Appendix F

Correspondence Associated with Site Transfer

Umetco Gas Hills Site

Fremont and Natrona Counties, Wyoming

Umetco Minerals Corporation
2754 Compass Drive, Suite 280
Grand Junction, Colorado 81506

May 2001

Umetco Minerals Corporation

P.O. BOX 1029
GRAND JUNCTION, COLORADO 81502
☎ (970) 245-3700

January 15, 1999

Mr. Russel Edge
Long-Term Surveillance and Maintenance Program Manager
U. S. Department of Energy
2597 B ¾ Road
Grand Junction, Colorado 81502

SUBJECT: Land Transfer at the Gas Hills Facility, Fremont and Natrona Counties, Wyoming.

Dear Mr. Edge:

Umetco Minerals Corporation is currently preparing an Alternate Concentration Limit (ACL) Application for the Gas Hills Facility in Fremont and Natrona Counties, Wyoming. The U. S. Nuclear Regulatory Commission (NRC) requires that a written assurance be secured and that an appropriate State or Federal agency accept the transfer of the property, including land in excess of that needed for tailings disposal. Umetco requests that the U. S. Department of Energy provide this written assurance pending NRC approval and title clearance by the U. S. Army Corps of Engineers. The Gas Hills site will consist of approximately 1,920 acres including tailings disposal areas, reclaimed mine lands, and the point of exposure locations as currently proposed in the ACL Application. However, the amount of acreage may change depending on requirements of the NRC and the Wyoming Department of Environmental Quality. A map is enclosed showing the approximate property boundary that is required for transfer. Umetco Minerals Corporation is looking forward to working with you on this matter. If you have any questions, please call me at (970) 256-8836.

Sincerely,

Curtis O. Sealy

Curtis O. Sealy, P. E.
General Manager

COS/lan

cc: file

99-003.doc

U.S. Department of Energy
Grand Junction Office
2597 B¾ Road
Grand Junction, CO 81503

FEB 16 1999

Mr. Curtis O. Sealy, P.E.
General Manager
UMETCO
P.O. Box 1029
Grand Junction, CO 81502

Subject: Land Transfer at the Gas Hills Facility, Fremont and Natrona Counties, Wyoming

Dear Mr. Sealy:

I am writing in response to your letter dated January 15, 1999, in which you ask for written assurance that the Department of Energy accepts the proposed site boundaries for the UMETCO Title II Gas Hills facility. Upon our initial review of the proposed boundaries, which will include 1,920 acres associated with tailings disposal areas, reclaimed mine lands, and encompasses point of exposure localities to support your ground water compliance strategy of the application of Alternate Concentration Limits (ACLs), we are agreeable to what has been presented. However, final acceptance and transfer of the property is subject to a title clearance review by the Army Corps of Engineers and approval of the ACL by the Nuclear Regulatory Commission, along with resolution of any outstanding issues that may arise.

We look forward to working with you in the future. Should you have any questions, please contact me at 248-6037.

Sincerely,

Russel Edge

Russel Edge
LTSM Program Manager

cc:
N. K. Stablein, NRC
File LUGH1.0 (H. Salter)

re\2-16ltr.doc

Appendix G

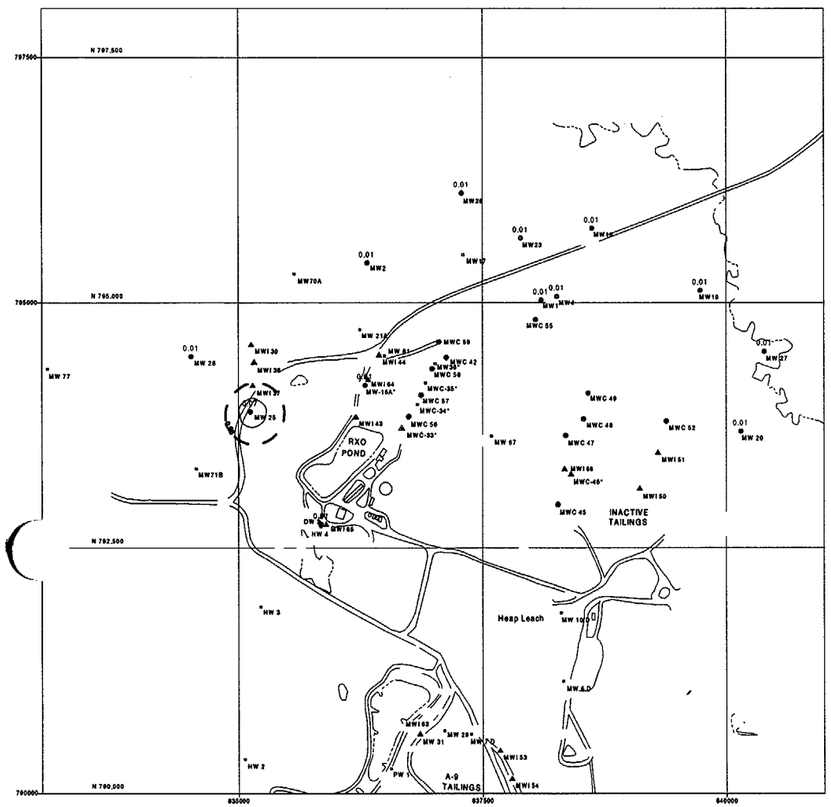
Isoconcentration Maps

Umetco Gas Hills Site

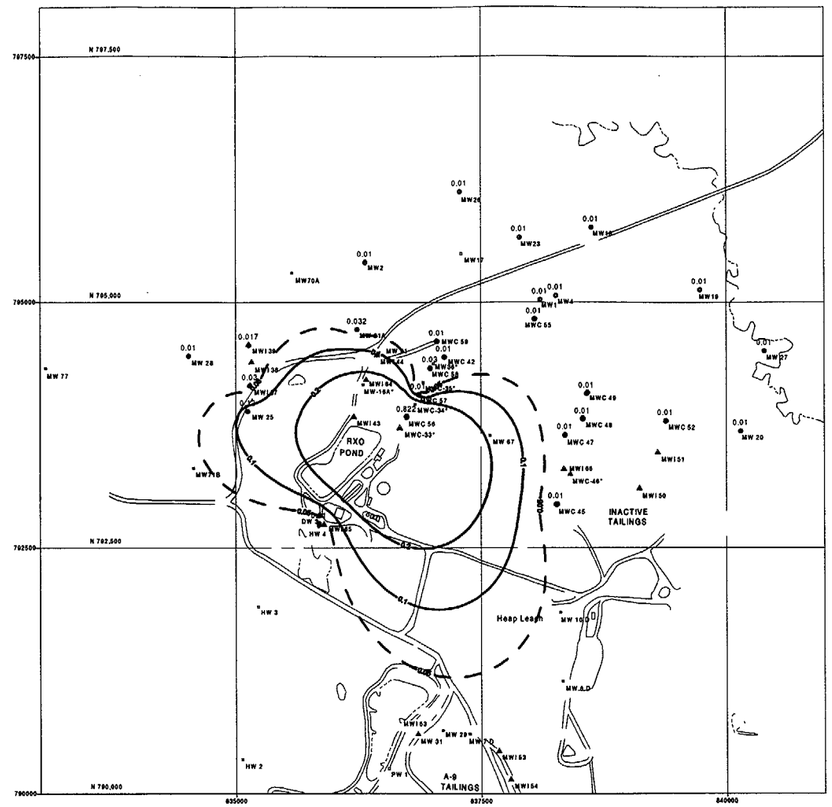
Fremont and Natrona Counties, Wyoming

Umetco Minerals Corporation
2754 Compass Drive, Suite 280
Grand Junction, Colorado 81506

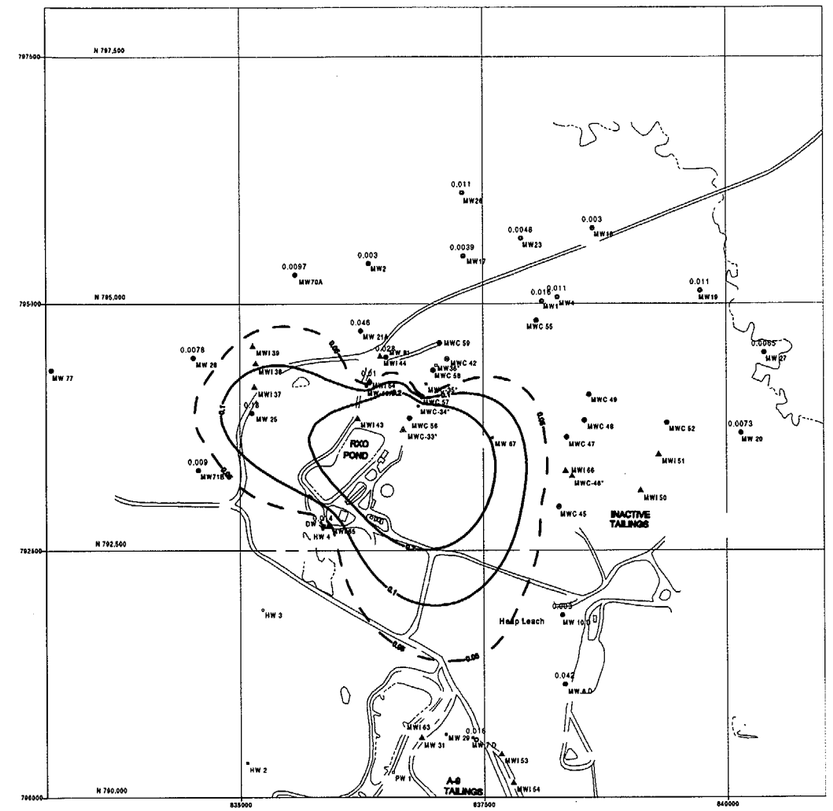
May 2001



April-June 1990



January-March 1995



January-March 2000

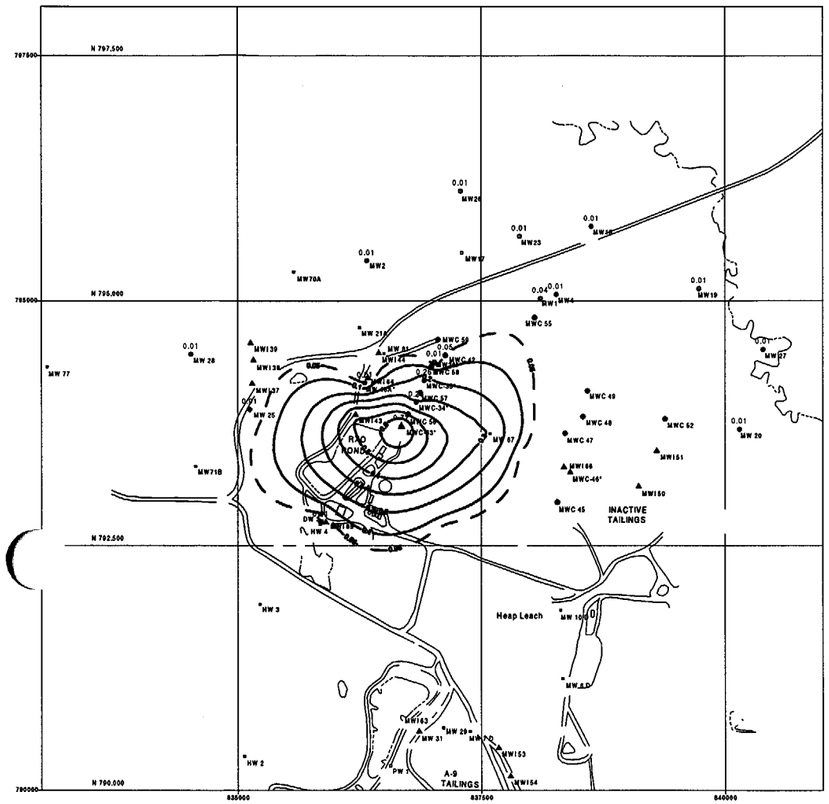
N

○ Measurement location (value in mg/L)

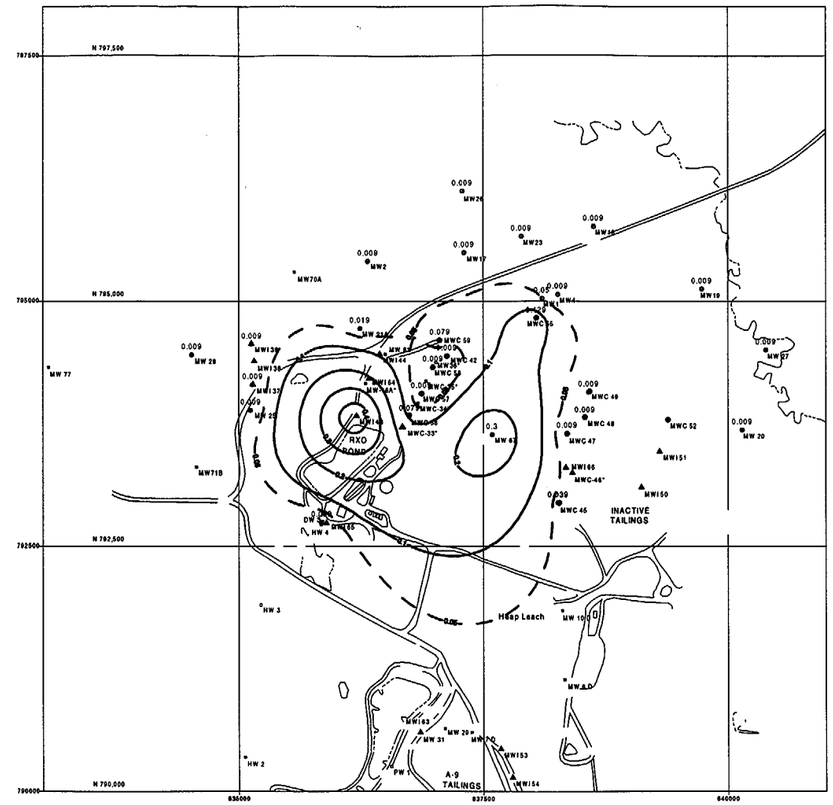
■ MW2 Monitoring well

— 0.05 — Ground-water protection standard

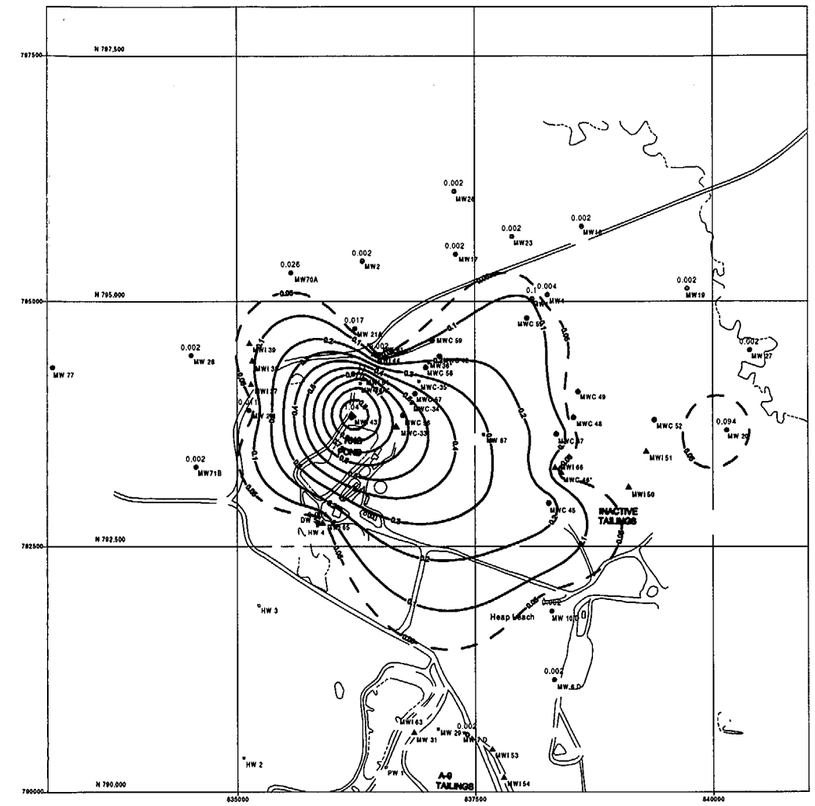
Figure G-1. Arsenic Distribution in Groundwater
Western Flow Regime (Lower Wind River)
Gas Hills Site, Umetco Minerals Corporation



April-June 1990



February-March 1995



January-March 2000

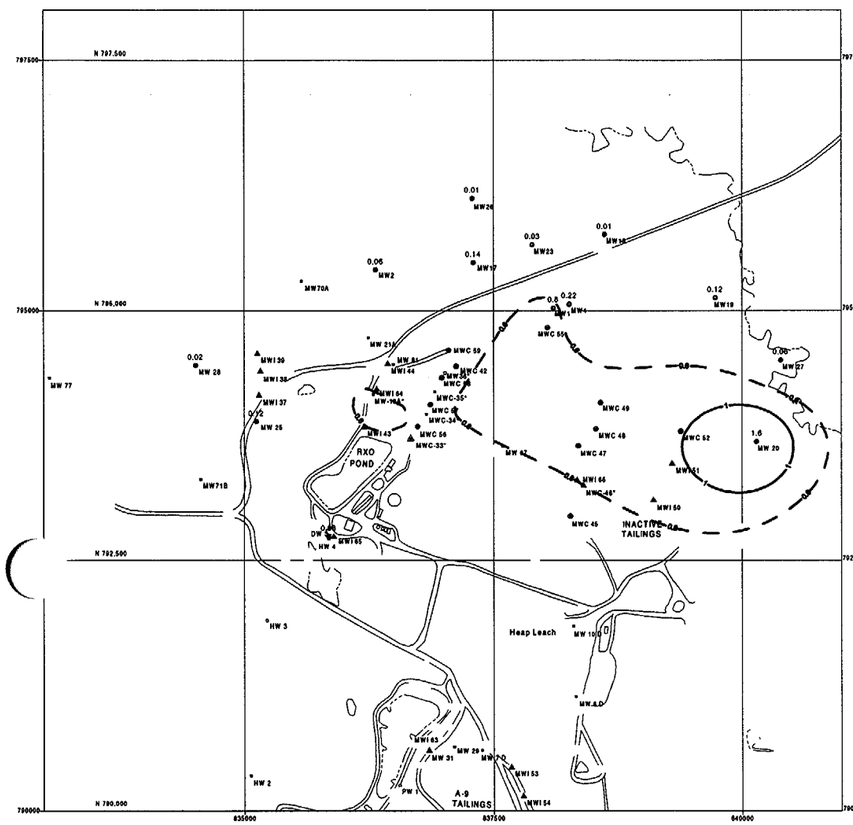
N

○ Measurement location (value in mg/L)

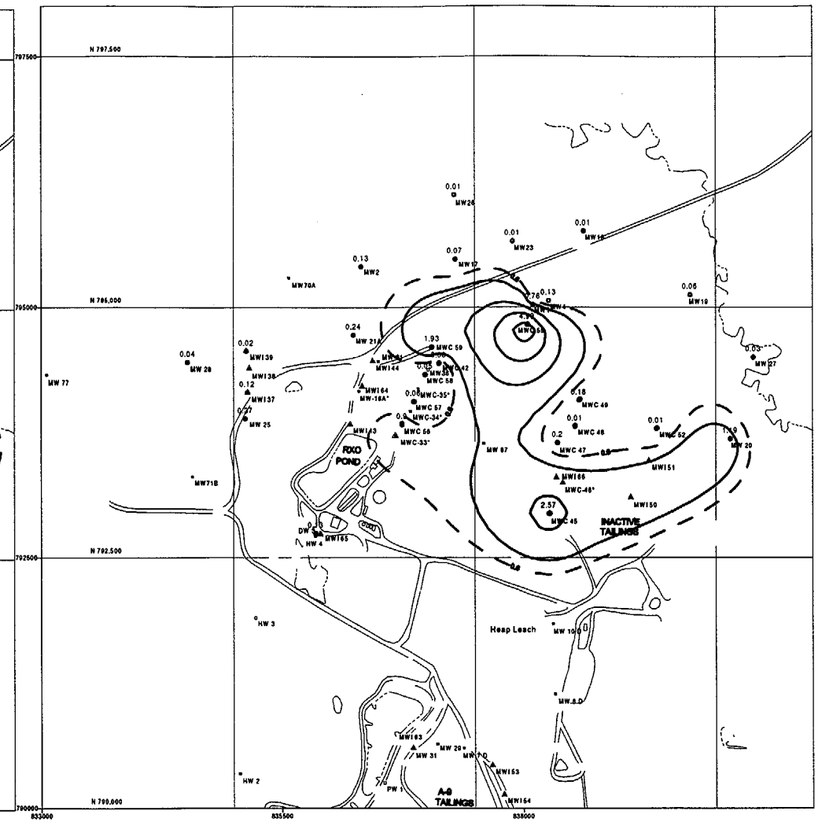
■ MW2 Monitoring well

0.05 Ground-water protection standard

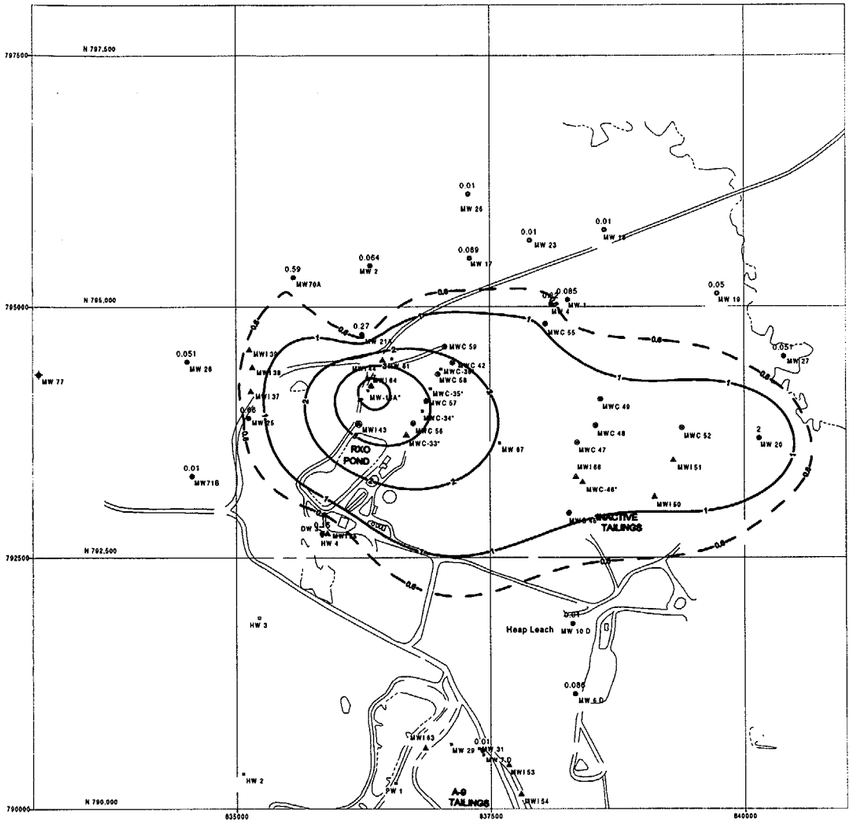
Figure G-2. Berylium Distribution in Groundwater
Western Flow Regime (Lower Wind River)
Gas Hills Site, Umetco Minerals Corporation



April-June 1990



February-March 1995



January-March 2000

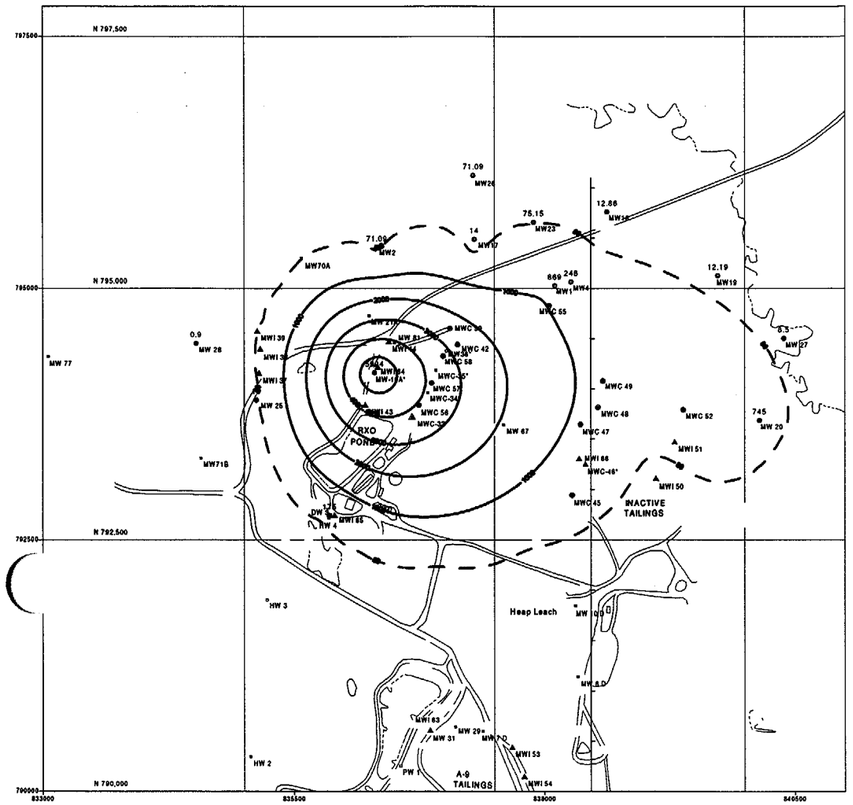
N

○ Measurement location (value in mg/L)

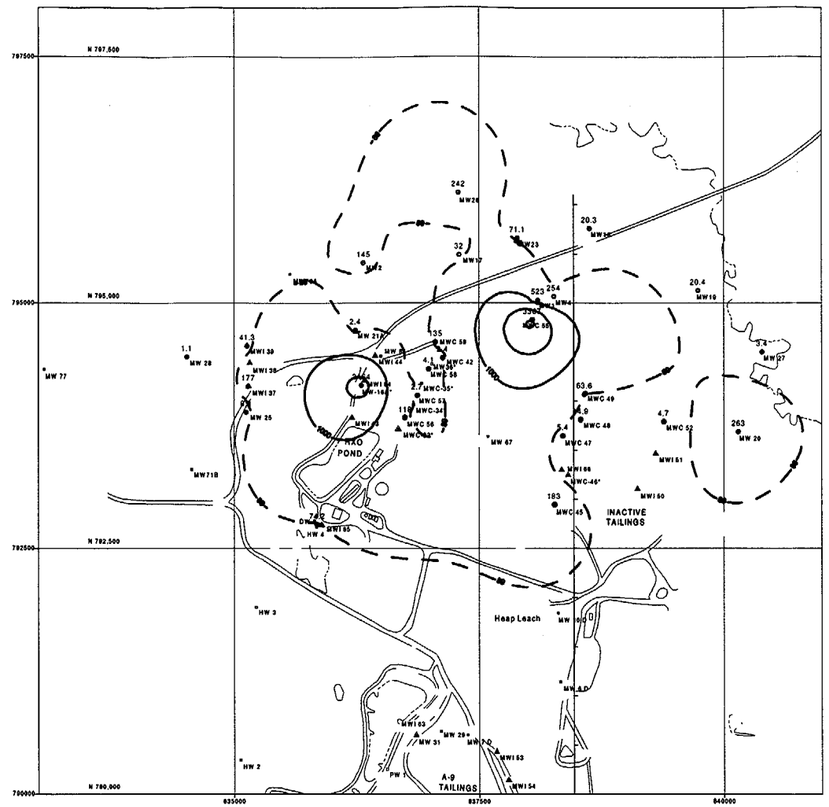
■ MW2 Monitoring well

0.6 Ground-water protection standard

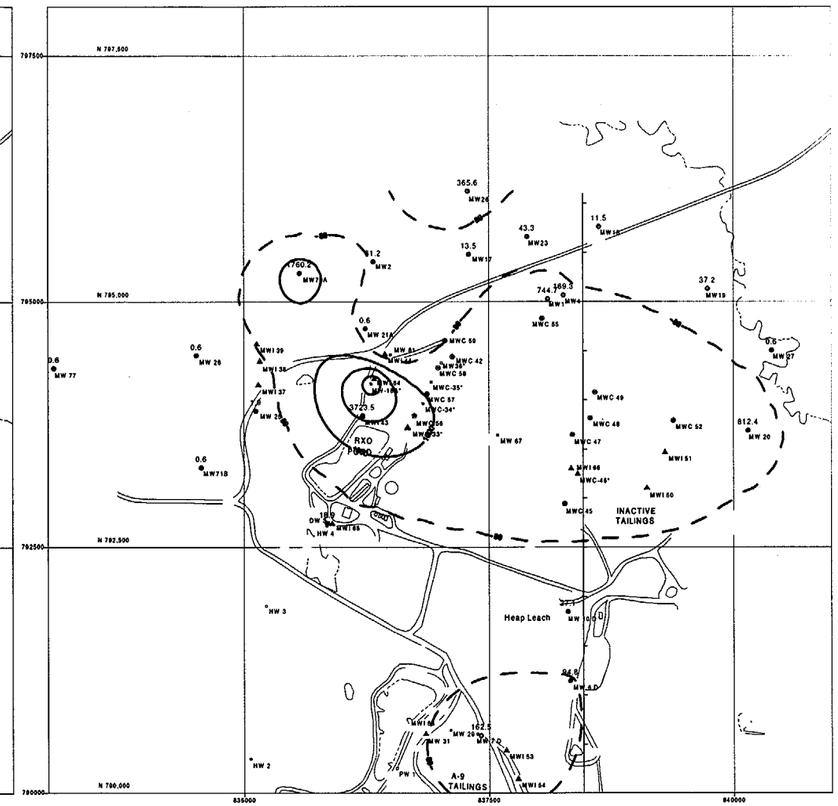
Figure G-3. Nickel Distribution in Groundwater
Western Flow Regime (Lower Wind River)
Gas Hills Site, UMETCO Minerals Corporation



April-June 1990



February-March 1995



January-March 2000

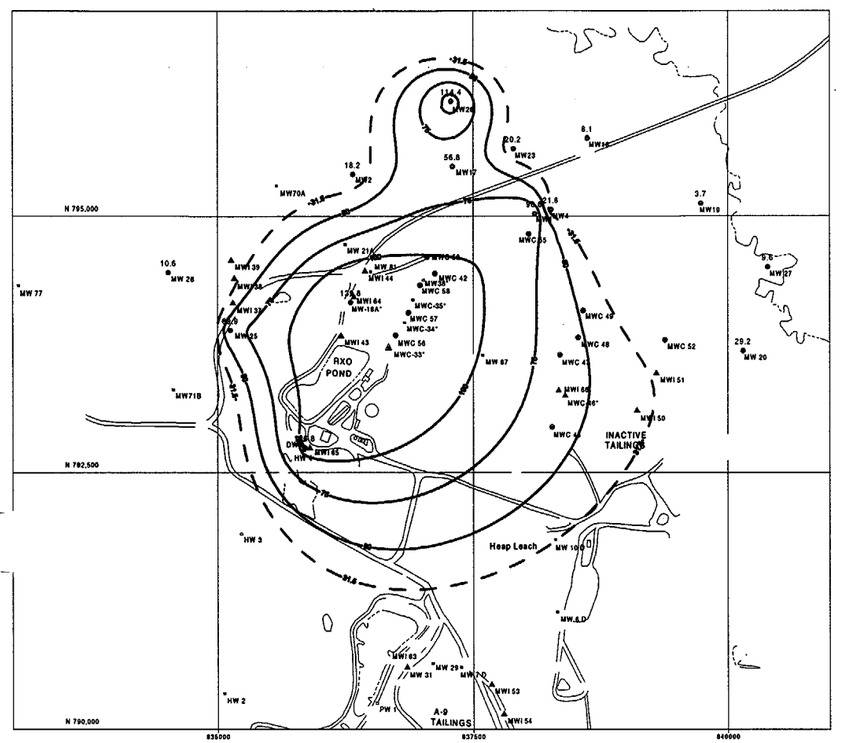
N

Measurement location (value in pCi/L)

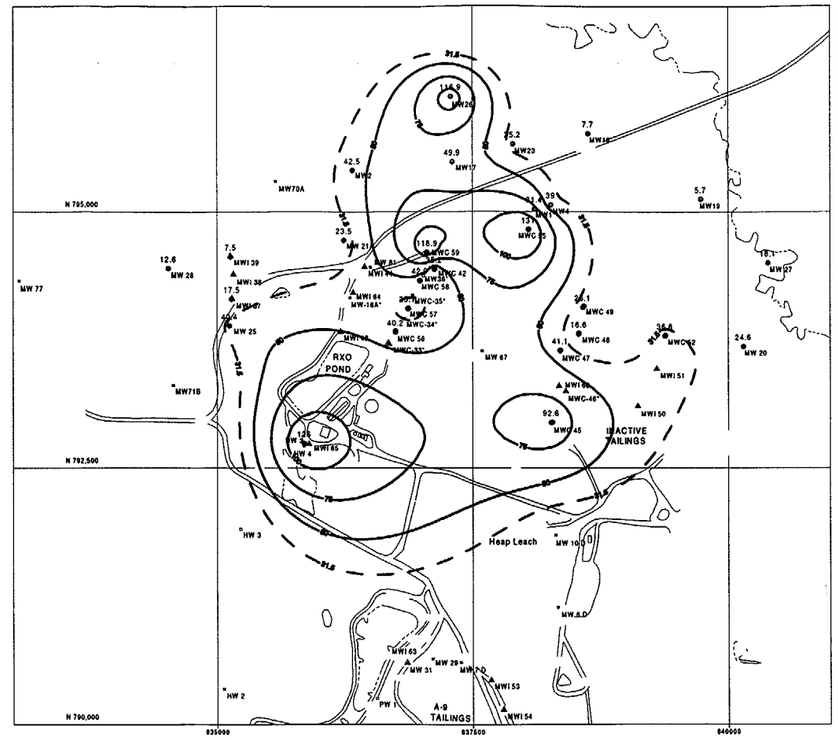
MW2 Monitoring well

89 Ground-water protection standard

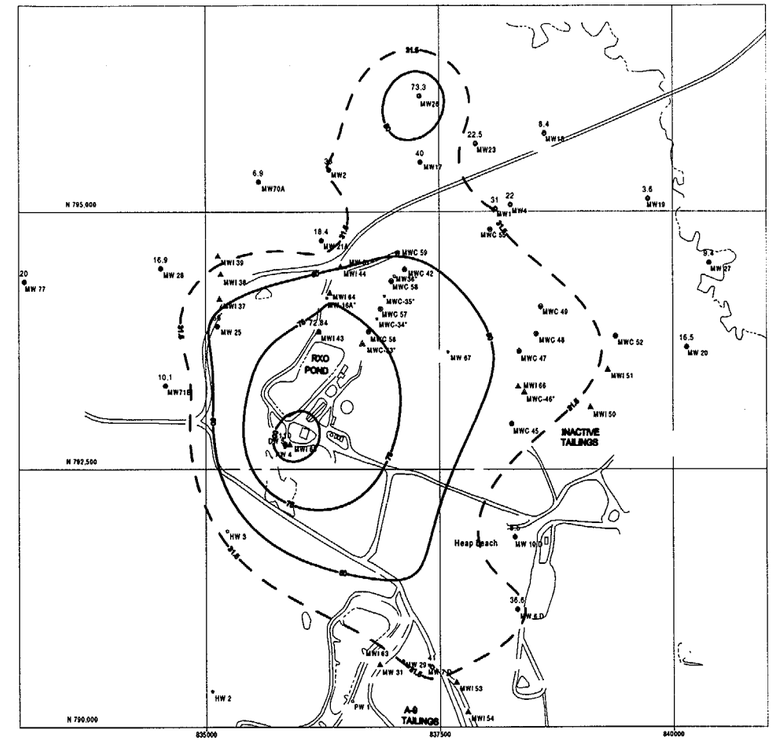
Figure G-4. Natural Uranium Distribution in Groundwater
Western Flow Regime (Lower Wind River)
Gas Hills Site, Umetco Minerals Corporation



April-June 1990



January-March 1995

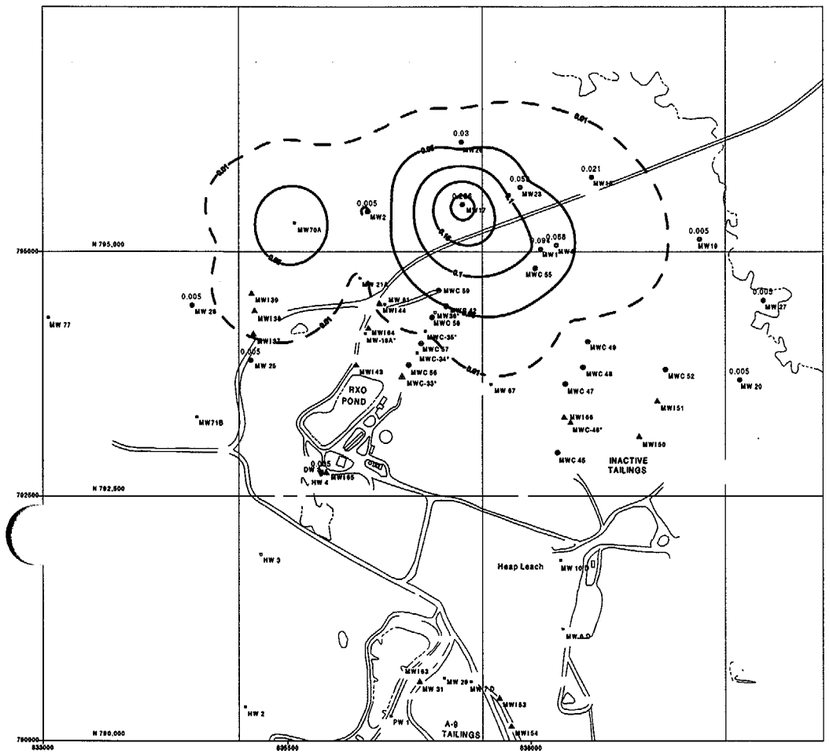


January-March 2000

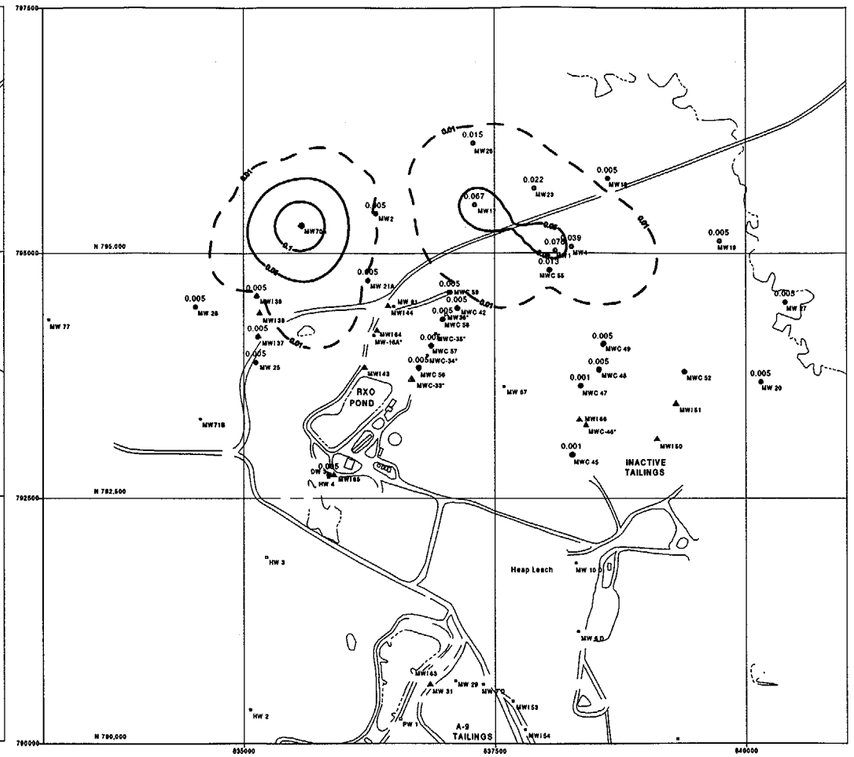
N

- Measurement location (value in pCi/L)
- MW2 Monitoring well
- 31.5 Ground-water protection standard

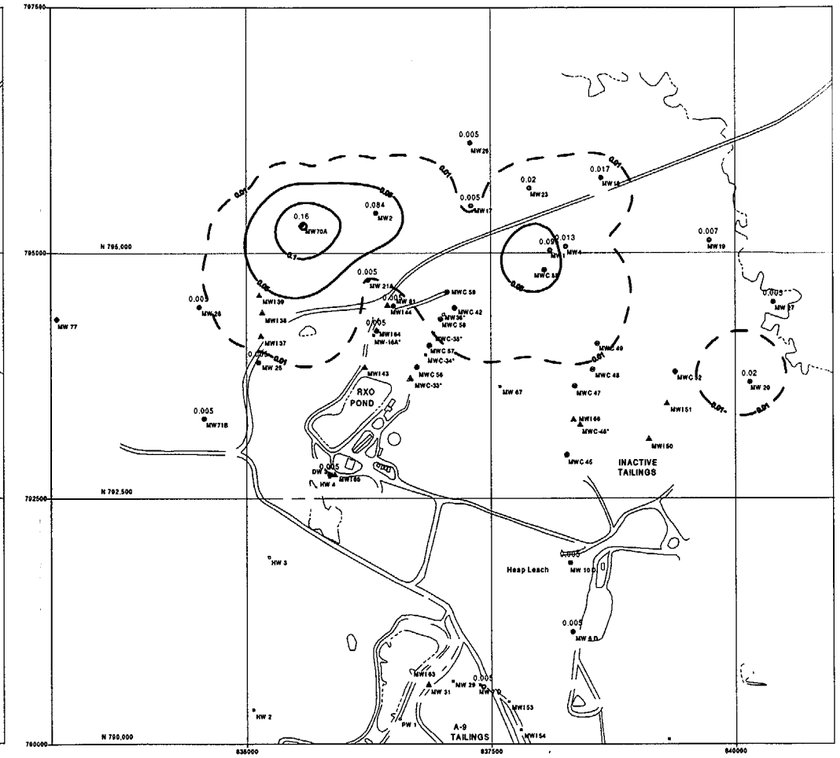
Figure G-5 Radium-226+228 Distribution in Groundwater
Western Flow Regime (Lower Wind River)
Gas Hills Site, Umetco Minerals Corporation



April-June 1990



January-March 1995



January-March 2000

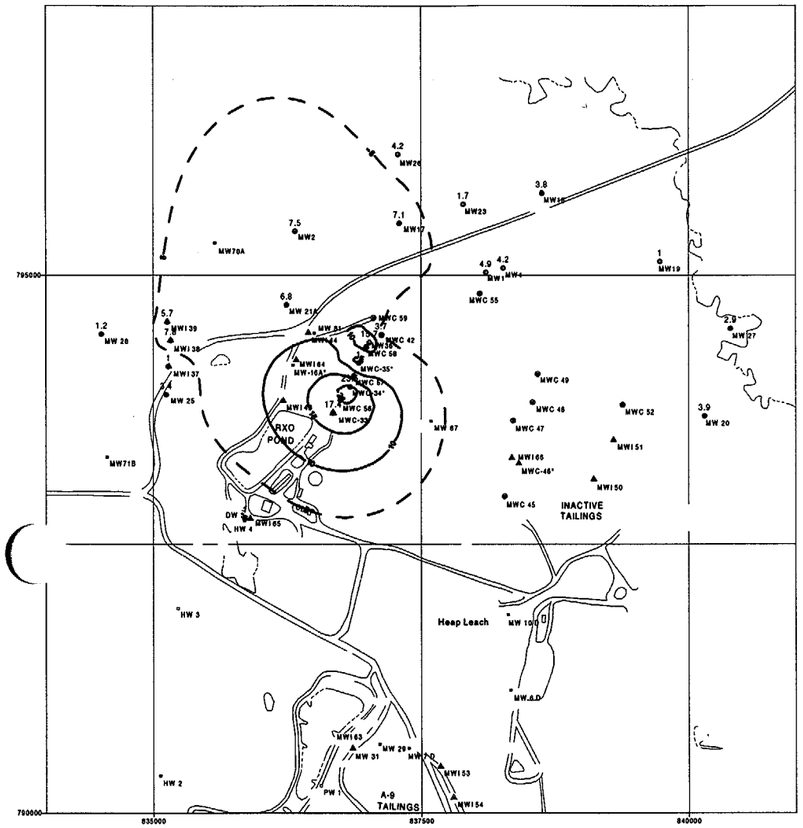
N

Measurement location (value in mg/L)

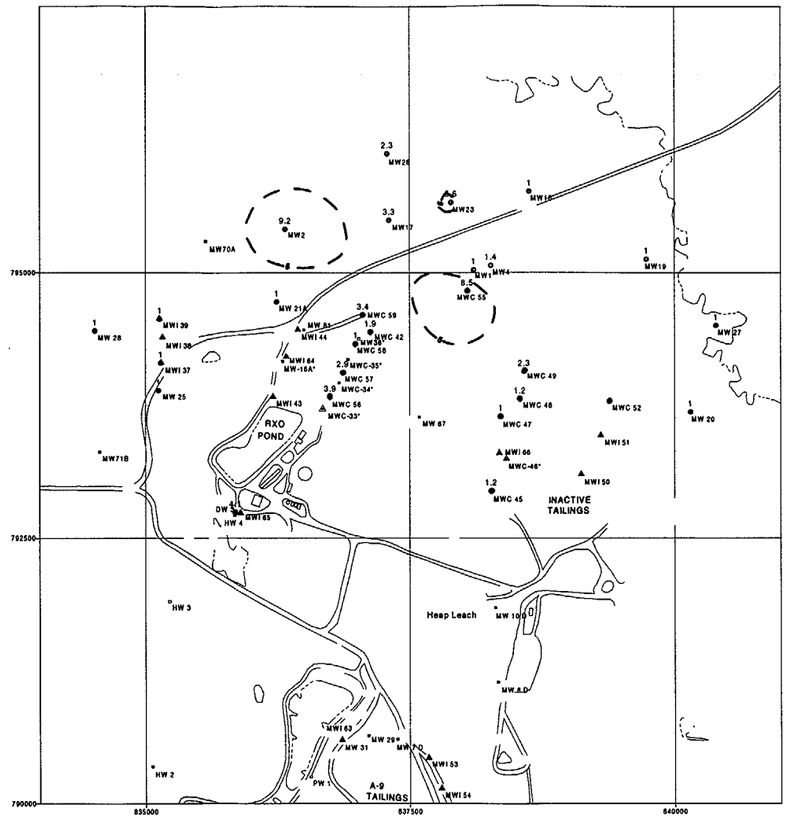
MW2 Monitoring well

0.01 Ground-water protection standard

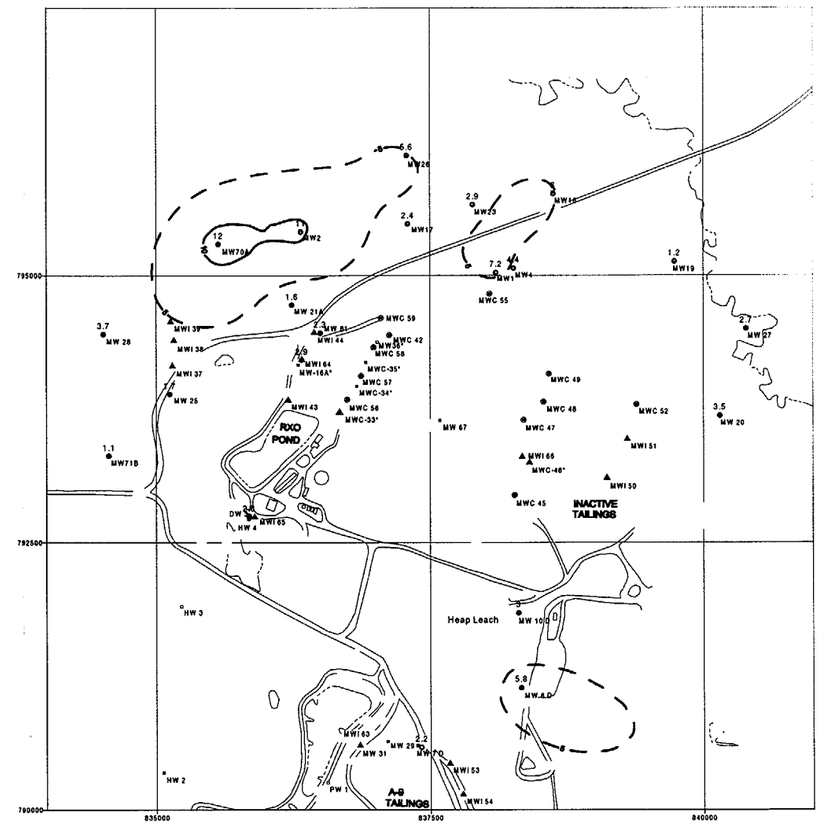
Figure G-6 Selenium Distribution in Groundwater
Western Flow Regime (Lower Wind River)
Gas Hills Site, Umetco Minerals Corporation



January-July 1990



January-March 1995

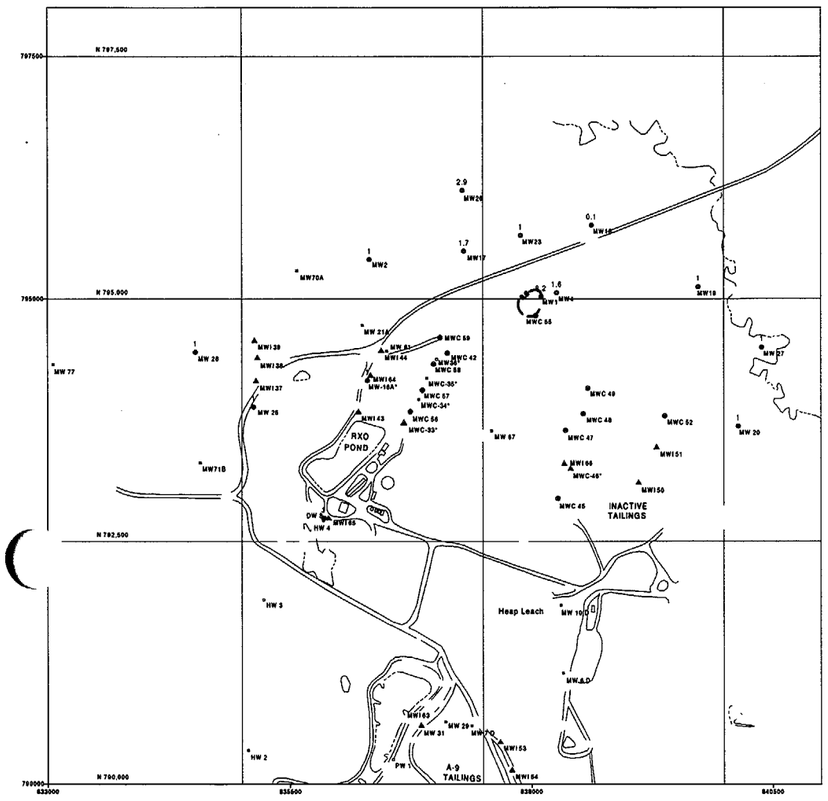


January-March 2000

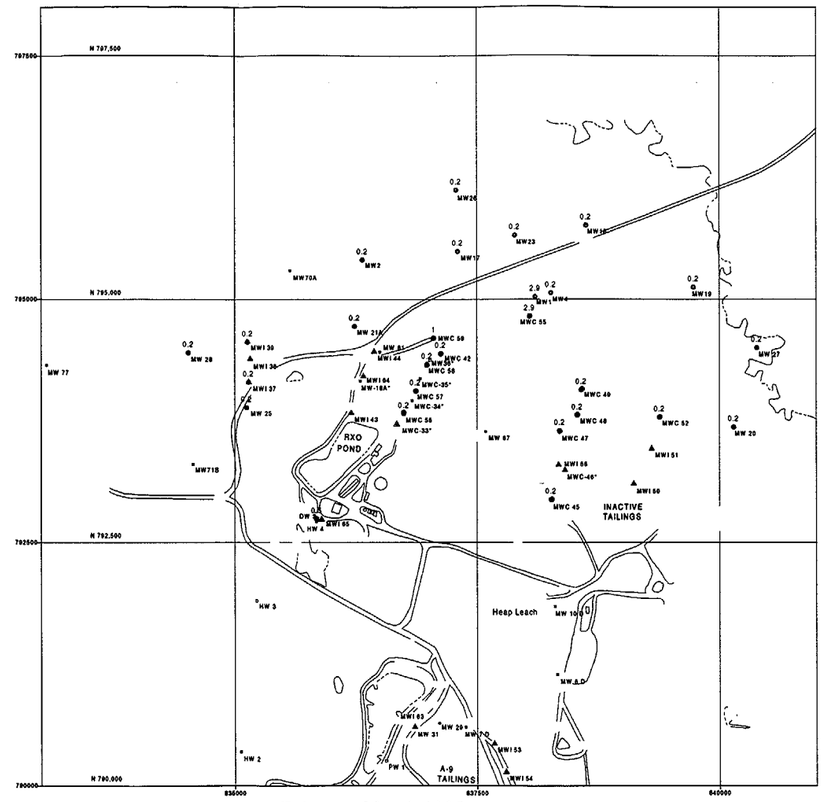
N

- Measurement location (value in pCi/L)
- Monitoring well
- MW2
- 5 · Ground-water protection standard

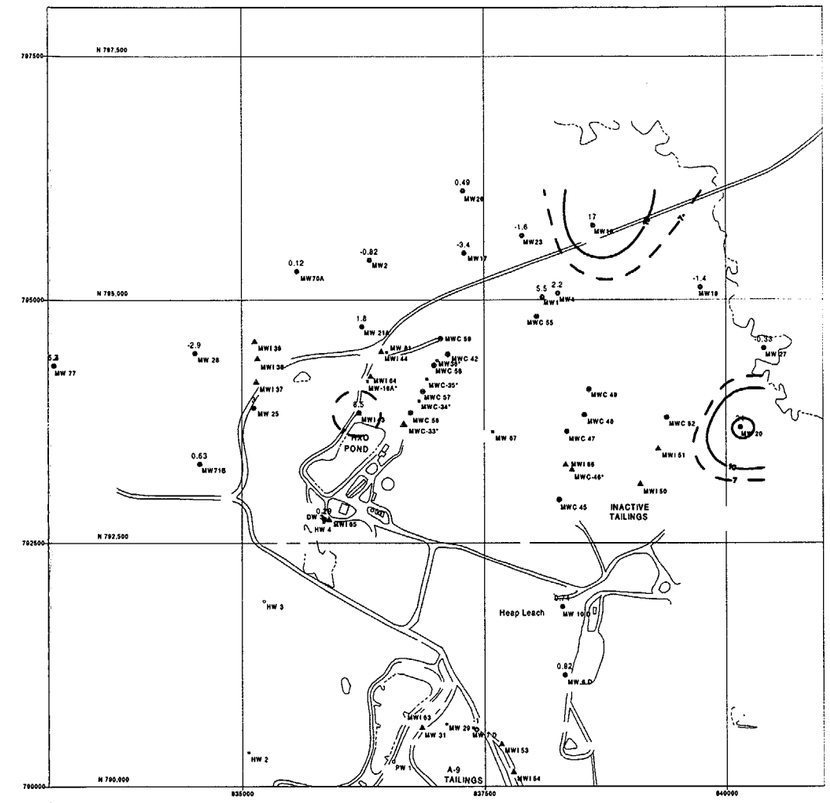
Figure G-7 Lead-210 Distribution in Groundwater
Western Flow Regime (Lower Wind River)
Gas Hills Site, Umetco Minerals Corporation



April-June 1990



February-March 1995



January-March 2000

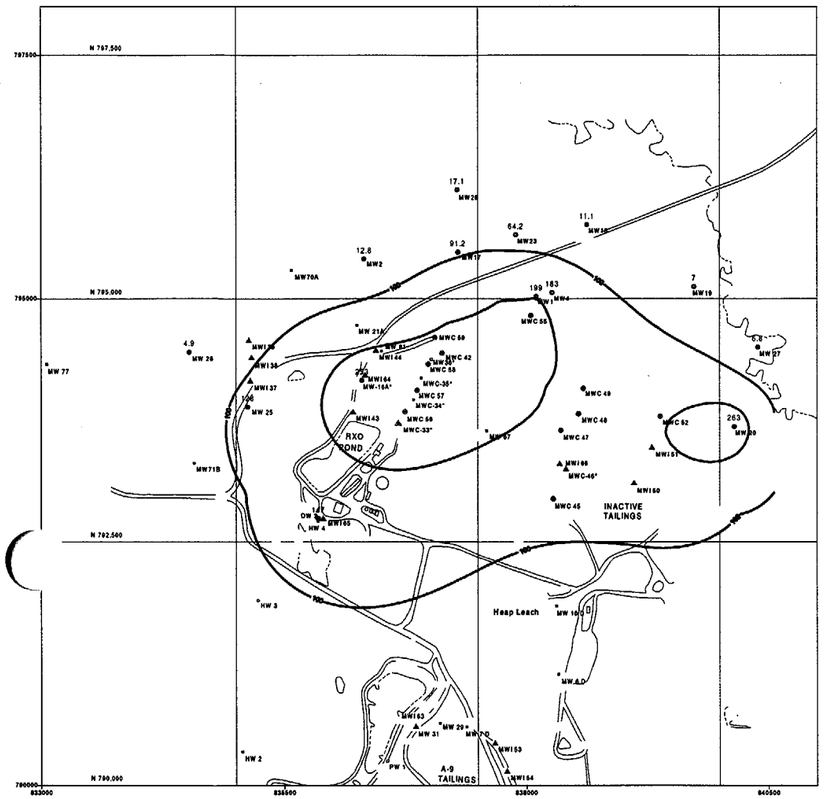
N

Measurement location (value in pCi/L)

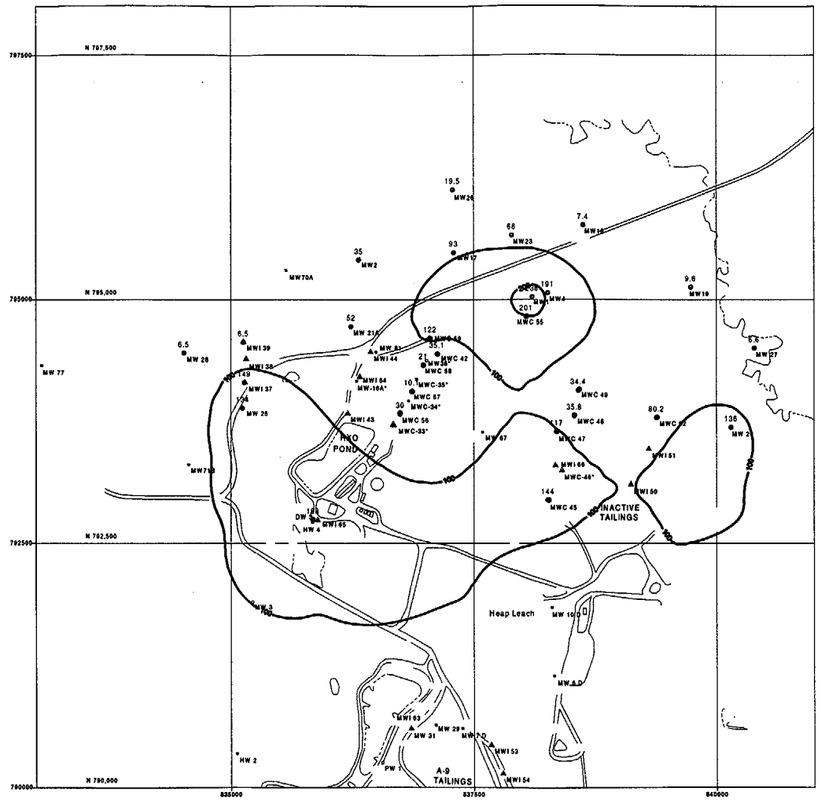
MW2 Monitoring well

6.6 Ground-water protection standard

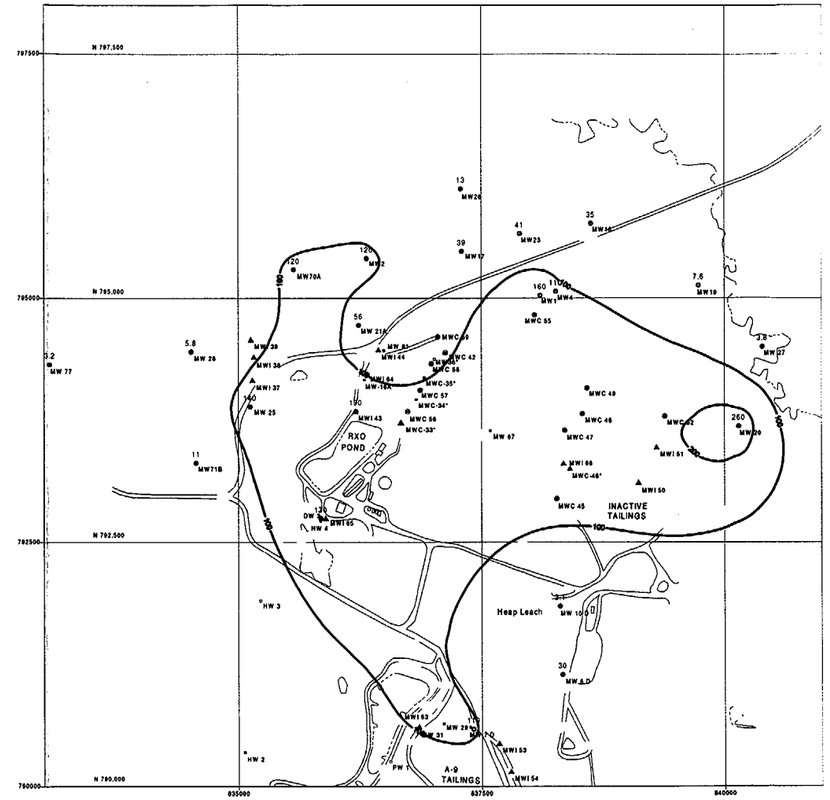
Figure G-8 Thorium-230 Distribution in Groundwater
Western Flow Regime (Lower Wind River)
Gas Hills Site, Umetco Minerals Corporation



April-June 1990



February-March 1995



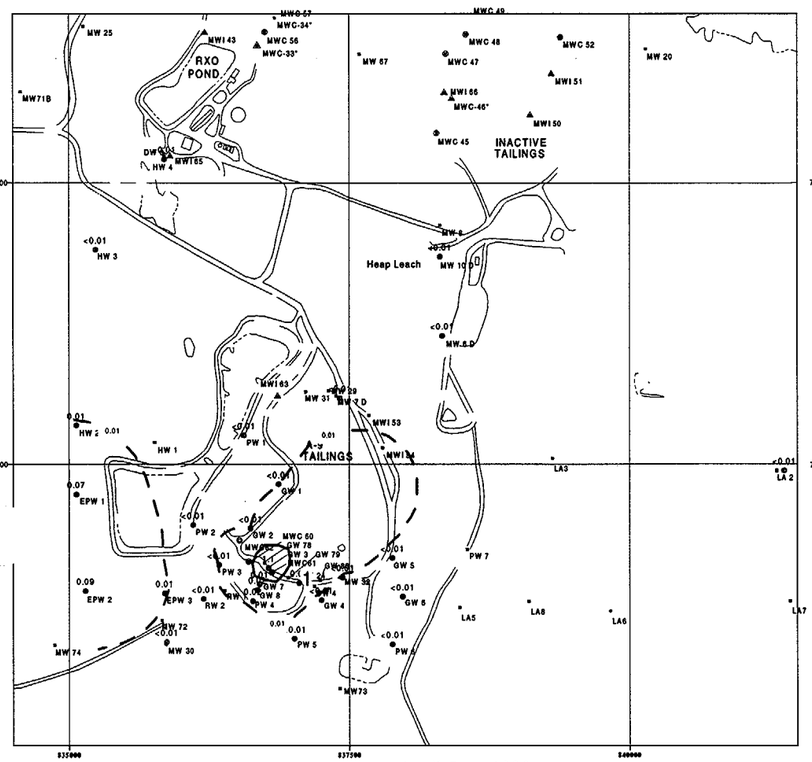
January-March 2000

N

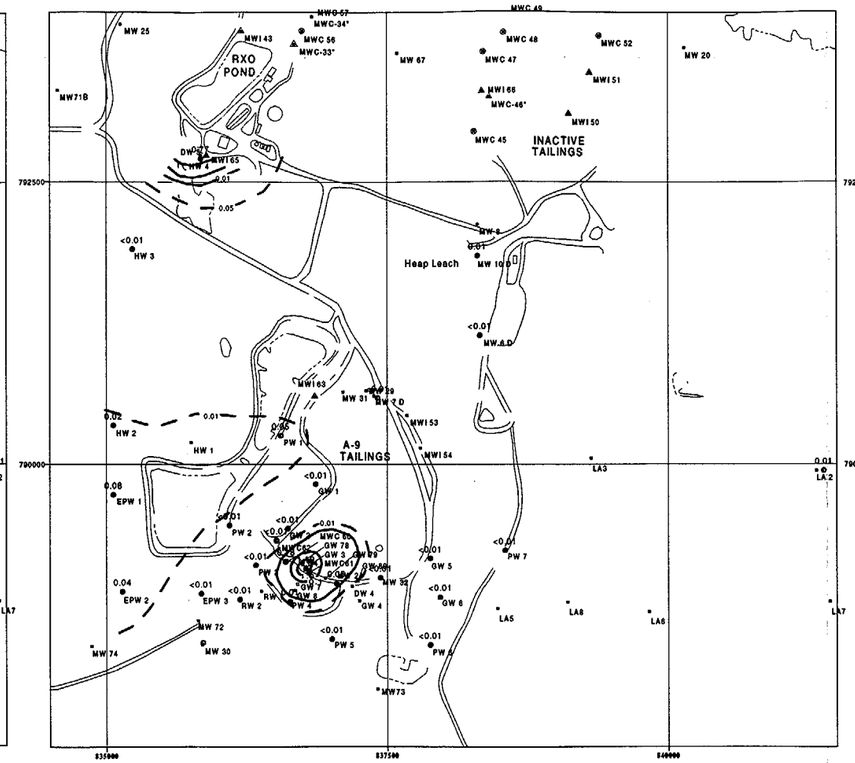
Measurement location (value in mg/L)

MW2 Monitoring well

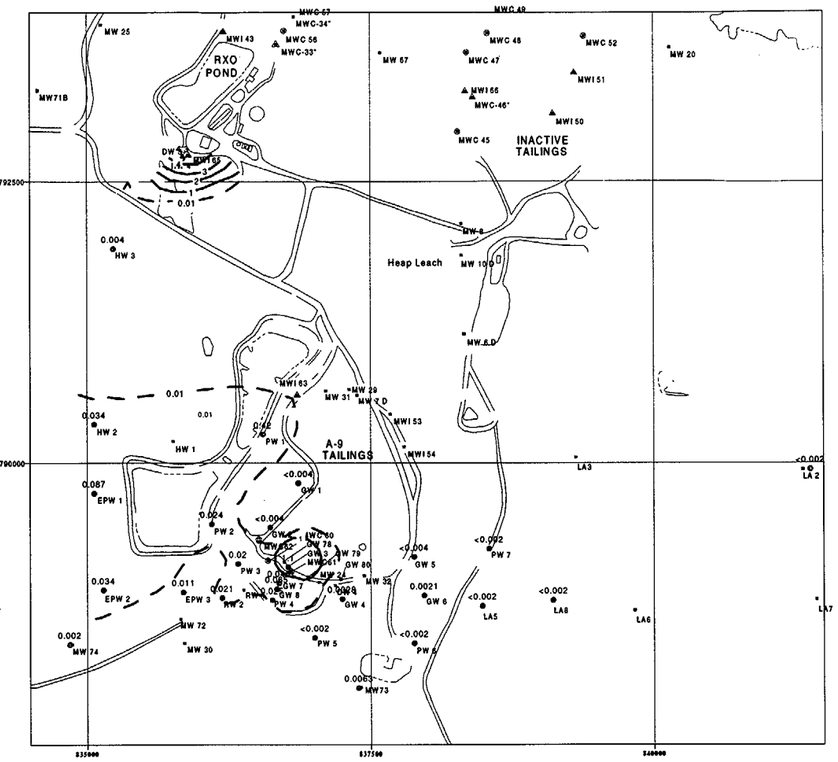
Figure G-9 Chloride Distribution in Groundwater
Western Flow Regime (Lower Wind River)
Gas Hills Site, Umetco Minerals Corporation



April-June 1990



January-March 1995



January - March 2000

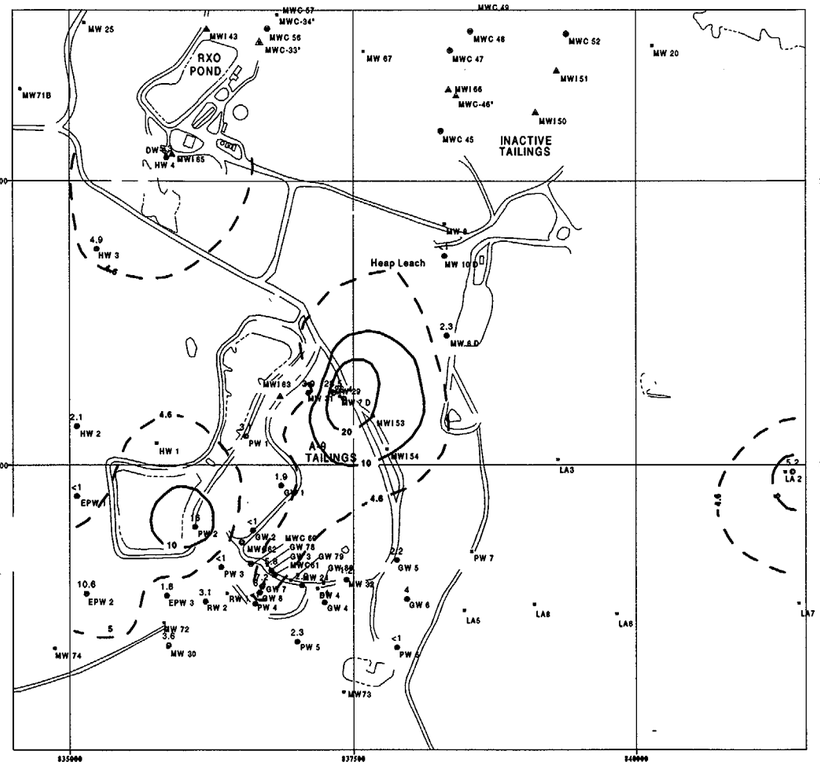
N

Measurement location (value in mg/L)

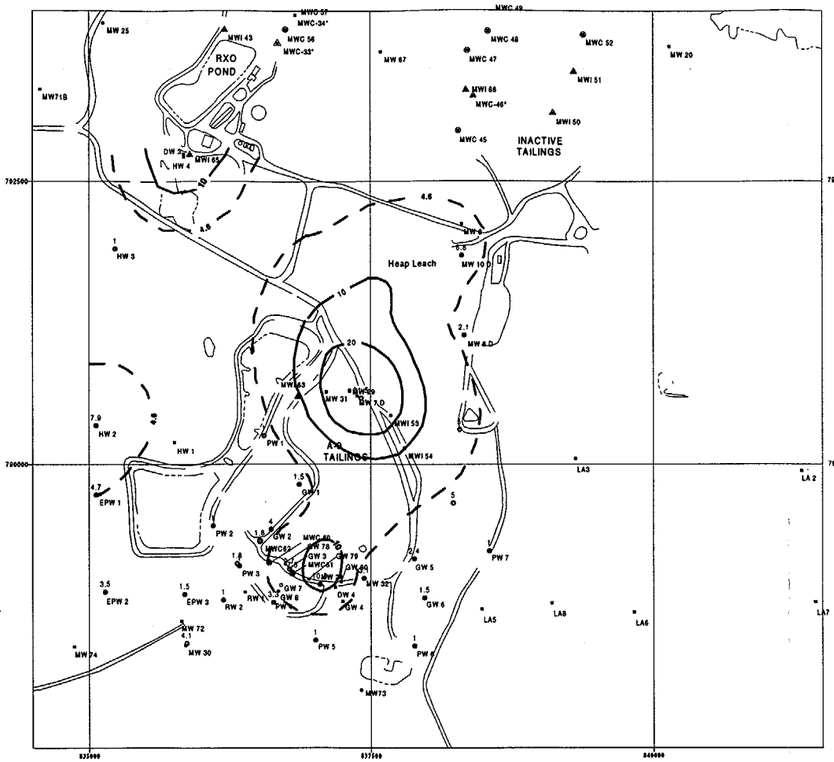
MW2 Monitoring well

0.01 Ground-water protection standard

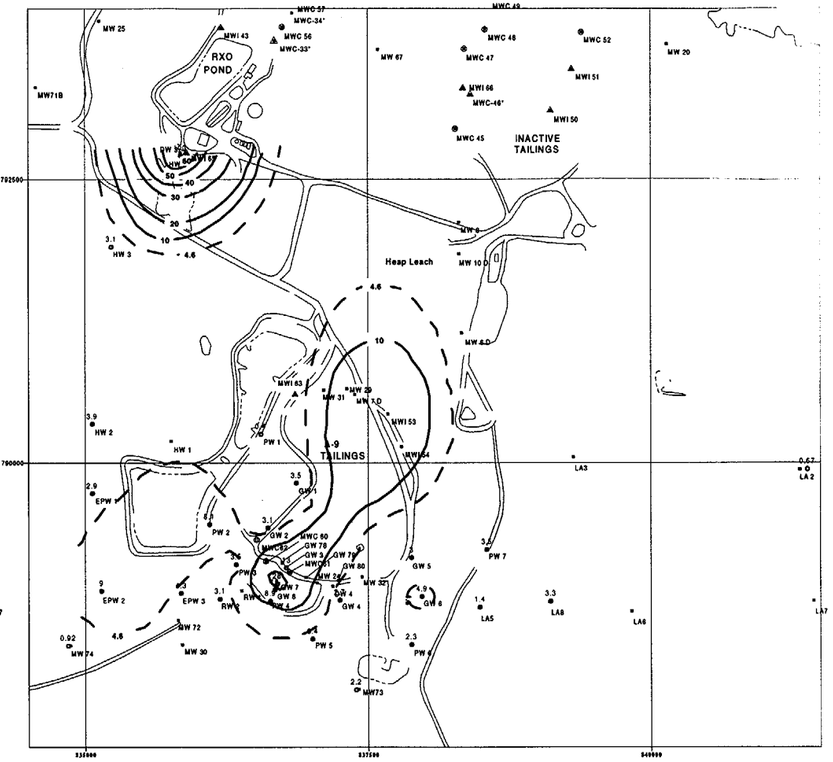
Figure G-10. Berylium Distribution in Groundwater
Southwestern Flow Regime (Upper Wind River)
Gas Hills Site, Umetco Minerals Corporation



April-June 1990



January - March 1995



January - March 2000

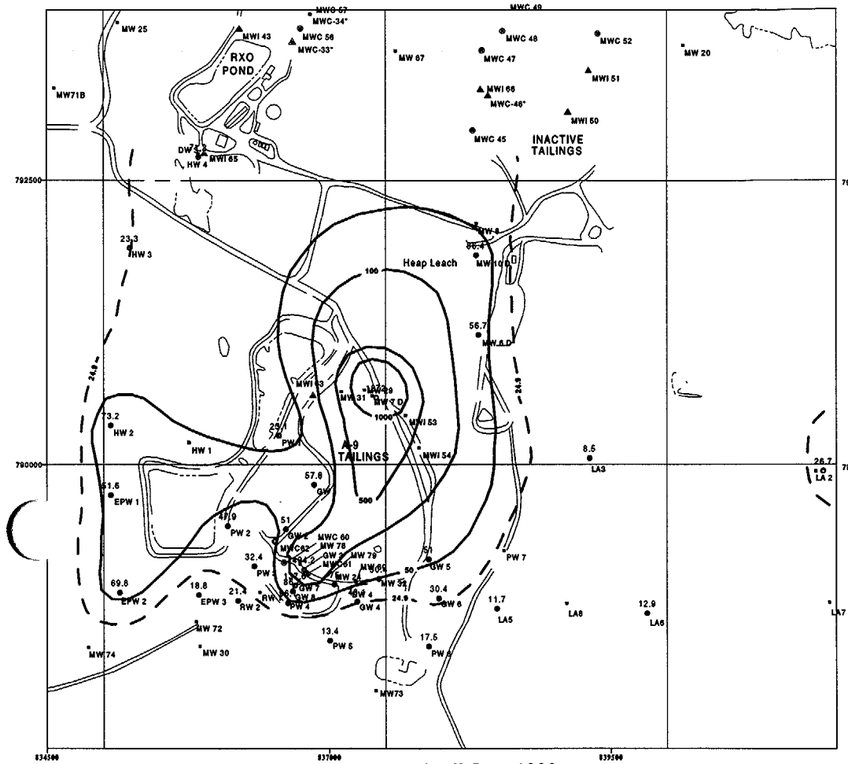
N

Measurement location (value in pCi/L)

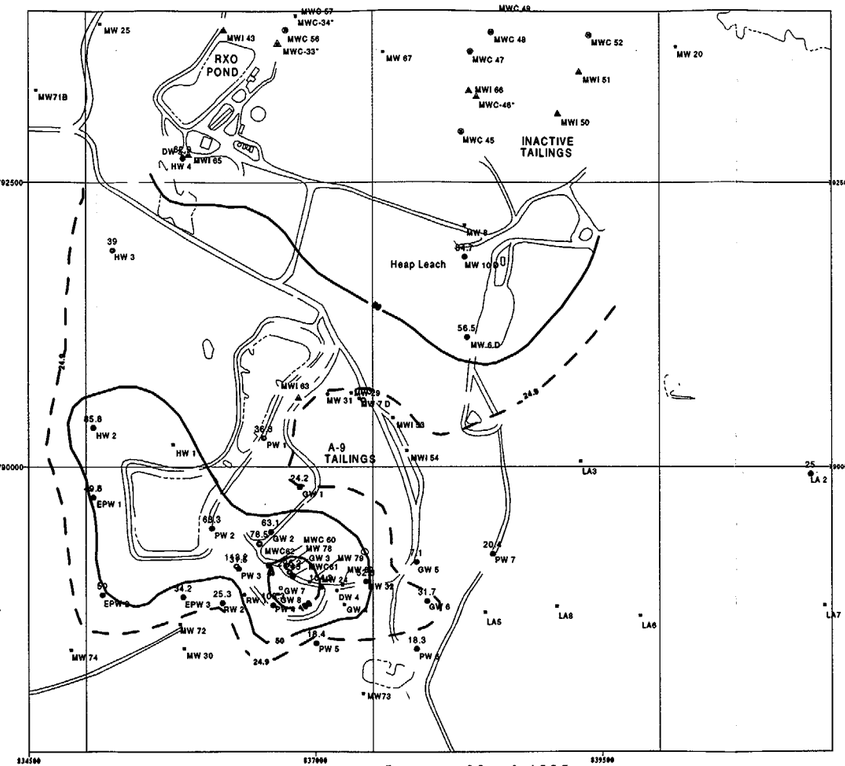
MW2 Monitoring well

4.6 Ground-water protection standard

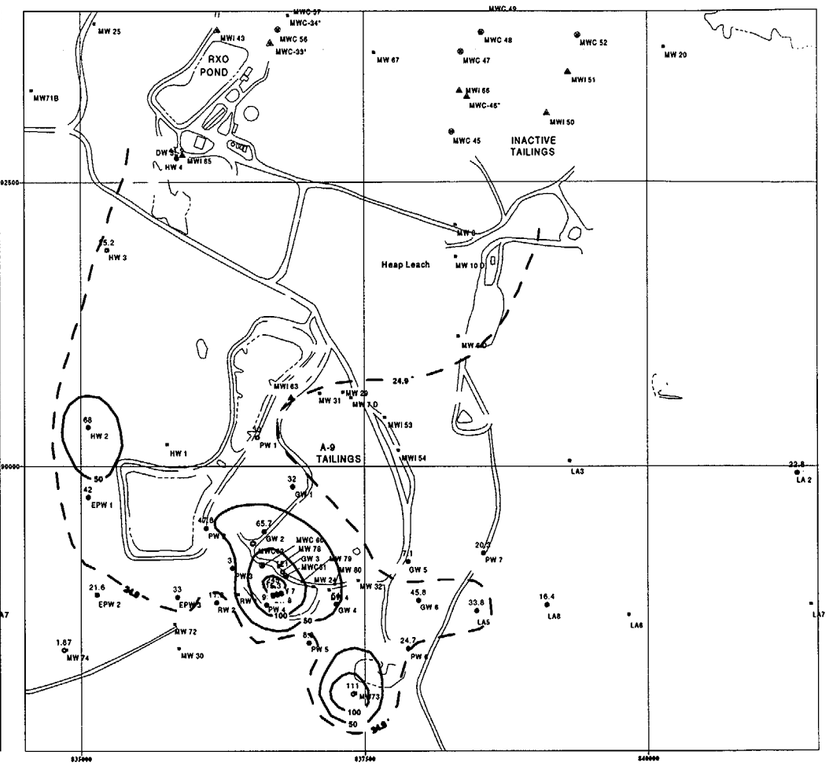
Figure G-11. Lead-210 Distribution in Groundwater
Southwestern Flow Regime (Upper Wind River)
Gas Hills Site, Umetco Minerals Corporation



April-June 1990



January - March 1995

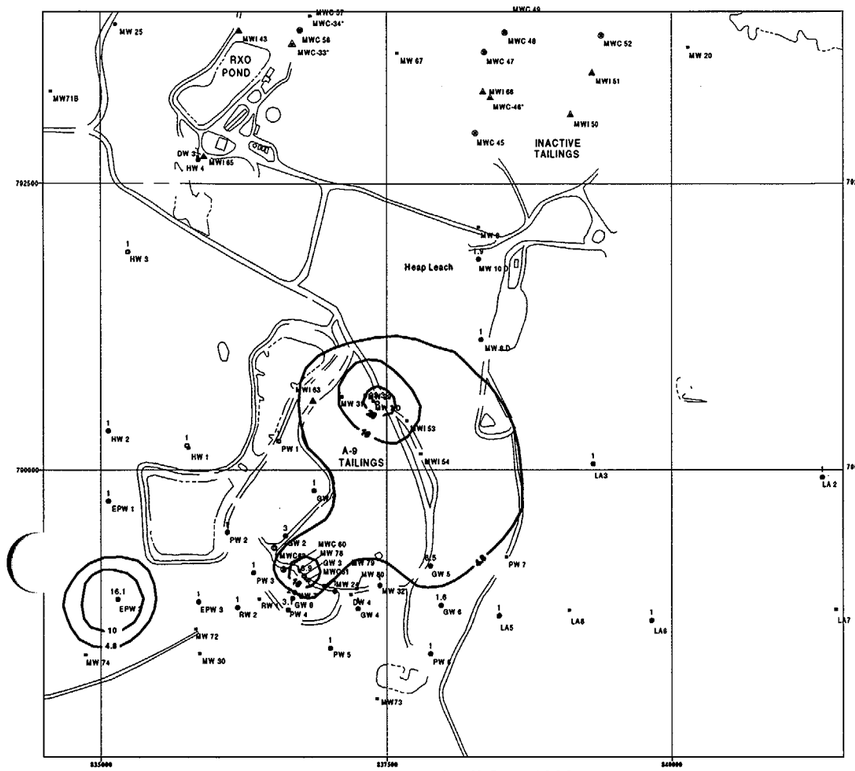


January - March 2000

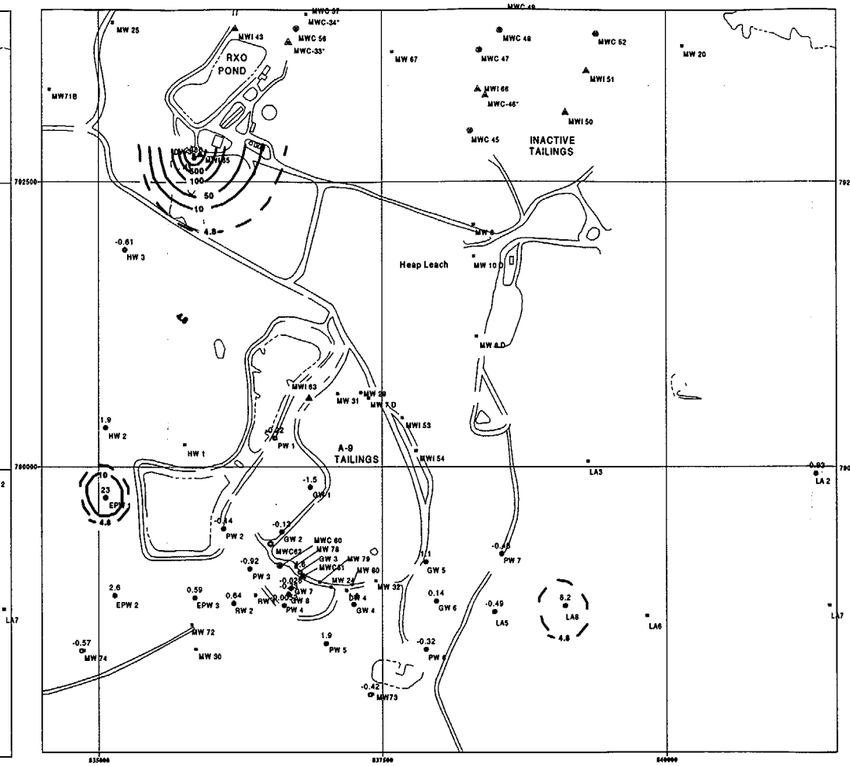
N

- Measurement location (value in pCi/L)
- MW2 Monitoring well
- 24.9 Ground-water protection standard

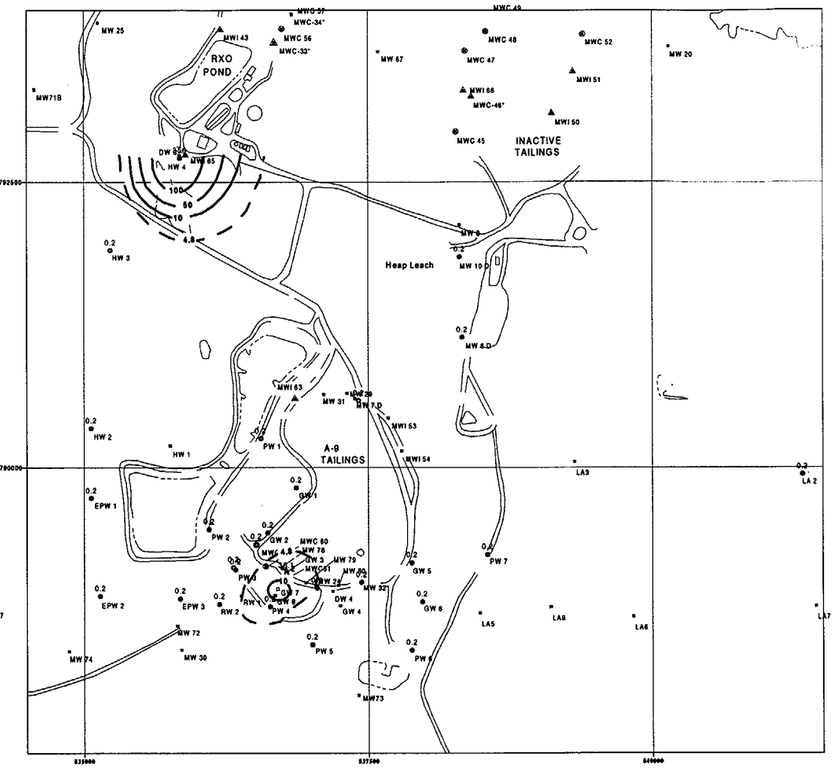
Figure G-12. Radium 226+ 228 Distribution in Groundwater Southwestern Flow Regime (Upper Wind River) Gas Hills Site, Umetco Minerals Corporation



April-June 1990



January - March 1995



January - March 2000

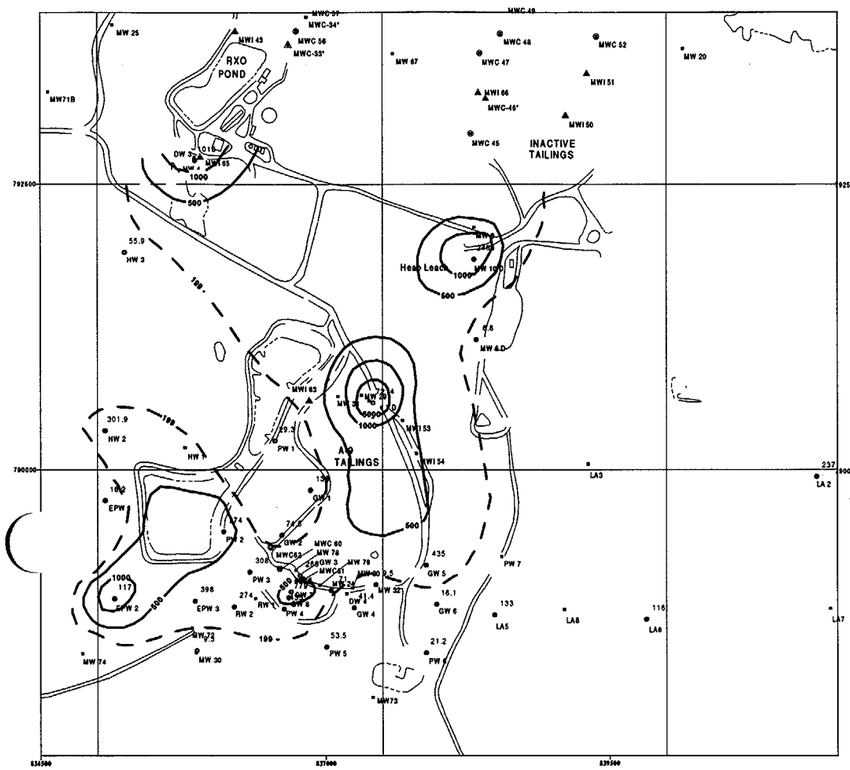
N

Measurement location (value in pCi/L)

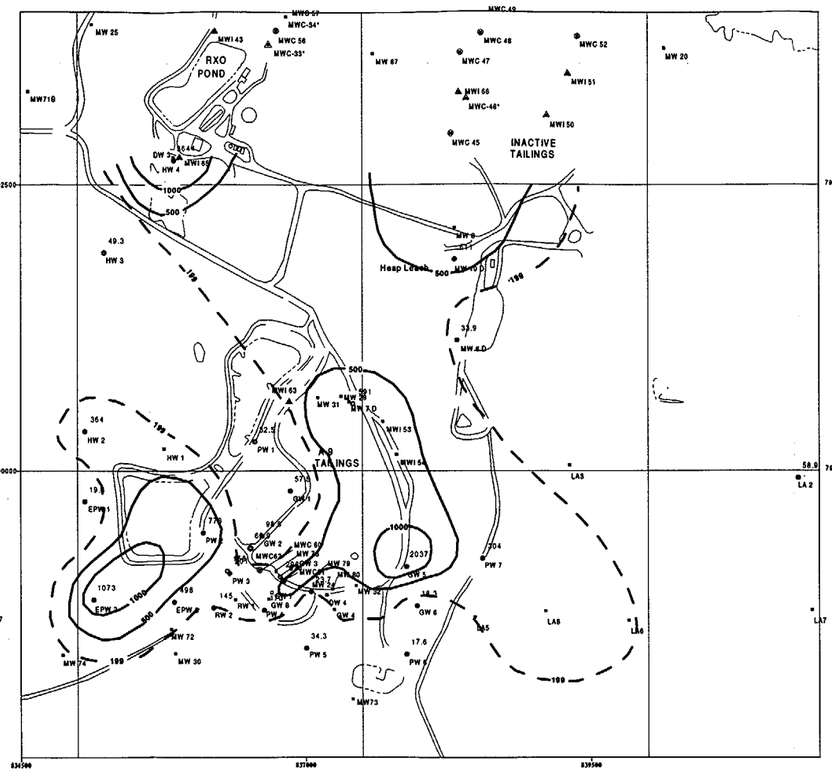
MW2 Monitoring well

4.8 Ground-water protection standard

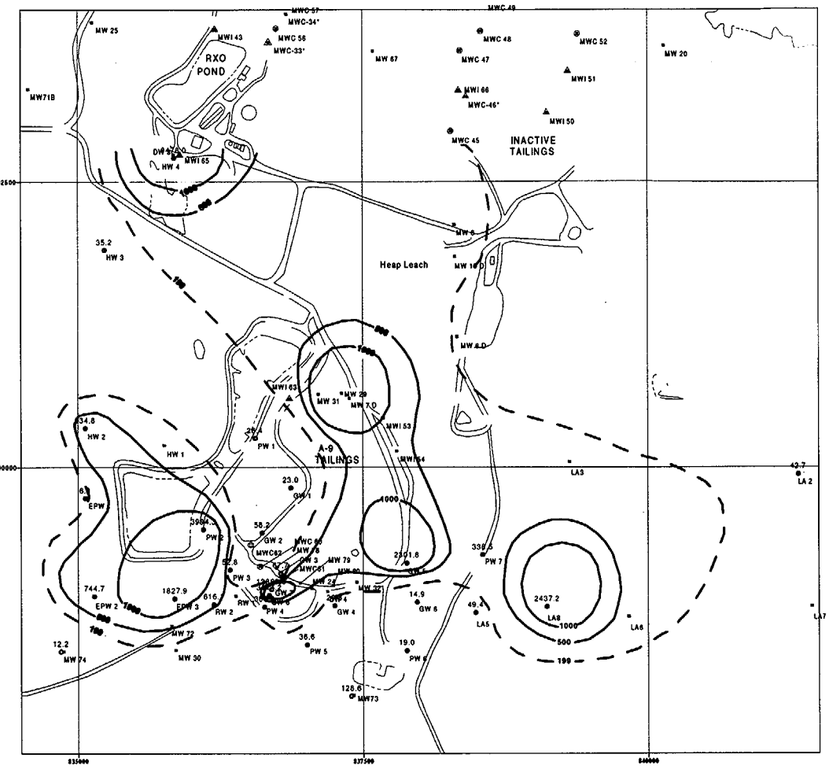
Figure G-13. Thorium-230 Distribution in Groundwater
Southwestern Flow Regime (Upper Wind River)
Gas Hills Site, Umetco Minerals Corporation



April-June 1990



January - March 1995



January - March 2000

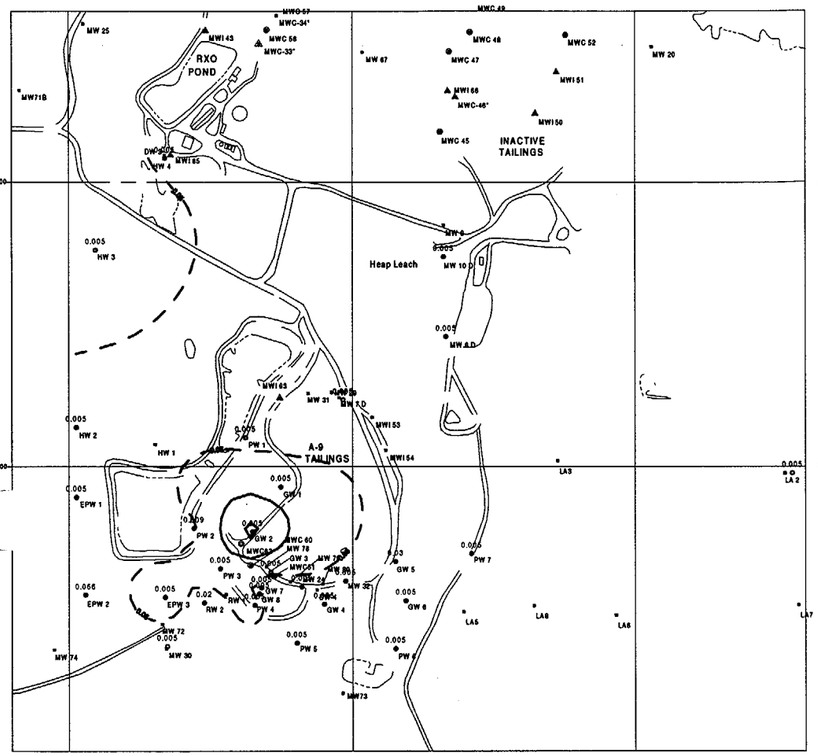
N

Measurement location (value in pCi/L)

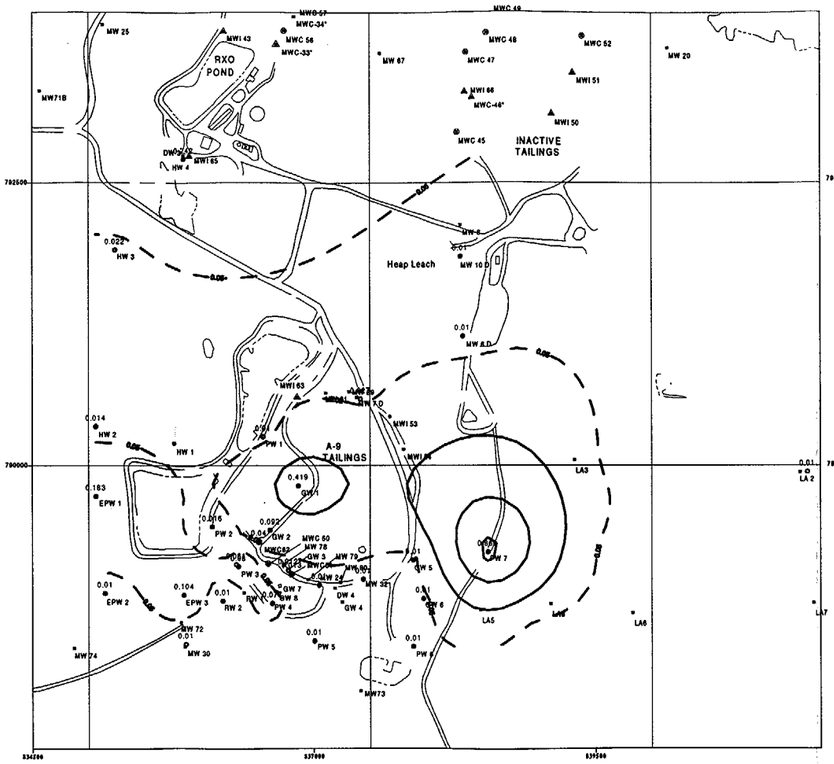
MW2 Monitoring well

199 *Ground-water protection standard

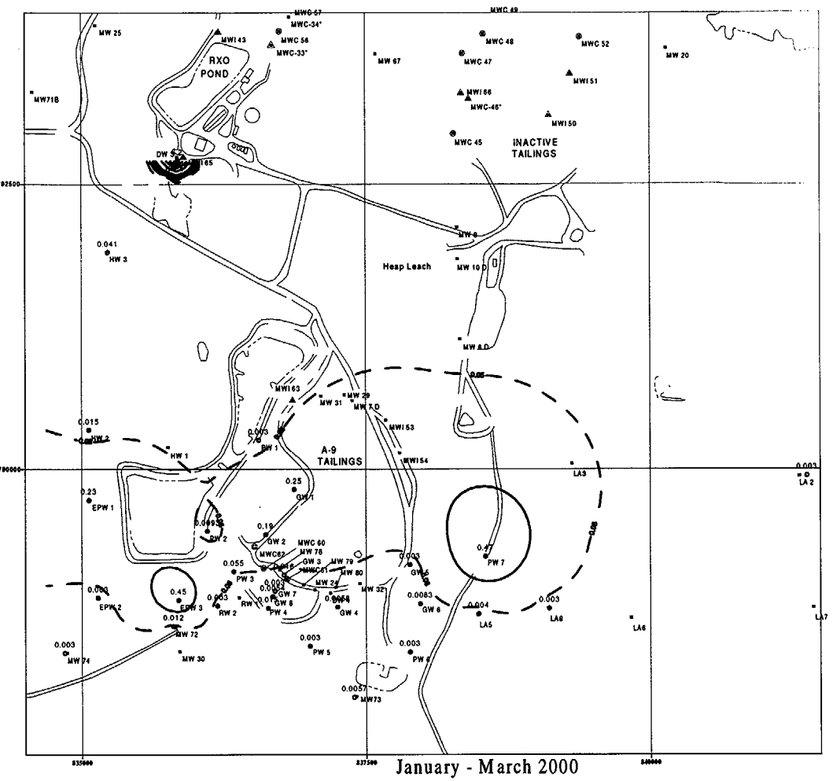
Figure G-14. Natural Uranium Distribution in Groundwater Southwestern Flow Regime (Upper Wind River) Gas Hills Site, Umetco Minerals Corporation



April-June 1990



January - March 1995



January - March 2000

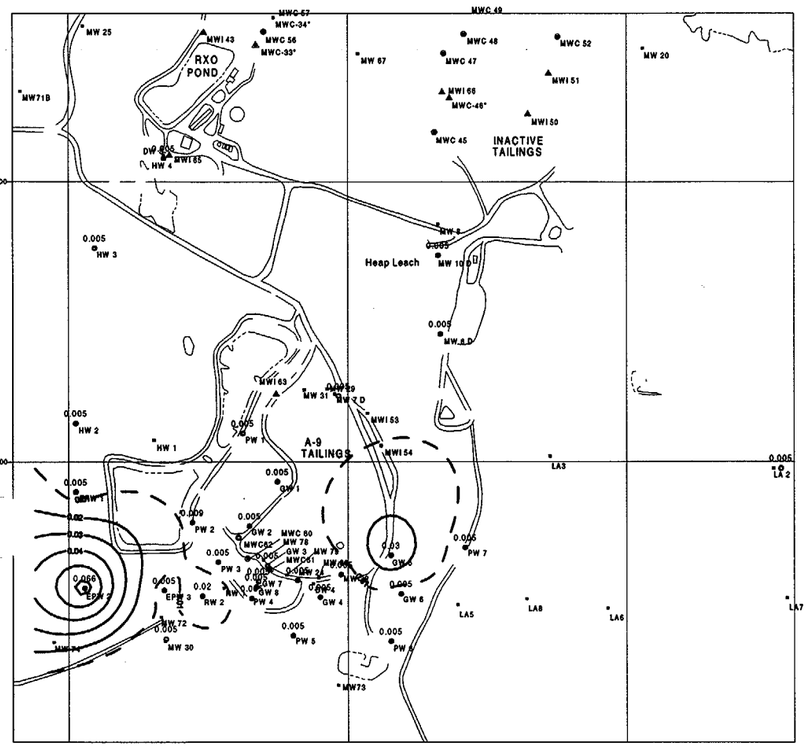
N

O Measurement location (value in mg/L)

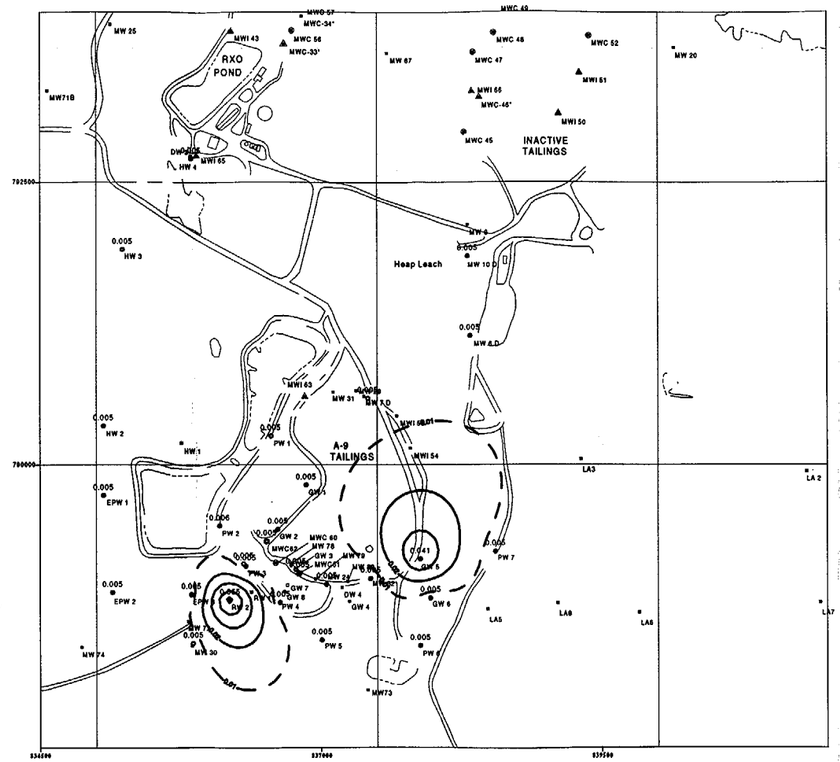
■ MW2 Monitoring well

- 0.05 - Ground-water protection standard

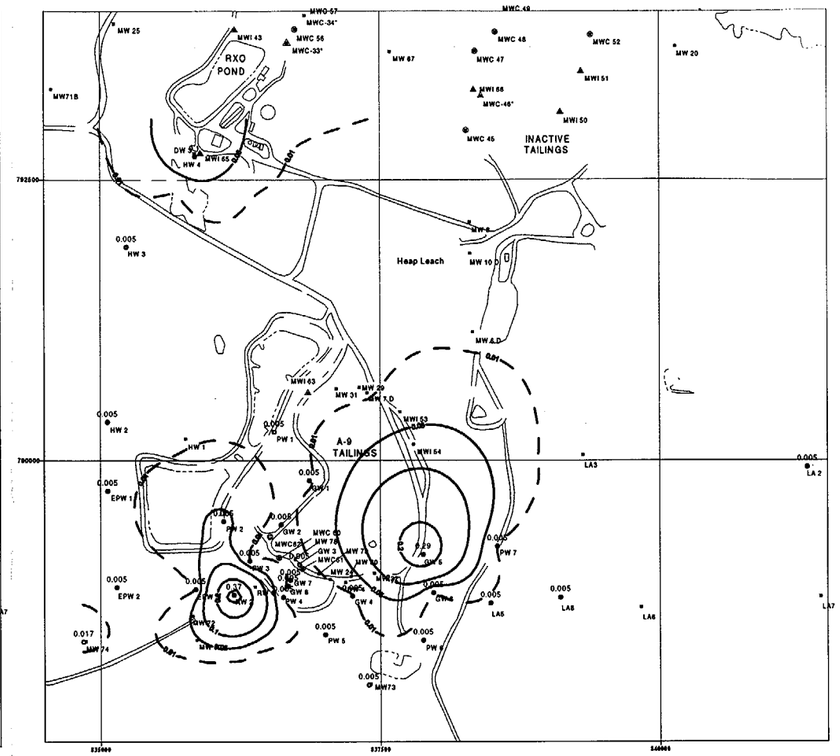
Figure G-15. Arsenic Distribution in Groundwater
Southwestern Flow Regime (Upper Wind River)
Gas Hills Site, Umetco Minerals Corporation



April-June 1990



January - March 1995



January - March 2000

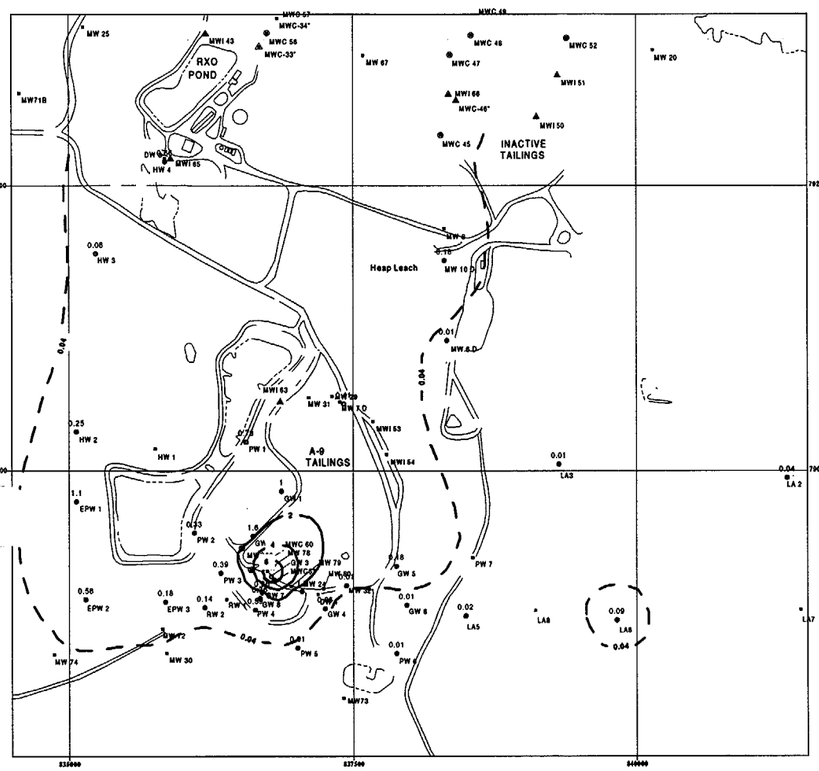
N

O Measurement location (value in mg/L)

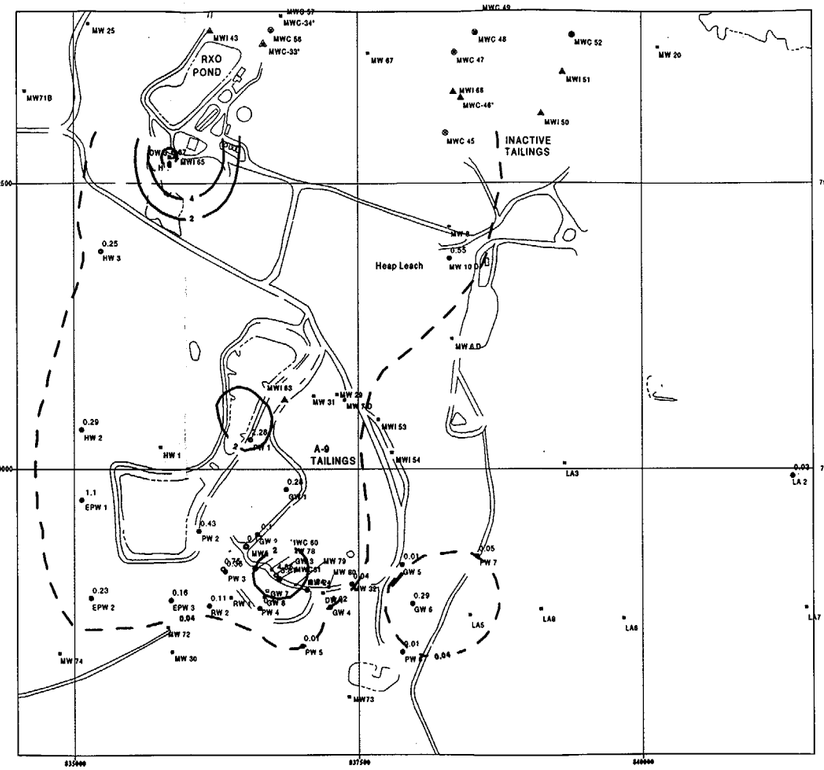
■ MW2 Monitoring well

- 0.01 - Ground-water protection standard

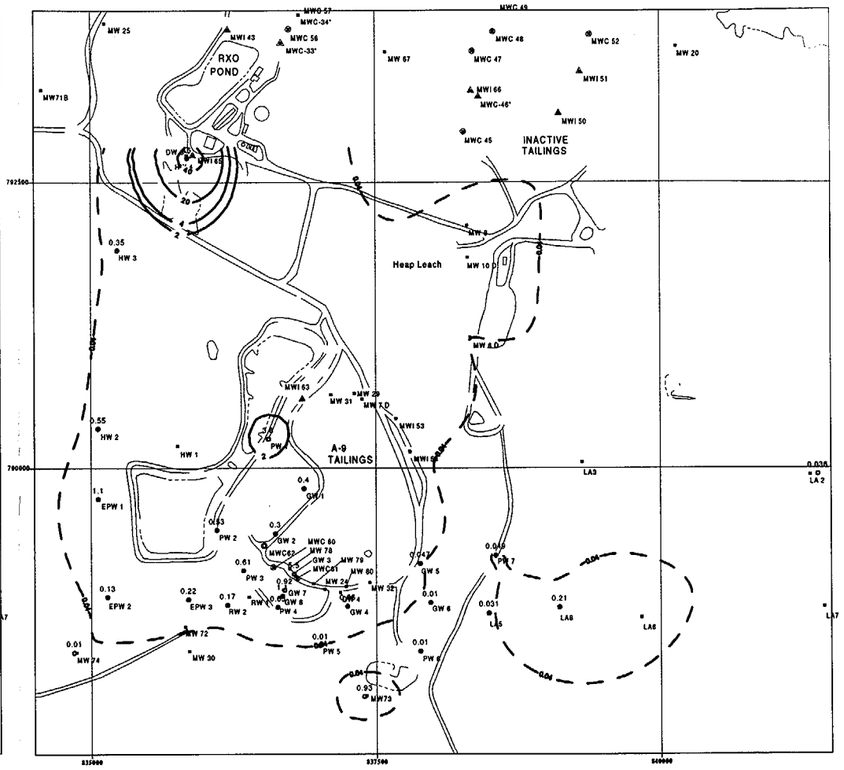
Figure G-16. Selenium Distribution in Groundwater
Southwestern Flow Regime (Upper Wind River)
Gas Hills Site, Umetco Minerals Corporation



April-June 1990



January-March1995



January-March 2000

N

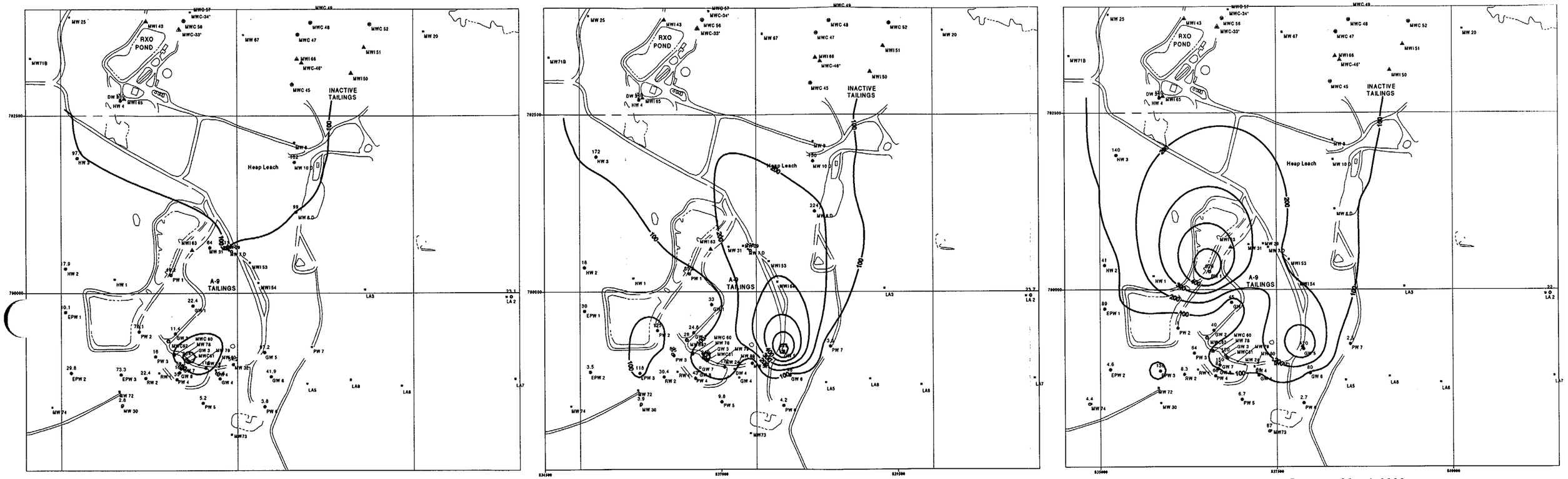
Measurement location (value in mg/L)

Monitoring well

MW2

0.04 Ground-water protection standard

Figure G-17. Nickel Distribution in Groundwater
Southwestern Flow Regime (Upper Wind River)
Gas Hills Site, Umetco Minerals Corporation



April-June 1990

January - March 1995

January - March 2000

N

Measurement location (value in mg/L)

MW2 Monitoring well

Figure G-18. Chloride Distribution in Groundwater
Southwestern Flow Regime (Upper Wind River)
Gas Hills Site, Umetco Minerals Corporation

Appendix H

Time Verses Concentration Data for Deep Well Completions

Umetco Gas Hills Site

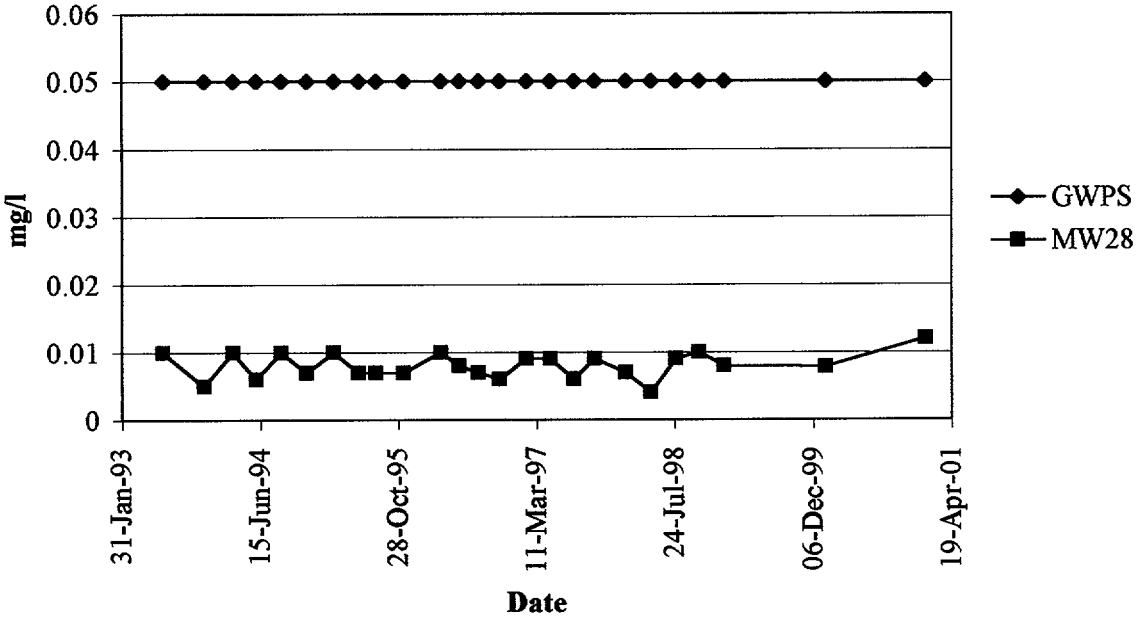
Fremont and Natrona Counties, Wyoming

Umetco Minerals Corporation
2754 Compass Drive, Suite 280
Grand Junction, Colorado 81506

May 2001

Figure H-1 Time vs. Concentration Data for Deep Well Completions

MW28 Arsenic



MW28 Beryllium

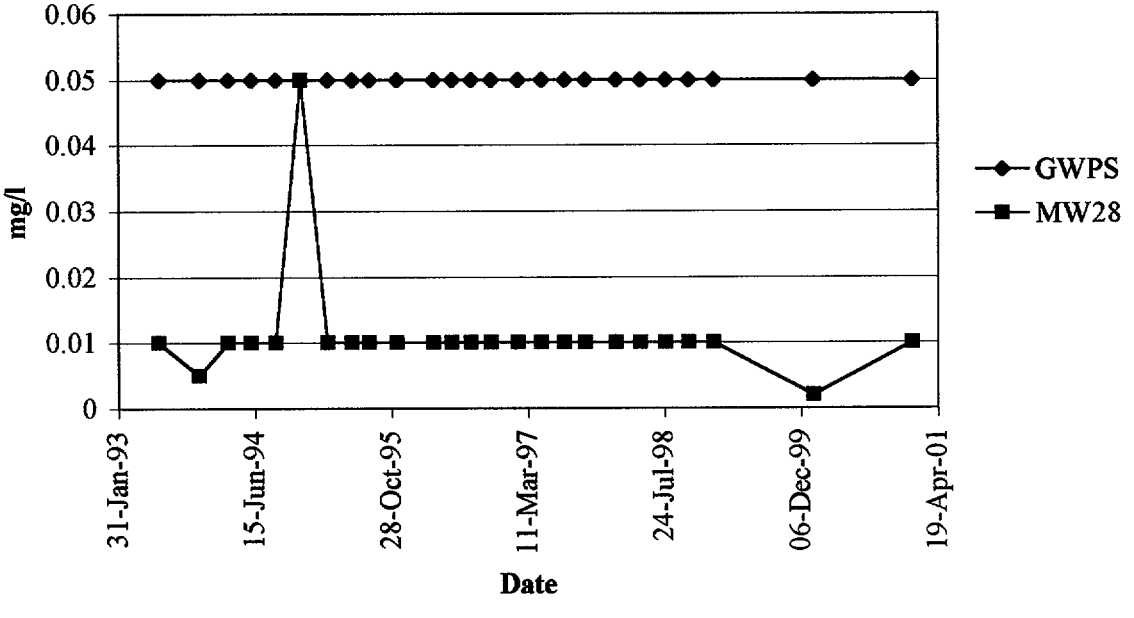
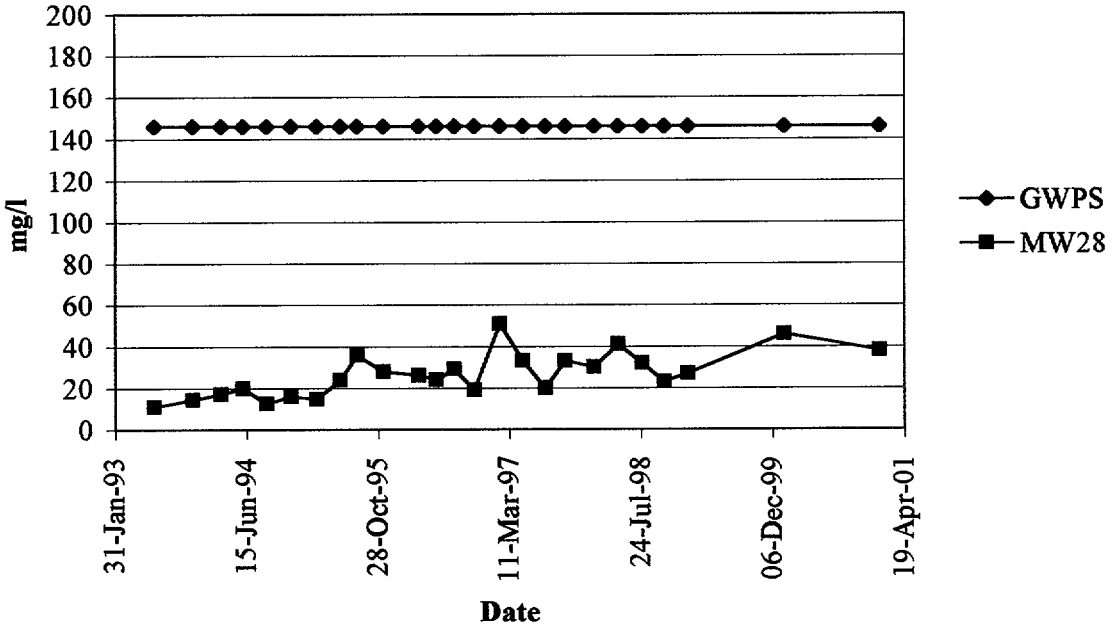


Figure H-1 Time vs. Concentration Data for Deep Well Completions

MW28 Gross Alpha



MW28 Lead-210

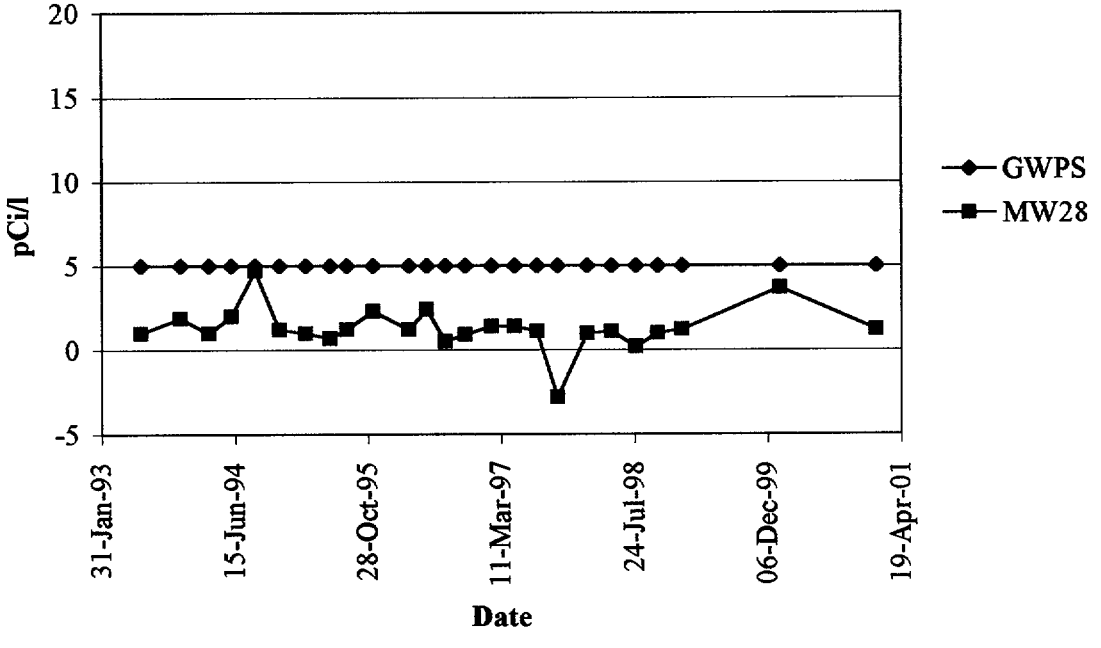
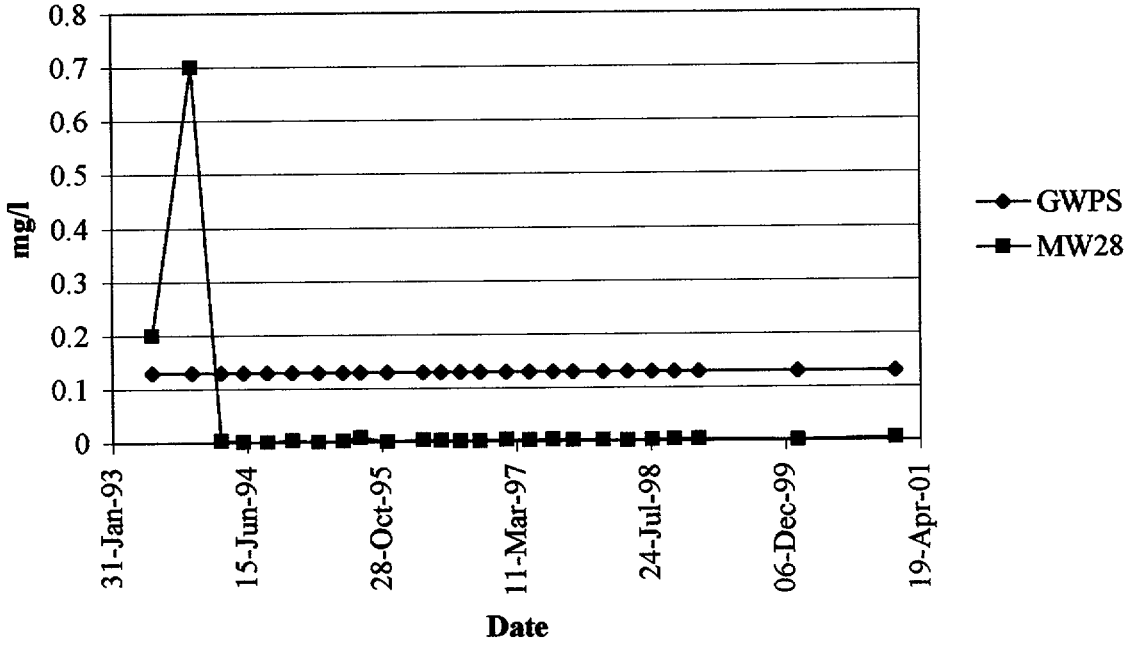


Figure H-1 Time vs. Concentration Data for Deep Well Completions

MW28 Natural Uranium



MW28 Nickel

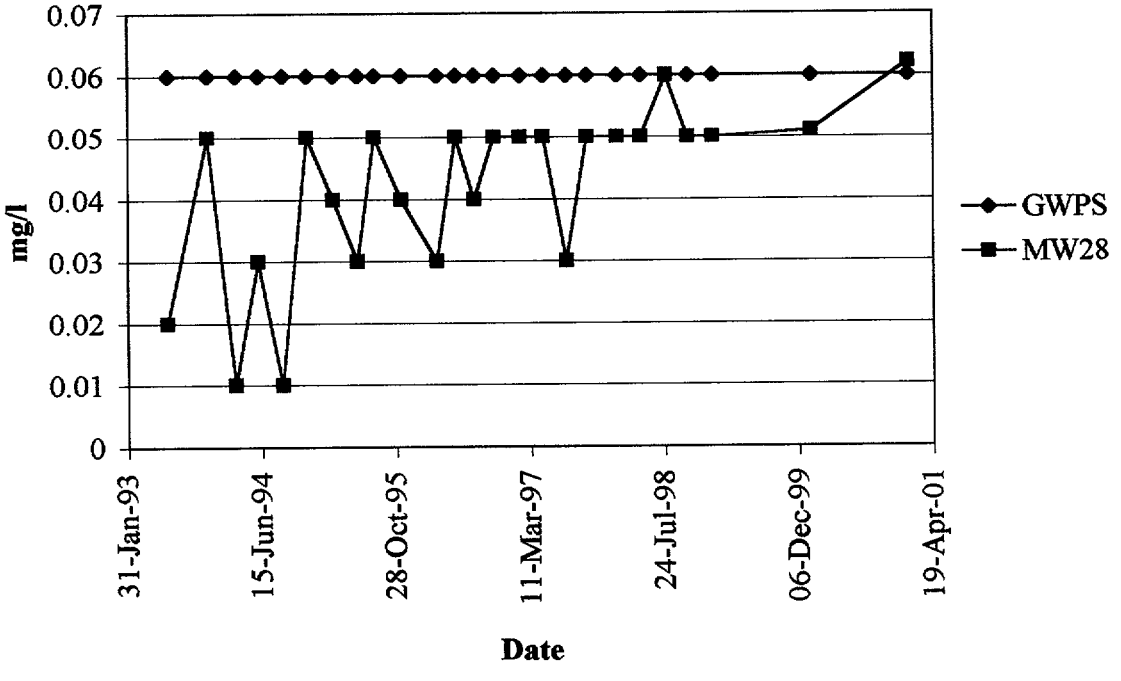
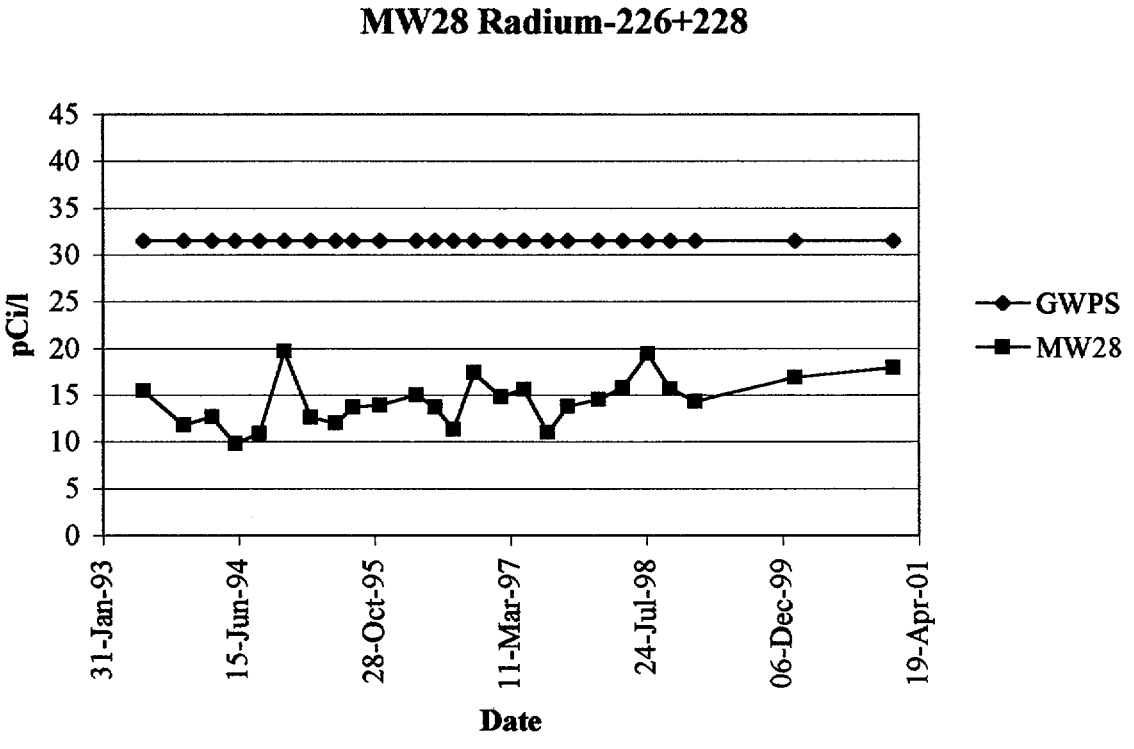


Figure H-1 Time vs. Concentration Data for Deep Well Completions



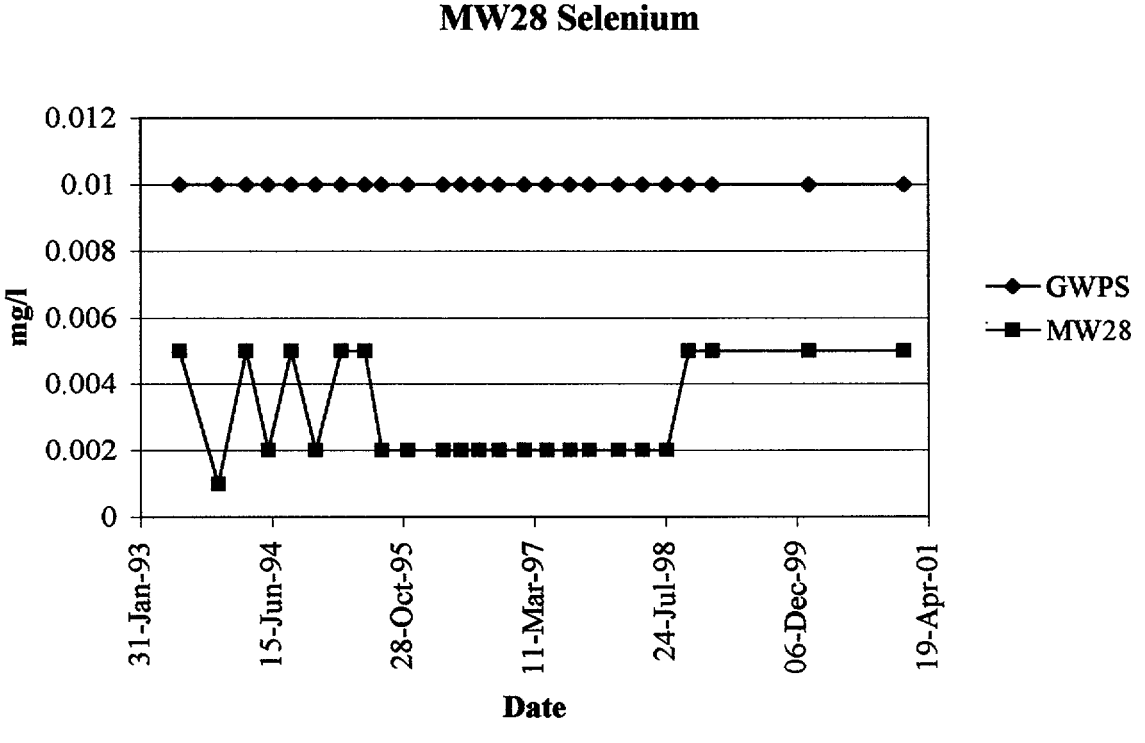


Figure H-1 Time vs. Concentration Data for Deep Well Completions

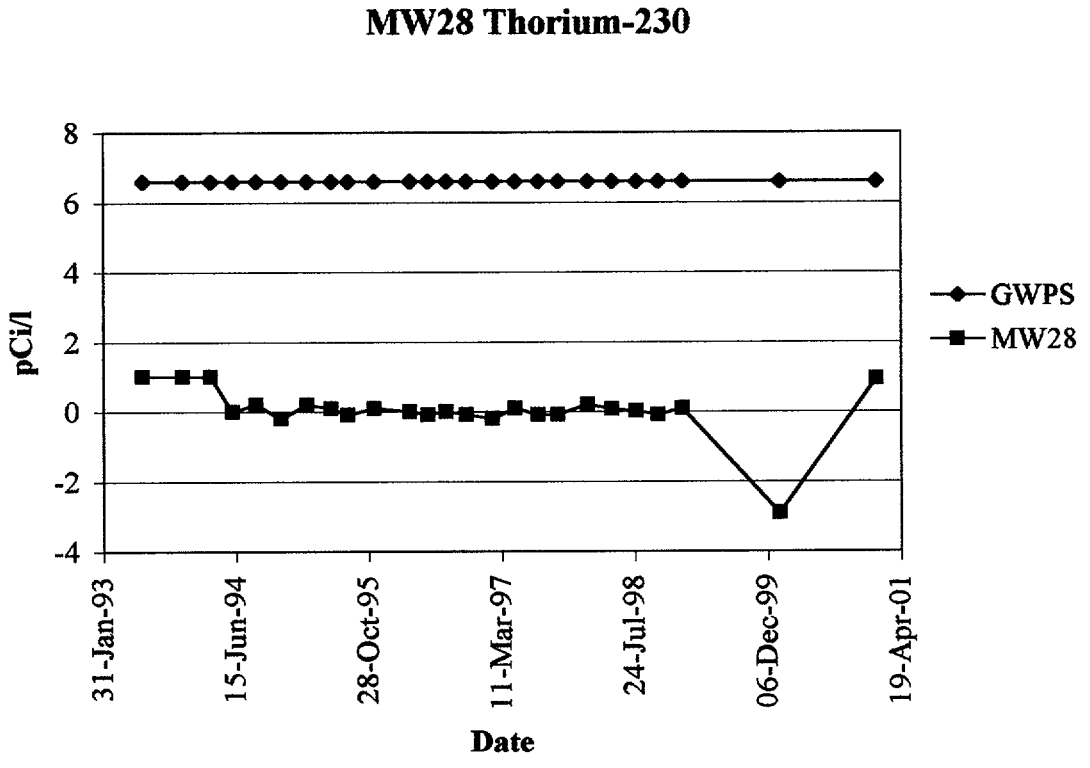
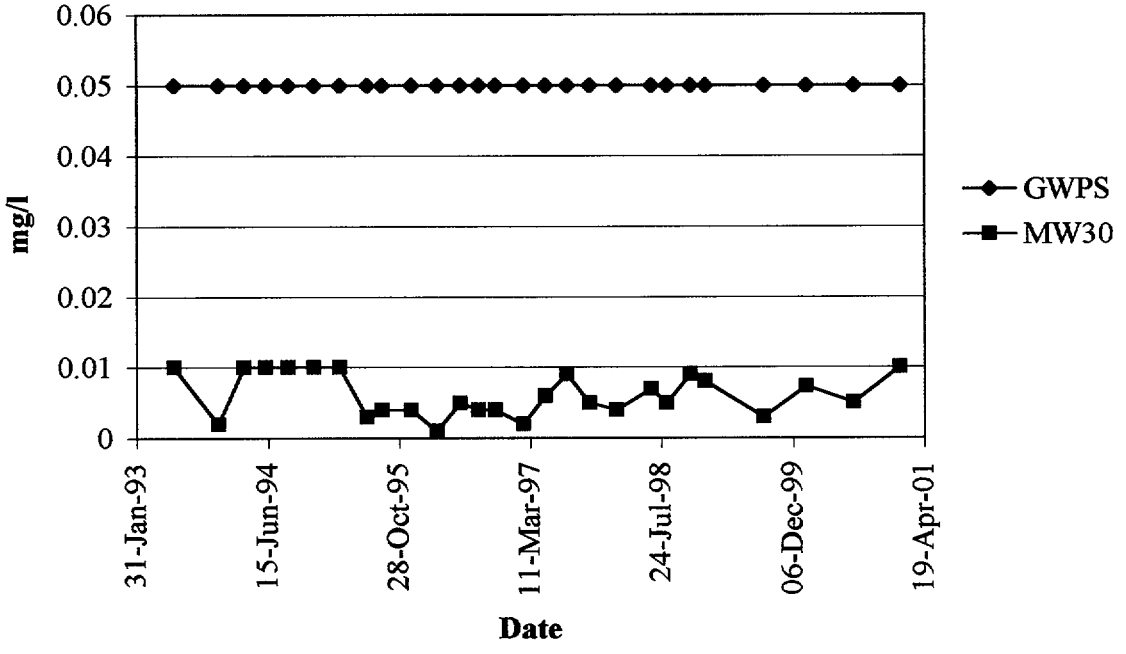


Figure H-2 Time vs. Concentration Data for Deep Well Completions

MW30 Arsenic



MW30 Beryllium

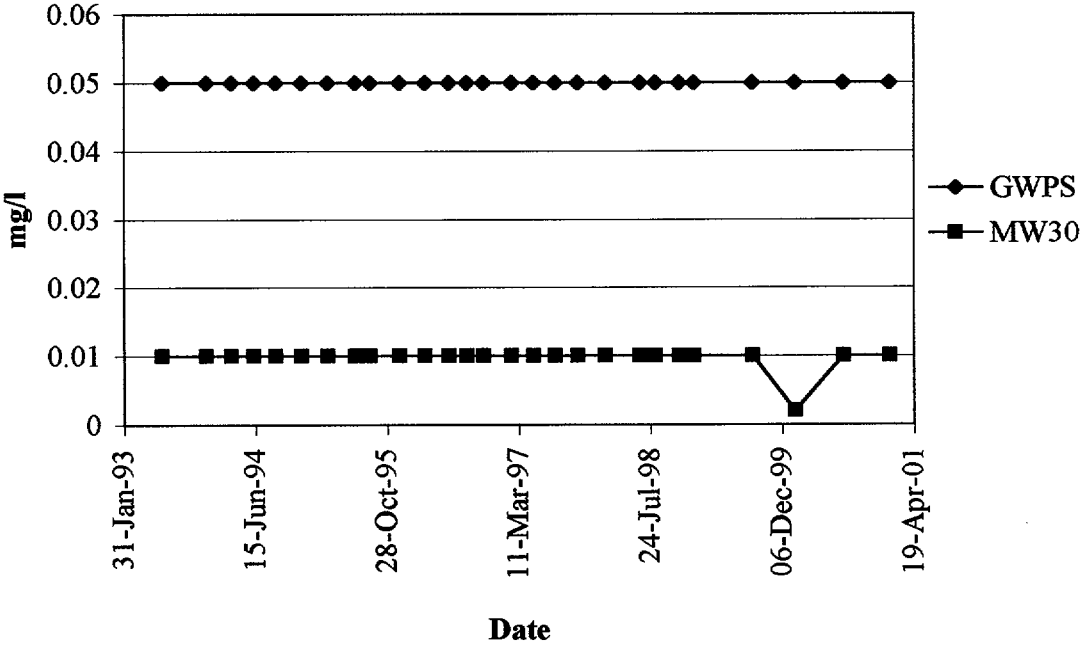
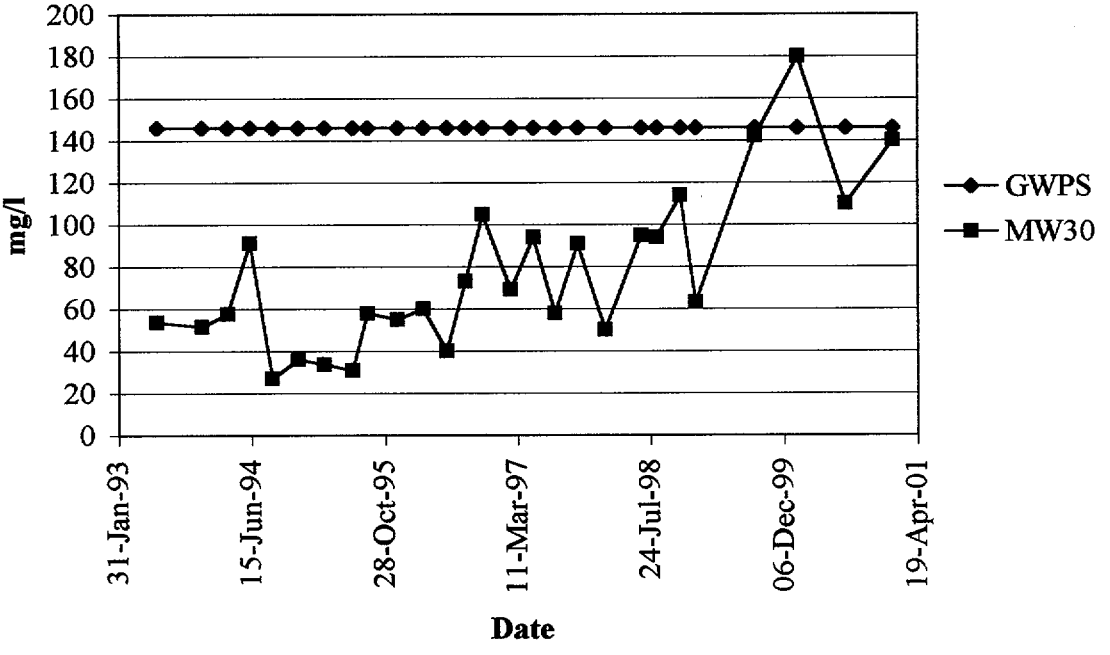


Figure H-2 Time vs. Concentration Data for Deep Well Completions

MW30 Gross Alpha



MW30 Lead-210

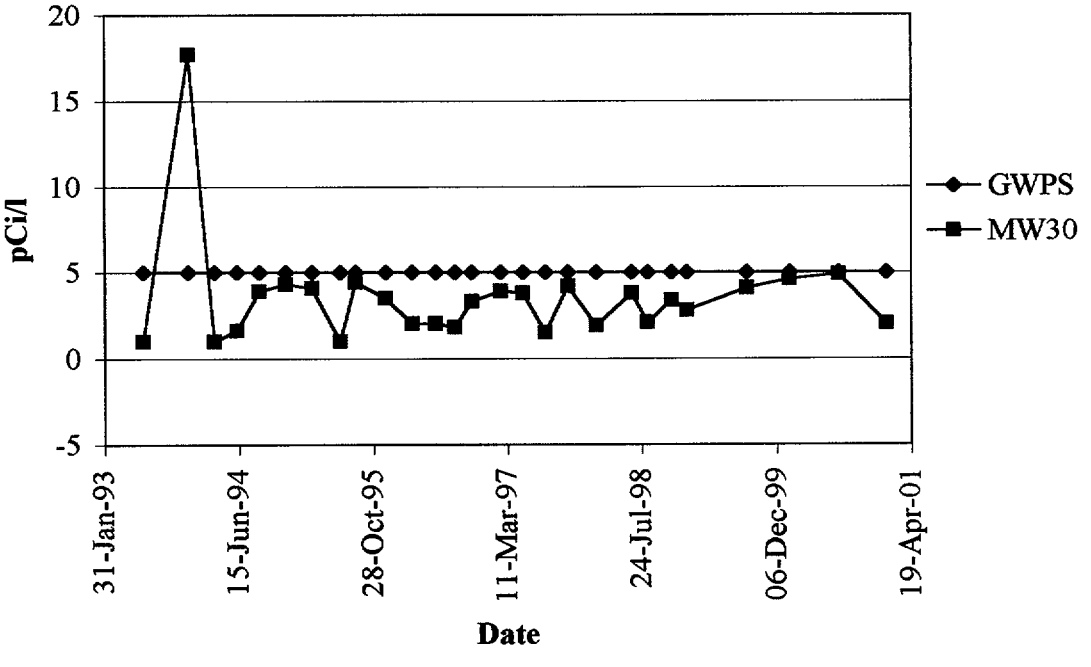
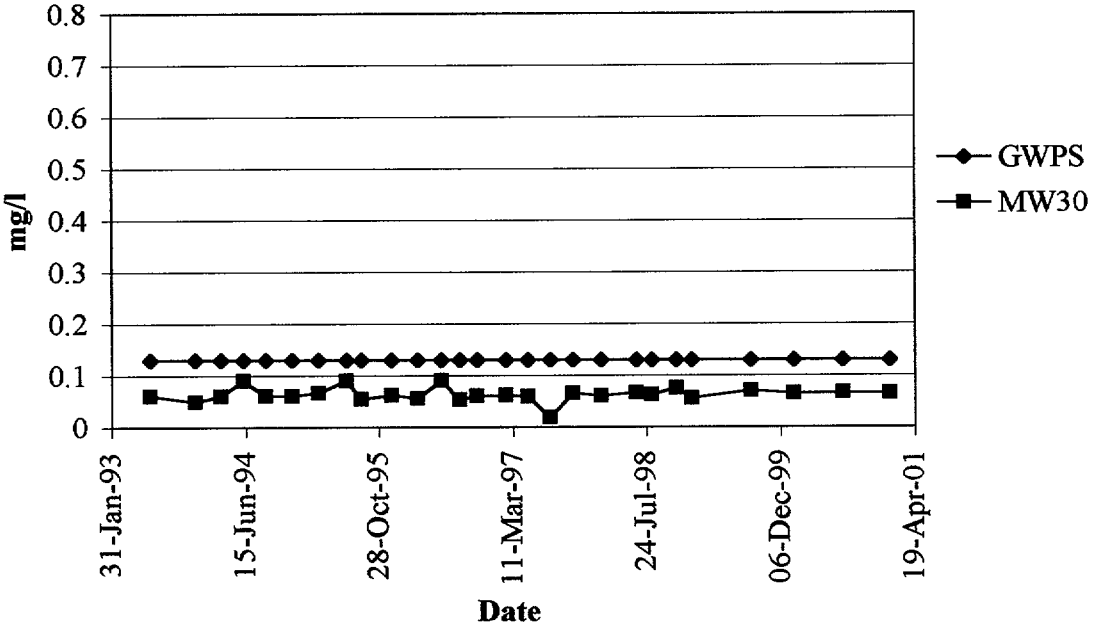


Figure H-2 Time vs. Concentration Data for Deep Well Completions

MW30 Natural Uranium



MW30 Nickel

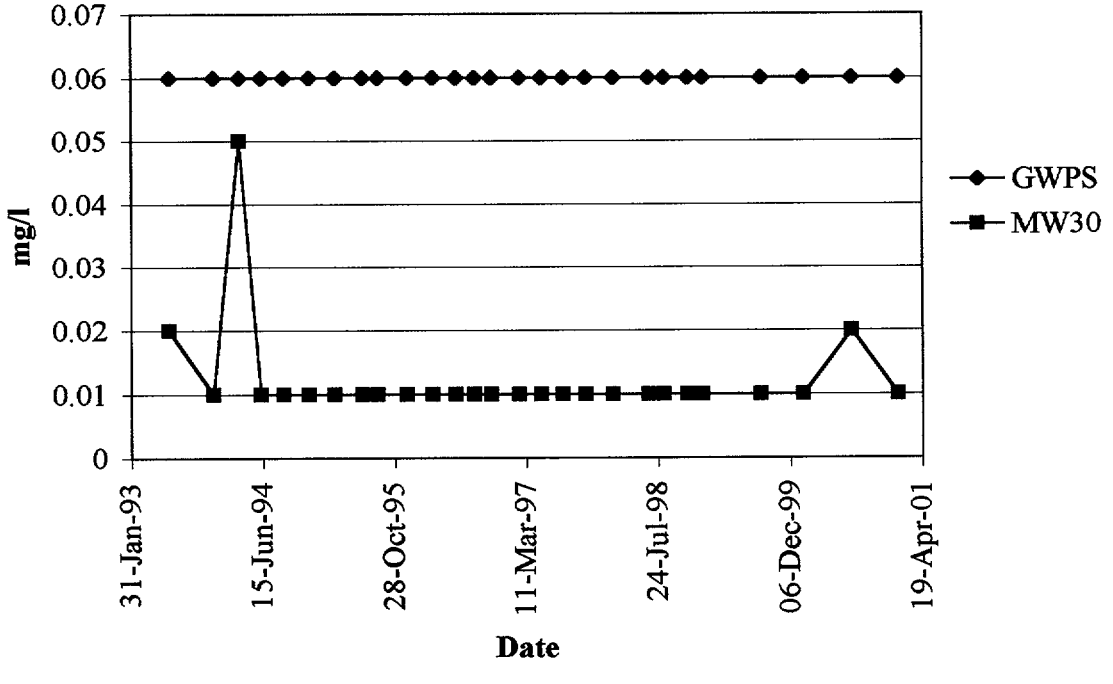
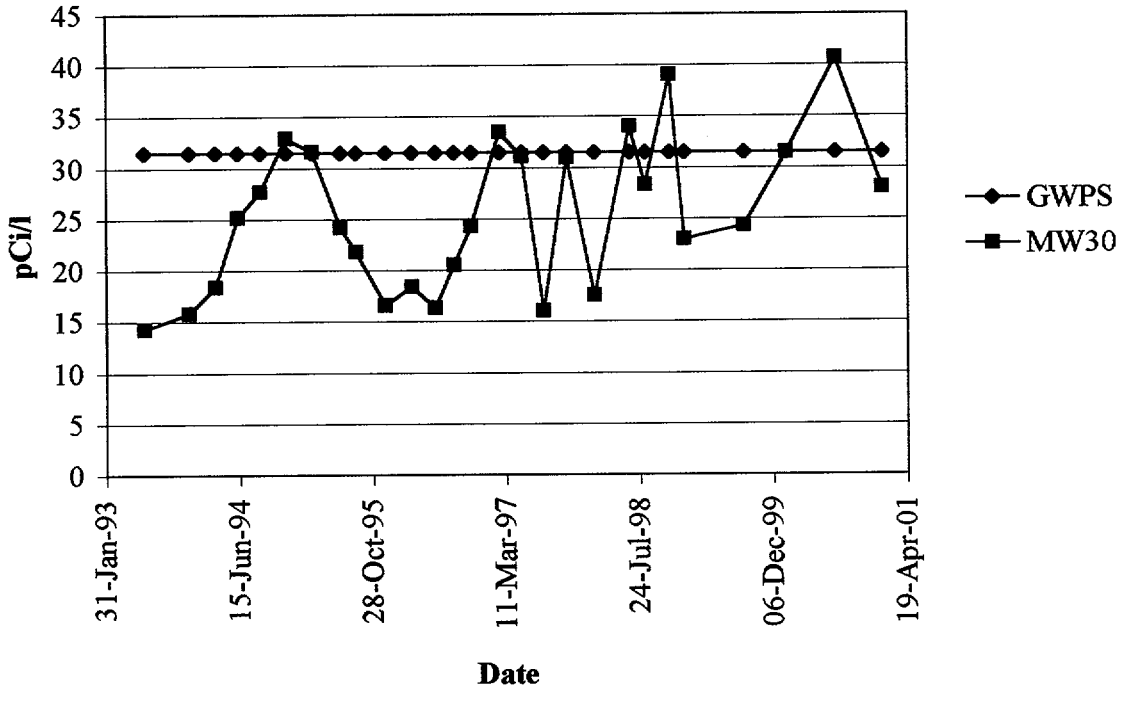


Figure H-2 Time vs. Concentration Data for Deep Well Completions

MW30 Radium-228+226



MW30 Selenium

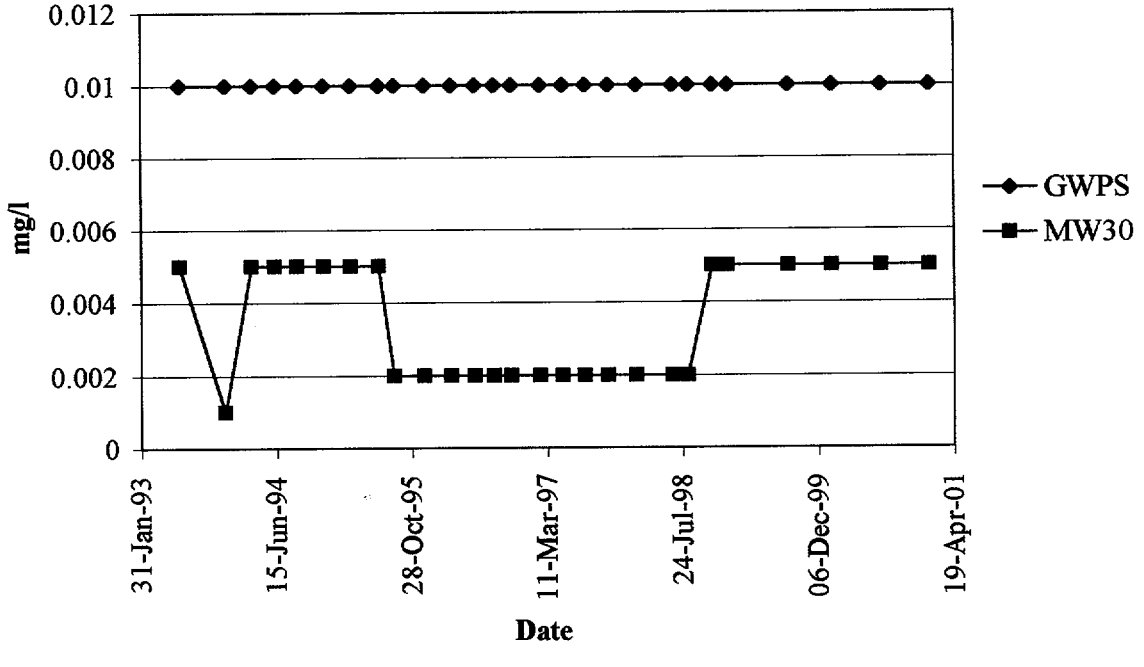
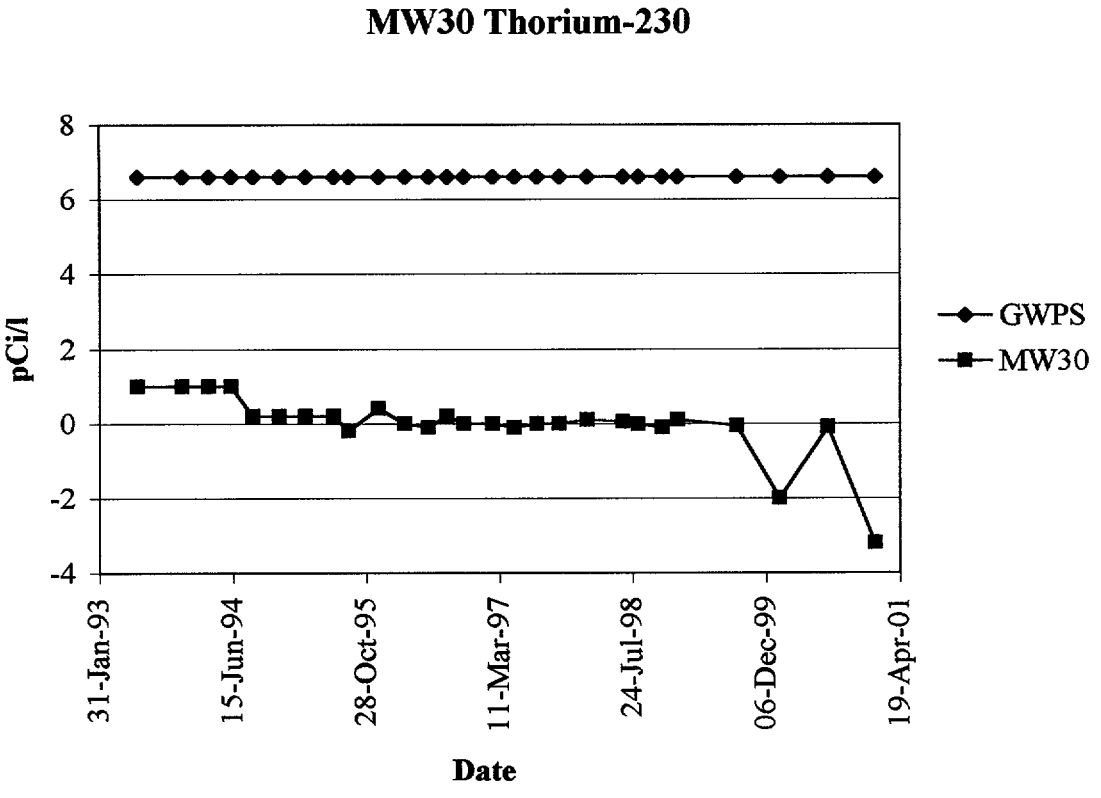
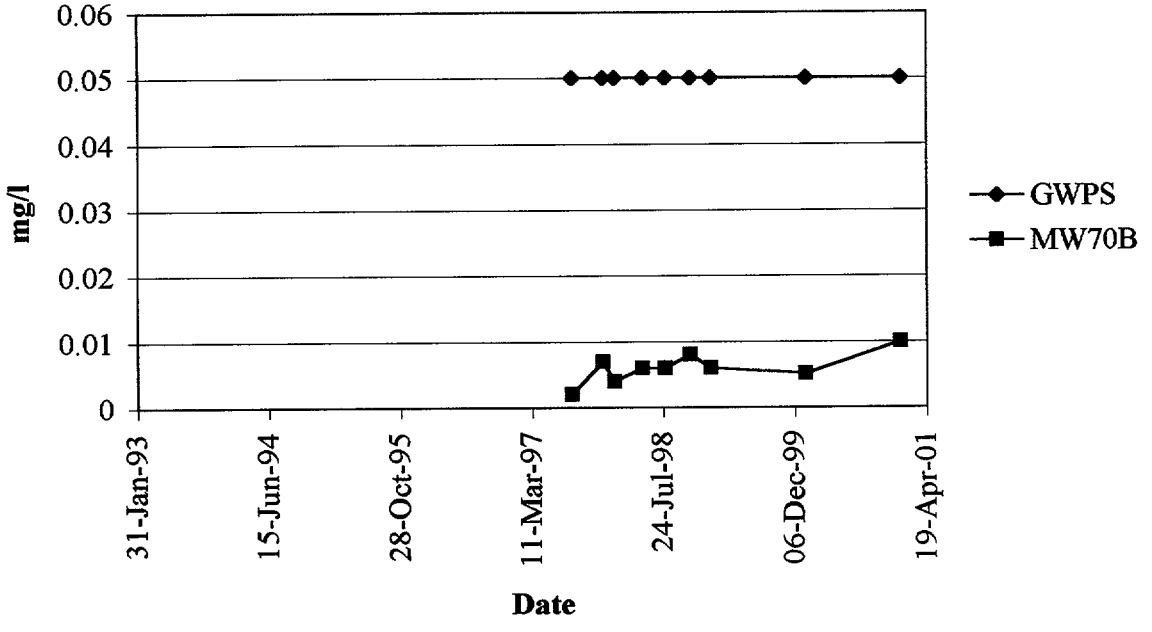


Figure H-2 Time vs. Concentration Data for Deep Well Completions

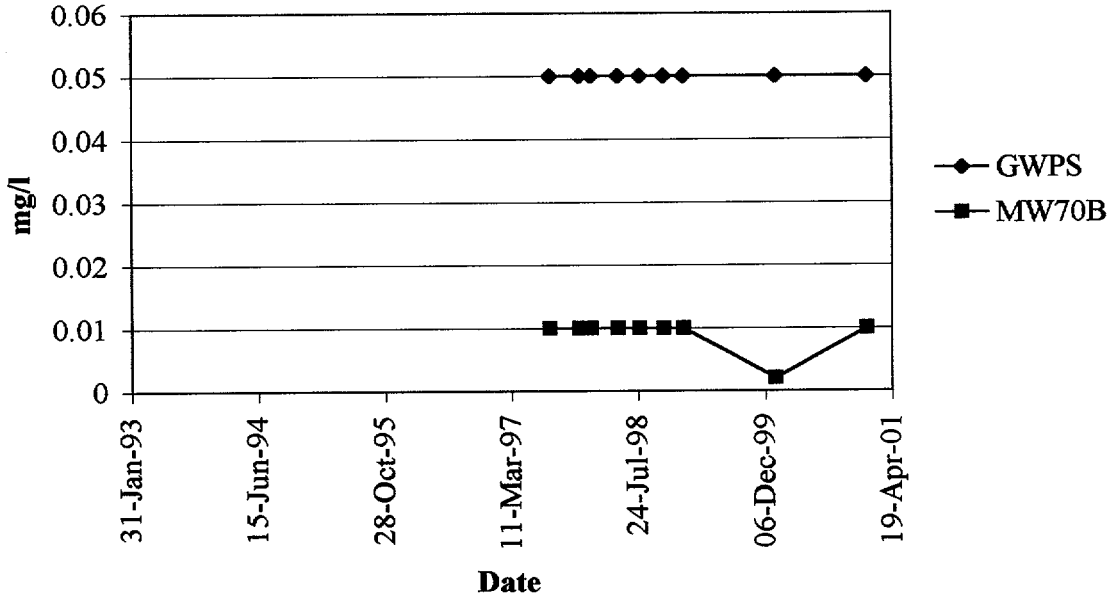


Figures H-3 Time vs. Concentration Data for Deep Well Completions

MW70B Arsenic

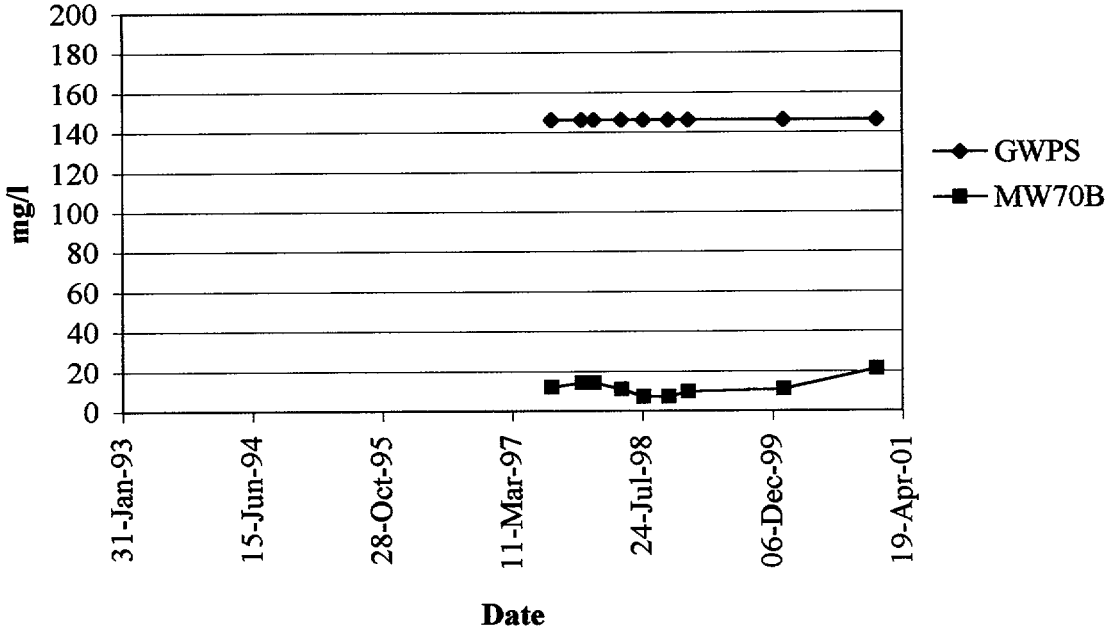


MW70B Beryllium

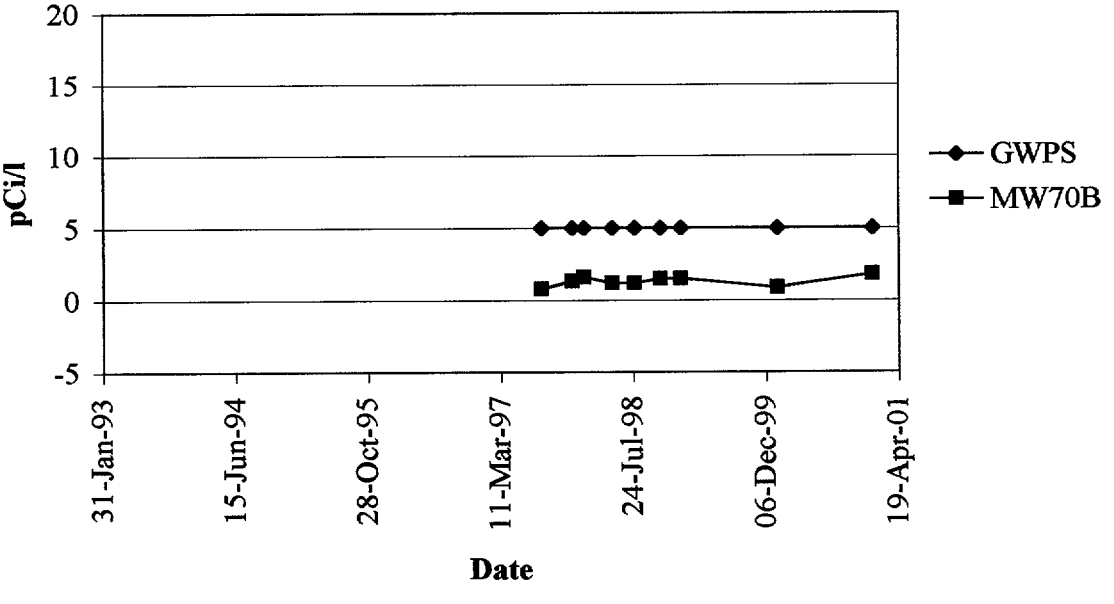


Figures H-3 Time vs. Concentration Data for Deep Well Completions

MW70B Gross Alpha

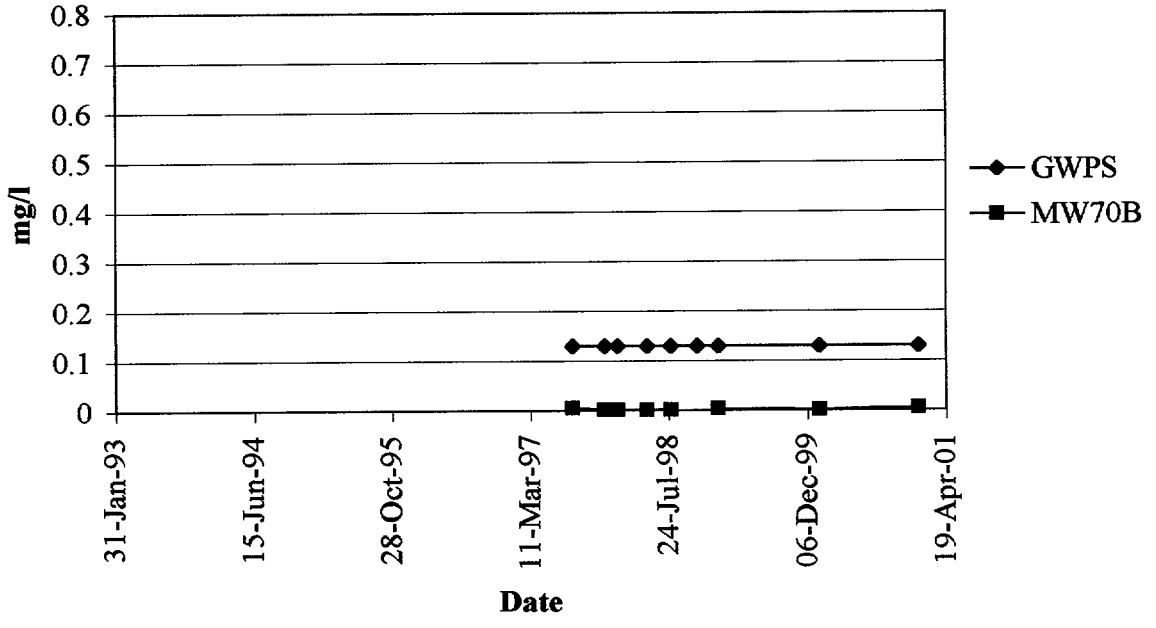


MW70B Lead-210

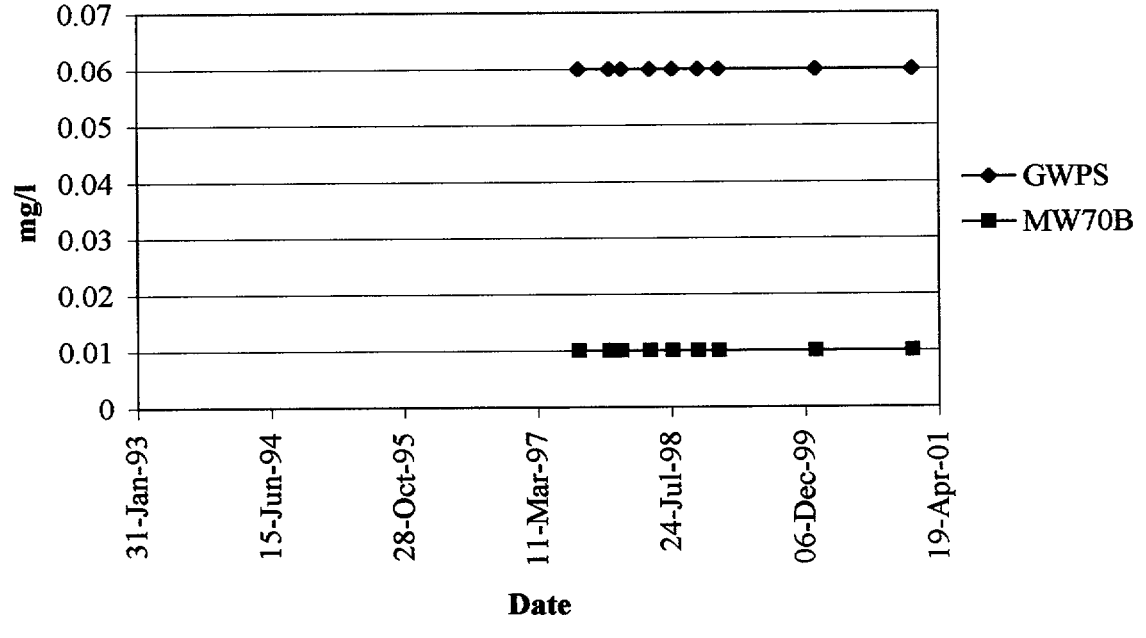


Figures H-3 Time vs. Concentration Data for Deep Well Completions

MW70B Natural Uranium

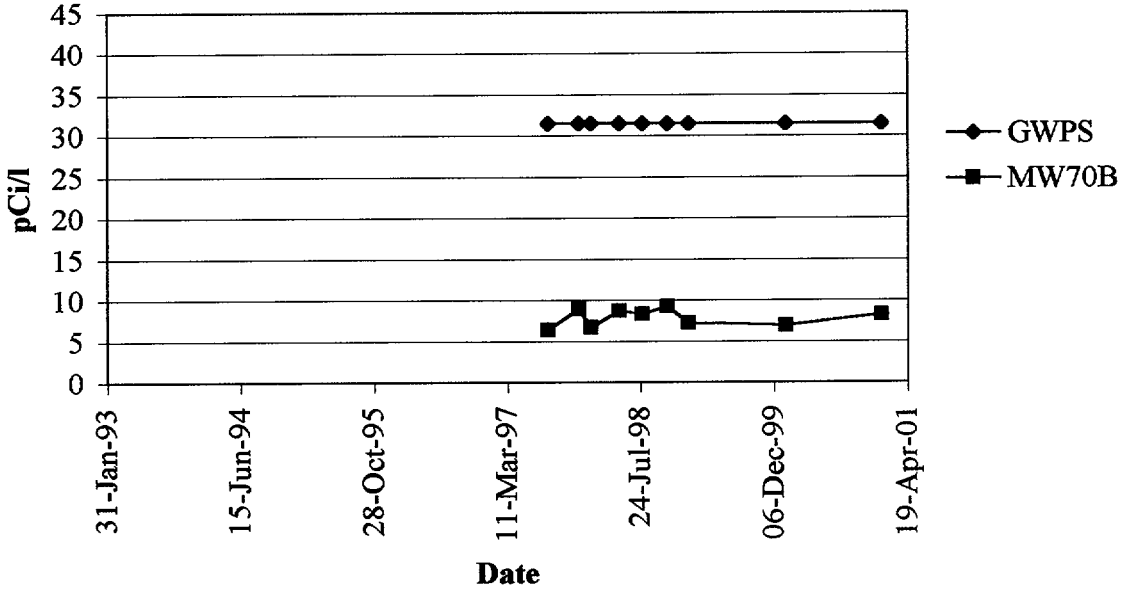


MW70B Nickel

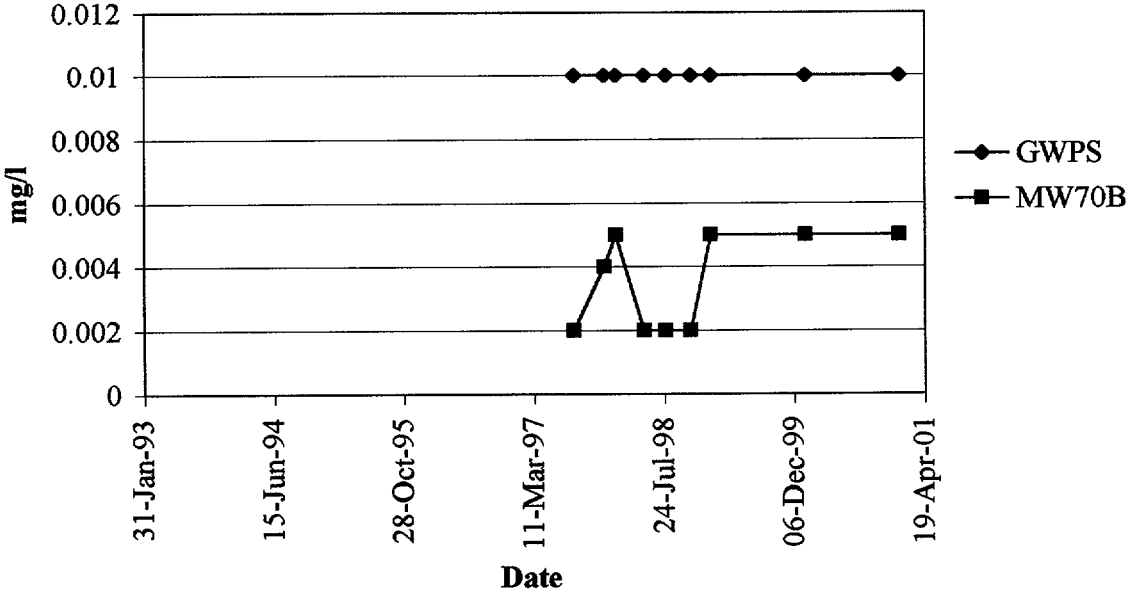


Figures H-3 Time vs. Concentration Data for Deep Well Completions

MW70B Radium-226+228



MW70B Selenium



Figures H-3 Time vs. Concentration Data for Deep Well Completions

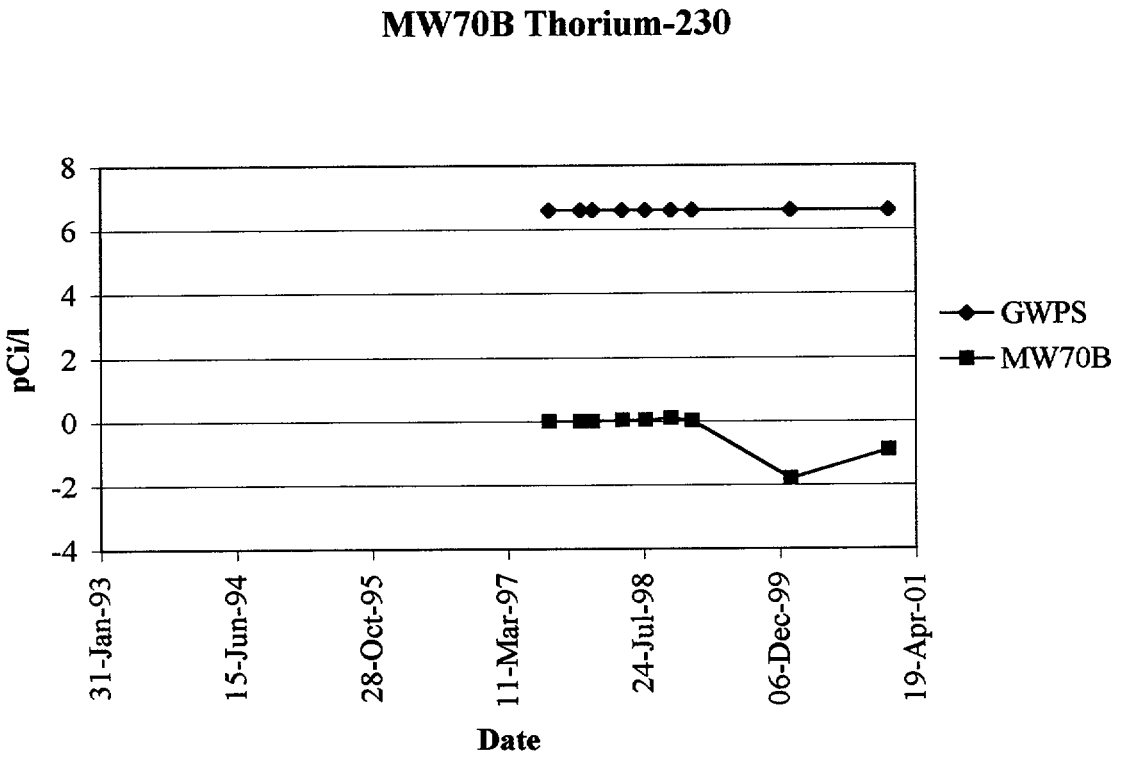
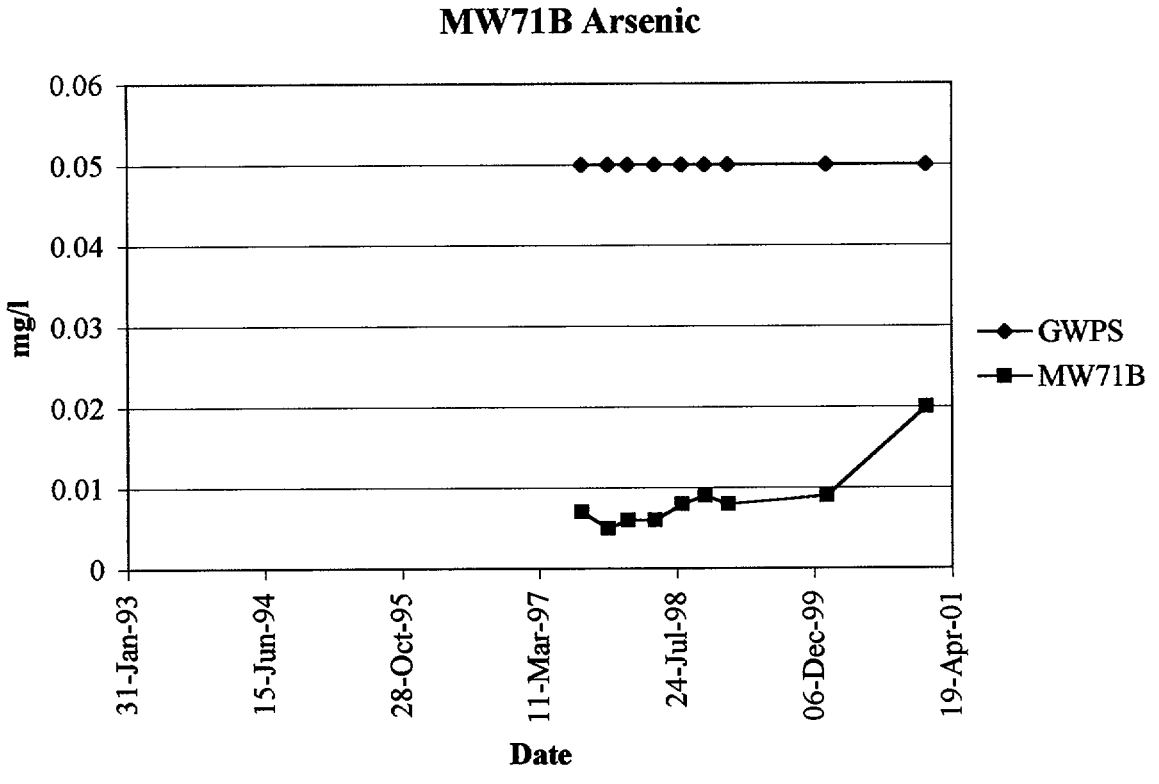


Figure H-4 Time vs. Concentration Data for Deep Well Completions



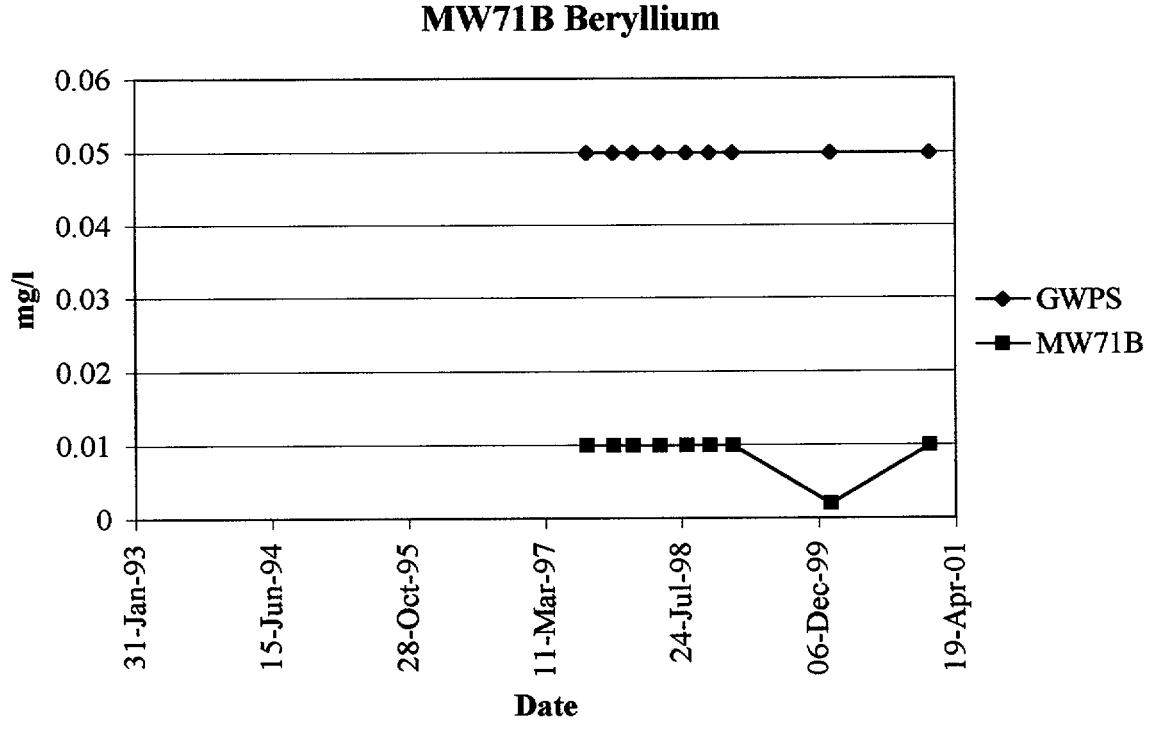
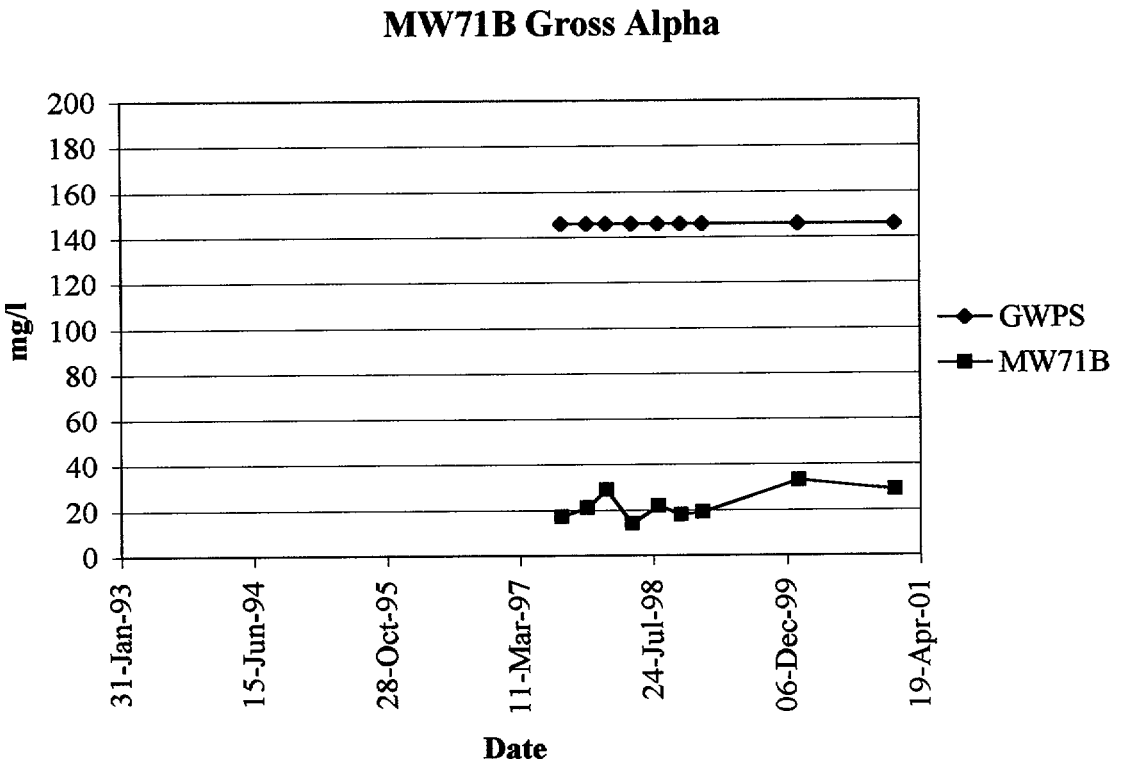


Figure H-4 Time vs. Concentration Data for Deep Well Completions



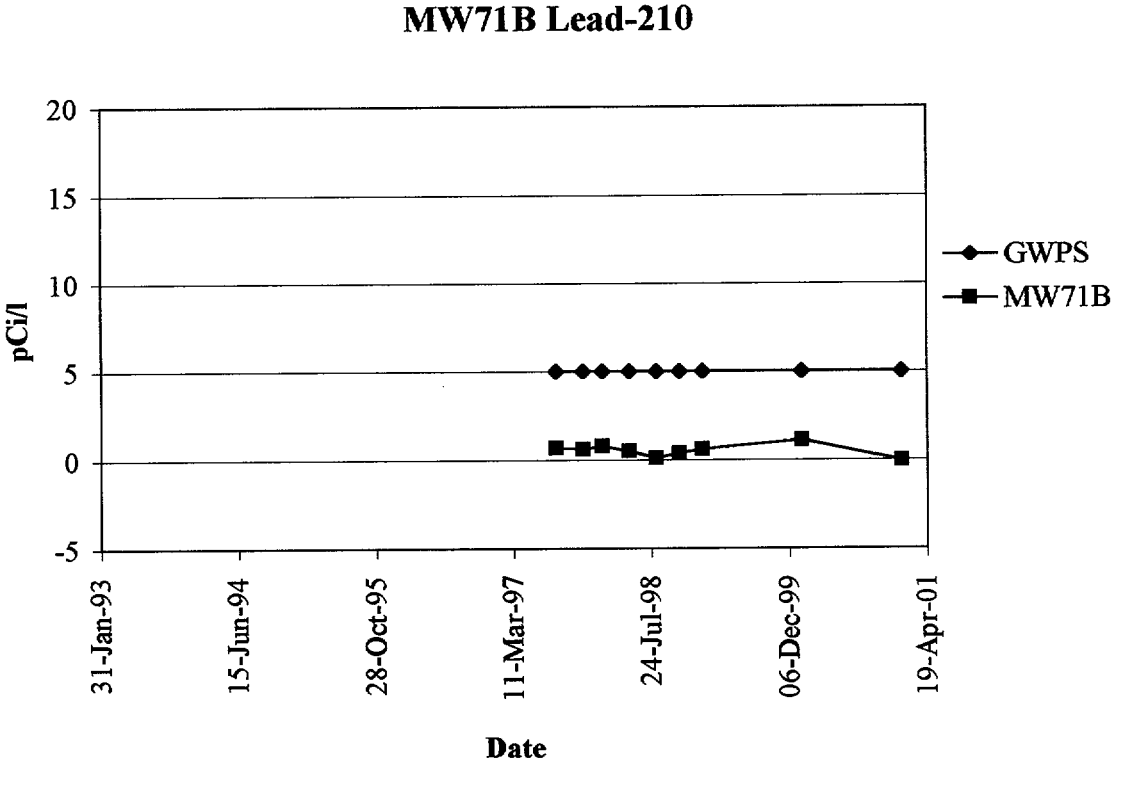
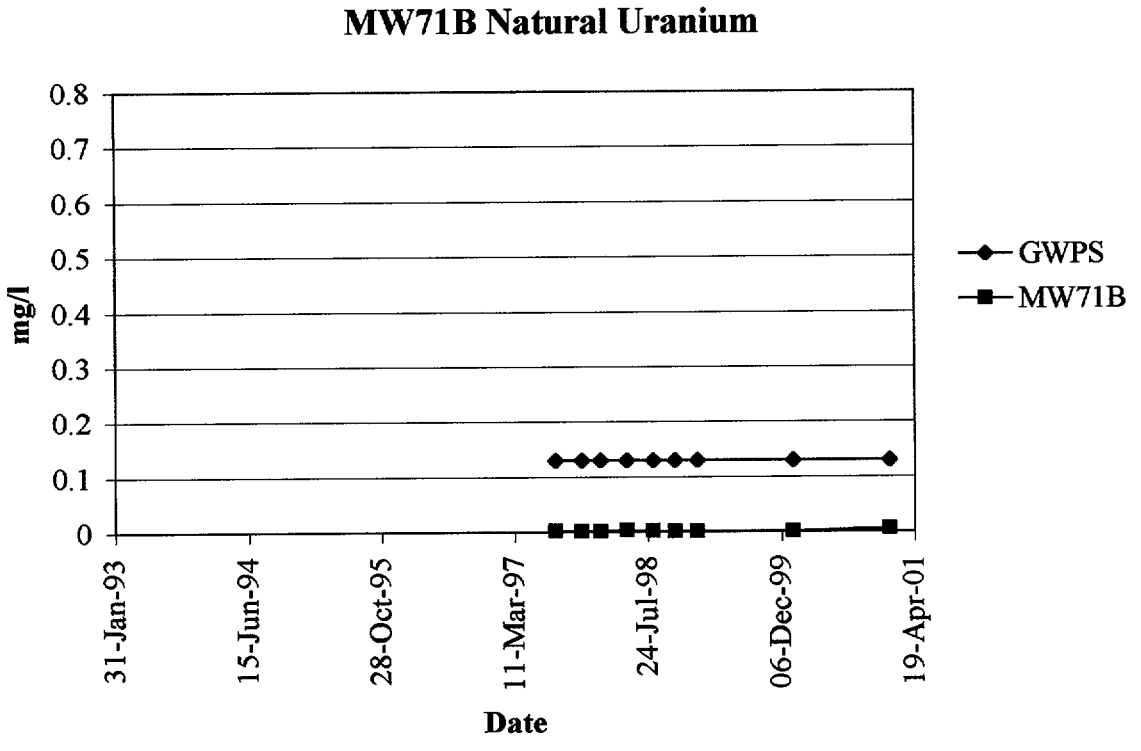


Figure H-4 Time vs. Concentration Data for Deep Well Completions



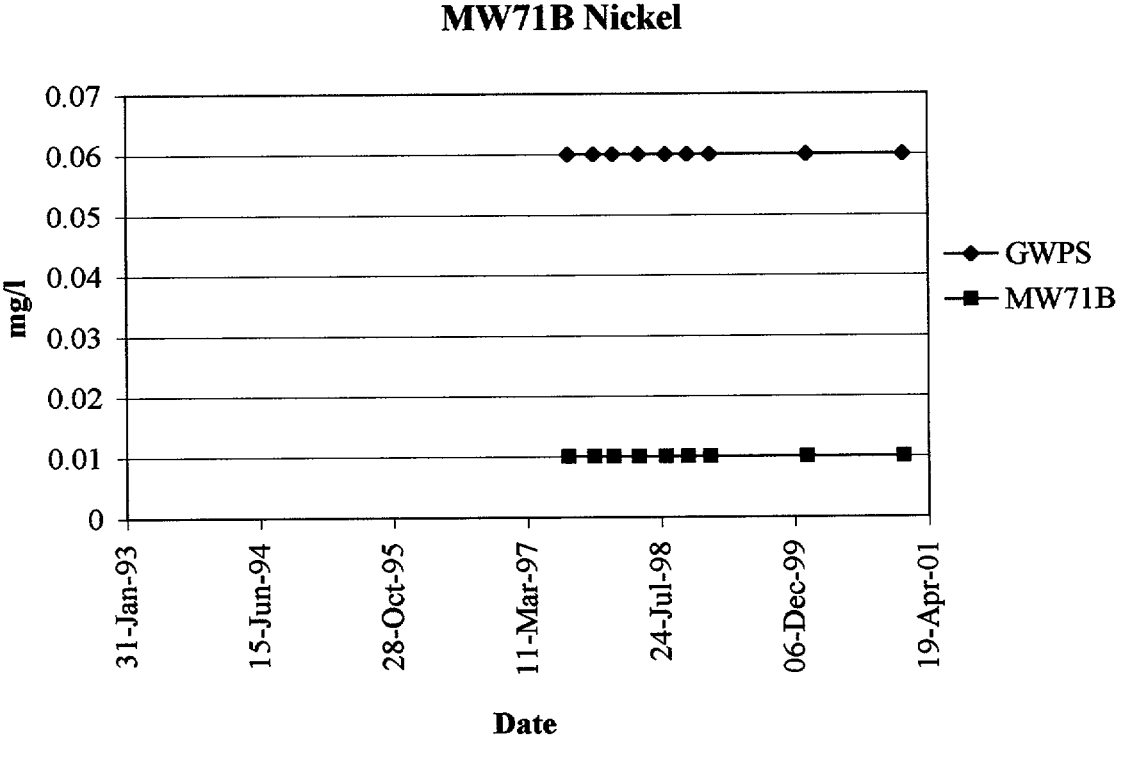
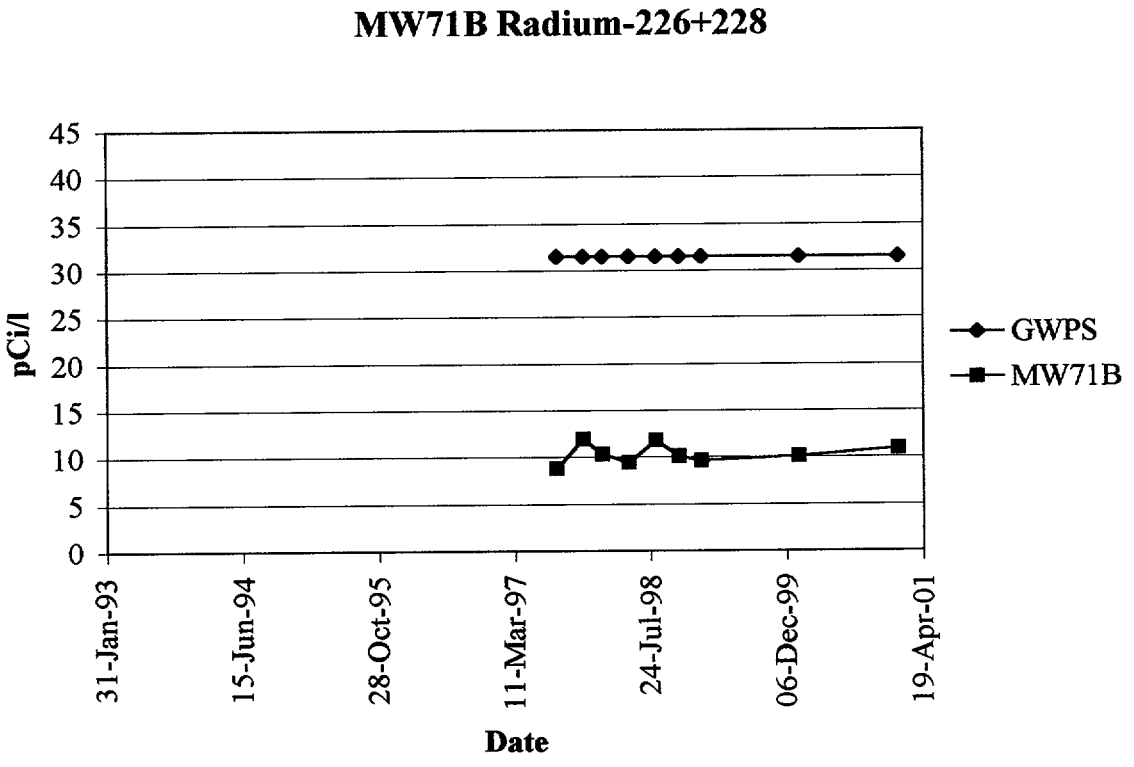


Figure H-4 Time vs. Concentration Data for Deep Well Completions



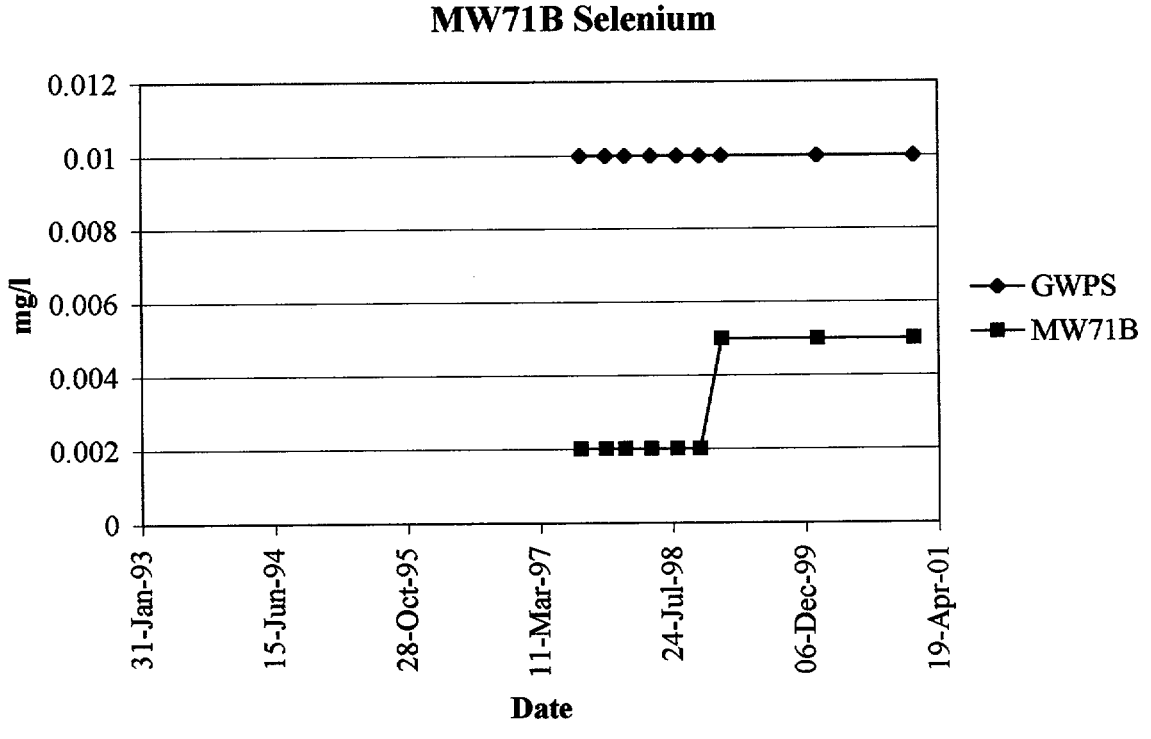
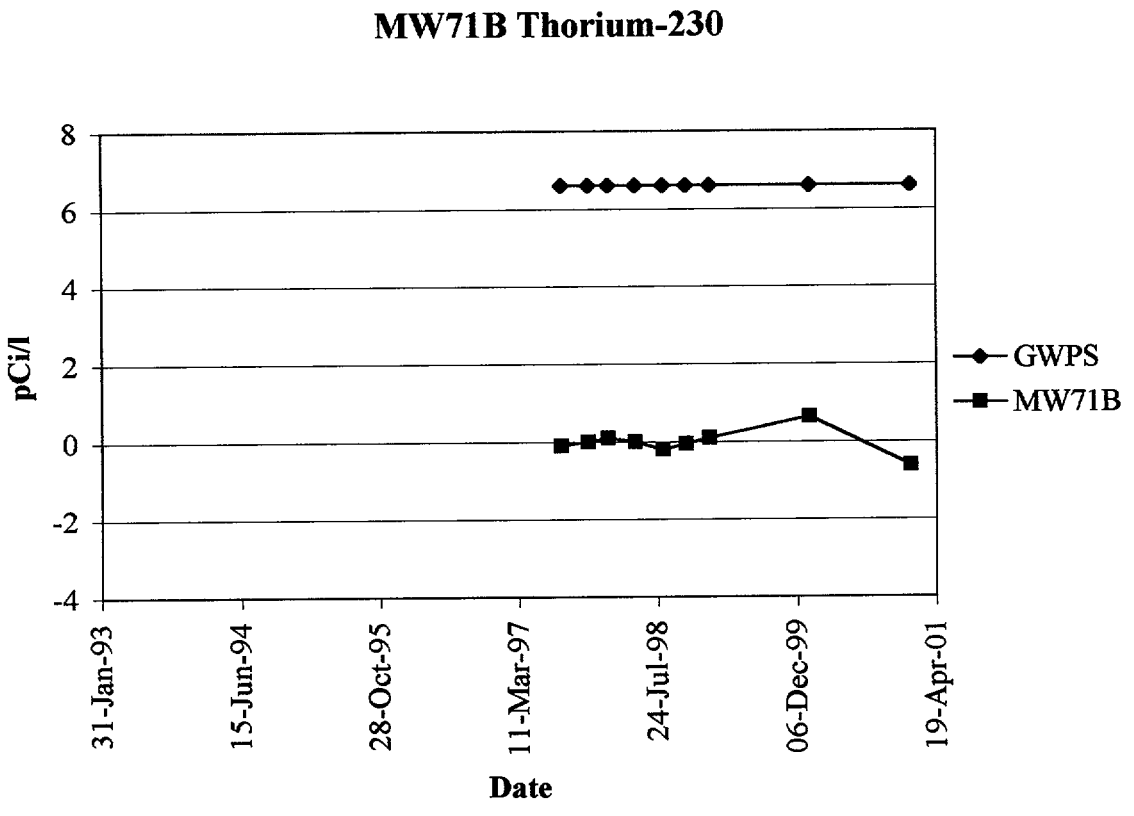


Figure H-4 Time vs. Concentration Data for Deep Well Completions



Appendix I

Water Quality Data for DW3, HW3, and HW4

Umetco Gas Hills Site

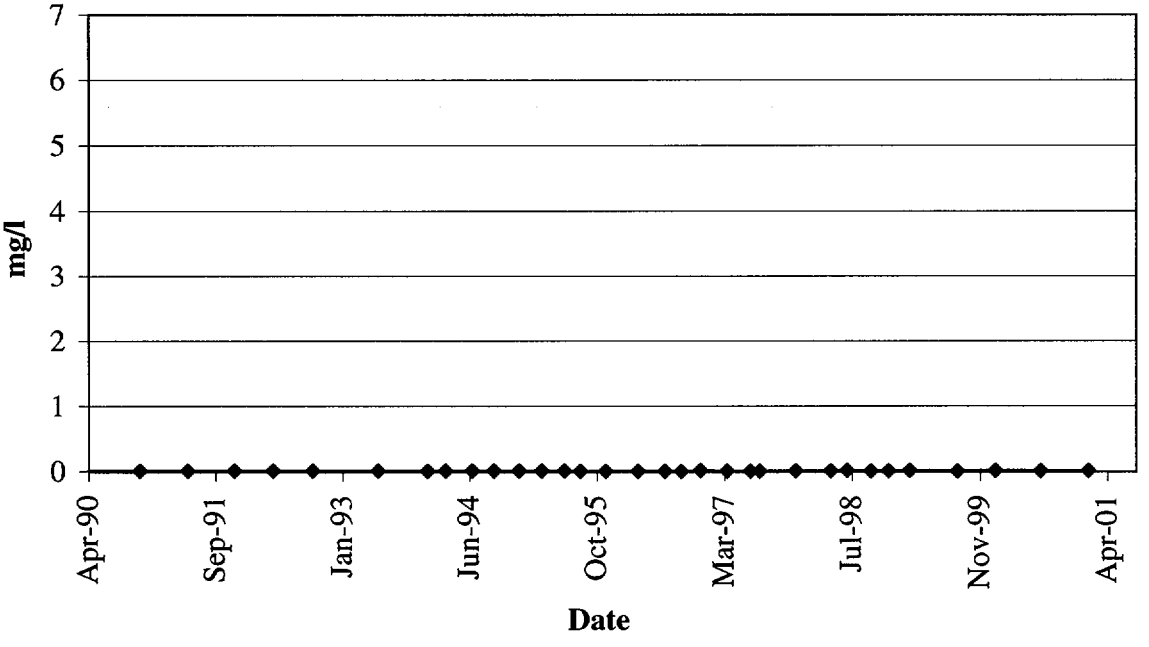
Fremont and Natrona Counties, Wyoming

Umetco Minerals Corporation
2754 Compass Drive, Suite 280
Grand Junction, Colorado 81506

May 2001

Figure I-1 Constituent Concentrations for DW3

Arsenic



Beryllium

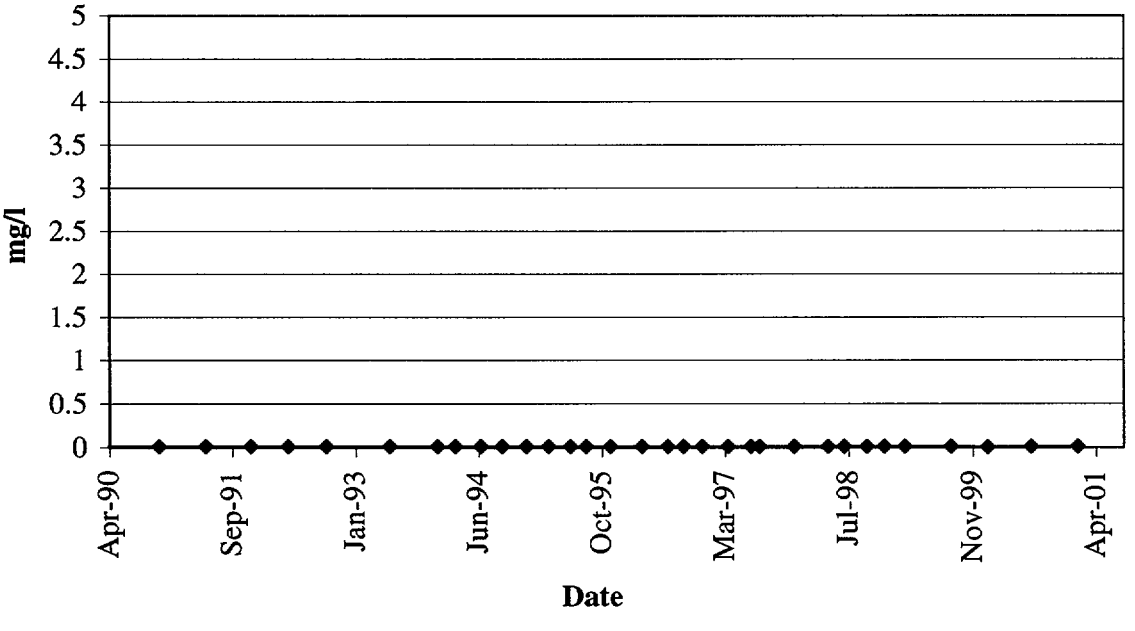
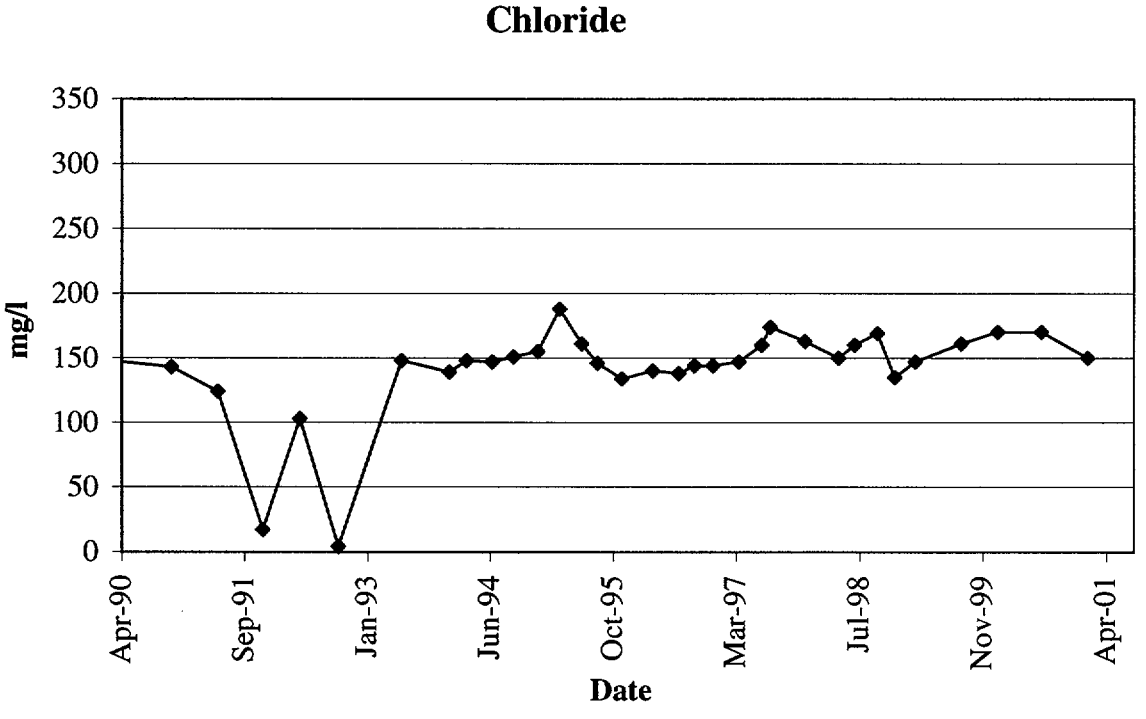


Figure I-1 Constituent Concentrations for DW3



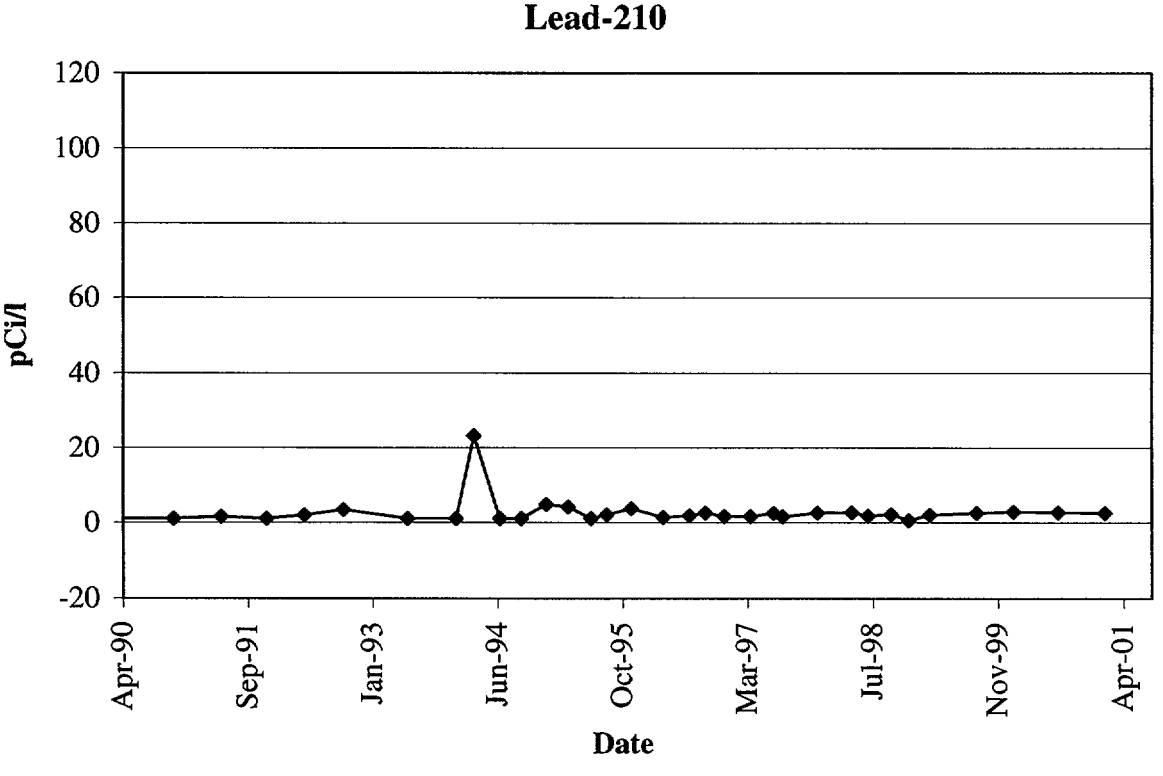
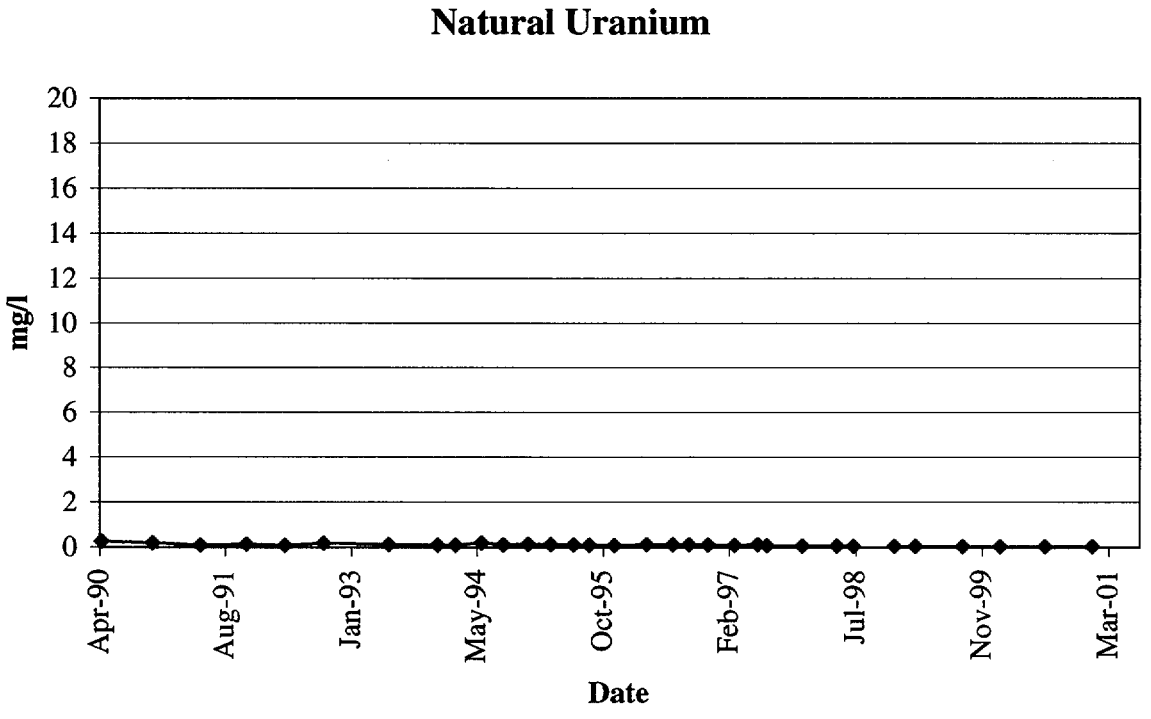


Figure I-1 Constituent Concentrations for DW3



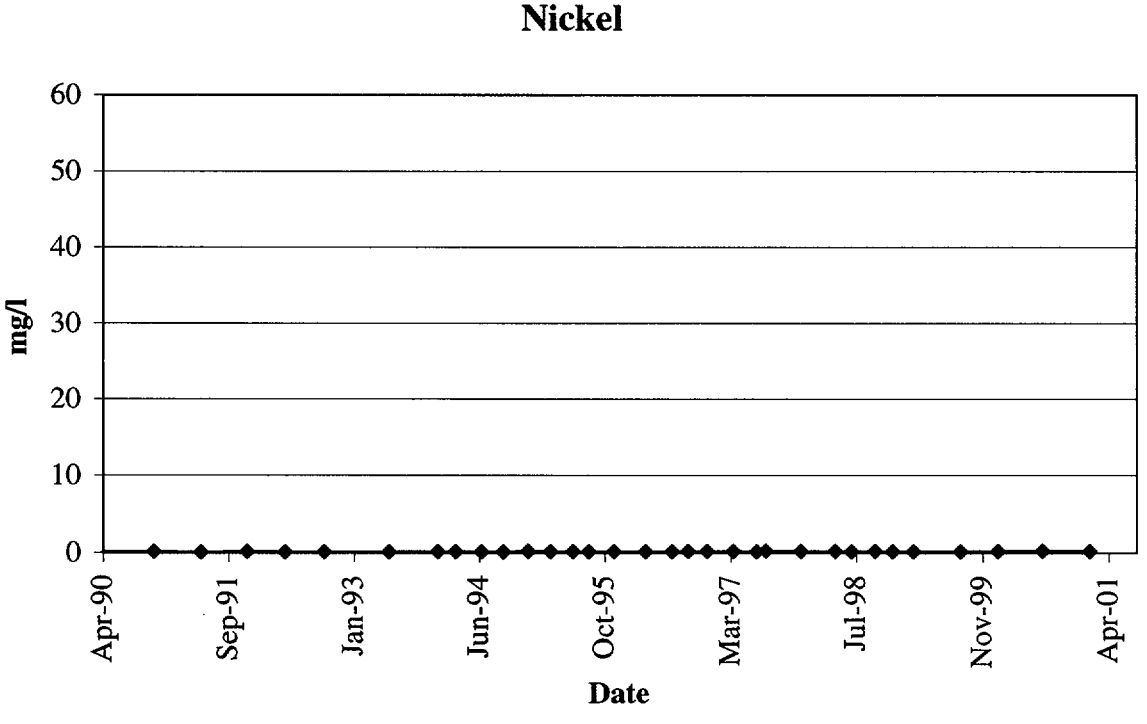
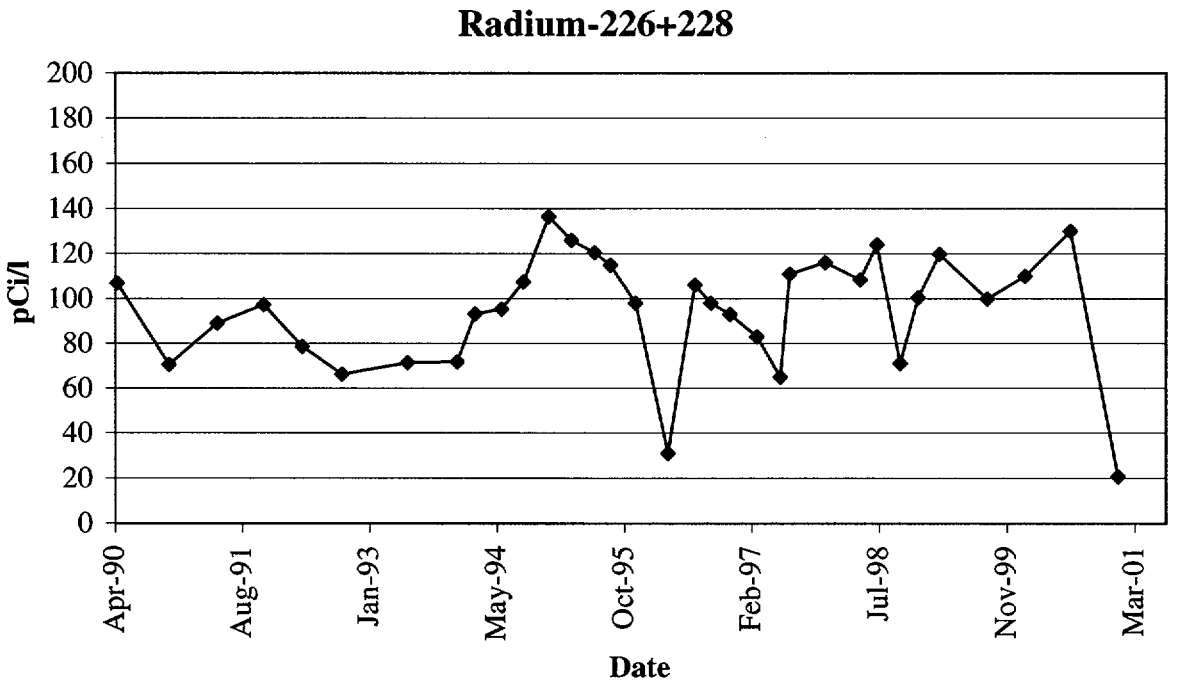


Figure I-1 Constituent Concentrations for DW3



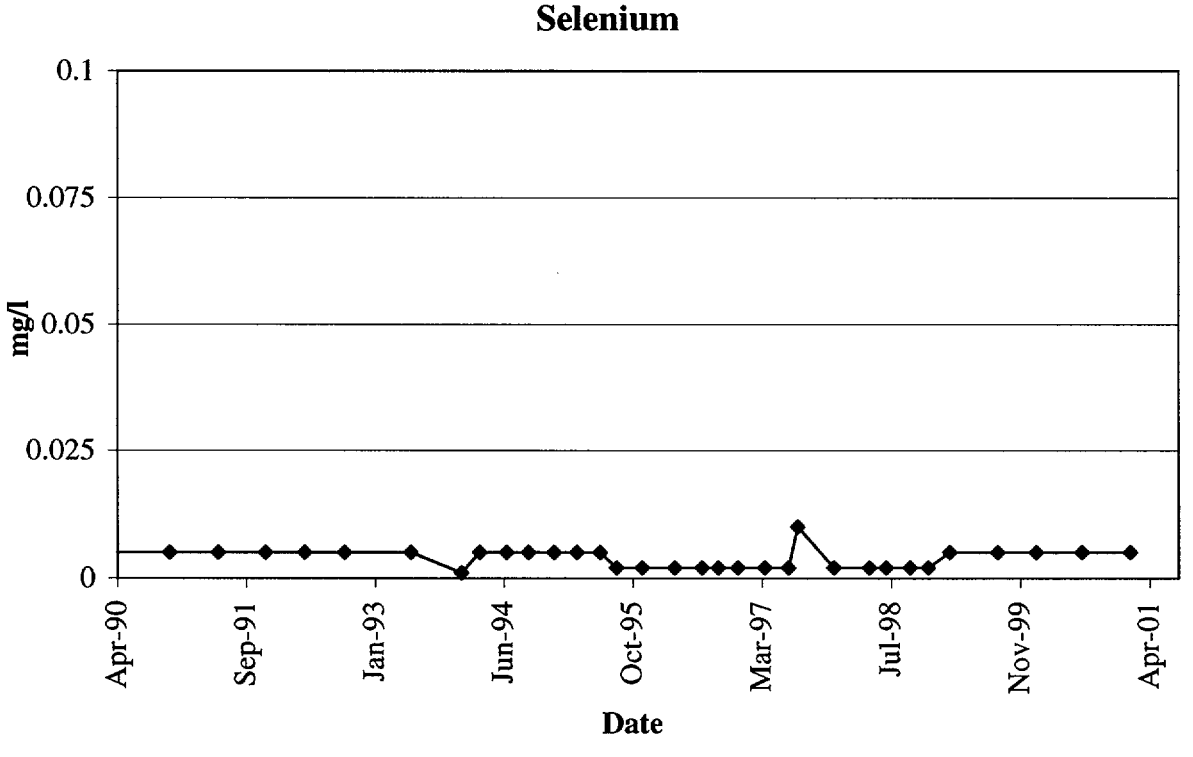
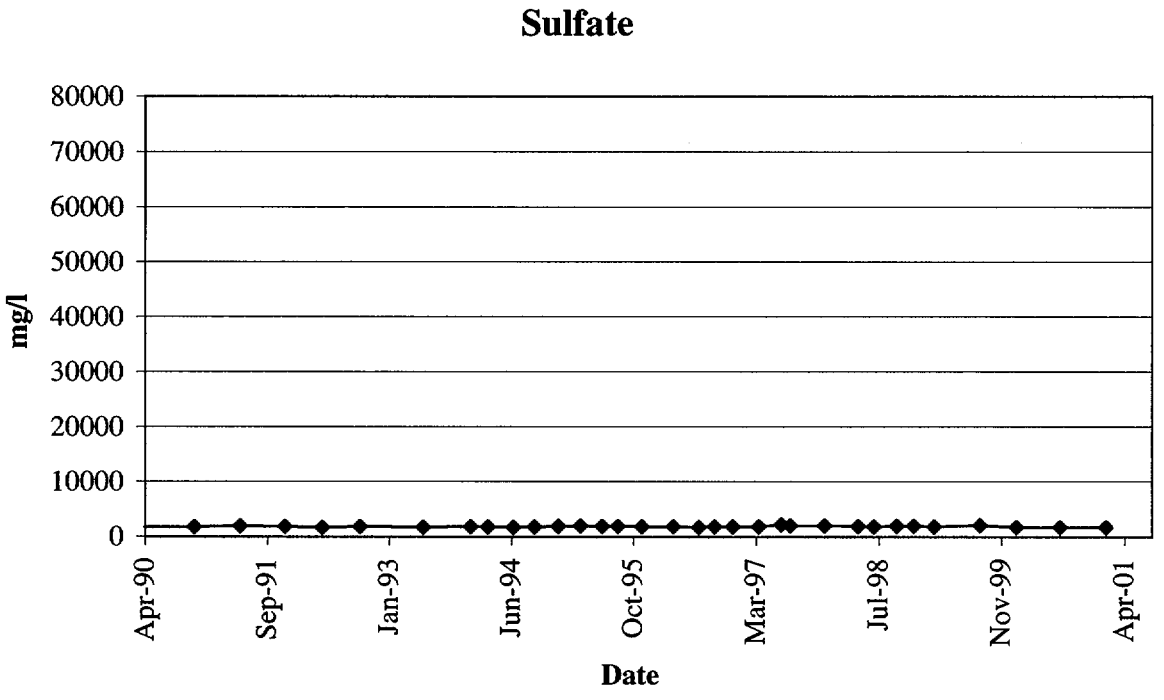


Figure I-1 Constituent Concentrations for DW3



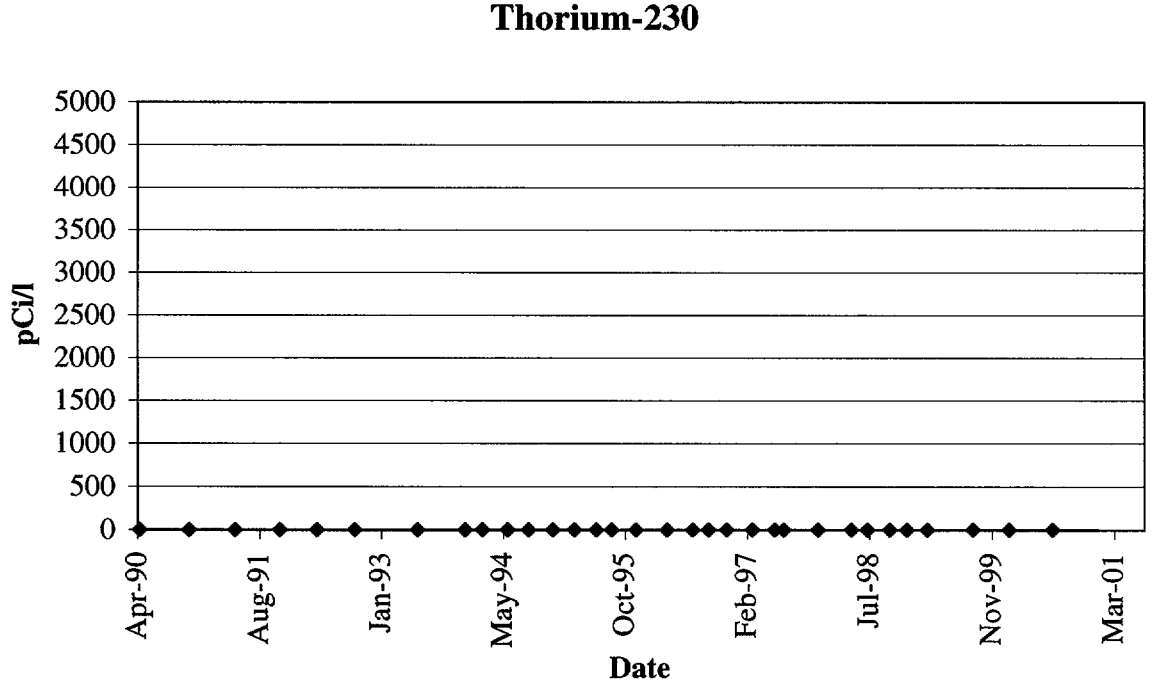


Figure I-1 Constituent Concentrations for DW3

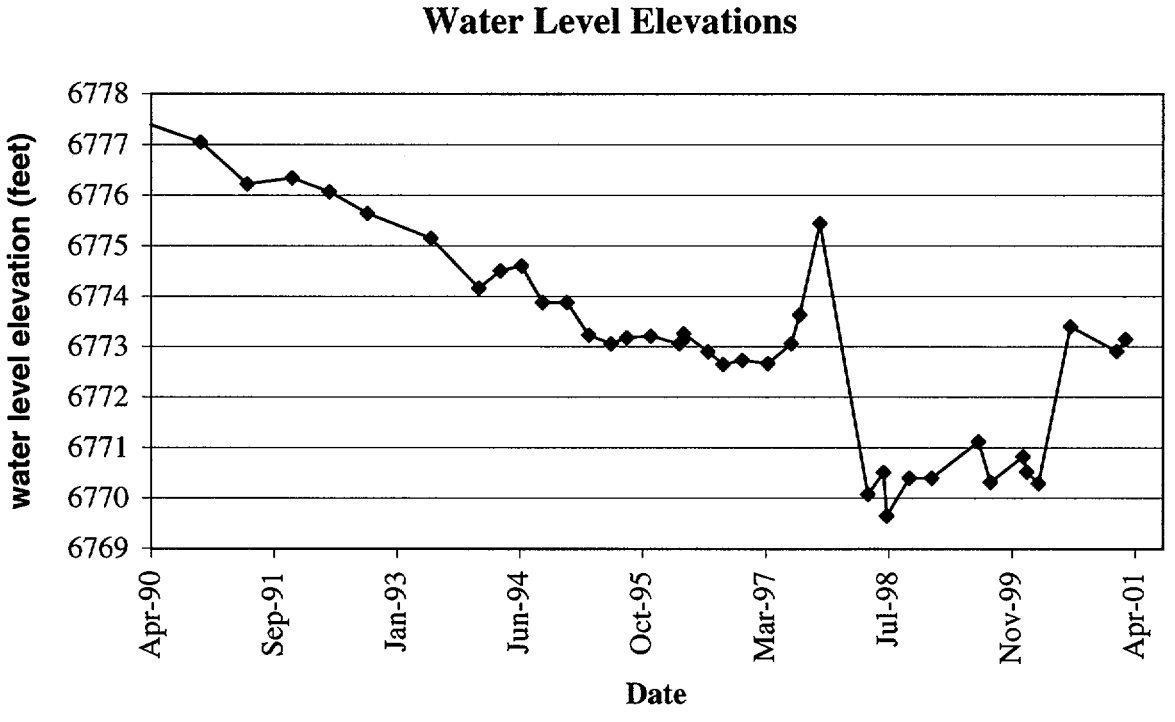
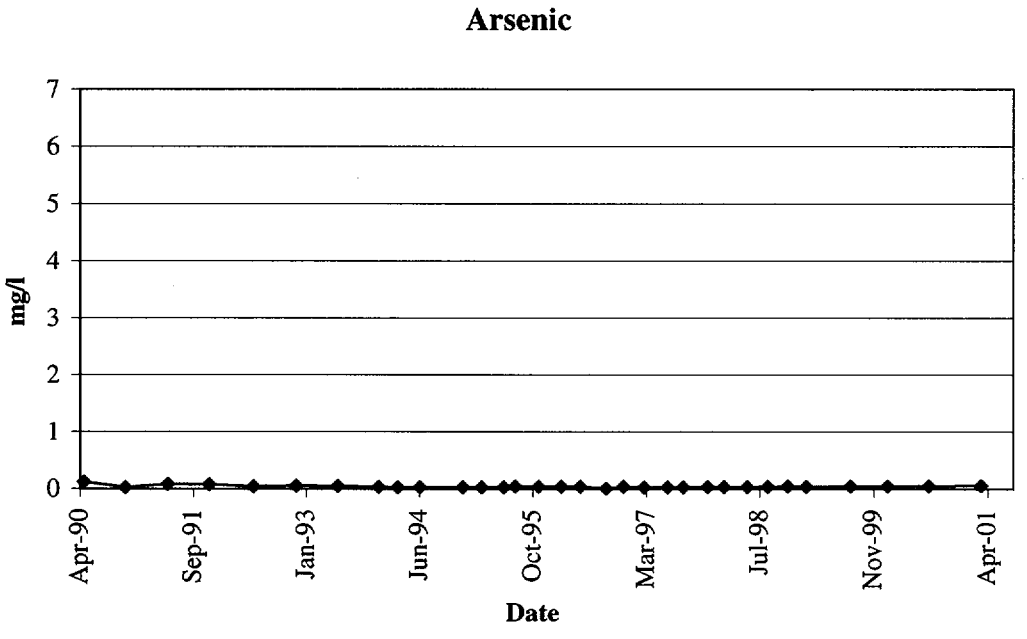


Figure I-2 Constituent Concentrations for HW3



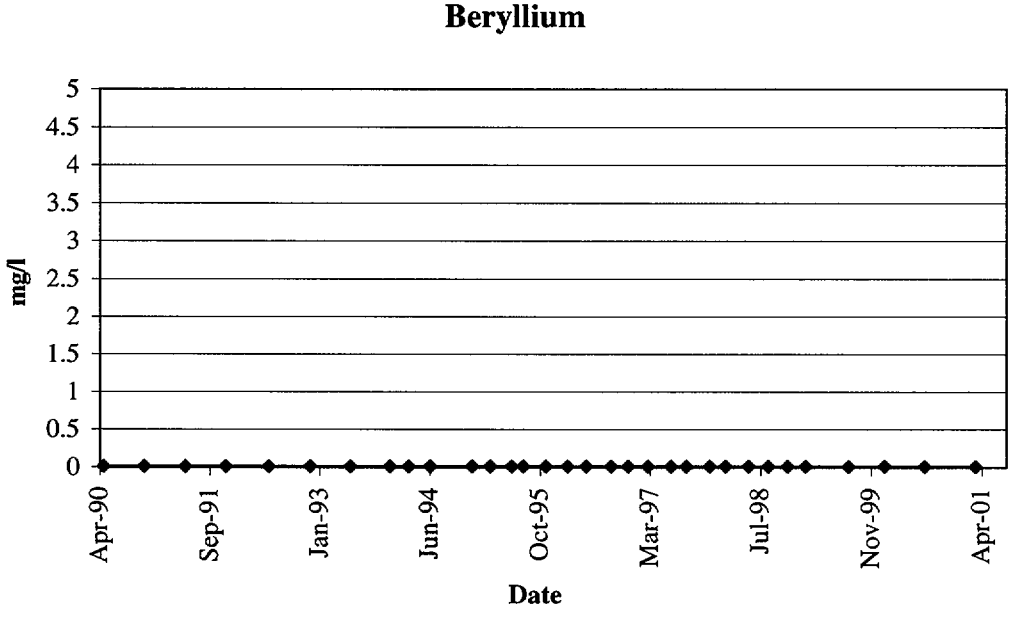
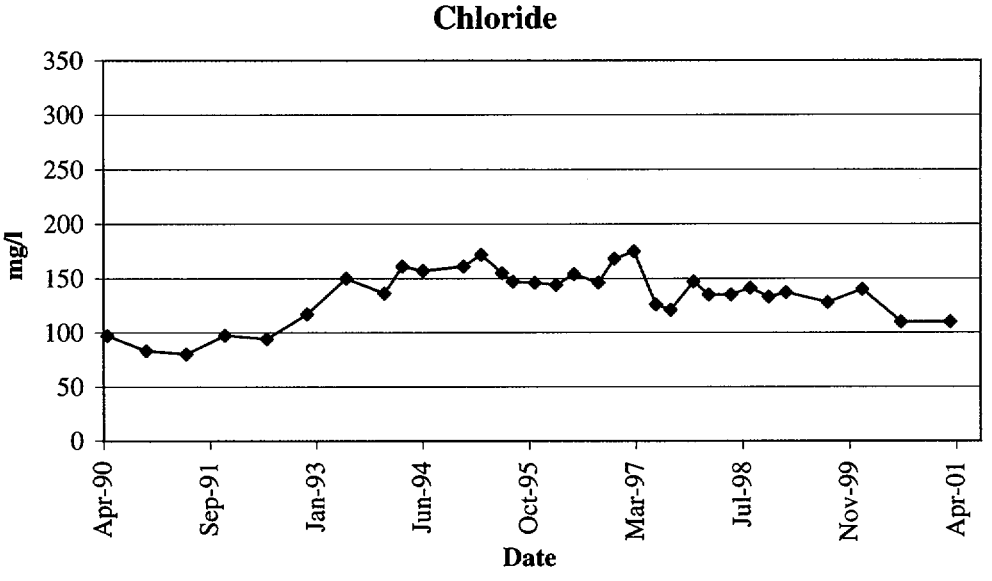


Figure I-2 Constituent Concentrations for HW3



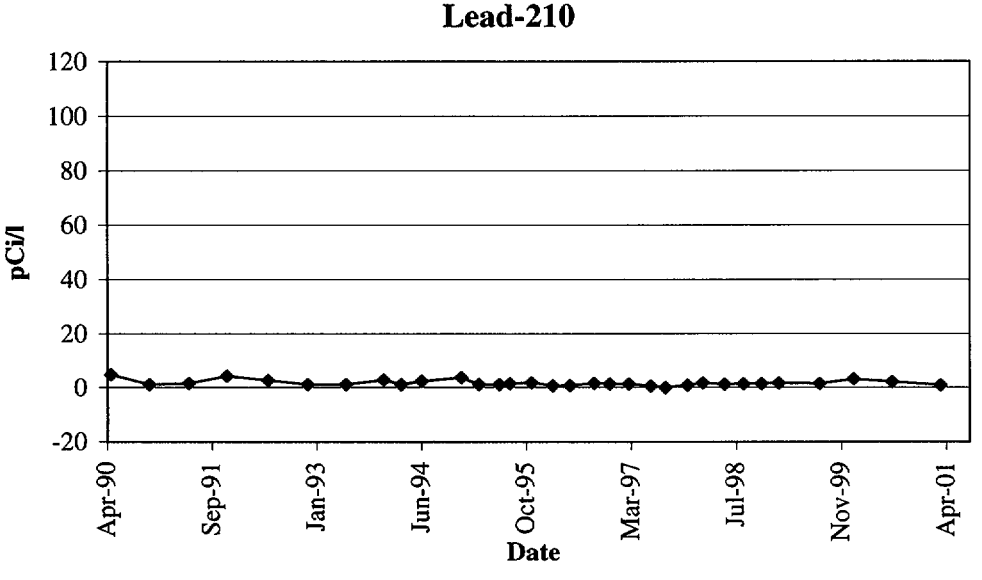
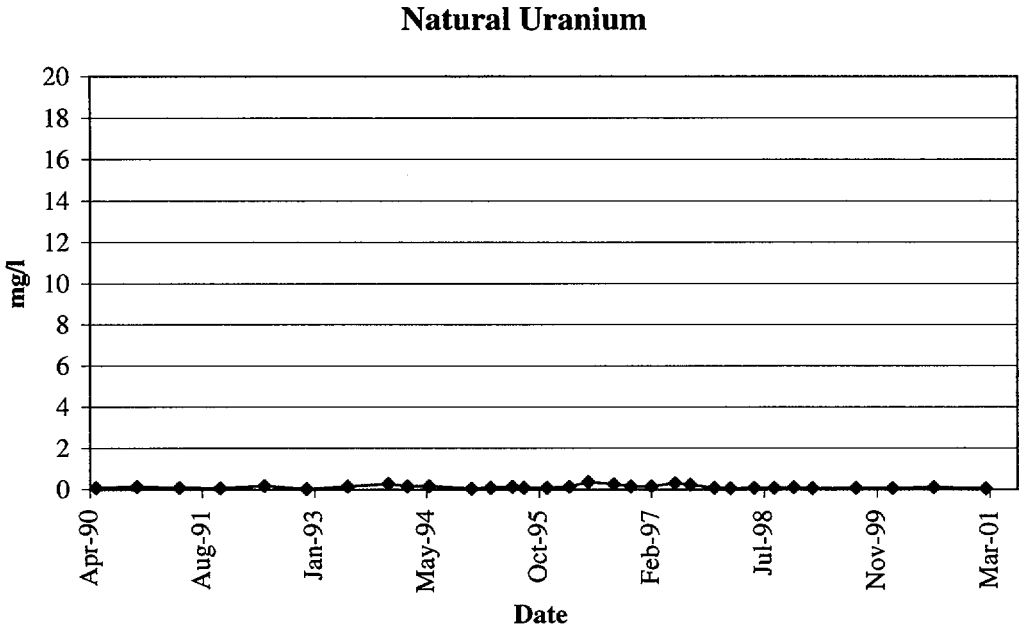


Figure I-2 Constituent Concentrations for HW3



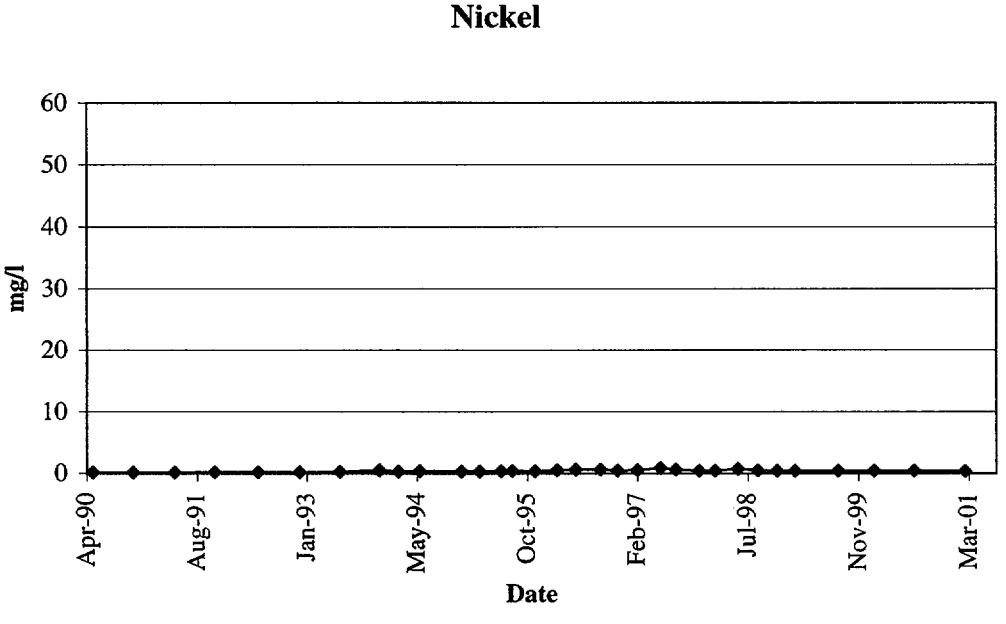
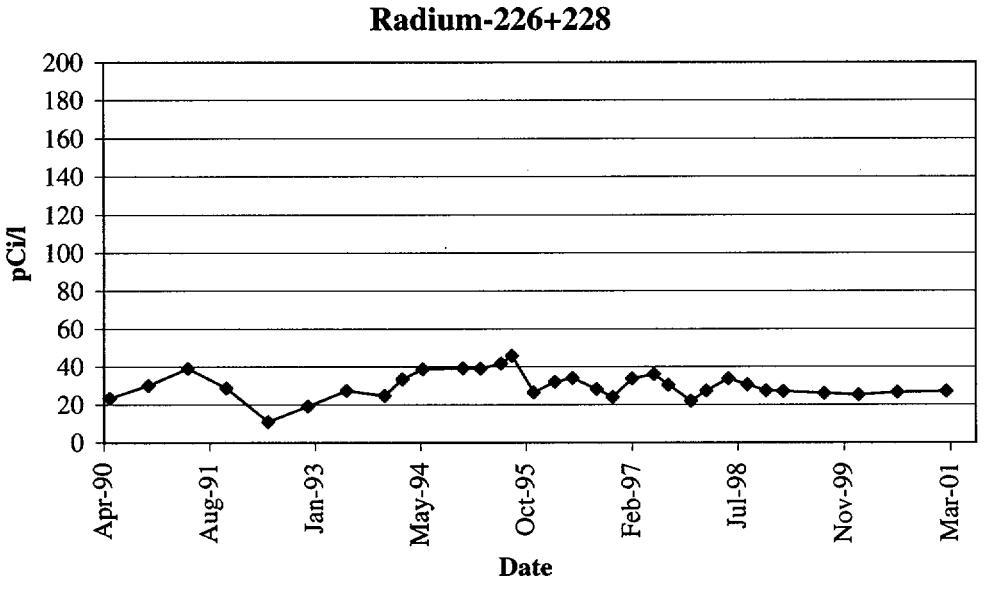


Figure I-2 Constituent Concentrations for HW3



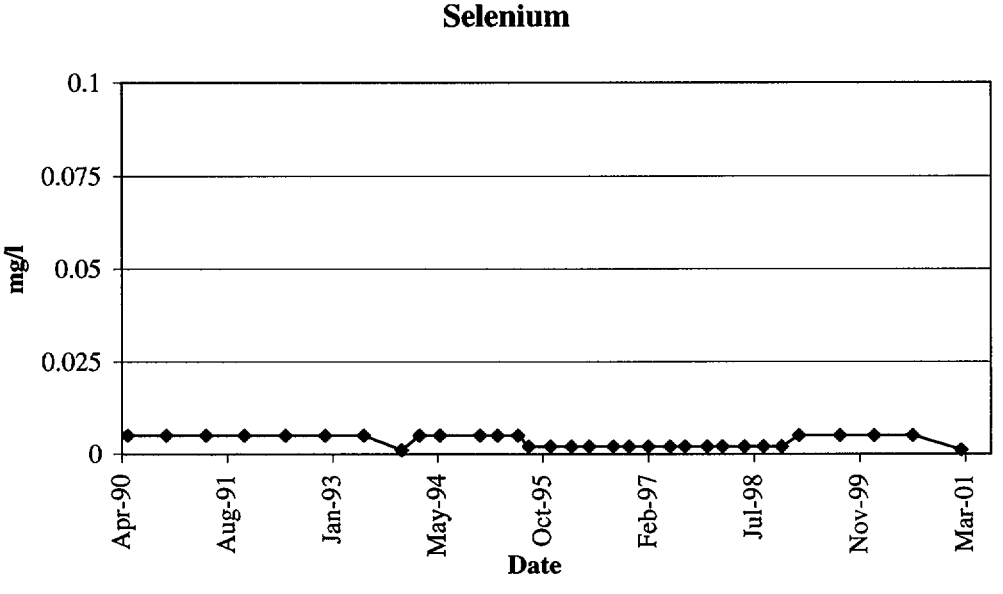
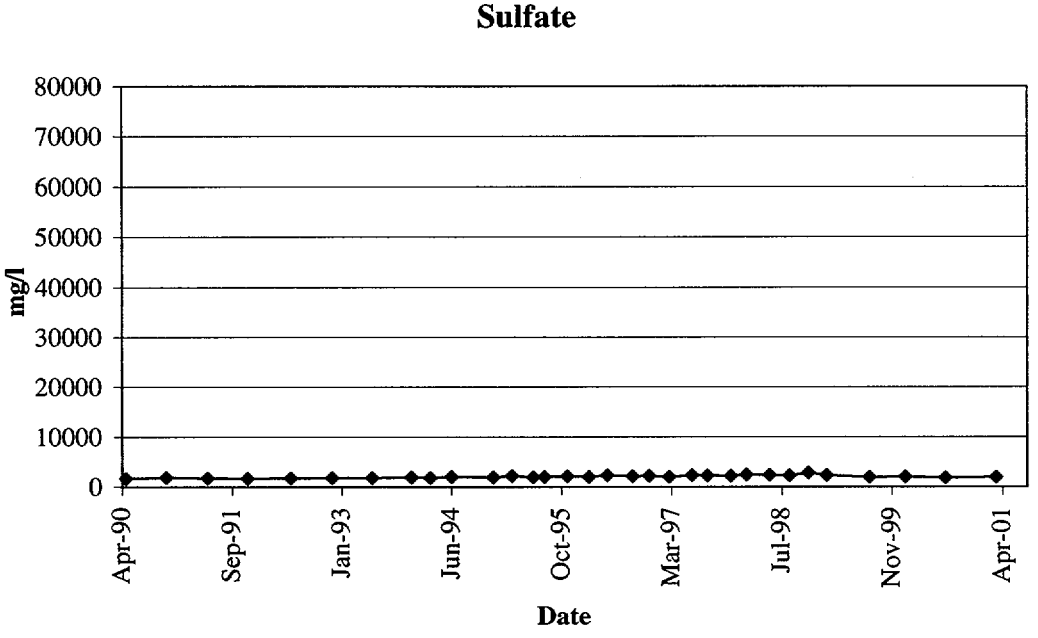


Figure I-2 Constituent Concentrations for HW3



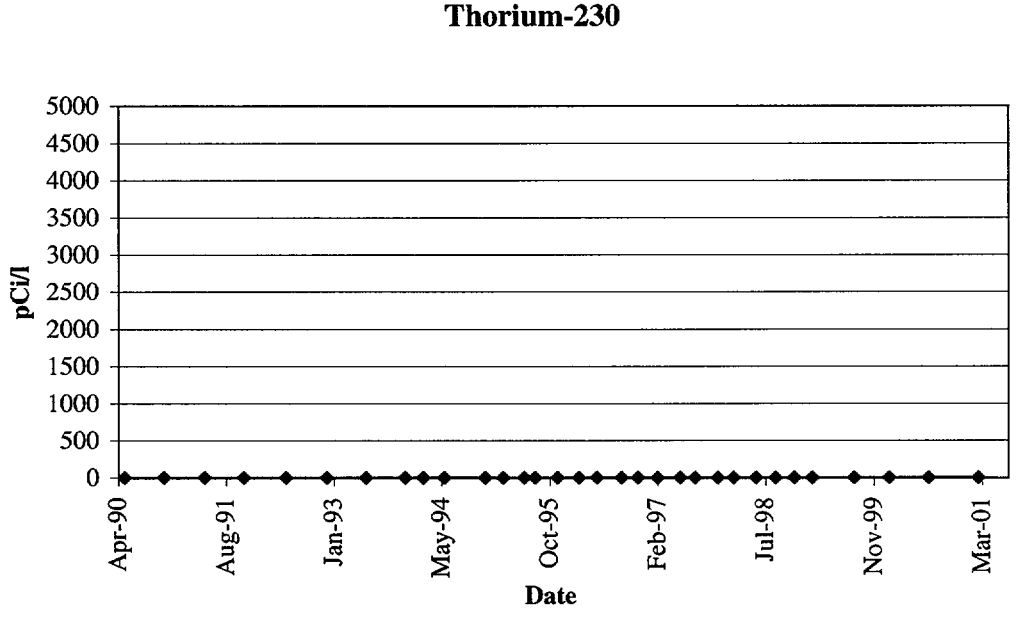


Figure I-2 Constituent Concentrations for HW3

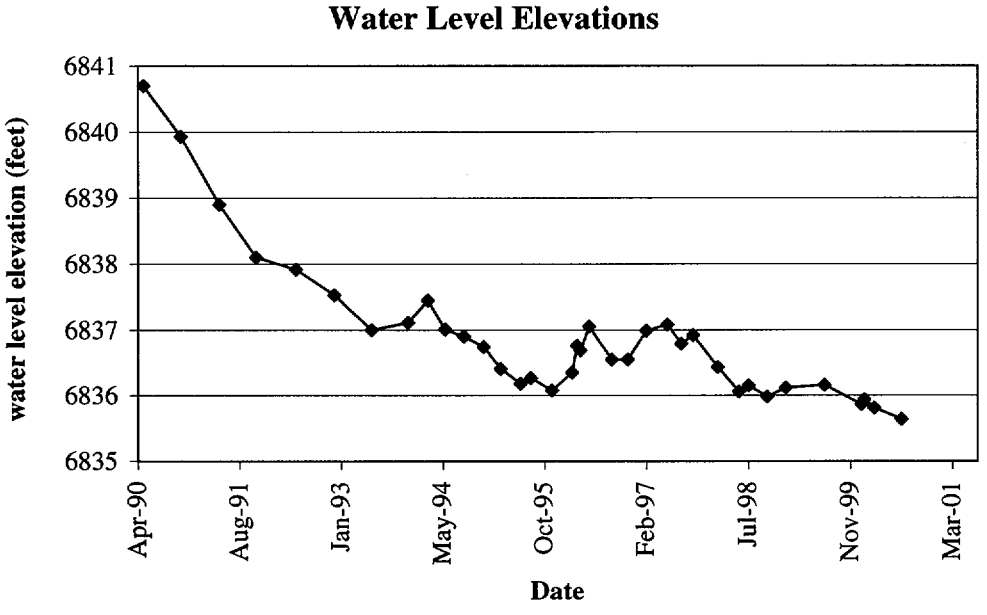
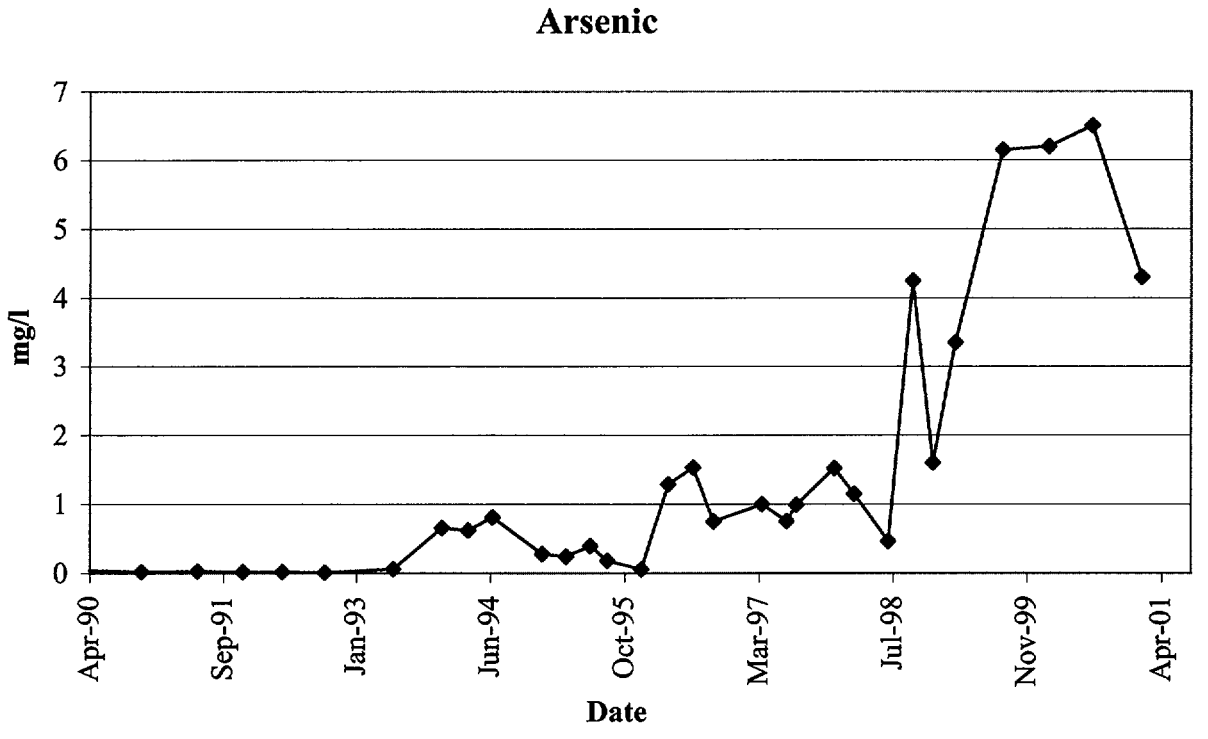


Figure I-3 Constituent Concentrations for HW4



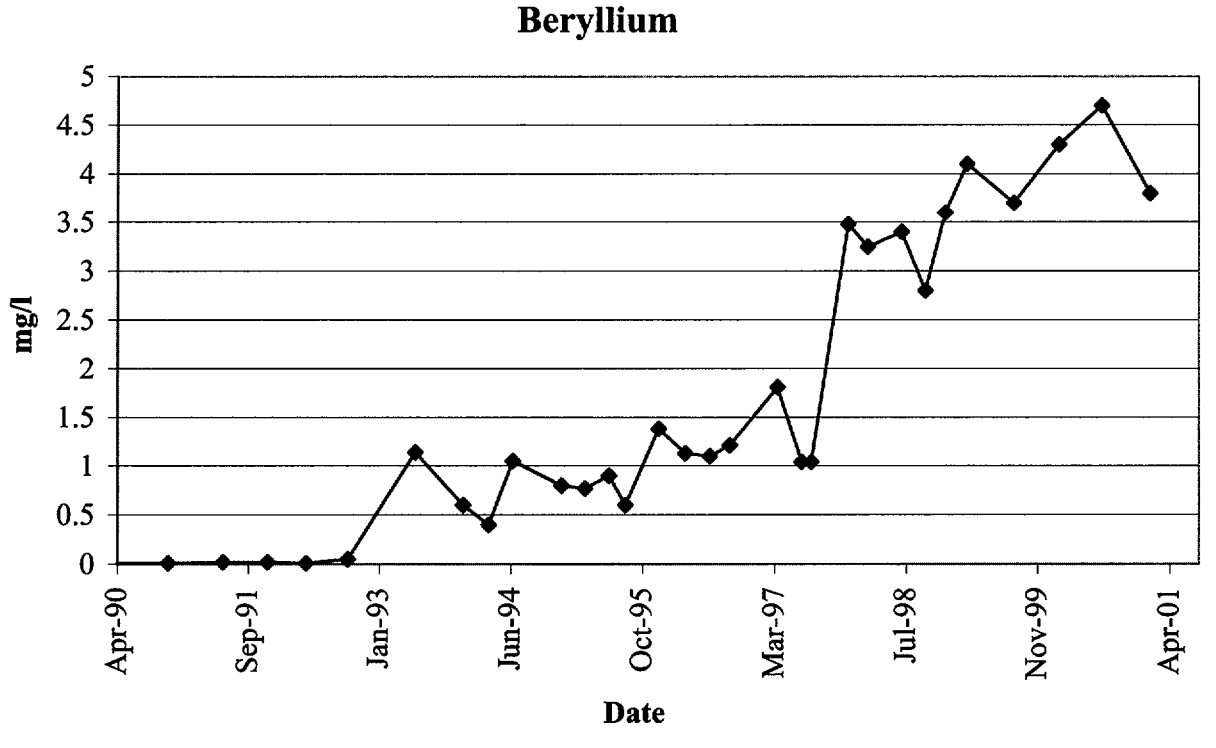
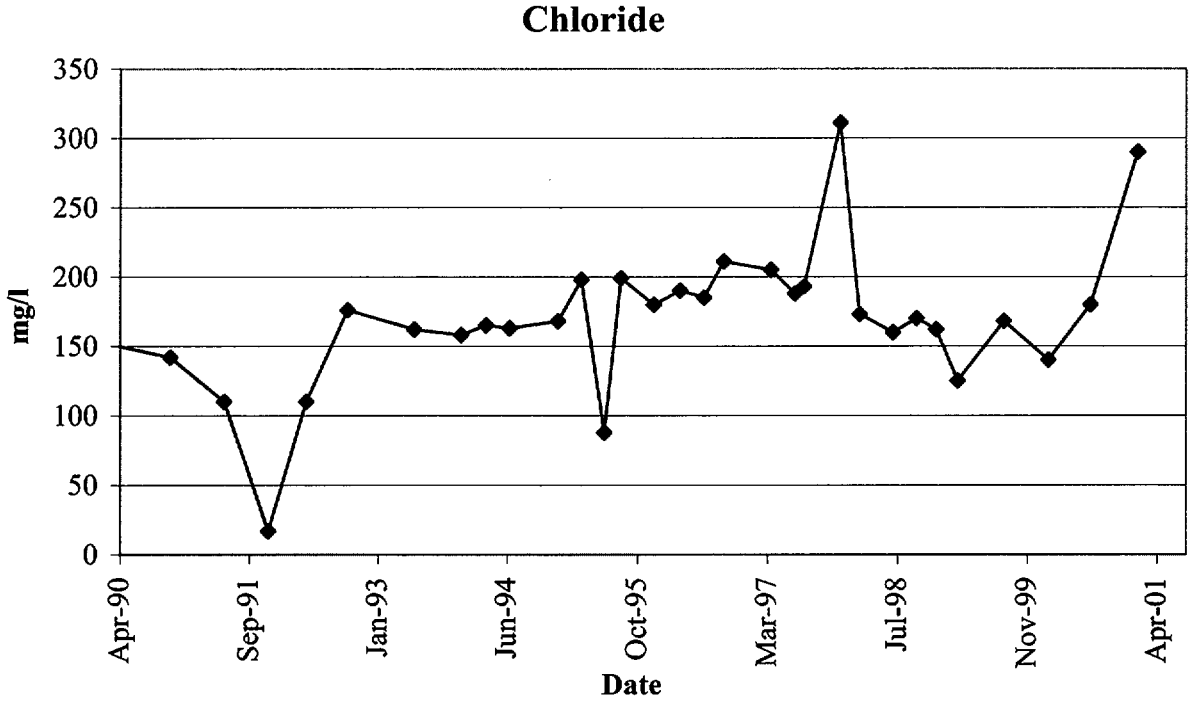


Figure I-3 Constituent Concentrations for HW4



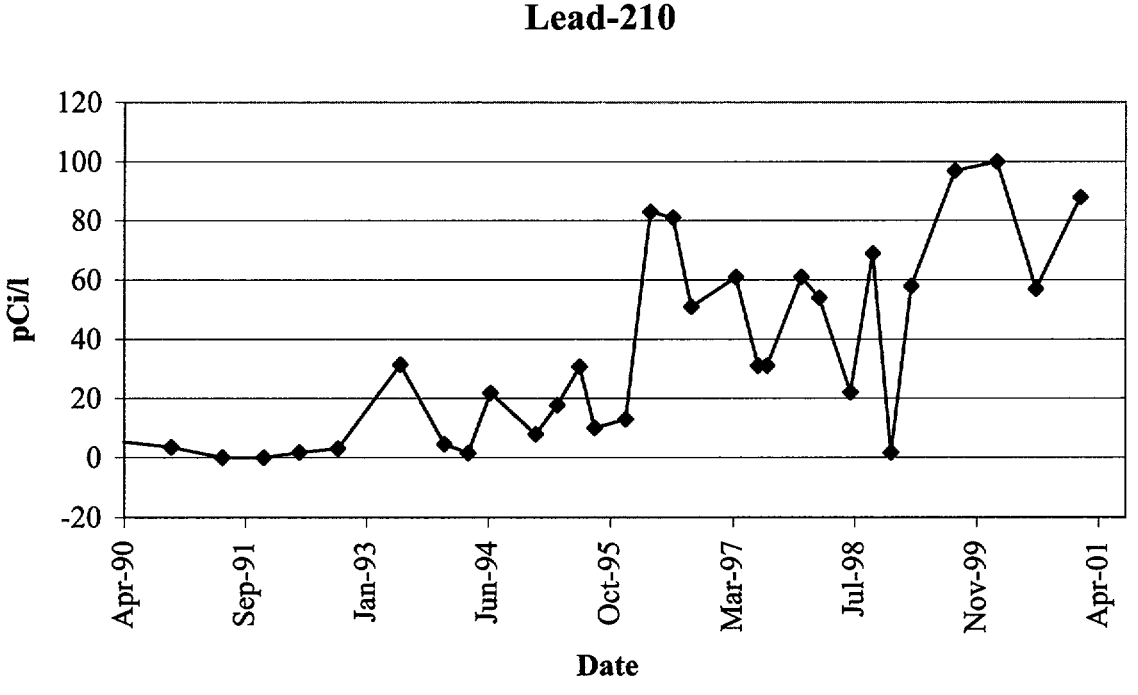
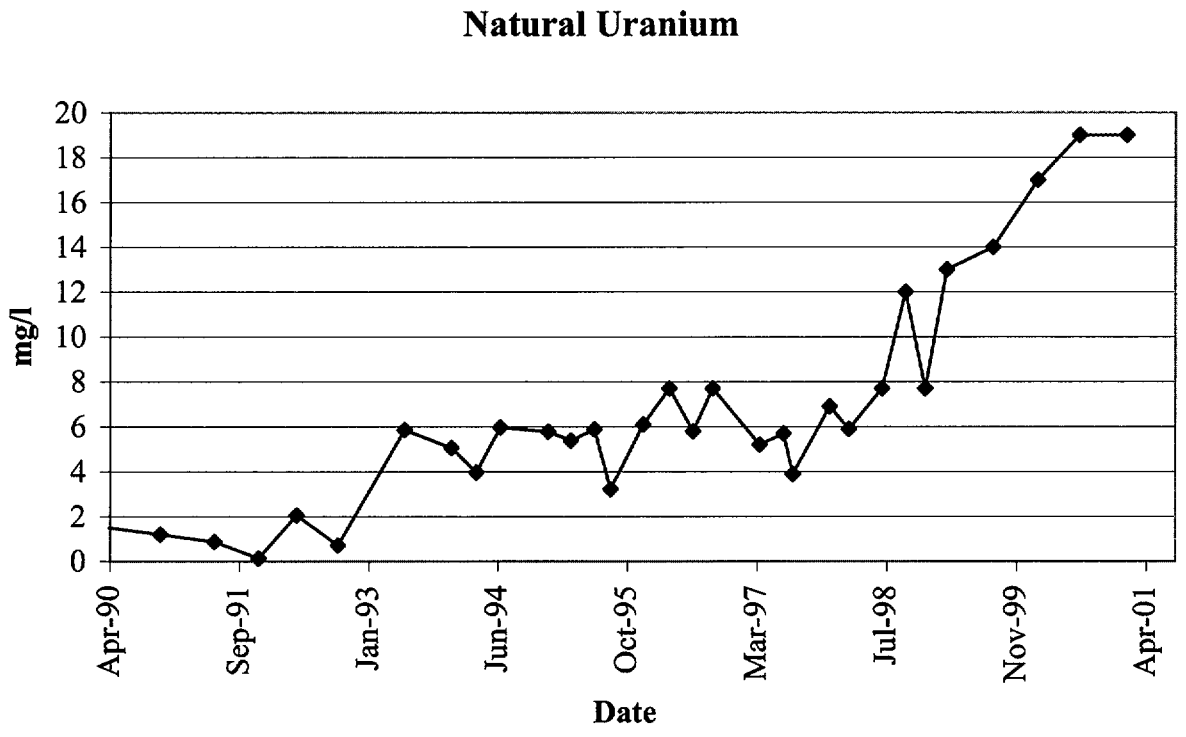


Figure I-3 Constituent Concentrations for HW4



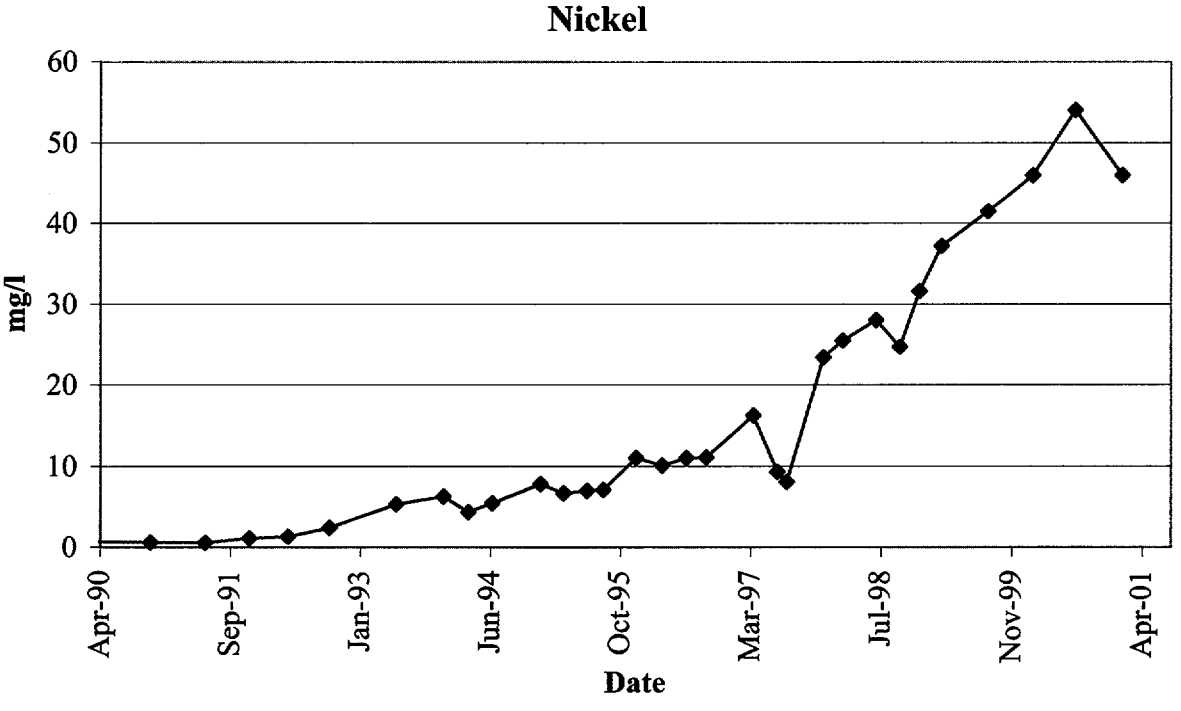
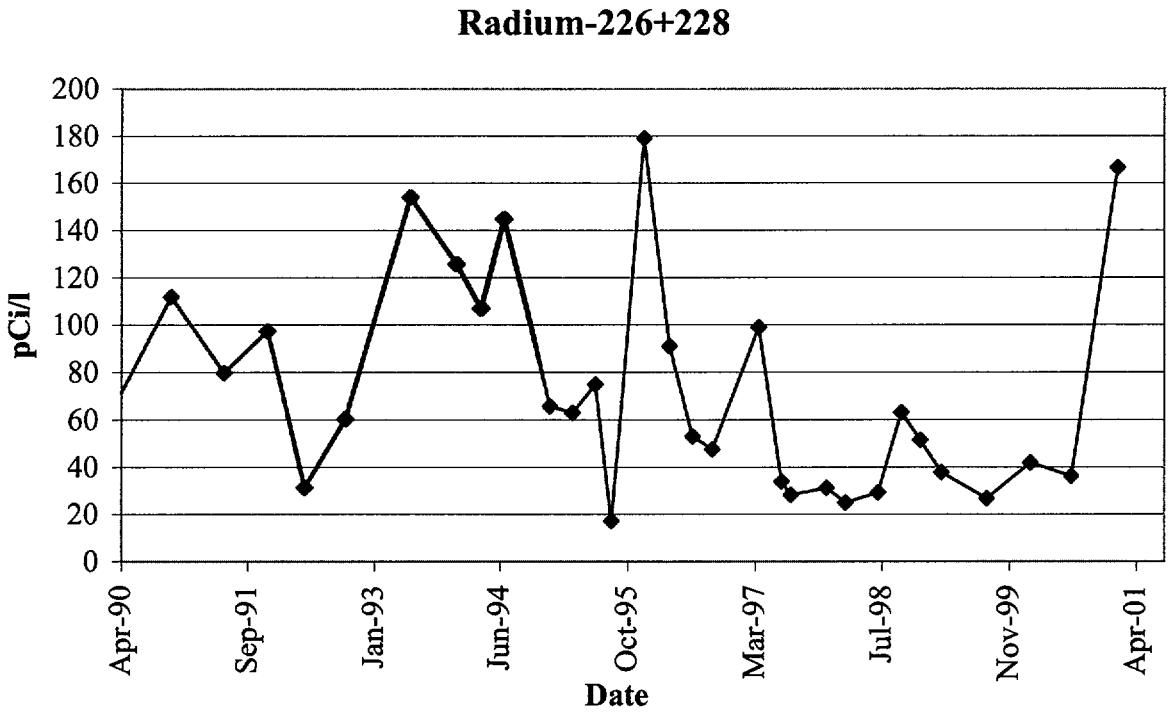


Figure I-3 Constituent Concentrations for HW4



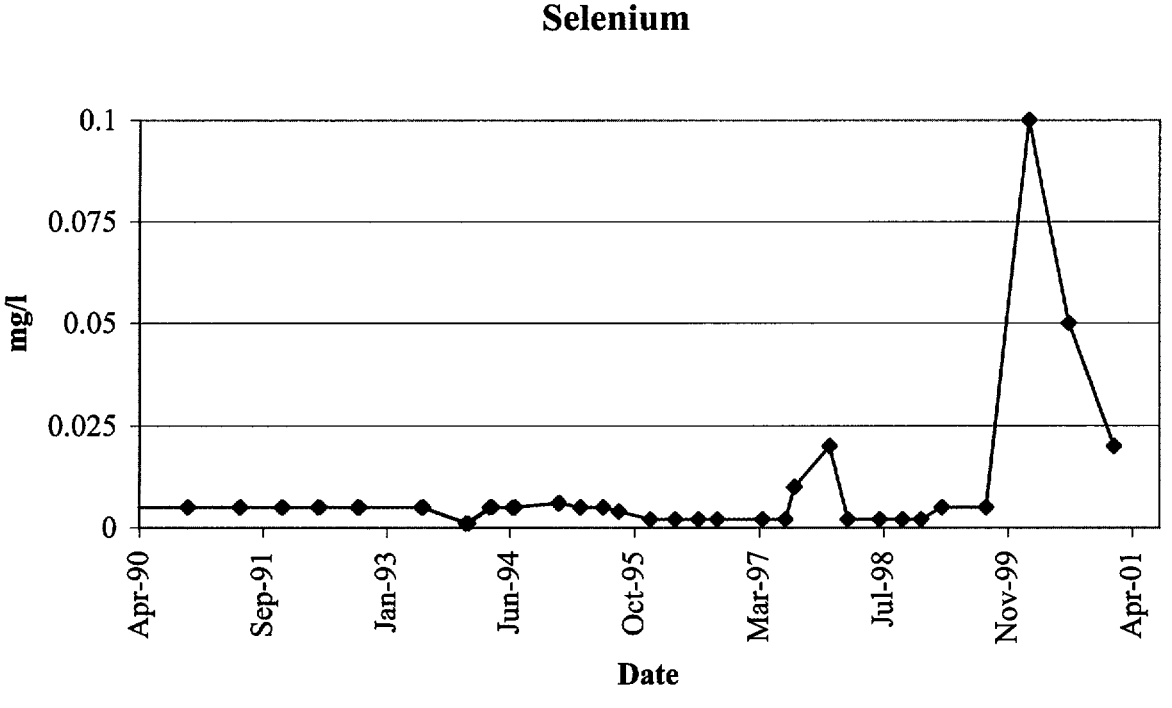
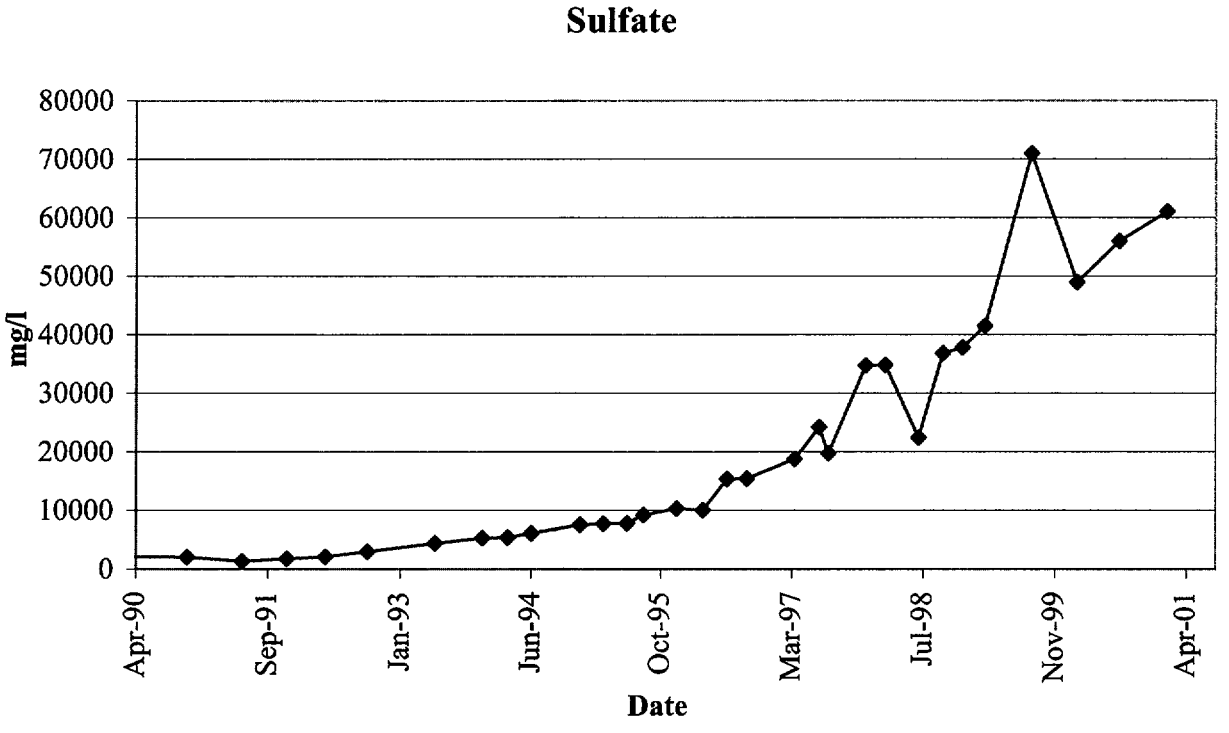


Figure I-3 Constituent Concentrations for HW4



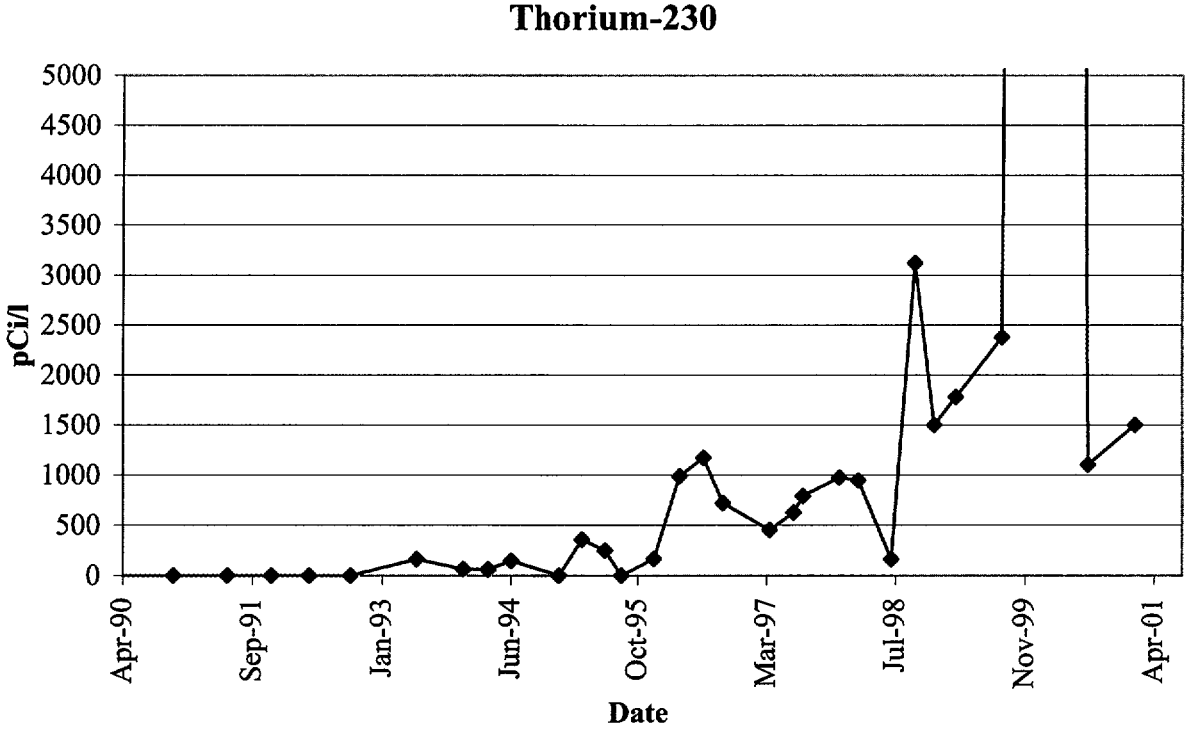
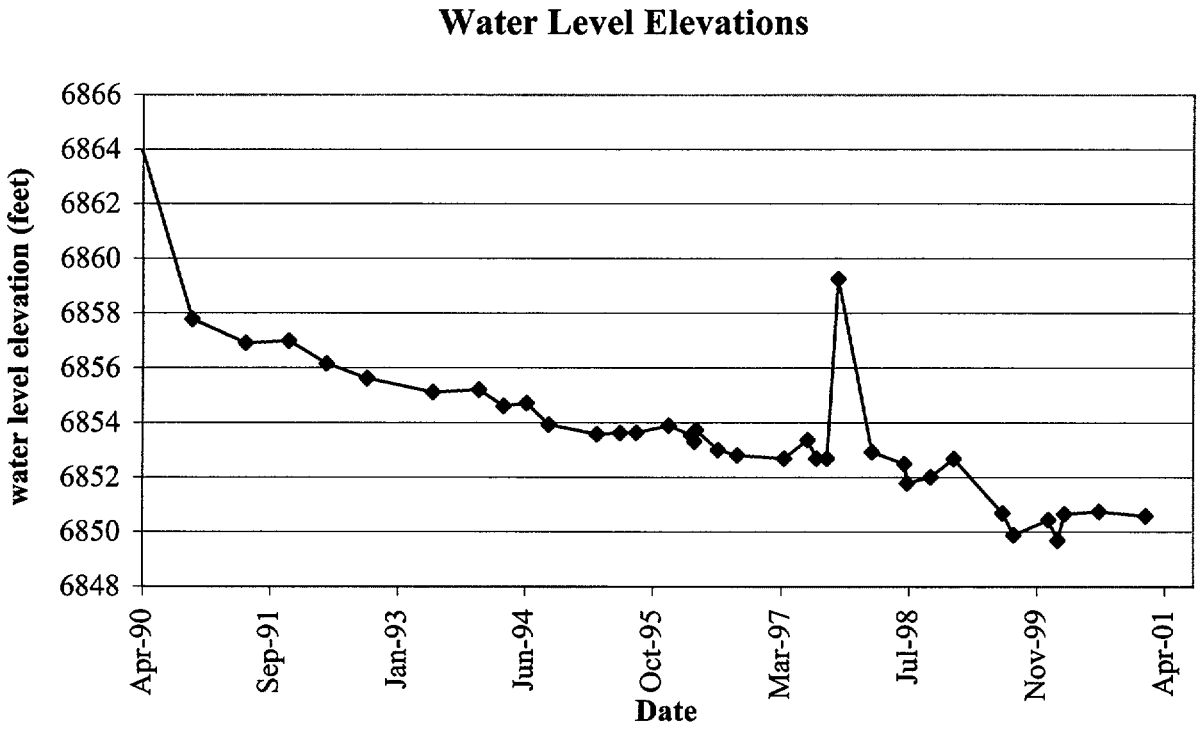


Figure I-3 Constituent Concentrations for HW4



Appendix J

Constituent Concentrations in the Point Of Compliance Wells

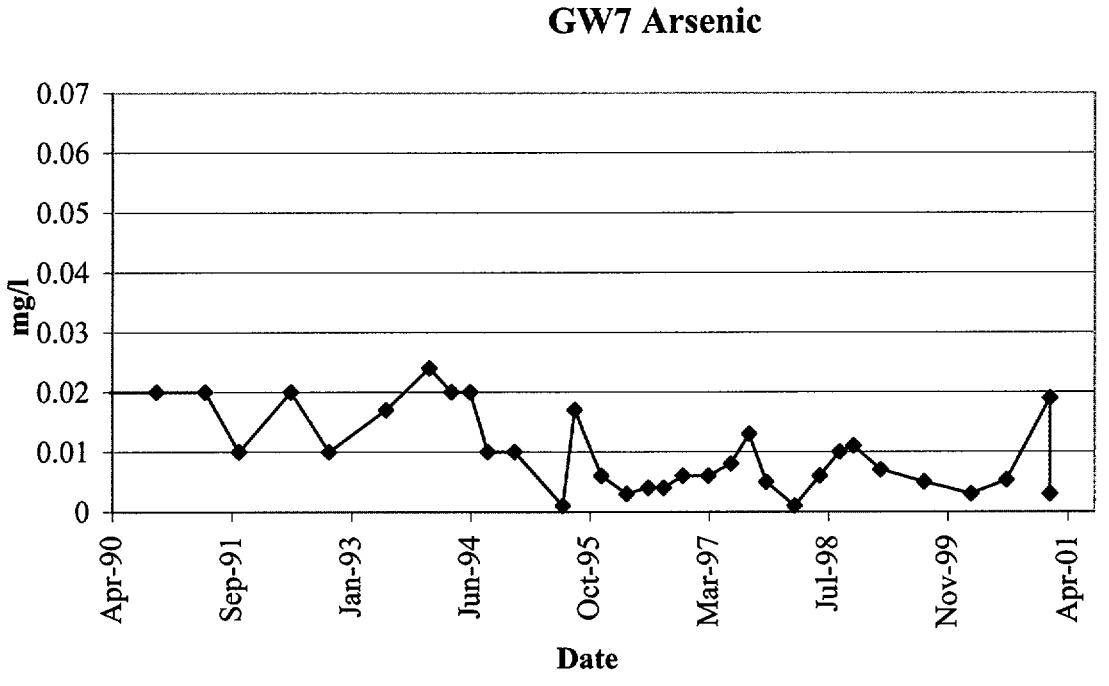
Umetco Gas Hills Site

Fremont and Natrona Counties, Wyoming

Umetco Minerals Corporation
2754 Compass Drive, Suite 280
Grand Junction, Colorado 81506

May 2001

Figure J-1 Constituent Concentrations Southwestern Flow Regime POC Wells



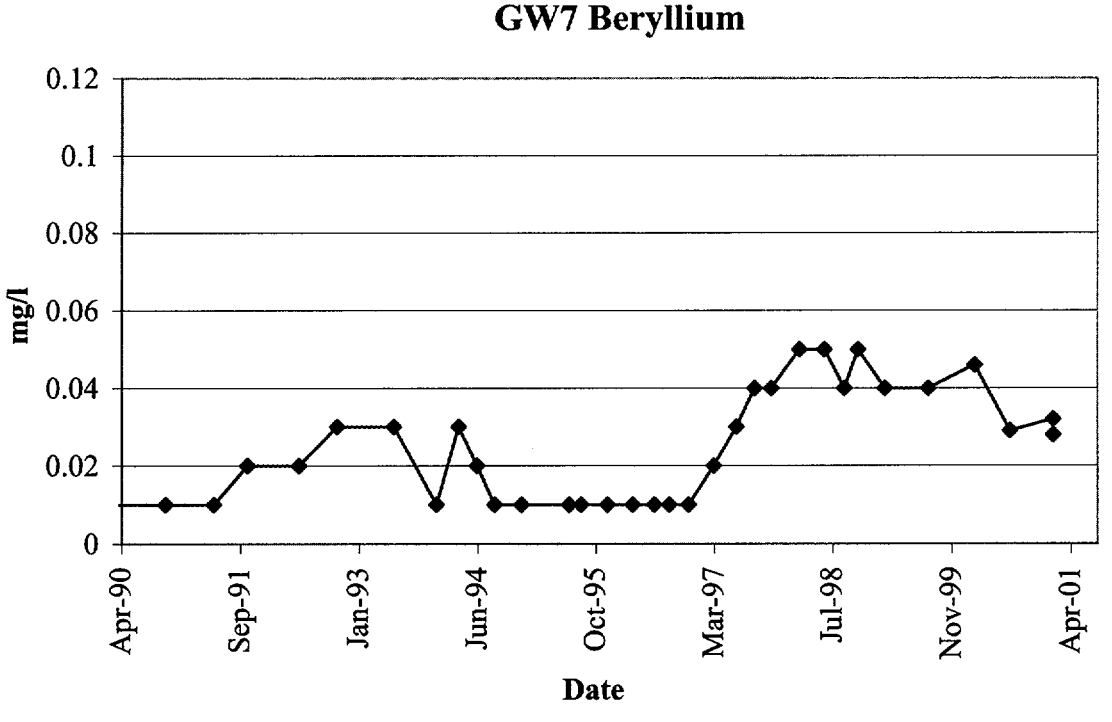
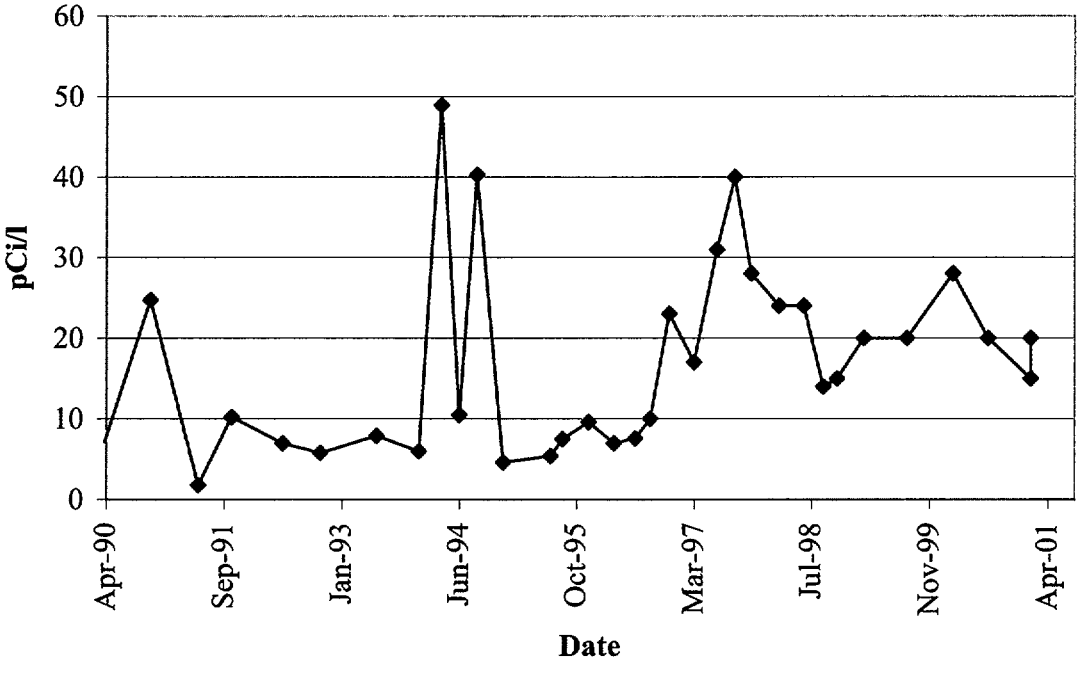


Figure J-1 Constituent Concentrations Southwestern Flow Regime POC Wells

GW7 Lead-210



GW7 Natural Uranium

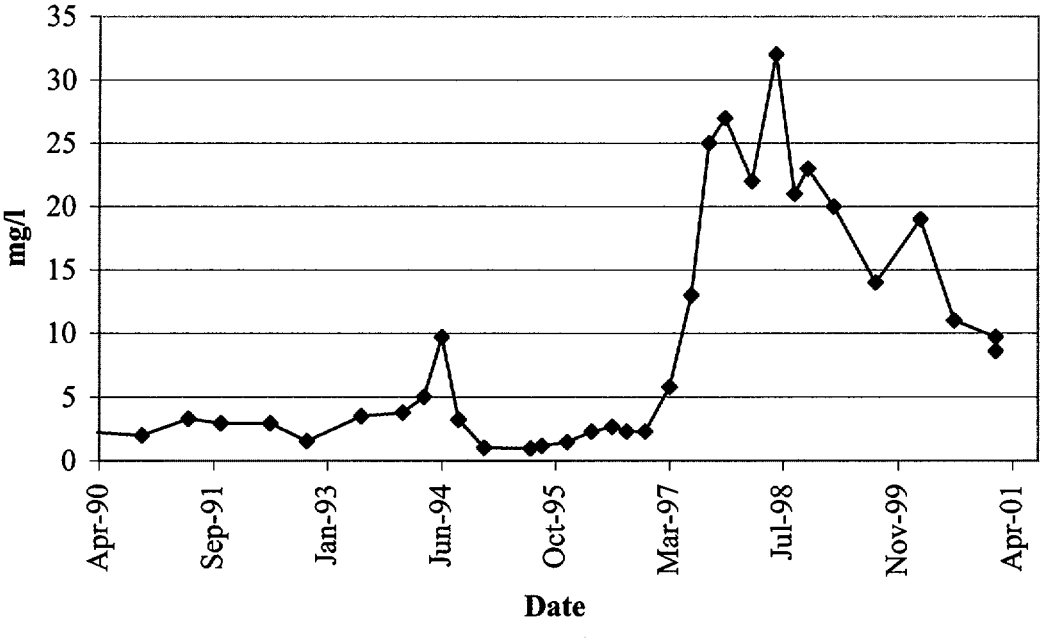
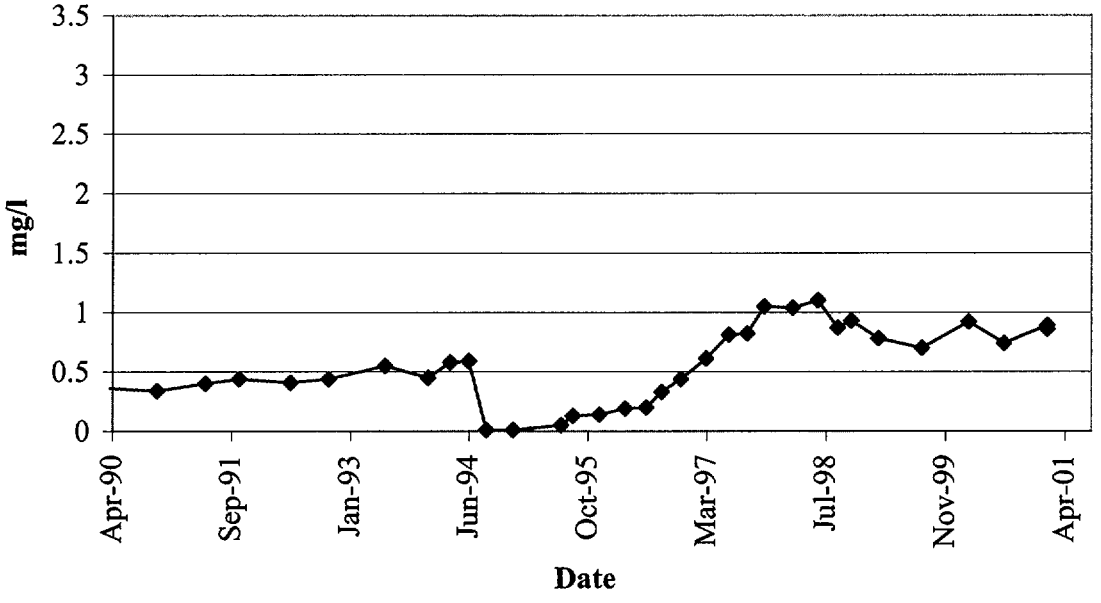


Figure J-1 Constituent Concentrations Southwestern Flow Regime POC Wells

GW7 Nickel



GW7 Radium-226+228

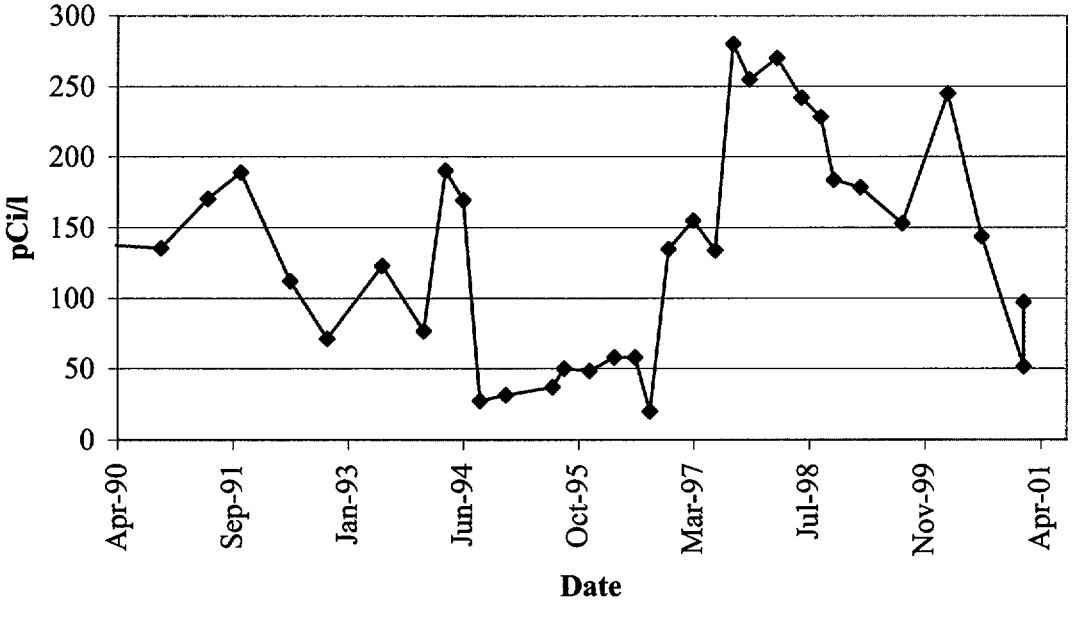
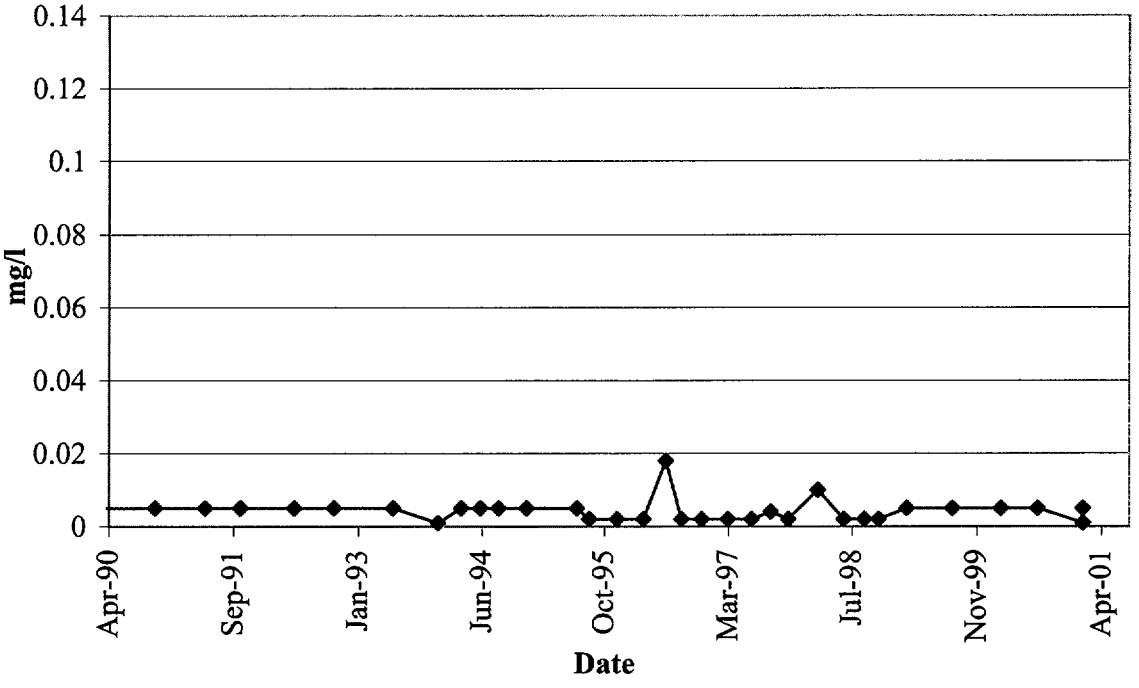


Figure J-1 Constituent Concentrations Southwestern Flow Regime POC Wells

GW7 Selenium



GW7 Thorium-230

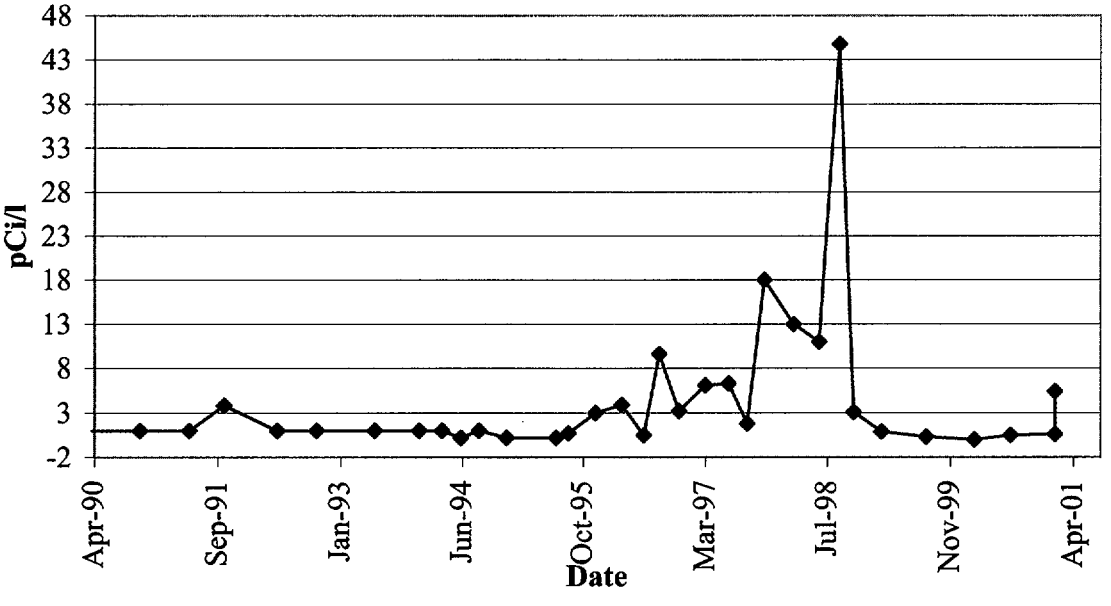
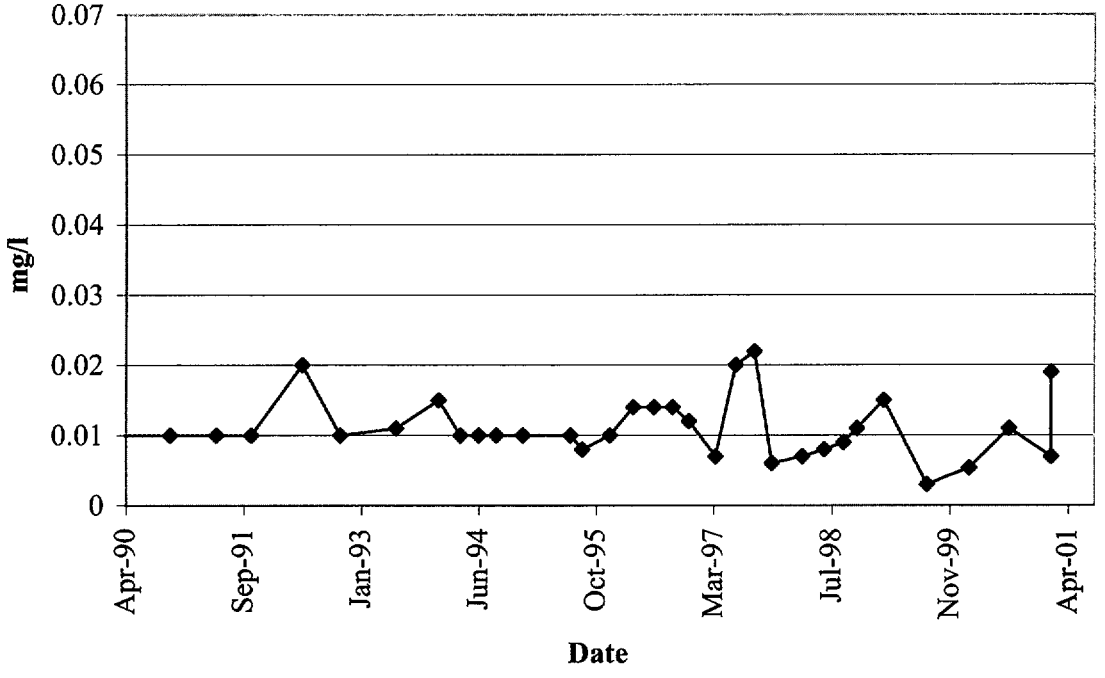


Figure J-2 Constituent Concentrations Southwestern Flow Regime POC Wells

GW8 Arsenic



GW8 Beryllium

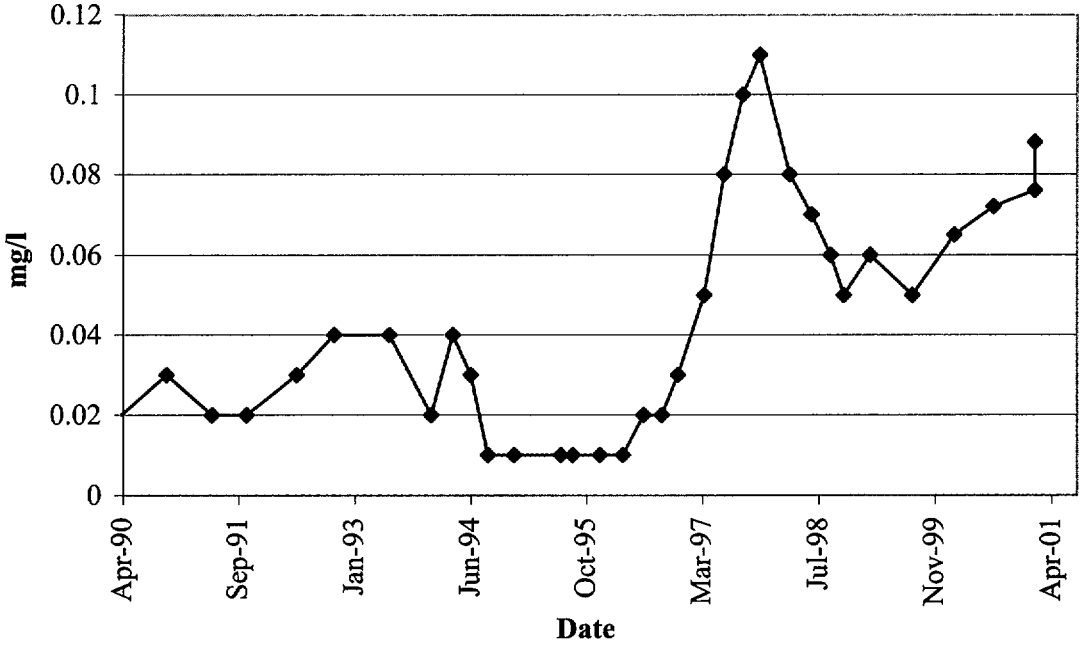
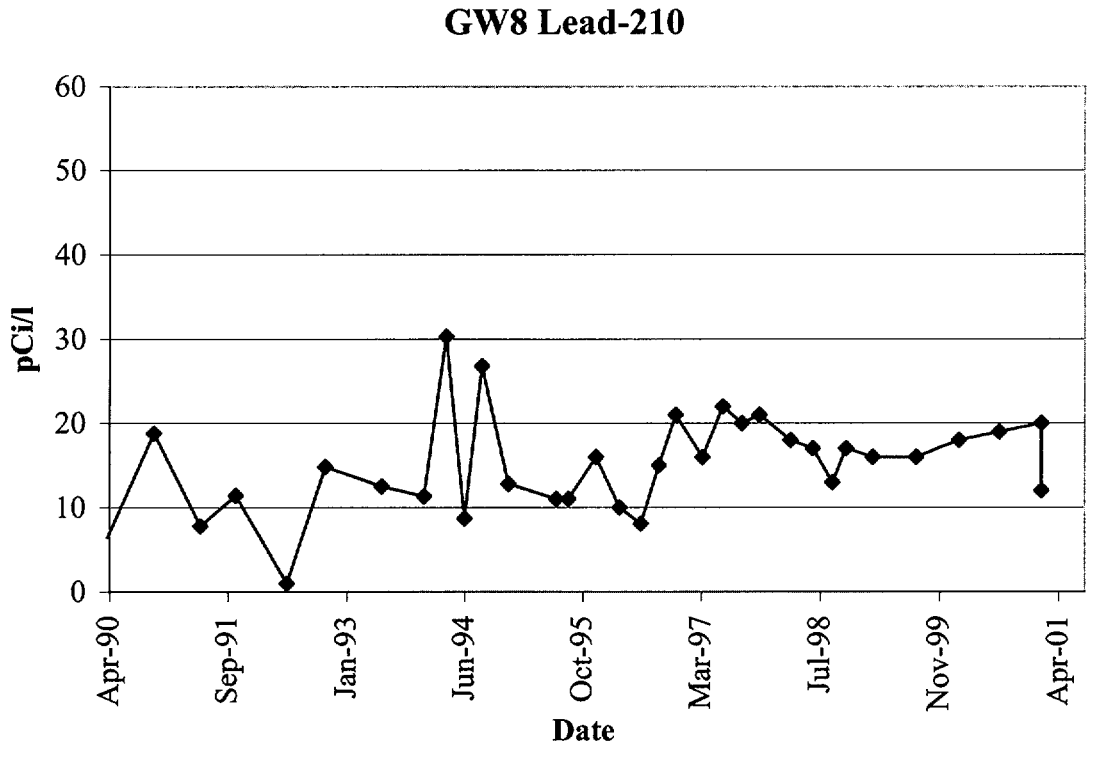


Figure J-2 Constituent Concentrations Southwestern Flow Regime POC Wells



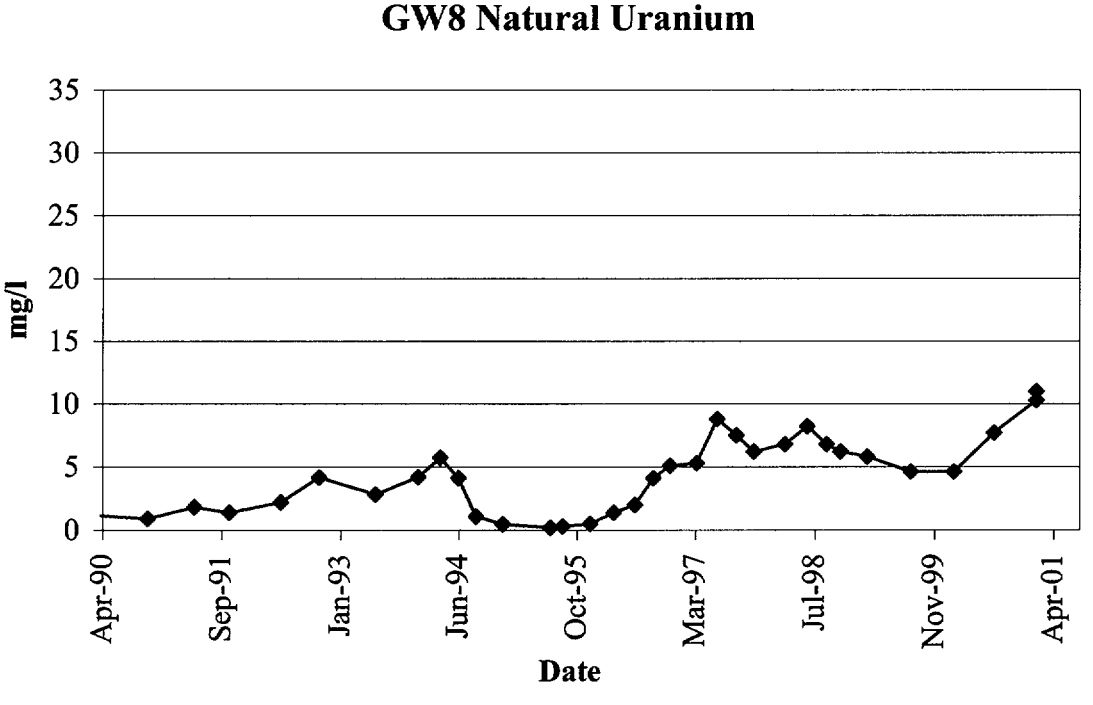
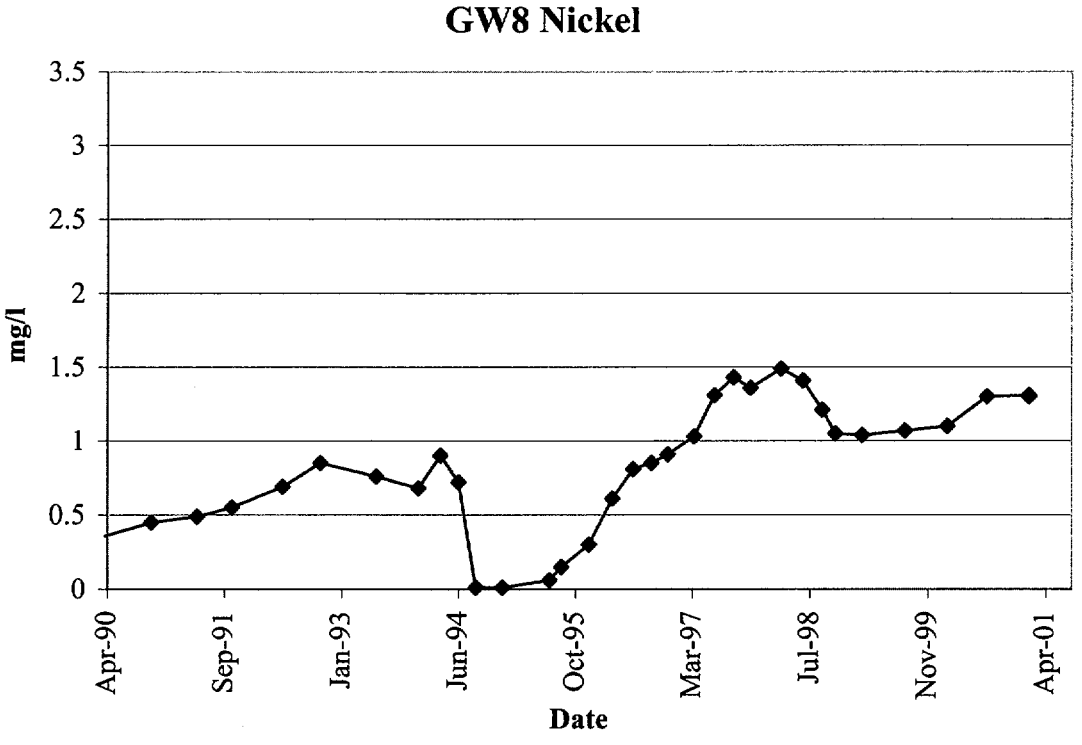


Figure J-2 Constituent Concentrations Southwestern Flow Regime POC Wells



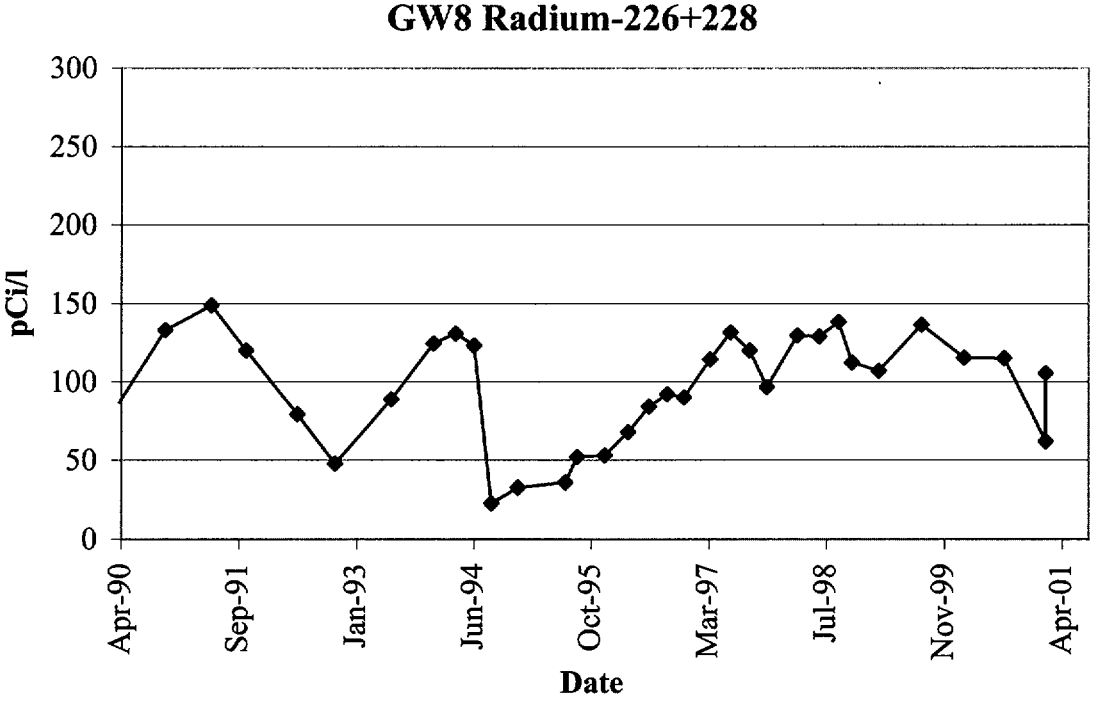
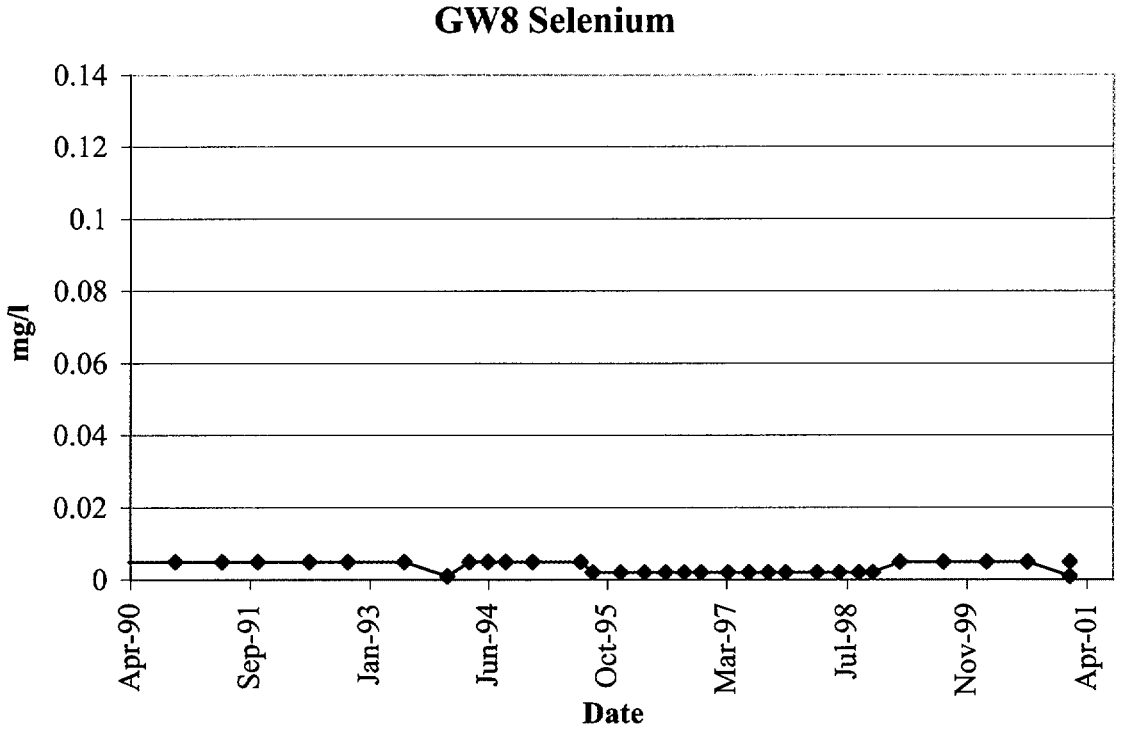


Figure J-2 Constituent Concentrations Southwestern Flow Regime POC Wells



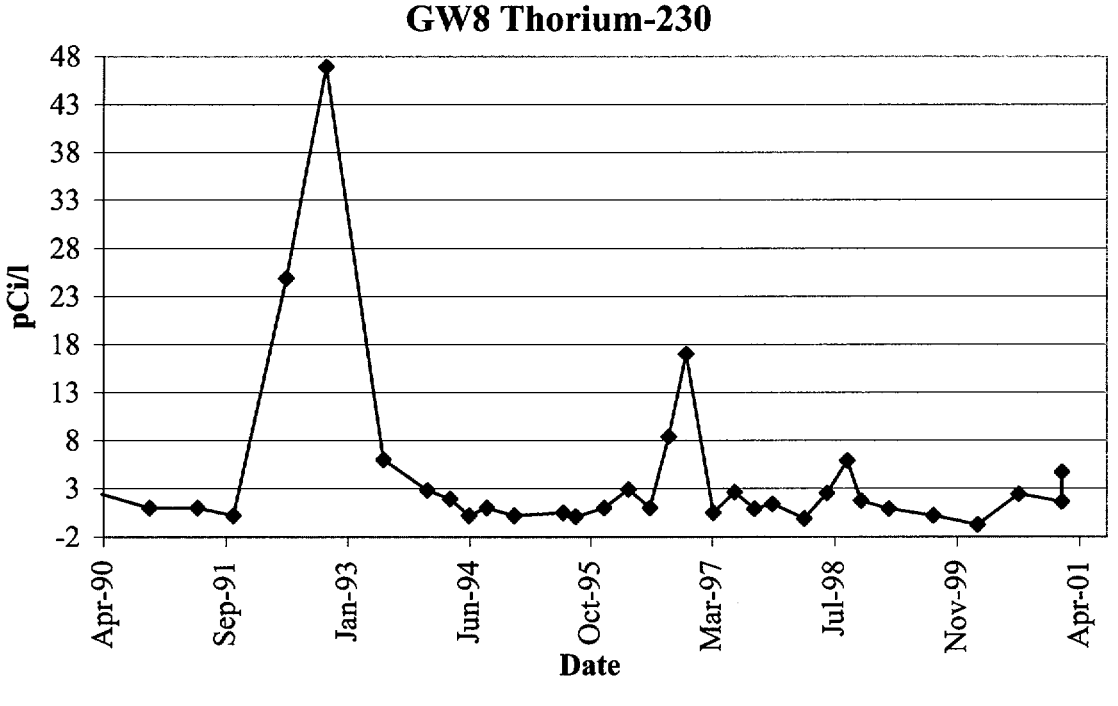
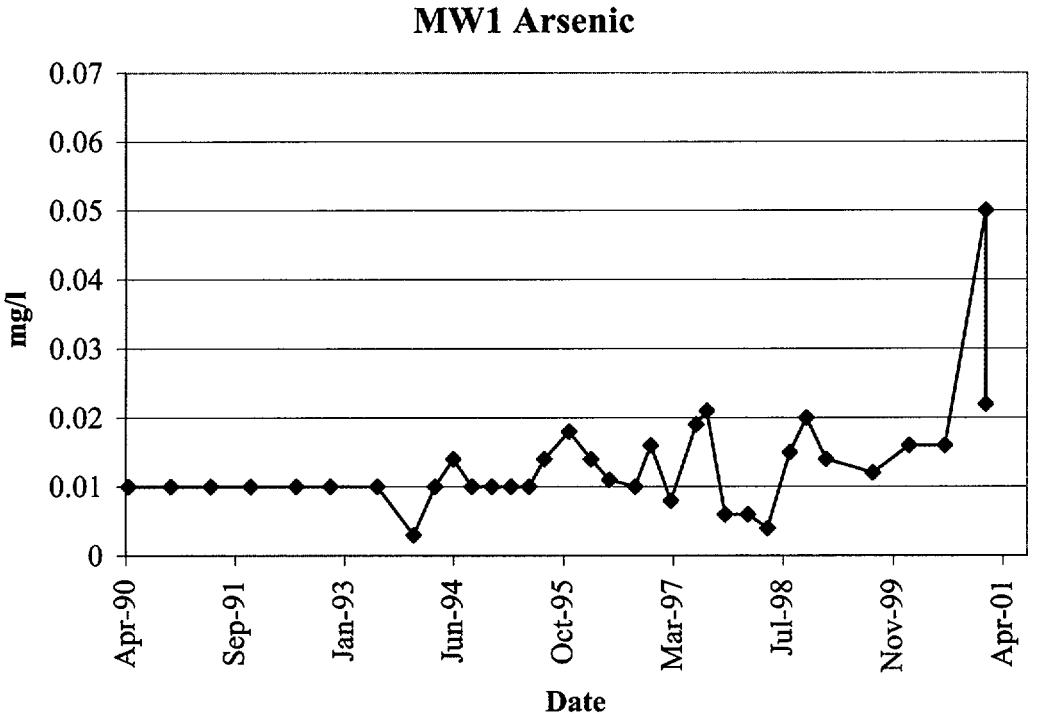


Figure J-3 Constituent Concentrations Western Flow Regime POC Wells



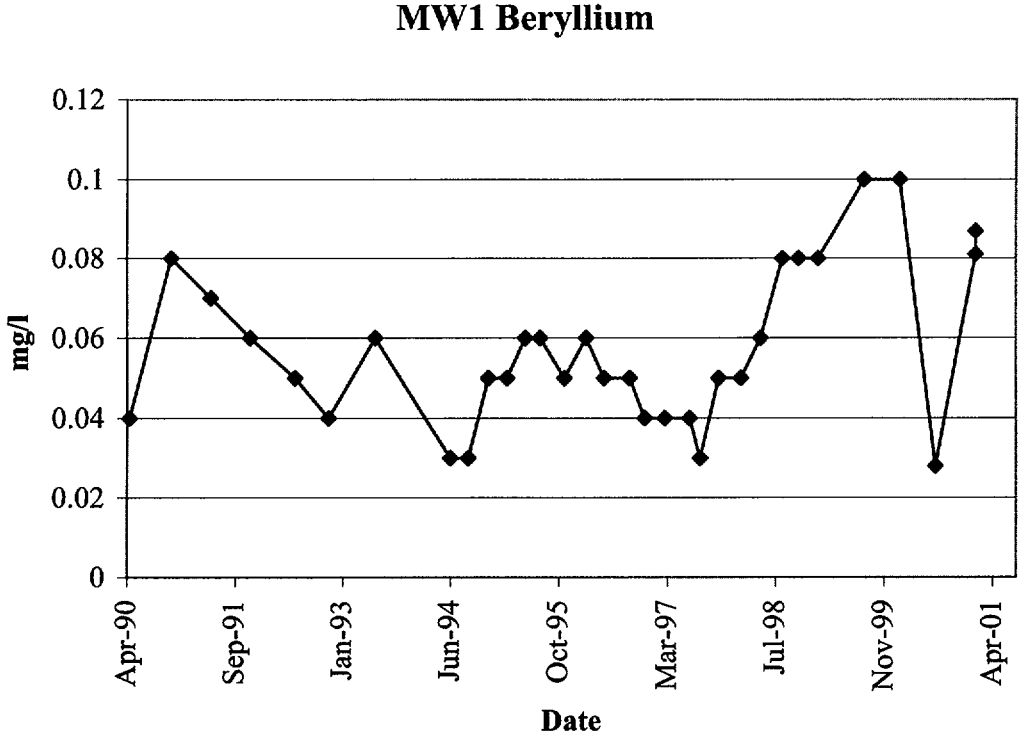
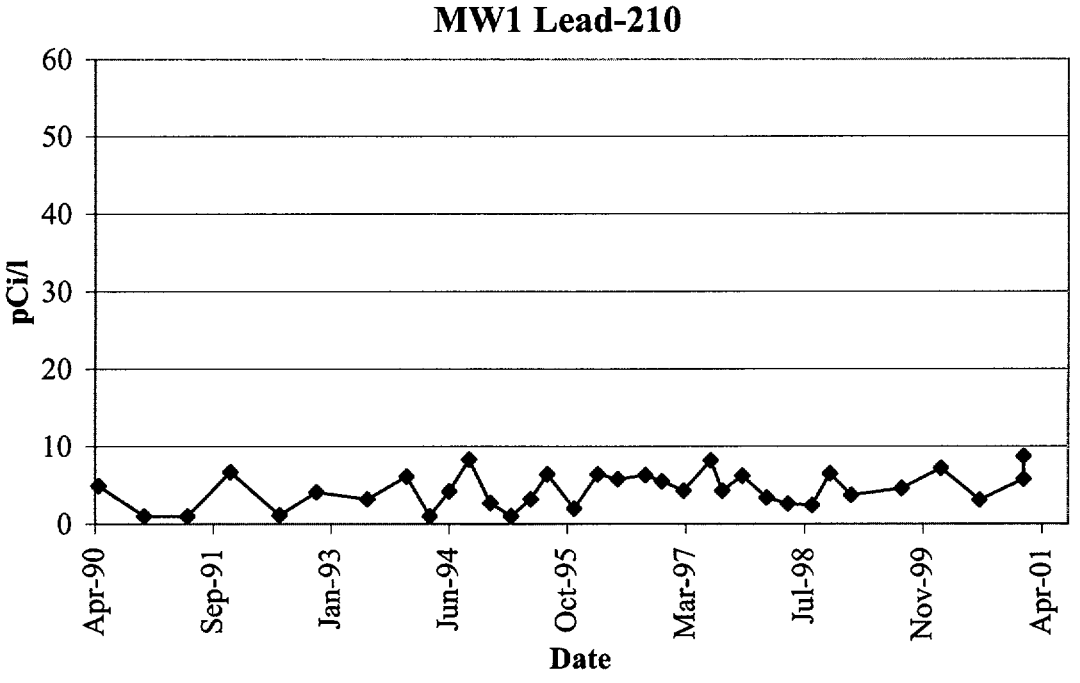


Figure J-3 Constituent Concentrations Western Flow Regime POC Wells



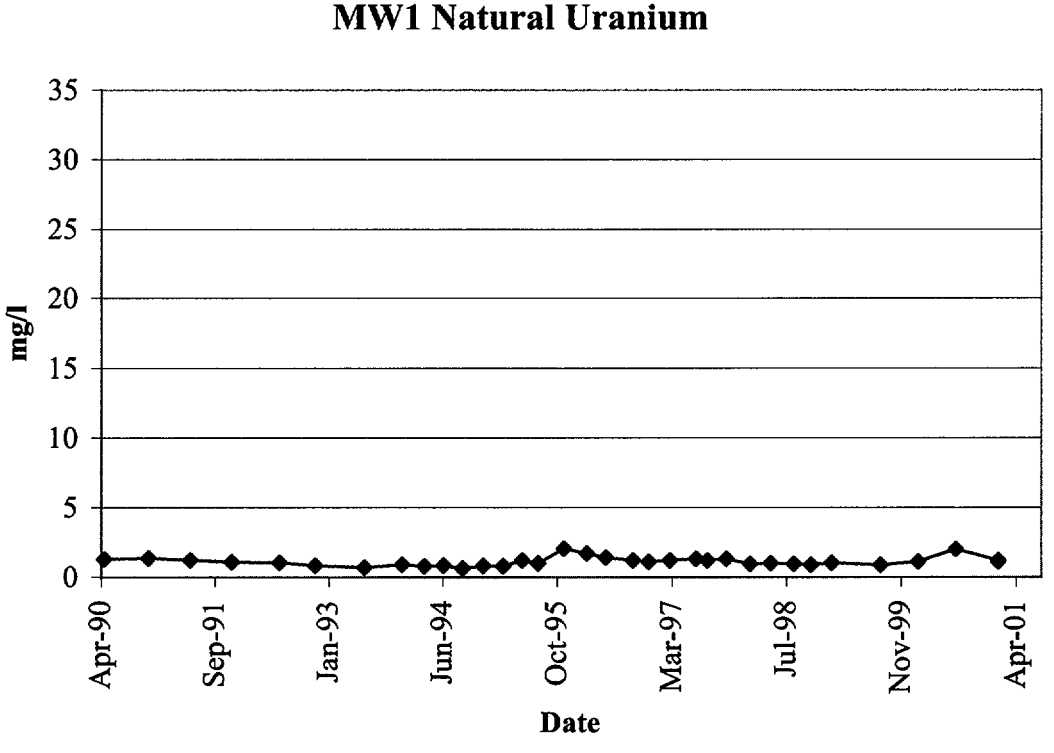
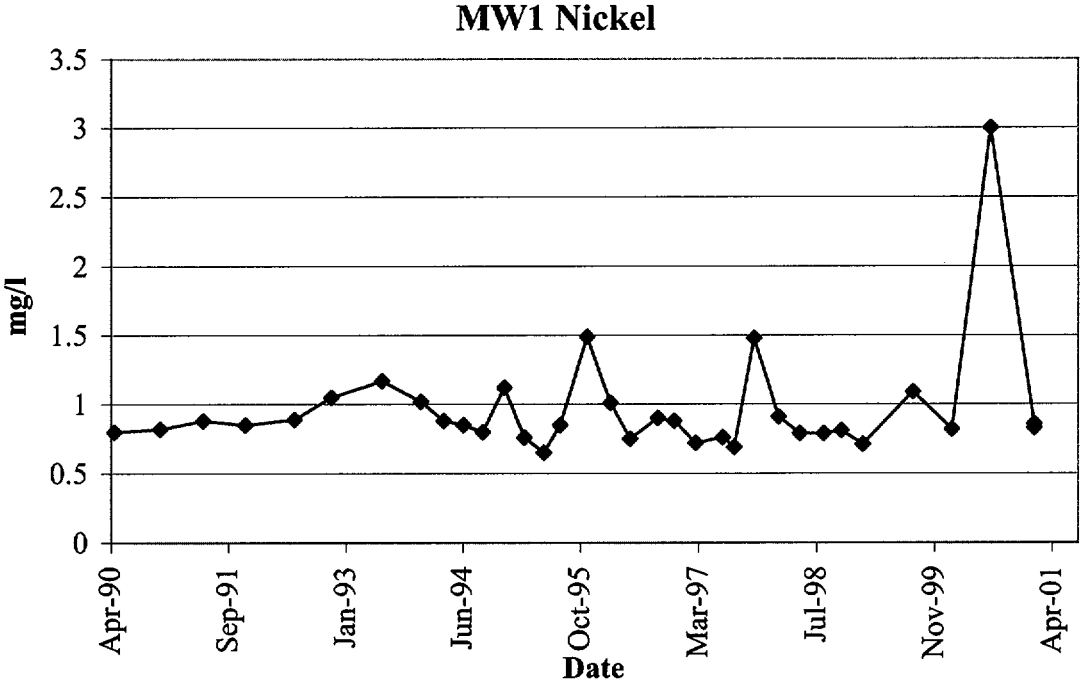


Figure J-3 Constituent Concentrations Western Flow Regime POC Wells



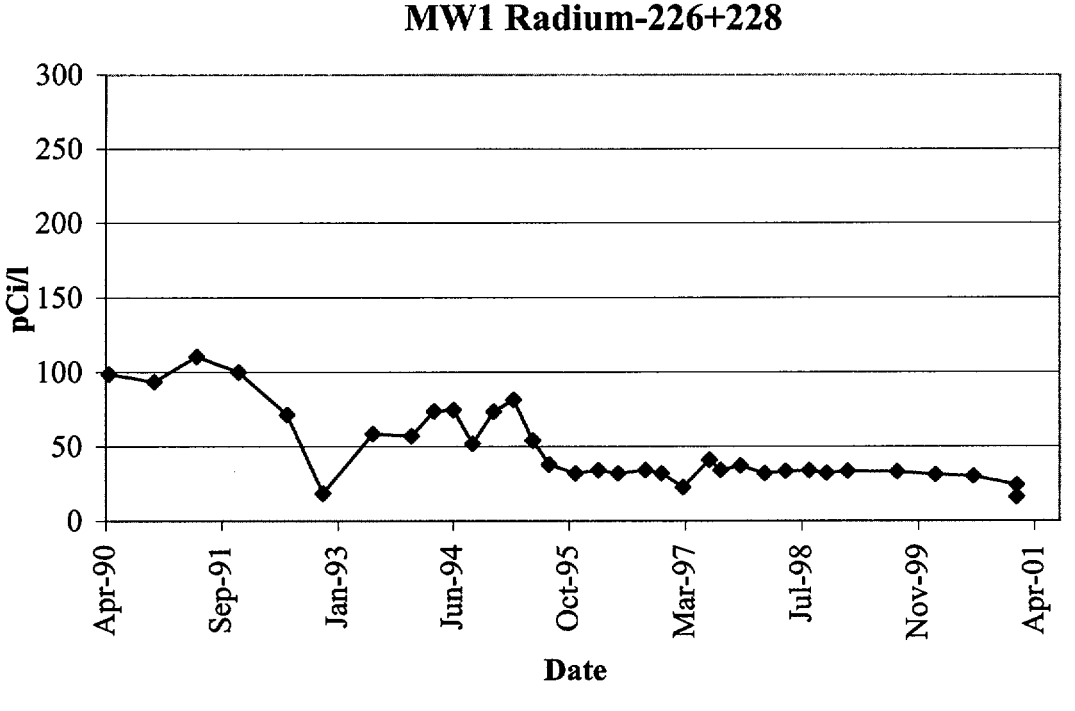
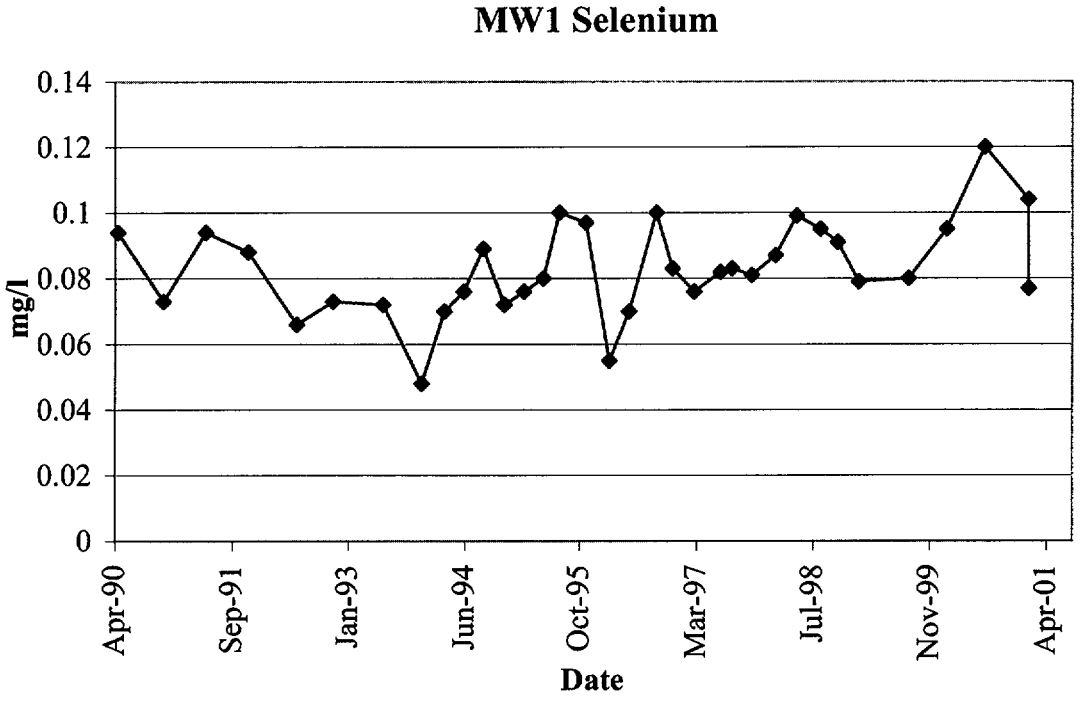


Figure J-3 Constituent Concentrations Western Flow Regime POC Wells



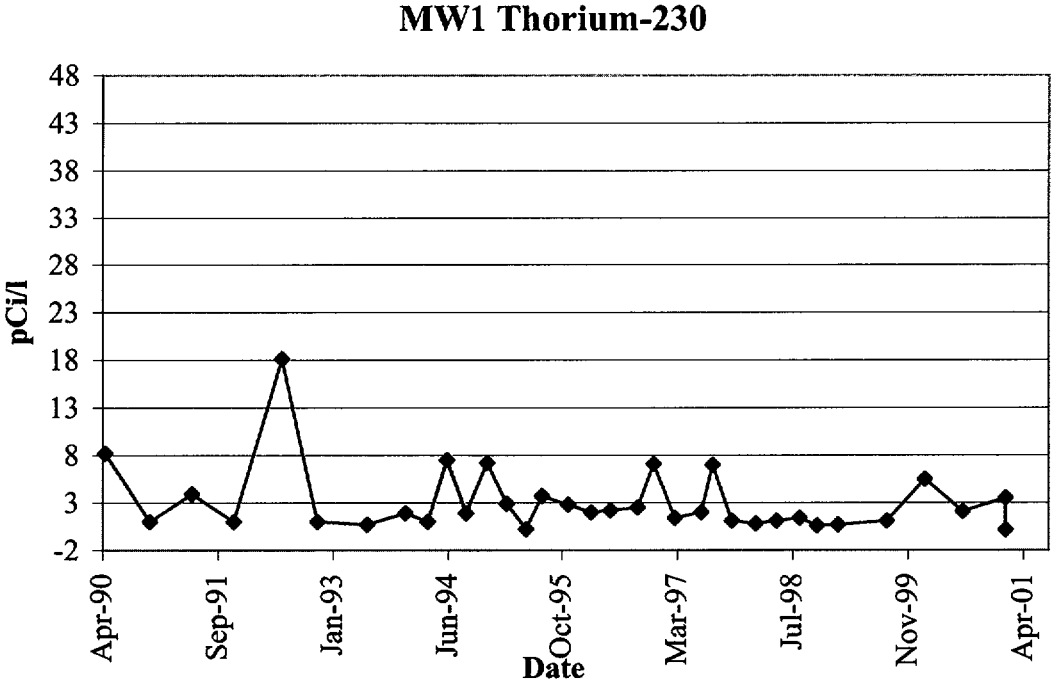
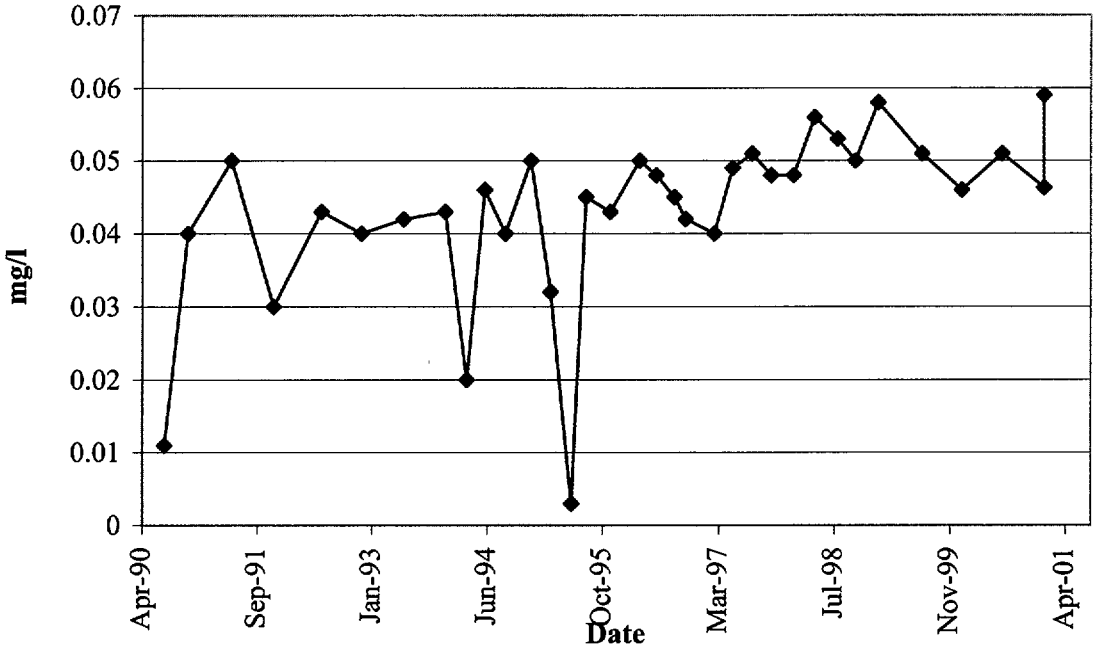


Figure J-4 Constituent Concentrations Western Flow Regime POC Wells

MW21A Arsenic



MW21A Beryllium

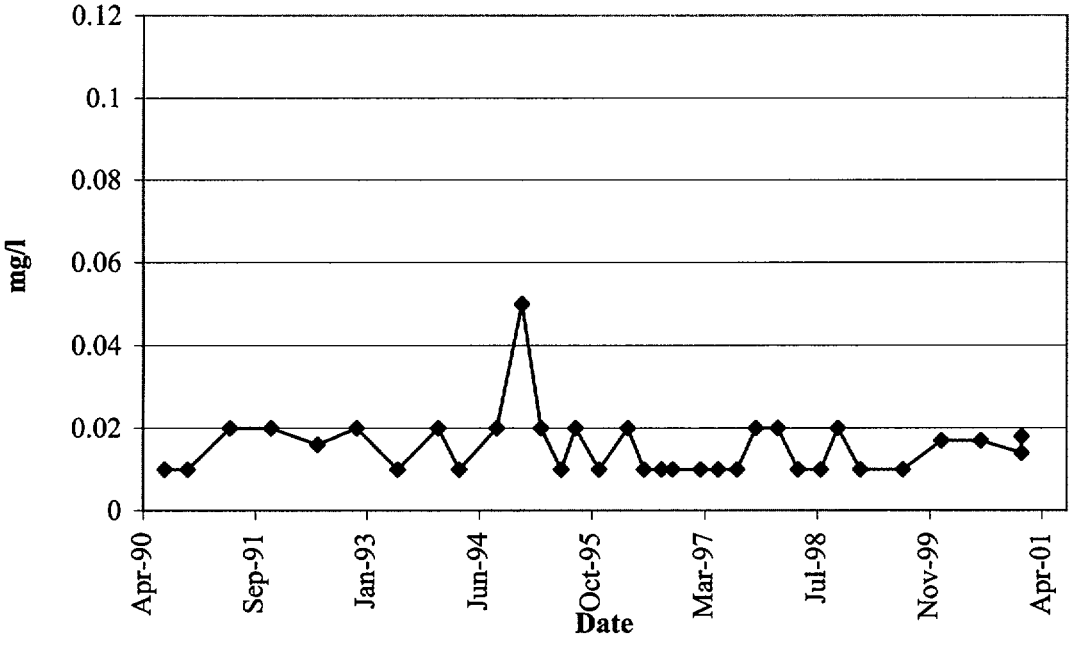
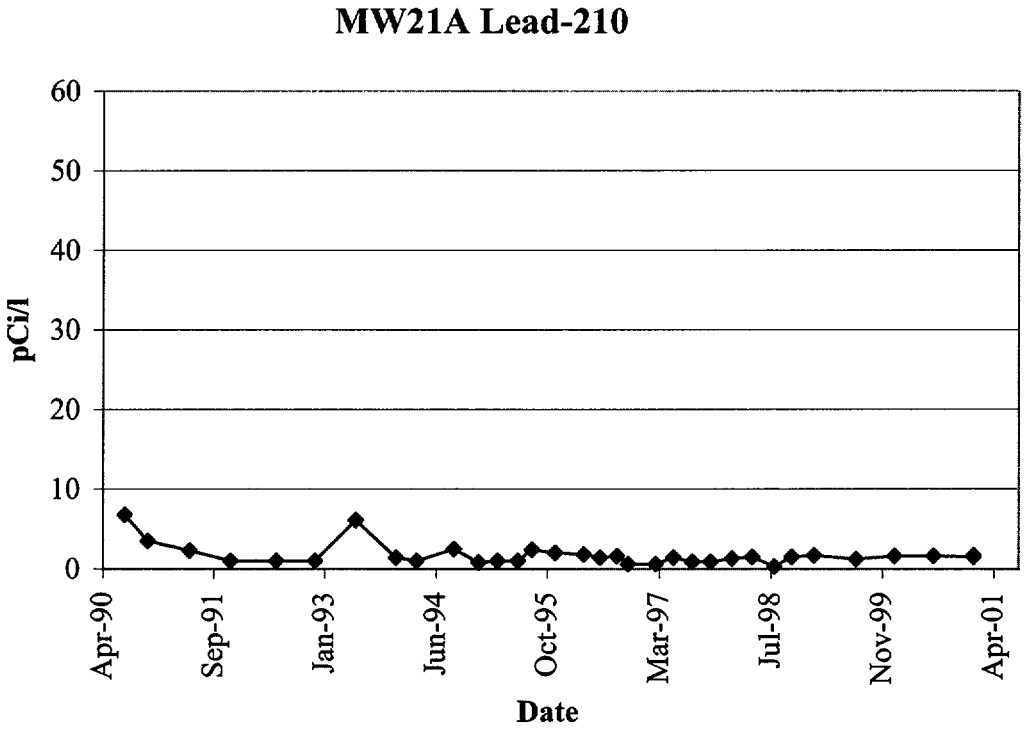


Figure J-4 Constituent Concentrations Western Flow Regime POC Wells



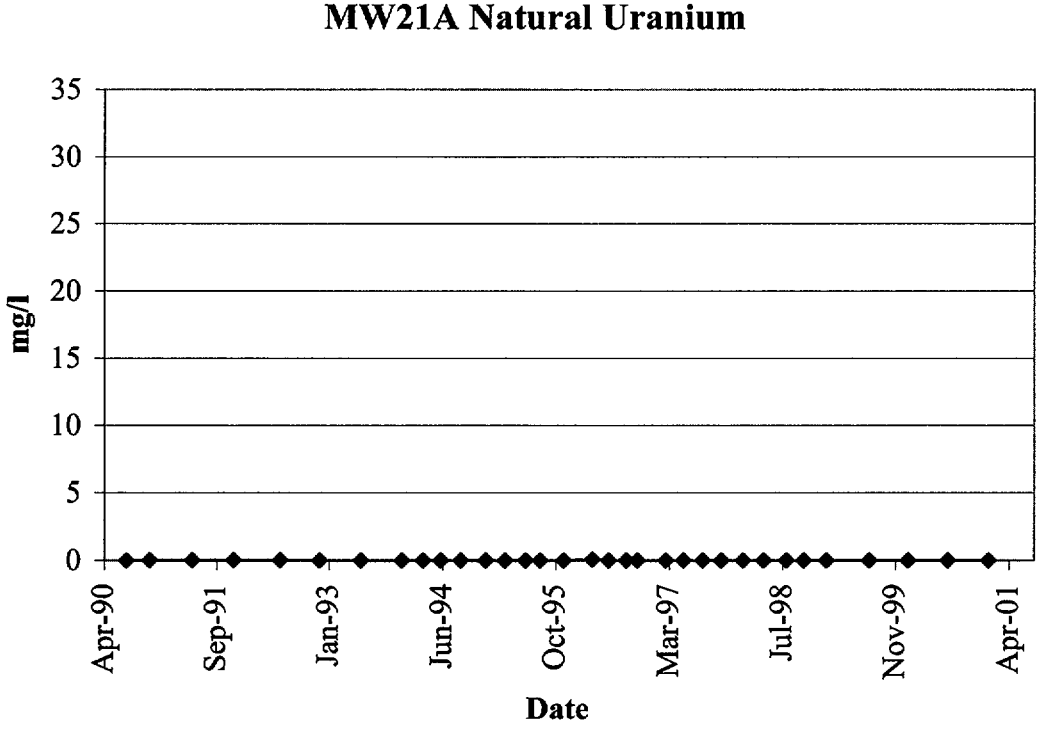
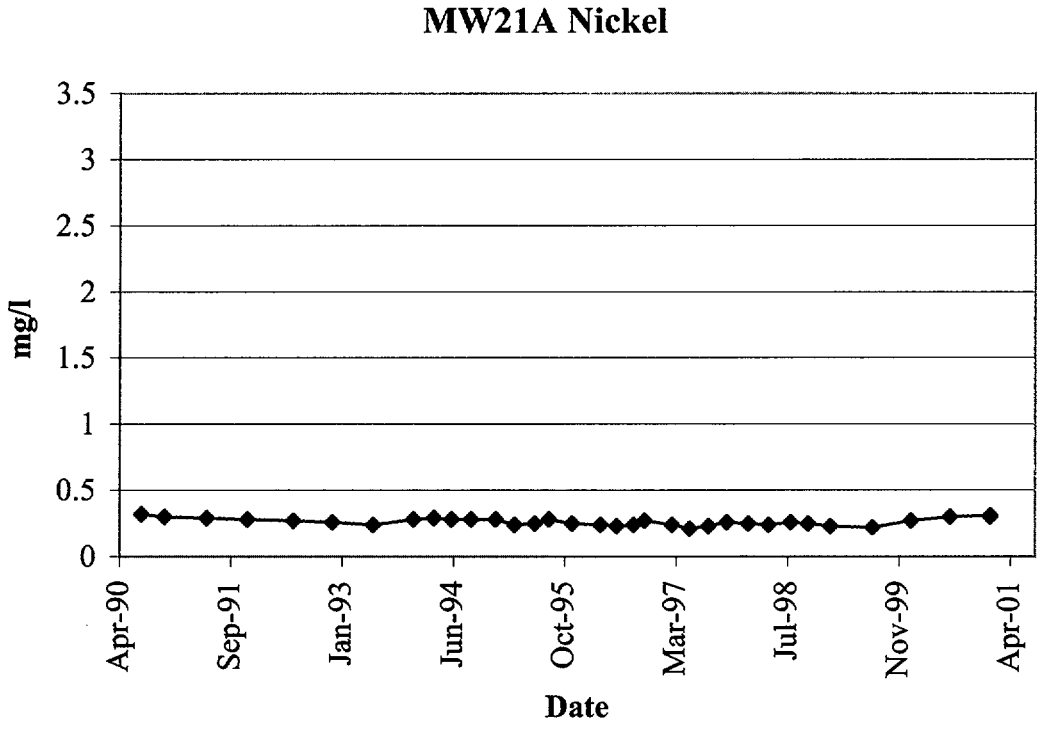


Figure J-4 Constituent Concentrations Western Flow Regime POC Wells



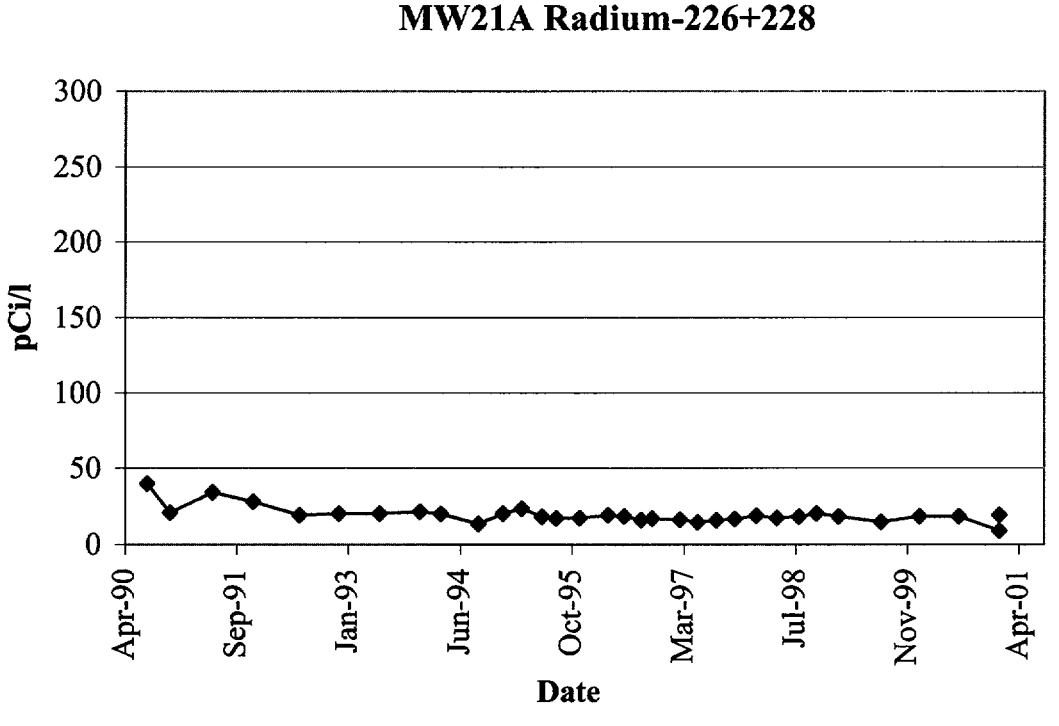
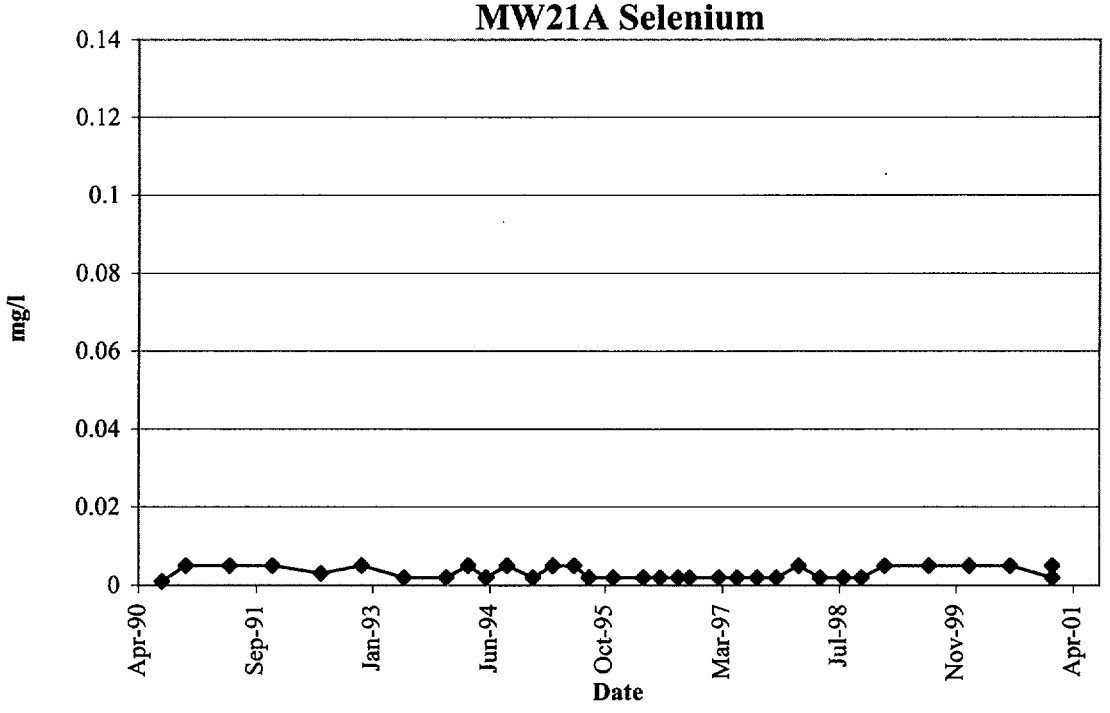
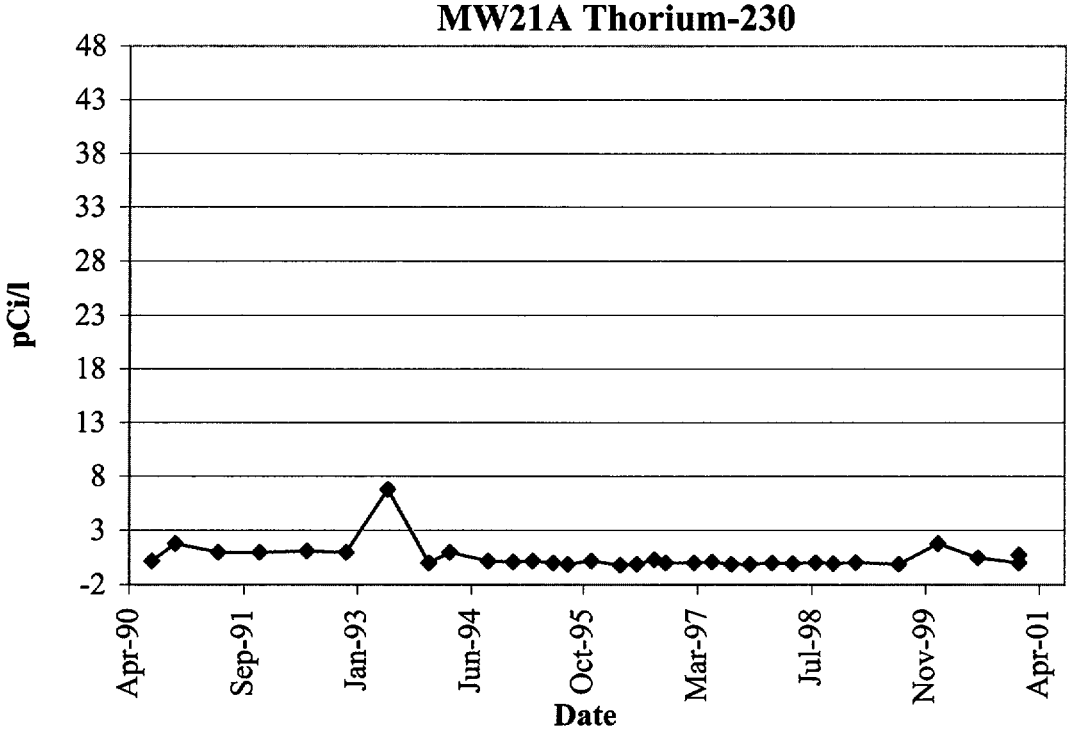


Figure J-4 Constituent Concentrations Western Flow Regime POC Wells





Appendix K

Analysis of Impact from Power Resources, Inc. In-Situ Leach Uranium Mine Operations

Umetco Minerals Corporation
2754 Compass Drive, Suite 280
Grand Junction, Colorado 81506

May 2001

Contents

1.0 INTRODUCTION **1**

2.0 COMPATIBILITY OF ACLS WITH LAND AND GROUNDWATER USES **1**

3.0 CHARACTERIZATION OF ISL MINE UNIT 5 ..... **2**

4.0 ISL OPERATIONS **2**

4.1 Hydrologic Testing and Baseline Characterization 2
4.2 Production and Recovery 3
4.3 Reclamation 4

5.0 Groundwater Flow Modeling **5**

5.1 Model Results 6
5.2 Groundwater Flow Direction and Velocity 6
5.3 Groundwater Quality 6

6.0 Summary **7**

Figures

K-1 Location of ISL Mine Unit No. 5 and Modeled Monitor Points

K-2 Model Simulation-Impact of ISL Operations on Groundwater Flowpaths

K-3 Model Simulation-Impact of ISL Operations on Sulfate Concentration

K-4 Modeled Sulfate Concentrations-Upgradient and Downgradient of Mine Unit No. 5- with and without ISL Operations

K-5 Model Simulation-Impact of ISL Operations on Chloride Concentration

K-6 Modeled Chloride Concentrations-Upgradient and Downgradient of Mine Unit No. 5- with and without ISL Operations

1.0 INTRODUCTION

Power Resources, Inc. (PRI) is permitting an in situ leach (ISL) uranium operation that is partially within the proposed long-term care boundary (LTCB) for the Umetco Minerals Corporation (Umetco) former uranium mill site in Gas Hills, Wyoming. The LTCB outlines property that will be transferred to the U.S. Department of Energy (DOE) upon termination of the U.S. Nuclear Regulatory Commission (NRC) Source Materials License 648 (Figure K-1). The NRC and the Wyoming Department of Environmental Quality (WDEQ) have expressed concerns regarding the compatibility of an ISL uranium operation with long-term surveillance and maintenance objectives for an UMTRCA Title II site. Umetco has prepared this document to demonstrate that use of the property for an ISL uranium operation is compatible with the restrictions and institutional controls within the LTCB.

Umetco has developed Alternate Concentration Limits (ACLs) as groundwater protection standards for the Gas Hills site. Geochemical and groundwater flow modeling has demonstrated that application of the proposed ACLs at the Point of Compliance (POC) wells is protective of human health and the environment at the Point of Exposure (POE) at the proposed LTCB. Milling-related constituents within the Wind River aquifer will attenuate to background levels before reaching the LTCB as demonstrated in the ACL application (Umetco 2001).

2.0 COMPATIBILITY OF ACLS WITH LAND AND GROUNDWATER USES

Implementation of the proposed ACLs as groundwater protection standards will require restrictions on groundwater use within the LTCB. Specifically, shallow groundwater would not be suitable for domestic or agricultural purposes. However, there are no current domestic or agricultural uses of groundwater within the LTCB, and ambient groundwater quality of the Wind River aquifer exceeds Class III (livestock) water standards for several constituents. Therefore, the proposed restrictions do not impose any change to current water usage within the LTCB. Groundwater quality within the LTCB is compatible, however, with certain industrial use, such as exploitation of mineral reserves, including uranium, oil, and gas. No restrictions are applied to groundwater use outside of the LTCB.

Current land use within the LTCB is limited to livestock grazing, wildlife habitat, and industrial (mining and reclamation). There are no surface water bodies within the LTCB with the exception of man-made surface impoundments that will be decommissioned as part of license termination. There are also no perennial springs. Depth to groundwater throughout the LTCB is on the order of tens to hundreds of feet below ground surface. Therefore, the only pathway for livestock or wildlife to come into contact with groundwater within the LTCB that has been impacted by milling activities is through some type of extraction (wells). There is no groundwater extraction for purposes of domestic, agricultural, or livestock use. The only current groundwater extraction from the Wind River aquifer is under the Corrective Action Program conducted by Umetco to abate milling impacts. Groundwater is also extracted from a deeper, unimpacted aquifer

for industrial use. Both of these activities will cease with license termination. Wells within the LTCB will be restricted to monitoring and, potentially, industrial use.

Procedures are stipulated within the PRI ISL permit application that prevent groundwater excursions or incursions during the production and groundwater restoration phases of operation. PRI will perform baseline characterization prior to mining and will monitor water quality throughout production and restoration operations. The closed nature of ISL wellfields, coupled with permit requirements to monitor and prevent excursions or incursions, will eliminate potential for impacts to or from milling-related constituents.

3.0 CHARACTERIZATION OF ISL MINE UNIT 5

PRI includes five mine units in its ISL permit application. A portion of one of these units, Mine Unit No. 5 (MU5), lies within the LTCB (Figure K-1). The targeted ore zone is identified by PRI as the "50 Sand". This ore zone varies in thickness from 50 to 70 feet. A confining mudstone unit is beneath the "50 Sand". The mudstone separates the "50 Sand" from the East Canyon Conglomerate. This confining unit correlates with the mudstone unit that has historically been used by Umetco to differentiate the Upper and Lower Wind River aquifer systems beneath Gas Hills.

The minimum distance from the southern limit of the A-9 Repository to the northern edge of MU5 is approximately 1,600 feet. Travel times for groundwater to reach MU5 from the A-9 Repository under non-pumping conditions, as calculated from a numerical model, is between 40 to 50 years.

PRI has submitted a schedule for development of the ISL mine units to occur from 2003 to 2020. Development of MU5 will occur toward the end of that period, if at all, based on preliminary assessment by PRI as to the economic viability of this ore body. MU5 has been characterized as having the lowest permeability of the five mine units and may not be suitable for ISL mining. The average hydraulic conductivity for MU5 is listed as 0.35 ft/d, approximately an order of magnitude less than the average for MU1, 2 and 3 and approximately 30 percent less than MU4.

4.0 ISL OPERATIONS

The proposed ISL uranium operation includes several major phases. These include hydrologic testing and baseline characterization, production and recovery, and reclamation. Each of these phases of operation are evaluated with respect to impacts or from milling-related constituents from the Umetco site.

4.1 Hydrologic Testing and Baseline Characterization

Prior to installing monitor wells in a proposed mine unit a hydrologic testing proposal (HTP) must be submitted to WDEQ. The HTP includes baseline geologic and hydrologic information pertaining to the mine unit as well as information on additional data collection efforts such as pumping tests, monitor well locations, etc. Baseline water quality for the mineralized production zone and the perimeter non-mineralized production zone will be determined during this initial phase of the ISL operation. The baseline water

quality determines the pre-mining Class of Use, Upper Control Limits and Restoration Target Values. These parameters provide guidelines for groundwater reclamation. For MU5 specific considerations for hydraulic testing include evaluation of water quality impacts associated with past mining at the Veca Pit and other upgradient sites and impacts of the Thunderbird Graben fault system and the Rox underground mine workings. The hydraulic testing program will also assist in determining the viability of ISL mining under the low hydraulic conductivities that prevail in MU5.

Because the hydraulic testing program will include relatively short term pumping tests and drilling and monitoring activities, no significant impacts to regional groundwater flow rates and direction or water quality are anticipated. Milling-related constituents will not be impacted by, nor cause impacts to, PRI's ISL operation during this phase.

4.2 Production and Recovery

ISL involves the use of a leaching solution (lixiviant) to extract economic mineral from the geologic formation without physically removing the geologic strata. Lixiviant is injected into the ore bearing strata to dissolve the uranium, and the solution is recovered via production wells. An ISL operation is a closed system and optimized for maximum ore contact with a minimum number of wells. Typically a "5-spot" well pattern is used for hydraulic control where four injection wells surround one production well. Extraction rates exceed injection rates by approximately 0.5 to 3 percent to produce a cone of depression so that the lixiviant is contained within the mining zone. Each mine unit will be surrounded by ore zone monitor wells to ensure lixiviant control.

The number of "5 spot" patterns projected for MU1 through 4 ranged from 300 to 624. No estimate was provided for MU5. Well spacing between like wells is 80 feet in each of the mine units. MU1 and 3 are comparable in size to MU5. MU1 and 3 each had 300 "5-spot" patterns. Therefore, it is assumed that MU5 would also require approximately 300 "5 spot" patterns during production.

The end of the primary economic recovery period for a mine unit, or a portion thereof, will occur when the flow rate and uranium concentrations fall below threshold values. Based on the PRI schedule, production for an individual mine unit will be completed within 3 to 4 years from startup. Because of the relatively small "bleed" during production (between 0.5 and 3 percent of the total extracted groundwater), impacts to regional groundwater flow will be minimal during this phase.

Additionally, the Operations and Mineral Extraction Plan of PRI's ISL application specifies procedures to prevent excursions and incursions during production and recovery. Specifically, Section 5.5.3-Wellfield Setback from Mine Workings states:

> *When a wellfield is located near a previously mined area that exhibits poorer groundwater quality than a proposed ISL mine unit, preventing an incursion will also factor into the overall wellfield design. ....Minimum setbacks from the mine workings to prevent excursions and incursions will be developed specifically for each mine unit based on the hydrologic data.*

Also, Section 5.5.5-High TDS Groundwater Movement Assessment states:

> *The movement of high TDS groundwater will be assessed prior to development of a mine unit. If areas of historically high TDS groundwaters are likely to move into a mine unit due to the ISL operational bleed, then engineered controls will be needed to prevent the mixing of the separate quality groundwaters. ....engineered controls.... include wellfield balancing, scheduling, setbacks, monitoring or secondary controls such as water fences.*

Based on the stipulated controls included in the PRI application and the closed nature of the wellfield design to optimize production, recovery operations at MU5 will not be impacted by, or have impacts to, constituents migrating from Umetco's site during the production/recovery phase of ISL operation.

4.3 Reclamation

Reclamation of the PRI ISL project includes the following activities; groundwater restoration, radiological decontamination, facility decommissioning, and surface reclamation. Only groundwater restoration activities are considered for possible impacts to or from milling related constituents. The other activities are restricted to surface reclamation and should have minimal impacts on groundwater quality.

The goal of the ISL reclamation is "*to return areas affected by ISL activities to a condition which will support the pre-mining land use of livestock grazing and wildlife habitat*" (PRI 1998). As previously described, there are no perennial surface water bodies within the LTCB other than man-made impoundments and there are no exposure pathways for livestock or wildlife to groundwater.

Groundwater restoration for a mine unit will commence once economic uranium recovery operations are completed for that unit. The initial phase of groundwater restoration is the groundwater sweep (GWS) followed by reinjection. The objective of the GWS is to pull back the edge of the affected water to the proximity of the peripheral wells in the mine unit. This ensures that once reinjection commences affected groundwater will not be pushed away from the mine unit. The schedule provided in the PRI permit application indicated a period of approximately 2 years for the GWS phase for each mine unit although MU5 was not included on the schedule. Restoration of particular sections of a mine unit may be done simultaneously while production is ongoing in other sections and injection of treated water is ongoing at other sections. The total required GWS volume for MU1 through 4 ranged from 155 to 294 million gallons with an average of 215 million gallons. Because of lower hydraulic conductivities, it is assumed that the total required GWS volume for MU5 would be lower than the average value cited for the other mine units. Approximately 75 to 99 percent of the extracted water is returned to the aquifer after treatment during the reinjection phase of groundwater restoration. This minimizes impact on regional groundwater gradients and flowpaths. The reinjection phase flushes residual fluids within the ore zone toward the production wells. Reinjection is also typically conducted for approximately 2 years per mine unit.

The final phase of groundwater restoration is the addition of a chemical reductant or oxygen scavenger to the injected water. This step will effectively minimize dissolved

concentrations of redox sensitive constituents such as uranium and iron through precipitation and adsorption. This restoration phase is generally limited to 1 to 3 months.

Under the PRI Reclamation Plan, Section 2.2.3-Groundwater Restoration Strategy it is stated:

> *Once the economic recovery limit of a mine unit has been reached, a strategy for restoring the groundwater in the most efficient manner will be derived from an analysis of the following wellfield characteristics...*
>
> Section 2.2.3 further states:
>
> *The location of any zones of previously affected or naturally degraded groundwater outside of the well field monitor well ring so that groundwater restoration activities can be designed to avoid drawing such water towards or into the wellfield pattern area.*

Based on the specified conditions included in the PRI application regarding groundwater restoration, there will be no impacts to or from milling-related constituents as a result of restoration operations at MU5. Umetco's POE is outside of and hydraulically downgradient of MU5. Based on PRI's permit, groundwater migrating from the mine unit must be of similar quality to pre-ISL conditions following restoration.

5.0 GROUNDWATER FLOW MODELING

Umetco developed a groundwater flow and transport model in support of the ACL Application that is described in Appendix C. The model was used to simulate impacts to the groundwater flow system that could occur under proposed operating conditions for MU5. Results of the modeling indicate minimal impacts to groundwater migrating from the Umetco site with respect to flow direction, velocity, and water quality.

MODFLOW (Harbaugh 1988), MODPATH (Pollack 1989, 1994) and MT3D (Zheng 1990) were the codes used to develop the model. The model was initially calibrated to site conditions, including operation of the Umetco Corrective Action Program (CAP) (Appendix C). From the base calibrated model, a transient simulation was run to represent potential impacts resulting from the proposed ISL operation at MU5. The following components were incorporated into the model simulation.

- ISL production/recovery operations would begin 18 years from the present.
- Production/recovery would be complete within 2 years.
- There were no impacts to the groundwater flow system outside of the mine unit during the production/recovery phase of the ISL operation because of the closed nature of the well arrays and the minimal bleed.
- GWS would operate for 2 years.
- 190 wells were used to simulate GWS.
- A total of 200 million gallons would be removed during GWS.
- Reinjection would operate for 2 years.

- A total of 300 million gallons would be reinjected.
- Injection wells were only placed around the perimeter of MU5.
- Initial chloride and sulfate concentrations were represented by 2000 water quality data.
- The Umetco CAP extraction wells were turned off for the simulation, simulating conditions following license termination.

5.1 Model Results

The model was run for a period of twenty years with the CAP turned off. This simulates movement of constituents from the Gas Hills site toward MU5 prior to the onset of the GWS and reinjection phases of restoration. Then the GWS and reinjection were simulated as described previously. Following restoration operations (a period of 4 years), the model run was continued for another 20 years to simulate post-ISL movement of groundwater and dissolved constituents. A simulation was also run without ISL operations in order to compare impacts of the two scenarios.

5.2 Groundwater Flow Direction and Velocity

Particle tracking was used to evaluate changes to groundwater flow direction and velocity that could occur between the A-9 Repository and MU5 under the proposed ISL mining.

Figure K-2 shows two sets of particles. One set represents conditions with ISL activity (red) and the other without (green). The arrows on the figure represent 5-year travel increments for each particle. Total travel time for each simulation is 44 years. As shown in the figure, there is a slight deviation to the southeast in the flowpaths as a result of the GWS phase of restoration compared to non-ISL conditions. This change in flow direction occurs before the particles reach MU5. However, particles revert back to non-ISL flowpaths within a short distance. The reinjection phase offsets the GWS before the particles reach MU5. At end of the simulation period (44 years) the particles for each simulation show no appreciable difference in location. The model simulations indicate that there is negligible impact to either groundwater flow direction or groundwater velocity as a result of the proposed ISL operation.

5.3 Groundwater Quality

Modeling indicates that groundwater migrating from the Gas Hills Site will not reach MU5 until 15 to 20 years following completion of ISL operations. Most of the milling-related constituents will attenuate along the flowpath and will not reach MU5. Also, the final stage of the reinjection phase includes introduction of reducing agents or oxygen scavengers, which will further enhance attenuation of most of the licensed constituents. Therefore, potential impacts to groundwater quality were evaluated using non-reactive constituents, chloride and sulfate.

The modeled sulfate distribution immediately after the cessation of ISL operations (24 years from present conditions) is illustrated in Figure K-3. For comparison, sulfate distribution for the non-mining scenario for the same time period is also included in the figure. The figure shows minimal difference in sulfate distribution between the

simulations. The figure also indicates that the core of the sulfate plume has not reached MU5 at the end of ISL operations.

Sulfate trend plots were generated from the model output to compare concentrations both upgradient and downgradient of MU5 under the mining and non-mining simulations (Figure K-4). The figure shows no significant difference between the simulations at the upgradient location (Figure K-1). There is a slight decrease after 24 years at the downgradient location in the ISL mining simulation. This decrease is the result of reinjection of clean water. The concentration at the downgradient location is essentially identical at the end of the mining and non-mining simulations.

The modeled chloride distribution for both the mining and non-mining simulations is shown in Figure K-5. As with sulfate, the figure shows minimal difference in chloride distribution between the simulations. Chloride trend plots for locations upgradient and downgradient of MU5 show similar patterns as for sulfate (Figure K-6).

Results of the modeling indicate that the PRI ISL uranium mine should not significantly alter groundwater flow rates or direction under the proposed operating parameters. Furthermore, ISL operations may enhance attenuation of milling-related constituents through introduction of reducing agents in the final stages of restoration.

6.0 SUMMARY

PRI's proposed ISL uranium operation is compatible with the implementation of ACLs as groundwater protection standards for the Umetco Gas Hills site. ISL mining, conducted under the conditions of the PRI permit, will not conflict with institutional controls required within the LTCB. ISL operations will have minimal and temporary effects on groundwater flow conditions between MU5 and the A-9 Repository. Water quality outside of MU5 will not be impacted as a result of ISL uranium mining.

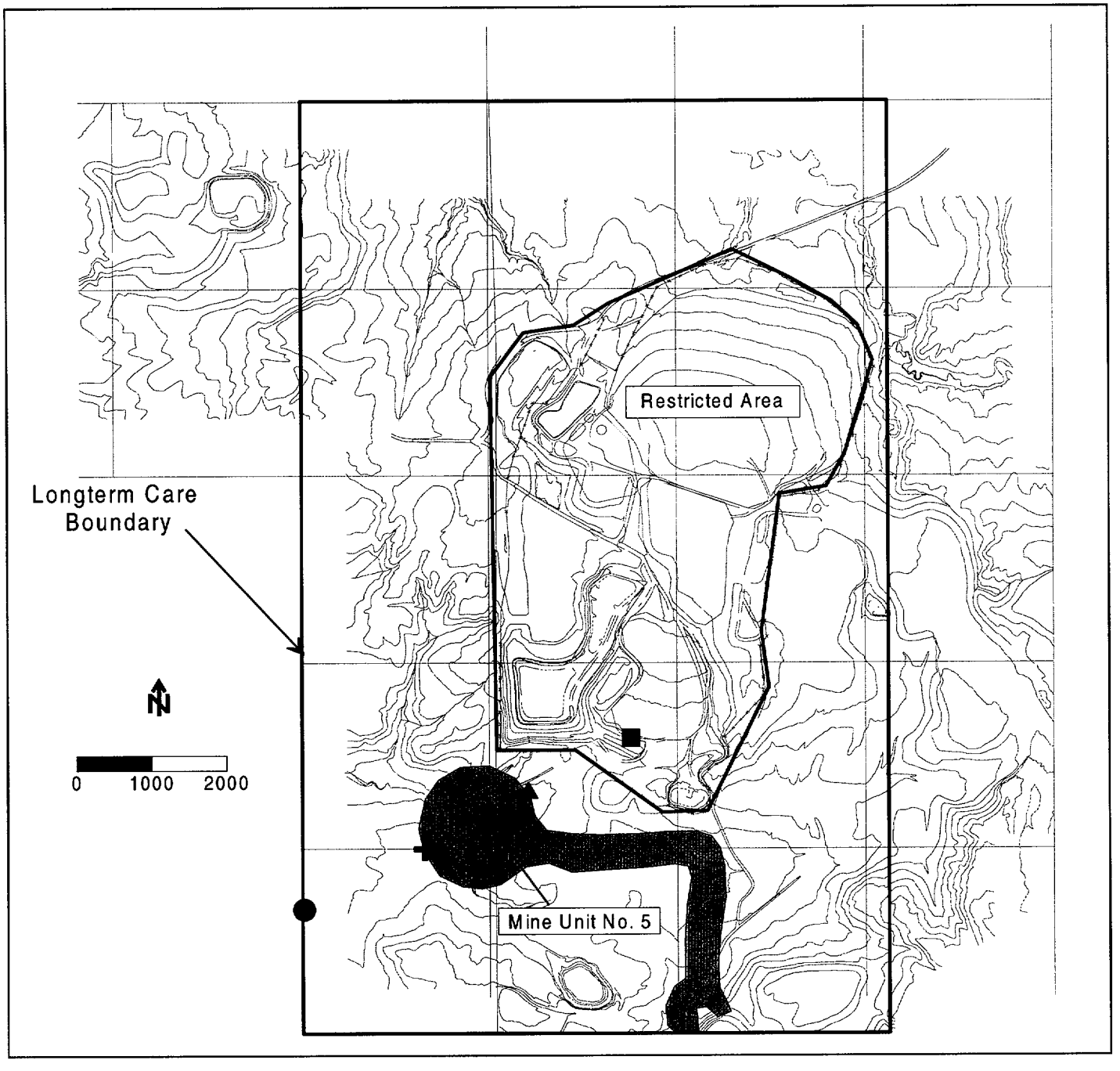
Shallow groundwater use within the proposed LTCB has been limited to industrial activities, primarily associated with uranium mining and reclamation. Ambient water quality exceeds Class III (livestock) standards for several constituents, including radium, but is suitable for industrial use. There are no surface water bodies (other than man-made surface impoundments) or groundwater discharge points within the LTCB. Wells within the LTCB will be restricted to monitoring and/or industrial use. ISL mining is consistent with this use of groundwater resources.

Conditions included in the PRI permit restrict impacts to areas within the mine units. The permit requires assessment of existing water quality prior to ISL mining. Also, mine wellfields must be designed to prevent incursions and excursions from the mine unit during production/recovery and restoration operations. The provisions of the permit will ensure that the aquifer system between MU5 and the A-9 Repository is not impacted by ISL mining. Furthermore, ISL operations will not lessen the natural attenuation capacity of the reduced portions of the Wind River aquifer. A potential benefit of the ISL operation will be increased attenuation capacity within the area of MU5 resulting from

introduction of reducing agents and oxygen scavengers during the restoration phase. The POE for the Umetco site is located outside of and downgradient of MU5

Even without appropriate wellfield management, any impacts to flow direction, velocity or water quality to groundwater migrating from the Umetco site would be minimal, as demonstrated with a calibrated numerical flow and transport model. Results of the modeling indicate groundwater flow direction or rates will not be significantly altered under the proposed ISL operating parameters.

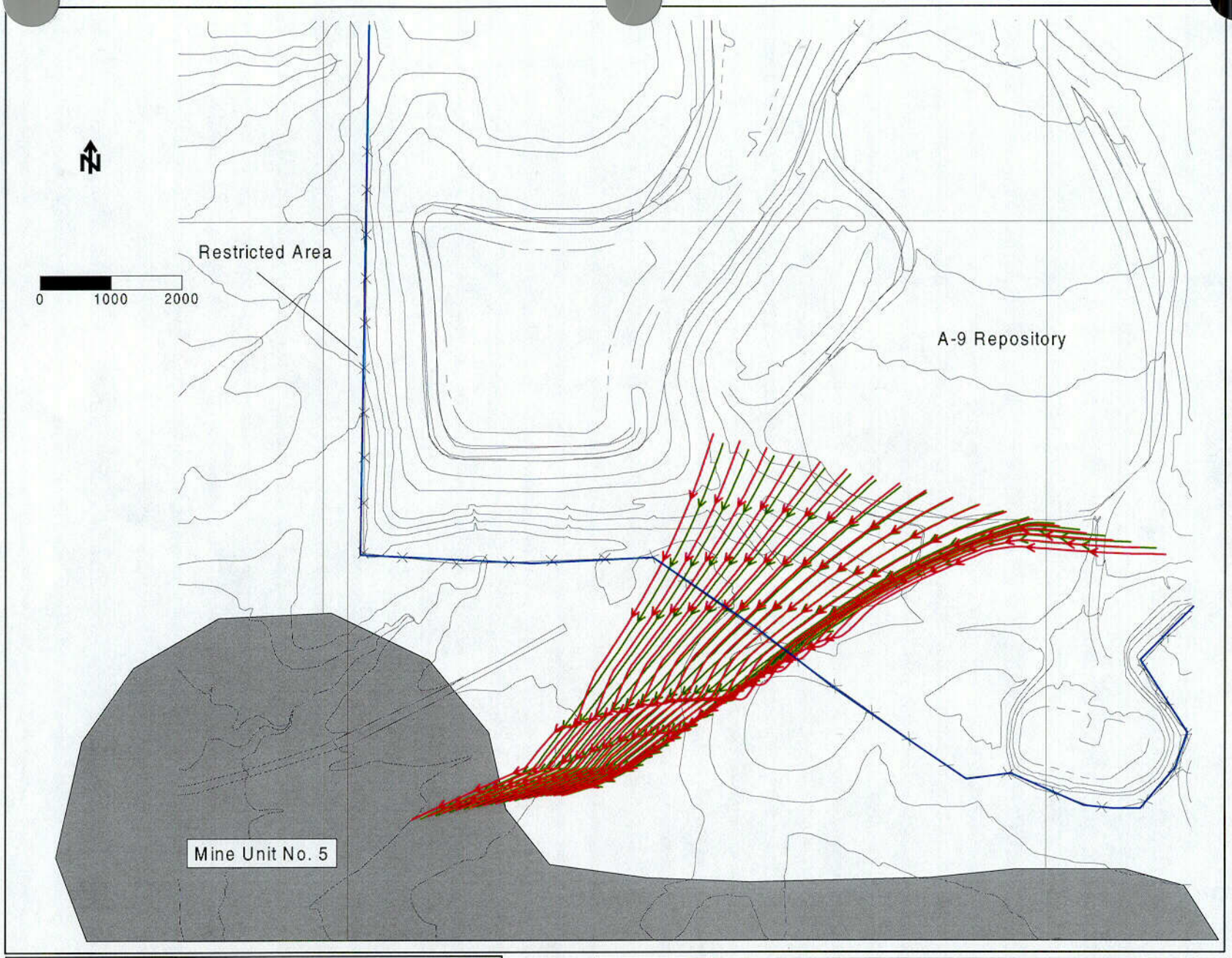
Based on the data included in the PRI permit application, Umetco's understanding of site hydrogeologic and geochemical conditions and the results of numerical groundwater flow and transport model, the proposed ISL uranium operation is compatible with the application of ACLs at the Gas Hills site.



Point of Compliance
Upgradient of Mine Unit No. 5
Point of Exposure
Downgradient of Mine Unit No. 5

Figure K-1. Location of ISL Mine Unit No. 5 and Modeled Monitor Points

Gas Hills Site, Wyoming
Umetco Minerals Corporation



Flowpath without ISL operations

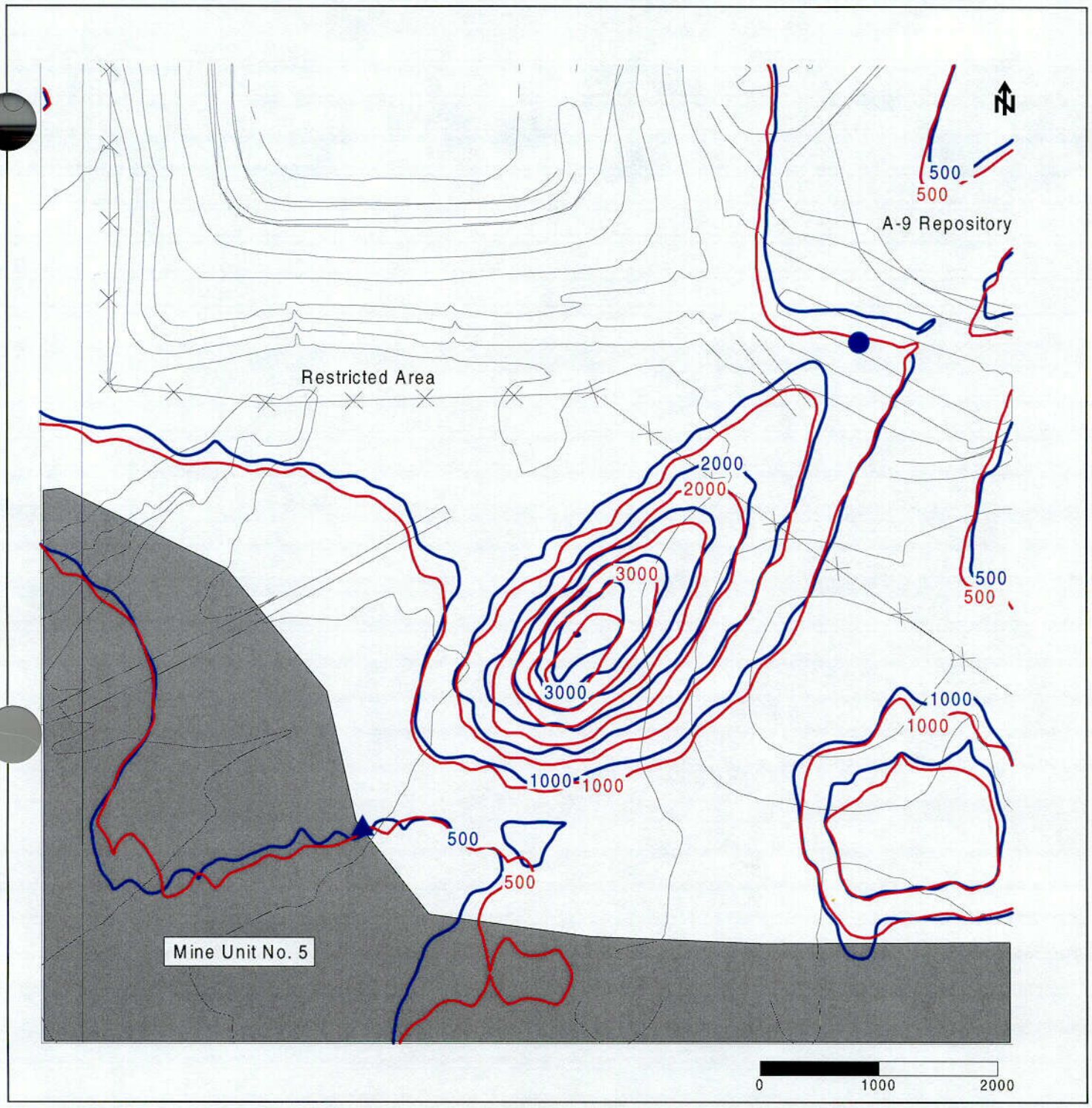
Flowpath with ISL operations

(arrows indicate 5 year increments in travel time)

Figure K-2. Model Simulation- Impact of ISL Operations on Groundwater Flowpaths

Gas Hills Site
Umetco Minerals Corporation

C-1



Sulfate distribution without ISL operations (contour interval is 500 milligrams per liter)

Sulfate distribution with ISL operations (contour interval is 500 milligrams per liter)

Point of Compliance

Upgradient Monitor Point for Mine Unit No. 5

Figure K-3. Model Simulation- Impact of ISL Operations on Sulfate Concentration

Gas Hills Site
Umetco Minerals Corporation

C-2

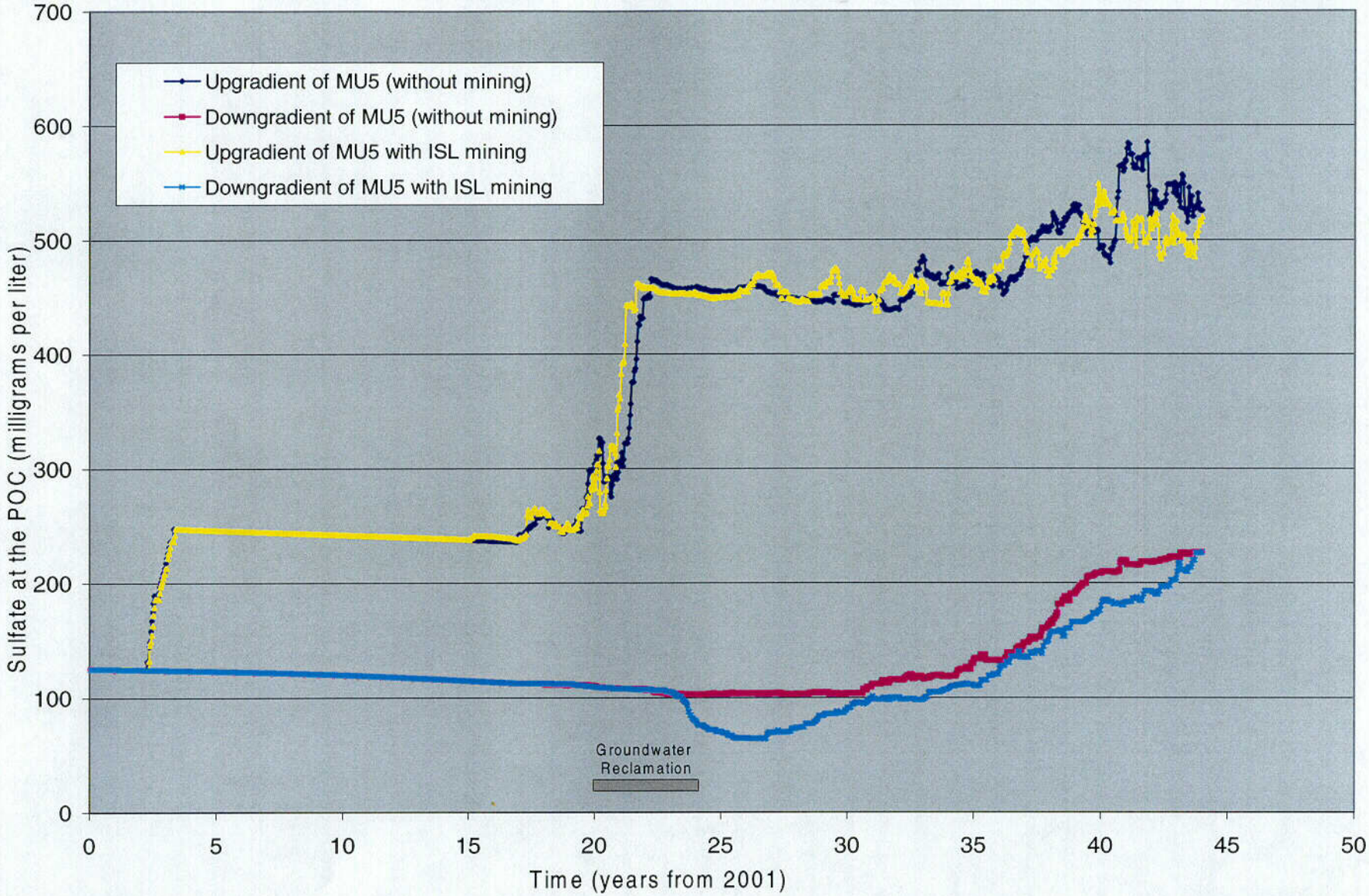
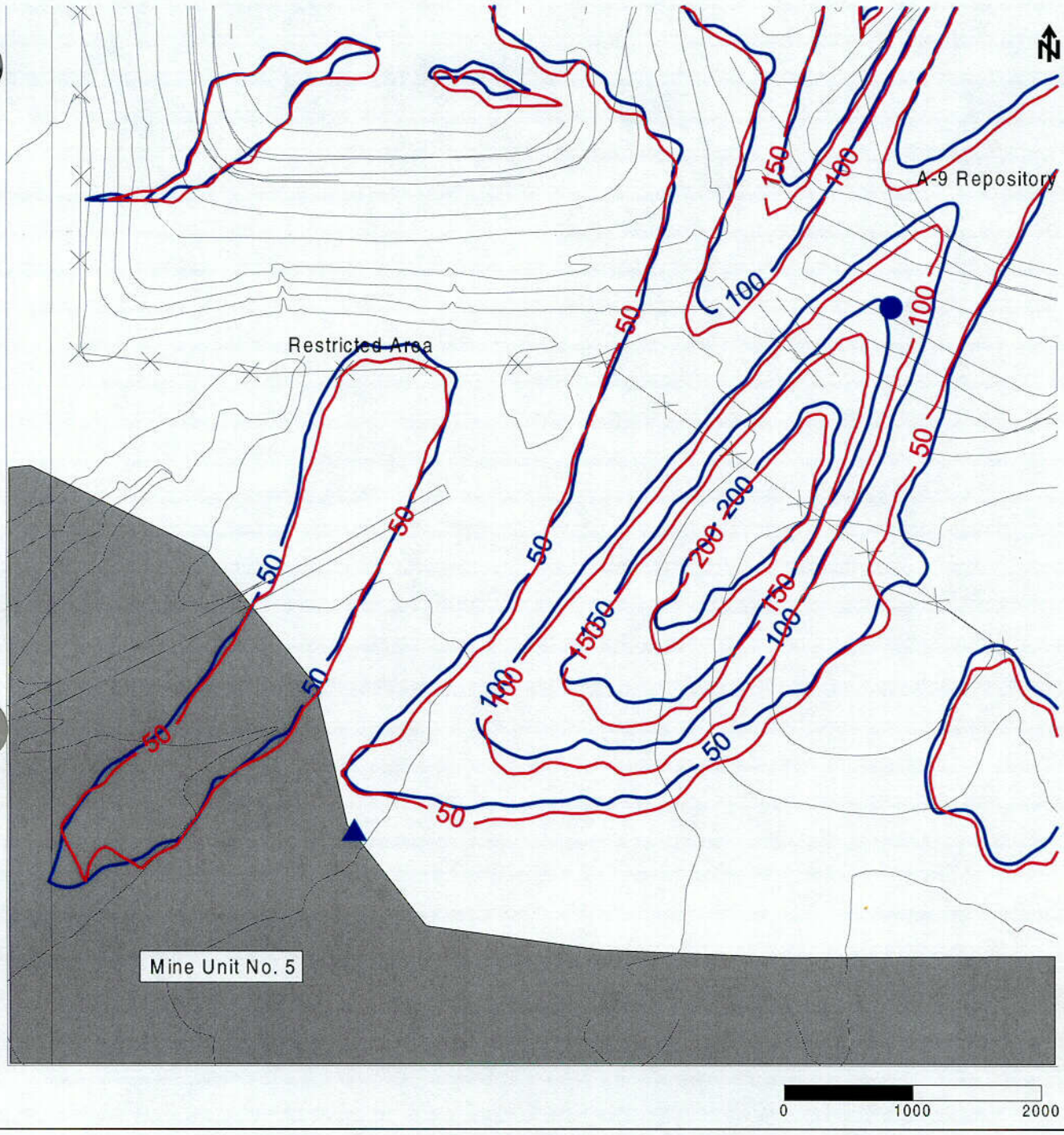


Figure K-4. Modeled Sulfate Concentrations
Upgradient and Downgradient of Mine Unit No. 5
with and without ISL Operations
Gas Hills Site
Umetco Minerals Corporation

C-4



Chloride distribution without ISL operations (contour interval is 50 milligrams per liter)

Chloride distribution with ISL operations (contour interval is 50 milligrams per liter)

Point of Compliance

Upgradient Monitor Point for Mine Unit No. 5

Figure K-5. Model Simulation- Impact of ISL Operations on Chloride Concentration

Gas Hills Site
Umetco Minerals Corporation

C-4

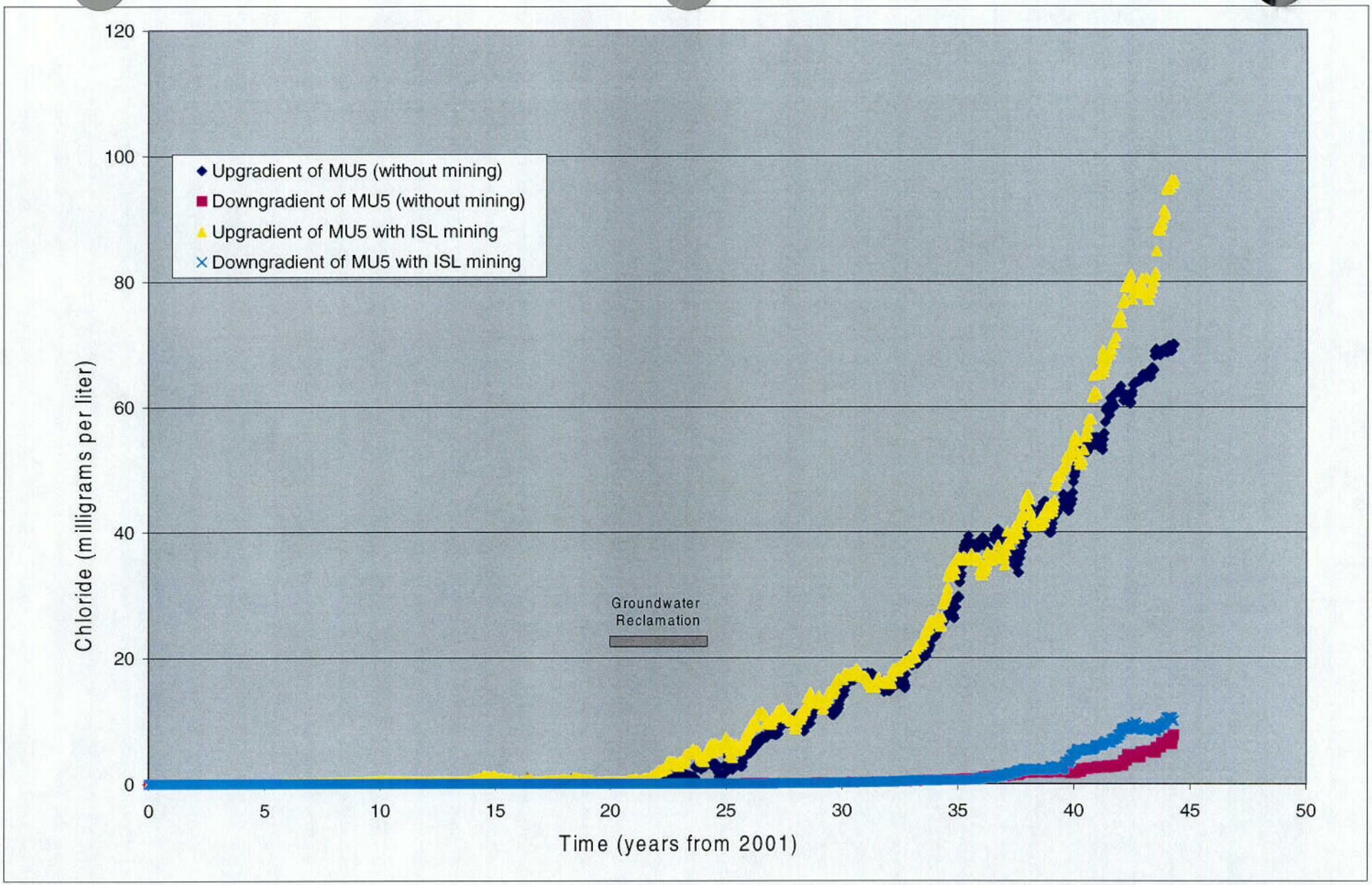


Figure K-6. Modeled Chloride Concentrations
Upgradient and Downgradient of Mine Unit No. 5
with and without ISL Operations
Gas Hills Site
Umetco Minerals Corporation

C-5