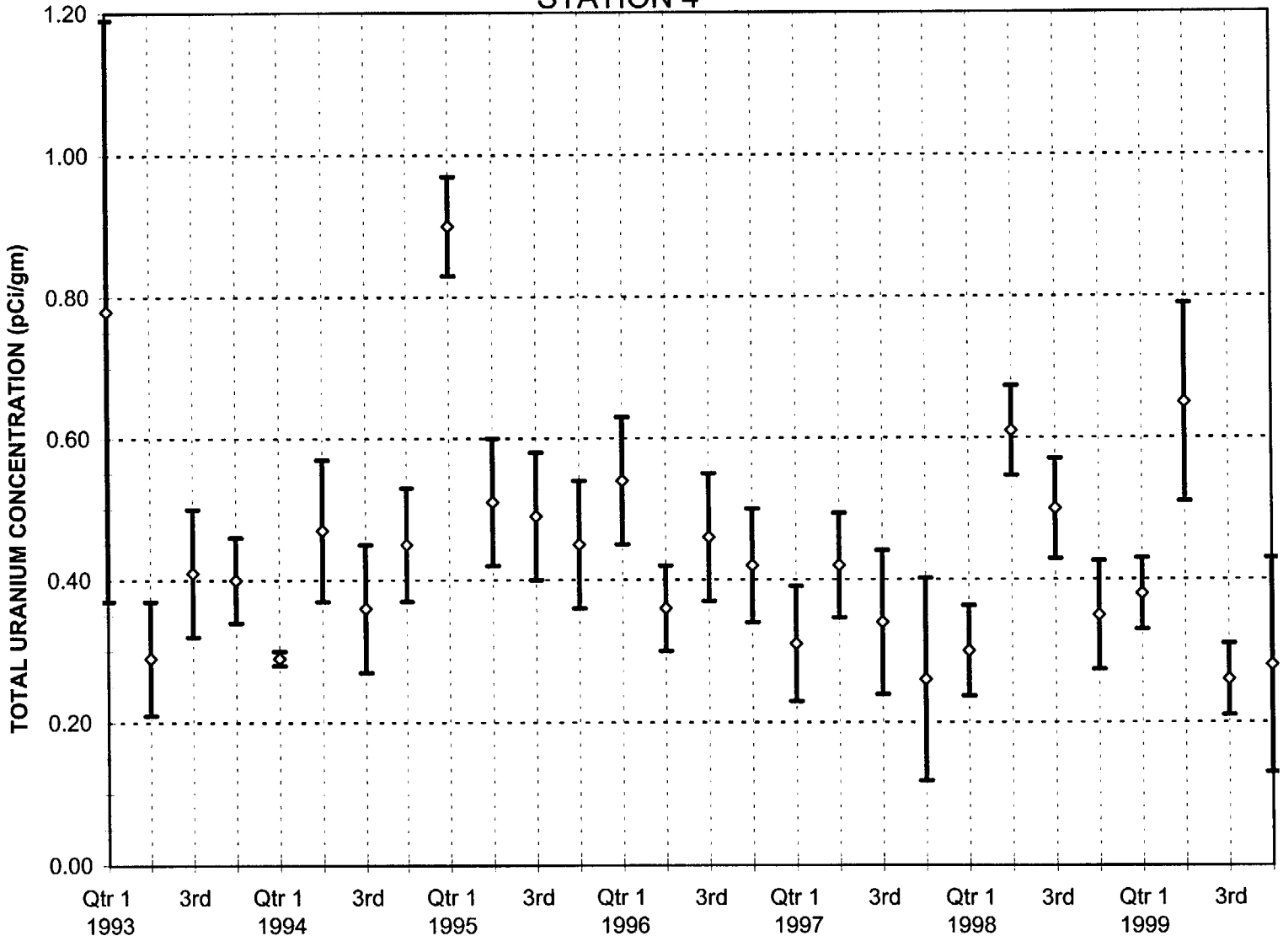
Total Uranium Action Level = 1 pCi/g

FIGURE 6.14
TOTAL URANIUM IN SOIL
STATION 3



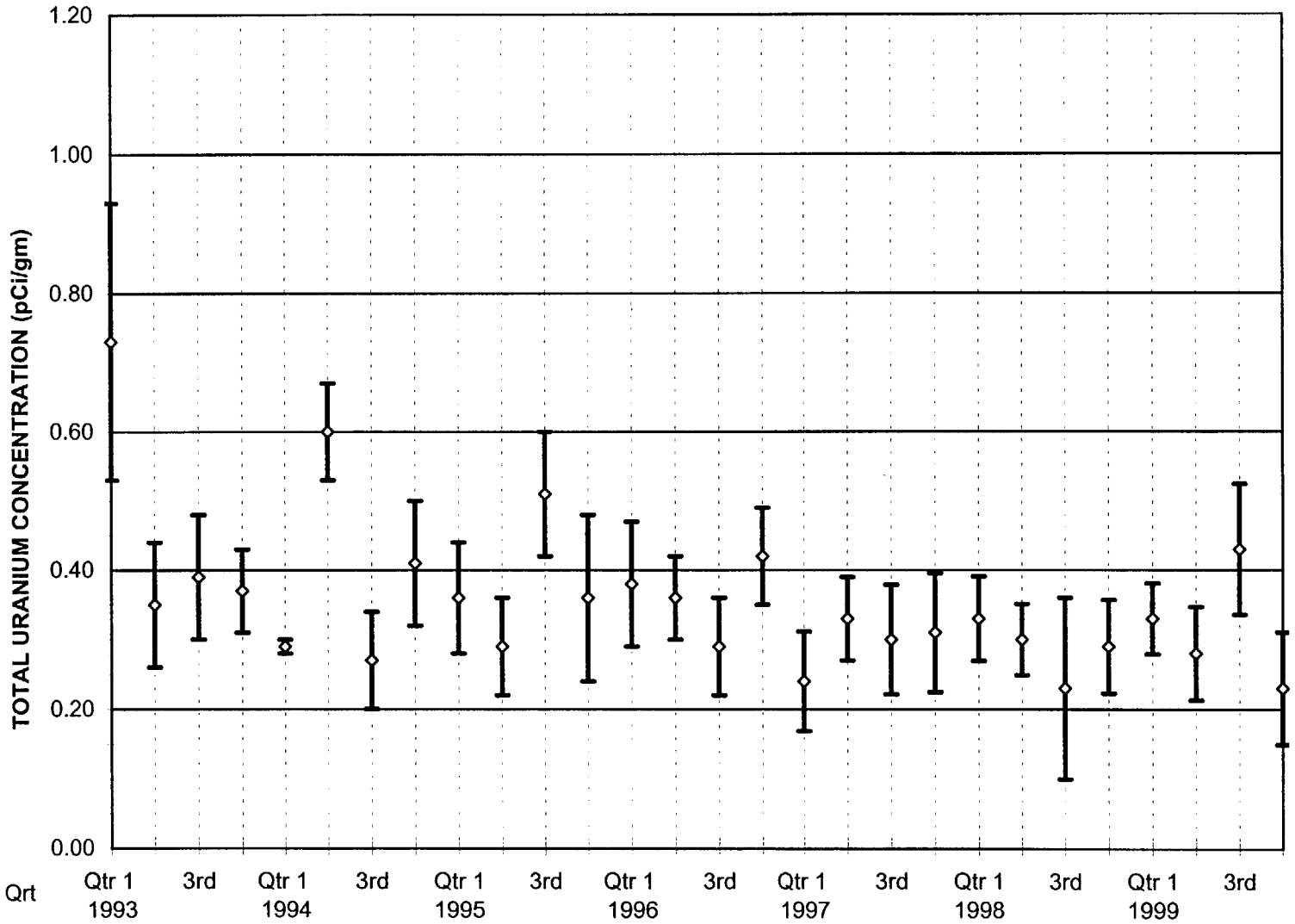
Total Uranium Action LEVEL = 1 pCi/g

FIGURE 6.15
TOTAL URANIUM IN SOIL
STATION 4



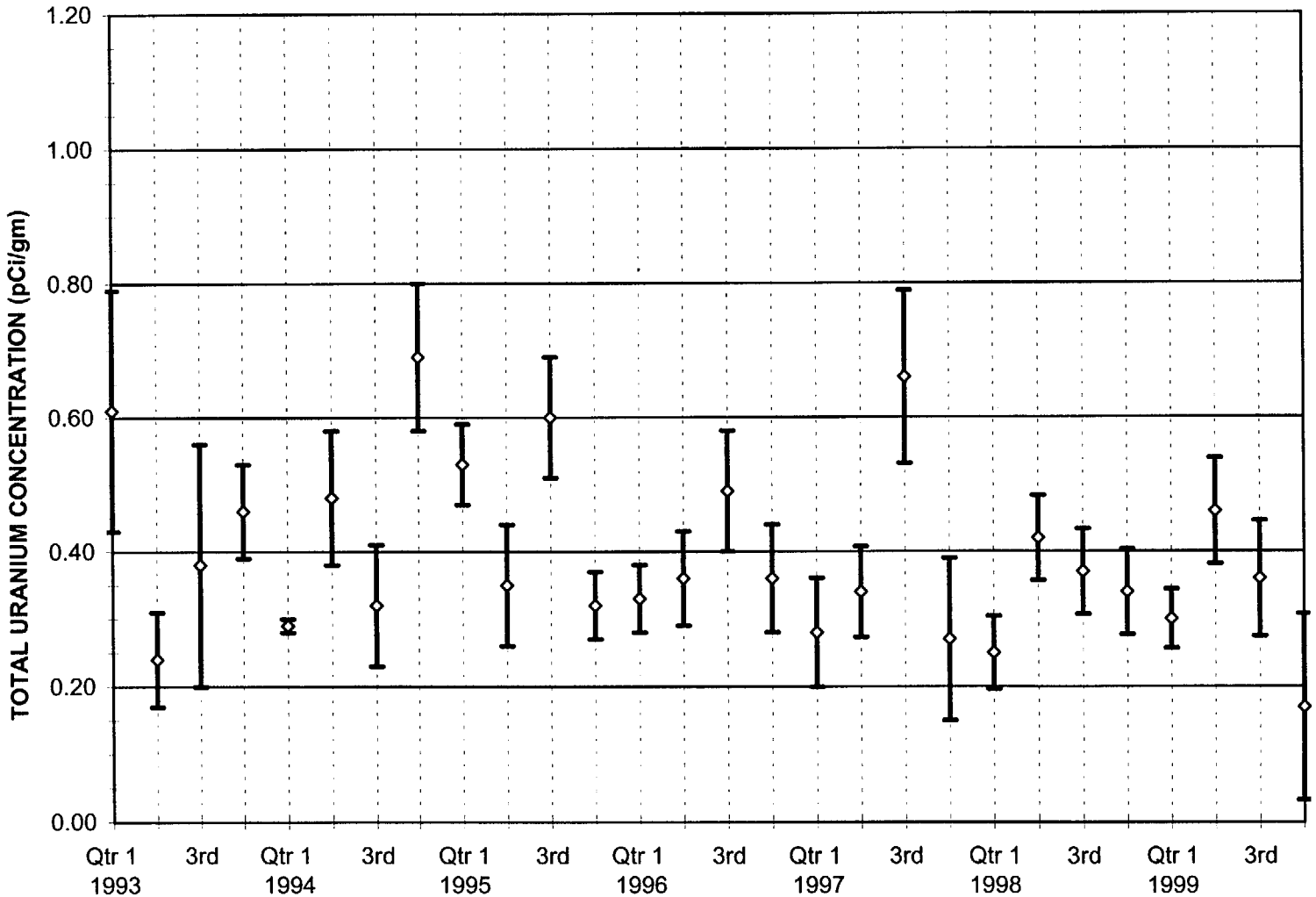
Total Uranium Action Level = 1 pCi/g

FIGURE 6.16
TOTAL URANIUM IN SOIL
STATION 5



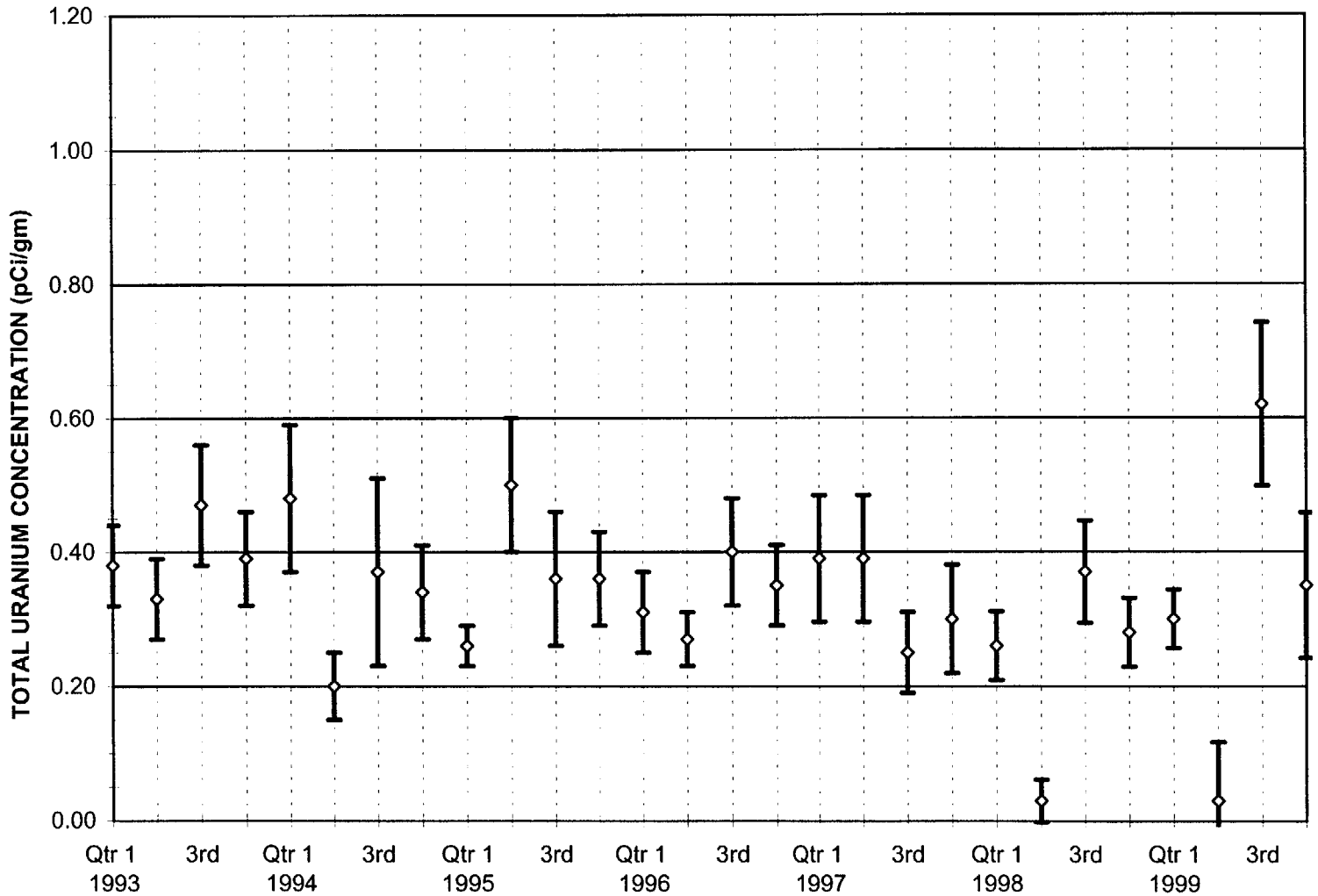
Uranium Action Level = 1 pCi/g

FIGURE 6.17
TOTAL URANIUM IN SOIL
STATION 6



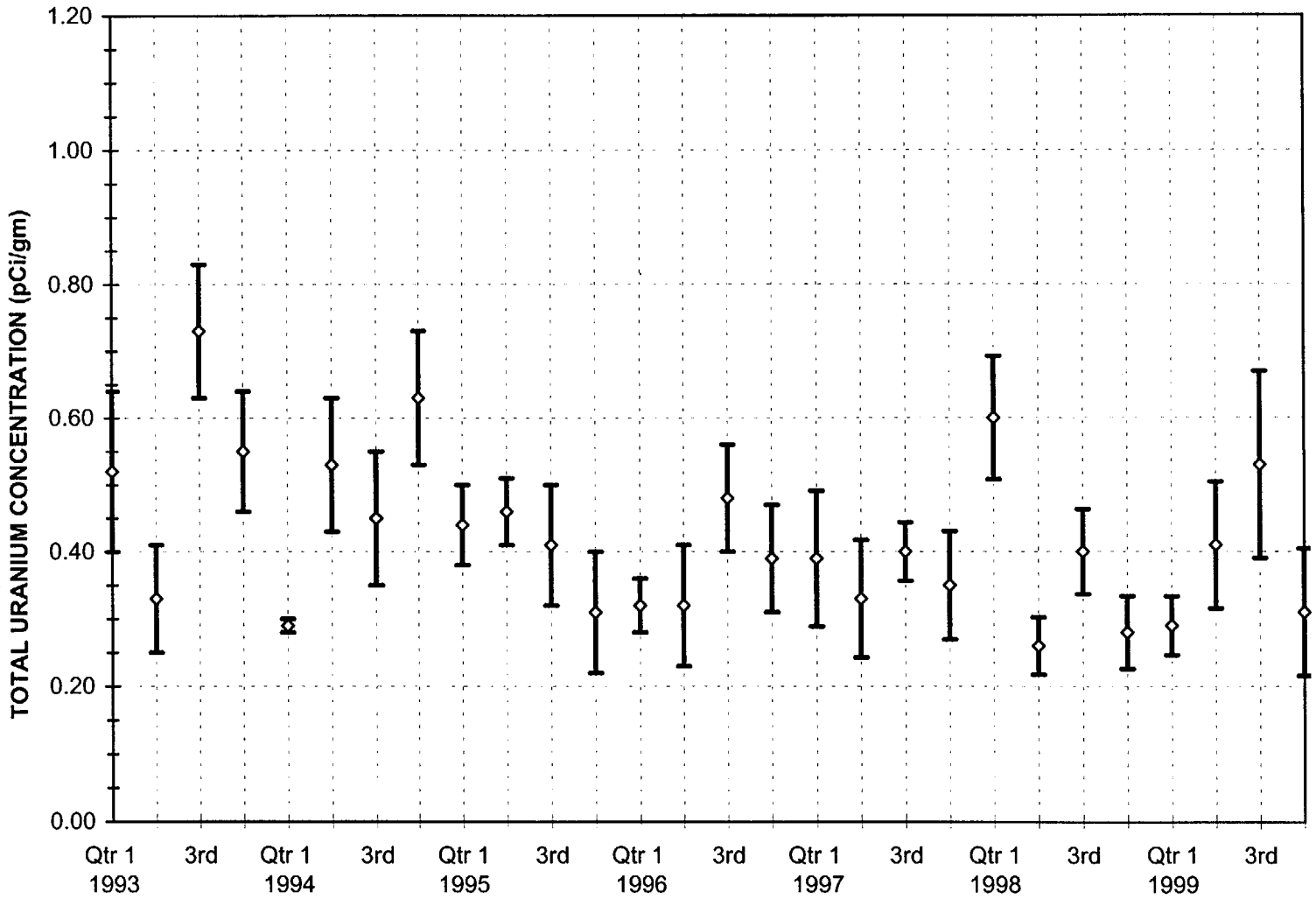
Total Uranium Action Level = 1 pCi/g

FIGURE 6.18
TOTAL URANIUM IN SOIL
STATION 7



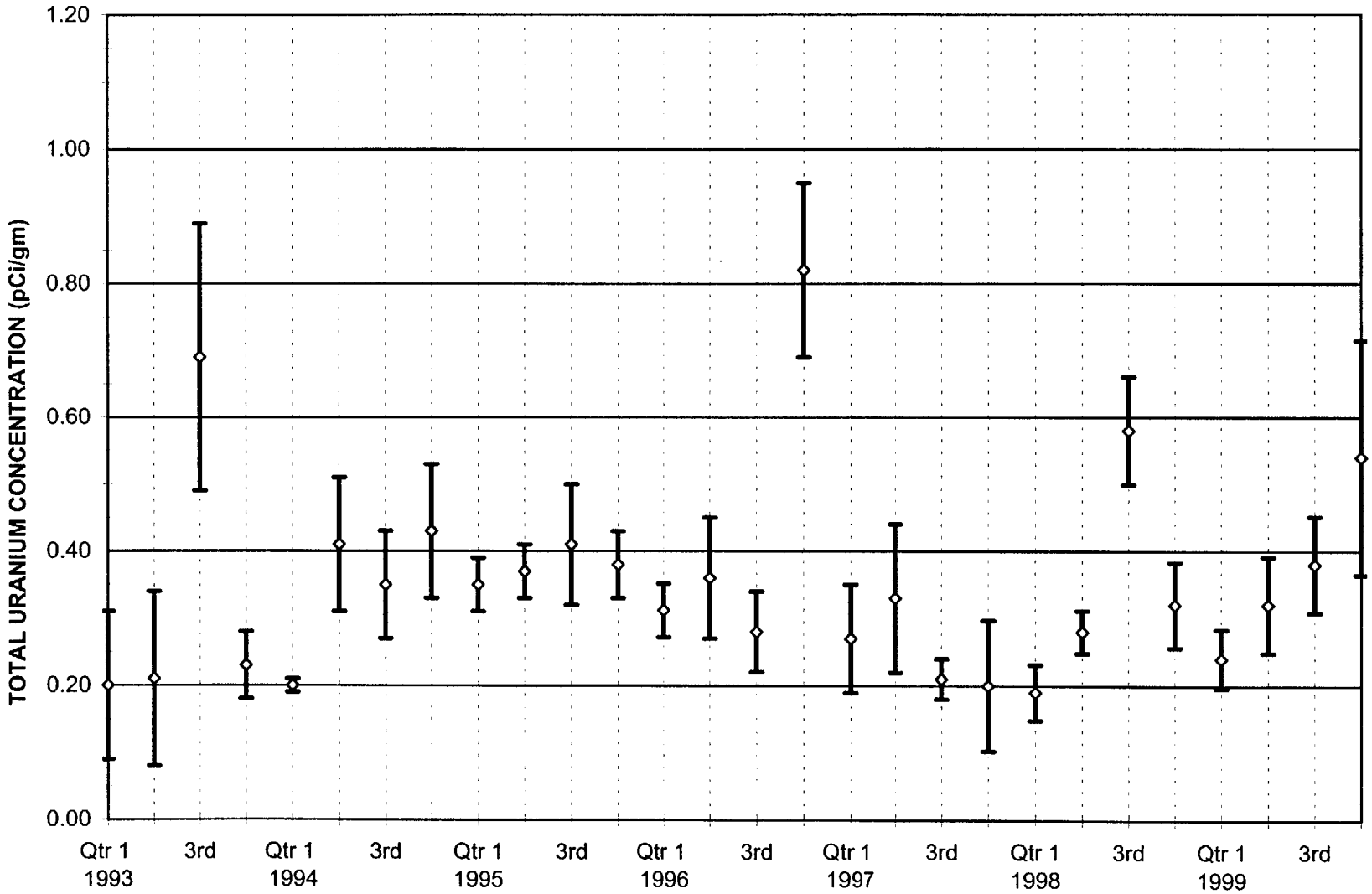
Total Uranium Action Level = 1 pCi/g

FIGURE 6.19
TOTAL URANIUM IN SOIL
STATION 8



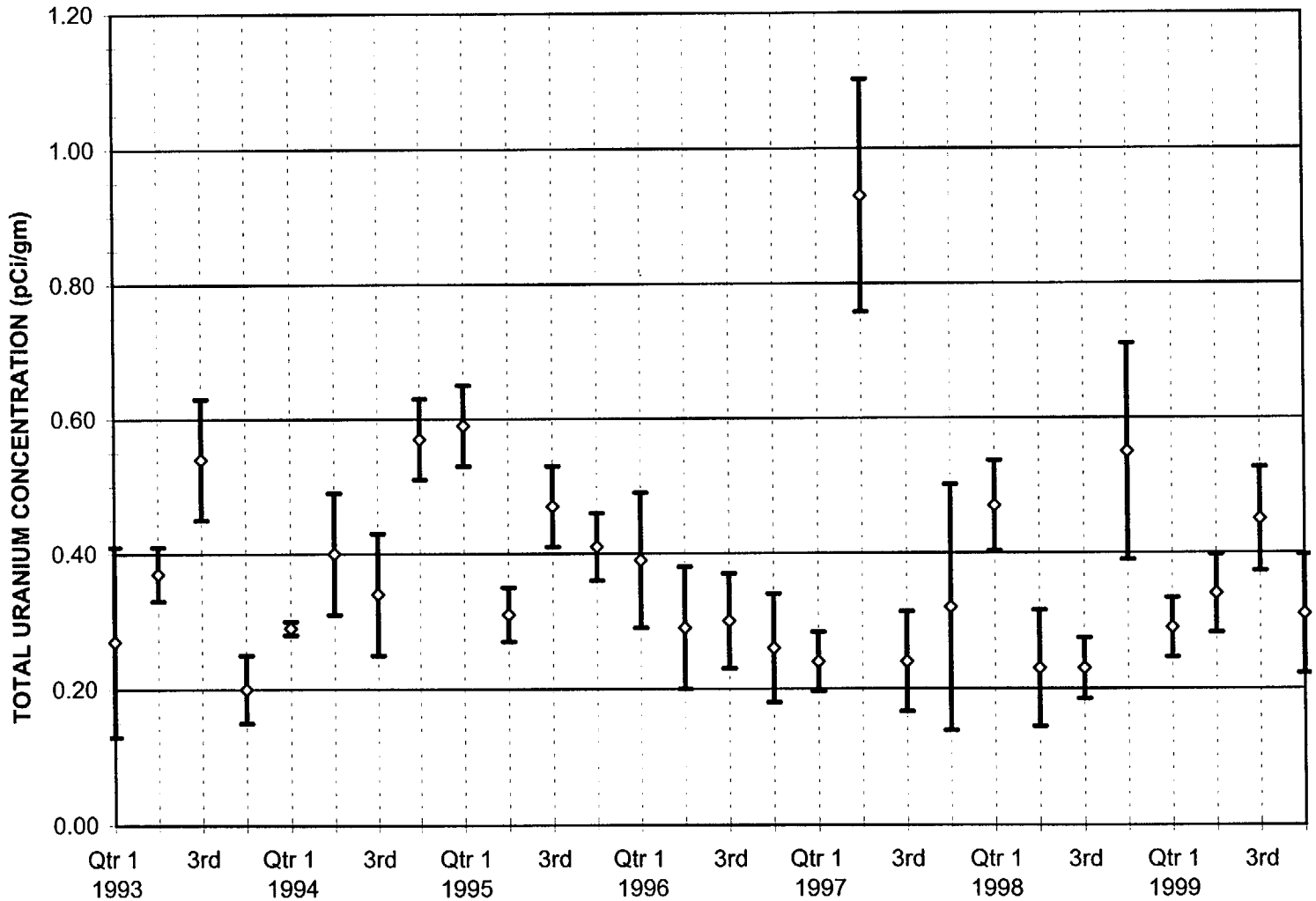
Total Uranium Action level = 1 pCi/g

FIGURE 6.20
TOTAL URANIUM IN SOIL
STATION 9



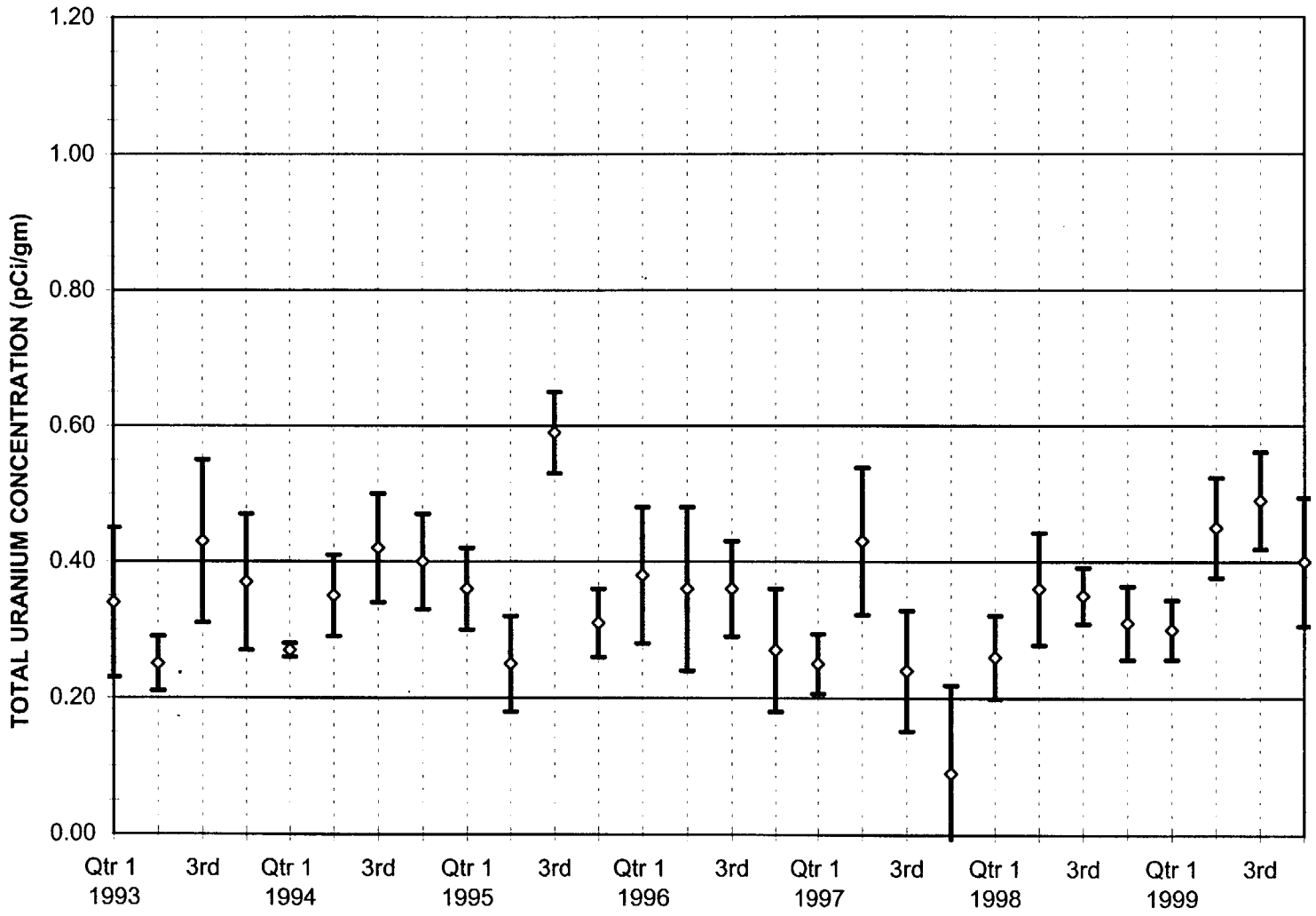
Total Uranium Action Level = 1 pCi/g

FIGURE 6.21
TOTAL URANIUM IN SOIL
NORTHEAST STATION



Total Uranium Action Levl = 1 pCi/g

FIGURE 6.22
TOTAL URANIUM IN SOIL
NORTHWEST STATION



Total Uranium Action Level = 1 pCi/g

7.0 VEGETATION SAMPLING

Vegetation is sampled quarterly at the nine environmental air-monitoring stations and at the northeast and northwest corners of the site whenever there is sufficient vegetation. Vegetation samples are also collected annually from the closed trench caps when sufficient vegetation is available. The vegetation sampling procedure requires a sufficient quantity of live vegetation to obtain a minimum 300 gram sample. Table 7.1 Lists the location where sufficient vegetation was present by quarter.

Table 7.1 Locations With Sufficient Vegetation in 1999

Quarter	Locations
1st	Northwest Corner and Station 1
2nd	NE Corner, NW Corner, Station 1, Station 2 and Station 7
3rd	All Sample Locations
3rd Qtr. Closed Trench Caps	Trench 1,2,3,4, 4B, 5, 6, 7, 8, 9, 10, 13, and Reactor Head Trench
4th	Northwest Corner

Vegetation samples are analyzed for gross beta, uranium and plutonium, in addition trench cap vegetation is analyzed for tritium. Vegetation samples are not analyzed for non-radiological constituents. All 1999 vegetation samples were below their investigation and reporting limits. There were no indications of increasing trends in site vegetation in 1999.

7.1 Gross Beta Activity in Vegetation

Gross beta results for 1999 environmental monitoring station vegetation samples ranged from a low of 11 pCi/g to a high of 77 pCi/g. The mean value for all environmental monitoring station vegetation samples was 36 pCi/g. No vegetation samples exceeded the action level for gross beta activity of 100 pCi/g.

Annual trench cap deep rooted vegetation samples were taken in the third quarter of 1999. Gross beta activity ranged from a low of 24 pCi/g to a high of 34 pCi/g. The mean value for trench cap vegetation gross beta was 28 pCi/g.

Results from 1999 were compared to data from previous years. The Department of Energy does not report gross beta concentrations in vegetation at the Hanford Reservation. Onsite monitoring stations and trench cap vegetation gross beta concentrations and worldwide gross beta concentration are given in Table 7.2. Table 7.3 provides the gross beta activity for the environmental monitoring stations. Trench cap gross beta activity along with plutonium and uranium concentration is provided in Table 7.8.

According to the National Council on Radiation Protection and Measurements in Environmental Radiation Measurements (NCRP-50), gross beta activity is due mainly to potassium-40, lead-210, bismuth-210 and the uranium and thorium

series. Gross beta activity from both trench cap vegetation and environmental monitoring station vegetation samples in 1999 are consistent with historical results for the facility and expected values throughout the world. Figures 7.1 through 7.11 compare gross beta concentrations from 1993 through 1999 for environmental monitoring station vegetation samples. Figures 7.12 – 7.28 compare gross beta concentrations from 1992 through 1999 for trench cap vegetation samples. None of these figures indicate any increasing trends.

Table 7.2
Comparison of Gross Beta in Vegetation (pCi/g dry)

	Minimum	Maximum	Average
1999 – Env. Monitoring Stations	1.10 E+1	7.74 E+1	3.56 E+1
1999 - Trench Caps	2.40 E+1	3.42 E+1	2.78 E+1
1998 - Env. Mon. Stations	7.79 E+0	5.30 E+1	2.00 E+1
1998 - Trench Caps	2.03 E+1	4.09 E+1	2.66 E+1
1997 Annual Report - Env. Mon. Stations	1.18 E+1	6.79 E+1	3.21 E+1
1997 Annual Report – Trench Caps	1.95 E+1	3.85 E+1	
1996 Annual Report - Env. Mon. Stations	8.40 E+0	7.26 E+1	3.54 E+1
1996 Annual Report – Trench Caps	1.99 E+1	5.84 E+1	
Historical Report	2.36 E+0	1.17 E+2	2.53 E+1
Worldwide	8.0 E+0	1.23 E+2	

TABLE 7.3
Gross Beta Analysis of Vegetation During 1999
GROSS BETA CONCENTRATION (pCi/g, dry)

	First Quarter		Second Quarter		Third Quarter		Fourth Quarter	
	Beta pCi/g	Error pCi/g	Beta pCi/g	Error pCi/g	Beta pCi/g	Error pCi/g	Beta pCi/g	Error pCi/g
Station 1	14.2	0.4	22.5	0.5	19.46	0.95	NS	NS
Station 2	NS	NS	58.74	1.29	11.11	0.48	NS	NS
Station 3	NS	NS	NS	NS	75.71	2.63	NS	NS
Station 4	NS	NS	NS	NS	28.31	1.29	NS	NS
Station 5	NS	NS	NS	NS	35.76	1.32	NS	NS
Station 6	NS	NS	NS	NS	31	0.94	NS	NS
Station 7	NS	NS	60.38	1.26	38.63	0.92	NS	NS
Station 8	NS	NS	NS	NS	33.35	0.82	NS	NS
Station 9	NS	NS	NS	NS	31.56	0.83	NS	NS
NE Corner	NS	NS	77.47	1.61	69.49	2.08	NS	NS
NW Corner	14.6	0.4	17.28	0.37	26.59	0.91	11.02	0.09

NOTES: All vegetation was deep rooted.
Minimum detectable concentration: 1.0 pCi/g.
Error is 95% confidence level.
NS - No sample taken due to lack of sufficient vegetation.
Investigation Level = 100 pCi/g (dry)
Reporting Level = 100 pCi/g (dry)

7.2 Total Uranium Concentration in Vegetation

Total uranium concentration in vegetation is measured using alpha spectroscopy. Vegetation samples were taken at all monitoring stations in the third quarter. Only limited vegetation sampling was possible in the first, second and fourth quarters. Table 7.4 compares 1999 total uranium in vegetation results with previous years and other locations. Table 7.5 presents the analytical results for the total uranium concentration in vegetation samples collected at the US Ecology facility environmental monitoring locations. Table 7.8 presents the trench cap sample total uranium results.

Table 7.4
Comparison of Total Uranium in Vegetation (pCi/g dry)

	Maximum	Average
1999 Env. Monitoring Stations	0.05	0.02
1999 Trench Caps	0.12	0.06
1998 Env. Mon. Stations	0.05	0.02
1998 Trench Caps	0.1	0.08
1997 Env. Mon. Stations	0.1	0.05
1997 Trench Caps	0.09	0.04
1998 Hanford Report	ND	ND
1997 Hanford 200 Area	870	ND
1997 Hanford 300 Area	0.04	0.02
1997 Franklin County (Hanford Report)	0.04	0.03

TABLE 7.5
Total Uranium in Vegetation During 1999
TOTAL URANIUM (pCi/g, dry)

	First Quarter		Second Quarter		Third Quarter		Fourth Quarter	
	Total U pCi/g	Error pCi/g	Total U pCi/g	Error pi/g	Total U pCi/g	Error pCi/g	Total U pCi/g	Error pCi/g
Station 1	0.044	0.007	0.013	0.006	0.011	0.003	NS	NS
Station 2	NS	NS	0.020	0.010	0.016	0.003	NS	NS
Station 3	NS	NS	NS	NS	0.040	0.010	NS	NS
Station 4	NS	NS	NS	NS	0.054	0.014	NS	NS
Station 5	NS	NS	NS	NS	0.028	0.009	NS	NS
Station 6	NS	NS	NS	NS	0.011	0.044	NS	NS
Station 7	NS	NS	0.045	0.015	0.038	0.007	NS	NS
Station 8	NS	NS	NS	NS	0.022	0.008	NS	NS
Station 9	NS	NS	NS	NS	0.018	0.008	NS	NS
NE Corner	NS	NS	0.018	0.013	0.010	0.005	NS	NS
NW Corner	0.036	0.010	0.009	0.004	0.014	0.006	0.014	0.002

NOTES: All vegetation was deep rooted.
Minimum detectable concentration: 1.0 E-1 pCi/g (dry).
Error is 95% confidence level.
NS - No sample taken due to lack of sufficient vegetation.
Investigation Level = 0.25 pCi/g (dry) Reporting Level = 0.25 pCi/g (dry)

7.3 Plutonium Concentration in Vegetation

Vegetation samples from environmental monitoring stations and trench caps were analyzed for Pu-238 and Pu-239/240. All environmental station and trench cap vegetation samples were less than the minimum detectable concentration of 0.01 pCi/g for Pu-238 and Pu 239/240 in 1999. 1998 and 1997. The Hanford 1997 Environmental Report did not report any Pu measurements on offsite or 300 Area vegetation samples. An investigative grass sample from 200 E had concentration of 3.9 pCi/g for Pu 239/240 Table 7.6 presents the environmental monitoring station Pu sample results.

TABLE 7.6
Plutonium Concentrations in Vegetation During 1999
TOTAL PLUTONIUM CONCENTRATION (pCi/g, dry)

	First Qtr.		Second Qtr.		Third Qtr.		Fourth Qtr.	
	Total Pu pCi/g	Error pCi/g	Total Pu pCi/g	Error pCi/g	Total Pu pCi/g	Error pCi/g	Total Pu pCi/g	Error pCi/g
Station 1	-0.001	0.007	0.000	0.003	0.000	0.001	NS	NS
Station 2	NS		0.002	0.006	0.000	0.001	NS	NS
Station 3	NS		NS		-0.002	0.004	NS	NS
Station 4	NS		NS		-0.001	0.014	NS	NS
Station 5	NS		NS		-0.001	0.009	NS	NS
Station 6	NS		NS		-0.001	0.044	NS	NS
Station 7	NS		0.000	0.015	-0.001	0.007	NS	NS
Station 8	NS		NS		-0.001	0.008	NS	NS
Station 9	NS		NS		0.000	0.008	NS	NS
NE Corner	NS		-0.002	0.013	0.000	0.005	NS	NS
NW Corner	-0.001	0.010	0.000	0.004	0.000	0.006	0.002	0.002

NOTES: All vegetation was deep rooted.
All samples were below the minimum detectable concentration.
Minimum detectable concentrations: Pu-238, and 239/240 = 1.0 E-2 pCi/g.
Errors are 2 sigma (95% confidence level).
NS - No sample taken due to lack of sufficient vegetation.
Investigation Level = 0.02 pCi/g (dry)
Reporting Level = 0.02 pCi/g (dry)

All US Ecology vegetation plutonium results were less than minimum detectable. Therefore, no plutonium in vegetation is attributable to LLRW facility operations.

7.4 Spectrometry Analysis of Gamma Emitters in Vegetation

Vegetation samples were taken in the third quarter from all environmental monitoring locations. Sufficient vegetation was not available for sampling at most locations during first, second and fourth quarters. Trench cap vegetation samples for gamma spectrometry were taken in the third quarter. All gamma emitters in vegetation samples were less than the minimum detectable concentrations listed in Table 7.7

TABLE 7.7
Required Minimum Detectable Concentrations for Vegetation
Gamma Spectrometry Analysis

Nuclide	pCi/g(dry)	Nuclide	pCi/g(dry)	Nuclide	pCi/g(dry)
Na-22	0.09	Mn-54	0.09	Co-58	0.09
Co-60	0.09	Fe-59	0.15	Zn-65	0.18
Zr/Nb-95	0.15	Ru-103	0.09	Ru-106	0.78
Sb-124	0.09	Sb-125	0.21	Cs-134	0.09
Cs-137	0.09	Ba/La-140	0.21	Ce-141	0.09
Ce/Pr144	0.30	Eu-152	0.51	Eu-154	0.24
Eu-155	0.21				

7.5 Trench Cap Vegetation

Trench cap vegetation is monitored annually for, gross beta, Plutonium, uranium and tritium. Table 7.8 present trench cap vegetation analytical results. Tritium is analyzed by extracting the water from the plant mass. At this time, tritium monitoring of vegetation is experimental and there is no consensus opinion on interpretation of results. Dose consequences from even the maximum concentrations measured are negligible. Table 7.9 compares 1999 tritium in trench cap vegetation results with previous years. The locations of the maximum and minimum sample have varied from trench to trench, there are no apparent trends.

TABLE 7.8
Radionuclide Concentrations for 1999 Trench Cap Vegetation (pCi/g)

	H-3	Error	Gross Beta	Error	Pu-238	Error	Pu-239/40	Error	Tot. Pu	Error	Tot. U	Error
Trench 1	2.11	0.12	30.72	1.29	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.02
Trench 2	2.09	0.13	34.19	1.24	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.01
Trench 3	9.59	0.22	24.61	1.05	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.01
Trench 4	0.46	0.07	23.96	1.16	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.02
Trench 4A	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Trench 4B	0.14	0.06	32.59	1.31	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01
Trench 5	0.57	0.07	25.78	1.14	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.01
Trench 6	8.02	0.19	25.83	1.24	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.02
Trench 7	2.85	0.13	25.39	1.34	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.01
Trench 7A	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Trench 8	7.30	0.20	30.18	1.22	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.01
Trench 9	9.57	0.22	29.02	1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.01
Trench 10	1.35	0.10	25.29	1.23	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.02
Trench 11A	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Trench 13	29.51	0.38	26.42	1.18	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.01
Tank Farm	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Reactor Head	1.54	0.11	21.28	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.01

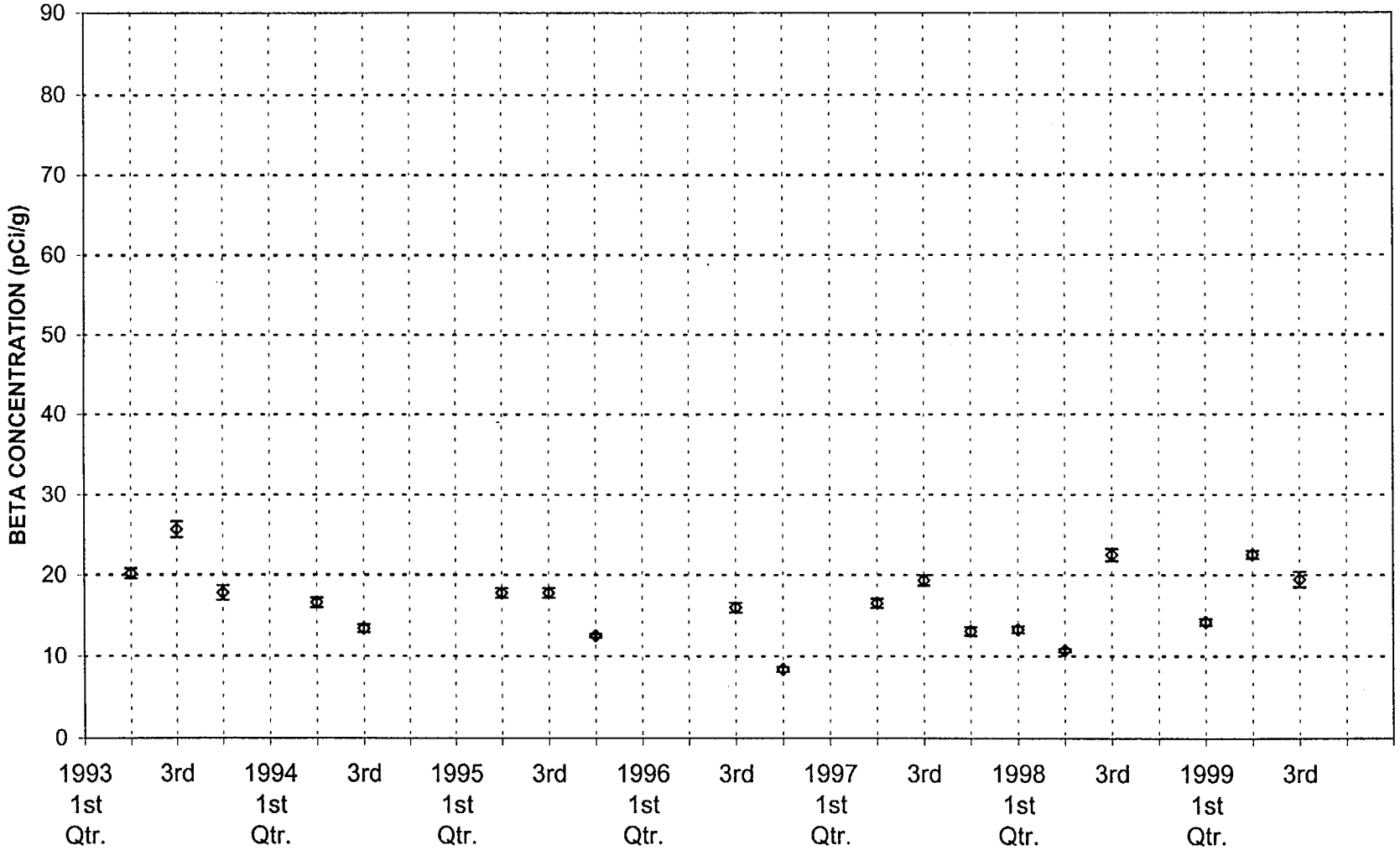
NOTES: Errors are 2 sigma (95% confidence level).
NS means sample not taken do to lack of vegetation.
Action levels (Investigation and Reporting)
Gross Beta: 100 pCi/g (dry) Total Uranium: 0.25 pCi/g (dry)
Pu-238: 0.02 pCi/g (dry) Pu-239/240: 0.02 pCi/g (dry)

Table 7.9
Comparison of Trench Cap Tritium in Vegetation (pCi/g dry)

	Minimum	Maximum	Average
1999 Trench Caps	0.14	30	6.1
1998 Trench Caps	0.06	74	16.6
1997 Trench Caps	0.19	43	7.5
1996 Trench Caps	0.1	143	
1995 Trench Caps	0.29	212	

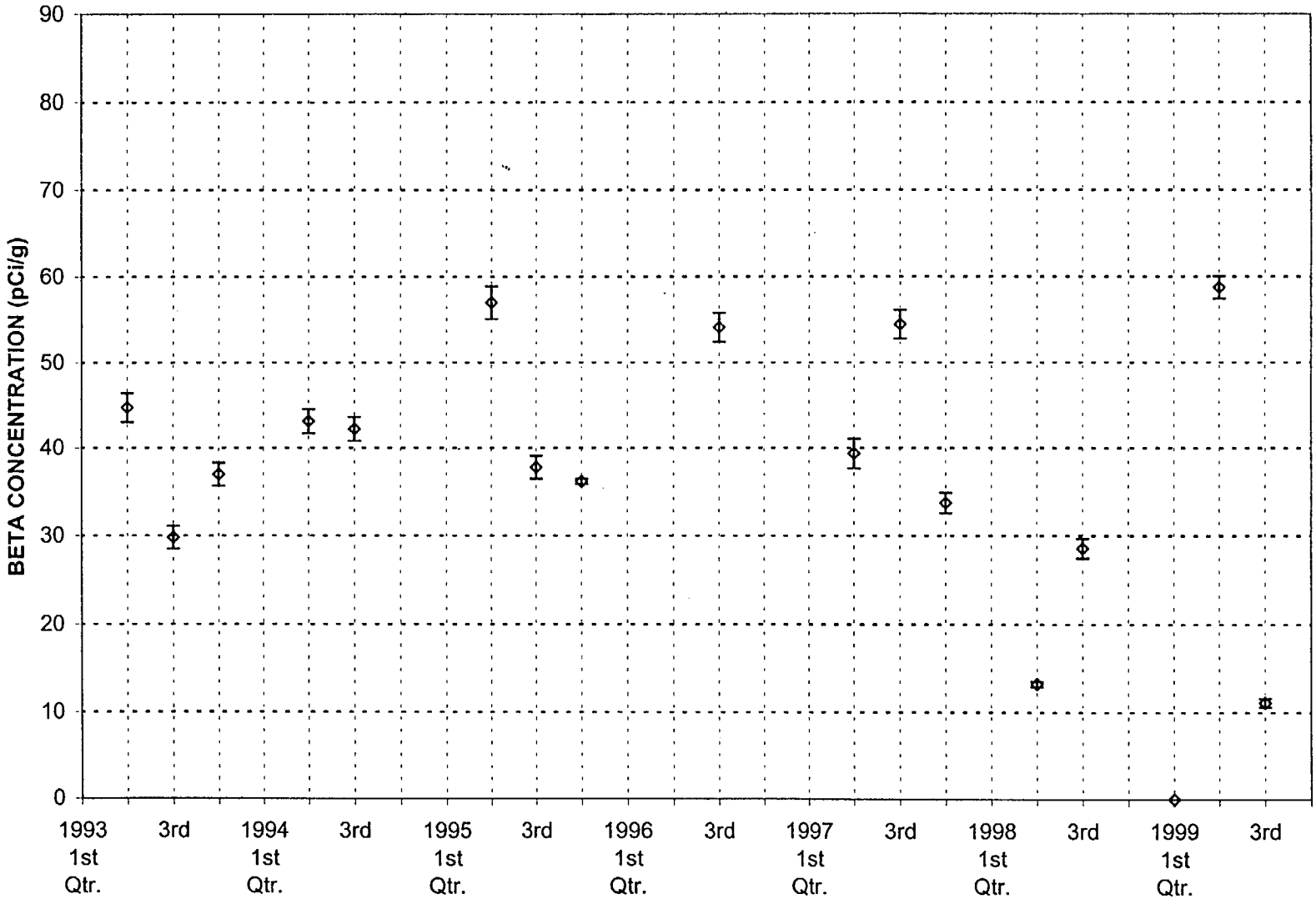
The 1998 and 1997 Hanford Environmental Report only provides tritium in vegetation results for fruit tree leaves at the old town site and 100 area locations. Fruit tree tritium concentrations ranged from 12 - 620 pCi/g. However, comparing trench cap vegetation to fruit tree leaves has only limited applicability. Comparing tritium concentrations in trench cap vegetation for 1999, 1998, 1997, 1996 and 1995 and Hanford data shows that there are no apparent trends.

FIGURE 7.1
GROSS BETA IN VEGETATION
STATION 1 - RICHLAND, WASHINGTON



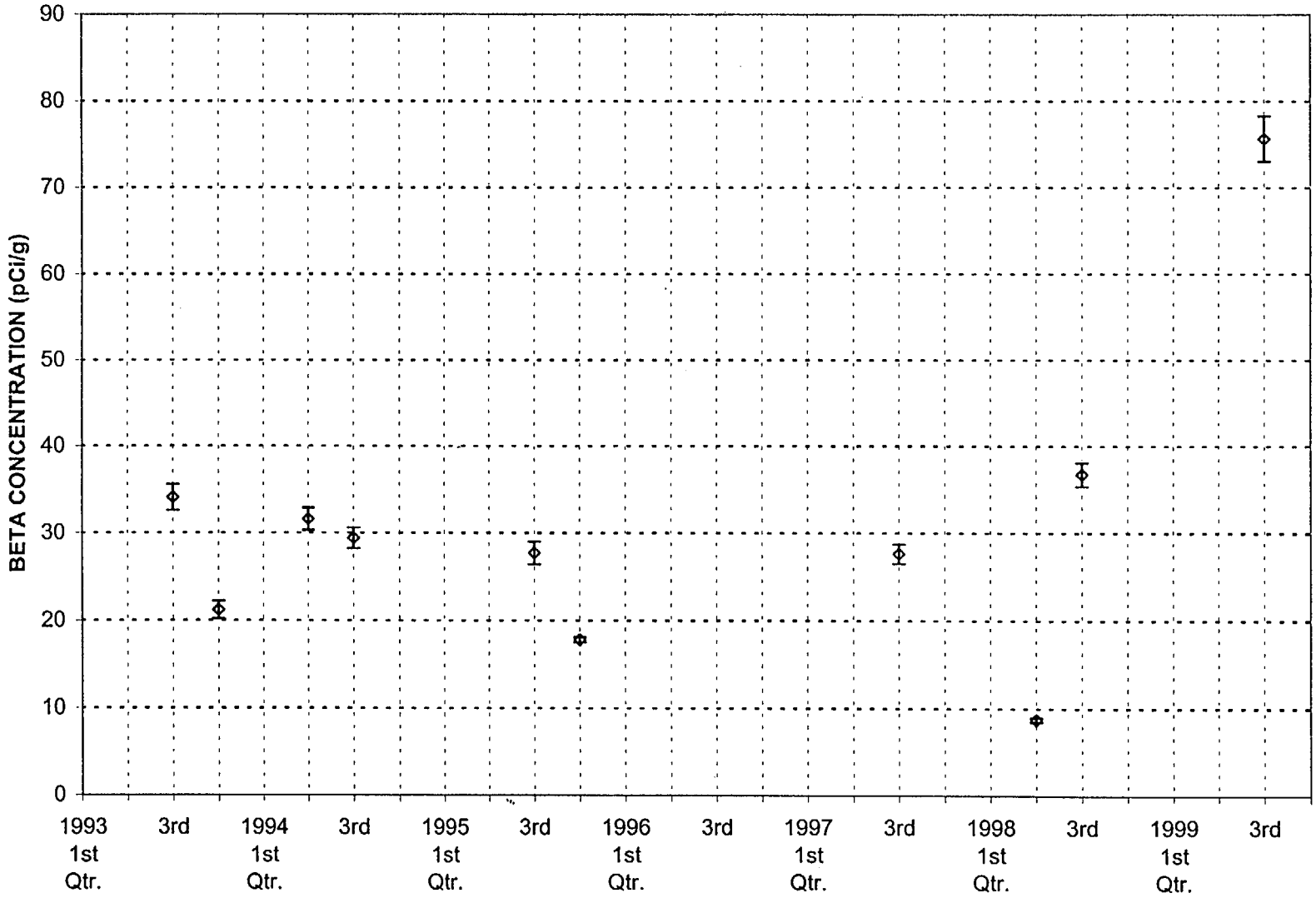
Vegetation Beta Action Level = 100 pCi/g (dry)

FIGURE 7.2
GROSS BETA IN VEGETATION
STATION 2 - RICHLAND, WASHINGTON



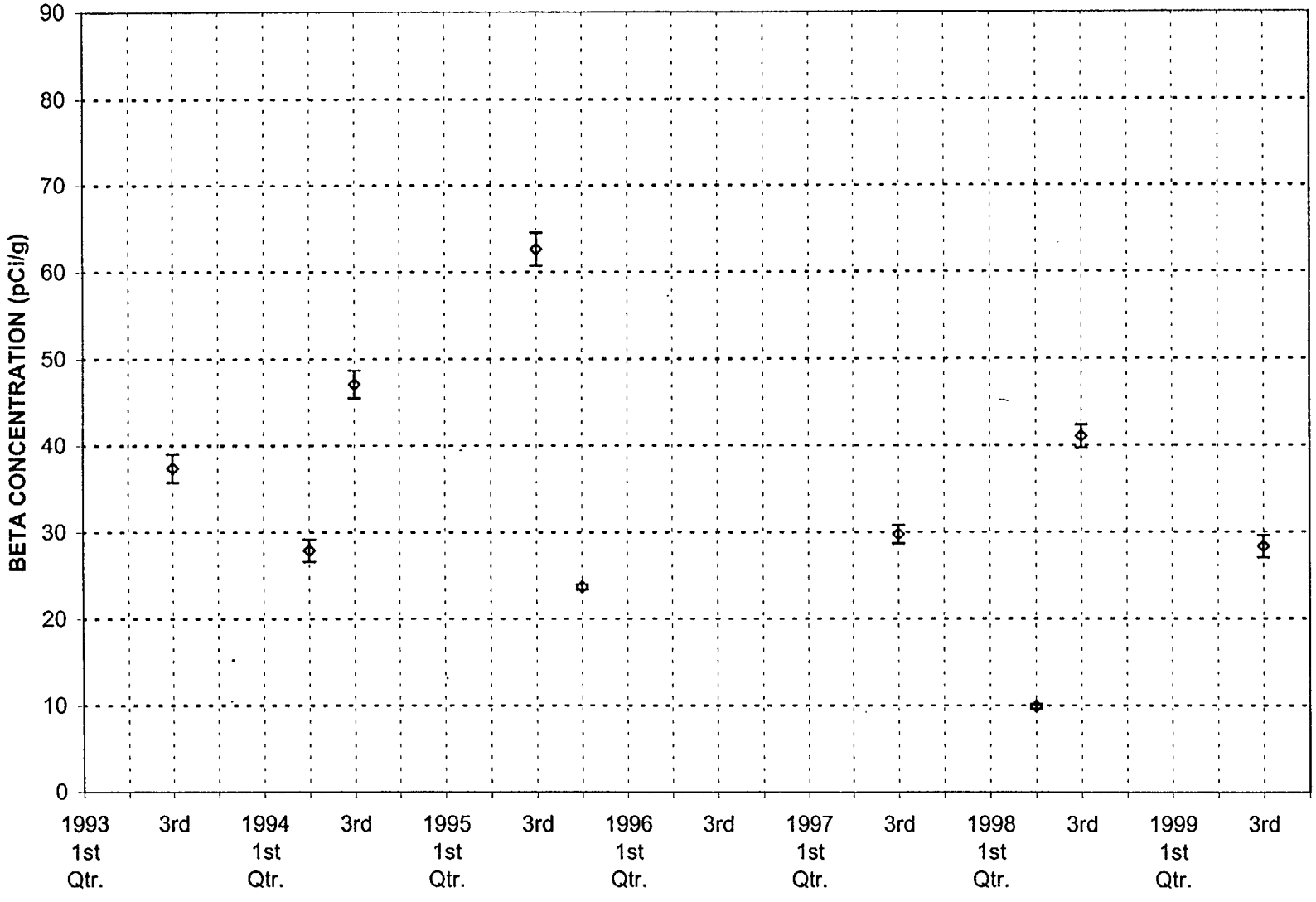
Vegetation beta Action Level = 100 pCi/g (dry)

FIGURE 7.3
GROSS BETA IN VEGETATION
STATION 3 - RICHLAND, WASHINGTON



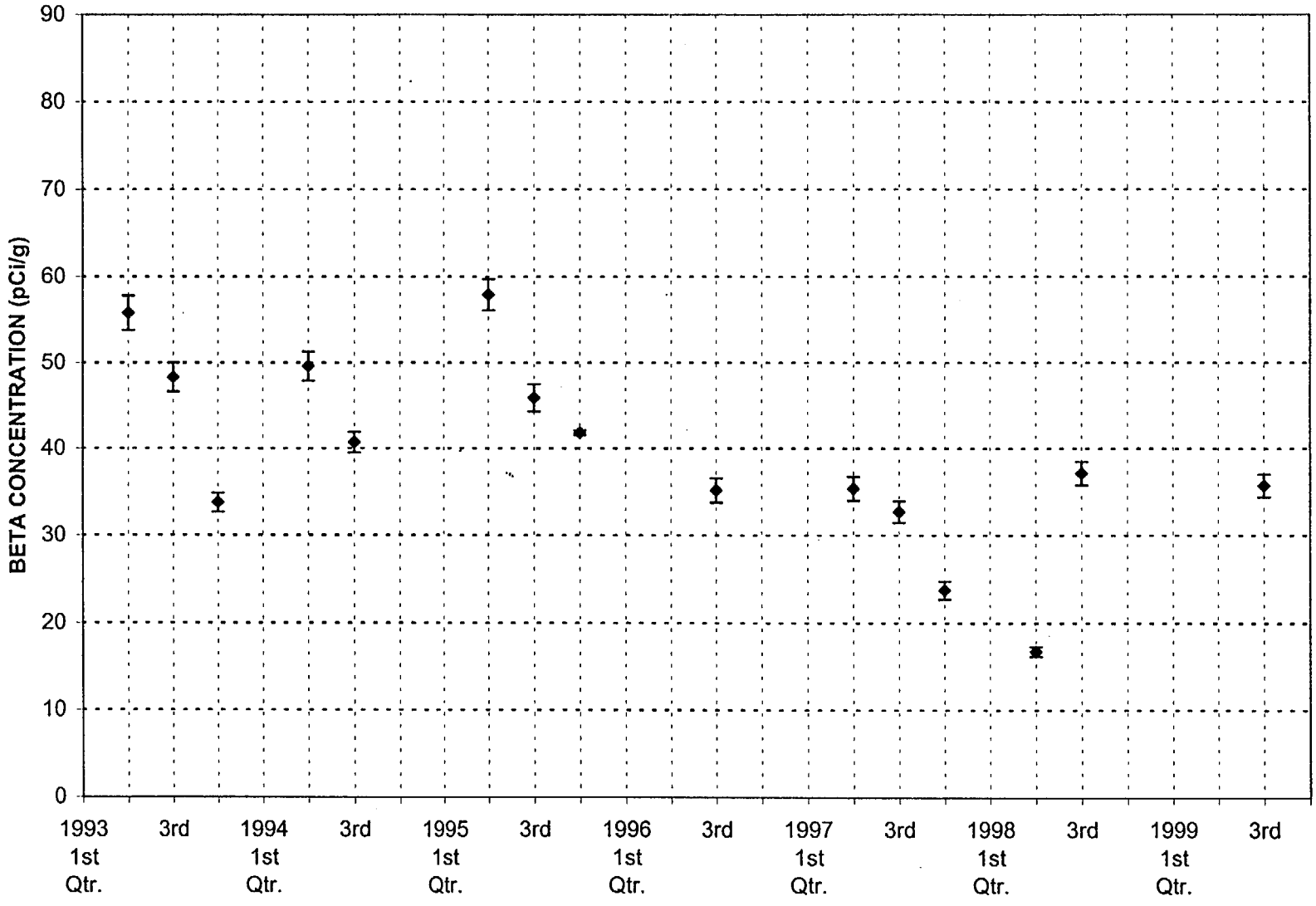
Vegetation Beta Action level =100 pCi/g (dry)

FIGURE 5.81
GROSS BETA IN VEGETATION
STATION 4 - RICHLAND, WASHINGTON



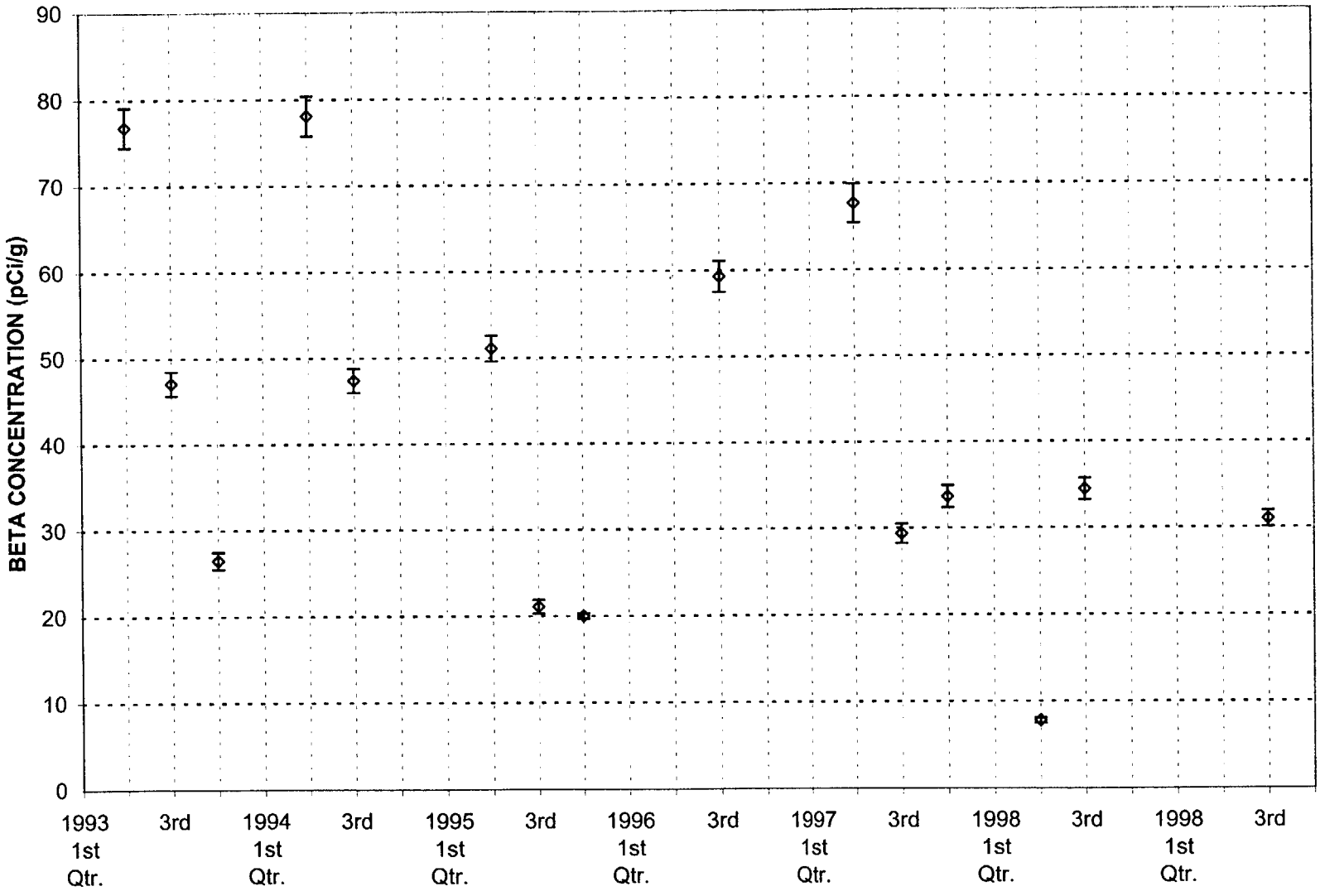
Vegetation Beta Action Level = 100pCi/g (dry)

FIGURE 7.5
GROSS BETA IN VEGETATION
STATION 5 - RICHLAND, WASHINGTON



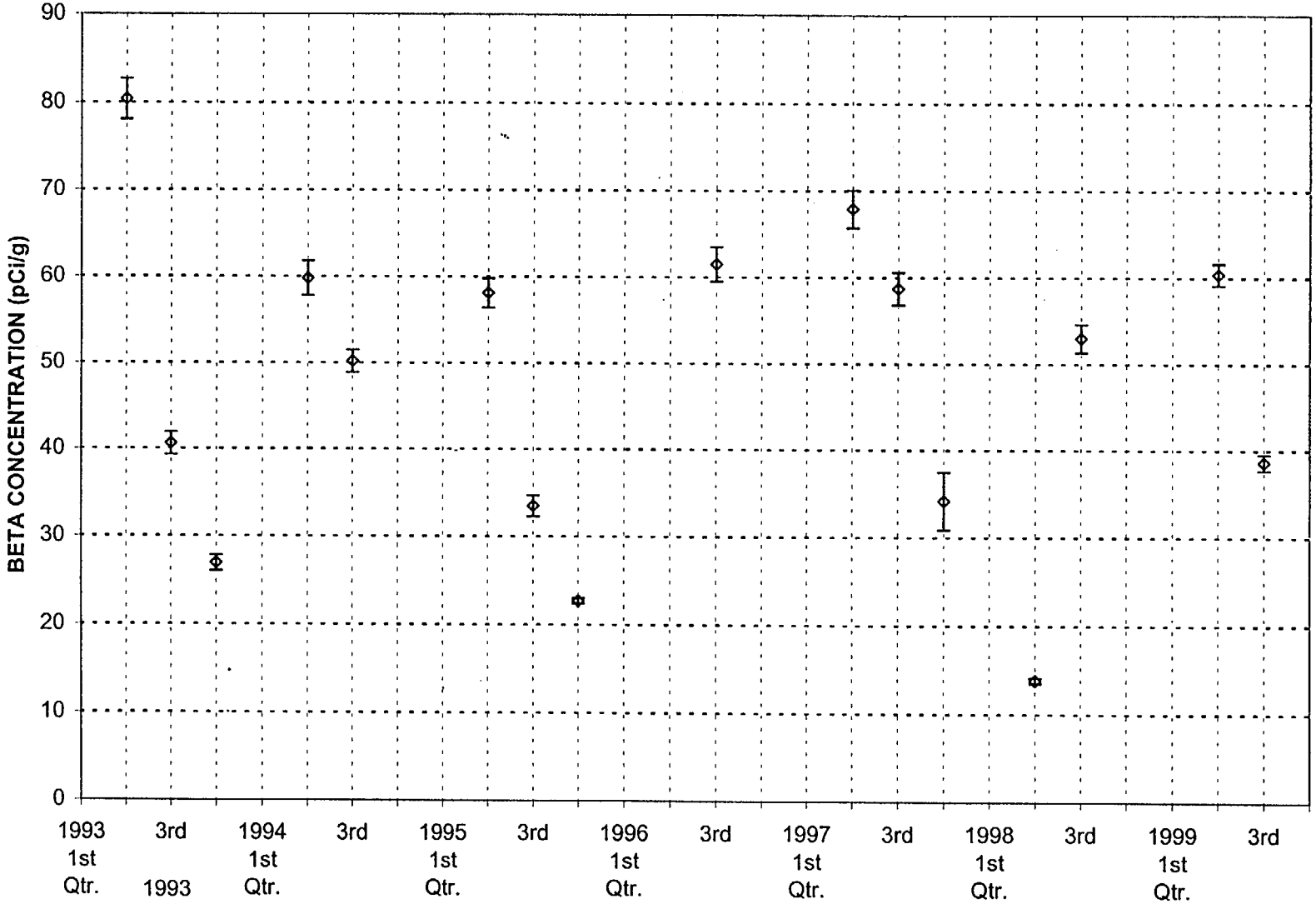
Vegetation Beta Action Level = 100 p Ci/g (dry)

FIGURE 7.6
GROSS BETA IN VEGETATION
STATION 6 - RICHLAND, WASHINGTON



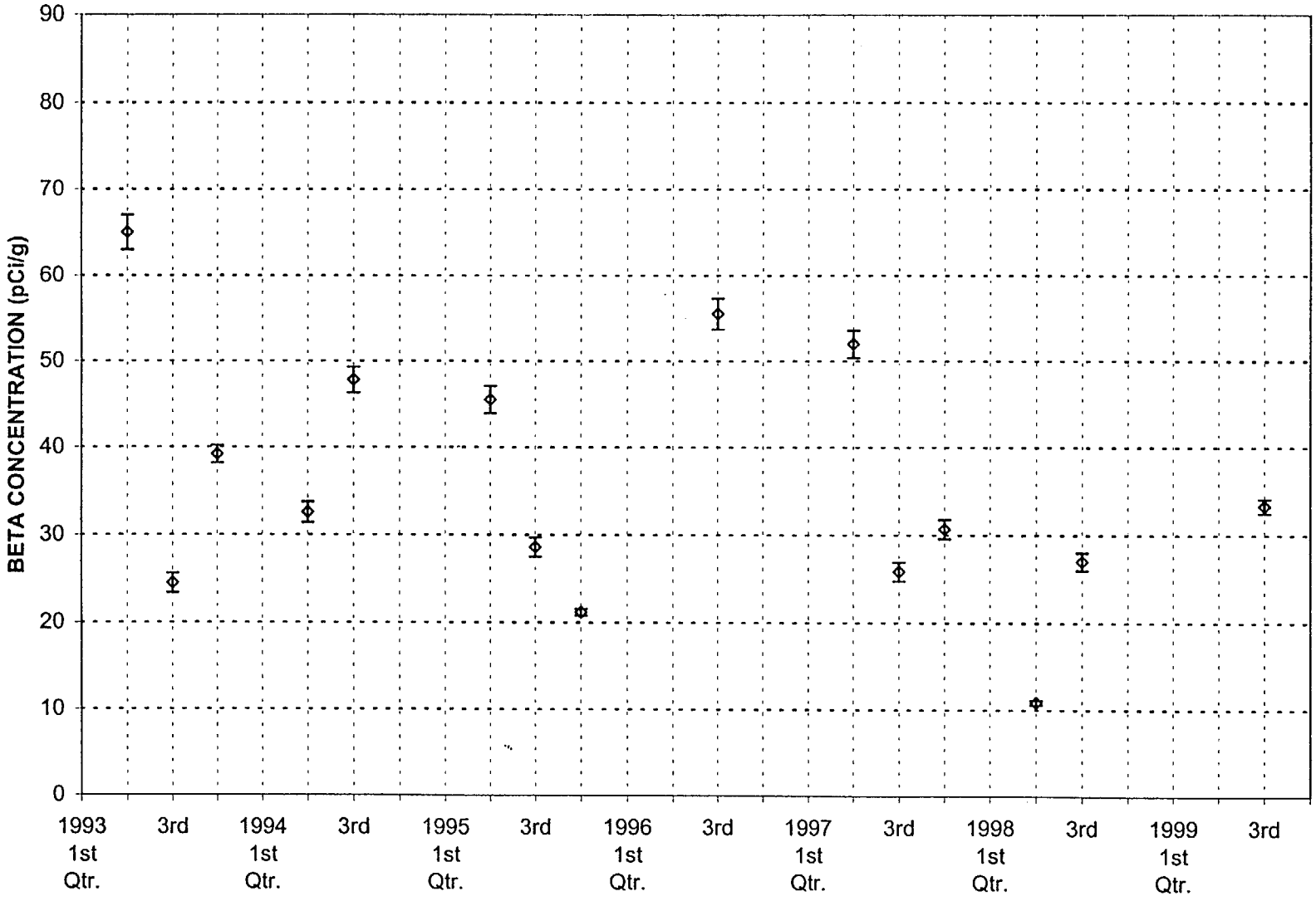
Vegetati- beta Action Level = 100 pCi/g

FIGURE 7.7
GROSS BETA IN VEGETATION
STATION 7 - RICHLAND, WASHINGTON



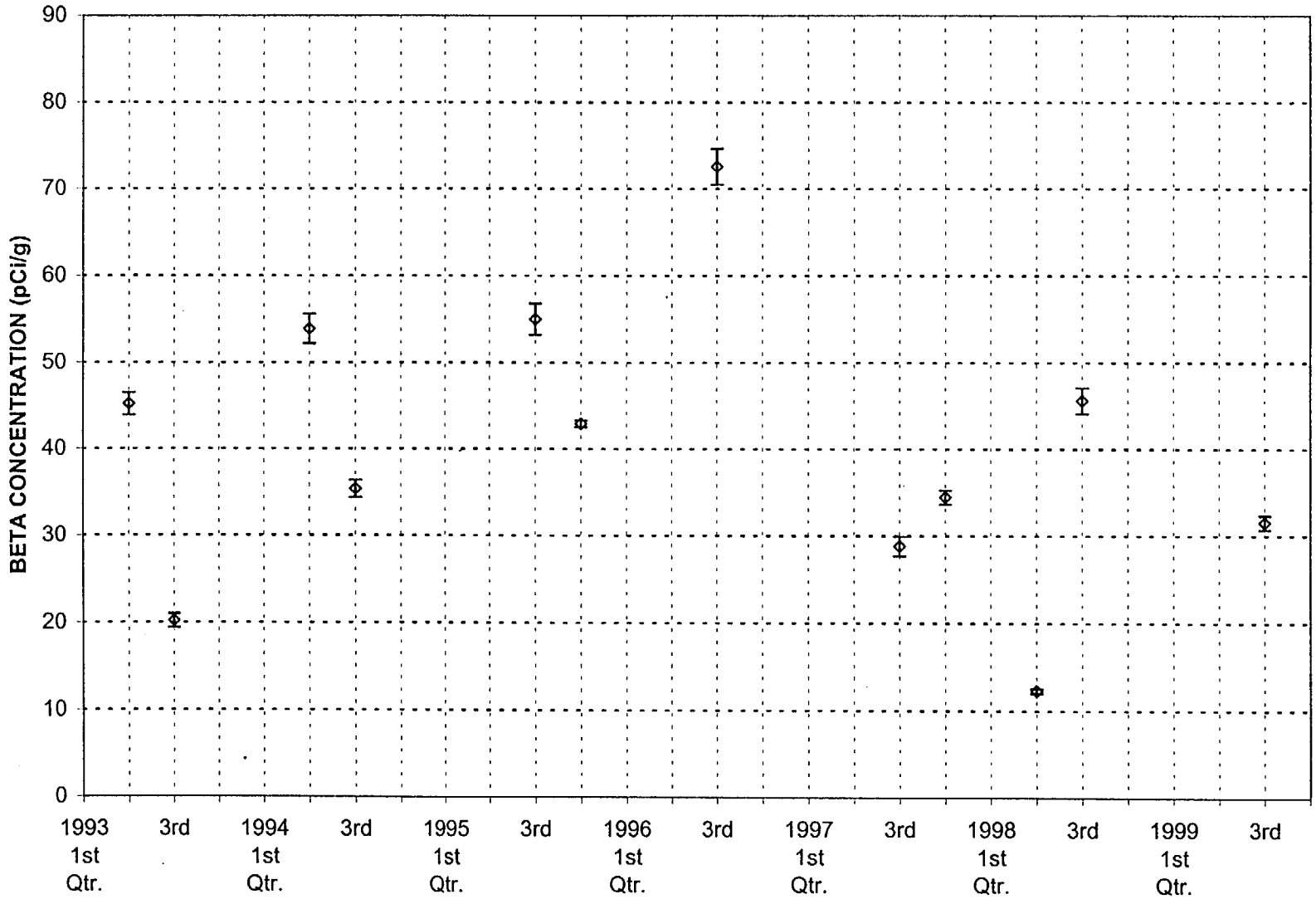
Vegetation Beta Action level = 100 PCi/g (dry)

FIGURE 7.8
GROSS BETA IN VEGETATION
STATION 8 - RICHLAND, WASHINGTON



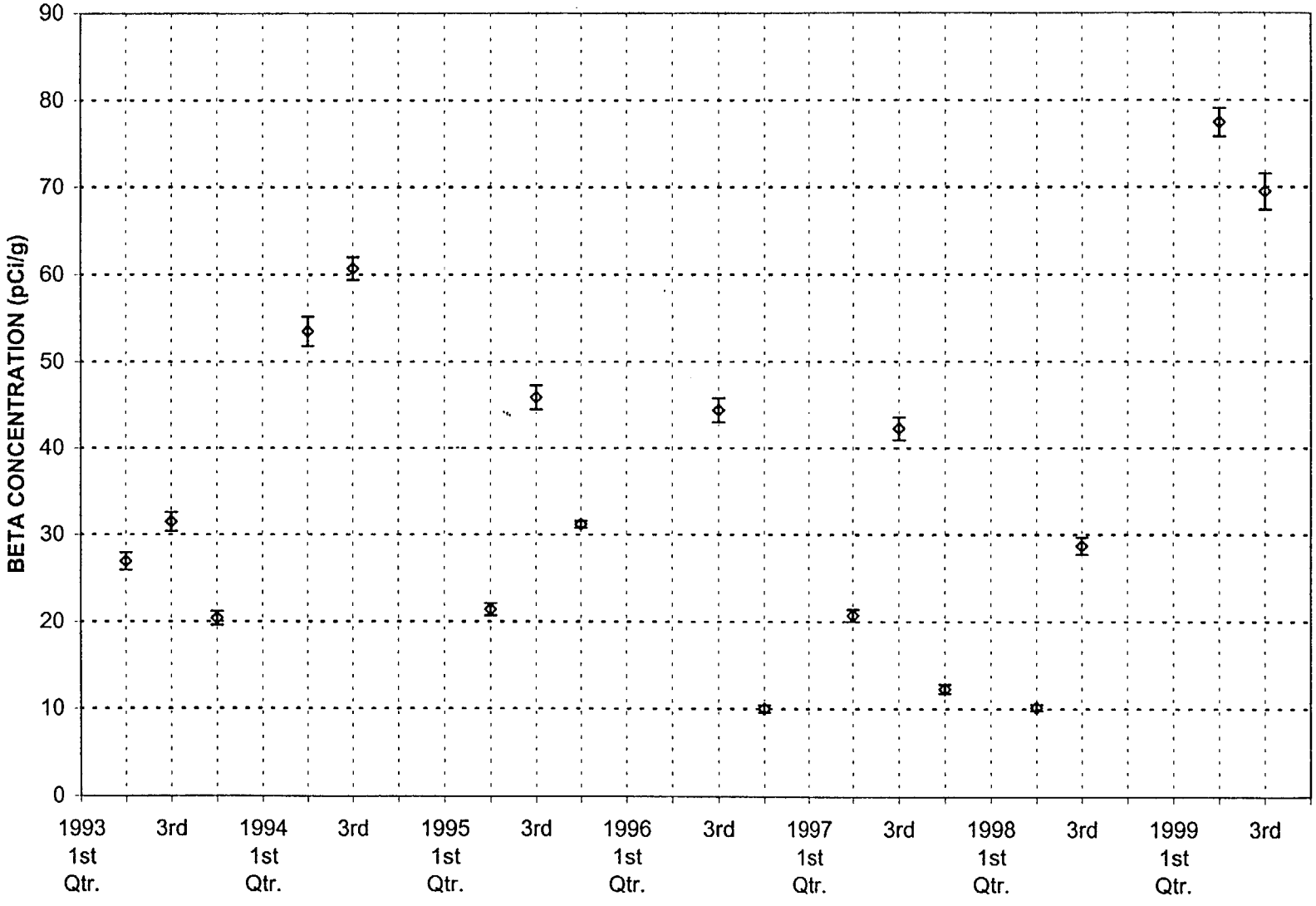
Vegetation Beta Action Level = 100 pCi/g (dry)

FIGURE 7.9
GROSS BETA IN VEGETATION
STATION 9 - RICHLAND, WASHINGTON



Vegetation Beta Action level = 100 pCi/g (dry)

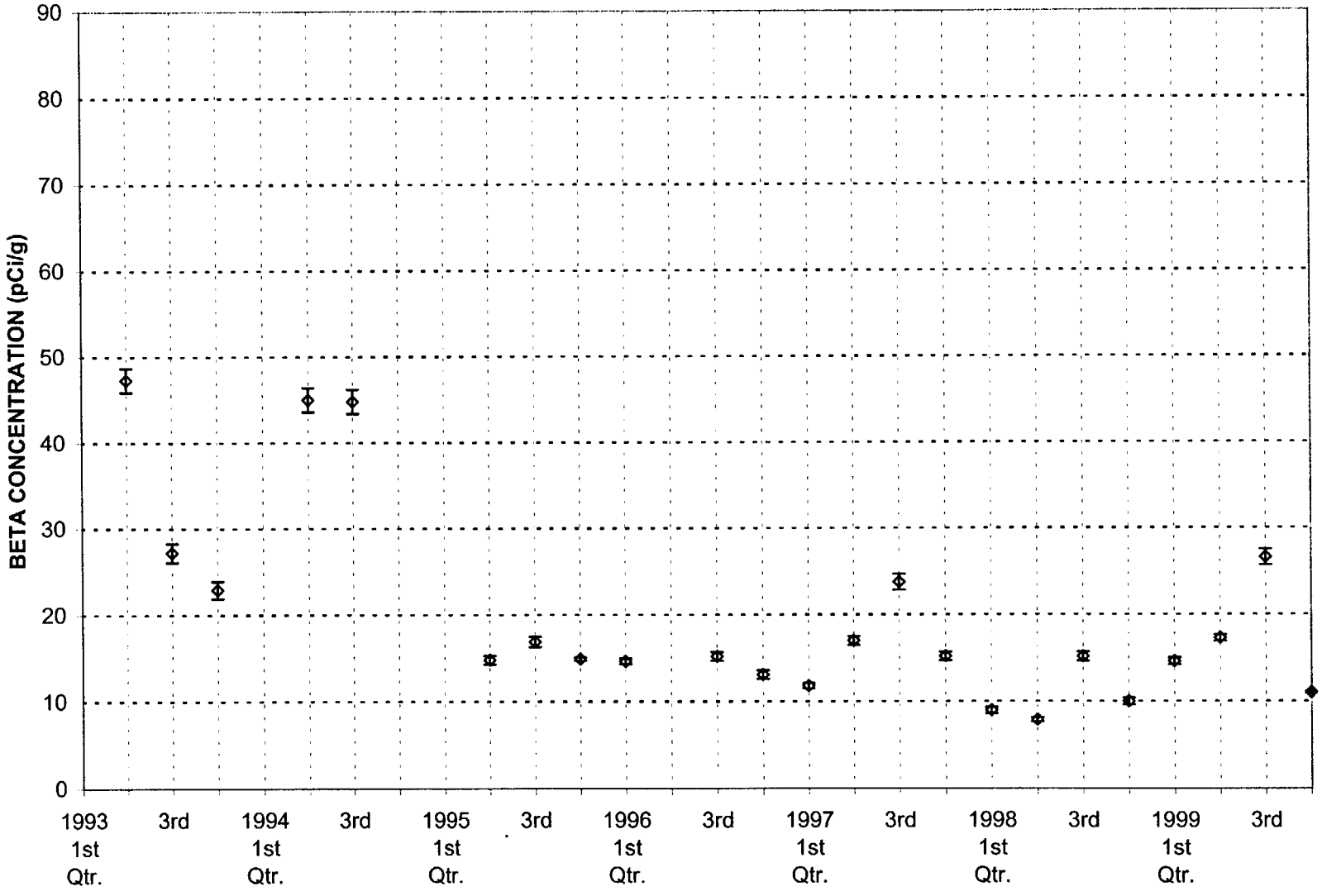
FIGURE 7.10
GROSS BETA IN VEGETATION
NORTHEAST STATION - RICHLAND, WASHINGTON



19

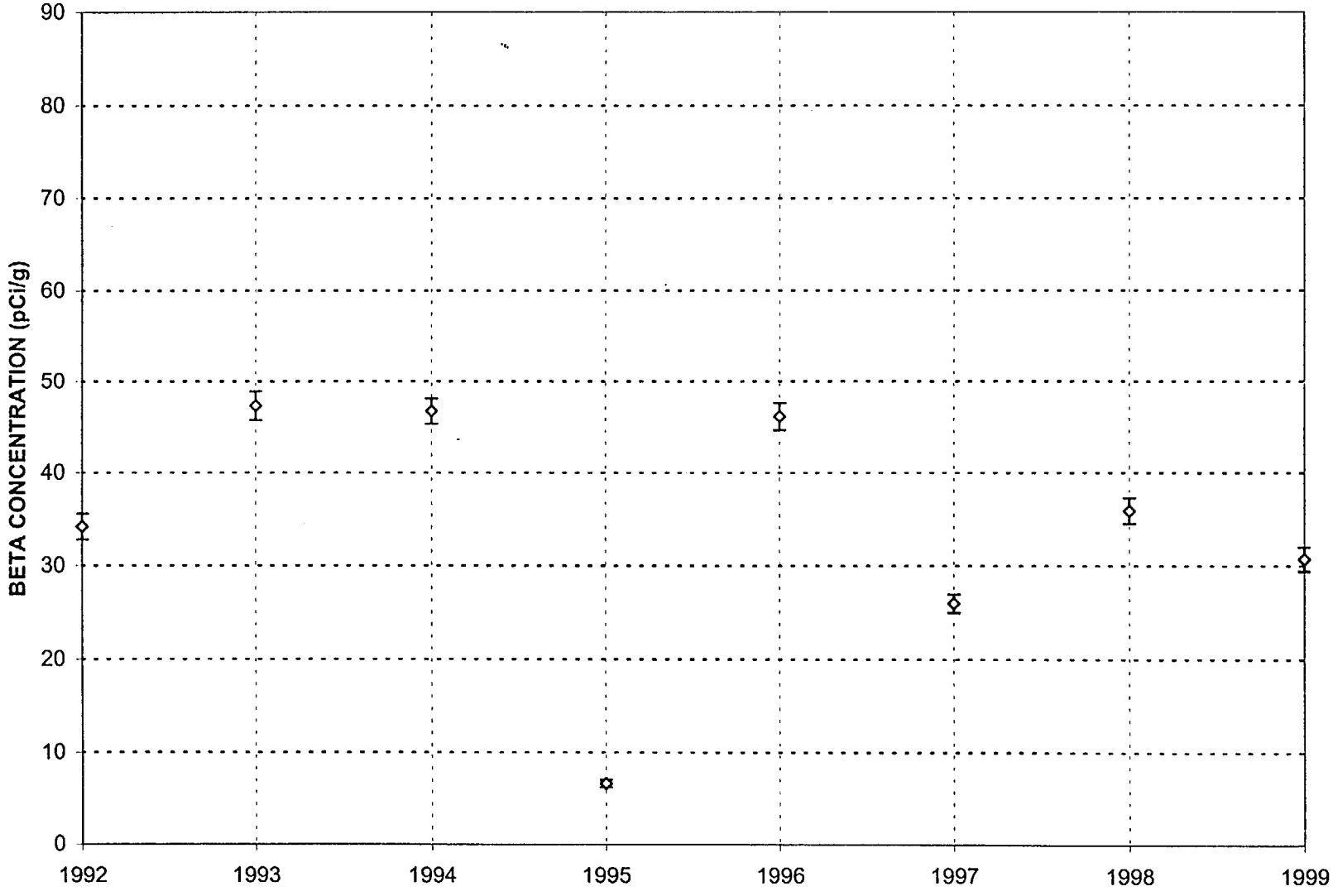
Vegetation Beta Action Level = 100 pCi/g (dry)

FIGURE 7.11
GROSS BETA IN VEGETATION
NORTHWEST STATION - RICHLAND, WASHINGTON



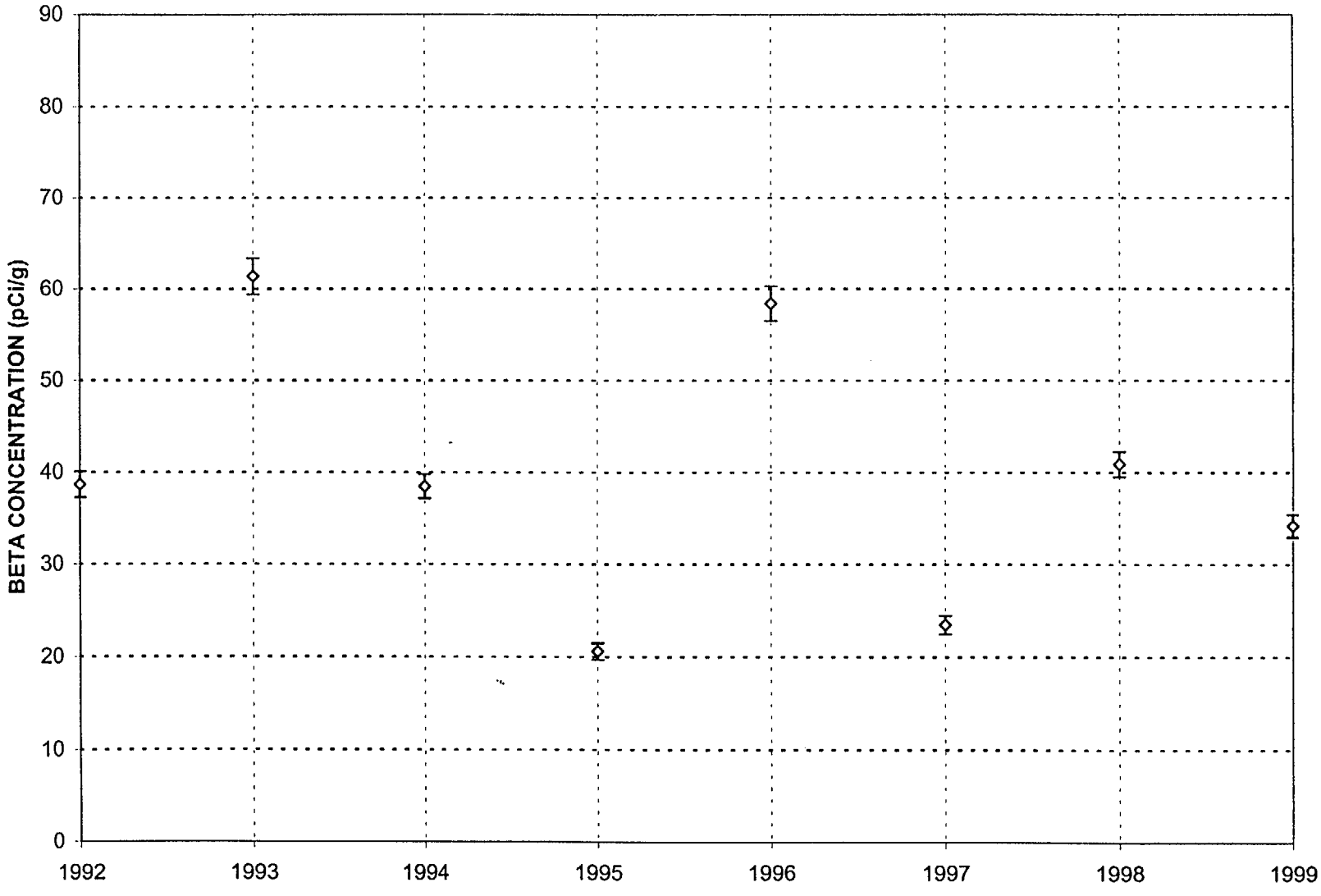
Vegetation Beta Action level = 100 pCi/g

FIGURE 7.12
ANNUAL GROSS BETA TRENCH CAP VEGETATION
TRENCH 1 - RICHLAND, WASHINGTON



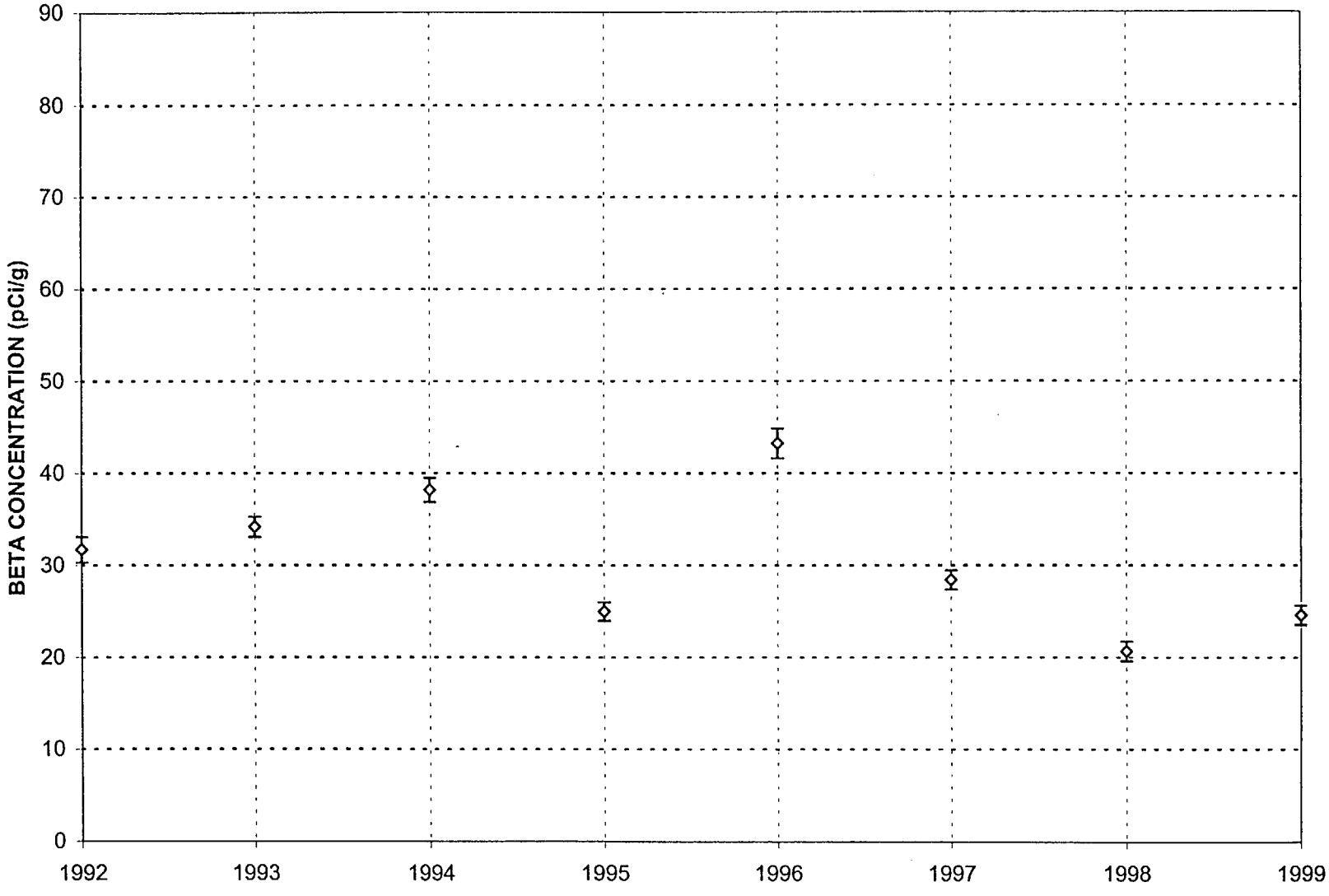
Vegetation Beta Action Level = 100 pCi/g (dry)

FIGURE 7.13
ANNUAL GROSS BETA TRENCH CAP VEGETATION
TRENCH 2 - RICHLAND, WASHINGTON



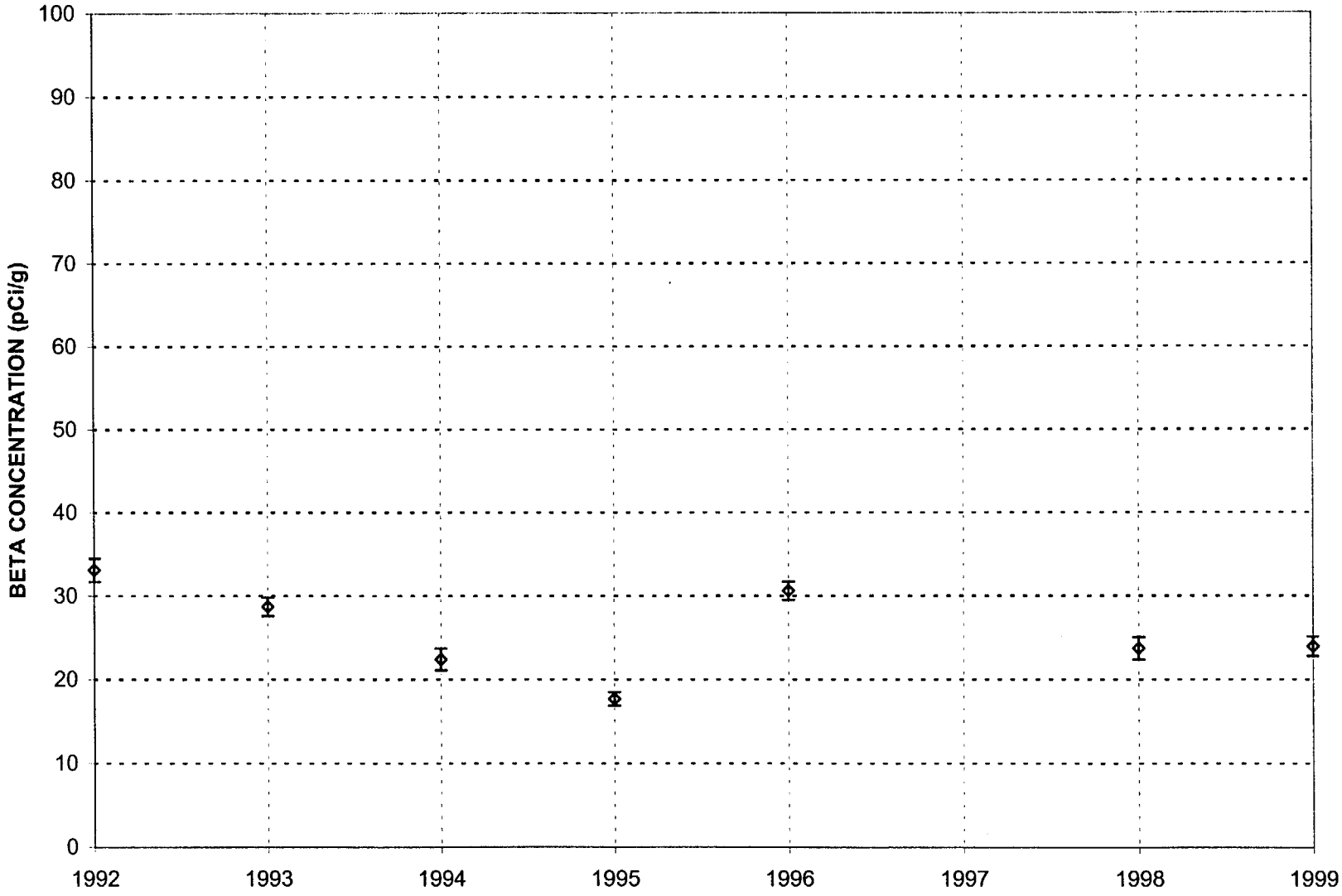
Vegetation Beta Action Level = 100 pCi/g

FIGURE 7.14
ANNUAL GROSS BETA TRENCH CAP VEGETATION
TRENCH 3 - RICHLAND, WASHINGTON



Vegetation Beta Action Level = 100 pCi/g (dry)

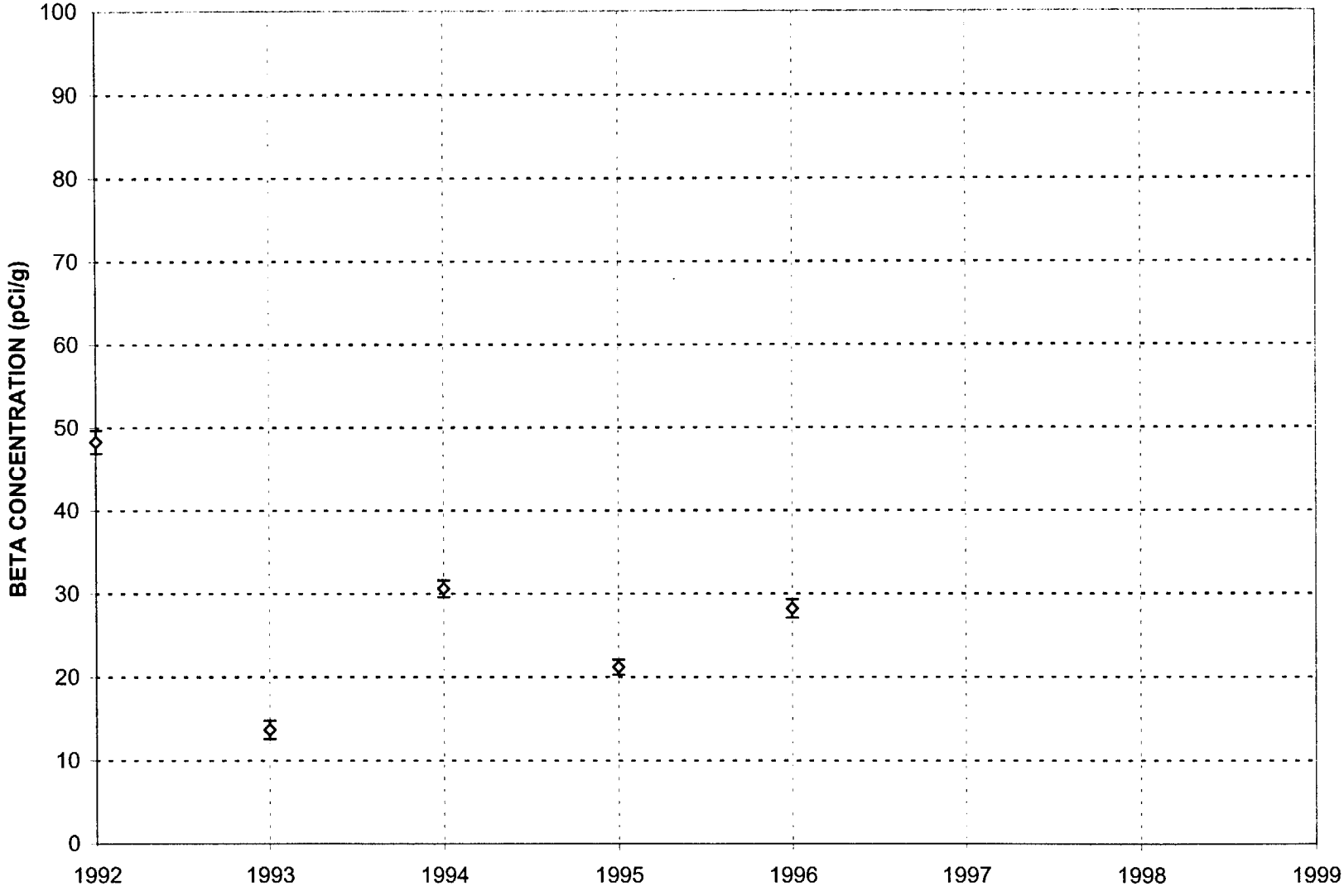
FIGURE 7.15
ANNUAL GROSS BETA TRENCH CAP VEGETATION
TRENCH 4 - RICHLAND, WASHINGTON



Vegetation Beta Action Level = 100 pCi/g (dry)

No vegetation avaialble in 1997

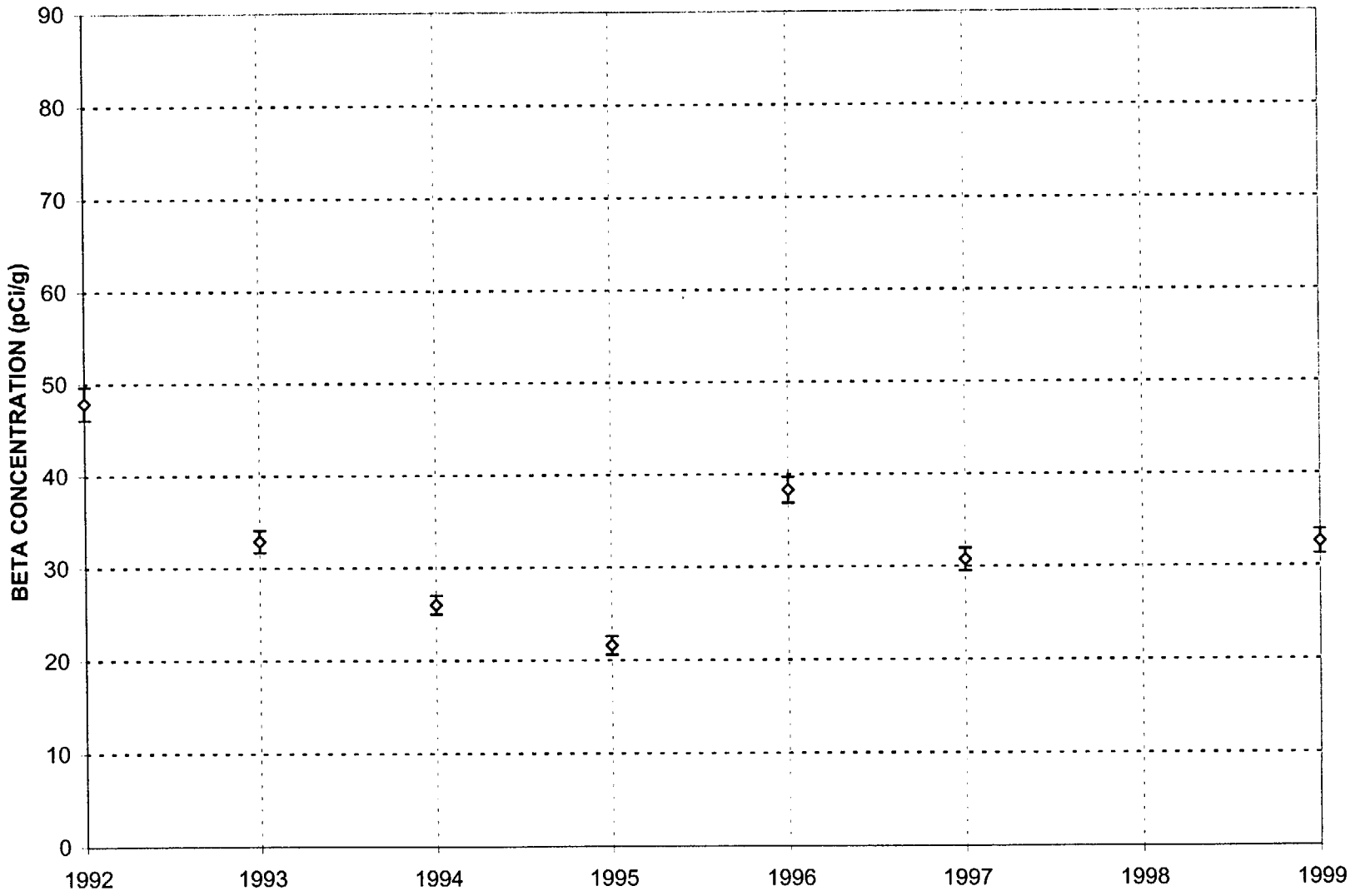
FIGURE 7.16
ANNUAL GROSS BETA TRENCH CAP VEGETATION
TRENCH 4A - RICHLAND, WASHINGTON



Vegetation Beta Action Level = 100 pCi/g (dry)

No vegetation available in 1997, 1998,and 1999

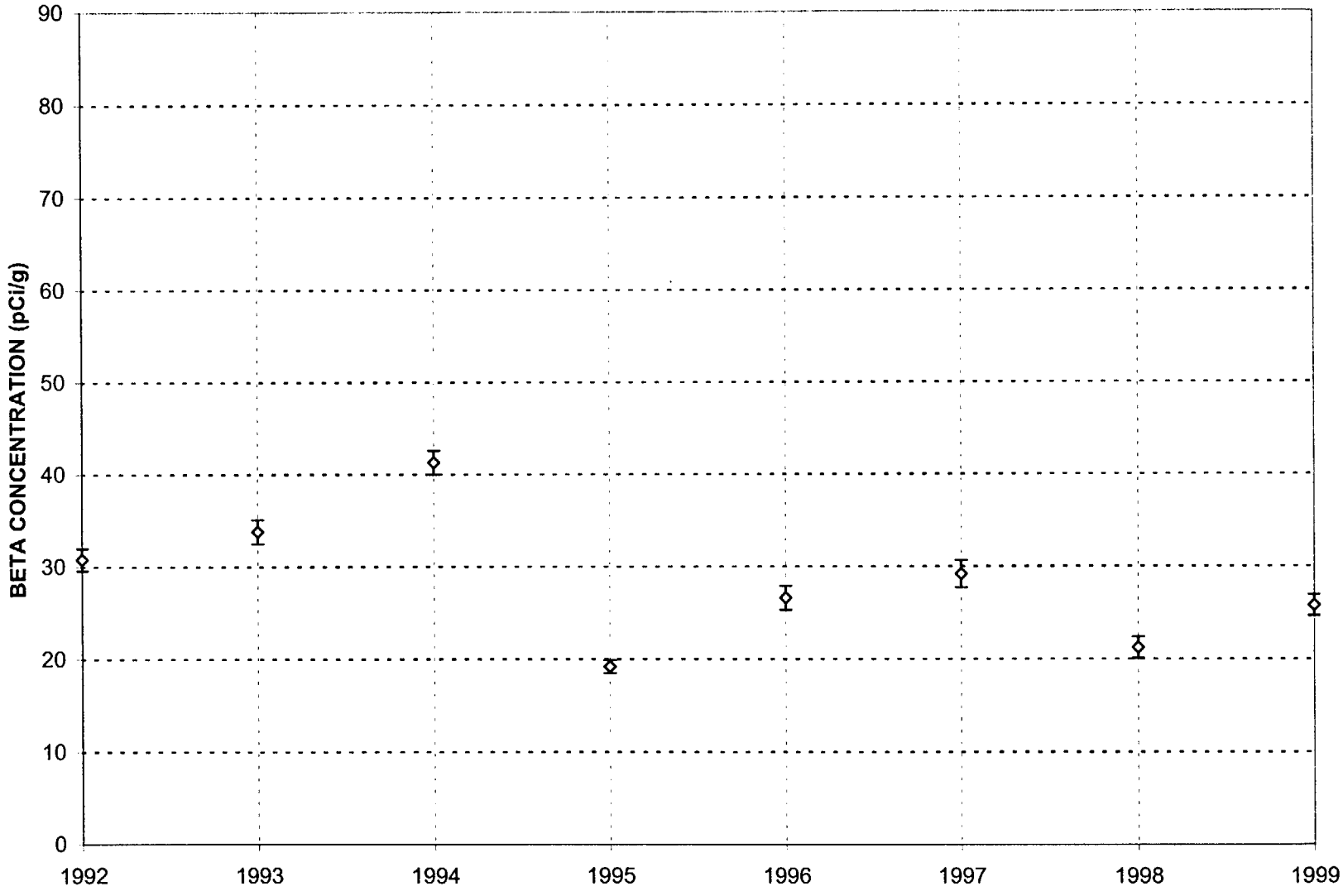
FIGURE 7.17
ANNUAL GROSS BETA TRENCH CAP VEGETATION
TRENCH 4B - RICHLAND, WASHINGTON



Vegetation Beta Action Level = 100 pCi/g (dry)

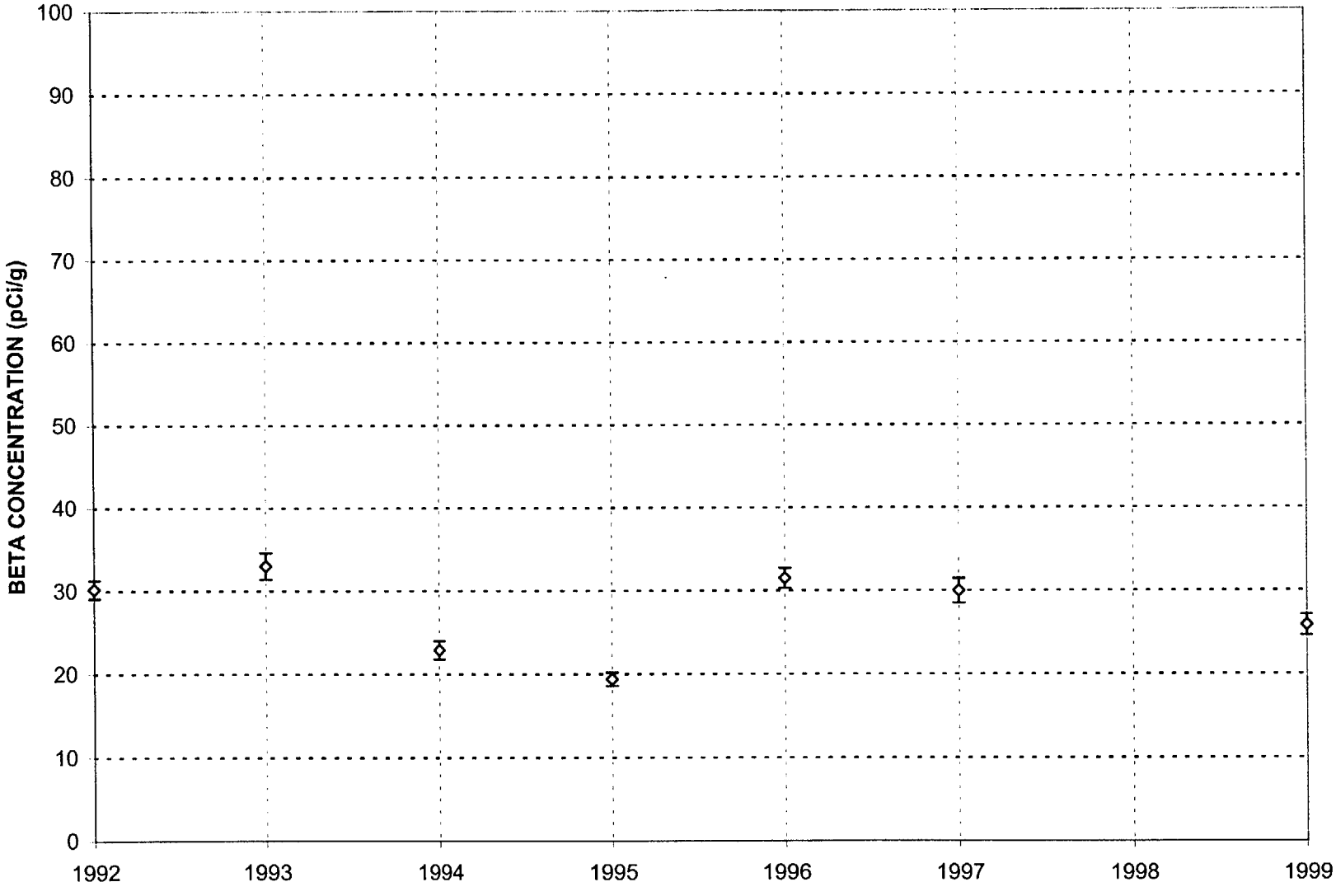
No trench cap vegetation available in 1998

FIGURE 7.18
ANNUAL GROSS BETA TRENCH CAP VEGETATION
TRENCH 5 - RICHLAND, WASHINGTON



Vegetation Beta Action Level = 100 pCi/g (dry)

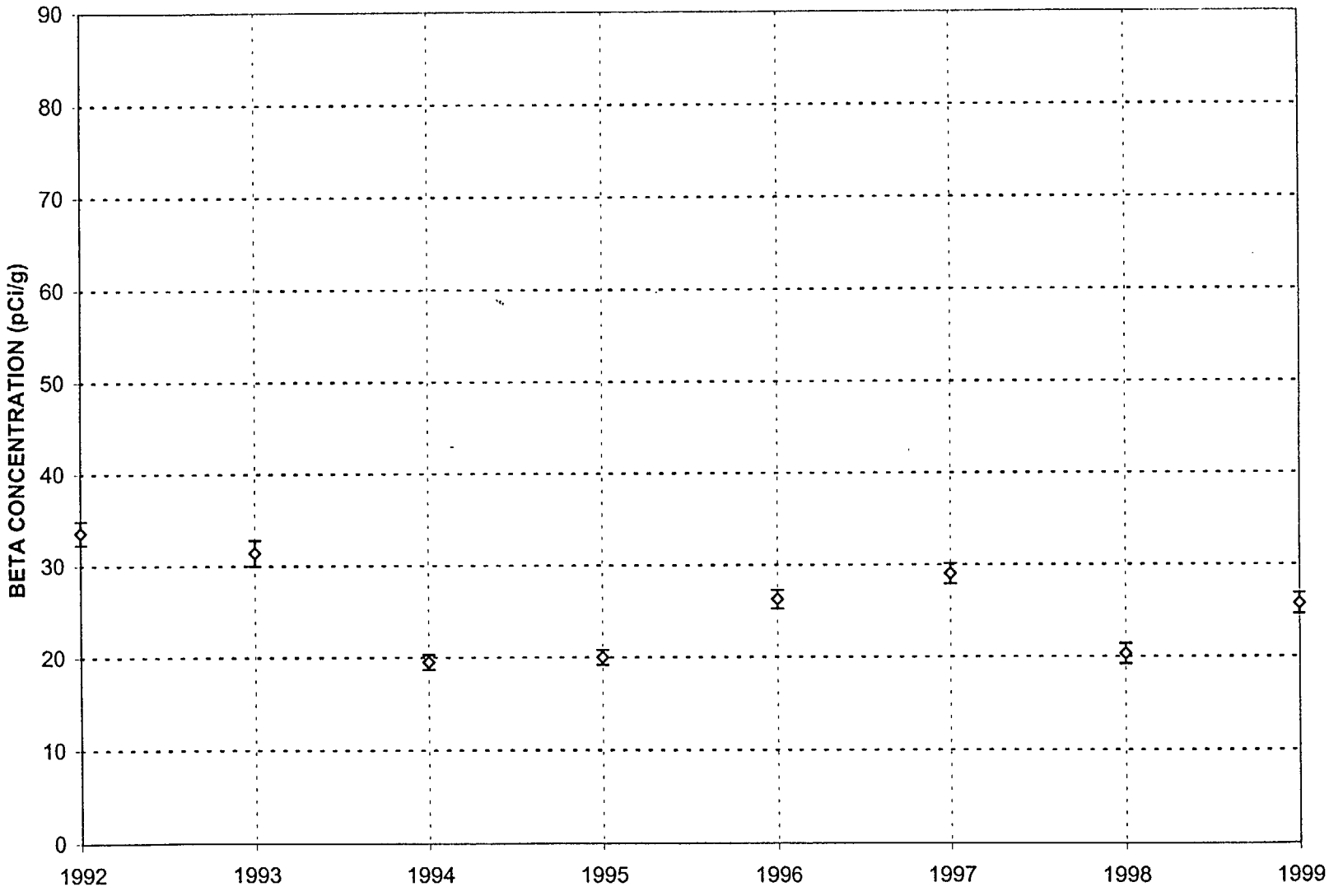
FIGURE 7.19
ANNUAL GROSS BETA TRENCH CAP VEGETATION
TRENCH 6 - RICHLAND, WASHINGTON



Vegetation Beta Action Level = 100 pCi/g (dry)

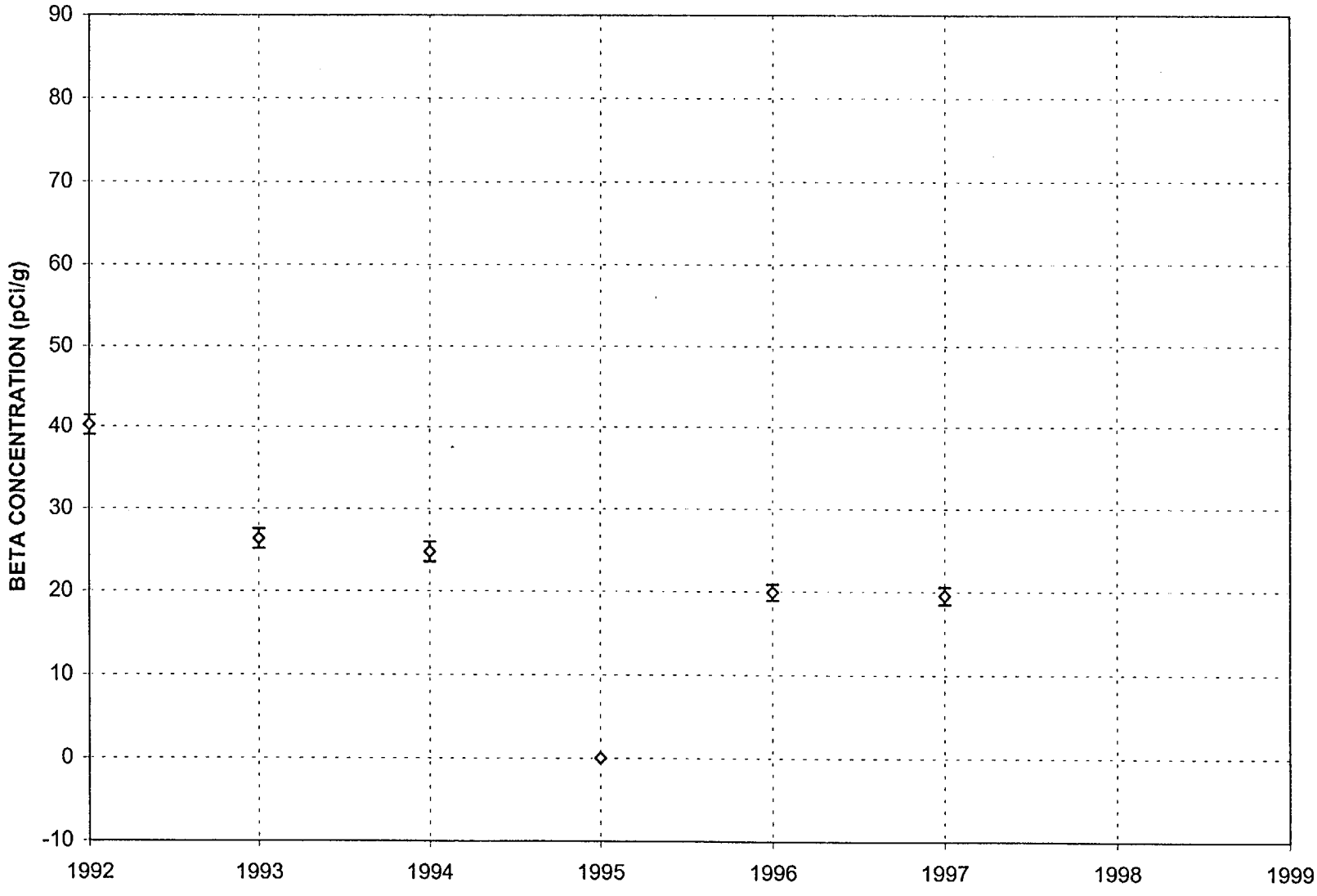
No trench cap vegetation available in 1998

FIGURE 7.20
ANNUAL GROSS BETA TRENCH CAP VEGETATION
TRENCH 7 - RICHLAND, WASHINGTON



Vegetation Beta Action Level = 100 pCi/g

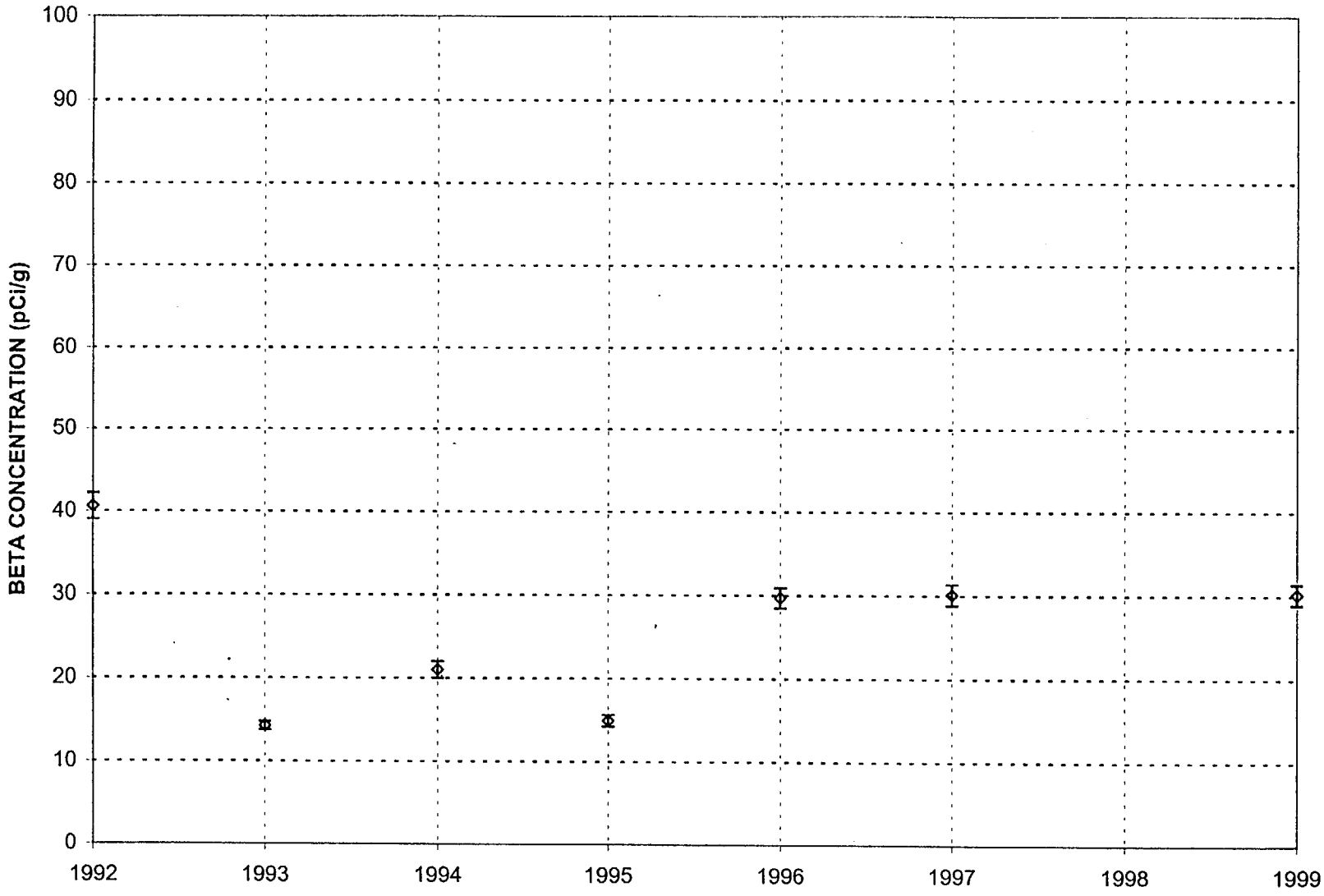
FIGURE 7.21
ANNUAL GROSS BETA TRENCH CAP VEGETATION
TRENCH 7A - RICHLAND, WASHINGTON



Vegetation Beta Action Level = 100 pCi/g (dry)

* No vegetation available in 1995, 1998 and 1999.

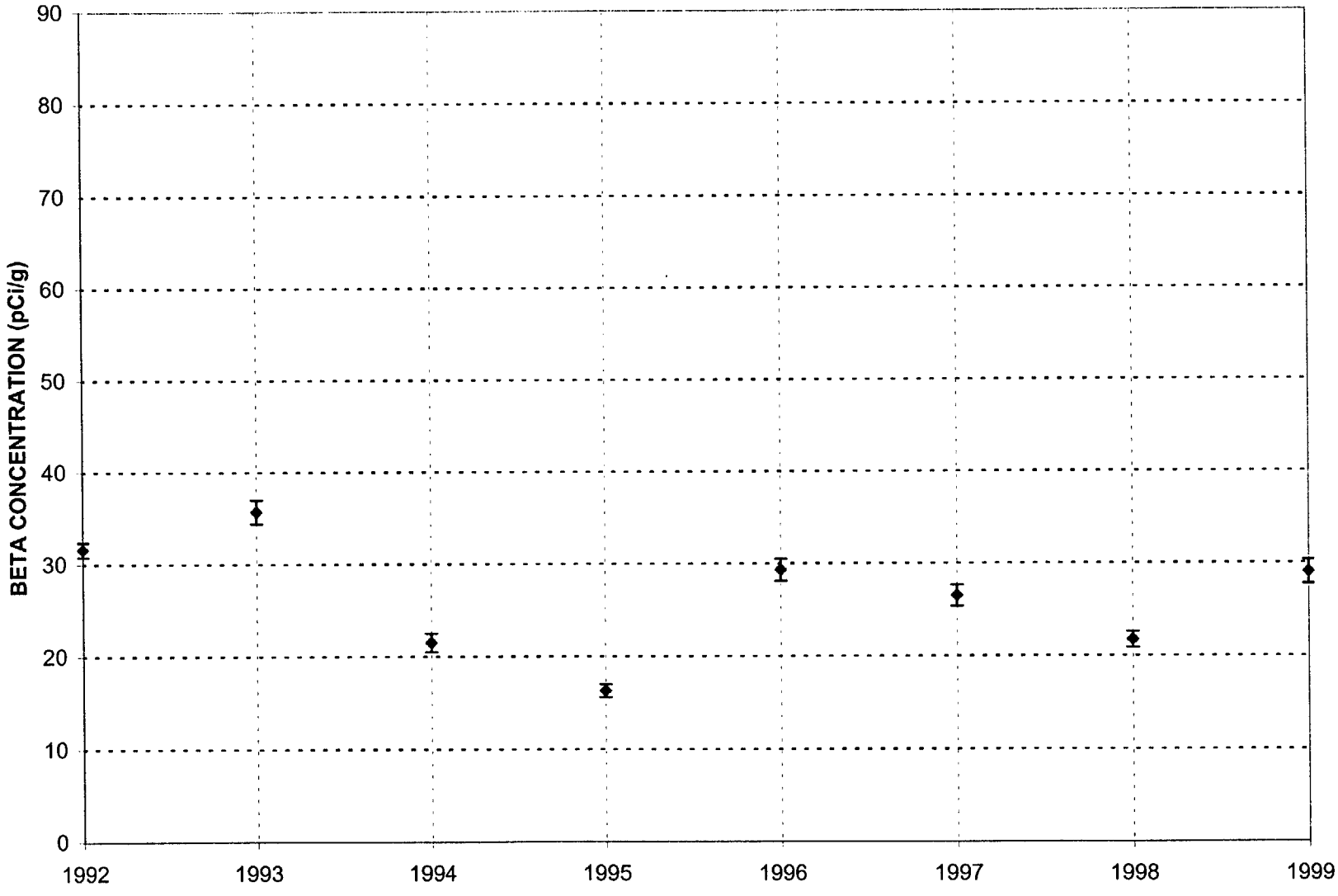
FIGURE 7.22
ANNUAL GROSS BETA TRENCH CAP VEGETATION
TRENCH 8 - RICHLAND, WASHINGTON



Vegetation Beta Action Level = 100 pCi/g (dry)

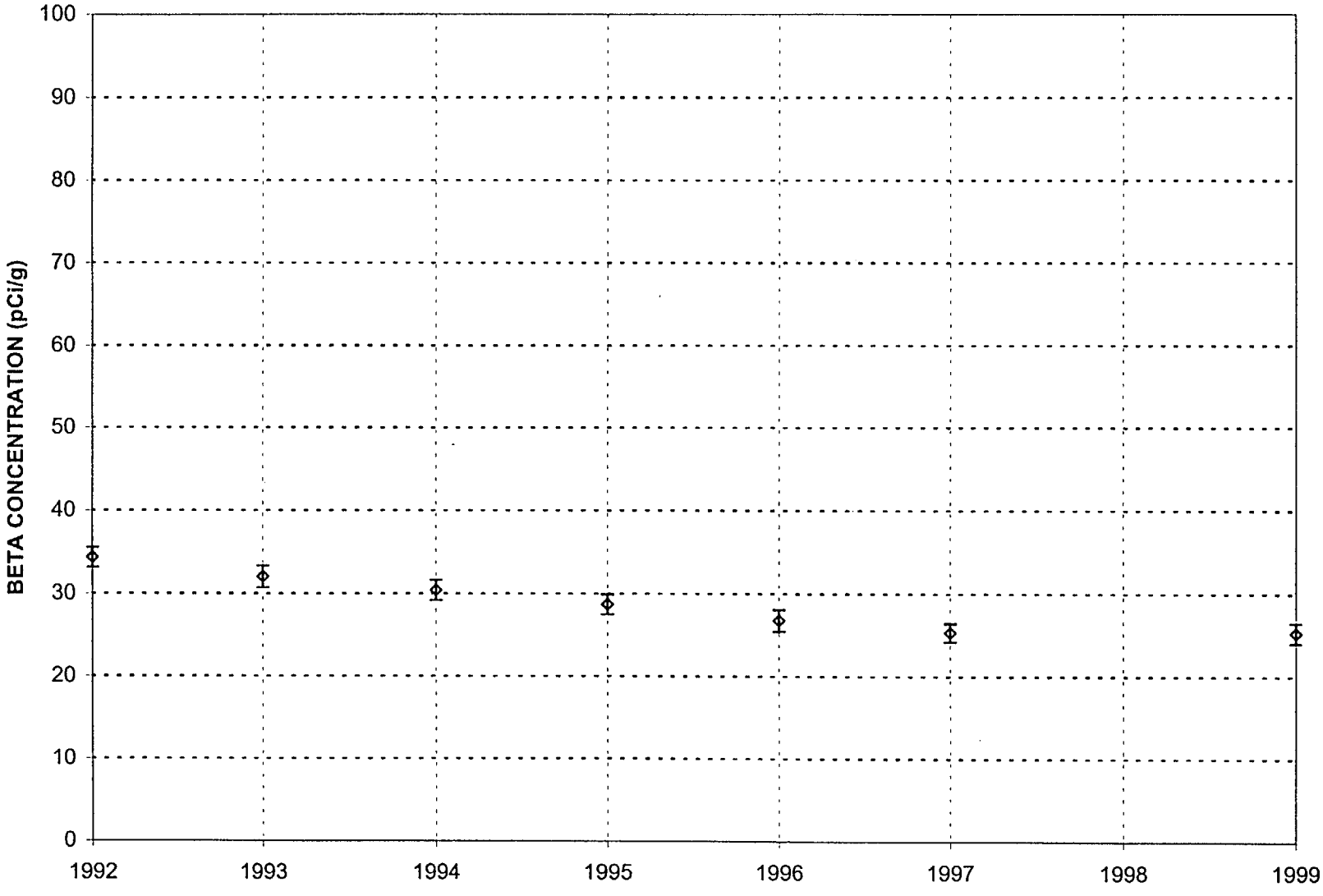
No vegetation available in 1998.

FIGURE 7.23
ANNUAL GROSS BETA TRENCH CAP VEGETATION
TRENCH 9 - RICHLAND, WASHINGTON



Vegetation Beta Action Level = 100 pCi/g (dry)

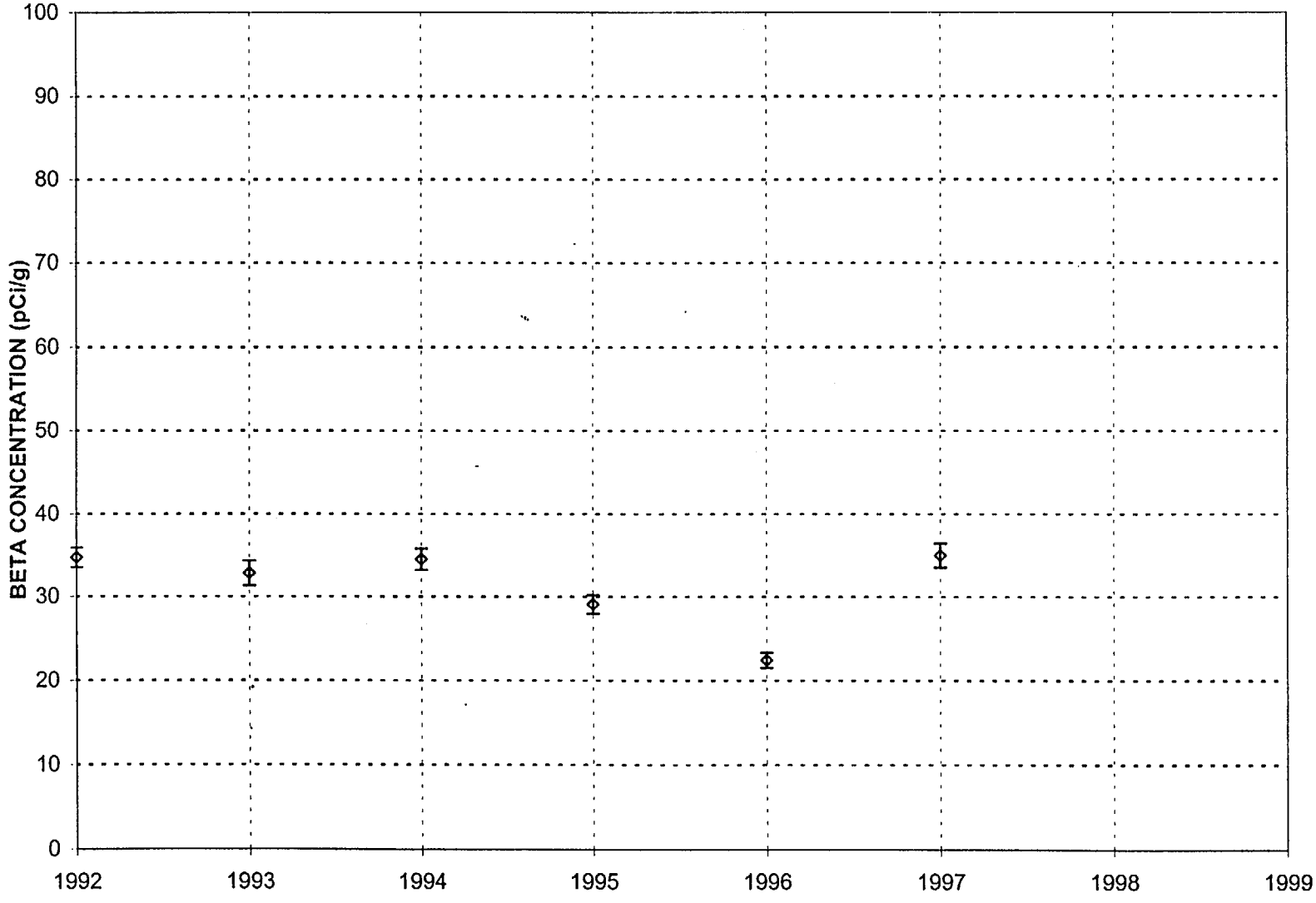
FIGURE 7.24
ANNUAL GROSS BETA TRENCH CAP VEGETATION
TRENCH 10 - RICHLAND, WASHINGTON



Vegetation Beta Action Level = 100 pCi/g (dry)

No vegetation available in 1998.

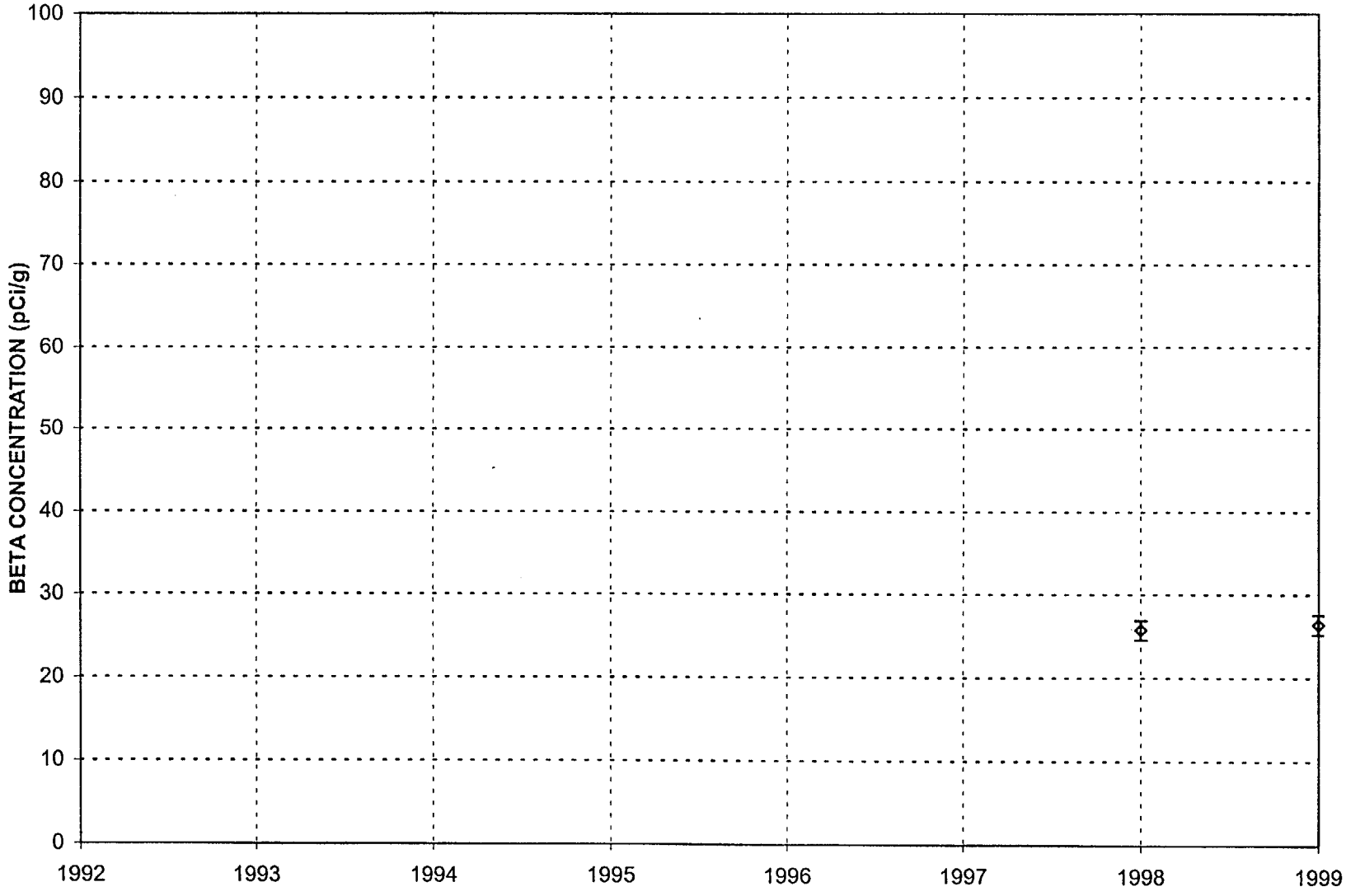
FIGURE 7.25
ANNUAL GROSS BETA TRENCH CAP VEGETATION
TRENCH 11A - RICHLAND, WASHINGTON



Vegetation Beta Action Level = 100 pCi/g (dry)

No vegetation available in 1998 and 1999.

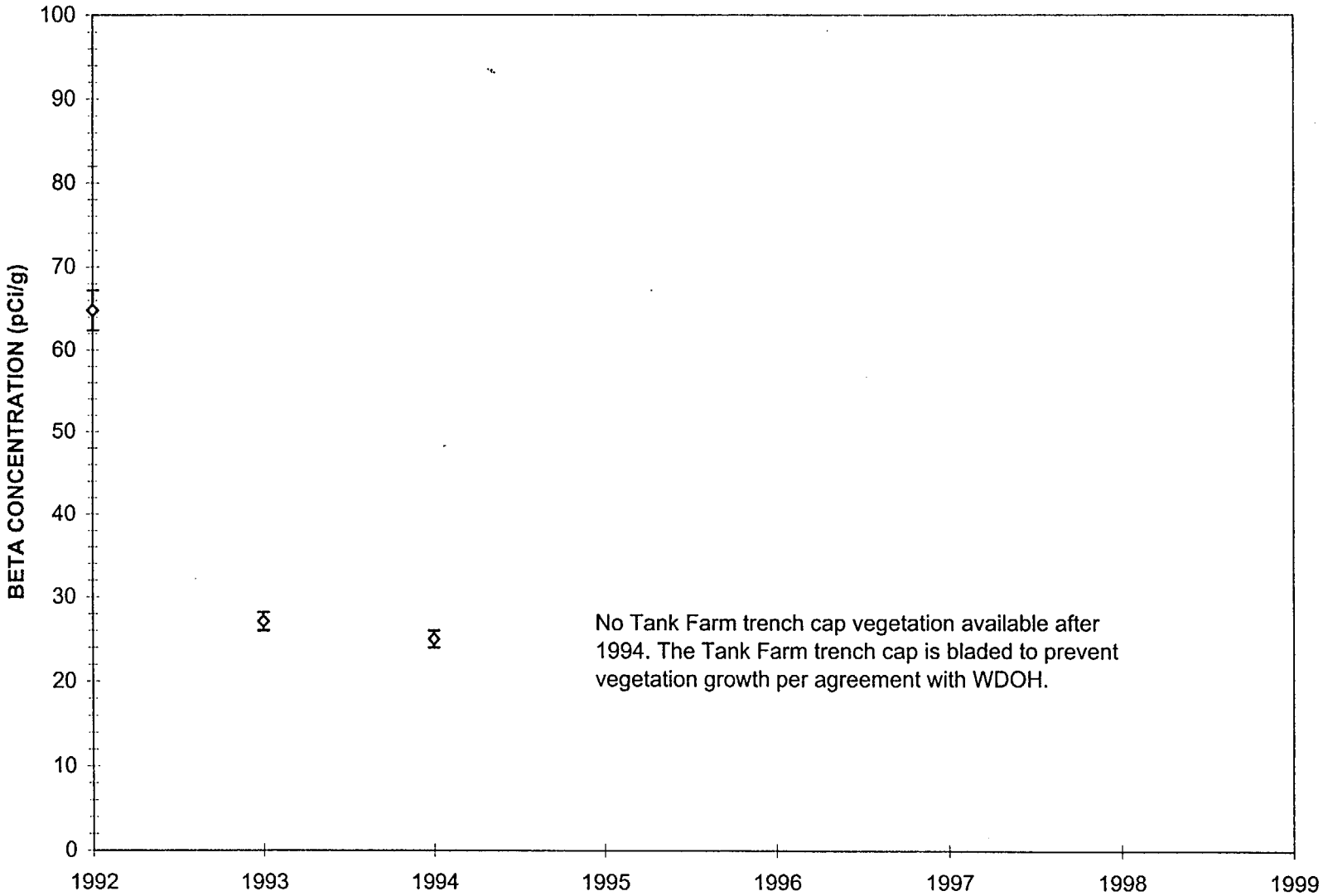
Figure 7.26
ANNUAL GROSS BETA TRENCH CAP VEGETATION
TRENCH 13 - RICHLAND WASHINGTON



Vegetation Action Level = 100 pCi/g

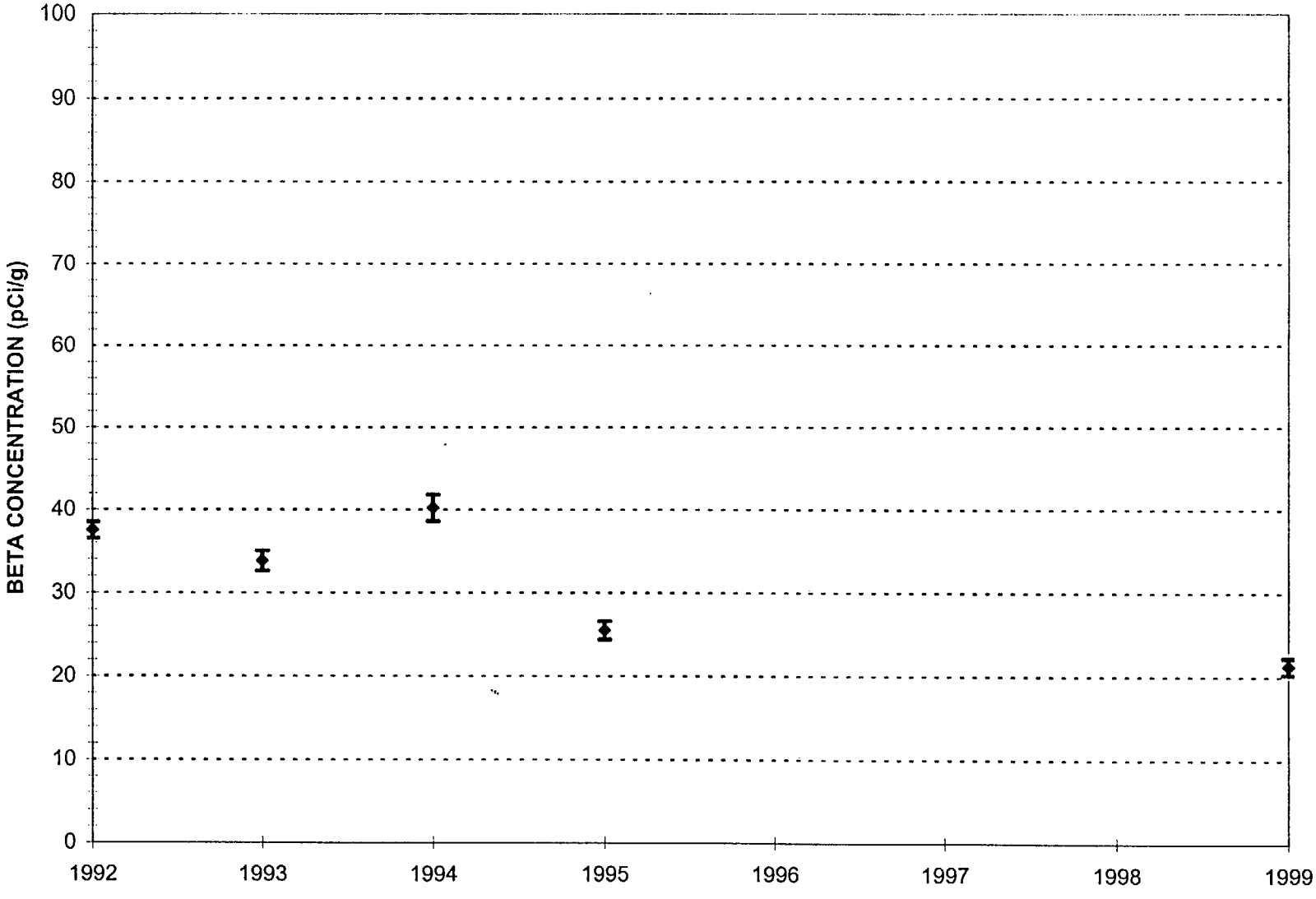
1998 is first year with acceptable Trench 13 vegetation sample.

FIGURE 7.27
ANNUAL GROSS BETA TRENCH CAP VEGETATION
TANK FARM - RICHLAND, WASHINGTON



Vegetation Beta Action Level = 100 pCi/g (dry)

FIGURE 7.28
ANNUAL GROSS BETA TRENCH CAP VEGETATION
REACTOR HEAD - RICHLAND, WASHINGTON



Vegetation Beta Action Level = 100 pCi/g (dry)

*No Vegetation avaialble in 1996, 1997,1998.

8.0 Penetrating Radiation Monitoring

Penetrating radiation is measured at several site perimeter locations using thermoluminescent dosimetry (TLD). These locations define the site boundary where an individual not associated with LLRW site operation could be exposed to external radiation from the site. Since the US Ecology Site is located on the DOE Hanford Site, there are no residences nor unrestricted land use near the US Ecology boundary. Therefore the maximum possible exposures an individual could actually receive would be less than 25% (40 hours/week) of the exposures measured on the site boundary thermoluminescent dosimeters (TLDs). Penetrating radiation is measured at the following locations.

- One on each of the east, west and south fence lines and two on the north fence line; changed monthly.
- A second TLD at each of the above locations; changed quarterly.
- One at each of the northeast, northwest, southeast and southwest facility corners; also changed quarterly.
- One on the fence line at the closest point to each active disposal unit; changed monthly.
- One every 200 feet on the fence line closest to Trench 14; changed monthly.
- One every 200 feet on the portion of the west site fence adjacent to Trench 16; changed monthly. One of Trench 16 Badges, AM025, was temporarily placed at the midpoint of Trench 12 A (Trojan Reactor Vessel Trench) during the time Trench 12A was open.
- One every 200 feet adjacent to Trench 18; changed monthly.
- Two background TLDs are positioned at environmental air monitoring station number one. One of these provides monthly background readings; the other provides quarterly background.

TLD locations are plotted on Figure 4.1, "Environmental Monitoring stations".

Environmental TLDs are supplied by RADIATION DETECTION COMPANY (RDC) of Sunnyvale, California. The RDC "Type 14" badge consists of two polyethylene capsules, each containing 34 mg of $CaSO_4$:Dy (TLD-900) powder as the detection element. The capsules are enclosed within a tubular 30-mil cadmium shield monitor and sealed against the

weather. The shield attenuates low energy photons to compensate for $CaSO_4$:Dy over response to low energy photons. The cadmium also shields the capsules from thermal neutrons.

$CaSO_4$ is a good choice for low level environmental measurements. $CaSO_4$:Dy is approximately 30 times more sensitive than lithium fluoride, the most common TLD element. $CaSO_4$:Dy also has a low rate of fade, and a reasonable energy response for photon energies > 100 keV, which is the primary region of interest for US Ecology activities. The minimum reportable exposure is one milliroentgen for RDC dosimeters exchanged on a monthly basis and two milliroentgen for quarterly dosimeters. The low fade rate of 2% per month makes a quarterly period practical.

8.1 Monthly Environmental TLDs

Tables 8.1 provides the readings from monthly environmental monitoring TLDs. TLD monitoring program results confirm compliance with the 400 mrem/year site boundary limit established in the Richland Facility Standards Manual (FSM). The highest annual total for monthly badges was 114 mrem near the west end Trench 14. This value includes a background contribution of 37 mrem. Therefore, the highest offsite penetrating radiation exposure attributable to site operations is 77 mrem a year. This value is 19% of the site boundary exposure limit. The equivalent daily exposure rate is 0.2 mrem/day. As stated earlier, the US Ecology Site is on the DOE Hanford Reservation and no individual who is not associated with US Ecology operations would be at the site boundary for more than 40 hours a week. An individual standing 40 hours per week at the maximum location for 50 weeks would receive approximately 14 mrem for the year.

The burial of the intact Trojan Reactor Vessel occurred in 1999. To evaluate this special evolution, a monthly TLD AM025 was temporarily moved from the west side of closed Trench 16 to the mid point on the east side of Trojan Reactor Vessel trench. During the time when the reactor vessel was not covered AM025 had net monthly readings 32 and 20 mrem (background subtracted). After the reactor vessel was buried, the net readings returned to background. Thus, the maximum external offsite exposure for the Trojan Reactor Vessel work was 52 mrem. The total net exposure for the year on AM025 was 61 mrem, which includes both Trench 16 and Reactor Vessel Trench exposure periods.

8.2 Quarterly Environmental TLDs

The highest annual total for quarterly badges was 65 mrem near the southwest corner of the site. This includes a background contribution of 35 mrem. Consequently, the net annual exposure attributable to site operations is 30 mrem. This value is 8 % of the site boundary exposure limit. The equivalent

daily exposure rate is 0.1 mrem/day. Tables 8.2 provides the quarterly environmental monitoring TLDs readings.

In addition to US Ecology quarterly TLDs, the Washington Department of Health (WDOH) also places quarterly TLDs badges along the perimeter of the US Ecology Site. Table 8.3 compares US Ecology quarterly environmental TLD results with proximally located WDOH quarterly environmental TLD results. Both WDOH and US Ecology TLD results are only a fraction of the allowed site boundary limit.

US Ecology 1999 TLDs average significantly less than proximally placed State TLDs. This difference has been observed over several years. The observed differences between quarterly WDOH and RDC TLDs are discussed further in Section 8.3.

TABLE 8.1
Monthly Fence line Environmental TLD Summary – 1999

Month	Days	AB001 BKGD Gross	Net for Month Net	Total Year Net	Ave mr/day Net	AM006 S. Fence Gross	Net for Month Net	Total Year Net	Ave mr/day Net
Jan	28	11	NA	11	0.39	12	1	1	0.04
Feb	27	9	NA	20	0.33	11	2	3	0.07
Mar	31	10	NA	30	0.32	12	2	5	0.06
Apr	32	11	NA	41	0.34	13	2	7	0.06
May	28	10	NA	51	0.36	11	1	8	0.04
Jun	31	11	NA	62	0.35	12	1	9	0.03
Jul	32	10	NA	72	0.31	11	1	10	0.03
Aug	30	13	NA	85	0.43	12	-1	10	-0.03
Sep	31	11	NA	96	0.35	13	2	12	0.06
Oct	34	12	NA	108	0.35	14	2	14	0.06
Nov	30	11	NA	119	0.37	12	1	15	0.03
Dec	33	11	NA	130	0.33	12	1	16	0.03
Total	367	130	NA		0.35	145	15		0.04
		Percent of Limit		NA	%	Percent of Limit		4.0	%

		AM007 W. Fence Gross	Net for Month Net	Total Year Net	Ave mr/day Net	AM008 NE Fence Gross	Net for Month Net	Total Year Net	Ave mr/day N
Jan	28	12	1	1	0.04	11	0	0	0.0
Feb	27	10	1	2	0.04	10	1	1	0.04
Mar	31	11	1	3	0.03	10	0	1	0.00
Apr	32	12	1	4	0.03	12	1	2	0.03
May	28	10	0	4	0.00	24	14	16	0.50
Jun	31	12	1	5	0.03	11	0	16	0.00
Jul	32	11	1	6	0.03	11	1	17	0.03
Aug	30	12	-1	6	-0.03	12	-1	17	-0.03
Sep	31	12	1	7	0.03	12	1	18	0.03
Oct	34	14	2	9	0.06	13	1	19	0.03
Nov	30	12	1	10	0.03	11	0	19	0.00
Dec	33	11	0	10	0.00	11	0	19	0.00
Total	367	139	9		0.02	148	18		0.05
		Percent of Limit		2.5	%	Percent of Limit		9.8	%

NOTES:

1. Gross readings are in mR and include control and background AB001.
2. 2. Net readings are with background subtracted. Net negative values are not subtracted from the total.
3. Investigation level: = 30 mrem/month; Reporting level = 400 mrem/year.

TABLE 8.1 (Continued)
Monthly Fence line Environmental TLD Summary – 1999

Month	Days	AM009 NE Fence Gross	Net for Month Net	Total Year Net	Ave mr/day Net	AM010 E Fence Gross	Net for Month Net	Total Year Net	Ave mr/day Net
Jan	28	10	-1	0	-0.04	11	0	0	0
Feb	27	9	0	0	0.00	10	1	1	1
Mar	31	10	0	0	0.00	11	1	2	3
Apr	32	11	0	0	0.00	11	0	2	5
May	28	9	-1	0	-0.04	9	-1	2	7
Jun	31	11	0	0	0.00	11	0	2	9
Jul	32	10	0	0	0.00	10	0	2	11
Aug	30	11	-2	0	-0.07	12	-1	2	13
Sep	31	12	1	1	0.03	12	1	3	16
Oct	34	13	1	2	0.03	13	1	4	20
Nov	30	11	0	2	0.00	11	0	4	24
Dec	33	11	0	2	0.00	11	0	4	28
Total	367	128	2		-0.01	132	2		11.42
	Percent of Limit			0.5	%	Percent of Limit		1.0	%

		AM015 E-TR-14 Gross	Net for Month Net	Total Year Net	Ave mr/day Net	AM016 S-TR-14 Gross	Net for Month Net	Total Year Net	Ave mr/day Net
Jan	28	10	-1	0	-0.04	11	0	0	0.00
Feb	27	10	1	1	0.04	10	1	1	0.04
Mar	31	10	0	1	0.00	11	1	2	0.03
Apr	32	11	0	1	0.00	11	0	2	0.00
May	28	10	0	1	0.00	10	0	2	0.00
Jun	31	11	0	1	0.00	11	0	2	0.00
Jul	32	10	0	1	0.00	10	0	2	0.00
Aug	30	12	-1	1	-0.03	12	-1	2	-0.03
Sep	31	12	1	2	0.03	12	1	3	0.03
Oct	34	13	1	3	0.03	13	1	4	0.03
Nov	30	11	0	3	0.00	11	0	4	0.00
Dec	33	11	0	3	0.00	11	0	4	0.00
Total	367	131	1		0.00	133	3		0.01
	Percent of Limit			0.8	%	Percent of Limit		1.0	%

NOTES:

1. All gross readings are in mR and include control and background AB001.
2. Net readings are with background subtracted. Net negative values are not subtracted from the total.
3. Investigation level: = 30 mrem/month Reporting level: = 400 mrem/year.

TABLE 8.1 (Continued)
Monthly Fence line Environmental TLD Summary – 1999

		AM017 S TR-14 400	Net for Month	Total Year	Ave mr/day	AM018 S TR-14 600'	Net for Month	Total Year	Ave mr/day
		Gross	Net	Net	Net	Gross	Net	Net	Net
Jan	28	11	0	0	0.00	11	0	0	0.00
Feb	27	10	1	1	0.04	10	1	1	0.04
Mar	31	11	1	2	0.03	11	1	2	0.03
Apr	32	11	0	2	0.00	12	1	3	0.03
May	28	10	0	2	0.00	11	1	4	0.04
Jun	31	11	0	2	0.00	12	1	5	0.03
Jul	32	10	0	2	0.00	11	1	6	0.03
Aug	30	12	-1	2	-0.03	12	-1	6	-0.03
Sep	31	12	1	3	0.03	12	1	7	0.03
Oct	34	13	1	4	0.03	13	1	8	0.03
Nov	30	11	0	4	0.00	12	1	9	0.03
Dec	33	11	0	4	0.00	11	0	9	0.00
Total	367	133	3		0.01	138	8		0.02
	Percent of Limit			1.0	%	Percent of Limit		2.3	%

		AM019 S-TR-14 800'	Net for Month	Total Year	Ave mr/day	AM020 S -TR-14 1000'	Net for Month	Total Year	Ave mr/day
		Gross	Net	Net	Net	Gross	Net	Net	Net
Jan	28	12	1	1	0.04	16	5	5	0.18
Feb	27	12	3	4	0.11	15	6	11	0.22
Mar	31	13	3	7	0.10	16	6	17	0.19
Apr	32	12	1	8	0.03	14	3	20	0.09
May	28	11	1	9	0.04	34	24	44	0.86
Jun	31	13	2	11	0.06	15	4	48	0.13
Jul	32	12	2	13	0.06	14	4	52	0.13
Aug	30	13	0	13	0.00	15	2	54	0.07
Sep	31	13	2	15	0.06	16	5	59	0.16
Oct	34	14	2	17	0.06	17	5	64	0.15
Nov	30	12	1	18	0.03	14	3	67	0.10
Dec	33	12	1	19	0.03	15	4	71	0.12
Total	367	149	19		0.05	201	71		0.20
	Percent of Limit			4.8		Percent of Limit		17.8	

NOTES:

1. Gross readings are in mR and include control and background AB001.
2. Net readings are with background subtracted. Net negative values are not subtracted from the total.
3. Investigation level: 30 mrem/month Reporting level: 400 mrem/year.

TABLE 8.1 (Continued)
Monthly Fence line Environmental TLD Summary – 1999

		AM021 S TR-14 1200'	Net for Month	Total Year	Ave mr/day	AM022 W TR-14	Net for Month	Total Year	Ave mr/day
		Gross	Net	Net	Net	Gross	Net	Net	Net
Jan	28	9	-2	0	-0.07	15	4	4	0.14
Feb	27	10	1	1	0.04	14	5	9	0.19
Mar	31	12	2	3	0.06	16	6	15	0.19
Apr	32	15	4	7	0.13	18	7	22	0.22
May	28	8	-2	7	-0.07	13	3	25	0.11
Jun	31	8	-3	7	-0.10	14	3	28	0.10
Jul	32	8	-2	7	-0.06	13	3	31	0.09
Aug	30	9	-4	7	-0.13	15	2	33	0.07
Sep	31	8	-3	7	-0.10	15	4	37	0.13
Oct	34	10	-2	7	-0.06	16	4	41	0.12
Nov	30	8	-3	7	-0.10	14	3	44	0.10
Dec	33	9	-2	7	-0.06	14	3	47	0.09
Total	367	114	-16		-0.04	177	47		0.13
		Percent of Limit		1.8	%	Percent of Limit		11.8	%

		AM023 W TR-16 100'	Net for Month	Total Year	Ave mr/day	AM024 W TR-16 300'	Net for Month	Total Year	Ave mr/day
		Gross	Net	Net	Net	Gross	Net	Net	Net
Jan	28	13	2	2	0.07	12	1	1	0.04
Feb	27	12	3	5	0.11	11	2	3	0.07
Mar	31	13	3	8	0.10	12	2	5	0.06
Apr	32	14	3	11	0.09	12	1	6	0.03
May	28	11	1	12	0.04	11	1	7	0.04
Jun	31	13	2	14	0.06	12	1	8	0.03
Jul	32	12	2	16	0.06	11	1	9	0.03
Aug	30	13	0	16	0.00	12	-1	9	-0.03
Sep	31	14	3	19	0.10	14	3	12	0.10
Oct	34	14	2	21	0.06	13	1	13	0.03
Nov	30	12	1	22	0.03	12	1	14	0.03
Dec	33	13	2	24	0.06	12	1	15	0.03
Total	367	154	24		0.07	144	14		0.04
		Percent of Limit		6.0		Percent of Limit		3.8	

NOTES:

1. All gross readings are in mR and include background AB001.
2. Net readings are with background subtracted. Net negative values are not subtracted from the total.
3. Investigation level: 30 mrem/month Reporting level: 400 mrem/year.

TABLE 8.1 (Continued)
Monthly Fence line Environmental TLD Summary – 1999

		AM025 W TR-16 500' Gross	Net for Month Net	Total Year Net	Ave mr/day Net	AM026 W TR-16 700' Gross	Net for Month Net	Total Year Net	Ave mr/day Net
Jan	28	12	1	1	0.04	12	1	1	0.04
Feb	27	11	2	3	0.07	11	2	3	0.07
Mar	31	11	1	4	0.03	11	1	4	0.03
Apr	32	12	1	5	0.03	12	1	5	0.03
May	28	11	1	6	0.04	10	0	5	0.00
Jun	31	12	1	7	0.03	11	0	5	0.00
Jul	32	11	1	8	0.03	11	1	6	0.03
Aug	30	45	32	40	1.07	12	-1	6	-0.03
Sep	31	31	20	60	0.65	12	1	7	0.03
Oct	34	12	0	60	0.00	13	1	8	0.03
Nov	30	12	1	61	0.03	12	1	9	0.03
Dec	33	11	0	61	0.00	11	0	9	0.00
Total	367	191	61		0.17	138	8		0.02
		Percent of Limit		15.3		Percent of Limit		2.3	

		AM027 W TR-18 50' Gross	Net for Month Net	Total Year Net	Ave mr/day Net	AM028 W-TR-18 250" Gross	Net for Month Net	Total Year Net	Ave mr/day Net
Jan	28	11	0	0	0.00	11	0	0	0.00
Feb	27	10	1	1	0.04	11	2	2	0.06
Mar	31	11	1	2	0.03	11	1	3	0.03
Apr	32	12	1	3	0.03	12	1	4	0.04
May	28	11	1	4	0.04	11	1	5	0.03
Jun	31	11	0	4	0.00	12	1	6	0.03
Jul	32	11	1	5	0.03	11	1	7	0.03
Aug	30	12	-1	5	-0.03	12	-1	7	-0.03
Sep	31	12	1	6	0.03	13	2	9	0.06
Oct	34	13	1	7	0.03	13	1	10	0.03
Nov	30	11	0	7	0.00	12	1	11	0.03
Dec	33	12	1	8	0.03	12	1	12	0.00
Total	367	137	7		0.02	129	10		0.03
		Percent of Limit		2.0	%	Percent of Limit		3.0	

NOTES:

1. All gross readings are in mR and include background AB001.
2. Net readings are with background subtracted. Net negative values are not subtracted from the total.
3. Investigation level: 30 mrem/month Reporting level: 400 mrem/year.

TABLE 8.1 (Continued)
Monthly Fence line Environmental TLD Summary – 1999

Month	Days	AM029 W TR-18 450' Gross	Net for Month Net	Total Year Net	Ave mr/day Net	AM030 W-TR-18 650" Gross	Net for Month Net	Total Year Net	Ave mr/day Net
Jan	27	12	1	1	0.04	14	3	3	0.11
Feb	31	12	3	4	0.11	14	5	8	0.16
Mar	32	13	3	7	0.10	15	5	13	0.16
Apr	28	13	2	9	0.06	15	4	17	0.14
May	31	12	2	11	0.07	13	3	20	0.10
Jun	32	13	2	13	0.06	15	4	24	0.13
Jul	30	12	2	15	0.06	15	5	29	0.17
Aug	31	13	0	15	0.00	16	3	32	0.10
Sep	34	13	2	17	0.06	15	4	36	0.12
Oct	30	14	2	19	0.06	17	5	41	0.17
Nov	33	13	2	21	0.07	17	6	47	0.18
Dec	367	14	3	24	0.09	21	10	57	0.03
Total	339	154	24		0.07	166	47		0.13
		Percent of Limit		6.0	%	Percent of Limit		14.3	%

Month	Days	AM031 W-TR-18 850' Gross	Net for Month Net	Total Year Net	Ave mr/day Net	AM032 W-TR-18 325' Gross	Net for Month Net	Total Year Net	Ave mr/day Net
Jan	27	13	2	2	0.07	12	1	1	0.04
Feb	31	13	4	6	0.13	12	3	4	0.10
Mar	32	14	4	10	0.13	12	2	6	0.06
Apr	28	14	3	13	0.11	12	1	7	0.04
May	31	13	3	16	0.10	11	1	8	0.03
Jun	32	14	3	19	0.09	12	1	9	0.03
Jul	30	14	4	23	0.13	12	2	11	0.07
Aug	31	14	1	24	0.03	12	-1	11	-0.03
Sep	34	14	3	27	0.09	13	2	13	0.06
Oct	30	15	3	30	0.10	14	2	15	0.07
Nov	33	17	6	36	0.18	13	2	17	0.06
Dec	367	20	9	45	0.02	14	3	20	0.01
Total	339	155	45		0.10	135	19		0.04
		Percent of Limit		11.3	%	Percent of Limit		5.0	%

NOTES:

1. All gross readings are in mR and include background AB001.
2. Net readings are with background subtracted. Net negative values are not subtracted from the total.
3. Investigation level: 30 mrem/month Reporting level: 400 mrem/year.

TABLE 8.1 (Continued)
Monthly Fence line Environmental TLD Summary – 1999

Month	Days	AM033 NW Fence Gross	Net for Month Net	Total Year Net	Ave mr/day Net
Jan	28	13	2	2	0.07
Feb	27	11	2	4	0.07
Mar	31	12	2	6	0.06
Apr	32	12	1	7	0.03
May	28	11	1	8	0.04
Jun	31	12	1	9	0.03
Jul	32	11	1	10	0.03
Aug	30	12	-1	10	-0.03
Sep	31	12	1	11	0.03
Oct	34	13	1	12	0.03
Nov	30	13	2	14	0.07
Dec	33	13	2	16	0.06
Total	367	145	15		0.04
		Percent of Limit		4.0	%

NOTES:
1. All gross readings are in mR and include background AB001.
2. Negative values are not subtracted from the total.
3. Investigation Level: 40 mrem/month Reporting Level: 400 mrem/year.

TABLE 8.2
Quarterly Environmental TLDs Summary – 1999

Exposure - mR

QTR	Days	AB002	AM101	AM102	AM103	AM104
1st	98	8	9	10	19	9
2nd	90	8	8	9	16	9
3rd	98	10	9	8	15	9
4th	94	9	9	10	15	11
Total	380	35	35	37	65	38

Net Exposure - mR

QTR	Days	AM105	AM106	AM107	AM108	AM109	AM110
1st	98	9	15	13	10	9	14
2nd	90	8	11	10	9	7	12
3rd	98	9	13	11	10	8	13
4th	94	10	13	11	11	10	15
Total	380	36	52	45	40	34	54

NOTES: 1. Total is the cumulative quarterly total for the year.
2. .Investigation Level = 90 mrem/qtr above background (AB002)
3. Reporting Level = 400 mrem/year above background (AB002).

TABLE 8.3
WDOH/US Ecology Environmental TLD Results

QUARTER	LOCATION	RDC #	ICN #	WDOH 1999 mrem/day	RDC 1999 mrem/day	ICN 1999 mrem/day
1 st	NE CORNER	AM101	43	0.26	0.09	0.10
2 nd	NE CORNER	AM101	43	0.24	0.09	0.08
3 rd	NE CORNER	AM101	43	0.22	0.09	0.09
4 th	NE CORNER	AM101	43	0.23	0.10	0.10
Ave.	NE CORNER	AM101	43	0.24	0.09	0.09
1 st	SE CORNER	AM102	44	0.25	0.09	0.09
2 nd	SE CORNER	AM102	44	0.25	0.09	0.09
3 rd	SE CORNER	AM102	44	0.21	0.09	0.09
4 th	SE CORNER	AM102	44	0.26	0.09	0.09
Ave.	SE CORNER	AM102	44	0.24	0.09	0.09
1 st	SW CORNER	AM103	45	0.35	0.19	0.14
2 nd	SW CORNER	AM103	45	0.31	0.18	0.16
3 rd	SW CORNER	AM103	45	0.27	0.15	0.13
4 th	SW CORNER	AM103	45	0.30	0.16	0.14
Ave.	SW CORNER	AM103	45	0.31	0.17	0.15
1 st	NW CORNER	AM104	46	0.25	0.10	0.09
2 nd	NW CORNER	AM104	46	0.24	0.10	0.08
3 rd	NW CORNER	AM104	46	0.22	0.08	0.07
4 th	NW CORNER	AM104	46	0.24	0.11	0.09
Ave.	NW CORNER	AM104	46	0.24	0.10	0.08
1 st	SW T14	AM021	52	0.66	0.36	0.33
2 nd	SW T14	AM021	52	0.66	0.34	0.41
3 rd	SW T14	AM021	52	0.48	0.27	0.27
4 th	SW T14	AM021	52	0.57	0.28	0.33
Ave.	SW T14	AM021	52	0.59	0.31	0.33

NOTES:

1. US Ecology environmental TLD results were converted to millirem per day (mrem/day) for comparison with WDOH data.
2. AM021 is a monthly badge with readings averaged over the quarter.

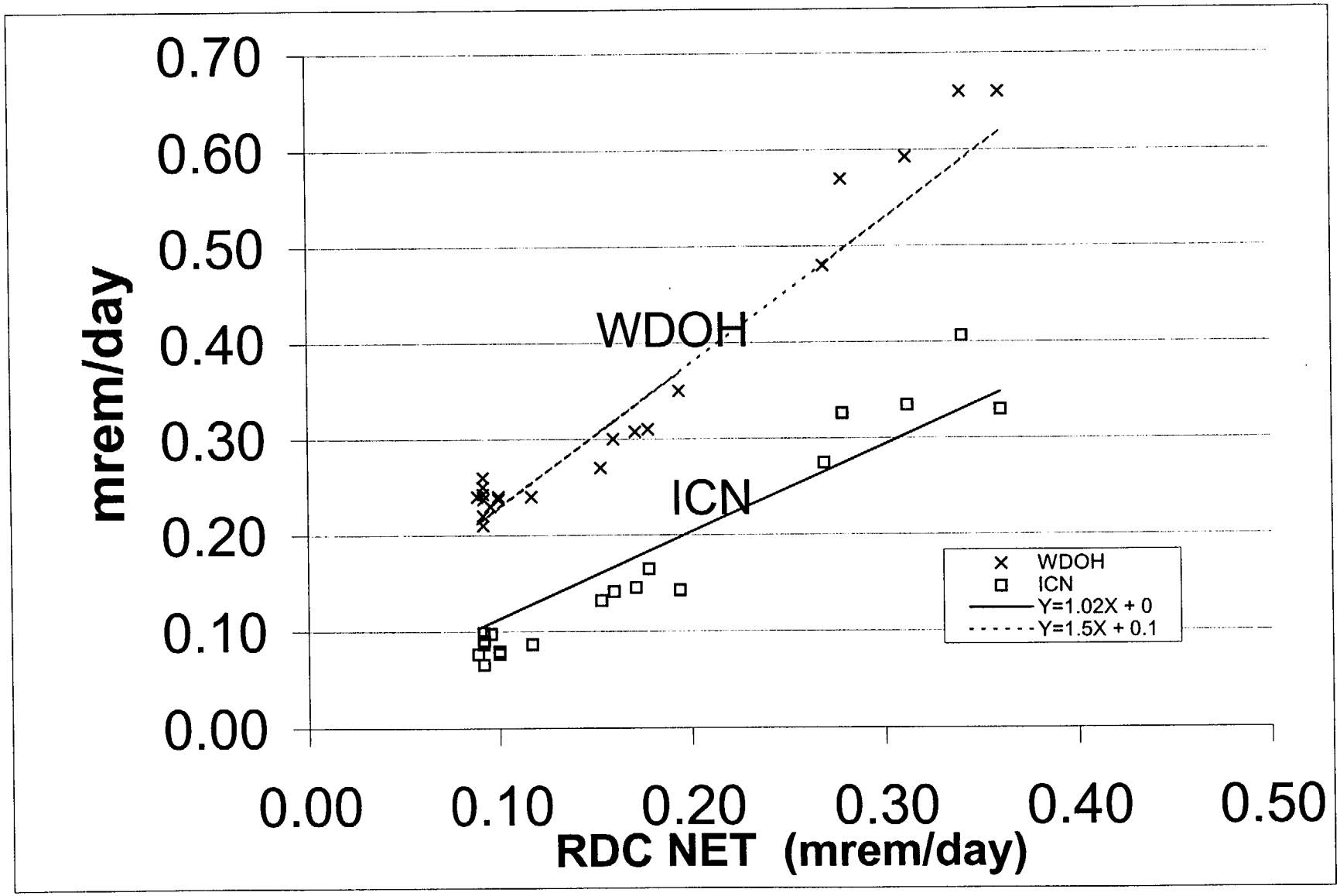
8.3 Analysis of Environmental Badge Response

As identified in Section 8.2, US Ecology 1999 TLD readings average less than proximally placed State TLDs. This difference has been observed over several years. US Ecology badges are calibrated with Co-60 and State TLD badges are calibrated with Cs-137. However, calibration source differences should not be large enough to explain the observed differences.

To further evaluate WDOH/US Ecology Environmental TLD differences, US Ecology placed ICN Environmental dosimeters next to quarterly RDC environmental dosimeters. The ICN environmental dosimeters contain both CaSo4 and LiF chips. This design utilizes CaSo4's better sensitivity, while using LiF to help compensate for CaSo4's over response to low energy gamma.

Linear regressions were calculated for both the ICN and WDOH badges using the RDC data as the independent variable. There is better agreement between ICN and RDC readings than with WDOH badges. Table 8.3 lists the mrem/day for RDC, ICN and WDOH badges. The WDOH readings had a slope of 1.5 and an intercept of 0.10. The ICN badges had a slope of 1.02 and an intercept of 0.0. Both linear regressions had reasonable fit factors (WDOH $R^2 = 0.8$ and ICN $R^2 = 0.74$. Figure 8.1 plots the linear regressions for ICN and WDOH badges.

FIGURE 8.1 WDOH and ICN VERSUS RDC



9.0 Vadose and Solar Still Sampling

This section presents the results of ongoing monitoring programs for vadose zone and solar still vapors. This section also contains the final summary of trench cap soil gas radon monitoring. Vadose media sampled includes gases, organic vapor, radon, and soil vapor moisture tritium. Solar still soil vapor moisture tritium is also sampled. All of these measurements are experimental and do not have applicable environmental standards or action levels.

In November 1991, US Ecology installed three vapor wells into the unsaturated soil zone as a research project conducted at the request of the Washington State Department of Health. Well VW-101 is between Trenches 4 and 5 at the east end. Well VW-102 is located between Trenches 10 and 11A, also on the east end. Background Well VW-100 is located away from disposal areas in the northwest corner of the site.

The "Vadose Zone Monitoring Program," submitted to the state on March 31, 1992, contains a complete description of the design and installation of the wells. The submittal included proposed sampling procedures. Vadose monitoring tests for the following soil gas constituents: organic vapors of xylene, toluene and methane/combustible gasses. Radiological parameters analyzed include tritium and radon. The frequency for vadose zone radon and tritium monitoring was increased from quarterly to monthly in 1997 to provide improved assessment of maximum radon levels.

9.1 Vadose Non-radiological Vapor Sampling

Vapor is sampled by withdrawing a gas sample from the vadose well into an evacuated chamber. The chamber is then sent to an offsite laboratory for analysis. Oxygen, nitrogen and carbon dioxide are present in all vadose vapor samples. Non-radiological vadose sampling was suspended in the third quarter of 1999. This was due the analytical laboratory discontinuing services due to concern over the vadose gases radiological constituents. US Ecology has not been able to obtain another laboratory for non-radiological analysis of vadose gases.

VW-100 has carbon dioxide, nitrogen and oxygen levels that are consistent with air. Vadose Well 101 and 102 had elevated carbon dioxide and lower oxygen levels in 1999, which might be indicative of organic material breaking down. VW-100, VW-101 and 102 methane and carbon monoxide were all less than detection limits in 1999. Organic vapors were below detection levels in all vadose wells for the first, and second quarter. No samples were obtained in the third or fourth quarter. Table 9.1 contains the results for non-radiological vapor sampling for the three vadose wells. Vadose vapor sampling is experimental and does not have applicable environmental standards or action levels.

TABLE 9.1
Quarterly Vadose Zone Non-Radiological Vapor Sample Results, 1999

	Well 100				Well 101				Well 102			
Analysis/Quarter	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Carbon monoxide (ppmv)	<200	<200	NS	NS	<200	<200	NS	NS	<200	<200	NS	NS
Carbon Dioxide (%)	0.2	0.18	NS	NS	4	3.7	NS	NS	1	1.3	NS	NS
Methane (ppmv)	<100	<100	NS	NS	<100	<100	NS	NS	<100	<100	NS	NS
Nitrogen (%)	77	77	NS	NS	80	80	NS	NS	77	80	NS	NS
Oxygen (%)	23	23	NS	NS	16	16	NS	NS	22	19	NS	NS
Benzene (mg/m3)	<1	<1	NS	NS	<1	<1	NS	NS	ND	ND	NS	NS
Ethyl Benzene (mg/m3)	<1	<1	NS	NS	<1	<1	NS	NS	ND	ND	NS	NS
Toluene (mg/m3)	<5	<5	NS	NS	<5	<5	NS	NS	<5	<5	NS	NS
Xylenes (mg/m3)	<2	<2	NS	NS	<2	<2	NS	NS	<2	<2	NS	NS
Total Petroleum Hydrocarbon (mg/m3)	<100	<100	NS	NS	<100	<100	NS	NS	<100	<100	NS	NS
Trifluorotoluene (PID) (% rec/surr)	95	106	NS	NS	98	113	NS	NS	93	95	NS	NS
Trifluorotoluene (FID) (% rec/surr)	100	99	NS	NS	94	105	NS	NS	110	93	NS	NS

NS = No Sample Taken

9.2 Vadose Zone Radon

Radon measurements are made by attaching an airborne radon track etch detector to the tritium sample chambers containing the silica gel used to collect soil water vapor. Table 9.2 presents 1999 vadose radon results. Table 9.3 compares the annual maximum and average concentrations for 1999 and previous years. Compared to 1998, VW #101 decreased but VW #100 and VW #102 increased in 1999. There may be a general upward trend in VW #102. Figures 9-1 through 9-3 plot the vadose well radon concentrations. There are no applicable environmental standards or limits for vadose zone radon concentrations.

TABLE 9.2
Vadose Zone Radon Measurements (pCi/L)

MONTH	VW-100 pCi/L	ERROR pCi/L	VW-101 pCi/L	ERROR pCi/L	VW-102 pCi/L	ERROR pCi/L
Jan	378	20	1355	10	451	18
Feb	432	17	522	16	1949	8
March	364	19	951	12	455	17
April	449	16	1512	9	401	18
May	384	17	1443	9	489	15
June	301	20	818	12	373	18
July	359	17	1222	9	327	18
Aug	254	22	861	12	339	19
Sept	361	18	1264	10	373	18
Oct	316	19	1473	9	403	16
Nov	333	20	1346	10	346	20
Dec	339	19	1865	8	351	19

VW-100 serves as background.

Table 9.3
Vadose Well Radon Concentrations (pCi/L)

Location		1996		1997		1998		1999	
		Max	Ave	Max	Ave	Max	Ave	Max	Ave
VW #100		348	324	296	285	369	317	449	356
VW #101		1521	1316	>4000	1471	>5000	1774	1865	1219
VW #102		406	363	486	381	487	344	1949	521

9.3 Vadose Zone Tritium

Sampling for tritium vapor involves placing a perforated cylinder filled with silica gel into the well so that it can absorb water vapor present in the vadose zone. Vadose wells 101 and 102 tritium in air moisture concentrations are higher than VW-100. Since VW-101 and VW-102 are located closer to waste trenches than VW-100, therefore buried waste is the likely source of elevated vadose tritium. Table 9.4 present monthly 1999 vadose zone tritium measurements. Table 9.5 compares the annual maximum and average tritium concentration for each Vadose Well. There appears to be an upward trend in VW #102. VW #101 has elevated tritium concentrations when compared to VW #100. However, there is no apparent upward trend in VW #101. Vadose tritium sampling is an experimental program and there are no applicable environmental standards or limits for vadose zone tritium. Figures 9-4 through 9-6 plot the vadose tritium concentrations.

TABLE 9.4
Vadose Zone Moisture Tritium Measurements (pCi/L), 1999

MONTH	VW-100	ERR.	VW-101	ERR.	VW-102	ERR.
	pCi/l	pCi/l	pCi/l	pCi/l	pCi/l	pCi/l
Jan	1.23E+03	1.30E+02	3.15E+05	1.00E+03	5.58E+05	2.00E+03
Feb	1.05E+03	1.20E+02	3.05E+05	1.00E+03	5.64E+05	2.00E+03
March	1.15E+03	1.60E+02	2.70E+05	1.00E+03	5.30E+05	2.00E+03
April	1.17E+03	1.20E+02	2.44E+05	1.00E+03	5.27E+05	2.00E+03
May	8.63E+02	1.20E+02	2.35E+05	1.00E+03	5.70E+05	2.00E+03
June	3.99E+02	1.00E+02	2.35E+05	1.00E+02	5.41E+05	2.00E+02
July	6.95E+02	1.14E+02	2.32E+05	1.00E+03	5.73E+05	2.00E+03
Aug	5.40E+01	1.01E+02	2.79E+05	2.00E+03	6.12E+05	2.00E+03
Sept	1.77E+03	1.50E+02	2.92E+05	1.00E+03	5.89E+05	2.00E+03
Oct	5.97E+02	1.00E+01	2.97E+05	1.00E+03	5.94E+05	2.00E+03
Nov	4.95E+02	1.00E+01	2.71E+05	1.00E+03	5.79E+05	2.00E+03
Dec	1.62E+02	1.00E+01	2.64E+05	1.00E+03	5.69E+05	2.00E+03

Notes: VW-100 serves as background.

Table 9.5
Annual Vadose Well Tritium Concentrations (pCi/L)

Location	VW #100		VW #101		VW #102	
Year	Max	Ave	Max	Ave	Max	Ave
1996	716	229	337000	295000	497000	460250
1997	564	121	270000	190375	488000	395125
1998	1570	1054	280000	240000	580000	478833
1999	1770	803	315000	269917	612000	567167

9.4 In-Ground Solar Stills

In October 1994, the site began a trial program to measure the tritium vapor released from soil. Three solar stills were placed adjacent to each vadose monitoring well (100, 101, 102). A fourth solar still was installed adjacent to the up-gradient ground water Well 13 to investigate if tritium vapor migrates like ground water tritium. A solar still consists of a 55-gallon drum with the bottom removed. The drum is partially buried, with the top extending 12-18 inches above the ground. The desiccant holder is placed inside the drum and the drum lid is installed. Solar stills are an experimental program to investigate possible soil vapor tritium migration. The water vapor contained in the drum collects in a desiccant column, which is analyzed for tritium.

In 1999, solar still tritium concentration ranged from less than detectable at SS-103 to a maximum of 3.1 E+4 at SS-102. Solar stills 101 and 102 tritium concentrations are usually higher than SS 100 and 103. SS-101 and SS-102 are located closer to waste trenches than SS-100 and SS-103. Therefore, buried waste is a more likely source of elevated tritium than ground water. However, all solar stills tritium concentrations tend to trend up or down at the same time.

Table 9.6 tabulates monthly solar still sample results. Table 9.7 provides annual maximums and average tritium concentrations for each solar still. Figures 9-7 through 9-10 plot solar still tritium concentrations. Comparison of 1999 results with previous years indicates that 1999 solar still tritium levels increased at all locations including background and up-gradient locations. Therefore, this increase, may be due at least in part to different temperature and barometric pressure profiles. As with vadose tritium, there are no applicable environmental standards or limits for solar stills.

TABLE 9.6
Monthly Solar Still Tritium Measurements (pCi/L), 1999

	SS-100 pCi/l	ERR. pCi/l	SS-101 pCi/l	ERR. pCi/l	SS-102 pCi/l	ERR. pCi/l	SS-103 pCi/l	ERR. pCi/l
Jan	162	88	692	109	16325	359	203	92
Feb	27419	505	20389	399	31191	490	14365	338
March	164	183	611	153	15499	394	187	136
April	359	93	1166	136	17575	372	426	95
May	354	123	982	118	17766	363	187	93
June	545	149	1408	165	19173	385	491	107
July	1894	250	1925	203	21358	406	597	111
Aug	516	175	1060	141	22603	438	115	100
Sept	438	166	1153	149	22064	414	229	90
Oct	192	103	899	113	22239	415	221	99
Nov	5462	226	5805	232	24966	450	2043	156
Dec	306	103	736	118	22985	435	311	103

Table 9.7
Annual Solar Still Tritium Concentrations (pCi/L)

Location	SS #100		SS #101		SS #102		SS #103	
Year	Max	Ave	Max	Ave	Max	Ave	Max	Ave
1996	4094	599	5437	2233	12006	7780	NA	NA
1997	423	200	2103	1422	12801	9790	293	235
1998	560	347	1086	1064	22454	16005	6932	1165
1999	27419	3151	20389	3069	31191	21145	14365	1615

9.5 Trench Cap Soil Gas Radon Monitoring

In August 1992, US Ecology began a trial program to measure radon gas concentrations in soil near the surfaces of trench caps. Trench 7 and Trench 5 were selected for monitoring purposes. Based on site disposal records, Trench 7 contains 131,803 mCi of Ra-226; Trench 5 contains 4,227 mCi Ra-226. Other site disposal trenches contain between 0 and 10,000 mCi Ra-226. Measurements were made by placing soil gas track etch detectors at three locations along the long axis of each trench. A background detector was placed in soil at the site background monitoring station.

Soil gas radon monitored in January, February and March of 1996 ranged from 98.2 pCi/l (Trench 5, west end) to 951.4 pCi/l (Trench 5, east end). The average concentration measured at the background station was 87.4 pCi/l. There are no environmental standards or limits applicable to soil gas radon concentrations at the Richland site.

Trench cap radon monitoring was terminated March of 1996 because the manufacturer no longer provides the detectors used. Data results from this experimental monitoring program indicated a possible increase in radon emanations coming from the trench cap soil. The elevated onsite vadose well radon levels found support this conclusion.

FIGURE 9 -1
VW 100 RADON

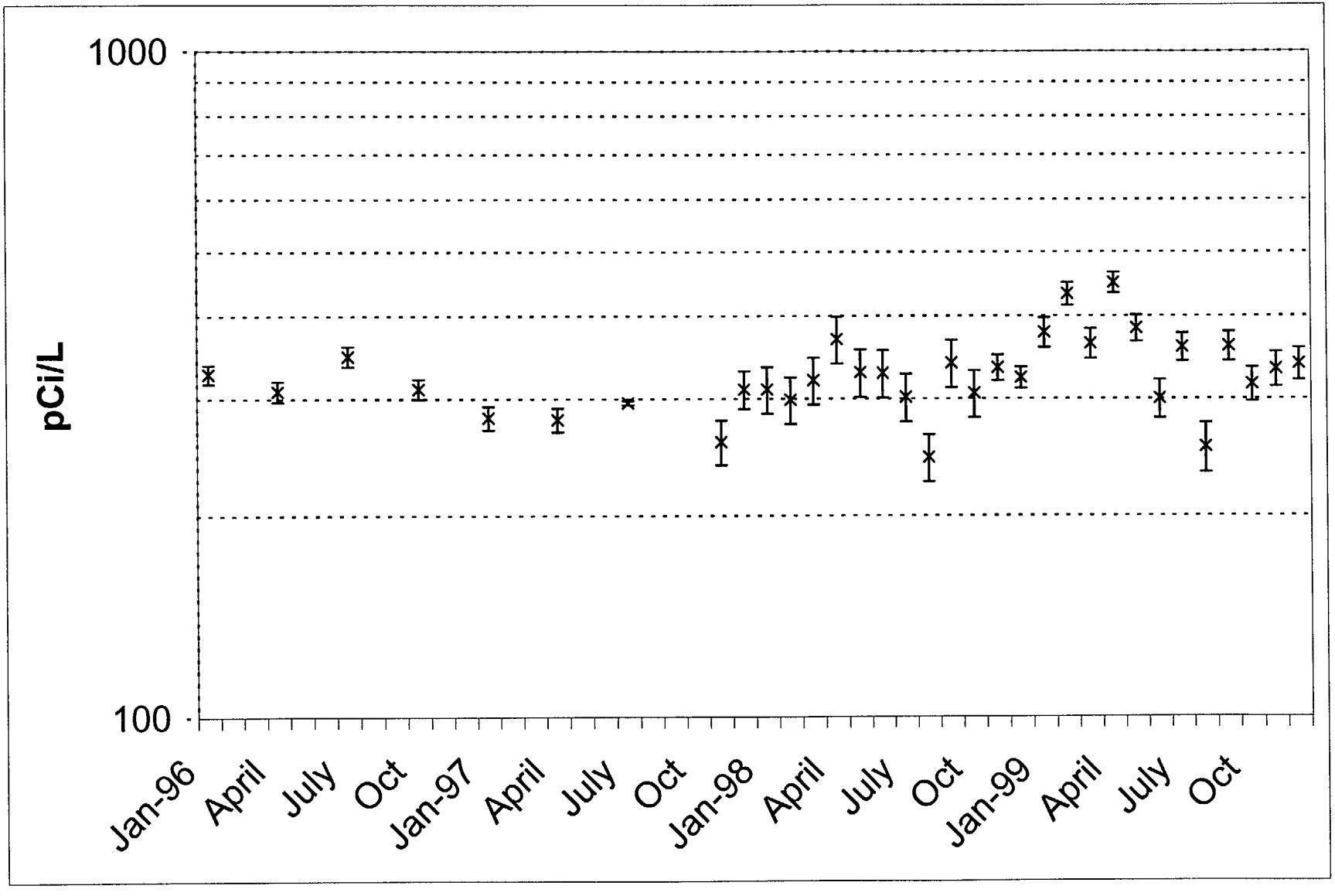
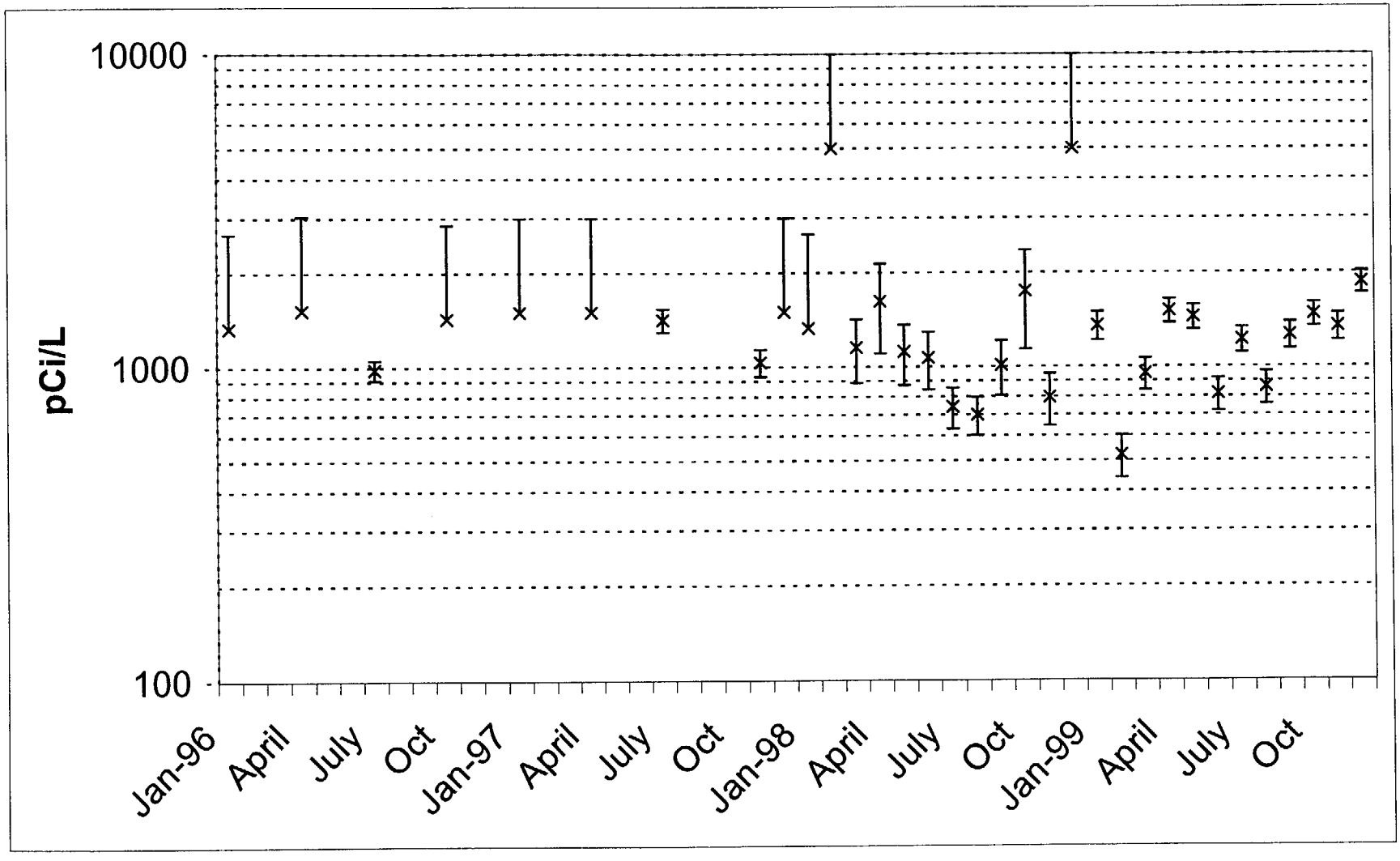


FIGURE 9 -2
VADOSE WELL 101 RADON



1. Sample period changed from quarterly to monthly in Nov. of 1997.
2. Offscale high error bars set at 100% of value.
3. Plus side only error bars are offscale high results.
4. Monthly monitoring eliminated majority of offscale high problems.

FIGURE 9-3
VW 102 RADON

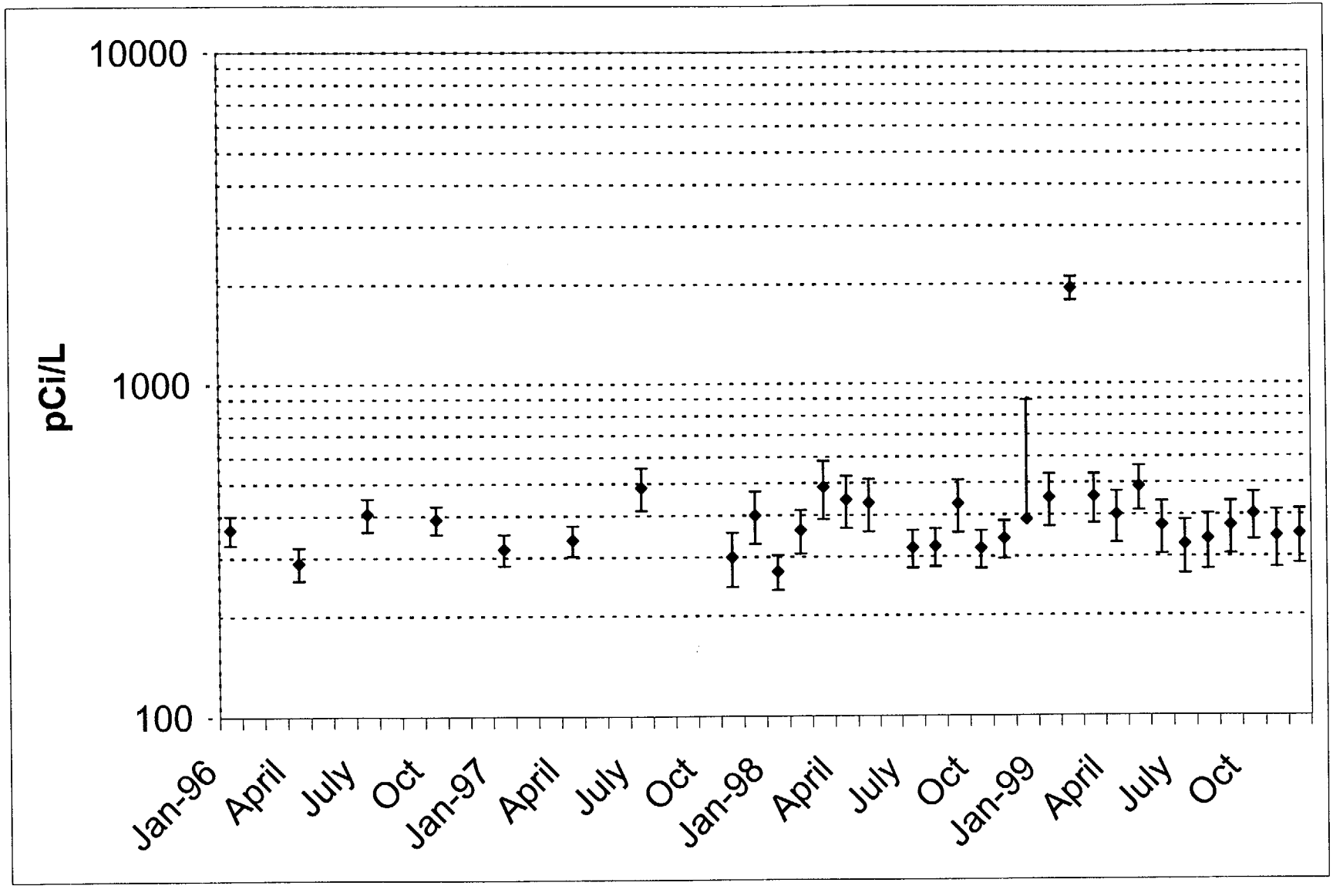
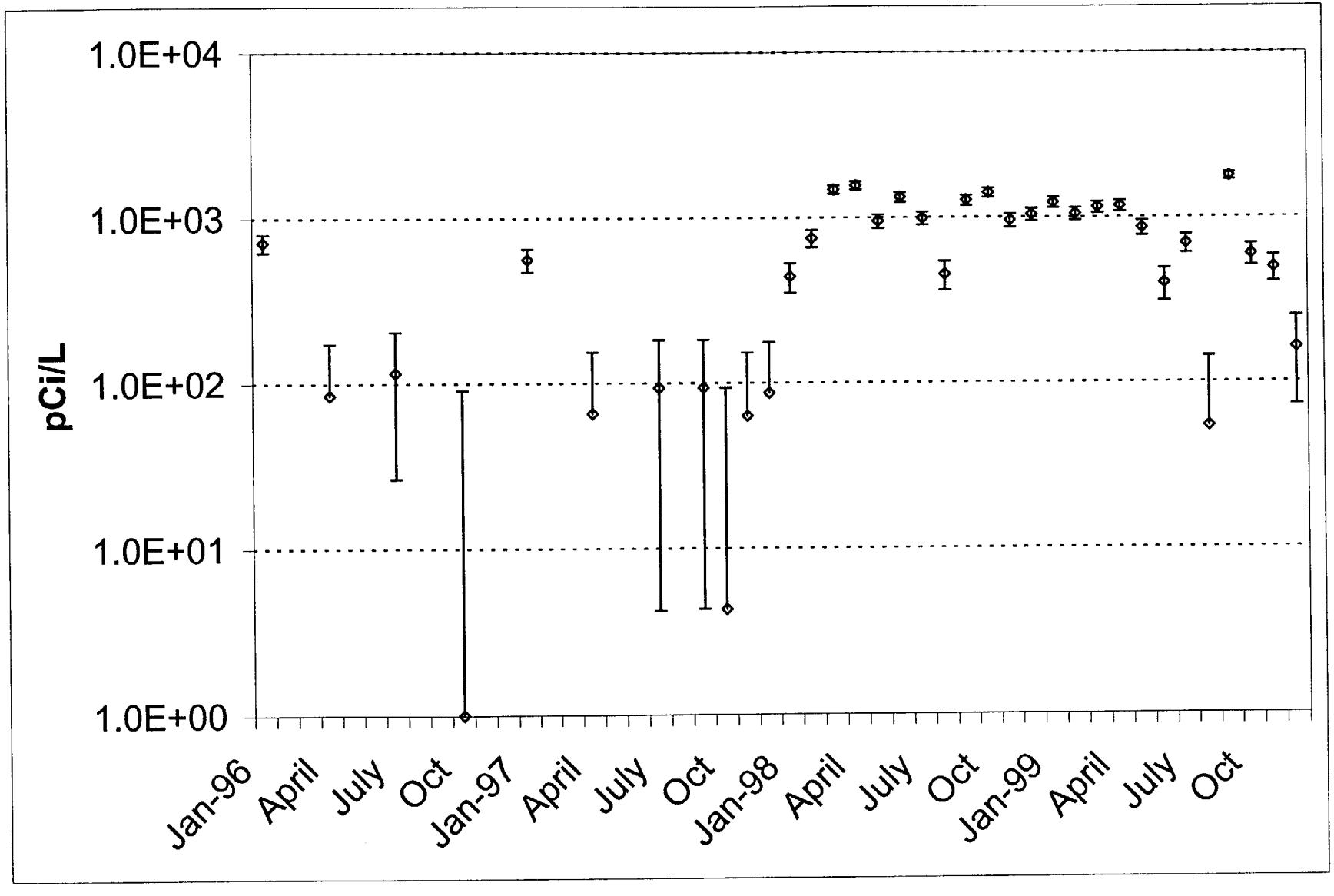
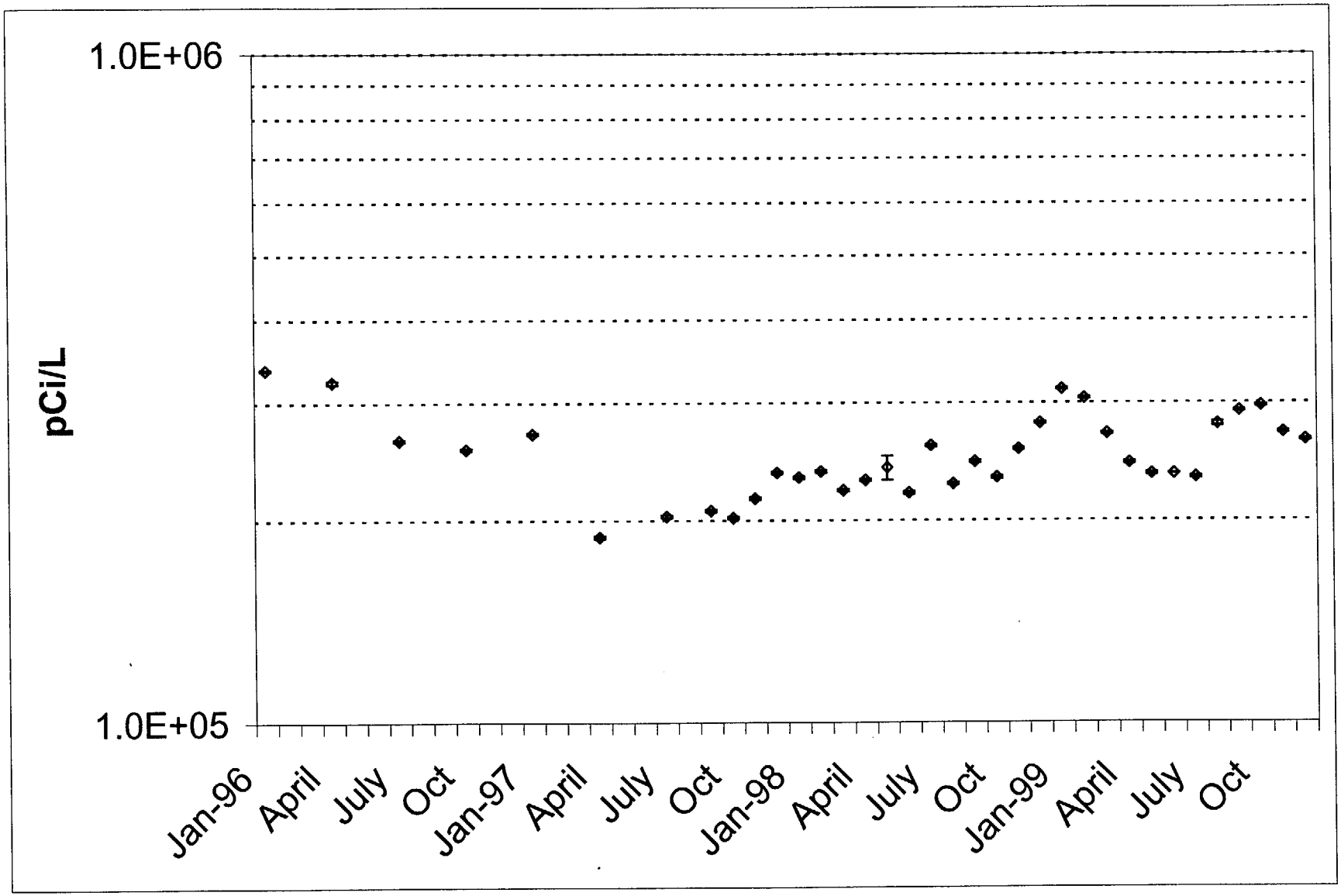


FIGURE 9-4
VW 100 TRITIUM



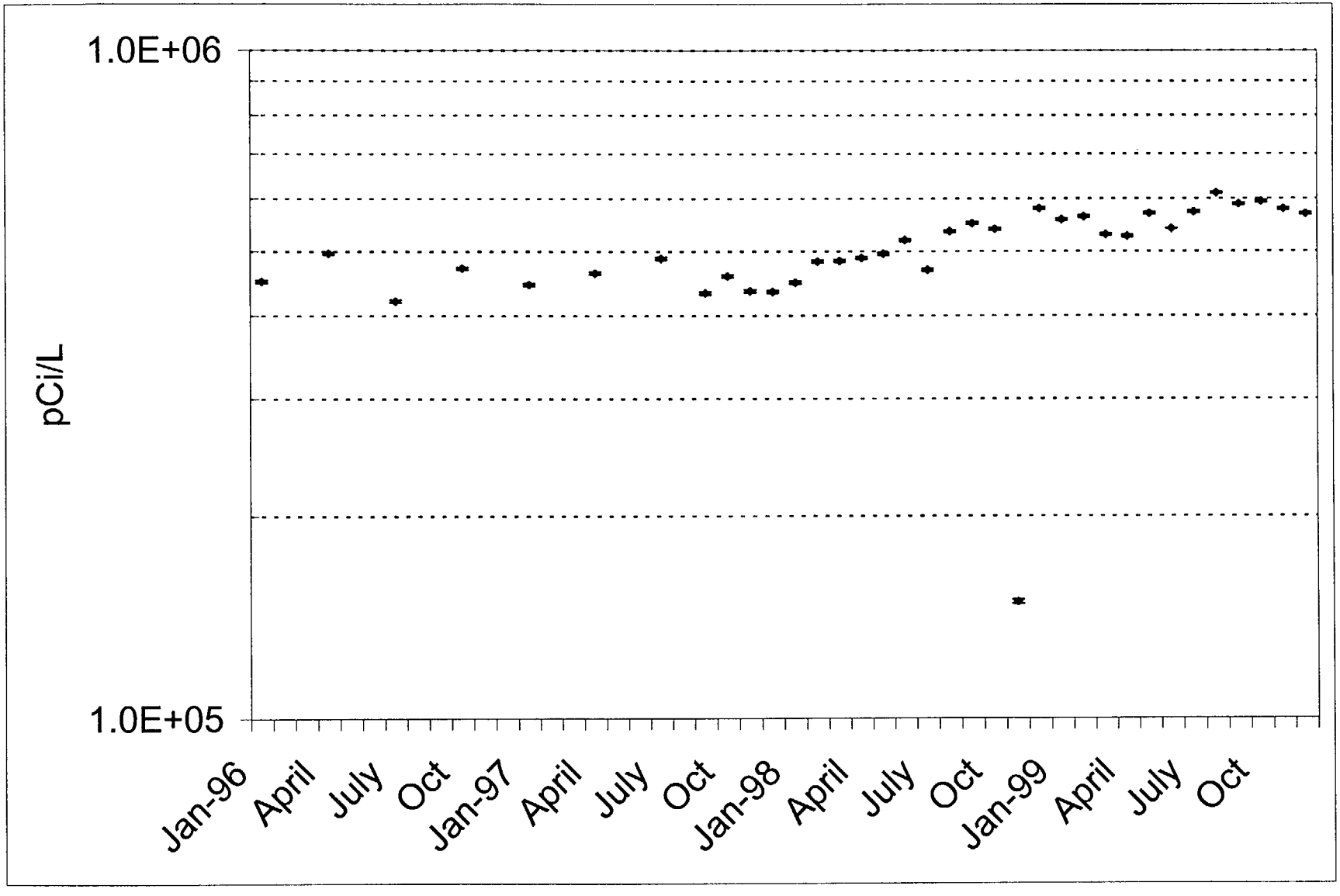
Note:
1. Minus error bars that go below 0 do not plot.
2. Sample frequency changed from quarterly to monthly in 1997

FIGURE 9 - 5
VW 101 TRITIUM



Notes:
1. Sample frequency changed from quarterly to monthly in 1997.

FIGURE 9-6
VW 102 TRITIUM



Notes:
1. Frequency changed from quarterly to monthly in 1998

FIGURE 9 - 7
SOLAR STILL 100 TRTIUM

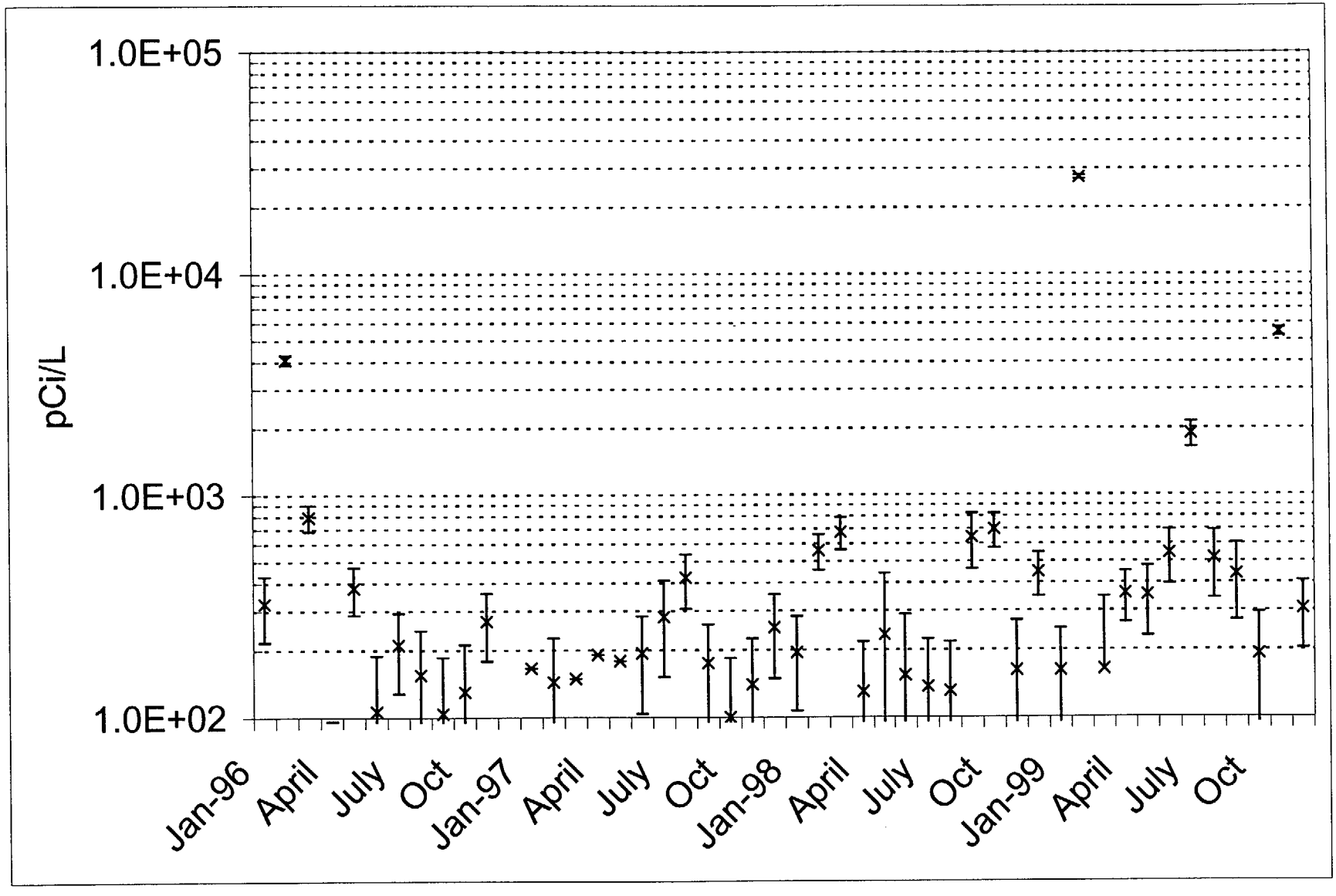


FIGURE 9 -8
SOLAR STILL 101 TRITUIM

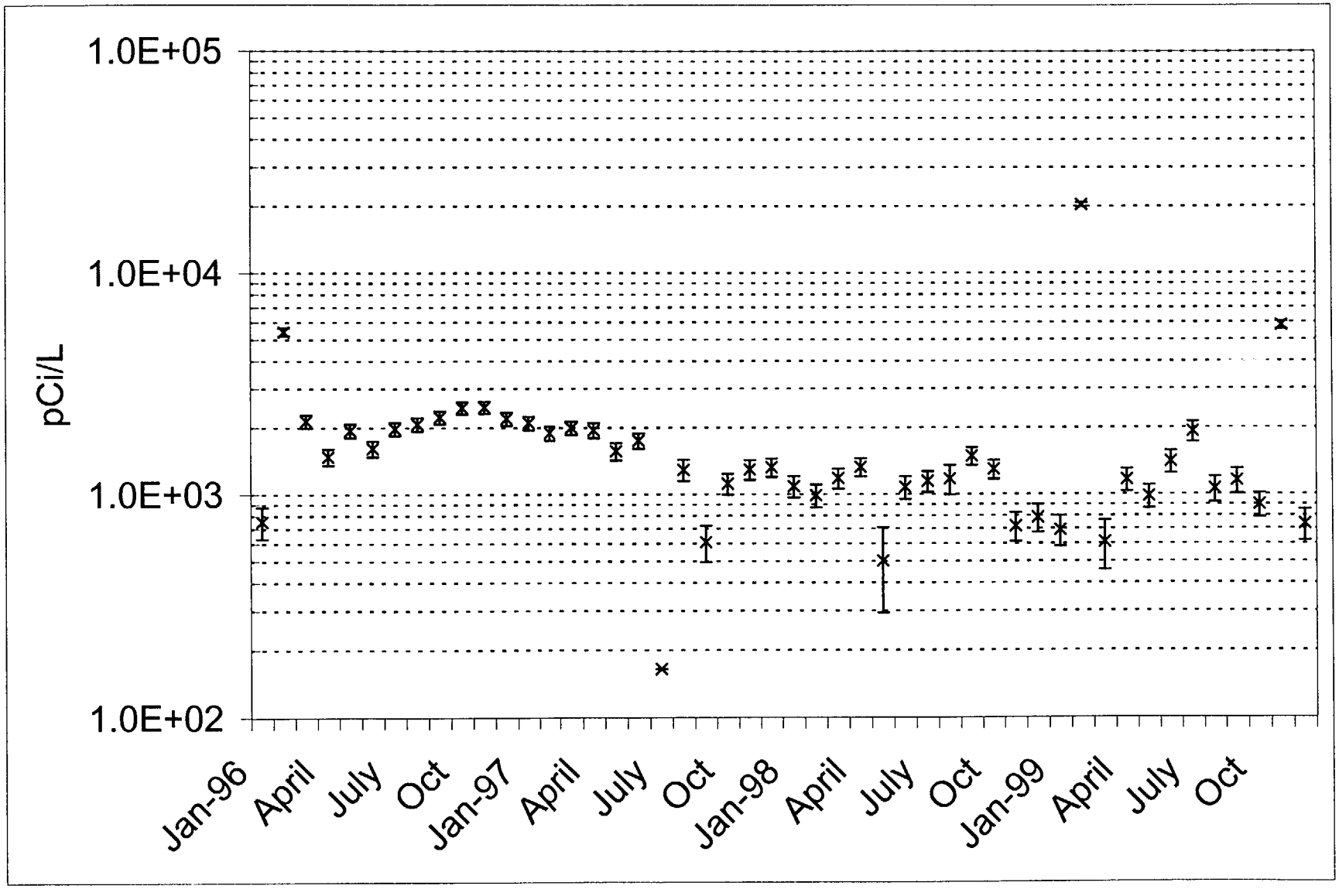


FIGURE 9 - 9
SOLAR STILL 102 TRITIUM

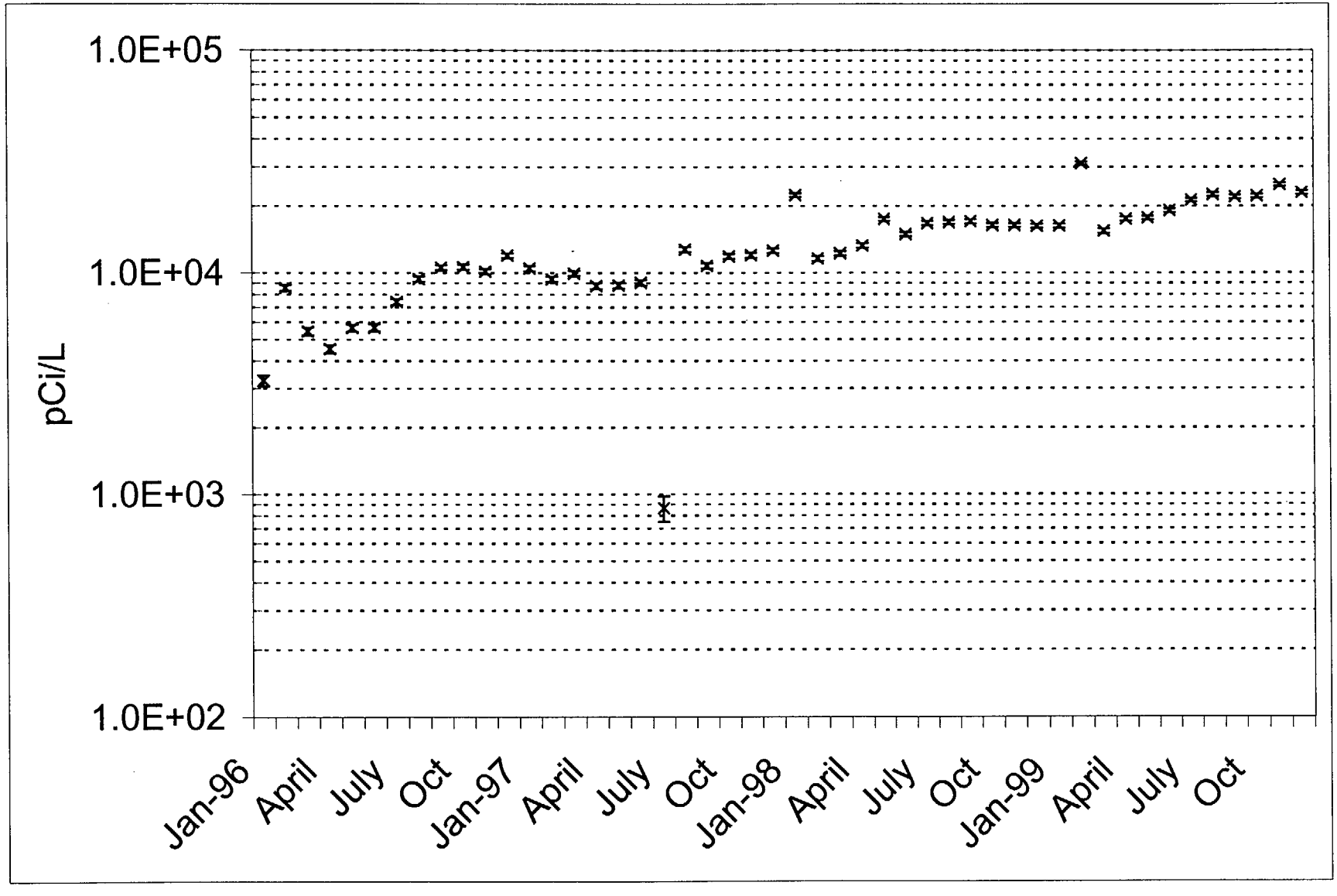
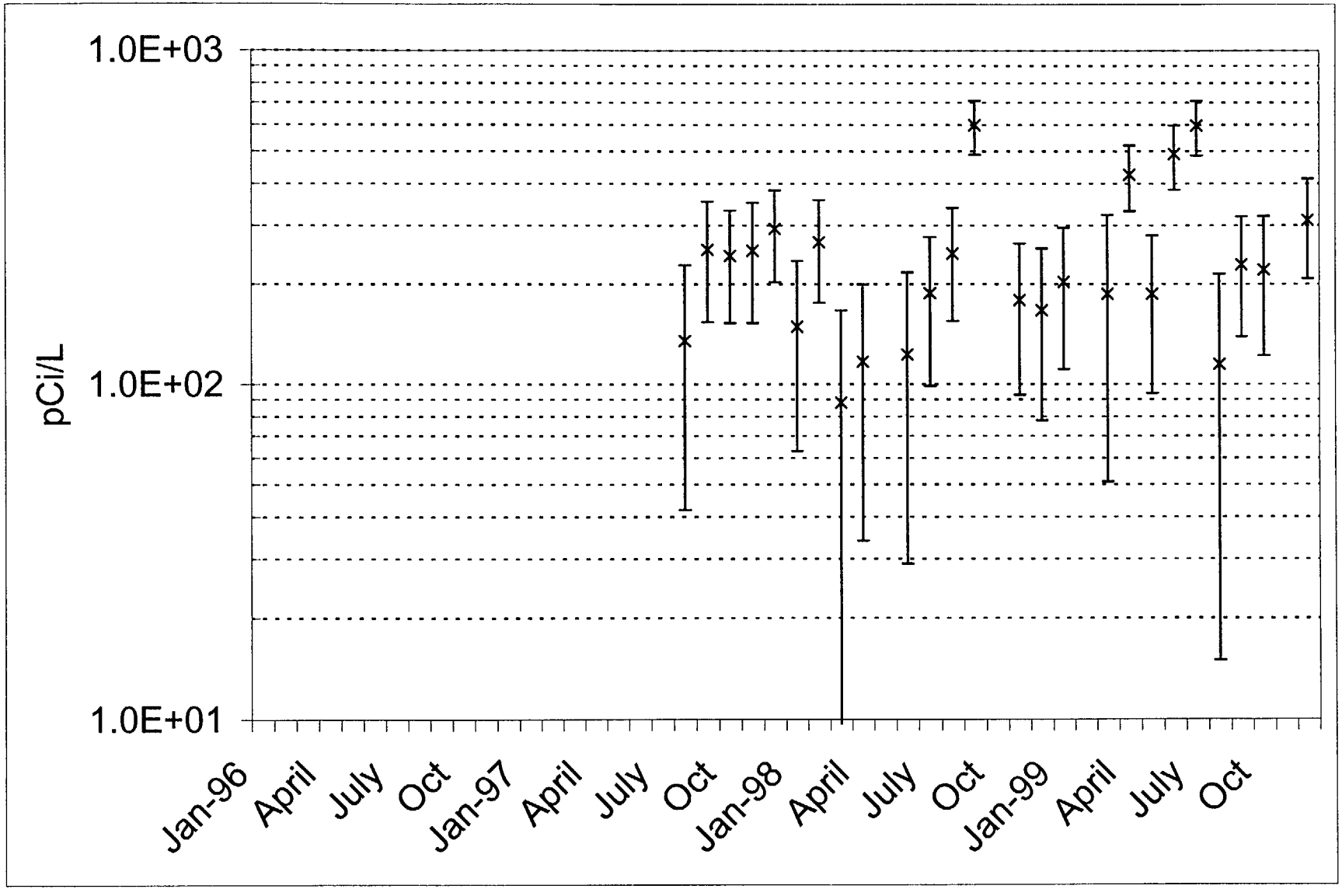


FIGURE 9 - 10
SOLAR STILL 103 TRITIUM



Notes:
1. Solar Still 103 was started in 1997

10.0 ANALYSES OF WELL WATER SAMPLES

US Ecology collects and analyzes groundwater samples quarterly at seven (7) wells to determine the presence of possible contamination from facility operations or other activities on the Hanford Reservation. Wells 3, 5, 8 and 10 are down gradient of the disposal units and Wells 9, 9a and 13 are upgradient. The groundwater samples were analyzed for potential radiological and chemical contaminants. Table 10.1 provides a historical comparison of groundwater gross alpha and gross beta data. Tables 10.2 through 10.5 present the radiological analysis results from radiological analyses. Table 10.6 through 10.9 presents non-radiological analysis results. Table 10.10 lists groundwater elevations for each well.

10.1 Gross Alpha and Beta Activity

Gross beta and gross alpha are sensitive and effective methods of detecting radioactivity in ground water. Gross alpha and gross beta measurements are useful for screening and identifying trends in radionuclide concentrations. However, the variability in naturally occurring radioactivity hinders distinguishing between naturally occurring radioactivity and low level contamination that may have migrated to ground water. In addition, the US Ecology Site is located close to and down-gradient from the Hanford Tank Farm leaks that have started to impact ground water.

The 1999 gross alpha activity concentration in groundwater samples varied from 0.7 pCi/l to 4.0 pCi/l. The mean gross alpha concentration was 2.1 pCi/l. There were no indications of increased gross alpha activity in any ground water samples. The investigation level for gross alpha activity is 12 pCi/l.

Gross beta activity varied from 6.0 pCi/l to 10.0 pCi/l. The mean beta concentration was 7.7 pCi/l. There were no indications of increased gross beta activity in ground water samples during 1999.

Table 10.1 gives the range of results for gross alpha and beta activity analysis in groundwater at the US Ecology site during previous years. Gross beta and alpha activity results for 1999 are similar to previous years. Results from upgradient and down gradient wells are also similar for gross alpha and gross beta concentrations. Review of upgradient versus down gradient groundwater monitoring well concentrations with previous year results, shows site operations have no discernible impact on gross alpha and gross beta activity in groundwater. Table 10.2 contains 1999 analytical results for groundwater samples. Figures 10.1 through 10.7 compare 1993 through 1999 gross beta results. Gross alpha plots are not provided, since well water alpha levels are consistently close to minimum detectable levels with no observable trends.

Table 10.1
Ground Water Gross Alpha and Gross Beta Comparisons

Year	Gross Alpha Activity Range (pCi/l)	Gross Beta Activity Range (pCi/l)
1991	< 2.0 to 4.0 E+0 ± 2.0 E+0	< 3.0 to 7.0 E+0 ± 4.0 E+0
1992	< 2.0 to 5.0 E+0 ± 2.0 E+0	4.2 E+0 ± 7.0 E-1 to 1.0 E+1 ± 3.0 E+0
1993	<2.0 to 2.4 E+0 ± 8.0 E-1	4.40 E+0 ± 7.0 E-1 to 7.60 E+0 ± 8.0 E-1
1994	6.0 E-1 ± 5.0 E-1 to 2.5 E+0 ± 7.0 E-1	4.6 E+0 + 5.0 E-1 to 8.6 E+0 + 9.0 E-1
1995	5.0 E-1 ± 8.0 E-1 to 2.9 E+0 ± 1.0 E 0	4.6 E-1 ± 1.2 E 0 to 11.7 E+0 ± 1.4 E 0
1996	7.0 E-1 ± 6.0 E-1 to 7.5 E+0 ± 8.0 E-1	1.9 E-0 ± 7.0 E-1 to 8.4 E+0 ± 8.0 E-1
1997	1.1 E+0 ± 6.0E-1 to 3.1 E+0 ± 9.0 E-1	5.1 E+0 ±8.0 E-1 14.4 E+0 ± 9.0 E-1
1998	1.1E+0 ± 7.0 E-1 to 3.3 E+0 ± 7.0 E-1	4.6 E+0 ± 7.0 E-1 to 1.46 E+1 ± 8.0 E+0
1999	7.0 E-1 ± 1.1 E+0 to 4.0 E+0 ± 9.0 E-1	6.0 E+0 ± 1.3 E+0 to 1.0 E+1 ± 1.3 E+0

Analytical uncertainties presented are two sigma of sample analytical result.
Well 13, 9 and 9a are upgradient wells.
Well 9 and 9a are the same location, but 9a is deeper and screened at a lower depth.

Action Levels:	Investigation Level	Reporting Level
Gross Alpha	12 pCi/L	15 pCi/L
Gross Beta	12 pCi/L	50 pCi/L
Tritium	3,600 pCi/L	20,000 pCi/L
Carbon-14	250 pCi/L	2,000 pCi/L

TABLE 10.2
Tritium, Carbon-14, Gross Alpha and Gross Beta Analytical Results

	Quarter	H-3 (pCi/l)			C14 (pCi/L)			Alpha (pCi/l)			Beta (pCi/l)		
WELL # 3	1ST 99	3279	+/-	177	-28	+/-	59	2.6	+/-	0.7	8.7	+/-	0.8
	2ND 99	3176	+/-	179	-26	+/-	63	2.2	+/-	1.1	10.0	+/-	1.3
	3RD 99	3352	+/-	191	48	+/-	60	1.4	+/-	0.6	7.8	+/-	0.7
	4TH 99	3131	+/-	171	31	+/-	69	1.3	+/-	0.7	7.7	+/-	0.8
WELL # 5	1ST 99	2011	+/-	148	10	+/-	58	2.4	+/-	0.7	7.5	+/-	0.7
	2ND 99	1669	+/-	144	1	+/-	67	0.8	+/-	0.9	6.6	+/-	1.3
	3RD 99	2017	+/-	161	53	+/-	60	2.9	+/-	0.8	6.8	+/-	0.8
	4TH 99	1672	+/-	136	11	+/-	64	1.2	+/-	0.6	7.0	+/-	0.7
WELL # 8	1ST 99	2493	+/-	160	-96	+/-	74	2.8	+/-	0.8	7.6	+/-	0.7
	2ND 99	2489	+/-	164	12	+/-	59	0.7	+/-	1.1	7.3	+/-	1.4
	3RD 99	2389	+/-	170	24	+/-	59	2.2	+/-	0.6	7.7	+/-	0.8
	4TH 99	2498	+/-	157	8	+/-	67	1.6	+/-	0.6	7.7	+/-	0.7
WELL #9	1ST 99	2884	+/-	169	4	+/-	58	2.6	+/-	0.7	8.1	+/-	0.7
	2ND 99	3115	+/-	178	123	+/-	61	1.4	+/-	0.9	7.6	+/-	1.4
	3RD 99	3385	+/-	189	51	+/-	60	2.5	+/-	0.8	8.0	+/-	0.7
	4TH 99	3286	+/-	174	3	+/-	62	1.6	+/-	0.6	6.9	+/-	0.7
WELL #9a	1ST 99	1245	+/-	128	-36	+/-	58	4.0	+/-	0.9	8.4	+/-	0.7
	2ND 99	1375	+/-	136	70	+/-	60	2.5	+/-	1.3	7.7	+/-	1.4
	3RD 99	1629	+/-	147	51	+/-	60	2.2	+/-	0.7	6.9	+/-	0.8
	4TH 99	1570	+/-	133	12	+/-	62	1.4	+/-	0.7	7.8	+/-	0.8
WELL #10	1ST 99	2155	+/-	152	-9	+/-	58	2.8	+/-	0.8	6.6	+/-	0.7
	2ND 99	2439	+/-	163	-1	+/-	66	1.1	+/-	1.1	6.0	+/-	1.3
	3RD 99	2413	+/-	170	-38	+/-	58	2.5	+/-	1.2	7.7	+/-	0.8
	4TH 99	2407	+/-	155	-21	+/-	64	2.4	+/-	0.7	6.4	+/-	0.7
WELL # 13	1ST 99	5469	+/-	219	-28	+/-	65	2.2	+/-	0.8	8.9	+/-	0.9
	2ND 99	4990	+/-	214	59	+/-	60	2.2	+/-	1.0	8.7	+/-	1.3
	3RD 99	5591	+/-	231	3	+/-	59	1.7	+/-	0.7	8.8	+/-	0.8
	4TH 99	5368	+/-	214	49	+/-	71	2.5	+/-	0.8	9.6	+/-	0.8
WELL # 16	1ST 99	-14	+/-	83	-54	+/-	58	0.3	+/-	0.4	0.1	+/-	0.6
(Field Blank)	2ND 99	-26	+/-	89	19	+/-	73	0.2	+/-	0.4	0.0	+/-	1.0
	3RD 99	-21	+/-	97	-7	+/-	59	0.2	+/-	0.3	2.0	+/-	0.6
	4TH 99	49	+/-	80	40	+/-	64	-0.2	+/-	0.2	0.1	+/-	0.6

Analytical uncertainties presented are two sigma of sample analytical result.
Well 13, 9 and 9a are upgradient wells.
Wells 9 and 9a are the same location, but Well 9a is deeper and screened at a lower depth.

Action Levels:	Investigation Level	Reporting Level
Gross Alpha	12 pCi/L	15 pCi/L
Gross Beta	12 pCi/L	50 pCi/L
Tritium	3,600 pCi/L	20,000 pCi/L
Carbon-14	250 pCi/L	2,000 pCi/L

10.2 Tritium and Carbon-14

Tritium is present in groundwater at the Hanford site due to both natural processes and previous tritium contaminated liquid waste ground discharges from Hanford Department of Energy facilities. The US Ecology LLRW disposal facility is adjacent to the 200 East and 200 West facilities of the Department of Energy Hanford Reservation. As presented in DOE's Hanford Site Environmental Report 1996, tritium concentrations can exceed 200,000 pCi/l in the regions surrounding the 200 East and 200 West areas. As expected, tritium contamination from these plumes is increasing the levels observed in US Ecology monitoring wells. Since down-gradient wells have lower tritium concentrations than upgradient wells, there is no detectable increase in ground water tritium due to US Ecology operations.

Results in 1999 ranged from 5591 pCi/l at Well 13 to 1245 at Well 9a. Well 13 has the highest tritium concentrations and appears to have an increasing trend. The investigation level for tritium in groundwater samples is 5000 pCi/l in Well 13 and 3600 pCi/L in the other wells. Well 13 consistently exceeds the tritium investigation level. Since Well 13 is an upgradient well, its tritium concentration is attributed to past DOE Hanford activities. Well 9 and 9a are also upgradient wells that draw their samples from the same location but at different depths. Well 9a, which is deeper and screened at a lower depth, has significantly lower tritium concentrations than Well 9. Table 10.2 presents 1999 tritium in groundwater concentrations. Figures 10.8 through 10.14 compare 1994 through 1999 groundwater tritium results. Table 10.3 compares tritium concentrations for down gradient wells with Well 13 by year.

Table 10.2 also presents 1999 carbon-14 measurements in groundwater samples. All 1999 results were less than the minimum detectable concentration of 200 pCi/l. These results are the same as those seen for carbon-14 in 1998. The investigation level for carbon-14 in groundwater is 250 pCi/l. Analytical results do not indicate any trends in carbon-14 concentrations.

Table 10.3
Comparison of Ground Water Tritium by Year

		Down Gradient Well 3,5,8,10	Upgradient Well 13
1994	Mean	2087	3289
	Max	3250	3559
	Min	1538	3010
1995	Mean	2222	3664
	Max	3329	3780
	Min	1646	3579
1996	Mean	2529	4030
	Max	3984	4106
	Min	1969	3941
1997	Mean	2494	4466
	Max	3297	4714
	Min	1953	4275
1998	Mean	2561	4846
	Max	3450	5062
	Min	2073	4642
1999	Mean	2474	5355
	Max	3352	5591
	Min	1669	4990

10.3 Gamma Emitting Radioisotopes in Groundwater

Water samples from the seven site environmental monitoring wells were analyzed by gamma spectrometry for the presence of gamma emitting radionuclides. No positive values were reported for man-made radioisotopes in groundwater. Table 10.4 lists minimum detectable concentrations for various isotopes. Therefore, site operations had no discernible effect on groundwater gamma emitting isotope concentrations.

TABLE 10.4
Minimum Detectable Concentrations for Gamma Spectroscopy Analyses of Groundwater

Radionuclide	(pCi/l)	Radionuclide	(pCi/l)	Radionuclide	(pCi/l)
Na-22	10	Co-58	10	Co-60	6
Fe-59	17	Zr/Nb-95	17	Ru-103	10
Ru-106	85	Sb-124	10	Sb-125	24
Cs-134	11	Cs-137	7	Ba/La-140	24
Ce-141	10	Ce/Pr-144	92	Eu-152	56
Eu-154	27	Eu-155	24	Zn-65	21

10.4 Plutonium in Groundwater

Groundwater samples taken from site monitoring wells were analyzed for Pu-238 and Pu-239/240. Table 10.5 presents the results of these analyses. All Pu-238 and Pu 239/240 samples were less than the minimum detectable concentration of 1.0 E-2 pCi/l. This is consistent with the results from previous years. The Pu-238 and Pu-239/240 investigation level is 3.0 E-2 pCi/l. No samples exceeded investigation levels.

TABLE 10.5

Plutonium in Groundwater 1999

	Quarter	Pu238 (pCi/l)			Pu239/240 (pCi/l)			Total Pu (pCi/l)	
WELL # 3	1ST 99	-0.001	+/-	0.003	-0.001	+/-	0.003	-0.002	0.004
	2ND 99	0.000	+/-	0.003	0.000	+/-	0.003	0.000	0.004
	3RD 99	0.006	+/-	0.007	0.000	+/-	0.003	0.006	0.008
	4TH 99	-0.001	+/-	0.007	-0.001	+/-	0.008	-0.002	0.011
WELL # 5	1ST 99	-0.002	+/-	0.015	0.000	+/-	0.008	-0.002	0.017
	2ND 99	0.000	+/-	0.003	0.000	+/-	0.003	0.000	0.004
	3RD 99	0.001	+/-	0.005	0.000	+/-	0.004	0.001	0.006
	4TH 99	-0.001	+/-	0.008	0.000	+/-	0.005	-0.001	0.009
WELL # 8	1ST 99	0.000	+/-	0.003	0.000	+/-	0.003	0.000	0.004
	2ND 99	0.005	+/-	0.006	0.000	+/-	0.003	0.005	0.007
	3RD 99	0.000	+/-	0.003	0.000	+/-	0.003	0.000	0.004
	4TH 99	0.001	+/-	0.006	0.000	+/-	0.004	0.001	0.007
WELL #9	1ST 99	0.001	+/-	0.003	0.000	+/-	0.003	0.001	0.004
	2ND 99	0.000	+/-	0.003	0.000	+/-	0.003	0.000	0.004
	3RD 99	0.000	+/-	0.004	0.003	+/-	0.005	0.003	0.006
	4TH 99	0.000	+/-	0.005	0.000	+/-	0.005	0.000	0.007
WELL #9a	1ST 99	-0.001	+/-	0.003	-0.001	+/-	0.003	-0.002	0.004
	2ND 99	0.000	+/-	0.004	0.001	+/-	0.005	0.001	0.006
	3RD 99	0.000	+/-	0.005	0.000	+/-	0.005	0.000	0.007
	4TH 99	0.000	+/-	0.007	0.002	+/-	0.011	0.002	0.013
WELL #10	1ST 99	0.000	+/-	0.002	0.000	+/-	0.002	0.000	0.003
	2ND 99	0.000	+/-	0.003	0.000	+/-	0.003	0.000	0.004
	3RD 99	0.000	+/-	0.007	0.000	+/-	0.007	0.000	0.010
	4TH 99	0.000	+/-	0.003	-0.001	+/-	0.003	-0.001	0.004
WELL # 13	1ST 99	-0.001	+/-	0.002	0.000	+/-	0.003	-0.001	0.004
	2ND 99	0.000	+/-	0.003	0.000	+/-	0.004	0.000	0.005
	3RD 99	0.000	+/-	0.005	0.000	+/-	0.005	0.000	0.007
	4TH 99	0.003	+/-	0.009	0.001	+/-	0.006	0.004	0.011
WELL # 16	1ST 99	0.000	+/-	0.003	0.000	+/-	0.003	0.000	0.004
	2ND 99	0.002	+/-	0.008	0.005	+/-	0.010	0.007	0.013
	3RD 99	0.000	+/-	0.003	0.000	+/-	0.003	0.000	0.004
	4TH 99	0.000	+/-	0.005	0.000	+/-	0.005	0.000	0.007

Action Levels:	Investigation Level	Reporting Level
Plutonium-238, 239/240	0.03 pCi/L	40 pCi/L

10.5 Uranium in Groundwater

Table 10.6 contains the analytical results for total uranium. Total uranium consists of the sum of uranium-234, 235 and 238 concentrations. Reported values for total uranium varied from a maximum of 2.86 pCi/l at Well 8 to a minimum of 1.01 pCi/l in Well 9a. The mean concentration was 2.3 pCi/l. All total uranium sample concentrations were less than the investigation level of 4.5 E+0 pCi/l. There were no trends or other indications of elevated uranium concentrations at any location.

Figures 10.15 through 10.24 compare 1994 through 1999 groundwater total uranium results. No discernible trends in total uranium concentrations are evident.

TABLE 10.6

Total Uranium in Groundwater (pCi/L)1999

WELL # 3	1ST 99	2.60 +/- 0.42		WELL #9a	1ST 99	2.70 +/- 0.45	
	2ND 99	2.29 +/- 0.31			2ND 99	2.08 +/- 0.20	
	3RD 99	2.35 +/- 0.21			3RD 99	2.16 +/- 0.20	
	4TH 99	1.93 +/- 0.30			4TH 99	1.01 +/- 0.31	
WELL # 5	1ST 99	2.36 +/- 0.37		WELL #10	1ST 99	2.39 +/- 0.42	
	2ND 99	2.54 +/- 0.24			2ND 99	1.80 +/- 0.18	
	3RD 99	2.77 +/- 0.20			3RD 99	2.17 +/- 0.27	
	4TH 99	2.31 +/- 0.36			4TH 99	1.87 +/- 0.46	
WELL # 8	1ST 99	2.86 +/- 0.41		WELL # 13	1ST 99	2.66 +/- 0.39	
	2ND 99	2.65 +/- 0.23			2ND 99	2.50 +/- 0.21	
	3RD 99	2.57 +/- 0.22			3RD 99	2.17 +/- 0.20	
	4TH 99	2.29 +/- 0.37			4TH 99	2.51 +/- 0.35	
WELL #9	1ST 99	2.27 +/- 0.43		WELL # 16	1ST 99	0.12 +/- 0.16	
	2ND 99	2.17 +/- 0.22		(Field Blank)	2ND 99	0.01 +/- 0.08	
	3RD 99	2.43 +/- 0.20			3RD 99	0.06 +/- 0.15	
	4TH 99	1.72 +/- 0.37			4TH 99	0.08 +/- 0.08	

Action Levels:
Total Uranium Investigation Level 4.5 pCi/L Reporting Level 30 pCi/L

10.6 Nonradiological Analysis

US Ecology performs quarterly groundwater monitoring for nonradiological constituents. The procedure for gathering these samples is the same as that for radiological samples with the exception that nonradiological samples are placed in an ice chest and maintained at four degrees Celsius. In 1999, groundwater samples were analyzed for specific conductivity, total organic carbon (TOC), total organic halogens (TOX), nitrates, chlorides, sulfates, dissolved solids, benzene, ethyl-benzene, toluene and xylene. Table 10.7 summarizes the results for chlorides, nitrites, pH, Specific Conductance and sulfate for ground water samples. Table 10.8 provides the results of non-radiological sampling for 1999.

Table 10.7
Summary of Non-Radiological Groundwater Analysis

		Chloride ppm	Nitrate ppm	pH	TDS ppm	Conduct. umhos/cm	Sulfate Ppm
1994	Mean	6.7	3.8	7.3	268.8	408	24.1
	Max	19.0	5.0	7.9	442.0	446	28.0
	Min	5.0	3.2	7.3	241.0	406	23.0
1995	Mean	6.3	3.9	7.4	241.0	383	24.0
	Max	12.0	4.8	8.0	286.0	430	28.0
	Min	5.0	3.5	7.6	201.0	378	21.0
1996	Mean	7.6	4.2	7.2	233.5	373	26.2
	Max	12.0	5.9	8.4	280.0	422	30.0
	Min	5.0	3.5	7.4	187.0	368	26.0
1997	Mean	7.6	4.7	7.3	234.3	378	23.9
	Max	32.0	6.5	7.9	349.0	405	29.0
	Min	5.0	3.9	7.1	174.0	374	21.0
1998	Mean	7.8	4.8	7.4	255.8	359	24.1
	Max	9.0	6.0	8.2	288.0	395	31.0
	Min	7.0	3.4	7.3	244.0	312	10.0
1999	Mean	7.7	4.5	7.5	258.9	377	24.4
	Max	9.0	5.6	8.1	342.0	401	29.0
	Min	7.0	4.0	7.5	230.0	376	20.0

As can be seen from Table 10.7, chlorides, nitrites, pH, specific conductance, sulfates and total dissolved solids are similar for all wells and have not changed appreciably over time. In addition, nitrate concentrations are low in comparison to surrounding areas, which range from 20 to over 1,000 ppm in the region surrounding Hanford's 200 East and 200 West. Chlorides, nitrites, sulfates, total dissolved solids and specific conductance are compared by well in Figures 10-29 through 10–33. Well water pH was not plotted by well location, due to inconsistent tracking between field measurements and laboratory analysis. Although there are occasional elevated or depressed values, ground water quality does not appear to vary by well or have changed over time.

During the second quarter of 1999, US Ecology also, analyzed groundwater wells for the following 40 CFR 264, Appendix IX constituents: barium, calcium, cadmium, chromium, magnesium, manganese, mercury, potassium, silver, and sodium. Table 10.9 presents the sample results. Comparison of the results from groundwater Wells 3, 5, 8, and 10 to the upgradient Wells 9, 9a and 13 results demonstrate that the US Ecology disposal site has not contributed to hazardous waste contamination in the groundwater.

Table 10- 8
Chemical Anlaysis of Well Water Samples 1999

		Chloride	Nitrate	pH	TDS	Specific Conduct.	Sulfate	TOC a	TOC b	TOC c	TOC d	TOXa	TOXb	TOX c	TOXd	Benzene	Ethly-Benzene	Toluene	Xylene	Phenols
		ppm	ppm		mg/l	umhos/cm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	ppb	ppb	ppb	ppb
WELL # 3	1ST 99	8	5.0	7.93	272	379	26	<1.0	<1.0	<1.0	<1.0	0.019	0.014	0.016	0.015	<1.0	<1.0	<1.0	<1.0	
	2ND 99	8	5.1	7.87	250	401	26	17.2	15.8	15.9	15.1	0.015	0.013	0.015	0.014	<1.0	<1.0	<1.0	<1.0	<0.020
	3RD 99	8	4.7	7.86	306	400	29	<1.0	<1.0	<1.0	<1.0	0.015	0.020	0.016	0.014	<1.0	<1.0	<1.0	<3.0	
	4TH 99	8	5.3	7.87	234	396	27	<1.0	<1.0	<1.0	<1.0	0.017	0.022	0.019	0.022	<1.0	<1.0	<1.0	<3.0	
WELL # 5	1ST 99	8	4.3	7.68	262	377	27	<1.0	<1.0	<1.0	<1.0	<0.010	<0.010	<0.010	<0.010	<1.0	<1.0	<1.0	<1.0	
	2ND 99	7	4.5	7.84	252	399	20	22.6	21.1	21.0	22.1	0.013	0.013	0.011	<0.01	<1.0	<1.0	<1.0	<1.0	<0.020
	3RD 99	8	4.1	7.83	314	396	27	<1.0	<1.0	<1.0	<1.0	<1.0	0.015	0.019	0.016	0.0	<1.0	<1.0	<1.0	
	4TH 99	8	4.5	7.52	252	393	26	<1.0	<1.0	<1.0	<1.0	0.015	0.018	0.027	0.018	<1.0	<1.0	<1.0	<3.0	
WELL # 8	1ST 99	8	4.8	7.74	260	376	25	<1.0	<1.0	<1.0	<1.0	<0.010	<0.010	<0.010	<0.010	<1.0	<1.0	<1.0	<1.0	
	2ND 99	8	4.9	7.86	263	394	21	23.0	23.3	22.9	22.8	<0.01	<0.01	<0.01	<0.01	4.5	<1.0	2.7	2.9	<0.020
	3RD 99	8	4.5	7.93	280	398	28	<1.0	<1.0	<1.0	<1.0	<0.010	<0.010	<0.010	<0.010	<1.0	<1.0	<1.0	<3.0	
	4TH 99	8	5.0	7.60	236	389	27	<1.0	<1.0	<1.0	<1.0	<0.010	<0.010	<0.010	<0.010	<1.0	<1.0	<1.0	<3.0	
WELL #9	1ST 99	8	5.4	7.67	263	376	24	<1.0	<1.0	<1.0	<1.0	<0.010	<0.010	<0.010	<0.010	<1.0	<1.0	<1.0	<1.0	
	2ND 99	8	4.5	7.76	233	395	26	22.1	18.4	19.4	21.1	<0.010	<0.010	<0.010	<0.010	<1.0	<1.0	1.0	<1.0	<0.020
	3RD 99	8	4.1	7.31	303	397	26	<1.0	<1.0	<1.0	<1.0	<0.010	<0.010	<0.010	<0.010	<1.0	<1.0	<1.0	<3.0	
	4TH 99	8	4.9	7.84	254	390	26	<1.0	<1.0	<1.0	<1.0	<0.010	<0.010	<0.010	<0.010	<1.0	<1.0	<1.0	<3.0	
WELL #9a	1ST 99	8	4.6	7.62	260	385	26	<1.0	<1.0	<1.0	<1.0	<0.010	<0.010	<0.010	<0.010	<1.0	<1.0	<1.0	<1.0	
	2ND 99	7	4.9	7.77	235	401	26	11.5	10.2	10.7	10.6	<0.010	<0.010	<0.010	<0.010	<1.0	<1.0	<1.0	<1.0	<0.020
	3RD 99	8	4.3	7.73	334	402	27	<1.0	<1.0	<1.0	<1.0	<0.010	<0.010	<0.010	<0.010	<1.0	<1.0	<1.0	<3.0	
	4TH 99	8	5.0	7.79	272	395	24	<1.0	<1.0	<1.0	<1.0	<0.010	<0.010	<0.010	<0.010	<1.0	<1.0	<1.0	<3.0	
WELL #10	1ST 99	7	4.2	7.75	260	380	24	<1.0	<1.0	<1.0	<1.0	<0.01	<0.01	<0.01	<0.01	<1.0	<1.0	<1.0	<1.0	
	2ND 99	7	4.4	8.10	269	393	24	18.1	18.0	18.1	17.9	<0.01	<0.01	<0.01	<0.01	<1.0	<1.0	<1.0	<1.0	<0.020
	3RD 99	8	4.0	8.10	342	392	27	<1.0	<1.0	<1.0	<1.0	<0.010	<0.010	<0.010	<0.010	<1.0	<1.0	<1.0	<3.0	
	4TH 99	8	4.2	8.06	264	388	25	<1.0	<1.0	<1.0	<1.0	<0.010	<0.010	<0.010	<0.010	<1.0	<1.0	<1.0	<3.0	
WELL # 13	1ST 99	9	4.8	7.70	240	379	24	<1.0	<1.0	<1.0	<1.0	<0.010	<0.010	<0.010	<0.010	<1.0	<1.0	<1.0	<1.0	
	2ND 99	8	4.9	7.84	268	393	20	14.8	14.0	13.9	14.1	<0.010	<0.010	<0.010	<0.010	<1.0	<1.0	<1.0	<1.0	<0.020
	3RD 99	9	4.4	7.86	301	388	26	<1.0	<1.0	<1.0	<1.0	<0.010	<0.010	<0.010	<0.010	<1.0	<1.0	<1.0	<3.0	
	4TH 99	8	5.6	7.89	230	383	24	<1.0	<1.0	<1.0	<1.0	<0.010	<0.010	<0.010	<0.010	<1.0	<1.0	<1.0	<3.0	
WELL # 16	1ST 99	5	<1.0	8.42	<25	1	<10	<1.0	<1.0	<1.0	<1.0	<0.01	<0.01	<0.01	<0.01	<1.0	<1.0	<1.0	<1.0	
Field Blank	2ND 99	5	<1.0	5.48	<25	2	<10	<1.0	<1.0	<1.0	<1.0	<0.01	<0.01	<0.01	<0.01	<1.0	<1.0	<1.0	<1.0	<0.020
	3RD 99	5	<1.0	5.87	<25	<1.0	<10	<1.0	<1.0	<1.0	<1.0	<0.010	<0.010	<0.010	0.011	<1.0	<1.0	<1.0	<3.0	
	4TH 99	5	<1.0	6.70	<25	4	<10	<1.0	<1.0	<1.0	<1.0	<0.010	<0.010	<0.010	<0.010	<1.0	<1.0	<1.0	<3.0	

Phenol analysis was only performed in the second quarter.
Four seperate sample (A,B,C,D) are collected for TOC and TOX analysis.
BC = broken container
Wells 1[illegible] [illegible]nd 9a are the upgradient wells.

TABLE 10.9
40 CFR 264, Appendix IX Metals
GROUNDWATER MONITORING WELLS

	Ca ppm	Mg ppm	Hg ppm	K ppm	Ag Ppm	Na Ppm	Ba ppm	Cd Ppm	Cr Ppm	Fe ppm	Mn ppm
WELL # 3	42	15	<0.0002	5	<0.040	18	0.038	<0.01	0.11	0.051	<0.01
WELL # 5	41	14	<0.0002	5	<0.040	17	0.038	<0.01	0.06	0.083	<0.01
WELL # 8	40	15	<0.0002	5	<0.040	21	0.042	<0.01	0.06	0.055	<0.01
WELL #9	39	15	<0.0002	4	<0.040	16	0.041	<0.01	0.09	<0.05	<0.01
WELL #9A	42	16	<0.0002	4	<0.040	16	0.046	<0.01	0.10	<0.05	<0.01
WELL #10	38	15	<0.0002	5	<0.040	17	0.045	<0.01	0.05	<0.05	<0.01
WELL # 13	40	14	<0.0002	5	<0.040	18	0.045	<0.01	0.09	0.124	<0.01
WELL # 16	<1.0	<1.0	<0.0002	<1.0	<0.040	<1.0	<0.020	<0.01	<0.04	0.053	<0.01

10.7 Groundwater Elevations

The elevation above sea level (MSL) for the top of the wells concrete pad and sounding tube, the top of water, and the bottom of each well are provided in Table 10.10. The elevation of the top of water by quarter and year are graphed in Figures 10.22 through 10.28.

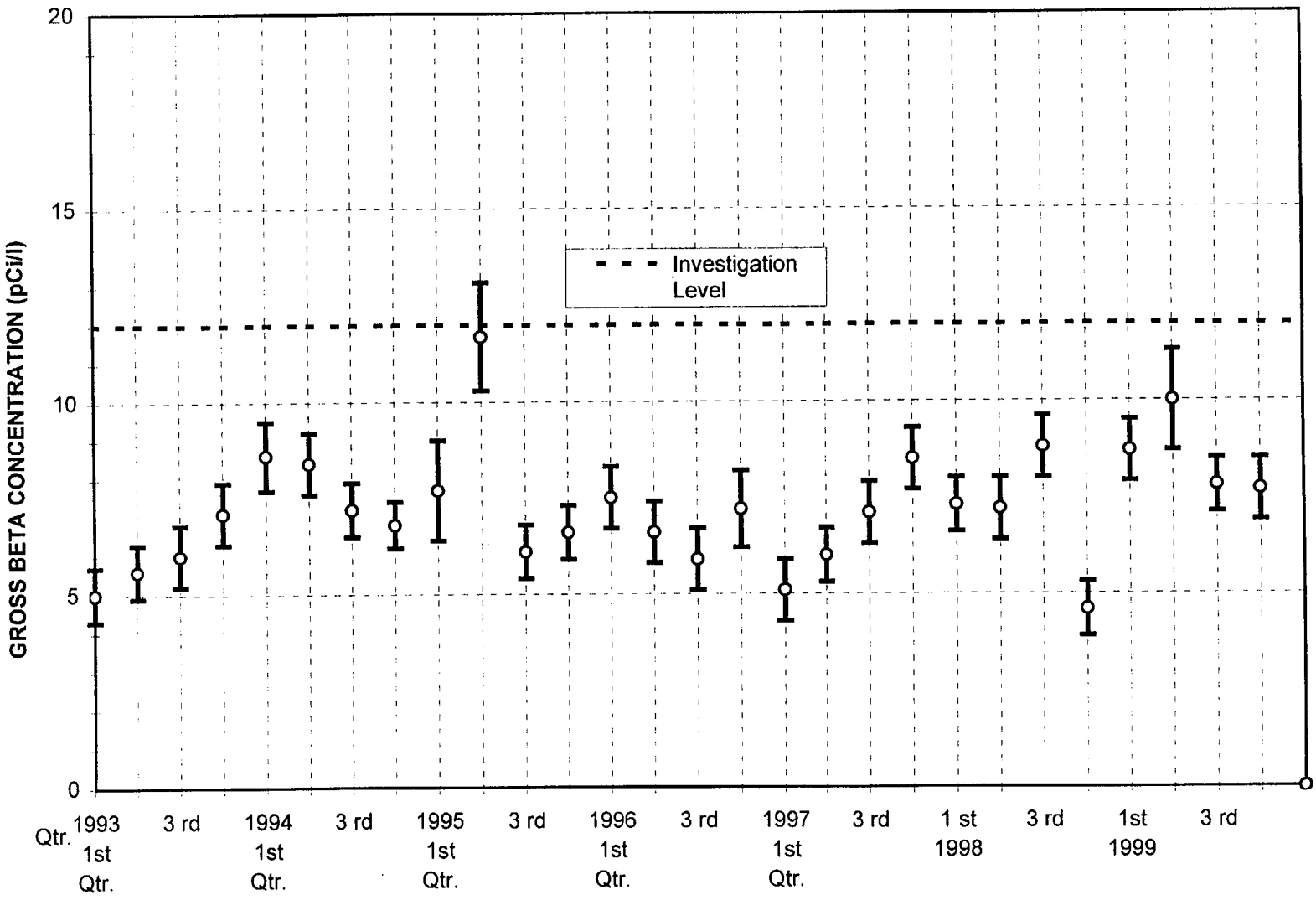
TABLE 10.10

Groundwater Elevations (ft.) 1999

				1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
	MSL Top of Pad	MSL Top Sounding Tube	MSL to Bottom of Well	MSL to Top of Water	MSL to Top of Water	MSL to Top of Water	MSL to Top of Water
Well 3	723.1	725.8	371.8	401.4	401.9	400.5	400.4
Well 5	722.0	723.6	370.6	400.2	400.3	400.4	400.2
Well 8	724.6	726.8	373.5	400.4	400.1	400.3	400.0
Well 9	722.4	725.0	372.6	404.8	404.8	404.8	404.3
Well 9a	722.3	725.2	347.6	404.8	404.8	404.8	404.6
Well 10	734.0	736.57	371.9	400.3	400.1	400.1	400.0
Well 13	723.6	726.2	374.0	404.7	406.7	406.6	406.3

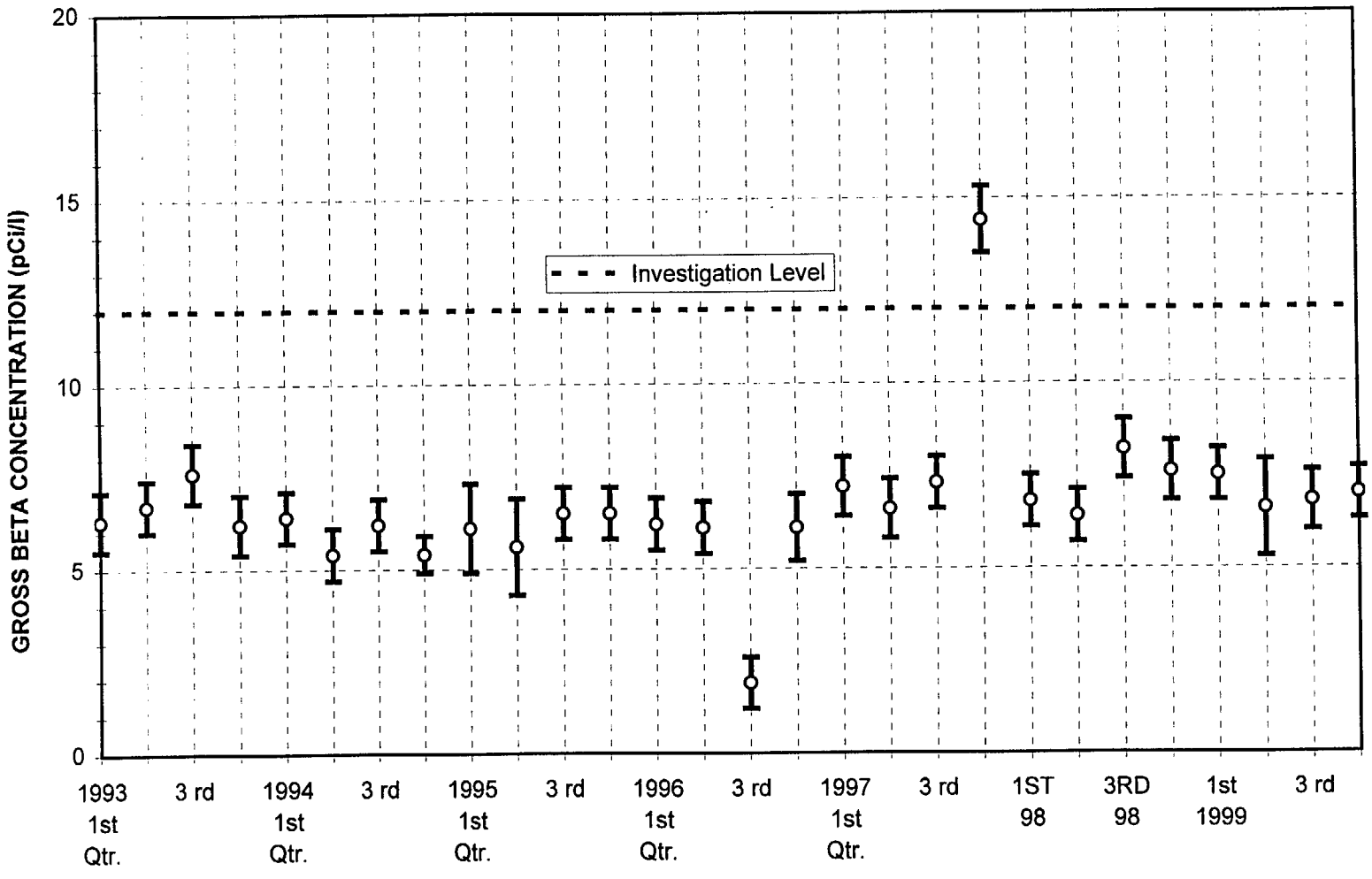
Notes:
1. Depth to bottom of well measured only once per year.
2. Each well uses its own sounding device. An equipment malfunction required replacing Well 13's probe in the first quarter of 1999.

FIGURE 10.1
GROSS BETA IN GROUNDWATER
WELL 3 - RICHLAND, WASHINGTON



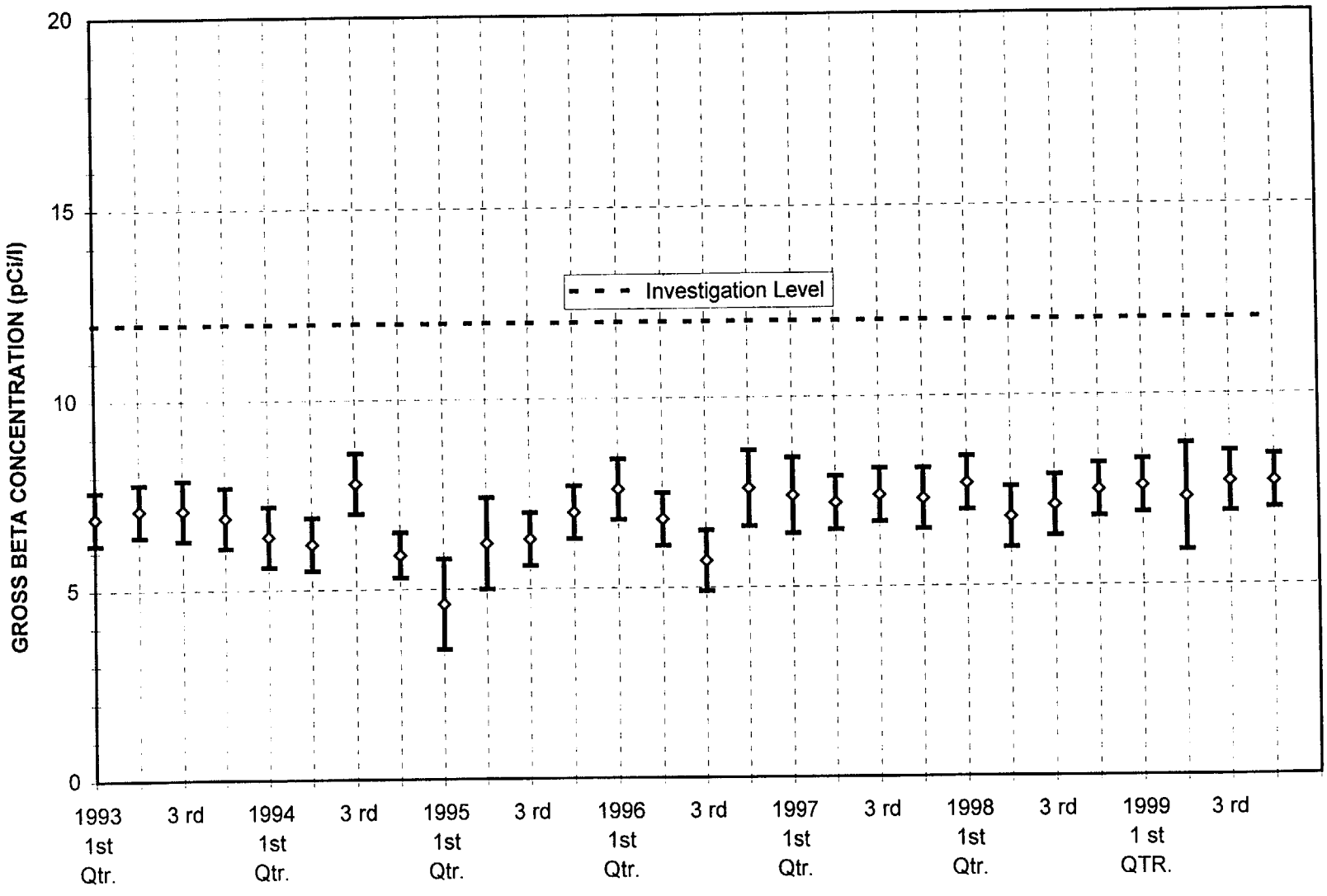
Gross Beta in Ground Water Investigation Level = 12 pCi/L
Gros[illegible]ta in Ground Water reporting level = 50 pCi/L

FIGURE 10.2
GROSS BETA IN GROUNDWATER
WELL 5 - RICHLAND, WASHINGTON



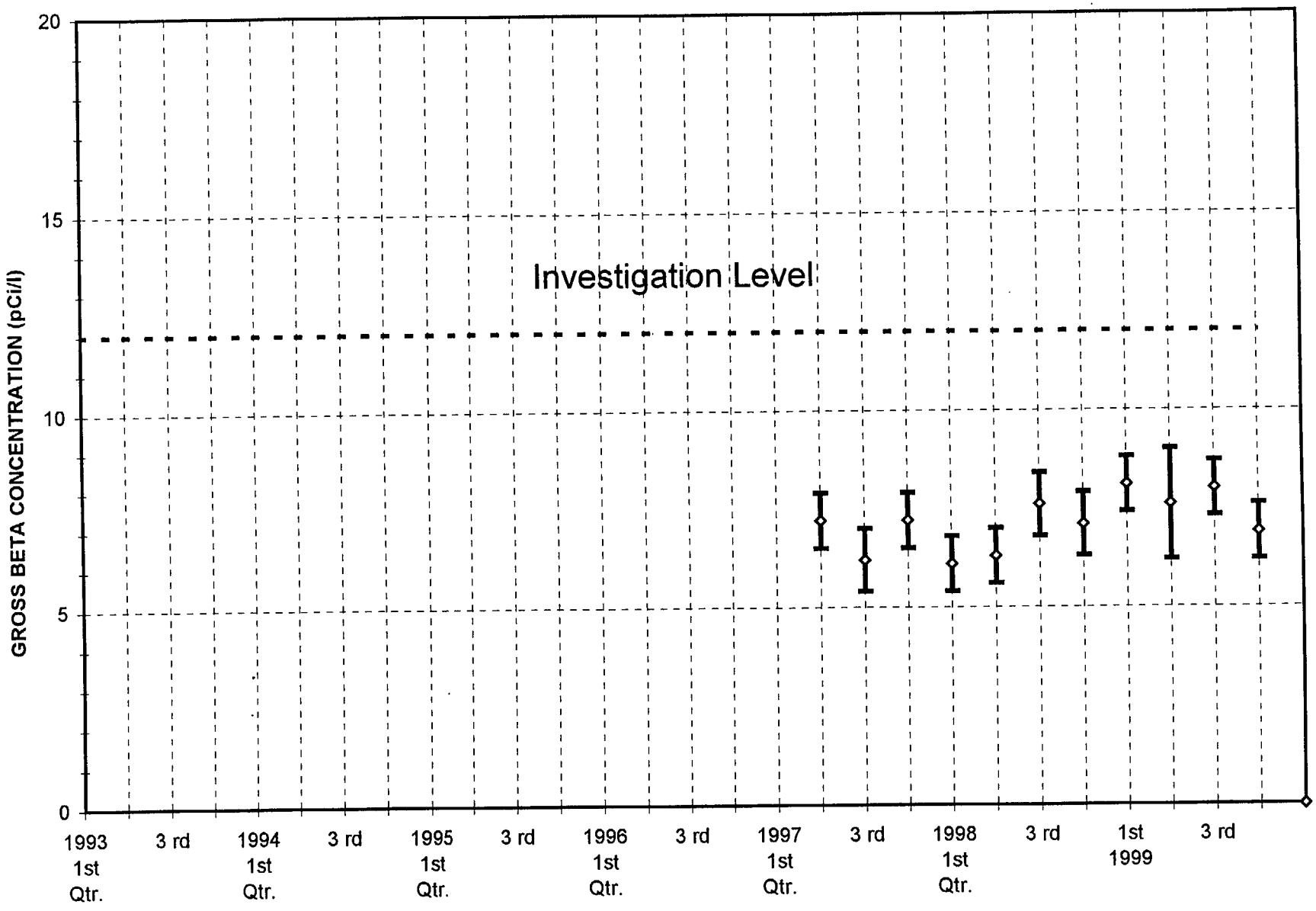
Gross beta in Groundwater Investigation Level = 12 pCi/L
Gross Beta in Groundwater Reporting Level = 50 pCi/L

FIGURE 10.3
GROSS BETA IN GROUNDWATER
WELL 8 - RICHLAND, WASHINGTON



Gross Beta in Groundwater Investigation Level = 12 pCi/L
Gros[illegible]eta in Groundwater Reporting Level = 50 pCi/L

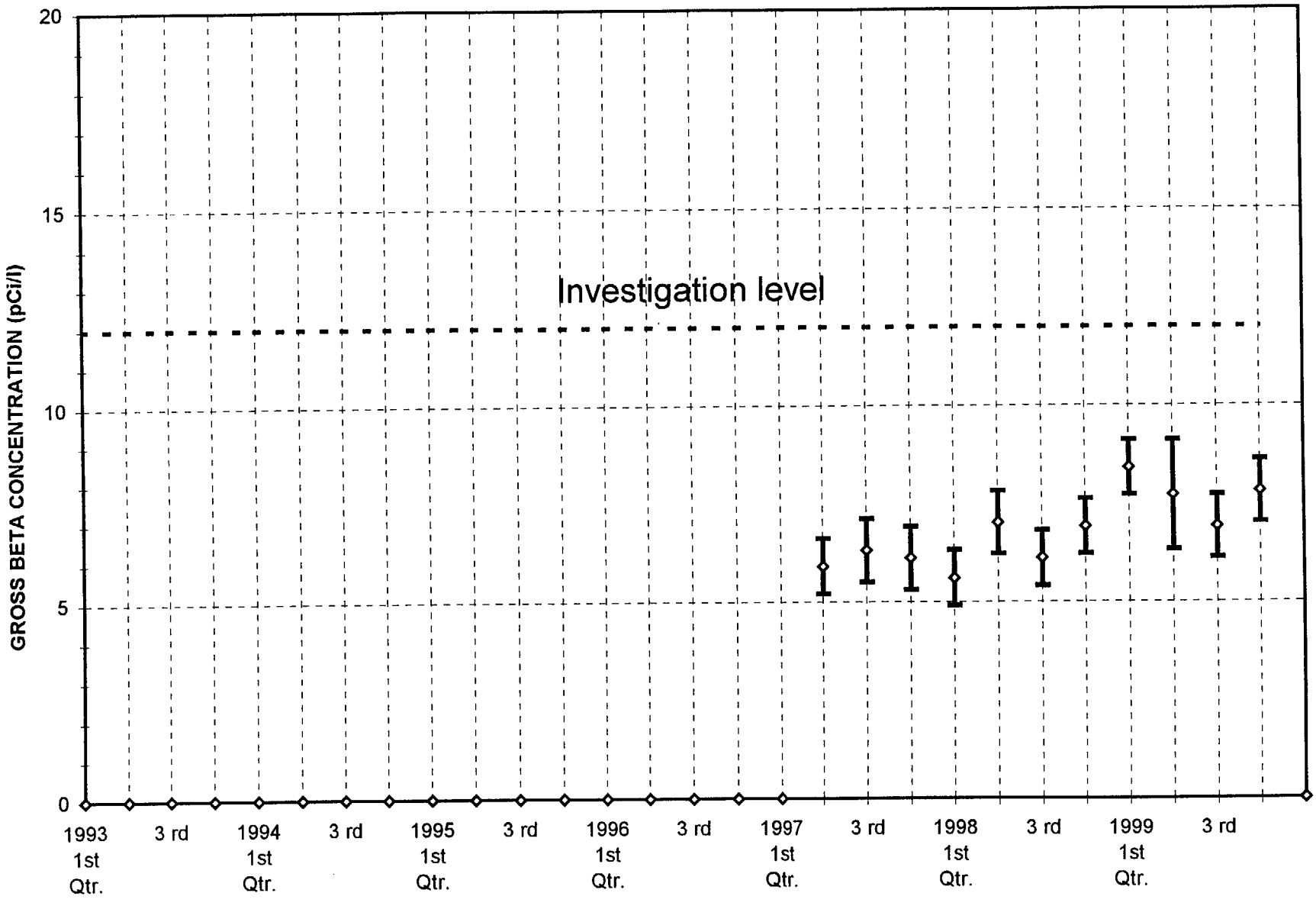
Figure 10.4
Gross Beta in Groundwater Well 9 - Richland Washington



Gross Beta in Groundwater Investigation Level = 12 pCi/L
Gross Beta in Groundwater Reporting Level = 50 pCi/L

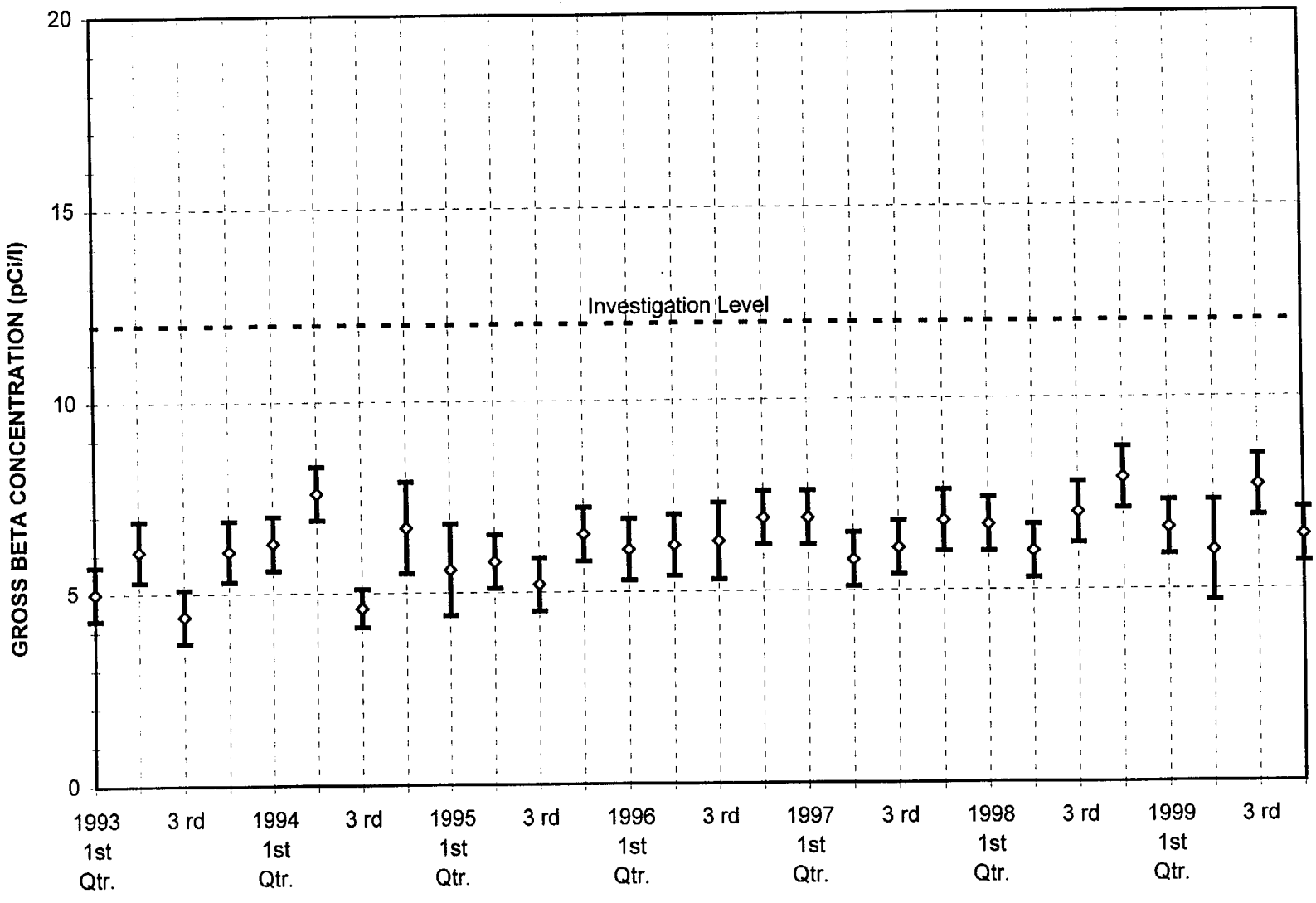
Well 9 Operational Second Quarter 1997.

Figure 10.5
Gross Beta in Groundwater
Well 9a - Richland Washington



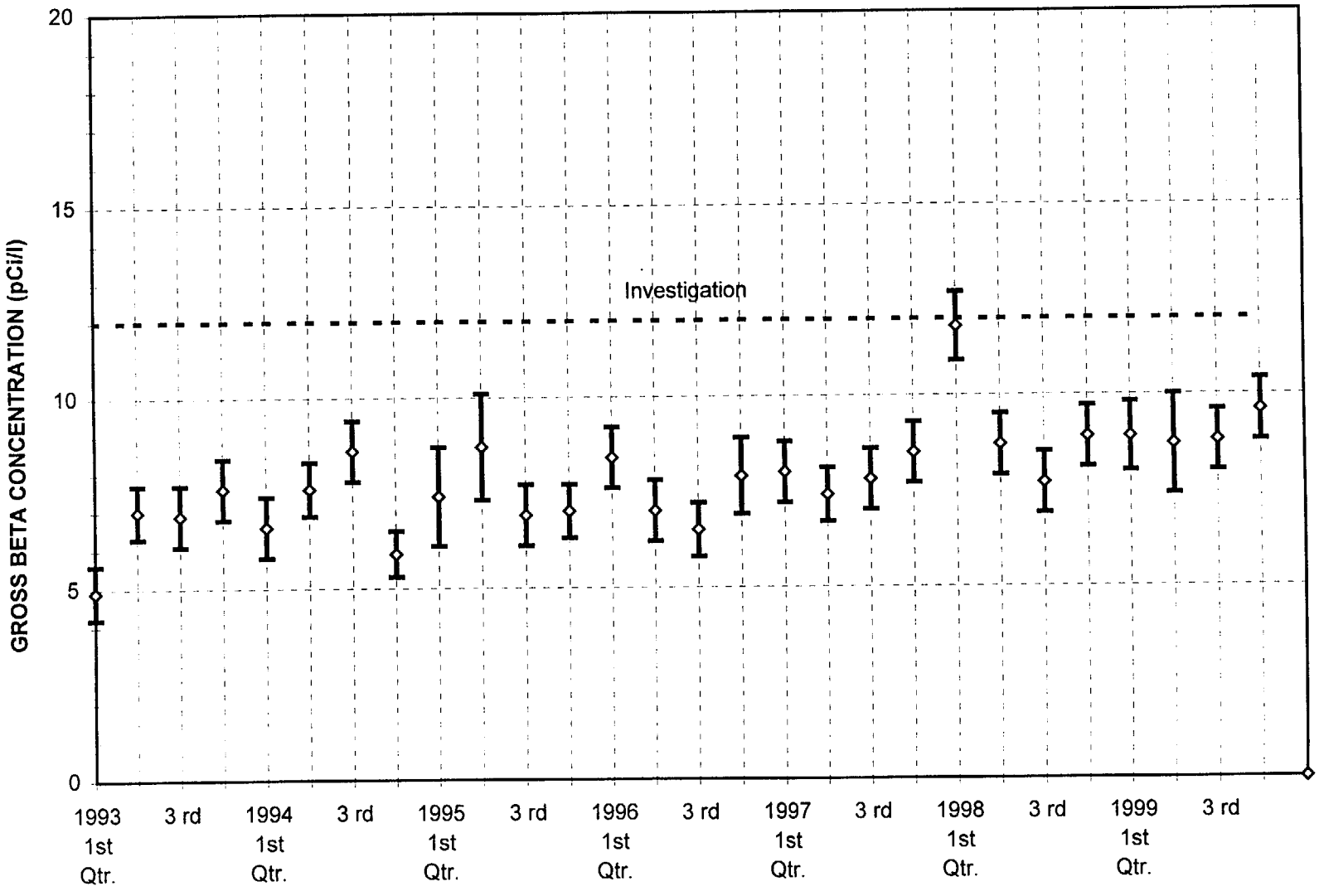
Gross Beta in Groundwater Investigation Level = 12 pCi/L
Gross Beta in Groundwater Reporting level = 50 pCi/L

FIGURE 10.6
GROSS BETA IN GROUNDWATER
WELL 10 - RICHLAND, WASHINGTON



Gross Beta in Groundwater Investigation Level = 12 pCi/L
Gross Beta in Groundwater Reporitng Level = 50 pCi/L

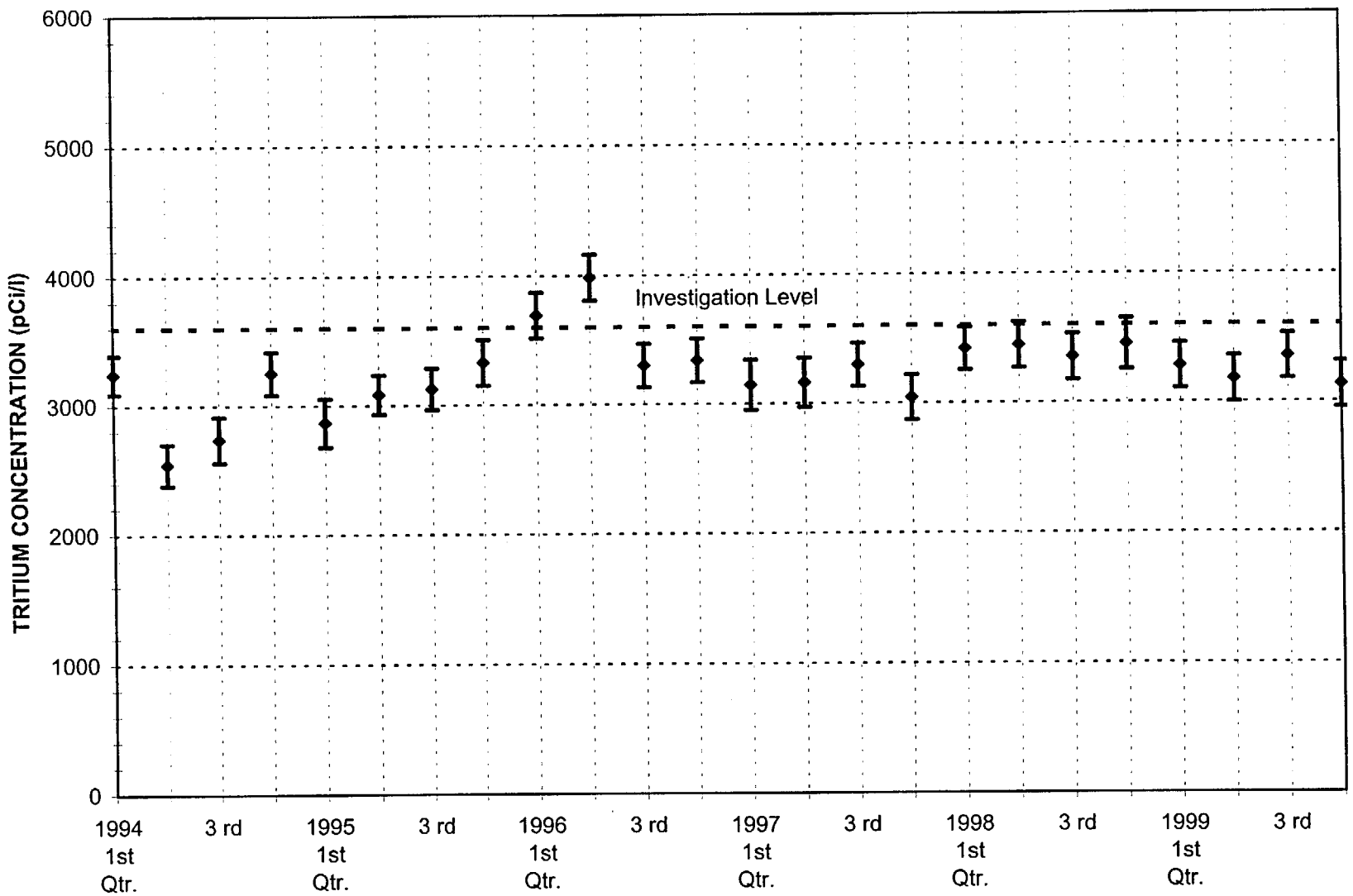
FIGURE 10.7
GROSS BETA IN GROUNDWATER
WELL 13 - RICHLAND, WASHINGTON



Gro[illegible]eta In Groundwater Investigation Level = 12 pCi/L

FIGURE 10.8
TRITIUM IN GROUNDWATER

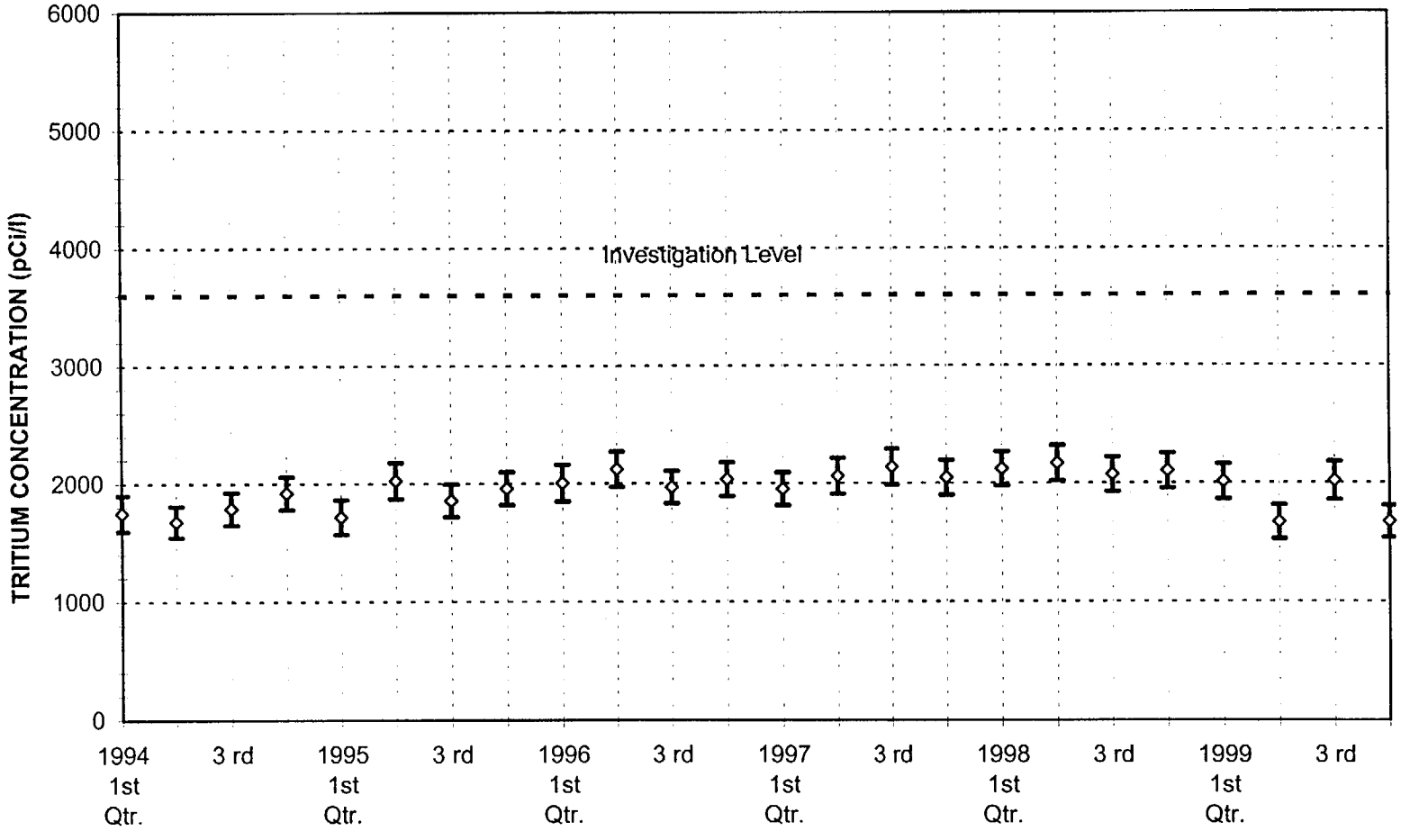
WELL 3 - RICHLAND, WASHINGTON



Tritium Investigation Level 3,600 pCi/L
Tritium Reporting Level 20,000 pCi/L

FIGURE 10.9
TRITIUM IN GROUNDWATER

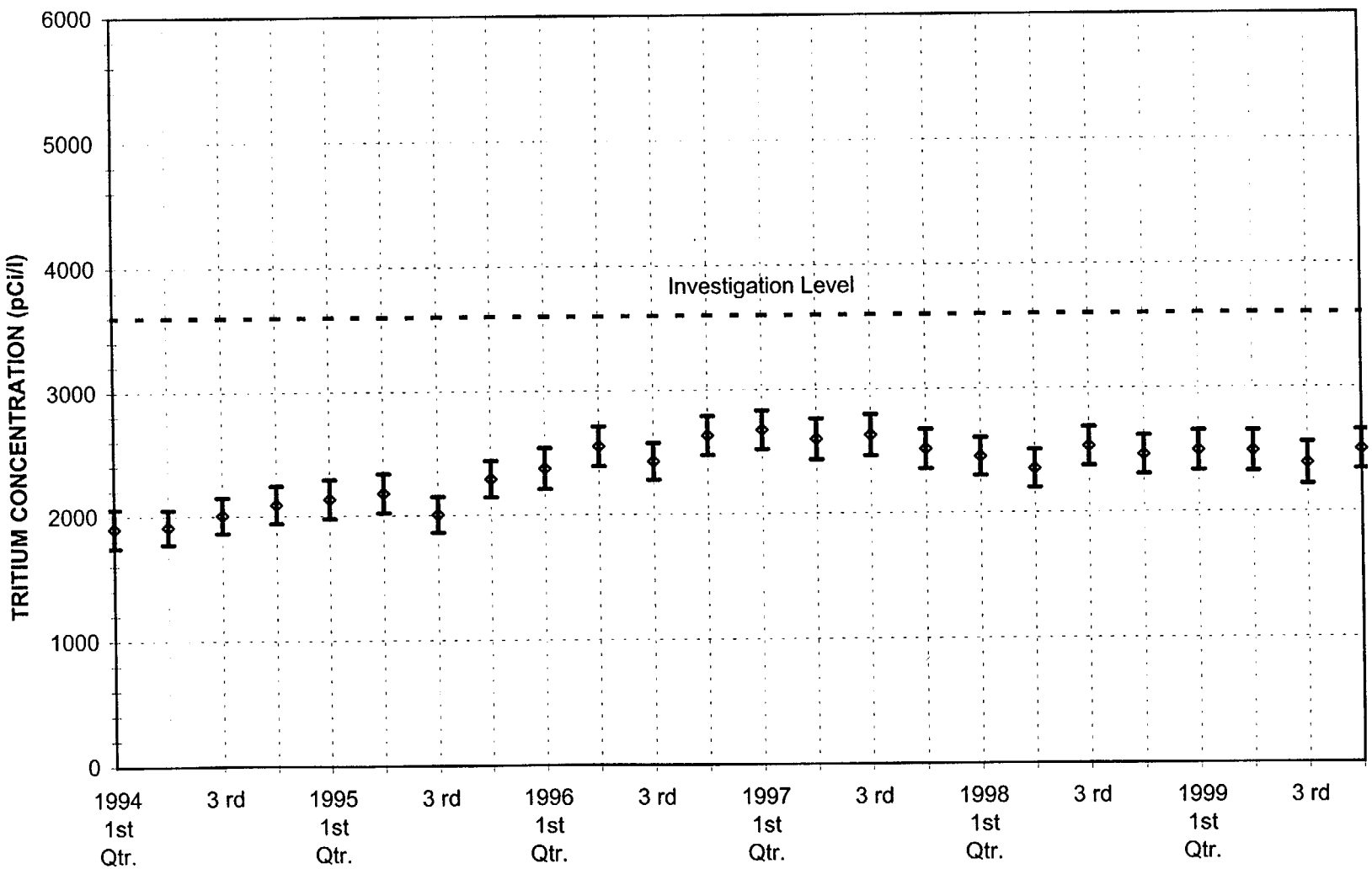
WELL 5 - RICHLAND, WASHINGTON



Tritium Investigation Level = 3,600 pCi/L
Tritium Reporting Level = 20,000 pCi/L

FIGURE 10.10
TRITIUM IN GROUNDWATER

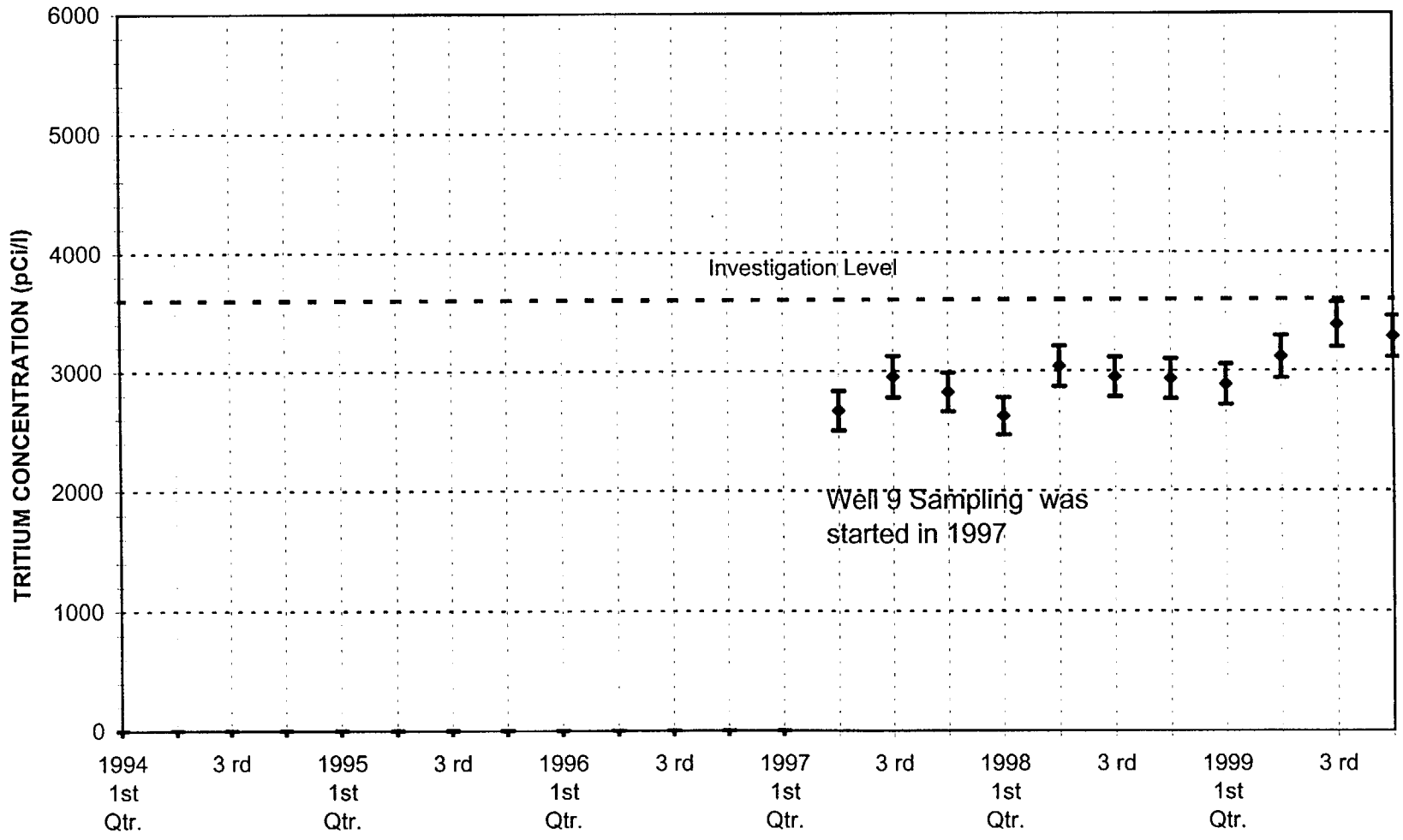
WELL 8 - RICHLAND, WASHINGTON



Tritium Investigation Level = 3,600 pCi/L
Tritium Reporting Level = 20,000 pCi/L

FIGURE 10.11
TRITIUM IN GROUNDWATER

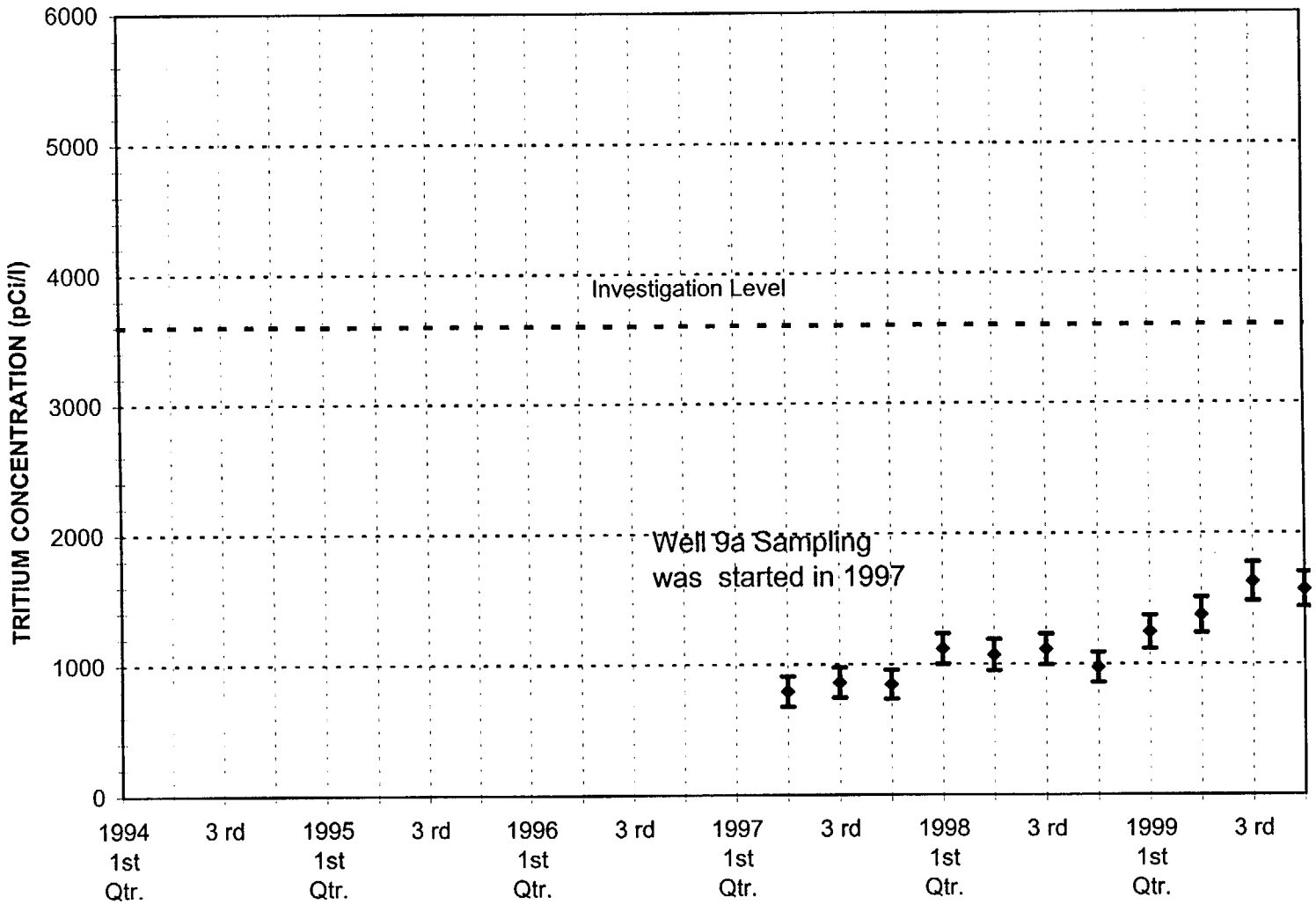
WELL 9 - RICHLAND, WASHINGTON



Tritium Investigation Level = 3,600 pCi/L
Tritium [illegible] porting Level = 20,000 pCI/L

FIGURE 10.12
TRITIUM IN GROUNDWATER

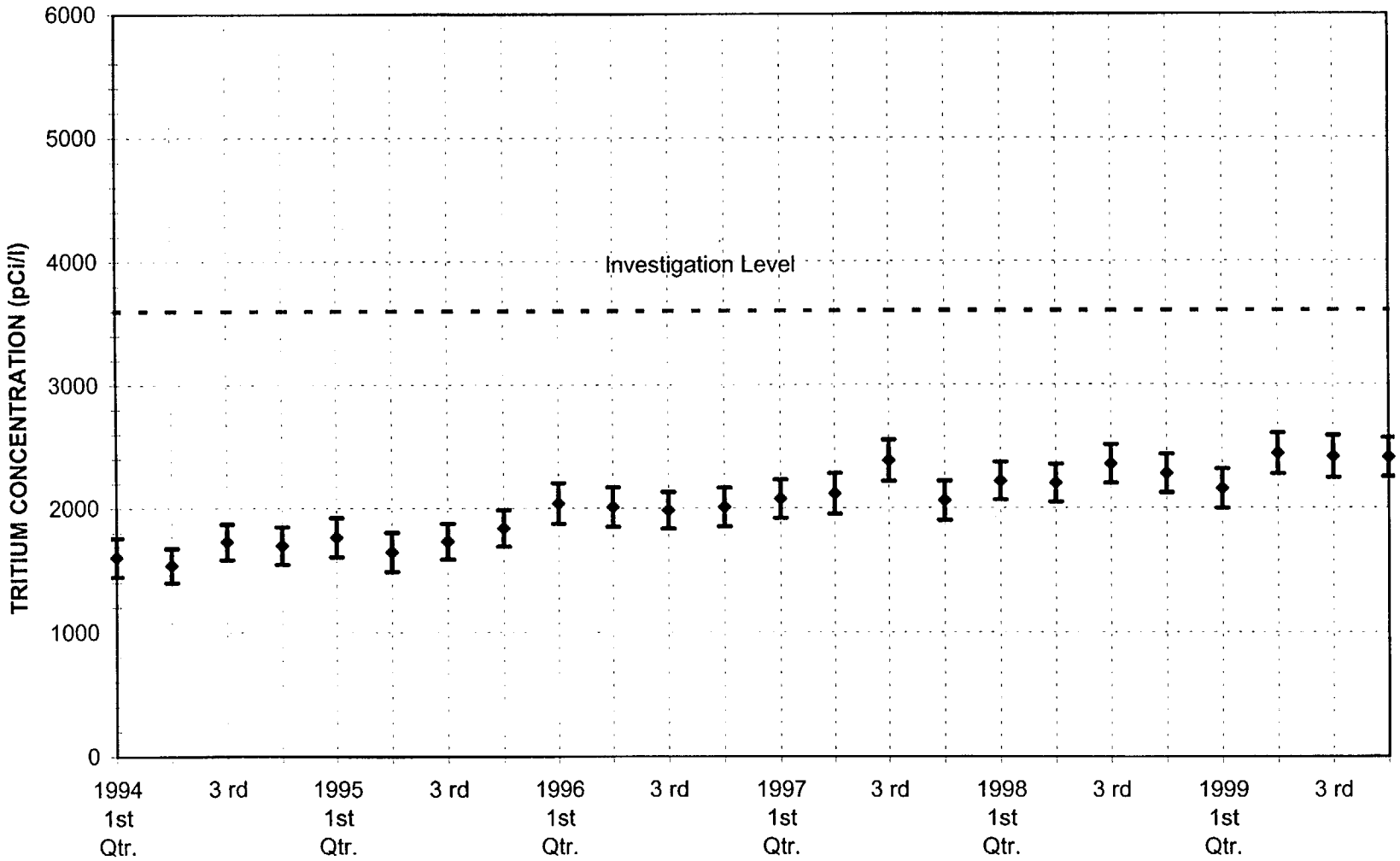
WELL 9a - RICHLAND, WASHINGTON



Tritium Investigation Level = 3,600 pCi/L
Tritium Reporting Level = 20,000 pCi/L

FIGURE 10.13
TRITIUM IN GROUNDWATER

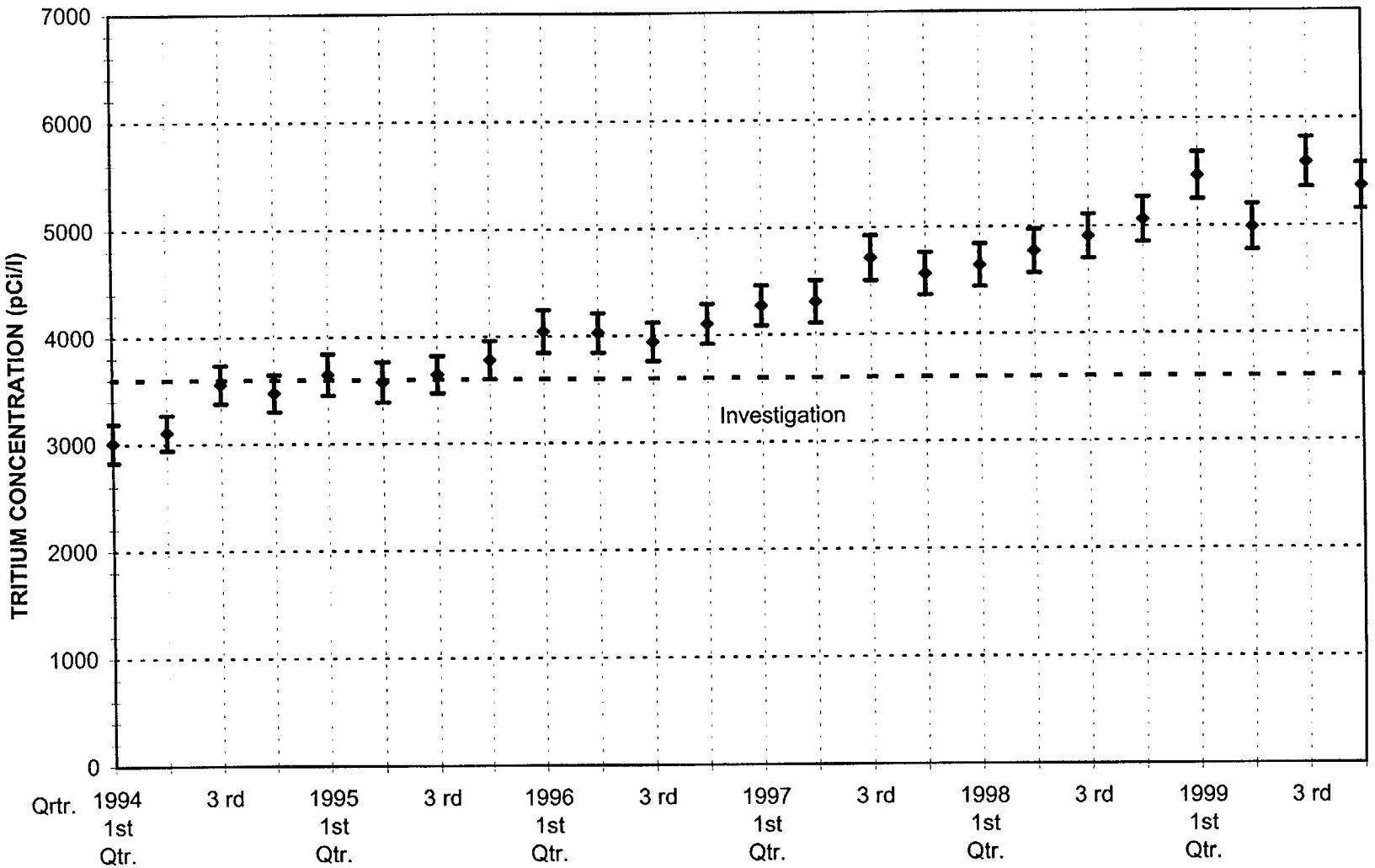
WELL 10 - RICHLAND, WASHINGTON



Tritium Investigation level =3,600 pCi/L
Tritium Reporting Level = 20,000 pCi/L

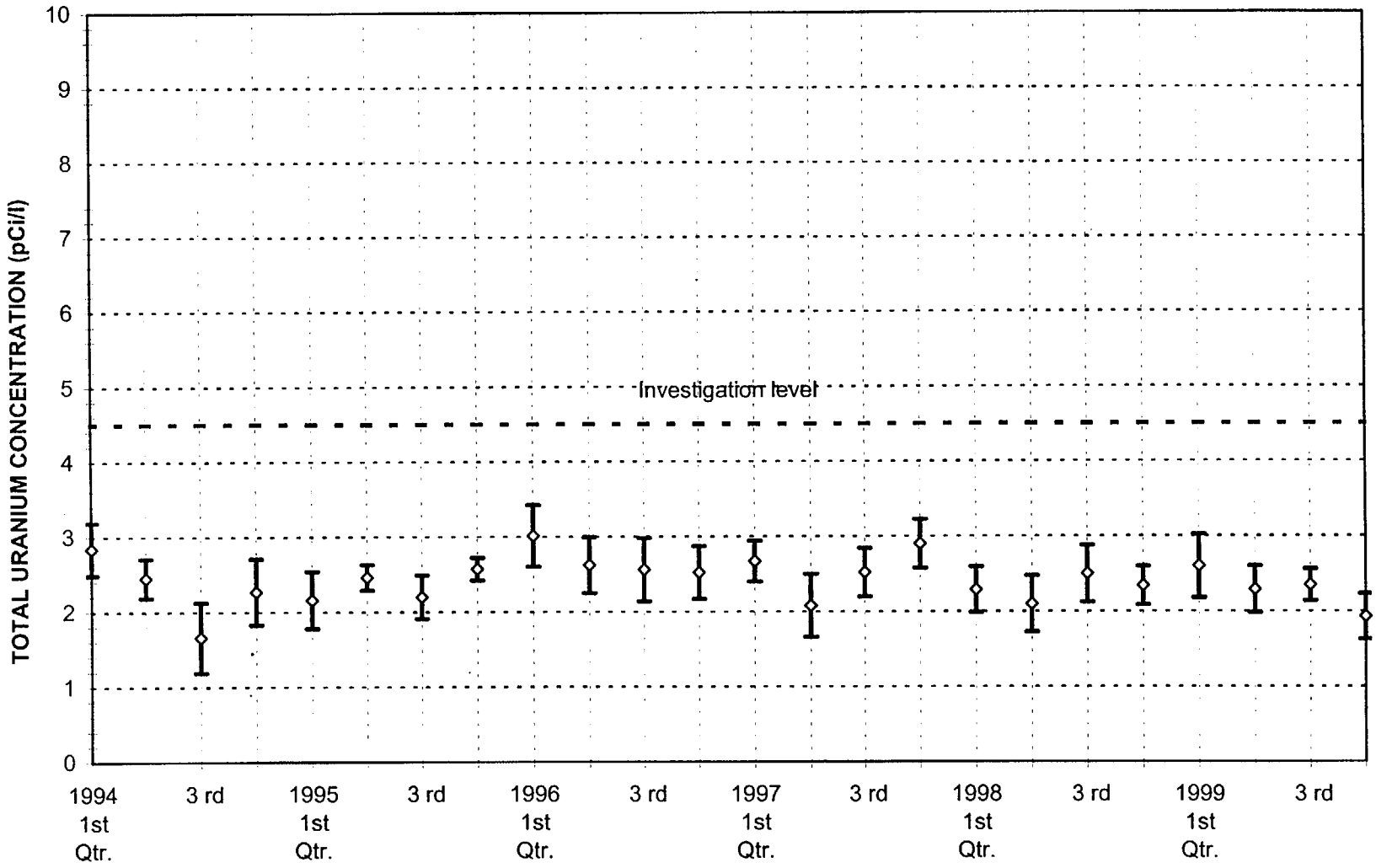
FIGURE 10.14
TRITIUM IN GROUNDWATER

WELL 13 - RICHLAND, WASHINGTON



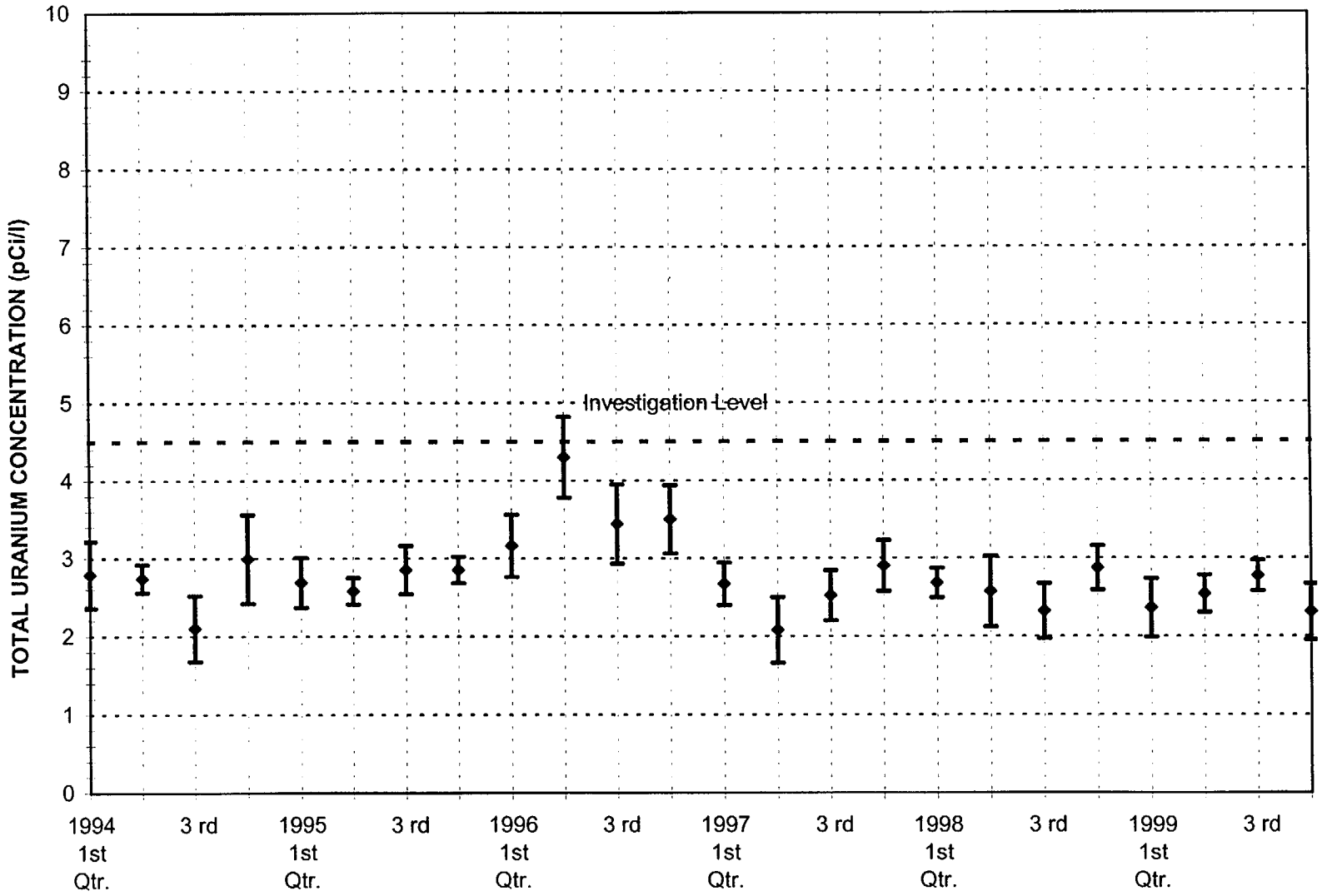
Trituim Investigation Level = 3,600 pCi/L
Tritium Reporting Level = 20,000 pCi/L

FIGURE 10. 15
TOTAL URANIUM IN GROUNDWATER
WELL 3 - RICHLAND, WASHINGTON



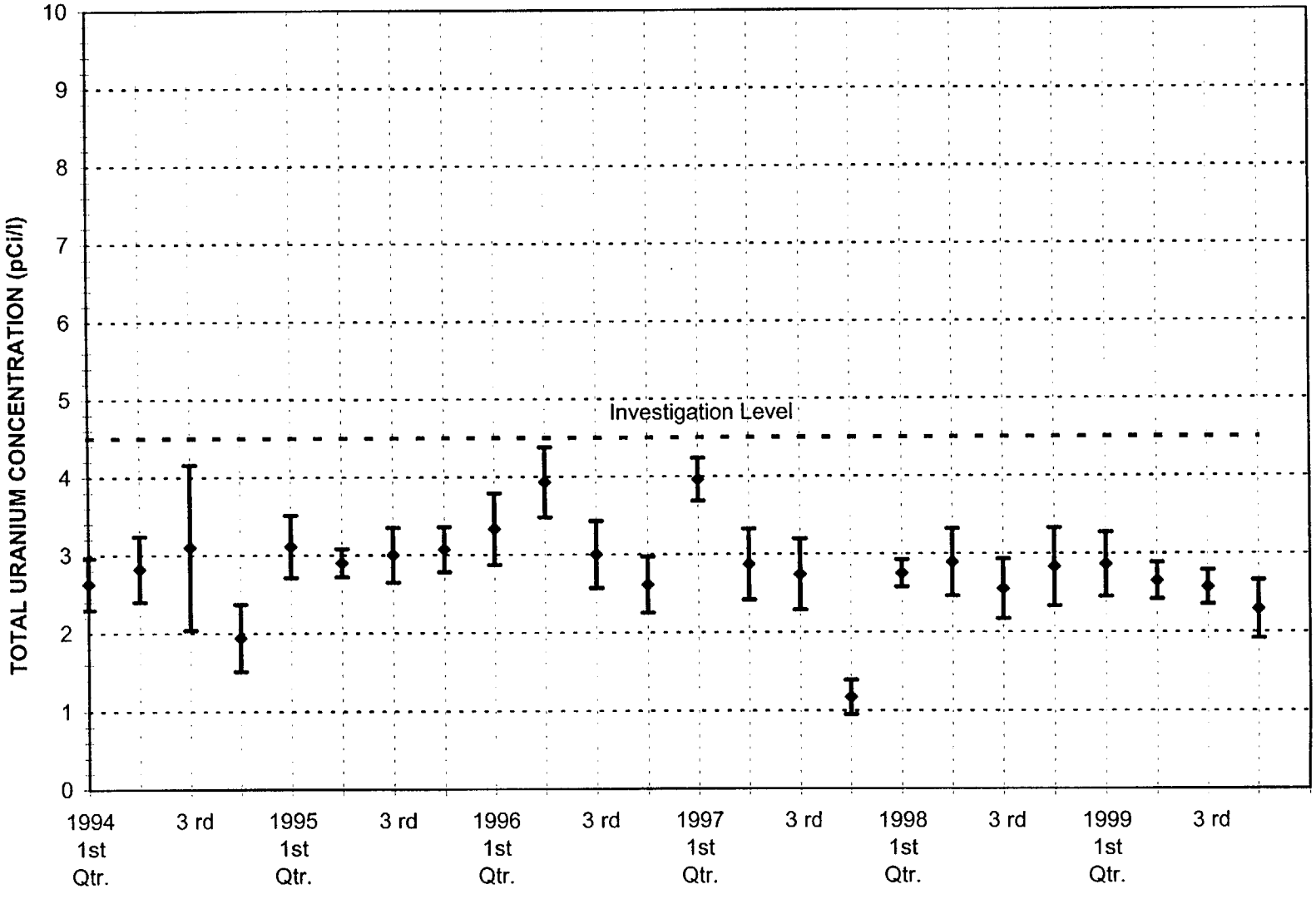
Total Uranium in Groundwater Investigation Level = 4.5 pCi/L
Total U[illegible]nium in Groundwater Reporting Level = 30 pCi/L

FIGURE 10.16
TOTAL URANIUM IN GROUNDWATER
WELL 5 - RICHLAND, WASHINGTON



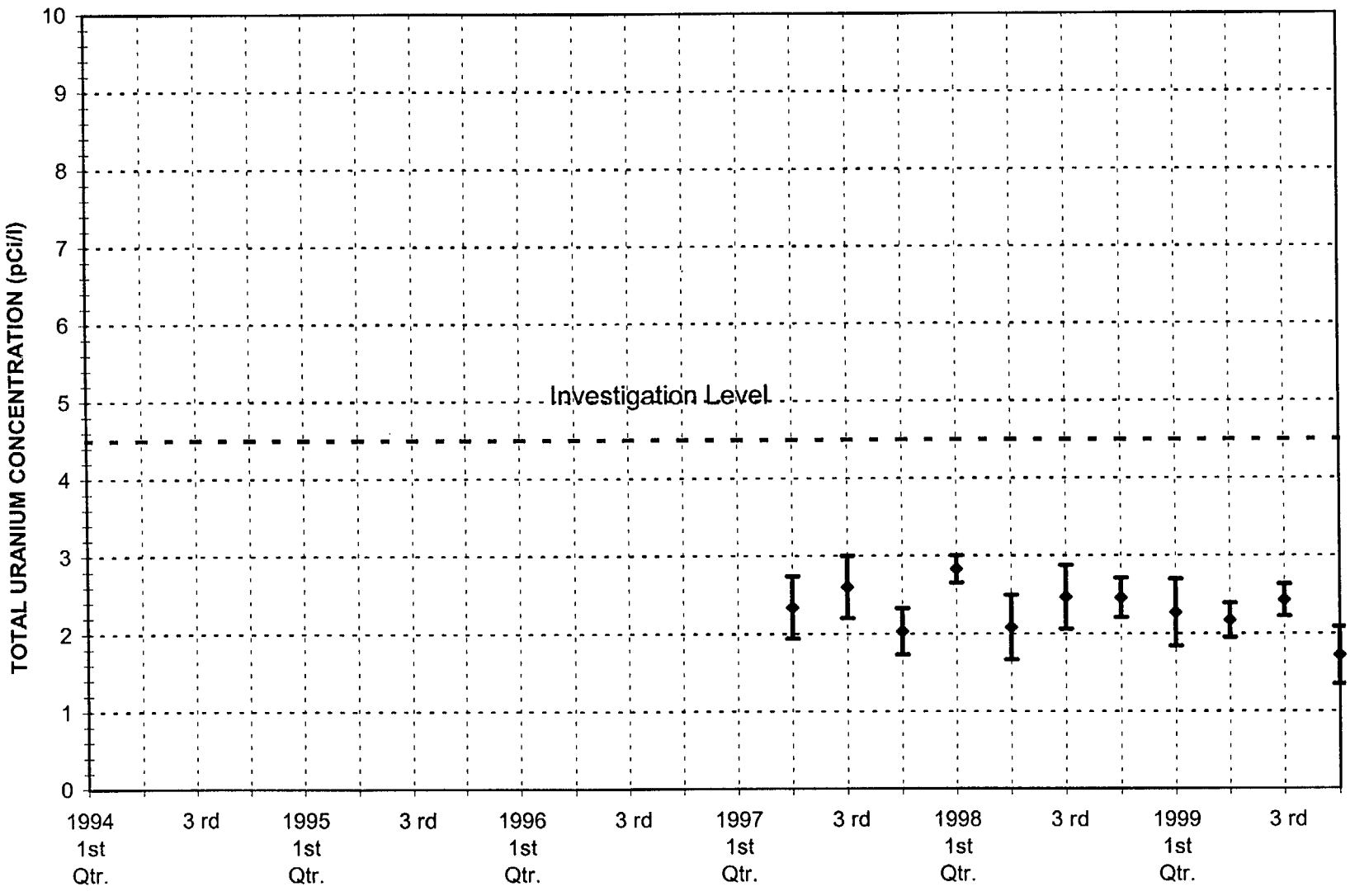
Total Uranium in Groundwater Investigation Level = 4.5 pCi/L
Total Uranium in Groundwater Reporting Level = 30 pCi/L

FIGURE 10.17
TOTAL URANIUM IN GROUNDWATER
WELL 8 - RICHLAND, WASHINGTON



Total Uranium in Groundwater Investigation Level = 4.5 pCi/L
Total Uranium ingroundwater Reporting Level = 30 PCi/L

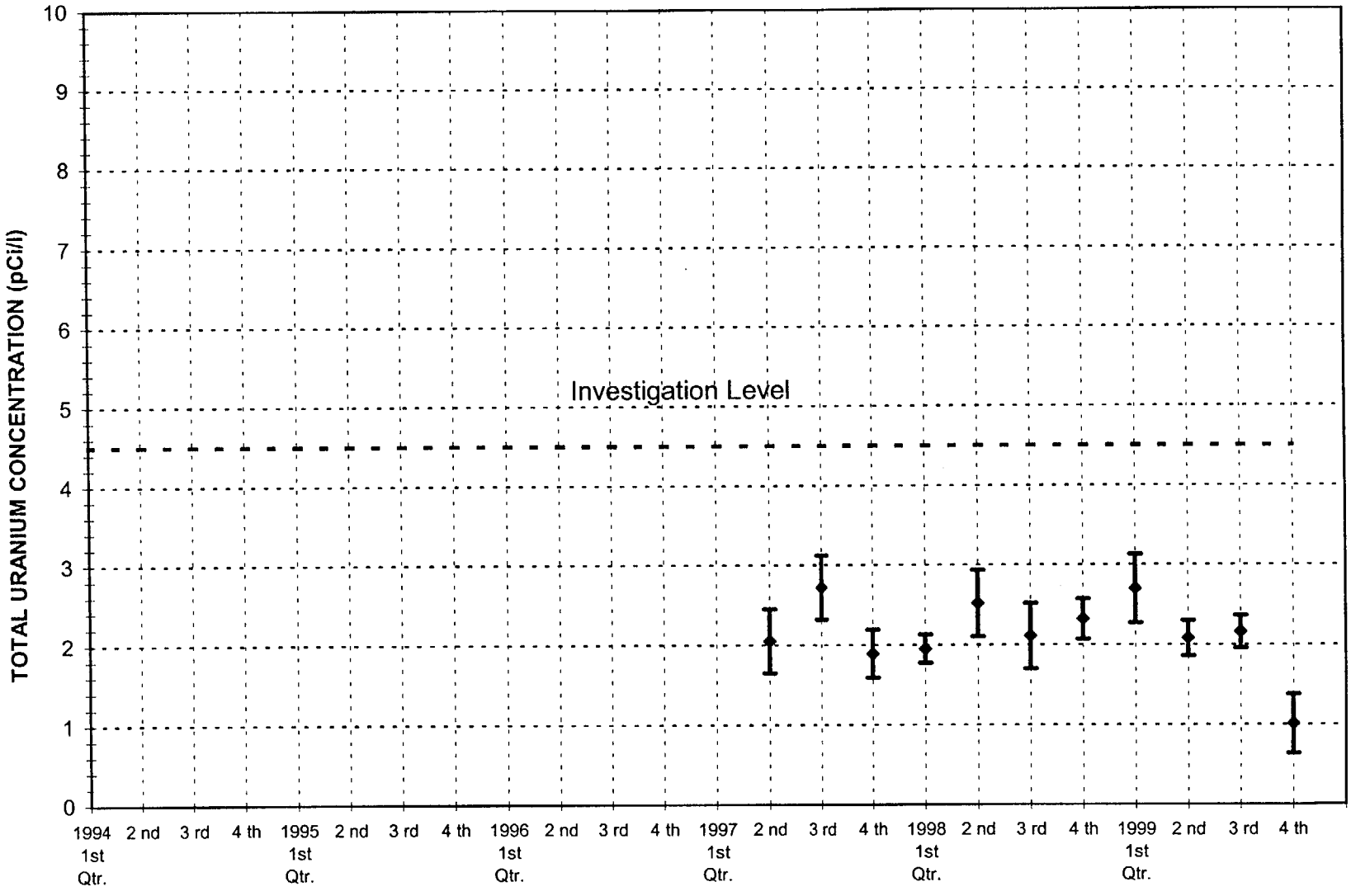
FIGURE 10.18
TOTAL URANIUM IN GROUNDWATER WELL 9 -RICHLAND WASHINGTON



Total Uranium in Groundwater Investigation level = 4.5 pCi/L
Total Uranium in Groundwater Reporting Level = 30 pCi/L

Well 9 Operational Second Quarter of 1997

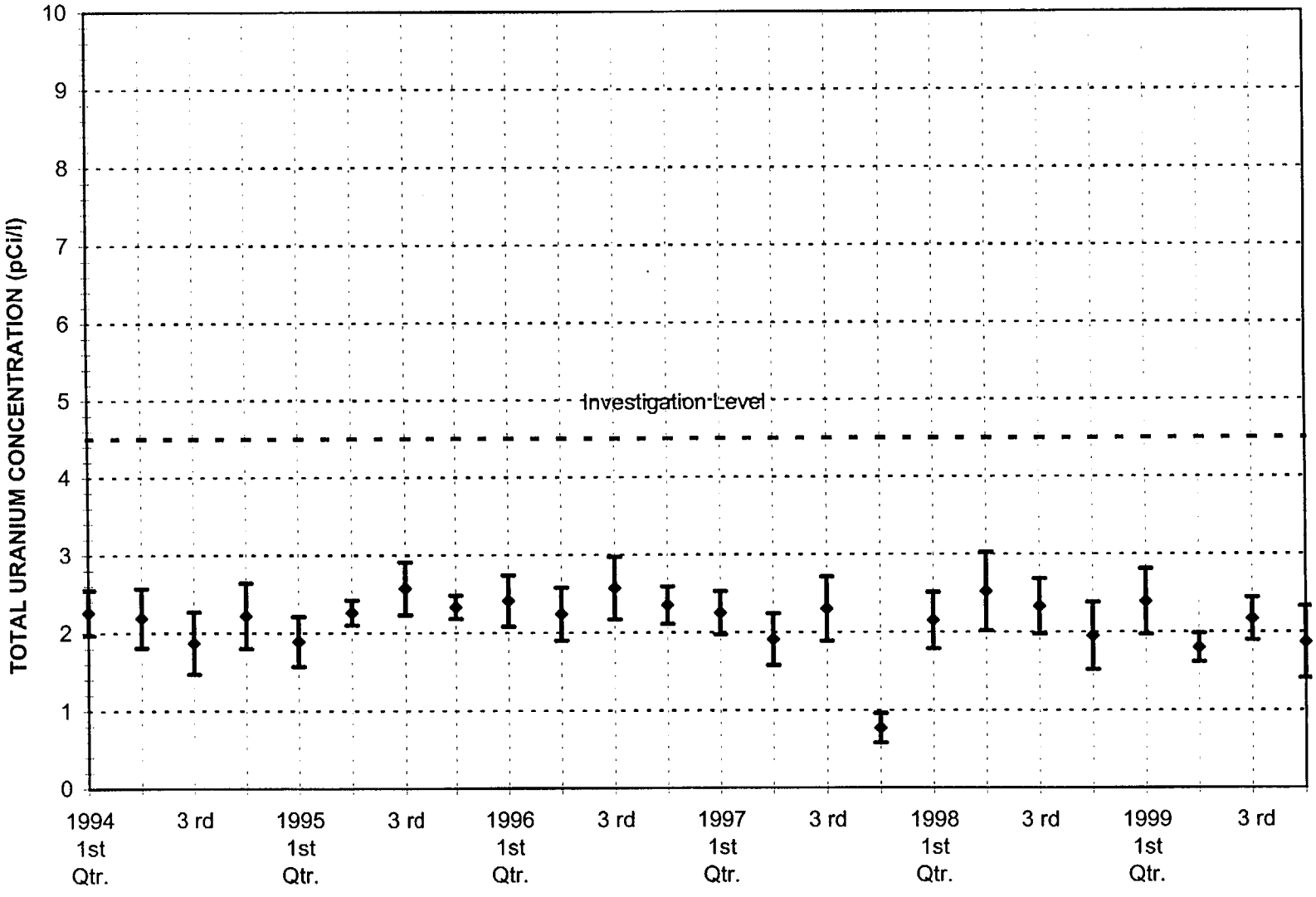
FIGURE 10.19
TOTAL URANIUM IN GROUNDWATER
WELL 9A - RICHLAND, WASHINGTON



Total Uranium in Groundwater Investigation Level = 4.5 pCi/L
Total Uranium in Groundwater Reporting Level = 30 pCi/L

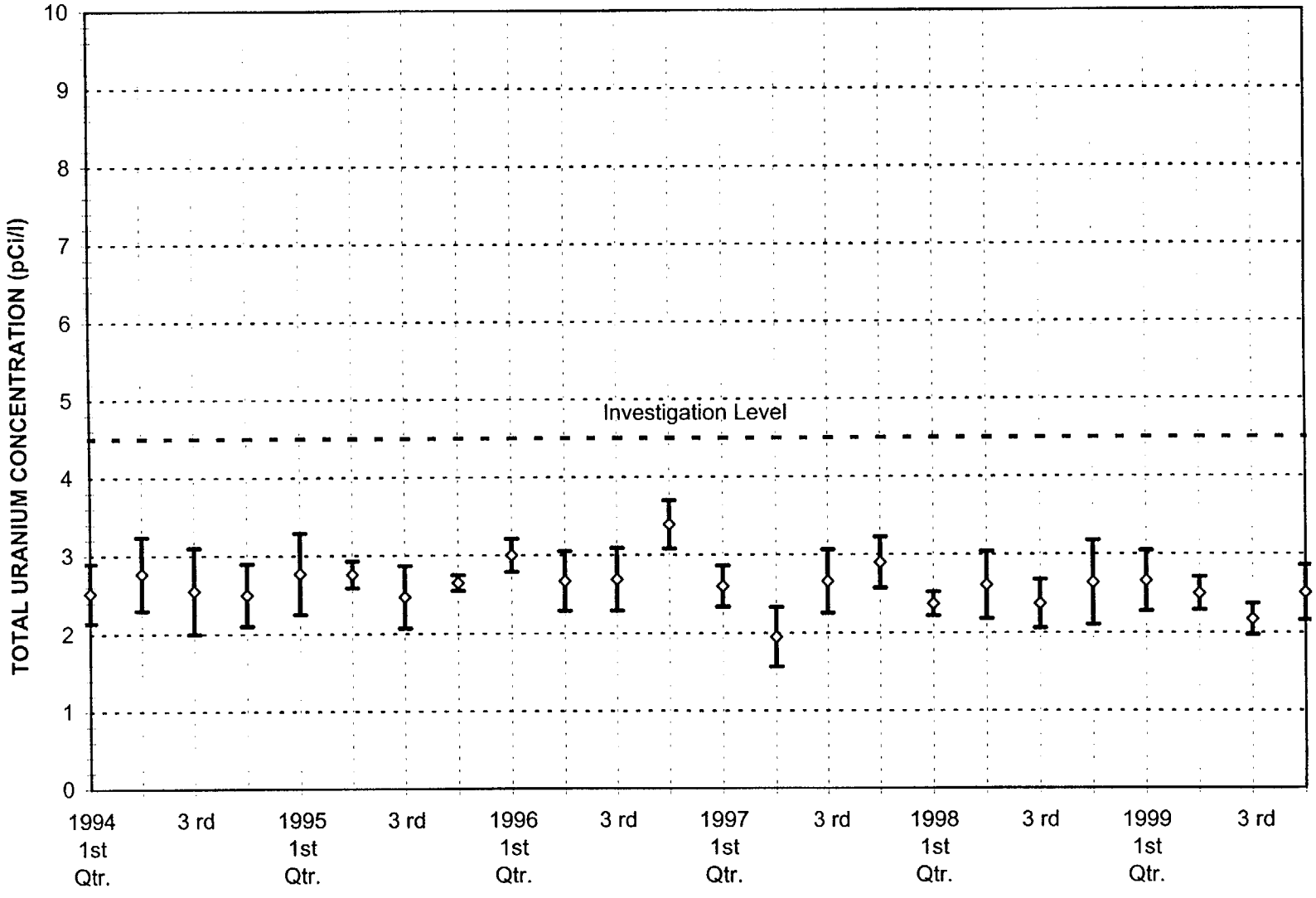
Well 9a Operational Second Quarter 1997

FIGURE 10.20
TOTAL URANIUM IN GROUNDWATER
WELL 10 - RICHLAND, WASHINGTON



Total Uranium in Groundwater Investigation Level = 4.5 pCi/L
Total uranium Reporting Level = 30 pCi/L

FIGURE 10.21
TOTAL URANIUM IN GROUNDWATER
WELL 13 - RICHLAND, WASHINGTON



Total Uranium in Groundwater Investigation level =4.5 pCi/L
Total Uranium in Groundwater Reproting level = 30 pCi/L

FIGURE 10.22
WELL 3 TOP of WATER HEIGHT ABOVE MSL

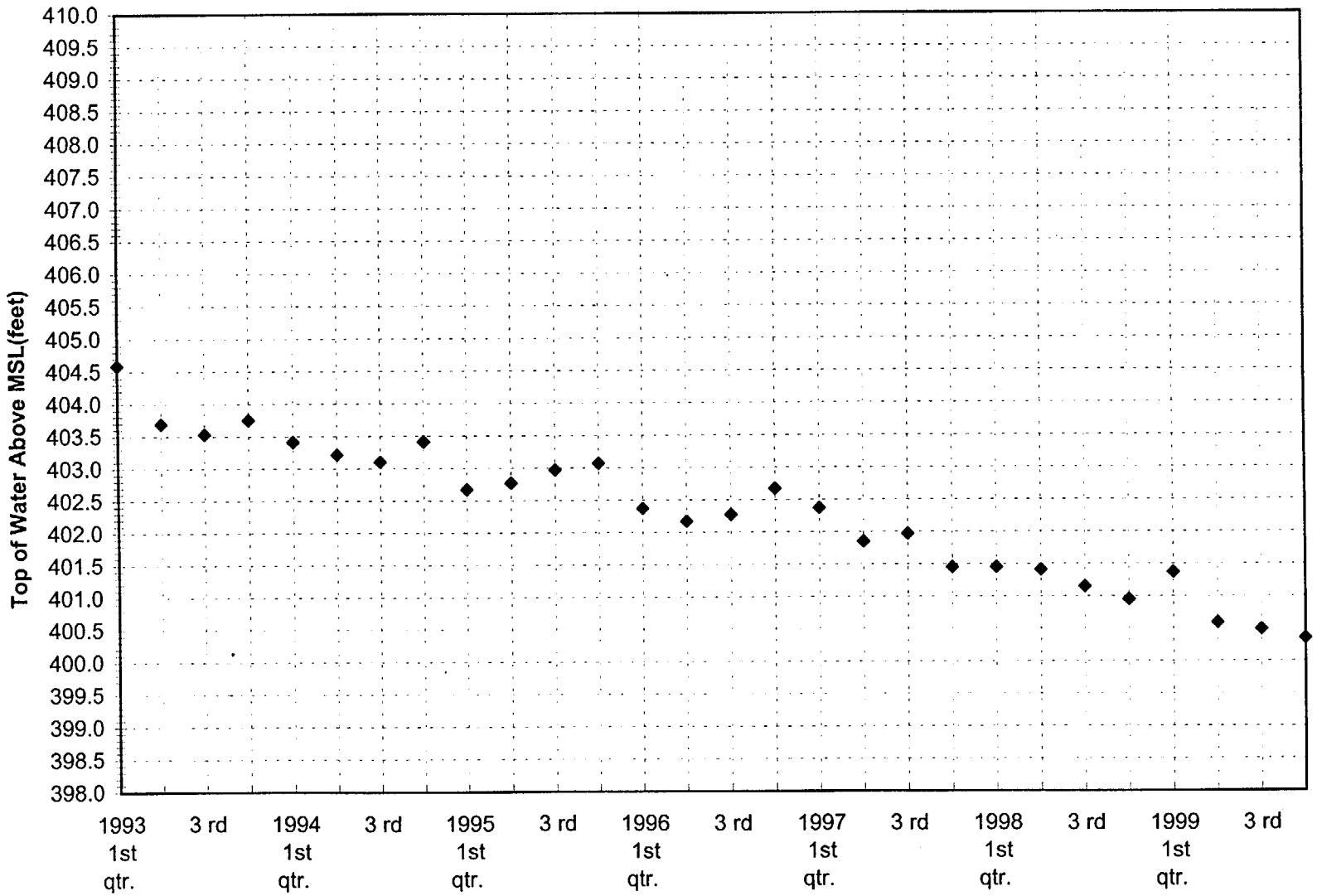


FIGURE 10.23
WELL 5 TOP of WATER HEIGHT ABOVE MSL

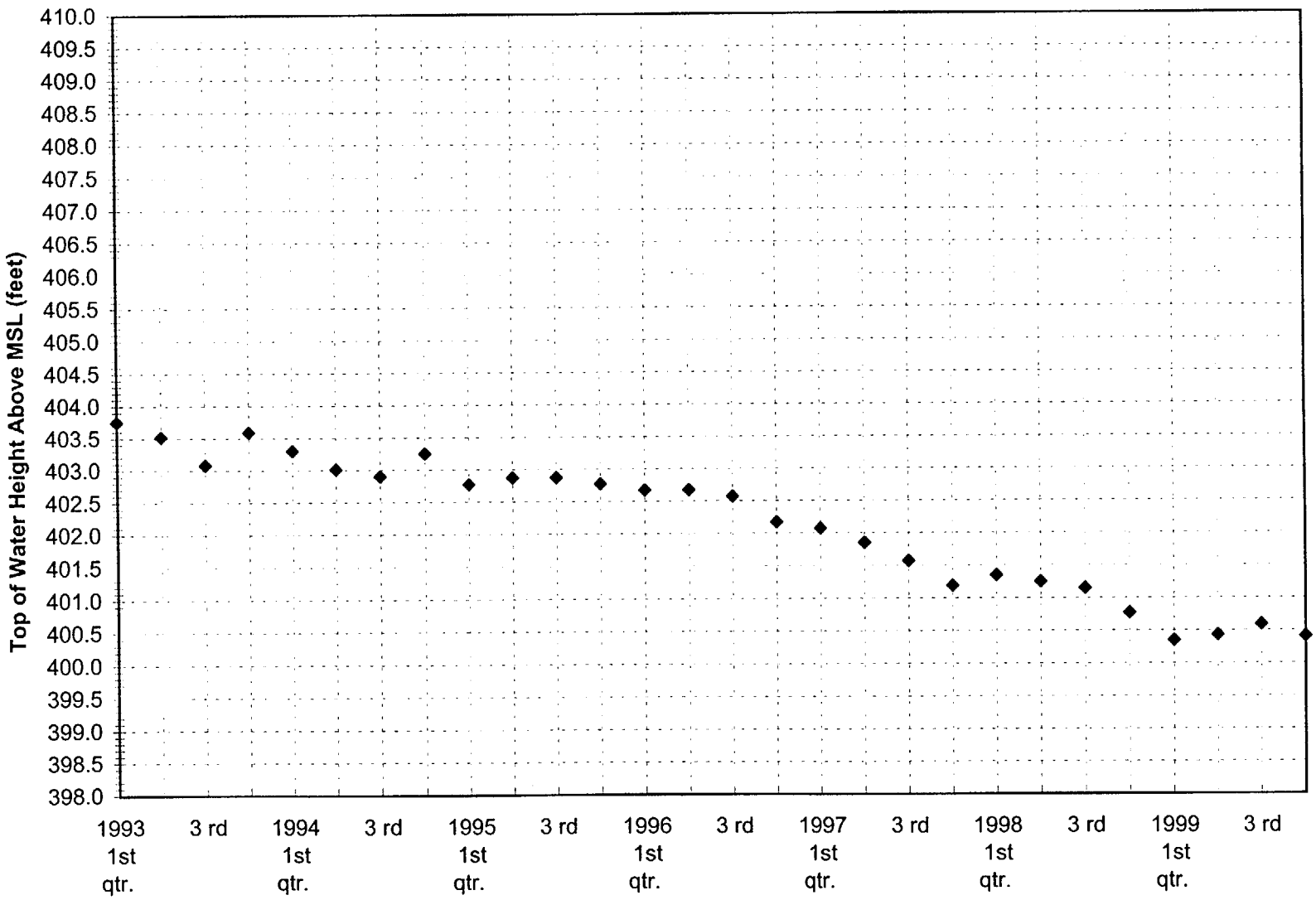


FIGURE 10.24
WELL 8 TOP of WATER HEIGHT ABOVE MSL

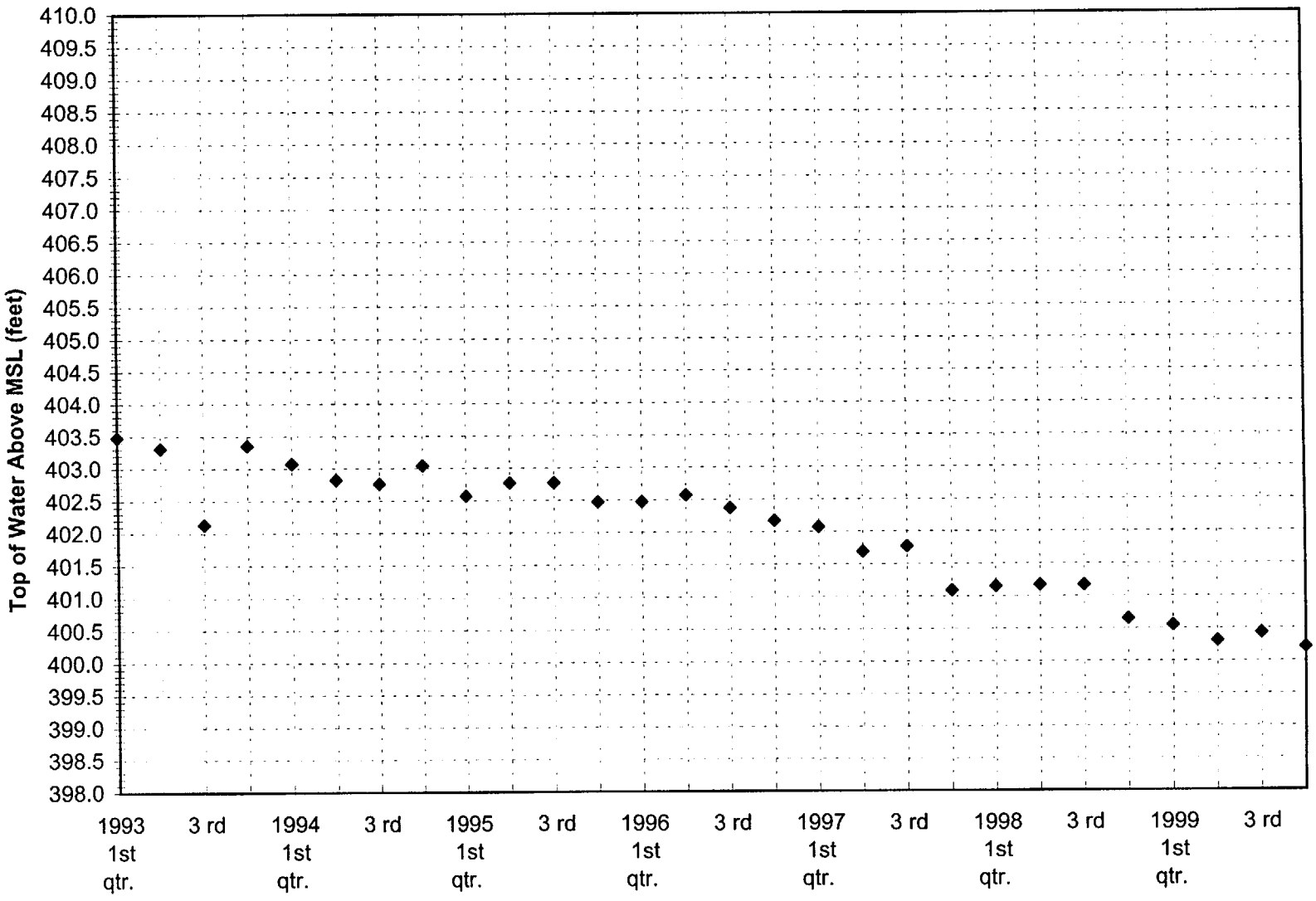


Figure 10.25
Well 9 Top of Water Height Above Mean Sea Level

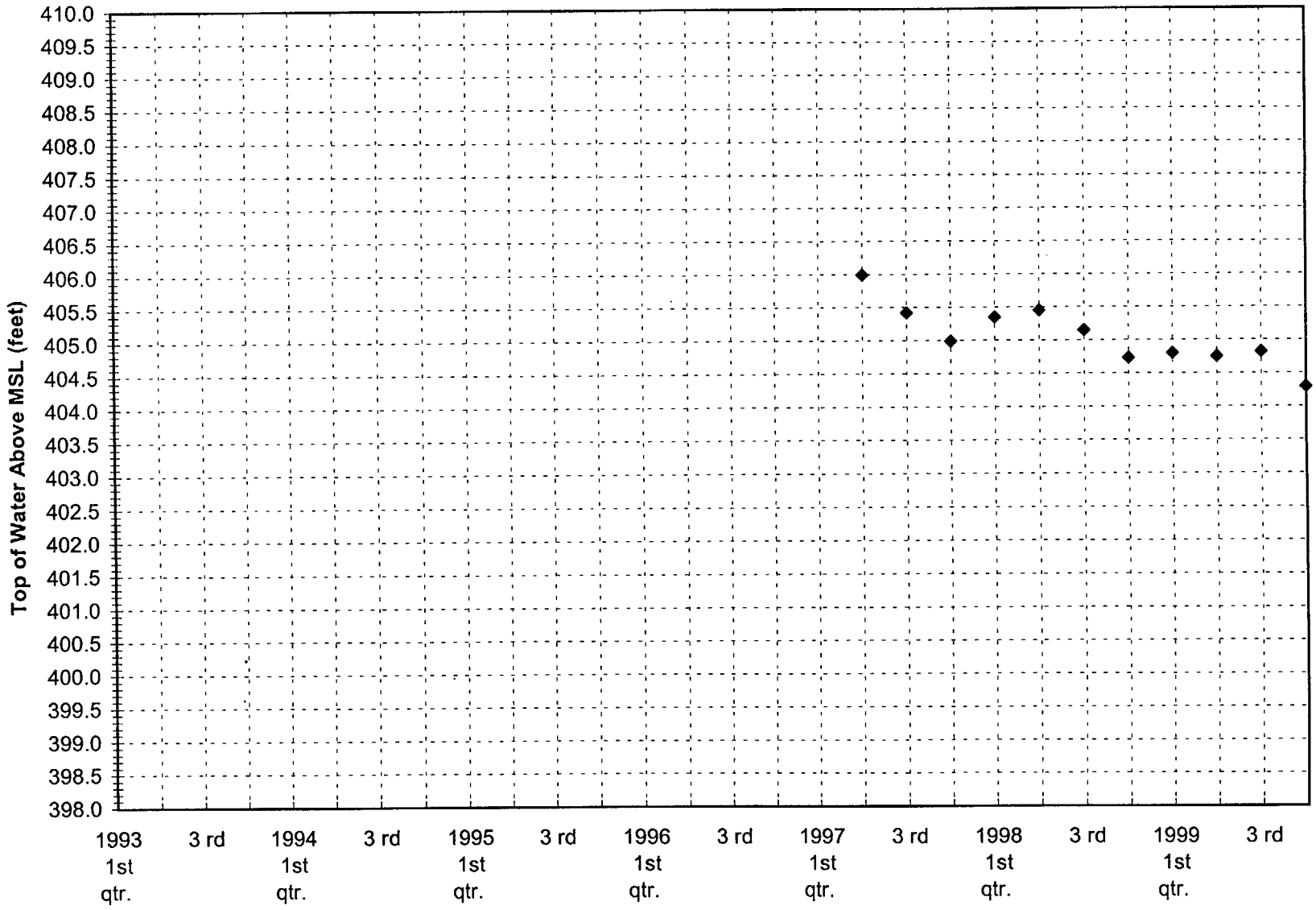


Figure 10.26
Well 9a Top of Water Height Above MSL

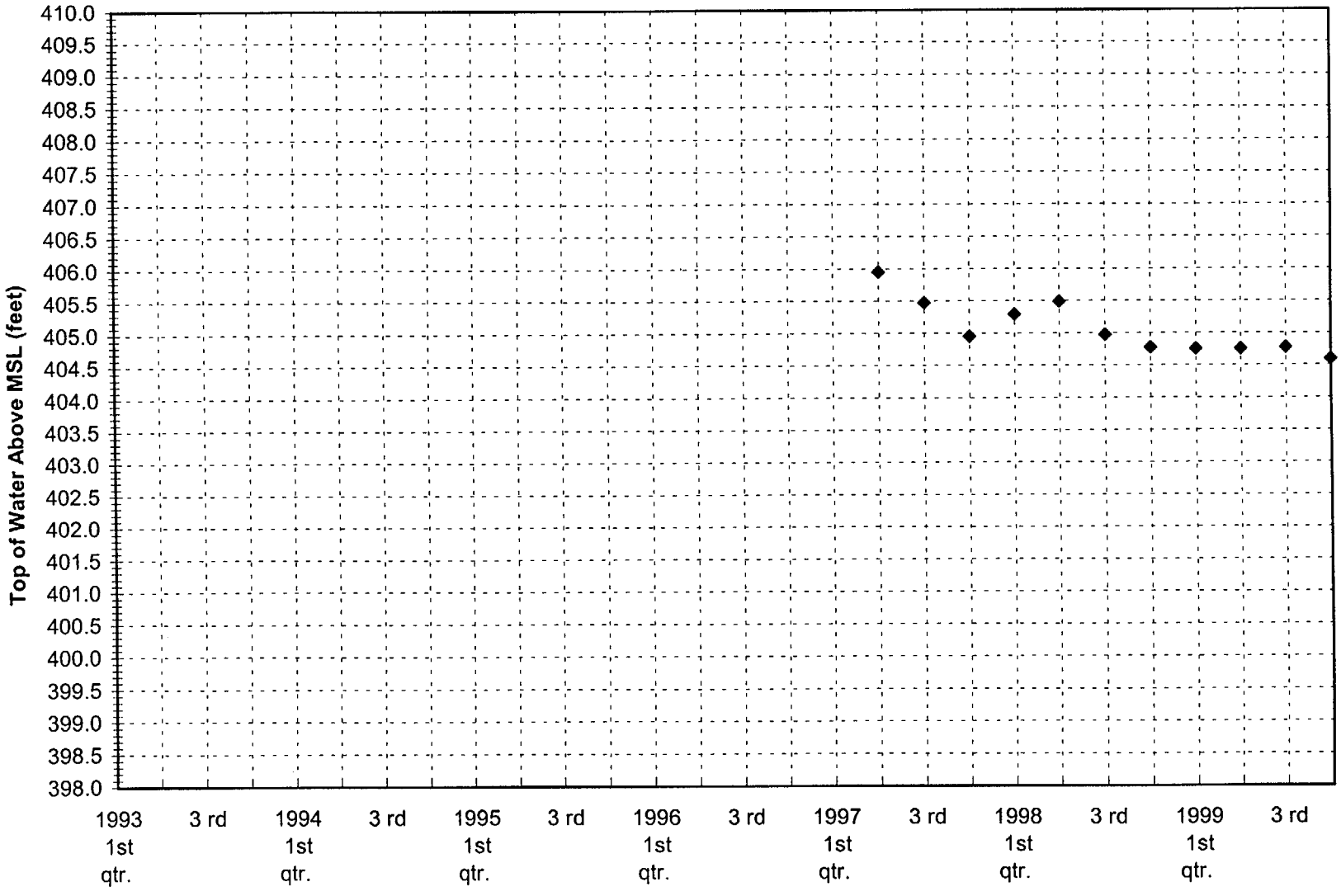


FIGURE 10.27
WELL 10 TOP of WATER HEIGHT ABOVE MSL

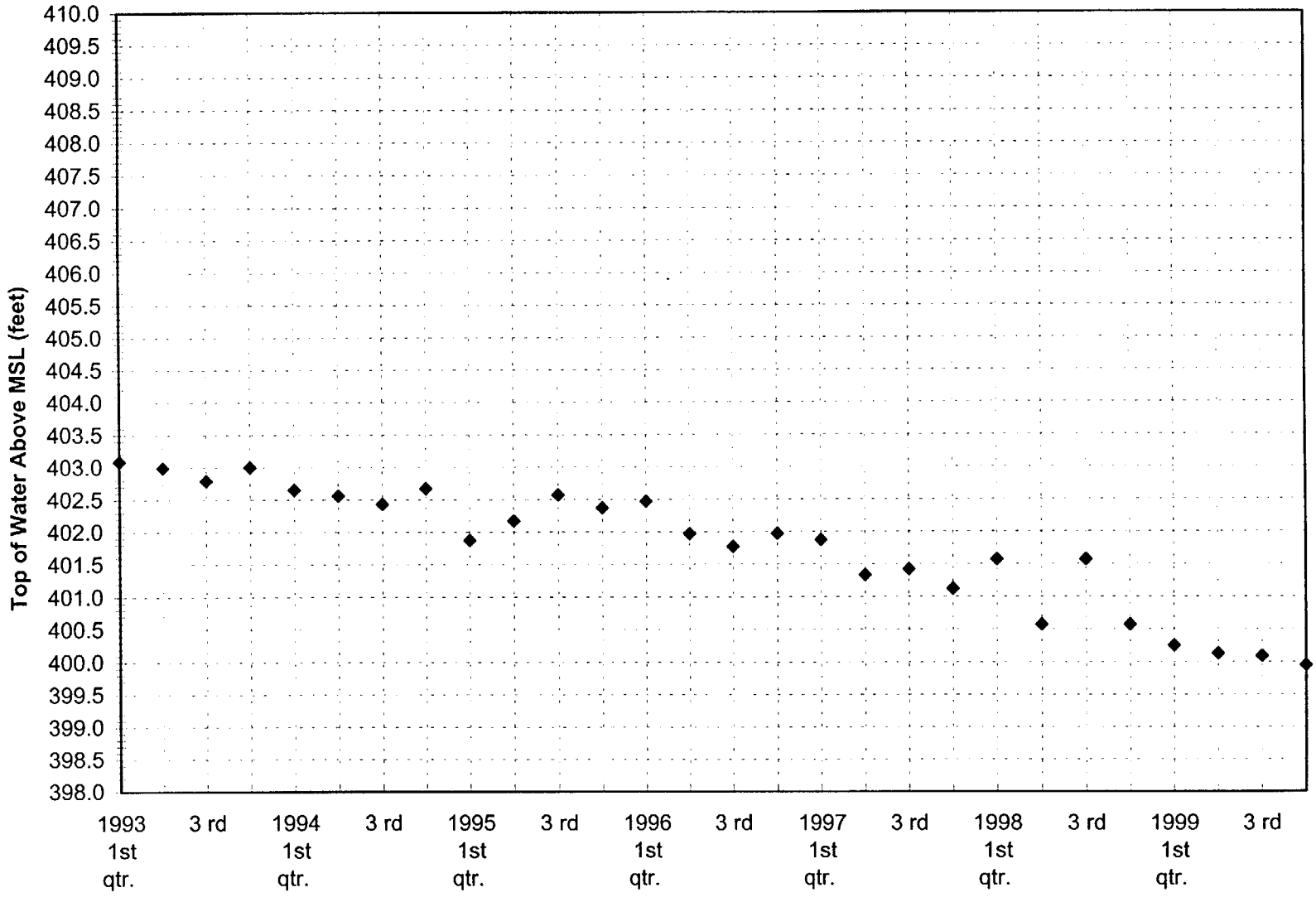
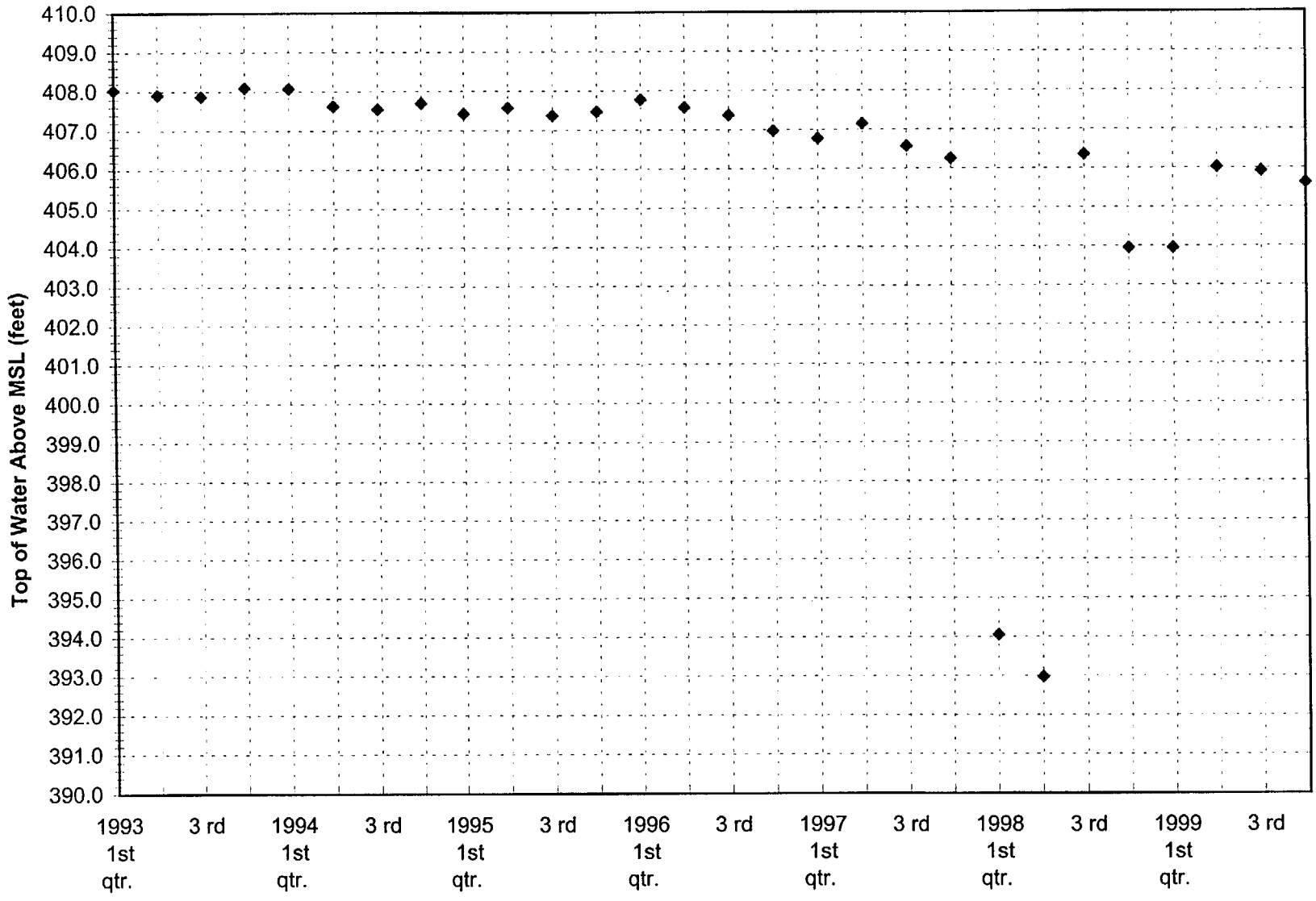


FIGURE10.28
WELL 13 TOP of WATER HEIGHT ABOVE MSL



Each well uses its own soundind device. 1998 Well 13 water depths are suspect due to possible sensor malfunction.
Fourth quarter Well 13 water depths based on first quarter 99 readings using a new sensor.

FIGURE 10 - 29
GROUND WATER CHLORIDE

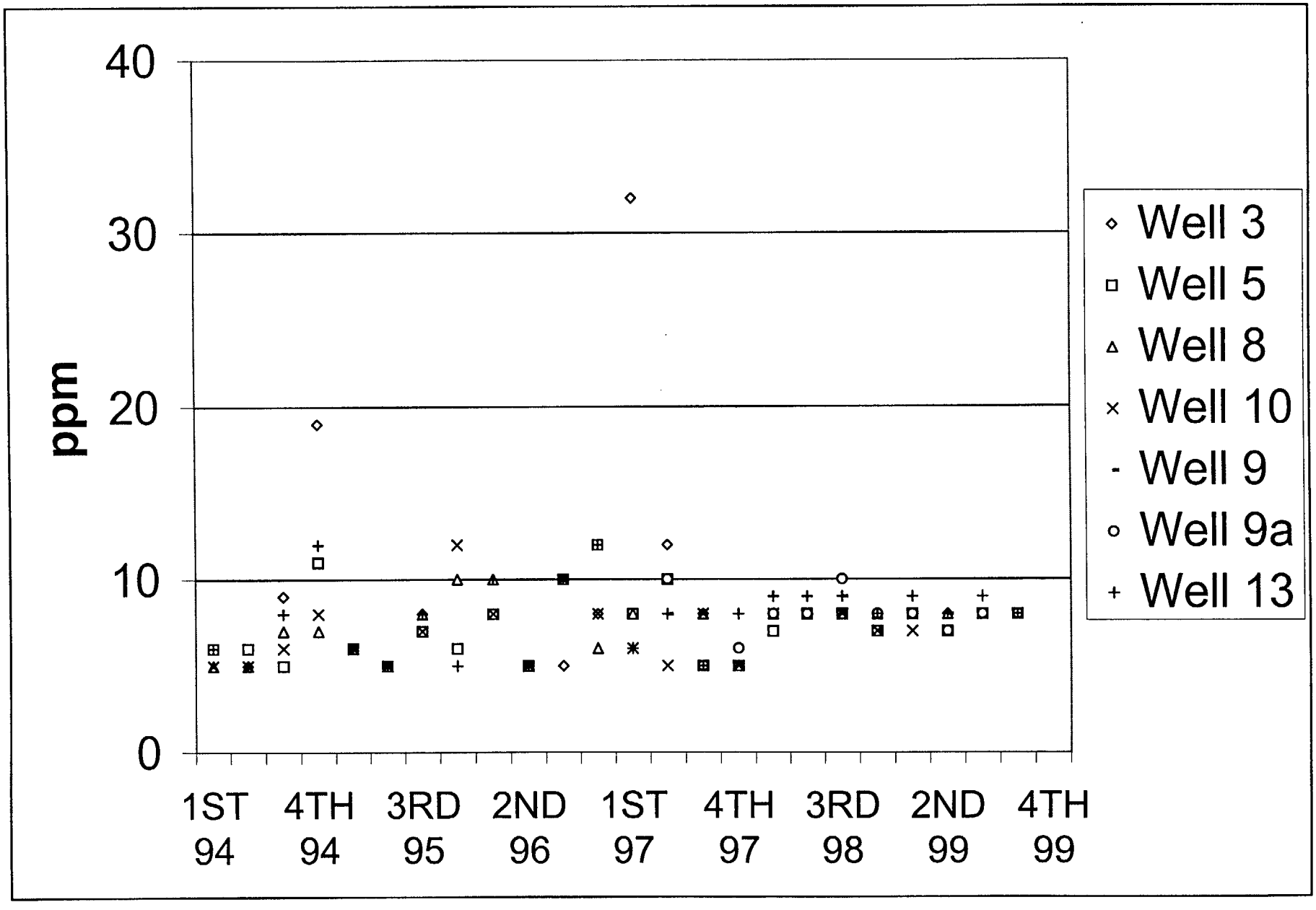


Figure 10 - 30
GROUND WATER NITRATES

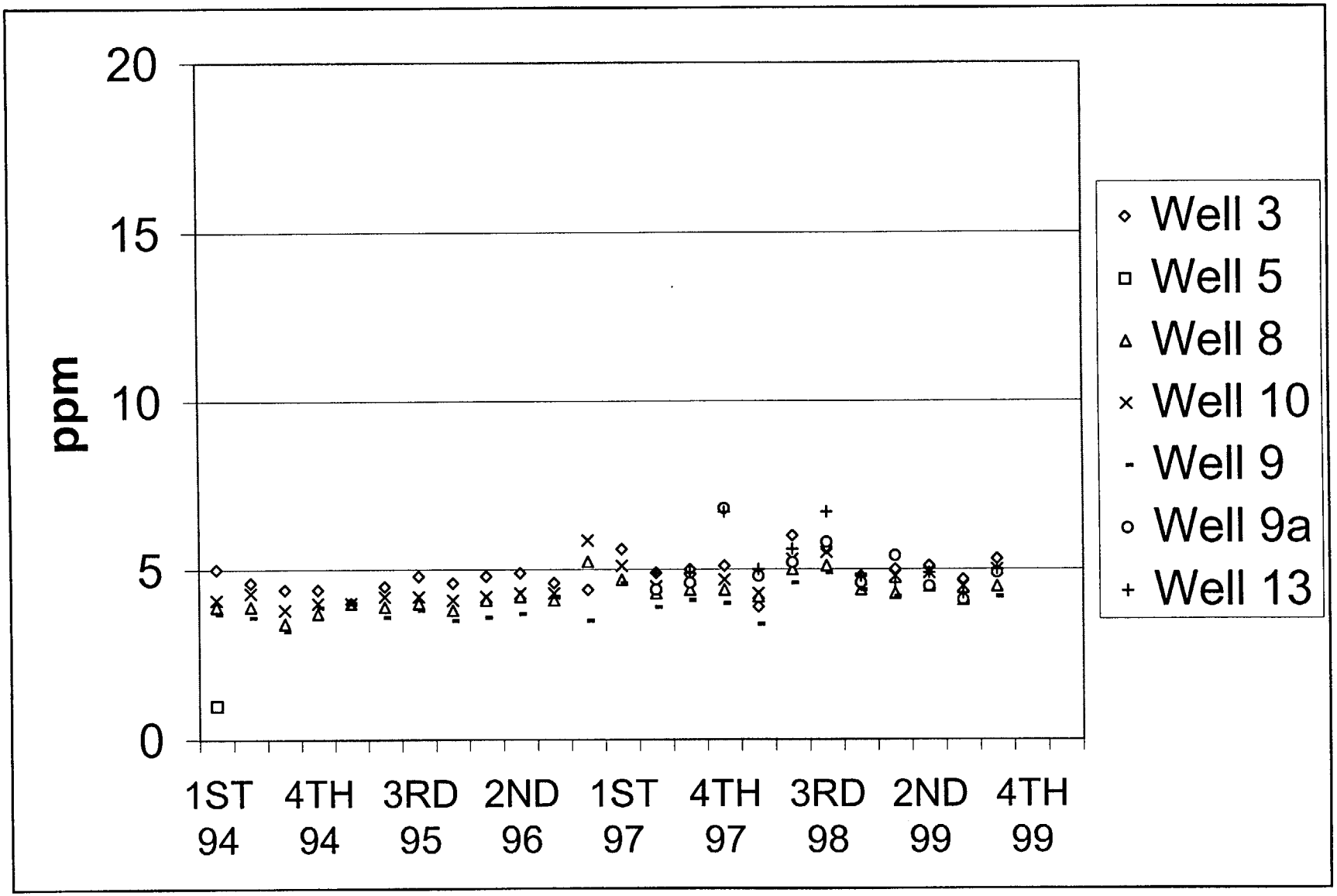


Figure 10 - 31
GROUND WATER SULFATES

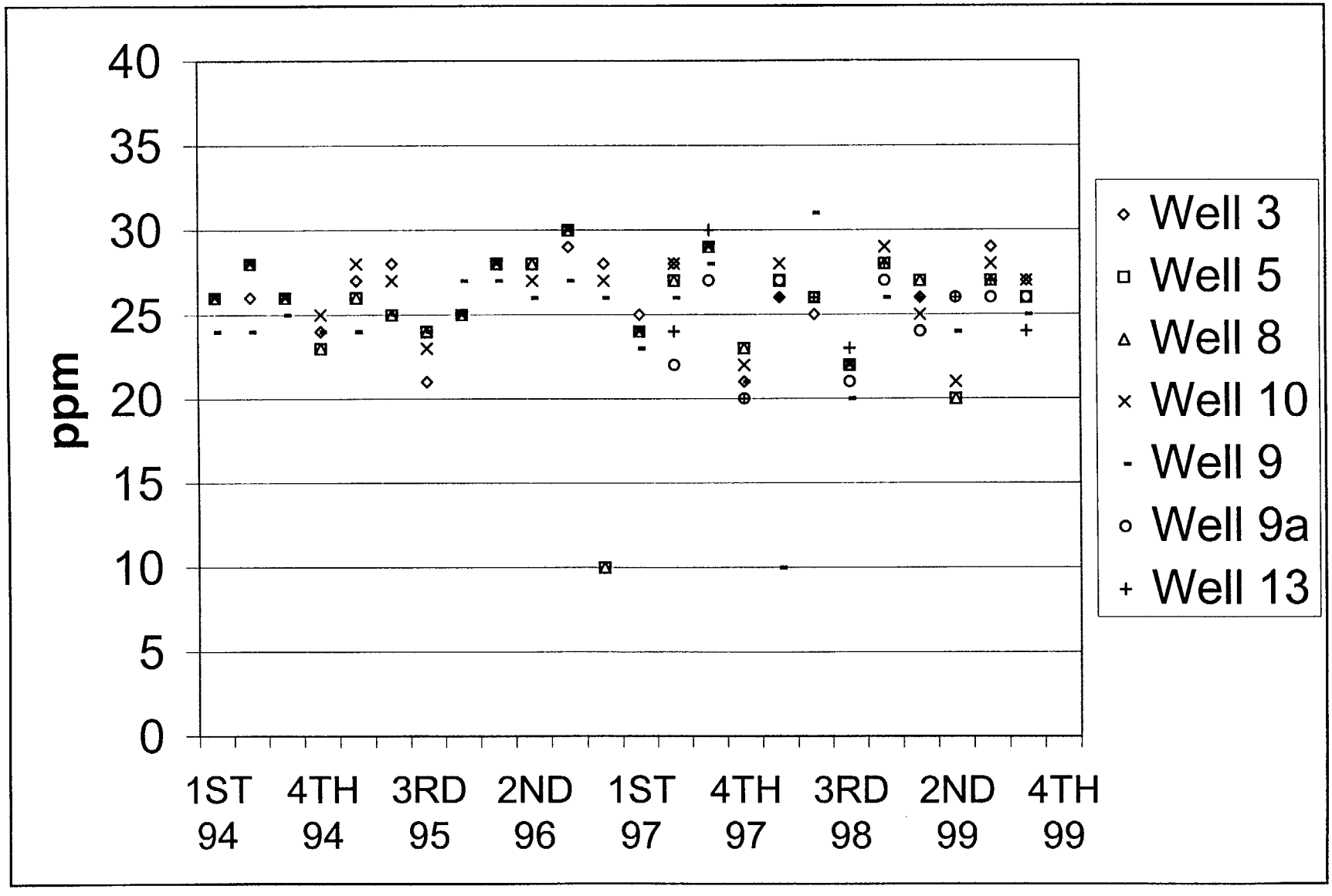


FIGURE 10 - 32
GROUND WATER
TOTAL DISOLVED SOLIDS

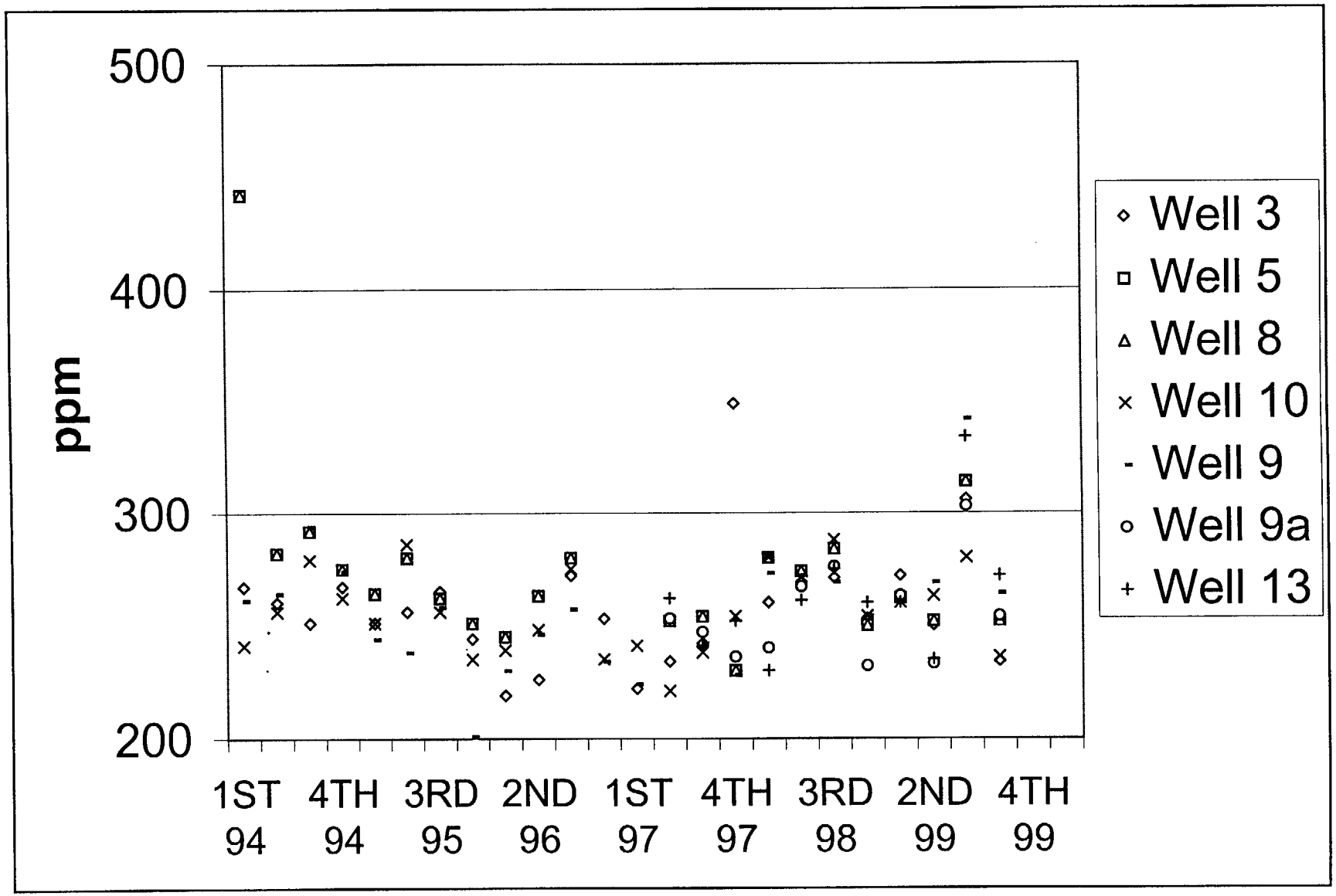
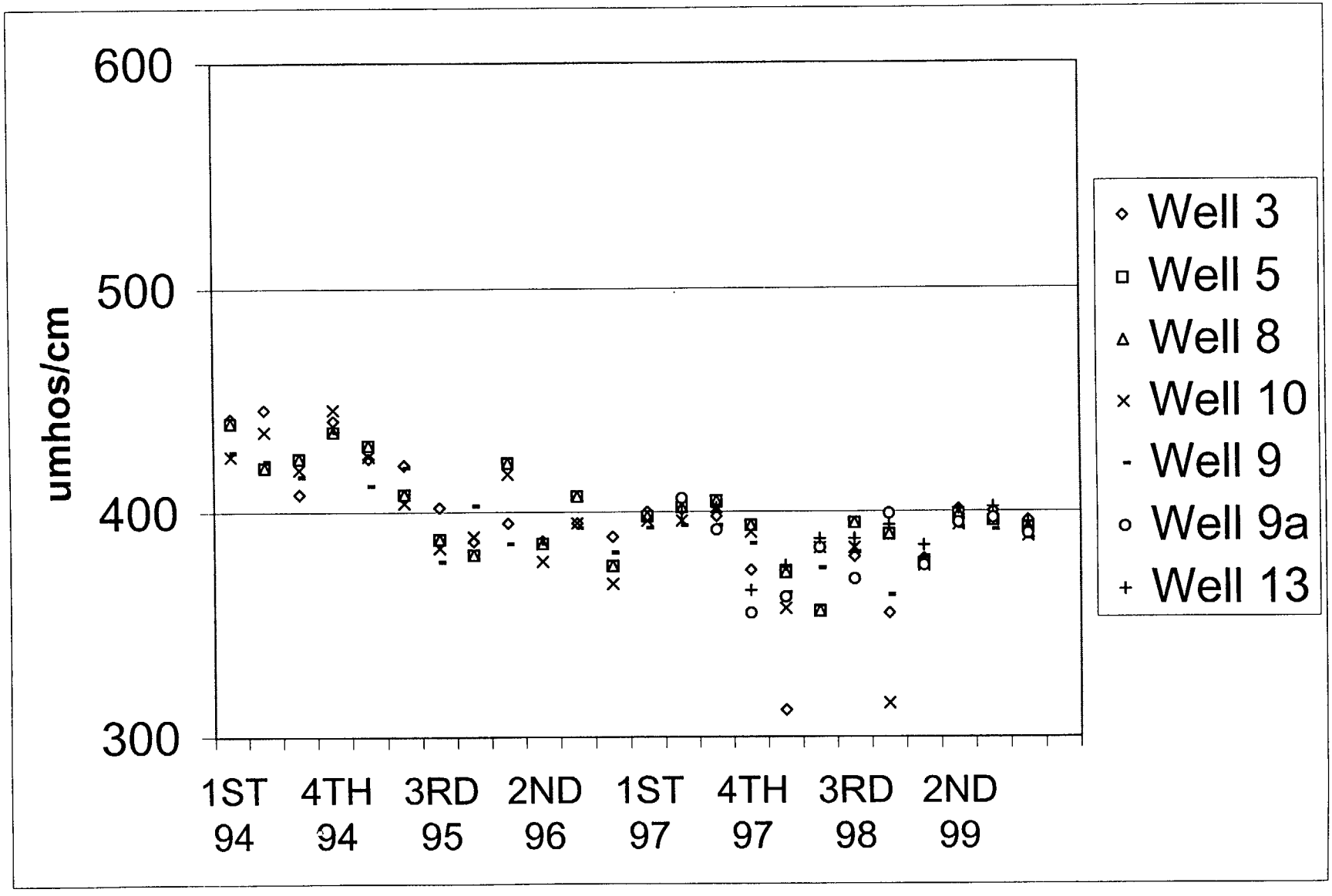


FIGURE 10 - 33
GROUNDWATER CONDUCTANCE



11.0 QUALITY ASSURANCE

Environmental samples are collected by qualified radiation control and safety technicians (RC&STs) following written procedures contained in the US Ecology Richland Operating Procedures Manual. RC&ST qualification covers all aspects of the environmental monitoring program and includes training, demonstration of practical factors, and written and oral examinations.

Routine radiochemical analyses for the environmental monitoring samples are performed by Teledyne Isotopes Midwest Laboratory (TIML) of Illinois. TIML maintains an internal quality assurance program that involves routine calibration of counting instruments, daily source and background checks, yield determinations of radiochemical procedures, replicate analysis to check precision and analyses of reagents to ensure purity of chemicals. Calibration standards traceable to the National Institute of Standards and Technology (NIST) are used for radiochemical calibrations when available.

In addition, TIML participates in the Environmental Protection Agency's (EPA) Laboratory Intercomparison Studies Program. These programs provide standard samples of various environmental media (water, milk, air filters, soil, food stuffs and tissue ash) containing one or more radionuclides in known amounts. After samples are analyzed, results are forwarded to EPA for comparison with known values and with results from other laboratories. EPA has established criteria for evaluating the accuracy of results. These programs provide a regular means of evaluating laboratory analytical performance.

Environmental gamma radiation levels are measured using thermoluminescent dosimeters (TLDs) place along the site boundary. TLDs are exchanged monthly and quarterly. Real time confirmatory measurements are made using microR radiation survey instruments and integrating self-reading dosimeters. Washington Department of Health and Hanford Contractor TLDs are co-located at several of the environmental TLD locations.

Site fence-line TLDs are supplied by and processed by Radiation Detection Company (RDC). RDC is accredited by the National Voluntary Laboratory Accreditation Program for dosimetry processors. This program is administered by NIST for ensuring accuracy and precision of TLD results.

Radiation counting instruments used to count air samples and iodine cartridges are checked daily and evaluated using statistical quality control. Gas proportional counters used for counting air samples are checked monthly for operating characteristics and CHI^2. Radiation detection instruments used to measure fence-line dose rates in support of TLD monitoring are calibrated by an independent calibration facility. The companies contracted to perform calibration services are Ludlum Measurements, Inc. and Pacific Northwest National Laboratory (PNNL).

An integral part of supplier selection and qualification is auditing of vendor quality assurances. Each supplier of environmental, laboratory or calibration services is required to maintain an internal quality assurance program and to conduct operations in accordance with approved procedures. The implementation of quality assurance programs and operational procedures is reviewed during quality assurance and technical audits.

Radiation Detection Company, the supplier and processor of fenceline TLDs, was audited in November 1999. Teledyne Isotopes Midwest Laboratories (TIML) was audited in November 1999. Ludlum Instruments, Inc. was audited in February 1999, Pacific Northwest National Laboratory was audited in December 1999 and Landauer, the supplier of radon track etch detectors was audited in November 1999.

These audits focus on implementation of quality assurance programs, calibration and processing procedures, and analysis of samples including air, soil, water, vegetation and TLD materials as appropriate. These audits indicated that these vendors are maintaining acceptable quality assurance programs.

In addition to the formal QA program described above, US Ecology participates with the Washington Department of Health and Hanford Area contractors in environmental radiation intercomparison studies. In 1999, these activities included splitting vegetation samples with WDOH, and having spiked ground water samples analyzed as part of the Environmental Radiation Monitoring Quality Assurance Task Force.

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APPENDIX A

ASSESSMENT OF US ECOLOGY, RICHLAND, WASHINGTON INSPECTION FACILITY VENTILATION EXHAUST CALENDAR YEAR 1999

APPENDIX A

ASSESSMENT OF US ECOLOGY, RICHLAND, WASHINGTON INSPECTION FACILITY VENTILATION EXHAUST

Summary

This appendix evaluates ventilation exhaust from the US Ecology inspection facility to verify compliance with Clean Air Act emissions standards. The upper bound source term is based on results of air sampling performed in 1999 and a conservative isotopic distribution of waste inspected.

This source term is input to the US Environmental Protection Agency (EPA) "Comply" Code and National Council on Radiation Protection and Measurements (NCRP) Commentary 3, "Screening Techniques for Determining Compliance with Environmental Standards" to demonstrate compliance. In spite of a number of conservative assumptions and the conservative nature of the models themselves, the ventilation exhaust dose contribution is negligible.

Description of Facility

The package inspection facility at US Ecology's Richland, Washington Low-Level Radioactive Waste (LLRW) disposal site is a concrete block room in the south end of the laboratory building approximately 16' by 23' with a 12' ceiling. An enclosed hood in the center of the room controls airborne radioactive contamination generated during waste package inspections or remediation evolutions. The hood is 8' wide by 8' long and approximately 8' tall. The hood has flexible sides of heavy gauge plastic sheets, creating a tent-like structure within the room. Two 1000 cfm axial fans (one normally operating) ventilate the inspection hood.

Air from the inspection room is drawn under the inspection hood skirt (due to negative pressure), around the package being inspected and up to an exhaust duct located in the top-center of the hood. The air then passes through roughing, charcoal and HEPA filters before entering the exhaust fans. Downstream of the fans, the air exits the building through a 16" square duct attached to louvers on the east side of the building.

Normal operation of the facility involves placing a package selected at random by the Washington State Department of Health (WDOH) site inspector under the hood for waste form verification. Waste form verification may include opening and/or punching a hole in the package, followed by package contents inspection. After confirmation, the package is closed and/or patched as necessary prior to disposal. In addition, packages are also remediated inside the inspection tent.

Portable air samplers monitor airborne activity during these inspections. One air sampler is inside the hood, one is in the inspection room outside the hood and one is at the air exhaust in the side of the building. These samplers start before the package is opened and are changed and counted after the evolution is complete.

APPENDIX A

In 1999, there were 59 package inspection/remediation evolutions in the inspection facility. In some cases, more than one package was inspected at a time; therefore, one air sample may cover more than one package. The typical duration of each evolution was 10 to 15 minutes. However, the ventilation and it associated air sampler operate for one hour to achieve sufficient airflow to meet the required analytical sensitivity.

Source Term Evaluation

To demonstrate compliance with Clean Air Act emissions standards for potential airborne radioactive releases, US Ecology used the results of airborne monitoring performed in 1999 and data on isotopic content of waste received. US Ecology evaluated the data using the methodology contained in NCRP Commentary 3 and the EPA "Comply " Code, Version 1.5d.

Table 1 lists the airborne radioactivity concentrations for the inspection facility's ventilation exhaust during the 59 package inspections of 1999. US Ecology averaged the results of the 59 vent exhaust samples taken during the year to obtain an operating stack concentration. The averaging process uses calculated values, both positive and negative. This minimizes the introduction of bias. The average PI vent exhaust concentration were:

Alpha 7.7 E-14 uCi/cc
Beta 4.8 E-13 uCi/cc
Iodine 2.7 E-12 uCi/cc

Table 2 lists the isotopes and activities contained in the inspected containers that contributed at 0.1% of the 1999 inspected package inventory. In deciding which radionuclides to consider, Table 2 isotopes are categorized as alpha emitters, beta emitters, and iodines. Each category is evaluated for isotopes that contribute at least 0.5 % to the category. These isotopes are then compared with respect to their inhalation dose conversion factors (DCFs) contained in Federal Guidance Report 11 "Limiting Values of Radionuclide Intake, Air Concentration and Dose Conversion Factors For Inhalation, Submersion, And Ingestion" (FRG 11). The isotopes with the highest DCFs are then selected. Based on FRG 11, the alpha emitter with the highest dose conversion factor was Th-232 (DCF = 1.6 E+5 mrem uCi). Iodine 125 is the most conservative radioiodine with a DCF of 2.4 mrem-uCi. Co-60 is the most conservative beta emitter with a DCF of 220 mrem uCi.

To determine the most conservative bounding case as well as to simplify the analysis, all air sample concentrations were assigned to one of these three isotopes. That is, the average alpha air sample activity was assumed to be entirely due to the presence of Th-232. Similarly, all beta activity was assumed to be Co-60 and all iodine activity was assumed to be I-125. This assignment adds to the conservatism already contained in the analysis.

APPENDIX A

Input for Comply Code (Level 2)

The 1999 package inspections are considered as 59 one-hour releases at the average concentrations of.

Th-232	Alpha	7.7 E-14 uCi/cc
Co-60	Beta	4.8 E-13 uCi/cc
I-125	Iodine	2.7 E-12 uCi/cc 8

The release rates in Ci/s for input into the "Comply" code are calculated as follows:

The release rate for each isotope is the total activity released in the year divided by the number of seconds in a year. These results are used to calculate concentrations for release rates used in COMPLY.

Assume all air sample activity is due to above stated isotopes. Calculate average release rate as follows:

$$\text{Average Release Rate} = \frac{\text{Vent. Flow x Concentration x Duration}}{\text{1 Year}}$$

For alpha emitters:

$$= \frac{(1000\ ft^3/min)(2.83\ E4\ cc/ft^3)(7.7\ E\text{-}14\ \mu Ci/cc)(59\ hrs/yr)(60\ min/hr)}{3.2\ E\ 7\ sec/yr}$$

= 2.5 E-10 μCi/sec or 2.5 **E-16 Ci/sec**
(Assumed to be Th-232)

For beta emitters:

$$= \frac{(1000\ ft^3/min)(2.83\ E4\ cc/ft^3)(4.8\ E\text{-}13\ \mu Ci/cc)(59\ hrs/yr)(60\ min/hr)}{3.2\ E\ 7\ sec/yr}$$

= 1.5 E-09 μCi/sec or **1.5 E-15 Ci/sec** (Assumed to be Co-60)

For iodines:

$$= \frac{(1000\ ft^3/min)(2.83\ E4\ cc/ft^3)(2.2\ E\text{-}13\ \mu Ci/cc)(59\ hrs/yr)(60\ min/hr)}{3.2\ E\ 7\ sec/yr}$$

= 6.1 E-9 μCi/sec or **6.1 E-15 Ci/sec** (Assumed to be I-125)

APPENDIX A

Results

The "Comply" Code Level 2 estimates doses at 100 meters from the stack exhaust to the receptor. The actual distance from source to nearest resident is greater than ten miles. Attachment 1 provides the Comply Code output.

The dose results based on COMPLY are:

Effective dose equivalent: 2.1 E-3 mrem/yr due to alpha and beta emitters
Effective dose equivalent: 1.9 E-4 mrem/yr due to iodine

Therefore, this level demonstrates compliance in spite of the conservative assumptions and the inherent conservatism of the models.

APPENDIX A

Table 1
Package Inspection Vent Exhaust Concentrations

Date	Alpha	Error	Beta	Error	Iodine	Error
1/14/99	-3.5E-14	1.13E-13	2.79E-13	2.44E-13	1.54E-12	9.81E-13
1/19/99	9.19E-14	1.5E-14	4.62E-13	1.99E-13	1.08E-12	9.56E-13
1/29/99	0	5.09E-14	5.15E-13	1.9E-13	1.2E-12	1.36E-12
2/1/99	2.41E-13	1.12E-13	7.49E-13	2.13E-13	2.46E-12	5.4E-12
2/4/99	3.45E-14	4.78E-14	3.53E-13	1.34E-13	8.15E-13	7.25E-13
2/10/99	1.07E-13	6.37E-14	1.31E-13	4.41E-13	6.48E-13	9.76E-13
2/11/99	1.58E-13	8.19E-14	6.87E-13	1.19E-13	1.01E-12	8.05E-13
2/23/99	0	7.12E-14	6.18E-13	2.07E-13	4.17E-13	1.43E-12
3/1/99	2.76E-14	1.44E-14	1.55E-13	3.79E-14	1.75E-13	1.67E-13
3/8/99	1.26E-13	1.03E-13	7.14E-13	2.14E-13	1.6E-12	1.04E-12
3/24/99	1.84E-13	8.06E-14	5.92E-13	1.69E-13	1.07E-12	7.9E-13
3/29/99	6.89E-14	5.51E-14	5.92E-13	2.15E-13	2.67E-12	1.41E-12
4/2/99	1.15E-14	3.9E-14	4.18E-13	1.93E-13	7.47E-13	1E-12
4/9/99	3.45E-14	6.19E-14	3.4E-13	1.24E-13	6.43E-13	5.78E-13
4/20/99	1.38E-14	4.27E-14	3.03E-13	1.22E-13	1.07E-12	5.94E-13
4/21/99	3.45E-14	4.05E-14	3.45E-13	1.3E-13	2.83E-13	6.06E-13
5/3/99	4.6E-14	7.8E-14	6.18E-13	1.94E-13	1.72E-12	9.84E-13
5/5/99	5.17E-14	3.73E-14	2.79E-13	9.88E-14	2.08E-12	7.36E-13
5/10/99	4.6E-14	4.77E-14	4.53E-13	1.58E-13	9.52E-13	7.99E-13
5/11/99	3.45E-14	7.45E-14	6.27E-13	2.09E-13	3.38E-13	1.38E-12
5/21/99	3.66E-14	6.74E-14	4.81E-13	1.62E-13	5.85E-13	9.16E-13
6/1/99	3.45E-14	4.78E-14	1.87E-13	1.1E-13	6.35 e-13	6.88E-13
6/4/99	8.11E-15	4.21E-14	3.93E-13	1.38E-13	9.42E-13	9.75E-13
6/15/99	5.99E-14	4.7E-14	3.91E-13	1.17E-13	3.09E-13	7.1E-13
6/15/99	6.89E-14	7.8E-14	6.53E-14	2.17E-14	2.13E-12	1.4E-12
6/23/99	3.61E-14	2.8E-14	1.77E-13	6.27E-14	3E-13	3.95E-13
7/9/99	4.6E-14	2E-14	5.13E-13	1E-13	2.25E-12	4E-12
7/21/99	4.6E-14	1E-13	7.49E-13	2.13E-13	9.79E-13	1.37E-12
7/21/99	2.3E-14	9.55E-14	6.45E-13	2.05E-13	4.55E-13	1.36E-12
7/26/99	-2.8E-14	6.98E-14	3.41E-13	1.91E-13	9.6E-13	1.11E-12
8/2/99	1.15E-13	8.43E-14	5.57E-13	2.15E-13	1.53E-12	4.04E-12
8/6/99	-3E-14	6.96E-14	5.23E-13	1.9E-13	9.15E-13	2.72E-12

APPENDIX A

Table 1 (Continued)
Package Inspection Vent Exhaust Concentrations

Date	Alpha	Error	Beta	Error	Iodine	Error
8/25/99	5.36E-13	6.19E-14	6.74E-13	1.66E-13	3.7E-13	2.64E-12
8/25/00	1.53E-13	5.2E-14	2.96E-13	1.38E-13	3.39E-13	2.64E-12
8/26/99	8.62E-14	4.64E-14	4.18E-13	1.16E-13	1.05E-12	1.62E-12
8/26/99	8.62E-14	4.64E-14	4.18E-13	1.16E-13	1.05E-12	1.62E-12
8/26/99	4.6E-14	4.25E-14	2.44E-13	1.31E-13	3.11E-13	2.68E-12
8/26/99	8.62E-14	4.64E-14	4.18E-13	1.16E-13	1.05E-12	1.62E-12
9/9/99	4.6E-14	7.12E-14	9/06E-13	2.28E-13	2.62E-12	3.28E-12
9/9/99	1.26E-13	9.29E-14	7.93E-13	2.19E-13	6.98E-12	4.14E-12
9/21/99	6.89E-14	8.43E-14	7.49E-13	2.53E-13	8.14E-12	4.11E-12
9/30/99	-2.2E-14	5.88E-14	6.03E-13	2.02E-23	2.22E-12	3.61E-12
10/5/99	1.84E-13	9.19E-19	5.29E-13	1.89E-13	1.59E-12	3.08E-12
10/13/99	2.4E-13	2E-13	9.06E-13	5E-13	6.52E-12	5E-12
10/18/99	9.85E-14	6.69E-14	4.4E-13	1.83E-13	1.58E-12	3.39E-12
10/22/99	1.72E-14	3.38E-14	3.53E-13	1.58E-13	3.26E-12	2.88E-12
11/2/99	1.72E-13	1.03E-13	8.18E-13	2.84E-13	7.3E-12	4.02E-12
11/8/99	0	3.68E-14	4.24E-13	1.56E-13	1.27E-12	2.34E-12
11/11/99	1.38E-13	1.01E-13	6.18E-13	2.22E-13	9.71E-14	4.03E-12
11/16/99	9.19E-14	9.55E-14	6.62E-13	2.26E-13	3.44E-12	3.41E-12
11/16/99	9.19E-14	9.55E-14	6.62E-13	2.26E-13	3.44E-12	3.41E-12
11/24/99	4.6E-14	5.52E-14	5.66E-13	2.19E-13	5.23E-12	3.71E-12
12/9/99	9.19E-14	5.62E-14	3.54E-13	1.39E-13	5.92E-12	2.45E-12
12/9/99	1.47E-13	7.64E-13	4.88E-13	1.72E-13	2.02E-12	2.72E-12
12/15/99	1.15E-13	9.01E-14	7.75E-13	2.22E-13	7.59E-12	3.59E-12
12/16/99	-7.3E-15	4.72E-14	3.58E-14	1.29E-13	2.43E-12	2.2E-12
12/22/99	9.19E-14	6.3E-14	4.53E-13	1.25E-13	3.12E-12	2E-12
12/29/99	1.72E-14	4.78E-14	3.92E-13	1.5E-13	5.1E-12	2.62E-12

APPENDIX A

Table 2
Package Inspection Major Isotopes (>0.1%)

Beta Emitters	mCi	%
Ag-110	0.13	0.01
C-14	259.00	21.9
Ce-144	0.35	0.03
Cl-36	0.29	0.02
Co-57	64.30	5.44
Co-58	20.70	1.75
Co-60	348.00	29.5
Cr-51	72.20	6.11
Cs-134	0.42	0.04
Cs-137	11.10	0.94
Fe-55	127.00	10.8
Mn-54	18.70	1.58
Na-22	0.48	0.04
Ni-63	42.00	3.56
P-32	14.90	1.26
Pb-210	0.39	0.03
Pu-241	0.29	0.02
Ru-106	0.13	0.01
S-35	90.60	7.67
Sb-125	3.92	0.33
Sr-90	1.15	0.10
Sb-125	3.92	0.33
Tc99	0.07	0.01
Zn-65	101.00	8.55
Total B/G	**1181.03**	

Iodines	mCi	%
I-125	53.6	93.2
I-129	0.11	0.19
I-131	3.80	6.61
TOTAL IODINE	**57.5**	

Alpha	mCi	%
Am-241	0.02	0.01
Pu-238	0.01	0.01
Pu239/40	0.01	0.01
Ra-226	103.00	68.1
Ra-228	0.05	0.03
Th-232	1.84	1.22
Th-Nat	15.70	10.4
U233	0.56	0.37
U-234	0.00	0.00
U-235	2.59	1.71
U-238	1.54	1.02
U-Nat	26.00	17.2
TOTAL ALPHA	**151.3**	

H3	**379.0**	

40 CFR Part 61
National Emission Standards
for Hazardous Air Pollutants

REPORT ON COMPLIANCE WITH THE CLEAN AIR ACT LIMITS FOR RADIONUCLIDE EMISSIONS FROM THE COMPLY CODE, VERSION 1.5d

Prepared by:

US Ecology Inc.
Richland LLRW Disposal Facility
RIchland Washington

Robert F. Haight
509-377-2411

Prepared for:

U.S. Environmental Protection Agency
Office of Radiation Programs
Washington, D.C. 20460

COMPLY: V1.5d. 3/24/ 0 12:56

1999 Vent Exhaust

SCREENING LEVEL 2

DATA ENTERED:

Nuclide		Release Rate (curies/SECOND)
TH-232	W	2.500E-16
CO-60	Y	1.500E-15
I-125	D	6.100E-15

Release height 3 meters.

Building height 4 meters.

The source and receptor are not on the same building.

Distance from the source to the receptor is 100 meters.

Building width 10 meters.

Default mean wind speed used (2.0 m/sec).

NOTES:

Input parameters outside the "normal" range:

None.

RESULTS:

Effective dose equivalent: 2.1E-03 mrem/yr.

Effective dose equivalent: 1.9E-04 mrem/yr due to Iodine.

*** Comply at level 2.

This facility is in COMPLIANCE.

It may or may not be EXEMPT from reporting to the EPA.

You may contact your regional EPA office for more information.

********** END OF COMPLIANCE REPORT **********

APPENDIX B

CLIMATOLOGICAL SUMMARY and WIND ROSE
US ECOLOGY, RICHLAND, WASHINGTON
ANNUAL ENVIRONMENTAL REPORT
CALENDAR YEAR 1999

Copied from the "Hanford Site, Climatological Data Summary 1999".

2.0 Calendar Year 1999 Summary

This section summarizes climatology for calendar year 1999. More detailed information can be found in Section 3.0 Temperature Climatology, Section 4.0 Precipitation Climatology, and Section 5.0 Wind Climatology.

The 1998-99 winter season (December, January, and February) was much warmer than normal, averaging 37.7°F, 4.1° above normal (33.6°F), and tied the winter of 1997-98 as the sixth warmest winter on record. The warmest was 40.6°F in 1966-67, and the coldest was 24.2°F in 1948-49. The coldest temperature during the winter was -1°F on December 21. Precipitation for the 1998-99 winter season was below normal, totaling 2.03 inches, 83% of normal (2.44 inches). The wettest winter, in 1996-97, received 5.45 inches; while the driest, 1946-47, received only 0.70 inch.

Spring 1999 (March, April, and May) was cooler than normal, averaging 51.7°F, 1.5° below normal (53.2°F). The warmest spring, in 1992, averaged 58.2°F, while the coolest (1955) averaged 48°F. Spring 1999 was the sixth driest on record with precipitation totaling 0.40 inch, 29% of normal (1.40 inches). The wettest spring, in 1995, received 3.28 inches, while the driest (1968) received only 0.09 inch.

The summer of 1999 (June, July, and August) was cooler than normal, averaging 72.5°F, 1.2° below normal (73.7°F). The hottest summer, in 1958, averaged 78.2°F, while the coolest, in 1980, averaged 70.2°F. The highest temperature was 105°F on July 28. Precipitation for the summer season totaled 0.95 inch, 115% of normal (0.83 inch). The wettest summer, in 1950, received 2.99 inches, while the driest, in 1973, received only 0.03 inch.

Autumn 1999 (September, October, and November) was warmer and drier than normal. The average temperature was 54.2°F, 1.3°F above normal (52.9°F). The warmest autumn (1990) averaged 57.1°F, while the coolest (1985) averaged 44.5°F. Precipitation totaled 0.74 inch, 46% of normal (1.60 inches). The wettest autumn (1973) received 4.79 inches, while the driest (1976) received only 0.04 inch.

The atmospheric pressure on Christmas Day reached 30.91 inches of mercury, the highest pressure since 31.12 inches on January 1, 1979 (the highest on record).

APPENDIX B

CLIMATOLOGICAL SUMMARY and WIND ROSE
US ECOLOGY, RICHLAND, WASHINGTON
ANNUAL ENVIRONMENTAL REPORT
CALENDAR YEAR 1999

Copied from the "Hanford Site, Climatological Data Summary 1999".

The following are some additional statistics for 1999:

Category	Number of Days	Normal	Record Maximum	Record Minimum
Maximum temperatures ≥100°F	7	13	28	1
Maximum temperatures ≥90°F	49	52	79	29
Maximum temperatures ≤32°F	7	24	58	2
Minimum temperatures ≥70°F	9	7	21	0
Minimum temperatures ≤32°F	95	107	139	77
Minimum temperatures ≤0°F	0	3	18	0
Thunderstorms	10	10	23	3
Fog (visibility ≤6 mi)	27	45	76	22
Dense fog (visibility ≤0.25 mi)	15	24	42	9
Peak wind gusts ≤12 mph	34	50	87	28
Peak wind gusts ≥25 mph	192	155	192	123
Peak wind gusts ≥40 mph	48	26	57	10
Peak wind gusts ≥50 mph	10	5	18	0

2.1 Temperature

Calendar year 1999 was warmer than normal at the Hanford Meteorology Station. The average temperature was 54.4°F, 1.1° above normal (53.3°F). The warmest years on record are 1992 and 1998, which averaged 56.4°F, while the coldest year on record is 1985, which averaged 49.6°F. The hottest temperature of 1999 was 105°F on July 28, while the coldest was 18°F on January 3.

The year was evenly divided with 6 months warmer than normal, and 6 months cooler than normal. Four months were 3° or more above normal, with January warmer by 7°. January was the fifth warmest on record, November the third warmest, and December the fifth warmest. Only one month (May) was more than 3° cooler than normal, and that by 3.4°. January 1999 was much warmer than normal, averaging 38.3°F, 7° above normal (31.3°F), and was the fifth warmest January on record. The warmest January occurred in 1953 and averaged 42.5°F, while the coldest was 12.1°F in 1950.

January 1999 was much warmer than normal, averaging 38.3°F, 7° above normal (31.3°F), and was the fifth warmest January on record. The warmest January occurred in 1953 and averaged 42.5°F, while the coldest was 12.1°F in 1950.

February 1999 was warmer than normal, averaging 41.7°F, 3.7° above normal (38°F). The warmest February occurred in 1958 and averaged 44.5°F, while the coldest was 25.6°F in 1956.

March 1999 was slightly warmer than normal, averaging 46.3°F, 0.7° above normal (45.6°F). The warmest March occurred in 1992 and averaged 51.5°F, while the coldest was 39.4°F in 1955.

April 1999 was cooler than normal, averaging 50.9°F, 1.8° below normal (52.7°F). The warmest April occurred in 1994 and averaged 58.2°F, while the coldest was 47.5°F in 1955.

May 1999 was cooler than normal, averaging 57.9°F, 3.4° below normal (61.3°F). The first three weeks of the month averaged 7.2° below normal, with the first above normal day for the month not occurring until May 22. The warmest May occurred in 1947 and averaged 68.7°F, while the coolest was 56°F in 1984.

June 1999 was cooler than normal, averaging 67.4°F, 2.3° below normal (69.7°F). The warmest June occurred in 1992 and averaged 76.8°F, while the coolest was 63.0°F in 1953.

July 1999 was cooler than normal, averaging 73.8°F, 2.4° below normal (76.2°F). This was the fourth consecutive month with a below normal average temperature following a period (August 1997 through March 1999) when the monthly average temperature was above normal for 19 out of 20 months. The warmest July occurred in 1985 and averaged 82.2°F, while the coolest was 70.5°F in 1993.

August 1999 was slightly warmer than normal, averaging 76.2°F, 1.1° above normal (75.1°F). The warmest August occurred in 1967 and averaged 81.5°F, while the coolest was 69.8°F in 1964.

September 1999 was slightly cooler than normal, averaging 65.0°F, 0.7° below normal (65.7°F). The warmest September occurred in 1990 and averaged 72.4°F, while the coolest was 58.8°F in 1985. For calendar year 1999 there were 49 days with maximum temperatures ≥90°F compared to a normal of 52 days, and 7 days with maximum temperatures ≥100°F compared to a normal of 13 days.

October 1999 was cooler than normal, averaging 51.8°F, 1.1° below normal (52.9°F). The warmest October occurred in 1988 and averaged 59.6°F, while the coolest was 47.9°F in 1984. The first official (measured at the Hanford Meteorology Station) freezing temperature (minimum temperature ≤32°F) occurred on October 17. The average date for the first freezing temperature is October 20, with the earliest occurring on September 25, 1972, and the latest on November 12, 1962.

November 1999 was the third warmest November on record, averaging 45.8°F, 5.6° above normal (40.2°F). The average temperature for every day after November 5 was normal or above, with the period from November 8 through 17 averaging 11.4° above normal. The maximum temperature of 76°F on November 13 was the warmest temperature ever recorded in November, breaking the record of 75°F recorded just the day before, and also on November 3, 1975. The warmest November occurred in 1990 and averaged 46.5°F, while the coolest was 24.8°F in 1985.

December 1999 was the fifth warmest December on record, averaging 37.7°F, 6.3° above normal (31.4°F). The period from December 11–19 averaged 14.1° above normal. The warmest December occurred in 1957 and averaged 38.5°F, while the coolest was 21.0°F in 1985.

Table 2.1 lists the daily temperature records for 1999 along with the previous record and year of occurrence. Table 2.2 lists the monthly and annual totals for numerous meteorological parameters for 1999. Table 2.3 lists the 1999 monthly and seasonal temperature and precipitation compared to normals and extremes. Tables 2.4, 2.5, and 2.6 list the 1999 monthly and annual average temperature, precipitation, and wind speed, respectively, from the Hanford Meteorological Monitoring Network.

Table 2.1. 1999 Daily Temperature Records (previous record and year of occurrence in parentheses)

	Maximum		Minimum	
Date	High	Low	High	Low
Jan 14	62 (60, 1961)			
Jan 28			42 (41, 1953)	
Jan 29			47 (44, 1992)	
Feb 6			44 (37, 1961)	
Feb 22			42[a](42,1958)	
May 7		59 (61, 1990)		
May 8		56[a](56,1962)		
May 9				34[a](34,1996[b])
May 24	97 (96, 1962)			
Jun 2		65[a](65,1980)		
Jun 6				38 (46, 1962)
Jun 7				42 (44, 1961)
Jun 9				42 (44, 1985)
Jun 13			70 (67, 1989)	
Jun 15	102[a] (102, 1961)			
Jul 3				45 (46, 1990)
Jul 5				47[a](47,1980)
Jul 26				53 (54, 1948)
Aug 3			75[a](75,1994)	
Aug 30		64[c](68,1951)		
Aug 31		72[a](72, 1971)		43 (45, 1965)
Sep 1				43 (44, 1980)
Oct 3				39[a](33,1973[b])
Oct 13	81 (79, 1945)			
Oct 27		43[a](43, 1993[b])		
Nov 12	75 (65, 1991)			
Nov 13	76[d](64, 1987)			
Dec 12	57[a](57, 1988)			
Dec 15			49 (41, 1956)	
Dec 16	56 (56, 1956)		44 (43, 1973)	
Dec 18	56[a](56, 1956)		42 (38, 1994)	

(a) Ties record.

(b) Most recent of several occurrences.

(c) All-time low maximum for month of August, previous record 67°F on August 20, 1959.

(d) All-time high maximum for month of November, previous record 75°F on November 12, 1999 and November 3, 1975.

Table 2.2. 1999 Climatological Data Summary

Month	Temperatures, °F: Averages: Daily Maximum	Daily Minimum	Monthly	Departure[a]	Extremes: Highest	Date	Lowest	Date	Degree Days Base 65, °F: Heating	Departure[a]	Cooling	Departure[a]	Precipitation, inches: Total	Departure[a]	Greatest in 24 Hours	Date	Snow, Ice Pellets, inches: Total	Departure[a]	Greatest in 24 Hours	Date	Relative Humidity, %: Average	Departure[a]
J	46.5	30.1	38.3	+7.0	62	14	18	3	829	-215	0	0	0.89	+0.10	0.51	22-23	T	-3.9	T	22[c]	74.0	-2.4
F	50.7	32.7	41.7	+3.7	62	24	20	11	651	-113	0	0	0.70	+0.08	0.32	27	T	-2.0	T	18	61.5	-8.8
M	57.4	35.2	46.3	+0.7	75	20	25	2	581	-21	0	0	0.06	-0.41	0.02	21[c]	0	-0.3	0	-	52.8	-3.1
A	65.4	36.4	50.9	-1.8	82	24	25	10	424	+52	0	-3	T	-0.41	T	19[c]	0	-T[b]	0	-	43.7	-3.5
M	71.8	43.9	57.9	-3.4	97	24	30	8	265	+101	43	-5	0.34	-0.17	0.18	6	0	0	0	-	41.0	-1.7
J	81.4	53.4	67.4	-2.3	102	15	38	6	62	+30	135	-40	0.31	-0.07	0.20	8	0	0	0	-	39.8	+1.0
J	88.9	58.6	73.8	-2.4	105	28	45	3	8	+3	281	-70	0.07	-0.11	0.05	17	0	0	0	-	34.2	+0.7
A	90.7	61.7	76.2	+1.1	101	2	43	31	17	+12	366	+49	0.57	+0.30	0.48	5	0	0	0	-	40.9	+5.1
S	81.4	48.6	65.0	-0.7	91	22[c]	36	28	65	-13	66	-32	0.00	-0.31	0.00	-	0	0	0	-	36.3	-6.7
O	64.7	39.0	51.8	-1.1	81	13	27	27	407	+30	0	-3	0.48	+0.10	0.36	27	0	-0.1	0	-	49.4	-5.8
N	54.6	36.9	45.8	+5.6	76	13	26	3	576	-170	0	0	0.26	-0.65	0.14	5-6	0	-1.8	0	-	72.2	-1.2
D	44.5	31.0	37.7	+6.3	62	16	20	8	846	-196	0	0	0.07	-0.96	0.03	31	0.6	-5.1	0.6	31	75.4	-4.9
Year	66.5	42.3	54.4	+1.1	105	Jul 28	18	Jan 3	4,731	-500	891	-104	3.75	-2.51	0.51	Jan 22-23	0.6	-13.2	0.6	Dec 31	51.8	-2.5

Table 2.2. (contd)

Month	Mean Sky Cover, Tenths		Solar Radiation, Langleys						50-ft Wind					Number of Days							
											Peak Gusts							Maximum Temperature, °F		Minimum Temperature, °F	
	Average	Departure[a]	Average Daily Total	Departure[a]	Greatest Daily Total	Date	Least Daily Total	Date	Average Speed, mph	Departure[a]	Speed, mph	Direction	Date	Thunderstorms	Heavy Fog	Precipitation ≥1 in.	Snowfall ≥1 in.	≥90°F	≤32°F	≤32°F	≤0°F
J	8.7	+0.6	82	-27	151	18	22	5	7.7	+1.2	55	S	29	0	9	3	0	0	3	20	0
F	7.7	+0.1	155	-32	319	28	53	24	11.1	+3.9	65	SSW	6	0	0	2	0	0	0	15	0
M	7.0	+0.2	296	-28	465	26	109	2	9.3	+1.0	52	SW	29	0	0	0	0	0	0	13	0
A	5.3	-1.3	433	-19	593	29	206	18	8.8	-0.2	40	NW	2	3	0	0	0	0	0	7	0
M	4.2	-1.8	547	-13	702	26	253	2	10.4	+1.3	45	WNW	25	0	0	2	0	2	0	2	0
J	5.2	0.0	586	-29	717	26	293	2	9.7	+0.5	42	W	8	4	0	2	0	5	0	0	0
J	1.8	-1.5	643	+11	737	1	402	17	9.4	+0.6	44	NW	24	2	0	0	0	17	0	0	0
A	3.8	+0.3	483	-55	640	1	88	30	8.2	+0.3	44	NW	29	4	0	1	0	21	0	0	0
S	1.7	-2.3	425	+17	511	3[c]	289	23	7.7	+0.3	43	WSW	25	0	0	0	0	4	0	0	0
O	4.7	-1.0	241	-18	371	1	46	26	7.7	+1.2	46	W	31	0	1	1	0	0	0	6	0
N	7.4	-0.4	107	-16	227	4	23	24	7.5	+1.1	41	SW	8	0	1	1	0	0	0	10	0
D	8.0	-0.1	70	-16	148	7	8	27	7.5	+1.6	62	WSW	18	0	4	0	0	0	4	22	0
Year	5.5	-0.6	339	-19	737	Jul 1	8	Dec 27	8.8	+1.1	65	SSW	Feb 6	10	15	12	0	49	7	95	0

(a) Departure columns indicate positive or negative departure of meteorological parameters from 30-year (1961-1990) climatological normals.
(b) Trace of snowfall is normal; no occurrence in April.
(c) Latest date of multiple occurrences.
T = Trace.

Table 2.3. 1999 Monthly and Seasonal Temperature and Precipitation

Month/ Season	Average Temperature, °F	Departure[a]	Normal, °F	Warmest of Record, °F	Year	Coolest of Record, °F	Year	Precipitation, in.	Percent of Normal	Normal	Wettest of Record, in.	Year	Driest of Record, in.	Year
Jan	38.3	+7.0	31.3	42.5	1953	12.1	1950	0.89	113	0.79	2.47	1970	0.08	1977
Feb	41.7	+3.7	38.0	44.5	1958	25.6	1956	0.70	113	0.62	2.10	1961	T	1988[b]
Mar	46.3	+0.7	45.6	51.5	1992	39.4	1955	0.06	13	0.47	1.86	1957	0.02	1968
Apr	50.9	-1.8	52.7	58.2	1994	47.5	1955	T	0	0.41	1.54	1995	T	1999[b]
May	57.9	-3.4	61.3	68.7	1947	56.0	1984	0.34	67	0.51	2.03	1972	T	1992[b]
Jun	67.4	-2.3	69.7	76.8	1992	63.0	1953	0.31	82	0.38	2.92	1950	T	1986[b]
Jul	73.8	-2.4	76.2	82.2	1985	70.5	1993	0.07	39	0.18	1.76	1993	T	1980[b]
Aug	76.2	+1.1	75.1	81.5	1967	69.8	1964	0.57	211	0.27	1.36	1977	0	1988[b]
Sep	65.0	-0.7	65.7	72.4	1990	58.8	1985	0.00	0	0.31	1.34	1947	0	1999[b]
Oct	51.8	-1.1	52.9	59.6	1988	47.9	1984	0.48	126	0.38	2.72	1957	T	1987[b]
Nov	45.8	+5.6	40.2	46.5	1990	24.8	1985	0.26	29	0.91	2.67	1996	T	1976
Dec	37.7	+6.3	31.4	38.5	1957	21.0	1985	0.07	7	1.03	3.69	1996	0.07	1999
Winter	37.7	+4.1	33.6	40.6	1966-67	24.2	1948-49	2.03	83	2.44	5.45	1996-97	0.70	1946-47
Spring	51.7	-1.5	53.2	58.2	1992	48.0	1955	0.40	29	1.40	3.28	1995	0.09	1968
Summer	72.5	-1.2	73.7	78.2	1958	70.2	1980	0.95	115	0.83	2.99	1950	0.03	1973
Autumn	54.2	+1.3	52.9	57.1	1990	44.5	1985	0.74	46	1.60	4.79	1973	0.04	1976
Calendar year	54.4	+1.1	53.3	56.4	1998[b]	49.6	1985	3.75	60	6.26	12.31	1995	2.99	1976

(a) Departure indicates positive or negative departure from 30-year (1961-1990) climatological normals.
(b) Latest of multiple occurrences.
T = Trace.

Table 2.4. 1999 Monthly and Annual Average Temperatures (°F) from the Hanford Meteorological Monitoring Network

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1 PROS	38.3	41.8	45.5	50.7	58.0	68.0	74.3	76.5	62.6	50.7	45.6	38.4	54.3
2 EOC	39.8	41.4	45.5	51.7	57.3	66.5	73.7	76.4	65.9	53.3	47.0	38.2	54.8
3 ARMY	38.1	42.5	46.0	51.7	58.8	68.3	75.2	77.4	64.5	51.8	47.3	38.8	55.2
4 RSPG	39.3	42.8	45.6	51.3	58.1	67.5	74.2	76.8	63.6	51.0	45.7	38.7	54.6
5 EDNA	41.1	45.5	47.2	52.8	59.2	68.3	74.4	76.4	63.1	51.1	45.5	38.2	55.3
6 200E	38.7	42.3	46.7	53.1	59.7	68.9	75.9	77.9	66.4	53.4	47.0	39.2	55.9
7 200W	37.3	41.1	45.0	50.3	58.0	67.8	74.6	76.6	62.5	50.1	45.3	38.1	54.0
8 BVLY	38.6	41.5	46.4	52.7	59.0	67.7	74.0	76.0	64.3	52.4	46.7	39.0	54.9
9 FFTF	39.1	42.1	45.9	51.7	58.5	67.9	74.5	76.7	64.6	52.4	46.8	38.8	55.0
10 YAKB	37.8	41.1	45.9	52.1	58.6	68.0	75.0	77.2	65.8	52.5	46.2	38.3	55.0
11 300A	39.6	42.6	45.7	51.4	58.4	67.8	73.7	75.8	63.0	51.5	47.0	39.9	54.7
12 WYEB	38.3	41.9	45.7	51.9	58.7	68.2	75.0	77.0	64.4	52.1	46.0	38.5	54.9
13 100N	37.5	40.9	45.4	51.6	58.3	67.8	73.9	75.9	64.0	52.0	45.6	38.4	54.3
14 WPPS	38.3	41.8	45.2	50.7	58.3	68.4	74.9	77.0	63.4	51.7	46.1	38.7	54.6
15 FRNK	38.8	41.2	45.0	50.6	56.9	65.1	70.7	72.2	61.8	51.0	45.6	38.2	53.2
16 GABL	39.1	41.3	45.7	52.3	58.0	66.7	74.2	76.7	66.9	53.8	46.6	38.2	55.1
17 RING	38.2	41.5	45.6	50.3	57.4	64.9	70.7	72.8	60.8	50.3	45.3	38.5	53.0
18 RICH	40.8	43.4	46.5	52.3	59.0	68.0	74.0	76.5	64.0	52.7	47.5	40.2	55.5
19 PFP	37.9	41.6	45.8	51.7	58.5	67.8	74.9	77.1	65.0	52.1	46.0	38.4	54.8
20 RMTN	33.5	31.6	36.0	42.4	47.6	56.8	64.8	68.1	59.0	47.0	41.3	30.6	46.7
21 HMS	38.3	41.7	46.3	50.9	57.9	67.4	73.8	76.2	65.0	51.8	45.8	37.7	54.4
22 PASC	40.2	43.4	46.4	52.2	59.5	68.6	74.3	76.8	63.3	52.0	46.8	39.9	55.4
23 GABW	36.7	40.7	44.8	50.5	58.0	68.0	74.4	76.1	62.5	50.4	45.0	37.5	53.8
24 100F	37.6	41.4	45.3	51.2	58.5	68.2	74.4	76.4	63.3	51.1	45.3	38.3	54.3
25 VERN	38.4	41.9	46.6	53.0	59.6	68.3	74.8	77.1	65.7	53.3	47.4	39.5	55.5
26 BENT	38.3	40.5	44.8	51.0	56.7	66.3	72.4	74.4	63.9	51.6	45.4	37.4	53.6
27 VSTA	41.6	44.0	47.0	53.0	59.4	68.2	74.4	76.5	64.4	52.9	48.1	40.5	55.9
28 SURF	40.6	42.2	45.1	51.5	57.3	66.3	73.4	75.9	64.1	52.2	46.6	40.3	54.6
29 100K	37.4	41.3	45.8	51.9	58.9	68.4	74.8	76.5	64.4	52.1	45.9	38.4	54.7
30 HAMR	40.8	42.8	46.2	51.8	58.7	67.7	74.0	76.7	63.8	51.9	47.8	39.6	55.4

Table 2.5. 1999 Monthly and Annual Average Precipitation (inches) from the Hanford Meteorological Monitoring Network[a]

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1 PROS	0.74	0.74	0.07	0.06	0.39	0.03	0.01	0.11	0.00	0.33	0.39	0.35	3.22
2 EOC	1.17	1.65	0.14	0.11	0.46	0.13	0.00	0.31	0.00	0.46	0.81	0.64	5.88
3 ARMY	0.66	0.52	0.02	0.01	0.27	0.04	0.01	0.17	0.00	0.45	0.39	0.15	2.69
4 RSPG	0.58	0.51	0.09	0.21	0.22	0.08	0.11	0.12	0.02	0.41	0.40	0.23	2.98
6 200E	0.77	0.52	0.03	0.01	0.42	0.06	0.03	0.34	0.00	0.36	0.18	0.02	2.74
7 200W	0.59	0.35	0.07	0.02	0.24	0.48	0.10	0.08	0.00	0.44	0.34	0.16	2.87
8 BVLY	1.03	0.47	0.02	0.05	0.34	0.12	0.01	0.24	0.02	0.32	0.31	0.04	2.97
9 FFTF	0.52	0.33	0.03	0.02	0.19	0.06	0.02	0.12	0.00	0.24	0.14	0.23	1.90
10 YAKB	0.48	0.30	0.02	0.02	0.21	0.38	0.42	0.13	0.00	0.33	0.17	0.11	2.57
11 300A	0.57	0.50	0.06	0.17	0.34	0.02	0.00	0.30	0.00	0.35	0.23	0.25	2.79
12 WYEB	0.66	0.58	0.00	0.04	0.34	0.02	0.00	0.24	0.00	0.36	0.35	0.26	2.85
13 100N	0.82	0.66	0.00	0.01	0.34	0.07	0.04	0.21	0.00	0.26	0.21	0.15	2.77
14 WPPS	0.76	0.66	0.01	0.10	0.38	0.02	0.02	0.46	0.00	0.46	0.38	0.32	3.57
17 RING	0.65	0.80	0.02	0.09	0.55	0.29	0.05	0.55	0.00	0.45	0.41	0.42	4.28
18 RICH	0.58	0.47	0.04	0.19	0.27	0.03	0.00	0.05	0.00	0.38	0.42	0.23	2.66
20 RMTN	0.71	0.63	0.09	0.10	0.53	0.08	0.02	0.14	0.01	0.31	0.32	0.30	3.24
21 HMS	0.89	0.70	0.06	0.00	0.34	0.31	0.07	0.57	0.00	0.48	0.26	0.07	3.75
22 PASC	0.63	0.65	0.12	0.20	0.44	0.01	0.19	0.20	0.00	0.44	0.35	0.24	3.47
24 100F	0.78	0.69	0.02	0.02	0.40	0.08	0.02	0.18	0.01	0.36	0.40	0.28	3.24
26 BENT	0.84	0.83	0.08	0.09	0.37	0.05	0.00	0.09	0.00	0.56	0.48	0.29	3.68
27 VSTA	0.60	0.54	0.04	0.08	0.22	0.00	0.14	0.13	0.00	0.44	0.24	0.22	2.65
28 SURF	1.41	1.12	0.22	0.02	0.45	0.00	0.00	0.36	0.00	0.58	1.21	0.45	5.82
29 100K	0.87	0.61	0.04	0.05	0.35	0.16	0.07	0.28	0.25	0.33	0.31	0.17	3.49

(a) Stations 5, 15, 16, 19, 23, and 25 are solar powered; therefore, insufficient power is available to operate the heated tipping-bucket precipitation gauges.

Table 2.6. 1999 Monthly and Annual Average Wind Speed (mph) from the Hanford Meteorological Monitoring Network

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1 PROS	7.3	10.7	9.1	7.6	8.6	8.8	7.7	7.1	6.1	7.0	7.2	8.1	7.9
2 EOC	10.8	14.9	11.3	9.8	10.3	8.5	8.3	8.0	8.4	8.8	10.6	11.4	10.1
3 ARMY	6.4	10.8	8.3	7.5	8.6	7.8	7.6	6.3	6.3	6.2	6.4	7.5	7.5
4 RSPG	7.0	10.0	8.7	8.4	9.2	7.5	7.8	6.7	8.0	7.8	6.7	7.5	7.9
5 EDNA	6.0	8.3	7.2	6.8	8.3	8.1	7.5	6.5	5.8	5.8	5.8	6.1	6.8
6 200E	6.4	10.1	8.8	8.6	10.1	9.5	9.0	7.5	7.3	7.2	6.6	6.9	8.2
7 200W	5.8	9.1	7.3	6.7	8.5	7.6	7.3	6.0	5.6	5.6	5.5	6.2	6.7
8 BVLY	6.0	8.5	7.5	7.7	8.3	8.7	7.9	6.5	5.8	5.5	6.2	5.5	7.0
9 FFTF	7.9	11.3	9.7	8.3	9.4	9.0	7.9	7.5	6.9	7.6	7.8	8.6	8.5
10 YAKB	7.0	9.9	8.9	8.6	10.3	9.6	9.4	7.6	7.7	7.3	6.9	6.9	8.3
11 300A	7.9	10.9	9.1	7.9	8.8	8.9	8.2	7.1	6.3	6.8	7.2	8.5	8.1
12 WYEB	7.4	10.1	8.4	7.7	9.0	8.4	7.8	7.0	6.6	7.2	7.1	7.6	7.8
13 100N	5.2	7.6	6.5	7.2	8.0	8.3	7.8	5.8	5.6	5.4	5.0	5.7	6.5
14 WPPS	7.2	9.8	8.3	7.1	8.4	8.0	7.4	6.8	5.7	6.3	6.8	7.5	7.4
15 FRNK	8.0	10.0	8.3	6.9	7.0	7.1	6.2	6.1	5.5	6.1	6.7	7.9	7.1
16 GABL	10.9	15.1	12.4	12.6	13.9	13.4	12.3	11.0	10.4	10.5	10.1	10.7	11.9
17 RING	6.5	8.6	7.7	7.0	7.7	7.0	6.0	5.5	5.7	5.7	5.5	6.8	6.6
18 RICH	7.0	9.5	7.9	6.8	7.9	7.6	6.5	6.1	5.1	5.4	6.2	7.4	6.9
19 PFP	4.8	7.6	6.0	5.5	6.7	5.9	5.8	4.7	4.3	4.3	4.1	4.8	5.4
20 RMTN	21.7	27.6	20.6	20.8	19.2	16.1	14.7	14.3	16.3	17.9	21.8	24.1	19.5
21 HMS	7.7	11.1	9.3	8.8	10.4	9.7	9.4	8.2	7.7	7.7	7.5	7.5	8.8
22 PASC	5.9	8.2	7.0	5.8	6.7	6.8	5.4	5.7	4.2	4.7	5.2	6.4	6.0
23 GABW	5.6	8.5	7.2	7.2	9.0	8.7	8.2	6.7	5.9	6.2	5.6	6.0	7.1
24 100F	5.7	8.1	6.8	6.8	8.3	8.2	7.2	6.3	5.5	5.6	5.3	5.9	6.6
25 VERN	6.4	9.0	8.4	8.8	10.1	10.3	9.6	7.8	7.1	7.0	6.9	6.7	8.2
26 BENT	7.2	8.6	7.6	8.2	7.8	6.7	6.6	5.9	6.7	6.1	5.9	7.1	7.0
27 VSTA	7.0	9.3	7.8	6.5	7.6	7.6	6.0	7.4	4.6	5.4	6.1	7.5	6.9
28 SURF	8.7	10.0	9.8	11.3	12.1	15.4	12.2	11.5	8.2	8.2	7.1	8.0	10.1
29 100K	5.1	7.9	6.6	7.0	8.5	8.6	7.7	6.2	5.5	5.5	5.0	5.7	6.6
30 HAMR	6.9	9.8	8.4	7.5	8.2	8.1	7.2	6.8	6.0	6.4	6.6	7.5	7.4

Figure 2.1 depicts the 1999 observed daily maximum and minimum temperatures and the normal maximum, minimum, and mean daily temperatures for the Hanford Meteorology Station.

2.2 Precipitation

1999 was the fourth driest year on record. Precipitation totaled 3.75 inches, 60% of normal (6.26 inches). The wettest year was 1995 with 12.31 inches; the driest was 1976 with only 2.99 inches. Calendar year snowfall totaled 0.6 inch, least on record. The previous low was 0.9 inch in 1958, with an annual normal snowfall of 13.8 inches. The greatest calendar year snowfall was 57.5 inches (1996).

January 1999 had a total of 0.89 inch of precipitation, 113% of normal (0.79 inch). The wettest January, in 1970, received 2.47 inches, while the driest, in 1977, received 0.08 inch. There was only a trace of snowfall recorded in January 1999, compared to a January normal of 3.9 inches. The snowiest January received 23.4 inches (1950), while January 1994 received no snowfall.

Precipitation for February 1999 totaled 0.70 inch, 113% of normal (0.62 inch). The wettest February, in 1961, received 2.10 inches, while the driest, in 1988, received only a trace. There was only a trace of snowfall recorded in February 1999, compared to a February normal of 2.0 inches. The snowiest February received 17.0 inches (1989), while February 1991 received no snowfall.

Precipitation for March 1999 totaled only 0.06 inch, 13% of normal (0.47 inch). The wettest March, in 1957, received 1.86 inches, while the driest, in 1968, received only 0.02 inch. No snowfall was recorded in March 1999, compared to a March normal of 0.3 inch. The snowiest March received 4.2 inches (1951), while numerous March's have received no snowfall.

There was only a trace of precipitation in April 1999, 0% of normal (0.41 inch), tying four prior Aprils (1986, 1977, 1973, and 1956) as the driest on record. The wettest April, in 1995, received 1.54 inches. No snowfall was recorded in April 1999, compared to an April normal of a trace. The snowiest April received 1.0 inch (1982), while numerous Aprils have received no snowfall.

May 1999 had a total of 0.34 inch of precipitation, 67% of normal (0.51 inch). The wettest May, in 1972, received 2.03 inches, while the driest, in 1992 and earlier years, received only a trace.

June 1999 had a total of 0.31 inch of precipitation, 82% of normal (0.38 inch). The wettest June, in 1950, received 2.92 inches, while the driest, in 1986 and earlier years, received only a trace.

Precipitation for July 1999 totaled 0.07 inch, 39% of normal (0.18 inch). The wettest July, in 1993, received 1.76 inches, while the driest, in 1980 and earlier years, received only a trace.

Precipitation for August 1999 totaled 0.57 inch, 211% of normal (0.27 inch). Most of the precipitation (0.48 inch) was received during a thunderstorm on August 5, with 0.40 inch falling in a 35-minute period. The wettest August, in 1977, received 1.36 inches, while the driest, in 1988, received no precipitation.

No precipitation was recorded during September, tying the record for the driest September on record. September 1991 was also totally dry. There have only been 4 months since recordkeeping began at the

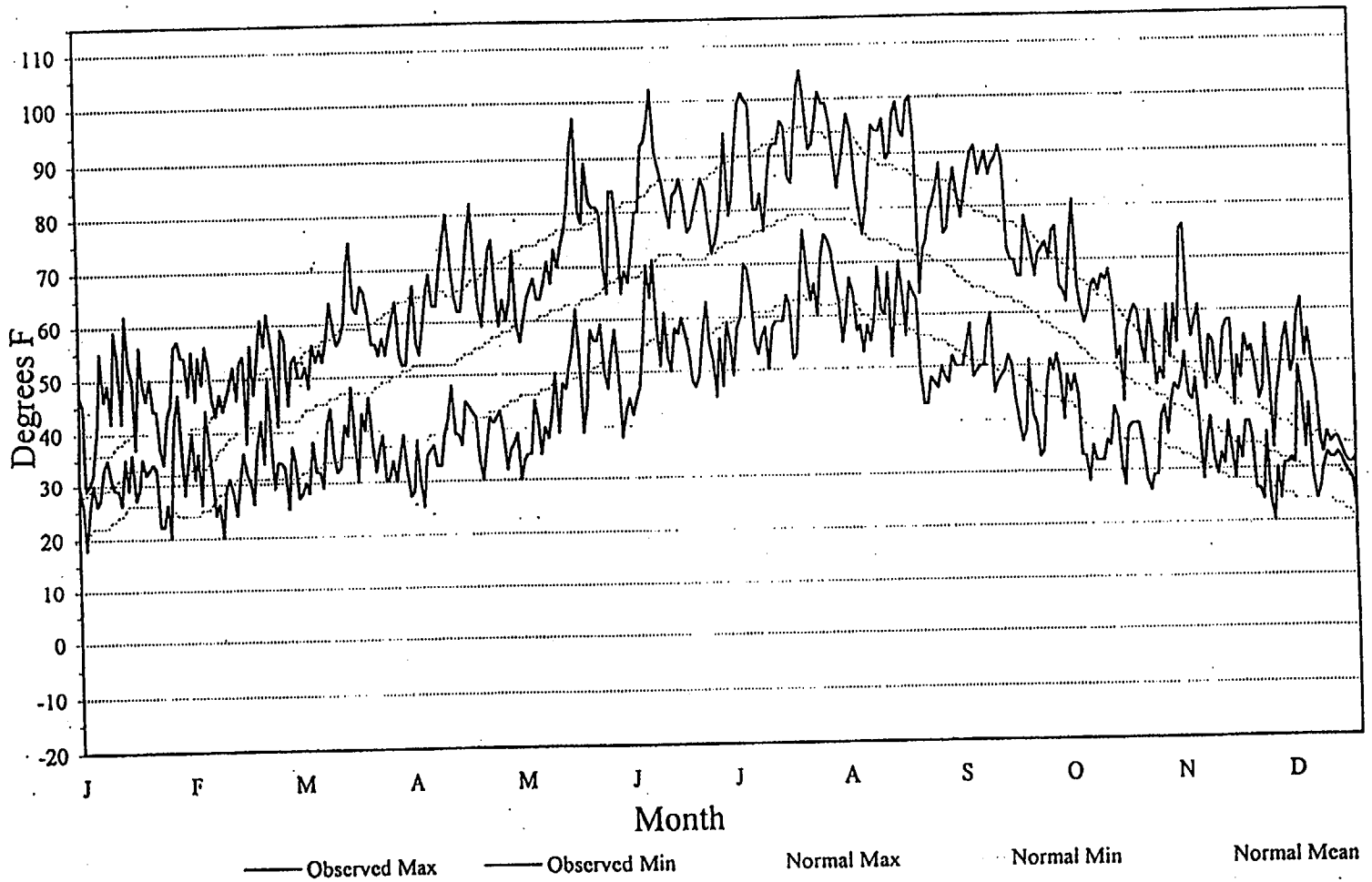

Figure 2.1. 1999 Observed Daily Temperatures from the Hanford Meteorology Station

Hanford Meteorology Station that have received no precipitation–August 1955 and 1988, and September 1991 and 1999. The normal rainfall amount for September is 0.31 inch. The wettest September, in 1947, received 1.34 inches.

Precipitation for October 1999 totaled 0.48 inch, 126% of normal (0.38 inch). The wettest October, in 1957, received 2.72 inches, while the October with the least precipitation (1987 and earlier years) received only a trace.

November 1999 had a total of 0.26 inch of precipitation, 29% of normal (0.91 inch). The wettest November, in 1996, received 2.67 inches, while November 1976 received only a trace. No snowfall was recorded during November 1999, compared to a normal of 1.8 inches. The snowiest November (1985) received 18.3 inches, while many Novembers have been without snow.

December 1999 had a total of 0.07 inch of precipitation, 7% of normal (1.03 inches) and was the driest December on record. The previous driest December was 1976 with 0.11 inch. The wettest December, in 1996, received 3.69 inches. Snowfall for December 1999 totaled 0.6 inch, compared to a normal of 5.7 inches. The snowiest December (1996) received 22.6 inches, while December 1962 received only a trace. Snowfall for the 1999-2000 winter season (through December 1999) is 0.6 inch, compared to a normal through December of 7.6 inches.

2.3 Wind

1999 was the windiest year on record, averaging 8.8 miles per hour (mph), 1.1 mph above normal (7.7 mph). The previous windiest year was 1983, which averaged 8.4 mph. The peak gust for the year was 65 mph on February 6.

The average wind speed for January 1999 was 7.7 mph compared to a January normal of 6.5 mph. The peak wind gust for the month was 55 mph recorded on January 29. The record wind gust for January was 80 mph in 1972. The windiest January averaged 10.3 mph (1972); while the January with the lightest winds (1985) averaged 2.9 mph.

February 1999 was the windiest February on record, and tied April 1972 as the windiest month ever recorded at the Hanford Meteorology Station. The average wind speed for the month was 11.1 mph, compared to a February normal of 7.2 mph. The previous windiest February was 10.8 mph in 1976. The February with the lightest winds was 4.6 mph in 1963. The peak gust for the month was 65 mph on February 6, tying the record gust for February. A 65-mph gust was also recorded in February 1971. There were 10 days in February 1999 with gusts of 40 mph or greater; this tied February 1976 for most wind gusts ≥40 mph. The most for any month was 11 in January 1990.

March 1999 was windier than normal, with an average wind speed of 9.3 mph, 1.0 mph above normal (8.3 mph). The windiest March on record averaged 10.7 mph (1977), while the March with the lightest winds (1958) averaged 5.9 mph. The peak gust for the month was 52 mph on March 29. The record wind gust for March was 70 mph in 1956.

The average wind speed for April 1999 was nearly normal, with an average speed of 8.8 mph, 0.2 mph below normal (9.0 mph). The windiest April on record averaged 11.1 mph (1972), while the

April with the lightest winds (1989) averaged 7.4 mph. The peak gust for the month was 40 mph on April 2. The record wind gust for April was 73 mph in 1972.

The average wind speed for May 1999 was 10.4 mph, 1.3 mph above normal (9.1 mph). The windiest May on record averaged 10.7 mph (1983), while the May with the lightest winds (1957) averaged 5.8 mph. The peak gust for the month was 45 mph on May 25. The record wind gust for May was 71 mph in 1948.

The average wind speed for June 1999 was 9.7 mph, 0.5 mph above normal (9.2 mph). The windiest June on record averaged 10.7 mph (1983), while the June with the lightest winds (1950) averaged 7.7 mph. The peak gust for the month was 42 mph on June 8. The record wind gust for June was 72 mph in 1957.

The average wind speed for July 1999 was 9.4 mph, 0.6 mph above normal (8.8 mph). The windiest July on record averaged 10.7 mph (1983), while the July with the lightest winds (1955) averaged 6.8 mph. The peak gust for the month was 44 mph on July 24. The record wind gust for July was 69 mph in 1979.

The average wind speed for August 1999 was 8.2 mph, 0.3 mph above normal (7.9 mph). The windiest August on record averaged 9.5 mph (1996), while the August with the lightest winds (1956) averaged 6.0 mph. The peak gust for the month was 44 mph on August 29. The record wind gust for August was 66 mph in 1961.

The average wind speed for September 1999 was 7.7 mph, 0.3 mph above normal (7.4 mph). The windiest September on record averaged 9.2 mph (1961), while the September with the lightest winds (1957) averaged 5.4 mph. The peak gust for the month was 42 mph on September 25. The record wind gust for September was 65 mph in 1953.

The average wind speed for October 1999 was 7.7 mph, 1.2 mph above normal (6.5 mph). The windiest October on record averaged 9.1 mph (1946), while the October with the lightest winds (1952) averaged 4.4 mph. The peak gust for the month was 46 mph on October 31. The record wind gust for October was 72 mph in 1997.

The average wind speed for November 1999 was 7.5 mph, 1.1 mph above normal (6.4 mph). The windiest November on record averaged 10.0 mph (1990), while the November with the lightest winds (1956) averaged 2.9 mph. The peak gust for the month was 41 mph on November 8. The record wind gust for November was 67 mph in 1993.

The average wind speed for December 1999 was 7.5 mph, 1.6 mph above normal (5.9 mph). The windiest December on record averaged 8.3 mph (1968), while the December with the lightest winds (1985) averaged 3.3 mph. The peak gust for the month was 62 mph on December 18. The record wind gust for December was 71 mph in 1955.

Figures 2.2 and 2.3 give a composite of the wind roses (at the 10- and 60-meter levels, respectively) from the Hanford Meteorological Monitoring Network for 1999. The appendix gives the individual 1999 wind roses from the Hanford Meteorological Monitoring Network stations.

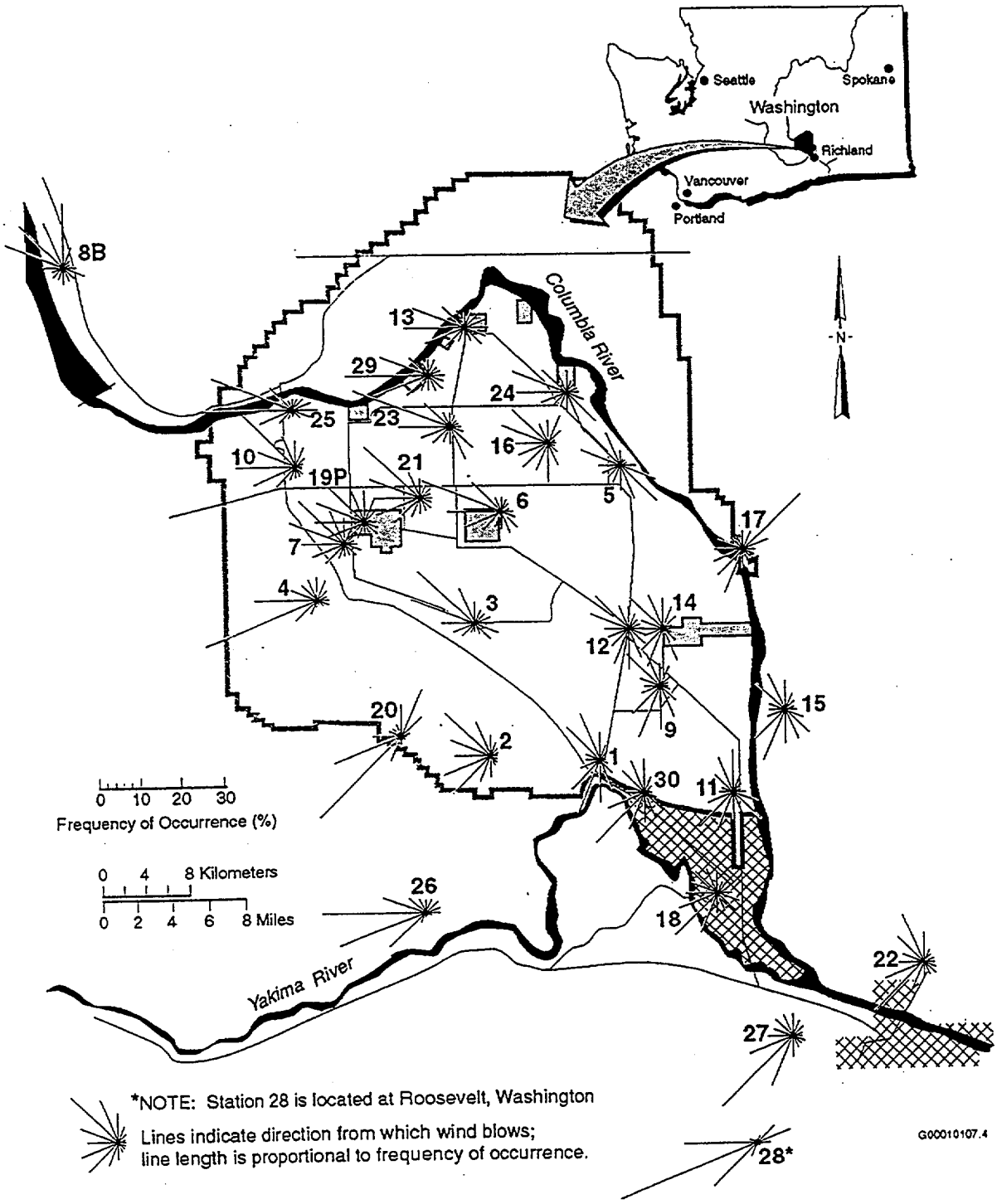

Figure 2.2. 1999 Hanford Meteorological Monitoring Network Wind Roses at 10-Meter Level (see Appendix for station-specific wind rose)

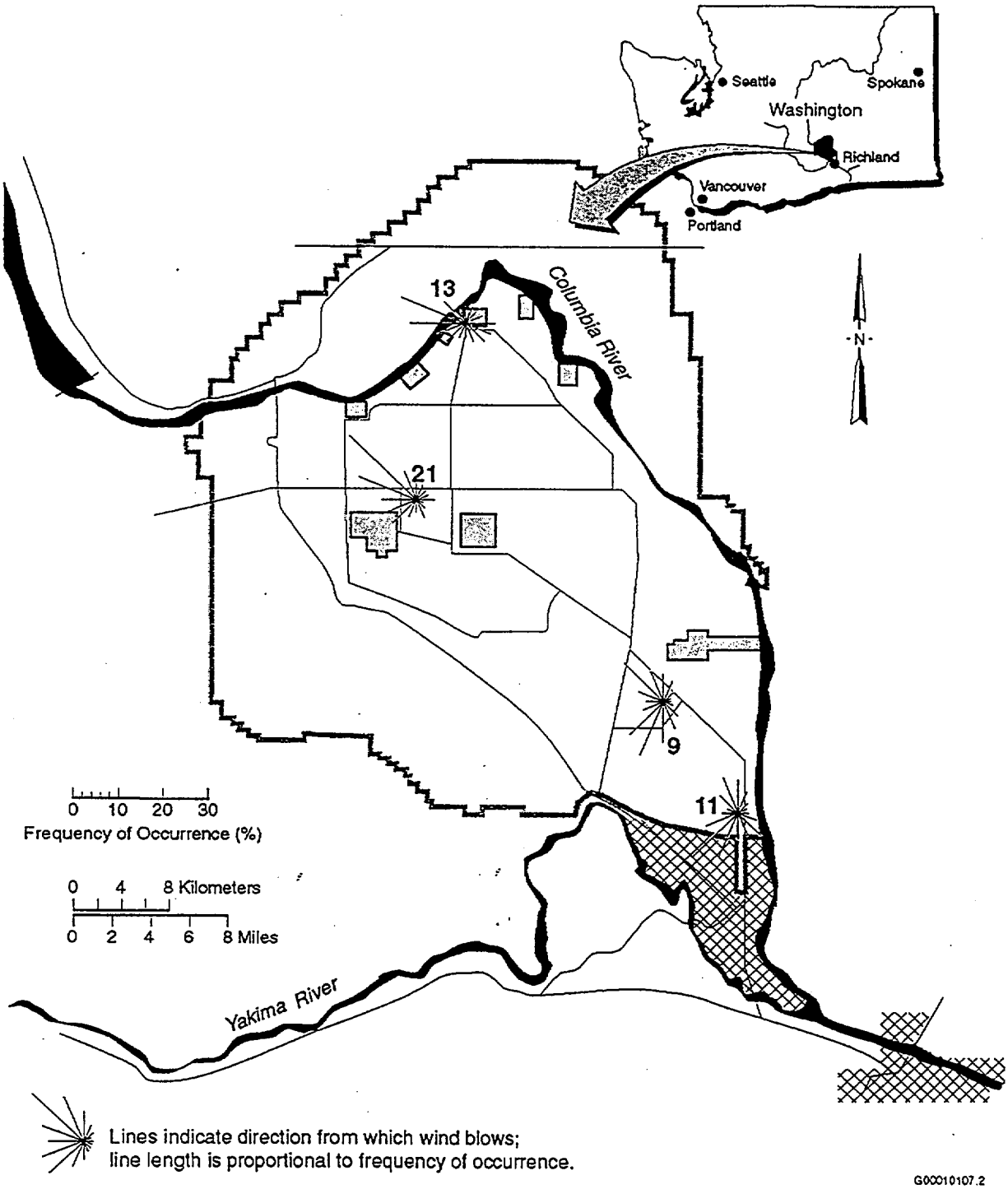

Figure 2.3. 1999 Hanford Meteorological Monitoring Network Wind Roses at 60-Meter Level (see Appendix for station-specific wind rose)