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RESTORATION AREA VERIFICATION SAMPLING PROGRAM PROJECT SPECIFIC PLAN - JANUARY 1997 - REV C - DRAFT FINAL - 2505-PSP-0003

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RESTORATION AREA VERIFICATION SAMPLING PROGRAM PROJECT SPECIFIC PLAN

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FERNALD, OHIO

JANUARY 1997

U.S. DEPARTMENT OF ENERGY
FERNALD AREA OFFICE

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Appendix A Evaluation of FRL Exceedances Which Occur Outside of the Restoration Footprint

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1.0 INTRODUCTION

The intent of the Restoration Area Verification Sampling Plan PSP can be summarized as follows:

- To evaluate all existing non-uranium groundwater data gathered outside of the uranium-based restoration footprint, and determine which sporadic FRL exceedances can be dismissed now, as non-FEMP related and/or not of concern. (Note that this analysis was accomplished as part of the development of the PSP, and is furnished in the PSP as Appendix A.) The intent of this evaluation is to satisfy a key data limitation noted in the Operable Unit 5 RI/FS regarding the sporadic and isolated detections above background. These isolated detections were not formally dismissed during the RI/FS process. Now that final FRLs are available with the issuance of the OU5 ROD, it is an appropriate and necessary step of the design process to assess these occurrences with respect to the FRLs.

- From the above evaluation, to determine which of the sporadic FRL exceedances require additional sampling before a final decision can be made regarding whether the exceedances drive a need to expand the restoration footprint beyond that based on uranium. (This determination was also conducted during the development of the PSP.) The results indicated that five constituents (antimony, manganese, cadmium, zinc, and lead) would require follow-up sampling before a final restoration footprint determination can be made.

- In parallel with the evaluation for the non-uranium constituents, to further define the vertical and lateral extent of uranium contamination above the FRL in the vicinity of Monitoring Well 3069, which was identified as a necessary follow-up activity through the FEMP's DMEPP sampling program.

~~This PSP presents the results of a data evaluation of non uranium FRL exceedances detected outside of the uranium based restoration footprint, and outlines a sampling program for determining the vertical and lateral extent of the 20 μg/L uranium plume in the area of monitoring Well 3069 to support the remedial design of the aquifer remedy.~~

The need to evaluate FRL exceedances outside of the aquifer restoration footprint has been reported in the OU5 FS Report (DOE 1995a) and the Draft Integrated Environmental Monitoring Plan (IEMP, DOE 1996a). The need to further delineate the 20 μg/L uranium plume in the area of Monitoring Well 3069 to support remedial design of the aquifer remedy is identified in the South Plume Removal Action, Design Monitoring Evaluation Program Plan, System Evaluation Report, for January 1, 1996 - June 30, 1996, (DOE 1996c). Restoration area verification was identified as part of the remedial design for aquifer restoration in the Operable Unit 5 Remedial Design Work Plan (DOE 1996b).

1.1 FRL EXCEEDANCES DETECTED OUTSIDE OF THE RESTORATION FOOTPRINT

The aquifer restoration footprint, shown in Figure 1-1, is the modeled non-retarded hydraulic capture zone which is predicted to result from the aquifer restoration under the 10-year restoration scenario presented in the Baseline Remedial Strategy Report for Aquifer Restoration (Remedial Design, Task 1). The size and dimension of the aquifer restoration footprint is dependent upon the amount and rate of pumping and/or injection which will be conducted to capture the 20 μg/L total uranium plume.

As noted in the Remedial Design Work Plan an evaluation of all existing non-uranium groundwater data for final remediation level (FRL) exceedances located outside of the restoration footprint was a necessary part of the remedial design for the aquifer restoration. The evaluation was conducted to determine if the non-uranium exceedances are attributable to the FEMP, are one time occurrences, are persistent and of such magnitude that they require a modification of the uranium based groundwater remedy or require additional monitoring to determine what additional action, if any, should be taken.

The establishment of FRLs provided a benchmark for the evaluation of all existing groundwater data. An evaluation of the groundwater data with respect to the ROD established FRLs was initiated in support of the 1995 RCRA Annual Report and the IEMP. The evaluation was completed in support of the preparation of this Project Specific Plan (PSP). As explained below, the results of this evaluation indicate that the majority of the FRL exceedances detected outside of the restoration footprint were either one time occurrences or are not attributable to the FEMP due to the upgradient position of the monitoring locations. The evaluation recommends additional monitoring for three constituents at three separate locations. It is proposed that this monitoring effort be incorporated into the IEMP.

The study area for the data evaluation found in Appendix A is the area outside of the aquifer restoration hydraulic capture zone but north of the Administrative Boundary for Aquifer Restoration, established in the Operable Unit 5 FS (Figure 1-1). Groundwater contamination attributed to the Paddys Run Road Site (PRRS), exists south of the Administrative Boundary. In the Operable Unit 5 Proposed Plan (DOE 1995b) it was acknowledged that DOE's role and involvement in OEPA's ongoing assessment and/or clean up of the PRRS plume, if any, would be defined separately as part of the PRRS response obligations and in accordance with the Paddys Run Road Site Project schedule.

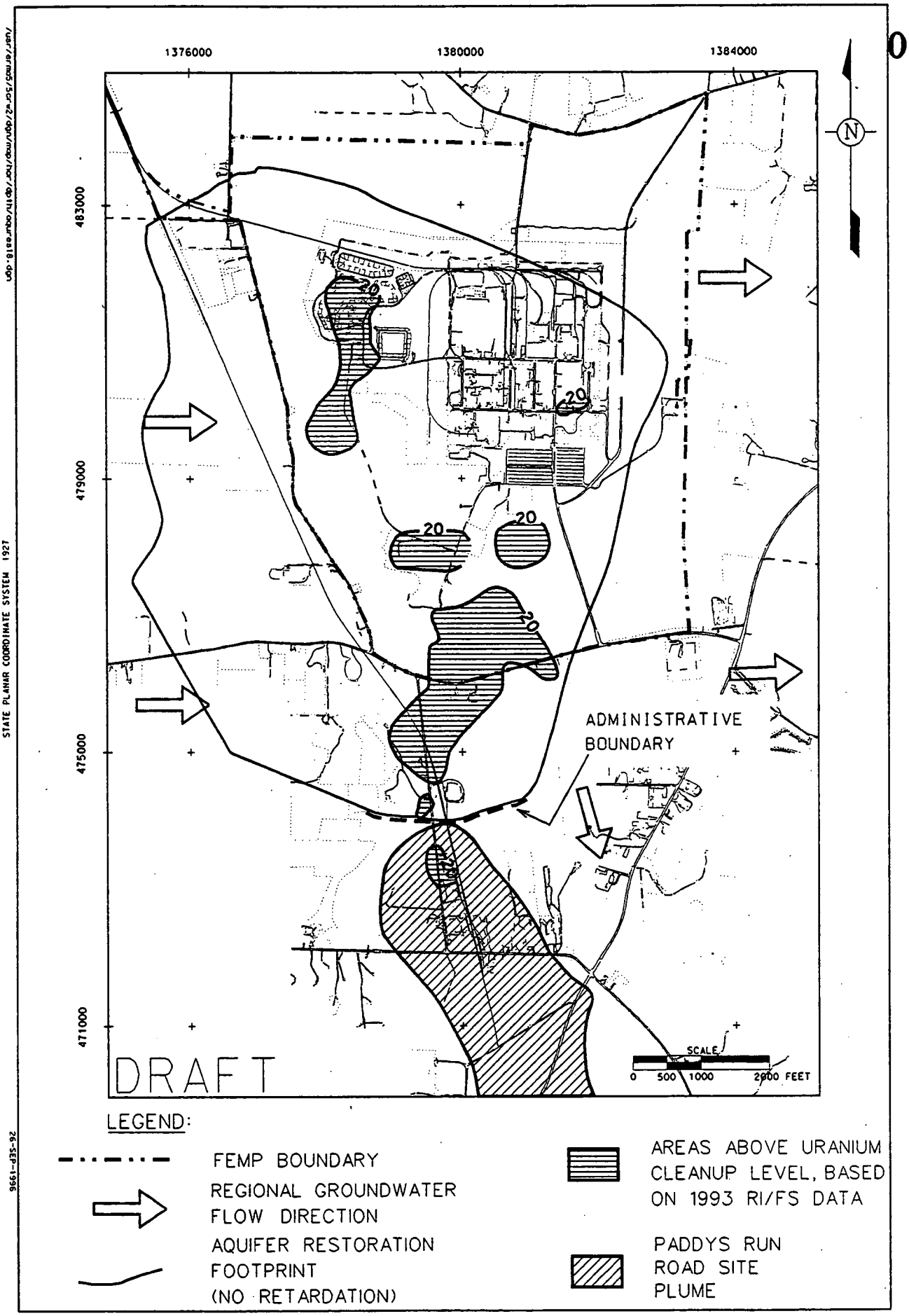


FIGURE 1-1 AREAS OF THE GREAT MIAMI AQUIFER REQUIRING REMEDIATION AND AQUIFER RESTORATION FOOTPRINT

DOE The evaluation found in Appendix A concludes that the uranium based restoration area does not require modification at this time due to FRL exceedances identified in this evaluation. Of the 50 FRL constituents listed in the OU5 ROD, 14 have had at least 1 FRL exceedance outside the restoration footprint and north of the Administrative Boundary. The fourteen constituents are manganese, fluoride, nitrate, cadmium, lead, zinc, antimony, arsenic, mercury, nickel, trichloroethene, silver, thorium-228, and thorium-232. Of these fourteen constituents;

- Mercury, nickel, trichloroethene, silver, thorium-228, and thorium-232 can be dismissed from further monitoring outside the restoration footprint because the FRL exceedances were a one time occurrence with subsequent data indicating concentrations below the FRL.

1 • Fluoride can be dismissed from further monitoring outside the restoration footprint because the exceedances were identified using an FRL based on a background value of 0.89 mg/L. The MCL for fluoride is 4 mg/L. The MCL should be used to guide the restoration. When fluoride detects are compared against the MCL, no FRL exceedances result. Appendix A provides additional justification for changing the fluoride FRL.

16 • Nitrate can be dismissed from further monitoring outside of the restoration footprint. FRL exceedances for nitrate have been recorded at six location outside of the restoration footprint. Five of the locations are upgradient of the AL. The sixth location is an agricultural area downgradient of the AL. It is believed that this exceedance is due to fertilizer or some other agricultural activity and is not AL related. Additional information can be found in Appendix A.

- Arsenic can be dismissed from further monitoring outside of the restoration footprint. FRL exceedances for arsenic have been recorded at 10 locations outside of the restoration footprint. At six of the locations the last two sampling events have been below the FRL. The remaining four locations are upgradient of AL source areas. Additional information can be found in Appendix A.

~~• Nitrate can be dismissed from further monitoring outside the restoration footprint because the FRL exceedances are either within the range used to define background or not attributable to the AL.~~

~~• Arsenic can be dismissed from further monitoring outside the restoration footprint because the FRL exceedances are not attributable to the AL.~~

1 • Many of the lead exceedances can be dismissed from further monitoring outside of the restoration footprint because they were identified using an FRL based on a background value of 0.002 mg/L. The Safe Drinking Water Action (SDWA) action level for lead is 0.015 mg/L. The SDWA action level should be used to guide the restoration. It is proposed that the decision to monitor outside of the restoration footprint (as well as to monitor the restoration within the footprint) for lead be based on the SDWA action level. Using the

SDWA action level does not eliminate all of the FRL exceedances for lead, but it does eliminate a majority of them. Appendix A provides additional justification for changing the lead FRL.

- Exceedances for antimony, manganese, cadmium, zinc and lead, at several locations outside of the aquifer restoration footprint, are not one time occurrences and due to their location relative to the ODA could be attributable to the D. Therefore they cannot be dismissed from further monitoring at this time.

2 The RCRA property boundary monitoring program currently monitors the majority of the locations where potentially D related and persistent FRL exceedances are found outside of the aquifer restoration footprint. Only three of the identified exceedance locations are currently not being monitored by the RCRA Property Boundary Program; Well 3423 for antimony, Well 2436 for manganese, and Well 3091 for zinc. Figure 1-2 identifies the locations where monitoring for FRL exceedances outside the aquifer restoration footprint is recommended. It is proposed that quarterly sampling at these locations for the noted FRL constituents be completed as part of the IEMP groundwater sampling. The quarterly sampling would continue for a period of one year at which time data would be evaluated to determine additional actions at these locations.

2 The decision process for determining the final restoration footprint (and necessary follow-up actions, as appropriate) will follow these steps:

- Collect four quarter's worth of focused data for the parameters with FRL exceedances at the eight specified locations
- Complete geoprobe activity to refine the depth and lateral extent of uranium contamination triggered by findings in the vicinity of Well 3069
- Prepare a summary report including recommendations regarding the need for modification of the footprint beyond that dictated by uranium. The report will be submitted 90 days following compilation of the fourth quarter's data, in accordance with the final RD Work Plan.
- Finalize report following input from EPA and OEPA
- Proceed with any design modifications/additions to affected restoration modules, if necessary
- Incorporate any monitoring based actions arising from this process into the IEMP scope.

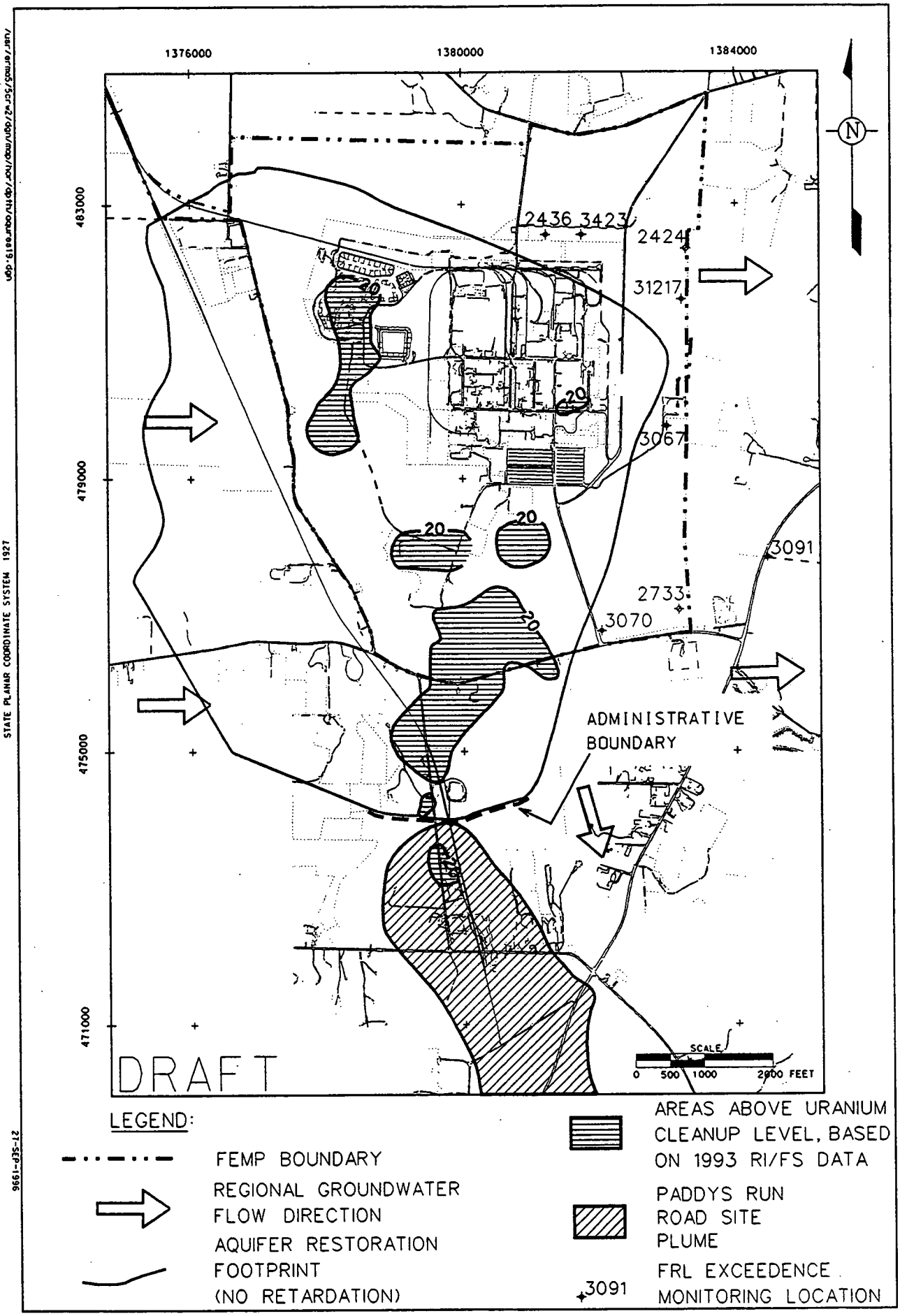


FIGURE 1-2. FRL EXCEEDANCE LOCATIONS TO BE MONITORED

The sampling discussed above, to support the Restoration Area Verification Sampling PSP, is a focused effort targeted solely at confirming/refining the restoration area footprint for design purposes. Outside of this effort, the ongoing routine sampling that will be conducted through the IEMP will be utilized for the following broader purposes: to track remedy performance; confirm the success of hydraulic containment; and to continue to fulfill regulatory-driven groundwater monitoring obligations at the property boundary.

1.2 URANIUM PLUME DELINEATION IN THE AREA OF MONITORING WELL 3069

6 In the area of monitoring Well 3069, the total uranium plume appears to bifurcate near the water table, and yet is present at relatively high concentration at depth. A recent interpretation for the behavior of the plume in this area, as reported in the South Plume Removal Action, Design Monitoring Evaluation Program Plan, System Evaluation Report, for January 1, 1996 to June 30, 1996, (DOE, 1996c) is that recharge from a nearby drainage ditch is causing the uranium plume to dilute near the water table and appears to be pushing higher uranium concentrations deeper into the aquifer. Figures 1-3 and 1-4 illustrate the situation being described. At Well 2434 uranium concentrations are below 20 μg/L. However, at Monitoring Well 3069, which is adjacent to monitoring Well 2434 but completed at a deeper level, uranium concentrations as high as 223 μg/L, with an average concentration of 156 μg/L during the first half of 1996, have been recorded since the 1993 Remedial Investigation sampling which indicated a concentration of 20 μg/L at Monitoring Well 3069. The area of identified recharge is the ditch labeled "Southeast Drainage Ditch" on the figures. To further substantiate the recharge theory, water chemistry of the surface water will be determined and compared with water chemistry of the aquifer as part of the Injection Demonstration Project.

DOE The 20 μg/L total uranium plume may not be accurately defined by the 2000 and 3000 series monitoring well network in this area, and therefore additional sampling to determine the vertical and lateral extent of the > 20 μg/L uranium plume is needed. As discussed in Section 3, six locations have been selected for sampling, Figure 1-3. Collection of additional uranium data is needed to support the restoration design, which is in progress. The sampling program is presented in Section 3.2. Based on the findings at the initial six locations more sampling locations may be required. Additional sampling locations, if required, will follow the same sampling protocol as noted for the initial six locations in Section 3.2.

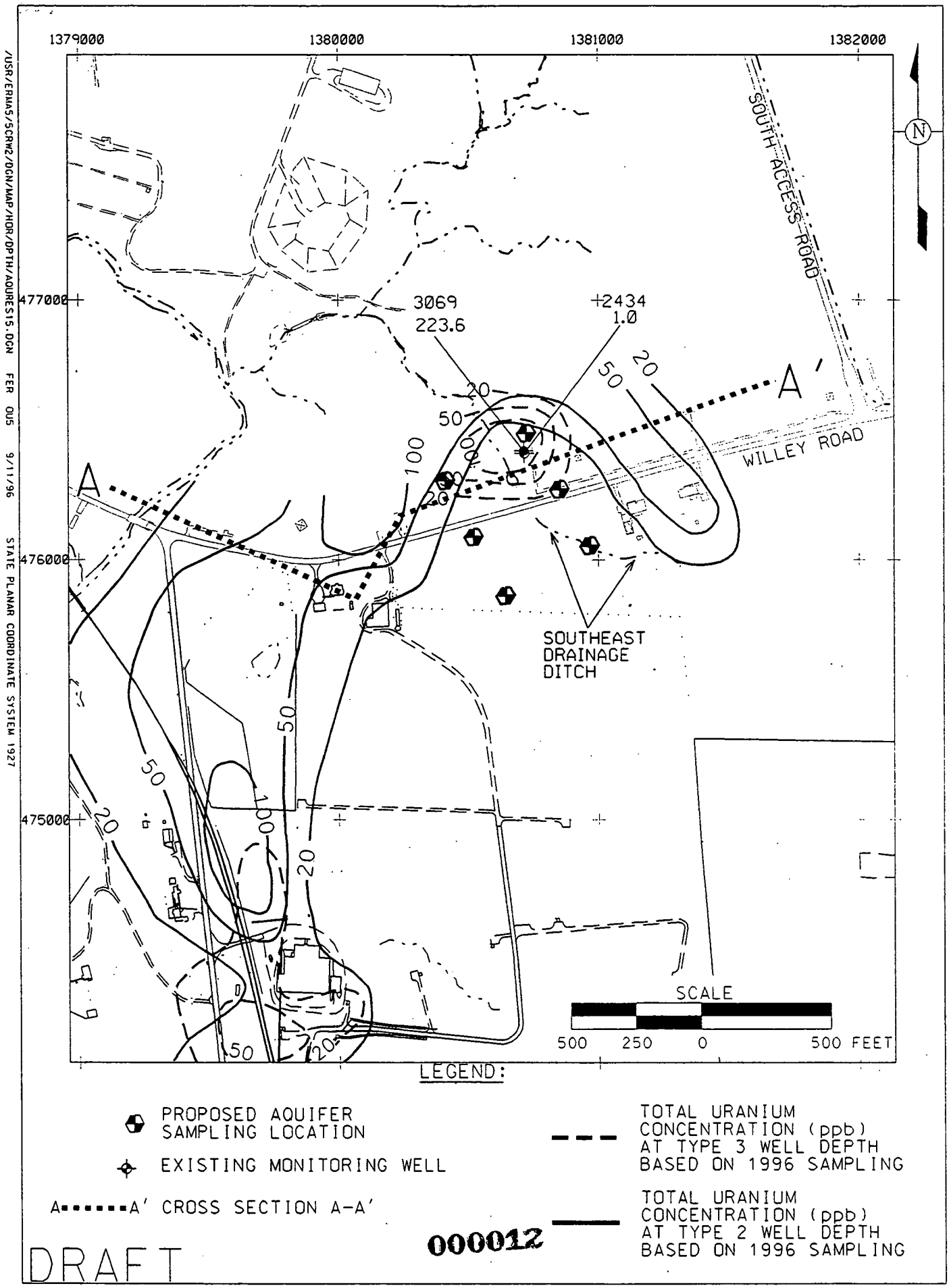
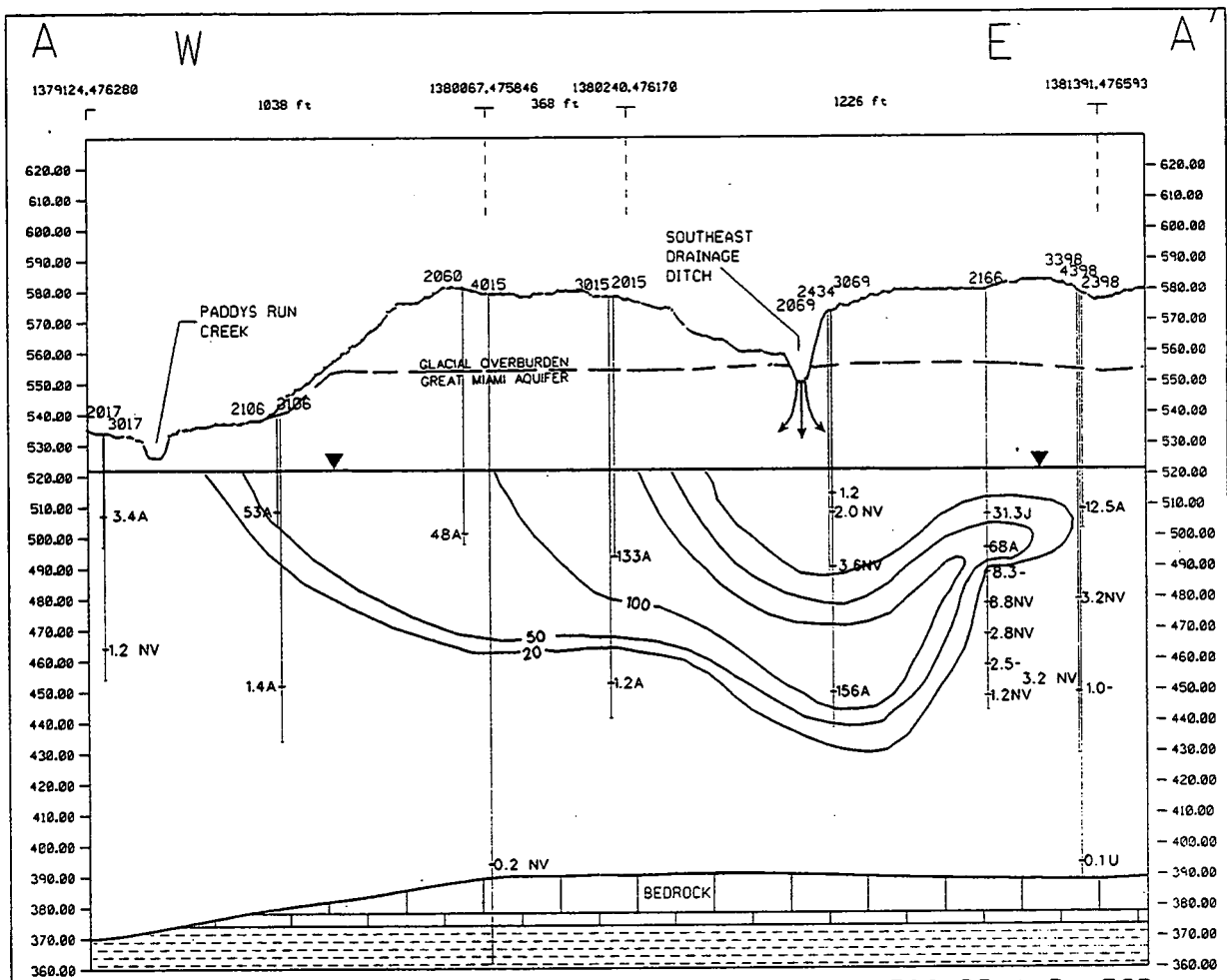


FIGURE 1-3. LOCATION MAP FOR PLUME DELINEATION ACTIVITY



REFERENCE FIGURE 1-3. FOR CROSS-SECTION LOCATION

LEGEND:

+ 77.1 TOTAL URANIUM IN GROUNDWATER (ug/L)

—20— TOTAL URANIUM ISOPLETH FOR GROUNDWATER (ug/L)

— — — GLACIAL OVERBURDEN/ GREAT MIAMI AQUIFER BOUNDARY

1771 MONITORING WELL/ BORING NUMBER

▼ WATER ELEVATION

REPRESENTS INFILTRATION OF "CLEAN" SURFACE WATER

DATA QUALIFIERS:

NV = NONVALIDATED

\- = VALIDTED, NOT QUALIFIED

J = VALIDATED, ESTIMATED

A = AVERAGE OF 1996 1st. AND 2nd. QUARTER DATA

NOTE:
URANIUM VALUES ARE FROM FIGURE 4-104 OF THE OU5 RI REPORT UNLESS QUALIFIED WITH AN "A". THE WATER ELEVATION SHOWN IS ESTIMATED.

SCALE

500 250 0 500 FEET

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FIGURE 1-4. TOTAL URANIUM IN GROUNDWATER CROSS-SECTION A-A'

/usr/erma5/5crw2/dgn/map/hor/dpth/pspsec01.dgn

STATE PLANAR COORDINATE SYSTEM 1927

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2.0 MANAGEMENT AND ORGANIZATION

This section defines the roles and responsibilities of key management and technical personnel associated with the completion of the work defined in this PSP. Sampling activities defined in this PSP will be performed by FERMCO. Descriptions of some of the key technical responsibilities of project personnel or organizations are provided below.

The DOE Operable Unit 5 Team Leader is responsible for:

- Providing direction and oversight to the completion of PSP activities
- Acting as the point of contact within DOE and for the regulators and stakeholders for all communications concerning work carried out under this PSP.

The FERMCO Aquifer Restoration Project Director is responsible for:

- Providing overall project management and technical guidance to the FERMCO team
- Ensuring the necessary resources are allocated to the project for the efficient and safe completion of PSP activities
- Overseeing and auditing PSP activities to ensure that the work is being performed efficiently and in accordance with all regulatory requirements and commitments, DOE Orders, site policies and procedures, and safe working practices.

The FERMCO Project Manager is responsible for:

- The safe and prompt completion of work outlined in the PSP
- Oversight and programmatic direction of sampling activities
- Providing a technical lead for the collection and interpretation of sampling data
- Establishing and maintaining the scope, schedule, and cost baseline
- Reporting to the DOE Aquifer Restoration Project Team Leader and FERMCO Aquifer Restoration Project Manager on the status of PSP activities and on the identification of any problems encountered in the accomplishment of the PSP
- Obtaining the necessary funding to complete the sampling and data analysis activities

The FERMCO Technical Lead is responsible for:

- Reporting to the FERMCO Project Manager on the progress of PSP activities
- Interpreting and reporting the sampling results

3.0 SAMPLING PROGRAM

Analytical Program Requirements are summarized in Table 3-1. All monitoring wells will be purged and sampled using procedures specified in SCQ Section 6.2. All analyses will be conducted by the appropriate C or contracted laboratory using procedures which meet the standards for these analytical support levels as established in the SCQ. Sample collection procedures and guidance sections of the SCQ are used to conduct groundwater monitoring:

Standard Operating Procedures

ADM-02	Field Project Prerequisites
EM-EQT-06	Geoprobe Operation (Draft)
EM-GWM-FO-201	Groundwater Sampling Activities
EM-GWM-202	Groundwater Sample Shipment

Sitewide CERCLA Quality (SCQ) Assurance Project Plan

Section 5	Field Activities
Section 6	Sampling Requirements
Section 7	Sample Custody
Section 9	Analytical Procedures
Appendix I	Field Calibration Requirements
Appendix J	Field Activity Methods
Appendix K	Sampling Methods

3.1 FRL EXCEEDANCES DETECTED OUTSIDE OF THE RESTORATION FOOTPRINT

The following scope of work will be added to the IEMP. Quarterly groundwater samples will be collected from Monitoring Wells 3423, 2436, and 3091 and sampled for antimony, manganese, and zinc respectively, at ASL Level B (see Table 3-1). Detection limits used will be the limits that are identified in the Operable Unit 5 FS Report as being the lowest achievable.

3.2 URANIUM PLUME DELINEATION IN THE AREA OF MONITORING WELL 3069

A Geoprobe™ screen point or mill-slotted well point sampler will be used to collect groundwater samples from the six locations shown in Figure 1-3. Collection of off property samples will be subject to the approval of the land owner. Sampling will take place at depth increments of 10 feet from the top of the water table to a depth of approximately 150 feet below the ground surface to obtain a complete vertical profile of the greater than 20 $\mu g/L$ total uranium plume. The depths

required to obtain this vertical profile are near the depth limits of the Geoprobe tool. If sampling indicates that the deeper sampling is required to profile the plume, then a different method for obtaining the sample may need to be used. Groundwater samples will be analyzed for total uranium at ASL Level B (see Table 3-1). One matrix spike duplicate and one rinsate sample shall be collected at each location.

It is estimated that the water table is located at a depth of approximately 60 feet below the ground surface in this area. It is expected that nine depth intervals can be sampled at each location (one every ten foot of depth) for a total of 54 sampling events.

Past experience with groundwater samples collected using the Geoprobe™ screen point sampler has indicated high sample turbidity (due to suspended solids) which requires excessive amounts of HNO_3 to preserve the sample. Dissolution of suspended solids by HNO_3 results in a sample that is not representative of groundwater in the aquifer. Analysis of samples of this type (where sediments have been dissolved) leads to biased results and could lead to inaccurate assessments of contaminant concentrations in the aquifer. A pre-filtering step described below will be used to alleviate this problem.

Groundwater samples collected using the Geoprobe™ screen point or mill-slotted well point sampler will be pre-filtered using a 11 micron filter to remove the majority of suspended solids. The pre-filtered sample will then be split into a filtered sample (0.45 micron filter) and an unfiltered total sample per Section 5.8.4 and 5.8.5 of procedure SC-GWM-FO-201. Duplicate filtered and unfiltered samples will also be prepared. The duplicate samples will be archived temporarily for re-analysis purposes if necessary. All samples will be filtered or poured into 250-ml containers preserved with HNO_3 (0.4 mL). Groundwater sample collection will be accomplished using a 3/8 inch O.D. polyethylene tubing equipped with a ball check valve. New tubing will be used for each sample collected.

During pre-probing and deployment of the sampling screen, it may be necessary to remove the tool screen from the hole which may result in partial hole collapse. The amount of time the probe hole is left open will be minimized to the extent practical. The glacial till in the planned investigation area contains no constituents of concern above FRLs.

9 The 1.0 - 1.5 inch diameter probe will be plugged with a bentonite slurry following groundwater sample collection. The bentonite will be mixed to SCQ density specifications (approximately 9.4 lbs. per gallon) and pumped through probe rods to the bottom of the bore hole as the probe rods are removed. For the purpose of this PSP, the aquifer material will be allowed to collapse naturally up to the water table. Plugging of the probed hole with bentonite slurry will begin 3 feet above the water table and continue to the ground surface. ~~For the purposes of this PSP, the bottom of the probed hole shall be 3 feet above the water table.~~ The volume of the bentonite slurry used in the plugging process will be monitored and recorded.

TABLE 3-1

ANALYTICAL PROGRAM REQUIREMENTS

Constituent	Sample Type	ASL	Holding Time	Preservation	Container[a]
Metals	Grab	B	6 months	HNO_3 to pH < 2	Plastic or glass
Total Uranium	Grab	B	6 months or 5x half-life, whichever is less	HNO_3 to pH < 2	Plastic or glass
Field Parameters[a]	Grab	A	NA[b]	NA[b]	NA[b]

[a]Field parameters include dissolved oxygen, pH, specific conductance, temperature and turbidity
[b]NA = Not applicable

4.0 QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS

Groundwater Monitoring Sampling events follow Quality Assurance/Quality Control (QA/QC) protocol established in Section 4 and Appendix K of the SCQ.

4.1 PROJECT REQUIREMENTS FOR SURVEILLANCES

Self-assessment of work processes and operations shall be undertaken to assure quality of performance. Self-assessment shall be performed by the Project Manager, and shall encompass technical and procedure requirements. Such self-assessment may be conducted at any point in the project.

Independent assessment shall be performed by the FEMP QA organization by conducting surveillances. At a minimum, one surveillance shall be conducted, consisting of monitoring/observing ongoing project activity and work areas to verify conformance to specified requirements. Surveillances shall be planned and documented in accordance with Section 12.3 of the SCQ.

4.2 FIELD CHANGES TO THE PROJECT SPECIFIC PLAN

Prior to the implementation of field changes, the Project Manager shall be informed of the proposed field changes. Once approval has been obtained (verbal or written) from the Project Manager and QA representative for the field changes to the PSP, the field changes may be implemented. Field changes to the PSP shall be noted on a Variance Request form. QA must receive the completed Variance Request form, which includes the signatures of the Project Manager, and the QA/QC Representative, within one week of the granting of the verbal approval.

4.3 QUALITY ASSURANCE SAMPLES

Field quality assurance samples shall include one rinsate per geoprobe location, and one matrix spike duplicate for each analytical batch.

5.0 EQUIPMENT DECONTAMINATION

Sampling equipment shall be decontaminated prior to transport to the sample field site and after all sampling is completed to limit the introduction of contaminants from equipment to sampled media and to protect worker safety and health.

The decontamination of equipment that comes into contact with groundwater shall be a Level II Decontamination as referenced in Section K.11 of the SCQ and as described in Section 6.4.1 of the SCQ and Section 5.7.6 of SOP EM-GWM-FO-201, "Groundwater Sampling Activities." Probing equipment that will not be in contact with the groundwater shall be decontaminated at Level 1 per SCQ procedures.

6.0 HEALTH & SAFETY

EM Sampling Technicians shall conform to precautionary surveys performed by the personnel representing the Utility Engineer, Industrial Hygiene, and Radiological Control. Concurrence to applicable safety permits (indicated by the signature of each EM Sampling Technician assigned to this project) is expected by EM Sampling Technicians in the performance of their assigned duties.

The EM Field Supervisor or the Lead Sampling Technician will ensure that each EM Sampling Technician performing sampling related to this project has read the Programmatic Health and Safety Plan (PHSP) and the applicable surveys that protect worker safety and health. EM Sampling Technicians who do not sign these documents shall not participate in the execution of sampling activities related to the completion of assigned project responsibilities. A copy of applicable safety permits/surveys issued for worker safety and health shall be posted at each sample location and at the completion of the project, the completed forms shall be submitted for incorporation into the project files.

7.0 DISPOSITION OF INVESTIGATION-DERIVED WASTES

During completion of sampling activities, EM Sampling Technicians may generate contact wastes, purge water, and decontamination waste. Following completion of sampling, the EM Sampling Technicians shall place contact wastes into properly labeled bags and disposition in accordance with appropriate FEMP waste management policies. The EM Sampling Technicians shall decant decontamination solution into appropriate containers which will be ultimately transferred to Plant 8 for treatment.

8.0 DATA MANAGEMENT

This data management plan will be implemented so information collected during the investigation will be properly managed following completion of the field activities. As specified in Section 5.1 of the SCQ, sampling teams shall describe daily activities on the Field Activity Log (FAL) sufficient for the sampling team to reconstruct a particular situation without reliance on memory. Sample collection logs shall be completed according to instructions specified in Appendix B of the SCQ.

8.1 VALIDATION

To assure appropriate documentation was completed during field activities and that documentation was completed correctly, field documentation shall be validated.

Analytical data shall be validated upon receipt. Validation shall be performed to the highest ASL permitted by the data.

The Data Quality Group shall provide to the Project Manager and to Analytical Data Management (ADM) copies of the summary reports listing validation qualifiers applied along with copies of the validated data sheets. All original validation summary forms and validation reports shall be submitted to ADM for permanent storage.

8.2 DATA ENTRY

Analytical data shall be received from the contract laboratory by electronic data transfer in a compatible format with the FEMP database and in hard-copy format. Hard-copy documents are kept in permanent storage in the Project Files; the electronic database is permanently archived in a neutral ASCII file format.

9.0 REFERENCES

U.S. Dept. of Energy, 1996a, "Integrated Environmental Monitoring Plan, Draft," Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Field Office, Cincinnati, OH.

U.S. Dept. of Energy, 1996b, "Remedial Design Work Plan for Remedial Actions at Operable Unit 5," Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Field Office, Cincinnati, OH.

U.S. Dept. of Energy, 1996c, "South Plume Removal Action Design Monitoring Evaluation Program Plan, System Evaluation Report for January 1, 1996-June 30, 1996," Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Field Office, Cincinnati, OH.

U.S. Dept. of Energy, 1995a, "Feasibility Study Report for Operable Unit 5," Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Field Office, Cincinnati, OH.

U.S. Dept. of Energy, 1995b, "Proposed Plan for Operable Unit 5," Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Field Office, Cincinnati, OH.

APPENDIX A

EVALUATION OF FRL EXCEEDANCES WHICH OCCUR OUTSIDE OF THE RESTORATION FOOTPRINT

A.1 Introduction

Constituents (uranium and non-uranium) which will be used to assess the progress and success of the aquifer restoration have been assigned Final Remediation Levels (FRLs) in the Operable Unit 5 ROD and are referred to in this evaluation as FRL constituents. If an FRL constituent is detected in the Great Miami Aquifer at a concentration above its FRL, then it is referred to as an FRL exceedance.

Data evaluation in support of the Integrated Environmental Monitoring Plan (IEMP, DOE 1996a) indicated that fourteen FRL constituents have had at least one FRL exceedance at some location outside of the restoration footprint, and north of the PRRS Administrative Boundary, Figure A.1-1. The fourteen FRL exceedances, which are the scope of this evaluation, are: manganese, fluoride, nitrate, cadmium, lead, zinc, antimony, arsenic, mercury, nickel, trichloroethene, silver, thorium-228, and thorium-232. As explained in the IEMP, FRL exceedances located outside of the restoration footprint will not be addressed by the planned configuration of pumping and injection wells designed for the aquifer restoration. A decision needs to be made on whether or not the exceedances outside of the restoration footprint are attributable to the FEMP and need to be monitored and remediated.

The evaluation presented in this appendix reviews the Operable Unit 5 remedial investigation study groundwater data set, supplemented with groundwater data collected in 1994 and 1995 to further evaluate the nature of the 14 FRL exceedances located outside the restoration footprint.

During the preparation of this PSP it was discovered that FRLs for two constituents (fluoride and lead) were not selected in accordance with the approved FRL development protocol found in the Operable Unit 5 Feasibility Study. The Operable Unit 5 Feasibility Study (Section 2, page 2-54) outlined two Cases for potential groundwater FRLs. These two Cases are: Case 1 which "considered a target risk level of 10^{-6} ILCR and an HI of 0.2 to a resident farmer," and Case 2 which "employed the MCLs, proposed MCLs and nonzero MCLGs as target cleanup values. For those COCs with no MCLs, proposed MCLS, or nonzero MCLGs, Case 2 considered a target risk level of 10^{-5} and an HI of 0.2 to a resident farmer."

Case 2 was ultimately selected as part of the preferred alternative in the approved Operable Unit 5 Proposed Plan and was subsequently utilized to establish the groundwater FRLs found in the final

Operable Unit 5 ROD. Figure A.1-2 (Process For Development of Groundwater FRLs) illustrates the Case 2 FRL development process. In the OU5 FS process for the development of the fluoride FRL, the MCL for fluoride (4 mg/L) was inadvertently overlooked, and according to the approved Case 2 development process the MCL should have been selected as the FRL; (the current FRL was inadvertently established based on the 95th percentile background concentration of fluoride, which is 0.89 mg/L) therefore DOE recommends the MCL for fluoride be adopted as the FRL.

In light of the approved Case 2 FRL development process, the current background based FRL for lead (0.002 mg/L) is also not appropriate. There is no MCL for lead and currently there are no toxicity data from which to derive specific health-based cleanup levels for lead. The apparent reason for this lack of toxicity information is that the appropriate reference dose for lead is widely disputed among toxicologists. However, the 0.015 mg/L action level for lead was promulgated as a protective standard for all drinking water supplies nationwide. In the absence of additional toxicological data, it is reasonable to apply this standard as an appropriate lead cleanup level for the FEMP. DOE understands that U.S. EPA has adopted this approach for lead at a number of Superfund sites nationwide.

The SDWA action level for lead was documented in the Operable Unit 5 Feasibility Study and ROD ARAR tables, however, since it was not a true MCL it was overlooked in the development of the lead FRL for groundwater. In the absence of an MCL for lead DOE believes that the SDWA health based action level of 0.015 mg/L is an appropriate substitute for the MCL and therefore recommends that it be adopted as the groundwater FRL for lead.

Based on the above information the evaluation lead and fluoride contained in this appendix (and summarized in Section 1.0) was completed utilizing the MCL for fluoride (4 mg/L) and the SDWA action level for lead (0.015 mg/L) rather than the using the inappropriate background-based FRLs.

A.2 Background

The aquifer restoration footprint, shown in Figure A.2-1, is the modeled non-retarded hydraulic capture zone which is predicted to result from the aquifer restoration under the 10-year restoration scenario presented in the Baseline Remedial Strategy Report for Aquifer Restoration (Remedial Design, Task 1). The size and dimension of the aquifer restoration footprint is dependent upon the

amount and rate of pumping and/or injection which will be conducted to capture the 20 μg/L total uranium plume.

In general, FRLs assigned for the cleanup are based on either a promulgated ARAR value, the 95th percentile background concentration, the lowest reasonable and achievable detection limit, or the risk based Preliminary Remediation Goal (PRG). A promulgated ARAR value takes precedence, unless background concentrations are higher than the ARAR value. If an ARAR does not exist for a constituent, then the FRL is usually based on the 95th percentile background concentration or the PRG, whichever is higher. A detailed discussion of FRL development is provided in Section 2 of the approved Operable Unit 5 FS Report.

A.3 Evaluation

As noted in the RD Work Plan, an evaluation of all existing non-uranium groundwater data for final remediation level (FRL) exceedances located outside of the restoration footprint was a necessary part of the remedial design for the aquifer restoration. The focus of this evaluation was to determine if the non-uranium exceedances are attributable to the FEMP, are one time occurrences, are persistent and of such magnitude that they require a modification of the uranium based groundwater remedy or require additional monitoring to determine what additional action, if any, should be taken.

As mentioned above, there are 14 constituents that have had an FRL exceedance outside of the aquifer restoration footprint and north of the Administrative Boundary for aquifer restoration. Concentration data were graphed at each of the exceedance locations to identify the persistence of the exceedance. To be conservative, the values plotted on the graphs represent the greatest reported concentration for each date of filtered and unfiltered samples, as well as normal and duplicate samples. Any large discrepancy between concentrations of the same constituent on the same date were noted on the individual graphs.

If an exceedance was a one time occurrence and is no longer occurring, then there is no need to continue monitoring for the constituent or to remediate the location. If two or more sampling events following an exceedance indicate that concentrations are below the FRL, then the location will not be

considered for further monitoring or remediation. The evaluation of each of the 14 constituents with FRL exceedances is described below.

Antimony

The FRL for antimony is 0.006 mg/L, which is an MCL under the Safe Drinking Water Act. FRL exceedances for antimony have been recorded at 5 locations (Monitoring Wells 2432, 3070, 2424, 3423, and 2066) outside of the restoration footprint, Figure A.3-1. The FRL exceedances range from 0.0245 mg/L to 0.116 mg/L. Figures A.3-2 through A.3-6 show the concentration versus sample date for the five different locations.

Data from Monitoring Wells 2432, 3070, and 2424 (Figures A.3-2 through A.3-4 respectively) indicate that the FRL exceedance was a one time event and subsequent sampling indicates that the concentration is below the FRL, therefore monitoring for FRL exceedances of antimony at these locations is not necessary. However, Monitoring Wells 2432, 3070, and 2424 will continue to be monitored for antimony as part of the IEMP RCRA Property Boundary Program.

Data from Monitoring Well 2066 (Figure A.3-5) indicates that the last sampling event measured an FRL exceedance. This well is upgradient of the FEMP and has been used as a background well for the FEMP. Because of its upgradient location, the antimony exceedance is not attributed to the FEMP; therefore, it is proposed that no additional monitoring for antimony take place at Monitoring Well 2066.

Data from Well 3423 (Figure A.3-6) indicates that the FRL exceedance for antimony was not a one time event. Given the location of this well the exceedance could be attributable to the FEMP and should be monitored. It is proposed that the task of sampling Monitoring Well 3423 for antimony be added to the IEMP.

Arsenic

The FRL for arsenic is 0.05, which is an MCL established by the Safe Drinking Water Act. FRL exceedances for arsenic have been recorded at 10 locations (Monitoring Wells 2026, 2036, 2056, 2105, 2679, 3063, 3066, 3092, 3679, and 3678) outside of the restoration footprint, Figure A.3-7.

Figures A.3-8 through A.3-17 are graphs of the concentration versus sampling date for the 10 different locations.

At Wells 2026, 2036, 2056, 2105, 3063, and 3092 (Figures A.3-8 through A.3-13 respectively), the last two (or more) sampling events indicate that arsenic concentrations are below the FRL. With the exception of Monitoring Well 3092, all of the wells are upgradient of the FEMP. The remaining 4 wells (3066, 3679, 2679 and 3678) are all located upgradient (north) of the former production area and Waste Storage Area (Figure A.3-7). FRL exceedances for arsenic at wells 3066, 3679, 2679, and 3678 are not one time occurrences (Figures A.3-14 through A.3-17 respectively). FRL exceedances for arsenic at these locations are not attributable to former FEMP operations because these locations are upgradient of the FEMP and therefore will not be monitored or remediated. It is proposed that with the exception of those wells currently being sampled as part of the RCRA Property Boundary Program, no additional monitoring take place outside of the Aquifer Restoration Footprint for arsenic.

Cadmium

The FRL for cadmium is 0.014 mg/L and is based on background which ranges from 0.0022 mg/L to 0.014 mg/L (DOE 1994). FRL exceedances of cadmium have been recorded at four locations outside of the restoration footprint (Monitoring Wells 3898, 2733, 3067, and 2424), Figure A.3-18. The FRL exceedances range from 0.0155 mg/L to 0.0285 mg/L.

At Wells 2424, 2733, 3067, and 3898 (Figures A.3-19 through A.3-22 respectively) the FRL exceedances for cadmium were one time occurrences. It is proposed that with the exception of those wells currently being sampled as part of the RCRA Property Boundary Program, no additional monitoring take place outside of the Aquifer Restoration Footprint for cadmium.

Fluoride

The FRL for fluoride is recorded as 0.89 mg/L in the OU5 ROD (DOE 1996a) and is based on background which ranges from 0.1 mg/L to 1.9 mg/L (DOE 1994). The MCL for fluoride is

4 mg/L. The MCL value for fluoride was inadvertently overlooked in the development of the fluoride FRL. The fluoride MCL should be used as the FRL since MCLs, when higher than background, take precedence over background in the FRL development process.

FRL exceedances of fluoride have been recorded at 16 locations outside of the restoration footprint, Figure A.3-23. The FRL exceedances range from 0.9 mg/L to 1.8 mg/L. When the MCL value is used as the FRL, there are no fluoride exceedances outside of the restoration footprint.

It is recommended that the FRL value for fluoride be changed from 0.89 mg/L to 4 mg/L. With this change, exceedances outside of the aquifer restoration footprint are no longer an issue.

It is proposed that with the exception of those wells currently being sampled as part of the RCRA Property Boundary Program, no additional monitoring take place outside of the Aquifer Restoration Footprint for fluoride.

Lead

The FRL for lead is recorded as 0.002 mg/L in the OU5 ROD (DOE 1996a) and is based on background which ranges from <0.001 mg/L to 0.002 mg/L (DOE 1994). The SDWA action level for lead is 0.015 mg/L. It is proposed that the decision to monitor and remediate outside of the restoration footprint for lead be based on the SDWA action level. FRL exceedances of lead (based on 0.002 mg/L) have been recorded at 26 locations outside of the restoration footprint, Figure A.3-24. The FRL exceedances range from 0.0021 mg/L to 0.08 mg/L. Compared against the SDWA action level, exceedances have only been recorded at the five locations (Monitoring Wells 2056, 2121, 2122, 2733, and 3070) as shown in Figures A.3-25 to A.3-29. Three of these exceedances are located upgradient of the FEMP (Monitoring Wells 2056, 2121, and 2122). Two of the exceedances are located downgradient of the southern portion of the FEMP (Monitoring Wells 3070 and 2733).

The lead exceedances recorded at the upgradient locations (Monitoring Wells 2056, 2121, and 2122) are not attributable to the FEMP. The exceedances recorded in the downgradient locations 3070 and 2733 could be attributed to the FEMP and should be monitored. Both locations are currently being monitored as part of the RCRA Property Boundary Monitoring network.

Manganese

The FRL for manganese is 0.9 mg/L and is based on background which ranges from 0.0043 mg/L to 0.904 mg/L. FRL exceedances of manganese have been recorded at three locations outside of the restoration footprint (Monitoring Wells 2424, 2436, and 2733), Figure A.3-30. The FRL exceedances range from 0.931 mg/L to 1.13 mg/L. Figures A.3-31 through A.3-33 show the concentrations versus sample date for Wells 2733, 2424, and 2436 respectively.

The graph for Well 2733 (Figure A.3-31) indicates that the FRL exceedance for manganese was a one time occurrence. The graphs for Monitoring Wells 2424 and 2436 (Figures A.3-32 and A.3-33 respectively) indicate that the FRL exceedance for manganese was not a one time event and given their location the exceedances could be attributed to the FEMP. These two locations outside of the aquifer restoration footprint should be monitored for manganese. Both locations (Monitoring Wells 2424 and 2436) are currently being monitored as part of the RCRA Property Boundary Monitoring network.

Mercury

The FRL for mercury is 0.002 mg/L, which is an MCL established by the Safe Drinking Water Act. One location (Monitoring Well 2091) had a one time FRL exceedance which was outside of the restoration footprint (Figure A.3-34). Figure A.3-35 shows the concentration versus sample date for this location. As the graph illustrates, six sampling events subsequent to the one detection indicate that mercury levels at this location are below the FRL. It is proposed that no additional monitoring for mercury outside of the aquifer restoration footprint be conducted, above and beyond what is already being conducted as part of the RCRA Property Boundary Monitoring Program.

Nickel

The FRL for nickel is 0.1 mg/L, which is an MCL established by the Safe Drinking Water Act. FRL exceedances for nickel have been recorded at two Monitoring wells (3092 and 2067) outside of the restoration footprint (Figure A.3-36). The FRL exceedances range from 0.218 mg/L to 0.26 mg/L. Figures A.3-37 and A.3-38 show the concentration versus sample date for the two different locations. These figures indicate that the FRL exceedance for nickel at both locations was a one time occurrence. It is proposed that no additional monitoring for nickel outside of the aquifer restoration

footprint be conducted, above and beyond what is already being conducted as part of the RCRA Property Boundary Monitoring Program.

Nitrate

The FRL for nitrate is 11 mg/L and is based on background which ranges from 0.014 mg/L to 24.9 mg/L (DOE 1994). FRL exceedances of nitrate have been recorded at six locations outside of the restoration footprint, Figure A.3-39. The FRL exceedances range from 11.1 mg/L to 24.9 mg/L; within the range used to define background. Five of the six locations with FRL exceedances (Monitoring Wells 2036, 2123, 2098, 3099, and 2026) were used to define background in 1994. Concentration versus sample date plots for Monitoring Wells 2036, 2123, 2098, 3099, and 2026 are provided in Figures A.3-40 through A.3-44 respectively.

Well 2091 is the only location with an FRL exceedance outside of the restoration footprint that was not also used to define background in 1994. Figure A.3-45 is a concentration versus sample date plot for Well 2091. This well is located east of the FEMP near State Route 128 in an agricultural area. It is believed that this exceedance is due to fertilizer or other agricultural activities and is not FEMP related.

It is proposed that no additional monitoring for nitrate outside of the aquifer restoration footprint be conducted, above and beyond what is already being conducted as part of the RCRA Property Boundary Monitoring Program. The nitrate exceedances located outside of the aquifer restoration footprint are judged to either be within the range of values used to define background, or not attributable to former production at the FEMP due to their location relative to known agricultural areas.

Silver

The FRL for silver is 0.005 mg/L, which is a proposed MCL under the Safe Drinking Water Act. One location outside of the restoration footprint, Monitoring Well 2036 which is located upgradient of the FEMP, had a one time FRL exceedance, Figure A.3-46. Figure A.3-47 shows the concentration versus sample date for this location. It is proposed that no additional monitoring for silver outside of the aquifer restoration footprint be conducted, above and beyond what is already being conducted as part of the RCRA Property Boundary Monitoring Program.

Trichloroethene

The FRL for Trichloroethene is 0.005 mg/L, which is an MCL established by the Safe Drinking Water Act. One location (Monitoring Well 3051) had a one time FRL exceedance which was outside of the restoration footprint (Figure A.3-48). Figure A.3-49 shows the concentration versus sample date for this location.

Well 3051 was plugged and abandoned and replaced by Monitoring Well 31217. Figure A.3-50 is the concentration versus sample date graph for trichloroethene data collected at well 31217. The data indicates that no exceedances of trichloroethene have been detected in this well. It is proposed that no additional monitoring for trichloroethene outside of the aquifer restoration footprint be required, above and beyond what is already being conducted as part of the RCRA Property Boundary Monitoring Program.

Thorium-228 and Thorium-232

Both thorium-228 and thorium-232 have been detected outside of the restoration footprint at concentrations above their FRL (Figure A.3-51). The FRL for thorium-228 and thorium 232 is 4 pCi/L and 1.2 pCi/L, respectively. These exceedances occurred at only one location (Monitoring Well 2092) north of the Administrative Boundary for aquifer restoration. Figures A.3-52 and A.3-53 show the concentration versus sample date for thorium-228 and thorium-232, respectively. These figures indicate that the detections were one time occurrences which took place on 04/24/90. Subsequent sampling events indicate that the concentrations are below the FRL. It is proposed that no additional monitoring for thorium-228 or thorium-232 outside of the aquifer restoration footprint be conducted, above and beyond what is already being conducted as part of the RCRA Property Boundary Monitoring Program.

Zinc

The FRL for zinc is 0.021 mg/L and is based on background which ranges from 0.0087 mg/L to 0.021 mg/L (DOE 1994). FRL exceedances of zinc have been recorded at 12 locations outside of the restoration footprint, Figure A.3-54. The FRL exceedances range from 0.0238 mg/L to 0.124 mg/L.

Figures A.3-55 through A.3-66 show the concentration versus sample data for the twelve locations. FRL exceedances for zinc at Monitoring Wells 2426, 2431, 3733, and 2432 (Figures A.3-55

through A.3-58 respectively) were one time occurrences. The last two or more sampling events at each location indicate that concentrations are below the FRL. It is proposed that no additional monitoring for zinc be conducted at these four locations.

FRL exceedances at Monitoring Wells 2051, 3431, 3066, and 2733, were not one time occurrences, but the last two or more sampling events at each well indicated that no FRL exceedance was present (Figures A.3-59 through A.3-62). It is proposed that no additional monitoring for zinc be conducted at these four locations.

FRL exceedances at Monitoring Wells 2066, 2424, 3091, and 3051, were not one time occurrences Figures A.3-63 through A.3-66 respectively. Monitoring Well 2066 is located upgradient of the FEMP former Production Area and the Waste Storage Area. Therefore, zinc exceedances at this location are not attributable to the FEMP. It is proposed that no additional monitoring for zinc be conducted at Monitoring Well 2066. As mentioned earlier, Monitoring Well 3051 has been plugged and abandoned and replaced with Monitoring Well 31217. It is proposed that groundwater monitoring for zinc be conducted at Monitoring Wells 2424, 3091, and 31217. All three of these wells are currently being monitored as part of the RCRA Property Boundary Monitoring Program.

A.4 Conclusions

Of the 50 FRL constituents listed in the OU5 ROD, 14 have had at least 1 FRL exceedance outside the restoration footprint and north of the Administrative Boundary. The fourteen constituents are manganese, fluoride, nitrate, cadmium, lead, zinc, antimony, arsenic, mercury, nickel, trichloroethene, silver, thorium-228, and thorium-232. Of these fourteen constituents;

- Mercury, nickel, trichloroethene, silver, thorium-228, and thorium-232 can be dismissed from further monitoring outside the restoration footprint because the FRL exceedances were a one time occurrence with subsequent data indicating concentrations below the FRL.

- Fluoride can be dismissed from further monitoring outside the restoration footprint because the exceedances were identified using an FRL based on a background value of 0.89 mg/L. The MCL for fluoride is 4 mg/L. The MCL should be used to guide the restoration. When fluoride detects are compared against the MCL, no FRL exceedances result.

- Nitrate can be dismissed from further monitoring outside the restoration footprint because the FRL exceedances are either within the range used to define background and/or not attributable to the FEMP.

- Arsenic can be dismissed from further monitoring outside the restoration footprint because the FRL exceedances are not attributable to the FEMP.

- Many of the lead exceedances can be dismissed from further monitoring outside of the restoration footprint because they were identified using an FRL based on a background value of 0.002 mg/L. The SDWA action level for lead is 0.015 mg/L. The SDWA action level should be used to guide the restoration. It is proposed that the decision to monitor and remediate outside of the restoration footprint (as well as to monitor the restoration within the footprint) for lead be based on the SDWA action level. Using the SDWA action level does not eliminate all of the FRL exceedances for lead, but it does eliminate a majority of them.

- Exceedances for antimony, manganese, cadmium, zinc and lead, at several locations outside of the aquifer restoration footprint, are not one time occurrences and due to their location relative to the FEMP could be attributable to the FEMP. Therefore they cannot be dismissed from further monitoring at this time.

The RCRA property boundary monitoring program currently monitors the majority of the locations where potentially FEMP related and persistent FRL exceedances are found outside of the aquifer restoration footprint. Only three of the identified exceedance locations are currently not being monitored by the RCRA Property Boundary Program; Monitoring Well 3423 for antimony, Monitoring Well 2436 for manganese, and Monitoring Well 3091 for zinc. It is proposed that quarterly sampling at these locations for the noted FRL constituents be added to the scope of the IEMP. The quarterly sampling will continue for a period of one year at which time data will be evaluated to determine the need for additional actions at these locations.

A.5 References

U.S. Dept. of Energy, 1996a, "Integrated Environmental Monitoring Plan, Draft," Fernald Environmental Management Project, DOE, Fernald Field Office, Cincinnati, OH.

U.S. Dept. of Energy, 1996b, "Record of Decision for Remedial Actions at Operable Unit 5, Final," Fernald Environmental Management Project, DOE, Fernald Field Office, Cincinnati, OH.

U.S. Dept of Energy, 1994. "Characterization of Background Water Quality for Stream and Groundwater, Final," Fernald Environmental Management Project, DOE, Fernald Field Office, Cincinnati, OH.

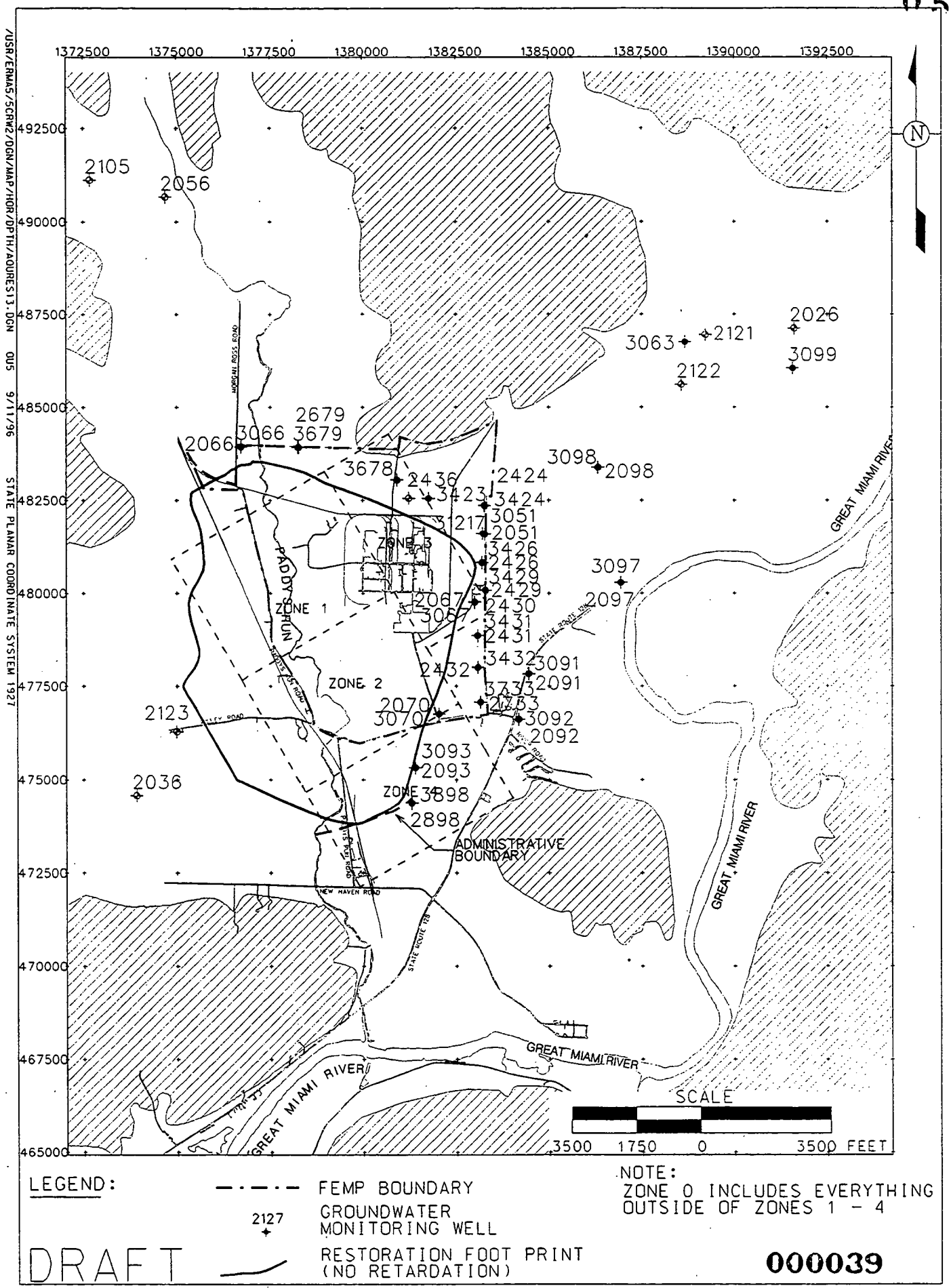


FIGURE A.1-1. MONITORING WELLS WITH FRL EXCEEDENCES LOCATED OUTSIDE THE RESTORATION FOOTPRINT AND NORTH OF THE ADMINISTRATIVE BOUNDARY

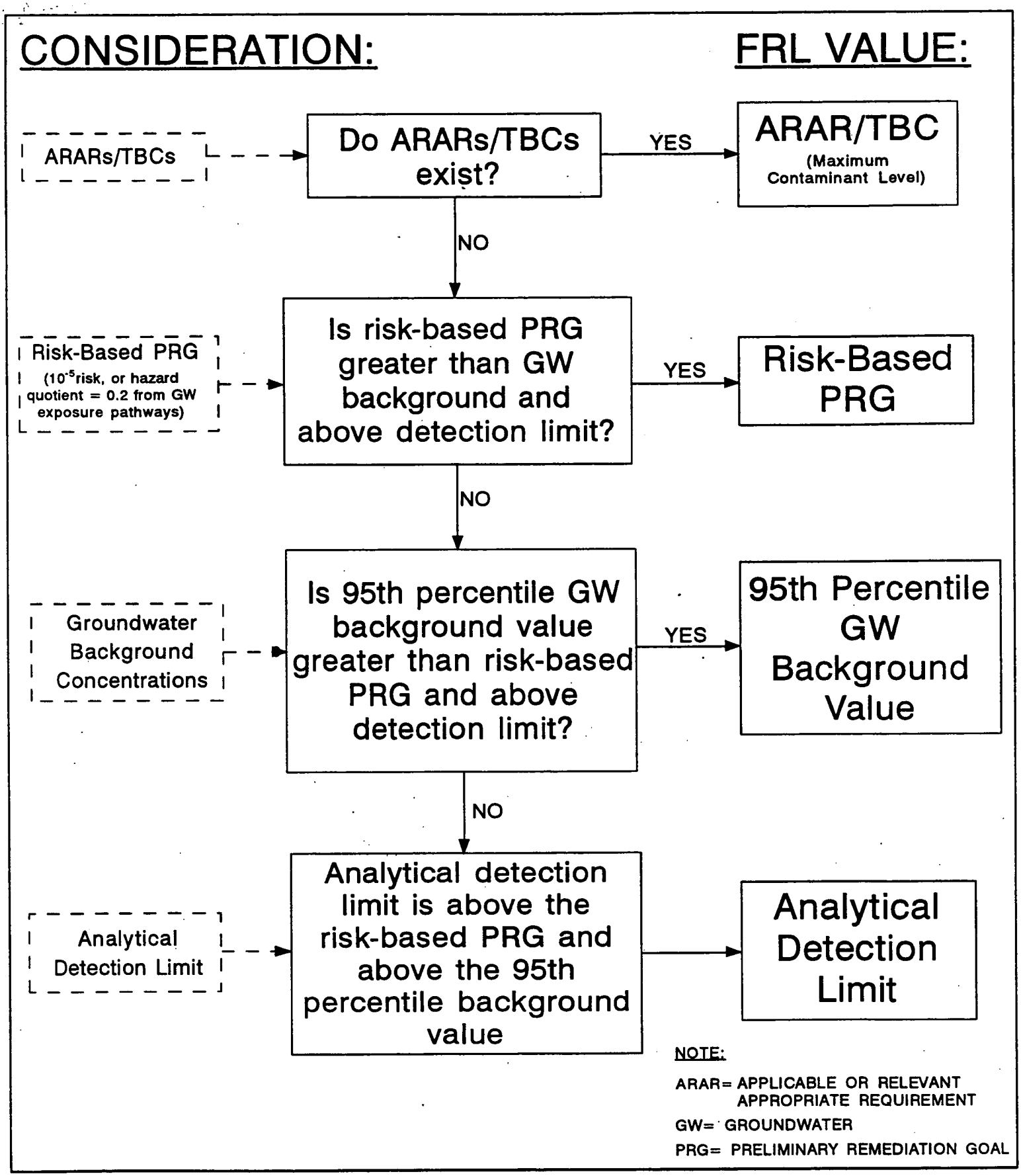


FIGURE A.1-2. PROCESS FOR DEVELOPMENT OF GROUNDWATER FRLs.

(ARAR/10^{-5} Case Contained in the OU5 Proposed Plan and Ultimately Selected in the OU5 ROD [Ref. OU5 FS p. 2-54])

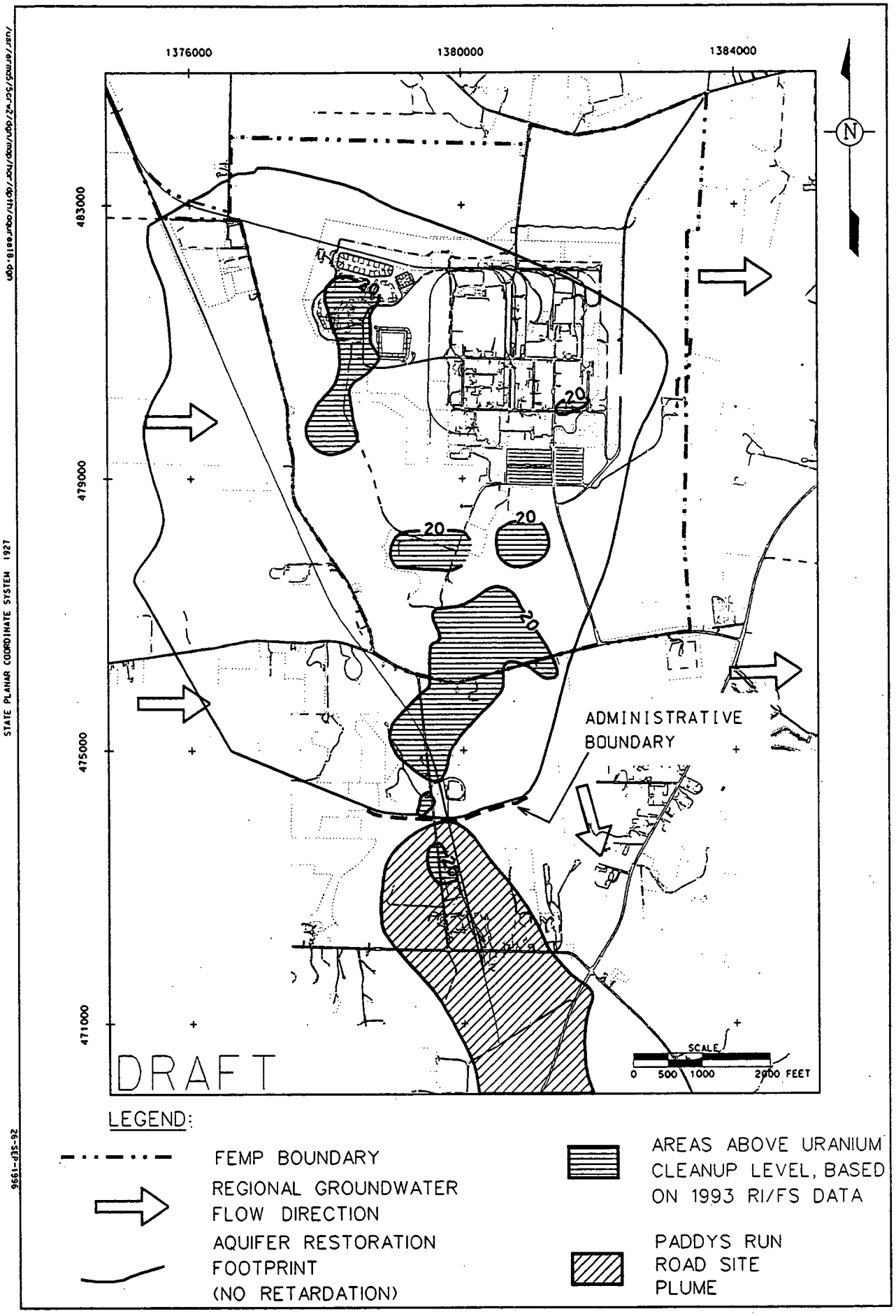
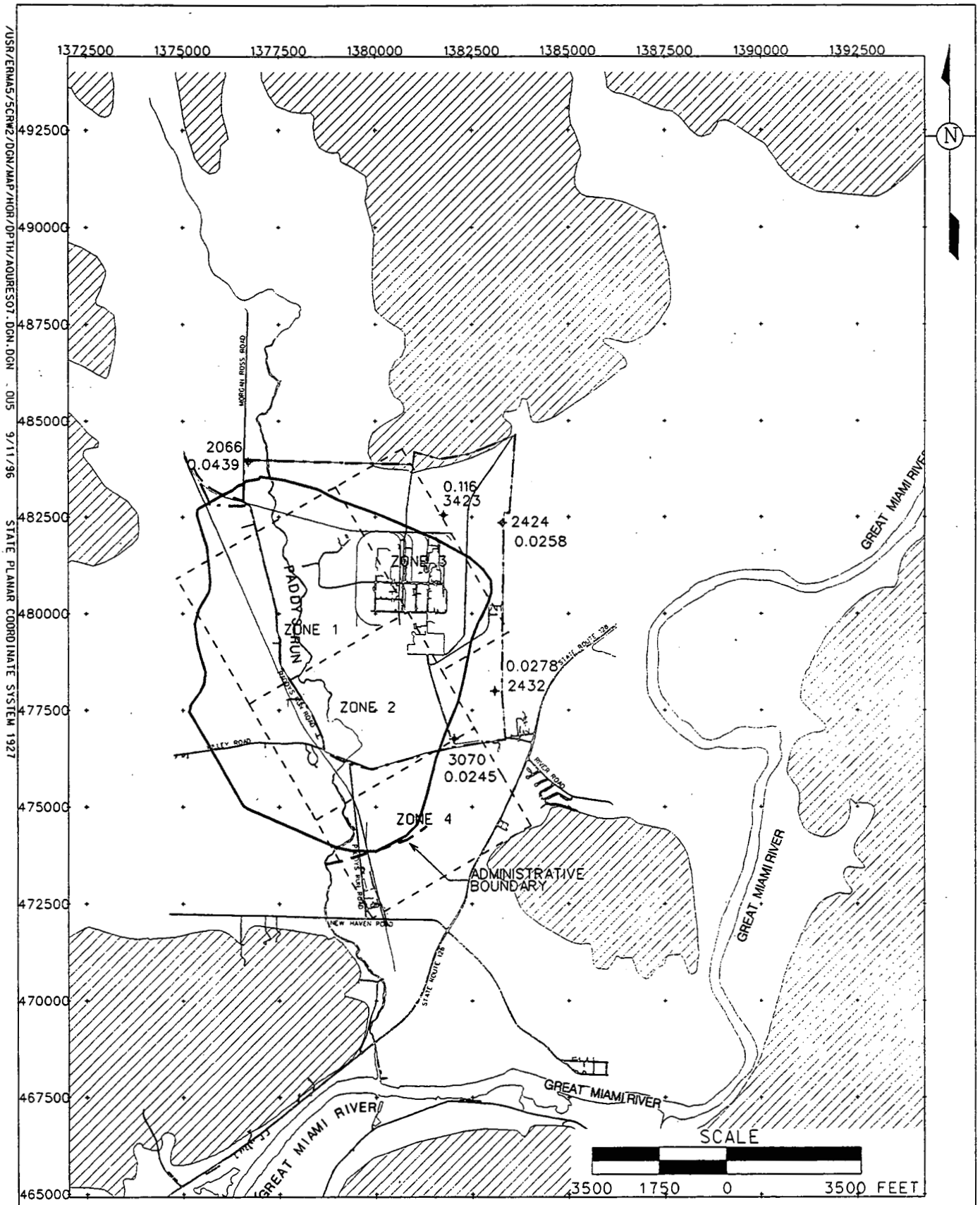


FIGURE A.2-1. AREAS OF THE GREAT MIAMI AQUIFER REQUIRING REMEDIATION AND AQUIFER RESTORATION FOOTPRINT



LEGEND:

- FEMP BOUNDARY
- 2127 GROUNDWATER MONITORING WELL
- .002 ANTIMONY (MAXIMUM VALUE)
- RESTORATION FOOT PRINT (NO RETARDATION)

NOTE:
ZONE 0 INCLUDES EVERYTHING OUTSIDE OF ZONES 1 - 4

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FIGURE A.3-1. FRL EXCEEDENCES FOR ANTIMONY LOCATED OUTSIDE OF THE RESTORATION FOOTPRINT AND NORTH OF ADMINISTRATION BOUNDARY

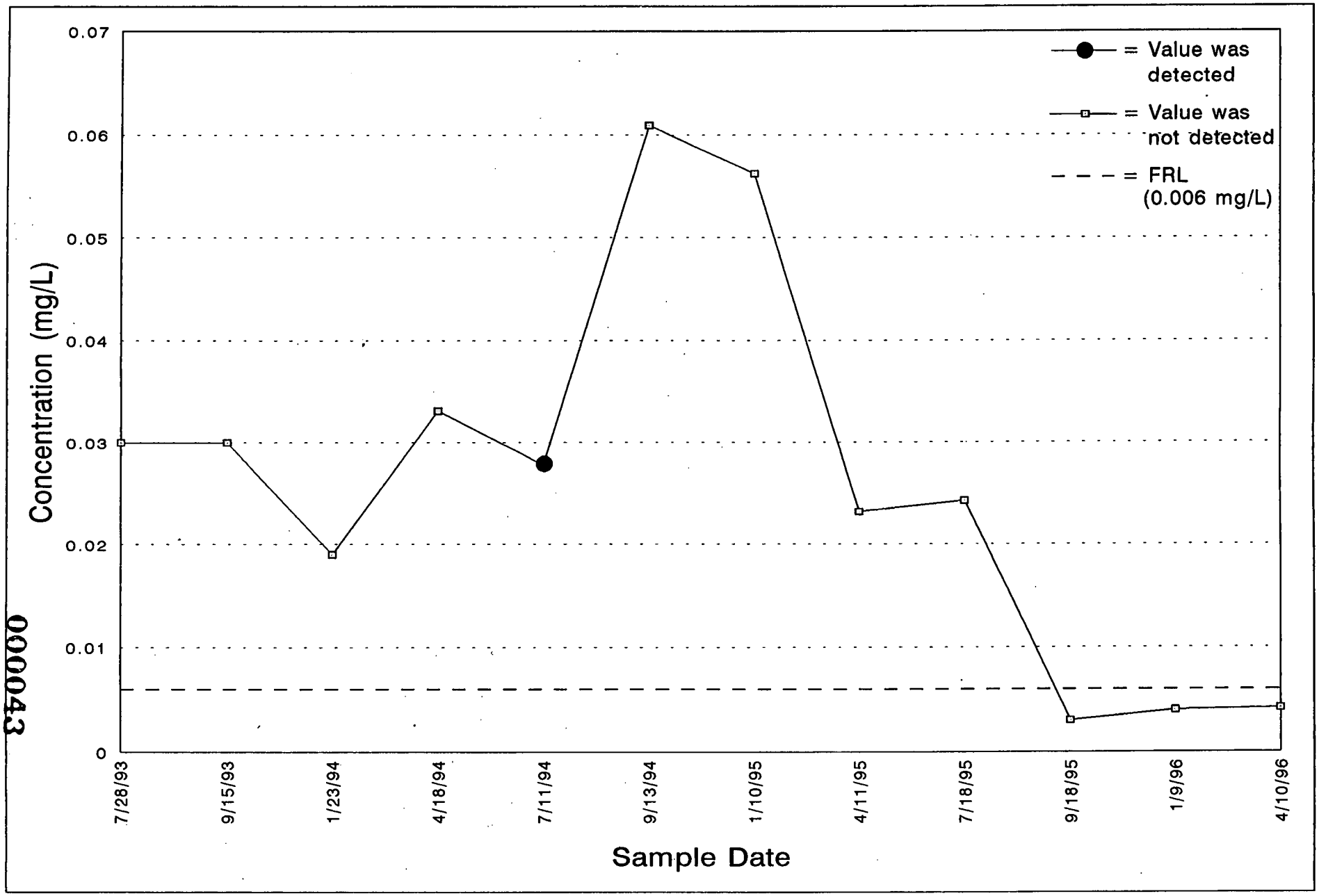


FIGURE A.3-2. ANTIMONY CONCENTRATION VS. TIME, WELL 2432

000043

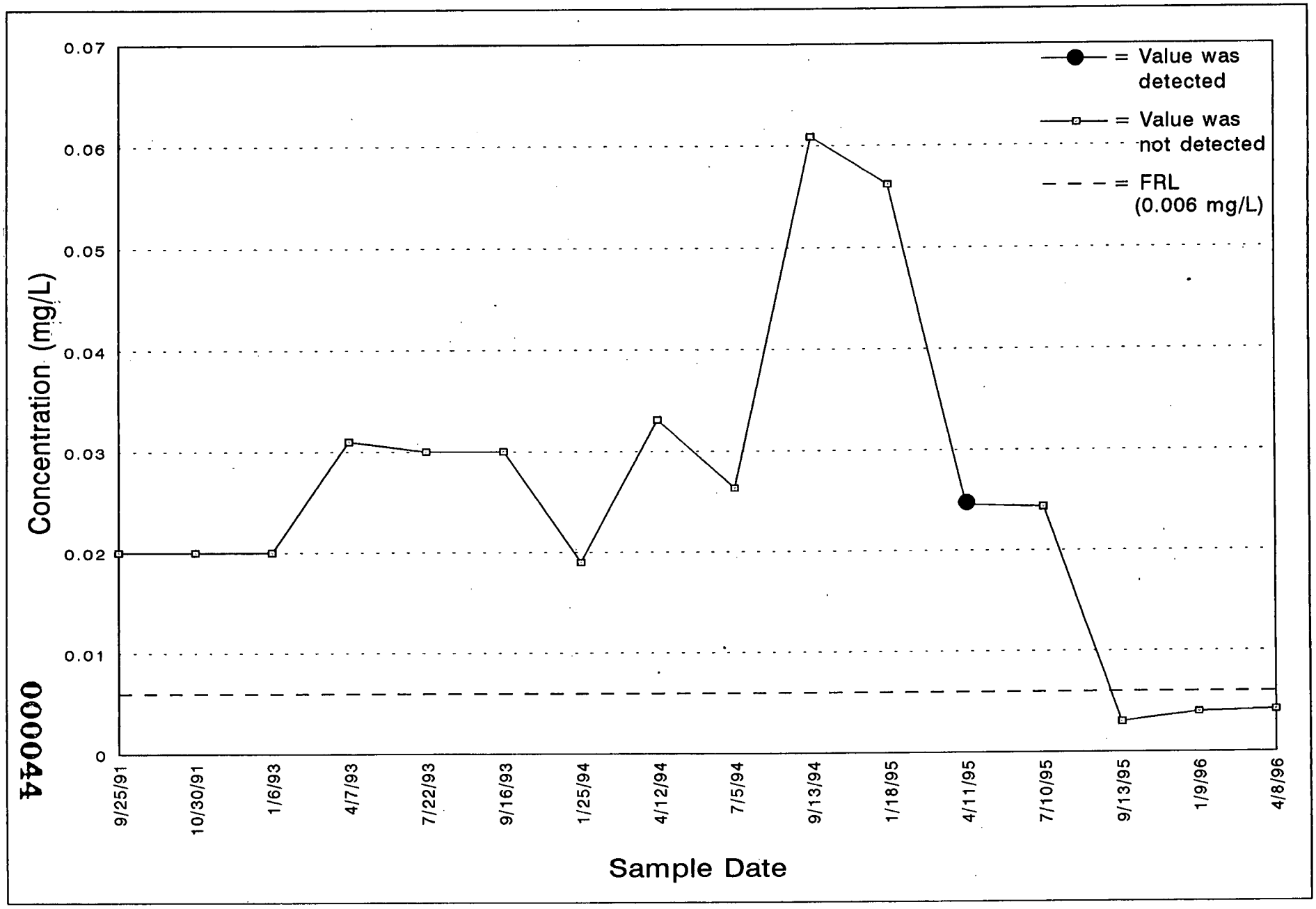


FIGURE A.3-3. ANTIMONY CONCENTRATION VS. TIME, WELL 3070

000044

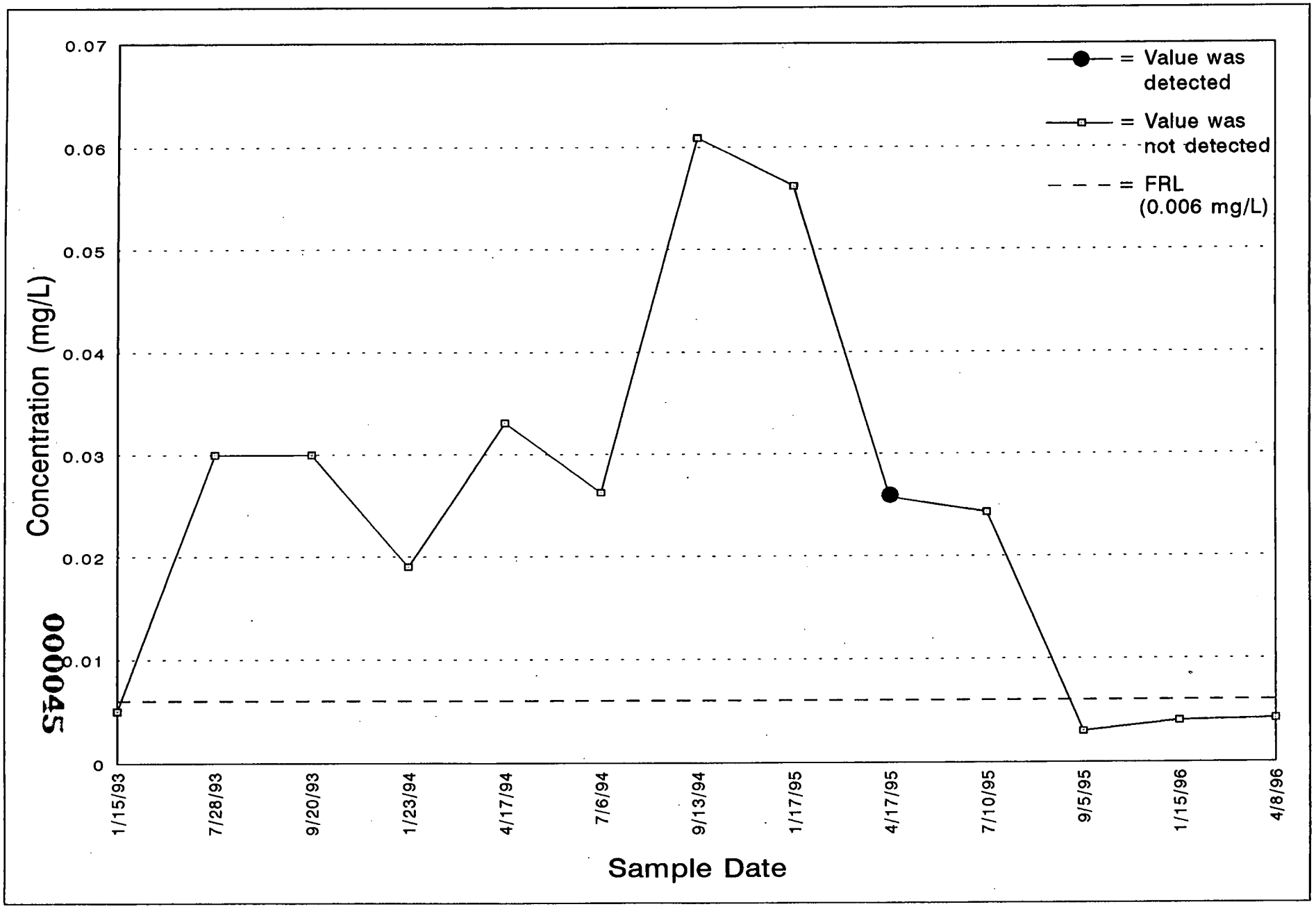


FIGURE A.3-4. ANTIMONY CONCENTRATION VS. TIME, WELL 2424

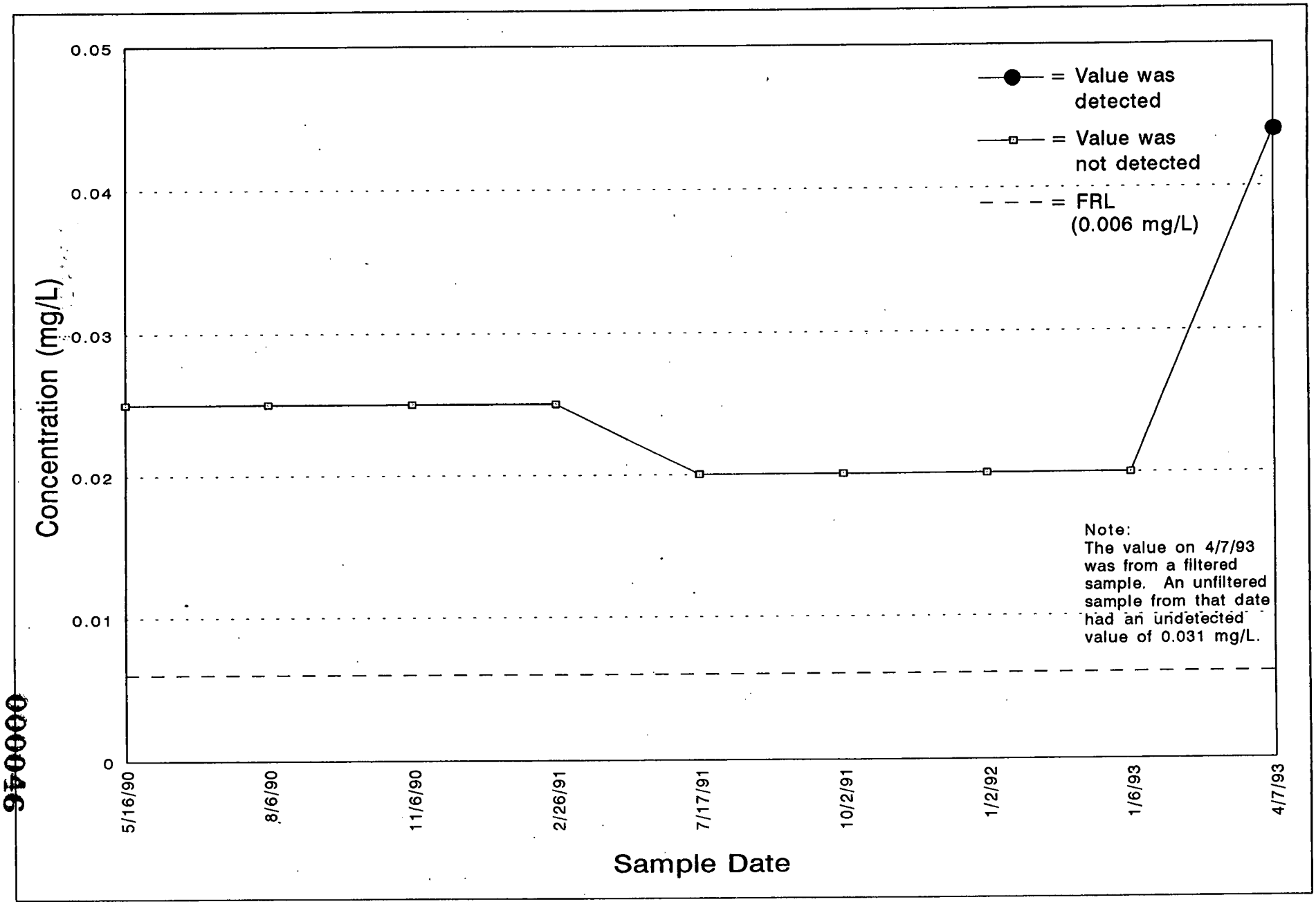


FIGURE A.3-5. ANTIMONY CONCENTRATION VS. TIME, WELL 2066

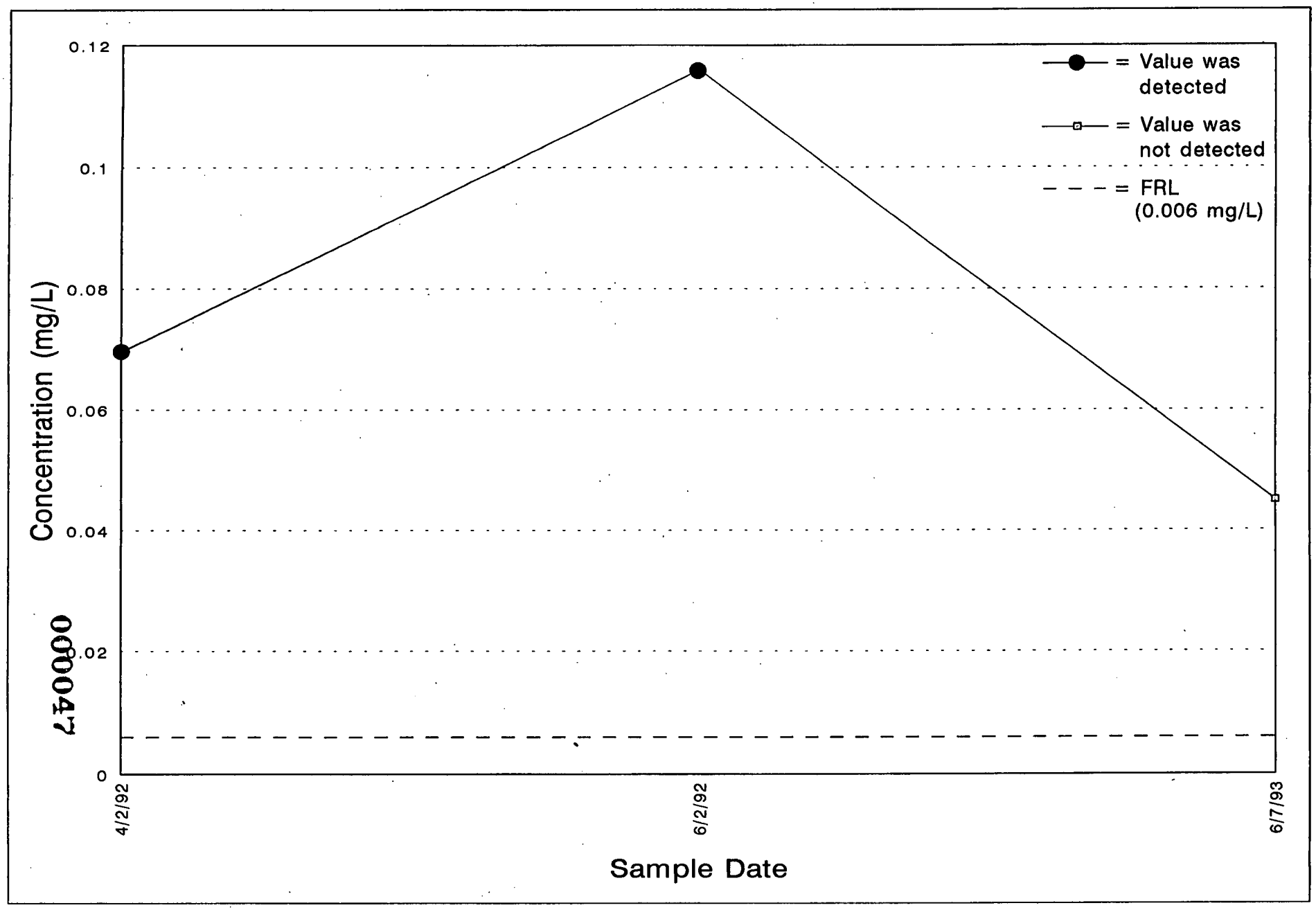
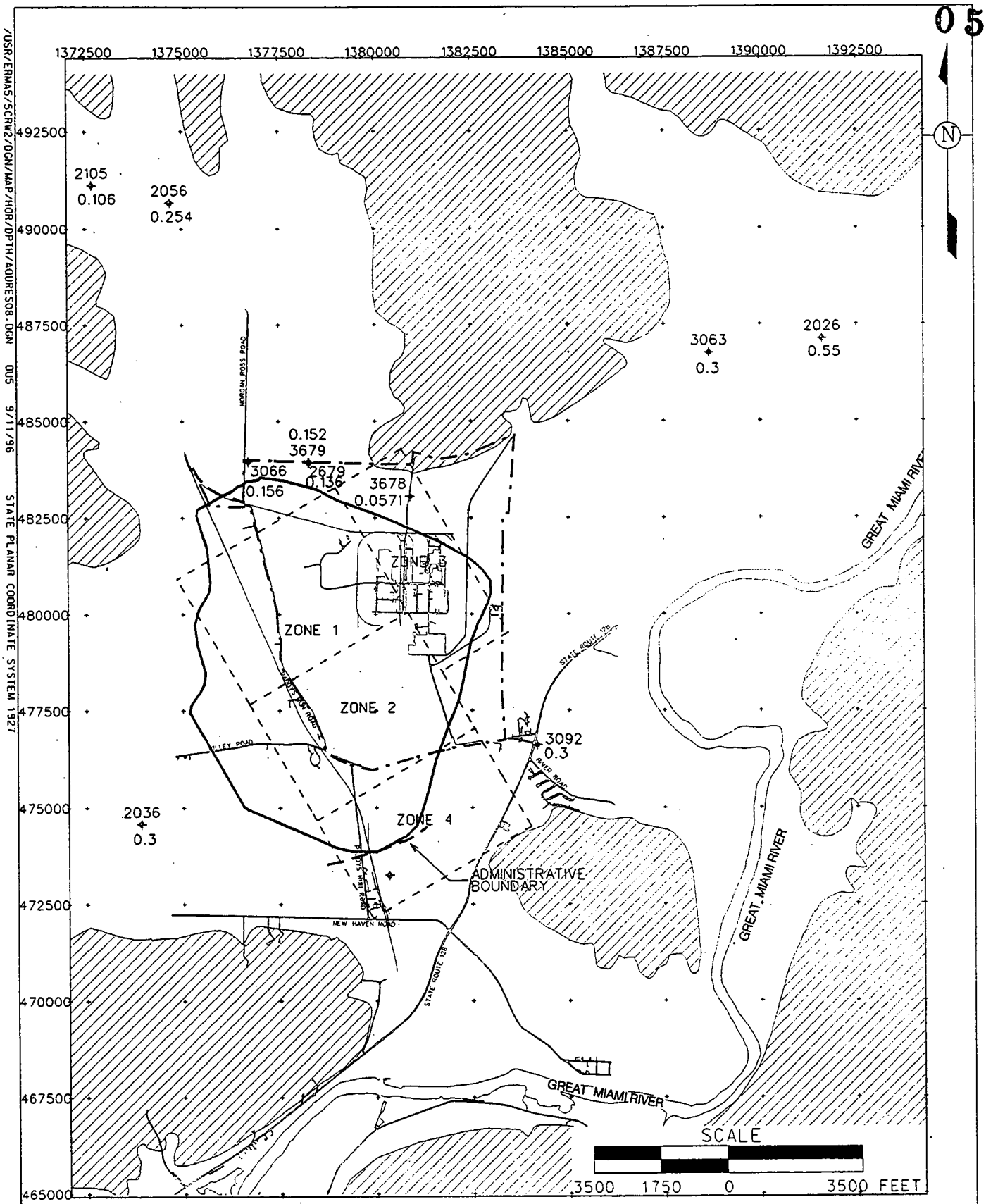


FIGURE A.3-6. ANTIMONY CONCENTRATION VS. TIME, WELL 3423

000047



LEGEND:

— · — · — FEMP BOUNDARY

2127 ✦ GROUNDWATER MONITORING WELL

0.3 ARSENIC (MAXIMUM VALUE)

RESTORATION FOOT PRINT (NO RETARDATION)

NOTE:
ZONE 0 INCLUDES EVERYTHING OUTSIDE OF ZONES 1 - 4

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000048

FIGURE A.3-7. FRL EXCEEDENCES FOR ARSENIC LOCATED OUTSIDE OF THE RESTORATION FOOTPRINT AND NORTH OF ADMINISTRATION BOUNDARY

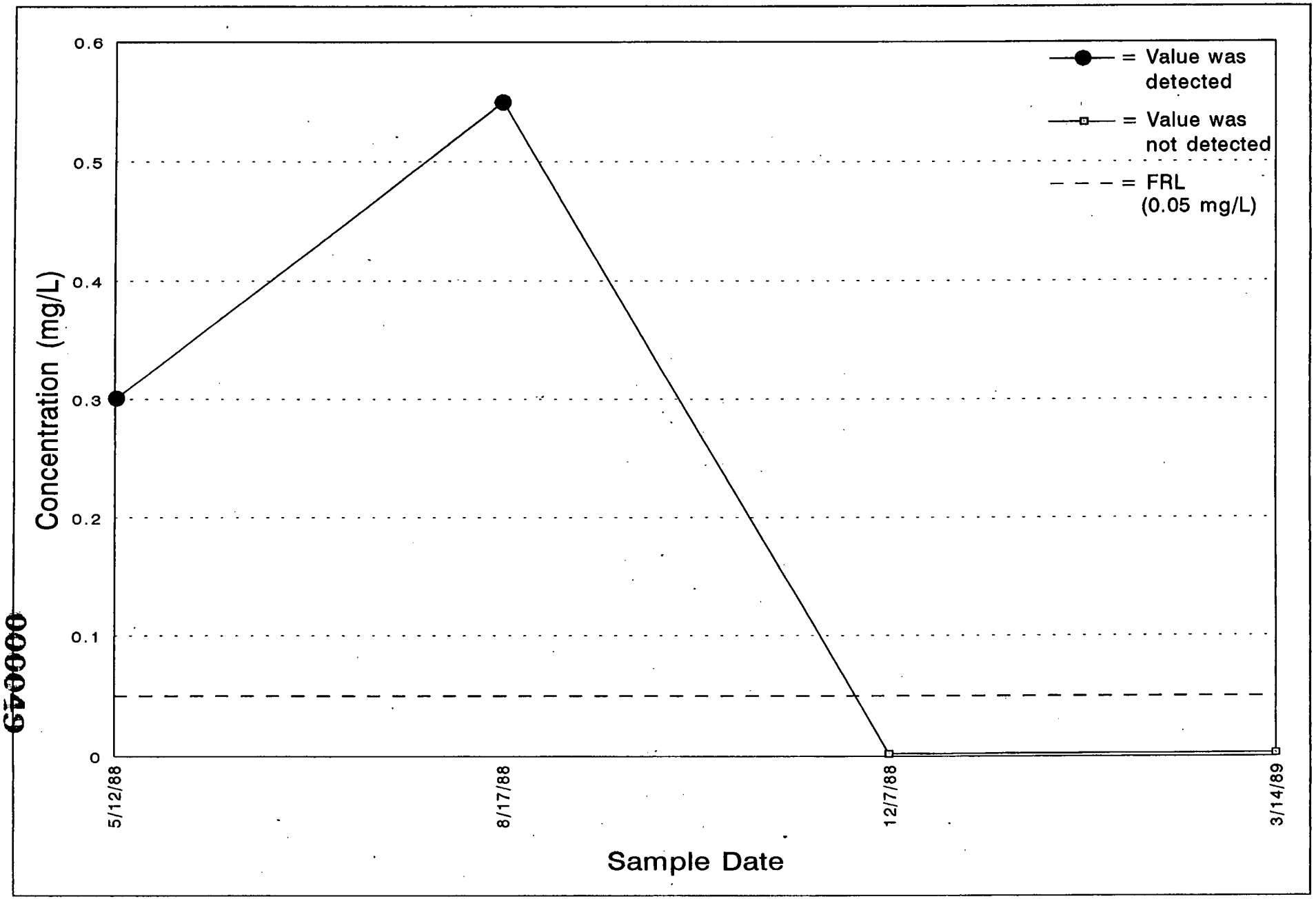

FIGURE A.3-8. ARSENIC CONCENTRATION VS. TIME, WELL 2026

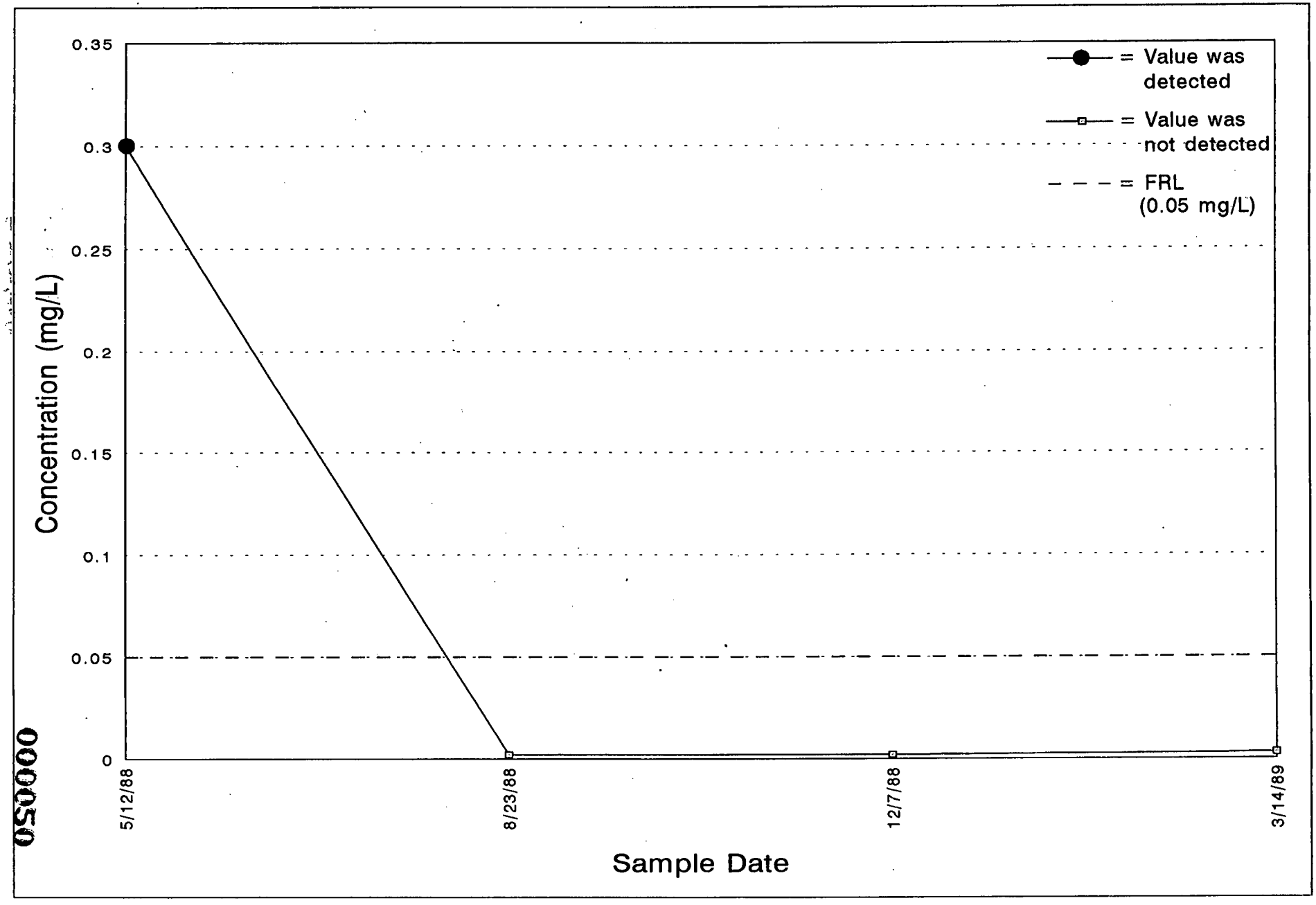

FIGURE A.3-9. ARSENIC CONCENTRATION VS. TIME, WELL 2036

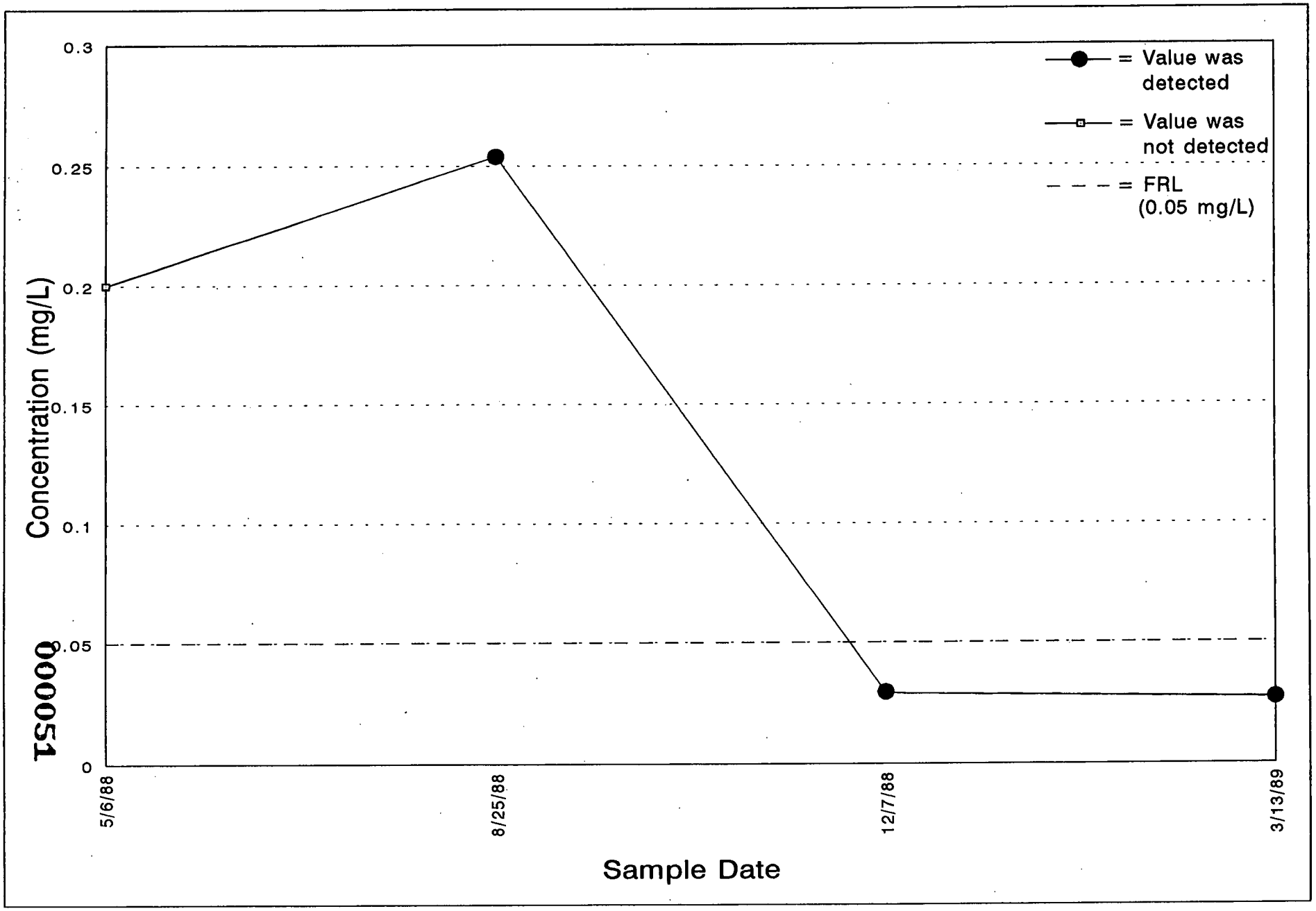

FIGURE A.3-10. ARSENIC CONCENTRATION VS. TIME, WELL 2056

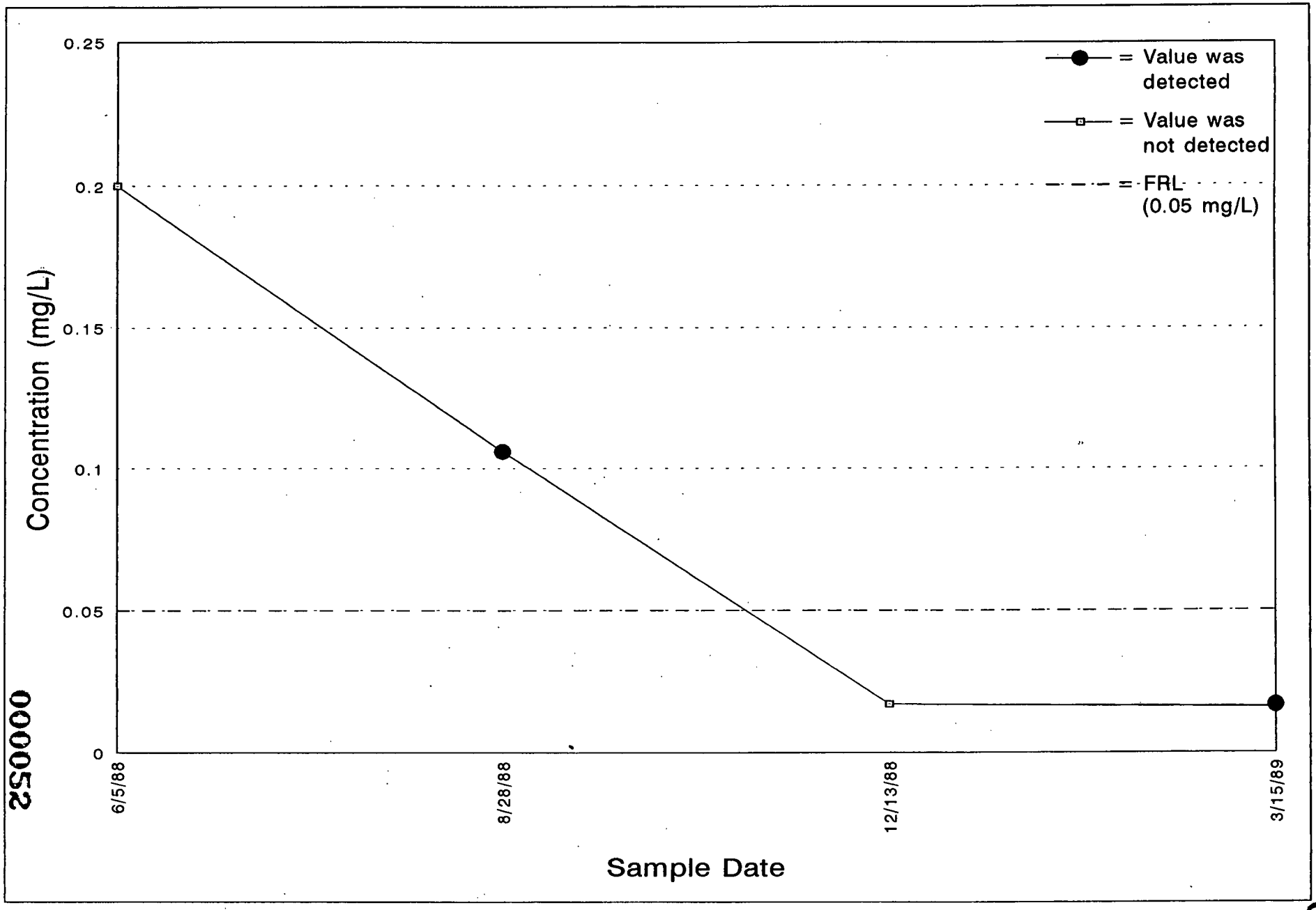

FIGURE A.3-11. ARSENIC CONCENTRATION VS. TIME, WELL 2105

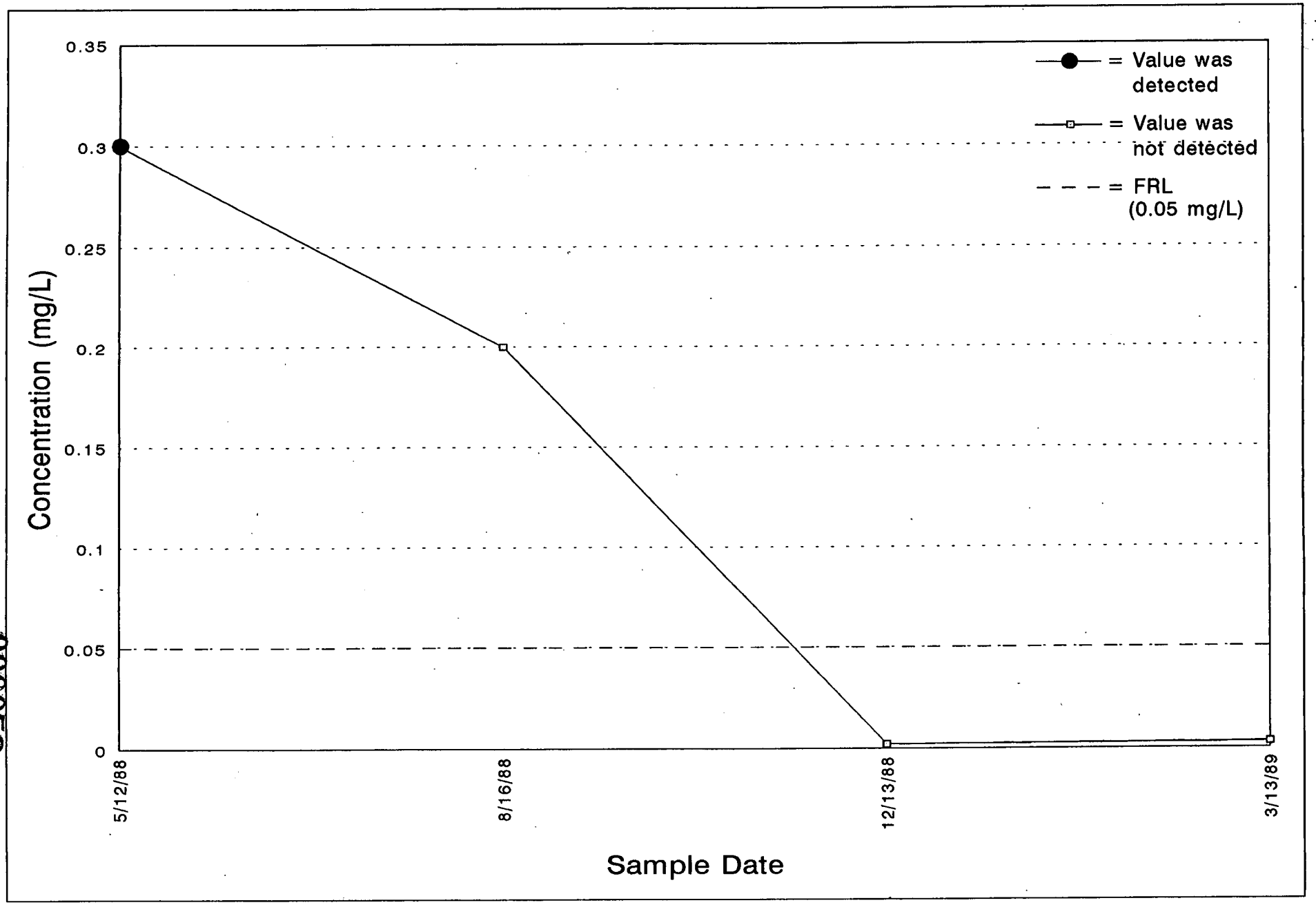

FIGURE A.3-12. ARSENIC CONCENTRATION VS. TIME, WELL 3063

000053

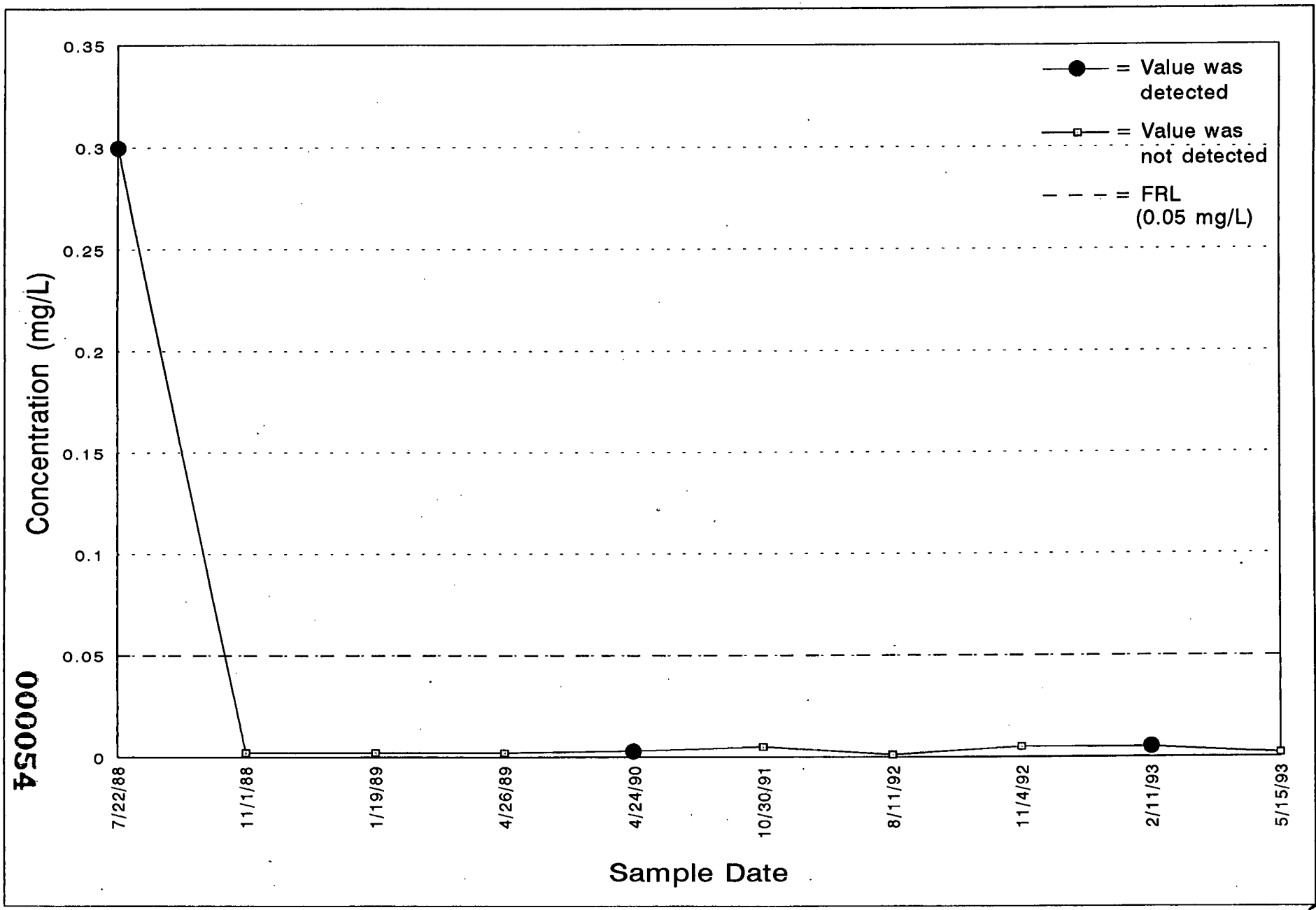

FIGURE A.3-13. ARSENIC CONCENTRATION VS. TIME, WELL 3092

000054

0543

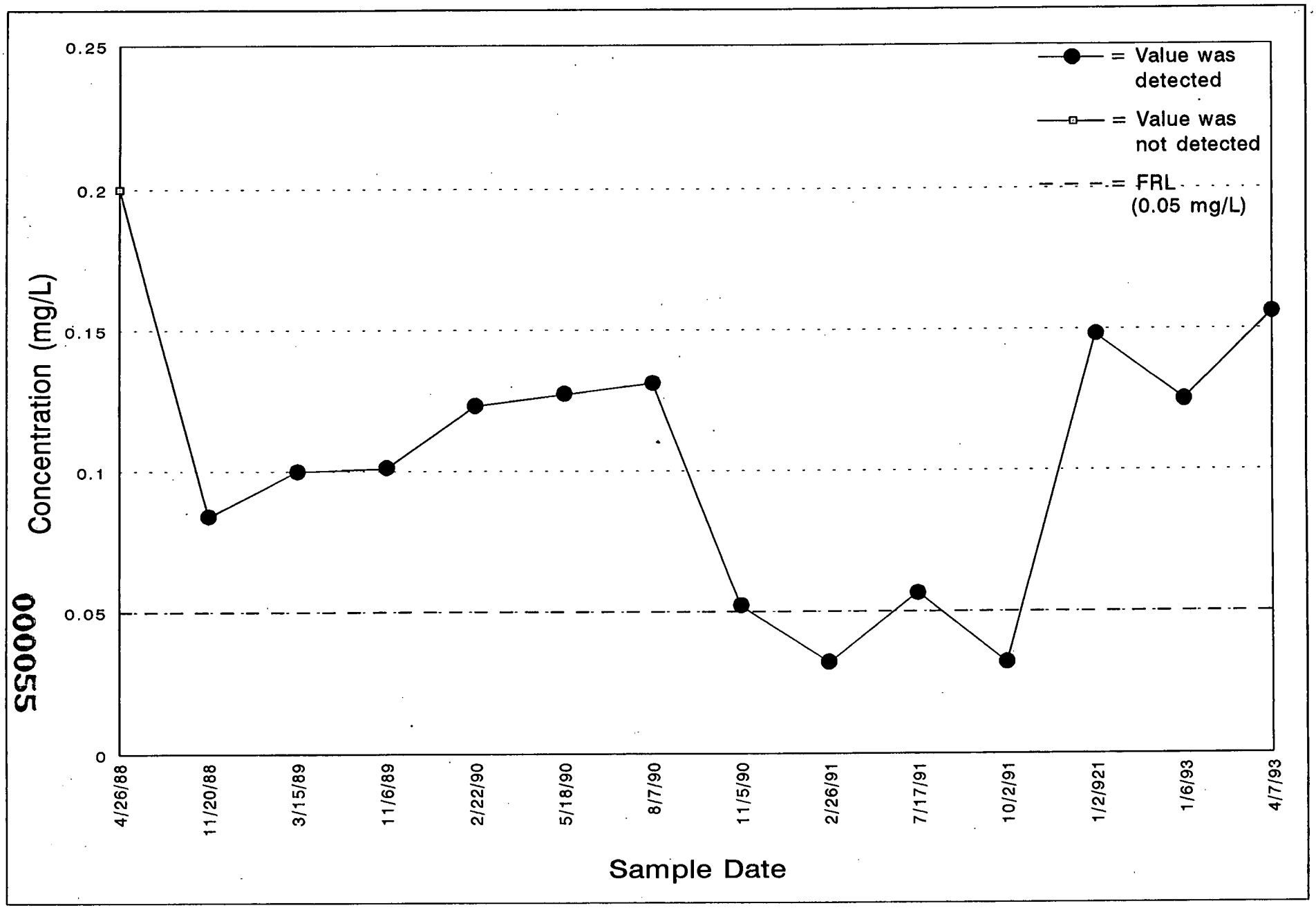

FIGURE A.3-14. ARSENIC CONCENTRATION VS. TIME, WELL 3066

SS0000

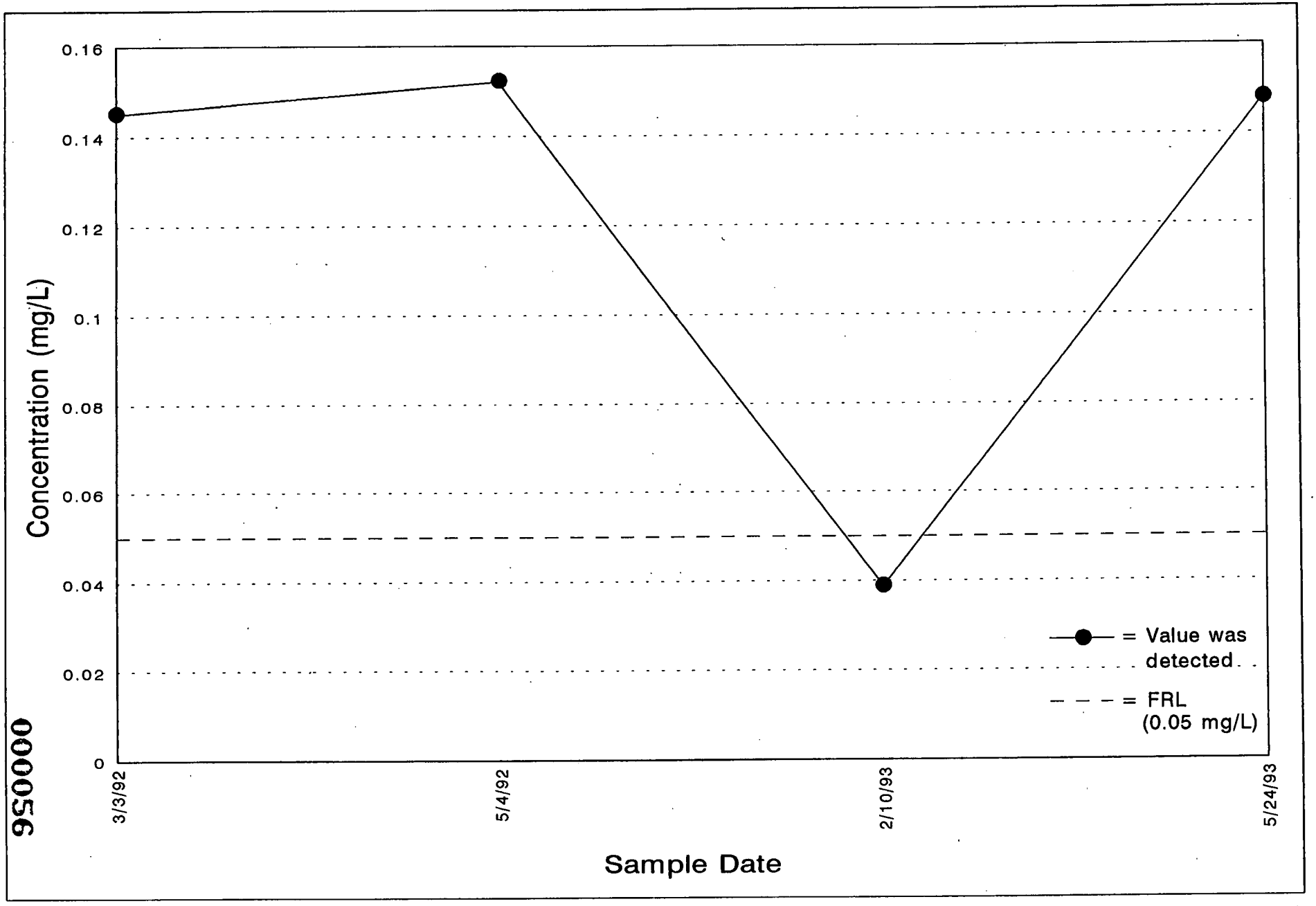

FIGURE A.3-15. ARSENIC CONCENTRATION VS. TIME, WELL 3679

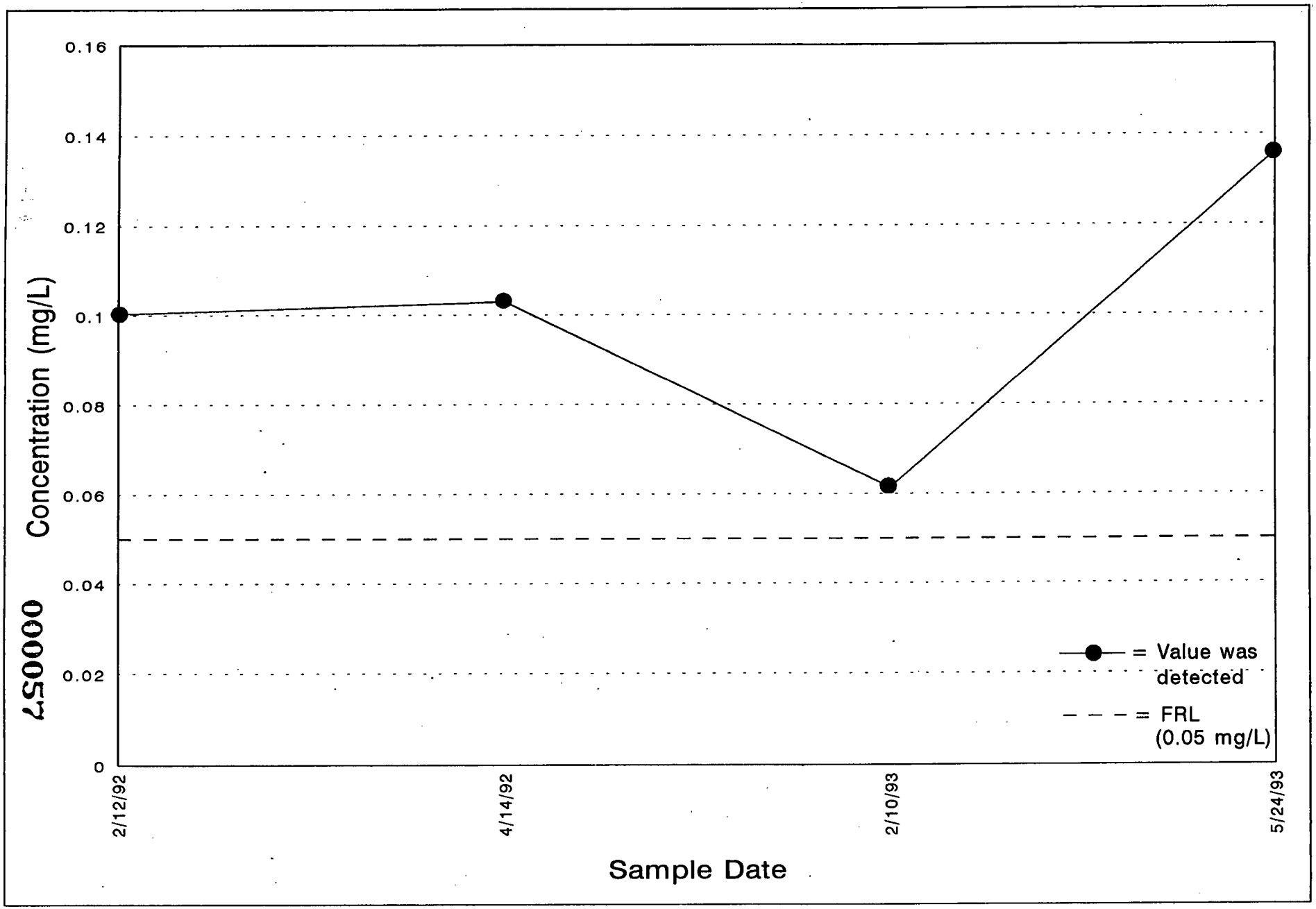

FIGURE A.3-16. ARSENIC CONCENTRATION VS. TIME, WELL 2679

000057

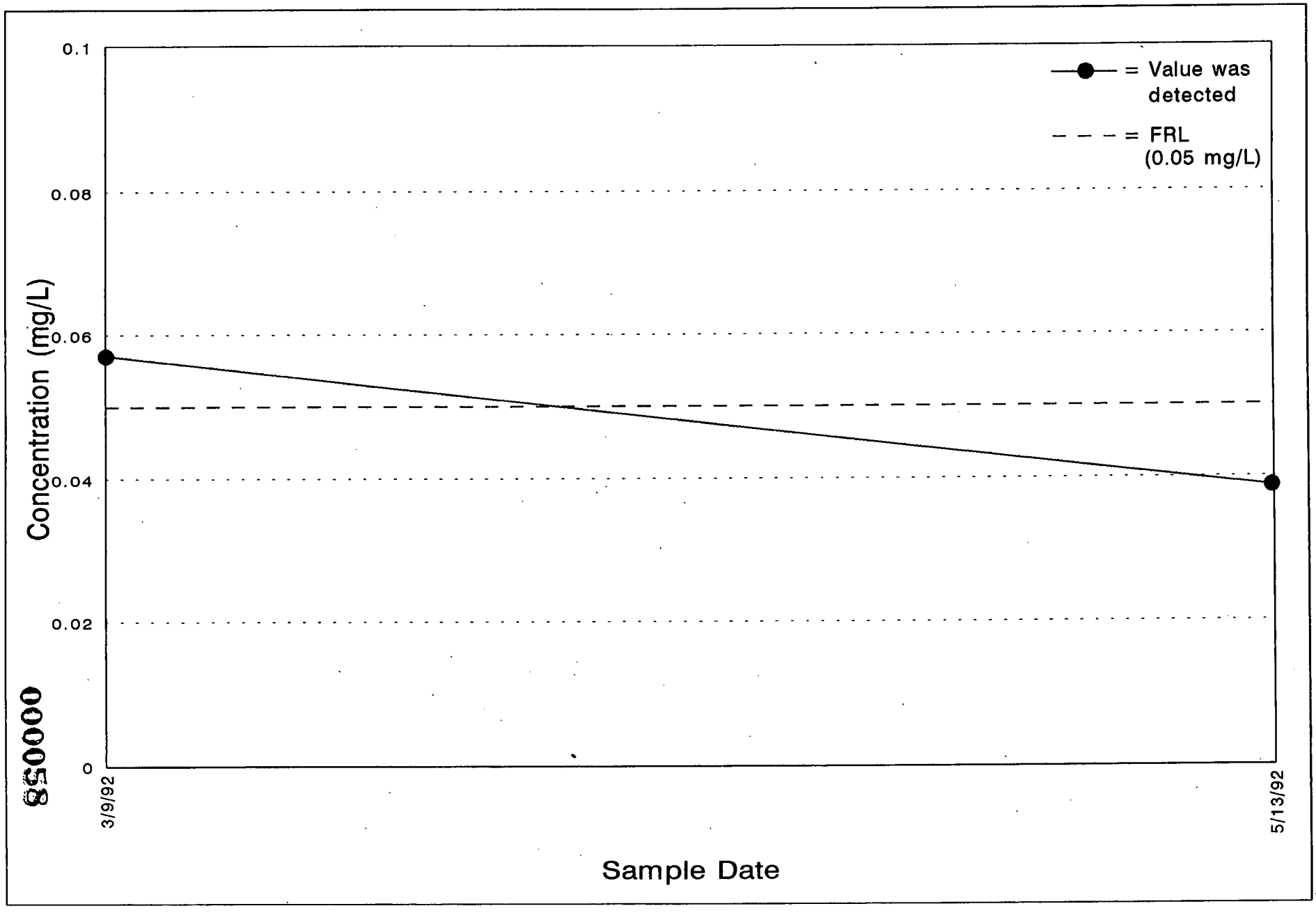

FIGURE A.3-17. ARSENIC CONCENTRATION VS. TIME, WELL 3678

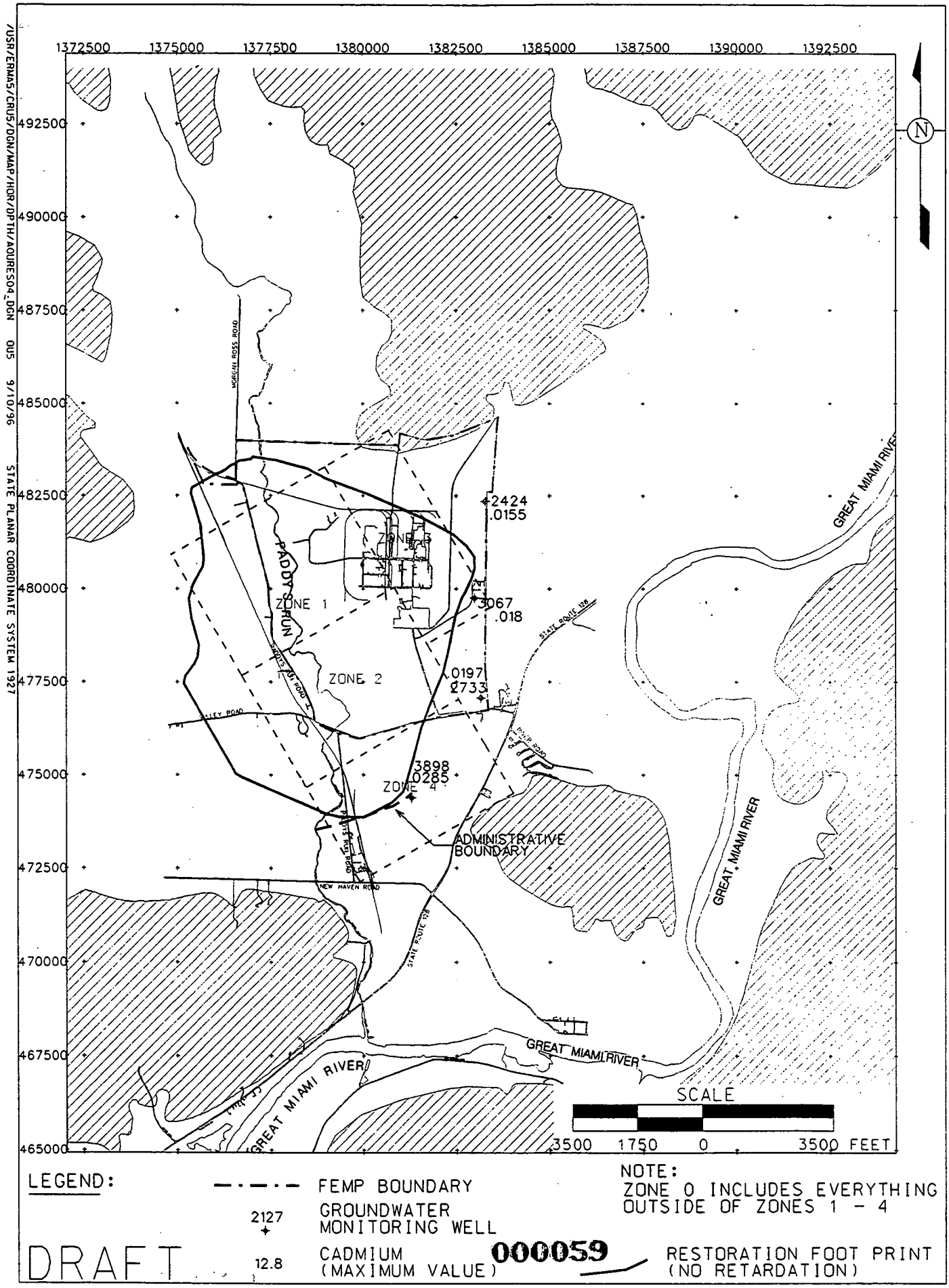

FIGURE A.3-18. FRL EXCEEDENCES FOR CADMIUM LOCATED OUTSIDE OF THE RESTORATION FOOTPRINT AND NORTH OF ADMINISTRATION BOUNDARY

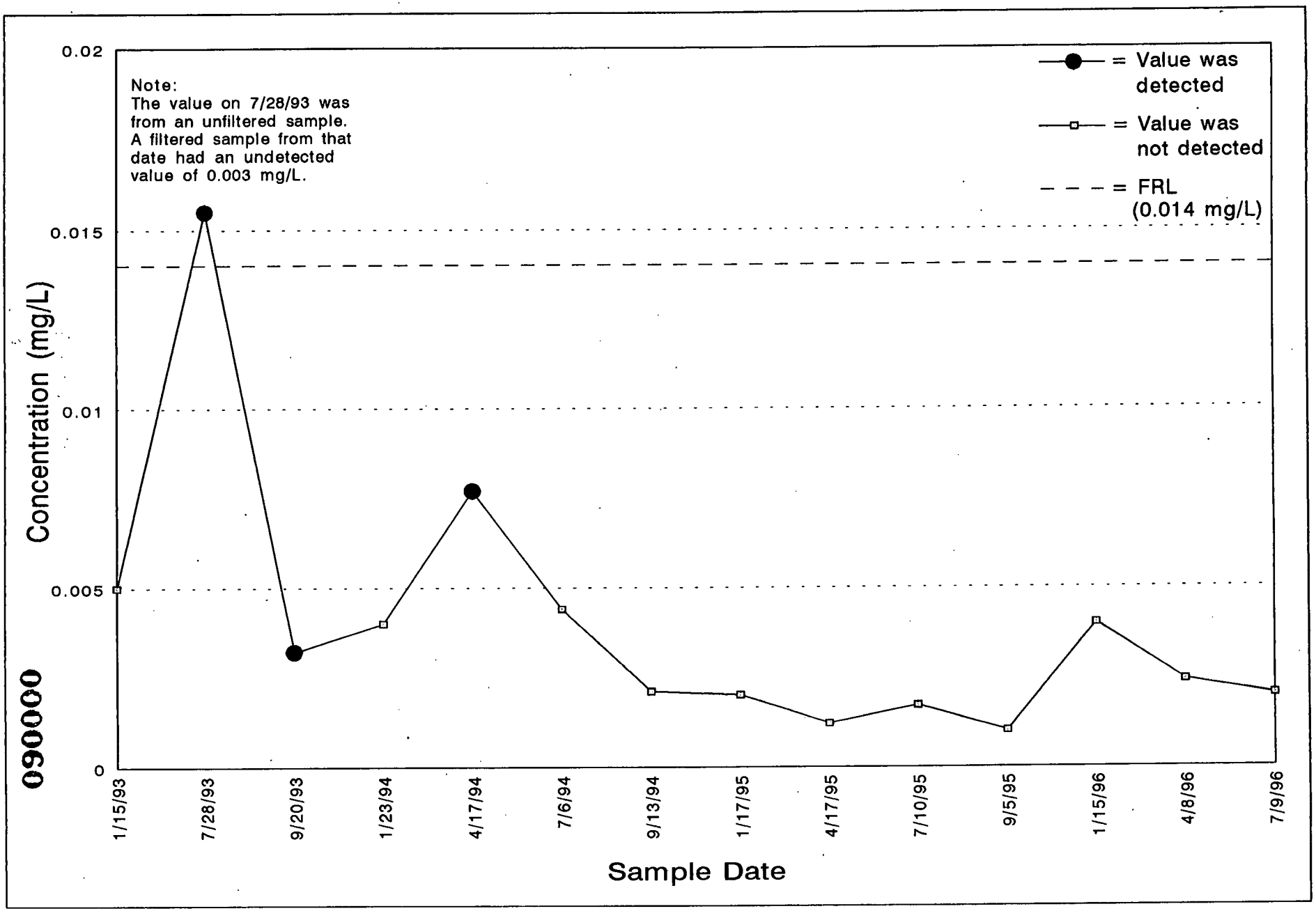

FIGURE A.3-19. CADMIUM CONCENTRATION VS. TIME, WELL 2424

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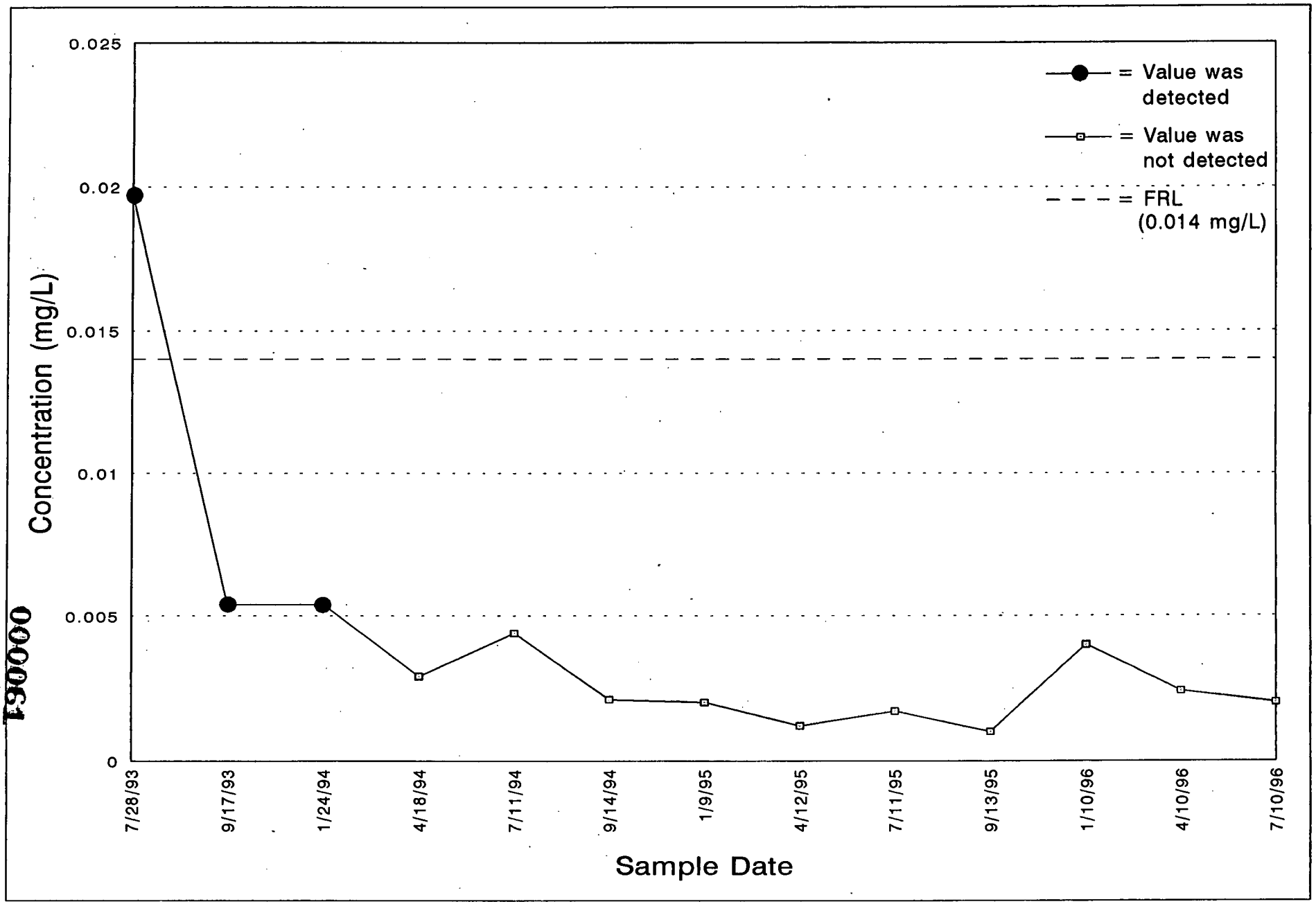


FIGURE A.3-20. CADMIUM CONCENTRATION VS. TIME, WELL 2733

000061

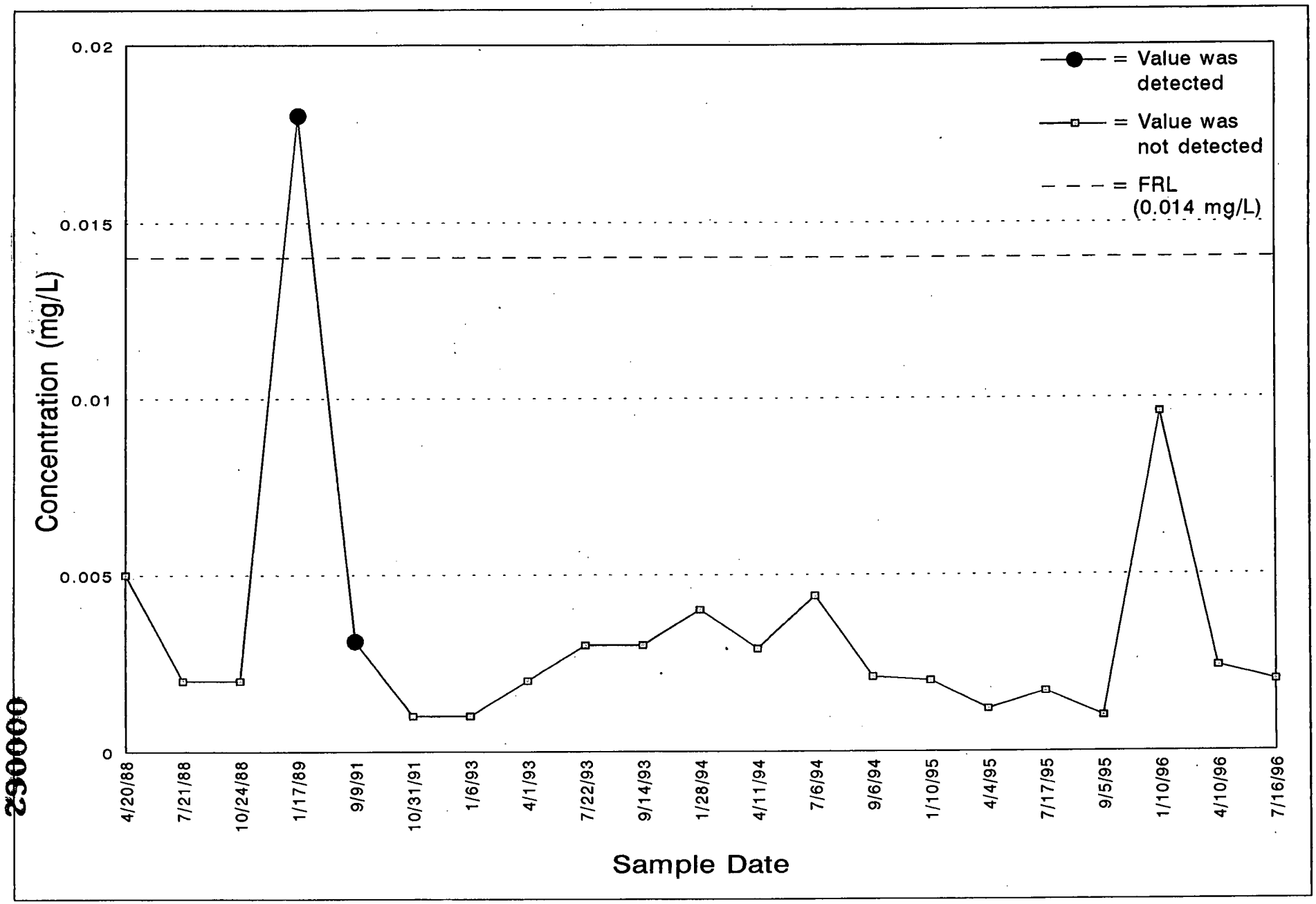


FIGURE A.3-21. CADMIUM CONCENTRATION VS. TIME, WELL 3067

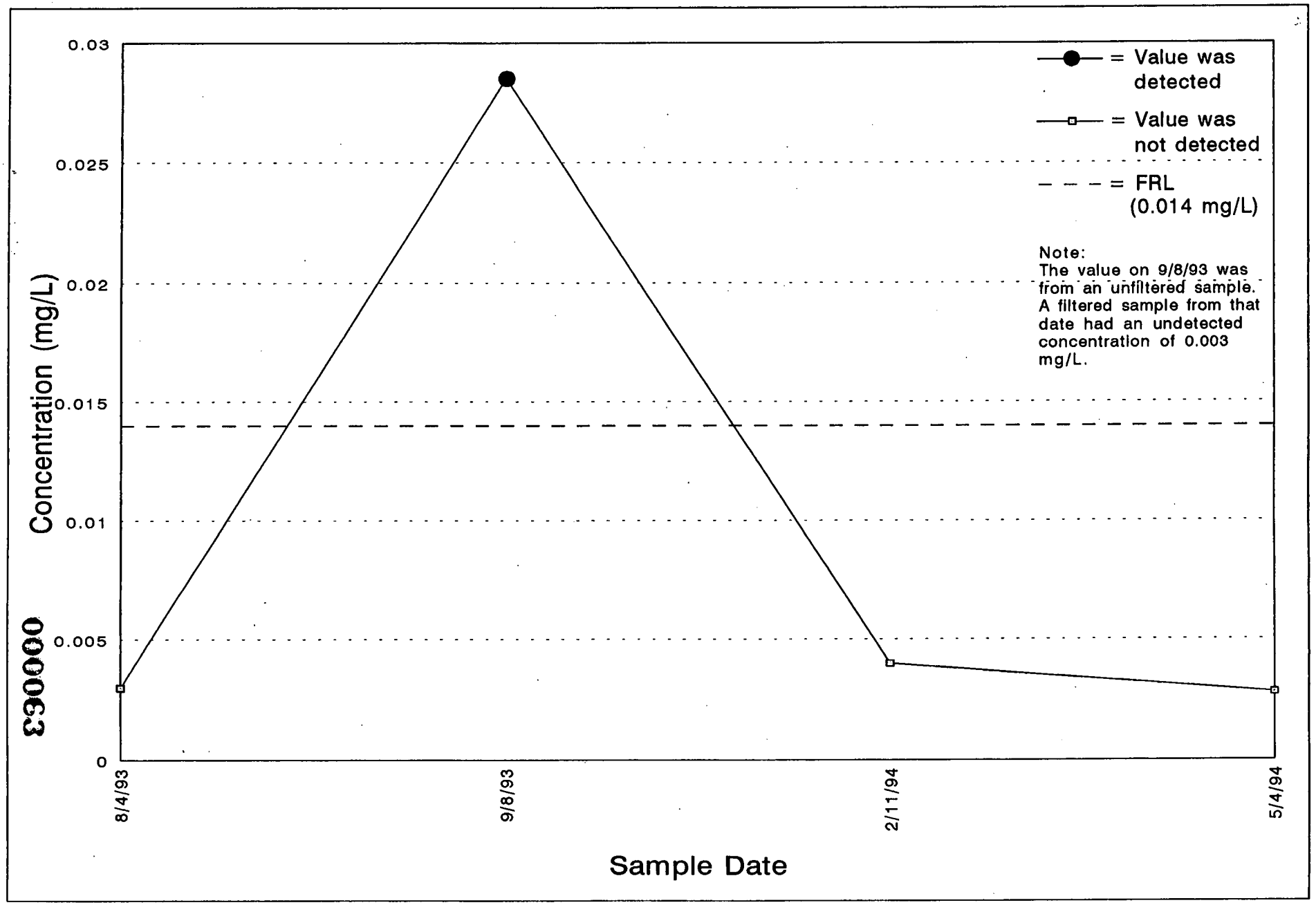
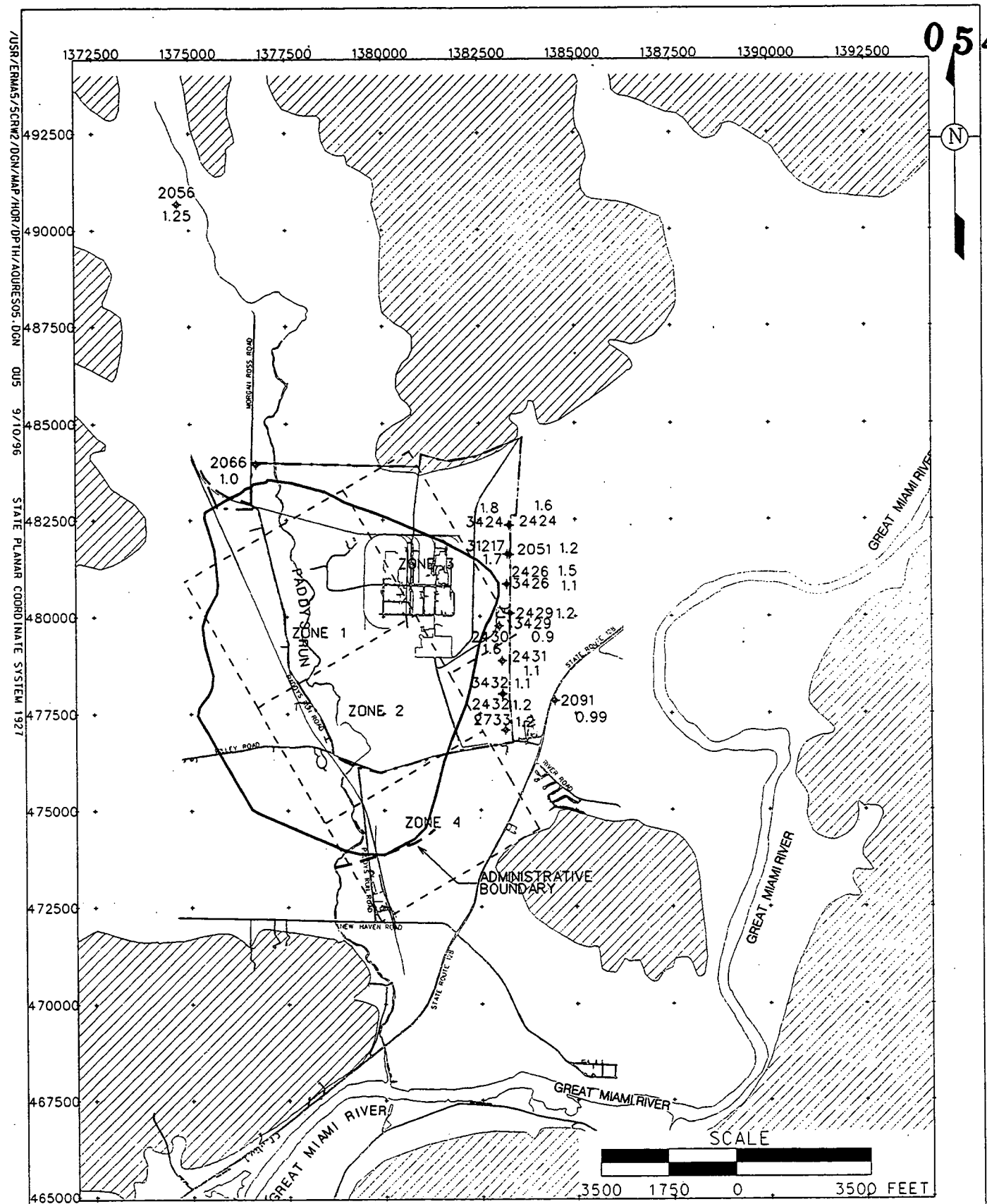


FIGURE A.3-22. CADMIUM CONCENTRATION VS. TIME, WELL 3898

000063



LEGEND:

FEMP BOUNDARY

2127 GROUNDWATER MONITORING WELL

1.8 FLUORIDE (MAXIMUM VALUE)

RESTORATION FOOT PRINT (NO RETARDATION)

NOTE:
ZONE 0 INCLUDES EVERYTHING OUTSIDE OF ZONES 1 - 4

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FIGURE A.3-23. FRL EXCEEDENCES FOR FLUORIDE LOCATED OUTSIDE OF THE RESTORATION FOOTPRINT AND NORTH OF ADMINISTRATION BOUNDARY

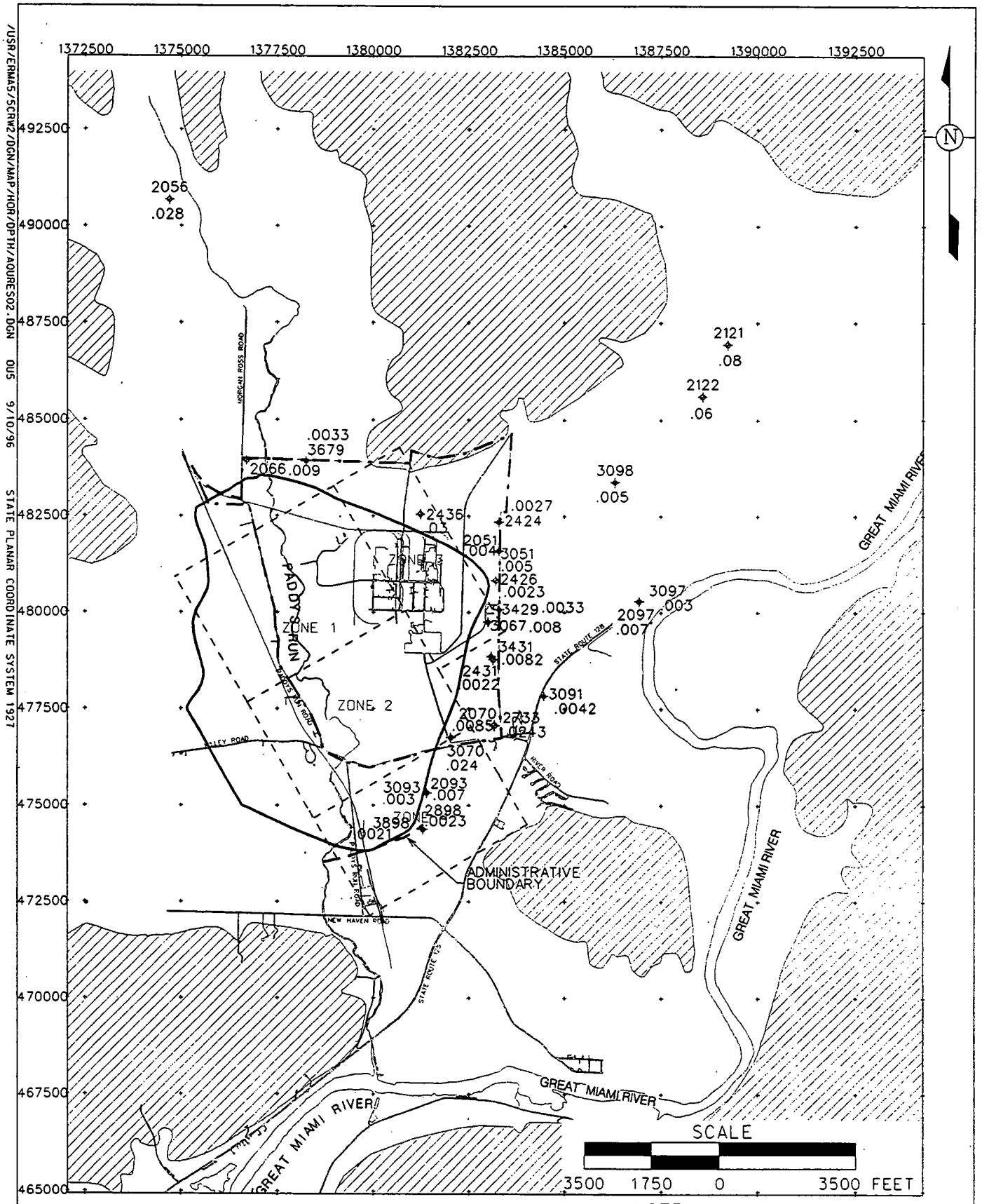

FIGURE A.3-24. FRL EXCEEDENCES FOR LEAD LOCATED OUTSIDE OF THE RESTORATION FOOTPRINT AND NORTH OF ADMINISTRATION BOUNDARY

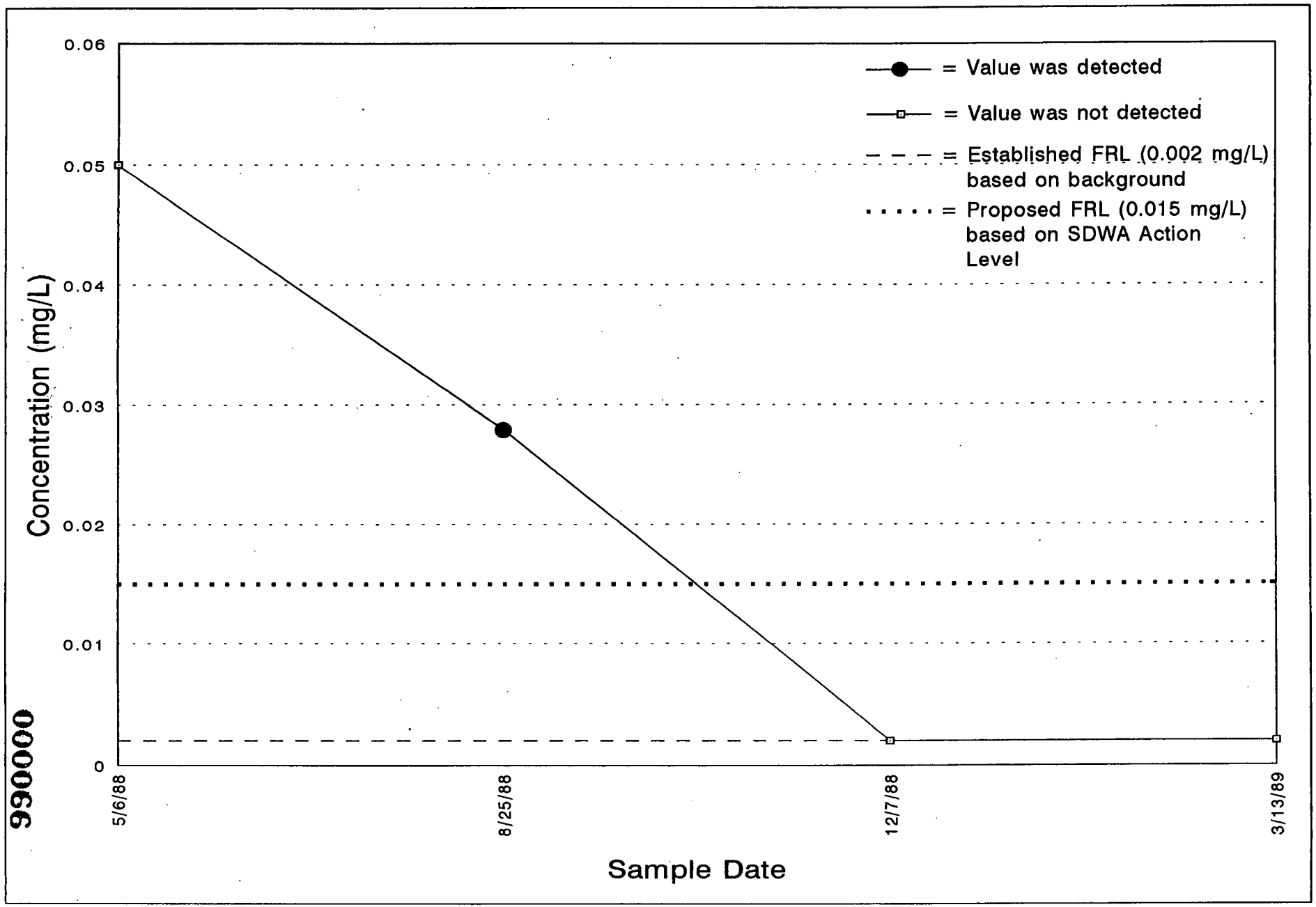

FIGURE A.3-25. LEAD CONCENTRATION VS. TIME, WELL 2056

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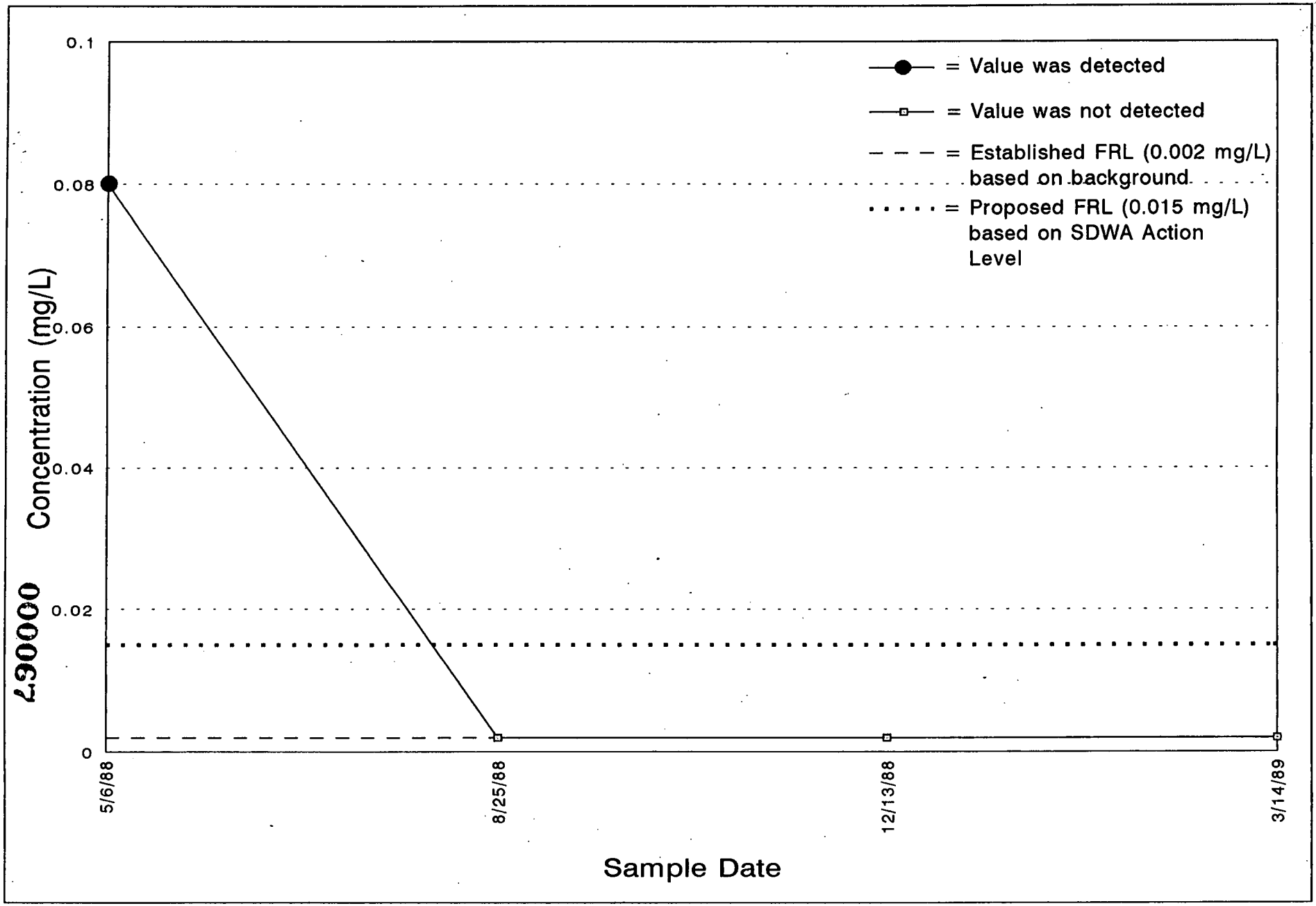


FIGURE A.3-26. LEAD CONCENTRATION VS. TIME, WELL 2121

000067

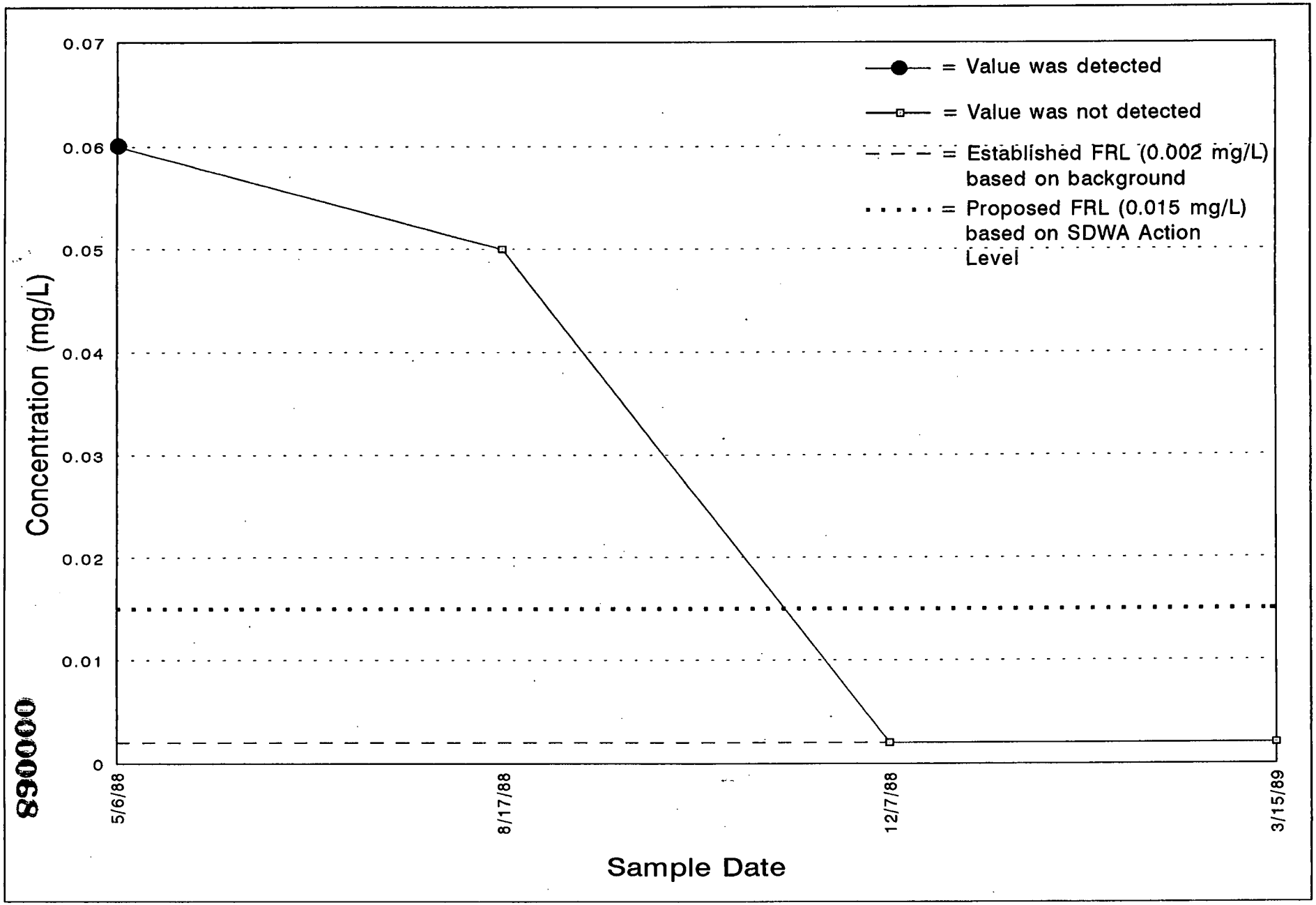


FIGURE A.3-27. LEAD CONCENTRATION VS. TIME, WELL 2122

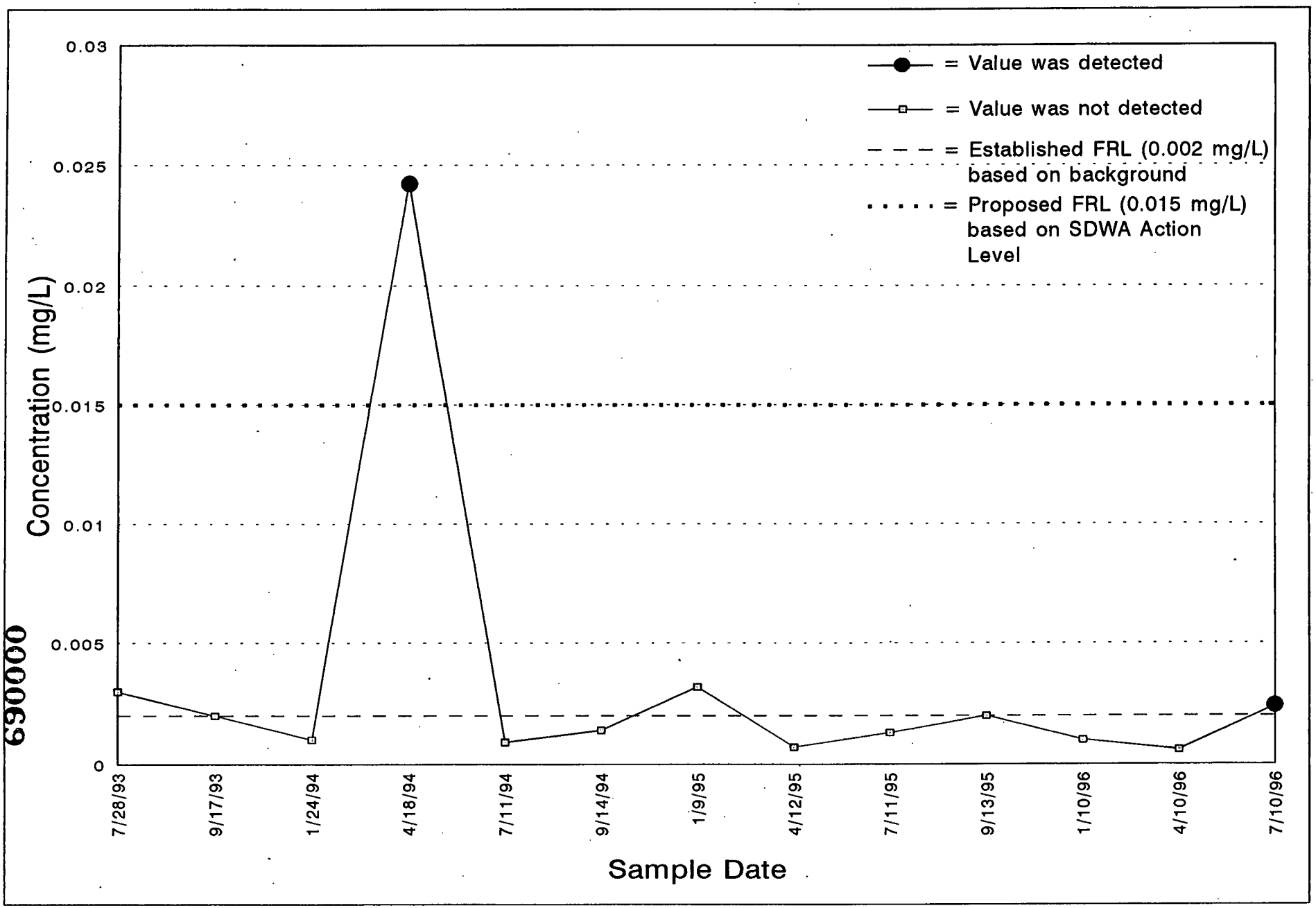


FIGURE A.3-28. LEAD CONCENTRATION VS. TIME, WELL 2733

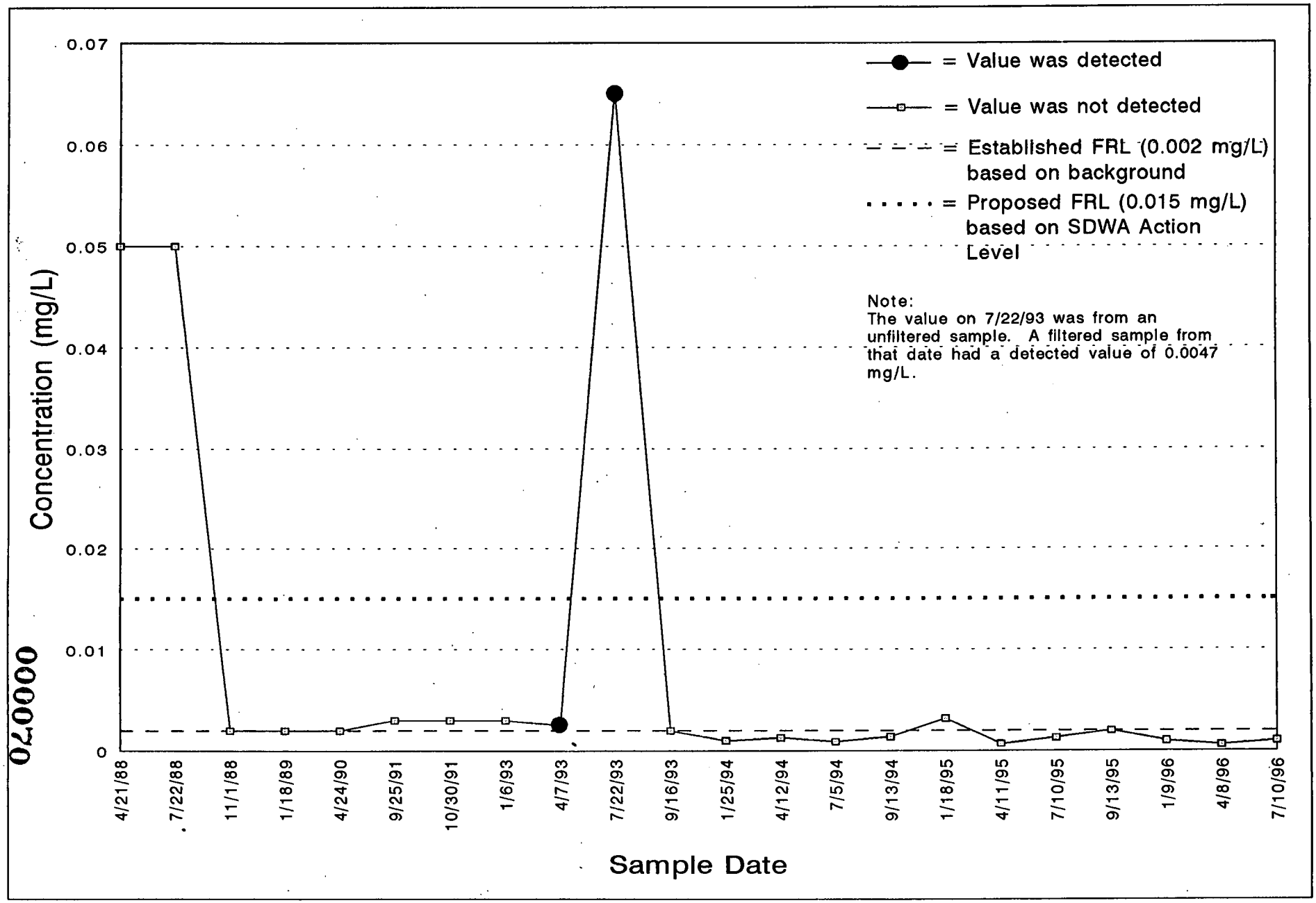
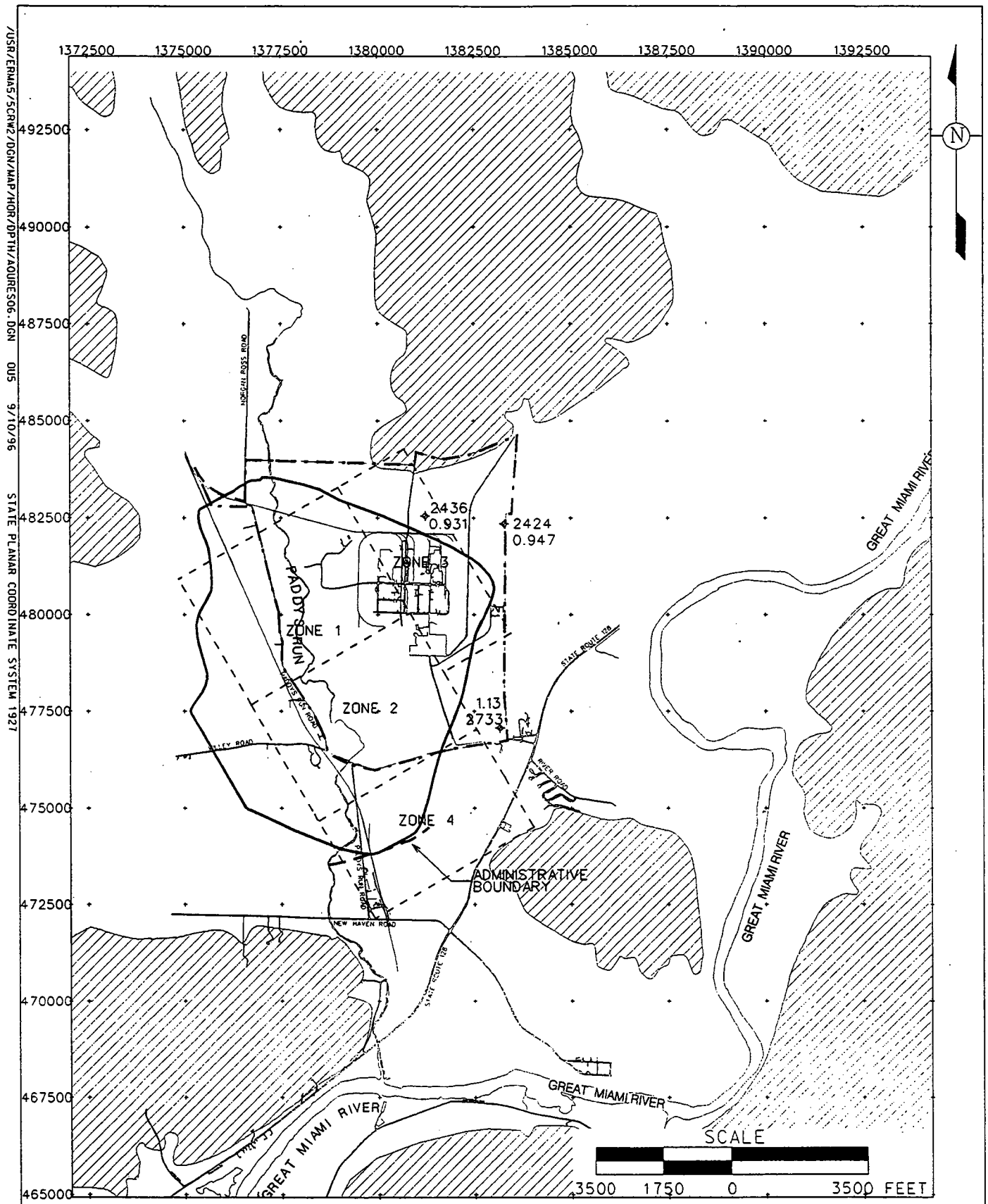


FIGURE A.3-29. LEAD CONCENTRATION VS. TIME, WELL 3070



LEGEND:

- — · — · — FEMP BOUNDARY
- 2127 ✦ GROUNDWATER MONITORING WELL
- 1.8 MANGANESE (MAXIMUM VALUE)
- RESTORATION FOOT PRINT (NO RETARDATION)

NOTE:
ZONE 0 INCLUDES EVERYTHING OUTSIDE OF ZONES 1 - 4

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FIGURE A.3-30. FRL EXCEEDENCES FOR MANGANESE LOCATED OUTSIDE OF THE RESTORATION FOOTPRINT AND NORTH OF ADMINISTRATION BOUNDARY

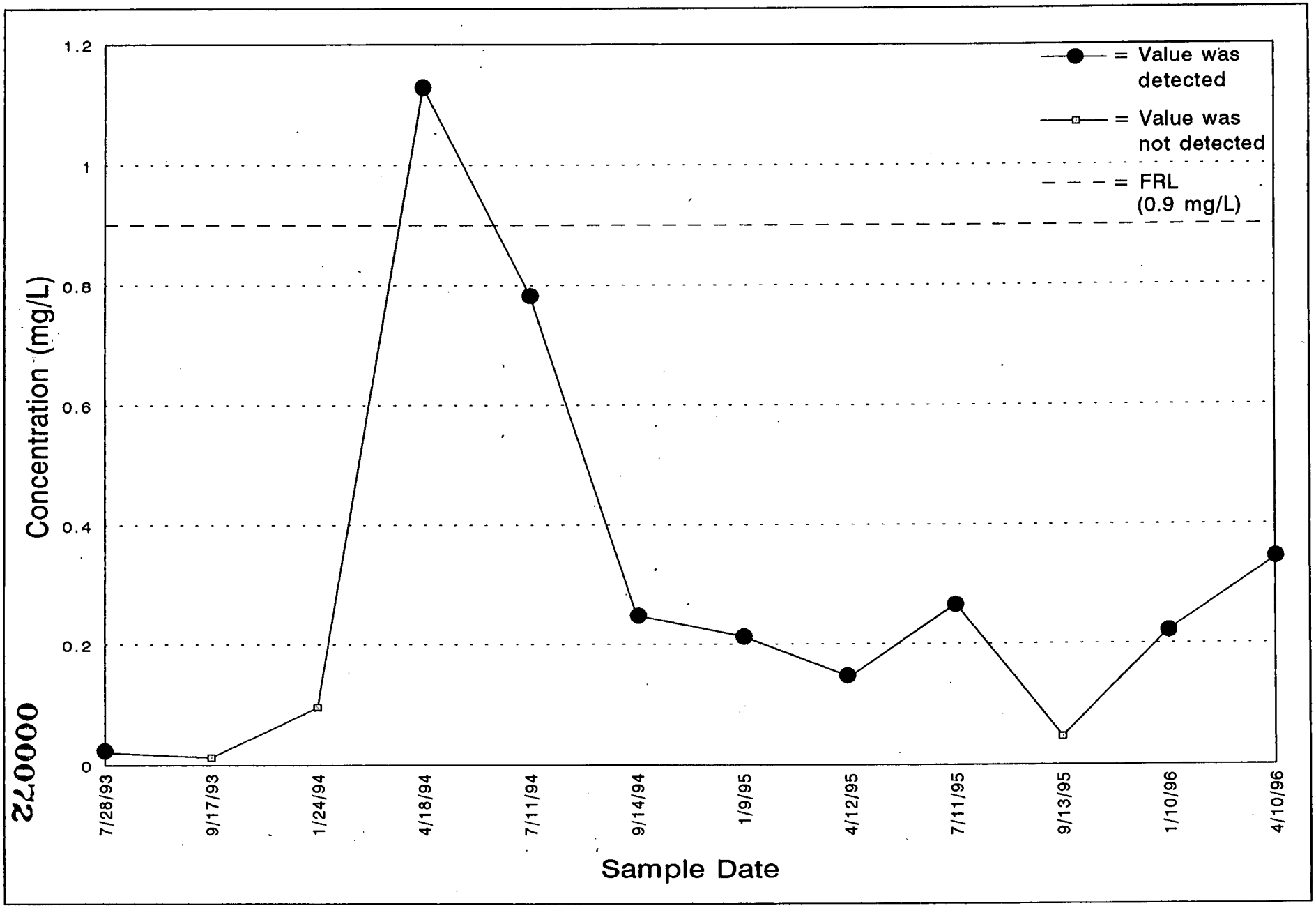

FIGURE A.3-31. MANGANESE CONCENTRATION VS. TIME, WELL 2733

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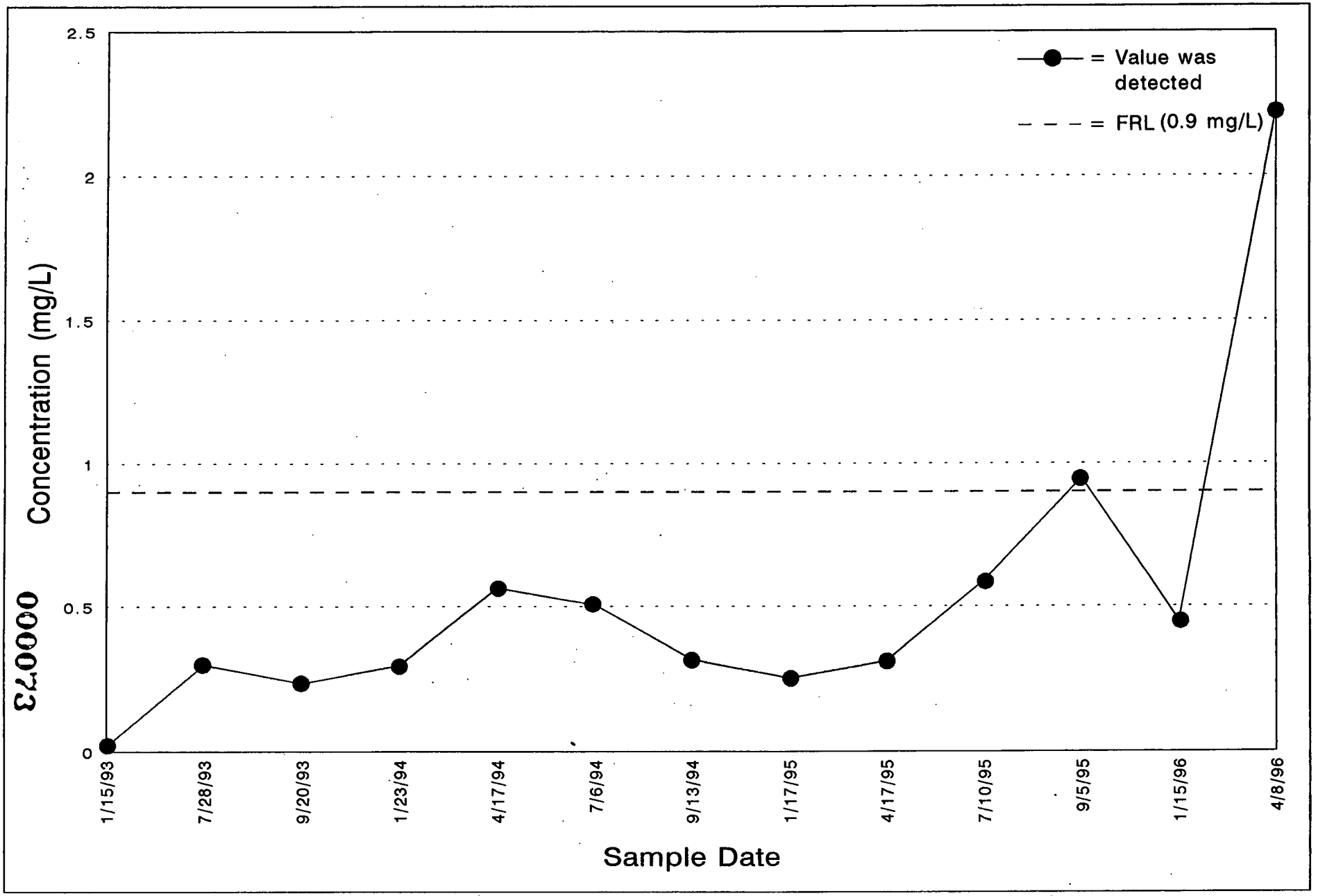

FIGURE A.3-32. MANGANESE CONCENTRATION VS. TIME, WELL 2424

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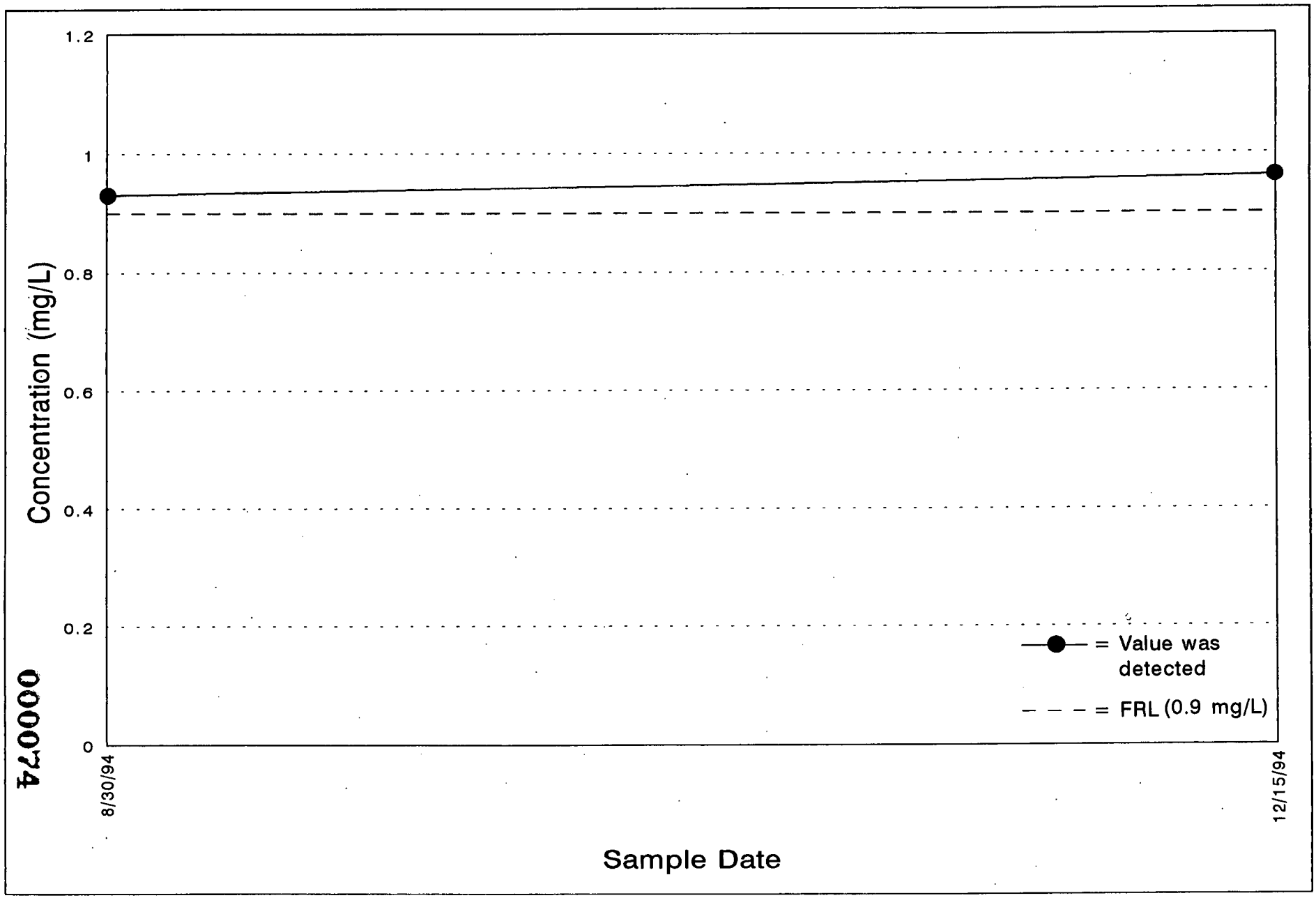

FIGURE A.3-33. MANGANESE CONCENTRATION VS. TIME, WELL 2436

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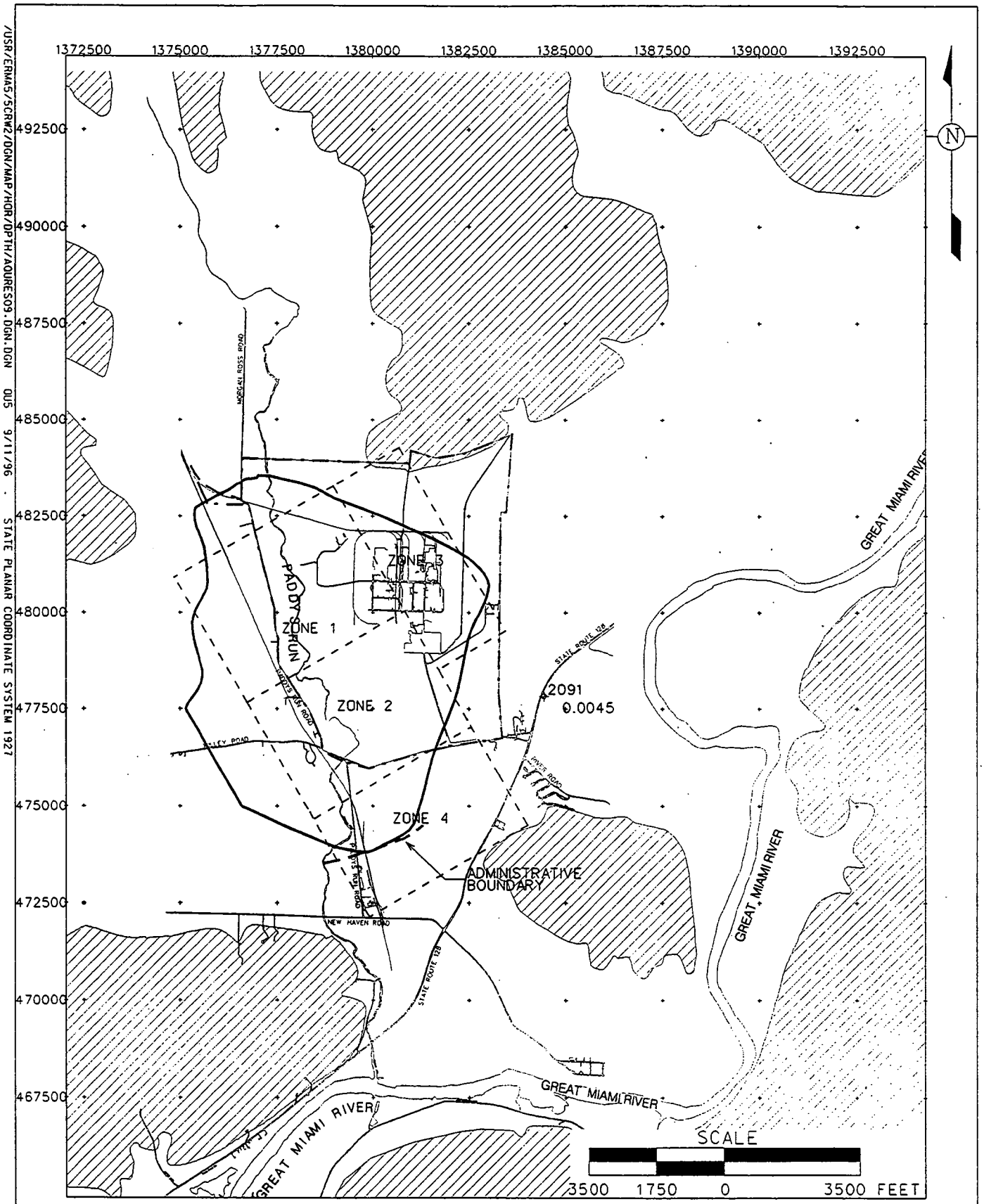
0543



LEGEND:

— · — · — FEMP BOUNDARY

2127 ✦ GROUNDWATER MONITORING WELL

.004 MERCURY (MAXIMUM VALUE)

RESTORATION FOOT PRINT (NO RETARDATION)

NOTE:
ZONE 0 INCLUDES EVERYTHING OUTSIDE OF ZONES 1 – 4

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FIGURE A.3-34. FRL EXCEEDENCES FOR MERCURY LOCATED OUTSIDE OF THE RESTORATION FOOTPRINT AND NORTH OF ADMINISTRATION BOUNDARY

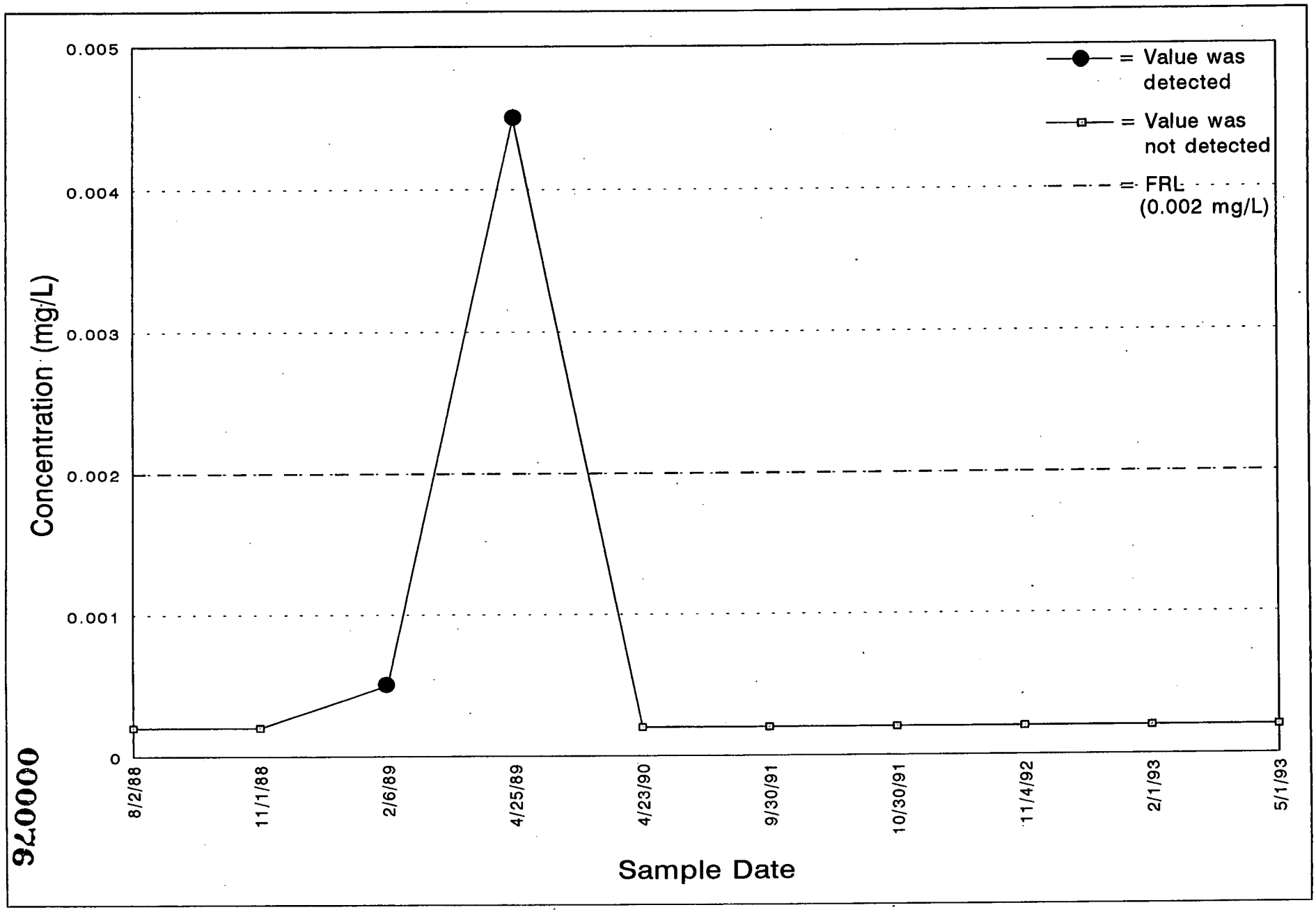
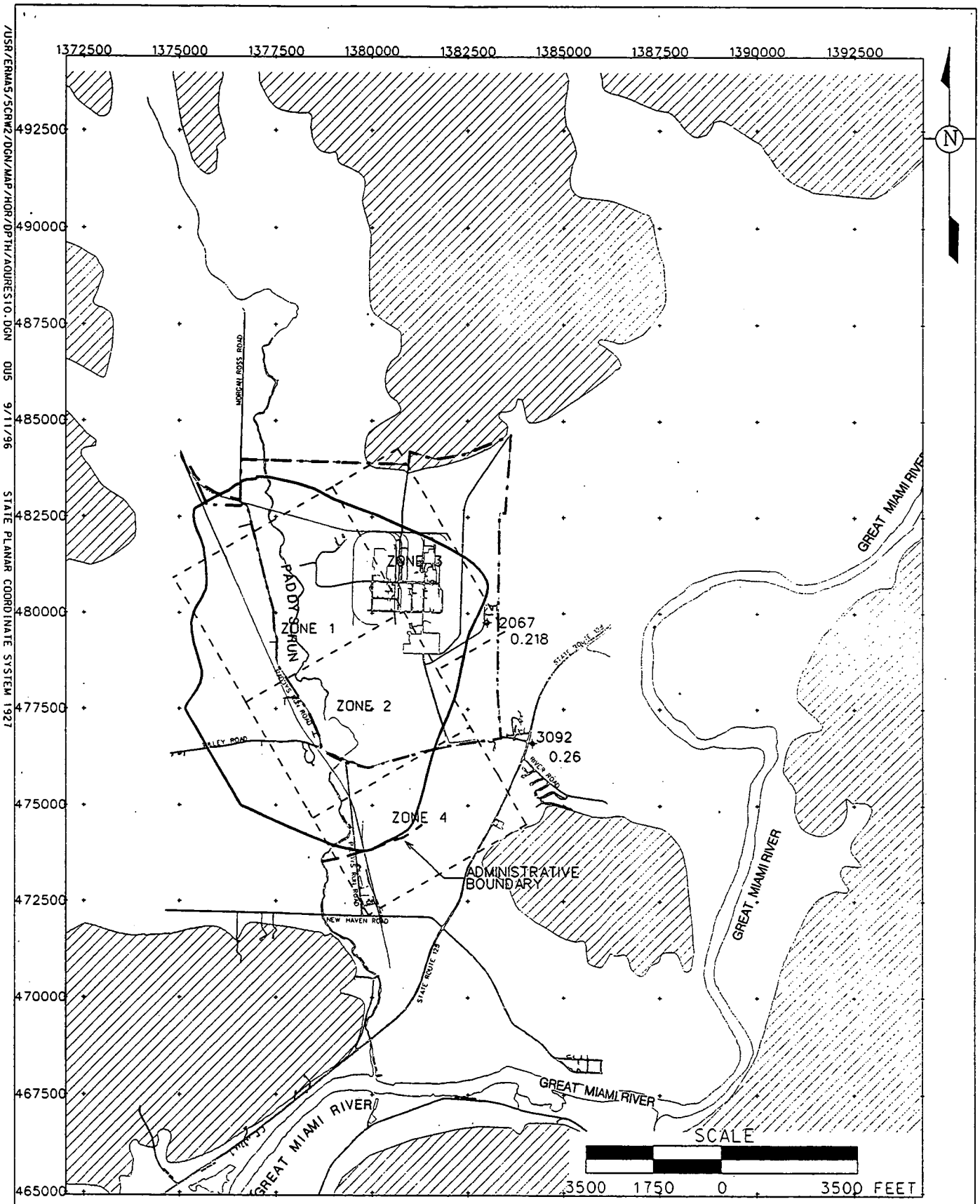


FIGURE A.3-35. MERCURY CONCENTRATION VS. TIME, WELL 2091



LEGEND:

— · — · — FEMP BOUNDARY

2127 ✦ GROUNDWATER MONITORING WELL

0.26 NICKEL (MAXIMUM VALUE)

RESTORATION FOOT PRINT (NO RETARDATION)

NOTE:
ZONE 0 INCLUDES EVERYTHING OUTSIDE OF ZONES 1 - 4

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FIGURE A.3-36. FRL EXCEEDENCES FOR NICKEL LOCATED OUTSIDE OF THE RESTORATION FOOTPRINT AND NORTH OF ADMINISTRATION BOUNDARY

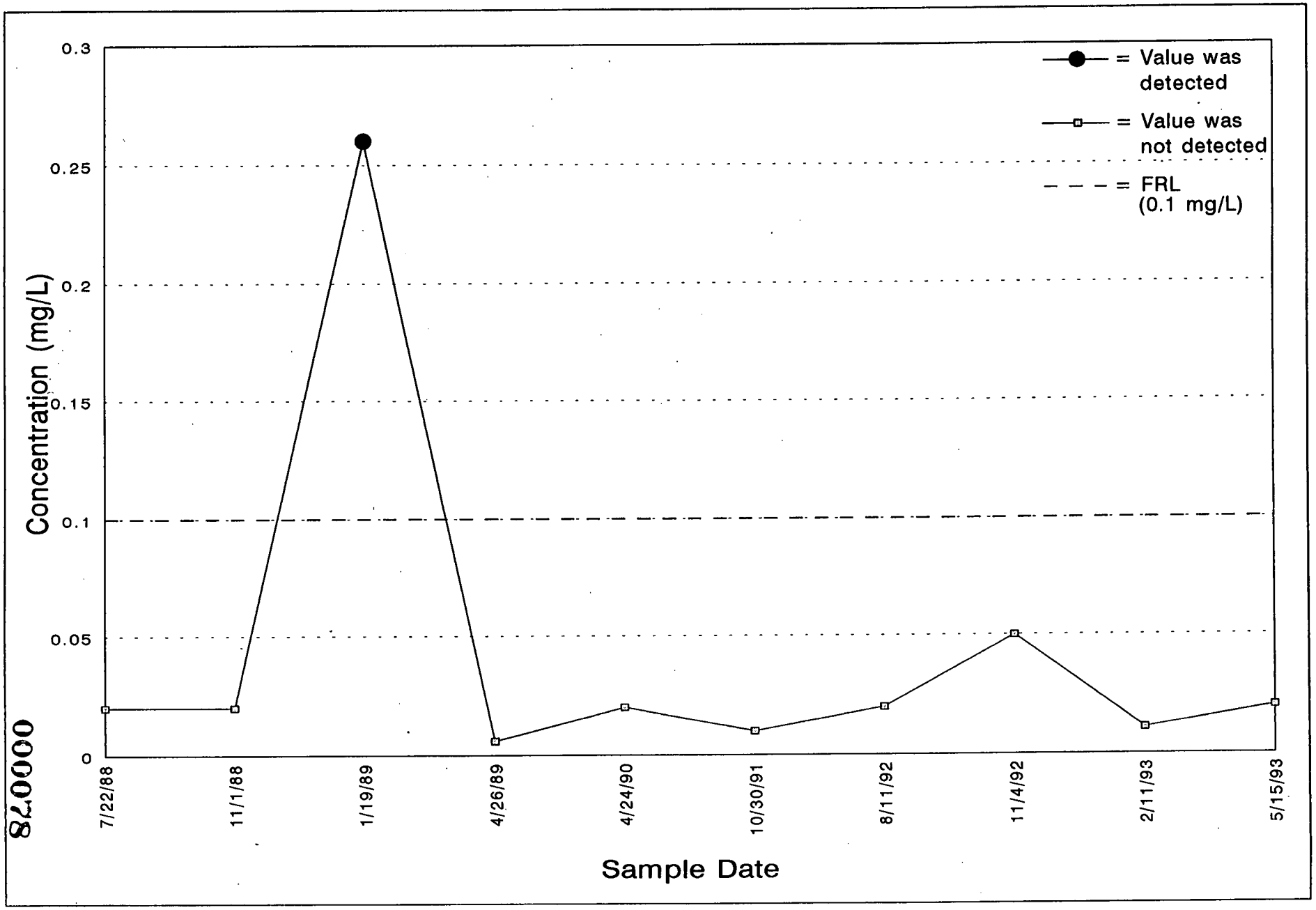


FIGURE A.3-37. NICKEL CONCENTRATION VS. TIME, WELL 3092

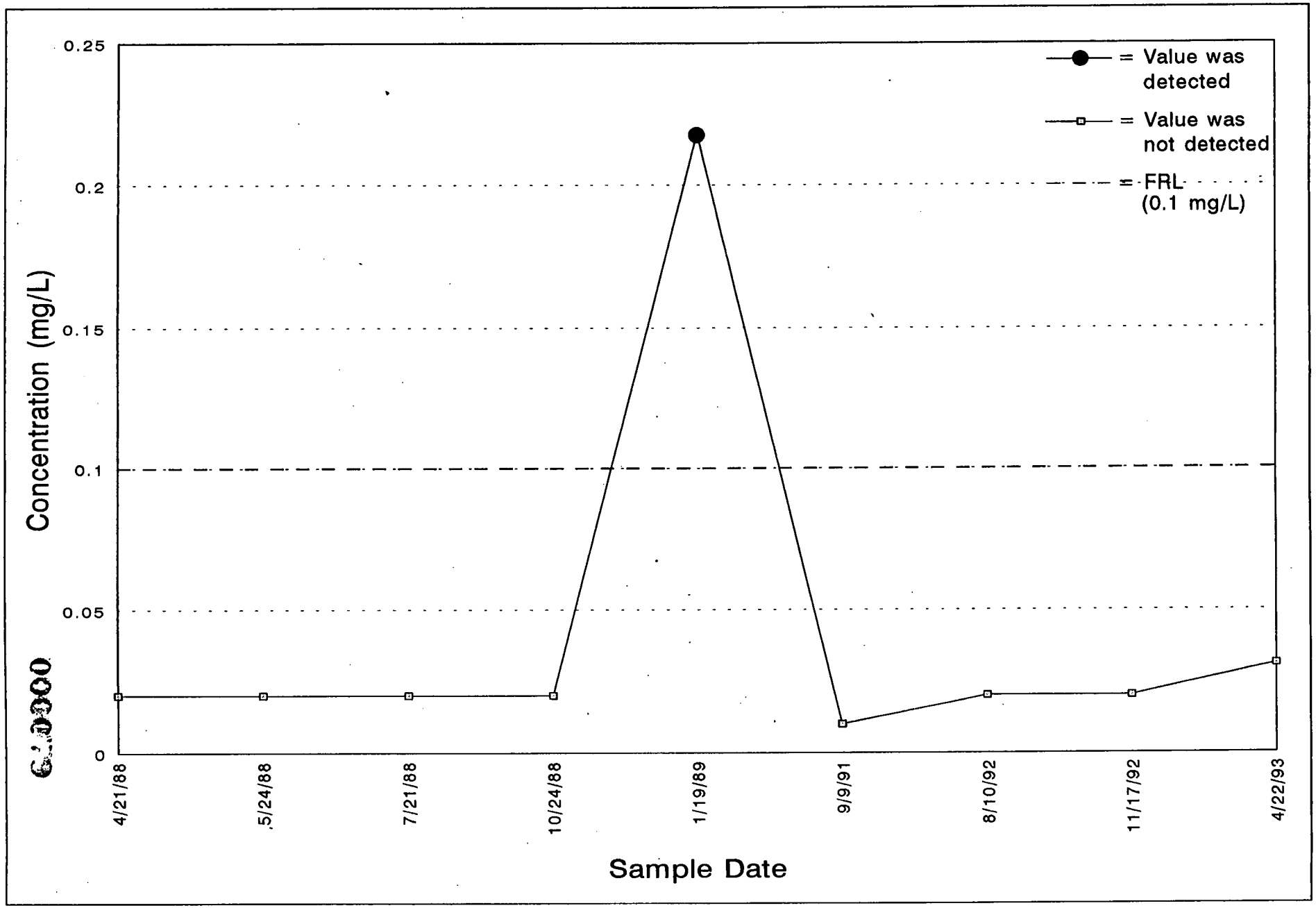
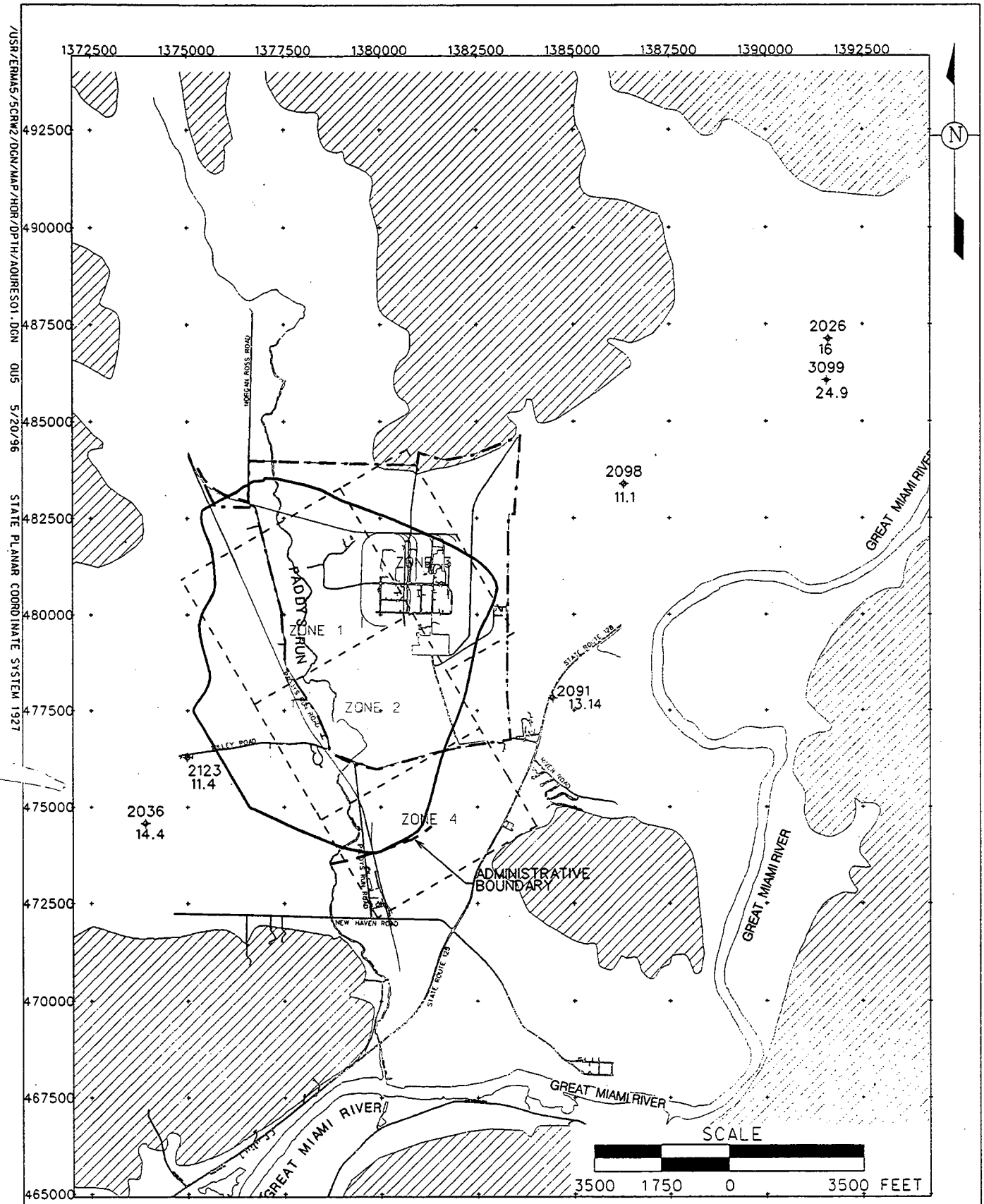


FIGURE A.3-38. NICKEL CONCENTRATION VS. TIME, WELL 2067



LEGEND:

— · — · — FEMP BOUNDARY

2127 ✦ GROUNDWATER MONITORING WELL

12.8 NITRATE (MAXIMUM VALUE)

NOTE:
ZONE 0 INCLUDES EVERYTHING OUTSIDE OF ZONES 1 - 4

RESTORATION FOOT PRINT (NO RETARDATION)

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FIGURE A.3-39. FRL EXCEEDENCES FOR NITRATE LOCATED OUTSIDE OF THE RESTORATION FOOTPRINT AND NORTH OF ADMINISTRATION BOUNDARY

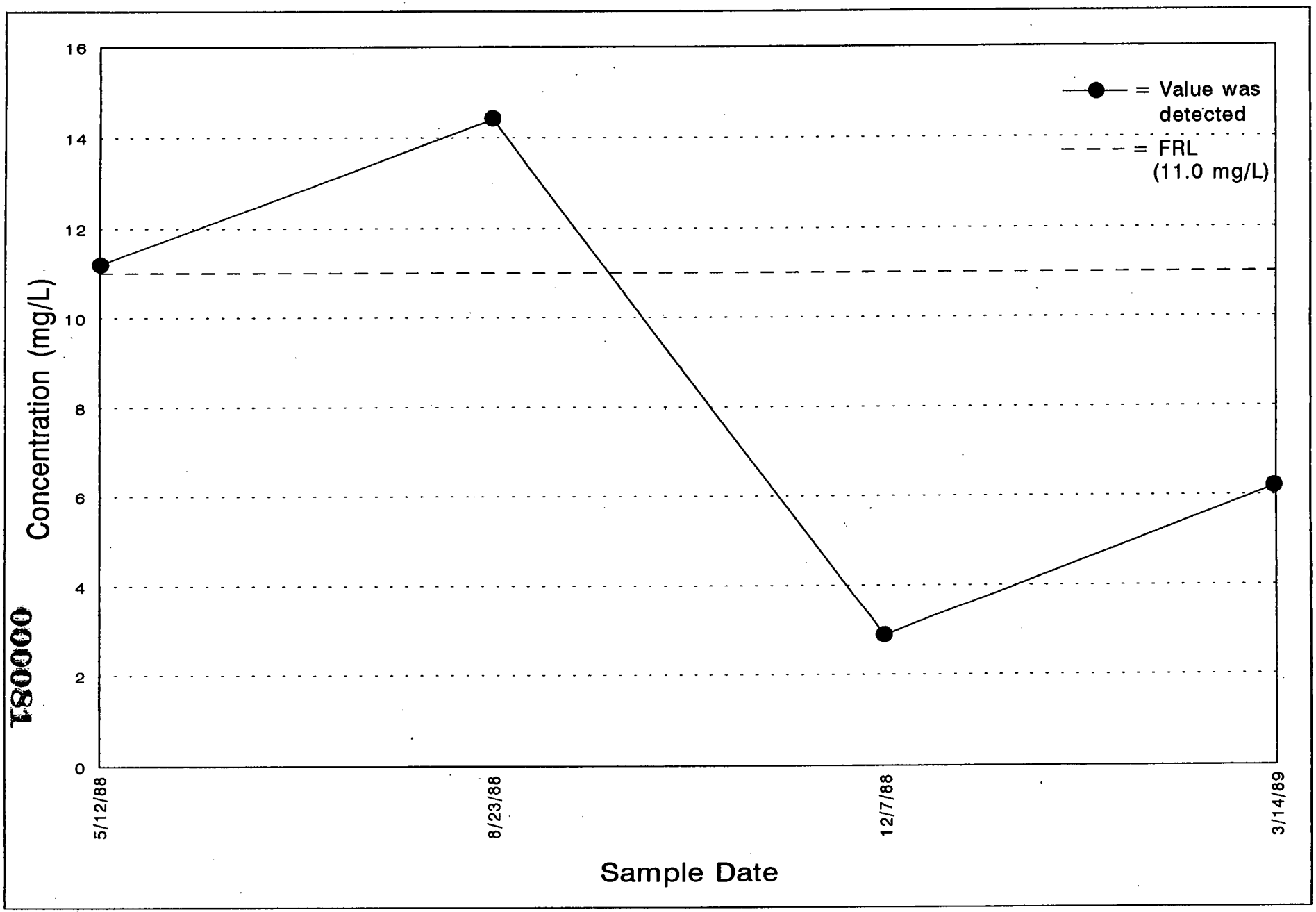


FIGURE A.3-40. NITRATE CONCENTRATION VS. TIME, WELL 2036

180000

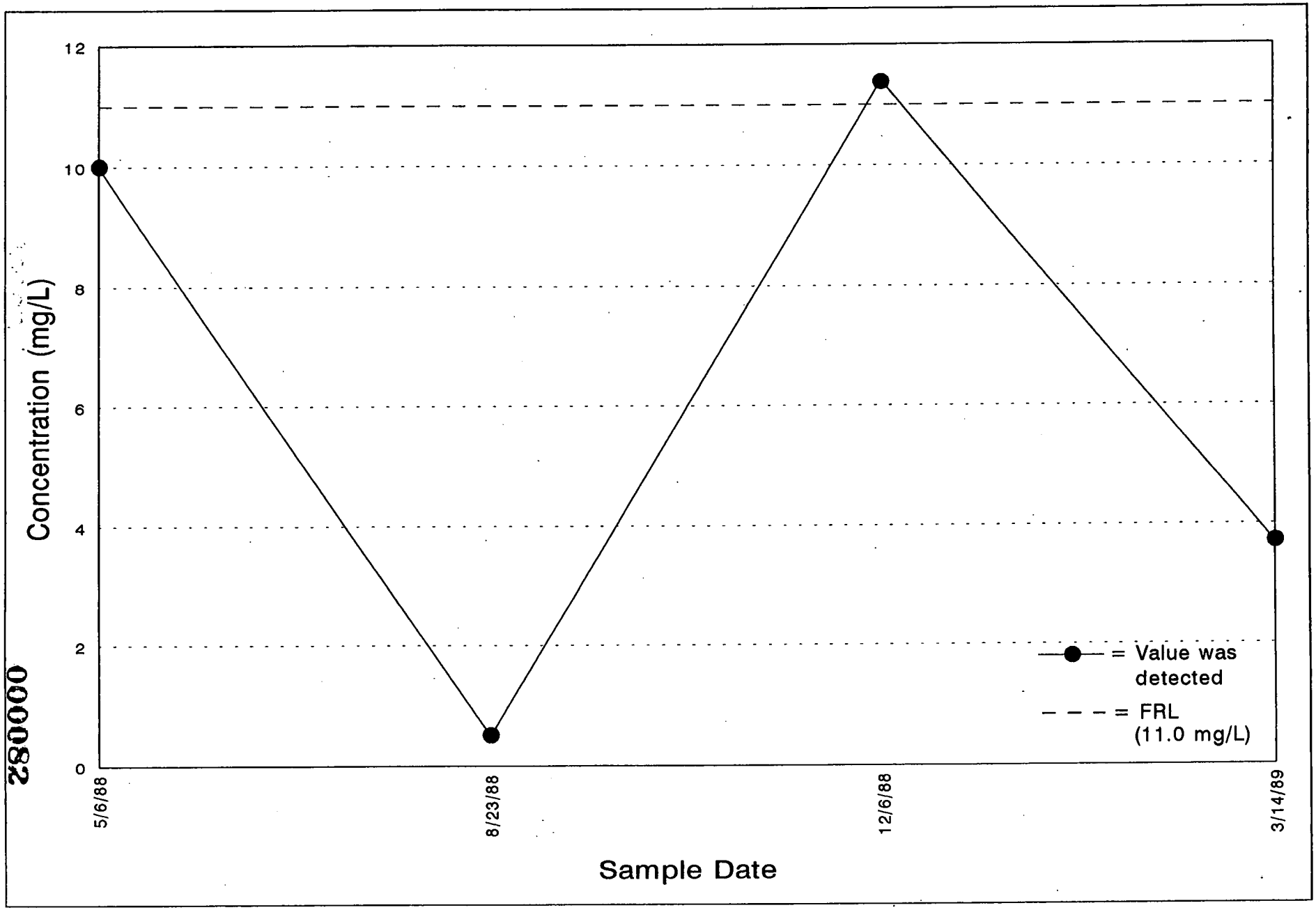


FIGURE A.3-41. NITRATE CONCENTRATION VS. TIME, WELL 2123

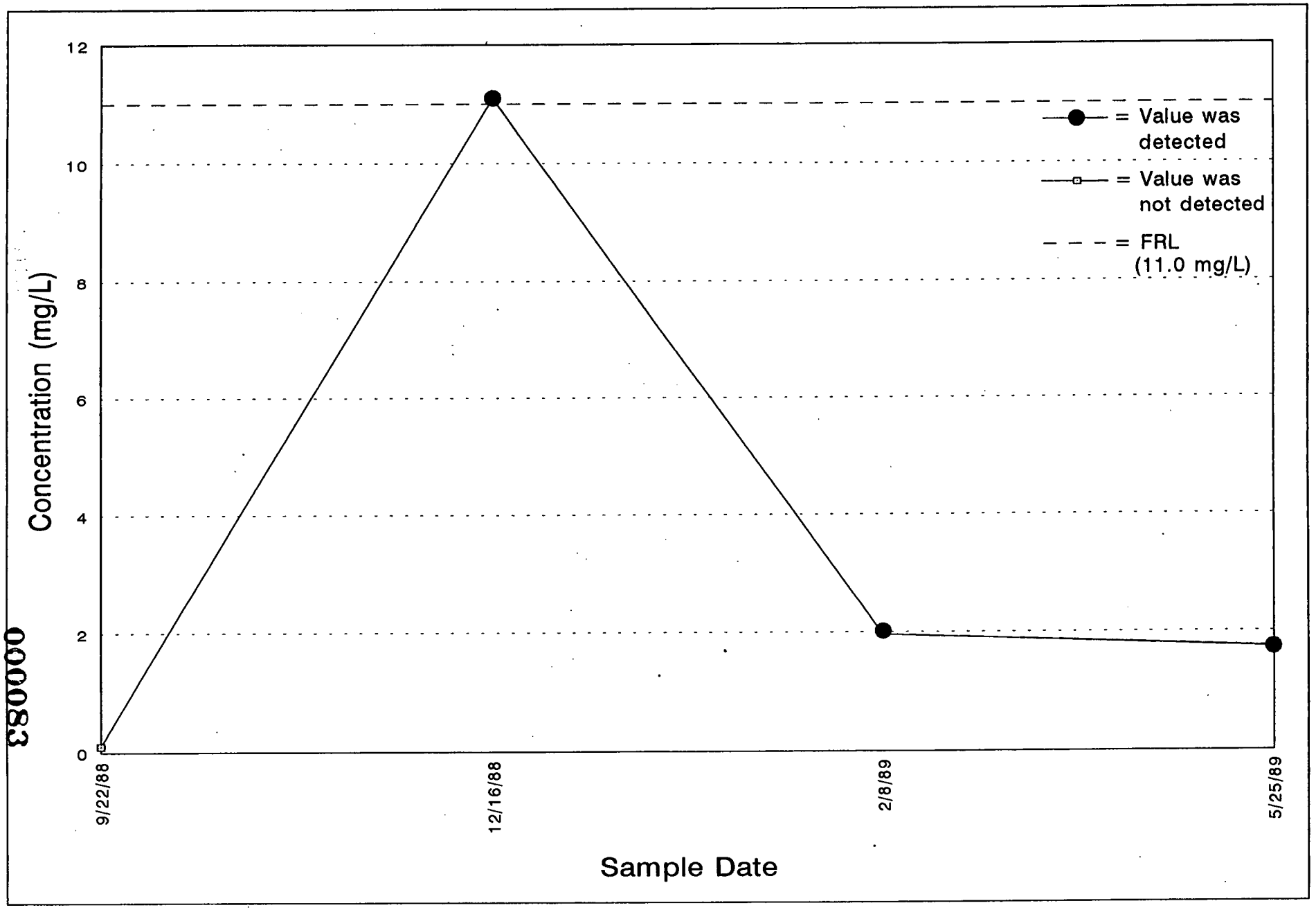


FIGURE A.3-42. NITRATE CONCENTRATION VS. TIME, WELL 2098

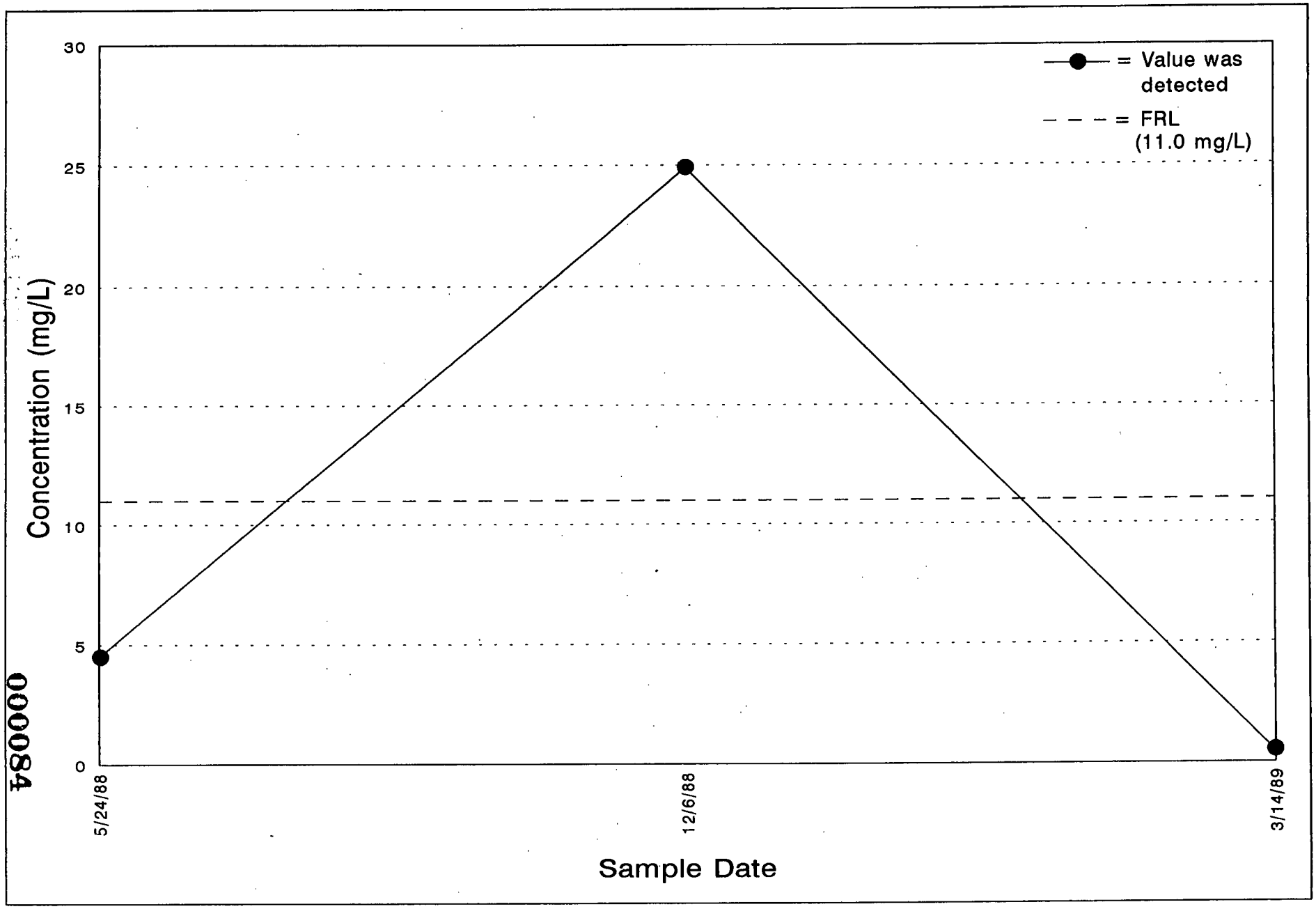


FIGURE A.3-43. NITRATE CONCENTRATION VS. TIME, WELL 3099

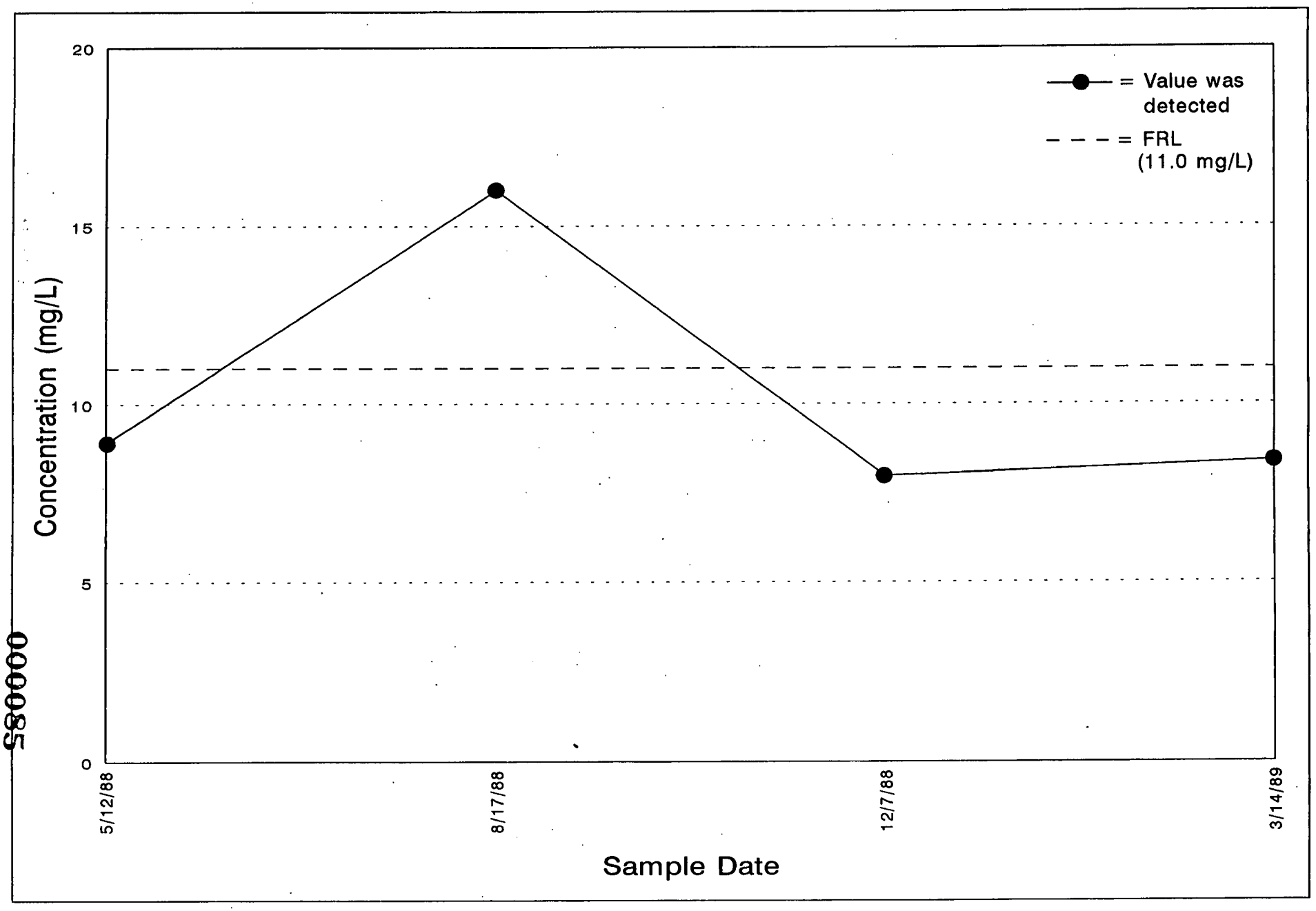


FIGURE A.3-44. NITRATE CONCENTRATION VS. TIME, WELL 2026

S80000

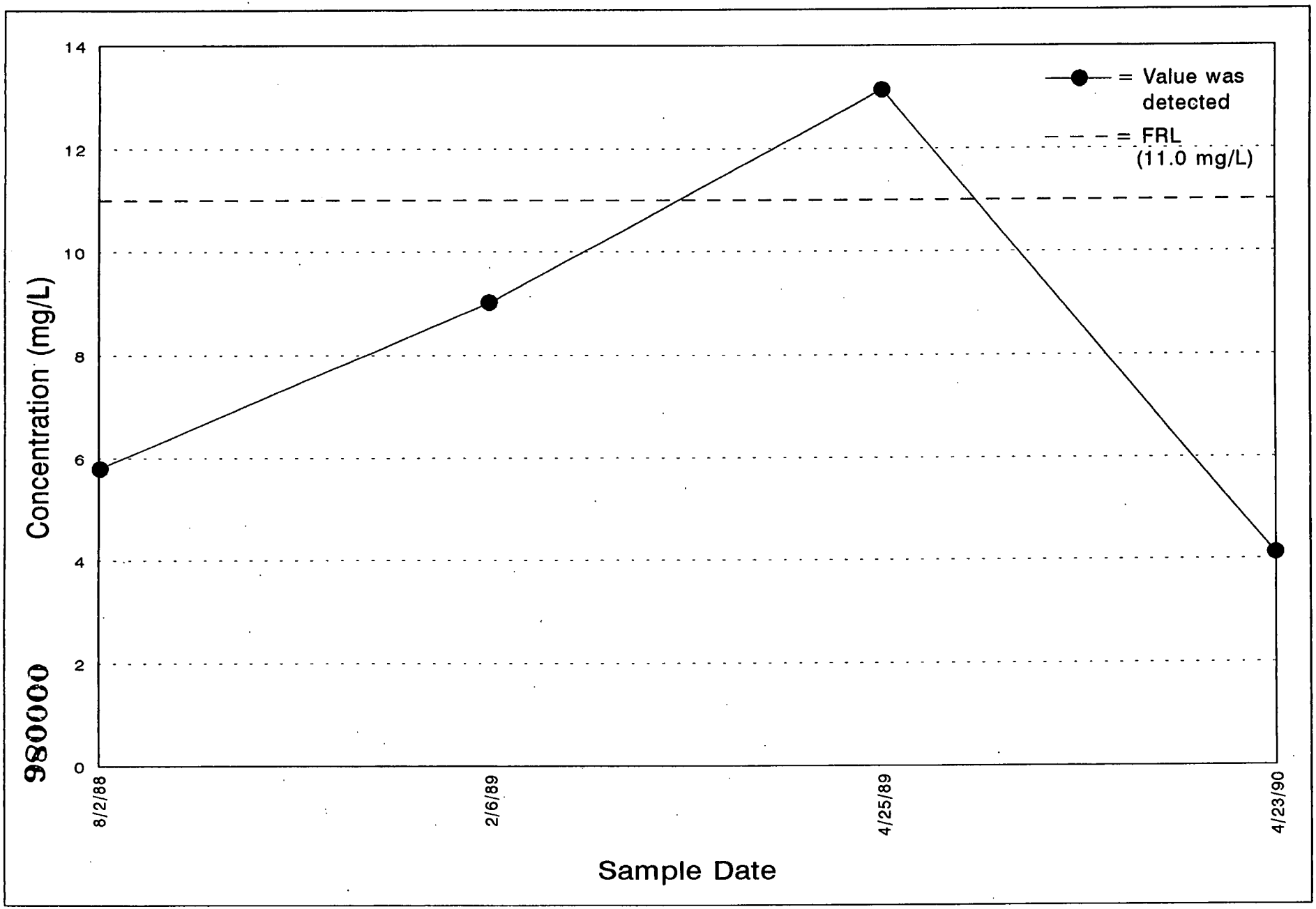


FIGURE A.3-45. NITRATE CONCENTRATION VS. TIME, WELL 2091

980000

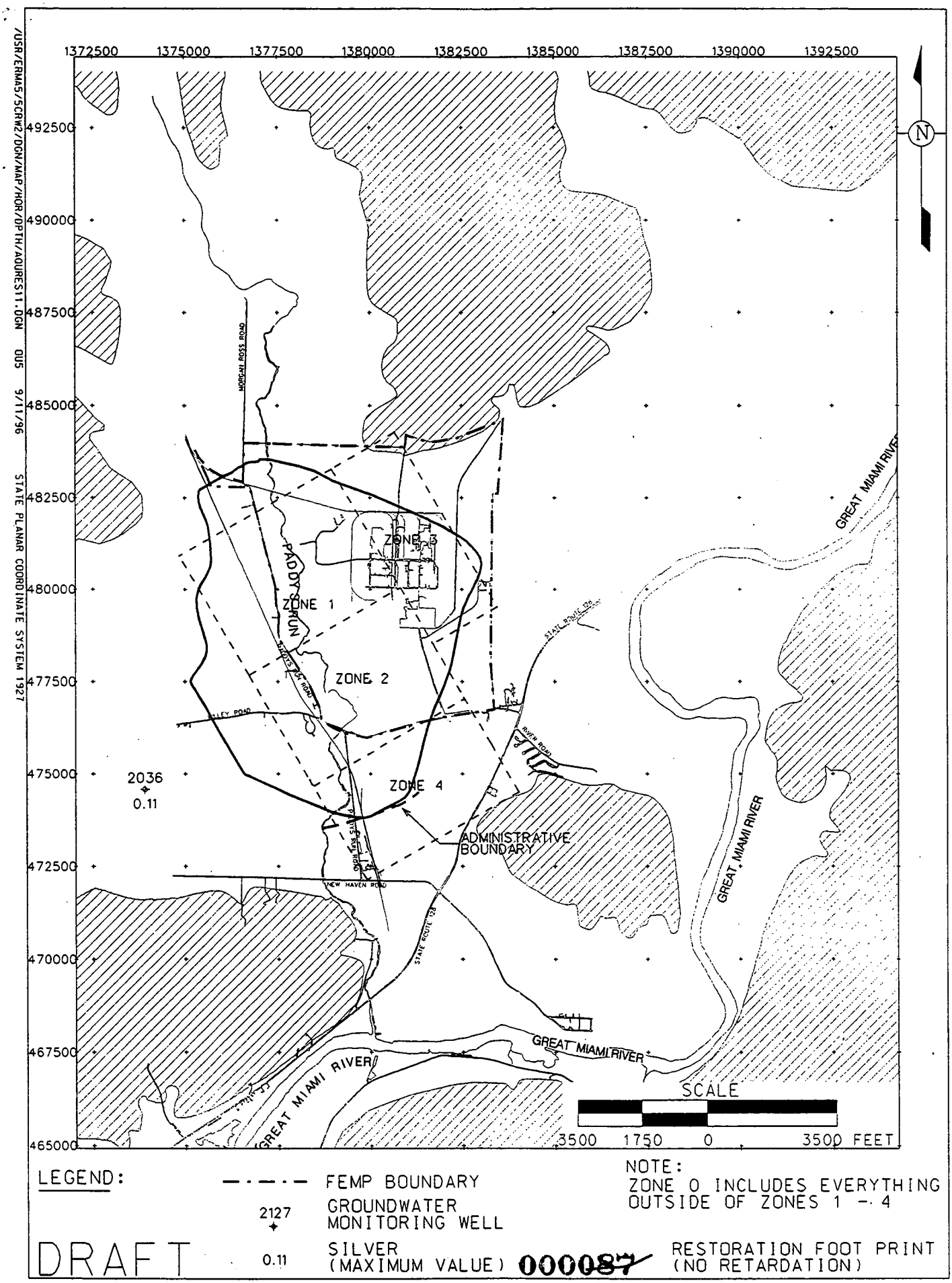


FIGURE A.3-46. FRL EXCEEDENCES FOR SILVER LOCATED OUTSIDE OF THE RESTORATION FOOTPRINT AND NORTH OF ADMINISTRATION BOUNDARY

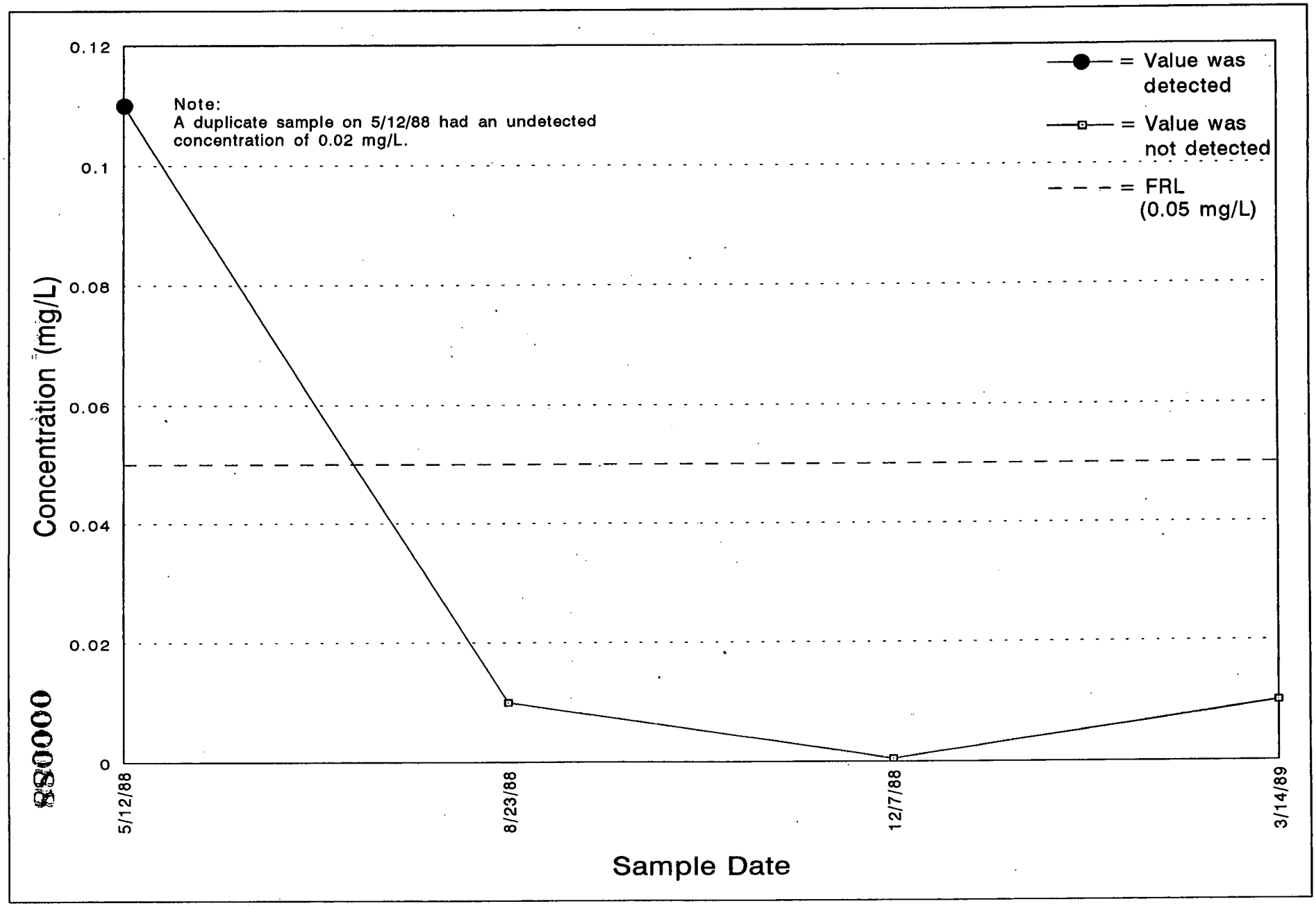


FIGURE A.3-47. SILVER CONCENTRATION VS. TIME, WELL 2036

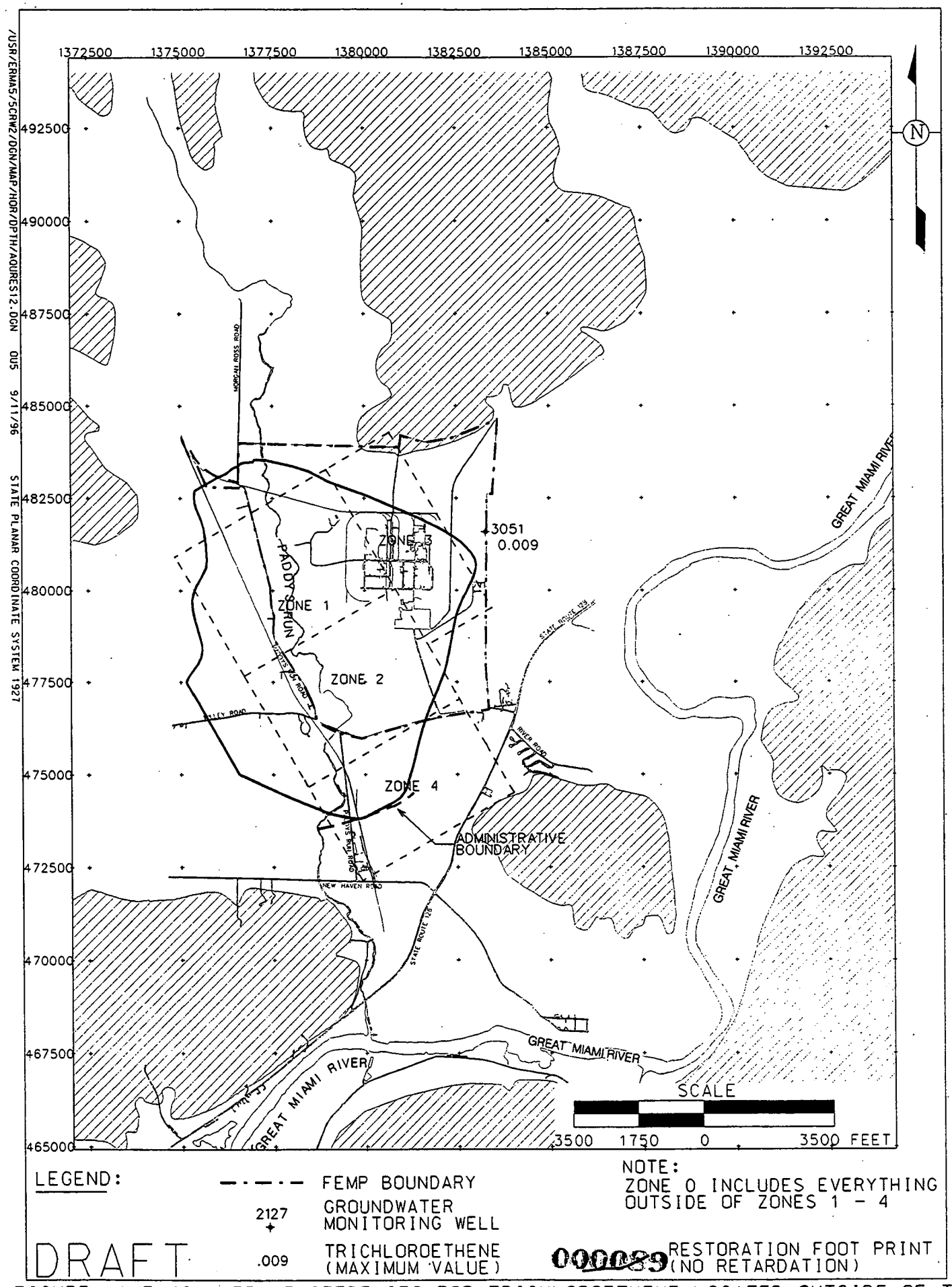


FIGURE A.3-48. FRL EXCEEDENCES FOR TRICHLOROETHENE LOCATED OUTSIDE OF THE RESTORATION FOOTPRINT AND NORTH OF ADMINISTRATION BOUNDARY

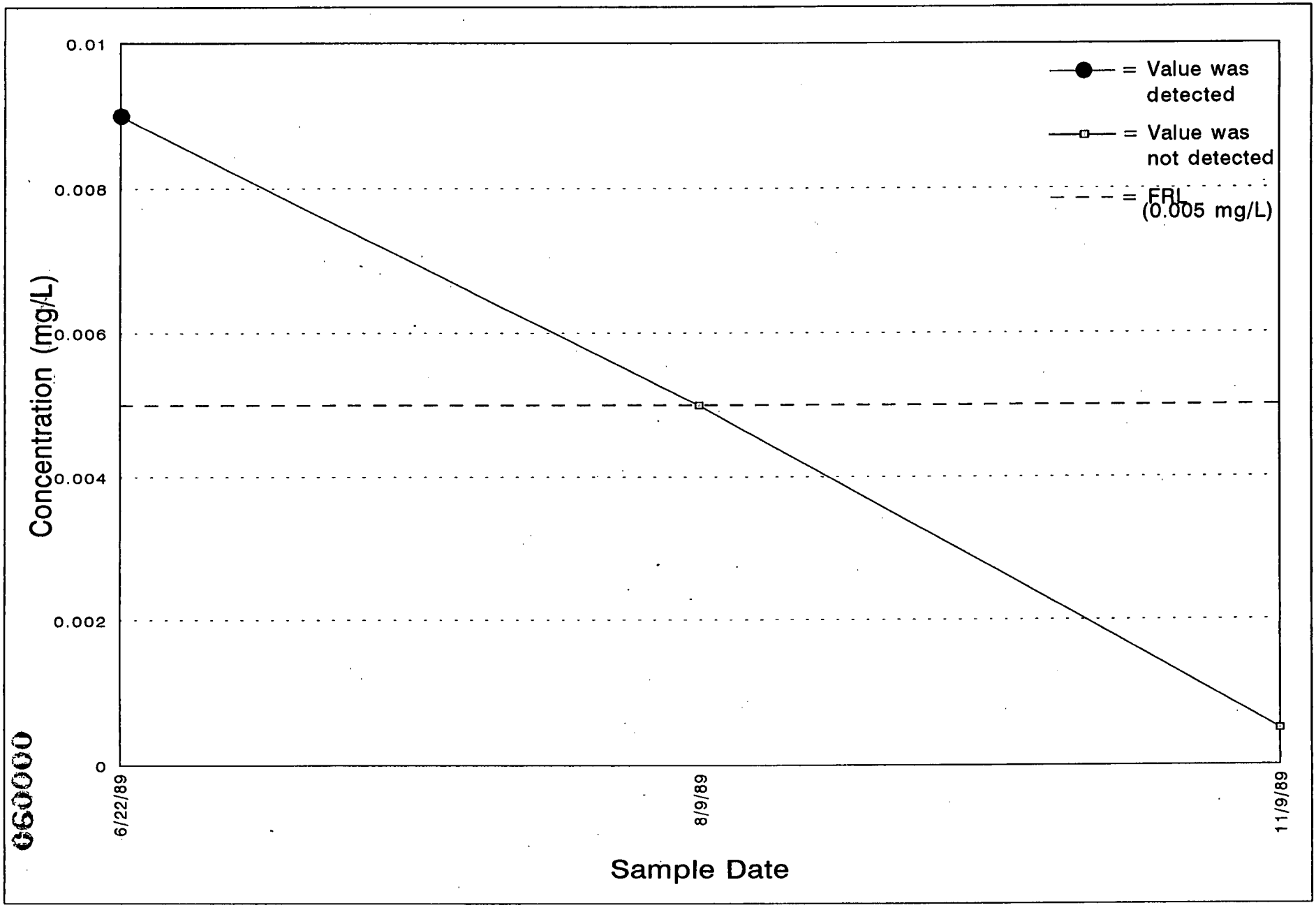


FIGURE A.3-49. TRICHLOROETHENE CONCENTRATION VS. TIME, WELL 3051

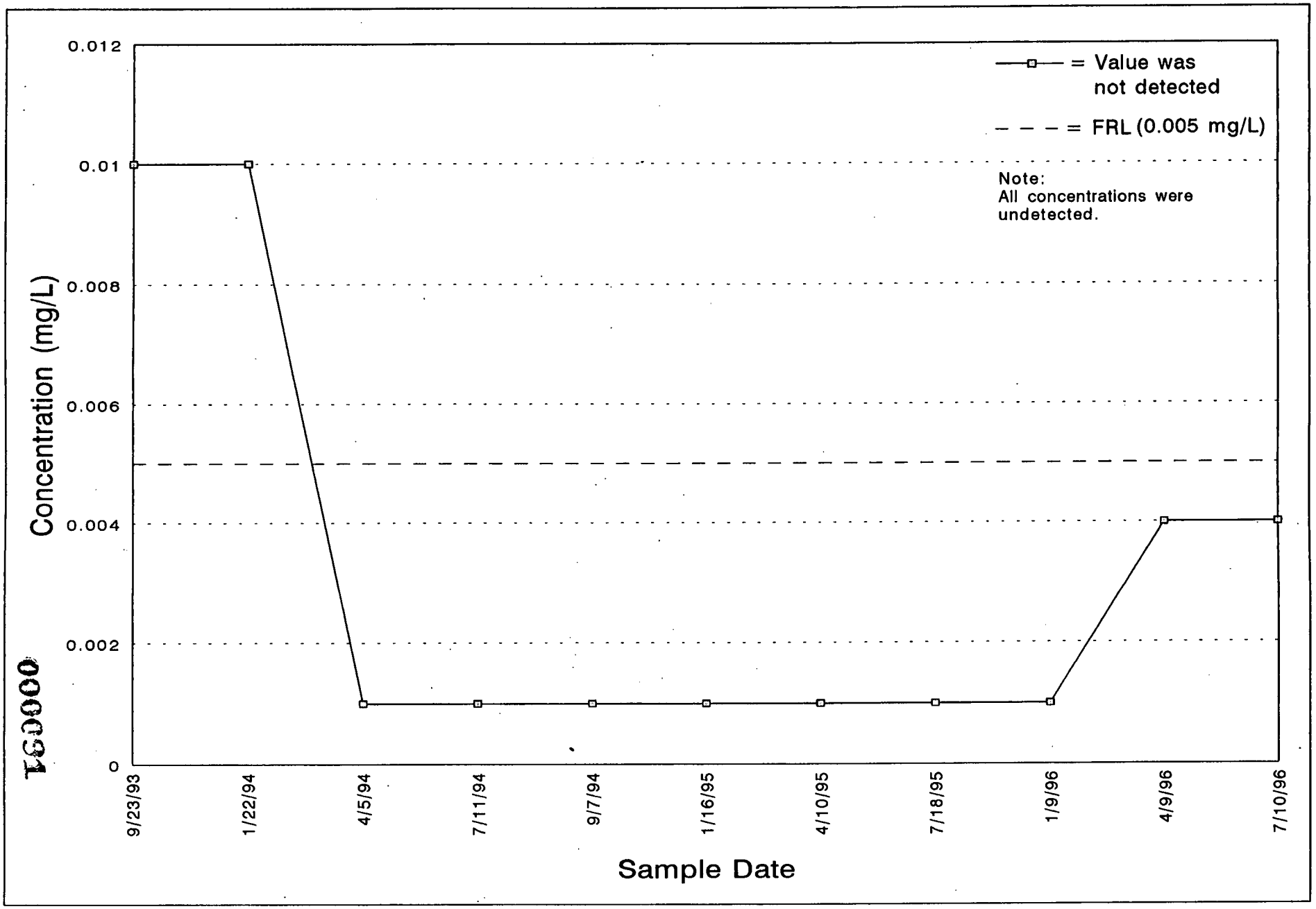


FIGURE A.3-50. TRICHLOROETHENE CONCENTRATION VS. TIME, WELL 31217

160000

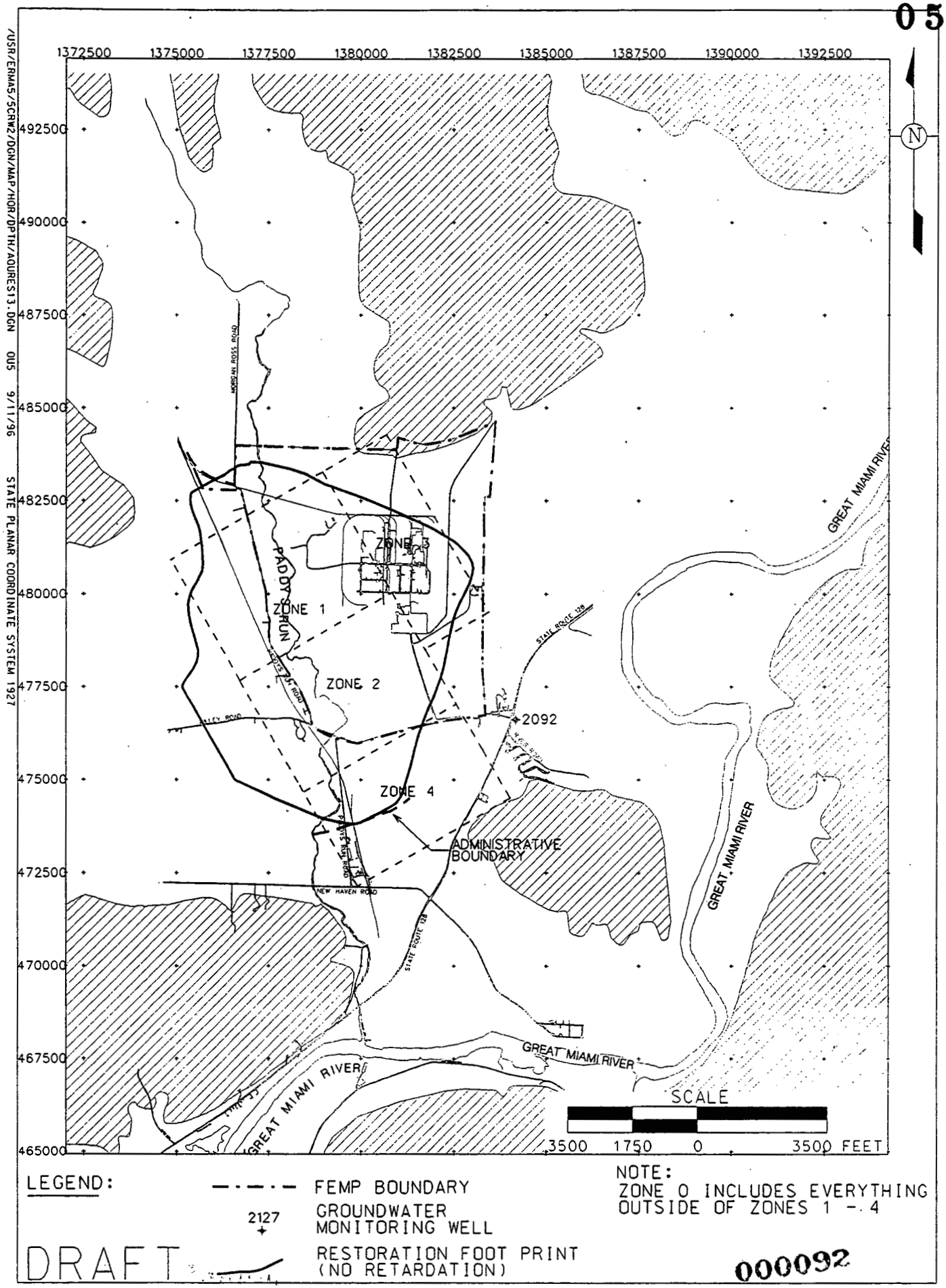


FIGURE A.3-51. LOCATION OF FRL EXCEEDENCES FOR THORIUM-228 AND THORIUM-232 LOCATED OUTSIDE OF THE RESTORATION FOOTPRINT AND NORTH OF ADMINISTRATION BOUNDARY

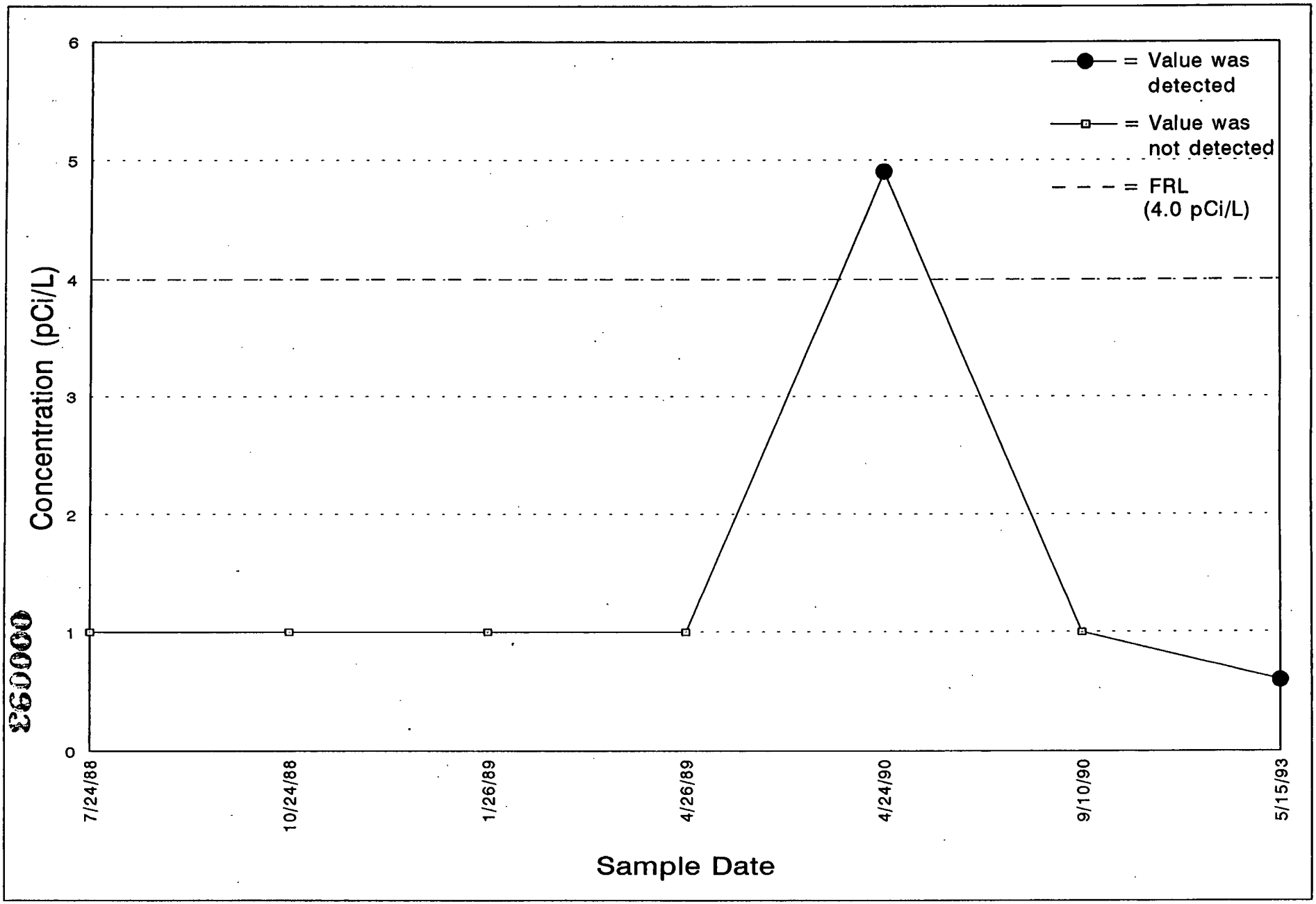


FIGURE A.3-52. THORIUM-228 CONCENTRATION VS. TIME, WELL 2092

2600093

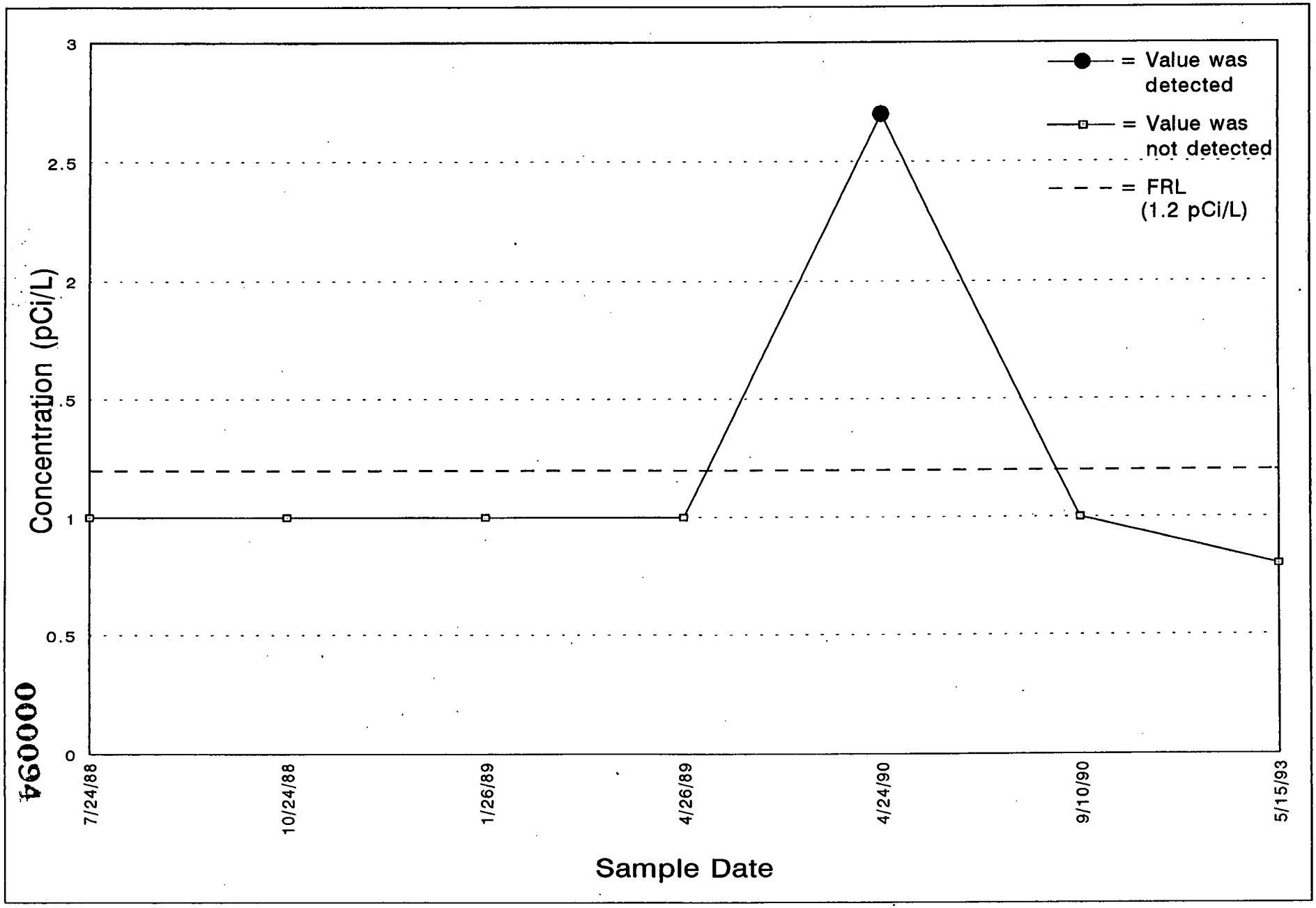
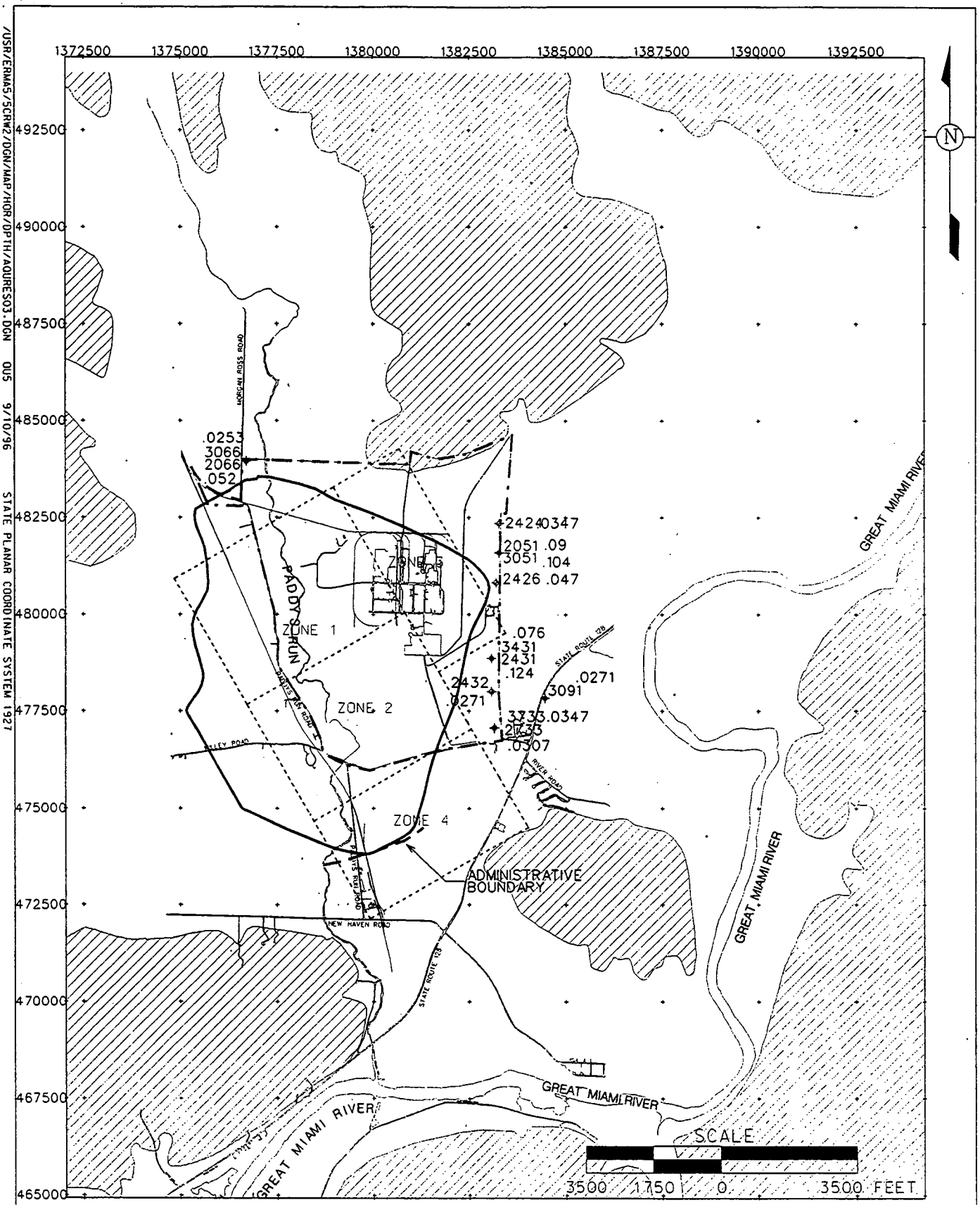


FIGURE A.3-53. THORIUM-232 CONCENTRATION VS. TIME, WELL 2092



LEGEND:

- — · — · — FEMP BOUNDARY
- 2127 ✦ GROUNDWATER MONITORING WELL
- 12.8 ZINC (MAXIMUM VALUE)
- RESTORATION FOOT PRINT (NO RETARDATION)

NOTE:
ZONE 0 INCLUDES EVERYTHING OUTSIDE OF ZONES 1 - 4

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FIGURE A.3-54. FRL EXCEEDENCES FOR ZINC LOCATED OUTSIDE OF THE RESTORATION FOOTPRINT AND NORTH OF ADMINISTRATION BOUNDARY

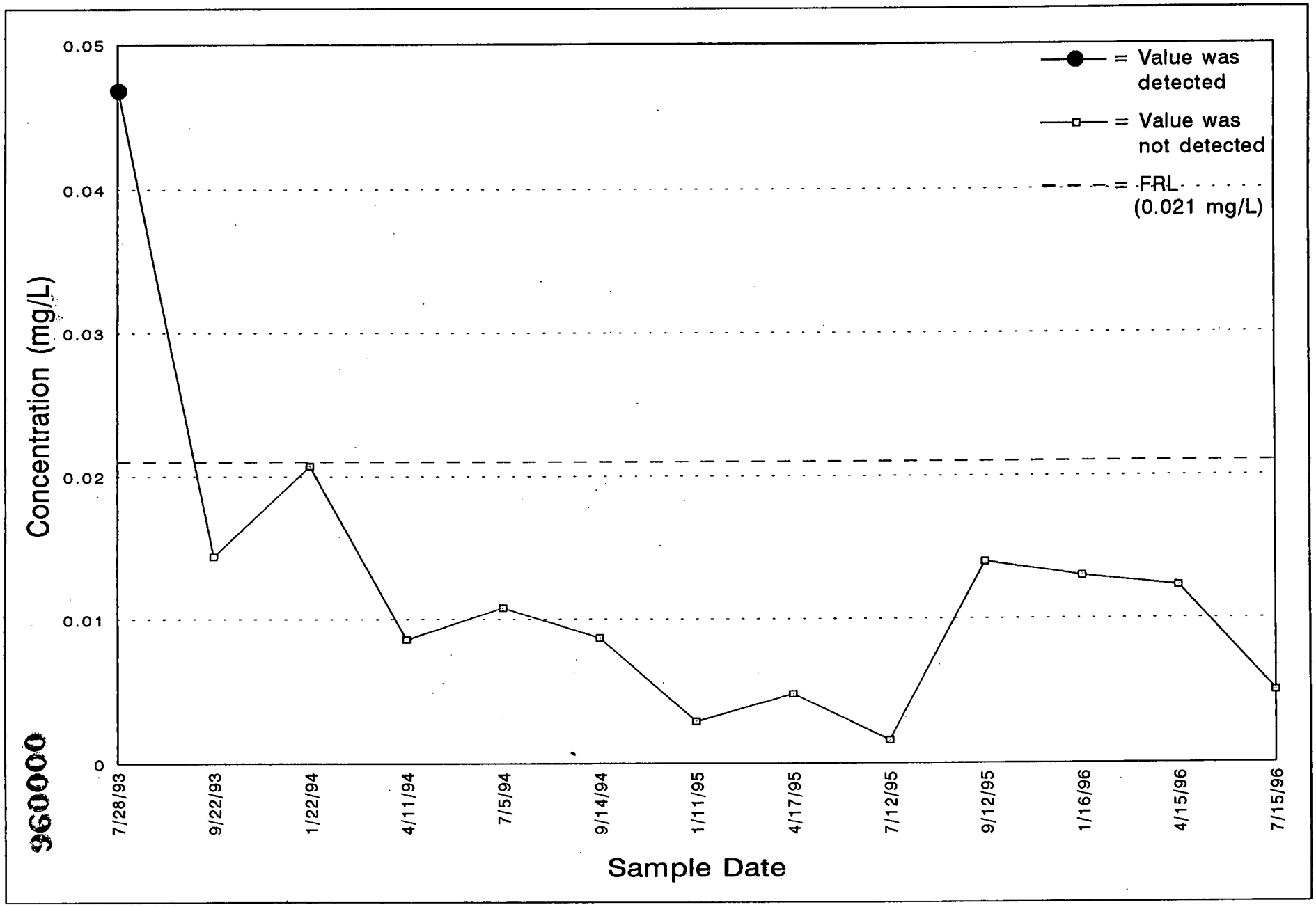

FIGURE A.3-55. ZINC CONCENTRATION VS. TIME, WELL 2426

960000

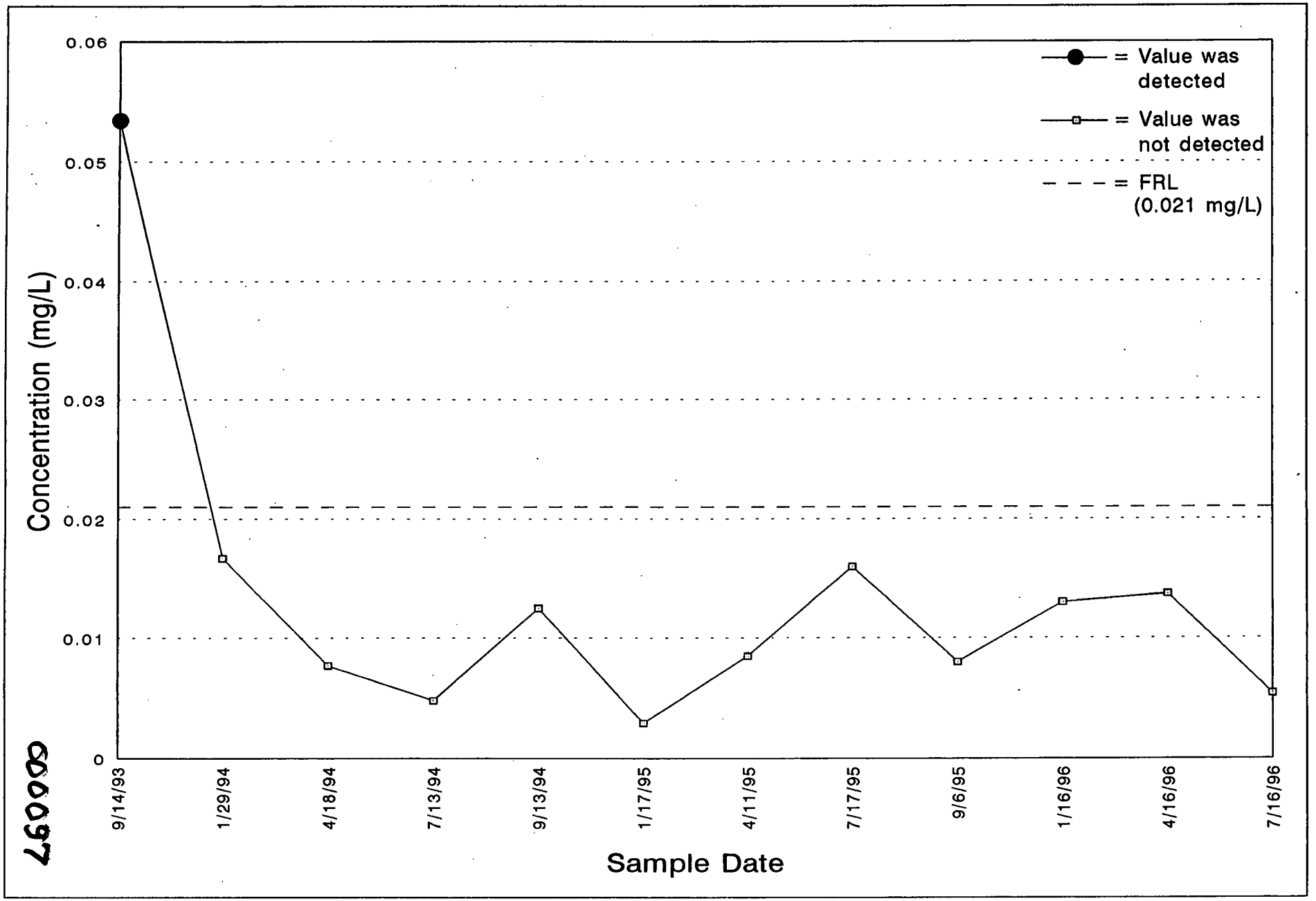

FIGURE A.3-56. ZINC CONCENTRATION VS. TIME, WELL 2431

000097

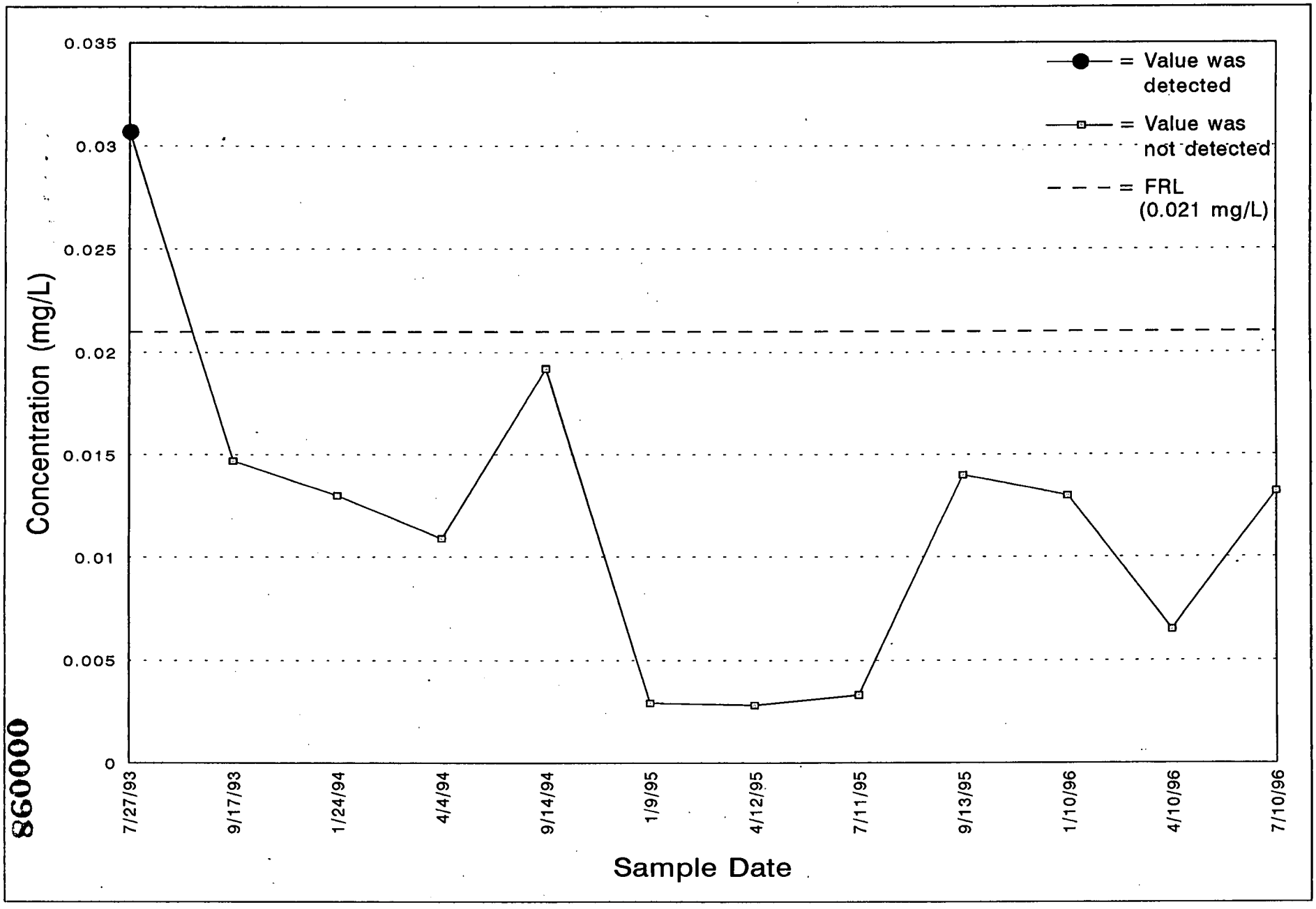

FIGURE A.3-57. ZINC CONCENTRATION VS. TIME, WELL 3733

860000

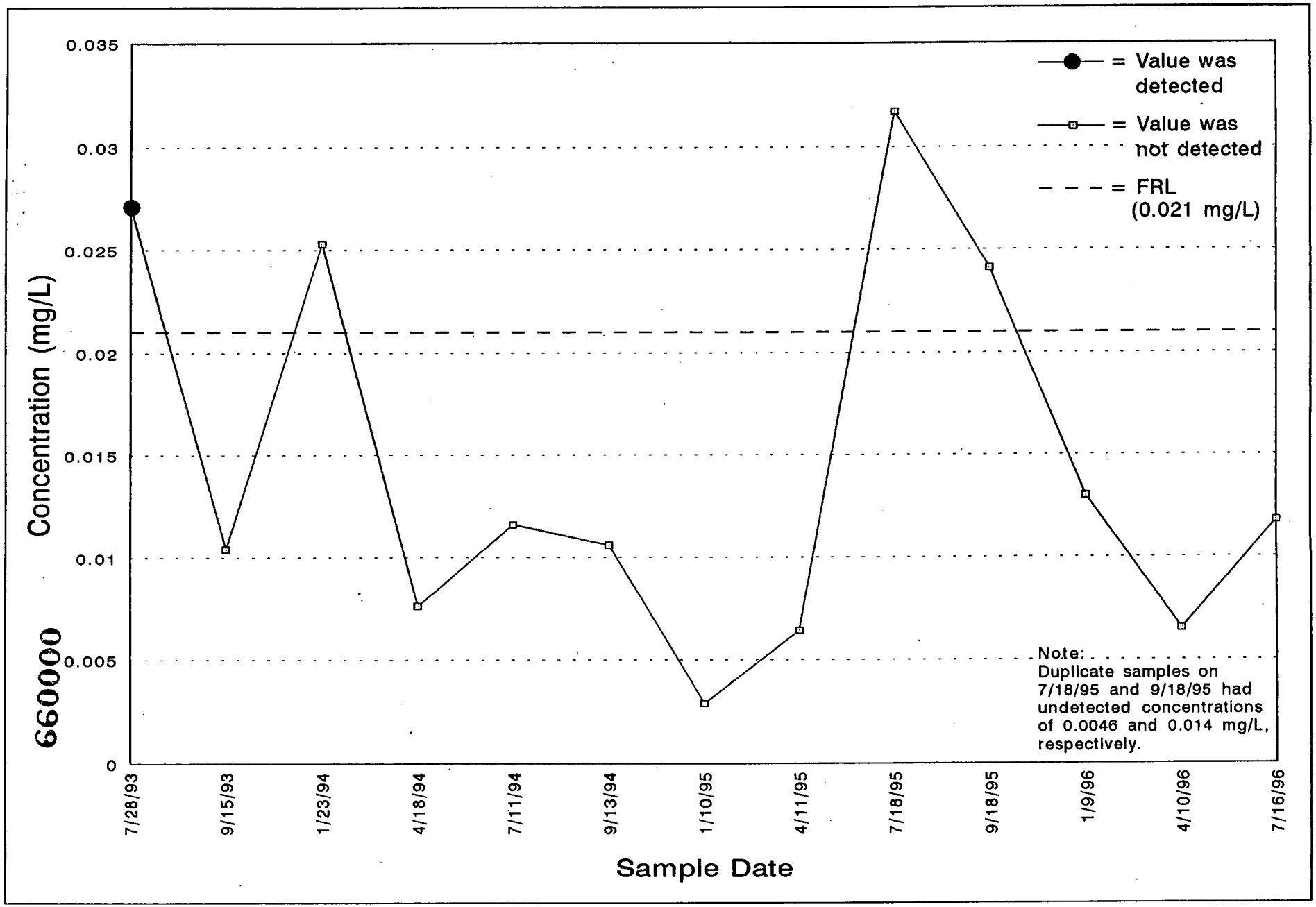

FIGURE A.3-58. ZINC CONCENTRATION VS. TIME, WELL 2432

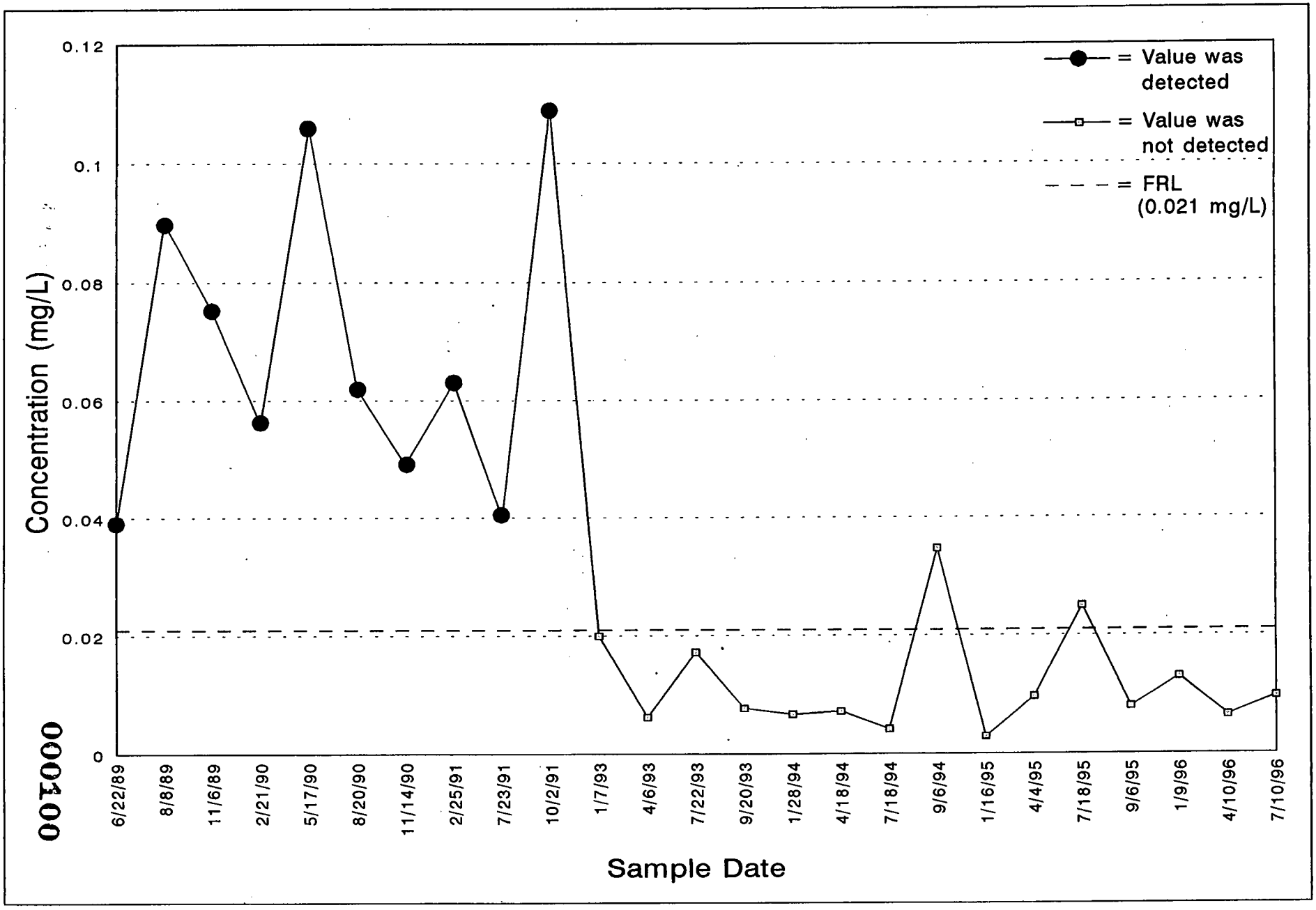

FIGURE A.3-59. ZINC CONCENTRATION VS. TIME, WELL 2051

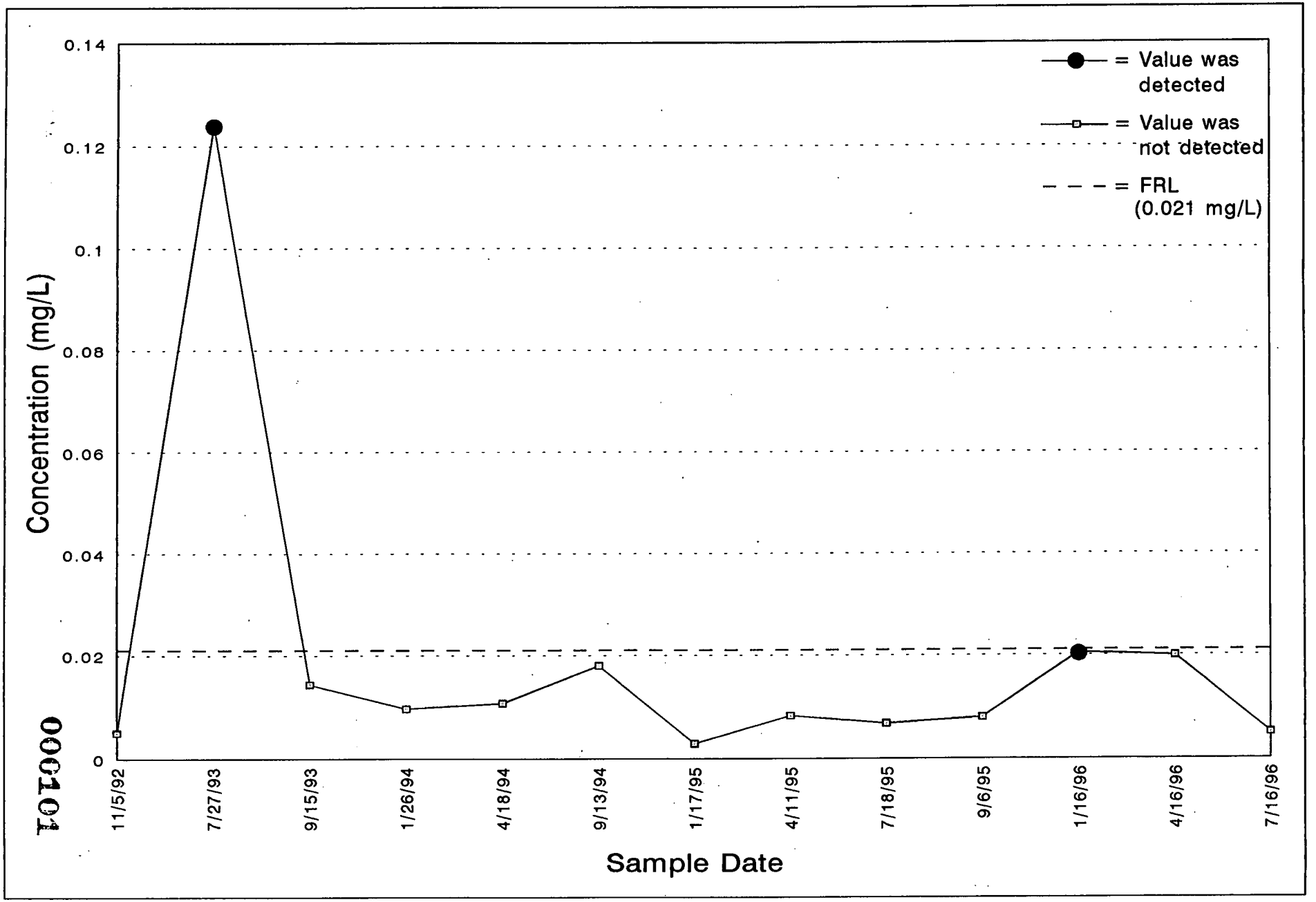

FIGURE A.3-60. ZINC CONCENTRATION VS. TIME, WELL 3431

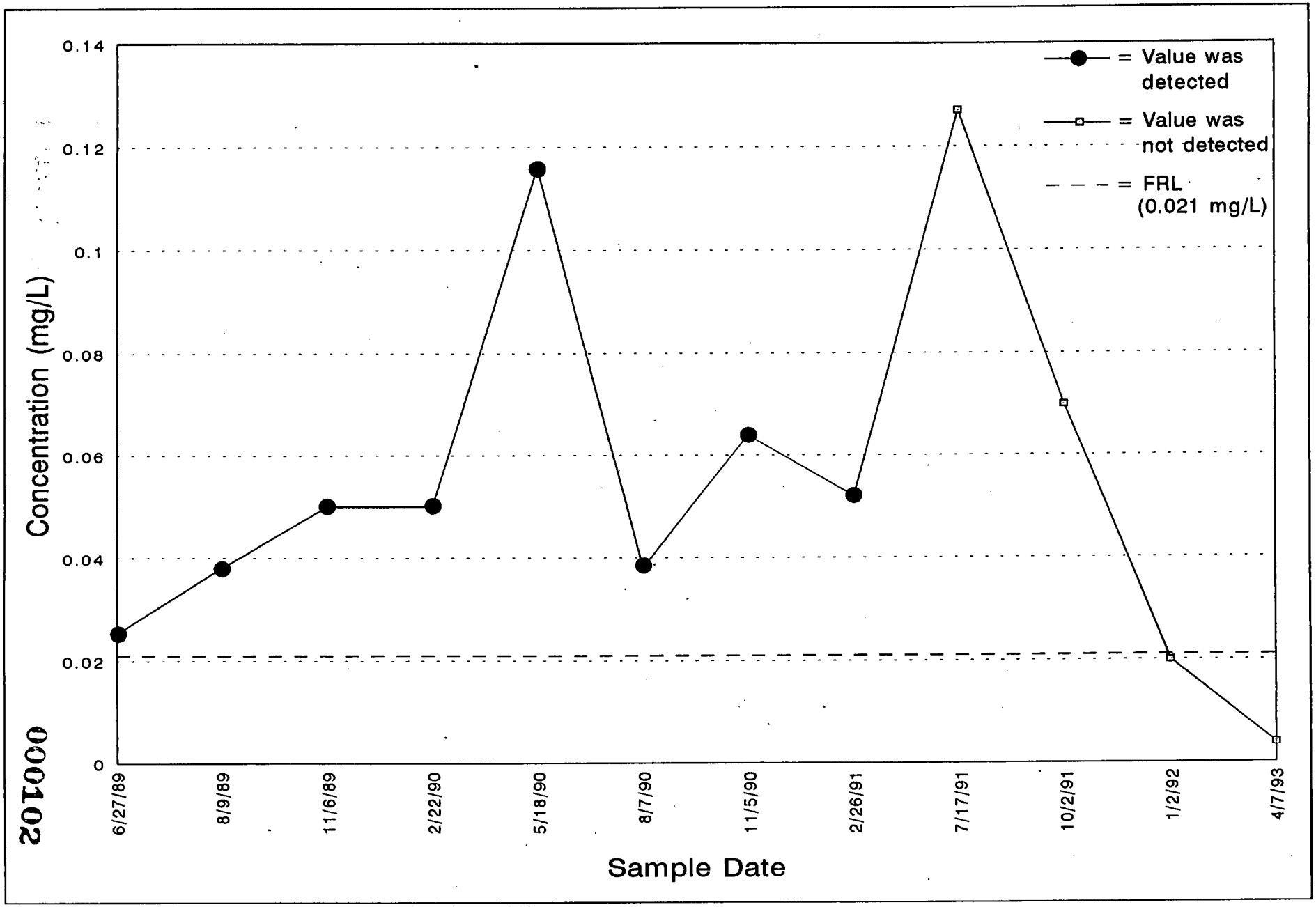

FIGURE A.3-61. ZINC CONCENTRATION VS. TIME, WELL 3066

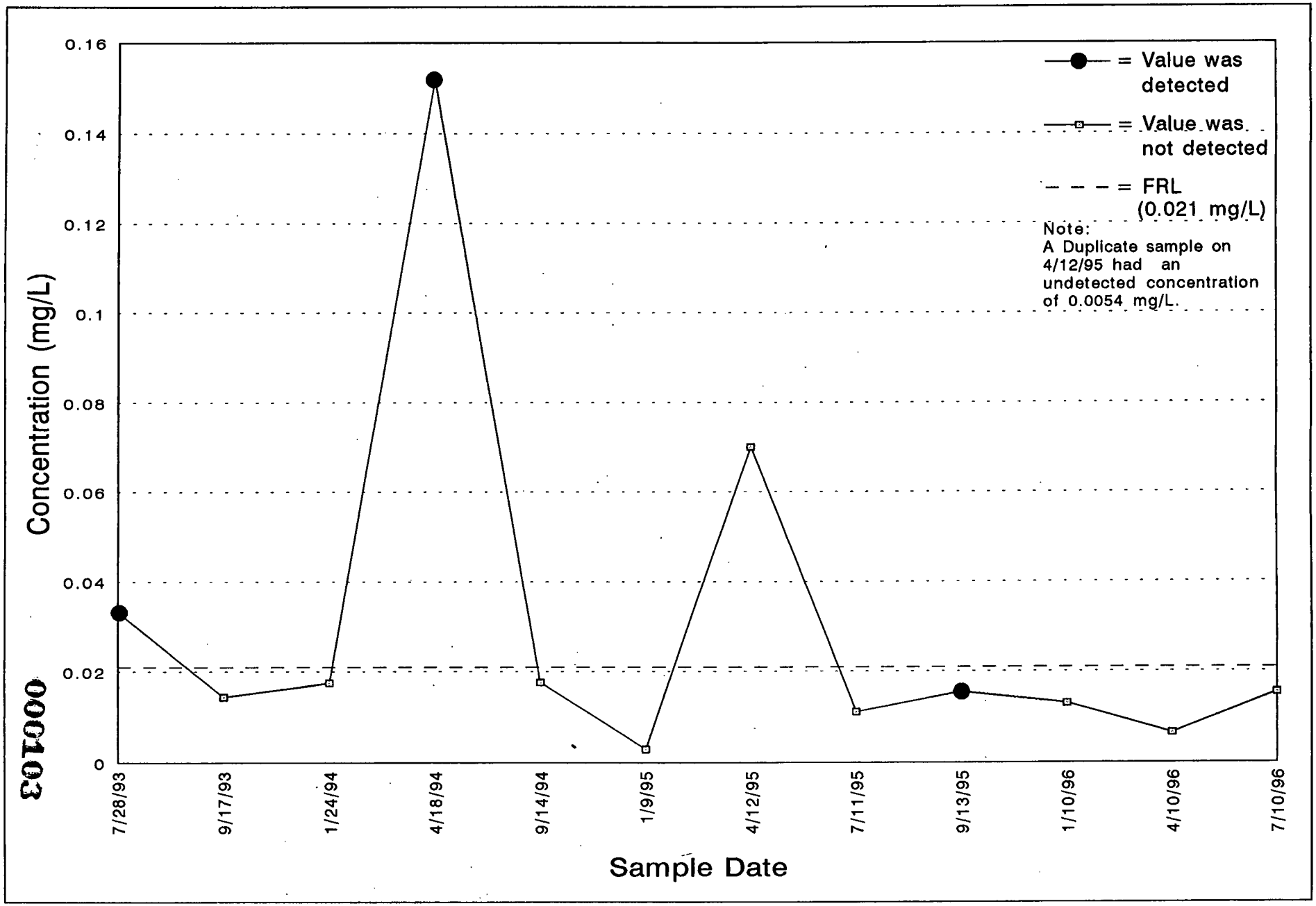

FIGURE A.3-62. ZINC CONCENTRATION VS. TIME, WELL 2733

000103

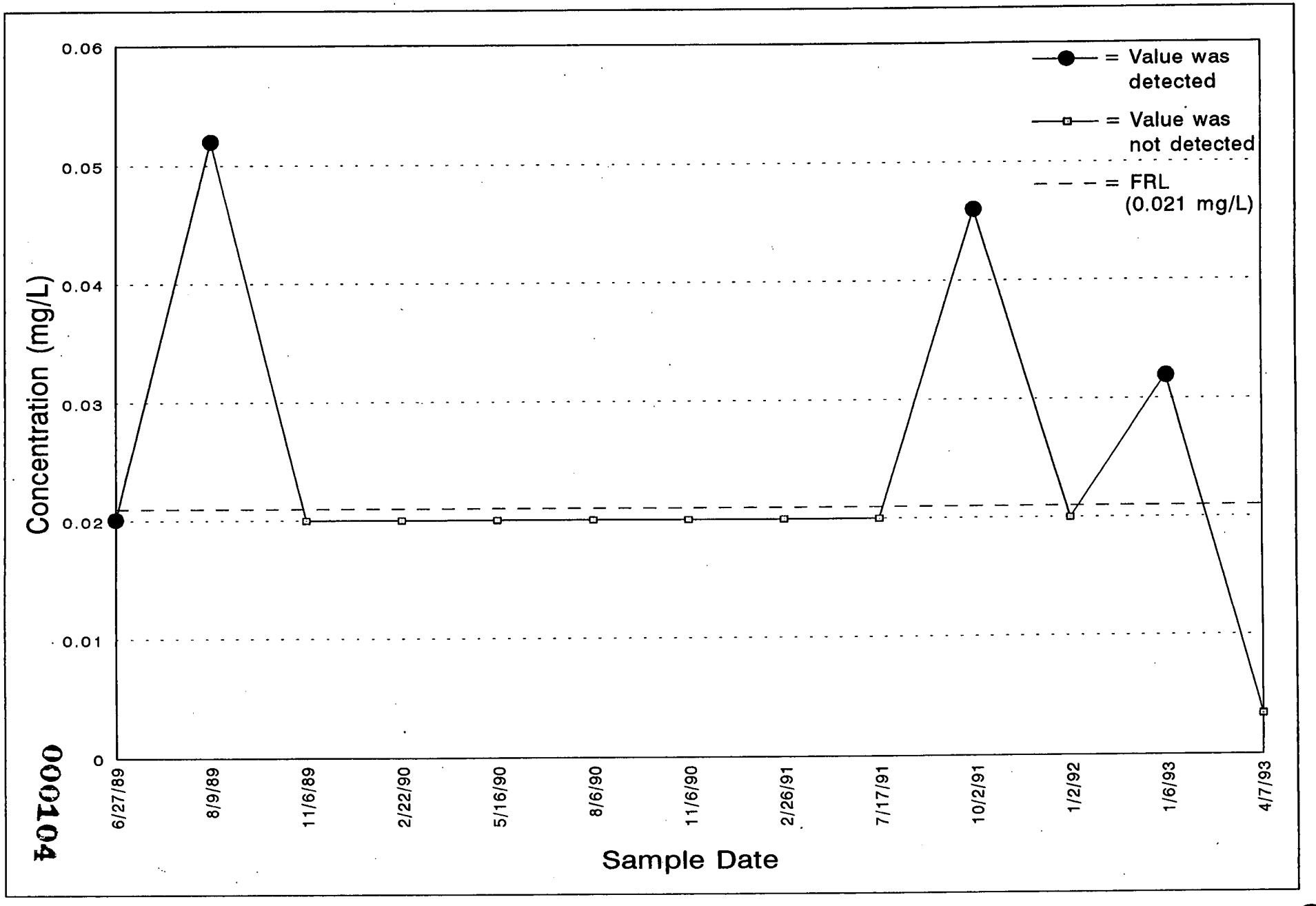

FIGURE A.3-63. ZINC CONCENTRATION VS. TIME, WELL 2066

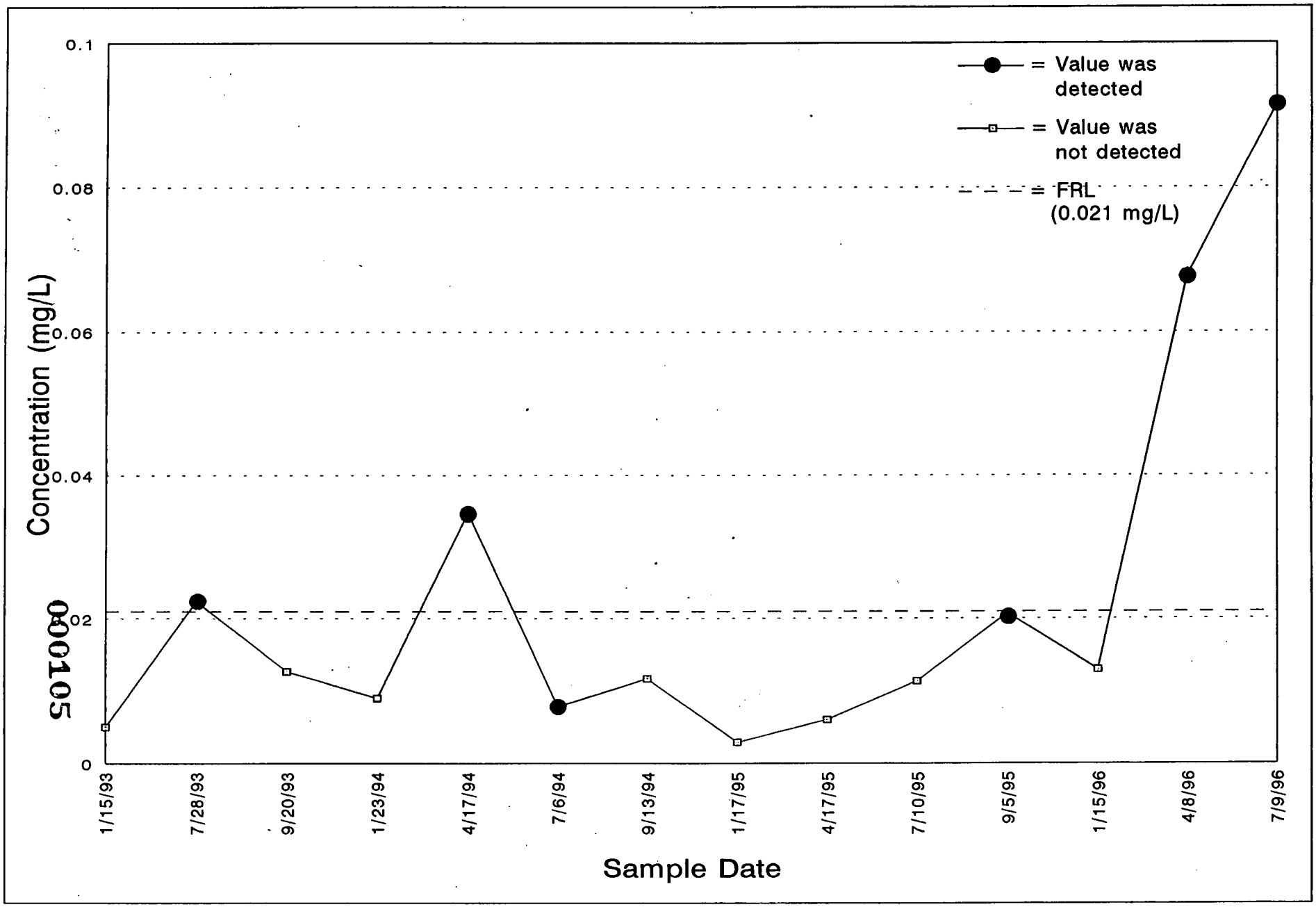

FIGURE A.3-64. ZINC CONCENTRATION VS. TIME, WELL 2424

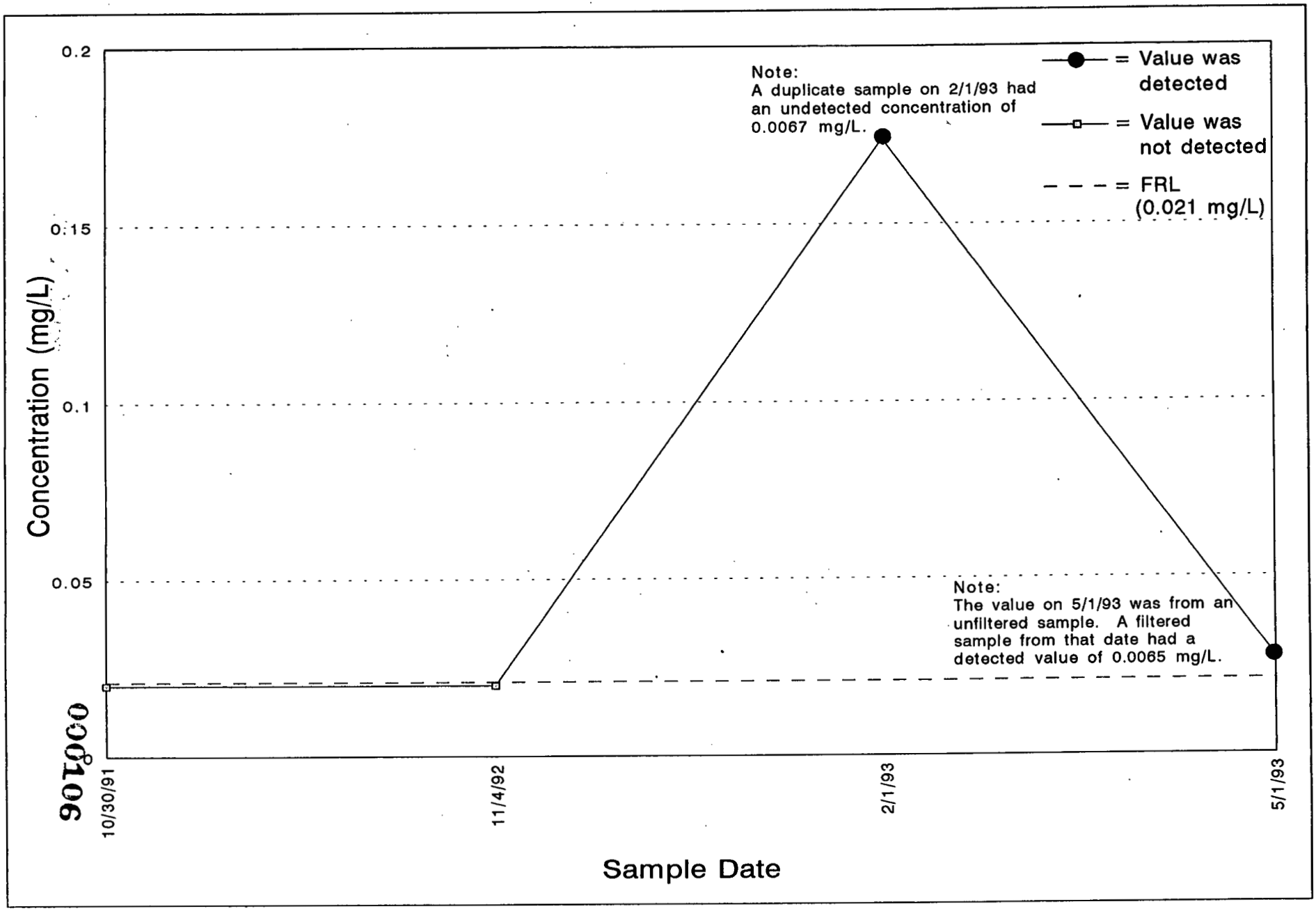

FIGURE A.3-65. ZINC CONCENTRATION VS. TIME, WELL 3091

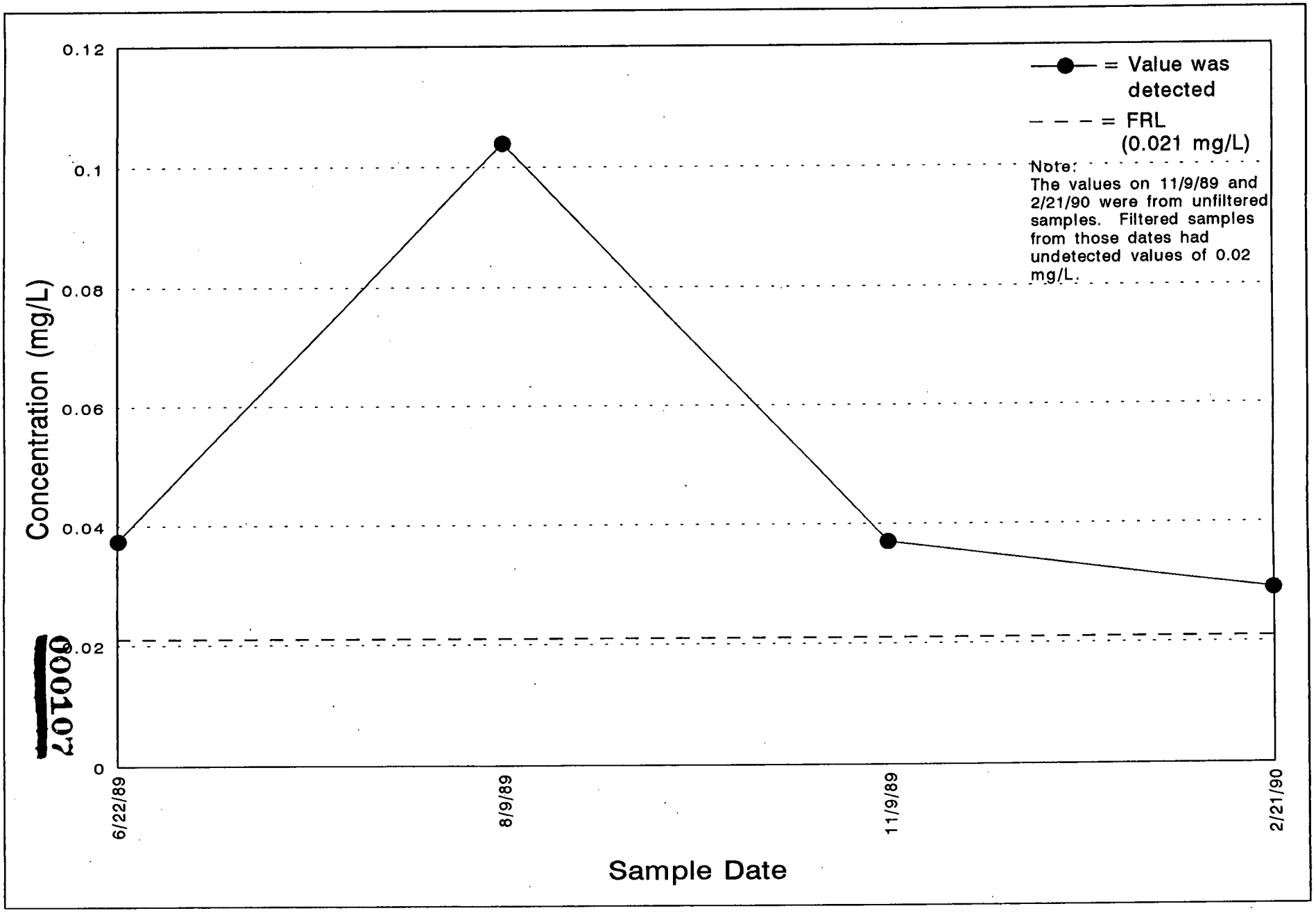

FIGURE A.3-66. ZINC CONCENTRATION VS. TIME, WELL 3051

001007