LEE COUNTY
SOUTHWEST FLORIDA

REVIEW OF OPERATIONAL TESTING CYCLES 4, 5, AND 6 FOR THE LEE COUNTY UTILITIES ASR (WELLS 1-5), CORKSCREW WATER TREATMENT PLANT LEE COUNTY, FL

February, 2007

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REVIEW OF OPERATIONAL TESTING CYCLES 4, 5, AND 6 FOR THE LEE COUNTY UTILITIES ASR SYSTEM (WELLS 1-5), CORKSCREW WATER TREATMENT PLANT LEE COUNTY, FLORIDA

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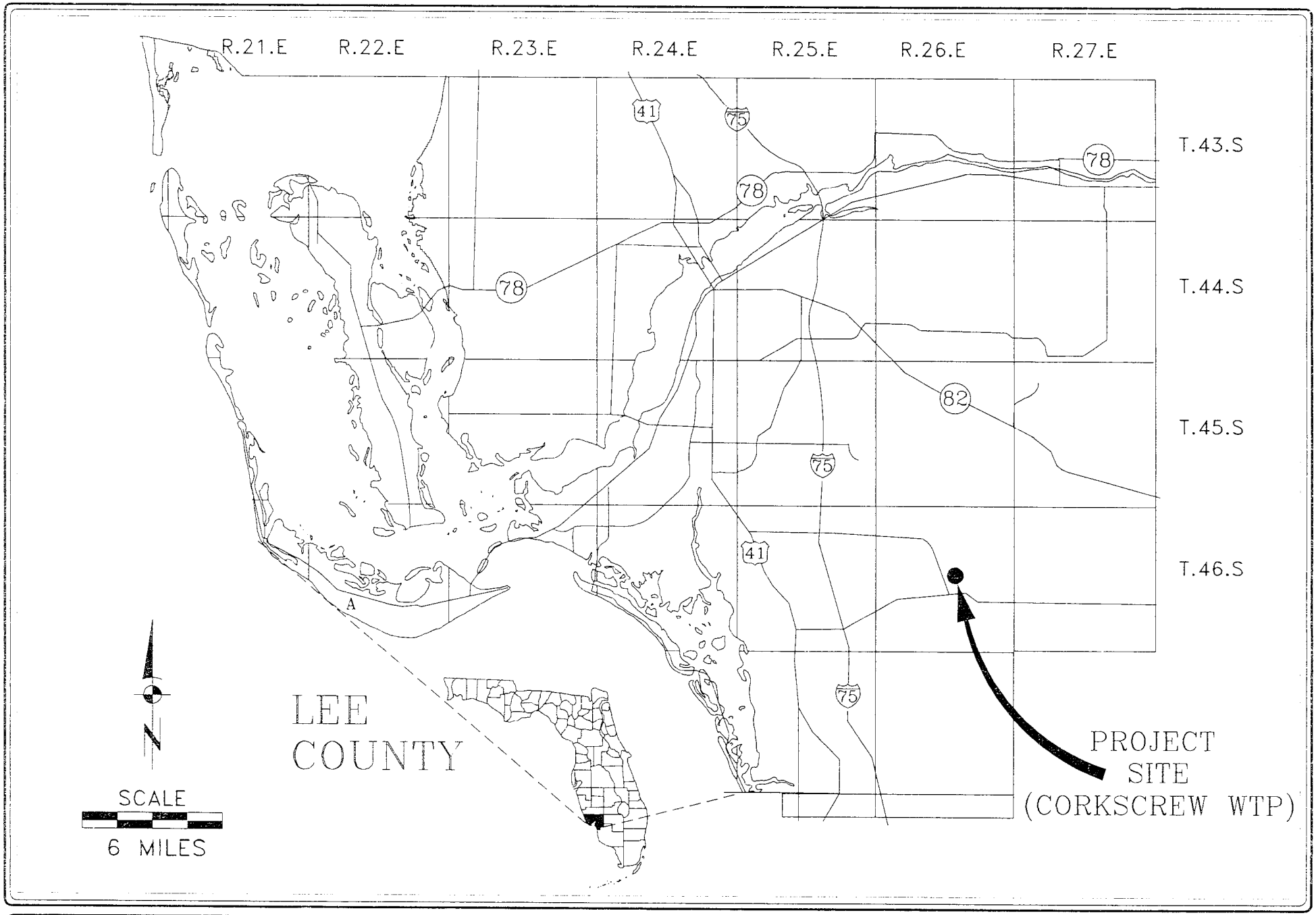
I. INTRODUCTION

The Corkscrew aquifer storage and recovery (ASR) system is located at the Lee County Utilities Corkscrew water treatment plant (WTP) in central Lee County, Florida (Figure 1-1). The system consists of five 12-inch diameter ASR wells (ASR-1 through ASR-5) and five storage zone monitoring wells (MW-A, MW-C, and SZMW-1 through SZMW-3). The locations of these wells are shown on the site map (Figure 1-2). ASR-1 was constructed, along with storage zone monitoring wells A and C, as a pilot system in 1995. The additional ASR wells and storage zone monitoring wells were constructed in 1999 after the viability of ASR at the site had been demonstrated by the pilot system.

The five year construction permit for wells ASR-2 through ASR-5 was renewed in 2005 with a two-year duration (Water Resource Solutions, 2004). The reason for renewing the construction permit, rather applying for an operating permit, was related to some arsenic concentrations in the recovered water which slightly exceeded the new regulatory criteria of 10 micrograms per liter (ug/l). Typically, arsenic concentrations in recovered water from ASR systems in South Florida decline with each successive injection-storage-recovery cycle. As documented herein, this is the case at Corkscrew where arsenic concentrations in the recovered water during the last two cycles have not exceeded regulatory criteria. A five-year renewal of the construction permit is requested herein in order to obtain data from several more injection-storage-recovery cycles before applying for an operating permit for the Corkscrew ASR system.

The ASR storage zone is a limestone interval in the upper part of the Miocene-age (approximately 5 to 25 million years ago) Arcadia formation referred to as Mid Hawthorn Zone I of the Intermediate aquifer system between the approximate depths of 250 and 350 feet below land surface (Figure 1-3). Confining units are present, above and below this interval which serve to isolate it from other portions of the aquifer. The system was designed and permitted to inject potable water from the WTP during peak wet season periods (i.e. from about June 15 to November 15 in a typical year), store it for several months, and recover it during the dry season when potable water demands are highest.



Water Resource Solutions	PROJECT NAME: CORKSCREW ASR	DWG. NUMBER: DESKTOP-DAN
	PROJECT NUMBER: XXXX	DATE: 03/01/07

FIGURE 1-1. GENERAL SITE LOCATION MAP.

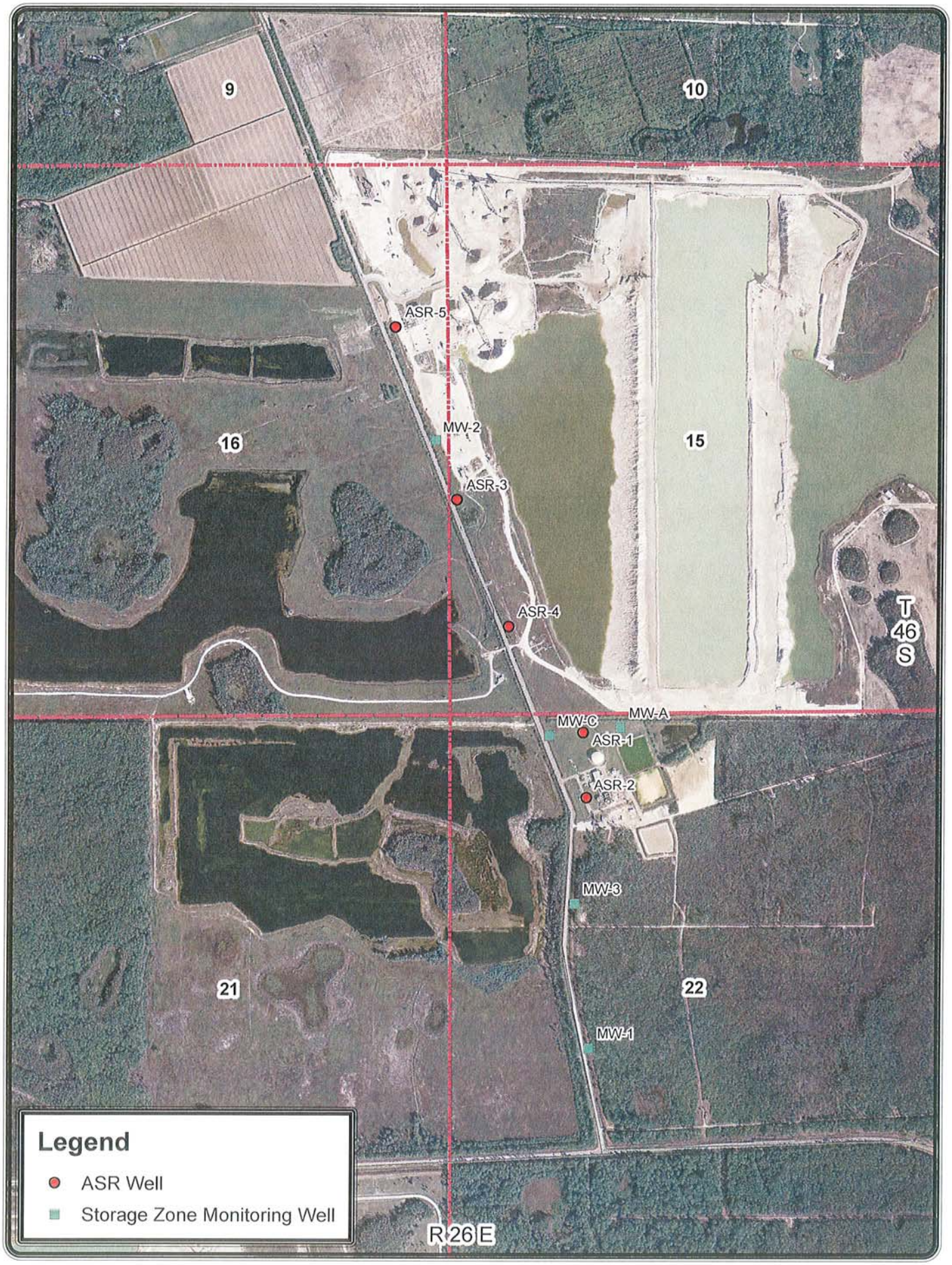


FIGURE 1-2. AERIAL PHOTO SHIOWING LOCATIONS OF ASR AND STORAGE ZONE MONITORING WELLS.

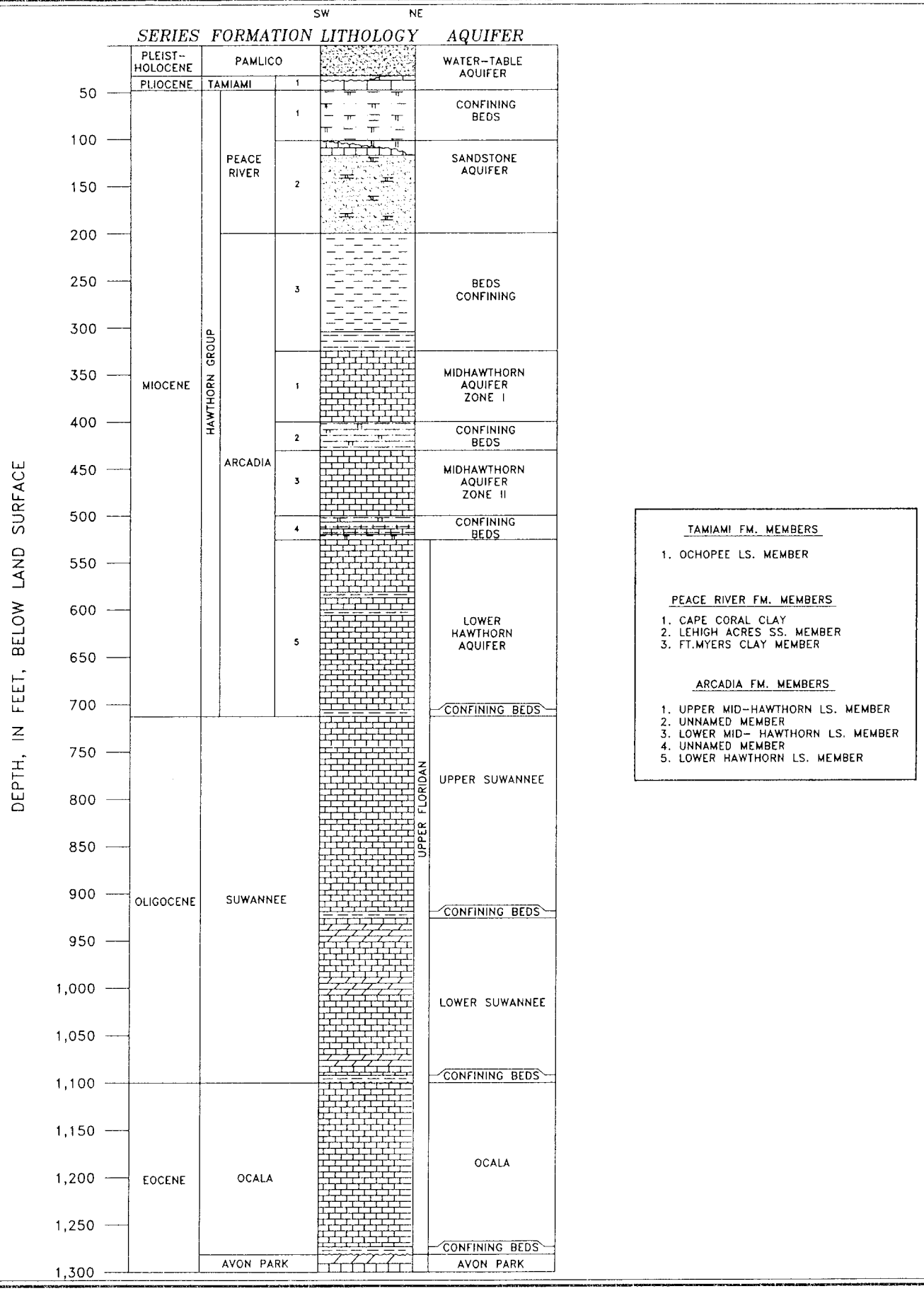


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FIGURE 1-3. GENERALIZED HYDROSTRATIGRAPHIC COLUMN FOR THE CORKSCREW WTP AREA.

The source water which supplies the Corkscrew WTP is from 32 wells completed in the overlying shallow surficial and Sandstone aquifers, as well as two deep brackish water Upper Floridan aquifer wells which are used for blending purposes during peak demand periods.

Through the end of 2006, five complete and one partial (recovery for Cycle 6 has not yet commenced) have been conducted for the Corkscrew ASR system. Each injection-storage-recovery has been conducted under operational conditions. As the injected water moves into the storage zone away from the ASR wells, a zone containing the fresh injected water is created. At the interface between the injected water and the native water in the storage zone a mixing zone is formed. The width of the mixing zone and the amount of mixing that occurs between the two waters is dependent on the hydrogeological characteristics of the selected storage zone, including its thickness, transmissivity, heterogeneity, the thickness of overlying and underlying confining units, and the native water quality. In a storage zone containing relatively fresh water, such as at the Corkscrew site, a recovery efficiency can best be determined by calculating the amount of formation water that has mixed with the injected water. The water quality parameter of total dissolved solids is best used for this purpose for the Corkscrew ASR system. The recovery percentages for the Corkscrew ASR system have increased with each successive cycle, with the last major complete cycle (Cycle 5) for all five ASR wells having a 80% recovery by volume of the injected water.

The Corkscrew ASR wells are each permitted to inject at a maximum rate of 450 gallons per minute (gpm), which is a combined total of 3.24 million gallons per day (MGD). Total volumes injected for Cycles 4, 5, and 6 were 290.3 MG, 116.9 MG, and 316.3 MG respectively. Recovered volumes for Cycles 4 and 5 were 270.9 and 93.4 MG respectively.

The current report provides the operational cycle data collected during Cycles 4 through that portion of Cycle 6 which was performed through the end of 2006.

II. SUMMARY OF CYCLE 4 OPERATIONS FOR THE CORKSCREW ASR SYSTEM

A. Cycle 4 Injection

Cycle 4 injection commenced on July 7, 2004 and continued to January 31, 2005. Approximately 290.3 MG of water was injected. The average TDS concentration of the injected water was 177 milligrams per liter (mg/l). Injection ceased when the potable water demands from the Corkscrew WTP increased to the point that excess water was no longer available to inject into the ASR system. Plots of injection water quality are provided on Figures 2-1 and 2-2.

The injection water quality was monitored on a daily basis by LCU personnel for the parameters shown on Table 2-1. In compliance with the Florida Department of Environmental Protection (FDEP) underground injection control (UIC) permit (#142222-007 through 010-UC) for the system, the injection water quality was sampled on a weekly basis by LCU and the samples were transported to the Lee County Environmental Laboratory (LCEL) for analyses of the additional water quality parameters shown on Table 2-2. Monthly operational reports were provided to the FDEP.

A summary of the range in concentrations for the various injection water quality parameters and a comparison to regulatory criteria is provided on Table 2-3. The injected water met all Primary and Secondary Drinking Water Standards throughout the approximate 7-month injection period.

In addition to monitoring injection water quality, LCU adjusted and controlled the injection rate on a daily basis. During Cycle 4 injection the monthly average day per well injection rate varied between 117 gpm (in ASR-4 in November, 2004) and 384 gpm (in ASR-5 in July, 2004) and averaged 249 gpm per well for the entire injection period. The injection rates were influenced by the availability of finished water from the WTP.

FIGURE 2-1. PLOT OF WATER QUALITY INJECTED INTO THE ASR WELLS DURING CYCLE 4 (PART 1)

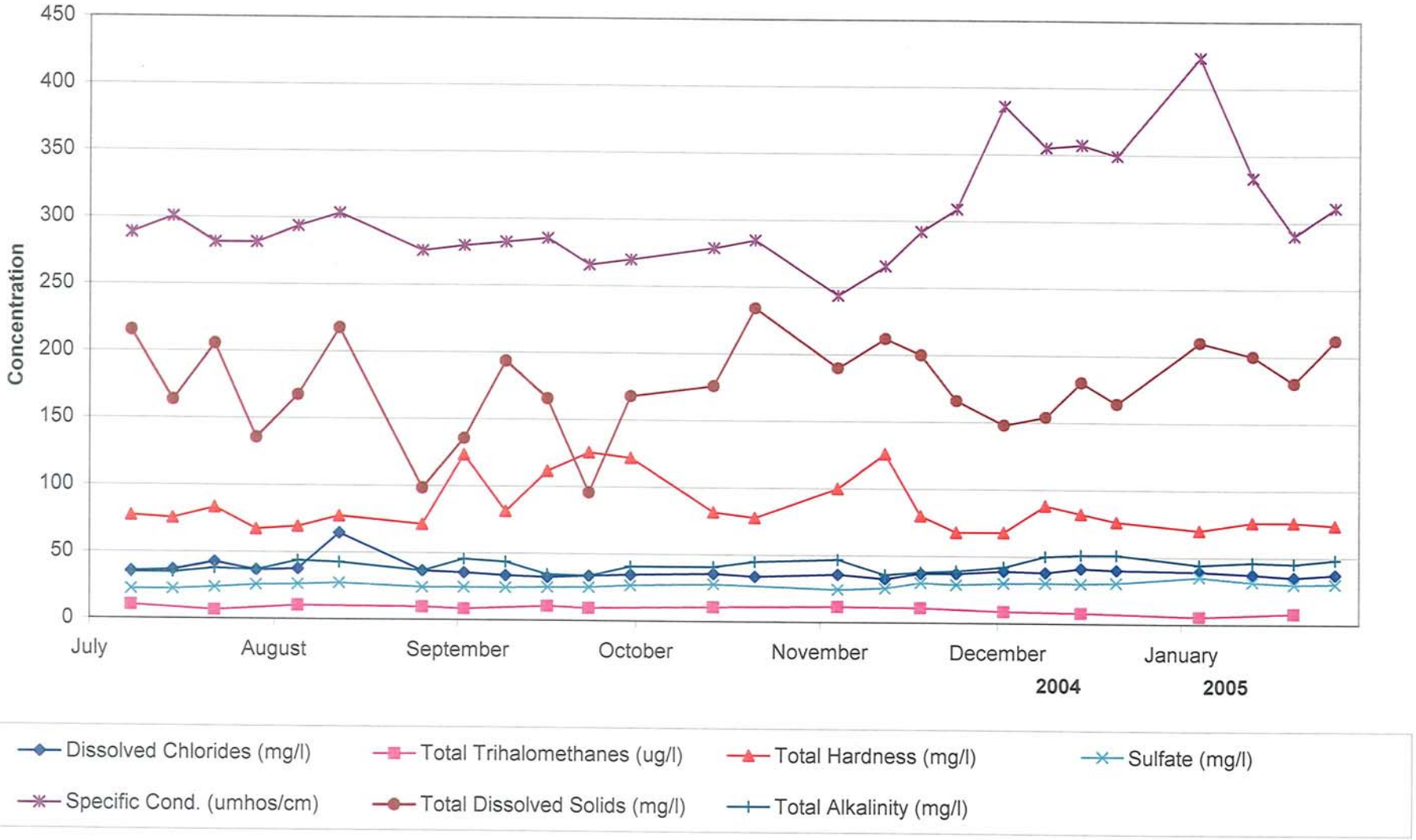


FIGURE 2-2. PLOT OF WATER QUALITY INJECTED INTO ASR WELLS DURING CYCLE 4 (PART 2)

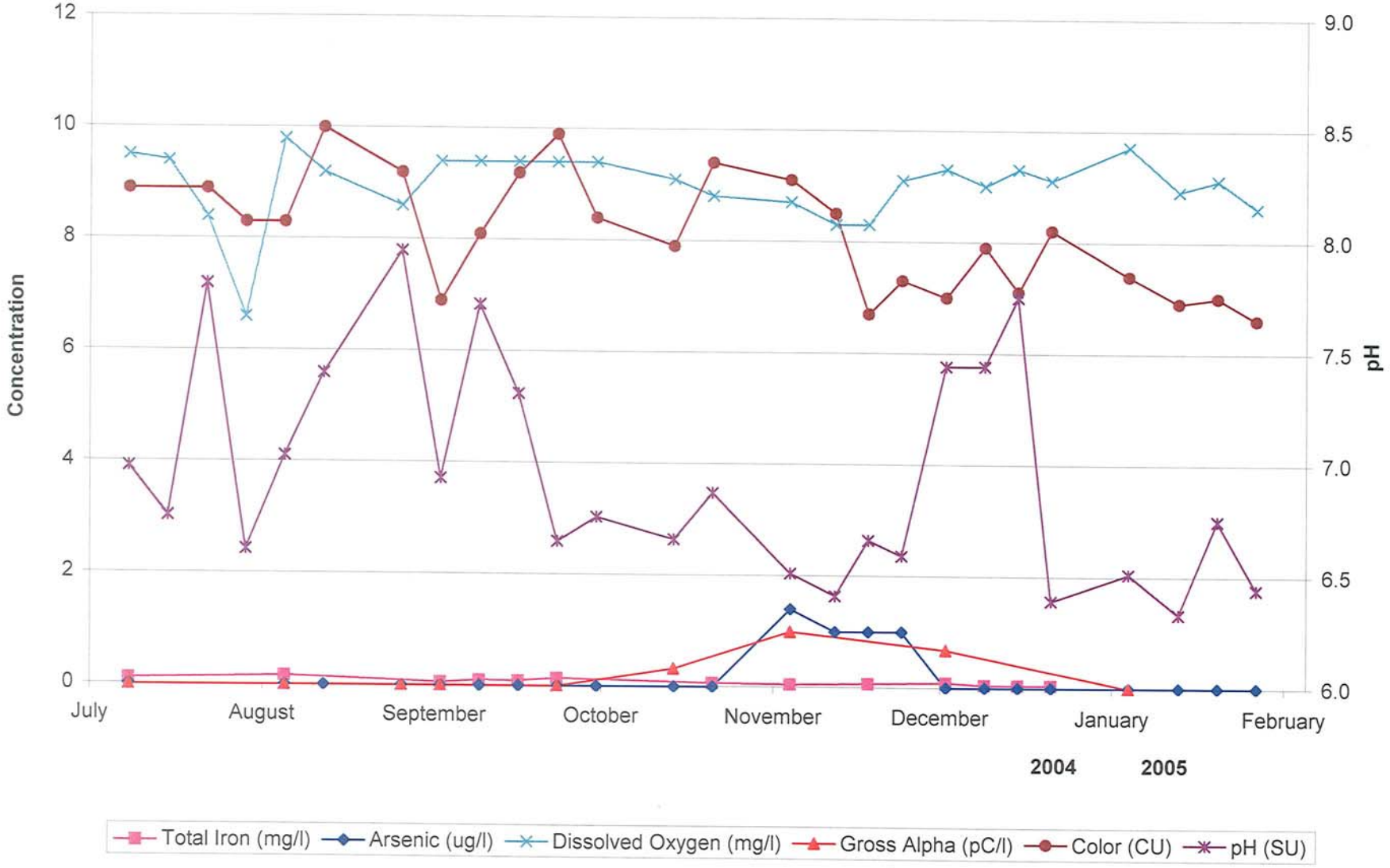


TABLE 2-1

SUMMARY OF FIELD ANALYZED HYDRAULIC AND
WATER QUALITY PARAMETERS
FOR ASR-1 DURING CYCLE 4

Parameter	Analysis Frequency
Injection Pressure (psi)	Daily
Injection/Recovery rate (gpm)	Daily
Total Volume Injected/Recovered (gals)	Daily
Specific Capacity/Injectivity	Weekly
Dissolved Chloride (mg/l)	Daily
Specific Conductance (umhos/cm)	Daily
Temperature (°C)	Daily
Turbidity (NTU)	Daily
Dissolved Oxygen (mg/l)	Weekly
Free Chlorine (mg/l)	Daily
Total Chlorine (mg/l)	Daily
pH (SU)	Daily

TABLE 2-2

SUMMARY OF LABORATORY ANALYZED WATER QUALITY PARAMETERS FOR ASR-1 DURING CYCLE 4

Parameter	Analysis Frequency
Arsenic (ug/l)	Weekly
Total Iron (mg/l)	Weekly
Total Trihalomethanes (mg/l)	Weekly
Total Dissolved Solids (mg/l)	Weekly
Dissolved Chloride (mg/l)	Weekly
Specific Conductance (umhos/cm)	Weekly
Total Alkalinity (mg/l)	Weekly
Sulfate (mg/l)	Weekly
Total Hardness (mg/l)	Weekly
Calcium Hardness (mg/l)	Weekly
Total Color (CU)	Weekly
Gross Alpha (pC/l)	Beginning and End of Injection and Recovery

TABLE 2-3

SUMMARY OF INJECTION WATER QUALITY RANGES
VERSUS REGULATORY CRITERIA DURING CYCLE 4

Parameter	Minimum Concentration	Maximum Concentration	Regulatory Criteria	Units
Total Iron	0.05	0.17	0.3	Mg/l
Total Arsenic	BDL	1.4	10	Ug/l
Total Dissolved Solids	96	264	500*	Mg/l
Total Color	6.7	10.0	15	CU
Sulfate	22.6	34.8	250	Mg/l
Chloride	33	65	250	Mg/l
pH	6.83	7.69	6.5 - 8.5	SU
Gross Alpha	BDL	0.99	15	pC/l
Turbidity	0.01	0.38	N/A	NTU
Total Alkalinity	35	51	N/A	Mg/l
Total Hardness	68	126	N/A	Mg/l
Total Trihalomethanes	5.57	11.90	50	Ug/l

* may be greater if no other maximum contaminant level is exceeded

BDL = below detection limit

Injection rates and pressures are shown on Figures 2-3 through 2-7. In order to maintain adequate injection rates and injection pressures, a pH adjustment system was utilized and adjusted on a daily basis by LCU personnel. This system uses carbonic acid to lower the pH of the finished water from the Corkscrew WTP.

Potentiometric water levels in the five storage zone observation wells were monitored on a daily basis. Water samples were obtained from the five storage zone observation wells on a weekly basis and analyzed for those parameters shown on Tables 2-4 and 2-5. An annotated plot of potentiometric water levels for the five storage zone observation wells for the entire Cycle 4 injection/storage/recovery period is provided as Figure 2-8. Plots of water quality parameters for each of the storage zone observation wells C, 2, and 3 for the entire Cycle 4 injection/storage/recovery period are provided as Figure 2-9 through 2-14. Na water quality was monitored in storage zone observation wells A and 1 during this cycle. The progressive improvement in water quality in these wells during injection into the ASR system and the similar progressive decline in water quality during recovery from ASR system are apparent on these graphs.

FIGURE 2-3. PLOT OF INJECTION PRESSURE, RATE, AND CUMULATIVE VOLUME INJECTED INTO ASR WELL 1 DURING CYCLE 4

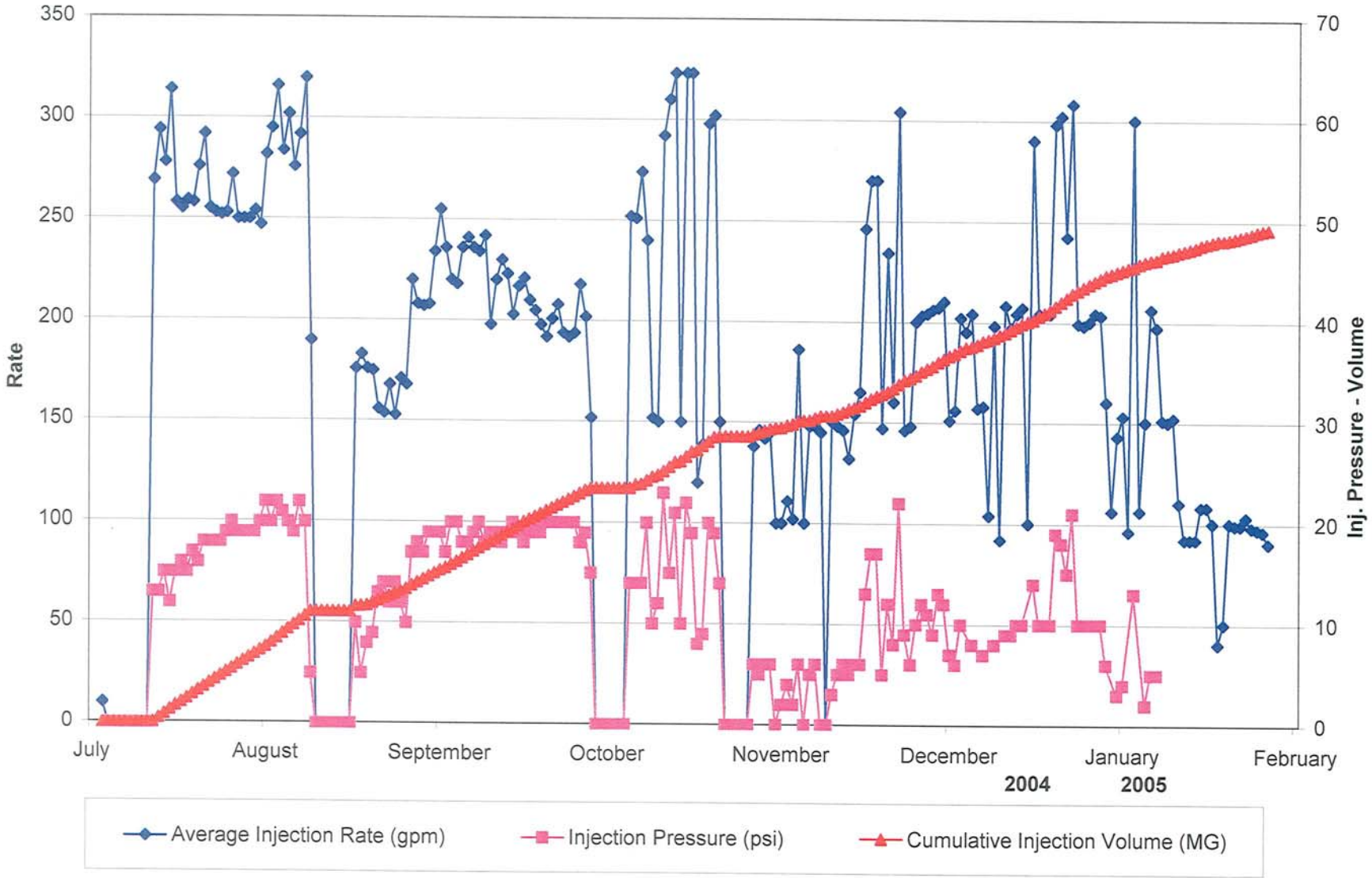


FIGURE 2-4. PLOT OF INJECTION PRESSURE, RATE, AND CUMULATIVE VOLUME INJECTED INTO ASR WELL 2 DURING CYCLE 4

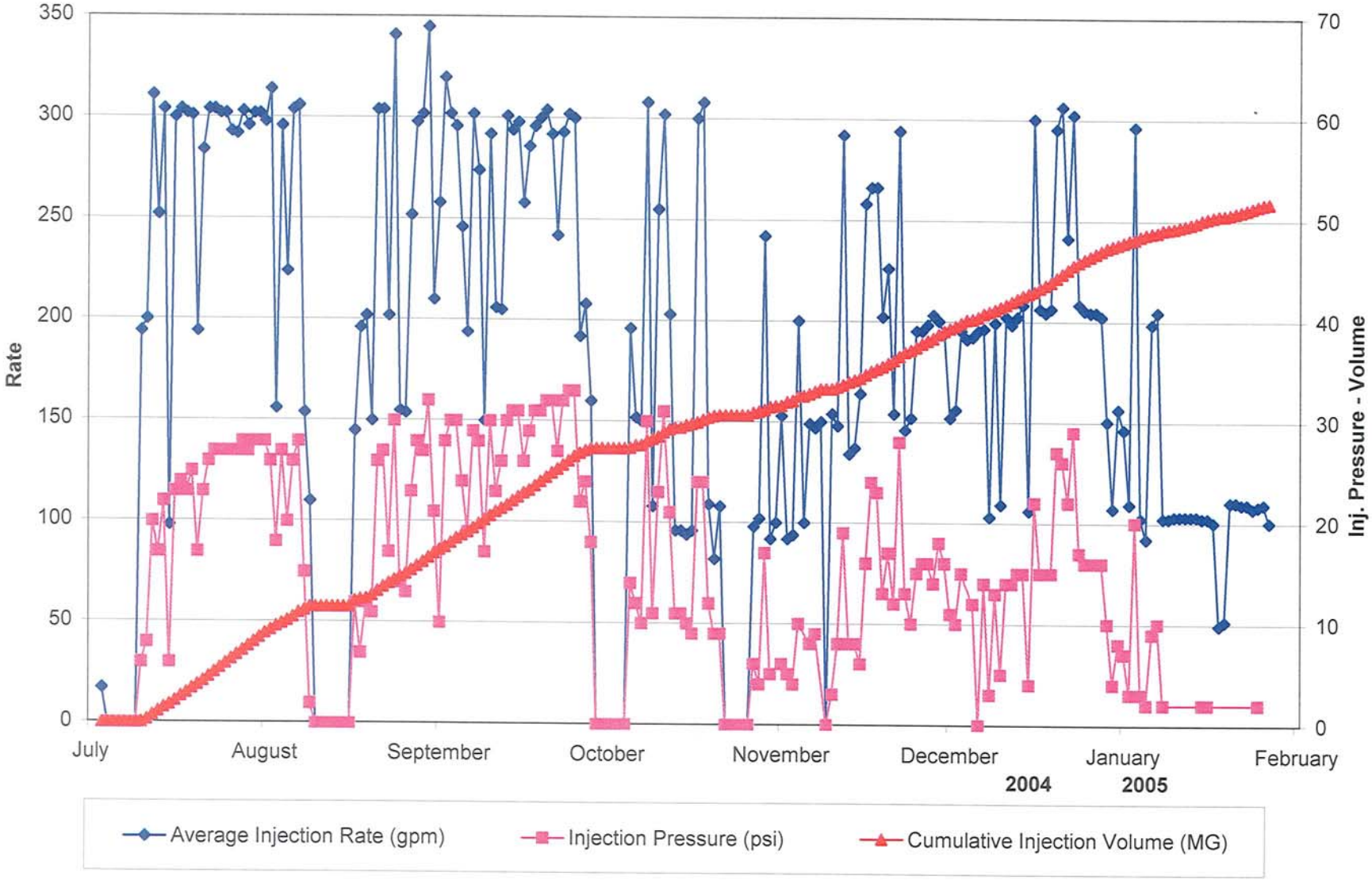


FIGURE 2-5. PLOT OF INJECTION PRESSURE, RATE, AND CUMULATIVE VOLUME INJECTED INTO ASR WELL 3 DURING CYCLE 4

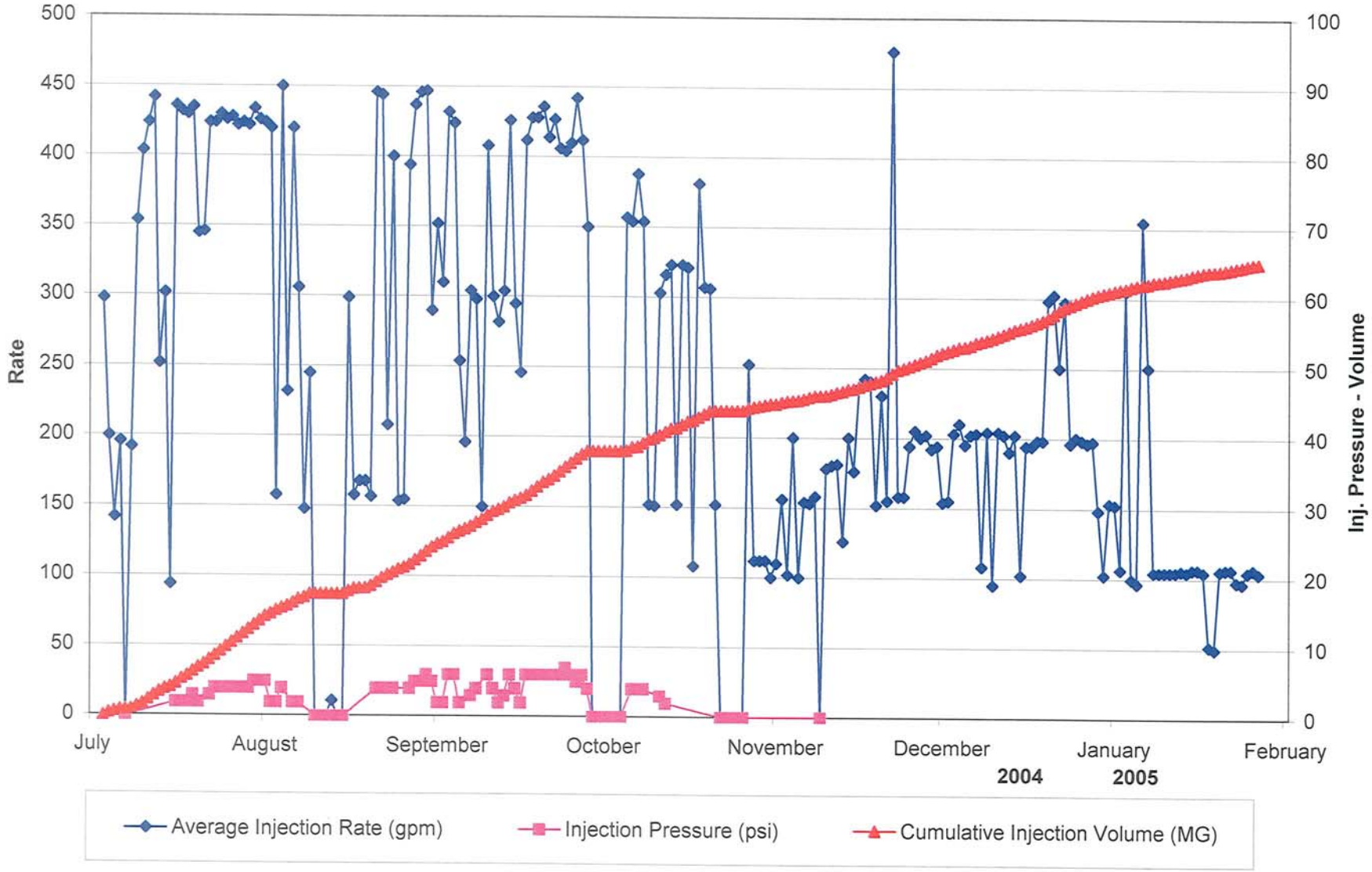


FIGURE 2-6. PLOT OF INJECTION PRESSURE, RATE, AND CUMULATIVE VOLUME INJECTED INTO ASR WELL 4 DURING CYCLE 4

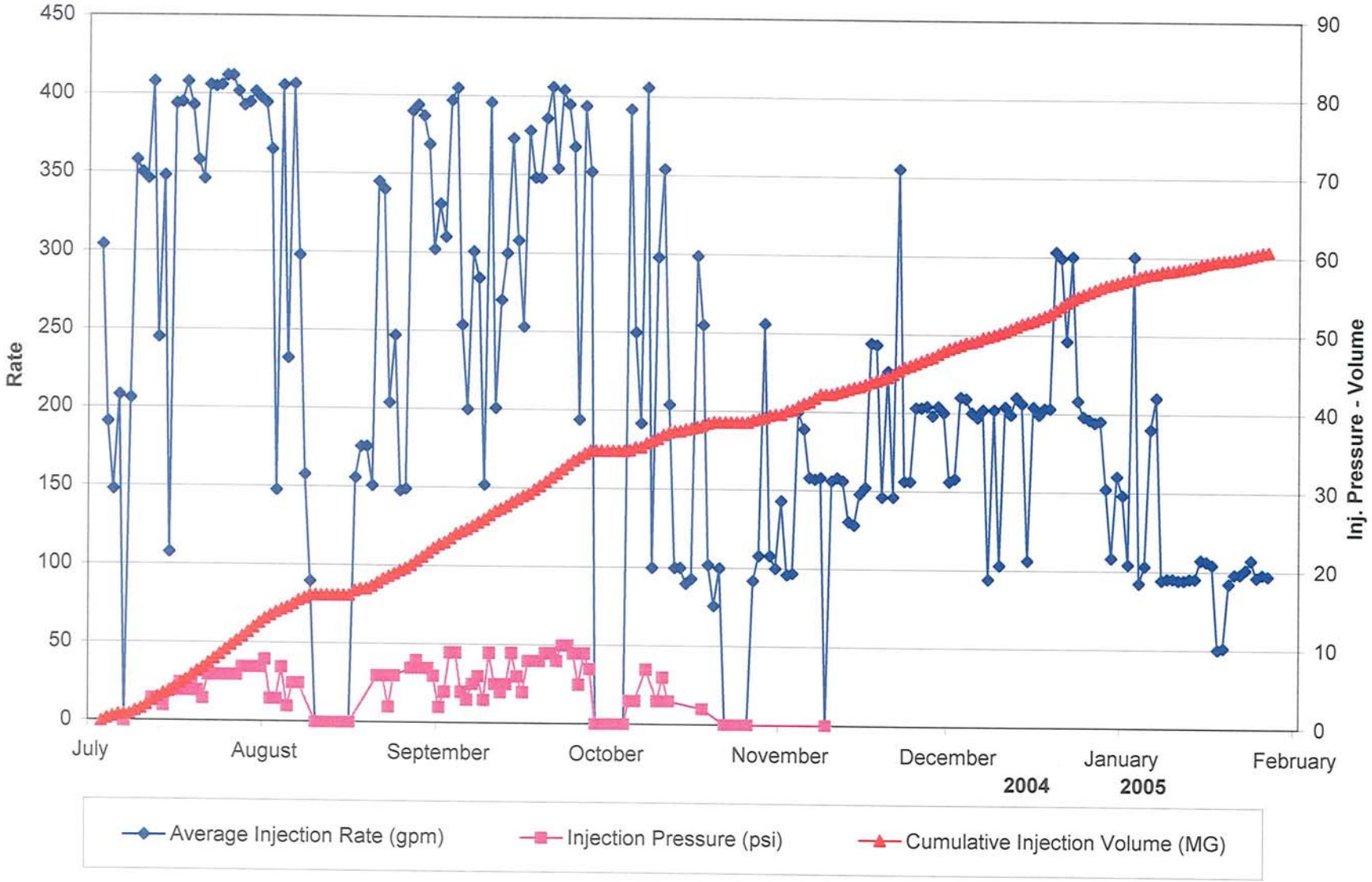


FIGURE 2-7. PLOT OF INJECTION PRESSURE, RATE, AND CUMULATIVE VOLUME INJECTED INTO ASR WELL 5 DURING CYCLE 4

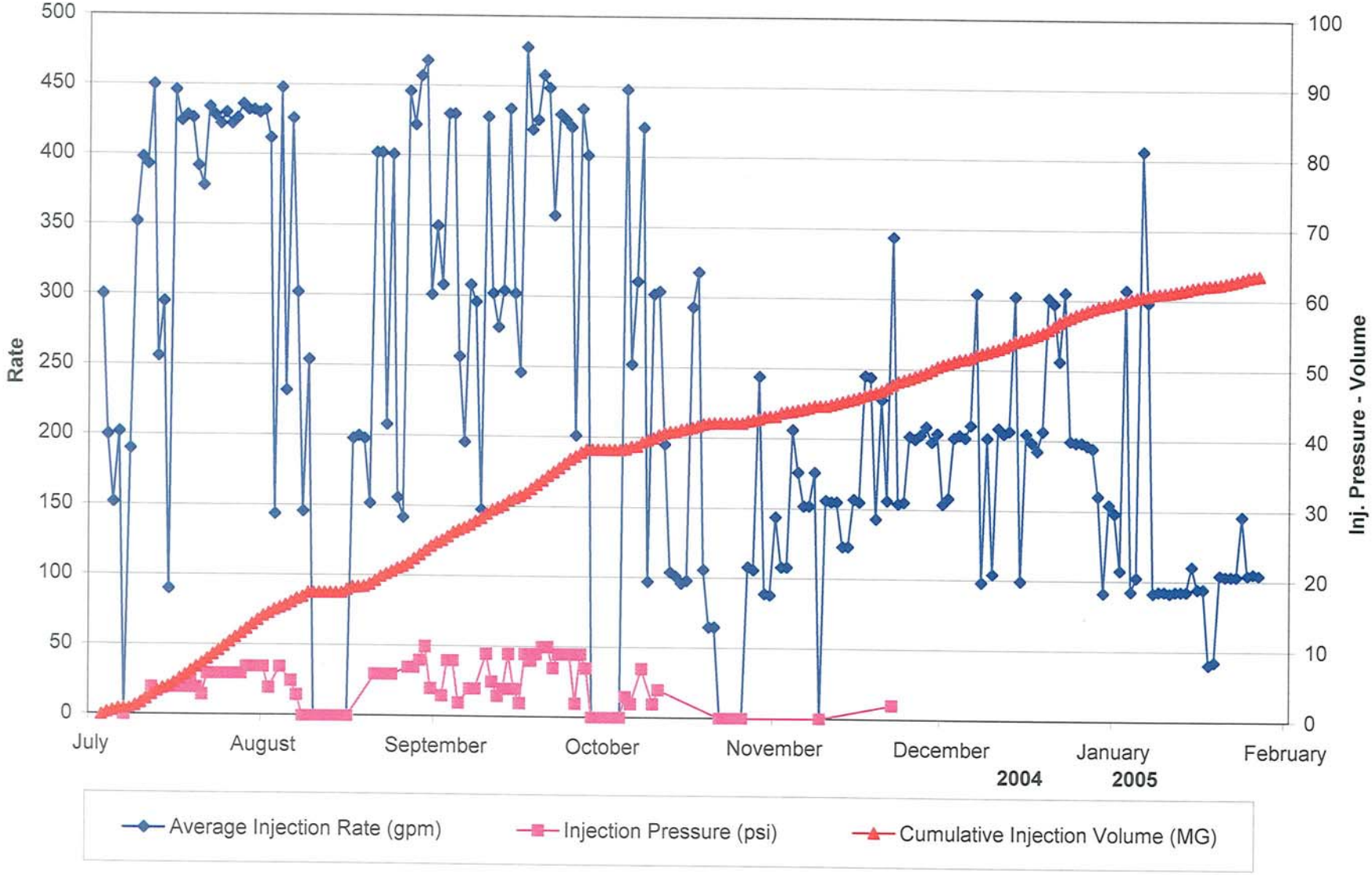


TABLE 2-4

SUMMARY OF FIELD ANALYZED HYDRAULIC AND
WATER QUALITY PARAMETERS
FOR MW-A, MW-C, AND SZMW-1 THROUGH 3 DURING CYCLE 4

Parameter	Analysis Frequency
Potentiometric Pressure (psi)	Daily
Dissolved Chloride (mg/l)	Weekly
Specific Conductance (umhos/cm)	Weekly
Temperature (°C)	Weekly
Turbidity (NTU)	Weekly
Dissolved Oxygen (mg/l)	Weekly
Free Chlorine (mg/l)	Weekly
Total Chlorine (mg/l)	Weekly
pH (SU)	Weekly

TABLE 2-5

SUMMARY OF LABORATORY ANALYZED WATER QUALITY
PARAMETERS FOR MW-A, MW-C, AND SZMW-1 THROUGH -3 DURING CYCLE 4

Parameter	Analysis Frequency
Arsenic (ug/l)	Weekly
Total Iron (mg/l)	Weekly
Total Trihalomethanes (mg/l)	Weekly
Total Dissolved Solids (mg/l)	Weekly
Dissolved Chloride (mg/l)	Weekly
Specific Conductance (umhos/cm)	Weekly
Total Alkalinity (mg/l)	Weekly
Sulfate (mg/l)	Weekly
Total Hardness (mg/l)	Weekly
Calcium Hardness (mg/l)	Weekly
Total Color (CU)	Weekly
Gross Alpha (pC/l)	Monthly

FIGURE 2-8. PLOT OF DAILY WATER LEVELS IN STORAGE ZONE OBSERVATION WELLS DURING CYCLE 4

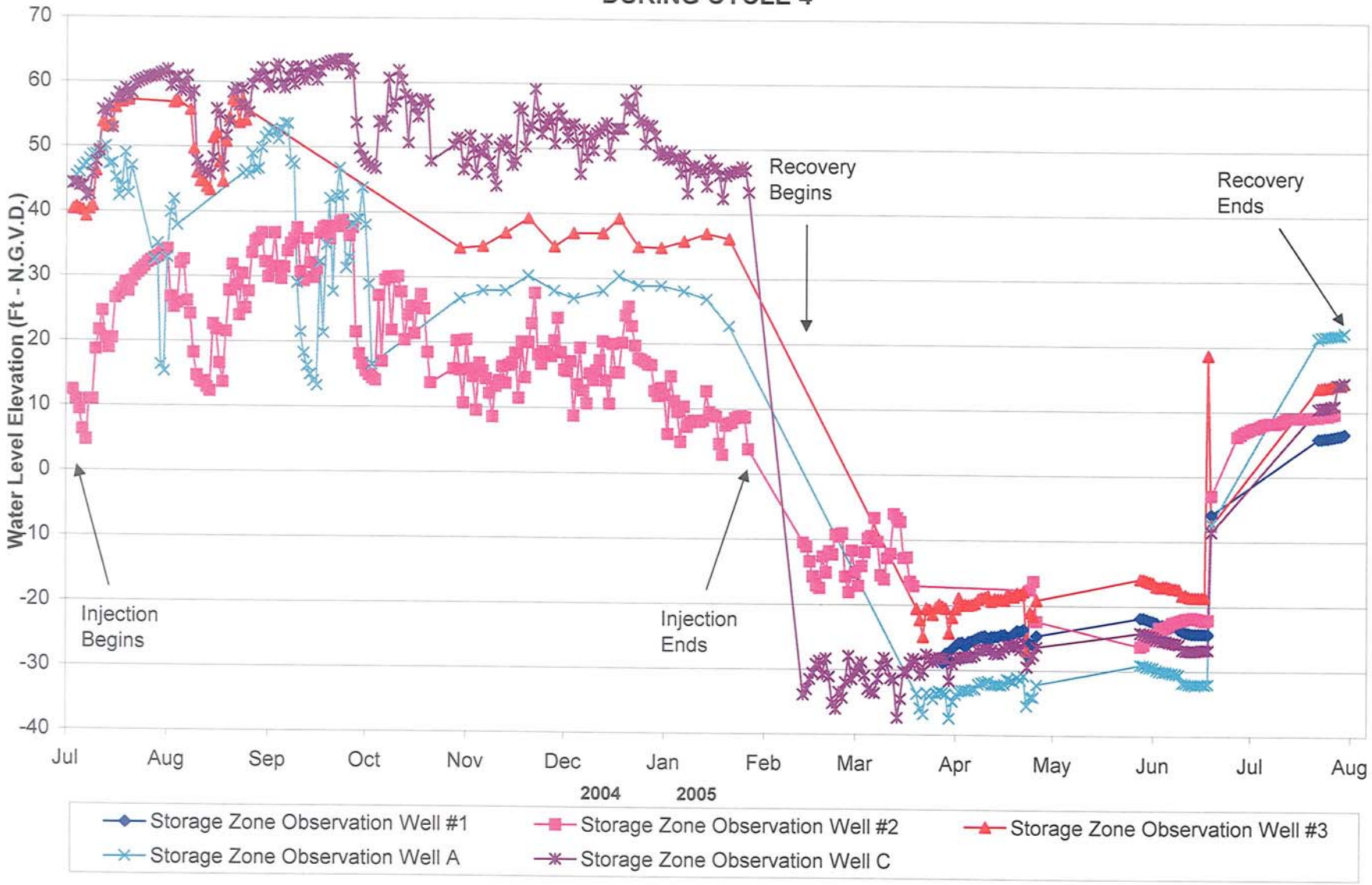


FIGURE 2-9. PLOT OF WATER QUALITY IN STORAGE ZONE OBSERVATION WELL C DURING CYCLE 4 (PART 1)

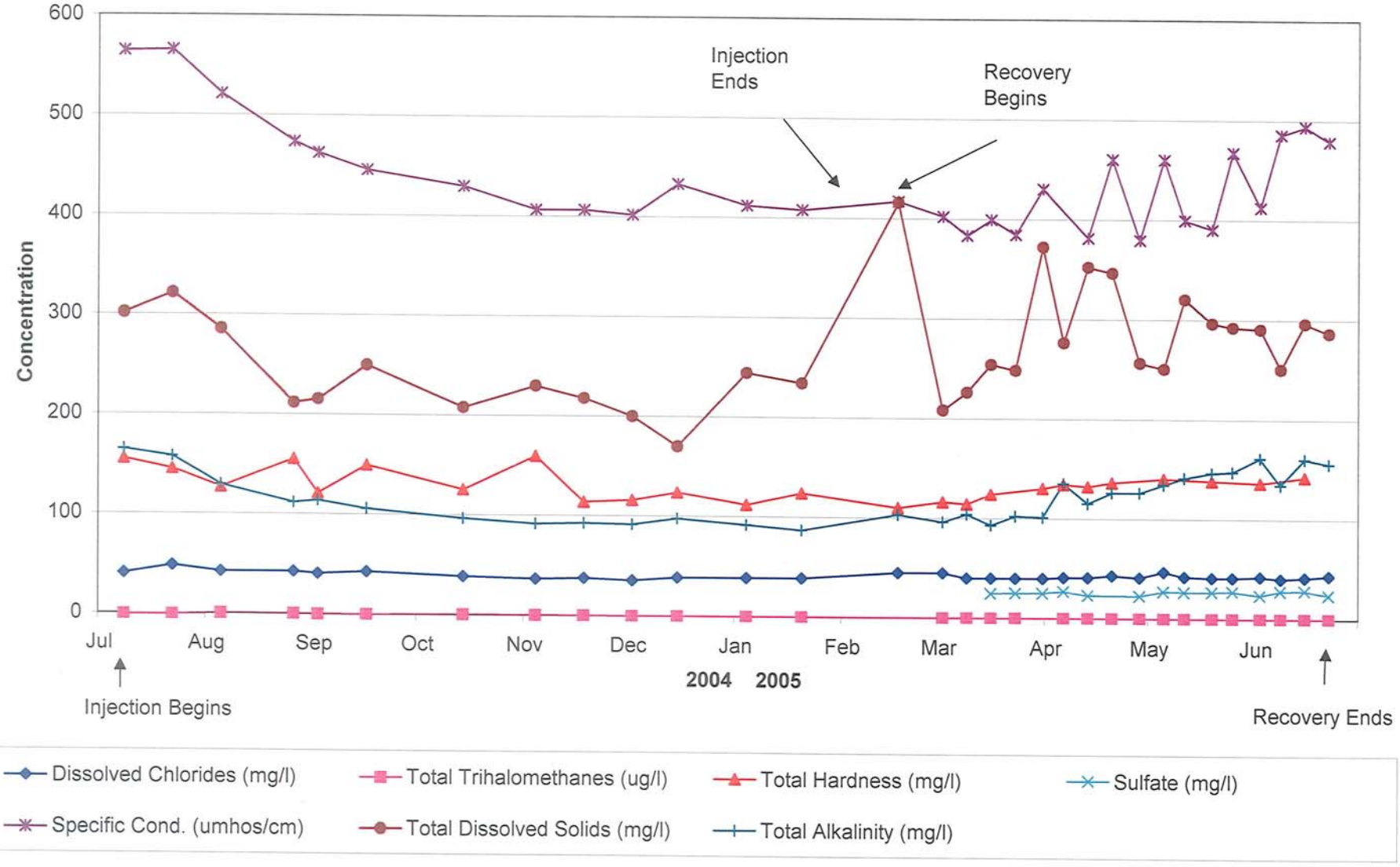


FIGURE 2-10. PLOT OF WATER QUALITY IN STORAGE ZONE OBSERVATION WELL C DURING CYCLE 4 (PART 2)

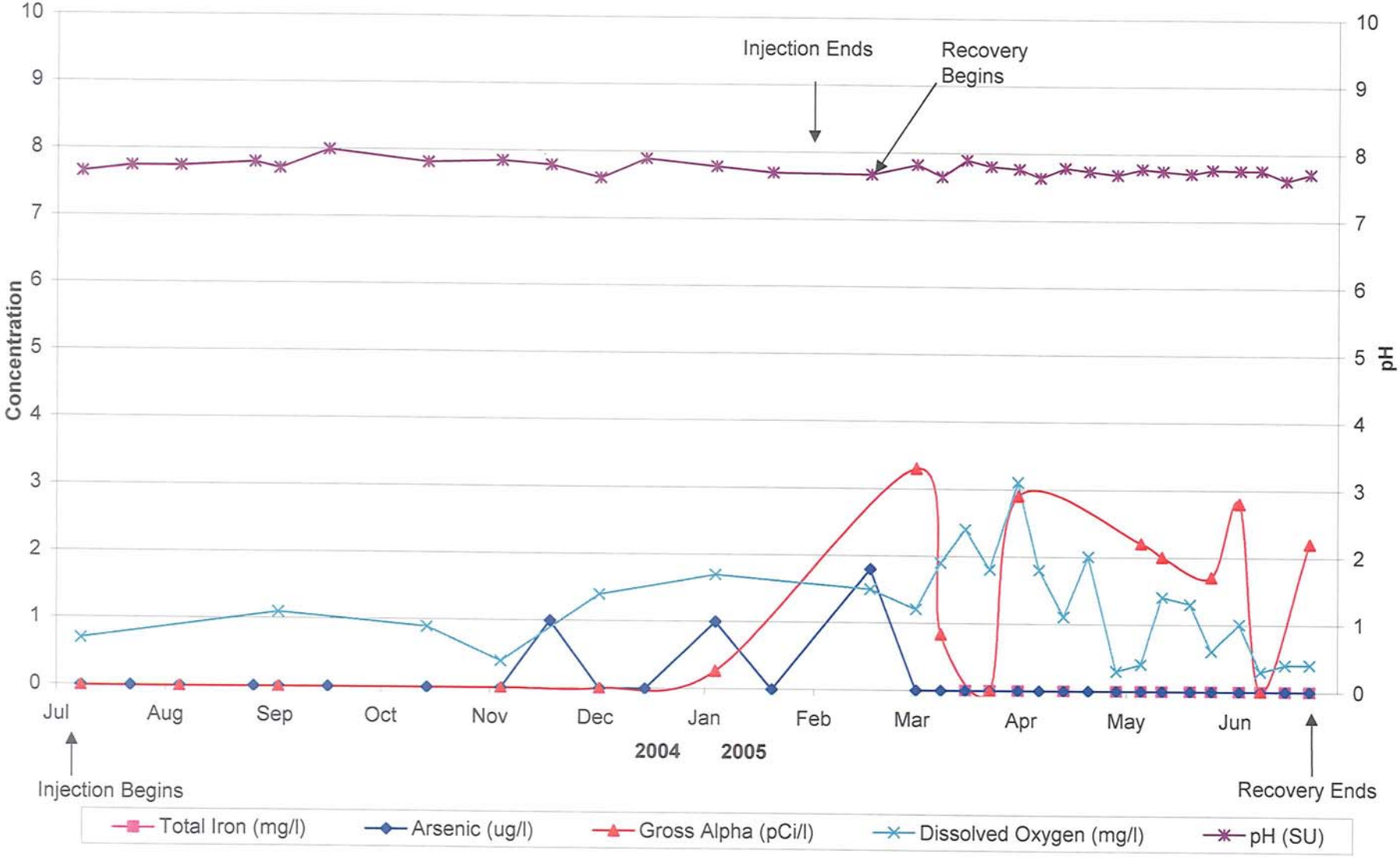


FIGURE 2-11. PLOT OF WATER QUALITY IN STORAGE ZONE OBSERVATION WELL 2 DURING CYCLE 4 (PART 1)

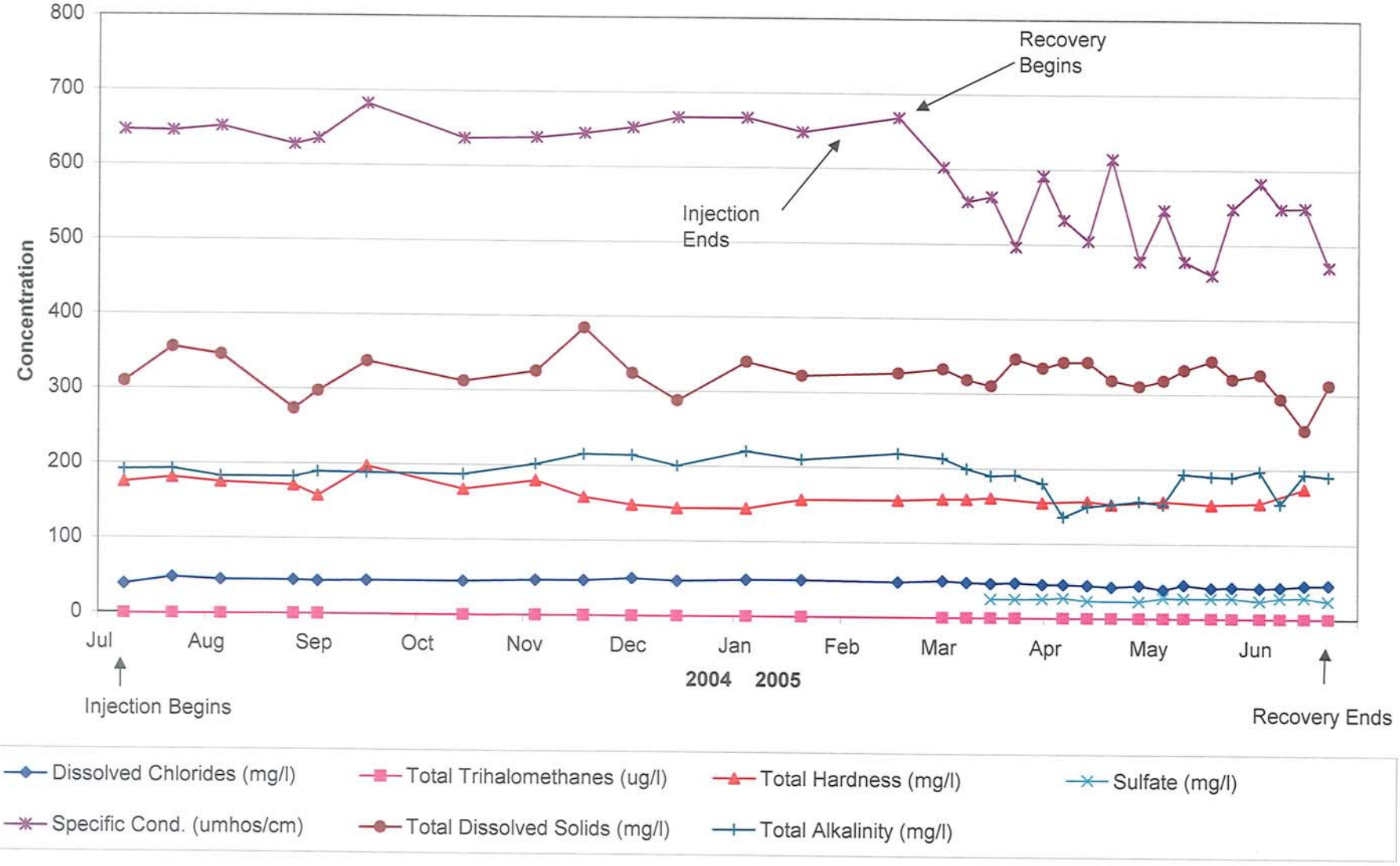


FIGURE 2-12. PLOT OF WATER QUALITY IN STORAGE ZONE OBSERVATION WELL 2 DURING CYCLE 4 (PART 2)

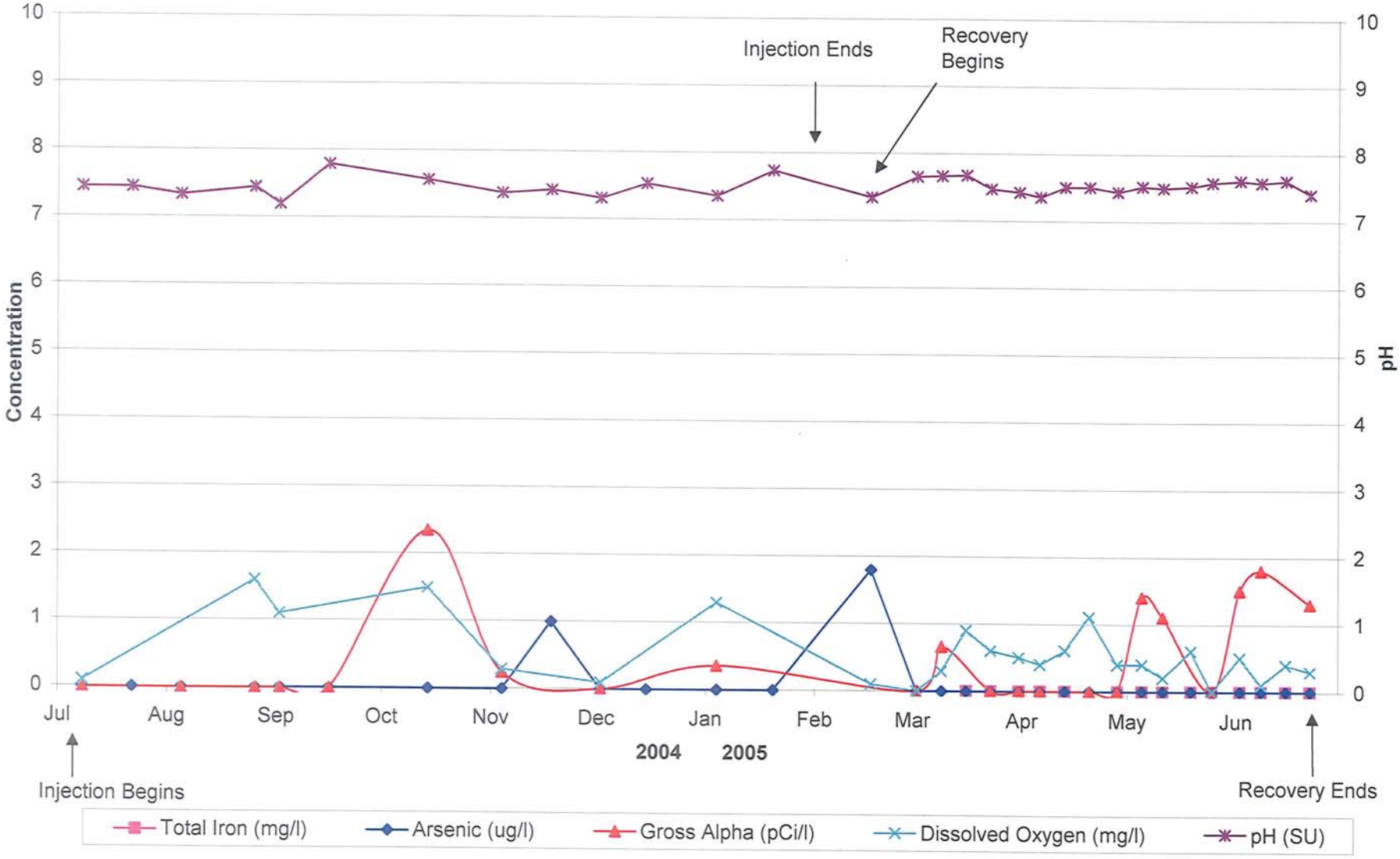


FIGURE 2-13. PLOT OF WATER QUALITY IN STORAGE ZONE OBSERVATION WELL 3 DURING CYCLE 4 (PART 1)

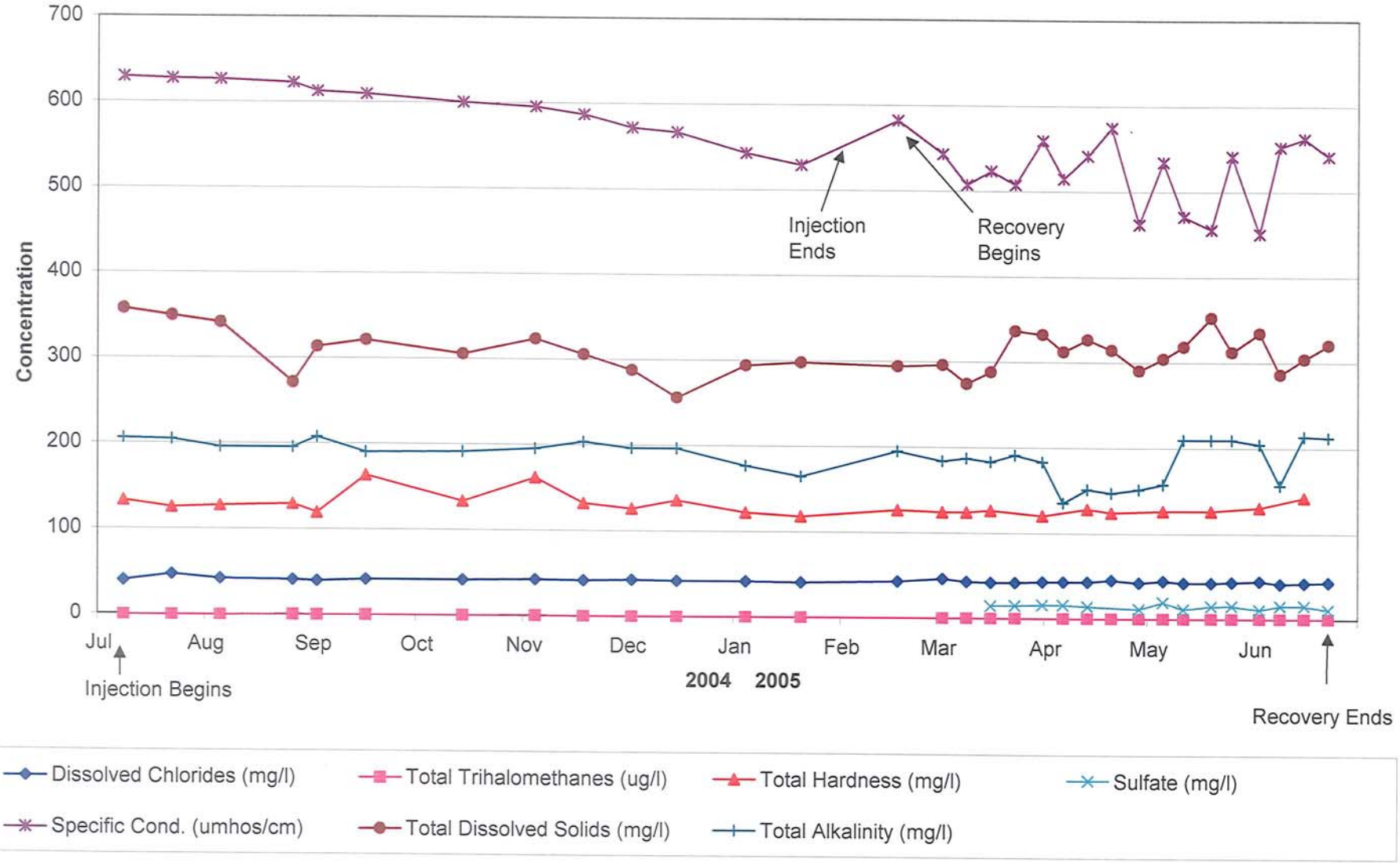
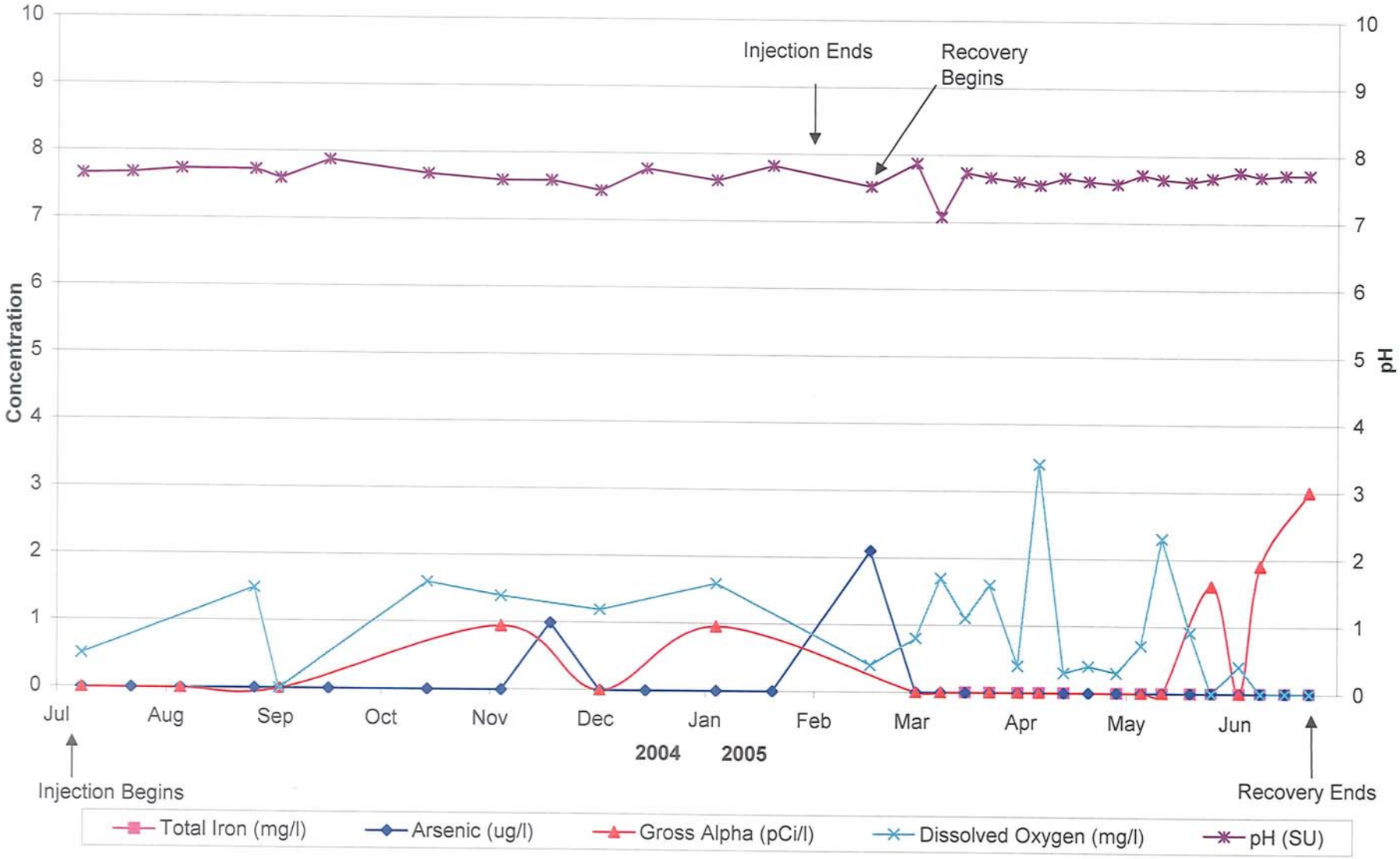


FIGURE 2-14. PLOT OF WATER QUALITY IN STORAGE ZONE OBSERVATION WELL 3 DURING CYCLE 4 (PART 2)



B. Cycle 4 Storage

Cycle 4 storage commenced on February 1, 2005 and continued until February 16, 2005. Therefore, the storage duration was for approximately 0.5 months. During this period water quality sampling of the five storage zone observation wells was suspended.

C. Cycle 4 Recovery

Cycle 4 recovery commenced from the Corkscrew ASR system on February 16, 2005. Recovery continued until June 23, 2005. By which time, the TDS concentration of the recovered water reached 344 mg/l. Plots of recovered water quality are provided on Figures 2-15 through 2-24.

A total of 270.9 MG of water was recovered. This represents approximately 93% of the injected volume. A plot of TDS concentrations in the recovered water versus percent and volume of injected water recovered are provided as Figures 2-25 and 2-26 respectively.

The recovered water quality was monitored on a daily basis by Corkscrew WTP personnel for the same parameters shown on Table 2-1. In compliance with the Florida Department of Environmental Protection (FDEP) underground injection control (UIC) permit (#142222-007 through -010-UC), the recovered water quality was sampled on a weekly basis by Corkscrew WTP personnel and the samples were transported to the Lee County Environmental Laboratory (LCEL) for analyses of the additional water quality parameters shown on Table 2-2.

A summary of the range in concentrations for the various recovered water quality parameters and a comparison to regulatory criteria is provided on Table 2-6. The recovered water met all Primary and Secondary Drinking Water Standards throughout the approximate 4-month recovery period, including arsenic, which had a maximum analyzed value of 9.2 ug/l.

Arsenic concentrations in the recovered water in previous cycles had exceeded the regulatory criteria of 10 micrograms per liter (ug/l). During Cycle 3 a maximum arsenic concentration of 19.0 ug/l was recorded. However, because the recovered water is blended with water from the Corkscrew WTP before entering the distribution system and the distribution system water quality is monitored as it exits the WTP site, there is no

FIGURE 2-15. PLOT OF RECOVERED WATER QUALITY FROM WELL ASR-1 DURING CYCLE 4 (PART 1)

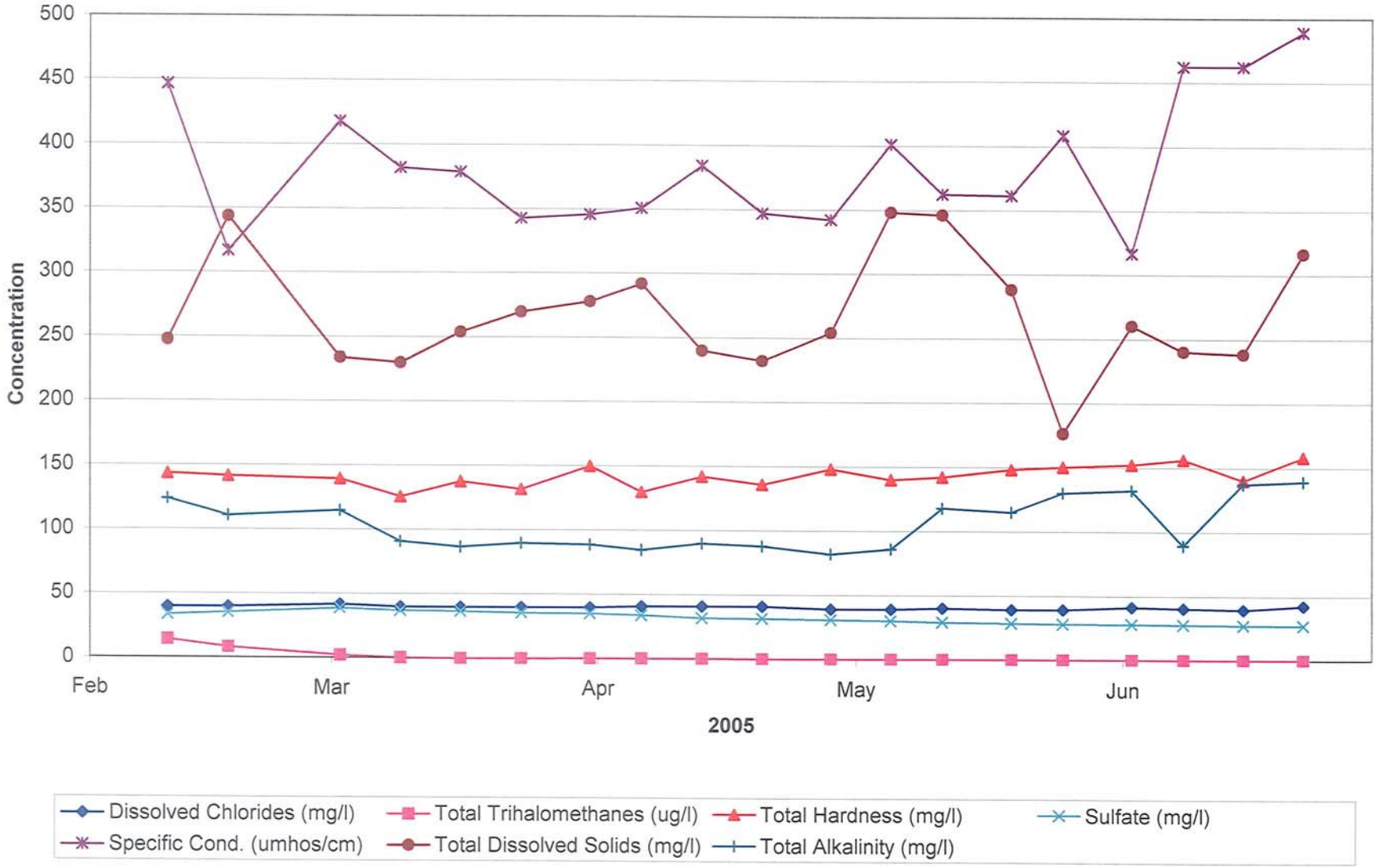


FIGURE 2-16. PLOT OF RECOVERED WATER QUALITY FROM WELL ASR-1 DURING CYCLE 4 (PART 2)

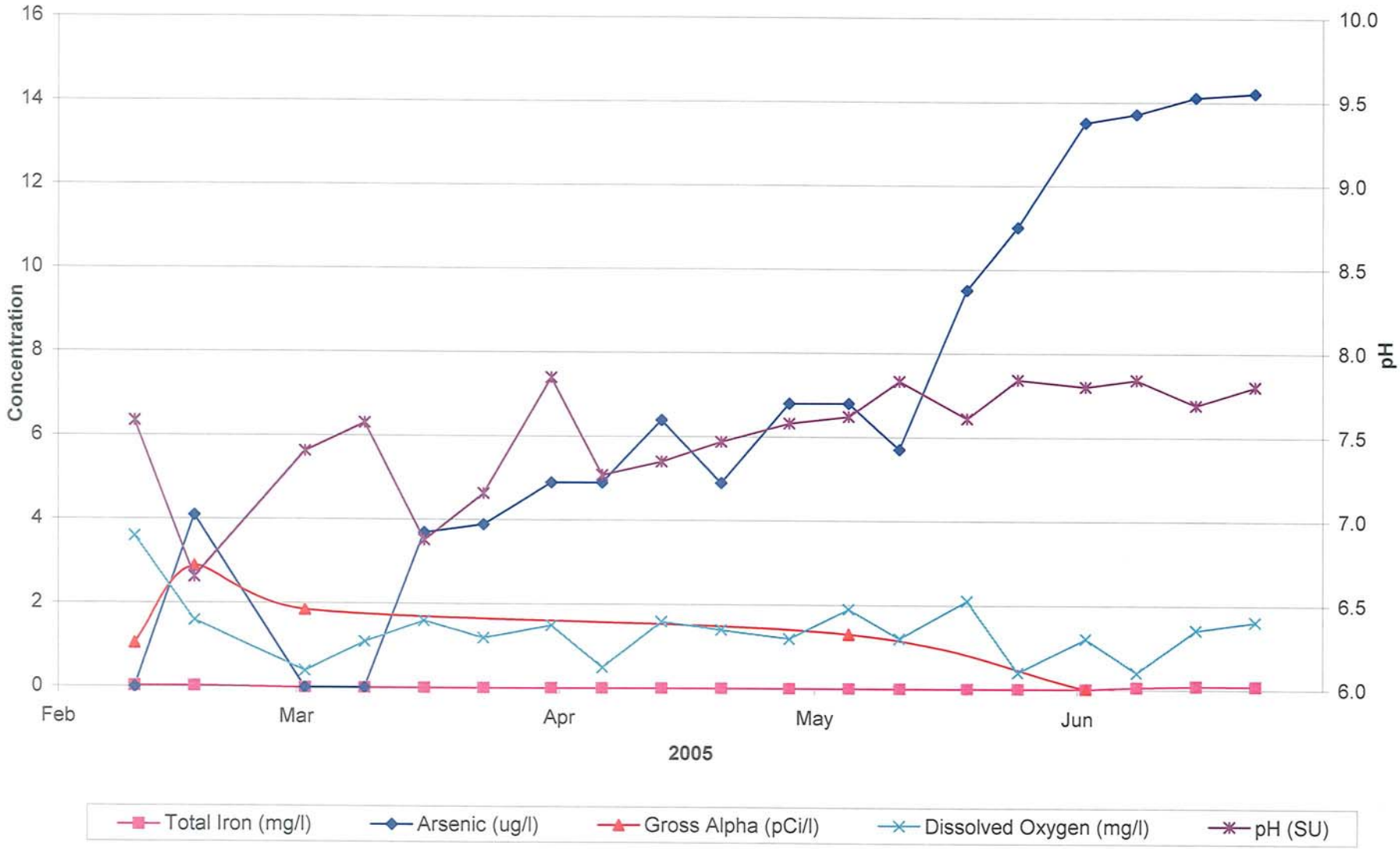


FIGURE 2-17. PLOT OF RECOVERED WATER QUALITY FROM WELL ASR-2 DURING CYCLE 4 (PART 1)

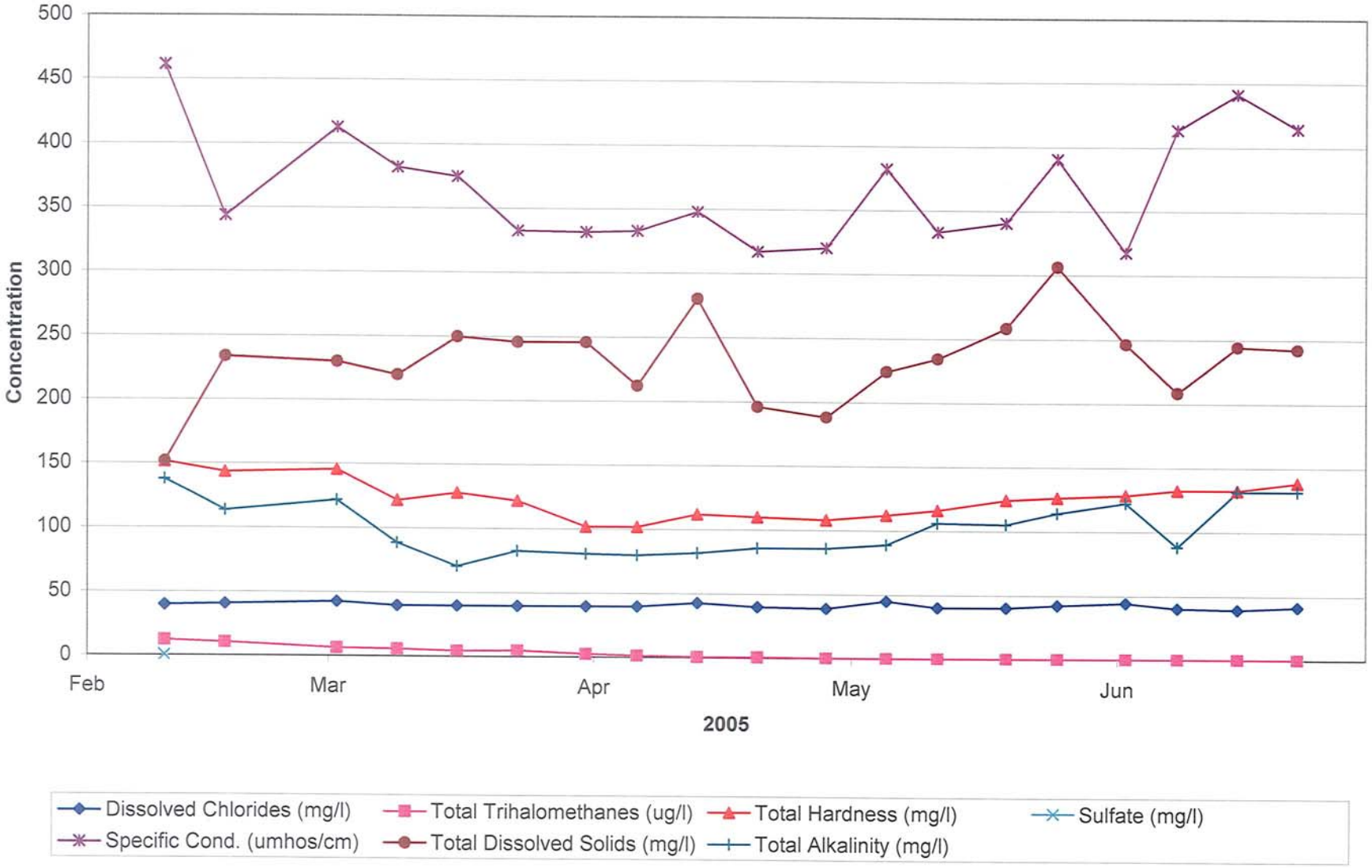


FIGURE 2-18. PLOT OF RECOVERED WATER QUALITY FROM WELL ASR-2 DURING CYCLE 4 (PART 2)

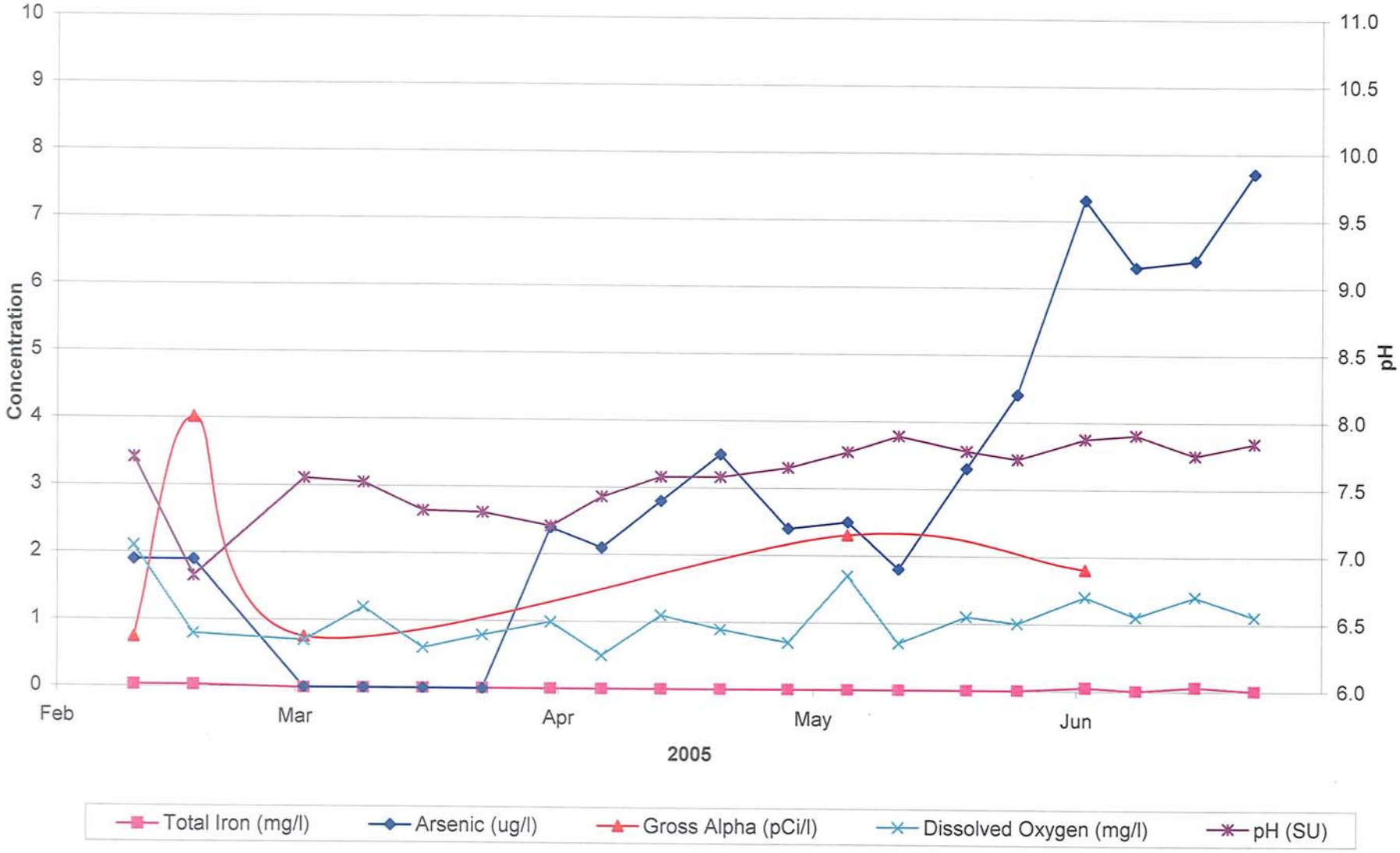


FIGURE 2-19. PLOT OF RECOVERED WATER QUALITY FROM WELL ASR-3 DURING CYCLE 4 (PART 1)

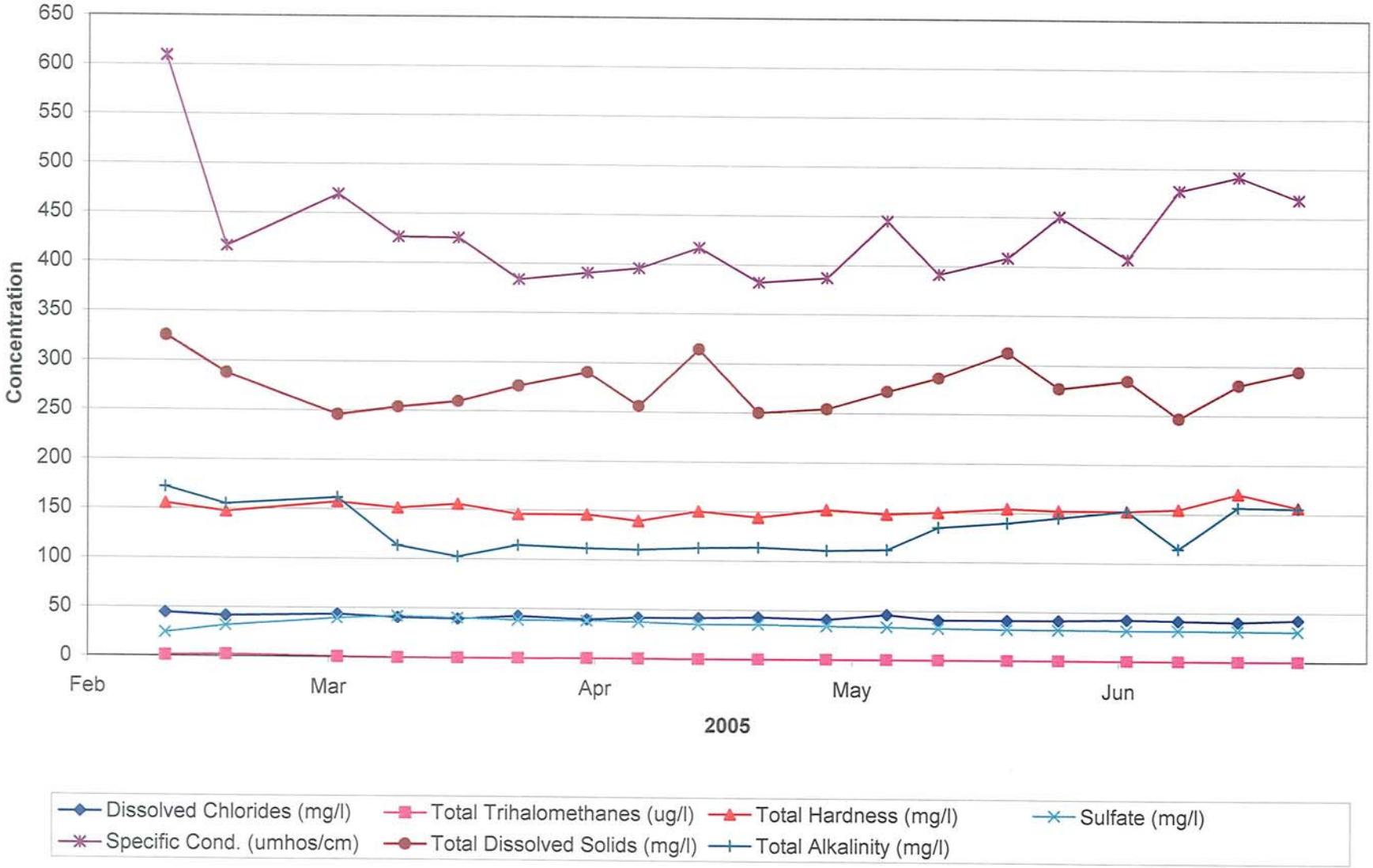


FIGURE 2-20. PLOT OF RECOVERED WATER QUALITY FROM WELL ASR-3 DURING CYCLE 4 (PART 2)

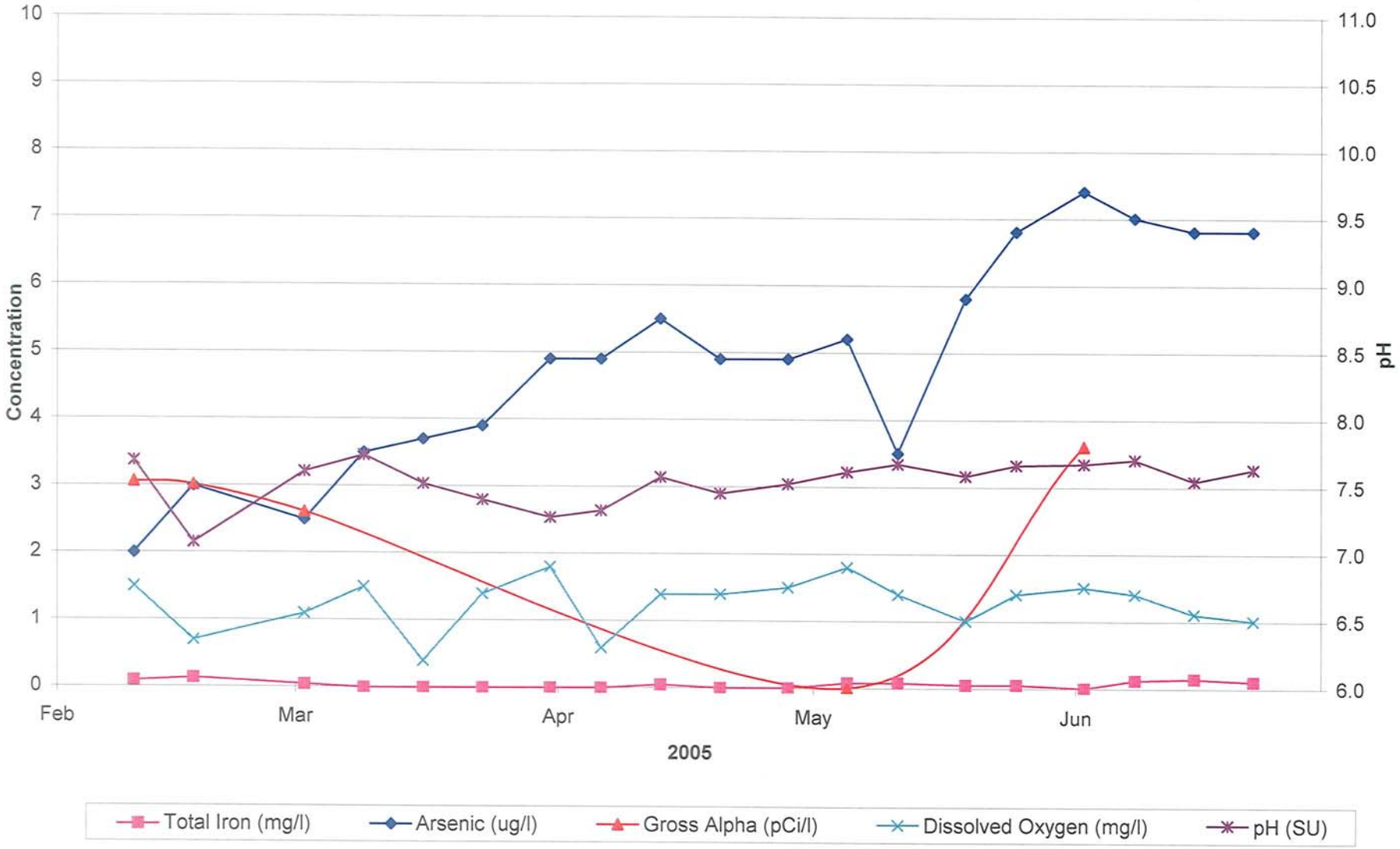


FIGURE 2-21. PLOT OF RECOVERED WATER QUALITY FROM WELL ASR-4 DURING CYCLE 4 (PART 1)

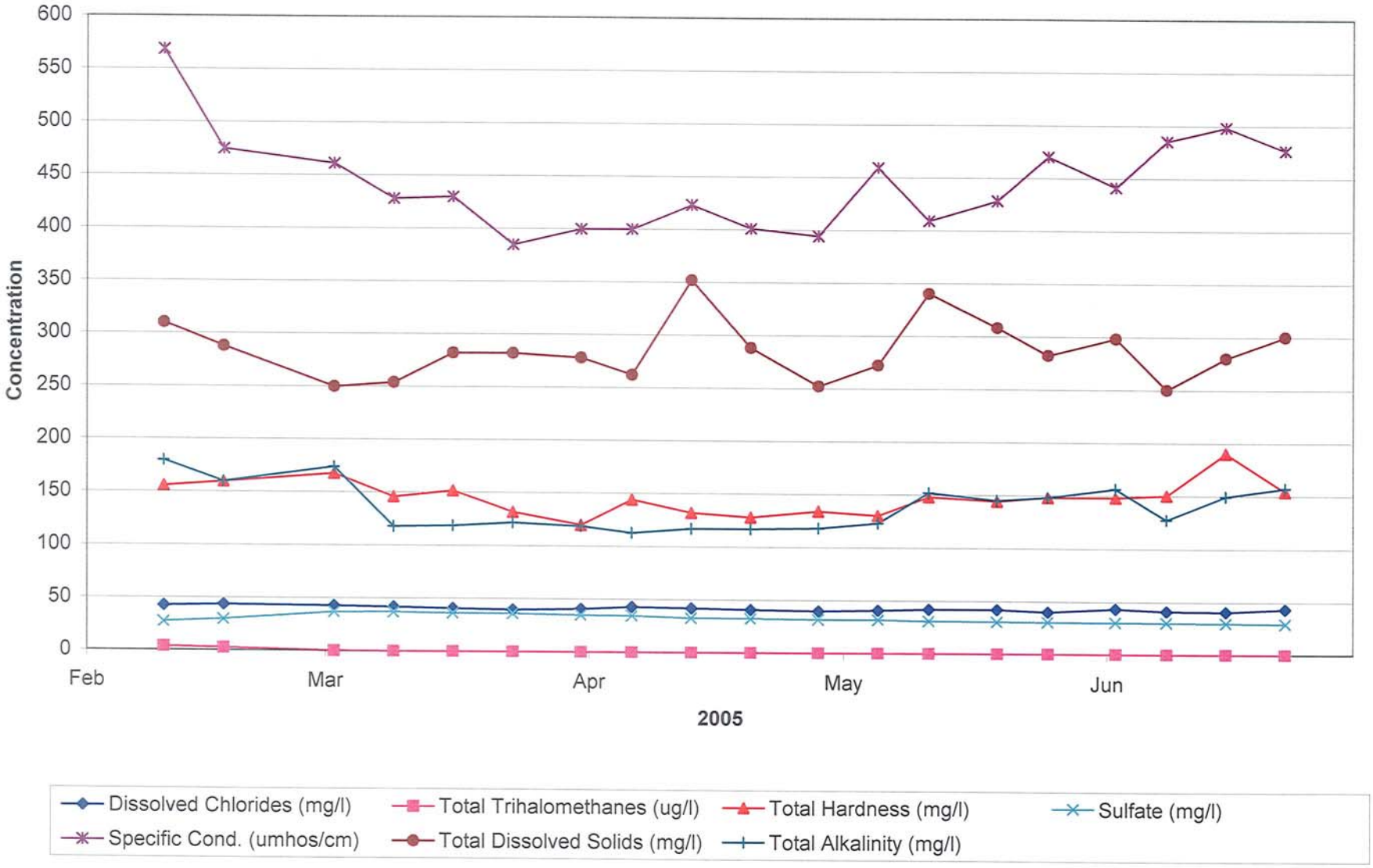


FIGURE 2-22. PLOT OF RECOVERED WATER QUALITY FROM WELL ASR-4 DURING CYCLE 4 (PART 2)

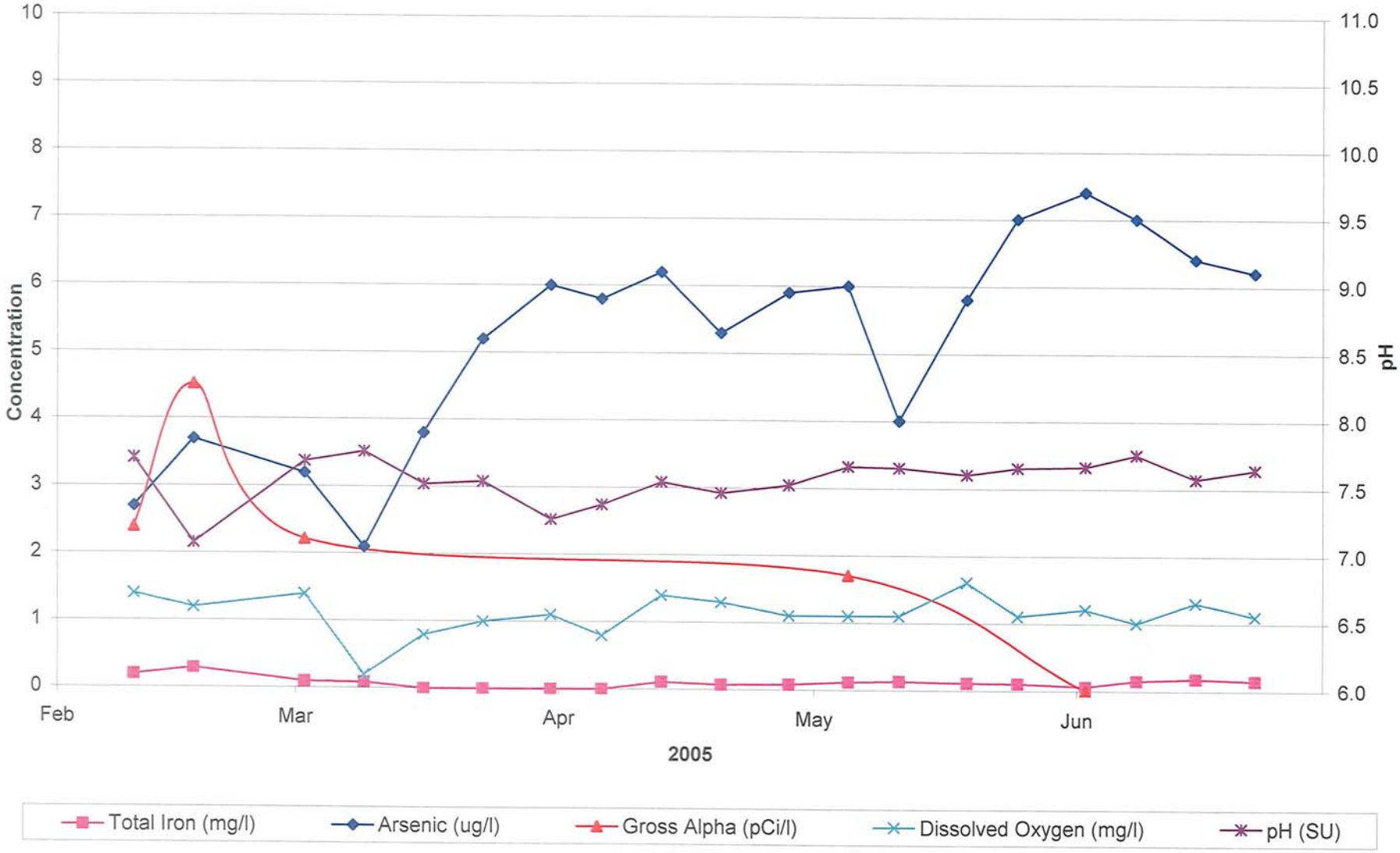


FIGURE 2-23. PLOT OF RECOVERED WATER QUALITY FROM WELL ASR-5 DURING CYCLE 4 (PART 1)

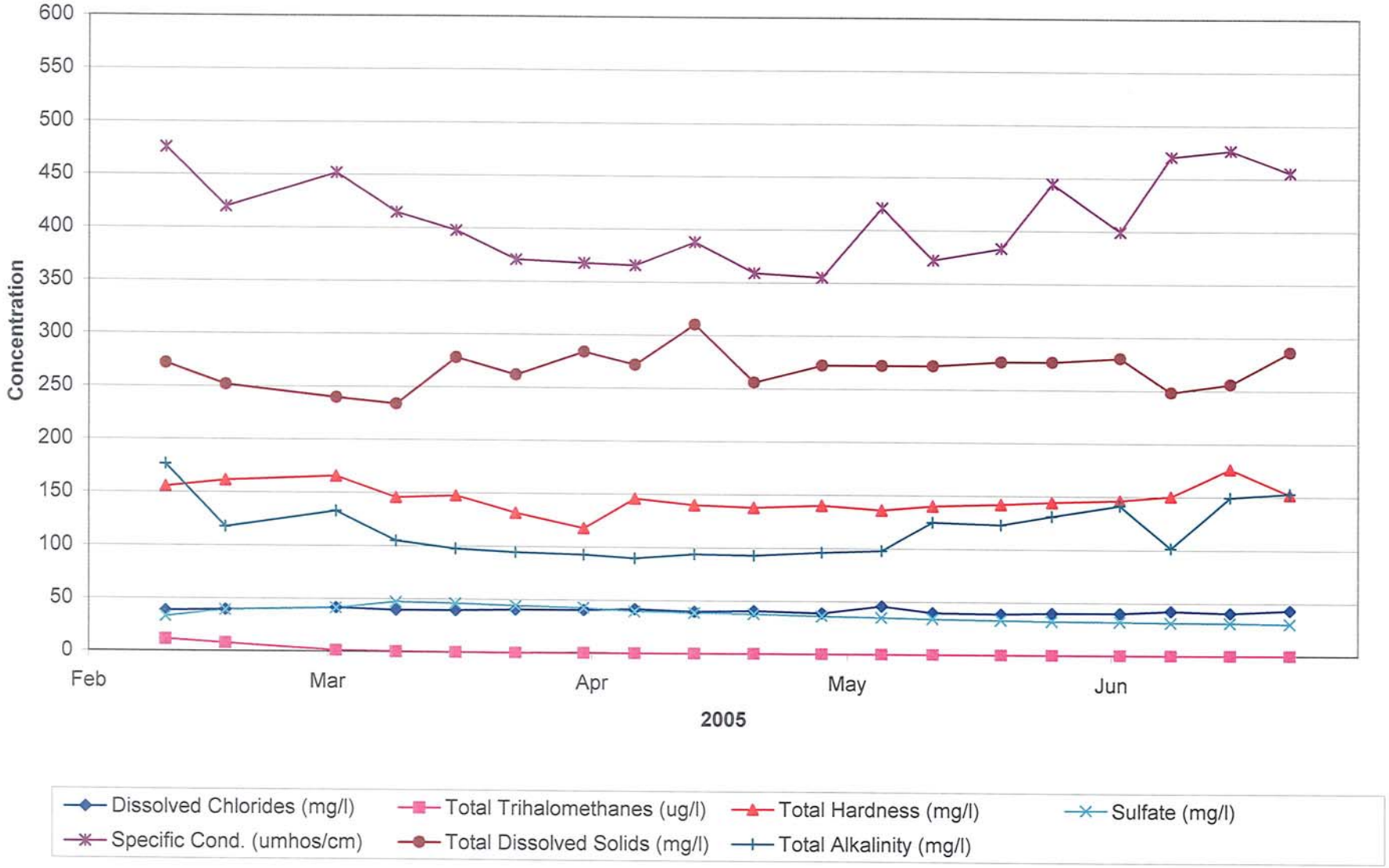


FIGURE 2-24. PLOT OF RECOVERED WATER QUALITY FROM WELL ASR-5 DURING CYCLE 4 (PART 2)

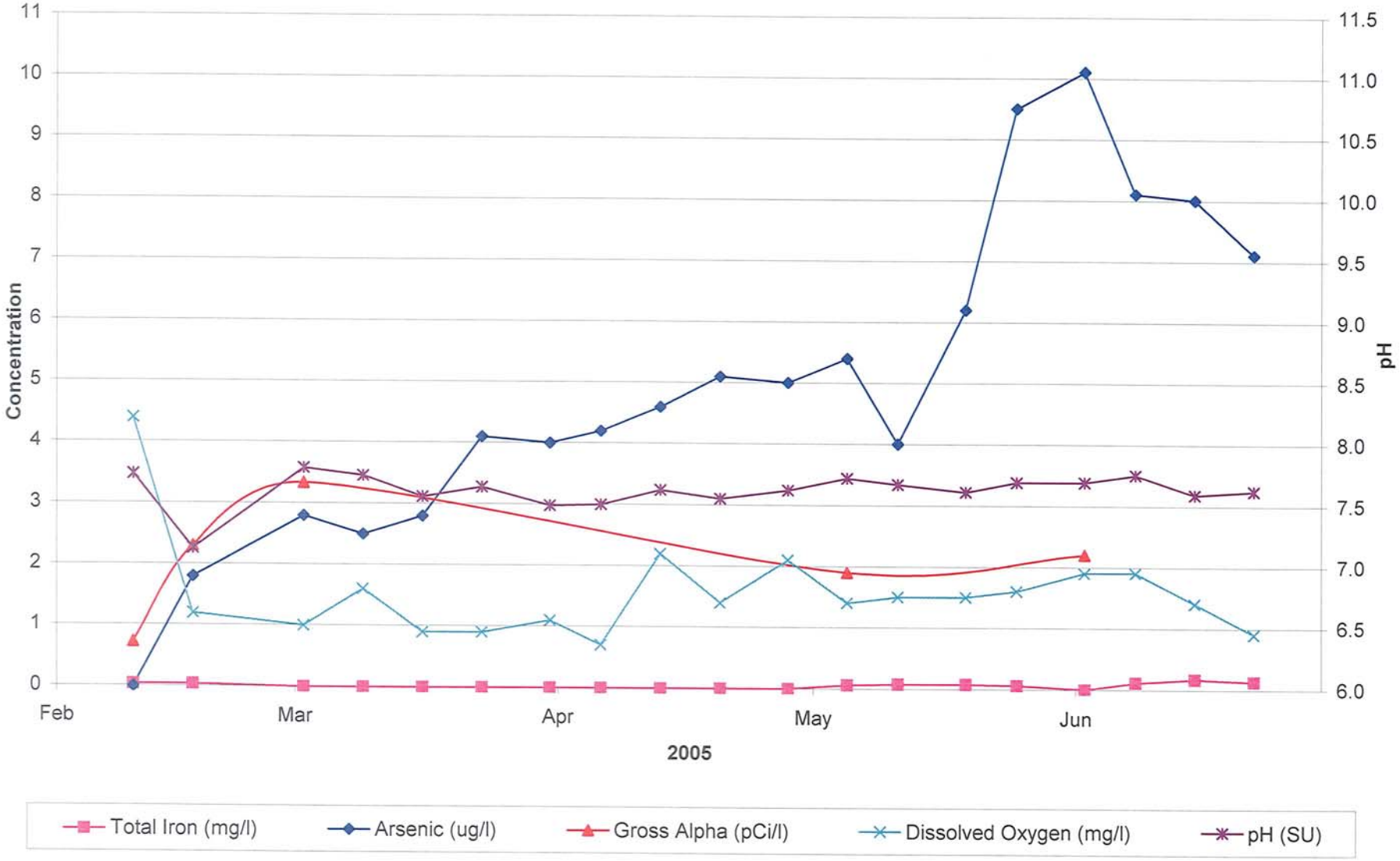


FIGURE 2-25. PLOT OF TOTAL DISSOLVED SOLIDS VERSUS PERCENT OF INJECTED WATER RECOVERED FOR THE ASR WELLS FOR CYCLE 4

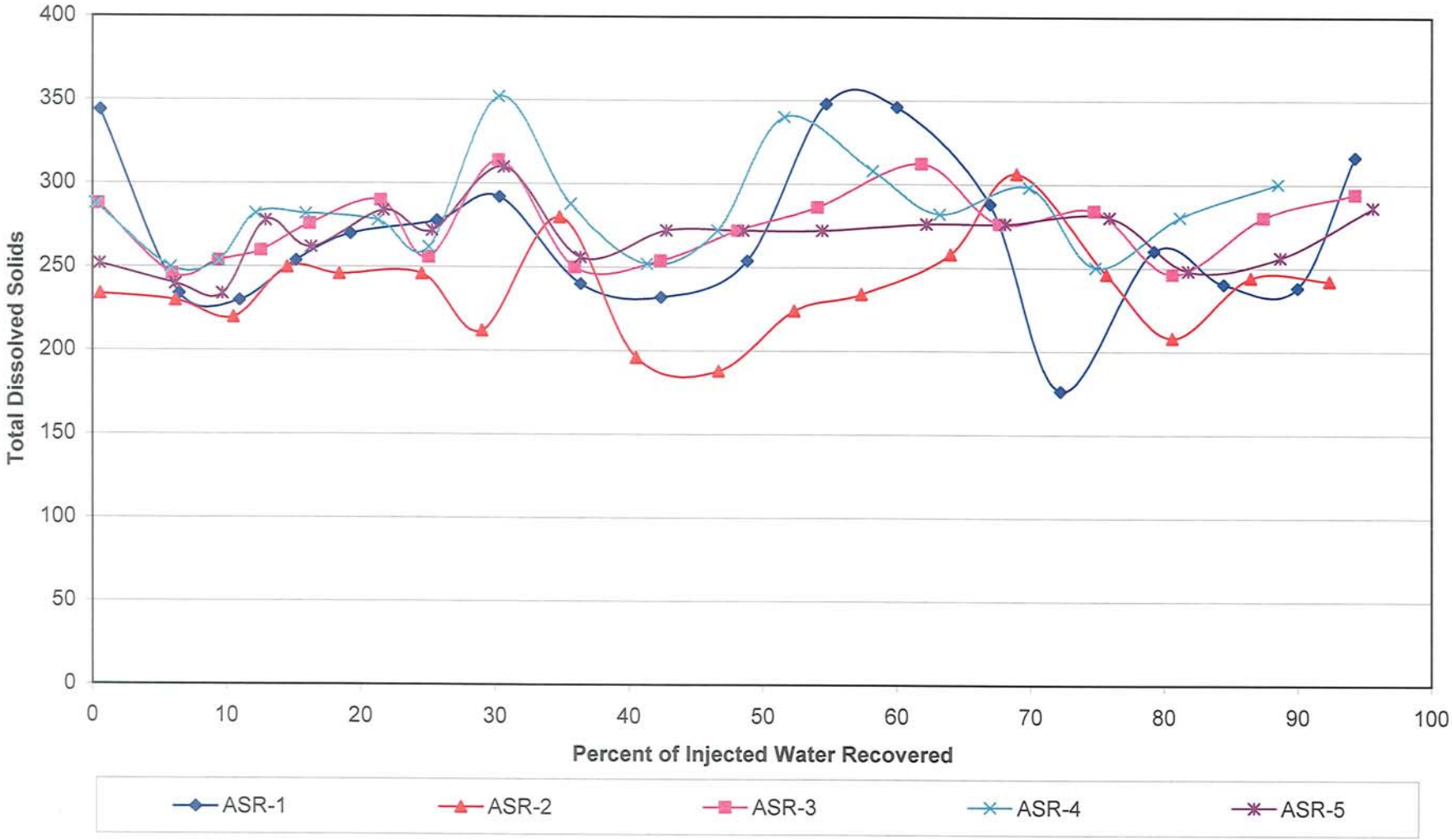


FIGURE 2-26. PLOT OF TOTAL DISSOLVED SOLIDS VERSUS VOLUME OF INJECTED WATER RECOVERED FOR THE ASR WELLS FOR CYCLE 4

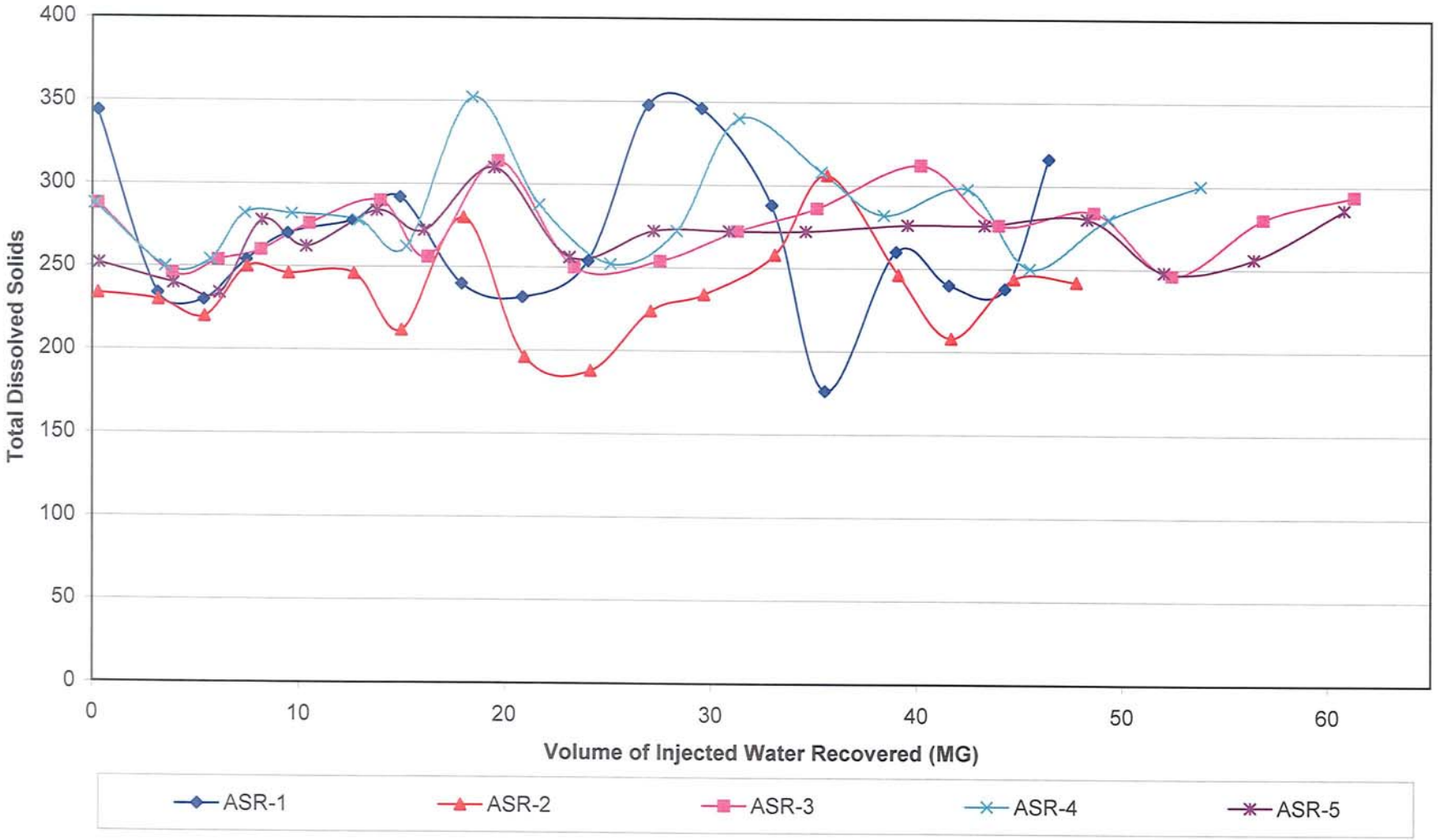


TABLE 2-6

SUMMARY OF RECOVERED WATER QUALITY RANGES
VERSUS REGULATORY CRITERIA DURING CYCLE 4

Parameter	Minimum Concentration	Maximum Concentration	Regulatory Criteria	Units
Total Iron	0.04	0.11	0.3	Mg/l
Total Arsenic	2.1	9.2	10	Ug/l
Total Dissolved Solids	216	344	500*	Mg/l
Total Color	9.5	13.9	15	CU
Sulfate	28.6	40.3	250	Mg/l
Chloride	39	45	250	Mg/l
pH	6.93	8.00	6.5 - 8.5	SU
Gross Alpha	2.60	2.62	15	pC/l
Turbidity	0.02	0.48	N/A	NTU
Total Alkalinity	93	154	N/A	Mg/l
Total Hardness	108	154	N/A	Mg/l
Total Trihalomethanes	0.21	5.70	50	Ug/l

* may be greater if no other maximum contaminate level is exceeded

BDL = below detection limit

potential for water not meeting the arsenic drinking water standard to enter the distribution system.

During ASR Cycle 4 recovery, the maximum arsenic concentration of 9.2 ug/l occurred when the TDS concentration in the recovered water was approximately 344 mg/l. This compares to an arsenic concentration of 19 ug/l with a TDS concentration of 280 mg/l during Cycle 3.

The monthly average daily recovery rate per well varied between 158 gpm (for well ASR-2 in February, 2005) and 440 gpm (for well ASR-3 in June, 2005), and averaged 314 gpm per well. Recovery rates and cumulative volumes recovered versus time are shown on Figure 2-27 through 2-31.

Potentiometric water levels in the five storage zone observation wells were monitored on a daily basis during recovery operations. An annotated plot of potentiometric water levels for the five storage zone observation wells for the entire Cycle 4 injection/storage/recovery period is provided as Figure 2-8.

Water samples were obtained from the five storage zone observation wells on a weekly basis during recovery operations from the ASR wells and analyzed for those parameters shown on Table 2-4. Plots of water quality parameters for storage zone observation wells C, 2, and 3 for the entire Cycle 4 injection/storage/recovery period are provided as Figure 2-9 through 2-14. The progressive improvement in water quality in these wells during injection into the ASR wells and the similar progressive decline in water quality during recovery from ASR wells are apparent on these graphs.

FIGURE 2-27. PLOT OF RECOVERY RATE AND CUMULATIVE VOLUME RECOVERED FOR ASR WELL 1 DURING CYCLE 4

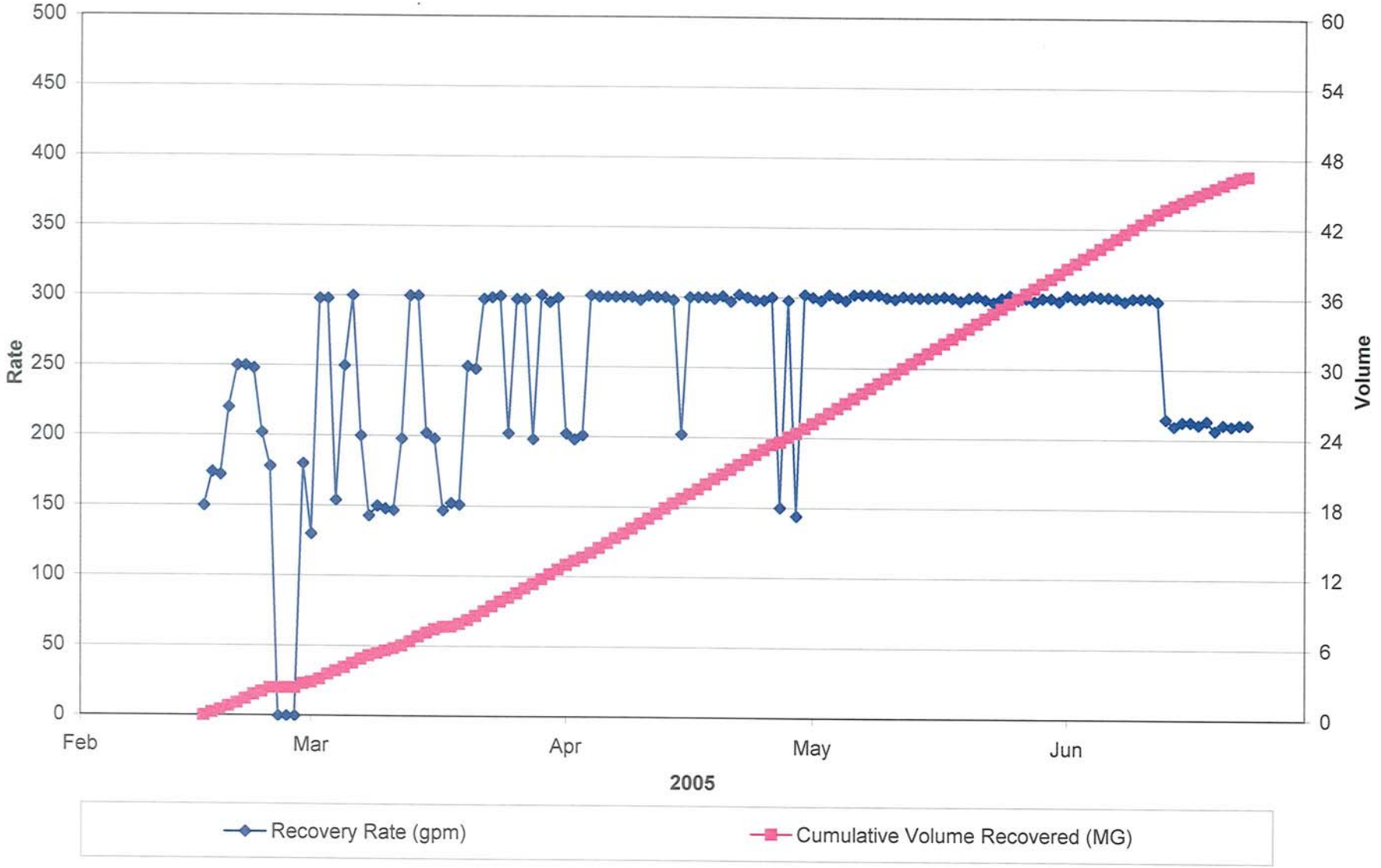


FIGURE 2-28. PLOT OF RECOVERY RATE AND CUMULATIVE VOLUME RECOVERED FOR ASR WELL 2 DURING CYCLE 4

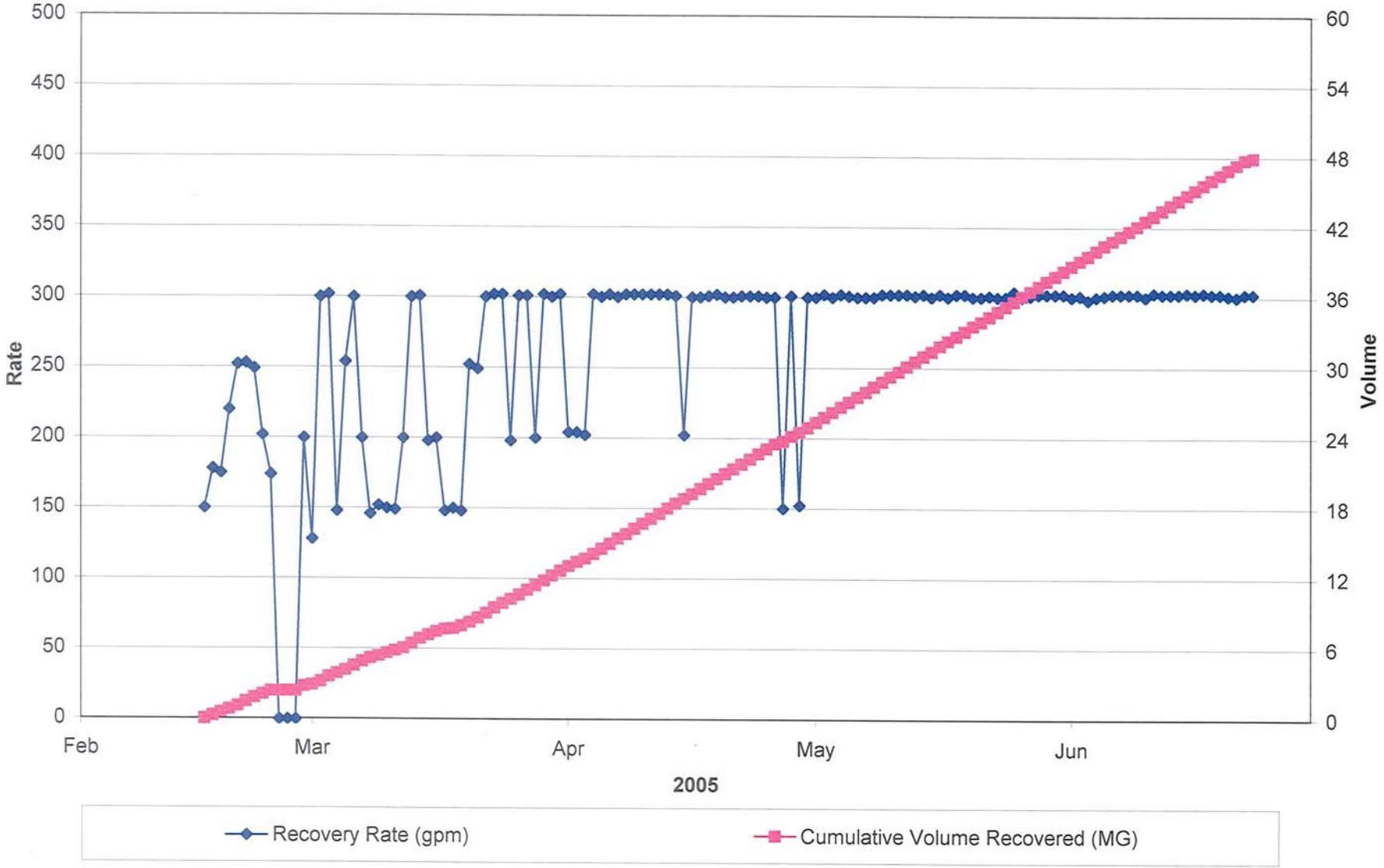


FIGURE 2-29. PLOT OF RECOVERY RATE AND CUMULATIVE VOLUME RECOVERED FOR ASR WELL 3 DURING CYCLE 4

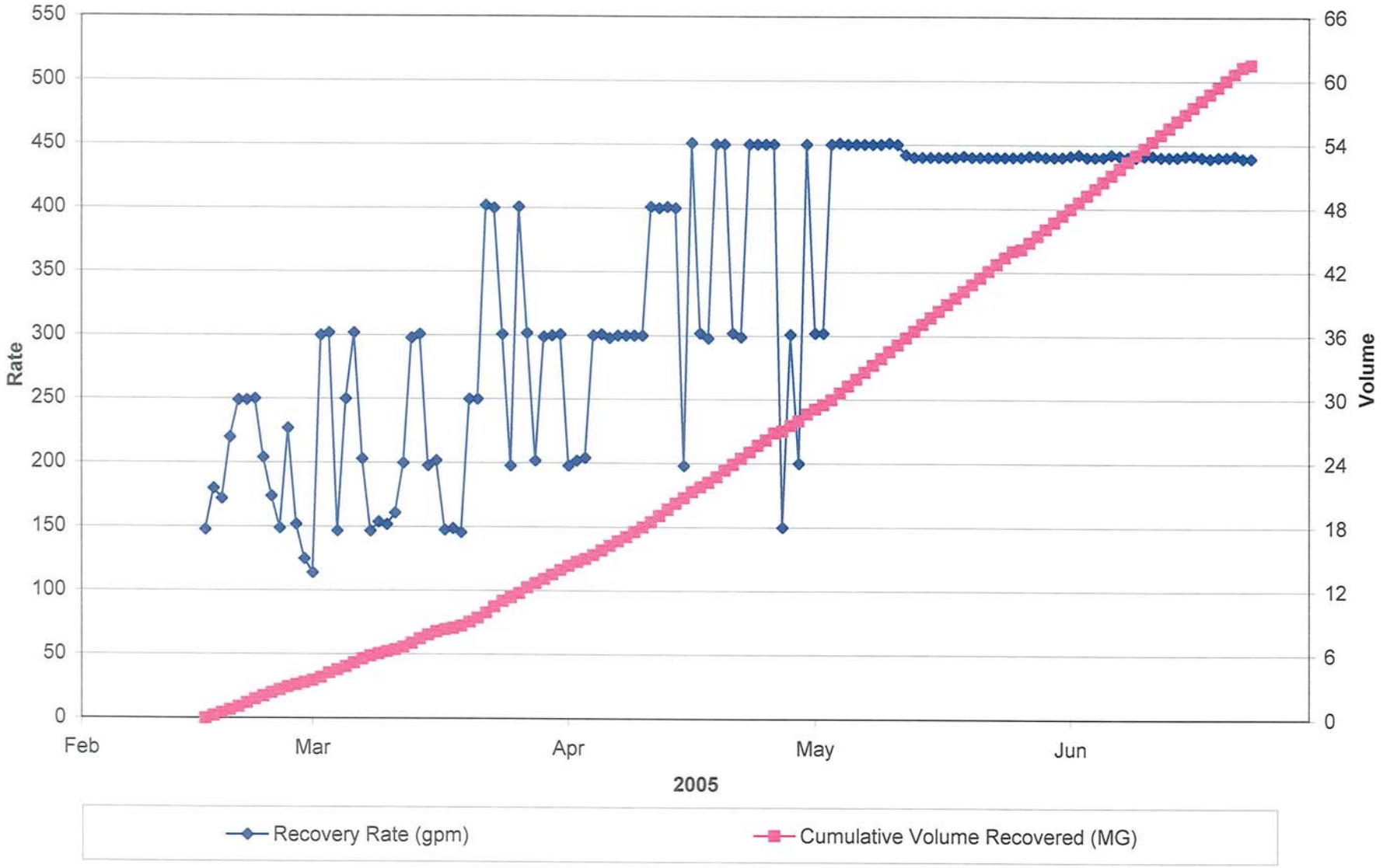


FIGURE 2-30. PLOT OF RECOVERY RATE AND CUMULATIVE VOLUME RECOVERED FOR ASR WELL 4 DURING CYCLE 4

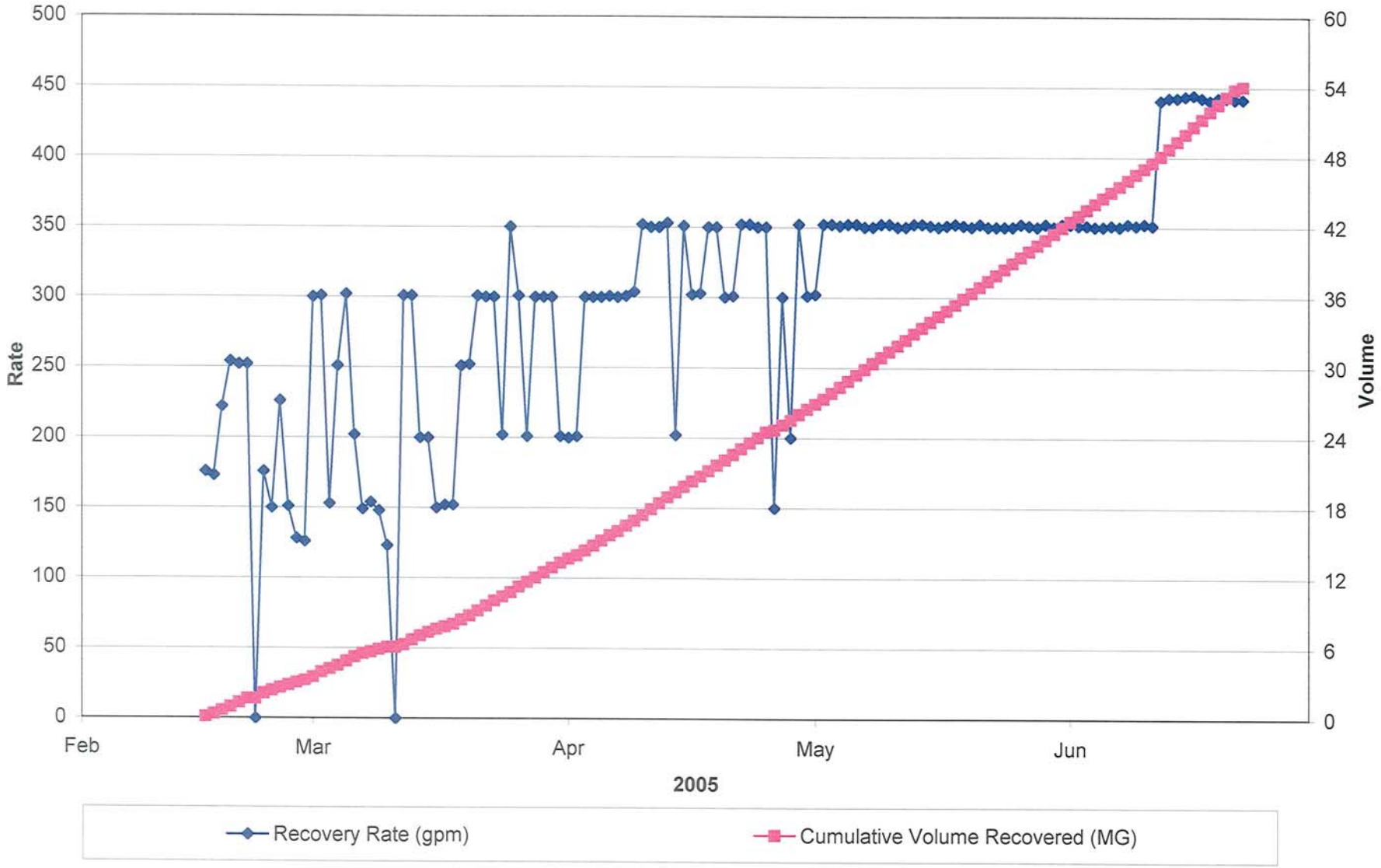
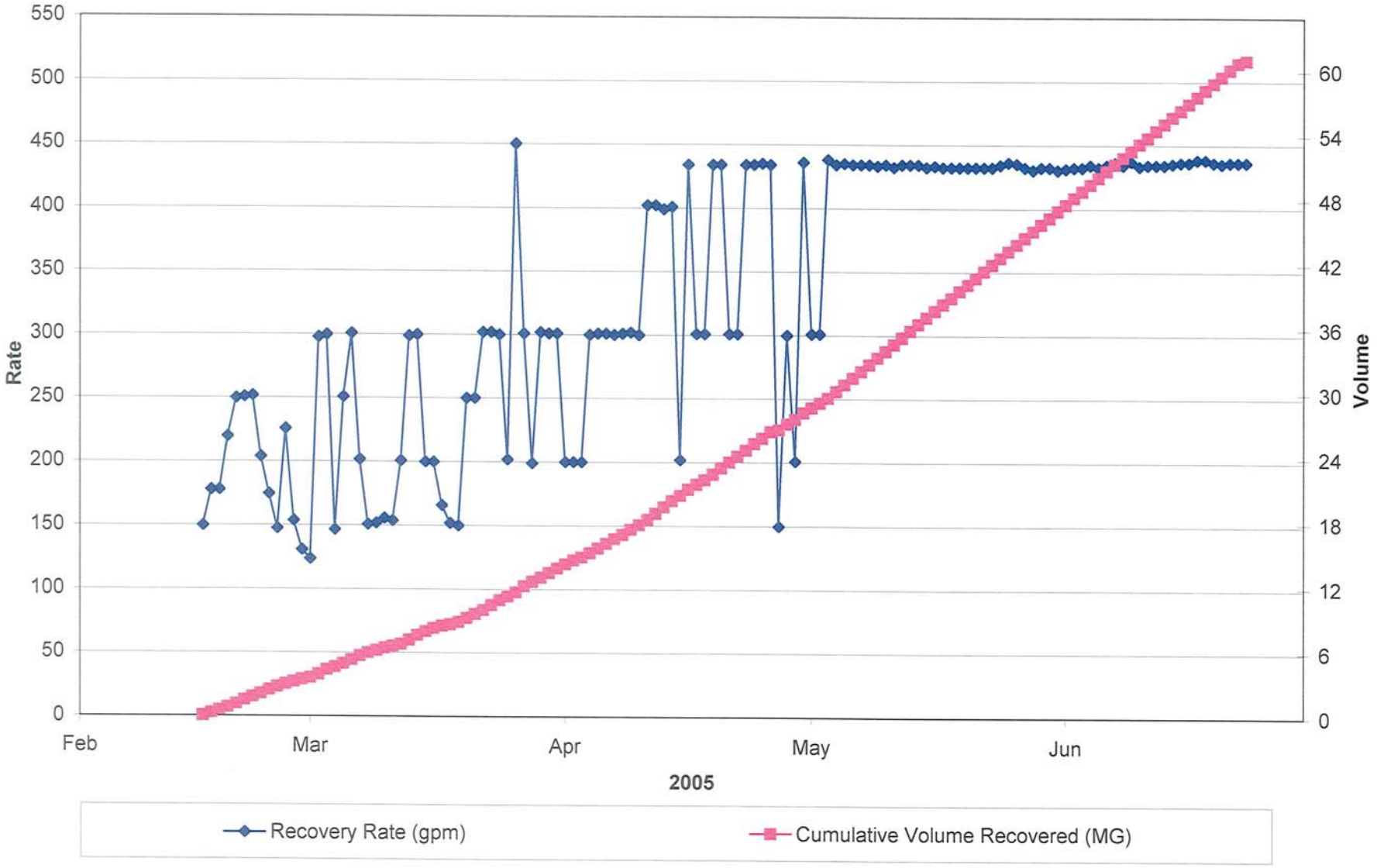


FIGURE 2-31. PLOT OF RECOVERY RATE AND CUMULATIVE VOLUME RECOVERED FOR ASR WELL 5 DURING CYCLE 4



III. SUMMARY OF CYCLE 5 OPERATIONS FOR THE CORKSCREW ASR SYSTEM

A. Cycle 5 Injection

Cycle 5 injection into Corkscrew ASR system began on August 4, 2005 and continued to November 7, 2005. Approximately 116.9 MG of water was injected. The average TDS concentration of the injected water was 205 mg/l. Injection ceased when the potable water demands from the Corkscrew WTP increased to the point that excess water was no longer available to inject into the ASR system. Plots of injection water quality are provided on Figures 3-1 and 3-2.

The injection water quality was monitored on a daily basis by LCU personnel for the parameters shown on Table 3-1. In compliance with the Florida Department of Environmental Protection (FDEP) underground injection control (UIC) permit (#142222-007 through -010-UC) for the system, the injection water quality was sampled on a weekly basis by LCU and the samples were transported to the Lee County Environmental Laboratory (LCEL) for analyses of the additional water quality parameters shown on Table 3-2. Monthly operational reports were provided to the FDEP.

A summary of the range in concentrations for the various injection water quality parameters and a comparison to regulatory criteria is provided on Table 3-3. The injected water met all Primary and Secondary Drinking Water Standards throughout the approximate 3-month injection period, with the exception of one slightly elevated field pH measurement.

In addition to monitoring injection water quality, LCU adjusted and controlled the injection rate on a daily basis. During Cycle 5 injection, on a monthly basis, the daily average injection rate varied between 194 gpm (for ASR-1 in November, 2005) and 419

FIGURE 3-1. PLOT OF WATER QUALITY INJECTED INTO THE ASR WELLS DURING CYCLE 5 (PART 1)

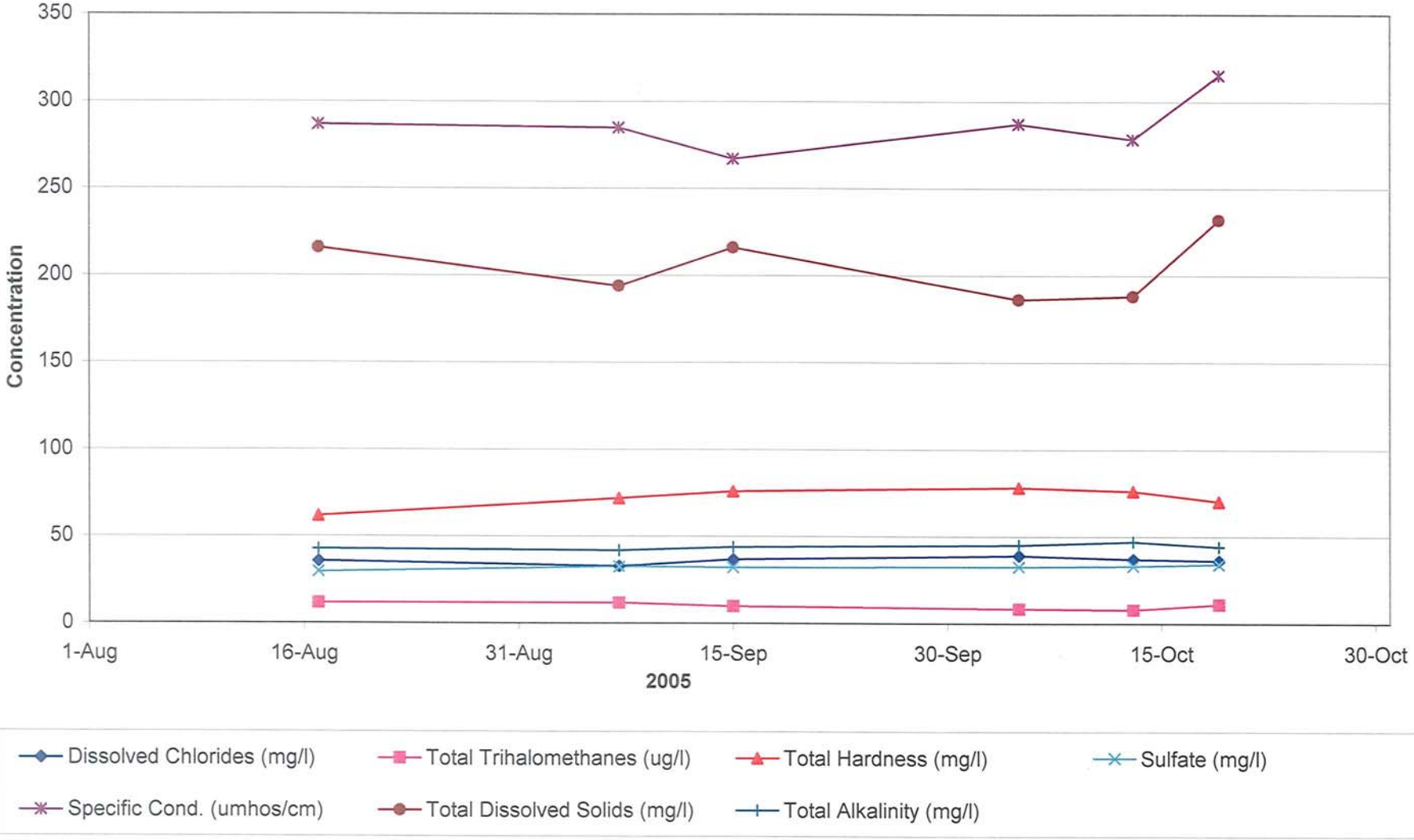


FIGURE 3-2. PLOT OF WATER QUALITY INJECTED INTO ASR WELLS DURING CYCLE 5 (PART 2)

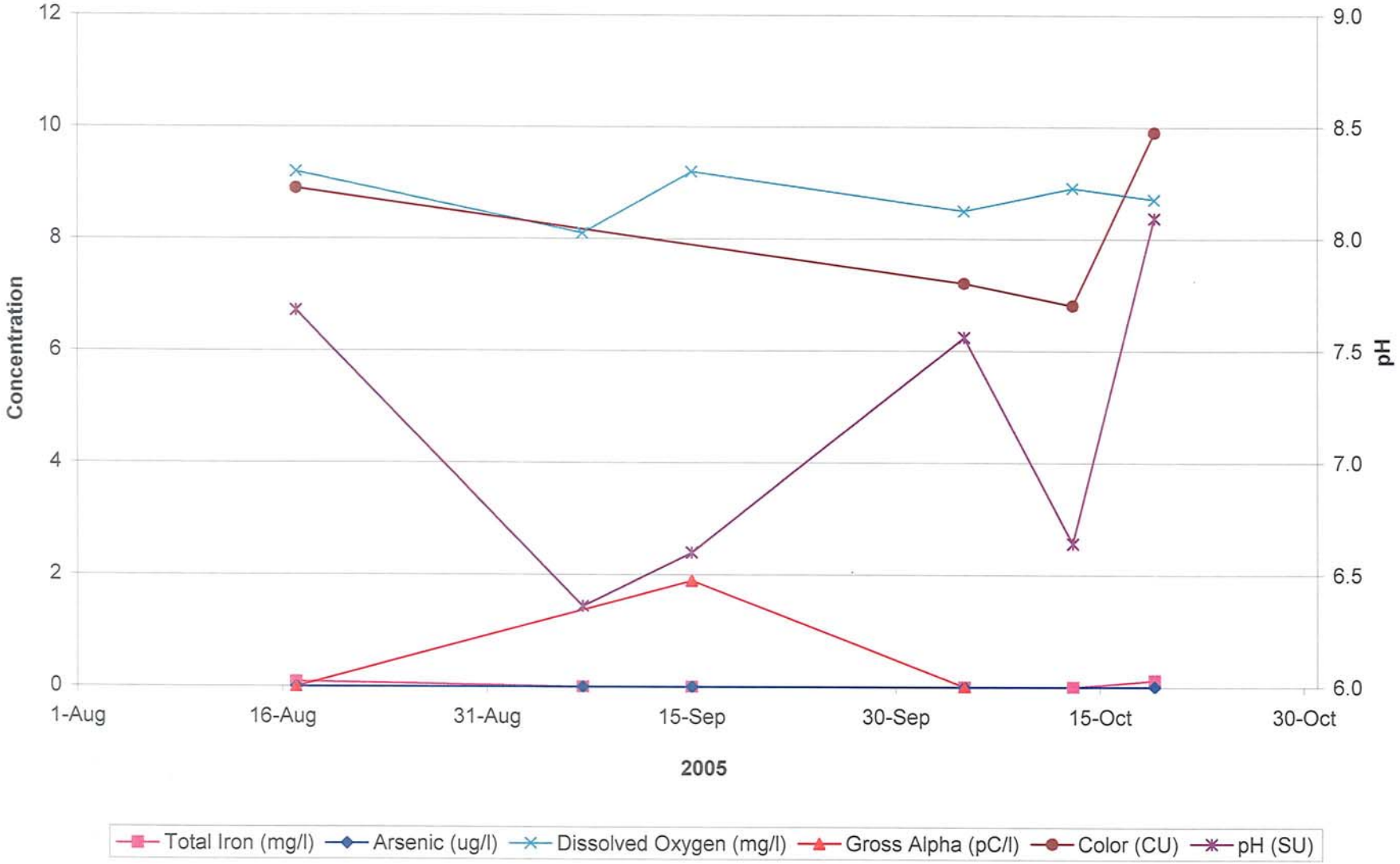


TABLE 3-1

SUMMARY OF FIELD ANALYZED HYDRAULIC AND
WATER QUALITY PARAMETERS
FOR THE ASR WELLS DURING CYCLE 5

Parameter	Analysis Frequency
Injection Pressure (psi)	Daily
Injection/Recovery rate (gpm)	Daily
Total Volume Injected/Recovered (gals)	Daily
Specific Capacity/Injectivity	Weekly
Dissolved Chloride (mg/l)	Daily
Specific Conductance (umhos/cm)	Daily
Temperature (°C)	Daily
Turbidity (NTU)	Daily
Dissolved Oxygen (mg/l)	Weekly
Free Chlorine (mg/l)	Daily
Total Chlorine (mg/l)	Daily
pH (SU)	Daily

TABLE 3-2

SUMMARY OF LABORATORY ANALYZED WATER QUALITY PARAMETERS FOR THE ASR WELLS DURING CYCLE 5

Parameter	Analysis Frequency
Arsenic (ug/l)	Weekly
Total Iron (mg/l)	Weekly
Total Trihalomethanes (mg/l)	Weekly
Total Dissolved Solids (mg/l)	Weekly
Dissolved Chloride (mg/l)	Weekly
Specific Conductance (umhos/cm)	Weekly
Total Alkalinity (mg/l)	Weekly
Sulfate (mg/l)	Weekly
Total Hardness (mg/l)	Weekly
Calcium Hardness (mg/l)	Weekly
Total Color (CU)	Weekly
Gross Alpha (pC/l)	Beginning and End of Injection and Recovery

TABLE 3-3

SUMMARY OF INJECTION WATER QUALITY RANGES
VERSUS REGULATORY CRITERIA DURING CYCLE 5

Parameter	Minimum Concentration	Maximum Concentration	Regulatory Criteria	Units
Total Iron	BDL	0.12	0.3	Mg/l
Total Arsenic	BDL	BDL	10	Ug/l
Total Dissolved Solids	186	232	500*	Mg/l
Total Color	6.8	9.9	15	CU
Sulfate	29.9	34.0	250	Mg/l
Chloride	33	39	250	Mg/l
pH	6.50	8.73	6.5 - 8.5	SU
Gross Alpha	BDL	1.9	15	pC/l
Turbidity	BDL	0.71	N/A	NTU
Total Alkalinity	42	47	N/A	Mg/l
Total Hardness	62	78	N/A	Mg/l
Total Trihalomethanes	7.9	12.0	50	Ug/l

* may be greater if no other maximum contaminant level is exceeded

BDL = below detection limit

gpm (for ASR-5 in October, 2005) and averaged 292 gpm per well. The injection rate was influenced by the availability of finished water from the WTP.

Injection rates and pressures are shown on Figures 3-3 through 3-7. In order to maintain adequate injection rates and injection pressures, a pH adjustment system was utilized and adjusted on a daily basis by Corkscrew WTP personnel. This system uses carbonic acid to lower the pH of the finished water from the Corkscrew WTP.

Potentiometric water levels in the five storage zone observation wells were monitored on a daily basis. Water samples were obtained from the five storage zone observation wells on a weekly basis and analyzed for those parameters shown on Tables 3-4 and 3-5. An annotated plot of potentiometric water levels for the five storage zone observation wells for the entire Cycle 5 injection/storage/recovery period is provided as Figure 3-8. Plots of water quality parameters for storage zone observation wells C, 1, 2, and 3 for the entire Cycle 5 injection/storage/recovery period are provided as Figure 3-9 through 3-16. No water quality was monitored in storage zone observation well A during this cycle. The progressive improvement in water quality in these wells during injection into the ASR wells and the similar progressive decline in water quality during recovery from the ASR wells are apparent on these graphs.

FIGURE 3-3. PLOT OF INJECTION PRESSURE, RATE, AND CUMULATIVE VOLUME INJECTED INTO ASR WELL 1 DURING CYCLE 5

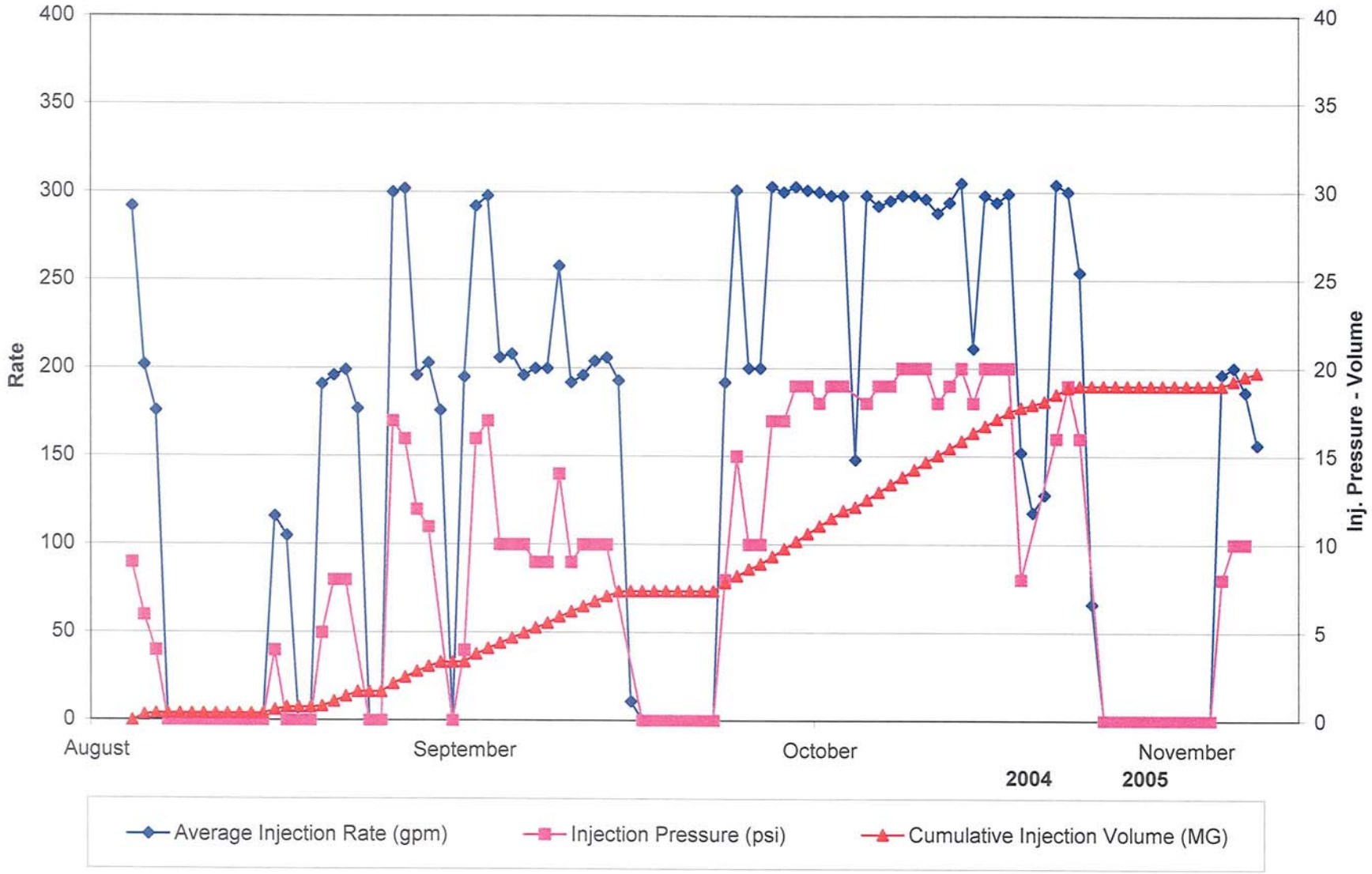


FIGURE 3-4. PLOT OF INJECTION PRESSURE, RATE, AND CUMULATIVE VOLUME INJECTED INTO ASR WELL 2 DURING CYCLE 5

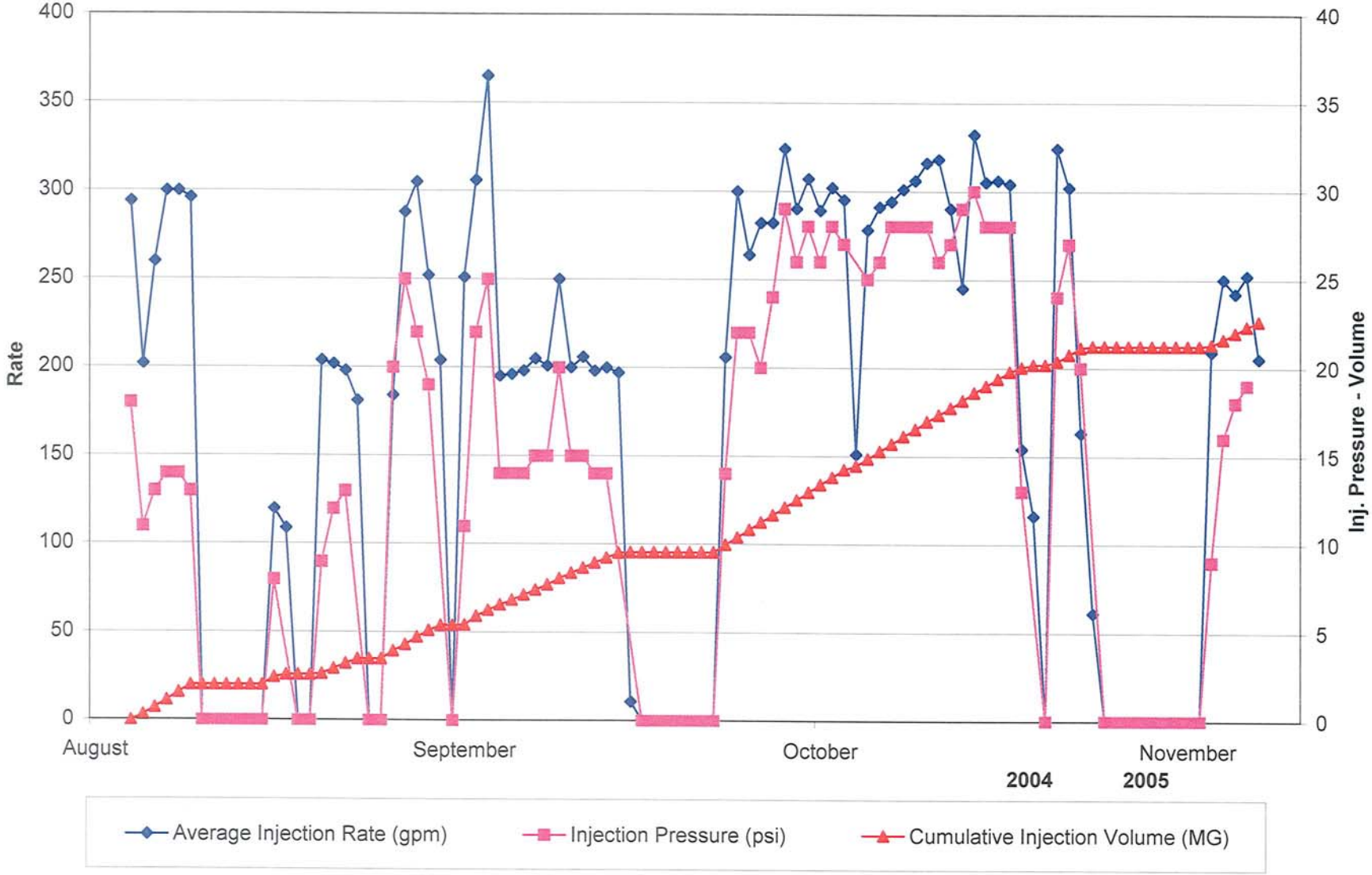


FIGURE 3-5. PLOT OF INJECTION PRESSURE, RATE, AND CUMULATIVE VOLUME INJECTED INTO ASR WELL 3 DURING CYCLE 5

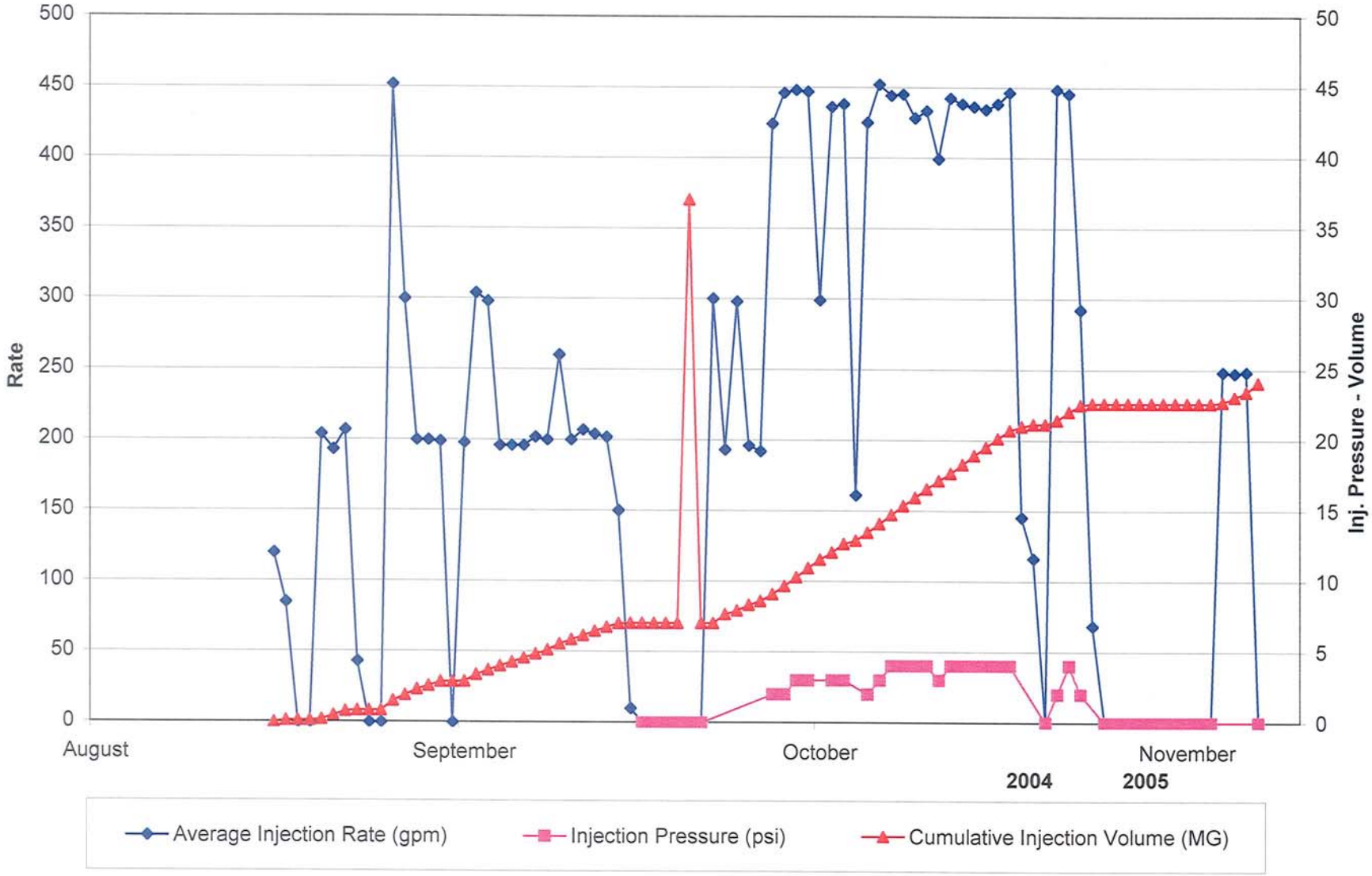


FIGURE 3-6. PLOT OF INJECTION PRESSURE, RATE, AND CUMULATIVE VOLUME INJECTED INTO ASR WELL 4 DURING CYCLE 5

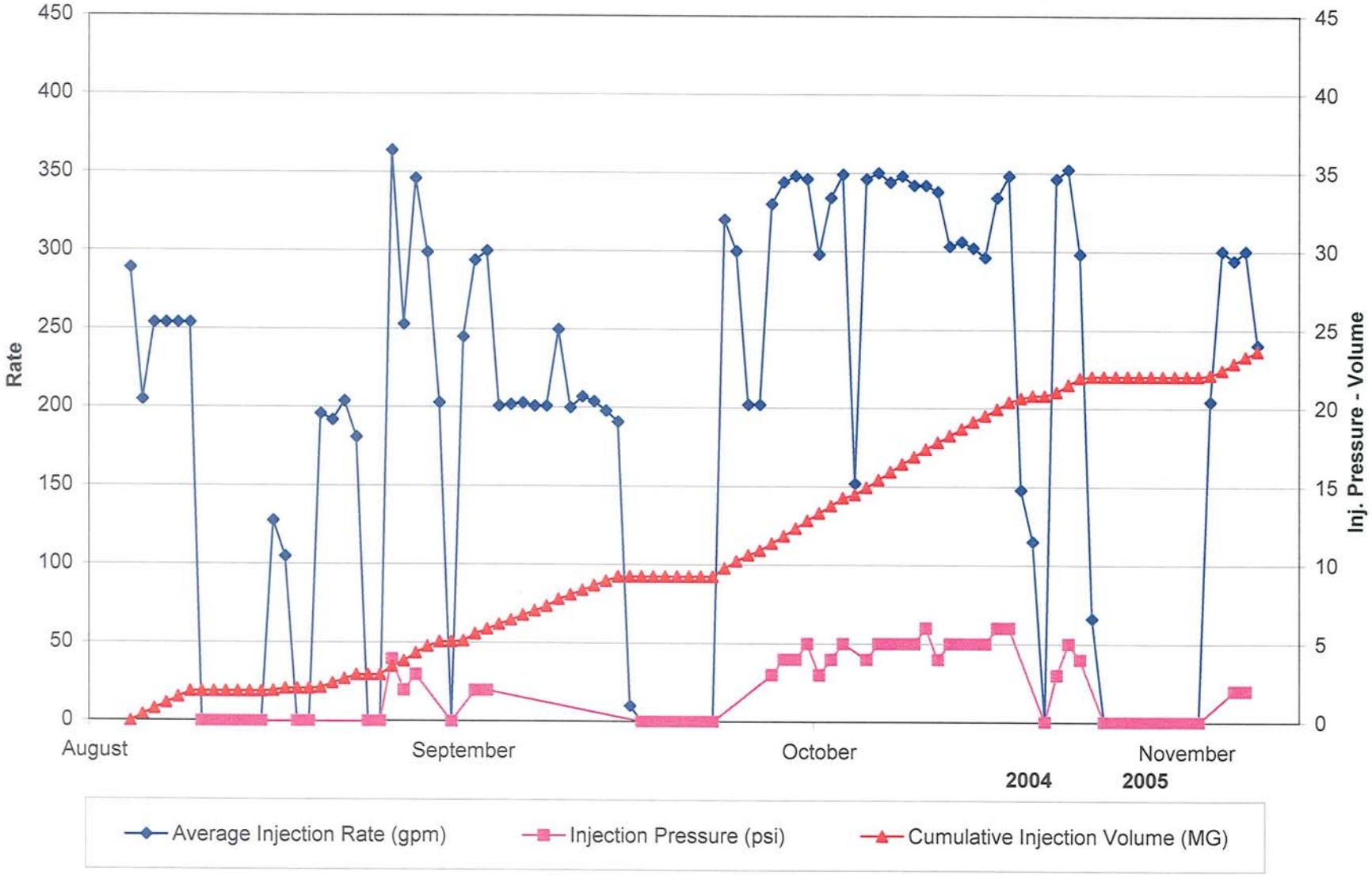


FIGURE 3-7. PLOT OF INJECTION PRESSURE, RATE, AND CUMULATIVE VOLUME INJECTED INTO ASR WELL 5 DURING CYCLE 5

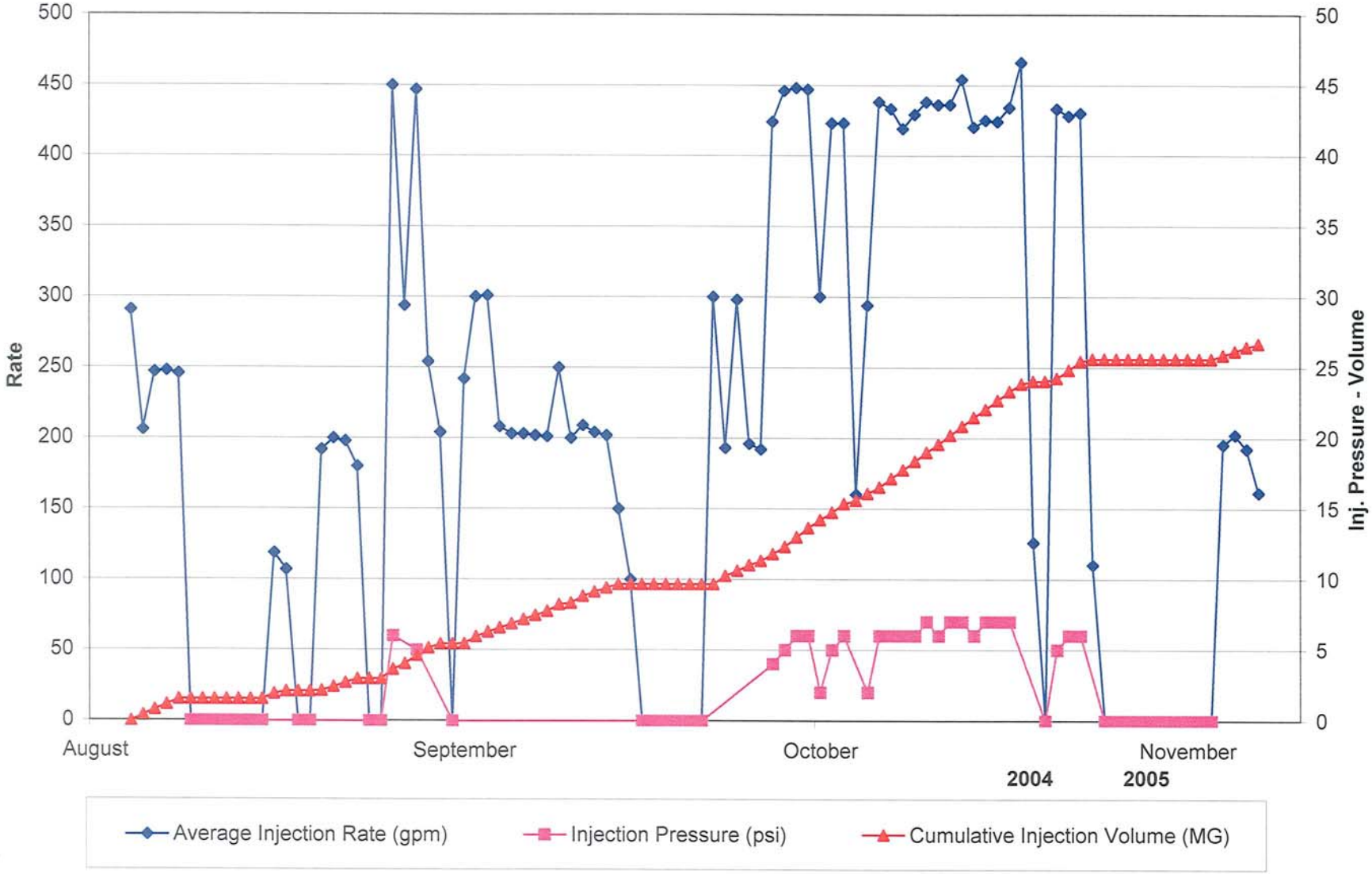


TABLE 3-4

SUMMARY OF FIELD ANALYZED HYDRAULIC AND WATER QUALITY PARAMETERS FOR MW-A, MW-C, AND SZMW-1 DURING CYCLE 5

Parameter	Analysis Frequency
Potentiometric Pressure (psi)	Daily
Dissolved Chloride (mg/l)	Weekly
Specific Conductance (umhos/cm)	Weekly
Temperature (°C)	Weekly
Turbidity (NTU)	Weekly
Dissolved Oxygen (mg/l)	Weekly
Free Chlorine (mg/l)	Weekly
Total Chlorine (mg/l)	Weekly
pH (SU)	Weekly

TABLE 3-5

SUMMARY OF LABORATORY ANALYZED WATER QUALITY PARAMETERS FOR MW-A, MW-C, AND SZMW-1 THROUGH SZMW-3 DURING CYCLE 5

Parameter	Analysis Frequency
Arsenic (ug/l)	Weekly
Total Iron (mg/l)	Weekly
Total Trihalomethanes (mg/l)	Weekly
Total Dissolved Solids (mg/l)	Weekly
Dissolved Chloride (mg/l)	Weekly
Specific Conductance (umhos/cm)	Weekly
Total Alkalinity (mg/l)	Weekly
Sulfate (mg/l)	Weekly
Total Hardness (mg/l)	Weekly
Calcium Hardness (mg/l)	Weekly
Total Color (CU)	Weekly
Gross Alpha (pC/l)	Monthly

FIGURE 3-8. PLOT OF DAILY WATER LEVELS IN STORAGE ZONE OBSERVATION WELLS DURING CYCLE 5

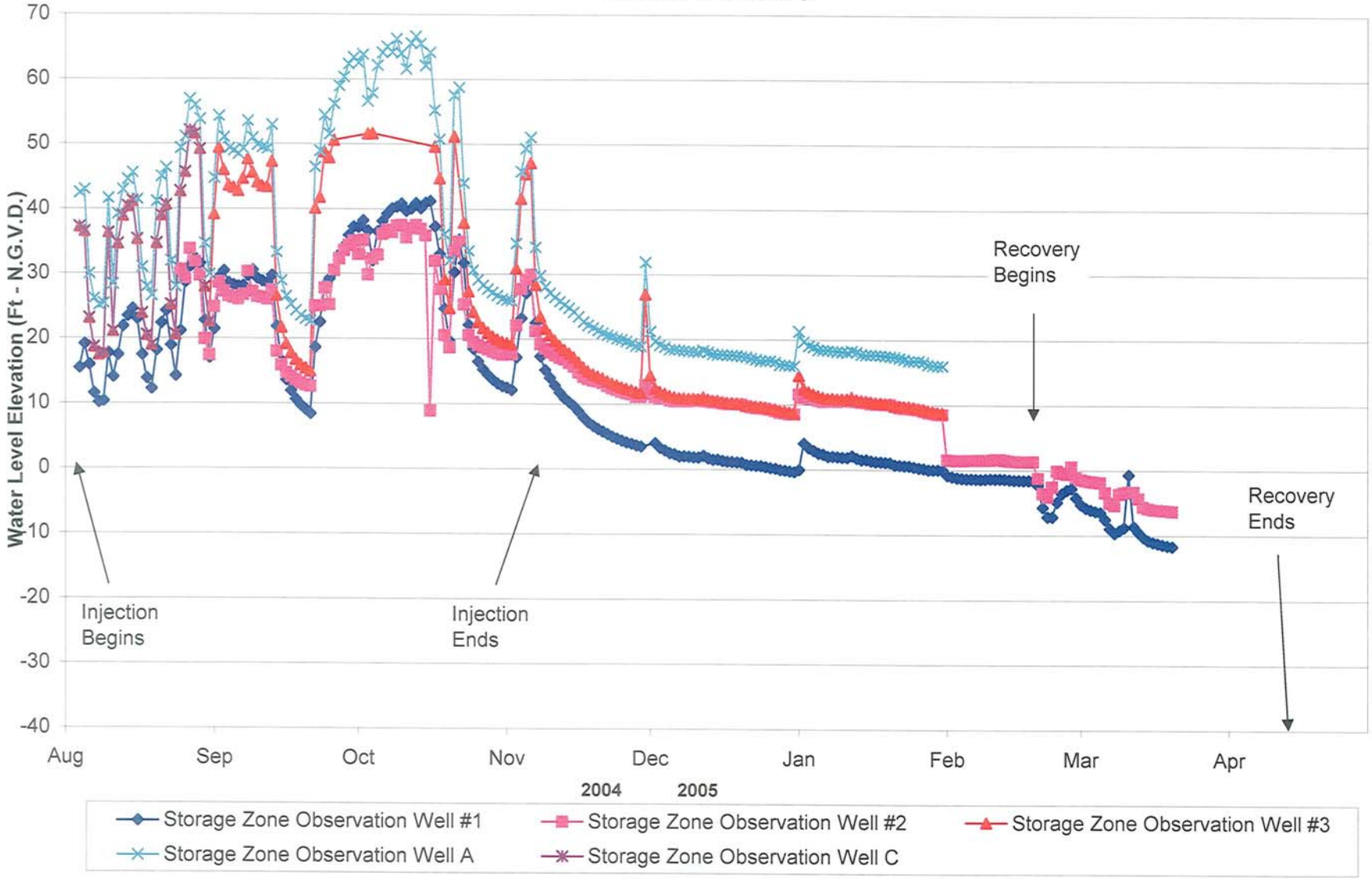


FIGURE 3-9. PLOT OF WATER QUALITY IN STORAGE ZONE OBSERVATION WELL C DURING CYCLE 5 (PART 1)

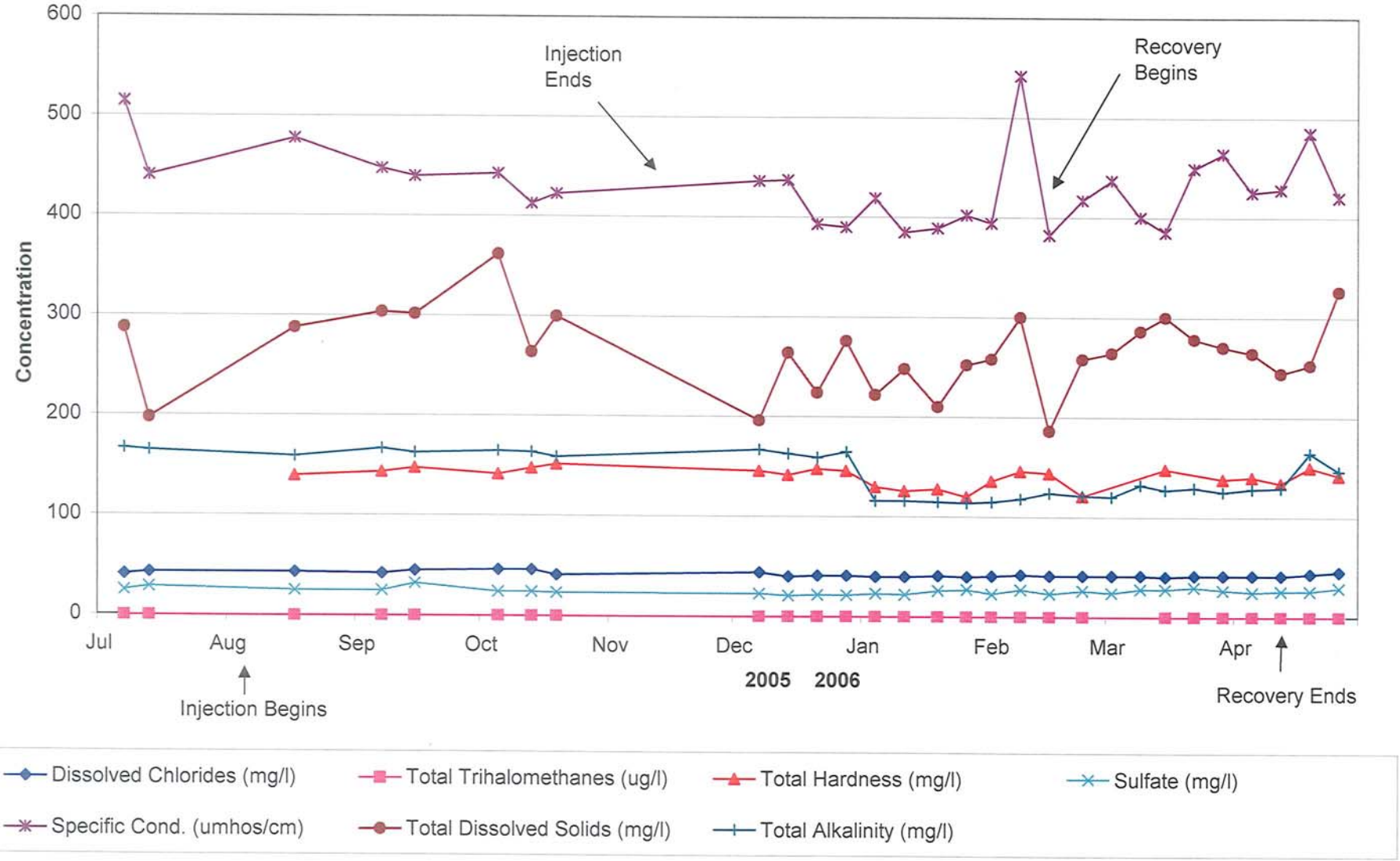


FIGURE 3-10. PLOT OF WATER QUALITY IN STORAGE ZONE OBSERVATION WELL C DURING CYCLE 5 (PART 2)

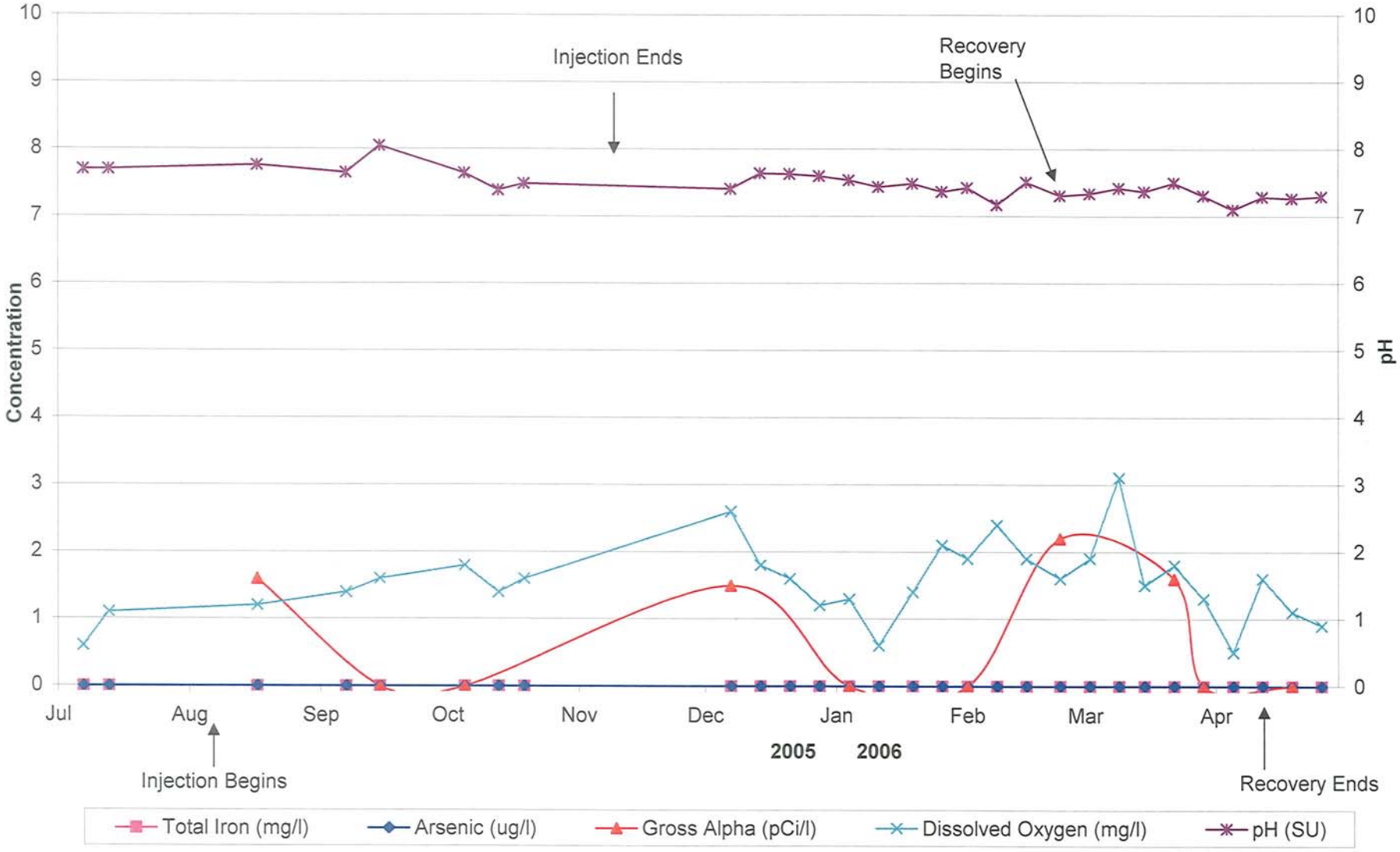


FIGURE 3-11. PLOT OF WATER QUALITY IN STORAGE ZONE OBSERVATION WELL 1 DURING CYCLE 5 (PART 1)

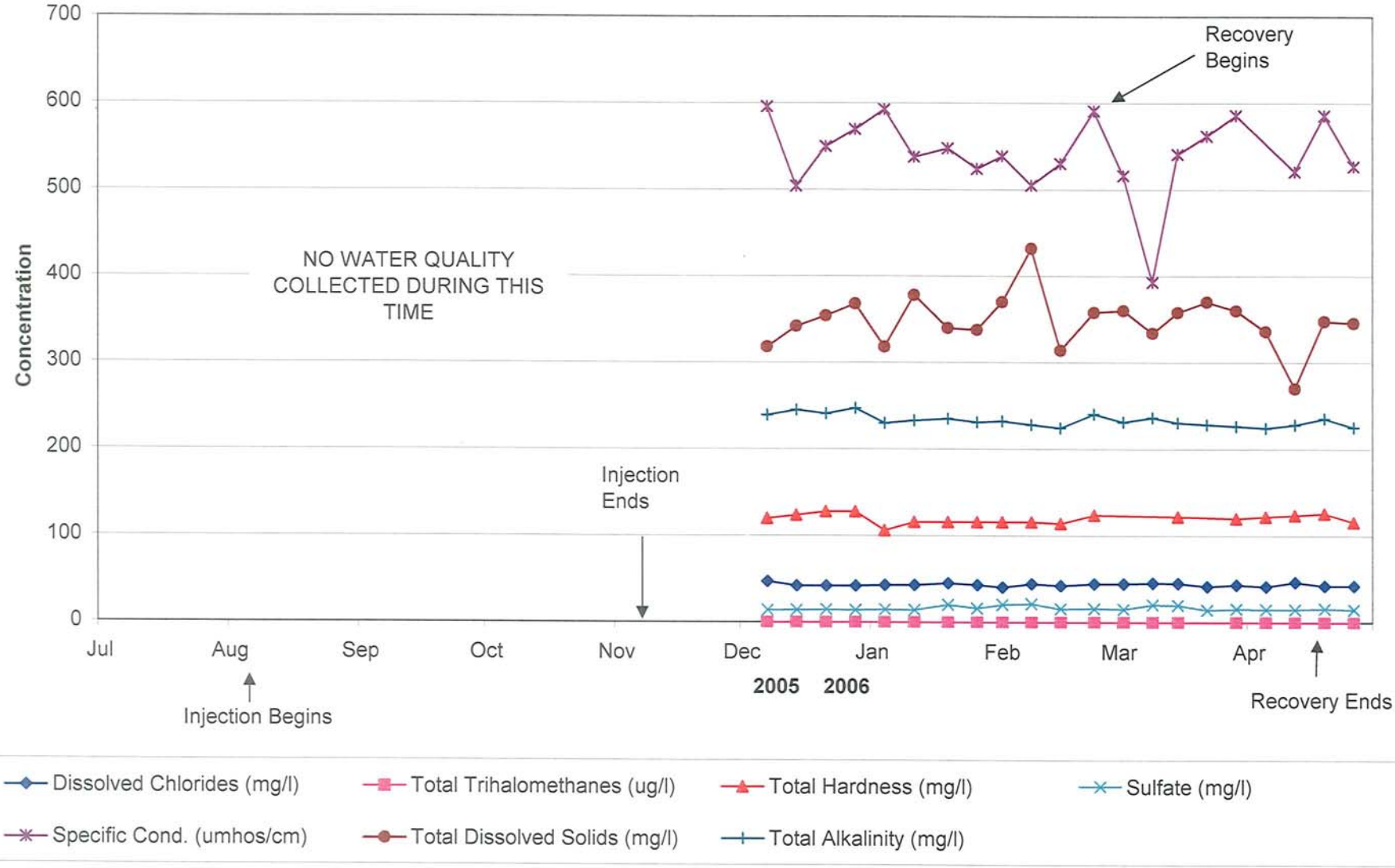


FIGURE 3-12. PLOT OF WATER QUALITY IN STORAGE ZONE OBSERVATION WELL 1 DURING CYCLE 5 (PART 2)

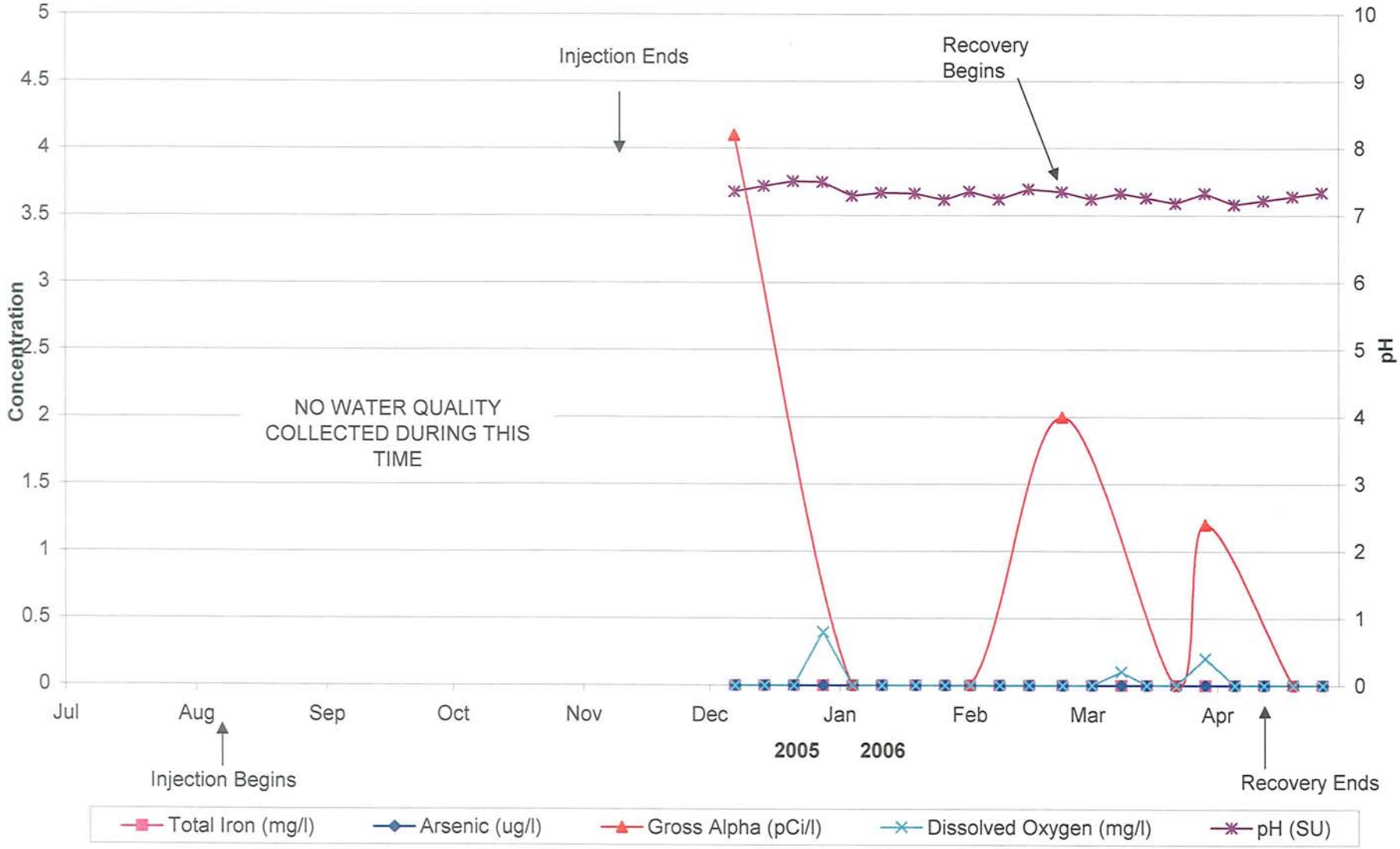


FIGURE 3-13. PLOT OF WATER QUALITY IN STORAGE ZONE OBSERVATION WELL 2 DURING CYCLE 5 (PART 1)

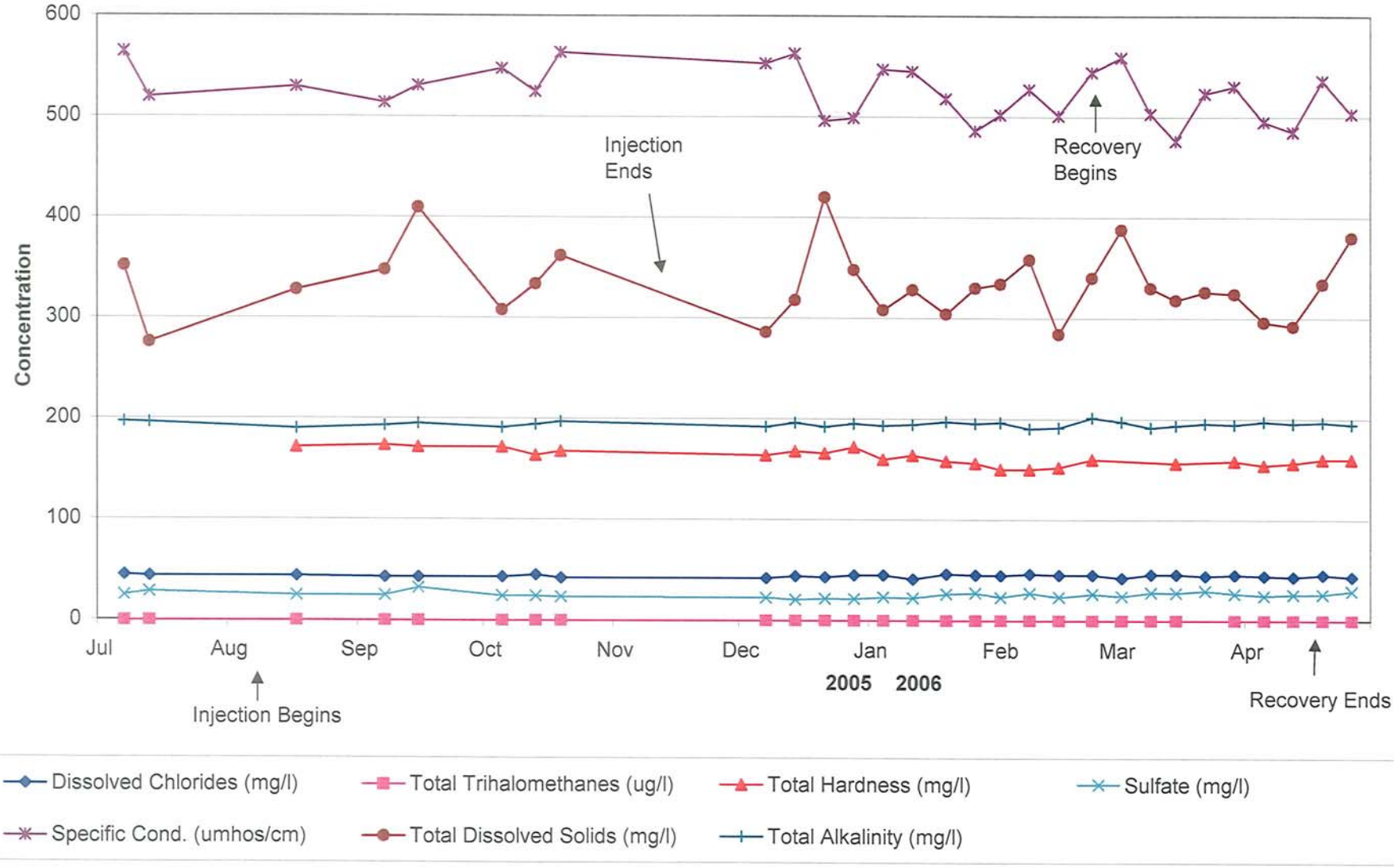


FIGURE 3-14. PLOT OF WATER QUALITY IN STORAGE ZONE OBSERVATION WELL 2 DURING CYCLE 5 (PART 2)

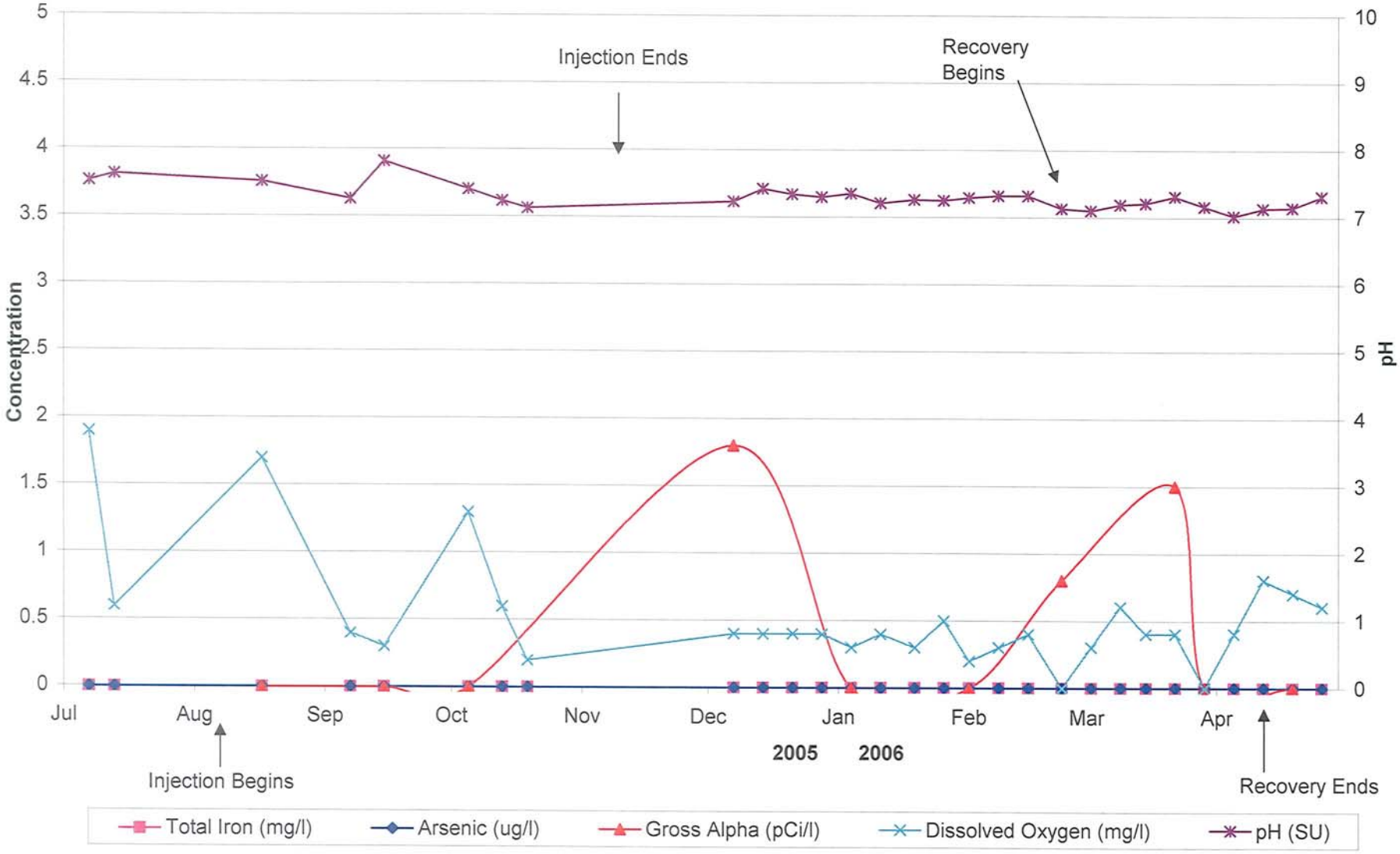


FIGURE 3-15. PLOT OF WATER QUALITY IN STORAGE ZONE OBSERVATION WELL 3 DURING CYCLE 5 (PART 1)

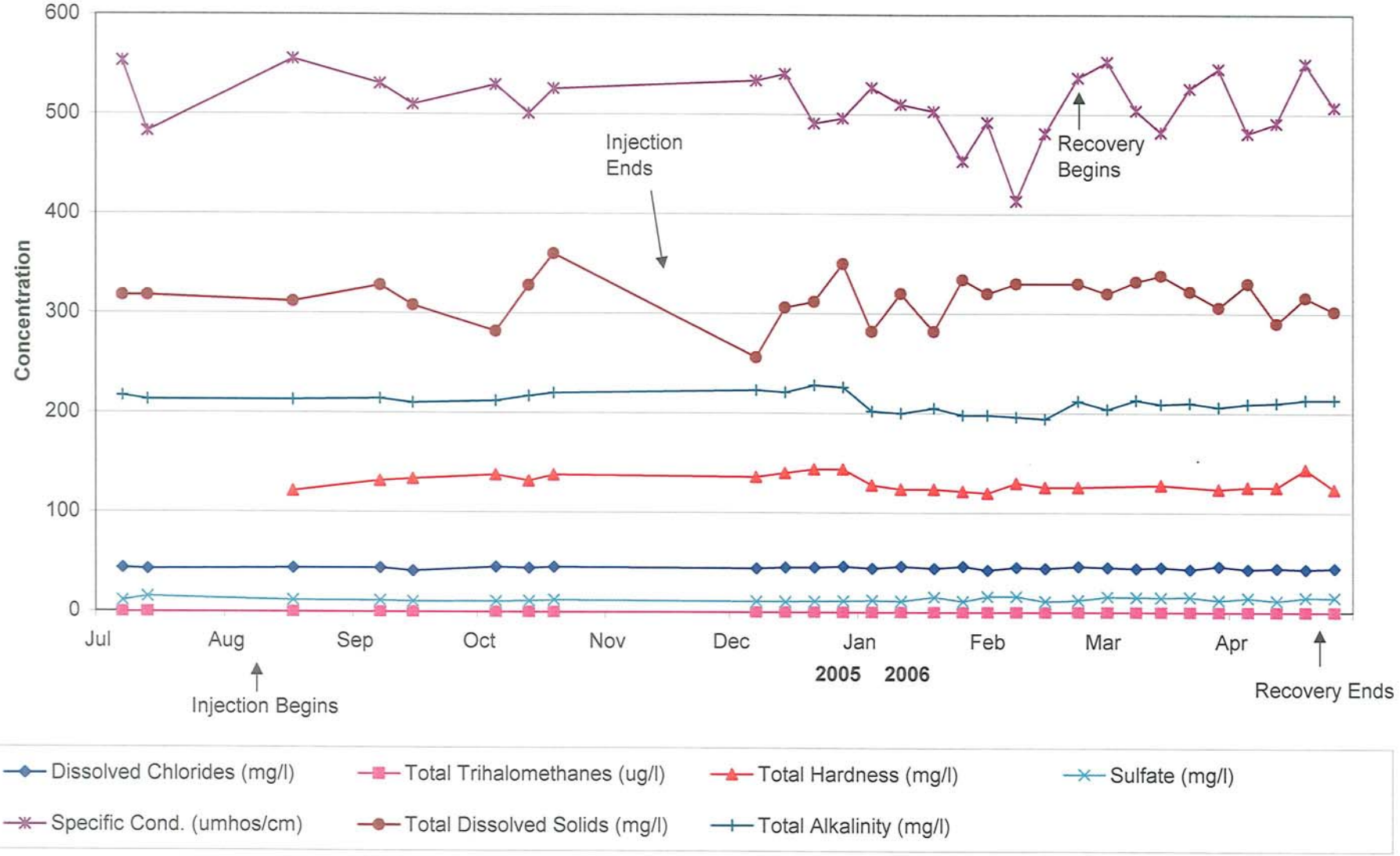
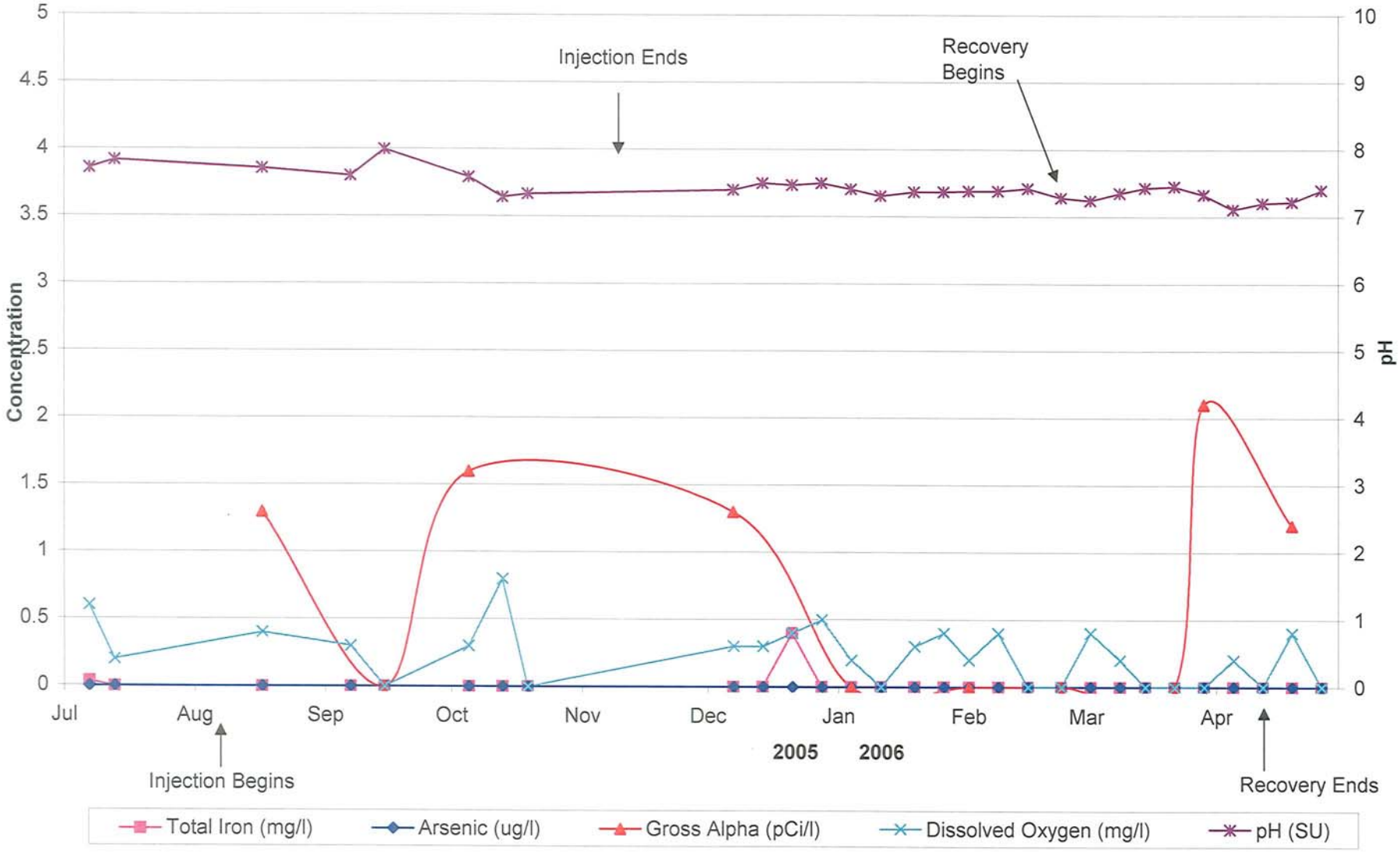


FIGURE 3-16. PLOT OF WATER QUALITY IN STORAGE ZONE OBSERVATION WELL 3 DURING CYCLE 5 (PART 2)



B. Cycle 5 Storage

Cycle 5 storage commenced on November 7, 2005 and continued until February 21, 2006. Therefore the storage duration was for approximately 3.5 months.

C. Cycle 5 Recovery

Cycle 5 recovery commenced from the Corkscrew ASR system on February 21, 2006. Recovery continued until April 13, 2006. At which time, the recovered water had a TDS concentration of approximately 244 mg/l. Plots of recovered water quality are provided on Figures 3-17 through 3-26.

A total of 93.4 MG of water was recovered. This represents approximately 80% of the injected volume.

The recovered water quality was monitored on a daily basis by Corkscrew WTP personnel for the same parameters shown on Table 3-1. In compliance with the Florida Department of Environmental Protection (FDEP) underground injection control (UIC) permit (#142222-007 through -010-UC), the recovered water quality was sampled on a weekly basis by Corkscrew WTP and the samples were transported to the Lee County Environmental Laboratory (LCEL) for analyses of the additional water quality parameters shown on Table 3-2.

A summary of the range in concentrations for the various recovered water quality parameters and a comparison to regulatory criteria is provided on Table 3-6. The recovered water met all Primary and Secondary Drinking Water Standards throughout the approximate 2-month recovery period.

Arsenic concentrations in the recovered water reached a maximum of 6.5 ug/l at the end of the recovery period.

A plot of TDS concentrations versus percent recovered and volume of injected water recovered are provided as Figures 3-27 and 3-28 respectively.

FIGURE 3-17. PLOT OF RECOVERED WATER QUALITY FROM WELL ASR-1 DURING CYCLE 5 (PART 1)

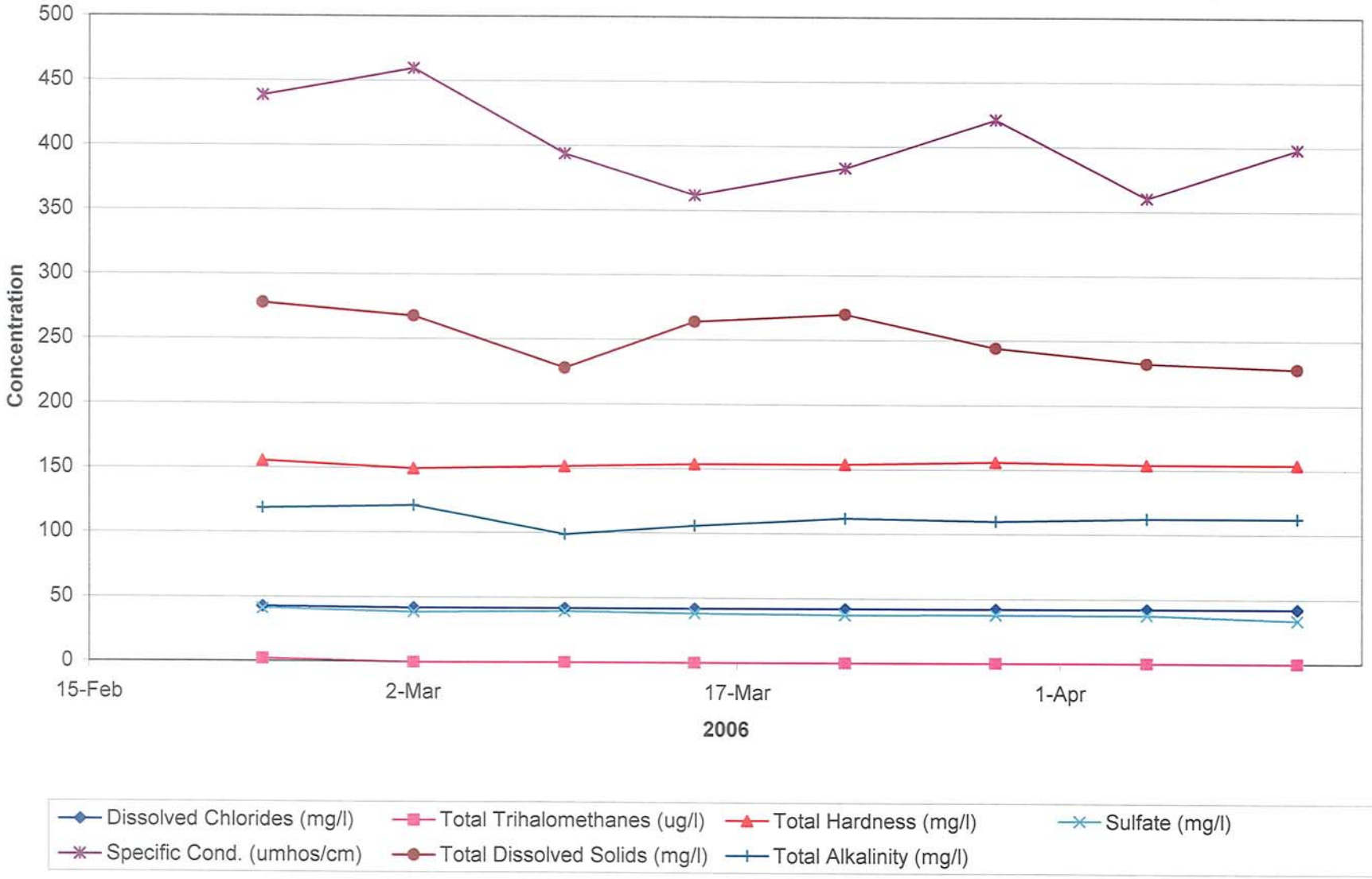


FIGURE 3-18. PLOT OF RECOVERED WATER QUALITY FROM WELL ASR-1 DURING CYCLE 5 (PART 2)

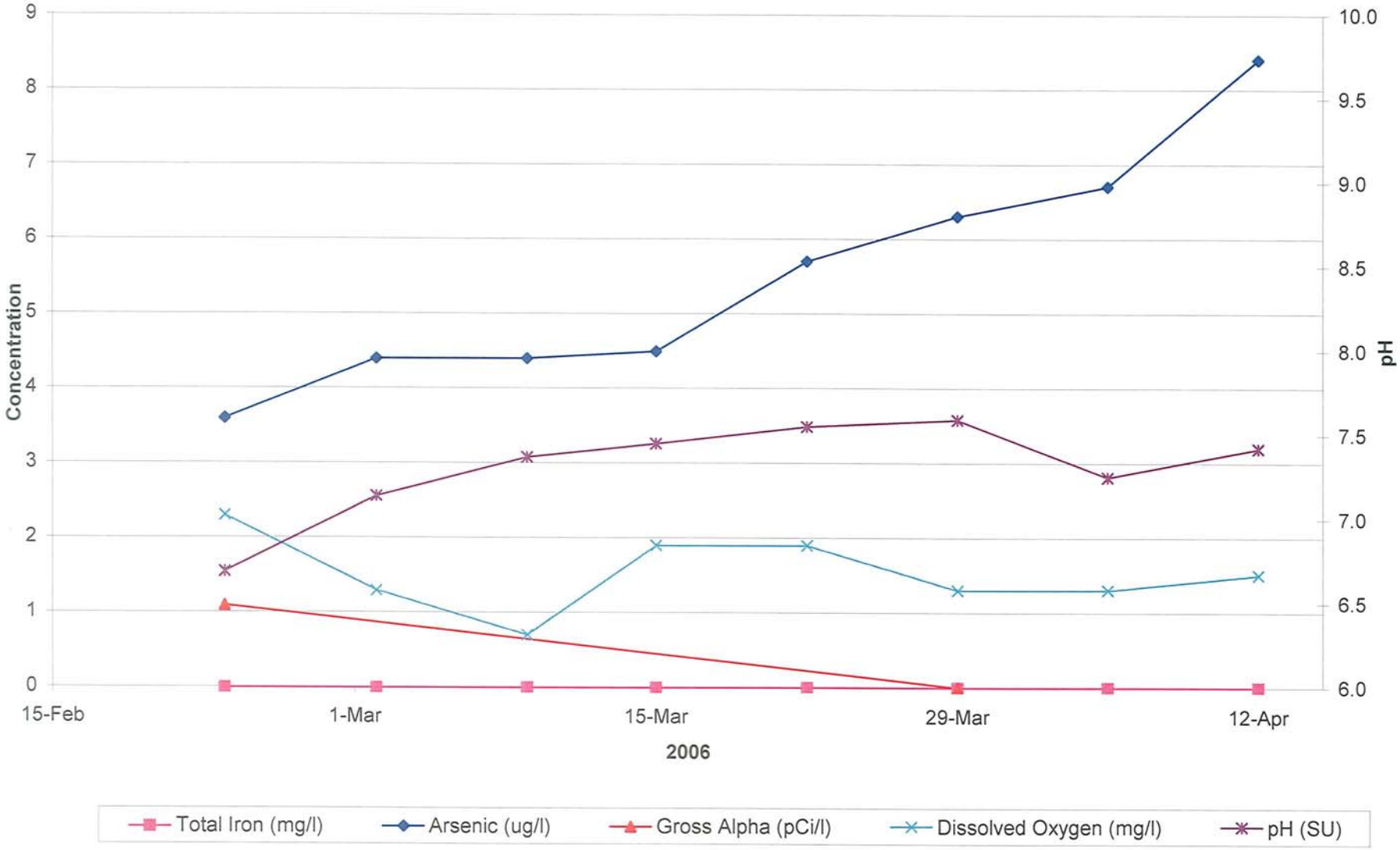


FIGURE 3-19. PLOT OF RECOVERED WATER QUALITY FROM WELL ASR-2 DURING CYCLE 5 (PART 1)

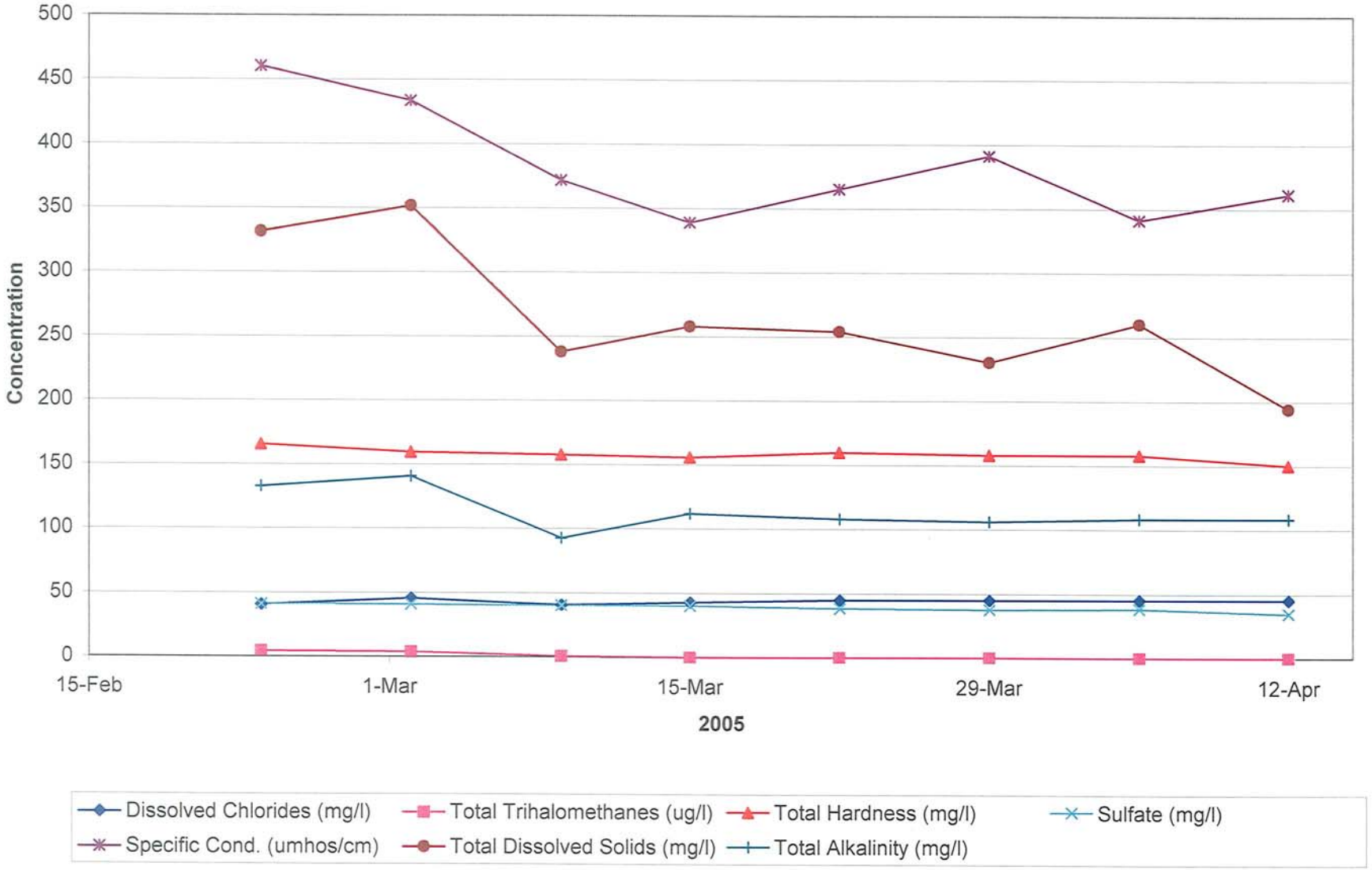


FIGURE 3-20. PLOT OF RECOVERED WATER QUALITY FROM WELL ASR-2 DURING CYCLE 5 (PART 2)

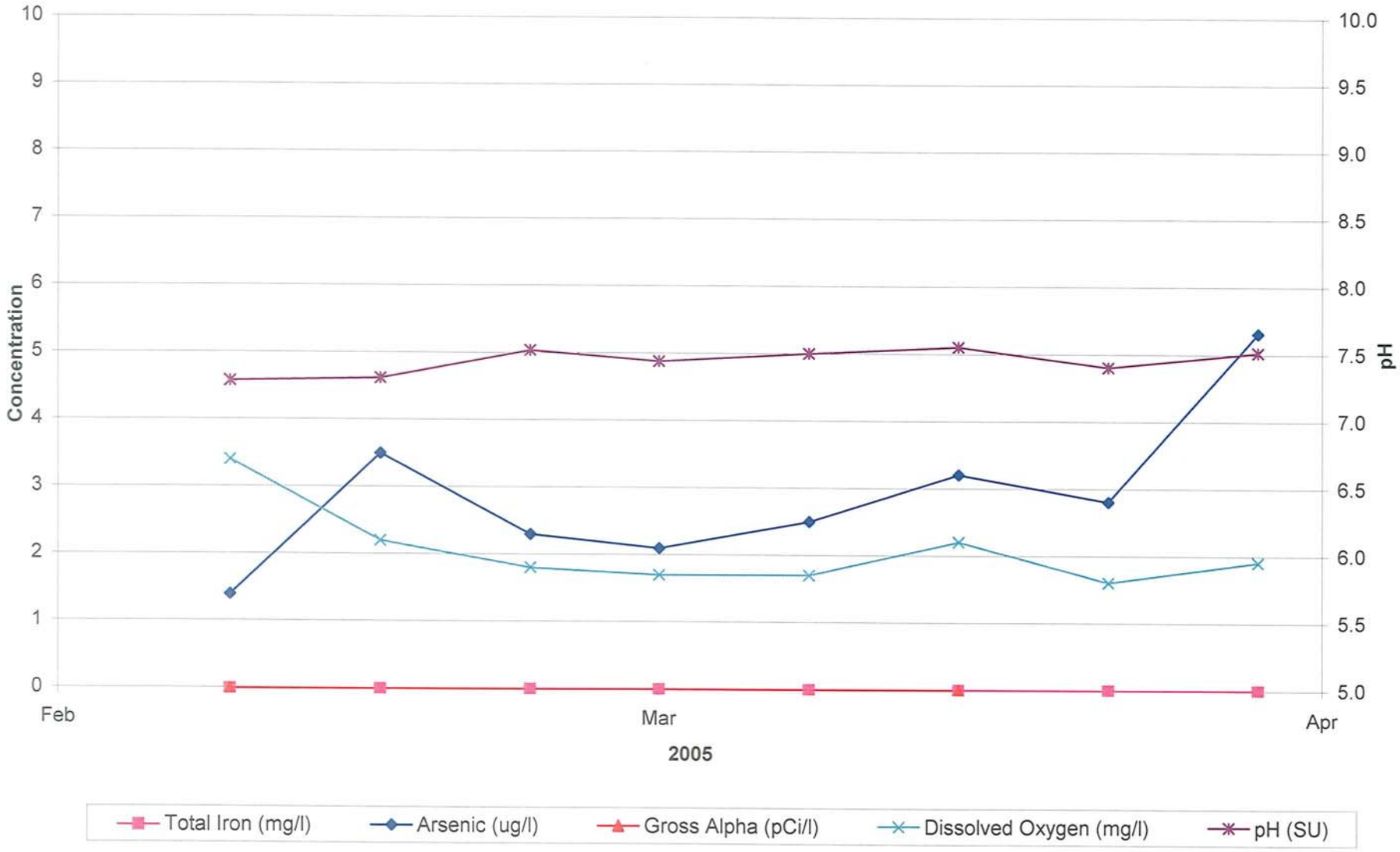


FIGURE 3-21. PLOT OF RECOVERED WATER QUALITY FROM WELL ASR-3 DURING CYCLE 5 (PART 1)

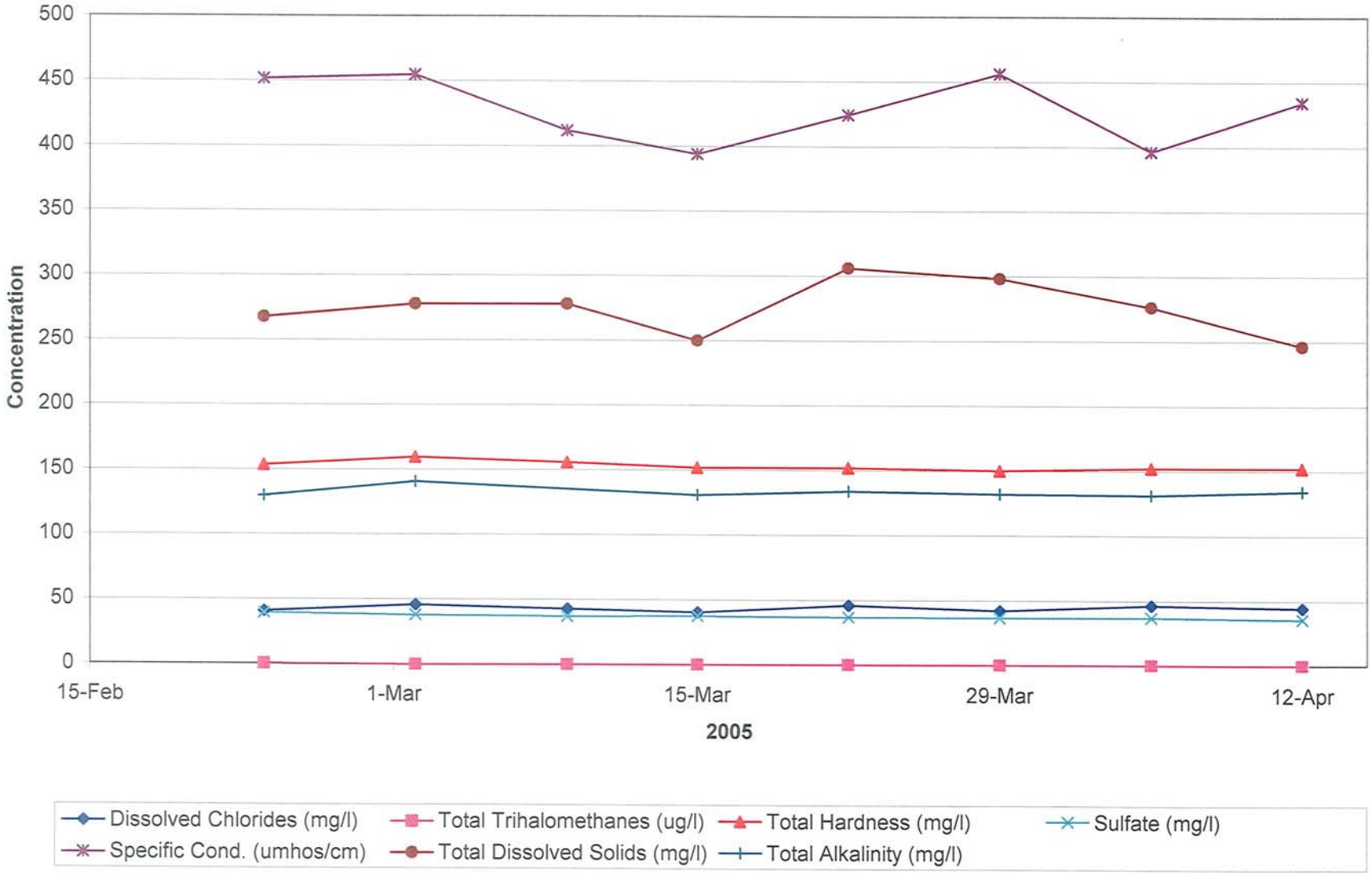


FIGURE 3-22. PLOT OF RECOVERED WATER QUALITY FROM WELL ASR-3 DURING CYCLE 5 (PART 2)

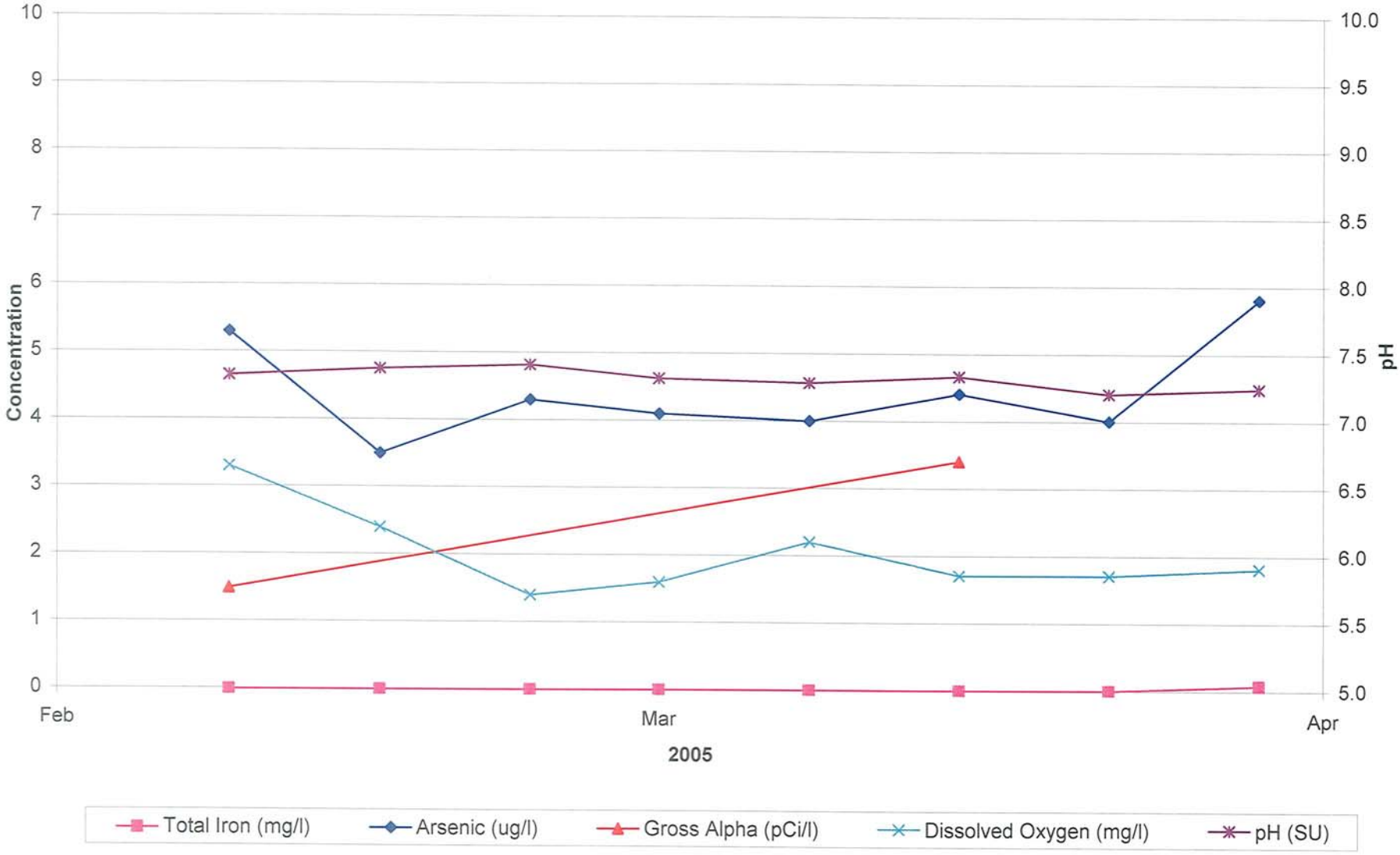


FIGURE 3-23. PLOT OF RECOVERED WATER QUALITY FROM WELL ASR-4 DURING CYCLE 5 (PART 1)

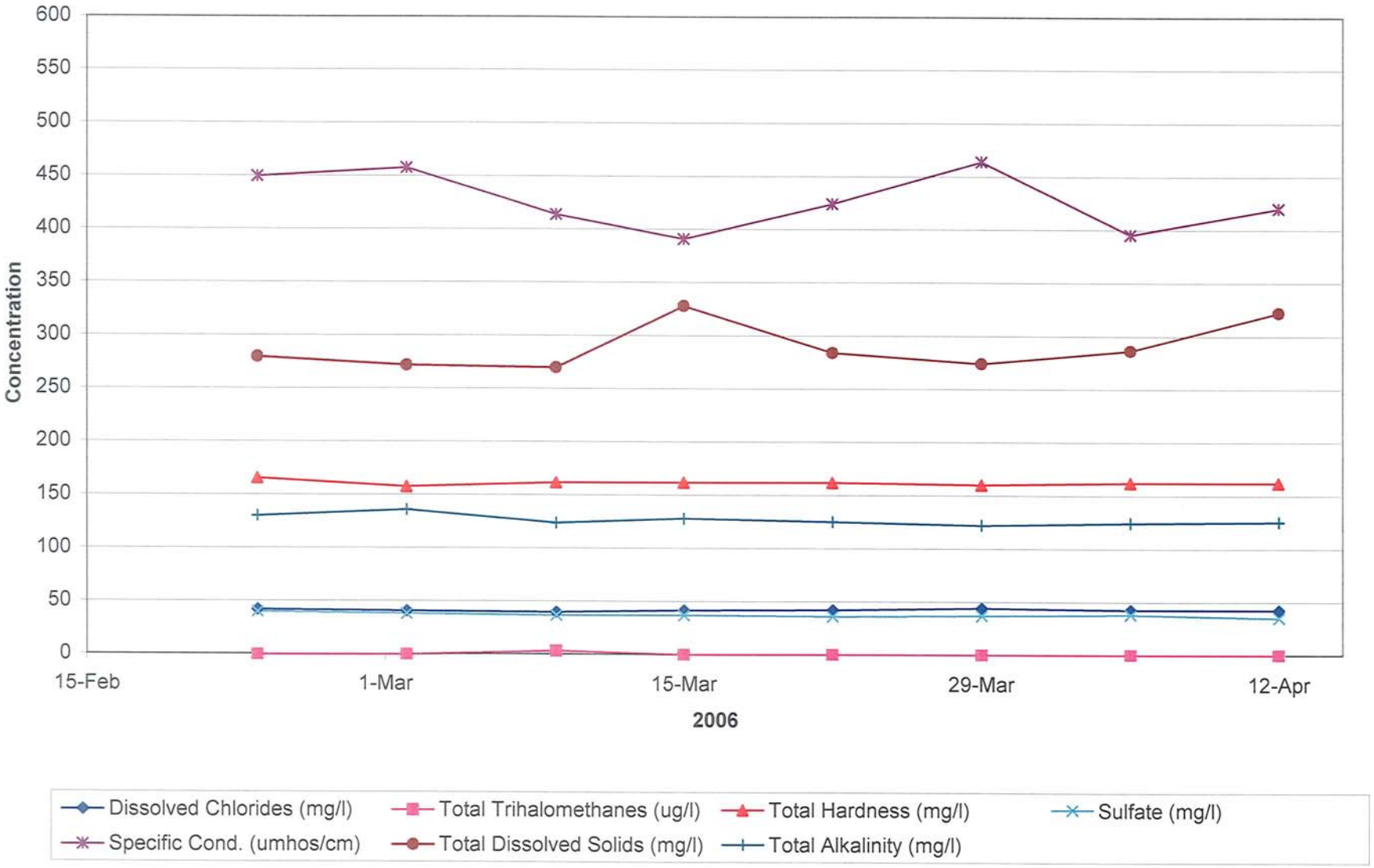


FIGURE 3-24. PLOT OF RECOVERED WATER QUALITY FROM WELL ASR-4 DURING CYCLE 5 (PART 2)

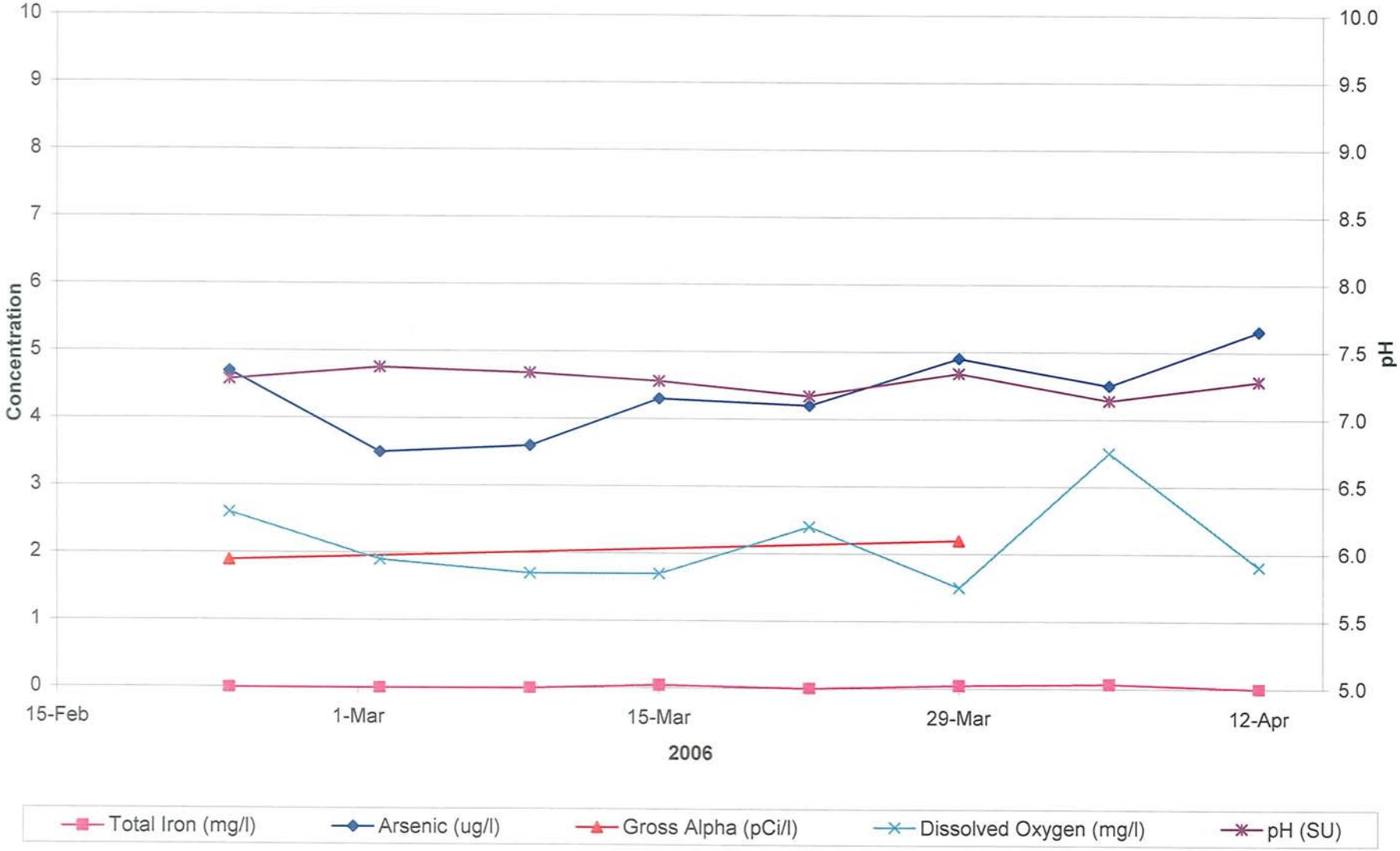


FIGURE 3-25. PLOT OF RECOVERED WATER QUALITY FROM WELL ASR-5 DURING CYCLE 5 (PART 1)

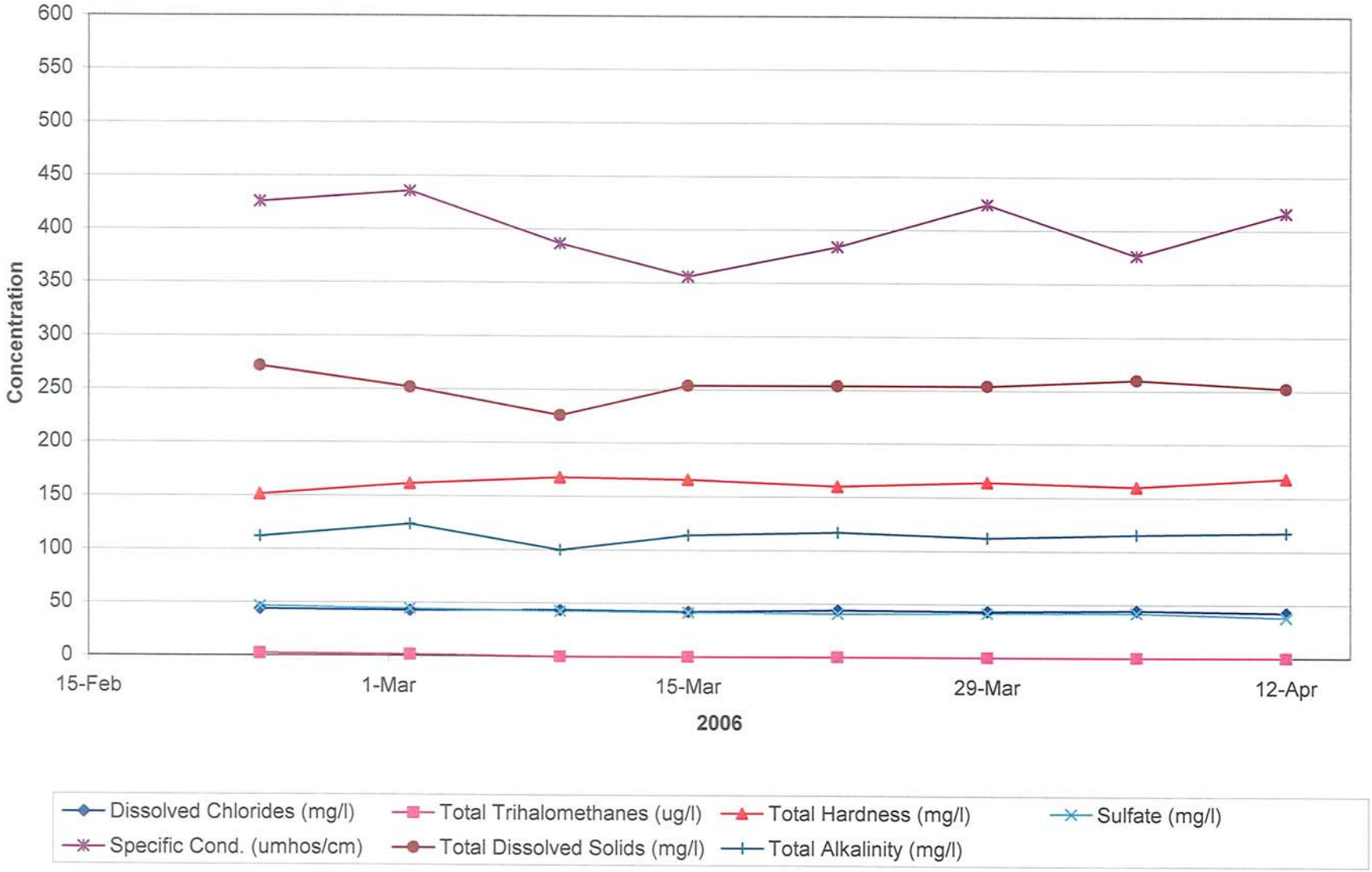


FIGURE 3-26. PLOT OF RECOVERED WATER QUALITY FROM WELL ASR-5 DURING CYCLE 5 (PART 2)

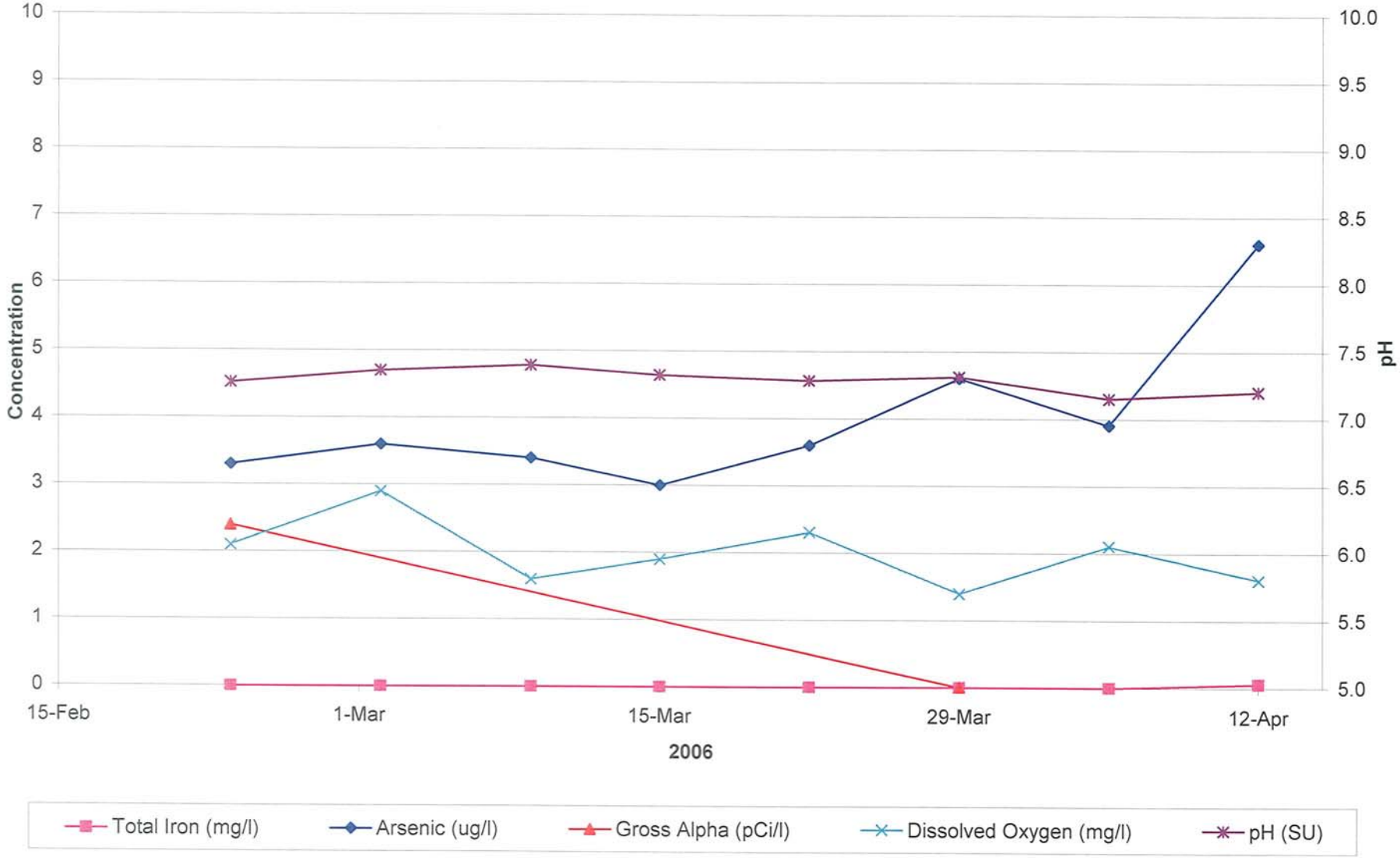


TABLE 3-6

SUMMARY OF RECOVERED WATER QUALITY RANGES
VERSUS REGULATORY CRITERIA DURING CYCLE 5

Parameter	Minimum Concentration	Maximum Concentration	Regulatory Criteria	Units
Total Iron	BDL	0.05	0.3	Mg/l
Total Arsenic	2.9	6.5	10	Ug/l
Total Dissolved Solids	232	282	500*	Mg/l
Total Color	8.8	13.8	15	CU
Sulfate	35.1	41.9	250	Mg/l
Chloride	40	45	250	Mg/l
pH	7.3	8.5	6.5 - 8.5	SU
Gross Alpha	BDL	1.1	15	pC/l
Turbidity	BDL	1.2	N/A	NTU
Total Alkalinity	108	123	N/A	Mg/l
Total Hardness	152	166	N/A	Mg/l
Total Trihalomethanes	BDL	0.5	50	Ug/l

* may be greater if no other maximum contaminant level is exceeded

BDL = below detection limit

FIGURE 3-27. PLOT OF TOTAL DISSOLVED SOLIDS VERSUS PERCENT OF INJECTED WATER RECOVERED FOR THE ASR WELLS FOR CYCLE 5

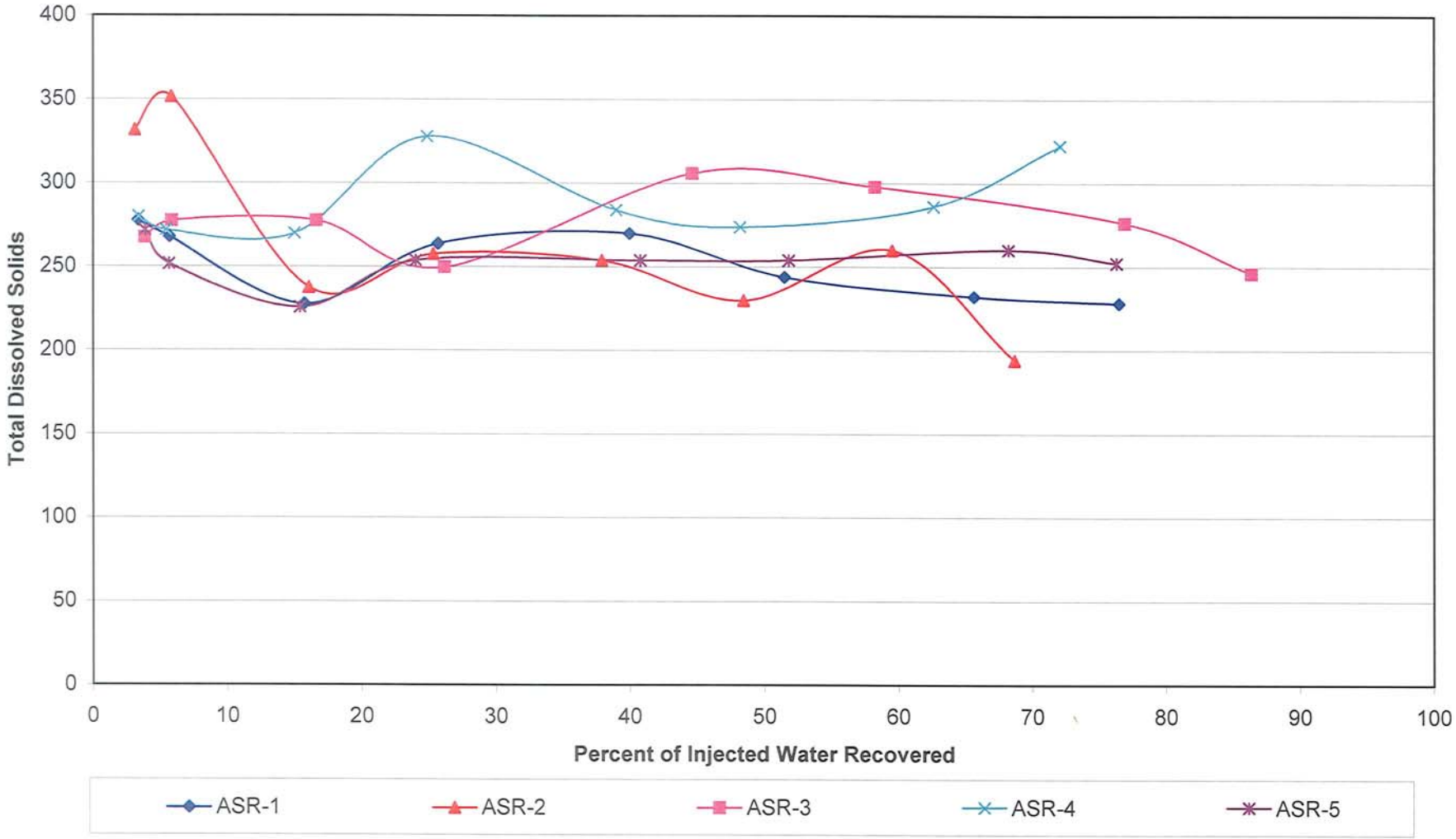
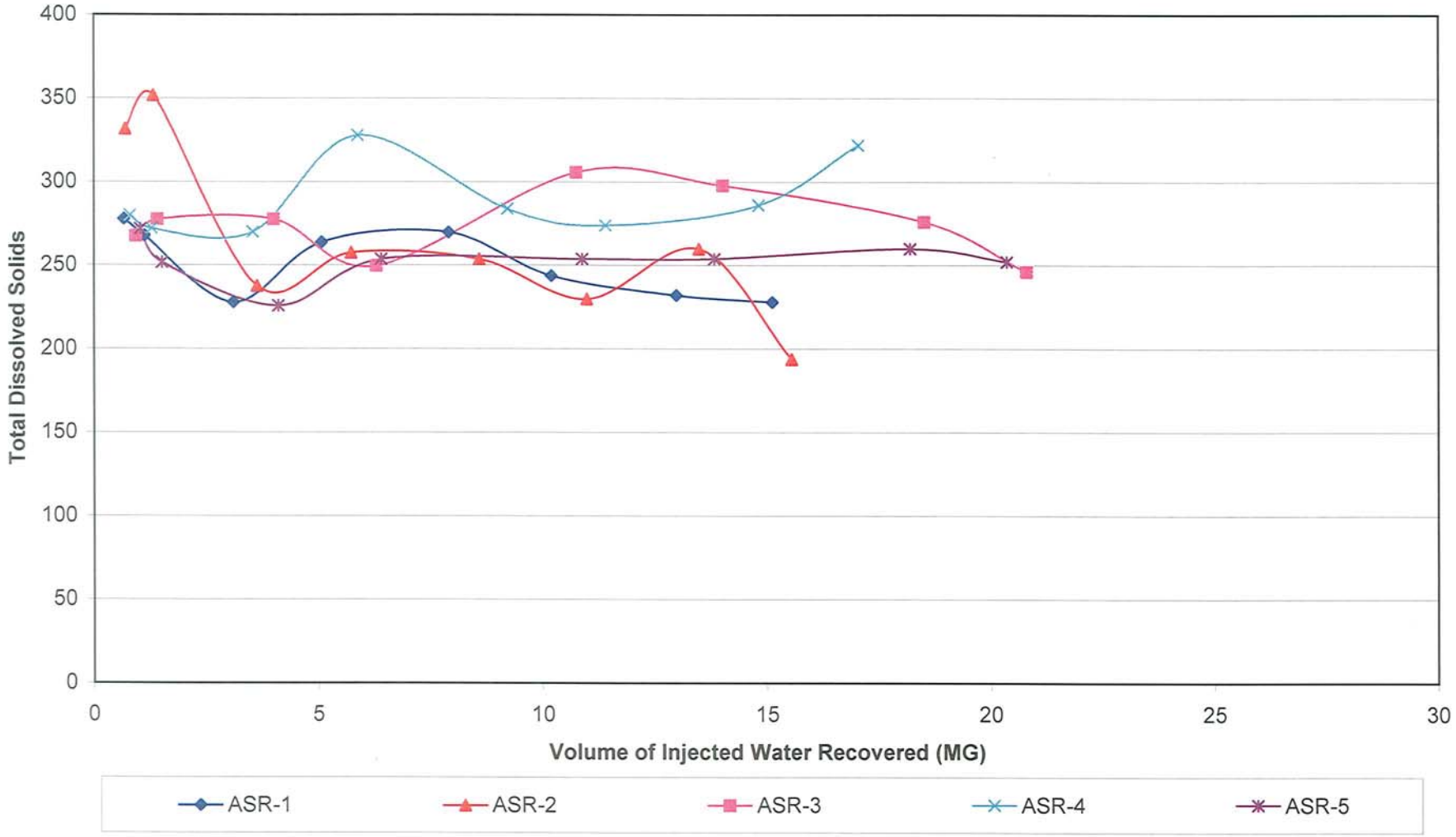


FIGURE 3-28. PLOT OF TOTAL DISSOLVED SOLIDS VERSUS VOLUME OF INJECTED WATER RECOVERED FOR THE ASR WELLS FOR CYCLE 5



The average daily recovery rate, on a monthly basis, varied between 209 gpm from well ASR-2 in February, 2006) and 347gpm (from well ASR-3 in March, 2006), and averaged 287 gpm per well. Recovery rates and cumulative volume recovered are shown on Figures 3-29 through 3-33.

Potentiometric water levels in the five storage zone observation wells were monitored on a daily basis during recovery operations. Water samples were obtained from the five storage zone observation wells on a weekly basis during recovery operations from the ASR wells and analyzed for those parameters shown on Table 3-4. An annotated plot of potentiometric water levels for the five storage zone observation wells for the entire Cycle 5 injection/storage/recovery period is provided as Figure 3-8. Plots of water quality parameters for storage zone observation wells C, 1, 2, and 3 for the entire Cycle 5 injection/storage/recovery period are provided as Figure 3-9 through 3-16. The progressive improvement in water quality in these wells during injection into the ASR wells and the similar progressive decline in water quality during recovery from the ASR wells are apparent on these graphs.

FIGURE 3-29. PLOT OF RECOVERY RATE AND CUMULATIVE VOLUME RECOVERED FOR ASR WELL 1 DURING CYCLE 5

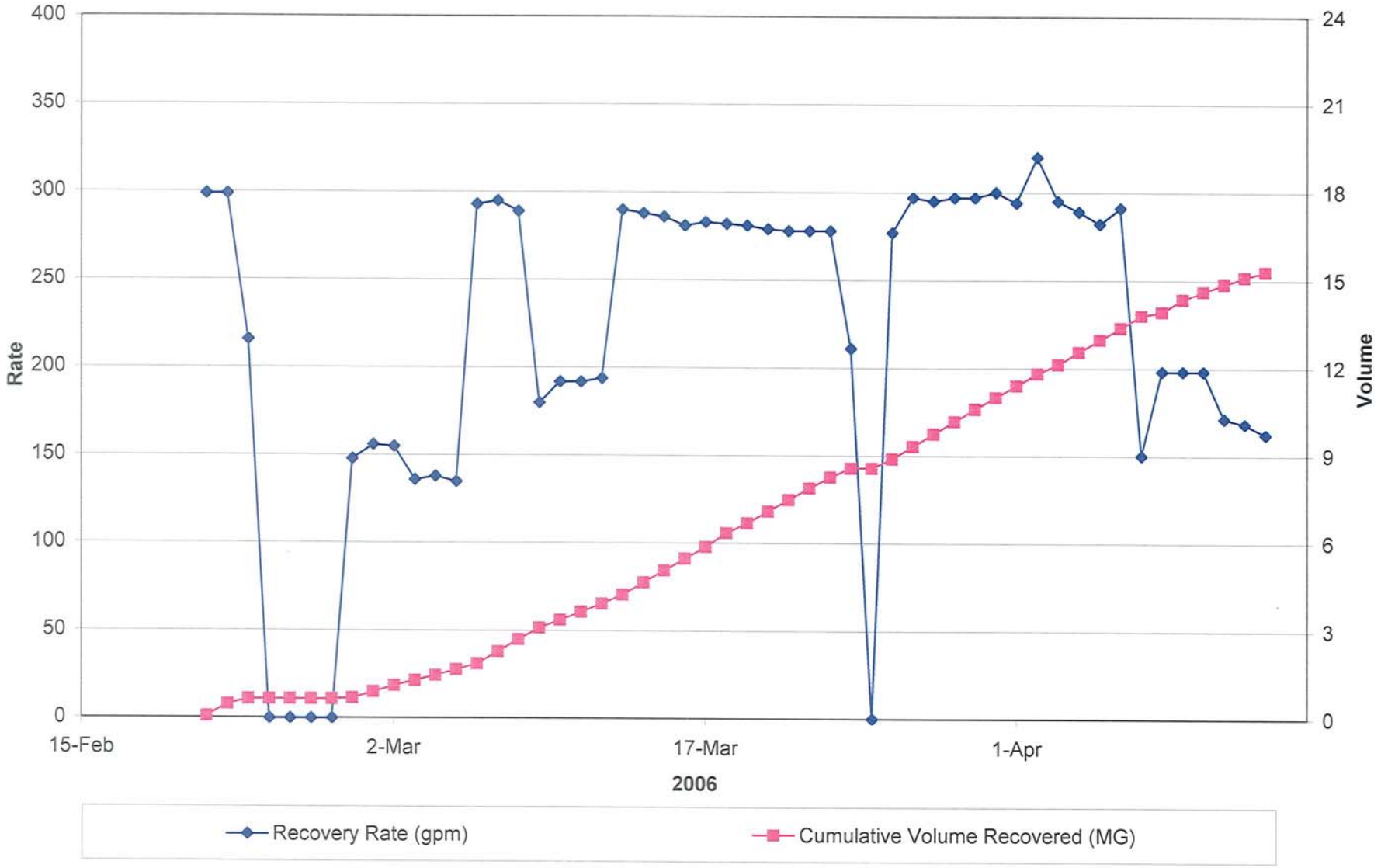


FIGURE 3-30. PLOT OF RECOVERY RATE AND CUMULATIVE VOLUME RECOVERED FOR ASR WELL 2 DURING CYCLE 5

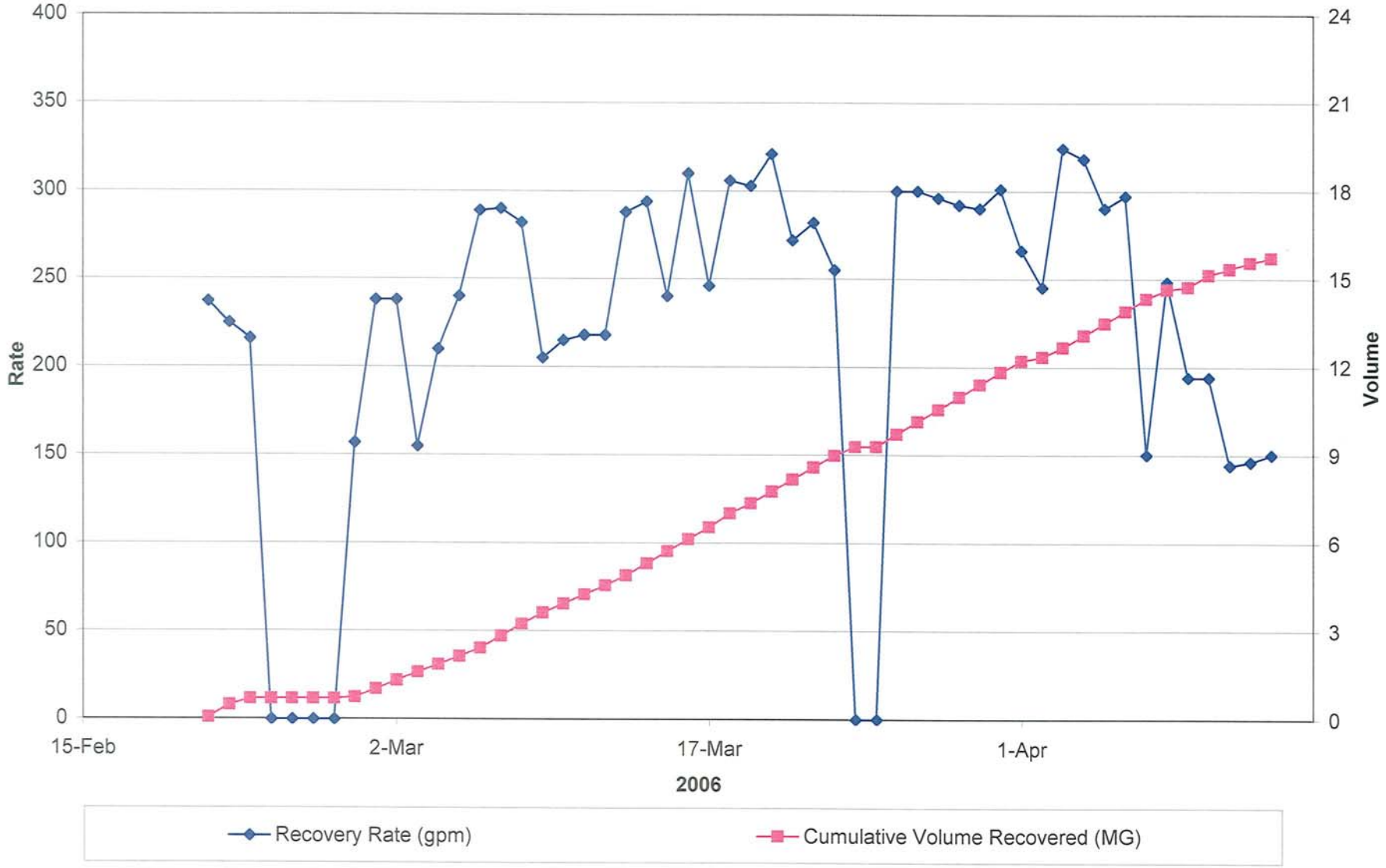


FIGURE 3-31. PLOT OF RECOVERY RATE AND CUMULATIVE VOLUME RECOVERED FOR ASR WELL 3 DURING CYCLE 5

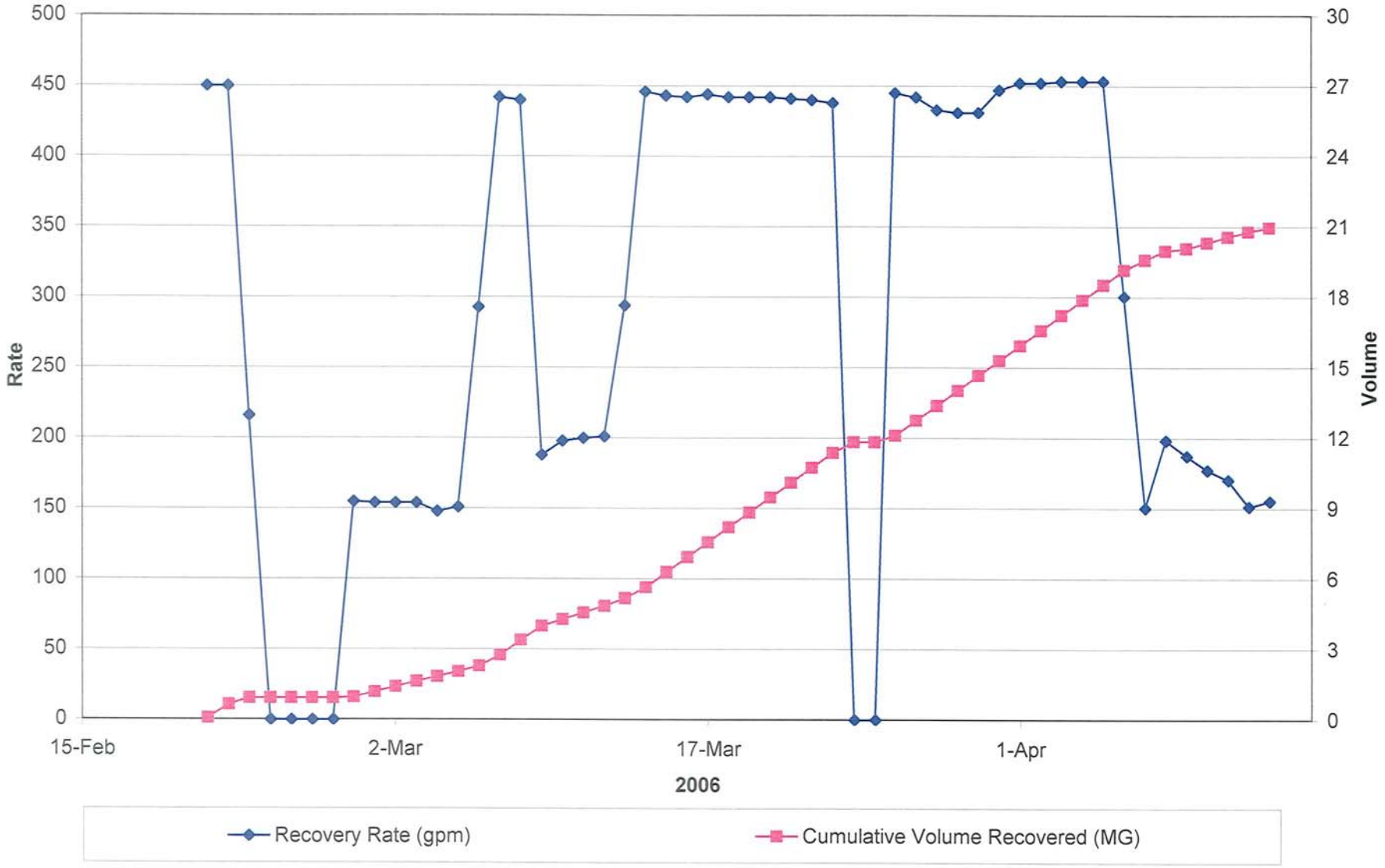


FIGURE 3-32. PLOT OF RECOVERY RATE AND CUMULATIVE VOLUME RECOVERED FOR ASR WELL 4 DURING CYCLE 5

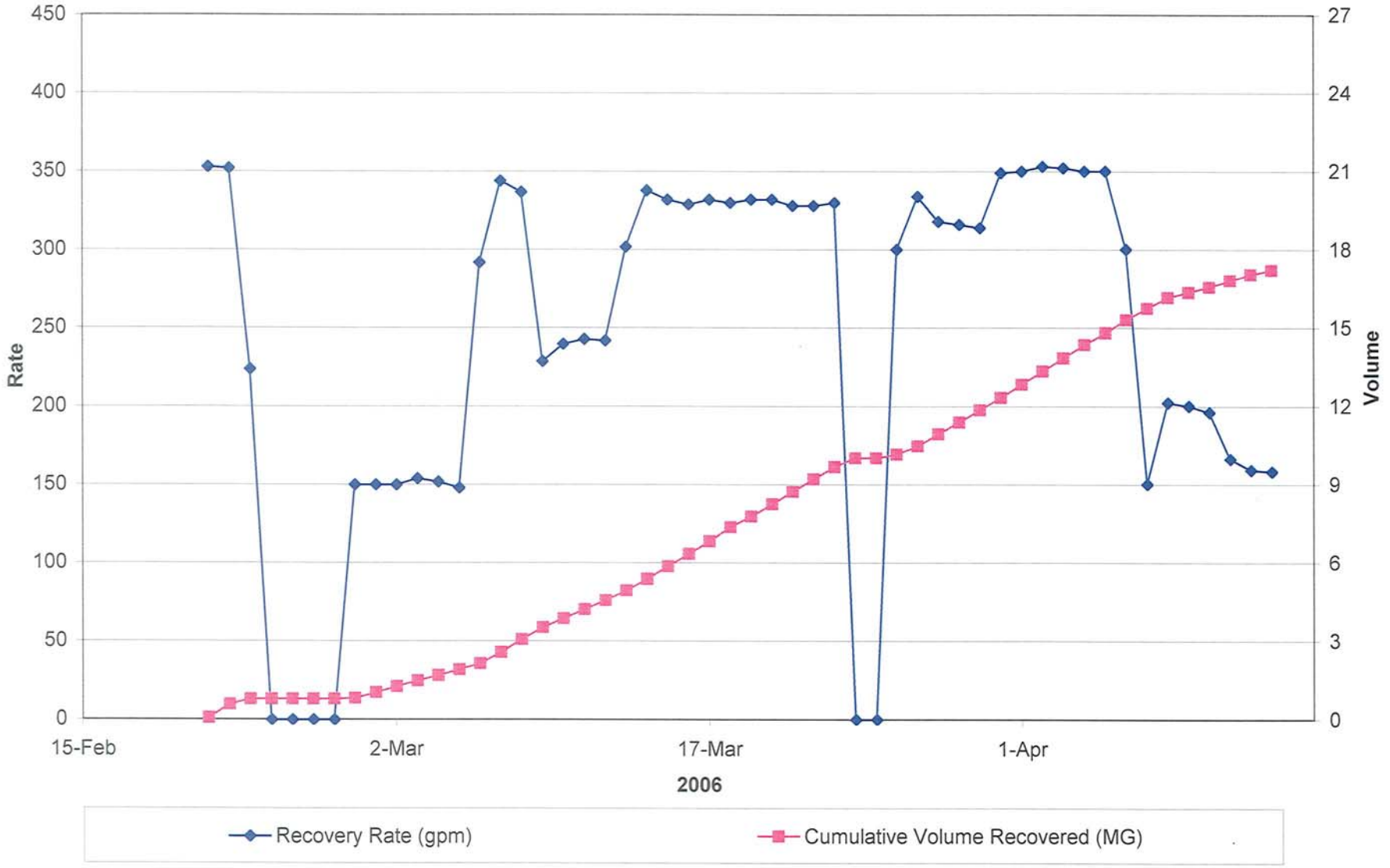
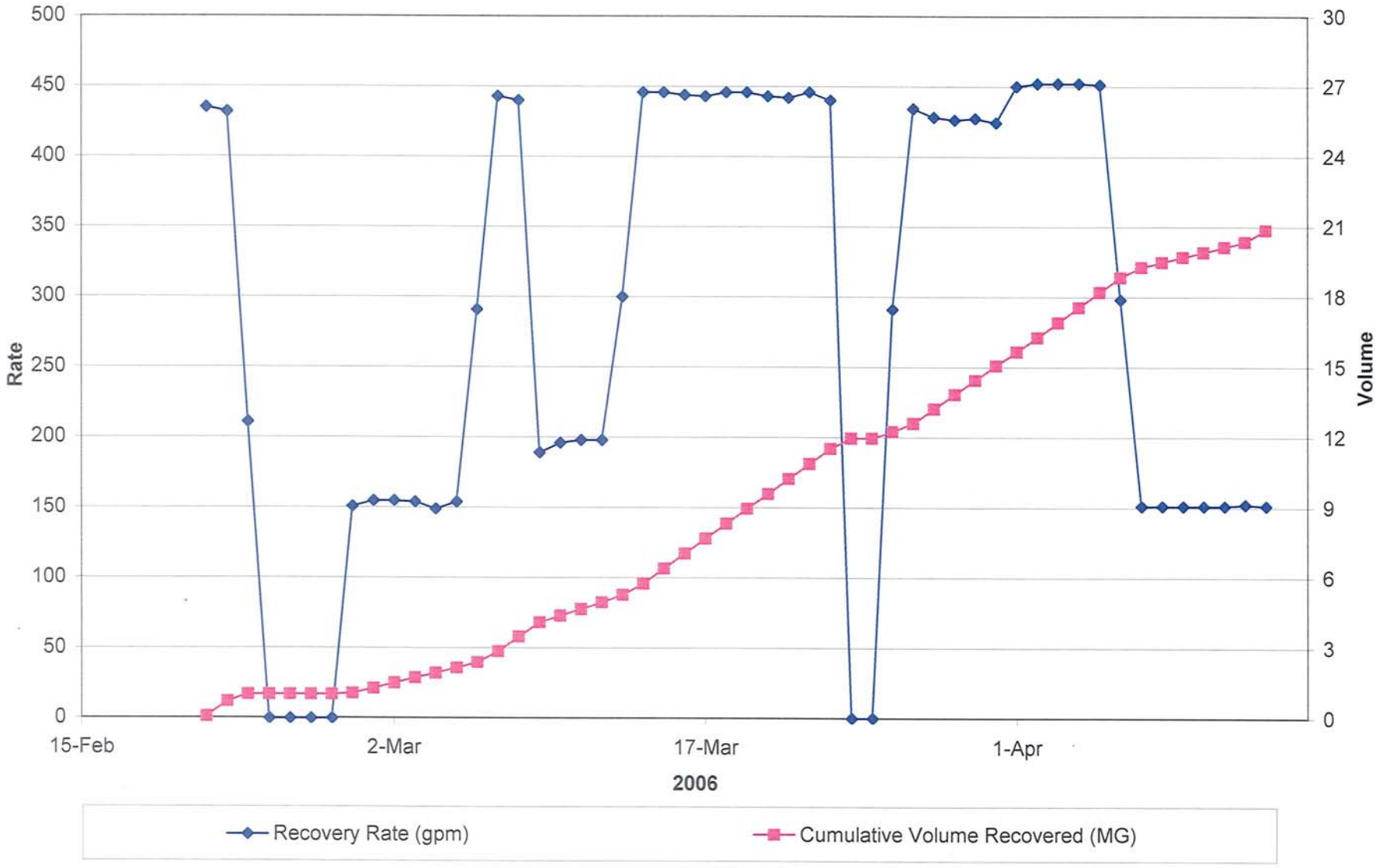


FIGURE 3-33. PLOT OF RECOVERY RATE AND CUMULATIVE VOLUME RECOVERED FOR ASR WELL 5 DURING CYCLE 5



IV. SUMMARY OF CYCLE 6 OPERATIONS FOR THE CORKSCREW ASR SYSTEM

A. Cycle 6 Injection

Cycle 6 injection into Corkscrew ASR system began on June 6, 2006 and continued to October 29, 2006. Approximately 316.3 MG of water was injected. The average TDS concentration of the injected water was 252 milligrams per liter. Injection ceased when the potable water demands from the Corkscrew WTP increased to the point that excess water was no longer available to inject into the ASR system. Plots of injection water quality are provided on Figures 4-1 and 4-2.

The injection water quality was monitored on a daily basis by LCU personnel for the parameter shown on Table 4-1. In compliance with the Florida Department of Environmental Protection (FDEP) underground injection control (UIC) permit (#142222-007 through -010-UC) for the system, the injection water quality was sampled on a weekly basis by LCU and the samples were transported to the Lee County Environmental Laboratory (LCEL) for analyses of the additional water quality parameters shown on Table 4-2. Monthly operational reports were provided to the FDEP.

A summary of the range in concentrations for the various injection water quality parameters and a comparison to regulatory criteria is provided on Table 4-3. The injected water met all Primary and Secondary Drinking Water Standards throughout the approximate 4.5-month injection period.

In addition to monitoring injection water quality, LCU adjusted and controlled the injection rate on a daily basis. During Cycle 6 injection, the daily average injection rate, on a monthly basis, varied between 203 gpm (into well ASR-2 during October, 2006) and 439 gpm (into well ASR-3 during July, 2006) and averaged 356 gpm per well. The injection rate was influenced by the availability of finished water from the WTP.

FIGURE 4-1. PLOT OF WATER QUALITY INJECTED INTO THE ASR WELLS DURING CYCLE 6 (PART 1)

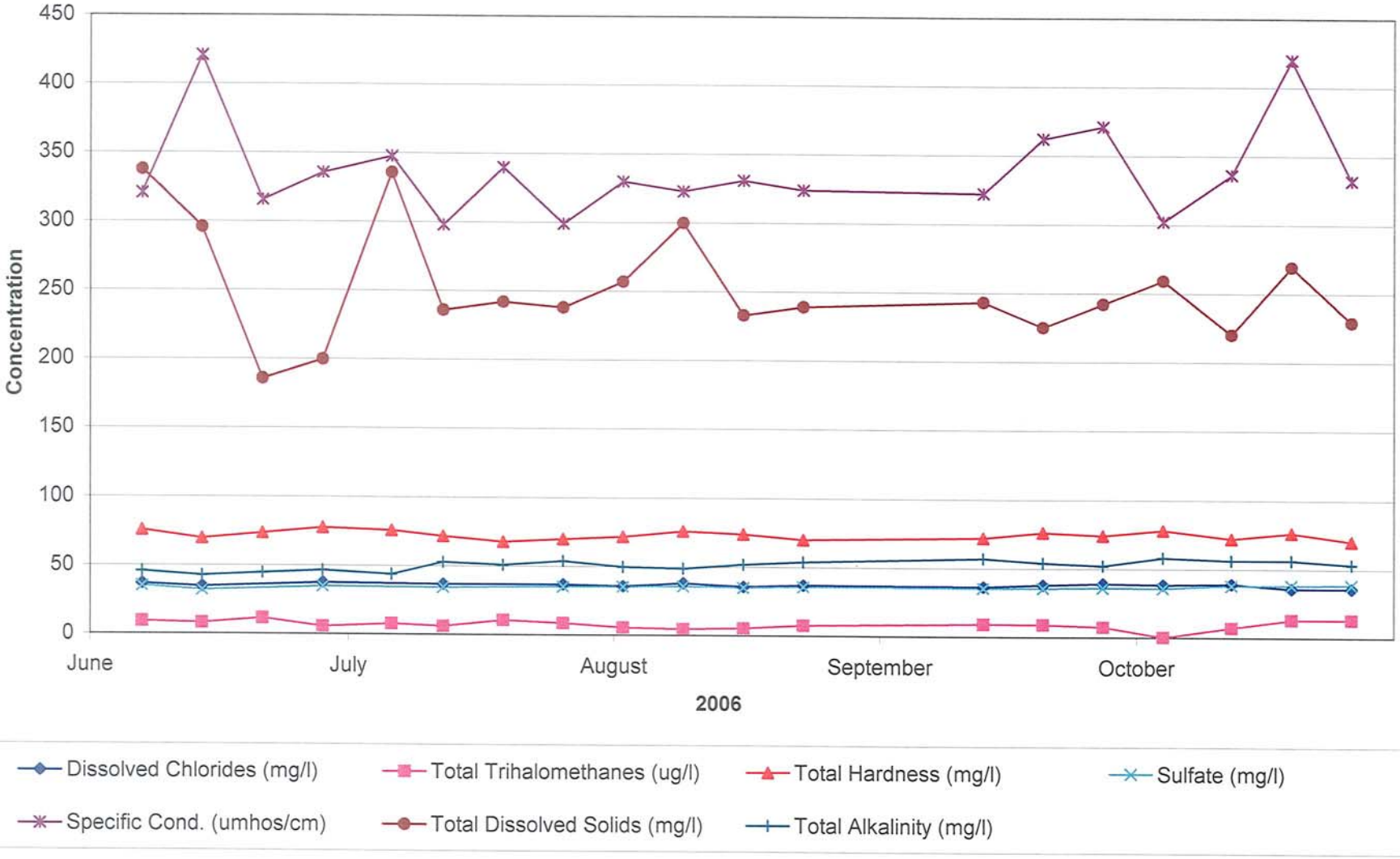


FIGURE 4-2. PLOT OF WATER QUALITY INJECTED INTO ASR WELLS DURING CYCLE 6 (PART 2)

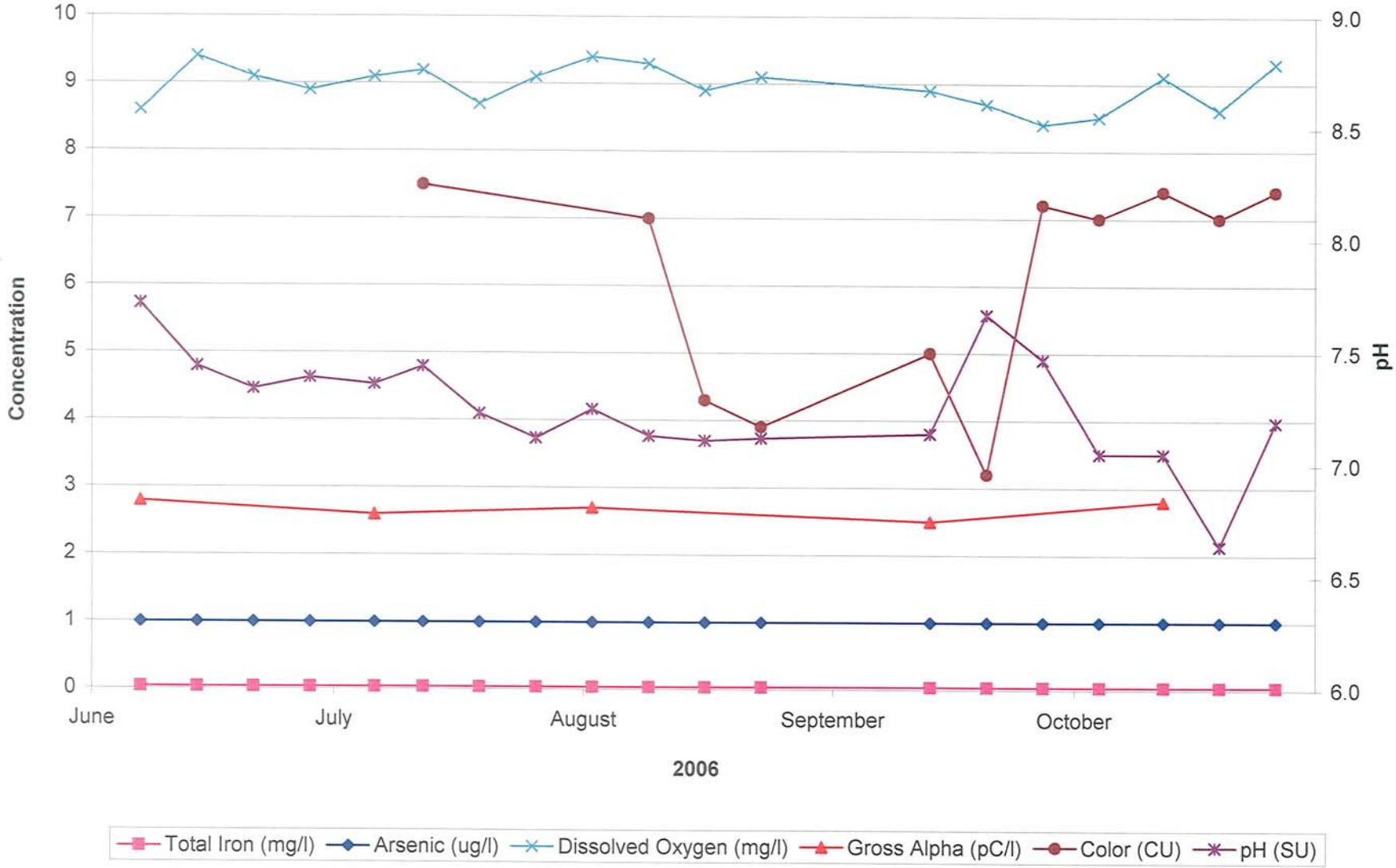


TABLE 4-1

SUMMARY OF FIELD ANALYZED HYDRAULIC AND WATER QUALITY PARAMETERS FOR THE ASR WELLS DURING CYCLE 6

Parameter	Analysis Frequency
Injection Pressure (psi)	Daily
Injection/Recovery rate (gpm)	Daily
Total Volume Injected/Recovered (gals)	Daily
Specific Capacity/Injectivity	Weekly
Dissolved Chloride (mg/l)	Daily
Specific Conductance (umhos/cm)	Daily
Temperature (°C)	Daily
Turbidity (NTU)	Daily
Dissolved Oxygen (mg/l)	Weekly
Free Chlorine (mg/l)	Daily
Total Chlorine (mg/l)	Daily
pH (SU)	Daily

TABLE 4-2

SUMMARY OF LABORATORY ANALYZED WATER QUALITY PARAMETERS FOR THE ASR WELLS DURING CYCLE 6

Parameter	Analysis Frequency
Arsenic (ug/l)	Weekly
Total Iron (mg/l)	Weekly
Total Trihalomethanes (mg/l)	Weekly
Total Dissolved Solids (mg/l)	Weekly
Dissolved Chloride (mg/l)	Weekly
Specific Conductance (umhos/cm)	Weekly
Total Alkalinity (mg/l)	Weekly
Sulfate (mg/l)	Weekly
Total Hardness (mg/l)	Weekly
Calcium Hardness (mg/l)	Weekly
Total Color (CU)	Weekly
Gross Alpha (pC/l)	Beginning and End of Injection and Recovery

TABLE 4-3

SUMMARY OF INJECTION WATER QUALITY RANGES
VERSUS REGULATORY CRITERIA DURING CYCLE 6

Parameter	Minimum Concentration	Maximum Concentration	Regulatory Criteria	Units
Total Iron	0.04	0.04	0.3	mg/l
Total Arsenic	1.0	1.0	10	ug/l
Total Dissolved Solids	186	338	500*	mg/l
Total Color	3.2	7.5	15	CU
Sulfate	32.4	38.0	250	mg/l
Chloride	35	39	250	mg/l
pH	7.3	8.1	6.5 - 8.5	SU
Gross Alpha	2.5	2.8	15	pC/l
Turbidity	0.2	1.0	N/A	NTU
Total Alkalinity	43	58	N/A	mg/l
Total Hardness	68	78	N/A	mg/l
Total Trihalomethanes	0.2	13.0	50	ug/l

* may be greater if no other maximum contaminant level is exceeded

BDL = below detection limit

Injection rates and pressures are shown on Figures 4-3 through 4-7. In order to maintain adequate injection rates and injection pressures, a pH adjustment system was utilized and adjusted on a daily basis by Corkscrew WTP personnel. This system uses carbonic acid to lower the pH of the finished water from the Corkscrew WTP.

Potentiometric water levels in the five storage zone observation wells were monitored on a daily basis. Water samples were obtained from the five storage zone observation wells on a weekly basis and analyzed for those parameters shown on Tables 4-4 and 4-5. An annotated plot of potentiometric water levels for the five storage zone observation wells for the Cycle 6 injection and storage period is provided as Figure 4-8. Plots of water quality parameters for storage zone observation wells C, 1, 2, and 3 for the Cycle 6 injection and storage period are provided as Figure 4-9 through 4-16. No water quality was monitored in storage zone observation well A during this cycle. The progressive improvement in water quality in these wells during injection into the ASR wells is apparent on these graphs.

FIGURE 4-3. PLOT OF INJECTION PRESSURE, RATE, AND CUMULATIVE VOLUME INJECTED INTO ASR WELL 1 DURING CYCLE 6

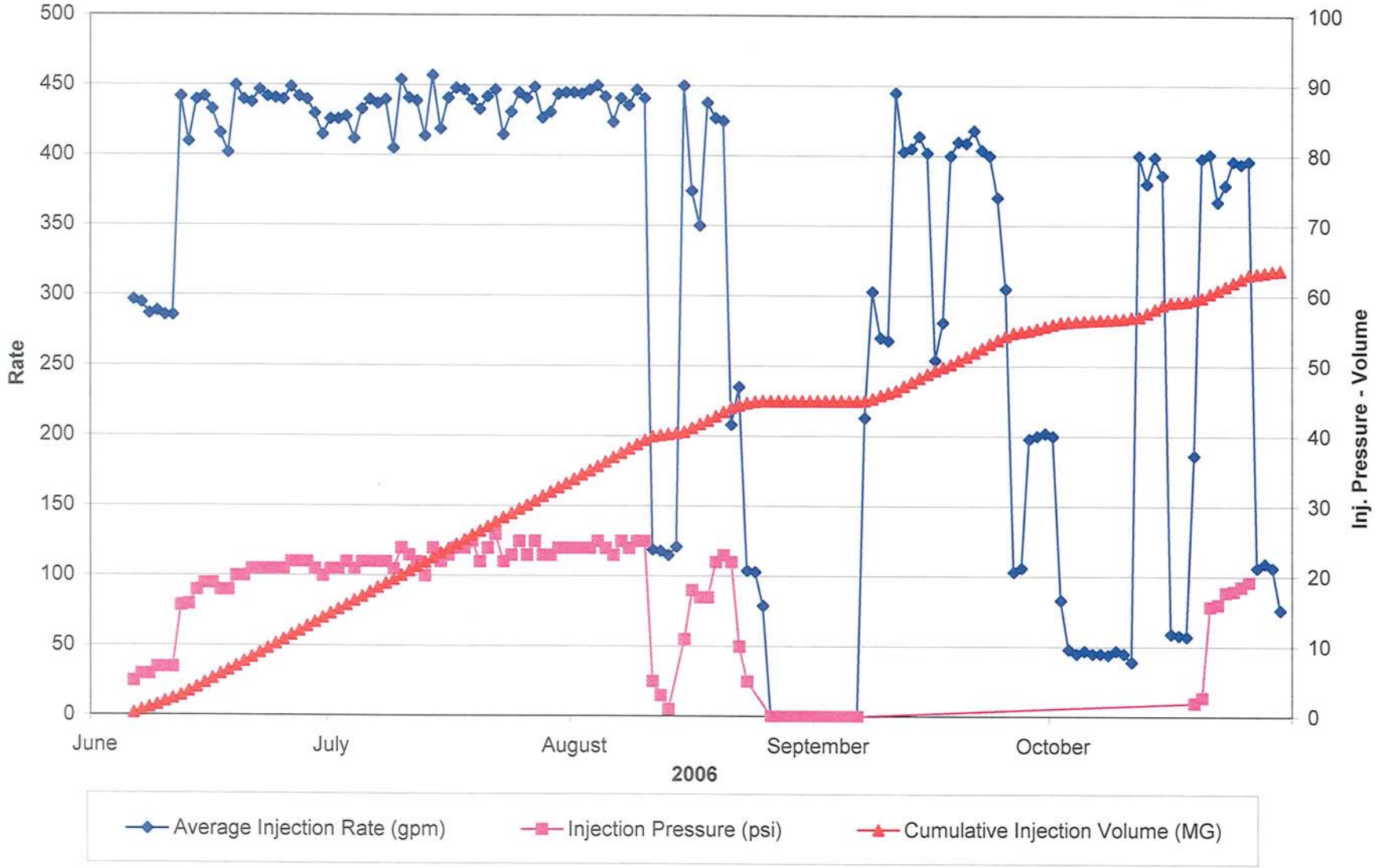


FIGURE 4-4. PLOT OF INJECTION PRESSURE, RATE, AND CUMULATIVE VOLUME INJECTED INTO ASR WELL 2 DURING CYCLE 6

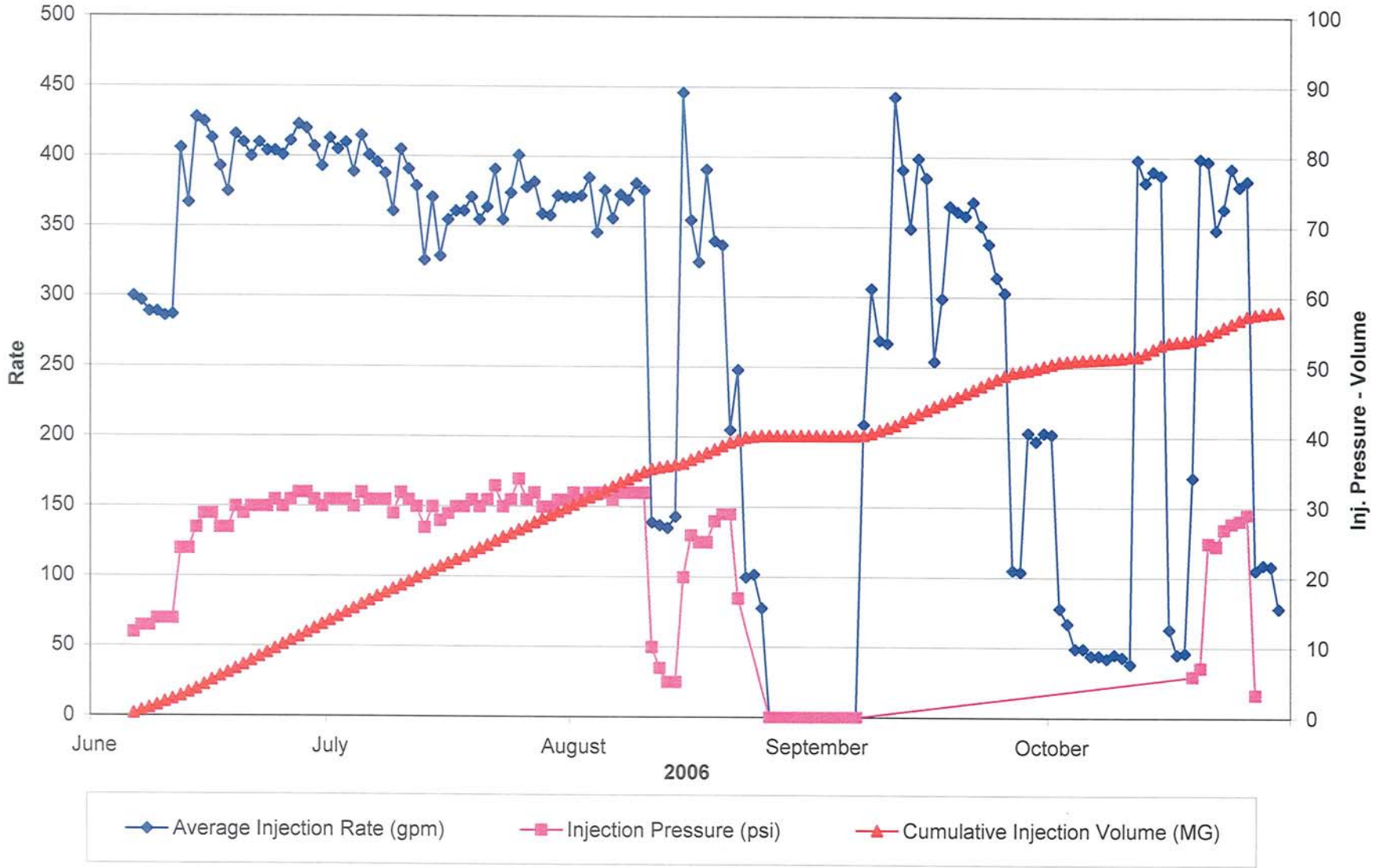


FIGURE 4-5. PLOT OF INJECTION PRESSURE, RATE, AND CUMULATIVE VOLUME INJECTED INTO ASR WELL 3 DURING CYCLE 6

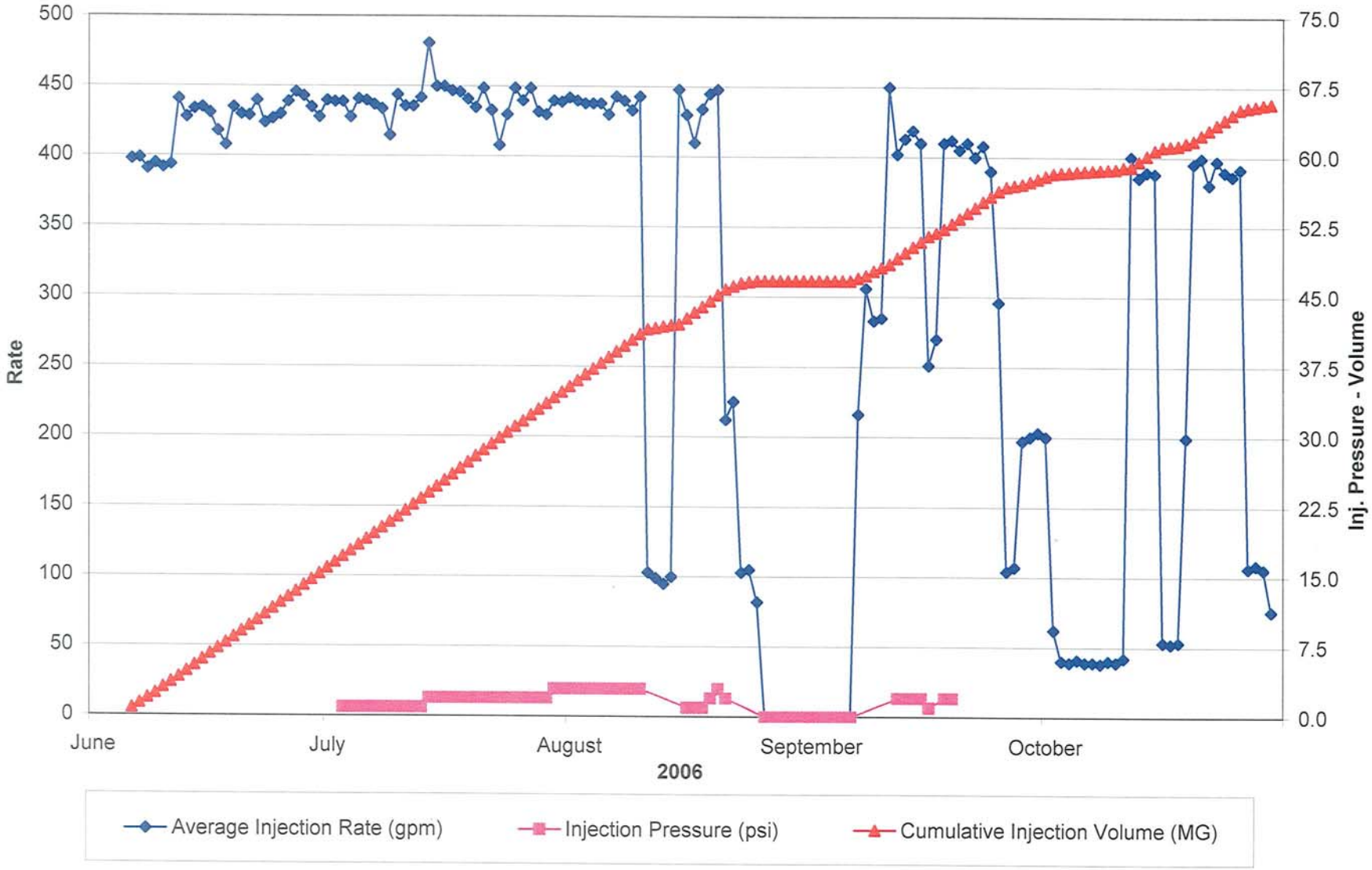


FIGURE 4-6. PLOT OF INJECTION PRESSURE, RATE, AND CUMULATIVE VOLUME INJECTED INTO ASR WELL 4 DURING CYCLE 6

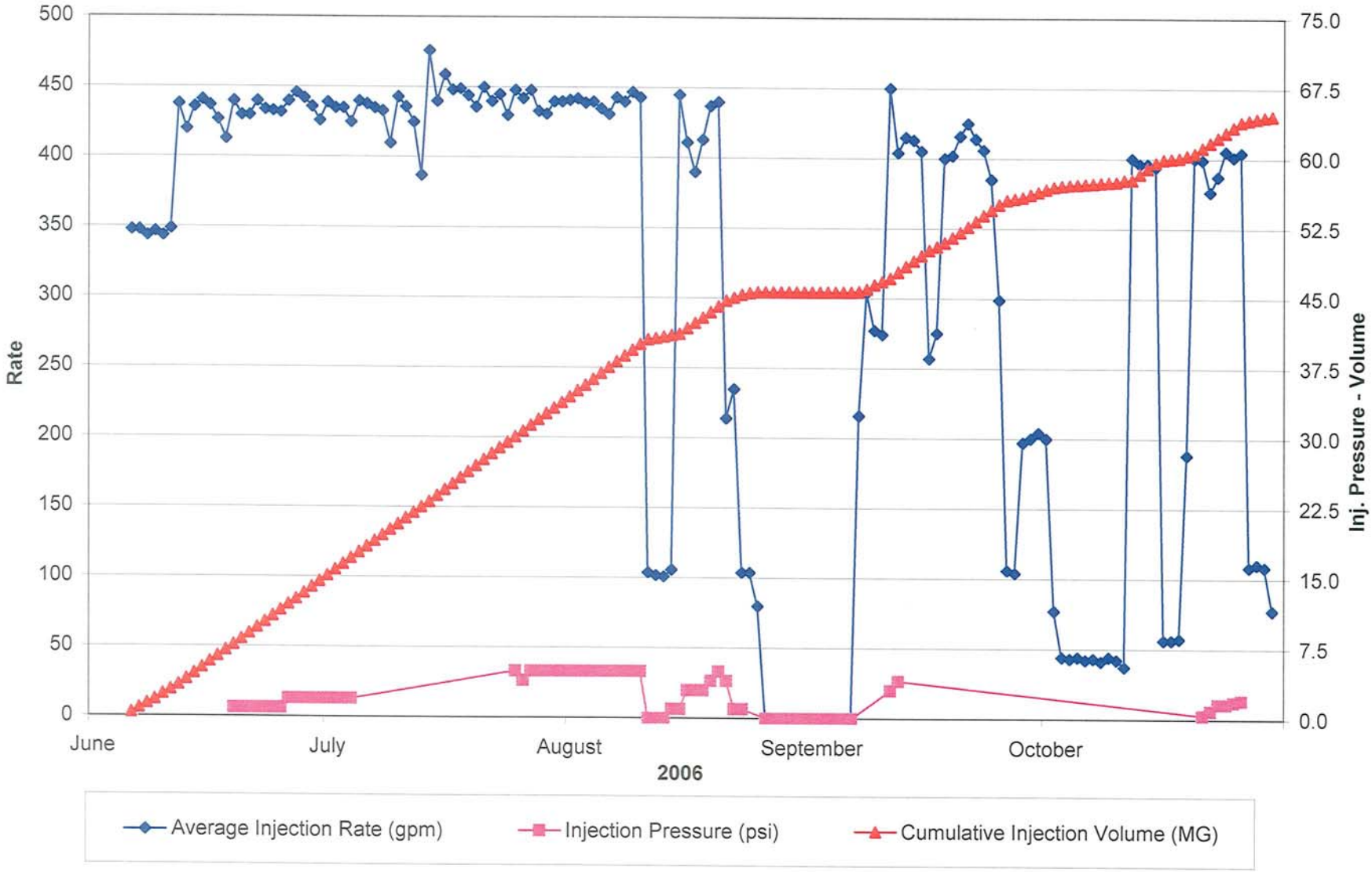


FIGURE 4-7. PLOT OF INJECTION PRESSURE, RATE, AND CUMULATIVE VOLUME INJECTED INTO ASR WELL 5 DURING CYCLE 6

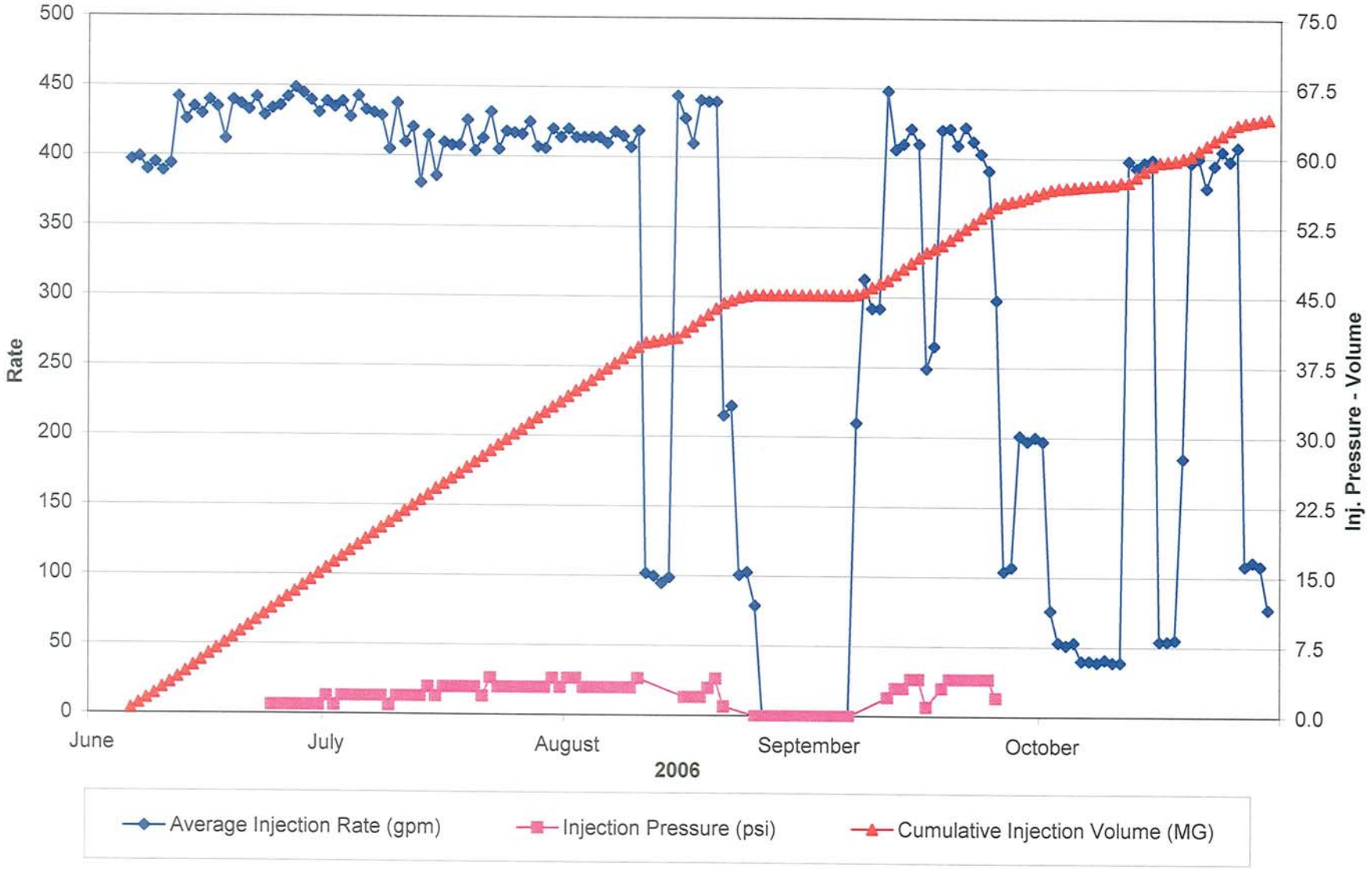


TABLE 4-4

SUMMARY OF FIELD ANALYZED HYDRAULIC AND
WATER QUALITY PARAMETERS
FOR MW-A, MW-C, AND SZMW-1 DURING CYCLE 6

Parameter	Analysis Frequency
Potentiometric Pressure (psi)	Daily
Dissolved Chloride (mg/l)	Weekly
Specific Conductance (umhos/cm)	Weekly
Temperature (°C)	Weekly
Turbidity (NTU)	Weekly
Dissolved Oxygen (mg/l)	Weekly
Free Chlorine (mg/l)	Weekly
Total Chlorine (mg/l)	Weekly
pH (SU)	Weekly

TABLE 4-5

SUMMARY OF LABORATORY ANALYZED WATER QUALITY PARAMETERS FOR MW-A, MW-C, AND SZMW-1 THROUGH SZMW-3 DURING CYCLE 6

Parameter	Analysis Frequency
Arsenic (ug/l)	Weekly
Total Iron (mg/l)	Weekly
Total Trihalomethanes (mg/l)	Weekly
Total Dissolved Solids (mg/l)	Weekly
Dissolved Chloride (mg/l)	Weekly
Specific Conductance (umhos/cm)	Weekly
Total Alkalinity (mg/l)	Weekly
Sulfate (mg/l)	Weekly
Total Hardness (mg/l)	Weekly
Calcium Hardness (mg/l)	Weekly
Total Color (CU)	Weekly
Gross Alpha (pC/l)	Monthly

FIGURE 4-8. PLOT OF DAILY WATER LEVELS IN STORAGE ZONE OBSERVATION WELLS DURING CYCLE 6

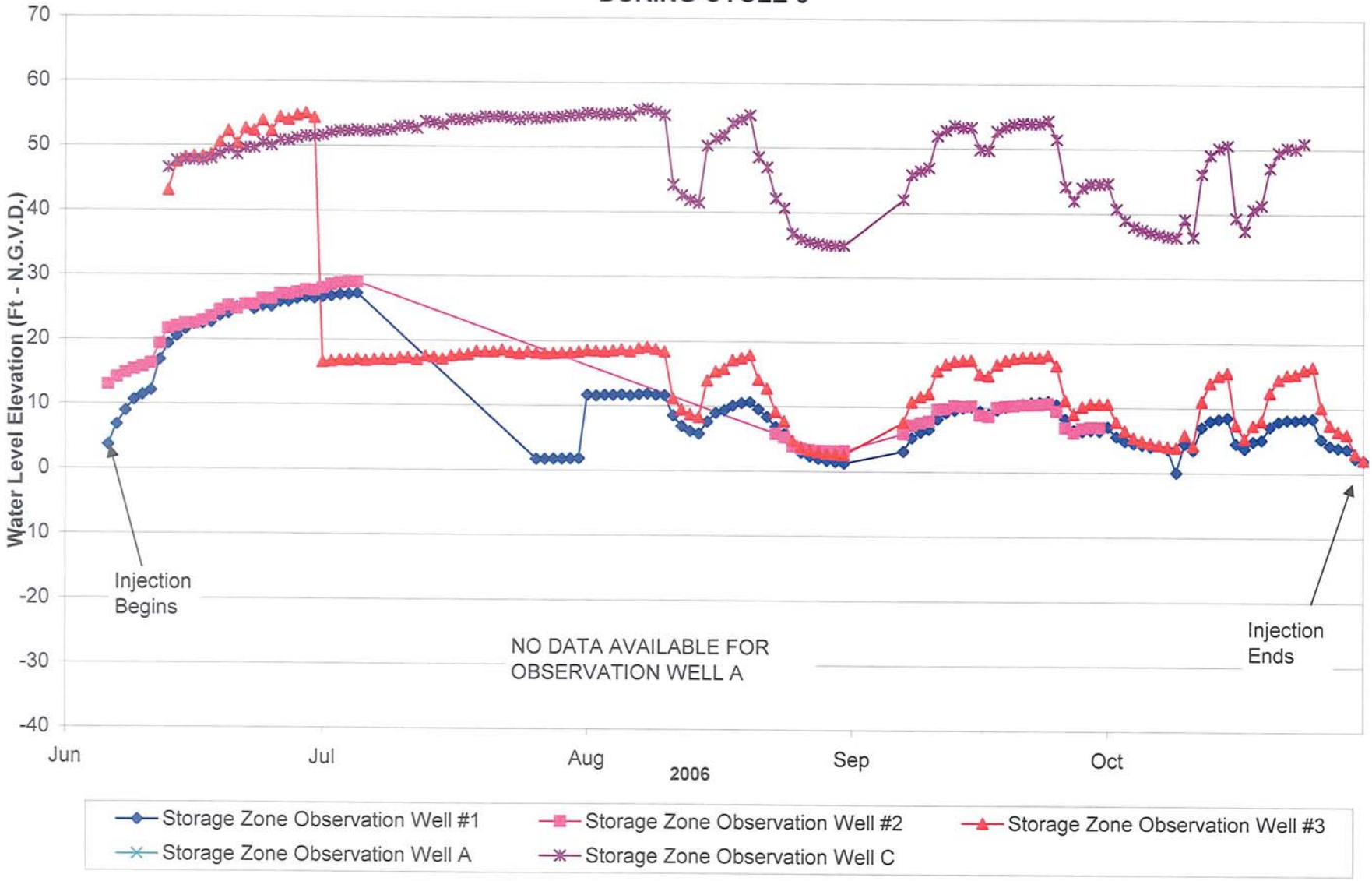


FIGURE 4-9. PLOT OF WATER QUALITY IN STORAGE ZONE OBSERVATION WELL C DURING CYCLE 6 (PART 1)

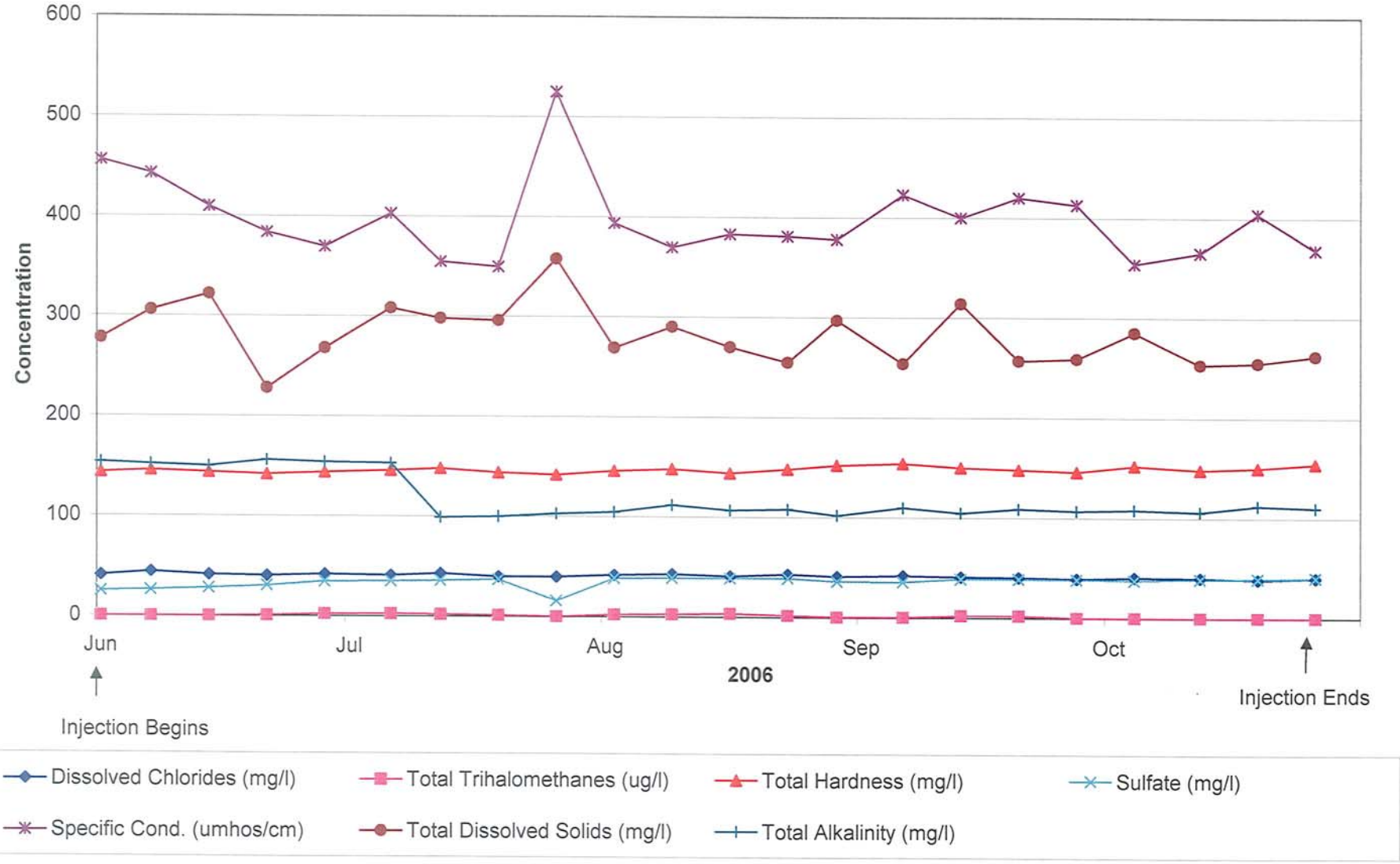


FIGURE 4-10. PLOT OF WATER QUALITY IN STORAGE ZONE OBSERVATION WELL C DURING CYCLE 6 (PART 2)

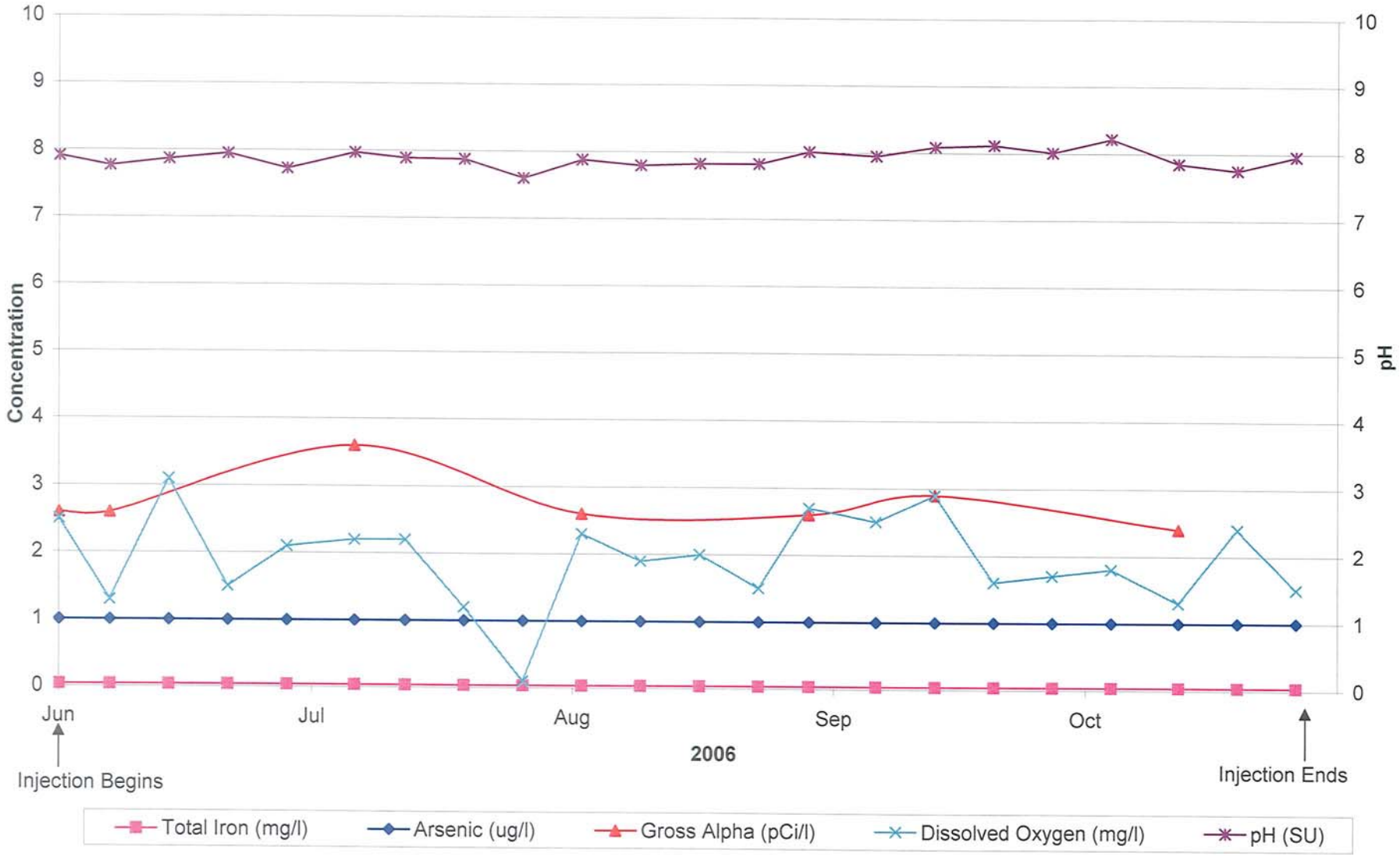


FIGURE 4-11. PLOT OF WATER QUALITY IN STORAGE ZONE OBSERVATION WELL 1 DURING CYCLE 6 (PART 1)

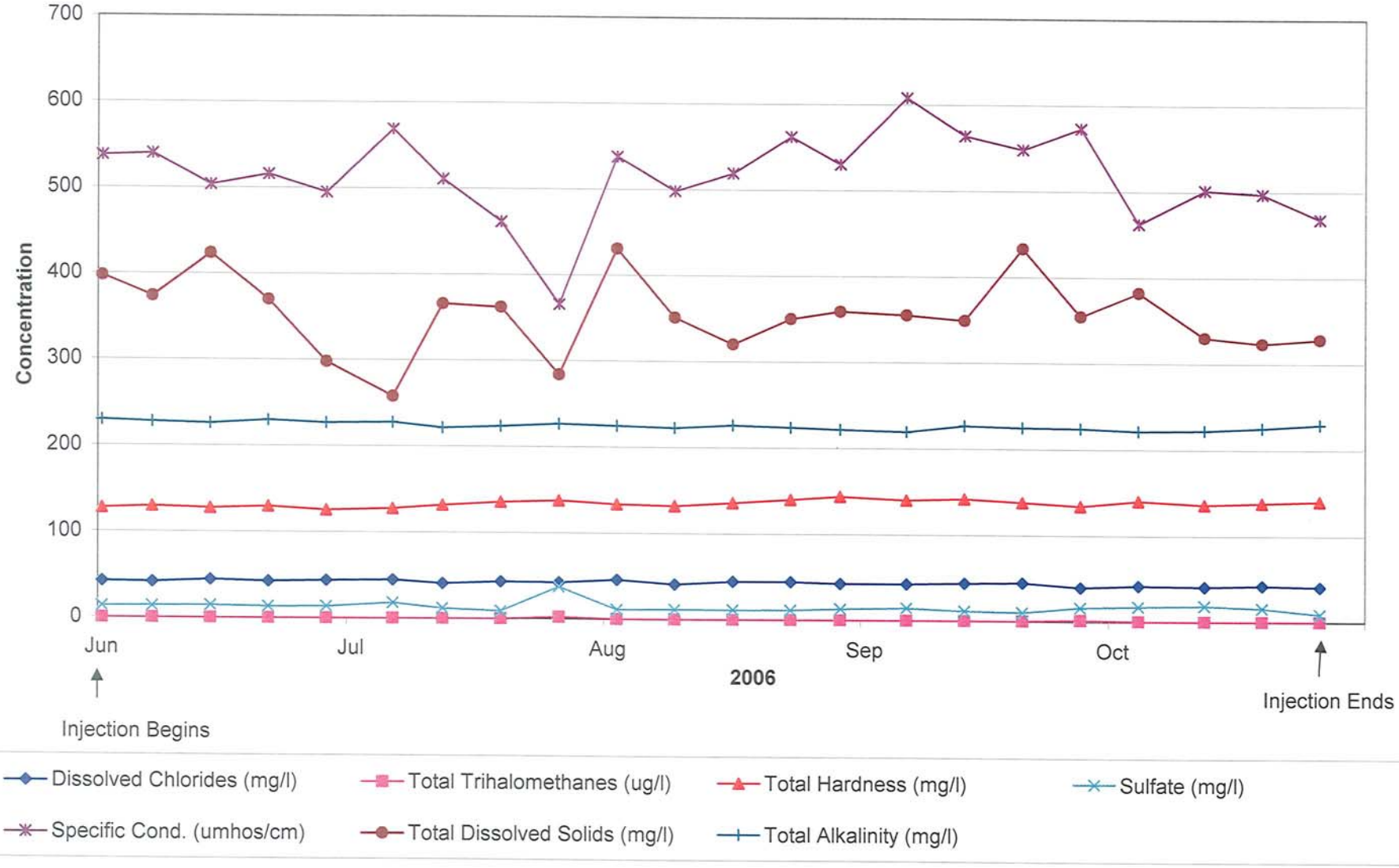


FIGURE 4-12. PLOT OF WATER QUALITY IN STORAGE ZONE OBSERVATION WELL 1 DURING CYCLE 6 (PART 2)

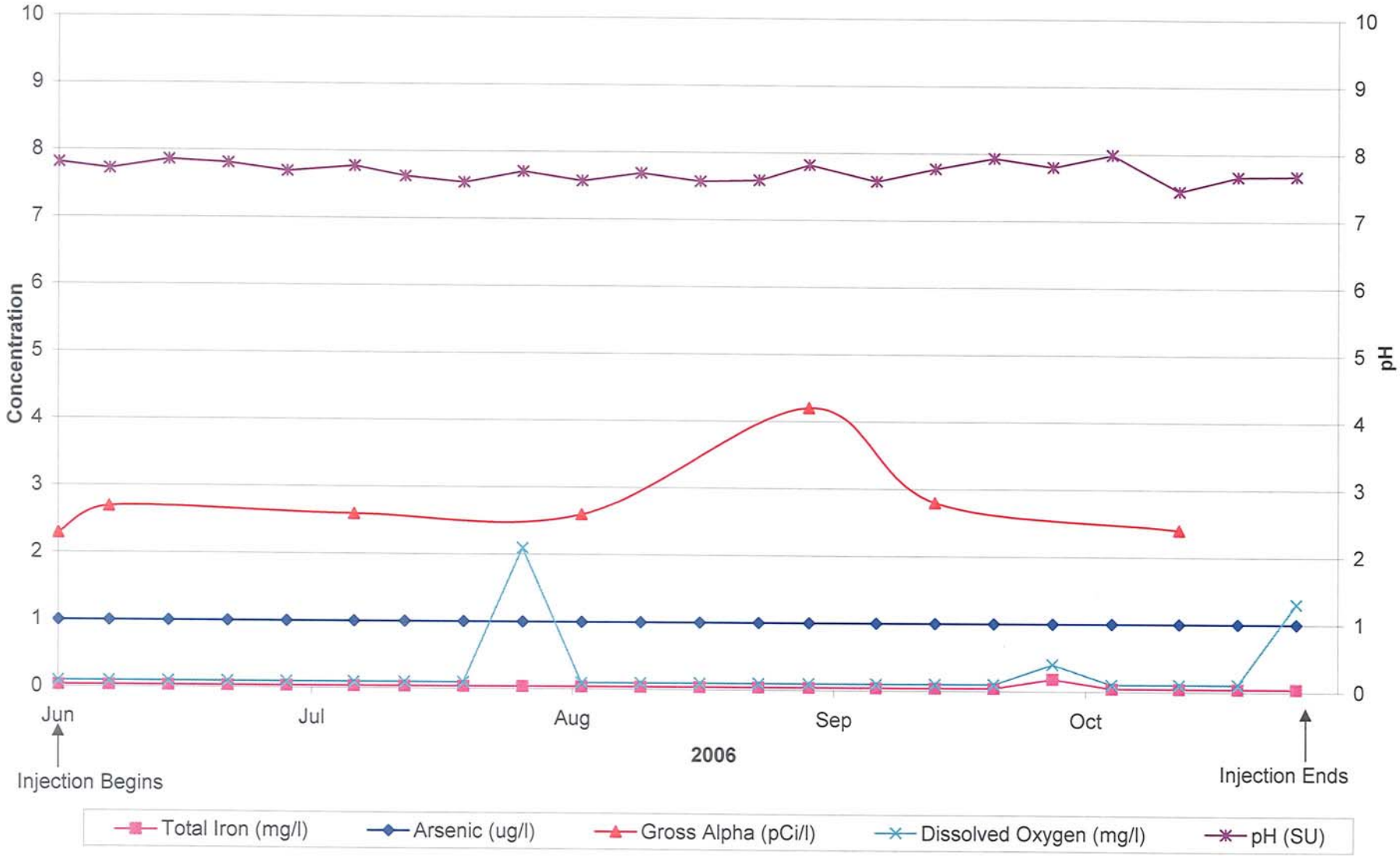


FIGURE 4-13. PLOT OF WATER QUALITY IN STORAGE ZONE OBSERVATION WELL 2 DURING CYCLE 6 (PART 1)

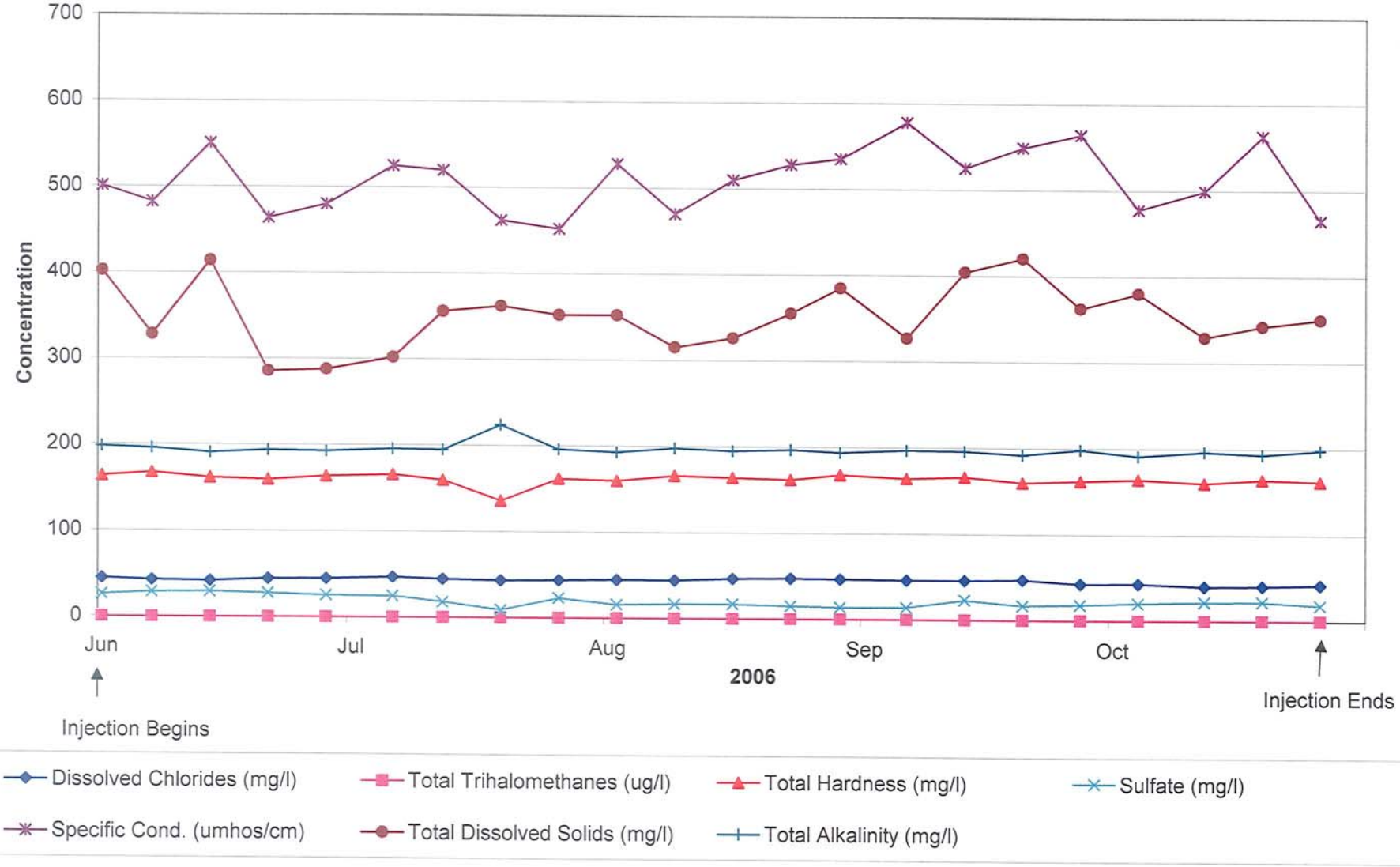


FIGURE 4-14. PLOT OF WATER QUALITY IN STORAGE ZONE OBSERVATION WELL 2 DURING CYCLE 6 (PART 2)

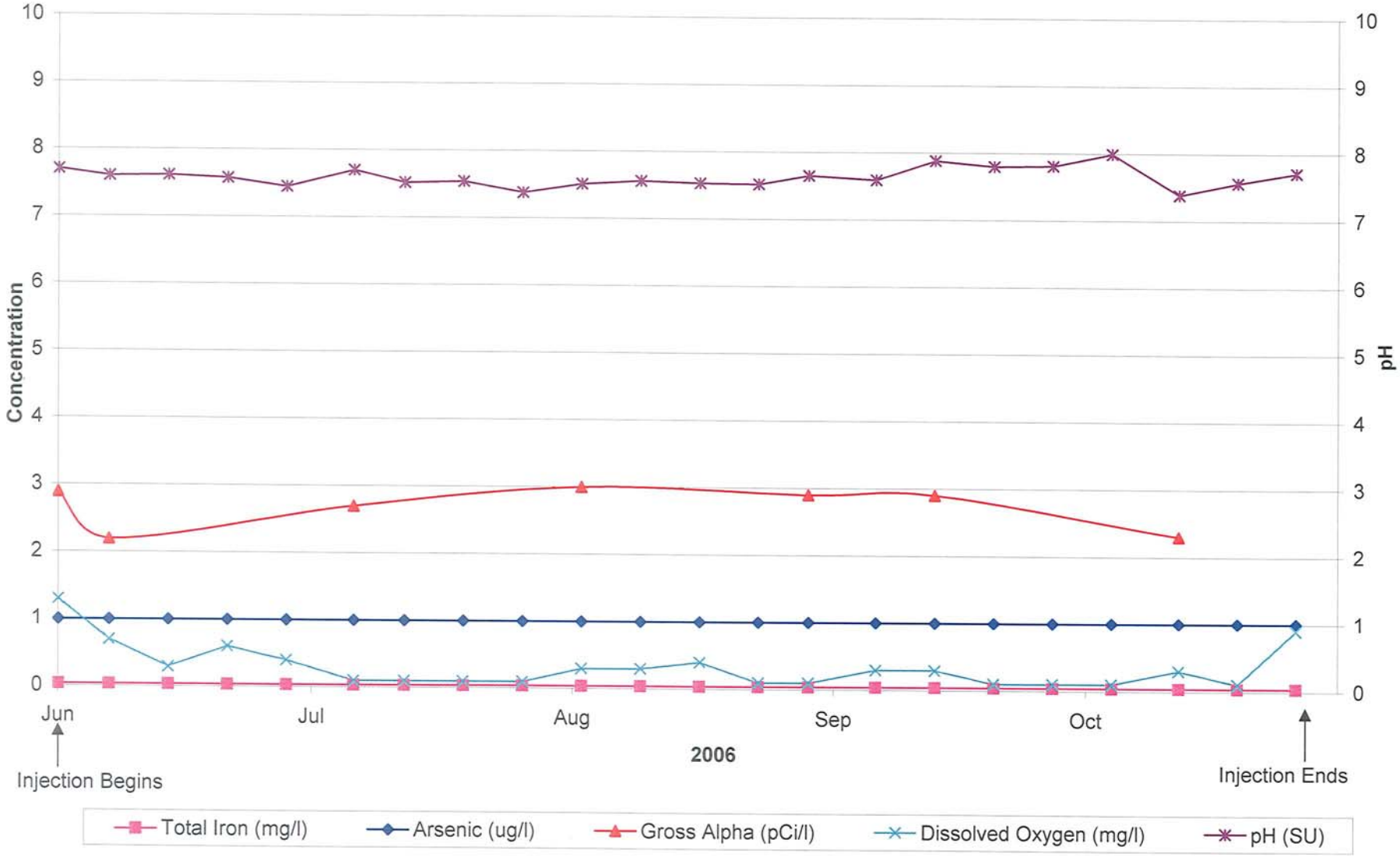


FIGURE 4-15. PLOT OF WATER QUALITY IN STORAGE ZONE OBSERVATION WELL 3 DURING CYCLE 6 (PART 1)

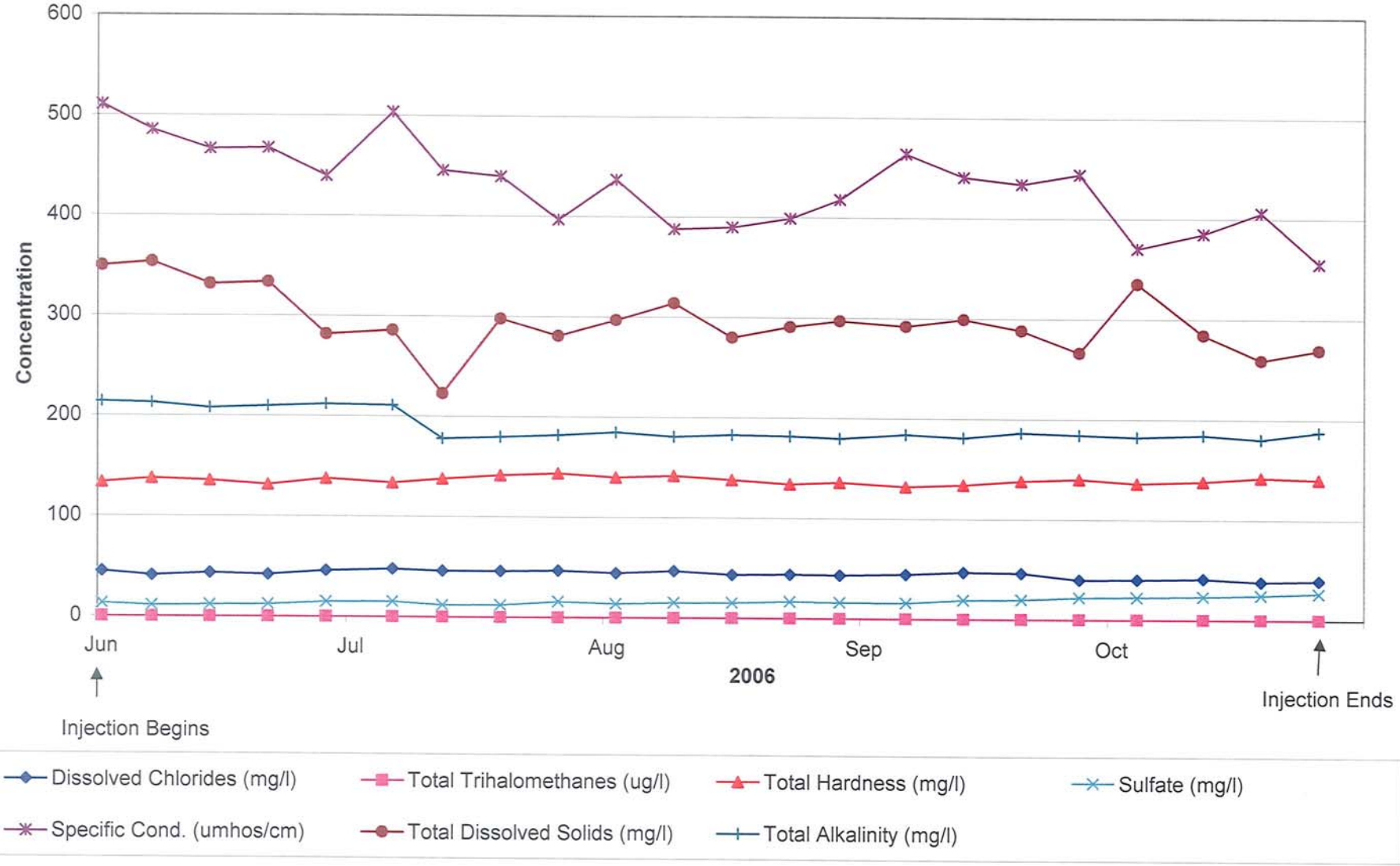
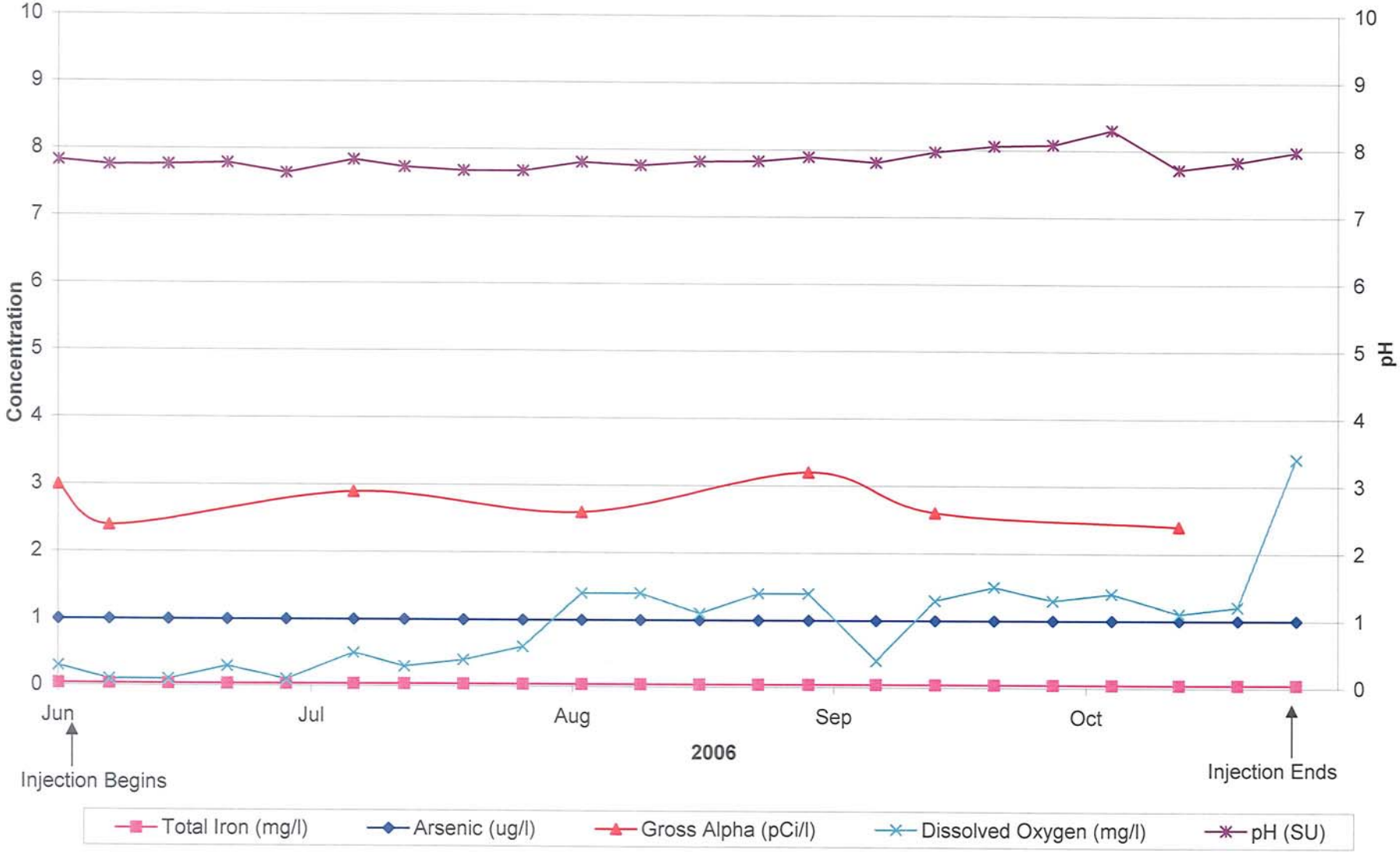


FIGURE 4-16. PLOT OF WATER QUALITY IN STORAGE ZONE OBSERVATION WELL 3 DURING CYCLE 6 (PART 2)



B. Cycle 6 Storage

Cycle 65 storage commenced on October 30, 2006 and has continued until the date of this report (i.e. February, 2007).

V. UPDATE OF AREA OF REVIEW

The Area of Review (AOR) for the Corkscrew ASR system was last updated in 2004. A summary of inventoried wells and water use permits for the approximate 12 square mile AOR are provided on the updated Tables 5-1 and 5-2. Maps showing the locations of these wells and permitted areas for the water use permits are provided as Figures 5-1 and 5-2.

TABLE 5-1. SUMMARY OF PERTINENT INFORMATION FOR WELLS INVENTORIED IN THE AREA OF REVIEW

WRS #	Other #	LOCATION Qtr Qtr S-T-R	Total Depth (ft)	Casing Depth (ft)	Casing Dia. (in)	Aquifer	Cl (mg/L)	Owner/Comments	Use	Data Source
959		SW NE 09-46-26	185		2		70		IRR	WRS
7520	47A-GW5	NE NW 09-46-26	3			WT		Lee County Dept. of Natural Resources	MON	Lee County
9786	2	SW NE 09-46-26	120	99	4.00	SS		WUP 36-00286-W	AGR	SFWMD
9787	1	SW NE 09-46-26	125	101	14.00	SS		WUP 36-00286-W	AGR	SFWMD
9788	MW1	NW NW 09-46-26	220	220	4.00	SS		WUP 36-00003-W	PWS	SFWMD
9815		NW NW 09-46-26	90	86	4	SS	157	WEL000019234	DOM	Lee County
9816		SW NW 09-46-26	112	92	4	SS	176	WEL2004-02453	DOM	Lee County
9817		SE SW 09-46-26	140	92	4	SS	63	WEL000028441	DOM	Lee County
9818		NW SW 09-46-26	100	80	4	SS	92	WEL000019434	DOM	Lee County
9819		SW NW 09-46-26	110	93	4	SS	96	WEL000011720	DOM	Lee County
9820		NW NE 09-46-26	115	95	4	SS	230	WEL2002-01953	DOM	Lee County
9821		SW SW 09-46-26	60	40	4	WT	31	WEL000013858	DOM	Lee County
9822		NW SW 09-46-26	117	97	4	SS	94	WEL2002-00074	DOM	Lee County
9823		C SW 09-46-26	128	95	4	SS	109	WEL000021677	DOM	Lee County
9824		SW NW 09-46-26	120	60	4	SS	141	WEL000018619	IRR	Lee County
9825		SW NW 09-46-26	110	90	4	SS	228	WEL2001-00504	DOM	Lee County
9826		NW NW 09-46-26	110	90	4	SS	212	WEL000009060	DOM	Lee County
9827		NE NW 09-46-26	15	5	2	SS		WEL2004-03629	MON	Lee County
680	L-1630	SE NE 10-46-26	165				40			USGS
7532	49-GW4	SE NW 10-46-26	5			WT		Lee County Dept. of Natural Resources	MON	Lee County
9789	1	SW NE 10-46-26	115	76	4.00	WT		WUP 36-02570-W	AGR	SFWMD
9828		NW SW 10-46-26	118	98	4	SS	38	WEL000022640	DOM	Lee County
9829		NE SW 10-46-26	120	105	4	SS	34	WEL000009250	DOM	Lee County
9830		SW NW 10-46-26	118	106	4	SS	92	WEL000015324	DOM	Lee County
9831		NW SW 10-46-26	170	100	4	SS	116	WEL2004-02717	PWS	Lee County
9832		NW NW 10-46-26	140	84	2	SS	32	WEL000011135	DOM	Lee County
9833		NW NW 10-46-26	120	105	4	SS	96	WEL2001-01267	DOM	Lee County
9834		NE NW 10-46-26	122	102	4	SS	100	WEL000022205	DOM	Lee County
9835		NW SE 10-46-26	160	100	4	SS	32	WEL2000-01911	IRR	Lee County
9836		NW SE 10-46-26	130	100	4	SS	38	WEL000016798	DOM	Lee County
1892	LM-1892	NE NE 11-46-26	0	0	0.00	WT		WUP 36-00413-W	IND	SFWMD
2484	CORE #2	NW 11-46-26								WRS
2556	1	SW SW 11-46-26	57		8	WT		WUP # 36-00283-W	AGR	SFWMD
2557		SW SE 11-46-26	40		8	WT			IRR	WRS
2559	3	SE SE 11-46-26	60		8	WT		WUP # 36-00283-W	IRR	SFWMD
7133	P-919	NE 11-46-26	11890	3868				R.L. Burns'78 #11-1		BOG
7531	49-GW3	NE NE 11-46-26	4			WT		Lee County Dept. of Natural Resources	MON	Lee County
2558	2	NE NW 14-46-26	19		8	WT		WUP # 36-00283-W	AGR	SFWMD
2560		SE NE 14-46-26	24		8	WT			IRR	WRS
2561		NE SE 14-46-26	26		8	WT			IRR	WRS
6807	ASR-4	SW SW 15-46-26	368	310	12	MH		Corkscrew ASR System	ASR	WRS

TABLE 5-1. SUMMARY OF PERTINENT INFORMATION FOR WELLS INVENTORIED IN THE AREA OF REVIEW

WRS #	Other #	LOCATION Qtr Qtr S-T-R	Total Depth (ft)	Casing Depth (ft)	Casing Dia. (in)	Aquifer	Cl (mg/L)	Owner/Comments	Use	Data Source
6809	ASR-3	NW SW 15-46-26	347	285	12	MH		Corkscrew ASR System	ASR	WRS
6810	MW-2	NW SW 15-46-26	354	283	6	MH		Corkscrew ASR System	MON	WRS
7134	W-14072	NW NW 15-46-26	310					#2 Bad Luck Sue	TEST	FGS
687	L-988	SE NE 16-46-26	465						TEST	USGS
6808	ASR-5	SE NE 16-46-26	291	253	12	MH		Corkscrew ASR System	ASR	WRS
7135	LE-39	SE SW 16-46-26	1550					Alico'82	TEST	FGS
9790	20	NW NW 16-46-26	40	25	16.00	WT		WUP 36-00102-W	AGR	SFWMD
9791	21	NW NW 16-46-26	40	25	16.00	WT		WUP 36-02415-W	AGR	SFWMD
9792	20	NE NE 16-46-26	40	25	16.00	WT		WUP 36-02415-W	AGR	SFWMD
625	L-2183	SE NW 21-46-26	513						TEST	USGS
626	L-634	SE SE 21-46-26	1418	200	6		920		TEST	USGS
2037		SW SW 21-46-26	14	11	2	WT			OBS	WRS
7670	25S	SW SW 21-46-26	80	30	12	WT		LCU Corkscrew Wellfields	PWS	SFWMD
7671	25D	SW SW 21-46-26	180	115	12	WT		LCU Corkscrew Wellfields	PWS	SFWMD
9837		SE SW 21-46-26	135	120	4	WT	31	WEL000025574	PWS	Lee County
627	L-1984	SW NE 22-46-26	486	206	4				OBS	USGS
922		SW NW 22-46-26	304						TEST	WRS
923		SW SE 22-46-26	324						TEST	WRS
924		SE SE 22-46-26	130	67	6	WT		LCU Corkscrew Observation	TEST	WRS
925		NE NW 22-46-26	50	30	4	WT		LCU Corkscrew Observation	OBS	WRS
926		NE NW 22-46-26	195	155	4	SS		LCU Corkscrew Observation	OBS	WRS
927		NE SW 22-46-26	40	20	4	WT		LCU Corkscrew Observation	OBS	WRS
928		SE NW 22-46-26	264	200	4	SS		LCU Corkscrew Observation	OBS	WRS
929		SW NE 22-46-26	284					LCU Corkscrew Observation	TEST	WRS
930		NE SE 22-46-26	44	30	4	WT		LCU Corkscrew Observation	OBS	WRS
931		NE SE 22-46-26	290	225	4	SS		LCU Corkscrew Observation	OBS	WRS
933		SE NE 22-46-26	305		4			LCU Corkscrew Observation	TEST	WRS
934		NE SE 22-46-26	305	205	6	SS		LCU Corkscrew PWS	PWS	WRS
935		NE NE 22-46-26	36	30	4	WT		LCU Corkscrew Observation	OBS	WRS
936		NE NE 22-46-26	284	195	4	SS		LCU Corkscrew Observation	OBS	WRS
937		SE SW 22-46-26	45	32	4	WT		LCU Corkscrew Observation	OBS	WRS
938		SE SW 22-46-26	285	195	4	SS		LCU Corkscrew Observation	OBS	WRS
940		SW SE 22-46-26	284	220	4	SS		LCU Corkscrew Observation	OBS	WRS
1494	1	NE NW 22-46-26	205	135	8	SS	42	LCU Corkscrew PWS	PWS	WRS
1495	2	NW NE 22-46-26	250	160	8	SS		LCU Corkscrew PWS	PWS	WRS
1496	3	NE NE 22-46-26	260	180	8	SS		LCU Corkscrew PWS	PWS	WRS
1497	4	SE SW 22-46-26	300	190	8	SS	50	LCU Corkscrew PWS	PWS	WRS
1498	5	SW SE 22-46-26	300	205	8	SS	43	LCU Corkscrew PWS	PWS	WRS
1499	6	SE SE 22-46-26	300	215	8	SS	45	LCU Corkscrew PWS	PWS	WRS
1500	7	NE SW 22-46-26	135	45	8	WT	27	LCU Corkscrew PWS	PWS	WRS
1501	8	NE SW 22-46-26	145	51	8	WT	25	LCU Corkscrew PWS	PWS	WRS

TABLE 5-1. SUMMARY OF PERTINENT INFORMATION FOR WELLS INVENTORIED IN THE AREA OF REVIEW

WRS #	Other #	LOCATION Qtr Qtr S-T-R	Total Depth (ft)	Casing Depth (ft)	Casing Dia. (in)	Aquifer	Cl (mg/L)	Owner/Comments	Use	Data Source
1502	9	NW SE 22-46-26	140	55	8	WT		LCU Corkscrew PWS	PWS	WRS
1503	10	NE SE 22-46-26	156	60	8	WT	26	LCU Corkscrew PWS	PWS	WRS
1504	11	NE SE 22-46-26	150	55	8	WT	25	LCU Corkscrew PWS	PWS	WRS
1505	12	SE SW 22-46-26	145	50	8	WT	27	LCU Corkscrew PWS	PWS	WRS
1506	13	SE SW 22-46-26	140	50	8	WT	25	LCU Corkscrew PWS	PWS	WRS
1507	14	SW SE 22-46-26	150	55	8	WT	30	LCU Corkscrew PWS	PWS	WRS
1508	15	SE SE 22-46-26	150	58	8	WT		LCU Corkscrew PWS	PWS	WRS
1509	16	SE SE 22-46-26	155	60	8	WT		LCU Corkscrew PWS	PWS	WRS
1510	A-1	NW NE 22-46-26	31		4	WT		LCU Corkscrew Observation	OBS	WRS
1511	A-2	NW NE 22-46-26	170	150	4	SS		LCU Corkscrew Observation	OBS	WRS
1512	B-1	NE NE 22-46-26	34		4	WT		LCU Corkscrew Observation	OBS	WRS
1513	B-2	NE NE 22-46-26	156		4			LCU Corkscrew Observation	OBS	WRS
1514	C-1	SW NW 22-46-26						LCU Corkscrew Observation	OBS	WRS
1515	C-2	SW NW 22-46-26						LCU Corkscrew Observation	OBS	WRS
1516	D-1	SW NE 22-46-26						LCU Corkscrew Observation	OBS	WRS
1517	D-2	SW NE 22-46-26	132		4			LCU Corkscrew Observation	OBS	WRS
1518	D-3	SW NE 22-46-26				WT		LCU Corkscrew Observation	OBS	WRS
1519	D-4	SW NE 22-46-26	498				44		TEST	WRS
1870	24	NE NE 22-46-26	120	50	8	WT	26	LCU Corkscrew PWS	PWS	WRS
1871	23	NE NE 22-46-26	115	45	8	WT	26	LCU Corkscrew PWS	PWS	WRS
1872	22	NW NE 22-46-26	110	40	8	WT	26	LCU Corkscrew PWS	PWS	WRS
1873	21	NE NW 22-46-26	105	35	8	WT	36	LCU Corkscrew PWS	PWS	WRS
1874	20	SE NE 22-46-26	120	50	8	WT	28	LCU Corkscrew PWS	PWS	WRS
1875	19	SW NE 22-46-26	120	50	8	WT	26	LCU Corkscrew PWS	PWS	WRS
1876	18	SE NW 22-46-26	115	45	8	WT	30	LCU Corkscrew PWS	PWS	WRS
2120		SW 22-46-26							OBS	WRS
2121		SW 22-46-26							OBS	WRS
2486	CORE #4	SE 22-46-26								WRS
3982	MW-A	NE NW 22-46-26	779	340				Corkscrew ASR System Test Well	MON	WRS
4266	MW-C	NW NW 22-46-26	400	330	6	MH		Corkscrew ASR System	MON	WRS
6805	ASR-1	NW NW 22-46-26	397	328	12	MH		Corkscrew ASR System	ASR	WRS
6806	ASR-2	NW NW 22-46-26	397	337	12	MH		Corkscrew ASR System	ASR	WRS
6811	MW-1	NE SW 22-46-26	410	358	6	MH		Corkscrew ASR System	MON	WRS
6812	MW-3	SW NW 22-46-26	411	355	6	MH		Corkscrew ASR System	MON	WRS
7139	L-1985	NW SE 22-46-26	50	43	4	WT			MON	USGS
7548	FP2	SW NW 22-46-26	16			WT			MON	SFWMD
7589	L-01	C SE 22-46-26	80	67		WT		Knapp, 86	TEST	SFWMD
2574		NE NE 23-46-26	46		6	WT			IRR	WRS
7192	W-9356	SW 23-46-26	1330					Humble oil & Ref Comp Core Test #3		BOG
9793	1	C SE 23-46-26	116	40	4.00	WT		WUP 36-03938-W	LIV	SFWMD
9838		SW NE 23-46-26	800	450	4	LH/SUW	295	WEL000013946	FIRE	Lee County

TABLE 5-1. SUMMARY OF PERTINENT INFORMATION FOR WELLS INVENTORIED IN THE AREA OF REVIEW

WRS #	Other #	LOCATION Qtr Qtr S-T-R	Total Depth (ft)	Casing Depth (ft)	Casing Dia. (in)	Aquifer	Cl (mg/L)	Owner/Comments	Use	Data Source
9839		SW SE 23-46-26	67	54	4	WT	125	WEL000023794	DOM	Lee County
9840		NW SE 23-46-26	41	36	2	WT	78	WEL000011651	DOM	Lee County
9841		NW SE 23-46-26	240	156	4	SS	37	WEL2003-01120	DOM	Lee County
9842		NW NE 23-46-26	130	110	4	WT	29	WEL2002-00349	DOM	Lee County
9843		SW SE 23-46-26	115	90	4	WT	27	WEL2003-02975	DOM	Lee County
9844		NW SE 23-46-26	100	90	4	WT	32	WEL2003-00517	DOM	Lee County
9845		SW NE 23-46-26	680	280	4	MH/LH	338	WEL000015097	DOM	Lee County
9846		SW NE 23-46-26	740	375	4	MH/LH	320	WEL000016453	DOM	Lee County
9847		SW NE 23-46-26	100	86	4	WT	35	WEL000021160	IRR	Lee County
9848		NW NE 23-46-26	80	74	4	WT	19	WEL000022762	DOM	Lee County
9794	22	NW NE 26-46-26	310	240	12.00	SS		WUP 36-00218-W	AGR	SFWMD
9795	21	SE SE 26-46-26	350	278	12.00	SS		WUP 36-00218-W	AGR	SFWMD
9796	18	SW NE 26-46-26	100	60	8.00	WT		WUP 36-00218-W	AGR	SFWMD
9797	17	SW NE 26-46-26	100	60	8.00	WT		WUP 36-00218-W	AGR	SFWMD
9798	16	SW NE 26-46-26	120	60	12.00	WT		WUP 36-00218-W	AGR	SFWMD
9799	15	SW NE 26-46-26	120	60	12.00	WT		WUP 36-00218-W	AGR	SFWMD
9800	14	SW NE 26-46-26	110	60	12.00	WT		WUP 36-00218-W	AGR	SFWMD
9801	12	SW NE 26-46-26	120	60	12.00	WT		WUP 36-00218-W	AGR	SFWMD
9802	11	SW NE 26-46-26	120	60	12.00	WT		WUP 36-00218-W	AGR	SFWMD
9803	10	SW NE 26-46-26	120	60	12.00	WT		WUP 36-00218-W	AGR	SFWMD
9804	9	SW NE 26-46-26	120	60	12.00	WT		WUP 36-00218-W	AGR	SFWMD
9805	8	NE SW 26-46-26	110	60	12.00	WT		WUP 36-00218-W	AGR	SFWMD
9806	7	NE SE 26-46-26	100	60	12.00	WT		WUP 36-00218-W	AGR	SFWMD
9807	6	NE NE 26-46-26	120	60	12.00	WT		WUP 36-00218-W	AGR	SFWMD
9808	5	SE NW 26-46-26	120	60	12.00	WT		WUP 36-00218-W	AGR	SFWMD
9809	4	SE NE 26-46-26	110	60	12.00	WT		WUP 36-00218-W	AGR	SFWMD
9810	3	NW NE 26-46-26	120	60	12.00	WT		WUP 36-00218-W	AGR	SFWMD
9811	2	SW NE 26-46-26	80	60	12.00	WT		WUP 36-00218-W	AGR	SFWMD
9812	1	SW NE 26-46-26	120	60	12.00	WT		WUP 36-00218-W	AGR	SFWMD
9813	20	SW NE 26-46-26	100	60	8.00	WT		WUP 36-00218-W	AGR	SFWMD
9814	19	SW NE 26-46-26	100	60	8.00	WT		WUP 36-00218-W	AGR	SFWMD
7549	FP3	NW SE 28-46-26	20			WT			MON	SFWMD
7590	L-13	SW 28-46-26	20			WT		Knapp, 86	TEST	SFWMD
7672	26S	NW NW 28-46-26	80	30	12	WT		LCU Corkscrew Wellfields	PWS	SFWMD
7673	26D	NW NW 28-46-26	170	120	12	WT		LCU Corkscrew Wellfields	PWS	SFWMD
7674	27S	SW SW 28-46-26	80	30	12	WT		LCU Corkscrew Wellfields	PWS	SFWMD
7675	27D	SW SW 28-46-26	170	120	12	WT		LCU Corkscrew Wellfields	PWS	SFWMD

TABLE 5-2. SUMMARY OF PERTINENT INFORMATION FOR SFWMD WATER USE PERMITS IN THE AREA OF REVIEW.

PERMIT #	SEC-TWP-RGE	Annual Allocation MG	Max. Monthly Allocation MG	Max. Daily Allocation (MG)	USE	ACRES SERV.	# WELLS	SOURCE	COMMENTS	PROJECT OWNER/NAME
36-00003-W	MULTIPLE	7749.47	941.38	30.37	PWS		38	WT/SS/LH	Corkscrew Wellfield	LEE COUNTY UTILITIES
36-00218-W	26- 46- 26	447.17	102.93		AGR	608	21, 6p	SAS, SS		GROVE 4
36-00283-W	11,14- 46- 26	228.31		1.54	AGR	276	3	LT		R & B FARMS
36-00286-W	9- 46- 26	69.57		0.39	AGR	18	2	SS		ALICO RD NURSERY
36-00413-W	35- 45 26	4131.80		18.51	IND	1520	7	WT		HARPER BROTHERS ROCK MINE
36-02415-W	8,9,16, 17- 46- 26	139.50		0.97	AGR	197	2	WT	Permit Expired	MILTON E SMITH & PACIFIC TOMATO GROWERS
36-02570-W	10- 46- 26	10.51		0.86	AGR	10	1	SAS	Permit Expired	DEVORE FARM
36-03207-W	21,28- 46- 26	2190.00		7.20	IND	174	0	SW		CORKSCREW WOODS MINING
36-03242-W	21- 46- 26			0.01	LAN	1		MH		YOUNGQUIST BROTHERS ROCK
36-03478-W	9- 46- 26	22.20		3.03	LAN	20	1p	SS	Under Review	SUNNY GROVE NURSERY
36-03938-W	10- 46- 24				LIV	5	1, 1p	LT		MICHAEL P ELLARD
36-04121-W	15,16- 46- 26	1620.60		5.33	IND	667	0	SW		UNIVERSITY LAKES EXCAVATION
36-04542-W	15,16- 46- 26	1620.60	159.90		IND	513	0	SW		WEST LAKES EXCAVATION
36-04618-W	10- 46- 26	21.91	2.89		AGR	15	1p	WT		RICHARD NURSERY
36-04902-W	9- 46- 26	0.60	0.08		NUR	1	1p	SS		FRANK BARBER PROPERTY
36-04971-W	10- 46- 26	7.58	1.25		LIV, AGR	10	1p	MH		EUGENE ATCHISON WELL
36-05016-W	16- 46- 26	0.43	0.05		LAN, PWS	0	1p	SS		BETTER ROADS ASPHALT PLANT
36-05258-W	16- 46- 26		<3		IND, PWS	1	1p	SS		WEST LAKES CONCRETE PLANT
36-05544-W	22- 46- 26		<3		LAN	4		MH	Under Review	ESTERO BAY BAPTIST CHURCH
36-05871-W	9,3- 46- 26		<3		LAN	1		2p		ALICO QUARRY

p = Proposed
SW = Surface Water

WT = Water-table Aquifer
SS = Sandstone Aquifer

MH = Mid Hawthorn Aquifer
LH = Lower Hawthorn Aquifer

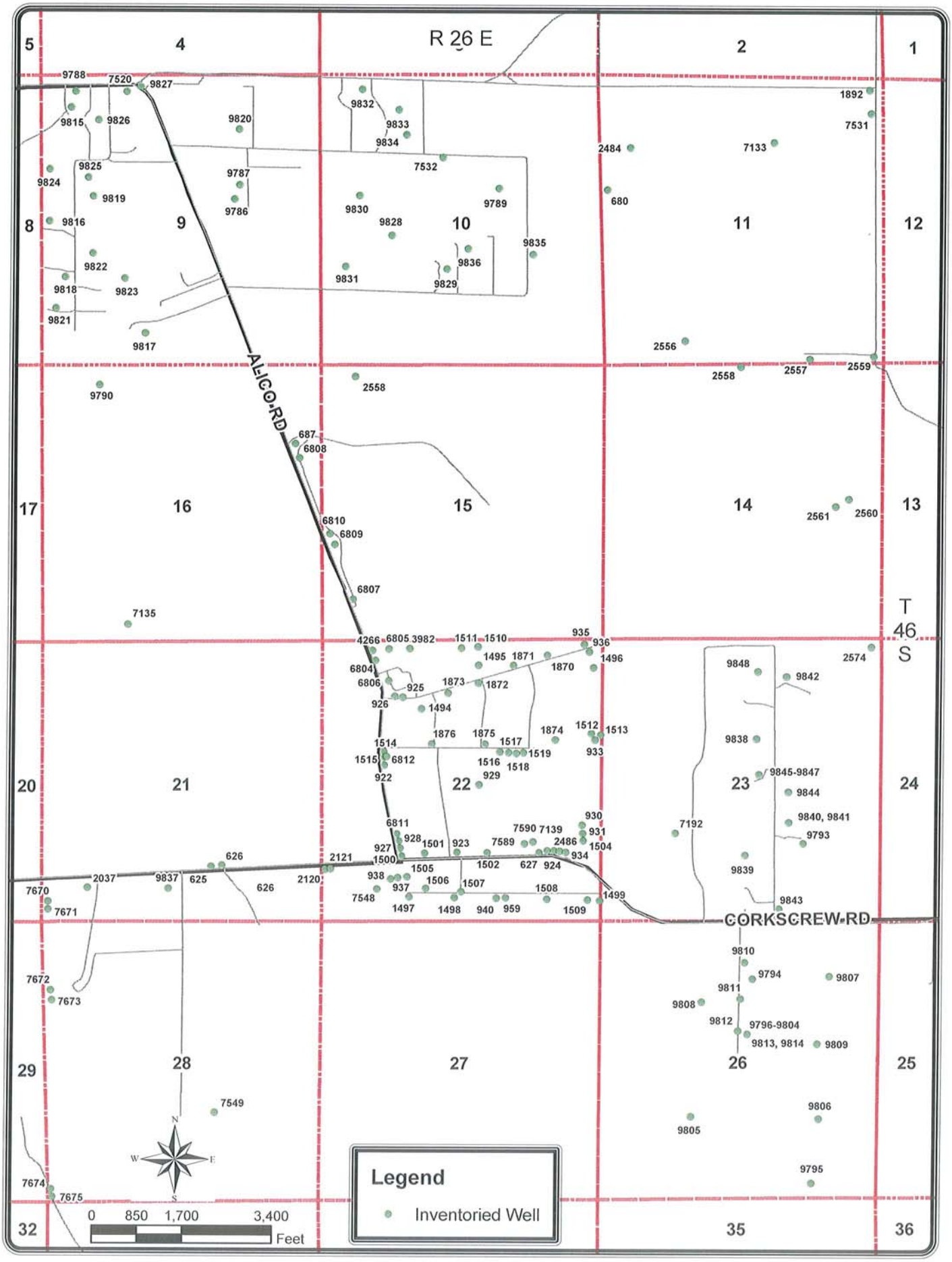


FIGURE 5-1. MAP SHOWING LOCATION OF INVENTORIED WELLS IN THE AREA OF REVIEW.

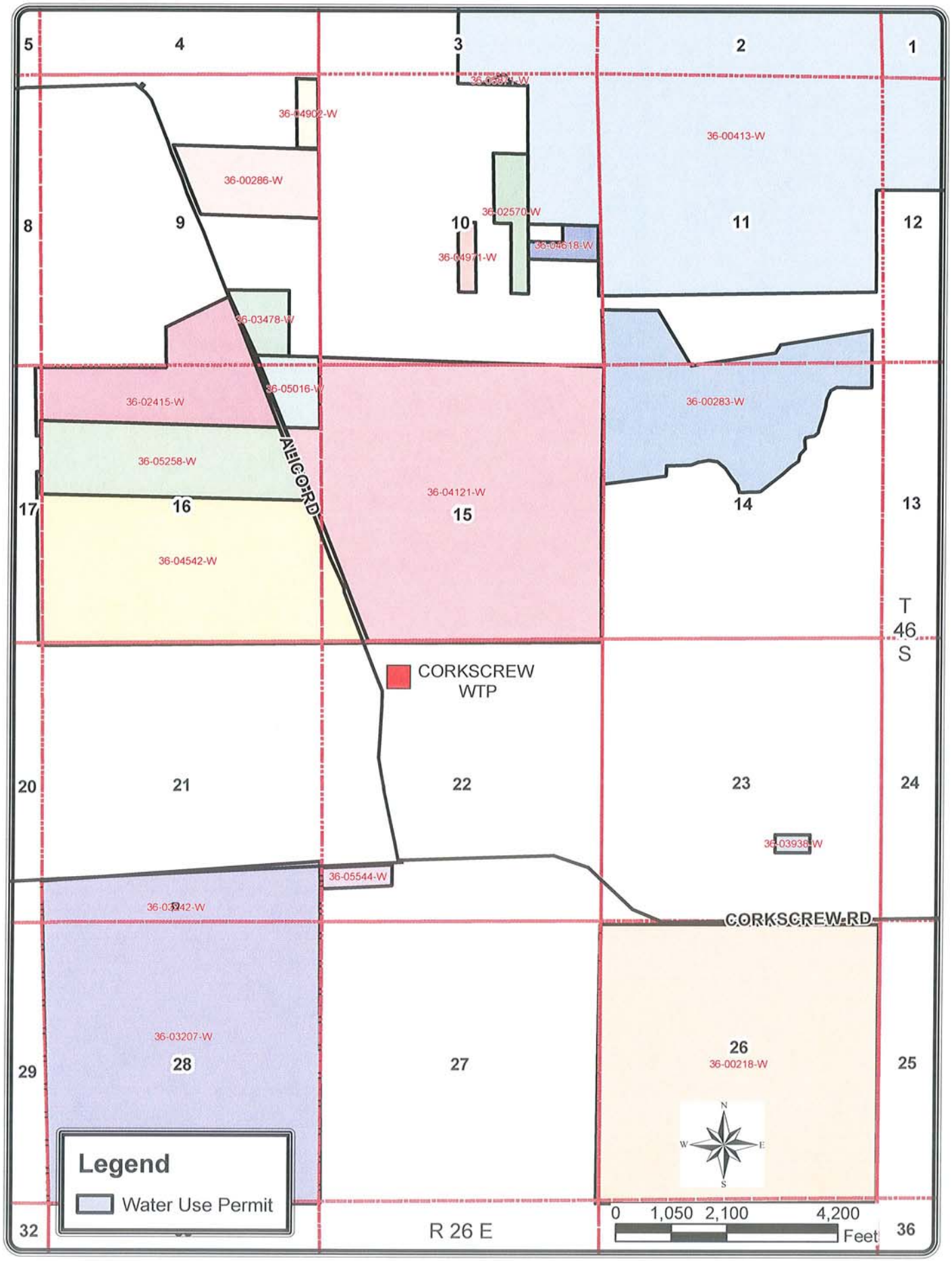


FIGURE 5-2. MAP SHOWING LOCATION OF SFWMD WATER USE PERMITS IN THE AREA OF REVIEW.

VI. REVIEW OF CORKSCREW ASR SYSTEM PERFORMANCE AFTER FIVE COMPLETE CYCLES

The Corkscrew WTP ASR system, installed in 1995 as a pilot system, and expanded in 1999, has undergone five complete operational cycles of injection, storage, and recovery for all five ASR wells. The system has performed as well as or better than expected, with recovery percentages increasing with each successive cycle, with the last major complete cycle (i.e. Cycle 4) obtaining an approximate 93% recovery by volume of the injected water. The criteria used for determining recovery efficiency is the Secondary Drinking Water parameter of total dissolved solids.

The recovered water quality data indicate that a progressive decline in arsenic has occurred with each successive cycle. The monitoring data collected in the storage zone observation wells during five complete operational cycles indicated that arsenic concentrations did not exceed the maximum contaminant limit established by the FDEP. Therefore, no arsenic mobilization in the storage zone beyond the location of those wells has occurred.

VII. CONCLUSIONS

A. Conclusions

The following conclusions are made as a result of this study:

(1) The Corkscrew ASR system has performed as well as or better than expected through five complete cycles of injection/storage/recovery. The last major cycle (i.e. Cycle 4) had a recovery efficiency of 93% by volume of the injected water.

(2) The hydraulic and water quality data during the five operational cycles indicate no anomalies in the system performance or any adverse impact on the groundwater resources. In addition, the water quality data collected in the five storage zone observation wells indicate that no arsenic mobilization outside the radius of the monitoring wells has occurred.

VIII. REFERENCES

Water Resource Solutions, 2004, Lee County Utilities' Corkscrew ASR Project, Cycles 1-3 Operational Testing Report in Support of Construction Permit Renewal for ASR-2, 3, 4, and 5, Permit Numbers 142222-001 Through -005-UC, 39 p.