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TECHNICAL MEMORANDUM FOR THE ON-SITE DISPOSAL FACILITY CELL 1 BASELINE GROUNDWATER CONDITIONS

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FERNALD, OHIO

SEPTEMBER 1998

U.S. DEPARTMENT OF ENERGY
FERNALD AREA OFFICE

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LIST OF ACRONYMS

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ARARs	applicable or relevant and appropriate requirements
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FEMP	Fernald Environmental Management Project
GWLMP	Groundwater Leak Detection/Leachate Monitoring Plan
IEMP	Integrated Environmental Monitoring Plan
LCS	leachate collection system
LDS	leak detection system
OAC	Ohio Administrative Code
PCB	polychlorinated biphenyl
RCRA	Resource Conservation and Recovery Act
RI/FS	remedial investigation/feasibility study
μg/L	micrograms per liter

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Main Text

1.0 INTRODUCTION

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This technical memorandum has been prepared to document the results of baseline groundwater monitoring activities (prior to waste placement) for Cell 1 of the on-site disposal facility per the requirements of the Groundwater/Leak Detection and Leachate Monitoring Plan (GWLMP) (DOE 1997). This technical memorandum also documents the selection of the statistical method used to develop control limits for evaluating post-baseline groundwater data as part of the on-site disposal facility leak identification/evaluation program.

In addition, this document has been developed to fulfill the applicable or relevant and appropriate requirements (ARARs) to the Final Record of Decision for Remedial Actions at Operable Unit 2 as noted in Appendix A of the GWLMP. ARARs pertinent to the on-site disposal facility groundwater monitoring program include:

- Ohio Municipal Solid Waste Rules - Ground Water Sampling, Analysis, and Statistical Methods, Ohio Administrative Code (OAC) 3745-27-10(C)
- Ohio Hazardous Waste General Facility Standards - New Facilities Rules – General Groundwater Monitoring Requirements, OAC 3745-54-97-98
- Resource Conservation and Recovery Act (RCRA) Groundwater Protection Standards (Landfills), 40 Code of Federal Regulations (CFR) 264.97–98
- Radioactive Waste Management, U.S. Department of Energy (DOE) Order 5820.2A, Chapter III(3)(k).

This technical memorandum presents the following Cell 1 groundwater information:

- Groundwater monitoring sampling protocol (Section 2.0)
- Data evaluation and statistical methodology (Section 3.0)
- Baseline statistical groundwater results (Section 4.0)
- Post-baseline monitoring, data evaluation, and reporting (Section 5.0)
- Conclusions (Section 6.0).

The baseline data set for Cell 1 of the on-site disposal facility is provided in Appendix A. The statistical equations for the Shewhart-Cusum methodology are provided in Appendix B. Shewhart-Cusum control charts are provided in Appendix C.

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2.0 GROUNDWATER MONITORING SAMPLING PROTOCOL

This section discusses the monitoring locations, constituents, sampling period, and total number of samples collected to establish baseline conditions for Cell 1 of the on-site disposal facility.

As identified in the GWLMP, the groundwater monitoring network for each cell of the on-site disposal facility is comprised of the following components:

- Horizontal till well along the west side of the on-site disposal facility and below the leachate collection system (LCS) and leak detection system (LDS) sump area
- Upgradient Type 2 Great Miami Aquifer monitoring well
- Downgradient Type 2 Great Miami Aquifer monitoring well.

As shown on Figure 1, with respect to Cell 1, the horizontal till well is identified as 12338, the upgradient Type 2 Great Miami Aquifer well is identified as 22201 and the downgradient Type 2 Great Miami Aquifer well is identified as 22198. The upgradient and downgradient designations for Type 2 monitoring wells relate to the natural west to east flow gradient for groundwater which exists in the vicinity of the on-site disposal facility. At times during remediation of the Great Miami Aquifer, pumping operations are projected to temporarily change this gradient. The change in flow direction during aquifer remediation will affect the approach to data interpretation. Specifically, data evaluation will focus on "intra-well" comparisons rather than the standard upgradient to downgradient inter-well comparisons. This approach is reflected in the GWLMP and in Section 3.0 of this document. The on-site disposal facility perched water and groundwater monitoring locations are shown on Figure 1, which also depicts the footprint of the on-site disposal facility within the Fernald Environmental Management Project (FEMP) site boundary.

The list of constituents monitored at these locations (referred to as the on-site disposal facility leak detection groundwater monitoring constituent list) was developed in accordance with Ohio Solid Waste and Hazardous Waste Regulations, which are discussed in Sections 3.0 and 4.5 of the on-site disposal facility GWLMP. These constituents were selected from the 41 FEMP waste acceptance criteria

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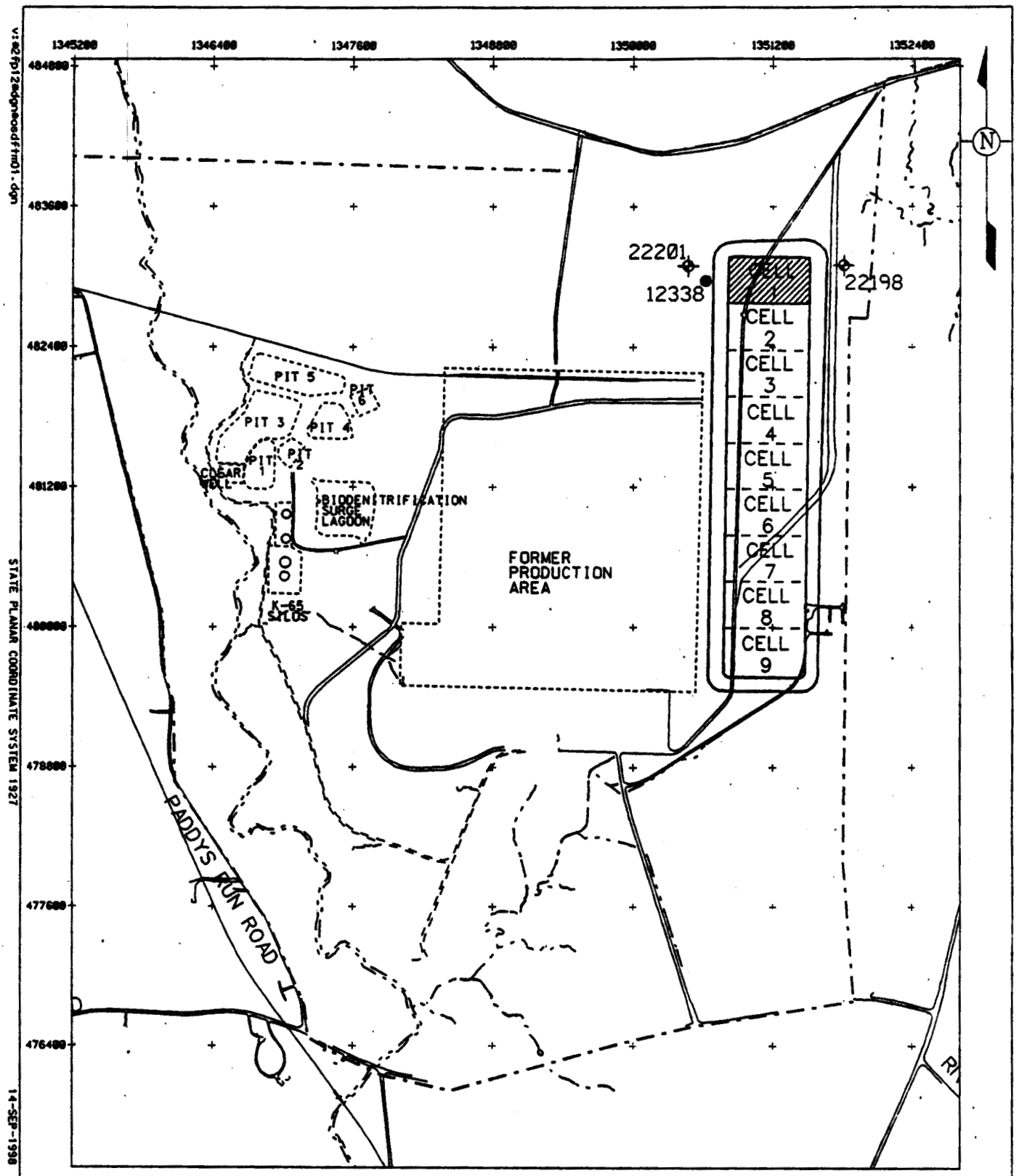

LEGEND:

FEMP BOUNDARY

OSDF MONITORING WELL IN GREAT MIAMI AQUIFER

HORIZONTAL TILL WELL IN PERCHED GROUNDWATER

SCALE

1200 600 0 1200 FEET

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FIGURE 1. ON-SITE DISPOSAL FACILITY CELL 1 MONITORING WELL LOCATIONS AND FOOTPRINT

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constituents listed in the Operable Unit 5 Record of Decision as noted in Section 4.5.2.1 of the GWLMP. Selections were made according to the following information, as detailed in Section 4.5.2 of the GWLMP:

- Type, quantity, and concentration of waste constituents to be disposed of at the facility
- Mobility, stability, and persistence of waste constituents or their reaction products in the unsaturated zone beneath the facility
- Detection of the groundwater monitoring constituents, waste constituents, and their reaction products in the groundwater
- Concentration of groundwater monitoring constituents or waste constituents in background groundwater.

Table 1 presents the groundwater monitoring constituents identified in the GWLMP for the on-site disposal facility groundwater leak detection monitoring program. These constituents supplement the list identified for the leachate flow and water quality monitoring conducted in the LCS and LDS layers of Cell 1. Together, information gathered from the perched water, groundwater, LCS and LDS provide the basis for the on-site disposal facility leak identification/evaluation program.

The sampling criteria for establishing baseline perched water and Great Miami Aquifer conditions, as defined in the GWLMP, included the collection of at least 12 samples from each well prior to waste placement. During the Cell 1 baseline sampling period greater than 12 samples, in most cases 15 were collected at each monitoring location. Laboratory analyses were performed on all groundwater samples for each constituent listed in Table 1.

The GWLMP generally envisioned a monthly sampling frequency for baseline monitoring in order to evaluate seasonal variation, however, the plan acknowledges the potential for accelerating this schedule, as necessary, to accommodate construction and waste placement activities. For collection of the Cell 1 groundwater baseline data, an increased sampling frequency (i.e., greater than one sample per month) was necessary due to the construction schedule associated with the installation and development of the Cell 1 perched water and Great Miami Aquifer wells. The sampling frequency was increased to support the collection of the required number of samples to support statistical evaluations

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TABLE 1

CONSTITUENTS OF THE GROUNDWATER LEAK DETECTION MONITORING PROGRAM

Constituent Suite	Specific Constituents
General Chemistry	Total Organic Carbon
	Total Organic Halogens
Inorganics	Boron
	Mercury
Radionuclides	Technetium-99
	Uranium, Total
Volatile Organics	1,1-Dichloroethene
	1,2-Dichloroethene (total)
	Bromodichloromethane
	Tetrachloroethene
	Trichloroethene
	Vinyl Chloride
Semi-volatile Organics	4-Nitroaniline
	bis(2-Chloroisopropyl)ether
	Carbazole
Pesticides/PCBs	alpha-Chlordane

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and to provide, to the degree possible, an evaluation of the range in natural variability of groundwater quality.

Installation and development of the Great Miami Aquifer wells (22201 and 22198) for Cell 1 were completed in March 1997. Baseline monitoring in the Great Miami Aquifer was conducted over a 10-month period beginning in March 1997 and continuing through early December 1997. During this time, a total of 15 sampling rounds were completed for each well. The 10-month period of sampling the aquifer provides reasonable assurance that the data encompasses seasonal fluctuations in groundwater quality.

Unlike the Great Miami Aquifer wells which lie outside the on-site disposal facility footprint and can be installed independent of the facility's construction, the perched water well is an integral part of the construction of each cell of the on-site disposal facility. The sequence of construction activities includes the installation of the perched water well prior to the construction of the secondary clay liner system. In the case of Cell 1, installation of the perched water well (12338) was completed in October 1997. The sampling of the perched water for Cell 1 was conducted from the end of October through early December during which time 15 sampling rounds were completed. This sampling was successful in fulfilling the minimum baseline sample requirements and providing a snapshot of baseline perched water conditions prior to first waste placement. However, due to the compressed sampling schedule, the data set is limited in regards to representing the full range of seasonal variability in perched water quality underlying the on-site disposal facility. Recommendations for addressing this issue and for modifying the overall approach for establishing baseline perched water conditions are discussed in detail in Section 4.

3.0 DATA EVALUATION AND STATISTICAL METHODOLOGY

This section identifies the process for evaluating baseline data, the data methodology prior to performing statistics, and the statistical methodology used to establish "control limits" from baseline conditions. The baseline data for Cell 1 are provided in Appendix A.

3.1 DATA EVALUATION AND PREPARATION

The baseline data from each well were reviewed to determine detected constituents. Table 2 highlights constituents (by location) which were detected and presents the frequency of detection. If at least one detection occurred per constituent, per well, then further statistical evaluation was conducted. If there were no detectable concentrations, per well, then no statistical evaluation was performed and baseline conditions for that constituent and well are considered to be "non-detectable".

For detectable constituents highlighted in Table 2, the following criteria were used to prepare the data for statistical analysis:

- Use half the non-detectable concentration (results with validation qualifer of U or UJ)
- Use a concentration of zero if the validated result was less than zero (e.g., radiological constituents can have negative concentrations when laboratory backgrounds are subtracted from results.)
- Use the maximum result of either field duplicate or normal sample, if more than one sample exist for a given location on the same day
- Do not use rejected data (results with validation qualifier Z or R).

Appendix A provides the data prior to executing the above criteria.

TABLE 2

FREQUENCY OF BASELINE CONSTITUENT DETECTIONS IN GROUNDWATER FOR CELL 1 OF THE ON-SITE DISPOSAL FACILITY

Constituent	Perched Water Horizontal Till Well 12338 (Number of Samples with Detections[a,b]/Number of Samples[b])	Great Miami Aquifer Monitoring Well 22201 Upgradient (Number of Samples with Detections[a,b]/Number of Samples[b])	Great Miami Aquifer Monitoring Well 22198 Downgradient (Number of Samples with Detections[a,b]/Number of Samples[b])
General Chemistry			
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
Inorganics			
[redacted]	[redacted]	[redacted]	[redacted]
Mercury	0/15	0/15	0/15
Radionuclides			
[redacted]	[redacted]	[redacted][c]	0/15
[redacted]	[redacted]	[redacted]	[redacted]
Volatile Organics			
1,1-Dichloroethene	0/15	0/15	0/15
1,2-Dichloroethene (total)	0/15	0/15	0/15
[redacted]	[redacted][d]	0/15	0/15
[redacted]	0/15	[redacted][e]	0/15
Trichloroethene	0/15	0/15	0/15
Vinyl Chloride	0/15	0/15	0/15
Semi-volatile Organics			
4-Nitroaniline	0/15	0/15	0/15
bis(2-Chloroisopropyl)ether	0/15	0/15	0/15
Carbazole	0/15	0/15	0/15
Pesticides/PCBs			
alpha-Chlordane	0/15	0/15	0/15

Note: [redacted] indicates the constituent has detectable concentrations for at least one monitoring location.

[a]The number of samples with detections is based on results qualified with either a – or J qualifier.
[b]If there was more than one sample collected per well per constituent per day (e.g., a duplicate sample), then only the maximum concentration was counted.
[c]The detectable concentrations from samples collected on August 26, 1997, are thought to be suspect; however, there was not enough sample left for reanalyses.
[d]All five detections for bromodichloromethane were estimated (J validation qualifier) at a concentration that was below the contract required detection limit.
[e]The one detection for tetrachloroethene was estimated (J validation qualifier) at a concentration that was well below the contract required detection limit.

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3.2 STATISTICAL METHODOLOGY

Following data preparation, an intra-well, or well-by-well, trend analysis control chart methodology was selected for Cell 1 for the following reasons:

- Conforms with the guidance as set forth in the Operable Unit 2 ARARs as listed in Section 1.0
- Control charts are simple; they use standardized limits against which to compare a standardized mean and cumulative difference in standard deviations
- Suitable for Great Miami Aquifer wells because groundwater flow direction will vary throughout the course of groundwater restoration
- Suitable for perched water because the primary flow direction within the glacial till is vertical (i.e., there is no discernable upgradient versus downgradient)
- Consistent with the U.S. Environmental Protection Agency (EPA) Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Interim Final Guidance (EPA 1989).

Control charts are widely used as a relatively simple statistical tool. The statistics of interest are computed and plotted together with upper and/or lower predetermined limits on a chart where the x-axis represents time. These limits, or control limits, are determined from baseline monitoring data. If a result falls outside these boundaries, then it is considered a significant change from baseline conditions.

The statistical method selected for developing the control limits is the combined Shewhart-cumulative sum (Shewhart-CUSUM) control chart method. Under this method, results are plotted over time and compared to control limits which are determined from the baseline data set. Specifically, the baseline data were used to establish the mean and standard deviation in order to determine control limits. The control limits established through this method provide the basis for identifying significant changes in perched water and groundwater quality relative to baseline conditions. A control chart was constructed for each well and detected constituent, thus providing a record of trend and the ability to observe significant changes in the data. This type of control chart has been selected as the most appropriate for the on-site disposal facility because RCRA guidance specifically identifies it in relation to statistical analysis of groundwater monitoring data. Appendix B provides the equations used to construct the Shewhart-CUSUM control charts.

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4.0 BASELINE STATISTICAL GROUNDWATER RESULTS

This section presents groundwater baseline statistical results for Cell 1 of the on-site disposal facility. For Cell 1, of the 16 constituents monitored during the baseline period, the following constituents were detected:

- Six constituents were detected in the perched water (Horizontal Till Well 12338)
- Six constituents were detected in the Great Miami Aquifer well 22201
- Four constituents were detected in the Great Miami Aquifer well 22198.

Appendix C presents the control charts by well for each detected constituent. These control charts identify that no baseline data are "out of control" for either the Shewhart or CUSUM control limit. Table 3 presents summary information from the control charts provided in Appendix C, including the mean (μ), sample standard deviation (σ), and the Shewhart and CUSUM control limit concentrations that will be used to identify sample concentrations that are "out of control". Appendix B provides the equations to generate the Shewhart and CUSUM control limit concentrations. Table 3 also presents the range of baseline data for the perched water and Great Miami Aquifer wells, respectively.

4.1 PERCHED WATER

Table 3 identifies the range of concentrations for the six constituents detected during baseline sampling. As identified in Section 2.0, due to the compressed sampling schedule, the baseline data set is limited in regards to representing the range of variability in perched water quality underlying Cell 1 of the on-site disposal facility. Further evidence supporting this determination is found in the comparison of baseline results with the initial post-baseline perched water sample results for Cell 1 and in data presented in the Pre-design Investigation and Site Selection Report for the On-site Disposal Facility and Addendum (DOE 1995 and DOE 1996, respectively). This information is summarized below.

- The first quarter (February 1998) post-baseline total uranium concentration from horizontal till well 12338 of 19 micrograms per liter (μg/L) was determined to exceed both the maximum baseline datum and respective Shewhart control limit (11.3 μg/L) established from the baseline data. When compared to uranium data collected from the LCS and LDS (49.3 and 1.5 μg/L, respectively), it is clear that the perched water data exceeds the concentration measured in the LDS and was therefore determined to be unrelated to leakage from the disposal facility. Rather, this data point is considered to reflect a natural fluctuation in uranium concentration.

- Data collected for the pre-design report indicated a greater variability for total uranium concentrations. Total uranium concentrations from the pre-design report ranged from not detectable to 35 μg/L, whereas the concentrations from the baseline data set ranged from 1.37 to 7.454 μg/L.

TABLE 3

INTRA-WELL STATISTICS FOR DETECTED BASELINE CONSTITUENTS FOR ON-SITE DISPOSAL FACILITY CELL 1

	Perched Water Horizontal Till Well 12338[a,b,c,d]						Great Miami Aquifer Monitoring Well 22201[a,b,c,d]						Great Miami Aquifer Monitoring Well 22198[a,b,c,d]					
					Control Limit Concentration[e]						Control Limit Concentration[e]						Control Limit Concentration[e]	
Constituent	Min.	Max.	Mean (μ)	Standard Deviation (σ)	Shewhart	CUSUM	Min.	Max.	Mean (μ)	Standard Deviation (σ)	Shewhart	CUSUM	Min.	Max.	Mean (μ)	Standard Deviation (σ)	Shewhart	CUSUM
General Chemistry				mg/L						mg/L						mg/L		
Total Organic Carbon	2.1	11.6	7.79	2.84	20.6	24.8	0.0186	24	10.3	8.37	48.0	60.6	0.0143	25	7.65	8.13	44.2	56.4
Total Organic Halogens	0.0043	0.077	0.02	0.02	0.11	0.15	0.0025	0.078	0.020	0.022	0.12	0.15	0.0025	0.0526	0.0109	0.014	0.07	0.09
Inorganics																		
Boron	0.02035	0.685	0.11	0.17	0.89	1.15	0.0253	0.123	0.073	0.035	0.23	0.28	0.0095	0.0805	0.0481	0.022	0.15	0.18
Radionuclides				pCi/L						pCi/L						pCi/L		
Technetium-99	0.37	21.1	7.60	6.34	36.1	45.6	0[f]	13.41	2.64	3.44	18.1	23.3	NA	NA	NA	NA	NA	NA
				μg/L						μg/L						μg/L		
Uranium, Total	1.37	7.454	3.83	1.67	11.3	13.8	0.014	5.196	0.522	1.30	6.38	8.33	0.645	3.12	1.46	0.827	5.18	6.42
Volatile Organics																		
Bromodichloromethane	2	8	4.47	1.60	11.7	14.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	NA	NA	NA	NA	NA	NA	0.5	5	3.53	2.15	13.2	16.4	NA	NA	NA	NA	NA	NA

[a]If more than one sample is collected per well per day (e.g., duplicate), then only the sample with the maximum concentration is used.
[b]Rejected data qualified with either a R or Z were not included.
[c]For values where the concentrations are below the detection limit, the results used are set at half the detection limit.
[d]NA = not applicable; there were no detected concentrations for this constituent.
[e]Equations used to calculate concentrations for Shewhart and CUSUM control limits are provided in Appendix B.
[f]For values where the lowest concentration is below zero, the minimum value is set at zero.

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The comparisons between the pre-design, baseline, and post-baseline data sets highlight the variability of the perched water quality that can be expected, and therefore suggests that the baseline data set used to calculate the control limits for Cell 1 does not adequately account for this variability. The potential impact of utilizing this limited, pre-waste placement baseline data set alone in developing control limits for Cell 1 is the increased likelihood that false positive results will occur. In other words, results exceeding the control limits will be identified as significant changes in water quality from baseline conditions when in fact these results reflect the natural variability in perched water quality.

To remedy this problem, the DOE is recommending modification to the approach in defining baseline conditions for the perched water beneath those cells where construction and waste placement schedules do not allow adequate time to assess the seasonal variability in pre-waste placement perched water quality. The DOE proposes to use the additional baseline data from the horizontal till well for Cell 2 to create a single, comprehensive baseline data set for the perched water underlying Cells 1 and 2. This additive approach will enable the establishment of a perched water data set that incorporates seasonal variability. When the pre-waste placement characterization is complete for Cell 2 (fourth quarter 1998) and the validated analytical results are available a comprehensive pre-waste placement perched water baseline for Cells 1 and 2 will be established. However, until the perched water baseline is further established, the limits identified in Table 3, will be used to compare to post-baseline data and will be referred to as interim limits.

4.2 GREAT MIAMI AQUIFER

Table 3 identifies ranges of concentrations for the six constituents detected in the Great Miami Aquifer. With the exception of boron, generally the concentrations from the aquifer wells are consistent with those identified during the Operable Unit 5 remedial investigation/feasibility study (RI/FS) process and in RCRA annual reports. During the RI/FS process, boron was not considered a significant groundwater contaminant, and therefore it was not extensively sampled.

5.0 POST-BASELINE MONITORING, DATA EVALUATION, AND REPORTING

This section identifies the on-site disposal facility post-baseline monitoring requirements, the proposed evaluation methodology for post-baseline data, and the mechanism of reporting this data.

5.1 POST-BASELINE MONITORING REQUIREMENTS:

Post-baseline monitoring for Cell 1 was initiated during the first quarter of 1998 and consists of the following:

- Quarterly monitoring of the perched water horizontal till well for Table 1 constituents
- Quarterly monitoring of the Great Miami Aquifer wells for Table 1 constituents
- Quarterly monitoring of the LCS and the LDS for Table 1 constituents
- Monthly monitoring of leachate volumes in the LCS
- Weekly monitoring of liquid volumes in the LDS manhole.

The above monitoring is consistent with the requirements of the GWLMP. In addition, the LCS will be monitored annually for a longer list of constituents which are provided in the GWLMP.

5.2 POST-BASELINE DATA EVALUATION:

The methodology described below outlines the manner in which all 16 on-site disposal facility constituents of concern will be evaluated with respect to baseline conditions and the overall Cell 1 system.

- Constituents that are detected during post-baseline monitoring and were also detected during the baseline period will be evaluated to ensure that they are within the established control limits. In addition, the reasonableness of these data will be evaluated by comparison to their corresponding perched water, LCS and LDS concentrations.

- Constituents that are detected in the perched water during post-baseline monitoring, but were not detected during the baseline period will be compared to their corresponding concentrations in the LCS and LDS to determine if their presence in the perched water could be indicative of a release.

- Constituents that are detected in the Great Miami Aquifer during post-baseline, but were not detected during baseline will be compared to their respective concentrations in the perched water, LCS and LDS along with upgradient groundwater conditions to determine if their presence in the aquifer could be indicative of a release.

- Constituents that are neither detected during post-baseline nor were detected during baseline will be considered within control limits.

In addition to the control chart analysis of groundwater samples, the quantity and quality of water detected in the LCS and LDS will be reviewed for trends over time. The data review will determine if the volume of water observed in the LDS and LCS is increasing. If increases are observed, then the data will be further evaluated to determine if a correlation between analytes in the two systems exist that could indicate a potential release.

5.3 POST-BASELINE REPORTING

Consistent with the reporting strategy outlined in the GWLMP, monitoring results will be reported through the Integrated Environmental Monitoring Plan (IEMP) quarterly status reports and annual report. IEMP quarterly status reports will include the following:

- A summary of results from quarterly post-baseline groundwater sampling for Cell 1, which was initiated following first waste placement in the cell.
- A summary of LCS and LDS volumes and constituent concentrations
- A summary of groundwater monitoring activities associated with the other on-site disposal facility cells.

The following information will be included in the IEMP annual report:

- The control charts for the on-site disposal facility groundwater monitoring program and discussion of results.
- Graphical presentations of LCS and LDS volume measurements and constituent concentrations and discussion of results.

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6.0 CONCLUSIONS

The information provided in this technical memorandum meets the objectives and specific requirements of the groundwater leachate monitoring program by:

- Documenting the results of baseline monitoring for perched water and groundwater conditions for Cell 1of the on-site disposal facility
- Establishing control charts and control limits via appropriate statistical methods to be used for the post-baseline evaluation of perched water and groundwater data for Cell 1, as part of the overall leak detection/evaluation program for the on-site disposal facility.

The data compiled over the baseline period for Cell 1 provides a snapshot of groundwater conditions prior to waste placement in the cell. This data is of sufficient quantity and quality to support the selection and development of a statistical tool (combined Shewhart-CUSUM control charts) for conducting future comparisons of Great Miami Aquifer quality to baseline conditions. The combined Shewhart-CUSUM control charts provide an effective means of assessing trends in the data and identifying significant changes in water quality relative to baseline conditions.

The Shewhart-CUSUM control charts were also determined to be an acceptable method for evaluating changes in perched water quality. However, the baseline data was found to be insufficient in representing the potential temporal variability of perched water conditions beneath Cell 1. Therefore, the reasonableness of the perched water control limits established from the current baseline data set is questionable in that future false positives will likely occur. Additional perched water quality data is required to establish a representative perched water data set for Cell 1. To provide the additional temporal data, the DOE recommends combining the baseline data sets for Cells 1 and 2 to create a comprehensive baseline data set for the perched water underlying those cells.

The remaining cells of the on-site disposal facility will be designed similar to Cell 1, and will have similar well configurations; therefore, the Shewhart-CUSUM charts are expected to be used for the perched water and groundwater data evaluation process for each successive cell. Should any changes to the evaluation approach be required, the modifications will be proposed in future technical memoranda.

The data collected through the on-site disposal facility groundwater monitoring program provides part of the overall leak identification/evaluation program for the disposal facility. The results from post-baseline perched water and Great Miami Aquifer sampling will be assessed against the control

limits and interim control limits established in this report. In addition, these data will be evaluated with volume measurements and constituent concentrations measured in the LCS and LDS to gain a comprehensive understanding of the system dynamics. Together this information provides for ongoing assurance that the on-site disposal facility cap and liner systems are performing as designed, by establishing a mechanism for early leak detection and assessment.

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APPENDIX A

ON-SITE DISPOSAL FACILITY CELL 1 BASELINE DATA SET

APPENDIX A

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The following data table, Table A-1, includes well number, constituent, date sampled, validated result, validation qualifier, units, and type (e.g., N = Normal and FD = Field Duplicate). The data in the table are sorted in the following order by well number (12338, 22201, and 22198), constituents (as defined in Table 1 of the report), and sample date. An explanation of validation qualifier codes can be found in Appendix D, Section D.2.4.1, of the Sitewide CERCLA Quality Assurance Project Plan (DOE 1998).

It is important to note that several baseline technetium samples were reanalyzed due to the suspect nature of the concentrations. Reanalysis were performed for the following:

- Horizontal Till Well 12338 - sample from November 3
- Great Miami Aquifer Well 22201 - samples from June 25
- Great Miami Aquifer Well 22198 - sample from June 25.

All reanalysis yielded non-detectable concentrations. The original analysis (qualified with either a R or Z) and reanalysis are provided within this appendix. The normal and field duplicate sample results from Monitoring Well 22201 on August 26, 1997, are also thought to be suspect; however, there was not enough sample left for reanalyses. These data were used in the statistical evaluation.

All data provided in this appendix, with the exception of the technetium-99 reanalysis, has been previously provided to the agencies in electronic format through the IEMP quarterly and annual reports.

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TABLE A-1

COMPLETE ON-SITE DISPOSAL FACILITY CELL 1 BASELINE DATA SET

Well Number	Constituent	Date Sampled	Validated Result	Validation Qualifier	Units	Type
12338	Total Organic Carbon	10/30/97	3.1	J	mg/L	N
12338	Total Organic Carbon	10/31/97	6.3	-	mg/L	N
12338	Total Organic Carbon	11/3/97	3.7	-	mg/L	N
12338	Total Organic Carbon	11/4/97	2.1	J	mg/L	N
12338	Total Organic Carbon	11/5/97	7.9	J	mg/L	N
12338	Total Organic Carbon	11/6/97	9.2	J	mg/L	N
12338	Total Organic Carbon	11/7/97	9.3	J	mg/L	N
12338	Total Organic Carbon	11/10/97	8.8	J	mg/L	N
12338	Total Organic Carbon	11/12/97	8.1	J	mg/L	N
12338	Total Organic Carbon	11/14/97	11.4	J	mg/L	N
12338	Total Organic Carbon	11/17/97	9.4	J	mg/L	N
12338	Total Organic Carbon	11/17/97	8.8	J	mg/L	FD
12338	Total Organic Carbon	11/18/97	8.5	J	mg/L	N
12338	Total Organic Carbon	11/25/97	9.7	J	mg/L	N
12338	Total Organic Carbon	12/1/97	7.7	J	mg/L	N
12338	Total Organic Carbon	12/8/97	11.6	J	mg/L	N
12338	Total Organic Halogens	10/30/97	0.0085	-	mg/L	N
12338	Total Organic Halogens	10/31/97	0.077	-	mg/L	N
12338	Total Organic Halogens	11/3/97	0.056	-	mg/L	N
12338	Total Organic Halogens	11/5/97	0.0207	-	mg/L	N
12338	Total Organic Halogens	11/6/97	0.0148	-	mg/L	N
12338	Total Organic Halogens	11/7/97	0.0115	-	mg/L	N
12338	Total Organic Halogens	11/10/97	0.0132	-	mg/L	N
12338	Total Organic Halogens	11/12/97	0.0115	-	mg/L	N
12338	Total Organic Halogens	11/14/97	0.0156	U	mg/L	N
12338	Total Organic Halogens	11/17/97	0.0096	U	mg/L	N
12338	Total Organic Halogens	11/17/97	0.0092	U	mg/L	FD
12338	Total Organic Halogens	11/18/97	0.0227	U	mg/L	N
12338	Total Organic Halogens	11/25/97	0.0086	U	mg/L	N
12338	Total Organic Halogens	12/1/97	0.0126	U	mg/L	N
12338	Total Organic Halogens	12/8/97	0.00591	-	mg/L	N
12338	Boron	10/30/97	0.103	-	mg/L	N
12338	Boron	10/31/97	0.0934	-	mg/L	N
12338	Boron	11/3/97	0.293	J	mg/L	N
12338	Boron	11/4/97	0.685	J	mg/L	N
12338	Boron	11/5/97	0.0493	-	mg/L	N
12338	Boron	11/6/97	0.0375	-	mg/L	N
12338	Boron	11/7/97	0.0477	-	mg/L	N
12338	Boron	11/10/97	0.0501	-	mg/L	N
12338	Boron	11/12/97	0.0476	-	mg/L	N
12338	Boron	11/14/97	0.0448	-	mg/L	N
12338	Boron	11/17/97	0.0623	-	mg/L	N
12338	Boron	11/17/97	0.0452	-	mg/L	FD

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TABLE A-1
(Continued)

Well Number	Constituent	Date Sampled	Validated Result	Validation Qualifier	Units	Type
12338	Boron	11/18/97	0.0333	-	mg/L	N
12338	Boron	11/25/97	0.0415	U	mg/L	N
12338	Boron	12/1/97	0.0407	U	mg/L	N
12338	Boron	12/8/97	0.0277	-	mg/L	N
12338	Mercury	10/30/97	0.0001	U	mg/L	N
12338	Mercury	10/31/97	0.0001	U	mg/L	N
12338	Mercury	11/3/97	0.0001	U	mg/L	N
12338	Mercury	11/4/97	0.0001	U	mg/L	N
12338	Mercury	11/5/97	0.0001	U	mg/L	N
12338	Mercury	11/6/97	0.0001	U	mg/L	N
12338	Mercury	11/7/97	0.0001	U	mg/L	N
12338	Mercury	11/10/97	0.0001	U	mg/L	N
12338	Mercury	11/12/97	0.0001	U	mg/L	N
12338	Mercury	11/14/97	0.0001	U	mg/L	N
12338	Mercury	11/17/97	0.0001	U	mg/L	N
12338	Mercury	11/17/97	0.0001	U	mg/L	FD
12338	Mercury	11/18/97	0.0001	U	mg/L	N
12338	Mercury	11/25/97	0.0001	U	mg/L	N
12338	Mercury	12/1/97	0.0001	U	mg/L	N
12338	Mercury	12/8/97	0.0001	U	mg/L	N
12338	Technetium-99	10/30/97	6.49	UJ	pCi/L	N
12338	Technetium-99	10/31/97	16.94	J	pCi/L	N
12338	Technetium-99	11/3/97	71.3	Z	pCi/L	N
12338	Technetium-99	11/3/97	16.25	R	pCi/L	N
12338	Technetium-99	11/3/97	0.74	U	pCi/L	N
12338	Technetium-99	11/4/97	21.1	-	pCi/L	N
12338	Technetium-99	11/4/97	7.36	R	pCi/L	N
12338	Technetium-99	11/5/97	13.7	-	pCi/L	N
12338	Technetium-99	11/5/97	4.6	R	pCi/L	N
12338	Technetium-99	11/6/97	12.39	J	pCi/L	N
12338	Technetium-99	11/7/97	7.84	R	pCi/L	N
12338	Technetium-99	11/7/97	5.05	U	pCi/L	N
12338	Technetium-99	11/10/97	4.07	UJ	pCi/L	N
12338	Technetium-99	11/12/97	11.52	J	pCi/L	N
12338	Technetium-99	11/14/97	5.12	UJ	pCi/L	N
12338	Technetium-99	11/17/97	7.07	J	pCi/L	N
12338	Technetium-99	11/17/97	8.51	J	pCi/L	FD
12338	Technetium-99	11/18/97	9.5	J	pCi/L	N
12338	Technetium-99	11/25/97	5.68	UJ	pCi/L	N
12338	Technetium-99	12/1/97	5.5	UJ	pCi/L	N
12338	Technetium-99	12/8/97	7.96	UJ	pCi/L	N
12338	Uranium, Total	10/30/97	1.417	J	µg/L	N
12338	Uranium, Total	10/31/97	3.867	J	µg/L	N
12338	Uranium, Total	11/3/97	4.673	J	µg/L	N

TABLE A-1
(Continued)

Well Number	Constituent	Date Sampled	Validated Result	Validation Qualifier	Units	Type
12338	Uranium, Total	11/4/97	4.192	J	µg/L	N
12338	Uranium, Total	11/5/97	4.18	J	µg/L	N
12338	Uranium, Total	11/6/97	5.106	J	µg/L	N
12338	Uranium, Total	11/7/97	4.19	J	µg/L	N
12338	Uranium, Total	11/10/97	4.345	J	µg/L	N
12338	Uranium, Total	11/12/97	7.454	J	µg/L	N
12338	Uranium, Total	11/14/97	4.334	J	µg/L	N
12338	Uranium, Total	11/17/97	4.453	J	µg/L	N
12338	Uranium, Total	11/17/97	4.76	J	µg/L	FD
12338	Uranium, Total	11/18/97	4.323	J	µg/L	N
12338	Uranium, Total	11/25/97	1.37	J	µg/L	N
12338	Uranium, Total	12/1/97	1.57	J	µg/L	N
12338	Uranium, Total	12/8/97	1.74	J	µg/L	N
12338	1,1-Dichloroethene	10/30/97	3	U	µg/L	N
12338	1,1-Dichloroethene	10/31/97	3	U	µg/L	N
12338	1,1-Dichloroethene	11/3/97	3	U	µg/L	N
12338	1,1-Dichloroethene	11/4/97	3	U	µg/L	N
12338	1,1-Dichloroethene	11/5/97	3	U	µg/L	N
12338	1,1-Dichloroethene	11/6/97	3	U	µg/L	N
12338	1,1-Dichloroethene	11/7/97	3	U	µg/L	N
12338	1,1-Dichloroethene	11/10/97	3	U	µg/L	N
12338	1,1-Dichloroethene	11/12/97	3	U	µg/L	N
12338	1,1-Dichloroethene	11/14/97	3	U	µg/L	N
12338	1,1-Dichloroethene	11/17/97	3	U	µg/L	N
12338	1,1-Dichloroethene	11/17/97	3	U	µg/L	FD
12338	1,1-Dichloroethene	11/18/97	3	U	µg/L	N
12338	1,1-Dichloroethene	11/25/97	3	U	µg/L	N
12338	1,1-Dichloroethene	12/1/97	3	U	µg/L	N
12338	1,1-Dichloroethene	12/8/97	3	U	µg/L	N
12338	1,2-Dichloroethene (Total)	10/30/97	10	U	µg/L	N
12338	1,2-Dichloroethene (Total)	10/31/97	10	U	µg/L	N
12338	1,2-Dichloroethene (Total)	11/3/97	10	U	µg/L	N
12338	1,2-Dichloroethene (Total)	11/4/97	10	U	µg/L	N
12338	1,2-Dichloroethene (Total)	11/5/97	10	U	µg/L	N
12338	1,2-Dichloroethene (Total)	11/6/97	10	U	µg/L	N
12338	1,2-Dichloroethene (Total)	11/7/97	10	U	µg/L	N
12338	1,2-Dichloroethene (Total)	11/10/97	10	U	µg/L	N
12338	1,2-Dichloroethene (Total)	11/12/97	10	U	µg/L	N
12338	1,2-Dichloroethene (Total)	11/14/97	10	U	µg/L	N
12338	1,2-Dichloroethene (Total)	11/17/97	10	U	µg/L	N
12338	1,2-Dichloroethene (Total)	11/17/97	10	U	µg/L	FD
12338	1,2-Dichloroethene (Total)	11/18/97	10	U	µg/L	N
12338	1,2-Dichloroethene (Total)	11/25/97	10	U	µg/L	N
12338	1,2-Dichloroethene (Total)	12/1/97	10	U	µg/L	N

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TABLE A-1 (Continued)

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Well Number	Constituent	Date Sampled	Validated Result	Validation Qualifier	Units	Type
12338	1,2-Dichloroethene (Total)	12/8/97	10	U	µg/L	N
12338	Bromodichloromethane	10/30/97	10	U	µg/L	N
12338	Bromodichloromethane	10/31/97	8	J	µg/L	N
12338	Bromodichloromethane	11/3/97	10	U	µg/L	N
12338	Bromodichloromethane	11/4/97	3	J	µg/L	N
12338	Bromodichloromethane	11/5/97	2	J	µg/L	N
12338	Bromodichloromethane	11/6/97	2	J	µg/L	N
12338	Bromodichloromethane	11/7/97	10	U	µg/L	N
12338	Bromodichloromethane	11/10/97	2	J	µg/L	N
12338	Bromodichloromethane	11/12/97	10	U	µg/L	N
12338	Bromodichloromethane	11/14/97	10	U	µg/L	N
12338	Bromodichloromethane	11/17/97	10	U	µg/L	N
12338	Bromodichloromethane	11/17/97	10	U	µg/L	FD
12338	Bromodichloromethane	11/18/97	10	U	µg/L	N
12338	Bromodichloromethane	11/25/97	10	U	µg/L	N
12338	Bromodichloromethane	12/1/97	10	U	µg/L	N
12338	Bromodichloromethane	12/8/97	10	U	µg/L	N
12338	Tetrachloroethene	10/30/97	10	U	µg/L	N
12338	Tetrachloroethene	10/31/97	10	U	µg/L	N
12338	Tetrachloroethene	11/3/97	10	U	µg/L	N
12338	Tetrachloroethene	11/4/97	10	U	µg/L	N
12338	Tetrachloroethene	11/5/97	10	U	µg/L	N
12338	Tetrachloroethene	11/6/97	10	U	µg/L	N
12338	Tetrachloroethene	11/7/97	10	U	µg/L	N
12338	Tetrachloroethene	11/10/97	10	U	µg/L	N
12338	Tetrachloroethene	11/12/97	10	U	µg/L	N
12338	Tetrachloroethene	11/14/97	10	U	µg/L	N
12338	Tetrachloroethene	11/17/97	10	U	µg/L	N
12338	Tetrachloroethene	11/17/97	10	U	µg/L	FD
12338	Tetrachloroethene	11/18/97	10	U	µg/L	N
12338	Tetrachloroethene	11/25/97	10	U	µg/L	N
12338	Tetrachloroethene	12/1/97	10	U	µg/L	N
12338	Tetrachloroethene	12/8/97	10	U	µg/L	N
12338	Trichloroethene	10/30/97	2	U	µg/L	N
12338	Trichloroethene	10/31/97	2	U	µg/L	N
12338	Trichloroethene	11/3/97	2	U	µg/L	N
12338	Trichloroethene	11/4/97	2	U	µg/L	N
12338	Trichloroethene	11/5/97	2	U	µg/L	N
12338	Trichloroethene	11/6/97	2	U	µg/L	N
12338	Trichloroethene	11/7/97	2	U	µg/L	N
12338	Trichloroethene	11/10/97	2	U	µg/L	N
12338	Trichloroethene	11/12/97	2	U	µg/L	N
12338	Trichloroethene	11/14/97	2	U	µg/L	N
12338	Trichloroethene	11/17/97	2	U	µg/L	N

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TABLE A-1
(Continued)

Well Number	Constituent	Date Sampled	Validated Result	Validation Qualifier	Units	Type
12338	Trichloroethene	11/17/97	2	U	µg/L	FD
12338	Trichloroethene	11/18/97	2	U	µg/L	N
12338	Trichloroethene	11/25/97	2	U	µg/L	N
12338	Trichloroethene	12/1/97	2	U	µg/L	N
12338	Trichloroethene	12/8/97	2	U	µg/L	N
12338	Vinyl chloride	10/30/97	1	U	µg/L	N
12338	Vinyl chloride	10/31/97	1	U	µg/L	N
12338	Vinyl chloride	11/3/97	1	U	µg/L	N
12338	Vinyl chloride	11/4/97	1	U	µg/L	N
12338	Vinyl chloride	11/5/97	1	U	µg/L	N
12338	Vinyl chloride	11/6/97	1	U	µg/L	N
12338	Vinyl chloride	11/7/97	1	U	µg/L	N
12338	Vinyl chloride	11/10/97	1	U	µg/L	N
12338	Vinyl chloride	11/12/97	1	U	µg/L	N
12338	Vinyl chloride	11/14/97	1	U	µg/L	N
12338	Vinyl chloride	11/17/97	1	U	µg/L	N
12338	Vinyl chloride	11/17/97	1	U	µg/L	FD
12338	Vinyl chloride	11/18/97	1	U	µg/L	N
12338	Vinyl chloride	11/25/97	1	U	µg/L	N
12338	Vinyl chloride	12/1/97	1	U	µg/L	N
12338	Vinyl chloride	12/8/97	1	U	µg/L	N
12338	4-Nitroaniline	10/30/97	25	U	µg/L	N
12338	4-Nitroaniline	10/31/97	25	U	µg/L	N
12338	4-Nitroaniline	11/3/97	25	U	µg/L	N
12338	4-Nitroaniline	11/4/97	25	U	µg/L	N
12338	4-Nitroaniline	11/5/97	25	U	µg/L	N
12338	4-Nitroaniline	11/6/97	25	U	µg/L	N
12338	4-Nitroaniline	11/7/97	25	U	µg/L	N
12338	4-Nitroaniline	11/10/97	25	U	µg/L	N
12338	4-Nitroaniline	11/12/97	25	U	µg/L	N
12338	4-Nitroaniline	11/14/97	25	U	µg/L	N
12338	4-Nitroaniline	11/17/97	25	U	µg/L	N
12338	4-Nitroaniline	11/17/97	25	U	µg/L	FD
12338	4-Nitroaniline	11/18/97	25	U	µg/L	N
12338	4-Nitroaniline	11/25/97	25	U	µg/L	N
12338	4-Nitroaniline	12/1/97	25	U	µg/L	N
12338	4-Nitroaniline	12/8/97	25	U	µg/L	N
12338	bis(2-Chloroisopropyl) ether	10/30/97	2	UJ	µg/L	N
12338	bis(2-Chloroisopropyl) ether	10/31/97	2	U	µg/L	N
12338	bis(2-Chloroisopropyl) ether	11/3/97	2	U	µg/L	N
12338	bis(2-Chloroisopropyl) ether	11/4/97	2	U	µg/L	N
12338	bis(2-Chloroisopropyl) ether	11/5/97	2	U	µg/L	N
12338	bis(2-Chloroisopropyl) ether	11/6/97	2	U	µg/L	N
12338	bis(2-Chloroisopropyl) ether	11/7/97	2	U	µg/L	N

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TABLE A-1 (Continued)

1736

Well Number	Constituent	Date Sampled	Validated Result	Validation Qualifier	Units	Type
12338	bis(2-Chloroisopropyl) ether	11/10/97	2	U	µg/L	N
12338	bis(2-Chloroisopropyl) ether	11/12/97	2	U	µg/L	N
12338	bis(2-Chloroisopropyl) ether	11/14/97	2	U	µg/L	N
12338	bis(2-Chloroisopropyl) ether	11/17/97	2	U	µg/L	N
12338	bis(2-Chloroisopropyl) ether	11/17/97	2	U	µg/L	FD
12338	bis(2-Chloroisopropyl) ether	11/18/97	2	U	µg/L	N
12338	bis(2-Chloroisopropyl) ether	11/25/97	2	U	µg/L	N
12338	bis(2-Chloroisopropyl) ether	12/1/97	2	U	µg/L	N
12338	bis(2-Chloroisopropyl) ether	12/8/97	2	U	µg/L	N
12338	Carbazole	10/30/97	5	U	µg/L	N
12338	Carbazole	10/31/97	5	U	µg/L	N
12338	Carbazole	11/3/97	5	U	µg/L	N
12338	Carbazole	11/4/97	5	U	µg/L	N
12338	Carbazole	11/5/97	5	U	µg/L	N
12338	Carbazole	11/6/97	5	U	µg/L	N
12338	Carbazole	11/7/97	5	U	µg/L	N
12338	Carbazole	11/10/97	5	U	µg/L	N
12338	Carbazole	11/12/97	5	U	µg/L	N
12338	Carbazole	11/14/97	5	U	µg/L	N
12338	Carbazole	11/17/97	5	U	µg/L	N
12338	Carbazole	11/17/97	5	U	µg/L	FD
12338	Carbazole	11/18/97	5	U	µg/L	N
12338	Carbazole	11/25/97	5	U	µg/L	N
12338	Carbazole	12/1/97	5	U	µg/L	N
12338	Carbazole	12/8/97	5	U	µg/L	N
12338	Alpha-Chlordane	10/30/97	0.05	U	µg/L	N
12338	Alpha-Chlordane	10/31/97	0.05	U	µg/L	N
12338	Alpha-Chlordane	11/3/97	0.05	U	µg/L	N
12338	Alpha-Chlordane	11/4/97	0.05	U	µg/L	N
12338	Alpha-Chlordane	11/5/97	0.05	U	µg/L	N
12338	Alpha-Chlordane	11/6/97	0.05	U	µg/L	N
12338	Alpha-Chlordane	11/7/97	0.05	U	µg/L	N
12338	Alpha-Chlordane	11/10/97	0.05	U	µg/L	N
12338	Alpha-Chlordane	11/12/97	0.05	U	µg/L	N
12338	Alpha-Chlordane	11/14/97	0.05	U	µg/L	N
12338	Alpha-Chlordane	11/17/97	0.05	U	µg/L	N
12338	Alpha-Chlordane	11/17/97	0.05	U	µg/L	FD
12338	Alpha-Chlordane	11/18/97	0.05	U	µg/L	N
12338	Alpha-Chlordane	11/25/97	0.05	U	µg/L	N
12338	Alpha-Chlordane	12/1/97	0.05	U	µg/L	N
12338	Alpha-Chlordane	12/8/97	0.05	U	µg/L	N
22201	Total Organic Carbon	3/31/97	13.7	-	mg/L	N
22201	Total Organic Carbon	3/31/97	11.7	-	mg/L	FD
22201	Total Organic Carbon	4/30/97	1.9	-	mg/L	N

TABLE A-1
(Continued)

Well Number	Constituent	Date Sampled	Validated Result	Validation Qualifier	Units	Type
22201	Total Organic Carbon	5/14/97	4.1	J	mg/L	N
22201	Total Organic Carbon	5/14/97	1.8	J	mg/L	FD
22201	Total Organic Carbon	5/28/97	1.5	-	mg/L	N
22201	Total Organic Carbon	6/17/97	3.4	-	mg/L	N
22201	Total Organic Carbon	6/25/97	2.4	J	mg/L	N
22201	Total Organic Carbon	6/25/97	2.5	J	mg/L	FD
22201	Total Organic Carbon	7/9/97	4.48	-	mg/L	N
22201	Total Organic Carbon	7/9/97	3.7	-	mg/L	FD
22201	Total Organic Carbon	7/30/97	22.5	J	mg/L	N
22201	Total Organic Carbon	8/7/97	13.5	J	mg/L	N
22201	Total Organic Carbon	8/7/97	20.9	J	mg/L	FD
22201	Total Organic Carbon	8/26/97	37.6	Z	mg/L	N
22201	Total Organic Carbon	8/26/97	7.39	J	mg/L	N
22201	Total Organic Carbon	8/26/97	9.66	J	mg/L	FD
22201	Total Organic Carbon	9/16/97	0.0186	J	mg/L	N
22201	Total Organic Carbon	9/16/97	0.014	J	mg/L	FD
22201	Total Organic Carbon	10/1/97	24	-	mg/L	N
22201	Total Organic Carbon	11/25/97	16.5	J	mg/L	N
22201	Total Organic Carbon	12/2/97	16.3	J	mg/L	N
22201	Total Organic Carbon	12/8/97	13.7	J	mg/L	N
22201	Total Organic Carbon	12/8/97	12.5	J	mg/L	FD
22201	Total Organic Halogens	3/31/97	0.078	J	mg/L	N
22201	Total Organic Halogens	3/31/97	0.024	UJ	mg/L	FD
22201	Total Organic Halogens	4/30/97	0.061	-	mg/L	N
22201	Total Organic Halogens	5/14/97	0.022	J	mg/L	N
22201	Total Organic Halogens	5/14/97	0.0265	J	mg/L	FD
22201	Total Organic Halogens	5/28/97	0.0268	-	mg/L	N
22201	Total Organic Halogens	6/17/97	0.0074	U	mg/L	N
22201	Total Organic Halogens	6/25/97	0.0176	-	mg/L	N
22201	Total Organic Halogens	6/25/97	0.0202	-	mg/L	FD
22201	Total Organic Halogens	7/9/97	0.0069	J	mg/L	N
22201	Total Organic Halogens	7/9/97	0.005	UJ	mg/L	FD
22201	Total Organic Halogens	7/30/97	0.005	U	mg/L	N
22201	Total Organic Halogens	8/7/97	0.0066	U	mg/L	N
22201	Total Organic Halogens	8/7/97	0.0056	U	mg/L	FD
22201	Total Organic Halogens	8/26/97	0.005	UJ	mg/L	N
22201	Total Organic Halogens	8/26/97	0.0055	J	mg/L	FD
22201	Total Organic Halogens	9/16/97	0.005	UJ	mg/L	N
22201	Total Organic Halogens	9/16/97	0.005	UJ	mg/L	FD
22201	Total Organic Halogens	10/1/97	0.012	UJ	mg/L	N
22201	Total Organic Halogens	11/25/97	0.029	-	mg/L	N
22201	Total Organic Halogens	12/2/97	0.0228	U	mg/L	N
22201	Total Organic Halogens	12/8/97	0.0214	-	mg/L	N
22201	Total Organic Halogens	12/8/97	0.0236	-	mg/L	FD

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TABLE A-1
(Continued)

Well Number	Constituent	Date Sampled	Validated Result	Validation Qualifier	Units	Type
22201	Boron	3/31/97	0.0575	-	mg/L	N
22201	Boron	3/31/97	0.0444	-	mg/L	FD
22201	Boron	4/30/97	0.07	-	mg/L	N
22201	Boron	5/14/97	0.0777	-	mg/L	N
22201	Boron	5/14/97	0.0812	-	mg/L	FD
22201	Boron	5/28/97	0.0869	-	mg/L	N
22201	Boron	6/17/97	0.0544	U	mg/L	N
22201	Boron	6/25/97	0.0732	U	mg/L	N
22201	Boron	6/25/97	0.0724	U	mg/L	FD
22201	Boron	7/9/97	0.0651	U	mg/L	N
22201	Boron	7/9/97	0.0644	U	mg/L	FD
22201	Boron	7/30/97	0.0506	U	mg/L	N
22201	Boron	8/7/97	0.0735	U	mg/L	N
22201	Boron	8/7/97	0.0794	U	mg/L	FD
22201	Boron	8/26/97	0.0819	-	mg/L	N
22201	Boron	8/26/97	0.0748	-	mg/L	FD
22201	Boron	9/16/97	0.1	-	mg/L	N
22201	Boron	9/16/97	0.102	-	mg/L	FD
22201	Boron	10/1/97	0.105	-	mg/L	N
22201	Boron	11/25/97	0.123	-	mg/L	N
22201	Boron	12/2/97	0.114	-	mg/L	N
22201	Boron	12/8/97	0.114	-	mg/L	N
22201	Boron	12/8/97	0.112	-	mg/L	FD
22201	Mercury	3/31/97	0.0001	U	mg/L	N
22201	Mercury	3/31/97	0.0001	U	mg/L	FD
22201	Mercury	4/30/97	0.0001	U	mg/L	N
22201	Mercury	5/14/97	0.0001	U	mg/L	N
22201	Mercury	5/14/97	0.0001	U	mg/L	FD
22201	Mercury	5/28/97	0.0001	U	mg/L	N
22201	Mercury	6/17/97	0.0001	U	mg/L	N
22201	Mercury	6/25/97	0.0001	U	mg/L	N
22201	Mercury	6/25/97	0.0001	U	mg/L	FD
22201	Mercury	7/9/97	0.0001	U	mg/L	N
22201	Mercury	7/9/97	0.0001	U	mg/L	FD
22201	Mercury	7/30/97	0.0001	U	mg/L	N
22201	Mercury	8/7/97	0.0001	U	mg/L	N
22201	Mercury	8/7/97	0.0001	U	mg/L	FD
22201	Mercury	8/26/97	0.0001	U	mg/L	N
22201	Mercury	8/26/97	0.0001	U	mg/L	FD
22201	Mercury	9/16/97	0.0001	U	mg/L	N
22201	Mercury	9/16/97	0.0001	U	mg/L	FD
22201	Mercury	10/1/97	0.0001	U	mg/L	N
22201	Mercury	11/25/97	0.0001	U	mg/L	N
22201	Mercury	12/2/97	0.0001	U	mg/L	N

TABLE A-1
(Continued)

Well Number	Constituent	Date Sampled	Validated Result	Validation Qualifier	Units	Type
22201	Mercury	12/8/97	0.0001	U	mg/L	N
22201	Mercury	12/8/97	0.0001	U	mg/L	FD
22201	Technetium-99	3/31/97	6.01	Z	pCi/L	N
22201	Technetium-99	3/31/97	6.86	U	pCi/L	FD
22201	Technetium-99	3/31/97	6.01	U	pCi/L	N
22201	Technetium-99	3/31/97	6.86	U	pCi/L	FD
22201	Technetium-99	4/30/97	6.99	U	pCi/L	N
22201	Technetium-99	5/14/97	12.5	UJ	pCi/L	N
22201	Technetium-99	5/14/97	4.12	U	pCi/L	FD
22201	Technetium-99	5/28/97	-2.02	UJ	pCi/L	N
22201	Technetium-99	6/17/97	0.69	UJ	pCi/L	N
22201	Technetium-99	6/25/97	21.57	Z	pCi/L	N
22201	Technetium-99	6/25/97	0.87	U	pCi/L	N
22201	Technetium-99	6/25/97	16.3	Z	pCi/L	FD
22201	Technetium-99	6/25/97	4.52	U	pCi/L	FD
22201	Technetium-99	7/9/97	5.05	UJ	pCi/L	N
22201	Technetium-99	7/9/97	4.43	UJ	pCi/L	FD
22201	Technetium-99	7/30/97	-4.46	UJ	pCi/L	N
22201	Technetium-99	8/7/97	-3.43	UJ	pCi/L	N
22201	Technetium-99	8/7/97	-3.23	UJ	pCi/L	FD
22201	Technetium-99	8/26/97	10.13	J	pCi/L	N
22201	Technetium-99	8/26/97	13.41	J	pCi/L	FD
22201	Technetium-99	9/16/97	0.67	UJ	pCi/L	N
22201	Technetium-99	9/16/97	3.57	UJ	pCi/L	FD
22201	Technetium-99	10/1/97	-2.08	UJ	pCi/L	N
22201	Technetium-99	11/25/97	4.62	UJ	pCi/L	N
22201	Technetium-99	12/2/97	4.25	UJ	pCi/L	N
22201	Technetium-99	12/8/97	3.37	UJ	pCi/L	N
22201	Technetium-99	12/8/97	2.27	UJ	pCi/L	FD
22201	Uranium, Total	3/31/97	5.089	-	µg/L	N
22201	Uranium, Total	3/31/97	5.196	-	µg/L	FD
22201	Uranium, Total	4/30/97	0.028	U	µg/L	N
22201	Uranium, Total	5/14/97	0.617	-	µg/L	N
22201	Uranium, Total	5/14/97	0.697	-	µg/L	FD
22201	Uranium, Total	5/28/97	0.125	-	µg/L	N
22201	Uranium, Total	6/17/97	0.08	-	µg/L	N
22201	Uranium, Total	6/25/97	0.174	J	µg/L	N
22201	Uranium, Total	6/25/97	0.029	U	µg/L	FD
22201	Uranium, Total	7/9/97	0.129	J	µg/L	N
22201	Uranium, Total	7/9/97	0.099	J	µg/L	FD
22201	Uranium, Total	7/30/97	0.161	J	µg/L	N
22201	Uranium, Total	8/7/97	0.175	J	µg/L	N
22201	Uranium, Total	8/7/97	0.144	J	µg/L	FD
22201	Uranium, Total	8/26/97	0.204	J	µg/L	N

TABLE A-1 (Continued)

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Well Number	Constituent	Date Sampled	Validated Result	Validation Qualifier	Units	Type
22201	Uranium, Total	8/26/97	0.155	J	µg/L	FD
22201	Uranium, Total	9/16/97	0.154	J	µg/L	N
22201	Uranium, Total	9/16/97	0.195	J	µg/L	FD
22201	Uranium, Total	10/1/97	0.203	J	µg/L	N
22201	Uranium, Total	11/25/97	0.091	J	µg/L	N
22201	Uranium, Total	12/2/97	0.172	J	µg/L	N
22201	Uranium, Total	12/8/97	0.107	J	µg/L	N
22201	Uranium, Total	12/8/97	0.209	J	µg/L	FD
22201	1,1-Dichloroethene	3/31/97	1	UJ	µg/L	N
22201	1,1-Dichloroethene	3/31/97	1	UJ	µg/L	FD
22201	1,1-Dichloroethene	4/30/97	1	UJ	µg/L	N
22201	1,1-Dichloroethene	5/14/97	1	UJ	µg/L	N
22201	1,1-Dichloroethene	5/14/97	1	UJ	µg/L	FD
22201	1,1-Dichloroethene	5/28/97	1	UJ	µg/L	N
22201	1,1-Dichloroethene	6/17/97	3	U	µg/L	N
22201	1,1-Dichloroethene	6/25/97	3	U	µg/L	N
22201	1,1-Dichloroethene	6/25/97	3	U	µg/L	FD
22201	1,1-Dichloroethene	7/9/97	3	U	µg/L	N
22201	1,1-Dichloroethene	7/9/97	3	U	µg/L	FD
22201	1,1-Dichloroethene	7/30/97	3	U	µg/L	N
22201	1,1-Dichloroethene	8/7/97	3	U	µg/L	N
22201	1,1-Dichloroethene	8/7/97	3	U	µg/L	FD
22201	1,1-Dichloroethene	8/26/97	3	U	µg/L	N
22201	1,1-Dichloroethene	8/26/97	3	U	µg/L	FD
22201	1,1-Dichloroethene	9/16/97	3	U	µg/L	N
22201	1,1-Dichloroethene	9/16/97	3	U	µg/L	FD
22201	1,1-Dichloroethene	10/1/97	3	U	µg/L	N
22201	1,1-Dichloroethene	11/25/97	3	U	µg/L	N
22201	1,1-Dichloroethene	12/2/97	3	U	µg/L	N
22201	1,1-Dichloroethene	12/8/97	3	U	µg/L	N
22201	1,1-Dichloroethene	12/8/97	3	U	µg/L	FD
22201	1,2-Dichloroethene (Total)	3/31/97	1	UJ	µg/L	N
22201	1,2-Dichloroethene (Total)	3/31/97	1	UJ	µg/L	FD
22201	1,2-Dichloroethene (Total)	4/30/97	1	UJ	µg/L	N
22201	1,2-Dichloroethene (Total)	5/14/97	1	UJ	µg/L	N
22201	1,2-Dichloroethene (Total)	5/14/97	1	UJ	µg/L	FD
22201	1,2-Dichloroethene (Total)	5/28/97	1	UJ	µg/L	N
22201	1,2-Dichloroethene (Total)	6/17/97	10	U	µg/L	N
22201	1,2-Dichloroethene (Total)	6/25/97	10	U	µg/L	N
22201	1,2-Dichloroethene (Total)	6/25/97	10	U	µg/L	FD
22201	1,2-Dichloroethene (Total)	7/9/97	10	U	µg/L	N
22201	1,2-Dichloroethene (Total)	7/9/97	10	U	µg/L	FD
22201	1,2-Dichloroethene (Total)	7/30/97	10	U	µg/L	N
22201	1,2-Dichloroethene (Total)	8/7/97	10	U	µg/L	N

TABLE A-1
(Continued)

Well Number	Constituent	Date Sampled	Validated Result	Validation Qualifier	Units	Type
22201	1,2-Dichloroethene (Total)	8/7/97	10	U	µg/L	FD
22201	1,2-Dichloroethene (Total)	8/26/97	10	U	µg/L	N
22201	1,2-Dichloroethene (Total)	8/26/97	10	U	µg/L	FD
22201	1,2-Dichloroethene (Total)	9/16/97	10	U	µg/L	N
22201	1,2-Dichloroethene (Total)	9/16/97	10	U	µg/L	FD
22201	1,2-Dichloroethene (Total)	10/1/97	10	U	µg/L	N
22201	1,2-Dichloroethene (Total)	11/25/97	10	U	µg/L	N
22201	1,2-Dichloroethene (Total)	12/2/97	10	U	µg/L	N
22201	1,2-Dichloroethene (Total)	12/8/97	10	U	µg/L	N
22201	1,2-Dichloroethene (Total)	12/8/97	10	U	µg/L	FD
22201	Bromodichloromethane	3/31/97	1	UJ	µg/L	N
22201	Bromodichloromethane	3/31/97	1	UJ	µg/L	FD
22201	Bromodichloromethane	4/30/97	1	UJ	µg/L	N
22201	Bromodichloromethane	5/14/97	1	UJ	µg/L	N
22201	Bromodichloromethane	5/14/97	1	UJ	µg/L	FD
22201	Bromodichloromethane	5/28/97	1	UJ	µg/L	N
22201	Bromodichloromethane	6/17/97	10	U	µg/L	N
22201	Bromodichloromethane	6/25/97	10	U	µg/L	N
22201	Bromodichloromethane	6/25/97	10	U	µg/L	FD
22201	Bromodichloromethane	7/9/97	10	U	µg/L	N
22201	Bromodichloromethane	7/9/97	10	U	µg/L	FD
22201	Bromodichloromethane	7/30/97	10	U	µg/L	N
22201	Bromodichloromethane	8/7/97	10	U	µg/L	N
22201	Bromodichloromethane	8/7/97	10	U	µg/L	FD
22201	Bromodichloromethane	8/26/97	10	U	µg/L	N
22201	Bromodichloromethane	8/26/97	10	U	µg/L	FD
22201	Bromodichloromethane	9/16/97	10	U	µg/L	N
22201	Bromodichloromethane	9/16/97	10	U	µg/L	FD
22201	Bromodichloromethane	10/1/97	10	U	µg/L	N
22201	Bromodichloromethane	11/25/97	10	U	µg/L	N
22201	Bromodichloromethane	12/2/97	10	U	µg/L	N
22201	Bromodichloromethane	12/8/97	10	U	µg/L	N
22201	Bromodichloromethane	12/8/97	10	U	µg/L	FD
22201	Tetrachloroethene	3/31/97	1	UJ	µg/L	N
22201	Tetrachloroethene	3/31/97	1	UJ	µg/L	FD
22201	Tetrachloroethene	4/30/97	1	UJ	µg/L	N
22201	Tetrachloroethene	5/14/97	1	UJ	µg/L	N
22201	Tetrachloroethene	5/14/97	1	UJ	µg/L	FD
22201	Tetrachloroethene	5/28/97	1	UJ	µg/L	N
22201	Tetrachloroethene	6/17/97	10	UJ	µg/L	N
22201	Tetrachloroethene	6/25/97	10	U	µg/L	N
22201	Tetrachloroethene	6/25/97	10	U	µg/L	FD
22201	Tetrachloroethene	7/9/97	10	U	µg/L	N
22201	Tetrachloroethene	7/9/97	10	U	µg/L	FD

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TABLE A-1
(Continued)

Well Number	Constituent	Date Sampled	Validated Result	Validation Qualifier	Units	Type
22201	Tetrachloroethene	7/30/97	10	U	µg/L	N
22201	Tetrachloroethene	8/7/97	10	U	µg/L	N
22201	Tetrachloroethene	8/7/97	10	U	µg/L	FD
22201	Tetrachloroethene	8/26/97	10	U	µg/L	N
22201	Tetrachloroethene	8/26/97	10	U	µg/L	FD
22201	Tetrachloroethene	9/16/97	1	J	µg/L	N
22201	Tetrachloroethene	9/16/97	10	U	µg/L	FD
22201	Tetrachloroethene	10/1/97	10	U	µg/L	N
22201	Tetrachloroethene	11/25/97	10	U	µg/L	N
22201	Tetrachloroethene	12/2/97	10	U	µg/L	N
22201	Tetrachloroethene	12/8/97	10	U	µg/L	N
22201	Tetrachloroethene	12/8/97	10	U	µg/L	FD
22201	Trichloroethene	3/31/97	1	UJ	µg/L	N
22201	Trichloroethene	3/31/97	1	UJ	µg/L	FD
22201	Trichloroethene	4/30/97	1	UJ	µg/L	N
22201	Trichloroethene	5/14/97	1	UJ	µg/L	N
22201	Trichloroethene	5/14/97	1	UJ	µg/L	FD
22201	Trichloroethene	5/28/97	1	UJ	µg/L	N
22201	Trichloroethene	6/17/97	2	U	µg/L	N
22201	Trichloroethene	6/25/97	2	U	µg/L	N
22201	Trichloroethene	6/25/97	2	U	µg/L	FD
22201	Trichloroethene	7/9/97	2	U	µg/L	N
22201	Trichloroethene	7/9/97	2	U	µg/L	FD
22201	Trichloroethene	7/30/97	2	U	µg/L	N
22201	Trichloroethene	8/7/97	2	U	µg/L	N
22201	Trichloroethene	8/7/97	2	U	µg/L	FD
22201	Trichloroethene	8/26/97	2	U	µg/L	N
22201	Trichloroethene	8/26/97	2	U	µg/L	FD
22201	Trichloroethene	9/16/97	2	U	µg/L	N
22201	Trichloroethene	9/16/97	2	U	µg/L	FD
22201	Trichloroethene	10/1/97	2	U	µg/L	N
22201	Trichloroethene	11/25/97	2	U	µg/L	N
22201	Trichloroethene	12/2/97	2	U	µg/L	N
22201	Trichloroethene	12/8/97	2	U	µg/L	N
22201	Trichloroethene	12/8/97	2	U	µg/L	FD
22201	Vinyl chloride	3/31/97	1	UJ	µg/L	N
22201	Vinyl chloride	3/31/97	1	UJ	µg/L	FD
22201	Vinyl chloride	4/30/97	1	UJ	µg/L	N
22201	Vinyl chloride	5/14/97	1	UJ	µg/L	N
22201	Vinyl chloride	5/14/97	1	UJ	µg/L	FD
22201	Vinyl chloride	5/28/97	1	UJ	µg/L	N
22201	Vinyl chloride	6/17/97	1	UJ	µg/L	N
22201	Vinyl chloride	6/25/97	1	UJ	µg/L	N
22201	Vinyl chloride	6/25/97	1	UJ	µg/L	FD

TABLE A-1
(Continued)

Well Number	Constituent	Date Sampled	Validated Result	Validation Qualifier	Units	Type
22201	Vinyl chloride	7/9/97	1	U	µg/L	N
22201	Vinyl chloride	7/9/97	1	U	µg/L	FD
22201	Vinyl chloride	7/30/97	1	U	µg/L	N
22201	Vinyl chloride	8/7/97	1	U	µg/L	N
22201	Vinyl chloride	8/7/97	1	U	µg/L	FD
22201	Vinyl chloride	8/26/97	1	U	µg/L	N
22201	Vinyl chloride	8/26/97	1	U	µg/L	FD
22201	Vinyl chloride	9/16/97	1	U	µg/L	N
22201	Vinyl chloride	9/16/97	1	U	µg/L	FD
22201	Vinyl chloride	10/1/97	1	U	µg/L	N
22201	Vinyl chloride	11/25/97	1	U	µg/L	N
22201	Vinyl chloride	12/2/97	1	U	µg/L	N
22201	Vinyl chloride	12/8/97	1	U	µg/L	N
22201	Vinyl chloride	12/8/97	1	U	µg/L	FD
22201	4-Nitroaniline	3/31/97	25	U	µg/L	N
22201	4-Nitroaniline	3/31/97	25	U	µg/L	FD
22201	4-Nitroaniline	4/30/97	25	UJ	µg/L	N
22201	4-Nitroaniline	5/14/97	25	U	µg/L	N
22201	4-Nitroaniline	5/14/97	25	U	µg/L	FD
22201	4-Nitroaniline	5/28/97	25	U	µg/L	N
22201	4-Nitroaniline	6/17/97	25	U	µg/L	N
22201	4-Nitroaniline	6/25/97	1.8	U	µg/L	N
22201	4-Nitroaniline	6/25/97	1.8	U	µg/L	FD
22201	4-Nitroaniline	7/9/97	25	U	µg/L	N
22201	4-Nitroaniline	7/9/97	25	U	µg/L	N
22201	4-Nitroaniline	7/9/97	25	U	µg/L	FD
22201	4-Nitroaniline	7/30/97	25	U	µg/L	N
22201	4-Nitroaniline	8/7/97	25	U	µg/L	N
22201	4-Nitroaniline	8/7/97	25	U	µg/L	FD
22201	4-Nitroaniline	8/26/97	25	U	µg/L	N
22201	4-Nitroaniline	8/26/97	25	U	µg/L	FD
22201	4-Nitroaniline	9/16/97	25	U	µg/L	N
22201	4-Nitroaniline	9/16/97	25	U	µg/L	FD
22201	4-Nitroaniline	10/1/97	25	U	µg/L	N
22201	4-Nitroaniline	11/25/97	25	U	µg/L	N
22201	4-Nitroaniline	12/2/97	25	U	µg/L	N
22201	4-Nitroaniline	12/8/97	25	U	µg/L	N
22201	4-Nitroaniline	12/8/97	25	U	µg/L	FD
22201	bis(2-Chloroisopropyl) ether	3/31/97	5	U	µg/L	N
22201	bis(2-Chloroisopropyl) ether	3/31/97	5	U	µg/L	FD
22201	bis(2-Chloroisopropyl) ether	4/30/97	5	UJ	µg/L	N
22201	bis(2-Chloroisopropyl) ether	5/14/97	10	U	µg/L	N
22201	bis(2-Chloroisopropyl) ether	5/14/97	10	U	µg/L	FD
22201	bis(2-Chloroisopropyl) ether	5/28/97	5	U	µg/L	N

TABLE A-1 (Continued)

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Well Number	Constituent	Date Sampled	Validated Result	Validation Qualifier	Units	Type
22201	bis(2-Chloroisopropyl) ether	6/17/97	2	U	µg/L	N
22201	bis(2-Chloroisopropyl) ether	6/25/97	1.8	UJ	µg/L	N
22201	bis(2-Chloroisopropyl) ether	6/25/97	1.8	UJ	µg/L	FD
22201	bis(2-Chloroisopropyl) ether	7/9/97	2	U	µg/L	N
22201	bis(2-Chloroisopropyl) ether	7/9/97	2	U	µg/L	N
22201	bis(2-Chloroisopropyl) ether	7/9/97	2	U	µg/L	FD
22201	bis(2-Chloroisopropyl) ether	7/30/97	2	U	µg/L	N
22201	bis(2-Chloroisopropyl) ether	8/7/97	2	U	µg/L	N
22201	bis(2-Chloroisopropyl) ether	8/7/97	2	U	µg/L	FD
22201	bis(2-Chloroisopropyl) ether	8/26/97	2	U	µg/L	N
22201	bis(2-Chloroisopropyl) ether	8/26/97	2	U	µg/L	FD
22201	bis(2-Chloroisopropyl) ether	9/16/97	2	U	µg/L	N
22201	bis(2-Chloroisopropyl) ether	9/16/97	2	U	µg/L	FD
22201	bis(2-Chloroisopropyl) ether	10/1/97	2	U	µg/L	N
22201	bis(2-Chloroisopropyl) ether	11/25/97	2	U	µg/L	N
22201	bis(2-Chloroisopropyl) ether	12/2/97	2	U	µg/L	N
22201	bis(2-Chloroisopropyl) ether	12/8/97	2	U	µg/L	N
22201	bis(2-Chloroisopropyl) ether	12/8/97	2	U	µg/L	FD
22201	Carbazole	3/31/97	10	UJ	µg/L	N
22201	Carbazole	3/31/97	10	UJ	µg/L	FD
22201	Carbazole	4/30/97	10	U	µg/L	N
22201	Carbazole	5/14/97	10	U	µg/L	N
22201	Carbazole	5/14/97	10	U	µg/L	FD
22201	Carbazole	5/28/97	10	U	µg/L	N
22201	Carbazole	6/17/97	5	U	µg/L	N
22201	Carbazole	6/25/97	2.1	U	µg/L	N
22201	Carbazole	6/25/97	2.1	U	µg/L	FD
22201	Carbazole	7/9/97	5	U	µg/L	N
22201	Carbazole	7/9/97	5	U	µg/L	N
22201	Carbazole	7/9/97	5	U	µg/L	FD
22201	Carbazole	7/30/97	5	U	µg/L	N
22201	Carbazole	8/7/97	5	U	µg/L	N
22201	Carbazole	8/7/97	5	U	µg/L	FD
22201	Carbazole	8/26/97	5	U	µg/L	N
22201	Carbazole	8/26/97	5	U	µg/L	FD
22201	Carbazole	9/16/97	5	U	µg/L	N
22201	Carbazole	9/16/97	5	U	µg/L	FD
22201	Carbazole	10/1/97	5	UJ	µg/L	N
22201	Carbazole	11/25/97	5	U	µg/L	N
22201	Carbazole	12/2/97	5	U	µg/L	N
22201	Carbazole	12/8/97	5	U	µg/L	N
22201	Carbazole	12/8/97	5	U	µg/L	FD
22201	Alpha-Chlordane	3/31/97	0.05	U	µg/L	N
22201	Alpha-Chlordane	3/31/97	0.05	U	µg/L	FD

TABLE A-1
(Continued)

Well Number	Constituent	Date Sampled	Validated Result	Validation Qualifier	Units	Type
22201	Alpha-Chlordane	4/30/97	0.05	Z	µg/L	N
22201	Alpha-Chlordane	4/30/97	0.05	U	µg/L	N
22201	Alpha-Chlordane	5/14/97	0.05	UJ	µg/L	N
22201	Alpha-Chlordane	5/14/97	0.05	U	µg/L	FD
22201	Alpha-Chlordane	5/28/97	0.05	U	µg/L	N
22201	Alpha-Chlordane	6/17/97	0.05	U	µg/L	N
22201	Alpha-Chlordane	6/25/97	0.05	U	µg/L	N
22201	Alpha-Chlordane	6/25/97	0.05	U	µg/L	FD
22201	Alpha-Chlordane	7/9/97	0.05	U	µg/L	N
22201	Alpha-Chlordane	7/9/97	0.05	U	µg/L	FD
22201	Alpha-Chlordane	7/30/97	0.05	U	µg/L	N
22201	Alpha-Chlordane	8/7/97	0.05	U	µg/L	N
22201	Alpha-Chlordane	8/7/97	0.05	U	µg/L	FD
22201	Alpha-Chlordane	8/26/97	0.05	U	µg/L	N
22201	Alpha-Chlordane	8/26/97	0.05	U	µg/L	FD
22201	Alpha-Chlordane	9/16/97	0.05	U	µg/L	N
22201	Alpha-Chlordane	9/16/97	0.05	U	µg/L	FD
22201	Alpha-Chlordane	10/1/97	0.05	U	µg/L	N
22201	Alpha-Chlordane	11/25/97	0.05	U	µg/L	N
22201	Alpha-Chlordane	12/2/97	0.05	U	µg/L	N
22201	Alpha-Chlordane	12/8/97	0.05	U	µg/L	N
22201	Alpha-Chlordane	12/8/97	0.05	U	µg/L	FD
22198	Total Organic Carbon	3/31/97	0.96	-	mg/L	N
22198	Total Organic Carbon	4/30/97	6.3	J	mg/L	N
22198	Total Organic Carbon	4/30/97	2.7	J	mg/L	FD
22198	Total Organic Carbon	5/14/97	1.4	-	mg/L	N
22198	Total Organic Carbon	5/28/97	2.8	J	mg/L	N
22198	Total Organic Carbon	5/28/97	0.71	J	mg/L	FD
22198	Total Organic Carbon	6/17/97	2	UJ	mg/L	N
22198	Total Organic Carbon	6/17/97	2.4	J	mg/L	FD
22198	Total Organic Carbon	6/25/97	2.8	J	mg/L	N
22198	Total Organic Carbon	7/9/97	3.67	-	mg/L	N
22198	Total Organic Carbon	7/31/97	2.1	J	mg/L	N
22198	Total Organic Carbon	8/7/97	4.9	J	mg/L	N
22198	Total Organic Carbon	8/26/97	24.1	-	mg/L	N
22198	Total Organic Carbon	9/16/97	0.0143	J	mg/L	N
22198	Total Organic Carbon	10/1/97	8.4	J	mg/L	N
22198	Total Organic Carbon	10/1/97	25	J	mg/L	FD
22198	Total Organic Carbon	11/25/97	12.8	J	mg/L	N
22198	Total Organic Carbon	12/1/97	13.7	J	mg/L	N
22198	Total Organic Carbon	12/1/97	11.1	J	mg/L	FD
22198	Total Organic Carbon	12/8/97	11.8	J	mg/L	N
22198	Total Organic Halogens	3/31/97	0.024	U	mg/L	N
22198	Total Organic Halogens	4/30/97	0.0323	-	mg/L	N

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TABLE A-1
(Continued)

Well Number	Constituent	Date Sampled	Validated Result	Validation Qualifier	Units	Type
22198	Total Organic Halogens	4/30/97	0.0526	-	mg/L	FD
22198	Total Organic Halogens	5/14/97	0.0264	J	mg/L	N
22198	Total Organic Halogens	5/28/97	0.0222	-	mg/L	N
22198	Total Organic Halogens	5/28/97	0.0217	-	mg/L	FD
22198	Total Organic Halogens	6/17/97	0.005	U	mg/L	N
22198	Total Organic Halogens	6/17/97	0.005	U	mg/L	FD
22198	Total Organic Halogens	6/25/97	0.014	-	mg/L	N
22198	Total Organic Halogens	7/9/97	0.005	UJ	mg/L	N
22198	Total Organic Halogens	7/31/97	0.005	U	mg/L	N
22198	Total Organic Halogens	8/7/97	0.0076	U	mg/L	N
22198	Total Organic Halogens	8/26/97	0.005	UJ	mg/L	N
22198	Total Organic Halogens	9/16/97	0.005	UJ	mg/L	N
22198	Total Organic Halogens	10/1/97	0.005	UJ	mg/L	N
22198	Total Organic Halogens	10/1/97	0.0063	UJ	mg/L	FD
22198	Total Organic Halogens	11/25/97	0.0078	U	mg/L	N
22198	Total Organic Halogens	12/1/97	0.012	U	mg/L	N
22198	Total Organic Halogens	12/1/97	0.0085	U	mg/L	FD
22198	Total Organic Halogens	12/8/97	0.0062	-	mg/L	N
22198	Boron	3/31/97	0.0723	-	mg/L	N
22198	Boron	4/30/97	0.052	-	mg/L	N
22198	Boron	4/30/97	0.0558	-	mg/L	FD
22198	Boron	5/14/97	0.0511	-	mg/L	N
22198	Boron	5/28/97	0.0577	-	mg/L	N
22198	Boron	5/28/97	0.0506	-	mg/L	FD
22198	Boron	6/17/97	0.0492	U	mg/L	N
22198	Boron	6/17/97	0.0488	U	mg/L	FD
22198	Boron	6/25/97	0.0524	U	mg/L	N
22198	Boron	7/9/97	0.0444	U	mg/L	N
22198	Boron	7/31/97	0.019	U	mg/L	N
22198	Boron	8/7/97	0.0407	U	mg/L	N
22198	Boron	8/26/97	0.0514	-	mg/L	N
22198	Boron	9/16/97	0.0576	-	mg/L	N
22198	Boron	10/1/97	0.059	-	mg/L	N
22198	Boron	10/1/97	0.059	-	mg/L	FD
22198	Boron	11/25/97	0.0594	-	mg/L	N
22198	Boron	12/1/97	0.0805	J	mg/L	N
22198	Boron	12/1/97	0.0661	UJ	mg/L	FD
22198	Boron	12/8/97	0.0736	-	mg/L	N
22198	Mercury	3/31/97	0.0001	U	mg/L	N
22198	Mercury	4/30/97	0.0001	U	mg/L	N
22198	Mercury	4/30/97	0.0001	U	mg/L	FD
22198	Mercury	5/14/97	0.0001	U	mg/L	N
22198	Mercury	5/28/97	0.0001	U	mg/L	N
22198	Mercury	5/28/97	0.0001	U	mg/L	FD

TABLE A-1
(Continued)

Well Number	Constituent	Date Sampled	Validated Result	Validation Qualifier	Units	Type
22198	Mercury	6/17/97	0.0001	U	mg/L	N
22198	Mercury	6/17/97	0.0001	U	mg/L	FD
22198	Mercury	6/25/97	0.0001	U	mg/L	N
22198	Mercury	7/9/97	0.0001	U	mg/L	N
22198	Mercury	7/31/97	0.0001	U	mg/L	N
22198	Mercury	8/7/97	0.0001	U	mg/L	N
22198	Mercury	8/26/97	0.0001	U	mg/L	N
22198	Mercury	9/16/97	0.0001	U	mg/L	N
22198	Mercury	10/1/97	0.0001	U	mg/L	N
22198	Mercury	10/1/97	0.0001	U	mg/L	FD
22198	Mercury	11/25/97	0.0001	U	mg/L	N
22198	Mercury	12/1/97	0.0001	U	mg/L	N
22198	Mercury	12/1/97	0.0001	U	mg/L	FD
22198	Mercury	12/8/97	0.0001	U	mg/L	N
22198	Technetium-99	3/31/97	8.91	U	pCi/L	N
22198	Technetium-99	3/31/97	8.91	U	pCi/L	N
22198	Technetium-99	4/30/97	3.36	U	pCi/L	N
22198	Technetium-99	4/30/97	12.8	U	pCi/L	FD
22198	Technetium-99	5/14/97	8.6	U	pCi/L	N
22198	Technetium-99	5/28/97	-7.77	U	pCi/L	N
22198	Technetium-99	5/28/97	-4.59	UJ	pCi/L	FD
22198	Technetium-99	6/17/97	-0.8	UJ	pCi/L	N
22198	Technetium-99	6/17/97	-3.9	UJ	pCi/L	FD
22198	Technetium-99	6/25/97	17.56	Z	pCi/L	N
22198	Technetium-99	6/25/97	5.91	U	pCi/L	N
22198	Technetium-99	7/9/97	3.25	UJ	pCi/L	N
22198	Technetium-99	7/31/97	1.82	UJ	pCi/L	N
22198	Technetium-99	8/7/97	1.71	UJ	pCi/L	N
22198	Technetium-99	8/26/97	5.89	UJ	pCi/L	N
22198	Technetium-99	9/16/97	-0.4	UJ	pCi/L	N
22198	Technetium-99	10/1/97	-2.26	UJ	pCi/L	N
22198	Technetium-99	10/1/97	-3.89	UJ	pCi/L	FD
22198	Technetium-99	11/25/97	2.12	UJ	pCi/L	N
22198	Technetium-99	12/1/97	6.43	UJ	pCi/L	N
22198	Technetium-99	12/1/97	5.15	UJ	pCi/L	FD
22198	Technetium-99	12/8/97	4.1	UJ	pCi/L	N
22198	Uranium, Total	3/31/97	2.906	-	µg/L	N
22198	Uranium, Total	4/30/97	1.35	J	µg/L	N
22198	Uranium, Total	4/30/97	1.36	J	µg/L	FD
22198	Uranium, Total	5/14/97	3.12	-	µg/L	N
22198	Uranium, Total	5/28/97	2.45	-	µg/L	N
22198	Uranium, Total	5/28/97	2.15	-	µg/L	FD
22198	Uranium, Total	6/17/97	0.794	-	µg/L	N
22198	Uranium, Total	6/17/97	0.801	-	µg/L	FD

TABLE A-1
(Continued)

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Well Number	Constituent	Date Sampled	Validated Result	Validation Qualifier	Units	Type
22198	Uranium, Total	6/25/97	0.767	J	µg/L	N
22198	Uranium, Total	7/9/97	0.645	J	µg/L	N
22198	Uranium, Total	7/31/97	1.62	J	µg/L	N
22198	Uranium, Total	8/7/97	1.86	J	µg/L	N
22198	Uranium, Total	8/26/97	1.757	J	µg/L	N
22198	Uranium, Total	9/16/97	1.489	J	µg/L	N
22198	Uranium, Total	10/1/97	0.866	J	µg/L	N
22198	Uranium, Total	10/1/97	0.877	J	µg/L	FD
22198	Uranium, Total	11/25/97	0.782	J	µg/L	N
22198	Uranium, Total	12/1/97	0.627	J	µg/L	N
22198	Uranium, Total	12/1/97	0.748	J	µg/L	FD
22198	Uranium, Total	12/8/97	0.692	J	µg/L	N
22198	1,1-Dichloroethene	3/31/97	1	UJ	µg/L	N
22198	1,1-Dichloroethene	4/30/97	1	UJ	µg/L	N
22198	1,1-Dichloroethene	4/30/97	1	UJ	µg/L	FD
22198	1,1-Dichloroethene	5/14/97	1	UJ	µg/L	N
22198	1,1-Dichloroethene	5/28/97	1	UJ	µg/L	N
22198	1,1-Dichloroethene	5/28/97	1	UJ	µg/L	FD
22198	1,1-Dichloroethene	6/17/97	3	U	µg/L	N
22198	1,1-Dichloroethene	6/17/97	3	U	µg/L	FD
22198	1,1-Dichloroethene	6/25/97	3	U	µg/L	N
22198	1,1-Dichloroethene	7/9/97	3	U	µg/L	N
22198	1,1-Dichloroethene	7/31/97	3	U	µg/L	N
22198	1,1-Dichloroethene	8/7/97	3	U	µg/L	N
22198	1,1-Dichloroethene	8/26/97	3	U	µg/L	N
22198	1,1-Dichloroethene	9/16/97	3	U	µg/L	N
22198	1,1-Dichloroethene	10/1/97	3	U	µg/L	N
22198	1,1-Dichloroethene	10/1/97	3	U	µg/L	FD
22198	1,1-Dichloroethene	11/25/97	3	U	µg/L	N
22198	1,1-Dichloroethene	12/1/97	3	U	µg/L	N
22198	1,1-Dichloroethene	12/1/97	3	U	µg/L	FD
22198	1,1-Dichloroethene	12/8/97	3	U	µg/L	N
22198	1,2-Dichloroethene (Total)	3/31/97	1	UJ	µg/L	N
22198	1,2-Dichloroethene (Total)	4/30/97	1	UJ	µg/L	N
22198	1,2-Dichloroethene (Total)	4/30/97	1	UJ	µg/L	FD
22198	1,2-Dichloroethene (Total)	5/14/97	1	UJ	µg/L	N
22198	1,2-Dichloroethene (Total)	5/28/97	1	UJ	µg/L	N
22198	1,2-Dichloroethene (Total)	5/28/97	1	UJ	µg/L	FD
22198	1,2-Dichloroethene (Total)	6/17/97	10	U	µg/L	N
22198	1,2-Dichloroethene (Total)	6/17/97	10	U	µg/L	FD
22198	1,2-Dichloroethene (Total)	6/25/97	10	U	µg/L	N
22198	1,2-Dichloroethene (Total)	7/9/97	10	U	µg/L	N
22198	1,2-Dichloroethene (Total)	7/31/97	10	U	µg/L	N
22198	1,2-Dichloroethene (Total)	8/7/97	10	U	µg/L	N

TABLE A-1
(Continued)

Well Number	Constituent	Date Sampled	Validated Result	Validation Qualifier	Units	Type
22198	1,2-Dichloroethene (Total)	8/26/97	10	U	µg/L	N
22198	1,2-Dichloroethene (Total)	9/16/97	10	U	µg/L	N
22198	1,2-Dichloroethene (Total)	10/1/97	10	U	µg/L	N
22198	1,2-Dichloroethene (Total)	10/1/97	10	U	µg/L	FD
22198	1,2-Dichloroethene (Total)	11/25/97	10	U	µg/L	N
22198	1,2-Dichloroethene (Total)	12/1/97	10	U	µg/L	N
22198	1,2-Dichloroethene (Total)	12/1/97	10	U	µg/L	FD
22198	1,2-Dichloroethene (Total)	12/8/97	10	U	µg/L	N
22198	Bromodichloromethane	3/31/97	1	UJ	µg/L	N
22198	Bromodichloromethane	4/30/97	1	UJ	µg/L	N
22198	Bromodichloromethane	4/30/97	1	UJ	µg/L	FD
22198	Bromodichloromethane	5/14/97	1	UJ	µg/L	N
22198	Bromodichloromethane	5/28/97	1	UJ	µg/L	N
22198	Bromodichloromethane	5/28/97	1	UJ	µg/L	FD
22198	Bromodichloromethane	6/17/97	10	U	µg/L	N
22198	Bromodichloromethane	6/17/97	10	U	µg/L	FD
22198	Bromodichloromethane	6/25/97	10	U	µg/L	N
22198	Bromodichloromethane	7/9/97	10	U	µg/L	N
22198	Bromodichloromethane	7/31/97	10	U	µg/L	N
22198	Bromodichloromethane	8/7/97	10	U	µg/L	N
22198	Bromodichloromethane	8/26/97	10	U	µg/L	N
22198	Bromodichloromethane	9/16/97	10	U	µg/L	N
22198	Bromodichloromethane	10/1/97	10	U	µg/L	N
22198	Bromodichloromethane	10/1/97	10	U	µg/L	FD
22198	Bromodichloromethane	11/25/97	10	U	µg/L	N
22198	Bromodichloromethane	12/1/97	10	U	µg/L	N
22198	Bromodichloromethane	12/1/97	10	U	µg/L	FD
22198	Bromodichloromethane	12/8/97	10	U	µg/L	N
22198	Tetrachloroethene	3/31/97	1	UJ	µg/L	N
22198	Tetrachloroethene	4/30/97	1	UJ	µg/L	N
22198	Tetrachloroethene	4/30/97	1	UJ	µg/L	FD
22198	Tetrachloroethene	5/14/97	1	UJ	µg/L	N
22198	Tetrachloroethene	5/28/97	1	UJ	µg/L	N
22198	Tetrachloroethene	5/28/97	1	UJ	µg/L	FD
22198	Tetrachloroethene	6/17/97	10	UJ	µg/L	N
22198	Tetrachloroethene	6/17/97	10	U	µg/L	FD
22198	Tetrachloroethene	6/25/97	10	U	µg/L	N
22198	Tetrachloroethene	7/9/97	10	U	µg/L	N
22198	Tetrachloroethene	7/31/97	10	U	µg/L	N
22198	Tetrachloroethene	8/7/97	10	U	µg/L	N
22198	Tetrachloroethene	8/26/97	10	U	µg/L	N
22198	Tetrachloroethene	9/16/97	10	U	µg/L	N
22198	Tetrachloroethene	10/1/97	10	U	µg/L	N
22198	Tetrachloroethene	10/1/97	10	U	µg/L	FD

TABLE A-1 (Continued)

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Well Number	Constituent	Date Sampled	Validated Result	Validation Qualifier	Units	Type
22198	Tetrachloroethene	11/25/97	10	U	µg/L	N
22198	Tetrachloroethene	12/1/97	10	U	µg/L	N
22198	Tetrachloroethene	12/1/97	10	U	µg/L	FD
22198	Tetrachloroethene	12/8/97	10	U	µg/L	N
22198	Trichloroethene	3/31/97	1	UJ	µg/L	N
22198	Trichloroethene	4/30/97	1	UJ	µg/L	N
22198	Trichloroethene	4/30/97	1	UJ	µg/L	FD
22198	Trichloroethene	5/14/97	1	UJ	µg/L	N
22198	Trichloroethene	5/28/97	1	UJ	µg/L	N
22198	Trichloroethene	5/28/97	1	UJ	µg/L	FD
22198	Trichloroethene	6/17/97	2	U	µg/L	N
22198	Trichloroethene	6/17/97	2	U	µg/L	FD
22198	Trichloroethene	6/25/97	2	U	µg/L	N
22198	Trichloroethene	7/9/97	2	U	µg/L	N
22198	Trichloroethene	7/31/97	2	U	µg/L	N
22198	Trichloroethene	8/7/97	2	U	µg/L	N
22198	Trichloroethene	8/26/97	2	U	µg/L	N
22198	Trichloroethene	9/16/97	2	U	µg/L	N
22198	Trichloroethene	10/1/97	2	U	µg/L	N
22198	Trichloroethene	10/1/97	2	U	µg/L	FD
22198	Trichloroethene	11/25/97	2	U	µg/L	N
22198	Trichloroethene	12/1/97	2	U	µg/L	N
22198	Trichloroethene	12/1/97	2	U	µg/L	FD
22198	Trichloroethene	12/8/97	2	U	µg/L	N
22198	Vinyl chloride	3/31/97	1	UJ	µg/L	N
22198	Vinyl chloride	4/30/97	1	UJ	µg/L	N
22198	Vinyl chloride	4/30/97	1	UJ	µg/L	FD
22198	Vinyl chloride	5/14/97	1	UJ	µg/L	N
22198	Vinyl chloride	5/28/97	1	UJ	µg/L	N
22198	Vinyl chloride	5/28/97	1	UJ	µg/L	FD
22198	Vinyl chloride	6/17/97	1	UJ	µg/L	N
22198	Vinyl chloride	6/17/97	1	UJ	µg/L	FD
22198	Vinyl chloride	6/25/97	1	UJ	µg/L	N
22198	Vinyl chloride	7/9/97	1	U	µg/L	N
22198	Vinyl chloride	7/31/97	1	U	µg/L	N
22198	Vinyl chloride	8/7/97	1	U	µg/L	N
22198	Vinyl chloride	8/26/97	1	U	µg/L	N
22198	Vinyl chloride	9/16/97	1	U	µg/L	N
22198	Vinyl chloride	10/1/97	1	U	µg/L	N
22198	Vinyl chloride	10/1/97	1	U	µg/L	FD
22198	Vinyl chloride	11/25/97	1	U	µg/L	N
22198	Vinyl chloride	12/1/97	1	U	µg/L	N
22198	Vinyl chloride	12/1/97	1	U	µg/L	FD
22198	Vinyl chloride	12/8/97	1	U	µg/L	N

TABLE A-1
(Continued)

Well Number	Constituent	Date Sampled	Validated Result	Validation Qualifier	Units	Type
22198	4-Nitroaniline	3/31/97	25	U	µg/L	N
22198	4-Nitroaniline	4/30/97	25	UJ	µg/L	N
22198	4-Nitroaniline	4/30/97	25	UJ	µg/L	FD
22198	4-Nitroaniline	5/14/97	25	U	µg/L	N
22198	4-Nitroaniline	5/28/97	25	U	µg/L	N
22198	4-Nitroaniline	5/28/97	25	U	µg/L	FD
22198	4-Nitroaniline	6/17/97	25	U	µg/L	N
22198	4-Nitroaniline	6/17/97	25	U	µg/L	FD
22198	4-Nitroaniline	6/25/97	1.8	U	µg/L	N
22198	4-Nitroaniline	7/9/97	25	U	µg/L	N
22198	4-Nitroaniline	7/31/97	25	U	µg/L	N
22198	4-Nitroaniline	8/7/97	25	U	µg/L	N
22198	4-Nitroaniline	8/26/97	25	U	µg/L	N
22198	4-Nitroaniline	9/16/97	25	U	µg/L	N
22198	4-Nitroaniline	10/1/97	25	U	µg/L	N
22198	4-Nitroaniline	10/1/97	25	U	µg/L	FD
22198	4-Nitroaniline	11/25/97	25	U	µg/L	N
22198	4-Nitroaniline	12/1/97	25	U	µg/L	N
22198	4-Nitroaniline	12/1/97	25	U	µg/L	FD
22198	4-Nitroaniline	12/8/97	25	U	µg/L	N
22198	bis(2-Chloroisopropyl) ether	3/31/97	5	U	µg/L	N
22198	bis(2-Chloroisopropyl) ether	4/30/97	5	UJ	µg/L	N
22198	bis(2-Chloroisopropyl) ether	4/30/97	5	UJ	µg/L	FD
22198	bis(2-Chloroisopropyl) ether	5/14/97	10	U	µg/L	N
22198	bis(2-Chloroisopropyl) ether	5/28/97	5	U	µg/L	N
22198	bis(2-Chloroisopropyl) ether	5/28/97	5	U	µg/L	FD
22198	bis(2-Chloroisopropyl) ether	6/17/97	2	U	µg/L	N
22198	bis(2-Chloroisopropyl) ether	6/17/97	2	U	µg/L	FD
22198	bis(2-Chloroisopropyl) ether	6/25/97	1.8	UJ	µg/L	N
22198	bis(2-Chloroisopropyl) ether	7/9/97	2	U	µg/L	N
22198	bis(2-Chloroisopropyl) ether	7/31/97	2	U	µg/L	N
22198	bis(2-Chloroisopropyl) ether	8/7/97	2	U	µg/L	N
22198	bis(2-Chloroisopropyl) ether	8/26/97	2	U	µg/L	N
22198	bis(2-Chloroisopropyl) ether	9/16/97	2	U	µg/L	N
22198	bis(2-Chloroisopropyl) ether	10/1/97	2	U	µg/L	N
22198	bis(2-Chloroisopropyl) ether	10/1/97	2	U	µg/L	FD
22198	bis(2-Chloroisopropyl) ether	11/25/97	2	U	µg/L	N
22198	bis(2-Chloroisopropyl) ether	12/1/97	2	U	µg/L	N
22198	bis(2-Chloroisopropyl) ether	12/1/97	2	U	µg/L	FD
22198	bis(2-Chloroisopropyl) ether	12/8/97	2	U	µg/L	N
22198	Carbazole	3/31/97	10	UJ	µg/L	N
22198	Carbazole	4/30/97	10	U	µg/L	N
22198	Carbazole	4/30/97	10	U	µg/L	FD
22198	Carbazole	5/14/97	10	U	µg/L	N

TABLE A-1 (Continued)

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Well Number	Constituent	Date Sampled	Validated Result	Validation Qualifier	Units	Type
22198	Carbazole	5/28/97	10	U	µg/L	N
22198	Carbazole	5/28/97	10	U	µg/L	FD
22198	Carbazole	6/17/97	5	U	µg/L	N
22198	Carbazole	6/17/97	5	U	µg/L	FD
22198	Carbazole	6/25/97	2.1	U	µg/L	N
22198	Carbazole	7/9/97	5	U	µg/L	N
22198	Carbazole	7/31/97	5	U	µg/L	N
22198	Carbazole	8/7/97	5	U	µg/L	N
22198	Carbazole	8/26/97	5	U	µg/L	N
22198	Carbazole	9/16/97	5	U	µg/L	N
22198	Carbazole	10/1/97	5	UJ	µg/L	N
22198	Carbazole	10/1/97	5	UJ	µg/L	FD
22198	Carbazole	11/25/97	5	U	µg/L	N
22198	Carbazole	12/1/97	5	U	µg/L	N
22198	Carbazole	12/1/97	5	U	µg/L	FD
22198	Carbazole	12/8/97	5	U	µg/L	N
22198	Alpha-Chlordane	3/31/97	0.05	U	µg/L	N
22198	Alpha-Chlordane	4/30/97	0.05	Z	µg/L	N
22198	Alpha-Chlordane	4/30/97	0.05	U	µg/L	N
22198	Alpha-Chlordane	4/30/97	0.05	U	µg/L	FD
22198	Alpha-Chlordane	4/30/97	0.05	Z	µg/L	FD
22198	Alpha-Chlordane	5/14/97	0.05	U	µg/L	N
22198	Alpha-Chlordane	5/28/97	0.05	U	µg/L	N
22198	Alpha-Chlordane	5/28/97	0.05	U	µg/L	FD
22198	Alpha-Chlordane	6/17/97	0.05	U	µg/L	N
22198	Alpha-Chlordane	6/17/97	0.05	U	µg/L	FD
22198	Alpha-Chlordane	6/25/97	0.05	U	µg/L	N
22198	Alpha-Chlordane	7/9/97	0.05	U	µg/L	N
22198	Alpha-Chlordane	7/31/97	0.05	U	µg/L	N
22198	Alpha-Chlordane	8/7/97	0.05	U	µg/L	N
22198	Alpha-Chlordane	8/26/97	0.05	U	µg/L	N
22198	Alpha-Chlordane	9/16/97	0.05	U	µg/L	N
22198	Alpha-Chlordane	10/1/97	0.05	U	µg/L	N
22198	Alpha-Chlordane	10/1/97	0.05	U	µg/L	FD
22198	Alpha-Chlordane	11/25/97	0.05	U	µg/L	N
22198	Alpha-Chlordane	12/1/97	0.05	U	µg/L	N
22198	Alpha-Chlordane	12/1/97	0.05	U	µg/L	FD
22198	Alpha-Chlordane	12/8/97	0.05	U	µg/L	N

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APPENDIX B

SHEWHART-CUSUM METHODOLOGY

APPENDIX B

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This appendix shows the equations used to develop Shewhart-CUSUM control charts, equations to calculate Shewhart and CUSUM control limit concentrations, and an example of sample calculations. Section B.1 identifies the equations used to generate the charts and control limit concentrations and Section B.2 provides an example of sample calculations. The control charts and control limit concentrations are provided in Appendix C.

B.1 SHEWHART-CUSUM CONTROL CHART AND CONTROL LIMIT CONCENTRATION EQUATIONS

The following steps outline the procedure used to generate the Shewhart-CUSUM control charts (Steps 1 through 5) and the associated control limit concentrations (Steps 6 and 7). The Shewhart-CUSUM charts in Appendix C were created with baseline data. Thus, baseline data were standardized and graphed to show the relationship of control limits to the baseline data and also to use for informational purposes. Pertinent numerical values and statistics from these charts are summarized in Table 3 of the report.

Step 1. Select the following three parameters:

- SCL, the Shewhart control limit in standardized units
- *h*, the cumulative sum (CUSUM) control limit in standardized units
- *k*, a reference value used in the CUSUM calculations.

For groundwater, EPA guidance recommends a SCL equal to 4.5; *h* equal to 5; and *k* equal to 1.

Step 2. Calculate the mean, μ, and sample standard deviation, σ, from the baseline data set using the standard equations.

Step 3. Calculate the standardized mean. For the Shewhart-CUSUM control charts presented in Appendix C, each of the baseline sample points were treated as a monitoring period mean result. In other words, each monitoring period consists of one sample ($n_i = 1$) so the monitoring period mean is equivalent to the sample result. For each of the ith monitoring periods, T_i, at each well, for each constituent, the mean is standardized with respect to the baseline mean and sample standard deviation. The standardized mean, Z_i, is calculated using the following equation:

$$Z_i = (\bar{X}_i - \mu)\frac{\sqrt{n_i}}{\sigma}$$

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Since, for each of the ith monitoring periods n_i equals 1 and the mean equals the sample value, x_i, the equation becomes:

$$Z_i = \frac{(\bar{X}_i - \mu)}{\sigma}$$

Step 4. Calculate the cumulative sum, S_i at each time point, T_i, in this case each sample date, such that:

$$S_i = \max\{0, (Z_i - k) + S_{i-1}\}$$

where max{A,B} is the function that selects the maximum of the two expressions A and B. In this case A = 0 and B = $(Z_i - k) + S_{i-1}$, thus, if B calculates to less than zero then zero is used. In this way, only positive cumulative deviations from the baseline mean are recorded. For the first time period (i = 1) replace S_{i-1} with zero such that $S_0 = 0$ (EPA 1989). The CUSUM, S_i, tracks cumulative positive deviations from the standardized mean over a continuous time span.

Step 5. Plot the values of Z_i and S_i versus time, T_i, on a chart for this combined Shewhart-CUSUM procedure (EPA 1989). "Out-of-control" limit conditions would occur during any T_i if for the first time $S_i \geq h$ (i.e., the sample period when the cumulative means [minus the k reference value] sum to greater than 5) or when $Z_i \geq$ SCL (i.e., the standardized sample period mean is greater than 4.5 standard deviations away). This may indicate contamination at the well (EPA 1989).

The Shewhart value, Z_i, detects abnormally high individual sample period mean deviations from baseline, whereas the CUSUM value, S_i, detects positive changes (i.e., those greater than baseline) whether they are increased mean, standard deviation, or both.

Step 6 and Step 7 demonstrate how to calculate concentrations associated with the SCL and h in non-standardized units. In order to demonstrate these calculations, the following terms SCL′ and h' will be used to describe the associated concentration values for the Shewhart control limit (SCL) and the CUSUM control limit (h), respectively.

Step 6: SCL′ (Shewhart Control Limit Concentration)

To determine the associated concentration values for SCL′, we start with the equation for the normalized sampling period average and work backwards to derive the value that is equivalent to 4.5 standardized units.

$$Z_i = (\bar{X}_i - \mu)\frac{\sqrt{n_i}}{\sigma}$$

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where

Z_i = standardized mean,

$\overline{X}_i$ = sampling period mean for the ith period,

μ = baseline mean,

$\sqrt{n_i}$ = sample size for the ith period, and

σ = baseline standard deviation.

Because we are looking for the sampling period mean that would exceed 4.5 in standard units, we replace Z_i with 4.5. In the planned monitoring scheme, there will be one sample taken per sampling period. Therefore, n_i equals 1 and ($\overline{x}_i$) equals the single sample result (x_i). The new equation is:

{substituting x_i for $\overline{X}_i$ and 1 for n_i}

$$SCL = (x_i - \mu)\frac{\sqrt{1}}{\sigma}$$

{substituting 4.5 for SCL}

$$4.5 = \frac{(x_i - \mu)}{\sigma}$$

{multiplying both sides by s}

$$4.5\sigma = x_i - \mu$$

{and, finally, adding m to both sides}

$$4.5\sigma + \mu = x_i$$

So, the value that would exceed the Shewhart Control Limit of 4.5 is equivalent to baseline mean plus 4.5 times the baseline standard deviation. Therefore,

$$SCL' = 4.5\sigma + \mu$$

Step 7: *h'* (CUSUM Control Limit Concentration)

To determine the associated concentration values for *h'*, we start with the equation for the normalized sampling period average and work backwards to derive the value that is equivalent to 5 standardized units.

The CUSUM control limit is the level that the cumulative positive deviation, S_i, from the baseline mean can not exceed. If the cumulative deviation calculates to a negative value, then S_i is set to 0 for use in the subsequent equation. The equation to calculate the current CUSUM S_i is:

$$S_i = \max \{ 0, (Z_i - k) + S_{i-1} \}$$

where

S_i = the current sampling period's CUSUM,
max = function that selects the maximum of the two values,
Z_i = standardized mean,
k = CUSUM reference value (1), and
S_{i-1} = the previous sampling period's CUSUM.

Clearly, the only choice in the "max" function that could exceed an h value of 5 is the "$(Z_i-k)+S_{i-1}$" part. Therefore, the equation to determine h' is:

$S_i = (Z_i - k) + S_{i-1}$
{substituting the h-value of 5 for S_i, 1 for the k-value}
$5 = (Z_i - 1) + S_{i-1}$
{adding 1 to each side}
$6 = Z_i + S_{i-1}$

So, the sum of the current standardized mean and the previous CUSUM cannot exceed 6. Because we are interested in the non-standardized value that represents the CUSUM control limit and not the additional Z_i that would put us over the control limit, we set S_{i-1} equal to 0. Substituting in the equation for the standardized mean, Z_i, we solve for x_i as we did for the SCL (see above):

$$6 = \frac{(x_i - \mu)}{\sigma}$$

{multiplying both sides by σ}
$6\sigma = x_i - \mu$
{and, finally, adding μ to both sides}
$6\sigma + \mu = x_i$

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So, the value that would exceed the CUSUM control limit of 5 is equivalent to baseline mean plus 6 times the baseline standard deviation. Therefore,

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$$h' = 6\sigma + \mu$$

B.2 SAMPLE CALCULATIONS

To illustrate the process of creating a Shewhart-CUSUM control chart the following example calculations are presented using total organic carbon data from horizontal till well 12338.

Step 1: Select Shewhart-CUSUM parameters

SCL (the Shewhart Control Limit in standardized units) = 4.5
h (the cumulative sum (CUSUM) control limit in standardized units) = 5
k (a reference value used in the CUSUM calculations) = 1.

Step 2: Calculate the mean and standard deviation of the baseline data set

Using the equations for mean and sample standard deviation:

mean, μ = 7.79 mg/L
standard deviation, σ = 2.84 mg/L.

Step 3: Calculate the Z_i (standardized mean) for each sampling period

For this example only the standardized mean for the first sampling period will be calculated. The other remaining standardized means are calculated in a similar manner.

$$Z_i = (\overline{X}_i - \mu)\frac{\sqrt{n_i}}{\sigma}$$

where

Z_i = standardized mean,
$\overline{X}_i$ = sampling period mean for the ith period,
μ = baseline mean (7.79),
$\sqrt{n_i}$ = sample size for the ith period, and
σ = baseline standard deviation (2.84).

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There was only one sample taken for the first sampling period, $i=1$, (Total Organic Carbon = "3.1 J" in mg/L total organic carbon) so n_i equals 1 and ($\bar{x}_i$) equals the single sample result (3.1). Substituting the known values into the above equation:

$$Z_1 = (3.1 - 7.79)\frac{\sqrt{1}}{2.84}$$

the square root of 1 is 1, and 3.1 - 7.79 = -4.69, so

$$Z_1 = \frac{(-4.69)}{2.84}$$

therefore,

$$Z_1 = -1.65$$

The standardized mean of the first sampling period is -1.65 in standardized units.

Step 4: Calculate the cumulative sum, S_i

Again, for this example, only the cumulative sum, S_i, for the first sampling period will be calculated. Using the equation:

$$S_i = \max\{0,(Z_i - k) + S_{i-1}\}$$

and substituting in the standardized mean calculated in Step 3 (-1.65) and the *k* value of 1. The remaining parameter value needed is S_{i-1}. Since i=1 for the first sampling period, i-1=0 and by definition $S_0 = 0$. Therefore,

$$S_1 = \max\{0,(-1.65 - 1) + 0\}$$

then

$$S_1 = \max\{0,-2.65\} = 0.$$

So the cumulative sum, $S_1=0$.

Step 5: Plot the Z_i and S_i values

The following table shows the baseline data and calculated results for total organic carbon at horizontal till well 12338 which would then be plotted on the control chart.

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TABLE B-1

DATA COMBINED FOR SHEWHART-CUSUM CHART TOTAL ORGANIC CARBON FROM WELL 12338

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Sample, i	Sample Date	Total Organic Carbon, X_i (mg/L)	Standard Mean, Z_i	Z_i-k	$(Z_i-k)+S_{i-1}$	CUSUM, S_i
1	30-Oct-97	3.1	-1.65	-2.65	-2.65	0.00
2	31-Oct-97	6.3	-0.52	-1.52	-1.52	0.00
3	03-Nov-97	3.7	-1.44	-2.44	-2.44	0.00
4	04-Nov-97	2.1	-2.00	-3.00	-3.00	0.00
5	05-Nov-97	7.9	0.04	-0.96	-0.96	0.00
6	06-Nov-97	9.2	0.50	-0.50	-0.50	0.00
7	07-Nov-97	9.3	0.53	-0.47	-0.47	0.00
8	10-Nov-97	8.8	0.36	-0.64	-0.64	0.00
9	12-Nov-97	8.1	0.11	-0.89	-0.89	0.00
10	14-Nov-97	11.4	1.27	0.27	0.27	0.27
11	17-Nov-97	9.4	0.57	-0.43	-0.16	0.00
12	18-Nov-97	8.5	0.25	-0.75	-0.75	0.00
13	25-Nov-97	9.7	0.67	-0.33	-0.33	0.00
14	01-Dec-97	7.7	-0.03	-1.03	-1.03	0.00
15	08-Dec-97	11.6	1.34	0.34	0.34	0.34

Step 6: Shewhart Control Limit Concentration

The following example shows the derived formula for calculating the associated concentration (non-standardized value) of the Shewhart control limit for total organic carbon baseline data from horizontal till well 12338. Starting with the derived formula for the SCL':

$$SCL' = 4.5\sigma + \mu$$

{substituting 2.84 mg/L for σ and 7.79 mg/L for μ}

$$SCL' = (4.5 \times 2.84) + 7.79$$

$$SCL' = 20.6 \text{ mg/L}$$

So the Shewhart control limit calculated from the baseline data is equivalent to 20.6 mg/L for total organic carbon at the horizontal till well 12338.

Step 7: CUSUM Control Limit Concentration

The following example shows the derived formula for calculating the associated concentration (non-standardized value) of the CUSUM control limit for total organic carbon baseline data from horizontal till well 12338. Starting with the derived formula for the h':

$$h' = 6\sigma + \mu$$

{substituting 2.84 mg/L for σ and 7.79 mg/L for μ

$$h' = (6 \times 2.84) + 7.79$$

$$h' = 24.8 \text{ mg/L}$$

So the CUSUM control limit calculated from the baseline data is equivalent to 24.8 mg/L for total organic carbon at the horizontal till well 12338.

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Appendix C

APPENDIX C

SHEWHART-CUSUM CONTROL CHARTS

APPENDIX C

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This appendix provides a combined Shewhart-CUSUM control chart (Figures C-1 through C-16) for each detected constituent in each monitoring well as follows:

Horizontal Till Well 12338:	**Monitoring Well 22201:**	**Monitoring Well 22198:**
Total Organic Carbon	Total Organic Carbon	Total Organic Carbon
Total Organic Halogens	Total Organic Halogens	Total Organic Halogens
Boron	Boron	Boron
Technetium-99	Technetium-99	Uranium, Total
Uranium, Total	Uranium, Total	
Bromodichloromethane	Tetrachloroethene	

The equations provided in Appendix B were used to standardize the baseline data for comparison to the Shewhart and CUSUM control limits. The charts show standardized concentrations for both the standardized mean (Z_i) and for the cumulative sum (S_i) versus time. These charts also show the standardized Shewhart control limit of 4.5, and the CUSUM limit of 5, along with the calculated constituent concentrations corresponding to the control limits for use in future comparisons.

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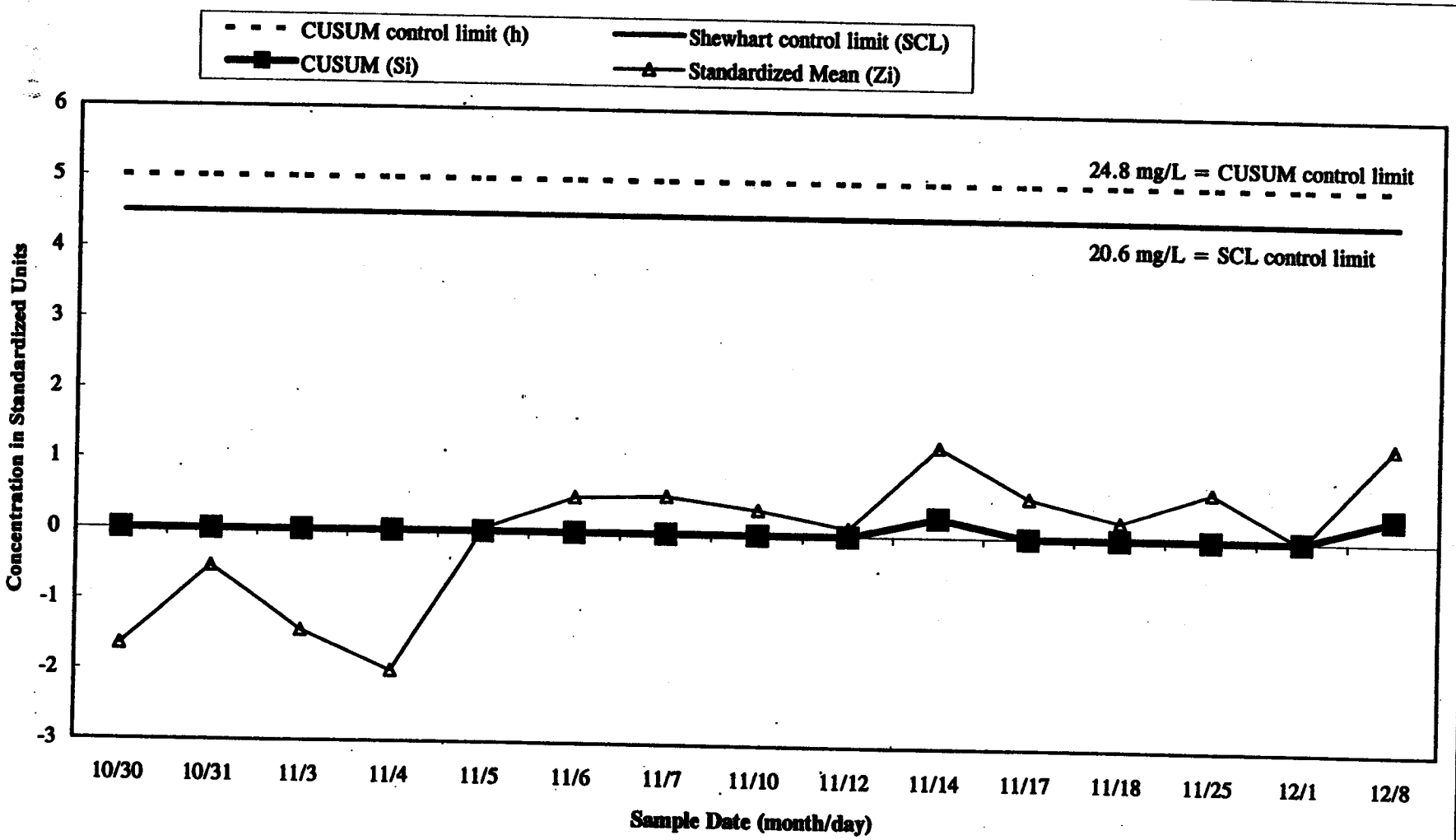

FIGURE C-1. STANDARDIZED 1997 TOTAL ORGANIC CARBON CONCENTRATIONS FROM WELL 12338 - BASELINE CONTROL CHART

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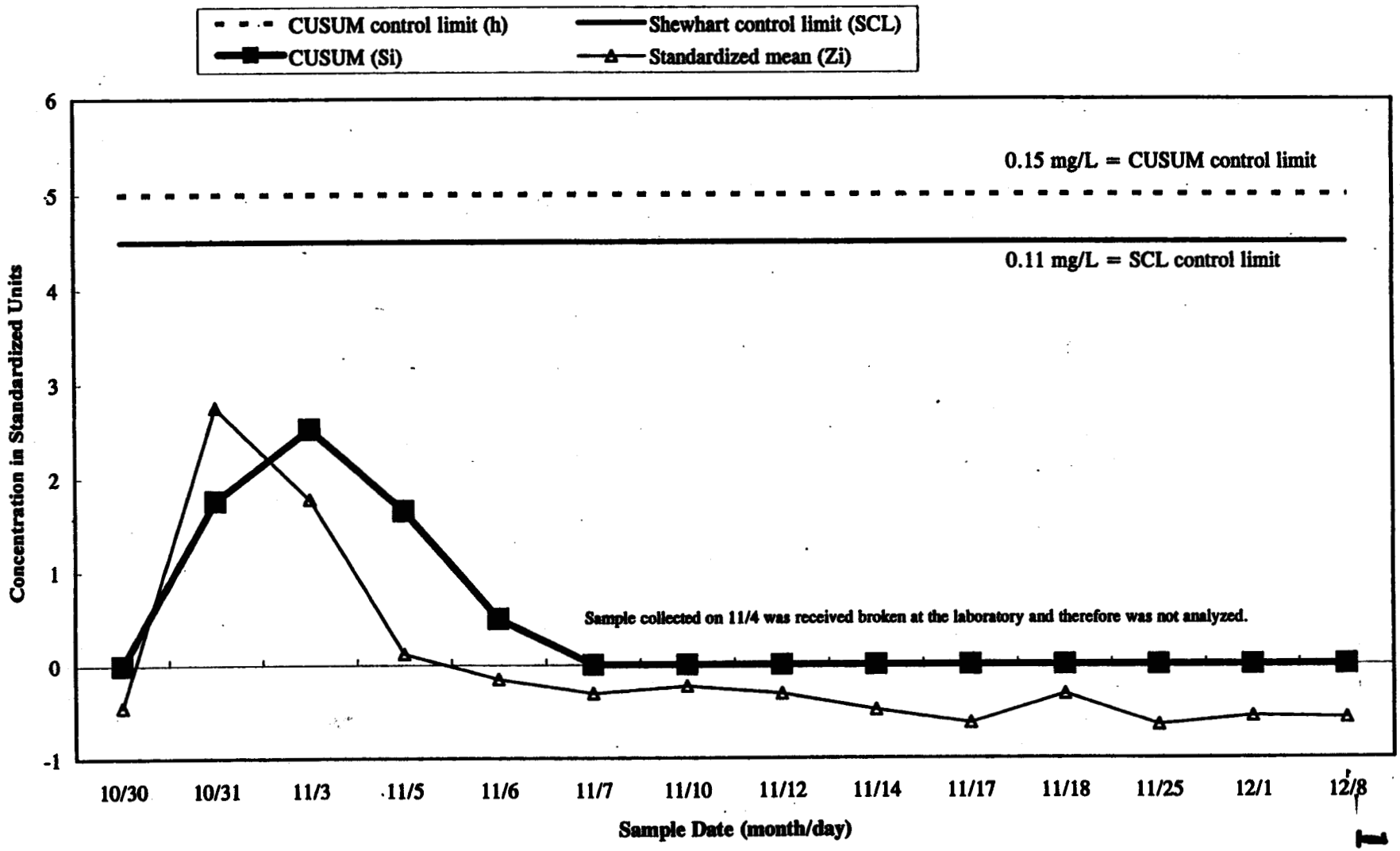

FIGURE C-2. STANDARDIZED 1997 TOTAL ORGANIC HALOGENS CONCENTRATIONS FROM WELL 12338 - BASELINE CONTROL CHART

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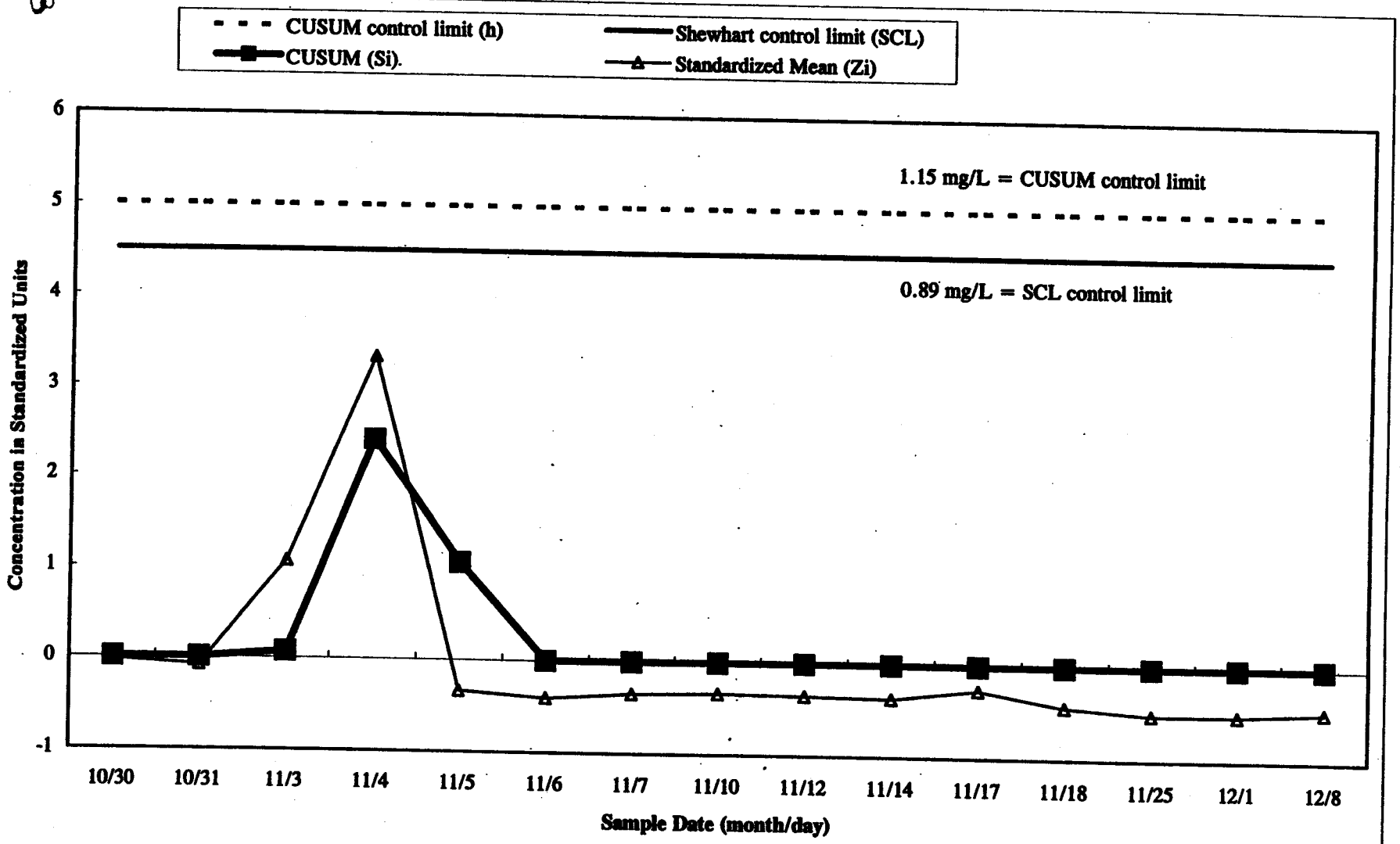

FIGURE C-3. STANDARDIZED 1997 BORON CONCENTRATIONS FROM WELL 12338 - BASELINE CONTROL CHART

DRAFT

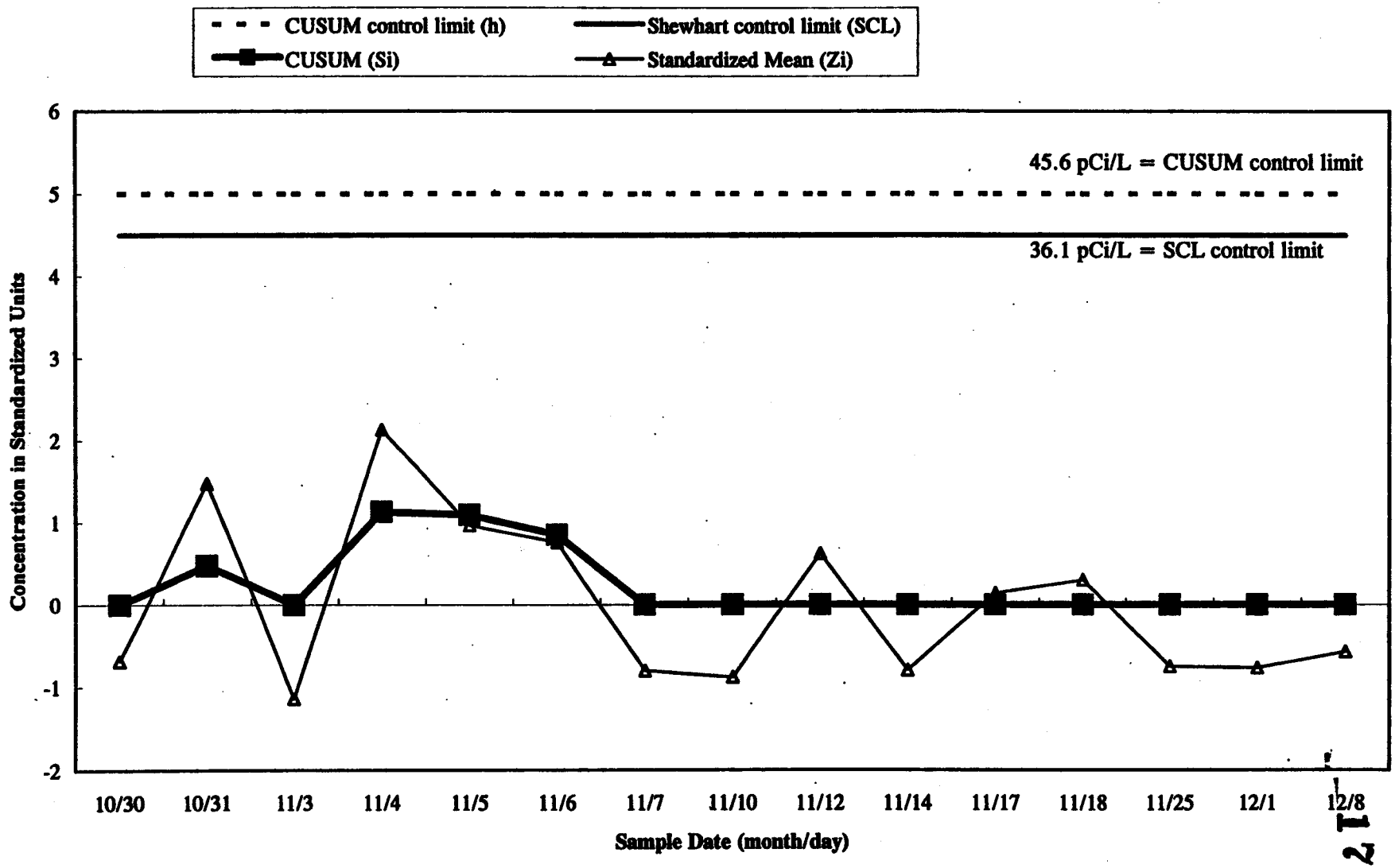

FIGURE C-4. STANDARDIZED 1997 TECHNETIUM-99 CONCENTRATIONS FROM WELL 12338 - BASELINE CONTROL CHART

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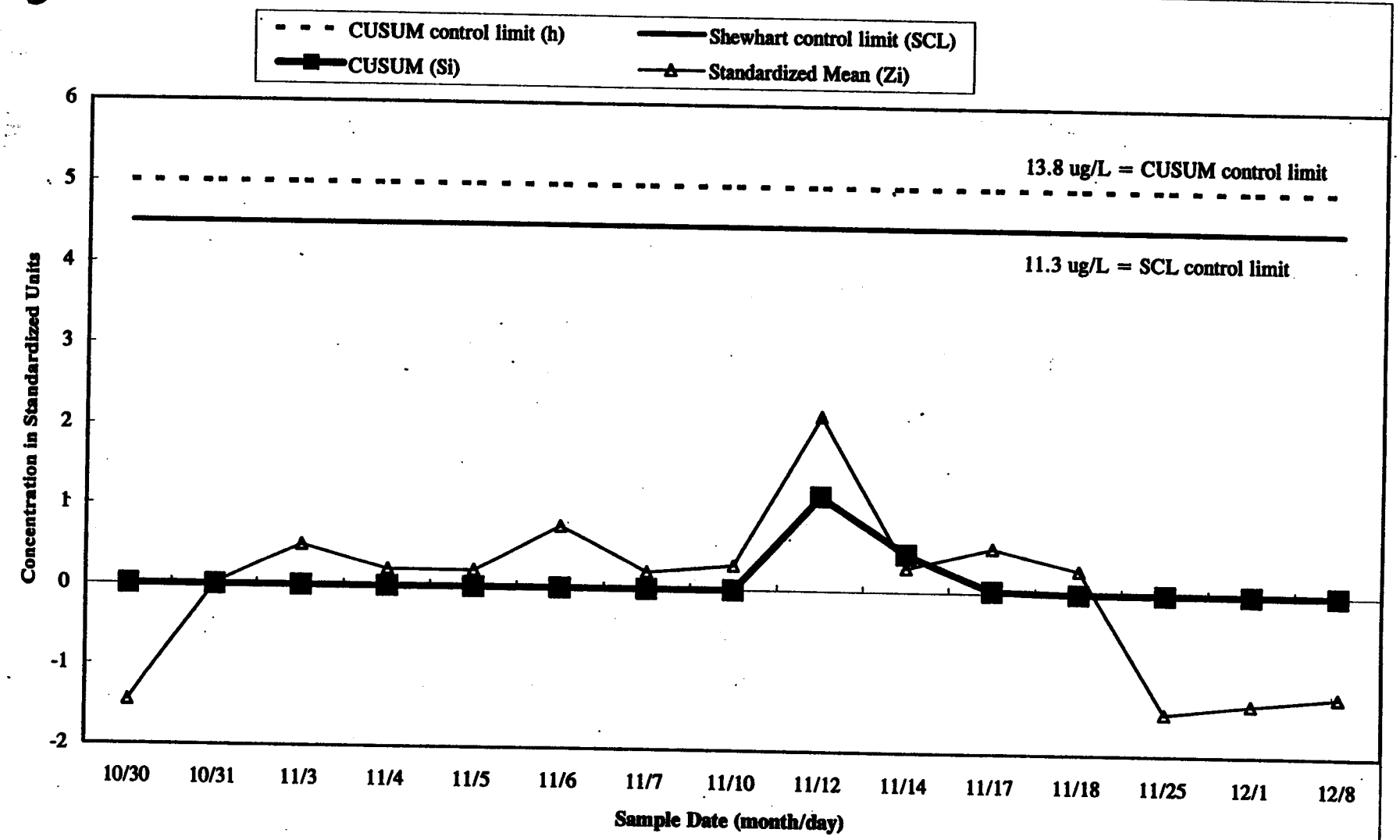

FIGURE C-5. STANDARDIZED 1997 TOTAL URANIUM CONCENTRATIONS FROM WELL 12338 - BASELINE CONTROL CHART

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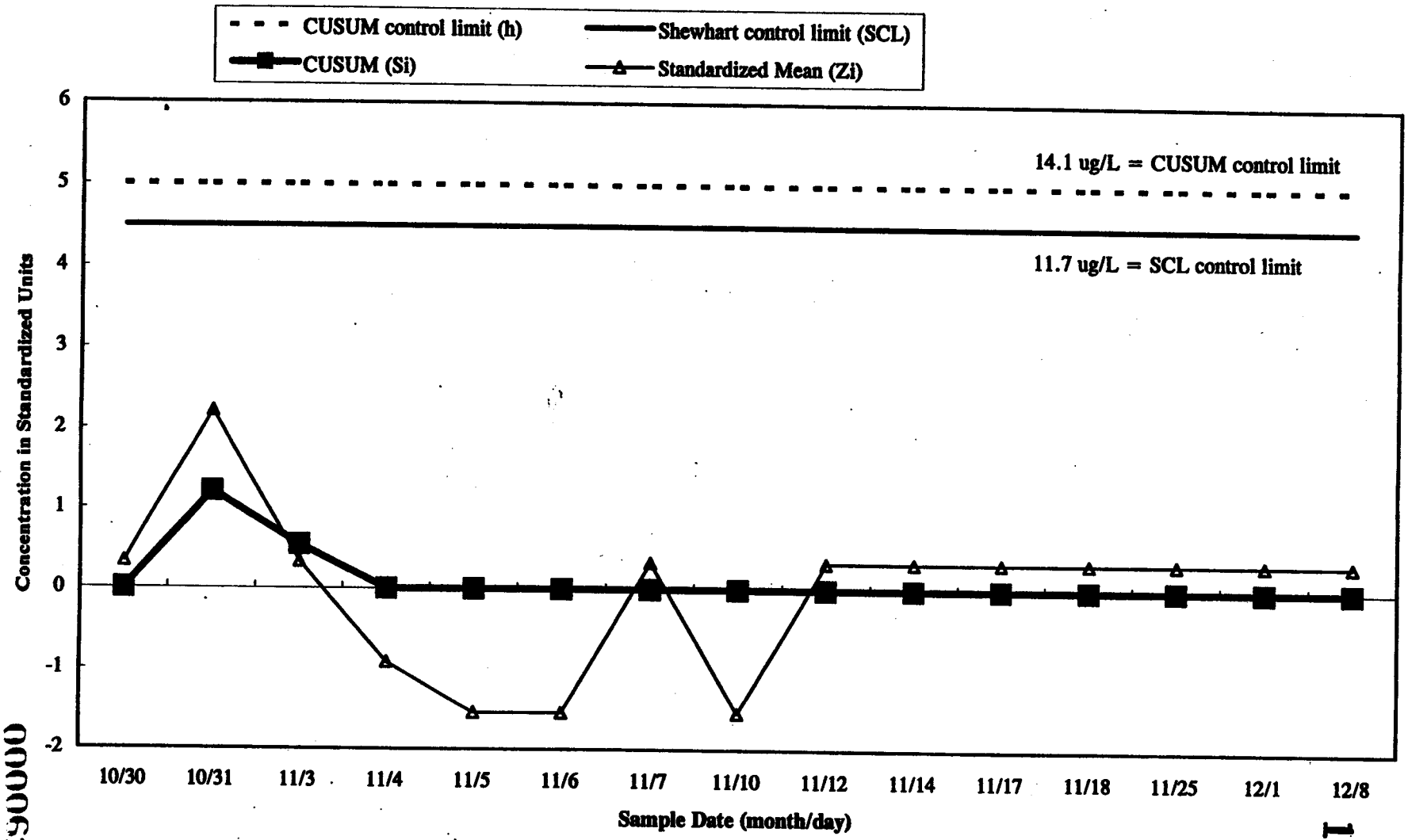

FIGURE C-6. STANDARDIZED 1997 BROMODICHLOROMETHANE CONCENTRATIONS FROM WELL 12338 - BASELINE CONTROL CHART

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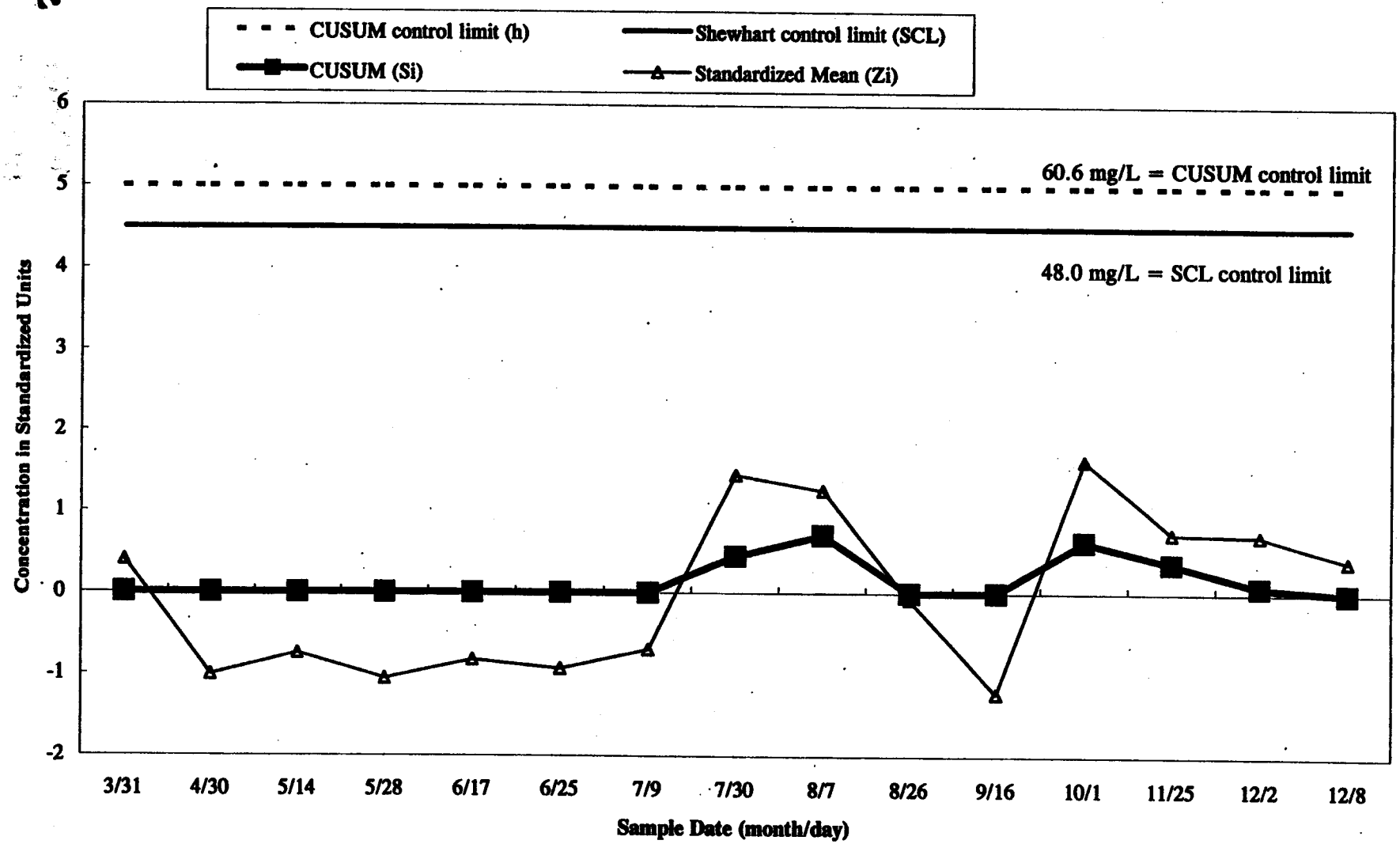

FIGURE C-7. STANDARDIZED 1997 TOTAL ORGANIC CARBON CONCENTRATIONS FROM WELL 22201 - BASELINE CONTROL CHART

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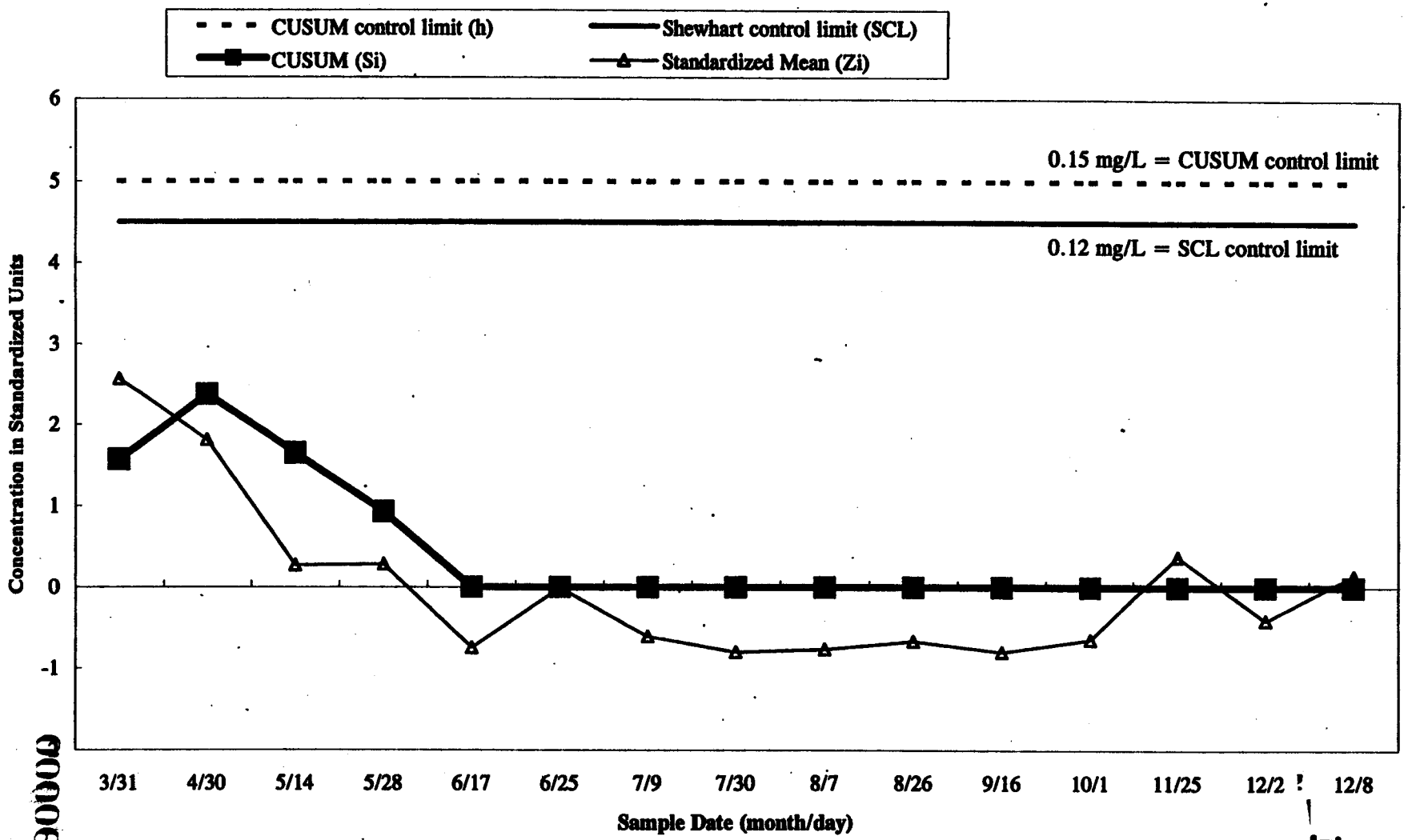

FIGURE C-8. STANDARDIZED 1997 TOTAL ORGANIC HALOGENS CONCENTRATIONS FROM WELL 22201 - BASELINE CONTROL CHART

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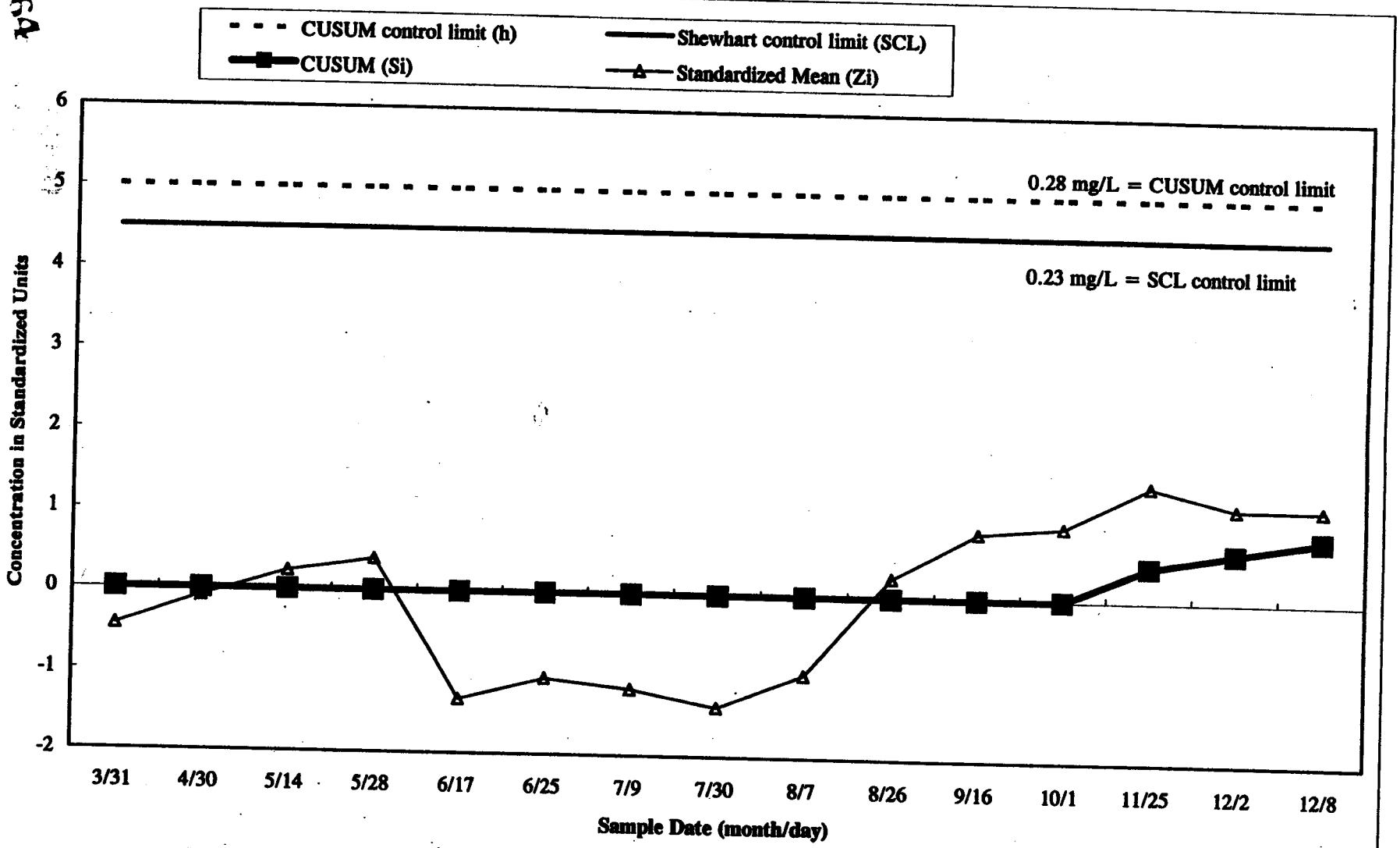

FIGURE C-9. STANDARDIZED 1997 BORON CONCENTRATIONS FROM WELL 22201 - BASELINE CONTROL CHART

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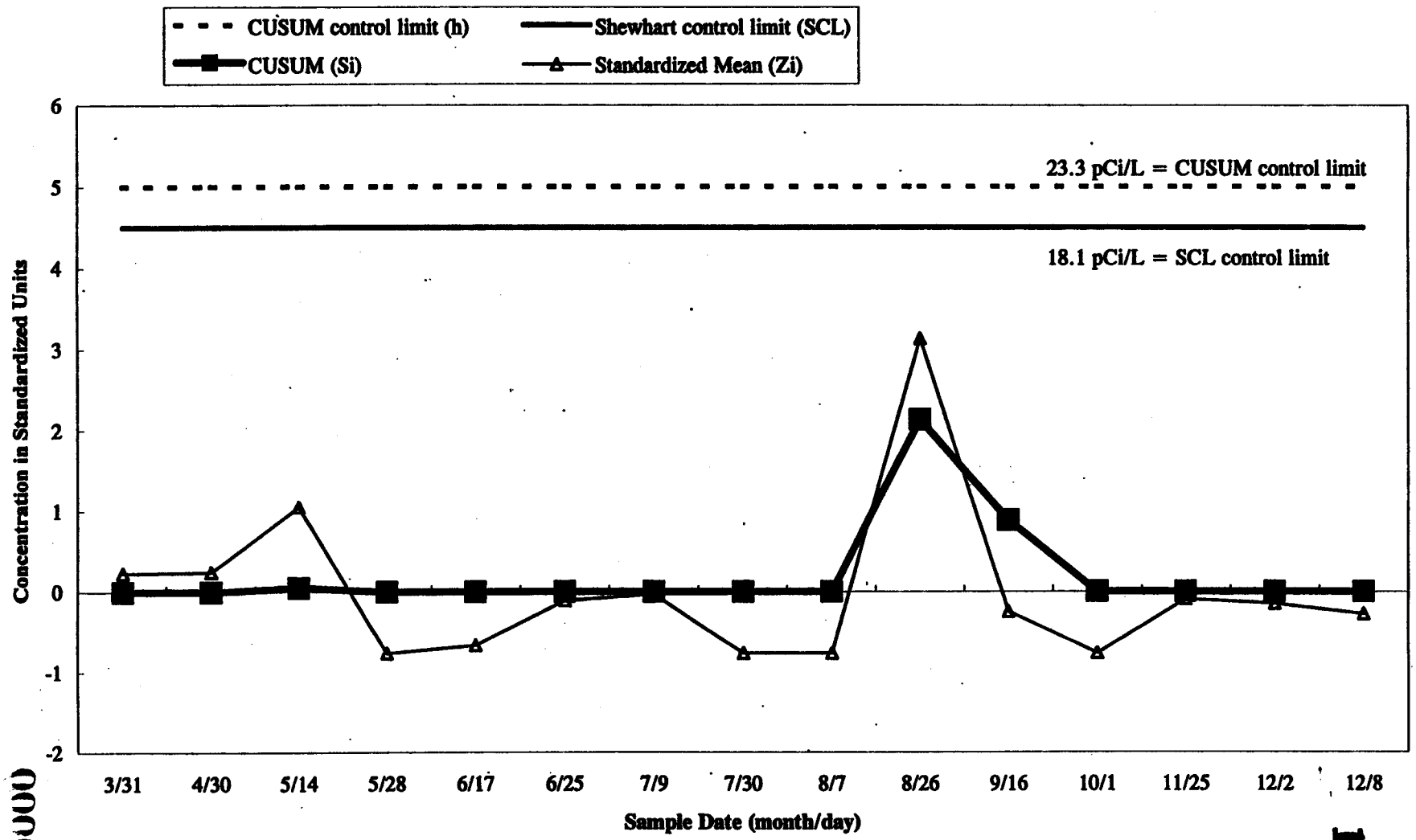

FIGURE C-10. STANDARDIZED 1997 TECHNETIUM-99 CONCENTRATIONS FROM WELL 22201 - BASELINE CONTROL CHART

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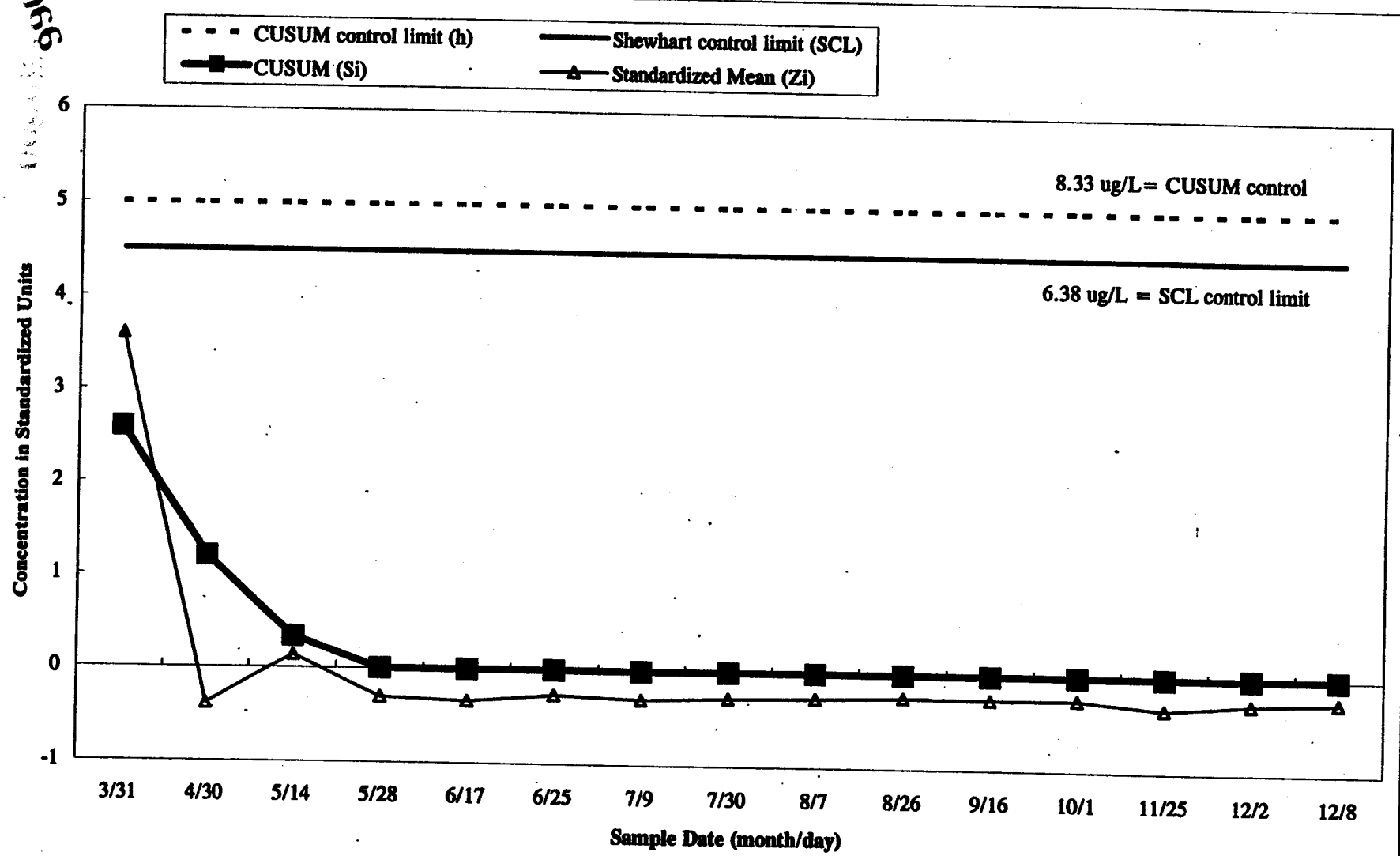

FIGURE C-11. STANDARDIZED 1997 TOTAL URANIUM CONCENTRATIONS FROM WELL 22201 - BASELINE CONTROL CHART

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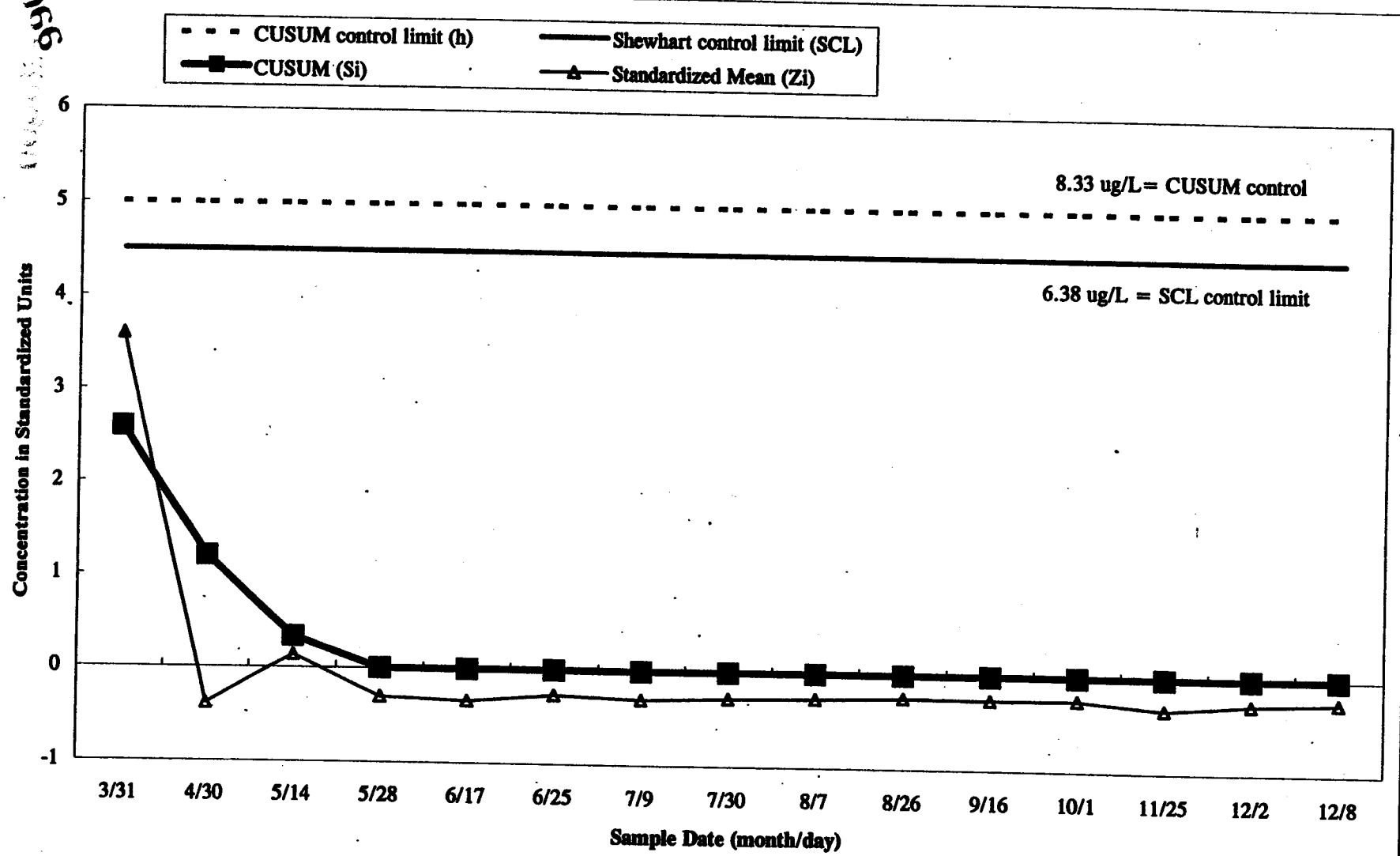

FIGURE C-11. STANDARDIZED 1997 TOTAL URANIUM CONCENTRATIONS FROM WELL 22201 - BASELINE CONTROL CHART

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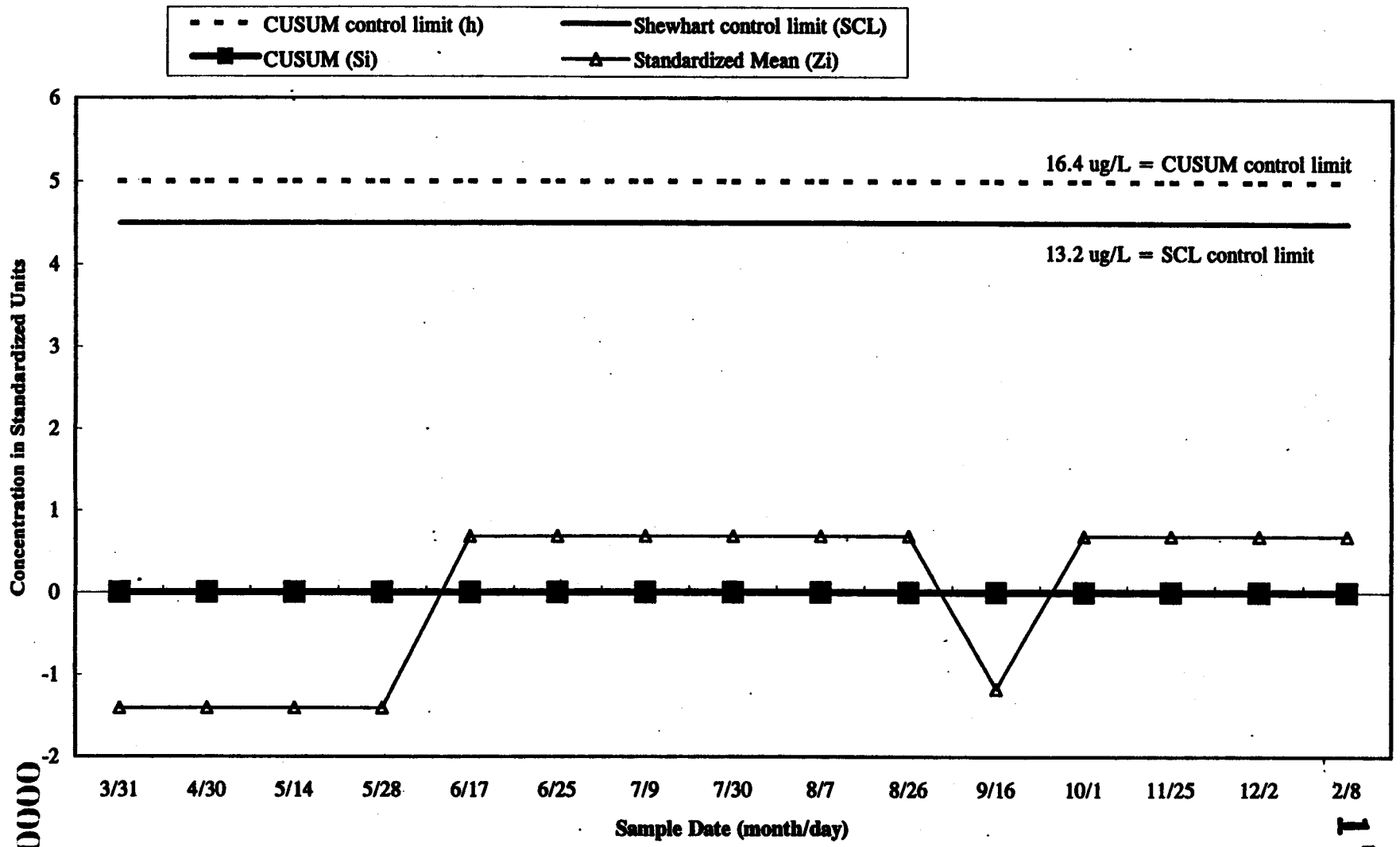

FIGURE C-12. STANDARDIZED 1997 TETRACHLOROETHENE CONCENTRATIONS FROM WELL 22201 - BASELINE CONTROL CHART

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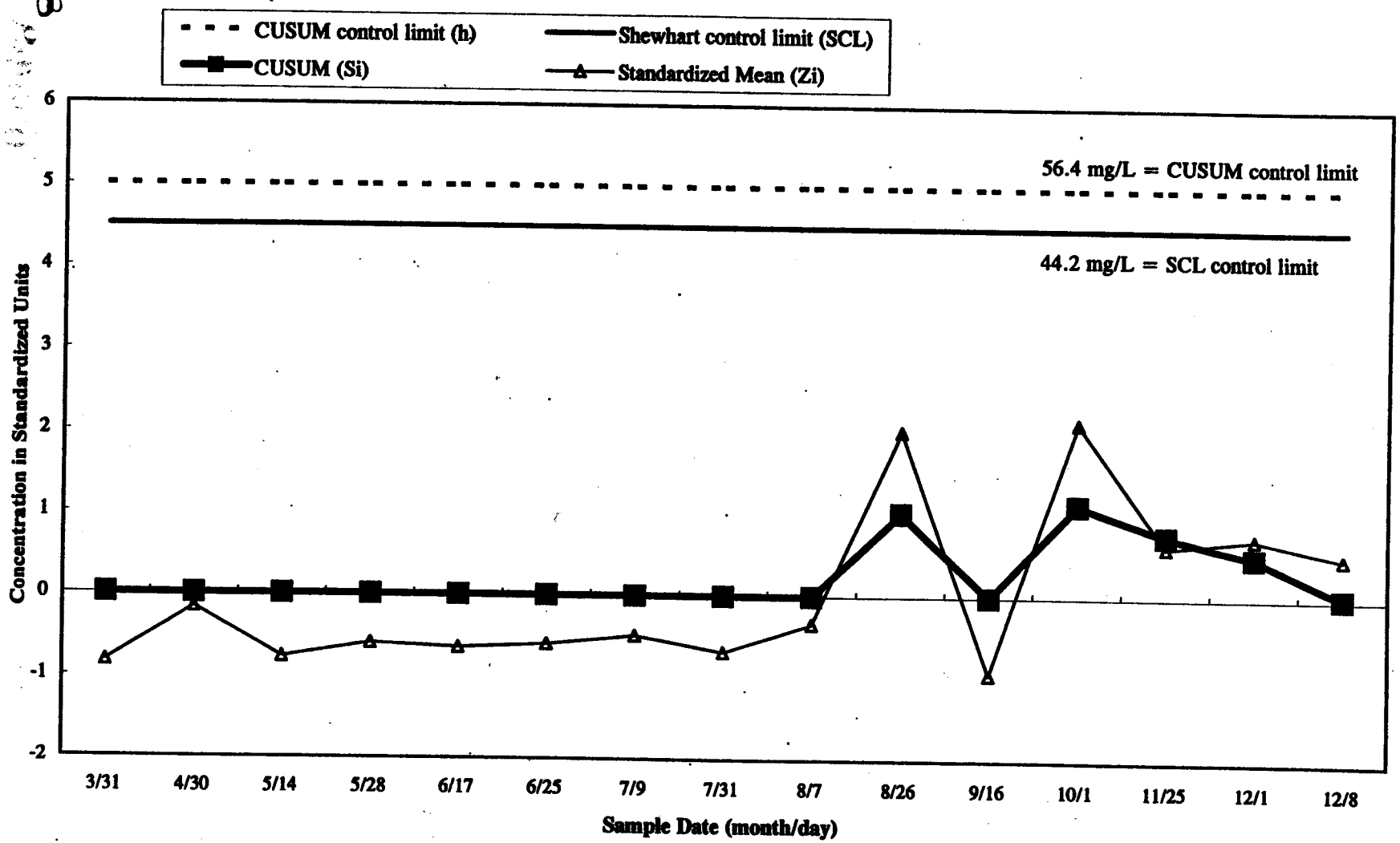

FIGURE C-13. STANDARDIZED 1997 TOTAL ORGANIC CARBON CONCENTRATIONS FROM WELL 22198 - BASELINE CONTROL CHART

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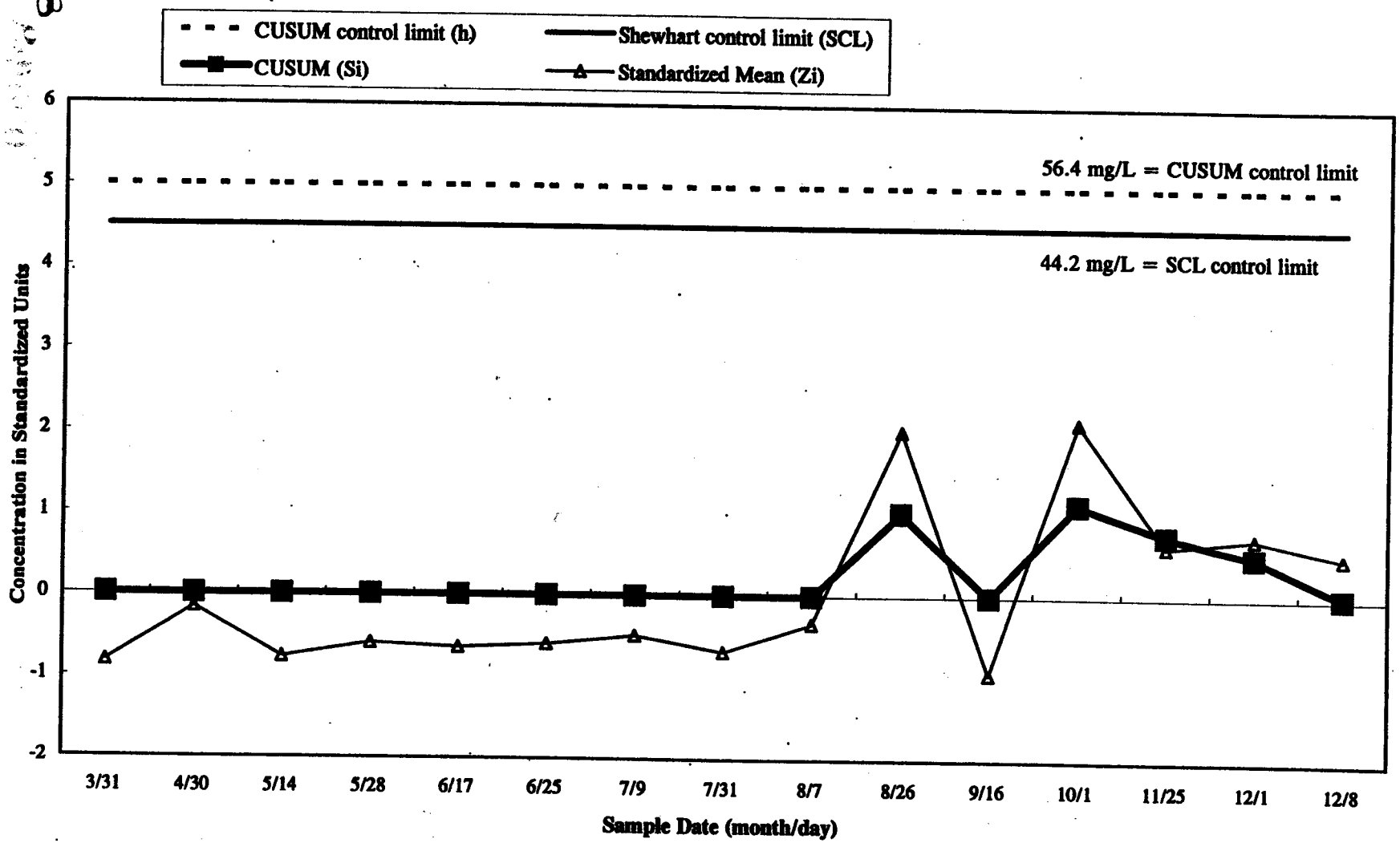

FIGURE C-13. STANDARDIZED 1997 TOTAL ORGANIC CARBON CONCENTRATIONS FROM WELL 22198 - BASELINE CONTROL CHART

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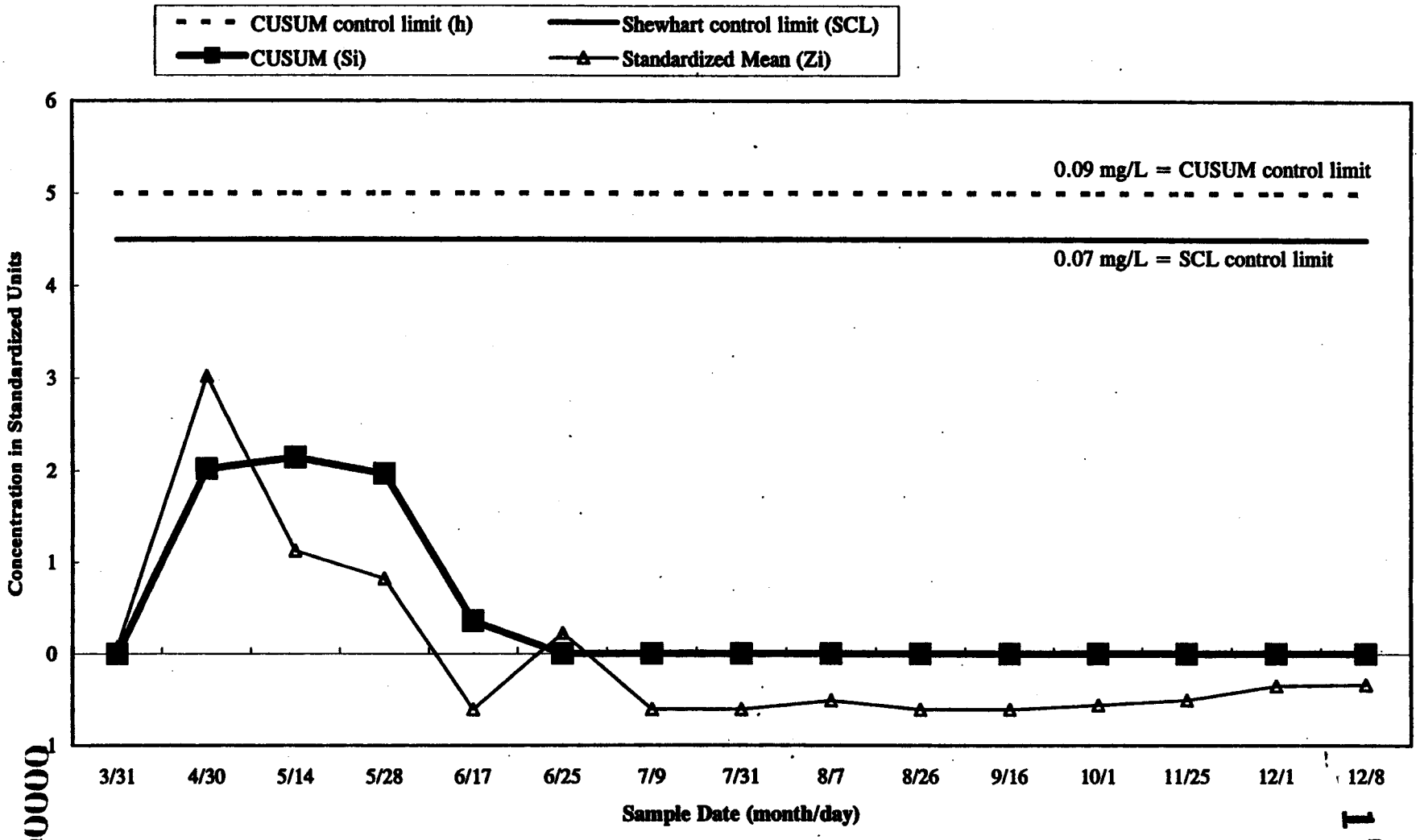

FIGURE C-14. STANDARDIZED 1997 TOTAL ORGANIC HALOGENS CONCENTRATIONS FROM WELL 22198 - BASELINE CONTROL CHART

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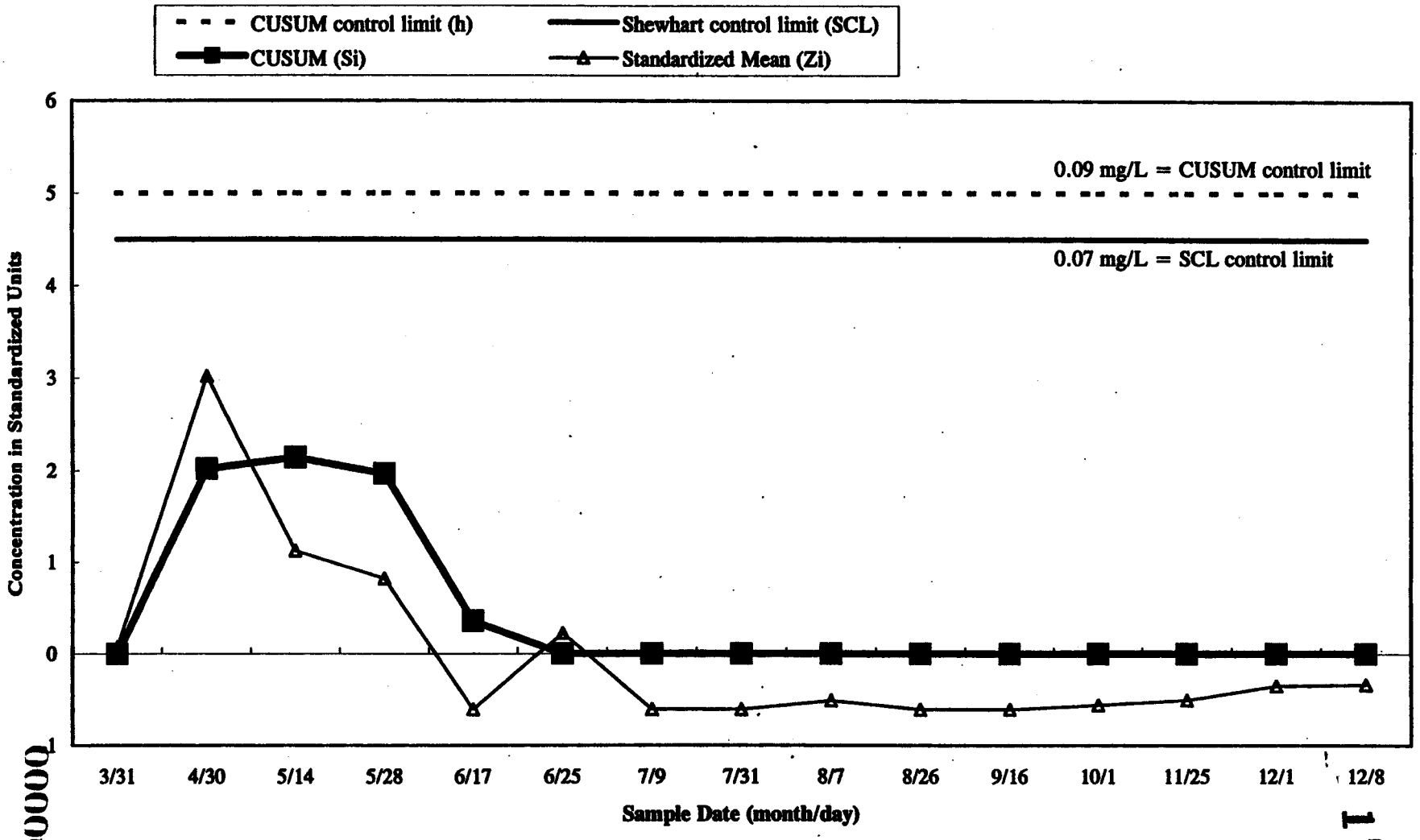

FIGURE C-14. STANDARDIZED 1997 TOTAL ORGANIC HALOGENS CONCENTRATIONS FROM WELL 22198 - BASELINE CONTROL CHART

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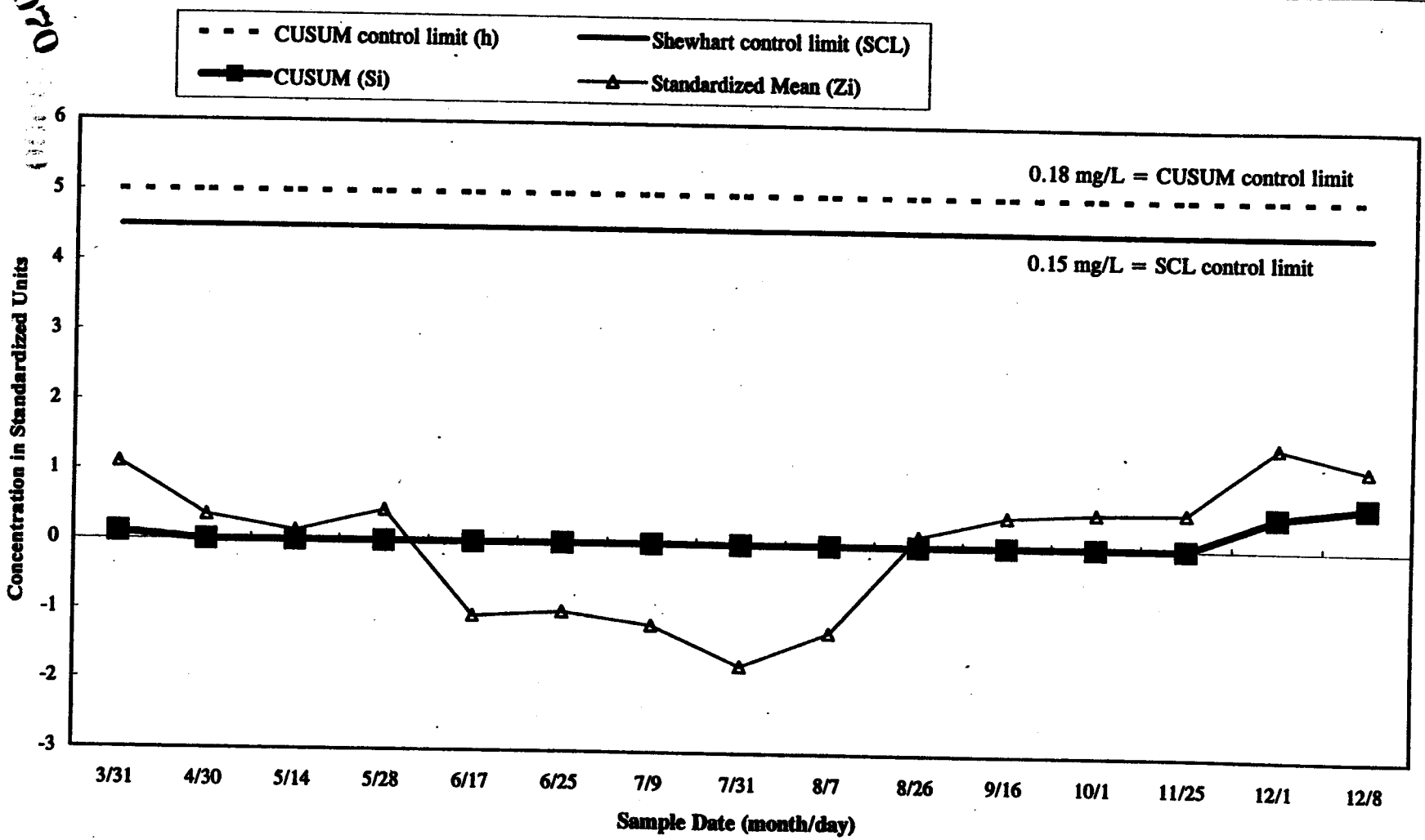

FIGURE C-15. STANDARDIZED 1997 BORON CONCENTRATIONS FROM WELL 22198 - BASELINE CONTROL CHART

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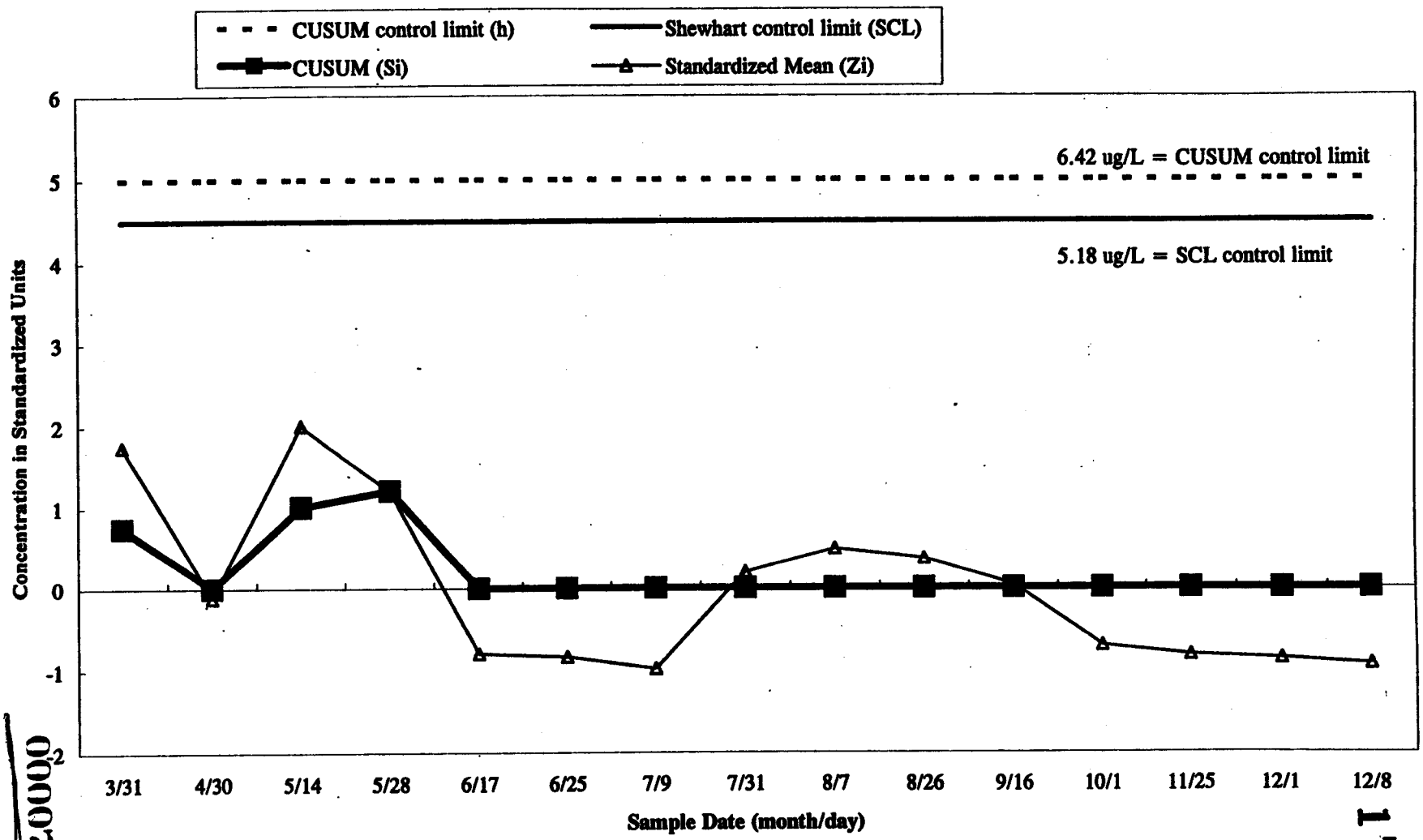

FIGURE C-16. STANDARDIZED 1997 TOTAL URANIUM CONCENTRATIONS FROM WELL 22198 - BASELINE CONTROL CHART

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