

Innovative Environmental Solutions



Evaluation of Analytical Procedures for Groundwater Monitoring

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Report to

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1. INTRODUCTION

For most of 1996, monitoring wells at the Envirocare 11e.(2), located in Clive, Utah, routinely registered apparent exceedences with respect to arsenic and occasionally for other elements of concern (e.g. selenium). Previously, only one arsenic exceedence had been observed, for one specific well (GW-57 in January 1995). Some elements have registered exceedences, which were confirmed during subsequent confirmation sampling. All, except arsenic and selenium have returned to within compliance limits. Only arsenic and selenium concentrations have display systematic, sustained change, evidenced by an apparent excess of compliance limits. All other monitored metals have either been in compliance or have displayed only random exceedences and thus do not present a persistent problem to reconcile. These exceedences appear to be variations that are attributable to expected variations in analysis.

Over the period of time that the 11e.(2) facility has operated two distinct changes have occurred which may contribute to the observed arsenic exceedences:

- there has been a change in the contract laboratory that performs the analyses
- groundwater elevations at each of the monitoring wells has slowly increased

The purpose of this report is to provide an analysis of contract laboratory and analytical methodology related performance as it relates to developing an understanding of the apparent exceedences for arsenic in groundwater at the 11e.(2) cell location. It also considers implications for selenium background concentrations. The report will describe the currently established background conditions and will subsequently present the results of a quality assurance program that evaluates the validity of current apparent exceedences in light of background. Lastly, a modification to currently established background concentrations for arsenic and selenium is presented.

2. ESTABLISHED BACKGROUND AND RECENT EXCEEDENCES

This report section reviews the activities related to establishing background concentrations and their reliability. Later sections speak to the issue of current observations, which are interpreted to be regulatory exceedences.

2.1 Background Data Collection

Each of the monitoring wells surrounding the 11e.(2) cell were sampled routinely prior to May, 1994. Some wells had background sampling periods that began as far back as January 1991 and have as many as sixteen data points, others were not sampled for background until August of 1993 and have only four data points. Data collected as part of background monitoring for arsenic and selenium are reported in Table 1.

2.2 Analytical Procedures

Analyses of background groundwater samples were performed by American West Analytical Laboratories (AWAL) of Salt Lake City, Utah. All arsenic and selenium analyses were performed using a graphite furnace atomic absorption (GFAA) methodology.

Concentrations of arsenic in monitoring wells were observed to be low, but commonly greater than the detection limit (DL) of the analytical instrumentation. However, due to the high salinity of the groundwater, which produces significant method interferences, analytical results often fell below the Practical Quantitation Limit (PQL). Thus, the analytical results are necessarily considered semi-quantitative at best and would be anticipated to have large uncertainties associated with them. According to Diane Baker, Laboratory Director for AWAL, the sample preparation procedure used for arsenic and selenium analyses was refined over the period of time that background data were collected which resulted in a more reproducible analysis. During this same period, the average arsenic concentration in groundwater appears to have increased. As a result, the AWAL data immediately postdating the background period itself shows a generally higher average than the background period.

2.3 Evaluation of Established Background

After all background data had been collected, they were statistically evaluated to determine a regulatory limit for background concentrations of arsenic and selenium at the site. The procedure followed (by the Nuclear Regulatory Commission, NRC) for this determination generally included

- review of data for distribution characteristics (Gaussian or log normal)
- deletion of statistical outliers
- calculation of the statistical mean
- calculation of the associated standard deviation
- calculation of a representative background concentration for each well as the mean plus two standard deviations

The present study confirms that for samples collected and analyzed prior to May 1994

- normal Gaussian distributions are applicable
- outliers were correctly identified and discarded
- standard deviations and their addition to calculated means are consistent
- During the evaluation of background data, each well was determined to be statistically different from other site wells and background conditions for the site were established on an individual well basis. Figure 1 illustrates the variability of arsenic concentrations observed in groundwater associated with the 11e.(2) cell using data collected in November 1996.

Groundwater Arsenic (Nov. 1996)

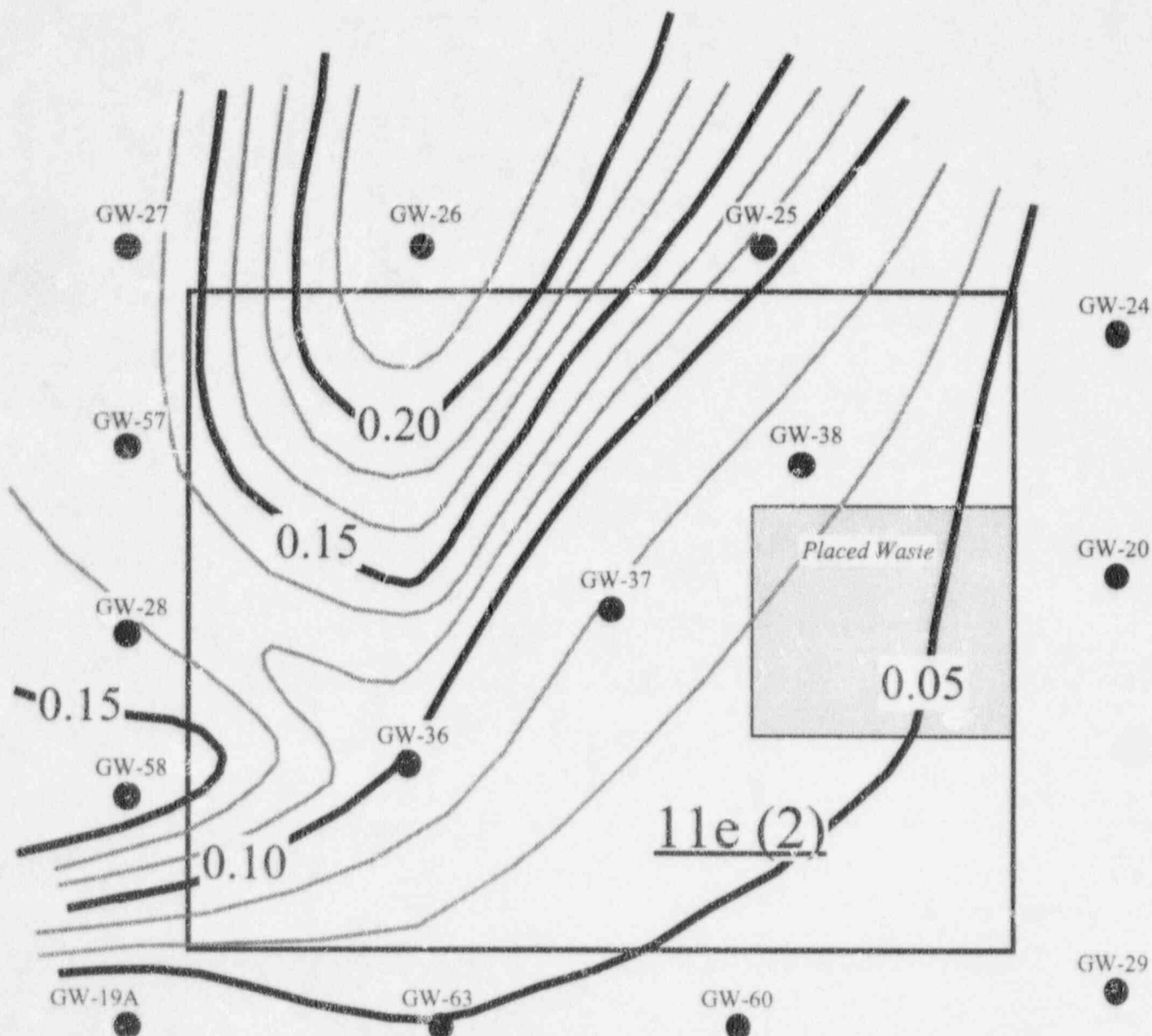


Figure 1. Groundwater arsenic concentrations.

2.4 Change in Contract Laboratory

In January of 1996, Envirocare terminated its contract with AWAL in favor of Mountain States Analytical Lab (MSA). This change was driven by concerns on the part of Envirocare related to quality assurance issues of data produced by AWAL. Similar concerns were raised by the U.S. Environmental Protection Agency (EPA). After changing the service provider, the initial samples analyzed by MSA indicated exceedences for arsenic while the previous quarter's results were below compliance concentrations.

Though the change in analytical laboratory services was driven by issues of quality control, it resulted in a change of analytical procedure. QA/QC efforts on the part of MSA resulted in a change of analytical protocol and Method 7060 (GFAA) was discarded in favor of Method 7061, a hydride generation atomic absorption (HAA) technique. This change intended to reduce interferences from the saline matrix associated with the groundwater at the 11c.(2) cell ($\geq 20,000$ ppm chloride). This provided better sensitivity and lower PQL's.

In response, Envirocare initiated a program to submit splits of monitoring well samples for the remainder of 1996 to both MSA and AWAL. This action was taken in support of an internal quality assurance/quality control (QA/QC) program to assess the consistency between laboratory performance to provide an evaluation of the comparison of AWAL background data and current MSA performance.

3. QUALITY ASSURANCE PROGRAM

Although AWAL performed all analyses that established background and initial phases of operational monitoring through January 1996, they did not collect many analytical results during 1996.

3.1 Splits to MSA and AWAL

Immediately after MSA began reporting results that were significantly inconsistent with AWAL, a program was established that sent split samples to MS and AWAL. This program began in August of 1996 and has continued to the present time.

3.1.1 Approach

For all monitoring wells associated with the 11c.(2) cell, split samples were sent to both MS and AWAL. MS continued to perform analyses of arsenic and selenium with the hydride generation and AWAL used the graphite furnace approach. Analysis of all other constituents was also continued by each lab, using principally ICP techniques.

In addition to spike recovery determinations, each lab also analyzed a series of field duplicates to determine relative precision for each analytical technique, in each respective lab. The determined precision was reported simply as relative percent difference and was computed by the formula

$$RPD = \frac{(S-D)}{(S+D)/2} \times 100$$

where RPD- relative percent difference

S- sample result

D- duplicate result

3.1.2 Results

The split samples analyzed by both AWAL and MS contrast markedly for arsenic. As the data reported in Appendix A indicate, MS analytical results are consistently higher than AWAL. MS data for arsenic are consistently above the previously determined background concentrations for each well location while AWAL's results are consistently below. This implies that a direct comparison of MS data for current conditions at the site might not be fairly compared to background concentrations established using AWAL data. As illustrated in Figure 2 below, there is a good correlation between the results reported by AWAL and those by MS, with the latter being about 1.6 times higher on average.

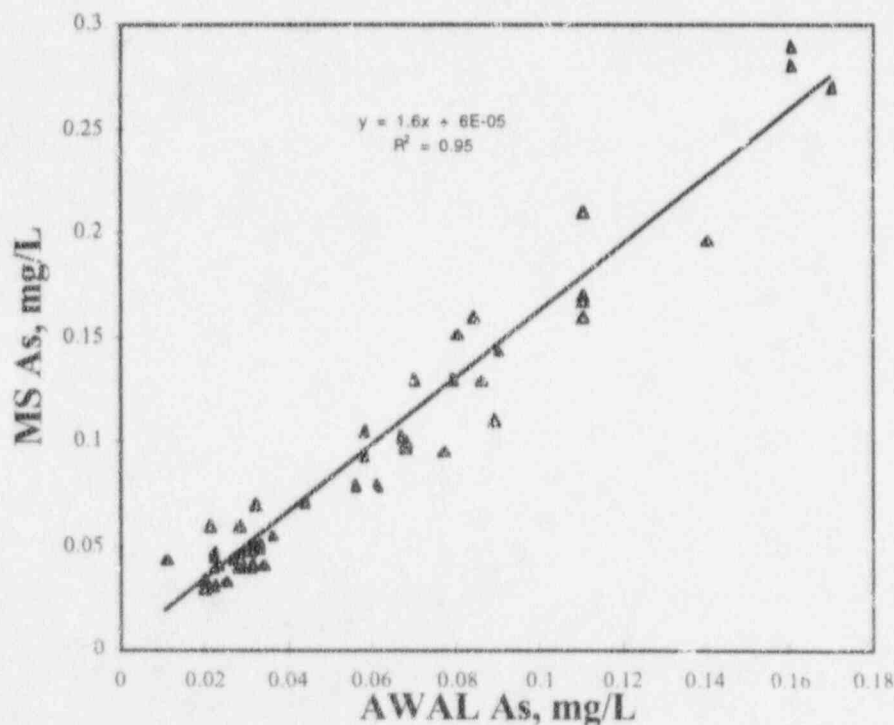


Figure 2. Correlation between MSA and AWAL for As analyses.

AWAL generally reports selenium below detection limits while MSA has reported measurable quantities more often. However, because selenium has been reported by AWAL as generally below the detection limit, it is not possible to establish a similar relationship for this element between AWAL and MSA. It can only generally be stated that MSA routinely reports selenium concentrations that are greater than those reported by AWAL.

The precision for arsenic and selenium determinations are variable. Table 1 reports the values determined for each lab for each monitoring period as well as the average precision.

Table 1. Field duplicate results 1991-1997.

DATE	WELL ID	As (S/D)	RPD	Se (S/D)	RPD
AWAL					
2/9/94	25	0.079/0.083	4.9	ND	ND
	29	0.022/0.021	4.7		
4/30/94	29	0.010/0.019	62.1	ND	ND
7/14/94	38	0.030/0.035	15.4	ND	ND
1/26/95	19A	0.023/0.023	0	ND	ND
4/7/95	29	0.013/0.011	16.7	ND	ND
10/10/95	63	0.033/0.026	23.7	ND	ND
2/8/96	29	0.014/0.015	6.9	ND	NA
7/20/96	38	0.044/0.046	4.4	0.019/0.018	5.4
10/7/96	38	0.041/0.041	0	ND	ND
MSA					
5/9/96	20	0.038/0.06	44.9	ND	ND
8/15/96	58	0.127/0.132	3.9	0.01/0.008	22.2
12/15/96	29	0.030/0.030	0	ND	ND

*ND- Not detected

For the results shown, the average RPD for AWAL is calculated to be $\pm 13.9\%$ ($n = 10$) and for MSA ± 16.3 ($n = 3$). With only three data points, the average value reported for MSA seems to be biased high, but is reported here owing to the paucity of data. Selenium is typically at the detection limit in field duplicate wells and thus a direct evaluation of MS and AWAL is not possible. However, uncertainties

consistent with those determined for arsenic are assumed to be reasonable and applicable to selenium trends as well.

Concentration *versus* time graphs for all monitoring wells, found in Appendix B, include error bars for the analysis that represent the *average* precision for each of the labs. Inspection of these figures indicates that when comparing split samples for a specific sampling time, the difference between MS and AWAL performance for arsenic analyses is statistically different.

3.2 Splits to MSA, AWAL and UDEQ

3.2.1 Approach

For a series of samples collected November 18-22, 1996, the Utah Department of Environmental Quality (UDEQ) analyzed a split sample for several wells, in addition to MSA and AWAL. UDEQ used an inductively coupled plasma emission (ICP) technique for analysis. This technique is generally considered to have higher detection limits on average than hydride generation analysis, but low interferences.

3.2.2 Results

Figure 3 below illustrates the variability in the analytical results for arsenic. Figure 4 reports results for selenium.

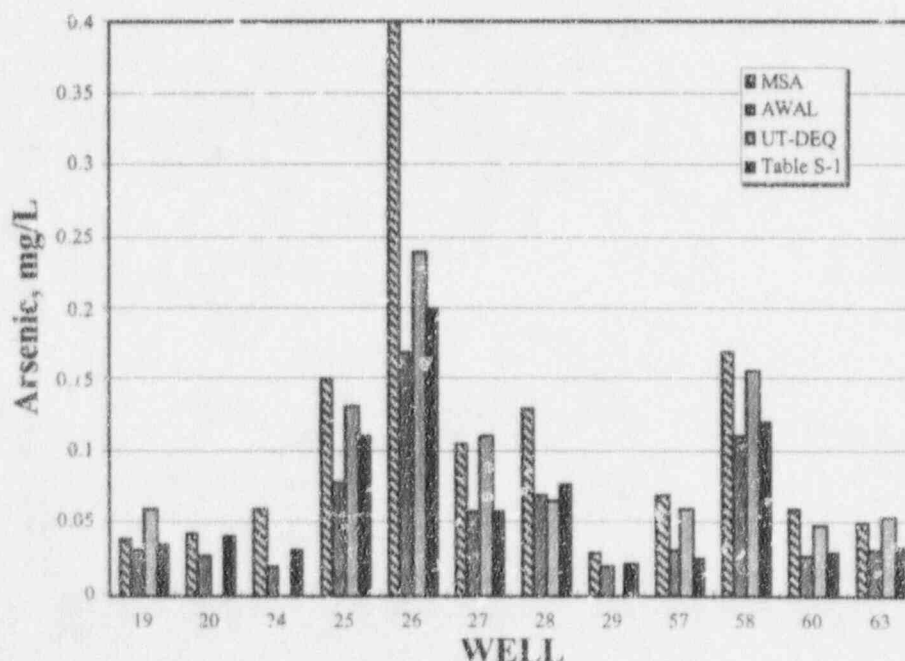


Figure 3. Results of split analyses by MSA, AWAL and UDEQ for As (Nov. 1996).

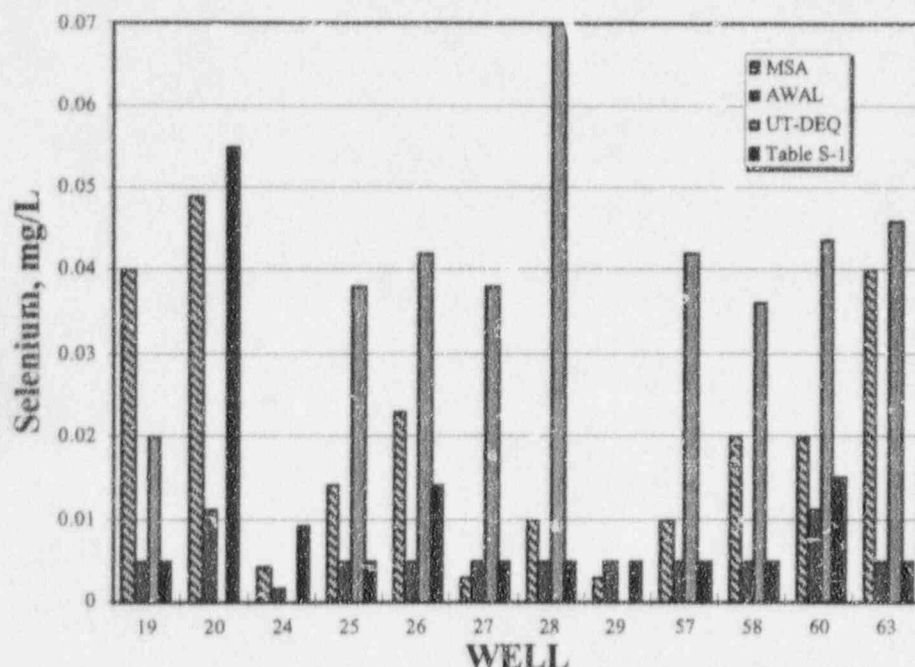


Figure 4. Results of split analyses by MSA, AWAL and UDEQ for Se (Nov. 1996).

There is a noticeable disparity between the analytical results for all labs reported and is greater for selenium than for arsenic. The better agreement between MSA and UDEQ, both using techniques that are less susceptible to interferences than graphite furnace analysis (AWAL), suggests that AWAL data may be biased low.

3.3 Splits to MSA, AWAL and CDS

3.3.1 Approach

Similar to the program reported in Section 3.2, a third party analytical laboratory was identified that might reconcile the differences observed between MSA and AWAL. Casa Del Sol Labs (CDS), located in Durango, CO, specializes in the analysis of high salinity aqueous solutions, particularly arsenic and selenium. CDS is currently reported to be the only commercial laboratory which participates in a program sponsored by EPRI (Electric Power Research Institute) to verify US EPA analytical methods for brine solutions. Thus, they were identified as an acceptable third party referee. A copy of CDS's analytical QA/QC program is contained in Appendix C.

For the current program, split samples were taken from GW-19A, GW-26 and GW-27 (see Figure 1 for locations). These wells were selected because previous analytical results from MSA and AWAL both

identify these wells as having a reasonable range of arsenic concentrations and at least one of them has detectable selenium.

3.3.2 Results

The analytical results for each of the split samples are reported in Table 2 and illustrated in Figure 5 and Figure 6.

Table 2. Results of split sample analysis by MSA, AWAL and CDS for As and Se.

	AWAL	MS	CDS
GW-19A			
As	0.039	0.023	0.035
Se	<0.005	<0.005	<0.001
GW-26			
As	0.20	0.142	0.153
Se	0.009	0.010	0.016
GW-27			
As	0.078	0.034	0.063
Se	<0.005	<0.005	0.005

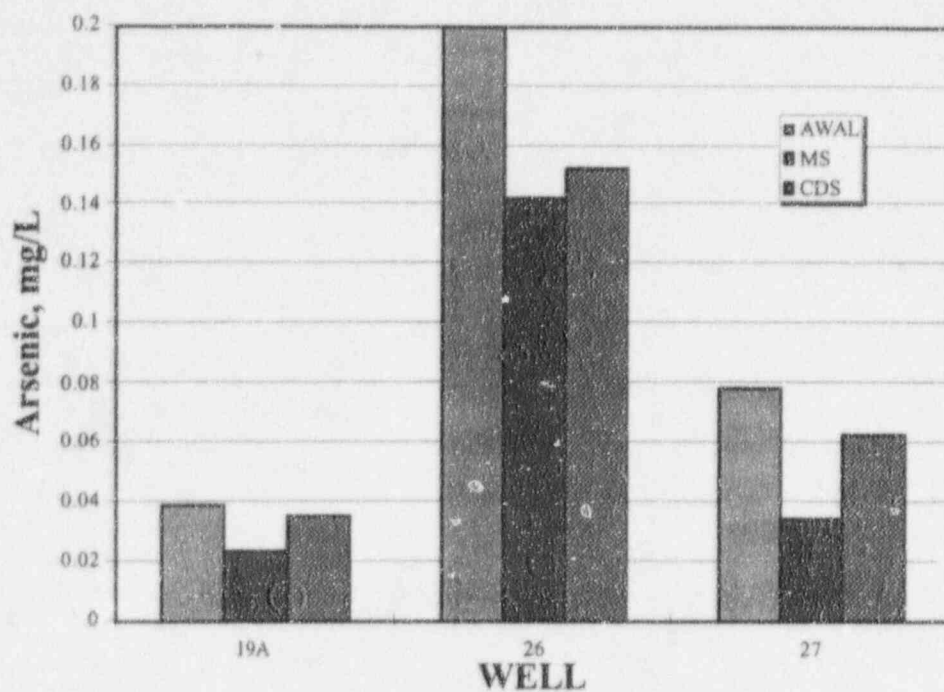


Figure 5. Split analyses for MSA, AWAL and CDS for As.

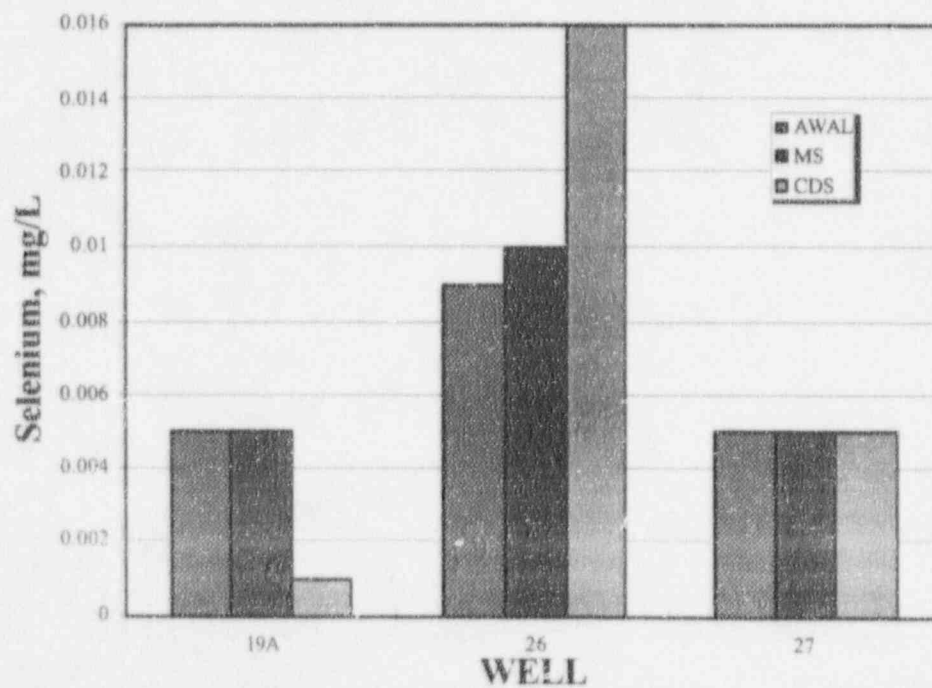


Figure 6. Split analyses for MSA, AWAL and CDS for Se.

These data indicate that the agreement among all three labs is reasonably good for arsenic. For selenium it is more problematic.

The agreement between MSA and AWAL for arsenic is anomalous given the historical performance. Below, Figure 7, which illustrates the historical relationship between MSA and AWAL for arsenic, is the same as Figure 2 but also includes the results of the current split analyses. Current splits analyzed by AWAL are clearly different from all other analyses from August 1996 to February 1997. As seen for the time-concentration graph for wells reported in Appendix B, the current split analysis by MSA is consistent with their historical reports, while AWAL is inconsistent. It is not clear at this time how AWAL can produce such markedly different results using the same analytical technique in light of the abundant historical record over the course of 1996.

Some communications occurred between AWAL and UDEQ, prior to submission of the current splits, regarding the contrast between AWAL and MSA analyses for arsenic. The degree to which this prior knowledge may have contributed to bias in the current QA/QC program cannot be demonstrated.

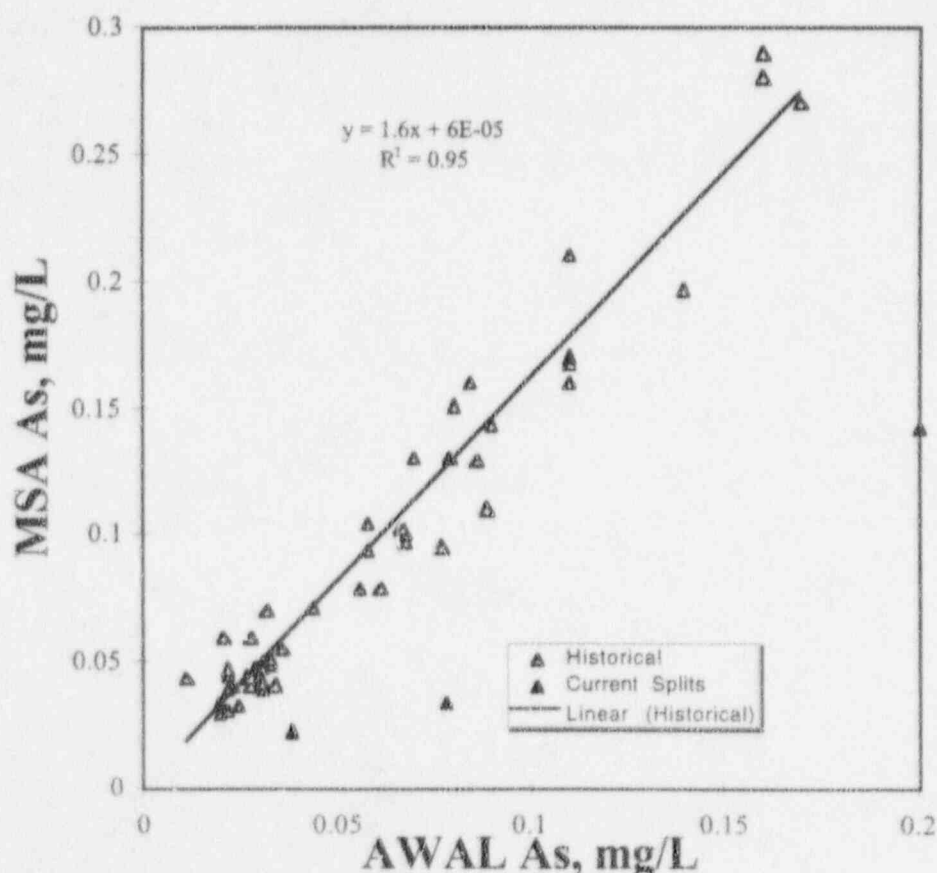


Figure 7. MSA versus AWAL As analyses, historical and current.

3.4 Laboratory Prepared Knowns

3.4.1 Approach

As a supplement to analysis of splits from site wells, high salinity solutions were prepared with accurately known concentrations of arsenic and selenium and sent to AWAL, MSA and CDS. The salinity of the bulk solution was prepared to be consistent with site conditions and the arsenic and selenium concentrations were selected to span the range observed to date at the site. The bulk solution composition for all prepared samples is reported in Table 3 and the arsenic and selenium concentrations for all solutions is reported in Table 4. All solutions were prepared by ACZ Labs of Steamboat Springs, CO. Certificates of analysis for reagent used to prepare solutions can be found in Appendix D.

Table 3. Composition of bulk solution for prepared knowns.

Constituent	Site Concentration*	Prepared Concentration mg/L
Na	16,000	14,000
K	500	400
Ca	620	706
Mg	930	930
Cl	23,000	21,963
SO ₄	5500	5368

* Example given is GW-26 January 1995

Table 4. Concentration (mg/L) of arsenic and selenium in prepared samples.

Sample Label	Arsenic	Selenium
SR	0.050	0.015
ZA	0.100	0.030
PQ	0.250	0.045

3.4.2 Results

The analytical results reported by each lab facility for the prepared solutions are reported in Table 5. Included is a calculation of the percent error for each of the determinations. Percent error was calculated as

$$\% \text{ Error} = \frac{|M - A|}{A} \times 100$$

where M - measured

A - actual

|| - absolute value

Table 5. Analysis of prepared knowns by MSA, AWAL and CDS.

ID	AWAL	% Error	MS	% Error	CDS	% Error	ACTUAL
SR							
As	0.024	-52.0	0.066	+32.0	0.025	-50	0.050
Se	0.006	-60.0	0.014	-6.7	0.005	-66.7	0.015
ZA							
As	0.057	-43.0	0.096	-4.0	0.076	-24.0	0.100
Se	0.014	-53.0	0.026	-13.3	0.010	-66.7	0.030
PQ							
As	0.15	-40.0	0.184	-26.4	0.210	-16.0	0.250
Se	0.020	-55.6	0.034	-24.4	0.012	-73.3	0.045

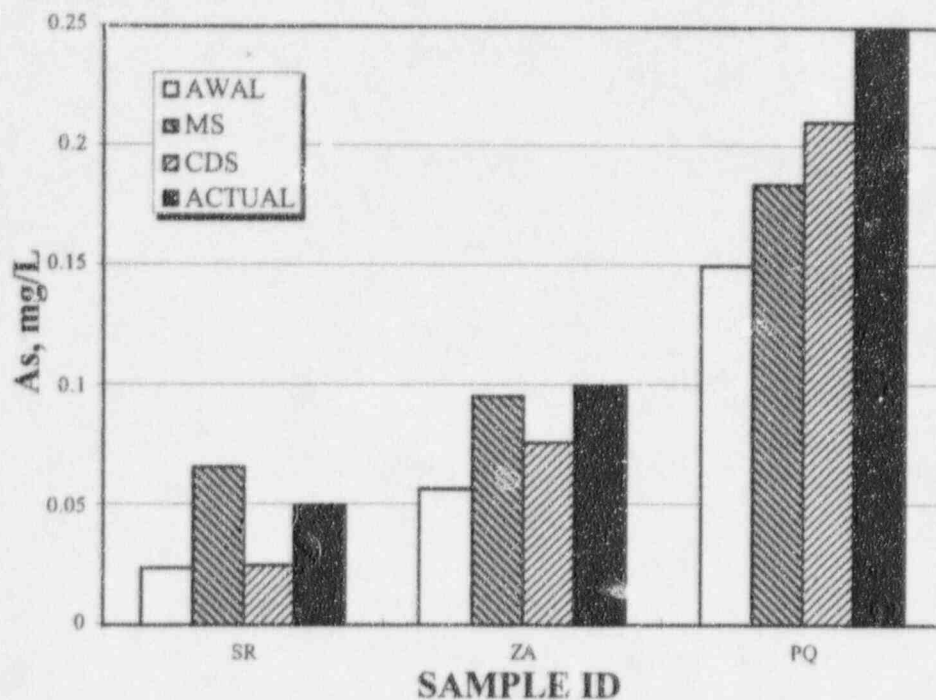


Figure 8. Lab comparisons for As knowns.

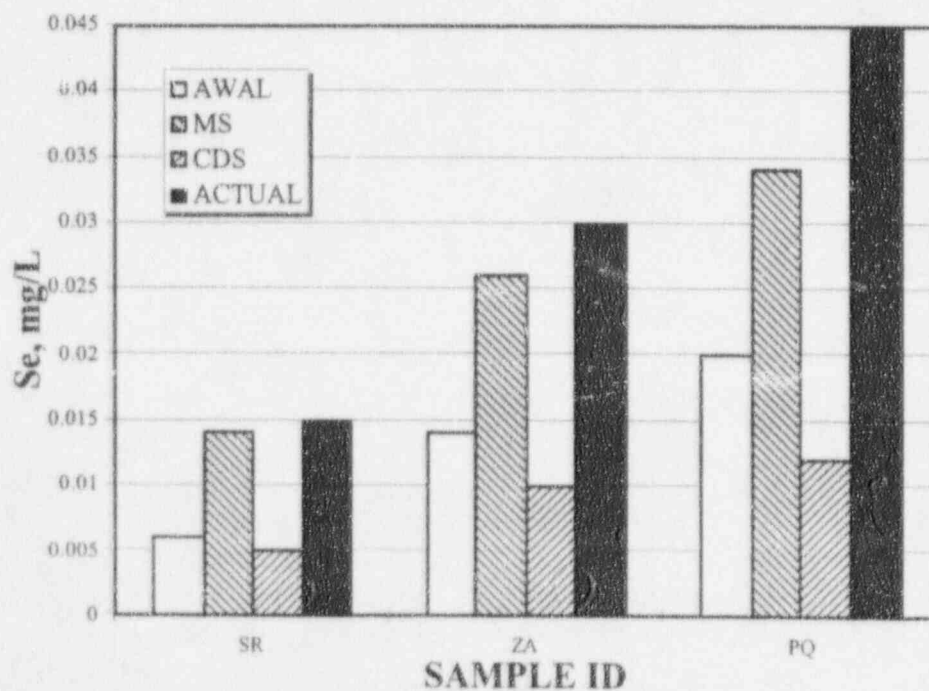


Figure 9. Lab results for Se knowns.

The results for the prepared knowns indicate that analysis of solutions with bulk compositions consistent with the high salinity brines associated with groundwater at the Envirocare 11e.(2) cell is a difficult task. The results also indicate that MSA performed a more accurate analysis. The marked contrast between MSA and CDS suggests that even with the same methodology, low accuracy and precision can be expected for these analyses, for both arsenic and selenium. In sum, however, the hydride generation technique would appear, on average, to be more accurate.

4. IMPLICATIONS FOR ESTABLISHED BACKGROUND

Figure 2 suggests that background concentrations, to be compared directly to the current MS data may require revision and may be principally due to the differences in analytical methodologies. The least squares regression of the relationship between the two labs can be used to produce alternative background concentrations for monitoring wells that may be more representative of the concentrations that would have been observed had MS been performing the analytical work from the beginning. Table 6 reports the results of that exercise and shows the current background concentration for each well and the revised value based on the best fit equation of Figure 2. Corrected background concentrations have also been calculated on a well by well basis, consistent with the original license approach, using only the data for the specific well. Values reported in italics in Table 6 for corrected background exceed maximum contaminant levels for arsenic of 0.05 mg/L.

Table 6. Present and corrected background concentrations.

WELL ID	TABLE S-1 BACKGROUND	GLOBAL FACTOR	GLOBAL CORRECTION	INDIVIDUAL FACTOR	INDIVIDUAL CORRECTION
GW-19A	0.036	1.6	<i>0.058</i>	1.48	<i>0.053</i>
GW-20	0.042	1.6	<i>0.067</i>	1.45	<i>0.061</i>
GW-24	0.032	1.6	<i>0.051</i>	2.92	<i>0.093</i>
GW-25	0.11	1.6	<i>0.18</i>	1.56	<i>0.17</i>
GW-26	0.2	1.6	<i>0.32</i>	1.87	<i>0.37</i>
GW-27	0.059	1.6	<i>0.094</i>	1.60	<i>0.94</i>
GW-28	0.076	1.6	<i>0.12</i>	1.58	<i>0.12</i>
GW-29	0.023	1.6	0.037	1.55	0.036
GW-57	0.026	1.6	0.042	1.60	0.042
GW-58	0.12	1.6	<i>0.19</i>	1.61	<i>0.19</i>
GW-60	0.029	1.6	0.046	1.40	0.041
GW-63	0.034	1.6	<i>0.054</i>	1.52	<i>0.052</i>

This approach corrects the inconsistencies between analytical methodologies used to determine background and current analytical practices. However, the methodology used by AWAL was improved

during collection of the background data (personal communication with Diane Baker, AWAL Lab Director) that reduced the variability of determination and appears to have resulted in a general increase in concentrations measured over that time period. Thus, the current differences between AWAL and MSA data are less than would be expected if MSA analyses were available for the background data collection period and the correction factor(s) applied above represent a minimum correction.

Due to hydrogeologic conditions at the Envirocare site, it is reasonable to expect that current data reported by MSA represents background conditions. Accordingly, a background concentration for each well based upon MSA analyses can be calculated that would be higher than the value determined using the correction factor(s) approach. Table 7 reports background arsenic and selenium concentrations based upon MSA data. For selenium, the AWAL methodology did not detect selenium for many of the wells. Therefore, there is no direct method for calculating a correction factor to apply to the original AWAL selenium data.

Table 7. Calculated background for As and Se using MSA data.

WELL ID	As	Se
GW-19A	0.052	0.003
GW-20	0.052	0.056
GW-24	0.045	0.050
GW-25	0.168	0.015
GW-26	0.311	0.032
GW-27	0.134	0.006
GW-28	0.130	0.012
GW-29	0.039	0.008
GW-57	0.054	0.013
GW-58	0.208	0.024
GW-60	0.044	0.042
GW-63	0.053	0.008

5. CONCLUSIONS

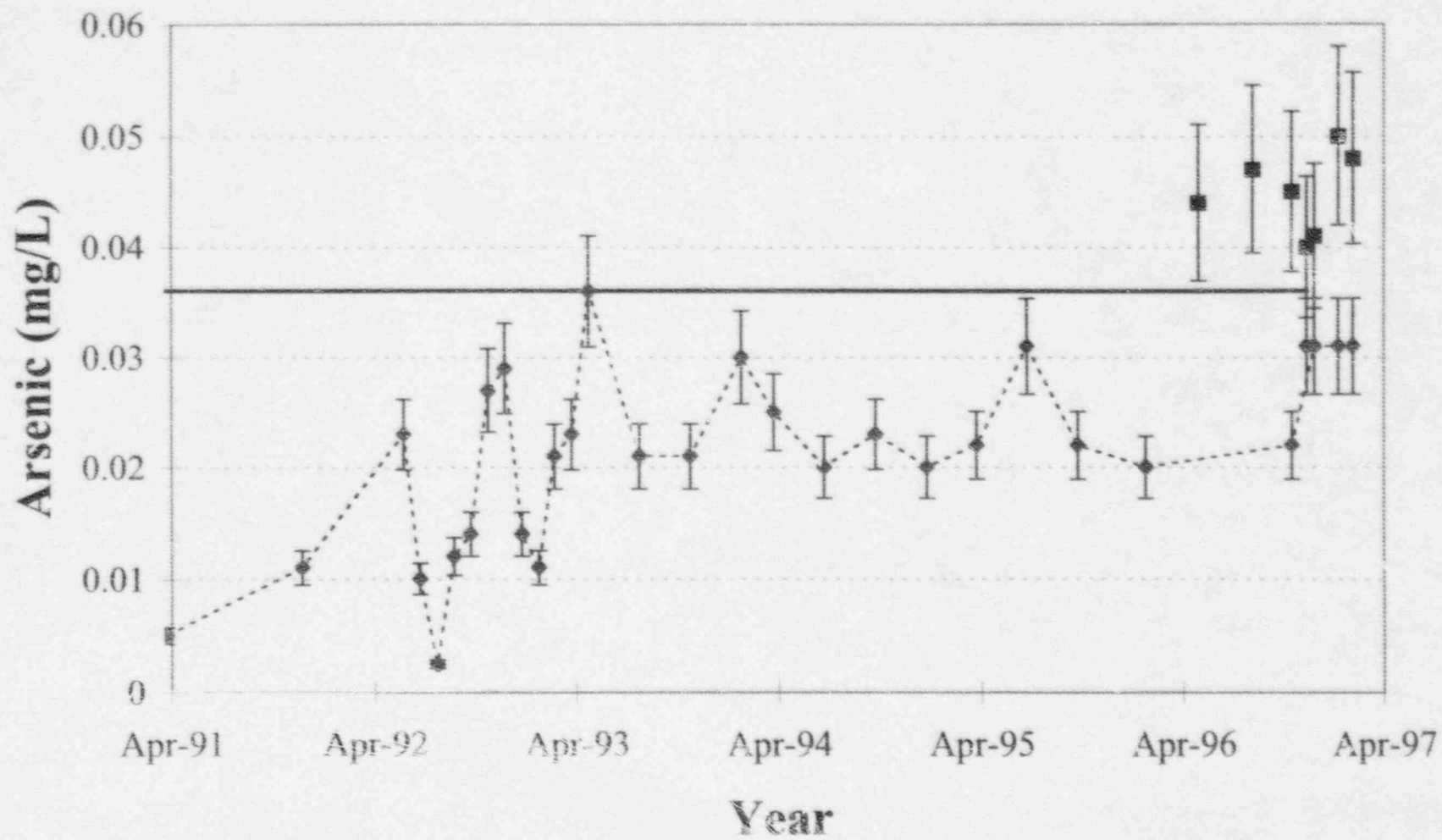
This evaluation of analytical procedures for monitoring groundwater produces several significant conclusions related to apparent regulatory exceedences for arsenic, and selenium, and leads to proposed recalculated background concentrations for these elements.

- No revision of background concentrations for inorganic species other than arsenic and selenium appears necessary as these other elements are determined by ICP, a method with generally low interferences, and have only displayed sporadic exceedences that are associated with the statistical error expected.
- The data produced by AWAL is inconsistent with that produced by MS, with the latter routinely fifty percent higher than the former. This means that the data collected by MS cannot be directly compared to AWAL data collected for background.
- Currently established background concentrations can be corrected to reflect the change in analytical methodology, which leads to higher limits. This correction has been performed for both a global approach and a well by well basis.
- Because the earliest data collected by AWAL reports concentrations of arsenic that are lower than any data they report subsequently, application of a correction factor derived from comparison of recent AWAL and MSA data may not be adequate and produce less of a correction than appropriate. Background concentrations for arsenic and selenium can, and have been, recalculated using only current MSA data.
- The current method of sampling or calculation of background for arsenic and selenium may require revision as the accuracy associated with the analysis demonstrated in the present dataset is very large and on the order of 35 to 50 percent.

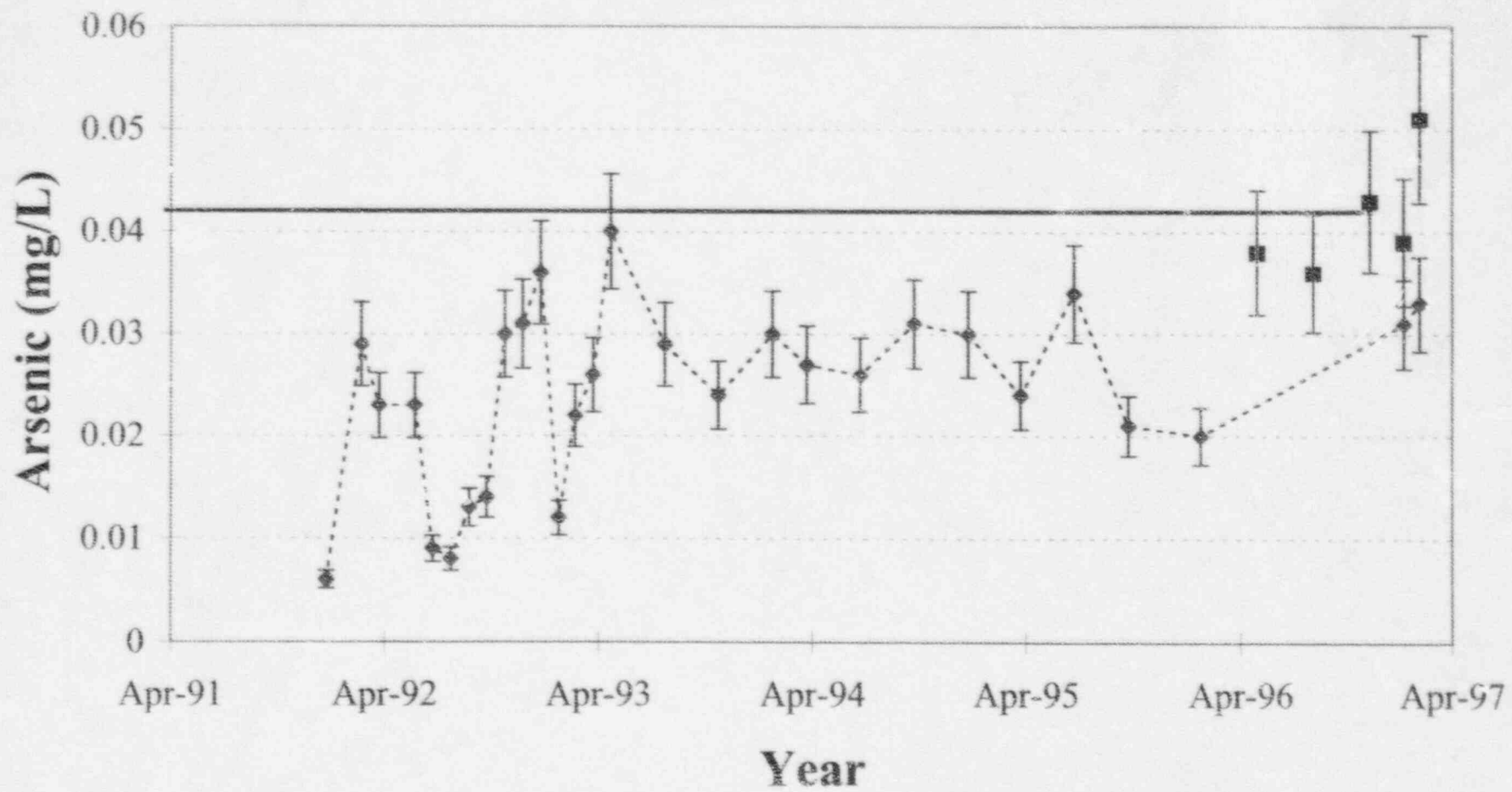
Well No.	Analyte	Lab.	Initial Result, Q2 May 7-9, 1996	Confirm., Q2, Aug 9, 13-15, 1996	Initial Result, Q3, Aug 13- 15, 1996	Confirm., Q3 Oct 24- 25, 1996	Confirm., Q3, Dec 4-5, 1996	Initial, Q4, Nov 18-22, 1996	Confirm., Q4, Jan 15- 17, 1997	Confirm., Q4, Feb 18- 21, 1997
GW-28	Arsenic	AWAL				0.056	0.068	0.07	0.068	0.067
	Arsenic	MSAL	0.075		0.09	0.079	0.098	0.13	0.1	0.102
	Selenium	AWAL				<0.005	<0.005	<0.005	<0.005	<0.005
	Selenium	MSAL			0.007	0.007	<0.003	0.01	0.008	0.008
GW-29	Arsenic	AWAL				0.016	0.021	0.02	0.022	0.022
	Arsenic	MSAL	0.028	0.029	0.029	0.028	0.037	0.03	0.031	0.039
	Selenium	AWAL						<0.005	<0.005	<0.005
	Selenium	MSAL			0.004			<0.003	0.007	<0.003
GW-57	Arsenic	AWAL				0.022	0.033	0.032	0.032	0.036
	Arsenic	MSAL	0.046	0.047	0.047	0.047	0.049	0.07	0.049	0.055
	Selenium	AWAL				<0.005	<0.005	<0.005	<0.005	<0.005
	Selenium	MSAL			0.008	0.009	<0.003	0.01	0.007	0.007
GW-58	Arsenic	AWAL				0.086	0.11	0.11	0.11	0.11
	Arsenic	MSAL	0.135	0.129	0.127	0.129	0.21	0.17	0.16	0.168
	Selenium	AWAL				<0.005	<0.005	<0.005	<0.005	<0.005
	Selenium	MSAL			0.01	0.018	<0.003	0.02	0.007	0.009
GW-60	Arsenic	AWAL				0.022	0.025	0.028	0.034	0.031
	Arsenic	MSAL	0.035	0.034	0.034	0.039	0.033	0.06	0.041	0.042
	Selenium	AWAL				<0.005	0.013	0.011	0.016	0.013
	Selenium	MSAL			0.031	0.027	<0.003	0.02	0.026	0.027
GW-63	Arsenic	AWAL				0.023	0.029	0.033	0.033	0.028
	Arsenic	MSAL	0.036	0.039	0.039	0.041	0.047	0.05	0.049	0.044
	Selenium	AWAL						<0.005	<0.005	<0.005
	Selenium	MSAL			0.005			0.04	0.006	<0.003

Well No.	Analyte	Lab.	Initial Result, Q2 May 7-9, 1996	Confirm., Q2, Aug 9, 13-15, 1996	Initial Result, Q3, Aug 13- 15, 1996	Confirm., Q3, Oct 24- 25, 1996	Confirm., Q3, Dec 4-5, 1996	Initial, Q4, Nov 18-22, 1996	Confirm., Q4, Jan 15- 17, 1997	Confirm., Q4, Feb 18- 21, 1997
GW-19A	Arsenic	AWAL				0.022	0.031	<0.005	0.031	0.031
	Arsenic	MSAL	0.044	0.047	0.047	0.045	0.041	0.04	0.05	0.048
	Selenium	AWAL						<0.005	<0.005	<0.005
	Selenium	MSAL						0.04	<0.003	<0.003
GW-20	Arsenic	AWAL						0.027	0.031	0.033
	Arsenic	MSAL	0.038		0.036			0.043	0.039	0.051
	Selenium	AWAL						0.011		0.012
	Selenium	MSAL			0.023			0.049		0.022
GW-24	Arsenic	AWAL				0.02	0.028	0.021	0.027	0.028
	Arsenic	MSAL	0.033	0.034	0.034	0.034	0.04	0.06	0.044	0.041
	Selenium	AWAL				<0.005	0.014	0.015	0.021	0.014
	Selenium	MSAL	0.032	0.033	0.039	0.028	<0.003	0.004	0.022	0.032
GW-25	Arsenic	AWAL				0.077	0.089	0.08	0.084	0.09
	Arsenic	MSAL	0.117	0.117	0.117	0.095	0.11	0.151	0.16	0.143
	Selenium	AWAL				<0.005	<0.005	<0.005	<0.005	<0.005
	Selenium	MSAL			0.009	0.009	<0.003	0.014	0.008	0.007
GW-26	Arsenic	AWAL				0.14	0.17	0.17	0.16	0.16
	Arsenic	MSAL	0.234	0.215	0.218	0.197	0.27	0.4	0.29	0.28
	Selenium	AWAL				<0.005	0.006	<0.005	0.005	0.005
	Selenium	MSAL			0.018	0.027	<0.003	0.023	0.01	0.01
GW-27	Arsenic	AWAL				0.044	0.061	0.059	0.058	0.079
	Arsenic	MSAL	0.11	0.071	0.104	0.072	0.079	0.105	0.094	0.13
	Selenium	AWAL						<0.005	<0.005	<0.005
	Selenium	MSAL			0.005			0.003	0.004	<0.003

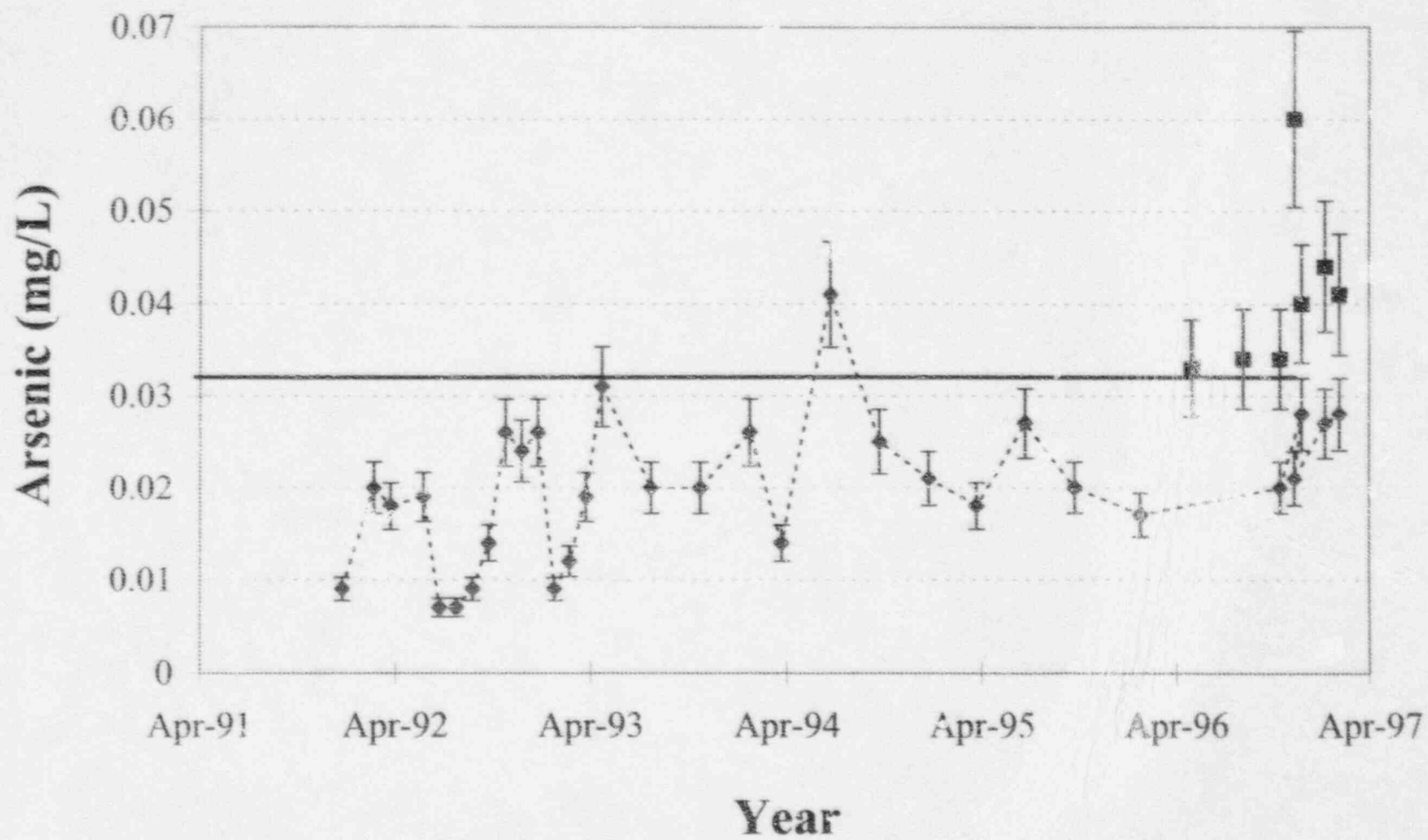
GW-19A



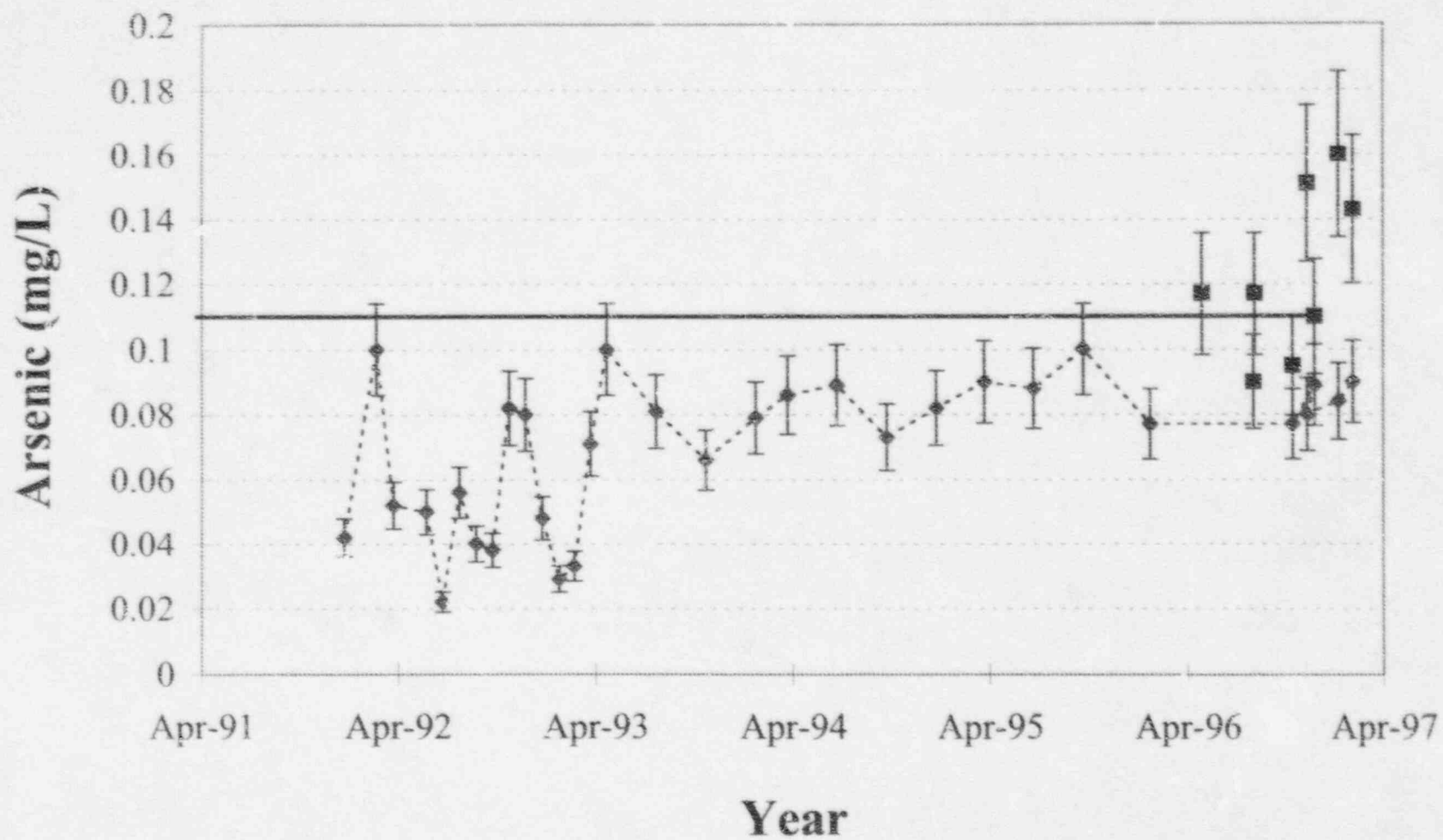
GW-20



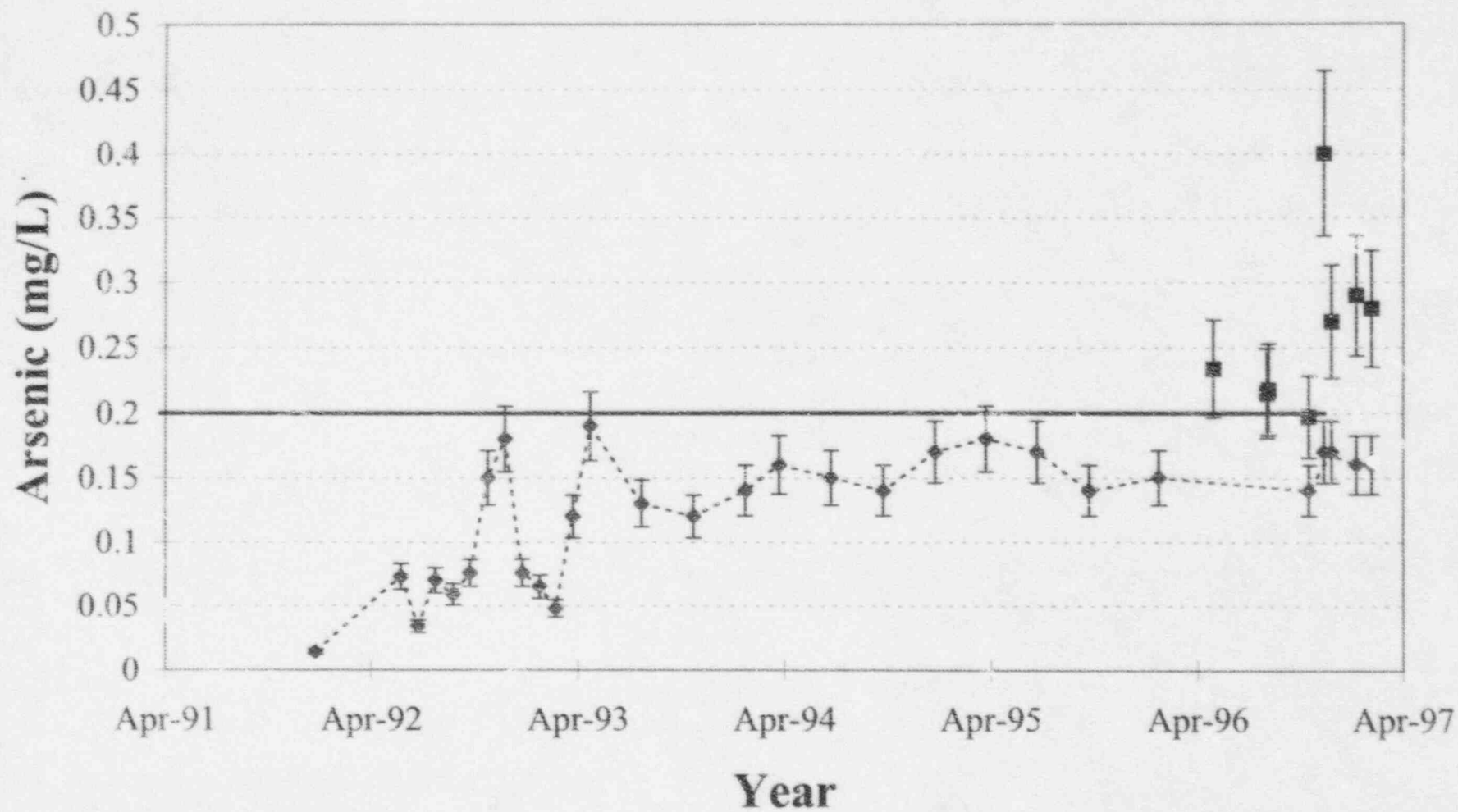
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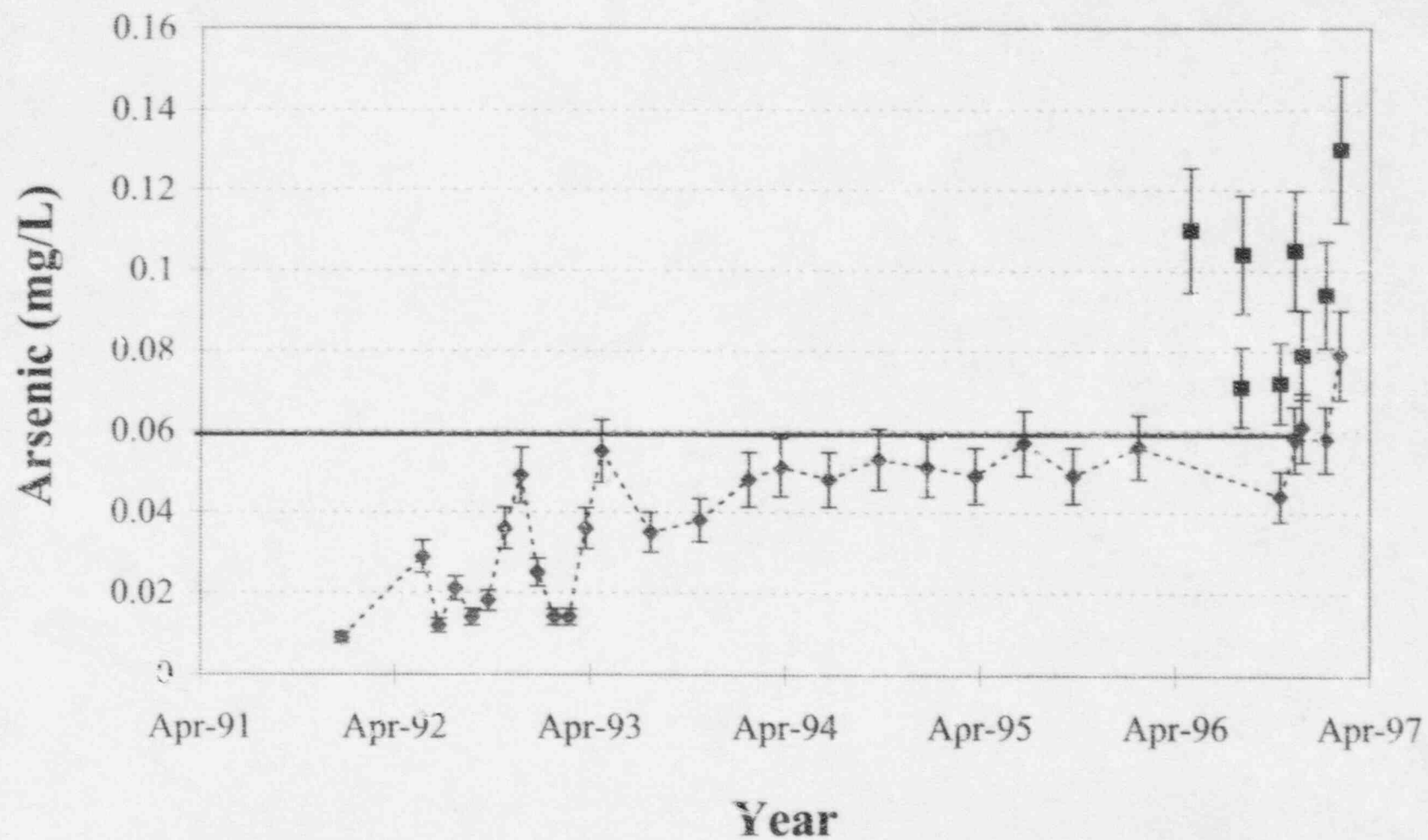
GW-25



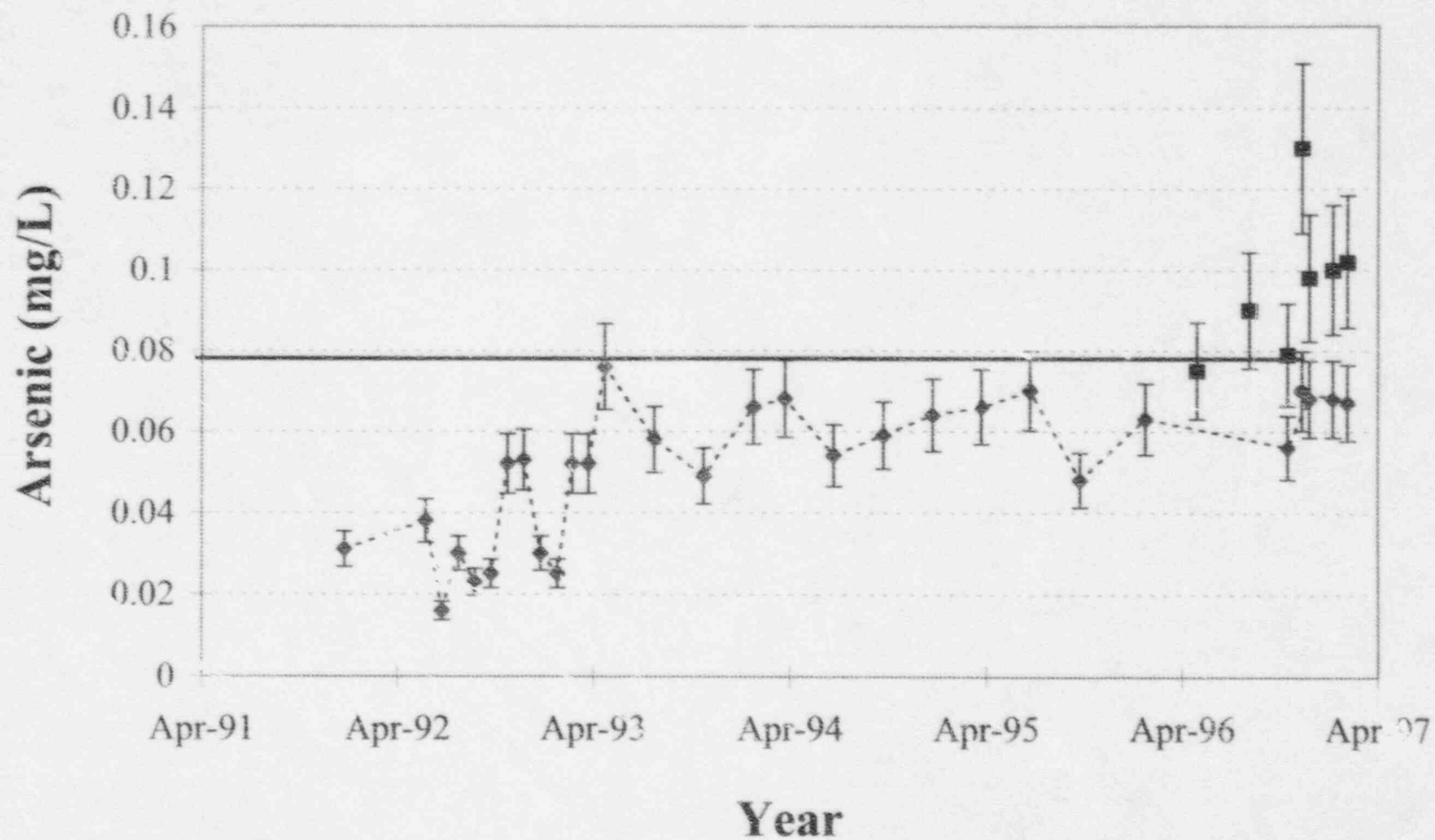
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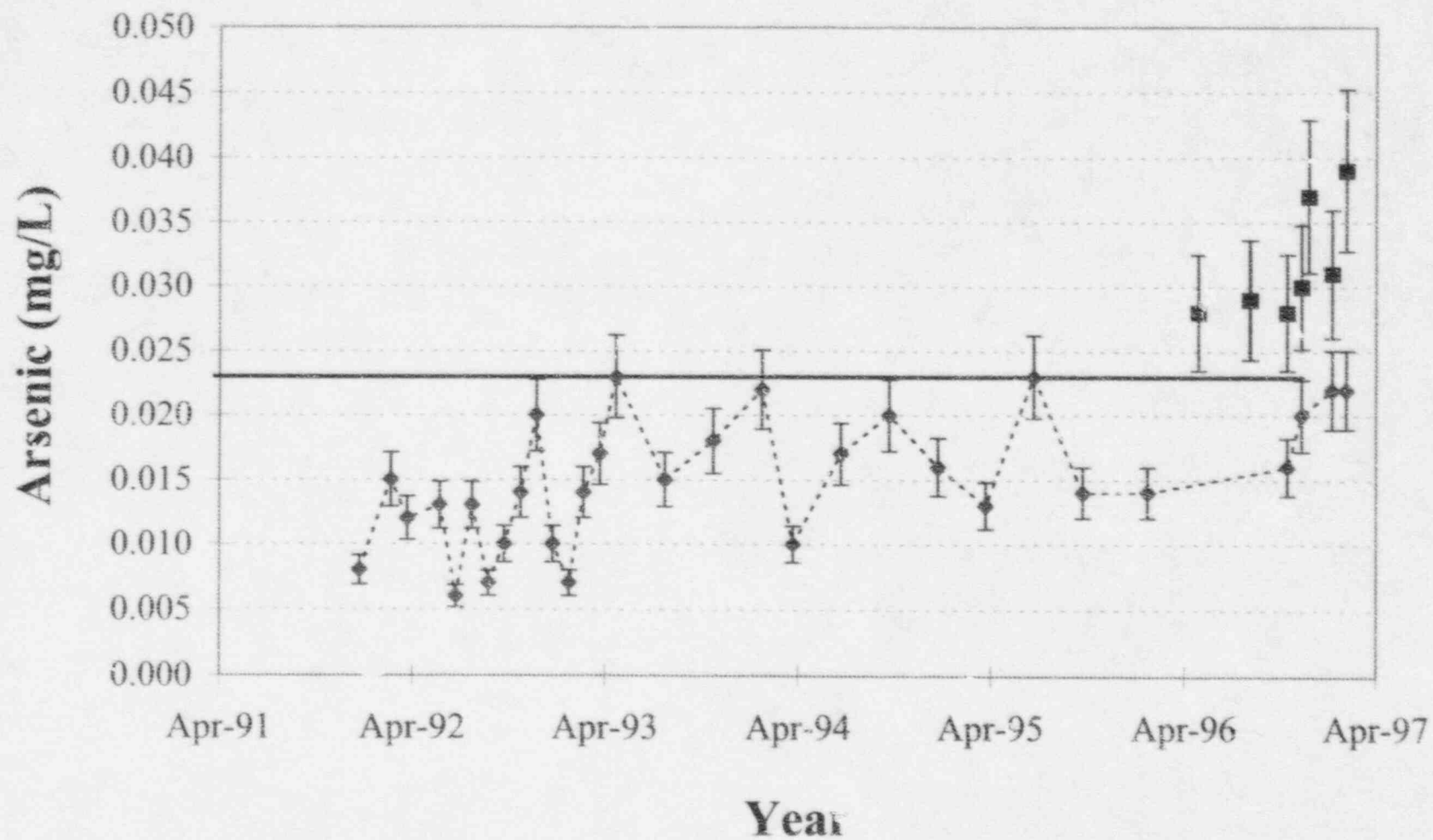
GW-27



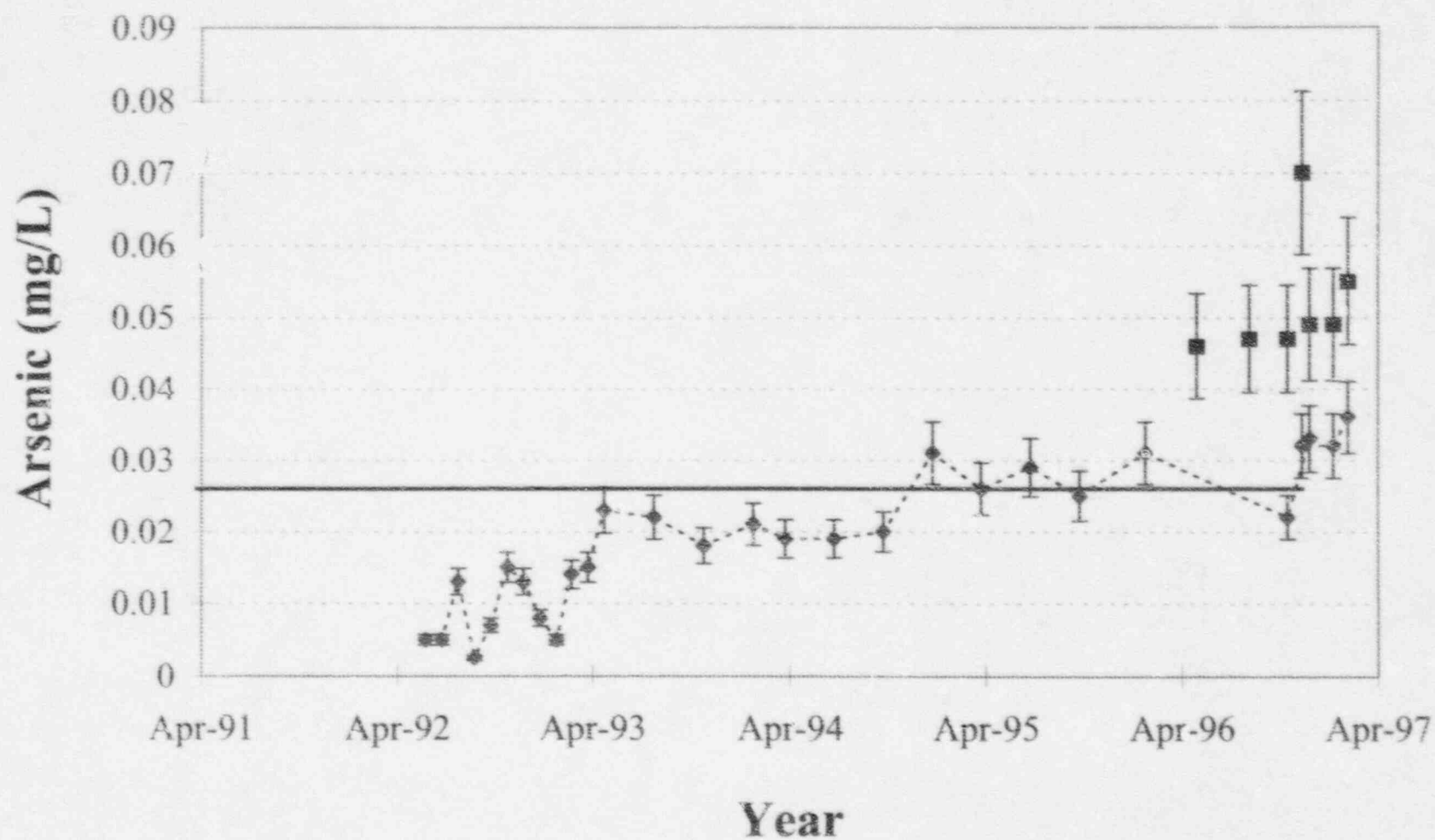
GW-28



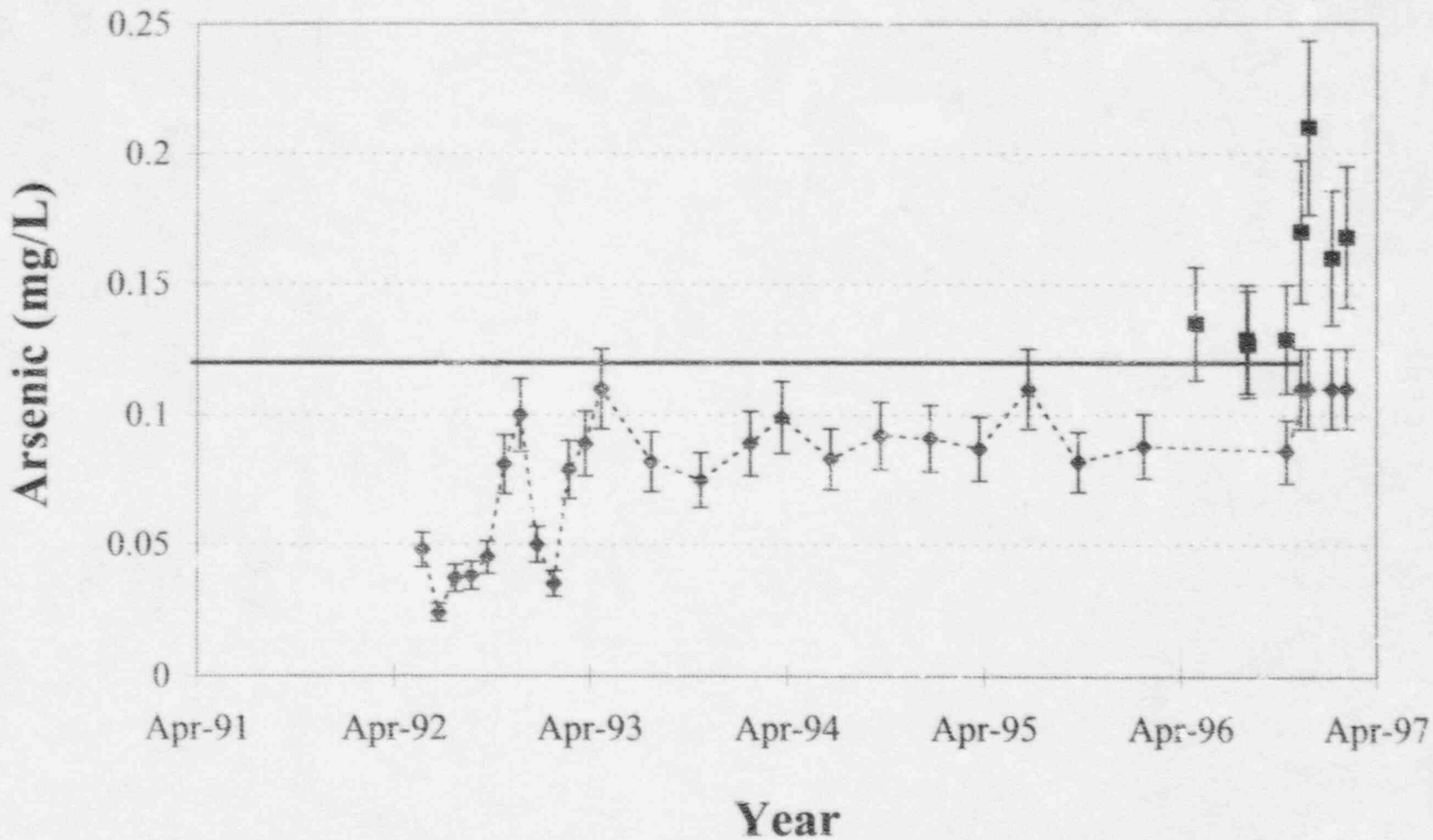
GW-29



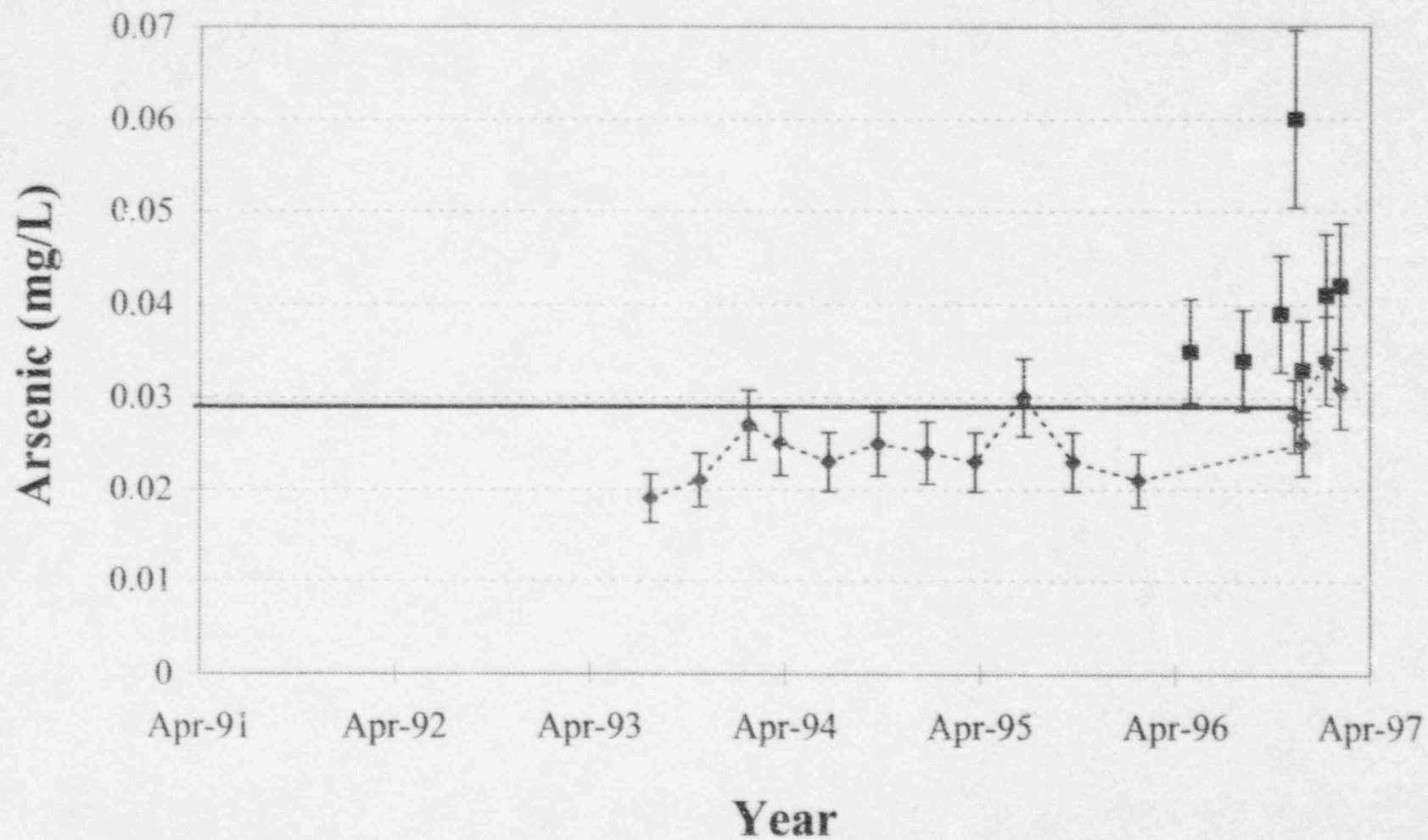
GW-57



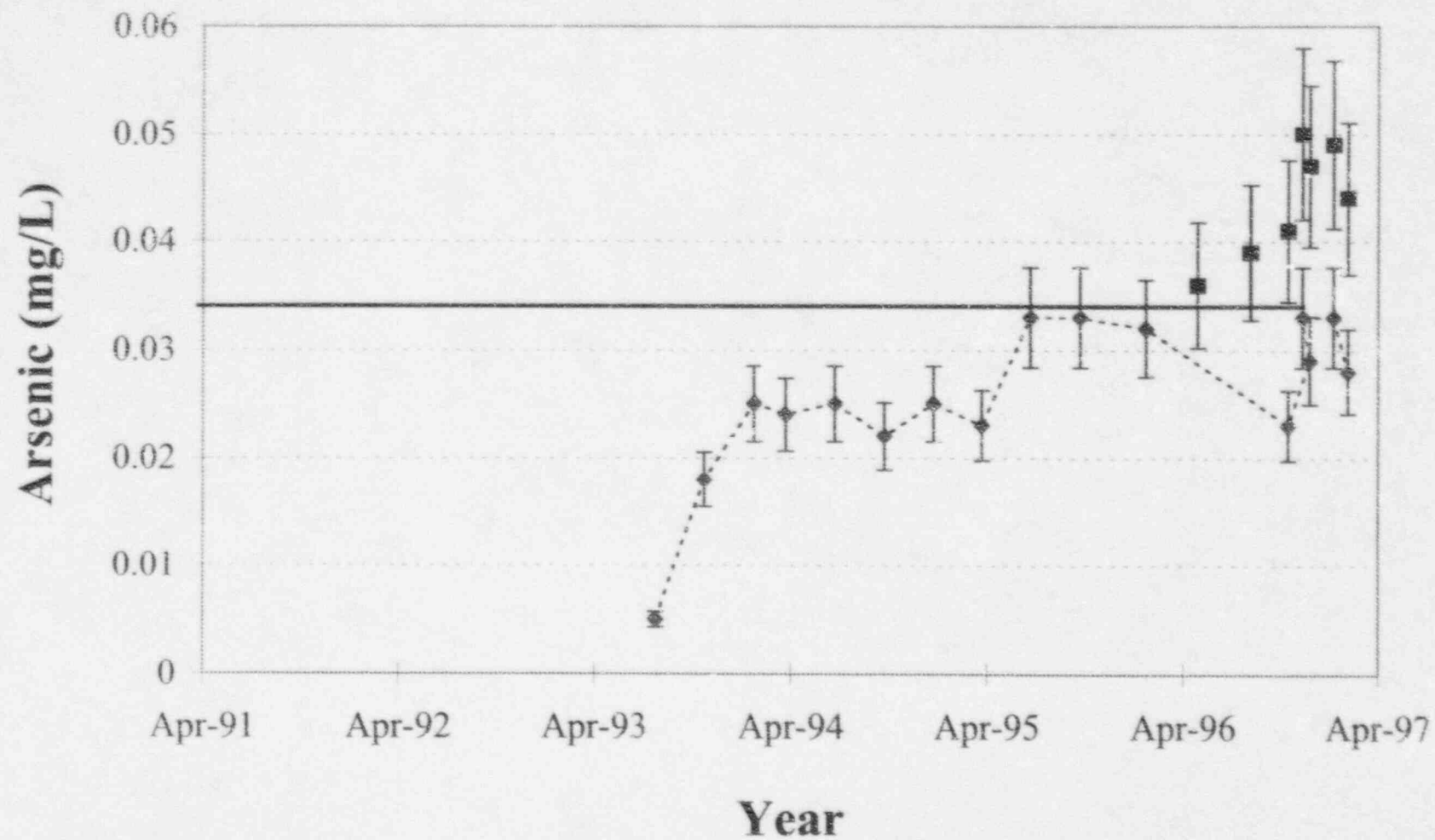
GW-58



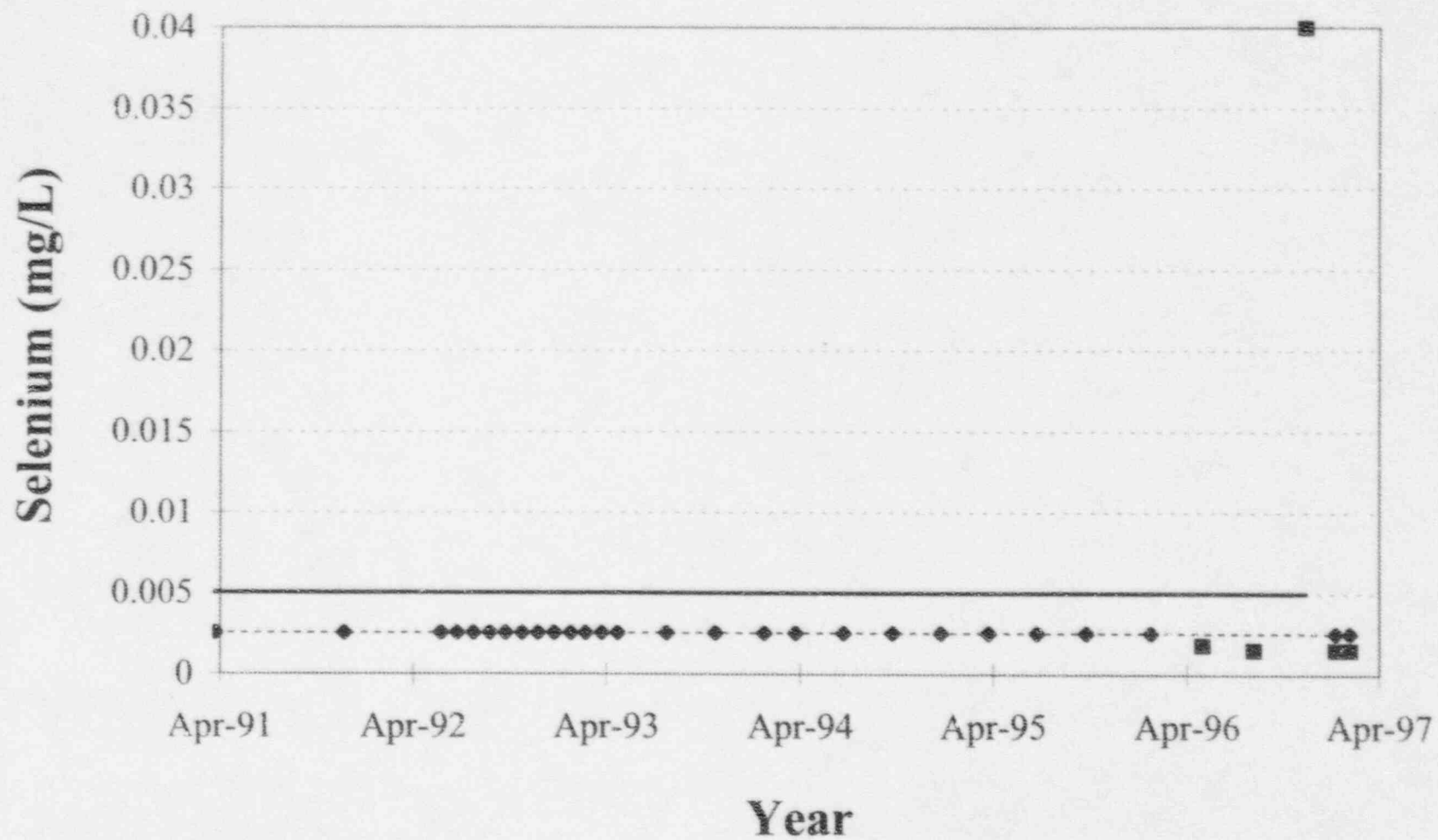
GW-60



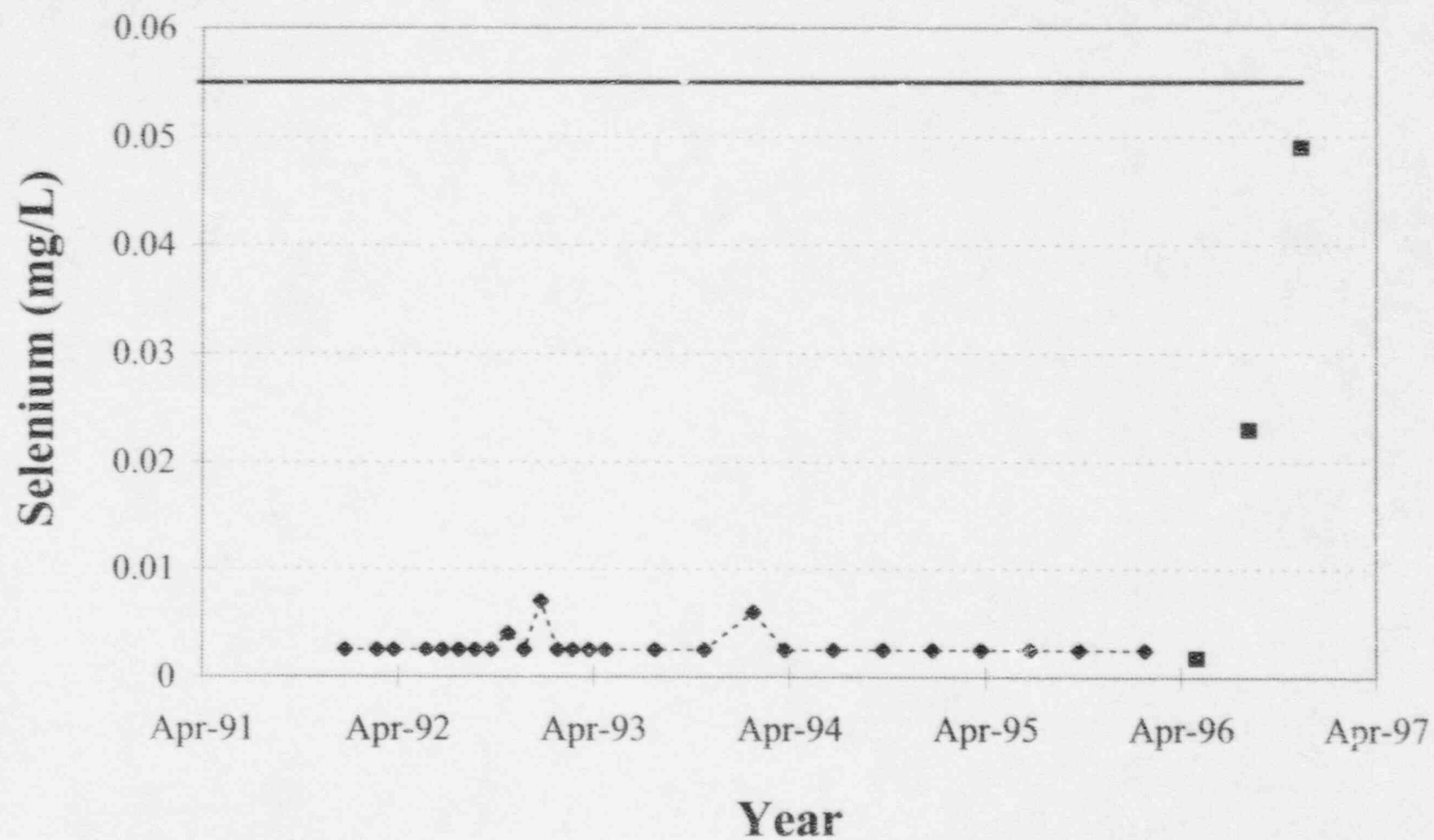
GW-63



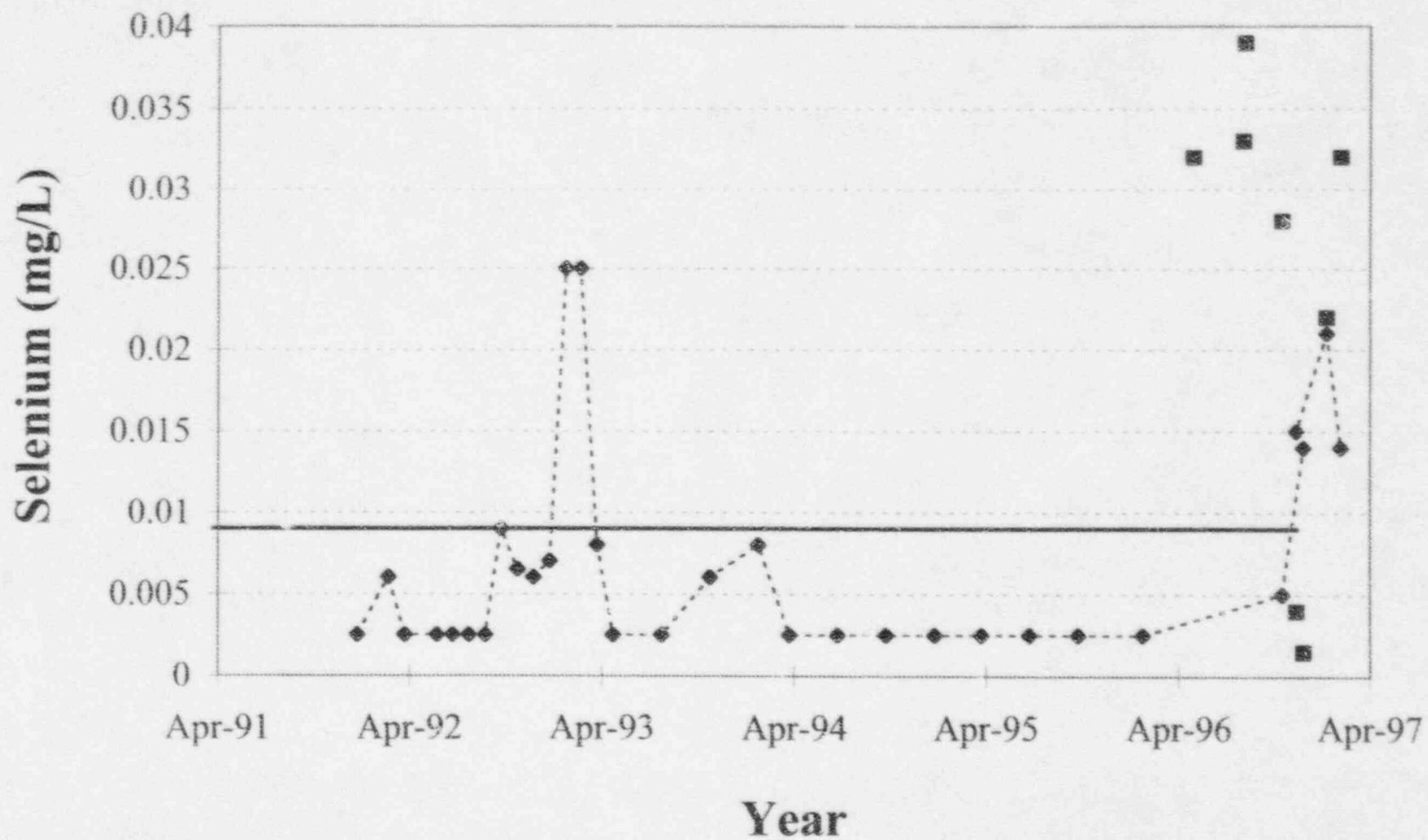
GW-19A



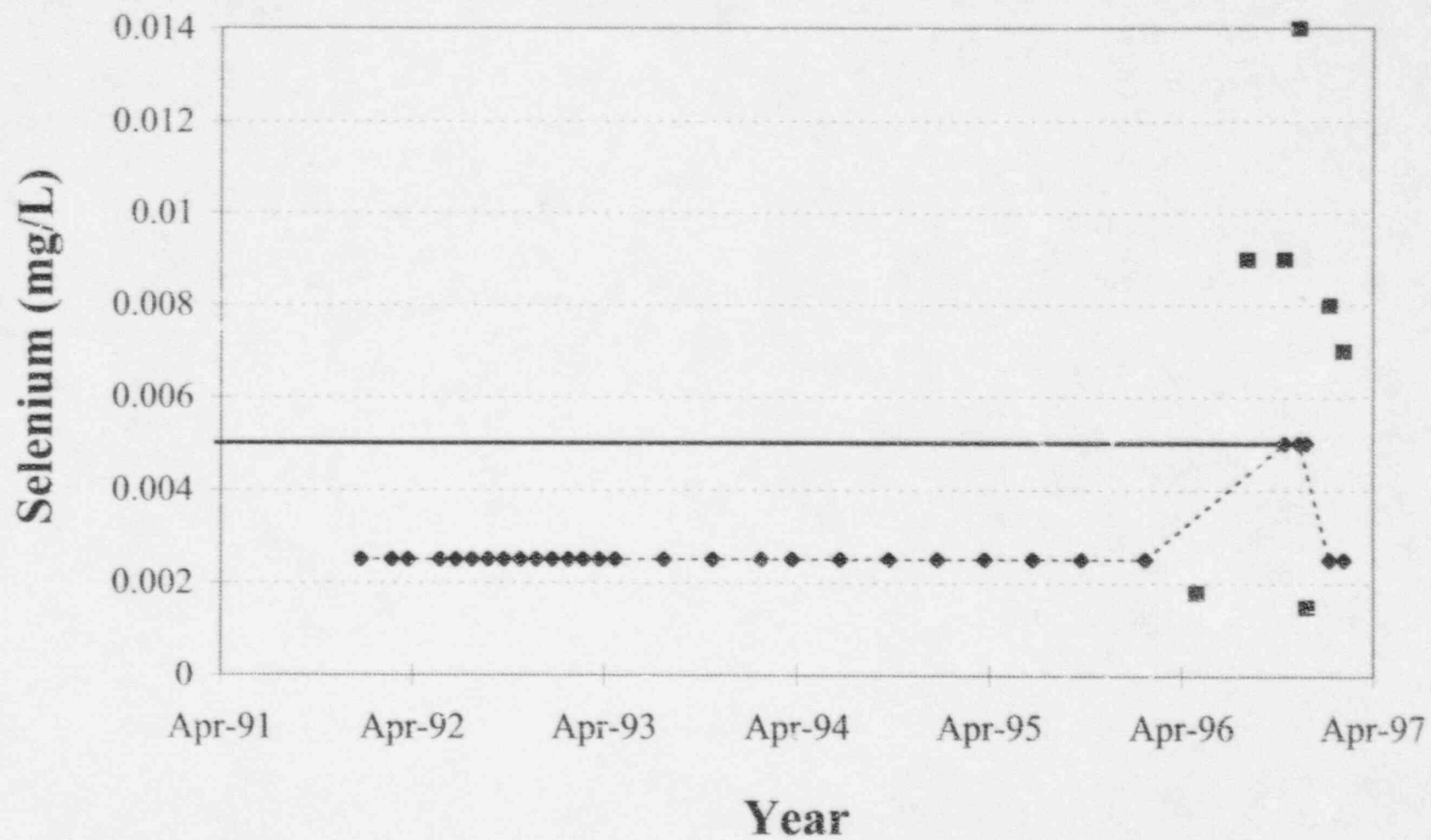
GW-20



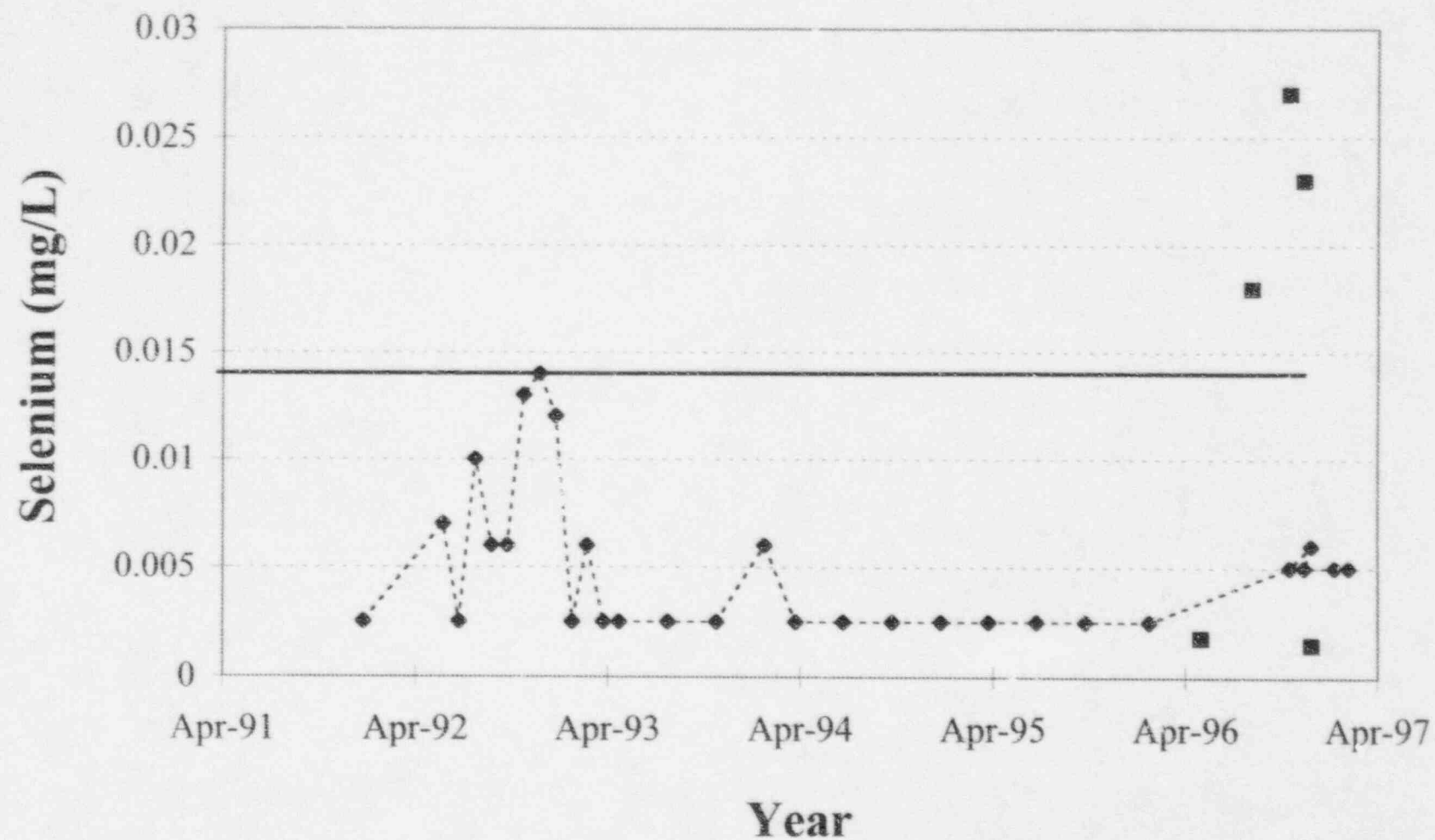
GW-24



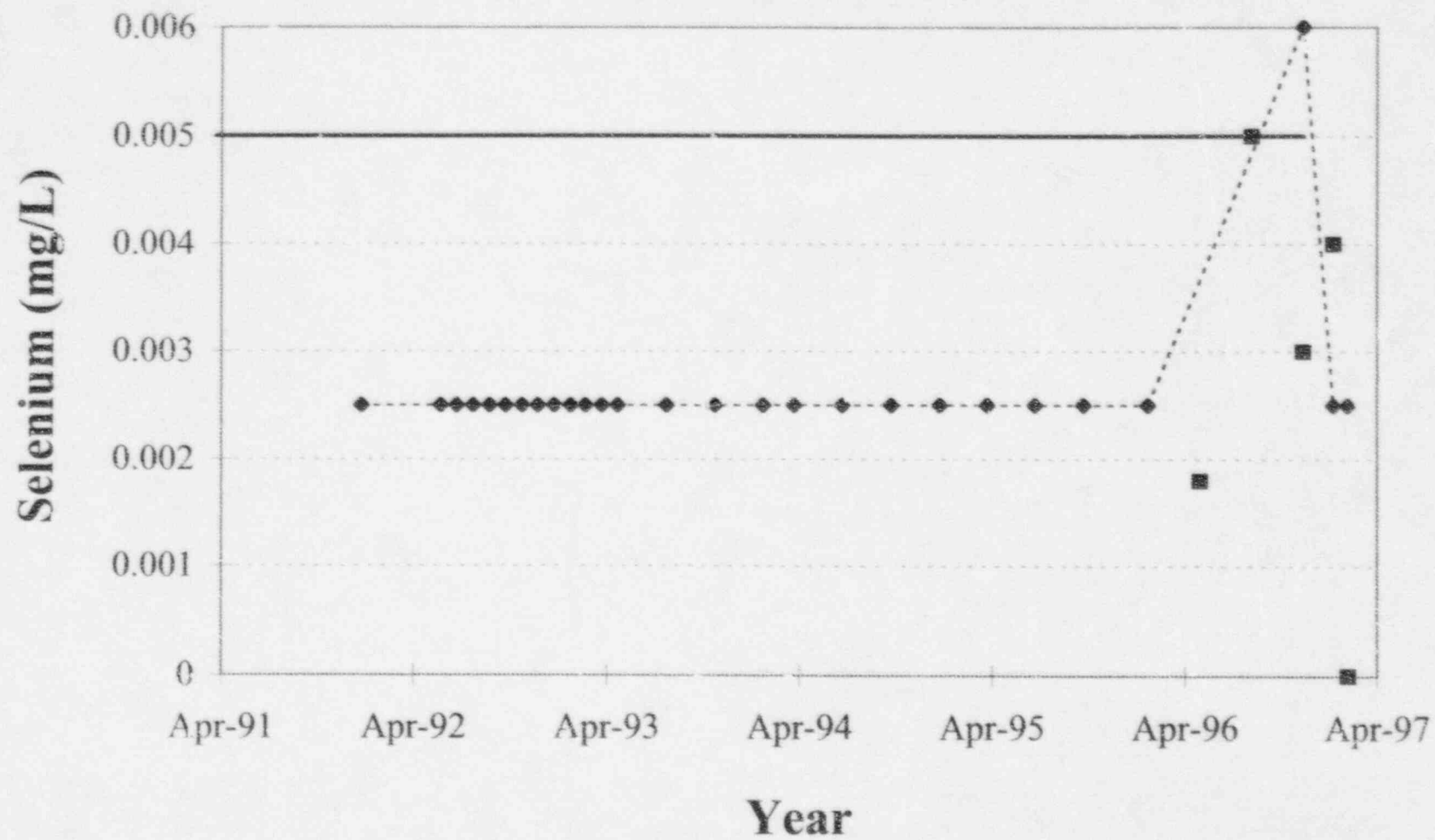
GW-25



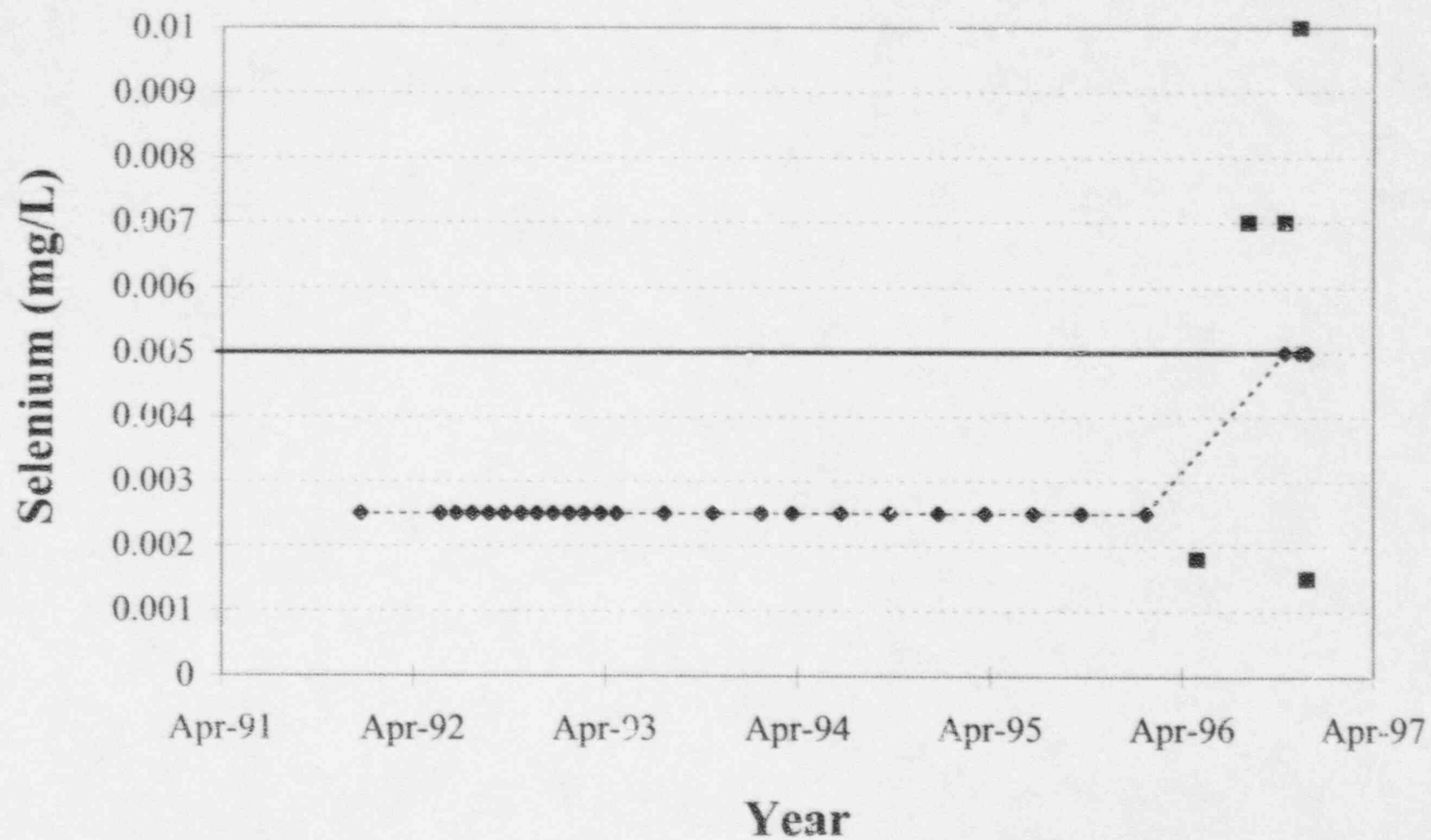
GW-26



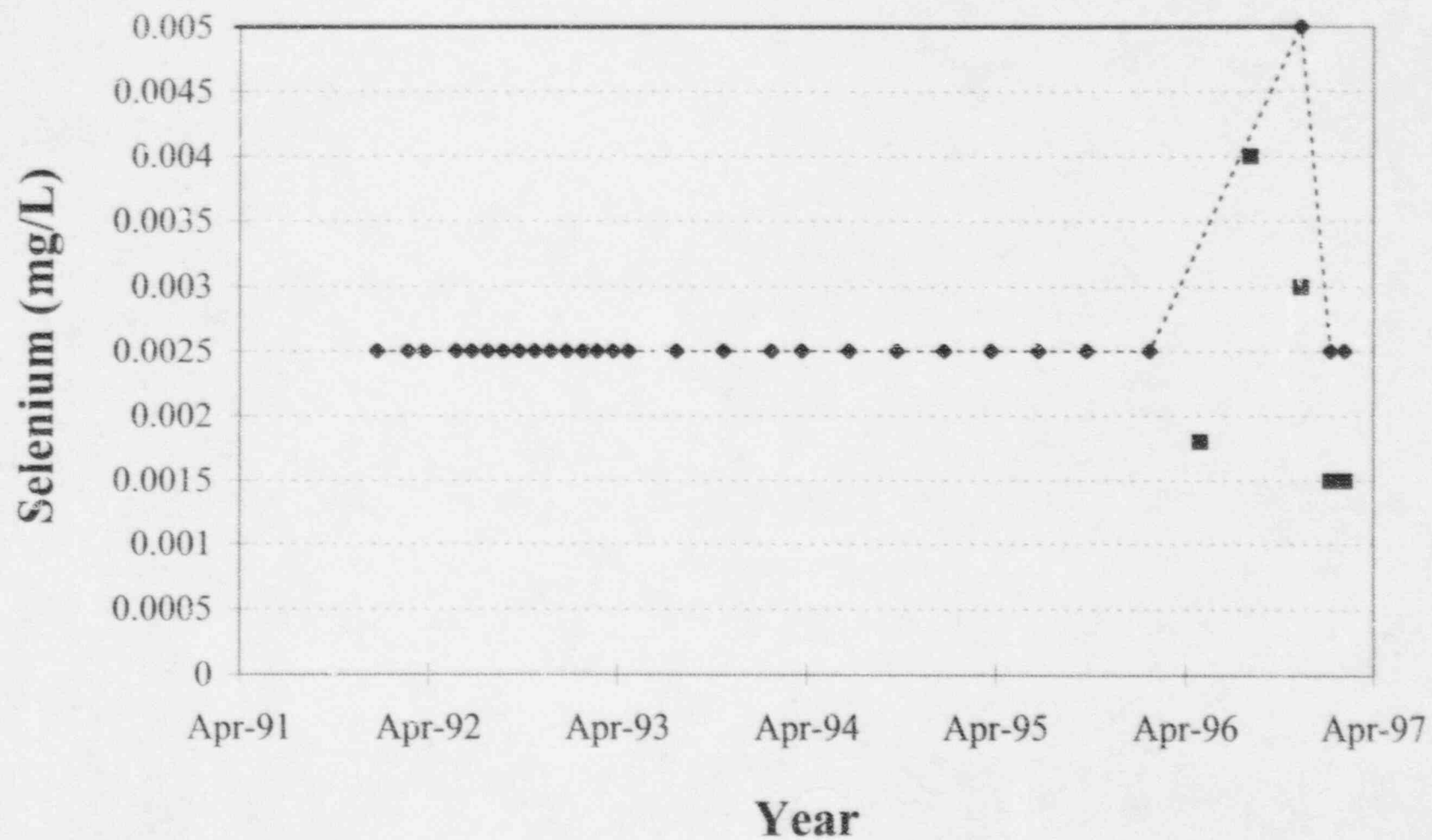
GW-27



10



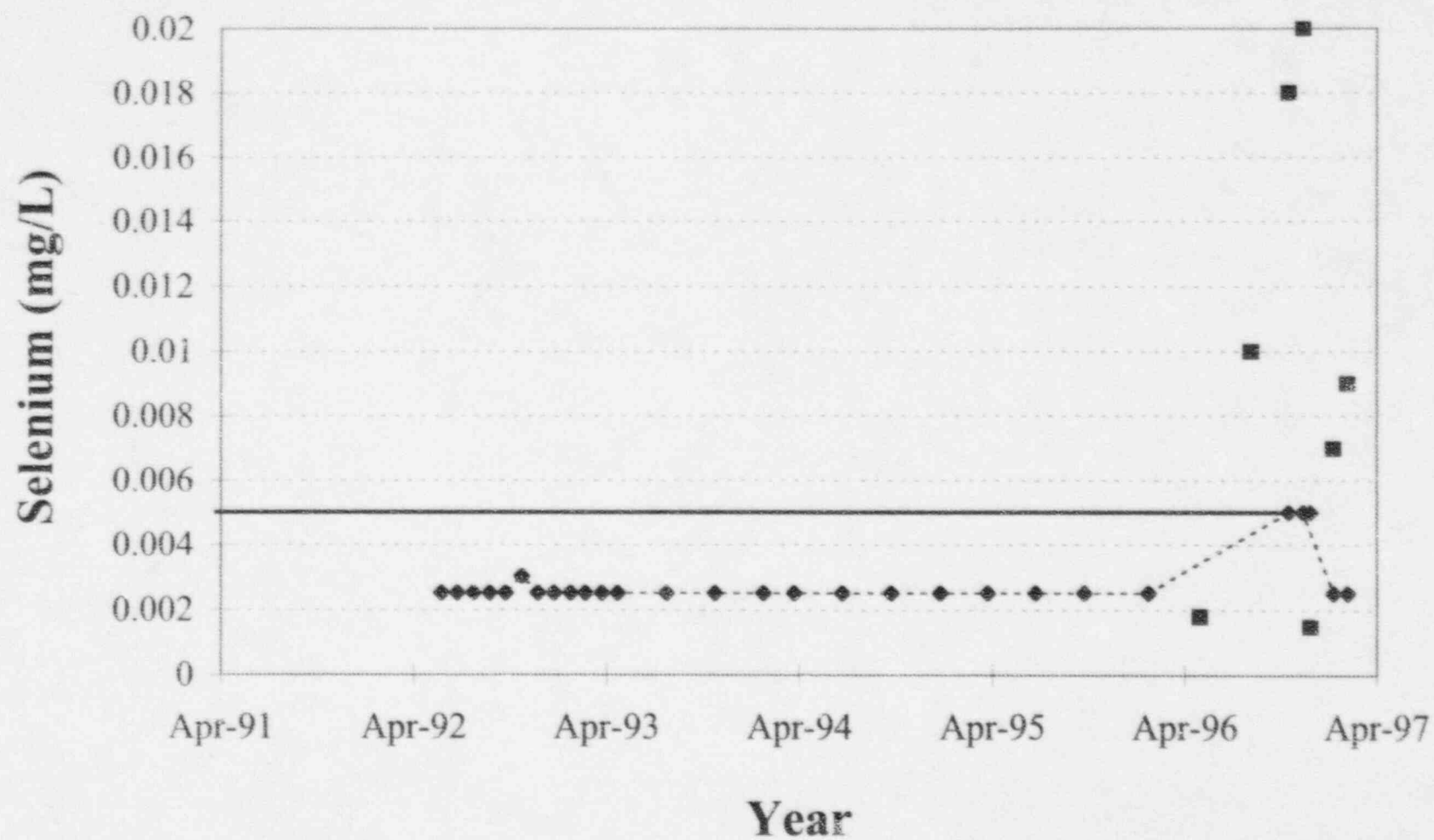
GW-29



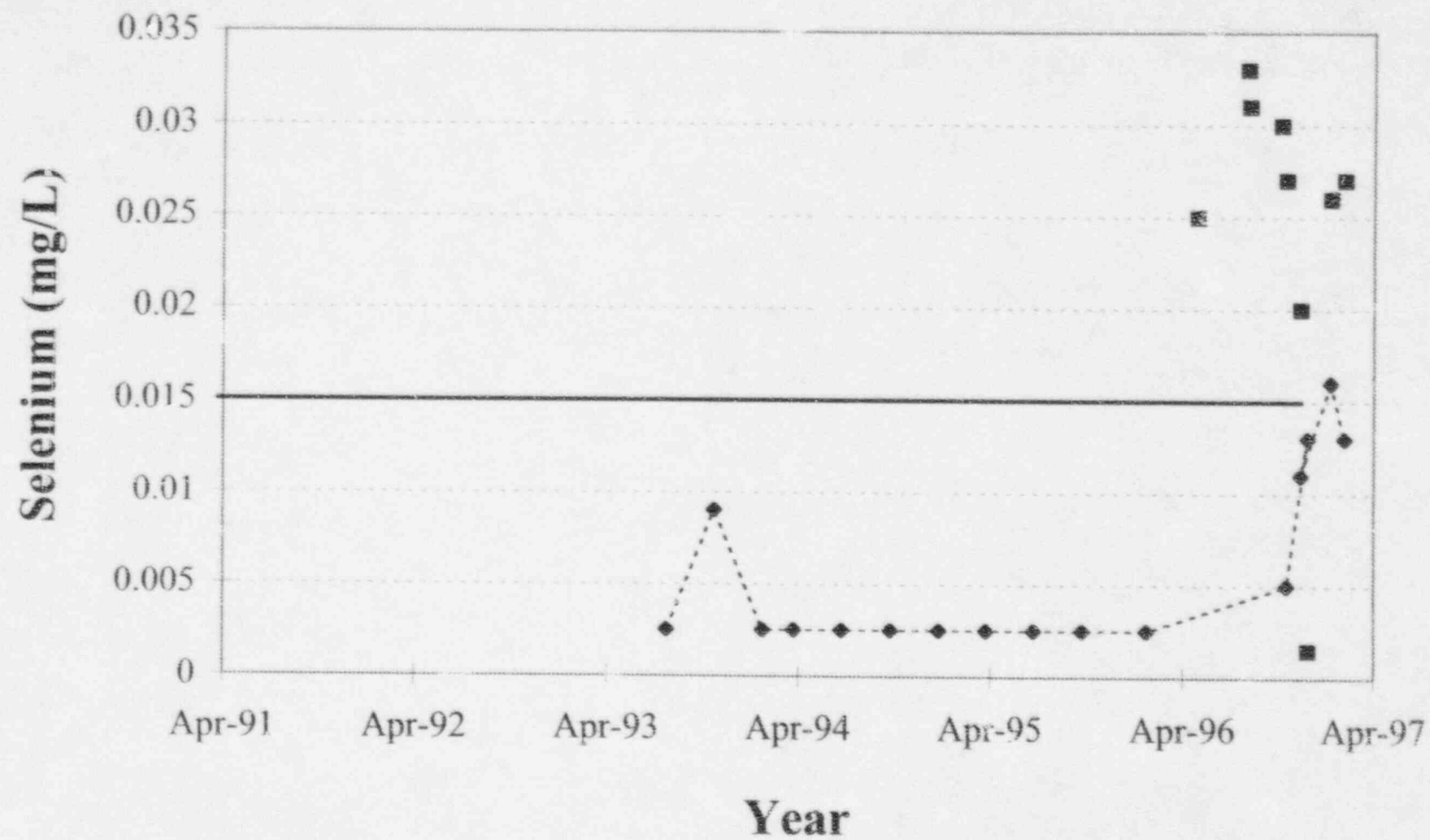
01-22-10



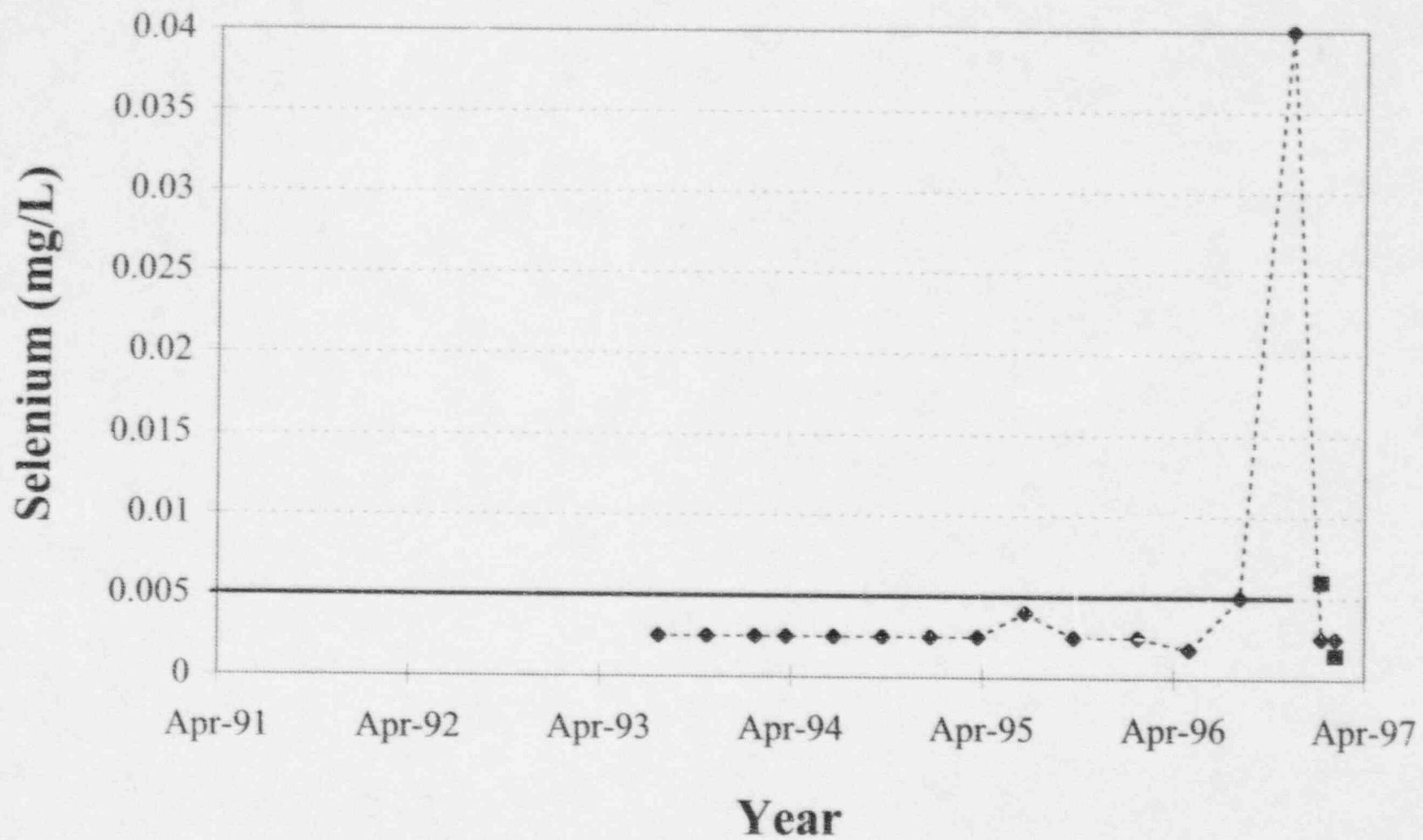
GW-58



GW-60



GW-63



CDS Laboratories Durango, Colorado
ANALYTICAL QA/QC SUMMARY STATEMENT
1995

As part of an overall commitment to a high degree of quality control our cooperative directed policy is to provide at least 25% of our laboratory and data production budget to quality control and quality assurance. This includes the use of standard curves for data calculation, knowns, and second source standards. All data is double checked outside of the computer and all reports are double signed before release to our valued clients. Using the 25% value the following are the QA/QC goals for any given set of samples:

- A. At least 10% of all samples are run in duplicate.
- B. At least 10% of all samples are spiked for recovery.
- C. 2-6 standards are run for each analytical set.
- D. Additional standards are run throughout the series of samples at the rate of one per 10 or less samples
- E. A standard and a blank are run at the end of each set.
- F. An EPA or NTIS traceable standard is run for each set of 20 or less samples.
- G. All equipment is checked against standards when possible (eg. NTIS wavelength calibration, NTIS thermometer, class S weights, - etc.).
- H. All major equipment is under service contract.
- I. All balances are under certification contracts and weights are traceable Class S.

In addition the following external QA/QC programs are in effect:

- A. Colorado State Dept. of Health SWDA Certification
 - EPA/Region VIII audit programs
 - State of Wyoming Certification [BY EPA]
 - State of New Mexico Certification
 - EPA Audit for NPDES permits (WP program)
 - EPA Acid Rain audit program EPA
 - TSP Filter audit program
 - EPA Air Parameters audit program

- B. Additional Round Robin Programs available
 - 1. Inner laboratory programs, when available
 - 2. Western Soils/Overburden Task Force
 - 3. US Office of Surface Mining
 - 4. EPA approved commercial suppliers
 - 5. Industry supplied QA samples, when available
- C. EPA external audit program, where available
EPA internal audit program, where available
- D. Methods Verification Program with EPRI
(Electric Power Research Institute for water)
- E. Split samples are run with other laboratories
when appropriate and available to our client
- F. Additional accreditation programs are
considered as they become available to CDS.
- G. Membership in the following Professional Societies:
 - 1. ASTM - American Standard Test Methods
 - 2. ACS - American Chemical Society
 - 3. ASBCMB - American Society of Biological Chemists &
Molecular Biologists
 - 4. ASA - American Scientific Affiliation
 - 5. AAAS - American Association for the Advancement of
Science
 - 6. Western Soils Overburden Task Force
 - 7. ASSMR - American Society for Surface Mining and
Reclamation
- H. The laboratory subscribes to several
professional journals, maintains an inhouse library of several thousand
reports, reference books and summaries and subscribes to a computer
library service
- I. All reports are computer generated via a LIMS
program to reduce errors and all reports are checked against lab data
books before approval and release to the client.
- J. All QA/QC data is available for observation
and review by our clients and actual printouts of the QC data in force at
the time of their analysis is available at a fixed cost per page.



PCN 4552

Certificate of Analysis



CUSTOM-GRADE SOLUTION 1000 $\mu\text{g/mL}$ Arsenic in 3.5% HNO_3 (abs)
 Catalog No: CGAS1-1 and CGAS1-5

Starting Material: Arsenic Metal
 Starting Material Purity: 99.999%
 Starting Material Lot No: G21F16

CERTIFIED VALUE FOR SOLUTION STANDARD - Lot No: L-AS01119

Certified Value: 1001 $\mu\text{g/mL}$

The certified value is the average of the classical wet assay and instrument analysis unless otherwise specified. All standards are accurate to a relative precision of $\pm 0.5\%$ at the 95% confidence level for a period of 1 year. (See expiration date below)

TRACEABILITY DOCUMENTATION:

Classical Wet Assay:

Actual Value: 1002 $\mu\text{g/mL}$

Method: Gravimetric as the Metal, Calculated

Sufficient number of sample measurements were made to give a minimum relative precision of $\pm 0.3\%$ at the 95% confidence level.

Instrumentation Analysis by Inductively Coupled

Plasma Spectroscopy (ICP): 1000 $\mu\text{g/mL}$ vs NIST SRM 3103a

Sufficient number of sample measurements were made to give a minimum relative precision of $\pm 0.5\%$ at the 95% confidence level.

We use purified acids, 18 megohm double deionized water & spectroscopically selected bottles in the manufacturing of Custom-Grade standards. We always use "in-house calibration checked" Class A Glassware. Our volumetric glassware is made gravimetrically using balances that are calibrated with NIST Weight Sets #NJB9074, #NJB9075, #NJB9076 and #NJB9077. These weights are registered with the US Office of Weights and Measures and are traceable through the standards of the State of NJ to NIST (formerly NBS).

TRACE METALLIC IMPURITIES IN ACTUAL SOLUTION STANDARD IN $\mu\text{g/mL}$:

* Al <0.02 ND	D Dy	* Li <0.03 ND	D Pr	D Te
* Sb <0.02 ND	D Er	D Lu	D Re	D Tb
* As	D Eu	* Mg <0.01 ND	D Rh	* Tl <0.05 ND
* Ba <0.01 ND	D Gd	* Mn <0.01 ND	D Rb	D Th
* Be <0.01 ND	* Ga <0.02 ND	* Hg <0.15 ND	D Ru	D Tm
* Bi <0.05 ND	D Ge	* Mo <0.03 ND	D Sm	D Sn
* B <0.02 ND	D Au	D Nd	D Sc	D Ti
* Cd <0.01 ND	D Hf	* Ni <0.01 ND	* Se <0.20 ND	D W
* Ce <0.01 ND	D Ho	D Nb	* Si <0.02 ND	D U
D Ce	* In <0.03 ND	D Os	* Ag <0.01 ND	* V <0.01 ND
D Cs	D Ir	D Pd	* Na <0.05 ND	D Yb
* Cr <0.01 ND	* Fe <0.02 ND	* P <0.05 ND	* Sr <0.01 ND	D Y
* Co <0.01 ND	D La	D Pt	D S	D Zn <0.01 ND
* Cu <0.01 ND	* Pb <0.04 ND	* K <0.40 ND	D Ta	D Zr

* - element checked for i - spectral interference n - not checked for ND - not detected D - detected s - solution standard element

ANALYZED DENSITY OF SOLUTION (measured at 22°C): 1.024 g/mL

The thermometers used in the determination of the final density are calibrated versus standard thermometer no. 903-2680 which was certified in accordance with the procedures outlined by ASTM E77-87 and NIST Monograph 150 using NIST Test#, Std#s: 769543, 217368/769543, 217368/P14452, 176240/P14452, 176240.

QA:MNG Rev. 01/97

Inorganic Ventures, Inc.

195 Lehigh Avenue • Suite 4 • Lakewood, NJ 08701

Orders: 800-669-6799 • FAX (908) 901-1903

Technical Support: 800-569-6799

Quality Assurance Manager

EXPIRES

12-01-97

PCN 4550



Certificate of Analysis

CUSTOM-GRADE SOLUTION 1000 $\mu\text{g/mL}$ Selenium in 1.4% HNO_3 (abs)
 Catalog No: CGSE1-1 and CGSE1-5

Starting Material: Selenium metal
 Starting Material Purity: 99.999%
 Starting Material Lot No: A09C08

CERTIFIED VALUE FOR SOLUTION STANDARD - Lot No: L-QSE01016

Certified Value: 1001 $\mu\text{g/mL}$

The certified value is the average of the classical wet assay and instrument analysis unless otherwise specified. All standards are accurate to a relative precision of $\pm 0.0\%$ at the 95% confidence level for a period of 1 year. (See expiration date below)

TRACEABILITY DOCUMENTATION:

Classical Wet Assay:

Actual Value: 1002 $\mu\text{g/mL}$

Method: Calculated, based on starting material

Sufficient number of sample measurements were made to give a minimum relative precision of $\pm 0.3\%$ at the 95% confidence level.

Instrumentation Analysis by Inductively Coupled

Plasma Spectroscopy (ICP): 999 $\mu\text{g/mL}$ vs NIST SRM 3148

Sufficient number of sample measurements were made to give a minimum relative precision of $\pm 0.5\%$ at the 95% confidence level.

We use purified acids, 18 megohm double deionized water & meticulously cleaned bottles in the manufacturing of Custom-Grade standards. We always use "in-house calibration checked" Class A Glassware. Our standards are made gravimetrically using balances that are calibrated with Intered NJ Weight Sets #NJ89074, N189034, N189052 and N189091. These weights are registered with the NJ Office of Weights and Measures and are traceable through the standards of the State of NJ to NIST (formerly NBS).

TRACE METALLIC IMPURITIES IN ACTUAL SOLUTION STANDARD IN $\mu\text{g/mL}$:

* Al <0.02 ND	□ Dy	* Li <0.03 ND	□ Pr	□ Te
* Sb <0.02 ND	□ Er	□ Lu	□ Re	□ Tb
* As <0.04 ND	□ Eu	* Mg <0.01 ND	□ Rh	* Ti <0.06 ND
* Ba <0.01 ND	□ Gd	* Mn <0.01 ND	□ Rb	□ Th
* Be <0.01 ND	□ Ge <0.02 ND	* Hg <0.15 ND	□ Ru	□ Tm
* Bi <0.08 ND	□ Ga	* Mo <0.03 ND	□ Sm	□ Sn
* B <0.02 ND	□ Au	□ Nd	□ Sc	□ Ti
* Cd <0.01 ND	□ Hf	* Ni <0.01 ND	* Se	□ W
* Ca <0.01 ND	□ Ho	□ Nb	□ Si <0.02 ND	□ U
□ Ce	* In <0.03 ND	□ Os	* Ag <0.01 ND	* V <0.01 ND
□ Cs	□ Ir	□ Pd	* Na <0.05 ND	□ Yb
* Cr <0.01 ND	□ Fe <0.02 ND	* P <0.05 ND	* Sr <0.01 ND	□ Y
* Co <0.01 ND	□ La	□ Pt	□ S	* Zn <0.01 ND
* Cu <0.01 ND	* Pb <0.04 ND	* K	□ Ta	□ Zr

* - element checked for i - spectral interference n - not checked for ND - not detected D - detected s - solution standard element

ANALYZED DENSITY OF SOLUTION (measured at 22°C): 1.010 g/mL

The thermometers used in the determination of the final densities are calibrated versus standard thermometer no. 903-2680 which was certified in accordance with the procedures outlined by ASTM E77-87 and NIST Monograph 150 using NIST Test, Std's: 769543, 217368/769543, 217368/P14452, 176240/P14452, 176240.

QA: MING

Inorganic Ventures, Inc.

195 Lough Avenue • Suite 4 • Lakewood, NJ 08701

Orders: 800-669-6799 • FAX (908) 901-1903

Technical Support: 800-669-6799

Quality Assurance Manager

EXPIRES

12-01-97

CERTIFICATE OF ANALYSIS

General Product Data
 CAS No : 100
 FW : 246
 Molecular formula : Mg

34-99-8
 48
 5.04 - 7 H2 O

Quality assay Compl. (%)
 Heavy metals
 Trace analysis

: 99.98
 : <0.0005 (MEASURE: %)
 : TYPE: CL MEASURE
 : TYPE: P04 MEASURE
 : TYPE: R03 MEASURE
 : TYPE: R04 MEASURE
 : TYPE: AS MEASURE
 : TYPE: CA MEASURE
 : TYPE: CU MEASURE
 : TYPE: FE MEASURE
 : TYPE: K MEASURE
 : TYPE: NI MEASURE
 : TYPE: BA MEASURE
 : TYPE: NI MEASURE
 : TYPE: PB MEASURE
 : TYPE: SI MEASURE
 : TYPE: SR MEASURE
 : TYPE: ZN MEASURE
 : PH (5% SOL.) : 5.04
 : INSOLUBLE IN H2O : 0.0
 : 890852

0.5%

Product 42390.0000
 Lot No. A0106434
 MAGNESIUM SULFATE HEPTAHYDRATE, REAGENT
 ACS (CRYSTALS)

ACROS

Issued: 27-01-1997
 A. Vanneste Quality Control Manager
 This report has been computer generated and does not contain a signature.

FROM: Fisher Scientific TO: Extension PAGES: 4 2

Fisher Scientific Company
Chemical Manufacturing Division**Certificate of Analysis**

1 Reagent Lane

Fair Lawn, NJ 07410


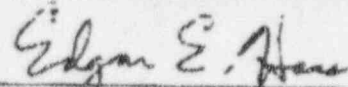
Phone: (201) 796-7100 Fax: (201) 796-1329

Catalog Number	S271	Report Date	2/10/97	Mfg. Date	1/24/97
Lot Number	972274	Sample ID	S271..972274.CQS		
Description	SODIUM CHLORIDE, A.C.S.				

This is to certify that units of the above mentioned lot number were tested and found to comply with the specifications of the grade listed. The following are the actual analytical results obtained:

Result Name	Units	Test Value
APPEARANCE	PASS/FAIL	SMALL WHITE CRYSTALS
ASSAY	%	99.6000
BARIUM (Ba)	PASS/FAIL	PASS
BROMIDE IN %	%	<0.010
CHLORATE & NITRATE	%	0.0010
HEAVY METALS	PPM	1.00
IDENTIFICATION		PASS
INSOLUBLE MATTER	%	0.0020
IODIDE	%	0.0010
IRON (Fe)	PPM	1.000
NITROGEN COMPOUNDS	%	0.0010
PH OF A 5% SOLUTION		7.00
PHOSPHATE (PO4)	PPM	1.000
POTASSIUM	%	0.00200
CA, MG, & R2O3 PPT	%	0.001
SULFATE (SO4)	%	0.0030

CERTIFIED BY:


Lab Manager Fair Lawn
Lab Manager BPF

Note: The data listed is valid for all package sizes of this lot of product, expressed as a extension of the catalog number listed above. If there are any questions with this certificate, please call Chemical Services at (800) 227-6701

FROM: Fisher Scientific TO: Extension PAGES: 4 3

FISHER SCIENTIFIC CHEMICAL DIVISION
One Reagent Lane, Fair Lawn, NJ 07410

ANALYTICAL CONTROL LABORATORY ANALYSIS

Name & Grade:

CALCIUM SULFATE NATIVE POWDER

Catalog Number: C138

Lot Number: 951554

Date of Testing/Mfg: 05/09/95

P.O. / Other Customer ID:

This is to certify that units of the above mentioned lot number were tested and found to comply with the specifications of the grade listed. The following are the actual analytical results obtained:

Test	Unit	Result
APPEARANCE	PASS/FAIL	PASS-SLIGHT OFF-WHITE POWDER
IDENTIFICATION		PASS

Approved by: Frederick H. Turk,
FL Liquid Supv.Robert Dowd
FL Dry Supv.Edgar E. Hess,
BPF Lab Supv.

Date: 05/17/95 (Signed and dated original is on file)

NOTE: The data listed is valid for all package sizes of this lot of product, expressed as a extension of the catalog number listed above. If there are any questions with this certificate, please call Chemical Services (option 5) at (800) 388-8355.

Ref. No. C138..951554.B1.

Location: FL

FROM: Fisher Scientific TO: Extension PAGES: 4 4

FISHER SCIENTIFIC CHEMICAL DIVISION
One Reagent Lane, Fair Lawn, NJ 07410

ANALYTICAL CONTROL LABORATORY ANALYSIS

Name & Grade:

POTASSIUM CHLORIDE, USP/FCC

Catalog Number: P330

Lot Number: 062013

P.O. / Other Customer ID:

Date of Testing/Mfg: 07/00/96

This is to certify that units of the above mentioned lot number were tested and found to comply with the specifications of the grade listed. The following are the actual analytical results obtained:

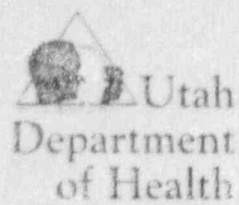
Test	Unit	Result
APPEARANCE	PASS/FAIL	PASS-WHITE GRANULAR PHDR
ACIDITY- ALKALINITY	PASS/FAIL	(1) PASS
ARSENIC (As)	PPM	(1) 0.600
ASSAY	%	(1) 99.6000
CALCIUM & MAGNESIUM	PASS/FAIL	(1) PASS
HEAVY METALS	%	(1) 0.0002
IDENTIFICATION		(1) PASS
IODIDE & BROMIDE	PASS/FAIL	(1) PASS
LOSS ON DRYING IN %	%	(1) 0.20000
ORGANIC VOLATILE IMP		(1) PASS
SODIUM	PASS/FAIL	(1) PASS

Approved by: Frederick H. Turk,
FL Liquid Supv.Robert Dowd
FL Dry Supv.Edgar E. Hess,
BPF Lab Supv.

Date: 07/09/96 (Signed and dated original is on file)

NOTE: The data listed is valid for all package sizes of this lot of product, expressed as a extension of the catalog number listed above. If there are any questions with this certificate, please call Chemical Services (option 5) at (800) 388-8355

Rcid URB
4-4-97



State of Utah

Michael O. Leavitt
Governor
Rod L. Bennett
Executive Director
Charles D. Brokopp, Dr. PH.
Director



Bureau of Laboratory Improvement
46 North Medical Drive
Salt Lake City, Utah 84143-1105
Telephone: 801-584-8469
Fax: 801-584-8501

March 21, 1997

Loren B. Morton
Division of Radiation Control
Department of Environmental Quality
168 North 1950 West
Salt Lake City, UT 84114

Dear Mr. Morton:

This letter is a follow-up of a letter dated March 5, 1997 that I sent to you about the requested investigation of the discrepancies of the methods analyzing arsenic (As) and selenium (Se).

The final conclusions of this report is that the methodologies employed by both American West Analytical Laboratories (AWAL) and Mountain States Analytical (MSA) are significantly different. The results of both the graphite furnace atomic absorption spectrophotometer employed by AWAL and the hydride atomic absorption spectrophotometer by MSA do produce different results.

In the attached table to this letter has all the results of the analytical batches you requested me to investigate. The results indicated, for the most part, that the results from MSA were higher than the AWAL results. It seems that both methods are precise because blind duplicate samples had close agreement with the exception of MSA batch 14550. Again this can be attributed or related directly to the different digestion and instrumental analysis employed by both laboratories.

There is a need for clarification from my report of March 5, 1997. The finding of the MSA not performing Method 7061A came from the regularly scheduled recertification audit which is scheduled every two years. It was a finding in this year MSA recertification survey. MSA will be required to respond to this deficiency to Mr. Karl Oberg. Further, Mr. Oberg indicated in his report to MSA that the digestion procedure using ASTM method D3859 was used for soil analysis, not for water analysis. A different digestion procedure for waters is required under the Standard Methods 3114 C. I apologize for any confusion that it might have caused.

As a final conclusion, methods reviewed for AWAL and MSA were deviations of promulgated methodology under the Resource Conservation and Recovery Act certification program. However, data generated by these two methods could be validate to be correct and complete. It is my opinion that data generated could be determined to be valid but it may not be acceptable for compliance work because it did not follow the promulgated methodology under Utah Rule R444-14.

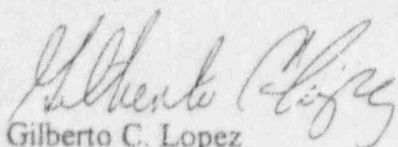
Loren B. Morton

March 21, 1997

Page 2 of 2

If you need additional information regarding this report, please contact me at your convenience at (801) 584-8466.

Sincerely,

A handwritten signature in cursive script, appearing to read "Gilberto C. Lopez".

Gilberto C. Lopez

Laboratory Certification Officer

encl 1

TABLE 1. COMPARISON OF DATA REVIEWED.

MSA sample group	RESULTS (mg/L)	AWAL sample group	RESULTS (mg/L)
54861-14089	0.095	L27508-1	0.077
54862-14089	0.034	L27508-2	0.02
54863-14089	0.197	L27508-3	0.14
54864-14089	0.072	L27508-4	0.044
54865-14089	0.047	L27508-5	0.022
54866-14089	0.079	L27508-6	0.056
54867-14089+	0.129	L27508-7+	0.086
54868-14089	0.045	L27508-8	0.022
54869-14089	0.041	L27508-9	0.023
54870-14089	0.039	L27508-10	0.022
54871-14089+	0.129	L27508-11+	0.088

MSA sample group	RESULTS (mg/L)	AWAL sample group	RESULTS (mg/L)
56355-14550	0.11	L27900-1	0.089
56356-14550	0.27	L27900-2	0.17
56357-14550	0.079	L27900-3	0.061
56358-14550	0.049	L27900-4	0.033
56359-14550	0.098	L27900-5	0.068
56360-14550+	0.21	L27900-6+	0.11
56361-14550+	0.13	L27900-7+	0.11
56362-14550	0.04	L27900-8	0.028
56363-14550	0.041	L27900-9	0.031
56364-14550	0.047	L27900-10	0.029
56365-14550	0.033	L27900-11	0.025

+ Duplicate samples of well GW-58.

TABLE 1. COMPARISON OF DATA REVIEWED (continued).

MSA sample group	RESULTS (mg/L)	AWAL sample group	RESULTS (mg/L)
56490-14591	0.037	L27927-1	0.021



State of Utah

DEPARTMENT OF ENVIRONMENTAL QUALITY DIVISION OF RADIATION CONTROL

Michael G. Leavitt
Governor

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April 2, 1997

Mr. Mark Williamson
Adrian Brown Consultants
155 S. Madison St., Suite 230
Denver, CO 80209-3013

Dear Mr. ^{Mark}Williamson:

This letter is in response to your request for an electronic copy of our groundwater quality database for the Envirocare of Utah facility near Clive, Utah. As previously discussed, our Envirocare groundwater quality database operates on Dataease software.

During our discussion today, it was agreed that we would provide you with electronic copy of Dataease backup files of the database in question. These files are found on the three floppy disks enclosed.

As mentioned previously, our Envirocare groundwater database contains data up thru and including the February 27, 1997 report by EarthFax Engineering entitled "1996 Second Semiannual LARW/11e.(2) Groundwater Monitoring Event Report". However, we have identified several missing data items from this report, and are awaiting Envirocare's resolution of these needed data. These needed data will be added to our database after receipt from Envirocare.

Please be advised that the Envirocare enclosed database backup files do not contain any inorganic or organic groundwater quality data for the Mixed Waste disposal unit. In addition, we are about to undertake a major change in our Envirocare database by adding radiological groundwater quality data from the Mixed Waste disposal unit. These data will be added shortly after receipt from Envirocare.

If you have any questions regarding the backup files enclosed, please call me at (801) 536-4262.

Sincerely,

Loren B. Morton
Hydrogeologist



Mr. Mark Williamson

April 2, 1997

Page 2

enclosures (3 floppy disks)

cc: Ken Alkema, Envirocare
Otis Willoughby, DS/HW
Latif Hamden, NRC-Washington, D.C.
Fred Ross, NRC-Washington, D.C.

F:\ABCgwreq.ltr

File: Envirocare GW Permit, GW Correspondence