

# INDIAN WELLS GROUNDWATER

# VALLEY PROJECT

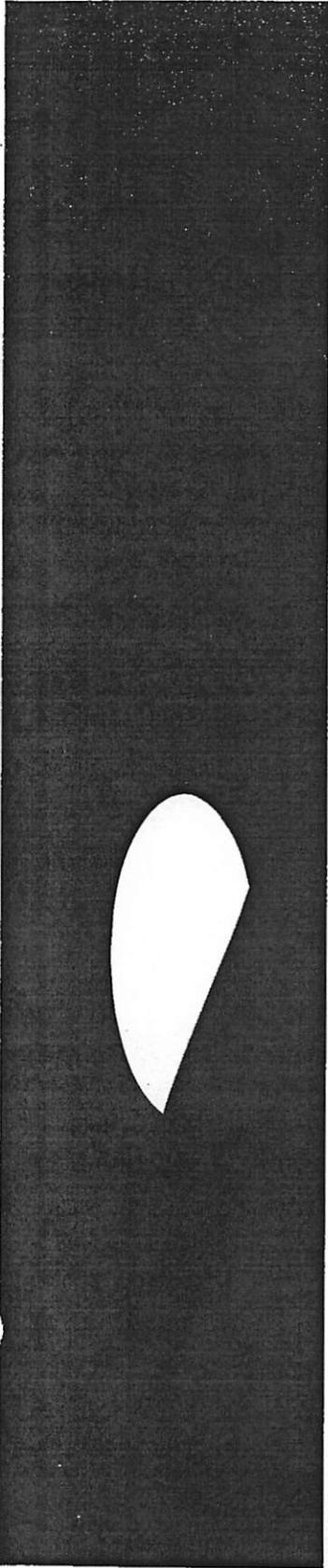
VOLUME II

TECHNICAL REPORT

DECEMBER 1993

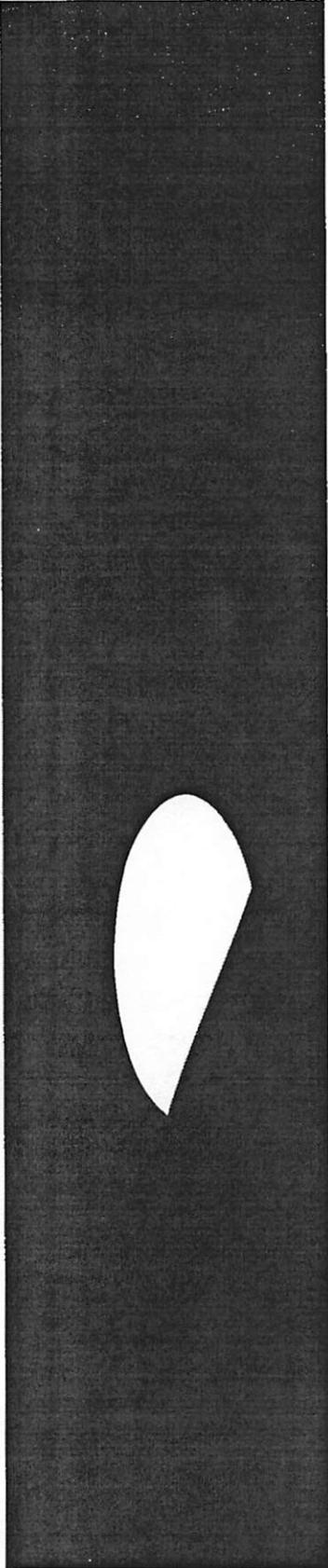


FOR THE FUTURE  
Department of the Interior  
Bureau of Reclamation



# **OUR MISSION**

**To manage, develop, and protect water  
and related resources in an  
environmentally and economically  
sound manner in the interest  
of the American public.**



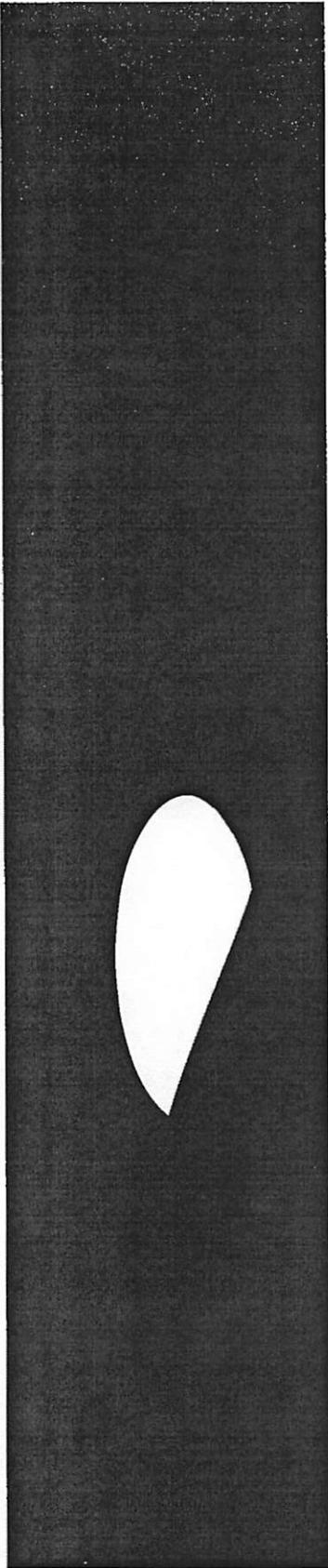
# **INDIAN WELLS VALLEY GROUNDWATER PROJECT**

**A cooperative effort among  
the Bureau of Reclamation,  
the Indian Wells Valley Water District,  
the North American Chemical Company,  
and the Naval Air Weapons Station**

## **TECHNICAL REPORT**

**Prepared By  
Bureau of Reclamation  
Lower Colorado Region**

**December 1993**



# **DISCLAIMER**

**Publication of the study results presented herein should not be construed as representing either the approval or disapproval of the commissioner of the Bureau of Reclamation or the Secretary of the Interior.**

**The purpose of this document is to provide the Indian Wells Valley community with information concerning groundwater resources and to provide optional implementation plans for future development.**

# PREFACE

Documentation of the Indian Wells Valley Groundwater Project is contained in two report volumes. Volume I, the Summary Report, is intended for a general audience. It contains an explanation of the administrative, institutional, and financial aspects of the Project; a description of Project activities; and a non-technical presentation of Project activity results, conclusions, and recommendations.

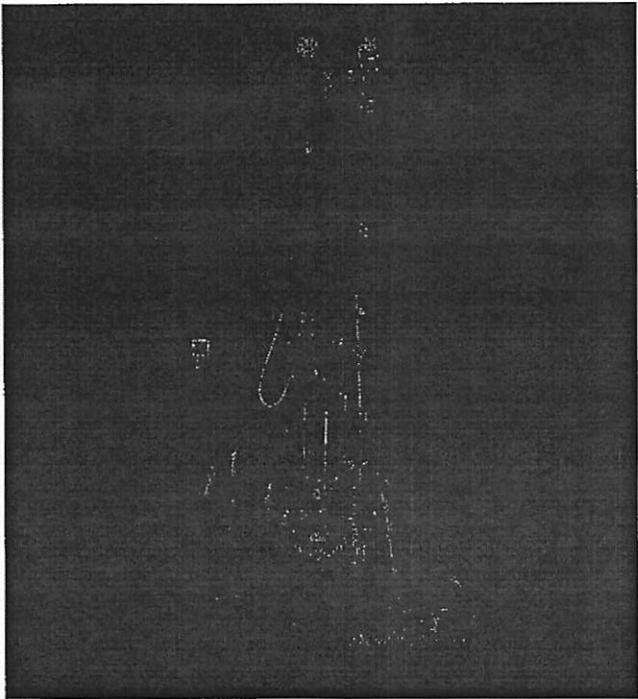
Volume II, the Technical Report, is intended for a technical audience. It provides all of the technical details concerning the test wells, data collected, data analysis, groundwater modeling, and recommendations for future investigations. Technical discussion on groundwater recharge quantities, recharge distribution, pneumatic slug testing, and a hypothesis for the anomalously low transmissivities found in many of the shallow piezometers are appended to this volume. Also included in this volume, are all of the data collected as part of this Project.

Mr. John A. Johnson, civil engineer in the Bureau of Reclamation's Lower Colorado Regional office in Boulder City, Nevada, was the primary author of Volume I, while Mr. Dennis E. Watt, hydrologist for the Bureau of Reclamation in Boulder City, was the principal contributor to Section A of Volume II. Section B of Volume II was done by personnel in the Bureau of Reclamation's Denver office in Denver, Colorado. Mr. Leslie Pehrson, an engineering intern in the Bureau of Reclamation's Boulder City office, performed the calculations in Section C of Volume II. Mr. Gail F. Moulton, chief geologist for the North American Chemical Company of Trona, California; Mr. Michael D. Stoner, geologist with the Naval Air Weapons Station at China Lake, California; and Dr. Don Decker, a physicist with the Naval Air Weapons Station, reviewed drafts of both volumes and provided significant technical and editorial suggestions.

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# EXECUTIVE SUMMARY

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# **EXECUTIVE SUMMARY**

## **PROJECT OBJECTIVE**

The primary objective of the Indian Wells Valley Groundwater Project (Project) was to refine estimates of the life of the natural groundwater resource in the Indian Wells Valley (Valley) and to identify management concepts to conserve and extend the useful life of this resource.

## **APPROACH**

In the Memorandum of Understanding which established the Project, the participants agreed on the goals to be achieved:

- ✓ Refine groundwater resource quantity and quality
- ✓ Refine recharge quantities and locations to the extent possible
- ✓ Model aquifer performance under pumping scenarios that meet future demands
- ✓ Develop future water resource management options, including conservation

To accomplish these goals, the following approach was taken:

- ✓ Summarize existing data and findings
- ✓ Obtain additional information by drilling test wells and collecting data from those wells
- ✓ Evaluate existing recharge and aquifer performance studies
- ✓ Analyze all data and integrate all information into potential water resource utilization plans for the future

## **PROJECT DESCRIPTION**

Ten monitoring wells were drilled during the Project—seven were funded under the Project and three were funded separately by individual Project participants. All wells, irrespective of funding source, were designed and constructed in a similar manner. These wells were located to provide critical water quality and recharge data in areas of the Valley where such information was sparse. Areas of greatest need were in the Southwest, West, and

**Northwest Areas.** All wells were completed with multiple piezometers or sampling tubes within a given bore hole to obtain water samples and water table elevations at selected zones down as deep as 2,000 feet. Data collected and analyzed during the Project included drilling logs; electric, gamma ray, and down-hole temperature logs; stratigraphic interpretations of drill cuttings; static water table levels; water quality at selected depths; and measurements of aquifer transmission characteristics. It was specifically intended that these wells be located and constructed to allow convenient monitoring in the future.

## **MAJOR FINDINGS**

- The Valley fill consists predominantly of sands and fine gravels in the heavily pumped area west of Ridgecrest, in the southwest, and along the extreme western boundary of the Valley.
- Chemical analyses indicate a predominate sodium bicarbonate water in most areas of the Valley.
- Water quality patterns imply that the Sierra Nevada watershed contributes a major portion of the groundwater recharge into the Valley.
- Poor water quality was found in the northwest and north central portions of the Valley associated with a thick organic-bearing clay layer.
- Good quality water was found down to the 2,000-foot drilling depth in the Intermediate and Southwest Areas.
- The west-to-east groundwater surface gradient in the Leliter area (about 4 miles north of Inyokern) indicates minimal recharge into this area from the west.
- A very steep apparent groundwater surface gradient exists in the extreme south and southwest portion of the Valley. This is probably a result of either faults or structural features which restrict groundwater flow.
- A fairly steep groundwater surface gradient exists in the northwest corner of the Valley (Louisiana Pacific Sawmill site), which implies groundwater recharge from the Sierran watershed to the northwest or north (Rose Valley).

- In most cases, aquifer transmission properties, which were computed from measurements made in each piezometer, are consistent with drill log data.
- Temperature profiles indicate the presence of geothermal sources underlying the Valley at depth.

## **CONCLUSIONS AND RECOMMENDATIONS**

Three very important major discoveries were made during the course of this Project:

- A greater quantity of high quality water is in storage at depth in the Intermediate and Southwest Areas than previously known.
- Data concerning recharge into the Southwest Area is contradictory and will require additional exploration to reconcile data obtained during this Project with earlier results from the southwest. Some earlier work implies a very low recharge rate.
- Much of the west and northwest parts of the Valley have relatively poor water at depth associated with a very thick and extensive clay layer.

There are three major avenues for extending the life of the groundwater resources in the Indian Wells Valley:

- Blend good quality water with poorer quality water
- Expand pumping to "new" areas, such as the southwest
- Treat poorer quality water

Either blending or treatment would be governed by the appropriate water quality standards for the application (potable, industrial, or agricultural).

From a technical perspective the near-term recommended approach to extend the life of the groundwater resource is to immediately begin to blend water from the northwest part of the Valley with water from the Intermediate Area. In the long-term, the Southwest Area should be further studied to better define availability of groundwater in that area. Water quality treatment technology and costs should also be studied further.

*Executive Summary*

While this Project made significant contributions to the water resource data base in the Valley, there are still many areas of uncertainty. In order to accommodate this uncertainty in data, a probable data range from a worst or conservative case to an optimistic case was established. An intermediate case within those limits was then determined. Table 1 presents the assumptions used to develop the intermediate case. More detailed information on these values and how they were selected can be obtained in Volume II, Technical Report, Section C.

Demand Projections	NAWS, NACC, and agricultural users continue to pump current levels; pumping from Water District, Inyokern CSD, and private residential wells increases by 50% by the year 2010
Specific Yield	20% or 0.20
Saturated Thickness That Can be Dewatered	200 feet
Natural Recharge	3,000 acre-ft/yr into the Southwest Area, 3,000 acre-ft/yr into the Northwest Area, 0 acre-ft/yr into the Intermediate Area
Migration of Surrounding Water Into Pumped Areas	Constant 5% of pumped volume
Water Quality	250 mg/L in the Southwest and Intermediate Areas and surrounding the Southwest Area; 1,000 mg/L in the Northwest Area and area surrounding the Northwest and Intermediate Areas

Using the assumptions in table 1, the following calculated projections can be made to guide future water production management:

- Implementation of blending Intermediate Area and Northwest Area water could extend the life to the Intermediate Area resource by 13 years, to a total of 42 years.
- Expanding pumping into the Southwest Area and continued pumping from the Intermediate Area could provide acceptable quality water for 68 years.

- Blending Northwest Area water with water from both the Intermediate Area and Southwest Area could provide acceptable quality water for 92 years.
- Because the Northwest Area appears to contain zones of water with high concentrations of specific ions, treatment of Northwest Area water may be necessary in order to do any blending.

Additional resource life would be obtained by not only practicing conservation through pumping/blending management of the aquifer, but also through continued and effective conservation at consumption.

Willingness to dewater a thickness greater than 200 feet would also substantially increase the life of the water resources in the Intermediate and Southwest Areas. For each 100 feet of additional dewatering in those areas, the resource life would be extended about 30 years.

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*About the cover: This nighttime photo of the Bureau of Reclamation drill rig at well site #4 was taken by Don Decker. Once started, drilling at all wells proceeded around the clock. Some hours after this shot, the well was "bottomed out" at 2,020 feet.*

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# INTRODUCTION

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# I. INTRODUCTION

## DESCRIPTION OF AREA

Indian Wells Valley (Valley) is located just east of the southern Sierra Nevada about 150 miles north of Los Angeles. Prior to World War II human activity in the Valley was largely confined to Indians, miners, pioneers, and adventurers. Significant military presence began during and immediately after the war when the Navy established the Naval Ordnance Test Station at China Lake. This facility later became the Naval Weapons Center and now is called the Naval Air Weapons Station. Establishment of a military base in the Valley resulted in rapid development of an active on-base community. The town of Ridgecrest—the outside-the-gate community—was little more than a crossroads and general store in 1943 but began to grow rapidly in the 1950's as the influx of military personnel demanded goods and services beyond what the Navy offered on base (Marcoa, 1990). Today Ridgecrest has a population of about 30,000 with a "trade area" of about 65,000 (Marcoa 1990).

U.S. 395 is the main route between population centers of southern California and recreational opportunities in the eastern Sierra Nevada range and the high desert. Located just a few miles east of U.S. 395, Ridgecrest offers food and lodging opportunity for travelers. In addition to the Navy and tourism, employment by the North American Chemical Company, a mining facility located 25 miles to the east in Searles Valley, also makes a significant contribution to the economic activity in the Valley.

At an elevation of about 2,300 feet, Ridgecrest has a climate typical of the high desert area. Summers are hot and normally very dry. Winters are cool, but not unpleasant. Average annual precipitation ranges between 4 and 6 inches, with most of that coming as rainfall between October and March. Occasional short duration thundershowers occur during summers (Krieger and Stewart, 1990).

Grant Bowman, a pioneering farmer in the Valley, recorded in his diary pumping 500 miner inches (approximately 12.5 cubic feet a second) to irrigate 260 acres of alfalfa between the years 1910 and 1925. He pumped from two 24-inch diameter wells. Static water levels were 90 feet below ground surface.<sup>1</sup> The first farming activity was along Bowman Road in the southeastern part of the Valley, but in the early 1950's farming expanded to the northwest. Groundwater pumping for agricultural purposes has been estimated at an annual average of 1,000 acre-feet from 1920 to 1951, increasing to about 1,400 acre-feet a year from 1951 to 1968. Farming in the Bowman Road area ceased in 1969, but pumping of 300 to 800 acre-feet a year to support farming along Brown Road in the Northwest Area

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<sup>1</sup> Personal communication with Mr. Jim Bosanko, Grant Bowman's grandson, November 5, 1993.

(see figure 2 of Section C, page C6 for the location of specific areas) continued until 1976 when the major expansion of agricultural pursuits occurred (Berenbrock and Martin, 1991). Early pumping for domestic needs was from the Ridgecrest Area. Between 1930 and 1985 pumping gradually increased to about 3,500 acre-feet a year. Then, as water quality worsened to unacceptable levels, wells were abandoned and pumping volumes declined in that Area (Berenbrock and Martin, 1991). Extraction of water from the Valley for industrial purposes also began in the early 1920's when West End Chemical Company (later Stauffer Chemical Company) began pumping up to 1,000 gallons a minute for transfer to their facilities in Searles Valley. American Potash and Chemical Company, the predecessor to North American Chemical Company, began pumping about 750 gallons a minute from the Valley in the early 1940's.

## **PROJECT PURPOSE**

Groundwater aquifers are the sole source of water for the Valley, and pumping has concentrated in areas where aquifer characteristics, water quality, and water elevations are known. For domestic and industrial use, this has been in an area immediately west of the city of Ridgecrest. Agricultural pumping has been concentrated in the northwest portion of the Valley.

Data show a gradual, continuing rate of decline in water elevations in these areas of most heavy pumping. This decline not only results in increasing pumping heads and requires adjusting pumps to lower elevations, but it also may signal a depletion of the groundwater resource.

For many years local water experts have been debating the natural recharge quantity and safe yield from the groundwater aquifers underlying the Valley. Average published recharge numbers range from 10,000 (St.-Amand, 1986) to 15,800 (Bean, 1989) acre-feet a year. Suggestions of recharge up to 30,000 acre-feet have been made.<sup>2</sup> With current withdrawals from the groundwater of about 30,000 acre-feet a year (see chapter III, Summary Report), it appears from the published reports that the Valley is in a state of overdraft and pumping groundwater to meet expected future demands will result in continued depletion of the resource.

Resolution of the disparity in recharge estimates would be very difficult under any data collection program and, even with unlimited funding, answers may never be obtained to everyone's satisfaction. In the meantime, water purveyors must make plans for serving their customers' needs in the future.

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<sup>2</sup> *The Daily Independent*, July 22, 1988.

designed to obtain as much practical additional information on the groundwater resource as possible within funding and temporal constraints. This additional information would then be used, along with existing data, to:

- Help define the groundwater resource extent in terms of both volume and quality
- Help define recharge quantities and locations to the extent possible
- Help define groundwater performance under pumping scenarios that match future demands
- Develop future water development plans, including conservation of existing resources

## **PROJECT FORMULATION**

Groundwater is the sole source of supply for meeting the increasing water needs of the Valley. Groups responsible for nearly all utilization of the groundwater resources include:

- Indian Wells Valley Water District (Water District), major water purveyor to residents of the city of Ridgecrest, California
- North American Chemical Company (NACC), which extracts water for use in its facilities and to serve domestic needs in Searles Valley
- Naval Air Weapons Station (NAWS), which provides water for military use and residents on the base
- Inyokern Community Services District (CSD), which serves the town of Inyokern, California
- Agricultural interests and individual well owners

The importance of the groundwater resource led many of these entities to actively seek additional information on the extent and quality of the resource. Through individual data collection efforts and financial participation with the U.S. Geological Survey (USGS), Soil Conservation Service, and Kern County Water Agency, local entities have attempted to increase knowledge of the resource so they could make better future water management decisions. However, many of these efforts were limited by funding constraints or institutional considerations, such as access to well sites and jurisdictional responsibilities.

*Introduction*

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The absence of hard data in many areas of the Valley and at depth has contributed to differences of opinion over the expected life of the groundwater resource. This debate and the necessity to make long-term plans for continued provision of future water delivery service resulted in the Water District and the Bureau of Reclamation (Reclamation) initiating discussions in 1988 on a joint groundwater investigation. Those discussions were then expanded to include all local entities with an interest in water issues and eventually led to the development of a work plan for a \$1-million data collection and analysis effort.

Although all local entities with an interest in water issues had input into the work plan, three entities elected to provide financial contributions to the investigation—Indian Wells Valley Water District, North American Chemical Company (formerly Kerr-McGee Chemical Corporation), and the Naval Air Weapons Station (formerly Naval Weapons Center). These three entities agreed to provide half of the funding for the effort on an equal basis, with the other half coming from Reclamation.

With the investigation having been defined to the satisfaction of participating entities and the funding commitments having been made, the work plan was initiated in March 1990.

**PROJECT PARTICIPANTS**

The Project was a cooperative effort among Reclamation and local entities. As pointed out above, while a number of local entities expressed interest in and provided input to the Project, three entities participated financially. The Kern County Water Agency could not provide funding for the Project, but that agency did contribute the expertise of a staff geologist to help formulate Project activities and assist in data collection and interpretation.

The original Project budget was \$1,050,000 over a 3-year period. Commitments for Project financing were:

Bureau of Reclamation	\$ 525,000
Indian Wells Valley Water District	175,000
North American Chemical Company	175,000
Naval Air Weapons Station	175,000
<b>TOTAL</b>	<b>\$1,050,000</b>

Under the original agreement among the participating parties, Reclamation would conduct the investigation, and the local entities would transfer their funding commitment to Reclamation for use in Project activities. However, early in the Project it became apparent that more efficient use would be made of Project funds by contracting for test well drilling locally. Consequently,

local entities used their funds for contract drilling, while Reclamation funds were used for data collection and analysis activities, as well as for drilling.

Because information obtained from the early drilling activity were so valuable in helping define the groundwater resource, the Water District and NAWS determined that funding additional wells would be of benefit to their respective agencies and to the Project. In order to ensure compatibility of data from all wells, the design, drilling, installation, and data collection procedures were made consistent among all the wells, irrespective of funding source. Contributions to the drilling program by each of the participating entities is shown below.

- |   |  |
|---|--|
| <b>Bureau of Reclamation</b>              | <ul style="list-style-type: none"> <li>• Drilled Test Well BR-4 with in-house drilling crews</li> <li>• Partially funded Test Well BR-10.</li> </ul> |
| <b>Indian Wells Valley Water District</b> | <ul style="list-style-type: none"> <li>• Fully funded Test Wells BR-1, BR-3, NR-1, NR-2, and MW-32.</li> </ul>                                       |
| <b>North American Chemical Company</b>    | <ul style="list-style-type: none"> <li>• Fully funded Test Well BR-2</li> <li>• Partially funded BR-10.</li> </ul>                                   |
| <b>Naval Air Weapons Station</b>          | <ul style="list-style-type: none"> <li>• Fully funded Test Wells BR-5 and BR-6 and partially funded BR-10.</li> </ul>                                |

The final identifiable contributions to the Project are given below:

Bureau of Reclamation	\$525,000.00
Indian Wells Valley Water District	635,247.56
North American Chemical Company	175,000.00
Naval Air Weapons Station	298,000.00
<b>TOTAL</b>	<b>\$1,633,247.56</b>

In addition to the increased funding for drilling shown above, each of the local participants provided professional services and equipment that have not been recorded separately as services to the Project. Local participants contributed personnel and equipment necessary for contract administration, compilation of information required to develop an estimate of future water demands for the Valley, surveying services, environmental field inspection and evaluation in support of access permit applications, drilling administration and logging the drill holes, installation of security devices on the wells, and obtaining temperature profiles at each of the wells. In addition, many hundreds of hours of volunteer labor were offered. The total value of these activities is no doubt in the range of tens of thousands of dollars.

## COMMUNICATION WITH THE PUBLIC

During the course of the Project, aggressive efforts were made to maintain contact with the general public in order to provide information on Project progress and solicit input on Project direction. Presentations were made at public meetings in Ridgecrest and at briefings to the Water District board of directors. Communication was established early in the Project with local residents having multiple views on water issues in the Valley in order to obtain a wide perspective of how the Project might be formulated. Frequent technical briefings were made to local groups with interest in the progress of the Project. Local newspapers covered Project activities and published press releases concerning the Project.

## PROJECT MANAGEMENT

In order to ensure appropriate direction and progress of the Project, an administrative structure was implemented that established clear responsibilities and accountability. Figure 1 illustrates the structure that was employed. Each of the participating entities named a manager from its organization as a representative to a Steering Committee. This committee acted as the executive group that provided overall direction and guidance to the Project effort. The committee met on an approximate monthly basis to review Project progress, approve technical activities, approve budgets, and make any other executive decisions necessary. Reclamation's representative to the Steering Committee chaired the meetings.

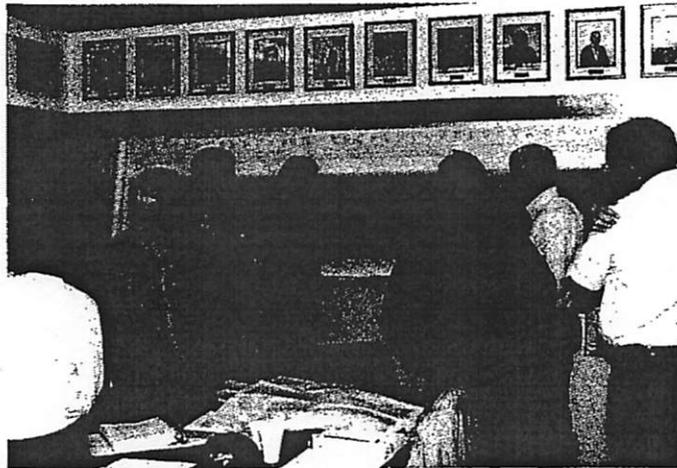


Photo by J. Johnson

Technical Subcommittee in session. From left to right: Dennis Watt, Gail Moulton, Don Decker, Ken Turner, Mike Stoner, Frank Monastero and Mike Lovejoy.

Day-to-day management of the Project was the responsibility of a program manager, employed by Reclamation, who tracked technical activities, expenditures, and schedules. Deviations from the program were taken to the Steering Committee for action or adjustments.

# PROJECT ADMINISTRATION

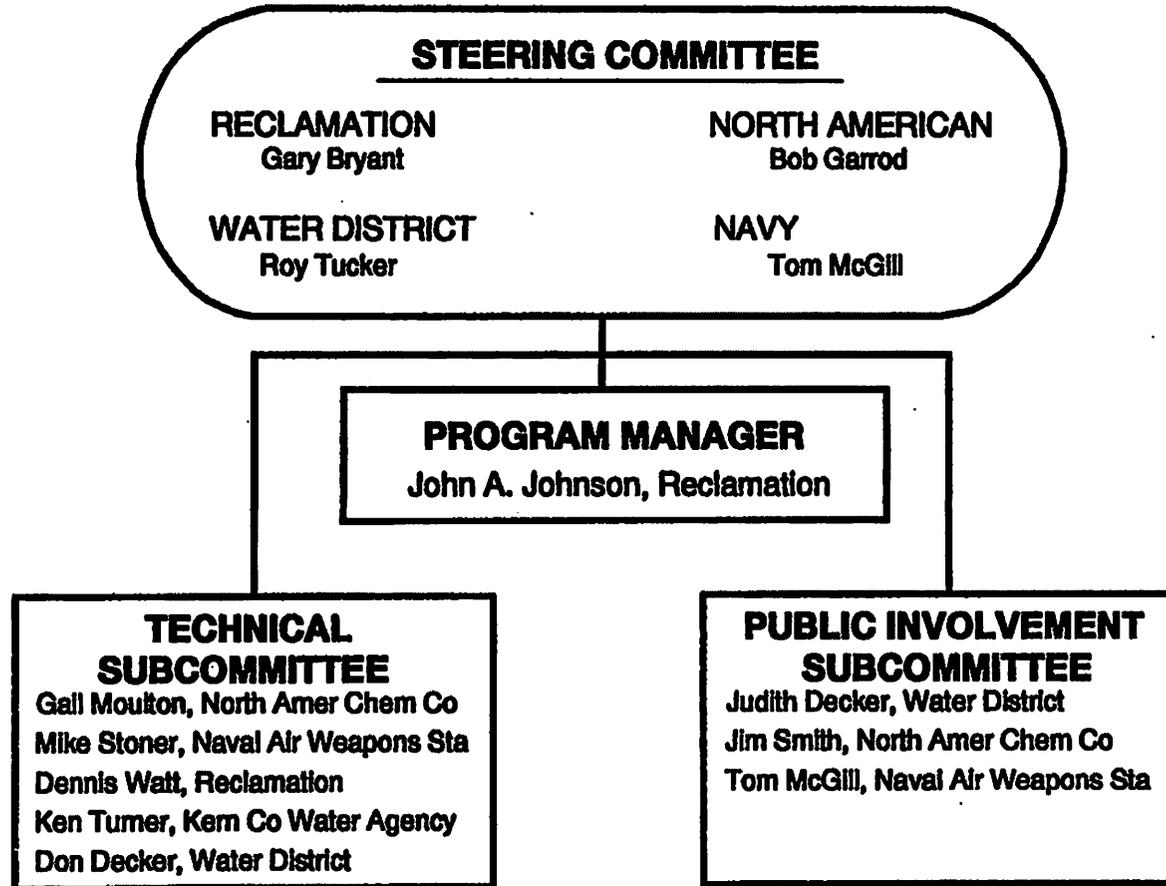


Figure 1: Project Administrative Structure

## Introduction

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A Technical Subcommittee was established to develop technical requirements, determine appropriate data collection techniques, provide quality assurance during drilling and sampling, evaluate data as it became available, and provide technical advice to the Steering Committee. Technical experts from each of the participating entities and the Kern County Water Agency made up this subcommittee. The Technical Subcommittee often solicited input from technical specialists within other interested organizations.

A Public Involvement Subcommittee was established to provide a link between the Project and interested publics and news media. This subcommittee was responsible for hosting public forums and producing news releases that kept the public informed of Project progress and solicited public comment and input.

## **AUTHORITY**

This Project was undertaken by Reclamation under the authority of the Act of June 17, 1902 (32 Stat. 388) and its amendments and the Contributed Funds Acts of 1921 (41 Stat. 1404, 43 U.S.C. 395). First year Federal funding was provided by Public Law 100-371, the Energy and Water Development Appropriations Act of 1989. Remaining Federal funding was provided by subsequent appropriations acts.

## **ACKNOWLEDGMENTS**

**Bureau of Reclamation:** Reclamation personnel in the Lower Colorado Regional office located in Boulder City, Nevada, were responsible for overall accomplishment of the Project. Project management was performed by Mr. John A. Johnson. Mr. Gary L. Bryant, Planning and Loans Officer, was responsible for administrative supervision and management. Mr. Dennis Watt performed major portions of the geohydrologic research and analysis. Ms. Shirley Nutter, Ms. Sierra Slentz, Ms. Christina Robinson, and Ms. Tina Bellis provided the graphic, editorial, and layout expertise required to produce this report.

While Reclamation personnel were responsible for Project oversight and many of the technical aspects of the investigation, the enthusiastic technical and management support of personnel from local participating entities was crucial to successful accomplishment of Project objectives.

**Naval Air Weapons Station:** Mr. Michael D. Stoner, geologist with NAWS, provided not only technical capability in the field of geology, but also many hours of field work and local coordination. He played a critical role in doing the necessary field work in siting the wells, advising the drilling contractors,

obtaining environmental clearance for drilling, surveying, and many other tasks that were necessary for smooth accomplishment of the Project. When Dr. Francis C. Monastero became head of the NAWS Geothermal Project Office late in the Project, he immediately saw a cooperative opportunity and followed up on that opportunity by providing his staff, particularly Mr. Michael A. Hasting, for technical consultation and contract administration. He also provided funding from his budget for mutually beneficial activities, as well as invaluable technical advice.

Dr. Thomas J. McGill, head of the Environmental Project Office, provided management support from the NAWS.

**Indian Wells Valley Water District:** The Water District Board of Directors' support for the Project went beyond normal expectations. They consistently supported the Project by providing funding beyond contractual requirements. Several hundreds of thousands of dollars worth of test well construction and other Project features would not have been possible without the funding approval of the Water District board. Mrs. Judith A. Decker, one of the board members, took a special interest in the Project, and her staunch advocacy position was of frequent help. Dr. Don Decker represented the Water District as technical expert. His depth of knowledge in many relevant technical areas, his willingness to listen to and consider different points of view, and his ability to present Project accomplishments with aplomb were irreplaceable benefits to the Project. The Project was actively supported by former General Manager, Mr. Joe B. Mont-Eton; present General Manager, Mr. Warren McGowen; and Mr. LeRoy O. Tucker, Assistant General Manager, who also represented the Water District in providing management direction to the Project. Mr. Tucker contributed further to the Project by successfully arguing the merits of designing and completing the Water District monitoring wells using Project well specifications.

**The North American Chemical Company:** NACC was also generous in providing top quality personnel and equipment to support the Project. Mr. Gail F. Moulton, chief geologist, was actively involved in providing input to all technical aspects of the Project and was instrumental in obtaining company equipment for collecting water samples, measuring water levels, and measuring down-hole temperatures. Mr. Moulton also served as chairman of the Technical Subcommittee. Technical expertise, including much of the logging of the drill cuttings, was provided by Mrs. Dipti Barari, staff geologist. Mr. Robert R. Garrod provided the management link between the Project and NACC. His committed support was responsible for the active financial and technical involvement by the company. The Project was also the beneficiary of the creative and thoughtful mind of Mr. Thomas S. Bunn III, legal counsel for NACC.

**Kern County Water Agency:** This agency, represented by Mr. Darrell D. Sorenson, graciously extended the services of Mr. Ken Turner, staff hydrogeologist. Mr. Turner helped develop the work plan, logged some of the drill cuttings, and provided technical expertise throughout the investigation.

**Other:** Many people and organizations contributed to the Project by providing background information, a forum for discussing Project activities and new ideas, or previously published data. These include Mr. Leroy Marquardt of the East Kern County Resource Conservation District, the San Diego office of the USGS, and Ms. Peggy Breeden, past president of the local Well Owners' Association.

## **PROBLEM DEFINITION**

Prior to establishment of a military base in 1943, population in the Indian Wells Valley was sparse. In 1953, the population of Ridgecrest was only about 2,000 and Inyokern had a population of about 800, while the base itself had a population of about 10,000 (Kunkel and Chase, 1969). Through the 1950's and early 1960's the population of Ridgecrest grew slowly--about three percent a year (Marcoa, 1990). During the late 1960's more and more employees at the Naval facility chose to reside outside the base. Growth in Ridgecrest accelerated in the 1970's due to a NAWS policy which encouraged employees to live off base. Irrigation of larger parcels of agriculture, primarily alfalfa, also began in the 1970's. Population growth of Ridgecrest continued to accelerate until annual growth rates reached 8 to 10 percent in the late 1980's (Krieger and Stewart, 1990); since then, however, rates have declined somewhat. Data from the 1980 and 1990 census show a population in Ridgecrest of 15,929 and 27,725, respectively. Population in the Valley outside the city boundaries grew in parallel with Ridgecrest.

Increasing population has resulted in increasing demands on the groundwater as a source of domestic, industrial, and agricultural use. Major users of water from the groundwater aquifer underlying Indian Wells Valley include the agricultural sector, consisting primarily of the Brown Road Land and Farming Company; the Indian Wells Valley Water District, serving the city of Ridgecrest and surrounding county areas; the NACC, serving domestic water to the town of Trona as well as industrial needs of the company; the Inyokern Community Services District, serving the town of Inyokern; the Naval Air Weapons Station, serving base residents and providing water for military purposes; and private wells, serving individual houses or small groups of houses.

Estimates of water produced by each of these segments in 1990 and estimated pumping requirements through the year 2010 are shown in figure 2. It is obvious from this graph that the future water needs of the Valley are being driven by the Indian Wells Valley Water District. Future water production by other entities are expected to remain fairly constant, relative to the total Valley-wide pumping quantity. An exception is the Community Services District where future demand is projected to increase significantly. More detail on future water use projections are contained in Section B of this volume.

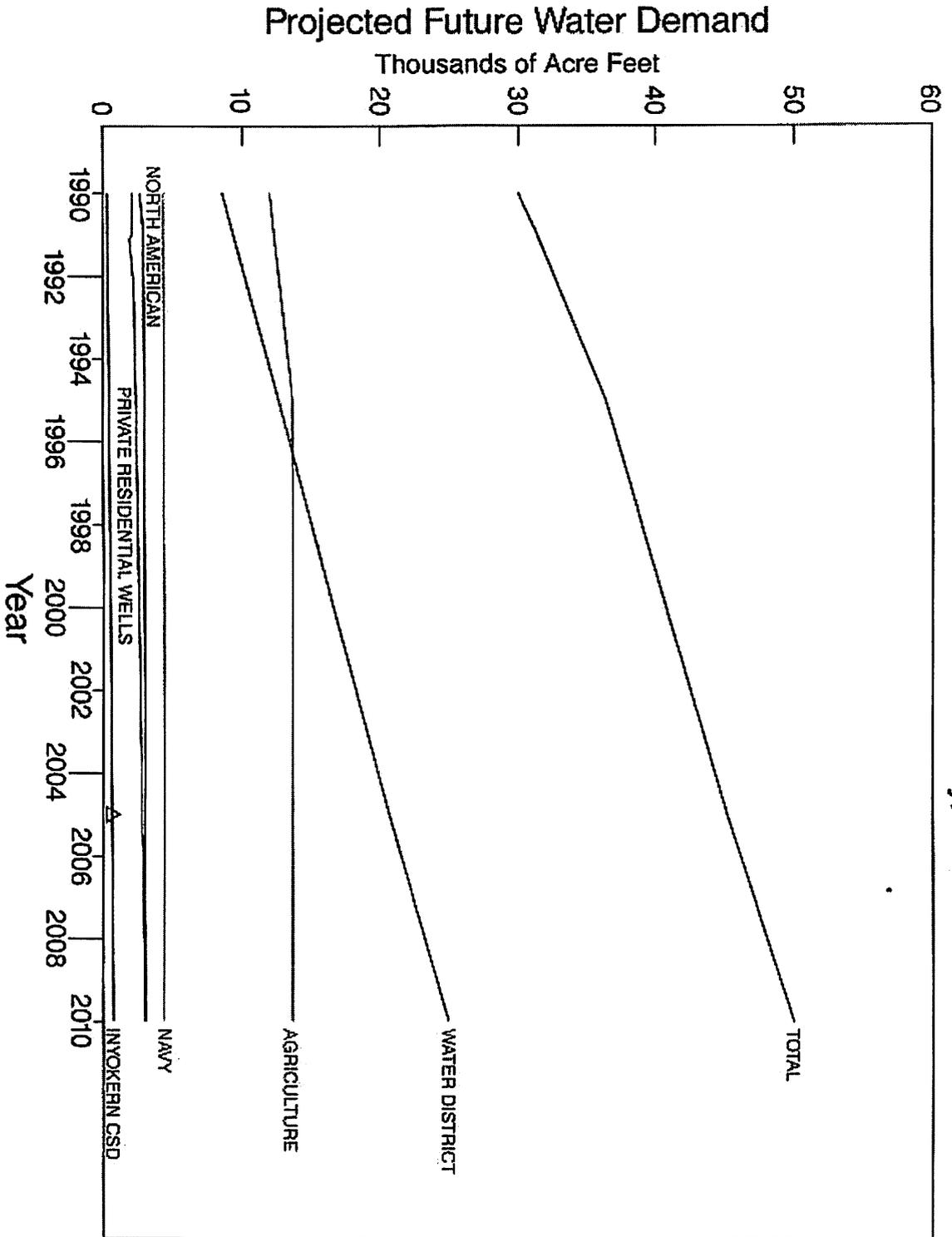
Data used to develop the water demand projections on figure 2 were based on information available through the late 1980's. High population growth rates in the Valley during the 1980's have more recently moderated or even declined and agricultural use has not expanded as anticipated. These conditions led to consideration of revising the future demand projections. This was not done, however, because the altered conditions are so recent that a trend cannot be established and it is possibly only a temporary phenomenon.

Except for pumping by large agricultural users, which is confined to the northwest portion of the Valley, most of the pumping occurs in an area known as the intermediate pumping zone, Intermediate Area, or Intermediate Wellfield. This is an area immediately west of Ridgecrest with good quality groundwater at fairly shallow depths. Since 1921 groundwater elevations have been declining. The water table has declined about 80 feet in the Intermediate Area, 70 feet in the Ridgecrest area, 30 feet in Inyokern, and 15 feet or more in the agricultural area. Declining water table elevations in the Intermediate Area has introduced a reverse gradient potential for poor quality water to backflow into the Intermediate Area from the brackish and salty water areas, although no noticeable degradation has occurred at this time (Krieger and Stewart, 1988). Poor quality water surrounding the Intermediate and Southwest Areas could, therefore, pose a threat to existing and additional wells in those areas.

Because of the projected increases in pumping requirements and concerns over the ability of the Intermediate Area to tolerate this increased pumping without potential adverse impacts, water purveyors needed additional information on the quality and availability of groundwater in other areas of the Valley so that expansion could occur in the most appropriate way.

This need for additional information on groundwater resources in the Valley led to discussion among local water purveyors and Reclamation on ways of addressing the future water supply problem. Those discussions, in turn, led to the development of the Indian Wells Valley Groundwater Project.

Figure 2: Projected Future Water Demands  
 Indian Wells Valley, California



## PROJECT DESCRIPTION

The Project was originally designed to be completed in three phases--compilation of existing data, collection of additional data, and development of implementation plans for future development of the groundwater resource. However, there was an understanding that the plan was open to adjustment as additional information became available.

Compilation, evaluation, and display of existing data was essentially completed during the first six months of the Project. During that time a field data collection program was defined.

The nucleus of the field data collection program was the installation of up to ten multi-piezometer test wells.

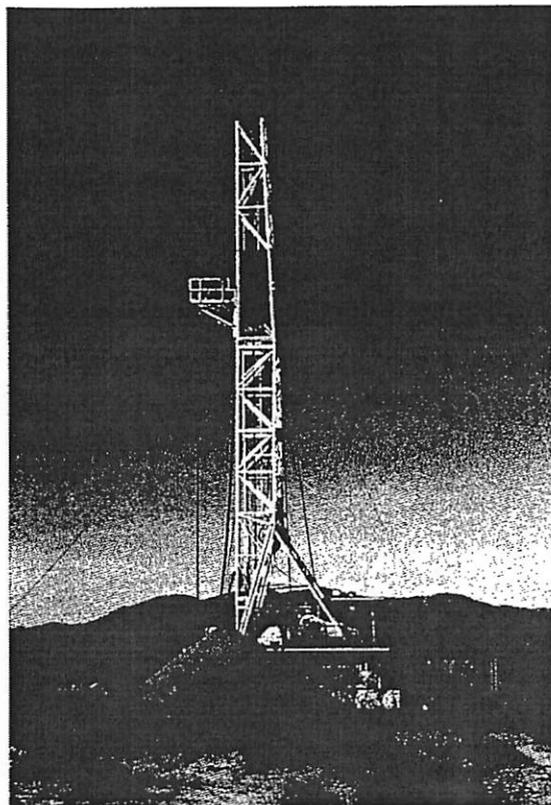


Photo by Mike Stoner

Indian Wells Valley Groundwater well drilling in progress.

Ten wells were eventually installed under this project, but not necessarily in the original priority order or original location. Details concerning the design of the test wells can be found in the Test Wells chapter of Section A in this volume.

BR-4 (number is the priority, 1 being the highest priority) was drilled first with Reclamation drill crews; all other wells were drilled by contract. Table 1 shows the order of drilling, the funding source, and the contracting entity for each well installed under this Project. In addition to the wells shown on table 1, the Navy's Geothermal Project Office drilled a very deep well (7,400 feet) between the proposed location of BR-7 and BR-8 to test for geothermal potential in the middle of the Valley.

Designated SNORT-1, this well offered groundwater data unavailable from other sources. Adjustments in the location of BR-5 and BR-6 and the

installation of SNORT-1 eliminated the need to drill BR-7 and BR-8. After installation of the casing in SNORT-1, perforations at appropriate levels were made under Project funding contributed by the Navy. After review of all data obtained prior to drilling the last well, the decision was made to construct BR-10 rather than complete a well at one of the BR-7, BR-8, or BR-9 sites. Construction costs for Project wells contracted by both the NAWS and the Water District exceeded those participant's cost share under the Project agreement. Those additional costs were contributed by the respective entity.

<b>WELL</b>	<b>FUNDING SOURCE</b>	<b>CONTRACTING ENTITY</b>
BR-4	Project	Reclamation Force Account
BR-2	Project	NACC
NR-1	Water District	Water District
NR-2	Water District	Water District
BR-1	Project	Water District
BR-3	Project	Water District
MW-32	Water District	Water District
BR-5	Project	NAWS
BR-6	Project	NAWS
BR-10	Project	NAWS
SNORT-1	NAWS/Project	NAWS

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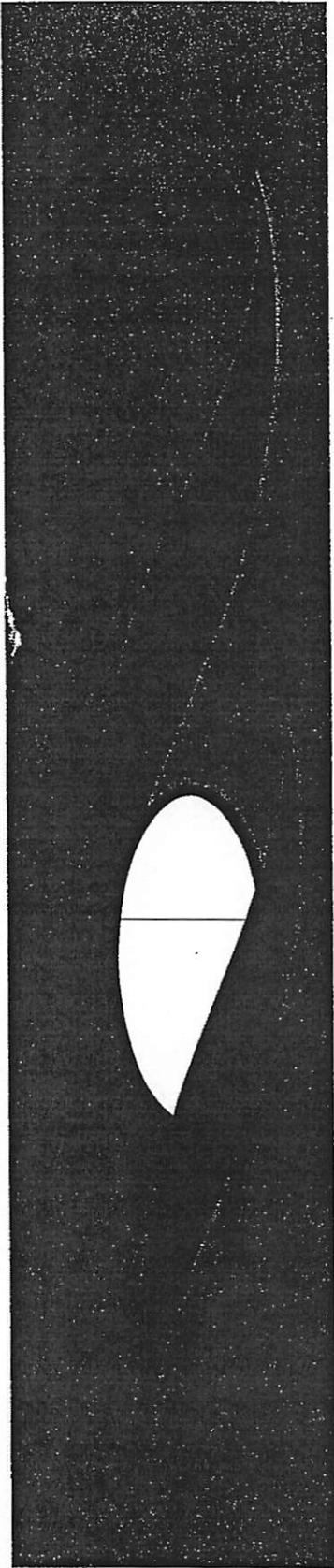
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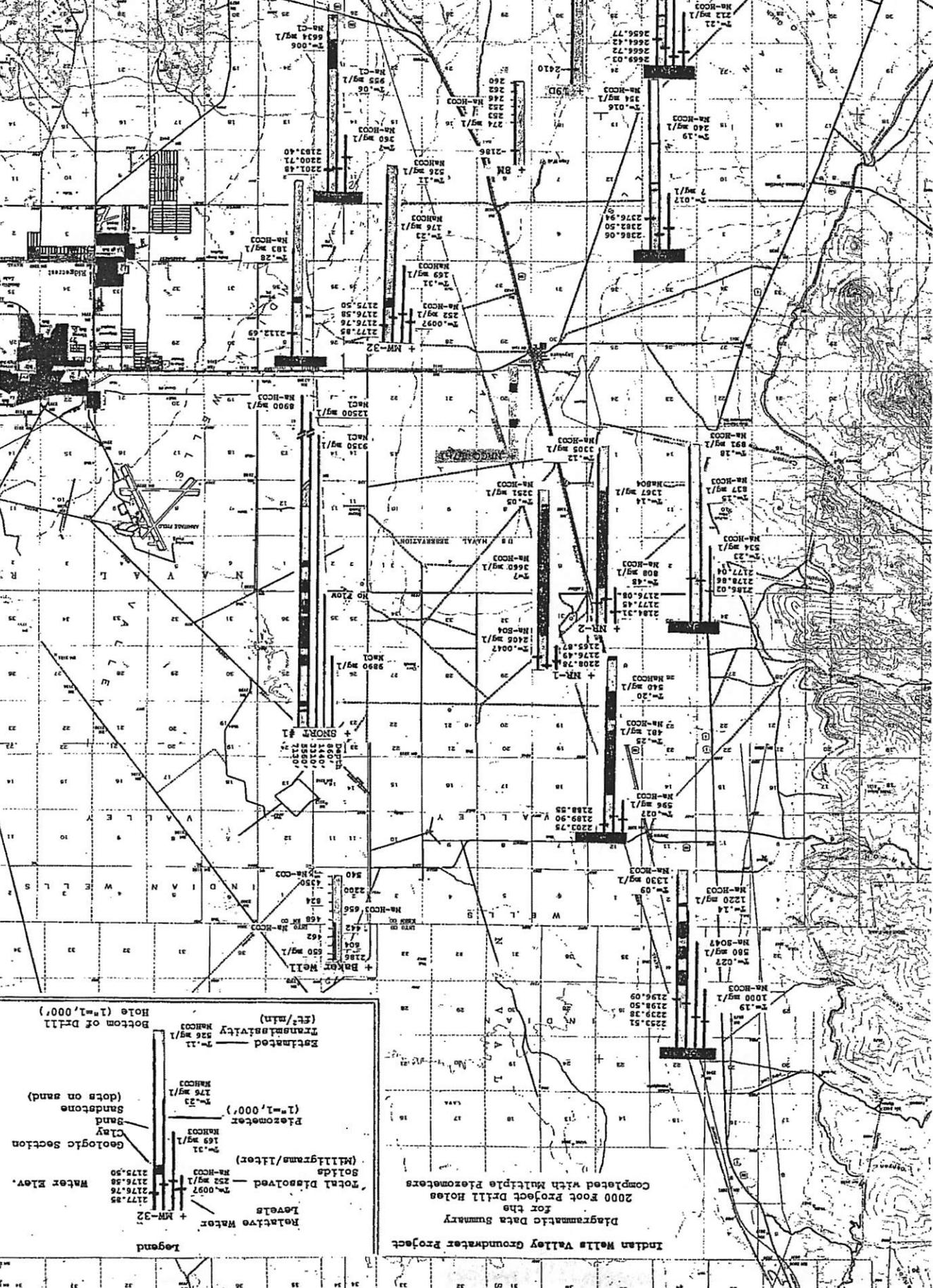


**SECTION A -  
GEOHYDROLOGY**

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Figure 4

Figure 4. Groundwater elevation (feet), water quality (total dissolved solids, mg/l, estimated transmissivity (T<sub>20</sub>/min) from log tests, and geologic section shown diagrammatically at the location of each completed project drill hole. In the depletion each piezometer, vertical depth scale is 1" = 1,000 feet. The bold horizontal bars represent depths to groundwater relative to each other (but not at the vertical depth scale). Elevation of groundwater is shown to the right (except for 5) of the piezometer and piezometric column shown to the left (area between project drill holes). Well 19D (Water District southwest monitoring well #3) shown for water elevation.



Indian Wells Valley Groundwater Project Diagrammatic Data Summary for the 2000 Foot Project Drill Holes Completed with Multiple Piezometers

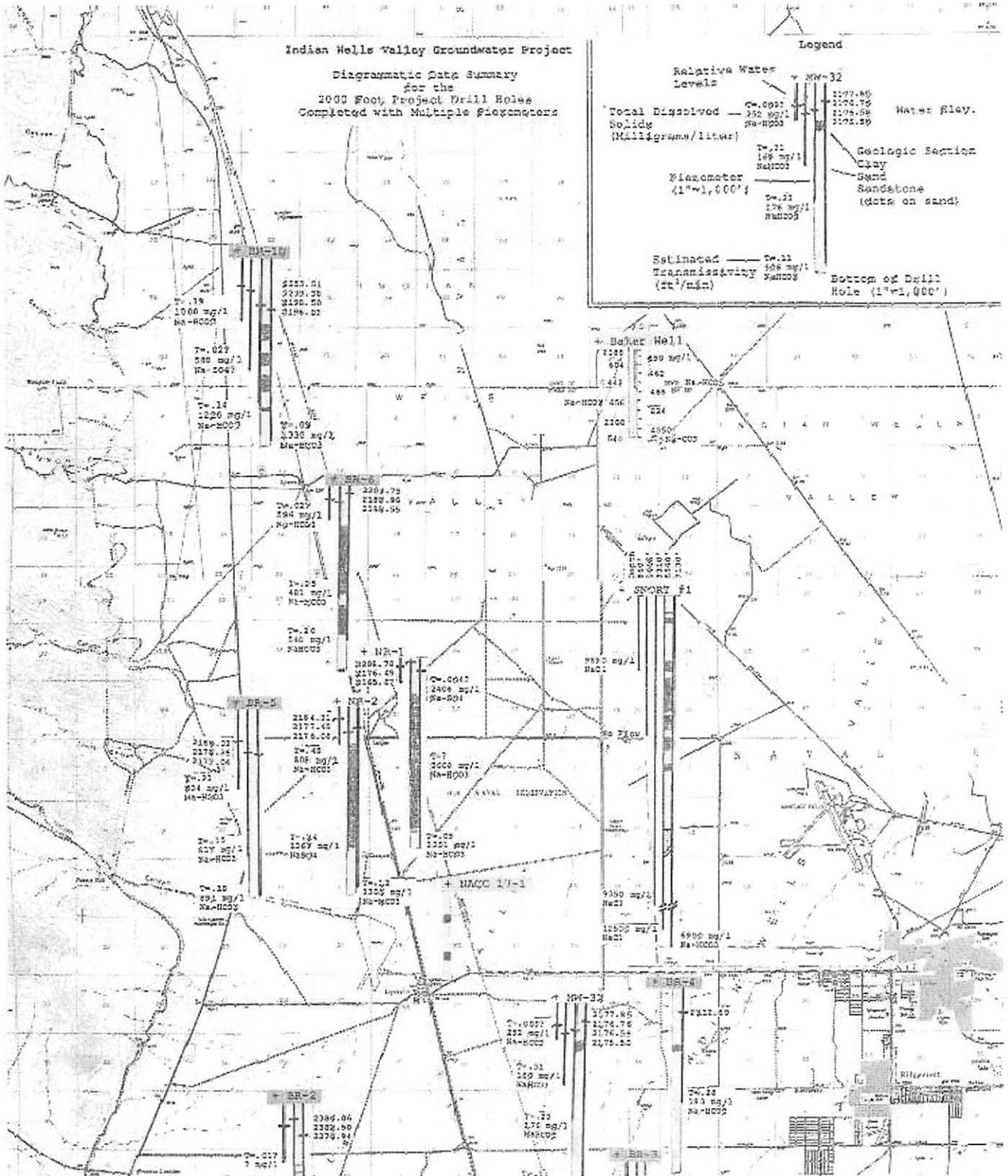
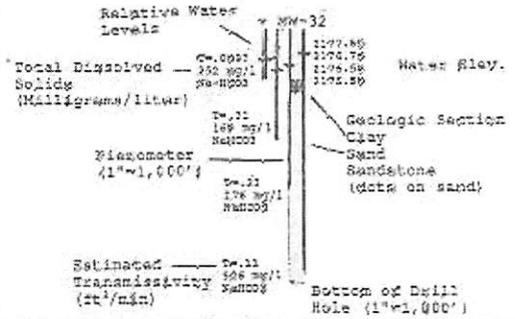
**Legend**

- Relative Water Levels
- Total Dissolved Solids (Milligrams/Liter)
- Piezometer (1"=1,000')
- Estimated Transmissivity (T<sub>20</sub>/min) (1"=1,000')
- Bottom of Drill Hole (1"=1,000')
- Geologic Section
- Clay
- Sand
- Sandstone
- Sands on sand

Indian Wells Valley Groundwater Project

Diagrammatic Data Summary  
for the  
2000 Foot, Project Drill Holes  
Completed with Multiple Piezometers

Legend



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# **GROUNDWATER SYSTEM**

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# **GROUNDWATER SYSTEM**

Berenbrock and Martin (1991) note that the geohydrology of the Valley is discussed in detail in reports by Von Huene (1960), Zbur (1963), Kunkel and Chase (1969), and Dutcher and Moyle (1973). The reader is referred to these reports for a more complete description of the geology and hydrology of the Valley. Only a brief summary of the geohydrology from Berenbrock and Martin (1991) is given below.

## **DESCRIPTION OF AQUIFER SYSTEM**

All of the following summary description of the valley geohydrology is from Berenbrock and Martin (1991); however, it is not their complete description. See figure 2 for the surface distribution of most of the features described below.

"Indian Wells Valley is a structural and topographic depression in the southwestern part of the Basin and Range province. The lithologic units mapped by Von Huene (1960), Zbur (1963), and Kunkel and Chase (1969) can be grouped into two categories: (1) consolidated rocks, which commonly have low porosity and permeability and do not readily transmit water, except where highly fractured, and (2) unconsolidated deposits, which generally transmit water readily."

## **CONSOLIDATED ROCKS**

"The consolidated rocks include the basement complex, continental deposits, and volcanic rocks. The basement complex consists of pre-Tertiary igneous and metamorphic rocks and underlies the younger rocks and deposits of the Valley and composes the surrounding mountains and hills. The continental deposits of Tertiary age overlie the basement complex. Kunkel and Chase (1969) reported that the continental deposits are indurated and poorly sorted and they considered the deposits to be virtually non-water bearing. The volcanic rocks include the Miocene Black Mountain Basalt near the El Paso Mountains (Diggles and others, 1985) and the Quaternary unnamed volcanic rocks described by Kunkel and Chase (1969). The volcanic rocks are nearly impermeable except where weathered or fractured and are not considered an important source of groundwater."

## **UNCONSOLIDATED BASIN FILL**

"The unconsolidated basin fill deposits include alluvium, and lacustrine, playa, and sand-dune deposits. The alluvium of Pleistocene and Holocene

age includes older alluvium, younger alluvium, alluvial fans, and elevated pediment veneers and stream-terrace deposits. These deposits consist of unconsolidated moderately to well-sorted gravel, sand, silt, and clay and generally are highly permeable. The percentage of silt and clay increases toward the central part of the Valley and China Lake. The lacustrine deposits consist predominantly of silt and silty clay of Pleistocene age (Kunkel and Chase, 1969). The lacustrine deposits are interbedded with and overlie the alluvial deposits in the central part of the Valley. The playa deposits, of Holocene age, also generally are of low permeability, consisting of silt and clay with occasional sand lenses. The sand-dune deposits, of Holocene age, consist of a thin veneer of windblown sand (100 feet or less in thickness) covering the underlying deposits (Warner, 1975). These sand deposits are not considered a source of ground water because they generally are above the water table."

"On the basis of lithologic logs from wells, previous investigators have divided the unconsolidated deposits in the Valley into two main aquifers: (1) the shallow aquifer (shallow water body of Kunkel and Chase, 1969) and (2) the deep aquifer (main water body of Kunkel and Chase, 1969)."

## SHALLOW AQUIFER

"The shallow aquifer includes (from land surface to the top of the deep aquifer) sand-dune deposits, playa deposits, younger lacustrine deposits, shallow alluvium where underlain by lacustrine deposits, and probably some older lacustrine deposits. The shallow aquifer as defined by Kunkel and Chase (1969) extends from China Lake westward to the center of the Valley and from the area south of Airport Lake southward to the community of China Lake. The base of the shallow aquifer is poorly defined. For the purpose of this study, however, the base was assumed to slope from an altitude of 1,950 feet above sea level on the west to an altitude of 1,850 feet on the east beneath China Lake. This assumption was based in part on the geologic and electric logs of several wells that were drilled through the shallow aquifer near the community of China Lake."

"The water-bearing deposits in the shallow aquifer consists primarily of fine sand, silt, and clay of low permeability. These deposits confine or partly confine the underlying deep aquifer in the eastern part of the Valley. The shallow aquifer does not yield water freely to wells and contains water of poor quality (dissolved-solids concentration greater than 1,000 milligrams per liter (mg/L)) (Warner, 1975; Berenbrock, 1987)."

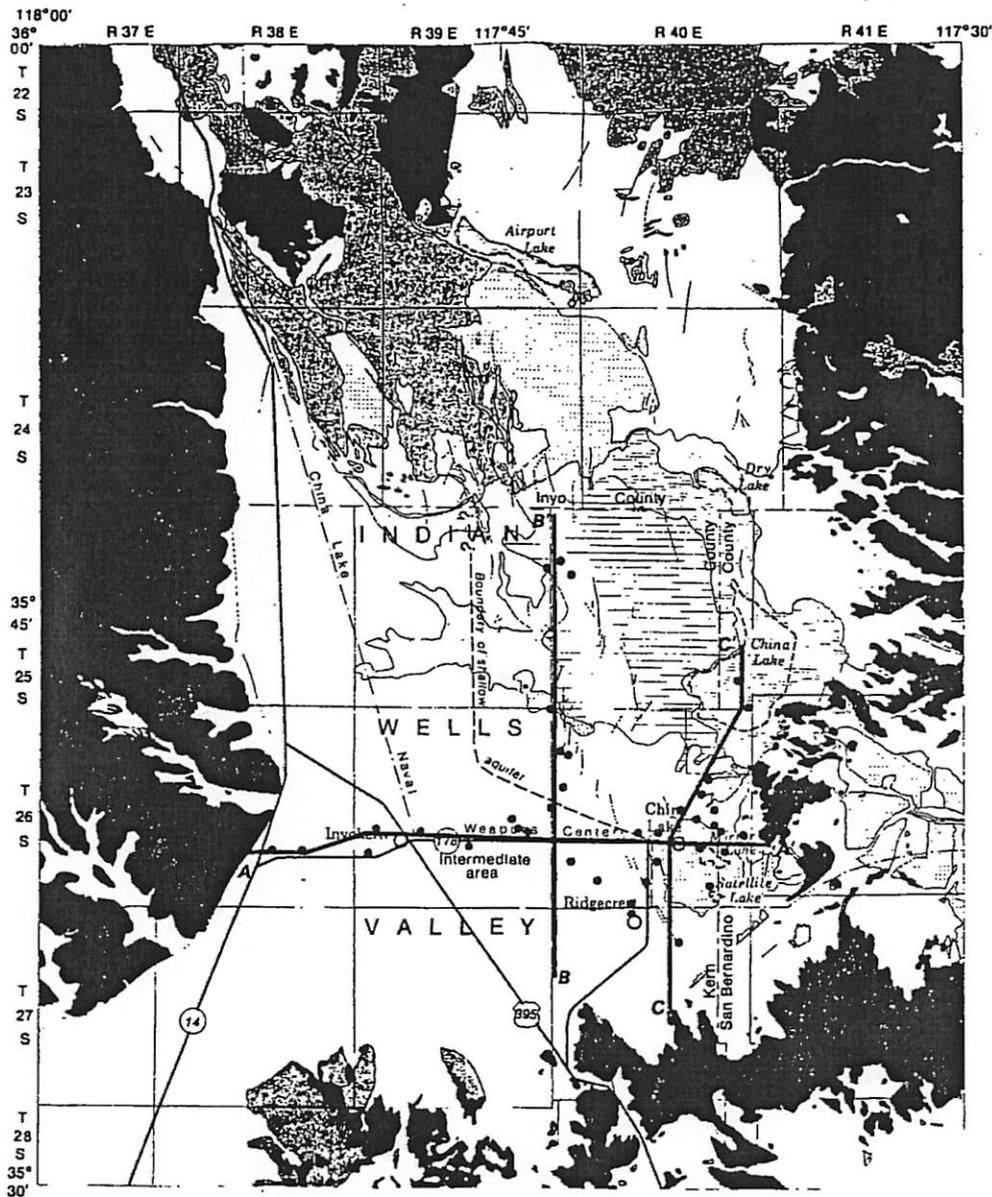


Figure 2. Generalized geology, from Berenbrock and Martin (1991), of Indian Wells Valley. Geologic sections along the lines (B---B') are included in Berenbrock and Martin (1991). The dots are the wells shown in the geologic sections.

**GEOLOGIC UNITS**

**UNCONSOLIDATED DEPOSITS --**

- Quaternary
  - Sand dunes (Holocene)
  - Sand dunes and playa deposits (Holocene)
  - Playa deposits (Holocene)
  - Alluvium (Holocene and Pleistocene)
  - Lacustrine deposits (Pleistocene)

**CONSOLIDATED ROCKS --**

- Quaternary and Tertiary
  - Volcanic rocks (Pleistocene and Miocene)
- Tertiary
  - Continental deposits (Pliocene and Miocene)
- Pre-Tertiary
  - Basement complex

--- FAULTS--Dashed where approximate

--- BOUNDARY OF SHALLOW AQUIFER (Kunkel and Chase, 1969)

## DEEP AQUIFER

"The deep aquifer includes the total saturated thickness of the alluvium and lacustrine deposits where the shallow aquifer is not present and the alluvium and lacustrine deposits that underlie the shallow aquifer in the eastern part of the Valley. The base of the deep aquifer is the base of the alluvium. Beneath most of the central part of the Valley, the saturated thickness of the deep aquifer is estimated to be at least 1,000 feet (Kunkel and Chase, 1969)."

At Project well MW-32, completed in the center of the Valley as part of this project, the saturated thickness was found to be at least 1,700 feet.

"The deep aquifer in most places is unconfined; however, in the eastern part of the Valley the deep aquifer is confined by silt and clay lenses of the lacustrine and playa deposits. This aquifer consists of medium-to-coarse sand and gravel of high permeability and is the main source of water to wells in the Valley. The deep aquifer commonly yields more than 1,000 gal/min to wells, and some wells in the Intermediate and Inyokern areas yield more than 2,000 gal/min. The dissolved-solids-concentration in samples from wells perforated in the deep aquifer generally is less than 1,000 mg/L (Warner, 1975). Wells perforated in the deep aquifer near Inyokern; in the Intermediate Area; and in the southwest part of the Valley near the Little Dixie Wash have dissolved-solids concentration less than 400 mg/L (Berenbrock, 1987)."

## NATURAL RECHARGE AND DISCHARGE

"Natural recharge to the groundwater system in the Valley consists almost entirely of runoff from the surrounding mountains. Because infiltration of the runoff occurs near the mountain front where the runoff first crosses the unconsolidated deposits of the Valley, the natural recharge is termed mountain-front recharge. Little, if any, direct infiltration of precipitation recharges the Valley groundwater system. Precipitation averages only 4 to 6 in/yr on the Valley floor, and most is lost to evaporation, which averages about 80 in/yr from ponded water (Farnsworth and others, 1982)."

"Prior to extensive pumping in the Valley, recharge to the groundwater system was balanced by natural discharge. Except for a small amount of groundwater outflow to Salt Wells Valley, natural discharge occurred almost entirely by evapotranspiration from the shallow aquifer in the vicinity of China Lake in the eastern part of the Valley. By mapping areas of phreatophytes and moist lands present in 1912 in and around China Lake and multiplying the areas by assigned evapotranspiration rates, Lee

(1912) estimated evapotranspiration in the Valley to be 31,600 acre-feet per year."

"Kunkel and Chase (1969) considered Lee's estimate to be inaccurate because when the estimate was made in 1912, maps of the area were poor, aerial photographs were not available, and little work had been done on the evapotranspiration rates for the various phreatophytes. Using modern maps, Kunkel and Chase (1969) classified 33,000 acres of moist lands in and around China Lake as areas of evapotranspiration. They then assigned evapotranspiration rates to the area on the basis of a nonlinear relation between a maximum evapotranspiration rate when the water table is at land surface and zero evapotranspiration when the depth to water approaches 10 feet below land surface. The nonlinear relation was based on research in other desert basins since Lee's work in 1912 (Smith and Skarn, 1927; Young and Blaney, 1942; Blaney, 1952)."

"Using the revised values for area and evapotranspiration rates, Kunkel and Chase (1969) estimated the total groundwater discharge by evapotranspiration for 1912 to be 11,000 acre-feet per year, about 20,600 acre-feet less than Lee's (1912) estimate. The main reason for the difference in the estimates is that Kunkel and Chase used a nonlinear relation between evapotranspiration and depth to water. The maximum evapotranspiration rates used by both Lee and Kunkel and Chase are about the same; however, the nonlinear relation between evapotranspiration and depth to water (used by Kunkel and Chase) predicts much lower evapotranspiration rates than the linear relation (used by Lee) as the depth to water increases."

"In addition to revising Lee's estimate of evapotranspiration for 1912, Kunkel and Chase (1969) estimated the total evapotranspiration for 1953. The total area of evapotranspiration for 1953 was assumed to be the same as in 1912; however, different evapotranspiration rates were assigned to areas according to the measured depth to water in 1953. Total groundwater discharge by evapotranspiration in 1953 was estimated by Kunkel and Chase to be 8,000 acre-feet per year, about 3,000 acre-feet less than their revised estimate of evapotranspiration for 1912. Kunkel and Chase attributed the decrease in evapotranspiration to an increase since 1912 in groundwater pumpage from the deep aquifer. They suggested that the increased pumpage caused a net decline in water levels in the shallow aquifer near China Lake, thereby reducing evapotranspiration."

"Bloyd and Robson (1971) used the 1912 and 1953 estimates of average annual evapotranspiration by Kunkel and Chase as initial estimates of natural recharge and discharge for the model that they developed. In calibrating the model, Bloyd and Robson determined the natural recharge and discharge to be 9,850 acre-feet per year."

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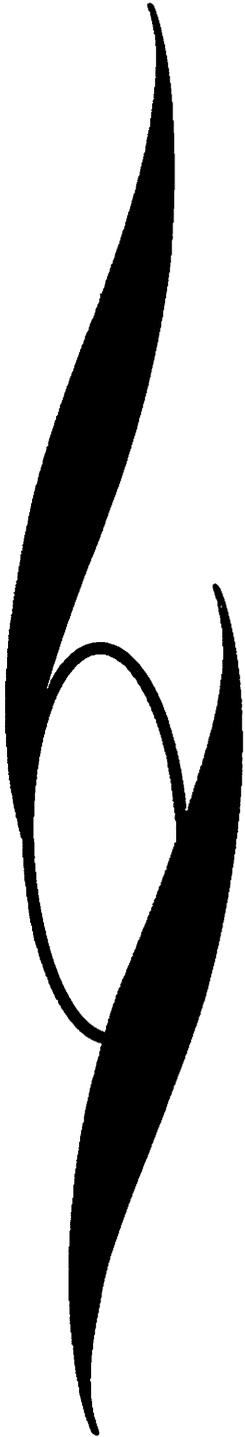
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# **PREVIOUS GROUNDWATER DATA**

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# **PREVIOUS GROUNDWATER DATA**

## **INTRODUCTION**

Compilation and display of water well data from pre-Project databases were the first technical tasks of the Project. This information was used to assist in the selection of sites for the proposed Project deep aquifer exploration wells.

The U.S. Geological Survey (USGS) has by far been the most comprehensive collector and compiler of groundwater and water well related data for the Valley. Their data base for 131 wells includes physical attributes of the wells, water levels, hydrographs, and for many at least one water quality analysis. This data is occasionally published in open-file reports. The latest open-file report is by Berenbrock (1987) and presents data collected between 1977 and 1984.

Groundwater quality data has also been recently compiled and published by Whelan and others (1989) under contract to the East Kern County Resource Conservation District (EKCRCD). Of the nearly 1200 analyses reported for over 370 sites, all but 23 were previously available. Of the 23 sites, 8 are wells in the Valley. Many of the other sites are springs, seeps and wells in the consolidated rock bounding the Valley.

Cornerstone Engineering of Bakersfield, also under contract to the EKCRCD, has compiled water well related data for the Valley. Their database consists of data for about 785 wells. However, only location, type, and depth is given for most of them. Even though there is only minimal data for most of the wells, this database is valuable in that it is probably a fairly complete list of all the wells in the Valley.

## **U.S. GEOLOGICAL SURVEY DATA**

The various USGS open-file reports for the Valley list much data for their observation wells and is by far the most complete database for the wells included. The USGS did not include all wells in the Valley; however, that was not their intent.

The latest open-file report (Berenbrock) gives data for 131 wells and includes records of water levels at selected wells along with long-term hydrographs for four wells. A well description is included in the water level record which includes, but is not limited to, location (legal and descriptive), use, diameter, depth, date drilled, altitude of land surface, highest water level and date, and lowest water level with the date.

Water quality analyses for 85 wells are also reported in the latest USGS report. These should be representative of the water in the aquifer because the samples were usually collected after the well had been pumped. Berenbrock (1987) reports:

"Where possible, samples were collected from pumped wells. Where pumped wells were not available, wells were pumped with a portable submersible pump. Specific conductance of discharge water was monitored, and sampling was delayed until after specific conductance had stabilized and a least 1.5 times the casing volume had been pumped. Water samples were not collected after pressure tanks or treatment apparatus had been used. If untreated water could not be obtained from a well, that well was not sampled".

All water quality analyses reported by Berenbrock were performed at the USGS's Water-Quality Laboratory in Denver, Colorado. The water quality section also lists the number of wells that equaled or exceeded primary and secondary maximum contaminant levels for selected chemical constituents as set by the U.S. Environmental Protection Agency.

### **EAST KERN COUNTY RESOURCE CONSERVATION DISTRICT DATA (Whelan)**

Whelan and others (1989) used nearly 1200 water quality analyses from previous studies (representing over 370 sites) and analyses from their 23 new sites to make various kinds of water chemistry plots and diagrams. The previously available analyses appear to be from the USGS based on the format of a computer print-out. Since the analyses include sample sites in Rose Valley, the Coso Range, the Argus Range, and Salt Wells, many of the more than 370 sites do not represent the Valley. Of the 23 newly sampled sites, only 8 are wells in the Valley. Many are springs and wells from the consolidated rock surrounding the Valley.

Water quality analyses reported by Whelan should be representative of the local groundwater since the samples appear to have been collected from sources (wells and springs) actively producing groundwater. Flow estimates are reported for most of the sites. It is assumed that the wells were pumping at the time of sample collection because the reported collection point for the samples is the wellhead. On-site measurements at the sampled source included temperature, pH, and electrical conductivity. It appears that the water quality samples were collected following USGS procedures.

## **EAST KERN COUNTY RESOURCE CONSERVATION DISTRICT DATA (Cornerstone Engineering)**

Cornerstone Engineering of Bakersfield (Conerstone), under contract to EKCRCD, has also compiled water well related data for the Valley. Their data base consists of data for about 785 wells in the Valley. Location, type, and depth is given for most of the wells. Some of the wells have a value for temperature listed. The rest of the data for some of the wells such as ground elevation, test (pumping?) date, and water quality analysis availability appear to be from the USGS.

This data set is valuable in that it is an attempt to document all the wells in the Valley. However, it is difficult to determine the method Cornerstone used in compiling the data base because the text is not yet available. Since almost all the wells listed have a location, owner, type (domestic, agricultural, public), depth, and permit number, it is surmised that they used various county records for information sources. It appears that they field checked some of the locations based on the "yes" or "no" tabulated under the column headed "Located." Only location and depth is given for many of the wells.

### **MAPS SHOWING PRE-PROJECT WATER WELL DATA**

Maps (figures) were prepared to visually display the water well related data from existing databases. All the figures described below are in Appendix V of this volume. Except for Details A, B, and C, they are all one half the size of the originals.

The first set of figures--1 and 1a--display the data from the Cornerstone Engineering Data Base for the northwest area of the Valley. The numbered figure is the Cornerstone map showing the location of the wells and the "underlying" figure (with the figure number followed by an "a") shows the "stick" representation of the wells. The horizontal scale on the stick map is the same as the overlying location map and the point at the top of each "stick" underlies the well location on the map. The length of the stick is proportional the total depth of the well per the vertical scale shown.

Each of the other figure sets--2 and 2a through 8 and 8a--are constructed as described above. The first figure set (1 and 1a) covers the northwest part of the Valley. The following figure sets are sequenced from west to east and tiered from north to south. The last figure set (8 and 8a) covers the extreme southwest part of the Valley.

Figure sets 9 and 9a through 11 and 11a cover Details A, B, and C as shown on figures 3 and 4: The detail maps were constructed by Cornerstone to clearly show well locations in high density areas.

Figure sets 12 through 12d are constructed as described above using USGS data from Open-File Report 86-315 (Berenbrock, 1987). Figure 12 is the location map from Open-File Report 86-315. The "a" figure shows all the USGS observation wells with a reported total depth. The figures lettered "b," "c," and "d" show the wells from the preceding figure that have a measured water elevation, known screen interval(s), and a water quality analysis, respectively. The "e" figure shows all the water quality analyses without regard for missing well data, i.e. water elevation, screen interval(s), and total depth.

Water quality analyses are shown as bar-type Stiff diagrams with each bar representing the constituent shown in the legend. Any constituent over 1000 parts per million (ppm) is represented by a one-half inch bar with the actual concentration listed. If there is more than one water quality analysis for the well, the most recent is shown.

The "f" figure shows a colored ball (will not show on black and white copies) at the top of each well from figure "e". The colors are coded as shown in the legend. The colors were selected so as to intuitively convey the relative water quality to the viewer.

Figures 13 through 13f represent the detail area shown on figure 12 and are constructed the same as the figure 12 set described above.

## **CONCLUSIONS**

The intent of the well attribute displays (the appended figures) is not to portray all known well data, although most is, but to visually portray most of the known data in simulated three dimensions. Data deficient zones (location and depth) are readily apparent from inspection of the figures. As can be seen, there are relatively few wells in the Valley with a known depth, screen interval(s), water elevation, and water quality. Many of the wells with many known attributes are in the Intermediate Area. Many of the wells with a water quality analysis are missing one or more of the other attributes. Although there are many wells (mostly domestic) surrounding the Naval Air Weapons Station, most are relatively shallow.

**REFERENCES**

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**TEST WELLS**

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# TEST WELLS

## INTRODUCTION

The overall Project goal was to determine aquifer and groundwater related parameters in areas where little data had been previously collected and to depths not usually explored for groundwater production. Maximizing future usability and the number of parameters that could be determined while minimizing the short and long-term costs was the general design criteria for the test wells. The following narrative section explains the process used to develop the test well design. Data collected from the wells is discussed in the following chapter.

## TEST WELL DESIGN

The first design consideration was depth. Two thousand feet was selected as a compromise between the desire for collecting groundwater related data to as deep as possible but at the same time from as many locations as possible. Furthermore, the drill rig needed to drill a 2,000 foot hole of the required diameter is relatively mobile compared to the rig needed to drill the required diameter to much beyond 2,000 feet. For holes much deeper than 2,000 feet, rig mobility generally decreases and the need for additional equipment increases such that the marginal cost increases at a higher rate.

Two general well design types were considered for completion of Project test wells. One proposed completion consists of a single casing "string" from the ground surface to depth with a variable number of like diameter screens at selected depth intervals. The annular space would be filled with the appropriate size filter pack. Bentonite (or some other non-permeable material) seals would be set at appropriate intervals between the screens to prevent vertical flow in the annulus during pumping. Six inches was selected as the casing diameter so as to easily accommodate widely available submersible electric pumps. The advantages of this type of well are: any number of screens can be set at zones of interest; the relatively large diameter will accommodate off-the-shelf submersible electric pumps; flow during pumping with submersible electric pumps is constant and easily measured; head can be measured below, in, and above the packer isolated screen during pumping; and specific capacity can be determined for each screened interval.

The disadvantages of the single string, large diameter completion are: a packer above and below the pump is required to isolate pumping to one screen and likewise the head at each screen can only be determined by packer isolation of the screen. Packer installation requires some type of rig. This means that any time a water quality sample or a head measurement is desired, a rig and crew would be needed to set the packer equipment for the measurements.

Measurements after the departure of the drilling and well completion drill rig would clearly be very time consuming and expensive.

The other well completion design considered for the Project drill holes is commonly called a "nested well" completion. A nested well refers to a drill hole completed with more than one small diameter well with screens at different intervals.<sup>1</sup> Because of the small diameter of the individual wells, the drill hole diameter for this type of completion would be about the same as for the larger diameter single string well completion. As in the single string well completion, the annular space would be filled with filter pack and bentonite seals would be set between the screens at appropriate intervals to prevent inter-screen flow during pumping.

The ability to make water level measurements and collect water samples without packer isolation equipment is the advantage of a nested completion. The only equipment needed to measure head at any time is a well sounder. The disadvantages of the nested completion are: specific capacity can not be determined during pumping because measurements of depth to water are not possible during air-lift pumping from a small diameter well, and a maximum of about 4 wells (4 screened intervals) can be installed in the same diameter hole as would be needed for the "large" diameter single string completion.

After much discussion of the advantages and disadvantages of each completion, the subcommittee reached a consensus that the nested completion was more advantageous, especially in the long-term. Of particular advantage would be the ability to sample water and measure depth to water in the nested completion without a rig (to install screen isolation packers). The cost of a packer setting rig would be a major hindrance to any potential future research use of the wells. In addition, the nested completion allows easy installation of pressure transducers for depth to water measurements by a data logger.

Two inches was selected as the diameter for each of the piezometers in the nested completion because the minimum diameter of semi-off-the-shelf submersible pumps capable of lifting water from 300 to 400 feet is about 1-7/8 inches. This allows water samples to be pumped instead of air-lifted. Pumped samples (non-aerated) may be required for some future investigation. Obviously more piezometers (more screened intervals) can be installed in a given diameter drill hole as the diameter of the individual piezometers is decreased, however the smaller the diameter the higher the probability of limiting some future research.

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<sup>1</sup>According to Nielsen (1991), nested wells can also mean closely spaced wells, installed in separate drill holes, with screens at different depths. As used herein, "well" refers to the full drill hole completion and "piezometer" refers to one of the three or four individual small diameter wells in the nested completion.

All of the screens were 20 foot long except in well BR-4. Twenty feet was a trade-off between the desire for a long screen, so that aquifer parameters determined from slug test would represent more of an aquifer "average," and a short screen so that the head would not be an average of a large aquifer thickness.

## **DRILLING AND COMPLETION SEQUENCE**

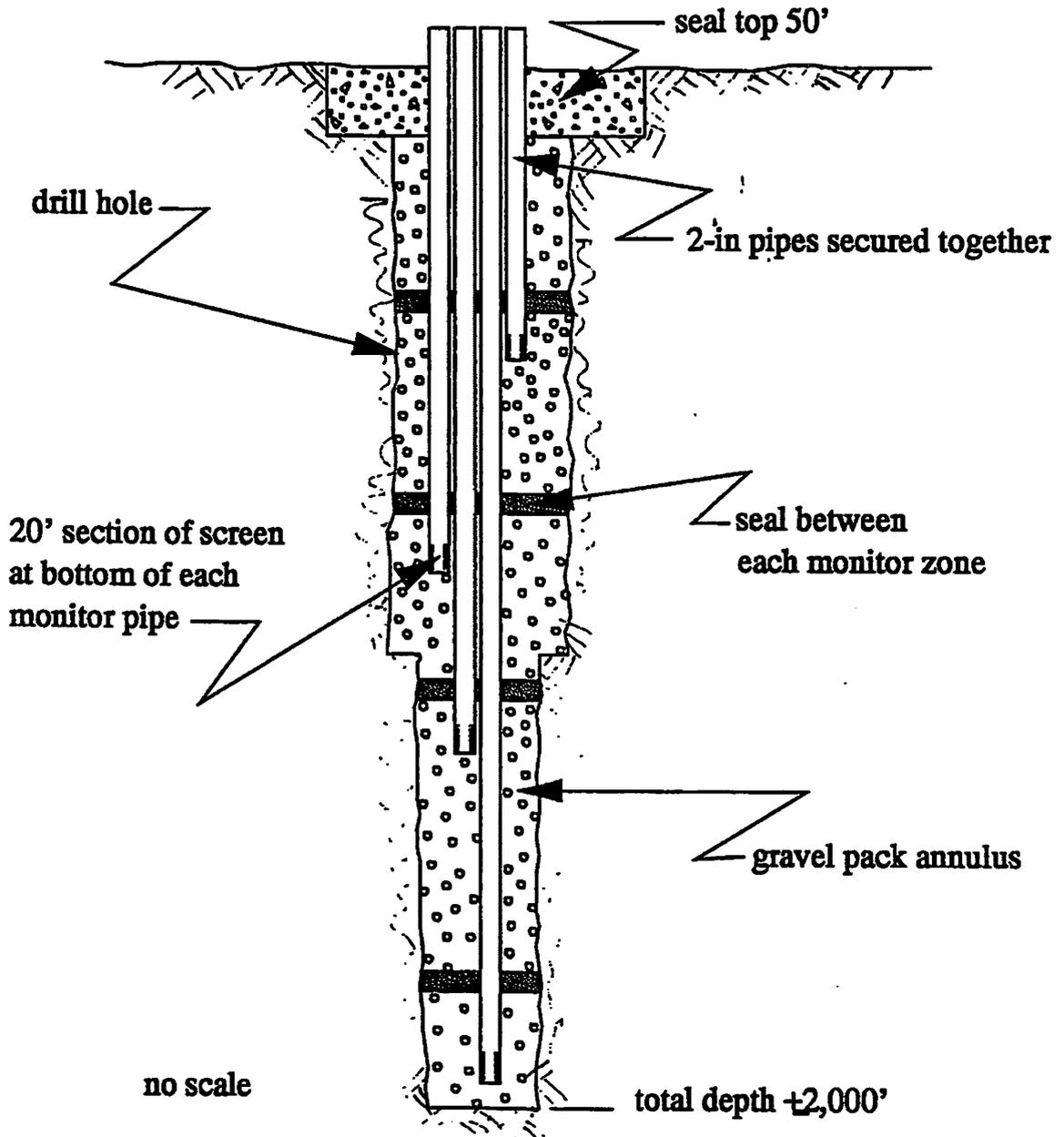
All of the holes for the test wells were drilled by conventional circulation mud rotary. The diameter of the first pass to total depth was at the drillers discretion. Most chose to drill the hole to completion diameter on one pass to total depth as opposed to reaming a smaller diameter pilot hole.

The drillers were required to maintain a complete drillers log which included "joint" number, drilling start time, drilling stop time, circulation time, joint length, total drill string length, and formation and construction notes. Cuttings, retained in clear zip-lock bags for later description by one of the subcommittee members, were sieved from the mud return every 10 feet during the drilling.

Electric and natural gamma logs were run immediately after the hole was drilled. The electric logs included spontaneous potential, 16-inch normal, 64-inch normal, and the 6-foot lateral. A long spaced sonic log (acoustic velocity) was run in the BR-10 drill hole. Temperature logs were run in the deep piezometer one to two months after completion by personnel from the Navy's Geothermal Programs Office. The temperature logs in Appendix XII were run by NACC.

The intervals to be screened were selected by a consensus among the subcommittee members at the drill site when the electric logging was completed. In many cases, if not most, this impromptu subcommittee meeting was in the pre-dawn hours. The screens were set opposite sandy intervals and the annular seals were set opposite significant clay layers if available. A typical completion is shown in figure 3.

The piezometers were developed by air-lift pumping. Most of the piezometers were air-lifted for about 12 hours (from drillers report) and the estimated flow rate on most was 5-10 gallons/minute. Poor development, however, is suspected in some of the piezometers. Slug test water level recovery in a number of the shallow piezometers was unexpectedly slow. Poor development, as opposed to the aquifer, is believed to be the cause of the slow



**Figure 3.** Schematic of typical drill hole completion with four piezometers. Some drill holes were completed with three piezometers.

recovery rate. Although the wells were designed to provide recommended submergence, the poor development was probably caused by too little air line submergence. See Appendix IV for a detailed explanation of the diagnosis. Less than complete development is suspected as the cause of the lower concentrations of some constituents in the filtered sample water quality analyses from the MW-32 piezometers as compared to the unfiltered samples.

A sample for water analysis was collected just before the air-lifting was stopped. The water quality samples were sent to Clinical Laboratory of San Bernardino or BC Laboratories of Bakersfield for a Title 22 Chemical Analysis. The Title 22 analysis covers all of the constituents and attribute standards for water in California. All of the analyses are included in Appendix VIII.

### **TEST WELL LOCATION SELECTION PROCESS**

Each member of the subcommittee submitted a prioritized list of 10 potential test well locations with a short rationale for each location. The 10 sites were selected from a preliminary list of 16 well sites which were selected by the subcommittee members based on existing geohydrologic conditions, interpretations of geophysical surveys (seismic, gravity, and magnetic), likely depth to water, potential recharge zones, and the density of existing well related data in the area. Each member developed his priority list based on the criteria the member believed to be important and without consultation with the other members.

The final Project prioritized list of general locations (township, range, and section) for the test holes evolved from the individual priority lists after lengthy discussions of the location rationales. The exact location was guided by ease of equipment access, environmental concerns, safety, and land ownership. All wells were located on public land so as to eliminate potential future access problems due to change of ownership.

The locations and priorities developed by each member were remarkably similar, especially the high and low priority locations. The highest priority locations selected by most members were in the Southwest Area (SW) along with one well in the middle of the Intermediate Area (Inter). Determination of the water quality at depth was the rationale for the Intermediate Area location. The Southwest Area of the Valley was, and is, of interest because of the paucity of existing wells and the indication from geophysical surveys that there may be a subsurface structural high. In addition, the watersheds in the Sierra Nevada upslope of the Southwest Area have been modeled as the area of greatest recharge to the Valley. There was general agreement that the east and northeast area was a lower priority. There was some disagreement on the

specific intermediate priority locations; however, in general they were in the center of the Valley north of the Intermediate Area.

## SELECTED PRIORITY LOCATIONS

The following is a list of the selected test well locations in decreasing order of priority. The number of the BR (Bureau of Reclamation) test well designation is the same as the priority. Ten sites were selected with the understanding that the sum of the actual well completion costs would probably not allow completion of all ten sites. The subcommittee agreed that the order of priority could change based on the findings as the wells were completed. The actual location of some of the wells may be as much as one section from the proposed location due to access considerations and the location of previously cleared areas. See figure 4 in the Data and Data Analysis chapter for actual well locations.

- Site 1**  
(SW)                    T27S/R38E Section 23(BR-1)  
Exposures of Pleistocene sediments coupled with Bouger gravity and refraction studies (Cal Tech and NWC) indicate the potential for a groundwater divide and or a structural high in the Southwest Area of the Valley. Hydraulic conductivity in this unit could be much lower than in the Valley fill. In addition, the apparent location of this feature could impact the estimate of recharge to the Valley from the southwest watersheds.
- Site 2**  
(SW)                    T27S/R38E Section 11(BR-2)  
The relationship of water levels, water quality, and the geologic log of this well as compared to those same attributes in BR-1 may lend insight into the area that has been modeled as the largest recharge source to the Valley. There may be distinct water quality and water level differences between sites 1 and 2 which may be based on the subsurface configuration of the potential structural high. To reduce disturbance of desert vegetation and increase the distance from BR-1, this well was completed in section 2 (the adjacent section to the north of 11) on an area already clear of vegetation.
- Site 3**  
(South)                T27S/R39E Section 10(BR-3)  
This site was selected to explore the southern "boundary" of the Intermediate Area. Water quality at depth could bear on long-term operation of the Intermediate Area well field. As the Valley fill may consist of interfingered Sierra Nevada derived sediments and sediments from the El Paso Mountains, there

may be a notable difference in hydraulic conductivity as compared to the wells on the west side of the Valley. To reduce disturbance of desert vegetation, this well was completed in the northwest corner of section 11 (the adjacent section to the east of 10) on an area already clear of vegetation.

**Site 4  
(Inter)**

**T26S/R39E Section 26(BR-4)**

This site is in the middle of the Intermediate Area. Water quality and stratigraphy below the pumping horizon of the wellfield is of particular interest because of the potential to affect wellfield water quality. A refraction survey (Charlie profile) shows a distinct velocity increase at a depth of approximately 1300 feet. This is thought to be the top of the Ricardo Formation. Some have suggested an upwelling of deep water in this area.

**Site 5  
(West)**

**T25S/R38R Section 34(BR-5)**

Bouger gravity, magnetic and refraction surveys (NWC, EKCRCD, and Cal Tech) indicate a potential depositional basin (fine-grained deposits) to the east and northeast of this site. The geologic and geophysical logs from this site and the Neal Ranch sites (NR-1 and NR-2) should indicate the depositional history of the area and the extent of the apparent fine-grained deposits. The water quality data may have an impact on future pumping distribution. The water table elevation at this site compared to the Neal Ranch sites will indicate recharge gradient.

**Site 6  
(West)**

**T25S/R38E Section 10(BR-6)**

The Sierra Nevada watersheds west of this site have been modeled as one of the larger recharge sources for the Valley. As mentioned under Site 5 the Bouger gravity, magnetic and refraction surveys (NWC, EKCRCD, and Cal Tech) indicate a potential depositional basin in this area. The geologic and geophysical logs from this site and Site 7 should indicate the depositional history of the area and the extent of the fine-grained deposits, if any. The water quality data should indicate the potential for future pumping distribution. The water table elevation at this site compared to Site 7 will indicate recharge gradient. This well was actually completed in section 12 after it became apparent that this would be the last Project well (BR-10 was completed with financial assistance from the NAWS Geothermal Office).

- Site 7  
(Cent)** T25S/R39E Section 8 (BR-7)[Not Completed]  
This site is a "companion" to Site 6. Data from each site (sites 6 and 7) would have much more meaning when compared to the other. Questions raised from the data collected at Site 6 could be partly answered by the data from Site 7. These questions may include: how extensive are the fine grained deposits (if found), how representative is the water quality variation with depth, and how steep is the water table gradient.
- Site 8  
(Cent)** T25S/R39E Section 34(BR-8)[Not Completed]  
Selection of this site was also based on the previously mentioned geophysical surveys by Cal Tech, NWC and EKCRCD. Here the southward extension of an indicated Pleistocene deposition basin (fine grained deposits) is of interest. The vertical and horizontal extent of these deposits can have an impact on the long-term pumping potential of an area because the groundwater yield from these deposits is low and in many cases the water quality is poor.
- Site 9  
(East)** T25S/R39E Section 30(BR-9)[Not Completed]  
A deep well in the China Lake Playa area would give insight into the depositional history of the Valley. The indication that there may have been a (pleistocene) depositional basin in the northwestern section of the Valley suggests that the center of fine grained deposition was not always on the east side of the Valley. Is there potential for groundwater production at depth below the playa? The horizontal and vertical extent of these deposits in the aquifer horizon can have a significant impact on future pumping distribution decisions because the groundwater yield from these deposits is low and in many cases the water quality is poor.
- Site 10  
(NW)** T24S/R38E Section 22(BR-10)  
By all estimates the Nine-Mile Canyon in the Sierra Nevada west of this site is a relatively large contributor of recharge to the Valley. Water quality differences with depth may yield insight as to the depth of section through which this recharge flows. In part, this site was also selected because of the potential depositional center migration during recent geologic time as mention above. This well was completed in section 21.

## SITES DRILLED AND COMPLETED

Priority sites 1 through 6 and site 10 were drilled and completed with piezometers. Two wells, completed to Project specifications, were installed by the Water District on their Neal Ranch property. These wells are designated NR-1 and NR-2. The Water District also completed well MW-32 as a Project well. Here the Water District only needed a pilot hole for a soon to be constructed large diameter supply well. A normal pilot hole would have been drilled to about 1200 feet at most and would have been completed with a single observation well.

As the drilling and completion of the wells progressed, well drilling costs increased to the point that some sites could not be completed. Sites 7, 8, and 9 were skipped for two reasons. The first was that the upper section of the Navy's SNORT well was made available to the Project for completion. The subcommittee decided that the central Valley location of the SNORT well would in general substitute for central Valley sites 7 and 8. The second reason was the discovery of the thick sections of clay in NR-1, NR-2, and BR-6, which made the BR-10 location ever more important because the location offered the most potential for exploring the extent of the thick subsurface clay.

## DRILL HOLE COMPLETION HISTORY

A short narrative of the drilling and completion is given below in the order of well location priority. Refer to figure 4 in the following chapter for the location of the Project test wells.

### \*Well BR-1

This well is about 200 feet west of the Red Rock Inyokern Road at a point about 5.2 miles south of Inyokern. Drilling by Southern California Drilling of Lancaster, California, began on February 15, 1991, and was completed on March 5. The 12¼-inch hole was drilled to 1,910 feet. Drilling rate was relatively consistent in this hole to about 1,700 feet. Drilling time per 30-foot joint down to 1,700 feet was about one hour. From about 1,700 to 1,830 feet the time per joint was about two hours. Drilling of the last full 30-foot joint took 6 hours. Although the change in penetration rate per joint is characteristic of bit failure, the bit was reported by several subcommittee members to be in relatively good shape. Four piezometers were set with the bottom of the 20 foot screens at 1,770, 1,520, 1,060, and 635 feet.

### \*Well BR-2

This well is about 1¼ miles south of Highway 178 at the south end of Sierra Vista Road (27S, 38E, 2C). Drilling by Southern California Drilling of Lancaster, California, began on October 1, 1990, and was completed on

October 24. The 12¼-inch hole was drilled to 2,020 feet and the penetration rate was relatively consistent in this hole. Three piezometers were set with the bottom of the 20 foot screens at 1,960, 1,480, and 640 feet.

**\*Well BR-3**

This well is about 100 feet south of Bowman Road and about 1,500 feet east of Highway 395 (27S, 39E, 11D). Drilling by Southern California Drilling of Lancaster, California, began on March 6, 1991, and was completed on March 19. The 12¼-inch hole was drilled to 2,024 feet and the penetration rate was relatively consistent. Three piezometers were set with the bottom of the 20 foot screens at 1,870, 1,340, and 670 feet.

**\*Well BR-4**

This well is about 600 feet south of Inyokern Road and about 300 feet west of the north-south dirt road on the eastern section line of section 26 (26S, 39E, 26A). Drilling by U.S. Bureau of Reclamation crews from Sacramento, California, and Phoenix, Arizona, began on August 28, 1990, and was completed on about September 27. The hole was drilled to 2,020 feet and electric logged. After the deep piezometer was set, the previously set filter pack tremie pipe could not be moved, either up or down. After removing the deep piezometer from the hole, many days were spent fishing out the tremie. Since it was coming out in ever shorter sections and the annulus appeared to be increasingly packed with sand, it was decided to install one piezometer in the remaining open hole. Only one piezometer was set with the bottom of the 10 foot screen at 1,200 feet.

**\*Well BR-5**

This well is about 200 feet west of Highway 395 at a point about one-half mile north of the Leliter Road intersection with Highway 395 (25S, 38E, 34G). Drilling by Welch and Howell Drilling of El Centro, California, began on December 19, 1991, and was completed on January 3, 1992. The hole was drilled to 1,014 feet with a 14¾-inch bit and a 12¼-inch bit was used to drill to total depth of 2,013 feet. The drilling rate was relatively consistent in this hole. Coarse alluvial fill, mostly sand, was penetrated to total depth. Three piezometers were set with the bottom of the 20 foot screens at 1,980, 1,610, and 870 feet.

**\*Well BR-6**

This well is just inside the Naval Air Weapons Station west boundary, which parallels Brown Road, along a dirt eastward extension of the east-west section (north end) of Brown Road (25S, 38E, 12F). Drilling by Welch and Howell Drilling of El Centro, California, began on January 6, 1992, and was completed on January 17. The hole was drilled to 1,008 feet with a 14¾-inch bit and a 12¼-inch bit was used to drill to total depth of 2,012 feet. Total

clay thickness penetrated by this hole was significant. From a depth of about 510 feet to about 1,480 feet the section is about 75 percent clay.

Curiously, the electric log of the section from about 1,815 feet to total depth (2,012 feet) looks like the indurated section at the bottom of BR-1. The description of the cuttings samples from this interval is consistently sand with some clay with no indication of cementation. Unfortunately the driller did not record drilling time for each joint. Three piezometers were set with the bottom of the 20 foot screens at 1,660, 1,210, and 350 feet.

#### **\*Well BR-10**

This well is about one tenth of a mile southeast of the intersection of Highway 395 and Ninemile Road in the northwest part of the Valley (24S, 38E, 21J). Drilling by Welch and Howell Drilling of El Centro, California, began on August 24, 1992, and was completed on September 2. The hole was drilled with a 17½-inch bit to 591 feet, a 14¾-inch bit to 1,002 feet, and a 12¼-inch bit to 2,005 feet. The cuttings from 680 feet to 1,440 feet are mostly described as clay, however, the electric logs indicate significant sand interbeds. Four piezometers were set with the bottom of the 20 foot screens at 660, 1,200, 1,580, and 1,950 feet.

### **WATER DISTRICT WELLS**

The following wells were completed by the Indian Wells Valley Water District. The Neal Ranch (NR) wells were completed to explore the geology and water quality under their Near Ranch property. Monitoring Well 32 (MW-32) was a pilot hole and observation well for production well #30. All three of the holes were drilled and completed as a standard Project test well. A normal pilot and exploration hole would probably have been about 1,000 feet deep and most likely would have been completed with one small diameter well.

#### **\*Well NR-1**

This well is located in the northeast corner of the Water District's Neal Ranch property (25S, 38E, 25J). Drilling by Southern California Drilling of Lancaster, California, began on January 7, 1991, and the wells were completed on February 6. The 12¼-inch hole was drilled to 2,012 feet. An extremely thick and relatively continuous clay and peat section was penetrated by this hole. The top of the clay is at a depth of about 340 feet and the bottom is at about 1,810 feet. Three piezometers were set with the bottom of the 20 foot screens at 1,980, 1,190, and 270 feet.

**\*Well NR-2**

This well is located in the southwest corner of the southwestern block of the Water District's Neal Ranch property (25S, 38E, 36F). Drilling by Southern California Drilling of Lancaster, California, began on February 4, 1991, and was completed on February 15. The 12¼-inch hole was drilled to 1,994 feet. The thick clay section penetrated by the drill hole for NR-1 was also encountered in this drill hole. Here the top of the clay is at a depth of about 445 feet and the bottom is at about 1,490 feet. Three piezometers were set with the bottom of the 20 foot screens at 1,930, 1,560, and 350 feet.

**\*Well MW-32**

This well is about 600 feet west of Victor Street and about 1,200 feet south of Inyokern Road (26S, 39E, 27D). Drilling by Rottman Drilling Company of Lancaster, California, began on September, 23, 1991, and was completed on October 8. The 12¼-inch hole was drilled to 1,968 feet. The section penetrated was a sandy alluvial fill with very little silt or clay. Four piezometers were set with the bottom of the 20 foot screens at 1,920, 1,260, 900, and 360 feet.

**NAVY GEOTHERMAL TEST WELL**

The Geothermal Program Office of the China Lake Naval Air Weapons Station allowed the Project to complete two intervals in the upper part of their geothermal exploration well (SNORT-1) located in the center of the Valley. Based on the electric logs the subcommittee selected 840-880 feet and 1,430-1,470 feet as the intervals for completion. The perforation and completion of these intervals was included in the perforation and completion contract for the deeper intervals of interest to the Geothermal Programs Office.

SNORT-1 is located about one mile northwest of the north end of the SNORT (Supersonic Naval Ordnance Research Track). Drilling by Welch and Howell Drilling Company of El Centro, California, began on September 8, 1991, and reached a total depth of 7,394 feet on September 30.

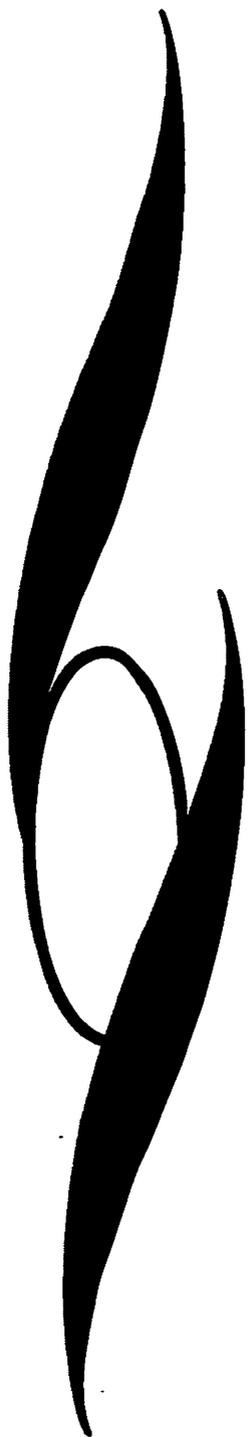
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# DATA COLLECTED

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# **DATA COLLECTED**

## **INTRODUCTION**

Information and data were collected during each phase of well construction and after completion. During drilling, a penetration rate log was maintained by the driller and samples of the formation cuttings were collected from the drilling mud return. Electric logs were run after the hole reached total depth.

Information collected from each piezometer after completion included: depth to groundwater measurements approximately every two months, laboratory analysis of water samples collected at the end of development, slug tests for transmissivity estimates, and pressure tests to check for hydraulic connection between the piezometer screens. Detailed logs and all of the data collected from the piezometers can be found in the Appendices. The appendix and data found therein are as follows:

- Appendix III - Pneumatic Slug Test Procedure and Data Analysis
- Appendix VI - Diagrammatic Piezometer Completion and Data Summary
- Appendix VII - Drill Hole Completion and Data Logs (with Electric Logs)
- Appendix VIII - Laboratory Water Quality Analyses (Title 22)
- Appendix IX - Water Elevation Hydrographs
- Appendix X - Depth to Water Measurements
- Appendix XI - Slug Test Data
- Appendix XII - "Down-Hole" Temperature Logs
- Appendix XIII - Project Well Location Map
- Appendix XIV - Well Site Elevations

## **DRILL HOLE CUTTINGS**

A sample of the formation cuttings was collected every ten feet during drilling of the test well hole. The samples were collected from the drilling mud return stream with a "kitchen strainer" and placed in a clear zip-lock plastic bag marked with the drill hole depth. All of the cuttings samples from each hole were packed into wood boxes for storage and later description by one of the subcommittee members. These boxes are in storage at Water District facilities.

## **DRILL HOLE COMPLETION AND DATA LOGS**

The "geologic" logs for this Project were designed to present essentially all of the information collected during drilling and testing of the completed wells. In some cases the electric logs as shown are a "trimmed" rendering of the

original. In each of these cases the log trace was not altered and as much of it is shown as possible within the space limit.

The descriptive cuttings log in the right column of the Drill Hole Completion and Data Log (see Appendix VII) is a summary of the detailed cuttings description. An interpretive adjustment to fit the depths to the electric logs was not made. The depth to water shown on the log is only one set of the measurements made during the course of the Project. They are, however, representative of the relative water level differences consistently noted between the piezometers. The rest of the information and data is believed to be self-explanatory.

## **LABORATORY WATER QUALITY ANALYSES**

Water samples were collected from each piezometer near the end of air-lift development pumping. Water was air-lifted about 12 hours at 5-10 gallons per minute based on the driller's report. Water samples were submitted to a California certified laboratory for Title 22 analysis.

The water samples were believed to be representative of aquifer water; however, poor development is suspected in some of the piezometers based on slow water level recovery rates during the slug test (see Appendix IV). Some constituent concentration differences between filtered and unfiltered water samples from MW-32 also suggest less than full development.

## **DEPTH TO WATER MEASUREMENTS**

Depth to water in each piezometer was generally measured whenever the Reclamation member of the subcommittee was in the Valley. All measurements were made with a 1,000 foot electric water level sounder. The cable on this sounder is the same as 300 ohm, twin-lead, TV antenna wire with measurement marks at a 0.05 foot-interval. Some piezometers have fewer depth to water measurements than others. The number of depth to water measurements is a function of the date the well was completed--the later the completion, the fewer the measurements. All depth to water measurements can be found in Appendix X and water elevation hydrographs are in Appendix IX.

All depth to water measurements were made from the top of each piezometer. The column headed by "TOC to TOP" on the depth to water data sheet is the distance (in feet) from the "top of casing (large diameter outer protective surface pipe) to top of piezometer." Water level elevation is the top of casing elevation minus the sum of depth to water and TOC to TOP.

The top of casing elevation was established at a mark on the casing by a Reclamation survey crew from the Yuma Projects Office, Yuma, Arizona (see Appendix XIV for well site elevations). The elevation survey was "closed" and the closure error and length of "run" was noted. A closed survey begins and ends at the same known elevation point. The difference between the starting elevation and the ending elevation at the know elevation point is an indication of the survey quality.

Two wells--BR-3 medium and MW-32 shallow--have an oil coating on the inside of the piezometer pipe above the water level. This coating is especially heavy in BR-3 medium. Based on an analysis, this oil probably came from the air compressor used for air-lifting. Water level measurements could only be made on a few occasions with the electric sounder in BR-3 medium. One of the water level measurements in this piezometer was made with the temperature probe on the NACC's logging van. The oil sample for analysis was retrieved from the logging cable squeegee. Several attempts to reduce or remove this coating have not been successful. However, later attempts to get an electric sounder probe down to the water level, were less difficult than early attempts.

## **SLUG TESTS AND TRANSMISSIVITY ESTIMATES**

A pneumatic slug test was conducted on each of the Project piezometers and the recorded recovery rate was used to estimate the transmissivity of the formation opposite the screened interval. The pneumatic technique, with an electric data logging devices used in conjunction with down hole pressure transducers, is a recent advancement in slug testing because it increases the range and application of slug tests. This method involves either injecting air into a sealed well to lower the water level (Leap, 1984) or applying a partial vacuum to a sealed well to raise the water level (Orient and others, 1987). This equipment and procedure for conducting slug tests allows testing in deep water level, small diameter wells screened in highly conductive aquifers.

The Cooper (1967) method for analyzing slug test recovery data was used to derive the estimated transmissivity of the 20 foot aquifer opposite the screen. The mathematical solution by Cooper and others (1967) for the instantaneous injection (or removal) of a volume of water (the "slug") assumes that the well fully penetrates the aquifer and that the aquifer is perfectly confined. This is clearly not the case in the Project test wells. However, Cooper and others (1967) conclude their paper with the following:

"Few wells completely penetrate an aquifer, but it is nevertheless possible under some circumstances for a hydrologist to derive useful information

from a test on a partially penetrating well. Since the vertical permeabilities of most stratified aquifers are only small fractions of the horizontal permeabilities, the induced flow within the small radius of the cone that develops during the short period of observation is likely to be essentially 2-dimensional. Therefore, the determined value of T [transmissivity] would represent approximately the transmissibility of that part of the aquifer in which the well is screened or open, provided that the aquifer is reasonably homogeneous and isotropic in planes parallel to the bedding and provided that the effective radius can be estimated closely."

It is believed that the physical properties around the Project's piezometer screens are sufficiently close to the conditions for which the Cooper method was derived because the estimated transmissivities when prorated over the full aquifer thickness seem reasonable. The raw slug test data is in Appendix XI.

AQTESOLV (Aquifer Test Solver), software from the Geraghty and Miller Modeling Group in Reston, Virginia, was used to estimate the transmissivity of the screened aquifer. The traditional Cooper solution for transmissivity relies on judgement of the best fit (overlay) between a plot of the recovery data and one curve from a family of type curves. Although the solution procedure in the software is not known, it is believed to offer a more consistent solution than overlay fitting. As a check, the transmissivity estimated from visual curve fitting was compared to the software solution for BR-4. The software solution for transmissivity was .28 ft<sup>2</sup>/min and the visual solution was .275 ft<sup>2</sup>/min.

## HYDRAULIC CONNECTION TESTS

Some of the slug test equipment was also used to test for an "open" hydraulic connection between the screens of each Project well. To conduct the test the electric sounder probe was lowered to about 0.02 feet above the water level in the next-to-the-deepest piezometer. The pneumatic slug test well head assembly was then secured to the deep piezometer and air from a SCUBA tank was used to bring the pressure in the piezometer up to about 15 pounds per square inch (psi). After noting any sounding from the sounder, testing continued by moving the electric sounder to the next piezometer up the hole and moving the well head assembly to the next piezometer up the hole.

It is assumed that an open connection between screens through the annulus would provide a conduit for pressure transmission. This condition would manifest itself by a rise in piezometer water level (which would sound the sounder) subsequent to pressurizing the next piezometer down the hole. Water level changes in the nearest up-hole piezometer were not observed during any of tests.

## TEMPERATURE PROFILES

Temperature logs were run in each deep piezometer using a ComProb/Gearhart Owens International temperature tool on a NACC wire line logger. Each piezometer was logged by lowering the temperature tool down the piezometer at five feet a minute. Data are recorded on a floppy disc for later printing. The temperature profiles are included in Appendix XII of this volume. The temperature gradients reported in the following chapter are mostly from logging by the NAWS Geothermal Projects Office.

## REFERENCES

Cooper, H.H., Bredehoeft, J.D., and Papadopoulos, I.S., 1967, *Response of a Finite-Diameter Well to an Instantaneous Charge of Water*, Water Resources Research, v.3, no.1, p.263-269.

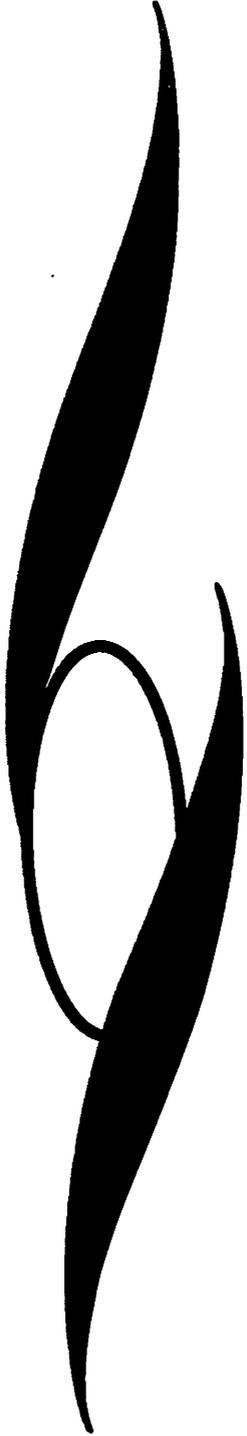
Leap, D.I., 1984 (Fall), *A Simple Pneumatic Device and Technique for Performing Rising Water Level Slug Tests*, Ground Water Monitoring Review, pp.141-146.

Orient, J.P., Nazar, A., and Rice, R.C., 1987 (Winter), *Vacuum and Pressure Test Methods for Estimating Hydraulic Conductivity*, Ground Water Monitoring Review, pp.49-50.

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# **DATA AND DATA ANALYSIS**

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# DATA AND DATA ANALYSIS

## INTRODUCTION

In this chapter the data collected from each Project well is discussed. Relative water levels are discussed first followed by water quality, estimated aquifer transmissivities derived from slug tests, deposits penetrated during drilling, and the results from the temperature log. Some interpretations are also offered; however, data collected in the future, especially isotopic analysis, could suggest alternative interpretations.

Another round of water sampling with a submersible pump is recommended for isotopic and water quality analysis. Stable isotope ratios, used to estimate water age, may be significant with respect to recharge. The water quality analyses will either confirm what appear to be unusual constituent concentrations in the aquifer water or suggest potential bias in the first sampling round.

The only groundwater quality attribute common to all waters from the test wells, except the BR-3 medium and deep piezometers and the SNORT-1 "piezometers," is that the predominant cation is sodium and the predominant anion is bicarbonate. The primary source of sodium in natural water is from the release of soluble products during the weathering of igneous rock (plagioclase feldspars) and its weathering products in other material (Davis and DeWiest, 1996 and Bouwer, 1978). Most carbonate and bicarbonate ions in groundwater are derived from the carbon dioxide in the atmosphere and in the soil and solution of carbonate rocks. Below a pH of 8.2 most of the carbonate ions take on hydrogen to become bicarbonate ions and the ratio of bicarbonate to carbonate ions increases to more than 100 to 1 (Davis and DeWiest, 1966).

Figure 4 is a depiction of the most pertinent groundwater related data collected from the Project wells. Depth of piezometer (1" = 1000'), elevation of groundwater (feet), water quality (total dissolved solids, mg/L), and estimated transmissivity (ft<sup>2</sup>/min) are shown. In the depiction, each vertical line below the Project well designation represents one piezometer. The length of the line is scaled to the piezometer depth (1" = 1,000'). The horizontal bars represent groundwater levels relative to each other but not at the piezometer depth vertical scale. Water elevation is shown to the right (except BR-5) of the piezometer cluster depiction.

The column representing geology exaggerates the thickness of thin clay layers (BR-1, BR-2, BR-5) however their location on the column is representative. Thick clay deposits, however, are to scale (BR-3, BR-6, NR-1, and NR-2). The single clay layer shown on BR-4 and MW-32 is somewhat vertically exaggerated in each case.



**SECTION A -  
GEOHYDROLOGY**

Reference to figure 4 will probably be helpful while reading the following discussion. Table 2 shows much of the same information in a different format. Detailed information for each well and individual piezometer can be found in the Appendices. The appendix and data found therein are as follows:

- Appendix III - Pneumatic Slug Test Procedure and Data Analysis
- Appendix VI - Diagrammatic Piezometer Completion and Data Summary
- Appendix VII - Drill Hole Completion and Data Logs (with Electric Logs)
- Appendix VIII - Laboratory Water Quality Analyses (Title 22)
- Appendix IX - Water Elevation Hydrographs
- Appendix X - Depth to Water Measurements
- Appendix XI - Slug Test Data
- Appendix XII - "Down-Hole" Temperature Logs
- Appendix XIII - Project Well Location Map
- Appendix XIV - Well Site Elevations

WELL	WATER ELEVATION feet (9/10/92)	WATER QUALITY mg/L	TRANS-MISSIVITY ft <sup>2</sup> /min	NOTES
BR-1				Mostly sand with some clay. Water from each piezometer is sodium bicarbonate. Temperature gradient is 2.0 °F per 100 feet.
Shallow	2666.72	212	0.21	
Medium-shallow	2669.03	243	0.24	
Medium-deep	2664.42	353	0.01	
Deep	2656.77	285	0.004	
BR-2				Mostly sand. Iron and manganese above recommended regulatory maximum contaminate level (MCL) in medium and deep piezometers. Temp. gradient is 2.3 °F per 100 feet.
Shallow	2382.50	NA	0.01	
Medium	2386.06	240	0.19	
Deep	2376.94	354	0.016	
BR-3				Mostly sand and fine gravel; clay between 1,380 and 1,740 feet. Chloride levels higher than bicarbonate in 2 lower aquifers. Temp. gradient is 2 °F per 100 feet.
Shallow	2183.40	360	0.06	
Medium	2200.71	955	NA	
Deep	2201.48	6,634	0.006	

Well ID	Temperature (°F)	Yield (gpm)	Specific Capacity (gpm/ft)	Geological Description
BR-4	2112.69	183	0.28	Fine to coarse sand. Water is sodium bicarbonate; iron exceeds MCL. Temp. gradient is 2.1 °F per 100 feet.
BR-5 Shallow Medium Deep	2186.02 2178.86 2177.04	534 837 891	0.23 0.15 0.18	Medium to coarse sand. All water is sodium bicarbonate; iron and manganese are higher than MCL; higher sulfate and chloride compared to BR-1, BR-2, and BR-4. Temp. gradient information is not available.
BR-6 Shallow Medium Deep	2189.90 2188.55 2203.75	596 481 540	0.02 0.25 0.20	Medium to coarse sand to 370 ft; clay from 370 to 1,700 ft; clayey to silty, medium sand 1,700 ft to bottom. All water is sodium bicarbonate with sulfate and chloride higher than BR-1, BR-2, and BR-4; arsenic, iron, manganese, and aluminum exceed MCL. Temp. gradient is 2.22 °F per 100 feet.
BR-10 Shallow Medium-shallow Medium-deep Deep	2253.51 2239.38 2198.50 2196.09	1,000 580 1,220 1,330	0.19 0.02 0.14 0.09	Medium to coarse sand to 680 feet; light gray/green clay with interbedded sand from 680 to 1,440 feet; medium to coarse sand from 1,440 to bottom. Water is predominately sodium bicarbonate; iron and manganese exceeded secondary MCL in lower aquifers. Temp. gradient is 1.7 °F per 100 feet.

NR-1				
Shallow	2176.49	2,406	0.004	Medium to coarse sand to 340 feet; clay from 340 to 1,820 feet; medium sand from 1,820 to bottom; fossils and methane gas were encountered in the hole. Water in shallow aquifer is sodium sulfate with high concentrations of calcium and magnesium; water in lower aquifers are sodium bicarbonate; Nitrate exceeded MCL in the shallow piezometer. Temp. gradient is 2.75 °F per 100 feet.
Medium	2208.78	3,660	NA	
Deep	2165.87	3,251	0.05	
NR-2				
Shallow	2184.31	808	0.48	Fine to coarse sand to 440 feet; clay from 440 to 1,480 feet; sand from 1,440 to 1,620 feet; interbedded sand and clay from 1,620 to bottom. Shallow and deep waters are sodium bicarbonate with high sulfate in shallow aquifer; medium aquifer is sodium sulfate with high bicarbonate, chloride, and nitrate; arsenic is above MCL. Temp. gradient is 2.7 °F per 100 feet.
Medium	2176.08	1,367	0.14	
Deep	2177.45	3,305	0.12	
SNORT-1				
Shallow	N/A	9,890	N/A	No flow in the deeper (1,430- to 1,450-foot) interval.
Deeper	N/A	N/A	N/A	
MW-32				
Shallow	2176.76	252	0.009	Mostly fine to medium sand. All waters are sodium bicarbonate. No constituents exceed MCL. Temp. data was not obtained.
Medium-shallow	2175.50	169	0.31	
Medium-deep	2176.58	176	0.23	
Deep	2177.85	526	0.11	

For convenience in the following discussion the term aquifer is used to denote only the twenty feet of formation at the screened interval of each piezometer. If there are three piezometers in a test well the aquifers are called shallow, medium, and deep. If there are four piezometers the two medium aquifers are called medium-shallow and medium-deep.

**BR-1**

The relative water levels in the piezometers, except the medium-shallow, are generally lower with increasing aquifer depth. In an area near surface recharge from mountain front runoff, water levels would be expected to be highest in the highest elevation aquifer and lowest in the lowest elevation aquifer. BR-1 is generally downslope of the watersheds which, by most estimates, are the largest source of recharge to the Valley. The higher water level in the medium-shallow piezometer, as compared to the shallow piezometer, is probably caused by clay layers confining the water in the aquifer screened by the medium-shallow piezometer. Figure 5 shows a physical arrangement in vertical section which could cause the relative water levels observed.

Total dissolved solids (TDS) of the water from the aquifers, based on the water samples collected at the end of air-lift development, ranged from 212 mg/L in the shallow aquifer to 353 mg/L in the medium-deep aquifer. All of the waters are sodium bicarbonate and none of the constituent concentrations exceeds a recommended limit.

The estimated transmissivity for the twenty foot screened interval in the upper two aquifers (0.21 and 0.24 ft/min) is nearly as high as those estimated for a like aquifer thickness in the Intermediate Area project wells (BR-4 and MW-32). The estimated transmissivity is an order of magnitude lower in the medium-deep aquifer and in the deep aquifer it is another order of magnitude lower.

The hole for these piezometers penetrated mostly alluvial sand with some clay. The dark brown clay noted at the bottom of the drill hole could be the continental deposits expected by some interpretations of geophysical surveys (see discussion under well location selection). The driller reported this clay to be hard and cemented. The Drillers Report shows the penetration rate slowing to six hours per 30 foot joint in this unit.

A temperature log was run in the deep well on June 5, 1991, three months after the well was pumped for development. The water temperature at the top of the water column (about 200 feet depth) was 75.5 degrees Fahrenheit (°F) and at a depth of 1,760 feet (bottom of the piezometer is 1,770 feet) the temperature was 106.9 °F. The rate of temperature increase is about 2.0 °F per 100 feet.

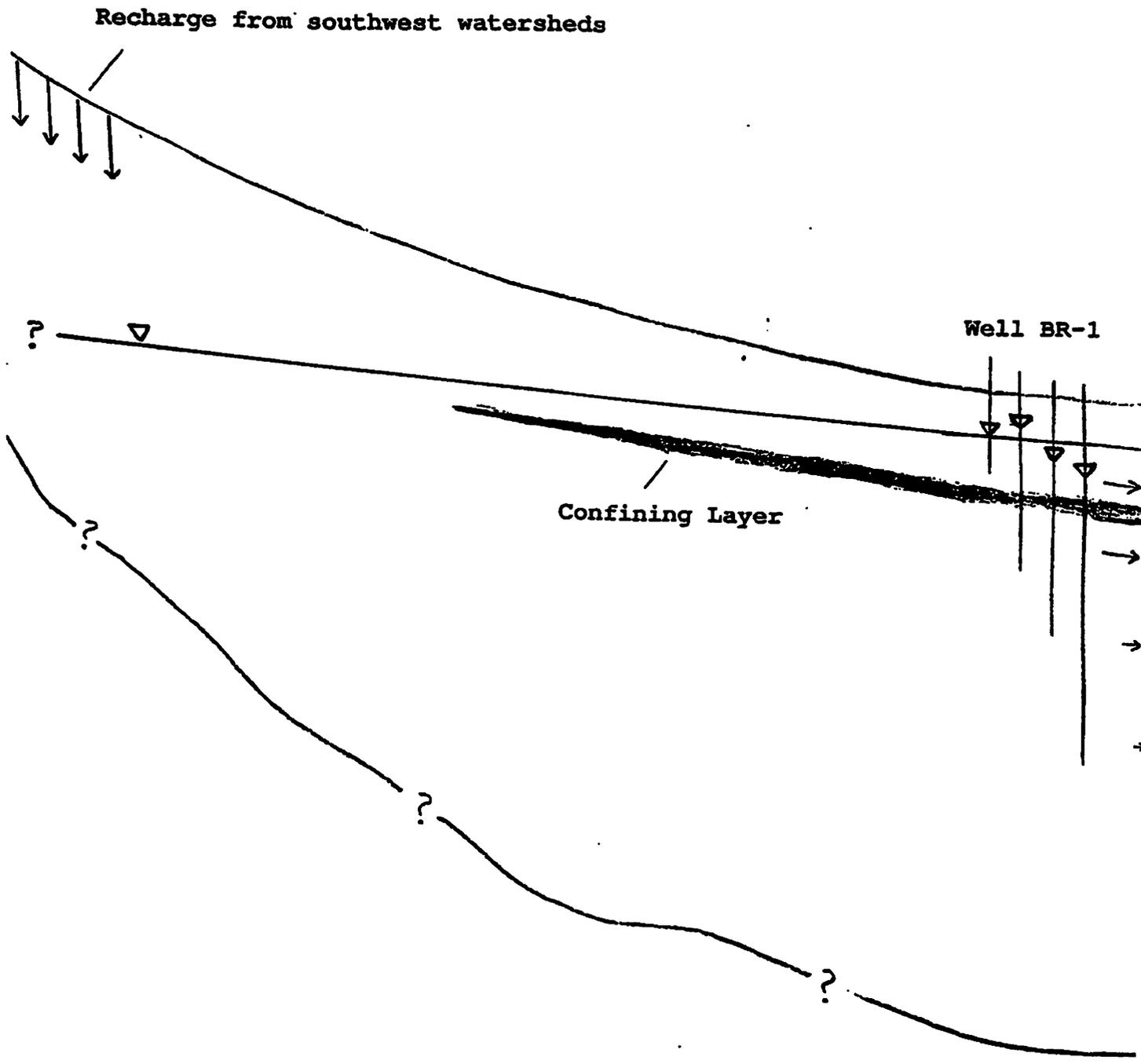


Figure 5. Hypothetical diagrammatic section between the southwestern recharge watersheds and Well BR-1. Confinement is probably the cause of the consistently higher water level in the shallow middle aquifer as compared to the water level in the shallow aquifer at well BR-1.

**BR-2**

Relative water levels in the BR-2 piezometers are the same as those in BR-1 in that the medium piezometer water level is higher than the shallow piezometer water level. In an area near surface recharge from mountain front runoff, water levels would be expected to be highest in the highest elevation aquifer and lowest in the lowest elevation aquifer. BR-2 is generally downslope of the watersheds which, by most estimates, are the largest source or recharge to the Valley. The higher water level in the medium piezometer is probably caused by confinement of the medium aquifer.

The TDS of the waters pumped from the BR-2 aquifers, based on the water samples collected at the end of air-lift development, ranged from 240 mg/L in the medium aquifer to 354 mg/L in the deep aquifer. The shallow aquifer escaped analysis due to an oversight. Both of the aquifer waters are sodium bicarbonate.

Although a water sample was not collected from the shallow aquifer, the TDS is probably less than 300 mg/L based on BR-1 shallow. The analysis suggests that iron is above the secondary maximum contamination level (SMCL) in both the medium and deep aquifer and manganese is above the SMCL in the deep aquifer but only slightly above in the medium aquifer. However, as mentioned in the introduction to this chapter, these concentrations may be a function of less-than-adequate development.

The estimated transmissivity of the medium aquifer is 0.19 ft<sup>2</sup>/min and 0.016 ft<sup>2</sup>/min in the deep aquifer. The medium aquifer transmissivity is nearly as high as those estimated in the Intermediate Area Project test wells (BR-4 and MW-32). The deep aquifer transmissivity is essentially the same as the estimate for the deep-medium aquifer at BR-1.

The low estimated transmissivity for the shallow aquifer (0.01) is believed to be a function of poor development. Insufficient airline submergence during air-lift development, although adequate by some texts, is thought to be the cause of inadequate development. See Appendix IV for a detailed explanation of the submergence hypothesis. Shallow aquifer transmissivity is probably about 0.20 based on the medium aquifer transmissivity and the BR-1 shallow and shallow-medium aquifer transmissivities.

The mud return formation samples and the drilling character indicate a non-cemented alluvial fill from the land surface to total depth. The alluvial fill is mostly subangular to subround, light gray to pale brown sand with scattered relatively thin clay layers.

A temperature log was run in the deep piezometer on November 15, 1990, about three weeks after the piezometer was air-lifted for development. The

water temperature at the top of the water column (about 280 foot depth) was 79 °F and at a depth of 1,950 feet (bottom of the well is 1,960 feet) the temperature was 117 °F. The rate of temperature increase is about 2.3 °F per 100 feet.

### **BR-3**

Confinement of the medium and deep aquifers at BR-3 is readily apparent based on piezometer water elevations. The lower elevation in the shallow piezometer, however, may be related to pumping in the Intermediate Area.

The laboratory reported TDS for the BR-3 aquifer waters are 955 mg/L in the shallow, 6,634 mg/L in the medium, and 360 mg/L in the deep. This aquifer depth water quality pattern is difficult to believe, especially since the 360 mg/L water is sodium bicarbonate and the others are sodium chloride bicarbonate. "Scrolling" each analysis to the next aquifer down yields a believable water quality versus aquifer depth trend. This hypothesis was confirmed by measuring the electrical conductivity of a water sample thieved from each of the piezometer screens by the NACC wire line logger. The electrical conductivities were found to increase with depth. This laboratory error is corrected in tabulated and graphical data.

Both of the lower aquifer waters have a greater concentration of chloride than bicarbonate. However, without the chloride the waters "look" the same as the waters from the rest of the test well piezometers. Primary sources of chloride in groundwater are evaporites, salty connate water, and marine water. Igneous rock materials contribute little chloride (Bouwer, 1978). The very high chloride concentration in the deep aquifer may be indicative of long residence time and little through-flow, connate water, or both.

The estimated transmissivity for the shallow aquifer is 0.06 ft<sup>2</sup>/min and 0.006 ft<sup>2</sup>/min for the deep aquifer. The shallow aquifer transmissivity is lower than those in the Intermediate Area and may be a function of poor development as mentioned in the chapter introduction. The deep aquifer transmissivity is much lower than in the Intermediate Area. Transmissivity was not estimated for the medium aquifer because the compressor oil film on the inside of the medium (depth) piezometer did not allow the slug test transducer to be set at an appropriate depth.

The mud return formation samples and the drilling character indicate a non-cemented alluvial fill from the land surface to total depth. The alluvial fill is mostly sand with scattered fine gravel; however, a significant clay section was penetrated in the lower part of the hole. The top of the clay section is about 1,380 feet deep and the bottom is at 1,740 feet.

A temperature log was run in the deep piezometer on December 12, 1991, nine months after the well was pumped for development. The water temperature at the top of the water column (about 310 feet depth) was 77.5 °F and at a depth of 1,170 feet (bottom of the piezometer is 1,870 feet) the temperature was 95 °F. The rate of temperature increase is about 2.0 °F per 100 feet. The temperature log was only run to 1,170 because of limited cable length.

#### **BR-4**

This well has only one piezometer due to completion difficulties as discussed in the Test Well chapter. The water level in this piezometer rises and falls in response to pumping of the nearby NACC well. A water elevation hydrograph for this well is in Appendix IX.

Total dissolved solids of the water pumped from the aquifer (1,200 feet depth), based on the water sample collected at the end of air-lift development, was 183 mg/L. The water is sodium bicarbonate. Iron, at 360 µ/l, slightly exceeds the 300 µ/l SMCL. All of the other analytes are below their respective maximum contaminant level (MCL).

The estimated transmissivity for the screened interval is 0.28 ft<sup>2</sup>/min. The mud return formation samples and the drilling character indicate a non-cemented alluvial fill from the land surface to total depth. The alluvial fill is mostly light brown to gray brown, fine to coarse sand.

A temperature log was run in the piezometer on November 15, 1990, three months after the piezometer was pumped for development. The water temperature at the top of the water column (about 250 feet depth) was 77.5 °F and a depth of 1,200 feet (bottom of the piezometer is 1,200 feet) the temperature was 97.8 °F. The rate of temperature increase is about 2.1 °F per 100 feet.

#### **BR-5**

Relative water levels in the BR-5 piezometers fit the expected pattern in an area near surface recharge, in this case from mountain front runoff. Head is lost as water moves downward from the surface; therefore, the head is highest in the higher elevation aquifer and lowest in the lowest aquifer.

Total dissolved solids of the water pumped from the aquifers, based on the water samples collected at the end of air-lift development, ranged from 530 mg/L in the shallow to 890 mg/L in the deep. Total dissolved solids in the medium aquifer is 840 mg/L. The trend of increasing dissolved solids with increasing depth matches the expected trend for recharge from relative low TDS mountain watershed spring runoff. As the recharge water moves downward through the alluvium, the dissolved solids increase with increasing

contact time with the alluvial sediments. It is interesting to note that these waters are not as low in dissolved solids as the waters in the BR-1 and BR-2 aquifers. If more spring runoff recharge is coming from the southwest watersheds than any of the other watersheds, then one could expect less dissolved solids in the southwest aquifers.

All of the waters are sodium bicarbonate; however, there are higher concentrations of sulfate and chloride as compared to the aquifer waters in BR-1, BR-2, and BR-4. The shallow aquifer water has especially notable sulfate (150 mg/L) and chloride (85 mg/L) concentrations. Sodium is 155 mg/L and bicarbonate is 227 mg/L in the shallow aquifer. Groundwater from igneous and metamorphic rocks or from sediments derived from them generally contain less than 100 ppm sulfate and may contain much less if sulfate reducing bacteria are active in the soil through which recharge water has percolated (Davis and DeWeist, 1966). However, Bouwer (1978) notes that in arid regions leaching of sulfate from the upper soil layers may be significant.

Iron and manganese concentrations are above their respective SMCL in each aquifer and arsenic is slightly above the MCL in the medium aquifer. These concentrations, however, may be influenced by development which is suspected to be less than complete.

Estimated transmissivity was 0.23 ft<sup>2</sup>/min for the shallow aquifer, 0.15 ft<sup>2</sup>/min for the medium aquifer, and 0.18 ft<sup>2</sup>/min for the deep aquifer. The upper aquifers are nearly as transmissive as those estimated for the upper aquifers in MW-32 (the Intermediate Area) and the lower aquifer is somewhat higher than the lower aquifer in MW-32.

The mud return formation samples and the drilling character indicate a non-cemented alluvial fill from the land surface to total depth. The alluvial fill is a fairly well sorted, subround, off-white, generally medium to coarse sand.

#### **BR-6**

The relative water levels in the BR-6 piezometers suggest confinement of the deep aquifer whereas the shallow aquifer water level may be influenced by nearby agricultural groundwater pumping. The low water level in the medium piezometer, as compared to the other piezometers, is probably not related to pumping because the medium aquifer is under a thick clay section and local pumping is above the clay.

Total dissolved solids in the aquifer water, based on the water samples collected at the end of air-lift development, ranged from 596 mg/L in the shallow aquifer to 481 mg/L in the medium aquifer. Total dissolved solids in the deep aquifer is 540 mg/L.

All of the waters are sodium bicarbonate; however, like the BR-5 aquifer waters, there are higher concentrations of sulfate and chloride as compared to the aquifer waters in BR-1, BR-2, and BR-4. The shallow aquifer water has especially notable sulfate (168 mg/L) and chloride (76 mg/L) concentrations. Sodium is 199 mg/L and bicarbonate is 234 mg/L in the shallow aquifer.

Arsenic is above the MCL and iron and manganese are somewhat above the SMCL in all of the aquifer waters. Aluminum is above the SMCL in the shallow and deep aquifer. As in the other wells, these concentrations may be a function of less than total development.

Estimated transmissivity for the medium and deep aquifers are 0.25 ft<sup>2</sup>/min and 0.20 ft<sup>2</sup>/min respectively. The unexpectedly low transmissivity in the shallow aquifer is believed to be an artifact of poor development which was probably caused by insufficient air-line submergence during air-lift pumping (see Appendix IV). With full development the estimated transmissivity would probably be 0.20 to 0.25. These transmissivities are essentially the same as those in the Intermediate Area Project wells. However, the total thickness of the BR-6 aquifers is much less than the total thickness in the Intermediate Area.

The mud return formation samples and the drilling character indicate a non-cemented alluvial fill from the land surface to total depth. A thick clay section, with some sand interbeds, was penetrated from about 370 to 1,700 feet. Above the clay section the alluvial sediment is mostly a light brown, medium to coarse sand. Below the clay section is generally a gray-green, clayey to silty, medium sand.

#### **BR-10**

The relative water levels in the BR-10 piezometers are as would be expected near an area receiving recharge from the surface. Head is lost as water moves downward from the surface, therefore the head is highest in the higher elevation aquifer and lowest in the lowest aquifer.

Total dissolved solids in the aquifer water, based on the water samples collected at the end of air-lift development, ranged from 1,330 mg/L in the deep aquifer to 580 mg/L in the medium-shallow aquifer. Total dissolved solids in the shallow aquifer is 1,000 mg/L.

All of the waters are sodium bicarbonate except the medium-shallow aquifer. Like the BR-5 aquifer waters, there are higher concentrations of sulfate and chloride as compared to the aquifer waters in BR-1, BR-2, and BR-4. The shallow aquifer water has especially notable sulfate (225 mg/L) and chloride (176 mg/L) concentrations. Iron and manganese exceed SMCL in the lower aquifers, however, these concentrations may be a function of less than total development.

Estimated transmissivity for the four screened aquifers are (from shallow to deep) 0.19, 0.02, 0.14, and 0.09 ft<sup>2</sup>/min respectively. The unexpectedly low transmissivity in the medium-shallow aquifer is believed to be an artifact of poor development which was probably caused by insufficient air-line submergence during air-lift pumping (see Appendix IV). With full development the estimated transmissivity would probably be around 0.20. The shallow and medium-deep transmissivities are similar to those in the Intermediate Area Project wells; however, the total thickness of the BR-10 aquifers is much less than the total thickness in the Intermediate Area.

The mud return formation samples and the drilling character indicate a non-cemented alluvial fill from the land surface to total depth. A thick light gray/green clay section, with some sand interbeds, was penetrated from about 680 to 1,440 feet. Above the clay section the alluvial sediment is mostly a light brown, medium to coarse sand. Below the clay section is generally a medium to coarse sand.

#### **NR-1**

The water level in the NR-1 shallow piezometer is higher than the water level in the deep piezometer. Both of these piezometers are screened in thick sand intervals. The water level in the medium piezometer is much higher than the other two piezometers. This interval produced some methane gas during development. The medium piezometer is screened in a relatively thin sand layer in a very thick organic bearing clay section. The high water level in the medium piezometer may be related to gas pressure.

Total dissolved solids of the water pumped from the aquifers, based on the water samples collected at the end of air-lift development, ranged from 2,406 mg/L TDS in the shallow to 3,660 mg/L in the medium. Total dissolved solids in the deep aquifer water is 3,251 mg/L. The deep aquifer quality is the same as in the deep aquifer at NR-2; however, the dissolved solids in the shallow aquifer is considerably higher than in the shallow aquifer at NR-2.

In irrigated arid areas, there can be a significant concentrating effect because plant roots take up only water and thereby concentrate the dissolved constituents in the remain soil water. With continued irrigation this "deep percolation" eventually reaches the water table. If groundwater is the source of the irrigation water, the salt concentration cycle is accelerated. The much higher shallow aquifer TDS may be related to "irrigation concentration". Neal Ranch was irrigated with groundwater for many years. The high TDS in the medium and deep aquifers may be a function of long residence time.

The estimated transmissivity for the lower aquifer is 0.05 ft<sup>2</sup>/min. The very low estimated transmissivity from the slug test in the shallow aquifer is believed to be an artifact of poor development which was probably caused by

insufficient airline submergence (see Appendix IV). Transmissivity of the shallow aquifer is probably about 0.30 ft<sup>2</sup>/min or even a little greater based on the estimated transmissivity of the NR-2 shallow aquifer.

A slug test was not conducted on the piezometer screened in the medium aquifer because there was not enough room inside the outer casing to remove the pressure gauge reducer with readily available tools. During completion, a pressure gauge was installed on the medium piezometer. After several months the pressure dropped to zero and the gauge and all accessory plumbing except the reducer were removed.

A temperature log was run in the deep piezometer on February 12, 1991, one week after the well was pumped for development. The water temperature at the top of the water column (about 100 foot depth) was 73.5 °F and a depth of 1,980 feet (bottom of the piezometer is 1,980 feet), the temperature was 125.2 °F. The rate of temperature increase is about 2.75 °F per 100 feet.

#### **NR-2**

The relative water levels in these piezometers is confusing. The head in the deep aquifer is slightly higher than in the medium aquifer and the medium aquifer head is lower than the shallow. The relative water levels between NR-2 and BR-5 suggest very little recharge from the Sierra Nevada watersheds west of BR-5.

Total dissolved solids in the aquifer waters, based on the water samples collected at the end of air-lift development, ranged from 808 mg/L in the shallow aquifer to 3,305 mg/L in the deep aquifer. Total dissolved solids of the water retrieved from the medium aquifer was 1,367 mg/L. The deep water quality is the same as the deep water quality in NR-1. The shallow aquifer water quality is much better than in NR-1 shallow.

The shallow and deep waters are sodium bicarbonate, although sulfate is relatively high in the shallow aquifer. The medium aquifer is sodium sulfate with high bicarbonate, chloride, and nitrate. The high sulfate in the shallow aquifer may have been caused by evaporative concentration from long-term groundwater irrigation. See the discussion under NR-1. Arsenic is the only analyte above a MCL.

Estimated transmissivity for the shallow aquifer is very high, 0.48 ft<sup>2</sup>/min. The water level rebounded rapidly during the slug test and displayed an "undamped" response--the water level oscillated above and below the static water level for several cycles. The amplitude of each succeeding cycle rapidly decreased. Figure 6 shows the response of the water level (NR-2 shallow) to the slug test.

The estimated transmissivity of the medium and deep aquifers are 0.14 ft<sup>2</sup>/min and 0.12 ft<sup>2</sup>/min respectively. These are nearly as high as those estimated for aquifer in the Intermediate Area project wells (BR-4 and MW-32).

A temperature log was run in the deep piezometer on June 5, 1991, three and one half months after the well was pumped for development. The water temperature at the top of the water column (about 140-foot depth) was 74.4 °F and a depth of 1,920 feet (bottom of the piezometer is 1,930 feet) the temperature was 122.5 °F. The rate of temperature increase is about 2.7 °F per 100 feet.

### **MW-32**

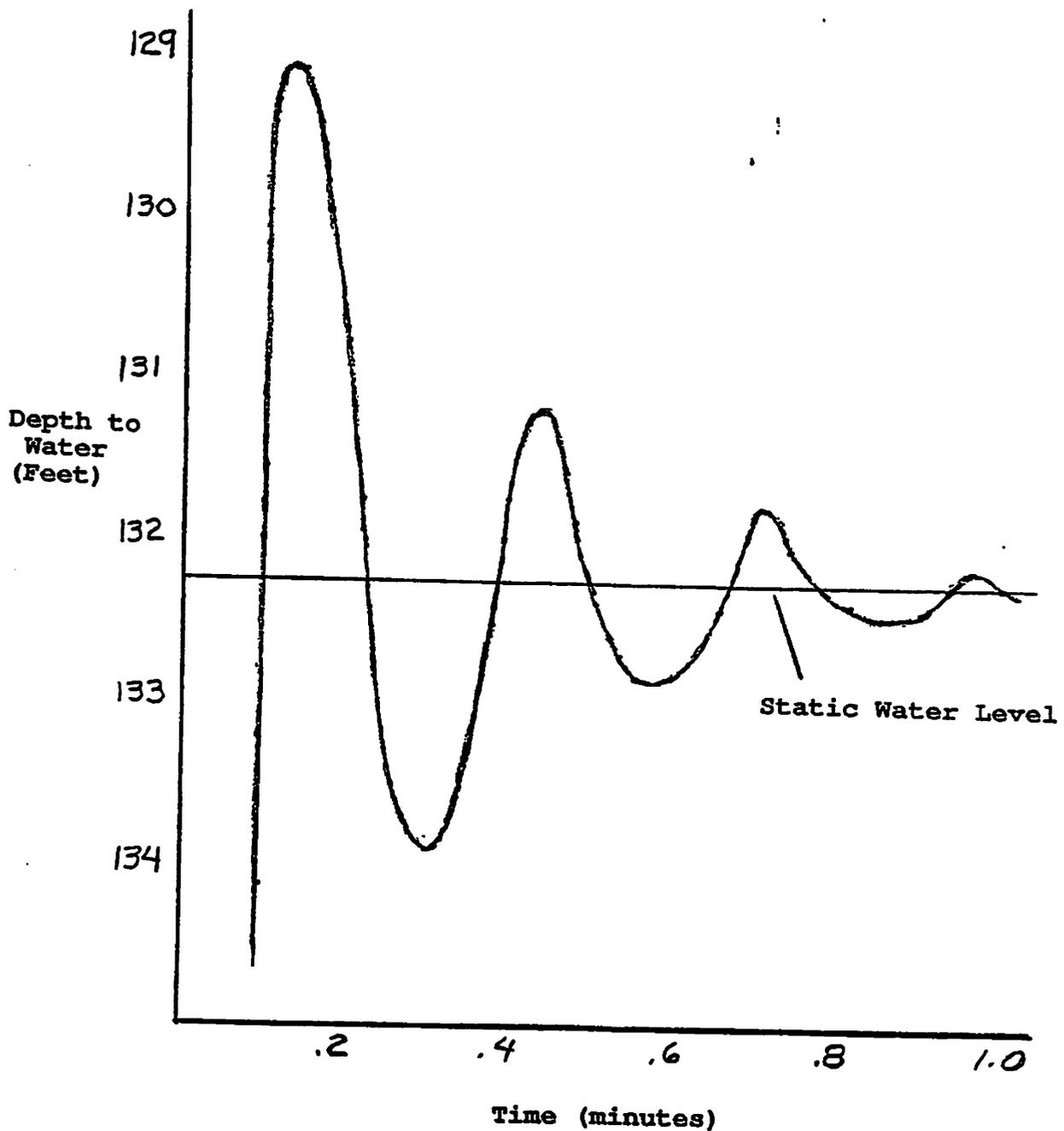
The relative water levels in the MW-32 piezometers, and lower water levels in the two medium piezometers, are probably related to Intermediate Area pumping. Only the water levels in the medium-shallow and medium-deep piezometers responded to a nearby 24-hour pumping test in the newly completed District Well #30. The medium-shallow well showed the greatest decline.

The shallow piezometer water level did not respond to the pumping test. Clay horizons between the shallow piezometer and the pumped well screened interval may have isolated the shallow aquifer for the short duration of the test. The water level in the deep well actually rose about one-half foot during the test. This temporary phenomena is called the Noordbergan effect and is caused by dewatering related load redistribution over a semi-confined aquifer.

Total dissolved solids of the water pumped from the aquifers, based on the water samples collected at the end of air-lift development, ranged from 169 mg/L in the medium-shallow aquifer to 526 mg/L in the deep aquifer. Total dissolved solids in the medium-deep aquifer is 176 mg/L and 252 mg/L in the shallow aquifer. These waters are all sodium bicarbonate.

Estimated transmissivity for the two medium aquifers are 0.31 ft<sup>2</sup>/min and 0.23 ft<sup>2</sup>/min respectively. The deep aquifer transmissivity, 0.11 ft<sup>2</sup>/min, is fairly high for an aquifer nearly 2,000 feet deep, although it is about the same as the deep aquifer transmissivity found in wells BR-5, BR-6, and NR-2.

The unexpectedly low transmissivity in the shallow aquifer is believed to be an artifact of poor development which was probably caused by insufficient airline submergence. See Appendix IV for a full explanation of the hypothesis. With full development the estimated transmissivity would probably be 0.20 to 0.30 based on transmissivity estimates for the two medium MW-32 aquifers.



**Figure 6.** Water level response, in NR-2 shallow, to the pneumatic slug test. Note that the water level recovered to the static water level in about 6 seconds (0.1 minutes). The first recorded depth to water after air release is 147.8 feet at about 0.01 minutes.

## **WATER TABLE GRADIENTS**

The groundwater table gradient is much higher in the higher elevation part of the Southwest Area (wells BR-1, BR-2, and 19D on figure 4) than in the lower elevation part. The gradient between lower Southwest Area wells, such as the Inyo Well and well 8M (one of several Water District test wells in the Inyo well area), and well MW-32 is about 2.5 feet per mile. In comparison, the gradient in the upper Southwest Area from well BR-1 through the Water District's monitoring well 3 [19D] to the Inyo Well area is about 130 to 140 feet per mile. Thus the water table gradient from the Inyo well area to the north and northeast is between one and two orders of magnitude less than the gradient to the southwest. In fact, the gradient in the vicinity of the Inyo Well and the Water District's nearby monitoring wells is virtually flat.

The change in gradient appears to occur just to the west of the Inyo Well (section 7 west of well 8M). By inspection of the water table elevations on figure 4, the break between the steep and relatively flat gradient appears to trend north-northwestward from just west of the Inyo Well to around the mouth of Indian Wells Canyon. This trend is especially suggested by the nearly equal water table elevation between wells 19D and BR-2. Therefore, groundwater elevation contours must trend close to the azimuth between 19D and BR-2.

It has been suggested that the dramatic gradient change in the Southwest Area is related to a fault. Kunkel and Chase (1969) inferred a northwest trending fault about three miles south of Inyokern based on a great increase in groundwater gradient or disparity of water levels between a well about one mile east of BR-2 and the wells around Inyokern. This inferred fault is labeled as a groundwater barrier on their figure 2. If this inferred fault is a hydraulic barrier, the water table gradient near the fault would be relatively flat. Further drilling to explore static water levels and extended aquifer testing in this area will be required to clarify these observations

Estimates of recharge based on the upper Southwest Area gradient, and assuming uniform horizontal flow through an aquifer of uniform hydraulic conductivity, will be much higher than a recharge estimate based on the lower Southwest Area gradient. However, the groundwater elevation differences in the BR-1 piezometers and the much steeper water table gradient in the upper Southwest Area suggest that there is a significant vertical flow component and that flow is not uniformly horizontal.

The apparent gradient between the shallow water level at BR-3 and the wells to the north is essentially the same as the gradient between the Inyo Well area and well MW-32. This could suggest, all other factors being equal, that the

recharge from the El Paso Mountains to the south is about the same as the recharge from the Sierra Nevada Mountain basins above the Southwest Area. However, a relatively poor hydraulic connection between the BR-3 area and the pumping center to the north (Intermediate Area) as compared to the connection between the Inyo Well area and the Intermediate Area could cause the water level in the Inyo Well area to drop much more than the BR-3 area in response to the pumping. Furthermore, the recharge from the El Paso Mountains must be much less than that from the Sierra Nevada Mountains because the annual precipitation is not enough to induce a pinyon-juniper woodland on the El Paso Mountains. See the Appendices for a discussion of the relationship between pinyon-juniper woodland, precipitation, and recharge.

The east-west water table gradient through wells BR-5 and the Neal Ranch wells (NR-1 and NR-2) is very low. The gradient is about one-half to one foot per mile depending on the piezometers being compared. This suggests that recharge to the aquifer from the Sierra Nevada Mountain watersheds in the area of BR-5 is relatively low. Relatively high TDS in the aquifers screened by the BR-5 piezometers also suggests relatively low recharge (long residence time); however, the TDS of a May 4, 1993, water sample collected from the lower Sand Canyon surface flow was about 500 mg/L. This may mean that the higher TDS concentration in the water in wells BR-5 and BR-10 is partially or mostly caused by relatively high TDS recharge and only partially by dissolution of the aquifer matrix from long residence time.

In the northwest the horizontal groundwater gradient from BR-10 to BR-6 is about 2.5 feet per mile based on the water level in the BR-10 deep middle piezometer and the BR-6 middle piezometer. The shallow water levels at BR-10 are not used to estimate a horizontal water table gradient because of the large apparent vertical flow component at BR-10. Thus the lower Southwest Area water table gradient and the water table gradient in the northwest is about the same. This suggests that the mountain front recharge from each Area is about the same if the aquifer transmissivities and cross-sectional areas are about the same.

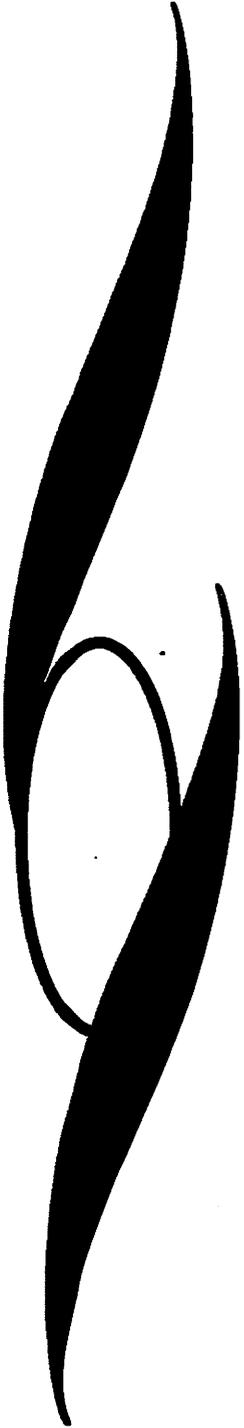
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# **AQUIFER MODELING**

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# **AQUIFER MODELING**

## **INTRODUCTION**

The Project participants agreed that there was a need for aquifer modeling, although this task was not in the original Project plan. The desire for a model (actually, adjustments to the USGS model) was based on new data from the Project wells and the timely USGS publication of the report documenting the modeling results from the most recent USGS groundwater model. In addition, the effects of future development scenarios could be examined through time. (Water-Resources Investigations Report 89-4191 by Berenbrock and Martin, 1991)

The USGS San Diego office provided the Project with a copy of all of the data files used in their model and the model code. The generic model code (MODFLOW) was developed by McDonald and Harbaugh in the early 1980's and it has become the standard in groundwater modeling practice.

To develop familiarity with the model, the Yuma office of the Bureau of Reclamation ran the three future development scenarios documented in the USGS report and all of the output matched that of the USGS. Since personnel at the Yuma office have experience with MODFLOW, the Project made arrangements with that office to re-run the USGS model using the data from the Project test wells.

Recharge quantity and distribution and the distribution of aquifer transmissivity are some of the key aquifer related inputs for any groundwater model. Because these distributions are interrelated, the procedure used to develop one distribution will effect the distribution of the other during calibration. During research into the derivation of these model distributions, serious doubt arose about the recharge quantity (seems too high) based on recent developments in estimating and measuring recharge in arid basins. Recharge quantity and distribution is the focus of several recommended post-Project investigations (see the recommendations chapter of this Volume).

Further model development as part of this Project was abandoned because of the questions regarding recharge quantity and distribution. However, recalibration of the Berenbrock and Martin model is recommended subsequent to a period of data collection from the recharge related recommended Project follow-on activities. It is believed that the recharge related activities will yield a much lower estimate of recharge to the Valley and will probably show that almost all of the recharge is from the Sierra Nevada watersheds.

Each of the model distributions is discussed below. The discussion includes the procedure used to develop the distribution, the concern with respect to that distribution, and recommendations, if any, for future investigation. Recharge quantity is probably the only input parameter bearing on the input distributions which is subject to relatively direct measurement. A recently developed technique from Australia appears promising.

## **PREVIOUS GROUNDWATER MODELS**

A two-dimensional mathematical groundwater flow model was developed in 1971 by the USGS (Bloyd and Robson, 1971) to make a quantitative assessment of the geohydrology of the Valley. The alternating-direction implicit method was used to compute the mathematical solution and it was assumed that there were two aquifers in the Valley, one being deep and the other shallow. The verified model was used to generate 1983 water-level conditions in the deep aquifer (Bloyd and Robson, 1971).

In 1980 the USGS, in cooperation with the China Lake Naval Weapons Center (now Naval Air Weapons Station) and the Indian Wells Valley Water District, developed a 10-year plan to study the aquifer system of the Valley (Lipinski and Knochenmus, 1981). One of the objectives of the plan was to collect data that could be used to gain an understanding of the three-dimensional aspects of the deep and shallow aquifers in the Valley. Initial information indicated that the Bloyd and Robson groundwater flow (model) did not adequately represent the three-dimensional flow system (Berenbrock and Martin, 1991).

In 1991, the USGS updated and evaluated the hydrologic data base compiled for the two-dimensional flow model and developed a three-dimensional, two aquifer, groundwater flow model for the Valley (Berenbrock and Martin, 1991). The modeled shallow aquifer, as defined by Kunkel and Chase (1969), extends from China Lake westward to the center of the Valley and from the area south of Airport Lake southward to the community of China Lake. The base of the shallow aquifer was assumed, based in part on geologic and electric logs, to slope from an altitude of 1,950 feet above sea level on the west to an altitude of 1,850 feet on the east beneath China Lake (Berenbrock and Martin, 1991). The deep aquifer includes the total saturated thickness of the alluvium and lake deposits where the shallow aquifer is not present and the alluvium and lake deposits that underlie the shallow aquifer (Berenbrock and Martin, 1991).

## RECHARGE QUANTITY

The recharge quantity used in both models is from Kunkel and Chase (1969). Kunkel and Chase estimated the quantity of diffuse groundwater discharge<sup>2</sup> from the China Lake Playa area (discharge equals recharge in a closed basin) by using an empirical method developed by Blaney (1951) and Blaney and Criddle (1949). The Kunkel and Chase assumptions with regard to saltgrass evapotranspiration (ET) and bare soil evaporation (E), as compared to measured diffuse discharge from recent investigations of other playas, are the basis of the concern over the modeled recharge quantity.

Recent investigators note that little detailed information existed before 1985 on diffuse discharge from wet salt desert surfaces. In contrast, many investigators have studied diffuse water losses from agricultural land, dense phreatophyte stands along apportioned rivers, and free-water surfaces in the southwest United States. Ullman (1985) lists various techniques that have been used to estimate the rate of evaporation from vegetation and from bare soil and sediment surfaces. These include empirical techniques relating evaporation to average climatic factors (Thornthwaite, 1948; Blaney and Criddle, 1950), energy budget calculations (Penman, 1948; Van Bavel, 1966), and extrapolation from free-surface evaporating pans (Gray, 1970).<sup>3</sup> Ullman notes that in arid and semi-arid environments these techniques may greatly overestimate the true rate of evaporative loss.

Since groundwater discharge is equal to groundwater recharge in a closed basin, recharge quantity can be determined by measuring or estimating groundwater discharge. Prior to the advent of European settlement in the Valley, groundwater discharge from the main water body occurred principally by ET and in very small part by underflow to Salt Wells Valley (Kunkel and Chase, 1969). Evapotranspiration, the combined processes of evaporation from moist soil and transpiration of plants, identified as phreatophytes, whose roots draw from groundwater or the capillary fringe, occurs in the eastern part of the Valley in the vicinity of China Lake.

Kunkel and Chase (1969) estimated that the total diffuse groundwater discharge from the China Lake playa area was 11,000 acre-feet/year in 1912 and 8,000 acre-feet/year in 1953. These rates were derived by applying an

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<sup>2</sup> This is evaporation from free water and nonvegetated surfaces and evapotranspiration (transpiration from vegetation and evaporation from surrounding nonvegetated surfaces) from vegetated areas.

<sup>3</sup> The authors given by Ullman (1985) are not listed in the references at the end of this chapter.

evaporation and evapotranspiration rate to various classifications of moist land in and around China Lake. The classifications were based on bare soil surface texture, surface moisture, alkali presence and expression, and vegetation density.

A curve of estimated evapotranspiration (consumptive use) versus depth to groundwater was made for 100 percent saltgrass cover by using the empirical equation developed by Blaney and Criddle in 1949 and Blaney in 1951<sup>4</sup>. The consumptive use coefficients for dense (100 percent) saltgrass growth were suggested by Blaney. A curve for 25 percent saltgrass (or pickleweed) cover and for fine-grained bare soil was estimated based on the curve for 100 percent saltgrass cover. Figure 7 shows each of these curves. Also shown is a line through the data points from Young and Blaney (1942) [as reported by Robinson (1958)] showing annual evapotranspiration of water by saltgrass grown in tanks in Owens Valley.

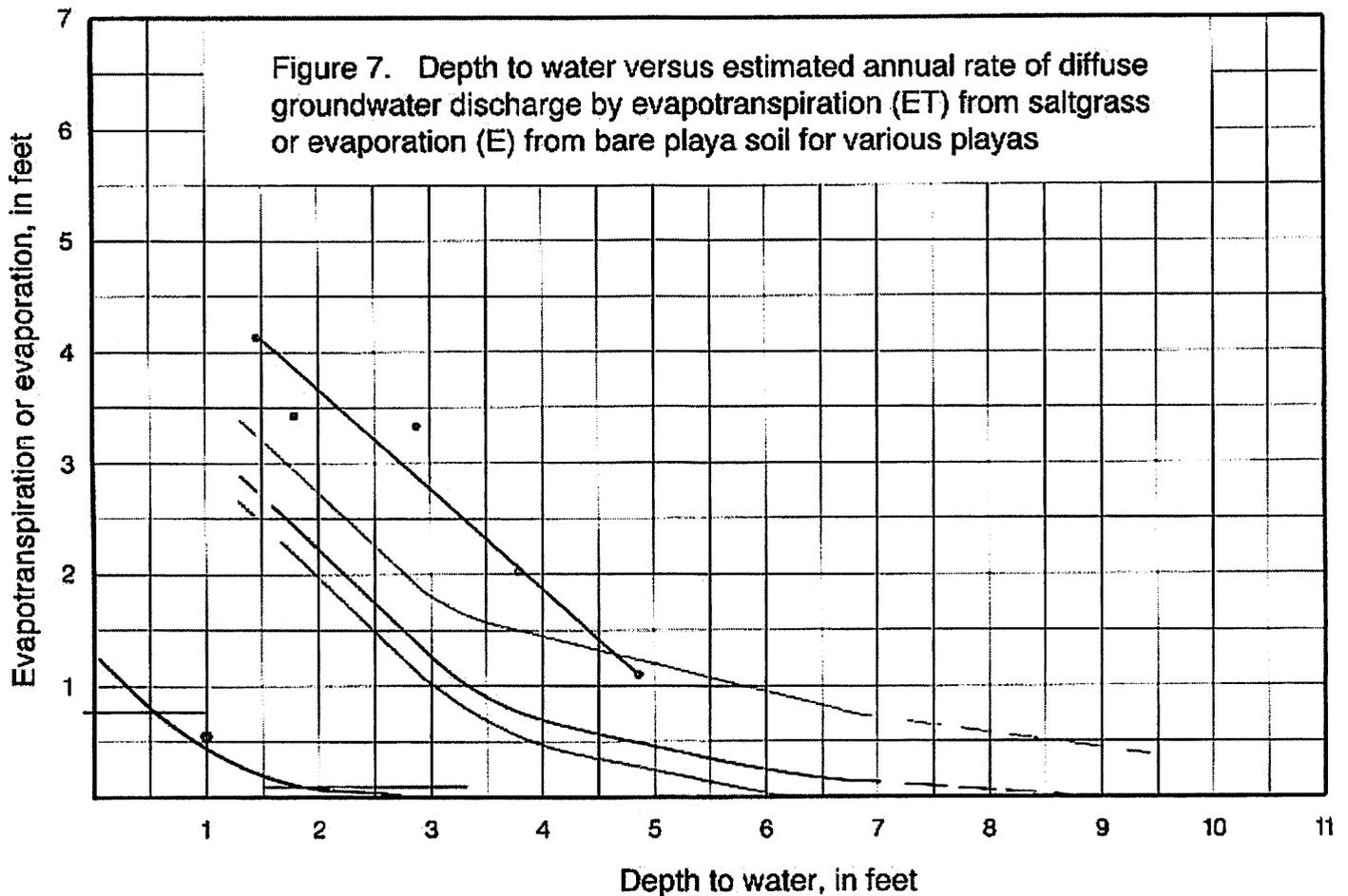
Recently published measured evaporation rates from bare soil on other playas [Malek and others (1990), Allison and Barnes (1985), and Ullman (1985)] are much lower for the depth to groundwater than the bare soil evaporation estimates of Kunkel and Chase. These measured rates are based on relatively direct measurement techniques developed over the last decade. Appendix II, gives a detailed account of recently developed, relatively direct methods of measuring diffuse discharge. A trial of the Ullman (1985) method on China Lake Playa is included as one of the recommended Project follow-on investigations.

## RECHARGE DISTRIBUTION

Distribution of recharge is one of the most important inputs in a groundwater model. In some groundwater models of desert basins, recharge distribution is based on flow data from stream gauges which can be used to calculate transmission loss from streams draining the surrounding mountains. Transmission loss from streams, usually ephemeral, is the predominant source of natural recharge to southwest desert valleys lacking a through-flowing stream. In some models recharge distribution may be based on precipitation

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<sup>4</sup> This is the same technique mentioned above by Ullman (1985) although the publication dates are different. Blaney and Criddle published a number of papers on applying essentially the same empirical technique to different types of vegetation. Ullman referenced their 1950 paper "Determining water requirements in irrigated areas from climatological and irrigation data." Kunkel and Chase (1969) used their 1949 paper "Consumptive use of water in the irrigated areas of Upper Colorado River Basin" and the 1951 paper by Blaney "Consumptive use of water."



#### 100 Percent Saltgrass Cover

- Indian Wells Valley rate from Kunkel and Chase (1969).
- Annual evapotranspiration of water by saltgrass grown in tanks in Owens Valley (Young and Blaney [1942] as reported by Robinson [1958]).

#### 25 Percent Saltgrass Cover

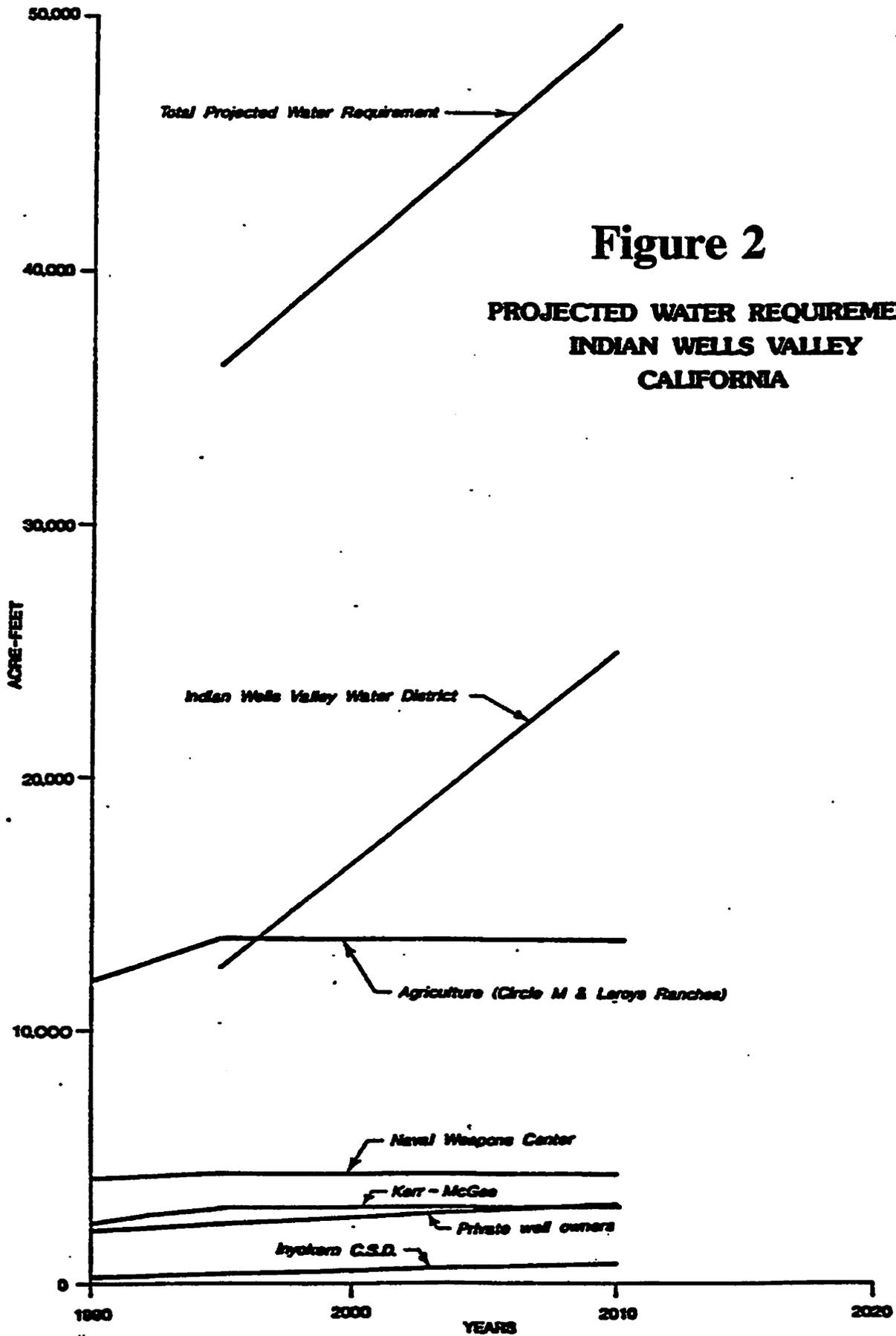
- Indian Wells Valley rate from Kunkel and Chase (1969).

#### Bare Soil with Salt Crust

- Indian Wells Valley rate from Kunkel and Chase (1969).
- Estimated annual evaporation of subsurface water is 0.75 feet (229 mm) from salt crust on Pilot Valley playa (western Utah) using the Bowen ratio method to reduce data from a microclimate station. (Malek and others, 1990).
- Estimated mean whole-lake evaporation rate from Lake Frome (northeastern South Australia) is 0.56 feet/year (170 mm/yr) with a water table at about 1 foot (about 300 mm). Estimate based on depth profiles of deuterium delta-values to about 3 feet. (Allison and Barnes, 1985).
- Maximum annual evaporation rate (0.19 feet) from salt crust on Owens Lake. Derived by multiplying the maximum reported daily rate (.0063 inches/day), based on salt flux, by 365. Maximum daily rate (.003 inches/day) from the evaporimeter [non-weighing lysimeter] was about 1/2 the salt flux rate. Lake-bed clays at this site are overlain by 12 to 24 inches of hard and largely insoluble salts. (Cochran and others, 1988).
- Diffuse discharge measured from salt pans with shallow water tables. Data from: Allison and Barnes (1985), Jacobson and Jankowski (1989), Malek and others (1990), and Woods (1990). [Thorburn and others, in press].

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**Inyokern (Inyokern Community Services District)**

The following information was provided by Pam Ernst, general manager. The annual water use is expected to reach 340-360 acre-feet by 1992. After 1992 they expect about 5 percent growth per year. This would put water use at about 400 and 735 acre-feet per year for 1995 and 2010 population levels, respectively.

**Louisiana - Pacific Corporation**

The sawmill is no longer in production and is not expected to operate in the future.

**Irrigation**

It is assumed that the Spike Leroy's Ranch will resume irrigation (1,600 acre-feet per year). Therefore, irrigation water use would reach 13,600 acre-feet per year (12,000 + 1,600). Future water use is assumed to be constant at 13,600 acre-feet per year.

**Private Wells**

It is assumed that there will be a 2 percent growth rate over a 20-year period. This would result in 2,400 and 3,100 acre-feet annually for 1995 and 2010 levels, respectively.

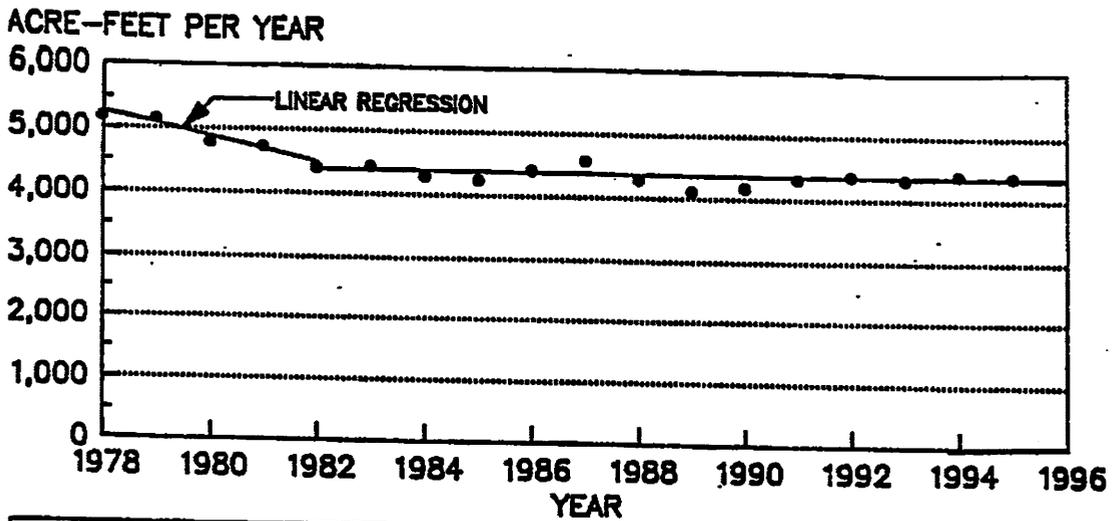
**Total Projected Future Water Use**

The following tabulation summarizes the projected water use for the Indian Wells Valley. The values are also portrayed in figure 2.

Water Use	Future Demand (Acre-Feet)	
	1995	2010
Naval Weapons Center	4,400	4,400
Kerr-McGee Chemical	3,000	3,000
I.W.V. District	12,500	25,000
Inyokern CSD	400	735
Irrigation	13,600	13,600
Private Wells	2,400	3,100
<b>Total Valley</b>	<b>36,300</b>	<b>49,835</b>
		<b>49,800 (rounded)</b>

# Figure 1

**NAVAL WEAPONS CENTER  
FUTURE WATER DEMAND PROJECTIONS  
INDIAN WELLS VALLEY GROUNDWATER PROJECT**



Based on data supplied by Michael Stoner,  
Naval Weapons Center, China Lake, CA

## Future Water Use

Certain water user entities have analyzed their future water needs in great detail while others have not. The following summarizes available data: When data are lacking, estimates are made instead.

### Naval Weapons Center

The historical and projected use was furnished by Michael Stoner, Naval Weapons Center, China Lake, California. This is shown in figure 1. The use is expected to be relatively constant at 4,400 acre-feet per year.

### Kerr-McGee Chemical Corporation

The following projections of water use were furnished by Bob Garrod of Kerr-McGee Chemical Corporation:

Year	Acre-Feet
1989	2320
1990	2500
1991	2800
1992 and future	2800-3000

### Indian Wells Valley Water District

The following information is from the Indian Wells Valley Water District's "1990 Water General Plan" (Krieger and Stewart, 1990). The projected water requirements are based on 0.86 acre-feet per year per connection:

Year	Projected Population	Projected Service Connections	Projected Water Requirements (Acre-feet)
1980	15,800	4,350	3,820
1990	36,000	10,000	8,600
1995	51,300	14,200	12,250
2000	69,050	19,200	16,500
2005	85,800	23,800	20,500
2010	104,650	29,100	25,000

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# **FUTURE WATER USE**

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**Inyokern (Inyokern Services District)**

This small community is presently pumping 259 acre-feet per year according to Pam Ernst, general manager. The community supplier was previously called the Antelope Valley Water Company. Reference may be to this entity in earlier reports.

**Louisiana-Pacific Corporation**

This sawmill is no longer in operation. The last water use was in 1986. The estimated past annual water use was about 3,000 acre-feet (St.-Amand, 1986).

**Irrigation**

In the past, three ranches have used most, if not all, of the water pumped for irrigated agriculture. They are: Brown Road Farming Company, (formerly Circle M Ranch), Neal Ranch, and Spike Leroy's Ranch. The Neal Ranch was purchased by the Indian Wells Valley Water District in 1988. Complete historical data are not available. Irrigation water use has decreased in recent years, however. Alfalfa is the primary crop grown. It was reported that the Brown Road Farming Company has seven center-pivot irrigation systems in operation pumping about 12,000 acre-feet annually. [Assuming six acre-feet per acre consumptive use (California Department of Water Resources, 1975, 1986, and Erie et al., 1982), 75 percent application efficiency and 130 acres per system, the estimated pumping would only be 7,300 acre feet per year.] The Spike Leroy's Ranch is estimated to have pumped about 1,600 acre-feet per year (estimate by Michael Stoner). This ranch is not presently irrigating but is expected to resume soon.

Some small orchards (almonds, pistachios and apricots) exist, but it is assumed the irrigation water is from individual domestic wells (See next section).

**Private Wells**

It has been reported that over 3,000 wells exist in the Indian Wells Valley. The majority of these have been abandoned. It is estimated that about 550 wells are currently in production that supply private water users. Little or no information exists about historical use of these wells.

The following derives a rough estimate of present annual use. Assuming two-thirds of the wells are serving individual users on 2.5 acre plots (one connection per well using 1.5 acre-feet per connection), these would pump about 550 acre-feet per year. Most (75 percent) of the remaining one-third of the wells serve about four households per well. These are estimated to pump 824 acre-feet per year. The remaining wells service larger plots up to 10 acres, having as many as 15 households per well. Assuming 1.1 acre-feet per connection per year, the remaining wells are estimated to pump 756 acre-feet per year. Total private ground water withdrawals would be about 2100 acre-feet per year (550 + 824 + 756), which may be conservatively high.

**TABLE 2**  
**INDIAN WELLS VALLEY WATER DISTRICT**  
**DOMESTIC WATER SYSTEM**  
**HISTORIC MONTHLY PRODUCTION**  
**1985 THROUGH 1988**

MONTH	1985		1986 <sup>1</sup>		1987 <sup>1</sup>		1988		1985 - 1988		% OF AVERAGE MONTHLY PRODUCTION
	AF	%	AF	%	AF	%	AF	%	AF	%	
JANUARY	213	4.28	256	4.34	235	3.65	288	3.61	992	3.92	47.05
FEBRUARY	222	4.46	233	3.95	279	4.33	394	4.94	1128	4.46	53.50
MARCH	256	5.14	369	6.26	391	6.07	468	5.86	1484	5.87	70.39
APRIL	447	8.98	485	8.23	546	8.47	563	7.05	2041	8.07	96.81
MAY	553	11.11	668	11.33	567	8.80	735	9.21	2523	9.97	119.67
JUNE	581	11.67	756	12.83	815	12.65	951	11.91	3103	12.27	147.18
JULY	656	13.18	752	12.76	872	13.53	1042	13.05	3322	13.13	157.57
AUGUST	613	12.31	696	11.81	895	13.89	1080	13.53	3284	12.98	155.77
SEPTEMBER	484	9.72	636	10.79	678	10.52	800	10.02	2598	10.27	123.23
OCTOBER	424	8.52	434	7.36	539	8.37	723	9.06	2120	8.38	100.56
NOVEMBER	271	5.44	349	5.92	344	5.34	502	6.29	1466	5.79	69.54
DECEMBER	259	5.20	260	4.41	282	4.38	437	5.47	1238	4.89	58.72
TOTAL	4979	100	5894	100	6443	100	7983	100	25299	100	

<sup>1</sup> Excludes Ridgcrest Heights

**TABLE 1**  
**INDIAN WELLS VALLEY WATER DISTRICT**  
**DOMESTIC WATER SYSTEM**  
**HISTORIC WATER PRODUCTION AND CONSUMPTION**

YEAR	AVERAGE SERVICE CONNECTIONS (EA)	POPULATION SERVED <sup>1</sup> (PERSONS)	PRODUCTION (AF)	CONSUMPTION (AF)	PRODUCTION CONSUMPTION RATIO	PRODUCTION		
						UNIT		PER CAPITA
						AF/CONN	AF	
1965	1,730 <sup>2</sup>	6,200	1,300	1,100	1.182	0.75	0.21	190
1970	2,220 <sup>2</sup>	8,000	1,900	1,600	1.188	0.86	0.24	210
1975	3,480 <sup>2</sup>	12,500	2,800	2,500	1.120	0.80	0.22	200
1980	4,860 <sup>2</sup>	17,500	3,820	3,820	1.000	0.79	0.22	190
1981	5,080 <sup>2</sup>	18,300	4,220	3,900	1.082	0.83	0.23	210
1982	5,210 <sup>2</sup>	18,800	3,960	3,860	1.026	0.76	0.21	190
1983	5,430 <sup>2</sup>	19,500	4,320	4,090	1.056	0.80	0.22	200
1984	5,730 <sup>2</sup>	20,600	4,940	4,310	1.146	0.86	0.24	210
1985	6,010	21,600	4,980	4,440	1.122	0.83	0.23	210
1986	6,840	24,600	5,900	5,750	1.026	0.86	0.24	210
1987	8,540	30,700	7,390	6,440	1.148	0.87	0.24	210
1988	9,210	33,200	7,900	6,290	1.256	0.86	0.24	210

<sup>1</sup> 1985 GENERAL PLAN AMENDMENT

<sup>2</sup> ESTIMATED BASED ON 3.6 PERSONS PER AVERAGE SERVICE CONNECTION

**Kerr-McGee Chemical Corporation**

Kerr-McGee pumps water from the Indian Wells Valley to supply not only their industrial process in the nearby Searles Valley, but the town of Trona as well. This water use has been listed under the name Searles Valley Water Users in other reports: e.g., St.-Amand, 1986. The following historical information was supplied by Michael Stoner, Naval Weapons Center, China Lake, California, and from the Kerr-McGee Chemical Corporation:

Year	Acre-Feet
1975	2781
1976	2911
1977	3315
1978	3081
1979	3081
1980	2887
1981	3065
1982	2887
1983	2476
1984	2307
1985	2397
1986	2557
1987	2560
1988	2560
1989	2320

1990-  
1991-  
1992-  
1993-  
1994-  
1995-

**Indian Wells Valley Water District**

The Indian Wells Valley Water District was originally formed as the Ridgecrest County Water District in 1955. It was to provide water to the city of Ridgecrest and the surrounding area (Krieger and Stewart, 1990). Ridgecrest Heights Water District (previously known as the Wilbur Stark Water Company) is now a part of the Indian Wells Valley Water District. Historic water production and consumption is shown in tables 1 and 2 (Krieger and Stewart, 1990). Note that Ridgecrest Heights Water District water use is excluded from some of the quantities in these tables. The Wilbur Stark Water Company (later the Ridgecrest Heights Water Company) used 993 and 1,700 acre-feet in 1980 and 1984, respectively (St.-Amand 1986). Ridgecrest Heights Water Company was acquired by the Indian Wells Valley Water District in 1987 or 1988.

## Water Requirements

The following is based on available information. Local water users have furnished historical and future water use data. In several cases this information is limited or incomplete. The purpose of this section is to assemble the information so that it is easily understandable and can be used in the formulation of Project alternatives and designs.

### Historical Water Use

Available data were analyzed in an attempt to gain insight about area water needs. The primary water users were Naval Weapons Center; Kerr-McGee Chemical Corporation; Indian Wells Valley Water District; Antelope Valley Water Company (Inyokern); Wilbur Stark Water Company; Louisiana Pacific Lumber Company; Ridgecrest Heights Water Company; several irrigated farms including Brown Road Farming Company (formerly Circle M), Spike Leroy's Ranch and Neal Ranch and several hundred operators of individual wells. In many cases, little or no data are available about historical water use. Attempts have been made to estimate past annual use in the Indian Wells Valley by St.-Amand, 1986, and others. These overall estimates of water pumped range from 21,000 acre-feet to over 30,000 acre-feet annually. No attempt will be made in this section to estimate the overall historical pumping in the Valley because of the missing data and conflicting information. The available historical water use data, however, can provide valuable insights to expected water use.

The following presents and discusses the available historical data:

### Naval Weapons Center

The following historical data were furnished by Michael Stoner, Naval Weapons Center, China Lake, California. It can be seen that water use has decreased and is now relatively constant at about 4,400 acre-feet per year. The decrease was probably due to the resident population shift to the city of Ridgecrest.

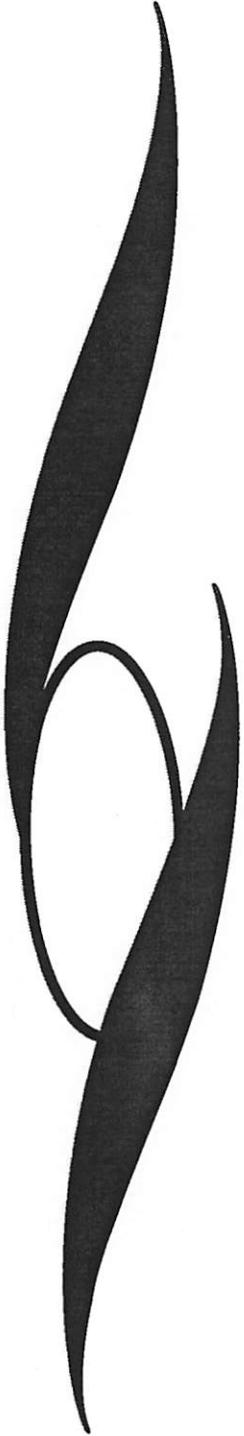
YEAR	ACRE-FEET
1978	5200
1979	5173
1980	4809
1981	4751
1982	4427
1983	4454
1984	4313
1985	4268
1986	4430
1987	4591
1988	4311
1989	4135

Year      AF  
1990      3667  
1991      3364  
1992      3351  
1997      3411  
1994      3684  
1995      3848  
1996

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# **WATER REQUIREMENTS**

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## **PREFACE**

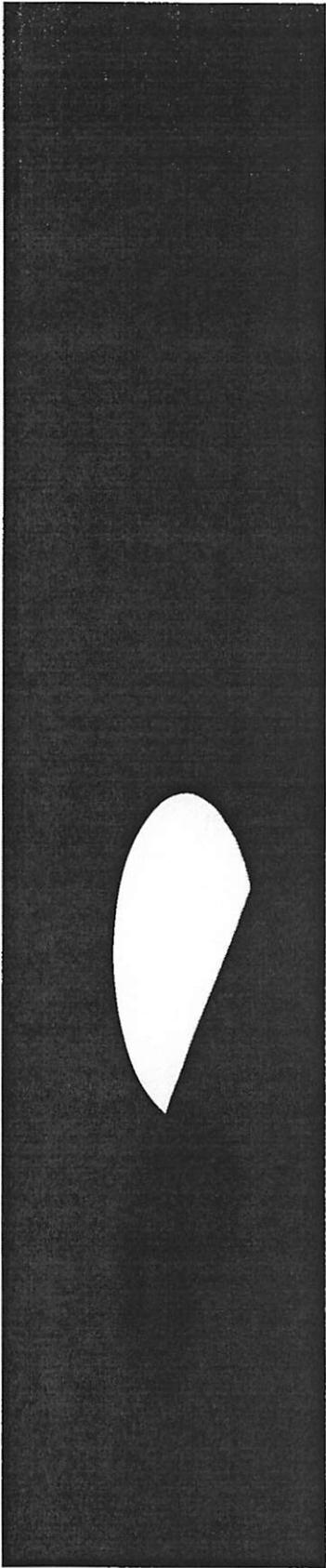
Material in this Section was originally prepared in September 1990. Data on estimated future water demands provided by local entities were based on information available through the late 1980's. At the time the Indian Wells Valley Groundwater Project was completed in December 1993, the high population growth rates of the 1980's had moderated and groundwater pumping for agricultural use had not expanded as anticipated several years earlier.

Those conditions led to consideration of revising the future water demand projections presented in this section. The decision was made to leave the projections as originally estimated. There were two dominant reasons for this decision:

- The current turndown in population growth is only a recent condition with minimal information on either the potential size or duration of the downturn and, therefore, whether or not the lower growth rate will constitute a future trend.
- Since it is uncertain at this time whether or not the current growth rate reduction is only a temporary phenomenon or the start of a long term situation, maintaining the original future water demand estimates constitutes either a reasonable or conservative projection.

As the future agricultural pumping and population growth develops, water use projections should be adjusted and their impacts on future water development should be re-evaluated.

It should also be noted that since completion of this Section in September 1990 names for two of the local entities have changed. Kerr-McGee Chemical Corporation sold its Trona operation to North American Chemical Company and as part of a major reorganization, the Naval Weapons Center became the Naval Air Weapons Station.



**SECTION B - FUTURE  
WATER REQUIREMENT  
PROJECTIONS**

However, if the piezometric head in the confined aquifer declines with the drop in the water table aquifer, due to less than perfect confinement, the effective stress throughout the section will increase. The magnitude of subsequent subsidence would depend on the decline in water table, drop in piezometric head, and the thickness and compressibility of the compacting deposits. The subsidence could be several feet or more.

These interpretations should be reviewed as a part of the analysis of the impact of pumping water from the northwest.

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stations would probably be best suited to long-term monitoring of bare soil evaporation and evapotranspiration from playa fringe phreatophytes.

## **RECOMMENDATIONS FOR FUTURE MODELING**

Transient state recalibration of the Berenbrock and Martin model is recommended subsequent to a period of data collection from the recharge related recommended Project follow-on activities noted above. It is believed that the recharge related activities will yield a much lower estimate of recharge to the Valley and will probably show that almost all of the recharge is from the Sierra Nevada watersheds. In addition, the response of the MW-32 piezometers to the pumping of District Wells 30 and 31 may suggest some reconfiguration of the model.

The Berenbrock and Martin model can be used without recalibration to predict drawdowns in areas where the model transmissivity compares well with measured transmissivity. Apportioning the measured transmissivities from the screened intervals of the Project wells over the full saturated thickness indicates a much higher transmissivity than that modeled along the western margin of the Valley.

## **REVIEW OF SUBSIDENCE POTENTIAL**

The extensive layer of clay in the northwest part of the Valley raises the potential for surface subsidence resulting from groundwater withdrawal in excess of recharge. Additional consideration should be given to this potential and its possible magnitude.

The thick clay section discovered by the Project in the northwest is cause for concern because groundwater pumping in other areas has induced compaction of clayey deposits. Subsidence is due to the compaction of the water-yielding deposits as the intergranular effective stresses increase (Lofgren and Klausung, 1969). The magnitude and rate of subsidence are directly related to the change in effective stress within the various compacting beds that results from water-level changes and the thickness and compressibility of the compacting deposits.

Based on the effective stress diagrams in Lofgren and Klausung (1969) and the general lack of compressible clayey units in the water table aquifer above the thick clay section, and assuming perfect confinement of the lower aquifer below the thick clay section, it appears that little or no subsidence would be induced if the water table above the thick clay in the northwest is significantly lowered.

### **Playa Investigations for Estimating Recharge**

Relatively direct measurement of current and historic bare ground China Lake playa evaporation, using the Allison and Barnes (1985) method, is recommended for comparison to the Kunkel and Chase (1969) empirical estimates. The estimate of average annual recharge to the Valley (about 10,000 acre-feet) used for the last two decades is based on the Kunkel and Chase empirical estimate of average annual China Lake playa area evapotranspiration. An estimate of playa area evapotranspiration is an estimate of recharge in a closed basin because discharge (playa area) equals recharge under equilibrium conditions. One of the Kunkel and Chase evapotranspiration estimates is based on depth to water under the playa before groundwater development in the Valley, when recharge and discharge were assumed to be in equilibrium.

Recent measured evaporation rates from bare soil on other playas seem low for the depth to groundwater when compared to the China Lake Playa estimates of Kunkel and Chase (1969). Ullman (1985) notes that the empirical technique used by many investigators may greatly overestimate the true value of evaporative loss from the water table in arid and semi-arid environments.

The playa soil core method, developed in Australia, seems to offer a relatively quick and easy method of determining historic playa evaporation. Allison and Barnes (1985) estimated diffuse groundwater discharge (evapotranspiration) from Lake Frome (playa) in northeastern South Australia based on depth profiles of deuterium delta-values to about 3 feet depth. The average depth to water was about one foot and the soil at several of the measurement sites was covered with a 0.20 inch (5 mm) salt crust. The estimates of diffuse groundwater discharge from the five sites ranged from 0.29 to 0.75 ft/yr. They noted that the estimated rate consistently decreased with increasing depth to water.

Weighing lysimeters, the only direct method of determining bare ground evaporation, may offer an alternative to the soil core method. However, for comparison to the Kunkel and Chase estimate, the lysimeters could only be installed in areas of the playa with the same depth to water as the 1953 water level used by Kunkel and Chase. The Desert Research Institute has recently developed a relatively simple weighing lysimeter (Tyler<sup>6</sup>, pers. commun.).

Further investigation of diffuse discharge may be deemed desirable based on the results of the initial testing and playa groundwater depths. Microclimate

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<sup>6</sup> Scott Tyler is an Assistant Research Soil Scientist with the Water Resources Center of the Desert Research Institute in Reno, Nevada.

The Maxey-Eakin method will probably estimate 2-3,000 acre-feet per year as the recharge to the Valley.

### **Watershed Investigations for Estimating Recharge**

Base flow gauging in the lower mountain valley section of several watersheds is recommended to help refine the estimate of recharge to the Valley and its distribution. Previous recharge estimates can be compared to actual average annual base flow, most of which probably becomes recharge, from the gauged watersheds. In addition, the average annual base flow may correlate with some watershed attribute and allow a better estimate of recharge from the non-gauged watersheds. As previously noted, the base flow from several Sierra Nevada watersheds during the spring of 1992 appeared to be much lower than that needed to match the recharge estimate for the watershed used in the groundwater models of the Valley.

Canyon constrictions formed by bedrock just upstream of the alluvial fan apex are ideal locations for base flow gauging. The bedrock constriction forces most of the water draining from the watershed to the surface for measurement and most of the base flow probably recharges the aquifer when it reaches the alluvial fan apex. Perennial flow in Sand Canyon at the lower wilderness study area boundary indicates a bedrock constriction which probably allows little underflow. This location appears to be ideal for gauging.

Gauging on Canebrake Creek (Kern River watershed, west side of the southern Sierra Nevada drainage divide) could be considered if there is a lack of relatively good gauging locations in the Sierra Nevada watersheds recharging the Valley. Canebrake Creek would offer the same potential for correlating average annual base flow with some watershed attribute, but it obviously would not help in refining recharge to the Valley. The southern gauged streams captured by the Los Angeles Aqueduct may offer further opportunities for correlation of base flow to some watershed attribute. The Haiwee Spring area may offer a gauging opportunity for Coso Mountain runoff if it is a barrier type spring.

The USGS is probably a good source for ideas on the type of gauge best suited to the requirements. In addition, they could estimate annual monitoring costs based on their experience. They may also have ideas for monitoring if the Valley interests want to monitor the stations. Weekly staff gauge readings might be sufficient for base flow hydrographs.

### **Maxey-Eakin Method for Estimating Recharge**

Application of the Maxey-Eakin method to the Valley is recommended as the first step in re-evaluating the Kunkel and Chase (1969) based recharge estimate. The Maxey-Eakin method for estimating recharge to a groundwater basin was developed by G. B. Maxey and T. E. Eakin between 1947 and 1951 and has been applied to over 200 basins in Nevada and other western states (Avon and Durbin, 1992). The Maxey-Eakin method is based on a direct relationship between precipitation and recharge. Avon and Durbin (1992) describe the application of the Maxey-Eakin method as follows: (1) estimating the mean annual volumes of precipitation within several precipitation zones for the drainage basin, (2) scaling these volumes by a factor [Maxey-Eakin coefficients] representing losses from evapotranspiration and surface-water runoff that does not become groundwater recharge, and (3) summing the resulting recharge volumes to obtain an estimate of total recharge to the groundwater basin.

The Maxey-Eakin method fell from favor in the mid-1970's as a recharge estimating method in the Great Basin based on the work of Watson and others (1976). However, the most recent investigation by Avon and Durbin (1992) concluded that the Maxey-Eakin method is a fairly reliable predictor.

Watson and others (1976) performed multiple-linear regressions to determine the individual Maxey-Eakin coefficients based on water-budget discharges for 63 basins as the dependent variable (Avon and Durbin, 1992). The method was then judged to be suspect based on the 95 percent confidence interval associated with each individual Maxey-Eakin coefficient computed by regression.

Avon and Durbin (1992) suggest that the overall predictive reliability of the Maxey-Eakin method is a more important indicator of the methods usefulness than the individual confidence intervals for each coefficient. To evaluate the method, Avon and Durbin (1992) compared Maxey-Eakin recharge estimates with water budget recharge estimates from 40 basins and with model based recharge estimates from 27 basins. For the group of 40 water-budget estimates the coefficient of variation of the Maxey-Eakin estimate is no greater than 44 percent. For the group of 27 model estimates the coefficient of variation is no greater than 25 percent (Avon and Durbin, 1992).

Bredenkamp (1990) also concluded that an empirical relationship between precipitation and recharge provides reasonably good estimates of recharge. Bredenkamp compared recharge estimates for 14 basins in South Africa, primarily from water balances, groundwater models, and chemical mass balances, to estimates based on an empirical relationship.

The Naval Air Weapons Station Geothermal Office plans to collect water samples from some of the Project wells for isotope analysis sometime in 1993. If the Navy's sampling plan does not include wells of interest to the other Project participants, consideration should be given to a financial contribution from the other participants to allow more sampling. The marginal cost of increasing the sampling scope should be relatively small.

Carbon 14 and tritium are the common isotopes used for dating groundwater. The carbon 14 content of plants, animals, water and anything else that reacts directly or indirectly with atmospheric carbon 14 will be essentially constant so long as the material is active and in equilibrium with the atmospheric CO<sub>2</sub>. When the material is cut off from the atmospheric CO<sub>2</sub> pool, as by percolation to aquifers for water, the material is no longer in equilibrium with atmospheric CO<sub>2</sub>. After that, its carbon 14 content will gradually decrease because of radioactive decay of carbon 14 and lack of replenishment with atmospheric carbon 14. The amount of carbon 14 remaining in the material in relation to the original concentration of carbon 14 when it was cut off from the atmosphere is an indicator of the time elapsed since the cutoff. Carbon 14 can be used to date groundwater to about 30,000 years (Bouwer, 1978).

Tritium is sometimes used to date young groundwater because it has a half-life of 12.4 years. It occurs as a natural isotope in the atmosphere. However, the amount of atmospheric tritium was greatly increased by atmospheric testing of nuclear weapons, starting about 1954. If groundwater is free of tritium, its last exposure to the atmosphere was before 1954. Significant tritium indicates fairly young groundwater (Fetter, 1980).

## **RECHARGE INVESTIGATIONS**

Several recent developments in estimating and measuring desert basin recharge suggest that the estimated recharge to the Valley (around 10,000 acre-feet per year) may be too high by a factor of two or more. The initial suspicion regarding recharge was prompted by periodic observation of spring runoff during 1992 in several Sierra Nevada watersheds. A suite of reasonable fabricated runoff hydrographs fitting the few visual flow estimates for each watershed all suggest an annual base flow, assuming all base flow recharges the aquifer, far less than the recharge estimated for the watershed (based on its percentage of the total watershed area recharging the Valley and assuming a total annual recharge of 9,850 acre-feet). The following recommended recharge investigation techniques begin with an empirical estimating method and progress toward increasingly direct measurement. Preliminary indications related to each of the recharge investigation techniques suggest that the recharge estimate of about 10,000 acre-feet per year is too high.

water district's southwest monitoring wells have been added to the water level measuring itinerary in order to better define the areal pattern of water level changes.

Frequency of measurement is problematic and could be adjusted based on recorded water level changes. More frequent measurements may be desirable some time after (unknown lag time) a period of significant winter rainfall, such as 1986, or after a heavy snow winter and wet spring. Any change in BR-1 measuring frequency should be accompanied by the same frequency at the southwest monitoring wells. The BR-10 piezometers may also warrant extra attention if water level changes appear significant. Some consideration could be given to maintaining the same personal and equipment for the follow-on water level measurements.

## **WATER LEVEL MONITORING**

Frequent water-level measurements in the four MW-32 piezometers during the first year of pumping from District Wells 30 and 31 could yield insight into short term aquifer dynamics. Response of the shallow and deep piezometer would be especially interesting. During a recent 24-hour pump test of Well 30, the water level in the shallow piezometer did not seem to respond (the transducer may have been set too deep) and the water level in the deep piezometer rose during the test (Noordbergen Effect). Long-term response of the deep aquifer is of interest because the total dissolved solids in the water is more than twice that of the intervals screened by the upper three piezometers. The initial and long-term water level responses in these piezometers would probably make an excellent model calibration set.

The water level in all of the Neal Ranch piezometers should be monitored if one of the Neal Ranch wells is pumped for a 30-day test as has been suggested. A data logger is probably the most efficient method for recording water levels. The Denver Office (Reclamation) data logger could be used; however, scheduling might be a problem for a 30-day test.

## **WATER SAMPLING FOR ISOTOPE ANALYSIS (Age Dating)**

Groundwater can be age dated from a complete isotopic analysis of the water. Isotope analyses may indicate that recharge is confined to relatively narrow flow paths as the relative water level changes in BR-1 and BR-2 seem to suggest. If this is the case, then recharge estimates based on uniform flow through an aquifer cross-section, such as in the southwestern part of the Valley, will overestimate recharge. Because of the recharge delineation potential, the wells of most interest for isotope analysis sampling would probably be those closest to the mountain front recharge watersheds. This would include wells BR-1,2,3,5,6, and 10.

# **RECOMMENDATIONS FOR FUTURE ACTIVITIES AND STUDIES**

## **INTRODUCTION**

The following recommendations are offered for consideration as follow-on activities to the Indian Wells Groundwater Project after Reclamation ends its formal involvement. Regardless of the actual follow-on activities with respect to those recommended, it is believed that periodic meetings of the subcommittee would be mutually beneficial to the respective participating entities because "formal" contact might induce greater interaction than might otherwise occur.

## **WATER QUALITY ANALYSES**

Additional water samples should be taken from most, if not all, of the Project piezometers for another Title 22 analysis. Some constituent concentrations in some of the air-lifted samples collected at the end of development suggest less than full development. The constituent concentrations exceeding regulatory limits may fall below those limits with further pumping. The new samples should be collected from a relatively steady discharge, positive displacement pump after electrical conductivity, pH, and temperature have stabilized. This will assure that the sample is reasonably representative of the aquifer water and reduce the uncertainty about any anomalous constituent concentrations. Consistency in constituent concentrations over several sampling episodes would instill even more confidence that the samples are representative.

## **WATER LEVEL MEASUREMENTS**

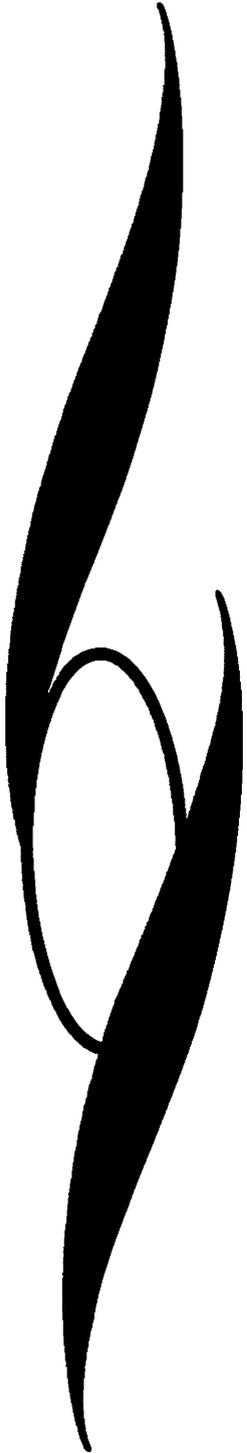
Water levels in the Project piezometers have been measured every 1-2 months during the course of the Project. It is recommended that this measuring frequency continue for the next one to two years. Long-term water elevation plots (hydrographs) for Project wells near the Sierra Nevada may yield insight into what appears to be relatively narrow recharge flow paths.

Water level declines in the four BR-1 piezometers have been especially intriguing and may represent the ebb of a recharge pulse from the southwest watersheds. From April 9, 1991, to May 18, 1992, the water level has dropped almost four feet in the shallow piezometer and over 16 feet in the shallow medium piezometer. The decline has been nearly 15 feet in the medium deep piezometer and a little over 13 feet in the deep piezometer. Over the same time period the water levels in BR-2 have dropped only 0.1 feet in the shallow piezometer and 0.5 feet in the deep piezometer. Several of the

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# **RECOMMENDATIONS FOR FUTURE ACTIVITIES AND STUDIES**

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Ullman, W.J., 1985, *Evaporation rate from a salt pan: Estimates from chemical profiles in near-surface groundwaters*, *J. Hydrol.*, 79: 365-373.

measured transmissivity, if data from the recommended recharge related activities indicate that total recharge and distribution is similar to that used in the model. Apportioning the measured transmissivities from the screened intervals of the Project wells over the full saturated thickness indicates a much higher transmissivity than that modeled along the western margin of the Valley.

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The percentage of the total recharge from a given watershed is assumed to be the same as the percentage of the total watershed pinon-juniper acreage in that watershed. Using this method and assuming the total recharge is 9,850 (used in both models), the annual recharge from the Coso and Argus Ranges is 975 acre-feet, or 10 percent of the total recharge. Berenbrock and Martin (1991) note in their table 7 that a Coso and Argus Range recharge between 1,585 and 792 acre-feet per year makes the best fit with measured water levels. This also agrees with the Kunkel and Chase (1969) qualitative description of recharge distribution noted at the end of the "Recharge Distribution" section above. The general agreement with these recharge distributions and the potential relationship between watershed soil moisture distribution (predominant factor in pinyon-juniper distribution) and recharge distribution would seem to lend some credence to this method.

## **CALIBRATION/VERIFICATION**

Berenbrock and Martin used all of the available water level record (1920-1985) for their transient-state calibration. By using all of the record for calibration, none is left to test the predictive accuracy of the model. The predictive ability of a model can be tested by dividing the available water level record into two parts--the first part is used for transient-state calibration and the later part is for comparison to predictive model runs over the later time period. Predictive tests were not run in the Bloyd and Robson model. Transient state calibration eliminates the need to reduce Valley margin transmissivities far below known values as is require for steady state calibration to historic water elevations. This is necessary because mountain front recharge flow is probably accommodated by much less than the full aquifer thickness.

## **RECOMMENDATIONS FOR FUTURE MODELING**

Transient state "recalibration" of the Berenbrock and Martin model is recommended subsequent to a period of data collection from the recharge related recommended Project follow-on activities (see the recommendations section). These recharge related activities are intended to refine recharge distribution and total recharge. There is some evidence that the empirical method used by Kunkel and Chase may have overestimated playa area evapotranspiration (this discharge is assumed to equal recharge). In addition, the response of the MW-32 piezometers to the pumping of District Wells 30 and 31 may suggest some reconfiguration of the model.

The Berenbrock and Martin model can be used without recalibration to predict drawdowns in areas where the model transmissivity compares well with

Based on all of the above it seems clear that recharge distribution in future groundwater models of the Valley aquifer should be based on some procedure which is independent of models.

## POTENTIAL RECHARGE DISTRIBUTION METHODS

The author investigated several potential methods for distributing recharge or mapping "recharge potential" based on the premise that most, if not all, of the natural recharge is from winter precipitation runoff. A number of authors (Simpson et al., 1970; Gallaher, 1979; and Mifflin, 1968) have suggested that mountain-front recharge in the southwest is a function of winter precipitation only.

The methods investigated included average annual "snow-pack" distribution, winter precipitation distribution based on long period National Oceanic and Atmospheric Administration (NOAA) atmospheric model runs for the proposed Yucca Mountain high level nuclear waste repository, isotope distribution in the aquifer (isotope sampling is recommended as a Project follow-on activity), and pinyon-juniper area in the recharge watersheds. Lack of snow-pack data and the extremely coarse grid in the NOAA model eliminated the first two potential methods. Isotope distribution may have some potential and is described in a University of Arizona M.S. thesis by Gallaher (1979) titled "Recharge properties of the Tucson Basin aquifer as reflected by the distribution of a stable isotope." The hypothesis that the percentage of pinyon-juniper in a given watershed, as compared to the total pinyon-juniper area in all watersheds, may be related to the recharge percentage from that watershed may have some merit (see the chapter on recommended post-Project activities). The method is summarized below and is fully developed in Appendix I.

## WATERSHED VEGETATION DISTRIBUTION

Recharge distribution using vegetation distribution is based on the premise that some plant specie in the recharge watershed is in equilibrium with an average long-term<sup>5</sup> moisture availability and that the moisture availability is proportional to recharge. Pinon and juniper was selected as the indicator plant specie based on the authors perception that the distribution of pinon and juniper woodlands is similar to the distribution of areas which receive some snow almost every year.

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<sup>5</sup> Changes in specie distribution and density may lag many decades behind long-term atmospheric changes. However, it is assumed that any change in long-term moisture availability will affect the specie distribution and density in all watershed areas equally.

The recharge from the Coso and Argus Ranges appears to be overestimated in both of the models. St. Amand (1986) notes the following below his figure 11,

"Figure 11 shows the water-level contours that are calculated by the mathematical model of Bloyd and Robson (1971) and are compared to the depth of water as shown in several wells. Wells 1K1, 6A1, and 22N1 show water at a considerably greater depth than the model indicates the water should be. The hydraulic gradient is only about 9 feet in over 8 miles. Considering the low transmissivity of the sediments, little or no water appears to be flowing from the Coso Basin into China Lake Basin."

Berenrock and Martin (1991) note the same in their model.

"Because few data are available in the northern part of the Valley, the recharge and transmissivity distribution determined by Bloyd and Robson (1971) for this area was used in the model with only slight modifications. However, model-simulated hydraulic heads in this part of the model are higher than available measured water levels (table 7); thus, these input data may be in error. Several steady-state and transient-state simulations were run to determine the effect on the model-simulated heads of decreasing the quantity of recharge originating along the Coso and Argus Ranges. The simulations with lower recharge rates more closely match the observed water levels (table 7). Lower recharge rates along the Coso and Argus Ranges, however, have little impact on the model-simulated hydraulic heads in other parts of the model (table 7)."

The lower Coso and Argus Range recharge (between 1,585 and 792 acre-feet per year) confirms the Kunkel and Chase (1969) qualitative description of recharge distribution. They stated,

"The largest increment of recharge for Indian Wells Valley is derived from the east slopes of the Sierra Nevada, west and southwest of Inyokern, where the heaviest precipitation in the area occurs. Second in importance are the steep fans and escarpment of the Sierra Nevada northwest of Inyokern, where the catchment area is smaller and the quantity of precipitation is less. A third increment, probably small, is derived from Rose Valley through a narrow channel at Little Lake. A very small quantity of recharge reaches the main water body from the Argus Range, but the quantity is small because of the small amount of precipitation in that area. Other very minor quantities are derived from Coso Basin and the El Paso Mountains.

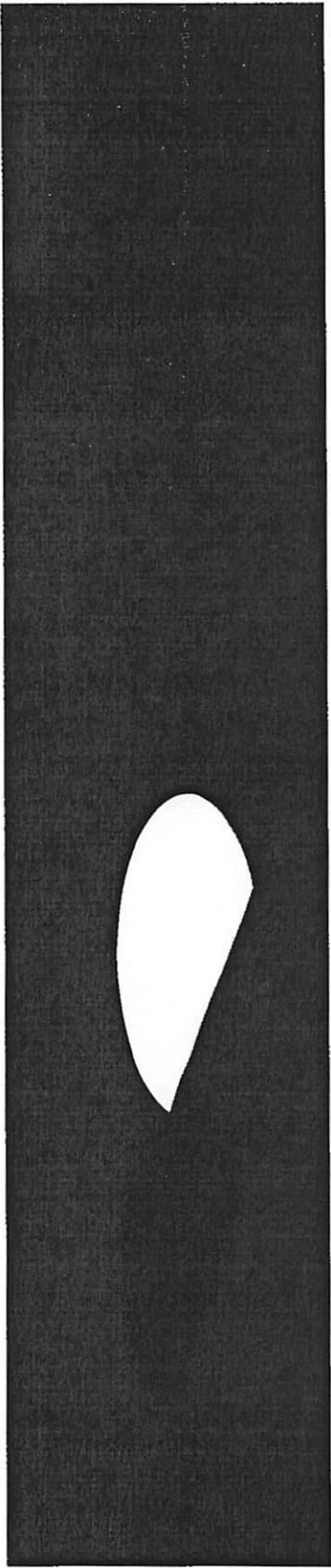
distribution which is determined from precipitation gauges in the mountain front watersheds surrounding the modeled valley. In Indian Wells Valley, however, none of the mountain front streams are gauged nor are there any precipitation gauges outside the Valley floor. Without any gauge data, some other basis must be devised to distribute recharge in a groundwater model of the Valley.

Bloyd and Robson (1971), the first Indian Wells Valley groundwater modelers, started with an assumption that natural recharge is directly proportional to watershed area above 4,500 feet in the Sierra Nevada and 5,000 feet in the Coso and Argus Ranges. This yielded 102 square miles of recharge contributing watershed area in the Coso and Argus Ranges and 88 square miles in the Sierra Nevada. This recharge apportionment resulted in too much recharge emanating from the Coso and Argus Ranges and too little recharge from the Sierra Nevada. A simple trial-and-error process was then used to make changes in recharge values until the head configuration determined by the model was in agreement with the 1920-21 water-level contour map drawn from available water-level measurements (Bloyd and Robson, 1971).

Unfortunately, Bloyd and Robson (1971) are not clear about the transmissivity distribution used in the recharge distribution trial-and-error runs. They state,

"Initial estimates of transmissivity and storage coefficient[s] for the aquifers were made by L.C. Dutcher and W.R. Moyle, Jr. (written commun., 1970). Refinements of the estimates were made during verification of the model."

Bloyd and Robson probably made the recharge trial-and-error runs after the transmissivity refinements, because if they made the recharge trial-and-error runs before refinement (with the Dutcher and Moyle transmissivity estimates) then transmissivity refinements would not be needed--the recharge (trial-and-error) would be adjusted until steady-state model water levels matched measured water levels. If this is what they did, then on what recharge distribution were the transmissivity refinements based? This is a critical question because transmissivity distribution and recharge distribution are interrelated; changes in one distribution necessitate changes in the other to match measured water levels (calibration). Furthermore, the Berenbrock and Martin (1991) transmissivity distribution is dependent on whatever process Bloyd and Robson used because they fixed the Bloyd and Robson gross recharge distribution (for the Sierra Nevada and for the Coso and Argus Ranges) in their model and then adjusted the transmissivity distribution for calibration to water levels.



**SECTION C -  
ESTIMATE OF WATER  
RESOURCE LIFE**

## **INTRODUCTION**

**This Section describes the methods used to estimate the life of six future groundwater development possibilities identified during the Project. The six possible future water development alternatives were:**

- 1. Continue pumping from the Intermediate Area only**
- 2. Continue pumping from the Intermediate Area and expand into the Southwest Area**
- 3. Continue pumping from the Intermediate Area and blend water from the Northwest Area**
- 4. Continue pumping from the Intermediate Area, expand into the Southwest Area, and blend water from the Northwest Area**
- 5. Continue pumping from the Intermediate Area and blend treated water from the Northwest Area**
- 6. Continue pumping from the Intermediate Area, expand into the Southwest Area, and blend treated water from the Northwest Area**

**In estimating the life of the water resource in Indian Wells Valley, major assumptions have to be made in three areas—future groundwater withdrawals, extractable groundwater volume, and recharge volume and distribution. Determination and usage of values in each of these areas in estimating resource life is the subject of this Section.**

**Models used here for developing the parameters that determine resource life are neither sophisticated nor complex. An elementary approach was used because uncertainty in available data would not have allowed additional accuracy even with a more rigorous mathematical approach. In order to compensate for uncertainties in assumptions and simplicity in the modelling effort, reasonable extremes were developed in an effort to bracket the parameters. Three scenarios were evaluated. A "worst case" condition was developed by using conservative values for all evaluation parameters. More optimistic values were used to develop a scenario at the other extreme of the range. Intermediate values based on interpretation of available data and professional judgement were then used to define a scenario that is considered to be a realistic representation of future conditions.**

## FUTURE WITHDRAWALS

Section B of this volume provides documentation of Valley water extraction projections made in 1990. Those projections were essentially a straight-line extrapolation resulting in annual withdrawal increases starting at about eight percent a year and decreasing to about four percent a year by the year 2010. For the purposes of this analysis, after the year 2010 the demand was assumed to remain constant at the 2010 level. That projection is now considered to be on the high side of the range of future withdrawal estimates and will represent the "worst case" condition.

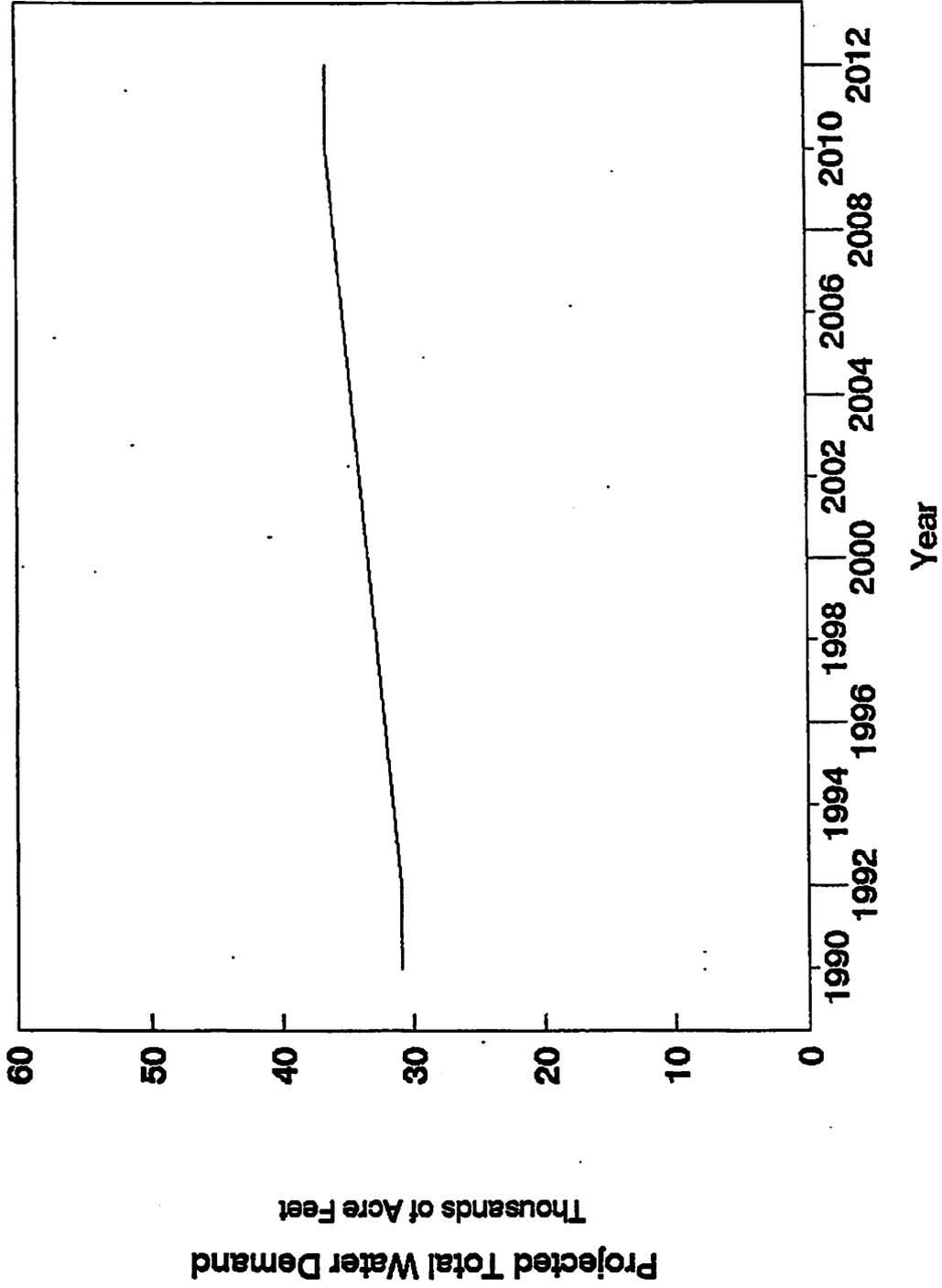
As pointed out in the Preface to Section B, Valley growth moderated in the early 1990's. Current population growth in the Valley is flat, as is the increase in water withdrawals. This condition will be used to represent the low side of the range of future withdrawal estimates. Current annual groundwater withdrawals as presented in Section B are:

Naval Air Weapons Station	4,400 acre-feet
North American Chemical Company	3,000
Indian Wells Valley Water District	9,000
Inyokern Community Services District	300
Agriculture	12,000
Private residential wells	<u>2,000</u>
Total	30,700 acre-feet

While it is conceivable that groundwater pumpage will remain at or near current levels, it is highly unlikely that the Valley will experience growth represented by the projections given in Section B. Perhaps a more likely groundwater withdrawal estimate would be derived by assuming that pumping for the Naval Air Weapons Station, North American Chemical Company, and agriculture will remain at current levels in the future and that the other entities will increase pumpage in a straight line so that by the year 2010 it will increase 50 percent. After 2010, pumpage is assumed constant. With these assumptions, the current and midrange or intermediate values for future annual water withdrawals in acre-feet are as shown below and in Figure 1:

	<u>1992</u>	<u>2010</u>
Naval Air Weapons Station	4,400	4,400
North American Chemical Company	3,000	3,000
Indian Wells Valley Water District	9,000	13,500
Inyokern Community Services District	300	450
Agriculture	12,000	12,000
Private residential wells	<u>2,000</u>	<u>3,000</u>
Total	30,700	36,350

**Figure 1: Revised Projected Total Future Water Demands**



## EXTRACTABLE GROUNDWATER VOLUMES

The Project identified three areas that could be used to provide future groundwater resources for the Valley. These are the Intermediate Area, the Northwest Area, and the Southwest Area (see Figure 2 for location). The Intermediate Area

is the traditional groundwater extraction area for the Indian Wells Valley and the area for volume calculation is assumed to be 4 miles by 6 miles. The Northwest Area is 9 miles by 4.5 miles and the Southwest Area is 4 miles by 7 miles.

To determine the extractable groundwater volume, assumptions were made on specific yield and the saturated thickness that would reasonably be expected to be dewatered. Specific yield was assumed to be 20 percent or 0.20, since most references suggest a range of 0.10 to 0.30 for sand aquifers. St.-Amand (1986) used a range from 0.10 to 0.20, depending upon Valley location.

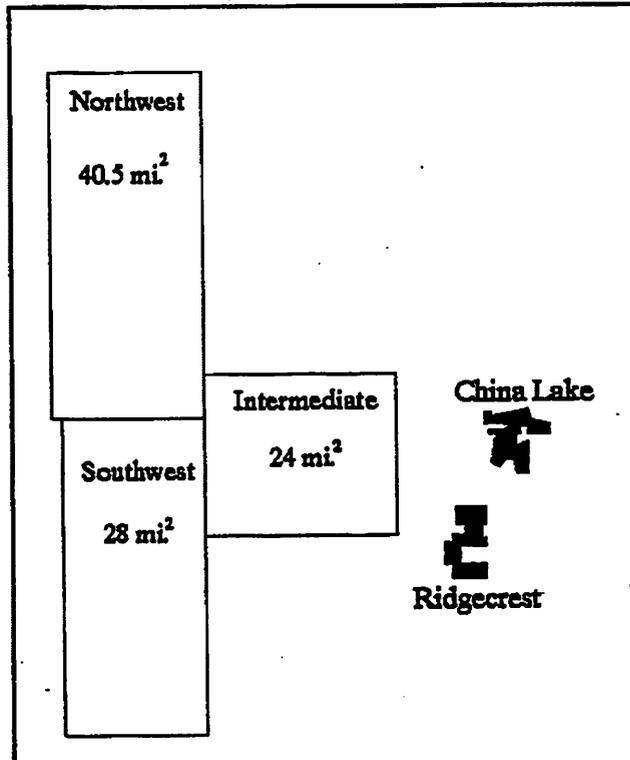


Figure 2

While data obtained during the Project indicate good quality water in the Intermediate Area and Southwest Area to a depth of at least 2,000 feet, dewatering the aquifer to that depth is not considered reasonable for both physical and economic reasons. However, given the high economic value of municipal and industrial water as compared to agricultural water, dewatering to depths of 500 to 600 feet is not unreasonable. Therefore, based on current depth to groundwater, as much as 300 feet of aquifer could be dewatered in the Intermediate and Southwest Area.

In order to bracket reasonable dewatering depths, dewatered thicknesses of 100, 200, and 300 feet are used. A dewatering depth of 100 feet is considered the low side of the range and 300 feet is assumed to be the high end of the range. With a 300-foot dewatered thickness the total static pumping head may be reaching the current edge of the economic pumping range. For this analysis, 200 feet of dewatering will be considered the realistic value of

dewatering depth. In the Northwest Area the depth to groundwater and depth to the top of the extensive clay layer limits dewatering to about 200 feet.

As pointed out in a later discussion on water quality, depression of the groundwater surface caused by pumping will result in a head difference between water in the pumped areas and water in surrounding areas. This will cause surrounding water to migrate into the pumped areas. This additional volume will be accounted for during the water quality calculations.

The extractable groundwater volumes in millions of acre feet based on the assumptions above are about:

Area	100-Foot Dewatering Depth	200-Foot Dewatering Depth	300-Foot Dewatering Depth
Intermediate	0.31	0.61	0.92
Southwest	0.36	0.72	1.06
Northwest	0.52	1.04	1.04

## RECHARGE VOLUME AND DISTRIBUTION

Recharge quantity and distribution has been the subject of speculation and discussion among local water experts. Resolution of the various viewpoints continues to be elusive, even with the additional data obtained under this Project. However, calculation of a resource life demands making recharge assumptions, so an attempt was made here to use all existing information, including data from other researchers, to develop reasonable resource life estimates.

Recent research suggests that the previous quantitative estimate of Valley recharge may be too high (see the **AQUIFER MODELING** chapter of Section A). Based on that possibility, the low estimate for recharge quantity used here was 3,000 acre-feet a year from the east slope of the Sierra Nevada. Distribution of this quantity was 1,000 acre-feet into the Southwest Area and 2,000 acre-feet into the Northwest Area. This distribution was based on the assumption that recharge distribution is proportional to watershed vegetation distribution as reported in Appendix I (see table 1 of that appendix).

For the intermediate recharge case, values and distribution presented in Berenbrock and Martin (1991) were used. Recharge developed by those researchers was about 6,000 acre-feet a year from the eastern Sierra Nevada, with about half coming into the Northwest Area and half into the Southwest Area.

The high end of the range for recharge from the eastern Sierra Nevada used in this analysis was 9,000 acre-feet a year. This was derived by assuming 3,000 acre-feet enters the Northwest Area from the Little Lake area in addition to the Berenbrock and Martin estimate. This assumption, then, gives 3,000 acre-feet a year recharge into the Southwest Area and 6,000 acre-feet a year recharge into the Northwest Area.

For all cases, it was assumed that there is no natural recharge into the Intermediate Area. This assumption is probably quite conservative for Alternative 1 where all the pumping occurs in the Intermediate Area, but may be more realistic under other alternative water development possibilities. As discussed on the next page, however, there is a five percent estimated annual contribution to pumping quantities from groundwater storage outside the pumped areas.

A summary of all the evaluation parameters discussed in the sections above are shown in the following table.

Evaluation Parameter	Conservative Condition	Intermediate Condition	Optimistic Condition
Future Withdrawals	1990 projections	50% increase in 18 years for some pumps	No change from current pumping quantities
Extractable Water Volume	100-foot dewatering depth	200-foot dewatering depth	300-foot dewatering depth
Total Recharge	3,000 a-f/yr	6,000 a-f/yr	9,000 a-f/yr

## DESCRIPTION OF RESOURCE LIFE MODEL

There are two prime considerations in determining a strategy for future water development and estimating the life of water resources in the Valley—volume of water available and water quality. Selection of a future groundwater development strategy will also depend upon the approach to water quality. As water quality declines from the good quality source areas there is less opportunity for use of poorer quality water by blending. Early blending of poorer quality water with good quality water will result in a rapid (but scarcely perceptible) decline in delivered water quality, but the total water volume available to the Valley will be expanded.

The model used to estimate resource life has three components--withdrawals from the groundwater, inflow into the groundwater from both natural recharge and migration of surrounding water, and changes in water quality.

Withdrawals are described under FUTURE WITHDRAWALS and natural recharge is described under RECHARGE VOLUME AND DISTRIBUTION. The method for determining surrounding water inflow and water quality is described below.

Historical data were used to estimate the amount of surrounding water that would migrate into the pumped areas. Between 1965 and 1985 groundwater elevations in the Intermediate Area dropped about 40 feet (Berenbrock, 1991, p. 45), a rate of decline of about 2 feet a year. If the pumped area is assumed to be round with a diameter of six miles and a specific yield of 20 percent, a 2-foot annual decline over the entire area would amount to an annual withdrawal of about 7,250 acre-feet. During the 1965 - 1985 time period, actual annual pumping from the Intermediate Area was about 7,500 acre-feet a year (Krieger and Stewart, 1988). It appears from this calculation that if the pumping cone of depression is inducing any inflow from the surrounding area, that amount of inflow is quite small in comparison with the pumped quantity. However, for the purposes of the resource life model developed here, it was assumed that inflow from the surrounding area is a constant five percent of the pumped quantity.

Inflow from the surrounding area will have an impact on the quality of water in the Intermediate Area because the surrounding water is of poorer quality. For purposes of this model, water surrounding the Intermediate Area was assumed to have a quality of 1,000 mg/l. Then, as surrounding water migrates into the Intermediate Area, water in the Intermediate Area will gradually become more saline. This change in dissolved solids concentration was calculated by combining the migrating 1,000 mg/l surrounding water with the 250 mg/l Intermediate Area water. The following equation was used:

$$Q_i^n = \{(V_i^o \times Q_i^o) + (Q_s \times I_s) - (Q_p \times V_p)\} / V_i^n$$

- Where,  $Q_i^o$  = Original Intermediate Area water quality  
 $V_i^o$  = Original Intermediate Area water volume  
 $Q_i^n$  = New Intermediate Area water quality  
 $V_i^n$  = New Intermediate Area water volume  
 $Q_s$  = Surrounding water quality  
 $I_s$  = Annual surrounding water inflow  
 $Q_p$  = Pumped water quality  
 $V_p$  = Annual pumped water volume

Since water surrounding the Southwest Area appears to have a dissolved solids concentration approximately equal to water in the Southwest Area, no water quality change would result from pumping that area. Similarly, water quality in the Northwest Area would not change from migration of surrounding water.

Natural recharge quality is assumed to be 250 mg/l in the Southwest Area. However, in the Northwest Area there is evidence that recharge is of poorer quality. In order to provide conservative results and to allow simple calculations, natural recharge to the Northwest Area was assumed to have a dissolved solids concentration of 1,000 mg/l.

A sample calculation is shown below. This example shows computations for first year pumping from the Intermediate Area (Alternative 1). The most conservative withdrawal parameter was used for this example--18,700 acre-feet of water pumped the first year. Recharge is assumed to be zero and so is not a consideration in this equation; however, recharge must enter into the calculation for other alternatives. Dewatered depth is also not a consideration in the calculation because volume is used here only in the determination of water quality, not in determining resource life.

$V_i^o = 2,150,000$  acre-feet. This assumes an area of 24 square miles and a water depth affected by incoming surrounding water of 700 feet. The 700-foot number was derived by assuming a well screen depth of 1,000 feet and a current groundwater surface elevation of 300 feet below ground level.

$$Q_i^o = 250 \text{ mg/l}$$

$$V_i^a = V_i^o - V_p + I_r = 2,132,235 \text{ acre-feet}$$

$$Q_r = 1,000 \text{ mg/l}$$

$$I_r = 5\% \text{ of } 18,700 = 935 \text{ acre-feet}$$

$Q_p = 250 \text{ mg/l}$  for the first year.  $Q_p$  is actually always the same as  $Q_i^a$  for the previous year.

$$V_p = 18,700 \text{ acre-feet}$$

$$\begin{aligned} \text{Then, } Q_i^a &= \{(2,150,000 \times 250) + (1,000 \times 935) - (250 \times 18,700)\} / 2,132,235 \\ &= 250.33 \text{ mg/l} \end{aligned}$$

For the second year calculation,  $Q_i^a$  becomes  $Q_i^o$  and  $V_i^a$  becomes  $V_i^o$ . The calculation is repeated until either the available water is depleted or  $Q_i^a$  reaches 500 mg/l.

## CALCULATED RESOURCE LIFE VALUES

Using the technique and assumptions described above, resource life values were calculated for each of the potential resource development alternatives. Since there are three evaluation parameters (recharge, dewatering depth, and future pumping), each with three possible values, there are 27 possible combinations of resource life for each potential development alternative. Instead of calculating a resource life for each combination, calculations were made only for the worst or conservative conditions, for optimistic conditions, and for what is considered here as more realistic conditions. Results of each of these calculations are shown in the table below.

Resource Development Alternative	Resource Life, years		
	Conservative Condition	Intermediate Condition	Optimistic Condition
No. 1--Pump Intermediate Area only	14	29	52
No. 2--Pump Intermediate Area, expand into the Southwest Area	26	68	134
No. 3--Pump Intermediate Area, blend Northwest Area water	19	42	77
No. 4--Pump Intermediate Area, expand into the Southwest Area, blend Northwest Area water	33	92	169
No. 5--Pump Intermediate Area, blend <u>treated</u> water from the Northwest Area	19	42	77
No. 6--Pump Intermediate Area, expand into the Southwest Area, blend <u>treated</u> water from the Northwest Area	33	92	169

For alternatives that included pumping from both Intermediate and Southwest Areas, the pumping distribution was adjusted to maximize the life of the resource. Pumping percentage from the Southwest Area varied between 55 and 61, with the rest being pumped from the Intermediate Area.

It should also be noted that water quality never became a limiting factor. That is, the water volume in the Intermediate or Southwest Area became depleted before the water quality reached the Environmental Protection Agency recommended total dissolved solids concentration of 500 mg/l. This is why the resource life for Alternatives 5 and 6 are the same as for Alternatives 3 and 4, respectively. This also means that treatment of the Northwest Area water for blending purposes is unnecessary if total dissolved solids is the only consideration. There are, however, individual constituents that may limit the blending associated with Alternatives 3 and 4: In that case, treatment is required in order to achieve the resource life values shown in the table on the previous page.

In several blending cases, water in the Northwest Area became depleted while there was still water available in the Intermediate Area or Southwest Area. In that event, agricultural pumping from the Northwest Area would be limited to the recharge volume and the quantity of water migrating in from the surrounding area, and pumping in the Intermediate or Southwest Areas would be increased to meet all municipal and industrial demands.

## **REFERENCES**

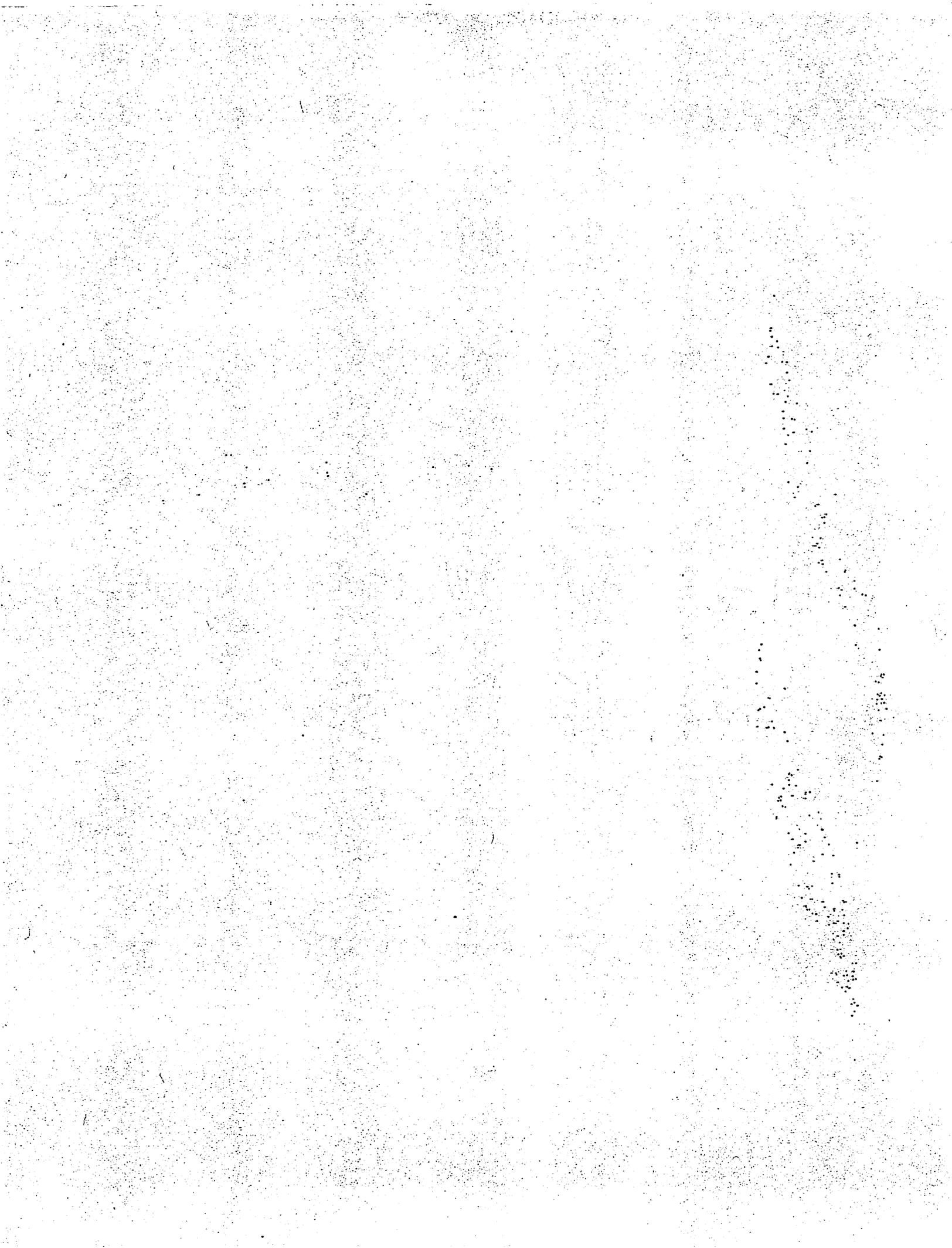
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# APPENDIXES

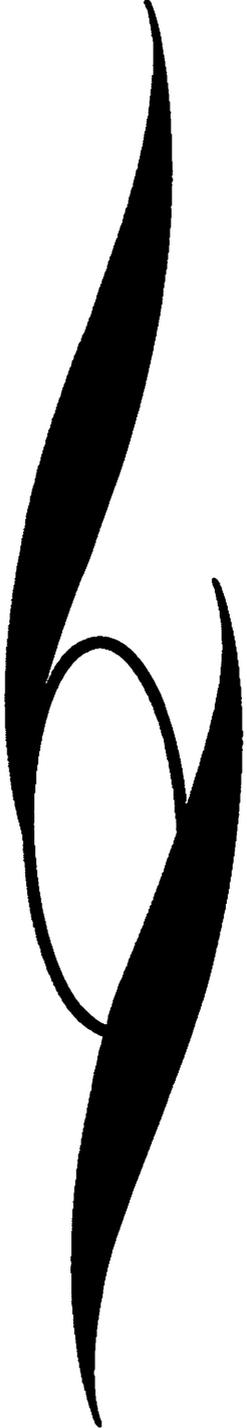


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# **APPENDIX I**

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**Estimating Recharge Distribution to Indian Wells Valley Based  
on Vegetation Distribution in the Recharge Watersheds**



## APPENDIX I.

### ESTIMATING RECHARGE DISTRIBUTION TO INDIAN WELLS BASED ON VEGETATION DISTRIBUTION IN THE RECHARGE WATERSHEDS

*Dennis E. Watt*

#### INTRODUCTION

Bloyd and Robson (1971) estimated, by trial-and-error using their groundwater model, that about 64 percent (6,250 acre-feet/year) of the mountain front recharge to Indian Wells Valley (Valley) originates from the Sierra Nevada on the west side of the Valley, about 32 percent (3,170 acre-feet/year) originates in the Coso and Argus Ranges on the north and northeast sides of the Valley, and about 4 percent (400 acre-feet/year) originates in the El Paso Mountains on the south side of the Valley (Berenbrock and Martin, 1991). Berenbrock and Martin (1991) also used this recharge distribution in their groundwater model of the Valley.

St. Amand (1986) and Berenbrock and Martin (1991) note that 3,170 acre-feet/year from the Coso and Argus Ranges is too much based on the simulated groundwater gradient in the northeast part of the Valley in the two groundwater models (Bloyd and Robson, 1971; Berenbrock and Martin, 1991). Kunkel and Chase (1969) seem to suggest a recharge distribution different from that in the models. They state,

"The largest increment of recharge for Indian Wells Valley is derived from the east slopes of the Sierra Nevada, west and southwest of Inyokern, where the heaviest precipitation with the area occurs. Second in importance are the steep fans and escarpment of the Sierra Nevada northwest of Inyokern, where the catchment area is smaller and the quantity of precipitation is less. A third increment, probably small, is derived from Rose Valley through a narrow channel at Little Lake. A very small quantity of recharge reaches the main water body from the Argus Range, but the quantity is small because of the small amount of precipitation in that area. Other very minor quantities are derived from Coso Basin and the El Paso Mountains."

The statements above suggest the need for another method of distributing recharge. Distributing recharge based on watershed vegetation distribution, as described below, may have merit.

## **PREVIOUS RECHARGE DISTRIBUTION METHOD**

Bloyd and Robson (1971), the first Indian Wells Valley groundwater modelers, started with an assumption that natural recharge is directly proportional to watershed area above 4,500 feet in the Sierra Nevada and 5,000 feet in the Coso and Argus Ranges. This yielded 102 square miles of recharge contributing watershed area in the Coso and Argus Ranges and 88 square miles in the Sierra Nevada. Apportioning this watershed area based recharge in the model resulted in too much recharge emanating from the Coso and Argus Ranges and too little recharge from the Sierra Nevada. A simple trial-and-error process was then used to make changes in recharge values until the head configuration determined by the model was in agreement with the 1920-21 water-level contour map drawn from available water-level measurements (Bloyd and Robson, 1971). Berenbrock and Martin (1991) used the Bloyd and Robson gross recharge distribution (for the Sierra Nevada and for the Coso and Argus Ranges) in their model.

## **OTHER POTENTIAL RECHARGE DISTRIBUTION METHODS**

The author investigated several potential methods for distributing recharge or mapping "recharge potential" based on the premise that most if not all recharge is from winter precipitation runoff. A number of authors (Simpson et al., 1970; Gallagher, 1979; and Mifflin, 1968) have suggested that mountain-front recharge in the southwest is a function of winter precipitation only. The methods investigated included a distribution based on: (1) average annual "snow-pack" distribution, (2) winter precipitation distribution based on long period National Oceanic and Atmospheric Administration (NOAA) atmospheric model runs for the proposed Yucca Mountain high level nuclear waste repository, and (3) vegetation distribution in the recharge watersheds.

The apparent lack of data eliminates any method based on measured or estimated "snowpack." Watershed snowpack measurements and estimates are only available for California watersheds draining to the large reservoirs, mostly west of the Sierra Nevada drainage divide. The only winter precipitation data available for the east slope is believed to be that collected in the Carson-Truckee watershed and the watersheds draining into Los Angeles Department of Water and Power (LADWP) eastern Sierra reservoirs and aqueducts.

The NOAA model is of little use because the 60 kilometer grid size is too coarse. The coarse grid is a function of the wide spacing of sites in the western U.S. for which relatively long term weather data is available. The

node size can be reduced to 10 kilometers (still much too coarse) locally with a local data collection effort.<sup>1</sup>

## RECHARGE DISTRIBUTION BASED ON WATERSHED VEGETATION DISTRIBUTION

Estimating recharge distribution from vegetation distribution is based on the premise that the areal distribution of some vegetation community in the recharge watershed may be in equilibrium with "some average long-term"<sup>2</sup> areal moisture availability in the watershed and that moisture availability may be proportional to recharge. Therefore, distribution of vegetation with high sensitivity to moisture availability and low sensitivity to other climatic and substrate conditions may be a potential indicator of watershed recharge potential.

Vegetation distribution may only indicate general moisture conditions in a watershed. Because of evapotranspiration, the amount of precipitation draining below the root zone (to become recharge) of watershed vegetation may be less than that draining below that same depth under less vegetated slopes. Ng and Miller (1980) found that drainage averaged 1 cm/yr [0.4 in/yr] on the north-facing slope but was almost 3 cm/yr [1.2 in/yr] on the less vegetated south-facing slope. Precipitation at the research site, in the mountains east of San Diego, for the water years 1972, 1973, and 1974 was 25.9 [10.2], 66.8 [26.3], and 35.1 [13.8] cm [in], respectively.

### PINYON-JUNIPER

Pinyon-juniper woodland area was selected as the watershed moisture distribution indicating vegetation based on the author's perception that the distribution of pinyon and juniper woodlands is similar to the distribution of areas which receive snow most every year and because a number of authors (Simpson et al., 1970; Gallagher, 1979; and Mifflin, 1968) have suggested that mountain-front recharge in the southwest is a function of winter precipitation only. Moreover, pinyon-juniper distribution seems to be sensitive to moisture availability and insensitive to substrate based on findings summarized below.

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<sup>1</sup> Personal communication with J.C. Lease, U.S. Bureau of Reclamation, Denver, 1992.

<sup>2</sup> Changes in specie distribution and density may lag many decades behind long-term atmospheric changes, however it is assumed that any change in long-term moisture availability will affect the specie distribution and density in all watershed areas equally.

Pinyon and juniper woodlands are found in many parts of California, although they are most extensive east of the Sierra Nevada and Cascade Ranges.

Pinyon-juniper trees generally grow where annual precipitation averages between 8 and 12 inches and the frost-free season is about 120 days (Arno and Hammerly, 1984; Garrison and others, 1977). Although soil and geology differ, the basic tree growth patterns appear to be similar (Young, 1984).

Daubenmire (1943) suggests that soil moisture availability is the most important factor in determining the lower limit of dominant tree and shrub species in Rocky Mountain vegetation zones. In the Great Basin, pinyon-juniper woodlands form a distinct zone on the mountain ranges, with upper and lower limits thought to be due primarily to water availability and extreme temperatures (Tueller and others, 1979).

Whittaker and Niering (1968) made traverses sampling species distribution and conducted a "special sample series" on various rock types on the north slope of the Santa Catalina Mountains [north of Tucson], Arizona. In comparing the vegetation supported by diorite [granitic rock] and limestone they noted that several species occurred on both alkaline and acid soils. These included Juniperus deppeana [juniper]. Bradbury (1969) found that the distribution of five tree forms in the southern Swisshelm Mountains of southeast Arizona [including Juniperus deppeana and J. monosperma] present the possibility of factors other than substrata influencing their distribution [in a limestone and igneous rock terrain]. Bradbury presumed that moisture factors are active in regard to the preferences of these species.

Wentworth (1981), on the other hand, found that within the Mule Mountains [southeast Arizona], limestone and granite sites existing under similar climatic regimes support markedly different plant communities. He attributed this to the finer texture of the calcareous soils which would tend to allow only shallow penetration of small amounts of precipitation which in turn would be more readily lost by evaporation than that penetrating to greater depth in a coarser textured granitic soil. However, based on the findings of Whittaker and Neiring (1968), Bradbury (1969), and the others noted above, the author believes the vegetation pattern found by Wentworth (1981) may be a function of slope or soil maturity or some other factor which causes shallow soil conductivity to supersede precipitation distribution as the primary factor in vegetation distribution. The potential for pinyon-juniper distribution shifts due to limestone versus igneous substrate does not exist in the watersheds recharging the Valley as there are no significant limestone outcrops.

## **PINYON-JUNIPER MAPS**

The green shading on the 1943-1956 vintage U.S. Geological Survey 15-minute topographic maps appears to be the only mapping available which shows pinyon-juniper woodland distribution in sufficient detail. Inquiries to various state and federal agency botanists for potential sources of vegetation mapping did not yield any likely sources. The vegetation map in "Terrestrial Vegetation of California" (Vasek, 1988) is not sufficiently detailed and does not show the pinyon-juniper woodland in the Coso Range.

The relatively small pinyon-juniper woodland area in the Coso Range relative to the pinyon-juniper woodland area in the Sierra Nevada, at the same elevation, may be a function the "moisture shadow" effect of the Sierra Nevada. Additionally, many of the watersheds trend north-south which limits winter shading of snow. Snow exposed to the sun may be more likely to sublimate instead of draining into the substrate as compared to snow shaded from direct solar radiation.

## **APPLICATION OF METHOD**

Table 1 lists the recharge for each watershed based on the percentage of pinyon-juniper woodland area in each recharge watershed as a percentage of the total pinyon-juniper area in all the potential recharge watersheds. Based on this recharge distribution procedure, the annual recharge from the Coso and Argus Ranges is 975 acre-feet per year, assuming the total recharge to the Valley is 9,850 acre-feet per year (as used in the groundwater models). This agrees with the model based findings of Berenbrock and Martin (1991). They note that a recharge from the Coso and Argus Ranges of between 1,585 and 792 acre-feet per year allows the groundwater model to make a good fit with measured water levels. This recharge distribution also seems to agree with the distribution described by Kunkel and Chase (1969) quoted in the introduction of this Appendix.

Note also that distributing recharge in proportion to watershed vegetation distribution indicates zero recharge from the El Paso Mountains, an area receiving 5 to 6 inches of average annual precipitation (Rantz, 1969). This agrees with the Maxey-Eakin (1949 and 1951) recharge coefficients for areas with less than 8 inches of precipitation. The Maxey-Eakin method for estimating recharge to a groundwater basin was developed by G. B. Maxey and T. E. Eakin between 1947 and 1951 and has been applied to over 200 basins in Nevada and other western states (Avon and Durbin, 1992). The Maxey-Eakin method is an empirical relation between annual precipitation rate and recharge efficiency in the Great Basin, see table 2.

**TABLE 1.**  
**DISTRIBUTION OF INDIAN WELLS VALLEY GROUNDWATER RECHARGE**

Watershed	Percentage of veg. indicating recharge potential		Recharge (af/yr)	
			<u>B &amp; M</u>	<u>B &amp; R</u>
<b>Coso</b>	9.9	975	3,170	3,168
<b>Sierra Nevada</b>				
Fivemile Cyn.	7.4	729	532	668 475
Deadfoot Cyn.	2.2	217	136	
Ninemile Cyn.	11.3	1,113	487	723 775
Noname Cyn.	1.2	118	236	
Sand Cyn.	18.1	1,783	659	495
Grapevine Cyn.	10.2	1,005	330	1,620
Short Cyn.	2.7	30	76	0
Indian Wells Cyn.	7.6	749	569	400
Freeman Cyn. and Cyns. south (Little Dixie)	31.8	3,132	983 2,065	430 2040
<b>El Paso Mtns.</b>		0	400	400

**Table 1.** Distribution of Indian Wells Valley groundwater recharge based on the percentage of the green shaded area (on 15-minute U.S.G.S. topographic maps) in each potential recharge watershed as a percentage of the total green shaded area mapped in all the potential recharge watersheds. Also shown is the recharge distributions from the models by Berenbrock and Martin (B & M) (1991) and Bloyd and Robson (B & R) (1971).

**TABLE 2**  
**MAXEY-EAKIN RECHARGE COEFFICIENTS**

Precipitation Zone	Maxey-Eakin Coefficient (%)
greater than 20 in.	25
15-20 in.	15
12-15 in.	7
8-12 in.	3
less than 8 in.	0 [to monitor] <sup>1</sup>

<sup>1</sup>Some investigators indicate that less than 8 inches of annual precipitation can yield minor recharge (Dettinger, 1989). This agrees with observations by the author in the Corn Springs watershed, about 40 miles west of Blythe, California, where 6 inches of annual precipitation (Rantz, 1969) yields spring flow of one percent or less of the watershed precipitation above this barrier type spring.

The vegetation based recharge percentage for each watershed shown in table 1 can be used to estimate recharge from each individual watershed if total recharge to the Valley is re-estimated in the future. Application of the Maxey-Eakin recharge estimating method to all of the recharge watersheds would probably yield less than one-half of the currently accepted annual recharge to the Valley of about 10,000 acre-feet (St. Amand, 1986).

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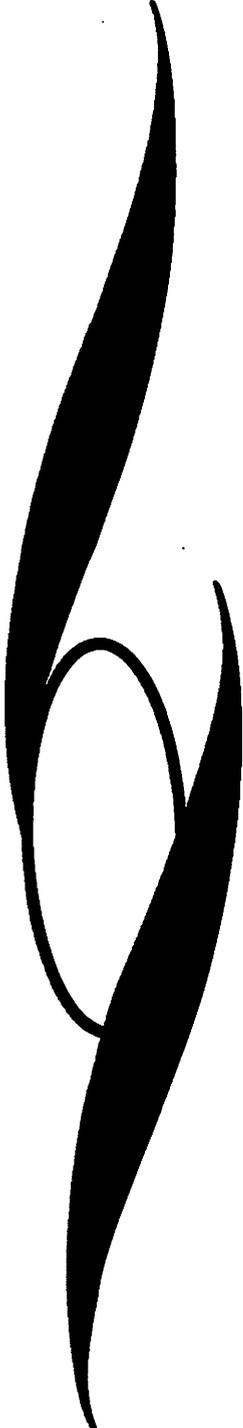
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# **APPENDIX II**

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**Re-evaluation of Recharge to the Indian Wells Valley  
Aquifer Based on Evaporation and Transpiration from China Lake Playa**



## APPENDIX II.

### RE-EVALUATION OF RECHARGE TO THE INDIAN WELLS VALLEY AQUIFER BASED ON EVAPORATION AND TRANSPIRATION FROM CHINA LAKE PLAYA

*Dennis E. Watt*

#### INTRODUCTION

Recent studies of other playas suggest that the rate of diffuse groundwater discharge<sup>1</sup> from the China Lake playa area as estimated by Kunkel and Chase (1969) for 1912 [before significant groundwater development] and 1953 may be too high. Recently measured diffuse discharge rates from bare soil on other playas, using several relatively direct measurement techniques developed over the last decade, are lower for a given depth to groundwater than those estimated for China Lake Playa. Diffuse groundwater discharge from the China Lake playa area is important because it is assumed to be the only significant natural, pre-development discharge from the Valley and is therefore equal to natural recharge.

Relatively direct measurement of historic diffuse discharge from the China Lake playa area, if feasible, could have significant aquifer management implications and would probably suggest modification of the most recent U.S. Geological Survey Indian Wells Valley aquifer model (Berenbrock and Martin, 1991).

#### PREVIOUS STUDIES

Little detailed information existed before 1985 on diffuse discharge from wet salt desert surfaces. In contrast, many investigators have studied diffuse water losses from agricultural land, dense phreatophyte stands along apportioned rivers, and free-water surfaces in the southwest United States. Ullman (1985) lists various techniques that have been used to estimate the rate of evaporation from vegetation and from bare soil and sediment surfaces. These include empirical techniques relating evaporation to average climatic factors (Thorntwaite, 1948; Blaney and Criddle, 1950), energy budget calculations (Penman, 1948; Van Bavel, 1966), and extrapolation from free-surface evaporating pans (Gray, 1970).<sup>2</sup> Ullman notes that in arid and semi-arid environments these techniques may greatly over estimate the true rate of evaporative loss.

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<sup>1</sup> Diffuse groundwater discharge is defined as evaporation from free water and nonvegetated surfaces and evapotranspiration (transpiration from vegetation and evaporation from surrounding nonvegetated surfaces) from vegetated areas.

<sup>2</sup> The authors given by Ullman (1985) are not listed in the references at the end of this section.

Most of the recent papers on relatively direct measurement of diffuse groundwater discharge from shallow groundwater bare soil areas are from Australia. Allison and Barnes (1985) used depth profiles of deuterium composition to estimate evaporation from the floor of the normally "dry" Lake Frome, a salt lake in northeastern South Australia. Ullman (1985) estimated evaporation using one-dimensional transport models for the distribution of Cl<sup>-</sup> and Br<sup>-</sup> from a salt-covered surface of Lake Eyre, also in South Australia.

In the United States, Cochran and others (1988) estimated maximum daily water table evaporation based on salt flux and non-weighing lysimeters from a thick salt crust site on Owens Lake in California. Malek and others (1990) estimated annual evaporation from Pilot Valley playa in western Utah using the Bowen ratio method to reduce microclimate data collected every 20 minutes.

### **CHINA LAKE PLAYA**

Kunkel and Chase (1969) estimated that the total diffuse groundwater discharge from the China Lake playa area was 11,000 acre-feet/year in 1912 and 8,000 acre-feet/year in 1953. These rates were derived by applying an evaporation and evapotranspiration rate to various classifications of the types of moist land in and around China Lake. The classifications were based on bare soil surface texture, surface moisture, alkali presence and expression, and vegetation density.

A curve of estimated evapotranspiration (consumptive use) versus depth to groundwater was made for 100 percent saltgrass cover by using the empirical equation developed by Blaney and Criddle in 1949 and Blaney in 1951<sup>3</sup>. The consumptive use coefficients for dense (100 percent) saltgrass growth were suggested by Blaney. A curve for 25 percent saltgrass (or pickleweed) cover and for fine-grained bare soil was estimated based on the curve for 100 percent saltgrass cover. Figure 1 shows each of these curves. Also shown is a line through the data points from Young and Blaney (1942) [as reported by Robinson (1958)] showing annual evapotranspiration of water by saltgrass grown in tanks in Owens Valley.

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<sup>3</sup> This is the same technique mentioned above by Ullman (1985) although the publication dates are different. Blaney and Criddle published a number of papers on applying essentially the same empirical technique to different types of vegetation. Ullman referenced their 1950 paper "Determining water requirements in irrigated areas from climatological and irrigation data." Kunkel and Chase (1969) used their 1949 paper "Consumptive use of water in the irrigated areas of Upper Colorado River Basin" and the 1951 paper by Blaney "Consumptive use of water."

## OTHER PLAYAS

Several recent papers present measured rates of groundwater evaporation from playas by use of relatively direct measurement techniques. Malek and others (1990) estimated 0.75 feet/year (229mm/yr) of subsurface water depletion from the Pilot Valley playa (western Utah) for a one year period beginning on October 1, 1986, see figure 1. They used the Bowen ratio method to reduce data collected every 20 minutes from a microclimate station. The water table at the site varied from 1 to 2 inches of surface water to about one foot below the surface as the season progressed. As soon as the surface water was lost, a salt crust began to form and by mid-summer it was about one inch thick. They note that the very high osmotic pressure of the soil and salt crust caused most of the absorbed radiation to be partitioned to sensible heat. Variation of the evaporation rate with changes in depth to water was not discussed, however their figure 9 shows that the rate was constant as long as the water was below the salt crust.

Allison and Barnes (1985) estimated 0.56 ft/yr (170 mm/yr) for the mean whole-lake diffuse groundwater discharge from Lake Frome (playa) in northeastern South Australia based on depth profiles of deuterium delta-values to about 3 feet. The average depth to water was about one foot and the soil at several of the measurement sites was covered with a 0.20 inch (5 mm) salt crust. The estimates of diffuse groundwater discharge from the five sites ranged from 0.29 to 0.75 ft/yr. They note that the estimated rate consistently decreased with increasing depth to water.

Cochran and others (1988) report 0.0063 in/day as the maximum daily evaporation rate of subsurface water at an Owens Lake site. Multiplying this rate by 365 days yields 0.19 feet/year. Depth to water ranged from about 20 to 40 inches. At the test site lake clays are overlain by 12 to 24 inches of hard, but porous and largely insoluble, salts. This in turn is overlain by 2 to 3 inches of unconsolidated and highly soluble salts which are capped by a ½ to 1 inch rind of salt crust. This site is probably not representative of the salt crust thickness on China Lake playa.

## DISCUSSION

Diffuse groundwater discharge rates from other playas may not be directly applicable in judging the 1912 and 1953 estimates of total evapotranspiration from the China Lake playa area. However, Ullman (1985) notes that the empirical technique used may greatly over estimate the true value of ~~evaporative loss from the water table in arid and semi-arid environments.~~

Thorburn and others (in press) confirm Ullman (1985). They draw a fitted curve through points representing diffuse discharge fluxes measured on salt pans versus depth to water using data from Allison and Barnes (1985), Jacobson and Jankowski (1989), Malek and others (1989), and Woods (1990). The fitted curve from Thorburn and others (in press) is shown on figure 1. Based on diffuse discharge from other playas, the estimate of bare soil diffuse discharge from the China Lake Playa area appears too high. However, the actual discharge may not be as low as that indicated by the "Thorburn curve" because the China Lake playa may differ from the playas used to develop the curve.

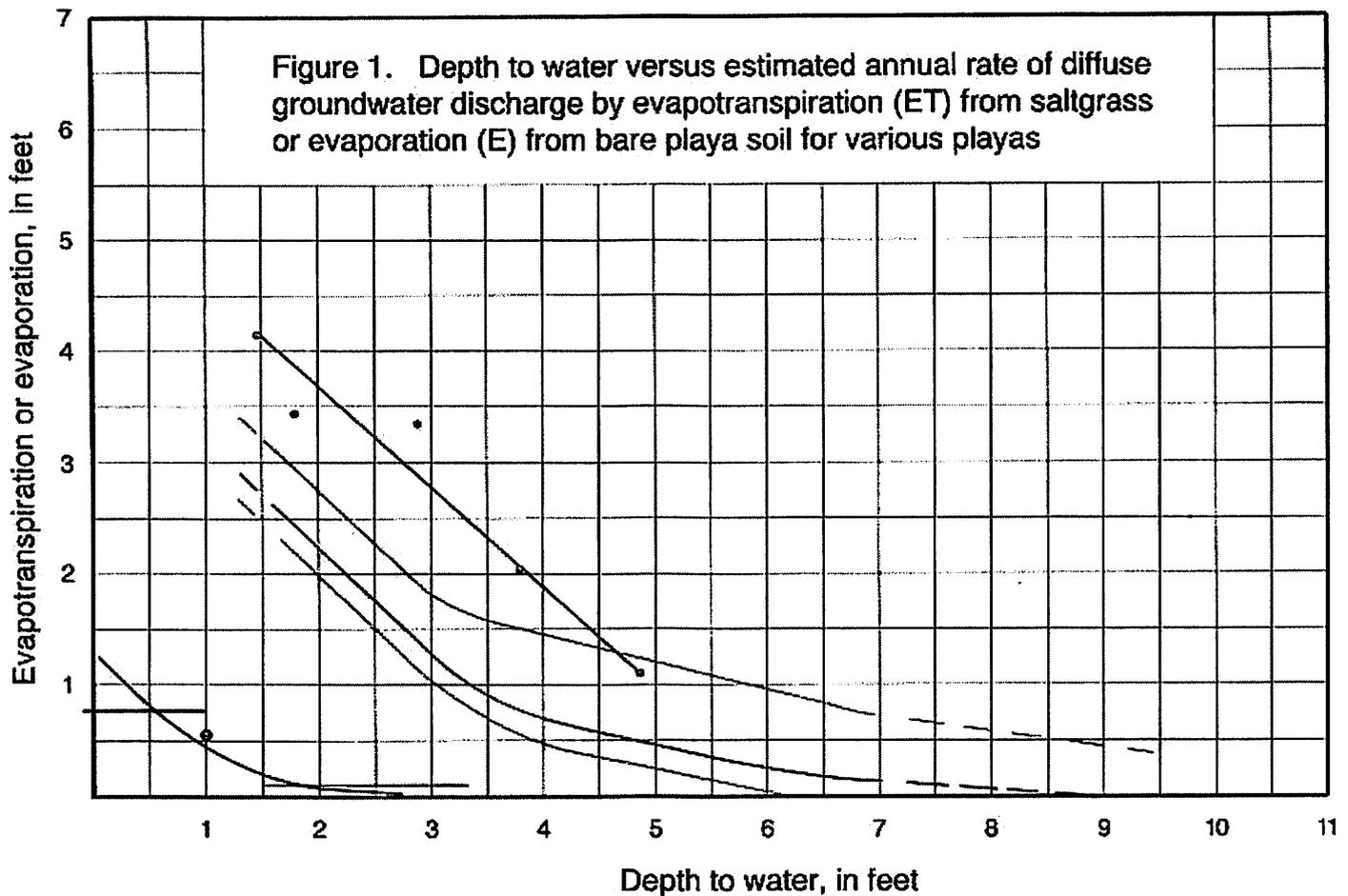
The presence of vegetation complicates the determination of diffuse discharge. Plants can take up water from close to the water table, overcoming the resistance to upward movement in the soil. However, Thornburn and others (in press) note that as plants usually have access to sources of water other than the water table, diffuse discharge of groundwater may be over estimated. They are currently using stable isotopes from plant tissues to partition transpired water sources.

### **PROPOSED DIRECT MEASUREMENT OF DIFFUSE DISCHARGE FROM THE CHINA LAKE PLAYA**

It is believed that some of the relatively direct methods discussed above (and below) for measuring diffuse discharge should be attempted on the China Lake playa in a reconnaissance level investigation. As previously mentioned, diffuse groundwater discharge from the playa is significant because it is assumed to be the only notable natural, pre-development discharge from the Valley and is therefore equal to natural recharge.

The Ullman (1985) method is based on the premise that evaporation of water from saturated saline soils or sediments induces gradients of the solutes in the remaining interstitial solution. These gradients lead to a systematic and predictable solute distribution in the soil solution which may be used to estimate the rate of evaporation. Long-term average annual evaporation estimates can be made based on the Cl<sup>-</sup> profile over long cores (two or more feet) whereas the evaporation over the most recent summer season can be estimated based on the concentration gradient over the top 2 to 3 inches. The Allison and Barnes (1985) method of estimating diffuse discharge is based on the same premise but uses depth profiles of deuterium composition expressed as delta-values.

Weighing lysimeters, the only direct method of determining diffuse discharge, would probably of little value for comparison to the estimates of Kunkel and Chase (1969) if the water table depth has declined from that mapped by Kunkel and Chase.



#### 100 Percent Saltgrass Cover

- Indian Wells Valley rate from Kunkel and Chase (1969).
- Annual evapotranspiration of water by saltgrass grown in tanks in Owens Valley (Young and Blaney [1942] as reported by Robinson [1958]).

#### 25 Percent Saltgrass Cover

- Indian Wells Valley rate from Kunkel and Chase (1969).

#### Bare Soil with Salt Crust

- Indian Wells Valley rate from Kunkel and Chase (1969).
- Estimated annual evaporation of subsurface water is 0.75 feet (229 mm) from salt crust on Pilot Valley playa (western Utah) using the Bowen ratio method to reduce data from a microclimate station. (Malek and others, 1990).
- Estimated mean whole-lake evaporation rate from Lake Frome (northeastern South Australia) is 0.56 feet/year (170 mm/yr) with a water table at about 1 foot (about 300 mm). Estimate based on depth profiles of deuterium delta-values to about 3 feet. (Allison and Barnes, 1985).
- Maximum annual evaporation rate (0.19 feet) from salt crust on Owens Lake. Derived by multiplying the maximum reported daily rate (.0063 inches/day), based on salt flux, by 365. Maximum daily rate (.003 inches/day) from the evaporimeter [non-weighting lysimeter] was about 1/2 the salt flux rate. Lake-bed clays at this site are overlain by 12 to 24 inches of hard and largely insoluble salts. (Cochran and others, 1988).
- Diffuse discharge measured from salt pans with shallow water tables. Data from: Allison and Barnes (1985), Jacobson and Jankowski (1989), Malek and others (1990), and Woods (1990). [Thorburn and others, in press].

Estimating vegetation transpiration will probably be more difficult than measuring evaporation from bare soil. The total leaf area measurement technique used by Groeneveld (1986) in Owens Valley, for determining areal transpiration from porometer<sup>4</sup> measurements, appears to be rather time consuming. A full-scale diffuse discharge measurement program might only include the bare soil methods, the results of which may be sufficient to either generally confirm the Kunkel and Chase estimates or suggest otherwise.

A reconnaissance investigation to measure diffuse discharge with relatively direct methods could be planned by the technical subcommittee with the participation of individuals experienced in the proposed methods. They would certainly have suggestions to enhance the soundness of the investigation and the validity of the resulting estimates. This type of investigation would probably be an excellent topic for a master's thesis.

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<sup>4</sup> A chamber temporarily clamped over a branchlet which measures transpiration and other parameters bearing on leaf transpiration.

*Appendix II*

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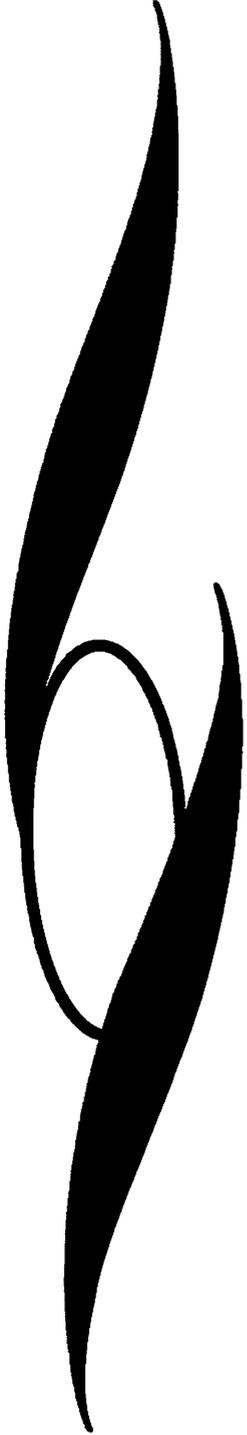
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# **APPENDIX III**

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**Pneumatic Slug Test Procedure and Data Analysis**



## APPENDIX III.

### PNEUMATIC SLUG TEST PROCEDURE AND DATA ANALYSIS

*Dennis E. Watt*

#### INTRODUCTION

A pneumatic slug test was conducted in each piezometer of the Project wells to collect the data needed to estimate the transmissivity of the screened aquifer. Some form of slug test is the only practical method by which to gather data needed to estimate transmissivity in small diameter, deep static water level wells (hundreds of feet) like the Project piezometers.

The pneumatic technique is a recent advancement in slug testing because it increases the aquifer hydraulic conductivity and depth to water range where slug tests can be applied. The test proceeds as follows: (1) a well head assembly is attached to the top of a piezometer and a pressure transducer, attached to an electronic data logger, is lowered down the piezometer and set below the static water level, (2) the water level is forced down by filling the piezometer with air [author used SCUBA tanks], (3) after equilibrium is re-established, the data logger is started and the air pressure is immediately released, (4) the data logger is stopped after water level recovery and the recovery data is inspected to determine if the test was "good." Calculation of estimated hydraulic conductivity is made in the office.

#### OTHER SLUG TEST METHODS

Hydraulic conductivity has long been successfully determined in single wells by introducing or removing water or solid slugs (Hvorslev; Ferris and Knowles, 1954; Cooper and others, 1967; Papadopulos and others, 1973; Bouwer and Rice, 1976). These methods, coupled with water level measurement devices such as electrical water level indicators or percussion sounding instruments [popper tape], can accurately determine hydraulic conductivities in the range of  $8 \times 10^4$  cm/sec to  $1 \times 10^3$  cm/sec (McLane and others, 1991).

McLane and others (1991) continue,

"The advent of data logging devices used in conjunction with pressure transducers allows successful slug testing in aquifers with hydraulic conductivities in the range of  $1 \times 10^2$  cm/sec. However, these methods typically cannot be applied in aquifers with hydraulic conductivities greater than  $1 \times 10^2$ . In these instances, water levels rapidly reach equilibrium before the entire slug is added or removed. This initial change in water level is neither instantaneous nor of great enough magnitude to adequately monitor the recovery period. The use of solid

slugs also makes it difficult to measure water levels, since the slug can jar and offset the pressure transducer suspended inside the well. This problem particularly occurs in small diameter wells. At sites where wells are to be sampled for environmental parameters, traditional slug test methods have the additional limitation because the addition of potentially contaminated solid slugs or clean water can bias subsequent sampling results.

The pneumatic method for conducting slug tests overcomes all of these limitations. This method involves either injecting air into a sealed well to lower the water level (Leap, 1984) or applying a partial vacuum to a sealed well to raise the water level (Orient and others, 1987)."

### **PNEUMATIC SLUG TEST DEVELOPMENT**

Krauss (1977) suggests, as an aside, that compressed air can be used in slug testing to lower the water level below the initial stage and that a pressure transducer can be used to record water levels after the pressure is suddenly released. However, based on the literature, Leap (1984) appears to have been the first to use an "automatic" water level recording device in conjunction with pneumatic slug tests. His pneumatic water level "depressor" consists of three major pieces of equipment: 1) a pneumatic system including a hand carried air tank for providing compressed air to the well; 2) a well head manifold which screws onto the casing top; and 3) an electrical system for recording water level recovery rate, see figure 1. Air pressure is released, initiating water level recovery, by knocking loose the knock-off plate with a hammer blow. A stop watch is started at the same instant to time the recovery of the water level. After the rising water level contacts each electrode hung at known depths in the well, and its time of arrival is noted by the stopwatch, the channel selector is switched to the next electrode above the rising water level. The process is repeated until the water level fully recovers and contacts the uppermost electrode at the full recovery position.

Orient and others (1987) appear to be the first to have used a down hole pressure transducer connected to an automatic data logger with a pneumatic slug testing device. Their device is shown in figure 2. McLane and others (1991) used a quick release pressure valve in place of a knock-off plate, see figure 3, and ran both rising and falling head slug tests. They used this method at sites with distinctly different geology and well construction which ranged from 2-inch wells where the depth to water was only 10 feet to 4-inch wells where depth to water was 125 feet.

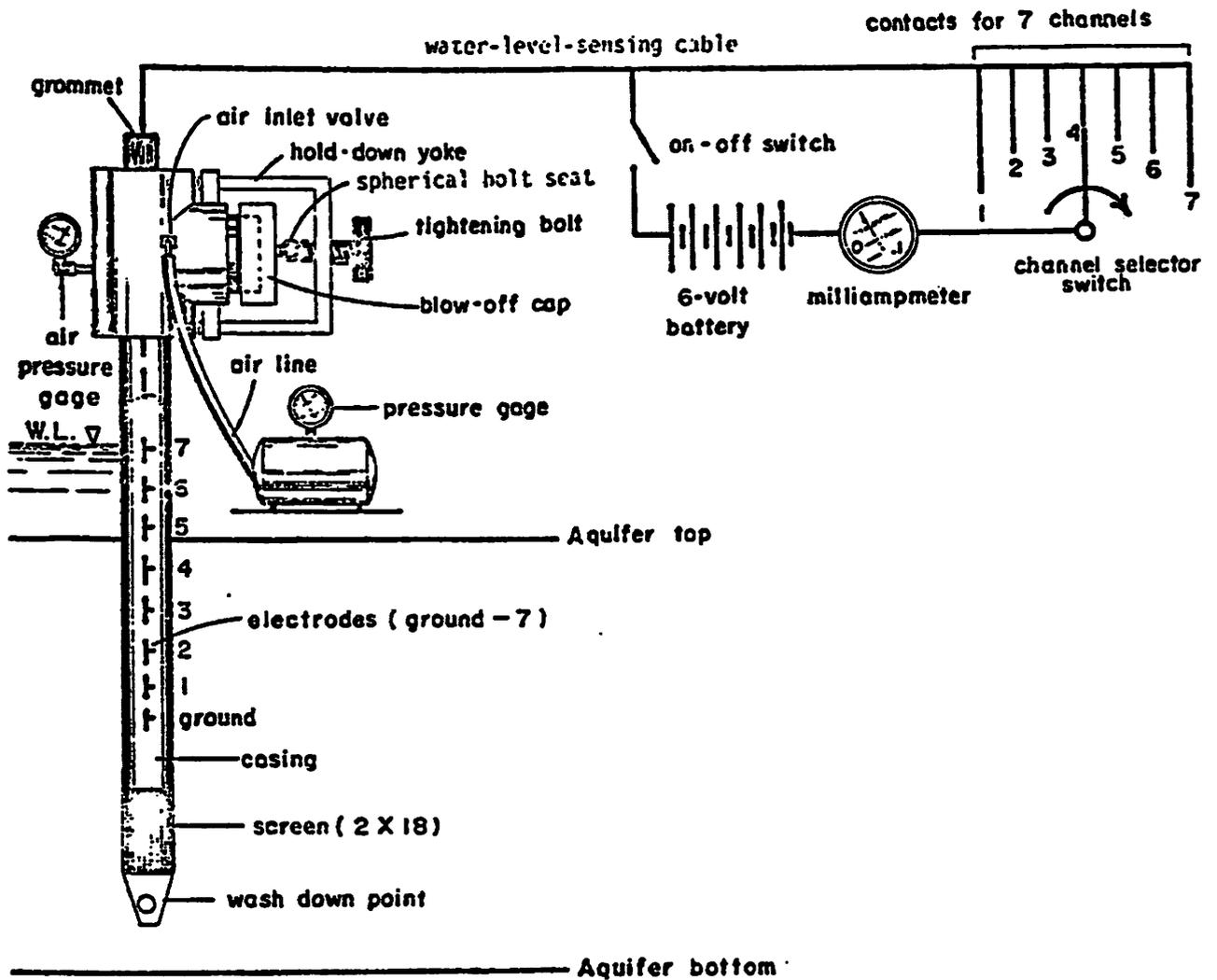
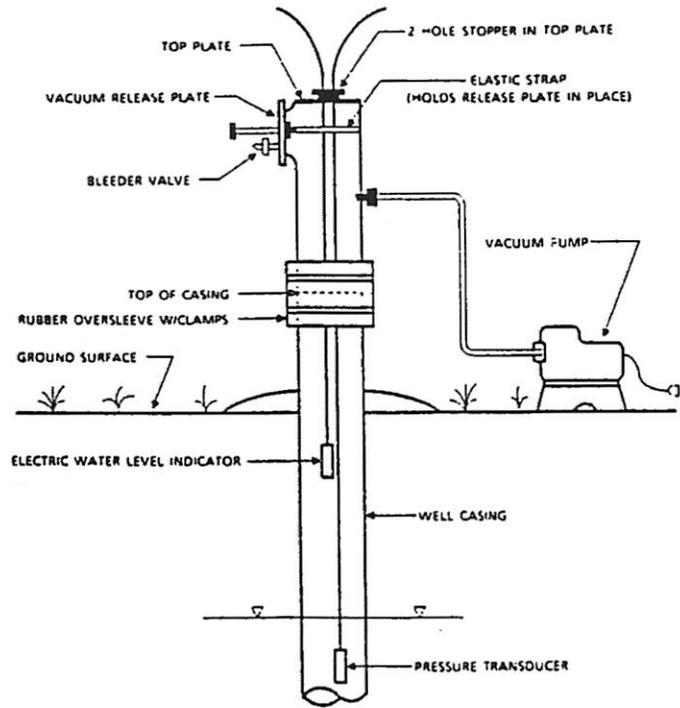
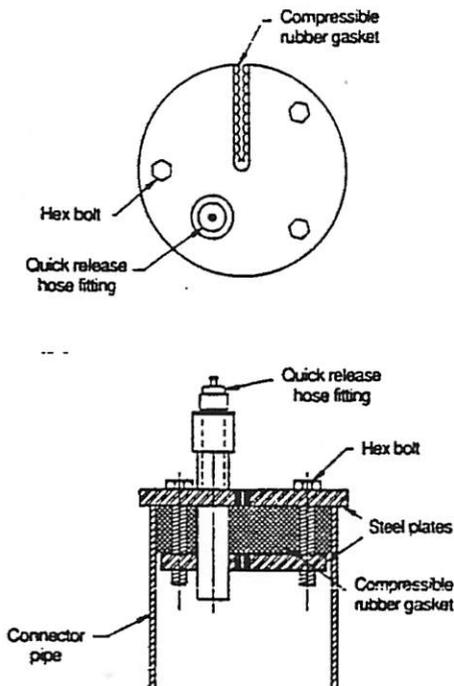


Figure 1. Slug testing apparatus developed by Leap (1984).

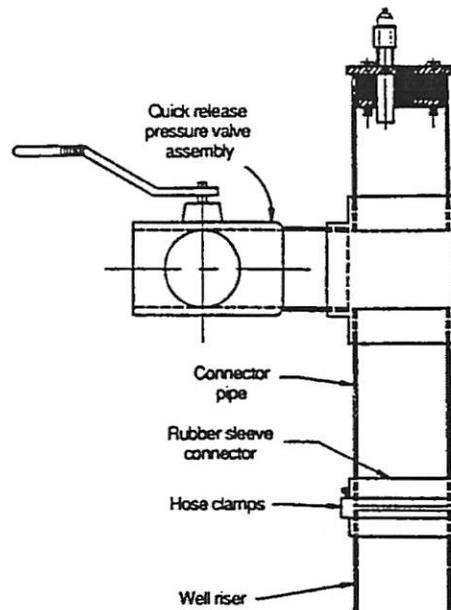


**Figure 2.** Pneumatic slug testing system designed by Orient and others (1987).

**Pneumatic well cap assembly**



**Pneumatic well head assembly**



**Figure 3.** Pneumatic well head assembly and cap constructed by McLane and others (1991).

## EQUIPMENT

The equipment used to conduct pneumatic slug tests in the Project piezometers includes a well head assembly, a pressure transducer coupled with a high speed electronic data logger, and a source of air. The principal component of this system is the well head assembly. The assembly consists of a rubber sleeve connector, a quick release pressure valve, and the fitting cap (see figure 4).

The well head assembly was designed by the author for relatively high positive pressure (tested to 15 psi) and easy field replacement of the parts subject to wear. Only the connector pipe, the threaded coupling for the ball-valve, and the fitting cap reducer are permanently glued to the central T-connector. The fitting cap is attached to the fitting cap reducer by a 4-inch rubber sleeve with four hose clamps. This type of mounting allows field removal of the fitting cap and easy replacement of the fittings in the cap. The threaded ball-valve coupling allows easy replacement of the quick release ball-valve should it begin to leak air.

A pressure gauge, truck tire air valve, and a cable tension relief fitting are mounted in the fitting cap. The most important fitting is the cable tension relief fitting<sup>5</sup>, see figure 5, which allows passage of a  $\frac{3}{4}$  inch pressure transducer and provides an air tight seal around the  $\frac{1}{4}$  inch transducer cable after the transducer is set in the well.

McLane (1991) notes that

"the internal diameters of the well head assembly should not be less than the well riser diameter to ensure that pressure equalization is not inhibited after the valve is opened. This relative sizing is required if air pressure inside the piezometer is to return to atmospheric pressure instantly. Smaller internal diameters prohibit the [near] instantaneous return to atmospheric pressure. This retards the water level recovery rate during the time period the internal air pressure is above atmospheric."

Graphs in McLane (1991) show the initial recovery rate lag caused by an apparatus that restricts air flow into or out of the well. However, a small diameter well with a static water level several hundred feet below the surface, such as in the Project piezometers, will probably not return instantly to atmospheric pressure on opening the quick release valve, even with the same diameter or larger diameter well head assembly. Total pressure release in the deep water level piezometers seemed to take about one second.

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<sup>5</sup> This fitting is commonly called a "CGB" fitting by personnel at electrical or lighting supply houses. The description on the invoice is "3/4 CGB .125-.250 CORD."

## **PNEUMATIC SLUG TEST PROCEDURE**

The well head assembly bottom is sealed to the well by pushing the 2 inch rubber sleeve over the top of the piezometer and tightening the hose clamps. The transducer is passed through the cable tension relief fitting (fitting) and lowered until it is about 30 feet (dependent on transducer pressure range) below the static water level. An adjustable length boom mounted on a pickup truck overhead rack and a large diameter opening block (snatch-block) hung on the end of the boom allows the transducer to be easily lowered down the piezometer. See figure 6 for a typical field set-up. The transducer cable is tied to the boom to hold the transducer at the proper depth. To fill the annular space between the transducer cable and fitting body, the vertical slit [cut with a single edge razor blade] in the rubber stopper is opened and the ¼ inch transducer cable is pushed through the slit into the ¼ inch stopper hole. The stopper is then slid down into the tension relief fitting, the two halves of the plastic washer [cut with tin snips] are set on top of the stopper, and the threaded fitting cap is lightly cinched with pliers on the tension relief fitting body. After the well is sealed, the data logger reading is set to the previously measured depth to static water level.

The water level is lowered in the well by adding air through the tire fitting. Air sources for wells needing only small air volumes to lower the water level (small diameter well with a shallow static water level) include small 12 volt air compressors and small compressed air storage tanks, both usually available at auto supply stores. Air sources for wells requiring a large volume of air include oil-less air compressors and, the author's choice, SCUBA tanks.

The water level in the Project piezometers was lowered 20 to 30 feet depending on the pressure range of the transducer. After the well is pressured, the apparent height of the water column above the transducer can be monitored with the data logger. The apparent height will rapidly return to static in wells screened opposite highly transmissive aquifers. The return to static will be slow in wells screened in poorly transmissive aquifers.

When the apparent water level has stabilized at the depressed static level for a few minutes, recording by the pre-programmed data logger is started and the quick release valve is immediately opened to release the pressure in the piezometer. The rate of water level recovery is automatically recorded by the data logger. Data recording is stopped after the water level has returned to static. The test data is printed for easy inspection and possession of a permanent record. The test is repeated in cases where the water level was lowered beyond the range of the transducer. Transducer "lock-up" is evidenced by numerous equal water level readings during the early portion of the recovery. Calculation of the estimated transmissivity is made in the office.

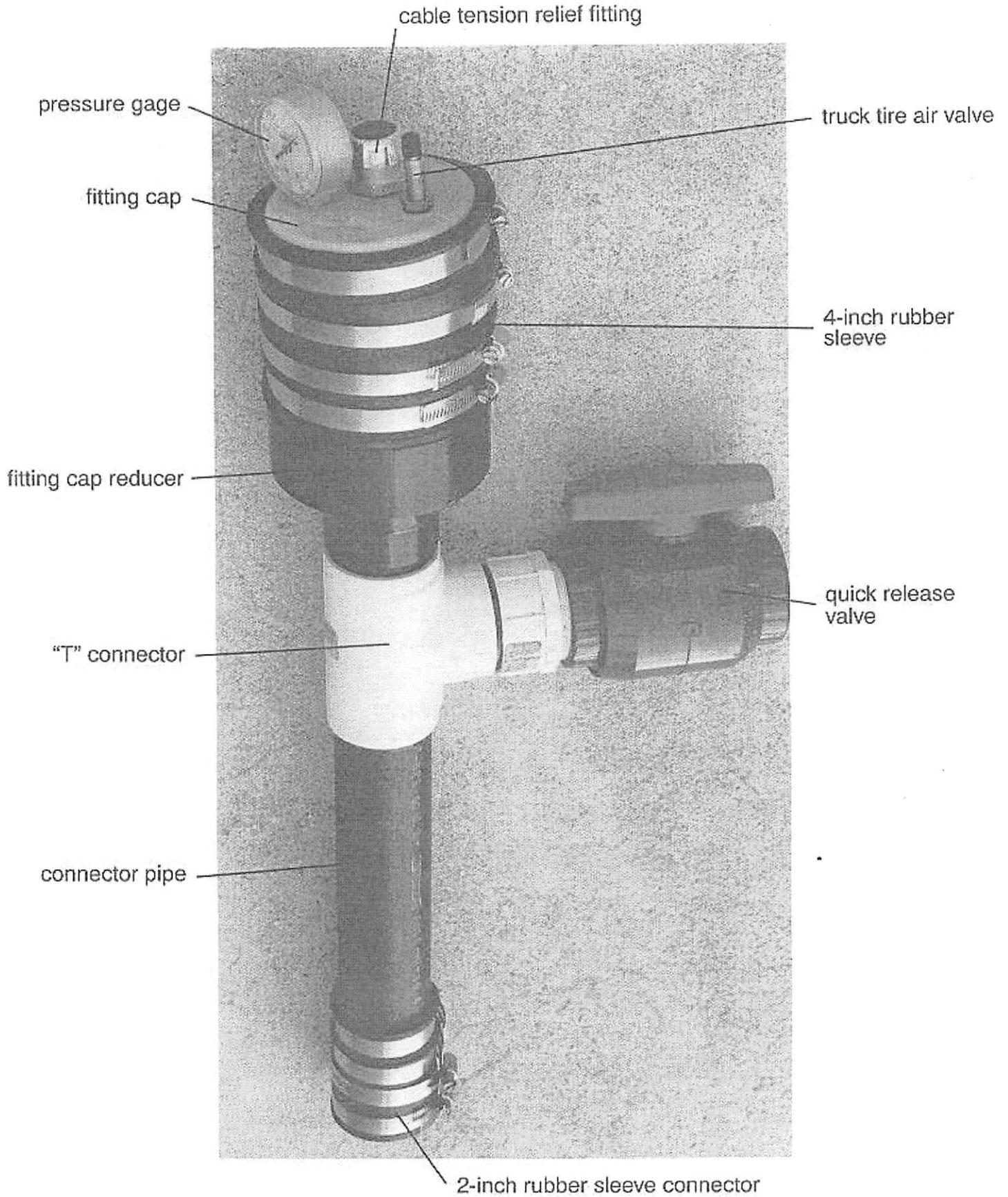
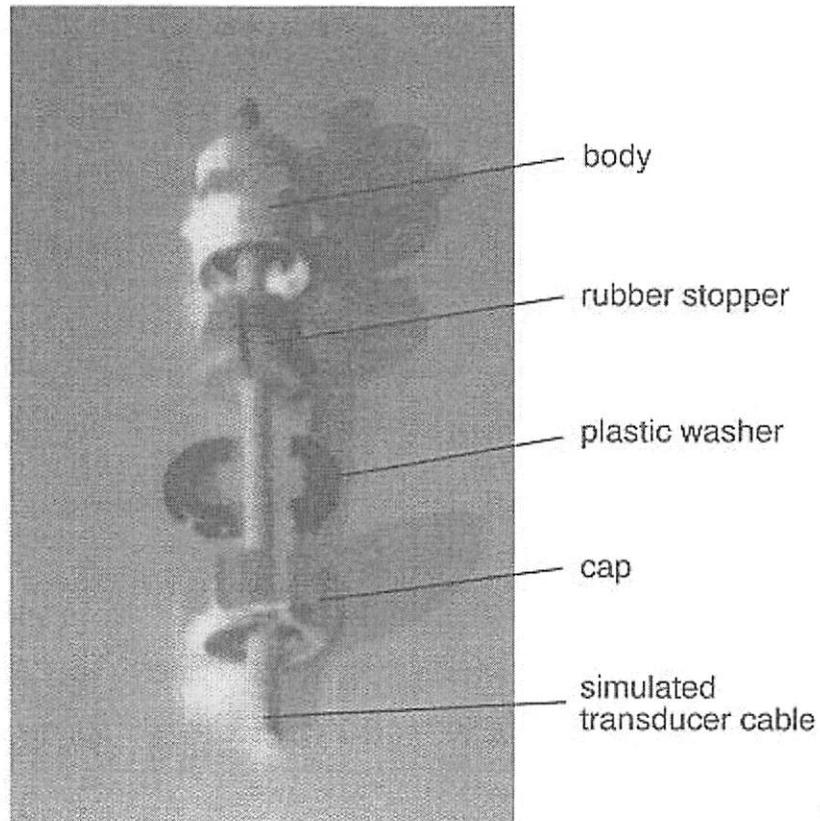


Figure 4. Pneumatic slug test well head assembly developed by the author.

### Cable Tension Relief Fitting (CGB)



**Figure 5.** Exploded view of the 3/4-inch cable tension relief fitting (CGB fitting) parts. The 1/4 inch diameter transducer cable is simulated by the 1/4 inch diameter eraser. This long eraser (used in electric erasers) was also used in cable tension relief fitting pressure tests and pressure tests of the complete well head assembly.



**Figure 6.** Pneumatic slug testing on well BR-6 (2-11-92). Pressuring the well (upper). Logging water level recovery (lower). The blue box is the data logger and the field printer is in the black, foam padded suitcase.

## SLUG TEST RECOVERY DATA ANALYSIS

The Cooper slug test solution was used to estimate transmissivity of the aquifer screened in each Project piezometer (see table 1). Cooper and others (1967) developed a solution to calculate transmissivity of confined aquifers from the rate of rise of the water level in a fully penetrating well after a sudden removal of a slug of water. Cooper and others (1967) note, however, that few wells completely penetrate an aquifer, but that it is nevertheless possible under some circumstances to derive useful information from a test on a partially penetrating well. They further conclude that

"Since the vertical permeabilities of most stratified aquifers are only small fractions of the horizontal permeabilities, the induced flow within the small radius of the cone that develops during the short period of observation is likely to be essentially 2-dimensional. Therefore, the determined value of transmissivity would represent approximately the transmissibility of that part of the aquifer in which the well is screened or open, provided that the aquifer is reasonably homogenous and isotropic in planes parallel to the bedding and provided that the effective radius can be estimated closely."

Cooper and others (1967) also suggest that the judgement of an experienced hydrologist is needed to decide the significance, if any, of a determination of transmissivity from a slug test. Furthermore, Ferris and others (1962) caution, "the duration of a "slug" test is very short, hence the estimated transmissibility determined from the test will be representative only of the water-bearing material close to the well [screen]."

The aquifers screened by the Project piezometer are assumed to sufficiently meet the conditions on which the Cooper (1967) method is based, that the resulting transmissivities are at least useful for relative comparison. Kunkel and Chase (1969) assumed that these conditions were met by the wells in which they ran pumping tests for determining transmissibility of the Valley alluvium. In support of their contention that "the transmissibility obtained probably apply almost wholly to the saturated deposits tapped by the wells," they cite

"...the very large differences between vertical and horizontal permeability of the deposits, as evidenced by the high barometric efficiency of the wells, by the lenticular character of the deposits, by the differences in head or water level between shallow and deep wells such as 26/40-22P1 and 22N1, and by the differences in the pumping-test results themselves."

Table 1. Estimated transmissivity from the slug recovery data as determined by the Cooper (1967) method for the 20 feet of aquifer opposite each piezometer screen.

Well	Piezometer	Transmissivity (ft <sup>2</sup> /min)	Comments
BR-1	tall (shal)	.21	
	next tall (sh/med)	.24	
	next short (dp/med)	.01	
	short (deep)	.004	
BR-2	tall (blue) (shal)	.01	Confirmed by second slug.
	(yellow) (med)	.19	
	(red) (deep)	.016	
BR-3	tall (shal)	.00005	Too low.
	medium (med)	.06	
	short (deep)	.006	
BR-4		.28	
BR-5	tall (shal)	.23	
	medium (med)	.15	
	short (deep)	.18	
BR-6	tall (shal)	.02	Suspiciously low.
	medium (med)	.25	
	short (deep)	.20	
BR-10	tall (shal)	.19	Too low
	next tall (sh/med)	.02	
	next short (dp/med)	.14	
	short (deep)	.09	
NR-1	(red) (shal)	.004	Confirmed by re-slug. Too low. Can't remove reducers (no room)
	(yellow) (med)	?	
	(white) (deep)	.05	
NR-2	tall (shal)	.48	
	medium (med)	.14	
	short (deep)	.12	
MW-32	tall (shal)	.009	Too low.
	next tall (sh/med)	.31	
	next short (dp/med)	.23	
	short (deep)	.11	

Note the number of shallow piezometers with low transmissivity (slow to very slow recovery rates). This is discussed in Attachment IV.

The estimated transmissivities presented herein (table 1) are meant to at least convey the relative difference in transmissivity between the aquifer screened by the Project piezometers. The actual degree to which the Project piezometers meet the governing assumptions for the Cooper method is not known exactly nor is the degree of development known. It is suspected that well development may be less than complete because of the relatively long screen and relatively small water quantity pumped (reported as 5-15 gal/min) during airlift development. The estimated aquifer transmissivities are less than the actual transmissivity if the screens are not fully developed.

## **SOLUTION SOFTWARE**

The Cooper slug test solution "package" in AQTESOLV (software from Geraghty and Miller, a Groundwater Consulting Company) was used to determine the transmissivities shown in table 1. The initial recovery to static water level portion of the slug induced water level response curve was used for the Cooper solution in the case of an undampened recovery (discussed below). The AQTESOLV Cooper slug solution was checked by the original curve-fitting procedure, described in the paper by Cooper and others (1967), for BR-4. The curve-fitting transmissivity was  $.275 \text{ ft}^2/\text{min}$  and the software solution was  $.28 \text{ ft}^2/\text{min}$ .

## **UNDAMPENED SLUG RECOVERIES**

Several of the slug test water level recoveries showed the effect of water column inertia; the water level recovery was "undampened." However, Cooper and others (1967), in the derivation of their slug test solution for transmissivity, did not account for water column inertia.

Bredehoeft and others (1966) discovered that the response of a well [water level] to a seismic disturbance [Cooper and others, 1965] was like the mechanical spring-mass system with viscous damping; i.e., as a simple harmonic oscillator. They demonstrated, by a series of field tests in wells in Florida and Georgia during July 1964, that the column of water in some wells can oscillate very much like the classic spring-mass system. It was apparent from these investigations that many wells will behave as underdamped oscillators—the water level will oscillate following a rapid disturbance. Van der Kamp (1976) found this especially true for deep wells and/or wells screening highly permeable aquifers. This fact places certain restrictions on the use of a number of accepted methods of aquifer analysis; perhaps the most obvious example of the importance of inertial effects concerns the slug test (Bredehoeft and others, 1966).

Van der Kamp (1976) classified slug test water level recoveries as follows:

- (1) Overdamped system [well-aquifer]--the water level returns to the equilibrium level in an approximately exponential manner.
- (2) Underdamped system - the water level oscillates about the equilibrium level (NR-2 shallow).
- (3) Critical damping - The transition between overdamped and underdamped (BR-4).

Several papers offer solutions for the underdamped case (van der Kamp, 1976; Krauss, 1977). Krauss (1977) notes that the parameters of the free oscillation, damping coefficient, and natural frequency are determined by the parameters of the aquifer, particularly the transmissibility, and well geometry. To determine transmissivity, Krauss (1977) offers a relation between the natural frequency and the height of the water column and he presents a graph relating the damping coefficient to a solution coefficient for a range of aquifer storage coefficients.

The Krauss (1977) solution is fairly simple and was applied to BR-4 and NR-2 shallow. The estimated transmissivity for BR-4 ranged from 0.15 ft<sup>2</sup>/min for a .001 storage coefficient to 0.50 ft<sup>2</sup>/min for a storage coefficient of  $1 \times 10^{-8}$ . The mean transmissivity over the range of storage coefficients is a little higher than the transmissivity of 0.28 ft<sup>2</sup>/min determined by the Cooper method over the initial recovery limb of the water level recovery oscillation. The Krauss transmissivity for NR-2 shallow ranged from 1.05 ft<sup>2</sup>/min for a .001 storage coefficient to 2.62 ft<sup>2</sup>/min for a storage coefficient of  $1 \times 10^{-8}$ . The mean of this range is considerably higher than the transmissivity of 0.48 ft<sup>2</sup>/min determined by the Cooper method using the initial recovery limb of the slug induced water level oscillation.

A rigorous analysis of the undamped slug test water level responses is beyond the needs of this Project. All of the data logger slug test print-outs are provided in Appendix XI for those readers interested in further investigation of underdamped or critical damped responses.

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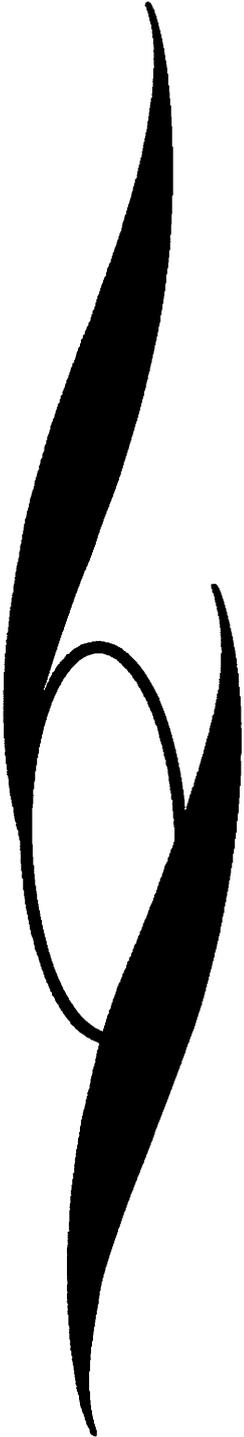
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# **APPENDIX IV**

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**Anomalously Low Shallow Aquifer Transmissivities**



## APPENDIX IV.

### ANOMALOUSLY LOW SHALLOW AQUIFER TRANSMISSIVITIES (Probably a Function of Poor Development)

*Dennis E. Watt*

#### INTRODUCTION

The water level recovery rate during the slug test was relatively slow in a number of the shallow Project piezometers as compared to the recovery rate in many of the deeper piezometers. The estimated transmissivity, therefore, was also relatively low in comparison. The relatively low shallow piezometer transmissivities (BR-2, MW-32, NR-1, BR-6, and the medium-shallow piezometer of BR-10) are not believed to be representative of the aquifer, but are probably a function of insufficient development. Insufficient air-line submergence during air-lift development and/or partial aquifer air lock may be the cause. It is assumed that the air-line was down to as near the top of the screen as possible, so as to maximize submergence yet minimize aquifer air locking potential, when the shallow wells were developed. Drill hole cuttings, drilling rate, and geophysical logs generally indicate a decreasing hydraulic conductivity trend with increasing depth, as is normal for alluvial basin fill aquifers.

#### PIEZOMETER DESIGN

Allowance for a minimum of 50 percent submergence of the air-line during air-lift development was the "rule-of-thumb" for the placement of the shallow piezometer screen relative to the apparent water level on the electric logs. All the completed shallow piezometers, except MW-32, will allow 50 percent or greater airline submergence based on the measured water level and the completed depth to the top of the piezometer screen.

Two curves are shown on figure 1. The upper curve is the approximate submergence percentage for optimum air-lift efficiency from Ingersoll-Rand (1971). The lower curve is the lower submergence percentage of the range called the "customary allowable submergence" from table 45T (originally from Compressed Air Magazine) in the appendix of Campbell and Lehr (1973). This table was the source of the 50 percent submergence design "rule-of-thumb" for air-lifting. However, based on the plot of the maximum possible submergence (figure 1) in the completed shallow piezometers and the apparently successful development of the shallow piezometers at BR-1, BR-5, and BR-10, it appears that optimum air-lift submergence may be the minimum needed for development of these mud drilled holes.

Maximum Possible Submergence (Air-Lifting)  
in the Shallow Piezometer

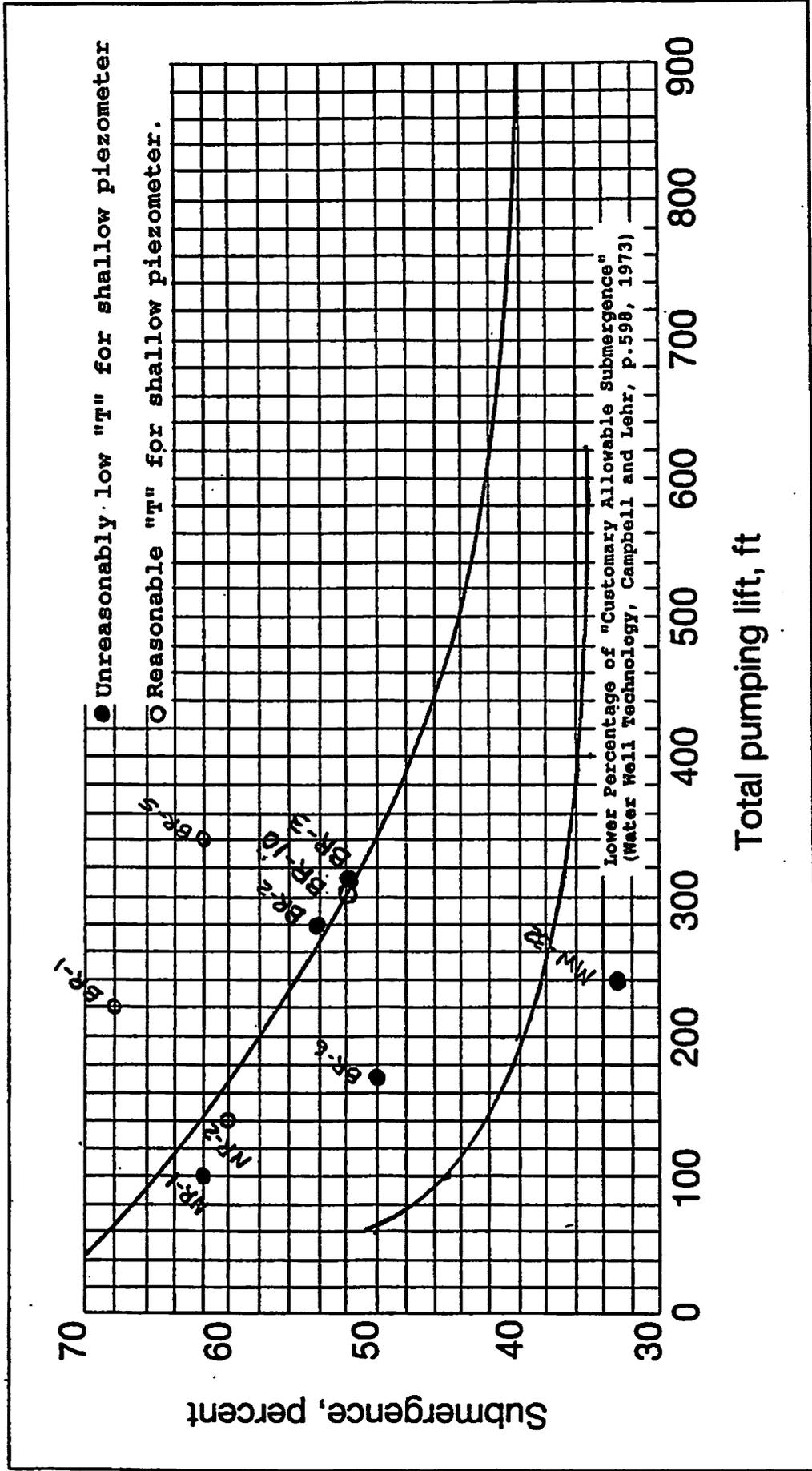


Figure 1. Approximate percent pumping submergence for optimum air-lift efficiency. In general, development proceeds most efficiently when the discharge is maximized. Therefore, the submergence should always be as great as possible within practical limits. (Ingersoll-Rand, 1971)

This conclusion assumes that the air line was down to near the top of the screen when the shallow piezometers were air-lift developed. If that was the case, then the "extra" submergence is probably needed in an undeveloped well when the initial air-lift pumping water level is potentially lower than the air-lift pumping water level for the same well after it is developed.

Inspection of the electric logs did not reveal any apparent water table responses above the measured water table. This could cause insufficient submergence if a shallow piezometer screen depth was selected based on an apparent water table which was above the actual water table. Most of the logs, however, showed the water table close to the actual, although the character on the BR-2 electrics is relatively indistinct.

### **AIR LOCKED AQUIFER**

The aquifer may become air locked if the airline is just above or in the screen. Driscoll (1986) notes that the aquifer may become air locked when a large burst of air is injected into the screened area of a well. He notes that certain kinds of formations are more prone to air locking, especially those formations that consist of stratified, coarse sand or gravel lenses separated by thin, impermeable clay layers. Aquifers with good vertical hydraulic conductivity are generally not affected. If some air becomes trapped in the aquifer, it may impede the flow of water toward the screen (Driscoll, 1968).

The degree to which air locking is a factor in the anomalously low shallow aquifer transmissivities is not known. However, if all other factors are equal, the apparent successful development of BR-10 shallow as compared to the apparent poor development of the shallow piezometers at BR-2 and BR-3, all on or very near the optimum submergence curve (see figure 1), may be an indication of some aquifer air locking in BR-2 and BR-3 shallow.

### **CONCLUSION**

It is suspected that poor development caused by inadequate submergence during air-lift development is the predominant cause of the anomalously low shallow piezometer transmissivities. Aquifer air locking may also have occurred during development and may play a part.

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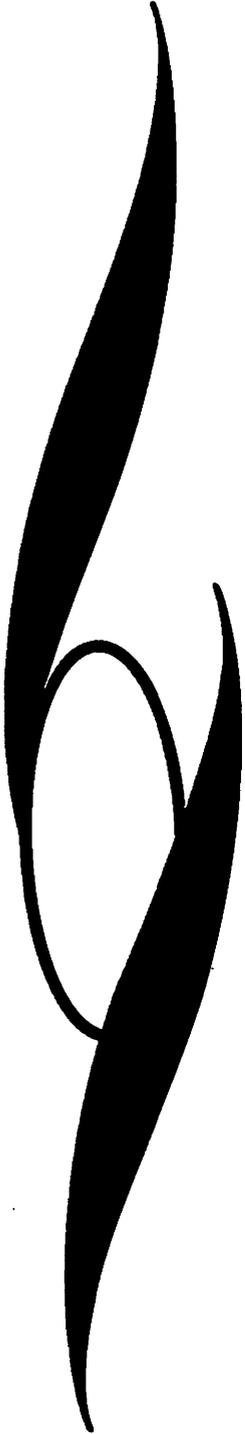
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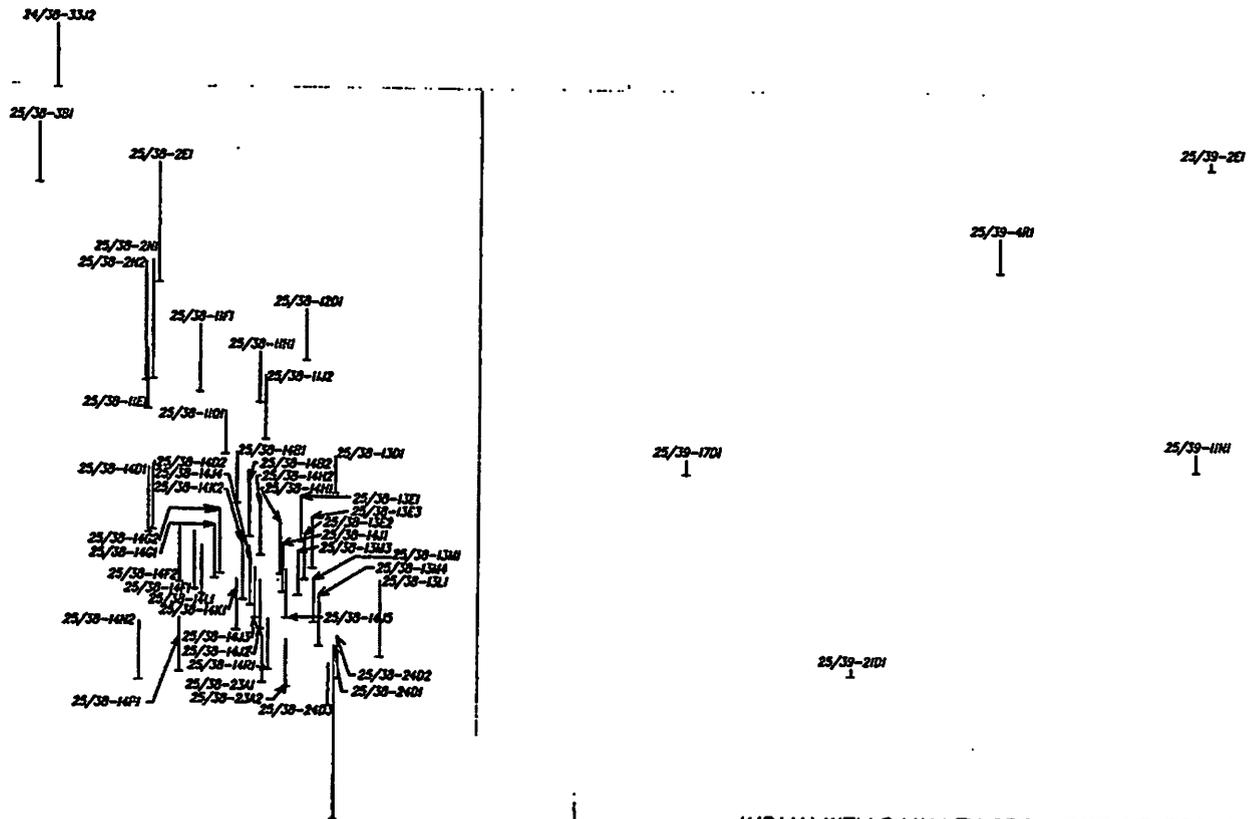
# **APPENDIX V**

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**Pre-Project Well Data Maps**







All wells in the East Kern County Resource Conservation District (EKCRCD) Database with a Total Depth

Each well is represented by a "stick".

This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the EKCRCD database.

INDIAN WELLS VALLEY GROUNDWATER PROJECT  
Pearsonville, CA



Figure 1a

Depiction of well depths from the EKCRCD database in the portion of the Indian Wells Valley shown on the preceding figure.

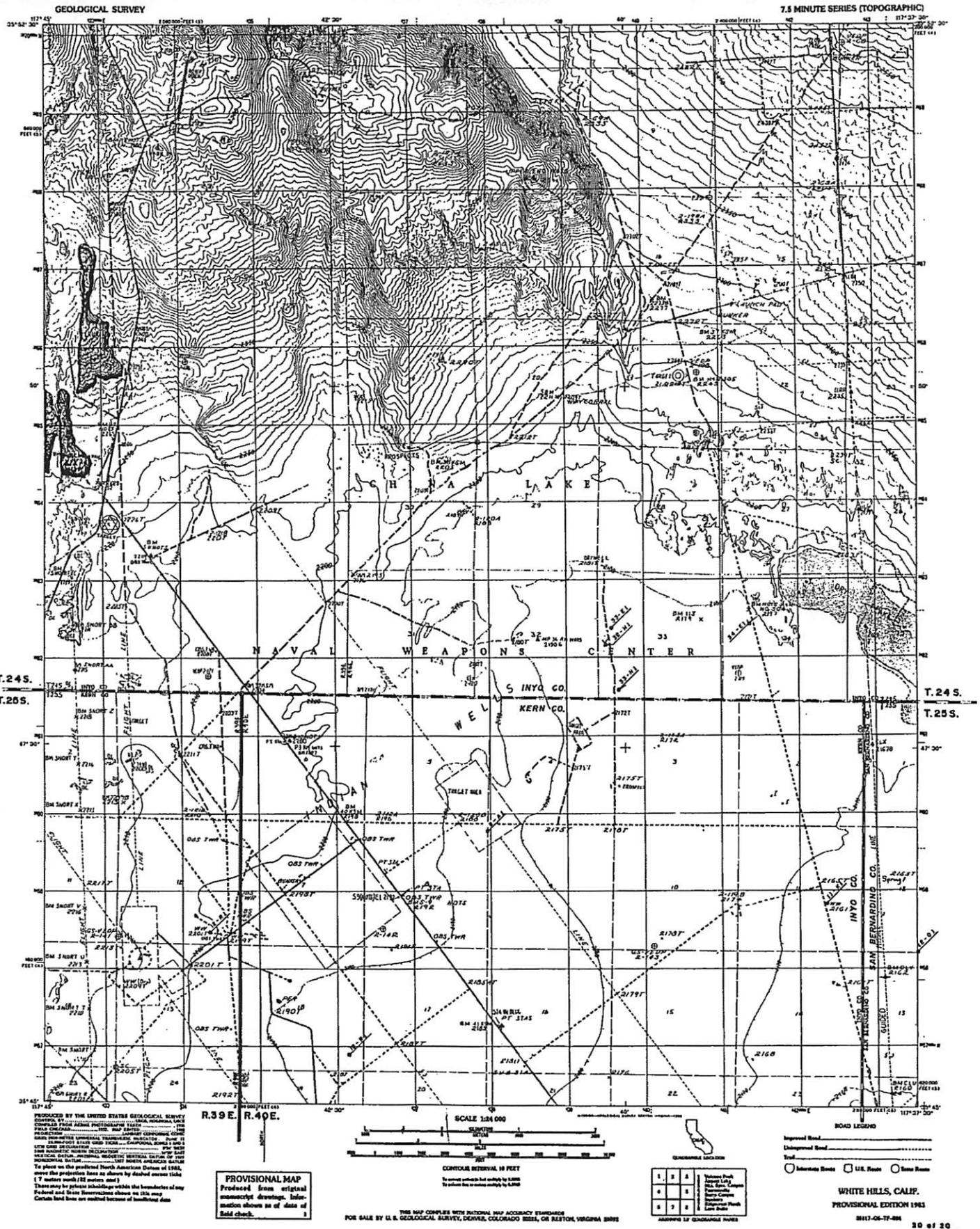
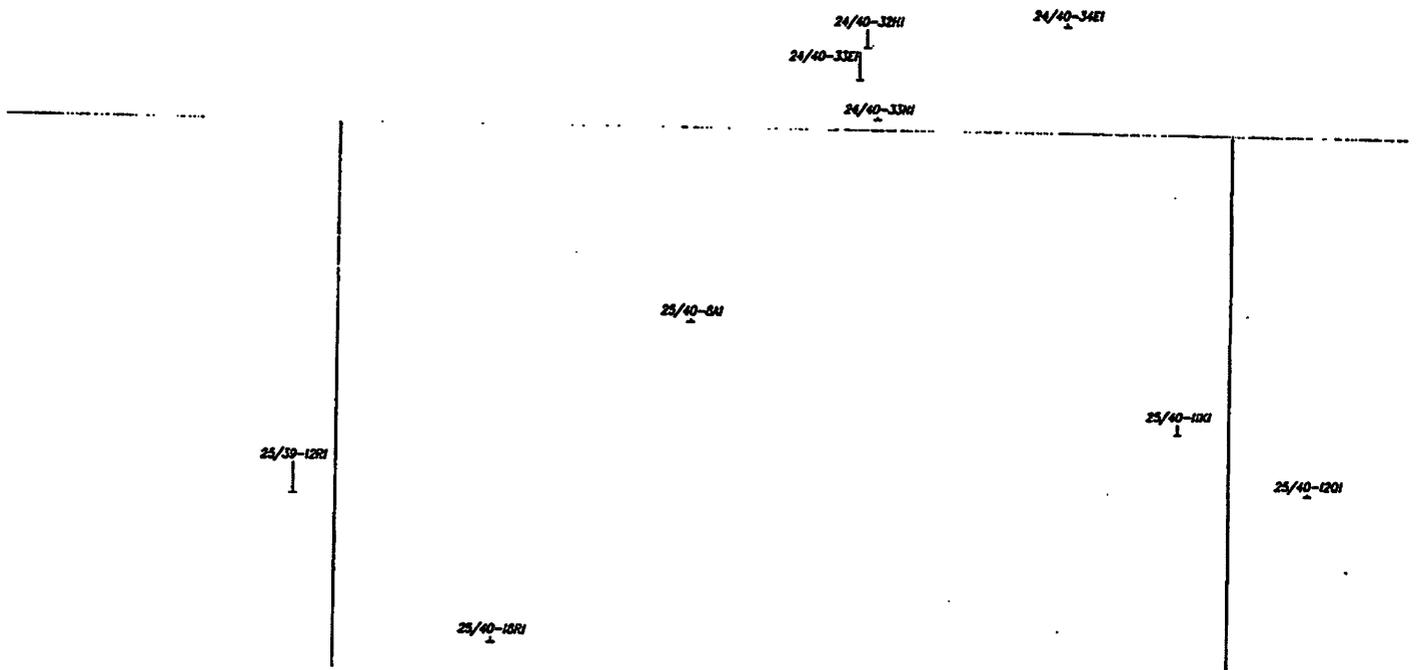


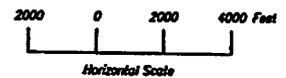
Figure 2

Map of a portion of Indian Wells Valley showing the location of the wells in the East Kern County Resource Conservation District well database. The well designation number preceding the hyphen is the section, the letter following the hyphen is the 40-acre subdivision, and the last number indicates the sequence in which the wells were inventoried.



**Indian Wells Valley Groundwater Project**

**White Hills, Calif.**



*All wells in the East Kern County Resource Conservation District (EKCRCD) Database with a Total Depth*

*Each well is represented by a "stick".*

*This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the EKCRCD database.*

**Figure 2a**

**Depiction of well depths from the EKCRCD database in the portion of the Indian Wells Valley shown on the preceding figure.**

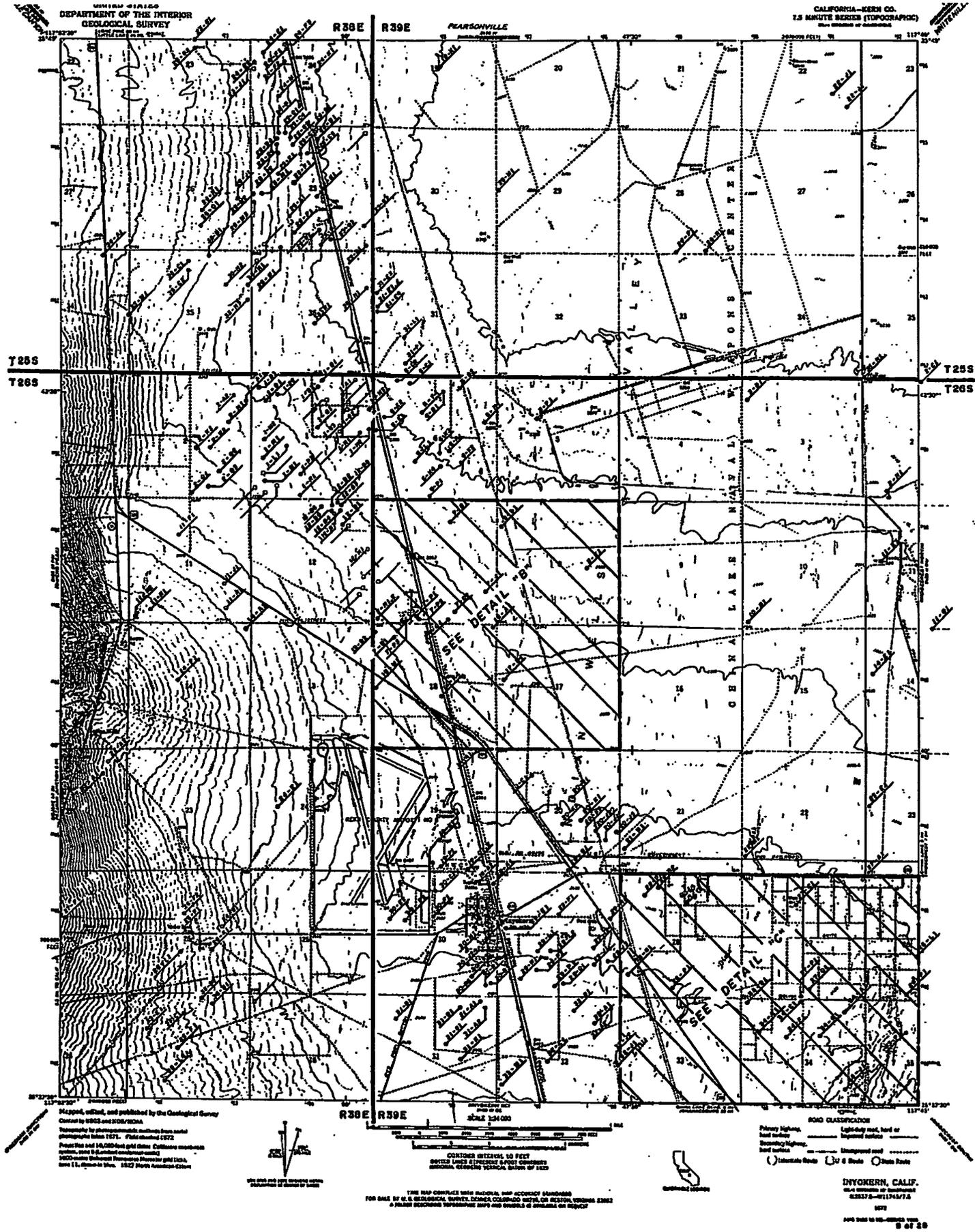
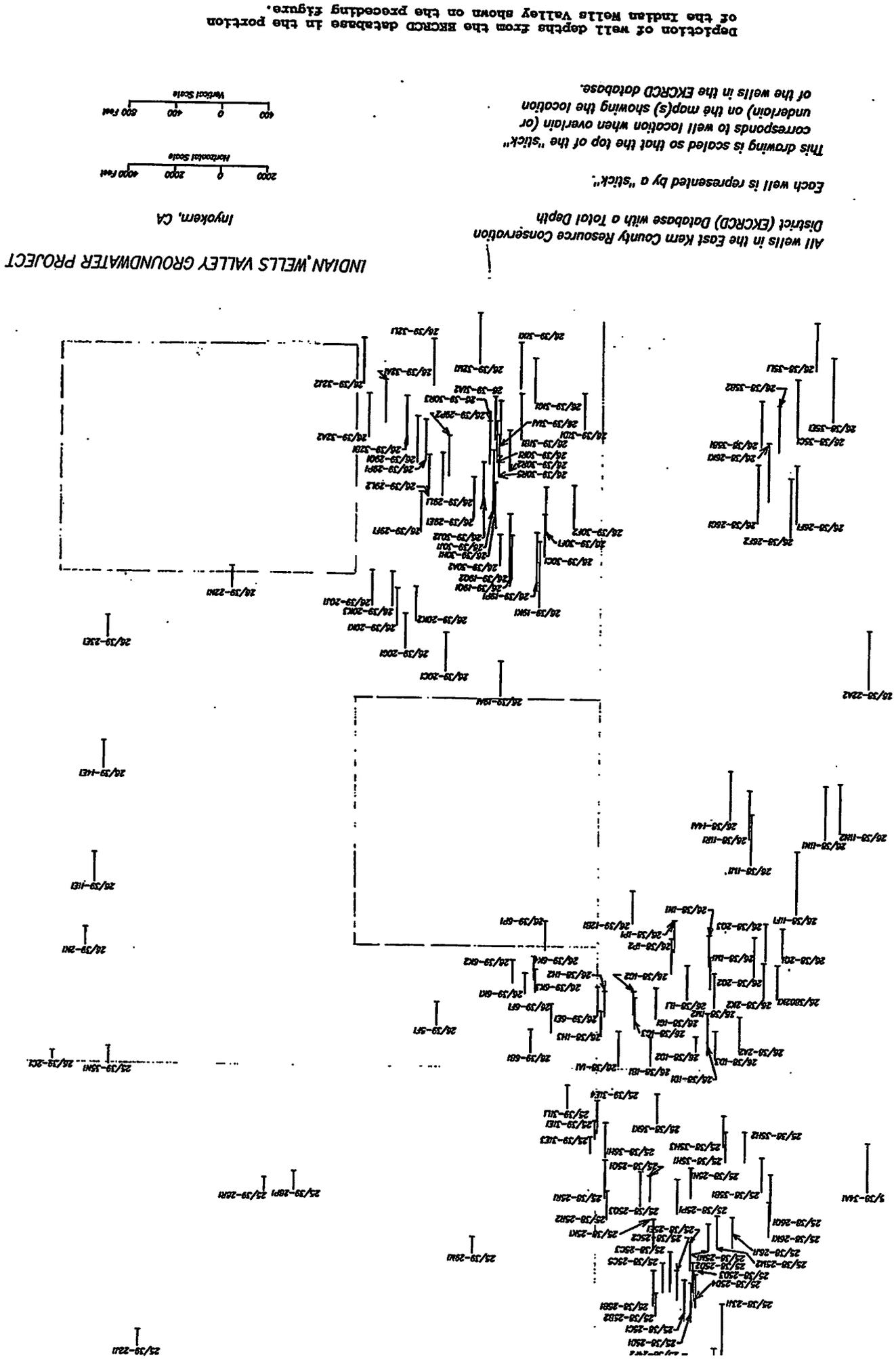


Figure 3

Map of a portion of Indian Wells Valley showing the location of the wells in the East Kern County Resource Conservation District well database. The well designation number preceding the hyphen is the section, the letter following the hyphen is the 40-acre subdivision, and the last number indicates the sequence in which the wells were inventoried.

INYO/KERN, CALIF.  
 Date of revision of boundary  
 6/25/78  
 62537-8-01174577A  
 1977  
 8 OF 28

Figure 3a







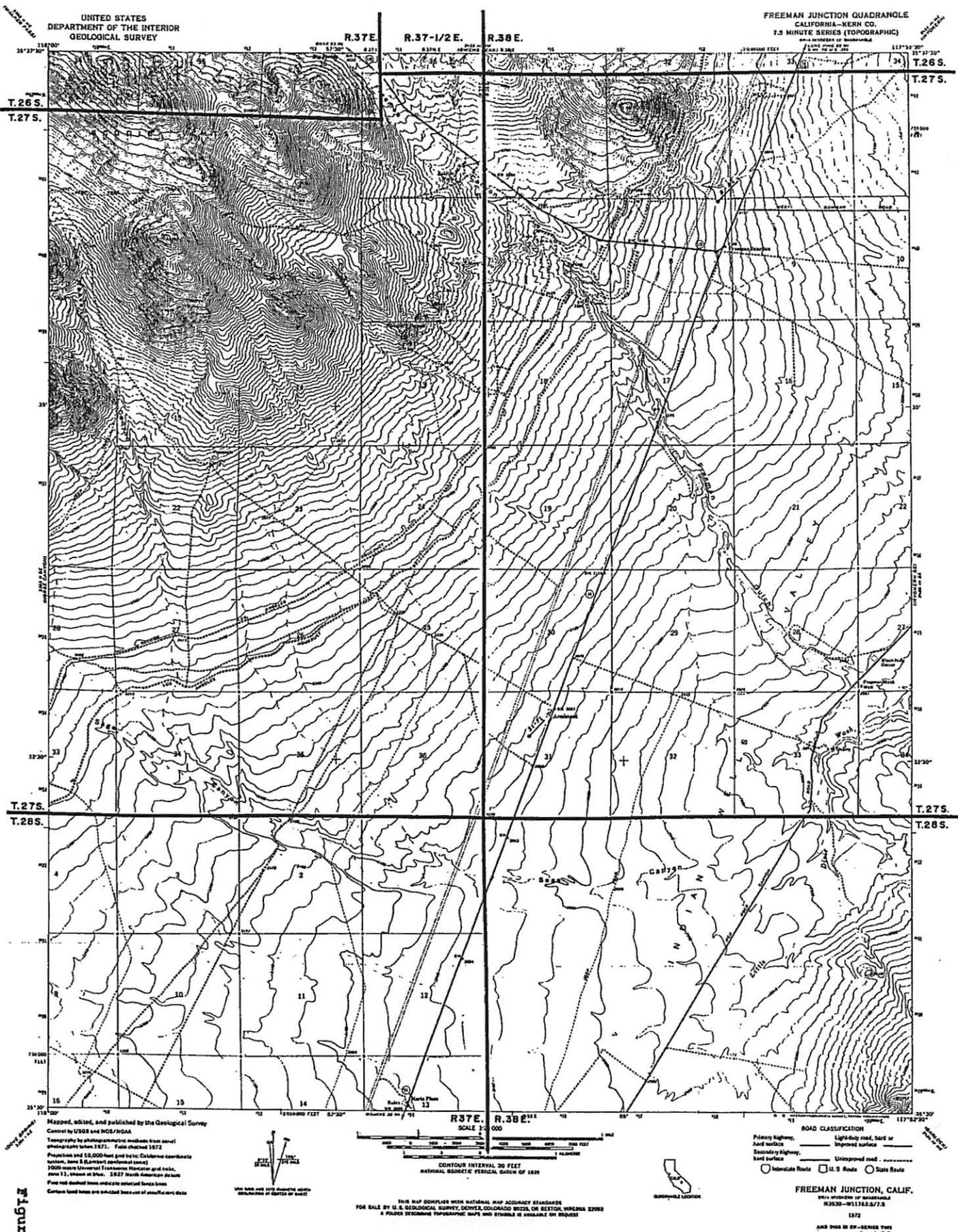


Figure 5

Map of a portion of Indian Wells Valley showing the location of the wells in the East Kern County Resource Conservation District well database. The well designation number preceding the hyphen is the section, the letter following the hyphen is the 40-acre subdivision, and the last number indicates the sequence in which the wells were inventoried.

27/38-387



*Indian Wells Valley Groundwater Project*

*All wells in the East Kern County Resource Conservation District (EKCRCD) Database with a Total Depth*

*Each well is represented by a "stick".*

*This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the EKCRCD database.*

*Freeman Junction, Ca.*

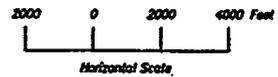


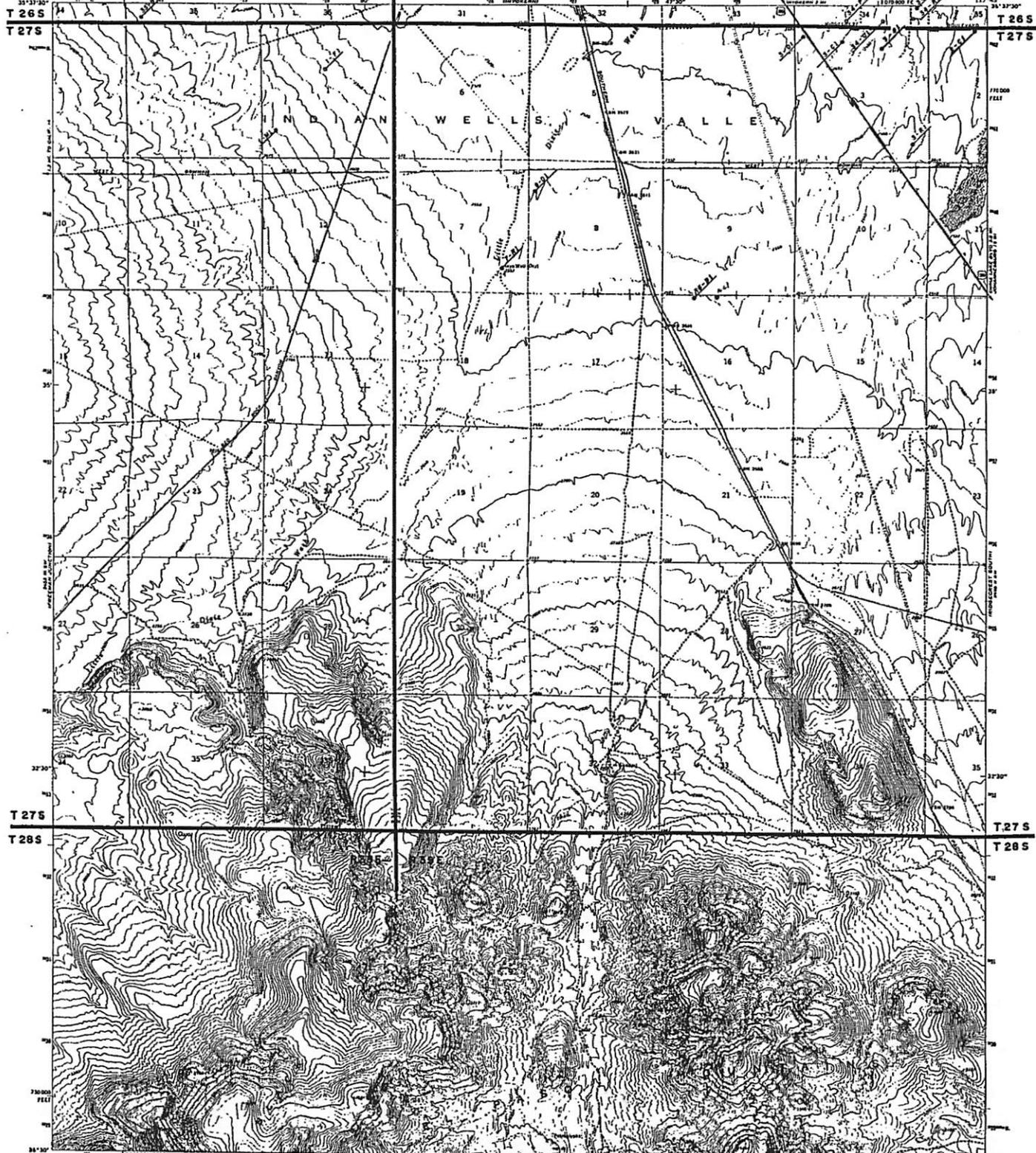
Figure 5a

Depiction of well depths from the EKCRCD database in the portion of the Indian Wells Valley shown on the preceding figure.

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

INYOKERN 6E QUADRANGLE  
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7.5 MINUTE SERIES (TOPOGRAPHIC)  
See website at [www.gsa.gov](http://www.gsa.gov)

R 38 E R 39 E



Mapped, edited, and published by the Geological Survey

Control by USGS and NGS/NOAA

Topography by stereogrammetric methods from aerial

photographs taken 1971. Field checked 1972

Projections and 50,000-foot grid ticks: California coordinate

system, zone 8 (Lambert conformal conic)

1000-meter Universal Transverse Mercator grid ticks,

zone 11, shown in black. 1927 North American datum

SCALE 1:24,000

CONTOUR INTERVAL 20 FEET

NATIONAL GEODETIC VERTICAL DATUM OF 1929

ROAD CLASSIFICATION

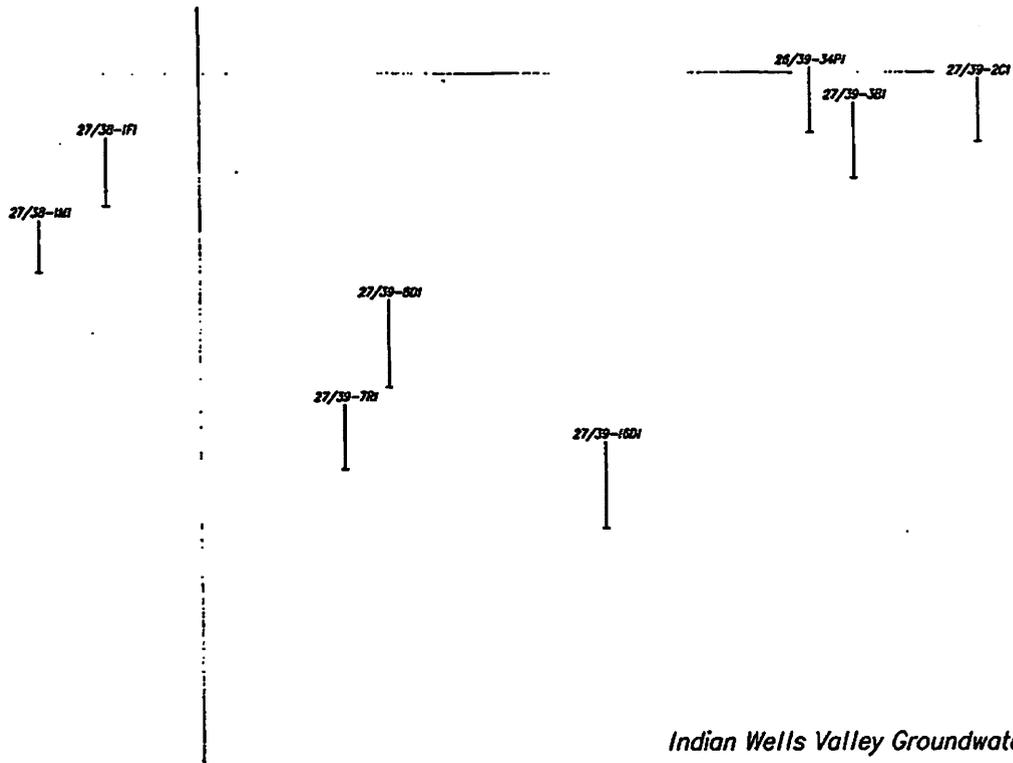
Primary highway, hard surface

Secondary highway, hard surface

Light-duty road, hard or improved surface

Unimproved road

Interstate Road U.S. Route State Route

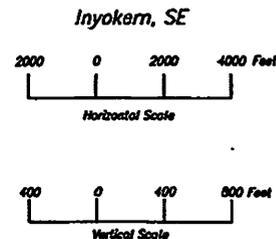


*Indian Wells Valley Groundwater Project*

*All wells in the East Kern County Resource Conservation District (EKCRCD) Database with a Total Depth*

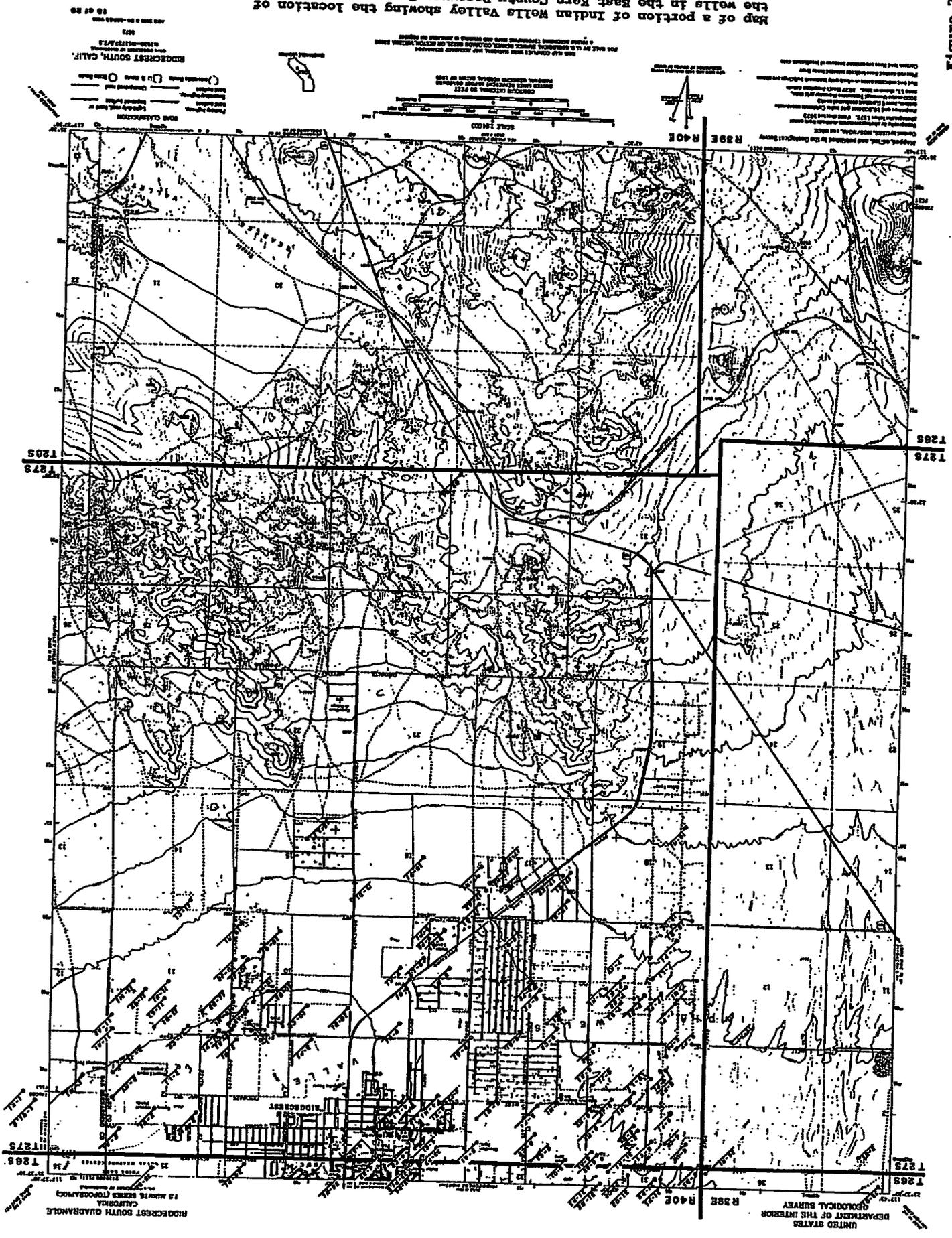
*Each well is represented by a "stick".*

*This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the EKCRCD database.*



Map of a portion of Indian Wells Valley showing the location of the wells in the East Kern County Resource Conservation District well database. The well designation number preceding the hyphen is the section, the letter following the hyphen is the 40-acre sub-division, and the last number indicates the sequence in which the wells were inventoried.

Figure 7

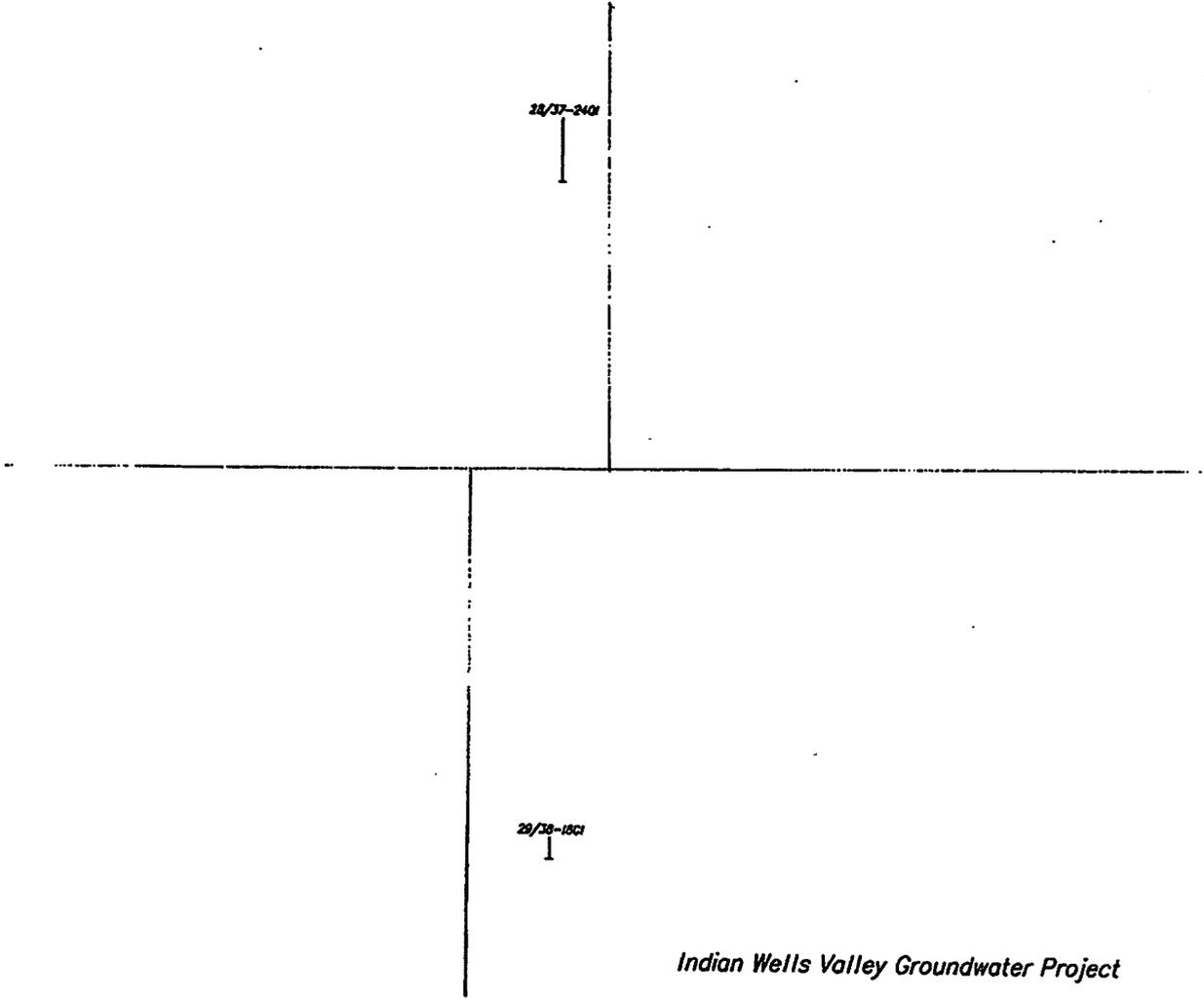


UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

ALABAMA  
CALIFORNIA  
STATE GEOLOGICAL SURVEY

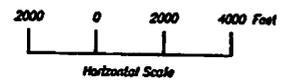






*Indian Wells Valley Groundwater Project*

*Saltdale NW*



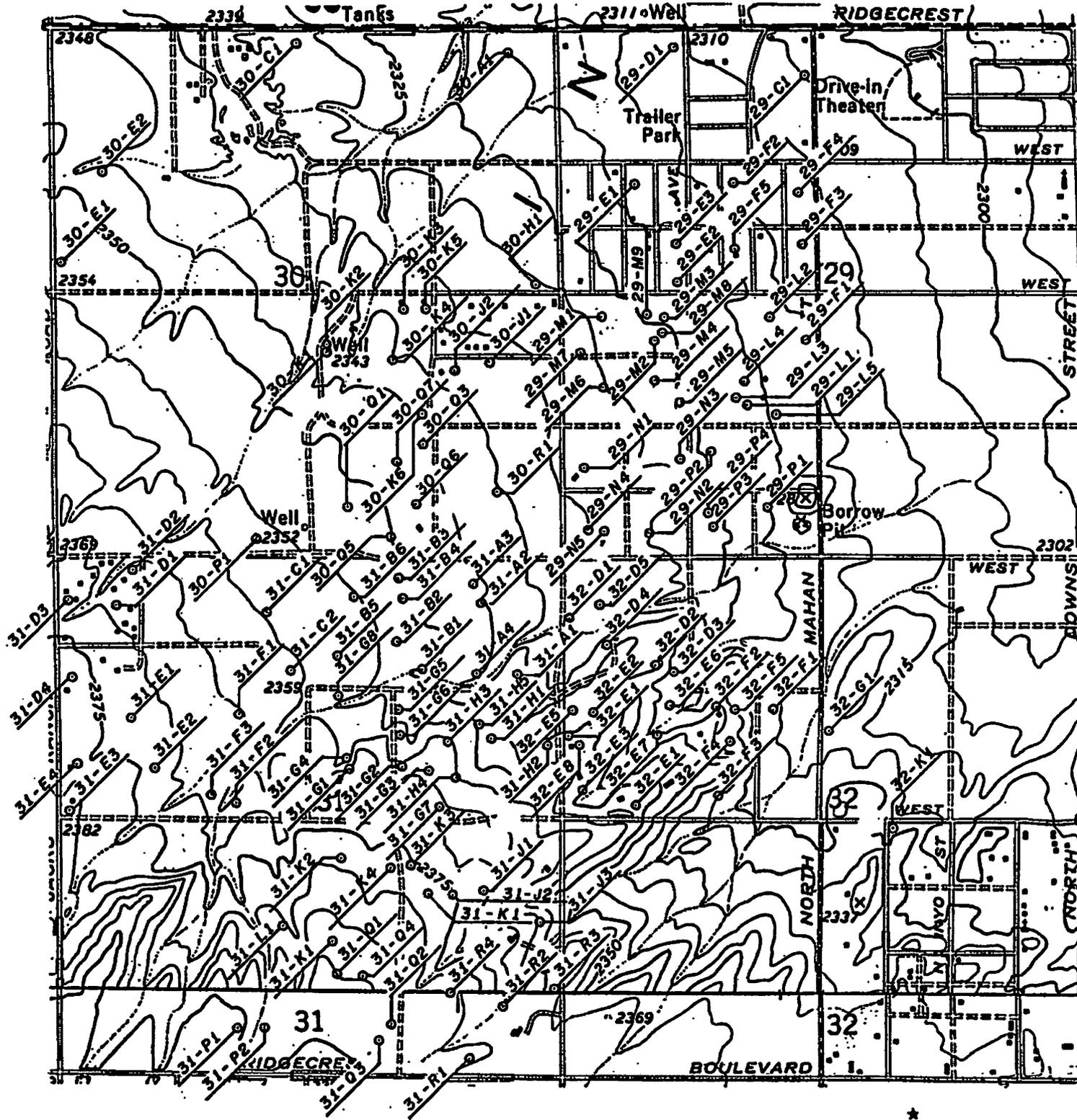
*All wells in the East Kern County Resource Conservation District (EKCRCD) Database with a Total Depth*

*Each well is represented by a "stick".*

*This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the EKCRCD database.*

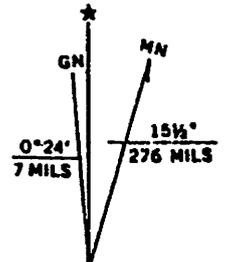
**Figure 8a**

**Depiction of well depths from the EKCRCD database in the portion of the Indian Wells Valley shown on the preceding figure.**



# DETAIL "A"

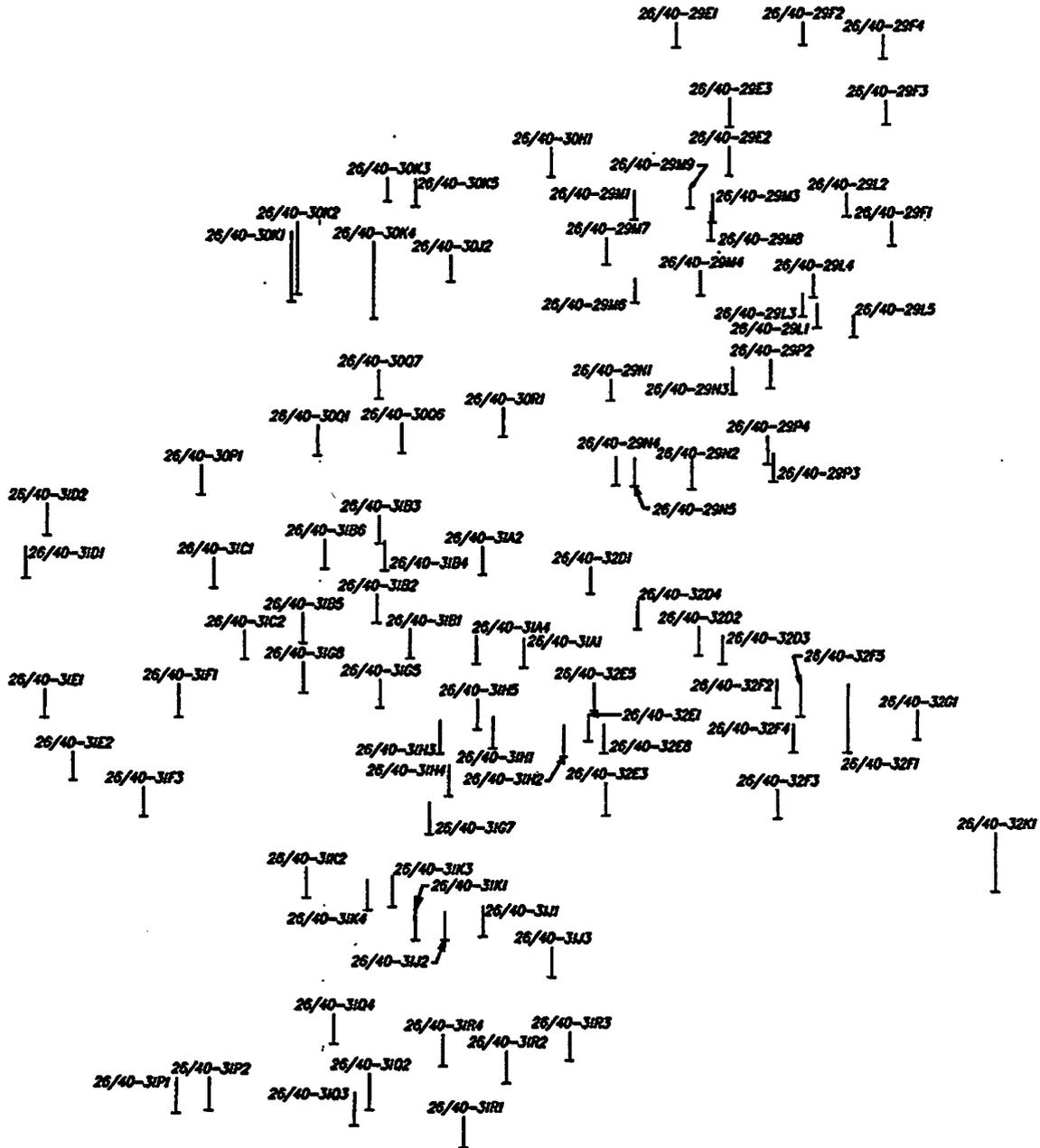
T. 26 S., R. 40 E.



UTM GRID AND 1973 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

Figure 9

Map of a portion of Indian Wells Valley showing the location of the wells in the East Kern County Resource Conservation District well database. The well designation number preceding the hyphen is the section, the letter following the hyphen is the 40-acre subdivision, and the last number indicates the sequence in which the wells were inventoried.



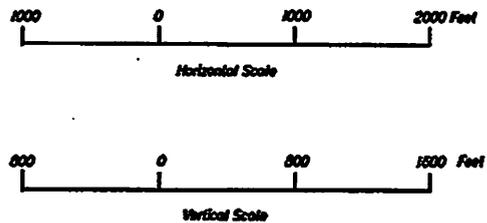
All wells in the East Kern County Resource Conservation District (EKCRCD) database with a total depth.

Each well is represented by a "stick".

This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the EKCRCD database.

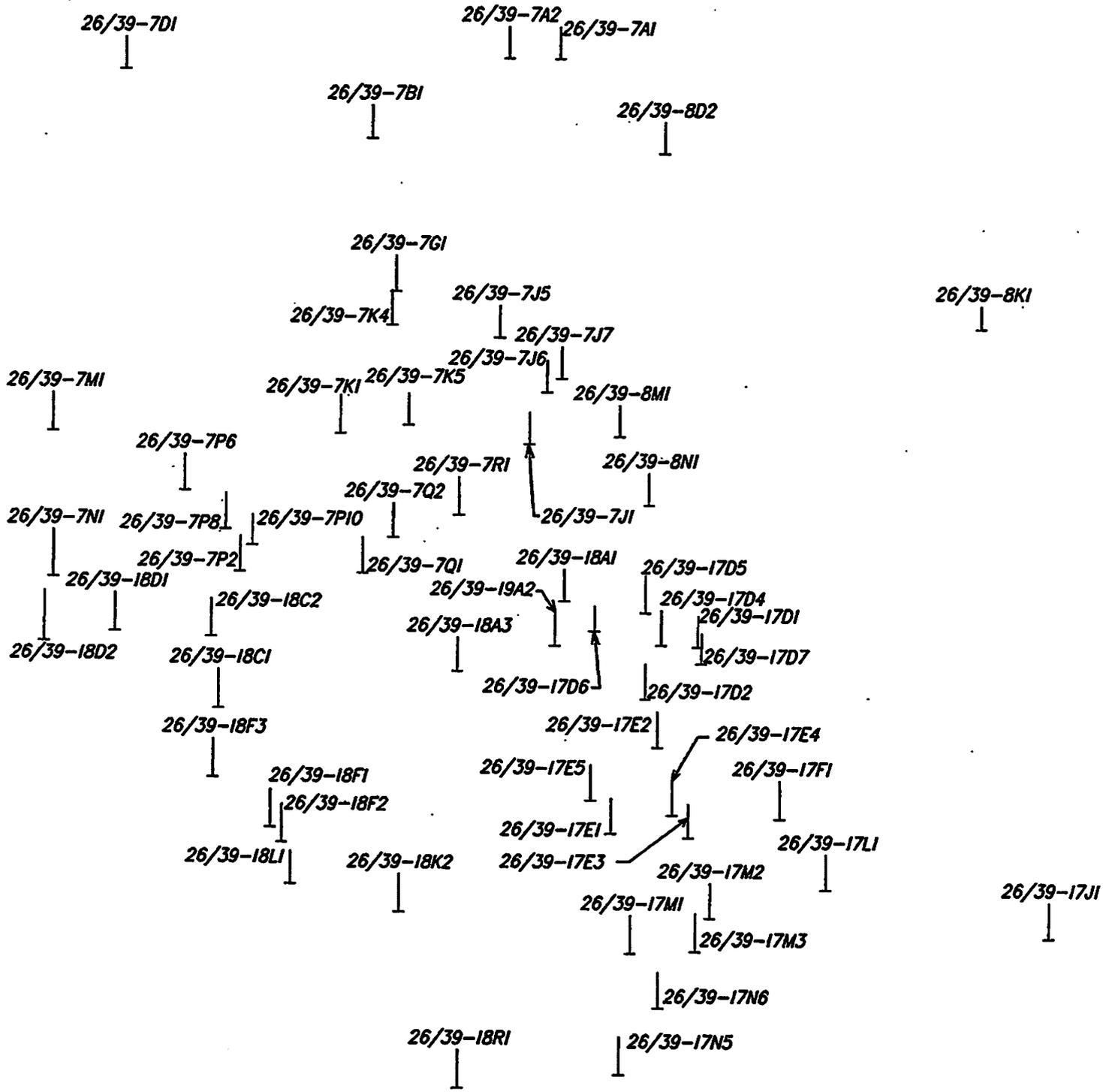
### INDIAN WELLS VALLEY GROUNDWATER PROJECT

Detail A



Depiction of well depths from the EKCRCD database in the portion of the Indian Wells Valley shown on the preceding figure.





INDIAN WELLS VALLEY GROUNDWATER PROJECT

Detail B

All wells in the East Kern County Resource Conservation District (EKCRCD) database with a total depth.

Each well is represented by a "stick".

This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the EKCRCD database.

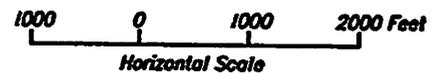
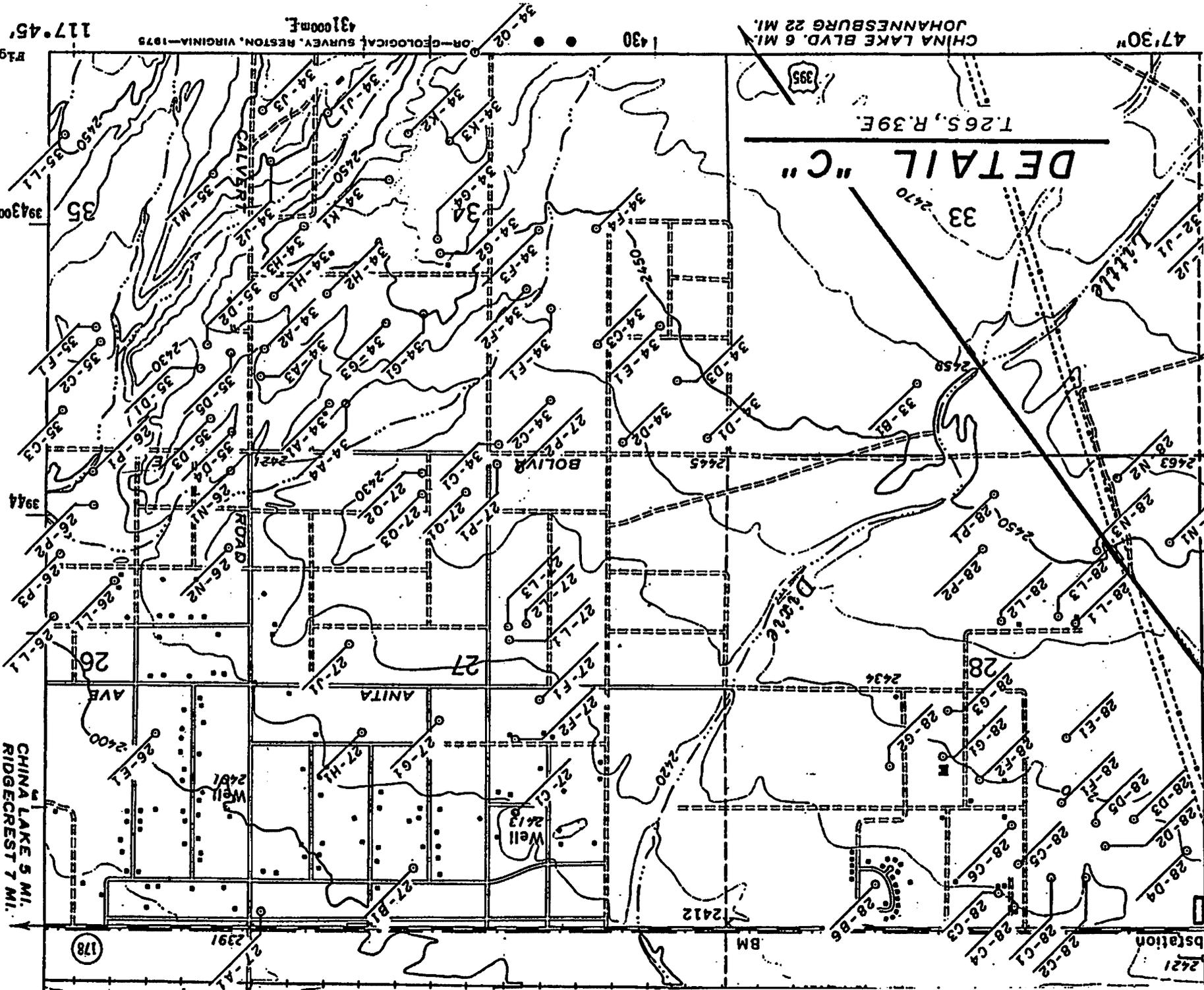


Figure 10a

Depiction of well depths from the EKCRCD database in the portion of the Indian Wells Valley shown on the preceding figure.



Map of a portion of Indian Wells Valley showing the location of the wells in the East Kern County Resource Conservation District well database. The well designation number preceding the hyphen is the section, the letter following the hyphen is the 40-acre subdivision, and the last number indicates the sequence in which the wells were inventoried.

Figure 11

CHINA LAKE 5 MI.  
RIDGECREST 7 MI.

(178)

BM

2421  
station

DETAIL "C"

T. 26 S., R. 39 E.

CHINA LAKE BLVD. 6 MI.  
JOHANNESBURG 22 MI.

OR-ECOLOGICAL SURVEY, RESTON, VIRGINIA-1975  
431000m F.

117° 45'

47° 30'

1430

3943000m N.

35

26

27

28

34

33

AVR

ANITA

Ditch

Well

395

2450

2430

3944

2400

2413

2413

2412

2434

2450

2458

2445

2430

2450

2430

0572

2450

2430

3944

2400

2413

2413

2412

2434

2450

2458

2445

2430

2450

2430

0572

2450

2430

3944

2400

2413

2413

2412

2434

2450

2458

2445

2430

2450

2430

0572

2450

2430

3944

2400

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2412

2434

2450

2458

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2430

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0572

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2434

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2458

2445

2430

2450

2430

0572

2450

2430

3944

2400

2413

2413

2412

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2430

0572

2450

2430

3944

2400

2413

2413

2412

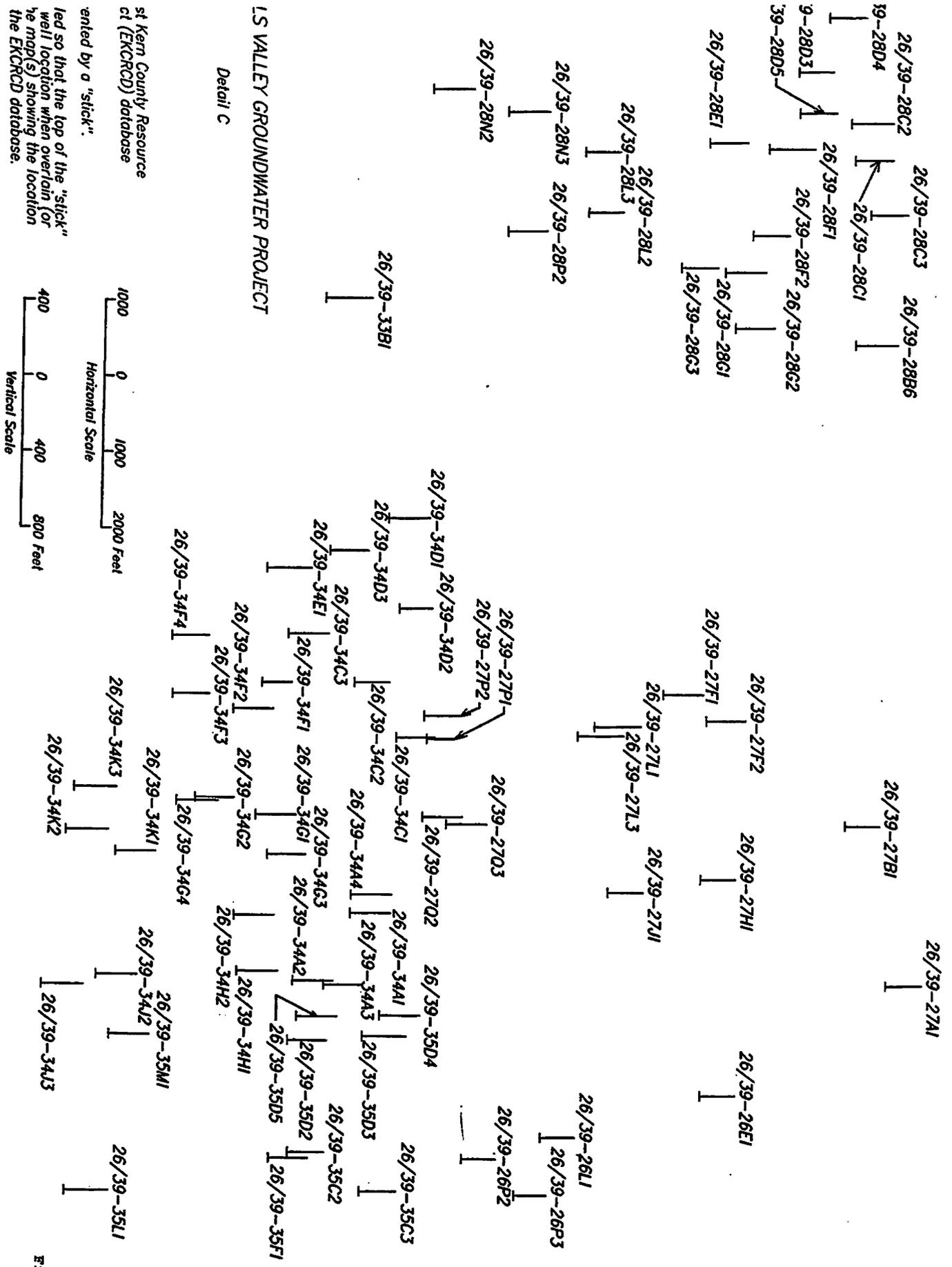
2434

2450

2458

2445

2430



Depiction of well depths from the EKCRCD database in the portion of the Indian Wells Valley shown on the preceding figure.

st Kern County Resource  
 ct (EKCRCD) database  
 ented by a "stick".  
 led so that the top of the "stick"  
 well location when overlain (or  
 he map(s) showing the location  
 the EKCRCD database.

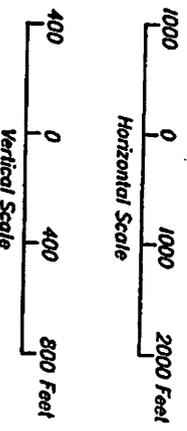
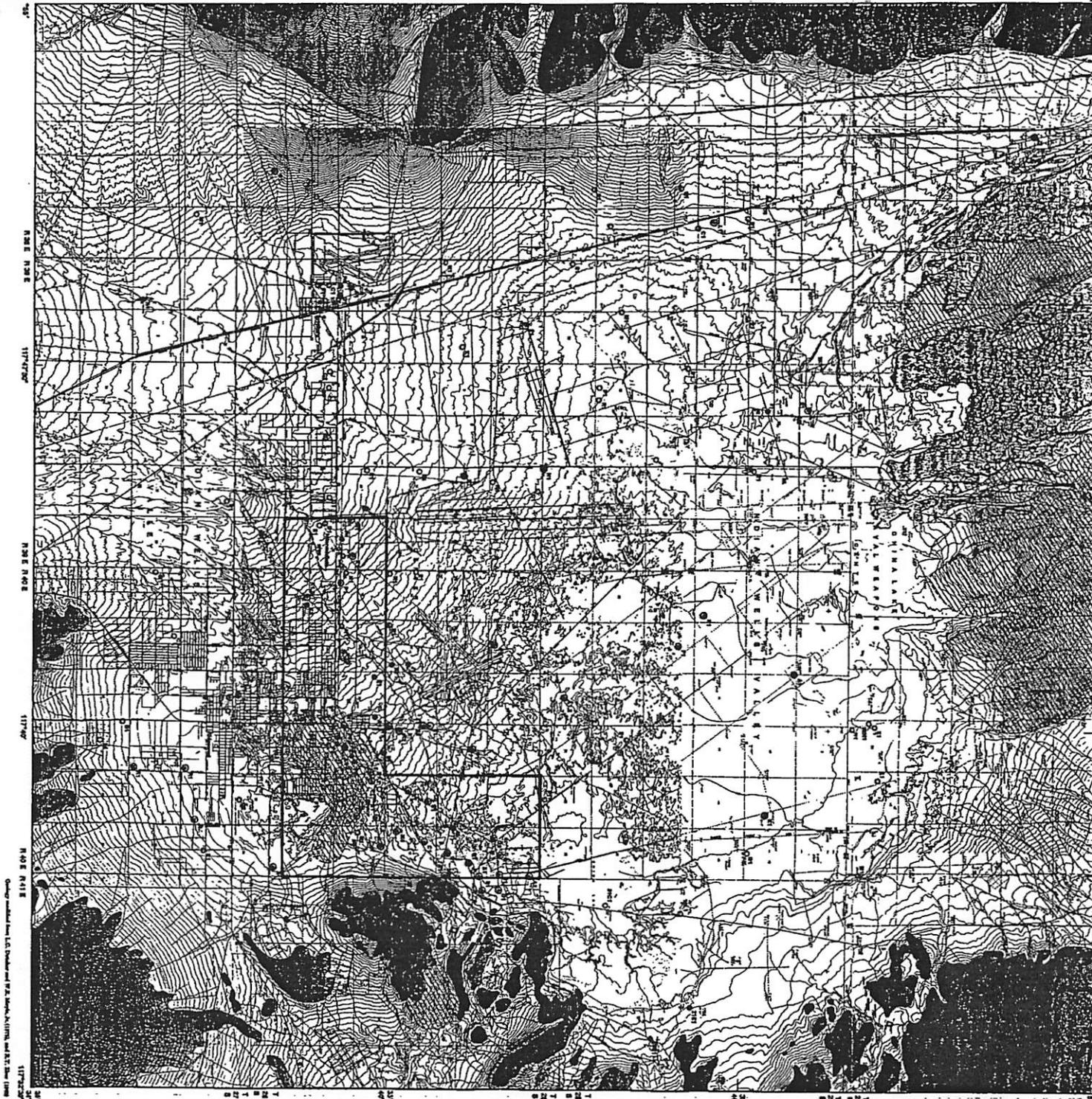


Figure 11a



Base from U.S. Geological Survey: Airport Lake, Preliminary Edition (PE) 1965; Sierra Canyon, PE 1962; Pinnacles Area, 1972; Inyo, 1972; Inyo and Kern, 1972; Lone Lake, PE 1965; Lone Lake, 1972; Mammoth Spring Canyon, PE 1965; Yosemite Canyon, PE 1962; Grand Peak, 1972; Pinnacles, PE 1962; Ridgecrest North, 1972; Ridgecrest South, 1972; Spring Lake, 1972; Yucca Peak, PE 1962; White Mts., PE 1962; and 1:50,000 scale maps.

Contour modified from L.C. Decker and W.R. Mark, p. 1170, and R.T. Dow (1962)

0 1 2 3 4 5 6 MILES  
0 1 2 3 4 5 6 KILOMETERS

CONTOUR INTERVAL VARIABLE  
Natural Contour Interval Datum of 1929

REPLACEMENT

<p>UNCONSOLIDATED DEPOSITS</p> <p>Unconsolidated Locusts</p> <p>CONSOLIDATED ROCKS</p> <p>Unconsolidated Basalt</p> <p>CONTACT—Dashed where approximately located</p>	<p>WELL AND NUMBER—</p> <p>○<sup>01</sup> Used for water-level measurements ○<sup>02</sup> Sampled for chemical analysis</p> <p>●<sup>01</sup> Used for water-level measurements ●<sup>02</sup> and sampled for chemical analysis</p> <p>Note: Some wells plot in sections differing from that indicated by the State well number designation. This occurs because State well numbers, once assigned to a well, remain unchanged even if some detailed maps show that the well is in a different location with respect to section lines from the original location used to assign the well number.</p>
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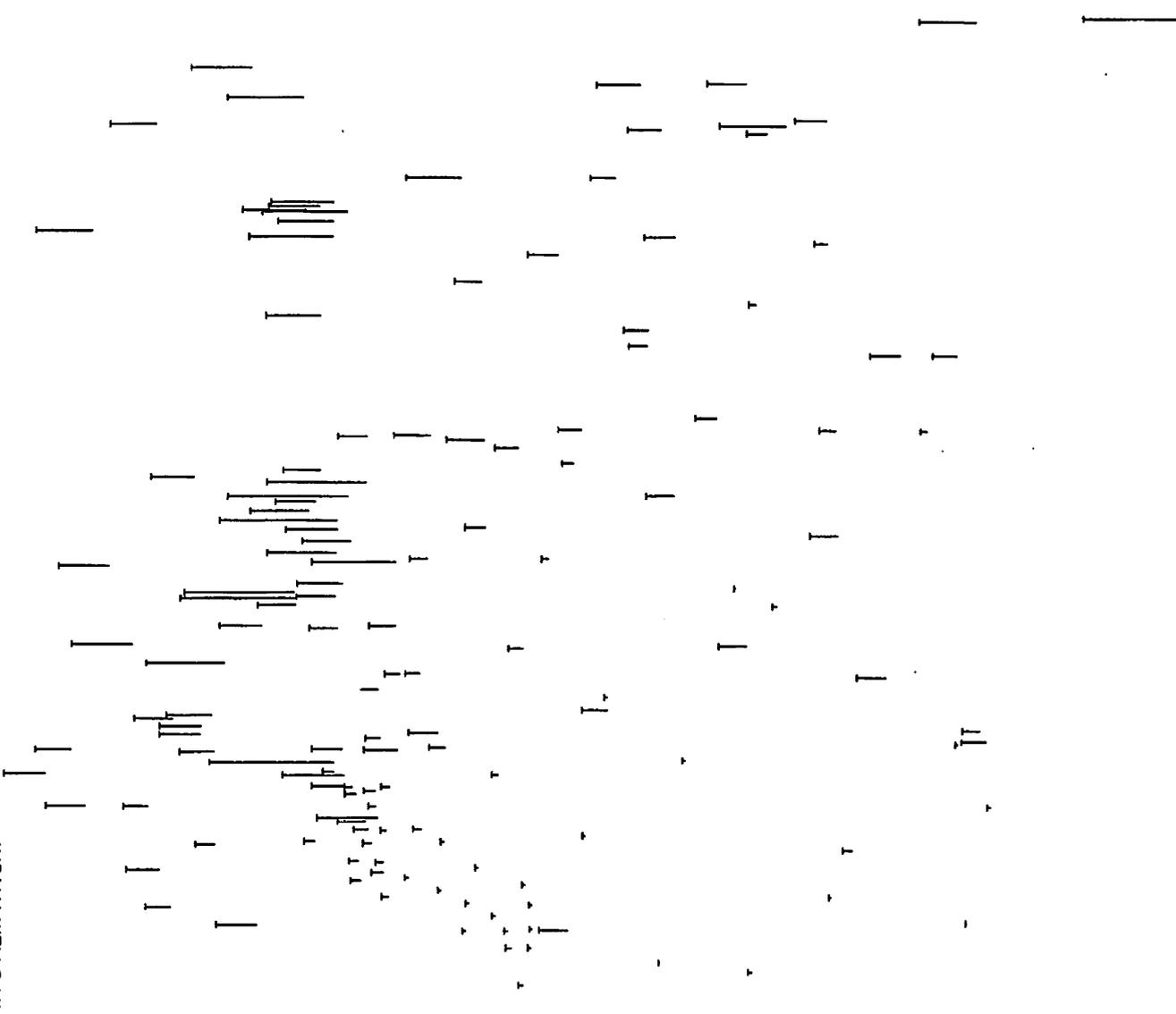
APPROXIMATE MEAN DECLINATION, 1978

STUDY AREA

**MAP OF INDIAN WELLS VALLEY, KERN, INYO, AND SAN BERNARDINO COUNTIES, CALIFORNIA, SHOWING GENERALIZED GEOLOGY AND LOCATION OF OBSERVATION WELLS, 1977-84**

(From: U.S. Geological Survey Open-File Report 86-315 by C. Berenbrock)

Figure 12

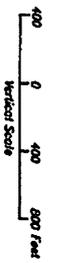
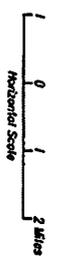


**INDIAN WELLS VALLEY GROUNDWATER PROJECT**

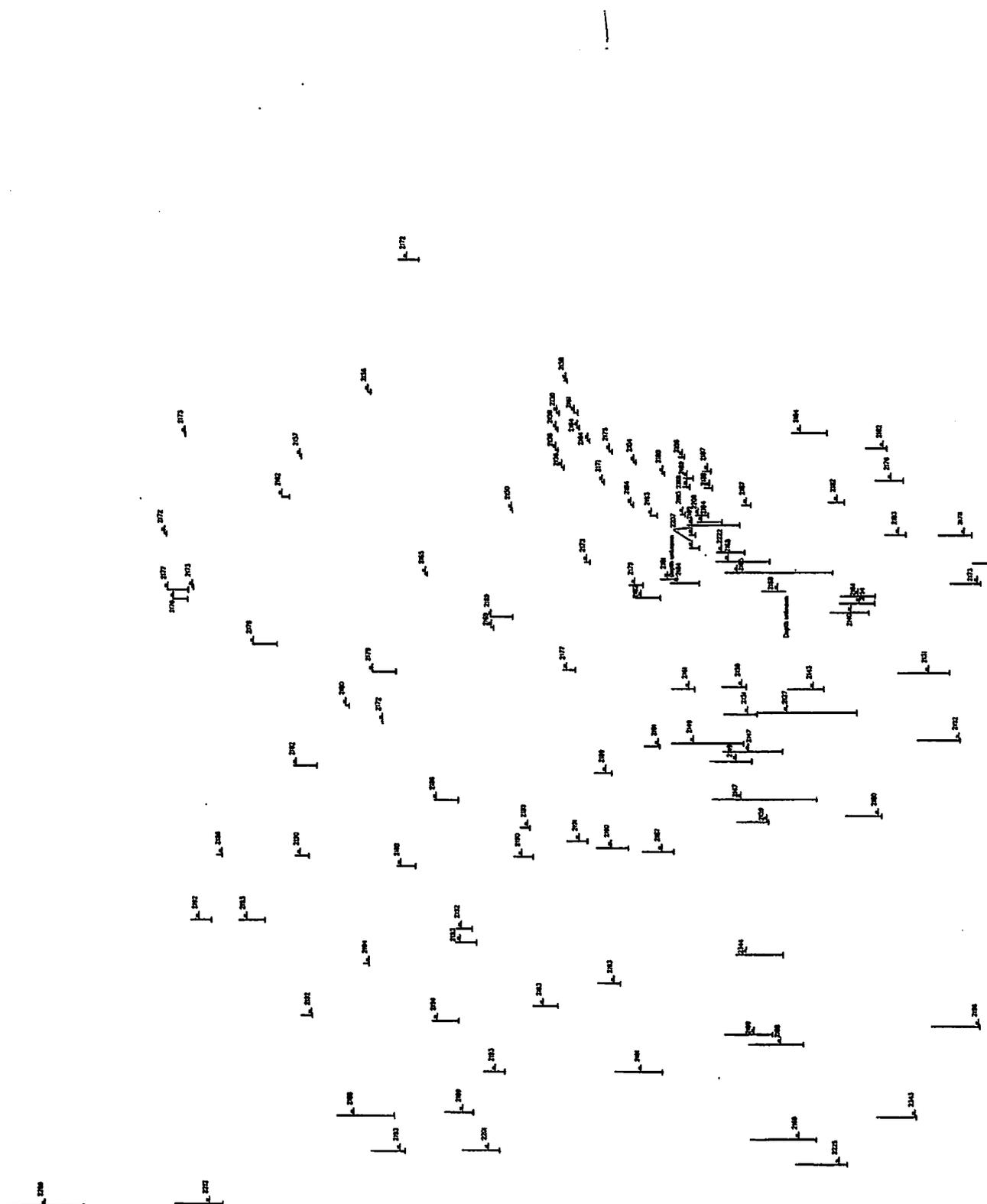
All wells in the USGS Open-file Report 86-315 with a total depth.

Each well is represented by a "stick".

This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the maps showing the location of the wells in the USGS Open-file Report 86-315.



**Figure 12a**



INDIAN WELLS VALLEY GROUNDWATER PROJECT

All wells in the USGS Open-file Report 86-315 with a total depth and water level.

LEGEND  
 | Groundwater elevation

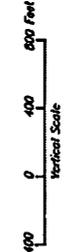
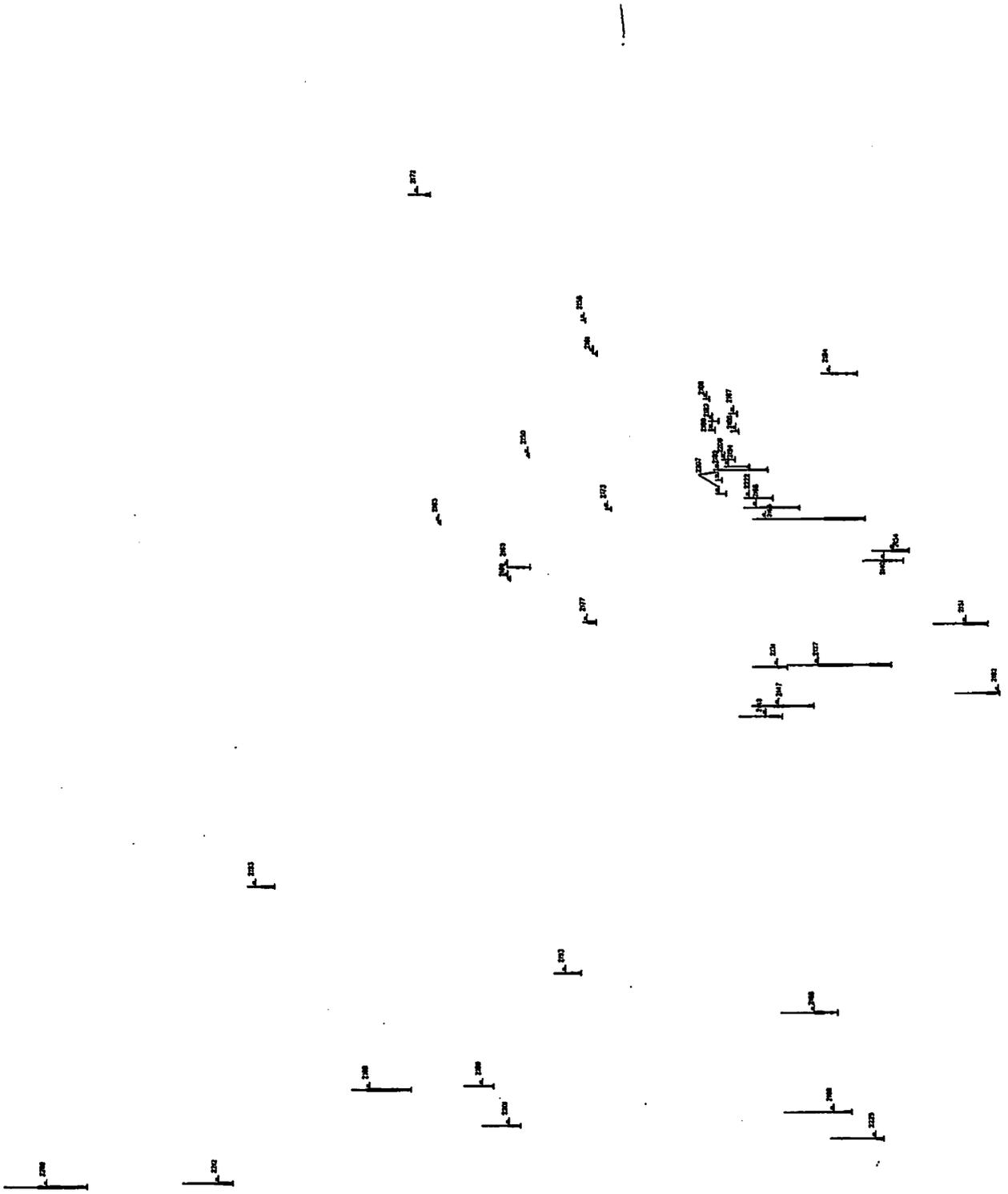
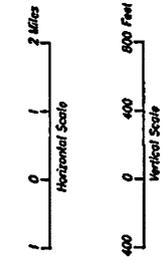


Figure 12b

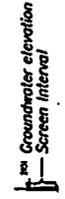
Each well is represented by a "stick".  
 This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the USGS Open-file Report 86-315.



INDIAN WELLS VALLEY GROUNDWATER PROJECT



LEGEND



All wells in the USGS Open-file Report 86-315 with a total depth, water level and screen interval(s). Each well is represented by a "stick".

This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the USGS Open-file Report 86-315.





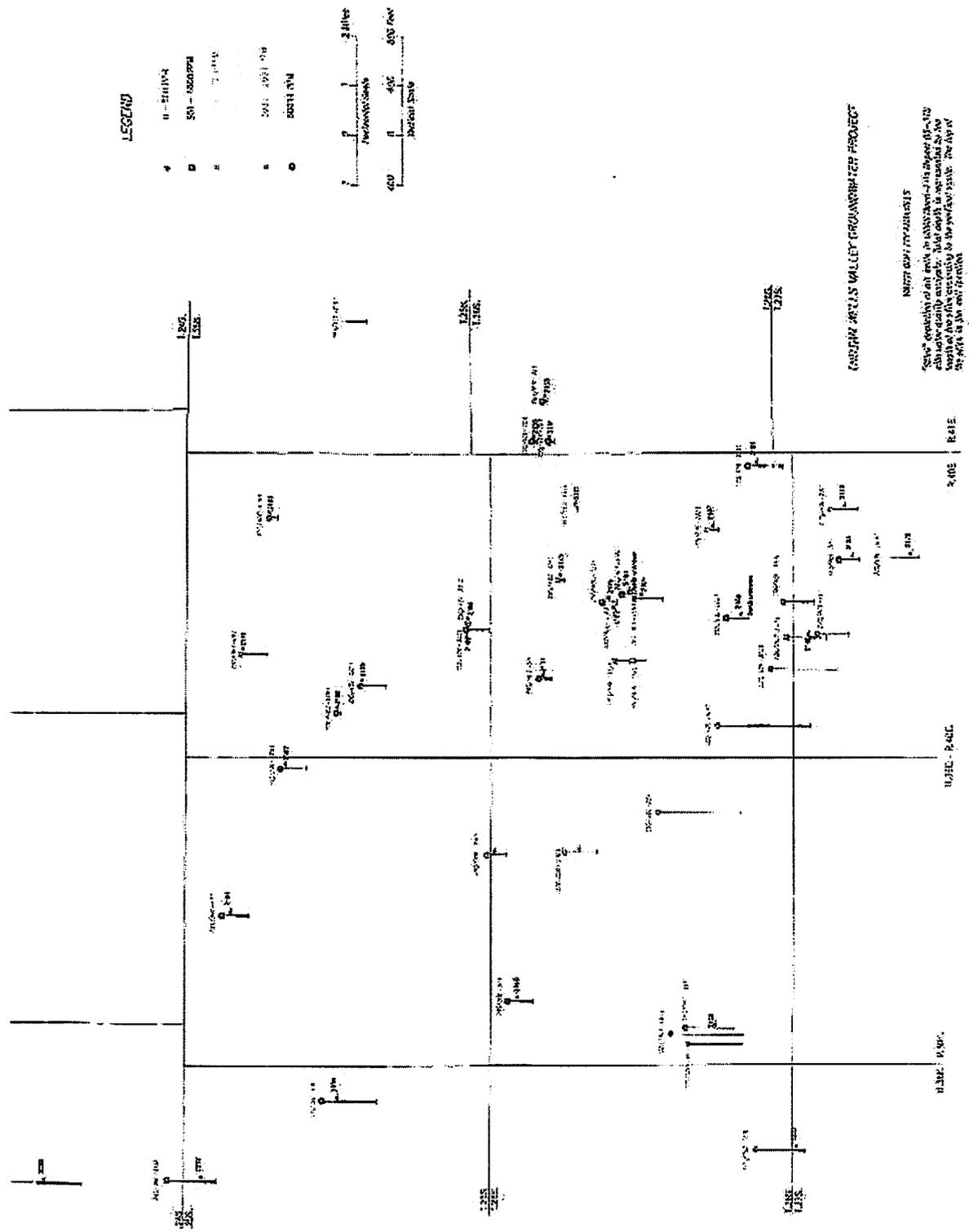
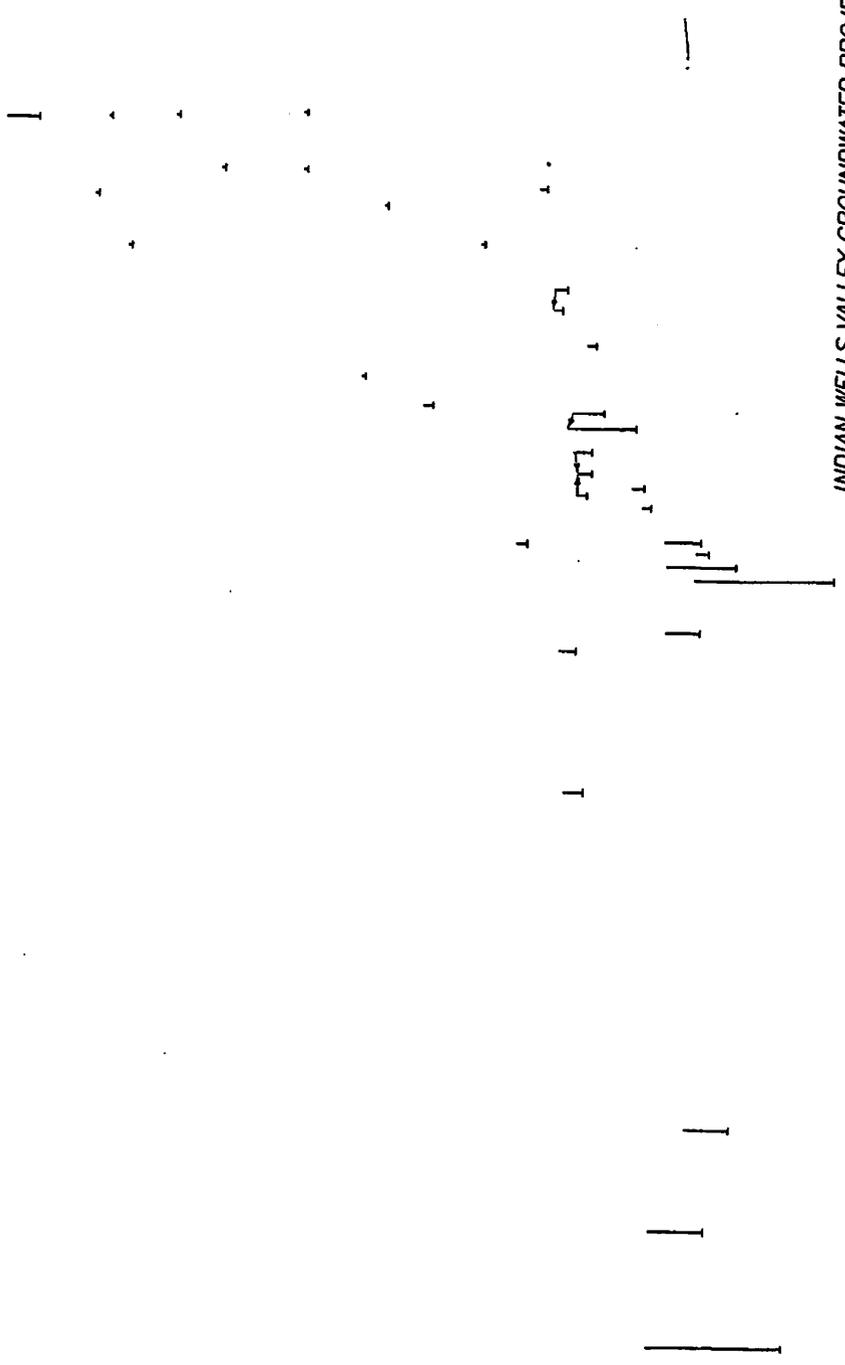


Figure 125





INDIAN WELLS VALLEY GROUNDWATER PROJECT

All wells in the USGS Open-file Report 86-315 with a total depth.

Each well is represented by a "stick".

This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the USGS Open-file Report 86-315.

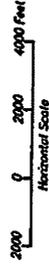
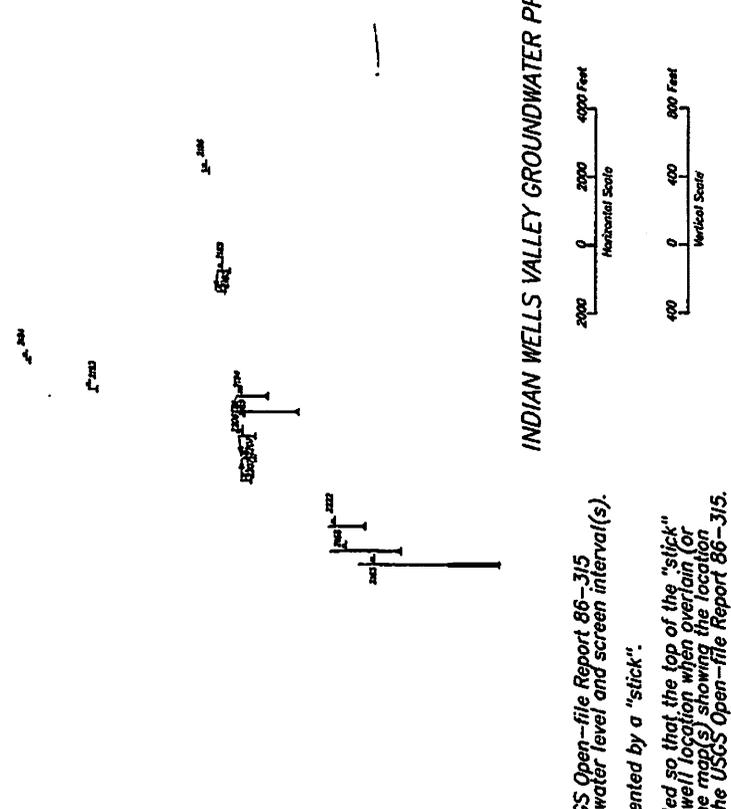


Figure 13a



INDIAN WELLS VALLEY GROUNDWATER PROJECT



LEGEND

— Groundwater elevation  
 |— Screen interval

All wells in the USGS Open-file Report 86-315 with a total depth, water level and screen interval(s).

Each well is represented by a "stick".

This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the USGS Open-file Report 86-315.

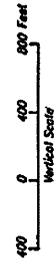
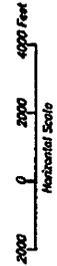


Figure 13c

T. 255E.  
1. 785E.

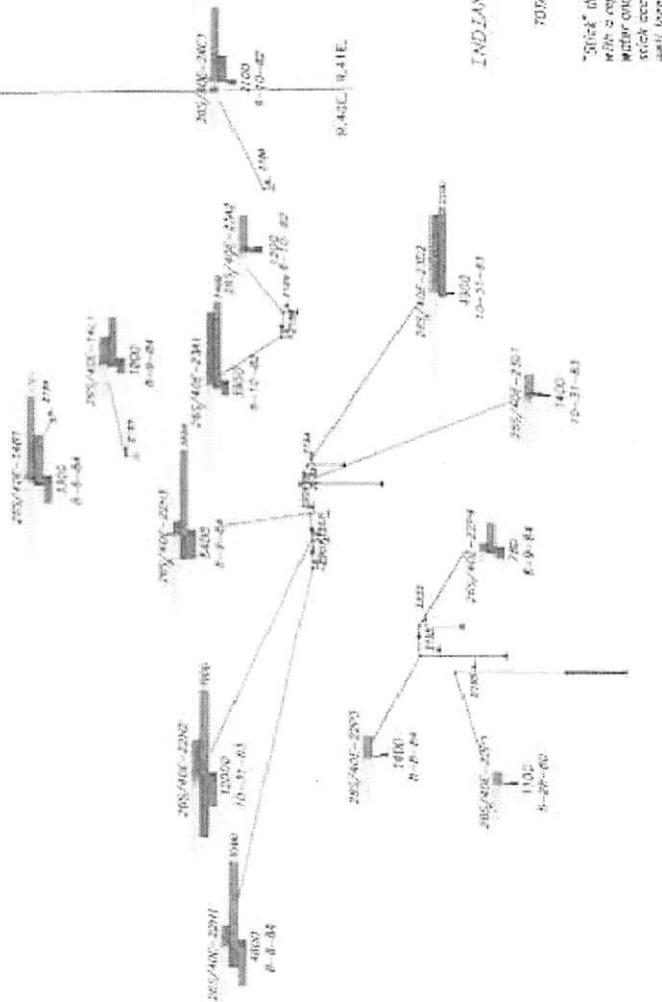
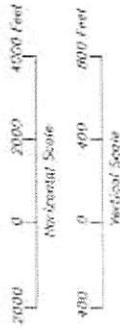
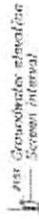
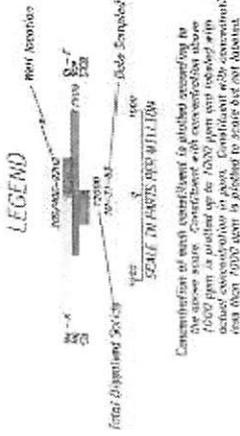
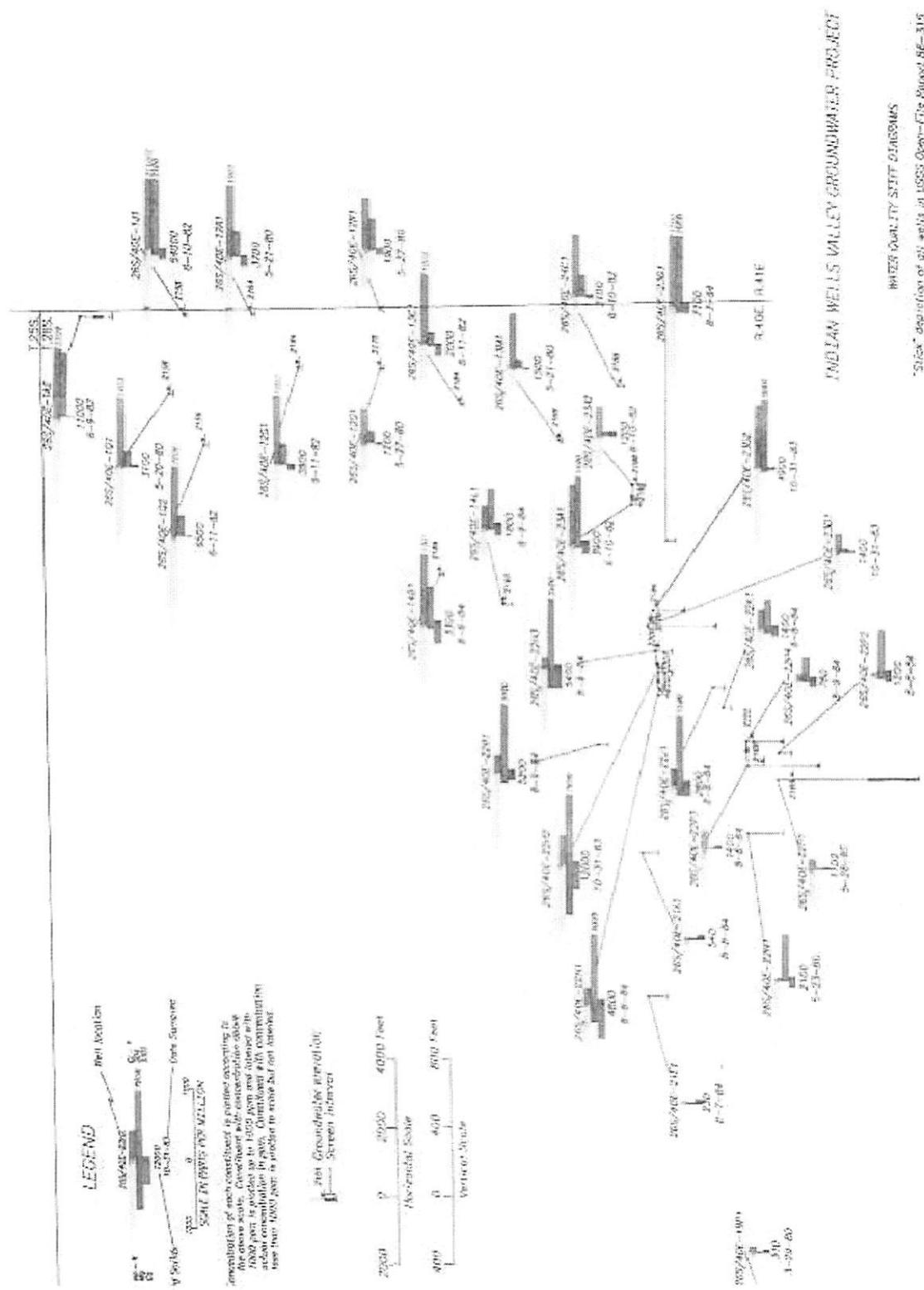


Figure 13d



WATER QUALITY STICK DIAGRAMS

"Stick" depiction of all wells in USGS Open-File Report 86-315 with a water quality stick diagram. Stick length is represented by line length at the stick according to the vertical scale. The top of the stick is the well location.

Figure 13e

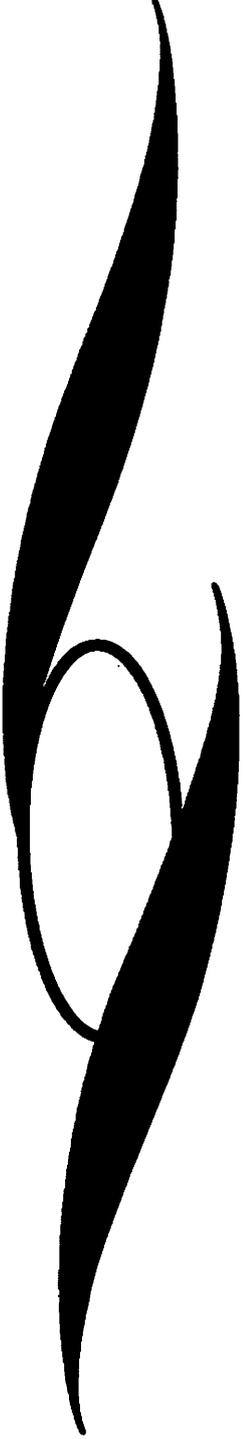


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# **APPENDIX VI**

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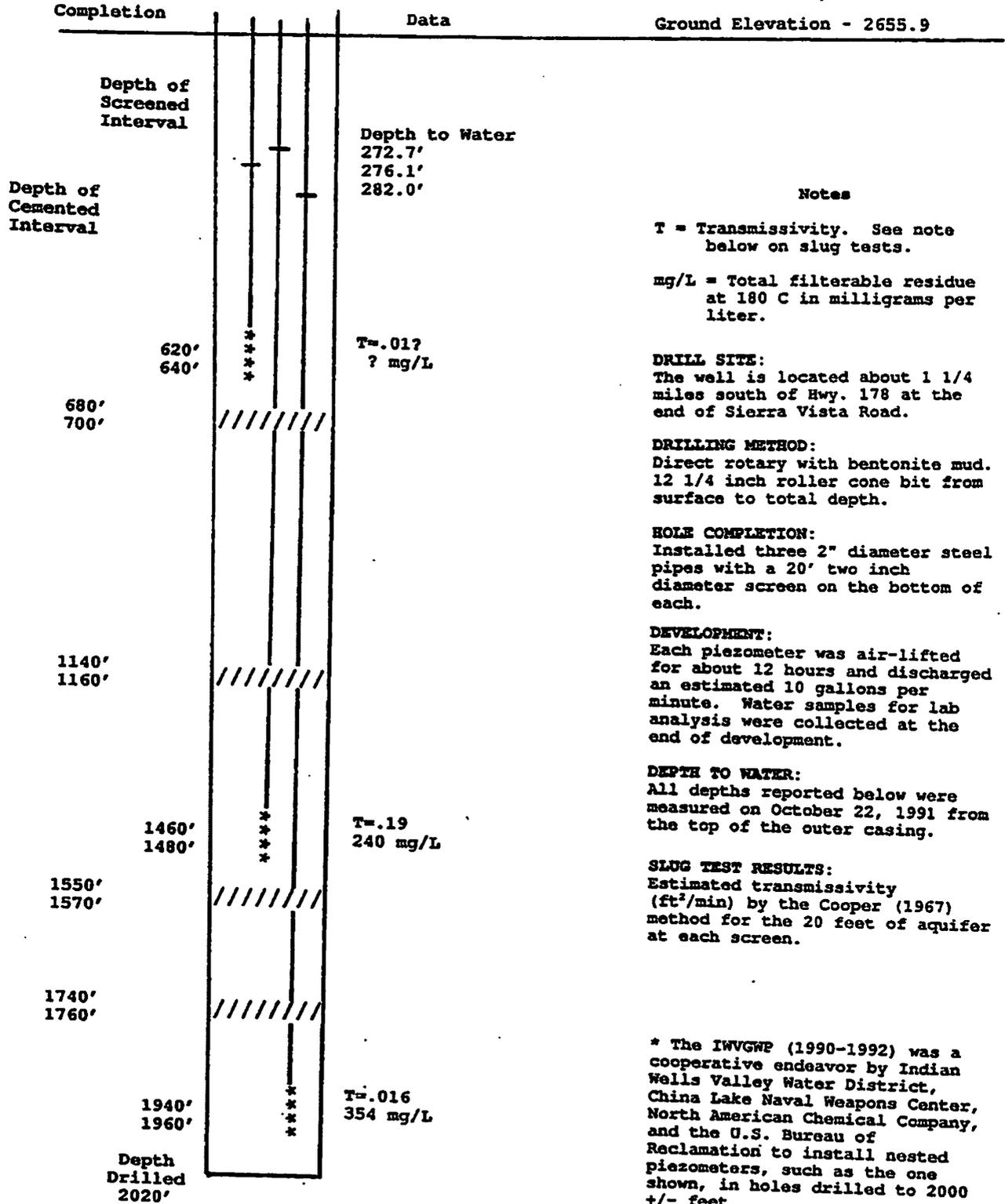
**Diagrammatic Piezometer Completion and Data Summary**





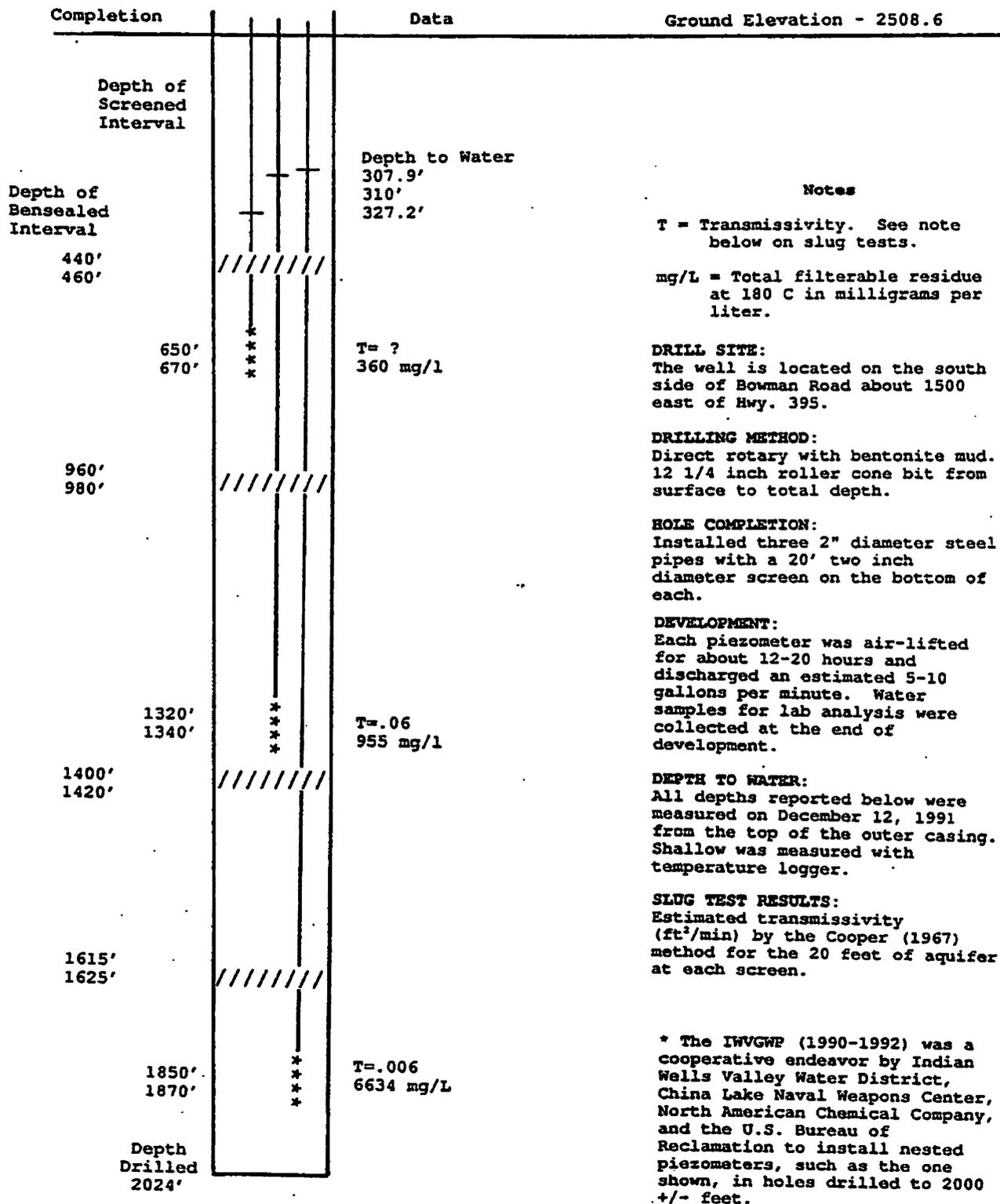
**Indian Wells Valley Groundwater Project (IWVGWP)\*  
Diagrammatic Completion and Data Summary Sheet**

**\*\* Well BR-2 \*\*  
3 - 2" Piezometers**



**Indian Wells Valley Groundwater Project (IWVGWP)\*  
Diagrammatic Completion and Data Summary Sheet**

**\*\* Well BR-3 \*\*  
3 - 2" Piezometers**



**Notes**

T = Transmissivity. See note below on slug tests.

mg/L = Total filterable residue at 180 C in milligrams per liter.

**DRILL SITE:**  
The well is located on the south side of Bowman Road about 1500 east of Hwy. 395.

**DRILLING METHOD:**  
Direct rotary with bentonite mud. 12 1/4 inch roller cone bit from surface to total depth.

**SOLE COMPLETION:**  
Installed three 2" diameter steel pipes with a 20' two inch diameter screen on the bottom of each.

**DEVELOPMENT:**  
Each piezometer was air-lifted for about 12-20 hours and discharged an estimated 5-10 gallons per minute. Water samples for lab analysis were collected at the end of development.

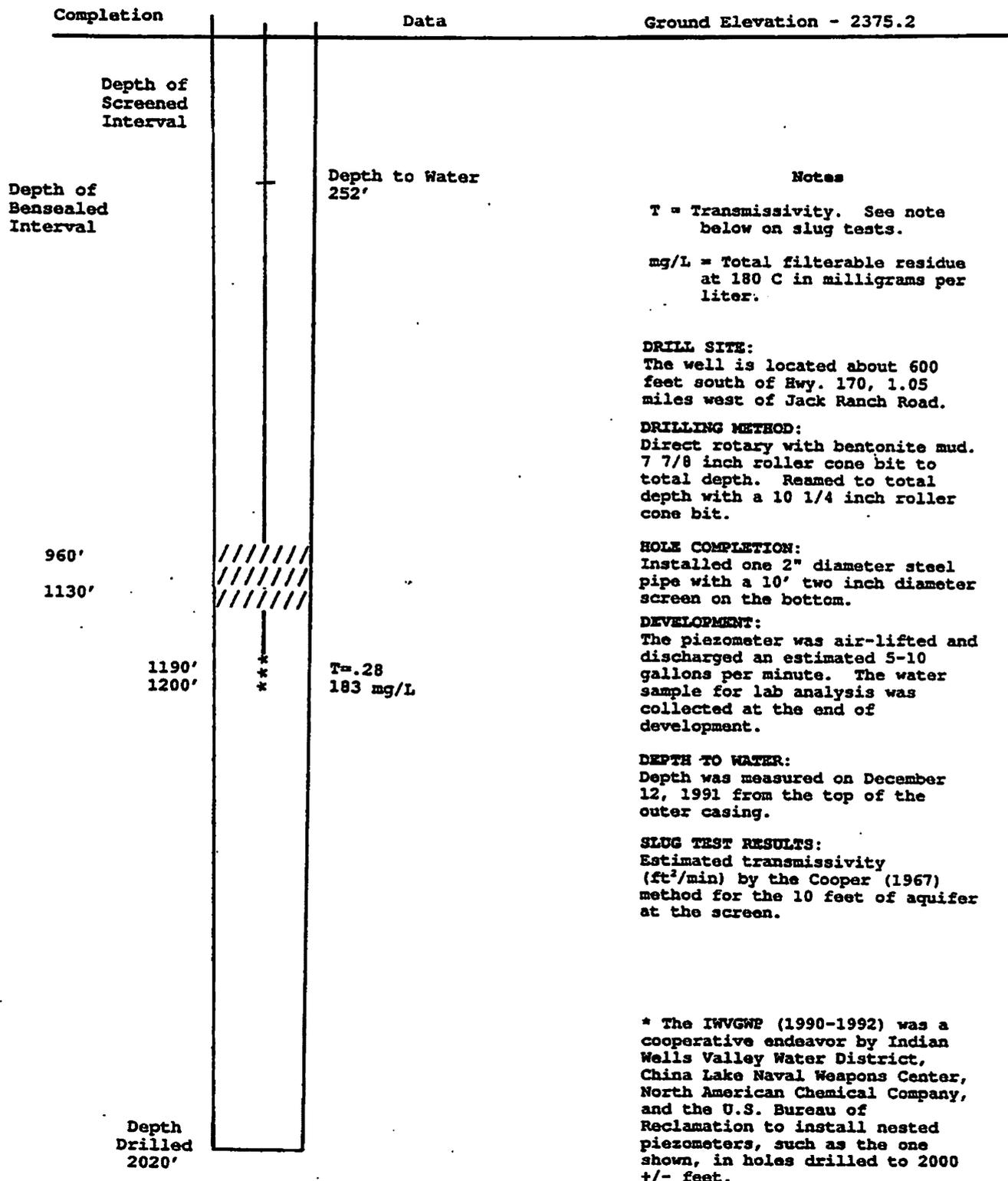
**DEPTH TO WATER:**  
All depths reported below were measured on December 12, 1991 from the top of the outer casing. Shallow was measured with temperature logger.

**SLUG TEST RESULTS:**  
Estimated transmissivity (ft<sup>2</sup>/min) by the Cooper (1967) method for the 20 feet of aquifer at each screen.

\* The IWVGWP (1990-1992) was a cooperative endeavor by Indian Wells Valley Water District, China Lake Naval Weapons Center, North American Chemical Company, and the U.S. Bureau of Reclamation to install nested piezometers, such as the one shown, in holes drilled to 2000 +/- feet.

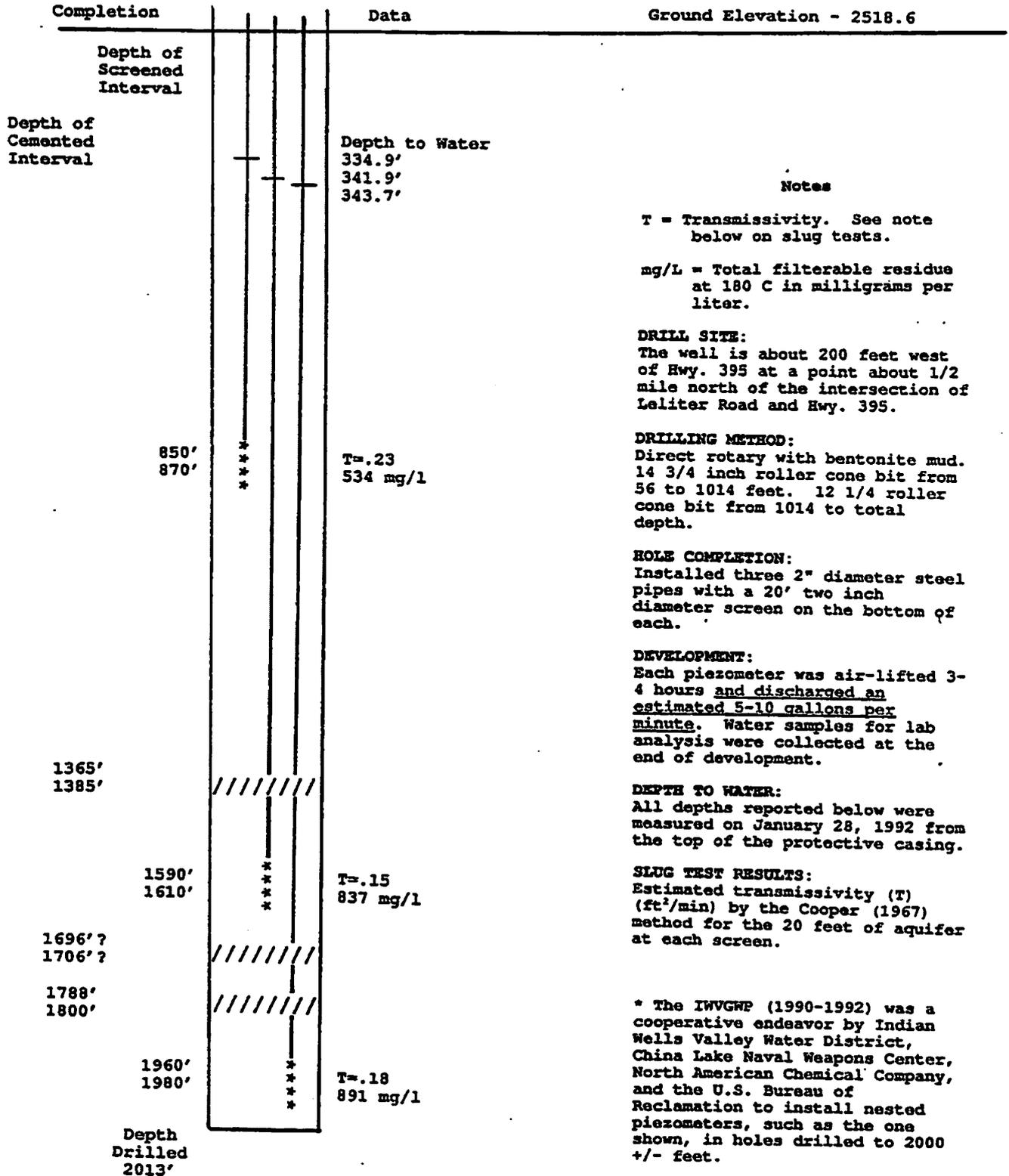
**Indian Wells Valley Groundwater Project (IWVGWP)\*  
Diagrammatic Completion and Data Summary Sheet**

\*\* Well BR-4 \*\*  
1 - 2" Piezometer



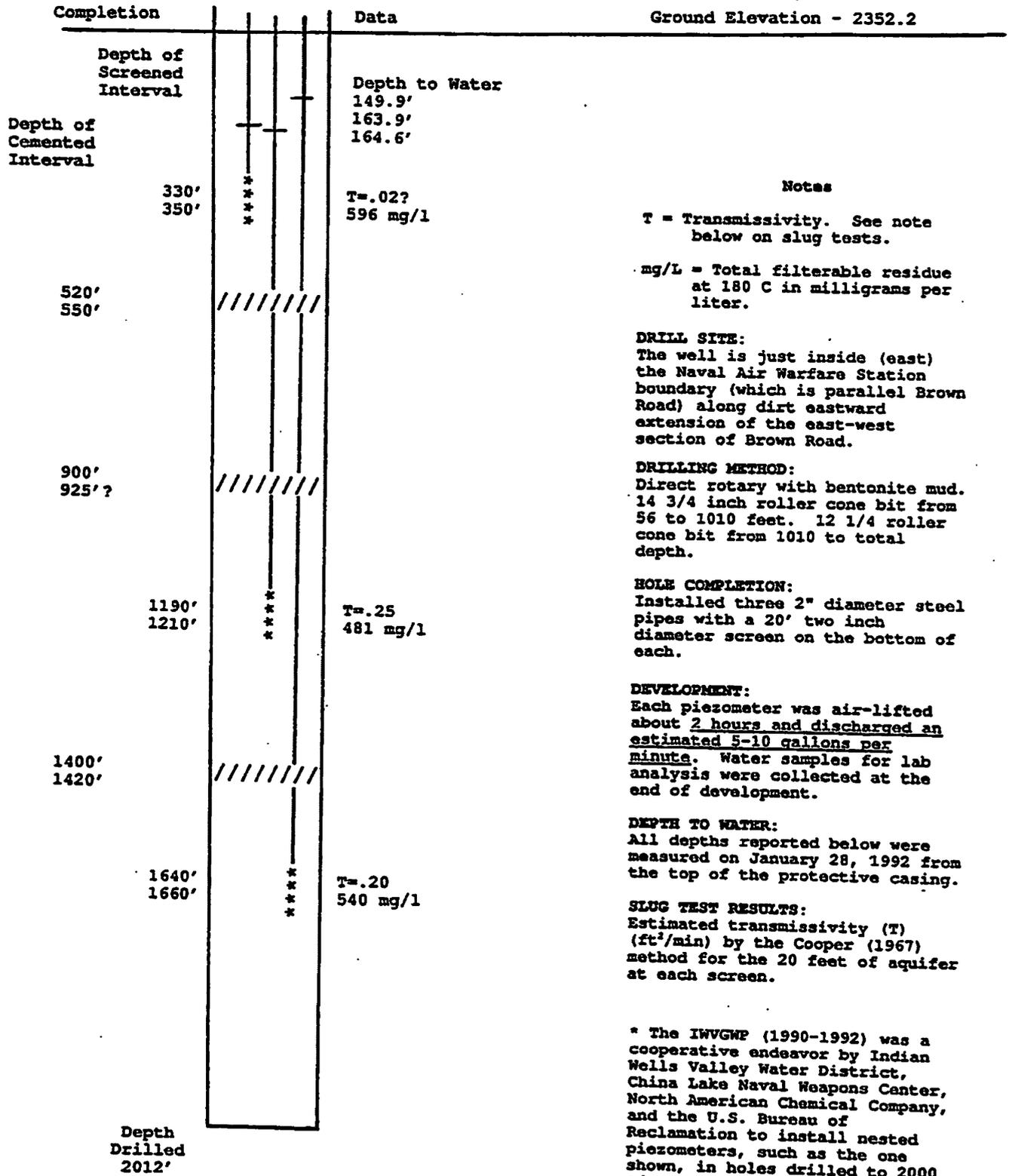
**Indian Wells Valley Groundwater Project (IWVGWP)\*  
Diagrammatic Completion and Data Summary Sheet**

**\*\* Well BR-5 \*\*  
3 - 2" Piezometers**



**Indian Wells Valley Groundwater Project (IWVGWP)\*  
Diagrammatic Completion and Data Summary Sheet**

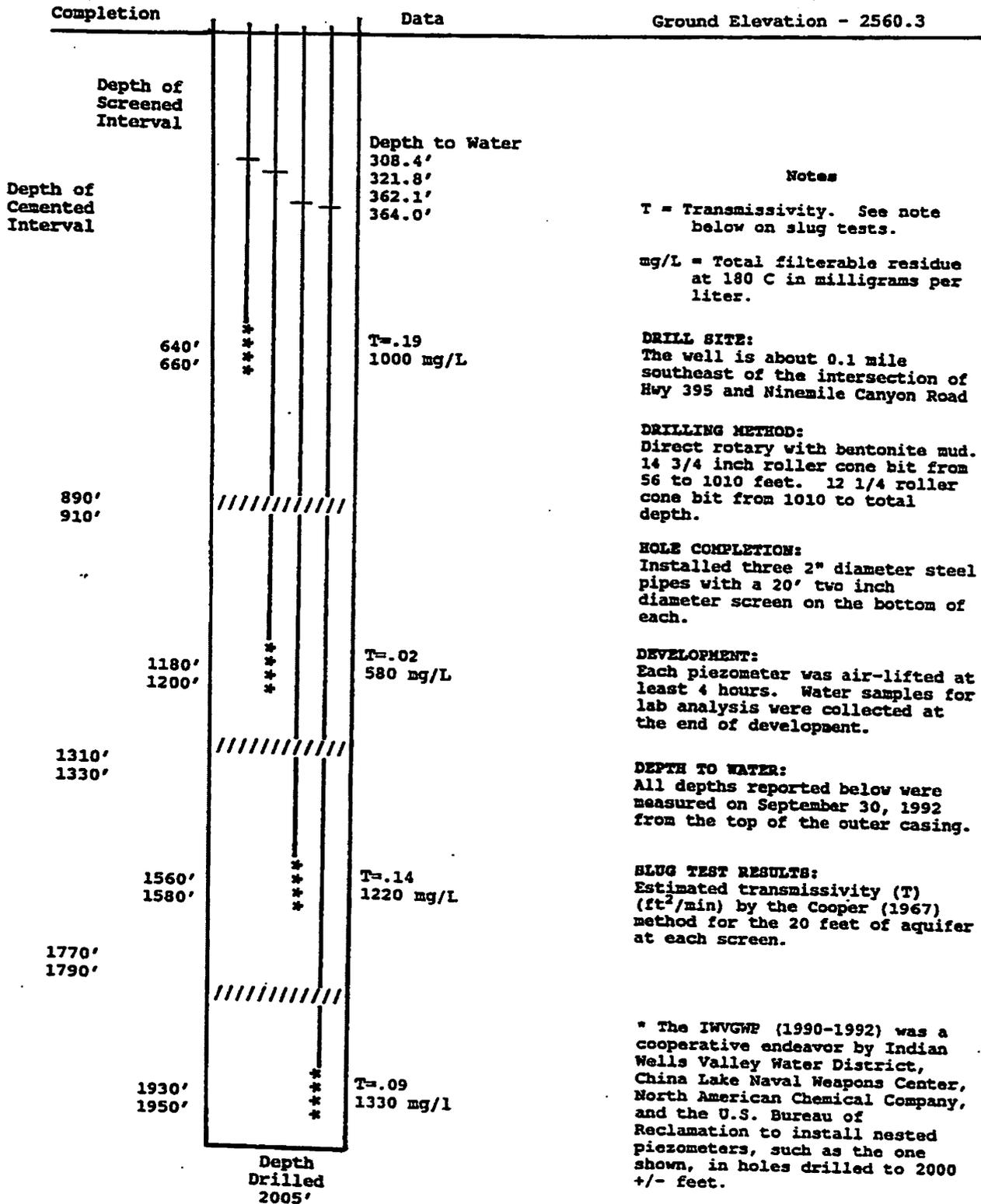
**\*\* Well BR-6 \*\*  
3 - 2" Piezometers**



\* The IWVGWP (1990-1992) was a cooperative endeavor by Indian Wells Valley Water District, China Lake Naval Weapons Center, North American Chemical Company, and the U.S. Bureau of Reclamation to install nested piezometers, such as the one shown, in holes drilled to 2000 +/- feet.

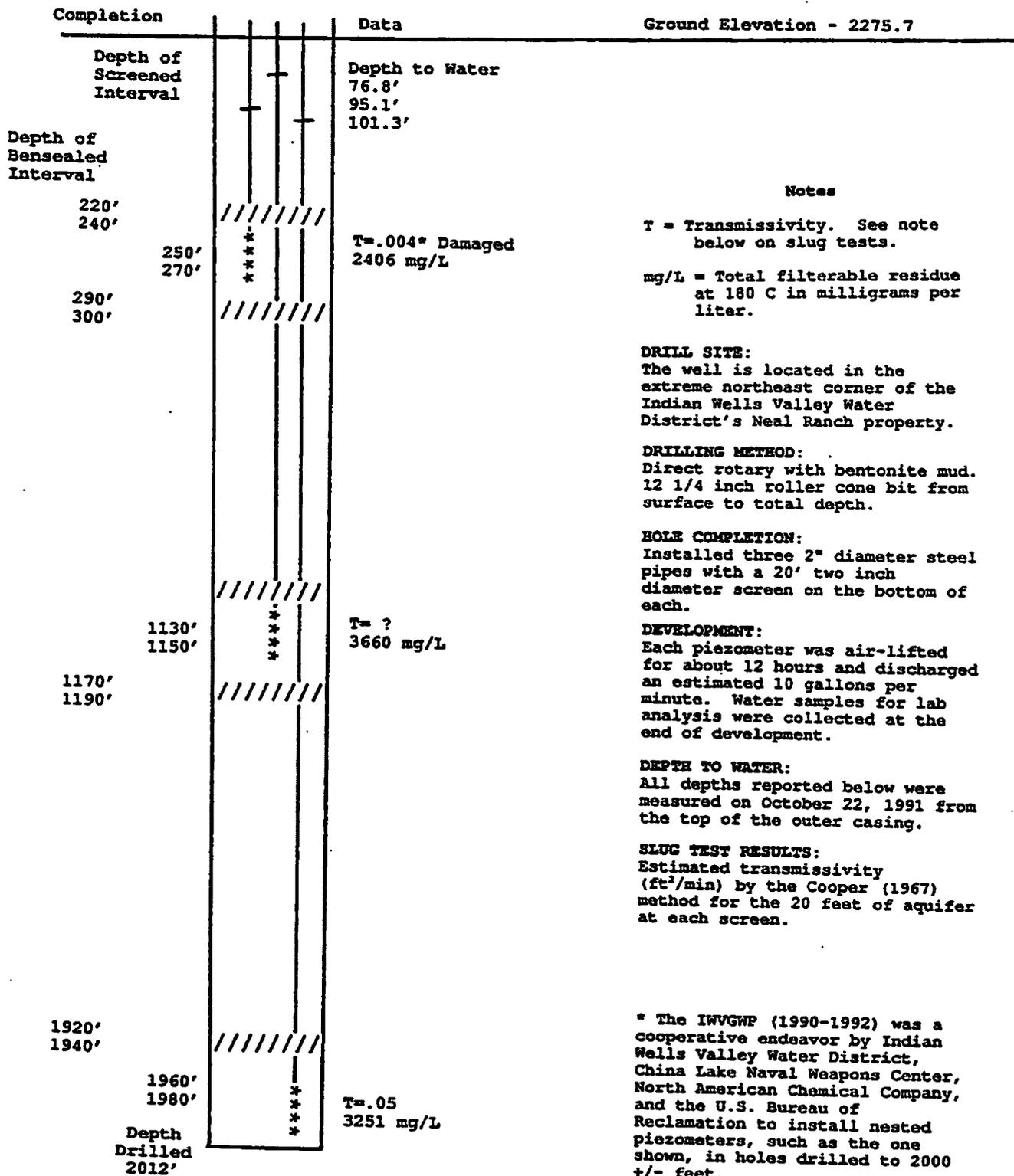
**Indian Wells Valley Groundwater Project (IWVGWP)\*  
Diagrammatic Completion and Data Summary Sheet**

**\*\* Well BR-10 \*\*  
4 - 2" Piezometers**



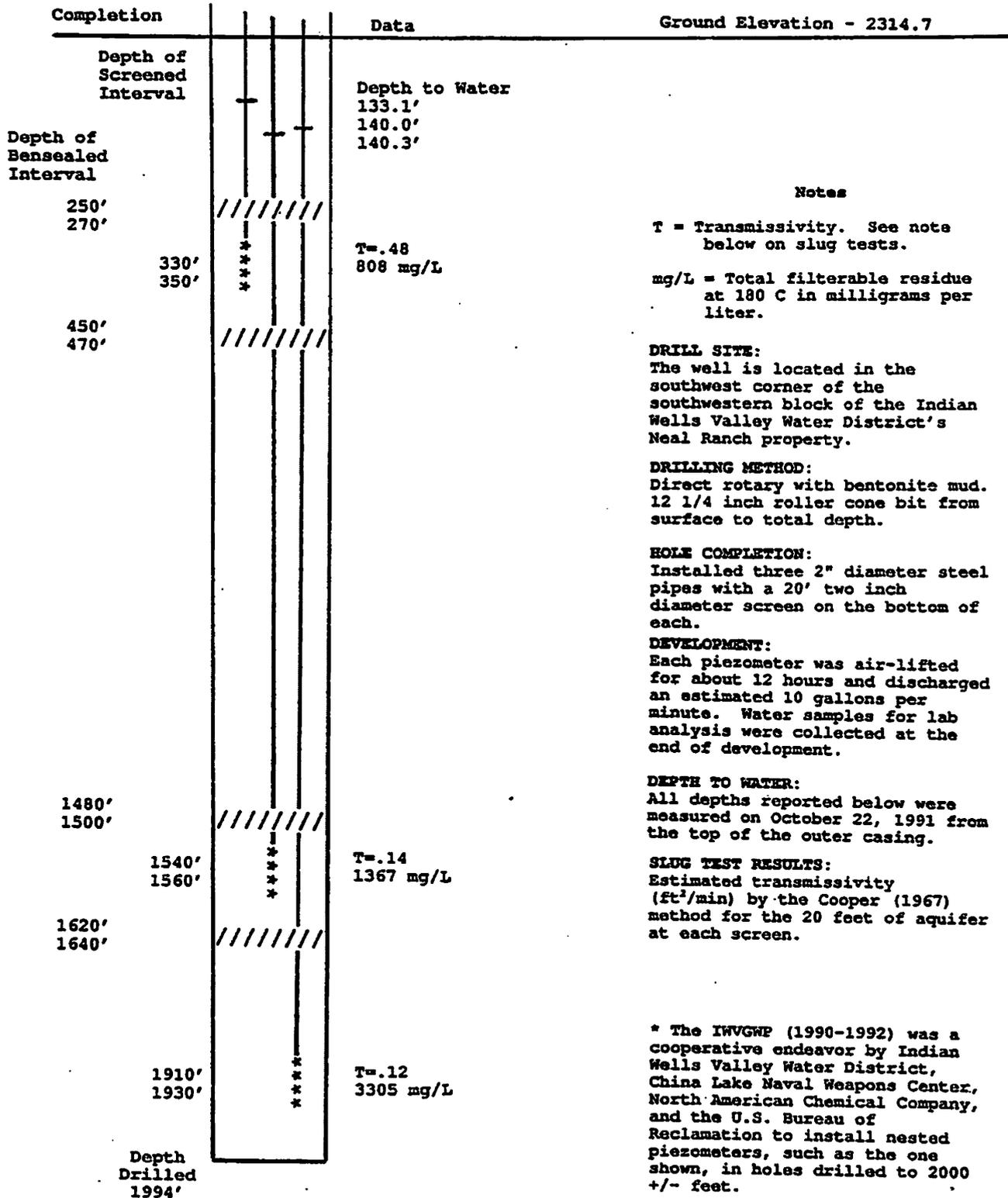
**Indian Wells Valley Groundwater Project (IWVGWP)\*  
Diagrammatic Completion and Data Summary Sheet**

**\*\* Well NR-1 \*\*  
[Water District Well]  
3 - 2" Piezometers**



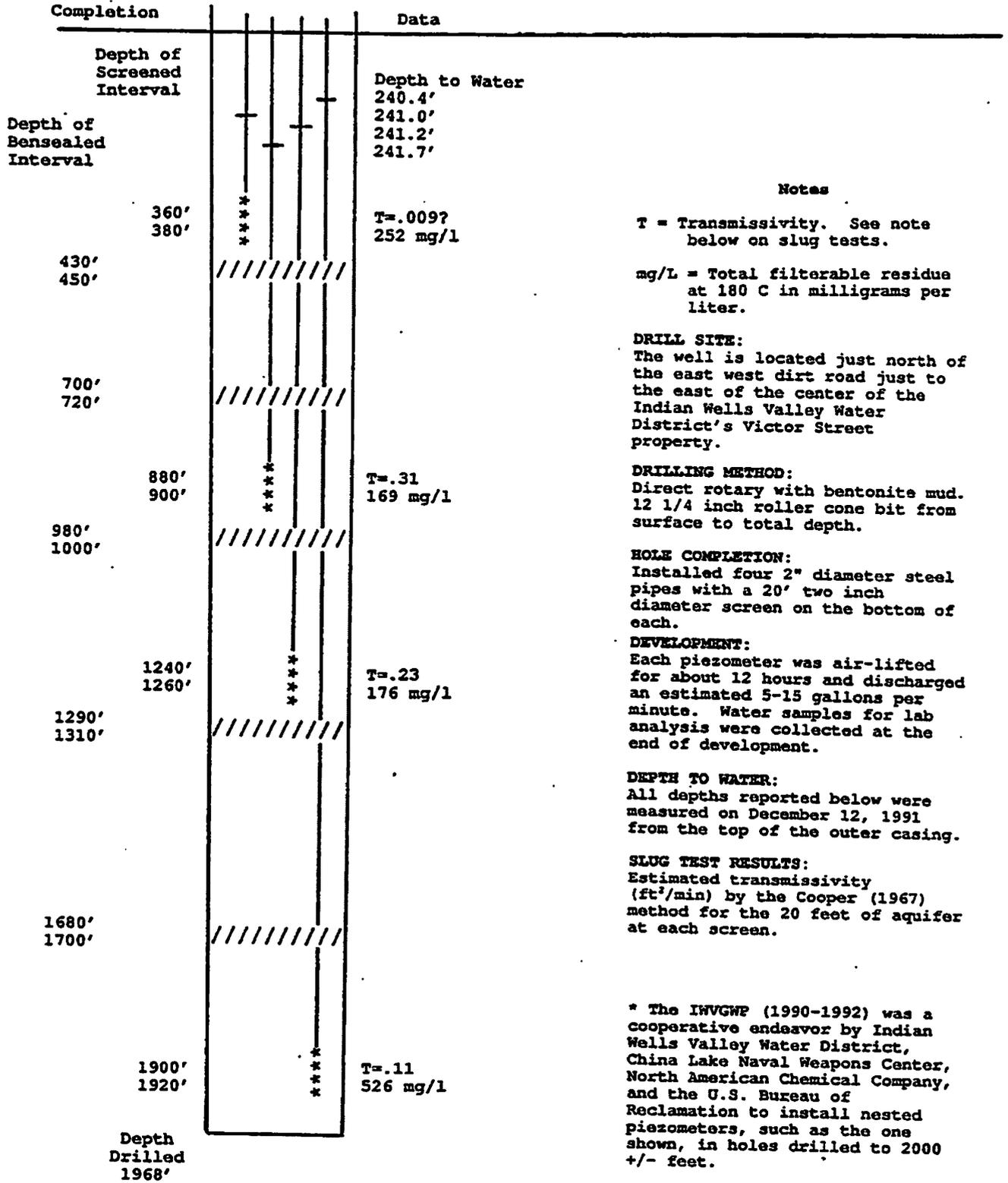
**Indian Wells Valley Groundwater Project (IWVGWP)\*  
Diagrammatic Completion and Data Summary Sheet**

**\*\* Well NR-2 \*\*  
[Water District Well]  
3 - 2" Piezometers**



**Indian Wells Valley Groundwater Project (IWVGWP)\*  
Diagrammatic Completion and Data Summary Sheet**

**\*\* Well MW-32 \*\*  
[Water District Well]  
4 - 2" Piezometers**

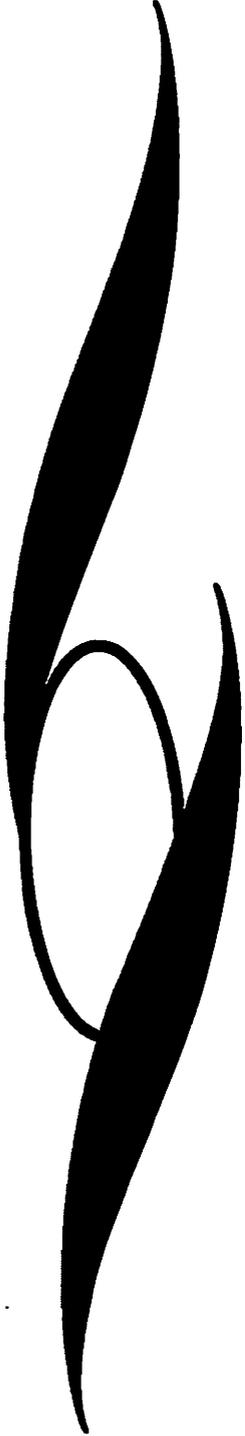


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# **APPENDIX VII**

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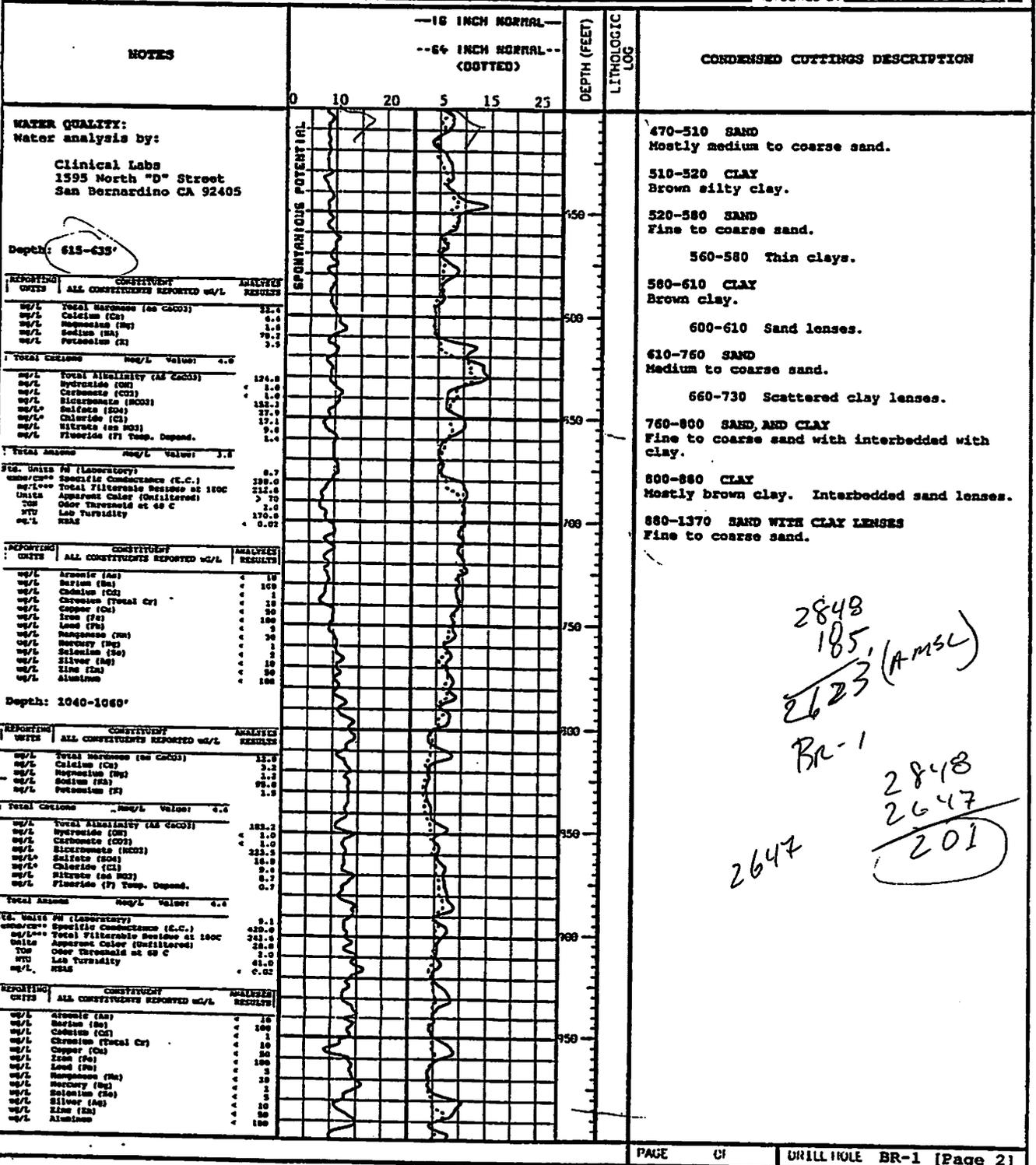
**Drill Hole Completion and Geologic Logs**





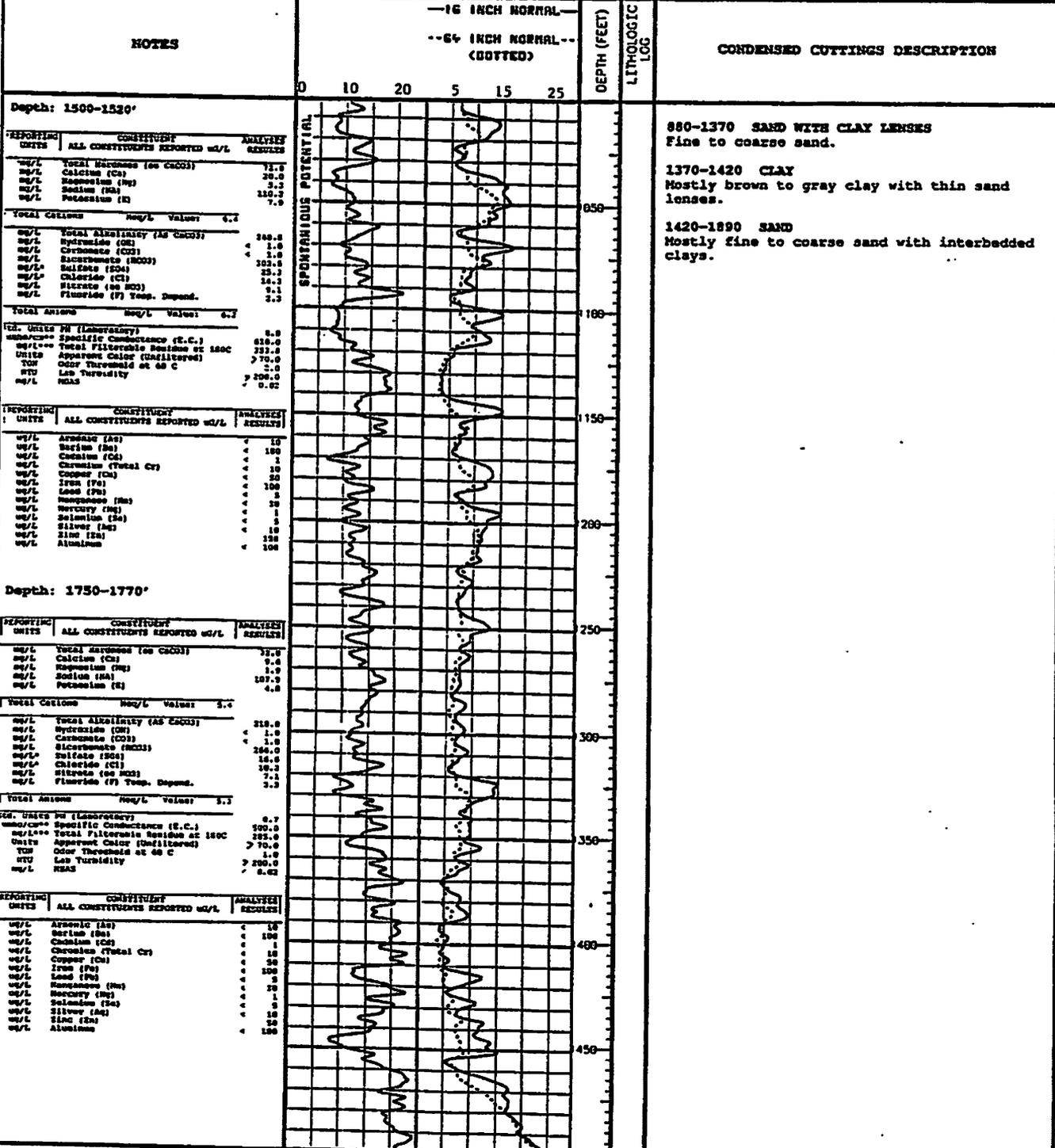
**USBR Drill Hole Completion and Data Log  
Monitoring Well BR-1**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 1910 Ft.  
 PROJECT Indian Wells Valley Groundwater Project COMPLETED DEPTH 1790 Ft.  
 LOCATION T.27 S., R.38 E., Sec. 23b STATE CA BEGUN 2-15-91  
 TYPE OF WELL Observation FINISHED 3-5-91  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION 2848.3  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. 2852.2  
 HOLE LOGGED BY Cuttings Description by Dinti Barari, N. Amer. Chem. Co., Trona CA DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral. LAB ANALYSIS Yes, See Notes  
 \_\_\_\_\_ Temperature \_\_\_\_\_ TDS See Notes  
 OTHER LOGS Drilling Time \_\_\_\_\_ REVIEWED BY Dennis Watt, USBR



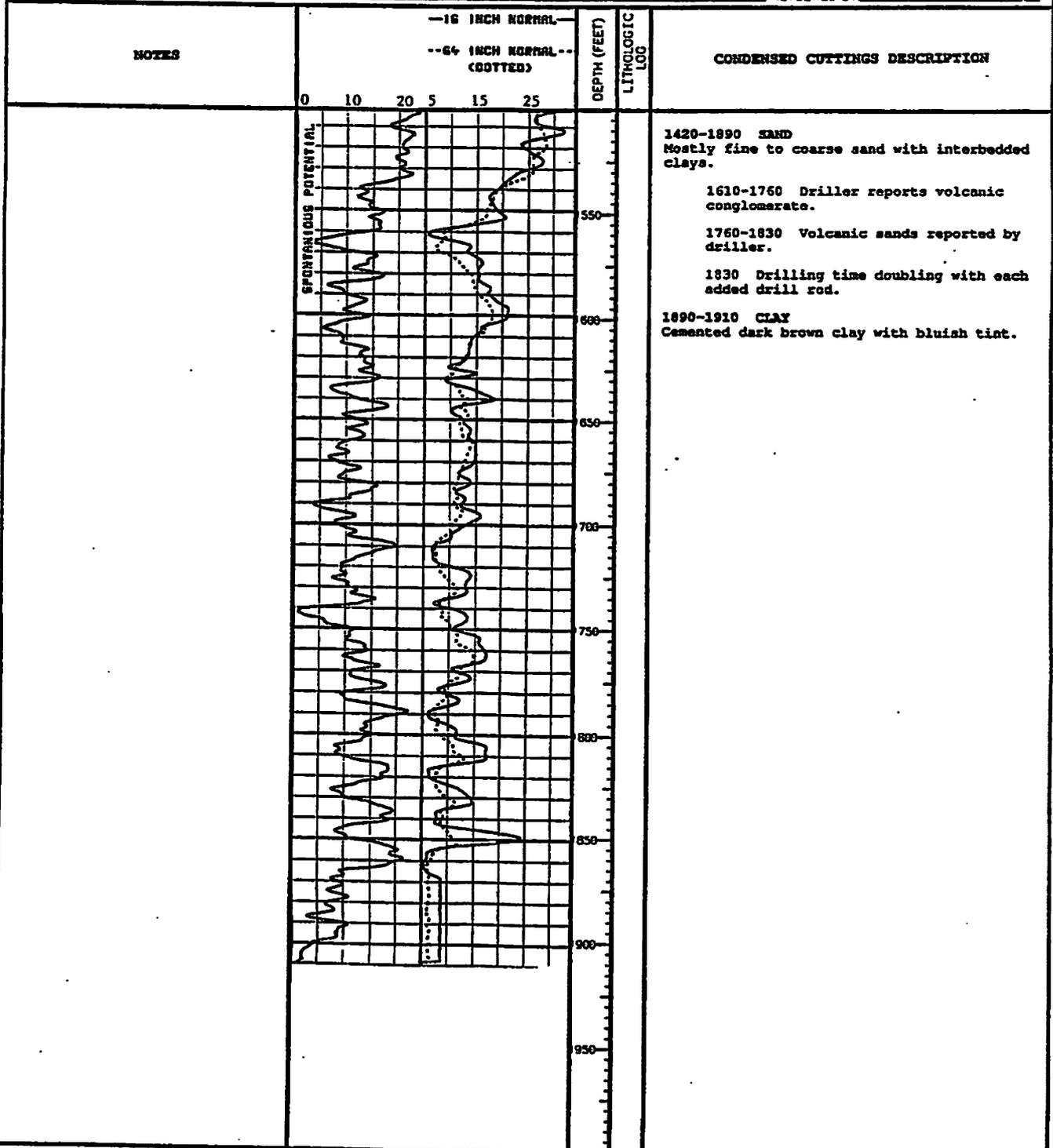
**USBR Drill Hole Completion and Data Log  
Monitoring Well BR-1**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 1910 Ft.  
 PROJECT Indian Wells Valley Groundwater Project COMPLETED DEPTH 1790 Ft.  
 LOCATION T.27 S., R.38 E., Sec. 23b STATE CA BEGUN 2-15-91  
 TYPE OF WELL Observation FINISHED 3-5-91  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION 2848.3  
 COORDINATES TOP OF CASING ELEV. 2852.2  
 HOLE LOGGED BY Cuttings Description by Dipti Barari, N. Amer. Chem. Co., Trona CA DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral. LAB ANALYSIS Yes, See Notes  
 OTHER LOGS Temperature TDS See Notes  
Drilling Time REVIEWED BY Dennis Watt, USBR



**USBR Drill Hole Completion and Data Log  
Monitoring Well BR-1**

**FEATURE** Drill Hole Completed with Nested Piezometers **GRILLED DEPTH** 1910 Ft.  
**PROJECT** Indian Wells Valley Groundwater Project **COMPLETED DEPTH** 1790 Ft.  
**LOCATION** T.27 S., R.38 E., Sec. 23b **STATE** CA **BEGUN** 2-15-91  
**TYPE OF WELL** Observation **FINISHED** 3-5-91  
**PURPOSE** Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity **GROUND ELEVATION** 2848.3  
**COORDINATES** \_\_\_\_\_ **TOP OF CASING ELEV.** 2852.2  
**HOLE LOGGED BY** Cuttings Description by Dipri Barari, N. Amer. Chem. Co., Trona CA **DEPTH TO WATER (DATE)** See Notes  
**GEOPHYSICAL LOGS** Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature **LAB ANALYSIS** Yes, See Notes  
**OTHER LOGS** Drilling Time **TOS** See Notes  
**REVIEWED BY** Dennis Watt, USBR



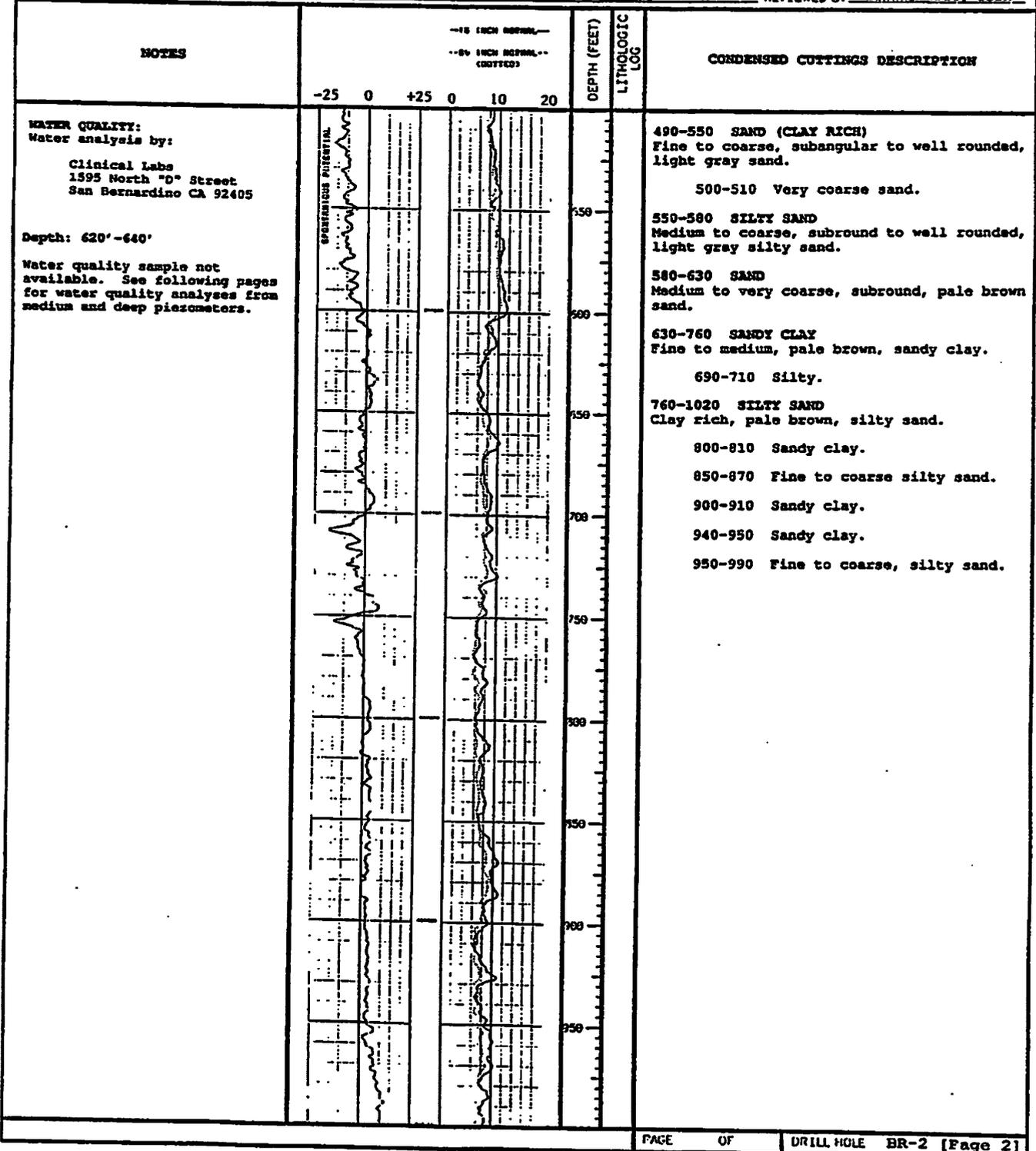
**USBR Drill Hole Completion and Data Log  
Monitoring Well BR-2**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 2020 Ft.  
 PROJECT Indian Wells Valley Groundwater Project COMPLETED DEPTH 1984 Ft.  
 LOCATION T.27 S., R 38 E., Sec. 2c STATE CA BEGUN 10-01-90  
 TYPE OF WELL Observation FINISHED 10-24-90  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION 2655.9  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. 2658.8  
 HOLE LOGGED BY Cuttings Description by Ken Turner, Kern Co. Water Agency DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature LAB ANALYSIS Yes, See Notes  
 OTHER LOGS Drilling Time TDS See Notes  
 REVIEWED BY Dennis Watt, USBR

NOTES	<p align="center"><b>BARBOUR CORP</b></p> <p align="center">WELL SURVEYING 802-482-1888</p> <p align="center"><b>ELECTRIC LOG</b></p>	DEPTH (FEET)	CONDENSED CUTTINGS DESCRIPTION																
<p><b>DRILL SITE:</b> The well is located about 1 1/4 miles south of Hwy. 178 at the end of Sierra Vista Road.</p> <p><b>DRILLED BY:</b> Southern California Drilling Company of Lancaster CA.</p> <p><b>DRILLING RIG:</b> Custom built small oil-field rotary rig.</p> <p><b>DRILLING METHOD:</b> Direct rotary with bentonite mud. 12 1/4 inch roller cone bit from surface to total depth.</p> <p><b>HOLE COMPLETION:</b> Installed three 2" diameter steel pipes with a 20" two inch diameter screen on the bottom of each. Screens are at the following depth intervals: 570'-590', 1460'-1480', 1940'-1960'. Twenty feet of 2" pipe below each screen. Nest cement plugs set at the following depth intervals: 680'-700', 1140'-1160', 1550'-1570', 1740'-1760'.</p> <p><b>DEVELOPMENT:</b> Each piezometer was air-lifted for about 12 hours and discharged an estimated 10 gallons per minute.</p> <p><b>DEPTH TO WATER:</b> All depths reported below were measured on October 22, 1991 from the top of the outer casing.</p> <table border="1"> <thead> <tr> <th>Screen Interval</th> <th>Depth (Ft.)</th> </tr> </thead> <tbody> <tr> <td>620'-640'</td> <td>276.1</td> </tr> <tr> <td>1460'-1480'</td> <td>282.0</td> </tr> <tr> <td>1940'-1960'</td> <td>272.7</td> </tr> </tbody> </table> <p>All depth to water measurements are available in an attachment to the Geohydrologic Appendix for this project.</p> <p><b>SLUG TEST RESULTS:</b> Estimated transmissivity (ft<sup>2</sup>/min) by the Cooper (1967) method for the 20 feet of aquifer at each screen.</p> <table border="1"> <thead> <tr> <th>Piezometer</th> <th>T</th> </tr> </thead> <tbody> <tr> <td>Shallow</td> <td>.017</td> </tr> <tr> <td>Medium</td> <td>.19</td> </tr> <tr> <td>Deep</td> <td>.016</td> </tr> </tbody> </table>	Screen Interval	Depth (Ft.)	620'-640'	276.1	1460'-1480'	282.0	1940'-1960'	272.7	Piezometer	T	Shallow	.017	Medium	.19	Deep	.016		<p>50</p> <p>100</p> <p>150</p> <p>200</p> <p>250</p> <p>300</p> <p>350</p> <p>400</p> <p>450</p>	<p>The interpretation below is reduced from a description of samples collected every 10 feet from the drilling mud return.</p> <p><b>GENERAL</b></p> <p>The collected samples and drilling character indicate a non-cemented alluvial fill from land surface to total depth.</p> <p>Depth intervals are feet below land surface.</p> <p>0-80 SAND Fine to coarse, subangular to subrounded, brown to light brown sand.</p> <p>0-10 Silty.</p> <p>30-40 Coarse to very coarse.</p> <p>70-80 Some small pebbles.</p> <p>80-250 SAND Medium to very coarse, mostly subangular with some subrounded, light brownish gray to light gray sand.</p> <p>150-160 Some pebbles.</p> <p>170-180 Some pebbles.</p> <p>190-220 Some pebbles.</p> <p>250-380 SAND Fine to coarse, subangular to subround, light gray sand.</p> <p>270-290 Medium to coarse.</p> <p>310-330 Medium to very coarse.</p> <p>330-340 Very fine to medium.</p> <p>350-370 Medium to very coarse.</p> <p>380-490 SILTY SAND Fine to coarse, subangular to subrounded, light gray, silty sand.</p> <p>400-490 Well rounded.</p>
Screen Interval	Depth (Ft.)																		
620'-640'	276.1																		
1460'-1480'	282.0																		
1940'-1960'	272.7																		
Piezometer	T																		
Shallow	.017																		
Medium	.19																		
Deep	.016																		

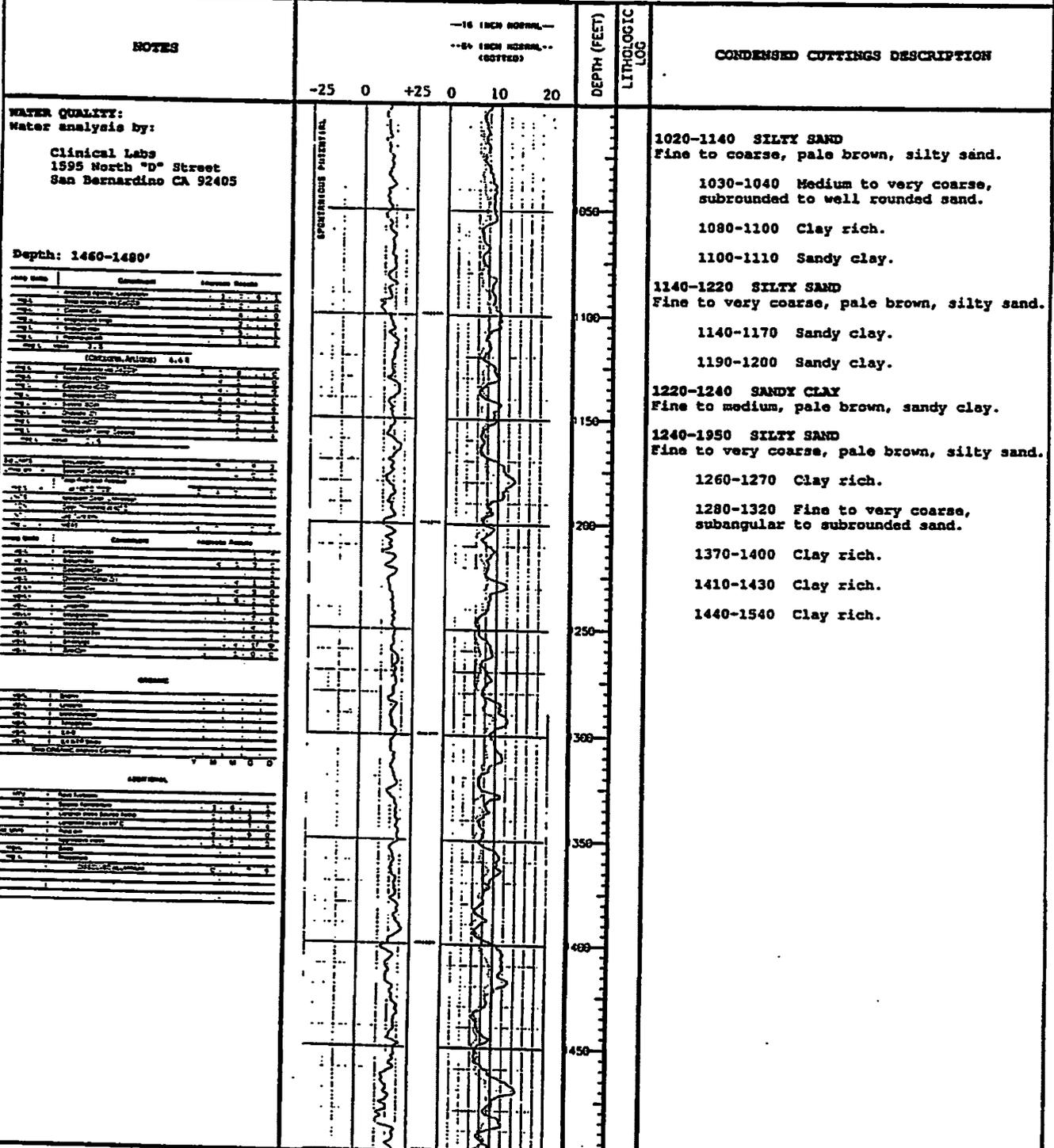
**USBR Drill Hole Completion and Data Log  
Monitoring Well BR-2**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 2020 Ft.  
 PROJECT Indian Wells Valley Groundwater Project COMPLETED DEPTH 1984 Ft.  
 LOCATION T.27 S., R 38 E., Sec. 2c STATE CA BEGUN 10-01-90  
 TYPE OF WELL Observation FINISHED 10-24-90  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION 2655.9  
 COORDINATES TOP OF CASING ELEV. 2658.8  
 HOLE LOGGED BY Cuttings Description by Ken Turner, Kern Co. Water Agency DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature LAB ANALYSIS Yes, See Notes  
 OTHER LOGS Drilling Time TDS See Notes  
 REVIEWED BY Dennis Watt, USBR



**USBR Drill Hole Completion and Data Log  
Monitoring Well BR-2**

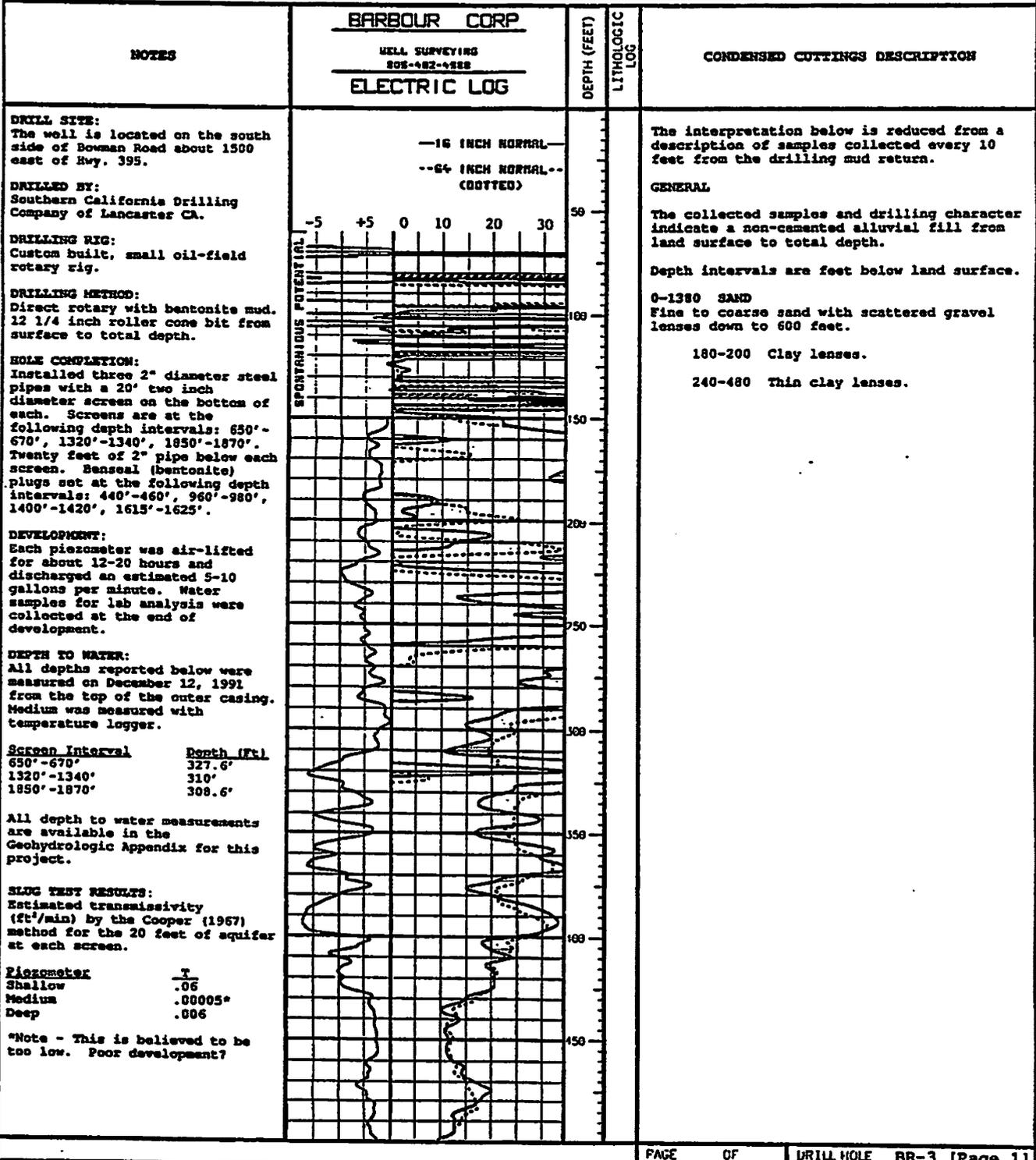
FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 2020 Ft.  
 PROJECT Indian Wells Valley Groundwater Project COMPLETED DEPTH 1984 Ft.  
 LOCATION T.27 S., R 38 E., Sec. 2c STATE CA BEGUN 10-01-90  
 TYPE OF WELL Observation FINISHED 10-24-90  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION 2655.9  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. 2658.8  
 HOLE LOGGED BY Cuttings Description by Ken Turner, Kern Co. Water Agency DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature LAB ANALYSIS Yes, See Notes  
 OTHER LOGS Drilling Time TDS See Notes  
 REVIEWED BY Dennis Watt, USBR





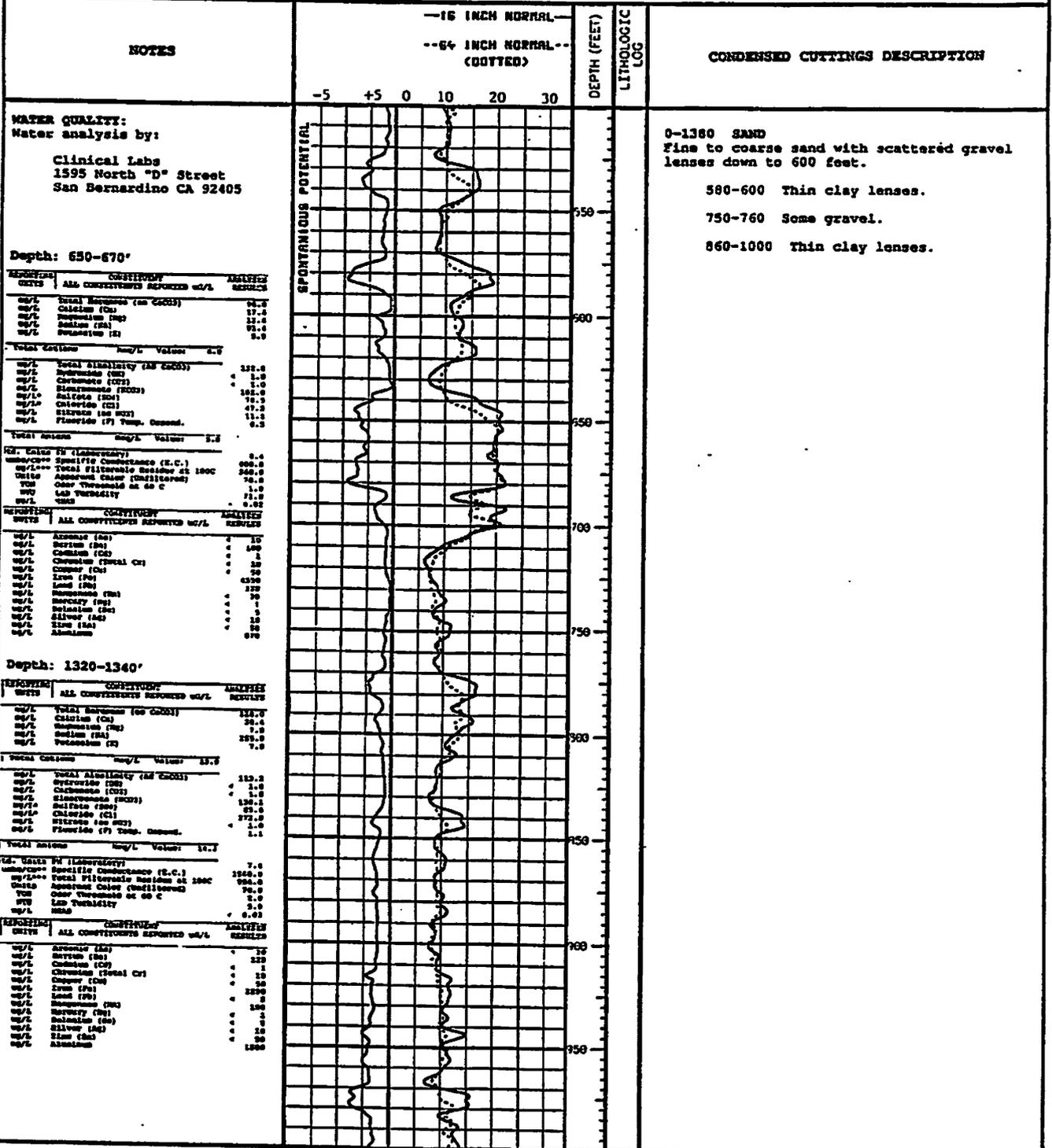
**USBR Drill Hole Completion and Data Log  
Monitoring Well BR-3**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 2024 Ft.  
 PROJECT Indian Wells Valley Groundwater Project COMPLETED DEPTH 1990 Ft.  
 LOCATION T.27 S., R.39 E., Sec. 11d STATE CA BEGUN 3-06-91  
 TYPE OF WELL Observation FINISHED 3-19-91  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION 2508.6  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. 2511.9  
 HOLE LOGGED BY Cuttings Description by Dipti Barari, N. Amer. Chem. Co., Trona CA DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, LAB ANALYSIS Yes, See Notes  
 \_\_\_\_\_ Temperature \_\_\_\_\_ IDS See Notes  
 OTHER LOGS Drilling Time \_\_\_\_\_ REVIEWED BY Dennis Watt, USBR



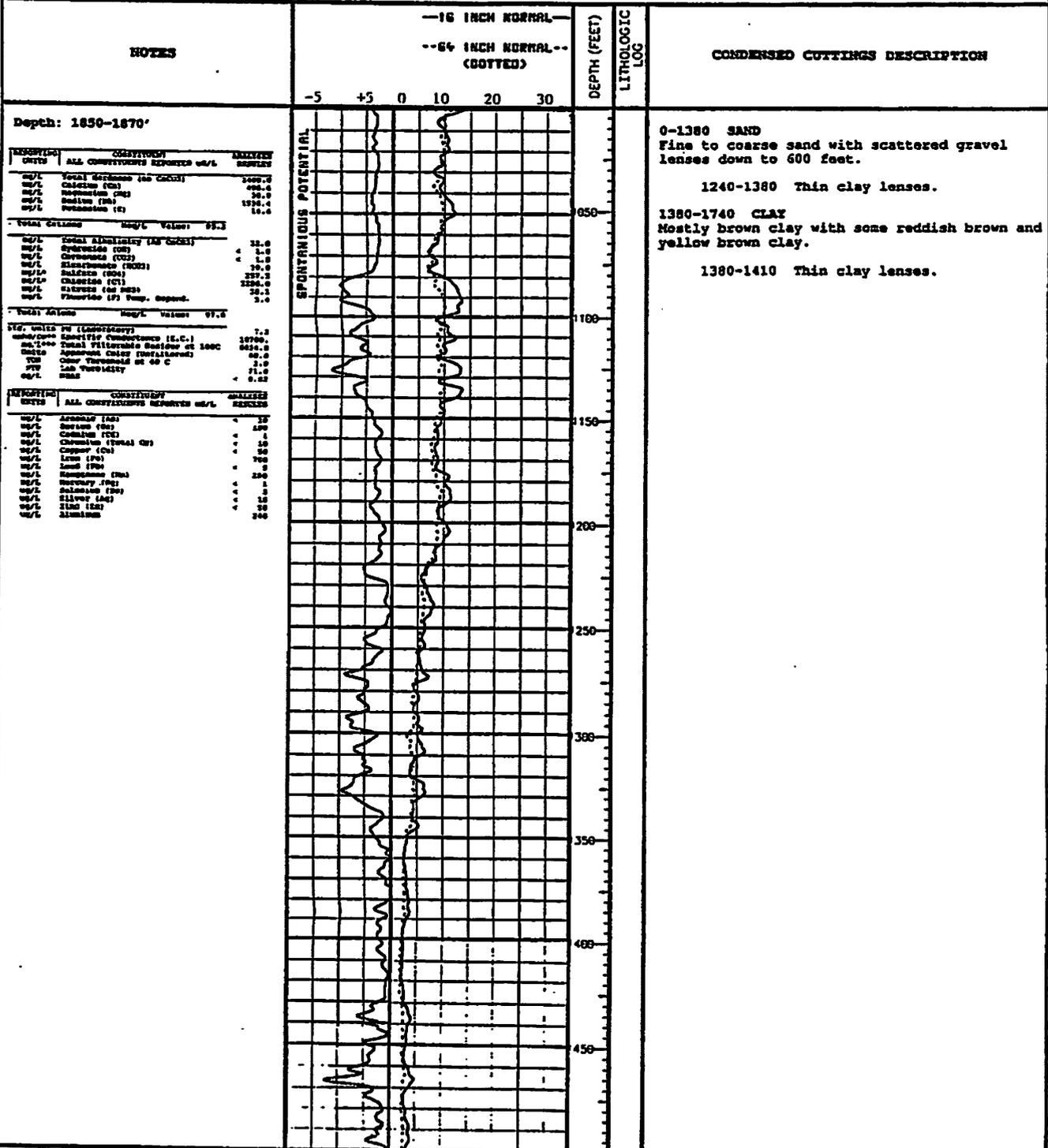
**USBR Drill Hole Completion and Data Log  
Monitoring Well BR-3**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 2024 Ft.  
 PROJECT Indian Wells Valley Groundwater Project COMPLETED DEPTH 1990 Ft.  
 LOCATION T.27 S., R.39 E., Sec. 11d STATE CA BEGUN 3-06-91  
 TYPE OF WELL Observation FINISHED 3-19-91  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION 2508.6  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. 2511.9  
 HOLE LOGGED BY Cuttings Description by Dipri Barari, N. Amer. Chem. Co., Trona CA DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature LAB ANALYSIS Yes, See Notes  
 OTHER LOGS Drilling Time TDS See Notes  
 REVIEWED BY Dennis Watt, USBR



**USBR Drill Hole Completion and Data Log  
Monitoring Well BR-3**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 2024 Ft.  
 PROJECT Indian Wells Valley Groundwater Project COMPLETED DEPTH 1990 Ft.  
 LOCATION T.27 S., R.39 E., Sec. 11d STATE CA BEGUN 3-06-91  
 TYPE OF WELL Observation FINISHED 3-19-91  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION 2508.6  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. 2511.9  
 HOLE LOGGED BY Cuttings Description by Dipti Barari, N. Amer. Chem. Co., Trona CA DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, LAB ANALYSIS Yes, See Notes  
 \_\_\_\_\_ Temperature \_\_\_\_\_ TDS \_\_\_\_\_ See Notes  
 OTHER LOGS Drilling Time \_\_\_\_\_ REVIEWED BY Dennis Watt, USBR



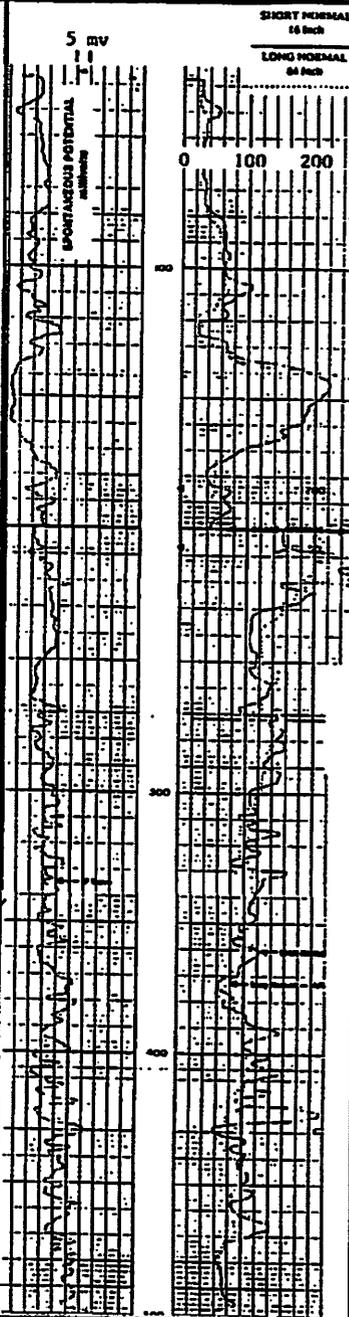
**USBR Drill Hole Completion and Data Log  
Monitoring Well BR-3**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 2024 Ft.  
 PROJECT Indian Wells Valley Groundwater Project COMPLETED DEPTH 1990 Ft.  
 LOCATION T.27 S., R.39 E., Sec. 11d STATE CA BEGUN 3-06-91  
 TYPE OF WELL Observation FINISHED 3-19-91  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION 2508.6  
 COORDINATES TOP OF CASING ELEV. 2511.9  
 HOLE LOGGED BY Cuttings Description by Dipri Barari, N. Amer. Chem. Co., Trona CA DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature LAB ANALYSIS Yes, See Notes  
 OTHER LOGS Drilling Time TDS See Notes  
 REVIEWED BY Dennis Watt, USBR

NOTES		DEPTH (FEET) LITHOLOGIC LOG	CONDENSED CUTTINGS DESCRIPTION
		550 600 650 700 750 800 850 900 950	<p>1380-1740 CLAY Mostly brown clay with some reddish brown and yellow brown clay.</p> <p>1680-1740 Sand layers.</p> <p>1740-1880 SAND WITH CLAY LAYERS Fine to coarse sand with brown clay layers.</p> <p>1880-1970 SAND Medium to coarse sand with a few thin clay lenses.</p> <p>1970-2024 SAND WITH CLAY LAYERS Mostly medium to coarse sand. Twenty to thirty percent of the cuttings were clay.</p>

**USBR Drill Hole Completion and Data Log  
Monitoring Well BR-4**

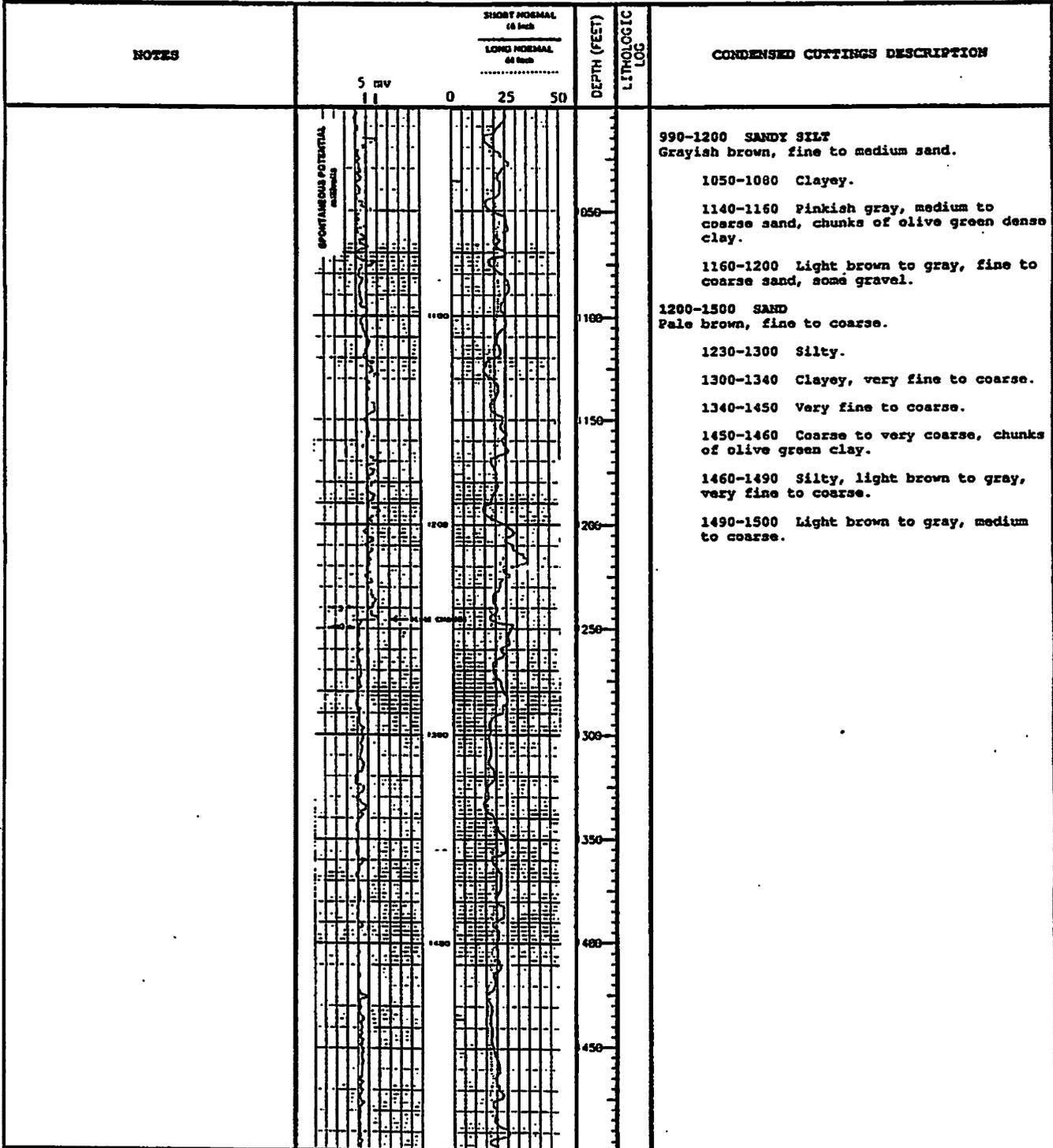
FEATURE Drill Hole Completed with Single Piezometer (Intended Multiple Completion) DRILLED DEPTH 2020 Ft.  
 PROJECT Indian Wells Valley Groundwater Project COMPLETED DEPTH 1210 Ft.  
 LOCATION T.26 S., R.39 E., Sec. 26a STATE CA BEGUN 8-29-90  
 TYPE OF WELL Observation FINISHED 9-14-90  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION 2375.2  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. 2377.5  
 HOLE LOGGED BY Cuttings Description by Ken Turner, Kern Co. Water Agency DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, LAB ANALYSIS Yes, See Notes  
 Temperature \_\_\_\_\_ TDS See Notes  
 OTHER LOGS Drilling Time REVIEWED BY Dennis Watt, USBR

NOTES	 ELECTRIC LOG	DEPTH (FEET) LITHOLOGIC LOG	CONDENSED CUTTINGS DESCRIPTION				
<p><b>DRILL SITE:</b> The well is located about 600 feet south of Hwy. 170, 1.05 miles west of Jack Ranch Road.</p> <p><b>DRILLED BY:</b> U.S. Bureau of Reclamation. One crew from Sacramento and the other from Phoenix.</p> <p><b>DRILLING RIG:</b> Truck mounted Portadrill TLS-542 rotary.</p> <p><b>DRILLING METHOD:</b> Direct rotary with bentonite mud. 7 7/8 inch roller cone bit to total depth. Reamed to total depth with a 10 1/4 inch roller cone bit.</p> <p><b>HOLE COMPLETION:</b> Installed one 2" diameter steel pipe with a 10' two inch diameter screen on the bottom. The screen is at a depth interval of 1190'-1200'. Benseal (bentonite) plug set at the following depth interval: 960'-1130'.</p> <p>This hole was to be completed with multiple piezometers. However, much difficulty ensued when the 2" filter pack tremie pipe could not be moved from the bottom of the hole. The deep piezometer (2000 ft.) was pulled out and the tremie broke during the attempt to pull it. An overshot was washed and rotated over the top of the stuck tremie. The overshot twisted off near the bottom after retrieving most of the tremie. Numerous fishing trips removed pipe down to 1220 feet. Lead impression showed that the hole was filled around the pipes at 1220 feet. Decided to complete the remaining open hole with one piezometer to 1200 feet. Nearby production wells are screened down to about 1000 feet.</p> <p><i>1224' casing drawn 5/22/91</i></p> <p><b>DEVELOPMENT:</b> The piezometer was air-lifted and discharged an estimated 5-10 gallons per minute. The water sample for lab analysis was collected at the end of development.</p> <p><b>DEPTH TO WATER:</b> Depth was measured on December 12, 1991 from the top of the outer casing.</p> <table border="1"> <tr> <td>Screen Interval</td> <td>Depth (Ft.)</td> </tr> <tr> <td>1190'-1200'</td> <td>252'</td> </tr> </table> <p>All depth to water measurements are available in the Geohydrologic Appendix for this project.</p>	Screen Interval	Depth (Ft.)	1190'-1200'	252'		0 50 100 150 200 250 300 350 400 450 500	<p>The interpretation below is reduced from a description of samples collected every 10 feet from the drilling mud return.</p> <p><b>GENERAL</b></p> <p>The collected samples and drilling character indicate a non-cemented alluvial fill from land surface to total depth.</p> <p>Depth intervals are feet below land surface.</p> <p>0-160 SAND Light brown, medium to coarse.</p> <p>40-60 Coarse.</p> <p>60-120 Coarse, occasional fine gravel.</p> <p>120-130 Yellowish brown, very fine to fine.</p> <p>130-140 Brownish gray.</p> <p>140-150 Pinkish gray.</p> <p>150-160 Gravelly, pinkish gray.</p> <p>160-250 GRAVELLY SAND Pinkish gray, fine to coarse.</p> <p>240-250 Dark gray to black, medium to coarse.</p> <p>250-270 Gray, medium to coarse.</p> <p>330-390 Silty with fine gravel, brownish gray.</p> <p>390-420 Brown.</p> <p>420-510 SILTY SAND Brown, fine to coarse.</p>
Screen Interval	Depth (Ft.)						
1190'-1200'	252'						



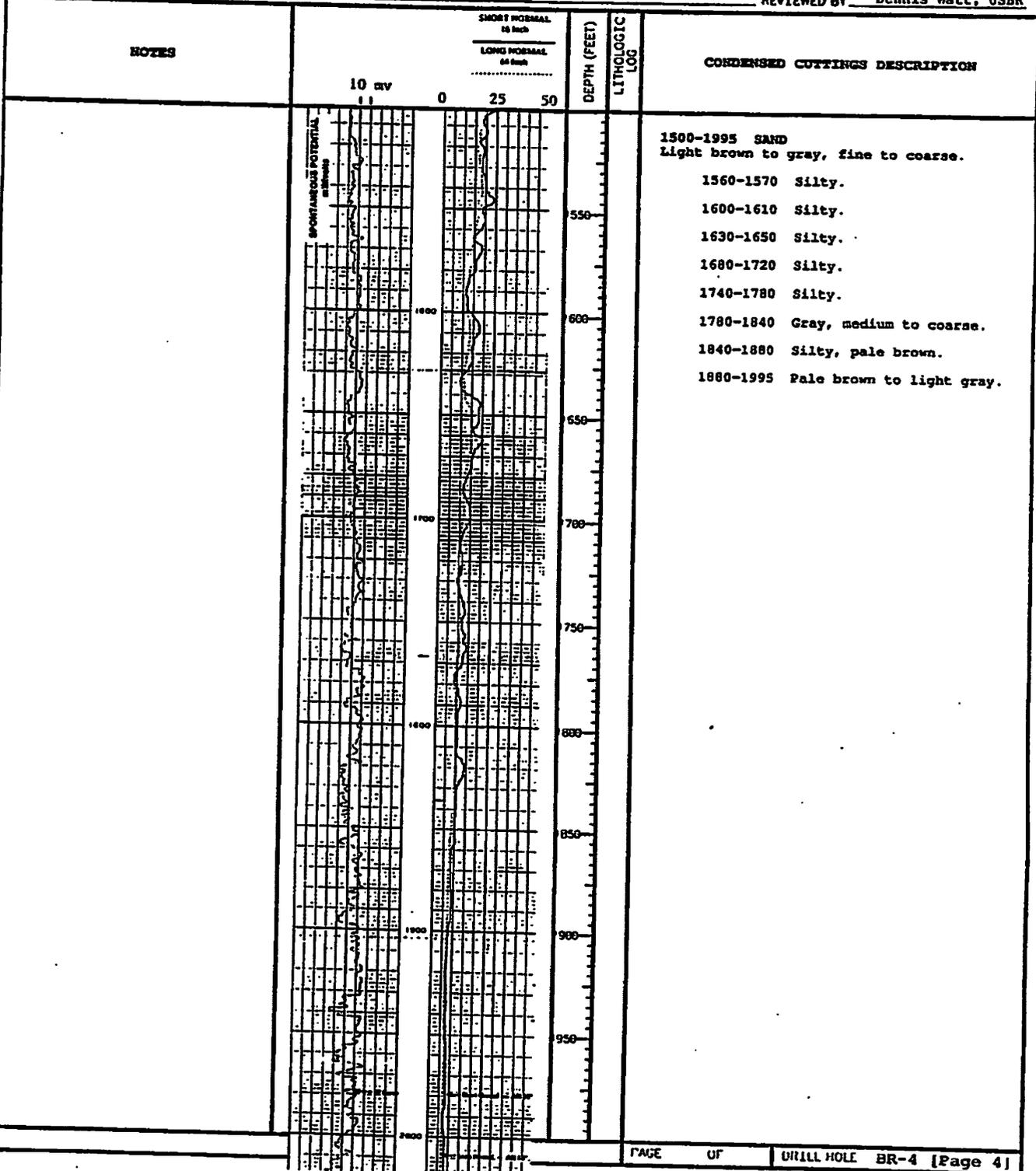
**USBR Drill Hole Completion and Data Log  
Monitoring Well BR-4**

FEATURE Drill Hole Completed with Single Piezometer (Intended Multiple Completion) DRILLED DEPTH 2020 Ft.  
 PROJECT Indian Wells Valley Groundwater Project COMPLETED DEPTH 1210 Ft.  
 LOCATION T.26 S., R.39 E., Sec. 26a STATE CA BEGUN 8-29-90  
 TYPE OF WELL Observation FINISHED 9-14-90  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION 2375.2  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. 2377.5  
 HOLE LOGGED BY Cuttings Description by Ken Turner, Kern Co. Water Agency DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, LAB ANALYSIS Yes, See Note  
Temperature TDS See Notes  
 OTHER LOGS Drilling Time REVIEWED BY Dennis Watt, USBR



**USBR Drill Hole Completion and Data Log  
Monitoring Well BR-4**

**FEATURE** Drill Hole Completed with Single Piezometer (Intended Multiple Completion) **DRILLED DEPTH** 2020 Ft.  
**PROJECT** Indian Wells Valley Groundwater Project **COMPLETED DEPTH** 1210 Ft.  
**LOCATION** T.26 S., R.39 E., Sec. 26a **STATE** CA **BEGUN** 8-29-90  
**TYPE OF WELL** Observation **FINISHED** 9-14-90  
**PURPOSE** Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity **GROUND ELEVATION** 2375.2  
**COORDINATES** \_\_\_\_\_ **TOP OF CASING ELEV.** 2377.5  
**HOLE LOGGED BY** Cuttings Description by Ken Turner, Kern Co. Water Agency **DEPTH TO WATER (DATE)** See Notes  
**GEOPHYSICAL LOGS** Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature **LAB ANALYSIS** Yes, See Note  
**OTHER LOGS** Drilling Time **TDS** See Notes  
**REVIEWED BY** Dennis Watt, USBR



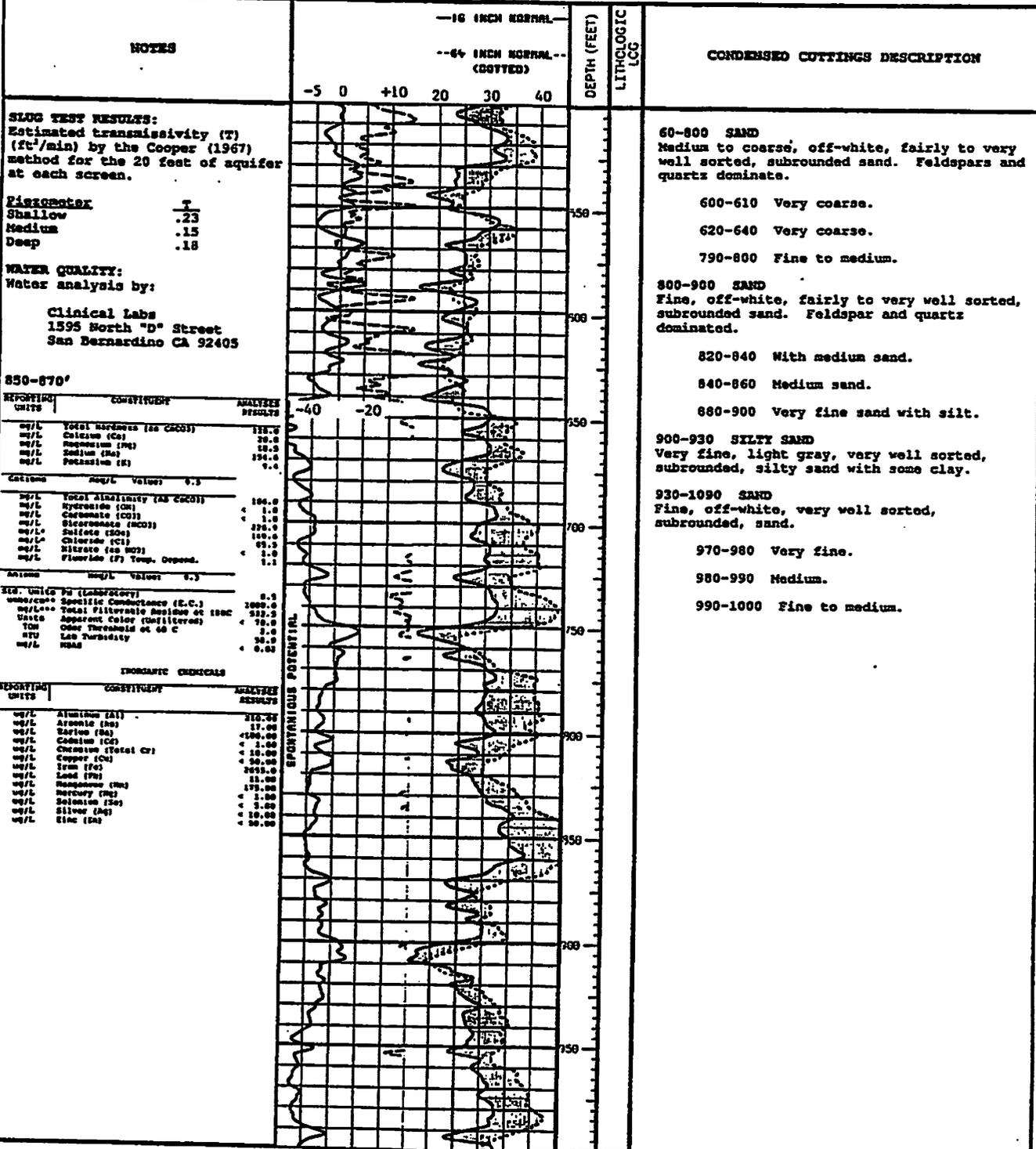
**USBR Drill Hole Completion and Data Log  
Monitoring Well BR-5**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 2013 Ft.  
 PROJECT Indian Wells Valley Groundwater Project COMPLETED DEPTH 1980 Ft.  
 LOCATION T.25 S., R.38 E., Sec. 341 STATE \_\_\_\_\_ BEGUN 12-19-91  
 TYPE OF WELL Observation FINISHED 1-03-92  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION 2518.6  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. 2512.5  
 HOLE LOGGED BY Cuttings Description by Mike Stoner, Naval Air Warfare Station DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral LAB ANALYSIS Yes, See Notes  
 Temperature \_\_\_\_\_ TDS See Notes  
 OTHER LOGS Drilling Time REVIEWED BY Dennis Watt, USBR

NOTES	<p align="center"><b>BARBOUR CORP</b></p> <p align="center">WELL SURVEYING 805-482-0888</p> <p align="center"><b>ELECTRIC LOG</b></p>	DEPTH (FEET) LITHOLOGIC LOG	CONDENSED CUTTINGS DESCRIPTION																
<p><b>DRILL SITE:</b> The well is about 200 feet west of Hwy. 395 at a point about 1/2 mile north of the intersection of Leliter Road and Hwy. 395.</p> <p><b>DRILLED BY:</b> Welch and Howell Drilling of El Centro CA.</p> <p><b>DRILLING RIG:</b> Mac double (106' total height) direct rotary rig.</p> <p><b>DRILLING METHOD:</b> Direct rotary with bentonite mud. 14 3/4 inch roller cone bit from 56 to 1014 feet. 12 1/4 roller cone bit from 1014 to total depth.</p> <p><b>SOLE COMPLETION:</b> Installed three 2" diameter steel pipes with a 20' two inch diameter screen on the bottom of each. Screens are at the following depth intervals: 850'-870', 1590'-1610', 1960'-1980'. Cement plugs set at the following depth intervals: 1365'-1385', 1696'-1706', 1788'-1800'.</p> <p><b>DEVELOPMENT:</b> Each piezometer was air-lifted 3-4 hours and discharged an estimated 5-10 gallons per minute. Water samples for lab analysis were collected at the end of development.</p> <p><b>DEPTH TO WATER:</b> All depths reported below were measured on January 28, 1992 from the top of the protective casing. These depths were measured only about 5 minutes after the cap was removed. Actual and relative depths may be different in subsequent measurements.</p> <table border="1"> <tr> <td>Screen Interval</td> <td>Depth (Ft.)</td> </tr> <tr> <td>850'-870'</td> <td>334.9</td> </tr> <tr> <td>1590'-1610'</td> <td>341.9</td> </tr> <tr> <td>1960'-1980'</td> <td>343.7</td> </tr> </table> <p>All depth to water measurements made during the project life are available in the Geohydrologic Appendix for this project.</p> <p><b>SLOG TEST RESULTS:</b> Estimated transmissivity (T) (ft<sup>2</sup>/min) by the Cooper (1967) method for the 20 feet of aquifer at each screen.</p> <table border="1"> <tr> <td>Piezometer</td> <td>T</td> </tr> <tr> <td>Shallow</td> <td>.23</td> </tr> <tr> <td>Medium</td> <td>.15</td> </tr> <tr> <td>Deep</td> <td>.18</td> </tr> </table>	Screen Interval	Depth (Ft.)	850'-870'	334.9	1590'-1610'	341.9	1960'-1980'	343.7	Piezometer	T	Shallow	.23	Medium	.15	Deep	.18		<p>50</p> <p>100</p> <p>150</p> <p>200</p> <p>250</p> <p>300</p> <p>350</p> <p>400</p> <p>450</p> <p>500</p>	<p>The description below is reduced from a description of samples collected every 10 feet from the drilling mud return.</p> <p><b>GENERAL</b></p> <p>The collected samples and drilling character indicate a non-cemented alluvial fill from land surface to total depth.</p> <p>Depth intervals are feet below land surface.</p> <p>0-60 No samples.</p> <p>60-800 SAND Medium to coarse, off-white, fairly to very well sorted, subrounded sand. Feldspars and quartz dominate.</p> <p>60-80 Well rounded.</p> <p>100-110 Very coarse.</p> <p>120-130 Coarse to very coarse.</p> <p>180-190 Very coarse.</p> <p>240-250 Very coarse.</p> <p>250-260 Subangular.</p> <p>300-310 Fine to medium and unsorted.</p> <p>440-450 Very coarse.</p> <p>490-500 Coarse to very coarse.</p>
Screen Interval	Depth (Ft.)																		
850'-870'	334.9																		
1590'-1610'	341.9																		
1960'-1980'	343.7																		
Piezometer	T																		
Shallow	.23																		
Medium	.15																		
Deep	.18																		

**USBR Drill Hole Completion and Data Log  
Monitoring Well BR-5**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 2013 Ft.  
 PROJECT Indian Wells Valley Groundwater Project COMPLETED DEPTH 1980 Ft.  
 LOCATION T.25 S., R.38 E., Sec. 341 STATE \_\_\_\_\_ BEGUN 12-19-91  
 TYPE OF WELL Observation FINISHED 1-03-92  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION 2518.6  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. 2512.5  
 HOLE LOGGED BY Cuttings Description by Mike Stoner, Naval Air Warfare Station DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral LAB ANALYSIS Yes, See Notes  
 OTHER LOGS Drilling Time TDS \_\_\_\_\_ See Notes  
 REVIEWED BY Dennis Watt, USBR



**NOTES**

**SLOG TEST RESULTS:**  
 Estimated transmissivity (T)  
 (ft<sup>2</sup>/min) by the Cooper (1967)  
 method for the 20 feet of aquifer  
 at each screen.

**Piezometer**      **T**  
 Shallow            .23  
 Medium            .15  
 Deep                .18

**WATER QUALITY:**  
 Water analysis by:  
 Clinical Labs  
 1595 North "D" Street  
 San Bernardino CA 92405

**850-870'**

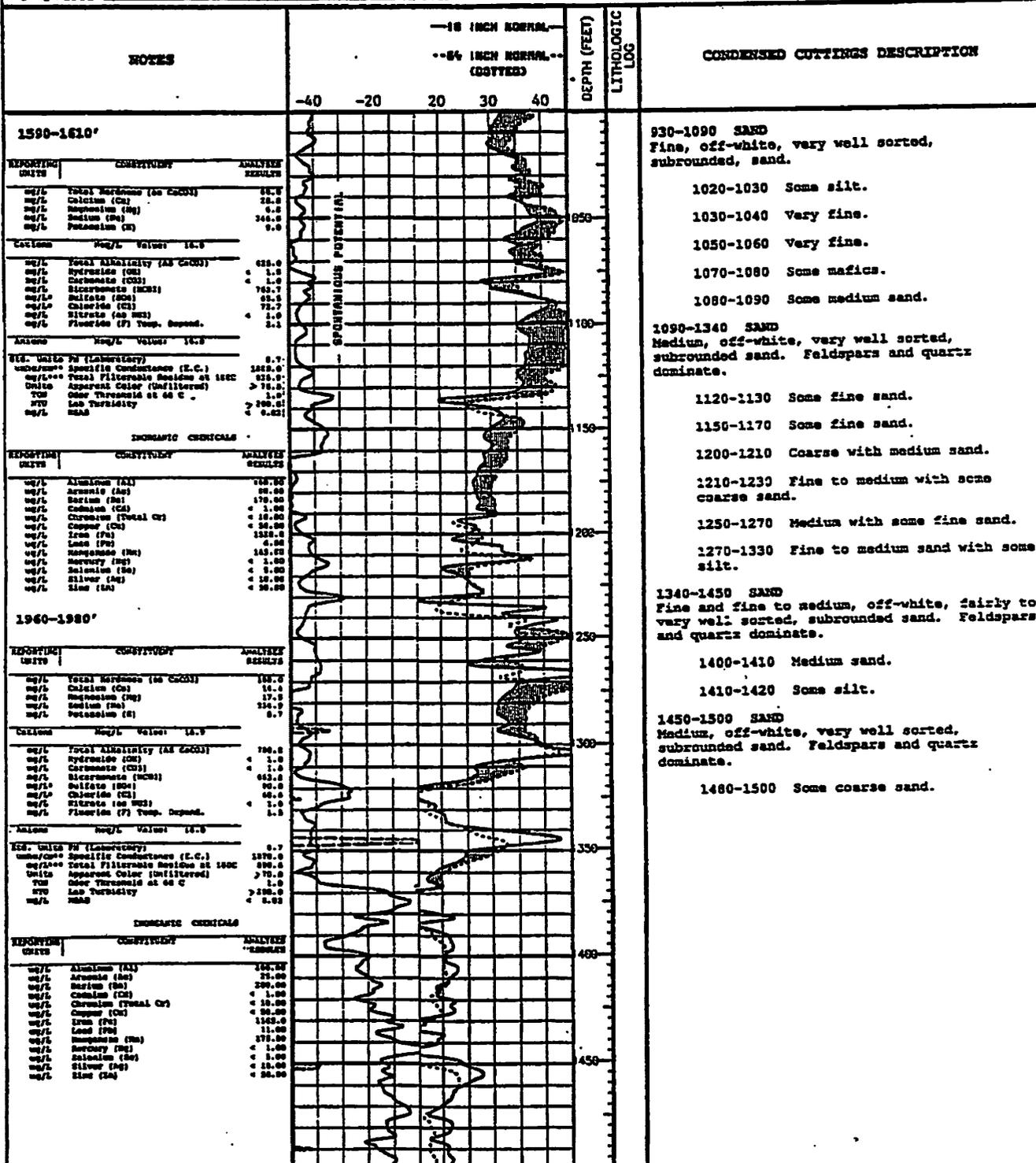
REPORTING UNITS	CONSTITUENT	ANALYSIS RESULTS
mg/L	Total hardness (as CaCO <sub>3</sub> )	118.0
mg/L	Calcium (Ca)	38.0
mg/L	Magnesium (Mg)	18.5
mg/L	Sodium (Na)	194.0
mg/L	Potassium (K)	9.4
Cations mg/L Values: 6.3		
mg/L	Total Alkalinity (as CaCO <sub>3</sub> )	106.0
mg/L	Bicarbonate (HCO <sub>3</sub> )	< 1.0
mg/L	Carbonate (CO <sub>3</sub> )	< 1.0
mg/L	Bicarbonate (HCO <sub>3</sub> )	104.0
mg/L	Sulfate (SO <sub>4</sub> )	99.0
mg/L	Chloride (Cl)	10.0
mg/L	Nitrate (as NO <sub>3</sub> )	< 1.0
mg/L	Fluoride (F) Temp. Depend.	1.1
Anions mg/L Values: 6.3		
mg/L	Total Solids (Lab/Factory)	6.3
mg/L	Specific Conductance (S.C.)	1000.0
mg/L	Total Filterable Residue at 180C	512.3
Units	Apparent Color (Nephelometric)	< 70.0
mg/L	Other Threshold at 60 C	< 1.0
mg/L	Lab Turbidity	30.0
mg/L	TSS	< 0.01

**INORGANIC CHEMICALS**

REPORTING UNITS	CONSTITUENT	ANALYSIS RESULTS
mg/L	Aluminum (Al)	310.00
mg/L	Arsenic (As)	17.00
mg/L	Boron (B)	<100.00
mg/L	Cadmium (Cd)	< 1.00
mg/L	Chromium (Total Cr)	< 10.00
mg/L	Copper (Cu)	< 50.00
mg/L	Iron (Fe)	305.00
mg/L	Lead (Pb)	11.00
mg/L	Manganese (Mn)	179.00
mg/L	Mercury (Hg)	< 1.00
mg/L	Selenium (Se)	< 5.00
mg/L	Silver (Ag)	< 10.00
mg/L	Zinc (Zn)	< 50.00

**USBR Drill Hole Completion and Data Log  
Monitoring Well BR-5**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 2013 Ft.  
 PROJECT Indian Wells Valley Groundwater Project COMPLETED DEPTH 1980 Ft.  
 LOCATION T.25 S., R.38 E., Sec. 341 STATE \_\_\_\_\_ BEGUN 12-19-91  
 TYPE OF WELL Observation FINISHED 1-03-92  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION 2518.6  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. 2512.5  
 HOLE LOGGED BY Cuttings Description by Mike Stoner, Naval Air Warfare Station DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral LAB ANALYSIS Yes, See Notes  
 Temperature \_\_\_\_\_ TDS \_\_\_\_\_ See Notes  
 OTHER LOGS Drilling Time REVIEWED BY Dennis Watt, USBR





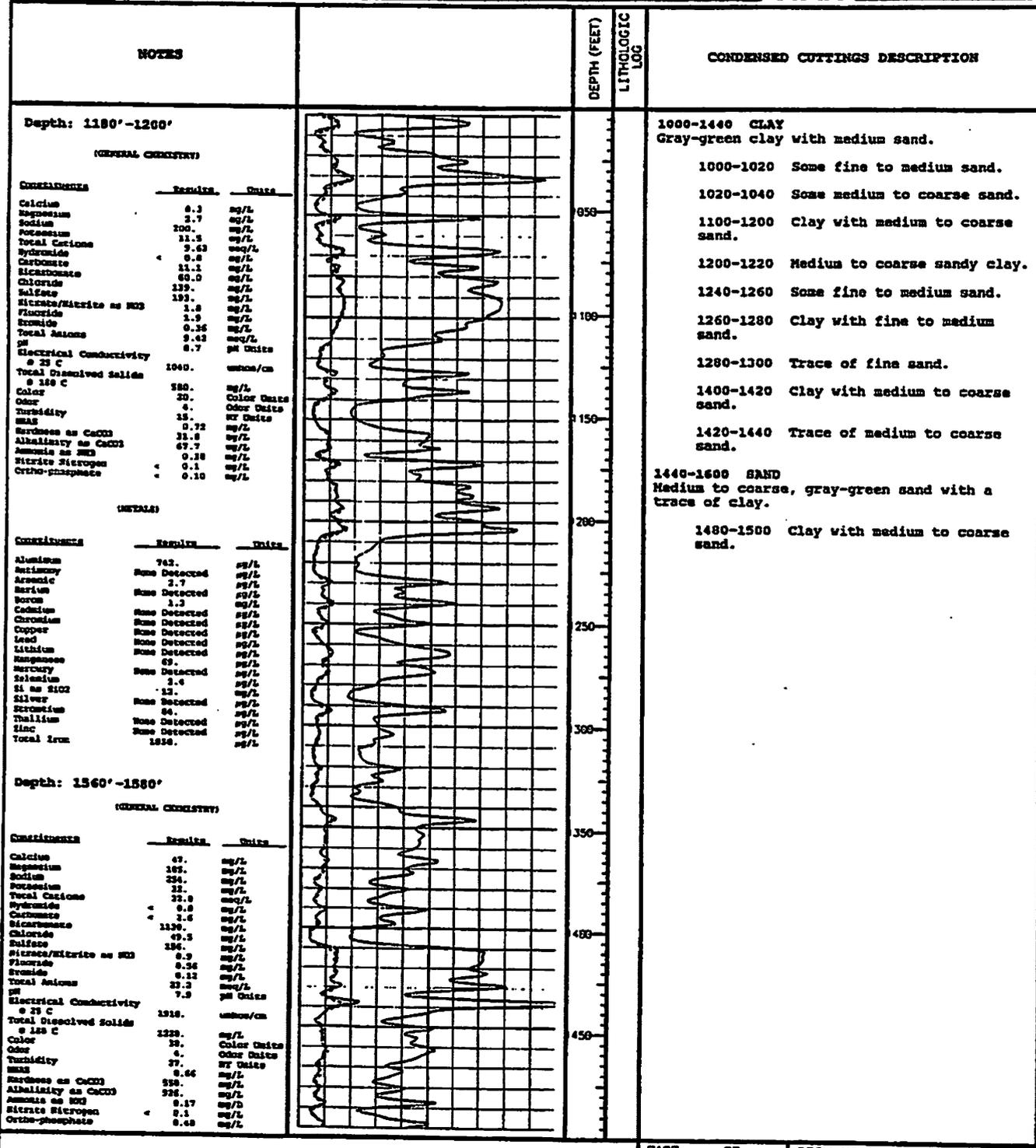
**USBR Drill Hole Completion and Data Log  
Monitoring Well BR-6**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 2012 Ft.  
 PROJECT Indian Wells Valley Groundwater Project COMPLETED DEPTH 1660 Ft.  
 LOCATION T.25 S., R. 38 E., Sec. 12m STATE CA BEGUN 1-10-92  
 TYPE OF WELL Observation FINISHED 1-17-92  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION 2352.2  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. 2354.1  
 HOLE LOGGED BY Cuttings Description by Mike Stoner, Naval Air Warfare Station DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral LAB ANALYSIS Yes, See Notes  
 \_\_\_\_\_ Temperature \_\_\_\_\_ TDS See Notes  
 OTHER LOGS Drilling Time REVIEWED BY Dennis Watt, USBR

NOTES	<p align="center"><b>BARBOUR CORP</b></p> <p align="center">WELL SURVEYING 805-482-4888</p> <p align="center"><b>ELECTRIC LOG</b></p>	DEPTH (FEET) LITHOLOGIC LOG	CONDENSED CUTTINGS DESCRIPTION																
<p><b>DRILL SITE:</b> The well is just inside (east) the Naval Weapons Center boundary (which is parallel Brown Road) along dirt eastward extension of the east-west section of Brown Road.</p> <p><b>DRILLED BY:</b> Welch and Howell Drilling of El Centro CA.</p> <p><b>DRILLING RIG:</b> Mac double (106' total height) direct rotary rig.</p> <p><b>DRILLING METHOD:</b> Direct rotary with bentonite mud. 14 3/4 inch roller cone bit from 56 to 1010 feet. 12 1/4 roller cone bit from 1010 to total depth.</p> <p><b>SOLE COMPLETION:</b> Installed three 2" diameter steel pipes with a 20' two inch diameter screen on the bottom of each. Screens are at the following depth intervals: 330'-350', 1190'-1210', 1640'-1660'. Cement plugs set at the following depth intervals: 520'-550', 900'-925', 1400'-1420'.</p> <p><b>DEVELOPMENT:</b> Each piezometer was air-lifted about 2 hours and discharged an estimated 5-10 gallons per minute. Water samples for lab analysis were collected at the end of development.</p> <p><b>DEPTH TO WATER:</b> All depths reported below were measured on January 28, 1992 from the top of the protective casing. These depths were measured only about 5 minutes after the cap was removed. Actual and relative depths may be different in subsequent measurements.</p> <table border="1"> <thead> <tr> <th>Screen Interval</th> <th>Depth (ft.)</th> </tr> </thead> <tbody> <tr> <td>330'-350'</td> <td>163.9</td> </tr> <tr> <td>1190'-1210'</td> <td>164.6</td> </tr> <tr> <td>1640'-1660'</td> <td>149.9</td> </tr> </tbody> </table> <p>All depth to water measurements made during the project life are available in the Geohydrologic Appendix for this project.</p> <p><b>SLUG TEST RESULTS:</b> Estimated transmissivity (T) (ft<sup>2</sup>/min) by the Cooper (1967) method for the 20 feet of aquifer at each screen.</p> <table border="1"> <thead> <tr> <th>Piezometer</th> <th>T</th> </tr> </thead> <tbody> <tr> <td>Shallow</td> <td>.02</td> </tr> <tr> <td>Medium</td> <td>.25</td> </tr> <tr> <td>Deep</td> <td>.20</td> </tr> </tbody> </table> <p>*Note - This is suspiciously low.</p>	Screen Interval	Depth (ft.)	330'-350'	163.9	1190'-1210'	164.6	1640'-1660'	149.9	Piezometer	T	Shallow	.02	Medium	.25	Deep	.20	<p align="center">-10 0 +10</p> <p align="center">--16 INCH NORMAL-- --64 INCH NORMAL-- (DOTTED)</p> <p align="center">10 20 30</p> <p align="center">SPONTANEOUS POTENTIAL</p>	<p>50</p> <p>100</p> <p>150</p> <p>200</p> <p>250</p> <p>300</p> <p>350</p> <p>400</p> <p>450</p>	<p>The interpretation below is reduced from a description of samples collected every 10 feet from the drilling mud return.</p> <p><b>GENERAL</b></p> <p>The collected samples and drilling character indicate a non-cemented alluvial fill from land surface to total depth.</p> <p>Depth intervals are feet below land surface.</p> <p>0-60 Missing samples.</p> <p>60-90 SAND Light brown medium sand.</p> <p>90-210 SAND Light brown coarse sand.</p> <p>90-100 Medium to coarse sand.</p> <p>120-130 Medium to coarse sand.</p> <p>140-150 Medium to coarse sand.</p> <p>170-180 Trace of volcanics.</p> <p>180-190 Very coarse sand and fine gravel.</p> <p>200-210 Medium to coarse sand.</p> <p>210-230 SAND Light brown medium sand.</p> <p>230-260 SAND Light brown, medium to coarse sand.</p> <p>260-290 SAND Light brown very coarse sand with fine gravel.</p> <p>290-320 SAND Light brown coarse to very coarse sand.</p> <p>310-320 Coarse.</p> <p>320-340 SAND Light brown medium to coarse sand.</p> <p>340-370 SAND Light brown medium sand.</p> <p>350-360 Silty.</p> <p>360-370 Medium to coarse, silty.</p> <p>370-400 CLAY Light gray-green clay.</p> <p>380-400 Some fine to medium sand.</p> <p>400-510 CLAY Sandy gray-green clay.</p> <p>440-450 Silty medium sand.</p> <p>460-470 Gray-green clay.</p>
Screen Interval	Depth (ft.)																		
330'-350'	163.9																		
1190'-1210'	164.6																		
1640'-1660'	149.9																		
Piezometer	T																		
Shallow	.02																		
Medium	.25																		
Deep	.20																		

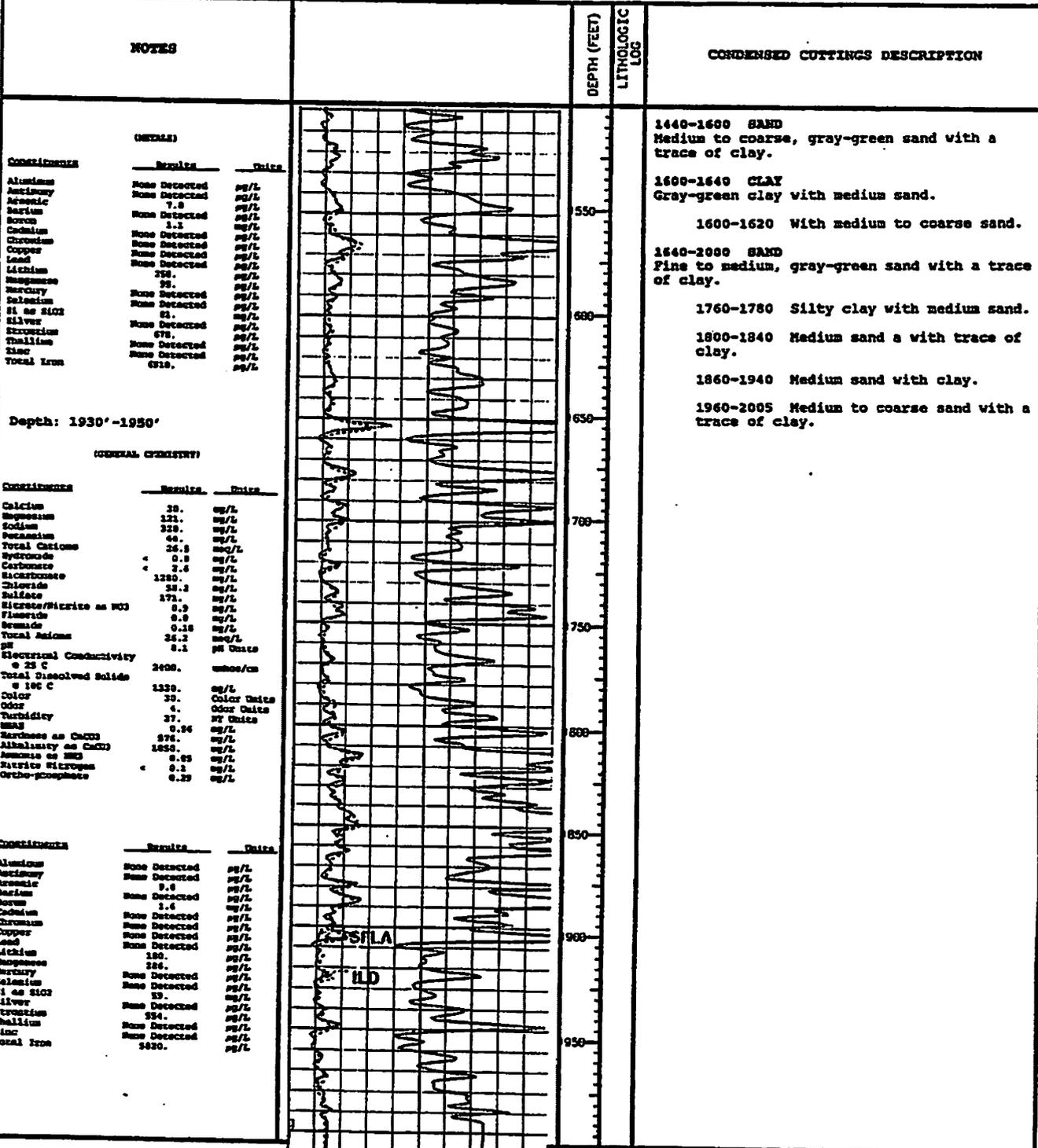
**USBR Drill Hole Completion and Data Log  
Monitoring Well BR-10**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 2005 Ft.  
 PROJECT Indian Wells Valley Groundwater Project COMPLETED DEPTH 1950 Ft.  
 LOCATION T.24 S., R.38 E., Sec. 21J STATE CA BEGUN 8-24-92  
 TYPE OF WELL Observation FINISHED 9-02-92  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION \_\_\_\_\_  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. 2561.4  
 HOLE LOGGED BY Cuttings Description by Mike Stoner, Naval Air Warfare Station DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Dual Induction, Natural Gamma Ray Spectrometry, Caliper LAB ANALYSIS See Notes  
Long Spaced Sonic Waveforms, Long Spaced Sonic, Temperature TDS See Notes  
 OTHER LOGS Drilling Time REVIEWED BY Dennis Watt, USBR



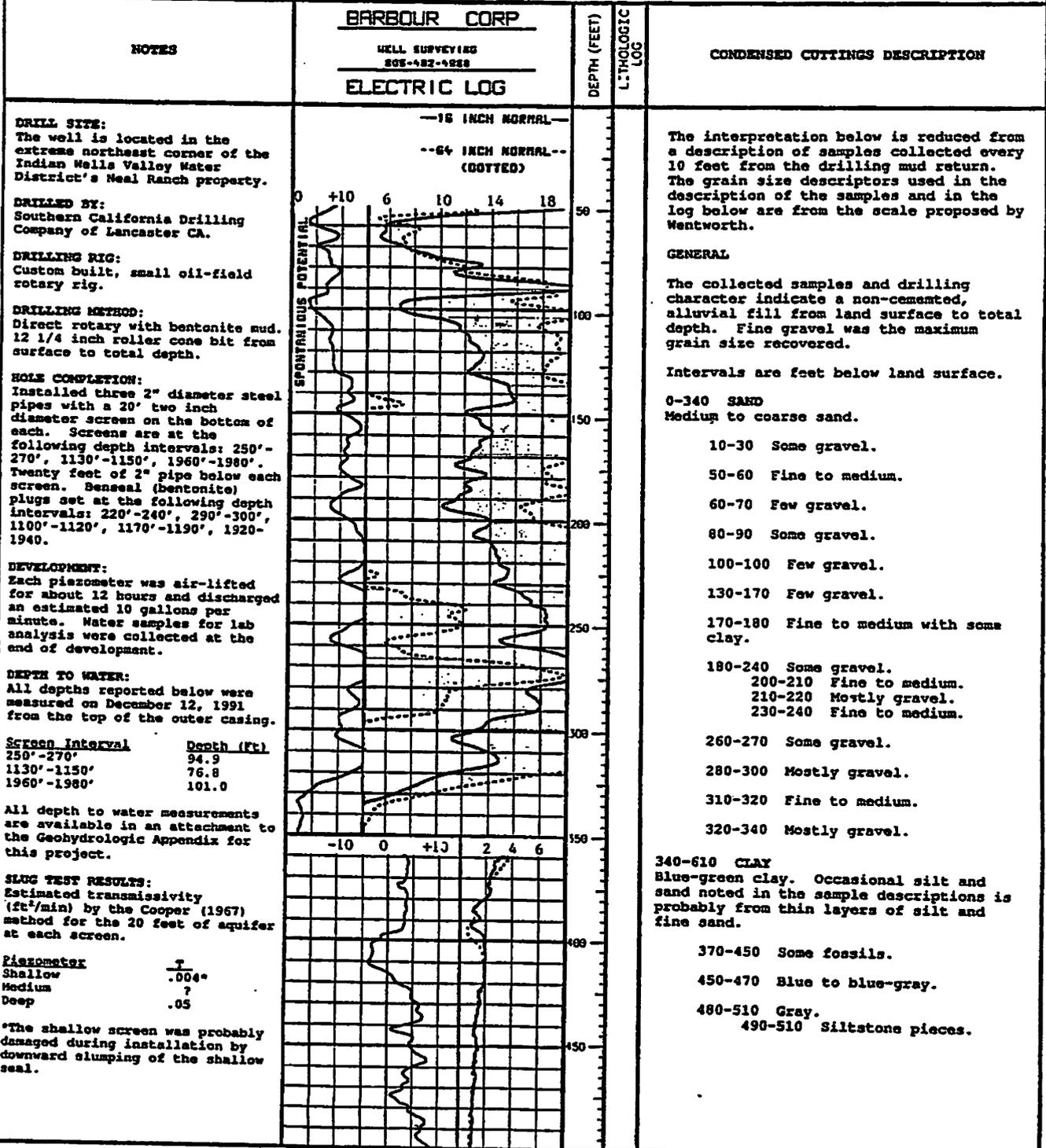
**USBR Drill Hole Completion and Data Log  
Monitoring Well BR-10**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 2005 Ft.  
 PROJECT Indian Wells Valley Groundwater Project COMPLETED DEPTH 1950 Ft.  
 LOCATION T.24 S., R.38 E., Sec. 21J STATE CA BEGUN 8-26-92  
 TYPE OF WELL Observation FINISHED 9-02-92  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION \_\_\_\_\_  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. 2561.4  
 HOLE LOGGED BY Cuttings Description by Mike Stoner, Naval Air Warfare Station DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Dual Induction, Natural Gamma Ray Spectrometry, Caliper LAB ANALYSIS See Notes  
Long Spaced Sonic Waveforms, Long Spaced Sonic, Temperature TDS See Notes  
 OTHER LOGS Drilling Time REVIEWED BY Dennis Watt, USBR



**USBR Drill Hole Completion and Data Log  
Monitoring Well NR-1**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 2012 Ft.  
 PROJECT Indian Wells Valley Groundwater Project (Water District Well) COMPLETED DEPTH 2001 Ft.  
 LOCATION T.25 S., R.38 E., Sec. 25 STATE CA BEGUN 1-07-91  
 TYPE OF WELL Observation FINISHED 2-06-91  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION 2275.7  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. 2278.6  
 HOLE LOGGED BY Cuttings Description by Dipci Barari, N. Amer. Chem. Co., Trona CA DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature LAB ANALYSIS Yes, See Notes  
 OTHER LOGS Drilling Time TDS See Notes  
 REVIEWED BY: Dennis Watt, USBR



**USBR Drill Hole Completion and Data Log  
Monitoring Well NR-1**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 2012 Ft.  
 PROJECT Indian Wells Valley Groundwater Project (Water District Well) COMPLETED DEPTH 2001 Ft.  
 LOCATION T.25 S., R.38 E., Sec. 25 STATE CA BEGUN 1-07-91  
 TYPE OF WELL Observation FINISHED 2-06-91  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION 2275.7  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. 2278.6  
 HOLE LOGGED BY Cuttings Description by Dipri Barari, N. Amer. Chem. Co., Trona CA DEPTH TO WATER (DATE) \_\_\_\_\_ See Notes  
 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature LAB ANALYSIS Yes, See Notes  
 OTHER LOGS Drilling Time TDS \_\_\_\_\_ See Notes  
 REVIEWED BY Dennis Watt, USBR

**NOTES**

-- 16 INCH NORMAL --  
 -- 64 INCH NORMAL --  
 (DOTTED)

-10 0 +10 2 4 6

DEPTH (FEET)

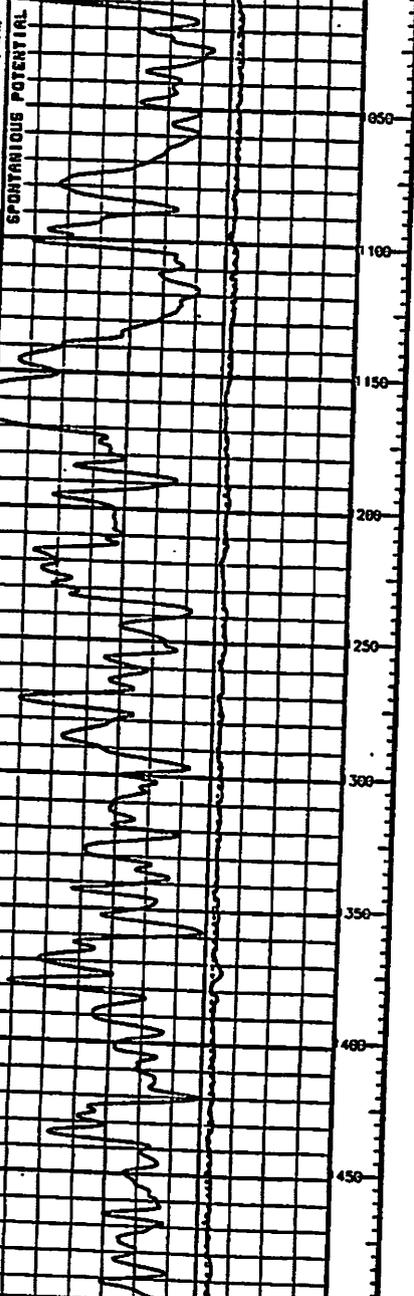
LITHOLOGIC LOG

**CONDENSED CUTTINGS DESCRIPTION**

Depth: 1960-1980'

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED	ANALYZED RESULTS
mg/L	Total Hardness (as CaCO <sub>3</sub> )	74.0
mg/L	Calcium (Ca)	11.0
mg/L	Magnesium (Mg)	11.2
mg/L	Sodium (Na)	158.0
mg/L	Potassium (K)	0.0
Total Cations mg/L Value: 48.3		
mg/L	Total Alkalinity (as CaCO <sub>3</sub> )	246.0
mg/L	Hydroxide (OH)	< 1.0
mg/L	Carbonate (CO <sub>3</sub> )	< 1.0
mg/L	Bicarbonate (HCO <sub>3</sub> )	300.3
mg/L	Sulfate (SO <sub>4</sub> )	304.8
mg/L	Chloride (Cl)	246.7
mg/L	Nitrate (as NO <sub>3</sub> )	33.0
mg/L	Fluoride (F) Temp. Depend.	3.3
Total Anions mg/L Value: 61.2		
Sta. Tests IN (Laboratory):		
mm/cm	Specific Conductance (S.C.)	9.6
mg/L	Total Filterable Residue at 180C	2310.0
Units	Apparent Color (Nephelometric)	2321.3
TOC	Organic Carbon	90
mg/L	Lab Turbidity	2.0
mg/L	ESL	32.0
		CAL

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED	ANALYZED RESULTS
mg/L	Arsenic (As)	< 1.0
mg/L	Boron (B)	< 1.0
mg/L	Cadmium (Cd)	< 1.0
mg/L	Chromium (total Cr)	< 1.0
mg/L	Copper (Cu)	< 1.0
mg/L	Iron (Fe)	< 1.0
mg/L	Manganese (Mn)	< 1.0
mg/L	Mercury (Hg)	< 1.0
mg/L	Selenium (Se)	< 1.0
mg/L	Silver (Ag)	< 1.0
mg/L	Zinc (Zn)	< 1.0
mg/L	Aluminum	1980



800-1250 CLAY  
 Black and gray-black clay. Occasional silt and sand noted in the sample descriptions is probably from thin layers of silt and fine sand.

1080-1130 Green clay.

1250-1400 MUD  
 Black and gray mud. Occasional silt and sand noted in the sample descriptions is probably from thin layers of silt and fine sand.

1270-1280 Some salt.

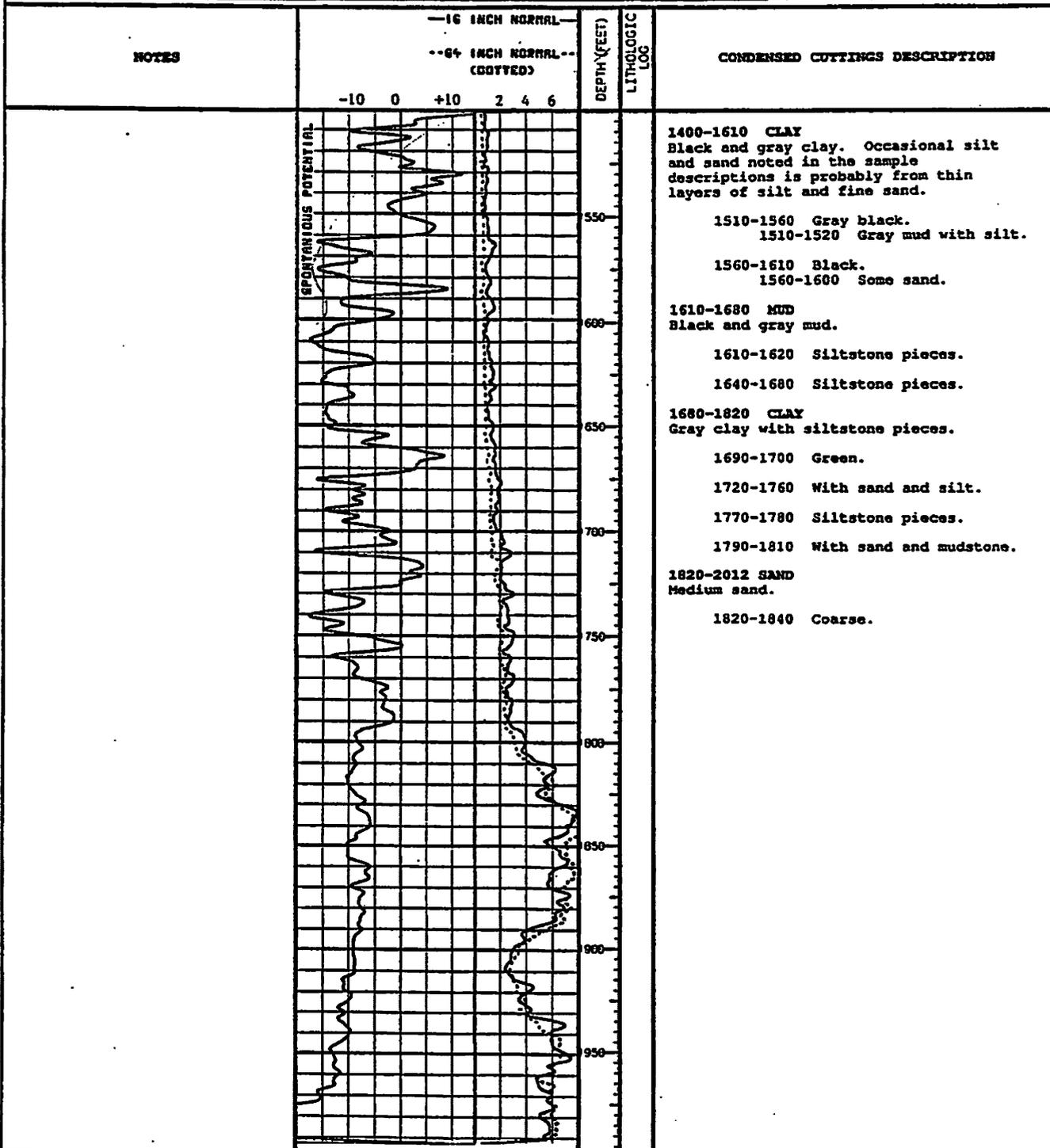
1310-1320 Black clay.

1400-1610 CLAY  
 Black and gray clay. Occasional silt and sand noted in the sample descriptions is probably from thin layers of silt and fine sand.

1400-1510 Black.  
 1400-1450 Some silt.

**USBR Drill Hole Completion and Data Log  
Monitoring Well NR-1**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 2012 Ft.  
 PROJECT Indian Wells Valley Groundwater Project (Water District Well) COMPLETED DEPTH 2001 Ft.  
 LOCATION T.25 S., R.38 E., Sec. 25 STATE CA BEGUN 1-07-91  
 TYPE OF WELL Observation FINISHED 2-06-91  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION 2275.7  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. 2278.6  
 HOLE LOGGED BY Cuttings Description by Diptl Barari, N. Amer. Chem. Co., Trona CA DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 Inch Resistivity, 6 Foot Lateral, LAB ANALYSIS Yes, See Notes  
 Temperature \_\_\_\_\_ TDS See Notes  
 OTHER LOGS Drilling Time REVIEWED BY Dennis Watt, USBR

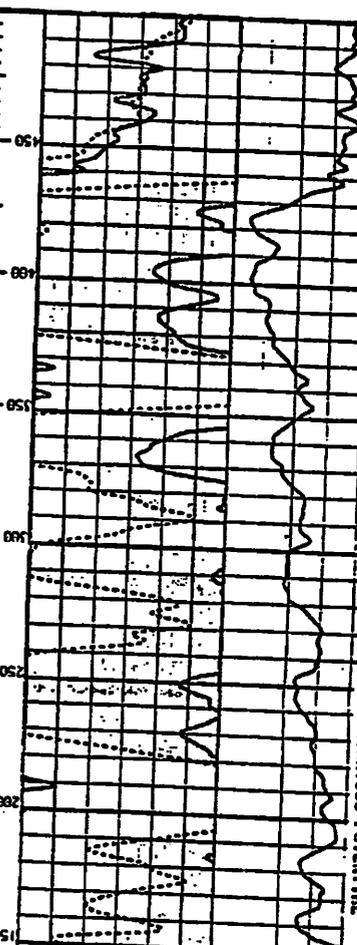
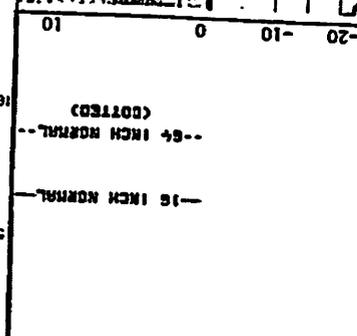


UABR Drill Hole Completion and Data Log  
Monitoring Well NR-2

FEATURE - Drill Hole Completed with Nested Piezometers  
PROJECT - Indian Wells Valley Groundwater Project (Water District Well)  
LOCATION - T. 25 S., R. 38 E., Sec. 368  
TYPE OF WELL - Observation  
PURPOSE - Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity  
COORDINATES -  
HOLE LOGGED BY - Cutting Description by Dipt. Barst, N. Amer., Chem., Civ., Tron CA DEPTH TO WATER (DATE)  
GEOLOGICAL LOGS - Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, LAB ANALYSIS Yes, See Notes  
OTHER LOGS - Drilling Time Temperature  
REVIEWED BY - Dennis Hale, USBR  
1994 FC.  
DRILLED DEPTH - 1950 FT.  
COMPLETED DEPTH - 1950 FT.  
CA -  
STATE -  
BEGUN - 2-04-91  
FINISHED - 2-15-91  
GROUND ELEVATION - 2314.7  
TOP OF CASING ELEV. - 2317.7  
See Notes  
JDS - See Notes  
REVIEWED BY - Dennis Hale, USBR

DRILL SITE:  
The well is located in the southern corner of the southwestern block of the Indian Wells Valley Water District's Neal Ranch property.  
DRILLED BY:  
Southern California Drilling Company of Lancaster CA.  
DRILLING HQ:  
Custom built small oil-field rotary rig.  
DRILLING METHOD:  
Direct rotary with bentonite mud. Direct rotary cone bit from surface to total depth.  
HOLE COMPLETION:  
Installed three 2" diameter steel pipes with a 20" two inch diameter screen on the bottom of each. Screens are at the following depth intervals: 330', 150', 1560', 1910'-1930'. Twenty feet of 2" pipe below each screen. General (bentonsite) plugs set at the following depth intervals: 250'-270', 450'-470', 1480'-1500', 1620'-1640'.  
DEVELOPMENT:  
Each piezometer was air-lifted for about 12 hours and discharged an estimated 10 gallons per minute.  
DEPTH TO WATER:  
All depths reported below were measured on October 22, 1991 from the top of the outer casing.  
Screen Interval  
Depth (ft)  
330'-350' 133.1  
1540'-1560' 140.3  
1910'-1930' 140.0  
All depths to water measurements are available in an attachment to the geologic Appendix for this project.  
SLUG TEST RESULTS:  
Estimated transmissivity (T2/m) by the Cooper (1967) method for the 20 feet of aquifer at each screen.  
Piezometer  
1  
Shallow .48  
Deep .12

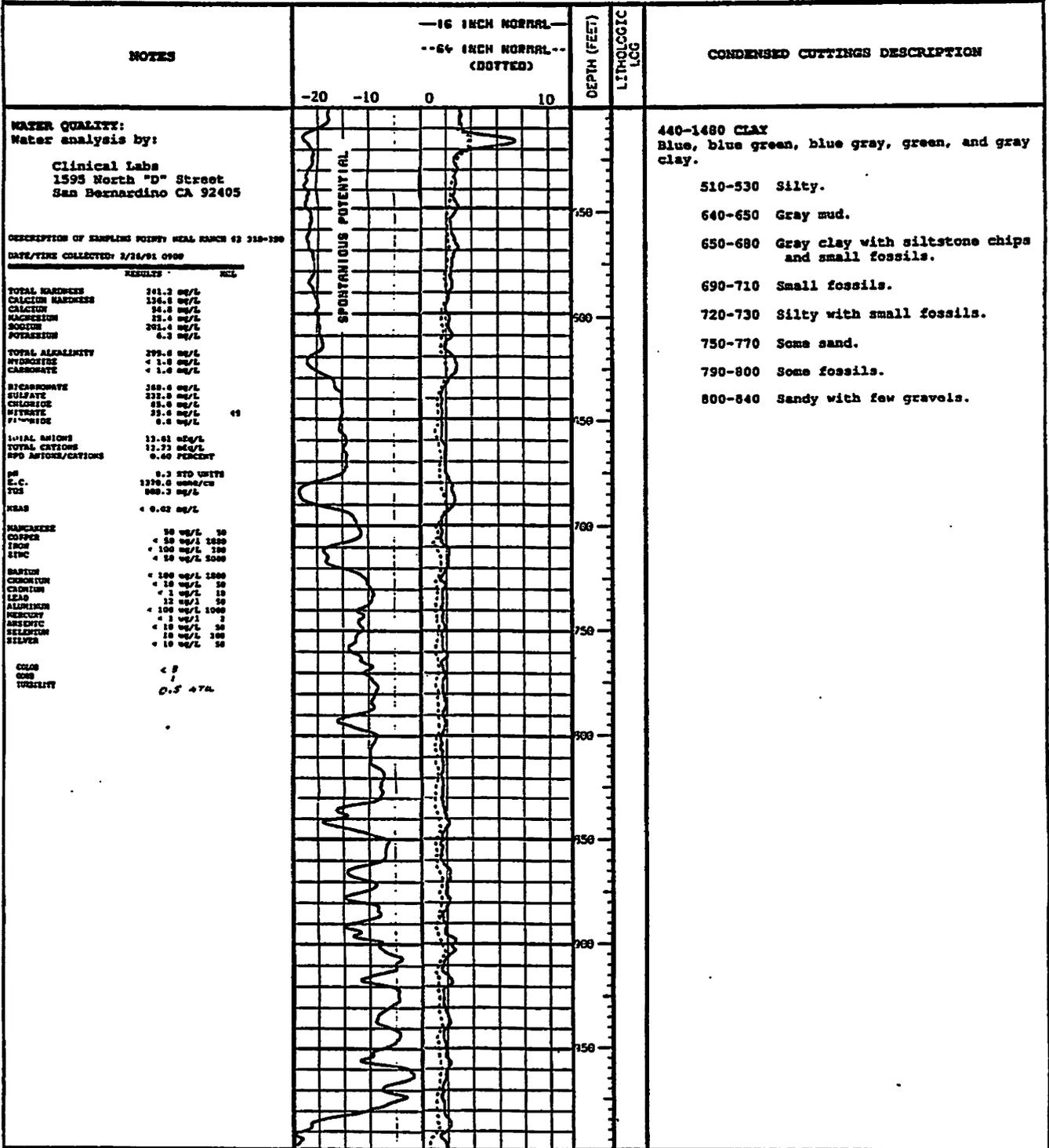
BARBOUR CORP  
WELL SURVEYING  
502-482-4888  
ELECTRIC LOG



CONDENSED CUTTINGS DESCRIPTION	DEPTH (FEET)	LITHOLOGIC LOG
0-440 SAND	0-440	FINE TO COARSE SAND
Depth intervals are feet below land surface. Land surface to total depth. The collected samples and drilling character indicate a non-cemented alluvial fill from		
GENERAL		
The interpretation below is reduced from a description of samples collected every 10 feet from the drilling mud return.		
90-100 Some fine gravel.	90-100	FINE TO COARSE SAND WITH SCATTERED FINE GRAVEL
100-110 SLTY.	100-110	SOME FINE GRAVEL
140-170 SLTY.	140-170	SLTY
220-250 Very coarse.	220-250	VERY COARSE
300-310 SLTY.	300-310	SLTY
350-370 Blue clay with sand and gravel.	350-370	Blue clay with sand and gravel
420-440 Black silty fine to coarse sand.	420-440	Black silty fine to coarse sand
440-460 With sand and some mudstone pieces.	440-460	440-1480 CLAY Blue, blue green, blue gray, green, and gray clay. With sand and some mudstone pieces.
470-490 SLTY.	470-490	SLTY

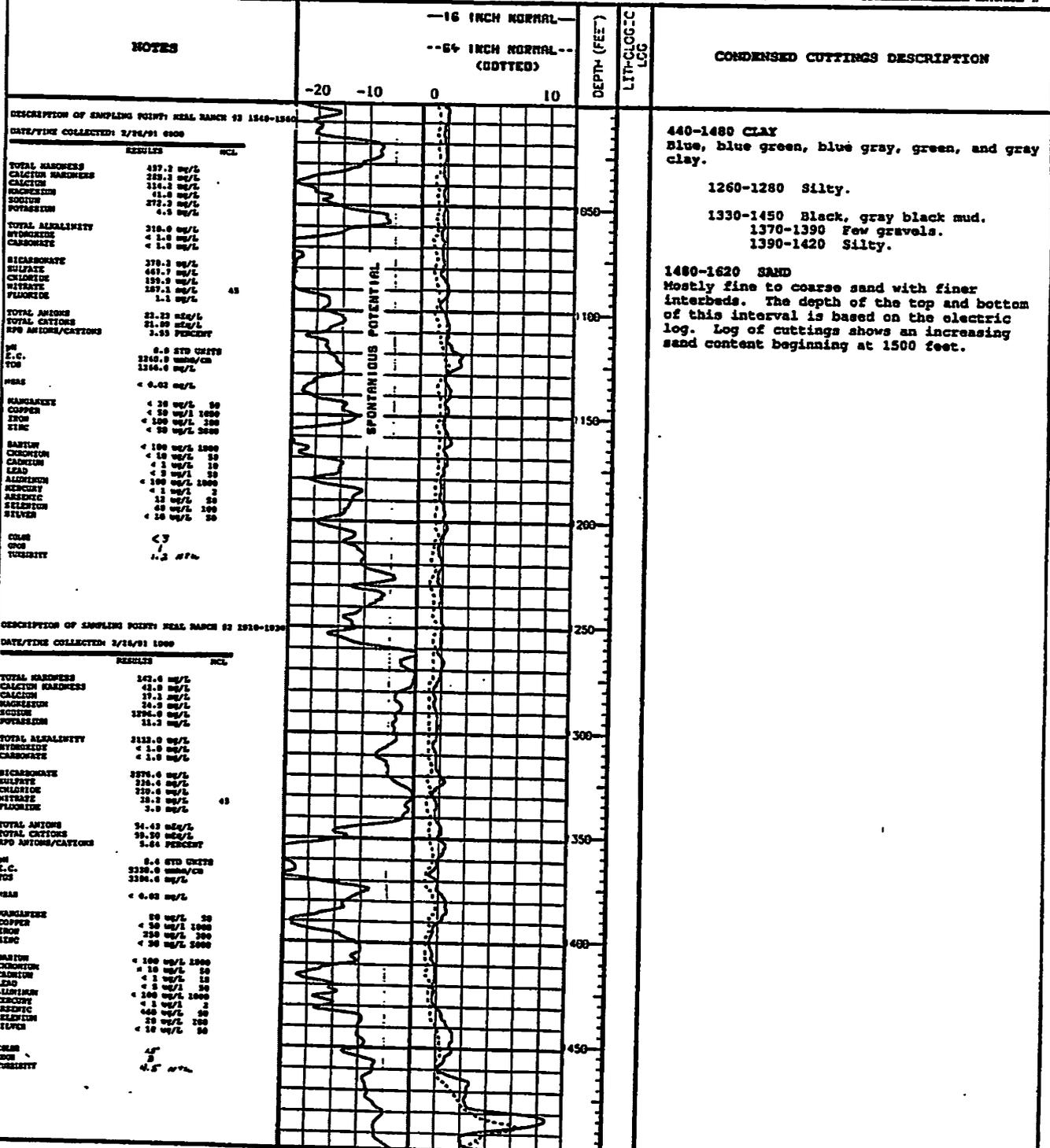
**USBR Drill Hole Completion and Data Log  
Monitoring Well NR-2**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 1994 Ft.  
 PROJECT Indian Wells Valley Groundwater Project (Water District Well) COMPLETED DEPTH 1950 Ft.  
 LOCATION T. 25 S., R. 38 E., Sec. 36g STATE CA BEGUN 2-04-91  
 TYPE OF WELL Observation FINISHED 2-15-91  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION 2314.7  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. 2317.7  
 HOLE LOGGED BY Cutting Description by Dipri Barari, N. Amrk, Chem., Co., Trona CA DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature LAB ANALYSIS Yes, See Notes  
 TDS See Notes  
 OTHER LOGS Drilling Time REVIEWED BY Dennis Watt, USBR



**USBR Drill Hole Completion and Data Log  
Monitoring Well NR-2**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 1994 Ft.  
 PROJECT Indian Wells Valley Groundwater Project (Water District Well) COMPLETED DEPTH 1950 Ft.  
 LOCATION T. 25 S., R. 38 E., Sec. 36g STATE CA BEGUN 2-04-91  
 TYPE OF WELL Observation FINISHED 2-15-91  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION 2314.7  
 COORDINATES TOP OF CASING ELEV. 2317.7  
 HOLE LOGGED BY Cutting Description by Dipri Barari, N. Amer. Chem. Co., Trona CA DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 Inch Resistivity, 6 Foot Lateral. LAB ANALYSIS Yes, See Notes  
 OTHER LOGS Temperature TDS See Notes  
 REVIEWED BY Dennis Watt, USBR



DESCRIPTION OF SAMPLING POINT: REAL MARCH 92 1548-1549  
DATE/TIME COLLECTED: 2/16/91 0900

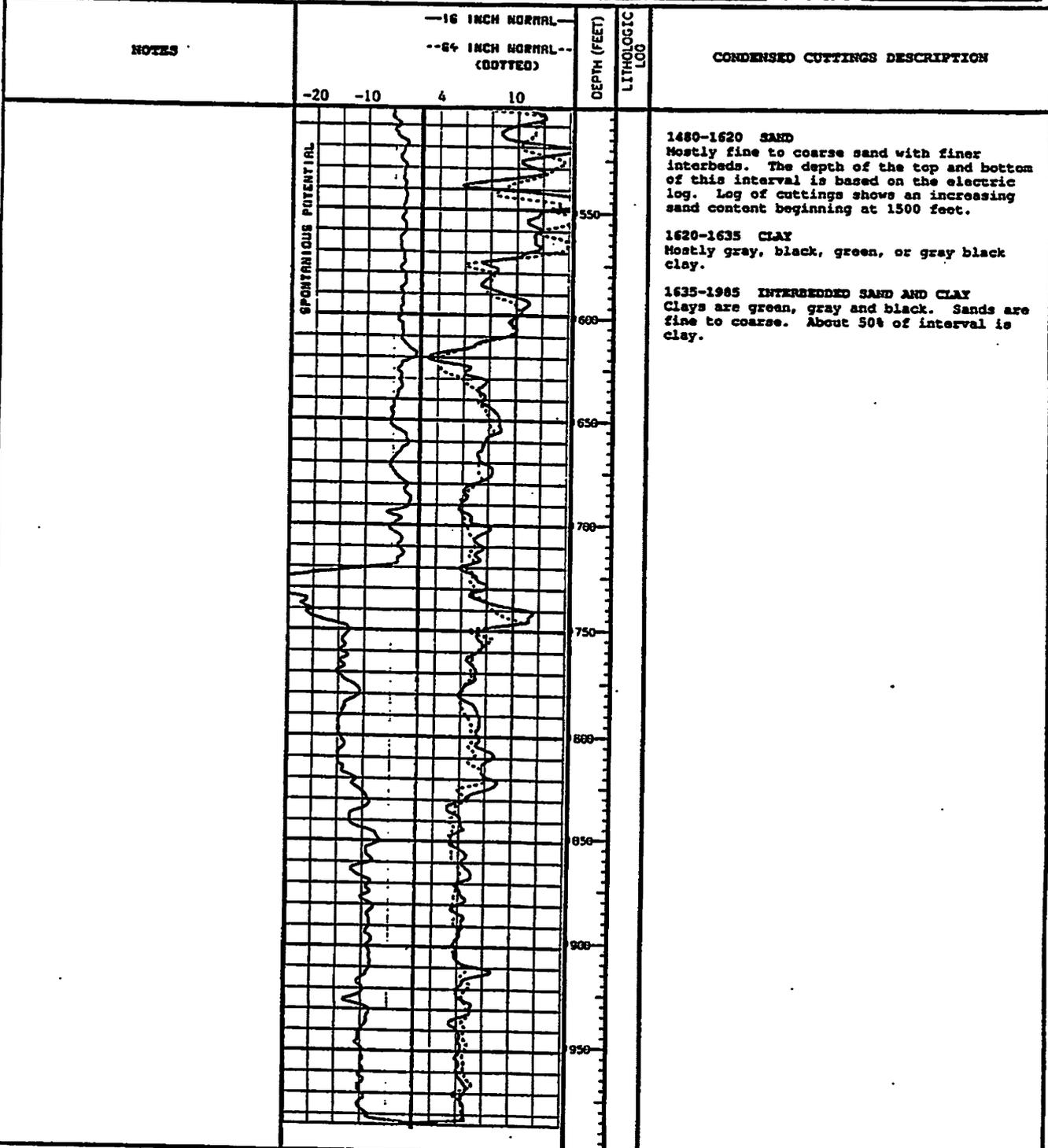
RESULTS	UCL
TOTAL HARDNESS	457.3 mg/L
CALCIUM HARDNESS	289.3 mg/L
CALCIUM	316.2 mg/L
MAGNESIUM	41.8 mg/L
SODIUM	272.3 mg/L
POTASSIUM	0.3 mg/L
TOTAL ALKALINITY	318.0 mg/L
HYDROXIDE	< 1.0 mg/L
CARBONATE	< 1.0 mg/L
BICARBONATE	279.3 mg/L
SULFATE	441.3 mg/L
CHLORIDE	159.3 mg/L
NITRATE	187.1 mg/L
FLUORIDE	1.1 mg/L
TOTAL ANIONS	22.23 mg/L
TOTAL CATIONS	21.80 mg/L
RPO ANIONS/CATIONS	1.93 PERCENT
pH	6.6 STD UNITS
E.C.	3245.0 umho/cm
TDS	3244.0 mg/L
NRAS	< 0.02 mg/L
MANGANESE	< 20 mg/L 50
COPPER	< 50 mg/L 1000
IRON	< 100 mg/L 200
ZINC	< 30 mg/L 2000
BARIUM	< 100 mg/L 1000
CHROMIUM	< 10 mg/L 50
CADMIUM	< 1 mg/L 10
LEAD	< 3 mg/L 50
ALUMINUM	< 100 mg/L 1000
MERCURY	< 1 mg/L 2
ARSENIC	< 10 mg/L 50
SELENIUM	< 20 mg/L 100
SILVER	< 10 mg/L 20
COBALT	< 3
ORP	1.3 mV

DESCRIPTION OF SAMPLING POINT: REAL MARCH 92 1510-1520  
DATE/TIME COLLECTED: 2/16/91 1000

RESULTS	UCL
TOTAL HARDNESS	342.6 mg/L
CALCIUM HARDNESS	43.0 mg/L
CALCIUM	27.3 mg/L
MAGNESIUM	24.3 mg/L
SODIUM	178.0 mg/L
POTASSIUM	11.3 mg/L
TOTAL ALKALINITY	213.0 mg/L
HYDROXIDE	< 1.0 mg/L
CARBONATE	< 1.0 mg/L
BICARBONATE	276.6 mg/L
SULFATE	216.4 mg/L
CHLORIDE	250.6 mg/L
NITRATE	29.2 mg/L
FLUORIDE	3.0 mg/L
TOTAL ANIONS	54.43 mg/L
TOTAL CATIONS	58.50 mg/L
RPO ANIONS/CATIONS	5.64 PERCENT
pH	6.4 STD UNITS
E.C.	2320.0 umho/cm
TDS	2320.0 mg/L
NRAS	< 0.02 mg/L
MANGANESE	50 mg/L 50
COPPER	< 50 mg/L 1000
IRON	250 mg/L 200
ZINC	< 30 mg/L 2000
BARIUM	< 100 mg/L 1000
CHROMIUM	< 10 mg/L 50
CADMIUM	< 1 mg/L 10
LEAD	< 3 mg/L 50
ALUMINUM	< 100 mg/L 1000
MERCURY	< 1 mg/L 2
ARSENIC	440 mg/L 50
SELENIUM	20 mg/L 100
SILVER	< 10 mg/L 20
COBALT	45
ORP	4.5 mV

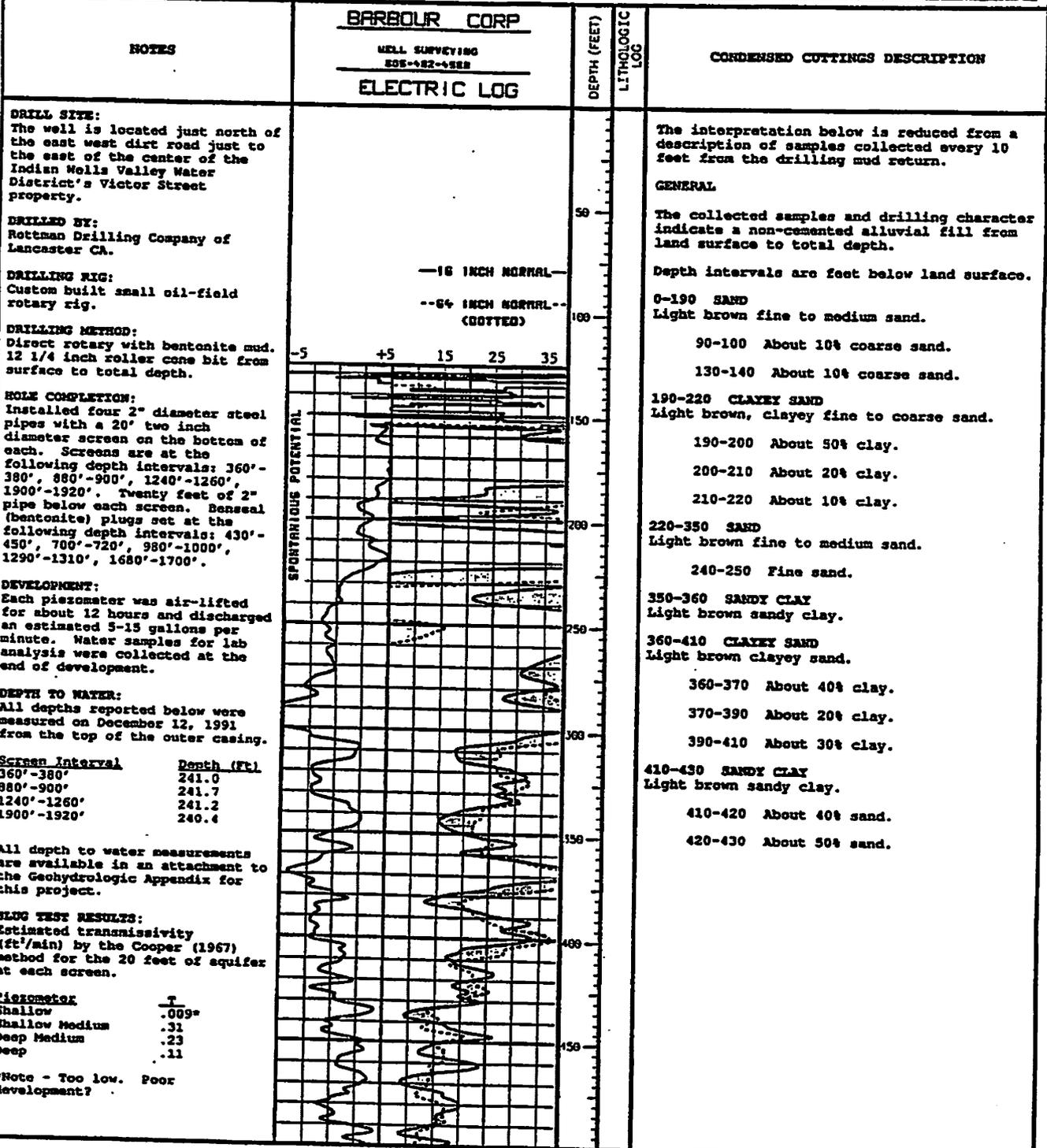
**USBR Drill Hole Completion and Data Log  
Monitoring Well NR-2**

**FEATURE** Drill Hole Completed with Nested Piezometers **DRILLED DEPTH** 1994 Ft.  
**PROJECT** Indian Wells Valley Groundwater Project (Water District Well) **COMPLETED DEPTH** 1950 Ft.  
**LOCATION** T. 25 S., R. 38 E., Sec. 36g **STATE** CA **BEGUN** 2-04-91  
**TYPE OF WELL** Observation **FINISHED** 2-15-91  
**PURPOSE** Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity **GROUND ELEVATION** 2314.7  
**COORDINATES**  **TOP OF CASING ELEV.** 2317.7  
**HOLE LOGGED BY** Cutting Description by Dipti Barari, N. Amer. Chem., Co., Trona CA **DEPTH TO WATER (DATE)** See Notes  
**GEOPHYSICAL LOGS** Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature **LAB ANALYSIS** Yes, See Notes  
**OTHER LOGS** Drilling Time **TDS** See Notes  
**REVIEWED BY** Dennis Watt, USBR



**USBR Drill Hole Completion and Data Log  
Monitoring Well MW-32**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 1968 Ft.  
 PROJECT Indian Wells Valley Groundwater Project (Water District Well) COMPLETED DEPTH 1941 Ft.  
 LOCATION T.26 S., R.39 E., Sec. 27d STATE CA BEGUN 9-23-91  
 TYPE OF WELL Observation FINISHED 10-8-91  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION \_\_\_\_\_  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. 2418.1  
 HOLE LOGGED BY Cuttings Description by Dipet Barari, N. Amer. Chem. Co., Trona CA DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature LAB ANALYSIS Yes, See Notes  
 OTHER LOGS \_\_\_\_\_ TDS See Notes  
 REVIEWED BY Demuis Watt, USBR

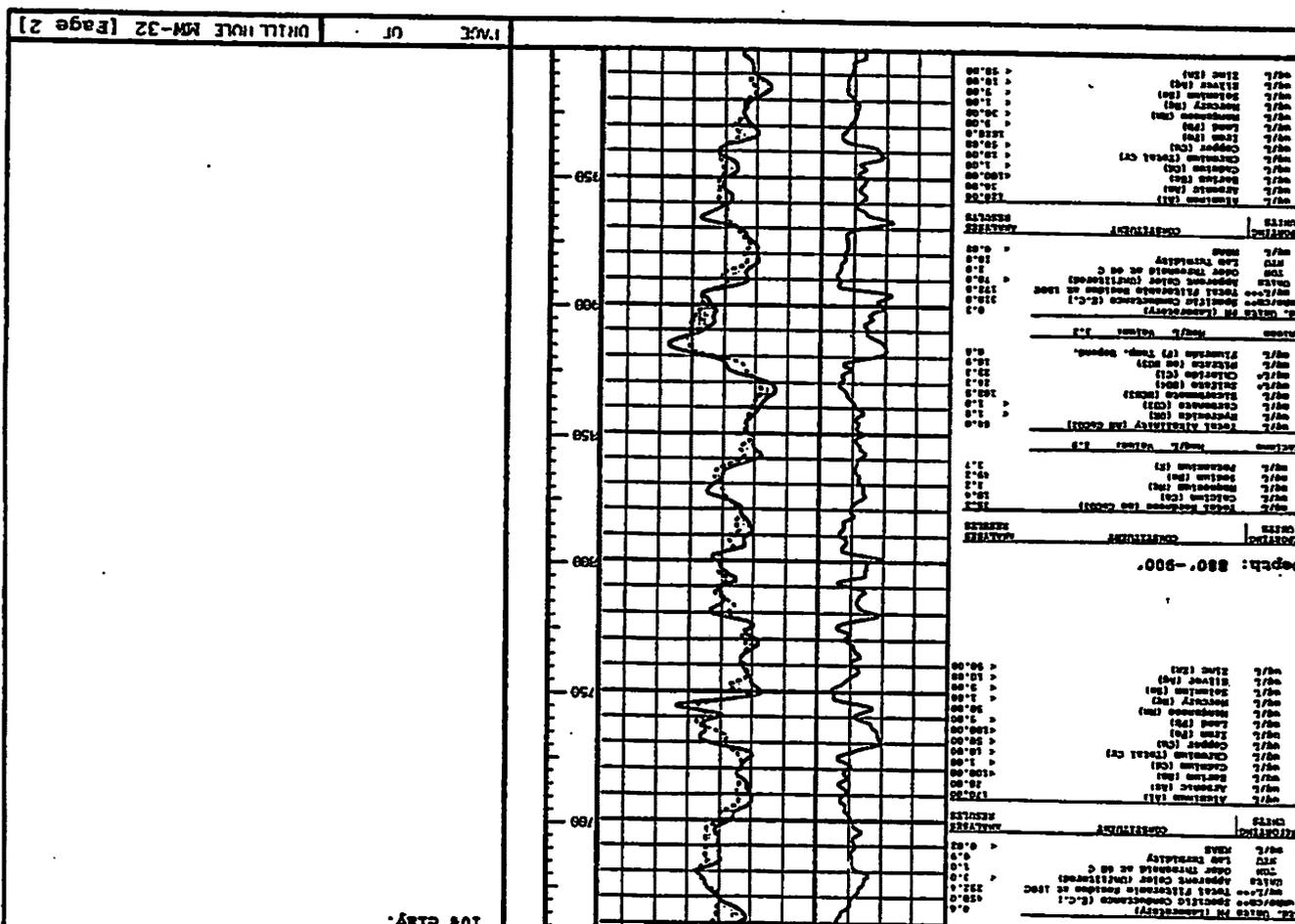


USBR Drill Hole Completion and Data Log  
Monitoring Well MW-32

FEATURE: Drill Hole Completed with Nested Piezometers  
PROJECT: Indian Wells Valley Groundwater Project (Water District Well)  
LOCATION: 126 S. R. 39 E., Sec. 27D  
TYPE OF WELL: Observation  
PURPOSE: Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity  
COORDINATES: GROUND ELEVATION 2418.1  
HOLE LOGGED BY: Cutlers Description by Diapl. Harari, N. Amer. Chem. Co., Trona CA. DEPTH TO WATER (DATE) TOP OF CASING ELEV. 2418.1  
GEOLOGICAL LOGS: Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, LAB ANALYSIS Yes, See Note  
OTHER LOGS: Temperature  
REVIEWED BY: Dennis Watt, USBR

WATER QUALITY: Water analysis by: Clinical Labs  
1595 North "D" Street  
San Bernardino CA 92405  
DEPTH: 360'-380'  
SPONTANEOUS POTENTIAL  
DEPTH (FEET)  
LITHOLOGIC LOG

430-480 SANDY CLAY Blue (on drillers log) sandy clay.  
430-450 About 10% sand.  
450-460 About 30% sand.  
460-470 About 10% sand.  
470-480 About 50% sand.  
480-500 CLAYEY SAND Blue clayey sand.  
500-560 SAND Light brown fine to medium sand with some clay.  
540-560 Some coarse sand.  
560-1960 SAND Light brown fine to medium sand with about 10% clay.



WATER QUALITY

DEPTH: 360'-380'

SPONTANEOUS POTENTIAL

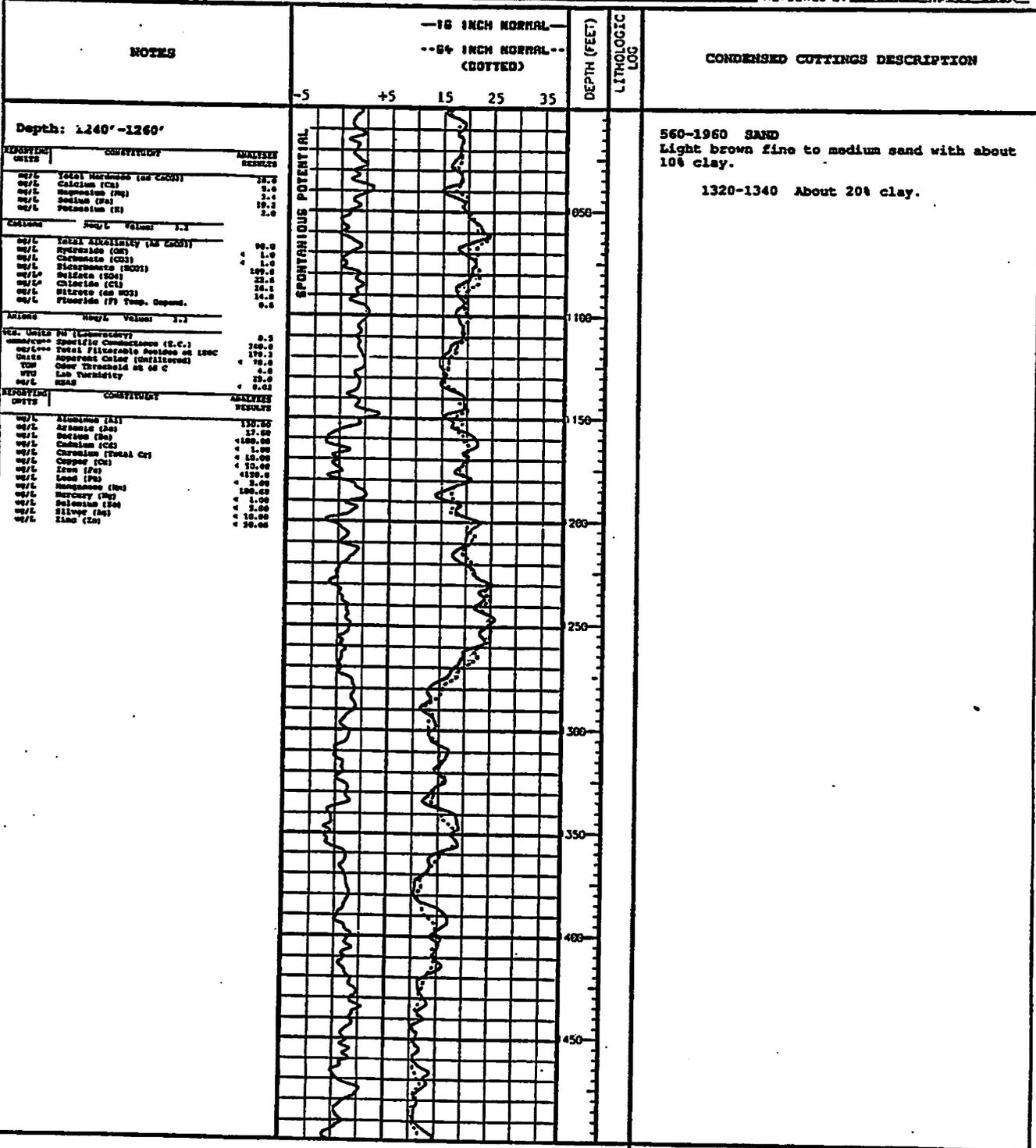
DEPTH (FEET)

LITHOLOGIC LOG

CONDENSED CUTTINGS DESCRIPTION

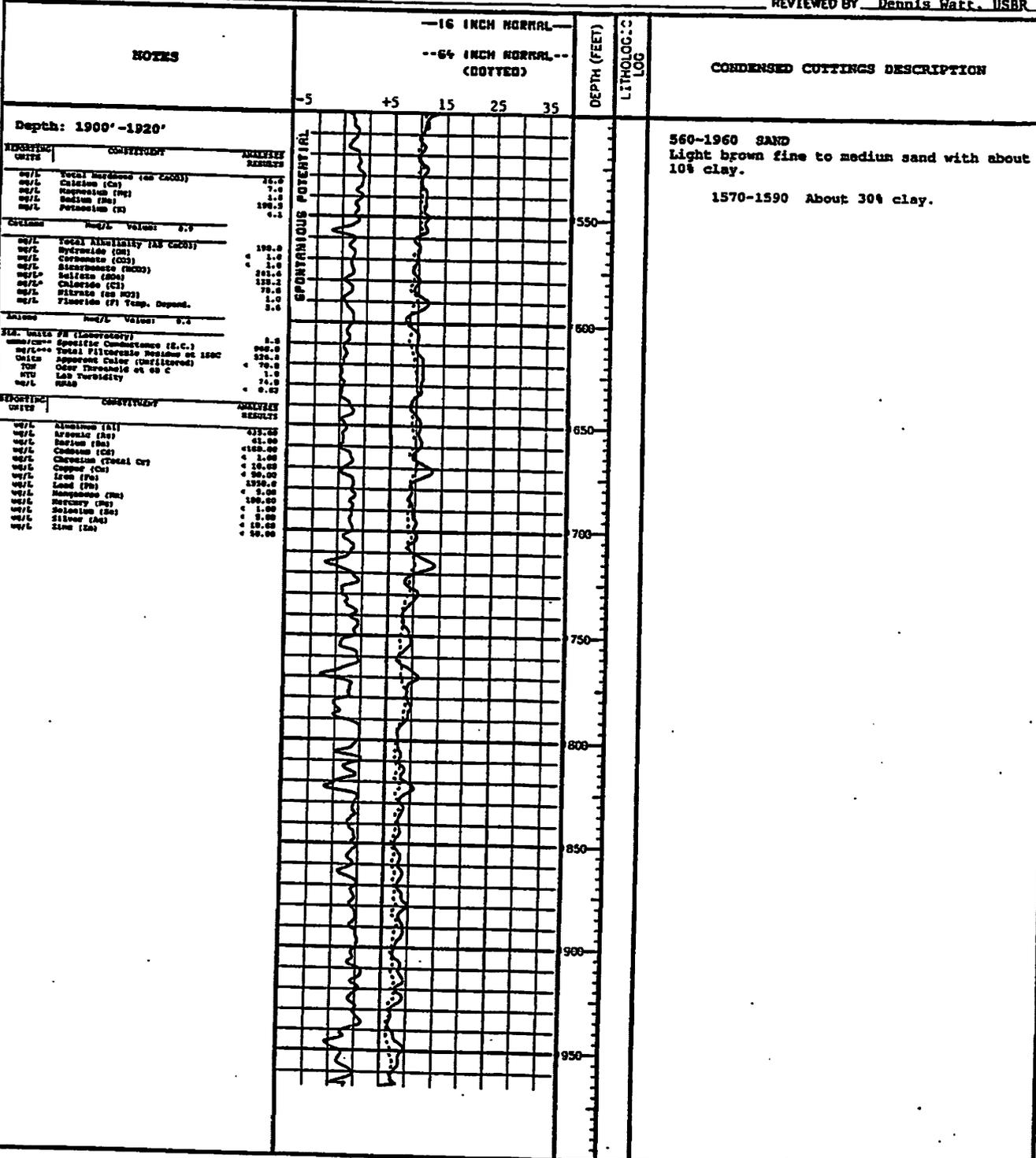
**USBR Drill Hole Completion and Data Log  
Monitoring Well MW-32**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 1968 Ft.  
 PROJECT Indian Wells Valley Groundwater Project (Water District Well) COMPLETED DEPTH 1941 Ft.  
 LOCATION T.26 S., R.39 E., Sec. 27d STATE CA BEGUN 9-23-91  
 TYPE OF WELL Observation FINISHED 10-8-91  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION \_\_\_\_\_  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. 2418.1  
 HOLE LOGGED BY Cuttings Description by Dipri Barari, N. Amer. Chem. Co., Trona CA DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature LAB ANALYSIS Yes, See Note  
 TDS See Notes  
 OTHER LOGS \_\_\_\_\_ REVIEWED BY Dennis Wirtz, USBR



**USBR Drill Hole Completion and Data Log  
Monitoring Well MW-32**

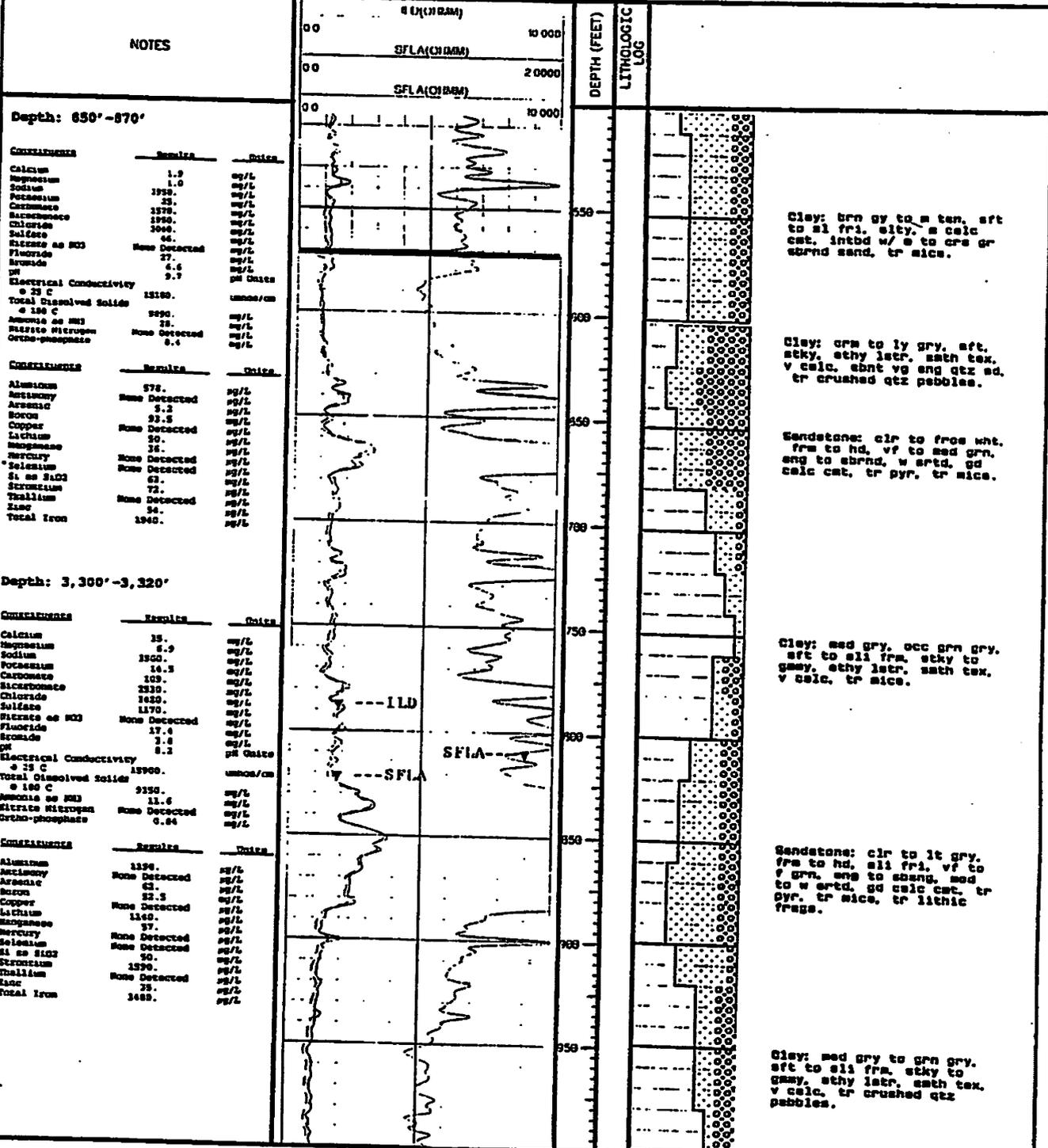
FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 1968 Ft.  
 PROJECT Indian Wells Valley Groundwater Project (Water District Well) COMPLETED DEPTH 1941 Ft.  
 LOCATION T.26 S., R.39 E., Sec. 27d STATE CA BEGUN 9-23-91  
 TYPE OF WELL Observation FINISHED 10-8-91  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION \_\_\_\_\_  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. 2418.1  
 HOLE LOGGED BY Cuttings Description by Dipri Barari, N. Amer. Chem. Co., Trona CA DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature LAB ANALYSIS Yes, See Note  
 OTHER LOGS \_\_\_\_\_ TDS See Notes  
 REVIEWED BY Dennis Watt, USBR





**USBR Drill Hole Completion and Data Log**  
 (Land Surface to 2,000 Feet)  
**Geothermal Test Well SNORT #1**

FEATURE Drill Hole Completed with Two "Shallow" Piezometers DRILLED DEPTH 7,394 Ft.  
 PROJECT Indian Wells Valley Groundwater Project (Navy Geothermal Test Well) COMPLETED DEPTH See Notes  
 LOCATION T. 25 S., R. 39 E., Sec. 23 STATE CA BEGUN 9-8-91  
 TYPE OF WELL Geothermal Test Well - Naval Air Warfare Station, Geothermal Office FINISHED 9-30-91  
 PURPOSE Temperature Gradient, Lithology, Groundwater Quality, Piezometric Level GROUND ELEVATION \_\_\_\_\_  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. \_\_\_\_\_  
 HOLE LOGGED BY Norm Wycoff and Doug Hosto DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Dual Induction (ILD, SFLA, CILD), Spontaneous Potential, Natural Gamma LAB ANALYSIS Yes, See Notes  
 OTHER LOGS Drilling Time TDS See Notes REVIEWED BY \_\_\_\_\_



**USBR Drill Hole Completion and Data Log  
(Land Surface to 2,000 Feet)  
Geothermal Test Well SNORT #1**

FEATURE Drill Hole Completed with Two "Shallow" Piezometers DRILLED DEPTH 7,394 Ft.  
 PROJECT Indian Wells Valley Groundwater Project (Navy Geothermal Test Well) COMPLETED DEPTH See Notes  
 LOCATION T. 25 S., R. 39 E., Sec. 23 STATE CA BEGUN 9-8-91  
 TYPE OF WELL Geothermal Test Well - Naval Air Warfare Station, Geothermal Office FINISHED 9-30-91  
 PURPOSE Temperature Gradient, Lithology, Groundwater Quality, Piezometric Level  
 COORDINATES \_\_\_\_\_ GROUND ELEVATION \_\_\_\_\_  
 HOLE LOGGED BY Norm Wycoff and Doug Hosto TOP OF CASING ELEV. \_\_\_\_\_  
 GEOPHYSICAL LOGS Dual Induction (ILD, SFLA, CILD), Spontaneous Potential, Natural Gamma DEPTH TO WATER (DATE) See Notes  
Temperature LAB ANALYSIS Yes, See Notes  
 OTHER LOGS Drilling Time TDS \_\_\_\_\_  
 REVIEWED BY \_\_\_\_\_

**NOTES**

Depth: 5,350' - 5,570'

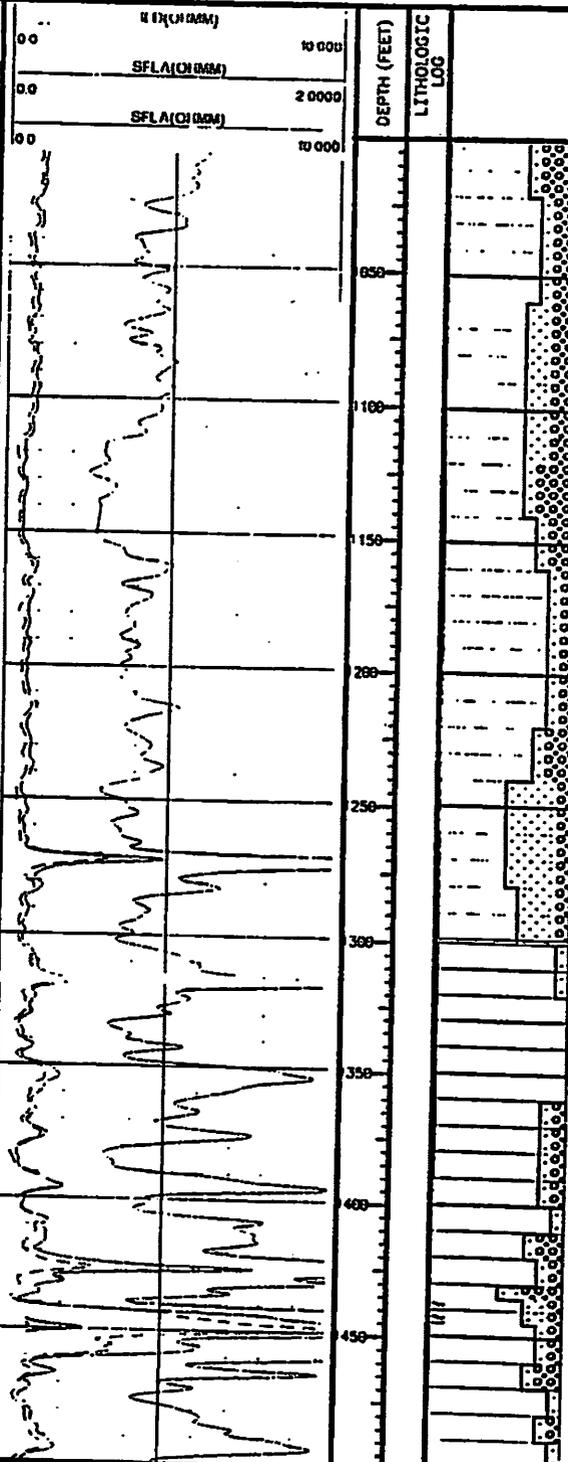
Constituents	Results	Units
Calcium	4.6	mg/L
Magnesium	3.2	mg/L
Sodium	4920.	mg/L
Potassium	22.	mg/L
Carbonate	77.0	mg/L
Bicarbonate	1370.	mg/L
Chloride	3100.	mg/L
Sulfate	2080.	mg/L
Nitrate as NO3	None Detected	mg/L
Fluoride	12.6	mg/L
Bromide	5.6	mg/L
ph	6.2	ph Units
Electrical Conductivity @ 25 C	24000.	umhos/cm
Total Dissolved Solids @ 180 C	12900.	mg/L
Ammonia as NH3	11.4	mg/L
Nitrite Nitrogen	None Detected	mg/L
Ortho-phosphate	0.44	mg/L

Constituents	Results	Units
Aluminum	761.	mg/L
Arsenic	None Detected	mg/L
Boron	57.	mg/L
Copper	60.6	mg/L
Lithium	None Detected	mg/L
Manganese	1520.	mg/L
Mercury	26.	mg/L
Selenium	None Detected	mg/L
Si as SiO2	43.	mg/L
Strontium	1200.	mg/L
Thallium	None Detected	mg/L
Zinc	19.	mg/L
Total Iron	605.	mg/L

Depth: 7,120' - 7,140'

Constituents	Results	Units
Calcium	4.6	mg/L
Magnesium	3.2	mg/L
Sodium	3440.	mg/L
Potassium	9.3	mg/L
Carbonate	456.	mg/L
Bicarbonate	1620.	mg/L
Chloride	2460.	mg/L
Sulfate	910.	mg/L
Nitrate as NO3	None Detected	mg/L
Fluoride	24	mg/L
Bromide	2.9	mg/L
ph	6.9	ph Units
Electrical Conductivity @ 25 C	13900.	umhos/cm
Total Dissolved Solids @ 180 C	6900.	mg/L
Ammonia as NH3	16.6	mg/L
Nitrite Nitrogen	None Detected	mg/L
Ortho-phosphate	0.24	mg/L

Constituents	Results	Units
Aluminum	1720.	mg/L
Arsenic	None Detected	mg/L
Boron	69.	mg/L
Copper	52.9	mg/L
Lithium	None Detected	mg/L
Manganese	509.	mg/L
Mercury	38.	mg/L
Selenium	None Detected	mg/L
Si as SiO2	43.	mg/L
Strontium	334	mg/L
Thallium	None Detected	mg/L
Zinc	61.	mg/L
Total Iron	6940.	mg/L



**LYTHOLOGIC LOG**

Clay: med gry. sft. v stky. stky lstr. smth tex. v calc. sbnt blk cong frags. tr chlorite, tr pyr.

Clay: med gry to gn gry. sft to all frm. v stky. stky lstr. smth tex. v calc. tr crushed qtz pebbles, tr lithic frags.

Clay: dk gry to blk. sft. stky, sooty lstr. smth tex. v calc. strong hydrocarbon odor.

Sand: clr to fros wht. f to med grn. sbnd to rnd. v ercd. pred uncons. occ wk stky calc cat. fri. tr fs str.

Clay: v dk gry to blk. sft to all frm. stky, sooty lstr. sm tex. mod to v calc. tr vf gr qtz sd. hydrocarbon odor.

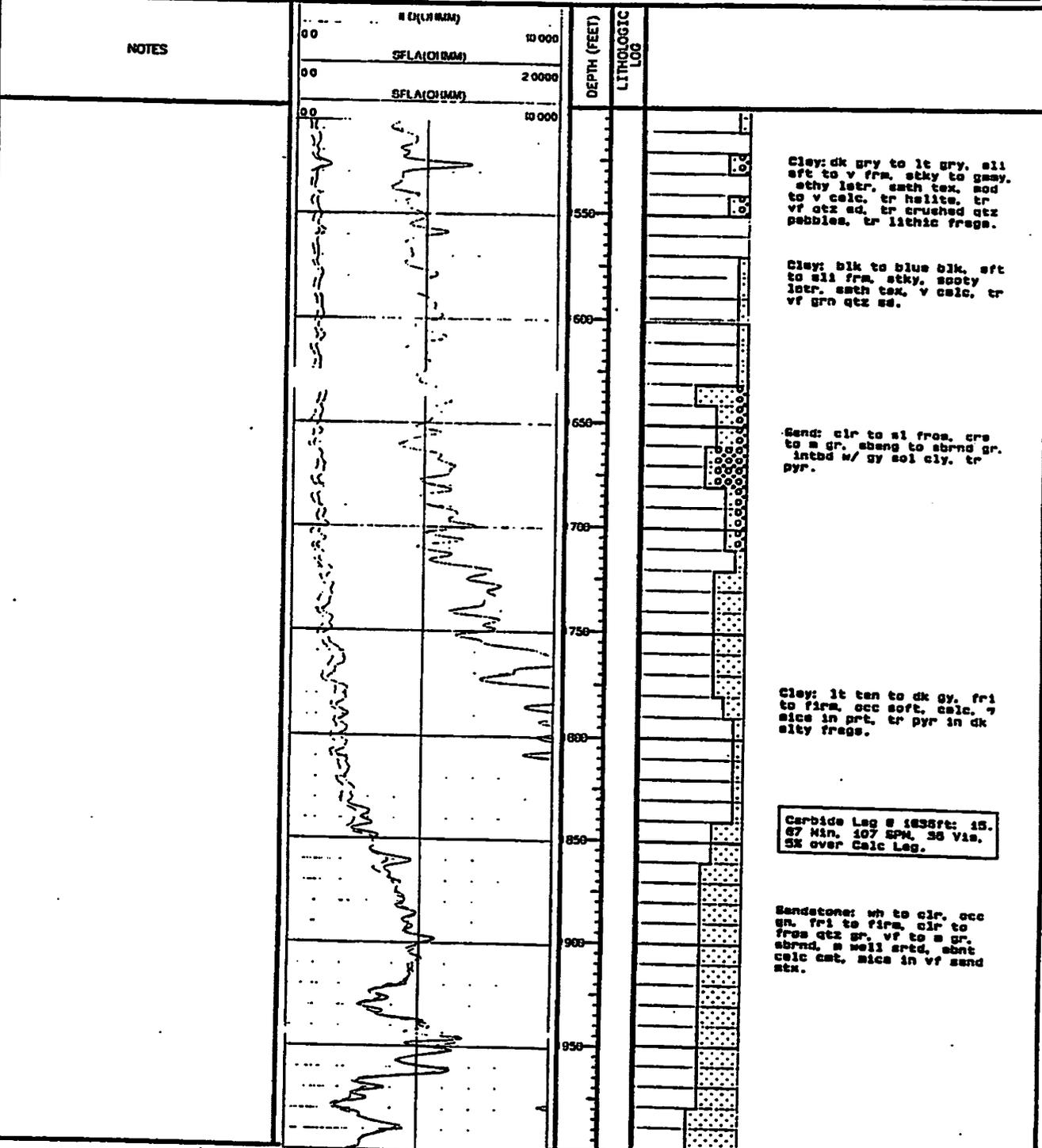
Clay: blk. occ med dk gry. sft to all frm. stky, sooty lstr. mod to v calc. hydrocarbon odor. tr crushed qtz pebbles.

Sand: clr to fros wht. vf to f grn. occ med to crs grn. grd to conglomerate. tr gd calc cat. sbnt qtz pebbles, tr lithic pebbles. tr lign.

Clay: dk gry. sft to all frm. stky. stky lstr. smth tex. mod to v calc. tr halite, tr crushed qtz pebbles, tr vf gr qtz sd.

**USBR Drill Hole Completion and Data Log  
(Land Surface to 2,000 Feet)  
Geothermal Test Well SNORT #1**

FEATURE Drill Hole Completed with Two "Shallow" Piezometers DRILLED DEPTH 7,394 Ft.  
 PROJECT Indian Wells Valley Groundwater Project (Navy Geothermal Test Well) COMPLETED DEPTH See Notes  
 LOCATION T. 25 S., R. 39 E., Sec. 23 STATE CA BEGUN 9-8-91  
 TYPE OF WELL Geothermal Test Well - Naval Air Warfare Station, Geothermal Office FINISHED 9-30-91  
 PURPOSE Temperature Gradient, Lithology, Groundwater Quality, Piezometric Level GROUND ELEVATION \_\_\_\_\_  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. \_\_\_\_\_  
 HOLE LOGGED BY Norm Wycoff and Doug Hosto DEPTH TO WATER (DATE) \_\_\_\_\_ See Notes  
 GEOPHYSICAL LOGS Dual Induction (ILD, SFLA, CILD), Spontaneous Potential, Natural Gamma LAB ANALYSIS Yes, See Notes  
 Temperature \_\_\_\_\_ TDS \_\_\_\_\_ See Notes  
 OTHER LOGS Drilling Time REVIEWED BY \_\_\_\_\_



Clay: dk gry to lt gry, sil  
 sft to v frm, stky to gasy,  
 sthy lstr, smth tex, sod  
 to v calc, tr halite, tr  
 vf qtz sd, tr crushed qtz  
 pebbles, tr lithic frags.

Clay: blk to blue blk, sft  
 to sil frm, stky, sooty  
 lstr, smth tex, v calc, tr  
 vf grn qtz sd.

Sand: clr to sl fros, crs  
 to m gr, sbng to sbnd gr.  
 Intbd w/ gy sol cly, tr  
 pyr.

Clay: lt tan to dk gy, fri  
 to firm, occ soft, calc, v  
 silc in prt, tr pyr in dk  
 silty frags.

Carbide Leg @ 1638ft: 15.  
 47 Min, 107 RPM, 30 Vis.  
 SK over Calc Leg.

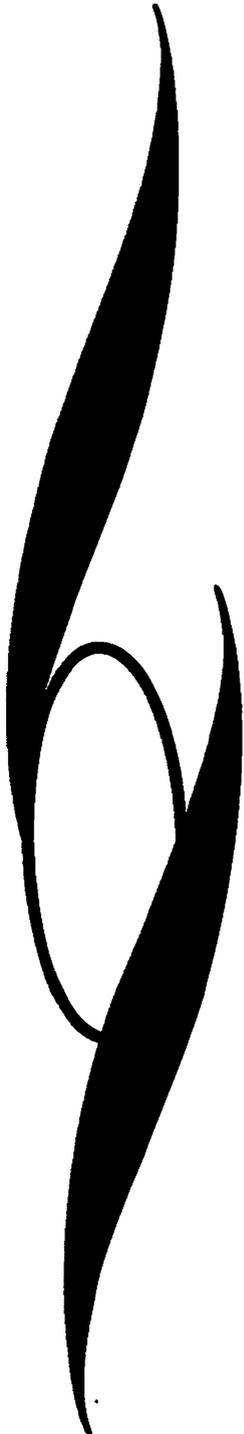
Sandstone: wh to clr, occ  
 gn, fri to firm, clr to  
 fros qtz gr, vf to m gr,  
 sbnd, m well srted, sbnt  
 calc cat, silc in vf sand  
 stx.

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# **APPENDIX VIII**

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**Water Quality Analyses**



CLINICAL LABS/SAN BERNARDINO  
1595 NORTH "D" STREET  
SAN BERNARDINO, CA. 92405

TITLE 22 CHEMICAL ANALYSIS

Date of Report: 03/18/91  
 Laboratory: CLINICAL LABORATORIES OF SAN BERNARDINO  
 Name of Sampler: GAIL MOULTON  
 Date/Time Sample Collected: 91/03/02/0900  
 Signature Lab Director: *C. Jolley*  
 Employed By: NAC  
 Date/Time Sample Received @ Lab: 91/03/02/0900  
 Sample ID No. 911862  
 Station Number: 036/042-BOR#1  
 Date Analyses Completed: 91/03/18

System Name: NORTH AMERICAN CHEMICAL - AKA KERR MCGEE  
 Name or Number of Sample Source: BOR #1  
 System Number: 36-042  
 Water Type: (G/S) |S| Station Number: 036/042-BOR#1  
 Date/Time of Sample: |91|03|02|0900| User ID: TAN  
 Y Y M M D D H H M M  
 Analyzing Agency Code: 3761 Date Analysis Completed: |91|03|18|  
 Y Y M M D D  
 Submitted by: Phone #:

Place an 'X' in box to delete all data for this station/date/time.

REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	MCL	DLR
mg/L	Total Hardness (as CaCO3)	00900	22.4		
mg/L	Calcium (Ca)	00916	6.4		
mg/L	Magnesium (Mg)	00927	1.6		30.0
mg/L	Sodium (NA)	00929	79.2		
mg/L	Potassium (K)	00937	3.5		

Total Cations Meq/L Value: 4.0

mg/L	Total Alkalinity (AS CaCO3)	00410	124.8		
mg/L	Hydroxide (OH)	71830	< 1.0		
mg/L	Carbonate (CO3)	00445	< 1.0		
mg/L	Bicarbonate (HCO3)	00440	152.3		
mg/L*	Sulfate (SO4)	00945	27.9		
mg/L*	Chloride (Cl)	00940	17.1		
mg/L	Nitrate (as NO3)	71850	9.8	45	
mg/L	Fluoride (F) Temp. Depend.	00951	1.4	****	0.1

Total Anions Meq/L Value: 3.8

Std. Units	PH (Laboratory)	00403	8.7		
umho/cm**	Specific Conductance (E.C.)	00095	380.0		
mg/L***	Total Filterable Residue at 180C (TDS)	70300	212.8		
Units	Apparent Color (Unfiltered)	00081	> 70		
TON	Odor Threshold at 60 C	00086	2.0		1.0
NTU	Lab Turbidity	82079	170.0		
mg/L	MBAS	38260	< 0.02	0.5	0.02

\* 250-500-600 \*\* 900-1600-2200 \*\*\* 500-100-1500 \*\*\*\* 1.4-2.4

## \* THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L \*

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
ug/L	Arsenic (As)	01002	< 10	50	10
ug/L	Barium (Ba)	01007	< 100	1000	100
ug/L	Cadmium (Cd)	01027	< 1	10	1
ug/L	Chromium (Total Cr)	01034	< 10	50	10
ug/L	Copper (Cu)	01042	< 50	1000	50
ug/L	Iron (Fe)	01045	< 100	300	100
ug/L	Lead (Pb)	01051	< 5	50	5
ug/L	Manganese (Mn)	01055	< 30	50	30
ug/L	Mercury (Hg)	71900	< 1	2	1
ug/L	Selenium (Se)	01147	< 5	10	5
ug/L	Silver (Ag)	01077	< 10	50	10
ug/L	Zinc (Zn)	01092	< 50	5000	50
ug/L	Aluminum	01105	< 100	1000	100

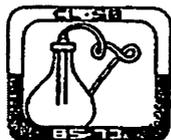
## ORGANIC CHEMICALS

ug/L	Endrin (Hexadrin)	39390		0.2	0.02
ug/L	Gamma-BHC (Lindane)	39340		4	0.4
ug/L	Methoxychlor	39480		100	10.0
ug/L	Toxaphene	39400		5	0.5
ug/L	2,4-D	39730		100	10.0
ug/L	2,4,5-TP (Silvex) (WEED-B-GON)	39045		10	

## ADDITIONAL ANALYSES

NTU	Field Turbidity	82078			0.1
C	Source Temperature C	00010			
	Langelier Index Source Temp.	71814			
	Langelier Index at 60 C	71813			
Std. Units	Field PH	00400			
	Agressiveness Index	82383			
mg/L	Silica	00955			
mg/L	Phosphate	00650			
mg/L	Iodide	71865			
	Sodium Absorption Ratio	00931			
	Asbestos	81855			
mg/L	Ammonia (NH3-N)	00612			
mg/L	Nitrite Nitrogen (NO2-N)	00615			
mg/L	Nitrate Nitrogen (NO3-N)	00618			1.0
mg/L	Nitrite (N)	00620			
mg/L	Beryllium	01012			
mg/L	Boron	01020			
mg/L	Thallium	01059			
mg/L	Nickel	01067			
mg/L	Antimony	01097			0.05
mg/L	Lithium	01132			
mg/L	Cyanide	01291			

# Clinical Laboratory of San Bernardino, Inc.



1595 N. "D" St., San Bernardino, CA 92405  
 Phone (714) 885-3216  
 P. O. Box 329  
 San Bernardino, CA 92402

## RADIOACTIVITY ANALYSES

Date of Report:		Lab Sample ID No. 91-1862	
Laboratory Name: CLINICAL LAB OF SAN BERNARDINO		Signature of Lab Director: <i>C. Jolly</i>	
Name of Sampler: Gail Moulton		Employed By: North American Chemical Co.	
Date/Time Sample Collected: 91/03/02 09:00	Date/Time Sample Received @ Lab: 91/03/14	Were Holding Times Observed: Yes	
System Name: North American Chemical Co.		System Number:	
Description of Sampling Point:			
Name/No. of Sample 615 - 635		Station Number:	
Source: I.W.V. Test Well #2 Bor #1			
Date & of Time Sample: 9 1   0 3   0 2   0 9   0 0	Water Type: <input type="checkbox"/> G/S	User ID: <input type="checkbox"/>	Submitted to SWQIS By:

MCL REPORTING UNITS	CONSTITUENT	T	STORET CODE	ANALYSES RESULTS
Analyzing Agency			28	, , 3 , 7 , 6 , 1
Date Analyses Completed			73672	9 , 1 , 0 , 3 , 1 , 8
				Y Y M M D D

5	pC/l Total Alpha		1501	, , , 3 , . 6
	pC/l Total Alpha Counting Error		1502	, , , 1 , . 6

50	pC/l Total Beta		3501	, , , , , ,
	pC/l Total Beta Counting Error		3502	, , , , , ,

	pC/l Natural Uranium		28012	, , , , , ,
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3	pC/l Total Radium 226		9501	, , , , , ,
	pC/l Total Radium 226 Counting Error		9502	, , , , , ,

	pC/l Total Radium 228		11501	, , , , , ,
	pC/l Total Radium 228 Counting Error		11502	, , , , , ,

5	pC/l Ra 226 + Ra 228		11503	, , , , , ,
	pC/l Ra 226 + Ra 228 Counting Error		11504	, , , , , ,

20,000	pC/l Total Tritium		7000	, , , , , ,
	pC/l Total Tritium Counting Error		7001	, , , , , ,

8	pC/l Total Strontium-90		13501	, , , , , ,
	pC/l Total Strontium-90 Counting Error		13502	, , , , , ,

BR-1 Shallow

CLINICAL LABS/SAN BERNARDINO  
 1595 NORTH "D" STREET  
 SAN BERNARDINO, CA. 92405

TITLE 22 CHEMICAL ANALYSIS

Date of Report: 03/18/91 Sample ID No, 911863  
 Laboratory Signature Lab *C. Jolly*  
 Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: \_\_\_\_\_  
 Name of Sampler: GAIL MOULTON Employed By: NAC 1040'-1060'  
 Date/Time Sample Date/Time Sample Date Analyses  
 Collected: 91/03/02/0900 Received @ Lab: 91/03/02/0900 Completed: 91/03/18

System System  
 Name: NORTH AMERICAN CHEMICAL - AKA KERR MCGEE Number: 36-042  
 Name or Number of Sample Source: BOR #1  
 \*\*\*\*\*  
 \* Water Type: (G/S) |S| Station Number: 036/042-BOR#1 \*  
 \* Date/Time of Sample: |91|03|02|0900| User ID: TAN \*  
 \* YY MM DD HHMM \*  
 \* Analyzing Agency Code: 3761 Date Analysis Completed: |91|03|18| \*  
 \* Submitted by: \_\_\_\_\_ Phone #: \_\_\_\_\_ \*  
 \* YY MM DD \*  
 \*\*\*\*\*

Place an 'X' in box to delete all data for this station/date/time.

REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	MCL	DLR
ALL CONSTITUENTS REPORTED ug/L					
mg/L	Total Hardness (as CaCO3)	00900	12.8		
mg/L	Calcium (Ca)	00916	3.2		
mg/L	Magnesium (Mg)	00927	1.2		30.0
mg/L	Sodium (NA)	00929	95.0		
mg/L	Potassium (K)	00937	1.5		
Total Cations		Meq/L	Value:	4.4	
mg/L	Total Alkalinity (AS CaCO3)	00410	183.2		
mg/L	Hydroxide (OH)	71830	< 1.0		
mg/L	Carbonate (CO3)	00445	< 1.0		
mg/L	Bicarbonate (HCO3)	00440	223.5		
mg/L*	Sulfate (SO4)	00945	16.0		
mg/L*	Chloride (Cl)	00940	9.4		
mg/L	Nitrate (as NO3)	71850	8.7	45	
mg/L	Fluoride (F) Temp. Depend.	00951	0.7	****	0.1
Total Anions		Meq/L	Value:	4.4	
Std. Units	PH (Laboratory)	00403	9.1		
umho/cm**	Specific Conductance (E.C.)	00095	420.0		
mg/L***	Total Filterable Residue at 180C (TDS)	70300	243.6		
Units	Apparent Color (Unfiltered)	00081	20.0		
TON	Odor Threshold at 60 C	00086	2.0		1.0
NTU	Lab Turbidity	82079	61.0		
mg/L	MBAS	38260	< 0.02	0.5	0.02
* 250-500-600    ** 900-1600-2200    *** 500-100-1500    **** 1.4-2.4					

\* THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L \*

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED UG/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
ug/L	Arsenic (As)	01002	< 10	50	10
ug/L	Barium (Ba)	01007	< 100	1000	100
ug/L	Cadmium (Cd)	01027	< 1	10	1
ug/L	Chromium (Total Cr)	01034	< 10	50	10
ug/L	Copper (Cu)	01042	< 50	1000	50
ug/L	Iron (Fe)	01045	< 100	300	100
ug/L	Lead (Pb)	01051	< 5	50	5
ug/L	Manganese (Mn)	01055	< 30	50	30
ug/L	Mercury (Hg)	71900	< 1	2	1
ug/L	Selenium (Se)	01147	< 5	10	5
ug/L	Silver (Ag)	01077	< 10	50	10
ug/L	Zinc (Zn)	01092	< 50	5000	50
ug/L	Aluminum	01105	< 100	1000	100

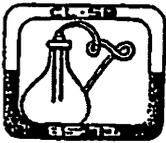
## ORGANIC CHEMICALS

ug/L	Endrin (Hexadrin)	39390		0.2	0.02
ug/L	Gamma-BHC (Lindane)	39340		4	0.4
ug/L	Methoxychlor	39480		100	10.0
ug/L	Toxaphene	39400		5	0.5
ug/L	2,4-D	39730		100	10.0
ug/L	2,4,5-TP (Silvex) (WEED-B-GON)	39045		10	

## ADDITIONAL ANALYSES

NTU	Field Turbidity	82078			0.1
C	Source Temperature C	00010			
	Langelier Index Source Temp.	71814			
	Langelier Index at 60 C	71813			
Std. Units	Field PH	00400			
	Agressiveness Index	82383			
mg/L	Silica	00955			
mg/L	Phosphate	00650			
mg/L	Iodide	71865			
	Sodium Absorption Ratio	00931			
	Asbestos	81855			
mg/L	Ammonia (NH3-N)	00612			
mg/L	Nitrite Nitrogen (NO2-N)	00615			
mg/L	Nitrate Nitrogen (NO3-N)	00618			1.0
mg/L	Nitrite (N)	00620			
mg/L	Beryllium	01012			
mg/L	Boron	01020			
mg/L	Thallium	01059			
mg/L	Nickel	01067			
mg/L	Antimony	01097			0.05
mg/L	Lithium	01132			
mg/L	Cyanide	01291			

# Clinical Laboratory of San Bernardino, Inc.



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## RADIOACTIVITY ANALYSES

Date of Report:		Lab Sample ID No. 91-1863	
Laboratory Name: CLINICAL LAB OF SAN BERNARDINO		Signature of Lab Director: <i>C. Jolly</i>	
Name of Sampler: Gail Moulton		Employed By: North American Chemical Co.	
Date/Time Sample Collected: 91/03/02 09:00	Date/Time Sample Received @ Lab: 91/03/14	Were Holding Times Observed: Yes	

System Name: North American Chemical Co. System Number:

### Description of Sampling Point:

Name/No. of Sample: IWV Test Well #1	Station Number:								
Source: BOR #1 1040' - 1060'									
Date & of Time: 9   1   0   3   0   2   0   9   0   0	Water Type: <input type="checkbox"/> G/S	User ID: <input type="checkbox"/>	Submitted to SWQIS By:						
Sample: Y Y M M D D T T T T									

MCL REPORTING UNITS	CONSTITUENT	T	STORET CODE	ANALYSES RESULTS
Analyzing Agency			28	3, 7, 6, 1
Date Analyses Completed			73672	9, 1, 0, 3, 1, 8 Y Y M M D D

5	pC/l Total Alpha		1501	2, 0
	pC/l Total Alpha Counting Error		1502	1, 3

50	pC/l Total Beta		3501	
	pC/l Total Beta Counting Error		3502	

	pC/l Natural Uranium		28012	
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3	pC/l Total Radium 226		9501	
	pC/l Total Radium 226 Counting Error		9502	

	pC/l Total Radium 228		11501	
	pC/l Total Radium 228 Counting Error		11502	

5	pC/l Ra 226 + Ra 228		11503	
	pC/l Ra 226 + Ra 228 Counting Error		11504	

20,000	pC/l Total Tritium		7000	
	pC/l Total Tritium Counting Error		7001	

8	pC/l Total Strontium-90		13501	
	pC/l Total Strontium-90 Counting Error		13502	

CLINICAL LABS/SAN BERNARDINO  
 1595 NORTH "D" STREET  
 SAN BERNARDINO, CA. 92405

TITLE 22 CHEMICAL ANALYSIS

Date of Report: 03/18/91 Sample ID No. 911864  
 Laboratory Signature Lab *C. Jolley*  
 Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: \_\_\_\_\_  
 Name of Sampler: GAIL MOULTON Employed By: NAC 1500'-1520'  
 Date/Time Sample Date/Time Sample Date Analyses  
 Collected: 91/03/02/0900 Received @ Lab: 91/03/02/0900 Completed: 91/03/18

System System  
 Name: NORTH AMERICAN CHEMICAL - AKA KERR MCGEE Number: 36-042  
 Name or Number of Sample Source: BOR #1  
 \*\*\*\*\*  
 \* Water Type: (G/S) |S| Station Number: 036/042-BOR#1 \*  
 \* Date/Time of Sample: |91|03|02|0900| User ID: TAN \*  
 \* YY MM DD HHMM \*  
 \* Analyzing Agency Code: 3761 Date Analysis Completed: |91|03|18| \*  
 \* YY MM DD \*  
 \* Submitted by: \_\_\_\_\_ Phone #: \_\_\_\_\_ \*  
 \*\*\*\*\*

Place an 'X' in box to delete all data for this station/date/time.

REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	MCL	DLR
	ALL CONSTITUENTS REPORTED ug/L				
mg/L	Total Hardness (as CaCO3)	00900	72.0		
mg/L	Calcium (Ca)	00916	20.0		
mg/L	Magnesium (Mg)	00927	5.3		30.0
mg/L	Sodium (NA)	00929	110.2		
mg/L	Potassium (K)	00937	7.9		

Total Cations Meq/L Value: 6.4

mg/L	Total Alkalinity (AS CaCO3)	00410	248.8		
mg/L	Hydroxide (OH)	71830	< 1.0		
mg/L	Carbonate (CO3)	00445	< 1.0		
mg/L	Bicarbonate (HCO3)	00440	303.5		
mg/L*	Sulfate (SO4)	00945	25.3		
mg/L*	Chloride (Cl)	00940	14.3		
mg/L	Nitrate (as NO3)	71850	9.1	45	
mg/L	Fluoride (F) Temp. Depend.	00951	2.3	****	0.1

Total Anions Meq/L Value: 6.2

Std. Units	PH (Laboratory)	00403	8.8		
umho/cm**	Specific Conductance (E.C.)	00095	610.0		
mg/L***	Total Filterable Residue at 180C (TDS)	70300	353.8		
Units	Apparent Color (Unfiltered)	00081	> 70.0		
TON	Odor Threshold at 60 C	00086	2.0		1.0
NTU	Lab Turbidity	82079	> 200.0		
mg/L	MBAS	38260	< 0.02	0.5	0.02

\* 250-500-600 \*\* 900-1600-2200 \*\*\* 500-100-1500 \*\*\*\* 1.4-2.4

\* THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L \*

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
ug/L	Arsenic (As)	01002	< 10	50	10
ug/L	Barium (Ba)	01007	< 100	1000	100
ug/L	Cadmium (Cd)	01027	< 1	10	1
ug/L	Chromium (Total Cr)	01034	< 10	50	10
ug/L	Copper (Cu)	01042	< 50	1000	50
ug/L	Iron (Fe)	01045	< 100	300	100
ug/L	Lead (Pb)	01051	< 5	50	5
ug/L	Manganese (Mn)	01055	< 30	50	30
ug/L	Mercury (Hg)	71900	< 1	2	1
ug/L	Selenium (Se)	01147	< 5	10	5
ug/L	Silver (Ag)	01077	< 10	50	10
ug/L	Zinc (Zn)	01092	150	5000	50
ug/L	Aluminum	01105	< 100	1000	100

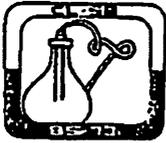
## ORGANIC CHEMICALS

ug/L	Endrin (Hexadrin)	39390		0.2	0.02
ug/L	Gamma-BHC (Lindane)	39340		4	0.4
ug/L	Methoxychlor	39480		100	10.0
ug/L	Toxaphene	39400		5	0.5
ug/L	2,4-D	39730		100	10.0
ug/L	2,4,5-TP (Silvex) (WEED-B-GON)	39045		10	

## ADDITIONAL ANALYSES

NTU	Field Turbidity	82078			0.1
C	Source Temperature C	00010			
	Langelier Index Source Temp.	71814			
	Langelier Index at 60 C	71813			
Std. Units	Field PH	00400			
	Agressiveness Index	82383			
mg/L	Silica	00955			
mg/L	Phosphate	00650			
mg/L	Iodide	71865			
	Sodium Absorption Ratio	00931			
	Asbestos	81855			
mg/L	Ammonia (NH3-N)	00612			
mg/L	Nitrite Nitrogen (NO2-N)	00615			
mg/L	Nitrate Nitrogen (NO3-N)	00618			1.0
mg/L	Nitrite (N)	00620			
mg/L	Beryllium	01012			
mg/L	Boron	01020			
mg/L	Thallium	01059			
mg/L	Nickel	01067			
mg/L	Antimony	01097			
mg/L	Lithium	01132			0.05
mg/L	Cyanide	01291			

# Clinical Laboratory of San Bernardino, Inc.



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## RADIOACTIVITY ANALYSES

Date of Report: <u>2/21/91</u>		Lab Sample ID No. <u>91-1864</u>	
Laboratory Name: <u>CLINICAL LAB OF SAN BERNARDINO</u>		Signature of Lab Director: <u>C. Jelliff</u>	
Name of Sampler: <u>Moulton</u>		Employed By: <u>North American Chemical Co.</u>	
Date/Time Sample Collected: <u>91/03/02 09:00</u>	Date/Time Sample Received @ Lab: <u>91/03/14</u>	Were Holding Times Observed: <u>Yes</u>	
System Name: <u>North American Chemical Co.</u>		System Number:	
Description of Sampling Point:			
Name/No. of Sample <u>IWV Test Well #1</u>		Station Number:	
Source: <u>BOR #1 1500' - 1520'</u>			
Date & of Time Sample: <u>9 1 0 3 0 2 0 9 0 0</u>	Water Type: <input type="checkbox"/> <u>G/S</u>	User ID: <input type="checkbox"/>	Submitted to SWQIS By:

MCL REPORTING UNITS	CONSTITUENT	T	STORET CODE	ANALYSES RESULTS
Analyzing Agency			28	. 3 . 7 . 6 . 1
Date Analyses Completed			73672	9 1 0 3 2 1 Y Y M M D D
5 pC/l	Total Alpha		1501	. 1 . 9 . . 3
pC/l	Total Alpha Counting Error		1502	. . . 2 . . 0
50 pC/l	Total Beta		3501	. . . . .
pC/l	Total Beta Counting Error		3502	. . . . .
pC/l	Natural Uranium		28012	. . . . .
3 pC/l	Total Radium 226		9501	. . . . .
pC/l	Total Radium 226 Counting Error		9502	. . . . .
pC/l	Total Radium 228		11501	. . . . .
pC/l	Total Radium 228 Counting Error		11502	. . . . .
5 pC/l	Ra 226 + Ra 228		11503	. . . . .
pC/l	Ra 226 + Ra 228 Counting Error		11504	. . . . .
20,000pC/l	Total Tritium		7000	. . . . .
pC/l	Total Tritium Counting Error		7001	. . . . .
8 pC/l	Total Strontium-90		13501	. . . . .
pC/l	Total Strontium-90 Counting Error		13502	. . . . .

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TITLE 22 CHEMICAL ANALYSIS

Date of Report: 03/18/91 Sample ID No. 911865  
 Laboratory Signature Lab *C. Jolly*  
 Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: \_\_\_\_\_  
 Name of Sampler: GAIL MOULTON Employed By: NAC 1750'-1770'  
 Date/Time Sample Date/Time Sample Date Analyses  
 Collected: 91/03/02/0900 Received @ Lab: 91/03/02/0900 Completed: 91/03/18

System System  
 Name: NORTH AMERICAN CHEMICAL - AKA KERR MCGEE Number: 36-042  
 Name or Number of Sample Source: BOR #1  
 \*\*\*\*\*  
 \* Water Type: (G/S) |S| Station Number: 036/042-BOR#1 \*  
 \* Date/Time of Sample: |91|03|02|0900| User ID: TAN \*  
 \* YY MM DD HHMM \*  
 \* \* \* \* \*  
 \* Analyzing Agency Code: 3761 Date Analysis Completed: |91|03|18| \*  
 \* YY MM DD \*  
 \* Submitted by: \_\_\_\_\_ Phone #: \_\_\_\_\_ \*  
 \*\*\*\*\*

Place an 'X' in box to delete all data for this station/date/time. |\_

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
mg/L	Total Hardness (as CaCO3)	00900	32.0		
mg/L	Calcium (Ca)	00916	9.6		
mg/L	Magnesium (Mg)	00927	1.9		30.0
mg/L	Sodium (NA)	00929	107.9		
mg/L	Potassium (K)	00937	4.8		
<b>Total Cations Meq/L Value: 5.4</b>					
mg/L	Total Alkalinity (AS CaCO3)	00410	218.0		
mg/L	Hydroxide (OH)	71830	< 1.0		
mg/L	Carbonate (CO3)	00445	< 1.0		
mg/L	Bicarbonate (HCO3)	00440	266.0		
mg/L*	Sulfate (SO4)	00945	16.6		
mg/L*	Chloride (Cl)	00940	10.2		
mg/L	Nitrate (as NO3)	71850	7.1	45	
mg/L	Fluoride (F) Temp. Depend.	00951	3.3	****	0.1
<b>Total Anions Meq/L Value: 5.3</b>					
Std. Units	PH (Laboratory)	00403	8.7		
umho/cm**	Specific Conductance (E.C.)	00095	500.0		
mg/L***	Total Filterable Residue at 180C (TDS)	70300	285.0		
Units	Apparent Color (Unfiltered)	00081	> 70.0		
TON	Odor Threshold at 60 C	00086	1.0		1.0
NTU	Lab Turbidity	82079	> 200.0		
mg/L	MBAS	38260	< 0.02	0.5	0.02

\* 250-500-600    \*\* 900-1600-2200    \*\*\* 500-100-1500    \*\*\*\* 1.4-2.4

\* THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L \*

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED UG/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
ug/L	Arsenic (As)	01002	< 10	50	10
ug/L	Barium (Ba)	01007	< 100	1000	100
ug/L	Cadmium (Cd)	01027	< 1	10	1
ug/L	Chromium (Total Cr)	01034	< 10	50	10
ug/L	Copper (Cu)	01042	< 50	1000	50
ug/L	Iron (Fe)	01045	< 100	300	100
ug/L	Lead (Pb)	01051	< 5	50	5
ug/L	Manganese (Mn)	01055	< 30	50	30
ug/L	Mercury (Hg)	71900	< 1	2	1
ug/L	Selenium (Se)	01147	< 5	10	5
ug/L	Silver (Ag)	01077	< 10	50	10
ug/L	Zinc (Zn)	01092	50	5000	50
ug/L	Aluminum	01105	< 100	1000	100

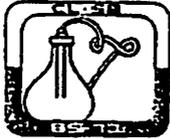
## ORGANIC CHEMICALS

ug/L	Endrin (Hexadrin)	39390		0.2	0.02
ug/L	Gamma-BHC (Lindane)	39340		4	0.4
ug/L	Methoxychlor	39480		100	10.0
ug/L	Toxaphene	39400		5	0.5
ug/L	2,4-D	39730		100	10.0
ug/L	2,4,5-TP (Silvex) (WEED-B-GON)	39045		10	

## ADDITIONAL ANALYSES

NTU	Field Turbidity	82078			0.1
C	Source Temperature C	00010			
	Langelier Index Source Temp.	71814			
	Langelier Index at 60 C	71813			
Std. Units	Field PH	00400			
	Agressiveness Index	82383			
mg/L	Silica	00955			
mg/L	Phosphate	00650			
mg/L	Iodide	71865			
	Sodium Absorption Ratio	00931			
	Asbestos	81855			
mg/L	Ammonia (NH3-N)	00612			
mg/L	Nitrite Nitrogen (NO2-N)	00615			
mg/L	Nitrate Nitrogen (NO3-N)	00618			1.0
mg/L	Nitrite (N)	00620			
mg/L	Beryllium	01012			
mg/L	Boron	01020			
mg/L	Thallium	01059			
mg/L	Nickel	01067			
mg/L	Antimony	01097			
mg/L	Lithium	01132			0.05
mg/L	Cyanide	01291			

# Clinical Laboratory of San Bernardino, Inc.



1595 N. "D" St., San Bernardino, CA 92405  
 Phone (714) 885-3216  
 P. O. Box 329  
 San Bernardino, CA 92402

## RADIOACTIVITY ANALYSES

Date of Report: 3/21/91		Lab Sample ID No. 91-1865	
Laboratory Name: CLINICAL LAB OF SAN BERNARDINO		Signature of Lab Director: C. J. Jelliff	
Name of Sampler: Moulton		Employed By: North American Chemical	
Date/Time Sample Collected: 91/03/02 09:00	Date/Time Sample Received @ Lab: 91/03/14	Were Holding Times Observed: Yes	
System Name: North American Chemical Co.		System Number:	
Description of Sampling Point:			
Name/No. of Sample: BOR #1 1750' - 1770'		Station Number:	
Date & of Time Sample: 9   1   0   3   0   2   0   9   0   0	Water Type: <input type="checkbox"/> G/S	User ID: <input type="checkbox"/>	Submitted to SWQIS By:

MCL REPORTING UNITS	CONSTITUENT	T	STORET CODE	ANALYSES RESULTS
Analyzing Agency			28	3, 7, 6, 1
Date Analyses Completed			73672	9, 1, 0, 3, 2, 1 Y Y M M D D
5 pC/l	Total Alpha		1501	5, ., 8
PC/l	Total Alpha Counting Error		1502	1, ., 2
50 pC/l	Total Beta		3501	
pC/l	Total Beta Counting Error		3502	
pC/l	Natural Uranium		28012	
3 pC/l	Total Radium 226		9501	
pC/l	Total Radium 226 Counting Error		9502	
pC/l	Total Radium 228		11501	
pC/l	Total Radium 228 Counting Error		11502	
5 pC/l	Ra 226 + Ra 228		11503	
pC/l	Ra 226 + Ra 228 Counting Error		11504	
20,000pC/l	Total Tritium		7000	
pC/l	Total Tritium Counting Error		7001	
8 pC/l	Total Strontium-90		13501	
pC/l	Total Strontium-90 Counting Error		13502	

# Clinical Laboratory of San Bernardino, Inc.

1048

Post Office Box 329  
 1595 North "D" Street  
 San Bernardino, California 92402  
 Phone (714) 885-3216

## TITLE 22 CHEMICAL ANALYSES

G, I, L, 97

Date of Report <b>11/09/1990</b>	Lab Sample I.D. Number. <b>90/C/5174</b>
Laboratory Name <b>Clinical Laboratory of San Bernardino, Inc.</b>	Signature Lab Director <i>C. Jelliff</i>
Name of Sampler <b>MOULTON</b>	Sampler Employed By <b>Kerr McGee Chemical Corporation</b>
Date/Time Sample Collected <b>10/30/1990 16:00</b>	Date / Time Sample Received at Lab. <b>10/31/1990</b>
Were Holding Times Observed? <b>Yes</b>	
System Name <b>Kerr McGee Chemical Corporation</b>	System Number
Description of Sampling Point	

Name/Number of Sample Source <b>BOR WELL 2 MID ZONE</b>	Station Number																				
Date and Time of Sample <table border="1"> <tr> <td>9</td><td>0</td><td>1</td><td>0</td><td>3</td><td>0</td><td>1</td><td>6</td><td>0</td><td>0</td> </tr> <tr> <td>Y</td><td>M</td><td>M</td><td>D</td><td>D</td><td>T</td><td>T</td><td>T</td><td>T</td><td>T</td> </tr> </table>	9	0	1	0	3	0	1	6	0	0	Y	M	M	D	D	T	T	T	T	T	Water Type <input type="checkbox"/> G/S
9	0	1	0	3	0	1	6	0	0												
Y	M	M	D	D	T	T	T	T	T												
User I.D.	Submitted to SWGIS By																				

MCL Reporting Units	Constituent	T T	Storet Code	Analyses Results
	Analyzing Agency (Laboratory)		28	3   7   6   1
mg/L	Total Hardness (as CaCO3)		900	2   2   .   0
mg/L	Calcium (Ca)		916	4   .   0
mg/L	Magnesium (mg)		927	2   .   9
mg/L	Sodium (Na)		929	7   5   .   1
mg/L	Potassium (K)		937	3   .   2
<b>Total Cations</b>	<b>mg/L Value: 3.8</b>			

(Cations, Anions) 4.4 % Meg Difference.

mg/L	Total Alkalinity (as CaCO3)		410	1   1   8   .   0
mg/L	Hydroxide (OH)		71830	<   1   .   0
mg/L	Carbonate (CO3)		445	<   1   .   0
mg/L	Bicarbonate (HCO3)		440	1   4   4   .   0
* mg/L +	Sulfate (SO4)		945	2   7   .   6
* mg/L +	Chloride (Cl)		940	2   0   .   8
45 mg/L	Nitrate (NO3)		71850	1   .   6
1.4-2.4 mg/L	Fluoride(F) Temp. Depend.		951	1   .   4
<b>Total Anions</b>	<b>mg/L Value: 3.6</b>			

Std UNITS	pH(Laboratory)		403	9   .   9   0
** umho/cm +	Specific Conductance(E.C.)		95	4   0   0
*** mg/L +	Total Filterable Residue at 180°C (TDS)		70300	2   4   0   .   0
UNITS	Apparent Color (Unfiltered)		81	
TON	Odor Threshold at 60°C		86	
NTU	Lab Turbidity		82079	
0.5 mg/L +	MBAS		38260	<   0   .   0   2

• 250-500-600

•• 900-1800-2200

••• 500-1000-1500

SYSTEM NAME AND NUMBER Kerr McGee Chemical Corporation

No Entry

\* THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L \*

90/C/5174

MCL Reporting Units	Constituent	T T	Storet Code	Analyses Results
50 ug/L	Arsenic(As)		1002	1   7
1000 ug/L	Barium(Ba)		1007	<   1   0   0
10 ug/L	Cadmium(Cd)		1027	2
50 ug/L	Chromium(Total Cr)		1034	<   1   0
1000 ug/L+	Copper(Cu)		1042	<   5   0
300 ug/L+	Iron(Fe)		1045	1   6   1   0
50 ug/L	Lead(Pb)		1051	1   1
50 ug/L+	Manganese(Mn)		1055	7   0
2 ug/L	Mercury(Hg)		71900	<   1
10 ug/L	Selenium(Se)		1147	<   5
50 ug/L	Silver(Ag)		1077	<   1   0
5000 ug/L	Zinc(Zn)		1092	1   0   0

## ORGANIC CHEMICALS

0.2 ug/L	Endrin		39390	
4 ug/L	Lindane		39340	
100 ug/L	Methoxychlor		39480	
5 ug/L	Toxaphene		39400	
100 ug/L	2,4-D		39730	
10 ug/L	2,4,5-TP Silvex		39045	
Date ORGANIC Analysis Completed			73672	
				Y Y M M D D

## ADDITIONAL ANALYSES

NTU	Field Turbidity		82078	
C	Source Temperature		10	3   6   .   1
	Langlier Index Source Temp.		71814	1   .   3   7
	Langlier Index at 60°C		71813	1   .   7   4
Std. Units	Field pH		00400	9   .   9   0
	Aggressive Index		82383	1   3   .   0
mg/L	Silica		00955	
mg/L	Phosphate		00650	
	DISSOLVED ALUMINUM			0   .   7   9

## RADIOLOGICAL

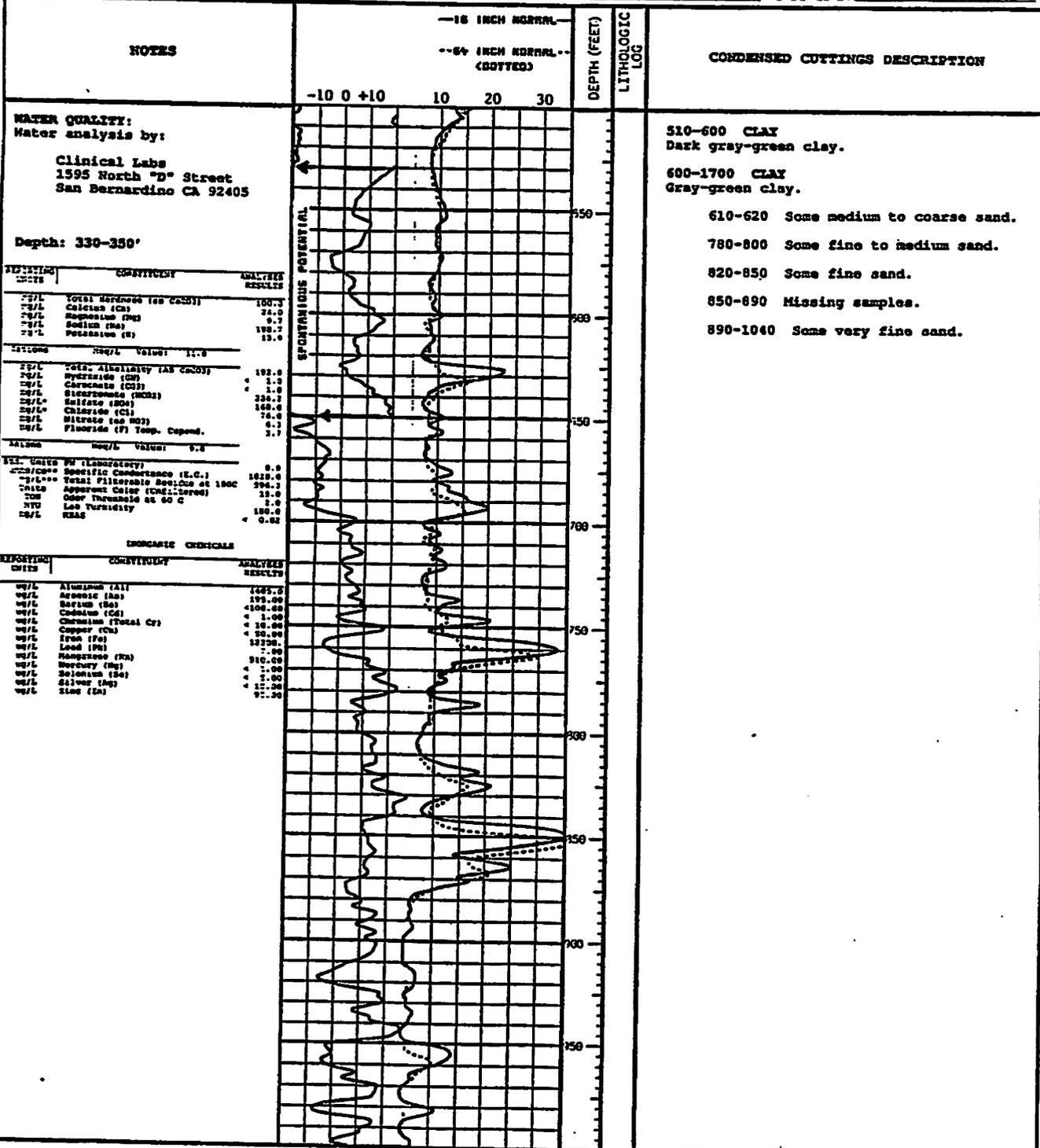
5 pC/L	Gross Alpha		1501	
pC/L	Counting Error 95%		1502	
50 pC/L	Gross Beta		3501	
pC/L	Counting Error 95%		3502	

+ indicates Secondary Drinking Water Standards

BR-2 Medium

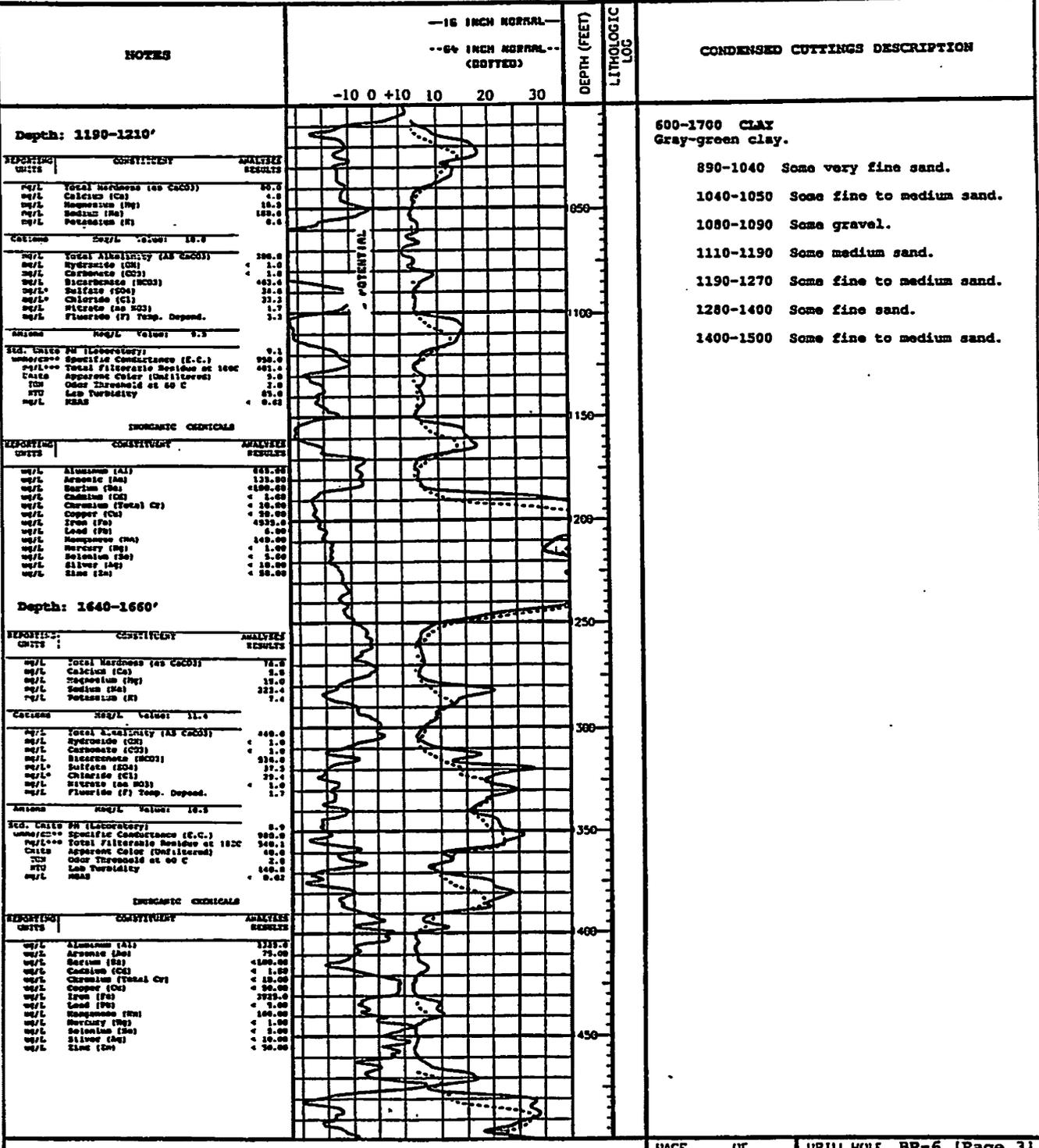
**USBR Drill Hole Completion and Data Log  
Monitoring Well BR-6**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 2012 Ft.  
 PROJECT Indian Wells Valley Groundwater Project COMPLETED DEPTH 1660 Ft.  
 LOCATION T.25 S., R. 38 E., Sec. 12m STATE CA BEGUN 1-10-92  
 TYPE OF WELL Observation FINISHED 1-17-92  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION 2352.2  
 COORDINATES TOP OF CASING ELEV. 2354.1  
 HOLE LOGGED BY Cuttings Description by Mike Stoner, Naval Air Warfare Station DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral Temperature LAB ANALYSIS Yes, See Notes  
 OTHER LOGS Drilling Time TDS See Notes  
 REVIEWED BY Dennis Watt, USBR



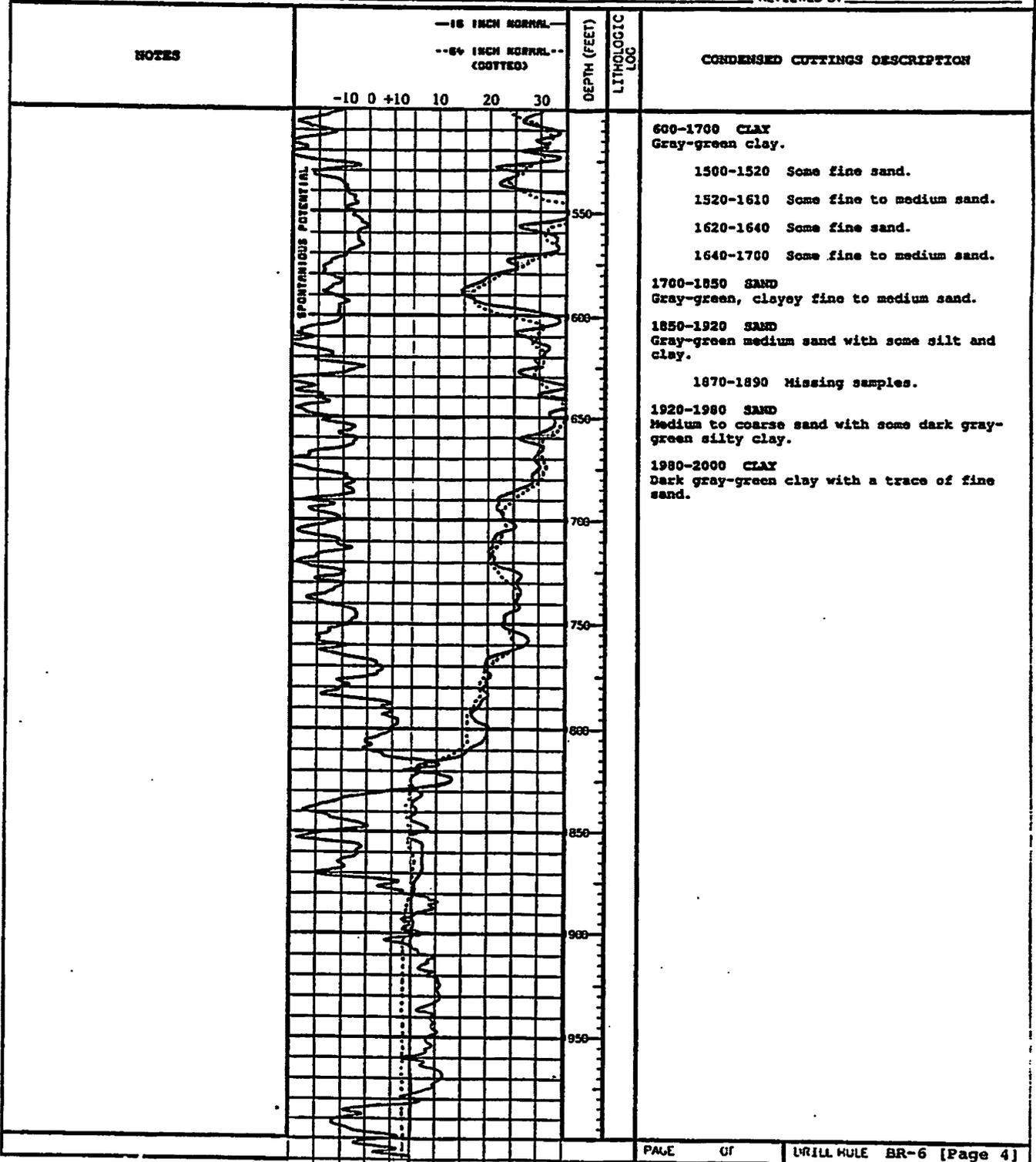
**USBR Drill Hole Completion and Data Log  
Monitoring Well BR-6**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 2012 Ft.  
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 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral LAB ANALYSIS Yes, See Notes  
 Temperature TDS See Notes  
 OTHER LOGS Drilling Time REVIEWED BY Dennis Watt, USBR



**USBR Drill Hole Completion and Data Log  
Monitoring Well BR-6**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 2012 Ft.  
 PROJECT Indian Wells Valley Groundwater Project COMPLETED DEPTH 1660 Ft.  
 LOCATION T.25 S., R. 38 E., Sec. 12m STATE CA BEGUN 1-10-92  
 TYPE OF WELL Observation FINISHED 1-17-92  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION 2352.2  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. 2354.1  
 HOLE LOGGED BY Cuttings Description by Mike Stoner, Naval Air Warfare Station DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral LAB ANALYSIS Yes, See Notes  
 Temperature \_\_\_\_\_ TDS See Notes  
 OTHER LOGS Drilling Time REVIEWED BY Dennis Watt, USBR



**USBR Drill Hole Completion and Data Log  
Monitoring Well BR-10**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 2005 Ft.  
 PROJECT Indian Wells Valley Groundwater Project COMPLETED DEPTH 1950 Ft.  
 LOCATION T.24 S., R.38 E., Sec. 21J STATE CA BEGUN 8-24-92  
 TYPE OF WELL Observation FINISHED 9-02-92  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION \_\_\_\_\_  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. 2561.4  
 HOLE LOGGED BY Cuttings Description by Mike Stoner, Naval Air Warfare Station DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Dual Induction, Natural Gamma Ray Spectrometry, Caliper LAB ANALYSIS See Notes  
Long Spaced Sonic Waveforms, Long Spaced Sonic, Temperature TDS See Notes  
 OTHER LOGS Drilling Time REVIEWED BY Dennis Watt, USBR

**NOTES**

**DRILL SITE:**  
The well is about 0.1 mile southeast of the intersection of Hwy 395 and Nine Mile Canyon Road

**DRILLED BY:**  
Welch and Howell Drilling of El Centro CA.

**DRILLING RIG:**  
Hac double (106' total height) direct rotary rig.

**DRILLING METHOD:**  
Direct rotary with bentonite mud. 14 3/4 inch roller cone bit from 56 to 1010 feet. 12 1/4 roller cone bit from 1010 to total depth.

**WELL COMPLETION:**  
Installed three 2" diameter steel pipes with a 20' two inch diameter screen on the bottom of each. Screens are at the following depth intervals: 640'-660', 1180'-1200', 1560'-1580', and 1930'-1950'. Cement plugs set at the following depth intervals: 890'-910', 1310'-1330', and 1770'-1790'.

**DEVELOPMENT:**  
Each piezometer was air-lifted at least 4 hours. Water samples for lab analysis were collected at the end of development.

**DEPTH TO WATER:**  
All depths reported below were measured on September 30, 1992 from the top of the outer casing.

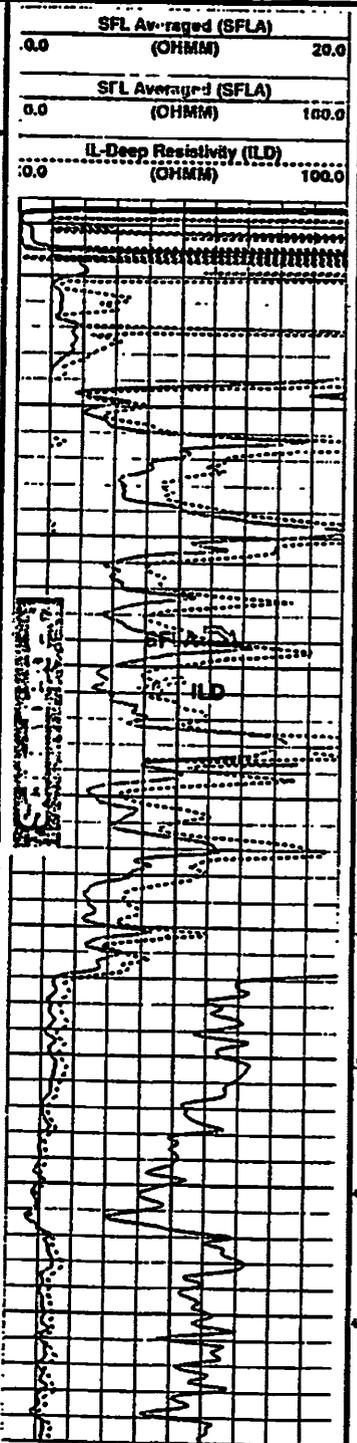
Screen Interval	Depth (Ft)
640'-660'	308.4
1180'-1200'	321.8
1560'-1580'	362.1
1930'-1950'	364.0

All depth to water measurements made during the project life are available in the Geohydrologic Appendix for this project.

**SLUG TEST RESULTS:**  
Estimated transmissivity (T) (ft<sup>2</sup>/min) by the Cooper (1967) method for the 20 feet of aquifer at each screen.

Piezometer	T
Shallow	.19
Shal/Med	.02*
Deep/Med	.14
Deep	.09

\*Note - This is suspiciously low.



**CONDENSED CUTTINGS DESCRIPTION**

The interpretation below is reduced from a description of samples collected every 10 feet from the drilling mud return.

**GENERAL**

The collected samples and drilling character indicate a non-cemented alluvial fill from land surface to total depth.

Depth intervals are feet below land surface.

0-40 Missing samples.

40-60 GRAVEL  
Dark salt and pepper color with basalt.

60-680 SAND  
Tan-gray medium to coarse sand.

80-120 Very coarse with gravel to 1/4 inch.

160-180 Coarse sand with gravel.

180-300 Medium sand with silt.

300-320 Fine to medium sand with some silt.

320-360 Silty.

360-380 Medium sand with silt.

380-400 Silt.

400-420 Silty medium sand.

420-460 Medium sand with silt.

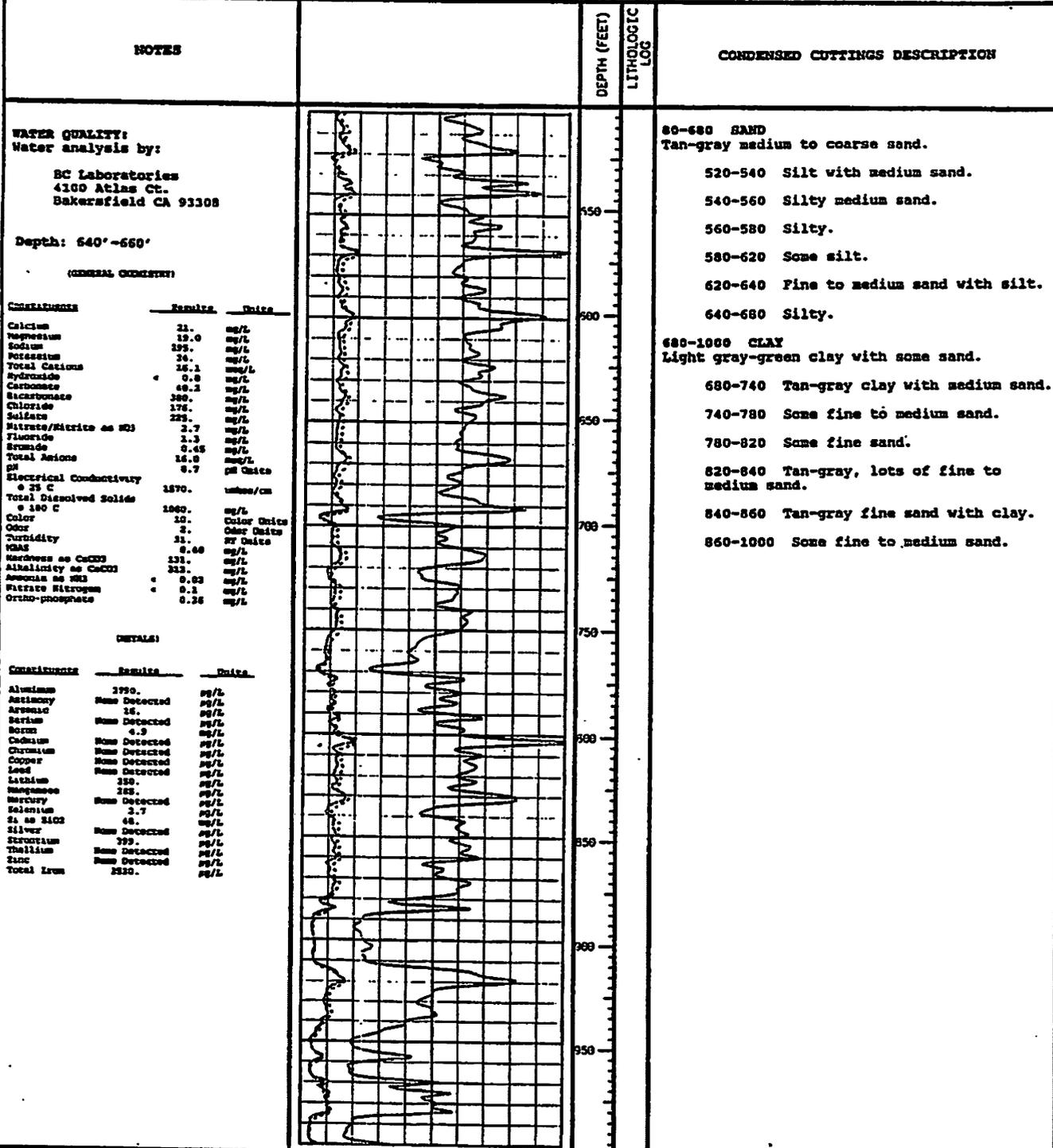
460-520 Silty.

*Cook - Cheryl HO. NASEN. 11/11/92*  
*[Log 294-1131]*

88 327-1631 X-109

**USBR Drill Hole Completion and Data Log  
Monitoring Well BR-10**

FEATURE Drill Hole Completed with Nested Piezometers DRILLED DEPTH 2005 Ft.  
 PROJECT Indian Wells Valley Groundwater Project COMPLETED DEPTH 1950 Ft.  
 LOCATION T.24 S., R.3B E., Sec. 21J STATE CA BEGUN 8-24-92  
 TYPE OF WELL Observation FINISHED 9-02-92  
 PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION \_\_\_\_\_  
 COORDINATES \_\_\_\_\_ TOP OF CASING ELEV. 2561.4  
 HOLE LOGGED BY Cuttings Description by Mike Stoner, Naval Air Warfare Station DEPTH TO WATER (DATE) See Notes  
 GEOPHYSICAL LOGS Dual Induction, Natural Gamma Ray Spectrometry, Caliper LAB ANALYSIS See Notes  
Long Spaced Sonic Waveforms, Long Spaced Sonic, Temperature TDS See Notes  
 OTHER LOGS Drilling Time REVIEWED BY Dennis Watt, USBR



# Clinical Laboratory of San Bernardino, Inc.



1595 N. "D" St., San Bernardino, CA 92405  
 Phone (714) 885-3216  
 P. O. Box 329  
 San Bernardino, CA 92402

## RADIOACTIVITY ANALYSES

Date of Report: NOV 08 1990		Lab Sample ID No. 90/C/5174	
Laboratory Name: CLINICAL LAB OF SAN BERNARDINO		Signature of Lab Director: <i>C. Jelliff</i>	
Name of Sampler: Moulton		Employed By: Kerr Mc Gee Chemical Corp.	
Date/Time Sample Collected: 10/30/90 15:00	Date/Time Sample Received @ Lab: 10/31/90	Were Holding Times Observed: Yes	
System Name: Kerr McGee Chemical Corporation		System Number:	
Description of Sampling Point:			
Name/No. of Sample		Station Number:	
Source: BOR Well 2. MID ZONE			
Date & of Time	Water Type: <input type="checkbox"/> G/S	User ID: <input type="checkbox"/>	Submitted to SWQIS By:
Sample: Y Y M M D D T T T T			

MCL REPORTING UNITS	CONSTITUENT	T	STORET CODE	ANALYSES RESULTS
Analyzing Agency			28	3, 7, 6, 1
Date Analyses Completed			73672	9 0 1 1 0 7 Y Y M M D D

5	pC/l	Total Alpha		1501	0.2
	pC/l	Total Alpha Counting Error		1502	0.7
50	pC/l	Total Beta		3501	
	pC/l	Total Beta Counting Error		3502	
	pC/l	Natural Uranium		28012	
3	pC/l	Total Radium 226		9501	
	pC/l	Total Radium 226 Counting Error		9502	
	pC/l	Total Radium 228		11501	
	pC/l	Total Radium 228 Counting Error		11502	
5	pC/l	Ra 226 + Ra 228		11503	
	pC/l	Ra 226 + Ra 228 Counting Error		11504	
20,000	pC/l	Total Tritium		7000	
	pC/l	Total Tritium Counting Error		7001	
8	pC/l	Total Strontium-90		13501	
	pC/l	Total Strontium-90 Counting Error		13502	

# Clinical Laboratory of San Bernardino, Inc.

1048

Post Office Box 329  
 1595 North D Street  
 San Bernardino, California 92402  
 Phone (714) 885-3216

## TITLE 22 CHEMICAL ANALYSES

G, I, L 110F

Date of Report	11/09/1990
Lab Sample I.D. Number	90/C/5175
Signature Lab Director	<i>C. Bernardino</i>
Sampler Employed By	Kerr McGee Chemical Corporation
Name of Sampler	Clinical Laboratory of San Bernardino, Inc.
MOULTON	
Date/Time Sample Collected	10/30/1990 15:00
Date / Time Sample Received at Lab.	10/31/1990
Were Holding Times Observed?	Yes
System Name	Kerr McGee Chemical Corporation
Description of Sampling Point	

Station Number: \_\_\_\_\_  
 BOR WELL #2 LOWER ZONR

Date and Time of Sample: 9 0 1 0 3 0 1 5 0 0  
 Y M D M D Y T T T  
 Water Type:  G/S  User I.D.: \_\_\_\_\_  
 Submitted to SWIS By: \_\_\_\_\_

MCL Reporting Units	Constituent	T	Storet Code	Analyses Results
mg/L	Total Alkalinity (as CaCO3)	410	8 6	0 0
mg/L	Hydroxide (OH)	71830	< 1	0 0
mg/L	Carbonate (CO3)	445	< 1	0 0
mg/L	Bicarbonate (HCO3)	440	1 0 4	9
mg/L	Sulfate (SO4)	945	8 1	3
mg/L	Chloride (Cl)	940	5 2	0
mg/L	Nitrate (NO3)	71850	4	8
mg/L	Fluoride (F) Temp. Depend.	951	8	4

### (Cations, Anions) 2.5 & Meg Difference.

Total Cations	mg/L	Value:	5.5
mg/L	Total Anions	mg/L	Value: 5.4
mg/L	Total Hardness (as CaCO3)	28	3 7 6 1
mg/L	Analizing Agency (Laboratory)	403	8 5 8 0
mg/L	pH (Laboratory)	403	8 5 8 0
mg/L	Specific Conductance (EC)	95	8 5 8 0
mg/L	Total Filterable Residue	70300	3 5 3 1 8
mg/L	Apparent Color (Unfiltered)	81	
mg/L	Odor Threshold at 60°C	86	
mg/L	Lab Turbidity	82079	
mg/L	MBAS	38260	

ONS 83511/83

250-500-600

900-1600-2200

500-1000-1500

BR-2 Deep

SYSTEM NAME AND NUMBER Kerr McGee Chemical Corporation

No Entry

• THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L •

90/C/5175

MCL Reporting Units	Constituent	T T	Store Code	Analyses Results
50 ug/L	Arsenic(As)		1002	1   4
1000 ug/L	Barium(Ba)		1007	<   1   0   0
10 ug/L	Cadmium(Cd)		1027	<   1
50 ug/L	Chromium(Total Cr)		1034	<   1   0
1000 ug/L+	Copper(Cu)		1042	<   5   0
300 ug/L+	Iron(Fe)		1045	1   5   0   0
50 ug/L	Lead(Pb)		1051	1   5
50 ug/L+	Manganese(Mn)		1055	2   5   0
2 ug/L	Mercury(Hg)		71900	<   1
10 ug/L	Selenium(Se)		1147	<   5
50 ug/L	Silver(Ag)		1077	<   1   0
5000 ug/L	Zinc(Zn)		1092	9   0

ORGANIC CHEMICALS

0.2 ug/L	Endrin		39390	
4 ug/L	Lindane		39340	
100 ug/L	Methoxychlor		39480	
5 ug/L	Toxaphene		39400	
100 ug/L	2,4-D		39730	
10 ug/L	2,4,5-TP Silvax		39045	
Date ORGANIC Analysis Completed			73672	

Y Y M M D D

ADDITIONAL ANALYSES

NTU	Field Turbidity		82078	
C	Source Temperature		10	4   3   .   3
	Langlier Index Source Temp.		71814	0   .   5   4
	Langlier Index at 60°C		71813	0   .   7   9
Std. Units	Field pH		00400	8   .   6   0
	Aggressive Index		82383	1   2   .   1
mg/L	Silica		00955	
mg/L	Phosphate		00650	
	DISSOLVED ALUMINUM			0   .   2   6

RADIOLOGICAL

5 pC/L	Gross Alpha		1501	
pC/L	Counting Error 95%		1502	
50 pC/L	Gross Beta		3501	
pC/L	Counting Error 95%		3502	

+ Indicates Secondary Drinking Water Standards

# Clinical Laboratory of San Bernardino, Inc.



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 San Bernardino, CA 92402

## RADIOACTIVITY ANALYSES

Date of Report: NOV 08 1990		Lab Sample ID No. 90/C/5175	
Laboratory Name: CLINICAL LAB OF SAN BERNARDINO		Signature of Lab Director: <i>C. Jelliff</i>	
Name of Sampler: Moulton		Sampler Employed By: Kerr McGee Chemical Corp.	
Date/Time Sample Collected: 10/30/90 03:00	Date/Time Sample Received @ Lab: 10/31/90	Were Holding Times Observed: Yes	
System Name: Kerr McGee Chemical Corporation		System Number:	
Description of Sampling Point:			
Name/No. of Sample		Station	
Source: BOR WELL 2 LOWER ZONE		Number:	
Date & of Time Sample: 9   0   1   0   3   0   3   0   0	Water Type: <input type="checkbox"/> G/S	User ID: <input type="checkbox"/>	Submitted to SWQIS By:
Sample: Y Y M M D D T T T T			

MCL REPORTING UNITS	CONSTITUENT	T	STORET CODE	ANALYSES RESULTS
Analyzing Agency			28	3 7 6 1
Date Analyses Completed			73672	9 0 1 1 0 7 Y Y M M D D

5	pC/l Total Alpha		1501	5.1
	pC/l Total Alpha Counting Error		1502	1.2
50	pC/l Total Beta		3501	
	pC/l Total Beta Counting Error		3502	
	pC/l Natural Uranium		28012	
3	pC/l Total Radium 226		9501	
	pC/l Total Radium 226 Counting Error		9502	
	pC/l Total Radium 228		11501	
	pC/l Total Radium 228 Counting Error		11502	
5	pC/l Ra 226 + Ra 228		11503	
	pC/l Ra 226 + Ra 228 Counting Error		11504	
20,000	pC/l Total Tritium		7000	
	pC/l Total Tritium Counting Error		7001	
8	pC/l Total Strontium-90		13501	
	pC/l Total Strontium-90 Counting Error		13502	

CLINICAL LABS/SAN BERNARDINO  
 1595 NORTH "D" STREET  
 SAN BERNARDINO, CA. 92405

TITLE 22 CHEMICAL ANALYSIS

Date of Report: 04/03/91  
 Laboratory Signature Lab  
 Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: C. Jolly  
 Name of Sampler: MOULTON Employed By: NAC ~~1850-1870 FEET~~  
 Date/Time Sample Date/Time Sample Date Analyses  
 Collected: 91/03/18/1400 Received @ Lab: 91/03/18/1400 Completed: 91/04/03

Sample ID No. 912079

System Name: NORTH AMERICAN CHEMICAL - AKA KERR MCGEE System Number: 36-042  
 Name or Number of Sample Source: BOR #1 Well 3

\*\*\*\*\*  
 \* Water Type: (G/S) |S| Station Number: 036/042-BOR#1 \*  
 \* Date/Time of Sample: |91|03|18|1400| User ID: TAN \*  
 \* YY MM DD HHMM \*  
 \* Analyzing Agency Code: 3761 Date Analysis Completed: |91|04|03| \*  
 \* YY MM DD \*  
 \* Submitted by: \_\_\_\_\_ Phone #: \_\_\_\_\_ \*  
 \*\*\*\*\*

Place an 'X' in box to delete all data for this station/date/time.

REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	MCL	DLR
mg/L	Total Hardness (as CaCO3)	00900	96.0		
mg/L	Calcium (Ca)	00916	17.6		
mg/L	Magnesium (Mg)	00927	12.6		30.0
mg/L	Sodium (NA)	00929	91.4		
mg/L	Potassium (K)	00937	5.9		
Total Cations Meq/L Value: 6.0					
mg/L	Total Alkalinity (AS CaCO3)	00410	132.8		
mg/L	Hydroxide (OH)	71830	< 1.0		
mg/L	Carbonate (CO3)	00445	< 1.0		
mg/L	Bicarbonate (HCO3)	00440	162.0		
mg/L*	Sulfate (SO4)	00945	78.5		
mg/L*	Chloride (Cl)	00940	47.3		
mg/L	Nitrate (as NO3)	71850	11.1	45	
mg/L	Fluoride (F) Temp. Depend.	00951	0.5	****	0.1
Total Anions Meq/L Value: 5.8					
Std. Units	PH (Laboratory)	00403	8.4		
umho/cm**	Specific Conductance (E.C.)	00095	600.0		
mg/L***	Total Filterable Residue at 180C (TDS)	70300	360.0		
Units	Apparent Color (Unfiltered)	00081	70.0		
TON	Odor Threshold at 60 C	00086	1.0		1.0
NTU	Lab Turbidity	82079	71.0		
mg/L	MBAS	38260	< 0.02	0.5	0.02

\* 250-500-600 \*\* 900-1600-2200 \*\*\* 500-100-1500 \*\*\*\* 1.4-2.4

\* THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L \*

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED UG/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
ug/L	Arsenic (As)	01002	< 10	50	10
ug/L	Barium (Ba)	01007	< 100	1000	100
ug/L	Cadmium (Cd)	01027	< 1	10	1
ug/L	Chromium (Total Cr)	01034	< 10	50	10
ug/L	Copper (Cu)	01042	< 50	1000	50
ug/L	Iron (Fe)	01045	4550	300	100
ug/L	Lead (Pb)	01051	130	50	5
ug/L	Manganese (Mn)	01055	< 30	50	30
ug/L	Mercury (Hg)	71900	< 1	2	1
ug/L	Selenium (Se)	01147	< 5	10	5
ug/L	Silver (Ag)	01077	< 10	50	10
ug/L	Zinc (Zn)	01092	< 50	5000	50
ug/L	Aluminum	01105	870	1000	100

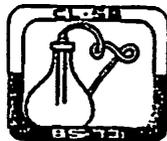
## ORGANIC CHEMICALS

ug/L	Endrin (Hexadrin)	39390		0.2	0.02
ug/L	Gamma-BHC (Lindane)	39340		4	0.4
ug/L	Methoxychlor	39480		100	10.0
ug/L	Toxaphene	39400		5	0.5
ug/L	2,4-D	39730		100	10.0
ug/L	2,4,5-TP (Silvex) (WEED-B-GON)	39045		10	

## ADDITIONAL ANALYSES

NTU	Field Turbidity	82078			
C	Source Temperature C	00010			0.1
	Langelier Index Source Temp.	71814			
	Langelier Index at 60 C	71813			
Std. Units	Field PH	00400			
	Agressiveness Index	82383			
mg/L	Silica	00955			
mg/L	Phosphate	00650			
mg/L	Iodide	71865			
	Sodium Absorption Ratio	00931			
	Asbestos	81855			
mg/L	Ammonia (NH3-N)	00612			
mg/L	Nitrite Nitrogen (NO2-N)	00615			
mg/L	Nitrate Nitrogen (NO3-N)	00618			
mg/L	Nitrite (N)	00620			1.0
mg/L	Beryllium	01012			
mg/L	Boron	01020			
mg/L	Thallium	01059			
mg/L	Nickel	01067			
mg/L	Antimony	01097			
mg/L	Lithium	01132			0.05
mg/L	Cyanide	01291			

# Clinical Laboratory of San Bernardino, Inc.



1595 N. "D" St., San Bernardino, CA 92405  
 Phone (714) 885-3216  
 P. O. Box 329  
 San Bernardino, CA 92402

## RADIOACTIVITY ANALYSES

Date of Report: 4/13/91		Lab Sample ID No. 91-2079																													
Laboratory Name: CLINICAL LAB OF SAN BERNARDINO		Signature of Lab Director: <i>Mehdi Qasbi</i>																													
Name of Sampler: Moulton		Sampler Employed By: North American Chemical																													
Date/Time Sample Collected: 91/03/18 11:00	Date/Time Sample Received @ Lab: 91/03/18	Were Holding Times Observed: Yes																													
System Name: North American Chemical		System Number:																													
Description of Sampling Point:																															
Name/No. of Sample: IWV Study BOR WELL 3	<del>1850</del> 1870	Station Number:																													
Date & of Time Sample: <table border="1"><tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr><tr><td>Y</td><td>Y</td><td>M</td><td>M</td><td>D</td><td>D</td><td>T</td><td>T</td><td>T</td><td>T</td></tr></table>											Y	Y	M	M	D	D	T	T	T	T	Water Type: <table border="1"><tr><td> </td><td> </td></tr><tr><td>G</td><td>S</td></tr></table>			G	S	User ID: <table border="1"><tr><td> </td><td> </td><td> </td><td> </td></tr></table>					Submitted to SWQIS By:
Y	Y	M	M	D	D	T	T	T	T																						
G	S																														

MCL REPORTING UNITS	CONSTITUENT	T	STORET CODE	ANALYSES RESULTS
Analyzing Agency			28	3 7 6 1
Date Analyses Completed			73672	9 1 0 4 0 2
				Y Y M M D D
5 pC/l	Total Alpha		1501	1 . . 8
PC/l	Total Alpha Counting Error		1502	1 . . 5
50 pC/l	Total Beta		3501	
pC/l	Total Beta Counting Error		3502	
pC/l	Natural Uranium		28012	
3 pC/l	Total Radium 226		9501	
pC/l	Total Radium 226 Counting Error		9502	
pC/l	Total Radium 228		11501	
pC/l	Total Radium 228 Counting Error		11502	
5 pC/l	Ra 226 + Ra 228		11503	
pC/l	Ra 226 + Ra 228 Counting Error		11504	
20,000pC/l	Total Tritium		7000	
pC/l	Total Tritium Counting Error		7001	
8 pC/l	Total Strontium-90		13501	
pC/l	Total Strontium-90 Counting Error		13502	

CLINICAL LABS/SAN BERNARDINO  
 1595 NORTH "D" STREET  
 SAN BERNARDINO, CA. 92405

TITLE 22 CHEMICAL ANALYSIS

Date of Report: 04/03/91 Sample ID No.912080  
 Laboratory Signature Lab  
 Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: C. Jelling  
 Name of Sampler: MOULTON Employed By: NAC ~~650-676-FEET~~  
 Date/Time Sample Date/Time Sample Date Analyses  
 Collected: 91/03/18/1000 Received @ Lab: 91/03/18/1000 Completed: 91/04/03

System System  
 Name: NORTH AMERICAN CHEMICAL - AKA KERR MCGEE Number: 36-042  
 Name or Number of Sample Source: BOR #1 Well 3  
 \*\*\*\*\*  
 \* Water Type: (G/S) |S| Station Number: 036/042-BOR#1 \*  
 \* Date/Time of Sample: |91|03|18|1000| User ID: TAN \*  
 \* YY MM DD HHMM \*  
 \* Analyzing Agency Code: 3761 Date Analysis Completed: |91|04|03| \*  
 \* YY MM DD \*  
 \* Submitted by: Phone #: \*  
 \*\*\*\*\*

Place an 'X' in box to delete all data for this station/date/time.

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED ug/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
mg/L	Total Hardness (as CaCO3)	00900	128.0		
mg/L	Calcium (Ca)	00916	38.4		
mg/L	Magnesium (Mg)	00927	7.8		30.0
mg/L	Sodium (NA)	00929	255.9		
mg/L	Potassium (K)	00937	7.9		
Total Cations Meq/L Value: 13.9					
mg/L	Total Alkalinity (AS CaCO3)	00410	113.2		
mg/L	Hydroxide (OH)	71830	< 1.0		
mg/L	Carbonate (CO3)	00445	< 1.0		
mg/L	Bicarbonate (HCO3)	00440	138.1		
mg/L*	Sulfate (SO4)	00945	65.6		
mg/L*	Chloride (Cl)	00940	372.0		
mg/L	Nitrate (as NO3)	71850	< 1.0	45	
mg/L	Fluoride (F) Temp. Depend.	00951	1.1	****	0.1
Total Anions Meq/L Value: 14.2					
Std. Units	PH (Laboratory)	00403	7.4		
umho/cm**	Specific Conductance (E.C.)	00095	1540.0		
mg/L***	Total Filterable Residue at 180C (TDS)	70300	954.8		
Units	Apparent Color (Unfiltered)	00081	70.0		
TON	Odor Threshold at 60 C	00086	2.0		1.0
NTU	Lab Turbidity	82079	5.9		
mg/L	MBAS	38260	< 0.02	0.5	0.02

\* 250-500-600 \*\* 900-1600-2200 \*\*\* 500-100-1500 \*\*\*\* 1.4-2.4

## \* THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L \*

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
ug/L	Arsenic (As)	01002	< 10	50	10
ug/L	Barium (Ba)	01007	120	1000	100
ug/L	Cadmium (Cd)	01027	< 1	10	1
ug/L	Chromium (Total Cr)	01034	< 10	50	10
ug/L	Copper (Cu)	01042	< 50	1000	50
ug/L	Iron (Fe)	01045	2290	300	100
ug/L	Lead (Pb)	01051	< 5	50	5
ug/L	Manganese (Mn)	01055	100	50	30
ug/L	Mercury (Hg)	71900	< 1	2	1
ug/L	Selenium (Se)	01147	< 5	10	5
ug/L	Silver (Ag)	01077	< 10	50	10
ug/L	Zinc (Zn)	01092	< 50	5000	50
ug/L	Aluminum	01105	1550	1000	100

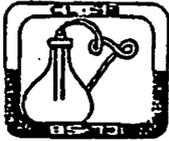
## ORGANIC CHEMICALS

ug/L	Endrin (Hexadrin)	39390		0.2	0.02
ug/L	Gamma-BHC (Lindane)	39340		4	0.4
ug/L	Methoxychlor	39480		100	10.0
ug/L	Toxaphene	39400		5	0.5
ug/L	2,4-D	39730		100	10.0
ug/L	2,4,5-TP (Silvex) (WEED-B-GON)	39045		10	

## ADDITIONAL ANALYSES

NTU	Field Turbidity	82078			0.1
C	Source Temperature C	00010			
	Langelier Index Source Temp.	71814			
	Langelier Index at 60 C	71813			
Std. Units	Field PH	00400			
	Agressiveness Index	82383			
mg/L	Silica	00955			
mg/L	Phosphate	00650			
mg/L	Iodide	71865			
	Sodium Absorption Ratio	00931			
	Asbestos	81855			
mg/L	Ammonia (NH3-N)	00612			
mg/L	Nitrite Nitrogen (NO2-N)	00615			
mg/L	Nitrate Nitrogen (NO3-N)	00618			1.0
mg/L	Nitrite (N)	00620			
mg/L	Beryllium	01012			
mg/L	Boron	01020			
mg/L	Thallium	01059			
mg/L	Nickel	01067			
mg/L	Antimony	01097			0.05
mg/L	Lithium	01132			
mg/L	Cyanide	01291			

# Clinical Laboratory of San Bernardino, Inc.



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 San Bernardino, CA 92402

## RADIOACTIVITY ANALYSES

Date of Report: 4/3/91		Lab Sample ID No. 91-2080	
Laboratory Name: CLINICAL LAB OF SAN BERNARDINO		Signature of Lab Director: Mehdi Siani	
Name of Sampler: Moulton		Sampler Employed By: North American Chemical	
Date/Time Sample Collected: 91/03/18 10:00	Date/Time Sample Received @ Lab: 91/03/18	Were Holding Times Observed: Yes	
System Name: North American Chemical		System Number:	
Description of Sampling Point:			
Name/No. of Sample: BOR WELL 3		Station Number:	
Source: IWV Study <del>650</del> 670		Water Type: <input type="checkbox"/> G/S	
Date & of Time Sample: Y Y M M D D T T T T		User ID: <input type="checkbox"/>	
		Submitted to SWQIS By:	

MCL REPORTING UNITS	CONSTITUENT	T	STORET CODE	ANALYSES RESULTS
Analyzing Agency			28	, , 3 , 7 , 6 , 1
Date Analyses Completed			73672	9 , 1 , 0 , 4 , 0 , 2
				Y Y M M D D

5	pC/l Total Alpha		1501	, , , , 0 , , 7
	pC/l Total Alpha Counting Error		1502	, , , , 1 , , 6
50	pC/l Total Beta		3501	, , , , , , , ,
	pC/l Total Beta Counting Error		3502	, , , , , , , ,
	pC/l Natural Uranium		28012	, , , , , , , ,
3	pC/l Total Radium 226		9501	, , , , , , , ,
	pC/l Total Radium 226 Counting Error		9502	, , , , , , , ,
	pC/l Total Radium 228		11501	, , , , , , , ,
	pC/l Total Radium 228 Counting Error		11502	, , , , , , , ,
5	pC/l Ra 226 + Ra 228		11503	, , , , , , , ,
	pC/l Ra 226 + Ra 228 Counting Error		11504	, , , , , , , ,
20,000pC/l	Total Tritium		7000	, , , , , , , ,
	pC/l Total Tritium Counting Error		7001	, , , , , , , ,
8	pC/l Total Strontium-90		13501	, , , , , , , ,
	pC/l Total Strontium-90 Counting Error		13502	, , , , , , , ,

CLINICAL LABS/SAN BERNARDINO  
 1595 NORTH "D" STREET  
 SAN BERNARDINO, CA. 92405

TITLE 22 CHEMICAL ANALYSIS

Date of Report: 04/04/91

Sample ID No.912078

Laboratory

Signature Lab

Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: C. J. Kelly

Name of Sampler: MOULTON

Employed By: NAC ~~1920-1940~~

Date/Time Sample

Date/Time Sample

Date Analyses

Collected: 91/03/18/1400

Received @ Lab: 91/03/18/1400

Completed: 91/04/04

System

System

Name: NORTH AMERICAN CHEMICAL - AKA KERR MCGEE

Number: 36-042

Name or Number of Sample Source: BOR #1 Well 3

\*\*\*\*\*  
 \* Water Type: (G/S) |S| Station Number: 036/042-BOR#1 \*  
 \* Date/Time of Sample: |91|03|18|1400| User ID: TAN \*  
 \* YY MM DD HHMM \*  
 \* Analyzing Agency Code: 3761 Date Analysis Completed: |91|04|04| \*  
 \* Submitted by: Phone #: \*  
 \* Y Y M M D D \*  
 \*\*\*\*\*

Place an 'X' in box to delete all data for this station/date/time.

REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	MCL	DLR
	ALL CONSTITUENTS REPORTED ug/L				
mg/L	Total Hardness (as CaCO3)	00900	1400.0		
mg/L	Calcium (Ca)	00916	496.6		
mg/L	Magnesium (Mg)	00927	38.9		30.0
mg/L	Sodium (NA)	00929	1536.4		
mg/L	Potassium (K)	00937	14.6		
Total Cations Meq/L Value: 95.2					
mg/L	Total Alkalinity (AS CaCO3)	00410	32.0		
mg/L	Hydroxide (OH)	71830	< 1.0		
mg/L	Carbonate (CO3)	00445	< 1.0		
mg/L	Bicarbonate (HCO3)	00440	39.0		
mg/L*	Sulfate (SO4)	00945	257.5		
mg/L*	Chloride (Cl)	00940	3200.0		
mg/L	Nitrate (as NO3)	71850	38.1	45	
mg/L	Fluoride (F) Temp. Depend.	00951	5.4	****	0.1
Total Anions Meq/L Value: 97.0					
Std. Units	PH (Laboratory)	00403	7.2		
umho/cm**	Specific Conductance (E.C.)	00095	10700.		
mg/L***	Total Filterable Residue at 180C (TDS)	70300	6634.0		
Units	Apparent Color (Unfiltered)	00081	40.0		
TON	Odor Threshold at 60 C	00086	3.0		1.0
NTU	Lab Turbidity	82079	71.0		
mg/L	MBAS	38260	< 0.02	0.5	0.02

\* 250-500-600 \*\* 900-1600-2200 \*\*\* 500-100-1500 \*\*\*\* 1.4-2.4

\* THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L \*

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED ug/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
ug/L	Arsenic (As)	01002	< 10	50	10
ug/L	Barium (Ba)	01007	< 100	1000	100
ug/L	Cadmium (Cd)	01027	< 1	10	1
ug/L	Chromium (Total Cr)	01034	< 10	50	10
ug/L	Copper (Cu)	01042	< 50	1000	50
ug/L	Iron (Fe)	01045	780	300	100
ug/L	Lead (Pb)	01051	< 5	50	5
ug/L	Manganese (Mn)	01055	280	50	30
ug/L	Mercury (Hg)	71900	< 1	2	1
ug/L	Selenium (Se)	01147	< 5	10	5
ug/L	Silver (Ag)	01077	< 10	50	10
ug/L	Zinc (Zn)	01092	< 50	5000	50
ug/L	Aluminum	01105	240	1000	100

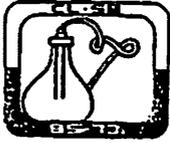
## ORGANIC CHEMICALS

ug/L	Endrin (Hexadrin)	39390		0.2	0.02
ug/L	Gamma-BHC (Lindane)	39340		4	0.4
ug/L	Methoxychlor	39480		100	10.0
ug/L	Toxaphene	39400		5	0.5
ug/L	2,4-D	39730		100	10.0
ug/L	2,4,5-TP (Silvex) (WEED-B-GON)	39045		10	

## ADDITIONAL ANALYSES

NTU	Field Turbidity	82078			0.1
C	Source Temperature C	00010			
	Langelier Index Source Temp.	71814			
	Langelier Index at 60 C	71813			
Std. Units	Field PH	00400			
	Agressiveness Index	82383			
mg/L	Silica	00955			
mg/L	Phosphate	00650			
mg/L	Iodide	71865			
	Sodium Absorption Ratio	00931			
	Asbestos	81855			
mg/L	Ammonia (NH3-N)	00612			
mg/L	Nitrite Nitrogen (NO2-N)	00615			
mg/L	Nitrate Nitrogen (NO3-N)	00618			1.0
mg/L	Nitrite (N)	00620			
mg/L	Beryllium	01012			
mg/L	Boron	01020			
mg/L	Thallium	01059			
mg/L	Nickel	01067			
mg/L	Antimony	01097			
mg/L	Lithium	01132			0.05
mg/L	Cyanide	01291			

# Clinical Laboratory of San Bernardino, Inc.



1595 N. "D" St., San Bernardino, CA 92405

Phone (714) 885-3216

P. O. Box 329

San Bernardino, CA 92402

## RADIOACTIVITY ANALYSES

Date of Report: 4/3/91		Lab Sample ID No. 91-2078	
Laboratory Name: CLINICAL LAB OF SAN BERNARDINO		Signature of Lab Director: Mehdi Gami	
Name of Sampler: Moulton		Employed By: North American Chemical	
Date/Time Sample Collected: 91/03/18 14:00	Date/Time Sample Received @ Lab: 91/03/18	Were Holding Times Observed: Yes	
System Name: North American Chemical		System Number:	
Description of Sampling Point:			
Name/No. of Sample: IWV Study		Station Number:	
Source: BOR WELL 3 1320 - 1340			
Date & of Time Sample: Y Y M M D D T T T T	Water Type: <input type="checkbox"/> G/S	User ID: <input type="checkbox"/>	Submitted to SWQIS By:

MCL REPORTING UNITS	CONSTITUENT	T	STORET CODE	ANALYSES RESULTS
Analyzing Agency		T	28	, 3 , 7 , 6 , 1
Date Analyses Completed			73672	9 1 0 4 0 2 Y Y M M D D

5	pC/l Total Alpha		1501	, , 1 , 1 , , 4
	PC/l Total Alpha Counting Error		1502	, , , 7 , , 2

50	pC/l Total Beta		3501	, , , , , ,
	pC/l Total Beta Counting Error		3502	, , , , , ,

	pC/l Natural Uranium		28012	, , , , , ,
--	----------------------	--	-------	-------------

3	pC/l Total Radium 226		9501	, , , , , ,
	pC/l Total Radium 226 Counting Error		9502	, , , , , ,

	pC/l Total Radium 228		11501	, , , , , ,
	pC/l Total Radium 228 Counting Error		11502	, , , , , ,

5	pC/l Ra 226 + Ra 228		11503	, , , , , ,
	pC/l Ra 226 + Ra 228 Counting Error		11504	, , , , , ,

20,000pC/l	Total Tritium		7000	, , , , , ,
	pC/l Total Tritium Counting Error		7001	, , , , , ,

8	pC/l Total Strontium-90		13501	, , , , , ,
	pC/l Total Strontium-90 Counting Error		13502	, , , , , ,

# Clinical Laboratory of San Bernardino, Inc.

1048

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 1595 North "D" Street  
 San Bernardino, California 92402  
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## TITLE 22 CHEMICAL ANALYSES

G, I, L 90F

Date Of Report <b>11/09/1990</b>		Lab Sample I.D. Number. <b>90/C/5176</b>	
Laboratory Name <b>Clinical Laboratory of San Bernardino, Inc.</b>		Signature Lab Director <i>C. J. Kelly</i>	
Name of Sampler <b>MOULTON</b>		Sampler Employed By <b>Kerr McGee Chemical Corporation</b>	
Date/Time Sample Collected <b>10/30/1990 12:30</b>	Date / Time Sample Received at Lab. <b>10/31/1990</b>	Were Holding Times Observed? <b>Yes</b>	
System Name <b>Kerr McGee Chemical Corporation</b>			System Number

Description of Sampling Point

Name/Number of Sample Source  
**BOR WELL 4 SEC 25 T26S R39E**

Date and Time of Sample <b>9   0   1   0   3   0   1   2   3   0</b> Y M M D D T T T T		Water Type <input type="checkbox"/> G/S	User I.D.	Submitted to SWDIS By
--	--	--	-----------	-----------------------

MCL Reporting Units	Constituent	T T	Storet Code	Analyses Results
	Analyzing Agency (Laboratory)		28	3   7   6   1
mg/L	Total Hardness (as CaCO3)		900	9   .   6
mg/L	Calcium (Ca)		916	1   .   3
mg/L	Magnesium (mg)		927	1   .   6
mg/L	Sodium (Na)		929	6   5   .   3
mg/L	Potassium (K)		937	0   .   4
Total Cations mg/L Value: <b>3.0</b>				

(Cations, Anions) 3.7 % Meq Difference.

mg/L	Total Alkalinity (as CaCO3)		410	1   1   2   .   0
mg/L	Hydroxide (OH)		71830	<   1   .   0
mg/L	Carbonate (CO3)		445	<   1   .   0
mg/L	Bicarbonate (HCO3)		440	1   3   6   .   6
mg/L +	Sulfate (SO4)		945	1   9   .   1
mg/L +	Chloride (Cl)		940	1   5   .   9
45 mg/L	Nitrate (NO3)		71850	<   1   .   0
1.4 - 2.4 mg/L	Fluoride (F) Temp. Depend.		951	1   .   1
Total Anions mg/L Value: <b>3.2</b>				

Std UNITS	pH(Laboratory)		403	8   .   8   0
** umho/cm +	Specific Conductance (E.C.)		95	3   1   0
*** mg/L +	Total Filterable Residue at 180° C (TDS)		70300	1   8   2   .   9
UNITS	Apparent Color (Unfiltered)		81	
TON	Odor Threshold at 60° C		86	
NTU	Lab Turbidity		82079	
0.5 mg/L +	MBAS		38260	<   0   .   0   2

• 250-500-600

\*\* 900-1800-2200

\*\*\* 500-1000-1500

SYSTEM NAME AND NUMBER Kerr McGee Chemical Corporation

No Entry

\* THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L \*

90/C/5176

MCL Reporting Units	Constituent	T T	Store Code	Analyses Results
50 ug/L	Arsenic(As)		1002	1   5
1000 ug/L	Barium(Ba)		1007	<   1   0   0
10 ug/L	Cadmium(Cd)		1027	<   1
50 ug/L	Chromium(Total Cr)		1034	<   1   0
1000 ug/L+	Copper(Cu)		1042	<   5   0
300 ug/L+	Iron(Fe)		1045	3   6   0
50 ug/L	Lead(Pb)		1051	<   2
50 ug/L+	Manganese(Mn)		1055	<   3   0
2 ug/L	Mercury(Hg)		71900	<   1
10 ug/L	Selenium(Se)		1147	<   5
50 ug/L	Silver(Ag)		1077	<   1   0
5000 ug/L	Zinc(Zn)		1092	7   0

ORGANIC CHEMICALS

0.2 ug/L	Endrin		39390	
4 ug/L	Lindane		39340	
100 ug/L	Methoxychlor		39480	
5 ug/L	Toxaphene		39400	
100 ug/L	2,4-D		39730	
10 ug/L	2,4,5-TP Silvex		39045	
Date ORGANIC Analysis Completed			73672	

Y Y M M D D

ADDITIONAL ANALYSES

NTU	Field Turbidity		82078	
C	Source Temperature		10	3   2   .   2
	Langlier Index Source Temp.		71814	7   .   4   9
	Langletier Index at 60°C		71813	7   .   9   3
Std. Units	Field pH		00400	8   .   8   0
	Aggressive Index		82383	1   1   .   4
mg/L	Silica		00955	
mg/L	Phosphate		00650	
	DISSOLVED ALUMINUM			0   .   4   9

RADIOLOGICAL

5 pC/L	Gross Alpha		1501	
pC/L	Counting Error 95%		1502	
50 pC/L	Gross Beta		3501	
pC/L	Counting Error 95%		3502	

+ indicates Secondary Drinking Water Standards



CLINICAL LABORATORY OF SAN BERNARDINO  
 1595 NORTH "D" STREET  
 SAN BERNARDINO, CA. 92405

RADIOACTIVITY ANALYSIS

Date of Report: 01/17/92

Sample ID No. 92-0122

Laboratory

Signature Lab

Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: *[Signature]*

Employed By: INDIAN WELLS VALLEY CWD

Name of Sampler: M. STONER

Date/Time Sample

Date/Time Sample

Date Analyses

Collected: 92/01/06/1000

Received @ Lab: 92/01/08/1700

Completed: 92/01/17

System

Name: INDIAN WELLS VALLEY CWD - RIDGECREST

System

Number: 15-017

Name or Number of Sample Source: IWV MONITORING WELL #5 840' TO 860'

\*\*\*\*\*

\* User ID: CYA

Station Number: \*

\* Date/Time of Sample: |92|01|06|1000|

Laboratory Code: 3761 \*

\* YY MM DD TTTT

Date Analysis Completed: |92|01|17| \*

\*

YY MM DD \*

\* Submitted by: \_\_\_\_\_

Phone #: \_\_\_\_\_ \*

\*\*\*\*\*

MCL REPORT UNITS	CONSTITUENT	STORET CODE	ANALYSES RESULTS	DLR
15 pCi/l Total Alpha		01501	4.0	
pCi/l Total Alpha Counting Error		01502	2.4	
50 pCi/l Total Beta		03501		4.0
pCi/l Total Beta Counting Error		03502		
20 pCi/l Natural Uranium		28012		2.0
pCi/l Total Radium 226		09501		.5
pCi/l Total Radium 226 Counting Error		09502		
pCi/l Total Radium 228		11501		.5
pCi/l Total Radium 228 Counting Error		11502		
5 pCi/l Ra 226 + Ra 228		11503		
pCi/l Ra 226 + Ra 228 Counting Error		11504		
20000 pCi/l Total Tritium		07000		1.0
pCi/l Total Tritium Counting Error		07001		
8 pCi/l Total Strontium - 90		13501		2.0
pCi/l Total Strontium - 90 Counting Error		13502		
pCi/l Total Radon 222		82303		100.0
pCi/l Total Radon 222 Counting Error		82302		

**CLINICAL LABORATORY OF SAN BERNARDINO  
1595 NORTH "D" STREET  
SAN BERNARDINO, CA. 92405**

**GENERAL MINERAL & PHYSICAL, INORGANIC, & RADIOLOGICAL CHEMICAL ANALYSIS**

Date of Report: 01/15/92 Sample ID No.92-0123  
 Laboratory Signature Lab  
 Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: Carol Jacoby  
 Name of Sampler: M. STONER Employed By: U.S. NAVY  
 Date/Time Sample Date/Time Sample Date Analyses  
 Collected: 92/01/06/1000 Received @ Lab: 92/01/08/1700 Completed: 92/01/14

**System** **System**  
 Name: INDIAN WELLS VALLEY CWD - RIDGECREST Number: 15-017  
 Name or Number of Sample Source: IWV MONITORING WELL #5 1580' - 1600'  
 \*\*\*\*\*  
 \* User ID: CYA Station Number: \*  
 \* Date/Time of Sample: |92|01|06|1000| Laboratory Code: 3761 \*  
 \* YY MM DD TTTT \*  
 \* Date Analysis Completed: |92|01|14| \*  
 \* YY MM DD \*  
 \* Submitted by: \_\_\_\_\_ Phone #: \_\_\_\_\_ \*  
 \*\*\*\*\*

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	mg/L	Total Hardness (as CaCO3)	00900	80.0	
	mg/L	Calcium (Ca)	00916	20.8	
	mg/L	Magnesium (Mg)	00927	6.8	
	mg/L	Sodium (Na)	00929	346.0	
	mg/L	Potassium (K)	00937	9.0	

| Total Cations Meq/L Value: 16.9 |

	mg/L	Total Alkalinity (AS CaCO3)	00410	626.0	
	mg/L	Hydroxide (OH)	71830	< 1.0	
	mg/L	Carbonate (CO3)	00445	< 1.0	
	mg/L	Bicarbonate (HCO3)	00440	763.7	
*	mg/L*	Sulfate (SO4)	00945	65.5	
*	mg/L*	Chloride (Cl)	00940	72.7	
45	mg/L	Nitrate (as NO3)	71850	< 1.0	
****	mg/L	Fluoride (F) Temp. Depend.	00951	2.1	0.1

| Total Anions Meq/L Value: 16.0 |

	Std. Units	PH (Laboratory)	00403	8.7	
**	umho/cm**	Specific Conductance (E.C.)	00095	1880.0	
***	mg/L***	Total Filterable Residue at 180C (TDS)	70300	836.9	
	Units	Apparent Color (Unfiltered)	00081	> 70.0	
	TON	Odor Threshold at 60 C	00086	1.0	
	NTU	Lab Turbidity	82079	> 200.0	
0.5	mg/L	MBAS	38260	< 0.02	

\* 250-500-600 \*\* 900-1600-2200 \*\*\* 500-1000-1500 \*\*\*\* 1.4-2.4

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
1000	ug/L	Aluminum (Al)	01105	460.00	100.0
50	ug/L	Arsenic (As)	01002	80.00	10.0
1000	ug/L	Barium (Ba)	01007	170.00	100.0
10	ug/L	Cadmium (Cd)	01027	< 1.00	1.0
50	ug/L	Chromium (Total Cr)	01034	< 10.00	10.0
1000	ug/L	Copper (Cu)	01042	< 50.00	50.0
300	ug/L	Iron (Fe)	01045	1520.0	100.0
50	ug/L	Lead (Pb)	01051	6.00	5.0
50	ug/L	Manganese (Mn)	01055	165.00	30.0
2	ug/L	Mercury (Hg)	71900	< 1.00	1.0
10	ug/L	Selenium (Se)	01147	< 5.00	5.0
50	ug/L	Silver (Ag)	01077	< 10.00	10.0
5000	ug/L	Zinc (Zn)	01092	< 50.00	50.0

## RADIOACTIVITY ANALYSIS

15	PCi/L	Total Alpha	01501		
	PCi/L	Total Alpha Counting Error	01502		
50	PCi/L	Total Beta	03501		4.0
	PCi/L	Total Beta Counting Error	03502		
20	PCi/L	Natural Uranium	28012		2.0
	PCi/L	Total Radium 226	09501		0.5
	PCi/L	Total Radium 226 Counting Error	09502		
	PCi/L	Total Radium 228	11501		0.5
	PCi/L	Total Radium 228 Counting Error	11502		
5	PCi/L	Ra 226 + Ra 228	11503		
	PCi/L	Ra 226 + Ra 228 Counting Error	11504		
	PCi/L	Radon 222	82303		100.0
	PCi/L	Radon 222 Counting Error	82302		
20000	PCi/L	Total Tritium	07000		1.0
	PCi/L	Total Tritium Counting Error	07001		
8	PCi/L	Total Strontium - 90	13501		2.0
	PCi/L	Total Strontium - 90 Counting Error	13502		

## ADDITIONAL ANALYSES

NTU	Field Turbidity	82078		0.1
C	Source Temperature C	00010		
	Langelier Index Source Temp.	71814		
	Langelier Index at 60 C	71813		
Std. Units	Field PH	00400		
	Agressiveness Index	82383		
mg/L	Silica	00955		
mg/L	Phosphate	00650		
mg/L	Iodide	71865		
	Sodium Absorption Ratio	00931		
	Asbestos	81855		
mg/L	Boron	01020		

CLINICAL LABORATORY OF SAN BERNARDINO  
 1595 NORTH "D" STREET  
 SAN BERNARDINO, CA. 92405

RADIOACTIVITY ANALYSIS

Date of Report: 01/17/92 Sample ID No. 92-0123  
 Laboratory Signature Lab  
 Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: *Carol Kelly*  
 Name of Sampler: M. STONER Employed By: INDIAN WELLS VALEY CWD  
 Date/Time Sample Date/Time Sample Date Analyses  
 Collected: 92/01/06/1000 Received @ Lab: 92/01/08/1700 Completed: 92/01/17

System Name: INDIAN WELLS VALLEY CWD - RIDGECREST System Number: 15-017  
 Name or Number of Sample Source: IWV MONITORING WELL #5 1580' - 1600'  
 \*\*\*\*\*  
 \* User ID: CYA Station Number: \*  
 \* Date/Time of Sample: |92|01|06|1000| Laboratory Code: 3761 \*  
 \* YY MM DD TTTT \*  
 \* Date Analysis Completed: |92|01|17| \*  
 \* YY MM DD \*  
 \* Submitted by: Phone #: \*  
 \*\*\*\*\*

MCL REPORT UNITS	CONSTITUENT	STORET CODE	ANALYSES RESULTS	DLR
15 pCi/l	Total Alpha	01501	9.8	
pCi/l	Total Alpha Counting Error	01502	2.3	
50 pCi/l	Total Beta	03501		4.0
pCi/l	Total Beta Counting Error	03502		
20 pCi/l	Natural Uranium	28012		2.0
pCi/l	Total Radium 226	09501		.5
pCi/l	Total Radium 226 Counting Error	09502		
pCi/l	Total Radium 228	11501		.5
pCi/l	Total Radium 228 Counting Error	11502		
5 pCi/l	Ra 226 + Ra 228	11503		
pCi/l	Ra 226 + Ra 228 Counting Error	11504		
20000 pCi/l	Total Tritium	07000		1.0
pCi/l	Total Tritium Counting Error	07001		
8 pCi/l	Total Strontium - 90	13501		2.0
pCi/l	Total Strontium - 90 Counting Error	13502		
pCi/l	Total Radon 222	82303		100.0
pCi/l	Total Radon 222 Counting Error	82302		

CLINICAL LABORATORY OF SAN BERNARDINO  
1595 NORTH "D" STREET  
SAN BERNARDINO, CA. 92405

GENERAL MINERAL & PHYSICAL, INORGANIC, & RADIOLOGICAL CHEMICAL ANALYSIS

Date of Report: 01/15/92 Sample ID No. 92-0124  
 Laboratory Signature Lab  
 Name of Sampler: M. STONER Employed By: U.S. NAVY Director: Carol Jacobs  
 Date/Time Sample Collected: 92/01/06/1000 Date/Time Sample Received @ Lab: 92/01/08/1700 Date Analyses Completed: 92/01/14

**System** **System**  
 Name: INDIAN WELLS VALLEY CWD - RIDGECREST Number: 15-017  
 Name or Number of Sample Source: IWY MONITORING WELL #5 1970' - 1990'  
 \*\*\*\*\*  
 \* User ID: CYA Station Number: \_\_\_\_\_ \*  
 \* Date/Time of Sample: |92|01|06|1000| Laboratory Code: 3761 \*  
 \* YY MM DD TTTT Date Analysis Completed: |92|01|14| \*  
 \* YY MM DD \*  
 \* Submitted by: \_\_\_\_\_ Phone #: \_\_\_\_\_ \*  
 \*\*\*\*\*

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	mg/L	Total Hardness (as CaCO3)	00900	108.0	
	mg/L	Calcium (Ca)	00916	14.4	
	mg/L	Magnesium (Mg)	00927	17.5	
	mg/L	Sodium (Na)	00929	334.9	
	mg/L	Potassium (K)	00937	8.7	

Total Cations Meq/L Value: 16.9

	mg/L	Total Alkalinity (AS CaCO3)	00410	708.0	
	mg/L	Hydroxide (OH)	71830	< 1.0	
	mg/L	Carbonate (CO3)	00445	< 1.0	
	mg/L	Bicarbonate (HCO3)	00440	863.8	
*	mg/L*	Sulfate (SO4)	00945	90.0	
*	mg/L*	Chloride (Cl)	00940	68.6	
45	mg/L	Nitrate (as NO3)	71850	< 1.0	
****	mg/L	Fluoride (F) Temp. Depend.	00951	1.5	0.1

Total Anions Meq/L Value: 18.0

	Std. Units	PH (Laboratory)	00403	8.7	
**	umho/cm**	Specific Conductance (E.C.)	00095	1870.0	
***	mg/L***	Total Filterable Residue at 180C (TDS)	70300	890.6	
	Units	Apparent Color (Unfiltered)	00081	> 70.0	
	TON	Odor Threshold at 60 C	00086	1.0	
	NTU	Lab Turbidity	82079	> 200.0	
0.5	mg/L	MBAS	38260	< 0.02	

\* 250-500-600    \*\* 900-1600-2200    \*\*\* 500-1000-1500    \*\*\*\* 1.4-2.4

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
1000	ug/L	Aluminum (Al)	01105	260.00	100.0
50	ug/L	Arsenic (As)	01002	25.00	10.0
1000	ug/L	Barium (Ba)	01007	200.00	100.0
10	ug/L	Cadmium (Cd)	01027	< 1.00	1.0
50	ug/L	Chromium (Total Cr)	01034	< 10.00	10.0
1000	ug/L	Copper (Cu)	01042	< 50.00	50.0
300	ug/L	Iron (Fe)	01045	1165.0	100.0
50	ug/L	Lead (Pb)	01051	11.00	5.0
50	ug/L	Manganese (Mn)	01055	175.00	30.0
2	ug/L	Mercury (Hg)	71900	< 1.00	1.0
10	ug/L	Selenium (Se)	01147	< 5.00	5.0
50	ug/L	Silver (Ag)	01077	< 10.00	10.0
5000	ug/L	Zinc (Zn)	01092	< 50.00	50.0

## RADIOACTIVITY ANALYSIS

15	PCi/L	Total Alpha	01501		
	PCi/L	Total Alpha Counting Error	01502		
50	PCi/L	Total Beta	03501		4.0
	PCi/L	Total Beta Counting Error	03502		
20	PCi/L	Natural Uranium	28012		2.0
	PCi/L	Total Radium 226	09501		0.5
	PCi/L	Total Radium 226 Counting Error	09502		
	PCi/L	Total Radium 228	11501		0.5
	PCi/L	Total Radium 228 Counting Error	11502		
5	PCi/L	Ra 226 + Ra 228	11503		
	PCi/L	Ra 226 + Ra 228 Counting Error	11504		
	PCi/L	Radon 222	82303		100.0
	PCi/L	Radon 222 Counting Error	82302		
20000	PCi/L	Total Tritium	07000		1.0
	PCi/L	Total Tritium Counting Error	07001		
8	PCi/L	Total Strontium - 90	13501		2.0
	PCi/L	Total Strontium - 90 Counting Error	13502		

## ADDITIONAL ANALYSES

NTU	Field Turbidity	82078		0.1
C	Source Temperature C	00010		
	Langelier Index Source Temp.	71814		
	Langelier Index at 60 C	71813		
Std. Units	Field PH	00400		
	Agressiveness Index	82383		
mg/L	Silica	00955		
mg/L	Phosphate	00650		
mg/L	Iodide	71865		
	Sodium Absorption Ratio	00931		
	Asbestos	81855		
mg/L	Boron	01020		

CLINICAL LABORATORY OF SAN BERNARDINO  
1595 NORTH "D" STREET  
SAN BERNARDINO, CA. 92405

RADIOACTIVITY ANALYSIS

Date of Report: 01/17/92 Sample ID No. 92-0124  
 Laboratory Signature Lab  
 Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: *[Signature]*  
 Name of Sampler: M. STONER Employed By: INDIAN WELLS VALEY CWD  
 Date/Time Sample Date/Time Sample Date Analyses  
 Collected: 92/01/06/1000 Received @ Lab: 92/01/08/1700 Completed: 92/01/17

System	System
Name: INDIAN WELLS VALLEY CWD - RIDGECREST	Number: 15-017
Name or Number of Sample Source: IWY MONITORING WELL #5 1970' - 1990'	
*****	
* User ID: CYA	Station Number: *
* Date/Time of Sample:  92 01 06 1000	Laboratory Code: 3761 *
* <span style="margin-left: 100px;">YY MM DD TTTT</span>	
	Date Analysis Completed:  92 01 17  *
	<span style="margin-left: 100px;">YY MM DD</span> *
* Submitted by: _____	Phone #: _____ *
*****	

MCL REPORT UNITS	CONSTITUENT	STORET CODE	ANALYSES RESULTS	DLR
15 pCi/l Total Alpha		01501	14.0	
pCi/l Total Alpha Counting Error		01502	3.7	
50 pCi/l Total Beta		03501		4.0
pCi/l Total Beta Counting Error		03502		
20 pCi/l Natural Uranium		28012		2.0
pCi/l Total Radium 226		09501		.5
pCi/l Total Radium 226 Counting Error		09502		
pCi/l Total Radium 228		11501		.5
pCi/l Total Radium 228 Counting Error		11502		
5 pCi/l Ra 226 + Ra 228		11503		
pCi/l Ra 226 + Ra 228 Counting Error		11504		
20000 pCi/l Total Tritium		07000		1.0
pCi/l Total Tritium Counting Error		07001		
8 pCi/l Total Strontium - 90		13501		2.0
pCi/l Total Strontium - 90 Counting Error		13502		
pCi/l Total Radon 222		82303		100.0
pCi/l Total Radon 222 Counting Error		82302		

CLINICAL LABORATORY OF SAN BERNARDINO  
1595 NORTH "D" STREET  
SAN BERNARDINO, CA. 92405

GENERAL MINERAL & PHYSICAL, INORGANIC, & RADIOLOGICAL CHEMICAL ANALYSIS

Date of Report: 02/06/92 Sample ID No. 92-0736  
 Laboratory Signature Lab  
 Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: Carol J. [Signature]  
 Name of Sampler: UNKNOWN Employed By: UNKNOWN  
 Date/Time Sample Date/Time Sample Date Analyses  
 Collected: 92/01/10/0000 Received @ Lab: 92/01/29/1700 Completed: 92/02/05

System System  
 Name: INDIAN WELLS VALLEY CWD - RIDGECREST Number: 15-017  
 Name or Number of Sample Source: BOR WELL 6 330 - 350

\*\*\*\*\*  
 \* User ID: CYA Station Number: \_\_\_\_\_ \*  
 \* Date/Time of Sample: |92|01|10|0000| Laboratory Code: 3761 \*  
 \* YY MM DD TTTT \*  
 \* Date Analysis Completed: |92|02|05| \*  
 \* YY MM DD \*  
 \* Submitted by: \_\_\_\_\_ Phone #: \_\_\_\_\_ \*  
 \*\*\*\*\*

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	mg/L	Total Hardness (as CaCO3)	00900	100.0	
	mg/L	Calcium (Ca)	00916	24.0	
	mg/L	Magnesium (Mg)	00927	9.7	
	mg/L	Sodium (Na)	00929	198.7	
	mg/L	Potassium (K)	00937	13.9	
Total Cations		Meq/L Value: 11.0			
	mg/L	Total Alkalinity (AS CaCO3)	00410	192.0	
	mg/L	Hydroxide (OH)	71830	< 1.0	
	mg/L	Carbonate (CO3)	00445	< 1.0	
	mg/L	Bicarbonate (HCO3)	00440	234.2	
*	mg/L*	Sulfate (SO4)	00945	168.0	
*	mg/L*	Chloride (Cl)	00940	76.0	
45	mg/L	Nitrate (as NO3)	71850	6.3	
****	mg/L	Fluoride (F) Temp. Depend.	00951	3.7	0.1
Total Anions		Meq/L Value: 9.8			
	Std. Units	PH (Laboratory)	00403	8.9	
**	umho/cm**	Specific Conductance (E.C.)	00095	1030.0	
***	mg/L***	Total Filterable Residue at 180C (TDS)	70300	596.3	
	Units	Apparent Color (Unfiltered)	00081	15.0	
	TON	Odor Threshold at 60 C	00086	2.0	
	NTU	Lab Turbidity	82079	180.0	
0.5	mg/L	MBAS	38260	< 0.02	

\* 250-500-600    \*\* 900-1600-2200    \*\*\* 500-1000-1500    \*\*\*\* 1.4-2.4

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
1000	ug/L	Aluminum (Al)	01105	1605.0	100.0
50	ug/L	Arsenic (As)	01002	195.00	10.0
1000	ug/L	Barium (Ba)	01007	<100.00	100.0
10	ug/L	Cadmium (Cd)	01027	< 1.00	1.0
50	ug/L	Chromium (Total Cr)	01034	< 10.00	10.0
1000	ug/L	Copper (Cu)	01042	< 50.00	50.0
300	ug/L	Iron (Fe)	01045	12300.	100.0
50	ug/L	Lead (Pb)	01051	7.00	5.0
50	ug/L	Manganese (Mn)	01055	510.00	30.0
2	ug/L	Mercury (Hg)	71900	< 1.00	1.0
10	ug/L	Selenium (Se)	01147	< 5.00	5.0
50	ug/L	Silver (Ag)	01077	< 10.00	10.0
5000	ug/L	Zinc (Zn)	01092	90.00	50.0

## RADIOACTIVITY ANALYSIS

15	PCi/L	Total Alpha	01501		
	PCi/L	Total Alpha Counting Error	01502		
50	PCi/L	Total Beta	03501		4.0
	PCi/L	Total Beta Counting Error	03502		
20	PCi/L	Natural Uranium	28012		2.0
	PCi/L	Total Radium 226	09501		0.5
	PCi/L	Total Radium 226 Counting Error	09502		
	PCi/L	Total Radium 228	11501		0.5
	PCi/L	Total Radium 228 Counting Error	11502		
5	PCi/L	Ra 226 + Ra 228	11503		
	PCi/L	Ra 226 + Ra 228 Counting Error	11504		
	PCi/L	Radon 222	82303		100.0
	PCi/L	Radon 222 Counting Error	82302		
20000	PCi/L	Total Tritium	07000		1.0
	PCi/L	Total Tritium Counting Error	07001		
8	PCi/L	Total Strontium - 90	13501		2.0
	PCi/L	Total Strontium - 90 Counting Error	13502		

## ADDITIONAL ANALYSES

NTU	Field Turbidity	82078		0.1
C	Source Temperature C	00010		
	Langelier Index Source Temp.	71814		
	Langelier Index at 60 C	71813		
Std. Units	Field PH	00400		
	Agressiveness Index	82383		
mg/L	Silica	00955		
mg/L	Phosphate	00650		
mg/L	Iodide	71865		
	Sodium Absorption Ratio	00931		
	Asbestos	81855		
mg/L	Boron	01020		

CLINICAL LABORATORY OF SAN BERNARDINO  
1595 NORTH "D" STREET  
SAN BERNARDINO, CA. 92405

GENERAL MINERAL & PHYSICAL, INORGANIC, & RADIOLOGICAL CHEMICAL ANALYSIS  
 Date of Report: 02/06/92 Sample ID No. 92-0734  
 Laboratory Signature Lab  
 Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: *Carol [Signature]*  
 Name of Sampler: UNKNOWN Employed By: UNKNOWN  
 Date/Time Sample Date/Time Sample Date Analyses  
 Collected: 92/01/10/0000 Received @ Lab: 92/01/29/1700 Completed: 92/02/05

System Name: INDIAN WELLS VALLEY CWD - RIDGECREST System Number: 15-017  
 Name or Number of Sample Source: BOR WELL 6 1190- 1210  
 \*\*\*\*\*  
 \* User ID: CYA Station Number: \*  
 \* Date/Time of Sample: |92|01|10|0000| Laboratory Code: 3761 \*  
 \* YY MM DD TTTT \*  
 \* Date Analysis Completed: |92|02|05| \*  
 \* YY MM DD \*  
 \* Submitted by: \_\_\_\_\_ Phone #: \_\_\_\_\_ \*  
 \*\*\*\*\*

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	mg/L	Total Hardness (as CaCO3)	00900	80.0	
	mg/L	Calcium (Ca)	00916	4.8	
	mg/L	Magnesium (Mg)	00927	16.5	
	mg/L	Sodium (Na)	00929	188.6	
	mg/L	Potassium (K)	00937	8.6	
Total Cations		Meq/L Value: 10.0			
	mg/L	Total Alkalinity (AS CaCO3)	00410	380.0	
	mg/L	Hydroxide (OH)	71830	< 1.0	
	mg/L	Carbonate (CO3)	00445	< 1.0	
	mg/L	Bicarbonate (HCO3)	00440	463.6	
*	mg/L*	Sulfate (SO4)	00945	34.6	
*	mg/L*	Chloride (Cl)	00940	33.3	
45	mg/L	Nitrate (as NO3)	71850	1.7	
****	mg/L	Fluoride (F) Temp. Depend.	00951	3.3	0.1
Total Anions		Meq/L Value: 9.5			
	Std. Units	PH (Laboratory)	00403	9.1	
**	umho/cm**	Specific Conductance (E.C.)	00095	950.0	
***	mg/L***	Total Filterable Residue at 180C (TDS)	70300	481.4	
	Units	Apparent Color (Unfiltered)	00081	5.0	
	TON	Odor Threshold at 60 C	00086	2.0	
	NTU	Lab Turbidity	82079	85.0	
0.5	mg/L	MBAS	38260	< 0.02	

\* 250-500-600 \*\* 900-1600-2200 \*\*\* 500-1000-1500 \*\*\*\* 1.4-2.4

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
1000	ug/L	Aluminum (Al)	01105	865.00	100.0
50	ug/L	Arsenic (As)	01002	135.00	10.0
1000	ug/L	Barium (Ba)	01007	< 100.00	100.0
10	ug/L	Cadmium (Cd)	01027	< 1.00	1.0
50	ug/L	Chromium (Total Cr)	01034	< 10.00	10.0
1000	ug/L	Copper (Cu)	01042	< 50.00	50.0
300	ug/L	Iron (Fe)	01045	4535.0	100.0
50	ug/L	Lead (Pb)	01051	6.00	5.0
50	ug/L	Manganese (Mn)	01055	140.00	30.0
2	ug/L	Mercury (Hg)	71900	< 1.00	1.0
10	ug/L	Selenium (Se)	01147	< 5.00	5.0
50	ug/L	Silver (Ag)	01077	< 10.00	10.0
5000	ug/L	Zinc (Zn)	01092	< 50.00	50.0

## RADIOACTIVITY ANALYSIS

15	PCi/L	Total Alpha	01501		
	PCi/L	Total Alpha Counting Error	01502		
50	PCi/L	Total Beta	03501		4.0
	PCi/L	Total Beta Counting Error	03502		
20	PCi/L	Natural Uranium	28012		2.0
	PCi/L	Total Radium 226	09501		0.5
	PCi/L	Total Radium 226 Counting Error	09502		
	PCi/L	Total Radium 228	11501		0.5
	PCi/L	Total Radium 228 Counting Error	11502		
5	PCi/L	Ra 226 + Ra 228	11503		
	PCi/L	Ra 226 + Ra 228 Counting Error	11504		
	PCi/L	Radon 222	82303		100.0
	PCi/L	Radon 222 Counting Error	82302		
20000	PCi/L	Total Tritium	07000		1.0
	PCi/L	Total Tritium Counting Error	07001		
8	PCi/L	Total Strontium - 90	13501		2.0
	PCi/L	Total Strontium - 90 Counting Error	13502		

## ADDITIONAL ANALYSES

NTU	Field Turbidity	82078		0.1
C	Source Temperature C	00010		
	Langelier Index Source Temp.	71814		
	Langelier Index at 60 C	71813		
Std. Units	Field PH	00400		
	Agressiveness Index	82383		
mg/L	Silica	00955		
mg/L	Phosphate	00650		
mg/L	Iodide	71865		
	Sodium Absorption Ratio	00931		
	Asbestos	81855		
mg/L	Boron	01020		

CLINICAL LABORATORY OF SAN BERNARDINO  
 1595 NORTH "D" STREET  
 SAN BERNARDINO, CA. 92405

RADIOACTIVITY ANALYSIS

Date of Report: 02/06/92  
 Laboratory Name: CLINICAL LABORATORIES OF SAN BERNARDINO  
 Name of Sampler: UNKNOWN  
 Date/Time Sample Collected: 92/01/29/0000  
 Signature Lab Director: *Carol Kelly*  
 Employed By: UNKNOWN  
 Date/Time Sample Received @ Lab: 92/01/29/1700  
 Sample ID No. 92-0734  
 Date Analyses Completed: 92/02/05

System Name: INDIAN WELLS VALLEY CWD - RIDGECREST  
 Name or Number of Sample Source: BOR WELL 6 1190- 1210  
 System Number: 15-017  
 \*\*\*\*\*  
 \* User ID: CYA Station Number: \*  
 \* Date/Time of Sample: |92|01|29|0000| Laboratory Code: 3761 \*  
 \* YY MM DD TTTT Date Analysis Completed: |92|02|05| \*  
 \* YY MM DD \*  
 \* Submitted by: Phone #: \*  
 \*\*\*\*\*

MCL REPORT UNITS	CONSTITUENT	STORET CODE	ANALYSES RESULTS	DLR
15 pCi/l	Total Alpha	01501	4.3	
	pCi/l Total Alpha Counting Error	01502	1.7	
50 pCi/l	Total Beta	03501		4.0
	pCi/l Total Beta Counting Error	03502		
20 pCi/l	Natural Uranium	28012		2.0
	pCi/l Total Radium 226	09501		.5
	pCi/l Total Radium 226 Counting Error	09502		
	pCi/l Total Radium 228	11501		.5
	pCi/l Total Radium 228 Counting Error	11502		
5 pCi/l	Ra 226 + Ra 228	11503		
	pCi/l Ra 226 + Ra 228 Counting Error	11504		
20000 pCi/l	Total Tritium	07000		1.0
	pCi/l Total Tritium Counting Error	07001		
8 pCi/l	Total Strontium - 90	13501		2.0
	pCi/l Total Strontium - 90 Counting Error	13502		
	pCi/l Total Radon 222	82303		100.0
	pCi/l Total Radon 222 Counting Error	82302		

CLINICAL LABORATORY OF SAN BERNARDINO  
1595 NORTH "D" STREET  
SAN BERNARDINO, CA. 92405

GENERAL MINERAL & PHYSICAL, INORGANIC, & RADIOLOGICAL CHEMICAL ANALYSIS  
 Date of Report: 02/06/92 Sample ID No. 92-0735  
 Laboratory Signature Lab  
 Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: Carol J. [Signature]  
 Name of Sampler: UNKNOWN Employed By: UNKNOWN  
 Date/Time Sample Date/Time Sample Date Analyses  
 Collected: 92/01/10/0000 Received @ Lab: 92/01/29/1700 Completed: 92/02/05

<b>System</b> Name: INDIAN WELLS VALLEY CWD - RIDGECREST Name or Number of Sample Source: BOR WELL 6 1640 - 1660 ***** * User ID: CYA * Date/Time of Sample:  92 01 10 0000  * <span style="margin-left: 100px;">YY MM DD TTTT</span> * * Submitted by: _____ *****	<b>System</b> Number: 15-017 Station Number: _____ Laboratory Code: 3761 Date Analysis Completed:  92 02 05  YY MM DD Phone #: _____ *****
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MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR						
	mg/L	Total Hardness (as CaCO3)	00900	76.0							
	mg/L	Calcium (Ca)	00916	5.8							
	mg/L	Magnesium (Mg)	00927	15.0							
	mg/L	Sodium (Na)	00929	223.4							
	mg/L	Potassium (K)	00937	7.4							
<table style="width: 100%; border: none;"> <tr> <td style="width: 15%;">Total Cations</td> <td style="width: 15%;">Meq/L</td> <td style="width: 55%;">Value:</td> <td style="width: 15%;">11.4</td> <td></td> <td></td> </tr> </table>						Total Cations	Meq/L	Value:	11.4		
Total Cations	Meq/L	Value:	11.4								
	mg/L	Total Alkalinity (AS CaCO3)	00410	440.0							
	mg/L	Hydroxide (OH)	71830	< 1.0							
	mg/L	Carbonate (CO3)	00445	< 1.0							
	mg/L	Bicarbonate (HCO3)	00440	536.8							
*	mg/L*	Sulfate (SO4)	00945	37.5							
*	mg/L*	Chloride (Cl)	00940	29.4							
45	mg/L	Nitrate (as NO3)	71850	< 1.0							
****	mg/L	Fluoride (F) Temp. Depend.	00951	1.7	0.1						
<table style="width: 100%; border: none;"> <tr> <td style="width: 15%;">Total Anions</td> <td style="width: 15%;">Meq/L</td> <td style="width: 55%;">Value:</td> <td style="width: 15%;">10.5</td> <td></td> <td></td> </tr> </table>						Total Anions	Meq/L	Value:	10.5		
Total Anions	Meq/L	Value:	10.5								
	Std. Units	PH (Laboratory)	00403	8.9							
**	umho/cm**	Specific Conductance (E.C.)	00095	980.0							
***	mg/L***	Total Filterable Residue at 180C (TDS)	70300	540.1							
	Units	Apparent Color (Unfiltered)	00081	40.0							
	TON	Odor Threshold at 60 C	00086	2.0							
	NTU	Lab Turbidity	82079	140.0							
0.5	mg/L	MBAS	38260	< 0.02							

\* 250-500-600      \*\* 900-1600-2200      \*\*\* 500-1000-1500      \*\*\*\* 1.4-2.4

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
1000	ug/L	Aluminum (Al)	01105	1325.0	100.0
50	ug/L	Arsenic (As)	01002	75.00	10.0
1000	ug/L	Barium (Ba)	01007	<100.00	100.0
10	ug/L	Cadmium (Cd)	01027	< 1.00	1.0
50	ug/L	Chromium (Total Cr)	01034	< 10.00	10.0
1000	ug/L	Copper (Cu)	01042	< 50.00	50.0
300	ug/L	Iron (Fe)	01045	3925.0	100.0
50	ug/L	Lead (Pb)	01051	< 5.00	5.0
50	ug/L	Manganese (Mn)	01055	160.00	30.0
2	ug/L	Mercury (Hg)	71900	< 1.00	1.0
10	ug/L	Selenium (Se)	01147	< 5.00	5.0
50	ug/L	Silver (Ag)	01077	< 10.00	10.0
5000	ug/L	Zinc (Zn)	01092	< 50.00	50.0

## RADIOACTIVITY ANALYSIS

15	PCi/L	Total Alpha	01501		
	PCi/L	Total Alpha Counting Error	01502		
50	PCi/L	Total Beta	03501		4.0
	PCi/L	Total Beta Counting Error	03502		
20	PCi/L	Natural Uranium	28012		2.0
	PCi/L	Total Radium 226	09501		0.5
	PCi/L	Total Radium 226 Counting Error	09502		
	PCi/L	Total Radium 228	11501		0.5
	PCi/L	Total Radium 228 Counting Error	11502		
5	PCi/L	Ra 226 + Ra 228	11503		
	PCi/L	Ra 226 + Ra 228 Counting Error	11504		
	PCi/L	Radon 222	82303		100.0
	PCi/L	Radon 222 Counting Error	82302		
20000	PCi/L	Total Tritium	07000		1.0
	PCi/L	Total Tritium Counting Error	07001		
8	PCi/L	Total Strontium - 90	13501		2.0
	PCi/L	Total Strontium - 90 Counting Error	13502		

## ADDITIONAL ANALYSES

	NTU	Field Turbidity	82078		0.1
	C	Source Temperature C	00010		
		Langelier Index Source Temp.	71814		
		Langelier Index at 60 C	71813		
	Std. Units	Field PH	00400		
		Agressiveness Index	82383		
	mg/L	Silica	00955		
	mg/L	Phosphate	00650		
	mg/L	Iodide	71865		
		Sodium Absorption Ratio	00931		
		Asbestos	81855		
	mg/L	Boron	01020		



Naval Air Warfare Center  
 Weapons Division  
 Code 2862  
 China Lake, CA 93555-6001  
 Attn.: Disbursing Officer 619-939-2116

Date Reported: 09/16/92  
 Date Received: 09/02/92  
 Laboratory No.: 7880-1

Sample Description: BOR-10 640. SAMPLE WAS TAKEN ON 09-01-92 @ 3:00AM BY HASTING.

WATER ANALYSIS  
 (GENERAL CHEMISTRY)

<u>Constituents</u>	<u>Results</u>	<u>Units</u>	<u>D.L.R.</u>	<u>Method</u>
Calcium	21.	mg/L	0.1	SW-7140
Magnesium	19.0	mg/L	0.01	SW-7450
Sodium	295.	mg/L	0.1	SW-7770
Potassium	24.	mg/L	0.1	SW-7610
Total Cations	16.1	meq/L	0.01	Calculated
Hydroxide	< 0.8	mg/L	0.8	SM-403
Carbonate	40.2	mg/L	2.6	SM-403
Bicarbonate	300.	mg/L	2.6	SM-403
Chloride	176.	mg/L	1.8	EPA-300.0
Sulfate	225.	mg/L	5.	EPA-300.0
Nitrate/Nitrite as NO3	2.7	mg/L	0.4	EPA-353.2
Fluoride	1.3	mg/L	0.05	EPA-340.2
Bromide	0.45	mg/L	0.05	EPA-300.0
Total Anions	16.0	meq/L	0.01	Calculated
pH	8.7	pH Units	0.1	SW-9040
Electrical Conductivity @ 25 C	1570.	umhos/cm	1.	SW-9050
Total Dissolved Solids @ 180 C	1000.	mg/L	10.	EPA-160.1
Color	10.	Color Units	1.0	EPA-110.2
Odor	2.	Odor Units	NA	EPA-140.1
Turbidity	31.	NT Units	0.05	EPA-180.1
MBAS	0.40	mg/L	0.02	EPA-425.1
Hardness as CaCO3	131.	mg/L	0.3	Calculated
Alkalinity as CaCO3	313.	mg/L	3.0	Calc
Ammonia as NH3	< 0.02	mg/L	0.02	EPA-350.1
Nitrite Nitrogen	< 0.1	mg/L	0.1	EPA-353.2
Ortho-phosphate	0.36	mg/L	0.10	EPA-365.1

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:

- EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
- SM = "Standard Methods for Examination of Water and Wastewater", 16th Edition 1986.
- SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

*M. Otencia*  
 Department Supervisor

cc: GEOTHERMAL PROGRAM



Naval Air Warfare Center  
Weapons Division  
Code 2862  
China Lake, CA 93555-6001  
Attn.: Disbursing Officer 619-939-2116

Date Reported: 09/16/92  
Date Received: 09/02/92  
Laboratory No.: 7880-1

Sample Description: BOR-10 640. SAMPLE WAS TAKEN ON 09-01-92 @ 3:00AM BY HASTING.

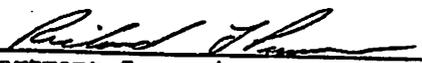
WATER ANALYSIS  
(METALS)

<u>Constituents</u>	<u>Results</u>	<u>Units</u>	<u>D.L.R.</u>	<u>Method</u>
Aluminum	2790.	µg/L	50.	SW-6010
Antimony	None Detected	µg/L	100.	SW-6010
Arsenic	16.	µg/L	2.	SW-7060
Barium	None Detected	µg/L	100.	SW-6010
Boron	4.9	mg/L	0.10	SW-6010
Cadmium	None Detected	µg/L	1.	SW-7131
Chromium	None Detected	µg/L	10.	SW-6010
Copper	None Detected	µg/L	10.	SW-6010
Lead	None Detected	µg/L	5.	SW-7421
Lithium	250.	µg/L	10.	SW-7430
Manganese	285.	µg/L	10.	SW-6010
Mercury	None Detected	µg/L	0.2	EPA-245.1
Selenium	2.7	µg/L	2.	SW-7740
Si as SiO2	48.	mg/L	0.2	SW-6010
Silver	None Detected	µg/L	10.	SW-6010
Strontium	399.	µg/L	10.	SW-6010
Thallium	None Detected	µg/L	5.	SW-7841
Zinc	None Detected	µg/L	10.	SW-6010
Total Iron	3530.	µg/L	50.	SW-6010

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:

- EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
- SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

  
Department Supervisor

cc: GEOTHERMAL PROGRAM



Naval Air Warfare Center  
Weapons Division  
Code 2862  
China Lake, CA 93555-6001  
Attn.: Disbursing Officer 619-939-2116

Date Reported: 09/15/92  
Date Received: 09/02/92  
Laboratory No.: 7880-2

Sample Description: BOR-10 1180. SAMPLE WAS TAKEN ON 09-01-92 @ 12:00PM BY HASTING.

WATER ANALYSIS  
(GENERAL CHEMISTRY)

<u>Constituents</u>	<u>Results</u>	<u>Units</u>	<u>D.L.R.</u>	<u>Method</u>
Calcium	8.3	mg/L	0.1	SW-7140
Magnesium	2.7	mg/L	0.01	SW-7450
Sodium	200.	mg/L	0.1	SW-7770
Potassium	11.5	mg/L	0.1	SW-7610
Total Cations	9.63	meq/L	0.01	Calculated
Hydroxide	< 0.8	mg/L	0.8	SM-403
Carbonate	11.1	mg/L	2.6	SM-403
Bicarbonate	60.0	mg/L	2.6	SM-403
Chloride	139.	mg/L	1.8	EPA-300.0
Sulfate	193.	mg/L	5.	EPA-300.0
Nitrate/Nitrite as NO3	1.8	mg/L	0.4	EPA-353.2
Fluoride	1.9	mg/L	0.05	EPA-340.2
Bromide	0.36	mg/L	0.05	EPA-300.0
Total Anions	9.42	meq/L	0.01	Calculated
pH	8.7	pH Units	0.1	SW-9040
Electrical Conductivity @ 25 C	1040.	umhos/cm	1.	SW-9050
Total Dissolved Solids @ 180 C	580.	mg/L	10.	EPA-160.1
Color	20.	Color Units	1.0	EPA-110.2
Odor	4.	Odor Units	NA	EPA-140.1
Turbidity	15.	NT Units	0.05	EPA-180.1
MBAS	0.72	mg/L	0.02	EPA-425.1
Hardness as CaCO3	31.8	mg/L	0.3	Calculated
Alkalinity as CaCO3	67.7	mg/L	3.0	Calc
Ammonia as NH3	0.38	mg/L	0.02	EPA-350.1
Nitrite Nitrogen	< 0.1	mg/L	0.1	EPA-353.2
Ortho-phosphate	< 0.10	mg/L	0.10	EPA-365.1

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:

- EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
- SM = "Standard Methods for Examination of Water and Wastewater", 16th Edition 1986.
- SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

M. Atencio  
Department Supervisor

cc: GEOTHERMAL PROGRAM



Naval Air Warfare Center  
 Weapons Division  
 Code 2862  
 China Lake, CA 93555-6001  
 Attn.: Disbursing Officer 619-939-2116

Date Reported: 09/15/92  
 Date Received: 09/02/92  
 Laboratory No.: 7880-2

Sample Description: BOR-10 1180. SAMPLE WAS TAKEN ON 09-01-92 @ 12:00PM BY HASTING.

WATER ANALYSIS  
 (METALS)

Constituents	Results	Units	D.L.R.	Method
Aluminum	742.	µg/L	50.	SW-6010
Antimony	None Detected	µg/L	100.	SW-6010
Arsenic	2.7	µg/L	2.	SW-7060
Barium	None Detected	µg/L	100.	SW-6010
Boron	1.3	mg/L	0.10	SW-6010
Cadmium	None Detected	µg/L	1.	SW-7131
Chromium	None Detected	µg/L	10.	SW-6010
Copper	None Detected	µg/L	10.	SW-6010
Lead	None Detected	µg/L	5.	SW-7421
Lithium	None Detected	µg/L	10.	SW-7430
Manganese	69.	µg/L	10.	SW-6010
Mercury	None Detected	µg/L	0.2	EPA-245.1
Selenium	2.4	µg/L	2.	SW-7740
Si as SiO2	12.	mg/L	0.2	SW-6010
Silver	None Detected	µg/L	10.	SW-6010
Strontium	84.	µg/L	10.	SW-6010
Thallium	None Detected	µg/L	5.	SW-7841
Zinc	None Detected	µg/L	10.	SW-6010
Total Iron	1830.	µg/L	50.	SW-6010

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:

- EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
- SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

Department Supervisor

cc: GEOTHERMAL PROGRAM



Naval Air Warfare Center  
Weapons Division  
Code 2862  
China Lake, CA 93555-6001  
Attn.: Disbursing Officer 619-939-2116

Date Reported: 09/15/92  
Date Received: 09/02/92  
Laboratory No.: 7880-3

Sample Description: BOR-10 1560. SAMPLE WAS TAKEN ON 09-01-92 @ 16:00PM BY HASTING.

WATER ANALYSIS  
(GENERAL CHEMISTRY)

<u>Constituents</u>	<u>Results</u>	<u>Units</u>	<u>D.L.R.</u>	<u>Method</u>
Calcium	47.	mg/L	0.1	SW-7140
Magnesium	105.	mg/L	0.01	SW-7450
Sodium	254.	mg/L	0.1	SW-7770
Potassium	32.	mg/L	0.1	SW-7610
Total Cations	22.8	meq/L	0.01	Calculated
Hydroxide	< 0.8	mg/L	0.8	SM-403
Carbonate	< 2.6	mg/L	2.6	SM-403
Bicarbonate	1130.	mg/L	2.6	SM-403
Chloride	49.5	mg/L	1.8	EPA-300.0
Sulfate	156.	mg/L	5.	EPA-300.0
Nitrate/Nitrite as NO3	0.9	mg/L	0.4	EPA-353.2
Fluoride	0.56	mg/L	0.05	EPA-340.2
Bromide	0.12	mg/L	0.05	EPA-300.0
Total Anions	23.2	meq/L	0.01	Calculated
pH	7.9	pH Units	0.1	SW-9040
Electrical Conductivity @ 25 C	1910.	umhos/cm	1.	SW-9050
Total Dissolved Solids @ 180 C	1220.	mg/L	10.	EPA-160.1
Color	30.	Color Units	1.0	EPA-110.2
Odor	4.	Odor Units	NA	EPA-140.1
Turbidity	27.	NT Units	0.05	EPA-180.1
MEAS	0.66	mg/L	0.02	EPA-425.1
Hardness as CaCO3	550.	mg/L	0.3	Calculated
Alkalinity as CaCO3	926.	mg/L	3.0	Calc
Ammonia as NH3	0.17	mg/L	0.02	EPA-350.1
Nitrite Nitrogen	< 0.1	mg/L	0.1	EPA-353.2
Ortho-phosphate	0.48	mg/L	0.10	EPA-365.1

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:

- EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
- SM = "Standard Methods for Examination of Water and Wastewater", 16th Edition 1986.
- SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

*M. Atencio*  
Department Supervisor

cc: GEOTHERMAL PROGRAM



Naval Air Warfare Center  
Weapons Division  
Code 2862  
China Lake, CA 93555-6001  
Attn.: Disbursing Officer 619-939-2116

Date Reported: 09/15/92  
Date Received: 09/02/92  
Laboratory No.: 7880-3

Sample Description: BOR-10 1560. SAMPLE WAS TAKEN ON 09-01-92 @ 16:00PM BY HASTING.

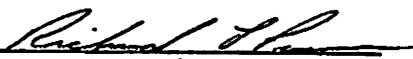
WATER ANALYSIS  
(METALS)

<u>Constituents</u>	<u>Results</u>	<u>Units</u>	<u>D.L.R.</u>	<u>Method</u>
Aluminum	None Detected	µg/L	50.	SW-6010
Antimony	None Detected	µg/L	100.	SW-6010
Arsenic	7.8	µg/L	2.	SW-7060
Barium	None Detected	µg/L	100.	SW-6010
Boron	1.1	mg/L	0.10	SW-6010
Cadmium	None Detected	µg/L	1.	SW-7131
Chromium	None Detected	µg/L	10.	SW-6010
Copper	None Detected	µg/L	10.	SW-6010
Lead	None Detected	µg/L	5.	SW-7421
Lithium	250.	µg/L	10.	SW-7430
Manganese	95.	µg/L	10.	SW-6010
Mercury	None Detected	µg/L	0.2	EPA-245.1
Selenium	None Detected	µg/L	2.	SW-7740
Si as SiO2	81.	mg/L	0.2	SW-6010
Silver	None Detected	µg/L	10.	SW-6010
Strontium	678.	µg/L	10.	SW-6010
Thallium	None Detected	µg/L	5.	SW-7841
Zinc	None Detected	µg/L	10.	SW-6010
Total Iron	6910.	µg/L	50.	SW-6010

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:

EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.  
SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods",  
EPA-SW-846, September, 1986.

  
Department Supervisor

cc: GEOTHERMAL PROGRAM



Naval Air Warfare Center  
 Weapons Division  
 Code 2862  
 China Lake, CA 93555-6001  
 Attn.: Disbursing Officer 619-939-2116

Date Reported: 09/15/92  
 Date Received: 09/02/92  
 Laboratory No.: 7880-4

Sample Description: BOR-10 1930. SAMPLE WAS TAKEN ON 09-02-92 @ 3:00AM BY HASTING.

WATER ANALYSIS  
 (GENERAL CHEMISTRY)

Constituents	Results	Units	D.L.R.	Method
Calcium	30.	mg/L	0.1	SW-7140
Magnesium	121.	mg/L	0.01	SW-7450
Sodium	320.	mg/L	0.1	SW-7770
Potassium	44.	mg/L	0.1	SW-7610
Total Cations	26.5	meq/L	0.01	Calculated
Hydroxide	< 0.8	mg/L	0.8	SM-403
Carbonate	< 2.6	mg/L	2.6	SM-403
Bicarbonate	1280.	mg/L	2.6	SM-403
Chloride	58.2	mg/L	1.8	EPA-300.0
Sulfate	171.	mg/L	5.	EPA-300.0
Nitrate/Nitrite as NO3	0.9	mg/L	0.4	EPA-353.2
Fluoride	0.8	mg/L	0.05	EPA-340.2
Bromide	0.18	mg/L	0.05	EPA-300.0
Total Anions	26.2	meq/L	0.01	Calculated
pH	8.1	pH Units	0.1	SW-9040
Electrical Conductivity @ 25 C	2400.	umhos/cm	1.	SW-9050
Total Dissolved Solids @ 180 C	1330.	mg/L	10.	EPA-160.1
Color	30.	Color Units	1.0	EPA-110.2
Odor	4.	Odor Units	NA	EPA-140.1
Turbidity	27.	NT Units	0.05	EPA-180.1
MBAS	0.96	mg/L	0.02	EPA-425.1
Hardness as CaCO3	576.	mg/L	0.3	Calculated
Alkalinity as CaCO3	1050.	mg/L	3.0	Calc
Ammonia as NH3	0.05	mg/L	0.02	EPA-350.1
Nitrite Nitrogen	< 0.1	mg/L	0.1	EPA-353.2
Ortho-phosphate	0.39	mg/L	0.10	EPA-365.1

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:

- EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
- SM = "Standard Methods for Examination of Water and Wastewater", 16th Edition 1986.
- SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

*M. Atencio*  
 Department Supervisor

cc: GEOTHERMAL PROGRAM



Naval Air Warfare Center  
Weapons Division  
Code 2862  
China Lake, CA 93555-6001  
Attn.: Disbursing Officer 619-939-2116

Date Reported: 09/15/92  
Date Received: 09/02/92  
Laboratory No.: 7880-4

Sample Description: BOR-10 1930. SAMPLE WAS TAKEN ON 09-02-92 @ 3:00AM BY HASTING.

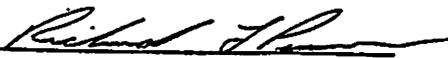
WATER ANALYSIS  
(METALS)

<u>Constituents</u>	<u>Results</u>	<u>Units</u>	<u>D.L.R.</u>	<u>Method</u>
Aluminum	None Detected	µg/L	50.	SW-6010
Antimony	None Detected	µg/L	100.	SW-6010
Arsenic	9.8	µg/L	2.	SW-7060
Barium	None Detected	µg/L	100.	SW-6010
Boron	1.6	mg/L	0.10	SW-6010
Cadmium	None Detected	µg/L	1.	SW-7131
Chromium	None Detected	µg/L	10.	SW-6010
Copper	None Detected	µg/L	10.	SW-6010
Lead	None Detected	µg/L	5.	SW-7421
Lithium	180.	µg/L	10.	SW-7430
Manganese	286.	µg/L	10.	SW-6010
Mercury	None Detected	µg/L	0.2	EPA-245.1
Selenium	None Detected	µg/L	2.	SW-7740
Si as SiO <sub>2</sub>	59.	mg/L	0.2	SW-6010
Silver	None Detected	µg/L	10.	SW-6010
Strontium	554.	µg/L	10.	SW-6010
Thallium	None Detected	µg/L	5.	SW-7841
Zinc	None Detected	µg/L	10.	SW-6010
Total Iron	5820.	µg/L	50.	SW-6010

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:

EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.  
SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods",  
EPA-SW-846, September, 1986.

  
Department Supervisor

cc: GEOTHERMAL PROGRAM

CLINICAL LABS/SAN BERNARDINO  
 1595 NORTH "D" STREET  
 SAN BERNARDINO, CA. 92405

TITLE 22 CHEMICAL ANALYSIS

Date of Report: 02/26/91 Sample ID No.910945  
 Laboratory Signature Lab  
 Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: C. Jolley  
 Name of Sampler: MOULTON Employed By: PURVEYOR  
 Date/Time Sample Date/Time Sample Date Analyses  
 Collected: 91/02/02/1200 Received @ Lab: 91/02/02/1200 Completed: 91/02/26

System System  
 Name: NORTH AMERICAN CHEMICAL - AKA KERR MCGEE Number: 36-042  
 Name or Number of Sample Source: NEAL RANCH #1 250-270  
 \*\*\*\*\*  
 \* Water Type: (G/S) |S| Station Number: 036/042-001 \*  
 \* Date/Time of Sample: |91|02|02|1200| User ID: TAN \*  
 \* YY MM DD HHMM \*  
 \* Analyzing Agency Code: 3761 Date Analysis Completed: |91|02|26| \*  
 \* YY MM DD \*  
 \* Submitted by: Phone #: \*  
 \*\*\*\*\*

Place an 'X' in box to delete all data for this station/date/time.

REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	MCL	DLR
mg/L	Total Hardness (as CaCO3)	00900	1030.0		
mg/L	Calcium (Ca)	00916	221.1		
mg/L	Magnesium (Mg)	00927	116.2		30.0
mg/L	Sodium (NA)	00929	456.8		
mg/L	Potassium (K)	00937	5.6		
Total Cations		Meq/L	Value:	40.6	
mg/L	Total Alkalinity (AS CaCO3)	00410	370.0		
mg/L	Hydroxide (OH)	71830	< 1.0		
mg/L	Carbonate (CO3)	00445	< 1.0		
mg/L	Bicarbonate (HCO3)	00440	451.4		
mg/L*	Sulfate (SO4)	00945	1094.7		
mg/L*	Chloride (Cl)	00940	290.7		
mg/L	Nitrate (as NO3)	71850	260.3	45	
mg/L	Fluoride (F) Temp. Depend.	00951	2.4	****	0.1
Total Anions		Meq/L	Value:	42.7	
Std. Units	PH (Laboratory)	00403	7.9		
umho/cm**	Specific Conductance (E.C.)	00095	3880.0		
mg/L***	Total Filterable Residue at 180C (TDS)	70300	2405.6		
Units	Apparent Color (Unfiltered)	00081	< 3.0		
TON	Odor Threshold at 60 C	00086	1.0		1.0
NTU	Lab Turbidity	82079	1.9		
mg/L	MBAS	38260	0.18	0.5	0.02

\* 250-500-600 \*\* 900-1600-2200 \*\*\* 500-100-1500 \*\*\*\* 1.4-2.4

# Clinical Laboratory of San Bernardino, Inc.

P. O. Box 329  
 1595 North "D" Street  
 San Bernardino, California 92405  
 (714) 885-3216

PURVEYOR: INDIAN WELLS VALLEY WATER

SAMPLE I.D.#: 911534

STREET ADDRESS:

DATE OF REPORT: 3/6/91

CITY, STATE, ZIP:

DESCRIPTION OF SAMPLING POINT: NEAL RANCH #2 330-350 *upper*

DATE/TIME COLLECTED: 2/26/91 0900

NAME OF SAMPLER: MOULTON

RESULTS		MCL		
TOTAL HARDNESS	241.2 mg/L			
CALCIUM HARDNESS	136.8 mg/L			
CALCIUM	54.8 mg/L		RESULTS	MCL
MAGNESIUM	25.4 mg/L		MANGANESE	50 ug/L 50
SODIUM	201.4 mg/L		COPPER	< 50 ug/l 1000
POTASSIUM	6.2 mg/L		IRON	< 100 ug/L 300
TOTAL ALKALINITY	295.6 mg/L		ZINC	< 50 ug/L 5000
HYDROXIDE	< 1.0 mg/L		BARIUM	< 100 ug/L 1000
CARBONATE	< 1.0 mg/L		CHROMIUM	< 10 ug/L 50
BICARBONATE	360.6 mg/L		CADMIUM	< 1 ug/L 10
SULFATE	232.8 mg/L		LEAD	12 ug/l 50
CHLORIDE	85.0 mg/L		ALUMINUM	< 100 ug/L 1000
NITRATE	25.6 mg/L	45	MERCURY	< 1 ug/l 2
FLUORIDE	0.8 mg/L		ARSENIC	< 10 ug/L 50
TOTAL ANIONS	13.61 mEq/L		SELENIUM	10 ug/L 100
TOTAL CATIONS	13.73 mEq/L		SILVER	< 10 ug/L 50
RPD ANIONS/CATIONS	0.60 PERCENT		COLOR	< 3
pH	8.3 STD UNITS		ODOR	1
E.C.	1370.0 umho/cm		TURBIDITY	0.5 NTU
TDS	808.3 mg/L			
MBAS	< 0.02 mg/L			

DATE(S) RECEIVED: 2/28/91

STARTED: 2/28/91

COMPLETED: 3/6/91

ALL ANALYSES ARE PERFORMED IN ACCORDANCE WITH APHA'S STANDARD METHODS, (17TH EDITION) OR EPA'S METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTE

ANALYST: \_\_\_\_\_

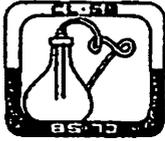
DIRECTOR: C. Jolly

NR-2 Shallow

\* THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L \*

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED UG/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
ug/L	Arsenic (As)	01002	< 10	50	10
ug/L	Barium (Ba)	01007	< 100	1000	100
ug/L	Cadmium (Cd)	01027	< 1	10	1
ug/L	Chromium (Total Cr)	01034	< 10	50	10
ug/L	Copper (Cu)	01042	< 50	1000	50
ug/L	Iron (Fe)	01045	100	300	100
ug/L	Lead (Pb)	01051	< 5	50	5
ug/L	Manganese (Mn)	01055	80	50	30
ug/L	Mercury (Hg)	71900	< 1	2	1
ug/L	Selenium (Se)	01147	170	10	5
ug/L	Silver (Ag)	01077	< 10	50	10
ug/L	Zinc (Zn)	01092	< 50	5000	50
ug/L	Aluminum	01105	180	1000	100
ORGANIC CHEMICALS					
ug/L	Endrin (Hexadrin)	39390		0.2	0.02
ug/L	Gamma-BHC (Lindane)	39340		4	0.4
ug/L	Methoxychlor	39480		100	10.0
ug/L	Toxaphene	39400		5	0.5
ug/L	2,4-D	39730		100	10.0
ug/L	2,4,5-TP (Silvex) (WEED-B-GON)	39045		10	
ADDITIONAL ANALYSES					
NTU	Field Turbidity	82078			0.1
C	Source Temperature C	00010			
	Langelier Index Source Temp.	71814			
	Langelier Index at 60 C	71813			
Std. Units	Field PH	00400			
	Agressiveness Index	82383			
mg/L	Silica	00955			
mg/L	Phosphate	00650			
mg/L	Iodide	71865			
	Sodium Absorption Ratio	00931			
	Asbestos	81855			
mg/L	Ammonia (NH3-N)	00612			
mg/L	Nitrite Nitrogen (NO2-N)	00615			
mg/L	Nitrate Nitrogen (NO3-N)	00618			
mg/L	Nitrite (N)	00620			1.0
mg/L	Beryllium	01012			
mg/L	Boron	01020			
mg/L	Thallium	01059			
mg/L	Nickel	01067			
mg/L	Antimony	01097			
mg/L	Lithium	01132			0.05
mg/L	Cyanide	01291			

# Clinical Laboratory of San Bernardino, Inc.



1595 N. "D" St., San Bernardino, CA 92405  
 Phone (714) 885-3216  
 P. O. Box 329  
 San Bernardino, CA 92402

## RADIOACTIVITY ANALYSES

Date of Report: FEB 29 1991		Lab Sample ID No. 91-0945	
Laboratory Name: CLINICAL LAB OF SAN BERNARDINO		Signature of Lab Director: <i>C. Jolly</i>	
Name of Sampler: Moulton		Sampler Employed By: North American Chemical	
Date/Time Sample Collected: 91/02/02/ 12:00	Date/Time Sample Received @ Lab: 91/02/02	Were Holding Times Observed: Yes	
System Name: North American Chemical		System Number:	
Description of Sampling Point: I.W.V. Test Well			
Name/No. of Sample Source: Neal Ranch #1 250-270		Station Number:	
Date & of Time Sample: 91   02   02   12   00	Water Type: <input type="checkbox"/> G/S	User ID: <input type="checkbox"/>	Submitted to SWQIS By:

MCL REPORTING UNITS	CONSTITUENT	T	STORET CODE	ANALYSES RESULTS
Analyzing Agency			28	. 3 7 6 .1
Date Analyses Completed			73672	9 1 0 2 2 0 Y Y M M D D

5	pC/l Total Alpha		1501	. 1 1 9 . 9
	pC/l Total Alpha Counting Error		1502	. 9 . . . 8
50	pC/l Total Beta		3501	. . . . .
	pC/l Total Beta Counting Error		3502	. . . . .
	pC/l Natural Uranium		28012	. . . . .
3	pC/l Total Radium 226		9501	. . . . .
	pC/l Total Radium 226 Counting Error		9502	. . . . .
	pC/l Total Radium 228		11501	. . . . .
	pC/l Total Radium 228 Counting Error		11502	. . . . .
5	pC/l Ra 226 + Ra 228		11503	. . . . .
	pC/l Ra 226 + Ra 228 Counting Error		11504	. . . . .
20,000	pC/l Total Tritium		7000	. . . . .
	pC/l Total Tritium Counting Error		7001	. . . . .
8	pC/l Total Strontium-90		13501	. . . . .
	pC/l Total Strontium-90 Counting Error		13502	. . . . .

CLINICAL LABS/SAN BERNARDINO  
 1595 NORTH "D" STREET  
 SAN BERNARDINO, CA. 92405

TITLE 22 CHEMICAL ANALYSIS

Date of Report: 02/26/91 Sample ID No. 910946  
 Laboratory Signature Lab  
 Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: C. J. Gelliff  
 Name of Sampler: MOULTON Employed By: PURVEYOR  
 Date/Time Sample Date/Time Sample Date Analyses  
 Collected: 91/02/02/1300 Received @ Lab: 91/02/02/1300 Completed: 91/02/26

System System  
 Name: NORTH AMERICAN CHEMICAL - AKA KERR MCGEE Number: 36-042  
 Name or Number of Sample Source: NEAL RANCH #1 1130-1150  
 \*\*\*\*\*  
 \* Water Type: (G/S) |S| Station Number: 036/042-002 \*  
 \* Date/Time of Sample: |91|02|02|1300| User ID: TAN \*  
 \* YY MM DD HHMM \*  
 \* Analyzing Agency Code: 3761 Date Analysis Completed: |91|02|26| \*  
 \* YY MM DD \*  
 \* Submitted by: \_\_\_\_\_ Phone #: \_\_\_\_\_ \*  
 \*\*\*\*\*

Place an 'X' in box to delete all data for this station/date/time. [ ]

REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	MCL	DLR
mg/L	Total Hardness (as CaCO3)	00900	310.0		
mg/L	Calcium (Ca)	00916	32.0		
mg/L	Magnesium (Mg)	00927	55.9		30.0
mg/L	Sodium (NA)	00929	1240.0		
mg/L	Potassium (K)	00937	14.6		
Total Cations <span style="float: right;">Meq/L Value: 60.5</span>					
mg/L	Total Alkalinity (AS CaCO3)	00410	2184.0		
mg/L	Hydroxide (OH)	71830	< 1.0		
mg/L	Carbonate (CO3)	00445	< 1.0		
mg/L	Bicarbonate (HCO3)	00440	2664.5		
mg/L*	Sulfate (SO4)	00945	125.4		
mg/L*	Chloride (Cl)	00940	245.0		
mg/L	Nitrate (as NO3)	71850	35.4	45	
mg/L	Fluoride (F) Temp. Depend.	00951	2.4	****	0.1
Total Anions <span style="float: right;">Meq/L Value: 53.9</span>					
Std. Units	PH (Laboratory)	00403	9.9		
umho/cm**	Specific Conductance (E.C.)	00095	6000		
mg/L***	Total Filterable Residue at 180C (TDS)	70300	3660.0		
Units	Apparent Color (Unfiltered)	00081	70		
TON	Odor Threshold at 60 C	00086	4.0		1.0
NTU	Lab Turbidity	82079	166.0		
mg/L	MBAS	38260	0.45	0.5	0.02

\* 250-500-600    \*\* 900-1600-2200    \*\*\* 500-100-1500    \*\*\*\* 1.4-2.4

\* THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L \*

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED ug/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
ug/L	Arsenic (As)	01002	28	50	10
ug/L	Barium (Ba)	01007	< 100	1000	100
ug/L	Cadmium (Cd)	01027	< 1	10	1
ug/L	Chromium (Total Cr)	01034	< 10	50	10
ug/L	Copper (Cu)	01042	< 50	1000	50
ug/L	Iron (Fe)	01045	750	300	100
ug/L	Lead (Pb)	01051	< 5	50	5
ug/L	Manganese (Mn)	01055	40	50	30
ug/L	Mercury (Hg)	71900	< 1	2	1
ug/L	Selenium (Se)	01147	40	10	5
ug/L	Silver (Ag)	01077	< 10	50	10
ug/L	Zinc (Zn)	01092	< 50	5000	50
ug/L	Aluminum	01105	240	1000	100

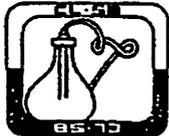
## ORGANIC CHEMICALS

ug/L	Endrin (Hexadrin)	39390		0.2	0.02
ug/L	Gamma-BHC (Lindane)	39340		4	0.4
ug/L	Methoxychlor	39480		100	10.0
ug/L	Toxaphene	39400		5	0.5
ug/L	2,4-D	39730		100	10.0
ug/L	2,4,5-TP (Silvex) (WEED-B-GON)	39045		10	

## ADDITIONAL ANALYSES

NTU	Field Turbidity	82078			0.1
C	Source Temperature C	00010			
	Langelier Index Source Temp.	71814			
	Langelier Index at 60 C	71813			
Std. Units	Field PH	00400			
	Agressiveness Index	82383			
mg/L	Silica	00955			
mg/L	Phosphate	00650			
mg/L	Iodide	71865			
	Sodium Absorption Ratio	00931			
	Asbestos	81855			
mg/L	Ammonia (NH3-N)	00612			
mg/L	Nitrite Nitrogen (NO2-N)	00615			
mg/L	Nitrate Nitrogen (NO3-N)	00618			1.0
mg/L	Nitrite (N)	00620			
mg/L	Beryllium	01012			
mg/L	Boron	01020			
mg/L	Thallium	01059			
mg/L	Nickel	01067			
mg/L	Antimony	01097			0.05
mg/L	Lithium	01132			
mg/L	Cyanide	01291			

# Clinical Laboratory of San Bernardino, Inc.



1595 N. "D" St., San Bernardino, CA 92405  
 Phone (714) 885-3216  
 P. O. Box 329  
 San Bernardino, CA 92402

## RADIOACTIVITY ANALYSES

Date of Report: FEB 29 1991		Lab Sample ID No. 91-0946	
Laboratory Name: CLINICAL LAB OF SAN BERNARDINO		Signature of Lab Director: <i>C. Jolly</i>	
Name of Sampler: Moulton		Employed By: North American Chemical	
Date/Time Sample Collected: 91/02/02 13:00	Date/Time Sample Received @ Lab: 91/02/02	Were Holding Times Observed: Yes	
System Name: North American Chemical		System Number:	
Description of Sampling Point: I.W.V. Test Well			
Name/No. of Sample Source: Neal Ranch #1 1130 - 1150		Station Number:	
Date & of Time Sample: 91   02   02   13   00	Water Type: <input type="checkbox"/> G/S	User ID: <input type="checkbox"/>	Submitted to SWQIS By:

MCL REPORTING UNITS	CONSTITUENT	T	STORET CODE	ANALYSES RESULTS
Analyzing Agency			28	, 3, 7, 6, 1
Date Analyses Completed			73672	9, 1, 0, 2, 2, 0
				Y Y M M D D

5	pC/l Total Alpha		1501	, 1, 4, 2, . 4
	pC/l Total Alpha Counting Error		1502	, 2, 8, . 7
50	pC/l Total Beta		3501	, . . . . .
	pC/l Total Beta Counting Error		3502	, . . . . .
	pC/l Natural Uranium		28012	, . . . . .
3	pC/l Total Radium 226		9501	, . . . . .
	pC/l Total Radium 226 Counting Error		9502	, . . . . .
	pC/l Total Radium 228		11501	, . . . . .
	pC/l Total Radium 228 Counting Error		11502	, . . . . .
5	pC/l Ra 226 + Ra 228		11503	, . . . . .
	pC/l Ra 226 + Ra 228 Counting Error		11504	, . . . . .
20,000	pC/l Total Tritium		7000	, . . . . .
	pC/l Total Tritium Counting Error		7001	, . . . . .
8	pC/l Total Strontium-90		13501	, . . . . .
	pC/l Total Strontium-90 Counting Error		13502	, . . . . .

CLINICAL LABS/SAN BERNARDINO  
 1595 NORTH "D" STREET  
 SAN BERNARDINO, CA. 92405

TITLE 22 CHEMICAL ANALYSIS

Date of Report: 02/26/91 Sample ID No.910947  
 Laboratory Signature Lab  
 Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: C. Jolly  
 Name of Sampler: MOULTON Employed By: PURVEYOR  
 Date/Time Sample Date/Time Sample Date Analyses  
 Collected: 91/02/02/1100 Received @ Lab: 91/02/02/1100 Completed: 91/02/26

System System  
 Name: NORTH AMERICAN CHEMICAL - AKA KERR MCGEE Number: 36-042  
 Name or Number of Sample Source: NEAL RANCH #1 1960-1980  
 \*\*\*\*\*  
 \* Water Type: (G/S) |S| Station Number: 036/042-003 \*  
 \* Date/Time of Sample: |91|02|02|1100| User ID: TAN \*  
 \* YY MM DD HHMM \*  
 \* Analyzing Agency Code: 3761 Date Analysis Completed: |91|02|26| \*  
 \* YY MM DD \*  
 \* Submitted by: \_\_\_\_\_ Phone #: \_\_\_\_\_ \*  
 \*\*\*\*\*

Place an 'X' in box to delete all data for this station/date/time. |\_

REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	MCL	DLR
mg/L	Total Hardness (as CaCO3)	00900	78.0		
mg/L	Calcium (Ca)	00916	12.8		
mg/L	Magnesium (Mg)	00927	11.2		30.0
mg/L	Sodium (NA)	00929	1340.0		
mg/L	Potassium (K)	00937	6.4		
<b>Total Cations Meq/L Value: 60.0</b>					
mg/L	Total Alkalinity (AS CaCO3)	00410	2460.0		
mg/L	Hydroxide (OH)	71830	< 1.0		
mg/L	Carbonate (CO3)	00445	< 1.0		
mg/L	Bicarbonate (HCO3)	00440	3001.2		
mg/L*	Sulfate (SO4)	00945	304.8		
mg/L*	Chloride (Cl)	00940	246.7		
mg/L	Nitrate (as NO3)	71850	35.0	45	
mg/L	Fluoride (F) Temp. Depend.	00951	3.3	****	0.1
<b>Total Anions Meq/L Value: 63.2</b>					
Std. Units	PH (Laboratory)	00403	8.6		
umho/cm**	Specific Conductance (E.C.)	00095	5330.0		
mg/L***	Total Filterable Residue at 180C (TDS)	70300	3251.3		
Units	Apparent Color (Unfiltered)	00081	50		
TON	Odor Threshold at 60 C	00086	2.0		1.0
NTU	Lab Turbidity	82079	32.0		
mg/L	MBAS	38260	0.20	0.5	0.02

\* 250-500-600    \*\* 900-1600-2200    \*\*\* 500-100-1500    \*\*\*\* 1.4-2.4

\* THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L \*

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED ug/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
ug/L	Arsenic (As)	01002	130	50	10
ug/L	Barium (Ba)	01007	< 100	1000	100
ug/L	Cadmium (Cd)	01027	< 1	10	1
ug/L	Chromium (Total Cr)	01034	< 10	50	10
ug/L	Copper (Cu)	01042	< 50	1000	50
ug/L	Iron (Fe)	01045	1180	300	100
ug/L	Lead (Pb)	01051	< 5	50	5
ug/L	Manganese (Mn)	01055	30	50	30
ug/L	Mercury (Hg)	71900	< 1	2	1
ug/L	Selenium (Se)	01147	15	10	5
ug/L	Silver (Ag)	01077	< 10	50	10
ug/L	Zinc (Zn)	01092	< 50	5000	50
ug/L	Aluminum	01105	1060	1000	100

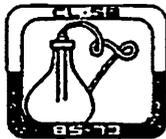
## ORGANIC CHEMICALS

ug/L	Endrin (Hexadrin)	39390		0.2	0.02
ug/L	Gamma-BHC (Lindane)	39340		4	0.4
ug/L	Methoxychlor	39480		100	10.0
ug/L	Toxaphene	39400		5	0.5
ug/L	2,4-D	39730		100	10.0
ug/L	2,4,5-TP (Silvex) (WEED-B-GON)	39045		10	

## ADDITIONAL ANALYSES

NTU	Field Turbidity	82078			0.1
C	Source Temperature C	00010			
	Langelier Index Source Temp.	71814			
	Langelier Index at 60 C	71813			
Std. Units	Field PH	00400			
	Agressiveness Index	82383			
mg/L	Silica	00955			
mg/L	Phosphate	00650			
mg/L	Iodide	71865			
	Sodium Absorption Ratio	00931			
	Asbestos	81855			
mg/L	Ammonia (NH3-N)	00612			
mg/L	Nitrite Nitrogen (NO2-N)	00615			
mg/L	Nitrate Nitrogen (NO3-N)	00618			1.0
mg/L	Nitrite (N)	00620			
mg/L	Beryllium	01012			
mg/L	Boron	01020			
mg/L	Thallium	01059			
mg/L	Nickel	01067			
mg/L	Antimony	01097			0.0
mg/L	Lithium	01132			
mg/L	Cyanide	01291			

# Clinical Laboratory of San Bernardino, Inc.



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 San Bernardino, CA 92402

## RADIOACTIVITY ANALYSES

Date of Report: FEB 20 1991		Lab Sample ID No. 91-0947	
Laboratory Name: CLINICAL LAB OF SAN BERNARDINO		Signature of Lab Director: <i>C. Jelliff</i>	
Name of Sampler: Moulton		Employed By: North American Chemical	
Date/Time Sample Collected: 91/02/02 11:00	Date/Time Sample Received @ Lab: 91/02/02	Were Holding Times Observed: Yes	
System Name: North American Chemical		System Number:	
Description of Sampling Point: I.W.V. Test Well			
Name/No. of Sample Source: Near Ranch #1 1960 - 1980		Station Number:	
Date & of Time Sample: 9   1   0   2   0   2   1   1   0   0	Water Type: <input type="checkbox"/> G/S	User ID: <input type="checkbox"/>	Submitted to SWQIS By:

MCL REPORTING UNITS	CONSTITUENT	T T	STORET CODE	ANALYSES RESULTS
Analyzing Agency			28	, 3, 7, 6, 1
Date Analyses Completed			73672	9, 1, 0, 2, 2, 0
				Y Y M M D D

5	pC/l Total Alpha		1501	, 3, 2, . 9
	pC/l Total Alpha Counting Error		1502	, , , 5, . 2
50	pC/l Total Beta		3501	, , , , , ,
	pC/l Total Beta Counting Error		3502	, , , , , ,
	pC/l Natural Uranium		28012	, , , , , ,
3	pC/l Total Radium 226		9501	, , , , , ,
	pC/l Total Radium 226 Counting Error		9502	, , , , , ,
	pC/l Total Radium 228		11501	, , , , , ,
	pC/l Total Radium 228 Counting Error		11502	, , , , , ,
5	pC/l Ra 226 + Ra 228		11503	, , , , , ,
	pC/l Ra 226 + Ra 228 Counting Error		11504	, , , , , ,
20,000	pC/l Total Tritium		7000	, , , , , ,
	pC/l Total Tritium Counting Error		7001	, , , , , ,
8	pC/l Total Strontium-90		13501	, , , , , ,
	pC/l Total Strontium-90 Counting Error		13502	, , , , , ,

CLINICAL LABS/SAN BERNARDINO  
 1595 NORTH "D" STREET  
 SAN BERNARDINO, CA 92405

RADIOACTIVITY ANALYSIS

Date of Report: 03/08/91  
 Laboratory: CLINICAL LABORATORIES OF SAN BERNARDINO  
 Name of Sampler: MOULTON  
 Date/Time Sample Collected: 91/02/26/0900  
 Signature Lab Director: *C. Jelliff*  
 Employed By: INDIAN WELLS VALLEY CWD  
 Date/Time Sample Received @ Lab: 91/02/26/0900  
 Date Analyses Completed: 91/03/08  
 Sample ID No. 91-1534

System Name: INDIAN WELLS VALLEY CWD - RIDGECREST  
 Name or Number of Sample Source: WELL 25 (NEAL 02) 330 - 350 (TEST WELL)  
 System Number: 15-017  
 \*\*\*\*\*  
 \* Water Type: (G/S) (G) Station Number: 259/39E-31C01 M \*  
 \* Date/Time of Sample: 191102:26:0900! User ID: CYA \*  
 \* YY MM DD HHMM \*  
 \* Analyzing Agency Code: 3761 Date Analysis Completed: 191103:08: \*  
 \* YY MM DD \*  
 \* Submitted by: Phone #: \*  
 \*\*\*\*\*

Place an 'X' in box to delete all data for this station/date/time.

MCL REPORT UNITS	CONSTITUENT	STORET CODE	ANALYSES RESULTS	DLR
15 pC/1	Total Alpha	01501	13.6	
pC/1	Total Alpha Counting Error	01502	3.2	
50 pC/1	Total Beta	03501		4.0
pC/1	Total Beta Counting Error	03502		
20 pC/1	Natural Uranium	28012		2.0
pC/1	Total Radium 226	09501		.5
pC/1	Total Radium 226 Counting Error	09502		
pC/1	Total Radium 228	11501		.5
pC/1	Total Radium 228 Counting Error	11502		
5 pC/1	Ra 226 + Ra 228	11503		
pC/1	Ra 226 + Ra 228 Counting Error	11504		
20000 pC/1	Total Tritium	07000		1.0
pC/1	Total Tritium Counting Error	07001		
8 pC/1	Total Strontium - 90	13501		2.0
pC/1	Total Strontium - 90 Counting Error	13502		
pC/1	Total Radon 222 Counting Error	82302		
pC/1	Total Radon 222	82303		100.0

# Clinical Laboratory of San Bernardino, Inc.

P. O. Box 329  
 1595 North "D" Street  
 San Bernardino, California 92405  
 (714) 885-3216

PURVEYOR: INDIAN WELLS VALLEY WATER

SAMPLE I.D.#: 911535

STREET ADDRESS:

DATE OF REPORT: 3/6/91

CITY, STATE, ZIP:

DESCRIPTION OF SAMPLING POINT: NEAL RANCH #2 1540-1560 *mid*

DATE/TIME COLLECTED: 2/26/91 0800

NAME OF SAMPLER: MOULTON

RESULTS		MCL	RESULTS		MCL
TOTAL HARDNESS	457.2 mg/L		MANGANESE	< 30 ug/L	50
CALCIUM HARDNESS	285.2 mg/L		COPPER	< 50 ug/l	1000
CALCIUM	114.2 mg/L		IRON	< 100 ug/L	300
MAGNESIUM	41.8 mg/L		ZINC	< 50 ug/L	5000
SODIUM	272.3 mg/L		BARIUM	< 100 ug/L	1000
POTASSIUM	4.5 mg/L		CHROMIUM	< 10 ug/L	50
TOTAL ALKALINITY	310.0 mg/L		CADMIUM	< 1 ug/L	10
HYDROXIDE	< 1.0 mg/L		LEAD	< 5 ug/l	50
CARBONATE	< 1.0 mg/L		ALUMINUM	< 100 ug/L	1000
BICARBONATE	378.2 mg/L		MERCURY	< 1 ug/l	2
SULFATE	467.7 mg/L		ARSENIC	12 ug/L	50
CHLORIDE	159.9 mg/L		SELENIUM	60 ug/L	100
NITRATE	107.1 mg/L	45	SILVER	< 10 ug/L	50
FLUORIDE.	1.1 mg/L		COLOR	< 3	
TOTAL ANIONS	22.23 mEq/L		ODOR	1	
TOTAL CATIONS	21.09 mEq/L		TURBIDITY	1.2 NTU	
RPD ANIONS/CATIONS	3.55 PERCENT				
pH	8.0 STD UNITS				
E.C.	2240.0 umho/cm				
TDS	1366.8 mg/L				
MBAS	< 0.02 mg/L				

DATE(S) RECEIVED: 2/28/91

STARTED: 2/28/91

COMPLETED: 3/6/91

ALL ANALYSES ARE PERFORMED IN ACCORDANCE WITH APHA'S STANDARD METHODS, (17TH EDITION) OR EPA'S METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTE

ANALYST: \_\_\_\_\_

DIRECTOR: C. Jolly NR-2 Medium

CLINICAL LABS/SAN BERNARDINO  
 1575 NORTH "D" STREET  
 SAN BERNARDINO, CA 92405

RADIOACTIVITY ANALYSIS

Date of Report: 03/08/91  
 Laboratory: Signature Lab  
 Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: *C. Jolly*  
 Name of Sampler: MOULTON Employed By: INDIAN WELLS VALLEY CWD  
 Date/Time Sample: Date/Time Sample Date Analyses  
 Collected: 91/02/26/0800 Received @ Lab: 91/02/26/0800 Completed: 91/03/08

=====  
 System System  
 Name: INDIAN WELLS VALLEY CWD - RIDGECREST Number: 15-017  
 Name or Number of Sample Source: WELL 25 (NEAL 02) 1540 - 1560 (TEST WELL)  
 \*\*\*\*\*  
 \* Water Type: (G/S) 181 Station Number: 25S/39E-31001 M \*  
 \* Date/Time of Sample: 191102126108001 User ID: CYA \*  
 \* YY MM DD HHMM \*  
 \* Analyzing Agency Code: 3761 Date Analysis Completed: 1911031081 \*  
 \* YY MM DD \*  
 \* Submitted by: Phone #: \*  
 \*\*\*\*\*

Place an 'X' in box to delete all data for this station/date/time.

MCL REPORT	CONSTITUENT	STORET CODE	ANALYSES RESULTS	DLR
UNITS				
15 pC/l	Total Alpha	01501	53.6	
pC/l	Total Alpha Counting Error	01502	5.0	
50 pC/l	Total Beta	03501		4.0
pC/l	Total Beta Counting Error	03502		
20 pC/l	Natural Uranium	28012		2.0
pC/l	Total Radium 226	09501		.5
pC/l	Total Radium 226 Counting Error	09502		
pC/l	Total Radium 228	11501		.5
pC/l	Total Radium 228 Counting Error	11502		
5 pC/l	Ra 226 + Ra 228	11503		
pC/l	Ra 226 + Ra 228 Counting Error	11504		
20000 pC/l	Total Tritium	07000		1.0
pC/l	Total Tritium Counting Error	07001		
8 pC/l	Total Strontium - 90	13501		2.0
pC/l	Total Strontium - 90 Counting Error	13502		
pC/l	Total Radon 222 Counting Error	82302		
pC/l	Total Radon 222	82303		

# Clinical Laboratory of San Bernardino, Inc.

P. O. Box 329  
1595 North "D" Street  
San Bernardino, California 92405  
(714) 885-3216

PURVEYOR: INDIAN WELLS VALLEY WATER

SAMPLE I.D.#: 911536

STREET ADDRESS:

DATE OF REPORT: 3/6/91

CITY, STATE, ZIP:

DESCRIPTION OF SAMPLING POINT: NEAL RANCH #2 1910-1930 *Lower*

DATE/TIME COLLECTED: 2/26/91 1000

NAME OF SAMPLER: MOULTON

	RESULTS	MCL		RESULTS	MCL
TOTAL HARDNESS	143.6 mg/L		MANGANESE	80 ug/L	50
CALCIUM HARDNESS	42.8 mg/L		COPPER	< 50 ug/l	1000
CALCIUM	17.1 mg/L		IRON	250 ug/L	300
MAGNESIUM	24.5 mg/L		ZINC	< 50 ug/L	5000
SODIUM	1296.0 mg/L		BARIUM	< 100 ug/L	1000
POTASSIUM	11.3 mg/L		CHROMIUM	< 10 ug/L	50
TOTAL ALKALINITY	2112.0 mg/L		CADMIUM	< 1 ug/L	10
HYDROXIDE	< 1.0 mg/L		LEAD	< 5 ug/l	50
CARBONATE	< 1.0 mg/L		ALUMINUM	< 100 ug/L	1000
BICARBONATE	2576.6 mg/L		MERCURY	< 1 ug/l	2
SULFATE	236.4 mg/L		ARSENIC	460 ug/L	50
CHLORIDE	230.6 mg/L		SELENIUM	20 ug/L	100
NITRATE	38.2 mg/L	45	SILVER	< 10 ug/L	50
FLUORIDE	3.0 mg/L		COLOR	<i>15</i>	
TOTAL ANIONS	54.43 mEq/L		ODOR	<i>3</i>	
TOTAL CATIONS	59.50 mEq/L		TURBIDITY	<i>4.5 NTU</i>	
RPD ANIONS/CATIONS	5.84 PERCENT				
pH	8.4 STD UNITS				
E.C.	5330.0 umho/cm				
TDS	3304.6 mg/L				
MBAS	< 0.02 mg/L				

DATE(S) RECEIVED: 2/28/91

STARTED: 2/28/91

COMPLETED: 3/6/91

ALL ANALYSES ARE PERFORMED IN ACCORDANCE WITH APHA'S STANDARD METHODS,  
(17TH EDITION) OR EPA'S METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTE

ANALYST: \_\_\_\_\_

DIRECTOR: \_\_\_\_\_

*C. Jelling*

NR-2 Deep

CLINICAL LABS/SAN BERNARDINO  
 1595 NORTH "D" STREET  
 SAN BERNARDINO, CA 92405

RADIOACTIVITY ANALYSIS

Date of Report: 03/08/91  
 Laboratory Name: CLINICAL LABORATORIES OF SAN BERNARDINO  
 Name of Sampler: MOULTON  
 Date/Time Sample Collected: 91/02/26/1000  
 Signature Lab Director: *C. Jelliff*  
 Employed By: INDIAN WELLS VALLEY CWD  
 Date/Time Sample Received @ Lab: 91/02/26/1000  
 Date Analyzes Completed: 91/03/08  
 Sample ID No. 91-1536

System Name: INDIAN WELLS VALLEY CWD - RIDGECREST  
 Name or Number of Sample Source: WELL 25 (NEAL 02)  
 System Number: 15-017  
 1910 - 1930 (TEST WELL)  
 \*\*\*\*\*  
 \* Water Type: (G/S) 1G1 Station Number: 25S/39E-31001 H \*  
 \* Date/Time of Sample: 1911022611000 User ID: CYA \*  
 \* YY MM DD HHMM \*  
 \* Analyzing Agency Code: 3761 Date Analysis Completed: 1911031081 \*  
 \* YY MM DD \*  
 \* Submitted by: Phone #: \*  
 \*\*\*\*\*

Place an 'X' in box to delete all data for this station/date/time.

MCL REPORT UNITS	CONSTITUENT	STORET CODE	ANALYSES RESULTS	DLP
15 pC/l	Total Alpha	01501	24.3	
pC/l	Total Alpha Counting Error	01502	4.5	
50 pC/l	Total Beta	03501		4.0
pC/l	Total Beta Counting Error	03502		
20 pC/l	Natural Uranium	28012		2.0
pC/l	Total Radium 226	09501		.5
pC/l	Total Radium 226 Counting Error	09502		
pC/l	Total Radium 228	11501		.5
pC/l	Total Radium 228 Counting Error	11502		
5 pC/l	Ra 226 + Ra 228	11503		
pC/l	Ra 226 + Ra 228 Counting Error	11504		
20000 pC/l	Total Tritium	07000		1.0
pC/l	Total Tritium Counting Error	07001		
8 pC/l	Total Strontium - 90	13501		2.0
pC/l	Total Strontium - 90 Counting Error	13502		
pC/l	Total Radon 222 Counting Error	82302		
pC/l	Total Radon 222	82303		100.0

CLINICAL\LABS SAN BERNARDINO  
1595 NORTH "D" STREET  
SAN BERNARDINO, CA. 92405

GENERAL MINERAL & PHYSICAL, INORGANIC, & RADIOLOGICAL CHEMICAL ANALYSIS  
 Date of Report: 10/25/91 Sample ID No 91-9450  
 Laboratory Signature Lab  
 Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: *Carol Quinn*  
 Name of Sampler: MIKE C. Employed By: ROTTMAN DRILLING CO.  
 Date/Time Sample Date/Time Sample Date Analyses  
 Collected: 91/10/17/2350 Received @ Lab: 91/10/21/1700 Completed: 91/10/25

System System  
 Name: INDIAN WELLS VALLEY CWD - RIDGECREST Number: 15-017  
 Name or Number of Sample Source: W32 P-1 (380') (This sample was filtered)  
 \*\*\*\*\*  
 \* User ID: CYA Station Number: 000/000-00X00 2 \*  
 \* Date/Time of Sample: |91|10|17|2350| Laboratory Code: 3761 \*  
 \* Y Y MM DD TTTT Date Analysis Completed: |91|10|25| \*  
 \* Y Y MM DD \*  
 \* Submitted by: Phone #: \*  
 \*\*\*\*\*

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	mg/L	Total Hardness (as CaCO3)	00900	86.0	
	mg/L	Calcium (Ca)	00916	24.0	
	mg/L	Magnesium (Mg)	00927	6.3	
	mg/L	Sodium (Na)	00929	60.0	
	mg/L	Potassium (K)	00937	4.6	
Total Cations		Meq/L Value: 4.4			
	mg/L	Total Alkalinity (AS CaCO3)	00410	104.0	
	mg/L	Hydroxide (OH)	71830	< 1.0	
	mg/L	Carbonate (CO3)	00445	< 1.0	
	mg/L	Bicarbonate (HCO3)	00440	126.9	
*	mg/L*	Sulfate (SO4)	00945	57.0	
*	mg/L*	Chloride (Cl)	00940	40.2	
45	mg/L	Nitrate (as NO3)	71850	7.2	
****	mg/L	Fluoride (F) Temp. Depend.	00951	1.1	0.1
Total Anions		Meq/L Value: 4.6			
	Std. Units	PH (Laboratory)	00403	8.6	
**	umho/cm**	Specific Conductance (E.C.)	00095	450.0	
***	mg/L***	Total Filterable Residue at 180C (TDS)	70300	252.4	
	Units	Apparent Color (Unfiltered)	00081	< 3.0	
	TON	Odor Threshold at 60 C	00086	1.0	
	NTU	Lab Turbidity	82079	0.9	
0.5	mg/L	MBAS	38260	< 0.02	

\* 250-500-600 \*\* 900-1600-2200 \*\*\* 500-1000-1500 \*\*\*\* 1.4-2.4

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
1000	ug/L	Aluminum (Al)	01105	170.00	100.0
50	ug/L	Arsenic (As)	01002	26.00	10.0
1000	ug/L	Barium (Ba)	01007	<100.00	100.0
10	ug/L	Cadmium (Cd)	01027	< 1.00	1.0
50	ug/L	Chromium (Total Cr)	01034	< 10.00	10.0
1000	ug/L	Copper (Cu)	01042	< 50.00	50.0
300	ug/L	Iron (Fe)	01045	<100.00	100.0
50	ug/L	Lead (Pb)	01051	< 5.00	5.0
50	ug/L	Manganese (Mn)	01055	50.00	30.0
2	ug/L	Mercury (Hg)	71900	< 1.00	1.0
10	ug/L	Selenium (Se)	01147	< 5.00	5.0
50	ug/L	Silver (Ag)	01077	< 10.00	10.0
5000	ug/L	Zinc (Zn)	01092	< 50.00	50.0

RADIOACTIVITY ANALYSIS

15	PCi/L	Total Alpha	01501		
	PCi/L	Total Alpha Counting Error	01502		
50	PCi/L	Total Beta	03501		4.0
	PCi/L	Total Beta Counting Error	03502		
20	PCi/L	Natural Uranium	28012		2.0
	PCi/L	Total Radium 226	09501		0.5
	PCi/L	Total Radium 226 Counting Error	09502		
	PCi/L	Total Radium 228	11501		0.5
	PCi/L	Total Radium 228 Counting Error	11502		
5	PCi/L	Ra 226 + Ra 228	11503		
	PCi/L	Ra 226 + Ra 228 Counting Error	11504		
	PCi/L	Radon 222	82303		100.0
	PCi/L	Radon 222 Counting Error	82302		
20000	PCi/L	Total Tritium	07000		1.0
	PCi/L	Total Tritium Counting Error	07001		
8	PCi/L	Total Strontium - 90	13501		2.0
	PCi/L	Total Strontium - 90 Counting Error	13502		

ADDITIONAL ANALYSES

NTU	Field Turbidity	82078		0.1
C	Source Temperature C	00010		
	Langelier Index Source Temp.	71814		
	Langelier Index at 60 C	71813		
Std. Units	Field PH	00400		
	Agressiveness Index	82383		
mg/L	Silica	00955		
mg/L	Phosphate	00650		
mg/L	Iodide	71865		
	Sodium Absorption Ratio	00931		2
	Asbestos	81855		
mg/L	Boron	01020		

# Clinical Laboratory of San Bernardino, Inc.

P. O. Box 329  
1595 North "D" Street  
San Bernardino, California 92405  
(714) 885-3216

PURVEYOR: KRIEGER AND STEWART (IWVWD)

SAMPLE I.D.#: 91-9450

STREET ADDRESS:

DATE OF REPORT:

CITY, STATE, ZIP:

ANALYSING AGENCY: 3761

DESCRIPTION OF SAMPLING POINT: W 32 P-1 (380') (SUPERNATE AFTER SETTLEING)

DATE/TIME COLLECTED: 10/17/91 23:50

NAME OF SAMPLER: UNKNOWN

CONSTITUENT	RESULTS	UNITS	MCL
SILVER	< 10	ug/L	50
ARSENIC	17	ug/L	50
ALUMINUM	705	ug/L	1000
SELENIUM	< 5	ug/L	10
CHROMIUM	< 10	ug/L	50
CADMIUM	< 1	ug/L	2
LEAD	17	ug/L	50
BARIUM	< 100	ug/L	1000
MERCURY	< 1	ug/L	2
IRON	1970	ug/L	300
MANGANESE	280	ug/L	50
ZINC	80	ug/L	5000

DATE(S) RECEIVED: 10/21/91

STARTED: 10/21/91

COMPLETED: 10/28/91

ALL ANALYSES ARE PERFORMED IN ACCORDANCE WITH APHA'S STANDARD METHODS,  
(17TH EDITION) OR EPA'S METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTE

ANALYST: \_\_\_\_\_

DIRECTOR: Mehdi Zaman

MW-32 Shallo

# Clinical Laboratory of San Bernardino, Inc.

P. O. Box 329  
1595 North "D" Street  
San Bernardino, California 92405  
(714) 885-3216

PURVEYOR: KRIEGER AND STEWART (IWVWD)

SAMPLE I.D.#: 91-9450

STREET ADDRESS:

DATE OF REPORT:

CITY, STATE, ZIP:

ANALYSING AGENCY: 3761

DESCRIPTION OF SAMPLING POINT: W 32 P-1 (380') (SAMPLE MIXED AND DIGESTED)

DATE/TIME COLLECTED: 10/17/91 23:50

NAME OF SAMPLER: UNKNOWN

---

CONSTITUENT	RESULTS	UNITS	MCL
SILVER	< 10	ug/L	50
ARSENIC	65	ug/L	50
ALUMINUM	19530	ug/L	1000
SELENIUM	6	ug/L	10
CHROMIUM	75	ug/L	50
CADMIUM	1.2	ug/L	2
LEAD	28	ug/L	50
BARIUM	180	ug/L	1000
MERCURY	< 1	ug/L	2
IRON	30400	ug/L	300
MANGANESE	520	ug/L	50
ZINC	220	ug/L	5000

---

DATE(S) RECEIVED: 10/21/91

STARTED: 10/21/91

COMPLETED: 10/28/91

ALL ANALYSES ARE PERFORMED IN ACCORDANCE WITH APHA'S STANDARD METHODS,  
(17TH EDITION) OR EPA'S METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTE

ANALYST: \_\_\_\_\_

DIRECTOR: Melinda Garcia

MW-32 Shallow

CLINICAL\LABS SAN BERNARDINO  
 1595 NORTH "D" STREET  
 SAN BERNARDINO, CA. 92405

GENERAL MINERAL & PHYSICAL, INORGANIC, & RADIOLOGICAL CHEMICAL ANALYSIS  
 Date of Report: 10/25/91 Sample ID No. 91-9451  
 Laboratory Signature Lab  
 Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: *Carol J. Kelly*  
 Name of Sampler: LEROY JONES "DRILLER" Employed By: ROTTMAN DRILLING CO.  
 Date/Time Sample Date/Time Sample Date Analyses  
 Collected: 91/10/18/2400 Received @ Lab: 91/10/21/1700 Completed: 91/10/25

System Name: INDIAN WELLS VALLEY CWD - RIDGECREST System Number: 15-017  
 Name or Number of Sample Source: W32 P-2 (900')  
 \*\*\*\*\*  
 \* User ID: CYA Station Number: 000/000-00X00 3 \*  
 \* Date/Time of Sample: |91|10|18|2400| Laboratory Code: 3761 \*  
 \* YY MM DD TTTT Date Analysis Completed: |91|10|25| \*  
 \* YYY MM DD \*  
 \* Submitted by: Phone #: \*\*\*\*\*

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	mg/L	Total Hardness (as CaCO3)	00900	35.2	
	mg/L	Calcium (Ca)	00916	10.4	
	mg/L	Magnesium (Mg)	00927	2.2	
	mg/L	Sodium (Na)	00929	49.2	
	mg/L	Potassium (K)	00937	3.7	
Total Cations		Meq/L Value: 2.9			
	mg/L	Total Alkalinity (AS CaCO3)	00410	84.0	
	mg/L	Hydroxide (OH)	71830	< 1.0	
	mg/L	Carbonate (CO3)	00445	< 1.0	
	mg/L	Bicarbonate (HCO3)	00440	102.5	
*	mg/L*	Sulfate (SO4)	00945	24.3	
*	mg/L*	Chloride (Cl)	00940	23.3	
45	mg/L	Nitrate (as NO3)	71850	16.9	
****	mg/L	Fluoride (F) Temp. Depend.	00951	0.8	0.1
Total Anions		Meq/L Value: 3.2			
	Std. Units	PH (Laboratory)	00403	8.3	
**	umho/cm**	Specific Conductance (E.C.)	00095	330.0	
***	mg/L***	Total Filterable Residue at 180C (TDS)	70300	172.8	
	Units	Apparent Color (Unfiltered)	00081	< 70.0	
	TON	Odor Threshold at 60 C	00086	3.0	
	NTU	Lab Turbidity	82079	20.0	
0.5	mg/L	MBAS	38260	< 0.02	
* 250-500-600		** 900-1600-2200	*** 500-1000-1500	**** 1.4-2.4	

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
1000	ug/L	Aluminum (Al)	01105	120.00	100.C
50	ug/L	Arsenic (As)	01002	36.00	10.0
1000	ug/L	Barium (Ba)	01007	<100.00	100.C
10	ug/L	Cadmium (Cd)	01027	< 1.00	1.C
50	ug/L	Chromium (Total Cr)	01034	< 10.00	10.C
1000	ug/L	Copper (Cu)	01042	< 50.00	50.C
300	ug/L	Iron (Fe)	01045	1880.0	100.C
50	ug/L	Lead (Pb)	01051	< 5.00	5.C
50	ug/L	Manganese (Mn)	01055	< 30.00	30.C
2	ug/L	Mercury (Hg)	71900	< 1.00	1.C
10	ug/L	Selenium (Se)	01147	< 5.00	5.C
50	ug/L	Silver (Ag)	01077	< 10.00	10.C
5000	ug/L	Zinc (Zn)	01092	< 50.00	50.C

## RADIOACTIVITY ANALYSIS

15	PCi/L	Total Alpha	01501		
	PCi/L	Total Alpha Counting Error	01502		
50	PCi/L	Total Beta	03501		4.C
	PCi/L	Total Beta Counting Error	03502		
20	PCi/L	Natural Uranium	28012		2.C
	PCi/L	Total Radium 226	09501		0.5
	PCi/L	Total Radium 226 Counting Error	09502		
	PCi/L	Total Radium 228	11501		0.5
	PCi/L	Total Radium 228 Counting Error	11502		
5	PCi/L	Ra 226 + Ra 228	11503		
	PCi/L	Ra 226 + Ra 228 Counting Error	11504		
	PCi/L	Radon 222	82303		100.C
	PCi/L	Radon 222 Counting Error	82302		
20000	PCi/L	Total Tritium	07000		1.C
	PCi/L	Total Tritium Counting Error	07001		
8	PCi/L	Total Strontium - 90	13501		2.C
	PCi/L	Total Strontium - 90 Counting Error	13502		

## ADDITIONAL ANALYSES

NTU	Field Turbidity	82078		0.5
C	Source Temperature C	00010		
	Langelier Index Source Temp.	71814		
	Langelier Index at 60 C	71813		
Std. Units	Field PH	00400		
	Agressiveness Index	82383		
mg/L	Silica	00955		
mg/L	Phosphate	00650		
mg/L	Iodide	71865		
	Sodium Absorption Ratio	00931		
	Asbestos	81855		
mg/L	Boron	01020		

# Clinical Laboratory of San Bernardino, Inc.

P. O. Box 329  
1595 North "D" Street  
San Bernardino, California 92405  
(714) 885-3216

PURVEYOR: KREIGER & STEWART (IWWVD)

SAMPLE I.D.#: 91-9451

STREET ADDRESS:

DATE OF REPORT: 11/6/91

CITY, STATE, ZIP:

DESCRIPTION OF SAMPLING POINT: W 32 P-2 (900') \*\* FILTERED \*\*

DATE/TIME COLLECTED: 10/18/91 14:00

NAME OF SAMPLER: UNKNOWN

GENERAL MINERAL	RESULTS	UNITS	MCL	G.M. CONT	RESULTS	UNITS	MCL
TOTAL HARDNESS	33.2	mg/L		MANGANESE	< 30	ug/L	50
CALCIUM HARDNESS	26.4	mg/L		COPPER	< 50	ug/l	1000
CALCIUM	10.6	mg/L		IRON	1210	ug/L	300
MAGNESIUM	1.7	mg/L		ZINC	< 50	ug/L	5000
SODIUM	48.2	mg/L		INORGANICS			
POTASSIUM	3.3	mg/L					
TOTAL ALKALINITY	82.0	mg/L		BARIUM	< 100	ug/L	1000
HYDROXIDE	< 1.0	mg/L		CHROMIUM	< 10	ug/L	50
CARBONATE	< 1.0	mg/L		CADMIUM	< 1	ug/L	10
BICARBONATE	100.0	mg/L		LEAD	< 5	ug/l	50
SULFATE	24.0	mg/L		ALUMINUM	< 100	ug/L	1000
CHLORIDE	22.4	mg/L		MERCURY	< 1	ug/l	2
NITRATE	16.7	mg/L	45	ARSENIC	25	ug/L	50
FLUORIDE	0.8	mg/L		SELENIUM	< 5	ug/L	100
				SILVER	< 10	ug/L	50
TOTAL ANIONS	3.1	mEq/L					
TOTAL CATIONS	2.8	mEq/L					
RPD ANIONS/CATIONS	2.0	PERCENT					
pH	8.1	STD UNITS					
E.C.	330.0	umho/cm					
TDS	168.6	mg/L					
MBAS	< 0.02	mg/L					

DATE(S) RECEIVED: 10/21/91

STARTED: 11/1/91

COMPLETED: 11/5/91

ALL ANALYSES ARE PERFORMED IN ACCORDANCE WITH APHA'S STANDARD METHODS,  
(17TH EDITION) OR EPA'S METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTE

ANALYST: \_\_\_\_\_

DIRECTOR: Carol J. Kelly

MW-32 Shal Med

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
1000	ug/L	Aluminum (Al)	01105	130.00	100.C
50	ug/L	Arsenic (As)	01002	17.00	10.C
1000	ug/L	Barium (Ba)	01007	<100.00	100.C
10	ug/L	Cadmium (Cd)	01027	< 1.00	1.C
50	ug/L	Chromium (Total Cr)	01034	< 10.00	10.C
1000	ug/L	Copper (Cu)	01042	< 50.00	50.C
300	ug/L	Iron (Fe)	01045	4150.0	100.C
50	ug/L	Lead (Pb)	01051	< 5.00	5.C
50	ug/L	Manganese (Mn)	01055	100.00	30.C
2	ug/L	Mercury (Hg)	71900	< 1.00	1.C
10	ug/L	Selenium (Se)	01147	< 5.00	5.C
50	ug/L	Silver (Ag)	01077	< 10.00	10.C
5000	ug/L	Zinc (Zn)	01092	< 50.00	50.C

## RADIOACTIVITY ANALYSIS

15	PCi/L	Total Alpha	01501		
	PCi/L	Total Alpha Counting Error	01502		
50	PCi/L	Total Beta	03501		4.C
	PCi/L	Total Beta Counting Error	03502		
20	PCi/L	Natural Uranium	28012		2.C
	PCi/L	Total Radium 226	09501		0.5
	PCi/L	Total Radium 226 Counting Error	09502		
	PCi/L	Total Radium 228	11501		0.5
	PCi/L	Total Radium 228 Counting Error	11502		
5	PCi/L	Ra 226 + Ra 228	11503		
	PCi/L	Ra 226 + Ra 228 Counting Error	11504		
	PCi/L	Radon 222	82303		100.C
	PCi/L	Radon 222 Counting Error	82302		
20000	PCi/L	Total Tritium	07000		1.C
	PCi/L	Total Tritium Counting Error	07001		
8	PCi/L	Total Strontium - 90	13501		2.C
	PCi/L	Total Strontium - 90 Counting Error	13502		

## ADDITIONAL ANALYSES

NTU	Field Turbidity	82078		0.1
C	Source Temperature C	00010		
	Langelier Index Source Temp.	71814		
	Langelier Index at 60 C	71813		
Std. Units	Field PH	00400		
	Agressiveness Index	82383		
mg/L	Silica	00955		
mg/L	Phosphate	00650		
mg/L	Iodide	71865		
	Sodium Absorption Ratio	00931		
	Asbestos	81855		
mg/L	Boron	01020		

CLINICAL\LABS SAN BERNARDINO  
1595 NORTH "D" STREET  
SAN BERNARDINO, CA. 92405

GENERAL MINERAL & PHYSICAL, INORGANIC, & RADIOLOGICAL CHEMICAL ANALYSIS  
 Date of Report: 10/25/91 Sample ID No.91-9499  
 Laboratory Signature Lab  
 Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: *Carol J. Kelly*  
 Name of Sampler: MICHAEL Employed By: ROTTMAN DRILLING CO.  
 Date/Time Sample Date/Time Sample Date Analyses  
 Collected: 91/10/21/0300 Received @ Lab: 91/10/23/1700 Completed: 91/10/25

System System  
 Name: INDIAN WELLS VALLEY CWD - RIDGECREST Number: 15-017  
 Name or Number of Sample Source: W32 P-3 (1200 FT.)  
 \*\*\*\*\*  
 \* User ID: CYA Station Number: 000/000-00X00 5 \*  
 \* Date/Time of Sample: |91|10|21|0300| Laboratory Code: 3761 \*  
 \* YY MM DD TTTT Date Analysis Completed: |91|10|25| \*  
 \* YY MM DD \*  
 \* Submitted by: \_\_\_\_\_ Phone #: \_\_\_\_\_ \*  
 \*\*\*\*\*

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	mg/L	Total Hardness (as CaCO3)	00900	28.0	
	mg/L	Calcium (Ca)	00916	5.6	
	mg/L	Magnesium (Mg)	00927	3.4	
	mg/L	Sodium (Na)	00929	59.2	
	mg/L	Potassium (K)	00937	2.0	
<hr/>					
Total Cations		Meq/L Value: 3.2			
	mg/L	Total Alkalinity (AS CaCO3)	00410	90.0	
	mg/L	Hydroxide (OH)	71830	< 1.0	
	mg/L	Carbonate (CO3)	00445	< 1.0	
	mg/L	Bicarbonate (HCO3)	00440	109.8	
*	mg/L*	Sulfate (SO4)	00945	22.6	
*	mg/L*	Chloride (Cl)	00940	26.1	
45	mg/L	Nitrate (as NO3)	71850	14.8	
****	mg/L	Fluoride (F) Temp. Depend.	00951	0.6	0.1
<hr/>					
Total Anions		Meq/L Value: 3.3			
	Std. Units	PH (Laboratory)	00403	8.5	
**	umho/cm**	Specific Conductance (E.C.)	00095	340.0	
***	mg/L***	Total Filterable Residue at 180C (TDS)	70300	179.3	
	Units	Apparent Color (Unfiltered)	00081	< 70.0	
	TON	Odor Threshold at 60 C	00086	4.0	
	NTU	Lab Turbidity	82079	25.0	
0.5	mg/L	MBAS	38260	< 0.02	
<hr/>					
* 250-500-600		** 900-1600-2200	*** 500-1000-1500	**** 1.4-2.4	

# Clinical Laboratory of San Bernardino, Inc.

P. O. Box 329  
 1595 North "D" Street  
 San Bernardino, California 92405  
 (714) 885-3216

PURVEYOR: KREIGER & STEWART (IWVWD)

SAMPLE I.D.#: 91-9499

STREET ADDRESS:

DATE OF REPORT: 11/6/91

CITY, STATE, ZIP:

DESCRIPTION OF SAMPLING POINT: W 32 P-3 (1200') \*\* FILTERED \*\*

DATE/TIME COLLECTED: 10/21/91 15:00

NAME OF SAMPLER: UNKNOWN

GENERAL MINERAL	RESULTS	UNITS	MCL	G.M. CONT	RESULTS	UNITS	MCL
TOTAL HARDNESS	26.0	mg/L		MANGANESE	65	ug/L	50
CALCIUM HARDNESS	16.0	mg/L		COPPER	< 50	ug/l	1000
CALCIUM	6.4	mg/L		IRON	3350	ug/L	300
MAGNESIUM	2.4	mg/L		ZINC	< 50	ug/L	5000
SODIUM	58.2	mg/L					
POTASSIUM	2.0	mg/L		INORGANICS	RESULTS	UNITS	MCL
TOTAL ALKALINITY	90.0	mg/L		BARIUM	< 100	ug/L	1000
HYDROXIDE	< 1.0	mg/L		CHROMIUM	< 10	ug/L	50
CARBONATE	< 1.0	mg/L		CADMIUM	< 1	ug/L	10
BICARBONATE	109.8	mg/L		LEAD	< 5	ug/l	50
SULFATE	22.1	mg/L		ALUMINUM	< 100	ug/L	1000
CHLORIDE	24.9	mg/L		MERCURY	< 1	ug/l	2
NITRATE	14.6	mg/L	45	ARSENIC	< 10	ug/L	50
FLUORIDE	0.7	mg/L		SELENIUM	< 5	ug/L	100
				SILVER	< 10	ug/L	50
TOTAL ANIONS	3.1	mEq/L					
TOTAL CATIONS	3.2	mEq/L					
RPD ANIONS/CATIONS	1.0	PERCENT					
pH	8.3	STD UNITS					
E.C.	330.0	umho/cm					
TDS	176.3	mg/L					
MBAS	< 0.02	mg/L					

DATE(S) RECEIVED: 10/23/91

STARTED: 11/1/91

COMPLETED: 11/5/91

ALL ANALYSES ARE PERFORMED IN ACCORDANCE WITH APHA'S STANDARD METHODS, (17TH EDITION) OR EPA'S METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTE

ANALYST: \_\_\_\_\_

DIRECTOR: \_\_\_\_\_

*Carol J. Kelly*

MW-32 Deep Med

CLINICAL\LABS SAN BERNARDINO  
 1595 NORTH "D" STREET  
 SAN BERNARDINO, CA. 92405

GENERAL MINERAL & PHYSICAL, INORGANIC, & RADIOLOGICAL CHEMICAL ANALYSIS

Date of Report: 10/25/91

Sample ID No. 91-9498

Laboratory

Signature Lab

Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: *Carol Peeling*

Name of Sampler: BILL B.

Employed By: ROTTMAN DRILLING CO.

Date/Time Sample

Date/Time Sample

Date Analyses

Collected: 91/10/21/2200

Received @ Lab: 91/10/23/1700

Completed: 91/10/25

System

System

Name: INDIAN WELLS VALLEY CWD - RIDGECREST

Number: 15-017

Name or Number of Sample Source: W32 P4 (1900 FT.)

\*\*\*\*\*

\* User ID: CYA

Station Number: 000/000-00X00 4 \*

\* Date/Time of Sample: |91|10|21|2200|  
 \* YY MM DD TTTT

Laboratory Code: 3761 \*

\* Date Analysis Completed: |91|10|25| \*

\* Submitted by: \_\_\_\_\_ Phone #: \_\_\_\_\_ \*

\*\*\*\*\*

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	mg/L	Total Hardness (as CaCO3)	00900	26.0	
	mg/L	Calcium (Ca)	00916	7.4	
	mg/L	Magnesium (Mg)	00927	1.8	
	mg/L	Sodium (Na)	00929	190.5	
	mg/L	Potassium (K)	00937	4.1	

Total Cations Meq/L Value: 8.9

	mg/L	Total Alkalinity (AS CaCO3)	00410	198.0	
	mg/L	Hydroxide (OH)	71830	< 1.0	
	mg/L	Carbonate (CO3)	00445	< 1.0	
	mg/L	Bicarbonate (HCO3)	00440	241.6	
*	mg/L*	Sulfate (SO4)	00945	138.2	
*	mg/L*	Chloride (Cl)	00940	78.8	
45	mg/L	Nitrate (as NO3)	71850	1.0	
****	mg/L	Fluoride (F) Temp. Depend.	00951	5.6	0.1

Total Anions Meq/L Value: 9.4

	Std. Units	PH (Laboratory)	00403	8.6	
**	umho/cm**	Specific Conductance (E.C.)	00095	960.0	
***	mg/L***	Total Filterable Residue at 180C (TDS)	70300	526.4	
	Units	Apparent Color (Unfiltered)	00081	< 70.0	
	TON	Odor Threshold at 60 C	00086	1.0	
	NTU	Lab Turbidity	82079	74.0	
0.5	mg/L	MBAS	38260	< 0.02	

\* 250-500-600 \*\* 900-1600-2200 \*\*\* 500-1000-1500 \*\*\*\* 1.4-2.4



Naval Air Warfare Center  
Weapons Division  
Code 2606  
China Lake, CA 93555-6001  
Attn.: DR. MONASTERO 619-939-2700

Date Reported: 09/09/92  
Date Received: 08/26/92  
Laboratory No.: 7640-1

Sample Description: GEOTHERMAL PROGRAM - PROJECT #1 SNORT: SDW-1, P-2, 08-24-92 @ 8:30  
COLLECTED BY HASTING

SNORT 7,120'-7,140'  
WATER ANALYSIS  
(METALS)

<u>Constituents</u>	<u>Results</u>	<u>Units</u>	<u>D.L.R.</u>	<u>Method</u>
Aluminum	1730.	µg/L	50.	SW-6010
Antimony	None Detected	µg/L	100.	SW-6010
Arsenic	80.	µg/L	2.	SW-7060
Boron	52.9	mg/L	0.10	SW-6010
Copper	None Detected	µg/L	10.	SW-6010
Lithium	560.	µg/L	10.	SW-7430
Manganese	98.	µg/L	10.	SW-6010
Mercury	None Detected	µg/L	0.2	EPA-245.1
* Selenium	None Detected	µg/L	10.	SW-7740
Si as SiO <sub>2</sub>	43.	mg/L	0.2	SW-6010
Strontium	350.	µg/L	10.	SW-6010
Thallium	None Detected	µg/L	5.	SW-7841
Zinc	46.	µg/L	10.	SW-6010
Total Iron	8960.	µg/L	50.	SW-6010

\* Detection limit increased due to matrix interferences.

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:

- EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
- SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

Department Supervisor

# Clinical Laboratory of San Bernardino, Inc.

P. O. Box 329  
 1595 North "D" Street  
 San Bernardino, California 92405  
 (714) 885-3216

PURVEYOR: KRIEGER AND STEWART (IWWVD)

SAMPLE I.D.#: SEE BELOW

STREET ADDRESS:

DATE OF REPORT: 10/31/91

CITY, STATE, ZIP:

DESCRIPTION OF SAMPLING POINT: SEE BELOW

DATE COLLECTED: 10/6/91

NAME OF SAMPLER: BILLY BONCHAIS

SAMPLE I.D. ~~~~~	SUPERNATE ~~~~~	MIXED ~~~~~	UNITS ~~~~~	MCL ~~~~~
91-9065 W32 P-1 (381')	Fe = 460 Mn = <30 Al = 1000	Fe = 7740 Mn = 3100 Al = 3699	mg/L mg/L mg/L	300 50 1000
91-9066 W32 P-2 (901')	Fe = 1179 Mn = 35 Al = <100	Fe = 1755 Mn = 35	mg/L mg/L mg/L	300 50 1000
91-9067 W32 P-3 (1261')	Fe = 818 Mn = 69 Al = <100	Fe = 2852 Mn = 51	mg/L mg/L mg/L	300 50 1000
91-9068 P-4	Fe = 1137 Mn = 127	Fe = 3790 Mn = 226	mg/L mg/L	300 50

DATE(S) RECEIVED: 10/6/91

STARTED: 10/18/91

COMPLETED: 10/30/91

ALL ANALYSES ARE PERFORMED IN ACCORDANCE WITH APHA'S STANDARD METHODS,  
 (17TH EDITION) OR EPA'S METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTE

ANALYST: \_\_\_\_\_

DIRECTOR: Mehdi Lami



Naval Air Warfare Center  
Weapons Division  
Code 2606  
China Lake, CA 93555-6001  
Attn.: DR. MONASTERO 619-939-2700

Date Reported: 09/09/92  
Date Received: 08/26/92  
Laboratory No.: 7640-4

Sample Description: GEOTHERMAL PROGRAM - PROJECT #1 SNORT: SDW-1, P-5, 08-25-92 @ 14:00  
COLLECTED BY HASTING

SNO  
WA ANALYSIS  
(GENERAL CHEMISTRY)

<u>Constituents</u>	<u>Results</u>	<u>Units</u>	<u>D.L.R.</u>	<u>Method</u>
Calcium	1.9	mg/L	0.1	SW-7140
Magnesium	1.0	mg/L	0.01	SW-7450
Sodium	3950.	mg/L	0.1	SW-7770
Potassium	25.	mg/L	0.1	SW-7610
Carbonate	1570.	mg/L	2.6	SM-403
Bicarbonate	1950.	mg/L	2.6	SM-403
Chloride	3040.	mg/L	1.8	EPA-300.0
Sulfate	46.	mg/L	5.	EPA-300.0
Nitrate as NO3	None Detected	mg/L	0.4	EPA-353.2
Fluoride	27.	mg/L	0.05	EPA-340.2
Bromide	6.6	mg/L	0.05	EPA-300.0
pH	9.7	pH Units	0.1	SW-9040
Electrical Conductivity @ 25 C	15100.	umhos/cm	1.	SW-9050
Total Dissolved Solids @ 180 C	9890.	mg/L	10.	EPA-160.1
Ammonia as NH3	28.	mg/L	0.02	EPA-350.1
Nitrite Nitrogen	None Detected	mg/L	0.10	EPA-353.2
Ortho-phosphate	8.4	mg/L	0.10	EPA-365.1

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:

- EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
- SM = "Standard Methods for Examination of Water and Wastewater", 16th Edition 1986.
- SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods",  
EPA-SW-846, September, 1986.

M. Stencio  
Department Supervisor



Naval Air Warfare Center  
Weapons Division  
Code 2606  
China Lake, CA 93555-6001  
Attn.: DR. MONASTERO 619-939-2700

Date Reported: 09/09/92  
Date Received: 08/26/92  
Laboratory No.: 7640-4

Sample Description: GEOTHERMAL PROGRAM - PROJECT #1 SNORT: SDW-1, P-5, 08-25-92 @ 14:00  
COLLECTED BY HASTING

SNORT 850'-870'  
WATER ANALYSIS  
(METALS)

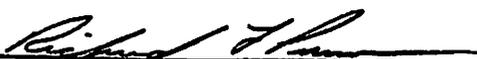
<u>Constituents</u>	<u>Results</u>	<u>Units</u>	<u>D.L.R.</u>	<u>Method</u>
Aluminum	578.	µg/L	50.	SW-6010
Antimony	None Detected	µg/L	100.	SW-6010
Arsenic	5.2	µg/L	2.	SW-7060
Boron	93.5	mg/L	0.10	SW-6010
Copper	None Detected	µg/L	10.	SW-6010
Lithium	50.	µg/L	10.	SW-7430
Manganese	36.	µg/L	10.	SW-6010
Mercury	None Detected	µg/L	0.2	EPA-245.1
* Selenium	None Detected	µg/L	10.	SW-7740
Si as SiO <sub>2</sub>	63.	mg/L	0.2	SW-6010
Strontium	72.	µg/L	10.	SW-6010
Thallium	None Detected	µg/L	5.	SW-7841
Zinc	54.	µg/L	10.	SW-6010
Total Iron	1940.	µg/L	50.	SW-6010

\* Detection limit increased due to matrix interferences.

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:

- EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.  
SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods",  
EPA-SW-846, September, 1986.

  
Department Supervisor



Naval Air Warfare Center  
Weapons Division  
Code 2606  
China Lake, CA 93555-6001  
Attn.: DR. MONASTERO 619-939-2700

Date Reported: 09/09/92  
Date Received: 08/26/92  
Laboratory No.: 7640-3

Sample Description: GEOTHERMAL PROGRAM - PROJECT #1 SNORT: SDW-1, P-4, 08-25-92 @ 8:00  
COLLECTED BY HASTING

SNORT 3,300'-3,320'  
WATER ANALYSIS  
(GENERAL CHEMISTRY)

<u>Constituents</u>	<u>Results</u>	<u>Units</u>	<u>D.L.R.</u>	<u>Method</u>
Calcium	35.	mg/L	0.1	SW-7140
Magnesium	6.9	mg/L	0.01	SW-7450
Sodium	3900.	mg/L	0.1	SW-7770
Potassium	14.5	mg/L	0.1	SW-7610
Carbonate	109.	mg/L	2.6	SM-403
Bicarbonate	2530.	mg/L	2.6	SM-403
Chloride	3420.	mg/L	1.8	EPA-300.0
Sulfate	1170.	mg/L	5.	EPA-300.0
Nitrate as NO3	None Detected	mg/L	0.4	EPA-353.2
Fluoride	17.4	mg/L	0.05	EPA-340.2
Bromide	3.8	mg/L	0.05	EPA-300.0
pH	8.2	pH Units	0.1	SW-9040
Electrical Conductivity @ 25 C	15900.	umhos/cm	1.	SW-9050
Total Dissolved Solids @ 180 C	9350.	mg/L	10.	EPA-160.1
Ammonia as NH3	11.6	mg/L	0.02	EPA-350.1
Nitrite Nitrogen	None Detected	mg/L	0.10	EPA-353.2
Ortho-phosphate	0.84	mg/L	0.10	EPA-365.1

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:

- EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
- SM = "Standard Methods for Examination of Water and Wastewater", 16th Edition 1986.
- SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

M. Atencio  
Department Supervisor



Naval Air Warfare Center  
Weapons Division  
Code 2606  
China Lake, CA 93555-6001  
Attn.: DR. MONASTERO 619-939-2700

Date Reported: 09/09/92  
Date Received: 08/26/92  
Laboratory No.: 7640-3

Sample Description: GEOTHERMAL PROGRAM - PROJECT #1 SNORT: SDW-1, P-4, 08-25-92 @ 8:00  
COLLECTED BY HASTING

SNORT 3,300'-3,320'  
WATER ANALYSIS  
(METALS)

<u>Constituents</u>	<u>Results</u>	<u>Units</u>	<u>D.L.R.</u>	<u>Method</u>
Aluminum	1190.	µg/L	50.	SW-6010
Antimony	None Detected	µg/L	100.	SW-6010
Arsenic	62.	µg/L	2.	SW-7060
Boron	52.5	mg/L	0.10	SW-6010
Copper	None Detected	µg/L	10.	SW-6010
Lithium	1140.	µg/L	10.	SW-7430
Manganese	57.	µg/L	10.	SW-6010
Mercury	None Detected	µg/L	0.2	EPA-245.1
*Selenium	None Detected	µg/L	10.	SW-7740
Si as SiO2	50.	mg/L	0.2	SW-6010
Strontium	1590.	µg/L	10.	SW-6010
Thallium	None Detected	µg/L	5.	SW-7841
Zinc	35.	µg/L	10.	SW-6010
Total Iron	3480.	µg/L	50.	SW-6010

\* Detection limit increased due to matrix interferences.

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:

- EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
- SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

Department Supervisor

SNORT 3,300-3,320



Naval Air Warfare Center  
Weapons Division  
Code 2606  
China Lake, CA 93555-6001  
Attn.: DR. MONASTERO 619-939-2700

Date Reported: 09/09/92  
Date Received: 08/26/92  
Laboratory No.: 7640-2

Sample Description: GEOTHERMAL PROGRAM - PROJECT #1 SNORT: SDW-1, P-3, 08-24-92 @ 15:00  
COLLECTED BY HASTING

SNORT 5,550'-5,570'  
WATER ANALYSIS  
(METALS)

<u>Constituents</u>	<u>Results</u>	<u>Units</u>	<u>D.L.R.</u>	<u>Method</u>
Aluminum	741.	µg/L	50.	SW-6010
Antimony	None Detected	µg/L	100.	SW-6010
Arsenic	57.	µg/L	2.	SW-7060
Boron	60.6	mg/L	0.10	SW-6010
Copper	None Detected	µg/L	10.	SW-6010
Lithium	1550.	µg/L	10.	SW-7430
Manganese	36.	µg/L	10.	SW-6010
Mercury	None Detected	µg/L	0.2	EPA-245.1
* Selenium	None Detected	µg/L	10.	SW-7740
Si as SiO <sub>2</sub>	45.	mg/L	0.2	SW-6010
Strontium	3100.	µg/L	10.	SW-6010
Thallium	None Detected	µg/L	5.	SW-7841
Zinc	19.	µg/L	10.	SW-6010
Total Iron	806.	µg/L	50.	SW-6010

\* Detection limit increased due to matrix interferences.

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:

- EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.  
SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods",  
EPA-SW-846, September, 1986.

Department Supervisor

SNORT 5,550-5,570



Naval Air Warfare Center  
 Weapons Division  
 Code 2606  
 China Lake, CA 93555-6001  
 Attn.: DR. MONASTERO 619-939-2700

Date Reported: 09/09/92  
 Date Received: 08/26/92  
 Laboratory No.: 7640-1

Sample Description: GEOTHERMAL PROGRAM - PROJECT #1 SNORT: SDW-1, P-2, 08-24-92 @ 8:30  
 COLLECTED BY HASTING (P-2, 7,120-7140')

SNORT 7,120'-7,140'  
 WATER ANALYSIS  
 (GENERAL CHEMISTRY)

<u>Constituents</u>	<u>Results</u>	<u>Units</u>	<u>D.L.R.</u>	<u>Method</u>
Calcium	4.6	mg/L	0.1	SW-7140
Magnesium	3.2	mg/L	0.01	SW-7450
Sodium	3480.	mg/L	0.1	SW-7770
Potassium	9.3	mg/L	0.1	SW-7610
Carbonate	456.	mg/L	2.6	SM-403
Bicarbonate	2620.	mg/L	2.6	SM-403
Chloride	2460.	mg/L	1.8	EPA-300.0
Sulfate	910.	mg/L	5.	EPA-300.0
Nitrate as NO3	None Detected	mg/L	0.4	EPA-353.2
Fluoride	24.	mg/L	0.05	EPA-340.2
Bromide	2.9	mg/L	0.05	EPA-300.0
pH	8.9	pH Units	0.1	SW-9040
Electrical Conductivity @ 25 C	13500.	umhos/cm	1.	SW-9050
Total Dissolved Solids @ 180 C	8900.	mg/L	10.	EPA-160.1
Ammonia as NH3	14.6	mg/L	0.02	EPA-350.1
Nitrite Nitrogen	None Detected	mg/L	0.10	EPA-353.2
Ortho-phosphate	0.24	mg/L	0.10	EPA-365.1

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:

- EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
- SM = "Standard Methods for Examination of Water and Wastewater", 16th Edition 1986.
- SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

*M. J. J. J.*  
 Department Supervisor

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
1000	ug/L	Aluminum (Al)	01105	635.00	100.C
50	ug/L	Arsenic (As)	01002	61.00	10.C
1000	ug/L	Barium (Ba)	01007	<100.00	100.C
10	ug/L	Cadmium (Cd)	01027	< 1.00	1.0
50	ug/L	Chromium (Total Cr)	01034	< 10.00	10.C
1000	ug/L	Copper (Cu)	01042	< 50.00	50.C
300	ug/L	Iron (Fe)	01045	1550.0	100.C
50	ug/L	Lead (Pb)	01051	< 5.00	5.C
50	ug/L	Manganese (Mn)	01055	100.00	30.C
2	ug/L	Mercury (Hg)	71900	< 1.00	1.C
10	ug/L	Selenium (Se)	01147	< 5.00	5.C
50	ug/L	Silver (Ag)	01077	< 10.00	10.C
5000	ug/L	Zinc (Zn)	01092	< 50.00	50.C

## RADIOACTIVITY ANALYSIS

15	PCi/L	Total Alpha	01501		
	PCi/L	Total Alpha Counting Error	01502		
50	PCi/L	Total Beta	03501		4.C
	PCi/L	Total Beta Counting Error	03502		
20	PCi/L	Natural Uranium	28012		2.C
	PCi/L	Total Radium 226	09501		0.5
	PCi/L	Total Radium 226 Counting Error	09502		
	PCi/L	Total Radium 228	11501		0.5
	PCi/L	Total Radium 228 Counting Error	11502		
5	PCi/L	Ra 226 + Ra 228	11503		
	PCi/L	Ra 226 + Ra 228 Counting Error	11504		
	PCi/L	Radon 222	82303		100.C
	PCi/L	Radon 222 Counting Error	82302		
20000	PCi/L	Total Tritium	07000		1.C
	PCi/L	Total Tritium Counting Error	07001		
8	PCi/L	Total Strontium - 90	13501		2.C
	PCi/L	Total Strontium - 90 Counting Error	13502		

## ADDITIONAL ANALYSES

NTU	Field Turbidity	82078		0.1
C	Source Temperature C	00010		
	Langelier Index Source Temp.	71814		
	Langelier Index at 60 C	71813		
Std. Units	Field PH	00400		
	Agressiveness Index	82383		
mg/L	Silica	00955		
mg/L	Phosphate	00650		
mg/L	Iodide	71865		
	Sodium Absorption Ratio	00931		
	Asbestos	81855		
mg/L	Boron	01020		



Naval Air Warfare Center  
Weapons Division  
Code 2606  
China Lake, CA 93555-6001  
Attn.: DR. MONASTERO 619-939-2700

Date Reported: 09/09/92  
Date Received: 08/26/92  
Laboratory No.: 7640-2

Sample Description: GEOTHERMAL PROGRAM - PROJECT #1 SNORT: SDW-1, P-3, 08-24-92 @ 15:00  
COLLECTED BY HASTING

SNORT 5,550'-5,570'  
WATER ANALYSIS  
(GENERAL CHEMISTRY)

<u>Constituents</u>	<u>Results</u>	<u>Units</u>	<u>D.L.R.</u>	<u>Method</u>
Calcium	4.6	mg/L	0.1	SW-7140
Magnesium	3.2	mg/L	0.01	SW-7450
Sodium	4920.	mg/L	0.1	SW-7770
Potassium	22.	mg/L	0.1	SW-7610
Carbonate	77.0	mg/L	2.6	SM-403
Bicarbonate	1270.	mg/L	2.6	SM-403
Chloride	5100.	mg/L	1.8	EPA-300.0
Sulfate	2080.	mg/L	5.	EPA-300.0
Nitrate as NO3	None Detected	mg/L	0.4	EPA-353.2
Fluoride	12.6	mg/L	0.05	EPA-340.2
Bromide	5.6	mg/L	0.05	EPA-300.0
pH	8.2	pH Units	0.1	SW-9040
Electrical Conductivity @ 25 C	24000.	umhos/cm	1.	SW-9050
Total Dissolved Solids @ 180 C	12500.	mg/L	10.	EPA-160.1
Ammonia as NH3	11.4	mg/L	0.02	EPA-350.1
Nitrite Nitrogen	None Detected	mg/L	0.10	EPA-353.2
Ortho-phosphate	0.44	mg/L	0.10	EPA-365.1

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:

- EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
- SM = "Standard Methods for Examination of Water and Wastewater", 16th Edition 1986.
- SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods",  
EPA-SW-846, September, 1986.

*JM Monastero*  
Department Supervisor

SNORT 5,550-5,570

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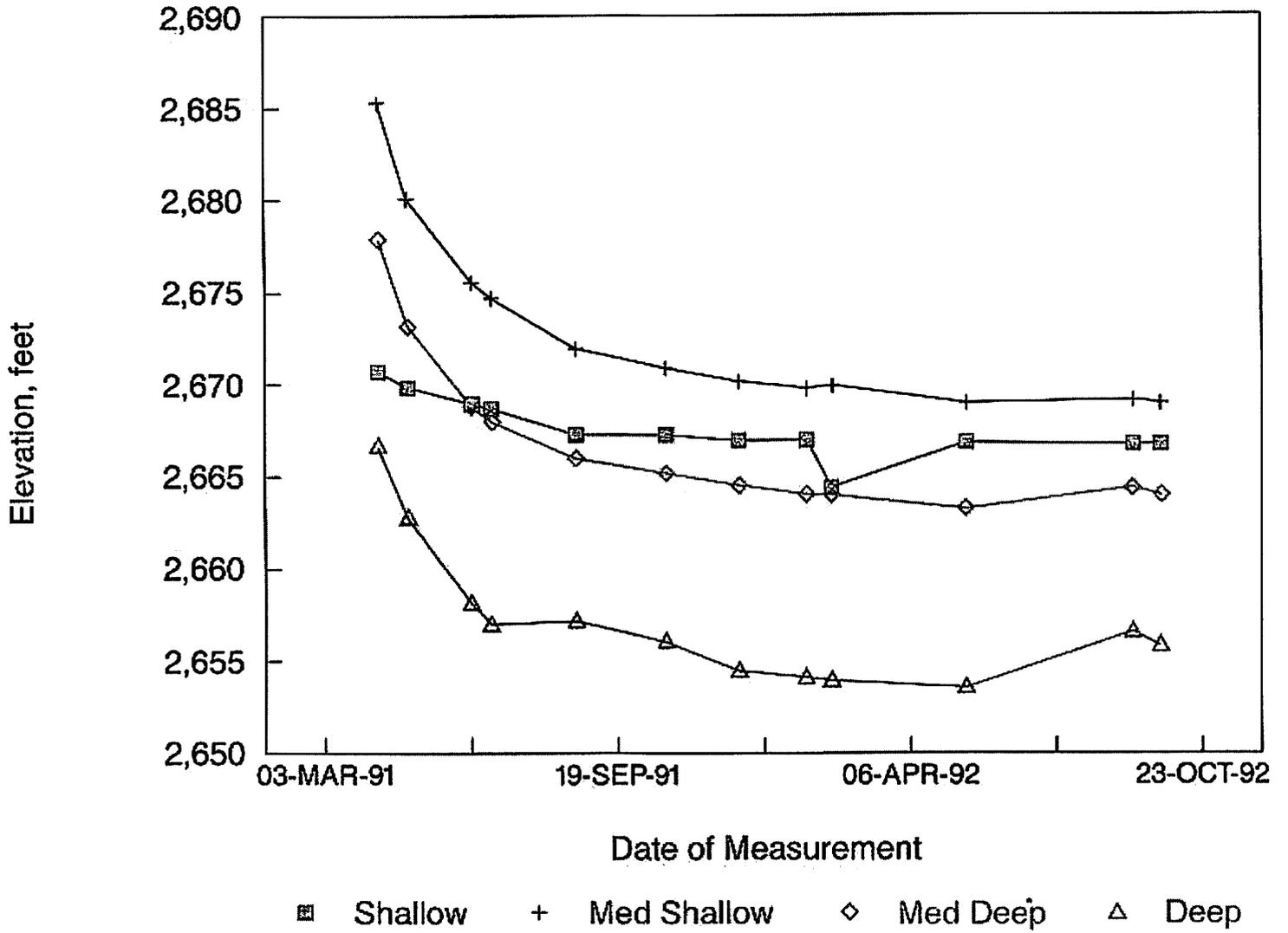
# **APPENDIX IX**

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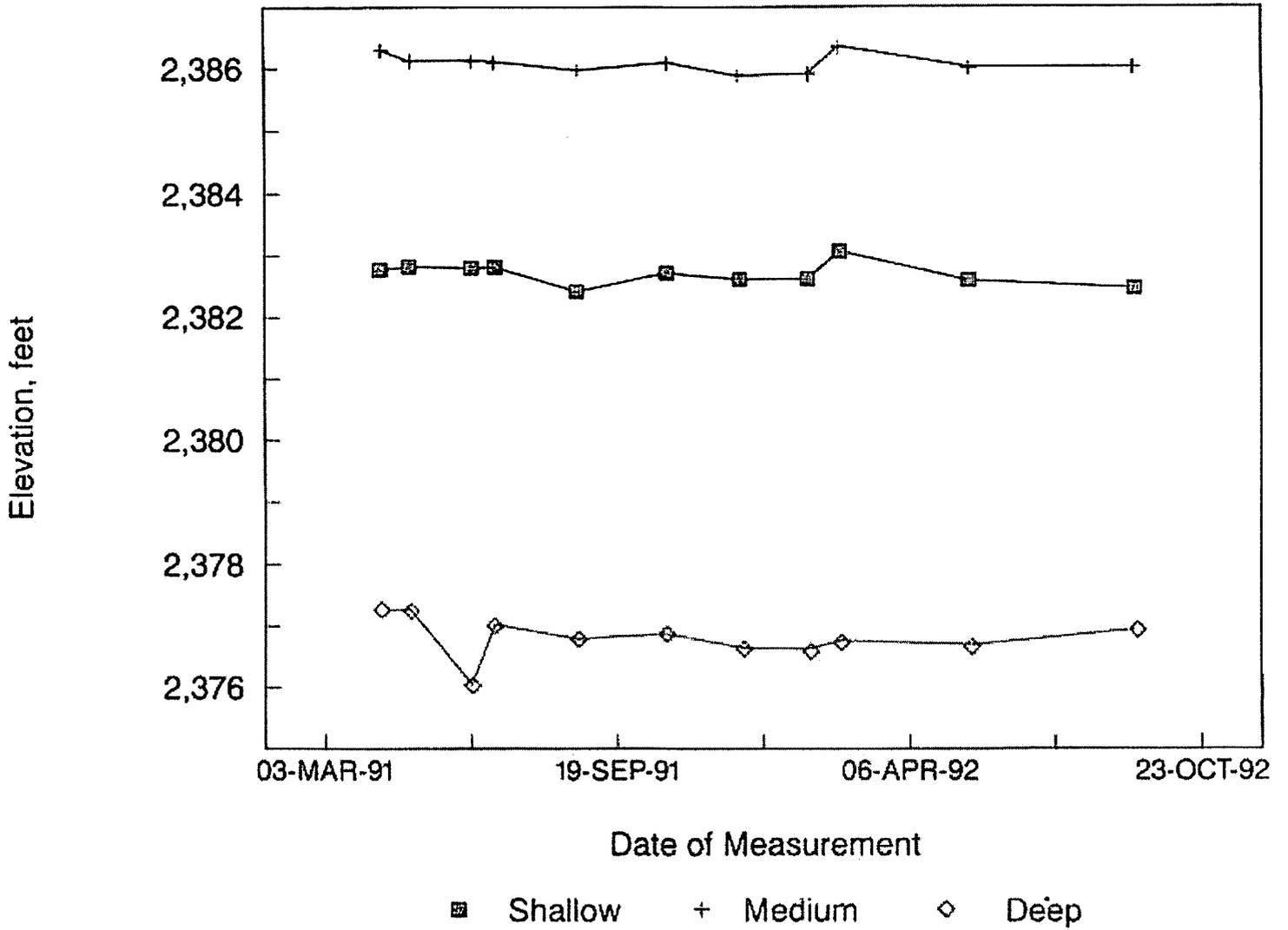
## **Water Elevation Hydrographs**



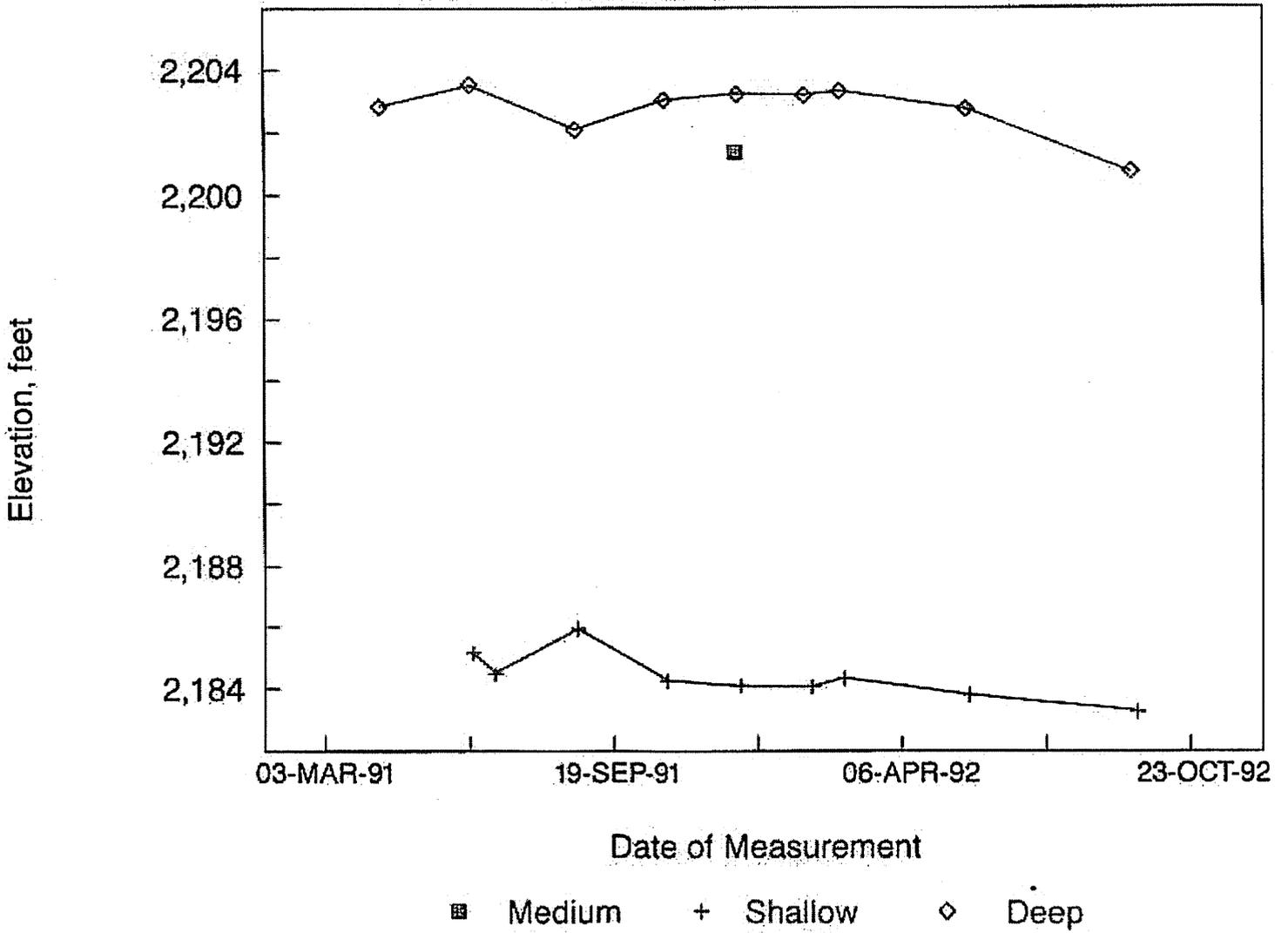
Well BR-1. Water elevation hydrograph.



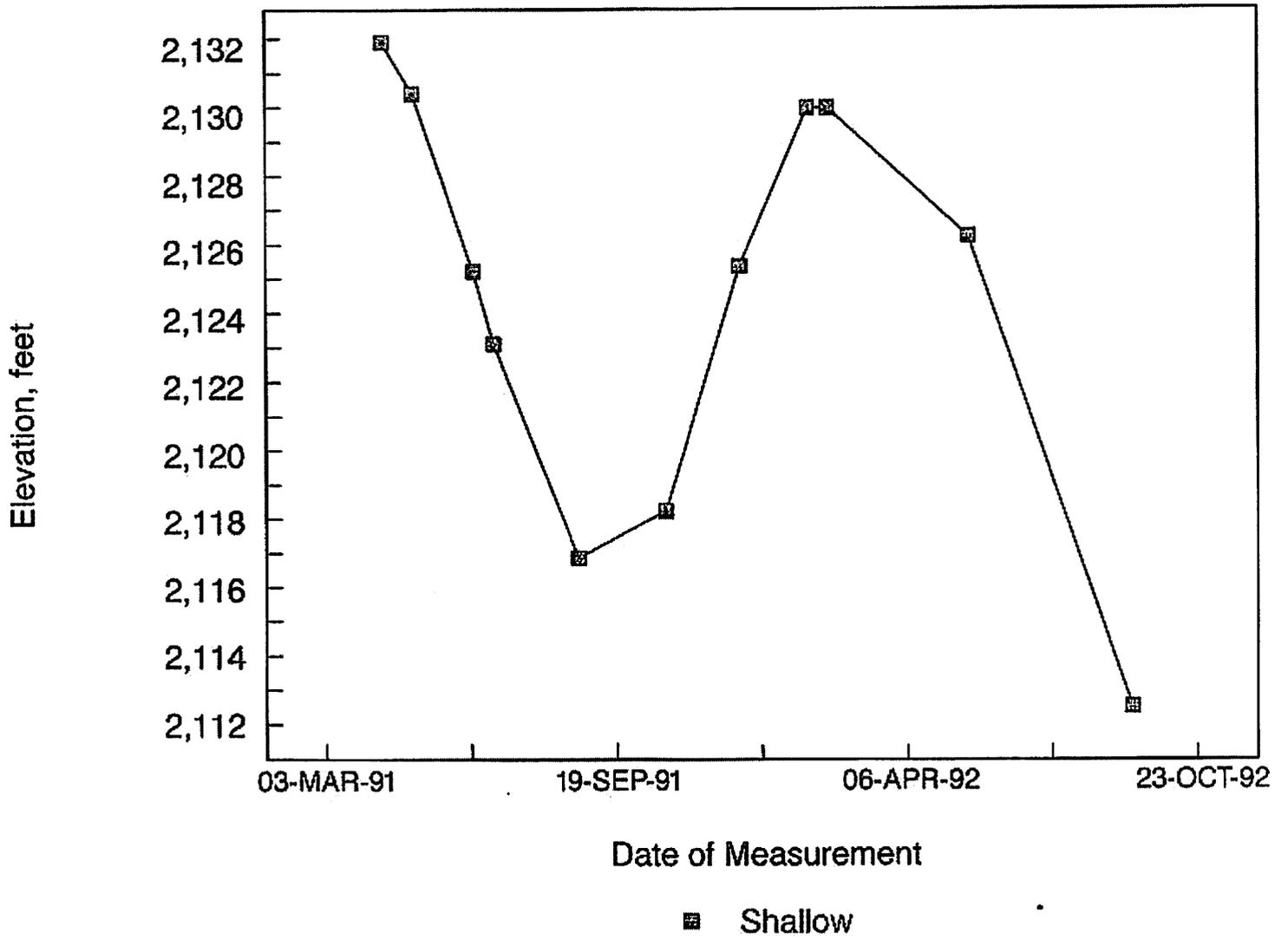
Well BR-2. Water elevation hydrograph.



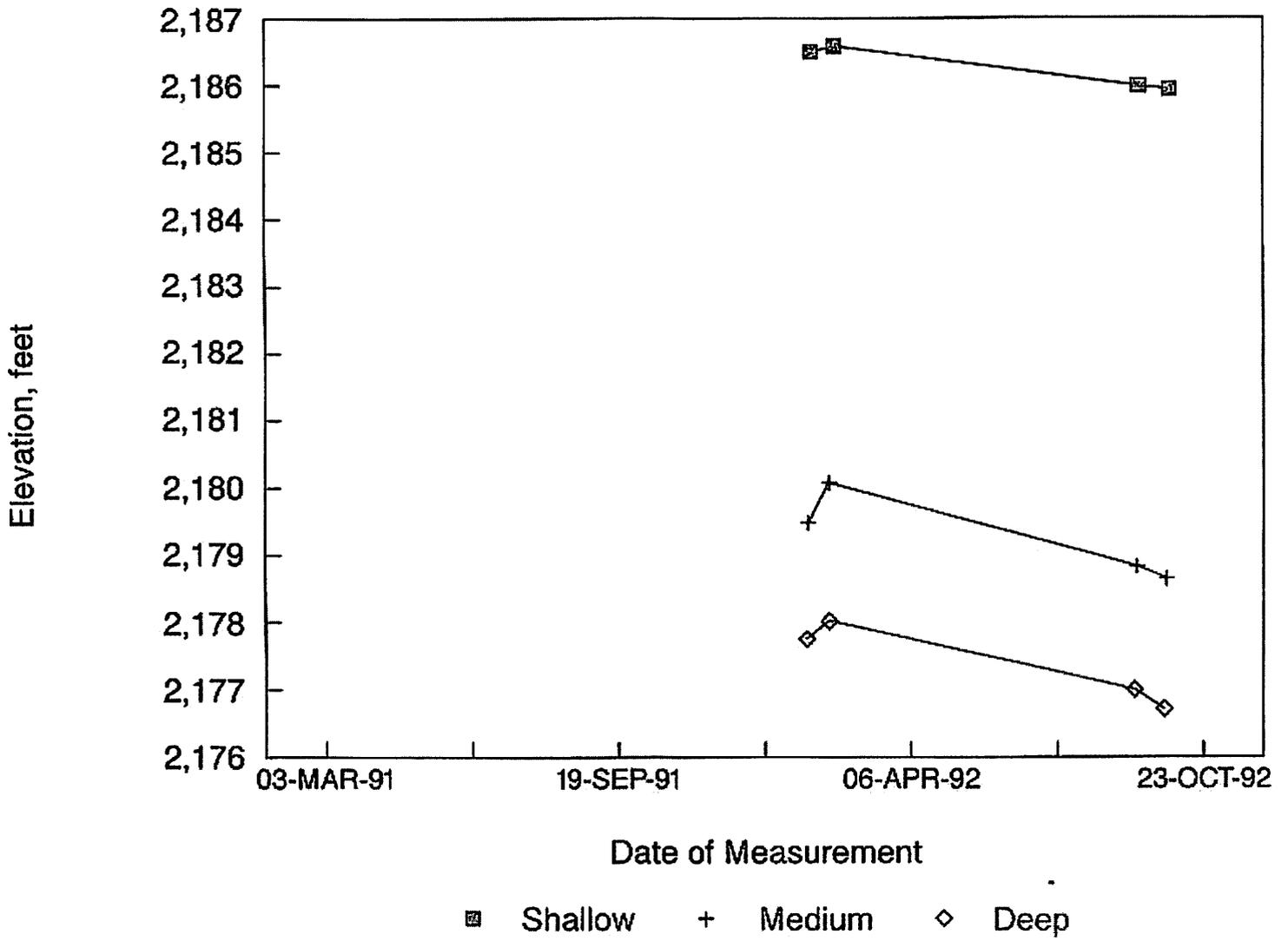
Well BR-3. Water elevation hydrograph.



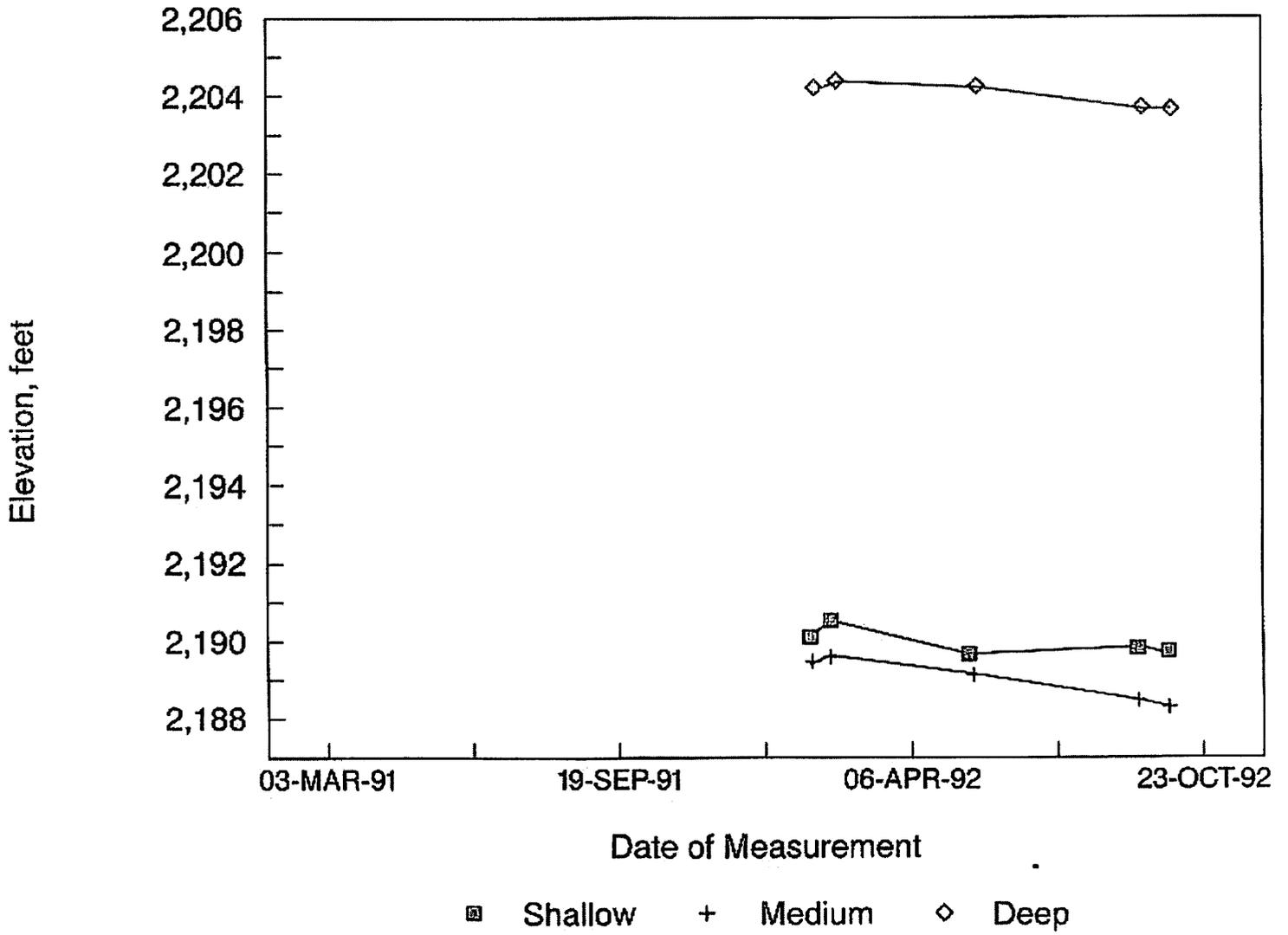
Well BR-4. Water elevation hydrograph.



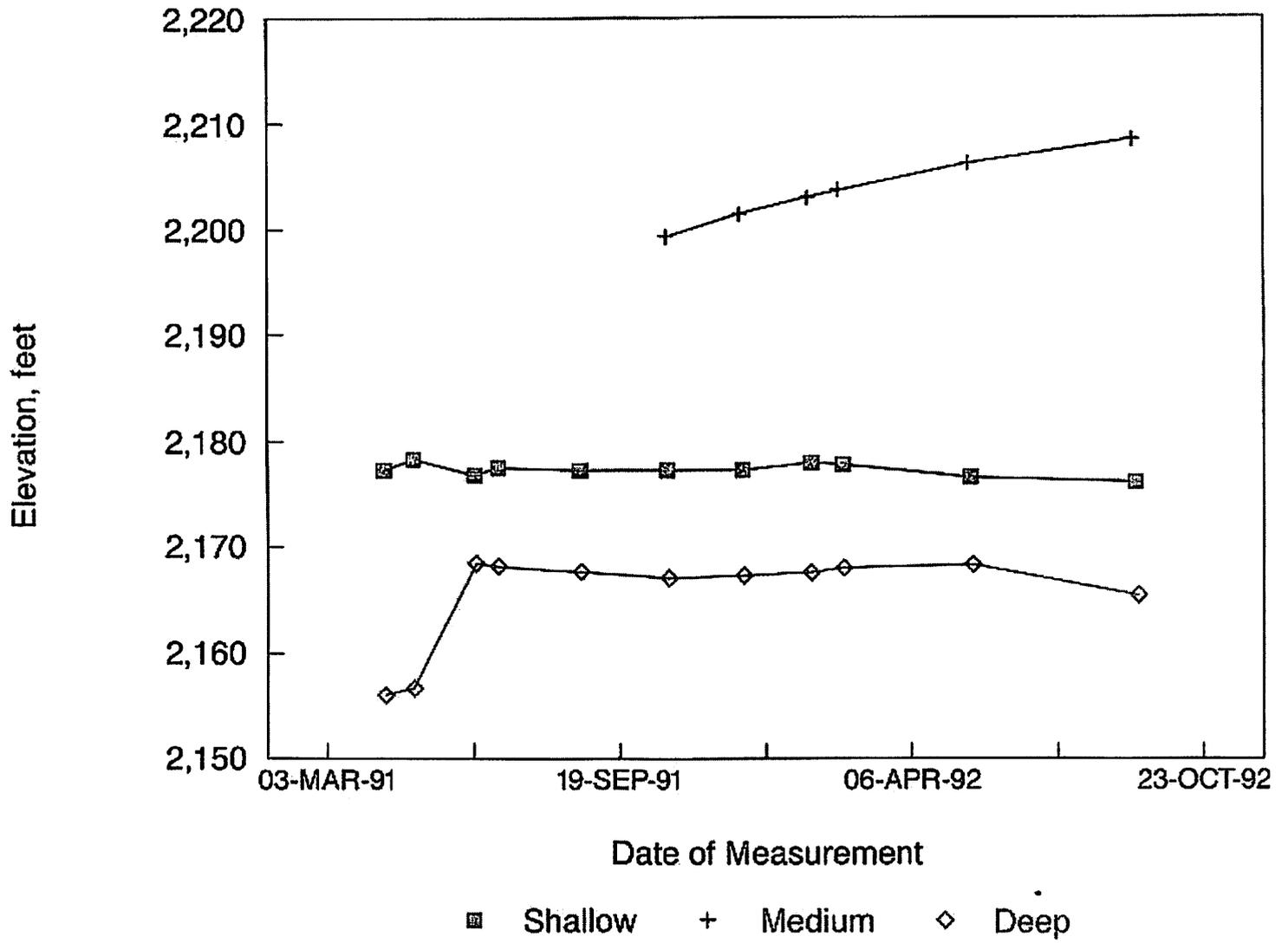
Well BR-5. Water elevation hydrograph.



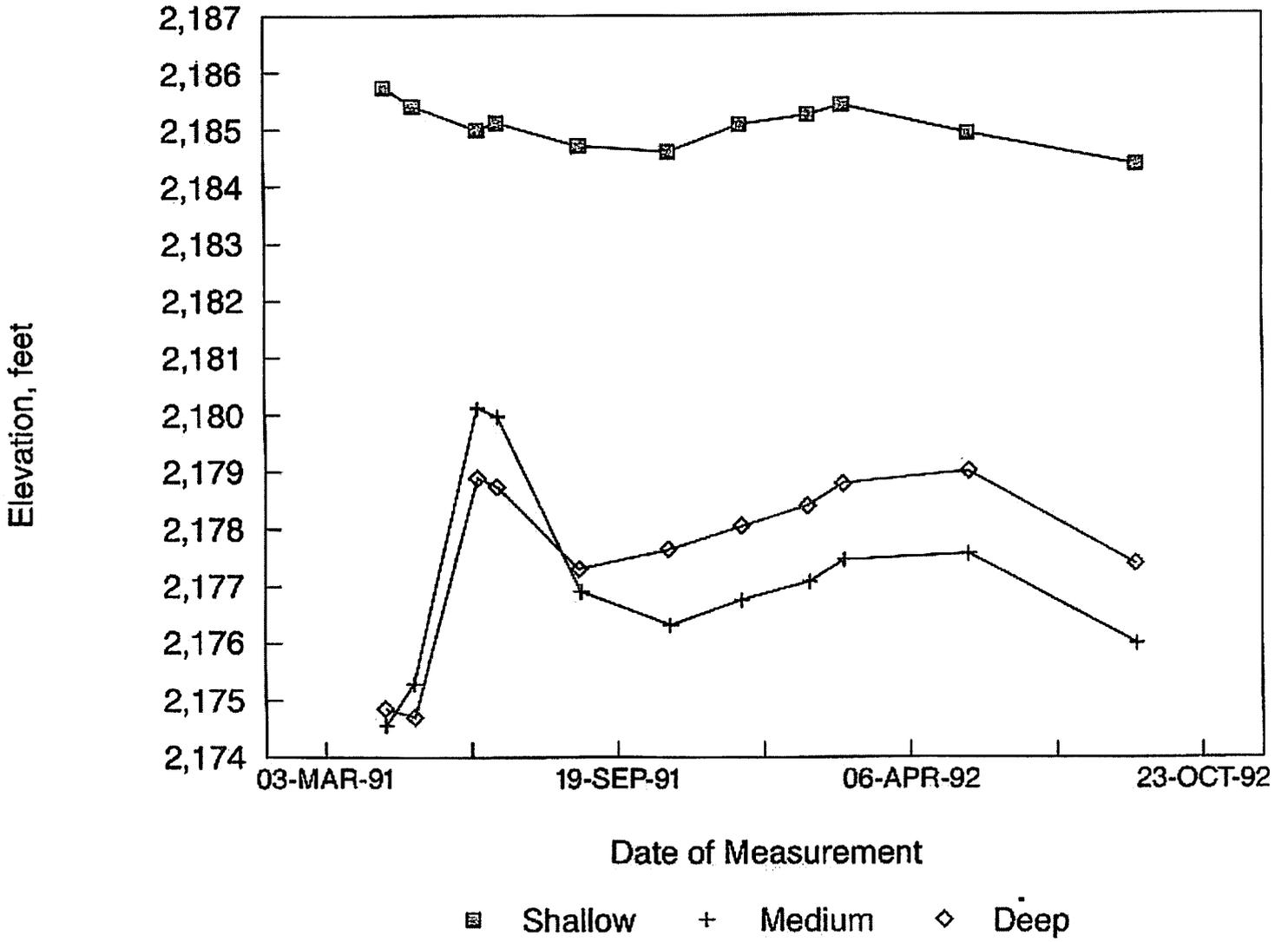
Well BR-6. Water elevation hydrograph.



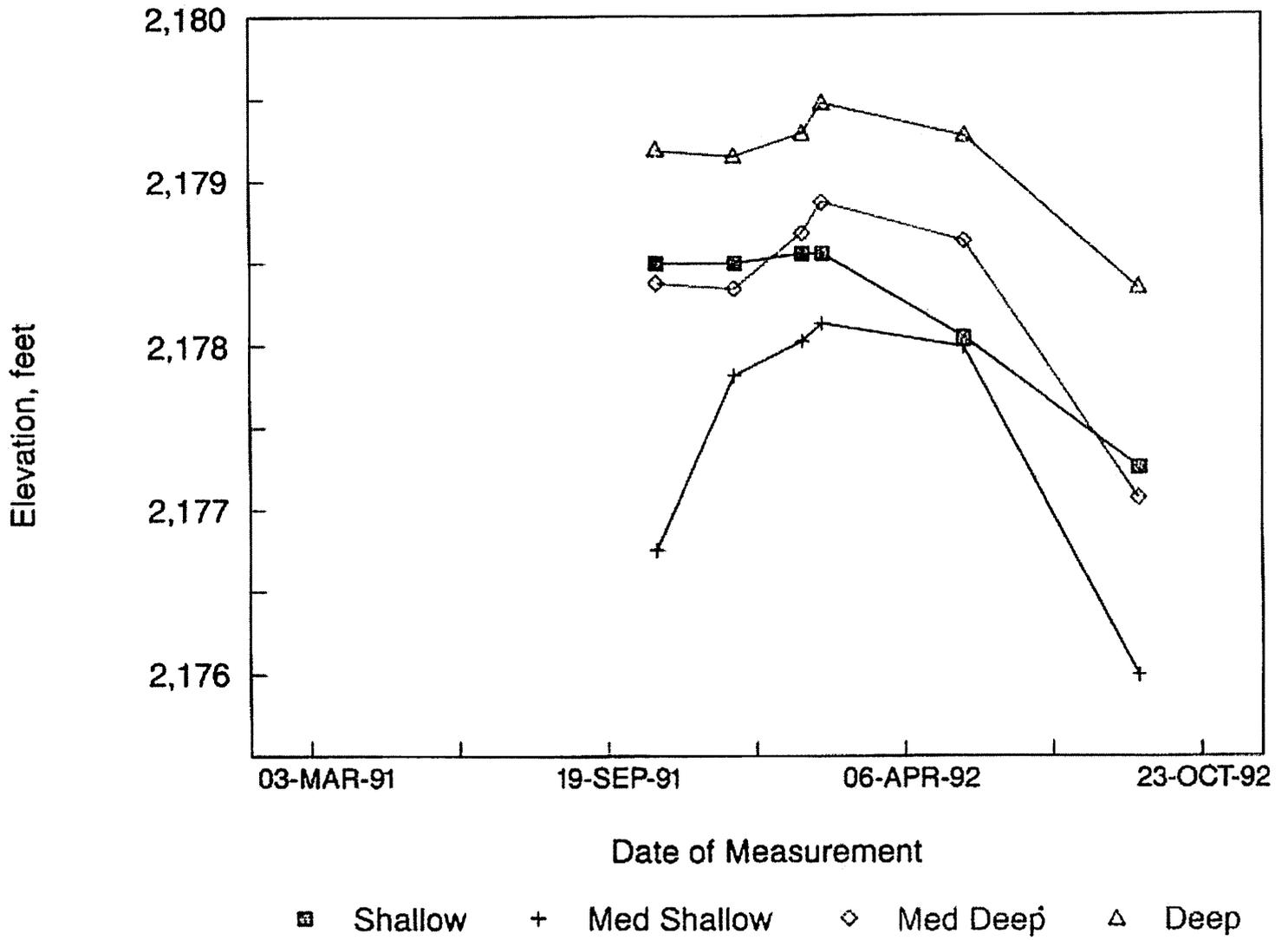
Well NR-1. Water elevation hydrograph.



Well NR-2. Water elevation hydrograph.



Well MW-32. Water elevation hydrograph.



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# APPENDIX X

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Depth to Water Measurements



**Indian Wells Valley Groundwater Project  
Depth to Water Measurements**

All measurements on April 9, 1991, by Dennis Watt using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer	Depth to Water	Comments
BR-3	medium	(shal) ?	
	tall	(med) ?	
	short	(deep) 308.44	
Black oily coating on inside of pipe. Due to "skin friction" could only get sounder down to about 150-170 feet.			
BR-1	tall	(shal) 181.30	TOC to TOP ----->.12
	next tall	(sh/med) 166.62	(Top of Casing to) .25
	next short	(dp/med) 173.84	(Top of 2" pipe) .36
	short	(deep) 184.96	.39
BR-2	tall (blue)	(shal) 275.9	.20
	(yellow)	(med) 272.13	.40
	(red)	(deep) 281.19	.42
NR-1	(red)	(shal) 94.14	.91
	(yellow)	(med) 4.0 psi (GAGE)	
	(white)	(deep) 111.51	.93
NR-2	tall	(shal) 131.72	.32
	medium	(med) 142.51	.59
	short	(deep) 141.98	.79
BR-4	10:20am	245.19	
	5:25pm	245.05	

**Indian Wells Valley Groundwater Project  
Depth to Water Measurements**

All measurements on April 29, 1991, by Dennis Watt and Bill Green using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer	Depth to Water	TOC to TOP	Comments
BR-3	medium	(shal)	?	Could not get sounder down. Heavy black "oil" in pipes.
	tall	(med)	?	
	short	(deep)	?	
BR-1	tall	(shal)	182.18	.12
	next tall	(sh/med)	171.80	.25
	next short	(dp/med)	178.65	.36
	short	(deep)	188.88	.39
BR-2	tall (blue)	(shal)	275.84	.20
	(yellow)	(med)	272.27	.40
	(red)	(deep)	281.21	.42
NR-1	(red)	(shal)	93.25	.91
	(yellow)	(med)	4.5 psi (GAGE)	
	(white)	(deep)	110.84	.93
NR-2	tall	(shal)	132.04	.32
	medium	(med)	141.77	.59
	short	(deep)	142.14	.79
BR-4		246.67		

**Indian Wells Valley Groundwater Project  
Depth to Water Measurements**

All measurements on June 11, 1991, by Dennis Watt using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer	Depth to Water	Comments
			TOC to TOP
BR-3	medium (shal)	326.2	
	tall (med)	?	Can't get sounder down
	short (deep)	307.66	
BR-1	tall (shal)	183.09	.12
	next tall (sh/med)	176.30	.25
	next short (dp/med)	183.00	.36
	short (deep)	193.37	.39
BR-2	tall (blue) (shal)	275.85	.20
	(yellow) (med)	272.30	.40
	(red) (deep)	282.41	.42
NR-1	(red) (shal)	94.58	.91
	(yellow) (med)	5.5 psi (GAGE)	
	(white) (deep)	98.98	.93
NR-2	tall (shal)	132.48	.32
	medium (med)	136.92	.59
	short (deep)	137.95	.79
BR-4		251.83	

**Indian Wells Valley Groundwater Project  
Depth to Water Measurements**

All measurements on June 24, 25, and 26, 1991, by Dennis Watt using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer		Depth to Water		Comments
				TOC to TOP	
BR-3	medium	(shal)	326.90		6-26
	tall	(med)	?		
	short	(deep)	?		
BR-1	tall	(shal)	183.38	.12	6-24
	next tall	(sh/med)	177.15	.25	
	next short	(dp/med)	183.83	.36	
	short	(deep)	194.51	.39	
BR-2	tall (blue)	(shal)	275.86	.20	6-26
	(yellow)	(med)	272.30	.40	
	(red)	(deep)	281.46	.42	
NR-1	(red)	(shal)	93.85	.91	6-26
	(yellow)	(med)	ZERO ? psi (GAGE)		
	(white)	(deep)	99.20	.93	
NR-2	tall	(shal)	132.33	.32	6-25
	medium	(med)	137.07	.59	
	short	(deep)	138.13	.79	
BR-4			253.98		6-25

**Indian Wells Valley Groundwater Project  
Depth to Water Measurements**

All measurements on August 22, 1991, by Dennis Watt using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer	Depth to Water	TOC to TOP	Comments
BR-3	medium	(shal) 325.4	Measure next time!!	Try chalk next time
	tall	(med) ?		
	short	(deep) 309.15		
BR-1	tall	(shal) 184.7	.12	
	next tall	(sh/med) 179.91	.25	
	next short	(dp/med) 185.53	.36	
	short	(deep) 194.49	.39	
BR-2	tall (blue)	(shal) 276.22	.20	
	(yellow)	(med) 272.45	.40	
	(red)	(deep) 281.66	.42	
NR-1	(red)	(shal) 94.11	.91	
	(yellow)	(med) 0 psi (GAGE)		
	(white)	(deep) 99.75	.93	
NR-2	tall	(shal) 132.72	.32	
	medium	(med) 140.12	.59	
	short	(deep) 139.52	.79	
BR-4		260.34		

**Indian Wells Valley Groundwater Project.  
Depth to Water Measurements**

All measurements on October 22, 1991, by Dennis Watt using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer		Depth to Water	TOC to TOP	Comments
BR-3	medium	(shal)	327.07	.43	
	tall	(med)	?	.39	
	short	(deep)	308.18	.64	
BR-1	tall	(shal)	184.78	.12	
	next tall	(sh/med)	181.07	.25	
	next short	(dp/med)	186.42	.36	
	short	(deep)	195.68	.39	
BR-2	tall (blue)	(shal)	275.92	.20	
	(yellow)	(med)	272.32	.40	
	(red)	(deep)	281.57	.42	
NR-1	(red)	(shal)	94.15	.91	
	(yellow)	(med)	78.55?	Measure	
	(white)	(deep)	100.35	.93	
NR-2	tall	(shal)	132.82	.32	
	medium	(med)	140.70	.59	
	short	(deep)	139.18	.79	
MW-32	tall	(shal)	?	Measure!	
	next tall	(sh/med)	242.32	.42	
	next short	(dp/med)	240.63	.50	
	short	(deep)	239.65	.64	
BR-4			258.88		

**Indian Wells Valley Groundwater Project  
Depth to Water Measurements**

All measurements on December 12, 1991, by Dennis Watt using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer	Depth to Water	TOC to TOP	Comments
BR-3	medium (shal)	327.20	.43	
	tall (med)	310.	.39	
	short (deep)	307.95	.64	
BR-1	tall (shal)	184.97	.12	
	next tall (sh/med)	181.81	.25	
	next short (dp/med)	187.07	.36	
	short (deep)	196.94	.39	
BR-2	tall (blue) (shal)	276.02	.20	
	(red) (med)	272.52	.40	
	(yellow) (deep)	281.79	.42	
NR-1	(red) (shal)	93.95	.91	Valve top = TOP
	(yellow) (med)	76.51	.33	
	(white) (deep)	100.11	.93	
NR-2	tall (shal)	132.35	.32	
	medium (med)	140.27	.59	
	short (deep)	138.77	.79	
MW-32	tall (shal)	240.7	.31	
	next tall (sh/med)	241.25	.42	
	next short (dp/med)	240.65	.50	
	short (deep)	239.71	.64	
BR-4		251.70		

**Indian Wells Valley Groundwater Project  
Depth to Water Measurements**

All measurements on January 28, 1992, by Dennis Watt (USBR) and Mike Hasting (NWC Geothermal Office) using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer		Depth to Water		Comments
				TOC to TOP	
BR-3	medium	(shal)	327.25	.43	Re-sound bottoms
	tall	(med)	?	.39	(Done 1-93)
	short	(deep)	308.04	.64	(tall = med piezo)
BR-1	tall	(shal)	185.04	.12	
	next tall	(sh/med)	182.23	.25	
	next short	(dp/med)	187.55	.36	
	short	(deep)	197.38	.39	
BR-2	tall (blue)	(shal)	276.02	.20	
	(yellow)	(med)	272.52	.40	Re-sound bottom
	(red)	(deep)	281.84	.42	
BR-5	tall	(shal)	334.75	.19	Pressure equalization
	medium	(med)	341.51	.41	(hiss) while unscrew-
	short	(deep)	343.05	.64	ing the cap!!
BR-6	tall	(shal)	163.56	.38	
	medium	(med)	163.88	.70	
	short	(deep)	148.81	1.08	
NR-2	tall	(shal)	132.20	.32	
	medium	(med)	139.96	.59	
	short	(deep)	138.42	.79	
NR-1	(red)	(shal)	93.41	.91	
	(yellow)	(med)	74.88	.33	Valve top = TOP
	(white)	(deep)	99.73	.93	
MW-32	tall	(shal)	240.64	.31	
	next tall	(sh/med)	241.06	.42	
	next short	(dp/med)	240.32	.50	
	short	(deep)	239.58	.64	
BR-4			247.11		Measure

**Indian Wells Valley Groundwater Project  
Depth to Water Measurements**

All measurements in mid-February 1992 by Dennis Watt using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer	Depth to Water	TOC to TOP	Comments
BR-3	medium	(shal) 326.95	.43	Feb. 20
	tall	(med) 310+/-	.39	
	short	(deep) 307.92	.64	
BR-1	tall	(shal) 187.54	.12	Feb. 20
	next tall	(sh/med) 182.10	.25	
	next short	(dp/med) 187.56	.36	
	short	(deep) 197.64	.39	
BR-2	tall (blue)	(shal) 275.57	.20	Feb. 19
	(yellow)	(med) 272.07	.40	
	(red)	(deep) 281.68	.42	
BR-5	tall	(shal) 334.68	.19	Feb. 12
	medium	(med) 340.93	.41	
	short	(deep) 342.78	.64	
BR-6	tall	(shal) 163.13	.38	Feb. 11
	medium	(med) 163.71	.70	
	short	(deep) 148.63	1.08	
NR-2	tall	(shal) 132.02	.32	Feb. 20
	medium	(med) 139.57	.59	
	short	(deep) 138.02	.79	
NR-1	(red)	(shal) 93.65	.91	Feb. 20
	(yellow)	(med) 74.09	.33	
	(white)	(deep) 99.21	.93	
MW-32	tall	(shal) 240.64	.31	Feb. 11
	next tall	(sh/med) 240.94	.42	
	next short	(dp/med) 240.13	.50	
	short	(deep) 239.37	.64	
BR-4		247.11		

**Indian Wells Valley Groundwater Project  
Depth to Water Measurements**

All measurements on May 18 and 19, 1992, by Dennis Watt using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer	Depth to Water	TOC to TOP	Comments
BR-3	medium (shal)	327.52	.43	Re-sound bottoms (Done 1-93) (tall = med piezo)
	tall (med)	?	.39	
	short (deep)	308.50	.64	
BR-1	tall (shal)	185.20	.12	
	next tall (sh/med)	182.96	.25	
	next short (dp/med)	188.38	.36	
	short (deep)	198.08	.39	
BR-2	tall (blue) (shal)	276.03	.20	Re-sound bottoms
	(yellow) (med)	272.40	.40	
	(red) (deep)	281.74	.42	
BR-5	tall (shal)	_____	.19	Different lock. Will cut next time.
	medium (med)	_____	.41	
	short (deep)	_____	.64	
BR-6	tall (shal)	163.97	.38	
	medium (med)	164.15	.70	
	short (deep)	148.74	1.08	
NR-2	tall (shal)	132.49	.32	
	medium (med)	139.46	.59	
	short (deep)	137.82	.79	
NR-1	(red) (shal)	94.62	.91	Valve top = TOP
	(yellow) (med)	71.65	.33	
	(white) (deep)	98.95	.93	
MW-32	tall (shal)	241.15	.31	
	next tall (sh/med)	241.09	.42	
	next short (dp/med)	240.40	.50	
	short (deep)	239.58	.64	
BR-4		250.82		Measure

**Indian Wells Valley Groundwater Project  
Depth to Water Measurements**

All measurements on September 10, 1992, by Dennis Watt using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer	Depth to Water	TOC to TOP	Elevations	
				<u>Elev TOP</u>	<u>Water Elev</u>
BR-3	medium (shal)	328.03	.43	2511.43	2183.40
	tall (med)	(310?)	.39	2511.48	2201.48
	short (deep)	310.51	.64	2511.22	2200.71
BR-1	tall (shal)	185.33	.12	2852.05	2666.72
	next tall (sh/med)	182.88	.25	2851.91	2669.03
	next short (dp/med)	187.38	.36	2851.80	2664.42
	short (deep)	195.00	.39	2851.77	2656.77
BR-2	tall (blue) (shal)	276.14	.20	2658.64	2382.50
	(yellow) (med)	272.38	.40	2658.44	2386.06
	(red) (deep)	281.48	.42	2658.42	2376.94
BR-5	tall (shal)	335.26	.19	2521.28	2186.02
	medium (med)	342.21	.41	2521.07	2178.86
	short (deep)	343.80	.64	2520.84	2177.04
BR-10	tall (shal)	307.63	.25	2561.14	2253.51
	next tall (sh/med)	321.59	.42	2560.97	2239.38
	next short (dp/med)	362.35	.54	2560.85	2198.50
	short (deep)	364.62	.68	2560.71	2196.09
BR-6	tall (shal)	163.85	.38	2353.75	2189.90
	medium (med)	164.88	.70	2353.43	2188.55
	short (deep)	149.30	1.08	2353.05	2203.75
NR-2	tall (shal)	133.07	.32	2317.38	2184.31
	medium (med)	141.08	.59	2317.11	2176.08
	short (deep)	139.46	.79	2316.91	2177.45
NR-1	(red) (shal)	95.18	.91	2271.67	2176.49
	(yellow) (med)	69.48	.33	2278.26	2208.78
	(white) (deep)	101.78	.93	2267.65	2165.87
MW-32	tall (shal)	241.93	.31	~2418.69	2176.76
	next tall (sh/med)	243.08	.42	~2418.58	2175.50
	next short (dp/med)	241.92	.50	~2418.50	2176.58
	short (deep)	240.51	.64	~2418.36	2177.85
BR-4		264.51	.27	2377.20	2112.69
SW Wells (SE Mon Well)		396.75		2582.82	2186.07

**Indian Wells Valley Groundwater Project  
Depth to Water Measurements**

All measurements on Sept 30 and Oct 1, 1992, by Dennis Watt using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer	Depth to Water	TOC to TOP	Comments	
BR-3	medium	(shal)	.43	Confirmed short s/u is deep piezo w/NACC thief sampler. Deep EC=11,450	
	tall	(med)	.39		
	short	(deep)	.64		
BR-1	tall	(shal)	185.39	.12	Sept 30.
	next tall	(sh/med)	183.04	.25	
	next short	(dp/med)	187.79	.36	
	short	(deep)	195.73	.39	
BR-2	tall (blue)	(shal)		.20	Re-sound bottoms
	(yellow)	(med)		.40	
	(red)	(deep)		.42	
BR-5	tall	(shal)	335.30	.19	Oct 1
	medium	(med)	342.39	.41	
	short	(deep)	344.08	.64	
BR-10	tall	(shal)	308.43	.25	
	next tall	(sh/med)	321.76	.42	
	next short	(dp/med)	362.14	.54	
	short	(deep)	363.95	.68	
BR-6	tall	(shal)	163.95	.38	
	medium	(med)	165.00	.70	
	short	(deep)	149.35	1.08	
NR-2	tall	(shal)		.32	
	medium	(med)		.59	
	short	(deep)		.79	
NR-1	(red)	(shal)		.91	Valve top = TOP
	(yellow)	(med)		.33	
	(white)	(deep)		.93	
MW-32	tall	(shal)		.31	
	next tall	(sh/med)		.42	
	next short	(dp/med)		.50	
	short	(deep)		.64	
BR-4				.27	

Sept 30, 1992.

SW Wells	Mon #1 [E]	Wood? at ~ 341'	Muted thud sound
	Mon #2 [SE]	396.93	
	Prod Well	373.85	TOP (2" pipe)
	Mon #3 [S]	201.82	

April 7, 1989

(from Tom Field, Krieger and Stewart)

SW Wells	Mon #1	365.9	TOC
	Mon #2	392.4	"
	Mon #3	196.2	"

**Indian Wells Valley Groundwater Project  
Depth to Water Measurements**

All measurements on January 5, 1993, by Dennis Watt using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer	Depth to Water	TOC to TOP	Comments
BR-3	medium (shal)		.43	
	tall (med)		.39	NACC test w/thief
	short (deep)	319.2?	.64	tall = med piezo
BR-1	tall (shal)	185.38	.12	
	next tall (sh/med)	183.38	.25	
	next short (dp/med)	188.18	.36	
	short (deep)	196.27	.39	
BR-2	tall (blue) (shal)	276.14	.20	
	(red) (med)	272.48	.40	
	(yellow) (deep)	281.68	.42	
BR-5	tall (shal)	335.43	.19	
	medium (med)	342.15	.41	
	short (deep)	343.73	.64	
BR-10	tall (shal)	307.70	.25	
	next tall (sh/med)	322.80	.42	
	next short (dp/med)	362.15	.54	
	short (deep)	363.87	.68	
BR-6	tall (shal)	163.08	.38	
	medium (med)	164.85	.70	
	short (deep)	149.63	1.08	
NR-2	tall (shal)	132.68	.32	
	medium (med)	140.81	.59	
	short (deep)	139.22	.79	
NR-1	(red) (shal)	95.21	.91	
	(yellow) (med)	68.61	.33	Valve top = TOP
	(white) (deep)	101.44	.93	
MW-32	tall (shal)	241.77	.31	
	next tall (sh/med)	241.98	.42	
	next short (dp/med)	241.44	.50	
	short (deep)	240.55	.64	
BR-4		250.00	.27	

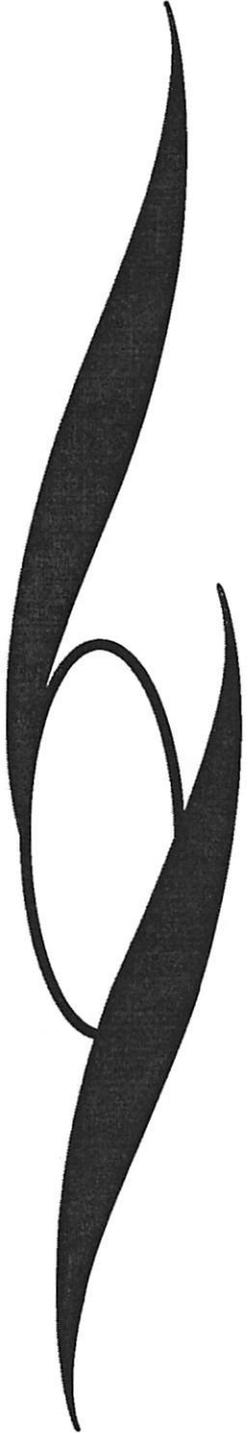
SW Wells	Mon #1 [E]	Wood block at ~ 341'
	Mon #2 [SE]	397.20
	Prod Well	
	Mon #3 [S]	201.96

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# APPENDIX XI

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Slug Test Data



BR-1 Shallow

SE2000  
Environmental Logger  
06/24 18:37

Unit# WATER:AD Test 7

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	BR:1SHAL
Reference	183.380
S6	1.000
Linearity	0.014
Scale factor	13.486
Offset	0.026
Delay mSEC	50.000

Step 0 06/24 18:20:23

Elapsed Time	INPUT 1
0.0000	183.857
0.0003	183.857
0.0166	183.897
0.0250	193.217
0.0333	202.555
0.0416	200.638
0.0500	200.422
0.0583	200.120
0.0666	198.756
0.0750	198.193
0.0833	197.392
0.1000	195.553
0.1166	194.227
0.1333	193.106
0.1500	192.164
0.1666	191.418
0.1833	190.802
0.2000	190.334
0.2166	189.872
0.2333	189.466
0.2500	189.115
0.2666	188.733
0.2833	188.406
0.3000	188.148
0.3166	187.901
0.3333	187.624
0.4166	186.620
0.5000	185.807
0.5833	185.302
0.6666	185.031
0.7500	184.803
0.8333	184.723
0.9166	184.741
1.0000	184.735
1.0833	184.667
1.1666	184.679
1.2500	184.661
1.3333	184.618
1.4166	184.636
1.5000	184.636
1.5833	184.630
1.6666	184.630
1.7500	184.624
1.8333	184.618
1.9166	184.605
2.0000	184.587
2.0833	184.583
2.1666	184.585
2.2500	184.575
2.3333	184.569
2.4166	184.569
2.5000	184.562
2.5833	184.559
2.6666	184.550
2.7500	184.552
2.8333	184.544
2.9166	184.556
3.0000	184.556
3.0833	184.550
3.1666	184.550
3.2500	184.544
3.3333	184.544
3.4166	184.538
3.5000	184.532
3.5833	184.544
3.6666	184.544
3.7500	184.544
3.8333	184.538
3.9166	184.532
4.0000	184.532
4.0833	184.532
4.1666	184.532
4.2500	184.532
4.3333	184.532
4.4166	184.532
4.5000	184.532
4.5833	184.532
4.6666	184.532
4.7500	184.532
4.8333	184.532
4.9166	184.532
5.0000	184.532
5.0833	184.532
5.1666	184.532
5.2500	184.532
5.3333	184.532
5.4166	184.532
5.5000	184.532
5.5833	184.532
5.6666	184.532
5.7500	184.532
5.8333	184.532
5.9166	184.532
6.0000	184.532

END

BR-1 Shal/Med

SE2000  
Environmental Logger  
06/24 17:42

Unit# WATER:AD Test 6

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	BR:1SMED
Reference	177.150
S6	1.000
Linearity	0.014
Scale factor	13.486
Offset	0.026
Delay mSEC	50.000

Step 0 06/24 17:22:21

Elapsed Time	INPUT 1
0.0000	177.150
0.0003	177.150
0.0166	177.150
0.0250	190.209
0.0333	195.130
0.0416	194.354
0.0500	193.498
0.0583	193.670
0.0666	192.931
0.0750	192.151
0.0833	191.767
0.1000	190.166
0.1166	188.860
0.1333	187.370
0.1500	186.082
0.1666	184.807
0.1833	183.711
0.2000	182.608
0.2166	181.613
0.2333	181.062
0.2500	180.336
0.2666	179.657
0.2833	179.398
0.3000	179.053
0.3166	178.745
0.3333	178.530
0.4166	178.006
0.5000	177.987
0.5833	178.000
0.6666	177.944
0.7500	177.852
0.8333	177.772
0.9166	177.673
1.0000	177.630
1.0833	177.559
1.1666	177.558
1.2500	177.544
1.3333	177.519
1.4166	177.501
1.5000	177.482
1.5833	177.464
1.6666	177.445
1.7500	177.433
1.8333	177.414
1.9166	177.414
2.0000	177.402
2.0833	177.347
2.1666	177.322
2.2500	177.322
2.3333	177.297
2.4166	177.279
2.5000	177.273
2.5833	177.257
2.6666	177.250
2.7500	177.248
2.8333	177.248
2.9166	177.254
3.0000	177.236
3.0833	177.242
3.1666	177.242
3.2500	177.236
3.3333	177.236
3.4166	177.236
3.5000	177.230
3.5833	177.230
3.6666	177.217
3.7500	177.230
3.8333	177.211
3.9166	177.211
4.0000	177.211

END

BR-1 Deep/Med

BR-1 Deep

Setups:	INPUT 1
Type	Level (F)
Mode	TGC
I.D.	BR:IDMED
Reference	183.830
SS	1.000
Linearity	0.014
Scale factor	19.486
Offset	0.026
Delay mSEC	50.000

Setups:	INPUT 1
Type	Level (F)
Mode	TGC
I.D.	BR:IDEEP
Reference	210.000
SS	1.000
Linearity	0.014
Scale factor	19.486
Offset	0.026
Delay mSEC	50.000

Step 0 05/24 16:18:43

Step 0 06/24 14:23:36

Elapsed Time	INPUT 1	
0.0000	183.514	
0.0083	183.514	
0.0166	183.514	
0.0250	183.525	
0.0333	199.870	
0.0416	198.020	
0.0500	200.000	
0.0583	199.236	
0.0666	198.959	
0.0750	199.193	15.421
0.0833	198.700	
0.1000	198.602	14.99
0.1166	198.263	
0.1333	198.029	14.317
0.1500	197.819	
0.1666	197.585	13.973
0.1833	197.376	
0.2000	197.142	13.43
0.2166	196.945	
0.2333	196.735	13.023
0.2500	196.544	
0.2666	196.341	12.629
0.2833	196.163	
0.3000	195.978	12.206
0.3166	195.799	
0.3333	195.600	11.876
0.4166	194.783	
0.5000	194.050	10.326
0.5833	193.335	
0.6666	192.726	9.014
0.7500	192.171	
0.8333	191.572	7.96
0.9166	191.186	
1.0000	190.754	7.042
1.0833	190.360	
1.1666	189.990	6.178
1.2500	189.639	
1.3333	189.362	5.65
1.4166	189.054	
1.5000	188.789	5.077
1.5833	188.530	
1.6666	188.303	4.591
1.7500	188.081	
1.8333	187.896	4.194
1.9166	187.711	
1.925	187.532	3.82
2.0000	186.595	
2.125	186.140	2.428
2.2500	185.758	
2.375	185.468	1.756
2.5000	185.247	
2.625	185.080	1.369
2.7500	184.932	
2.875	184.809	1.097
3.0000	184.784	
3.125	184.624	.912
3.2500	184.532	
3.375	184.476	.764
3.5000	184.396	
3.625	184.347	.635
3.7500	184.279	
3.875	184.230	.512
4.0000	184.070	
4.125	183.959	.247
4.2500	183.873	
4.375	183.811	.097
4.5000	183.768	
4.625	183.743	.031
4.7500	183.712	0
END		

Elapsed Time	INPUT 1	
0.0000	210.147	
0.0083	210.147	
0.0166	210.147	
0.0250	218.651	
0.0333	226.599	
0.0416	224.956	
0.0500	225.207	
0.0583	225.207	
0.0666	224.043	
0.0750	225.090	14.526
0.0833	224.831	
0.1000	224.825	14.371
0.1166	224.665	
0.1333	224.640	14.086
0.1500	224.609	
0.1666	224.566	14.012
0.1833	224.486	
0.2000	224.387	13.929
0.2166	224.338	
0.2333	224.264	13.71
0.2500	224.215	
0.2666	224.159	13.605
0.2833	224.098	
0.3000	224.042	13.488
0.3166	223.981	
0.3333	223.919	13.365
0.4166	223.642	
0.5000	223.365	12.931
0.5833	223.112	
0.6666	222.860	12.306
0.7500	222.625	
0.8333	222.385	11.921
0.9166	222.163	
1.0000	221.940	11.794
1.0833	221.738	
1.1666	221.535	10.991
1.2500	221.338	
1.3333	221.147	10.593
1.4166	220.950	
1.5000	220.777	10.323
1.5833	220.598	
1.6666	220.426	7.972
1.7500	220.253	
1.8333	220.106	7.452
1.9166	219.952	
1.925	219.791	9.277
2.0000	218.635	
2.125	218.159	7.605
2.2500	217.462	
2.375	216.871	6.217
2.5000	216.347	
2.625	215.854	5.3
2.7500	215.423	
2.875	215.022	4.469
3.0000	214.659	
3.125	214.332	3.778
3.2500	214.018	
3.375	213.740	3.186
3.5000	213.475	
3.625	213.241	2.697
3.7500	213.019	
3.875	212.828	2.274
4.0000	212.144	
4.125	211.688	1.134
4.2500	211.352	
4.375	211.115	.561
4.5000	210.949	
4.625	210.832	.278
4.7500	210.739	
4.875	210.665	.111
5.0000	210.622	
5.125	210.585	.031
5.2500	210.554	0
END		

BR-2 Shallow

BR-2 Medium

SE2000  
Environmental Logger  
05/31 09:34

SE2000  
Environmental Logger  
05/29 17:22

Unit# SE2000 Test 5  
Setup# 10001 (S)

Unit# SE2000 Test 6

Mode TOC  
I.D. BR2BLUE  
Reference 275.000  
SG 1.000  
Linearity 0.000  
Scale factor 10.041  
Offset -0.023  
Delay mSEC 50.000

Setups: INPUT 1  
Type Level (F)  
Mode TOC  
I.D. BR2YELLOW

Reference 100.000  
SG 1.000  
Linearity 0.000  
Scale factor 10.041  
Offset -0.023  
Delay mSEC 50.000

Step 0 05/31 09:27:35

Step 0 05/29 16:50:13

Elapsed Time INPUT 1

Elapsed Time INPUT 1

0.0000	276.773	
0.0083	276.055	
0.0166	275.590	
0.0250	275.409	
0.0333	275.342	
0.0416	275.320	
0.0500	275.234	
0.0583	275.180	
0.0666	275.069	
0.0750	274.923	
0.0833	274.990	
0.1000	274.828	
0.1166	274.730	
0.1333	274.603	
0.1500	274.457	
0.1666	274.295	
0.1833	274.225	
0.2000	274.137	
0.2166	273.918	
0.2333	273.981	
0.2500	274.003	
0.2666	273.940	
0.2833	274.000	
0.3000	274.003	
0.3166	274.143	
0.3333	274.162	
0.4166	274.324	2.304
0.5000	274.533	2.100
0.5833	274.765	2.864
0.6666	274.911	2.722
0.7500	275.057	2.576
0.8333	275.158	2.475
0.9166	275.265	2.367
1.0000	275.250	2.233
1.0833	275.342	2.091
1.1666	275.440	2.149
1.2500	275.494	2.034
1.3333	275.507	1.926
1.4166	275.320	2.913
1.5000	275.450	2.112
1.5833	275.536	2.017
1.6666	275.599	2.014
1.7500	275.675	1.952
1.8333	275.640	1.995
1.9166	275.723	1.910
2.0000	275.793	1.840
2.0833	276.395	1.222
3.0000	276.798	.935
3.0833	277.090	.543
4.0000	277.382	.251
4.0833	277.633	0

END

0.0000	99.384		
0.0083	110.276		
0.0166	116.113		
0.0250	115.814		16.326
0.0333	115.809		
0.0416	116.224		15.736
0.0500	115.485		
0.0583	115.409		14.921
0.0666	114.930		
0.0750	114.508		14.02
0.0833	114.149		
0.1000	113.178		12.64
0.1166	112.090		
0.1333	111.015		10.527
0.1500	109.959		
0.1666	108.873		8.325
0.1833	107.890		
0.2000	106.954	97.05	6.466
0.2166	106.075	93.98	
0.2333	105.295	90.91	4.27
0.2500	104.559	87.84	
0.2666	103.918	84.78	2.42
0.2833	103.353	81.65	
0.3000	102.845	78.46	2.257
0.3166	102.395	75.21	
0.3333	102.030	71.97	1.542
0.4166	100.926	67.67	
0.5000	100.501	63.5	0.02
0.5833	100.488	61.1	0
0.6666	100.567		
0.7500	100.618		
0.8333	100.571		
0.9166	100.488		
1.0000	100.395		
1.0833	100.317		
1.1666	100.234		
1.2500	100.187		
1.3333	100.152		
1.4166	100.111		
1.5000	100.098		
1.5833	100.069		
1.6666	100.050		
1.7500	100.031		
1.8333	100.003		
1.9166	99.993		
2.0000	99.965		
2.5000	100.019		
3.0000	100.003		
3.5000	99.987		
4.0000	99.968		
4.5000	99.949		
5.0000	100.000		
5.5000	99.895		
6.0000	99.873		
6.5000	99.854		
7.0000	99.838		

END

BR-2 Deep

SE2000  
Environmental Logger  
05/31 10:14

Unit# SE2000 Test 7

Setups: INPUT 1  
Type Level (F)  
Mode TOC  
I.D. BR2RED  
Reference 272.000  
SG 1.000  
Linearity 0.000  
Scale factor 10.041  
Offset -0.023  
Delay mSEC 50.000

Step 0 05/31 10:05:50

Elapsed Time	INPUT 1	
0.0000	272.117	
0.0083	271.178	
0.0166	270.553	
0.0250	270.185	
0.0333	269.966	
0.0416	269.848	
0.0500	269.722	
0.0583	269.620	
0.0666	269.595	
0.0750	269.506	
0.0833	269.407	
0.1000	269.312	
0.1166	269.214	
0.1333	269.122	
0.1500	269.046	
0.1666	268.989	
0.1833	268.884	
0.2000	268.786	
0.2166	268.735	
0.2333	268.729	
0.2500	268.640	
0.2666	268.570	
0.2833	268.586	
0.3000	268.545	
0.3166	268.529	
0.3333	268.513	
0.4166	268.827	
0.5000	269.881	2.919
0.5833	269.274	2.726
0.6666	269.401	2.571
0.7500	269.480	2.320
0.8333	269.598	2.142
0.9166	269.687	2.012
1.0000	269.826	2.174
1.0833	269.880	2.110
1.1666	269.934	2.066
1.2500	269.985	2.015
1.3333	270.086	1.914
1.4166	270.102	1.812
1.5000	270.125	1.715
1.5833	270.156	1.644
1.6666	270.191	1.509
1.7500	270.191	1.404
1.8333	270.220	1.78
1.9166	270.210	1.79
2.0000	270.293	1.707
2.5000	270.832	1.168
3.0000	271.124	.876
3.5000	271.371	.639
4.0000	271.533	.467
4.5000	271.695	.305
5.0000	271.803	.197
5.5000	271.882	.118
6.0000	272.000	0
6.5000	272.079	
7.0000	272.161	
7.5000	271.838	
8.0000	271.698	

END

BR-3 Shallow

SE2000  
Environmental Logger  
06/26 09:22

Unit# WATER:AD Test 2

Setups: INPUT 1  
Type Level (F)  
Mode TOC  
I.D. BR:3066 SHAL  
Reference 326.200  
SG 1.000  
Linearity 0.000  
Scale factor 10.003  
Offset -0.020  
Delay mSEC 50.000

Step 0 06/26 09:15:06

Elapsed Time	INPUT 1	
0.0000	326.200	
0.0083	326.200	
0.0166	326.200	
0.0250	327.965	
0.0333	335.866	
0.0416	336.580	12.39
0.0500	337.951	
0.0583	336.861	10.451
0.0666	336.721	
0.0750	335.523	7.323
0.0833	335.814	
0.1000	333.696	7.496
0.1166	332.922	
0.1333	332.410	6.21
0.1500	332.809	
0.1666	331.677	5.177
0.1833	331.392	
0.2000	331.121	4.921
0.2166	330.849	
0.2333	330.583	4.353
0.2500	330.330	
0.2666	330.097	3.997
0.2833	329.865	
0.3000	329.654	3.454
0.3166	329.445	
0.3333	329.253	2.053
0.4166	328.393	
0.5000	327.654	1.494
0.5833	327.141	
0.6666	326.782	.572
0.7500	326.354	
0.8333	326.200	0
0.9166	326.200	
1.0000	326.200	
1.0833	326.200	
1.1666	326.200	
1.2500	326.200	
1.3333	326.200	
1.4166	326.200	
1.5000	326.200	
1.5833	326.200	
1.6666	326.200	
1.7500	326.200	
1.8333	326.200	
1.9166	326.200	
2.0000	326.200	
2.5000	326.200	
3.0000	326.200	
3.5000	326.200	
4.0000	326.200	
4.5000	326.200	
5.0000	326.200	
5.5000	326.200	
6.0000	326.200	
6.5000	326.200	

END

BR-3 Deep

BR-3 Medium

SE2000  
Environmental Logger  
06/26 11:57

Elapsed Time	INPUT 1
0.0000	325.745
0.0083	325.745
0.0166	336.201
0.0250	341.122
0.0333	341.204
0.0416	340.534
0.0500	341.251
0.0583	340.696
0.0666	340.573
0.0750	340.945
0.0833	340.799
0.0916	340.825
0.1000	340.500
0.1083	340.916
0.1166	340.894
0.1250	340.872
0.1333	340.669
0.1416	340.572
0.1500	340.872
0.1583	340.669
0.1666	340.666
0.1750	340.859
0.1833	340.859
0.1916	340.855
0.2000	340.855
0.2083	340.855
0.2166	340.855
0.2250	340.847
0.2333	340.843
0.2416	340.840
0.2500	340.837
0.2583	340.657
0.2666	340.834
0.2750	340.834
0.2833	340.834
0.2916	340.834
0.3000	340.831
0.3083	340.828
0.3166	340.825
0.3250	340.825
0.3333	340.821
0.3416	340.821
0.3500	340.818
0.3583	340.818
0.3666	340.815
0.3750	340.815
0.3833	340.815
0.3916	340.809
0.4000	340.802
0.4083	340.799
0.4166	340.795
0.4250	340.793
0.4333	340.793
0.4416	340.790
0.4500	340.787
0.4583	340.787
0.4666	340.783
0.4750	340.780
0.4833	340.777
0.4916	340.777
0.5000	340.774
0.5083	340.774
0.5166	340.771
0.5250	340.771
0.5333	340.771
0.5416	340.768
0.5500	340.768
0.5583	340.768
0.5666	340.768
0.5750	340.768
0.5833	340.761
0.5916	340.761
0.6000	340.764
0.6083	340.758
0.6166	340.758
0.6250	340.758
0.6333	340.758
0.6416	340.755
0.6500	340.745
0.6583	340.749
0.6666	340.745
0.6750	340.745
0.6833	340.745
0.6916	340.745
0.7000	340.745
0.7083	340.739
0.7166	340.742
0.7250	340.742

END

Unit# WATER:AD Test 4

Setup:	INPUT 1
Type	Level (F)
Mode	TGC
I.D.	BR:3DEEP
Reference	307.000
56	1.000
Linearity	0.000
Scale Factor	10.005
Offset	-0.020
Delay #SEC	50.000

Step 0 06/26 11:22:05

Elapsed Time INPUT 1

0.0000	304.999	
0.0083	305.002	
0.0166	305.002	
0.0250	314.452	
0.0333	320.552	
0.0416	321.785	
0.0500	320.682	
0.0583	321.235	
0.0666	320.869	
0.0750	320.795	
0.0833	321.023	2.456
0.1000	320.655	
0.1166	320.723	12.156
0.1333	320.694	
0.1500	320.704	12.137
0.1666	320.675	
0.1833	320.510	12.051
0.2000	320.571	
0.2166	320.533	1.054
0.2333	320.498	
0.2500	320.464	11.977
0.2666	320.426	
0.2833	320.382	11.911
0.3000	320.353	
0.3166	320.315	11.712
0.3333	320.280	
0.4166	320.103	11.534
0.5000	319.333	
0.5833	319.760	11.221
0.6666	319.604	
0.7500	319.443	11.176
0.8333	319.288	
0.9166	319.133	10.561
1.0000	318.501	
1.0833	318.833	10.260
1.1666	318.684	
1.2500	318.539	9.970
1.3333	318.397	
1.4166	318.254	9.637
1.5000	318.118	
1.5833	317.976	9.407
1.6666	317.840	
1.7500	317.700	9.141
1.8333	317.572	
1.9166	317.442	8.875
2.0000	317.312	
2.0833	316.532	7.965
2.1666	315.630	
2.2500	315.182	6.615
2.3333	314.580	
2.4166	314.044	5.477
2.5000	313.551	
2.5833	313.103	4.536
2.6666	312.652	
2.7500	312.319	3.762
2.8333	311.974	
2.9166	311.658	3.071
3.0000	311.357	
3.0833	311.102	2.535
3.1666	310.852	
3.2500	310.640	2.073
3.3333	310.441	
3.4166	309.771	1.204
3.5000	309.323	
3.5833	309.035	1.463
3.6666	308.848	
3.7500	308.728	1.161
3.8333	308.652	
3.9166	308.615	0.948
4.0000	308.555	
4.0833	308.589	0.022
4.1666	308.580	
4.2500	308.577	0.01
4.3333	308.557	0

END

BR-4

SE2000  
Environmental Logger  
06/25 11:35

Unit# WATER:AD Test 9

Setups:		INPUT 1
Type	Level (F)	
Mode	TOC	
I.D.	BR:40R16	
Reference	253.800	
SS	1.000	
Linearity	0.014	
Scale factor	15.486	
Offset	0.026	
Delay mSEC	50.000	

Step 0 06/25 11:18:48

Elapsed Time	INPUT 1	
0.0000	254.029	
0.0083	254.029	
0.0166	254.029	
0.0250	268.500	
0.0333	272.146	
0.0416	270.551	H
0.0500	277.000	17.52
0.0583	270.015	
0.0666	269.688	16.124
0.0750	268.851	
0.0833	268.376	14.716
0.1000	266.837	
0.1166	265.186	11.646
0.1333	263.671	
0.1500	262.285	8.726
0.1666	260.868	
0.1833	259.759	6.199
0.2000	258.735	
0.2166	257.793	4.233
0.2333	257.029	
0.2500	256.358	2.790
0.2666	255.760	
0.2833	255.280	1.70
0.3000	254.867	
0.3166	254.516	0.705
0.3333	254.244	
0.4166	253.860	
0.5000	253.591	
0.5833	253.869	
0.6666	254.103	
0.7500	254.189	
0.8333	254.152	
0.9166	254.066	
1.0000	253.998	
1.0833	253.967	
1.1666	253.980	
1.2500	253.998	
1.3333	254.016	
1.4166	254.023	
1.5000	254.016	
1.5833	254.010	
1.6666	254.004	
1.7500	253.998	
1.8333	254.004	
1.9166	254.004	
2.0000	254.004	
2.5000	253.998	
3.0000	254.004	
3.5000	253.998	
4.0000	253.998	
4.5000	254.004	
5.0000	254.004	
5.5000	254.004	
6.0000	254.004	
6.5000	254.004	
7.0000	254.004	
7.5000	254.004	
8.0000	254.004	
8.5000	254.004	
9.0000	254.004	
9.5000	254.004	
10.0000	254.004	
12.0000	254.004	
14.0000	254.004	
16.0000	254.004	

END

BR-5 Shallow

SE2000  
Environmental Logger  
02/12 12:07

Unit# SE-2000 Test 9

Setups:		INPUT 1
Type	Level (F)	
Mode	TOC	
I.D.		
Reference	334.000	
SS	1.000	
Linearity	0.013	
Scale factor	10.508	
Offset	0.020	
Delay mSEC	50.000	

Step 0 02/12 11:55:23

Elapsed Time	INPUT 1	
0.0000	333.967	
0.0083	333.967	
0.0166	333.967	
0.0250	344.498	
0.0333	349.169	
0.0416	349.935	10.63
0.0500	348.530	
0.0583	348.255	14.43
0.0666	347.729	
0.0750	346.635	12.53
0.0833	346.167	
0.0916	344.576	10.47
0.1000	343.259	
0.1083	342.349	8.25
0.1166	341.465	
0.1250	340.808	6.69
0.1333	340.251	
0.1416	339.808	5.70
0.1500	339.381	
0.1583	338.966	4.16
0.1666	338.588	
0.1750	338.216	4.11
0.1833	337.870	
0.1916	337.547	3.44
0.2000	337.253	
0.2083	336.979	2.88
0.2166	336.724	
0.2250	336.484	1.74
0.2333	336.245	
0.2416	334.780	4.40
0.2500	334.505	
0.2583	334.355	1.8
0.2666	334.287	
0.2750	334.257	1.5
0.2833	334.251	
0.2916	334.244	1.4
0.3000	334.244	
0.3083	334.241	
0.3166	334.238	
0.3250	334.238	
0.3333	334.235	1.13
0.3416	334.231	
0.3500	334.228	
0.3583	334.225	
0.3666	334.225	
0.3750	334.221	
0.3833	334.218	1.11
0.3916	334.199	
0.4000	334.179	
0.4083	334.169	
0.4166	334.159	1.06
0.4250	334.153	
0.4333	334.150	
0.4416	334.138	
0.4500	334.120	1.02
0.4583	334.117	
0.4666	334.114	
0.4750	334.114	
0.4833	334.110	0
0.4916	334.110	
0.5000	334.110	
0.5083	334.107	
0.5166	334.104	

END

BR-5 Medium

SE2000  
Environmental Logger  
02/12 10:55

Unit# SE-2000 Test 8

Setup#	INPUT 1
Type	Level (F)
Mode	TOC
I.O.	
Reference	334.000
56	1.000
Linearity	0.013
Scale factor	10.308
Offset	0.020
Delay nSEC	50.000

Step 0 02/12 10:40:49

Elapsed Time	INPUT 1	
0.0000	334.254	
0.0083	334.254	
0.0166	340.834	
0.0250	346.755	
0.0333	349.101	- 14.55
0.0416	348.521	
0.0500	347.925	- 13.37
0.0583	348.238	
0.0666	347.589	- 13.04
0.0750	347.270	
0.0833	347.058	- 12.57
0.1000	346.171	
0.1166	345.311	- 10.76
0.1333	344.577	
0.1500	343.837	- 9.27
0.1666	343.176	
0.1833	342.536	- 7.99
0.2000	341.956	
0.2166	341.415	- 6.86
0.2333	340.906	
0.2500	340.430	- 5.88
0.2666	340.000	
0.2833	339.601	- 6.05
0.3000	339.217	
0.3166	338.954	- 4.30
0.3333	338.512	
0.4166	337.233	- 2.67
0.5000	336.160	
0.5833	335.419	- .87
0.6666	334.943	
0.7500	334.669	- .12
0.8333	334.541	
0.9166	334.512	- .04
1.0000	334.531	
1.0833	334.567	- +.02
1.1666	334.600	
1.2500	334.613	- +.06
1.3333	334.613	
1.4166	334.603	- +.05
1.5000	334.587	
1.5833	334.580	- .03
1.6666	334.574	
1.7500	334.574	- .02
1.8333	334.577	
1.9166	334.577	- .02
2.0000	334.577	
2.5000	334.571	
3.0000	334.567	
3.5000	334.567	
4.0000	334.564	
4.5000	334.561	
5.0000	334.561	
5.5000	334.559	
6.0000	334.554	
6.5000	334.554	
7.0000	334.554	
7.5000	334.554	
8.0000	334.554	
8.5000	334.554	
9.0000	334.554	
9.5000	334.554	
10.0000	334.554	
11.0000	334.551	
12.0000	334.551	
13.0000	334.551	
14.0000	334.551	
15.0000	334.551	

END

BR-5 Deep

SE2000  
Environmental Logger  
02/12 11:36

Unit# SE-2000 Test 9

Setup#	INPUT 1
Type	Level (F)
Mode	TOC
I.O.	
Reference	340.000
56	1.000
Linearity	0.013
Scale factor	10.306
Offset	0.020
Delay nSEC	50.000

Step 0 02/12 11:24:42

Elapsed Time	INPUT 1	
0.0000	340.319	
0.0083	340.319	
0.0166	340.326	
0.0250	340.868	
0.0333	354.656	
0.0416	355.467	14.17
0.0500	355.529	17.33
0.0583	355.317	17.02
0.0666	355.463	17.16 ?
0.0750	354.782	16.78
0.0833	354.532	16.23
0.1000	353.609	15.31
0.1166	352.749	14.45
0.1333	351.664	13.39
0.1500	350.478	12.18
0.1666	349.347	11.05
0.1833	348.212	9.93
0.2000	347.060	8.77
0.2166	345.982	7.68
0.2333	344.956	6.66
0.2500	344.019	5.72
0.2666	343.125	4.83
0.2833	342.332	4.03
0.3000	341.511	3.31
0.3166	340.956	2.66
0.3333	340.394	2.10
0.4166	338.717	.92
0.5000	338.299	0
0.5833	338.093	
0.6666	339.921	
0.7500	340.830	
0.8333	341.311	
0.9166	341.321	
1.0000	341.044	
1.0833	340.661	
1.1666	340.381	
1.2500	340.212	
1.3333	340.176	
1.4166	340.238	
1.5000	340.339	
1.5833	340.427	
1.6666	340.473	
1.7500	340.476	
1.8333	340.450	
1.9166	340.417	
2.0000	340.395	
2.5000	340.378	
3.0000	340.365	
3.5000	340.362	
4.0000	340.355	
4.5000	340.352	
5.0000	340.349	
5.5000	340.349	
6.0000	340.345	
6.5000	340.342	
7.0000	340.342	
7.5000	340.338	
8.0000	340.335	
8.5000	340.339	
9.0000	340.336	
9.5000	340.336	
10.0000	340.332	
11.0000	340.329	

END

*Unlabeled*

BR-6 Shallow

SE2000  
Environmental Logger  
02/11 14:14

Unit# SE-2000 Test 3

Elapsed Time	INPUT 1	
0.0000	140.557	
0.0083	140.557	
0.0166	140.554	
0.0250	140.557	
0.0333	162.776	13.70
0.0416	162.199	
0.0500	162.470	13.40
0.0583	161.577	
0.0666	160.154	11.07
0.0750	159.304	
0.0833	158.601	9.52
0.1000	157.332	
0.1166	156.605	7.20
0.1333	156.211	
0.1500	155.948	6.87
0.1666	155.718	
0.1833	155.502	6.42
0.2000	155.244	
0.2166	154.991	5.91
0.2333	154.781	
0.2500	154.603	5.52
0.2666	154.430	
0.2833	154.268	5.21
0.3000	154.171	
0.3166	154.036	4.96
0.3333	153.919	
0.4166	153.475	4.39
0.5000	153.105	
0.5833	152.803	3.72
0.6666	152.551	
0.7500	152.335	3.27
0.8333	152.132	
0.9166	151.941	2.76
1.0000	151.750	
1.0833	151.577	
1.1666	151.423	
1.2500	151.275	
1.3333	151.133	
1.4166	151.004	
1.5000	150.893	
1.5833	150.770	1.69
1.6666	150.647	
1.7500	150.529	
1.8333	150.425	
1.9166	150.338	
2.0000	150.265	1.18
2.0833	149.815	
2.1666	149.525	0.49
2.2500	149.345	
2.3333	149.241	0.16
2.4166	149.161	
2.5000	149.118	0.04
2.5833	149.105	
2.6666	149.081	0
2.7500	149.087	
2.8333	149.081	
2.9166	149.108	
3.0000	149.087	
3.0833	149.094	
3.1666	149.105	
3.2500	149.118	
3.3333	149.105	
3.4166	149.118	
3.5000	149.124	
3.5833	149.124	
3.6666	149.105	
3.7500	149.112	
3.8333	149.124	
3.9166	149.131	
4.0000	149.137	
4.0833	149.118	
4.1666	149.118	
4.2500	149.131	
4.3333	149.131	
4.4166	149.137	
4.5000	149.124	
4.5833	149.124	
4.6666	149.137	
4.7500	149.137	
4.8333	149.137	
4.9166	149.137	
5.0000	149.137	

END

BR-6 Medium

SE2000  
Type Level (F)  
Mode TOC  
I.D.

Reference	150.000
SG	1.000
Linearity	0.014
Scale factor	19.496
Offset	0.025
Delay mSEC	50.000

Step 0 02/11 12:55:41

Elapsed Time	INPUT 1	
0.0000	150.086	
0.0083	150.086	
0.0166	150.073	
0.0250	163.709	
0.0333	167.250	
0.0416	167.614	18.43
0.0500	166.517	17.33
0.0583	165.760	16.57
0.0666	165.735	16.55?
0.0750	165.150	15.96
0.0833	164.386	15.20
0.1000	163.203	14.02
0.1166	161.602	12.92
0.1333	160.166	10.99
0.1500	158.066	9.08
0.1666	157.634	8.45
0.1833	156.451	7.27
0.2000	155.354	6.17
0.2166	154.430	5.24
0.2333	153.566	4.39
0.2500	152.810	3.62
0.2666	152.107	2.92
0.2833	151.491	2.31
0.3000	150.982	1.81
0.3166	150.566	1.38
0.3333	150.166	0.98
0.4166	149.217	0.03
0.5000	149.166	0
0.5833	149.716	
0.6666	150.283	
0.7500	150.591	
0.8333	150.573	
0.9166	150.369	
1.0000	150.154	
1.0833	150.030	
1.1666	150.030	
1.2500	150.096	
1.3333	150.166	
1.4166	150.203	
1.5000	150.197	
1.5833	150.172	
1.6666	150.141	
1.7500	150.123	
1.8333	150.123	
1.9166	150.129	
2.0000	150.135	
2.5000	150.117	
3.0000	150.098	
3.5000	150.117	
4.0000	150.092	
4.5000	150.110	
5.0000	150.086	
5.5000	150.098	
6.0000	150.098	
6.5000	150.086	
7.0000	150.098	
7.5000	150.092	
8.0000	150.086	
8.5000	150.092	
9.0000	150.086	
9.5000	150.086	
10.0000	150.092	
11.0000	150.092	

END

BR-6 Deep

SE2000  
Environmental Logger  
02/11 12:36

Unit# SE-2000 Test 1

Setup: INPUT 1  
Type Level (F)  
Mode TUC  
L.D.  
Reference 150.000  
Sb 1.000  
Linearity 0.014  
Scale Factor 19.406  
Offset 0.026  
Delay nSEC 50.000

Step 0 02/11 12:27:20

Elapsed Time	INPUT 1	
0.0000	150.055	
0.0083	150.049	
0.0166	150.043	
0.0250	150.036	
0.0333	154.995	
0.0416	166.210	
0.0500	167.331	18.07
0.0583	167.115	17.25
0.0666	166.302	17.04
0.0750	165.791	16.53
0.0833	165.471	16.21
0.0916	164.645	15.38
0.1000	163.493	14.23
0.1083	162.384	13.12
0.1166	161.115	11.25
0.1250	160.093	9.33
0.1333	158.891	7.42
0.1416	157.955	6.67
0.1500	156.883	7.62
0.1583	155.106	6.74
0.1666	155.164	5.70
0.1750	154.547	5.08
0.1833	153.759	4.49
0.1916	153.204	3.94
0.2000	152.582	3.32
0.2083	152.107	2.84
0.2166	150.412	1.15
0.2250	149.469	.20
0.2333	149.266	0
0.2416	149.494	
0.2500	149.907	
0.2583	150.265	
0.2666	150.431	
0.2750	150.394	
0.2833	150.221	
0.2916	150.024	
0.3000	149.876	
0.3083	149.833	
0.3166	149.870	
0.3250	149.963	
0.3333	150.049	
0.3416	150.092	
0.3500	150.061	
0.3583	150.018	
0.3666	149.991	
0.3750	150.012	
0.3833	150.006	
0.3916	149.987	
0.4000	150.000	
0.4083	149.987	
0.4166	150.000	
0.4250	149.993	
0.4333	150.006	
0.4416	150.006	
0.4500	150.006	

Undamped !

END

BR-10 Shallow

SE1000C  
Environmental Logger  
02/11 06:51

Unit# 00505 Test 1

Setup: INPUT 1  
Type Level (F)  
Mode TUC  
L.D.  
Reference 321.000  
Linearity 0.010  
Scale Factor 10.020  
Offset 0.020  
Delay nSEC 50.000

Step 0 02/11 06:48:03

Elapsed Time	INPUT 1	
0.0000	322.652	
0.0083	322.652	
0.0166	322.652	
0.0250	322.652	
0.0333	322.855	
0.0416	322.855	
0.0500	322.655	
0.0583	322.855	
0.0666	323.483	
0.0750	327.246	
0.0833	329.536	
0.0916	336.456	12.20
0.1000	334.903	
0.1083	333.003	8.91
0.1166	331.256	
0.1250	329.820	5.64
0.1333	328.653	
0.1416	327.620	3.63
0.1500	327.175	
0.1583	326.760	2.57
0.1666	326.505	
0.1750	326.353	2.16
0.1833	326.265	
0.1916	326.197	2.01
0.2000	326.142	
0.2083	326.076	1.89
0.2166	326.000	
0.2250	325.912	1.70
0.2333	325.814	
0.2416	325.322	1.13
0.2500	325.000	
0.2583	324.776	.82
0.2666	324.612	
0.2750	324.489	.31
0.2833	324.417	
0.2916	324.357	.14
0.3000	324.316	
0.3083	324.254	.09
0.3166	324.259	
0.3250	324.243	.05
0.3333	324.221	
0.3416	324.221	.03
0.3500	324.215	
0.3583	324.206	.02
0.3666	324.205	
0.3750	324.202	.01
0.3833	324.193	
0.3916	324.196	.003
0.4000	324.196	
0.4083	324.193	0
0.4166	324.193	
0.4250	324.193	
0.4333	324.196	
0.4416	324.196	
0.4500	324.202	
0.4583	324.205	
0.4666	324.205	
0.4750	324.205	
0.4833	324.212	
0.4916	324.215	
0.5000	324.215	
0.5083	324.218	
0.5166	324.218	
0.5250	324.221	
0.5333	324.224	
0.5416	324.224	
0.5500	324.227	

END

BR-10 Shal/Med

BR-10 Deep/Med

SE1000C  
Environmental Logger  
09/14 08:53

SE1000C  
Environmental Logger  
09/14 08:55

Unit# 00506 Test 2

Unit# 00506 Test 3

Setups:	INPUT i
Type	Level (F)
Mode	TUC
I.D.	00000
Reference	321.000
Linearity	0.010
Scale Factor	10.020
Offset	0.020
Delay msec	50.000

Setups:	INPUT i
Type	Level (F)
Mode	TUC
I.D.	00000
Reference	362.000
Linearity	0.010
Scale Factor	10.020
Offset	0.020
Delay msec	50.000

Step 0 09/11 09:46:31

Step 0 09/11 10:17:06

Elapsed Time	INPUT i	
0.0000	320.656	
0.0033	320.656	
0.0066	320.659	
0.0100	320.662	
0.0133	320.665	
0.0166	320.669	
0.0200	320.669	
0.0233	320.672	
0.0266	323.171	
0.0300	320.542	
0.0333	321.237	
0.0366	336.485	14.84
0.0400	335.634	
0.0433	334.547	12.90
0.0466	333.857	
0.0500	333.359	11.71
0.0533	332.902	
0.0566	332.549	11.00
0.0600	332.276	
0.0633	332.079	10.43
0.0666	331.899	
0.0700	331.691	10.04
0.0733	331.471	
0.0766	331.246	9.60
0.0800	331.004	
0.0833	330.771	9.12
0.0866	330.544	
0.0900	330.326	8.68
0.0933	330.121	
0.0966	329.194	7.54
0.1000	328.366	
0.1033	327.637	5.19
0.1066	326.990	
0.1100	326.410	4.76
0.1133	325.893	
0.1166	325.432	3.78
0.1200	325.025	
0.1233	324.659	2.01
0.1266	324.335	
0.1300	324.044	2.31
0.1333	323.789	
0.1366	323.559	1.91
0.1400	323.353	
0.1433	323.174	1.52
0.1466	323.013	
0.1500	322.866	1.22
0.1533	322.742	
0.1566	322.628	.98
0.1600	322.527	
0.1633	322.407	.46
0.1666	321.906	
0.1700	321.808	.16
0.1733	321.754	
0.1766	321.723	.07
0.1800	321.707	
0.1833	321.697	.05
0.1866	321.680	
0.1900	321.675	.03
0.1933	321.666	
0.1966	321.666	.01
0.2000	321.650	

END

Elapsed Time	INPUT i	
0.0000	362.636	
0.0033	362.035	
0.0066	362.635	
0.0100	362.035	
0.0133	362.635	
0.0166	362.035	
0.0200	362.035	
0.0233	362.047	
0.0266	366.857	
0.0300	369.251	
0.0333	371.502	
0.0366	376.144	13.54
0.0400	375.180	
0.0433	374.455	11.95
0.0466	374.042	
0.0500	373.306	10.81
0.0533	372.554	
0.0566	371.966	9.47
0.0600	371.357	
0.0633	370.756	8.26
0.0666	370.226	
0.0700	369.724	7.22
0.0733	369.241	
0.0766	368.757	6.30
0.0800	368.306	
0.0833	367.866	5.47
0.0866	367.517	
0.0900	367.274	4.77
0.0933	366.952	
0.0966	366.587	3.45
0.1000	366.226	
0.1033	365.885	1.96
0.1066	365.511	
0.1100	365.205	.70
0.1133	364.886	
0.1166	364.566	.37
0.1200	364.274	
0.1233	363.932	.23
0.1266	363.594	
0.1300	363.264	.16
0.1333	362.944	
0.1366	362.625	.12
0.1400	362.306	
0.1433	361.986	.10
0.1466	361.666	
0.1500	361.351	.02
0.1533	361.032	
0.1566	360.714	.07
0.1600	360.396	
0.1633	360.077	.03
0.1666	359.758	
0.1700	359.439	.01
0.1733	359.120	
0.1766	358.801	.01
0.1800	358.482	
0.1833	358.163	.01
0.1866	357.844	
0.1900	357.525	.01
0.1933	357.206	
0.1966	356.887	.01
0.2000	356.568	

END

BR-10 Deep  
SE1666C  
Environmental Logger  
05/14 08:56

Unit# 06506 Test 4

Setups: INPUT 1  
-----  
Type Level (F)  
Mode TOC  
I.D. 66660  
  
Reference 364.500  
Linearity 0.010  
Scale factor 10.020  
Offset 0.020  
Delay mSEC 50.000

Step 0 05/11 10:43:28

Elapsed Time	INPUT 1	
0.0000	363.664	
0.0033	363.664	
0.0066	363.667	
0.0100	363.667	
0.0133	363.667	
0.0166	363.670	
0.0200	363.670	
0.0233	363.674	
0.0266	363.660	
0.0300	365.112	
0.0333	378.250	
0.0366	378.435	12.12
0.0400	377.401	
0.0433	377.300	12.79
0.0466	378.386	
0.0500	378.223	11.61
0.0533	375.778	
0.0566	375.350	10.74
0.0600	374.845	
0.0633	374.442	9.73
0.0666	374.045	
0.0700	373.870	9.06
0.0733	373.256	
0.0766	372.560	8.25
0.0800	372.656	
0.0833	372.306	7.70
0.0866	372.005	
0.0900	371.715	7.10
0.0933	371.435	
0.0966	370.174	6.56
0.1000	369.146	
0.1033	368.313	6.70
0.1066	367.845	
0.1100	367.185	6.49
0.1133	365.673	
0.1166	365.330	6.72
0.1200	365.045	
0.1233	365.825	6.21
0.1266	365.642	
0.1300	365.451	6.88
0.1333	365.371	
0.1366	365.270	6.66
0.1400	365.166	
0.1433	365.118	6.58
0.1466	365.062	
0.1500	365.014	6.40
0.1533	364.970	
0.1566	364.935	6.32
0.1600	364.907	
0.1633	364.781	6.17
0.1666	364.716	
0.1700	364.660	6.07
0.1733	364.650	
0.1766	364.642	6.03
0.1800	364.633	
0.1833	364.623	6.01
0.1866	364.617	
0.1900	364.611	6.00

END

NR-1 Shallow  
SE2000  
Environmental Logger  
05/30 11:47

Unit# SE2000 Test 1

Setups: INPUT 2  
-----  
Type Level (F)  
Mode TOC  
I.D. NR1RED  
  
Reference 0.000  
SG 1.000  
Linearity 0.000  
Scale factor 16.000  
Offset 4.000  
Delay mSEC 50.000

Step 0 05/30 11:26:39

Elapsed Time	INPUT 2	
0.0000	-0.171	
0.0033	-0.192	
0.0066	-0.166	
0.0100	-0.192	
0.0133	-0.131	
0.0166	-0.237	
0.0200	-0.247	
0.0233	-0.080	
0.0266	-0.065	
0.0300	-0.075	
0.0333	0.035	
0.0366	-0.060	
0.0400	0.010	
0.0433	-0.010	
0.0466	0.030	
0.0500	0.060	
0.0533	-0.045	
0.0566	-0.121	
0.0600	-1.744	
0.0633	-3.412	
0.0666	-5.414	
0.0700	-5.075	
0.0733	-9.767	
0.0766	-8.275	
0.0800	-13.417	
0.0833	-13.765	
0.0866	-21.819	
0.0900	-25.337	
0.0933	-25.580	
0.0966	-25.721	
0.1000	-25.605	
0.1033	-25.555	
0.1066	-25.393	
0.1100	-25.130	
0.1133	-24.877	
0.1166	-24.442	
0.1200	-25.732	
0.1233	-25.807	
0.1266	-25.782	
0.1300	-25.830	6.451
0.1333	-25.767	6.270
0.1366	-25.681	6.294
0.1400	-25.534	6.127
0.1433	-25.373	6.070
0.1466	-25.256	6.020
0.1500	-25.145	6.040
0.1533	-24.225	6.120
0.1566	-24.700	6.200
0.1600	-24.033	6.030
0.1633	-23.477	6.090
0.1666	-23.163	6.040
0.1700	-22.309	6.012
0.1733	-21.809	6.911
0.1766	-21.308	6.421
0.1800	-20.818	6.439
0.1833	-20.236	6.344
0.1866	-19.741	6.414
0.1900	-19.311	6.515
0.1933	-18.832	6.420
0.1966	-18.517	6.441
0.2000	-18.138	6.420
0.2033	-17.800	6.657
0.2066	-17.056	6.264
0.2100	-15.661	6.264
0.2133	-14.337	6.264

END

NR-1 Deep

SE2000  
Environmental Logger  
05/29 10:19

Unit# SE2000 Test 2

Setup:	INPUT 1	INPUT 2
Type	Level (F)	Level (F)
Mode	TOC	TOC
I.D.	NR1WHITE	NR1RED
Reference	100.000	100.000
S6	1.000	1.000
Linearity	0.000	0.000
Scale factor	10.000	10.001
Offset	-0.020	-0.023
Delay mSEC	50.000	50.000

Step 0 05/29 10:10:19

Elapsed Time	INPUT 1	INPUT 2
0.0000	91.494	100.000
0.0083	91.494	100.000
0.0166	97.474	100.000
0.0250	107.364	100.000
0.0333	107.325	100.000
0.0416	107.345	100.000
0.0500	107.332	100.000
0.0583	107.310	100.000
0.0666	107.272	100.000
0.0750	107.225	100.000
0.0833	107.168	100.000
0.1000	107.044	100.000
0.1166	106.905	100.000
0.1333	106.754	100.000
0.1500	106.595	100.000
0.1666	106.431	100.000
0.1833	106.264	100.000
0.2000	106.095	100.000
0.2166	105.922	100.000
0.2333	105.755	100.000
0.2500	105.584	100.000
0.2666	105.414	100.000
0.2833	105.246	100.000
0.3000	105.082	100.000
0.3166	104.921	100.000
0.3333	104.763	100.000
0.4166	104.001	100.000
0.5000	103.305	100.000
0.5833	102.667	100.000
0.6666	102.073	100.000
0.7500	101.536	100.000
0.8333	101.051	100.000
0.9166	100.611	100.000
1.0000	100.303	100.000
1.0833	100.012	100.000
1.1666	99.775	100.000
1.2500	99.589	100.000
1.3333	99.446	100.000
1.4166	99.342	100.000
1.5000	99.273	100.000
1.5833	99.241	100.000
1.6666	99.235	100.000
1.7500	99.235	100.000
1.8333	99.238	100.000
1.9166	99.238	100.000
2.0000	99.238	100.000
2.5000	99.244	100.000
3.0000	99.250	100.000
3.5000	99.254	100.000
4.0000	99.254	100.000
4.5000	99.257	100.000
5.0000	99.257	100.000
5.5000	99.260	100.000
6.0000	99.263	100.000
6.5000	99.260	100.000
7.0000	99.260	100.000

END

NK-2 SHALLOW

SE2000  
Environmental Logger  
06/25 13:59

Unit# WATER:AD Test 0

Setup:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	NR:25HAL
Reference	132.330
S6	1.000
Linearity	0.014
Scale factor	19.486
Offset	0.026
Delay mSEC	50.000

Step 0 06/25 13:29:29

Elapsed Time	INPUT 1
0.0000	132.336
0.0083	132.336
0.0166	147.765
0.0250	146.781
0.0333	145.987
0.0416	144.934
0.0500	143.565
0.0583	141.762
0.0666	139.938
0.0750	138.183
0.0833	136.458
0.1000	133.630
0.1166	131.535
0.1333	130.111
0.1500	128.353
0.1666	129.156
0.1833	129.409
0.2000	129.954
0.2166	130.814
0.2333	131.726
0.2500	132.576
0.2666	133.266
0.2833	133.728
0.3000	133.944
0.3166	133.813
0.3333	133.691
0.4166	131.707
0.5000	131.892
0.5833	132.059
0.6666	132.422
0.7500	132.052
0.8333	132.416
0.9166	132.490
1.0000	132.262
1.0833	132.305
1.1666	132.410
1.2500	132.348
1.3333	132.311
1.4166	132.354
1.5000	132.360
1.5833	132.336
1.6666	132.342
1.7500	132.354
1.8333	132.342
1.9166	132.336
2.0000	132.342
2.5000	132.336
3.0000	132.336
3.5000	132.336
4.0000	132.336
4.5000	132.336
5.0000	132.336
5.5000	132.336
6.0000	132.336
6.5000	132.336
7.0000	132.336
7.5000	132.336
8.0000	132.336
8.5000	132.336
9.0000	132.336
9.5000	132.336
10.0000	132.336
12.0000	132.336
14.0000	132.330
16.0000	132.330
18.0000	132.330
20.0000	132.323
22.0000	132.330
24.0000	132.323
26.0000	132.323
28.0000	132.323

END

NR-1 Deep  
SE2000  
Environmental Logger  
05/29 10:19

Unit# SE2000 Test 2

Setup:	INPUT 1	INPUT 2
Type	Level (F)	Level (F)
Mode	TOC	TOC
I.D.	NR1WHITE	NR1RED
Reference	100.000	100.000
SG	1.000	1.000
Linearity	0.000	0.000
Scale factor	10.003	10.041
Offset	-0.020	-0.023
Delay mSEC	50.000	50.000

Step 0 05/29 10:10:19

Elapsed Time	INPUT 1	INPUT 2
0.0000	91.494	100.000
0.0083	91.494	100.000
0.0166	97.474	100.000
0.0250	107.364	100.000
0.0333	107.325	100.000
0.0416	107.345	100.000
0.0500	107.332	100.000
0.0583	107.310	100.000
0.0666	107.272	100.000
0.0750	107.225	100.000
0.0833	107.168	100.000
0.1000	107.044	100.000
0.1166	106.905	100.000
0.1333	106.754	100.000
0.1500	106.596	100.000
0.1666	106.431	100.000
0.1833	106.264	100.000
0.2000	106.096	100.000
0.2166	105.922	100.000
0.2333	105.755	100.000
0.2500	105.584	100.000
0.2666	105.414	100.000
0.2833	105.246	100.000
0.3000	105.082	100.000
0.3166	104.921	100.000
0.3333	104.763	100.000
0.4166	104.001	100.000
0.5000	103.305	100.000
0.5833	102.667	100.000
0.6666	102.073	100.000
0.7500	101.536	100.000
0.8333	101.051	100.000
0.9166	100.621	100.000
1.0000	100.303	100.000
1.0833	100.012	100.000
1.1666	99.775	100.000
1.2500	99.589	100.000
1.3333	99.446	100.000
1.4166	99.342	100.000
1.5000	99.273	100.000
1.5833	99.241	100.000
1.6666	99.235	100.000
1.7500	99.235	100.000
1.8333	99.230	100.000
1.9166	99.230	100.000
2.0000	99.230	100.000
2.5000	99.244	100.000
3.0000	99.250	100.000
3.5000	99.254	100.000
4.0000	99.254	100.000
4.5000	99.257	100.000
5.0000	99.257	100.000
5.5000	99.250	100.000
6.0000	99.263	100.000
6.5000	99.260	100.000
7.0000	99.260	100.000

END

NR-2 Shallow  
SE2000  
Environmental Logger  
05/25 13:59

Unit# WATERPAD Test 0

Setup:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	NR:2SHAL
Reference	132.330
SG	1.000
Linearity	0.014
Scale factor	19.486
Offset	0.026
Delay mSEC	50.000

Step 0 05/25 13:29:29

Elapsed Time	INPUT 1
0.0000	132.336
0.0083	132.336
0.0166	147.785
0.0250	146.761
0.0333	145.967
0.0416	144.934
0.0500	143.565
0.0583	141.762
0.0666	139.938
0.0750	138.185
0.0833	136.458
0.1000	133.650
0.1166	131.535
0.1333	130.111
0.1500	129.253
0.1666	129.156
0.1833	129.409
0.2000	129.994
0.2166	130.814
0.2333	131.726
0.2500	132.576
0.2666	133.266
0.2833	133.728
0.3000	133.944
0.3166	133.913
0.3333	133.691
0.4166	131.707
0.5000	131.092
0.5833	132.059
0.6666	132.422
0.7500	132.052
0.8333	132.416
0.9166	132.490
1.0000	132.262
1.0833	132.385
1.1666	132.410
1.2500	132.348
1.3333	132.311
1.4166	132.354
1.5000	132.360
1.5833	132.336
1.6666	132.342
1.7500	132.354
1.8333	132.342
1.9166	132.336
2.0000	132.342
2.5000	132.336
3.0000	132.336
3.5000	132.336
4.0000	132.336
4.5000	132.336
5.0000	132.336
5.5000	132.336
6.0000	132.336
6.5000	132.336
7.0000	132.336
7.5000	132.336
8.0000	132.336
8.5000	132.336
9.0000	132.336
9.5000	132.336
10.0000	132.336
12.0000	132.336
14.0000	132.336
16.0000	132.336
18.0000	132.336
20.0000	132.323
22.0000	132.330
24.0000	132.323
26.0000	132.323
28.0000	132.323

END

NR-2 Medium

SE2000  
Environmental Logger  
06/25 15:35

Unit# WATER:AD Test 1

Setups: INPUT 1  
Type Level (F)  
Mode TOC  
I.D. NR:2MED

Step 0 06/25 14:58:30

Elapsed Time INPUT 1

Elapsed Time	INPUT 1	
0.0000	136.174	
0.0083	136.180	
0.0166	151.332	14.074
0.0250	149.700	11.742
0.0333	149.017	11.759
0.0416	149.152	11.974
0.0500	149.195	11.937
0.0583	149.072	11.944
0.0666	148.770	11.512
0.0750	148.573	11.315
0.0833	148.197	10.929
0.1000	147.483	10.227
0.1166	147.058	9.3
0.1333	146.344	9.086
0.1500	145.853	8.605
0.1666	145.272	8.014
0.1833	144.767	7.507
0.2000	144.256	6.992
0.2166	143.775	6.517
0.2333	143.326	6.068
0.2500	142.895	5.627
0.2666	142.484	5.236
0.2833	142.100	4.892
0.3000	141.749	4.491
0.3166	141.404	4.176
0.3333	141.050	3.832
0.4166	139.741	2.483
0.5000	138.755	1.497
0.5833	138.078	.92
0.6666	137.640	.382
0.7500	137.368	.13
0.8333	137.271	.013
0.9166	137.258	0
1.0000	137.295	
1.0833	137.369	
1.1666	137.425	
1.2500	137.455	
1.3333	137.462	
1.4166	137.449	
1.5000	137.431	
1.5833	137.412	
1.6666	137.394	
1.7500	137.369	
1.8333	137.357	
1.9166	137.344	
2.0000	137.344	
2.5000	137.344	
3.0000	137.344	
3.5000	137.338	
4.0000	137.332	
4.5000	137.332	
5.0000	137.332	
5.5000	137.332	
6.0000	137.320	
6.5000	137.320	
7.0000	137.308	
7.5000	137.301	
8.0000	137.289	
8.5000	137.277	
9.0000	137.271	
9.5000	137.264	
10.0000	137.252	
12.0000	137.221	
14.0000	137.197	
16.0000	137.178	
18.0000	137.166	
20.0000	137.154	
22.0000	137.129	
24.0000	137.135	
26.0000	137.129	
28.0000	137.123	
30.0000	137.117	
32.0000	137.117	
34.0000	137.117	
36.0000	137.104	

END

NR-2 Deep

SE2000  
Environmental Logger  
05/29 14:14

Unit# SE2000 Test 4

Setups: INPUT 3  
Type Level (F)  
Mode TOC  
I.D. NR2SHORT

Reference 100.000  
S6 1.000  
Linearity 0.000  
Scale factor 19.688  
Offset 0.212  
Delay mSEC 50.000

Step 0 05/29 14:10:33

Elapsed Time INPUT 3

Elapsed Time	INPUT 3	
0.0000	96.665	
0.0083	96.665	
0.0166	97.045	
0.0250	97.598	
0.0333	100.410	
0.0416	116.435	17.256
0.0500	115.402	16.322
0.0583	115.414	16.225
0.0666	115.315	16.236
0.0750	114.985	15.900
0.0833	115.013	
0.1000	114.568	15.499
0.1166	114.575	15.476
0.1333	114.276	15.197
0.1500	113.661	14.482
0.1666	112.242	13.162
0.1833	111.477	12.324
0.2000	110.674	11.575
0.2166	109.729	10.650
0.2333	108.485	9.406
0.2500	107.589	8.510
0.2666	106.811	7.722
0.2833	105.990	6.911
0.3000	105.044	5.765
0.3166	104.273	5.194
0.3333	103.651	4.672
0.4166	100.954	1.925
0.5000	99.533	4.74
0.5833	99.079	0
0.6666	99.280	
0.7500	99.025	
0.8333	100.385	
0.9166	100.750	
1.0000	100.908	
1.0833	100.852	
1.1666	100.698	
1.2500	100.516	
1.3333	100.404	
1.4166	100.335	
1.5000	100.317	
1.5833	100.329	
1.6666	100.354	
1.7500	100.385	
1.8333	100.404	
1.9166	100.391	
2.0000	100.391	
2.5000	100.335	
3.0000	100.323	
3.5000	100.304	

END

MW-32 Shallow

MW-32 Shal/Med

SE2000  
Environmental Logger  
02/11 19:16

SE2000  
Environmental Logger  
02/11 18:18

Unit# SE-2000 Test 7

Unit# SE-2000 Test 6

Reference 240.000  
SE 1.000  
Linearity 0.014  
Scale factor 19.486  
Offset 0.026  
Delay mSEC 50.000

Setups: INPUT 1  
Type Level (F)  
Mode TDC  
I.D.

Step @ 02/11 18:53:14

Reference 240.000  
SE 1.000  
Linearity 0.014  
Scale factor 19.486  
Offset 0.026  
Delay mSEC 50.000

Elapsed Time INPUT 1

Step @ 02/11 19:02:34

Elapsed Time INPUT 1

0.0000	239.414	
0.0003	239.414	
0.0166	249.279	
0.0250	254.151	13.78
0.0333	252.722	
0.0416	253.172	12.80
0.0500	251.977	
0.0583	251.587	11.32
0.0666	250.738	
0.0750	250.751	10.33
0.0833	250.400	
0.1000	250.092	9.72
0.1166	249.759	
0.1333	249.463	9.09
0.1500	249.192	
0.1666	248.940	8.57
0.1833	248.705	
0.2000	248.484	8.12
0.2166	248.274	
0.2333	248.077	7.71
0.2500	247.892	
0.2666	247.708	7.34
0.2833	247.547	
0.3000	247.391	7.01
0.3166	247.233	
0.3333	247.065	6.72
0.4166	246.494	
0.5000	245.952	6.53
0.5833	245.490	
0.6666	245.009	6.72
0.7500	244.744	
0.8333	244.436	6.07
0.9166	244.153	
1.0000	243.906	5.54
1.0833	243.678	
1.1666	243.475	
1.2500	243.284	
1.3333	243.111	
1.4166	242.951	
1.5000	242.803	5.49
1.5833	242.668	
1.6666	242.539	
1.7500	242.421	
1.8333	242.310	
1.9166	242.206	
2.0000	242.107	5.79
2.0833	241.932	
2.1666	241.800	
2.2500	241.659	
2.3333	241.559	
2.4166	241.459	
2.5000	241.300	
2.5833	241.159	
2.6666	240.993	5.52
2.7500	240.776	
2.8333	240.684	
2.9166	240.616	
3.0000	240.566	5.20
3.0833	240.523	
3.1666	240.492	
3.2500	240.458	
3.3333	240.443	5.07
3.4166	240.431	
3.5000	240.419	
3.5833	240.405	
3.6666	240.400	
3.7500	240.382	
3.8333	240.369	5.00
3.9166	240.359	
4.0000	240.353	
4.0833	240.353	
4.1666	240.357	
4.2500	240.353	
4.3333	240.353	
4.4166	240.353	
4.5000	240.359	
4.5833	240.375	
4.6666	240.382	
4.7500	240.388	
4.8333	240.388	
4.9166	240.394	

0.0000	240.812	
0.0003	240.812	
0.0166	251.207	
0.0250	258.088	19.76
0.0333	257.047	19.72
0.0416	256.985	18.58
0.0500	256.878	17.54
0.0583	255.433	17.10
0.0666	254.257	15.93
0.0750	253.252	14.92
0.0833	251.991	13.56
0.1000	249.685	11.36
0.1166	247.197	8.97
0.1333	245.077	6.75
0.1500	242.378	4.64
0.1666	241.201	2.87
0.1833	239.651	1.33
0.2000	238.329	0
0.2166	237.219	
0.2333	236.493	
0.2500	235.951	
0.2666	235.648	
0.2833	235.591	
0.3000	235.698	
0.3166	235.994	
0.3333	235.462	
0.4166	239.624	
0.5000	242.347	
0.5833	242.286	
0.6666	240.240	
0.7500	239.668	
0.8333	239.736	
0.9166	239.932	
1.0000	240.924	
1.0833	240.930	
1.1666	240.191	
1.2500	239.537	
1.3333	239.596	
1.4166	239.944	
1.5000	240.359	
1.5833	240.412	
1.6666	240.147	
1.7500	239.878	
1.8333	239.827	
1.9166	239.981	
2.0000	240.160	
2.0833	240.092	
2.1666	240.051	
2.2500	240.049	
2.3333	240.043	
2.4166	240.043	
2.5000	240.036	
2.5833	240.036	
2.6666	240.036	
2.7500	240.036	
2.8333	240.036	
2.9166	240.036	
3.0000	240.036	
3.0833	240.036	
3.1666	240.036	
3.2500	240.036	
3.3333	240.036	
3.4166	240.036	
3.5000	240.036	
3.5833	240.036	
3.6666	240.036	
3.7500	240.036	
3.8333	240.036	
3.9166	240.036	
4.0000	240.036	
4.0833	240.036	
4.1666	240.036	
4.2500	240.036	
4.3333	240.036	
4.4166	240.036	
4.5000	240.036	
4.5833	240.036	
4.6666	240.036	
4.7500	240.036	
4.8333	240.036	
4.9166	240.036	
5.0000	240.036	

*Undersampled*  
*Undersampled*

END

END

MW-32 Deep/Mad  
SE2000  
Environmental Logger  
02/11 17:42

Unit# SE-2000 Test 5

Setups: INPUT 1

Type	Level (F)
Mode	TOC
I.D.	
Reference	240.000
SS	1.000
Linearity	0.014
Scale factor	19.486
Offset	0.026
Delay mSEC	50.000

Step 0 02/11 17:30:06

Elapsed Time	INPUT 1	
0.0000	240.000	
0.0033	240.000	
0.0166	242.793	
0.0250	256.992	20.31
0.0333	256.542	19.76
0.0416	256.497	19.30
0.0500	255.883	19.20
0.0583	255.495	19.81
0.0666	254.516	17.93
0.0750	254.146	17.46
0.0833	253.358	16.67
0.0916	251.768	15.02
0.1000	250.874	13.39
0.1083	248.213	11.52
0.1250	246.599	9.72
0.1416	245.871	9.29
0.1583	243.666	6.98
0.1750	242.354	5.67
0.1916	241.072	4.37
0.2083	240.061	3.39
0.2250	239.174	2.49
0.2416	238.440	1.76
0.2583	237.818	1.13
0.2750	237.282	.59
0.2916	236.918	.23
0.3083	236.684	0
0.4166	236.912	
0.5000	238.022	
0.5833	240.930	
0.6666	241.947	
0.7500	241.589	
0.8333	240.456	
0.9166	239.383	
1.0000	238.084	
1.0833	239.254	
1.1666	239.826	
1.2500	240.466	
1.3333	240.653	
1.4166	240.431	
1.5000	240.049	
1.5833	239.753	
1.6666	239.685	
1.7500	239.933	
1.8333	240.055	
1.9166	240.203	
2.0000	240.221	
2.5000	240.061	
3.0000	240.000	
3.5000	240.012	
4.0000	240.018	
4.5000	240.018	
5.0000	240.024	
5.5000	240.018	
6.0000	240.018	
6.5000	240.018	
7.0000	240.024	
7.5000	240.024	
8.0000	240.016	
8.5000	240.016	
9.0000	240.012	
9.5000	240.018	
10.0000	240.024	
11.0000	240.018	

Handwritten  
↓

END

MW-32 Deep  
SE2000  
Environmental Logger  
02/11 17:08

Unit# SE-2000 Test 4

Setups: INPUT 1

Type	Level (F)
Mode	TOC
I.D.	
Reference	240.000
SS	1.000
Linearity	0.014
Scale factor	15.486
Offset	0.026
Delay mSEC	50.000

Step 0 02/11 16:54:54

Elapsed Time	INPUT 1	
0.0000	240.018	
0.0033	240.018	
0.0166	240.030	
0.0250	252.083	
0.0333	257.442	
0.0416	256.660	
0.0500	257.343	17.31
0.0583	256.044	
0.0666	256.709	16.68
0.0750	255.994	
0.0833	255.674	15.64
0.1000	255.144	
0.1166	254.294	14.26
0.1333	253.382	
0.1500	252.582	12.55
0.1666	251.762	
0.1833	250.949	10.92
0.2000	250.315	
0.2166	249.661	9.63
0.2333	249.033	
0.2500	248.534	9.50
0.2666	248.029	
0.2833	247.554	7.52
0.3000	247.166	
0.3166	246.772	6.74
0.3333	246.414	
0.4166	245.151	5.12
0.5000	244.122	
0.5833	243.340	3.31
0.6666	242.742	
0.7500	242.288	2.25
0.8333	241.910	
0.9166	241.626	1.60
1.0000	241.392	
1.0833	241.207	
1.1666	241.053	
1.2500	240.924	
1.3333	240.825	
1.4166	240.733	
1.5000	240.659	1.63
1.5833	240.597	
1.6666	240.540	
1.7500	240.499	
1.8333	240.462	
1.9166	240.425	
2.0000	240.384	1.35
2.5000	240.277	
3.0000	240.203	
3.5000	240.160	
3.95	240.129	1.10
4.0000	240.110	
4.5000	240.098	
5.0000	240.086	
5.5000	240.073	
6.0000	240.067	
6.5000	240.061	
7.0000	240.051	
7.5000	240.061	
7.95	240.055	1.03
8.0000	240.049	
8.5000	240.049	
9.0000	240.049	
9.5000	240.049	
10.0000	240.049	
11.0000	240.036	
11.95	240.030	0
13.0000	240.036	

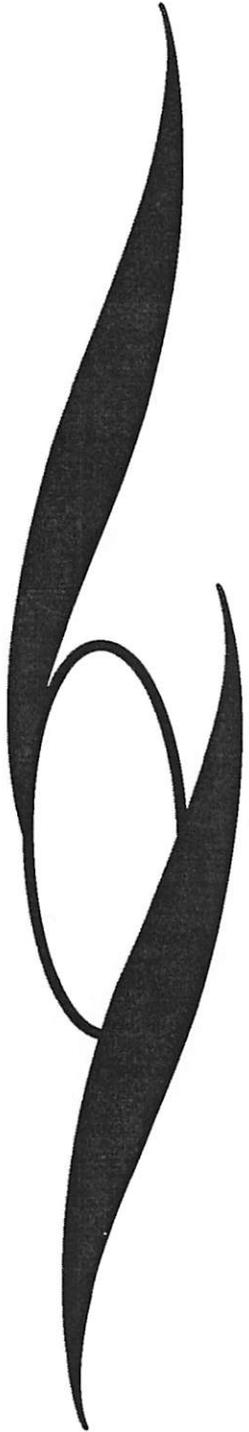
END

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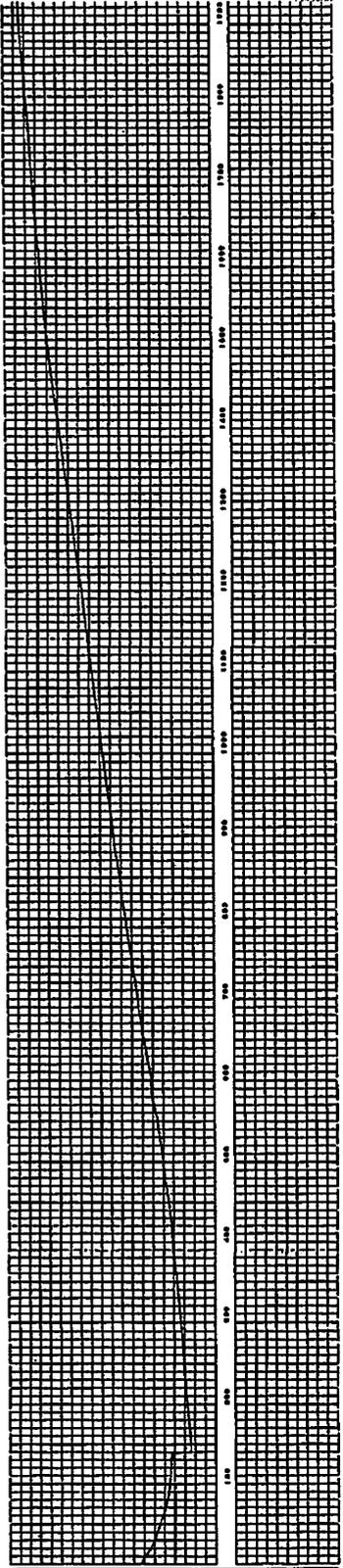
# **APPENDIX XII**

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**Down-Hole Temperature Logs**







**Temp Log**  
MR-2

DATE: 12/15/50  
TIME: 10:00 AM

WELL NO. 1000  
CORRECTION: 0.0

WELL DEPTH: 1000  
LOG DEPTH: 1000

WELL TYPE: OIL  
WELL STATUS: ACTIVE

WELL LOCATION: 1000  
WELL SURFACE: 1000

WELL OWNER: 1000  
WELL OPERATOR: 1000

WELL RECORD NO. 1000  
WELL LOG NO. 1000

WELL LOG DATE: 12/15/50  
WELL LOG TIME: 10:00 AM

WELL LOG BY: 1000  
WELL LOG CHECKED BY: 1000

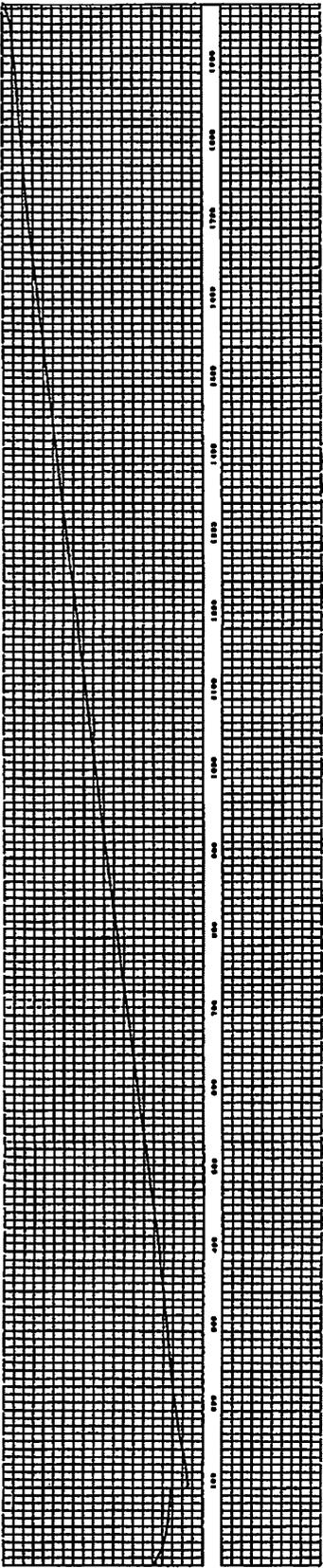
WELL LOG APPROVED BY: 1000  
WELL LOG REVIEWED BY: 1000

WELL LOG REVISIONS:

1. 12/15/50: Initial log.

2. 12/15/50: Revised log.

3. 12/15/50: Final log.



**Temp Log**  
MR-1

DATE: 12/15/50  
TIME: 10:00 AM

WELL NO. 1000  
CORRECTION: 0.0

WELL DEPTH: 1000  
LOG DEPTH: 1000

WELL TYPE: OIL  
WELL STATUS: ACTIVE

WELL LOCATION: 1000  
WELL SURFACE: 1000

WELL OWNER: 1000  
WELL OPERATOR: 1000

WELL RECORD NO. 1000  
WELL LOG NO. 1000

WELL LOG DATE: 12/15/50  
WELL LOG TIME: 10:00 AM

WELL LOG BY: 1000  
WELL LOG CHECKED BY: 1000

WELL LOG APPROVED BY: 1000  
WELL LOG REVIEWED BY: 1000

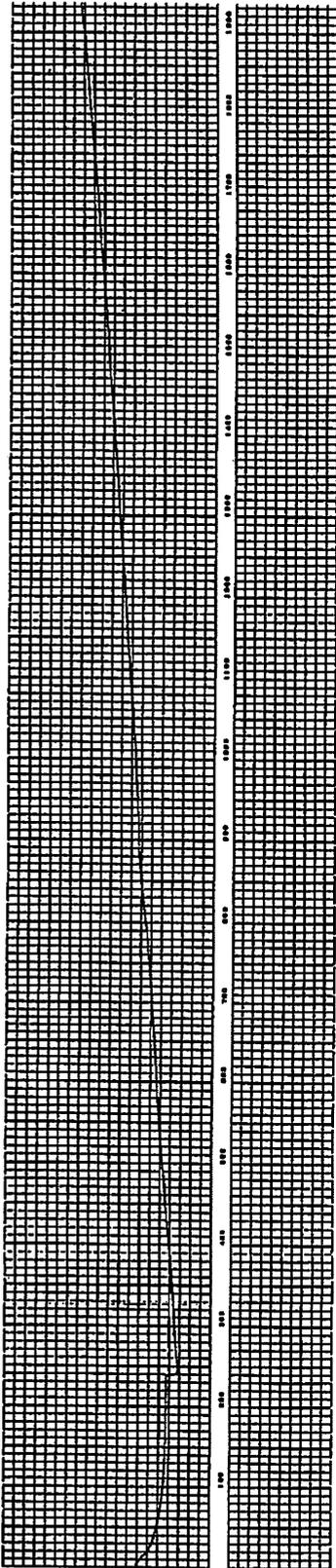
WELL LOG REVISIONS:

1. 12/15/50: Initial log.

2. 12/15/50: Revised log.

3. 12/15/50: Final log.



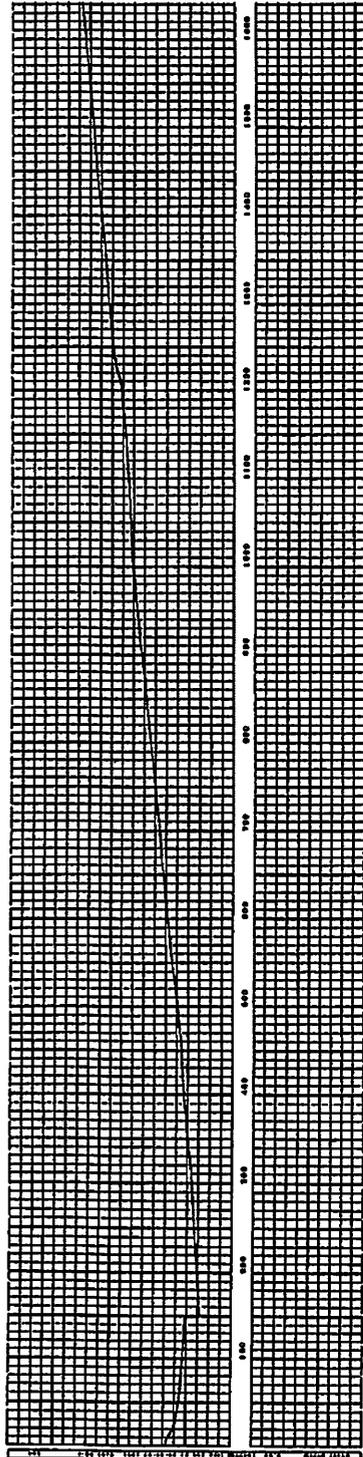


**Temp Log**  
2C-MH-32

Well Name: 2C-MH-32  
 Date: 11/11/54  
 Log No: 1111

Log Interval: 0 to 1700 feet

Temperature (°F): 170 at 0 feet, 160 at 100 feet, 150 at 200 feet, 140 at 300 feet, 130 at 400 feet, 120 at 500 feet, 110 at 600 feet, 100 at 700 feet, 100 at 800 feet, 100 at 900 feet, 100 at 1000 feet, 100 at 1100 feet, 100 at 1200 feet, 100 at 1300 feet, 100 at 1400 feet, 100 at 1500 feet, 100 at 1600 feet, 100 at 1700 feet.



**Temp Log**  
2C-MH-32

Well Name: 2C-MH-32  
 Date: 11/11/54  
 Log No: 1111

Log Interval: 0 to 1700 feet

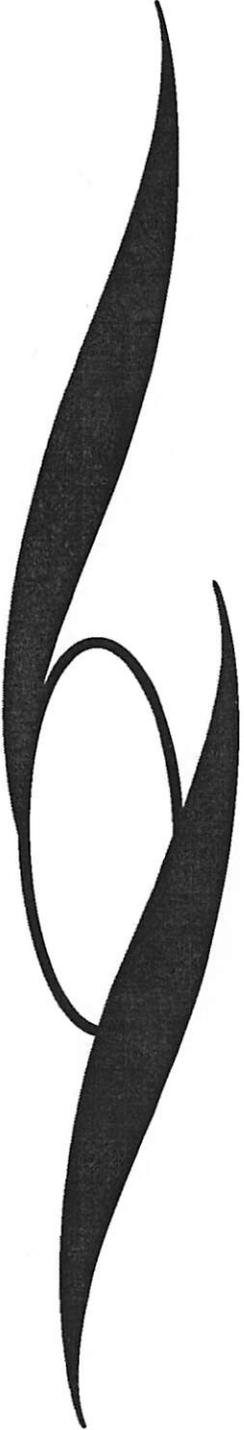
Temperature (°F): 170 at 0 feet, 160 at 100 feet, 150 at 200 feet, 140 at 300 feet, 130 at 400 feet, 120 at 500 feet, 110 at 600 feet, 100 at 700 feet, 100 at 800 feet, 100 at 900 feet, 100 at 1000 feet, 100 at 1100 feet, 100 at 1200 feet, 100 at 1300 feet, 100 at 1400 feet, 100 at 1500 feet, 100 at 1600 feet, 100 at 1700 feet.

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# APPENDIX XIII

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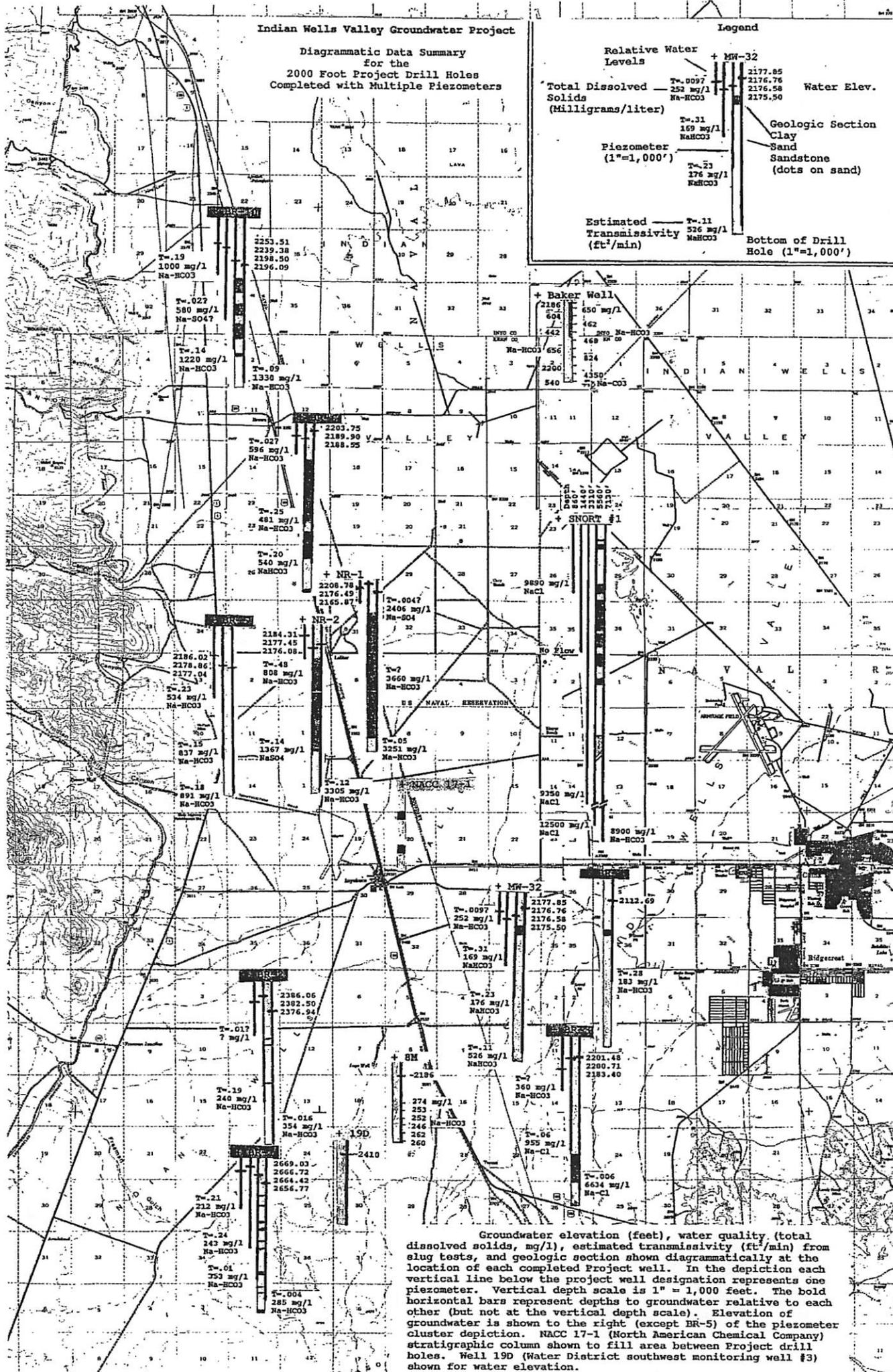
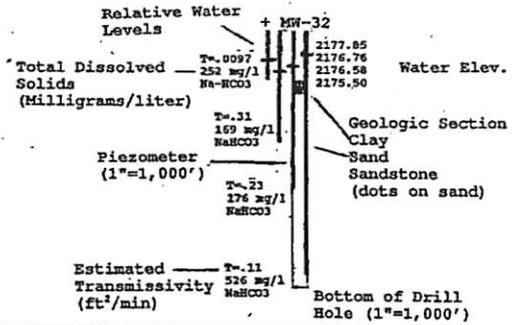
Project Well Location Map



Indian Wells Valley Groundwater Project

Diagrammatic Data Summary  
for the  
2000 Foot Project Drill Holes  
Completed with Multiple Piezometers

Legend



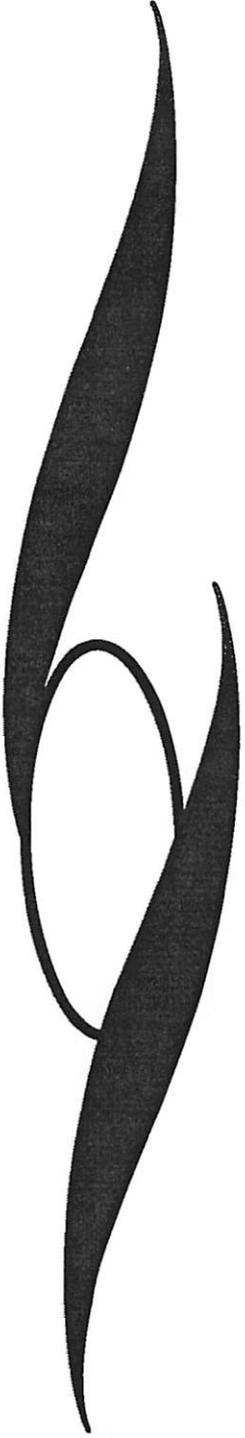
Groundwater elevation (feet), water quality (total dissolved solids, mg/l), estimated transmissivity (ft<sup>2</sup>/min) from slug tests, and geologic section shown diagrammatically at the location of each completed Project well. In the depiction each vertical line below the project well designation represents one piezometer. Vertical depth scale is 1" = 1,000 feet. The bold horizontal bars represent depths to groundwater relative to each other (but not at the vertical depth scale). Elevation of groundwater is shown to the right (except BR-5) of the piezometer cluster depiction. NACC 17-1 (North American Chemical Company) stratigraphic column shown to fill area between Project drill holes. Well 19D (Water District southwest monitoring well #3) shown for water elevation.

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# **APPENDIX XIV**

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**Project Well Site Elevations**



INDIAN WELLS VALLEY GROUND WATER PROJECT  
Elevation @ wells in Group I

Well	Elevation	2" Pipe Elev.	Description
BR-1	2852.17	2851.91	X stamped on rim of casing
		2851.80	Shallow Med.
		2852.05	Deep Med.
		2851.77	Shallow
	2849.2	Deep	
	2848.3	Concrete Pad	
BR-2	2658.84	2658.64	Ground
		2658.45	X stamped on rim of casing
		2658.42	Shallow
	2656.5	Deep	
	2655.9	Medium	
BR-3	2511.86	2511.23	Concrete Pad
		2511.44	Ground
		2511.48	X stamped on rim of casing
	2509.0	2" Pipe	
	2508.6	2" Pipe	
BR-4	2377.48	2377.19	2" Pipe
			Concrete Pad
	2375.7	Ground	
	2375.2		
BR-5	2521.48	2521.27	X stamped on rim of casing
		2521.06	2" Pipe
		2520.83	2" Pipe
	2519.2	2" Pipe	
	2518.6	Concrete Pad	
BR-6	2354.13	2353.06	Ground
		2353.43	X stamped on rim of casing
		2353.75	2" Pipe
	2352.6	2" Pipe	
	2352.2	Concrete Pad	

INDIAN WELLS VALLEY GROUND WATER PROJECT  
Elevation @ wells in Group I

Well	Elevation	2" Pipe Elev.	Description
BR-10	2558.77		5/8" rebar 100' East of proposed well BR-10 Ground @ proposed site
	2560.3		
NR-1	2278.58		X stamped on rim of casing Deep Shallow Medium with valve cap Concrete Pad Ground
		2277.67	
		2277.69	
		2278.26	
		2276.3	
NR-2			X stamped on rim of casing Deep Medium Shallow Concrete Pad Ground
	2317.69		
		2316.91	
		2317.11	
		2317.38	
MW-32			X stamped top of welded cover between two 2" pipes East 2" pipe West 2" pipe
	2418.06		
		2418.69	
		2418.69	

Note: All "X" stamped above latch area opposite the hinge of the cover unless noted otherwise.

## INDIAN WELLS VALLEY GROUND WATER PROJECT

### Elevations @ wells in Group II

Well	Elevation	Description
NAWS-13 (13J)	2295.03	X stamped on rim of casing Ground
	2291.3	
NAWS-31 (31R)	2263.40	Top of 4" pvc pipe Top of rim 30 gal drum Concrete Pad Ground
	2264.38	
	2261.1	
	2261.1	
NACC-17 (17-F01)	2355.79	NW corner of cover plate Top NW corner of cover box Ground
	2357.15	
	2354.3	
CSD # 1	2441.34	NE corner bottom of pump casing NE corner concrete pad Ground
	2441.21	
	2440.8	
CSD # 2	2443.19	NE corner bottom of pump casing NE corner concrete pad Ground
	2442.71	
	2441.4	
OW-8	2532.97	Chisled square SW corner of concrete pad Top west corner of welded cover plate over 8" well Ground
	2534.33	
	2532.5	
INYO WELL	2566.21	X stamped E. side rim casing Top of 1/2" cap inside casing Concrete Pad Ground
	2565.24	
	2562.8	
	2562.6	
INVWD-8	2582.82	X stamped on rim of 6" casing Ground Extra well is near S 1/4 corner of Section 8 T27S R39E
	2579.7	

**INDIAN WELLS VALLEY GROUND WATER PROJECT**  
**Distance and error of level loops to wells**

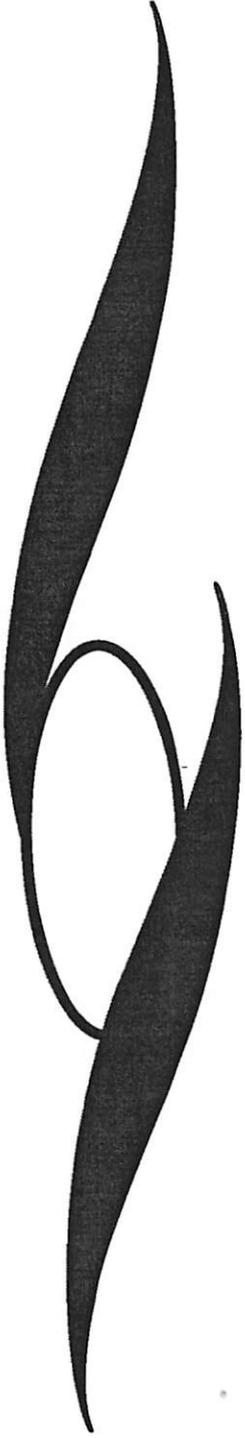
<b>Well</b>	<b>Distance in miles</b>	<b>Error of closure</b>
BR-1	3.5	-0.027
BR-2	1.5	+0.045
BR-3	2.5	+0.042
BR-4	0.3	+0.009
BR-5	2.0	-0.014
BR-6	0.5	+0.016
BR-10	0.2	-0.016
NR-1	0.3	-0.008
NR-2	0.7	-0.009
MW-32	0.2	-0.006
NAWS-13	1.3	-0.010
NAWS-31	1.0	+0.042
NACC-17-1	0.5	-0.002
CSD-1&2	0.2	+0.013
OW-8	0.2	-0.010
INYO WELL	0.8	+0.007
INVWD-8	0.5	-0.012

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# **APPENDIX XV**

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**Engineering Cost Calculations**



## APPENDIX XV

### CALCULATION OF ESTIMATED TRANSMISSION LINE COST

An estimate of the cost of building a 34.5kV electric transmission line from a substation in Inyokern to a pumping field in the southwest area of Indian Wells Valley was derived by indexing a 1978 engineers estimate of a similar transmission line. The engineer's estimate of the contract cost of a 7.86-mile 34.5kV woodpole transmission line on flat desert terrain south of Yuma, Arizona was \$135,082 in 1978. This is \$17,186 a mile.

Using a cost index of 2 to account for the difference in cost between 1978 and 1992, the unit contract cost becomes

$$\$17,186 \times 2 = \$34,372 \text{ a mile in 1992 costs.}$$

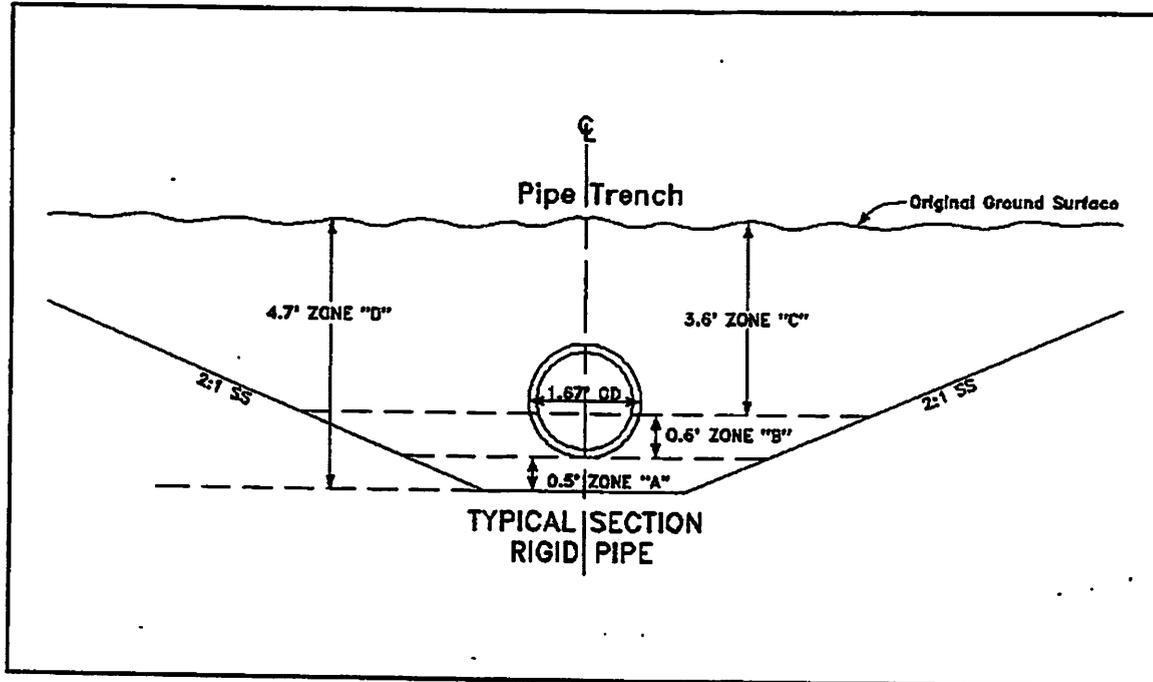
Adding 34 percent to account for engineering, inspection, contract administration, etc., the total unit cost is

$$\$34,372 \times 1.34 = \$46,000 \text{ a mile.}$$

For the 5 miles between Inyokern and the southwest area a transmission line is estimated to cost

$$\$46,000 \times 5 = \$230,000.$$

## CALCULATION OF ESTIMATED 20" AND 30" PIPELINE COST



### Estimated Cost for 20" Pipeline

#### Construction in Alluvial Fill

Minimum cover = 30 in.  
 Excavation depth = 4.7 ft.  
 Trench bottom width = 2.7 ft.  
 Trench top width = 21.5 ft.  
 Side Slope is 2:1

#### Excavation Zone D

$$\left\{ \frac{4.7(2.7 + 21.5)}{2} \right\} \frac{5,280}{27} \times \$3.50/\text{yd.}^3 = \$38,900/\text{mi.}$$

**Compacted Backfill**

(selected material)

Zone A + Zone B

$$\left\{ \left\{ 0.5'(2.7' + 4.7')/2 \right\} + \left\{ 0.6'(4.7' + 7.1')/2 \right\} - (0.37'(\pi 0.83^2)) \right\} / 27 \times 5,280' \\ @ \$5.00/\text{yd.}^3 \\ = \$4,500/\text{mi.}$$

**Backfill**

(common material)

Zone C

$$\left\{ 3.6'(7.1' + 21.5')/2 - (0.63(\pi 0.83^2)) \right\} / 27 \times 5,280' @ \$2.50/\text{yd.}^3 \\ = \$24,500/\text{mi.}$$

**Pipe**

(installed)

$$5,280/\text{ft.} \times \$26/\text{lin. ft.} = \$137,300/\text{mi.}$$

**Right of Way**

$$50' \text{ wide} \times 5,280 = 6 \text{ acres} \times \$200/\text{acre} = \$1,200/\text{mi.}$$

**Subtotal**

$$\text{Subtotal} = \$206,400/\text{mi.}$$

**Road Crossings**

Jacking

$$2 @ \$5,000 \text{ ea.} = \$10,000$$

### Subtotal

Subtotal =	\$216,400
+ unlisted items (15%) =	\$248,860
+ contingencies (25%) =	\$311,075
+ indirect costs (25%) =	\$388,844

**Total construction cost ≈ \$388,800/mi.**

14 mi. x \$388,800/mi. = \$5,400,000

7 mi. x \$388,800/mi. = \$2,700,000

### Estimated Cost for 30" Pipeline

#### Construction in Alluvial Fill

Minimum cover = 30 in.

Excavation depth = 5.3 ft.

Trench bottom width = 3.3 ft.

Trench top width = 24.5 ft.

Side Slope is 2:1

#### Excavation

Zone D

$$\left\{ \left[ 5.3' \left( \frac{3.3' + 24.5'}{2} \right) \right] \frac{5,280'}{27} \right\} \times \$3.50/\text{yd.}^3 = \$50,400/\text{mi.}$$

#### Compacted Backfill

(selected material)

Zone A + Zone B

$$\left\{ \left[ 0.5' \left( \frac{3.3' + 5.3'}{2} \right) \right] + \left[ 0.9' \left( \frac{5.3' + 8.9'}{2} \right) \right] - (0.37(\pi 1.12^2)) \right\} \frac{5,280'}{27} \times \$5.00/\text{yd.}^3 = \$6,900/\text{mi.}$$

**Backfill**  
(common material)  
Zone C

$$\left\{ 3.9' \left( \frac{8.9' + 24.5'}{2} \right) - 0.63(\pi 1.12^2) \right\} / 27 \times 5,280' @ \$2.50/\text{yd.}^3 \\ = \$30,600/\text{mi.}$$

**Pipe**  
(installed)

$$5,280/\text{ft.} \times \$55.00/\text{lin. ft.} = \$290,400/\text{mi.}$$

**Right of Way**

$$50' \text{ wide} \times 5,280 = 6 \text{ acres} \times \$200/\text{acre} = \$1,200/\text{mi.}$$

**Subtotal**

$$\text{Subtotal} = \$379,500/\text{mi.}$$

**Road Crossings**

**Jacking**

$$2 @ \$5,000 \text{ ea.} = \$10,000$$

**Subtotal**

Subtotal =	\$389,500
+ unlisted items (15%) =	\$447,925
+ contingencies (25%) =	\$559,906
+ indirect costs (25%) =	\$699,883

**Total construction cost  $\approx$  \$700,000/mi.**

$$10 \text{ mi.} \times \$700,000/\text{mi.} = \$7,000,000$$