# GROUNDWATER RESOURCE AND LAKE CONSTRUCTION INVESTIGATION

# CONWAY RANCH AT MONO LAKE, MONO COUNTY, CALIFORNIA

APPLIED GEOTECHNOLOGY INC. (1987)

A report prepared for

Conway Ranch
Post Office Box 179
June Lake, California 93529

**GROUNDWATER RESOURCE AND**
**LAKE CONSTRUCTION INVESTIGATION**
**CONWAY RANCH AT MONO LAKE**
**MONO COUNTY, CALIFORNIA**

AGI Project No. 15,248.001

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## 1.0 SUMMARY

We have investigated groundwater resources and near surface geologic conditions beneath the proposed lake on Conway Ranch. As part of the investigation, we:

- Reviewed available background information.
- Conducted a geologic and surface water reconnaissance.
- Installed a test well to a depth of 171 feet.
- Performed a pumping test using the existing domestic and fire pump wells.
- Excavated 17 test pits in the proposed lake area.

Results of the investigation are summarized below.

<u>Geology:</u> Conway Ranch is underlain by a variable thickness of unconsolidated sediments resting on metamorphic and granitic bedrock. Bedrock is close to the surface in the northeast quarter of the Ranch and across the southern edge of the Ranch. We suspect there is also a bedrock high trending north-south near the middle of the Ranch. This bedrock high separates a central basin from another basin in the southeast quarter of the Ranch.

The unconsolidated sediments overlying bedrock can be grouped into three major units. The uppermost unit is approximately 30 feet thick and consists of interbedded silt, silty sand, and silty clay. Underlying these sediments is approximately 40 to 100 feet of sand and gravel. The sands and gravels are underlain in turn by sandy clay in the central basin area and by clayey gravel in the southeastern basin.

Near surface sediments in the proposed lake area are complexly interbedded and do not lend themselves to a simple interpretation. However, the uppermost sediments tend to be organic rich, grading coarser with depth. Thus, near surface silty clays and clayey silts tend to grade downwards to silty sands and, in some areas, gravelly sands.

<u>Groundwater Occurrence and Flow:</u> Groundwater occurs under water table conditions in the unconsolidated sediments overlying bedrock ("Water Table Aquifer"). The sands and gravels are the chief water bearing deposits, although the overlying silts and sands also contain considerable water. The underlying sandy clays and clayey gravels impede groundwater flow and act as an aquitard.

The saturated thickness of the Water Table Aquifer was approximately 65 to 70 feet at the time of our investigations. Depth to the water table ranged from 5 to 6 feet in the central basin, to 68 feet in the extreme southeast corner of the Ranch. The high water levels in the central basin area appear to be maintained in part by the damming effect of the inferred bedrock high. Groundwater flow appears to be constrained by the bedrock configuration such that all off-site flow is through a narrow southeast trending channel.

Water Balance: A water balance was calculated for the Conway Ranch (the 870-acre parcel of property) assuming all inputs to the Ranch equal all outputs. Inputs are as follows:

- o Direct precipitation onto the Ranch property.
- o Surface water and groundwater runoff from the adjacent mountains.
- o Artificial diversion of surface water onto the Ranch from Wilson Creek and Virginia Creek.

Outputs are as follows:

- o Evapotranspiration (ET).
- o Surface water runoff principally through Wilson Creek.
- o Groundwater flow.

Values for these parameters are tabulated below as follows:

Inputs (cfs)

| | | | |
|---|---|---|---|
| Direct Precipitation | | | 1.79 |
| Runoff from adjacent mountains: | Area I | | 5.27 |
| | Area II | | 1.51 |
| | Area III | | 4.78 |
| Wilson Creek diversion | | | 19.00 |
| Virginia Creek diversion | | | 2.30 |
| | | Total | 34.65 |

Outputs (cfs)

| | | |
|---|---|---|
| Evapotranspiration | | 3.80 |
| Groundwater flow | | 2.40 |
| Surface water runoff | | 28.45 |
| | Total | 34.65 |

**Groundwater Safe Yield:** Safe yield is defined as the volume of groundwater which can be withdrawn from the Water Table Aquifer with no overall reduction in storage (i.e. no groundwater mining). We calculate a safe yield of 2.4 cfs or approximately 1,100 gallons per minute assuming complete off-site export of all extracted groundwater. However, this assumption is unrealistic as extracted groundwater will be used to supplement stream flows and lake storage on the Ranch and will therefore reinfiltrate and thus recharge groundwater supplies. We believe 30% reinfiltration is realistic and the safe yield would, therefore, be approximately 1,500 gallons per minute.

**Groundwater Storage:** Groundwater storage is defined as the volume of water held in the Water Table Aquifer which can be removed by pumping. We calculate the average annual storage as 4,900 acre feet assuming a specific yield of 30% and a saturated thickness of 60 feet in the central basin and 80 feet in the southeast quarter of the Ranch.

**Lake Evaporation Losses:** We calculate evaporation losses from the proposed 33-acre lake as 112.2 acre feet per year (.15 cfs) assuming an average annual evaporation rate of 40.8 inches/year. This evaporation rate is probably only slightly higher than the evapotranspiration rate from the existing land surface because of the high water table and thick vegetation growth in the proposed lake area.

**Lake Construction:** Because of the shallow water table and soft soils in the proposed lake area, it will be necessary to excavate the lake with a drag line or large hydraulic backhoe. The backhoe has several important advantages over a drag line, including the ability to excavate a smooth bottom and to deposit excavated soil directly into trucks for transport.

**Lake Seepage Losses:** There should be no seepage losses through the base of the lake because of the high groundwater table. However, water will flow out of the lake through the downstream side of the lake into the adjoining Water Table Aquifer. This outflow will be balanced in whole or part by groundwater inflow along the upstream side of the lake. We cannot quantify the outflow relative to inflow and therefore recommend that a liner be installed along the downstream edge of the lake. The simplest and least costly method to install a liner is to place a 2 to 3-foot thick layer of some of the clay-rich soils excavated from the lake.

**Organic Soil Volume:** We calculate the volume of organic-rich soil available from the proposed lake area is 2,100,000 cubic feet assuming an average thickness of 17.5 inches over 33 acres. The actual thickness is quite variable, ranging from essentially none to 84 inches.

# 2.0 INTRODUCTION

## 2.1 General

This report presents the results of our groundwater resource investigation and geotechnical evaluation of a proposed lake on Conway Ranch near Mono Lake, California. Conway Ranch is comprised of two parcels of property. A larger 870-acre parcel is located east of U.S. Highway 395 and north of California State Route 167, and a smaller 160-acre parcel is located west of the intersection between Highway 395 and SR 167. The location of the two parcels is shown on the Vicinity Map, Figure 1.

## 2.2 Project Description

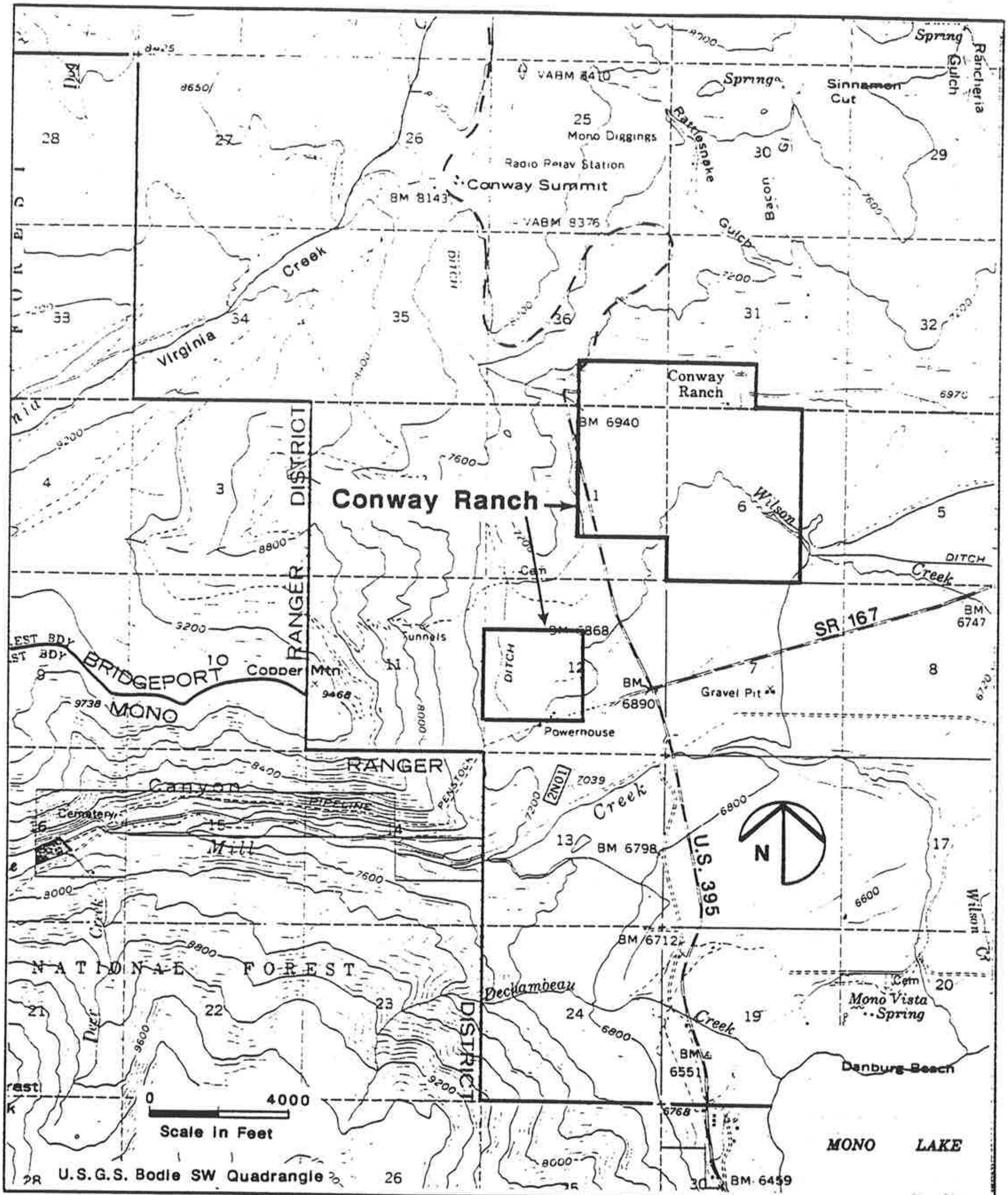
We understand the 870-acre portion of Conway Ranch will be developed as a fly fishing resort. The resort will include a number of communal buildings, condominiums, and private residences, as well as access roadways. Two new streams, in addition to the existing Wilson Creek, will be constructed for fly fishing. In addition, a 33-acre artificial lake will be built near the center of the property. Water for the lake and for the streams will be supplied by surface water from Wilson Creek and the Virginia Creek diversion, and supplemented by groundwater from wells drilled on-site. We understand approximately 1500 gallons per minute of groundwater will be necessary to sustain the new streams and lake during times of extreme drought.

## 2.3 Purpose

The purpose of our investigation is to assess groundwater availability and adequacy to supply resort requirements, and to assess geotechnical aspects of creating the new lake. Since only the 870-acre parcel is being developed, our investigation was directed specifically to that portion of the Conway Ranch.

Goals for the groundwater availability aspect include:

- Determine aquifer geometry and water bearing characteristics.
- Determine sources and nature of groundwater recharge, specifically including snow melt and surface water from Wilson Creek and the Virginia Creek diversion.
- Check water balance calculations as reported in Beak's 1987 Environmental Impact Review, particularly as they relate to evapotranspiration and groundwater recharge estimates.
- Determine aquifer storage, maximum safe yield, and the likelihood of sustaining 1500 gallons per minute withdrawal rate during periods of drought.

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## Vicinity Map

Conway Ranch at Mono Lake
Mono County, California

FIGURE
**1**

| JOB NUMBER | DRAWN | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| 15,248.001 | SL | MAA | 28 July 87 | | |

Goals for the geotechnical aspect include:

- o Estimate water losses from the lake through evaporation and leakage through the lake bottom.
- o Provide recommendations to minimize leakage, if necessary.
- o Evaluate the extent and volume of organic soils available in the proposed lake area for use as topsoil.
- o Evaluate construction and/or drainage problems relating to excavation of the lake bed.

Our scope of work to accomplish the goals described above is summarized in the following section.

2.4 <u>Scope of Work</u>

Our scope of work included data review, field investigations, and data analysis. Specifically, our scope included the following:

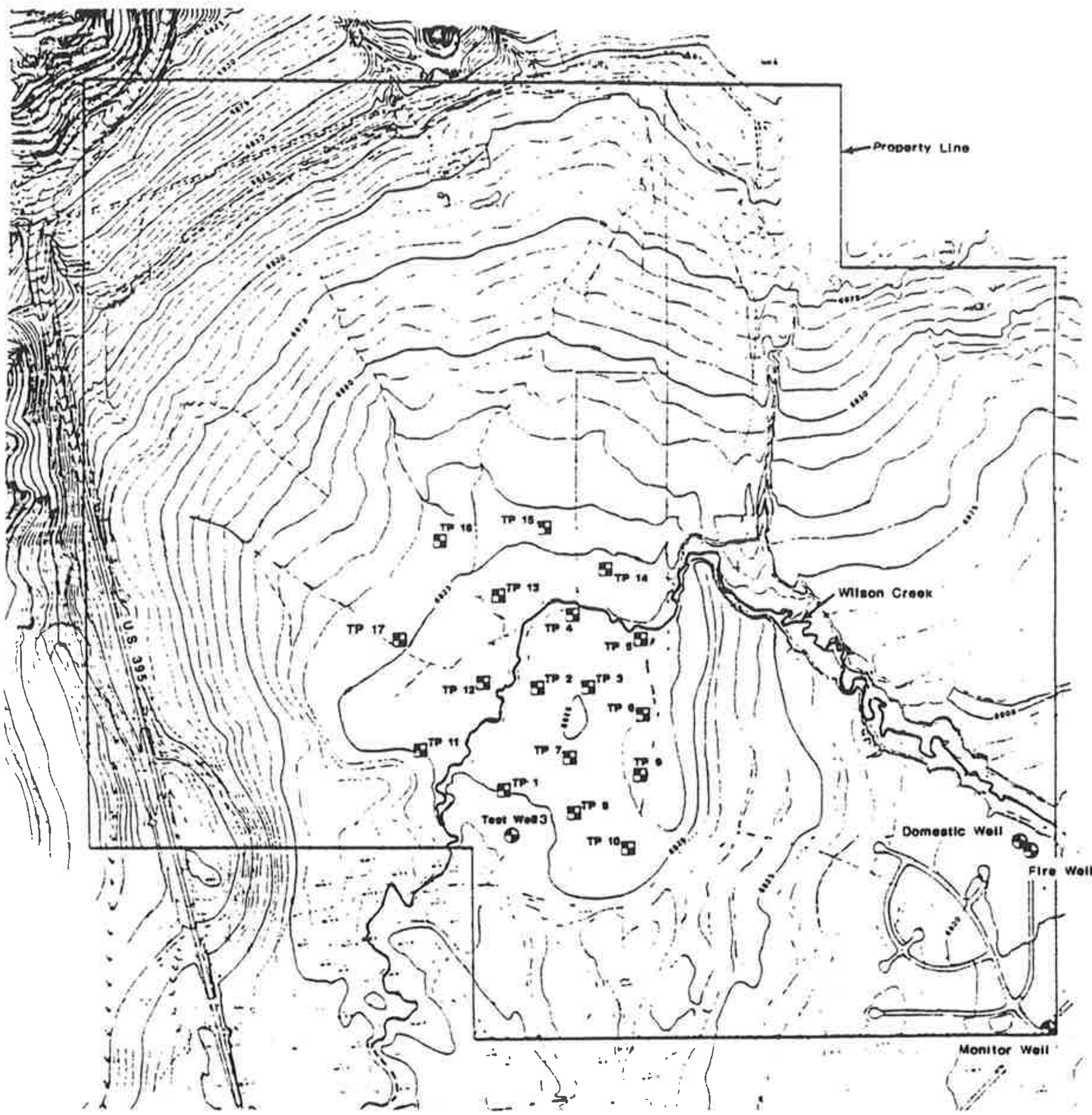
**Evaluate Existing Data**: Prior to beginning field investigations, we reviewed existing information and data concerning site hydrogeologic conditions, including studies by J.H. Kleinfelder and Associates (1983); Beak Consultants (1987); and Loeffler (1977). A list of references used in this investigation is included at the end of the report.

**Site Geologic/Hydrologic Reconnaissance**: We conducted a detailed site reconnaissance focusing on geologic structures as they might control groundwater movement and on microhydrologic conditions which govern surface water movement. As part of this task, site geology was mapped and surface water flows were measured in upgradient and downgradient locations in Wilson Creek. The surface water flows were determined by estimating water velocities and measuring the stream cross sectional area.

**Test/Production Wells**: We installed one test/production well (Test Well No. 3) near the middle of the Ranch at the location shown on the Site Plan, Plate 2. The purpose of the test well was primarily to obtain supplemental geologic and groundwater information in the central portion of the Ranch. The well boring was drilled to 171 feet and electric logs were run immediately following completion of the drilling. Based on the results from the electric logs and our observations during drilling, a well was installed to a total depth of 74 feet. The well was then developed for use as a possible water supply well. Well installation details and a geologic log are included in Appendix A.

__Aquifer Pumping Test__: We conducted a 16-hour pumping test using the existing domestic and fire water supply wells in the southeast corner of the site. The pumping test data were analyzed to determine aquifer hydraulic characteristics, including permeability, storage coefficient, and transmissivity. These parameters form the basis for assessing groundwater availability, storage, and maximum safe yield. The pumping test data and analysis are included in Appendix B.

__Proposed Lake Geotechnical Investigation__: We excavated 17 backhoe test pits to depths ranging from 8 to 13 feet to investigate geotechnical conditions in the proposed lake area. Test pit locations are shown on Figure 2, and logs of the test pits are included in Appendix E.




LEGEND:

Approximate location of groundwater monitoring or water supply well

7 Approximate location and number of test pit

—6825— Elevation in feet

N

0 200 400 800
Scale in Feet

Reference: Undated topographic base map provided by Triad Engineering, 1987

| Applied Geotechnology Inc. Geotechnical Engineering Geology & Hydrogeology | Site Plan<br>Conway Ranch at Mono Lake<br>Mono County, California | | FIGURE 2 |
|---|---|---|---|
| JOB NUMBER 15246.001 | DRAWN SL | APPROVED MAN | DATE 3 August 87 |

## 3.0 SITE CONDITIONS

### 3.1 Site Description

Conway Ranch lies at the foot of the Sierra Nevada Mountains in the extreme northwest corner of the Mono Lake Basin. This basin contains Mono Lake and extends some 20 to 30 miles south and east of the Ranch.

The Ranch topography slopes gently downwards from the north and west property lines towards a small basin in the central part of the property. South and east of the central basin, the land surface abruptly rises approximately 15 feet, and then slopes gently downwards to the southeast towards Mono Lake. Near the west and north property lines, the land surface rises steeply into the Sierra Nevada Mountains.

Much of the Ranch has been irrigated in the past for sheep or cattle pasture. Consequently, most of the central basin is covered with thick grass and a few scattered trees. The higher ground to the south and east is covered with native sage and high desert vegetation.

### 3.2 Surface Water

Surface water flow generally follows the land slope and is thus from the mountains downwards into the Ranch property. However, the natural flow regime has been extensively modified through excavation of numerous drainage ditches and the diversion of creek flows from other areas onto the Ranch. Wilson Creek, which passes through the Ranch, was created through diversion of water from Mill Creek. Surface water is also diverted from Virginia Creek and is carried onto the northeast corner of the Ranch through several ditches. Refer to Figure 1 for the location of Virginia Creek and Mill Creek. For a more detailed description of the diversion ditches and for historic flow rates in these ditches, refer to Beak (1987).

Wilson Creek enters the Ranch near the middle of the southern property line (see Figure 2, Site Plan). The creek meanders generally northeast and then abruptly turns and flows to the southeast after reaching the border of the central basin described previously. The stream gradient is nearly flat in the northeast trending portion where the stream is bordered by low banks less than 10 feet in height. In the southeast trending portion, however, the gradient steepens and the stream becomes deeply incised with bordering banks greater than 20 feet in height. A small dam with an adjustable spillway blocks Wilson Creek just east of the Ranch property. The dam was reportedly built to provide fish habitat.

### 3.3 Geology

**Regional Setting:** The Sierra Nevada Mountains surround Conway Ranch to the west and north. The mountains are composed of granitic bedrock of the Sierra Nevada Batholith and surrounding metamorphic bedrock. These rocks extend beneath unconsolidated sediments filling the Mono Basin.

Mono Basin is filled with a great thickness of unconsolidated sediment derived from erosion of the adjacent mountains. Considerable volcanic ash is interbedded with the sediment as a result of volcanic activity throughout the eastern Sierra Nevada. Much of the sediment was deposited in a prehistoric lake which filled most of the basin tens of thousands of years ago. The existing Mono Lake is a small remnant of the prehistoric lake.

Site Geology: Our geologic mapping indicates Conway Ranch is underlain by at least two types of bedrock - granitic and metamorphic. The metamorphic rock is a hornfels (a massive fine-grained metamorphosed mudstone or siltstone) which outcrops as a series of reddish, rubbly masses or platy fragments. The granitics outcrop as rounded whitish masses.

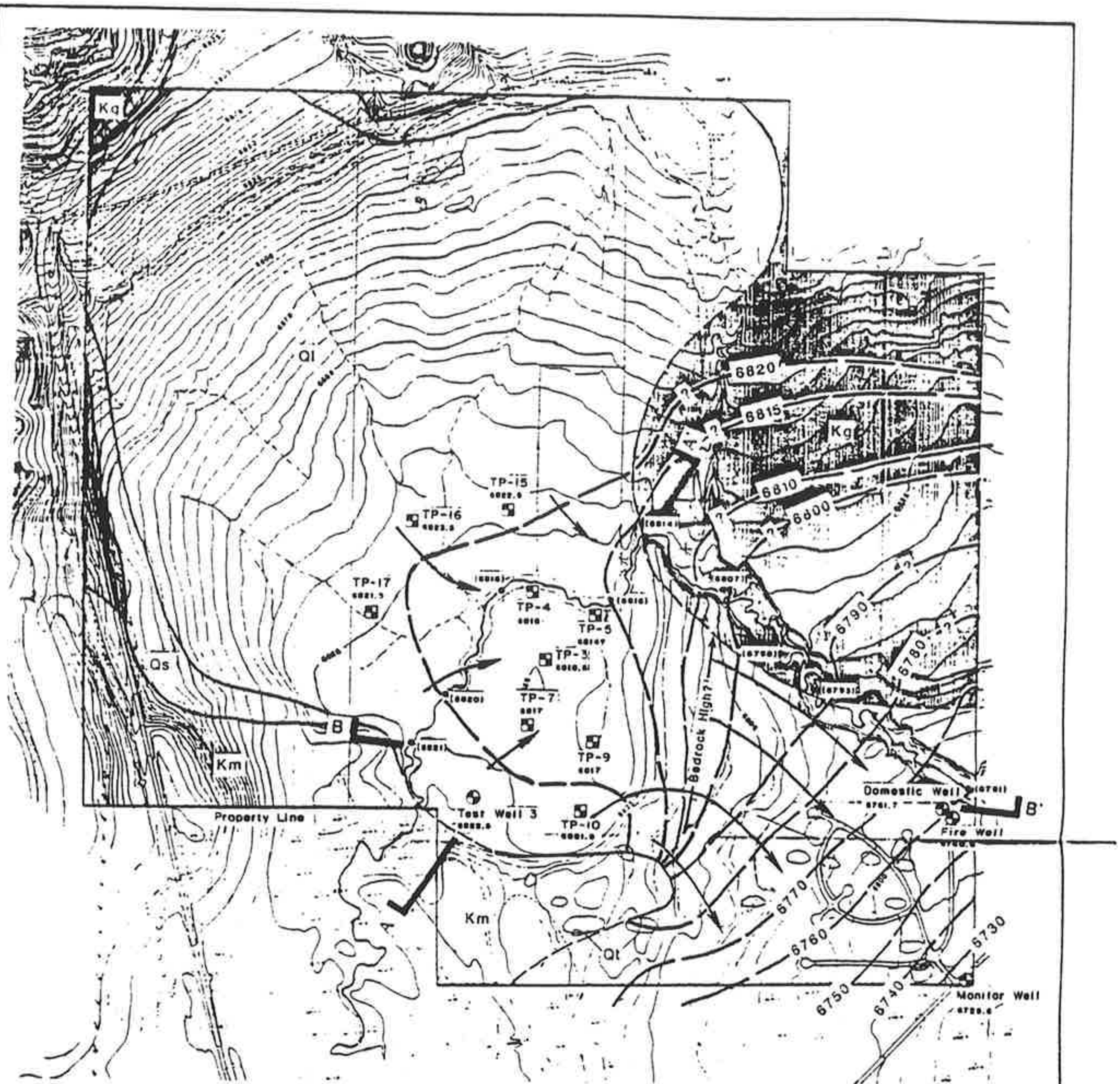
Depth to bedrock varies substantially across the Ranch with rock outcropping at the surface in some areas and bedrock greater than 200 feet deep in other areas. Figure 3, Geologic Map and Groundwater Flow Map, shows our interpretation of areas with near-surface bedrock occurrence. The bedrock is near the surface across the southern property line and in the northeastern portion of the Ranch. We suspect there is also a bedrock high extending north-south parallel to the eastern edge of the central basin. This feature is shown on Figure 3 as a queried bedrock high. Geologic Cross Sections A-A' and B-B' also show our interpretation of bedrock occurrence with depth across the central basin area. Observations from Test Well No. 3 and the well logs from the existing domestic and fire wells were used in developing the Cross Sections.

The bedrock configuration beneath Conway Ranch appears to have resulted in the formation of a small basin in the central part of the Ranch separated from the rest of the Ranch and Mono Basin. This central basin is reflected in the central topographic basin described previously. Basin depth is unknown although Test Well No. 3, located near the southwestern edge of the basin, was drilled to a depth of 171 feet without encountering bedrock.

Test Well No. 3 encountered an upper 30-foot of interbedded silts, sands, and silty clays, underlain by sandy gravels. The fine-grained silts, clays, and sands probably represent sediment deposited in alternating stream and lake environments. The underlying gravels which extend down to approximately 70 feet were likely deposited by high energy streams issuing from the Sierra Nevada. Periods of quiet water deposition are marked by silty clay layers near depths of 50 and 70 feet.

Underlying the sandy gravels is an approximately 20-foot thick layer of very tight mixed silt, sand, and gravel. This deposit appears to be a mudflow or glacial till deposit.

A fairly uniform sandy clay with varying proportions of fine gravel extends from 90 feet to the base of the boring (171 feet). We interpret this to be lake sediment deposited in a prehistoric lake. A detailed geologic log of Test Well 3, along with electric log results and well installation details, is included in Figure 6.




LEGEND:

| | |
|---|---|
| Qs | Slope Wash (Colluvium) or Terrace Deposits |
| Ql | Unconsolidated Sediments (predominantly lacustrine) |
| Qt | Tufa Mounds |
| Kg | Granitic Bedrock exposed at land surface or covered with thin layer of Slopewash or unconsolidated sediment |
| Km | Hornfels (Metamorphic Bedrock) exposed at land surface or covered with thin layer of Slopewash or unconsolidated sediment |
| — — — | Geologic Contact (dashed where inferred) |
| o (6821) | Approximate surface water elevation based on land surface elevation (Triad Survey) |
| 6821.5 | Ground Water Elevation measured in wells or estimated in test pits |
| TP-17 | Approximate location of test pit |
| Fire Well | Approximate location of water supply or groundwater monitoring well |
| —— 6820 | Water table elevation in feet, mid-July, 1987. Datum unknown. |
| → | Approximate direction of groundwater flow |
| A — A' | Conceptual Cross Section Location |

N

0 200 400 800

Scale in feet

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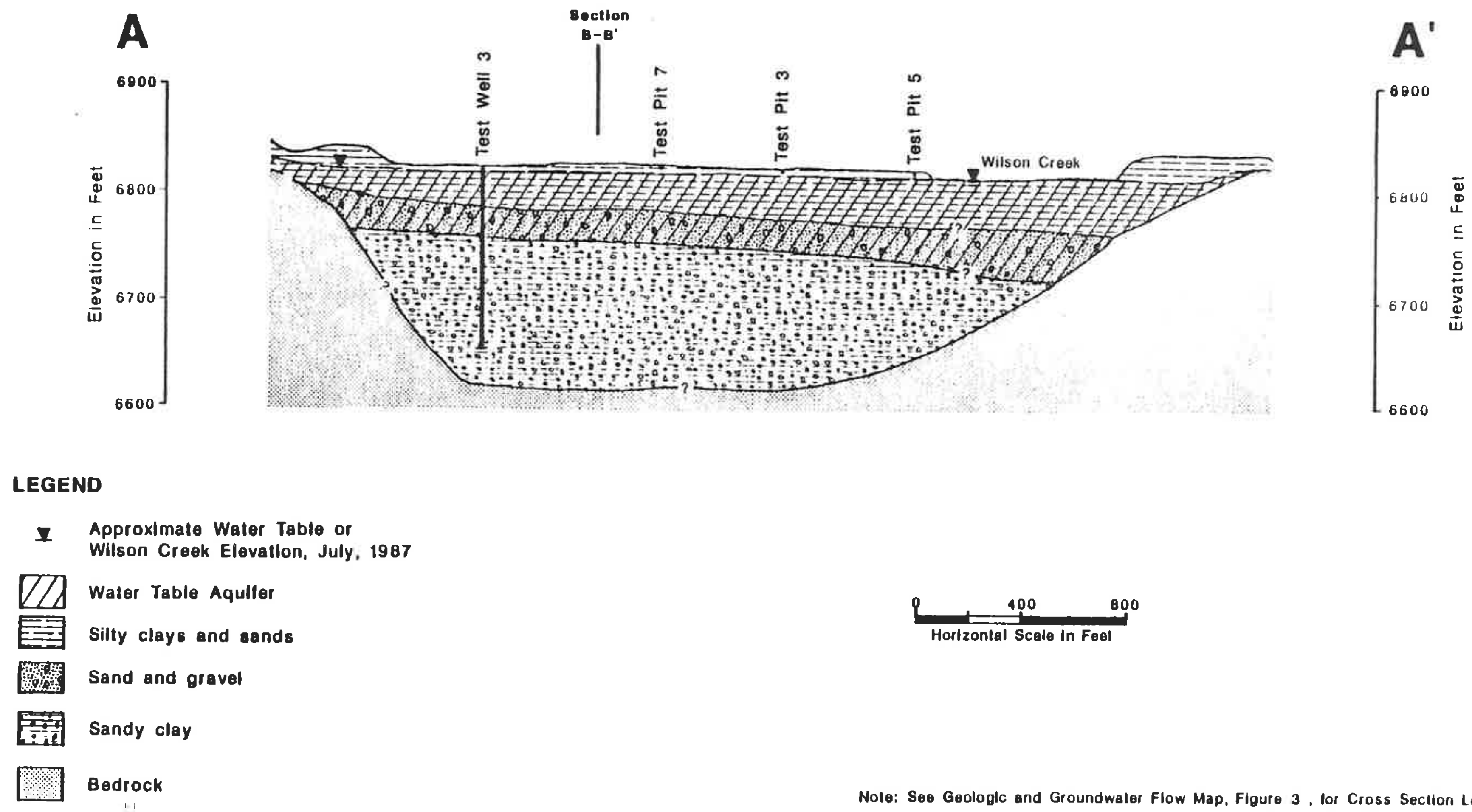
**Geologic and Groundwater Flow Map**
Conway Ranch at Mono Lake
Mono County, California

FIGURE 3

| JOB NUMBER | DRAWN | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| 15248.001 | SL | MAA | 3 August 87 | | |




Note: See Geologic and Groundwater Flow Map, Figure 3, for Cross Section Location.

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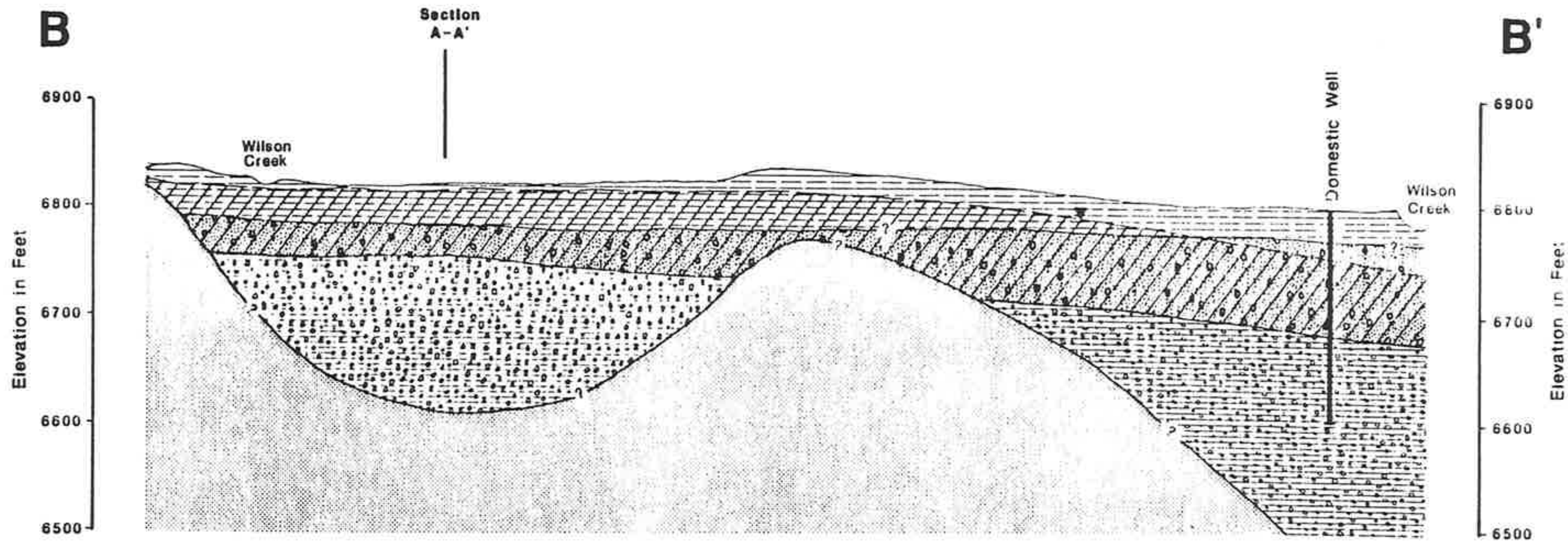
## Conceptual Cross Section A - A'

Conway Ranch at Mono Lake
Mono County, California

FIGURE **4**

| JOB NUMBER | DRAWN | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| 15,248.001 | SL | HAA | 29 July 87 | | |




**LEGEND**

- Approximate Water Table or Wilson Creek Elevation, July, 1987
- Water Table Aquifer
- Silty clays and sands
- Sand and gravel
- Clay and gravel (right side of section) Sandy Clay (left side of section)
- Bedrock

0 400 800
Horizontal Scale in Feet

Note: See Geologic and Groundwater Flow Map, Figure 3, for Cross Section Location.

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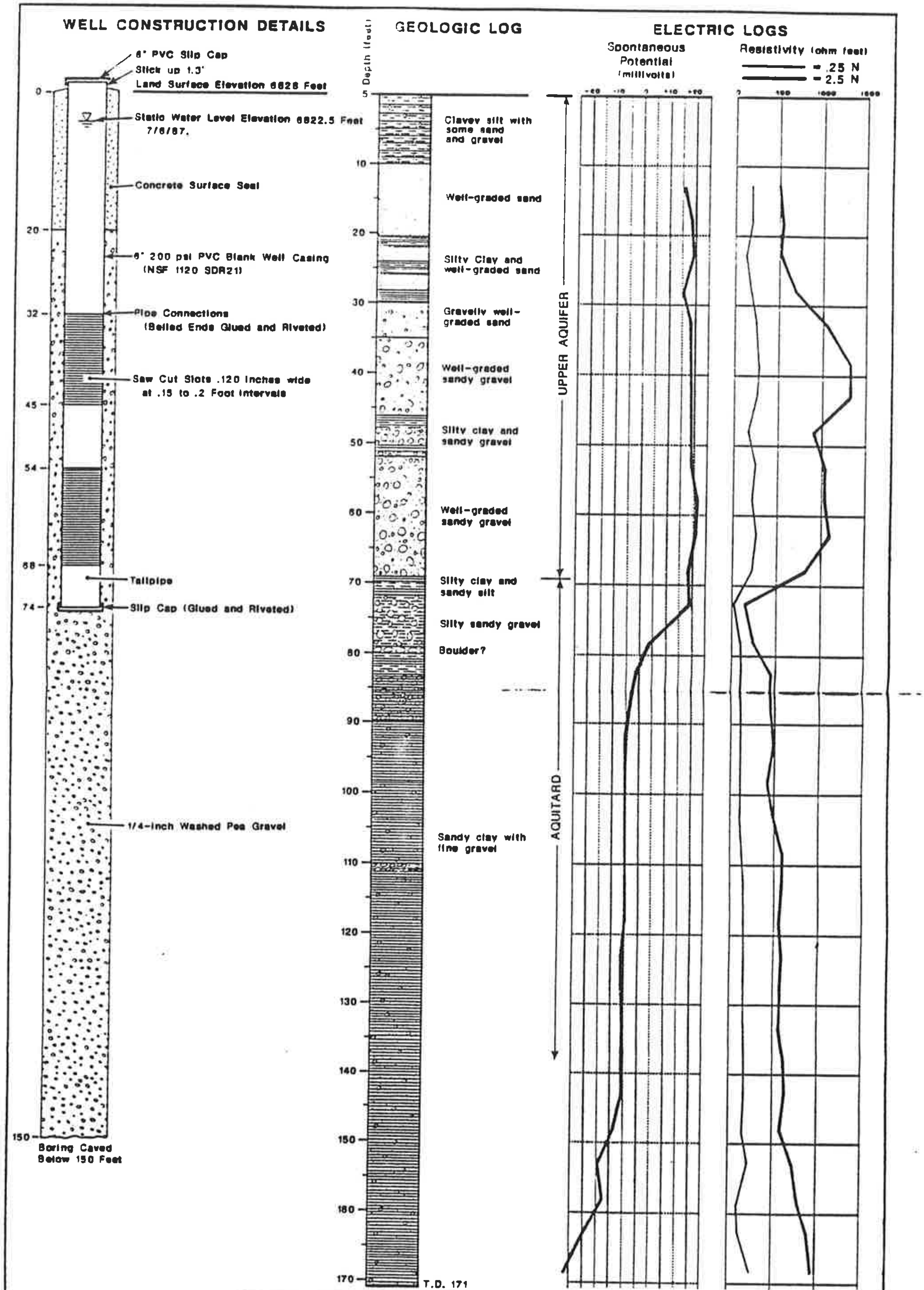
# Conceptual Cross Section B – B'

Conway Ranch at Mono Lake
Mono County, California

FIGURE **5**

| JOB NUMBER | DRAWN | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| 15,248 001 | SL | MAA | 29 July 87 | | |

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**Test Well 3 Geologic & Installation Data**

Conway Ranch at Mono Lake
Mono County, California

FIGURE 6

| JOB NUMBER | DRAWN | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| 15.248.001 | SL | MAA | 29 July 87 | | |

Geologic conditions appear to be somewhat similar on the east side of the bedrock high, based on the driller's logs for the domestic water supply and fire pump well. There are some differences, although it is difficult to tell whether these are true geologic differences or simply differences in interpretation. The sandy clay in Test Well No. 3 correlates with interbedded clay and gravelly clay in the well driller's logs. However, the top of the clayey sediments appears to begin at 115 to 120 feet below land surface, as compared to 70 feet in Test Well No. 3. Similarly, the sand and gravel encountered in Test Well 3 at 30 to 70 feet below land surface correlates with sand and gravel reported at 8 to 115 feet below land surface in the domestic well, and 25 to 120 feet in the fire pump well. Finer-grained silty clays and sands were logged as overlying the gravels in both the domestic and fire wells.

<u>Proposed Lake Area Geology:</u> Seventeen test pits were excavated in the proposed lake area to determine near-surface geologic conditions (test pit locations are shown on Figure 2, Site Plan). As anticipated, the near-surface deposits are comprised primarily of fine-grained silts, silty clays, and silty fine sands. Some organic rich silts and clays are also present as well as coarser-grained sands and gravels and a deposit of dense silty sandy gravel or gravelly sandy silt.

The dense silty sandy gravel deposit was encountered beneath the low ridge which trends north-south between Test Pits 3 and 7. It was also encountered south of Test Pit 7 in Test Pit 8 and north of Test Pit 3 in Test Pit 4. At Test Pit 8, this deposit was covered with approximately 2.5 feet of soft, saturated silty clay and silt. To the north, the deposit rises and was present at the surface in both Test Pits 7 and 3. Further north, the top of the deposit drops beneath overlying clayey silt. No further sign of this deposit was observed in either Test Pit 14 or 15 located north of Test Pit 4.

The silty sandy gravel thickness ranges from 2 feet (Test Pit 4) to greater than 7.5 feet (Test Pit 8). In all Test Pits (except Test Pit 8), the silty sandy gravel was underlain by much softer or looser sediments ranging from silty clay to sandy gravel. Test Pit 8 did not extend through the silty sandy gravel, so the underlying sediments were not reached.

The distribution and character of the silty sandy gravel suggests it is a mudflow deposit which originated in higher areas to the south and flowed out into the central basin. The mudflow deposit overlies older lake and stream sediment and is itself overlain by younger lake sediment.

The near surface sediments in areas away from the low ridge consist of complexly interbedded silts, clays, sands, and gravels. Because of this complexity, it is difficult to describe sediment distribution. However, the sediments observed in the test pits can be grouped into three basic units; uppermost sediments, massive silty clay, and underlying complexly interbedded sediments. In general, the uppermost sediments are the finest grained and grain size increases downward.

The uppermost sediments underlying the root mat (sod) generally consist of soft to hard, brown to dark brown silt, silty clay, or organic silt or clay. Roots from the overlying plants often penetrate this zone, and it is often organic rich. The uppermost sediments generally range between 6 and 24 inches in thickness, but an unusual organic rich black silty sand was encountered in Test Pit 16 extending to 7 feet below land surface.

The water table in the proposed lake area ranges from near land surface to 5 or 6 feet in depth. Consequently, the uppermost sediments range from dry to saturated depending on the water table depth. The sediments are typically hard when dry and soft when saturated.

Underlying the uppermost sediments is a fairly widespread 2 to 5-foot thick layer of massive gray silty clay or clayey silt. In many areas, the clay/silt is saturated and has the consistency of toothpaste. We interpret this deposit to be lake sediment deposited in a prehistoric lake

Beneath the massive silty clay is a complex sequence of interbedded silty clay, silt, silty sand, and sand. The character of these sediments suggests deposition from alternating lake and stream environments. Some coarse grained sandy gravels were also encountered in Test Pits 3 and 4, possibly representing high energy glacial outwash deposits.

### 3.4 <u>Groundwater</u>

<u>Occurrence and Flow</u>: Most groundwater beneath Conway Ranch occurs in the sediments which overlie bedrock. Some groundwater likely occurs in fractures in the bedrock, but is volumetrically insignificant relative to groundwater occurring in the sediments.

Groundwater in the sediments generally occurs under water table conditions. Consequently, the saturated sediments are referred to in this report as the "Water Table Aquifer."

Cross Sections A-A' and B-B' show the inferred location of the Water Table Aquifer. The uppermost silty clays and sands, and the intermediate gravels comprise the Water Table Aquifer. The underlying clayey sediments are not included as they are likely to impede groundwater movement rather than contribute to it. In this report, these clay sediments are referred to as the Clay Aquitard.

The Water Table Aquifer is approximately 65 feet thick at Test Well 3 and 70 feet thick at the Domestic Well. Although the aquifer thicknesses are similar at these two locations, depth to water table is not. Cross Section B-B' shows the water table within 5 to 6 feet of the surface in the central basin area, and dropping to approximately 45 feet below land surface at the Domestic Well. In terms of absolute elevations, the water table elevation was at 6822.5 feet in Test Well 3 and 6761.7 feet in the Domestic Well in July, 1987, an elevation difference of nearly 61 feet. Groundwater elevations measured in the various wells on Conway Ranch are listed in Table 1.

These water elevation relationships and our geologic mapping suggest that groundwater beneath the central basin is separated in part from groundwater in the southeast corner of the Ranch by a bedrock high. In effect, there are two groundwater basins beneath the Ranch.

Groundwater flow beneath the Ranch is generally from the northwest towards the southeast paralleling Wilson Creek as shown on Figure 3. Groundwater entering the central basin is constricted by areas of near surface bedrock such that virtually all outflow from the basin is through a small channel leading towards the southeast corner of the Ranch. Virtually all off-site groundwater flow occurs through this same area.

Recharge: The Water Table Aquifer beneath Conway Ranch is recharged through surface water infiltration and through subsurface lateral flow from the mountainous areas to the north and west. Precipitation in the mountainous areas which does not evaporate either runs off as surface water or infiltrates and moves downslope in bedrock fractures or in loose weathered soil atop unweathered bedrock. Groundwater in the loose weathered soil will readily flow into and recharge the Water Table Aquifer. Groundwater in fractures may or may not reach the Water Table Aquifer, depending on fracture continuity and orientation.

Surface water from the Virginia Creek diversion and from Wilson Creek and its various diversion ditches also serves to recharge the Water Table Aquifer. In the central basin area, groundwater elevations apparently are maintained near land surface by the damming effect of the inferred bedrock high. Consequently, only minor recharge occurs from surface water in this area, as evidenced by the similarity of Wilson Creek and water table elevations. However, significant leakage from Wilson Creek and recharge to the Water Table Aquifer occurs along the southeast trending portion of the creek, where the water table is some distance below the base of the creek. Near the Domestic Well, for example, the water table is 25 to 30 feet below the creek.

TABLE 1: WELL AND GROUNDWATER ELEVATION DATA

| Well No. 1) | Measuring Point | Measuring Point 2) Elevation (feet) | Stickup (feet) | Land Surface Elevation (feet) | Date | Depth to Water (feet) | Water Table Elevation (feet) |
|---|---|---|---|---|---|---|---|
| Test Well 3 | Top of PVC casing | 6829.62 | 1.3 | 6828.3 | 7/6/87 | 7.12 | 6822.5 |
| Domestic Well | Top of sounding tube | 6803.60 | .8 | 6802.8 | 7/6/87 | 41.90 | 6761.7 |
| Fire Well | Top of sounding tube | 6804.88 | 1.3 | 6803.6 | 7/6/87 | 44.31 | 6760.6 |
| Monitoring Well | Top of PVC casing | 6793.47 | 1.9 | 6791.6 | 7/6/87 | 67.92 | 6725.6 |

NOTES:

1) See Figure 2 for well locations.
2) Measuring point elevations based on survey by Triad Associates, assuming Measuring Point Elevation of 6829.62 at Test Well 3.

# 4.0 HYDROLOGIC ANALYSES

## 4.1 Water Balance

As part of this investigation, a water balance has been calculated for the 870-acre portion of the Conway Ranch to assess water flow and availability. The detailed water balance analysis is included in Appendix D. Following is a short discussion of the methodology and results.

The water balance was calculated by summing all inputs to the Ranch and balancing the total against all outputs.

Inputs to the Ranch are as follows:

- Direct precipitation (rain or snow) onto the Ranch property.
- Surface water and groundwater runoff from the adjacent mountains.
- Artificial diversion of surface water onto the Ranch from Wilson Creek and Virginia Creek.

All water entering the Ranch from one of the sources listed above then leaves the Ranch via one of the following routes:

- Evapotranspiration (ET) (combined evaporation and transpiration by plants).
- Surface water runoff principally through Wilson Creek.
- Groundwater flow.

Surface water and groundwater inputs were calculated by first defining three drainage basins in the surrounding mountains and summing the contribution from each basin. The three basins (Areas I, II, III) are slightly modified versions of those defined by Beak (1987). The Ranch property itself is defined as Area IV. Average annual precipitation values provided by Triad Engineering were used for the runoff calculations since the purpose of the analysis is to determine average conditions on the Ranch. Beak (1987) calculated runoff from the drainage basins using Thornthwaite's method as described in Dunne and Leopold (1978). To check Beak's calculations, we used a simplified method where total runoff was considered to be some percentage of average annual precipitation. The appropriate percentage was obtained from Boyle (1984) as reported in Beak (1987), and modified according to the specific conditions in each of the three drainage basins. Values for average annual inputs from the Wilson Creek diversion and the Virginia Creek diversion were also obtained from Beak (1987).

It was not possible to directly calculate surface water output from the Ranch. This is due in part to the fact that most runoff occurs during the spring from snow melt and spring storms, and in part to the lack of any stream discharge records. Without discharge records from a gaging station, it is virtually impossible to accurately calculate surface water outflow. Consequently, surface water output was determined by calculating and summing evapotranspiration and groundwater outflow and subtracting the sum from total inputs as follows:

Surface water output = total inputs to Ranch - (ET + Groundwater outflow)

Evapotranspiration calculations are described in Appendix D.

Groundwater outflow was calculated using Darcy's flow equation where the total discharge across a boundary (Q) is equal to the hydraulic conductivity of the aquifer (k) times the aquifer cross sectional area (A) times the hydraulic gradient (i), or:

$$Q = KiA$$

The cross sectional area thorough which discharge is occurring was determined from the drillers well logs and our geologic mapping. The hydraulic gradient was determined by interpolating water level elevations between the existing wells and the new well (Test Well 3). A value for K was obtained from the pumping test (see Appendix B for the pumping test data and analysis). Appendix C includes the groundwater discharge calculations.

Table 2 summarizes the water balance and compares our calculated values with Beak's (1987). As can be seen, the average annual total inputs and outputs are similar although individual inputs and outputs vary.

## 4.2 Groundwater Safe Yield

Safe yield is traditionally is defined as the volume of groundwater which can be withdrawn from an aquifer and exported from the area in question with no overall reduction in storage. Essentially, safe yield is equivalent to the average annual recharge, since groundwater withdrawals in excess of average annual recharge will result in groundwater "mining".

For the Conway Ranch it is difficult to directly calculate average annual recharge since the groundwater and surface water system (Wilson Creek) are in a state of dynamic balance. Recharge rates through seepage losses from the creek will be greater, for example, during periods of drought than during periods with above average precipitation. An additional difficulty concerns the aquifer configuration beneath the Ranch. As discussed previously, the central part of the Ranch appears to contain a groundwater basin separated to some extent from the larger Mono Basin.

TABLE 2: WATER BALANCE SUMMARY

| Inputs (cfs) | | | Beak (1987) Inputs | |
|---|---|---|---|---|
| Area I | Surface Water Runoff | 5.27 | "Other drainages, Wilson diversions, Groundwater" | 8.7 |
| Area II | Surface Water and Groundwater Runoff | 1.51 | | |
| Area III | Surface Water and Groundwater Runoff | 4.78 | | |
| Area IV | (Conway Ranch) Direct Precipitation | 1.79 | Area IV Precipitation | 0 |
| Wilson Creek Diversion | | 19.00 | Wilson Creek Diversion | 19.4 |
| Virginia Creek Diversion | | 2.30 | Virginia Creek Diverson | 2.3 |
| TOTAL | | 34.65 | TOTAL | 30.4 |

| Outputs | | Beak (1987) Outputs | |
|---|---|---|---|
| Evapotranspiration | 3.8 | Evapotranspiration | .1 |
| Groundwater Flow | 2.4 | Groundwater Flow | 3.0 |
| Surface Water Runoff (Wilson Creek) | 28.45 | Surface Water Runoff (Wilson Creek) | 27.2 |
| TOTAL | 34.65 | TOTAL | 30.4 |

Groundwater apparently fills this separate basin and the water level declines which would normally be expected during periods of drought do not occur in this basin. This results in part from the basin being continuously replenished through seepage from Wilson Creek and in part to the damming effect of the surrounding bedrock highs.

Groundwater flow out of the central basin appears to be constrained to a narrow southeast trending channel (see Figure 3, Geologic and Groundwater Flow Map) bordered by bedrock highs. Groundwater outflow in this channel is probably in a relatively steady-state condition as it appears to be controlled by discharge from the central basin which, as discussed previously, is itself continuously replenished from Wilson Creek. As a consequence, the best available estimate of average annual groundwater recharge is the average volume of off-site discharge through the bedrock channel.

Average annual groundwater discharge has already been calculated for the water balance as 2.4 cfs, or approximately 1100 gallons per minute (gpm). This value is essentially the traditional safe yield. However, for the Conway Ranch, this value is highly conservative since extracted groundwater will not be exported from the Ranch, but will be used to supplement flows in the streams and lake on the Ranch. Some percentage of the extracted groundwater will, therefore, reinfiltrate and recharge the groundwater. The longer the detention time in the lake and streams, the more water will reinfiltrate. Essentially, the Ranch could be considered a closed loop system with groundwater extraction at the lower edge of the property and reinjection in the upper part. Because of this situation, we believe a more realistic safe yield would be about 1500 gpm, assuming approximately 30% reinfiltration of extracted groundwater.

### 4.3 Groundwater Storage

Groundwater storage is the total volume of groundwater held within the Conway Ranch boundaries which can be removed by pumping. Since groundwater only occupies the pore spaces between sediment grains, the total volume of groundwater is dependent on aquifer porosity. However, not all groundwater in pores can be removed by drainage or pumping from a well as some water will be held through molecular and surface tension forces. The volume percentage of water which can be removed is called the specific yield, and generally ranges between 10% and 35% for sands and gravels. Clays and other fine grained sediments typically yield much less, on the order of 3% to 5%.

Based on the pumping test data from the domestic water supply and fire pump wells, the aquifer acts as though it were, on average, a coarse sand. A coarse sand generally has a porosity of 35 to 40% and will yield about 30% (Todd, 1959, p.24).

To calculate storage, the aquifer thickness and areal extent are multiplied to determine aquifer volume. The aquifer volume is then multiplied by the percentage yield (specific yield) to obtain total storage. For the Conway Ranch, the aquifer geometry is not known with certainty. However, we made conservative assumptions about the areal aquifer extent and then calculated aquifer volume assuming a saturated thickness of 80 feet southeast of the bedrock high and 60 feet in the central basin. The resulting total volume is 700,000,000 cubic feet. With a specific yield of 30%, the total volume of groundwater storage equals 212,100,000 $ft^3$ (or about 4,900 acre feet). Groundwater storage calculations are described in more detail in Appendix C.

## 4.4 Lake Evaporation Losses

Loeffler (1977) reports studies by the Los Angeles Department of Water and Power indicating 39.6 inches/year evaporation from an on-land pan near Grant Lake and 42 inches/year from a floating pan on Grant Lake. Evaporation at Grant Lake can be considered similar to evaporation from the proposed Conway Ranch lake. Grant Lake is a freshwater lake and is about 600 feet higher in elevation than Mono Lake. Conway Ranch will also be freshwater and 400-500 feet higher than Mono Lake. Assuming an average evaporation rate of 40.8 inches/year, the total evaporation which can be expected from the proposed 33 acre lake is 112.2 acre feet/year or .15 cfs.

The 40.8 inches/year evaporation rate is almost identical to the 40.4 inches/year average annual potential evapotranspiration rate calculated by Beak (1987) for Conway Ranch. Under most conditions, actual evapotranspiration from land areas is considerably less than potential evapotranspiration because of insufficient soil moisture during the dry season to satisfy vegetation demand. The proposed lake area, however, currently stays wet throughout the entire year because of the shallow groundwater table and numerous irrigation ditches. Consequently, the actual evapotranspiration rate is likely close to the potential rate. Replacing the land with a lake should, therefore, result in only slightly greater evaporation losses.

# 5.0 PROPOSED LAKE CONSTRUCTION

## 5.1 Lake Excavation

Construction of the 33-acre lake to a depth of 10 to 15 feet below existing grade, as currently planned, will entail a fairly significant earth moving operation. Heavy equipment will be necessary to excavate the required volume of soil, and trucks and bulldozers will be necessary to move the excavated soils away from the lake and then grade it to some planned elevation.

Because of the shallow water table and the soft to extremely soft soils in the proposed lake area, normal excavation procedures using trucks and bull-dozers will not be possible unless the excavation area is first dewatered. Dewatering might be accomplished through installation of shallow ground-water extraction wells around the proposed lake perimeter. However, we do not believe this would be feasible because of the large area involved. One way to compensate for the area limitation is to dewater and then excavate a series of smaller areas until the entire excavation was complete. However, this would be very costly as it would require the installation and removal of numerous wells.

Other excavation methods can be used below the water table. Below-water excavation can be accomplished with either a large hydraulic backhoe or a crane equipped with a drag line. The backhoe has several important advan-tages over the drag line including the ability to excavate a smooth, clean bottom and to deposit excavated soil directly into trucks for transport to the soil disposal area. Drag lines, by contrast, often leave a rough bottom, create more turbid conditions, and dump excavated soil onto the ground where it has to be picked up again for loading into trucks. Drag lines are also slower than backhoes, but they can reach further out into areas with difficult access. Backhoes with large 4 or 5 cubic yard buckets are available to expedite excavation work.

Whichever equipment is chosen, access onto the soft ground is likely to be a problem. Mud mats, wooden planks, or other support devices will almost assuredly be necessary.

## 5.2 Seepage Losses

Seepage losses through the bottom of the lake will be essentially nil because of the shallow groundwater conditions. However, water will flow through the downstream edge of the lake into the adjoining Water Table Aquifer. The rate of outflow will be balanced in whole or part by groundwater inflow along the upstream edge of the lake. It is not possible to calculate how much water will outflow laterally relative to lateral inflow without more information than is currently available. Consequently, we believe it would be prudent to provide some type of liner along the downstream edge of the lake to limit lateral seepage losses.

The simplest liner construction method would be to stockpile clay-rich soils during excavation of the lake area and then place these stockpiled soils as a 2 to 3-foot thick liner. Other commercial plastic liners or liner materials are available but would be costly.

### 5.3 Organic Soil Volume

The type and thickness of organic-rich sediment varies considerably across the proposed lake area. In some areas, there is essentially no topsoil or organic rich sediments (see logs from Test Pits 3, 4, and 7), and in others there is up to 84 inches of organic-rich sediment. Also, in some areas, the organic-rich material is at land surface and in others it is buried beneath 2 to 3 feet of non-organic soil. Because of this complexity, it is not possible to define distinct areas with uniform organic sediment thickness. Consequently, we have calculated the total volume of organic sediment by averaging thicknesses from all test pits and multiplying the resulting average by the proposed lake area (33 acres or 1,437,480 square feet). We believe this approach is relatively accurate since the test pits are spread fairly uniformly across the proposed lake area.

The average organic sediment thickness is 17.5 inches. This thickness over 33 acres results in a total volume of approximately 2,100,000 cubic feet.

The organic sediment varies from organic clay to silty sand, but generally is a brown silty clay or clayey silt with organic matter. Because it is typically clay rich, you might consider adding sand as an amendment before using it as topsoil in landscape or golf course areas.

# REFERENCES


Beak Consultants Inc., May 1987, Draft EIR Sections Conway Ranch at Mono Lake. Hydrology and Water Resources/Water Quality. Biological Resources. Mineral Resources; report submitted to Conway Ranch Partnership.

Dunne, T. and Leopold, L., 1978, Water in Environmental Planning, W.H. Freeman and Company, 818 pages.

J.H. Kleinfelder & Associates, Jan. 1983, Preliminary Geotechnical Engineering and Geology Report for Master Planning Purposes, Conway Ranch, Mono County, California; report submitted to Conway Ranch Development Company.

Todd, D.K., 1959, Ground Water Hydrology, John Wiley & Sons, 335 pages.

Loeffler, R.M., 1977, Geology and Hydrology, Chapter 2 in D.W. Winkler (editor), An Ecological Study of Mono Lake, California; University of California Davis Institute of Ecology Publication No. 12.

# APPENDIX A

## Test Well No. 3 Installation and Well Logs

### Well Drilling Procedures

Test Well No. 3 was drilled with an Ingersoll Rand T4W drill rig equipped for fluid rotary operations. Drilling fluid composed of a water/bentonite powder mixture was continually flushed down the bore hole as drilling proceeded. Returning fluid carrying drill cuttings was discharged into a small ditch which emptied into a larger settling pit.

Drilling began on July 2, 1987, and was completed on the same day with the borehole at a total depth of 171 feet. Our geologist was on the drill site essentially full time during drilling and made a careful record of drilling operations and geologic conditions encountered in the boring.

Prior to beginning drilling, the uppermost aquifer was anticipated to be approximately 120 feet thick, as measured from land surface. However, during drilling it appeared permeable, water-bearing sediments (Water Table Aquifer) only extended downwards to about 70 feet and were underlain by a thick sequence of non-water bearing sandy clays. Drilling was halted after penetrating 100 feet of the non-water bearing clays, as it did not appear worthwhile to continue drilling for purely exploratory purposes.

### Electrical Logging

Immediately following completion of the boring, downhole electrical logs were run to confirm and refine the geologic interpretations made during drilling. Results from the electrical logs confirmed our geologic interpretations and indicated two major water-bearing zones at approximately 30 to 45 feet and 52 to 69 feet below land surface. A well was then designed with screened sections in the two zones. Results from the electric logs as well as the geologic log are shown on Figure 6.

### Well Installation

Well installation began and was completed on July 3, 1987. Construction details are shown on Figure 6.

### Well Development

Immediately following well installation, well development began using air from a compressor mounted on the drill rig. Initially, approximately 50 gallons per minute was discharged from the well, but this increased to approximately 145 gpm by the end of development on July 6, 1987. During development, water conductivity and temperature were monitored as well as the volume of sand being discharged per liter of water. Initially, approximately 0.5 sf sand was being discharged. This reduced to approximately 0.02 ml by the end of development. A copy of our field well development record is included in this Appendix.

## Pumping Tests

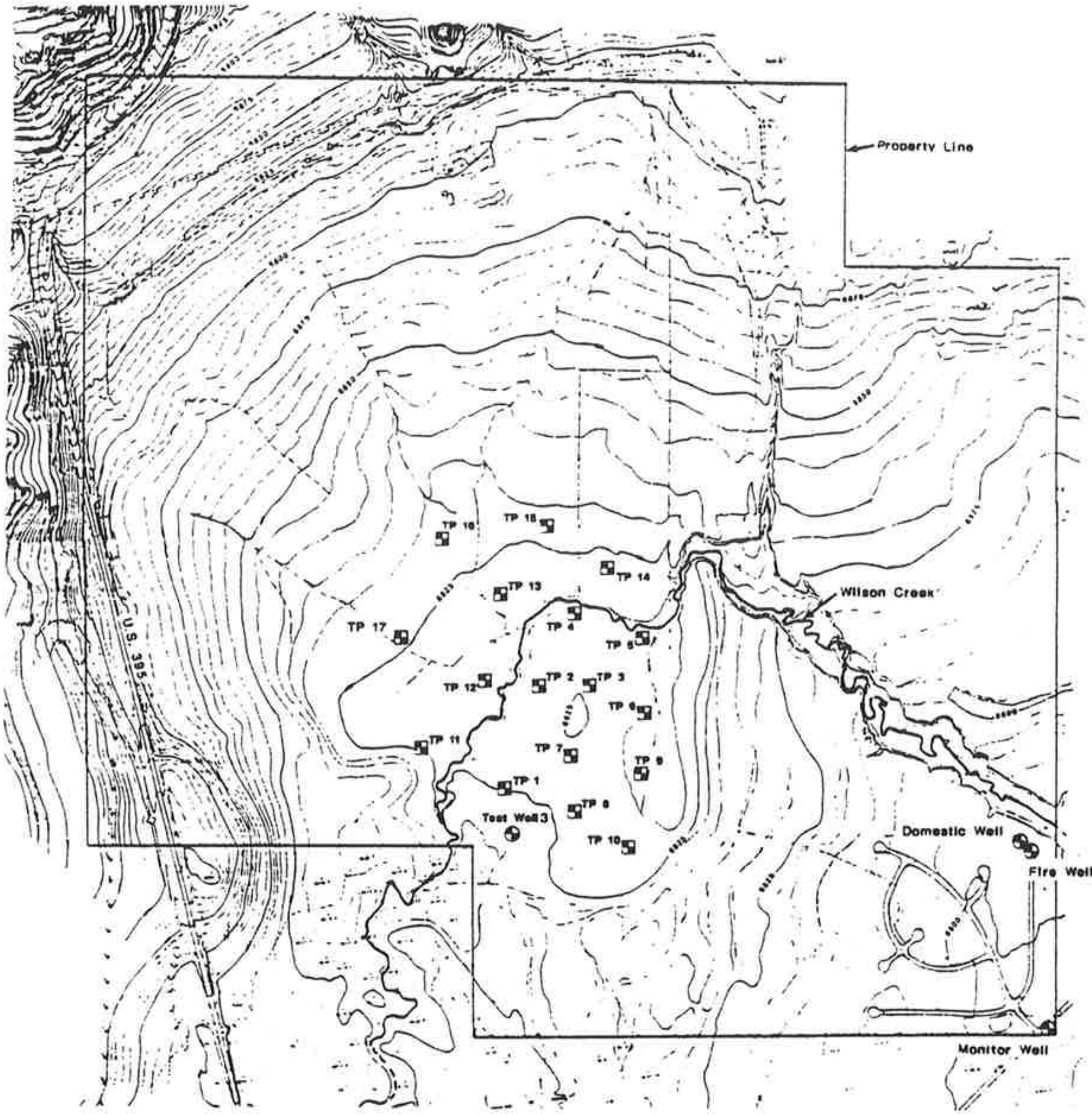
A crude water level recovery test was attempted after well development to evaluate aquifer parameters and well performance. The test consisted of monitoring water levels after shutting off the air lift. Unfortunately, the earliest water level measurement possible was 20 seconds after air lift shut-off and the water level rebounded to near static level within another 40 seconds. Consequently, no meaningful analysis could be performed, although the rapid water level rise does indicate fairly permeable conditions.

A second test was attempted using a electric submersible capable of discharging 30 gpm. This pump rate produced only 1.2 feet of drawdown.

## Well Specific Capacity and Allowable Pumping Rate

Since the best available well capacity data is from the air lift recovery test, we have used it to calculate a specific capacity of 3.8 gpm/foot of drawdown. Assuming 26 feet of available drawdown to the top of the uppermost screen, the allowable pumping rate would be 100 gpm. However, during well development a flow of nearly 150 gpm was sustained for over an hour suggesting the allowable pumping rate is probably higher than 100 gpm. If the well is ever utilized as a water supply, a more accurate pumping test at a higher pumping rate would be advisable.

Following is Figure 2 showing well locations and Figure 6 showing Test Well 3 construction details and the geologic and electric logs. Also included following Figure 6 is a well development record and copies of the well drilling logs for the Domestic, Fire Pump, and Monitoring Wells.




LEGEND:

Approximate location of groundwater monitoring or water supply well

7 Approximate location and number of test pit

—6825— Elevation in feet

N

0 200 400 800

Scale in Feet

Reference: Undated topographic base map provided by Triad Engineering, 1987

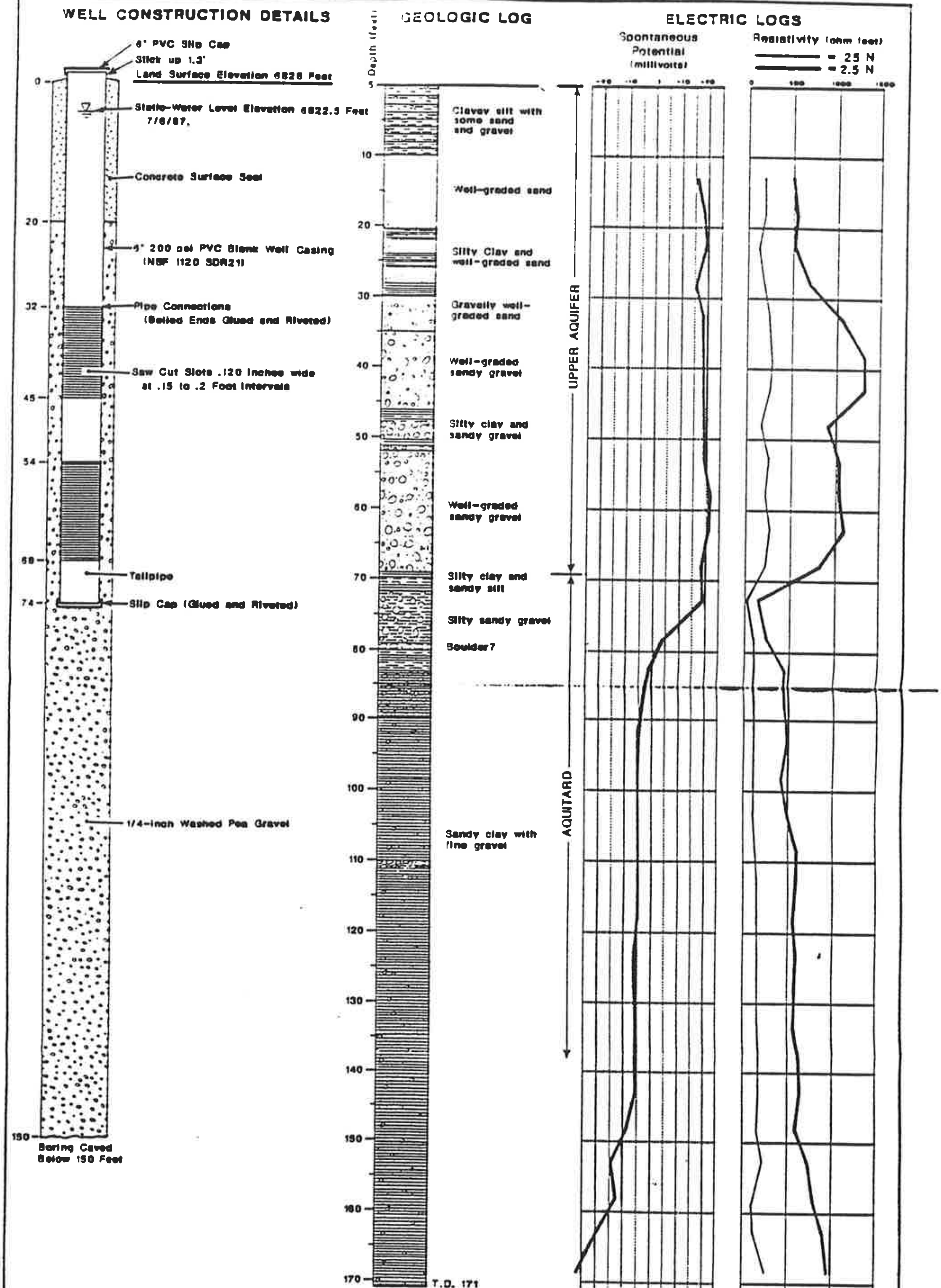
Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

**Site Plan**

Conway Ranch at Mono Lake
Mono County, California

FIGURE **2**

| JOB NUMBER | DRAWN | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| 15248.001 | SL | MAA | 3 August 87 | | |




Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

**Test Well 3 Geologic & Installation Data**

Conway Ranch at Mono Lake
Mono County, California

FIGURE 6

| JOB NUMBER | DRAWN | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| 15,248.001 | SL | MAA | 29 July 87 | | |

DUPLICATE
...ot comply with
...al requirements

Intent No. [illegible]

Permit No. or Date

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
# WATER WELL DRILLERS REPORT

Do not fill in

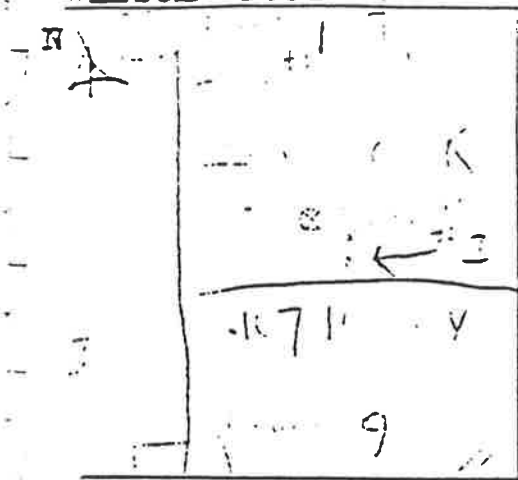
No. 231278

State Well No.

Other Well No.

OWNER: Name [illegible]
Address General Delevery
June Lake Ca. Zip 93529

LOCATION OF WELL (See instructions)
County Mono Owner's Well Number 3
Well address if different from above 395 Highway & 167 Highway
Township 3N Range 26E Section 6
Distance from cities, roads, railroads, fences, etc. 1/2 mi. north of Highway 167, 1.5 miles West of Highway 395, 275 ft. South West Wilson Creek



WELL LOCATION SKETCH

(3) TYPE OF WORK:
New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:
Domestic ☐
Irrigation ☐
Industrial ☐
Test Well ☒
Stock ☐
Municipal ☐
Other ☐

EQUIPMENT:
Rotary ☒ Reverse ☐
Cable ☐ Air ☐
Other ☐ Bucket ☐

(6) GRAVEL PACK:
Yes ☒ No ☐ Size 3/8"
Diameter of bore 18"
Packed from 20 to 80 ft.

CASING INSTALLED:
Steel ☐ Plastic ☐ Concrete ☐

(8) PERFORATIONS:
Type of perforation or size of screen

| From ft. | To ft. | Dia. in. | Gage or Wall | From ft. | To ft. | Slot size |
|---|---|---|---|---|---|---|
| | 80 | 8" | 1/4" | 25 | 85 | 1/8 X 3" |
| | | | | | | |
| | | | | | | |

WELL SEAL:
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 20 ft.
Were strata sealed against pollution? Yes ☐ No ☒ Interval ft.
Method of sealing Cement Grout

WATER LEVELS:
Depth of first water, if known ? ft.
Standing level after well completion ? US ft.

WELL TESTS:
Was well test made? Yes ☒ No ☐ If yes, by whom?
Type of test Pump ☐ Bailer ☐ Air lift ☐
Depth to water at start of test ft. At end of test ft.
Discharge gal/min after hours Water temperature
Chemical analysis made? Yes ☐ No ☐ If yes, by whom?
Electric log made? Yes ☐ No ☐ If yes, attach copy to this report

(12) WELL LOG: Total depth 80 ft. Depth of completed well 80

| from ft. | to ft. | Formation. Describe by color, character, size or material |
|---|---|---|
| 0 | 2 | Sand |
| 2 | 12 | Clay |
| 12 | 50 | Gravle |
| 50 | 80 | Gravle & Clay |

JUL 2 8 1982
MONO COUNTY HEALTH DEPARTMENT

Work started 5-25 1982 Completed 5-28 1982

WELL DRILLER'S STATEMENT:
*This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.*

SIGNED [signature]
(Well Driller)

NAME Maranatha Drilling & Pump Service
(Person, firm, or corporation) (Typed or printed)

Address Rt. 4 Box 18 C
City Bishop Ca. Zip 92514
License No. 417231 Date of this report 6-26-82

DWR 188 (REV. 7-76) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

[illegible]ICATE
[illegible]omply with
[illegible] requirements

180-20

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
# WATER WELL DRILLERS REPORT

Do not fill

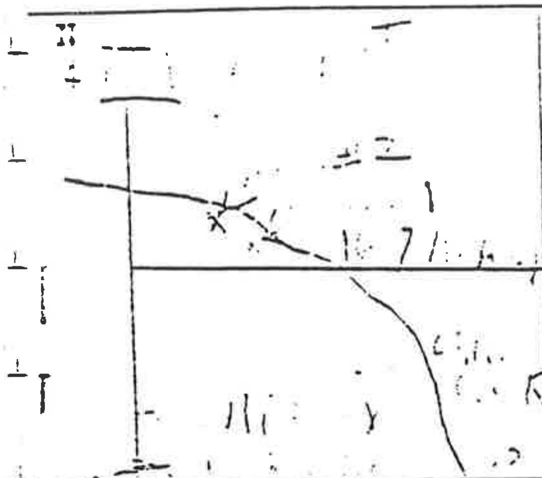
No. 231276

State Well No. ______
Other Well No. ______

[illegible] of Intent No. ______
[illegible] ermit No. or Date ______

**OWNER:** Name John Fredrickson
General Delevery
Address June Lake Ca. Zip 93529

**LOCATION OF WELL** (See instructions)
County ______ Owner's Well Number 2
Address if different from above 305 Highway [illegible]
Township 3[illegible] Range 26[illegible] Section 6
Distance from cities, roads, railroads, fences, etc. 1/2 Mile North of Highway 167, I [illegible] Miles East of Highway [illegible] [illegible] West of Wilson Creek



WELL LOCATION SKETCH

**(3) TYPE OF WORK:**
New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

**(4) PROPOSED USE:**
Domestic ☐
Irrigation ☐
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☒
Other ☐

**(12) WELL LOG:** Total depth 204 ft. Depth of completed well 200 ft.

| from ft. | to ft. | Formation (Describe by color, character, size of material) |
|---|---|---|
| 0 | - [illegible] | [illegible] |
| [illegible] | - [illegible] | [illegible] Clay |
| [illegible] | - 60 | Gravle & Sand |
| 60 | - 75 | [illegible] |
| 75 | - 85 | [illegible] |
| 85 | - 90 | [illegible] Gravle |
| 90 | - 95 | [illegible] & Gravle |
| 95 | - 100 | [illegible] |
| 100 | - 115 | [illegible] & Gravle |
| 115 | - 130 | Brown Clay |
| 130 | - 135 | Gravle |
| 135 | - 175 | Clay & Gravle |
| 175 | - 180 | Clay |
| 180 | - 190 | Clay & Gravle |
| 190 | - 200 | Clay |

RECEIVED
JUL [illegible] 1982
[illegible] COUNTY [illegible] HEALTH DEPARTMENT

**EQUIPMENT:**
Rotary ☒ Reverse ☐
[illegible] ☐ Air ☐
[illegible] ☐ Bucket ☐

**(6) GRAVEL PACK:**
Yes ☒ No ☐ Size 3/8"
Diameter of bore 18"
Packed from 50 to 204 ft.

**(7) CASING INSTALLED:**
Steel ☒ Plastic ☐ Concrete ☐

| From ft. | To ft. | Dia. in. | Gage or Wall |
|---|---|---|---|
| 0 | 204 | 16 | .219 |

**(8) PERFORATIONS:**
Type of perforation or size of screen

| From ft. | To ft. | Slot size |
|---|---|---|
| [illegible] | 180 | [illegible] |

**(9) WELL SEAL:**
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 50 ft.
Were strata sealed against pollution? Yes ☐ No ☒ Interval ______ ft.
Method of sealing Cement

**(10) WATER LEVELS:**
Depth of first water, if known 50 ft.
Standing level after well completion 40' 6" [illegible] ft.

**(11) WELL TESTS:**
Was well test made? Yes ☐ No ☐ If yes, by whom? [illegible]
Type of test Pump ☐ Bailer ☐ Air lift ☐
Depth to water at start of test 06 ft. At end of test 4[illegible] ft.
Discharge [illegible] gal/min after 4[illegible] hours Water temperature 46
Chemical analysis made? Yes ☐ No ☒ If yes, by whom?
Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

Work started 4-26 1982 Completed 7-4 19[illegible]

**WELL DRILLER'S STATEMENT:**
*This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.*

SIGNED [signature] (Well Driller)

NAME HARAHATHA Drilling & Pump Service
(Person, firm, or corporation) (Typed or printed)
Address Rt. 4 Box 180
City Bishop Ca. Zip 93514
License No. 417231 Date of this report 7-26-82

DWR 188 (REV. 7-76) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

FIRE PUMP WELL

Do not fill

..ICATE
. comply with
l requirements

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
WATER WELL DRILLERS REPORT

No. 231275

State Well No. ______

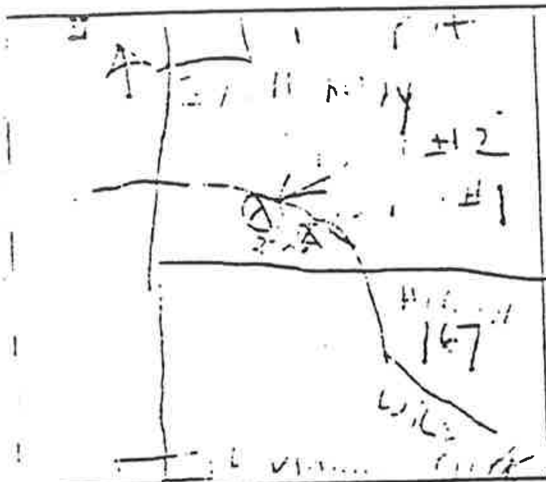
Other Well No. ______

Intent No. I30229

...ermit No. or Date ______

(1) OWNER: Name John Fredrickson
June Lake General Delivery Ca. 93529
June Lake Zip 93529

(2) LOCATION OF WELL (See instructions): I
County Mono Owner's Well Number ______
Address if different from above ______
Township 3. Range 26 Section 6
1/2 Mile North
Distance from cities, roads, railroads, fences, etc. Highway 167, .5 Miles East of Highway
.5 mi. West of Wilson Creek



WELL LOCATION SKETCH

(3) TYPE OF WORK:
New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:
Domestic ☐
Irrigation ☐
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☒
Other ☐

(12) WELL LOG: Total depth ______ ft. Depth of completed well ______ ft.
from ft. to ft. Formation (Describe by color, character, size of material)

| | | |
|---|---|---|
| 0 | 5 | Silty Clay |
| 5 | 15 | Gravle |
| 15 | 25 | Tan Clay |
| 25 | 35 | Gravle |
| 35 | 45 | Sand |
| 45 | 50 | Tan Clay |
| 50 | 85 | Sand |
| 85 | 120 | Gravle |
| 120 | 125 | Stickey Clay |
| 125 | 145 | Clay & Gravle |
| 145 | 150 | Clay |
| 150 | 155 | Gravle & Clay |
| 155 | 160 | Sand |
| 160 | 163 | Clay |
| 163 | 165 | Gravle |
| 165 | 169 | Stickey Clay Blue |
| 169 | 176 | Clay & Gravle |
| 176 | 206 | Gravle |

JUL 28 1982
MONO COUNTY HEALTH DEPARTMENT

(5) EQUIPMENT:
Rotary ☒ Reverse ☐
Cable ☐ Air ☐
Other ☐ Bucket ☐

(6) GRAVEL PACK:
Yes ☒ No ☐ Size 3/8
Diameter of bore 18" to 190
Packed from 50 to 190 ft.

(7) CASING INSTALLED:
Steel ☒ Plastic ☐ Concrete ☐

| From ft. | To ft. | Dia. in. | Gage or Wall |
|---|---|---|---|
| | 185 | 10 | .219 |

(8) PERFORATIONS:
Type of perforation or size of screen ______

| From ft. | To ft. | Slot size |
|---|---|---|
| | | |

(9) WELL SEAL:
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 50' ft.
Were strata sealed against pollution? Yes ☐ No ☒ Interval ______ ft.
Method of sealing Cement, Concret

(10) WATER LEVELS:
Depth of first water, if known 50' 6" ft.
Standing level after well completion 40' 3" ft.

(11) WELL TESTS:
Was well test made? Yes ☒ No ☐ If yes, by whom? US
Type of test Pump ☐ 40' Bailer ☐ Air lift 40
Depth to water at start of test 23' At end of test 46' ft
Discharge 630 gal/min after 48 hours Water temperature ______
Chemical analysis made? Yes ☐ No ☒ If yes, by whom? ______
Was electric log made? Yes ☐ No ☐ If yes, attach copy to this report

Work started ______ 19 82 Completed 7-1 19 ______

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
SIGNED ______ (Well Driller)
NAME ______ (Person, firm, or corporation) (Typed or printed)
Address Rt. 4 Box 15 C
City Bishop, Ca. Zip 93514
License No. 417271 Date of this report 7-22-82

DWR 188 (REV. 7-76) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

# APPENDIX B

## Pumping Test Data and Analyses

### Methodology

A pumping test was conducted on July 6 and 7, 1987, using the Fire Pump Well as a pumping well and the Domestic Well as a monitoring well. Depth to water was measured periodically in the other wells (Monitoring Well and Test Well No. 3); however, they snowed no effect from the pumping.

The Fire Pump Well was pumped at a rate of approximately 250 gpm, according to an in-line gage at the pump house. This pump rate was not verified independently.

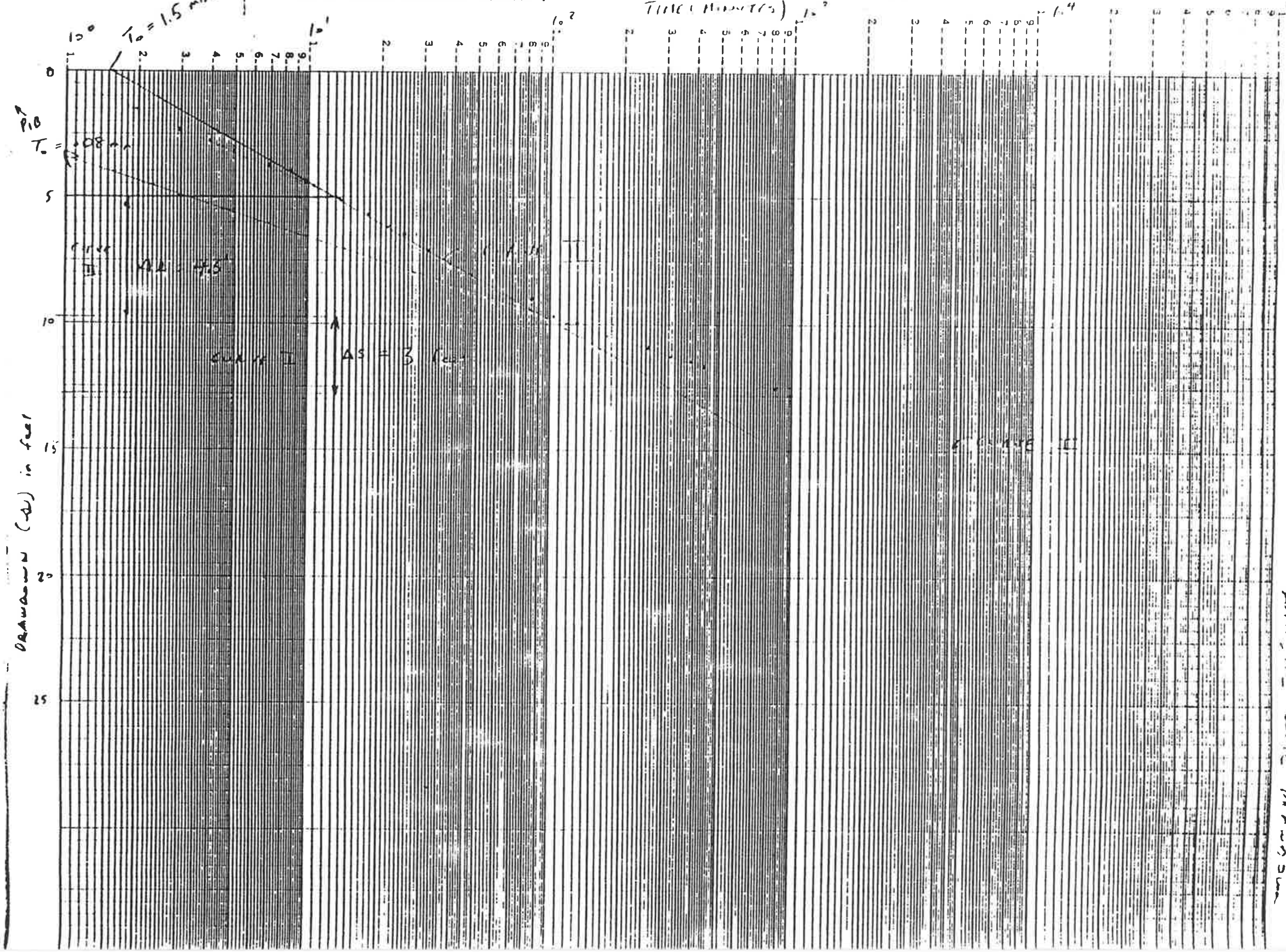
The Fire Pump Well was shut off after 16 hours because it appeared water levels had nearly stabilized in the Domestic Well. Total drawdown was approximately 20 feet in the pumped well and approximately 13 feet in the monitoring well. This data indicates a specific capacity of 12.5 gpm/foot of drawdown in the Fire Pump Well.

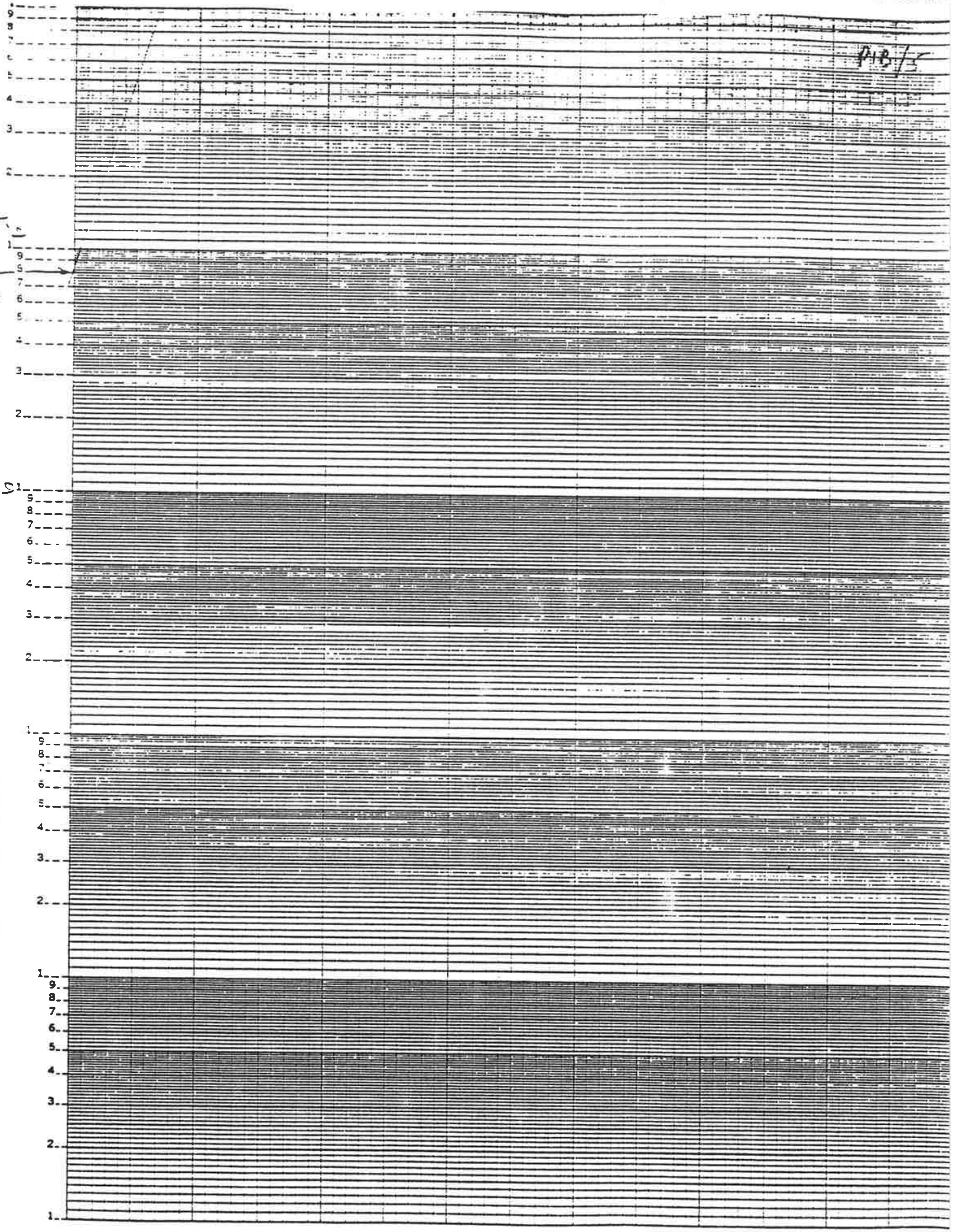
Data from the pumping was analyzed using several different methods includ-ing the This recovery, This drawdown, and Jacob straightline solutions. Results were fairly consistent with an average hydraulic conductivity of 0.017 feet/minute or 0.008 cm/sec.

Following is the pumping test data and analyses.

K•E SEMI-LOGARITHMIC 5 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 6210




P1B/3
$r_o = \#$
$h^{-1}$
46 6210
K•E SEMI-LOGARITHMIC 5 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

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SHEET 2 OF 5
JOB NO. 5-24f-001
DATE 7/15/97
COMPUTER BY MFA
CHECKED BY CJT

PROJECT Conway
SUBJECT Jacob: Analysis Domestic Well Drawdown

Reference: Kruseman + Ridder, 1979

CURVE I

ANALYSIS METHOD Jacob (Cooper + Jacob, 1946) where

$$K = \frac{2.30Q}{4\pi\Delta s}\frac{1}{D} \quad \text{and} \quad S = \frac{2.25KDt_0}{r^2}$$

where

K = hydraulic conductivity in feet/minute

D = Aquifer thickness in feet = 72'

Q = Pump discharge in $ft^3/min$ = (250 gpm)(=.1337) = 33.4

$\Delta s$ = Drawdown in feet over one log cycle = 3.0' (see P1)

$t_0$ = where s = 0 = .08 minutes (see P1)

r = distance in feet between observation well and pumped well = 99'

so:

$$K = \frac{(2.30)(33.4\ ft^3/min)}{(4)(3.14)(3.0\ ft)(72\ feet)} = 2.83 \times 10^{-2}\ feet/min$$

$$= 1.4 \times 10^{-2}\ cm/sec$$

$$S = \frac{(2.25)(2.83\times10^{-2}\ ft/min)(72\ feet)(.08\ min)}{(99)(99)\ ft^2}$$

$$= .000037 = 3.7 \times 10^{-5}$$

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SHEET 3a OF 5
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PROJECT
SUBJECT

Redo Jacobs calculations

$T = \frac{264\ Q}{\Delta s}$ and $S = \frac{0.3\ T\ t_0}{r^2}$ (from Johnson 1975)

where
T = Transmissivity in gpd/ft = KD
Q = discharge in gpm = 250
Δs = as before = 3 feet
$t_0$ = as before
S = Storage Coefficient

$T = \frac{(264)(250)}{3} = \frac{66000}{3} = 22,000$ gpd/ft

T = KD = 22,000 gpd/ft

$K = \frac{22,000 \text{ gpd/ft}}{72 \text{ ft}} = 305.6$ gal/day/ft$^2$ gpd/ft$^2$

(305.6 gal/day/ft$^2$)(.0000473) = .014 cm/sec
= $1.4 \times 10^{-2}$ cm/sec
(Same as on #2)

$S = \frac{(.3)(22,000)(\cancel{.07})}{(97)(99)}$ .0000556 day .000056

= ~~.054~~ $3.74 \times 10^{-5}$

So K = .014 cm/sec or $2.83 \times 10^{-2}$ ft/min

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SHEET 3b OF 5
JOB NO. 15 2-F 551
DATE 7/14/87
PROJECT Conurn
SUBJECT Draw-Down Analysis
COMPUTER BY MCN
CHECKED BY

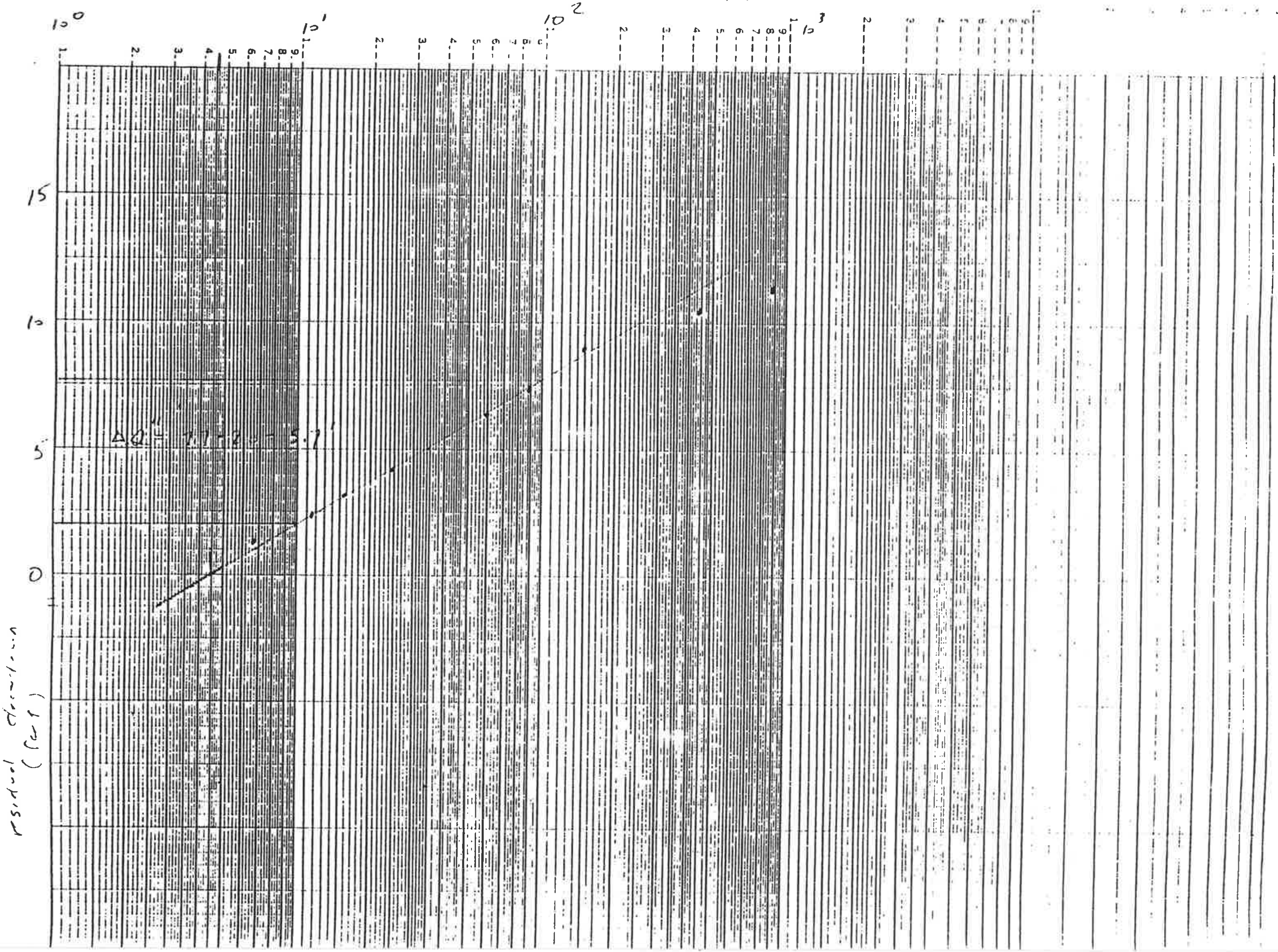
Curve II

$\Delta h$ new = 4.5'

$$K = \frac{(2.30)(33.4)}{(4)(3.14)(4.5)(72)} = .0189 \text{ ft/min} = 9.6 \times 10^{-3} \text{ cm/sec}$$

K·E SEMI-LOGARITHMIC 5 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 6210



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SHEET 5 OF 5
JOB NO. [illegible]
DATE [illegible]
COMPUTER BY [illegible]
CHECKED BY

PROJECT [illegible]
SUBJECT [illegible]

Method: Theis Recovery, as in Kruseman & Ridder, 1970

$$KD = \frac{2.30\,Q}{4\pi\,\Delta s''} \quad \therefore \quad K = \frac{2.30\,Q}{4\pi\,\Delta s''\,D}$$

$$= \frac{(2.30)(334\ \text{ft}^3/\text{min})}{(4)(3.14)(5.7')(72')} = .0149\ \text{ft/min}$$

$$= 7.5 \times 10^{-3}\ \text{cm/sec}$$

=

COMPARING

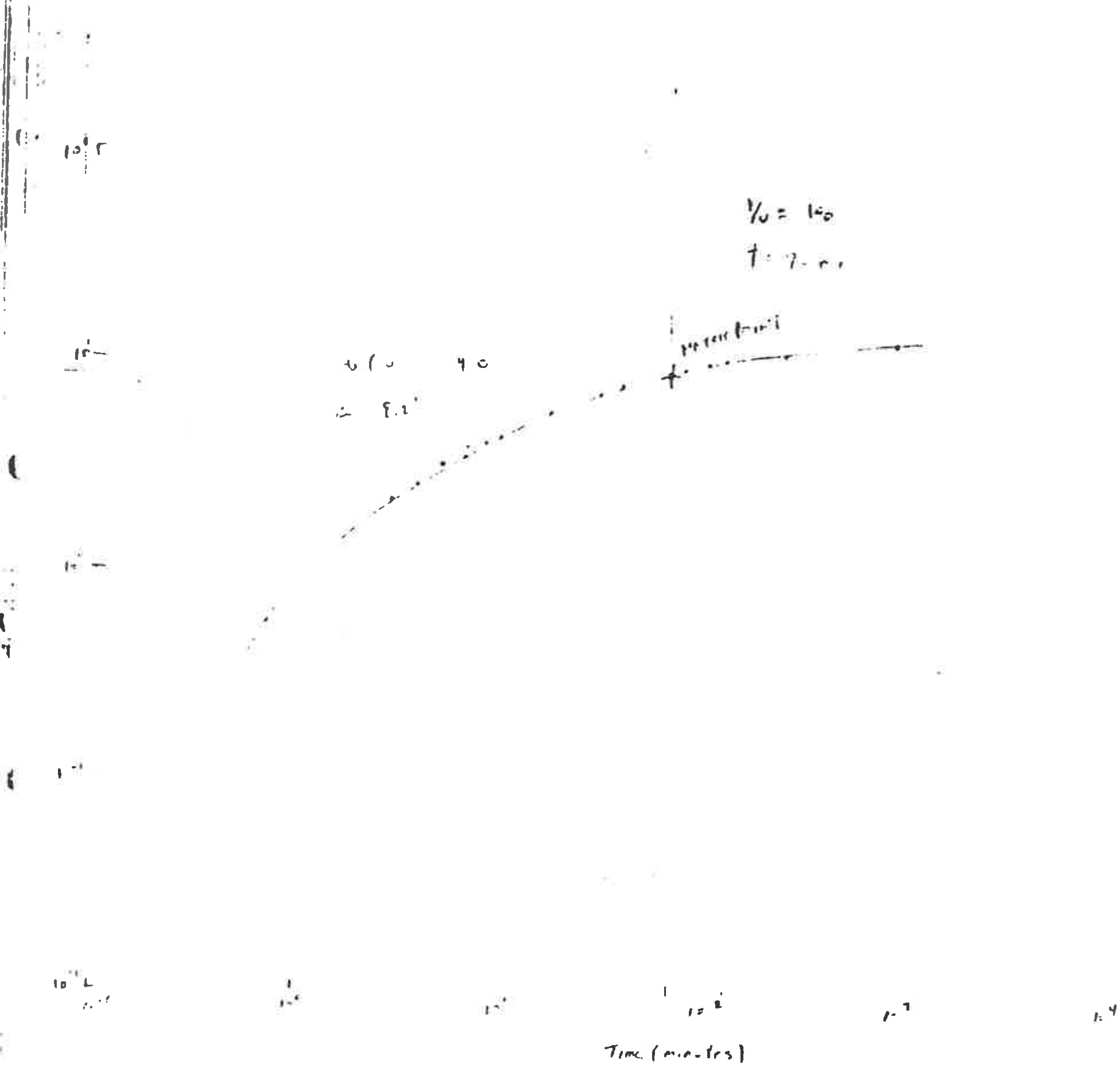
| | | | | |
|---|---|---|---|---|
| | Recovery | K = | .0149 | ft/min |
| Curve I | Drawdown | K = | .0283 | ft/min ← Do not use |
| Curve II | Drawdown | K = | .0189 | ft/min |
| | Theis Drawdown | K = | .018 | ft/min |
| Average | | | .017 | ft/min |

≈ .02 ft/min

= .017 ft/min

= .008 cm/sec

.009 ←
.015
.019
.028




$Q = 25$ gallons/min $= 3.34$ ft³/[illegible]

$s = 8.2'$

$t = 70$ min

$r = 40'$ [illegible]

$D = 72'$

Values of $1/u$ [illegible] Lohman, 1972 [illegible] 9, [illegible]

Theis (see Lohman, 1972)

$$T = \frac{Q}{4\pi s} (W)(u) = \frac{(3.34 \text{ ft}^3/\text{min})[illegible]}{[illegible]} = 1.3 \; [illegible]$$

$$K = \frac{T}{D} = \frac{.13 \text{ ft}^2/\text{min}}{72'} = .02 \text{ ft}/[illegible]$$

$= .0011$ [illegible]

$= .01$ cm/sec

Drawdown Analysis

# APPENDIX C

Groundwater Flow and Storage Analysis

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SHEET 1 OF 3
JOB NO. 15 248 001
DATE 7/14/87
COMPUTER BY MAA
CHECKED BY [illegible]

PROJECT Conway
SUBJECT Offsite G.W. Flow

Statement: G.W. flow will be calculated at the site exit (red line on following page 2) using Darcy's Law:

$$Q = kia$$

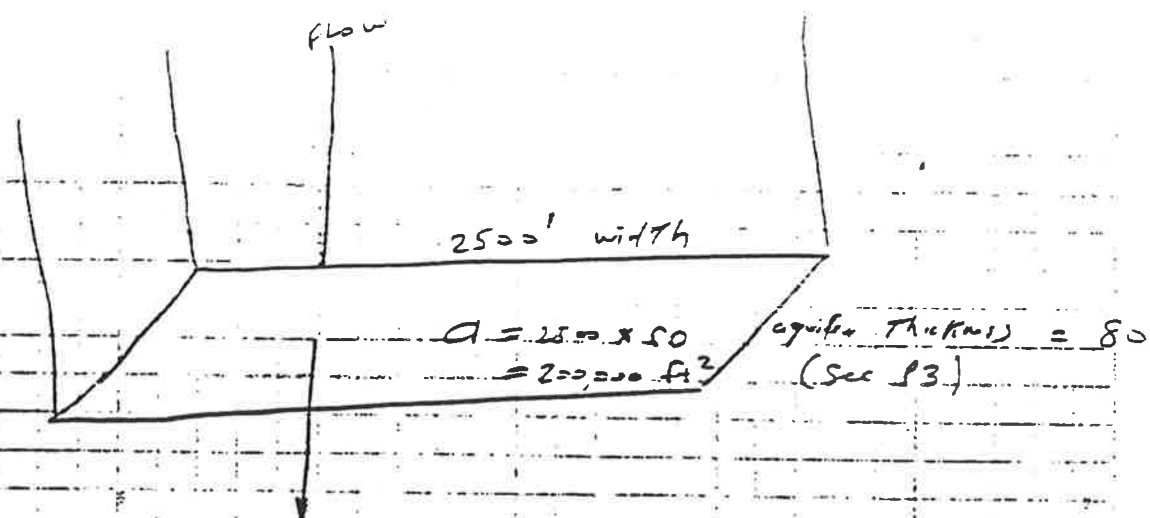
where:

$Q$ = Discharge in CFS

$k$ = hydraulic conductivity as determined from five well pumping test = .02 ft/min

$i$ = hydraulic gradient = .036 (see P2)

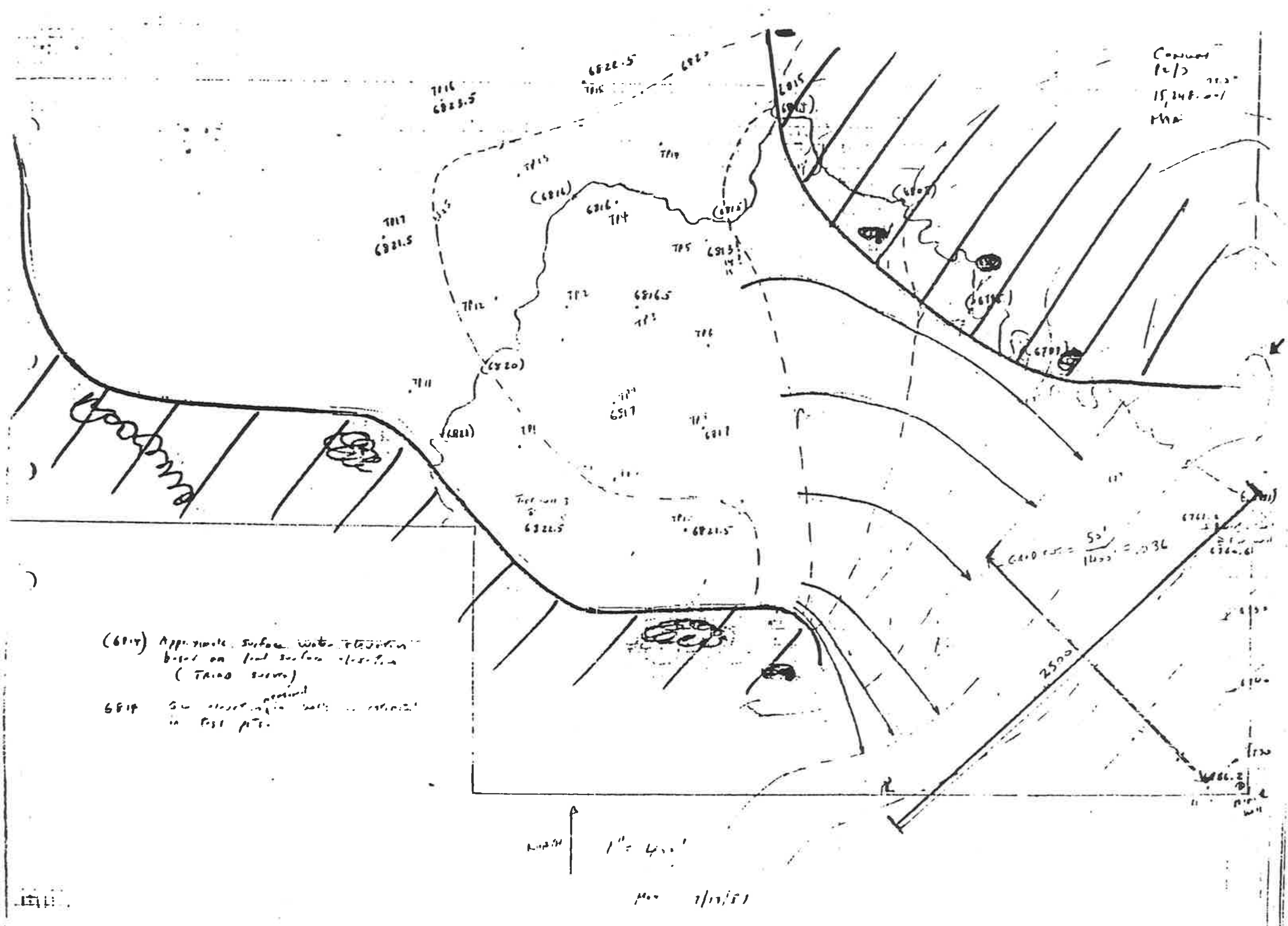
$a$ = area through which groundwater discharges perpendicular to flow (aquifer thickness times width) = 200,000 ft²




So

$$Q = (.02\ ft/min)(.036)(200{,}000\ ft^2)\left(\frac{1\ min}{60\ sec}\right)$$

$$= 2.40\ CFS\ \checkmark$$


6822.5
6823.5
6821.5
(6816)
6816
(6815)
6813
6816.5
(6820)
(6821)
6817
6822.5
6821.5
2500
NORTH
(6814) Approximate surface water elevation based on field surface elevation (TRIAD survey)

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SHEET 3 OF 3
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DATE
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PROJECT
SUBJECT

Aquifer Thickness

Domestic well: water depth below G. Surface = ~43'
base of aquifer (based on drillers logs) = 115

$\boxed{72}$

Fire well: water depth ~43
Base of aquifer 120

$\boxed{77}$

Monitor well

The aquifer thickness was measured in July 87 during a period of semi-drought (year).

Consequently water levels are probably slightly lower than normal.

Use 80 feet as average thickness.

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SHEET 1 OF ___
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DATE 7/17/87
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PROJECT [illegible]
SUBJECT G.W. Storage Calcs

Discussion

The calculation is of the total volume of water available storage of the (County Road) ground.

Available water is defined as the specific yield or that portion available from gravity drainage.

See Todd, G.W. Hydrology 1959 p 2– → For sands, the specific yield is generally 95 to 80% of the porosity.

The pumping test data from the domestic well indicates the aquifer is sand, therefore an average porosity of 30% will be assumed

Todd 1959 → with a specific yield of 25%

Calculation

Storage = (specific yield)(volume)

= (.25)(7 × 10⁸ ft³)

see 1.2/2

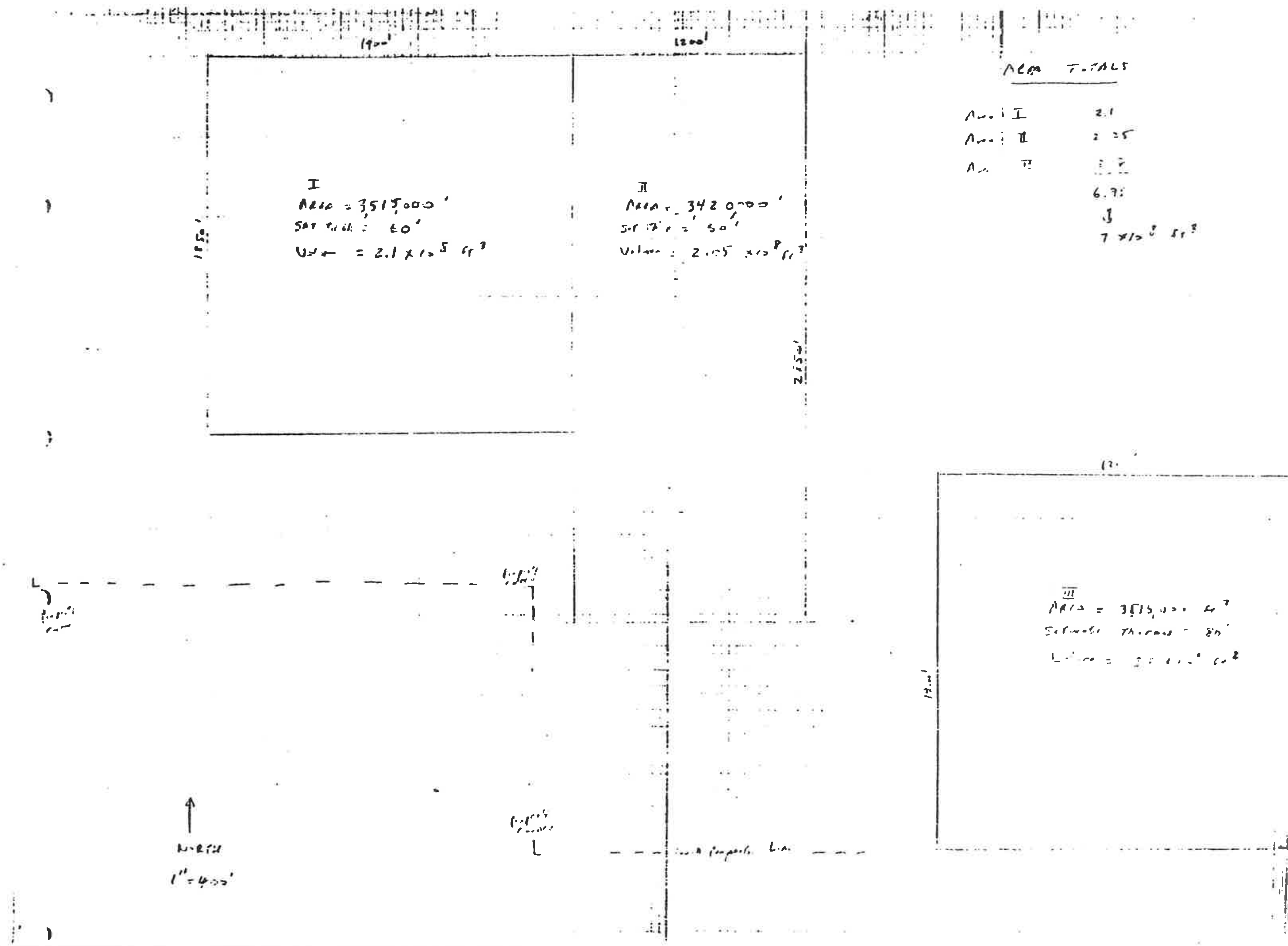
= 1.75 × 10⁸ ft³

= 175,000,000 ft³

Or

.30 × 7 × 10⁸ ft³

= 2.1 × 10⁸ ft³


1900'
1200'
I
Area = 3515,000'
Sat thick = 60'
Volume = 2.1 x 10^5 ft^3
II
Area = 3420000'
Sat thick = 50'
Volume = 2.05 x 10^8 ft^3
1850'
2150'
AREA TOTALS
Area I 2.1
Area II 2.35
6.75
7 x 10^8 ft^3
III
Area = 3515,000 ft^2
Saturated Thickness = 80'
North
1" = 400'

# APPENDIX D

Water Balance Analysis

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SHEET 1 OF [illegible]
JOB NO. [illegible]
DATE [illegible]
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PROJECT [illegible]
SUBJECT [illegible]

Area IV

[illegible] + [illegible] + [illegible]

= 37,574,200 ft² ÷ 5280 ft · 5280 ft = 1.35 mi²

Beak's [illegible] 1.43 mi²

Area I

looks about right

Beak calculated 5.74 mi² for a smaller area.

Area I as used in this analysis includes Beak's area I plus an additional area traversed by Wilson Creek

This area is essentially (3000 ft)(6000) = 18000000 ft²

(see attached drainage area)

18,000,000 ÷ (5280)(5280) = .65 mi²

So new Area I total = 5.74 + .65 = 6.39

Area II

BEAKS Area II essentially coincides with Area II as used in this analysis. They calculate 1.38 mi² which looks about right

Area III

Beak calculates 5.66 mi² for an Area III which includes part of Area IV as used in this analysis

The excluded area is = 1/2 (5300)(6500) − (1250)(1450) =

= 15,412,500 ft² ÷ 5280² ft²/mi² = .55 miles

So: 5.66 mi² − .55 mi² = 5.11 mi²

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SHEET 2 OF 3
JOB NO. [illegible]
DATE [illegible]
COMPUTER BY [illegible]
CHECKED BY

PROJECT
SUBJECT [illegible] Area Calcs.

| | [illegible] Area | AGI Area |
|---|---|---|
| I | 5.74 | 6.39 |
| II | 1.38 | 1.38 |
| III | 5.66 | 5.11 |
| IV | 1.43 | 1.35 |
| TOTAL | 14.21 | 14.23 |

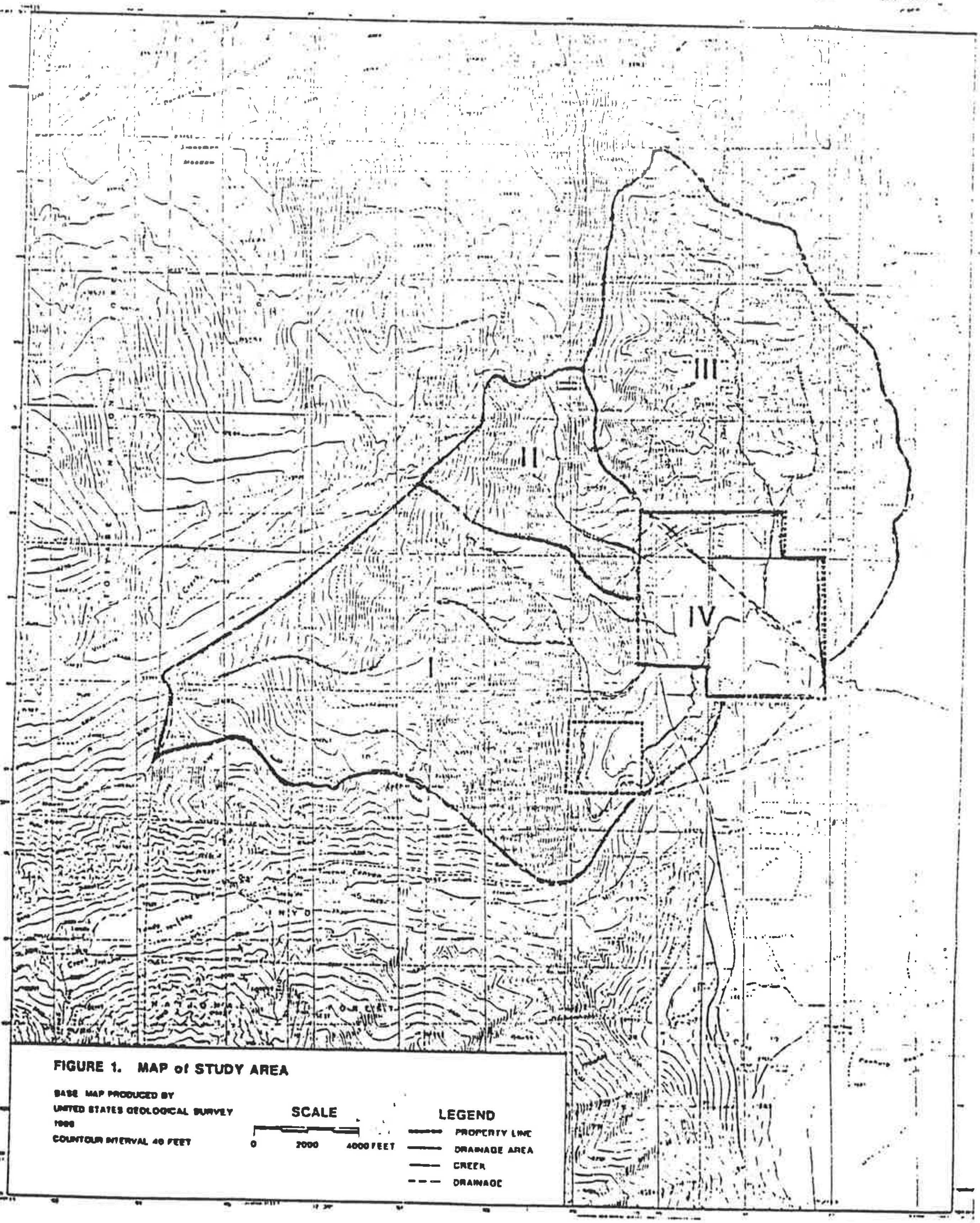


**FIGURE 1. MAP of STUDY AREA**

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DATE 7/13/87
COMPUTER BY MAB
CHECKED BY BF

PROJECT Conway Ranch
SUBJECT Water Balance

## Outline of Water Balance Analysis

Following is a schematic of the Conway Ranch water balance:

**INPUTS** = **OUTPUTS**

Inputs:

- Area I Surface water runoff
- Area II Surface water and groundwater runoff
- Area III Surface water and groundwater runoff
- Area IV Precipitation
- Wilson Creek discharge
- Virginia Creek Diversion

RANCH (Area IV)

Outputs:

- EVAPOTRANSPIRATION
- SURFACE WATER RUNOFF (Wilson Creek)
- Groundwater outflow

NOTE: Areas I, II, III, IV are BEAK drainage areas (Beak, 1987)

Calculations for each input and output are on the following pages 2 through 8. A summary table showing average ... values is on page 9.

Much of the data used in this analysis is from BEAK's 1987 report, "DRAFT EIR SECTIONS – CONWAY RANCH AT MONO LAKE." Drainage area calculations are separate

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PROJECT
SUBJECT Water Balance

## Area I inputs

Narrative: The only source of water to the area is from direct precipitation (snow or rain); we assume no groundwater underflow from higher areas to the west. Precipitation either runs off, infiltrates and flows towards as groundwater, or evapotranspirates. For this area, only surface water runoff inputs to Conway Ranch; Evapotranspiration is lost to the atmosphere and groundwater flow is diverted away from Conway Ranch by a bedrock high along the southern property line.

Runoff calculation: Thornthwaite method is not appropriate for this calculation, as most runoff occurs during storm events or as spring melting from snow packs. Consequently, we will use a factor X Annual precipitation to arrive at a runoff volume. Boyle (1984) (as reported in Beck, 1987) reports 40 to 60% of annual precip discharges as runoff. We will use 50% and consider it does not include groundwater flow (surface water infiltration).

So: 25.0" X .50 = 12.5 "/year ✓

Average Annual Precip
(Jim Cignisli, Communication, 1987)

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JOB NO. 15 246 ...
DATE 7/13/77
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PROJECT
SUBJECT WATER BALANCE

$12.5\ \text{in/year} = (12.5\ \text{in/year} \times .083\ \text{ft/in}) \times 6.79\ \text{mi}^2$ (drainage area)

$\times (2.79 \times 10^7\ \text{ft}^2/\text{mi}^2) \div (365\ \text{days/year}) \div (24\ \text{hrs/day})$

$\div (60\ \text{min/hr}) \div (60\ \text{sec/min})$

$$\boxed{12.5\ \text{in/year} = \quad = 5.83\ \text{ft}^3/\text{sec} \qquad \text{AREA I}}$$

✓ RUNOFF ALONE

## Area II Inputs

Narrative: All precipitation (snow + rain) in Area II eventually reaches Conway River through surface water runoff or groundwater flow, except that which evaporates. The input from this area is therefore precipitation minus evaporation or surface water runoff plus groundwater flow. We assume no underflow from higher areas to the west.

Calculation: The runoff calculation is essentially the same as already described for Area I (Page 2) with the following modifications:

- The percentage runoff is increased to 60% of annual precipitation because of the steep slopes in Area II.
- An additional 10% of annual precipitation is taken as water which has infiltrated and is traveling downslope as groundwater.

Therefore:

$$(.60 + .10) \times (20 \text{ in/year}) = 14 \text{ in/year}$$

Average Annual Precip - Jim Ognisty, 1987

.42

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SHEET 4b OF [illegible]
JOB NO. [illegible]
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PROJECT
SUBJECT [illegible]

Appr II [illegible]

14 in/year over 1.38 mi² =

↑ from 1985

$$14 \times (0.083\ ft/in) \times (1.38\ mi^2) \times (2.97 \times 10^7\ ft^2/mi^2)$$
$$\div (365\ days/year) \div (24\ hrs/day) \div (60\ min/hr) \div (60\ secs/min)$$

$$= \boxed{1.51\ cfs} \checkmark \quad or \quad 4.76 \times 10^7\ ft^3/year \checkmark$$

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SHEET 51 OF [illegible]
JOB NO. [illegible]
DATE [illegible]
COMPUTER BY [illegible]
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PROJECT
SUBJECT Water Balance

Area III Inputs

Narrative: The hydrologic situation in this area is essentially the same as in Area II (see page 4)

Calculation: The runoff calculation is essentially the same as already described for Area I & II with a .60 factor used including both surface water runoff and g.w. flow. This is probably conservative, as most water probably runs off in the spring and evaporation probably does not account for a full 40% of annual precipitation

Therefore:

$(.60) \times (18 \text{ in/year}) = 10.80 \text{ in/year runoff}$

Average Annual Precip - [illegible] Ogrisky, Trend

10.8 in/year over 5.11 mi² = (10.8 in/yr) × (.083 ft/in) × (5.11 × (2.97 × 10⁷ ft²/mi²) ÷ (365 [illegible]
÷ (24 hrs/day) ÷ (60 min/hr)
÷ (60 secs/min) = 4.32 c[illegible] ft[illegible]

$\boxed{= 4.32 \text{ cfs}}$ ✓

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SHEET 5B OF 9
JOB NO. 15,248.001
DATE 7/14/87
COMPUTER BY MAA
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PROJECT Conway...
SUBJECT Water Balance

## Area IV Inputs

The only input to this area is precipitation.

Average annual precip = 16 in/year (Jim Ogwin, 1987)

16 in/year over 1.35 mi² = (16 in/year)(.083 ft/in)(2.97×10⁷ ft²/mi²)(1.35 mi²) ÷ (365 days/year)(24 hr/day)(60 min/hr)(60 sec/min)

$\boxed{= 1.69\ ft^3/sec\ \ CFS}$ ✓

## Wilson Creek Inputs

Narrative: Wilson Creek receives most of its water from Lundy Lake diversions, and is thus mostly independent of runoff from the surrounding area I (Area I input is calculated separately on pages 2 and 3). According to DFAK, 1987 figures, the average annual discharge to Wilson Creek from the powerhouse is 24.3 CFS. Since Conway Ranch can only divert 19.0 CFS for its own use, we will use 19.0 CFS as the average annual usable discharge to the property. This is conservative as the excess over 19 CFS would also serve to recharge groundwater at Conway Ranch after times of drought. Note that 19 CFS includes the

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DATE [illegible]
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PROJECT
SUBJECT [illegible]

Combined [illegible] flow from the upper and lower [illegible] Creek, for purposes of this analysis, we are assuming no flow in the [illegible] and all flow through Wilson Creek.

Then for Wilson Creek Input = $\boxed{19 \text{ CFS}}$

## VIRGINIA CREEK DIVERSION INPUTS

Note: According to Beck (1987) the average annual input from Virginia Creek is 2.3 cfs

$\boxed{2.3 \text{ cfs}}$

most of which occurs between April and August

## INPUTS SUMMARY

| | INPUT FLOW |
|---|---|
| AREA I | 5.87 |
| AREA II | 1.51 |
| AREA III | 4.32 |
| AREA IV | 1.69 |
| WILSON CREEK | 19.00 |
| VIRGINIA CREEK | 2.30 |

✓ 34.69 cfs TOTAL AVERAGE ANNUAL INPUT TO CONWAY RANCH

$\boxed{\text{SAY } 35 \text{ cfs}}$

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PROJECT
SUBJECT WATER BALANCE

SHEET 7 OF 9
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DATE 7/14/87
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CHECKED BY

## EVAPOTRANSPIRATION OUTPUTS

Narrative: Evapotranspiration and near-surface water evaporation accounts for a significant portion of the water output to the Conway Ranch because of the large amount of irrigated pasture land. The areas covered with pasture generally have groundwater levels near the surface (on a year round basis) and shallow rooted grasses. The other areas are dryer but are covered with deeper rooted sage brush. Most evaporation and transpiration occurs between April and September. The weather is cold during the remainder of the year.

ET CALCULATION: The Thornthwaite method for calculating actual ET is appropriate as in BEAK, 1987 (Appendix A, Attachment B). This method reduces potential ET to account for available soil moisture. BEAK, 1987 uses potential ET from California isopleth maps supplied by TRIAD, for a total of 40.1 in/year total potential ET. We will use this figure as a most conservative value since it overstates actual ET by some quantity.

~~40.1~~ 36 in/year over 1.35 mi$^2$ = ~~4.23~~ 3.80 CFS

per Jim Ognutz

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SHEET 2 OF 9
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DATE 7/1?/87
COMPUTER BY MAR
CHECKED BY [illegible]

PROJECT
SUBJECT [illegible]

GROUNDWATER FLOW OUTPUT

2.4 CFS (see G.W flow calculations P1-3

WILSON CREEK OUTPUT

Method

Total input = ET + G.W outflow + Wilson Creek outflow

therefore

Wilson Creek out. = Total Input − (ET + G.W outflow)

= 34.65 cfs − ( ~~4.2?~~ 3.80 cfs + 2.4 cfs)

= 34.65 − 6.63 ~~35 6.88~~

= 28.~~37~~ CFS ✓

~~8~~.45

Check

Is 28 CFS reasonable.

Stream flow measured in July 1987 during reported drought.
Upstream Wilson Creek = 11.5 CFS
Downstream Wilson Creek = 9.0 CFS

11.5 ⟷ 28.4 doesn't seem too bad considering large percentage of runoff occurs during spring.

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SHEET 9 OF 9
JOB NO. [illegible]
DATE [illegible]
COMPUTER BY [illegible]
CHECKED BY [illegible]

PROJECT [illegible]
SUBJECT

WATER BALANCE SUMMARY

| INPUTS (cfs) | |
|---|---|
| Area I | 5.27 |
| Area II | 1.51 |
| Area III | 4.78 |
| Area IV | 1.79 |
| Wilson Creek | 19.0 |
| Virginia Creek | 2.30 |
| | 34.65 ✓ |
| | ⇓ |
| | 35 cfs |

| OUTPUTS (cfs) | |
|---|---|
| ET | 3.8 ~~4.2~~ |
| Groundwater | 2.4 |
| Wilson Ck | 28.45 |
| | 34.65 |
| | ⇓ |
| | 35 cfs |

G.W. output = safe yield = 2.4 cfs = 1077.18 gpm

≈ 1100 gpm

# APPENDIX E

## Test Pit Exploration and Logs

### Methodology

Seventeen test pits were excavated to depths ranging from 6.5 to 13 feet in depth on July 2 and 3, 1987, with a Case 580E backhoe. The test pits were logged by our geologist who kept a careful record of soil and groundwater conditions.

In many test pits, the water table elevation was clearly apparent. Logs from these test pits show the water table elevation. In other test pits, the water table elevation was not clear, and the logs instead describe the depth and intensity of groundwater seepage.

UNIFIED SOIL CLASSIFICATION SYSTEM

| MAJOR DIVISIONS | | | | | TYPICAL NAMES |
|---|---|---|---|---|---|
| COARSE GRAINED SOILS<br>MORE THAN HALF IS LARGER THAN NO. 200 SIEVE | GRAVELS<br>MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE | CLEAN GRAVELS WITH LITTLE OR NO FINES | GW | | WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES |
| | | | GP | | POORLY GRADED GRAVELS GRAVEL-SAND MIXTURES |
| | | GRAVELS WITH OVER 12% FINES | GM | | SILTY GRAVELS POORLY GRADED GRAVEL-SAND - SILT MIXTURES |
| | | | GC | | CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND - CLAY MIXTURES |
| | SANDS<br>MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE | CLEAN SANDS WITH LITTLE OR NO FINES | SW | | WELL GRADED SANDS, GRAVELLY SANDS |
| | | | SP | | POORLY GRADED SANDS GRAVELLY SANDS |
| | | SANDS WITH OVER 12% FINES | SM | | SILTY SANDS, POORLY GRADED SAND - SILT MIXTURES |
| | | | SC | | CLAYEY SANDS, POORLY GRADED SAND - CLAY MIXTURES |
| FINE GRAINED SOILS<br>MORE THAN HALF IS SMALLER THAN NO. 200 SIEVE | SILTS AND CLAYS<br>LIQUID LIMIT LESS THAN 50 | | ML | | INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILTS WITH SLIGHT PLASTICITY |
| | | | CL | | INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS |
| | | | OL | | ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY |
| | SILTS AND CLAYS<br>LIQUID LIMIT GREATER THAN 50 | | MH | | INORGANIC SILTS, MICACEOUS OR DIATOMACIOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS |
| | | | CH | | INORGANIC CLAYS OF HIGH PLASTICITY FAT CLAYS |
| | | | OH | | ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS |
| | | | Pt | | PEAT AND OTHER HIGHLY ORGANIC SOILS |

LEGEND

**SAMPLE**
- ■ "Undisturbed"
- ☒ Bulk
- ☐ Not Recovered

**GRAPHIC LOG**
- Well Defined Change
- Gradational Change
- Obscure Change
- End of Exploration

**BLOWS/FOOT**

Hammer is 140 pounds with 30 inch drop, unless otherwise noted

S - SPT Sampler (2.0 Inch O.D.)

T - Thin Wall Sampler (2.8 Inch Sample)

H - Split Barrel Sampler (2.4 Inch Sample)

**MOISTURE DESCRIPTION**

| | |
|---|---|
| Dry | - Considerably less than optimum for compaction |
| Moist | - Near optimum moisture content |
| Wet | - Over optimum moisture content |
| Saturated | - Below water table, in capillary zone, or in perched groundwater |

**LABORATORY TESTS**

| | |
|---|---|
| Consol | - Consolidation |
| LL | - Liquid Limit |
| PL | - Plastic Limit |
| Gs | - Specific Gravity |
| SA | - Size Analysis |
| Tx | - Triaxial Shear |
| DS | - Direct Shear |
| VS | - Vane Shear |
| Comp | - Compaction |

UU - Unconsolidated • Undrained

CU - Consolidated • Undrained

CD - Consolidated • Drained

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# SOIL CLASSIFICATION/LEGEND

Conway Ranch at Mono Lake
Mono County, California

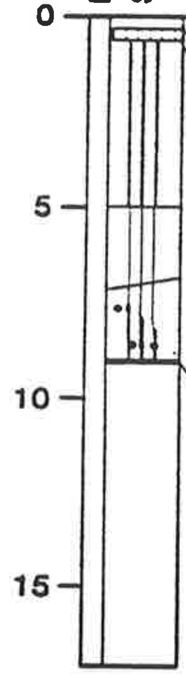
PLATE 1

| JOB NUMBER | DRAWN | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| 15,248.001 | SL | MAA | 28 July 87 | | |

Dry Density (pcf) | Moisture Content (%) | Depth (ft) | Sample

**Test Pit Number** 1

**Elevation** 6825 feet **Date** 7/2/87




Grass sod

DARK BROWN TOPSOIL WITH GRASS ROOTS (OL)

GRAY CLAYEY SILT (MH) very soft, saturated; with trace of sand

MOTTLED GRAY-ORANGE SILT (ML) soft, saturated

MOTTLED GRAY-ORANGE SILT (ML) AND SILTY SAND (SM) soft, saturated; fine-grained sand

Strong seepage below 7 feet from sand zones

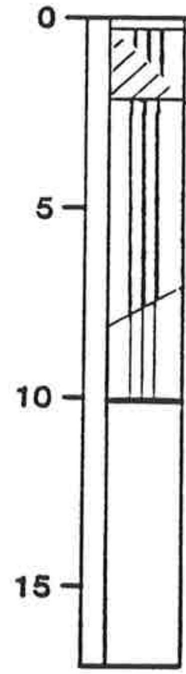
Sand size increases downwards to coarse at 9 feet

Test pit terminated at 9 feet on 7/2/87.

Sides caving.

**Test Pit Number** 2

**Elevation** 6822 feet **Date** 7/2/87




Grass sod

BROWN CLAYEY SILT (MH) AND SILTY CLAY (CL) soft to medium stiff, wet; with roots and organic pockets

GRAY CLAYEY SILT (MH) very soft, saturated; with trace fine to coarse sand

Light seepage at 7 feet

MOTTLED GRAY AND ORANGE SILT (ML) soft to medium stiff, saturated

Test pit terminated at 10 feet on 7/2/87.

Sides caving.

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**Log of Test Pits 1 and 2**

**Conway Ranch at Mono Lake**
**Mono County, California**

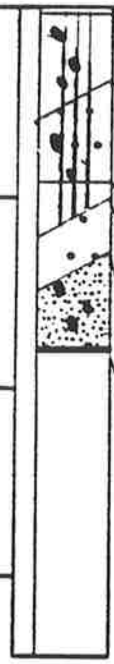
PLATE **2**

| JOB NUMBER | DRAWN | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| 15,248.001 | SL | MAA | 28 July 87 | | |

Dry Density (pcf) | Moisture Content (%) | Depth (ft) | Sample

**Test Pit Number** 3

**Elevation** 6824 feet **Date** 7/2/87




Approximate water table elevation

Sod

LIGHT GRAY-BROWN SANDY SILT (ML) hard, dry; with about 10% gravel

ORANGE-BROWN GRAVELLY SILTY SAND (SM) dense, dry; gravel angular to subrounded, ranging from fine gravel to coarse gravel

ORANGE-BROWN CLAYEY SILT (MH) medium stiff, moist; with some sand

ORANGE-BROWN GRAVELLY SAND (SW) medium dense, wet; with some silt

Seepage at 7.5 feet

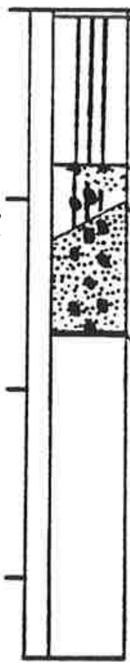
ORANGE-BROWN SANDY GRAVEL (GW) medium dense, saturated; with some silt, gravel to 3 inches but generally to 1 inch

Test pit terminated at 9 feet on 7/2/87.

Sides caving below 7 feet.

**Test Pit Number** 4

**Elevation** 6822 feet **Date** 7/2/87




Approximate water table elevation

Sod

BROWN CLAYEY SILT (MH) hard, dry; with some fine sand

Medium stiff, moist at 1 foot

Soft, wet at 3 feet

GRAY-BROWN SILTY SANDY GRAVEL (GP/GM) medium dense, wet

BROWN SANDY GRAVEL (GP) medium dense, saturated; gravel is coated with orange oxide stain and generally ranges from fine gravel to 1-inch diameter

Test pit terminated at 8.5 feet on 7/2/87.

Sides caving below 6 feet.

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**Log of Test Pits 3 and 4**

**Conway Ranch at Mono Lake**
**Mono County, California**

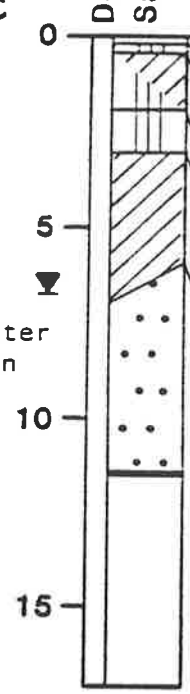
PLATE **3**

| JOB NUMBER | DRAWN | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| 15.248.001 | SL | MAA | 28 July 87 | | |

| Dry Density (pcf) | Moisture Content (%) | Depth (ft) | Sample |
|---|---|---|---|

**Test Pit Number** 5

**Elevation** 6820 feet **Date** 7/2/87




Sod

LIGHT BROWN SILT (ML) soft, dry; with roots

LAMINATED DARK BROWN SILTY CLAY (CL) AND LIGHT BROWN SILT (ML) hard, moist; with orange-brown staining on some laminating

GRAY SANDY SILT (ML) hard, moist

GRAY-BROWN SILTY CLAY (CL) stiff, wet

Approximate water table elevation

Soft at 6 feet

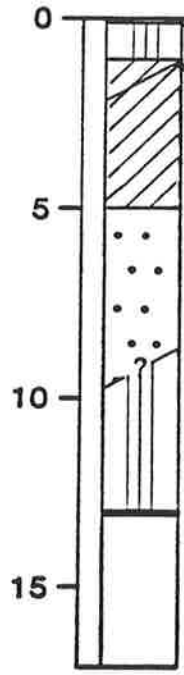
INTERLAYERED GRAY FINE SAND (SP) BROWN SILTY CLAY (CL) AND SILT (ML) loose, soft, saturated; sand layers less than 2 inches thick

Test pit terminated at 11.5 feet on 7/2/87.

Sides caving below 8 feet.

**Test Pit Number** 6

**Elevation** 6820 feet **Date** 7/2/87




Sod

BROWN SANDY SILT (ML) soft, dry; stiff at 6 inches

DARK BROWN SILTY CLAY (CL) stiff, wet; laminated

GRAY SILTY CLAY (CL) medium stiff, saturated; massive

INTERLAYERED GRAY FINE SAND (SP) BROWN SILTY CLAY (CL) AND ORANGE-BROWN FINE SANDY SILT (ML) loose, soft, saturated; sands and silts are water bearing, sand layers less than 2 inches thick

MOTTLED GRAY AND ORANGE SILT (ML) soft, saturated

Test pit terminated at 13 feet on 7/2/87.

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**Log of Test Pits 5 and 6**
**Conway Ranch at Mono Lake**
**Mono County, California**

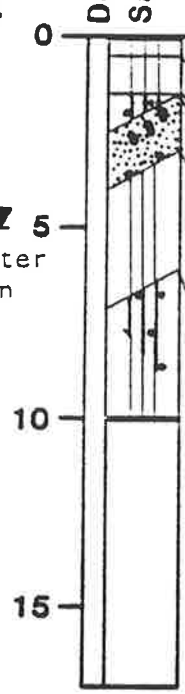
PLATE **4**

| JOB NUMBER | DRAWN | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| 15.248.001 | | SL / MAA | 28 July 87 | | |

| Dry Density (pcf) | Moisture Content (%) | Depth (ft) | Sample |
|---|---|---|---|

**Test Pit Number** 7

**Elevation** 6822 feet **Date** 7/2/87




Approximate water table elevation

BROWN SILT (ML) soft, dry; with trace of sand and gravel and with roots

BROWN GRAVELLY SANDY SILT (ML) hard, moist

ORANGE-BROWN GRAVELLY SILTY SAND (SM) dense, moist

ORANGE-BROWN SANDY GRAVEL (GP) medium dense, wet

MOTTLED ORANGE AND GRAY SILT (ML) soft, saturated

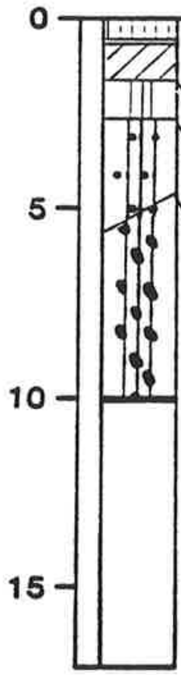
Water bearing layers of gray medium to coarse sand at 5 to 7 feet

ORANGE-BROWN SILTY SAND (SM) AND SANDY SILT (ML) loose, soft, saturated

Test pit terminated at 10 feet on 7/2/87.

**Test Pit Number** 8

**Elevation** 6822 feet **Date** 7/2/87




Sod with dark brown organic silt (OL)

Light seepage from base of organic silt

MEDIUM BROWN SILTY CLAY (CL) soft, saturated; with organics

GRAY SILT (ML) soft, saturated

ORANGE-BROWN GRAVELLY SILTY SAND (SM) loose, saturated

Moderate seepage from 3.0 to 3.5 feet

BROWN SILTY SANDY GRAVEL (GM) loose, saturated

Test pit terminated at 10 feet on 7/2/87.

Sides caving below 6 feet.

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**Log of Test Pits 7 and 8**

**Conway Ranch at Mono Lake**

**Mono County, California**

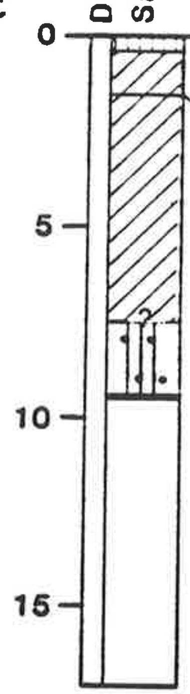
PLATE **5**

| JOB NUMBER | DRAWN | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| 15.248.001 | SL | MAA | 28 July 87 | | |

| Dry Density (pcf) | Moisture Content (%) | Depth (ft) | Sample |
| --- | --- | --- | --- |

**Test Pit Number** 9

**Elevation** 6819 feet **Date** 7/2/87




SOD WITH DARK BROWN ORGANIC SILT (OL)

MEDIUM BROWN SILTY CLAY (CL) (OL?) soft, saturated: with roots and organics

GRAY SILTY CLAY (CL) very soft, saturated; massive

Heavy seepage at 4 feet from silt or sand seams?

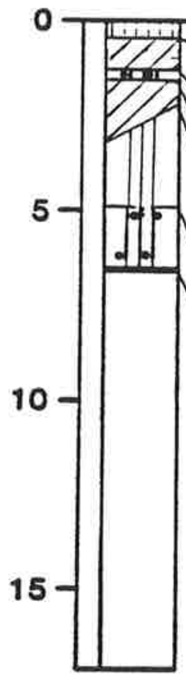
ORANGE AND BROWN SILTY SAND (SM) medium dense, saturated; with approximately 10% fine gravel

Test pit terminated at 9.5 feet on 7/2/87.

Sides caving bleow 4 feet.

**Test Pit Number** 10

**Elevation** 6822 feet **Date** 7/2/87




SOD WITH DARK BROWN ORGANIC SILT (OL)
Seepage from base of sod

MEDIUM BROWN SILTY CLAY (CL) (OL?) soft, saturated; with some roots and organics

GRAY SILTY SAND (SM) loose, saturated; light seepage from this layer

GRAY SILTY CLAY (CL) very soft, saturated; massive

GRAY AND ORANGE SILT (ML) AND SILTY CLAY (CL) soft, saturated

ORANGE-BROWN SILTY SAND (SM) very loose, saturated

Test pit terminated at 6.5 feet on 7/2/87.

Sides caving below 1.5 feet.

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**Log of Test Pits 9 and 10**

Conway Ranch at Mono Lake
Mono County, California

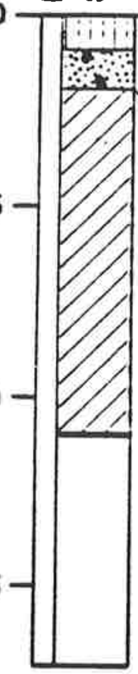
PLATE **6**

| JOB NUMBER | DRAWN | APPROVED | DATE | REVISED | DATE |
| --- | --- | --- | --- | --- | --- |
| 15,248.001 | SL | MAA | 28 July 87 | | |

| Dry Density (pcf) | Moisture Content (%) | Depth (ft) | Sample |
| --- | --- | --- | --- |

**Test Pit Number** 11

**Elevation** 6825 feet **Date** 7/3/87




SOD WITH DARK BROWN ORGANIC SILT (OL)

GRAY SANDY GRAVEL (GP) loose, wet, saturated at 18 inches; gravel ranges up to 1/2-inch diameter

GRAY SILTY CLAY (CL) very soft, saturated: with trace sand

Becomes mottled gray and orange below 6 feet

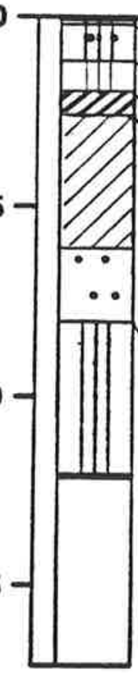
Heavy seepage at 8 feet

Some hard dessicated portions below 9 feet

Test pit terminated at 11 feet on 7/3/87.

**Test Pit Number** 12

**Elevation** 6820 feet **Date** 7/3/87




Light sod

LIGHT BROWN SILTY SAND (SM) loose, moist; with roots

GRAY-BROWN FINE SANDY SILT (ML) medium stiff, wet

MEDIUM BROWN CLAY (CH) stiff, wet; with organics

GRAY SILTY CLAY (CL) very soft, saturated

INTERLAYERED GRAY-PINK SAND (SP) GRAY SILT (ML) AND GRAY SILTY CLAY (CL) medium dense, medium stiff, saturated; silt predominates; moderate seepage from sand layers

MOTTLED GRAY-BROWN CLAYEY SILT (MH) soft, saturated

Test pit terminated at 12 feet on 7/3/87.

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**Log of Test Pits 11 and 12**
Conway Ranch at Mono Lake
Mono County, California

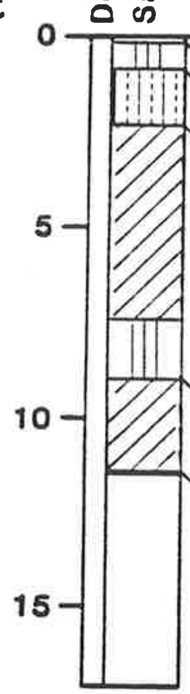
PLATE **7**

| JOB NUMBER | DRAWN | APPROVED | DATE | REVISED | DATE |
| --- | --- | --- | --- | --- | --- |
| 15,248.001 | SL | MAA | 28 July 87 | | |

| Dry Density (pcf) | Moisture Content (%) | Depth (ft) | Sample |
|---|---|---|---|

**Test Pit Number** 13

**Elevation** 6822 feet **Date** 7/3/87




Dark brown toposil and sod

LIGHT BROWN SILT (ML) soft, dry

MEDIUM TO DARK BROWN ORGANIC SILTY CLAY (OH) stiff, wet

GRAY SILTY CLAY (CL) very soft, saturated

Soft at 4 feet with sandy zones

INTERBEDDED SILT (ML) GRAY-PINK FINE SAND (SP) AND GRAY SILTY CLAY (CL) soft, loose, saturated

Seepage from sand zones

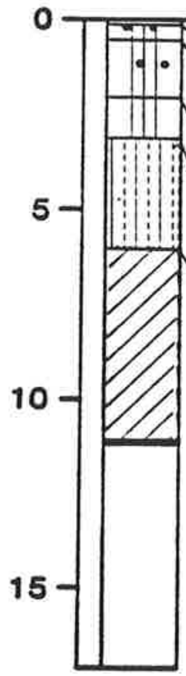
GRAY SILTY CLAY (CL) soft, saturated

Becomes mottled gray-brown and medium stiff at 10 feet

Test pit terminated at 11.5 feet on 7/3/87.

**Test Pit Number** 14

**Elevation** 6823 feet **Date** 7/3/87




Sod

LIGHT BROWN SILTY SAND (SM) very loose, dry; abundant coarse-grained quartz grains

LIGHT BROWN SILTY SAND (SM) loose, dry; fine-grained sand, abundant mica flakes

LIGHT BROWN AND ORANGE SANDY SILT (ML) medium stiff, moist

DARK BROWN ORGANIC CLAY (OH) stiff, wet

GRAY SILTY CLAY (CL) soft, wet to saturated

Medium stiff at 8 feet

Moderate seepage at 9 feet

Test pit terminated at 11 feet on 7/3/87.

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**Log of Test Pits 13 and 14**
Conway Ranch at Mono Lake
Mono County, California

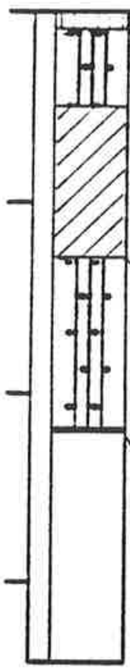
PLATE **8**

| JOB NUMBER | DRAWN | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| 15.248.001 | SL | MAA | 28 July 87 | | |

| Dry Density (pcf) | Moisture Content (%) | Depth (ft) | Sample |
|---|---|---|---|

## Test Pit Number 15

**Elevation** 6827 feet **Date** 7/3/87




Approximate water table elevation

SOD WITH DARK BROWN ORGANIC SILT (OL)

MOTTLED BROWN AND ORANGE SILTY SAND (SM) loose, moist

GRAY SILTY CLAY (CL) soft, wet; numerous mica flakes in thin layers

Saturated below 4.5 feet

Light to moderate seepage at 6.5 feet

GRAY SILTY SAND (SM) loose, saturated; fine-grained with abundant mica

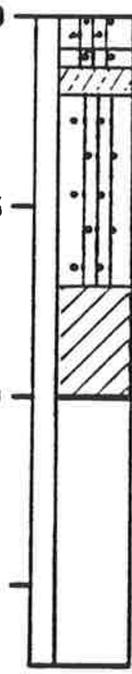
Contains contorted layers of laminated organic clay and silt at 8 to 9 feet

Heavy seepage at 9 feet

Test pit terminated at 11 feet on 7/3/87.

## Test Pit Number 16

**Elevation** 6827 feet **Date** 7/3/87




Approximate water table elevation

SILTY SAND (SM) with roots

MEDIUM BROWN SILTY SAND (SM) loose, moist

DARK BROWN SILTY ORGANIC CLAY (OH) medium stiff, wet

DARK GRAY-BLACK ORGANIC SILTY SAND (SM) loose, wet; saturated at 3.5 feet, swamp odor

Heavy seepage at and below 3.5 feet

GRAY-GREEN AND ORANGE SILTY CLAY (CL) soft, saturated; with thin layers of white granular volcanic ash(?)

Test pit terminated at 10 feet on 7/3/87.

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**Log of Test Pits 15 and 16**

Conway Ranch at Mono Lake
Mono County, California

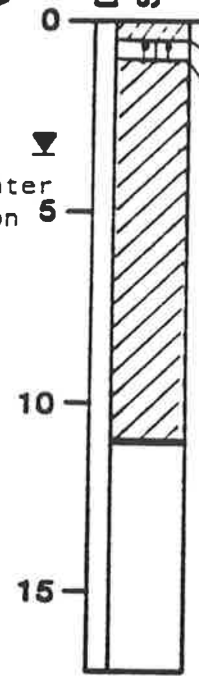
PLATE **9**

| JOB NUMBER | DRAWN | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| 15.248.001 | SL | MAA | 28 July 87 | | |

| Dry Density (pcf) | Moisture Content (%) | Depth (ft) | Sample |
|---|---|---|---|

**Test Pit Number** 17

**Elevation** 6825 feet **Date** 7/3/87




Approximate water tabel elevation

SOD AND DARK BROWN ORGANIC CLAY (OH)

BROWN SILTY SAND (SM) loose, wet

GRAY SILTY CLAY (CL) soft, saturated

Seepage at 3.7 feet

Heavy seepage at 6 feet

Medium stiff mottled gray and orange at 7 feet and below

Test pit terminated at 11 feet on 7/3/87.

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**Log of Test Pit 17**
Conway Ranch at Mono Lake
Mono County, California

PLATE **10**

| JOB NUMBER | DRAWN | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| 15.248.001 | SL | MAA | 28 July 87 | | |

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