HISTORY OF WATER DEVELOPMENT

HOLE-IN-THE-WALL AREA

MOJAVE NATIONAL PRESERVE

Technical Report NPS/NRWRD/NRTR-2002/298

July 2002

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INTRODUCTION

This is the history of the various efforts, data, and analyses from 1971 to 1999 to develop an adequate, potable water supply at the Hole-In-The-Wall site in Mojave National Preserve (MOJA). The need for such a supply has increased over the years, and hydrologic efforts have correspondingly increased. It is quite possible that what is developed in the near future will be inadequate in the long term due to increased visitation. Thus, it is realistic to believe that sometime in the future hydrologists will seek additional potable water. This material, including options and recommendations, is intended to assist that effort.

The Hole-In-The-Wall site is located in the western central portion of the preserve–just east of the Providence Mountains (Figure 1). The site name is derived from an arch (or "hole") in the consolidated rocks, which is large enough to be impressive and serve as a landmark.

The following is a chronological history of investigative efforts and other factors relevant to the issue. Well nomenclature is from Freiwald (1984).

1971

The Bureau of Land Management (BLM) administered the Hole-In-The-Wall site and the majority of the land in the general area for decades.

On May 14, 1971, the BLM completed a well in the Hole-In-The-Wall area to provide potable water for this site. This well, T 11 N / R 15 E - 8 K 1 (Figure 2), was drilled to a depth of 605 feet and completed with an 8" diameter casing. The water level was 510 feet below land surface datum. A four-hour aquifer test of the well was conducted, pumping at a rate of 7 gallons per minute (gpm) (Freiwald, 1984). Apparently the water level dropped 7 feet in the first minute and stayed at that level for the remainder of the test time. The Specific Capacity of the well was 1 gpm per foot of draw down, indicating that the production of the well was very limited. This well is located north of the trailers that now house MOJA personnel.

1981 - 1984

In an effort to acquire a better water source for the Hole-In-The-Wall Visitor Center, the BLM developed another well-drilling program sometime prior to August 1981. Three borings were drilled about 1/3 mile to the south of Well 11 N / 15 E – 8 K1. On August 18, 1981, the three borings (T 11 N / R 15 E - 8 R 1, 2, and 3) were inspected. The depths of the borings were 299.30, 398.00, and 149.50 feet respectively. No water levels were recorded, indicating the borings were dry (Freiwald, 1984).

About 1981 Paul Summers of the BLM contracted with the U.S. Geological Survey (USGS) to conduct a well and spring inventory and to map the geology of the Mojave Desert area in order to provide base line data and assist the development of more water supplies for visitors and cattle (Freiwald, 1984).

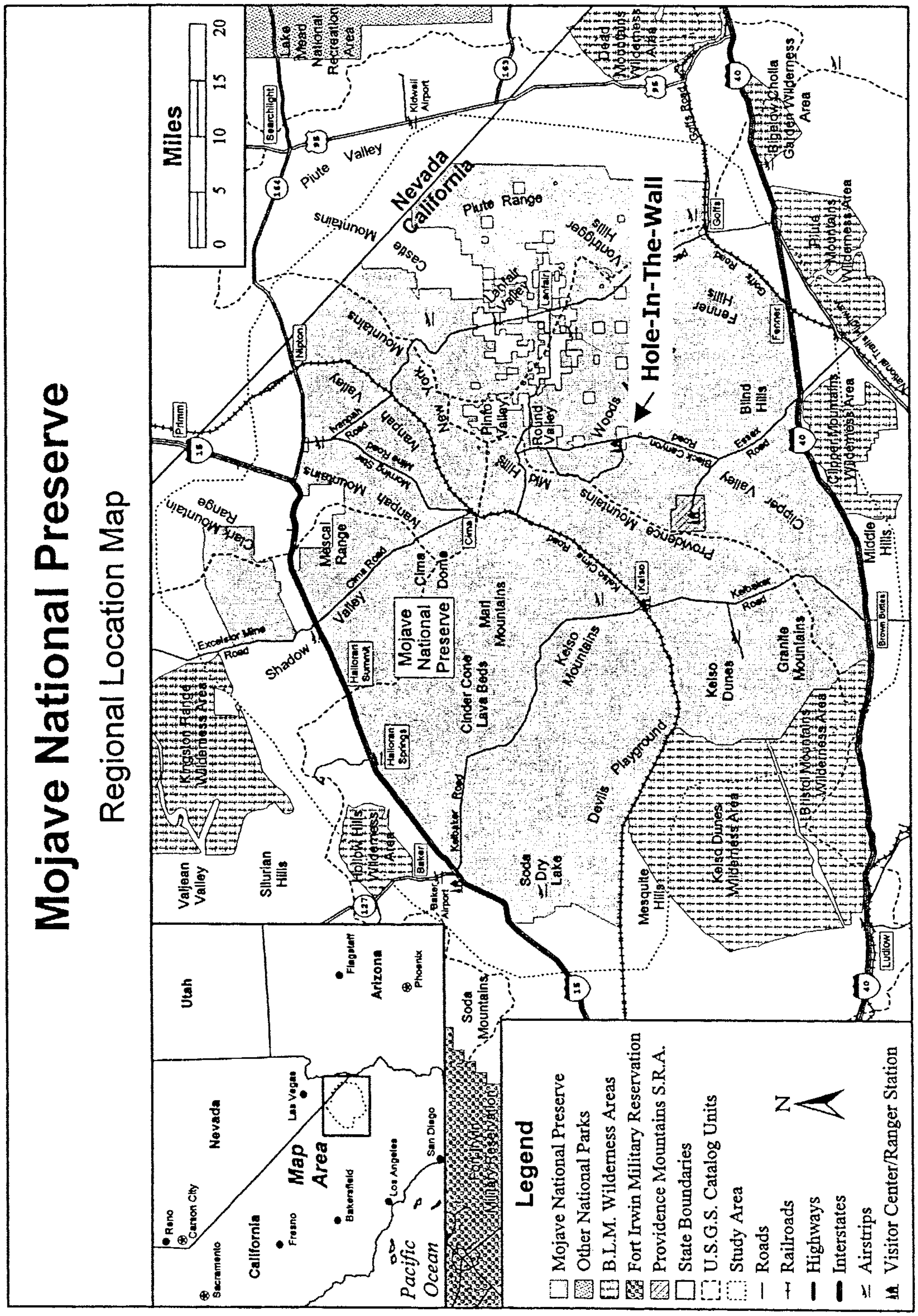

Figure 1. Location map for Hole-In-The-Wall area
(NPS, 2001)

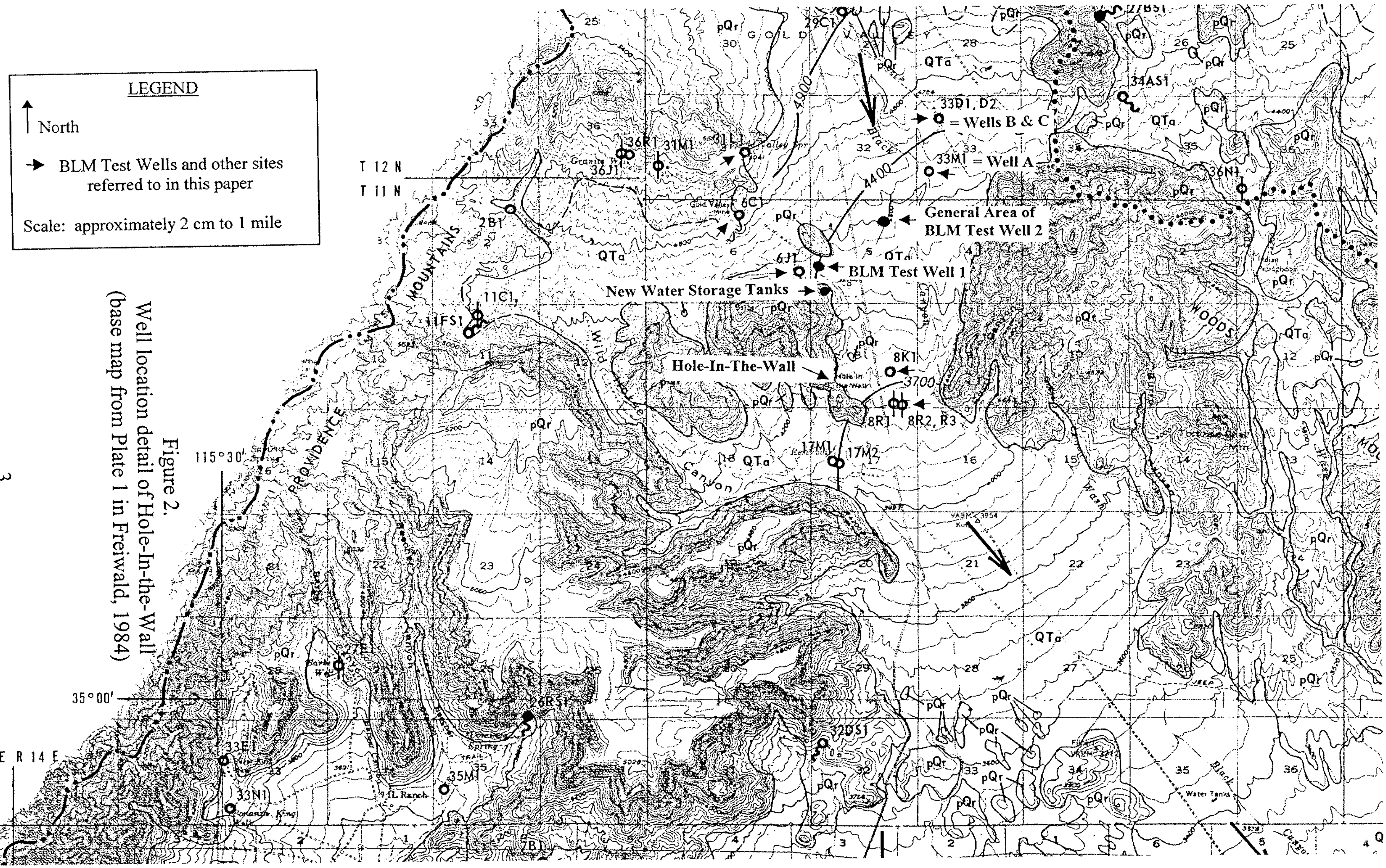

Figure 2.
Well location detail of Hole-In-the-Wall
(base map from Plate 1 in Freiwald, 1984)

1992

The Fain Drilling Company of Valley Center, CA, inspected and performed yield tests on Wells A, B, and C (Shelley, 1996). See page 15 of this report for identification of these wells and Figure 2 for location.

1993

In line with long-term BLM development plans a new Visitor Center was built at the Hole-In-The-Wall site and the camping facilities were upgraded.

1994

Through cooperation with the Marine Corps, a pipeline was constructed from the Visitor Center and Campground area north about one mile to the site of two new 10,000 gallon water storage tanks. These new tanks are in proximity to the site where a water tank and a stock holding pen had been constructed years ago by cattle ranchers. Water in the new storage tanks flowed by gravity to the new Visitor Center.

Summers was present during the above effort. He had recently let a contract to Fain Drilling Company to drill a test well in the area. Summers had made a preliminary investigation and identified possible drilling sites.

Summers' evaluation of supplementing the Hole-In-The-Wall water supply by drilling in this area was based on review of Freiwald's report and examination of the geology of the general area. Both Well T 11 N/ R 15 E - 8 K 1 and Well T 12 N/ R 15 E - 33 M 1 were deep (thus believed to have bottomed in volcanics) and had low yields (Freiwald, 1984). These data were interpreted to indicate that the tuffs (rocks composed of fine volcanic detritus) were a poor aquifer, having inherent low permeability and lacking fractures. Potential fractures in the granite outcrops located about a mile to the north-northwest of Hole-In-The-Wall were believed to be the best potential aquifer within a reasonable distance. The presence of a fault near this location suggested that the granite would be fractured (due to fault movement) and that a well drilled here would have a fair chance of producing water.

Early in 1994 (after years of consideration by various groups and entities), legislation was introduced to Congress by California Congresswoman Diane Fienstein to enlarge Joshua Tree National Monument and Death Valley National Monument and to re-designate them as National Parks. The bill also called for establishing Mojave National Park. There was much speculation about the bill's passage. The original bill was modified in several aspects (including changing Mojave from a National Park to a National Preserve) and passed on October 31, 1994, as the California Desert Protection Act of 1994 (P.L. 103-433). Management of Hole-In-The-Wall and the area for miles around was transferred to National Park Service.

As of October 31, 1994, the Fain Drilling Company contract had been awarded, but no work had been done. In harmony with the California Desert Protection Act of 1994, which called for new coordination among government agencies, the BLM proceeded with the test well drilling. Further, Paul Summers contacted William Werrell, hydrologist at Death Valley National Park (DEVA), and suggested coordination on the project. This effort was supported by both the Superintendent of DEVA and the Superintendent of MOJA because the staffing plan for MOJA did not include a hydrologist.

January 10-11, 1995

Summers and Werrell met on-site to select a specific test well drilling site. Summers was accompanied by Mark Graham of the Engineering Branch of the Riverside District of BLM, who served as Contracting Officer's Technical Representative for the contract. Observations and interpretations from that trip include:

1. An old, abandoned, water storage tank was seen from the dirt road which leads northwest from the new storage tanks. During an inspection of the general storage tank area, two wells were found. These wells are close together are were probably drilled by ranchers for watering stock on BLM lands.

Well T 11 N / R 15 E - 6 J 1 (Figure 2) This well is believed to be fairly recently drilled (within the last 20 years). The site was marked by an 8-inch diameter well casing, the top of which was 2.2 feet above land surface datum. Also present were four concrete footings, each of which had angle iron protruding for 2-3 feet, believed to be the remnants of a windmill. The well is located in a wash northeast of Well 6J2 (see photographs in Attachment A). It is surmised that this well was a replacement for Well 6J2.

Well T 11 N / R 15 E - 6 J 2 (Figure 2) (Note: This number was assigned by the authors; it is neither listed nor shown in Freiwald [1984]). A few old fence posts are present, indicating that this is an old well and that the site was probably used as a cattle pen many years ago. The well is located between two of the old posts. The thin gage, tin well casing protrudes an inch or so above the ground. The well is located south of the Well 6J2 wash, at the foot of the mountain (Attachment A). Water existed in both wells–determined by dropping a pebble down each well and hearing a splash.

Well T 11 N / R 15 E – 6 C 1 was inspected (Figure 2). This well site is shown on the Ivanpah topographic map (U.S. Geological Survey, 1985) as "Gold Valley Mine." It is at the end of a dirt road, about 1.5 miles northwest of the new storage tanks at Hole-In-The-Wall. It is equipped with a windmill and is within a fenced corral. The well site is covered by a thin layer of soil, which is underlain by granite. The well is used to provide water for a cattle-watering trough. Summers had conducted a cursory inspection of the site previously and noted that adequate water for stock was produced by the well–which supports the concept of fractures in the granite being capable of providing usable amounts of ground water. Mine tailings, present at the north end of the fenced area, reveal that the site is an abandoned mine in the granite. By looking down the mine entrance it was seen that the mine is flooded. The well appears to have been drilled such that the mine would have been encountered by the boring. However, it is not known whether the mine predated the well. It would be informative to know the history of the site to understand 1) whether the ground water flow was sufficient to flood the mine and stop the mining or 2) if the deposit 'worked out' and the mine slowly filled with water. The windmill water production is from the mine. Therefore, the well production is not considered indicative of expected yields from a well drilled where no mine cavity exists.

Granite outcrops in the area are extensively fractured, allowing rainfall percolation into fractures. We noted that a few springs are mapped along granite outcrops (Freiwald, 1984; California Division of Mines and Geology, 1961). While individual fractures may have permitted only very low flow rates, the mine could have encountered many such fractures, thus permitting an adequate total yield. Also, the mine allows thousands of gallons of water to be held in storage. A new well drilled in the general area might have to be drilled very deep to encounter a similar linear length of fractures, and well storage would probably be less.

Werrell and Summers noted the following factors relevant to the use of this well or site as the potable water supply for Hole-In-The-Wall:

A. Pipeline - The well is located about 1.5 miles northwest of the new storage tanks. That length of pipeline would be costly. Also, it would be desirable to have the pipeline buried both for protection of the pipe and to prevent the water being heated to unacceptable limits during the summer. Most of the trenching for the pipeline would be in hard quartz monzonite (granite), requiring an expensive construction contract.

B. Water Quality Aspects - Prior to any contracts, construction, or hydrologic testing, the site should be inspected by the Western Regional Public Health Service Representative to determine if the site could be mitigated to meet requirements for use as a Public Water Supply. Factors requiring evaluation include:

i. The surface has been used as a stock corral for many years and been subjected to defecation and urination, some of which may have infiltrated into the mine water below.

ii. The present well casing does not appear to have concrete around the casing (i.e., no sanitary seal exists). Indeed, no one spends the extra money for a sanitary seal on a stock well. Perhaps by some means a sanitary seal could be placed or a new well drilled with a sanitary seal. However, it is dubious if a fully required, 50-foot deep sanitary seal could be set due to the presence of the mine. Even if possible, the granite fractures at the general site should be expected to permit downward percolation of surface particles without filtration.

iii. Sealing of the mine entrance would probably be required to prevent contamination. How would this be accomplished?

iv. A chemical water quality analysis should be obtained. In selecting elements to be tested, the minerals extracted during mining should be known and tested for.

v. No action should be taken unless the Regional Public Health Service agrees that acceptable modifications or mitigation can be made.

C. Hydrologic Evaluation - An aquifer test should be conducted over several days to determine the aquifer transmissivity and storage coefficient. The test should be conducted during the late summer–at the end of the "dry period." Pumped water should be piped a considerable distance (e.g., 200 yards) down gradient, sufficient to insure that the discharge cannot infiltrate and percolate back into the mine–and invalidate test results. A contract with a well driller will be necessary to set and operate a pump, to generate power for the pump, and to supply and lay the discharge pipeline. The pump should be capable of pumping at least 50 gpm.

D. Present Well Use - The site was in good condition (i.e., fences were in good condition and the windmill was fully operational). This implies that the corral and the well were a portion of a previous BLM grazing lease. The present status was unknown due to the recent creation of Mojave National Preserve and some pending decisions regarding grazing permits. If the grazing lease remains in place, using the well (or even the site) for a public water supply would require elimination of stock presence. Thus, the rancher and/or agency would have to develop another water source.

3. Geologic maps of the area by both Freiwald (1984) and the California Division of Mines and Geology (1961) were reviewed in the field. These references present generalized geology, which (although helpful) lack the detail desired to select a test well drilling site. Primary aspects of our work included identification of faults in bedrock outcrops, speculation of fault traces under the alluvium, and determination of strike and dips of formations to achieve a concept of stratigraphic sequences. The presence of two faults (one mapped and one observed) along the north faces of Wildhorse Mesa and Woods Mountain and a mapped fault across the valley to the northeast raised speculation that perhaps the similar stratigraphic displacements were resultant of one fault that extends across the valley. If such were the case, the fault plane would be a relatively short distance north of the new storage tank area. Well T 11 N / R 15 E - 6 J 2 was observed to be directly in line with one fault trace. If possible, it would be desirable for the new test well to be drilled into or near a fault plane in order to encounter fractures resultant of faulting.

Based on the above findings and considerations, it was decided to begin ground water exploration activities by investigating and/or testing Wells T 11 N / R 15 E - 6 J 1 and J 2. That is, it was believed prudent to concentrate efforts here based on reduced costs of pipeline to place a source in service, potential Public Health Service problems in pursuing use of Well T 11 N / R 15 E - 6 C 1, and a fair possibility of drilling a new, satisfactory well in this area. Although neither existing well could be used for potable water supplies due to the lack of sanitary seals (no evidence or data of sanitary seals exist), the wells could provide valuable geologic and ground water information. Desired data include water level elevations, yield, and rock type (formation) at the bottom of Well J 1. Analysis of aquifer test data would indicate if the alluvium could yield an adequate water supply. Information from drill cuttings would help to locate the above-mentioned fault (i.e., if volcanic rocks are present under the alluvium at the well site the fault is located to the north of the site). It was assumed that the well had been drilled entirely in alluvium and that drilling stopping upon contact with bedrock. Thus, to evaluate this factor a few feet of extra depth could be drilled. This concluded the trip.

Accordingly, Summers modified the Fain Drilling Company contract to provide for setting up over Well J 1, drilling a few feet to determine the formation at the bottom of the well, and running a pump for an aquifer test.

March 21-23, 1995

Summers and Werrell traveled together to the site of Wells T 11 N/R 15 E – 6 J 1 and J 2. They paced off the distance between Well J 1 and Well J 2 as 140 yards. Well J 2 is southwest of Well J 1. Well J 2 was inspected and found to be only a few feet deep and dry. No further consideration of any action at Well J 2 was considered.

Summers and Werrell met with Contractor Joe Fain at Well T 11 N / R 15 E - 6 J 1. First, they requested the driller to acquire a water level. Using his electric water level probe with proper weight, the well depth was determined to be 90 feet below top of casing (TOC) with water barely in the well. The casing length is not known. This well may have been drilled deeper but caved in.

At Well J 1 the drilling rig was set up, necessitating the removal of three of the old windmill posts. Drilling began and proceeded to 120-foot depth (Attachment A). The well was then blown with air from a pipe set to the bottom. The well was blown dry in about 2 minutes after producing about 2 gallons per minute (gpm). Drilling proceeded to 140-foot depth, and the well was blown with air again, producing about 5 gpm for only 4 minutes. Drilling continued, and at 147-foot depth gravel was encountered. Drilling proceeded to 160-foot depth, and the well was again blown with air, producing about 5 gpm for only 4 minutes. Drilling continued to 180-foot depth. At this point the driller refused to drill further due to potential cave-in of the gravel and loss of the tools in the hole. The driller stopped pulling the tools at 140-foot depth and blew with air, producing water flow at 3-5 gpm, which after 15 minutes had decreased to 1-2 gpm. Examination of the drilling cuttings showed that the bottom formation was tuff. This was considered an indication that the hypothesized cross-valley fault was to the north of Well J 1.

On March 22nd, an aquifer test of Well J 1 was conducted, using a pump. The top of the casing was 2.2 feet above land surface datum (loose alluvial material in the stream bed). The pump intakes were set at 145 feet below TOC. Before pumping started the water level was 90.6 feet below TOC (determined by steel tape). Discharge was determined by volumetric measurement using a 5-gallon bucket and the second hand of a wristwatch. The pump was started, and discharge was regulated by valve to 10 gpm as quickly as possible. The pump was then shut off. After three minutes the water had regained a static level, as determined by electric probe. The pump was then turned on at 9:24 AM. The following data were collected:

Time – minutes after pumping started	Time – seconds to fill bucket	Water level - feet below TOC	Draw down - feet
10	36 (8.3 gpm)	---	0
15	38 (7.9 gpm)	108	17.4
20	40 (7.5 gpm)	112	21.4
25	38 (7.9 gpm)	115	24.4
30	45 (6.7 gpm)	121	30.4
35	45 (6.7 gpm)	126	35.4
40	50 (6.0 gpm)	131	40.4
45	45 (6.7 gpm)	134	43.4
50	44 (6.8 gpm)	---	---
55	47 (6.4 gpm)	144	53.4

At 10:21 AM, after 57 minutes of pumping, the pump broke suction. Recovery data was:

Time - minutes after pumping stopped	Water level – feet below TOC
06	140.5
10	138.8
15	136.8
20	134.5
32	129.2

Data collection ceased at 10:53 AM. The specific capacity of the well is about 2.5 gallons per foot of draw down. This indicated that the yield was inadequate to meet the Hole-In-The-Wall needs.

No further consideration was given to drilling a test well close to Well J 1. However, during the afternoon as the driller was setting up to begin drilling the first BLM test well, Werrell and Summers decided to utilize this time to conduct another test on Well J 1, which still had the pump in the well. At 3:45 PM the depth to water below TOC was 95 feet (i.e., about 4.5 feet of draw down was remaining from the first aquifer test when pumping had ceased 324 minutes earlier). The pump was then turned on, and during the first few minutes the discharge valve was closed in increments to reduce the rate of discharge to between 1 and 2 gpm. The following data were collected:

Time - minutes after pumping started	Water level - feet below TOC	
10	98.2	
20	101.3	
30	103.4	
42	105.4	
53	107.5	
64	109.0	Pump turned off

No visual change in flow rate was observed during pumping. A volumetric measurement of the discharge was taken just prior to turning the pump off. The rate was 1.75 gpm. The test was terminated at this time because the driller requested the removal of the pump and generator, thus completing his day's work.

The small discharge of this well indicated that the alluvium and underlying volcanics at this site were unable to yield an acceptable quantity of water for our needs, and therefore no further consideration was given to Well J 1.

BLM TEST WELL 1

Summers and Werrell selected the site for BLM Test Well 1 along the road to the northeast of Well T 11 N / R 15 E – 6 J 1 (Figure 2). They sought a site adjacent to the road and which would be in line with a fault plane as seen on the north face of Wild Horse Mesa. Positive aspects of the site included: 1) the selected site was very near the road (reducing drilling impacts to the extent possible), 2) a well drilled here would have a probability of encountering the fault plane, and 3) the site is north of Well J 1, indicating that drilling might encounter granite. We hypothesized that drilling would fully penetrate the terrace deposits within the first 100 feet and then encounter volcanics. The thickness of the volcanics was unknown but suspected to be a few hundred feet thick with granite below. The granite was the target formation. It was considered a possibility that water would be encountered at the volcanic/granite contact–if the granites in the immediate area were very poorly fractured. However, it was thought that a more probable circumstance would be that the granites were fractured to a degree that would permit water flow, and thus drilling would have to continue in the granite to seek a saturated zone/depth.

On March 22nd, Fain Drilling Company began drilling BLM Test Well 1. Mary Martin, then Assistant Superintendent of MOJA, was on-site for several hours as the exact site was selected and drilling started. The drilling method was by use of an air hammer with foam. At 94-foot depth volcanics were encountered. After drilling another 50 or so feet the crew shut down for the day. During the night temperatures fell to an unanticipated low level (below freezing), and a couple of inches of snow fell. While starting to drill the following morning, March 23rd, it was determined that the mud pump had frozen and the housing had cracked. The operation was shut down until parts could be delivered and the pump rebuilt. Photographs were taken (Attachment A). Werrell and Summers returned to their duty stations.

MAY 1995

About May 1st the pump had been replaced, and drilling of BLM Test Well 1 started again. Mark Graham, Engineering Branch of BLM, served as Contracting Officer's Technical Representative for the remainder of the drilling. Summers and Werrell did not return but remained in telephone contact with Graham as drilling progressed.

Drilling continued to 360 feet, where granite was encountered. Drilling continued to 900 feet without the driller reporting water, at which time the contractor was directed to cease drilling. A short piece of casing (about 10 feet) was placed at the surface of BLM Test Well 1 with one or two feet protruding from the ground and a lockable cap was installed. This was done so it would be possible to return at a later date and acquire a water level. Although the driller did not report encountering water, we realized that some flow could enter the boring undetected due to the drilling method, and, after a few weeks, the well could fill to some depth with water. This static water level would indicate the depth to saturation and assist in determining the direction of ground water flow.

BLM TEST WELL 2

By telephone Werrell and Summers discussed the situation and decided to drill a second test well. Because the first test well was "dry" and no casing costs had been incurred, considerable funds were still available in the contract. The balance was too small to fully complete another deep well, but it was enough to start another well. If production was found, additional funds could be sought. Site selection of the BLM Test Well 2 (Figure 2) was again based on the existence of a road and a projected trace of the fault plane at a location in the center of the valley. Also, a perceived increase in recharge area at this site was a major factor in this selection.

Drilling began on May 5th with Mark Graham again serving as Contracting Officer's Technical Representative. Mark selected the exact site based on instructions from Summers and Werrell. Tuff was encountered at 230-foot depth and granite at 420-foot depth. By May 10th drilling had proceeded to 710 feet without the driller reporting water. At that point the driller was instructed to cease drilling, ending the contract. Well completion reports (driller's logs) for these two test wells are Attachment B. They are also included in Shelley's report (1996).

On May 27th Werrell telephoned Joe Fain and asked how the well site was left. Very unfortunately, the process of setting casing at the surface and providing a locked cap (as was done on the first test well) had not been repeated. Werrell inquired if anything had been placed to mark the exact drilling site (e.g., a metal stake or large rock). Fain replied that nothing had been left to mark the site. He remembered that he had backed the truck off the road to the north. Thus, the exact well site should be at the north end of the disturbed site. Fain reported that the top 30 feet or so of the boring had been filled with native dirt and clay.

BLM funds were now exhausted. Further, the new Mojave National Preserve was underfunded and understaffed. Thus, while our activities were ended at this time, we proceeded to prepare a draft of this material and await renewed efforts in the future. Also, we developed a work plan for the future, which included the following:

1. Return to the Hole-In-The-Wall area. Using GPS instrumentation, prepare a map of the general area, showing all well sites (including old test wells south of Hole-In-The-Wall), roads, corrals, and water storage tanks. Also, acquire a water level in BLM Test Well 1 and attempt to locate the exact site of BLM Test Well 2.

2. Consider having a geophysical project completed prior to any more drilling. This project would be designed to determine fault trace(s) from several hundred yards west of BLM Test Well 1 to BLM Test Well 2, evaluate alluvial thickness and fault occurrence in the new storage tank area, and evaluate valley fill thickness near the center of the valley.

3. If the exact location of BLM Test Well 2 was found, acquire funding and have it redrilled (drill out clay and native dirt) to provide water level data and remain as a permanent observation well. Consider drilling deeper.

1996

During the year, Werrell telephoned the Chief of Maintenance at MOJA. He learned that the Park was very interested in acquiring an adequate water supply for Hole-In-The-Wall and that William Shelley of the NPS Denver Service Center was preparing a report. Werrell telephoned Shelley to discuss Shelley's findings and the efforts of Summers and Werrell. Shelley expressed that he did not wish to guide any ground water exploration.

Shelley (1996) provides a detailed engineering analysis of the potable and fire protection needs at the Hole-In-The-Wall facilities. It should be remembered that his analysis was of <u>present day</u> water needs and sets <u>minimum</u> requirements for potable water needed. The report is a major contribution in documenting the present pipelines and water system operation. As a portion of this effort, Shelley had an aquifer test run on Well T 11 N / R 15 E - 8 K 1 (the well in use since 1971); he also had the well videoed and logged. Shelley's report includes plots and raw data of the aquifer test, video survey data, chemical data, and gamma ray log data. Shelley's analysis indicates that the present well yield is barely adequate and does not provide any safety factor. He states that a new source, providing an additional 5-gpm, "would double the water producing capacity and improve the system reliability." In his summary Shelley states, "It is highly recommended that a new well be drilled in the near future."

Late in the year, while discussing interests and work with USGS personnel, Werrell learned that new geologic mapping of MOJA had been done by David Miller of the USGS Geologic Division, Menlo Park, CA. Werrell telephoned Miller and learned that the government-funded project had started several years ago to acquire knowledge of lands that could be affected by the pending California Desert Protection Act. Miller already had done extensive work and had produced a preliminary map of the geology of the Hole-In-The-Wall area. Although the initial funding for the project had been used and he had been assigned other projects, Miller continued some work on the mapping. Miller expressed interest in the work of Werrell and Summers and offered to meet with them in the field.

October 30, 1997

Werrell and Summers met David Miller (USGS), David Bradford (USGS), and Jim Newton (MOJA Maintenance Division) at Hole-In-The-Wall. Miller provided Werrell and Summers with a preliminary copy of his map of the area.

Newton led us to three wells northeast and across the valley from BLM Test Well 1. None of these wells were in production. Each well was closed with a plate welded to the casing. These wells are T 12 N / R 15 E - 33 D 1 and 2 and T 12 N / R 15 E - 33 M 1 (Freiwald, 1984) (Figure 2). Newton questioned if the wells could be opened and used for the needed water supply at Hole-In-The-Wall. It was noted that the lack of electricity nearby and a pipeline were major problems.

At Well 33 M 1 the wellhead was equipped with the remains of an old walking-beam pump, which indicated that someone once believed that well production was sufficient to provide enough water for their needs. What those needs were and the reason for abandoning the well are unknown. Could it have been insufficient yield? We discussed the efforts needed to determine if the well or well site could be used. If a 24-hour aquifer test (complete with recovery data and a water quality sample) indicated that quality and production justified the expense of running electricity to the site and placing a pipeline, a new well could be drilled. (Note: Two other old, capped wells were seen not far north of Well 33 M 1.)

Our route to Well 33 M 1 was circuitous–first north, then east to a ranch, and finally south–in order to avoid Wilderness Area land. Newton informed us that the valley north of Hole-In-The-Wall to a point about east of the three wells is Wilderness Area, the west boundary being the major dirt road leading north from Hole-In-The-Wall. Newton further explained that a dirt road (shown on Miller's preliminary map–not attached), leading from near the new storage tanks to the east side of the valley, is within the designated Wilderness Area. It was noted that BLM Test Well 2 is along this road, perhaps near its midpoint. The road is now closed to public use, causing a problem with access to private property to the east. The Wilderness Area north of this dirt road is triangular in shape. The reason for the odd shape is unknown. Newton stated that recently there had been discussion in the Park to request the withdrawal of Wilderness designation from the triangular area.

Newton departed, and we four remaining walked to the site of BLM Test Well 2, a disturbed area on the north side of the road. The exact location of the well cannot be seen. This site is about midway between the new water storage tanks and Well T 12 N / R 15 E – 33 M 1. We reviewed the geology of BLM Test Well 2 and then drove to BLM Test Well 1.

Summers and Werrell presented their fieldwork and conclusions to Miller and Bedford. BLM Test Well 1 was opened, and (using a steel tape) the water level was determined to be 161 feet below TOC. The fact that this well was reported by the driller as dry and now contains water was not surprising. Drilling was done using compressed air. Blowing the boring to test for water yield is recognized as a poor method of determining yield. Further, the deeper the boring the poorer the method. This is because water is driven in slugs up the boring and tends to "fall down" around the sides of the air bubble.

With new information gathered during the field inspection, Werrell and Summers formulated the following recommendations:

1. Conduct an aquifer test on BLM Test Well 1. From experience we have learned that relatively small quantities of water are undetected during a drilling process; this could be especially true when drilling with compressed air as was the case here. Thus there is a probability that the well could yield up to 10-15 gpm after being cleaned out. This quantity of water would meet the needs of Hole-In-The-Wall. An aquifer test would determine the long-term yield. Desirably, the pump could be set near the bottom and pumping would start at 20 gpm. Recognized problems with this alternative include:

   A. It was noted that vision down the well was relatively limited in depth due to boring curvature. Some curvature of borings is to be expected because of drilling aspects, but this boring is worse than the average. This factor is relevant when considering the possibility of lowering a pump into the well.

   B. Except for the first few feet where surface casing is set without a cement seal, the well is an open hole. Loose rock could fall into the boring and wedge so that a pump could not be removed. This possibility is accentuated by Item A. In fact, the corkscrew nature of the boring may preclude the installation of a pump at deep depths. Contractors are very aware of this risk and would demand contract provisions to pay for any pump and/or pipe lost. Thus, a special contract and contingency funding would be necessary.

2. Conduct geophysical surveys in the general area to provide geologic understanding of major faults and basin fill depths. These surveys would improve understanding of the setting of the two test wells and would greatly aid in the selection of another drilling site.

3. If the site of BLM Test Well 2 can be made available or the Wilderness Area designation removed, the exact well site should be found and the well reopened. Hand digging will be necessary to find the boring. Then the native material can be drilled out. Obtaining a static water level would greatly assist in understanding the water table characteristics in the valley. An aquifer test would determine if the well could meet the needs of Hole-In-The-Wall. The site is within a reasonable distance from the new storage tanks, and a pipeline could be laid in alluvial material. Permanent surface casing should be set at the surface and the well locked.

We proceeded to the northwest and inspected Valley Spring, T 12 N / R 15 E – 31 L 1. This spring is along an old road, and old physical evidence indicates that various efforts have been made to divert and pond the spring's flow. One small pool of water was observed. Flow was estimated at about one-half gpm. This spring is not considered a viable source for Hole-In-The-Wall.

November 1997

Werrell notified Mary Martin, now Superintendent of MOJA, of the results of the trip. He informed her that Miller had done substantial geologic work in the Park and could, with a new source of funding, complete the mapping. As base line scientific information, published geology of the Park would serve as the basis of evaluating potential threats to the ground water resources of the Park, soil surveys, various biological studies, and interpretation of the Park. Superintendent Martin was pleased to learn the background of this work and acquired Miller's phone number for future use in discussing a possible contract. Certainly this would be most beneficial if arranged in the near future, before Miller moves on to another position. The next geologist assigned to the project would not start with Miller's high level of understanding of the area. Regarding the present status of the Hole-In-The-Wall project, Martin asked that Werrell send a memorandum to David Paulissen of her staff. (Note: The Superintendent was aware that Werrell was on the verge of retiring.)

While reviewing data, Werrell found the Fain Drilling and Pump Company report in Shelley's report (1996). The data raised the question of exactly which wells the data referred to. Werrell telephoned Joe Fain and inquired which wells were indicated by Wells A, B, and C. Mr. Fain initially had some difficulty in remembering the job, but as the conversation continued it became clear that these wells are not those to the immediate east of Hole-In-The-Wall. Mr. Fain remembered that Well A had a windmill. When Werrell mentioned the well that had remains of a walking-beam pump (Well T 12 N / R 15 E - 33 M 1), Mr. Fain quickly remembered that this well corresponds to his Well A. Further, he stated that Wells B and C were close to each other and were "not very far" to the north of Well A.

Thus, the authors believe that Wells B and C are Wells T 12 N / R 15 E - 33 D 1 and D 2. However, it is unknown which well corresponds to Well B and which to Well C. Both wells were listed as having a casing diameter of 10.5 inches (Freiwald, 1984), while Fain's records indicate one well with a casing diameter of 8 inches. It is possible that Well C (listed by Fain as 545 feet deep) corresponds to Well 33 D 1 (listed by Freiwald as 540 feet deep), indicating that Fain simply cleaned the well out with little or no new drilling. Future fieldwork should clarify the well numbering. Fain remembered the job as one of deepening existing wells, but this may not have been the case. Rather, the job may have been to clean out old wells to restore yield, which may have included minor drilling. This would account for the small difference in depths recorded for Well 33 D 1 and for the fact that Freiwald reported the depth of Well 33 M 1 as 720 feet while Fain listed the depth as 740 feet.

December 22, 1997

Werrell sent a memorandum to David Paulissen, Chief of Maintenance at MOJA (Attachment C).

1998

Werrell retired on January 3, 1998. Contact between Werrell and Summers continued as did their mutual interest in resolving the Hole-In-The-Wall water supply problem. It was agreed that they would work together to prepare this report, which would include all the thoughts and efforts of the Hole-In-The-Wall project.

In July Werrell telephoned William Shelley and learned that the Park had hired a well driller to conduct tests in the Hole-In-The-Wall area. Shelley had not been present during the testing, but he forwarded the test data to Werrell. After reviewing the material, Werrell suspected that this work was done (at least to some degree) in response to his December 1997 memorandum to Paulissen. That is, the Park contracted for a pump test of BLM Test Well 1 and Well T 12 N / R 15 E – 33 M 1, which called for the pump to be set at 500 foot depth with a pumping rate of over 20 gpm. It is highly suspected that the Park had located a driller with much reduced costs than the one mentioned by Werrell in the memorandum. The work was conducted by Interstate Utility Service, which had offices in Bullhead City, AZ, and Yuma, AZ.

On May 16, 1998, the Interstate crew had set up over BLM Test Well 1 ("Test 1" in the driller's notes–Attachment B) and noted that the well had caved in at a depth of 190 feet. The water level was about 150 feet. (Note: The reference point for these two measurements was not provided.) No attempt to test the well yield was made, perhaps because the pump could not be placed at the 500-foot depth as may have been specified by the contract. It is unfortunate that BLM Test Well 1 was not tested, even though the pump could not have been set lower than 190 feet.

The crew then moved to Well 33 M 1 ("Test 2" in the driller's notes) and on May 18-19th conducted an aquifer test. The pump was set at 500-foot depth, and the static water level was 407.6 feet. Again, no reference point was given. Discharge began at 5 gpm for the first 5 minutes and then was reduced to 4.5 gpm due to "generator problems." The generator problem may well account for the relatively low discharge during the test. During the first 5 minutes the draw down reached 11.6 feet, and after reduction of discharge the draw down stabilized at 9.2 feet for the remainder of the pumping period, which was 474 minutes (7 hours and 54 minutes). Data indicated that the water level had fully recovered 10 minutes after pumping stopped. The depth of the well was reported as 718 feet.

In the fall Werrell telephoned MOJA Chief of Maintenance, Dave Paulissen, and learned that Park plans included proceeding to lay a pipeline from Well 33 M 1 to the new storage tanks, thus solving the Hole-In-The-Wall water supply problem. The Wilderness boundary problem also had been solved.

1999

Werrell learned from Miller that no funding had been achieved to support further geologic mapping of MOJA. However, Miller indicated that he had USGS permission to proceed, as time permitted, with work on and publication of quadrangles where preliminary mapping had already been accomplished. This new, more detailed, geologic information will assist the Park in hydrologic efforts and interpretation to visitors.

In January 1999 the Water Resources Division of NPS published a water resources scoping report for MOJA (NPS MOJA, NPS WRD, CSU Earth Resources, 1999). This well-prepared report discusses identified issues, presents sound project statements, and includes databases and a bibliography. Geologic mapping by Miller will contribute to all the proposed projects. The authors recommend that continuation of Miller's geologic mapping be promoted through Project Statement 5, which calls for a workshop on water resources and ground water impacts.

In March 1999 in order to clarify data, Werrell telephoned the Interstate Utility Service offices at both Yuma and Bullhead City. No one who was on their crew during the May 1998 testing at MOJA was still with the company. Werrell inquired how the water level data was obtained and was informed that the standard procedure for the company was use of an air line. It is therefore possible that Interstate's water level data is accurate to plus or minus one or two feet–depending on the actual accuracy of the pressure gage. This can account for the exact same drawdown on Well 33 M1 as recorded during the pumping period over an approximate 8-hour period. Even though the depth to water was recorded to within a tenth of a foot, the water level can be expected to have changed a small amount during this time. This would also account for the 2.4-foot jump of water level within one minute during recovery. Nevertheless, it appears that the well is capable of producing somewhat more than 5 gpm.

SUMMARY

1. BLM Test Well 1 is not a dry hole; both the water level measurement by the authors and the one by Interstate Utility Service confirm this. Both BLM Test Well 1 and BLM Test Well 2 potentially can provide data that will greatly assist in understanding ground water movement in the Hole-In-The-Wall area. Their actual potential to provide the necessary water requirements is unknown. If BLM Test Well 1 has the same hydraulic characteristics as Well 33 M 1, a pump test at the same discharge could have been made with the water level remaining above the 190-foot level. Also, the "caving in" of a well does not seal the well off from water movement at the level of the cave in. If any further work is done on Well 33 M 1, it is highly recommended that an aquifer test be made at BLM Test Well 1. If unused for production, BLM Test Well 1 should continue to be protected with a locking cap and used as a long-term monitoring well.

2. Regarding BLM Test Well 2, the authors surmise that this well is not truly dry but contains a static water level. If so, this information would be very helpful in fully understanding the ground water regime of the valley. The exact borehole should be found and opened. We suspect that the boring is filled with dirt to a very shallow depth and that rags or a rock will be found at the bottom. The installation of surface casing with a locking cap would permit collection of water levels.

3. Any support to promote geologic mapping is strongly encouraged.

4. Hopefully, this report will assist future efforts to provide a good water supply to the Hole-In-The-Wall area and also water quality and water quantity monitoring. A bibliography of geologic and hydrologic references for MOJA is included as Attachment D.

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California Division of Mines and Geology. 1961. Geologic map of California : Kingman Sheet. California Division of Mines and Geology: San Francisco, CA.

Freiwald, David A. 1984. Ground-water resources of Lanfair and Fenner Valleys and vicinity, San Bernardino County, California. U.S. Geological Survey: Sacramento, CA. Water-Resources Investigations Report 83-4082. 60 pages and 2 plates.

National Park Service, Mojave National Preserve; National Park Service, Water Resources Division; Colorado State University, Earth Resources Department. 1999. Water Resources Scoping Report : Mojave National Preserve. National Park Service, Water Resources Division: Fort Collins, CO. Technical Report NPS/NRWRD/NRTR-99/225. 116 pages.

National Park Service, Water Resources Division and Servicewide Inventory and Monitoring Program. 2001. Baseline Water Quality Data Inventory and Analysis : Mojave National Preserve. National Park Service: Fort Collins, CO. Technical Report NPS/NRWRD/NRTR-2001/285. 438 pp.+ 4 disks.

Shelley, William H. 1996. Design analysis and cost estimate : 95% review : Water system improvements : Mojave National Preserve, Hole-In-The-Wall. National Park Service, Denver Service Center: Denver, CO. MOJA-103. 50 pp. + 4 appendices.

U.S. Geological Survey. 1985. Ivanpah : California-Nevada 1:100 000-scale metric topographic map. U.S. Geological Survey: Reston, VA. 30 x 60 minute series 35115-A1-TM-100.

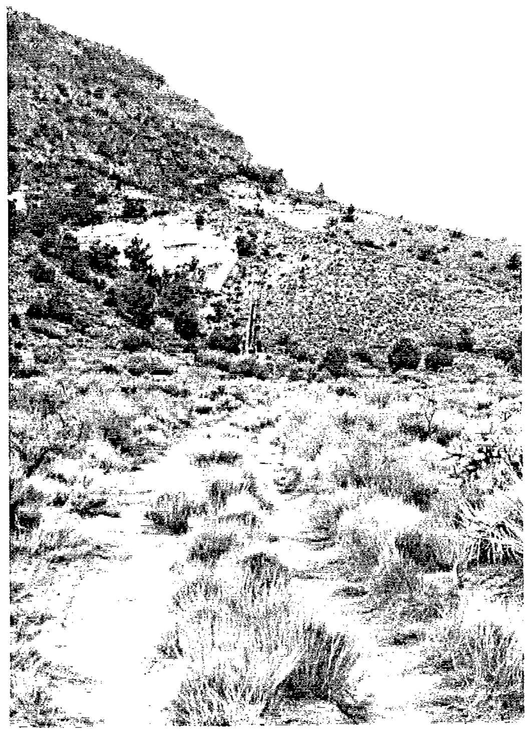
ATTACHMENTS

Attachment A.	**Photographs**
Attachment B.	**Well completion reports (driller's logs) for BLM Test Wells 1 and 2**
Attachment C.	**December 22, 1997, memo to David Paulissen from William Werrell**
Attachment D.	**Geologic and hydrologic references for Mojave National Preserve**

Attachment A

Photographs

Mojave National Preserve
Well T 11 N / R 15 E – 6 J 1



Looking southwest from the dirt road which extends to Well T 11 N / R 15 E – 6 C 1, this road is not seen in the photo. The drill rig is seen over Well T 11 N / R 15 E – 6 J 1. A two rut road extending to the well is seen in the photograph.

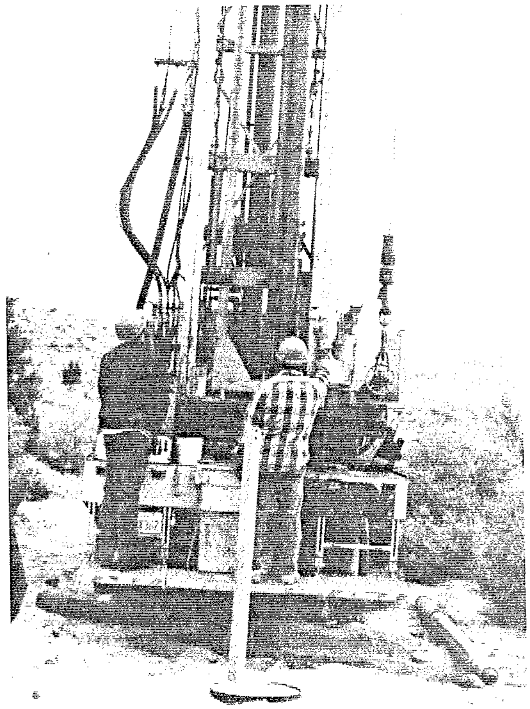
Photographs by William Werrell, Hydrologist, Death Valley National Park
Photographs of March 21, 1995

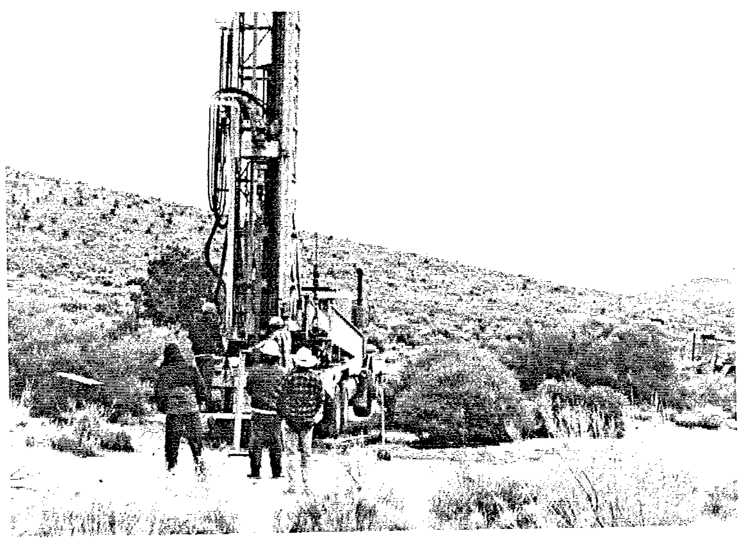
Mojave National Preserve
Well T 11 N / R 15 E – 6 J 1

Panorama of drill rig set up over the well, looking southwest.
Drill rig is seen at lower center of photo.

Photographs by William Werrell, Hydrologist, Death Valley National Park
Photographs of March 21, 1995

Mojave National Preserve
Well T 11 N / R 15 E – 6 J 1





Both photos – showing drilling operation on Well J 1

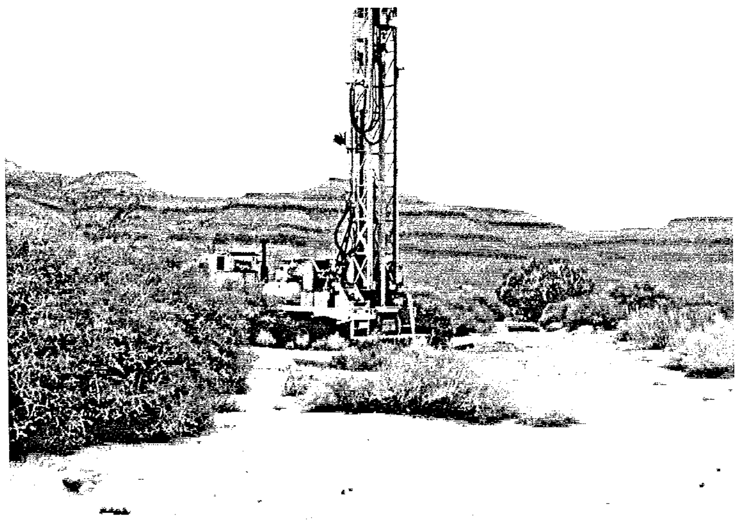
Photographs by William Werrell, Hydrologist, Death Valley National Park
Photographs of March 21, 1995

Mojave National Preserve
Well T 11 N / R 15 E – 6 J 1

Setting up to pump Well J 1, the drilling rig has been removed. Note the iron post to the left which was one of four before work began. The other three posts were cut off by the driller to permit access by the drill rig. These posts indicate that a windmill was once present at this well. The single post was left in place after the job was completed.

Photographs by William Werrell, Hydrologist, Death Valley National Park
Photographs of March 21, 1995

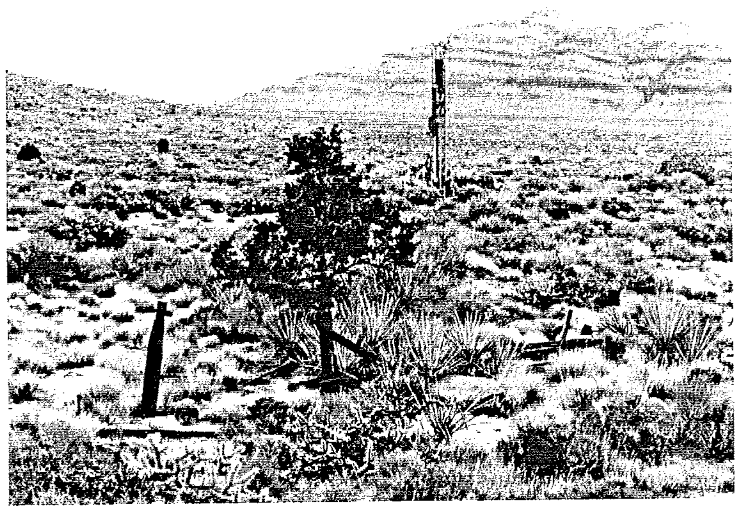
Close-up of drillers truck.



Looking downstream, east, showing drilling rig set up over well J 1. Note the alluvial sand in the wash

Photographs by William Werrell, Hydrologist, Death Valley National Park
Photographs of March 21, 1995

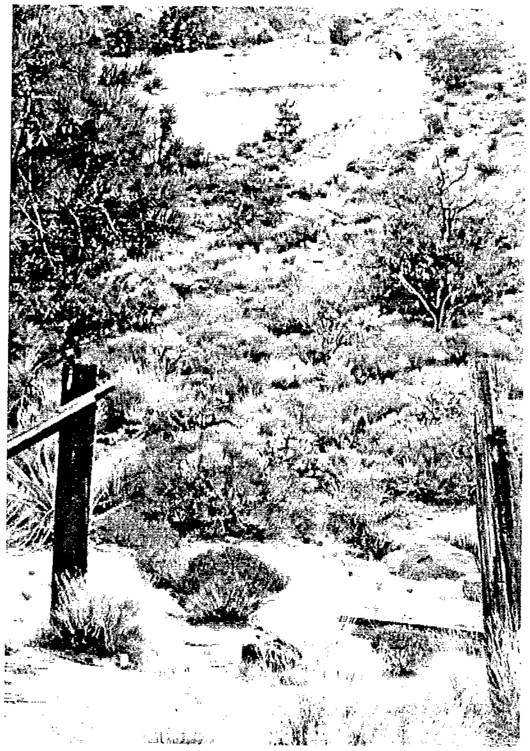
Mojave National Preserve
Well T 11 N / R 15 E – 6 J 2

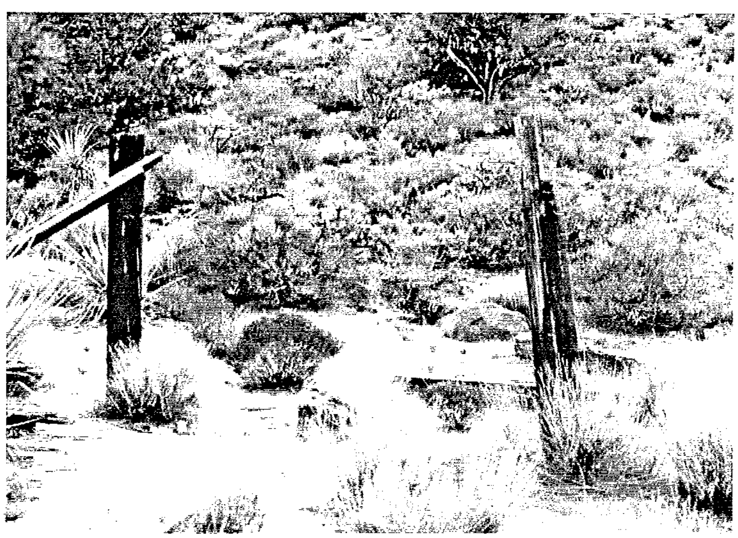


Looking northeast, showing well between the old fence posts at lower left. Drill rig in the background is set up over Well T 11 N/R 15 E – 6 J 1.

Photographs by William Werrell, Hydrologist, Death Valley National Park
Photographs of March 21, 1995

Mojave National Preserve
Well T 11 N / R 15 E - 6 J 2

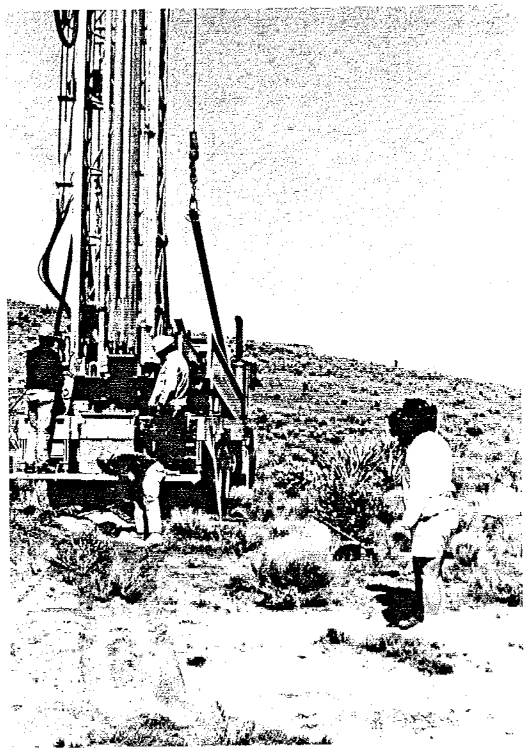


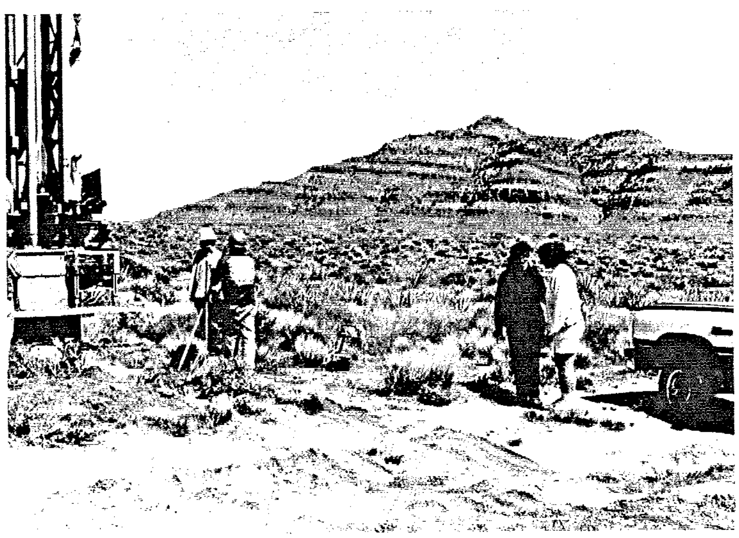


Both photos - looking southwest, showing well casing "stove pipe" between the fence posts.

Photographs by William Werrell, Hydrologist, Death Valley National Park
Photographs of March 21, 1995

Mojave National Preserve
Well T 11 N / R 15 E - ???
BLM Test Well 1

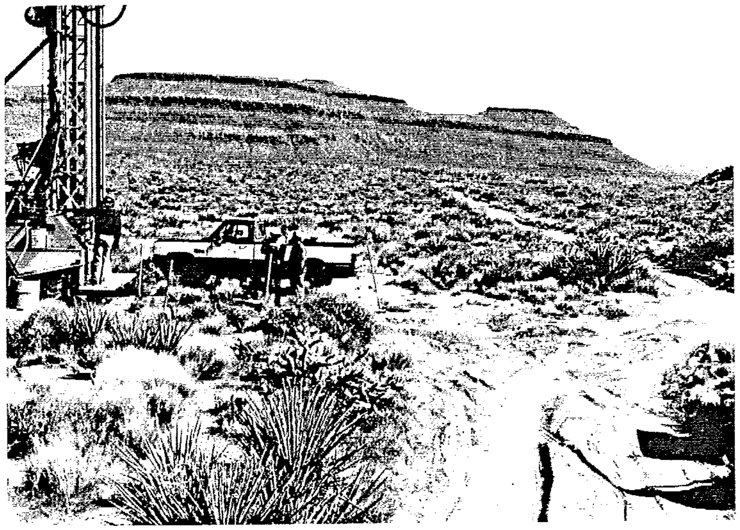




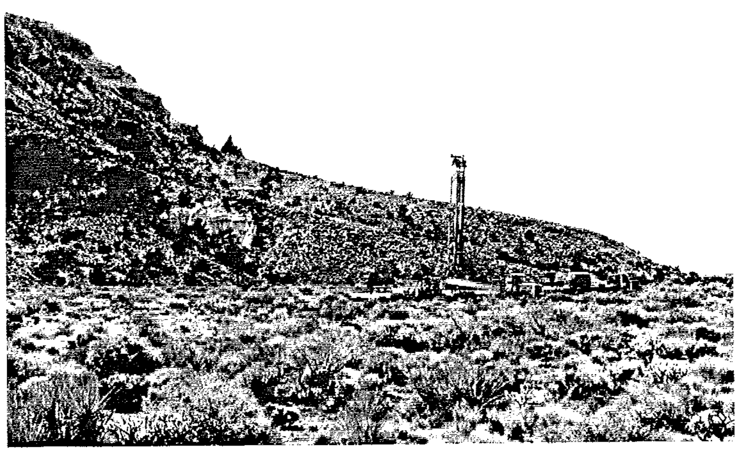
Both photos - drilling of Well T 11 N / R 15 E - ??? "BLM Test Well 1". Assistant Superintendent Mary Martin is seen to the right The dirt road seen at the bottom of the lower photo is very close to a junction of dirt roads which join from the east and extend west (to the left) to Well T 11 N / R 15 E - 6 C 1.

Photographs by William Werrell, Hydrologist, Death Valley National Park
Photographs of March 22, 1995

Mojave National Preserve
Well T 11 N / R 15 E – ???
BLM Test Well 1



Looking southeast showing drill rig at BLM Test Well 1, and junction of dirt roads. The road on the right extends to the new NPS storage tanks. Another road angles to the left behind the pickup.



Looking southwest showing drill rig at BLM Test Well 1.

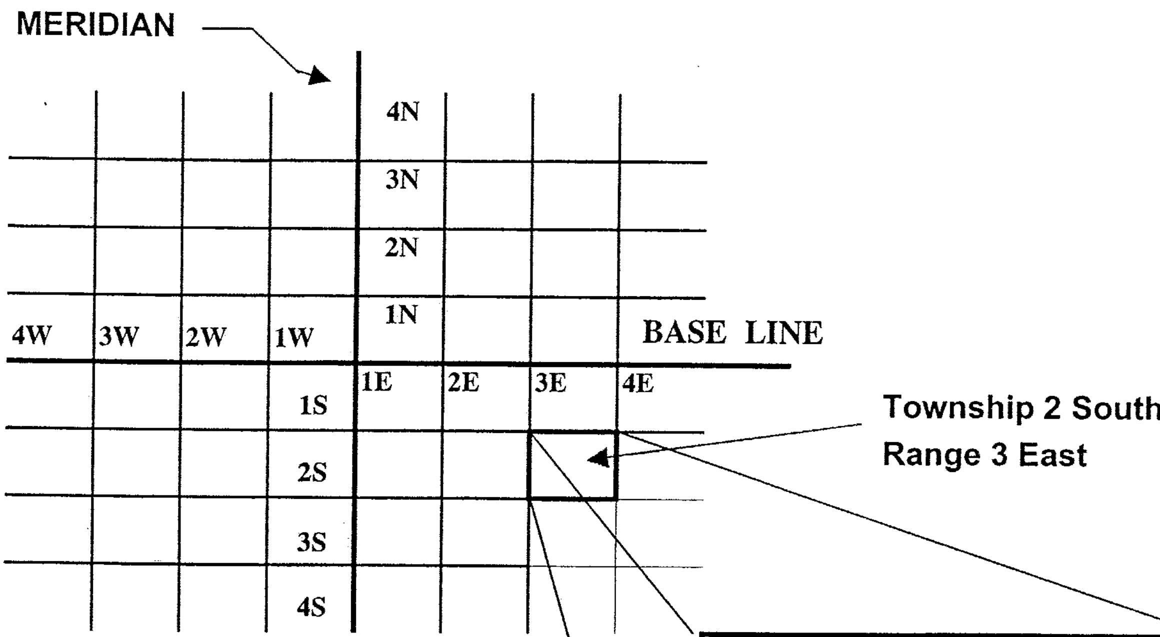
Photographs by William Werrell, Hydrologist, Death Valley National Park
Photographs of March 22, 1995

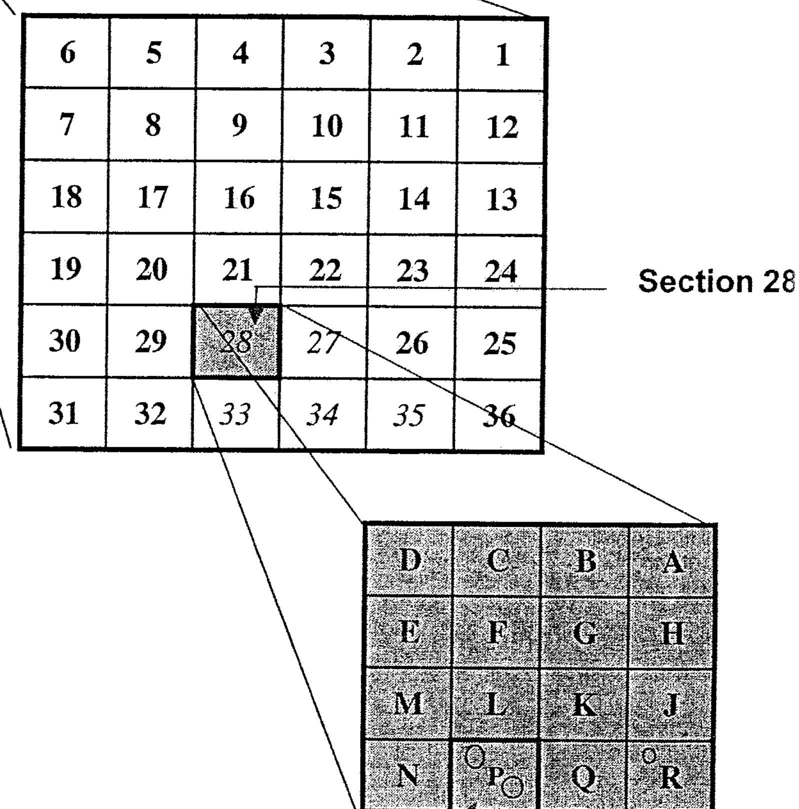
Attachment B

Well completion reports (driller's logs)

for BLM Test Wells 1 and 2

STATE WELL NUMBER SYSTEM





- A Township is approximately 6 miles x 6 miles and has 36 Sections.
- A Section is approimatelly 1 square mile and is divided into 16 Tracts.
- A Tract is approximately 1/4 mile x 1/4 mile and has about 40 acres.

In this example, if there are two wells in Tract P.

The State Well Number for the second well would be: **02S 03E 28 P OO2 S**

- Township
- Range
- Section
- Tract
- Sequence number of well within the tract
- Base and Meridian (S for San Bernardino and M for Mount Diablo)

TRIPLICATE
Owner's Copy

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

Page 1 of 2
Owner's Well No. Well One (Monitor) No. 463754
Date Work Began 3-20-95, Ended 4-5-95
Local Permit Agency Env Health serv San Bernardino
Permit No. 03159550 Permit Date 3/15/95

DWR USE ONLY — DO NOT FILL IN —
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE

DEPTH FROM SURFACE Ft. to Ft.		DESCRIPTION *Describe material, grain size, color, etc.*
0	4	Alluvial fill - fine to coarse sand with small aggregates brown color
4	20	fine to coarse sand - brown color
20	50	claey sand - light grey color
50	100	claey sand with small aggregates red/brown color
100	200	Meta volcanics - dark grey to black color
200	250	clay stone with small aggregates grey color
250	290	clay stone tan color
290	360	clay sandstone green/grey color
360	390	decomposed granite - green/grey color
390	480	granitics - grey color (high quartz content)
480	510	granitics - grey color with pink mineral
510	540	granite (hard) salt & Pepper mineral
540	750	granite (hard) salt & Pepper and orange mineral
750	900	granite (hard) overall color grey

TOTAL DEPTH OF BORING 900 (Feet)
TOTAL DEPTH OF COMPLETED WELL 900 (Feet)

WELL OWNER

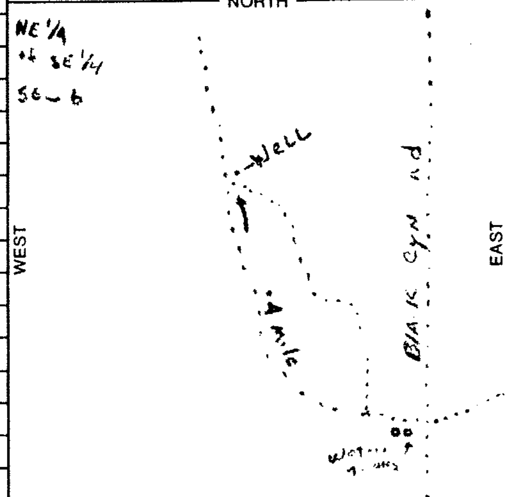
Name U.S. Dept. of the Interior - BLM
Mailing Address Denver Federal Center Bldg 50
CITY Denver, Colorado STATE ZIP 80225-0047

WELL LOCATION

Address Hole-In-The-Wall Camp Ground
City Barstow - Kelso
County San Bernardino
APN Book 657 Page 011 Parcel 01
Township 11N Range 15E Section 6
Latitude ___ DEG. MIN. SEC. NORTH Longitude ___ DEG. MIN. SEC. WEST

LOCATION SKETCH

NORTH



SOUTH
WEST EAST

Illustrate or Describe Distance of Well from Landmarks such as Roads, Buildings, Fences, Rivers, etc.
PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

X NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USE(S) (✓)

X MONITORING
WATER SUPPLY
___ Domestic
___ Public
___ Irrigation
___ Industrial
___ "TEST WELL"
___ CATHODIC PROTECTION
___ OTHER (Specify)

DRILLING METHOD Rotary FLUID Air & Water

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL none (Ft.) & DATE MEASURED ___
ESTIMATED YIELD* 0 (GPM) & TEST TYPE ___
TEST LENGTH ___ (Hrs.) TOTAL DRAWDOWN ___ (Ft.)
** May not be representative of a well's long-term yield.*

CASING(S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE: BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	26	16	X				A-53-B	10	.188	

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	23		X		

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
X Other Map

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Fain Drilling & Pump Co Inc.
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

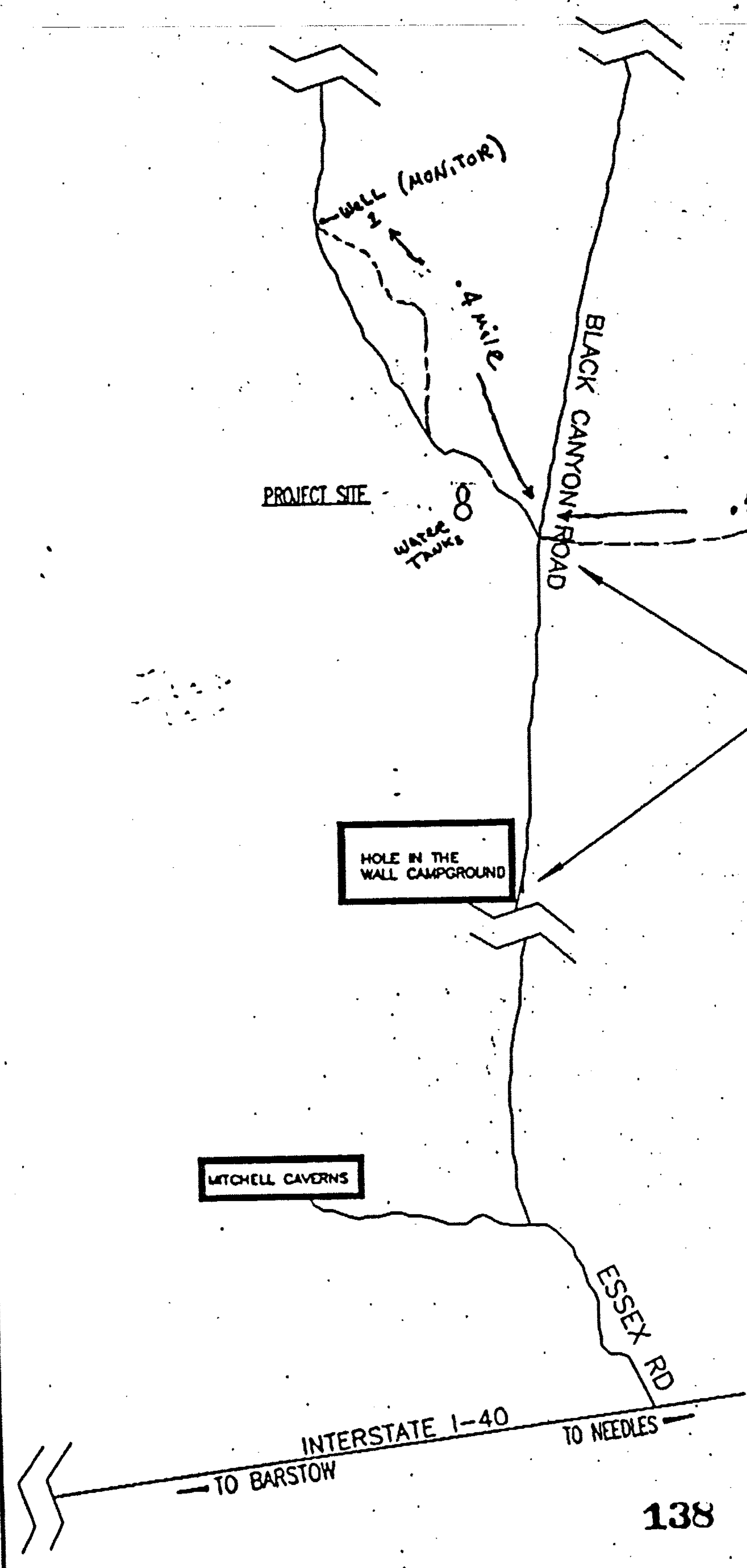
ADDRESS 12029 Old Castle Rd. CITY Valley Center, STATE Ca ZIP 92082

Signed Joe R. Fain
WELL DRILLER/AUTHORIZED REPRESENTATIVE

DATE SIGNED 4/20/95 C-57 LICENSE NUMBER 328287

DWR 188 REV. 7-90

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM



UNITED STATES DEPARTMENT OF THE INTERIOR
BLM CALIF DESERT DIST

HOLE IN THE WALL LOCATION

DESIGNED	by others
REVIEWED	
APPROVED	

DRAWN ROBT COLLINS	SCALE NONE
DATE APRIL 7, 1993	SHEET OF
DRAWING NO. 3 WELL 1	

138

ALWAYS THINK SAFETY

HWATER

TRIPLICATE
Owner's Copy

Page 1 of 2

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

No. 463756

DWR USE ONLY — DO NOT FILL IN —

STATE WELL NO./STATION NO.

LATITUDE | LONGITUDE

APN/TRS/OTHER

Owner's Well No. Two
Date Work Began 4/5/95, Ended 4/10/95
Local Permit Agency Env. Health Serv. San Bernardino
Permit No. 04059550 Permit Date 4/5/95

GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
0	230	Alluvial fan - glomerate
230		consisting of fine to coarse
		sand, partly cemented with some
		small aggregates
230	350	Meta volcanics
350	420	clay stone
420	580	granitics - soft broken- grey color
580	710	granite soft broken - red color
		NOTE: bore hole was backfilled
		with native sand to within 35 ft.
		of surface - remainder of hole
		filled with 3/8" bentonite chips

TOTAL DEPTH OF BORING 710 (Feet)
TOTAL DEPTH OF COMPLETED WELL 0 (Feet)

WELL OWNER

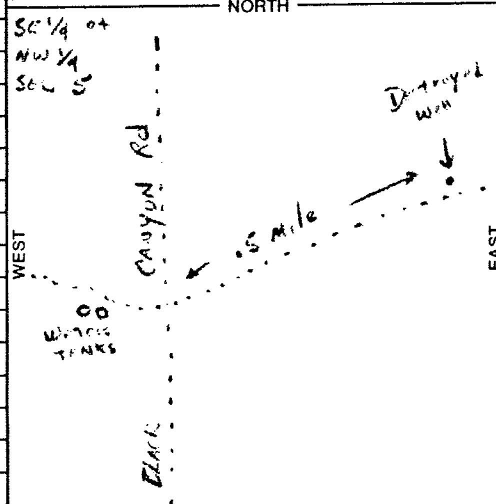
Name U. S. Dept of the Interior - BLM
Mailing Address Denver Federal Center Bldg 50
CITY Denver Colorado 80225-0047

WELL LOCATION

Address Hole-In-The-Wall Camp Ground
City Barstow-Kelso
County San Bernardino
APN Book 657 Page 011 Parcel 05
Township 11N Range 15E Section 5
Latitude ___ NORTH DEG. MIN. SEC. Longitude ___ WEST DEG. MIN. SEC.

LOCATION SKETCH

NORTH



WEST | EAST

SOUTH

Illustrate or Describe Distance of Well from Landmarks such as Roads, Buildings, Fences, Rivers, etc.
PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

XX NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)

___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USE(S) (✓)

___ MONITORING
WATER SUPPLY
___ Domestic
___ Public
___ Irrigation
___ Industrial
X "TEST WELL"
___ CATHODIC PROTECTION
___ OTHER (Specify)

DRILLING METHOD Rotary FLUID Air & Water

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL none (Ft.) & DATE MEASURED ___
ESTIMATED YIELD* 0 (GPM) & TEST TYPE ___
TEST LENGTH ___ (Hrs.) TOTAL DRAWDOWN ___ (Ft.)
** May not be representative of a well's long-term yield.*

CASING(S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
NONE										

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	35		X		

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
✓ Other MAP

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

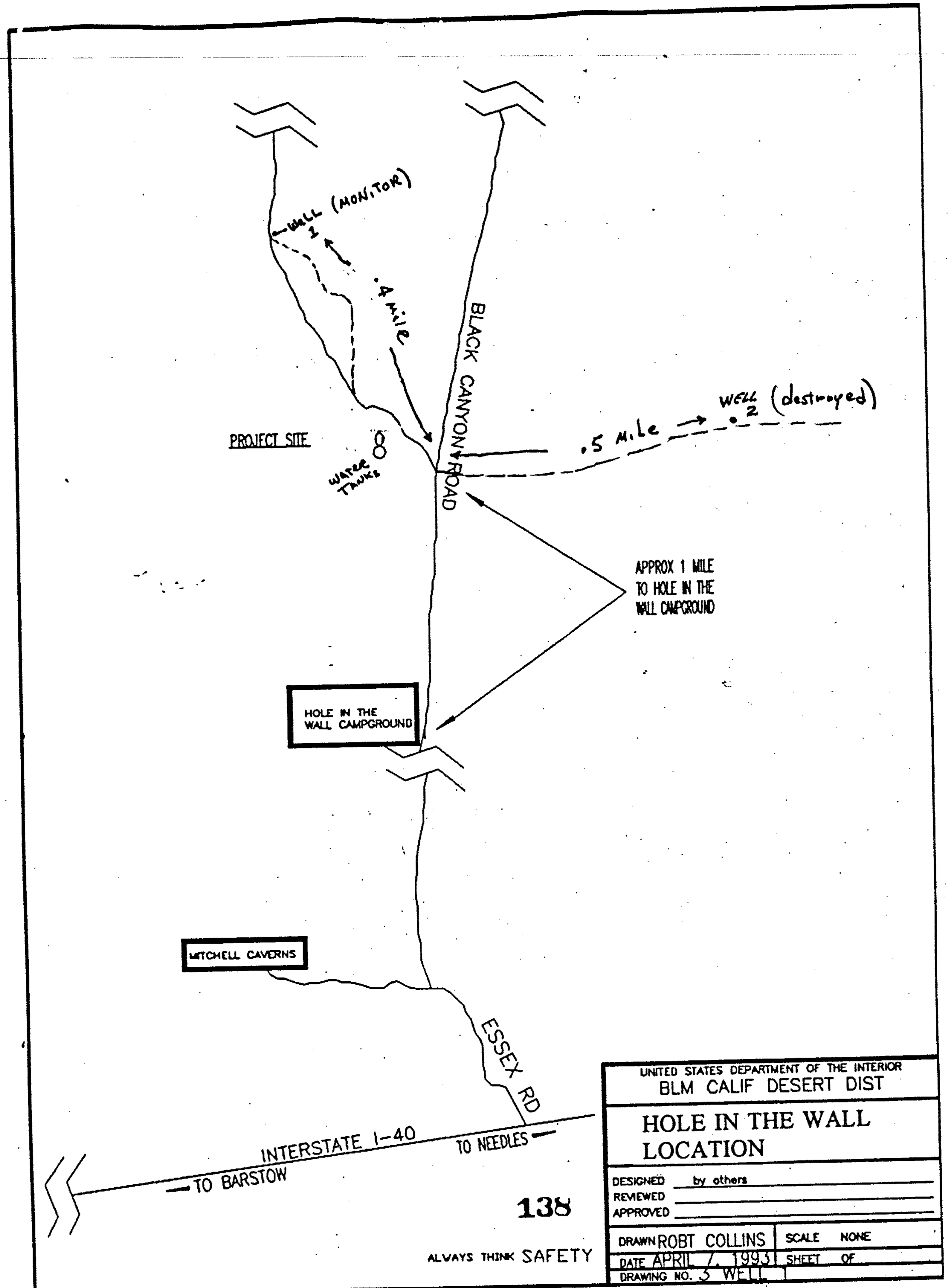
NAME Fain Drilling & Pump Co INc
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

12029 Old castle Rd Valley Center, Ca 92082
ADDRESS CITY STATE ZIP

Signed Joe R Fain 4/20/95 328287
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 7-90

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM


WELL (MONITOR)
1
.4 mile
BLACK CANYON ROAD
WELL (destroyed)
2
.5 mile
PROJECT SITE
water tanks
APPROX 1 MILE
TO HOLE IN THE
WALL CAMPGROUND
HOLE IN THE
WALL CAMPGROUND
MITCHELL CAVERNS
ESSEX RD
INTERSTATE I-40
TO NEEDLES
TO BARSTOW
138
ALWAYS THINK SAFETY
UNITED STATES DEPARTMENT OF THE INTERIOR
BLM CALIF DESERT DIST
HOLE IN THE WALL
LOCATION
DESIGNED by others
REVIEWED
APPROVED
DRAWN ROBT COLLINS
SCALE NONE
DATE APRIL 7, 1993
SHEET OF
DRAWING NO. 3 WELL 1

HWATER

Attachment C

December 22, 1997, memo to David Paulissen

from William Werrell

L 54
MOJA

December 22, 1997

Memorandum:

To: David Paulissen, Chief of Maintenance, MOJA

From: William Werrell, Hydrologist, DEVA

Subject: Water Supply for Hole-in-the-Wall

On October 30 I met with Paul Summers, Bureau of Land Management hydrologist, and David Miller, U.S. Geological Survey geologist to glean ideas of what the next step should be to acquire a potable water supply for Hole-in-the-Wall. Summers and I had prepared a draft of the well drilling history of the area based on his long career and programming for the two test wells when the area was managed by BLM. Also, he and I were present when drilling started on Test Well # 1, the well near the new water storage tanks. Both test wells were reported dry by the driller.

We met Jim Newton, who showed us the wells and situation in Gold Valley. We also visited the site of Test Well # 2, the exact well site is not marked. Newton informed us that the area containing Test Well # 2 was under consideration for being removed from Wilderness Area designation.

We were in the process of formulating several possible options of efforts which would provide information to direct/enhance further drilling when we visited the site of Test Well # 1. There we opened the well and determined that the well contained water at about 161 feet below the surface. This fact provides no information regarding the potential well yield. We believe that it is possible that the well could produce up to some 10 gallons per minute which could have been undetected by the driller. Further, we agreed that the testing of the well yield should be our first effort.

To explore the cost of this effort, I have contacted Thompson Drilling Co. of Las Vegas who presently has a contract with DEVA for drilling two monitoring wells. Mr. Thompson provided me with a "ball park" estimate of $ 7000.00. This estimate includes move-on, move-off, set pump capable of yielding 20 gpm to 500 foot depth, provide conductor tube for water level sounder, and operate the pump for 24 hours. Such a contract would have to include the possible purchase of the pump and pump column pipe which might become stuck in the well by a loose rock falling into the boring - this is because the test well is not cased. This contingency for pump and pipe would be about $ 6,500. Another option would be to only blow the well with air and determine if water soon refilled the boring. However, this option would then require the above pumping IF the well refilled, and of course the cost would be increased under this option. So, if we chose to gamble that the well yield is near zero we could save some money. But if the yield was very much, our testing would be more expensive. A consideration here is that the amount of yield we need is quite small compared to "average" wells, and pumping is the only method which will provide us with the data to recommend placing the well in service. Some drillers will argue that blowing the well is adequate but this is not true.

Placing the well in service will require modification of the upper portion of the well to provide a 50 foot sanitary seal as required by State law. Also, some consideration could be given to setting casing to some depth. Costs for this work are unknown.

Another thought, the cost of testing is considerable, but the well drilling cost was about $ 50,000. If the well proves to be adequate for our needs, its proximity to the storage tanks (length of pipeline required) and other costs mentioned above will be much cheaper than any other option known.

I recommend that we proceed to test the well by pumping. Other drillers can bid on the same job.

As you know, I am retiring on Jan 3, 1998. However, I would be willing to come down and run the test as a VIP. Perhaps Paul Summers would also be available. In any case, Paul and I will proceed to complete our paper on the drilling history of the area to serve as a reference for any future drilling.

My home phone is (702) 751-3405.

Attachment D

Geologic and hydrologic references

for Mojave National Preserve

GEOLOGIC AND HYDROLOGIC REFERENCES

FOR

MOJAVE NATIONAL PRESERVE

Compiled in 1997-98 by
William Werrell
Hydrologist, Death Valley National Park

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As the nation's principal conservation agency, the Department of the Interior has the responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The Department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

NPS D-33 **July 2002**