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FINAL IMPLEMENTATION DOCUMENT
OTHER CONTAMINATION SOURCES
INTERIM RESPONSE ACTION
SOUTH TANK FARM PLUME

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Shell Oil Company

REPORT DOCUMENTATION PAGE

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13. ABSTRACT *(Maximum 200 words)*
THE OBJECTIVE OF THIS IRA IS TO MONITOR THE SOUTH TANK PLUME TO VERIFY THE DATA UPON WHICH CONCLUSIONS ON THE RATE OF CONTAMINANT MIGRATION HAVE BEEN MADE, AND TO VERIFY THE LOCATION OF THE LEADING EDGE OF THE DISSOLVED PLUME OVER TIME.

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FINAL IMPLEMENTATION DOCUMENT
OTHER CONTAMINATION SOURCES
INTERIM RESPONSE ACTION
SOUTH TANK FARM PLUME

Prepared by
MK-Environmental Services
Denver, Colorado

Prepared for
Shell Oil Company/Holme Roberts & Owen
Denver, Colorado

August 1991

Rocky Mountain Arsenal
Information Center
Commerce City, Colorado

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1.0 INTRODUCTION

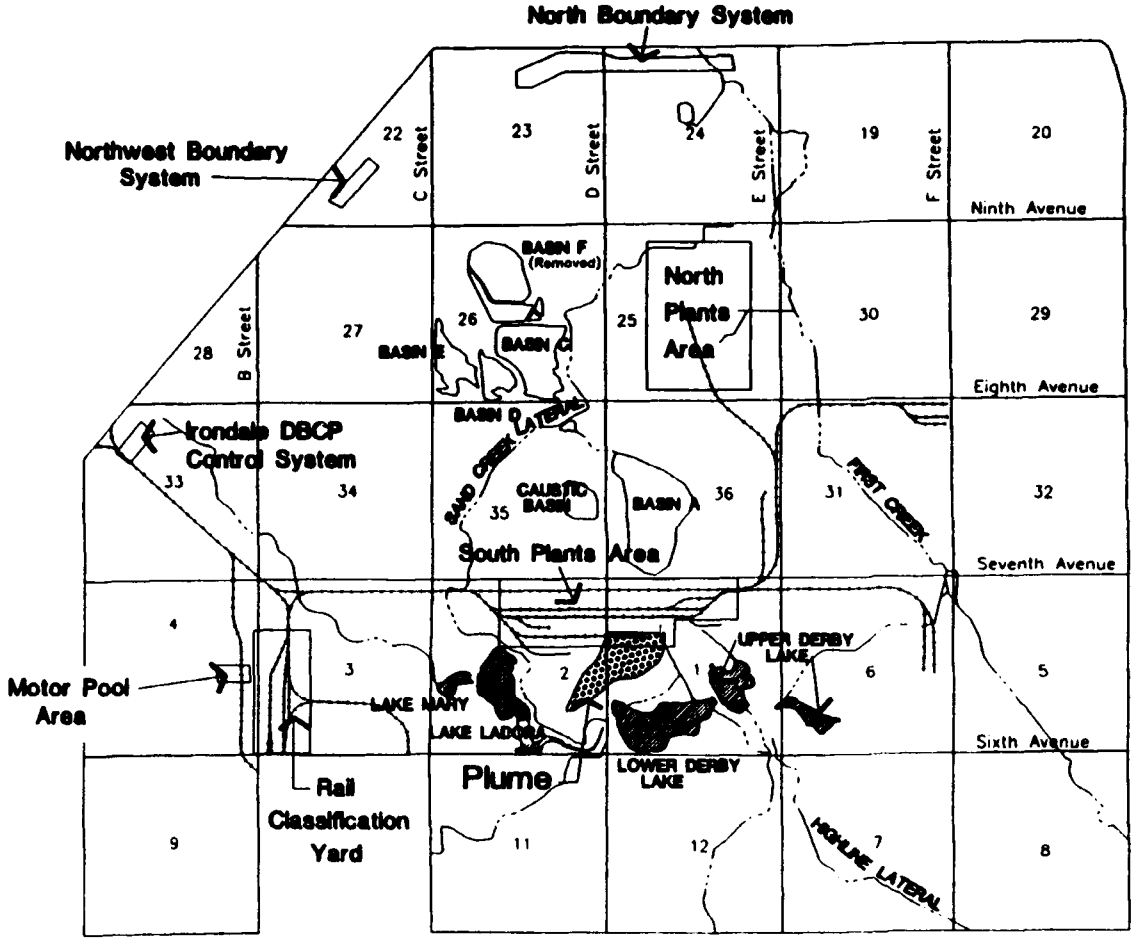
The Interim Response Action (IRA) for the South Tank Farm Plume (STFP) is being conducted as part of the Remediation of Other Contamination Sources IRA for the Rocky Mountain Arsenal (RMA) as defined in the Federal Facility Agreement (FFA). This IRA is being undertaken by Shell Oil Company (Shell) in accordance with the procedures set forth in the FFA.

In 1989 Shell proposed, and the Army and EPA agreed, that the STFP be added to the list of Other Contamination Sources IRAs. At that time, based on available data, the objective of this IRA was to prevent the migration of the plume from reaching Lake Ladora prior to the implementation of the final remedy. However, recent investigations have shown that the STFP is not expected to reach Lake Ladora. In accordance with the recent observations, the Final Decision Document for this IRA, issued May 8, 1991, selected groundwater monitoring as the appropriate course of action.

The STFP is located in the southern half of Sections 1 and 2 on the RMA (Figure 1). The STFP is a composite plume of benzene, toluene, xylenes (collectively referred to as BTX), bicycloheptadiene (BCHPD) and dicyclopentadiene (DCPD) dissolved in the uppermost water-bearing zone (WBZ1) groundwater. The STFP primarily originates from a light nonaqueous phase liquid (LNAPL) plume located adjacent to Tank 464A (Figure 2).

The objective of this IRA is to monitor the STFP to: 1) verify the data upon which conclusions on the rate of contaminant migration have been made; and 2) verify the location of the leading edge of the dissolved plume over time.

A cost estimate and schedule have been prepared for this IRA and are included. The estimated cost for completing this IRA is



Legend

- Railroad
- Stream/Drainage
- Plume
- Lakes

north

0 250 500 1000

SCALER

ROCKY MOUNTAIN ARSENAL
South Tank Farm Area

Figure 1

South Tank Farm Plume Location Map

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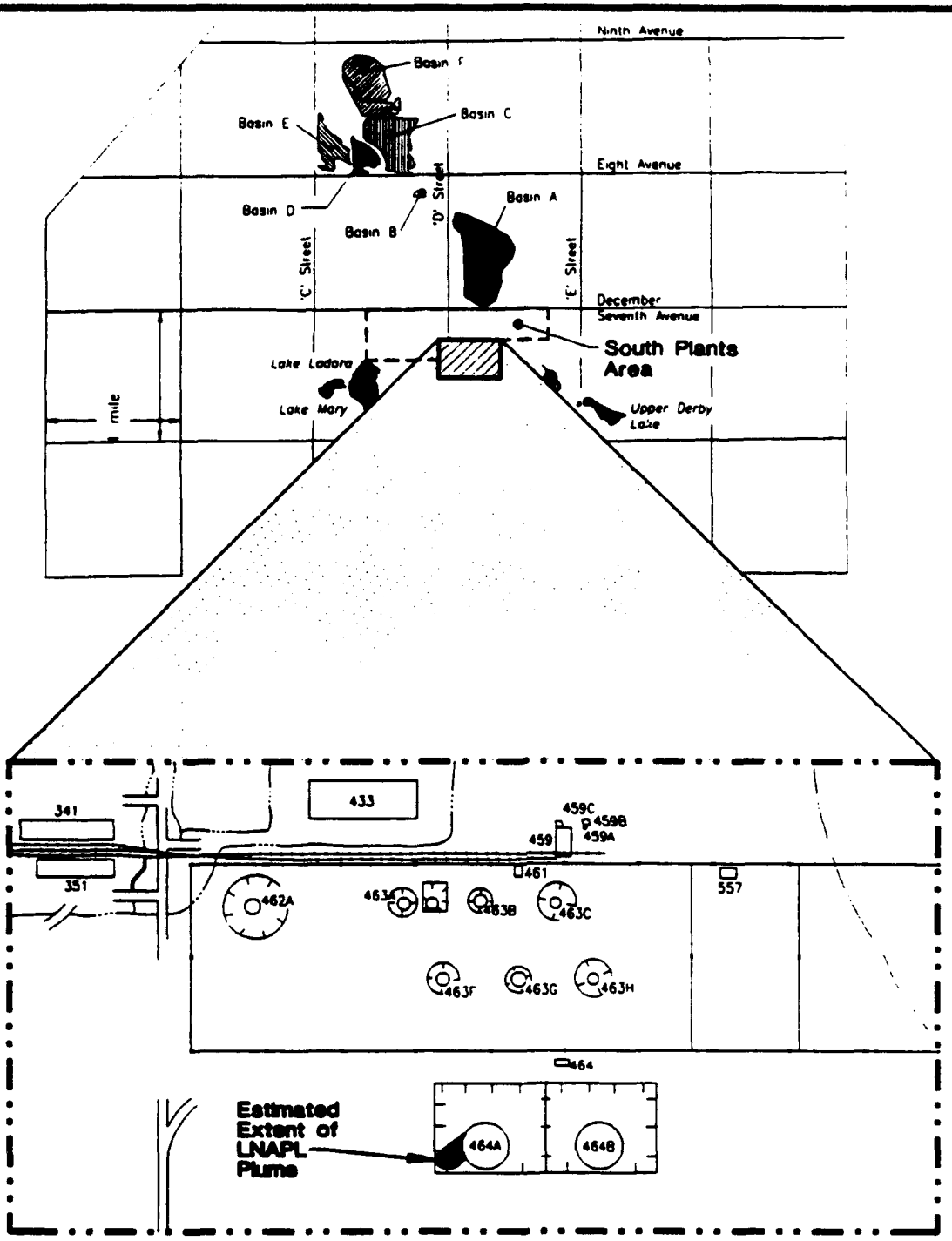

north

400 0 200 400 800

scale in feet

Figure 2

LNAPL Plume Location Map

Prepared by:

MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES GROUP

<CFN:2127G010.DWG> <CPD:12/10/90>

$325,000.00. The deadline for completion of this project (an "IRA Deadline" under the FFA) is May 13, 1994, subject to extension as described in Section XXVI of the FFA. Intermediate dates shown in this document comprise the "Schedule" (as defined in the FFA) and are not "Deadlines" under the FFA.

MEMORANDUM OF UNDERSTANDING BETWEEN THE DEPARTMENT OF THE ARMY AND SHELL OIL COMPANY WITH RESPECT TO RESPONSE ACTION WORK CONDUCTED PURSUANT TO THE FEDERAL FACILITY AGREEMENT

I. PARTIES

This Memorandum of Understanding ("MOU") specifies the cooperative undertakings which are to occur between the Army (a potentially responsible party under CERCLA) and Shell (a potentially responsible party under CERCLA) with respect to any Scope of Work developed pursuant to the Federal Facility Agreement now or hereafter attached as an exhibit to this MOU.

II. PURPOSE

The purpose of this MOU is to provide an appropriate basis pursuant to the Federal Facility Agreement for Shell to participate in the expeditious (a) assessment, selection, design and implementation of an IRA or (b) operation and maintenance of any Response Action Structure.

III. DEFINITIONS

The following terms, used in the MOU, shall have the meanings indicated:

(a) "Army" means the United States Department of the Army, and any successors or assigns thereof, and any agency, office or other subdivision thereof; and includes the officers, members, employees and agents of the Army when acting within the scope of their authority.

(b) "Arsenal" means the United States property known as the Rocky Mountain Arsenal and described more particularly on Exhibit A hereto.

(c) "CERCLA" means the Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986.

(d) "Contractor" means any commercial party not a part of Shell with which Shell contracts for the performance of Response Action work pursuant to this MOU. Unless otherwise indicated, the term also includes a subcontractor retained by a prime Contractor or another subcontractor.

(e) "Federal Facility Agreement" means the Federal Facility Agreement for Rocky Mountain Arsenal, effective February 17, 1989, including all exhibits thereto (and any amendments or modifications thereof or supplements thereto).

(f) "Financial Manual" means the document identified in paragraph 7.4 of the Settlement Agreement.

(g) "Force Majeure" means any event arising from causes beyond the control of an Organization that causes a delay in or prevents the performance of any obligation under this MOU. "Force Majeure" includes, but is not limited to: acts of God; fire; war; insurrection; civil disturbance; explosion; unanticipated breakage or accident to machinery, equipment or lines of pipe, despite diligent maintenance; adverse weather conditions which could not be reasonably anticipated; unusual delay in transportation; earthquake; restraint by court order or order of public authority; inability to obtain, at reasonable cost and after exercise of reasonable diligence, any necessary authorizations, approvals, permits or licenses as a result of the action or inaction of any governmental agency or authority other than the Army; delays caused by compliance with applicable statutes or regulations governing contracting, procurement or acquisition procedures, despite the exercise of reasonable diligence; and insufficient availability of appropriated funds, if the Army shall have made timely request for such funds as part of the budgetary process. "Force Majeure" also includes any strike or labor dispute, whether or not within the control of the Organization affected thereby, but shall not include increased costs or expenses of Response Actions, whether or not anticipated at the time such Response Actions were initiated.

(h) "IRA" means an Interim Response Action identified in Section XXII of the Federal Facility Agreement.

(i) "Lead Party" means the Organization that is designated with responsibility, in accordance with Section XLIII of the Federal Facility Agreement, for conducting a Response Action, or any part thereof.

(j) "MOU" or "Memorandum of Understanding" means to this entire document and any amendments or modifications hereof and supplements hereto, and all documents incorporated herein by reference.

(k) "NCP" means the National Oil and Hazardous Substances Pollution Contingency Plan, 50 Fed. Reg. 47912 (1985) (effective February 18, 1986), and all amendments thereto which are not inconsistent with CERCLA and which are effective and applicable to any activity undertaken pursuant to this MOU.

(l) "Organization" means the Army, EPA or Shell.

(m) "Party" means the Army or Shell; "Parties" means the Army and Shell.

(n) "Response Action" has the same meaning as "Respond" or "Response" as defined in Section 101(25) of CERCLA, 42 U.S.C. § 9601(25).

(o) "Scope of Work" means a document identified in Part VI by which any Response Action work for which Shell is the Lead Party shall be conducted.

(p) "Settlement Agreement" means the "Settlement Agreement Between the United States and Shell Oil Company Concerning Rocky Mountain Arsenal," effective February 17, 1989, including all exhibits thereto (and any amendments or modifications thereof or supplements thereto).

(q) "Shell" means (a) Shell Oil Company and its successors and assigns, (b) the divisions thereof, including Shell Chemical Company, (c) Julius Hyman & Co., and (d) Shell Chemical Corporation; and includes the officers, employees and agents of Shell when acting within the scope of their authority.

All other capitalized terms used in this MOU shall have the same meaning as in the Federal Facility Agreement or the Settlement Agreement or the meaning specified in an executed Scope of Work.

IV. SCOPE OF MOU

This MOU, the Federal Facility Agreement and the Settlement Agreement constitute the entire understanding between the Army and Shell with respect to Shell's assisting the Army in the Response Action work described in an executed Scope of Work, except for any subsequently executed Scope of Work which the Parties may execute with respect to such Response Action work; constitute the sole conditions controlling Shell's participation in such Response Action work; and with respect to such Response Action work, supersede any other agreement(s) between the Parties. In the event a conflict between the provisions of the Federal Facility Agreement and the Settlement Agreement and this MOU, the provisions of the Federal Facility Agreement and the Settlement Agreement shall govern.

V. OPERATION OF MOU

By their execution of this MOU, each of the Parties acknowledges and agrees as follows:

(a) The provision of the Response Action work pursuant to this MOU is a reasonable and appropriate contribution to the assessment, selection, design and implementation of Response Actions that are protective of the present and future public health and the environment.

(b) The Army's actions under this MOU are not inconsistent with the NCP.

(c) Shell's actions under this MOU, to the extent certified by the Army pursuant to Subpart VI.E., are consistent with the NCP.

(d) This MOU does not operate to establish or to excuse any Shell or Army liability under any law, the Federal Facility Agreement or the Settlement Agreement, except to the extent provided in this MOU.

(e) This MOU does not operate to render Shell or any of its Contractors a CERCLA response action contractor.

(f) This MOU does not operate to expand or limit any of the rights and obligations of the Army as Lead Agency or Shell as Lead Party under any law or the Federal Facility Agreement.

(g) Unless otherwise provided in a Scope of Work, upon acceptance of the Response Action work pursuant to Subpart VI.E, title to any Response Action Structure including all related systems and facilities constructed as a part of that Response Action work shall pass to the United States.

(h) The Army shall be solely responsible for obtaining necessary permits, if any, and for establishing substantive compliance with all permitting requirements pursuant to Section 121(e) of CERCLA, 42 U.S.C. 9621(c), for any activities conducted pursuant to this MOU. However, Shell shall provide any necessary technical support necessary for the Army to obtain such permits.

(i) This MOU has no precedential or controlling effect with respect to any matter which is not expressly the subject of this MOU.

(j) This MOU does not create or impose any obligations or responsibilities on the Parties or relieve them of any obligations or responsibilities, except to the extent expressly provided herein.

VI. SHELL'S PERFORMANCE OF RESPONSE ACTION WORK

A. Development of Scope of Work: Pursuant to Section XLIII of the Federal Facility Agreement, the Army and Shell shall develop Scopes of Work by which Response Action Work for which Shell is the Lead Party shall be conducted. A Scope of Work shall include any required data or specifications for the Response Action work to be performed, a projected schedule for completion and a statement as to the appropriate limits of insurance to be maintained by Shell pursuant to Part VII.

B. Incorporation into this MOU: Any Scope of Work developed pursuant to Subpart VI.A and executed by the Army and Shell, and all the terms and conditions therein are incorporated by reference into this MOU.

C. Performance of Work: Upon execution of the Scope of Work by the Army and Shell, Shell shall immediately commence, in consultation and cooperation with the Army, as provided in the Consent Decree, to perform the Response Action work described in the Scope of Work.

D. Hiring of Contractor: Subject to the approval of the Army, Shell may hire at its sole expense, subject to Part VII, a Contractor to perform any Response Action work described in a Scope of Work. A Contractor may be terminated by Shell with the approval of the Army, which approval shall not be unreasonably withheld. Any disagreement with respect to such termination not resolved informally shall be resolved in accordance with the provisions of Part XIII.

E. Acceptance of Work: 1. If Shell performs the Response Action work in accordance with the specifications set forth in the applicable Scope of Work, the Army shall accept Shell's work pursuant to this MOU. The Army shall act promptly to accept Shell's work, and acceptance shall not be unreasonably withheld. Should the Army decline acceptance, it shall promptly notify Shell in writing, stating with specificity the factual, technical and legal bases for such nonacceptance.

2. If Shell concludes that the Army is in error for treating Shell's performance as incomplete or unacceptable for any other reason, Shell shall give notice in writing, within ten business days of the receipt of the Army's written notification, that Shell disagrees. Any such disagreement, if not resolved informally, shall be resolved in accordance with the provisions in Part XIII.

VII. SHELL INSURANCE OBLIGATIONS

Shell shall maintain such insurance or self-insurance as is required by statute or regulation to cover any claims which may reasonably be anticipated to be made as a result of Response Action work done pursuant to any Scope of Work attached as an exhibit to this MOU. At a minimum, Shell shall, at its sole option, procure insurance, maintain insurance or self-insure sufficiently to cover the following:

1. Worker's compensation and occupational disease insurance in amounts sufficient to satisfy applicable state law;

2. Employer's liability insurance in the minimum amount of $100,000 per occurrence; and

3. Comprehensive general liability insurance for bodily injury, death or loss of or damage to property of third persons in the minimum amount of $100,000 per occurrence.

Upon this MOU becoming effective, Shell shall promptly provide the Army with an affidavit that Shell is in compliance with the minimum requirements of this Part. Upon the signing of a Scope of Work, Shell shall promptly provide the Army with an affidavit that Shell is in compliance with this Part as to that Scope of Work. Upon request, Shell shall discuss with the Army the manner in which Shell will fulfill its obligations under this Part.

VIII. ARMY SUPPLEMENTATION OF SHELL INSURANCE

If the Response Action work being performed is an Army-Only Response Action, as defined in the Settlement Agreement, the Army shall release, defend, indemnify and hold harmless Shell from all losses, fines, penalties, claims, suits, liabilities, judgments, or expenses (including expenses of litigation or settlement) (collectively hereinafter in this Part VIII, "claim") with respect to any death or injury to any person or loss of or damage to property to the extent that these result from the construction, operation, collapse, rupture or failure of any Response Action Structure, or any part thereof, after the Army's acceptance pursuant to Subpart VI.E. or the operation, collapse, rupture, failure or ineffectiveness of the Response Action Structure as a result of the construction, operation, collapse, rupture or failure of the Response Action work when such claim is not compensated by insurance or self-insurance, to the extent provided below:

(a) Shell is not in material breach of this MOU with respect to the Scope of Work pursuant to which such Response

such claims are represented by final judgments or by settlements approved in writing by the Department of Justice. This agreement to reimburse Shell for certain claims shall not be interpreted as implying that Congress shall, at a later date, appropriate funds sufficient to meet any deficiencies. During all times that claims remain unreimbursed due to lack of appropriated funds, the Army shall exert its best efforts to obtain appropriations for such reimbursement.

IX. TREATMENT OF COSTS INCURRED BY SHELL PURSUANT TO THIS MOU

Any costs incurred by Shell pursuant to this MOU are Reimbursable Costs and shall be governed by the Settlement Agreement and the Financial Manual.

X. DELAY OR PREVENTION OF PERFORMANCE

A. As provided in the Consent Decree, if a Party is rendered unable, wholly or in part, by Force Majeure to carry out its obligations under this MOU, then upon that Party's giving written notice as provided in Subpart XI.C., the obligations of that Party, so far as they are affected by the event of Force Majeure therein specified, shall be suspended during the continuance of such cause, but for no longer period, and such cause shall be remedied so far as possible with all reasonable dispatch.

B. The settlement of a strike or other labor dispute shall be entirely within the discretion of the Party involved with such strike or labor dispute, and the requirement that any event of Force Majeure shall be remedied with all reasonable dispatch shall not require the settlement of a strike or labor dispute by acceding to the demands of the opposing party when such course is inadvisable in the discretion of the Party involved with such strike or labor dispute.

C. When circumstances are occurring or have occurred that delay the completion of any obligation, and a Party believes such circumstances constitute an event of Force Majeure, such Party shall notify the other Organizations in writing within 15 days after the notifying Party obtains information indicating that a delay will occur. Such notice shall include a detailed explanation of the reason(s) for and anticipated duration of the delay, the measures taken and to be taken to prevent or minimize the delay, and a schedule for implementation of such measures. Failure to provide notice in accordance with this paragraph within the required 15-day period shall constitute a waiver of any claim of Force Majeure with respect to any event of Force Majeure for which notice was not timely given.

D. If the Organizations cannot agree whether a delay is or was attributable to an event of Force Majeure, any Organization may invoke Dispute Resolution pursuant to Section X of the Settlement Agreement.

E. Scope of Work Modification: If performance of this MOU is delayed because any Party finds it necessary to make modifications to address an unanticipated occurrence which may cause a delay of more than two weeks, such modifications shall be developed and implemented by Shell in consultation and cooperation with the Army. Any disputes not resolved informally shall be resolved pursuant to the provisions of Part XIV. Further, if Shell anticipates the delay resulting from any such modifications will necessitate the extension of a Deadline, it shall request such an extension in accordance with Section XXVI of the Federal Facility Agreement.

F. Unaffected Activities: To the extent that the unanticipated occurrence does not necessitate delay in any discrete portion(s) of the activities provided in Part VI, such portion(s) of the activities shall proceed as originally provided in the MOU irrespective of the need for modification of other parts of the MOU.

XI. SHELL ACCESS TO ROCKY MOUNTAIN ARSENAL

Shell and its Contractors shall be afforded access to all relevant portions of the RMA in order to perform its obligations under the MOU pursuant to the terms and conditions of the Access and Use Agreement attached as Exhibit E to the Settlement Agreement until such time as the Army and Shell execute an applicable superseding agreement.

XII. DISPUTE RESOLUTION AND JUDICIAL REVIEW

A. Dispute Resolution: Any dispute which arises in connection with this MOU may be submitted for resolution pursuant to Section X of the Settlement Agreement. Prior to any such submission, Shell and the Army shall meet and attempt to resolve the dispute informally.

B. Judicial Review: 1. Judicial review of issues arising in connection with this MOU shall be obtained pursuant to Section XI of the Settlement Agreement.

2. The pendency of any dispute shall not affect the responsibility of the United States or Shell to continue their involvement in the assessment, selection, design and implementation of Response Actions, or discrete portions of Response Actions, not subject to such dispute.

XIII. GENERAL

A. Term: This MOU shall continue in effect as to a specific Scope of Work until the Army, pursuant to Subpart VI.E., accepts Shell's work pursuant to this MOU, and the reimbursement or payment has been made pursuant to Part IX.

B. Modification: Any provision of this MOU or of any Scope of Work may be modified at any time by both Parties' agreement. Any modification must: (1) be in writing; (2) show the date signed by the Parties; (3) specify that it is intended to modify this MOU; (4) state the provisions of the MOU to be modified; (5) state the new provisions; and (6) state when the new provisions are to be effective.

C. Effect of Execution: This MOU shall become effective on the later of its execution by the Parties or the entry of the Consent Decree. A Scope of Work shall become effective, final and binding upon its execution.

IN WITNESS WHEREOF, I have hereunder set my hand as an authorized representative of the United States Department of the Army.

Date: 1/23/89

Lewis D. Walker
Lewis D. Walker
Deputy for Environment, Safety and Occupational Health

IN WITNESS WHEREOF, I have hereunder set my hand as an authorized representative of Shell Oil Company.

Date: _____

_____
R.G. Dillard
Vice President

KIS/BMB

XIII. GENERAL

A. Term: This MOU shall continue in effect as to a specific Scope of Work until the Army, pursuant to Subpart VI.E., accepts Shell's work pursuant to this MOU, and the reimbursement or payment has been made pursuant to Part IX.

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IN WITNESS WHEREOF, I have hereunder set my hand as an authorized representative of the United States Department of the Army.

Date: _____

Lewis D. Walker
Deputy for Environment, Safety
and Occupational Health

IN WITNESS WHEREOF, I have hereunder set my hand as an authorized representative of Shell Oil Company.

Date: 2/15/89

R.G. Dillard
Vice President

KES/3W0

SCOPE OF WORK

Shell will perform the following activities as lead party for the implementation of the South Tank Farm Plume IRA.

1. Prepare the Draft Implementation Document and Implementation Document for the STFP IRA for review and comment by the Organizations and State and implement the IRA.

2. Abandon and replace the Shell wells damaged during the Lower Derby Lake Spillway construction.

3. Install nine piezometers, six well points, and four monitoring wells along the the eastern edge of Lake Ladora. This was completed May 1991.

4. Perform the following monitoring program through the completion of this IRA or as otherwise modified:

   a. Conduct a one-time Verification Sampling of 46 wells in the STFP area. This was completed in December 1990, and results distributed to the Organizations and State (OAS).

   b. Collect Quarterly water-level measurements from a number of wells located throughout and beyond the STFP area, including along the eastern edge of Lake Ladora. The first round of which was collected in June 1991.

   c. Conduct an annual sampling of 24 selected wells in the STFP area.

5. Shell has contracted with Morrison-Knudsen (MK) for performance of the above tasks and any modifications thereto.

6. Shell will submit forty (40) copies of the Draft Implementation Document for the STFP IRA to the Army. Within 5 working days, the Army will issue these copies to the OAS. Comments regarding the document should be submitted within 30 days of issuance. Shell will submit forty (40) copies of the final Implementation Document for the STFP IRA within 20 working days of the deadline for comments. The Army will distribute the final Implementation Document to the OAS within 5 working days of receipt from Shell.

7. During the performance of this IRA, Shell shall submit to the Army, for distribution to the OAS, the following reports:

   a. Quarterly water-level monitoring reports summarizing the results of the most recent monitoring event. These reports shall be submitted to the Army within thirty (30) days of completion of the monitoring program. The Army will distribute these documents within 5 working days of receipt from Shell.

   b. An Annual Report summarizing the previous year's monitoring data. These reports shall be submitted to the Army within ninety (90) days of receipt of the analytical data for the Annual Sampling Program. The Army will distribute these documents within 5 working days of receipt from Shell.

IN WITNESS WHEREOF, I have hereunder set my hand as an authorized representative of the United States Department of the Army.

Date June 17, 1991

Program Manager

IN WITNESS WHEREOF, I have hereunder set my hand as an authorized representative of the Shell Oil Company.

Date Jun 17 1991

for Manager, Denver Site Project

3.0 GROUNDWATER MONITORING PROGRAM

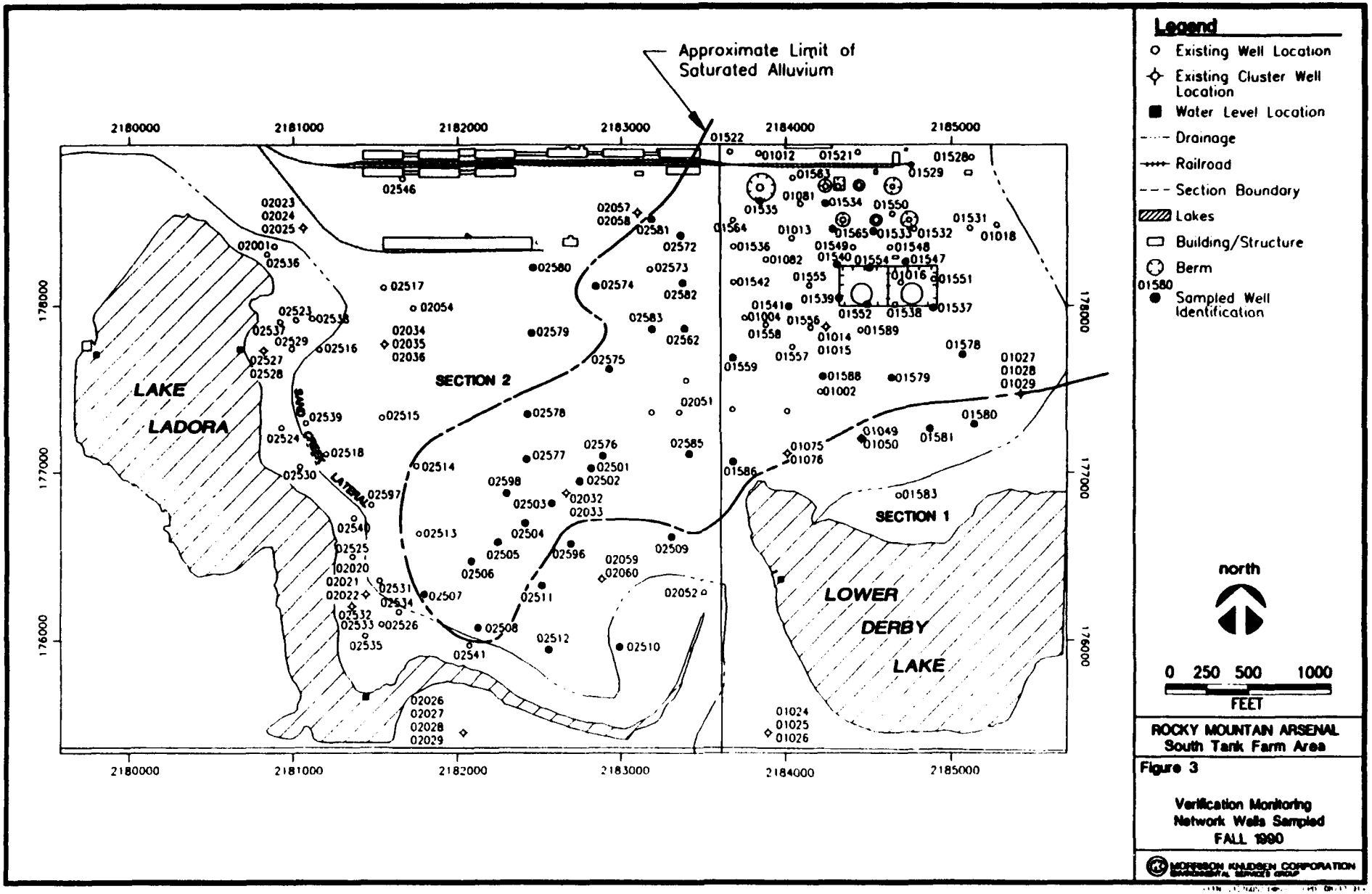
The groundwater monitoring program selected to meet the objectives of this IRA consists of three components:

- A one-time comprehensive verification sampling;
- An annual sampling of selected wells along the leading edge of the plume; and
- Quarterly water-level measurements throughout and beyond the STFP area, including along the eastern edge of Lake Ladora.

3.1 VERIFICATION SAMPLING PROGRAM

The verification sampling program was completed in December 1990, in support of this IRA's pre-decision documents. The verification sampling network consisted of 46 wells located throughout the STFP area (Figure 3). Water-levels and dissolved oxygen (DO) measurements were recorded for each well, and groundwater samples were collected for laboratory chemical analysis. Analyte concentrations were determined using USATHAMA Method UU-8 for volatile compounds. Information from this investigation was used to verify the extent of the STFP, the migration rate for the plume, and the existence of in situ conditions conducive for biodegradation.

Results of the verification sampling program show the results to be consistent with the Spring 1990 conditions. The latest distribution of the target analytes, particularly benzene, indicate that the plume has not advanced since the Spring of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LAKE LADORA
SAND CREEK LATERAL
SECTION 2
SECTION 1
LOWER DERBY LAKE
Legend
Existing Well Location
Existing Cluster Well Location
Water Level Location
Drainage
Railroad
Section Boundary
Lakes
Building/Structure
Berm
Sampled Well Identification
north
0 250 500 1000
FEET
ROCKY MOUNTAIN ARSENAL
South Tank Farm Area
Figure 3
Verification Monitoring Network Wells Sampled FALL 1990
MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES GROUP

1990. This observation, coupled with the field DO measurements and the observed presence of sufficient indigenous bacteria, suggests the leading edge of the plume is biodegraded naturally. The results of this program are detailed in Shell's December 1990 report.

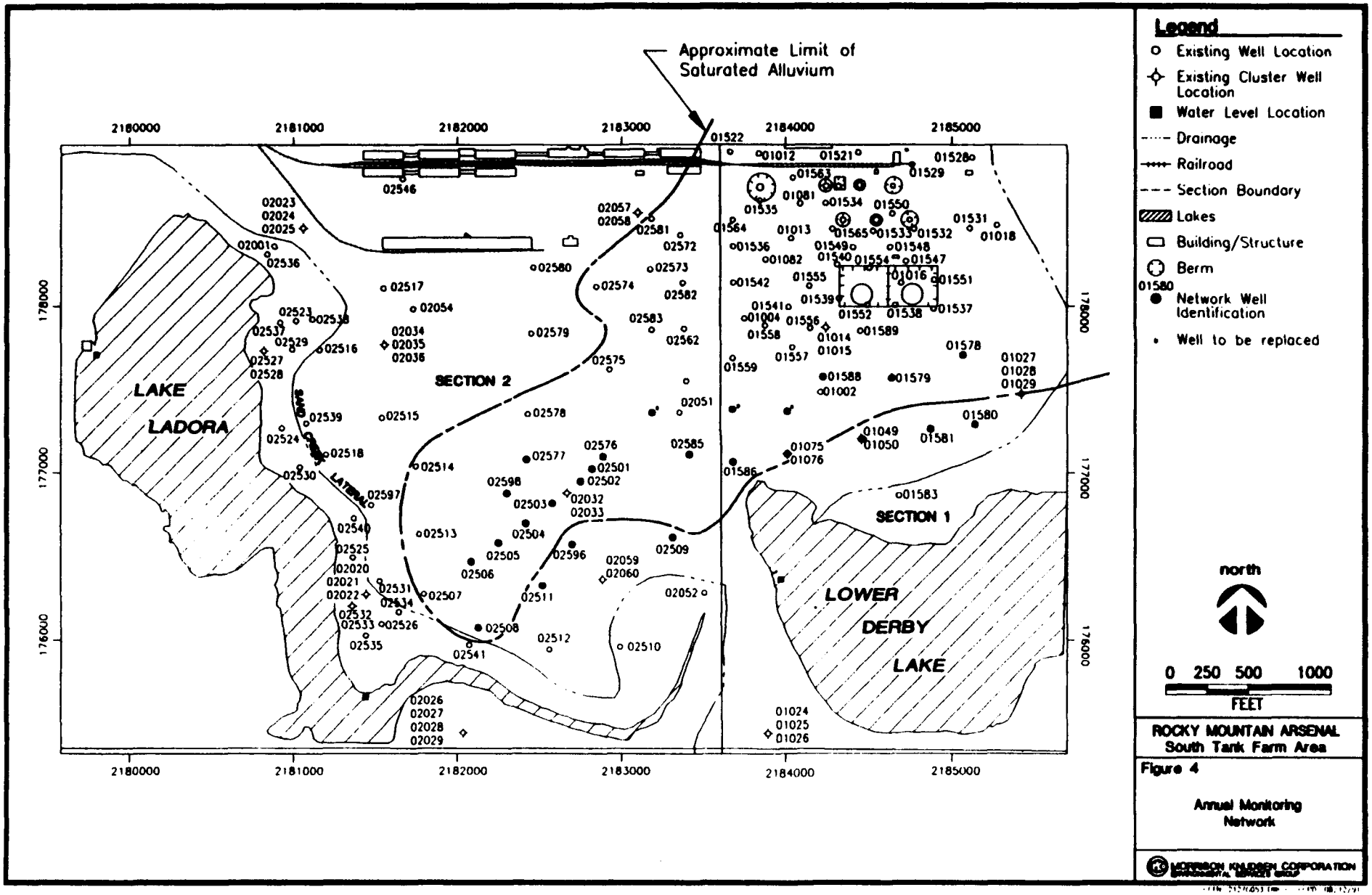
3.2 ANNUAL SAMPLING PROGRAM

Groundwater quality will be monitored annually to verify the location of the leading edge of the plume. Groundwater samples will be collected from the 24 wells shown on Figure 4. This program will be the same as that for the verification sampling in that water-level and DO measurements will be recorded, and groundwater samples collected for laboratory analysis.

3.2.1 Sampling Procedures

Groundwater sampling will be conducted according to approved PMRMA protocols as specified in the RMA Chemical Quality Assurance Plan.

The well sampling order will be governed by well location and historical contaminant levels. Wells will be sampled sequentially, beginning with wells with no historical contaminant detections, and ending with wells having the highest concentrations. This sampling sequence and standard decontamination procedures will be followed to minimize cross-contamination between samples. In addition, dedicated equipment will be used for sampling wells with historically higher concentrations. To minimize the loss of volatile compounds, either a stainless steel pump with a teflon bladder or a stainless steel submersible pump will be used to purge the wells and collect samples. As the wells are purged, groundwater pH,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2184000
2185000
178000
177000
176000
LAKE LADORA
SAND CREEK LATERAL
SECTION 2
SECTION 1
LOWER DERBY LAKE
Legend
Existing Well Location
Existing Cluster Well Location
Water Level Location
Drainage
Railroad
Section Boundary
Lakes
Building/Structure
Berm
01580 Network Well Identification
Well to be replaced
north
0 250 500 1000
FEET
ROCKY MOUNTAIN ARSENAL
South Tank Farm Area
Figure 4
Annual Monitoring Network
MORRISON KNUDSEN CORPORATION

temperature, electrical conductivity, and dissolved oxygen (DO) levels will be recorded.

Groundwater samples will be collected in three 40-ml vials. These samples will be stored and shipped in coolers packed with styrofoam and blue ice. Sample temperatures will be maintained at approximately 4°C within the coolers, until delivered to the off-post contract laboratory.

3.2.2 Analytical Program

Analyte concentrations will be measured using USATHAMA Method UU-8 for volatile compounds. The reporting limits for USATHAMA Method UU-8 are given in Table 1.

3.2.3 Quality Assurance/Quality Control

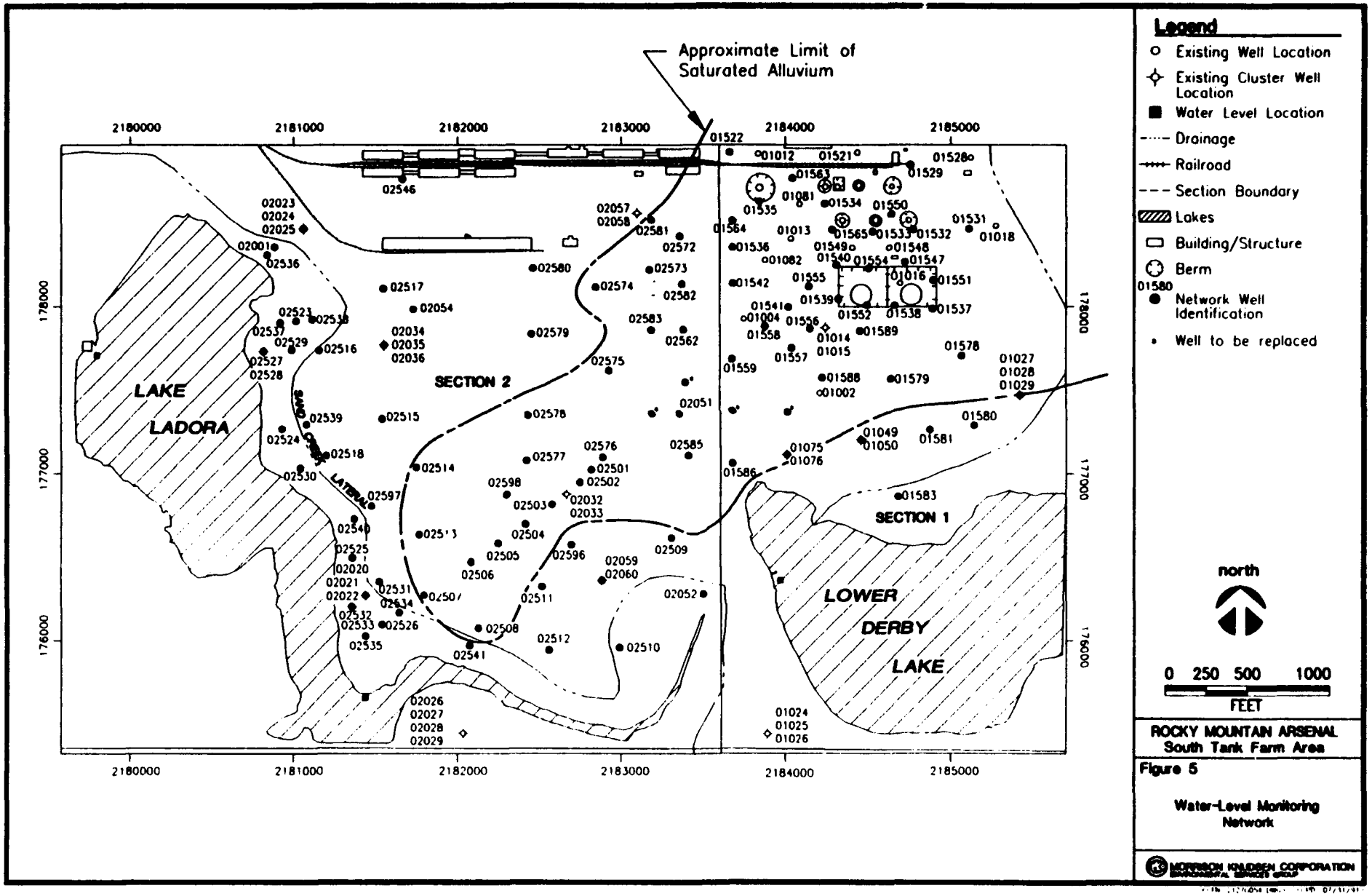
The QA/QC program for this IRA will consist of PMRMA approved requirements and procedures, as specified in the Sampling Design Plan and Standard Operating Procedures prepared for the Remediation of Other Contaminated Sources IRA (Woodward-Clyde, 1989). The number of field QA/QC samples will be approximately 10% of the total number of routine groundwater samples collected. These samples will include duplicate samples, matrix spike samples, field blanks, and rinse blanks. A trip blank will accompany each set of samples shipped to the laboratory.

Table 1. Reporting Limits for Method UU-8

Name	Certified Reporting Limit (ug/L)
1,1,1-TRICHLOROETHANE	2.4
1,1,2-TRICHLOROETHANE	1.6
1,1-DICHLOROETHANE	1.4
1,2-DICHLOROETHANE-D4	2.6
1,2-DICHLOROETHYLENES (CIS AND TRANS ISOMERS)	3.2
1,2-DICHLOROETHANE	0.72
1,3-DIMETHYLBENZENE/M-XYLENE	2.9
BICYCLO[2,2,1]HEPTA-2,5-DIENE	1.8
BENZENE	2.7
CARBON TETRACHLORIDE	4.9
METHYLENE CHLORIDE-D2	5.2
CHLOROFORM	1.7
CHLOROBENZENE	1.8
DIBROMOCHLOROPROPANE	5.6
DICYCLOPENTADIENE	3.7
DIMETHYL DISULFIDE	3.7
ETHYLBENZENE-D10	2.3
ETHYLBENZENE	2.4
TOLUENE	3.5
METHYLISOBUTYL KETONE	1.2
TETRACHLOROETHYLENE/TETRACHLOROETHENE	2.9
TRICHLOROETHYLENE/TRICHLOROETHENE	2.0
XYLENES	2.4

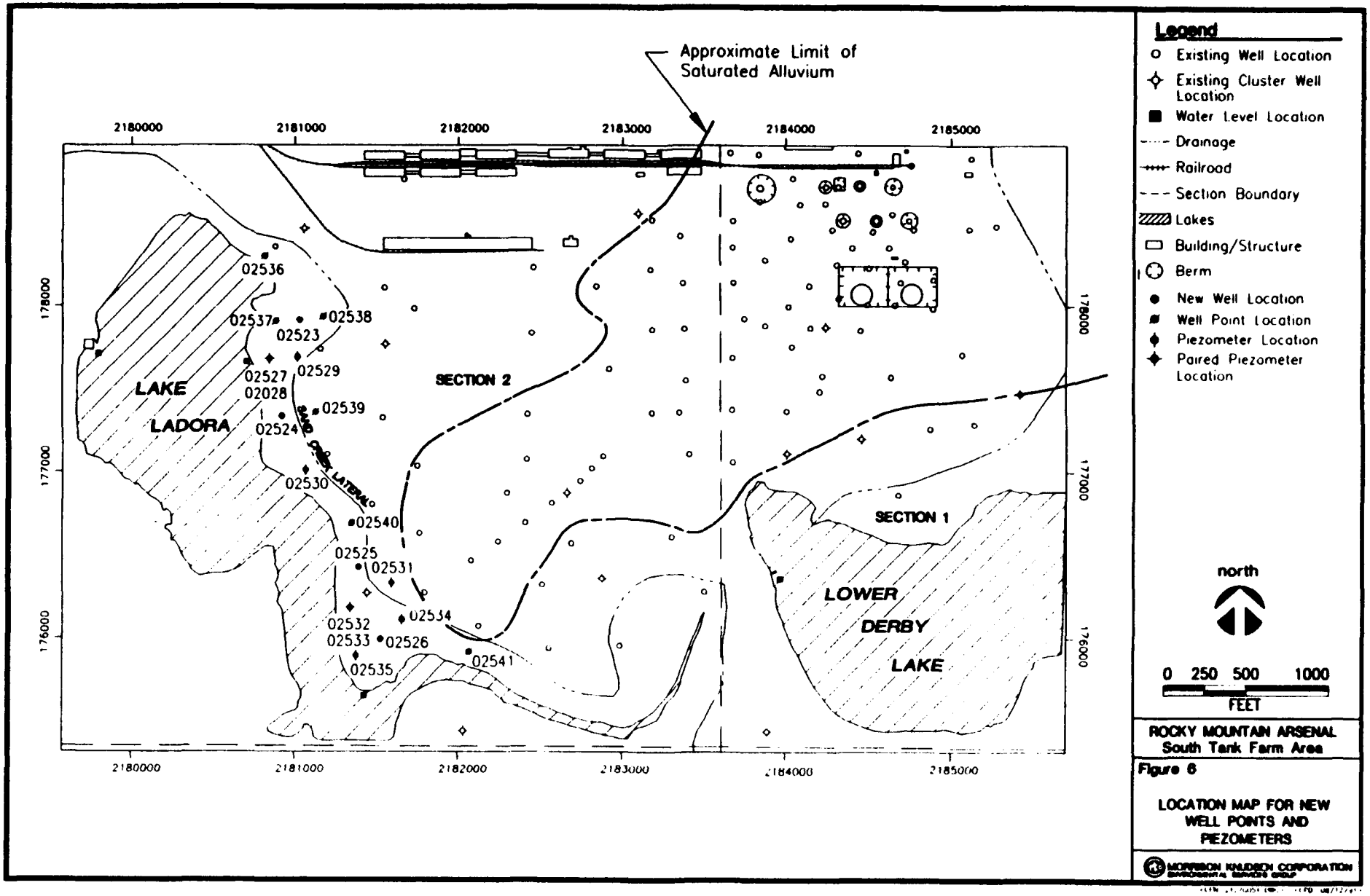
3.3 WATER-LEVEL MONITORING

Water-levels within and beyond the STFP area, including along the eastern edge of Lake Ladora, will be measured quarterly. These measurements will be utilized to monitor the hydraulic gradients and groundwater flowpaths. Groundwater level measurements will be collected from the wells shown on Figure 5. One of the quarterly water-level monitoring events will be coupled with the Annual Sampling Program. Groundwater level measurements will be taken according to PMRMA procedures outlined in the RMA Chemical Quality Assurance Plan.


Approximate Limit of Saturated Alluvium
2180000
2181000
2182000
2183000
2184000
2185000
178000
177000
176000
LAKE LADORA
SECTION 2
SECTION 1
LOWER DERBY LAKE
SAND CREEK LATERAL
Legend
Existing Well Location
Existing Cluster Well Location
Water Level Location
Drainage
Railroad
Section Boundary
Lakes
Building/Structure
Berm
01580
Network Well Identification
Well to be replaced
north
0 250 500 1000
FEET
ROCKY MOUNTAIN ARSENAL
South Tank Farm Area
Figure 5
Water-Level Monitoring Network
MORRISON KNUDSEN CORPORATION

In an effort to better understand the hydrogeology between Lake Ladora and the aquifer to the east of the lake, nine piezometers, six well points and four monitoring wells were installed near Lake Ladora. Figure 6 shows the location of the respective wells. These 19 locations were selected (as coordinated with the EPA) to fill in water-level data gaps between the lake and Sand Creek Lateral, and the information collected from these wells will be used to evaluate the interaction between Lake Ladora and the local groundwater.

As part of this program, the Army has agreed to closely monitor the level of Lake Ladora. If practicable, the Army will maintain the lake at an elevation which would cause the lake to recharge the local aquifer. In order to determine whether this may be accomplished, the first round of water-level measurements was collected. The results and analysis of this investigation are contained in Appendix A.


Approximate Limit of Saturated Alluvium
2180000
2181000
2182000
2183000
2184000
2185000
178000
177000
176000
02536
02537
02538
02523
02527
02529
02028
02539
02524
02530
02540
02525
02531
02532
02534
02533
02526
02535
02541
LAKE LADORA
SECTION 2
SECTION 1
LOWER DERBY LAKE
north
0 250 500 1000
FEET
Legend
Existing Well Location
Existing Cluster Well Location
Water Level Location
Drainage
Railroad
Section Boundary
Lakes
Building/Structure
Berm
New Well Location
Well Point Location
Piezometer Location
Paired Piezometer Location
ROCKY MOUNTAIN ARSENAL
South Tank Farm Area
Figure 6
LOCATION MAP FOR NEW WELL POINTS AND PIEZOMETERS
MORRISON KNUDSEN CORPORATION

4.0 REEVALUATION AND REPORTING PROCESS

4.1 REEVALUATION PROCEDURE

During the August 2, 1989 RMA subcommittee meeting for the Army Complex Disposal Trenches IRA, the OAS agreed that the Decision Flow Chart for Other Contamination Sources IRAs would be followed (Figure 7).

As information is collected and compared to previous data, a reevaluation will be performed to determine whether the basis for the present selection has changed.

Specific criteria which will be applied for determining whether Lake Ladora may be threatened by the STFP prior to implementation of the final remedy, and the subsequent necessity to consider other alternatives include, but are not limited to, the following:

- The observed rate of movement of the leading edge of the plume increases such that the plume is expected to reach the lake prior to the final remedy;
- The hydrogeologic conditions change such that the flowpaths or an increased hydraulic gradient indicate the plume may reach the lake prior to the final remedy;
- Changes in the DO levels which indicate a significant reduction in the potential or occurance of biodegradation; or
- Any combination of the above which creates a threatening situation.

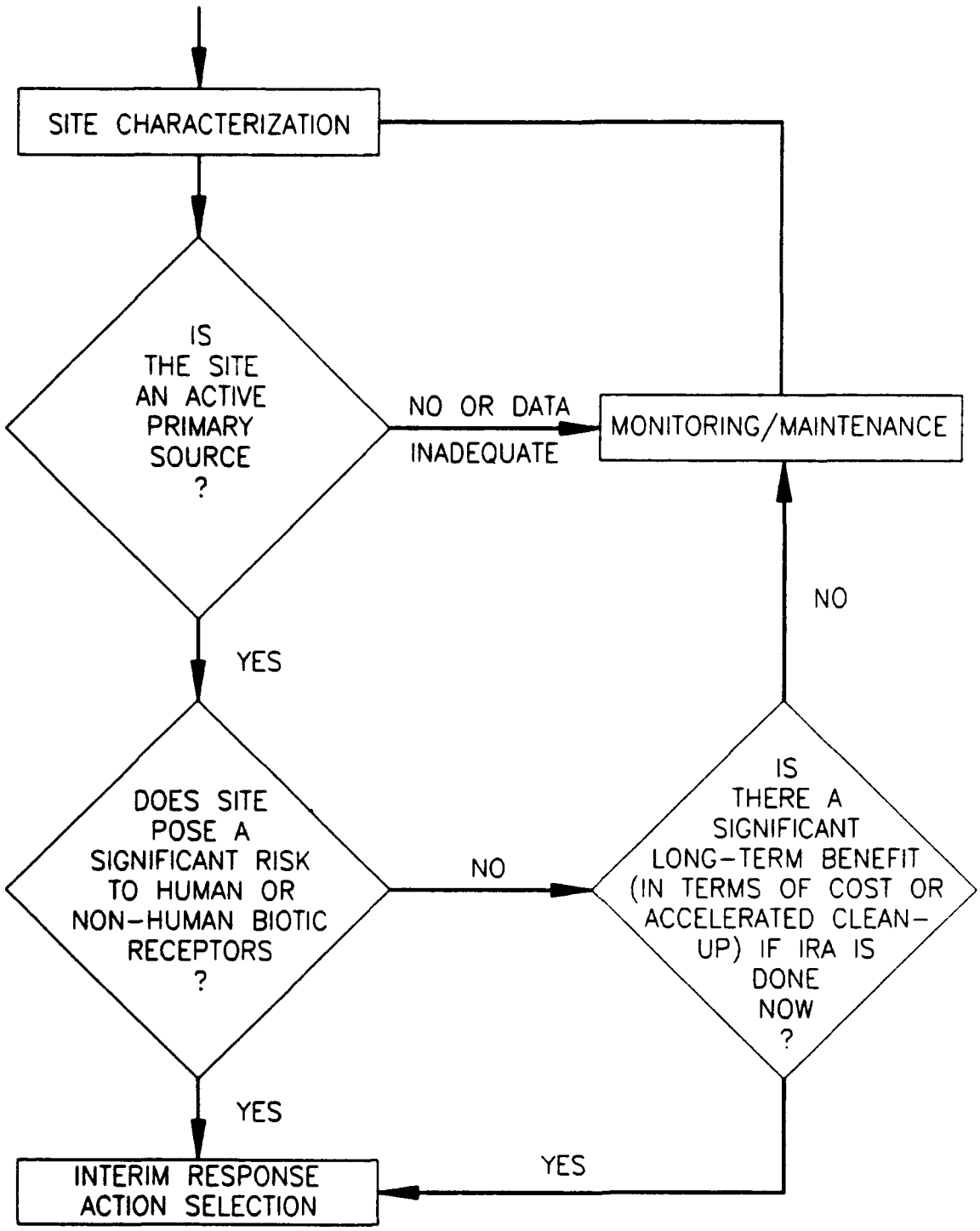


Figure 7

DECISION FLOW CHART FOR INTERIM REMEDIAL ACTION VERSUS MONITORING/MAINTENANCE

Prepared by:

MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES GROUP

FROM: WOODWARD-CLYDE 1989

<2127G049.DWG> <06/20/91>

4.2 REPORTING

4.2.1 Annual Report

The annual reports will include historical water quality and water-level data and an evaluation of this data. In particular, this report will focus on the most recent data, establishing the site conditions as they exist and have changed since the previous evaluation. The primary purpose of the report will be to determine whether site conditions have changed such that Lake Ladora is threatened.

The report will be submitted to the OAS approximately 3 months after receiving the laboratory results for the Annual Sampling Program. This report will include the water quality data, as well as that quarter's water-level monitoring data.

4.2.2 Quarterly Water-Level Reports

The Quarterly Water-Level Reports will be submitted to the OAS approximately 1 month after each monitoring event. These reports will include water-level data, a current water table contour map, and discussion of any significant changes. If indicated, modifications to the number or frequency of water-level measurements may be made.

4.3 HEALTH AND SAFETY PLAN

The site-specific Health & Safety Plan which has been developed for the S[illegible]FP area, will be followed to perform the work specified for this IRA.

5.0 SCHEDULE

The schedule for this program comprises a three year period, beginning September 1991 and ending in June 1994. Water-level monitoring will be collected quarterly throughout the duration of this program. Water quality sampling will be performed annually, beginning with the Verification Monitoring Program which was completed in December 1990. A schedule is provided in Table 2 below.

Table 2. Schedule for STFP IRA

Date	Activity
December 1990	Verification Monitoring Program
June 1991	Water-Level Measurements
September 1991	Water-Level Measurements
December 1991	Water-Level Measurements and Water Quality Sampling
March 1992	Water-Level Measurements
June 1992	Water-Level Measurements
September 1992	Water-Level Measurements
December 1992	Water-Level Measurements and Water Quality Sampling
March 1993	Water-Level Measurements
June 1993	Water-Level Measurements
September 1993	Water-Level Measurements
December 1993	Water-Level Measurements and Water Quality Sampling
March 1994	Water-Level Measurements
June 1994	Water-Level Measurements

6.0 COST

The estimated costs given below are for the entire IRA monitoring program over the course of the following three years. These costs reflect the performance of the Verification Monitoring program and report preparation, installation of the 19 new wells near Lake Ladora, the first round of water-level measuremnts (included in Appendix A of this document), the abandonment and replacement of the monitoring wells damaged during spillway construction, and the future sampling and water-level measurement events and respective reports.

Estimated STFP IRA Costs

Activity	Cost ($)
Verification Monitoring Program*	53,000
Installation of 19 Wells	12,000
Water-Level Measurements (6/91)*	5,000
Well Abandonment & Replacement	14,000
Chemical Analysis	110,000
Field Supplies and Small Tools	5,000
Waste Handling	7,500
Annual Sampling* (3 episodes)	48,500
Water-Level Measurements* (12 episodes)	70,000
TOTAL	$325,000

* - Includes preparation of reports.

APPENDIX A

WATER-LEVEL MONITORING RESULTS

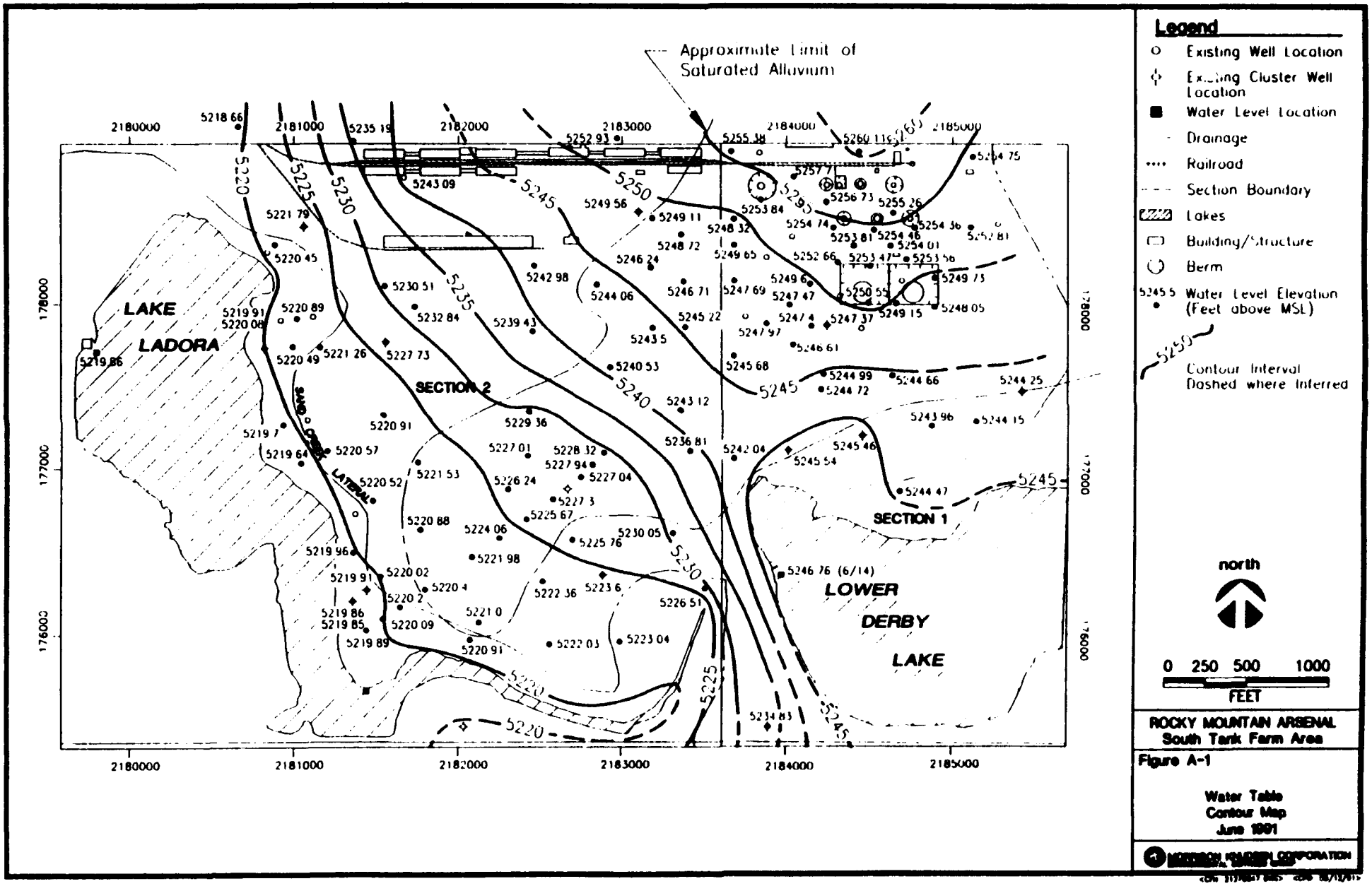
INTRODUCTION

During June 3 and 4, 1991, water-level measurements were recorded for over 100 wells in and beyond the South Tank Farm Plume (STFP) area, including along the eastern edge of Lake Ladora. An objective of this water-level measurement program was to gain a better understanding of the hydrology along the eastern edge of Lake Ladora. A component of this program was the installation of 9 piezometers, 6 well points, and 4 monitoring wells near Lake Ladora and Sand Creek Lateral. Installation of the wells was completed during the week of May 20, 1991.

The results of the water-level measurements collected during the June program are illustrated on the Water Table Contour Map shown by Figure A-1. The general groundwater hydrology did not change significantly since the December 1990 measurements. The largest change in elevation occurred near Lower Derby Lake. The current lake level is approximately 5 feet higher than last fall, when the lake was lowered for spillway construction. The local groundwater levels indicate the influence of Lower Derby Lake on the adjacent aquifer due to the lake recharging the aquifer.

Additional water-level measurements were collected on July 10, 1991. Water-levels for this monitorng event were recorded for the wells closest to Lake Ladora (Figure A-2). The July 10, 1991 measurements corraborate the June 1991 results.

Using the data collected from new wells installed adjacent to Lake Ladora, the local hydrogeology has been further characterized. Indications are that if the elevation of Lake Ladora is maintained at approximately 5220 feet (above mean sea level), then groundwater along the eastern edge of the lake will not impact the lake.

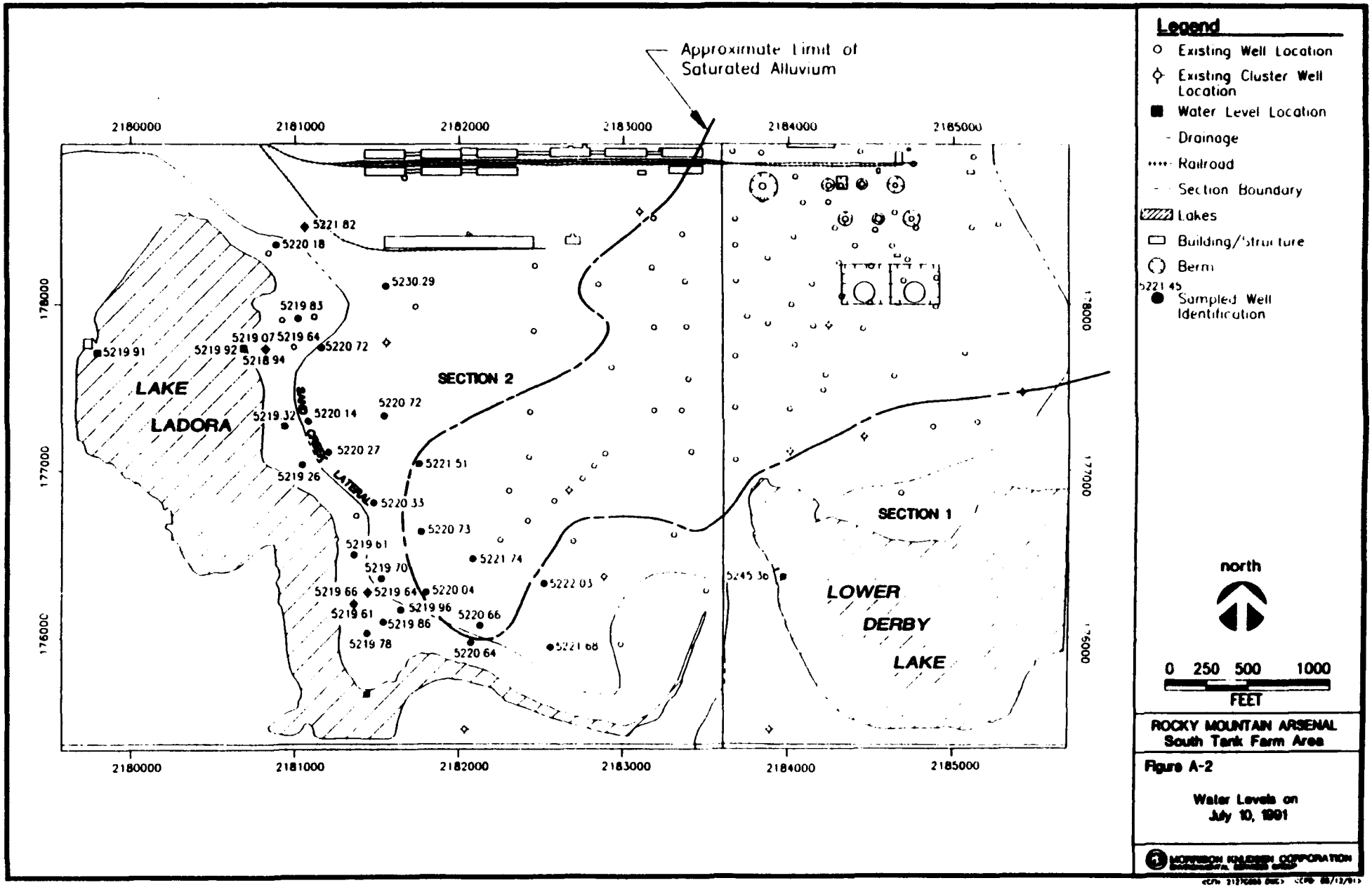


ROCKY MOUNTAIN ARSENAL
South Tank Farm Area

Figure A-1

Water Table
Contour Map
June 1991

MORRISON KNUDSEN CORPORATION


Approximate Limit of Saturated Alluvium
2180000
2181000
2182000
2183000
2184000
2185000
178000
177000
176000
5221 82
5220 18
5230 29
5219 83
5219 07
5219 64
5219 91
5219 92
5218 94
5220 72
LAKE LADORA
SECTION 2
5219 32
5220 14
5220 72
SAND CREEK LATERAL
5220 27
5219 26
5221 51
5220 33
5220 73
5219 61
5219 70
5221 74
5219 66
5219 64
5220 04
5222 03
5219 61
5219 96
5220 66
5219 86
5219 78
5220 64
5221 68
5245 36
SECTION 1
LOWER DERBY LAKE
Legend
Existing Well Location
Existing Cluster Well Location
Water Level Location
Drainage
Railroad
Section Boundary
Lakes
Building/Structure
Berm
5221 45
Sampled Well Identification
north
0 250 500 1000
FEET
ROCKY MOUNTAIN ARSENAL
South Tank Farm Area
Figure A-2
Water Levels on
July 10, 1991
MORRISON KNUDSEN CORPORATION

Installation of New Wells

The piezometers, well points and monitoring wells were installed during the week of May 20, 1991. The monitoring wells are located at well numbers 02523 through 02526. Well numbers 02527 through 02535 indicate the locations for the nine piezometers. The well points are located by well numbers 02536 through 02541. Two staff gages were installed on the eastern edge of Lake Ladora on June 12, 1991. The southern staff gage had to be relocated because it could not be properly read or surveyed at its original location. The gage was moved on August 7, 1991. Subsequent water-level measurements show that the lake level is the same at the two northernmost staff gages, and slightly higher at the southern gage.

During surveying for the new wells and staff gages, datum measurements were recorded for the Army's staff gages on Lake Ladora and Lower Derby Lake. The results of this survey show that for Lake Ladora a measurement of 12.9 feet corresponds to an elevation of 5219.96 feet, and for Lower Derby Lake a level of 16.5 feet corresponds to an elevation of 5246.66 feet. The two staff gages were surveyed for the water level at the time of survey, and future readings gaged from the surveyed datum given above. The datum (0.0 feet) for the new staff gage along the northeastern shore is at an elevation of 5216.98 feet, and that for the new staff gage along the southeastern shore is at an elevation of 5216.65 feet.

The new wells were surged and developed prior to collecting water-level measurements. After developing the wells it was evident that five of the well points (Wells 02536-02540) were clogged. In an attempt to unplug the well points, the spray nozzle for a steam/pressure cleaner was fitted with an extension so water could be sprayed into the wells. The well points were repeatedly surged, jet sprayed, and bailed. This procedure did

not unplug the wells. Using an air compressor and sealing the top of the well with a no-hub band, air was injected into the well points. A pressure of 60 psi could be reached without blowing off the fitting. After pressurizing the well point, it was again jet sprayed and bailed. Following this procedure, only Well 02539 was unplugged. Additional efforts will be made to unplug the remaining well points. If unsuccessful, these wells will be replaced.

Hydrology Near Lake Ladora

On June 3, 1991 the lowest measured elevation of the groundwater table was 5219.64 feet in Well 02530. Well 02524 had a water-level of 5219.7 feet. The surface elevation of Lake Ladora was 5219.86. As may be seen from a profile of groundwater elevation away from the lake (Figures A-3 through A-7), groundwater adjacent to the lake appears to reach a minimum elevation approximately 50 to 100 feet from the lake. On July 10, 1991 the lake elevation was 5219.91, a level ranging from 0.14 to 0.97 feet higher than levels in the wells immediately adjacent to the lake along the eastern shore.

According to the above results, there is a hydraulic gradient away from the lake for an approximate distance of 50 to 100 feet, and groundwater along the eastern edge of the lake will not impact the lake, if the lake elevation is maintained at approximately 5220 feet (an approximate stage of 12.9 feet as measured on the pump house staff gage).

Conclusions

If the elevation of Lake Ladora is maintained at approximately 5220 feet, groundwater along the eastern edge of the lake will

not impact the lake. This is based on recently observed hydrogeologic conditions. In addition, these results show that the vertical gradient is downward. These results indicate the lake is controlling the local groundwater hydrology and that groundwater will not impact the lake. Regular monitoring, as outlined in this document, will determine whether proper hydrogeologic conditions are maintained.

FIGURE A-3
WATER LEVELS NEAR LAKE LADORA

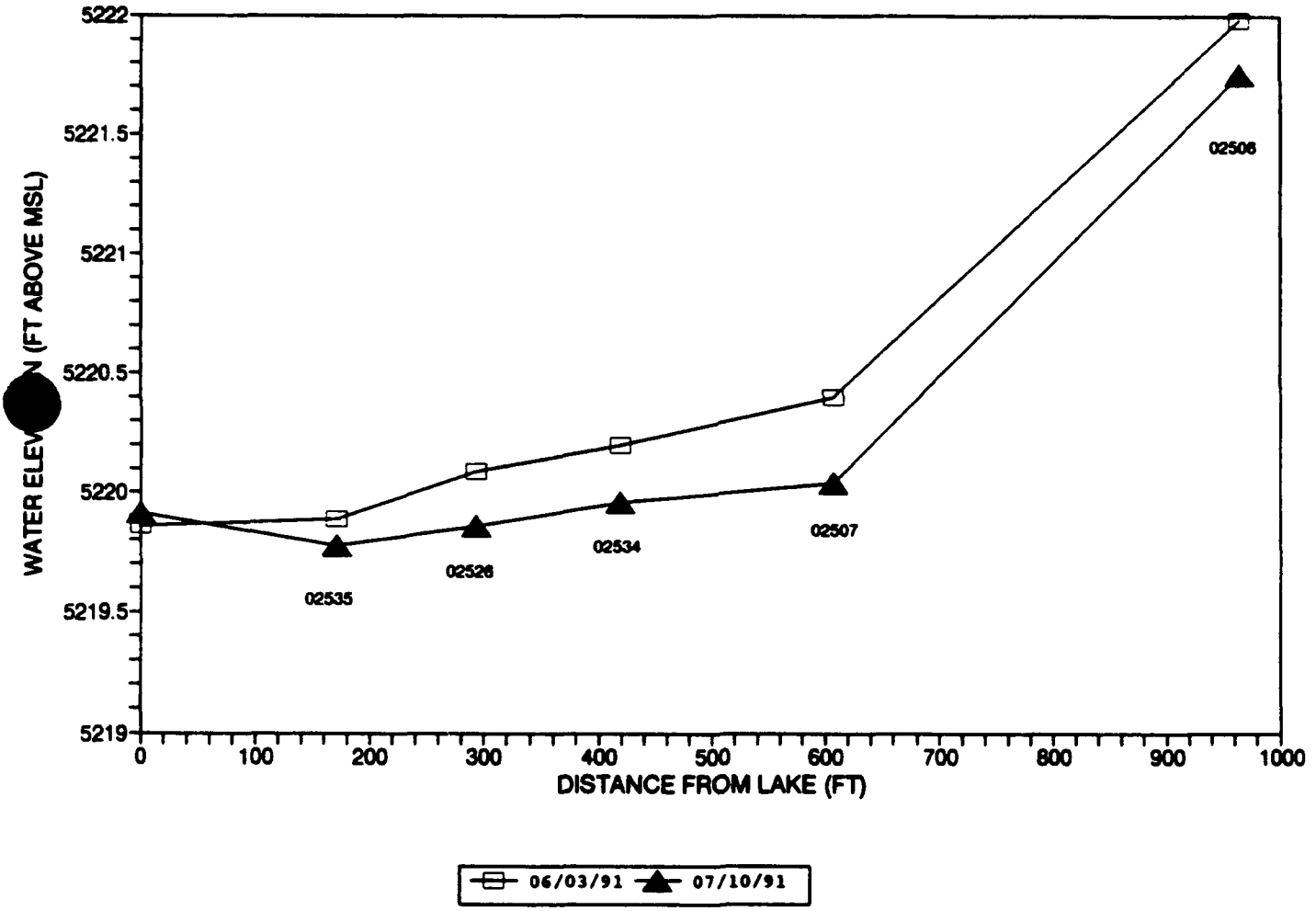


FIGURE A-4
WATER LEVELS NEAR LAKE LADORA

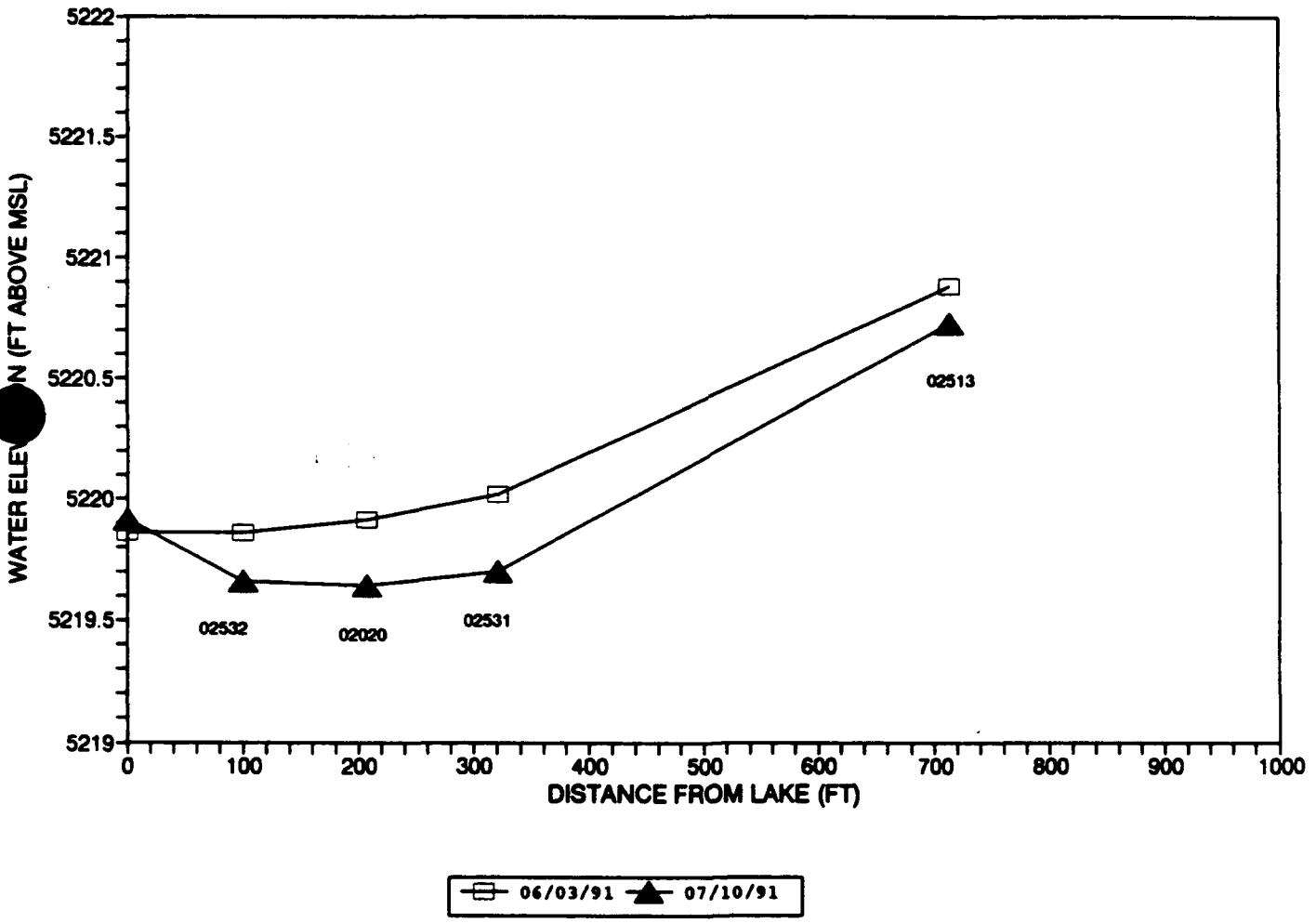


FIGURE A-5
WATER LEVELS NEAR LAKE LADORA

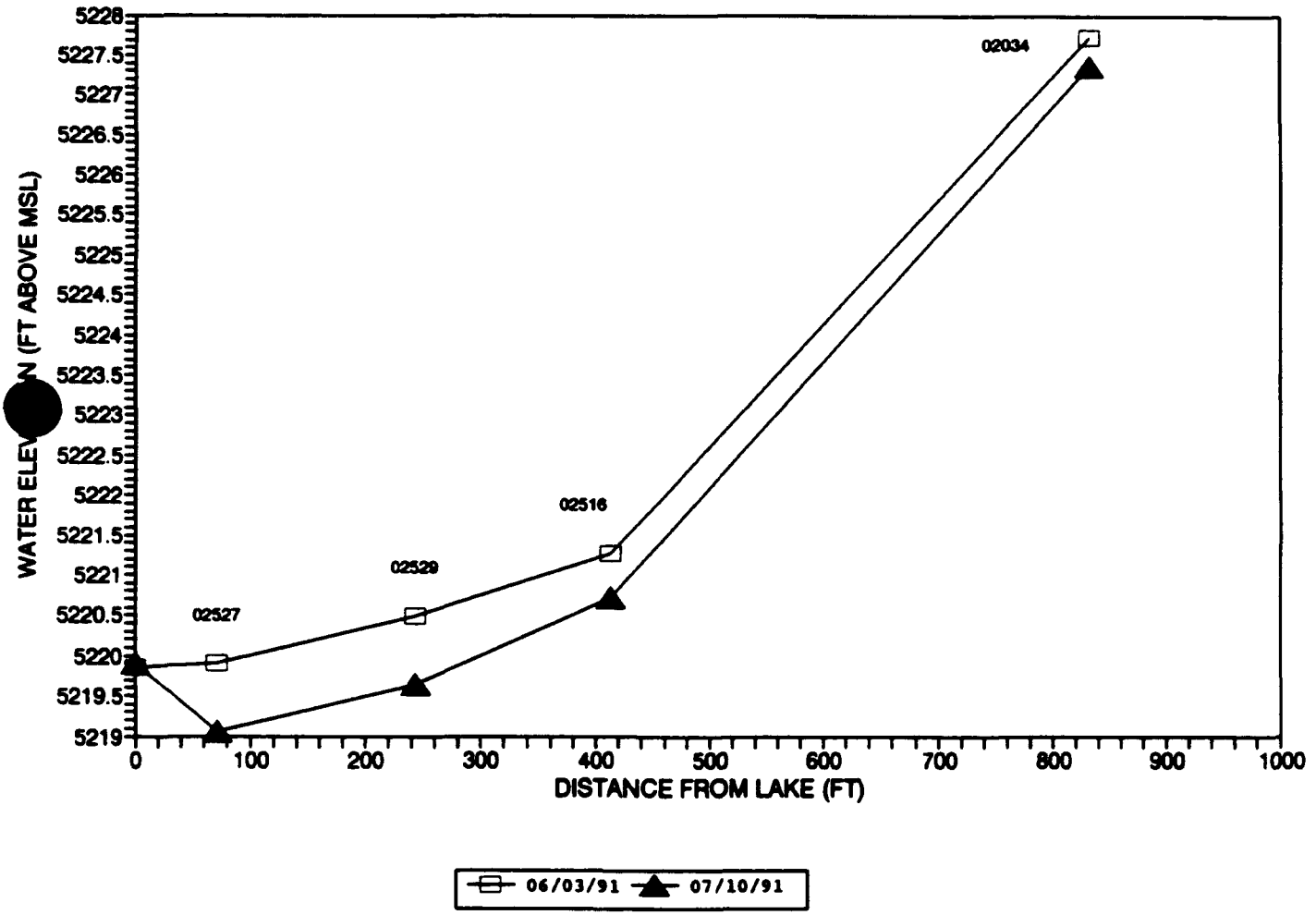


FIGURE A-6
WATER LEVELS NEAR LAKE LADORA

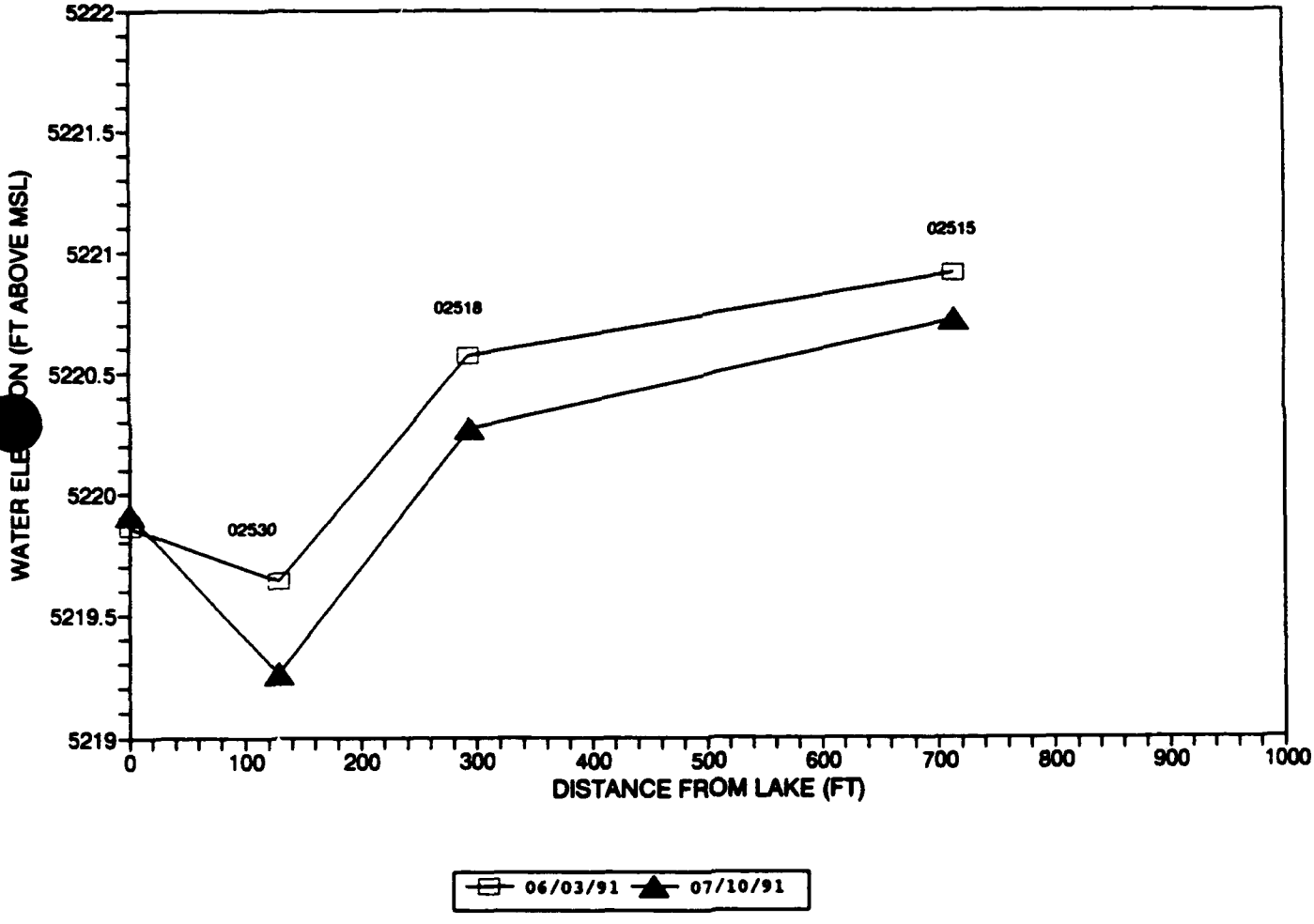
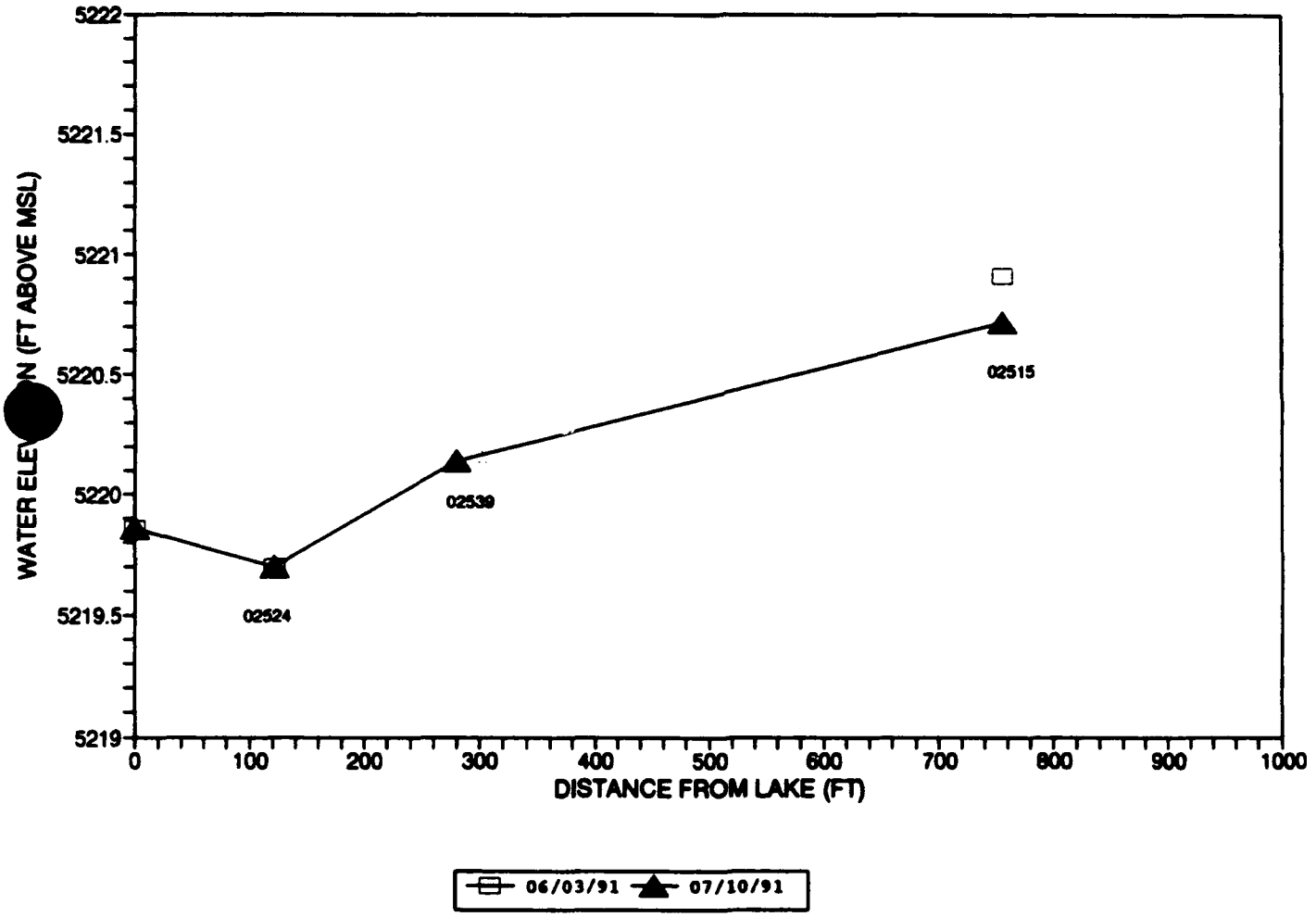


FIGURE A-7
WATER LEVELS NEAR LAKE LADORA



APPENDIX B

WELL COMPLETION RECORDS, MAY 1991

SAMPLE/CORE LOG SHEETS

WELL DEVELOPMENT RECORDS

MK-ENVIRONMENTAL SERVICES

RMA Well Completion Record

Well Number 02523

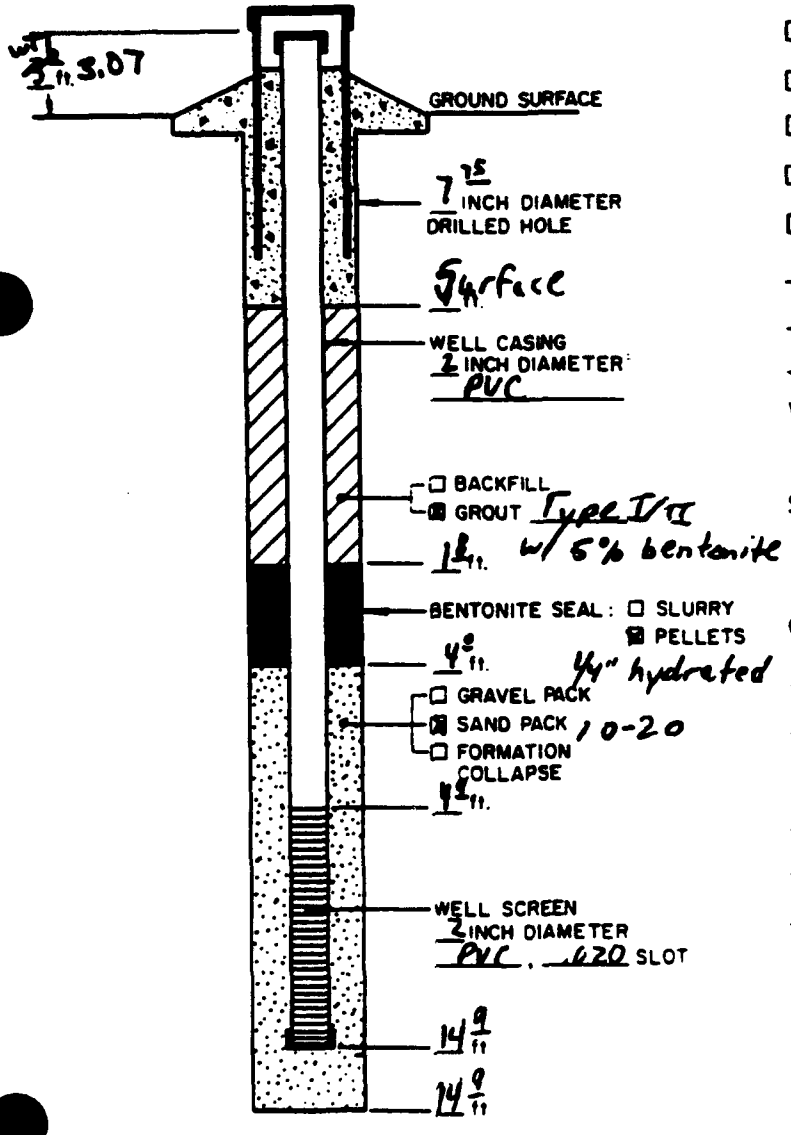
Borehole Number MW-1

Surveyed Location 177913.959 N
2191016.536 E

Project Lake Ladora Wells

Date 910522

Surveyed Elevation GS 5222.98 ft.
TOC 5226.05 ft.



Depths From Ground Surface
Unless Otherwise Noted

Installation Date 910522
Drilling Method Hollow Stem Auger
Drilling Contractor Layne
Drilling Fluid N/A
Development Date 6/5/91
Development Technique pump/surge

Water Removed ~37 gals.

Static Depth to Water 5.15 ft. below TOC
910523

Comments

Prepared By P.R. Berglund

MK-ENVIRONMENTAL SERVICES

RMA Well Completion Record

Well Number 02524

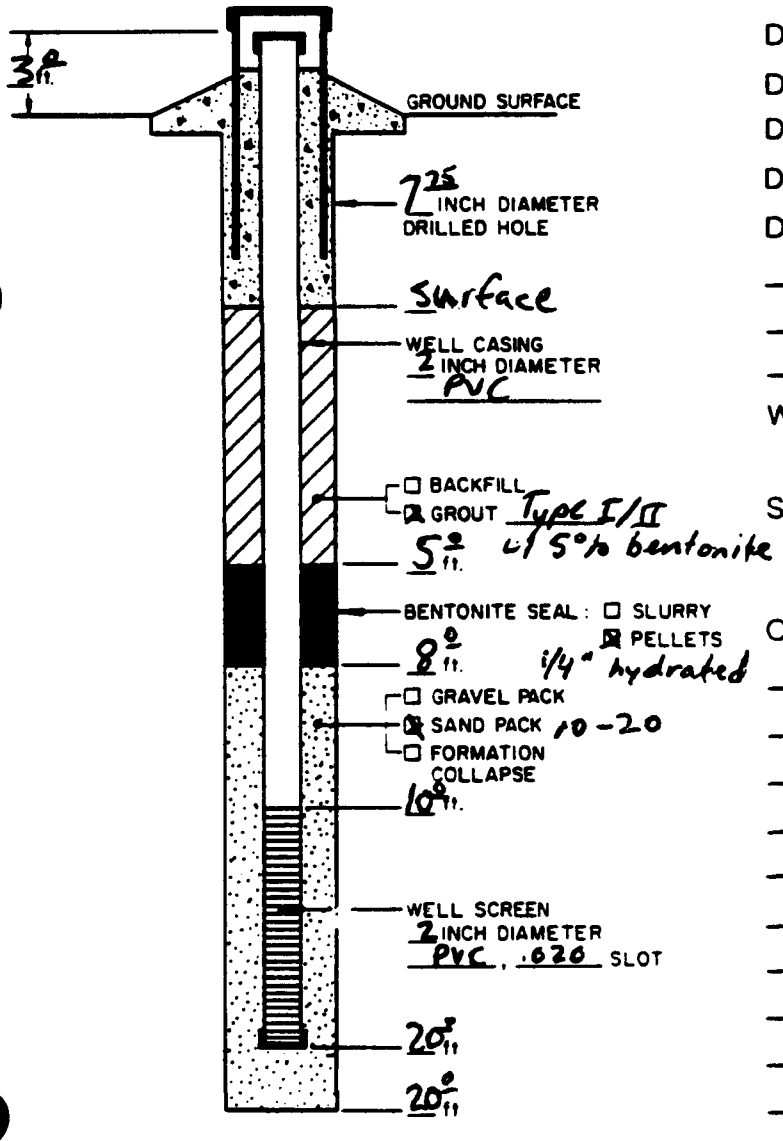
Borehole Number MW-2

Surveyed Location 177267.298 N
218093.298 E

Project Lake Ladora Wells

Date 910522

Surveyed Elevation GS 5227.10 ft.
TOC 5230.10 ft.



Depths From Ground Surface
Unless Otherwise Noted

Installation Date 910521

Drilling Method Hollow Stem Auger

Drilling Contractor Layne

Drilling Fluid N/A

Development Date 6/5/91

Development Technique pump/surge

Water Removed 36 gals.

Static Depth to Water ~~10.42~~ ~~7.30 MP~~ 10.42 ft. below TOC
910528

Comments

Prepared By Peter R Boyland

MK-ENVIRONMENTAL SERVICES

RMA Well Completion Record

Well Number 02525

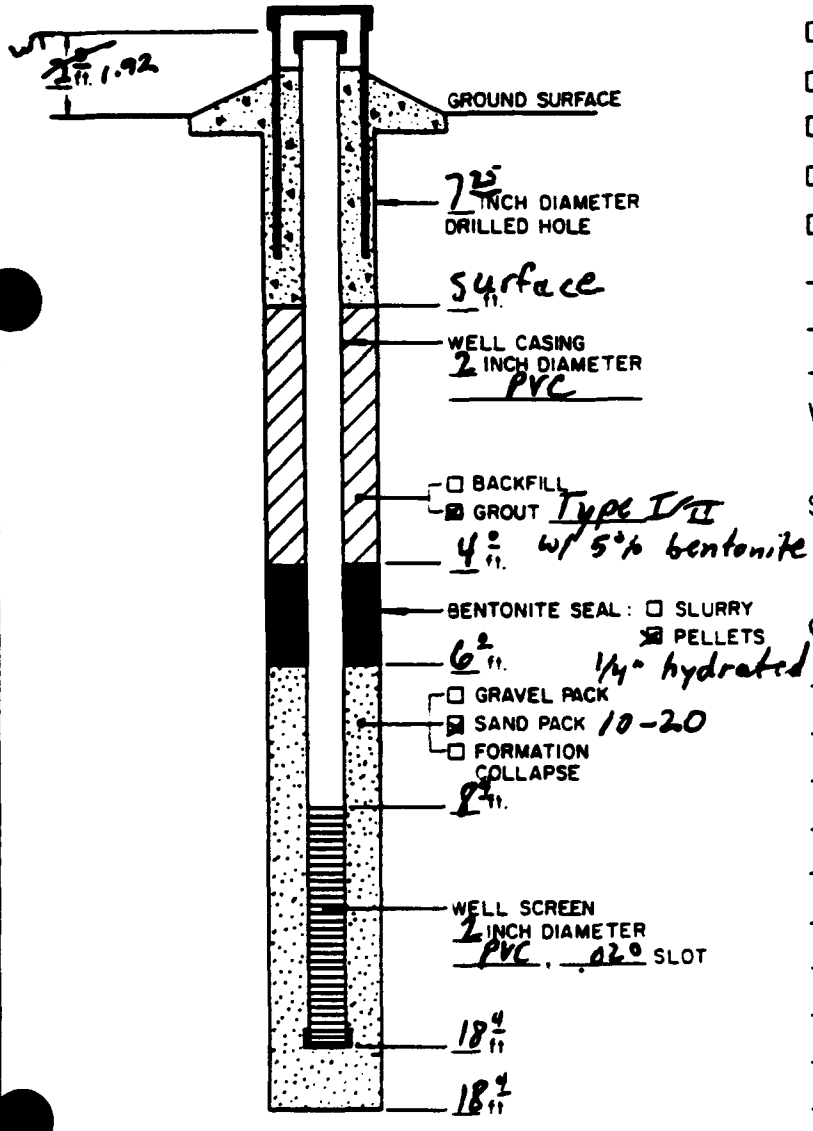
Borehole Number MW-3

Project Lake Ladora Wells

Date 910522

Surveyed Location 176495.347 N
218136.298 E

Surveyed Elevation GS 5224.74 ft.
TOC 5226.66 ft.



Depths From Ground Surface Unless Otherwise Noted

Installation Date 910521

Drilling Method Hollow Stem Auger

Drilling Contractor Layne

Drilling Fluid N/A

Development Date 5/31/91

Development Technique pump/surge

Water Removed ~30 gals.

Static Depth to Water 6.35 ft. below TOC
910528

Comments

Prepared By P.R. Berglund

MK-ENVIRONMENTAL SERVICES

RMA Well Completion Record

Well Number 02526

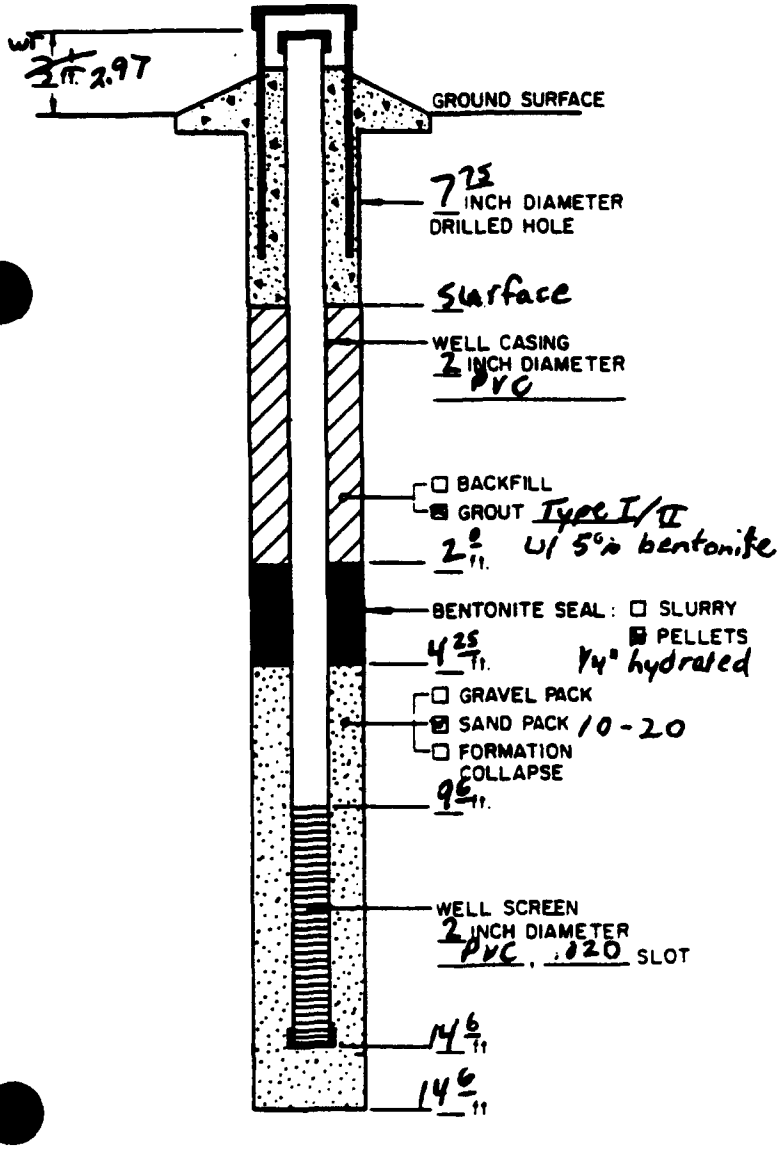
Borehole Number MW-4

Project Lake Ladora Wells

Date 910522

Surveyed Location 176095.800 N
2191540.777 E

Surveyed Elevation GS 5226.97 ft.
TOC 5229.94 ft.



Depths From Ground Surface
Unless Otherwise Noted

Installation Date 910520

Drilling Method Hollow Stem Auger

Drilling Contractor Layne

Drilling Fluid N/A

Development Date 5/31/91

Development Technique pump/surge

Water Removed 18 gals.

Static Depth to Water 9.90 ft. below TOC
910520

Comments

Prepared By Peter R. Berglund

MK-ENVIRONMENTAL SERVICES

RMA Well Completion Record

Well Number 02527

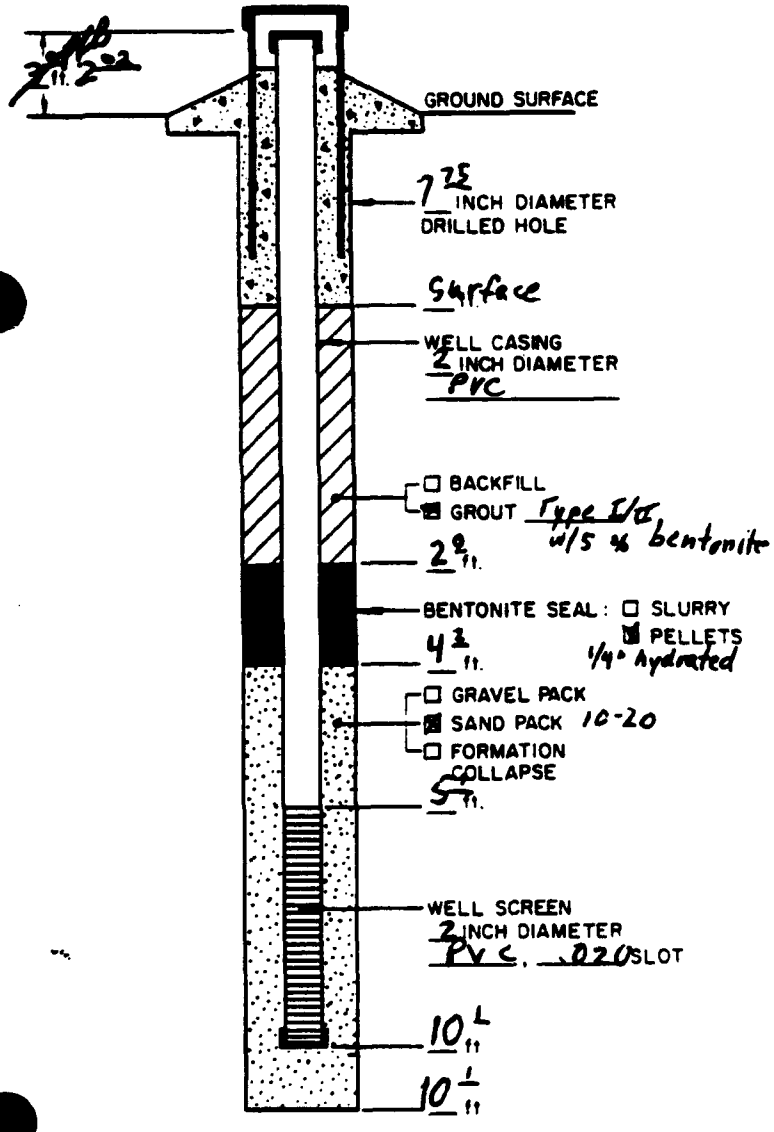
Borehole Number R1

Project Lake Ladora Wells

Date 910521

Surveyed Location 177732.881 N
2180818.150 E

Surveyed Elevation GS 5222.51 ft.
TOC 5224.53 ft.



Depths From Ground Surface
Unless Otherwise Noted

Installation Date 910521

Drilling Method Hollow Stem Auger

Drilling Contractor Layne

Drilling Fluid N/A

Development Date N/A

Development Technique N/A

Water Removed N/A gals.

Static Depth to Water 4.71 ft. below TOC
910523

Comments

Prepared By P.R. Berglund

MK-ENVIRONMENTAL SERVICES

RMA Well Completion Record

Well Number 02528

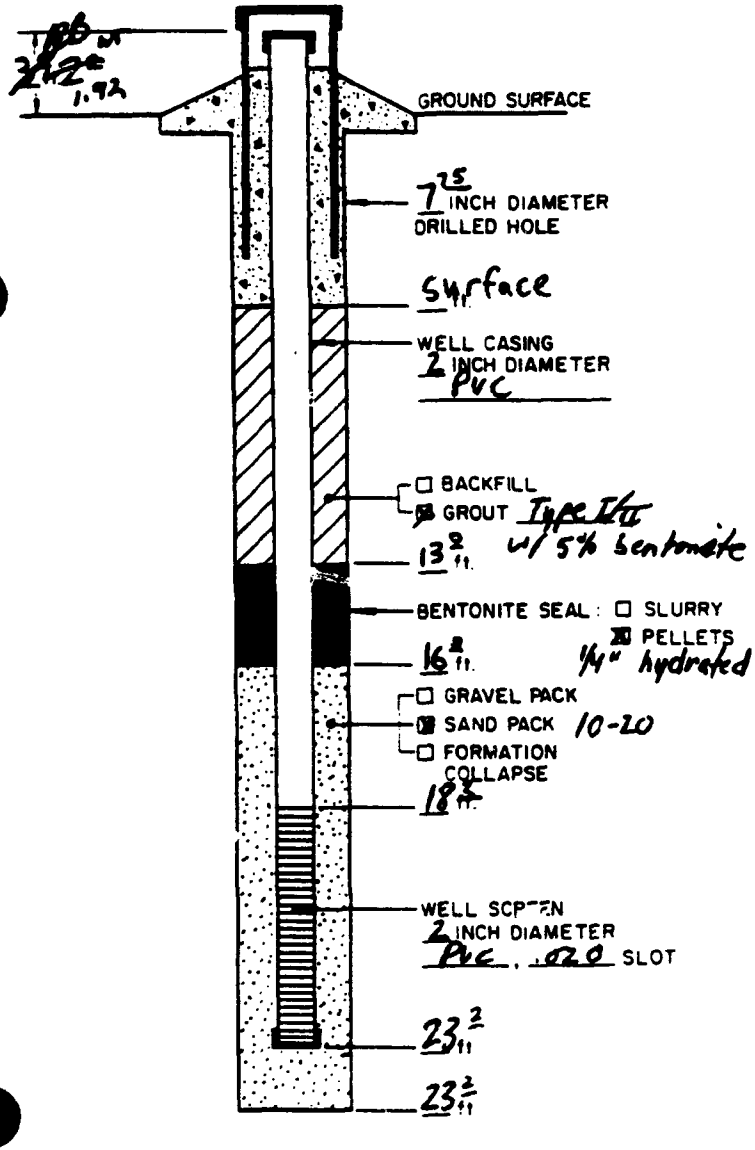
Borehole Number P-2

Surveyed Location 177733.565 N
2180821.131 E

Project Lake Ladora Wells

Date 910521

Surveyed Elevation GS 5222.500 ft.
TOC 5224.420 ft.



Depths From Ground Surface
Unless Otherwise Noted

Installation Date 910521

Drilling Method Hollow Stem Auger

Drilling Contractor Layne

Drilling Fluid N/A

Development Date N/A

Development Technique N/A

Water Removed N/A gals.

Static Depth to Water 4.57 ft. below TOC
910523

Comments

Prepared By P.R. Berglund

MK-ENVIRONMENTAL SERVICES

RMA Well Completion Record

Well Number 02529

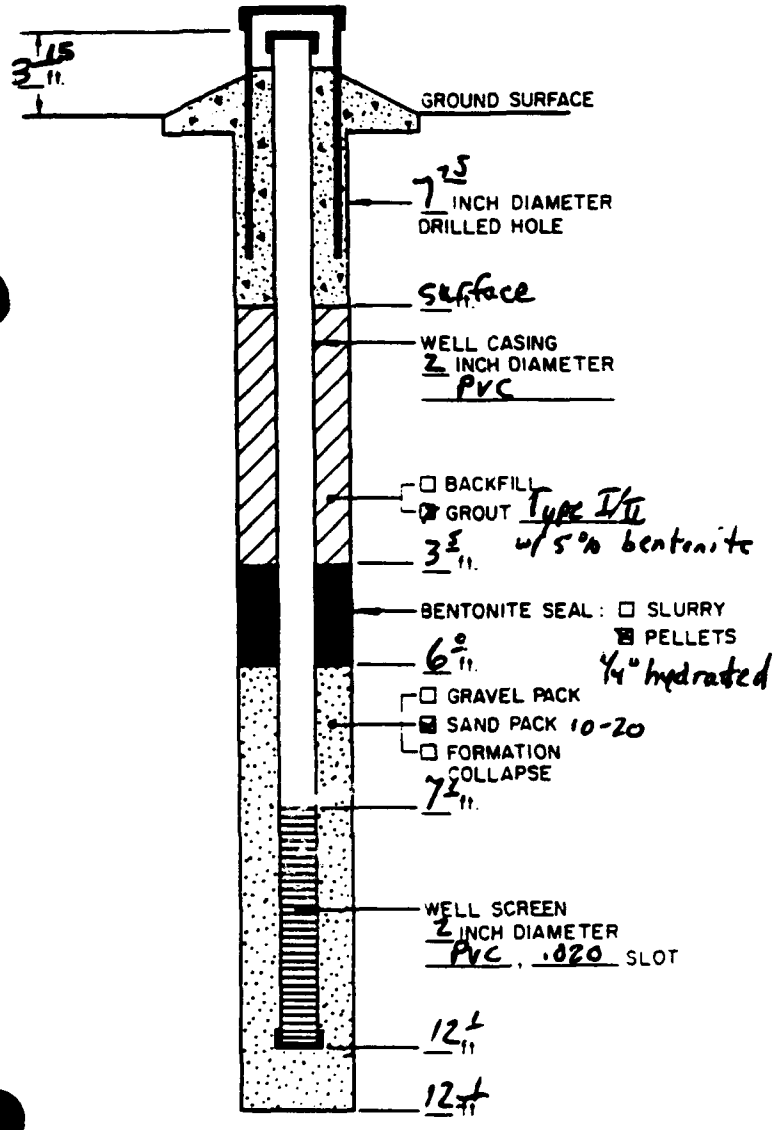
Borehole Number P-3

Project Lake Ladora Wells

Date 910523

Surveyed Location 177742.305 N
2180990.831 E

Surveyed Elevation GS 5225.790 ft.
TOC 5228.940 ft.



Depths From Ground Surface
Unless Otherwise Noted

Installation Date 910522

Drilling Method Hollow Stem Auger

Drilling Contractor Layne

Drilling Fluid N/A

Development Date N/A

Development Technique N/A

Water Removed N/A gals.

Static Depth to Water 8.69 ft. below TOC
910523

Comments

Prepared By P.R. Berglund

MK-ENVIRONMENTAL SERVICES
A DIVISION OF THE MORRISON

RMA Well Completion Record

Well Number 02530

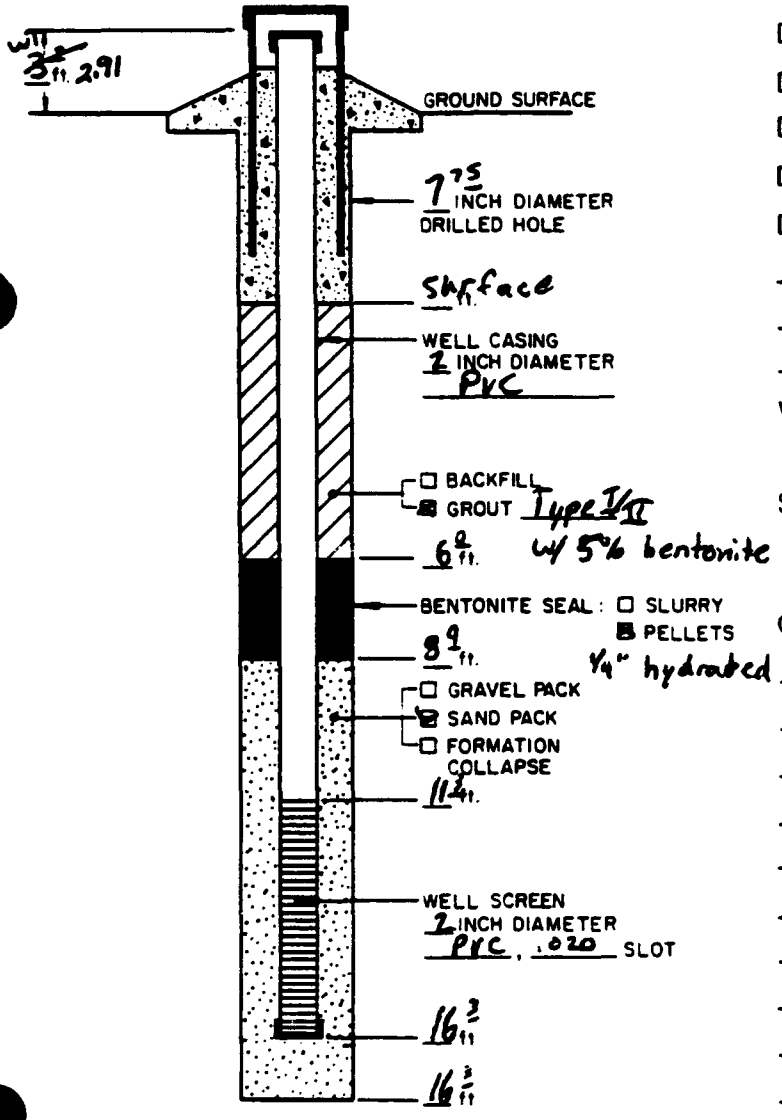
Borehole Number P-4

Project Lake Ladora Wells

Date 910521

Surveyed Location 177033.285 N
219104I.350 E

Surveyed Elevation GS 5225.970 ft.
TOC 5228.880 ft.



Depths From Ground Surface
Unless Otherwise Noted

Installation Date 910521

Drilling Method Hollow Stem Auger

Drilling Contractor Layne

Drilling Fluid N/A

Development Date N/A

Development Technique N/A

Water Removed N/A gals.

Static Depth to Water 9.30 ft. below TOC
910528

Comments

Prepared By P.R. Berglund

MK-ENVIRONMENTAL SERVICES

RMA Well Completion Record

Well Number 02531

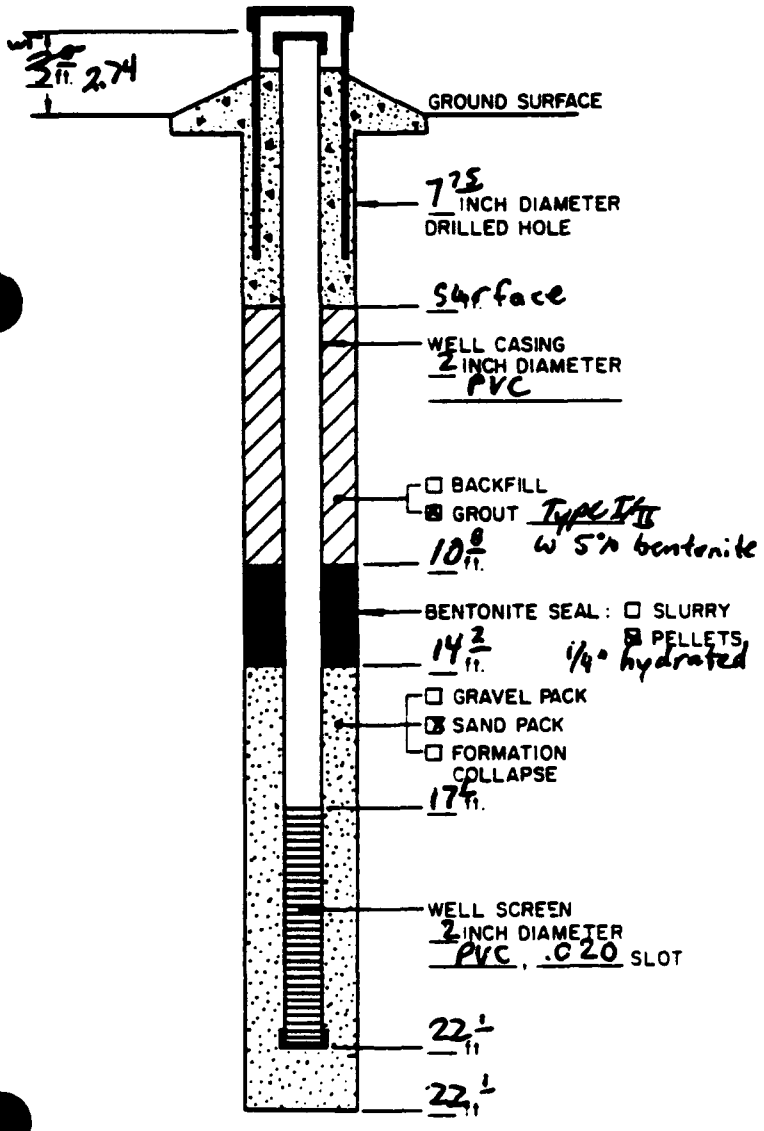
Borehole Number P-5

Project Lake Ladora Wells

Date

Surveyed Location 176353.042 N
2181526.517 E

Surveyed Elevation GS 5233.68 ft.
TOC 5236.42 ft.



Depths From Ground Surface
Unless Otherwise Noted

Installation Date 910522

Drilling Method Hollow Stem Auger

Drilling Contractor Layne

Drilling Fluid N/A

Development Date N/A

Development Technique N/A

Water Removed N/A gals.

Static Depth to Water 16.42 ft. below TOC
910523

Comments

Prepared By P.R. Berglund

MK-ENVIRONMENTAL SERVICES

RMA Well Completion Record

Well Number 02537

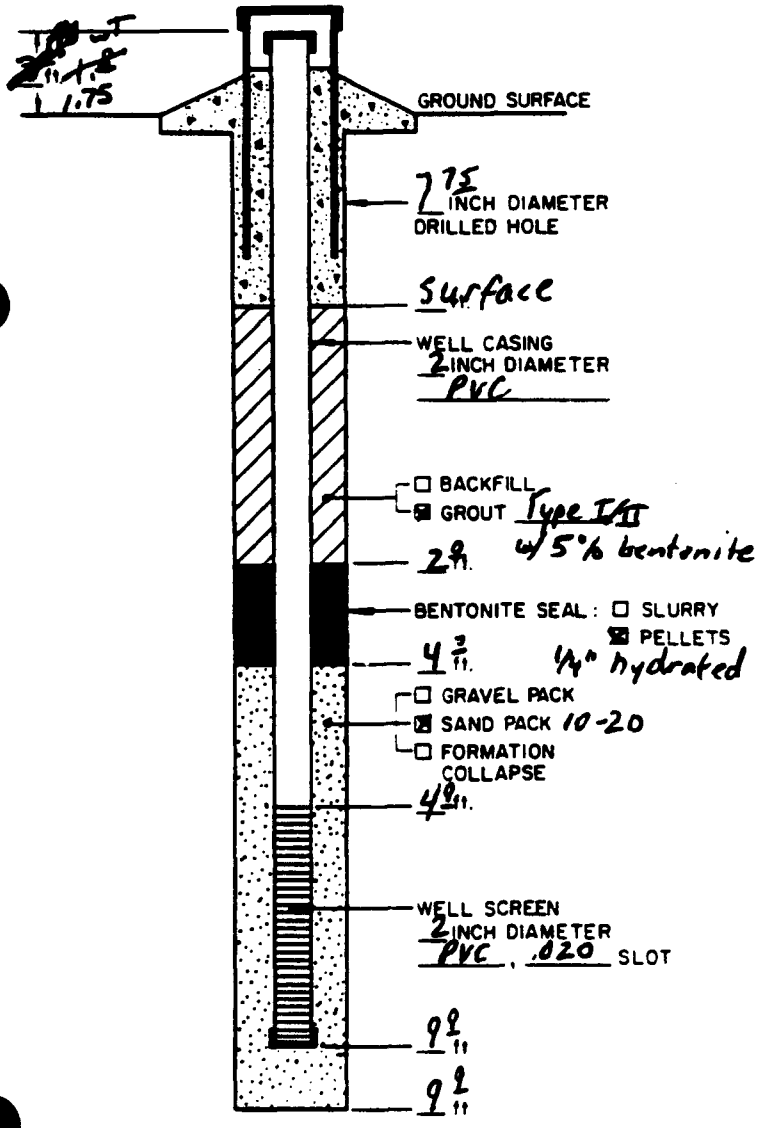
Borehole Number P-6

Project Lake Ladora Wells

Date 910522

Surveyed Location 176205.157 N
219363.002 E

Surveyed Elevation GS 5223.19 ft.
TOC 5224.94 ft.



Depths From Ground Surface Unless Otherwise Noted

Installation Date 910521

Drilling Method Hollow Stem Auger

Drilling Contractor Layne

Drilling Fluid N/A

Development Date N/A

Development Technique N/A

Water Removed N/A gals.

Static Depth to Water 5.13 ft. below TOC
910523

Comments

Prepared By P.R. Berglund

MK-ENVIRONMENTAL SERVICES
A DIVISION OF THE FERGUSON

RMA Well Completion Record

Well Number 02533

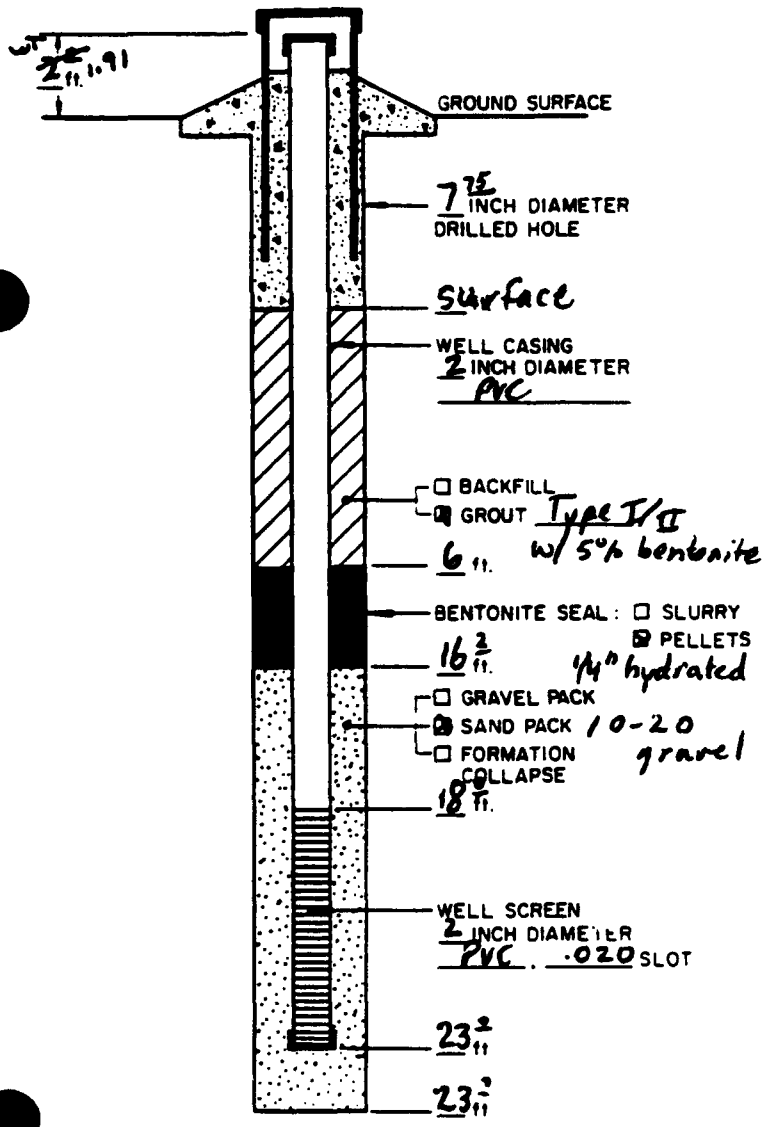
Borehole Number P-7

Project Lake Ladora Wells

Date 910522

Surveyed Location 176203.582 N
219360.203 E

Surveyed Elevation GS 5223.02 ft.
TOC 5224.93 ft.



Depths From Ground Surface
Unless Otherwise Noted

Installation Date 910520

Drilling Method Hollow Stem Auger

Drilling Contractor Layne

Drilling Fluid N/A

Development Date N/A

Development Technique N/A

Water Removed N/A gals.

Static Depth to Water 5.12 ft. below TOC
910523

Comments

Prepared By P.R. Berglund

MK-ENVIRONMENTAL SERVICES

RMA Well Completion Record

Well Number 02534

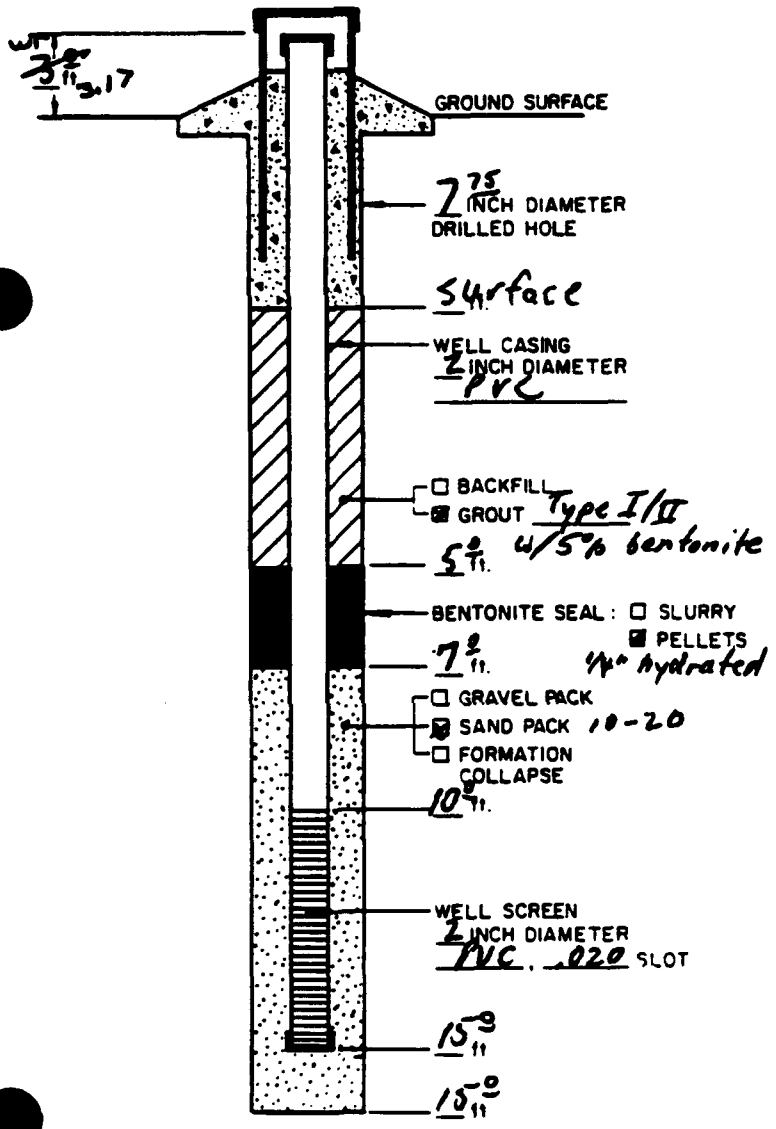
Borehole Number P-8

Project Lake Ladora Wells

Date 910522

Surveyed Location 176167.912 N
219645.89 E

Surveyed Elevation GS 5230.27 ft.
TOC 5233.44 ft.



Depths From Ground Surface
Unless Otherwise Noted

Installation Date 910520

Drilling Method Hollow Stem Auger

Drilling Contractor Layne

Drilling Fluid N/A

Development Date N/A

Development Technique N/A

Water Removed N/A gals.

Static Depth to Water 13.28 ft. below TOC
910523

Comments

Prepared By Peter C Beglund

MK-ENVIRONMENTAL SERVICES
A DIVISION OF MK FERGUSON

RMA Well Completion Record

Well Number 02535

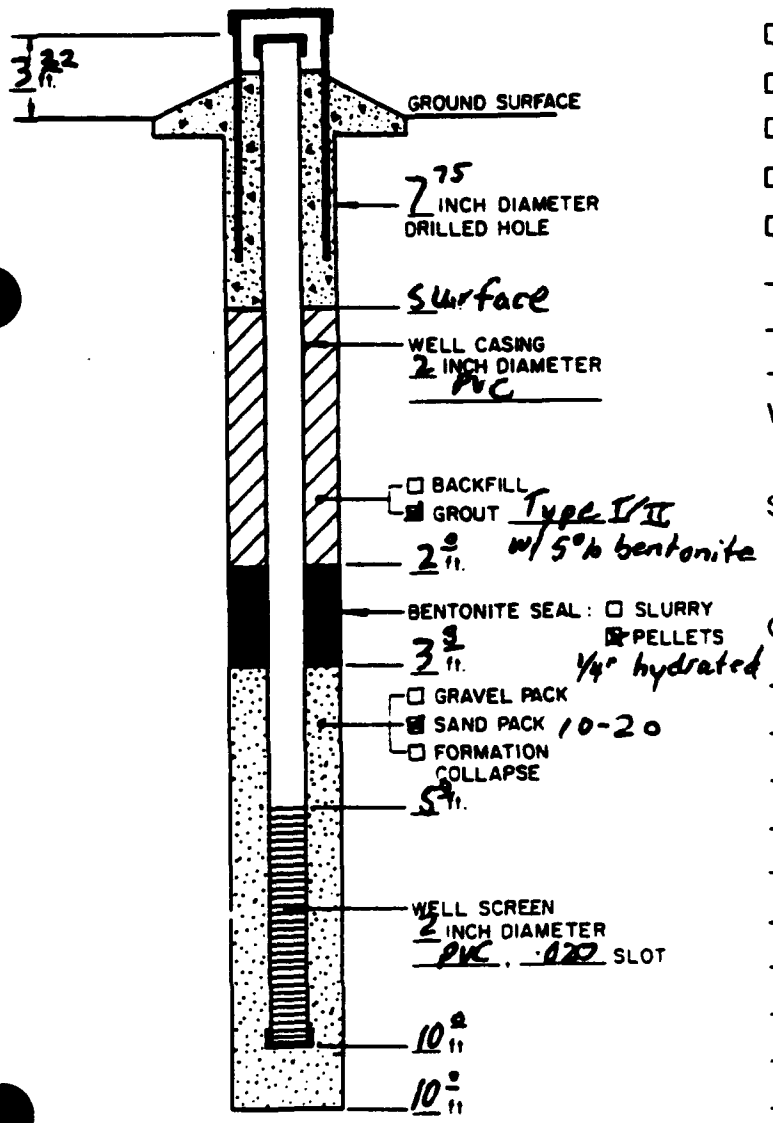
Borehole Number P-9

Project Lake Ladora Wells

Date 910522

Surveyed Location 176026.988 N
2181441.856 E

Surveyed Elevation GS 5223.98 ft.
TOC 5226.70 ft.



Depths From Ground Surface
Unless Otherwise Noted

Installation Date 910520

Drilling Method Hollow Stem Auger

Drilling Contractor Layne

Drilling Fluid N/A

Development Date N/A

Development Technique N/A

Water Removed N/A gals.

Static Depth to Water 6.89 ft. below TOC
910523

Comments

Prepared By P. R. Berglund

MK-ENVIRONMENTAL SERVICES
A Division of MK Petroleum

RMA Well-Point Completion Record

Well Point Number 02536

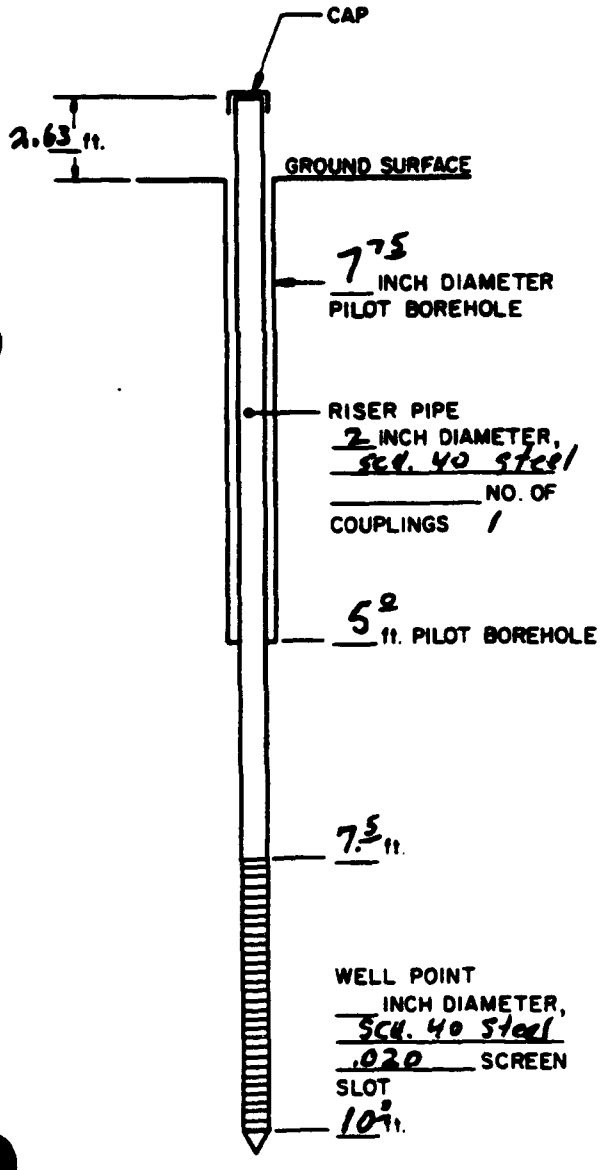
Borehole Number WP-1

Surveyed Location 1783123.328 N
2180938.685 E

Project Lake Ladora Wells

Date 910522

Surveyed Elevation GS 5322.38 ft.
TOC 5325.01 ft.



Depths From Ground Surface
Unless Otherwise Noted

Installation Date 910522

Drilling Method Hollow Stem Auger + Push Hammer

Drilling Contractor Layne

Drilling Fluid N/A

Development Date N/A

Development Technique N/A

Water Removed N/A gals.

Static Depth to Water 8.71 ft. below TOC
910520

Comments

Prepared By Peter L Berglund

MK-ENVIRONMENTAL SERVICES

RMA Well-Point Completion Record

Well Point Number 02537

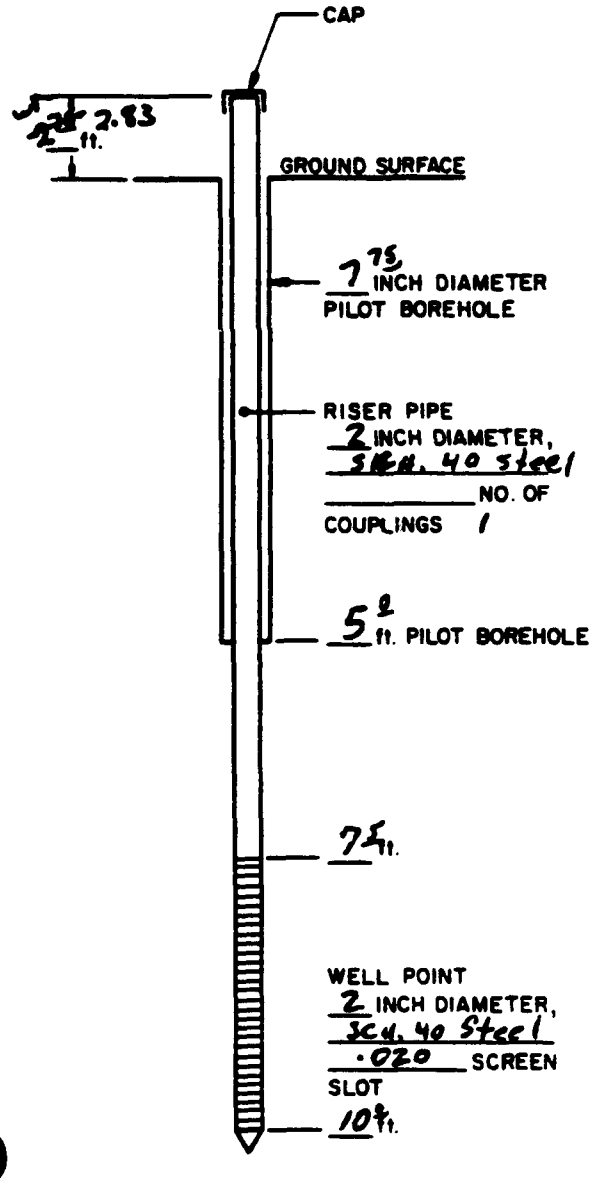
Borehole Number WP-2

Project Lake Ladora Wells

Date 910523

Surveyed Location 177903.414 N
2180919.247 E

Surveyed Elevation GS 5222.32 ft.
TOC 5225.15 ft.



Depths From Ground Surface
Unless Otherwise Noted

Installation Date 910523

Drilling Method HSA + Sample Hammer

Drilling Contractor Layne

Drilling Fluid N/A

Development Date N/A

Development Technique N/A

Water Removed N/A gals.

Static Depth to Water 12.56 ft. below TOC
910520

Comments

Prepared By Peter R Bergland

MK-ENVIRONMENTAL SERVICES

RMA Well-Point Completion Record

Well Point Number 02538

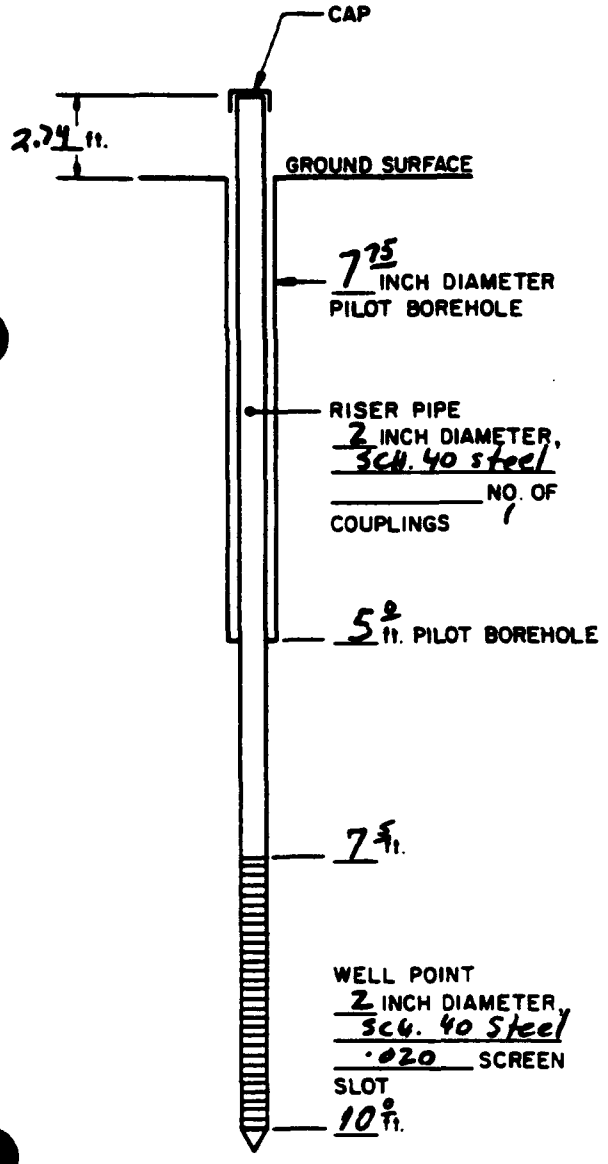
Borehole Number WP-3

Project Lake Ladora

Date 910523

Surveyed Location 177923.098 N
2181116.747 E

Surveyed Elevation GS 5224.55 ft.
TOC 5227.29 ft.



Depths From Ground Surface
Unless Otherwise Noted

Installation Date 910523

Drilling Method HSA + Sample Hammer

Drilling Contractor Layne

Drilling Fluid N/A

Development Date N/A

Development Technique N/A

Water Removed N/A gals.

Static Depth to Water 12.9 ft. below TOC
910528

Comments

Prepared By Peter C Beglund

MK-ENVIRONMENTAL SERVICES

RMA Well-Point Completion Record

Well Point Number 02539

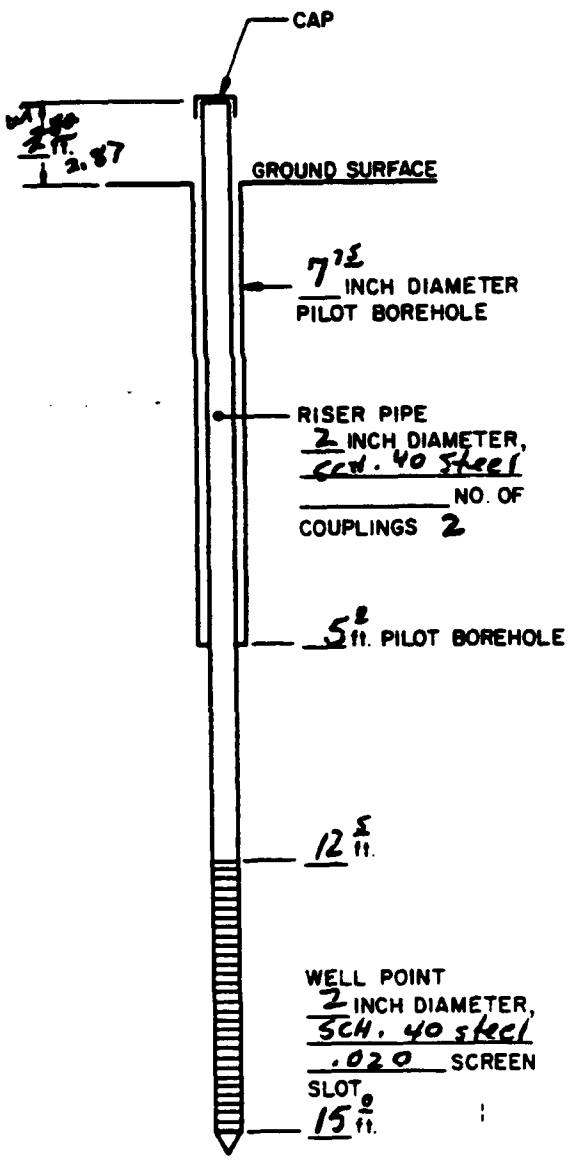
Borehole Number WP-4

Project Lake Ladora Wells

Date 910522

Surveyed Location 177295.933 N
2191079.887 E

Surveyed Elevation GS 5232.13 ft.
TOC 5235.00 ft.



Depths From Ground Surface
Unless Otherwise Noted

Installation Date 910522

Drilling Method HSA + Hammer

Drilling Contractor Layne

Drilling Fluid N/A

Development Date N/A

Development Technique N/A

Water Removed N/A gals.

Static Depth to Water 17.10 ft. below TOC
910528

Comments

Prepared By Peter C Berglund

NUS-ENVIRONMENTAL SERVICES

Sample/Core Log

Boring/Well 02523 Project/No. 2127 Page 1 of 1

Site Location Lake Ladora Drilling Started 910522 Drilling Completed 910522

Total Depth Drilled 15' feet Hole Diameter 7 7/5 inches Type of Sample/ Coring Device N/A

Length and Diameter of Coring Device N/A Sampling Interval N/A feet

Land-Surface Elev. 5222.98 feet ☒ Surveyed ☐ ~~Estimated~~ Datum MSL

Drilling Fluid Used N/A Drilling Method HSA

Drilling Contractor Layne Driller D. Werner Helper J. Oldham

Prepared By P. R. Berglund Hammer Weight N/A Hammer Drop N/A inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Time/Hydraulic Pressure or Blows per 6 inches	Sample/Core Description
0'	2'			silty sand; fine sand drk brn.
2'	5'			silty sand; fine + scattered med, wet
				some clays present
5'	11'			sandy clayey silt, brn. scattered fine
				sands.
11'	15'			same as above
EOH				

NBK-ENVIRONMENTAL SERVICES

Sample/Core Log

Borng/Well 02527 Project/No. 2127 Page 1 of 1

Site Location Lake Ladora Drilling Started 910521 Drilling Completed 910521

Total Depth Drilled 10± feet Hole Diameter 7¼ inches Type of Sample/ Conng Device N/A

Length and Diameter of Conng Device N/A Sampling Interval N/A feet

Land-Surface Elev. 5222± feet ☒ Surveyed ☐ ~~Estimated~~ Datum MSL

Drilling Fluid Used N/A Drilling Method HSA

Drilling Contractor Layne Driller D. Werner Helper J. Oldham

Prepared By P. R. Berglund Hammer Weight N/A Hammer Drop N/A inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Time/Hydraulic Pressure or Blows per 6 inches	Sample/Core Description
0±	2±			silty sand; fine sand drk brn.
				~~silty sand; fine~~
2±	4±			sandy silt; fine sand drk brn
4±	10±			sandy silt; fine sand brn. some clay
EOH				

MK-ENVIRONMENTAL SERVICES
A DIVISION OF MK-FERGUSON

Sample/Core Log

Boring/Well 02528 Project/No. 2127 Page 1 of 1

Site Location Lake Ladora Drilling Started 910521 Drilling Completed 910521

Total Depth Drilled 10± feet Hole Diameter 7.25 inches Type of Sample/ Coring Device N/A

Length and Diameter of Coring Device N/A Sampling Interval N/A feet

Land-Surface Elev. 5222.50 feet ☒ Surveyed ☐ ~~Estimated~~ Datum MSL

Drilling Fluid Used N/A Drilling Method HSA

Drilling Contractor Layne Driller D. Werner Helper J. Oldham

Prepared By P.R. Berglund Hammer Weight N/A Hammer Drop N/A inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Time/Hydraulic Pressure or Blows per 6 inches	Sample/Core Description
0±	2±			silty sand; fine sand drk brn
2±	4±			sandy silt; fine sand drk brn.
4±	10±			sandy silt; fine sand brn. some clay
EOH.				

MK-ENVIRONMENTAL SERVICES
A DIVISION OF THE FOUNDATION

Sample/Core Log

Boring/Well 02530 Project/No. 2127 Page 1 of 1

Site Location Lake Ladora Drilling Started 910521 Drilling Completed 910521

Total Depth Drilled 16.0 feet Hole Diameter 7.75 inches Type of Sample/ Coring Device N/A

Length and Diameter of Coring Device N/A Sampling Interval N/A feet

Land-Surface Elev. 5225.91 feet ☒ Surveyed ☐ Estimated Datum MSL

Drilling Fluid Used N/A Drilling Method HSA

Drilling Contractor Layne Driller D. Verner Helper J. Oldham

Prepared By P.R. Berglund Hammer Weight N/A Hammer Drop N/A inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Time/Hydraulic Pressure or Blows per 6 inches	Sample/Core Description
0.0	3.0			silty sand; fine grain sand drk. brn.
3.0	7.0			silty sand; fine sand brn.
7.0	9.0			clayey silt; lt brn moist very few fine grain sand
9.0	14.0			silty clay; green tint dry
14.0	16.0			brown + green tint blocky claystone dry
EOH.				

EBK-ENVIRONMENTAL SERVICES
A DIVISION OF EBK FOUNDATION

Sample/Core Log

Boring/Well D2531 Project/No. 2127 Page 1 of 1

Site Location Lake Ladora Drilling Started 910522 Drilling Completed 910522

Total Depth Drilled 22ft feet Hole Diameter 7.5 inches Type of Sample/ Coring Device N/A

Length and Diameter of Coring Device N/A Sampling Interval N/A feet

Land-Surface Elev. 5233.68 feet ☒ Surveyed ☐ Estimated Datum MSL

Drilling Fluid Used N/A Drilling Method HSA

Drilling Contractor Layne Driller D. Werner Helper J. Oldham

Prepared By P.R. Berglund Hammer Weight N/A Hammer Drop N/A inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Time/Hydraulic Pressure or Blows per 6 inches	Sample/Core Description
0ft	2ft			silty sand; fine sand, some med grains drk brn.
2ft	13ft			sand; brn fine sand w/ scattered med grains
13ft	22ft			silty sand; fine sand, moist, brn
Eott				

MK-ENVIRONMENTAL SERVICES

Sample/Core Log

Boring/Well 02532 Project/No. 2127 Page 1 of 1

Site Location Lake Ladora Drilling Started 910521 Drilling Completed 910521

Total Depth Drilled 10' feet Hole Diameter 7 7/8 inches Type of Sample/ Coring Device N/A

Length and Diameter of Coring Device N/A Sampling Interval N/A feet

Land-Surface Elev. 5223.19 feet ☒ Surveyed ☐ Estimated Datum MSL

Drilling Fluid Used N/A Drilling Method HSA

Drilling Contractor Layne Driller D. Wagner Helper J. Oldham

Prepared By P. R. Berglund Hammer Weight N/A Hammer Drop N/A inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Time/Hydraulic Pressure or Blows per 6 inches	Sample/Core Description
0'	2'			Sandy silt; fine grain sand drk brn.
				topsoil type material
2'	4'			sandy clayey silt, very little fine +
				v. fine sand, drk brn.
4'	10'			silty sand · < 10% silt, v. fine + fine
				grain sand brn.
EOH.				

ABB-ENVIRONMENTAL SERVICES
A DIVISION OF ABB-PETROCON

Sample/Core Log

Boring/Well 02533 Project/No. 2127 Page 1 of 1

Site Location Lake Ladora Drilling Started 910520 Drilling Completed 910520

Total Depth Drilled 23' feet Hole Diameter 7 7/8 inches Type of Sample/ Coring Device N/A

Length and Diameter of Coring Device N/A Sampling Interval N/A feet

Land-Surface Elev. 5223.03 feet ☒ Surveyed ☐ Estimated Datum MSL

Drilling Fluid Used N/A Drilling Method HSA

Drilling Contractor Layne Driller D. Werner Helper J. Oldham

Prepared By JWT Hammer Weight N/A Hammer Drop N/A inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Time/Hydraulic Pressure or Blows per 6 inches	Sample/Core Description
0'	3'			Dark loam
3'	5'			Same as above w/ more clay water approx 3'
5'	10'			sand, fine to med. grained dark biege in color, some clay moist
10'	15'			Same as above except very moist some coarse grains
15'	20'			Same as above
20'	23'			Same as above
EOH.				

SEC-ENVIRONMENTAL SERVICES
A DIVISION OF SEC PETROLEUM

Sample/Core Log

Boring/Well 02534 Project/No. 2127 Page 1 of 1

Site Location Lake Ladora Drilling Started 910520 Drilling Completed 910520

Total Depth Drilled 14± feet Hole Diameter 7 7/8 inches Type of Sample/ Coring Device N/A

Length and Diameter of Coring Device N/A Sampling Interval N/A feet

Land-Surface Elev. 5230 27 feet ☒ Surveyed ☐ Estimated Datum MSL

Drilling Fluid Used N/A Drilling Method HSA

Drilling Contractor Layne Driller D. Werner Helper J. Oldham

Prepared By JWT Hammer Weight N/A Hammer Drop N/A inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Time/Hydraulic Pressure or Blows per 6 inches	Sample/Core Description
0±	4±			sand, fine to med light colored, powdery texture
4±	9±			Coarser sand @ ~7± darker + more moisture @ 8±
				med to coarse grained from 7± to 9±
9±	14±			med to coarse grained sand w/ some clay intermixed (not clay lenses or beds) moist, med. color
EOH				

NUS-ENVIRONMENTAL SERVICES
A DIVISION OF NUS CORPORATION

Sample/Core Log

Boring/Well 02535 Project/No. 2127 Page 1 of 1

Site Location Lake Ladora Drilling Started 910520 Drilling Completed 910520

Total Depth Drilled 10± feet Hole Diameter 7 1/4 inches Type of Sample/ Coring Device N/A

Length and Diameter of Coring Device N/A Sampling Interval N/A feet

Land-Surface Elev. 5223.48 feet ☒ Surveyed ☐ Estimated Datum MSL

Drilling Fluid Used N/A Drilling Method HSA

Drilling Contractor Layne Driller D. Werner Helper J. Oldham

Prepared By JNT Hammer Weight N/A Hammer Drop N/A inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Time/Hydraulic Pressure or Blows per 6 inches	Sample/Core Description
0±	3±			Dark loam water approx 3±
3±	10±			moist, lt. colored med to coarse
				grained
EOH.				

SEC-ENVIRONMENTAL SERVICES
A DIVISION OF SEC-PACIFICORP

Sample/Core Log

Boring/Well 02536 Project/No. 2127 Page 1 of 1

Site Location Lake Ladora Drilling Started 910522 Drilling Completed 910522

Total Depth Drilled 4.0' feet Hole Diameter 7.25 inches Type of Sample/ Coring Device N/A

Length and Diameter of Coring Device N/A Sampling Interval N/A feet

Land-Surface Elev. 5222.38 feet ☒ Surveyed ☐ Estimated Datum MSL

Drilling Fluid Used N/A Drilling Method HSA

Drilling Contractor Layne Driller D. Werner Helper J. Oldham

Prepared By P. R Berglund Hammer Weight 140# Hammer Drop 30 inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Time/Hydraulic Pressure or Blows per 6 inches	Sample/Core Description
				pushed well point to 6.5
6.5	7.0		9	
7.0	7.5		11	
7.5	8.0		13	
8.0	8.5		20	
8.5	9.0		20	
9.0	9.5		23	
9.5	10.0		21	
SOH				

NUS-ENVIRONMENTAL SERVICES
A DIVISION OF NUS CORPORATION

Sample/Core Log

Boring/Well 02537 Project/No. 2127 Page 1 of 1

Site Location Lake Ladera Drilling Started 910523 Drilling Completed 910523

Total Depth Drilled 5± feet Hole Diameter 7 7/8 inches Type of Sample/ Coring Device N/A

Length and Diameter of Coring Device N/A Sampling Interval N/A feet

Land-Surface Elev. 522 32± feet ☒ Surveyed ☐ Estimated Datum MSL

Drilling Fluid Used N/A Drilling Method HSA

Drilling Contractor Layne Driller D. Werner Helper J. Oldham

Prepared By P.R. Berglund Hammer Weight 140# Hammer Drop 30 inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Time/Hydraulic Pressure or Blows per 6 inches	Sample/Core Description
				push well point to 7'
7±	7 5/8±		8	
7 5/8±	8±		11	
8±	8 5/8±		13	
8 5/8±	9±		12	
9±	9 5/8±		15	
9 5/8±	10±		15	
EOH				

MK-ENVIRONMENTAL SERVICES

Sample/Core Log

Boring/Well 02538 Project/No. 2127 Page 1 of 1

Site Location Lake Ladora Drilling Started 910523 Drilling Completed 910523

Total Depth Drilled 5° feet Hole Diameter 7 5/8 inches Type of Sample/ Coring Device N/A

Length and Diameter of Coring Device N/A Sampling Interval N/A feet

Land-Surface Elev. 5224 55 feet ☒ Surveyed ☐ Estimated Datum MSL

Drilling Fluid Used N/A Drilling Method HSA

Drilling Contractor Layne Driller D. Werner Helper J. Oldham

Prepared By P.R. Berglund Hammer Weight 140# Hammer Drop 30 inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Time/Hydraulic Pressure or Blows per 6 inches	Sample/Core Description
				pushed well point to 7°
7°	7 5/8		7	
7 5/8	8°		14	
8°	8 5/8		20	
8 5/8	9°		27	
9°	9 5/8		28	
9 5/8	10°		24	
	EOH			

NK-ENVIRONMENTAL SERVICES
A DIVISION OF NK-FOREMOST

Sample/Core Log

Boring/Well 02539 Project/No. 2127 Page 1 of 1

Site Location Lake Ladora Drilling Started 910522 Drilling Completed 910522

Total Depth Drilled 5' feet Hole Diameter 7 1/4 inches Type of Sample/ Coring Device N/A

Length and Diameter of Coring Device N/A Sampling Interval N/A feet

Land-Surface Elev. 5232.13 feet ☒ Surveyed ☐ Estimated Datum MSL

Drilling Fluid Used N/A Drilling Method HSA

Drilling Contractor Layne Driller D. Werner Helper J. Oldham

Prepared By P.R. Berglund Hammer Weight 140# Hammer Drop 30" inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Time/Hydraulic Pressure or Blows per 6 inches	Sample/Core Description
				pushed well point to 8.0
8.0	8.5		14	
8.5	9.0		18	
9.0	9.5		19	
9.5	10.2		19	
				at 10' the threads started to break
				due to the hammering. pushed well
				point to 14.2'
14.2	14.2		42	
14.2	15.0			did not get blow count for 14.2 to
				15.0 well point set at 15.0
EOH				

6 ½	7 ¤		9	
7 ¤	7 ½		11	
7 ½	8 ¤		17	
8 ¤	8 ½		18	
8 ½	9 ¤		21	
9 ¤	9 ½		19	
9 ½	10 ¤		21	
	Eoff.			

NUS-ENVIRONMENTAL SERVICES
A DIVISION OF NUS CORPORATION

Sample/Core Log

Boring/Well 02541 Project/No. 2127 Page 1 of 1

Site Location Lake Ladora Drilling Started 910523 Drilling Completed 910523

Total Depth Drilled 5± feet Hole Diameter 7 7/8 inches Type of Sample/ Coring Device N/A

Length and Diameter of Coring Device N/A Sampling Interval N/A feet

Land-Surface Elev. 5225.82± feet ☒ Surveyed ☐ Estimated Datum MSL

Drilling Fluid Used N/A Drilling Method HSA

Drilling Contractor Layne Driller D. Werner Helper J. Oldham

Prepared By P.R. Berglund Hammer Weight 140# Hammer Drop 30 inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Time/Hydraulic Pressure or Blows per 6 inches	Sample/Core Description
				pushed well point to 6±
6±	7±		4	
7±	7±		4	
7±	8±		4	
8±	8±		5	
8±	9±		5	
9±	9±		6	
9±	10±		8	
	EOH			

EBX-ENVIRONMENTAL SERVICES

Well Development Worksheet for 2 inch Wells

C 1 Well No.	C 2 Total Well Depth * (ft.)	C 3 Depth to Water * (ft.)	C 4 Height-Water Column (ft.)	C 5 Borehole Diameter (in.)	C 6 Water Volume in 7 3/4" Borehole [(C4)(0.75)] (gal.)	C 7 Water Volume in 10" Borehole [(C4)(1.48)] (gal.)	C 8 Minimum Water Volume Removed [(C6 or C7)(5)] (gal.)
02523 (MW1)	14.9'	5.15'	9.75'	7.75"	7.3	—	36.56 gal.
02524 (MW2)	20.0'	10.42'	9.58'	7.75"	7.2	—	35.93 gal.
02525 (MW3)	18.4'	6.15'	12.25'	7.75"	9.2	—	45.99 gal.
02526 (MW4)	14.6'	9.90'	4.7'	7.75"	3.5	—	17.63 gal.

* Reference : T.O.C.

APPENDIX C

RESPONSES TO COMMENTS ON THE DRAFT IMPLEMENTATION DOCUMENT OTHER CONTAMINATION SOURCES INTERIM RESPONSE ACTION SOUTH TANK FARM PLUME

RESPONSES TO COMMENTS BY THE
U. S. ENVIRONMENTAL PROTECTION AGENCY

GENERAL COMMENTS

1. In a special committee meeting held by the OAS on March 13, 1991 to resolve the STFP dispute, the Army indicated that continuous water-level measurements were recorded for Lake Ladora. EPA requests inclusion of these data for May and June 1991.

Response: Table C-1 presents the information requested by the EPA.

The Army typically collects lake level measurements every 2 hours, 7 days a week. These readings are recorded from the Army's staff gages for both Lower Derby Lake and Lake Ladora. At the end of the month, the Army averages the readings for a daily level. These data are readily available from the Army. To monitor variations in the lake, Shell examines the lake level log sheets for variations from typical management procedures and records a single measurement for two days per week (keeping a record of 8 to 10 readings per month). In addition, Shell records water levels for the lake staff gages whenever water levels are measured in the wells.

Due to management practices for the lakes, slight fluctuations in lake levels are inevitable. For example, Lake Ladora is typically brought up to level (12.9 feet on the staff gage) and allowed to decline a little (0.1 to 0.2 feet) before the lake is brought to level again. For Lower Derby Lake the water level drop is generally on the order of 0.5 to 1 feet before the lake is brought back to a level of

TABLE C-1. LAKE LADORA ARMY STAFF GAGE READINGS

DATE	STAFF GAGE READING (FT)	DATE	STAFF GAGE READING (FT)	DATE	STAFF GAGE READING (FT)*
01-May-91	12.8	01-Jun-91	12.8	01-Jul-91	12.7
02-May-91	12.8	02-Jun-91	12.8	04-Jul-91	12.7
03-May-91	12.8	03-Jun-91	12.8	08-Jul-91	12.8
04-May-91	12.8	04-Jun-91	12.8	11-Jul-91	12.7
05-May-91	12.8	05-Jun-91	12.8	15-Jul-91	12.85
06-May-91	12.8	06-Jun-91	12.8	18-Jul-91	12.7
07-May-91	12.8	07-Jun-91	12.9	22-Jul-91	12.8
08-May-91	12.7	08-Jun-91	12.8	25-Jul-91	12.8
09-May-91	12.7	09-Jun-91	12.8	29-Jul-91	12.9
10-May-91	12.7	10-Jun-91	12.8		
11-May-91	12.7	11-Jun-91	12.8		
12-May-91	12.6	12-Jun-91	12.8		
13-May-91	12.6	13-Jun-91	12.8		
14-May-91	12.6	14-Jun-91	12.7		
15-May-91	12.6	15-Jun-91	12.7		
16-May-91	12.6	16-Jun-91	12.7		
17-May-91	12.7	17-Jun-91	12.7		
18-May-91	12.9	18-Jun-91	12.7		
19-May-91	12.9	19-Jun-91	12.7		
20-May-91	12.9	20-Jun-91	12.9		
21-May-91	12.8	21-Jun-91	12.9		
22-May-91	12.8	22-Jun-91	12.9		
23-May-91	12.8	23-Jun-91	12.9		
24-May-91	12.9	24-Jun-91	12.9		
25-May-91	12.9	25-Jun-91	12.9		
26-May-91	12.9	26-Jun-91	12.8		
27-May-91	12.8	27-Jun-91	12.8		
28-May-91	12.9	28-Jun-91	12.8		
29-May-91	12.9	29-Jun-91	12.8		
30-May-91	12.8	30-Jun-91	12.8		
31-May-91	12.8				

A STAFF GAGE READING OF 12.9 FT EQUALS AN ELEVATION OF 5219.96 FT ABOVE MSL

* - MEASUREMENTS ARE FOR APPROXIMATELY 12:00 NOON

16.5 feet on the staff gage. These changes typically occur within a few days. However, these short-term fluctuations do not affect the overall hydrologic influence of the lake on the local groundwater.

2. We recommend that daily water levels be recorded at the Lake Ladora pump house. Also, quarterly staff gage readings at all staff gages for both Lake Ladora and Lower Derby Lake at the time that the wells are measured are recommended.

Response: See the response to General Comment 1.

3. The inoperative drive-point wells need to be replaced by operative wells as soon as possible, but before the next water-level measurement event. It is suggested that drilled piezometers can be used, based on past experience at these locations.

Response: Shell is currently undertaking other options for unplugging the four well points at issue (Wells 02536, 02537, 02538, and 02540). If these well points can not be unplugged, they will be replaced prior to the next quarterly-water level measurement event.

4. Page 3-1, Section 3.0. The Implementation Document needs to include the contingency actions that will be implemented if the results of the quarterly water-level measurements indicate that groundwater may be flowing into Lake Ladora. At a minimum, the four new monitoring wells installed along the eastern edge of the lake should be sampled and analyzed as agreed in the Army's dispute resolution letter of April 8, 1991.

Response: The contingency actions requested by the EPA were outlined in the Army's April 8, 1991 letter regarding the

agreements reached during the special RMA Committee meeting of March 13, 1991. This letter states:

> If evaluation of the water level monitoring data indicates groundwater may be flowing into Lake Ladora, and this process can not be controlled by managing the lake elevation, the Army agrees to collect groundwater samples from selected wells near Lake Ladora and analyze at a minimum for those compounds identified in the EPA's September 24, 1990 letter, Specific Comment 2, on the Proposed Decision Document . . . .

Water-level monitoring results show that the inflow of groundwater to Lake Ladora is controlled by maintaining the lake level. Therefore, according to the agreements outlined in the April 8, 1991 letter, it is not necessary to collect further groundwater samples.

The Army's agreement to conduct water sampling near Lake Ladora, if groundwater flow could not be controlled by lake management, would not be a future phase of the IRA. However, as stated in the April 8, 1991 letter:

> The results of the monitoring and sampling programs will be used in another phase of assessment and decision under the STFP IRA per the FFA process for 'Other Contamination Sources' IRAs.

It is therefore, inappropriate to include mention of additional sampling within the current IRA documentation.

5. From the information presented in this report, it is not necessarily conclusive that a reverse hydraulic gradient from the lake to the groundwater will be created even if the lake is maintained at 5220 feet. Therefore, to ensure that this reverse gradient is established, the lake would have to

be raised and maintained continuously at an elevation of 5221 feet above mean sea level. The continuous water-level measurements being made in the lakes should be provided in the Final Implementation Document.

Response: Regarding the water level measurements, please reference the response to General Comment 1.

While the information contained in the Draft Implementation Document and subsequent water level measurements (included in this document) show that maintaining the lake level at 5220 feet would be sufficient, raising the lake level to 5221 feet would indeed ensure that a larger (hence more conclusive) reverse gradient is established.

The Army is currently assessing the need to repair the dam on Lake Ladora. If repairs are required, it would be a good opportunity to increase the capacity of the lake such that higher lake water levels may be maintained.

SPECIFIC COMMENTS

1. Page following page 3-5, Figure 6. One of the piezometer locations is reported as Well 01231. This appears to be a typographical error. This location corresponds to Well 02531 shown on Figure 5. Please confirm this well's proper identification number and correct Figure 6 accordingly.

   Response: The well number has been corrected on the figure.

2. Appendix A, page A-1, second paragraph. The changes in water-table elevations since December 1990 are discussed in this paragraph. Please specify the actual amount of relative water level change discussed in this paragraph.

Response: The discussion provided in this paragraph is intended to qualitatively provide a general overview of the STFP area groundwater hydrology. This comparison is with respect to the results of the Fall 1990 water level measurements as provided in Figure 2-2 of the Final Decision Document (Shell 1991) or Figure 5 of the "Results of the Verification Monitoring Program, South Tank Farm Plume, RMA" (Shell 1990). The "actual amount of relative water level change" may be obtained by directly comparing the Fall 1990 water level for a specific well with the June 1991 level for that same well.

3. Appendix A, page A-2. Please clearly specify: exactly how many staff gages were installed; in which lake(s) they were installed; the date(s) measured; and the elevation datums for all staff gages, whether previously existing or new. Please show the location of the existing staff gages (and newly installed gages) on Figures 8 and A-1.

Response: Two staff gages were installed on the eastern edge of Lake Ladora. One is aligned with Wells 02527 and 02528, and the other was originally aligned with Well 02535. As stated on page A-2 of this document, this staff gage was relocated to the southern end of the lake on August 7, 1991. The text and figures have been modified according to the EPA's request.

4. Appendix A, page A-2, third paragraph, second to the last sentence. Well point 02539 was reported as unplugged after using a variety of well development techniques. However, the water-table elevation measurement for this well was not given. Please provide this information on Figure A-1.

Response: A water level was not provided for Well 02539 because the well was unplugged after the water level

measurements for the entire area had been collected. Water levels for this well have been provided for subsequent water level monitoring episodes.

5. Appendix A, page A-3, first paragraph, second sentence. Please explain the statement that the surface-water elevation, as measured at staff gages along the eastern and western edge of Lake Ladora, ranged from 5219.76 to 5219.95. Is this a temporal or spatial range in elevations? Please provide a table of all water-level elevations in the lake at all staff gages during the period of this investigation.

Response: As stated in paragraph 2 on page A-2, the existing Army staff gages on Lake Ladora and Lower Derby Lake and the new staff gages along the eastern edge of Lake Ladora were resurveyed by MK-ES. The results of this survey showed that the water surface elevation was the same at the two staff gages on the northern portion of Lake Ladora. The same has been true during subsequent measurements. It is an accurate conclusion that the lake water level is uniform throughout the lake between the staff gages. Hence, the observed changes in lake elevation are temporal. As per the EPA's request, a tabulation of the lake level measurements has been provided. In addition, please reference the response to General Comment 1.

6. Appendix A, page A-3, second and third paragraphs. The differences in water levels near the lake are very subtle and do not definitively support the conclusion that there is a hydraulic gradient away from the lake for a distance of 50 to 100 feet. However, this possibility may exist, but to only a limited degree, if the lake is maintained at a minimum elevation of 5220 feet above mean sea level.

The lowest groundwater elevation measured for the first round of water levels in the new wells was 5219.64 feet in Well 02530. Other wells at approximately the same distance from the lake both to the north and south of Well 02530 show groundwater elevations above the lake's water level. For instance, Wells 02528 and 02001 to the north of Well 02530 are reported at 5220.08 feet and 5220.45 feet. The water-level measurements reported for the paired Wells 02527 and 02528 indicate an upward hydraulic gradient, a common observation in areas of groundwater discharge, such as to lakes, rivers, and swamps.

Response: Regarding raising the lake level to 5221 feet and respective modifications to the spillway or dam, please reference the response to General Comment 5.

Water level data collected more recently (and included in this document) has shown that there is a more pronounced hydraulic gradient away from the lake. In addition, the more recent data shows a downward vertical gradient for both sets of paired piezometers.

7. Appendix B. Please provide complete geologic logs for the borings used to install the new wells and piezometers. Also, please provide a reference to the records for the development of these wells.

Response: Per the EPA's request, the boring logs have been included, as have the records of well development.

RESPONSES TO COMMENTS BY THE U.S. DEPARTMENT OF INTERIOR FISH AND WILDLIFE SERVICE

1. On page A-2, it was stated that five of the well points to measure water-level were clogged. After additional efforts were taken, only one well point was unplugged. No water-level data was taken from the remaining four well points. Will these wells be redrilled so a total of nineteen wells are used in determining water-level between the lakes and Sand Creek Lateral as agreed by the OAS?

   Response: Please refer to the response to EPA General Comment 3, regarding the replacement of the four plugged well points.

2. It appears from your first round of water-level monitoring that groundwater along the eastern edge of Lake Ladora is not expected to impact Lake Ladora, assuming hydrogeologic conditions remain similar to those currently observed. Continual monitoring will determine if these conditions are maintained.

   Response: The Fish and Wildlife Service's assessment of the first round of water-level monitoring is correct. For further details, please refer to the response to EPA General Comment 1, regarding continual monitoring of the lake's water elevation.

3. As a final comment, the Service would like to reiterate that although we have concurred with the proposed monitoring plan, the Service remains concerned in regards to the other contaminants present in the South Tank Farm Plume area (including chloroform, chlorobenzene, cyanide, and

dieldrin). The Service notes that cyanide, dieldrin, and other organochlorine pesticides have not been included in the analytical program Page 3-4, Table 1. These compounds have been included in previous analytical efforts. Why have they been deleted from the program?

Response: A detailed explanation of this issue was provided in the response to the EPA's General Comment on the Draft Final Decision Document for the South Tank Farm Plume IRA (Page A-1 of the Final Decision Document for the STFP IRA). In addition, according to the Army's April 8, 1991 letter, the Final Decision Document for this IRA was accepted by the organizations, given the conditions outlined within the letter. The Army's letter explains under what condition additional samples would be collected and analyzed for other compounds (please reference the response to EPA General Comment 4). As such, the organizations accepted the monitoring and sampling program described in the Final Decision Document (and subsequently included in this Implementation Document).

RESPONSES TO COMMENTS BY THE COLORADO DEPARTMENT OF HEALTH

GENERAL COMMENTS

1. In its June 6, 1991 letter to the Army regarding the South Tank Farm Plume Dispute Resolution, the State requested that criteria upon which the water quality sampling program identified in the Army April 8, 1991, letter to the State would be initiated, be included in the Final Decision Document; however, the criteria were also not included in the Draft Implementation Document. Please include the requested criteria in the Final Implementation Document, possibly in Section 4.2.

Response: The criteria upon which additional groundwater sampling would be undertaken by the Army, were clearly defined in the Army's April 8, 1991 letter (see response to EPA General Comment 4).

In its June 24, 1991 response to the CDH's letter of June 6, 1991, the Army states:

> After review of the Draft Implementation Document, the Army will determine whether chemical analysis should be performed as stated in the April 8, 1991 letter. It should be noted, however, that the chemical analysis program would not be a part of the implementation of this IRA, but rather a separate study (i.e. a chemical analysis program will not be identified in the Implementation Document).

Therefore, these criteria are not included in this IRA document.

2. The State and EPA both provided comments to the Army by March of 1991 on the Verification Monitoring Program Document. Although these comments and responses to the comments are not required as part of the Interim Response Action, the comments are directly applicable to sections of the Draft Implementation Document, and would help to clarify certain sections of that report and to minimize duplication of effort (for example, several of the questions presented in the prior comment package have been repeated in the comments on the Draft Implementation Document). Therefore, please include responses to comments on the Verification Monitoring Program Document in the Final Implementation Document.

Response: As stated by the CDH, the Verification Monitoring Program Document was not an IRA deliverable requiring responses. None will be furnished because responses to repeated comments have already been provided. Due to the excessive comments which have been processed regarding this IRA, Shell believes resources were better allocated in completing work required to progress the IRA.

3. Shell continues to reference and make interpretations based on data not included in the RMA Environmental Data Base (see Specific Comments 1 and 4). All data included in the database have passed RMAPMO validation, whereas the status of QA/QC procedures for data not included in the database cannot be verified. Therefore, the State is not able to properly evaluate data referenced by Shell but not included in the database. In an April 4, 1991 letter to the Army, the State requested that procedures followed by the Army for submittal and acceptance of dat- to the RMA Environmental Data Base also be required of Shell; only in this way can all parties be assured that referenced data have been properly validated. We again request that all Shell data be

included in the database, that procedures followed by the Army for submittal of data to the database be followed by Shell, and that only those data included in the database (or submitted to the database and under review) be referenced in RMA letters/documents.

Response: Shell has submitted the data to the RMA Environmental Data Base.

4. Prior to the artificial rise in surface water elevations of Lake Ladora, the eastern side of the lake served as a groundwater discharge area (Potential Migration of Contaminated Groundwater to Lakes Ladora and Lower Derby, December 1990, p. 1, Conclusion b.); however, increasing the elevation in the lake will cause discharge from the lake to the groundwater (and possible dissolution of contaminants in the sediment), and bypass of the upgradient groundwater around the lake. The impact of this modification on the flow system does not appear to have been evaluated by the Army or Shell. Examination of the unconfined flow system water table elevation map (Comprehensive Monitoring Program Annual Ground Water Report for 1990, Draft Report, February 1991, Figure 4.1-4) indicates that groundwater which would migrate around the lake to the north and south would then move to the west-northwest, eventually migrating offpost in either Sections 28 or 33, and possibly Section 27. Currently, no CMP wells exist in the area to the west-southwest of Lake Ladora; therefore, wells in this area would have to be added to the list of annual monitoring wells as part of this IRA. We request a meeting with Shell and the Army to finalize selection of monitoring wells in this area to determine how the increase in surface water elevation affects the local hydrologic regime.

Wells do exist to the north of the lake, and data from these wells indicate the presence of dieldrin, chloroform, and DIMP. It is not known how bypassing of groundwater around the lake to the north may influence the distribution of these analytes, but a probable impact will be dilution and dispersion of the contaminants, possibly making remediation more difficult, time-consuming, and expensive.

Response: There is no artificial rise in surface water elevations of Lake Ladora. Figure 2.4-28 of Appendix F of the Final Water RI illustrates that the general lake management practices described in the response to EPA General Comment 1 have been ongoing for several years. According to this management practice, the average lake elevation is approximately 5219.5 feet. In the past six months this practice has been modified for Lake Ladora to decrease the level fluctuations. Conclusion b of the December 1990 report is in error regarding the status of Lake Ladora and the average lake elevation, as it pertains to the last 5 plus years.

5. An examination of the limited temporal chemical groundwater data from wells located within the South Tank Farm benzene plume, and wells located on the downgradient and lateral edges of the plume, indicate that there may be cyclicity in the data, and that the cyclicity in the two sets of wells are lagged. Wells within the plume appear to have peak concentrations in the months of November/December (fall sampling episode) and decreased concentrations in spring, while wells on the edges of the plume appear to have peak concentrations in March/April (winter and spring sampling episodes) and decreased concentrations in the latter part of the year. Examples of well data on which the above observations are based are presented below.

Well No.	Benzene Concentration (ug/l)	Date-1 Sample Collected	Location With Respect To Plume	% Increase (+) or Decrease (-)
02583	18,900 23,600	90080-2 90305-3	In	+25%
02576	9,430 18,900/47,200	90086 90304	In	+100%/+400%
02501	37,700 47,200	90094 90305	In	+25%
02502	18,900 33,000	89108-4 90305	In	+75%
02503	5,660 9,430/13,200	89107 90304	In In	+67%/+133%
02580	20.8 <2.7	90081 90302	Edge	>-87%
02578	13.2 <2.7	90081 90299	Edge	>-8%
02504	1,420 70.8/94.3 377/472 3.87/3.96	89107 89313 90093 90303	Edge	-95%/-93% -99% in all cases

1. -- Julian date.

2. -- The 80th day of 1990 is equivalent to March 21, 1990 (fiscal year winter or spring sampling programs).

3. -- The 305th day of 1990 is equivalent to November 2, 1990 (fiscal year fall sampling program).

4. -- Data are not available for spring of 1990, so data from spring of 1989 used; 75% increase is probably greater than if data from the same year had been available.

Chemical data are currently limited to annual, and sometimes semi-annual sampling programs; a much greater sampling frequency would be necessary to better define peaks-troughs in the data and interpret the cause of the cyclicity. Although the observation regarding cyclicity in the benzene data is based on a limited temporal data set, the semi-annual changes in concentrations are great enough that the variation in benzene concentrations should be investigated.

This is especially important in defining the downgradient extent of the plume. If cyclicity is present in any well defining the edge of the plume (e.g., in 1989, Well 02504 showed a decrease in benzene concentrations from 1420 ug/l to approximately 90 ug/l in 6.5 months; the next year, a similar decrease from approximately 400 ug/l to 4 ug/l was noted over the same time period) then, at the very least, the well should be sampled during the period when concentrations in the well reach a maximum. Currently, there is no understanding of the temporal variations in concentration, or of the magnitude of the changes. To correct this and optimize data collected as part of the IRA sampling program, the State requests that two wells, one within the plume and one on the downgradient edge of the plume (Wells 02576 and 02504 respectively), be sampled only for benzene on a monthly basis for a period of one year. This program will provide information on: 1. cyclicity in benzene concentrations; 2. the magnitude of changes in benzene concentrations; and 3. lag times between maximum/minimum concentrations in wells on the edge of the plume versus wells within the plume. Based on findings from this study, it is possible that the chemical sampling program may have to be changed from its current year fall schedule.

Response: Benzene was detected in Well 02504 and not in Wells 02505 or 02506 of the Phase II monitoring program during May 1990. These results are considered more accurate than the Phase I results cited by the State (see the response to Specific Comment 1 below). The Phase II results clearly indicate that the benzene plume has been adequately characterized, and the leading edge of the plume is somewhere downgradient of Well 02504 and upgradient of Well 02505. This has been the case for over 2 years (as demonstrated by the data provided in the State's comment),

resulting in the conclusion that the leading edge of the STFP is migrating at an immeasurable rate and the plume is not going to impact Lake Ladora.

SPECIFIC COMMENTS

1. Page 3-1. Shell states:

> Results of the verification sampling program show the results to be consistent with the Spring 1990 conditions.

This interpretation is based on a comparison between Shell's spring and fall 1990 benzene data, as shown in Figures 18 and 23 of the Verification Monitoring Program Document. However, examination of spring 1990 data in the RMA Environmental Data Base indicates that Wells 02505 and 02506, located downgradient of the leading edge of the plume as identified by Shell, had benzene detections of 10.4 ug/l and 13.2 ug/l, respectively. A Phase II program conducted in May of 1990, the results of which are listed in Appendix A of the Hydrogeologic and Water Quality Conditions South Tank Farm Plume, RMA, May 1990, but not included in the RMA Environmental Data Base, resulted in benzene values below CRLs for both wells, and these were the data accepted by Shell, though with no explanation. Without such an explanation as to why the original data are not valid, the spring data indicating benzene detections cannot be ignored. Additionally, the first sampling round occurred in the time period when concentrations appear to be higher in wells in the edge of the STFP than at other times of the year (General Comment 5). Therefore, until and unless subsequent data sampling events verify that the benzene detections in Wells 02505 and 02506 were anomalous, the conservative

assumption is to assume that low concentrations of benzene are present in these wells, and that the leading edge of the plume is dispersed and not as well-defined as currently presented. Please modify the text accordingly.

Response:

Please refer to the response to General Comment 3 above.

Phase II of the Spring 1990 sampling program was conducted to assess the extent of sample cross-contamination during the Phase I investigation. The results of the Phase II sampling are considered more accurate than the Phase I data because a sequenced sampling approach was utilized and more stringent decontamination procedures followed.

2. Page 3-1. Shell states:

> The latest distribution of the target analytes, particularly benzene, indicate that the plume not only has not advanced but has receded slightly since the Spring of 1990.

As pointed out by the State in its February 20, 1991 letter to the Army regarding the Verification Monitoring Program Document (Comment 4), benzene concentrations at the downgradient extent of the plume appear to increase in the spring months (March and beginning of April) and decrease during the fall and winter months. The benzene concentrations and sample collection dates for Well 02504, which defines the downgradient extent of the benzene plume as currently identified by Shell, are again presented below:

Benzene Concentration (ug/l)	Sample Collection Data
1420-1	89107
70.8/94.3	89313
377/472	90093
3.87/3.96	90303

1 -- RMA Environmental Data Base.

The reason for the cyclic behavior of the concentrations is not clear (General Comment 4); however, because of the cyclicity, the data should not be used to make interpretations about changes in the extent of the plume based on one fall sample.

Additionally, Shell states that the fall 1990 distribution of the other Shell-defined target analytes (toluene, xylene, DCPD, and BCHPD) also indicates that the STFP has receded slightly since spring of 1990. However, examination of Figures 24-27 in the Verification Monitoring Program Document indicate that matrix interference effects and the resultant high CRLs for the contaminants in the areas of historical contamination make it impossible to compare these data with the spring 1990 data. Therefore, the State again requests that this statement be deleted from the text.

Response: Please refer to the response to General Comment 5.

3. Figure 3. The figure indicates that Well 01538 was sampled during the fall 1990 sampling program, and Well 01537 was not. Based upon the Appendix to the Verification Monitoring

Program Document, these two wells should be reversed; please modify the figure accordingly.

Response: Figure 3 has been corrected.

4. **Page 3-2.** Shell states that wells included in the annual monitoring network were selected to verify the location of the leading edge of the plume. However, the lateral extent on the northwest side of the benzene plume also needs to be characterized. Examination of well data on the RMA Environmental Data Base indicates that several wells located in the saturated alluvium north of the unsaturated alluvium/ weathered Denver Formation in which the majority of the plume is migrating, have benzene detections. These wells and the corresponding benzene concentrations and sampling dates are listed below:

Well No.	Benzene Concentration (ug/l)	Sample Collection Data
02580	<2.7	89104
	20.8	90081
	<2.7	90302
02034	13.	88349
	6.17	89145
	2.7	89312
	7.69	89363

(Well 02518 was only sampled on 89101, and had a benzene value and duplicate value of <2.7 ug/l, and 37.7 ug/l; therefore, these data are inconclusive.)

Well 02578, located along the northern boundary of the unsaturated alluvium and the benzene plume, had the following benzene detections:

Benzene Concentration (ug/l)	Sample Collection Data
13.3	88110
<2.7	89107
13.2	90081
<2.7	90299

while Well 02514, downgradient of Well 02578, had no benzene detections above a CRL of 2.7 ug/l (two measurements). Therefore, to evaluate the northwestern extent of the plume, we request that the following wells be added to the annual water quality monitoring program: 02580, 02514, and 02516. Depending upon data from these wells, the program may have to be modified further.

Response: The annual monitoring program is intended to verify the location of the leading edge of the plume as it pertains to the original objective of this IRA. As stated on page 1-1, the original objective of this IRA was to prevent the migration of the plume from reaching Lake Ladora. In accordance with this, the leading edge is that portion of the plume nearest the lake and migrating towards the lake. As determined from the Fall 1990 Verification Monitoring results, the annual monitoring network is appropriate for monitoring the leading edge of the plume according to these criteria.

5. Examination of data from wells located in the saturated alluvium south of the benzene plume indicates that the following wells have had benzene detections:

Well No.	Concentration (ug/l)	Collection Data
02596	<2.7	89354
	566.	90085
	<2.7	90297
02509	<2.7	89025
	<1.05	90005
	377.	90085

In the Results of Lab and Field QA/QC section of the Hydrogeologic and Water Quality Conditions South Tank Farm Plume, RMA (May 1990), Shell states that spring 1990 benzene detections may represent cross-contamination from Well 02561. A Phase II sampling program, presented in Appendix A but not included in the RMA Environmental Data Base, resulted in benzene concentrations below CRLs for both wells, and these data were selected by Shell as representative of spring 1990 benzene concentrations for the two wells. Additional spring sampling must be conducted to confirm that the 1990 data is invalid; if such subsequent sampling indicates the presence of benzene in the wells, it will be necessary to determine the downgradient extent of the contaminant by adding a downgradient well in the saturated alluvium to the annual monitoring program.

Response: The Verification Monitoring Program (Fall 1990) and the Phase II investigation during the Spring 1990 both resulted in Wells 02509 and 02596 having no benzene concentrations above CRLs. The Phase II results were considered more accurate because greater care was taken to minimize sample cross-contamination. There is no need to expand the frequency of sample collection.

6. Figure 4. The annual monitoring network as presented by Shell in this figure excludes two wells originally included

in the sampling program in the Final Decision Document Other Contamination Sources Interim Response Action South Tank Farm Plume, May 1991 ([Final Decision Document], Figure 4-2), Wells 02577 and 02598. Well 02577 had spring 1988 and spring 1990 benzene detections of 94.2 ug/l and 37.7 ug/l, respectively, and Well 02598 had a spring 1990 benzene detection of 89.6 ug/l (these two wells both had fall 1989 and fall 1990 concentrations below detection limits, again indicating cyclicity in the data). Additionally, both wells had detections of 11DCLE, 12DCE, CHCL3, and TRCLE. Please include these wells in the annual monitoring network as originally presented in the Final Decision Document.

Response: Figure 4 has been corrected to show that these wells are included in the monitoring network.

7. Page A-2. Shell states that two staff gages were installed along the eastern edge of Lake Ladora, however, the gage locations are not presented on Figure A-1. Please include these locations on the figure.

Response: The figures now include the location of the two new staff gages.

8. Page A-2. Shell presents the datum for only one of the two new staff gages. Please present the respective datum for each gage, and clearly label the gages on Figure A-1.

Response: Please refer to the response to EPA Specific Comment 3.

9. Page A-2. Shell states that four of the six newly installed well points are permanently plugged; yet, it does not propose to replace those well points with new well points, monitoring wells or piezometers. Have Shell and the

Army determined that additional data on the eastern edge of the lake are not necessary to characterize the hydrogeologic interaction between the lake and the groundwater? If not, such data should be collected now as part of the proposed monitoring plan.

Response: Please refer to the response to EPA General Comment 3.

10. Page A-3. Shell states:

> The surface elevation of Lake Ladora, measured at the staff gages along the eastern and western edge of the lake, ranged from 5219.96 to 5219.76 feet . . . . This may be seen from Figures A-2 through A-11 where the lake levels for both May 28 and June 6, 1991 are compared to the observed groundwater table elevations. These are the two closest dates for measurements of the lake, prior to installation and survey of the staff gages [on the eastern edge].

This paragraph is confusing. Shell appears to be stating that comparisons between lake stage levels on the eastern side of Lake Ladora were made to upgradient groundwater as a part of this evaluation. However, Figure A-1, showing the location of a single gaging stating on the western shore of the lake, and the final sentence in this paragraph indicate that no lake stage levels on the eastern shore of Lake Ladora were taken as part of this study. If the two gaging stations on the eastern side of the lake had not been completed and surveyed prior to this study, and were therefore not used in this evaluation, the reference to the eastern edge of the lake in the above paragraph should be deleted, and the paragraph rewritten to clarify that only data from the western shore of Lake Ladora were compared to groundwater data upgradient of the lake.

Response: Please refer to the response to EPA Specific Comment 5.

11. Please provide the actual dates during which the water level measurements were taken. Additionally, please provide the dates on which lake stage levels were measured, and the corresponding lake stage elevations (including values for the two new gage stations on the eastern shore of Lake Ladora). In future annual water sampling summaries, these data are also requested.

Response: The groundwater level measurements were collected on June 3 and 4, 1991. The lake stage levels have been provided (see response to EPA General Comment 1).

12. Page A-3. Shell states:

> . . . groundwater along the eastern edge of the lake is not expected to impact the lake, if the lake elevation is maintained at 5,220 feet or above (an average stage of 12.9 feet or greater as measured on the pump house staff gage).

In its June 6, 1991 letter to the Army regarding the South Tank Farm Dispute Resolution, the State summarized information from the May 1990 Comprehensive Monitoring Program Final Surface Water Data Assessment Report for 1988 (Appendix A-2, Table A-2-3) which indicated that lake overflow occurs at a stage level of 12.4 feet, corresponding to an approximate water level of 5,219.5 feet above mean sea level. Please provide the values for the maximum Lake Ladora stage level and corresponding lake water surface elevation, and discuss the feasibility based on these values of maintaining a lake elevation of 5,220 feet or greater.

Response: If the information contained in the May 1990 CMP was correct for the period covering the CMP, those conditions no longer pertain. According to the Army, the lake overflows at a stage exceeding 12.9 feet on the pumphouse gage. This has been corroborated by the recent MK-ES survey of the staff gages and the spillway. The maximum lake water elevation is therefore, in excess of 5219.96 feet.

Please refer to the response to EPA General Comment 5.

13. Page A-3. According to page 1 of the Potential Migration of Contaminated Groundwater to Lakes Ladora and Lower Derby, December 1990, the average lake elevation is 5,208 feet, significantly lower than the 5,219.76 to 5,219.96 elevations recorded by the staff gages recently installed. Please identify the source of water used to maintain the higher lake level.

Response: Please refer to the response to General Comment 4 above.

The majority of water for Lake Ladora comes from Lower Derby Lake. Ultimately this water comes from the Highline Canal and passes through both Upper and Lower Derby Lakes.

14. Figures A-2 to A-6. Please provide the numerical value for the lake water level on May 28, 1991, and for consistency, include this value on Figure A-1 (instead of the 5/23 measurement).

Response: The figure has been modified to include the appropriate information.

15. Figures A-7 to A-11. Please provide the numerical value for the lake water level on June 6, 1991, and for consistency, include this value on Figure A-1 (instead of the 6/14 measurement).

Response: The figure has been modified to include the appropriate information.