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EXPANDED SITE INSPECTION REPORT

NASA - JET PROPULSION LABORATORY
4800 Oak Grove Drive
Pasadena, California 91109

May 1990

prepared by **EBASCO ENVIRONMENTAL**
A Division of EBASCO SERVICES INCORPORATED
3000 West MacArthur Boulevard
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EXECUTIVE SUMMARY

The NASA-Jet Propulsion Laboratory (JPL) in Pasadena, California has generated and disposed of hazardous materials during its research and development activities. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, stipulates that such federal facilities perform a preliminary assessment at sites where hazardous materials may have entered the environment. Ebasco Services conducted a preliminary assessment/site inspection of JPL in 1988 (Ebasco, 1988a 1988b). The data collected during this PA/SI was used for a preliminary Hazard Ranking System (HRS) score. The HRS score is used to rank sites for potential listing on the National Priorities List (NPL). During the early part of 1990, Ebasco Services conducted an Expanded Site Inspection (ESI) of JPL to provide additional support and documentation for a final HRS score.

During the ESI of JPL, five groundwater monitoring wells were installed and 38 soil gas collectors were used to outline the nature and extent of groundwater and soil gas contamination. Two of the monitoring wells were drilled to crystalline basement rock, as deep as 725 feet below ground level, and were completed with a multi-port casing system which allows for the simultaneous monitoring of separate water-bearing zones within the aquifer. Groundwater samples were collected and sent for laboratory analysis of volatile and semivolatile organics, California Title 22 metals plus strontium, pesticides and PCBs, Total Petroleum Hydrocarbons, and cyanide. These data were collected for input for the final HRS evaluation. The laboratory data indicate that groundwater at JPL is contaminated with volatile organic compounds including carbon tetrachloride, trichloroethene, and tetrachloroethene at concentrations above state and federal regulatory thresholds.

The HRS score calculated for JPL is 38.3, based on the data collected. This score is above the 28.5 level required to be considered for the NPL.

1.0 INTRODUCTION

Ebasco Environmental (Ebasco) has completed an Expanded Site Inspection (ESI) of the Jet Propulsion Laboratory (JPL) in Pasadena, California. This work was conducted for NASA in response to requirements of the U.S. Environmental Protection Agency (EPA). Section 120 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA) mandated that the Environmental Protection Agency establish a "docket" of Federal facilities where hazardous waste is generated and/or stored, treated or disposed of currently or in the past. Section 120(d) required a preliminary assessment (PA) for those facilities on the docket by April 18, 1988. The purpose of the PA was to identify sites requiring further study under a site inspection (SI). Ebasco conducted a PA/SI at JPL during the month of February, 1988. Based on data from the PA/SI, a score using the Hazard Ranking System (HRS) was obtained. The HRS is used to rank sites for potential listing on the National Priorities List (NPL).

The purpose of this report is to provide additional support for an HRS score and present the results of groundwater and soil gas investigations performed between January and March 1990 as part of an ESI of JPL. This report discusses the methods used by Ebasco during this work, identifies and discusses the physical characteristics of JPL geology and hydrogeology and presents the findings.

1.1 OBJECTIVES AND ORGANIZATION OF REPORT

The objectives of this report are as follows:

- o To support an HRS score with additional groundwater and soil gas data;
- o To outline the nature of JPL groundwater and soil gas contaminants (i.e., type and concentration); and

- o To identify to the extent possible the horizontal and vertical extent of groundwater contaminants based on a limited number of wells and soil collectors.

Sections 1.0 and 2.0 of this report provide introductory and background information. Section 3.0 identifies and describes site investigation methodologies. Section 4.0 discusses the results of field investigations. Section 5.0 provides the Hazard Ranking System score.

2.0 SITE DESCRIPTION

JPL is located in Pasadena, California, northeast of Interstate 210, the Foothill Freeway. The site covers 176 acres and is situated on a south-facing slope of a foothill ridge of the San Gabriel Mountains. JPL is immediately west and north of the Arroyo Seco intermittent stream bed, and north of the Devil's Gate Reservoir. Figure 2-1 shows the location of JPL.

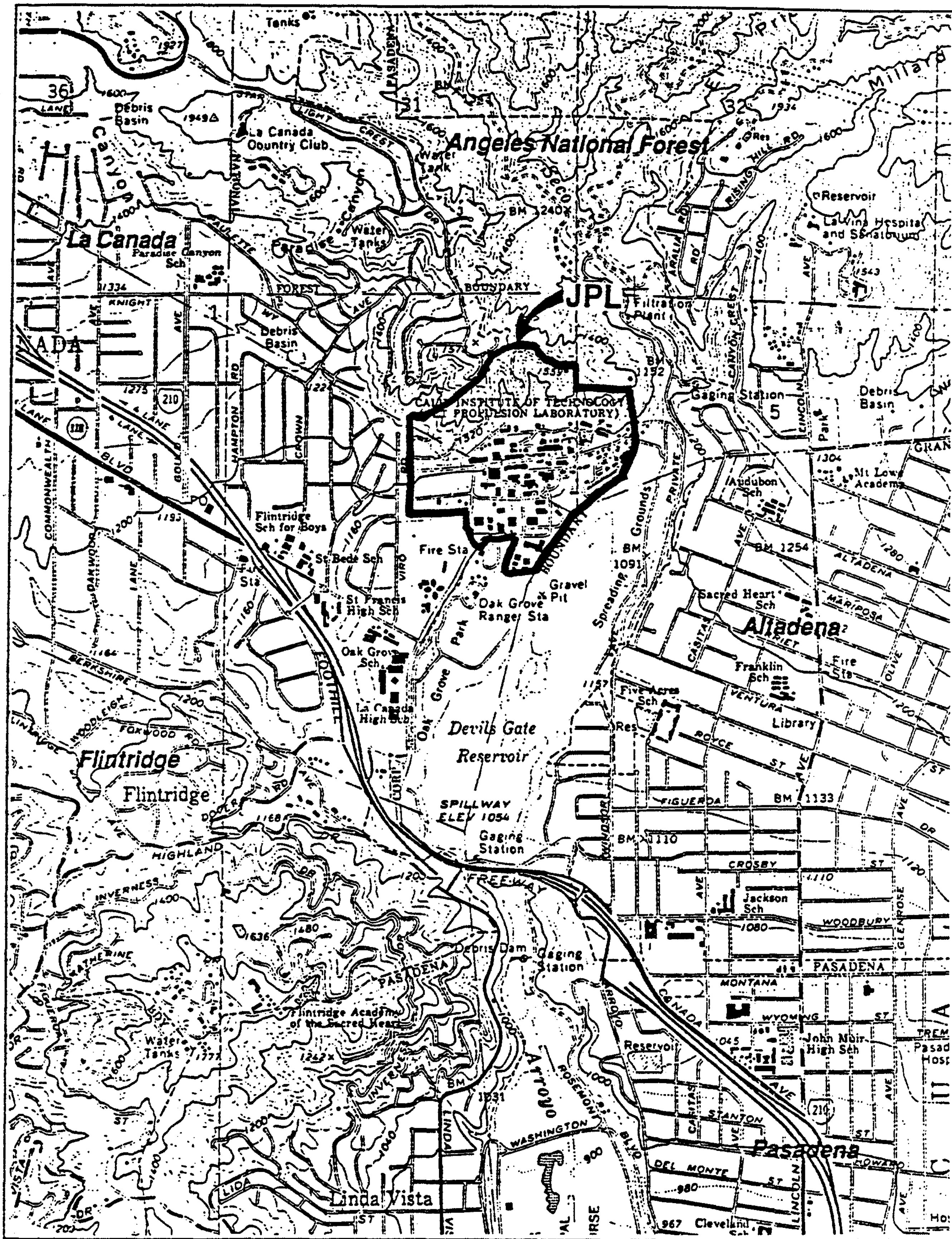
JPL is bordered on the west by a residential neighborhood, and on the south by an equestrian club and an L.A. County Fire Station. A U.S. Forest Service Ranger Station, high school and county park also lie to the south of JPL. The facility lies partially within the cities of Pasadena and La Canada-Flintridge. Residential areas of these cities and of Altadena are within one to three miles of JPL. The total population residing in the vicinity of JPL is as follows:

- within one mile of the site - 9,500;
- within two miles of the site - 17,000; and
- within three miles of the site - 20,000.

Residential property is adjacent to JPL property. The nearest offsite building is also adjacent to JPL property. The total number of buildings within two miles of the facility is approximately 2,500 (Ebasco, 1988b).

2.1 HISTORY OF SITE

The NASA-Jet Propulsion Laboratory was developed and operated by the Army between 1945 and 1957; jurisdiction was transferred to NASA in 1958. The California Institute of Technology (Cal Tech) is currently under contract to NASA to conduct research and development at JPL. JPL currently employs almost 8,000 people. JPL's mission is research and development in aeronautics, space technology, and space transportation. JPL's primary activities include exploration of the earth and solar system with automated spacecraft, the design and operation of the global Deep Space Tracking Network, and other research and development activities. Since 1958 JPL has



Source: U.S. Geological Survey

Scale: 1:24,000

N
W E
S

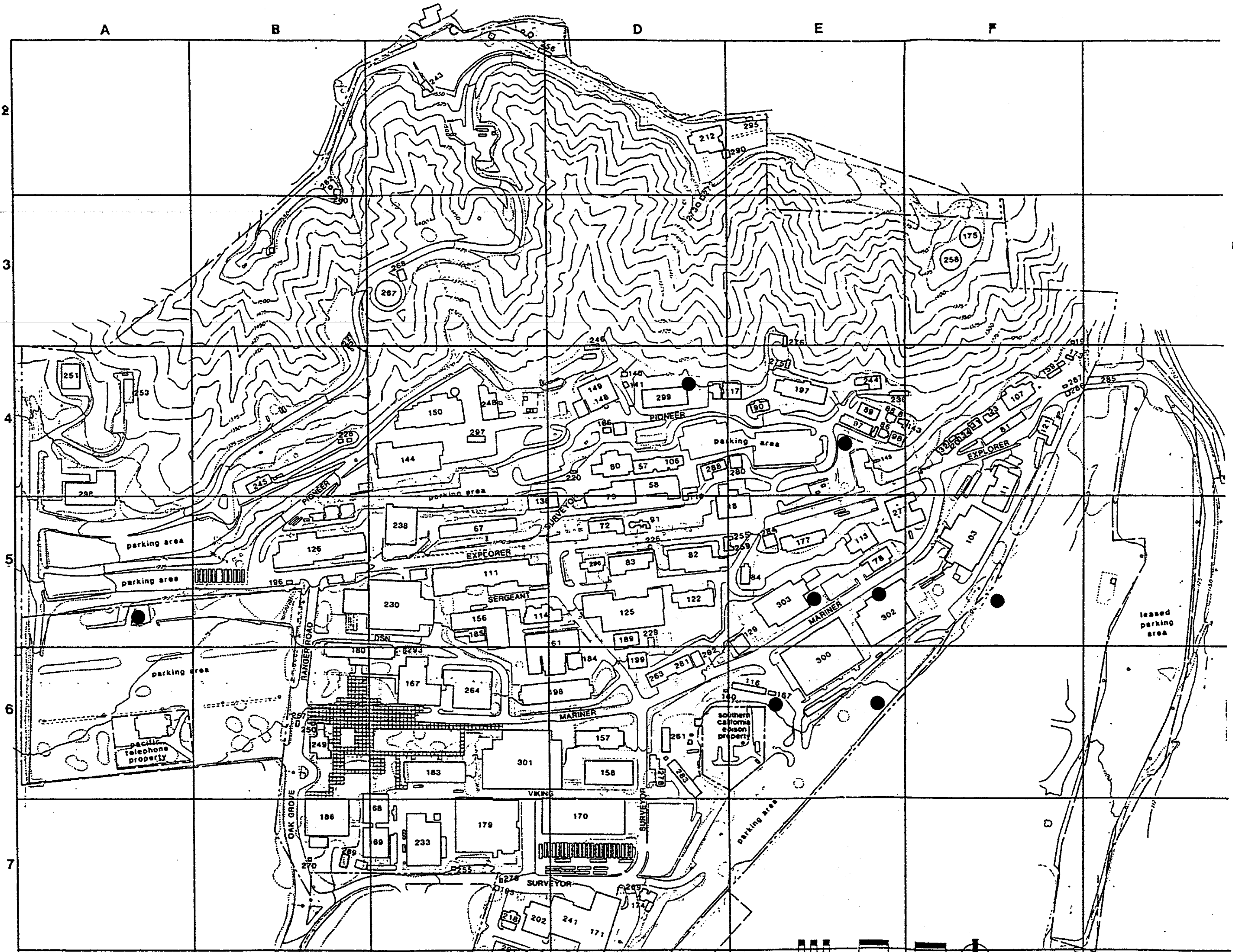
Figure 2-1
SITE LOCATION MAP
Jet Propulsion Laboratories

managed the Ranger and Surveyor missions to the moon; the Mariner missions that explored Mars, Venus, and Mercury; the Viking Mars Orbiters; the Voyager missions to Jupiter, Saturn, Uranus, and Neptune; and the earth-orbiting Infrared Astronomical Satellite (IRAS). The latest of JPL missions to explore the planets in more detail include Galileo, a Jupiter orbiter and probe and Magellan, a Venus orbiter. To accomplish these tasks a variety of support functions and research and development laboratories using various chemicals are present at JPL. The general types of material present at JPL, now and in the past, include solvents such as tetrachloroethene (PCE), solid rocket fuel propellants, cooling tower chemicals, sulfuric acid, freon, mercury, and chemical lab wastes. Between 1945 and 1960, at least eight separate areas used to dispose of wastes were present on JPL where the above mentioned materials may have been or are suspected to have been disposed. Figure 2-2 shows the locations of the buildings and road system at JPL and the approximate locations of these old waste disposal sites.

At JPL there have been two documented chemical spills. One involved a battery acid spill between Buildings 230 and 180 in 1988. The battery acid found its way to the storm drain and was pumped out where the storm drainage system enters the Arroyo. The second incident, also in 1988, involved a one gallon methylene chloride spill on the loading dock of Building 241. The methylene chloride was contained and cleaned up.

2.2 GROUNDWATER HYDROLOGY

The JPL facilities are located within the Monk Hill Subarea of the Raymond Basin (see Figure 2-3). The Raymond Basin is a small triangular groundwater basin bounded on the north by the San Gabriel Mountains, on the west by the San Rafael Hills and on the south by the Raymond Fault. Raymond Basin's groundwater is an important source of potable groundwater for many communities in the area including Pasadena, La Canada-Flintridge, San Marino, Sierra Madre, Altadena, Alhambra, and Arcadia. The aquifer under JPL is not designated as the sole or principal drinking water source for JPL.



Legend:

● Suspected Seepage Sites used for waste disposal

JPL

Jet Propulsion Laboratory
California Institute of Technology

EXISTING LABORATORY FACILITIES

NO.	BUILDING TITLE	LOCATION
11	Space Sciences Laboratory	4-F
18	Structural Test Laboratory	5-D
20	Thermionic Converter Laboratory	4-F
23	Vacuum Furnace Laboratory	4-F
31	Metallographic Laboratory	4-F
32	Thermionic Converter Laboratory	4-F
57	Anechoic Laboratory	4-D
58	Compressor Building	4-D
67	Material Research	5-C
72	Engineering Offices	5-D
78	Hydraulics Laboratory	5-E
79	Wind Tunnel (20 inch)	4-D
80	Wind Tunnel (21 inch)	4-D
81	Space Sciences Laboratory	4-F
82	High Vacuum Laboratory	5-D
83	Quality Assurance	5-D
84	Chemical Materials Laboratory	5-E
86	Solid Oxidizer Laboratory	4-E
87	Propellant Conditioning Laboratory	4-E
88	Mixing Laboratory	4-E
89	Laser Laboratory	4-E
90	Pyrotechnics Laboratory	4-E
91	Air Dryer	5-D
97	Development Laboratory and Offices	4-E
98	Solid Fuel Laboratory	4-E
103	Fabrication Shop	5-F
106	Glassblowing Laboratory	4-D
107	Laser Research Laboratory	4-F
110	Fuel Storage Dock	4-D
111	Technical Information	5-C
113	Pneumatics Laboratory	5-E
114	Electronics Development	5-C
116	Propellant Storage Dock	6-E
117	Liquid and Solid Propellant Laboratory	4-D
121	Employee Development Center	4-F
122	Energy Conversion Systems	5-D
125	Combined Engineering Support	5-D
126	Information Systems Development	5-B
129	Combustion Research Laboratory	5-E
134	Thermionic Assembly Laboratory	4-F
138	Mission Operations	5-C
140	Propulsion Materials Storage	4-D
141	Propulsion Materials Storage	4-D
143	Solid Rocket Dock	4-E
144	Environmental Laboratory	4-C
145	Magazine Propellant	4-E
148	Energy Conversion Laboratory	4-D
149	Energy Conversion Development	4-D
150	25 Ft. Space Simulator	4-C
156	Computer Program Offices	5-C
157	Applied Mechanics	6-D
158	Materials Research Processing Laboratory	6-D
159	Pump House (Water)	4-F
160	Pump House (Sewage)	6-D
161	Telecommunications Laboratory	5-C
166	Cooling Tower	4-D
167	Cafeteria	6-C
168	Instrument Systems Laboratory	7-C
169	Earth Space Science	7-C
170	Fabrication Shop	7-D
171	Material Services	7-D
173	Test Shelter	4-F
175	Water Reservoir	3-F
177	Transportation Garage	5-E
179	Spacecraft Assembly Facility	7-C
180	Administration	6-B
183	Physical Sciences Laboratory	6-C
184	Electronic Stores	6-D
185	Programming Office	5-C
186	Science Exhibits and Engineering	7-B
187	Chemical Storage	6-E
189	Electronic Laboratory Annex	5-D
190	Procurement Offices	8-C
191	Materials Compatibility Laboratory	3-F
195	Guard Shelter	7-C
196	Guard Shelter	5-B
197	Solid Propellant Engineering Laboratory	4-E
198	Control Systems Laboratory	6-D
199	Celestial Simulator	6-D
200	Facilities Engineering and Service	8-C
201	Carpenter Shop	8-C
202	Procurement and Communications Support	7-C
212	Antenna Laboratory	2-D
218	Credit Union	7-C
220	ICS Terminal	4-D
224	Sewage Lift Station	8-C
225	Nitrogen Facility Office	5-D
226	Solvent Storage	5-D
227	Guard Shelter (Mesa)	2-C
228	Cooling Tower (A-B)	4-B
229	Shielded Room Building	5-D
230	Space Flight Operations Facility	5-C
231	Paint Shop	8-C
233	Systems Development	7-C
234	Lumber Storage	8-C
237	Cooling Tower	4-E
238	Telecommunications	5-C
239	Propellant Conditioning Laboratory	4-E
241	Receiving and Shipping	7-D
243	Remote Antenna Range Control	2-C
244	Chemical Engineering	4-E
245	Spectroscopy Laboratory	4-B
246	Soils Test Laboratory	4-D
248	10-Ft. Space Simulator	4-C
249	Visitor Reception	6-B
250	Main Guard Shelter	6-B
251	Gyro Laboratory	4-A
252	Guard Shelter	6-B
253	Magnetics Laboratory	4-A
255	Sewage Lift Station	7-C
256	Model Range Control	2-C
257	Main Guard Island	6-B
258	Water Reservoir	3-F
259	Liquid Nitrogen Bottling Storage	5-D
260	Illuminator Equipment	3-B
261	Controlled Storage	6-D
262	Radiometer	2-B
263	First Aid	6-D
264	Space Flight Support	6-C
267	Water Reservoir	3-C
268	Pump House	3-C
269	Grounds Maintenance	7-D
270	Sewage Metering Station	7-B
271	Oil Storage	6-D
272	East Illuminator	3-D
273	Antenna Tower	3-D
274	Cooling Tower	7-D
275	Pyrotechnic Storage	4-E
276	Propellant Storage	3-E
277	Isotope Thermoelec. Sys. Appl. Lab.	5-E
278	Robotics Laboratory	6-D
279	Guard Shelter - Gate "E"	7-C
280	Static Test Tower	4-D
281	Fireman and Guard Station	6-D
283	Metal Storage	6-D
284	Transportation Office	5-E
285	Arroyo Bridge	4-G
286	Guard Shelter	4-F
287	Guard Island	4-F
288	Project Equipment Storage	4-D
289	Main Sewage Lift Station	7-B
290	Antenna Inspection	2-D
291	Procurement Services	8-C
292	Fire Truck Shelter	6-C
293	Instrumentation Cable Amplifier Building	6-C
295	Antenna Test Facility	2-E
296	Central Cooling Tower	5-D
297	Xenon Test Laboratory	4-C
298	Frequency Standards Laboratory	5-A
299	Assembly, Handling, Shiping Equip Fac	4-D
300	Earth and Space Sciences Laboratory	5-E
301	Central Engineering Building	6-C
302	Micro Devices Laboratory	5-E
303	Engineering Support Building	5-E

Figure 2-2
SITE PLAN
Jet Propulsion Laboratory

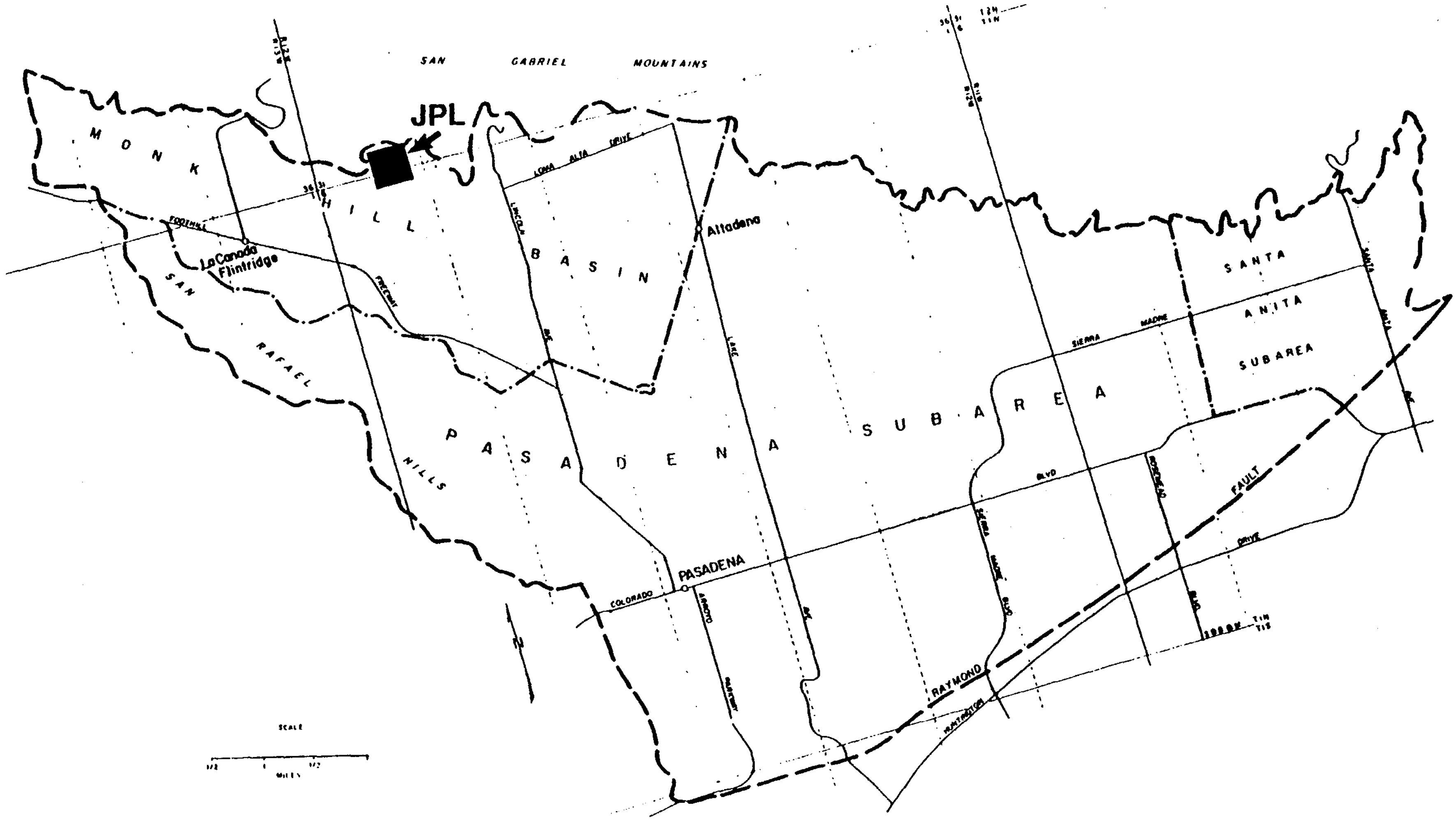


Figure 2-3
Location of JPL within the Monk Hill Subarea of the Raymond Basin.
(Modified from Nagler, 1985).

The Raymond Basin's climate is semiarid, Mediterranean characterized by hot, dry summers and mild winters with intermittent rain. The long-term average annual precipitation in the area is 22.5 inches. Approximately three-fourths of the annual precipitation occurs during the months of December through March. Groundwater levels also fluctuate during the year with lower elevations usually encountered between July and December and higher elevations occurring between January and June.

The groundwater table below JPL has been encountered in monitoring wells at depths from 100 to 240 feet below ground level. The groundwater table tends to conform to the surface topography with the predominant groundwater movement to the south and southeast from the foothills toward the Arroyo Seco Valley. The estimated hydraulic gradient in this area is between 200 feet per mile to 100 feet per mile (Raymond Basin Management Board, 1985). The average transmissivity of the underlying aquifer ranges from approximately 50,000 gallons per day per foot (gpd/ft) in the La Canada Valley to about 200,000 gpd/ft near the Arroyo Seco and Devil's Gate Dam (Raymond Basin Management Board, 1985).

The groundwater basin is being replenished by both natural and artificial recharge. Several groundwater recharge basins are located in the Arroyo Seco downstream from the JPL site. In addition, three City of Pasadena supply wells and one monitoring well are located within 2,000 feet downgradient from JPL. These Pasadena City wells have been shut down for several years due to contamination. The City of Pasadena has previously conducted water sampling at these wells and monitoring well MH-01 located in the Arroyo Seco. The analyses of these samples indicated the presence of small amounts of TCE (trichloroethene), CCl_4 (carbon tetrachloride), PCE (tetrachloroethene) and 1,2-DCA (1,2-dichloroethane). Since no other major industrial establishment is present near these wells, JPL's former waste seepage sites are generally suspected as a likely source of this groundwater contamination. The City of Pasadena's Water Department currently serves a population of approximately 150,000 people.

2.3 GEOLOGY

JPL is located adjacent to the southwestern edge of the San Gabriel Mountains (see Figure 2-4). The San Gabriel Mountains together with the San Bernardino Mountains to the east and the Santa Monica Mountains to the west make up a major part of the east-west trending Transverse Range province of California. This province is dominated by east-west trending folds, reverse faults, and thrust faults indicating a history dominated by north-south compressional deformation.

The San Gabriel Mountains are mainly composed of crystalline basement rocks. These rocks range in age from Precambrian to Tertiary and include various types of diorites, granites, monzonites, and granodiorites with a complex history of intrusion and metamorphism. Immediately north of JPL the San Gabriel Mountains are comprised of the Quaternary Pacoima Formation. This formation is composed of conglomeratic arkosic sandstones of stream channel and fanglomeratic origin (Smith, 1986). The color of the Pacoima Formation is buff or tan where unweathered and ranges from orange to dark reddish orange where weathered.

Periodic tectonic uplift of the San Gabriel Mountains has occurred during the past 1 to 2 million, years producing the present topography of the area (Smith, 1986). Most of this uplift has occurred along north to northeast dipping reverse and thrust faults located along the south to southwest edges of the San Gabriel Mountains. As Figure 2-5 shows, the thrust faults near JPL include the Mt. Lukens Fault, the south branch of the San Gabriel Fault, and the JPL Fault ("bridge fault"). East of the Arroyo Seco the south branch of the San Gabriel Fault is the primary range-front fault. West of JPL the Mt. Lukens thrust fault is the main range-front fault, and across JPL the JPL Fault and associated branches is the primary range-front fault. These faults, along with others along the southern edge of the San Gabriel Mountains, comprise the Sierra Madre Fault system.

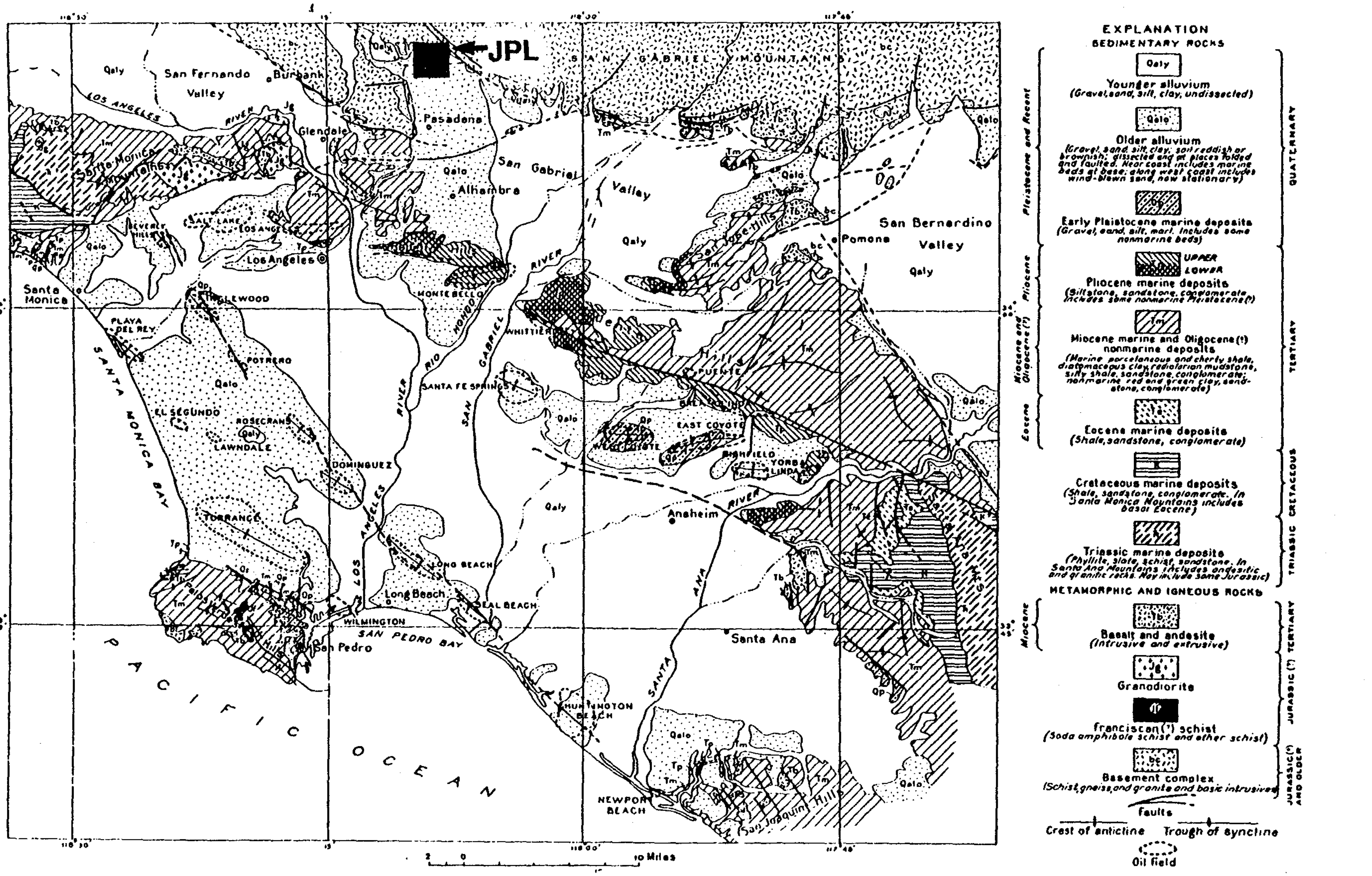


Figure 2-4
Generalized Geologic Map of Los Angeles Basin and Borders
(Conrey, 1967).

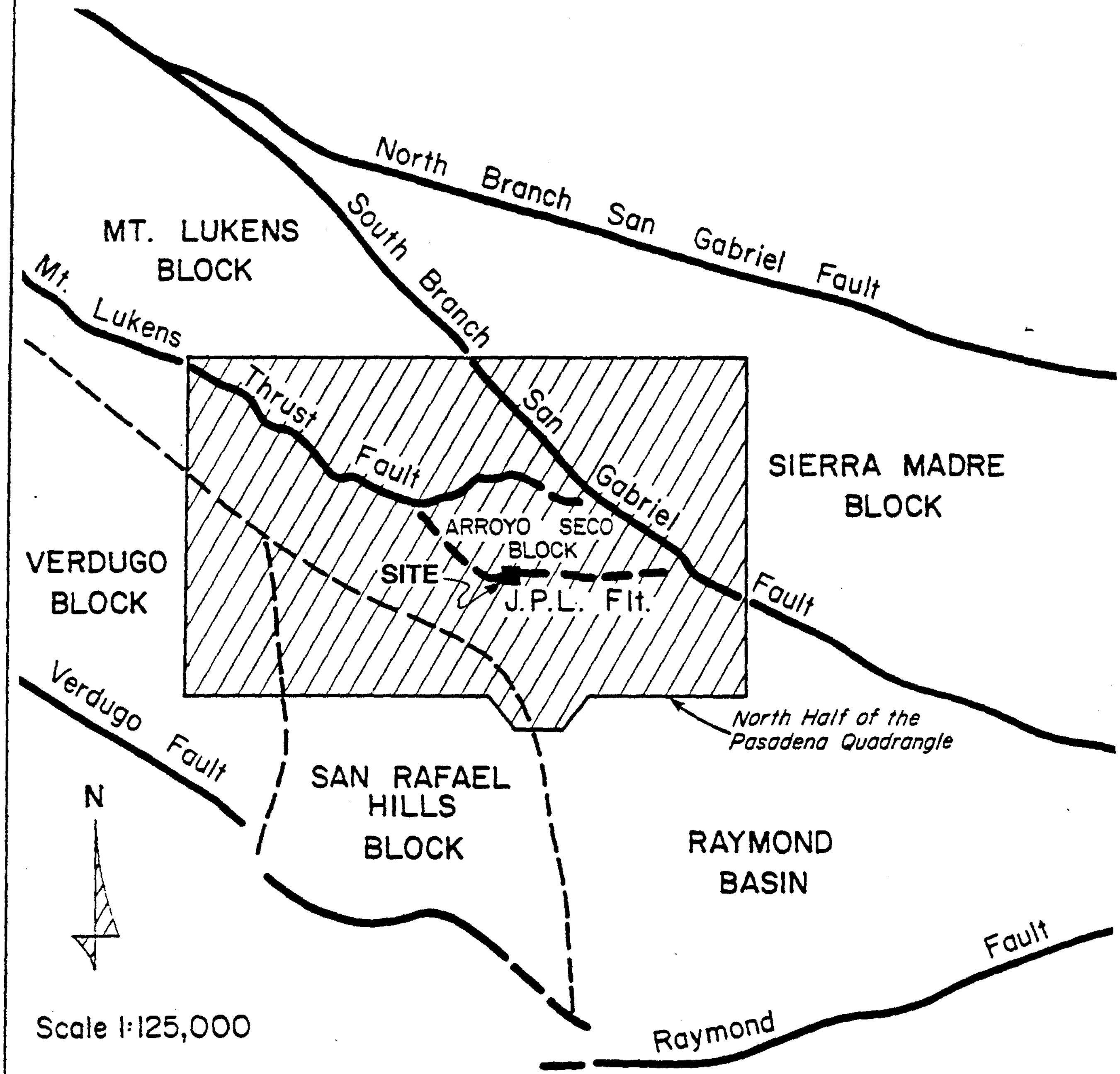


Figure 2-5
General Location of the Principal Structural Blocks and Faults near JPL. (Smith, 1986)

The Sierra Madre Fault system separates the San Gabriel Mountains to the north from the Raymond Basin to the south. The sediments of the Raymond Basin adjacent to and beneath JPL are the result of alluvial and fluvial deposition. Current fluvial deposition can be found in the Arroyo Seco where braided steam-channel deposits are now located. Older quaternary alluvial fan deposits or fanglomerates are located beneath JPL. Generally, these sediments are characterized by poorly sorted, poorly consolidated, coarse grained, brown sands with gravels, cobbles and boulders. The cobbles and boulders are primarily subrounded and are up to 3 feet in diameter. The provenance of the cobbles and boulders is clearly the San Gabriel Mountain crystalline basement complex. The fanglomerates also contain significant amounts of clay and silt. Bedding is very poorly developed in the fanglomerates where the percentages of silt, clay, cobbles, and boulders fluctuate throughout the stratigraphic column. These fanglomerates reach a maximum thickness of approximately 750 feet near JPL and the mouth of the Arroyo Seco and then gradually decreases south toward the South Pasadena area. Figure 2-6 is a contour map on top of the crystalline basement complex near JPL showing the general dip of the basement to the north-northeast.

During the current Expanded Site Investigation, Ebasco geologists performed a reconnaissance survey of the surface geology accessible at JPL. Of particular interest were the exposures of the JPL Thrust Fault. In 1977 Agbabian Associates completed a seismic study of JPL and mapped the JPL Fault. Figure 2-7 shows the trace of the JPL Fault behind Building 150 as mapped by Agbabian Associates (1977) and as mapped by Converse, et al. (1971). After visiting this area, Ebasco concluded that the general geometry of the fault trace more closely resembled that as mapped by Agbabian Associates. Ebasco could not confirm the locations of the two small normal faults as mapped by Agbabian Associates. The traces of these normal faults may have been covered by the thick natural vegetation currently on the hillside. Ebasco also field checked and confirmed the location of the trace of the JPL Fault exposed near Buildings 98 and 134 west of the present bridge across the Arroyo Seco. At this location the trace of the JPL Fault can be found at the contact between the granitic alluvium at the foot of the

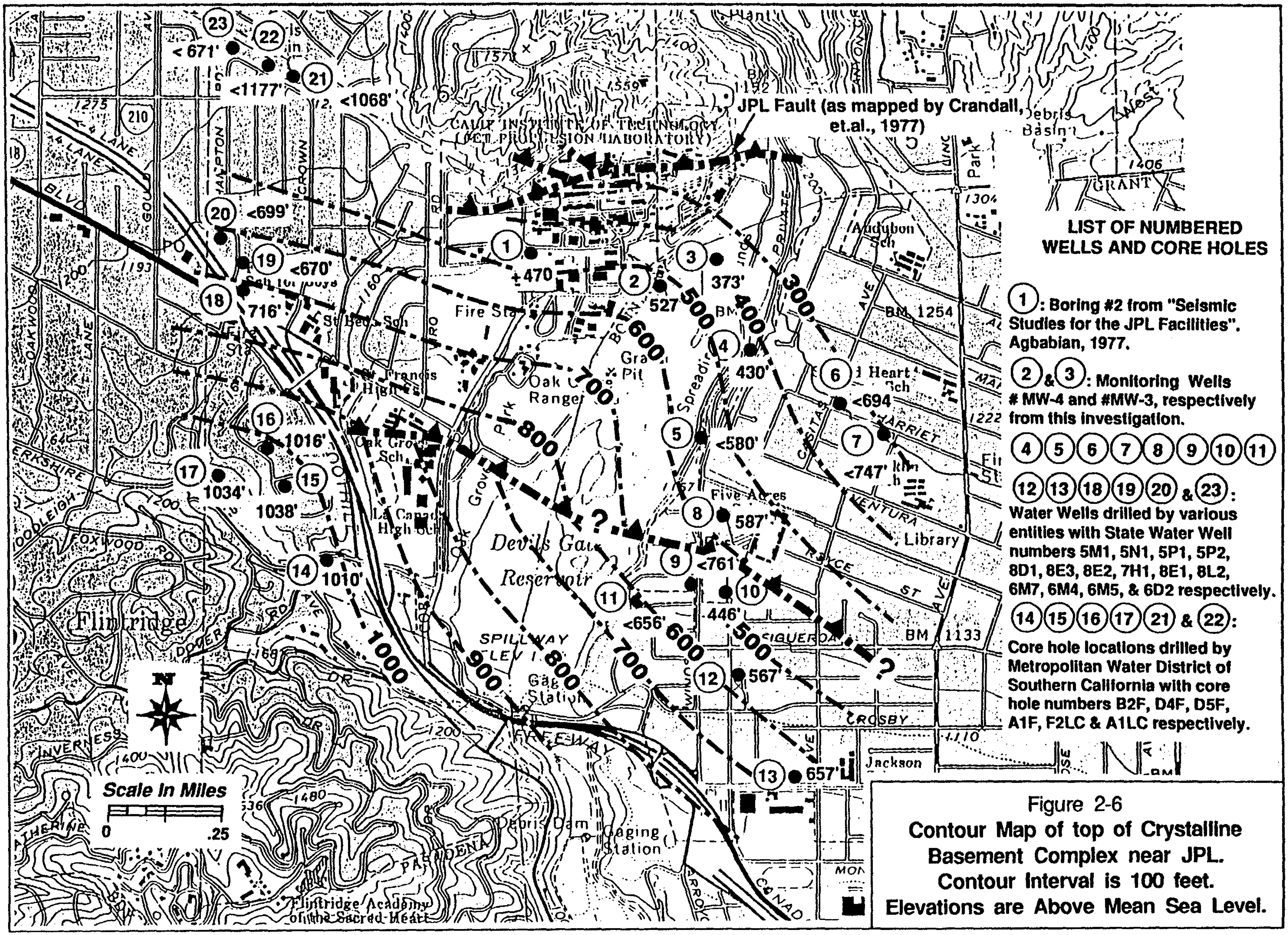
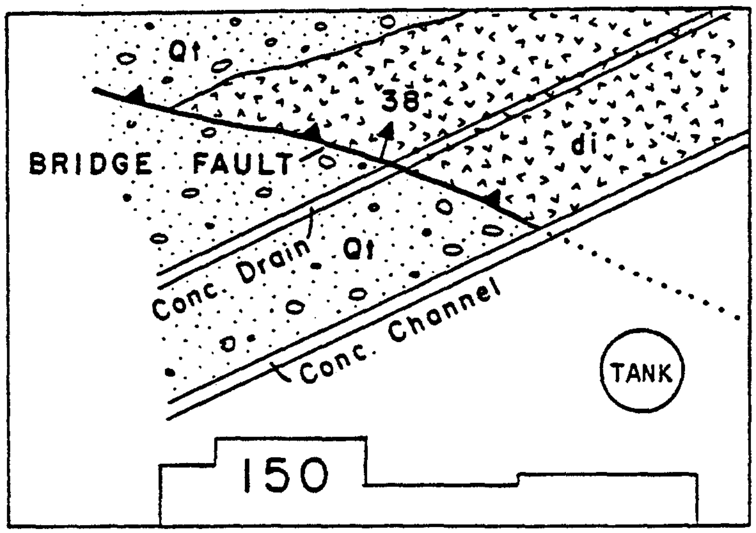
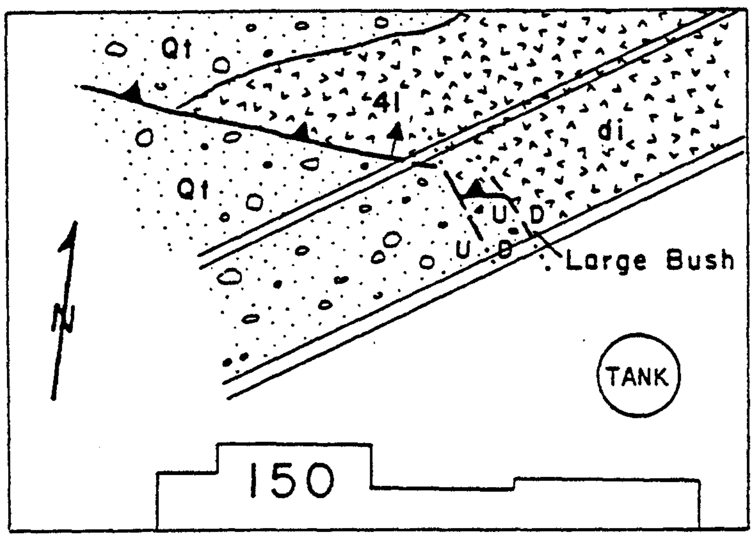


Figure 2-6
Contour Map of top of Crystalline Basement Complex near JPL. Contour Interval is 100 feet. Elevations are Above Mean Sea Level.



(a) As mapped by Converse, et al., 1971



(b) As mapped by Agbabian Associates, 1977

0' 50' 100'

Qt = QUATERNARY TERRACE DEPOSIT

di = DIORITE

38, 41 = DEGREES OF FAULT INCLINATION FROM THE HORIZONTAL

U = RELATIVELY UPWARD DISPLACEMENT OF FAULT WALL

D = RELATIVELY DOWNWARD DISPLACEMENT OF FAULT WALL

Figure 2-7
GEOLOGIC MAPS OF CUT SLOPE BEHIND JPL BUILDING 150
(Agbabian, 1977)

hill behind JPL and the crystalline basement (diorite at this location) above it. This contact is not as well exposed as at the previously discussed location.

The amount of influence, if any, faults on and near JPL have on the movement of groundwater is not currently known. More detailed data regarding groundwater elevations adjacent to faults are needed to evaluate the role they may, or may not, play in groundwater movement. It is possible the fault planes present on JPL do not influence local groundwater movement since sandy alluvium has apparently been faulted adjacent to similar sandy alluvium without appreciable fault gouge. Behind Building 150 at the northern edge of the facility, north of the JPL Fault, three shallow wells were drilled for a dewatering well system. Details of this system are presented in the following section describing previous investigations. During the drilling of these three wells crystalline basement rocks were drilled into at depths from 2 to 20 feet below grade and groundwater was detected from ground surface to 4.5 feet below ground surface. South of the JPL Fault, monitoring well EMW-7 found groundwater at 236 feet below grade and never did reach basement after penetrating 270 feet. (See Section 3.1 and 4.1 for more details.) It is possible local groundwater movement is influenced by the location, depth, and geometry of the basement complex which is influenced by the faults at JPL. The shallow groundwater north of the JPL Fault may be the result of the shallow basement north of the JPL Fault and may not be related to a potential barrier formed along the JPL Fault plane. Again, more data on groundwater elevations adjacent to faults at JPL are needed to accurately determine the influence faults have an local groundwater movement.

2.4 PREVIOUS INVESTIGATIONS

Numerous investigations focusing on the geotechnical nature of the site and previously identified environmental issues have been conducted at JPL.

JPL contains many buildings that host various experimental activities. From 1945 to 1960, several open areas or pits were used to dispose of a variety of solid and liquid wastes. Groundwater investigations of contamination identified in monitoring and water production wells have suggested that the pits may be the source of groundwater contamination. Geotechnical and environmental studies of JPL and Arroyo Seco have occurred sporadically over the past 14 years and include:

- o Agbabian Associates, 1977
- o LeRoy Crandall and Associates, 1981
- o Geotechnical Consultants, Inc., 1982
- o Richard C. Slade, 1984
- o James M. Montgomery, 1986
- o Ebasco Services, Inc., 1988
- o Geotechnical Consultants, 1989

The following discussions briefly summarize the results of each of these studies.

Agbabian Associates 1977

A three part seismic study of JPL conducted by Agbabian Associates was completed for JPL in 1977.

Part I, A Study of Seismic Criteria for the Jet Propulsion Laboratory Facilities, provided a state-of-the-art reappraisal of the seismic input criteria developed in 1972 for evaluating the earthquake resistance of JPL facilities. This report also provided a reevaluation of the JPL Thrust Fault, updated data on seismicity, and summarized recent subsurface investigations conducted at the site.

Part II, Supplemental Geologic Studies for the Jet Propulsion Laboratory Facilities, provided additional geological studies recommended in Part I, which included new trenching to locate materials suitable for dating the most recent activity along the JPL fault.

Part III, Implications of Fault Hazard for the Jet Propulsion Laboratory Master Plan, discussed recommendations for the use of existing facilities and the development of land within a zone of potential earthquake ground breakage on the property.

LeRoy Crandall and Associates, 1981

In 1981, LeRoy Crandall and Associates performed an evaluation of a dewatering system constructed for JPL around Building 150. Water wells were installed under contract to JPL by Barney's Hole Digging Service, Inc. and were logged by a Crandall field geologist.

The dewatering system consisted of one 12-inch diameter, 60-foot deep pumping well and two 4-inch diameter 40-feet deep observation wells set 40 feet and 80 feet, respectively, away from the pumping well.

Based on a performance record of about three months, the system appeared to be removing significant quantities of water north of the building; however, the entire area had not been dewatered as indicated by water levels in the observation wells. The water level in Observation Well No. 1, at a distance of 40 feet, had declined three feet during this period of time, and the water level in Observation Well No. 2, at 80 feet, had declined less than 0.5 feet.

Recommendations made by Crandall included modifying the operation of the pumping well to increase its area of influence and converting the observation wells into pumping wells.

Geotechnical Consultants, Inc., 1982

In 1982, Richard Slade of Geotechnical Consultants, Inc. (GTC) conducted a preliminary hydrologic assessment of potential volatile organic contamination in the groundwater in the Arroyo Seco for the City of Pasadena. This investigation involved the installation of a groundwater monitoring well, groundwater sampling and chemical analysis of water samples. A final report of this investigation was not submitted to the City of Pasadena because the appropriated budget had been exceeded before the project was completed. Ebasco obtained information on this investigation from a City of Pasadena Water and Power Department open file.

The GTC investigation included the drilling of a monitoring well, labeled MH-01 to a depth of 399 feet. MH-01 is located in Arroyo Seco approximately half way between Pasadena's existing Arroyo Well 25 and JPL Building 103. It was believed that a source of the volatile organics contamination in Arroyo Well 25 was a former disposal pit located near JPL Building 103. A 9-7/8-inch boring was cased to a depth of 366 feet with 6-inch PVC blank casing and 6-inch slotted PVC casing. The well was screened at nine different intervals between the depths of 145 feet and 355 feet (without any means of hydraulic separation between the screened intervals). A sandpack was placed from 366 feet to approximately 100 feet below ground level which hydraulically connected all screened intervals in this well.

Standard decontamination procedures were employed to minimize well contamination from well construction materials, drilling and sampling equipment. Soil and groundwater samples were collected from different depths in the boring and the well, respectively. Water samples were collected using syringes and by pumping. Samples were analyzed by Montgomery Laboratories for volatile organics, trihalomethanes/synthetic organics, pesticides, PCBs and herbicides. Chemical analyses of the water samples detected concentrations of carbon tetrachloride (CCl_4), trichloroethene (TCE) and tetrachloroethene (PCE) above drinking water standards. Concentrations of CCl_4, TCE and PCE ranged from non-detected (ND) to 17 ppb, ND to 59 ppb and 0.1 to 2.5 ppb, respectively.

Richard C. Slade, 1984

A preliminary hydrogeologic assessment of soils and groundwater monitoring at JPL was prepared by R. C. Slade in 1984. The purpose of this report was to provide JPL with a preliminary hydrogeologic assessment of quantitative results of laboratory analyses of soil and water samples collected on or near JPL.

This investigation involved subsurface exploration at two abandoned waste seepage pits at JPL and groundwater monitoring at the City of Pasadena monitoring well MH-01. The pits investigated are located southwest of

Building 59 and southwest of the now-destroyed Building 65. Both buildings were historically used for chemistry experiments.

Exploration of these former seepage pits consisted of digging several trenches at each site, logging the trenches and collecting in-situ and bulk samples for laboratory analysis. The trenches were excavated using a two foot wide backhoe and ranged in depth between 8 and 13 feet. None of the trenches were excavated to the bottom of the pits. Soil samples were collected from depths ranging from one to 9-1/2 feet. Soil samples were analyzed for CCl_4, TCE, PCE, 1,1,1-TCA, priority pollutant metals, chromium, fluoride, and pH.

The groundwater monitoring included collecting syringe samples from the nine different screened intervals in MH-01. It was noted that the well was not purged before sampling. Laboratory water quality tests conducted on each of these samples included heavy metals, fluoride, cyanide, hexane, TCE, PCE, CCl_4 and 1,1,1-TCA.

Laboratory analyses of soil samples collected from the trenches detected no volatile organic compounds. One possible anomaly in the heavy metal analysis was a Pb value of 200 ppm in one trench at a depth of seven feet. The source of this lead was not determined.

Laboratory results of water samples from MH-01 indicated heavy metals concentrations below maximum concentration levels (MCLs) except for mercury in the sample from the 182 foot depth. Fluoride was below its MCL except at sample depths of 234 feet and 265 feet (13 and 14 mg/l respectively). Cyanide was found to be below its MCL for all samples tested. Hexane and 1,1,1-TCA was not detected in any of the samples. PCE was found in all samples and ranged in concentration from 0.2 to 0.7 ug/l. TCE and CCl_4 was found only at depths below 265 feet. TCE and CCl_4 concentrations ranged from 1.3 and 0.2 ug/l to 7.5 and 2.4 ug/l, respectively.

James M. Montgomery, 1986

During 1986, James M. Montgomery conducted an evaluation of contaminant transport of volatile organic compound (VOC) contamination of the groundwater in the area of Arroyo Seco for the City of Pasadena. The objectives of this evaluation were to:

- o Estimate the location of the source of contamination;
- o Estimate the rate and direction of contaminant plume movement; and
- o Estimate the maximum expected contaminant levels (MECs) that might be anticipated at the contaminated wells.

Montgomery relied upon previous data collected either by the City of Pasadena Water and Power Department or by the Regional Water Quality Control Board. Their analyses and evaluations relied upon many assumptions and limited data.

The conclusions and recommendations made were that contamination to the City of Pasadena Arroyo Well appeared to originate from a source located north-northwest of the well. Based on review of historical data and parameter estimation, the contamination was from a source that originated within this century and was located less than 5000 feet from the Arroyo Well.

To permit accurate predictions of MECs, the locations of contaminant sources and a detailed understanding of the subsurface hydrogeology was needed. This information was not available to Montgomery for their study and therefore MEC predictions were based on limited information and several assumptions. The predictions suggested that MECs of about 170 ug/l could be expected at the City of Pasadena Arroyo Well providing current trends continued. They noted, however, that depending upon the precise location and strength of the contaminant source, higher concentrations could be observed.

Review of pumping records from water production wells in or near Arroyo Seco, together with rainfall suggested that pumping of the Arroyo Well was perhaps preventing contaminant migration to the south and southeast.

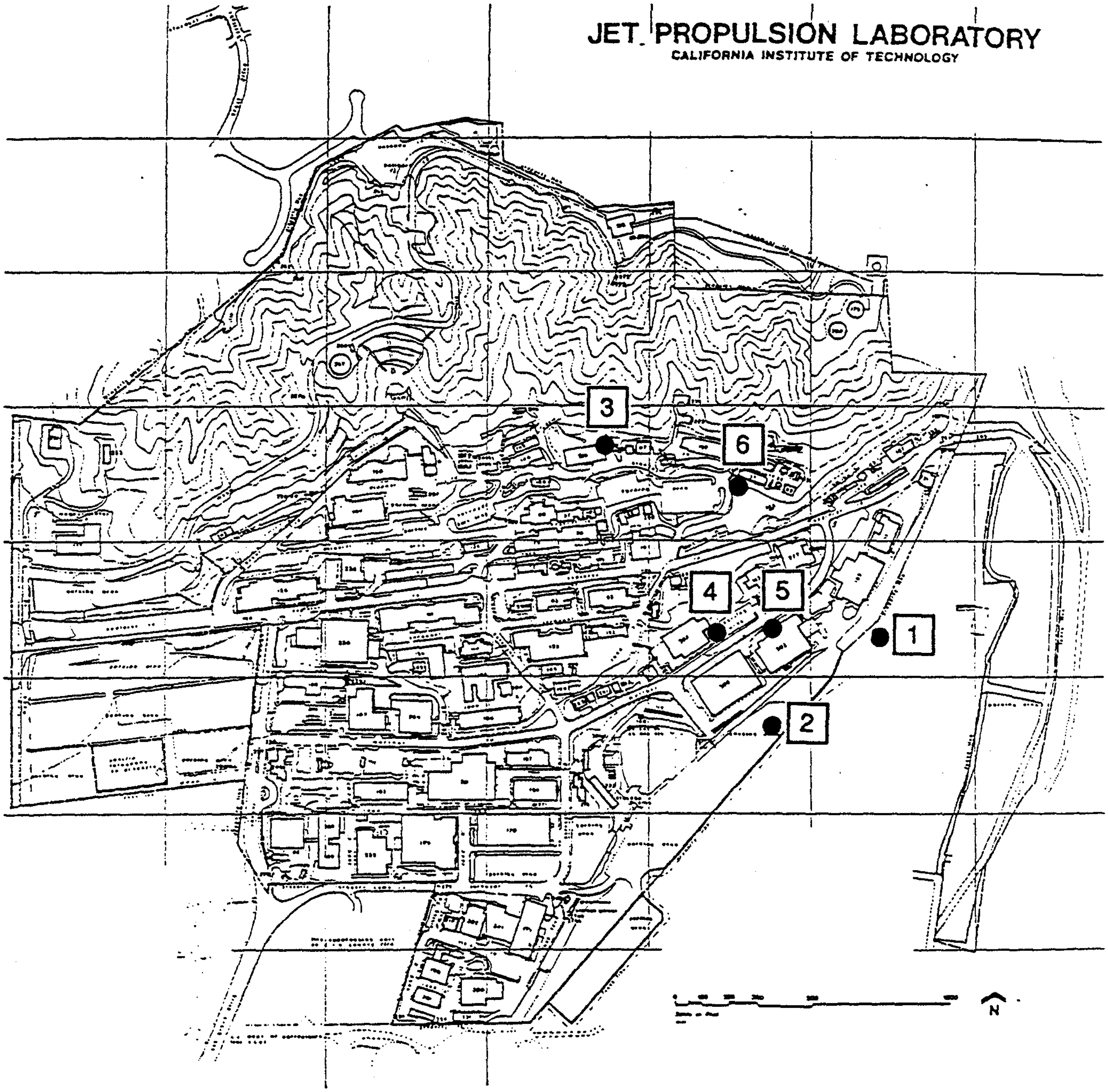
Information available to Montgomery suggested that JPL was the likely source for the contamination at Lincoln Avenue Water Company Wells No. 3 and No. 5. Montgomery estimated that the summed concentrations of VOCs could increase to about 150 ug/l in these wells. Again it was stressed that analyses were based on limited data and numerous assumptions. It was also suggested that all public water wells within a two-mile radius of the Arroyo Well be monitored for VOCs at least quarterly.

Ebasco Services, Inc., 1988

A Preliminary Assessment (PA) and a Site Inspection (SI) as mandated by the EPA was performed at JPL by Ebasco in 1988. The report included summaries outlining areas of concern and recommendations for further studies. The PA/SI reported on abandoned waste seepage pits, past chemical spills, and nearby municipal water wells. A preliminary Hazardous Ranking System score was computed for JPL following completion of the SI investigation.

The PA/SI report identified six pits or old waste disposal sites on and adjacent to JPL property (Figure 2-8). The pits ranged from 15 to 30 feet wide by 15 to 30 feet deep and were used between 1945 and 1960 for disposal of municipal wastes and solid and liquid hazardous wastes. Three of the pits were investigated to a depth of 11 feet by R. C. Slade in 1984. Lead in concentrations up to 200 ppm was found in one of these pits but no other contaminants were found above background concentrations. Below is a summary of each of the pits or sites:

- o <u>Seepage Pit #1</u> near Building #103 (see Figure 2-8 #1). The site was located outside of the JPL fence in the Arroya Seco dry wash, at the southeast corner of the lab. This site was approximately 15 feet wide by 15 feet deep, and was used primarily for disposal of municipal solid wastes. However, according to JPL personnel, chemical wastes were also disposed, including solvents, freon, mercury, solid rocket fuel propellants, cooling tower chemicals, and sulfuric acid. None



Legend:

● Suspected Seepage Sites used for waste disposal

Figure 2-8
Suspected Seepage Sites as Identified in the Preliminary Assessment/Site Inspection (From: Ebasco, 1988a, 1988b)

of the wastes were disposed in containers except for the mercury which was in small flasks. No sampling of this pit had been conducted prior to this study to verify types or current depths of contamination.

- Seepage Pit #2 near the south parking lot (see Figure 2-8 #2). This site was located east of the Southern California Edison substation and south of Building #300. This pit was approximately 30 feet wide and 15 feet deep. The pit is believed to be under the existing parking lot. Wastes disposed at this pit were similar to those at Pit #1. The site was also used for burning debris, and for disposal of fluorescent lights and waste magnesium. No sampling of this pit had been conducted prior to this study to verify types or current depths of waste.

- Seepage Pit #3 near Building #117 (see Figure 2-8 #3). This disposal pit was located just northwest of two current day bunkers #140 and #141, used for storing propellants. The pit was approximately 30 feet deep, and was used primarily for the disposal of propellants and mixed solvents. No sampling of this pit had been conducted prior to this study. Seepage pits #1, #2, and #3 received chemical wastes over the period 1954-1958 according to JPL personnel.

- Seepage Pit #4 near Building 303 and former Building 59 (see Figure 2-8). This pit was used exclusively for disposal of chemistry lab wastes. This pit location was investigated down to a depth of 11 feet in 1984 by R.C. Slade (Slade, 1984). Lead concentrations up to 200 ppm were found. No other contaminations were found.

- Seepage Pit #5 near Building 302 and former Building 65 (see Figure 2-8). This pit was also used exclusively for disposal of chemistry lab wastes. R.C. Slade also investigated this pit and did not find any contaminants down to the 11 foot level.

- Seepage Pit #6 near Building 97 (see Figure 2-8). This was the former site of a chemistry lab that used this pit for disposal of lab wastes. R.C. Slade investigated this pit to 11 feet and no contaminants above normal levels were found (Slade, 1984). Dispoal in Pits #4, #5, and #6 occurred during the approximate period of 1941-1960.

According to JPL personnel, waste solvents were also historically deposited onto soils near chemical storage building 187. No soil sampling had been conducted prior to this study in this area to confirm potential contamination.

In 1980, testing of three City of Pasadena water wells located 1000 feet down gradient from JPL indicated concentrations of TCE, PCE, and CCl_4 above drinking water standards. In 1982, Geotechnical Consultants, Inc. installed a monitoring well (MH-01) about half the distance between the three City production wells and JPL. This well showed contamination levels higher than those in the City wells and Geotechnical Consultants concluded that past JPL (and U.S. Army) activities probably contributed to the groundwater contamination. In a study conducted by J. M. Montgomery in 1986, treatment alternatives were evaluated which led to the installation of a pilot treatment plant at one of the contaminated City wells.

The resulting overall HRS score prepared by Ebasco for JPL was 38.3 which is well above the 28.5 criteria required for a site to be considered for the National Priorities List (NPL).

Geotechnical Consultants, 1989

An evaluation of groundwater quality upgradient of JPL was prepared by Geotechnical Consultants under an U.S. Army Corps of Engineers contract in 1989. The purpose of this investigation was to install two groundwater monitoring wells upgradient and outside the influence of JPL facility activities. These wells were sampled where possible and water quality analyses were performed to begin to establish background water quality data.

Monitoring well CMW-1 was located just off the northeast corner of JPL property and the second monitoring well CMW-2 was located in the southwest corner of JPL property. These four-inch PVC cased wells were completed to depths of 162 feet and 179 feet, respectively. The lower 99 feet of CMW-1 and the lower 79 feet of CMW-2 were screened based on interpretations from electric logs.

Water quality sampling was performed in CMW-1 and in an existing downgradient City of Pasadena monitoring well, MH-01. Monitoring well CMW-2 was not drilled deep enough to reach groundwater due to contractual limitations. Water samples obtained from CMW-1 and MH-01 were tested for volatile and semivolatile organics, total petroleum hydrocarbons, five target metals, pH and total dissolved solids. Laboratory test results revealed no evidence of organic contamination and/or elevated levels of the five target metals analyzed.

The report concluded that CMW-1 was a legitimate upgradient sampling point to monitor groundwater along the Arroyo Seco and that there is no immediate evidence of groundwater contamination either entering the northeast part of the study area along the Arroyo Seco or existing within the downgradient well, MH-01. Due to the configuration of facilities at JPL, well CMW-1 does not provide a complete evaluation of background groundwater conditions across the entire site. It was recommended that an additional upgradient monitoring well be installed along the north side of the facility to intercept shallow subsurface inflow from the adjacent hillside.

3.0 EXPANDED SITE INSPECTION METHODS

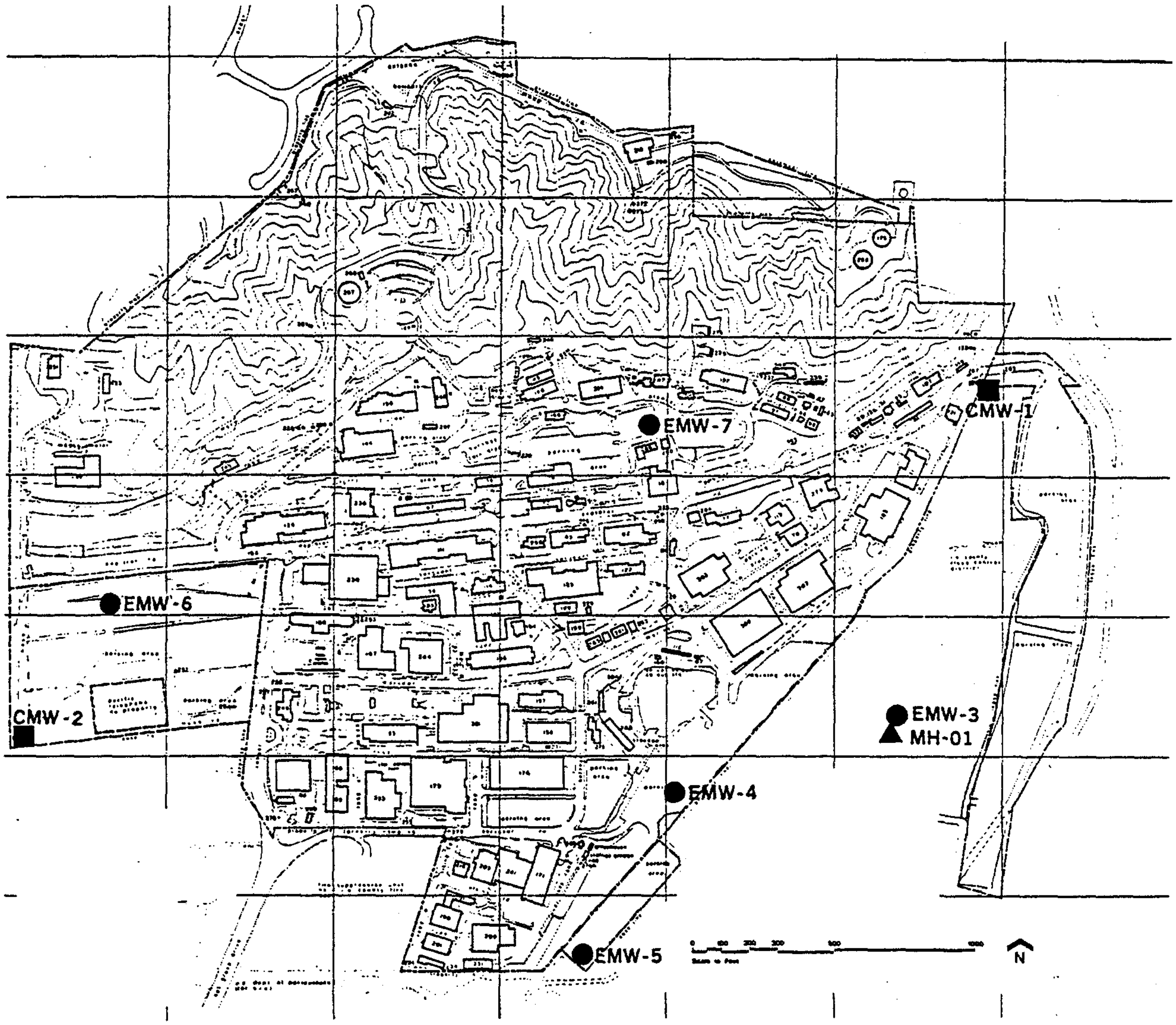
Field investigations at JPL were designed to further delineate the presence of groundwater contamination and the location of soil contaminants using soil gas. Groundwater monitoring wells were located to gain information on groundwater near the former waste disposal sites. The major components of this program are as follows:

- Design and install 2 deep groundwater monitoring wells to granitic basement equipped with a multiport casing system that allows simultaneous monitoring of 5 individual zones of the aquifer;
- Design and install 3 shallow groundwater wells to monitor the top of the groundwater;
- Install soil gas collectors around the areas formerly used for waste disposal;
- Measure water levels; collect groundwater and soil gas samples;
- Analyze groundwater and soil gas samples in the laboratory;
- Use water level measurements to identify the groundwater gradient and direction of flow; and
- Evaluate laboratory results to outline the nature and extent of groundwater and soil gas contamination.

The following sections describe the specific methodologies used during this work in more detail.

3.1 DESIGN AND INSTALLATION OF GROUNDWATER MONITORING WELLS

Of the eight groundwater monitoring wells currently on or near JPL, five of them were drilled during this investigation. These five include EMW-3, EMW-4, EMW-5, EMW-6, and EMW-7. Figure 3-1 shows the relative positions of



JPL
Jet Propulsion Laboratory
California Institute of Technology

Legend:

● Installed during this investigation

■ Installed by the Army Corps of Engineers in 1989.

▲ Installed by Geotechnical Consultants, Inc. in 1982.

Figure 3-1
Locations of Groundwater Monitoring Wells On or Near JPL

the monitoring wells with respect to JPL's facilities. Monitoring wells CMW-1 and CMW-2 were installed by the Army Corps of Engineers in 1989, and monitoring well MH-01 was installed by Geotechnical Consultants, Inc. in 1982. For more information regarding CMW-1, CMW-2, and MH-01 see Section 2.4 of this report concerning Previous Investigations.

3.1.1 Drilling Methods

Of the five monitoring wells drilled during this investigation, two of them, EMW-3 and EMW-4, were drilled to crystalline basement rock. The other three monitoring wells, EMW-5 through EMW-7, are "shallow" and were drilled to the top of the aquifer. Table 3-1 summarizes the drilling specifications for each well.

On January 9, 1990 Beylik Drilling, the drilling subcontractor, rigged up an Ingersoll Rand TH100 mud rotary drill rig at EMW-3. A 15-3/4-inch pilot hole was drilled to 22 feet into which 22 feet of 10-inch diameter low carbon steel conductor casing was cemented. A 9-7/8-inch tri-cone bit was then used to drill to a total depth of 730 feet. During all drilling operations the cuttings were routinely checked for organic vapors with an organic vapor analyzer (OVA) for health and safety purposes. No readings above background were detected on the OVA during drilling. Granitic basement rock was encountered at approximately 720 feet. Drilling continued below 720 feet to verify basement had been reached. During drilling a pure bentonite drilling mud and an environmental hydrocarbon-free pipe dope were used. The water used in making the drilling mud came from the fire hydrant system at JPL. The results of volatile organic analyses (EPA Method 624) completed on this water supply are in Appendix G and are discussed in Section 4.2. A directional survey was completed approximately every 140 feet during drilling. Near the total depth of EMW-3, at 680 feet, the angle of the boring was 1.5 degrees from vertical.

While drilling, the drilling mud was circulated over a screened shaker assembly and then through a de-sander to segregate the drill cuttings from the drilling mud. The drill cuttings were then collected in a plastic lined roll-off bin adjacent to the mud pits. Samples of the drill cuttings were collected after drilling began below the conductor casing and after every

TABLE 3-1

Groundwater Monitoring Well Drilling Specifications

Well	Location	Drilling Method	Total Drilled Depth	Hole Diameter	Surface Conductor	Drilling: Date Started	Drilling: Date Completed
EMW-3	Arroyo Seco	Mud Rotary	730'	9 7/8"	22'; 10" dia.	1-11-90	1-24-90
EMW-4	JPL South Parking Lot	Mud Rotary	605'	12 1/4"	18.5'; 16" dia.	1-31-90	2-6-90
EMW-5	JPL South Parking Lot	Percussion Hammer	145'	11"	None	2-12-90	2-13-90
EMW-6	JPL West Parking Lot	Percussion Hammer	247'	11"	None	2-15-90	2-24-90
EMW-7	JPL Parking Lot Near Bldgs. #288 and 290	Percussion Hammer	270'	11"	None	2-28-90	3-5-90

100 feet of drilling. Immediately after the drill cuttings were circulated out of the hole they were placed in 500 ml glass jars, labeled, and placed in a cooler with ice. A chain-of-custody form was completed and the samples sent to Curtis and Tompkins, Inc. a California Certified laboratory.

Upon completion of drilling the individual samples of cuttings were composited and the composite analyzed to determine the proper method of disposal for the cuttings. The composite was analyzed for volatile and semivolatile organics (EPA Methods 8240 and 8270), Title 22 metals plus strontium, pesticides and PCBs (EPA method 8080), total petroleum hydrocarbons (EPA method 418.1), and cyanide (EPA method 9010). The laboratory results are included in Appendix D and indicate the cuttings are not hazardous. The drill cuttings were deposited at JPL near a pistol range along Mesa Road behind JPL's main facilities.

Beylik Drilling then mobilized a Port-a-Drill TKT mud rotary drill rig and rigged up at EMW-4. An 18-1/2-inch pilot hole was drilled to 18.5 feet into which 18.5 feet of 16-inch diameter low carbon steel conductor casing was cemented. A 12-1/4-inch tri-cone bit was then used to drill to a total depth of 605 feet. During drilling the cuttings were routinely checked for organic vapors with an Organic Vapor Analyzer (OVA) for health and safety purposes. No readings above background were detected on the OVA during drilling. Basement type granitic rock was drilled into at 556 feet. Due to a significant amount of apparent slough material and weathered basement being circulated out of the hole, drilling continued well below 556 feet to verify basement type rock had been reached.

During the drilling operations a pure bentonite drilling mud with Drispac, a water-loss inhibitor, was used. As with EMW-3, hydrocarbon free pipe dope was used, the water to make the drilling mud came from the fire hydrant system at JPL (see Section 4.2), directional surveys were run approximately every 140 feet during drilling (at 605 feet hole angle was 3 degrees from vertical), the drill cuttings were collected in a plastic lined roll-off bin, and samples of drill cuttings were collected when drilling began below the conductor casing and after every 100 feet of drilling. The sample collection, documentation, labeling, transportation, compositing, and laboratory analyses were identical to those outlined above for EMW-3. The laboratory results are included in Appendix D and indicate the drill cuttings from EMW-4 are not hazardous. The drill cuttings were then deposited at JPL at the same location the cuttings from EMW-3 were deposited.

The three shallow monitoring wells, EMW-5 through EMW-7, were drilled using a Becker percussion hammer rig utilizing dual-wall drive pipe and reversed air circulation. The dual wall drive pipe was comprised of an 11 inch diameter outer tube and a 9 inch diameter inner tube. The dual-wall drive pipe was driven to depths of 145 feet, 247 feet, and 270 feet at wells EMW-5, EMW-6, and EMW-7 respectively. Granitic boulders were encountered at 218 feet at EMW-6 and at 242 feet at EMW-7 severely inhibiting penetration with the percussion hammer. To drill through these boulders an air rotary system was bolted to the derrick of the hammer rig and a 7-7/8-inch diameter tri-cone bit was run through the dual wall drive pipe. A pilot hole was then drilled in the granitic boulders before the dual-wall drive pipe was driven any further.

During drilling of the shallow wells the drill cuttings were circulated out of the hole and into a roll-off bin through a cyclone device. The cuttings were routinely checked for organic vapors with an OVA for health and safety purposes. No readings above background were detected on the OVA during drilling. Occasionally enough dust would be created while drilling to justify injecting small amounts of water obtained from the JPL fire hydrant system (see Section 4.2) into the rig's air circulating system.

Samples of drill cuttings were collected from just below the ground surface and after every 50 feet of drilling. Immediately after the drill cuttings were circulated out of the hole they were placed in 500 ml glass jars, labeled, and placed in a cooler with ice. A chain-of-custody form was completed and the samples sent to Curtis & Tompkins, a state certified laboratory. After the holes were drilled, the individual samples of cuttings from each well were composited and the composite analyzed to determine the proper method of disposal for the cuttings. As with the previous wells, the composites were analyzed for volatile and semivolatile organics (EPA Methods 8240 and 8270), Title 22 metals plus strontium, pesticides and PCBs (EPA Method 8080), total petroleum hydrocarbons (EPA Method 418.1), and cyanide (EPA method 9010).

The laboratory results are included in Appendix D and indicate the cuttings from EMW-5 and EMW-6 were not hazardous. The drill cuttings from these wells were then deposited with the rest of the cuttings near the pistol range along Mesa Road behind JPL's main facilities. The composite sample of the drill cuttings from EMW-7 contained 440 mg/kg of Total Petroleum Hydrocarbons (TPH).

Four additional samples of the cuttings from EMW-7 were then collected, composited and analyzed to confirm the presence of TPH in the cuttings. Analyses of the second composite confirmed the presence of TPH with a concentration of 176 mg/kg. The cuttings from EMW-7 were then properly disposed of offsite by JPL personnel.

3.1.2 Deep Well Design and Construction

The design and construction of the deep monitoring wells, EMW-3 and EMW-4, were in accordance with the general guidelines for monitoring well installation as described in the JPL Sampling Plan and Drilling Bid Specification. Monitoring wells EMW-3 and EMW-4 were designed to sample 5 separate zones of the aquifer near and below JPL. This was accomplished with a multi-port casing design system installed by Westbay Instruments Ltd., a subcontractor. The deep well installation procedure is described below.

Immediately after the deep wells were drilled, Welenco Incorporated was subcontracted to run an electric log and a gamma-guard log in each open hole. In addition to these wireline geophysical logs, a caliper log was run in EMW-3 and a sonic/variable density waveform log was run in EMW-4. Copies of these logs can be found in Appendix H. The caliper log was run in EMW-3 to determine if the hole needed to be reamed before casing was placed into the hole. The decision was made to ream the hole based on what appeared to be a 4-6 foot sloughing clay zone at 500 feet below the surface. The sonic/variable density waveform log was run in EMW-4 to determine if it could detect the water table. Along with the electric log and gamma-guard log, the sonic/variable density waveform log could not reliably detect the water table.

The wireline geophysical logs were used to select the 5 screened intervals in each deep well. The electric log measured the spontaneous potential (SP) and the shallow formation resistivity of the sediments in the borehole and the gamma-guard log recorded the natural gamma radiation and deep formation resistivity. These logs, along with the field boring logs, defined downhole lithologies and allowed well screens to be accurately placed next to the sandiest or most permeable sections of the boring. As mentioned in Section 2.3.2, the geological environment around JPL is dominated by granitic boulders and sand. In this environment the resistivity curves most accurately reflect downhole lithologies. The sections of the borehole with the best water-yielding capabilities have the highest electrical resisitivities. The character of the SP log was subdued due to the fact that fresh water drilling muds were used in a fresh water aquifer. The amount of natural gamma radiation recorded was the result of both the amount of clay present (high potassium content) and the amount of granitic material present (high potassium feldspar and biotite content) rendering lithology determinations from the natural gamma ray log at times unreliable.

The sandiest, and most permeable interval in the borehole approximately 30 to 50 feet below the static water level was chosen for the location of the uppermost screen in each well. The uppermost well screen was placed below the current water table to allow for seasonal water level fluctuations. The other four well screens in each deep well were initially located by evenly spacing them throughout the remaining aquifer. After evaluating the wireline geophysical logs and the field boring log the remaining screen locations were adjusted so that sections of the aquifer that were the sandiest, or had the best water-yielding capabilities, would be monitored.

After deciding where the well screens should be placed, the depths of the various sand packs and bentonite seals were determined. A 2-3/8-inch diameter tremie pipe was run into each hole followed by the well casing. The well casing consisted of 4-inch diameter low carbon blank and 4-inch diameter 304 stainless steel, wire wrap, well screen. Before each joint of casing was run into the boring it was steam cleaned and measured. Some sections of blank casing were cut to specified lengths for the well screens to be placed at the predetermined depths. As each joint of casing was run into the boring it was welded to the preceding joint. Where stainless steel was welded to low carbon steel a stainless steel welding rod was used. Centralizers were welded onto the casing immediately above the bottom cap and within 1 to 4 feet from the bottom of each well screen. Figure 3-2 shows the typical design of the deep monitoring wells. The details of screen intervals in the deep wells are on the Boring Log Forms in Appendix A.

The slot size of the well screens were determined from the results of two sieve analyses. Curtis and Tompkins, the subcontracted analytical laboratory, performed standard sieve analyses on drill cuttings collected at EMW-3 from the intervals 140 to 160 feet and 160 to 180 feet. The results of these sieve analyses are in Appendix F. Graphs of grain size versus cumulative percent material retained were produced from the sieve analyses results. These graphs are also in Appendix F. Following a procedure outlined in Driscoll (1986), the 70 percent retained size of the sediment was multiplied by a factor of 6 to 10 and replotted. A new curve with a uniformity coefficient of approximately 2.5 was drawn through this new point. A screen that would retain 90 percent of all sediment in the aquifer is desired. The new curves on the graphs indicated a .010-inch slot size would best fit the physical characteristics of the aquifer.

After the casing was landed, the bentonite seals and sand packs were tremied into place. A grout pump was connected to the tremie pipe. The grout pump was used to circulate the drilling fluid through the tremie pipe and pump the backfill materials into the boring. A large hopper was placed above the grout pump that fed the required backfill materials into the pump. When a sand pack was needed, clean, kiln dried, #2/12 Lonestar sand was put into the hopper and circulated through the tremie into the boring. The sand would fall into position while the fluid in the hole circulated out. If a bentonite seal was required, a 1 to 1 mixture of pure bentonite granules and clean, kiln dried, #3 Lonestar sand was placed in the hopper and circulated into the boring. The sand mixed into the bentonite seals will not compromise the integrity of the seals. The sand is used to give the bentonite some

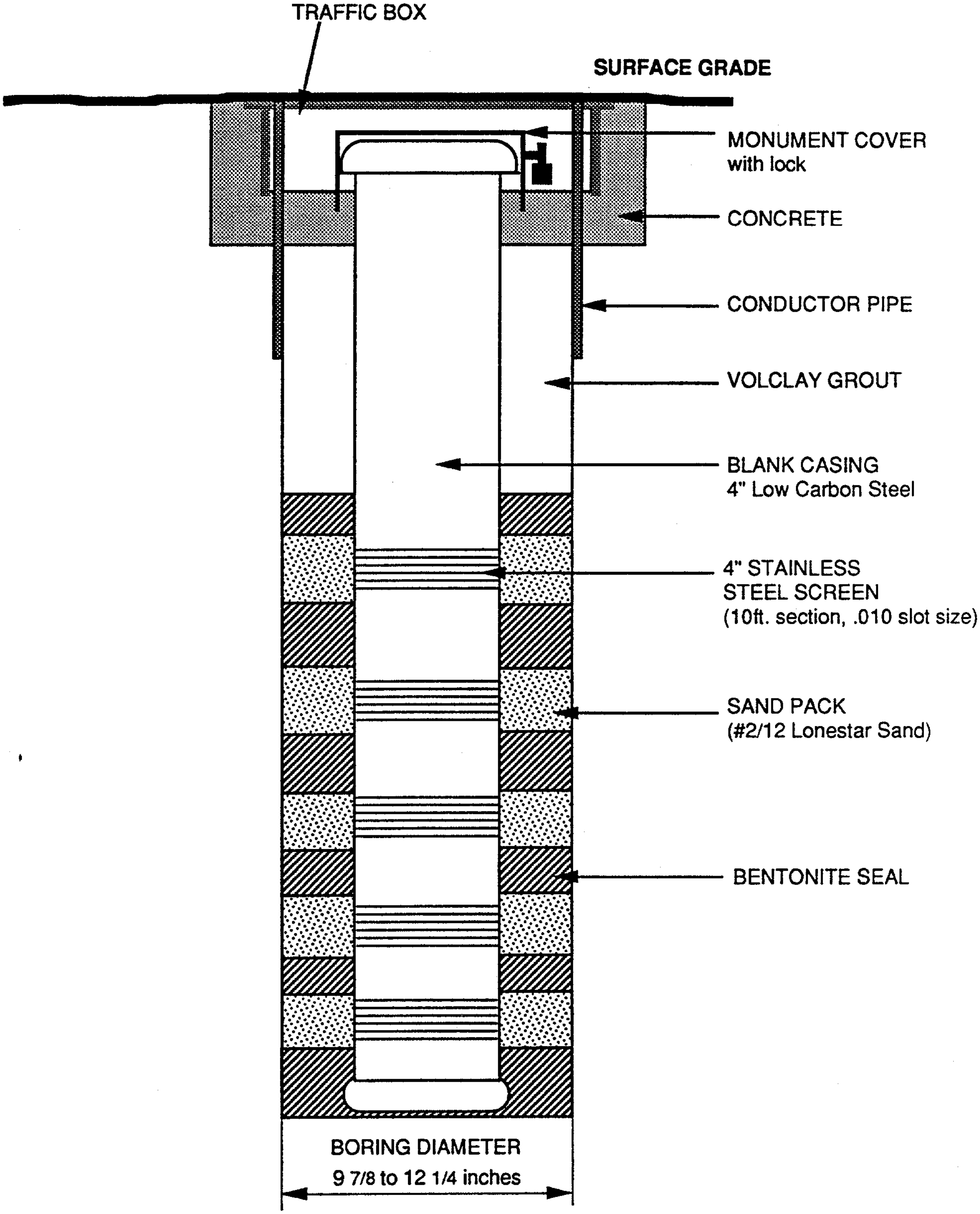


Figure 3-2
DESIGN OF TYPICAL DEEP MONITORING WELL

E#23-J

"body" so depth measurements on the bentonite seals could be obtained and to help the bentonite granules to fall into place. Throughout the backfilling procedure the drilling mud was continuously being diluted. The progress of the backfilling was carefully monitored with frequent depth measurements. Depth readings on the backfill material were obtained by lowering a weighted cable attached to a depth meter through the tremie pipe. The details on the depths of the various sand packs and bentonite seals are on the Boring Log Forms in Appendix A.

In each deep well the top of the last bentonite seal is at 98 feet below ground level. From 98 feet to just below the ground surface volclay grout was used to backfill the well. The volclay was mixed in large troughs and then pumped through the tremie into the well. After at least 8 hours the volclay grout would be hard enough to concrete into place a locking monument cover and traffic box. EMW-3 is located in the Arroyo Seco on a dirt road and instead of a traffic box, a 4 x 4 foot cement pad with a steel post at each corner was installed around a locking monument cover that extends approximately 2-1/2 feet above ground level.

3.1.3 Installation of Multiport Casing System in Deep Monitoring Wells

The multiport (MP) casing system is a product of Westbay Instruments, Ltd., Vancouver, British Columbia. The MP system is a modular, multiple-level groundwater monitoring device installed inside the 4 inch steel casing that employs a single closed tube with valved ports (Black, et al., 1986). The valved ports allow access to different levels in a single well casing. In each deep well, EMW-3 and EMW-4, there are 5 separate screened intervals that are accessed with the MP system. Before the MP casing was installed, the wells were developed by Beylik Drilling. Complete development details concerning the deep monitoring wells are described in Section 3.2.1.

The MP system consists of various casing components which are permanently installed in the well. The casing components include blank 1½-inch diameter schedule 80 PVC casing, regular PVC couplings that connect various casing component together, PVC measurement port couplings that allow pressure measurements and water samples to be collected, PVC pumping port couplings that allow well purging or hydraulic conductivity testing of the aquifer, and nitrile rubber inflatable packers that seal the annulus between monitoring or screened zones.

Before the MP system was installed in each deep well, the components were laid out in accordance with a casing installation log (Appendix B). This installation log was used to accurately place the packers and measurement ports at the correct levels. The MP casing string was then assembled by lowering the casing segments into the 4-inch steel casing by hand and attaching each successive segment to the adjacent coupling one at a time. Each joint was pressure tested before it was run into the hole to verify the integrity of the system during installation. To pressure test each joint of casing, a probe with 2 small packers was lowered into the casing so that the packers were located on each side of the joint. The packers were then inflated and water was injected under pressure into the casing opposite the joint. If the joint did not leak, it was lowered into the well.

Each MP casing component was scrubbed with TSP prior to arriving at the site. Once the MP casing had been placed in each well, the packers were inflated. The packers were inflated with water, one at a time beginning with the bottom most packer, through a packer inflation tool. Figure 3-3 shows a typical MP system installation. Details concerning the specific locations of the various casing components in each deep well are in Appendix B.

After installation of the MP casing several QA/QC checks were performed. These checks included an initial pressure profile to confirm the operation of the measurement ports, and observing head differences across the packers to confirm the packers had sealed the annulus. The details of these QA/QC checks are also located in Appendix B.

3.1.4 Shallow Well Design and Construction

The design and construction of the shallow monitoring wells, EMW-5 through EMW-7, were in accordance with the general guidelines for monitoring well installation as described in the JPL sampling plan. These monitoring wells were designed to sample the uppermost part of the aquifer below JPL.

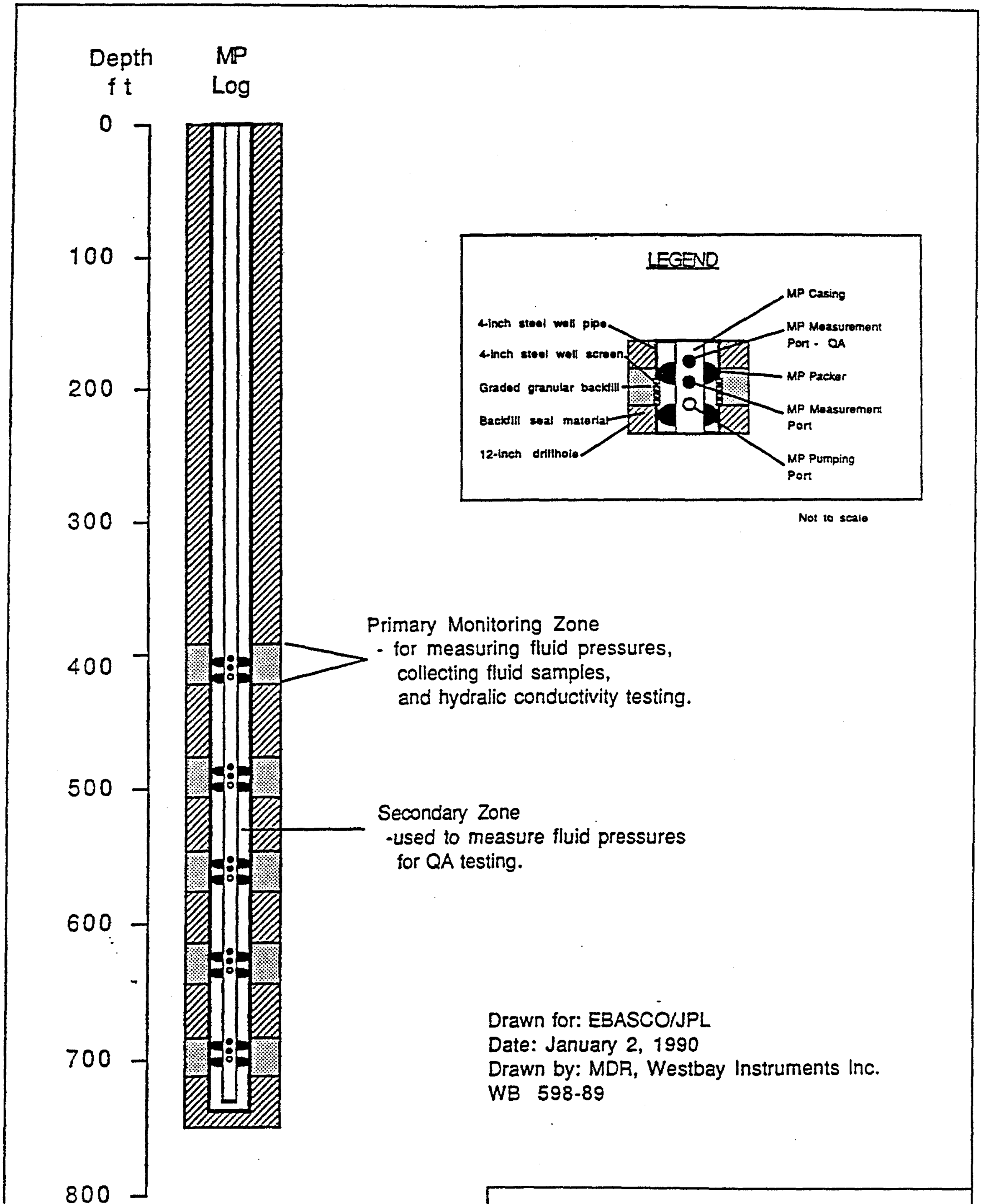


Figure 3-3
A Typical MP System Installation with 5 Monitoring Zones Completed Inside 4-inch Steel Well Pipe

The three shallow monitoring wells, EMW-5, EMW-6, and EMW-7, were completed at the water table at depths of 145 feet, 245 feet and 270 feet respectfully.This allowed for a 50 foot screen, with approximately 15 feet above the saturated zone and 35 feet below. The purpose of this design was to allow for the sampling of any possible free-floating contaminants on top of the water table, as well as dissolved-phase contaminants below the water table and to obtain groundwater elevation information.

The installation of the shallow monitoring wells was conducted in accordance with the following general procedure:

- Well depths were set by the rig geologist based on the location of the water table at the particular boring;

- Each well was drilled with a percussion hammer rig utilizing dual wall drive pipe and reversed air circulation. Section 3.1.2 describes the drilling method in detail;

- After each well was drilled, Welenco Inc. was subcontracted to run a gamma ray/neutron log in each well. For the log to be run the dual wall drive pipe used to drill the well was filled with water from JPL's fire hydrant system. Volatile organic analytical results of this water are presented in Appendix G and discussed in Section 4.2;

- Fifty (50) feet by 4-inch diameter, 304 stainless steel wire wrap well screen with .010-inch slots and a bottom cap was lowered into each hole through the middle of the dual wall drive pipe. The well screen was followed by 20 feet of 4-inch diameter 304 stainless steel blank casing which was followed by 4-inch diameter low carbon steel blank casing. Before each joint of casing was run into the boring it was steam cleaned and measured. As each joint of casing was lowered it was welded to the preceding joint. Where stainless steel was welded to low carbon steel a stainless steel welding rod was used. Figure 3-4 shows the typical design of the shallow monitoring wells. The details of the shallow well construction are on the Boring Log Forms in Appendix A;

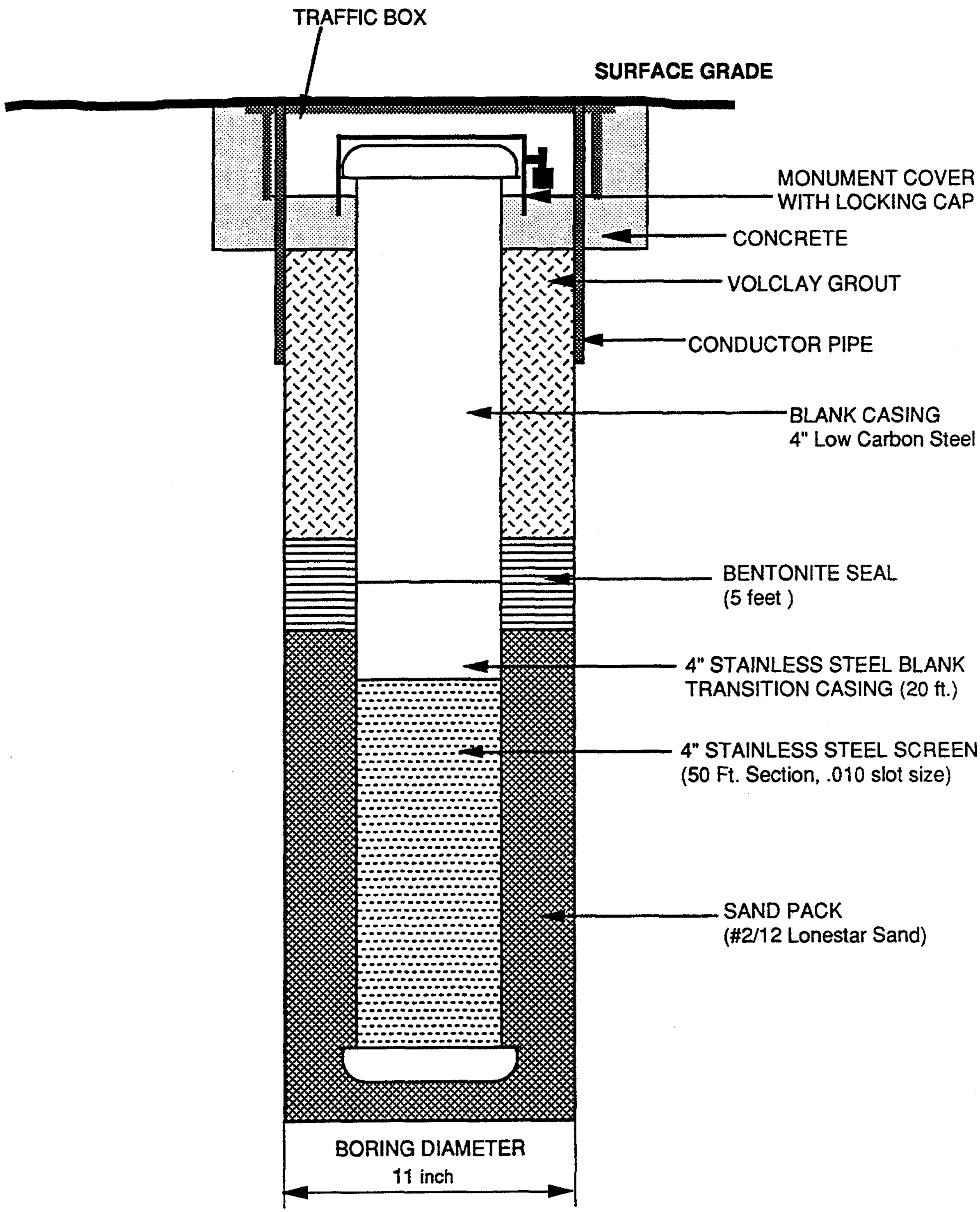


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Figure 3-4
DESIGN OF TYPICAL SHALLOW GROUNDWATER MONITORING WELL

- The dual wall drive pipe was removed from the borehole one section at a time to keep the formation from caving as backfill materials are added;

- The annular space between the steel casing and the boring wall was backfilled from the bottom of the well to at least 10 feet above the top of the well screen with clean, kiln dried, #2/12 Lonestar sand. A five foot section of bentonite seal was placed on the sand, and the remaining annular space was backfilled with volclay grout. The backfilling procedure was carefully monitored with frequent depth measurements;

- A locking monument cover and a steel and concrete traffic box were installed at each well. Ready mix concrete was used to secure the monument cover and traffic box in place; and

- The traffic box at each well was set just above grade in such a way as to direct surface runoff away from the casing.

3.2 GROUNDWATER SAMPLING PROCEDURES

Prior to collecting groundwater samples, all five monitoring wells installed by Ebasco were developed using several methods. The objectives of well development were 1) to promote settling of the sand packs adjacent to each screened interval, and 2) to remove any fluids or mobile sediments that were introduced during drilling or well installation so that a representative groundwater sample could be obtained.

In general, water was pumped from each screened zone of the wells until physical and chemical parameters stabilized and until at least 3-5 well volumes were removed. Physical parameters measured were total dissolved solids (TDS), suspended solids (using Imhoff Cones), a visual estimation of water clarity, and temperature. Chemical parameters measured were pH and electrical conductivity. Parameters were measured and recorded at 15 minute intervals during well development from the water discharge pipe or tubing. Water levels were recorded before and after each stage of development to evaluate water table draw-down. Development water was stored in portable storage tanks.

The first step in developing all the wells was to swab each screened interval from 1/2 to 1 hour by lowering and raising a heavy rubber disc attached to a steel rod and cable. The purpose of swabbing was to induce settling of the sand pack adjacent to each screened interval. Following swabbing, the heavy, sediment-rich fluid from the lower portions of each well was removed by bailing. To accomplish this, Beylik Drilling, used 10' or 20' long bottom-filling bailers, with capacities of 4 to 6 gallons, respectively. The remaining development procedures were specific to each well design and are described in subsequent sections.

3.2.1 Deep Well Development

After the initial bailing of the lower portions of deep wells EMW-3 and EMW-4, Beylik Drilling, focused on removing the sediment-rich fluid in the casing adjacent to each of the screened intervals. This was accomplished by bailing approximately 50 gallons from each zone.

Following bailing, Beylik Drilling lowered a submersible purge pump into the wells, suspended on 20'lengths of 2" O.D. steel discharge pipe. Inflatable rubber packers were placed on either side of the pump intake so that individual screened intervals could be isolated. After positioning the pump intake at the correct depth, the packers were inflated with compressed nitrogen gas.

At approximately 30 minute intervals, the pump was turned off and the packers were deflated, to allow the water in the casing to flow back into the screened interval and surge the formation. The driving force for this back-flushing was the small hydraulic head difference between the different screened zones. This procedure was shown to be effective on the basis of the color change in the development water after the packers were reinflated and pumping was resumed. For both deep wells, development proceeded from the uppermost screen (screen no. 1) to the lowest (screen no. 5). A summary of the volumes of water removed from each zone using the submersible pump, along with the final, stabilized parameters is included in Tables 3-2 and 3-3.

Development with the submersible pump was done until physical and chemical properties of the development water stabilized and for a sufficient length of time to generally remove at least 3 to 5 well volumes (calculated for each screened interval on the basis of the outer hole diameter and the height of the sand pack below water). Total gallons of fluid produced were calculated using measured flow rates from the discharge pipe and pumping time. Satisfying these criteria generally required about 6-10 hours of development at each screened interval.

At EMW-3, development using the submersible pump was immediately followed by the installation of the Westbay MP Casing System. After Westbay personnel conducted their QA/QC tests and down-hole pressure and temperature measurements, the final stage of development was begun using the Westbay MP system. As described in a previous section, the Westbay MP system effectively isolates each screened interval. Development at each zone was done by opening the pumping port valve located in that zone, and purging water using compressed nitrogen. An educator pipe, comprised of ten foot lengths of 1" OD PVC pipe were threaded together and lowered so that the bottom was just below the pumping port valve. A 1/4" OD plastic tubing was lowered to just above the pumping port valve. Compressed nitrogen was flowed down the plastic tubing which forced water up the educator pipe. By occasionally turning off the nitrogen stream, the water rising up the educator pipe was allowed to drop and surge the formation. This method proved to be more effective than the submersible pump for mobilizing fine sediment (drilling mud and formation fines) adjacent to the screened intervals, and Westbay development on EMW-3 required more time than was anticipated. During well development, the physical and chemical parameters of the purged water at each screened interval stabilized (Table 3-3).

Based on the knowledge gained from the development history at EMW-3, Beylik Drilling, performed additional development at EMW-4 using an air-lift system, prior to installing the Westbay MP system. Beylik's air-lift equipment was similar in principle and operation to Westbay's but differed

TABLE 3-2

Monitoring Well Development Specifications

Well Number	Screen Number	Date	Pumping Rate (gallons per minute)	Volume Pumped (gallons)
		<u>Submersible Purge Pump Development</u>		
EMW-3	1	2-7-90	6.0	1602
	2	2-7-90	4.8 - 6.7	2275
	3	2-8-90	1.1	383
	4	2-9-90	5.5	2277
	5	2-9 to 2-10-90	5.5	2315
EMW-4	1	2-11-90	6.8	422
	2	2-11 to 2-12-90	6.9	1511
	3	2-12-90	6.1	1834
	4	2-12 to 2-13-90	5.5	1683
	5	2-13-90	5.0	1235
EMW-5	-	2-20-90	7.0	729
EMW-6	-	2-28 to 3-6-90	4.0	1600
EMW-7	-	3-12 to 3-14-90	2.7 - 3.6	1090
		<u>Air Lift Development - (Beylik Drilling)</u>		
EMW-4	2	2-14-90	4.0 - 5.5	998
	3	2-14 to 2-15-90	4.0	920
	4	2-15-90	4.0 - 5.0	910
	5	2-15 to 2-16-90	5.0 - 5.5	1943
		<u>Air Lift Development - (Westbay Instruments)</u>		
EMW-3	1	2-20-90	0.3	73
	2	2-15-90	0.3	46
	3	2-14 to 2-15-90	0.3	58
	4	2-13 to 2-14-90	0.4	96
	5	2-12 to 2-13-90	0.2	74
EMW-4	1	2-26-90	0.4	65
	2	2-24-90	0.3	59
	3	2-24-90	0.4	78
	4	2-23-90	0.4	65
	5	2-23-90	0.4	63

TABLE 3-3

Summary of Monitoring
Well Development Specifications

Well Number	Screen Number	Screen Depth (ft)	Hole Volume[a] (gallons)	Total Fluid Removed (gallons)	Total Fluid Removed (Hole Volumes)	Temperature[b] °C	Conductivity[b] (µmhos/cm)	pH[b]	TDS[b] (mg/l)
EMW-3	1	170-180	147	1675	11.4	17.9	450	7.0	N/A
	2	250-260	187	2321	12.4	20.0	411	7.1	N/A
	3	344-354	183	441	2.4	16.8	325	8.4	N/A
	4	555-565	155	2373	15.3	18.4	440	7.5	N/A
	5	650-660	255	2389	9.4	15.6	380	7.1	N/A
EMW-4	1	147-157	294	487	1.7	16.6	401	6.9	N/A
	2	237-247	208	2568	12.3	18.7	450	7.8	N/A
	3	318-328	257	2832	11.0	17.7	347	7.9	N/A
	4	389-399	331	2658	8.0	16.2	311	7.5	N/A
	5	509-519	318	3241	10.2	16.8	425	7.6	N/A
EMW-5	-	85-135	230	729	3.2	16.6	653	6.9	326
EMW-6	-	195-245	203	1600	7.9	18.9	730	7.1	365
EMW-7	-	225-275	197	1090	5.6	21.6	531	8.2	265

Notes

a) Hole volume was calculated for each screened interval using the height of the sand pack below water level and the outer hole diameter (9.875 in. for EMW-3; 12.25 in. for EMW-4; and 11 in. for EMW-5, 6, 7).

b) Temperature, conductivity, pH, and Total Dissolved Solids (TDS) were measured immediately after laboratory samples were collected.

in the installation. Whereas Westbay utilized their sampling port valve and MP system packers, Beylik used rubber packers inflated with compressed nitrogen to isolate each screened interval. Again, physical and chemical parameters of the development water were measured and final values are reported in Table 3-3.

3.2.2 Shallow Well Development

Development of the shallow wells, EMW-5, EMW-6, and EMW-7 was done by initially swabbing the screened interval with a rubber-disc swab tool and bailing the lowermost portion of each well, after which pumping with a submersible purge pump was begun. As with the two deep wells, the pump was suspended on 2" OD steel pipe, but without the rubber packers. Initially, the pump intake was lowered to the bottom of the well and pumping was commenced for approximately 10 minutes to remove the heavy, sediment-laden fluid that had settled there. Then the pump intake was raised to about 5 feet below the water table. Pumping was begun and continued until physical and chemical parameters of the discharge water stabilized and at least 3 to 5 well volumes of water had been produced (Table 3-3). Occasionally, the pump was turned off to surge the formation. At least once during the later stages of development at each well, water exiting the discharge hose was directed back down the casing, to rinse off the inner surface of the casing which had a loose rust coating. Rinsing was continued until the discharge water color changed (requiring approximately 10 minutes) indicating that one rinse cycle had been completed.

When well development was finished, the pump and discharge pipe were quickly removed and sampling was conducted immediately thereafter. The discharge pipe had to be disassembled while full of development water because of a check valve located near the pump. Most of this water was collected in a bucket after disassembly of each joint. Care was taken to prevent any development water from dripping back into the well casing.

3.2.3 Deep Well Sampling

Sampling at each of the two deep wells was begun after Westbay development at each well was completed. Samples from each screened interval were obtained using a Westbay Sampler Probe with a total capacity of approximately one liter. The sampler probe consisted of a series of four 250 ml stainless steel collection tubes linked together with flexible, plastic lined hoses. The uppermost collection tube was linked to an electrically activated valve opening assembly. The entire apparatus was suspended and lowered down the MP casing on coaxial cable. Prior to sampling each screened interval, the sampler probe and collection tubes were disassembled and washed with Alconox brand detergent and rinsed with commercial bottled drinking water. The sampler probe was then lowered to several feet below the measurement port coupling adjacent to the screen of interest, and held while an initial water level measurement was taken.

The sampler probe was then raised and seated in the measurement port coupling. The measurement port coupling sample valve was opened remotely from the surface allowing the formation fluid to fill the collection tubes.

The sample valve was then closed and a second water level measurement was recorded. Comparison of the pre- and post-sampling water levels provided a check of whether the sampling had proceeded properly; a significant difference between the two measurements would indicate that the sampler probe had not properly seated in the measurement port coupling and that the collection tubes might contain water from inside the MP casing. When, on occasion this did occur, the water sample was discarded and the collection tubes were decontaminated again.

At each screened interval, pH and conductivity were measured at the beginning and end of the sampling run. These values were compared to the final development parameters to ensure that the water samples collected were representative. From each screen, a total of eight sample bottles were filled, requiring at least 7 sampling trips. At the surface, the water sample was emptied from the collection tubes through a valve at the lower end. Samples were collected in 1 liter amber glass bottles for semivolatile organics (EPA 625), Total Petroleum Hydrocarbons (EPA 418.1), and pesticides and PCBs (EPA 608), a one liter polyethylene bottle containing a nitric acid stabilizer for metal cations (Title 22 metals and Sr), a one liter polyethylene bottle containing a sodium hydroxide stabilizer for cyanide (EPA 9010), and 2-40 ml septum vials for volatile organics (EPA 624). An extra one liter amber glass bottle was filled in case additional water was needed for any of the above analyses. Immediately after filling, sample bottles and vials were labeled, sealed in plastic zip-lock brand bags, and placed on ice in a cooler for transport to the analytical laboratory.

3.2.4 Shallow Well Sampling

Immediately after the submersible pump and discharge pipe were removed after development of the shallow wells, water level measurements were recorded and sampling was begun. Samples were collected with 3 feet long, 750 ml capacity stainless steel (single check valve) or teflon (double check valve) bailers. The bailers were decontaminated before use by thoroughly washing the disassembled bailers with Alconox brand detergent and rinsing with de-ionized water.

At the beginning and after completion of sampling, pH, conductivity, and TDS parameters were measured and compared to the final development parameters to obtain representative samples. The same assortment of bottles and vials used for deep well sampling were collected from each of the shallow wells.

For several of the wells, water samples collected contained unacceptable levels of colloidal iron, apparently from water cascading down the inner, corroded surface of the casing. Those water sample sets were discarded and attempts were made to correct the problem. The inner surfaces of steel casing of the wells were rinsed and/or swabbed and the wells were redeveloped using a submersible pump for several hours. Sampling was conducted a second time with markedly improved results. Immediately after filling, all bottles and vials were labeled, sealed in plastic zip-lock brand bags and placed on ice in a cooler for transport to the analytical laboratory.

3.2.5 Analytical Methods

The groundwater samples collected as part of this investigation for laboratory analyses are as follows:

- o Thirteen (13) groundwater samples were collected for water quality analyses by Curtis and Tompkins, a state certified laboratory. This number corresponds to collection of one sample from each of the five screened intervals in each deep monitoring well (EMW-3 and EMW-4) and one sample from each shallow monitoring well (EMW-5 through EMW-7).

- o Two (2) groundwater samples were collected as duplicates, one from each of the uppermost screened intervals at the deep wells EMW-3 and EMW-4. In addition, duplicate volatile and semivolatile organic samples were collected from shallow monitoring well EMW-5.

- o One (1) groundwater sample was collected as a field blank from deep well EMW-4. Water from the final rinse of the decontamination procedure on the sampling device after screen 3 (third screen from top) was sampled and before screen 4 was sampled (fourth screen from top) was collected. In addition, final decontamination rinsate water was collected for volatile organic analyses from EMW-3 after screen 4 was sampled and before screen 5 was sampled.

- o Two (2) water samples were collected from 2 separate fire hydrants at JPL for volatile organic analyses. One sample was from the fire hydrant used as a water supply during the drilling of EMW-4 and EMW-5, and one sample was from the water supply used while EMW-6 was being drilled.

- o Two (2) 40 ml glass vials filled with deonized water in the lab and transported to the site were used as a trip blank. After sampling, the trip blank was sent to the lab for analyses.

The groundwater samples were analyzed for volatile organics (EPA method 624), semivolatile organics (EPA method 625), Title 22 metals plus strontium

(EPA methods 6010/7000/FAAS) organochlorine pesticides and PCBs (EPA method 608), Total Petroleum Hydrocarbons (EPA method 418.1), and cyanide (EPA method 9010). Drinking water level detection limits were used throughout the laboratory analyses. Table 3-4 outlines the locations and sample numbers of the groundwater samples collected and the associated laboratory analyses performed. Table 3-5 outlines the EPA analytical methods and associated sampling criteria. Table 3-6 lists the individual compounds analyzed for using the EPA methods listed above.

Laboratory analytical results were carefully examined to ensure that the data was valid and acceptable according to EPA criteria. Several items were considered. All samples were transported to the analytical laboratory under Ebasco's established chain-of-custody procedures. Chain-of-custody documentation returned to Ebasco by the analytical laboratory (included in Appendix C) was examined to ensure that samples were not tampered with and reached the analytical laboratory quickly. Dates of analyses were examined to ensure that holding times specified by the EPA were not exceeded. Analyte concentrations reported by the laboratory were inspected for gross aberrations that might indicate major errors. Finally, laboratory quality assurance/quality control (QA/QC) data was compared to acceptable tolerances published by the EPA, to evaluate potential inaccuracies stemming from instrument malfunctions, calibration errors, operator errors, matrix effects, etc. Guidelines described in Test Methods for Evaluating Solid Waste, Third edition, SW-846, 1986, EPA were used to evaluate laboratory QA/QC results for metals. Guidelines published in the EPA Contract Laboratory Program Statement of Work for Organic Analyses, 1990, were used to evaluate QA/QC results for organic constituents. Ebasco's evaluation of the laboratory QA/QC results is discussed in a later section.

3.3 SOIL GAS INVESTIGATION

A soil gas survey was conducted at JPL to outline the nature and extent of volatile organic compounds (VOCs) emanating from suspected contaminated soil. Previous investigations using this method have proved it to be an economical means to delineate localized subsurface regions contaminated with

TABLE 3-4
Summary of Chemical Analyses Performed on Water Samples

Sample Location	Sample Type	Sample Number	Volatile Organics (EPA 624)	Semi-volatile Organics (EPA 625)	Title 22 Metals plus Strontium (EPA 6010/7000)	Pesticides and PCBs (EPA 608)	Total Petroleum Hydrocarbons (EPA 418.1)	Cyanide (EPA 9010)
EMW-3 (Screen 1)*	Water Quality	MW-3-1	X	X	X	X	X	X
	Duplicate	MW-3-0	X	X	X	X	X	X
EMW-3 (Screen 2)	Water Quality	MW-3-2	X	X	X	X	X	X
EMW-3 (Screen 3)	Water Quality	MW-3-3	X	X	X	X	X	X
EMW-3 (Screen 4)	Water Quality	MW-3-4	X	X	X	X	X	X
	Field Blank	MW-3-4-FB	X	-	-	-	-	-
EMW-3 (Screen 5)	Water Quality	MW-3-5	X	X	X	X	X	X
EMW-4 (Screen 1)	Water Quality	MW-4-1	X	X	X	X	X	X
	Duplicate	MW-4-0	X	X	X	X	X	X
EMW-4 (Screen 2)	Water Quality	MW-4-2	X	X	X	X	X	X
EMW-4 (Screen 3)	Water Quality	MW-4-3	X	X	X	X	X	X
	Field Blank	MW-4-3-FB	X	X	X	X	X	X
EMW-4 (Screen 4)	Water Quality	MW-4-4	X	X	X	X	X	X
EMW-4 (Screen 5)	Water Quality	MW-4-5	X	X	X	X	X	X
EMW-5	Water Quality	MW-5	X	X	X	X	X	X
	Duplicate	MW-5D	X	X	-	-	-	-
EMW-6	Water Quality	MW-6	X	X	X	X	X	X
EMW-7	Water Quality	MW-7	X	X	X	X	X	X
Fire Hydrant Used for EMW-4/EMW-5	Quality Control	HY-4	X	-	-	-	-	-
Fire Hydrant Used for EMW-6	Quality Control	HY-6	X	-	-	-	-	-
Trip Blank	Quality Control	Trip Blank	X	-	-	-	-	-

*Screen 1 is uppermost screen in the multi-port wells.

TABLE 3-5

EPA Methods and Sampling Criteria for Water Samples

Analyses	EPA Method	Approximate Detection Limit	Container Type and Size	Preservative	Storage Temperature	Maximum Holding Times
Volatile Organics	624	5-10 ppb	40 ml glass vial, teflon-lined septum	None	4°C	14 days
Semivolatile Organics	625	5-25 ppb	1 L amber glass bottle, teflon-lined septum	None	4°C	7 days to extraction 40 days after extraction
Organochlorine Pesticides and PCBs	608	0.2-2.0 ppb	1 L amber glass bottle, teflon-lined septum	None	4°C	7 days to extraction 40 days after extraction
Title 22 Metals Plus Strontium	6010/7000 /FAAS	1-20 ppb	1 L polyethylene bottle	HNO_3	4°C	6 months, 13 days for mercury
Total Petroleum Hydrocarbons	418.1	0.2 ppm	1 L amber glass bottle, teflon-lined septum	None	4°C	28 days
Cyanide	9010	20 ppb	1 L polyethylene bottle	NaOH	4°C	14 days

TABLE 3-6

Laboratory Analyses Detection Limits

Compound	Detection Limit ug/L
Volatile Organics (EPA Method 624)	
Chloromethane	10
Bromomethane	10
Vinyl chloride	10
Chloroethane	10
Methylene chloride	5
Trichlorofluoromethane	5
1,1-dichloroethene	5
1,1-dichloroethane	5
Total-1,2-dichloroethene	5
Chloroform	5
1,2-dichloroethane	5
1,1,1-trichloroethane	5
Carbon tetrachloride	5
Bromodichloromethane	5
1,2-dichloropropane	5
Cis-1,3-dichloropropene	5
Trichloroethylene	5
Dibromochloromethane	5
1,1,2-trichloroethane	5
Benzene	5
Trans-1,3-dichloropropene	5
2-chloroethylvinyl ether	5
Bromoform	5
1,1,2,2-tetrachloroethane	5
Tetrachloroethene	5
Toluene	5
Chlorobenzene	5
Ethyl benzene	5
Hazardous Substance List Compounds	
Acetone	10
Carbon disulfide	5
2-butanone	10
Vinyl acetate	10
2-hexanone	10
4-methyl-2-pentanone	10
Styrene	5
Total xylenes	5

TABLE 3-6
(Continued)

Laboratory Analyses Detection Limits

Semivolatile Organics (EPA Method 625, Extraction 3510) Acid Compounds	Detection Limit ug/L
Phenol	5
2-Chlorophenol	5
2-Nitrophenol	25
2,4-Dimethylphenol	5
2,4-Dichlorophenol	5
4-Chloro-3-methylphenol	5
2,4,6-Trichlorophenol	5
2,4-Dinitrophenol	25
4-Nitrophenol	25
4,6-Dinitro-2-methylphenol	25
Pentachlorophenol	25
Base/Neutral Compounds	
Bis(2-chloroethyl)ether	5
1,3-Dichlorobenzene	5
1,4-Dichlorobenzene	5
1,2-Dichlorobenzene	5
Bis(2-chloroisopropyl)ether	5
N-Nitroso-di-n-propylamine	5
Hexachloroethane	5
Nitrobenzene	5
Isophorone	5
Bis(2-chloroethoxy)methane	5
1,2,4-Trichlorobenzene	5
Naphthalene	5
Hexachlorobutadiene	5
Hexachlorocyclopentadiene	5
2-Chloronaphthalene	5
Dimethylphthalate	5
Acenaphthylene	5
2,6-Dinitrotoluene	5
Acenaphthene	5
2,4-Dinitrotoluene	5
Diethylphthalate	5
4-Chlorophenyl-phenylether	5
Fluorene	5
N-Nitrosodiphenylamine	5

TABLE 3-6
(Continued)

Laboratory Analyses Detection Limits

Semivolatile Organics (EPA Method 625, Extraction 3510) Base/Neutral Compounds (Continued)	Detection Limit ug/L
4-Bromophenyl-phenylether	5
Hexachlorobenzene	5
Phenanthrene	5
Anthracene	5
Di-n-butylphthalate	5
Fluoranthene	5
Pyrene	5
Butylbenzylphthalate	5
3,3'-Dichlorobenzidine	25
Benzo (a) anthracene	5
Chrysene	5
Bis (2-ethylhexyl)phthalate	5
Di-n-octylphthalate	5
Benzo (b) fluoranthene	5
Benzo (k) fluoranthene	5
Benzo (a) pyrene	5
Indeno (1,2,3-cd) pyrene	5
Dibenzo (a,h) anthracene	5
Benzo (g,h,i) perylene	5
Hazardous Substance List Compounds	
Benzoic Acid	25
2-Methylphenol	5
4-Methylphenol	5
2,4,5-Trichlorophenol	25
Benzyl Alcohol	5
4-Chloroaniline	5
2-Methylnaphthalene	5
2-Nitroanline	25
3-Nitroaniline	25
Dibenzofuran	5
4-Nitroaniline	25

TABLE 3-6
(Continued)

Laboratory Analyses Detection Limits

Organochlorine Pesticides and PCBs (EPA Method 608, Extraction 3510) Compound	Detection Limit ug/L
Alpha-BHC	0.2
Beta-BHC	0.2
Gamma-BHC	0.2
Delta-BHC	0.2
Heptachlor	0.2
Aldrin	0.2
Heptachlor Epoxide	0.2
Endosulfan I	0.2
Dieldrin	0.2
pp-DDE	0.2
Endrin	0.2
Endosulfan II	0.2
Endosulfan Sulfate	0.2
4,4-DDD	0.2
Endrine Aldehyde	0.2
pp-DDT	0.2
Chlordane	2.0
Toxaphene	2.0
Methoxychlor	2.0
PCB 1016	2.0
PCB 1221	2.0
PCB 1232	2.0
PCB 1242	2.0
PCB 1248	2.0
PCB 1254	2.0
PCB 1260	2.0

TABLE 3-6

(Continued)

Laboratory Analyses Detection Limits

Metal	CAC Title 22 Metals Plus Strontium (EPA Methods 6010/7000/FAAS) Detection Limit mg/L
Antimony	0.05
Arsenic	0.005
Barium	0.01
Beryllium	0.01
Cadmium	0.001
Chromium (total)	0.01
Cobalt	0.01
Copper	0.02
Lead	0.005
Mercury	0.001
Molybdenum	0.01
Nickel	0.01
Selenium	0.005
Silver	0.02
Strontium	0.05
Thallium	0.005
Vanadium	0.02
Zinc	0.02

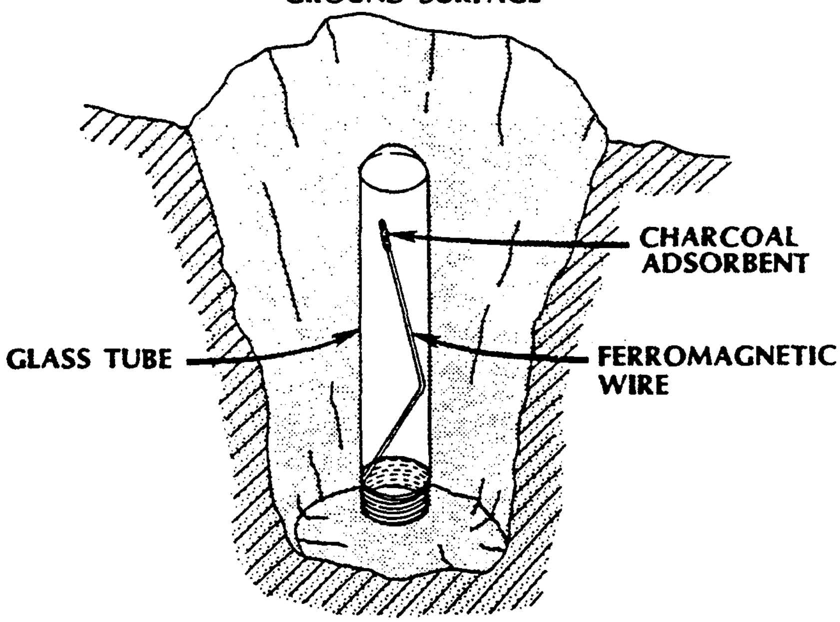
trace concentrations (ppb levels) of chlorinated ethanes (e.g., DCA and TCA) and chlorinated ethenes (e.g., DCE, TCE, and PCE).

3.3.1 Petrex Soil Gas Survey Method

The soil gas at JPL was sampled using static soil gas collectors developed and supplied by Petrex, a subcontractor located in Lakewood, Colorado. Each soil gas collector consists of a ferromagnetic wire coated with activated charcoal contained in a glass culture tube. The culture tubes were buried open-end down in shallow holes and left undisturbed for approximately 4 weeks. Figure 3-5 is a schematic diagram of a soil gas collector buried in the ground. During the 4 weeks, any volatiles present in the soil beneath the collectors could adsorb onto the charcoal. The collectors were then removed, immediately sealed, and transported to Petrex's analytical laboratory in Lakewood, Colorado where the absorbed compounds were desorbed and analyzed using Curie-point mass spectrometry. The results were then compared to a library of mass spectra of known compounds and identified. Results are reported in terms of ion counts at various mass-to-charge ratios (m/z) and provide a semi-quantitative measure of concentrations. The analytical results from this soil gas survey are discussed in detail in Section 4.4.

3.3.2 Installation of Soil Gas Collectors

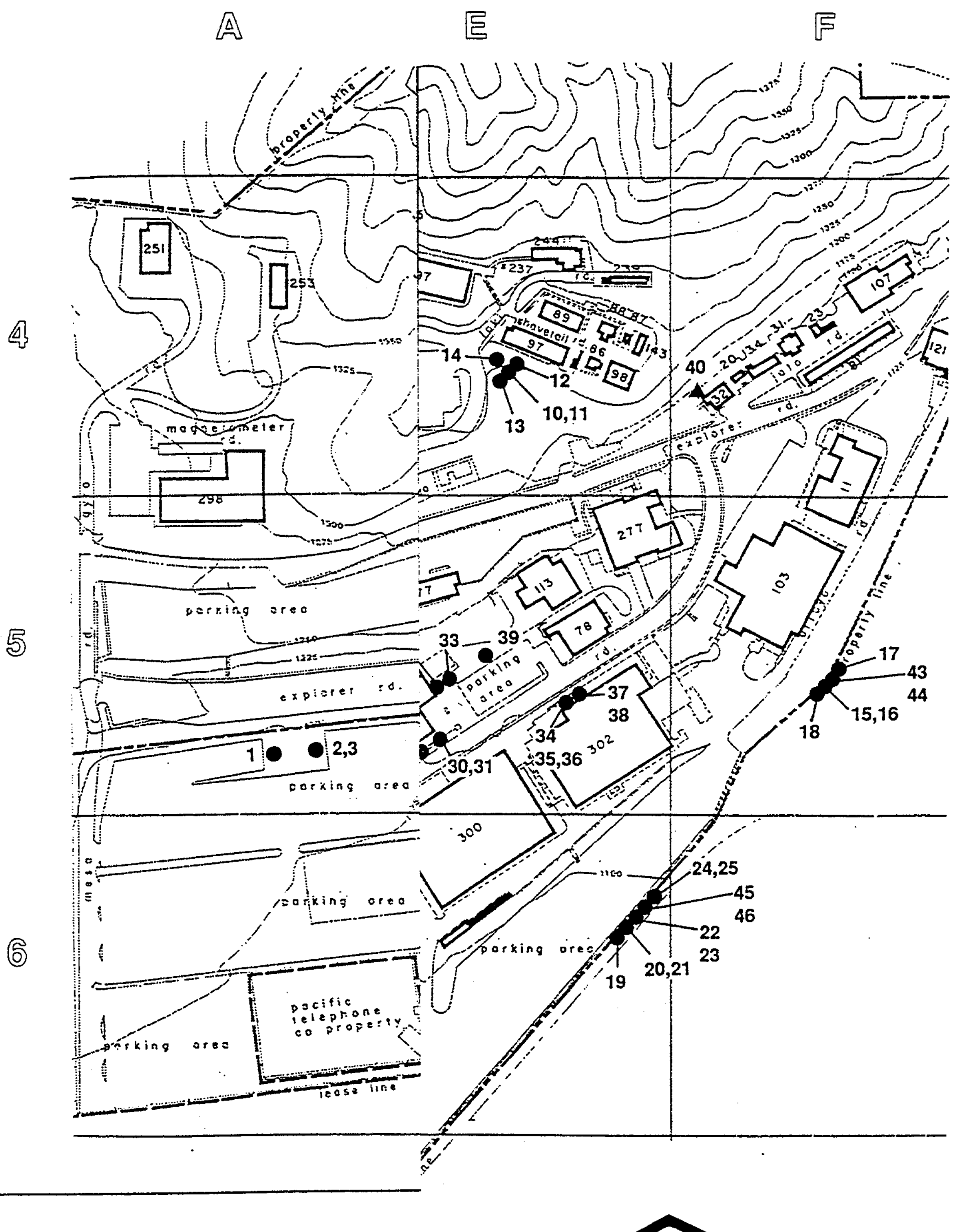
Eight suspected chemical disposal sites were identified by examining historical aerial photographs and through discussions with JPL personnel (Figure 2-2). Many of the past disposal sites are currently covered by buildings or pavement. In addition to the above mentioned disposal sites surveyed for soil gas, 2 locations were selected for background information. Figure 3-6 shows the locations of the soil gas collectors. A total of 46 Petrex wires were used to characterize the 10 locations (Table 3-7). Ten of those wires were used as replicates (two wires per culture tube) by Petrex for QA/QC purposes; 1 wire was used as a replicate by Ebasco for QA/QC purposes; and 6 wires were used for time trial tests to determine



ISOMETRIC VIEW

From: M.J. Malley, et al., 1985.

Figure 3-5
Schematic Diagram of Soil Gas Collector



Legend:

● SOIL GAS COLLECTOR LOCATION

▲ BACKGROUND SOIL GAS COLLECTOR LOCATION

Sample wire number indicated at each location

Figure 3-6
LOCATION OF SOIL GAS SURVEY COLLECTORS

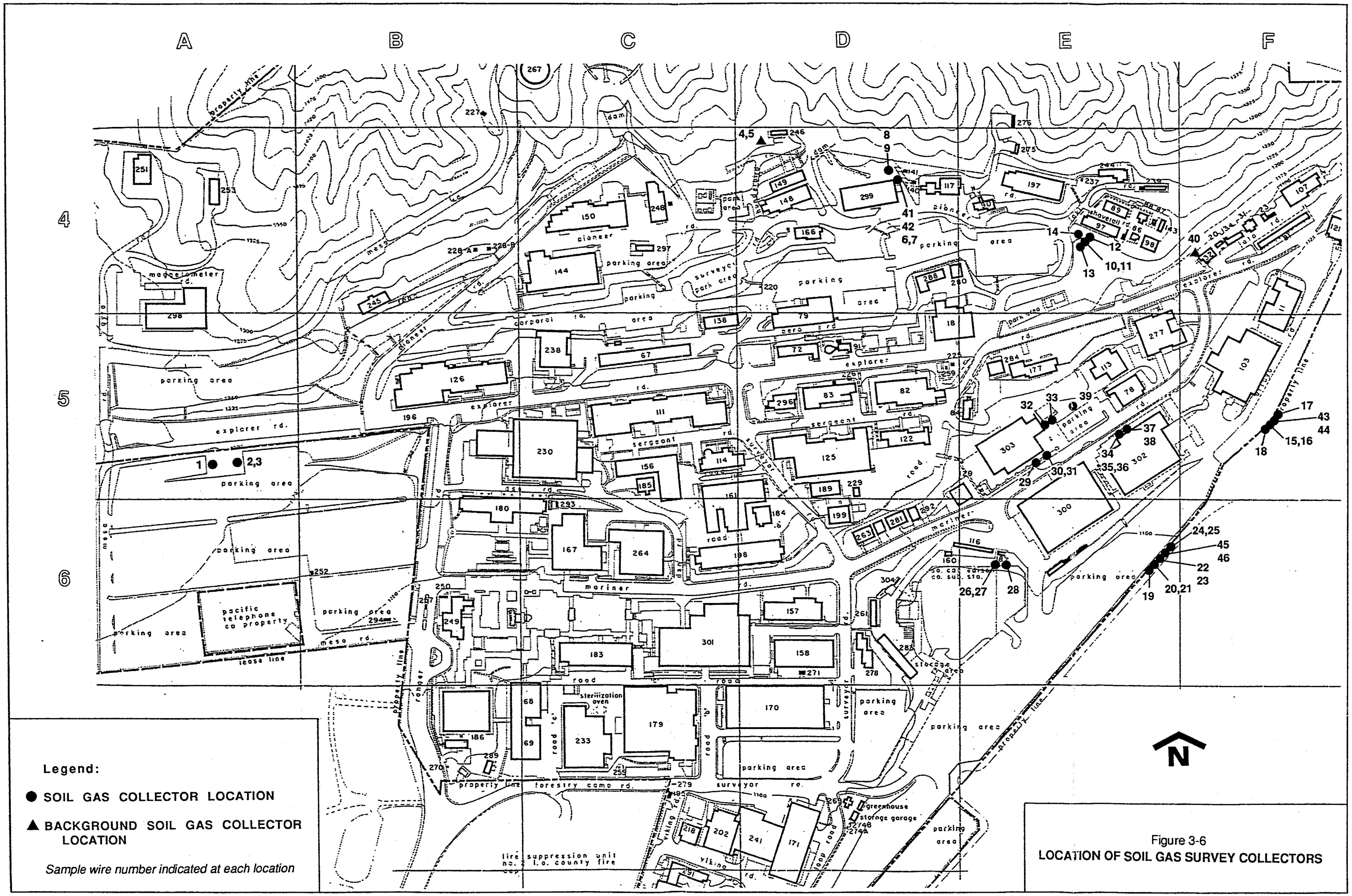


Figure 3-6
LOCATION OF SOIL GAS SURVEY COLLECTORS

TABLE 3-7

Locations and Purposes of Soil Gas Survey Collectors

Grid	Location	Suspected Problem/Purpose	Wire Number(s)	Collector* Type	Duration (days)
A5	W. Parking Log	Chemical Dumping Pit	1	S	29
		Chemical Dumping Pit	2,3	D	29
D4	E. of Bldg. 246	Background	4,5	D	29
D4	E. of Bldg. 299	Chemical Dumping Pit	6,7	D	29
		Chemical Dumping Pit	41	S,T	8
		Chemical Dumping Pit	42	S,T	22
E4	N. of Bldg. 299	Chemical Dumping Pit	8	S	29
		Chemical Dumping Pit	9	S	29
F5	S. of Bldg. 97	Chemical Dumping Area	10,11	D	29
		Chemical Dumping Area	12	S	29
		Chemical Dumping Area	13	S	29
		Chemical Dumping Area	14	S	29
E6	SE. of Bldg. 103	Chemical Dumping Area	15,16	D	28
		Chemical Dumping Area	17	S	28
		Chemical Dumping Area	18	S	28
		Chemical Dumping Area	43	S,T	7
		Chemical Dumping Area	44	S,T	21
E6	SE. of Bldg. 300,302	Chemical Dumping Pit	19	S	28
		Chemical Dumping Pit	20,21	D	28
		Chemical Dumping Pit	22	S	28
		Ebasco QA/QC for Wire 22	23	S	28
		Chemical Dumping Pit	24,25	D	28
		Chemical Dumping Pit	45	S,T	7
		Chemical Dumping Pit	46	S,T	21
E6	S. of Bldg. 187	Chemical Spill Area	26,27	D	28
		Chemical Spill Area	28	S	28
E5	SE. of Bldg. 303	Chemical Dumping Area	29	S	28
		Chemical Dumping Area	30,31	D	28
E5	E. of Bldg. 303	Chemical Dumping Area	32	S	28
		Chemical Dumping Area	33	S	28
E5	NW. of Bldg. 302	Chemical Dumping Area	34	S	28
		Chemical Dumping Area	35,36	D	28
		Chemical Dumping Area	37	S	28
		Chemical Dumping Area	38	S	28
E5	SW. of Bldg. 78	Chemical Dumping Area	39	S	28
F4	NW. of Bldg. 132	Background	40	S	28
-	—	Travel Blank	47	S	-
-	—	Travel Blank	48	S	-
-	—	Travel Blank	49	S	-

<u>NOTES</u>:

* S = single wire in one culture tube.
D = double wires in one culture tube. The second wire was used by Petrex for their QA/QC determination.
T = time trial test used to determine optimal duration of the collection period.

the optimal soil gas collection time. The soil gas collectors were installed in the following manner:

- o A hole approximately 12 in. deep was excavated with a 3-inch diameter hand auger.

- o A sealed Petrex culture tube containing one or two wires was opened and immediately inserted into the hole open-end down.

- o The hole was infilled with native soil and marked with a wire-stemmed flag.

- o After the appropriate time interval, each collector was removed, wiped clean, and immediately sealed, labeled and packaged in double zip-lock plastic bags.

- o The sealed tubes were sent to the Petrex laboratory (Lakewood, Colorado) via overnight delivery for analysis. Chain-of-Custody Records were maintained and are included in Appendix E.

When handling the open collectors, latex gloves were used to eliminate potential contamination. Care was taken that the collectors, open or sealed, were not exposed to smoke, exhaust fumes, or other potential contaminants.

Two sets of three single wire collectors (total of 6) were used for time trial tests to determine the optimal time for soil gas collection. The three locations selected for the time trial tests were sites that were considered to have the greatest potential for containing volatile compounds. The first set was removed and analyzed after 8 days and the second was removed and analyzed after 22 days. On the basis of those results, Petrex recommended that the remaining collectors had fully equilibrated with the soil and should be removed for analysis (those collectors were removed after 29 days).

Ten of the collectors contained double wires and were used by Petrex to determine sampling and analytical precision. Those double wire collectors were uniformly distributed at the sampling sites. In addition, Ebasco used one single wire collector as an independent QA/QC check. Two collectors (travel blanks) were left capped and transported along with the collectors used for sampling. Analytical results from those travel blanks ensured that no contamination had occurred during storage and transportation. The analytical results are presented in Appendix E.

4.0 PHYSICAL AND CHEMICAL CHARACTERISTICS OF JPL GROUNDWATER AND SOIL GAS

A description and evaluation of field measurements and laboratory analytical results concerning JPL groundwater and soil gas is presented in the following sections.

4.1 GROUNDWATER LEVEL MEASUREMENT

Groundwater elevations were measured at all monitoring well locations at JPL at least 24 hours after completion of well development. A 500 foot Solinst electric water level sounder was used to measure the water levels in the wells completed by Ebasco and the two wells completed by the Army Corps of Engineers (CMW-1 and CMW-2). The water levels in the deep monitoring wells completed with the multi-port casing system (EMW-3 and EMW-4) were measured prior to installation of the multi-port casing.

The electric water level sounder utilizes a water sensor probe attached to a measuring tape wound onto a reel. To measure the water level in a well, the probe was lowered into the well and upon contact with groundwater the circuit between the electrodes on the probe was completed and the sounding device and light on the reel were activated. The depth to groundwater was then read from the measuring tape. Measurements were made to the top of the well casing with an accuracy of ±0.01 feet. For consistency and accuracy of subsequent measurements, the location on the casing which was used to measure the depth-to-water was marked and noted. To obtain the groundwater elevations above mean sea level, the length of casing above ground surface, if any, was subtracted from the gross measurement along with the ground surface elevation (the groundwater elevations appear in Table 4-1). The ground surface elevations were not surveyed; however, detailed topographic maps available through JPL facilities personnel were used to estimate surface elevations via known nearby datum locations. A second round of groundwater level measurements were taken by Ebasco personnel on 3/27/90. The well locations and elevations for this round of measurements are presented in Figure 4-1 and Table 4-1. Water levels in wells MH-01, CMW-1, EMW-5, EMW-6

TABLE 4-1

Groundwater Level Measurements at JPL

All measurements in feet, all elevations above mean sea level

Well No.	Surface Elevation	Date	Depth to Groundwater	Groundwater Elevation	Date	Depth to Groundwater	Groundwater Elevation
MH-01	1,100	01/23/90	130.50	969.50	03/27/90	124.35	975.65
CMW-1	1,116	01/23/90	20.00	1,096.00	03/27/90	16.27	1,099.73
CMW-2	1,169	02/28/90	>179*	<989	03/27/90	>179*	<989
EMW-3	1,100	02/10/90	130.50	969.50	03/27/90	N/A**	N/A
EMW-4	1,083	02/16/90	108.60	974.40	03/27/90	N/A**	N/A
EMW-5	1,070	02/13/90	98.43	971.57	03/27/90	94.13	975.87
EMW-6	1,189	02/28/90	205.80	983.20	03/27/90	203.85	985.15
EMW-7	1,213	03/12/90	236.20	976.80	03/27/90	235.00	978.00

*No water in well, total depth of well is 179'.

**No measurement available, multi-port system precludes electric sounder use.

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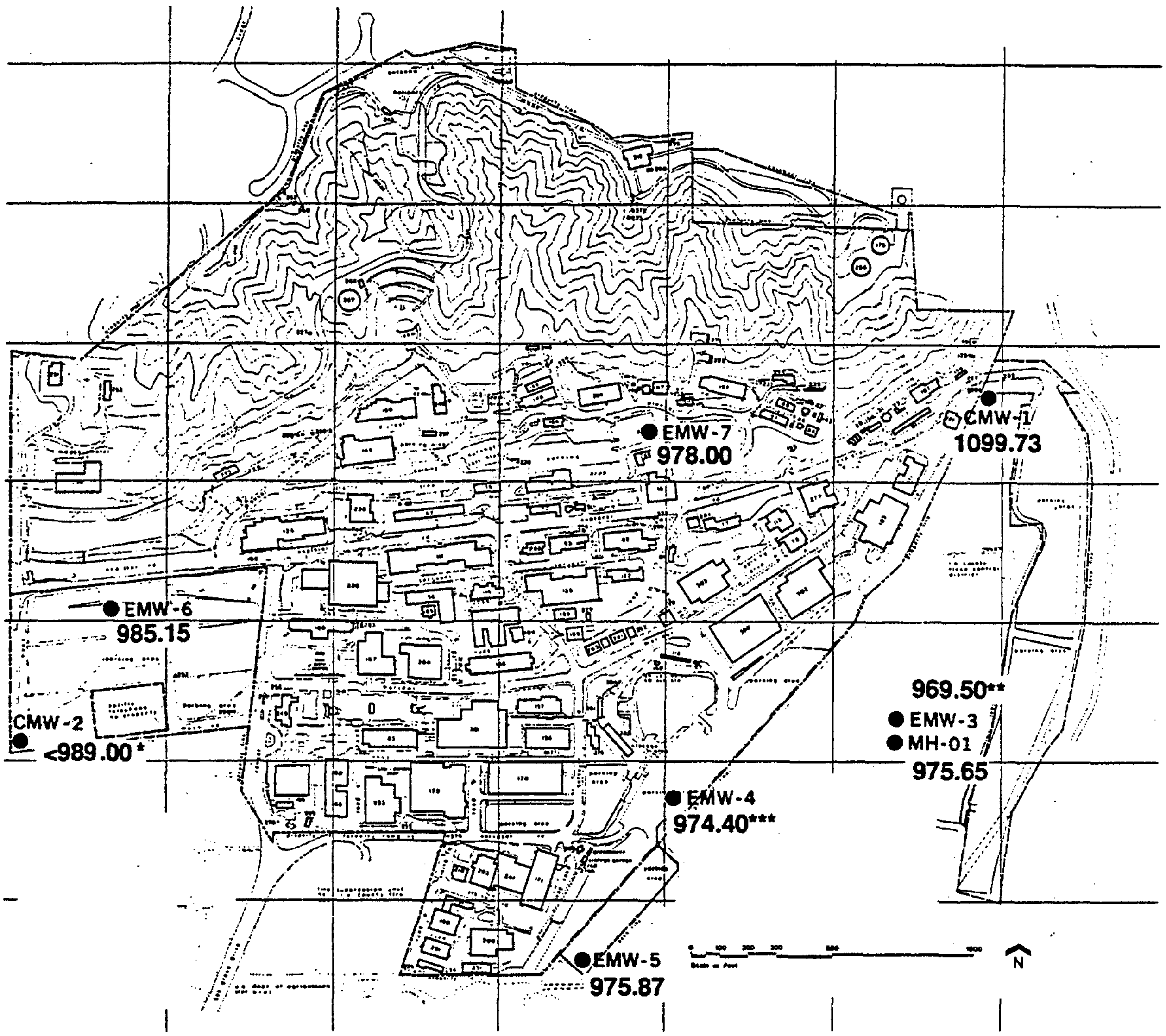


* Dry Well

** Measurement, 2/10/90

*** Measurement, 2/16/90

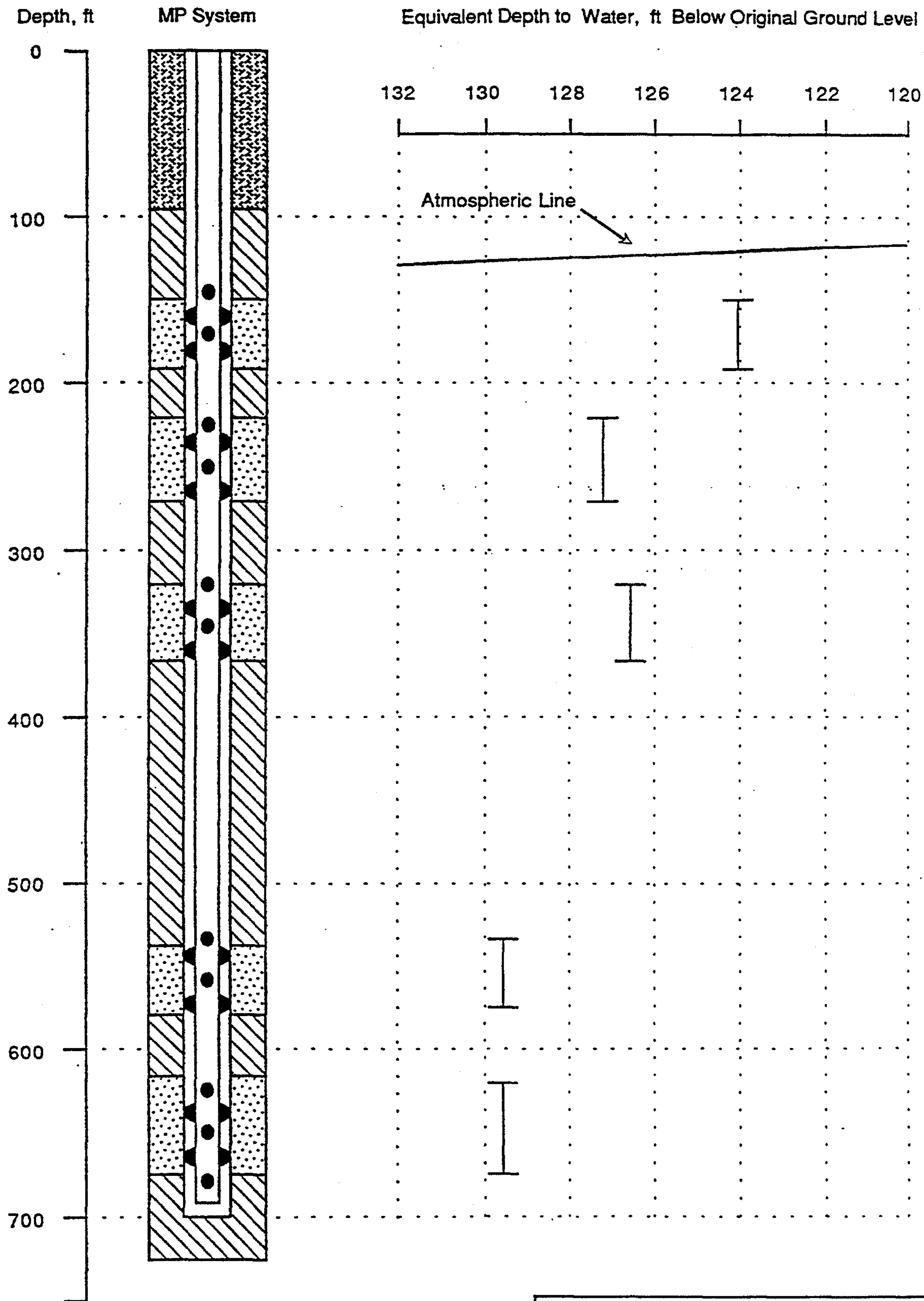
Figure 4-1
Groundwater Elevations At JPL, 3/27/90
All Measurements In Feet Above Mean Sea Level

and EMW-7 were measured with an electric water level sounder. Water levels in wells EMW-3 and EMW-4 were not measured, as the multi-port system precludes use of the electric sounder.

After installation of the multi-port casing system in wells EMW-3 and EMW-4, piezometric surfaces were obtained for each screened interval using a pressure probe/transducer device. The pressure probe/transducer unit was initially lowered to the deepest monitoring port at the deepest screened interval and moved upward to each successive screened interval as measurements were completed. To obtain each measurement the port was opened and the probe put into contact with the formation fluid. The fluid pressure was measured by the transducer and relayed to the surface. An equivalent depth to water below ground level was then derived for each screened interval. The fluid profiles generated for EMW-3 and EMW-4 are presented in Figures 4-2, 4-3 and Appendix B.

The transducer derived water level measurements vary from those water level measurements taken prior to multi-port installation. The uppermost interval of EMW-3 was initially measured at 130.5 feet below ground surface on 2/10/90. A transducer-derived measurement of the same interval on 3/3/90 yielded a figure of 124 ±0.3 feet below ground surface, a difference of 5.5 ±0.3 feet. The uppermost interval of EMW-4 was initially measured at 108.6 feet below ground surface on 2/16/90. A transducer-derived measurement of the same interval on 3/5/90 yielded a figure of 103.5 ±0.3 feet below ground surface, a difference of 5.1 ±0.3 feet. A period of approximately three weeks passed between the original water level measurements of each well and the subsequent pressure probe/transducer measurements. During the interim the site was subjected to periods of heavy rain and it is likely that the water level rose due to the recharge provided by the wet weather. This explanation is supported by the consistency of the water level differences in the wells, both in the five foot range and both higher than originally measured.

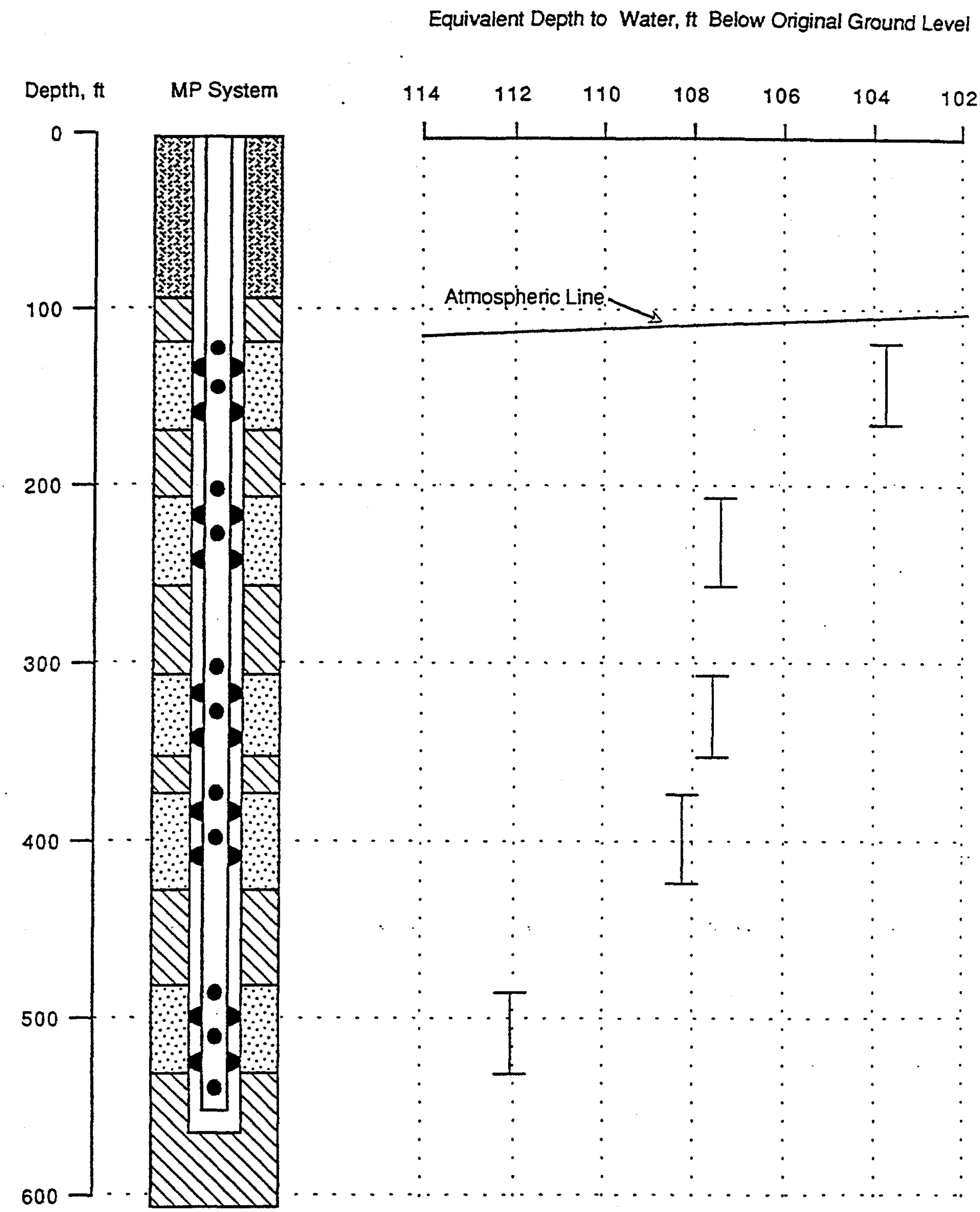
The transducer-derived water level measurements also vary between individual screened intervals within EMW-3 and EMW-4 (see Figures 4-2 and 4-3). In EMW-3 the fluid pressure results indicate a downward gradient of



Data Collected: March 3, 1990

Drawn By: D. McEachern, Westbay Instruments
Accuracy Of Readings : +/- 0.3 ft H2O

Figure 4-2
EMW-3 PRESSURE PROFILE



Data Collected: March 5, 1990
Drawn By: D. McEachern, Westbay Instruments
Accuracy Of Readings : +/- 0.3 ft H2O

Figure 4-3
EMW-4 PRESSURE PROFILE

approximately five feet of water from the top to the bottom of the well. The piezometric surface measurements vary from 124.0 ±0.3 feet below ground surface in the first, uppermost, screened interval to 129.5 ±0.3 feet below ground surface in the fourth and fifth screened intervals (see Figure 4-2). The second and third screened intervals have piezometric surface measurements of approximately 126.5 ±0.3 to 127.5 ±0.3 feet below ground surface. These levels suggest the presence of three slightly different hydrologic zones within the aquifer at this location.

Similarly, the screened intervals in EMW-4 exhibit a variation in piezometric surface measurements (see Figure 4-3). The fluid pressure results for this well indicate a downward gradient of approximately eight feet of water from the top to the bottom of the well. The piezometric surface measurements vary from 103.5 ±0.3 feet below ground surface in the first screened interval to 112.0 ±0.3 feet in the fifth and deepest screened interval. The three middle screened intervals have measurements of approximately 107.0 ±0.3 to 109.0 ±0.3 feet below ground surface. As was the case with EMW-3, these different levels suggest the presence of three slightly different hydrologic zones within the aquifer at this location.

4.2 GROUNDWATER AQUIFER PERMEABILITIES

Westbay Instruments personnel performed a rising head hydraulic conductivity test at each screened interval in the deep monitoring wells EMW-3 and EMW-4. The following steps were repeated to complete each hydraulic conductivity measurement: 1) water was bailed from the subject well to reduce the water level inside the MP casing below that of the aquifer, the final water level was recorded; 2) a pressure probe/transducer was lowered into the well and placed below the current water level inside the MP casing; 3) the purge port at each individual screened interval was opened to the outside formation; 4) the pressure probe/transducer was used to obtain a record of water head pressure versus time as the hydraulic head rose in the well.

Hydraulic conductivity values were then calculated using a method described by Hvorslev (1951) and are presented in Table 4-2. Details of these calculations and plots of head ratios versus time are presented in Appendix B. The

TABLE 4-2

Summary of Hydraulic Conductivity Results

Well Number	Screen Number	Westbay Zone No.	Screened Interval*	Conductivity (cm/s)
EMW-3	1	10	920.0 = >930.0	8.9×10^{-4}
	2	8	849.0 = >850.0	7.0×10^{-4}
	3	6	746.0 = >756.0	6.0×10^{-5}
	4	4	535.0 = >545.0	5.4×10^{-4}
	5	2	440.0 = >450.0	1.1×10^{-4}
EMW-4	1	10	926.2 = >936.2	7.2×10^{-4}
	2	8	835.8 = >845.8	3.6×10^{-4}
	3	6	753.4 = >763.4	4.1×10^{-4}
	4	4	684.1 = >694.1	3.0×10^{-4}
	5	2	563.6 = >573.6	1.1×10^{-4}

* Elevation in feet above mean sea level.

conductivity values measured from wells EMW-3 and EMW-4 range from 6.0 x 10^{-5} cm/sec to 8.9 x 10^{-4} cm/sec. These values are within the generally accepted range for aquifers comprised of silty sand. Slight variations in hydraulic conductivities between screened intervals is most likely a function of the composition of the aquifer immediately adjacent to each screened interval. A silty interval of the aquifer will have a lower hydraulic conductivity than a sandy interval of the aquifer.

4.3 GROUNDWATER QUALITY ANALYSES

The analytical results of the groundwater samples collected during this investigation are presented in this section. Complete laboratory reports are included in Appendix C. The field sampling and analytical procedures used are discussed in Sections 3.2.3 through 3.2.5. Table 4-3 summarizes the analytical results by presenting only the compounds or constituents detected. No cyanide, organochlorine pesticides or PCBs were detected in any water samples collected at JPL.

The analytical results indicate low levels of metals are present in each monitoring well. All concentrations of the metals detected are below regulatory threshold levels. Barium, zinc, and strontium are present in the groundwater in each monitoring well in various concentrations with maximum recorded concentrations of 0.05, 0.25 and 0.66 mg/l, respectively. Molybdenum is present in the bottom three screened intervals of EMW-3 and in the bottom two screened intervals of EMW-4 with a maximum recorded concentration of 0.04 mg/l. Nickel was detected in the uppermost screened interval of EMW-3, the second from the top screened interval of EMW-4 and in EMW-5 with a maximum concentration of 0.10 mg/l. Cobalt was detected in the bottom screened interval of EMW-3 with a concentration of 0.01 mg/l and antimony was detected in EMW-6 with a concentration of 0.008 mg/l. Monitoring well EMW-7 contained 0.02 mg/l of total chromium and monitoring well EMW-5 contained 0.02 mg/l and 0.0045 m/l of copper and lead, respectively.

Total Petroleum Hydrocarbons (TPH) were also detected in low levels in samples collected from each monitoring well. The samples collected from the lowermost 2 screened intervals of EMW-3, the lowermost two screened intervals

TABLE 4-3
Summary of Analytical Results of Water Samples

Compound	EMW-3 Screen 1	EMW-3 Screen 1	EMW-3 Screen 2	EMW-5	EMW-5 Duplicate	EMW-6	EMW-7	Fire Hydrant Used For EMW-4 and EMW-5	Fire Hydrant Used For EMW-6	Regulatory Threshold[a]
	Sample Location (all results in ug/l)									
Volatile Organics										
Carbon Tetrachloride	-	-	-	-	-	-	200	-	-	0.5
Tetrachloroethene	-	-	-	-	-	-	15	-	-	5
Trichloroethene	-	-	-	13	13	-	22	-	-	5
1,1-Dichloroethene	-	-	-	-	-	-	8	-	-	6
Chloroform	7	8	6	-	-	24	23	34	36	b
Bromodichloromethane	-	-	-	-	-	6	<5	16	16	b
Dibromochloromethane	-	-	-	-	-	-	<5	13	13	b
Bromoform	-	-	-	-	-	-	-	<5	<5	b
Semivolatile Organics										
Bis(2-ethylhexyl)pthalate)	-	-	17	-	-	-	-	-	-	-

[a]California Code of Regulations, Title 22, maximum contaminant levels for drinking water.
[b]Total trihalomethanes (chloroform, bromodichloromethane, dibromochloramethane, and bromoform) over 100 ug/L.

(Continued)

TABLE 4-3
(Continued)

Constituent	Sample Location (All Results in mg/l) EMW-3 Scr. 1	EMW-3 Screen 1 Duplicate	EMW-3 Scr. 2	EMW-3 Scr. 3	EMW-3 Scr. 4	EMW-3 Scr. 5	EMW-4 Scr. 1	EMW-4 Screen 1 Duplicate	EMW-4 Scr. 2	EMW-4 Scr. 3	EMW-4 Scr. 4	EMW-4 Scr. 5	EMW-5	EMW-6	EMW-7	Regulatory Threshold[c]
Antimony	-	-	-	-	-	-	-	-	-	-	-	-	-	0.008	-	-
Barium	0.04	0.04	0.03	0.02	0.04	0.02	0.05	0.05	-	0.03	0.02	0.04	0.05	0.02	0.03	1.0
Chromium (total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.02	0.05
Cobalt	-	-	-	-	-	0.01	-	-	-	-	-	-	-	-	-	-
Copper	-	-	-	-	-	-	-	-	-	-	-	-	0.02	-	0.02	1.0
Lead	-	-	-	-	-	-	-	-	-	-	-	-	0.0045	-	-	0.05
Molybdenum	-	-	-	0.02	0.02	0.04	-	-	-	-	0.01	0.02	-	-	-	-
Nickel	0.10	-	-	-	-	-	-	-	0.01	-	-	-	0.02	-	-	-
Zinc		0.10	0.03	0.02	0.06	0.20	0.06	0.03	0.04	0.11	0.02	0.01	0.23	0.13	0.25	5.0
Strontium	0.53	0.60	0.43	0.21	0.43	0.18	0.42	0.45	0.54	0.27	0.30	0.40	0.50	0.66	0.32	-
Total Petroleum Hydrocarbons	-	-	-	-	0.5	0.4	-	-	-	-	-	0.5	0.5	2.0	1.1	-

[c]California Administrative Code Title 22, maximum contaminant levels for drinking water.

of EMW-4, and the three shallow monitoring wells contained low levels of TPH. The maximum concentration of TPH detected was 2.0 mg/l in the sample from monitoring well EMW-6.

Only one semivolatile organic compound was detected in the samples collected. Bis(2-ethylhexyl)phthalate was detected in the sample collected from the second screened interval from the top of EMW-3 with a concentration of 17 ug/l. Phthalates are associated with plasticizers in vinyl tubing and are commonly found to be laboratory and/or field contaminants. It is likely the presence of bis(2-ethylhexyl)phthalate in this sample is related to laboratory and/or field procedures and is not representative of groundwater conditions.

The volatile organic compounds detected in the groundwater at JPL are of primary concern. As Figure 4-4 shows, samples collected from each well except EMW-4 contained one or more volatile organic compounds. The sample of groundwater from EMW-5 contained 13 ug/l of trichloroethene (TCE). The state maximum contaminant level (MCL) for TCE in drinking water is 5 ug/l. The sample of groundwater from EMW-7 contained 200 ug/l of carbon tetrachloride, 15 ug/l of tetrachloroethene (PCE), 22 ug/l of TCE, and 8 ug/l of 1,1-dichloroethene. The concentrations of all of the these compounds are above the state of California Department of Health Services MCLs for drinking water.

The samples from well EMW-7 also contained 23 ug/l of chloroform and trace amounts (<5 ug/l) of bromodichloromethane and dibromochloromethane. Chloroform, bromodichloromethane and dibromochloromethane along with bromoform (all trihalomethanes) were detected in the QA/QC water samples collected from the fire hydrant system at JPL (Table 4-3). This water is supplied to JPL from the City of Pasadena and the Metropolitan Water District. Permission was granted from JPL to use this fire hydrant water during field operations (mixing drilling muds, filling the drill pipe with water to run E-logs at the shallow wells, etc.). The levels of trihalomethanes in this water supply are within regulatory limits and may be the result of a water chlorination process.

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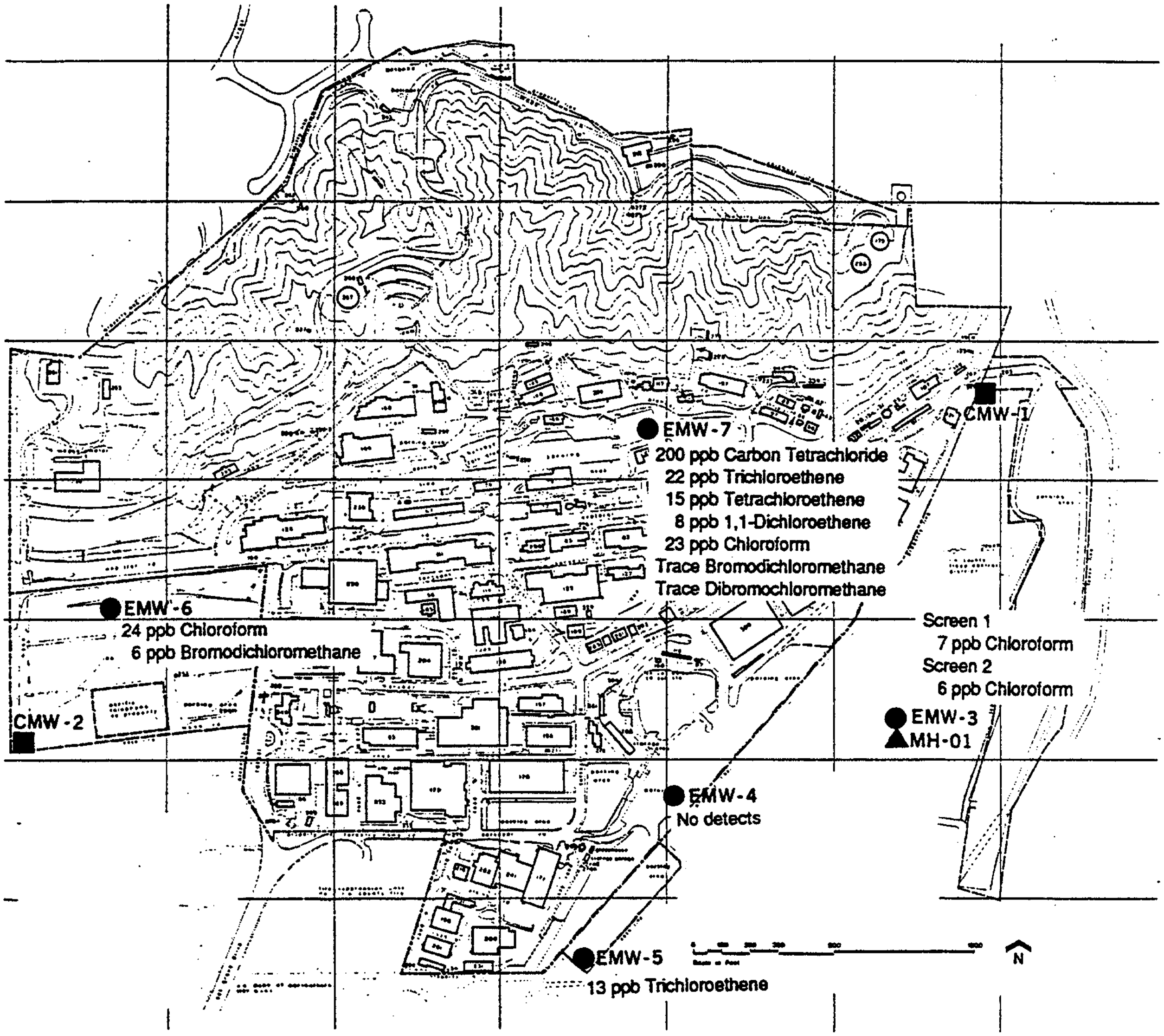

Legend:

● Installed during this investigation

■ Installed by the Army Corps of Engineers in 1989.

▲ Installed by Geotechnical Consultants, Inc. in 1982.

Figure 4-4
Locations of Volatile Organic Compounds Detected During this Investigation

Currently it is difficult to conclude whether the presence of chloroform, bromodichloromethane, and dibromochloromethane in the sample collected from EMW-7 is in any way related to the water added to the well during field operations or is representative of groundwater conditions. Prior to well development of EMW-7, 4 hole volumes of fire hydrant water were added so a gamma ray/neutron log could be run. During well development of EMW-7, 5.6 hole volumes were removed before a sample was collected (Table 3-3). The fact that the ratios of concentrations of contaminants in the water do not appear to match the ratios of concentrations of the same contaminants found in the sample from EMW-7 may suggest the results obtained for EMW-7 are representative of groundwater conditions. Analytical results obtained from future sampling events of this well should help resolve this question.

Chloroform and bromodichloromethane were also detected in the sample collected from EMW-6 in concentrations of 24 ug/l and 6 ug/l, respectively. Again it is difficult to conclude whether the presence of chloroform and bromodichloromethane in the sample collected from EMW-6 is related to the water used during field operations or is representative of groundwater conditions. Prior to well development of EMW-6, a significant amount of fire hydrant water was added to EMW-6 to unclog the drill bit and at least 3.5 hole volumes of the same water was added to EMW-6 so a gamma ray/neutron log could be run. During well development of EMW-6, 7.9 hole volumes were removed before a sample was collected (Table 3-3). Again, analytical results obtained from future sampling events of this well should help resolve this question.

Chloroform was again detected in some of the samples collected from well EMW-3. The sample collected from the uppermost screened interval of EMW-3 and its duplicate contained 7 ug/l and 8 ug/l of chloroform, respectively, and the sample collected from the second screened interval from the top of EMW-3 contained 6 ug/l of chloroform. JPL water containing chloroform (Table 4-3) was used to mix the drilling mud used during the drilling of EMW-3. Again it is difficult to conclude at this time that the chloroform detected in the samples from EMW-3 are not representative of groundwater conditions. During a hydrogeologic evaluation of the Arroyo Seco near JPL in late 1989, Ebasco sampled some of the City of Pasadena's water production wells (Ebasco, 1989) and found 8 ug/l of chloroform in the city's Arroyo well. The fact that chloroform was detected in the groundwater near EMW-3 in the Arroyo well in a concentration similar to the concentration of chloroform found in EMW-3, along with the fact that during extensive well development of EMW-3, 11.4 and 12.4 hole volumes were removed from the two screened intervals where chloroform was detected (Table 3-3), suggests that the chloroform detected in EMW-3 may be representative of current groundwater conditions and may not be related to contamination from the water supply used during field operations.

4.3.1 Quality Assurance and Quality Control (QA/QC)

Summaries of the analytical laboratory's QA/QC results on the groundwater samples are included in Appendix C along with the analytical reports.

The QA/QC procedure for each analytical method and the acceptable range for results, are specified by the EPA. For the fluid analyses discussed in this report, two different laboratory QA/QC approaches were used. For EPA methods for volatile organics (624) and semivolatile organics (625), several surrogate organic compounds (compounds with chemical properties similar to compounds of interest, but not normally present in contaminated groundwater) are added to the blanks, standards, and samples. The analytically determined concentration for each surrogate in the samples were compared to the actual concentration and expressed as a percentage, which ideally should be 100%. The ranges acceptable by the EPA are listed in Table 4-4.

For EPA methods for total petroleum hydrocarbons (418.1), Title 22 metals and Sr (6010/7000), organochlorine pesticides and PCBs (608), and total cyanide (9010), "Blank Spikes" were prepared by mixing a blank with metals or EPA specified compounds. Each blank spike was split to make a "Blank Spike Duplicate". For each EPA method, the analyte concentration in the appropriate blank spike is analytically determined and is reported as a percentage of the actual concentration. Those values, which ideally should be 100%, provide a measure of analytical accuracy. Analytical precision is determined by comparing the analytically determined concentrations of the blank spike and blank spike duplicate for each EPA Method and expressing the

TABLE 4-4

Acceptable Ranges for Analytical QA/QC
Results of Water Samples

QA/QC by Surrogate Recovery Method

Method and Surrogate Organic Compound	Acceptable Range (%)
EPA Method 624: Volatile Organics in Water	
1,2-Dichloroethane-d4	76-114
Toluene-d8	88-110
Bromofluorobenzene	86-115
EPA Method 625: Semivolatile Organics in Water	
2-Fluorophenol	21-100
Phenol-d5	10-94
2,4,6-Tribromophenol	10-123
Nitrobenzene-d5	35-114
2-Fluorobiphenyl	43-116
Terphenyl-d14	33-141

QA/QC by "Blank Spike" and "Blank Spike Duplicate" Method

Method and Analyte	Accuracy (Spike % Recovery)	Precision (Relative % Difference)
EPA Method 6010/7000: Title 22 Metals and Sr in Water		
All Metals	80-120	<20
EPA Method 418.1: Total Petroleum Hydrocarbons in Water		
	85-115	<20
EPA Method 608: Organochlorine Pesticides and PCBs in Water		
	47-125	<20
EPA Method 9010: Total Cyanide		
	80-120	<20

differences as a percentage. Those values should ideally be 0%. The acceptable ranges for accuracy and precision specified by the EPA are also listed in Table 4-4. All of the laboratory QA/QC results are within the EPA acceptable limits with the exceptions of spike % recovery (accuracy), for mercury in several analyses. The results, however, are just slightly (1-2%) greater than or less than the QA/QC specifications. Furthermore, mercury concentrations were below detection limits in all samples.

In addition to laboratory QA/QC procedures, Ebasco also incorporated field QA/QC procedures. Duplicate sets of samples were collected from the top screen (1) in EMW-3 and EMW-4 and submitted for the complete set of laboratory analyses. Of the constituents that were detected in the duplicate samples, metal cation concentrations (Ba, Ni, Sr, and Zn) matched to within 0.09 ppm. The chloroform concentrations in the EMW-3 samples were also close (7 and 8 ppb). A duplicate sample for EMW-5 was submitted for analyses for volatile and semivolatile organic compounds. Identical concentrations of trichloroethene, the only compound detected, were found in both samples.

A trip blank, which consisted of two 40 ml septum vials filled with deonized water by the analytical laboratory, were transported with all groundwater samples, providing proof that the groundwater samples were not contaminated during transport. After groundwater sampling was completed the trip blank was analyzed for volatile organic compounds. No compounds were detected.

Two field blanks were collected and analyzed to provide evidence of the effectiveness of the decontamination procedures for groundwater sampling equipment. After decontamination of the Westbay water sample collector prior to sampling screen 4 in EMW-3 and screen 3 in EMW-4, sample bottles were filled with used decon rinse water. The EMW-3 field blank was analyzed for volatile organic compounds and the EMW-4 field blank was submitted for the complete set of analyses. Concentrations of all constituents were below detection limits with the exception of Zn, which was just above detection limit in the EMW-4 field blank.

4.4 SOIL GAS ANALYSES

Results of the soil gas survey are presented in Appendix G, Table 1. Six different compounds were detected in one or more samples: 1) benzene, toluene, and xylene (BTX), 2) trichloroethane (TCA), 3) trichlorofluoromethane (Freon 11) or trichlorotrifluoroethane (Freon 113), 4) trichloroethylene (TCE), 5) tetrachloroethylene (PCE), and 6) chloroform. The concentrations are presented in terms of net "ion counts". No equations relating ion counts with the true concentrations and flux of analytes in soil gas are available. Ion counts from different compounds cannot be compared because of varying physiochemical properties of different compounds including diffusion rate and adsorption characteristics. In addition, ion counts obtained during different analytical runs should not be compared because of variations in instrument performance (unless a common sample is used to calibrate the analytical instruments during each run).

Results from the soil gas analyses were evaluated using an order-of-magnitude ranking system, in which net or background-corrected ion counts are ranked as not detected (0 ion counts), very low (1-4999), low (5000-9999), moderate (10,000-49,999), or high (50,000 or greater). Each pair of ion counts from the 10 duplicate wire collectors were averaged before ranking.

Samples 4 and 5 (duplicate wires) and sample 40 were placed off-site to provide background levels. Unfortunately, some materials may be present near where sample 40 was buried, judging from the particularly high ion counts for BTX and PCE in that sample (Appendix G, Table 1). Another complication in the background samples and some of the other samples resulted from terpenes, a naturally occurring hydrocarbon emitted from coniferous plants. Terpenes have similar physiochemical properties as BTX compounds. The collector for background samples 4 and 5 was apparently located near coniferous plants which rendered this sample useless for BTX background levels. Unlike the zero background levels (indicating no detection) for TCA, Freon 11 or 113, and TCE, the background levels for PCE was substantially above zero. PCE is a commonly used industrial solvent and is detected to some extent at nearly all the sites investigated by Petrex. Furthermore, the Petrex analytical equipment is especially sensitive to PCE. The above zero PCE background level at the JPL site may be an artifact of Los Angeles basin smog.

For order-of-magnitude ranking, no background correction was necessary for TCA, freon, or the TCE analyses, and no background correction was possible for the BTX analyses, for the PCE analyses, a background level of 5,000 ion counts were used. Net PCE ion counts between 0 and 5,000 were ranked as negligible, to indicate that some PCE was present but at concentrations at or below the background level. Ranking results are presented in Table 4-5. Results from two collectors had to be dismissed because of breakage during transportation (sample 14) and because of clearly non-representative sampling (sample 29). The latter collector was buried in a flower garden near building 303 in very fine grained, dark colored soil. Petrex analytical results suggest that the soil might contain fuel oil or kerosene.

There were two occurrences of freon ranked at low or above. Freon is extremely diffusive, however, and it is questionable whether the freon concentrations in those two samples are related to past disposal activities.

In Figure 4-5, the soil gas constituents present at ranking levels of low or greater are listed next to the respective sampling location. Those sampling locations delineate the locations in which the major suspected chemical waste disposal pits have been identified from old photographs or from recollections of JPL employees. "Low" concentrations of PCE were detected near the suspected disposal pit near building 299; "low" concentrations of BTX and "moderate" concentrations of PCE were detected near the disposal pit southeast of buildings 300 and 302; and "low" to "moderate" concentrations of BTX, TCA, TCE, PCE, and chloroform were detected near a suspected disposal area between buildings 300, 302, and 303. The presence of "moderate" levels of chloroform is particularly interesting, because the Petrex system is quite insensitive to chloroform. The fact that chloroform was detected at all is unusual. However, the source of the chloroform is questionable considering that trace levels of chloroform was found in the JPL water supply and that the Petrex sampler (numbers 30 and 31) were buried near a water irrigation sprinkler in a flower bed.

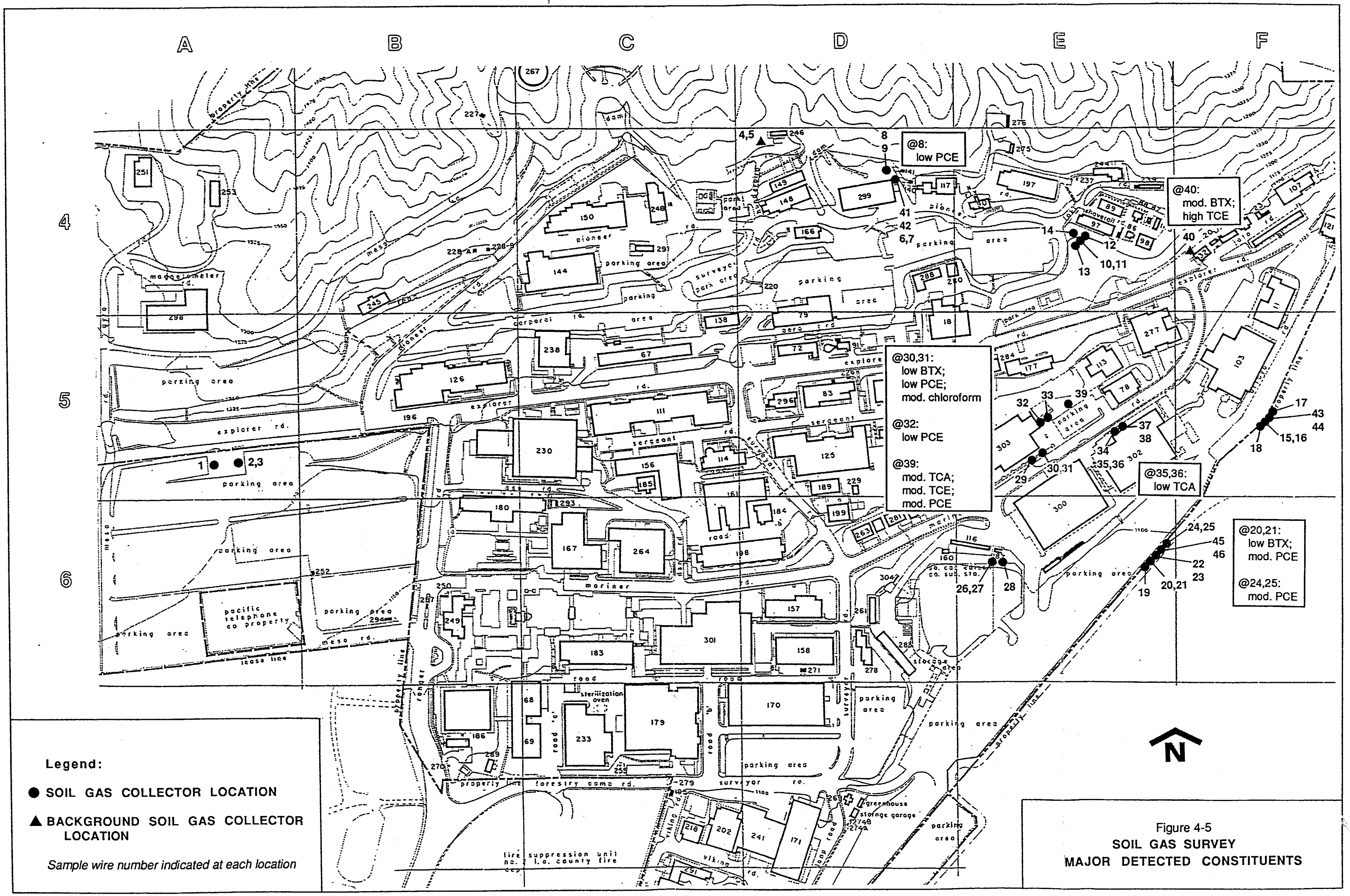

Figure 4-5
SOIL GAS SURVEY
MAJOR DETECTED CONSTITUENTS

TABLE 4-5

Relative Ranking of Soil Gas Survey Constituents

	BTX	TCA	Freon 11 or 113	TCE	PCE	Chloroform
1	I	-	-	-	Negligible	-
2,3	V. Low	V. Low	V. Low	-	Negligible	-
4,5	I	-	-	-	Negligible	-
6,7	V. Low	V. Low	V. Low	-	Negligible	-
8	I	-	-	-	Low	-
9	V. Low	V. Low	V. Low	-	V. Low	-
41*	NA	-	-	-	Negligible	-
42**	NA	-	-	-	V. Low	-
10,11	V. Low	V. Low	-	-	V. Low	-
12	V. Low	V. Low	-	-	Negligible	-
13	V. Low	-	V. Low	-	Negligible	-
15,16	V. Low	V. Low	V. Low	-	V. Low	-
17	I	-	-	-	Negligible	-
18	I	V. Low	-	-	V. Low	-
43*	NA	-	-	-	V. Low	-
44**	NA	-	-	-	Moderate	-
19	V. Low	V. Low	V. Low	-	V. Low	-
20,21	Low	-	Moderate+	-	Moderate	-
22	V. Low	-	V. Low	-	V. Low	-
23	V. Low	-	V. Low	-	V. Low	-
24,25	V. Low	V. Low	V. Low	-	Moderate	-
45	NA	V. Low	-	-	Moderate	-
46	NA	V. Low	Low+	V. Low	Moderate	-
26,27	V. Low	V. Low	-	-	Negligible	-
28	V. Low	V. Low	V. Low	V. Low	V. Low	-
30,31	Low	-	-	-	Low	Moderate
32	V. Low	-	V. Low	-	Low	-
33	V. Low	Low	V. Low	-	Moderate	-
34	V. Low	V. Low	V. Low	V. Low	Negligible	-
35,36	V. Low	Low	-	V. Low	Negligible	-
37	V. Low	V. Low	V. Low	V. Low	Negligible	V. Low
38	V. Low	V. Low	V. Low	-	Negligible	-
39	V. Low	Moderate	V. Low	Moderate	Moderate	-
40	Moderate	-	-	High	V. Low	-

NOTES:

Analyses are grouped according to location at the JPL site.
* = time trial sample.
** = time trial sample.
\+ = probably not real.
I = interference from organic materials emitted from conifers.
Negligible = for PCE only, ion counts (not background corrected) >0 and <=5,000
V. Low = net ion counts >0 and <=5,000
Low = net ion counts >5,000 and <=10,000
Moderate = net ion counts >10,000 and <=50,000
High = net ion counts >50,000
NA = analyte not investigated
"-" = below detection limit
Freon 11 = trichlorofluoromethane
Freon 113 = Trichlorotrifluoroethane

Constituents detected in the soil gas survey do not match well with the constituents detected in the underlying groundwater. It is probably unrealistic, however, to expect that the groundwater contaminants at JPL could migrate to the surface in great enough fluxes to be detected in a soil gas survey. Most of the Petrex case studies concerning groundwater contaminant plumes were conducted in areas where groundwater was significantly shallower than it is at JPL. It is more likely that the constituents detected in the soil gas are located in the near surface vadose zone. Data from the soil gas survey alone are not sufficient to determine whether those constituents represent remnants of wastes that have been flushed to groundwater, or whether those constituents have not yet reached groundwater.

4.4.1 Quality Assurance and Quality Control (QA/QC)

Several different approaches were taken to ensure that results from the soil gas survey are representative. Two sets of time trial test samples were analyzed to determine whether the activated charcoal on the collection wires had become fully equilibrated with the soil gas. Results from the time trial tests (Appendix G) indicated that the wires had reached equilibrium and could safely be removed after 3 weeks. The sample collection tubes, however, were left buried for an additional week to be absolutely certain of equilibration (4 weeks is typically the maximum length of time that Petrex uses for sampling).

Concentrations (in terms of ion counts) in the Ebasco duplicate samples (wire number 22 and 23) compare favorably and show that sampling and analytical precision is within an acceptable range. Petrex used some of the duplicate wires in the 10 duplicate wire collectors for calibration of analytical instruments and the remainder to measure analytical precision. Again, differences in the concentrations in duplicate wires are within acceptable limits. The methodology of determining analytical and sampling precision of the Petrex soil gas wires differs from other analytical methods in that a true duplicate (i.e., a subset or "split" of a sample) cannot be taken. Instead, a separate sample has to be used. Typically, the precision of the Petrex system is about 70%. The 30% variation is attributed mainly to small variations in the mass of activated charcoal attached to the wires. Analytical precision accounts for only about 5% of the variation (pers. Comm. Petrex, Inc., 1990).

Analysis of the 2 travel blanks (wires 47 and 48) showed very low concentrations of BTX compounds and freon 11 or freon 113. As discussed above, some compounds such as freon are very diffusive and ubiquitous in urban environments and consequently are commonly found in trace amounts in the samples and travel blanks. The concentrations present in samples 47 and 48 do not warrant concern.

In summary, all of the tests used to evaluate procedures used during preparation, collection of soil gas, transportation, and chemical analysis indicate a successful soil gas survey.

5.0 HAZARD RANKING SYSTEM SCORE

Following completion of the ESI, a Hazard Ranking System (HRS) score (using the current model) was computed for JPL. The overall HRS migration route score (S_m) is considered the HRS score and is a composite of three separate migration pathway scores; groundwater (S_{gw}), surface water (S_{sw}). The migration route score air (S_a). The migration route score is computed as follows:

$$S_m = \frac{\sqrt{S_{gw} + S_{sw} + S_a}}{1.73}$$

The overall HRS migration route score and the individual migration pathway scores as computed for JPL are summarized as follows:

S_m (weighted overall score)	=	38.3
S_{gw} (groundwater migration route score)	=	65.0
S_{sw} (surface water migration route score	=	7.4
S_a (air migration route score)	=	0

Details of how the overall HRS score and individual pathway scores were computed are presented in Figure 5-2 through 5-5. Figure 5-1 is a cover sheet associated with the HRS.

Data gathered during this ESI and the Preliminary Assessment/Site Inspection (PA/SI) of JPL conducted by Ebasco in 1988 (Ebasco, 1988 a,b) was used to complete the current HRS score. The preliminary HRS score tabulated during the PA/SI process has not been changed after evaluating the data collected during the ESI. What was anticipated during the PA/SI was confirmed during the ESI.

The HRS score of 38.3 is above the 28.5 level for consideration for the National Priorities List (NPL). The score for the groundwater migration route category dominates the final HRS score. Results obtained during the ESI support the conclusion that there has been a release of hazardous materials to the groundwater at JPL.

Facility name: NASA - JET PROPULSION LABORATORY

Location: Pasadena, CA

EPA Region: IX

Person(s) in charge of the facility: Pamela Cooley, Environmental Safety Group
Occupational Safety Office

Name of Reviewer: Ebasco Environmental   Date: April 11, 1990

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

Six seepage pits were used in the past for disposal of chemical wastes, such as solvents, mercury, sulfuric acids, and cooling tower blowdown. Municipal water supply wells, 1,000 ft. downgradient, have been shown to have elevated levels of TCE, PCE, and CCL_4.

Scores: S_M = 38.3 (S_{gw} = 65.9 S_{sw} = 7.4 S_a = 0)

S_{FE} = 15.2

S_{DC} = 16.6

Figure 5-1

HRS COVER SHEET

Ground Water Route Work Sheet					
Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 45	1	45	45	3.1
If observed release is given a score of 45, proceed to line 4. If observed release is given a score of 0, proceed to line 2.					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 3	2		6	
Net Precipitation	0 1 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 2 3	1		3	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	3.3
4 Waste Characteristics					3.4
Toxicity/Persistence	0 3 6 9 12 15 18	1	18	18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1	2	8	
	Total Waste Characteristics Score		20	26	
5 Targets					3.5
Ground Water Use	0 1 2 3	3	2	9	
Distance to Nearest Well/Population Served	0 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	40	40	
	Total Targets Score		42	49	
6 If line 1 is 45, multiply 1 x 4 x 5 45 x 20 x 42 If line 1 is 0, multiply 2 x 3 x 4 x 5			37,800	57,330	
7 Divide line 6 by 57,330 and multiply by 100	S_{gw} = 65.9				

Figure 5-2

GROUND WATER ROUTE WORK SHEET

Surface Water Route Work Sheet					
Rating Factor	**Assigned Value (Circle One)**	**Multi-plier**	**Score**	**Max. Score**	**R (Section)**
1 Observed Release	0 45	1	0	45	4.1
If observed release is given a value of 45, proceed to line 4. If observed release is given a value of 0, proceed to line 2.					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1	3	3	
1-yr. 24-hr. Rainfall	0 1 2 3	1	2	3	
Distance to Nearest Surface Water	0 1 2 3	2	6	6	
Physical State	0 1 2 3	1	3	3	
	Total Route Characteristics Score		14	15	
3 Containment	0 1 2 3	1	3	3	4.3
4 Waste Characteristics					4.4
Toxicity/Persistence	0 3 6 9 12 15 18	1	18	18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1	1	8	
	Total Waste Characteristics Score		19	26	
5 Targets					4.5
Surface Water Use	0 1 2 3	3	6	9	
Distance to a Sensitive Environment	0 1 2 3	2	0	6	
Population Served/Distance to Water Intake Downstream	0 4 6 8 10 12 16 18 20 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
6 If line 1 is 45, multiply 1 x 4 x 5 If line 1 is 0, multiply 2 x 3 x 4 x 5			4,788	64,350	
7 Divide line 6 by 64,350 and multiply by 100	S_{sw} = 7.4				

Figure 5-3

SURFACE WATER ROUTE WORK SHEET

Air Route Work Sheet					
Rating Factor	**Assigned Value (Circle One)**	**Multi-plier**	**Score**	**Max. Score**	**Ref. (Section)**
1 Observed Release	0 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If line 1 is 0, the S_a = 0. Enter on line 5. If line 1 is 45 then proceed to line 2.					
2 Waste Characteristics					5.2
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
	Total Waste Characteristics Score			20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
	Total Targets Score			39	
4 Multiply 1 x 2 x 3				35,100	
5 Divide line 4 by 35,100 and multiply by 100	S_a = 0				

Figure 5-4

AIR ROUTE WORK SHEET

	S	S^2
Groundwater Route Score (S_{gw})	65.9	4,342.8
Surface Water Route Score (S_{sw})	7.4	54.8
Air Route Score (S_a)	0	0
$S_{gw}^2 + S_{sw}^2 + S_a^2$		4,397.6
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		66.3
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		38.3

Figure 5-5

WORKSHEET FOR COMPUTING S_M

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APPENDIX A

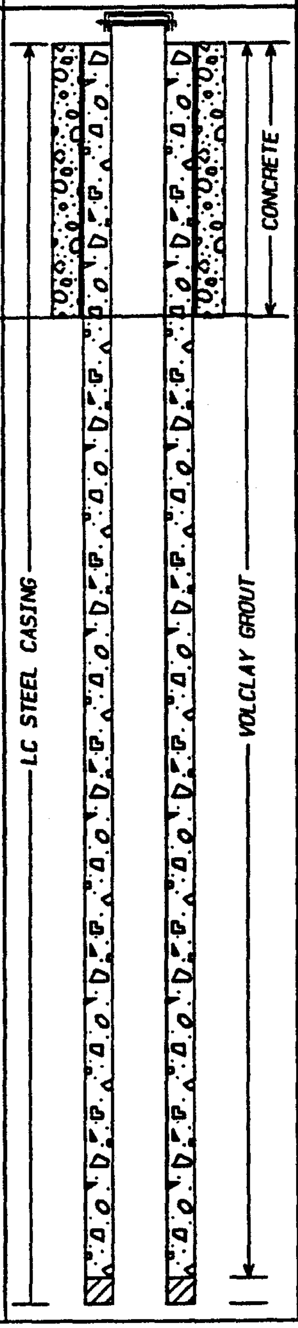
Boring Log and Well Completion Forms

EBASCO ENVIRONMENTAL

WELL NO. MW-3

PROJECT	JPL ESI	DRILL HOLE DIAMETER (in)	15.75/9.875
LOCATION	Pasadena, California	GROUND LEVEL ELEVATION (ft)	1100
GEOLOGIST/ENGINEER	M. Cutler, T. Tomczyk	TOTAL DEPTH OF HOLE (ft)	730
DRILLING COMPANY	Beylik	DEPTH TO WATER (ft)	130.50
DRILLING METHOD	Mud Rotary	DATE (start/finish)	1-11-90 to 1-24-90

WELL/BORING COMPLETION



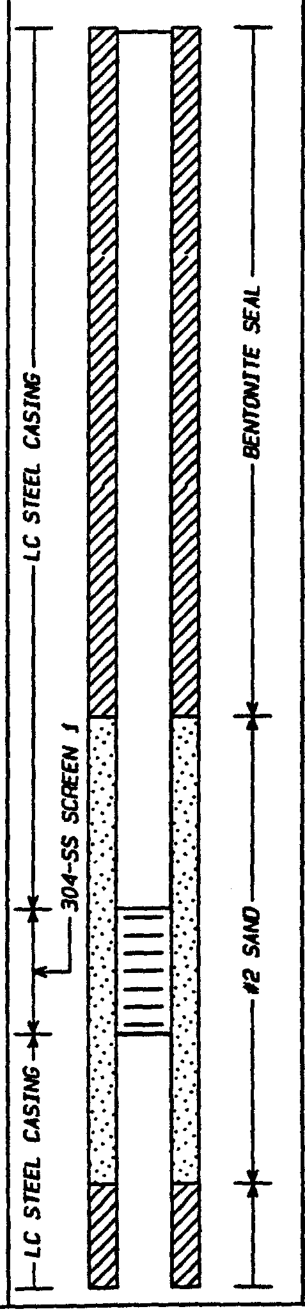
DEPTH (ft)	SAMPLE #	SAMPLES	OVA (ppm)	% LEL	ODOR	MOISTURE	USCS SYMBOL	DESCRIPTION AND NOTES
0			--	--	N	--	SP	SAND, MULTICOLORED medium to very coarse grained with abundant gravel, predominantly quartz and feldspar. BOULDERS granitic, rounded, up to 2 ft in diam.
10			--	--	N	--	SP	SAND, MULTICOLORED medium to very coarse grained with abundant gravel, predominantly quartz and feldspar. BOULDER granitic.
20	3-1	X	0	0	N	--	SP	SAND, MULTICOLORED medium to very coarse grained with abundant gravel, predominantly quartz and feldspar. (drilled 15.75 in. hole to 22 ft.; set conductor pipe; continued drilling with 9.875 in. bit) ("soil-3-1 collected at 9:10 on 1-17-90)
30			0	0	N	--	ML	SAND, MULTICOLORED medium to very coarse grained with scattered gravel predominantly quartz and feldspar.
40			0	0	N	--	SP / SP	SAND, SILTY, LIGHT BROWN moderate amount of very fine grained sand and scattered gravel.
50			0	0	N	--	SP	SAND, MULTI-COLORED medium to very coarse grained with some gravel, predominantly quartz and feldspar, occasional granitic cobbles. BOULDER
60			0	0	N	--	SP	SAND, MULTI-COLORED medium to coarse grained with some gravel, subangular to subrounded, few thin lenses of clayey silt.
70			0	0	N	--	SP	SAND, MULTI-COLORED fine to very coarse grained with abundant gravel, subangular, poorly sorted.
80			0	0	N	--	SP	SAND, MULTI-COLORED fine to very coarse grained with few granitic cobbles or boulders.
90	3-2	X	0	0	N	--	SP	BOULDERS SAND, MULTI-COLORED medium to coarse grained, with abundant gravel, predominantly quartz and feldspar. ("soil-3-2" collected at 12:35 on 1-17-90)
100								

EBASCO ENVIRONMENTAL

WELL NO. MW-3

PROJECT	JPL ESI	DRILL HOLE DIAMETER (in)	15.75/9.875
LOCATION	Pasadena, California	GROUND LEVEL ELEVATION (ft)	1100
GEOLOGIST/ENGINEER	M. Cutler, T. Tomczyk	TOTAL DEPTH OF HOLE (ft)	730
DRILLING COMPANY	Bevlik	DEPTH TO WATER (ft)	130.50
DRILLING METHOD	Mud Rotary	DATE (start/finish)	1-11-90 to 1-24-90

WELL/BORING COMPLETION



DEPTH (ft)	SAMPLE #	SAMPLES	OVA (ppm)	% LEL	ODOR	MOISTURE	USCS SYMBOL	DESCRIPTION AND NOTES
100			0	0	N	--	SP	SAND, MULTI-COLORED medium to coarse grained with trace gravel.
110			0	0	N	--	CL	SAND, MULTI-COLORED medium to coarse grained with trace gravel.
							SP CL	SILT, CLAYEY, LIGHT BROWN BOULDER
120			0	0	N	--	SP ML	SAND, MULTI-COLORED medium to coarse grained with common light brown clayey silt to sandy silt (~25%).
130			0	0	N	--	SC	SAND, BROWN medium to coarse grained with abundant brown clayey to sandy silt, percentage of silt increasing (~50%). (hole angle: 0.125 degrees)
140			0	0	N	--	SC	SAND, CLAYEY, BROWN very fine to coarse grained, large amount of clay and very fine sand matrix (~70%), occasional granite boulder.
150			0	0	N	--	SC	SAND, CLAYEY, BROWN very fine to medium grained, large amount of clay and very fine sand matrix, occasional gravel and coarse sand.
160			0	0	N	--	SC	SAND, CLAYEY, BROWN very fine to coarse grained, trace gravel, becoming coarser grained, silt and clay matrix.
170			0	0	N	--	SC	BOULDER SAND, CLAYEY, BROWN fine to coarse grained, occasional very coarse sand and gravel, silt and clay matrix.
180			0	0	N	--	SC	SAND, CLAYEY, BROWN fine to coarse grained, trace gravel, clay and very fine sand matrix (~20%)
190	3-3	X	0	0	N	--	SC	SAND, CLAYEY, BROWN-MULTI-COLORED fine to coarse grained, clay and silt matrix (~15%) ("soil-3-3" collected at 13:00 on 1-18-90)
200								

EBASCO ENVIRONMENTAL

WELL NO. MW-3

PROJECT	JPL ESI	DRILL HOLE DIAMETER (in)	15.75/9.875
LOCATION	Pasadena, California	GROUND LEVEL ELEVATION (ft)	1100
GEOLOGIST/ENGINEER	M. Cutler, T. Tomczyk	TOTAL DEPTH OF HOLE (ft)	730
DRILLING COMPANY	Beylik	DEPTH TO WATER (ft)	130.50
DRILLING METHOD	Mud Rotary	DATE (start/finish)	1-11-90 to 1-24-90

WELL/BORING COMPLETION: 200–300 ft LC STEEL CASING; 250–260 ft 304-SS SCREEN 2; 200–223 ft BENTONITE SEAL; 223–270 ft #2 SAND; 270–300 ft BENTONITE SEAL.

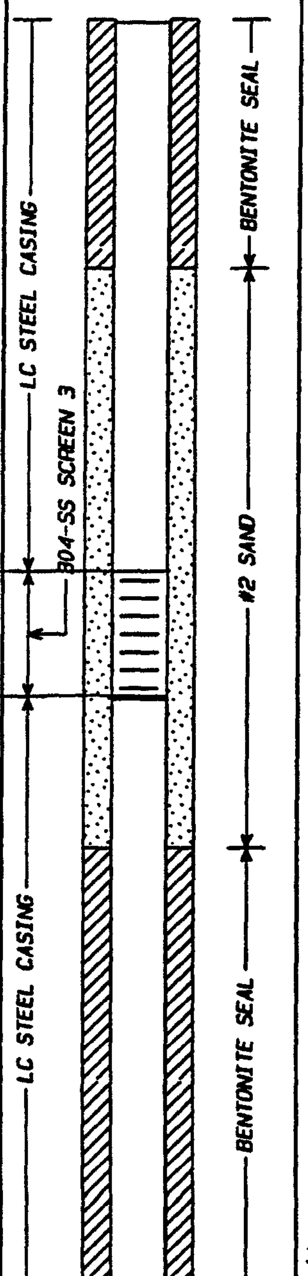
DEPTH (ft)	SAMPLE #	SAMPLES	OVA (ppm)	% LEL	ODOR	MOISTURE	USCS SYMBOL	DESCRIPTION AND NOTES
200			0	0	N	--	SC	SAND, CLAYEY, BROWN very fine to coarse grained, clay and silt matrix (~35%).
210			0	0	N	--	SC	SAND, CLAYEY, BROWN-MULTI-COLORED fine to medium grained, occasional gravel and coarse sand. BOULDER
220			0	0	N	--	SC	SAND, CLAYEY, BROWN very fine to coarse grained, abundant clay and silt matrix (~50%), occasional gravel.
230			0	0	N	--	SC	SAND, CLAYEY, BROWN very fine to coarse grained, clay and silt matrix (~40%).
240			0	0	N	--	SC	SAND, CLAYEY, BROWN very fine to medium grained, cuttings mostly clay and silt (~70%).
250			0	0	N	--	SC	SAND, CLAYEY, BROWN very fine to coarse grained, trace gravel, very abundant clay and silt matrix (~75%). (hole angle: 1 degree)
260			0	0	N	--	SC	SAND, CLAYEY, BROWN very fine to coarse grained, trace gravel, very abundant clay and silt matrix (~65%).
270			0	0	N	--	SC	SAND, CLAYEY, BROWN very fine grained to coarse grained, abundant clayey silt matrix, some silty clay present.
280			0	0	N	--	SC	SAND, CLAYEY, BROWN very fine to medium grained, abundant clay and silt matrix, occasional coarse sand and gravel.
290	3-4	X	0	0	N	--	SC	SAND, CLAYEY, BROWN very fine to medium grained, abundant clay and silt matrix, occasional coarse sand and gravel. ("soil-3-4" collected at 8:35 on 1-19-90)
300								

EBASCO ENVIRONMENTAL

WELL NO. MW-3

PROJECT	JPL ESI	DRILL HOLE DIAMETER (in)	15.75/9.875
LOCATION	Pasadena, California	GROUND LEVEL ELEVATION (ft)	1100
GEOLOGIST/ENGINEER	M. Cutler, T. Tomczyk	TOTAL DEPTH OF HOLE (ft)	730
DRILLING COMPANY	Beylik	DEPTH TO WATER (ft)	130.50
DRILLING METHOD	Mud Rotary	DATE (start/finish)	1-11-90 to 1-24-90

WELL/BORING COMPLETION



DEPTH (ft)	SAMPLE #	SAMPLES	OVA (ppm)	% LEL	ODOR	MOISTURE	USCS SYMBOL	DESCRIPTION AND NOTES
300			0	0	N	--	SC	SAND, CLAYEY, BROWN fine to coarse grained, common silt and clay matrix (~45%), occasional boulders.
310			0	0	N	--	SC	SAND, CLAYEY, BROWN fine to coarse grained, common silt and clay matrix (~45%), occasional boulders.
320			0	0	N	--	SC	SAND, CLAYEY, BROWN fine to coarse grained, common silt and clay matrix (~45%), occasional boulders and gravel.
330			0	0	N	--	SC	SAND, CLAYEY, BROWN very fine to coarse grained sand with silty clay matrix (~45%).
340			0	0	N	--	SC	SAND, CLAYEY, BROWN very fine to coarse grained sand with silty clay matrix (~45%).
350			0	0	N	--	SC	SAND, CLAYEY, BROWN very fine to coarse grained sand with silty clay matrix (~45%), occasional gravel. BOULDER
360			0	0	N	--	SP	SAND, CLAYEY, BROWN fine to coarse grained with silty clay matrix (~55%), occasional very coarse and and gravel.
370			0	0	N	--	SC	SAND, MULTI-COLORED medium to very coarse grained, minor amounts or brown silty clay, predominantly quartz and feldspar.
380			0	0	N	--	SP	SAND, CLAYEY, BROWN fine to very coarse grained sand with silty clay matrix (~50%), trace gravel.
390	3-5	X	0	0	N	--	SC	SAND, MULTI-COLORED medium to very coarse grained, minor brown silty clay, occasional gravel. ("soil-3-5" collected at 12:30 on 1-19-90)
400								

EBASCO ENVIRONMENTAL

WELL NO. MW-3

PROJECT: JPL ESI
LOCATION: Pasadena, California
GEOLOGIST/ENGINEER: M. Cutler, T. Tomczyk
DRILLING COMPANY: Beylik
DRILLING METHOD: Mud Rotary

DRILL HOLE DIAMETER (in): 15.75/9.875
GROUND LEVEL ELEVATION (ft): 1100
TOTAL DEPTH OF HOLE (ft): 730
DEPTH TO WATER (ft): 130.50
DATE (start/finish): 1-11-90 to 1-24-90

WELL/BORING COMPLETION: LC STEEL CASING; BENTONITE SEAL

DEPTH (ft)	SAMPLE #	SAMPLES	OVA (ppm)	% LEL	ODOR	MOISTURE	USCS SYMBOL	DESCRIPTION AND NOTES
400			0	0	N	--	SC	SAND, CLAYEY, BROWN fine to coarse grained sand with silty clay matrix (~35%). (hole angle: 0.75 degrees)
410			0	0	N	--	SC	SAND, CLAYEY, BROWN fine to coarse grained sand with silty clay matrix (~35%). BOULDER
420			0	0	N	--	SC	SAND, CLAYEY, BROWN fine to coarse grained sand with silty clay matrix (~30%), becoming coarser grained.
430			0	0	N	--	SP	SAND, CLAYEY, BROWN fine to coarse grained sand with silty clay matrix (~30%), becoming coarser grained.
440			0	0	N	--	SP	SAND, MULTI-COLORED medium to coarse grained, trace silty clay, occasional gravel. BOULDER
450			0	0	N	--	SP	SAND, MULTI-COLORED medium to coarse grained, trace silty clay, occasional gravel. BOULDERS
460			0	0	N	--	SC	SAND, MULTI-COLORED medium to coarse grained, some silty clay (~15%) occasional boulders.
470			0	0	N	--	SC	SAND, CLAYEY, BROWN fine to very coarse grained with silty clay (~25%), occasional gravel. BOULDER
480			0	0	N	--	SC	SAND, CLAYEY, BROWN fine to very coarse grained with silty clay matrix more predominant (~60%). BOULDER
490	3-6	X	0	0	N	--	SP	SAND, CLAYEY, BROWN fine to very coarse grained with silty clay matrix more predominant (~60%). ("soil-3-6" collected at 10:00 on 1-20-90)
500								

EBASCO ENVIRONMENTAL

WELL NO. MW-3

PROJECT JPL ESI
LOCATION Pasadena, California
GEOLOGIST/ENGINEER M. Cutler, T. Tomczyk
DRILLING COMPANY Beylik
DRILLING METHOD Mud Rotary

DRILL HOLE DIAMETER (in) 15.75/9.875
GROUND LEVEL ELEVATION (ft) 1100
TOTAL DEPTH OF HOLE (ft) 730
DEPTH TO WATER (ft) 130.50
DATE (start/finish) 1-11-90 to 1-24-90

DEPTH (ft)	WELL/BORING COMPLETION	SAMPLE #	SAMPLES	OVA (ppm)	% LEL	ODOR	MOISTURE	USCS SYMBOL	DESCRIPTION AND NOTES
500	LC STEEL CASING; BENTONITE SEAL			0	0	N	--	SC	SAND, MULTI-COLORED trace brown silty clay, trace gravel.
510				0	0	N	--	SC	SAND, CLAYEY, BROWN medium to coarse grained, silty clay matrix (~60%) BOULDERS
520				0	0	N	--	SC	SAND, CLAYEY, BROWN fine to coarse grained, silty clay matrix (~25%).
530				0	0	N	--	ML	SAND, CLAYEY, BROWN fine to coarse grained, silty clay matrix (~50%). (hole angle: 1.125 degrees)
540	304-SS SCREEN 4; #2 SAND			0	0	N	--	ML	SILT, CLAYEY, BROWN silty clay, occasional to common medium to coarse sand present (~10-15%), rare gravel.
550				0	0	N	--	SC	SILT, CLAYEY, BROWN silty clay, occasional to common medium to coarse sand present (~15%), rare gravel.
560				0	0	N	--	SP	SAND, CLAYEY, MULTI-COLORED medium to coarse grained, silty clay present (~40%).
570	LC STEEL CASING			0	0	N	--	SP	SAND, MULTI-COLORED medium to coarse grained, predominantly quartz and feldspar, minor silty clay present (~15%). BOULDERS
580	BENTONITE SEAL			0	0	N	--	SC	SAND, MULTI-COLORED medium to coarse grained, predominantly quartz and feldspar, silty clay increases to (~20%).
590		3-7	X	0	0	N	--	SC	SAND, CLAYEY, MULTI-COLORED medium to coarse grained, silty clay matrix (~40%). ("soil-3-7" collected at 11:35 on 1-22-90)
600									

EBASCO ENVIRONMENTAL

WELL NO. MW-3

PROJECT	JPL ESI	DRILL HOLE DIAMETER (in)	15.75/9.875
LOCATION	Pasadena, California	GROUND LEVEL ELEVATION (ft)	1100
GEOLOGIST/ENGINEER	M. Cutler, T. Tomczyk	TOTAL DEPTH OF HOLE (ft)	730
DRILLING COMPANY	Beylik	DEPTH TO WATER (ft)	130.50
DRILLING METHOD	Mud Rotary	DATE (start/finish)	1-11-90 to 1-24-90

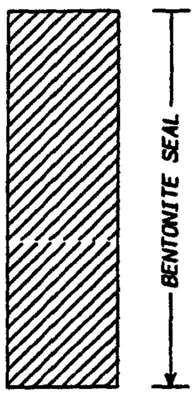
DEPTH (ft)	WELL/BORING COMPLETION	SAMPLE #	SAMPLES	OVA (ppm)	% LEL	ODOR	MOISTURE	USCS SYMBOL	DESCRIPTION AND NOTES
600	LC STEEL CASING; BENTONITE SEAL			0	0	N	--	SP	SAND, CLAYEY, MULTI-COLORED medium to coarse grained, silty clay matrix (~30%).
610	LC STEEL CASING; BENTONITE SEAL			0	0	N	--	SP	SAND, MULTI-COLORED medium to coarse grained, silty clay matrix (~15%).
620	LC STEEL CASING; #2 SAND			0	0	N	--	SC	SAND, MULTI-COLORED medium to coarse grained, silty clay matrix (~15%).
630	LC STEEL CASING; #2 SAND			0	0	N	--	SC	SAND, CLAYEY, LIGHT BROWN hard, medium to coarse grained, silty clay matrix (~60%). BOULDER
640	LC STEEL CASING; #2 SAND			0	0	N	--	SC	SAND, CLAYEY, LIGHT BROWN hard, medium to coarse grained, silty clay matrix (~60%), common boulders. CLAY, SILTY, BROWN
650	304-SS SCREEN 5; #2 SAND			0	0	N	--	SC	SAND, CLAYEY, BROWN hard, fine to coarse grained sand with silty clay matrix (~60%), some decomposed granite (~3-5%).
660	LC STEEL CASING; #2 SAND			0	0	N	--	SC	SAND, CLAYEY, BROWN hard, fine to coarse grained sand with silty clay matrix (~70%), common boulders.
670	LC STEEL CASING; #2 SAND			0	0	N	--	SC	SAND, CLAYEY, BROWN hard, fine to coarse grained sand with silty clay matrix (~60%), common boulders. (hole angle: 1.5 degrees)
680	LC STEEL CASING; BENTONITE SEAL			0	0	N	--	ML	SAND, CLAYEY, BROWN fine to coarse grained sand with abundant silty clay matrix (~75%).
690	LC STEEL CASING; BENTONITE SEAL	3-8	X	0	0	N	--	ML	CLAY, SILTY, BROWN some medium to coarse grained sand (~15%). ("soil-3-8" collected at 7:30 on 1-24-90)
700									

EBASCO ENVIRONMENTAL

WELL NO. MW-3

PROJECT JPL ESI
LOCATION Pasadena, California
GEOLOGIST/ENGINEER M. Cutler, T. Tomczyk
DRILLING COMPANY Beylik
DRILLING METHOD Mud Rotary

DRILL HOLE DIAMETER (in) 15.75/9.875
GROUND LEVEL ELEVATION (ft) 1100
TOTAL DEPTH OF HOLE (ft) 730
DEPTH TO WATER (ft) 130.50
DATE (start/finish) 1-11-90 to 1-24-90



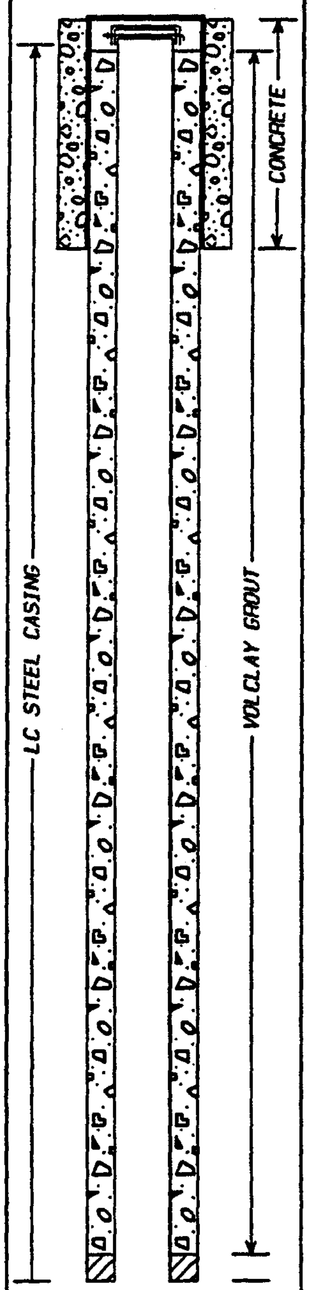
DEPTH (ft)	WELL/BORING COMPLETION	SAMPLE #	SAMPLES	OVA (ppm)	% LEL	ODOR	MOISTURE	SYMBOLS	USCS SYMBOL	DESCRIPTION AND NOTES
700	BENTONITE SEAL			0	0	N	--		ML	CLAY, SILTY, BROWN some medium to coarse grained sand (~20%), common boulders.
710				0	0	N	--		ML	CLAY, SILTY, GREY some medium to coarse grained sand (~15%).
720				0	0	N	--		ML	CLAY, SILTY, GREY some medium to coarse grained sand (~15%).
									GR	GRANITE, LIGHT BLUE hard, predominantly quartz, feldspar and mafics (40%). (granitic basement encountered at 724 ft.)
730										

EBASCO ENVIRONMENTAL

WELL NO. MW-4

PROJECT	JPL ESI	DRILL HOLE DIAMETER (in)	18.5/12.25
LOCATION	Pasadena, California	GROUND LEVEL ELEVATION (ft)	1083
GEOLOGIST/ENGINEER	M. Cutler, M. Barnes	TOTAL DEPTH OF HOLE (ft)	605
DRILLING COMPANY	Beylik	DEPTH TO WATER (ft)	108.6
DRILLING METHOD	Mud Rotary	DATE (start/finish)	1-31-90 to 2-6-90

WELL/BORING COMPLETION



DEPTH (ft)	SAMPLE #	OVA (ppm)	% LEL	ODOR	MOISTURE	USCS SYMBOL	DESCRIPTION AND NOTES
0		--	0	N	--	SP	SAND, OLIVE-BROWN coarse-medium grain, angular-subangular, poorly sorted, loose, occasional gravel. BOULDER
10		--	0	N	--	SP	SAND, OLIVE-BROWN coarse-medium grain, angular-subangular, poorly sorted, loose, occasional gravel. BOULDERS (drilled to 18.5 ft. with 18.5 in. bit; set conductor pipe; continued drilling with 12.25 in. bit)
20	4-1	0	0	N	--	SP	SAND, OLIVE-BROWN coarse-medium grain, angular-subangular, poorly sorted, loose, occasional gravel. BOULDERS ("soil-4-1" collected at 14:15 on 2-1-90)
30		0	0	N	--	SP	SAND, MULTICOLORED coarse grain, angular-subangular, poorly sorted, abundant boulder fragments. BOULDERS
40		0	0	N	--	SP	SAND, MULTICOLORED coarse grain, subangular-angular, poorly sorted, loose, abundant gravel.
50		0	0	N	--	SP	SAND, MULTICOLORED medium-coarse grain, angular-subangular, poorly sorted, abundant gravel.
60		0	0	N	--	SP	SAND, MULTICOLORED medium-coarse grain, angular-subangular, poorly sorted, occasional gravel.
70		0	0	N	--	SP	SAND, MULTICOLORED medium-coarse grain, angular-subangular, poorly sorted, occasional gravel, abundant rock fragments (schist).
80		0	0	N	--	SP	SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, occasional gravel.
90	4-2	0	0	N	--	SP	SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, occasional rock fragments. ("soil-4-2" collected on 2-2-90)
100							

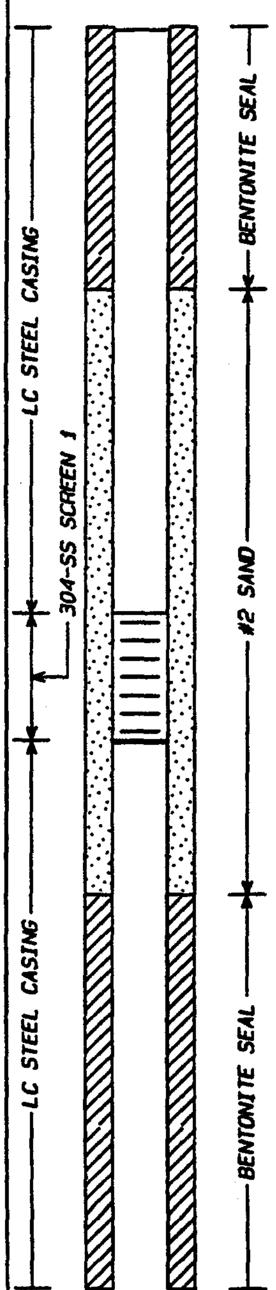
EBASCO ENVIRONMENTAL

WELL NO. MW-4

PROJECT: JPL ESI
LOCATION: Pasadena, California
GEOLOGIST/ENGINEER: M. Cutler, M. Barnes
DRILLING COMPANY: Beylik
DRILLING METHOD: Mud Rotary

DRILL HOLE DIAMETER (in): 18.5/12.25
GROUND LEVEL ELEVATION (ft): 1083
TOTAL DEPTH OF HOLE (ft): 605
DEPTH TO WATER (ft): 108.6
DATE (start/finish): 1-31-90 to 2-6-90

WELL/BORING COMPLETION



DEPTH (ft)	SAMPLE #	SAMPLES	OVA (ppm)	% LEL	ODOR	MOISTURE	USCS SYMBOL	DESCRIPTION AND NOTES
100			0	0	N	--	SP	SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, occasional gravel.
110			0	0	N	--	SP	SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, some rock fragments.
120			0	0	N	--	SP	SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose, occasional rock fragments.
130			0	0	N	--	SP	SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose.
140			0	0	N	--	SP	SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose. BOULDER
150			0	0	N	--	SP	SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose, occasional boulder fragments.
160			0	0	N	--	SP	SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose.
170			0	0	N	--	SP / CL	SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose. CLAY, BROWN
180			0	0	N	--	SP / CL	SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose. CLAY, SANDY, BROWN
190	4-3	X	0	0	N	--	SP	SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose. ("soil-4-3" collected on 2-2-90)
200								

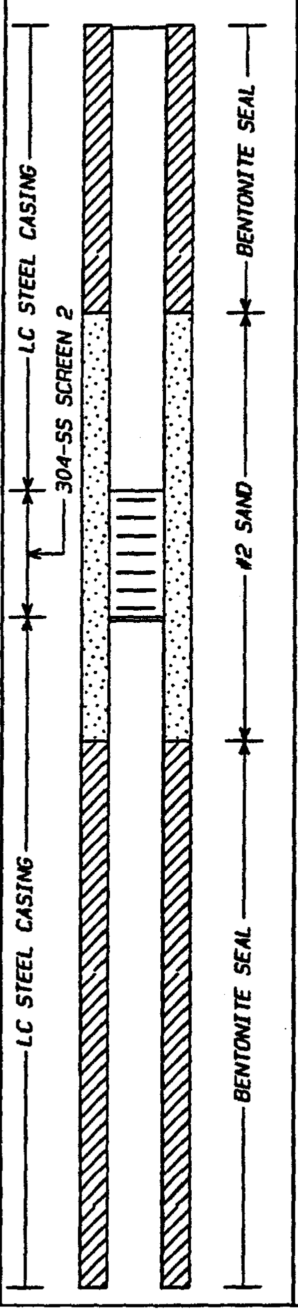
EBASCO ENVIRONMENTAL

WELL NO. MW-4

PROJECT: *JPL ESI*
LOCATION: *Pasadena, California*
GEOLOGIST/ENGINEER: *M. Cutler, M. Barnes*
DRILLING COMPANY: *Beylik*
DRILLING METHOD: *Mud Rotary*

DRILL HOLE DIAMETER (in): *18.5/12.25*
GROUND LEVEL ELEVATION (ft): *1083*
TOTAL DEPTH OF HOLE (ft): *605*
DEPTH TO WATER (ft): *108.6*
DATE (start/finish): *1-31-90 to 2-6-90*

WELL/BORING COMPLETION



DEPTH (ft)	SAMPLE #	SAMPLES	OVA (ppm)	% LEL	ODOR	MOISTURE	USCS SYMBOL	DESCRIPTION AND NOTES
200–210			0	0	N	--	SP	SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose. BOULDER
210–220			0	0	N	--	SP	SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose, occasional granite fragments.
220–230			0	0	N	--	SP	SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose, some rock fragments (metamorphic).
230–240			0	0	N	--	SP	SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose, some rock fragments (metamorphic).
240–250			0	0	N	--	SP	SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose, occasional rock fragments.
250–260			0	0	N	--	SP	SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose.
260–270			0	0	N	--	SP	SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose.
270–280			0	0	N	--	SP	SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose, occasional rock fragments.
280–290			0	0	N	--	SP	SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose, occasional rock fragments.
290–300	4-4	X	0	0	N	--	SP / CL	SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose, occasional rock fragments. CLAY, SILTY, BROWN ("soil-4-4" collected on 2-2-90)

EBASCO ENVIRONMENTAL

WELL NO. MW-4

PROJECT	JPL ESI	DRILL HOLE DIAMETER (in)	18.5/12.25
LOCATION	Pasadena, California	GROUND LEVEL ELEVATION (ft)	1083
GEOLOGIST/ENGINEER	M. Cutler, M. Barnes	TOTAL DEPTH OF HOLE (ft)	605
DRILLING COMPANY	Beylik	DEPTH TO WATER (ft)	108.6
DRILLING METHOD	Mud Rotary	DATE (start/finish)	1-31-90 to 2-6-90

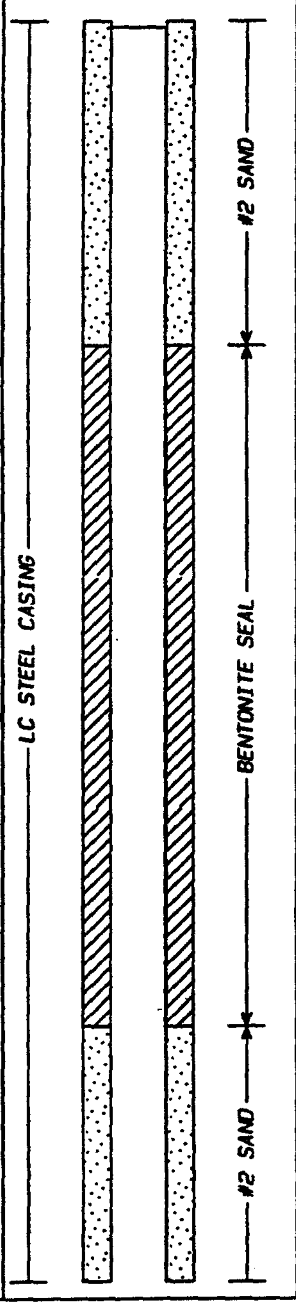
DEPTH (ft)	WELL/BORING COMPLETION	SAMPLE #	SAMPLES	OVA (ppm)	% LEL	ODOR	MOISTURE	USCS SYMBOL	DESCRIPTION AND NOTES
300	LC STEEL CASING			0	0	N	--	CL	CLAY, SILTY, OLIVE-BROWN SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose.
310	304-SS SCREEN 3; #2 SAND			0	0	N	--	SP / CL	SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose. CLAY, SILTY, OLIVE-BROWN
320	#2 SAND			0	0	N	--	SP	SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose. BOULDER
330				0	0	N	--	SP / CL	CLAY, SILTY, OLIVE-BROWN SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose.
340				0	0	N	--	SP / CL	SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose. CLAY, SILTY, OLIVE-BROWN
350	LC STEEL CASING; BENTONITE SEAL			0	0	N	--	SP / CL	CLAY, SILTY, OLIVE-BROWN SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose.
360				0	0	N	--	SP / CL	CLAY, SILTY, OLIVE-BROWN SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose.
370				0	0	N	--	SP / CL	CLAY, SILTY, OLIVE-BROWN SAND, MULTICOLORED medium to coarse grain, angular-subangular, poorly sorted, loose.
380	304-SS SCREEN 4; #2 SAND			0	0	N	--	SP / ML	SILT, CLAYEY, OLIVE-BROWN SAND, MULTICOLORED coarse to medium grain, angular-subangular, poorly sorted, loose.
390		4-5	X	0	0	N	--	SP / ML	SILT, CLAYEY, OLIVE-BROWN SAND, MULTICOLORED coarse to medium grain, angular-subangular, poorly sorted, loose. ("soil-4-5" collected at 11:40 on 2-5-90)
400									

EBASCO ENVIRONMENTAL

WELL NO. MW-4

PROJECT	JPL ESI	DRILL HOLE DIAMETER (in)	18.5/12.25
LOCATION	Pasadena, California	GROUND LEVEL ELEVATION (ft)	1083
GEOLOGIST/ENGINEER	M. Cutler, M. Barnes	TOTAL DEPTH OF HOLE (ft)	605
DRILLING COMPANY	Beylik	DEPTH TO WATER (ft)	108.6
DRILLING METHOD	Mud Rotary	DATE (start/finish)	1-31-90 to 2-6-90

WELL/BORING COMPLETION



DEPTH (ft)	SAMPLE #	SAMPLES	OVA (ppm)	% LEL	ODOR	MOISTURE	USCS SYMBOL	DESCRIPTION AND NOTES
400			0	0	N	--	SP / ML	SILT, CLAYEY, OLIVE-BROWN SAND, MULTICOLORED medium to coarse grain, subangular-angular, poorly sorted, loose.
410			0	0	N	--	SP / ML	SILT, CLAYEY, OLIVE-BROWN SAND, MULTICOLORED medium to coarse grain, subangular-angular, poorly sorted, loose.
420			0	0	N	--	SP / ML	SILT, CLAYEY, OLIVE-BROWN SAND, MULTICOLORED medium to coarse grain, subangular-angular, poorly sorted, loose (possibly recirculated material).
430			0	0	N	--	SP / ML	SILT, CLAYEY, OLIVE-BROWN SAND, MULTICOLORED medium to coarse grain, subangular-angular, poorly sorted, loose (possibly recirculated material).
440			0	0	N	--	SP / ML	SILT, CLAYEY, OLIVE-BROWN SAND, MULTICOLORED medium to coarse grain, subangular-angular, poorly sorted, loose (possibly recirculated material).
450			0	0	N	--	SP / ML	SILT, CLAYEY, OLIVE-BROWN SAND, MULTICOLORED medium to coarse grain, subangular-angular, poorly sorted, loose.
460			0	0	N	--	SP / ML	SILT, CLAYEY, OLIVE-BROWN SAND, MULTICOLORED medium to coarse grain, subangular-angular, poorly sorted, loose. BOULDER
470			0	0	N	--	SP / ML	SILT, CLAYEY, OLIVE-BROWN SAND, MULTICOLORED medium to coarse grain, subangular-angular, poorly sorted, loose.
480			0	0	N	--	SP / ML	SILT, CLAYEY, OLIVE-BROWN SAND, MULTICOLORED medium to coarse grain, subangular-angular, poorly sorted.
490	4-6	X	0	0	N	--	SP / ML	SAND, MULTICOLORED medium to coarse grain, subangular-angular, poorly sorted. SILT, CLAYEY, OLIVE-BROWN ("soil-4-6" collected at 15:30 on 2-5-90)
500								

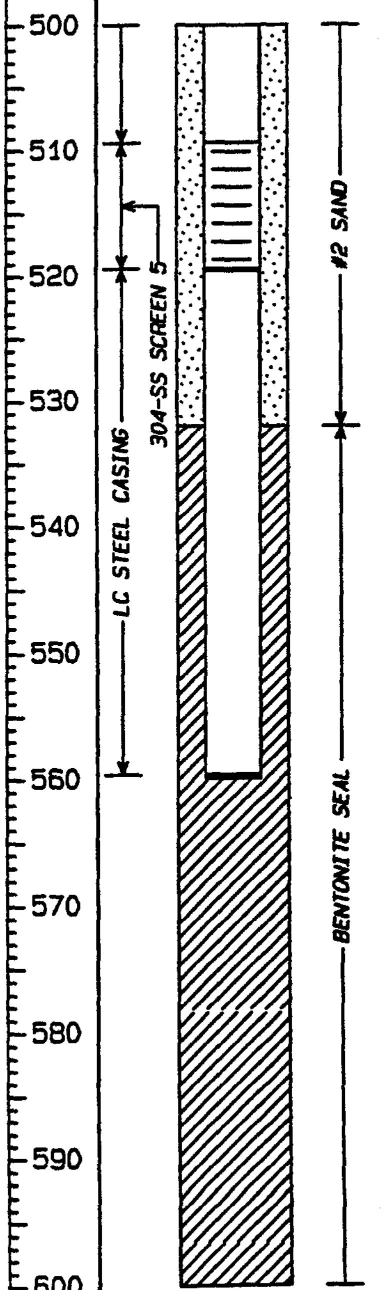
EBASCO ENVIRONMENTAL

WELL NO. MW-4

PROJECT JPL ESI
LOCATION Pasadena, California
GEOLOGIST/ENGINEER M. Cutler, M. Barnes
DRILLING COMPANY Beylik
DRILLING METHOD Mud Rotary

DRILL HOLE DIAMETER (in) 18.5/12.25
GROUND LEVEL ELEVATION (ft) 1083
TOTAL DEPTH OF HOLE (ft) 605
DEPTH TO WATER (ft) 108.6
DATE (start/finish) 1-31-90 to 2-6-90

WELL/BORING COMPLETION



DEPTH (ft)	SAMPLE #	SAMPLES	OVA (ppm)	% LEL	ODOR	MOISTURE	USCS SYMBOL	DESCRIPTION AND NOTES
500			0	0	N	--	SP ML	SILT, CLAYEY, OLIVE-BROWN SAND, MULTICOLORED medium to coarse grain, subangular-angular, poorly sorted.
510			0	0	N	--	SP ML	SILT, CLAYEY, OLIVE-BROWN SAND, MULTICOLORED medium to coarse grain, subangular-angular, poorly sorted. BOULDER
520			0	0	N	--	SP CL	SILT, CLAYEY, OLIVE-BROWN CLAY, SILTY, OLIVE-BROWN SAND, MULTICOLORED medium to coarse grain, subangular-angular, poorly sorted.
530			0	0	N	--	SP CL	SILT, CLAYEY, OLIVE-BROWN CLAY, SILTY, OLIVE-BROWN SAND, MULTICOLORED medium to coarse grain, subangular-angular, poorly sorted. BOULDER
540			0	0	N	--	SP CL	CLAY, SILTY, OLIVE-BROWN SILT, CLAYEY, OLIVE-BROWN
550			0	0	N	--	SP CL GR CL	CLAY, SILTY, OLIVE-BROWN GRANITIC ROCK, LIGHT BUFF hard, 7% mafics. (granitic basement rock encountered at 556 ft.)
560			0	0	N	--	GR CL	GRANITIC ROCK, LIGHT BUFF 7% mafics.
570			0	0	N	--	GR ML	SILT, CLAYEY, OLIVE-BROWN GRANITIC ROCK, LIGHT BUFF hard, 7% mafics.
580			0	0	N	--	GR ML	SILT, CLAYEY, GRAY-GREEN CLAY, SILTY, OLIVE-BROWN GRANITIC ROCK, LIGHT BUFF hard, 7% mafics.
590	4-7	X	0	0	N	--	GR	GRANITIC ROCK, LIGHT BUFF hard, 7% mafics. ("soil-4-7" collected on 2-6-90)
600								

EBASCO ENVIRONMENTAL

WELL NO. MW-4

PROJECT JPL ESI	DRILL HOLE DIAMETER (in) 18.5/12.25
LOCATION Pasadena, California	GROUND LEVEL ELEVATION (ft) 1083
GEOLOGIST/ENGINEER M. Cutler, M. Barnes	TOTAL DEPTH OF HOLE (ft) 605
DRILLING COMPANY Beylik	DEPTH TO WATER (ft) 108.6
DRILLING METHOD Mud Rotary	DATE (start/finish) 1-31-90 to 2-6-90

DEPTH (ft)	WELL/BORING COMPLETION	SAMPLE #	SAMPLES	OVA (ppm)	% LEL	ODOR	MOISTURE	SYMBOLS	USCS SYMBOL	DESCRIPTION AND NOTES
600				0	0	N	--		GR	GRANITIC ROCK, LIGHT BUFF hard, 7% mafics.

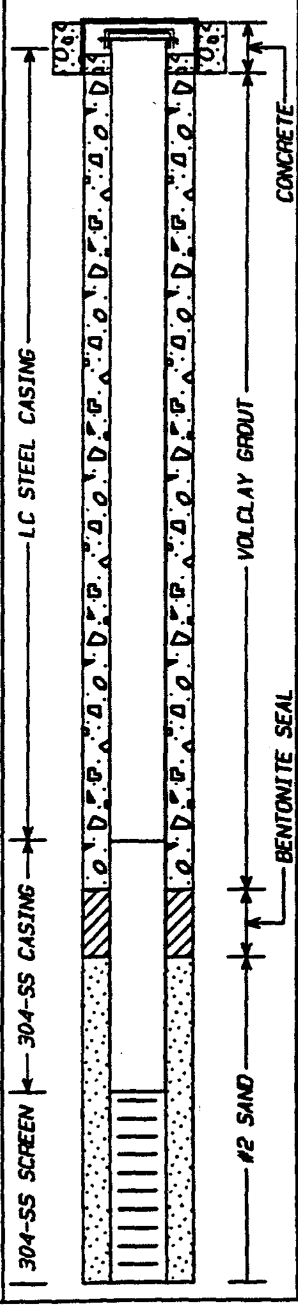
EBASCO ENVIRONMENTAL

WELL NO. MW-5

PROJECT: *JPL ESI*
LOCATION: *Pasadena, California*
GEOLOGIST/ENGINEER: *M. Cutler, M. Barnes*
DRILLING COMPANY: *Bevlik*
DRILLING METHOD: *Percussion Hammer*

DRILL HOLE DIAMETER (in): *11*
GROUND LEVEL ELEVATION (ft): *1070*
TOTAL DEPTH OF HOLE (ft): *145*
DEPTH TO WATER (ft): *98.43*
DATE (start/finish): *2-12-90 to 2-13-90*

WELL/BORING COMPLETION

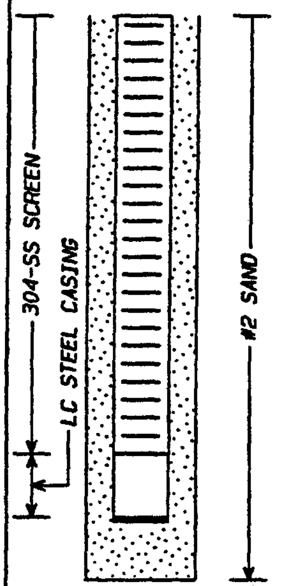


DEPTH (ft)	SAMPLE #	OVA (ppm)	% LEL	ODOR	MOISTURE	USCS SYMBOL	DESCRIPTION AND NOTES
0–10	5-1	0	0	N	SM	SW	SAND, OLIVE-BROWN coarse-fine grained, subangular, poorly sorted, abundant gravel ("soil-5-1" collected at 9:15 on 2-12-90)
10–20		0	0	N	SM	SW	SAND, OLIVE-BROWN fine-coarse grained, subangular, v.poorly sorted, abundant cobbles up to 6 cm.
20–30		0	0	N	SM	SW	SAND, RED-BROWN fine-coarse grained, subangular, v. poorly sorted, abundant gravel up to 3 cm.
30–40		0	0	N	SM	SW	SAND, RED-BROWN fine-coarse grained, subangular, v. poorly sorted, occasional gravel up to 3 cm.
40–50	5-2	0	0	N	SM	SW	SAND, RED-BROWN fine-coarse grained, subangular, v. poorly sorted, occasional gravel. ("soil-5-2" collected at 10:00 on 2-12-90)
50–60		0	0	N	SM	SW	SAND, RED-BROWN fine-coarse grained, subangular-subrounded, poorly sorted, abundant gravel up to 2 cm
60–70		0	0	N	SM	SW	SAND, TAN-MEDIUM BROWN fine-coarse grained, subangular, poorly sorted, abundant gravel up to 2 cm.
70–80		0	0	N	DR	SW / CL	SAND, SILTY, TAN fine-coarse grained, subangular, poorly sorted, some gravel, boulder at 73 ft., and CLAY, TAN
80–90		0	0	N	--	SW	SAND, TAN-RED BROWN fine-coarse grained, subangular, poorly sorted, some gravel, boulder at 84 ft.
90–100	5-3	0	0	N	--	SW	SAND, OLIVE BROWN-RED BROWN medium-coarse grained, subangular-angular, poorly sorted, occasional gravel up to 1.5 cm. ("soil-5-3" collected at 15:30 on 2-12-90)

EBASCO ENVIRONMENTAL

WELL NO. MW-5

PROJECT	*JPL ESI*	DRILL HOLE DIAMETER (in)	*11*
LOCATION	*Pasadena, California*	GROUND LEVEL ELEVATION (ft)	*1070*
GEOLOGIST/ENGINEER	*M. Cutler, M. Barnes*	TOTAL DEPTH OF HOLE (ft)	*145*
DRILLING COMPANY	*Beylik*	DEPTH TO WATER (ft)	*98.43*
DRILLING METHOD	*Percussion Hammer*	DATE (start/finish)	*2-12-90 to 2-13-90*



DEPTH (ft)	SAMPLE #	SAMPLES	OVA (ppm)	% LEL	ODOR	MOISTURE	USCS SYMBOL	DESCRIPTION AND NOTES
100			0	0	N	WT	SM	SAND, SILTY, BROWN medium-coarse grained, subangular-angular, poorly sorted, occasional gravel up to 1 cm.
110			0	0	N	WT	SP	SAND, SILTY, BROWN coarse grained, subangular, poorly sorted, occasional gravel up to 1.5 cm.
120			0	0	N	WT	SM	SAND, SILTY, BROWN coarse grained, subangular, poorly sorted, occasional gravel up to 2 cm.
130			0	0	N	WT	SW	SAND, MULTICOLORED coarse grained, subangular, moderately sorted, occasional gravel.
140	5-4	X						("soil-5-4" collected at 12:00 on 2-13-90)
			0	0	N	WT	SW	SAND, MULTICOLORED coarse grained, subangular, moderately sorted, occasional gravel.

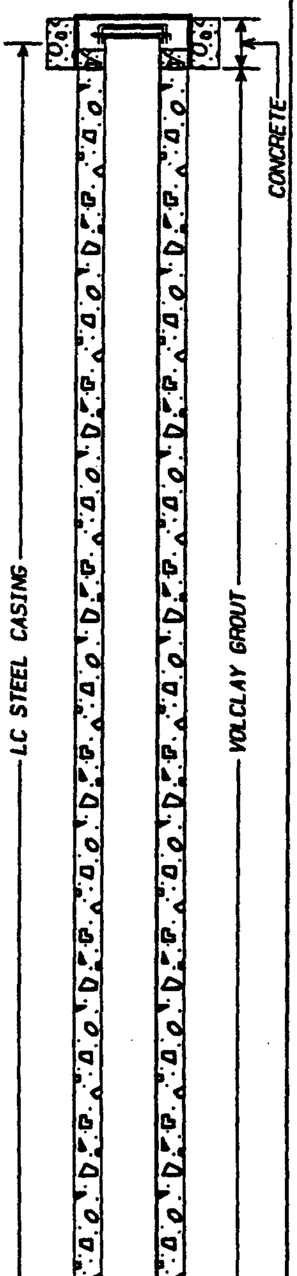
EBASCO ENVIRONMENTAL

WELL NO. MW-6

PROJECT JPL ESI
LOCATION Pasadena, California
GEOLOGIST/ENGINEER M. Cutler, H. Papenguth
DRILLING COMPANY Beylik
DRILLING METHOD Percussion Hammer

DRILL HOLE DIAMETER (in) 11
GROUND LEVEL ELEVATION (ft) 1189
TOTAL DEPTH OF HOLE (ft) 247
DEPTH TO WATER (ft) 205.8
DATE (start/finish) 2-15-90 to 2-24-90

WELL/BORING COMPLETION



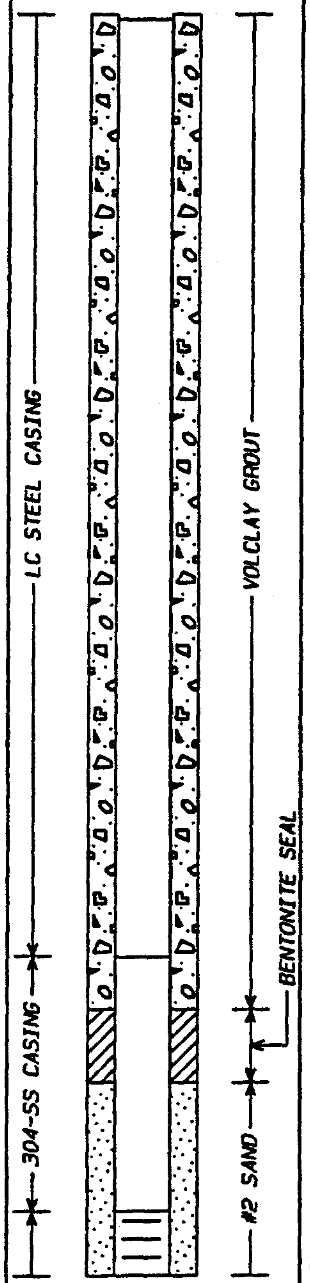
DEPTH (ft)	SAMPLE #	SAMPLES	OVA (ppm)	% LEL	ODOR	MOISTURE	USCS SYMBOL	DESCRIPTION AND NOTES
0			0	0	N	SM	SW	SAND, SILTY, BROWN medium grain, silty, subangular, moderately sorted, abundant gravel and cobbles. ("soil-6-1" collected at 14:45 on 2-15-90)
10	6-1	☒	0	0	N	SM	SW	SAND, SILTY, BROWN medium grain, subangular, moderately sorted.
20			0	0	N	SM	SW	SAND, SILTY, BROWN-RED BROWN medium grain, subangular, moderately sorted, occasional gravel.
30			0	0	N	SM	SW	SAND, SILTY, BROWN fine grain, subangular, moderately sorted, occasional gravel up to 1 cm.
40			0	0	N	SM	SW	SAND, SILTY, BROWN fine grain, subangular, moderately sorted, occasional gravel up to 1 cm. ("soil-6-2" collected at 15:20 on 2-15-90)
50	6-2	☒	0	0	N	SM	SW	SAND, SILTY, BROWN fine grain, subangular, moderately sorted, occasional gravel up to 1 cm.
60			0	0	N	SM	SW	SAND, SILTY, BROWN fine grain, subangular, moderately sorted, occasional gravel up to 1 cm.
70			0	0	N	SM	SW	SAND, SILTY, BROWN fine grain, subangular, moderately sorted, occasional gravel up to 1 cm.
80			0	0	N	SM	SW	SAND, SILTY, BROWN fine grain, subangular, moderately sorted, occasional gravel up to 1 cm.
90			0	0	N	SM	SW	SAND, BROWN medium grain, subangular, moderately sorted, occasional gravel up to 2 cm. BOULDER
100								("soil-6-3" collected at 16:40 on 2-15-90)

EBASCO ENVIRONMENTAL

WELL NO. MW-6

PROJECT	JPL ESI	DRILL HOLE DIAMETER (in)	11
LOCATION	Pasadena, California	GROUND LEVEL ELEVATION (ft)	1189
GEOLOGIST/ENGINEER	M. Cutler, H. Papenguth	TOTAL DEPTH OF HOLE (ft)	247
DRILLING COMPANY	Beylik	DEPTH TO WATER (ft)	205.8
DRILLING METHOD	Percussion Hammer	DATE (start/finish)	2-15-90 to 2-24-90

WELL/BORING COMPLETION



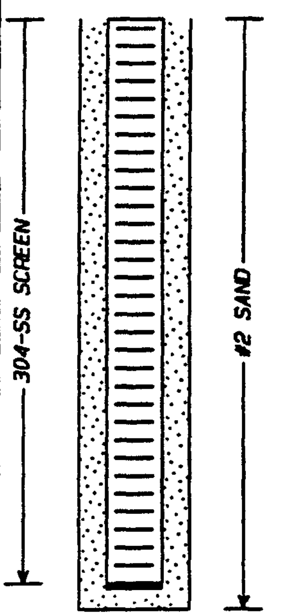
DEPTH (ft)	SAMPLE #	OVA (ppm)	% LEL	ODOR	MOISTURE	USCS SYMBOL	DESCRIPTION AND NOTES
100	6-3	0	0	N	SM	SW	SAND, BROWN medium grain, subangular, moderately sorted, occasional gravel up to 2 cm.
110		0	0	N	SM	SW	SAND, BROWN medium grain, gravely, subangular, moderately sorted.
120		0	0	N	SM	SW	SAND, BROWN medium grain, gravely, subangular, moderately sorted.
130		0	0	N	SM	SW	SAND, BROWN medium grain, gravely, subangular, moderately sorted.
140	6-4	0	0	N	SM	SM	SAND, SILTY, BROWN fine to coarse grained, occasional pebbles and cobbles of granitic rock. BOULDER ("soil-6-4" collected at 8:00 on 2-16-90)
150		0	0	N	SM	SW	SAND, SILTY, BROWN fine to coarse grained, occasional pebbles and cobbles.
160		0	0	N	SM	SW	SAND, SILTY, BROWN fine to coarse grained, occasional pebbles and cobbles.
170		0	0	N	SM	SW	SAND, BROWN very fine to coarse grained, poorly sorted, occasional gravel to cobbles.
180		0	0	N	SM	SW / ML	SAND, BROWN very fine to coarse grained, abundant silt and clay, few pebbles, and SILT, CLAYEY, BROWN-GRAY
190					DR		GRANITIC ROCK
190	6-5	0	0	N	SM	SW	SAND, BROWN fine to very coarse grained, abundant subrounded gravel. BOULDER ("soil-6-5" collected at 14:15 on 2-16-90)
200							

EBASCO ENVIRONMENTAL

WELL NO. MW-6

PROJECT	JPL ESI	DRILL HOLE DIAMETER (in)	11
LOCATION	Pasadena, California	GROUND LEVEL ELEVATION (ft)	1189
GEOLOGIST/ENGINEER	M. Cutler, H. Papenguth	TOTAL DEPTH OF HOLE (ft)	247
DRILLING COMPANY	Beylik	DEPTH TO WATER (ft)	205.8
DRILLING METHOD	Percussion Hammer	DATE (start/finish)	2-15-90 to 2-24-90

WELL/BORING COMPLETION

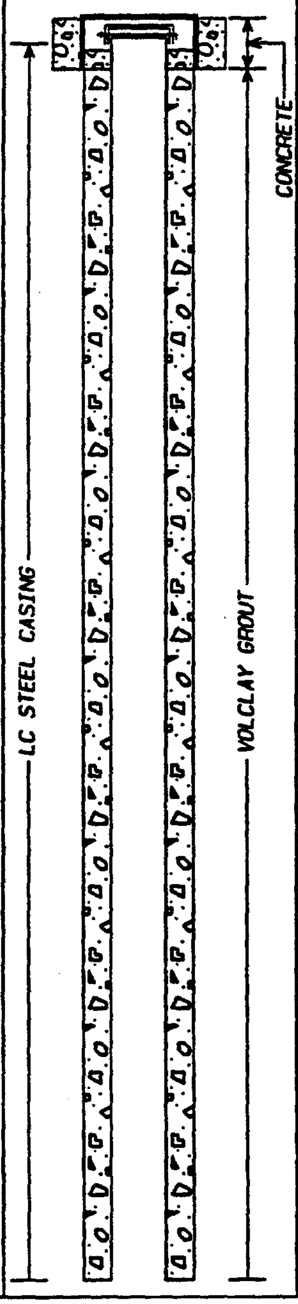


DEPTH (ft)	SAMPLE #	SAMPLES	OVA (ppm)	% LEL	ODOR	MOISTURE	USCS SYMBOL	DESCRIPTION AND NOTES
200–210			0	0	N		SW	SAND, BROWN fine to medium grained, abundant silt and clay, moderately sorted, abundant biotite, some metamorphic rock fragments. BOULDERS
210–220			0	0	N	DR	SW	SAND, BROWN fine to medium grained, abundant silt and clay, moderately sorted, abundant biotite, occasional igneous and metamorphic rock fragments. BOULDERS
220–230			0	0	N	SM	SW	SAND, SILTY, BROWN coarse grained, abundant clay, moderately sorted, igneous and metamorphic rock fragments, abundant gravel up to 8mm.
230–240			0	0	N	WT	SW	SAND, SILTY, BROWN coarse grained, abundant clay, moderately sorted, igneous and metamorphic rock fragments, abundant gravel up to 8mm.
240–247	6-6	☒	0	0	N	WT	SW	SAND, SILTY, BROWN coarse grained, abundant clay, moderately sorted, igneous and metamorphic rock fragments, abundant gravel up to 8mm. ("soil-6-6" collected at 8:10 on 2-23-90)

EBASCO ENVIRONMENTAL

WELL NO. MW-7

PROJECT	JPL ESI	DRILL HOLE DIAMETER (in)	11
LOCATION	Pasadena, California	GROUND LEVEL ELEVATION (ft)	1213
GEOLOGIST/ENGINEER	M. Cutler	TOTAL DEPTH OF HOLE (ft)	276
DRILLING COMPANY	Beylik	DEPTH TO WATER (ft)	236.2
DRILLING METHOD	Percussion Hammer	DATE (start/finish)	2-28-90 to 3-5-90



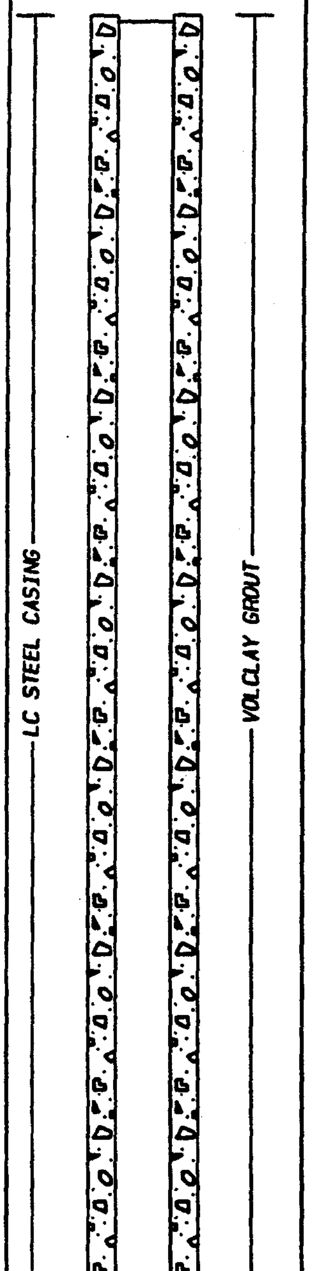
DEPTH (ft)	SAMPLE #	OVA (ppm)	% LEL	ODOR	MOISTURE	USCS SYMBOL	DESCRIPTION AND NOTES
0	7-1	0	0	N	SM	SC	SAND, BROWN very fine to coarse grained, abundant silt and clay, subangular, poorly sorted, common gravel and pebbles. ("soil-7-1" collected at 11:00 on 2-28-90)
10		0	0	N	SM	SC	SAND, BROWN very fine to coarse grained, abundant silt and clay, poorly sorted, common gravel.
20		0	0	N	SM	SC	SAND, BROWN very fine to medium grained, abundant silt and clay, poorly sorted, abundant cobbles of granite rock.
30		0	0	N	SM	SC	SAND, BROWN very fine to coarse grained, abundant silt and clay, subangular, poorly sorted, abundant pebbles and cobbles.
40	7-2	0	0	N	SM	SC	SAND, BROWN very fine to coarse grained, common silt, abundant gravel and pebbles. ("soil-7-2" collected at 11:50 on 2-28-90)
50		0	0	N	SM	SC	SAND, BROWN very fine to coarse grained, common silt, abundant gravel and pebbles. BOULDERS
60		0	0	N	SM	SC	SAND, BROWN fine to very coarse grained, abundant pebbles and cobbles.
70		0	0	N	SM	SC	SAND, BROWN fine to very coarse grained, abundant pebbles and cobbles.
80		0	0	N	SM	SC	SAND, BROWN very fine to coarse grained, abundant silt, subangular, poorly sorted, common gravel.
90	7-3	0	0	N	SM	SM	SAND, LIGHT BROWN fine to very coarse grained, subangular, poorly sorted, loose, abundant gravel. ("soil-7-3" collected at 13:05 on 2-28-90)
100							

EBASCO ENVIRONMENTAL

WELL NO. MW-7

PROJECT	JPL ESI	DRILL HOLE DIAMETER (in)	11
LOCATION	Pasadena, California	GROUND LEVEL ELEVATION (ft)	1213
GEOLOGIST/ENGINEER	M. Cutler	TOTAL DEPTH OF HOLE (ft)	276
DRILLING COMPANY	Bevlik	DEPTH TO WATER (ft)	236.2
DRILLING METHOD	Percussion Hammer	DATE (start/finish)	2-28-90 to 3-5-90

WELL/BORING COMPLETION



DEPTH (ft)	SAMPLE #	SAMPLES	OVA (ppm)	% LEL	ODOR	MOISTURE	USCS SYMBOL	DESCRIPTION AND NOTES
100			0	0	N	SM	SM	SAND, BROWN fine to very coarse grained, subangular, poorly sorted, common silt, common gravel and pebbles.
110			0	0	N	SM	SC	SAND, BROWN fine to very coarse grained, subangular, poorly sorted, with trace silt and clay. BOULDERS
120			0	0	N	DR	SC	SAND, BROWN fine to very coarse grained, subangular, poorly sorted, common silt, abundant pebbles and cobbles.
130			0	0	N	DR	SM	SAND, BROWN fine to very coarse grained, subangular, poorly sorted, with trace of clay and silt.
140			0	0	N	DR	SM	SAND, BROWN fine to very coarse grained, subangular, poorly sorted, common silt, common gravel and pebbles.
	7-4	X						("soil-7-4" collected at 14:15 on 2-28-90)
150			0	0	N	DR	SM	SAND, BROWN fine to very coarse grained, subangular, poorly sorted, common silt, common gravel and pebbles.
160			0	0	N	DR	SM	BOULDER SAND, BROWN fine to very coarse grained, subangular, poorly sorted, common silt, common gravel and pebbles.
170			0	0	N	SM	SM	SAND, BROWN fine to coarse grained, abundant silt, subangular, poorly sorted, common gravel and pebbles.
180			0	0	N	DR	SM	SAND, BROWN fine to very coarse grained, abundant silt, subangular, poorly sorted, abundant gravel to cobble sized granitic rocks.
190			0	0	N	DR	SM	SAND, BROWN fine to very coarse grained, abundant silt, subangular, poorly sorted, abundant gravel and cobble sized rocks.
200	7-5	X						("soil-7-5" collected at 16:50 on 2-28-90)

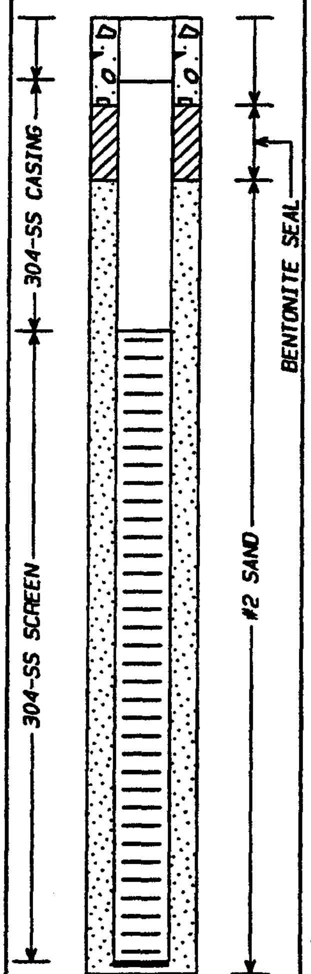
EBASCO ENVIRONMENTAL

WELL NO. MW-7

PROJECT: JPL ESI
LOCATION: Pasadena, California
GEOLOGIST/ENGINEER: M. Cutler
DRILLING COMPANY: Beylik
DRILLING METHOD: Percussion Hammer

DRILL HOLE DIAMETER (in): 11
GROUND LEVEL ELEVATION (ft): 1213
TOTAL DEPTH OF HOLE (ft): 276
DEPTH TO WATER (ft): 236.2
DATE (start/finish): 2-28-90 to 3-5-90

WELL/BORING COMPLETION



DEPTH (ft)	SAMPLE #	OVA (ppm)	% LEL	ODOR	MOISTURE	USCS SYMBOL	DESCRIPTION AND NOTES
200		0	0	N	DR	SM	SAND, BROWN fine to very coarse grained, abundant silt, subangular, poorly sorted, abundant gravel and cobble sized granitic rocks.
210		0	0	N	DR	SM	SAND, BROWN fine to very coarse grained, abundant silt, subangular, poorly sorted, abundant gravel and cobble sized granitic rocks.
220		0	0	N	DR	SC	SAND, BROWN fine to very coarse grained, abundant silt, subangular, poorly sorted, abundant silt and clay, common pebbles of granitic rocks. BOULDER
230		0	0	N	▽	SC	SAND, BROWN fine to very coarse grained, abundant silt, subangular, poorly sorted, abundant clay, pebbles, and cobbles, and boulders of granitic rocks. BOULDER
240	7-6	0	0	N	ST	SM	SAND, BROWN fine to very coarse grained, with abundant silt and gravel. BOULDERS ("soil-7-6" collected at 10:00 on 3-2-90)
250		0	0	N	ST	SM	SAND, BROWN fine to very coarse grained, abundant silt, subangular, poorly sorted, abundant cobbles. BOULDER
260		0	0	N	ST	SW	SAND, BROWN medium to coarse grained, subangular to subrounded, moderately sorted, abundant cobbles. BOULDER
270	7-7	0	0	N	ST	SW	SAND, BROWN medium to coarse grained, subangular, moderately sorted, abundant cobbles. BOULDER ("soil-7-7" collected at 8:10 on 3-5-90)

APPENDIX B

Westbay Report on Multi-Port Casing System in Deep Monitoring Wells EMW-3 and EMW-4

COMPLETION REPORT

NASA JET PROPULSION LABORATORY SITE

PASADENA, CALIFORNIA

MONITORING WELL MW-3 AND MW-4 EQUIPPED

WITH THE WESTBAY MP SYSTEM.

Ebasco Subcontract No. 7708-90S-2068

Prepared By:

Westbay Instruments Inc.

March 23, 1990

Westbay Ref.: WB650-90

Distribution List:

Ebasco Services Incorporated   Mr. Dan Melchior - 1 copy

Westbay Instruments Inc.

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FIGURES AND TABLES

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MW-3 Piezometric Pressures/Levels, Field Data Record, Feb 12,1990
MW-3 Piezometric Pressures/Levels, Field Data Record, Feb 21,1990
MW-3 Piezometric Pressures/Levels, Field Data Record, Mar 3, 1990

Appendix F

MW-4 Piezometric Pressures/Levels, Field Data Record, Feb 19,1990
MW-4 Piezometric Pressures/Levels, Field Data Record, Mar 2, 1990
MW-4 Piezometric Pressures/Levels, Field Data Record, Mar 5, 1990

Appendix G

MW-3 Groundwater Sampling Field Data Sheets - 6 pages.
MW-4 Groundwater Sampling Field Data Sheets - 6 pages.

1. INTRODUCTION

This report and attachments document the technical services carried out by Westbay Instruments Inc. under Ebasco Services Incorporated Subcontract Number 7708-90S-2068. The Westbay MP System for groundwater monitoring was installed in monitoring wells MW-3 and MW-4 located at the NASA Jet Propulsion Laboratory site in Pasadena, California. Both monitoring wells were completed in alluvial materials adjacent to Arroyo Seco. The monitoring well designs which specified the depth and number of monitoring zones were provided to Westbay by Mr. Mark Cutler of Ebasco Services Incorporated.

Westbay representatives Erik Rehtlane and Kurt Seedhouse were on site from February 9, 1990 to March 6, 1990 to conduct the technical services as specified under the subcontract. Westbay representative David McEachern was on site from February 23, 1990 to March 5, 1990 as a Westbay trainee.

2. PREVIOUS ACTIVITIES

2.1 Monitoring Well MW-3

Prior to the installation of the MP System, MW-3 had been drilled by Beylik Drilling to a depth of 720 feet below ground surface by a rotary drilling technique with bentonite mud. Following drilling, a number of geophysical logs were obtained. Five monitoring zone depths were chosen based on the geological and geophysical information available. A 4-inch nominal I.D. butt-welded mild steel casing with ten foot long stainless steel screens at the intended monitoring levels was lowered to a depth of 700 feet.

Clean sand (# 2/12 Monterey) was used as a filter pack opposite the screen sections. The backfill seal material was a 1:1 mix of sand (Monterey #3) and Benseal (powdered bentonite). All backfill materials were pumped into the drillhole through a tremmie pipe.

Following the backfill placement, the monitoring zones were developed by Beylik Drilling by swabbing and bailing between each screen. This was followed by setting a straddle packer across each screen and pumping with a submersible pump. A flow rate of 5-7 USGPM was achieved from each screen. The discharge from each screen was clear prior to termination of pumping. The MP casing was installed as soon as practical following development in order to minimize the potential for cross-contamination of monitoring zones.

2.2 Monitoring Well MW-4

Prior to the installation of the MP System, MW-4 had been drilled to a depth of 605 feet below ground surface by a technique similar to that used for MW-3. Following drilling, a number of geophysical logs were obtained.

Five monitoring zone depths were chosen based on the geological and geophysical information available. A 4-inch nominal I.D. butt-welded mild steel casing with ten foot long stainless steel screens at the intended monitoring levels was lowered to a depth of 559 feet.

Clean sand (#2/12 Monterey) was used as a filter pack opposite the screen sections. The backfill seal material was a 1:1 mix of sand (Monterey #3) and Benseal (powdered bentonite). All backfill materials were pumped into the drillhole through a tremmie pipe.

Following the backfill placement, the monitoring zones were developed by Beylik Drilling by swabbing and bailing between each screen. This was followed by setting a straddle packer across each screen and pumping with a submersible pump. A flow rate of 5-7 USGPM was achieved from each screen. The discharge from each screen was clear prior to termination of pumping. This in turn was followed by setting the straddle packer across each screen and air lifting through the rods. This resulted in increased surge action and the discharge was dirty for some time prior to becoming clear. The MP casing was installed as soon as practical following development in order to minimize the potential for cross-contamination of monitoring zones.

3. INSTALLATION AND MONITORING, MW-3

Installation and monitoring work began at MW-3 on February 10, 1990 and ended on March 3, 1990. The following is a description of the installation procedures.

3.1 Final Preparation of Monitoring Well Design

A casing installation log was prepared on January 19, 1990 showing an arrangement of MP Casing components compatible with the described positions of the five stainless steel well screens previously installed in monitoring well MW-3. This information was provided by Mark Cutler of Ebasco Services. The MP packers were positioned above and below each well screen. MP measurement ports and pumping ports were positioned within each of the well screen sections. Additional measurement ports were positioned between the monitoring zones for QA testing purposes (QA zones).

3.2 Layout of MP System Casing Components

On February 10, 1990 the MP casing lengths and packers for MW-3 were laid out on casing racks. The MP components were arranged in the order in which they were to be lowered, according to the casing installation log. Each casing length was numbered sequentially from the bottom of the monitoring well, and an appropriate MP coupling was attached to the casing top. The length of each MP casing was measured and recorded on a Casing Length Measurement Record, which is provided in Appendix A. The MP casing components were protected by plastic shipping covers which were left in place until installation. Magnetic location collars were clamped to the MP casing 2.2 ft above the center of each of the measurement ports located in a monitoring zone. Magnetic collars were not placed in the QA zones. The entire layout was stored in the Westbay rental truck overnight.

3.3 Lowering of the MP System Components

The MP casing was lowered on February 11, 1990. As each component was removed from the rack, the casing type, coupling type, and sequential number were checked against the casing installation log. The component was then attached to the MP Casing string being lowered into the drillhole. Each assembled pair of joints was hydraulically tested by applying a minimum internal pressure of about 80 psi for one minute. The pressures used and the test results were recorded on the Casing Installation Log. This procedure continued until all the MP System components had been placed in the drillhole. Table 5 is a summary of the depths of the MP System components installed. Table 6 is the MP System Casing Installation Log.

3.4 Inflation of MP System Casing Packers

On February 11, 1990, the MP casing packers were inflated in sequence beginning with the lowest packer in the monitoring well. Westbay's packer inflation tool was used for inflation. Pasadena City tap water provided by Beylik and obtained at the JPL site was used to inflate the packers. The gauge pressure and volume of water pumped were recorded at intervals and plotted for each packer. MP Packer Inflation Records for the 10 packers installed are provided in Appendix A.

3.5 Fluid Pressure Readings

Fluid pressures were measured February 12, February 21, and March 3, 1990. The plotted results are attached as Figures 1 and 2. Copies of the data sheets are included as Appendix E.

3.5.1 Monitoring Zone Fluid Pressure Readings

A plot of the equivalent depth to the water level in each monitoring zone is shown on Figure 1. Data from the five monitoring zones is shown, but data from the five QA zones has been omitted. The accuracy of each pressure reading is $\pm$ 0.5 psi or approximately $\pm$ 1.2 ft of water when the raw field pressure readings are used without further corrections. When a procedure that Westbay calls the Field Calibration Method is used in taking the readings an accuracy of approximately $\pm$ 0.13 psi or approximately $\pm$ 0.3 ft of water is obtained. Further increases in the accuracy of the pressure measurements can be made using the transducer calibration record with temperature corrections. These latter corrections have not been made in plotting Figures 1 and 2.

The fluid pressure results indicate that a downward gradient of approximately four feet of water exists from the top to the bottom of MW-3. It should be noted that DH-1, a nearby standpipe well drilled to a depth of 392 feet in 1982 and screened throughout its length, is approximately 75 feet from MW-3.

3.5.2 QA Port Fluid Pressure Readings

Figure 2 provides the equivalent depths to water for the monitoring zones, as well as the equivalent depths to water calculated from pressure measurements made through the QA ports. This data is used to help confirm that the MP packers are hydraulically sealing the annulus between the steel casing and the MP casing. The higher pressures measured at several QA ports in comparison to the pressures recorded at adjacent ports in screened monitoring zones indicate that the MP packers are hydraulically sealing the annulus as intended and that the steel casing welds are water-tight. The fluid pressures in the QA zones are expected to change and approach the pressure inside the MP casing as the pressure probe is repeatedly activated and deactivated in the QA port. Long term relaxation or creep of the MP packers may also permit a gradual decrease in the pressure measured outside the QA ports.

3.6 Hydraulic Conductivity Testing

A rising head hydraulic conductivity test was conducted at each monitoring zone prior to purging. Preliminary values for hydraulic conductivity were calculated using the method described by Hvorslev (1951). The hydraulic conductivity test field results for MW-3 are summarized on Table 1. Data sheets and plotted results are provided in Appendix B.

3.7 Purging

Development and primary purging of individual well screens had been carried out by the driller using a straddle packer apparatus and submersible pump. In addition, each monitoring zone was purged individually through the MP System pumping port coupling that had been installed. The purge criteria, as stated under the subcontract, was to airlift from each zone on the order of 3 hours. Purging was conducted from February 12 to February 20, 1990. Results are summarized on Table 3. The purge records (pumping logs) for each monitoring zone are provided in Appendix C.

3.8 Fluid Sampling

Fluid samples were taken from each monitoring zone with the Westbay electric sampler probe equipment and transferred to sample containers in accordance with instructions received from Ebasco representatives. Westbay's quality control checks for taking water samples were followed. If any of the quality control checks on a sampling run were found to be negative, the sample was discarded and the sampling run repeated following equipment decontamination. Sample documentation and sample custody at the wellhead were handled by Ebasco personnel.

Four 250 ml stainless steel sample bottles were run in tandem in order to obtain approximately 1 liter of sample fluid per run. The first run at a monitoring zone was used for field parameters only. Subsequent samples were transferred by opening the bottom valve of the bottom sample bottle and allowing the sample to flow into the appropriate container.

The decontamination procedure used on the MP System sampling equipment was to swab and rinse the sample bottles and sample pathways with an Alconox solution. This was followed by two rinses with clean water. Ebasco specified and supplied the cleaning agents, rinse water, and decontamination procedures.

4. INSTALLATION AND MONITORING, MW-4

Installation and monitoring work at MW-4 began on February 15, 1990 and ended on March 6, 1990. Following is a description of installation procedures.

4.1. Final Preparation of Monitoring Well Design

A casing installation log drawing was prepared on February 15, 1990 showing an arrangement of MP casing components compatible with the described positions of the five stainless steel well screens previously installed in monitoring well MW-4. This information was provided by Mark Cutler of Ebasco Services. The MP packers were positioned above and below each well screen. MP measurement ports and pumping ports were positioned within each of the well screen sections. Additional measurement ports were positioned between the monitoring zones for QA testing purposes (QA zones).

4.2 Layout of MP System Casing Components

On February 15, 1990 the MP casing lengths and packers for MW-4 were laid out on casing racks. The MP components were arranged in the order in which they were to be lowered according to the casing installation log. Each casing length was numbered sequentially from the bottom of the monitoring well, and an appropriate MP coupling was attached to the casing top. The length of each MP casing was measured and recorded on a Casing Length

Measurement Record, which is provided in Appendix A. The MP casing components were protected by plastic shipping covers which were left in place until installation. Magnetic location collars were clamped to the MP casing 2.2 ft above the center of each of the measurement ports located in a monitoring zone. Magnetic collars were not placed near the measurement ports in the QA zones. The entire layout was stored in the Westbay rental truck overnight.

4.3 Lowering of the MP System Components

The MP casing was lowered on February 16, 1990. As each component was removed from the rack, the casing type, coupling type, and sequential number were checked against the casing installation log. The component was then attached to the MP Casing string being lowered into the drillhole. Each assembled pair of joints was hydraulically tested by applying a minimum internal pressure of about 80 psi for one minute. The pressures used and the test results were recorded on the Casing Installation Log. This procedure continued until all the MP System components had been placed in the drillhole. Table 7 is a summary of the depths of the MP System components installed. Table 8 is the MP system Casing Installation Log.

4.4 Inflation of MP System Casing Packers

On February 17, 1990, the MP casing packers were inflated in sequence beginning with the lowest packer in the monitoring well. Westbay's packer inflation tool was used for inflation. Pasadena City tap water provided by Beylik and obtained at the JPL site was used to inflate the packers. The gauge pressure and volume of water pumped were recorded at intervals and plotted for each packer. MP Packer Inflation Records for the 10 packers installed are provided in Appendix A.

4.5 Fluid Pressure Readings

Fluid pressures were measured February 19, March 2 and March 5, 1990. The plotted results are attached as Figures 3 and 4. Copies of the data sheets are included as Appendix F.

4.5.1 Monitoring Zone Fluid Pressure Readings

A plot of the equivalent depth to the water level in each monitoring zone is shown on Figure 3. Data from the five monitoring zones is shown, but data from the five QA zones has been omitted. The accuracy of each pressure reading is ± 0.5 psi or approximately ± 1.2 ft of water when the raw field pressure readings are used without further corrections. When a procedure Westbay calls the Field Calibration Method is used in taking the readings an accuracy of approximately ± 0.13 psi or approximately ± 0.3 ft of water is obtained. Further increases in the accuracy of the pressure measurements can be made using the transducer calibration record with temperature corrections. These latter corrections have not been made in plotting Figures 3 and 4.

The fluid pressure results indicate that a downward gradient of approximately eight feet of water exists from the top to the bottom of MW-4. To our knowledge, no fully screened standpipe wells are in close proximity to MW-4.

4.5.2 QA Port Fluid Pressure Readings

Figure 4 provides the equivalent depths to water for the monitoring zones as well as the equivalent depths to water calculated from pressure measurements made through the QA ports. This data is used to help confirm that the MP packers are hydraulically sealing the annulus between the steel casing and the MP casing. The lower pressures measured March 5, 1990 at several QA ports in comparison to the pressures recorded at adjacent ports in screened monitoring zones indicate that the MP packers are hydraulically sealing the annulus as intended and that the steel welds are water-tight. These QA zone fluid pressures are expected to change and approach the pressure inside the MP casing as the pressure probe is repeatedly activated and deactivated in the QA port.

As indicated on Figure 4 the head in QA zone 9 on March 5 is similar to those recorded at the adjacent monitoring zones. A supplemental test was conducted March 6 to confirm the proper sealing of the MP packers. This supplemental test indicated that all of the MP packers are hydraulically sealing the annulus as intended and are functioning normally. An earlier supplemental test conducted soon after installation had not provided conclusive evidence that the MP packers were sealed against the 4" steel pipe. This was probably due to a suspected pronounced axial seam on the interior wall of the steel well casing. Long term packer creep into any irregularities on the interior casing wall over the intervening two week period most likely resulted in the differences between the results of these supplemental tests. These suspected pipe irregularities are not expected to adversely effect the long term use and performance of the MP packers.

4.6 Hydraulic Conductivity Testing

A rising head hydraulic conductivity test was conducted at each monitoring zone prior to purging. Preliminary values for hydraulic conductivity were calculated using the method described by Hvorslev (1951). The hydraulic conductivity test field results for MW-4 are summarized on Table 2. Data sheets and plotted results are provided in Appendix B.

4.7 Purging

Development and primary purging of individual well screens had been carried out by the driller using a straddle packer apparatus and submersible pump or airlift. In addition, each monitoring zone was purged individually through the MP System pumping port coupling that had been installed. The purge criteria, as set out in the subcontract, was to airlift from each zone on the order of 3 hours. Purging was conducted from February 22 to February 26, 1990. Results are summarized on Table 4. The purge records (pumping logs) for each monitoring zone are provided in Appendix D.

4.8 Fluid Sampling

The sampling protocol for MW-4 was the same as used for MW-3, as described in Section 3.8.

5. TRAINING ACTIVITIES AND FUTURE OPERATION

Several Ebasco representatives received an introduction to the basics of MP System installation and operation. They are: Mark Cutler, Hans Papenguth, David Nye, Abid Loan, and Mike Barnes. Future MP System installations at this site under the direction of Ebasco would initially require a 2-man Westbay installation crew. Similarly, subsequent purging or monitoring activities would initially require two Westbay representatives.

Following the installation of several more MP System wells it should be possible to reduce to one, or perhaps no, Westbay representatives provided the designated Ebasco personnel have been adequately trained. The individuals named above would require the least additional training time due to their exposure to the MP System with the work described in this report.

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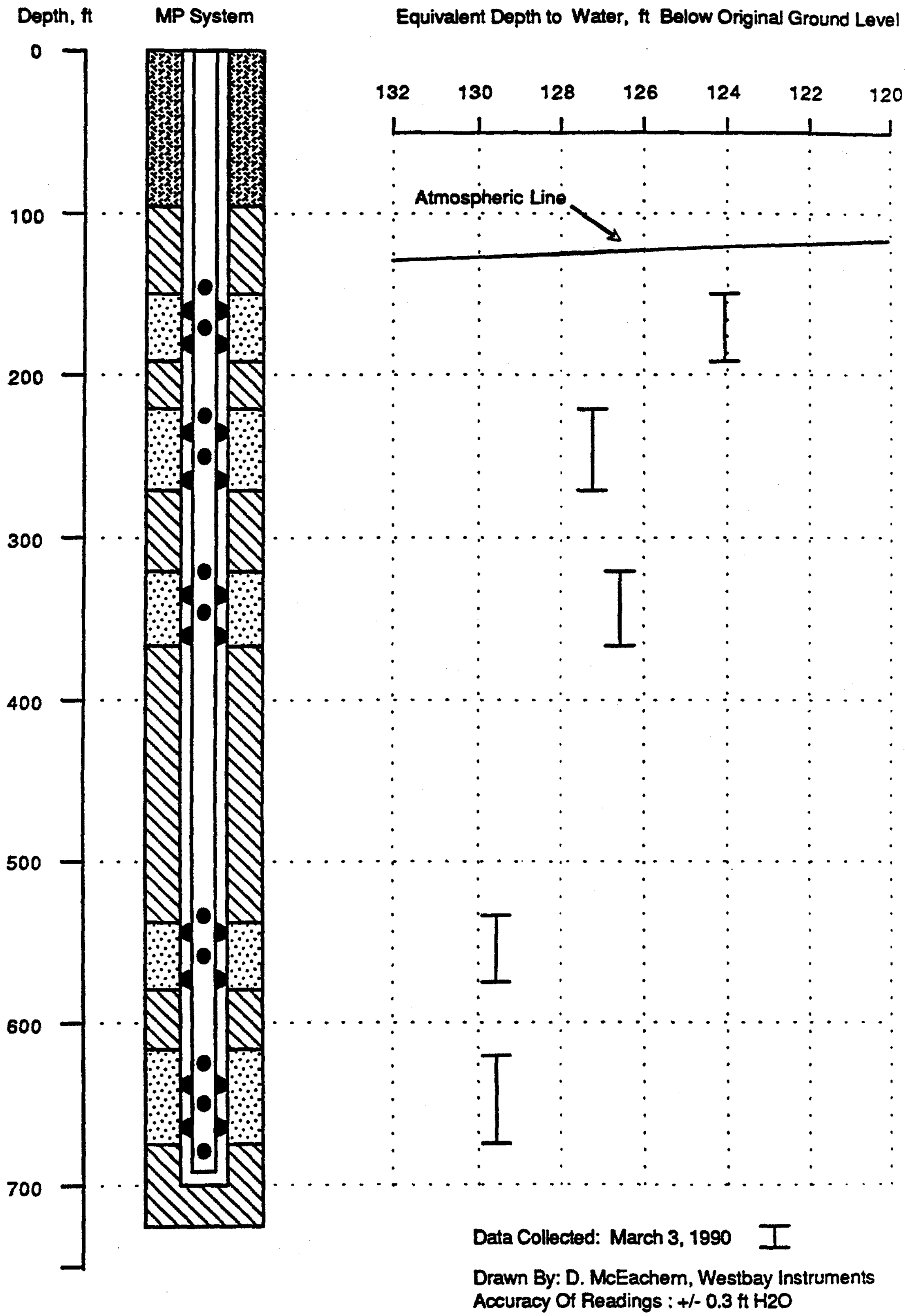


Figure 1. MW-3 Pressure Profile.

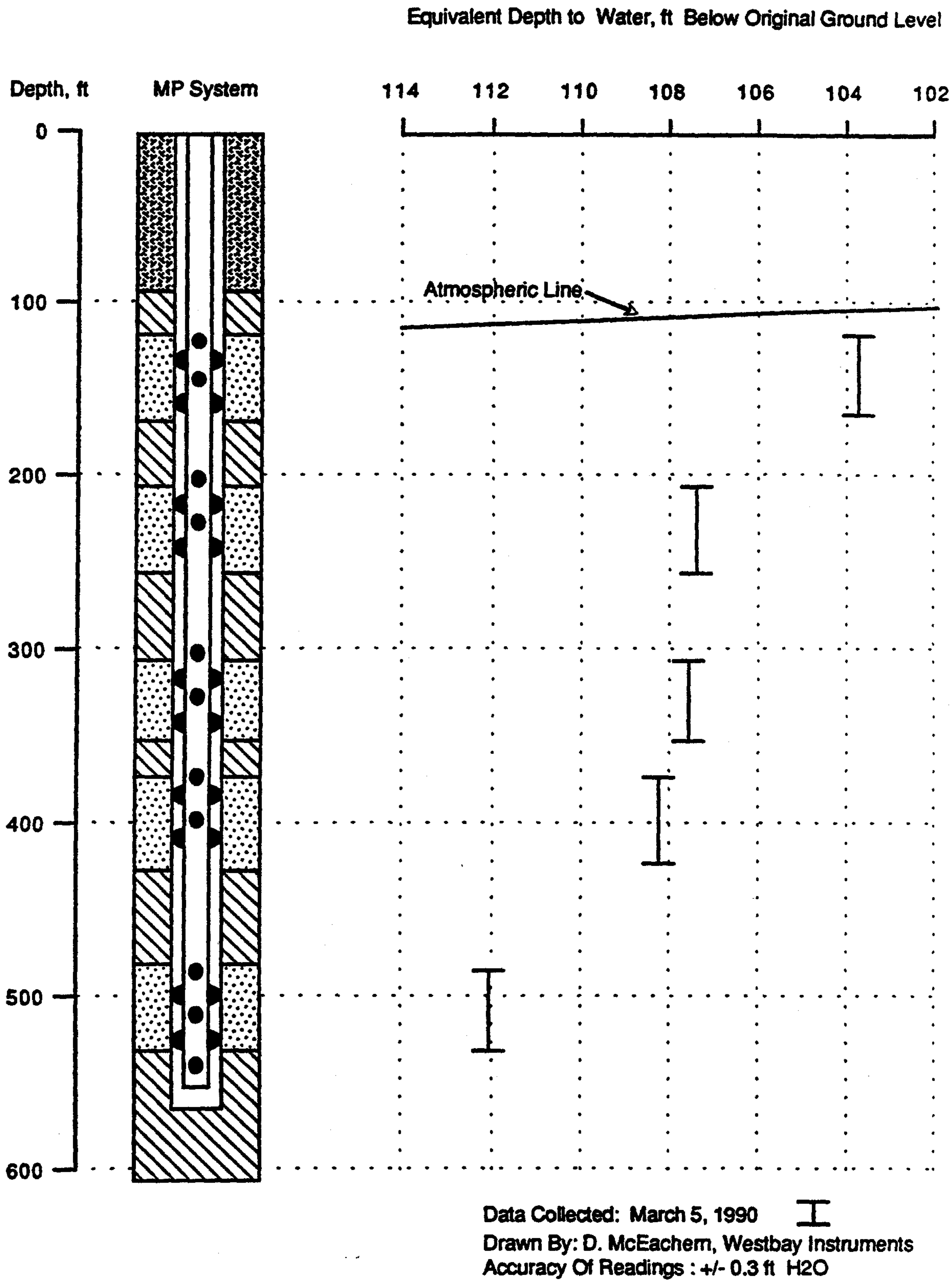
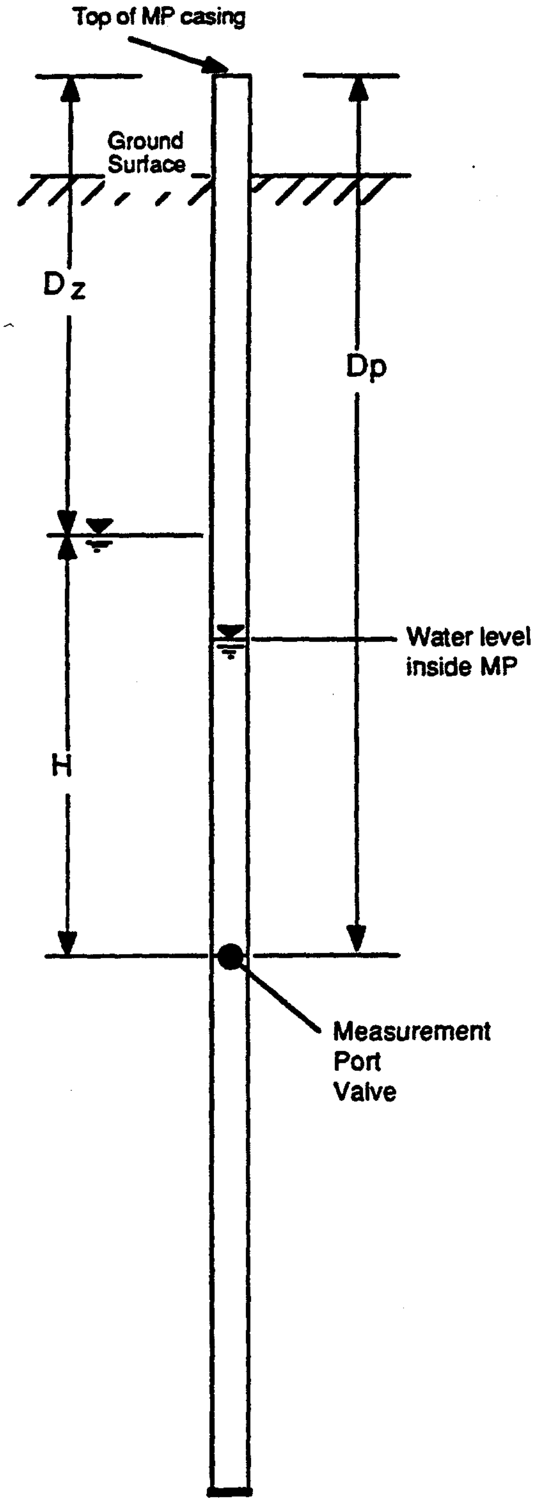


Figure 3: MW-4 Pressure Profile



Definition of Terms:

Dz = Depth to static water level for monitoring zone (below top of MP) (ft)

Dp = Depth of measurement port valve (below top of MP) (ft)

P = Outside pressure from field data (psi for pneumatic/ psia for electric)

P atm = Atmospheric pressure (psia)

H = Pressure head outside MP casing (ft)

w = weight of water with density of $1.0\ g/cm^3$ = 0.4335 psi/ft or 1.42 psi/m

Calculations:

$$H = \frac{P}{w} \quad \text{for pneumatic probe} \quad (1a)$$

$$H = \frac{(P - P\,atm)}{w} \quad \text{for electric probe} \quad (1b)$$

$$Dz = Dp - H \quad (2)$$

$$\text{Piezometric level} = \text{Elevation of top of MP} - Dz \quad (3)$$

Westbay Technical Note
Date: August 1, 1989

Figure 5. Piezometric Level Calculation Using Direct Method

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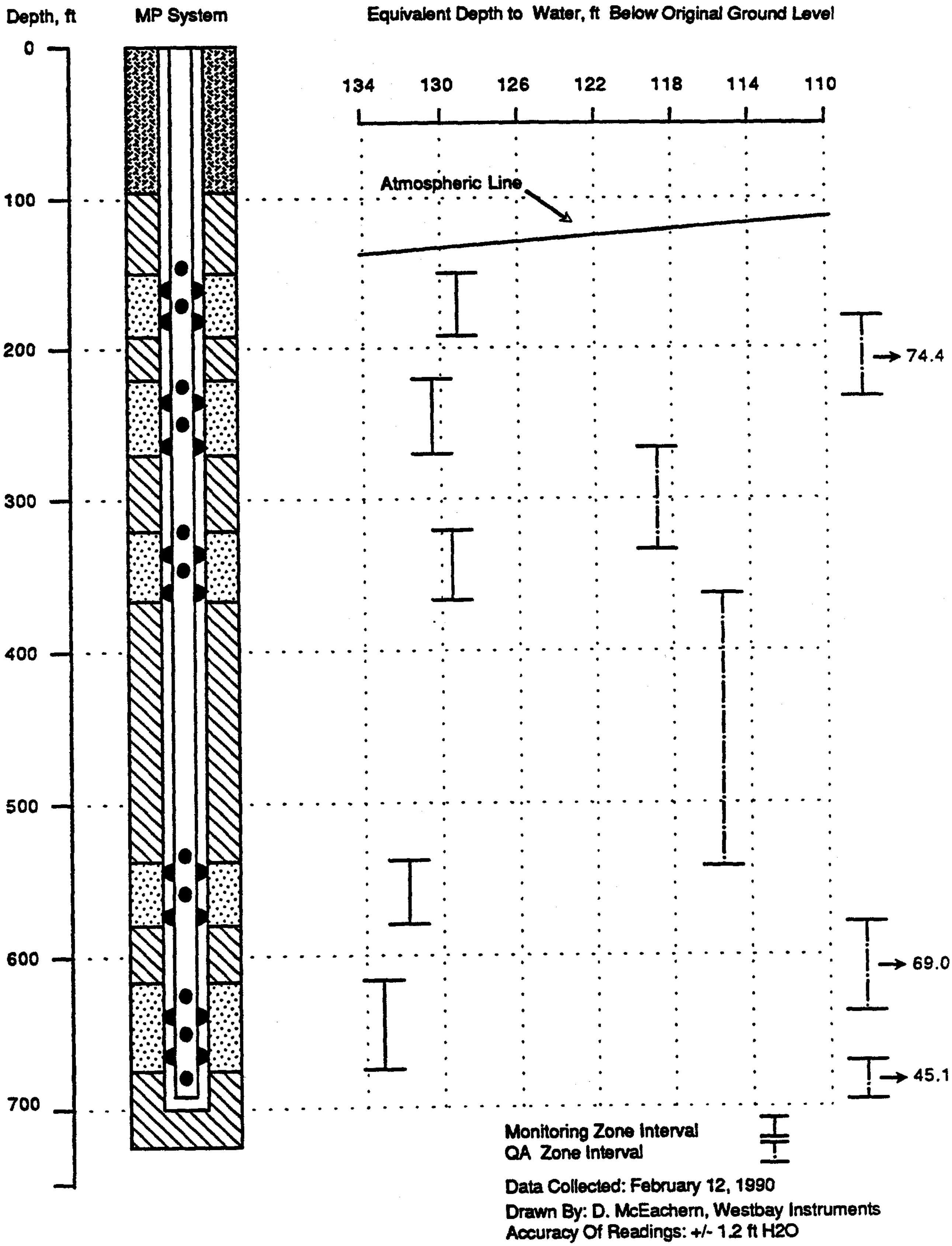


Figure 2. MW-3 Pressure Profile With QA Data Shown.

TABLE 1

Summary of Rising Head Hydraulic Conductivity Test Results, MW-3

Test Zone	K(est)* (cm/sec)
2	1.1×10^{-4}
4	5.4×10^{-4}
6	6.0×10^{-5}
8	7.0×10^{-4}
10	8.9×10^{-4}

* After Hvorslev (1951)

** Test zone numbers refer to the MW-3 casing completion summary, Table 5

Note: Data collected using pressure probe EE172 and a Toshiba Laptop computer.

TABLE 2

Summary of Rising Head Hydraulic Conductivity Test Results, MW-4

Test Zone	K(est)* (cm/sec)
2	1.1×10^{-4}
4	3.0×10^{-4}
6	4.1×10^{-4}
8	3.6×10^{-4}
10	7.2×10^{-4}

* After Hvorslev (1951)

** Test zone numbers refer to the MW-4 casing completion summary, Table 7.

Note: Data collected using pressure probe EE172 and Toshiba Laptop computer.

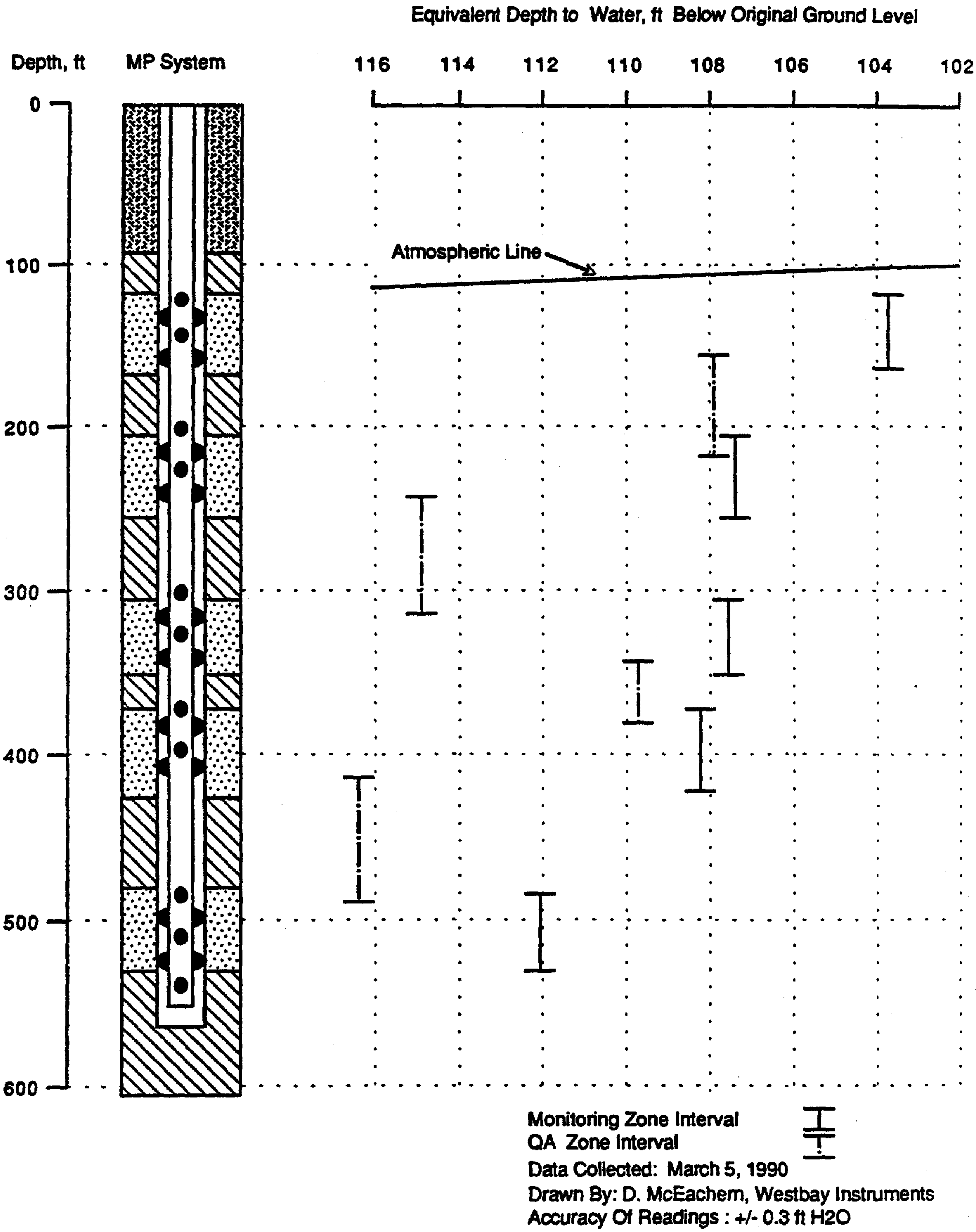


Figure 4. MW-4 Pressure Profile With QA Data Shown

TABLE 3

Purging Record Summary, MW-3

Project: NASA Jet Propulsion Laboratory
Location: Pasadena, California
Monitoring Well: MW-3
Westbay Project Reference: WB650-90

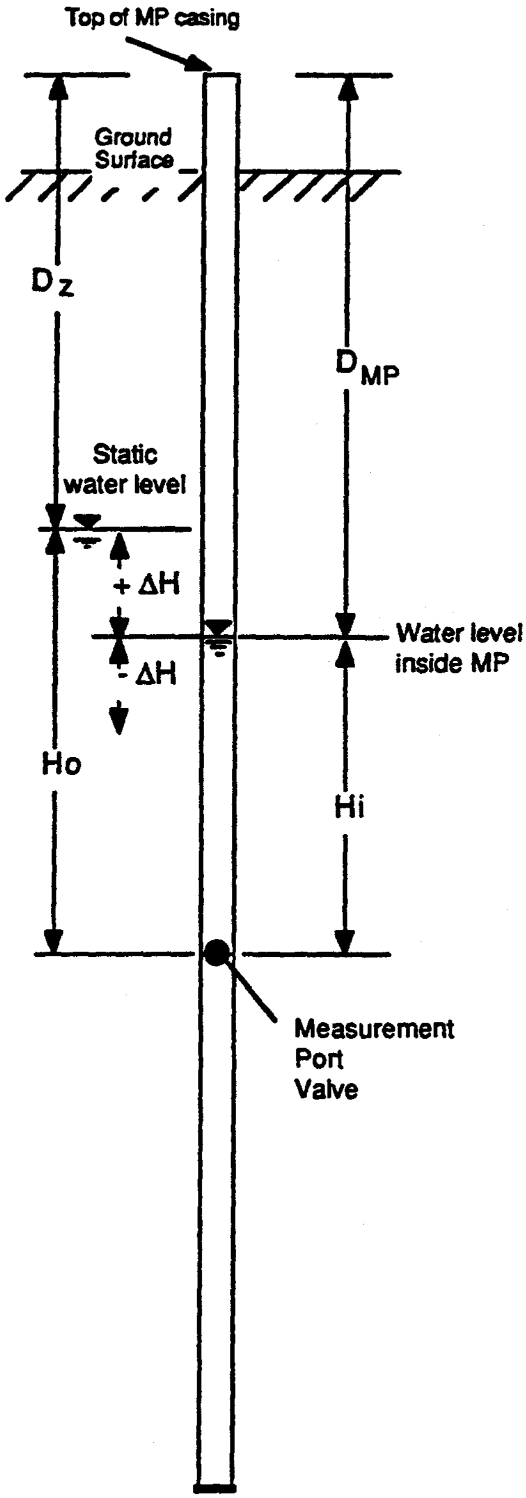
Monitoring Zone No.	Date Purged	Volume Purged	Purging Duration	Description of Discharge at End of Purging
2	Feb 12,13/90	74 gal.	5 1/4 hrs.	Hazy
4	Feb 13,14/90	96 gal.	4 hrs.	Light Brown
6	Feb 14/90	57.5 gal.	3 1/4 hrs.	Trace of Silt/ Cloudy
8	Feb 15/90	46 gal.	3 hrs.	Cloudy
10	Feb 20/90	73 gal.	4 hrs.	Hazy

TABLE 4

Purging Record Summary, MW-4

Project: NASA Jet Propulsion Laboratory
Location: Pasadena, California
Monitoring Well: MW-4
Westbay Project Reference: WB650-90

Monitoring Zone No.	Date Purged	Volume Purged	Purging Duration	Description of Discharge at End of Purging
2	Feb 23/90	63 gal.	3 hrs.	Clear
4	Feb 23/90	65 gal.	3 hrs.	Clear
6	Feb 24/90	78 gal.	3 hrs.	Clear
8	Feb 24/90	59 gal.	3 hrs.	Clear
10	Feb 26/90	65 gal.	3 hrs.	Clear



Definition of Terms:

D_z = Depth to static water level for monitoring zone (below top of MP) (ft)

D_{MP} = Depth to water inside MP casing, from field data (below top of MP) (ft)

Po = Pressure reading outside MP casing (psia)

Pi = Pressure reading inside MP casing (psia)

P atm = Atmospheric pressure (psia)

Hi = Pressure head inside MP casing (ft)

Ho = Pressure head outside MP casing (ft)

ΔH = Pressure head difference between monitoring zone pressure head and casing pressure head as measured at measurement port valve (ft)

w = weight of water with density of 1.0 g/cm^3 = 0.4335 psi/ft or 1.42 psi/m

Calculations:

$$Hi = \frac{(Pi - P\,atm)}{w} \quad (1)$$

$$Ho = \frac{(Po - P\,atm)}{w} \quad (2)$$

$$\Delta H = Ho - Hi = \frac{Po - Pi}{w} \quad (3)$$

$$Dz = D_{MP} - \Delta H \quad (4)$$

$$\text{Piezometric level} = \text{Elevation of top of MP} - Dz \quad (5)$$

Westbay Technical Note
Date: August 1, 1989

Figure 6. Piezometric Level Calculation Using Field Calibration Method

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CASING COMPLETION SUMMARY

Site Location: NASA JET PROPULSION LABORATORY

Drillhole No.: MW 3

Weather/Temperature: ___

Installation Date: Feb 11, 1990

Technician(s): ER/KS/D.NYE/M.CUTLER

Job No./Client: WB 650

Datum = Original Ground Surface

Completion Zone	BACKFILL Interval (ft)	SCREEN ~~Length~~ INTERVAL	Piezometer #	Piezometer Depth	Pumping Port #	Pumping Port Depth	Volume Pumped	Apparent "T"	Comments (Geology, etc.)
QA 1			2	668.0					Total Length MP = 688.0'
Zone 2	615-679	650-660	4	653.0	3	663.0			Midpoint of Coupling #81 1.0"
QA 3			7	633.0					Above Original Ground Surface
Zone 4	547-581	555-565	15	558.0	14	568.0			∴ MP Bottom at 687.9'
QA 5			18	538.0					
Zone 6	320-366	344-354	39	346.0	38	356.0			Depths to center of couplings;
QA 7			42	326.0					does not account for thermal or
Zone 8	223-270	250-260	52	252.0	51	262.0			compression or tension effects.
QA 9			55	232.0					
Zone 10	155-192	170-180	62	172.0	61	182.0			Depths of backfill and well
									screen intervals provided by
									EBASCO

TABLE 5

TABLE 6

Sheet 1 of 7

Westbay Instruments Inc.

MP System Casing Installation Log

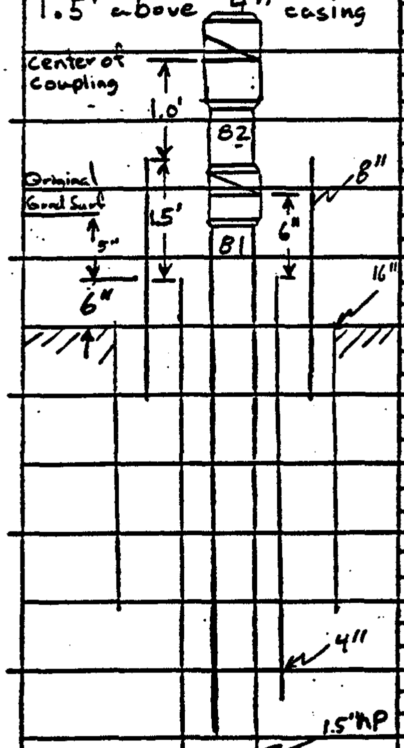
Project: NASA JET PROPULSION LABORATORY /EBASCO WB Ref: WB 650

Location: PASADENA, CALIFORNIA Hole No: MW3 Installed by: ER/KS/D.NYE/M.CUTLER

Hole Depth: 720 ft MP Depth: 688 ft Hole Diameter: 9 7/8"/4" STEEL Date Installed: FEB 11, 1990

Measurement Datum: ORIGINAL GROUND SURFACE Datum Elevation: Date Drawn: JAN 31/90

Depth ft	Geological Description	Geologic Log	MP Casing Log	Serial No. Batch No.	Final Packer Pressure/Volume	Comments	Joint Tests joint	Joint Tests pass
0			83 82 81			82 13:37	✓	✓
	Total length of steel 702'6"		80			81 - 90psi 13:33	✓	✓
	Original ground surface 2'6" Below top of steel					#80 - 90psi 13:39	✓	✓
10	Changed Ground Surface then cut off 2' 11" of		79			13:24	✓	✓
	4" steel Add 8" protective casing					+8 Litres +8 Litres		
20	1.5' above 4" casing		78			90psi 13:20	✓	✓
30			77			90psi 13:17	✓	✓
40			76			90psi 13:14	✓	✓
50			75			90psi 13:11	✓	✓
						+7 Litres +5 Litres H_2O		
60			74			90 psi 13:07	✓	✓
70			73			90psi 13:04	✓	✓
80	Hydraulic Integrity Test 392.7 @ 15:05		72			90psi 13:01	✓	✓
	392.62 @ 15:16 392.61 @ 15:24							
90	NOTE: 8" CASING HAS A LOCKABLE TOP.		71			90psi 12:58	✓	✓
100	Grout To 98' →							



Regular MP Casing | MP Packer | Settlement Casing | Measurement Port Coupling | Pumping Port Coupling | Regular Coupling

221187

Westbay Instruments Inc.

MP System Casing Installation Log

Project: NASA JET PROPULSION LABORATORY / EBASCO WB Ref: WB 650

Location: PASADENA, CALIFORNIA Hole No: MW 3 Installed by: ER/KS/D. NYE/M. CUTL

Hole Depth: 720 ft MP Depth: 688 ft ORIGINAL Hole Diameter: 9 7/8 / 4" STEEL Date Installed: FEB. 11, 1990

Measurement Datum: GROUND SURFACE Datum Elevation: Date Drawn: JAN 31/90

Depth ft	Geological Description	Geologic Log	MP Casing Log	Serial No. Batch No.	Final Packer Pressure/Volume	Comments	Joint Tests joint	Joint Tests pass
100			70		DEPTH TO MIDDLE OF COUPLING FROM ORIGINAL GROUND SURFACE	90 psi 12:51	✓	✓
	BENSEAL VOLCLAY							
110	GROUT TO 98'		69			90psi 12:47	✓	✓
						+7 Litres H_2O +8 Litres H_2O		
120	SEAL MATERIAL 1:1 MIX MONTEREY #3 SAND AND BENSEAL		68			90psi 12:42	✓	✓
130			67			90 psi 12:39	✓	✓
140			66			90psi 12:36	✓	✓
150			65			90psi 12:31	✓	✓
160	ZONE 10		64			90psi 12:28	✓	✓
			63			+8 Litres +8 Litres H_2O 90psi 12:25	✓	✓
170		SCREEN	62	5260	172.0'	90psi 12:20	✓	✓
180			61	2730 3059	182.0'	90 psi 12:16	✓	✓
			60			90psi 12:13	✓	✓
190			59			90psi 12:10	✓	✓
200								

Regular MP Casing | MP Packer | Settlement Casing | Measurement Port Coupling | Pumping Port Coupling | Regular Coupling

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Sheet 3 of 7

Westbay Instruments Inc.

MP System Casing Installation Log

Project: NASA JET PROPULSION LABORATORY / EBASCO WB Ref: WB 650

Location: PASADENA, CALIFORNIA Hole No: MW 3 Installed by: ER/KS/D.NYE/M.CUTLER

Hole Depth: 720 Ft MP Depth: 688 Ft. ORIGINAL Hole Diameter: 9⅞"/4" STEEL Date Installed: FEB 11, 1990

Measurement Datum: GROUND SURFACE Datum Elevation: ____ Date Drawn: JAN 31/90

Depth Ft	Geological Description	Geologic Log	MP Casing Log	Serial No. Batch No.	Final Packer Pressure/Volume	Comments	Joint Tests: joint	Joint Tests: pass
200			58			90psi 12:05	✓	✓
	SEAL MATERIAL 1:1 MIX MONTEREY #3							
210	SAND AND BENSEAL.		57			90psi 12:02	✓	✓
220			56			90psi 11:59	✓	✓
230	FILTER PACK MONTEREY #2/12 SAND		55	5262	232.0'	90psi 11:56	✓	✓
240	ZONE 8		54	3060		90psi 11:53	✓	✓
			53			90psi 11:50	✓	✓
250		SCREEN	52	5263	252.0'	90psi 11:47	✓	✓
						+8 litres +8 litres Tapwater		
260			51	2737 3061	262.0'	90psi 11:42	✓	✓
			50			90psi 11:38	✓	✓
270								
280			49			90psi 11:35	✓	✓
						90pst 11:31	✓	✓
290			48			90psi 11:25	✓	✓
			47, 46			90psi 11:23	✓	✓
300			45			90psi 11:28	✓	✓

Regular MP Casing | MP Packer | Settlement Casing | Measurement Port Coupling | Pumping Port Coupling | Regular Coupling

Sheet 4 of 7

Westbay Instruments Inc.

MP System Casing Installation Log

Project: NASA JET PROPULSION LABORATORY / EBASCO WB Ref: WB 650
Location: PASADENA, CALIFORNIA Hole No: MW 3 Installed by: ER/KS/D. NYE/M. CUTL
Hole Depth: 720 ft MP Depth: ORIGINAL 688 ft. Hole Diameter: 9 7/8"/4" STEEL Date Installed: FEB 11, 1990
Measurement Datum: GROUND SURFACE Datum Elevation: ____ Date Drawn: JAN 31/90

Depth ft	Geological Description	Geologic Log	MP Casing Log	Serial No. Batch No.	Final Packer Pressure/Volume	Comments	Joint Tests joint	Joint Tests pass
300								
			44			90psi 11:20	✓	✓
310								
			43			90psi 11:16	✓	✓
320	ZONE 6					Add 9 litres H_2O		
			42	5261	326.0'	90psi 11:11	✓	✓
330						Add 8 litres H_2O Pasadena City water from JPL Lab Tap.		
			41	3057		90psi 11:07	✓	✓
340			40			90psi 11:04	✓	✓
		SCREEN	39 M	5254	346.0'	90psi 11:00	✓	✓
350								
			38	2734 3056	356.0'	90psi 10:56	✓	✓
360			37			90psi 10:53	✓	✓
			36			90psi 10:47	✓	✓
			35			90psi 10:49	✓	✓
370								
380			34			90psi 10:43	✓	
390			33			90psi 10:40	✓	✓
400			32			90psi 10:36	✓	✓

Regular MP Casing | MP Packer | Settlement Casing | Measurement Port Coupling | Pumping Port Coupling | Regular Coupling

Westbay Instruments Inc.

MP System Casing Installation Log

Project: NASA JET PROPULSION LABORATORY / EBASCO WB Ref: WB 650

Location: PASADENA, CALIFORNIA Hole No: MW 3 Installed by: ER/KS/D.NYE/M.CUTLE

Hole Depth: 720 ft MP Depth: ORIGINAL 688 ft. Hole Diameter: 9 7/8/4" STEEL Date Installed: FEB. 11, 1990

Measurement Datum: GROUND SURFACE Datum Elevation: ______ Date Drawn: JAN 31/90

Depth, Ft	Geological Description	Geologic Log	MP Casing Log	Serial No. Batch No.	Final Packer Pressure/Volume	Comments	Joint Tests joint	Joint Tests pass
400								
410			31			90psi 10:32	✓	✓
420			30			90psi 10:28	✓	✓
430			29			90psi 10:25	✓	✓
440			28			90psi 10:09	✓	
450			27			90psi 10:06	✓	✓
460			26			90psi 10:01	✓	✓
470			25			90psi 9:57	✓	✓
480			24			90psi 9:54	✓	✓
490			23			90psi 9:50	✓	✓
500			22			90psi 9:45	✓	✓

Regular MP Casing | MP Packer | Settlement Casing | Measurement Port Coupling | Pumping Port Coupling | Regular Coupling

Westbay Instruments Inc.

MP System Casing Installation Log

Project: NASA JET PROPULSION LABORATORY / EBASCO WB Ref: WB 650

Location: PASADENA, CALIFORNIA Hole No: MW 3 Installed by: ER/KS/D. NYE/M. CU?LF

Hole Depth: 720 ft MP Depth: 688 ft Hole Diameter: 9 7/8 / 4" STEEL Date Installed: FEB. 11, 1990

Measurement Datum: ORIGINAL GROUND SURFACE Datum Elevation: Date Drawn: JAN 31/90

Depth ft	Geological Description	Geologic Log	MP Casing Log	Serial No. Batch No.	Final Packer Pressure/Volume	Comments	Joint Tests joint	Joint Tests pass
500								
510			21			90psi 9:42	✓	✓
520			20			90psi 9:37	✓	✓
530			19			90psi 9:34	✓	✓
540			18	5255	538.0'	9:31 90 psi ~~9:28~~	✓	✓
550	ZONE 4		17	3062		90psi 9:25	✓	✓
		SCREEN	16			90psi 9:22	✓	✓
560			15 (M)	5256	558.0'	90psi 9:19	✓	✓
570			14	2728 3055	568.0'	90psi 9:15	✓	✓
			13			90psi 9:11	✓	✓
580								
			12			90psi 9:07	✓	✓
590								
			11			90psi 9:03	✓	✓
600								

Regular MP Casing | MP Packer | Settlement Casing | Measurement Port Coupling | Pumping Port Coupling | Regular Coupling

Westbay Instruments Inc.

MP System Casing Installation Log

Project: NASA JET PROPULSION LABORATORY / EBASCO WB Ref: WB 650
Location: PASADENA, CALIFORNIA Hole No: MW 3 Installed by: ER/KS/D.NYE/M.CUTLER
Hole Depth: 720 ft MP Depth: 688 ft Hole Diameter: 9 3/8"/4" STEEL Date Installed: FEB. 11, 1990
Measurement Datum: ORIGINAL GROUND SURFACE Datum Elevation: Date Drawn: JAN 31/90

Depth ft.	Geological Description	Geologic Log	MP Casing Log	Serial No. Batch No.	Final Packer Pressure/Volume	Comments	Joint Tests joint	pass
600			10			90psi 08:59	✓	✓
610			9			90psi 08:56	✓	✓
620	ZONE 2		8			90psi 08:53	✓	✓
630			7	5258	633.0'	90psi 08:49	✓	✓
640			6	3054		90psi 08:45	✓	✓
						90psi 08:41	✓	✓
650		SCREEN	5					
			4 PM	5257	653.0'	90psi 08:34	✓	✓
660			3	2731 3053	663.0'	90psi 08:30	✓	✓
			2	5259	668.0'	90psi 08:26	✓	✓
670								
680			1			90psi 08:21	✓	✓
	INFLATION TOOL SET TO 280 psi AFTER 1 MINUTE STABILIZATION					250-160 = 90 psi 08:08	✓	✓
690	BOTTOM OF 4" STEEL CASING = 700' 2 3/4" BGL					4" STEEL HAS CAP WELDED ON BOTTOM.		
700	BOTTOM OF DRILLHOLE = 720 ft BGL				JOINT TEST TOOL SET TO 160 psi 8:00 am			

Regular MP Casing | MP Packer | Settlement Casing | Measurement Port Coupling | Pumping Port Coupling | Regular Coupling

Westbay Instruments Inc.

CASING COMPLETION SUMMARY

Page ____ of ____

Site Location: NASA JET PROPULSION LABORATORY

Drillhole No.: MW-4

Weather/Temperature:

Installation Date: Feb 16, 1990

Technician(s): ER/KS/M BARNES

Job No./Client: WB-650

Completion Zone	BACKFILL Interval (ft)	SCREEN ~~Length~~ INTERVAL	Piezometer		Pumping Port		Volume Pumped	Apparent "T"	Comments (Geology, etc.)
			#	Depth	#	Depth			
QA1			2	527.6'					
ZONE 2	480-532	509.4 - 519.4	4	512.6'	3	522.6'			
QA3			7	492.6'					
ZONE 4	370-426	388.9 - 398.9	20	391.6'	19	401.6'			
QA5			23	371.6'					
ZONE 6	303-348	319.6 - 329.6	29	321.6'	28	331.6'			
QA7			32	301.6'					
ZONE 8	203-257	237.2 - 247.2	38	239.6'	39	249.6'			
QA9			43	219.6'					
ZONE 10	121 - 169	146.8 - 156.8	51	149.6'	50	159.6'			

TABLE 7

TABLE 8

Sheet 1 of 6

Westbay Instruments Inc.

MP System Casing Installation Log

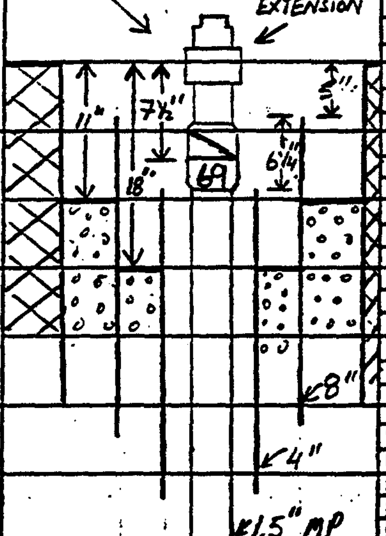
Project: NASA JET PROPULSION LABORATORY / EBASCO WB Ref: 650

Location: PASADENA, CALIFORNIA Hole No: MW-4 Installed by: ER/KS/M BARNES.

Hole Depth: 605' MP Depth: 547' Hole Diameter: 12¼"/4" STEEL Date Installed: FEB 16/90

Measurement Datum: GROUND SURFACE (ASPHALT) Datum Elevation: ______ Date Drawn: FEB 15/90

Depth, ft	Geological Description	Geologic Log	MP Casing Log	Serial No. Batch No.	Final Packer Pressure/Volume	Comments 400 16 ℓ H_2O	Joint Tests joint	Joint Tests pass
0	TEMPORARY EXTENSION { TOP OF CUTOFF MP 3' ABOVE G.L.		69		HYDRAULIC TEST @ 6:34 p.m.	69 1[illegible]	✓	✓
			68			68 100psi 18:17	✓	✓
			67		FEB 16 = 311.40 FROM TOP MP ~5 min after	67 100psi 18:16	✓	✓
10	MIDPOINT OF COUPLING #69 7½" BELOW GROUND SURFACE (ASPHALT)		66		adding H_2O 9:45 a.m. FEB 17 311.43 ∴ SEALED SYSTEM.	105psi 1820	✓	✓
20			65			100psi 1800	✓	✓
30	SUBSURFACE COMPLETION		64			90psi 17:58	✓	✓
40			63			100psi 17:54	✓	✓
50			62			110psi 17:52	✓	✓
60			61			100psi 17:48	✓	✓
70			60			130psi 17:47	✓	✓
80	BENSEAL VOLCLAY GROUT		59			100psi 17:44 400 14 ℓ	✓	✓
90			58			130psi 17:39	✓	✓
100	SEAL MIXTURE		57			105psi 17:37	✓	✓



Regular MP Casing | MP Packer | Settlement Casing | Measurement Port Coupling | Pumping Port Coupling | Regular Coupling

Westbay Instruments Inc.

Sheet 2 of 6

MP System Casing Installation Log

Project: NASA JET PROPULSION LABORATORY / EBASCO WB Ref: 650

Location: PASADENA, CALIFORNIA Hole No: MW-4 Installed by: ER/KS/M. BARNES

Hole Depth: 605' MP Depth: 547' Hole Diameter: 12¼" / 4" STEEL Date Installed: FEB 16/90

Measurement Datum: GROUND SURFACE (ASPHALT) Datum Elevation: Date Drawn: FEB 15/90

Depth ft	Geological Description	Geologic Log	MP Casing Log	Serial No. Batch No.	Final Packer Pressure/Volume	Comments	Joint Tests joint	Joint Tests pass
100					DEPTH TO MIDDLE OF COUPLING FROM GROUND SURFACE			
110	SEAL MATERIAL 1:1 MIX MONTEREY #3 SAND AND BENSEAL		56			110psi 17:35	✓	✓
120			55			105psi 17:33	✓	✓
130	FILTER PACK MONTEREY #2½ SAND		54			105psi 17:31	✓	✓
140			53	3051		100psi 17:28	✓	✓
						100psi 17:24	✓	✓
	ZONE 10	146.8' SCREEN	52			ADD 14 l H_2O		
150				5121	149.6'	100psi 17:19	✓	✓
			51					
		156.8'						
160			50	2732 3043	159.1'	95psi 17:16	✓	✓
			49			80psi 17:13	✓	✓
170			48			100 psi 17:09	✓	✓
180			47			110 psi 17:06	✓	✓
190			46			110psi 17:04	✓	✓
200			45			100psi 17:01	✓	✓

Regular MP Casing | MP Packer | Settlement Casing | Measurement Port Coupling | Pumping Port Coupling | Regular Coupling

Westbay Instruments Inc.

MP System Casing Installation Log

Project: NASA JET PROPULSION LABORATORY / EBASCO WB Ref: 650

Location: PASADENA, CALIFORNIA Hole No: MW-4 Installed by: ER/KS/M. BARNES

Hole Depth: 605' MP Depth: 547' Hole Diameter: 12¼" / 4" STEEL Date Installed: Feb 14/90

Measurement Datum: GROUND SURFACE/ASPHALT Datum Elevation: Date Drawn: FEB 15/90

Depth, ft	Geological Description	Geologic Log	MP Casing Log	Serial No. Batch No.	Final Packer Pressure/Volume	Comments	Joint Tests joint	Joint Tests pass
200								
						100psi 16:56	✓	✓
210			44			ADD 16 l H_2O		
220			43	5273 QA9	219.6'	120psi 16:51	✓	✓
	ZONE 8					100psi 16:47	✓	✓
230			42	3050				
						110psi 16:44	✓	✓
		237.2	41					
240		SCREEN	40	5264	239.6'	100psi 16:40	✓	✓
		247.2						
250			39	2729 3049	249.6'	100psi 16:35	✓	✓
			38			100psi 16:30	✓	✓
			37			110psi 16:22	✓	✓
260			36			110psi 16:26	✓	✓
270			35			120psi 16:17	✓	✓
280			34			100psi 16:14	✓	✓
290			33			115psi 16:10	✓	✓
300								

Regular MP Casing | MP Packer | Settlement Casing | Measurement Port Coupling | Pumping Port Coupling | Regular Coupling

Sheet 4 of 6

Westbay Instruments Inc.

MP System Casing Installation Log

Project: NASA JET PROPULSION LABORATORY / EBASCO WB Ref: 650

Location: PASADENA, CALIFORNIA Hole No: MW-4 Installed by: ER/KS/MIKE BARNES

Hole Depth: 605' MP Depth: 547' Hole Diameter: 12¼" / 4" STEEL Date Installed: FEB 16, 1990

Measurement Datum: GROUND SURFACE/ASPHALT Datum Elevation: Date Drawn: FEB 15, 1990

Depth, ft	Geological Description	Geologic Log	MP Casing Log	Serial No. Batch No.	Final Packer Pressure/Volume	Comments	Joint Tests joint	Joint Tests pass
300	ZONE 6		32	5267 QA7	301.6'	95psi 16:07	✓	✓
310			31	3048	16:04 ✓ 110 psi	LEAKS REPLACE 15:59	✓	—
			30			110psi 15:54	✓	✓
320		319.6 SCREEN	29	5120	321.6'	105psi 15:51	✓	✓
330		329.6	28	2735 3044	331.6	105psi 15:48	✓	✓
			27			100psi 15:45	✓	✓
340			26			105psi 15:41	✓	✓
350			25			105psi 15:39	✓	✓
360			24			110psi 15:35	✓	✓
370	ZONE 4		23	5119 QA5	371.6'	105psi 15:32	✓	✓
380			22	3052		110psi 15:29	✓	✓
		388.9	21			105psi 15:25	✓	✓
390		SCREEN	20	5265	391.6	95psi 15:23	✓	✓
400		398.9						

Regular MP Casing | MP Packer | Settlement Casing | Measurement Port Coupling | Pumping Port Coupling | Regular Coupling

Sheet 5 of 6

Westbay Instruments Inc.

MP System Casing Installation Log

Project: NASA JET PROPULSION LABORATORY / EBASCO WB Ref: 650

Location: PASADENA, CALIFORNIA Hole No: MW-4 Installed by: FR/ICS M. BARNES

Hole Depth: 605' MP Depth: 547' Hole Diameter: 12¼" / 4" STEEL Date Installed: Feb 16/90

Measurement Datum: GROUND SURFACE / ASPHALT Datum Elevation: Date Drawn: FEB 15, 1990

Depth. Ft	Geological Description	Geologic Log	MP Casing Log	Serial No. Batch No.	Final Packer Pressure/Volume	Comments	Joint Tests joint	pass
400	ZONE 4		19	2733 3045	401.6'	110psi 15:16	✓	✓
			18			100psi 15:09	✓	✓
410								
			17			105 psi 15:04	✓	✓
			16			110 psi 14:56	✓	✓
			15			115psi 14:59	✓	✓
420			14			95psi 15:01	✓	✓
430			13			100psi 14:52	✓	✓
440			12			100psi 14:47	✓	✓
450			11			95psi 14:42	✓	✓
460			10			100psi 14:39	✓	✓
470			9			100 psi 14:36	✓	
480	ZONE 2		8			80psi 14:32	✓	
490			7	4231 QA3	492.6'	80psi 14:29	✓	✓
500								

Regular MP Casing | MP Packer | Settlement Casing | Measurement Port Coupling | Pumping Port Coupling | Regular Coupling

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Sheet 6 of 6

Westbay Instruments Inc.

MP System Casing Installation Log

Project: NASA JET PROPULSION LABORATORY / EBASCO   WB Ref: 650

Location: PASADENA, CALIFORNIA   Hole No: MW-4   Installed by: ER/KS/M. BARNES

Hole Depth: 605'   MP Depth: 547'   Hole Diameter: 12¼" / 4" STEEL   Date Installed: Feb 16/90

Measurement Datum: GROUND SURFACE / ASPHALT   Datum Elevation: Date Drawn: FEB 15, 1990

Depth, ft.	Geological Description	Geologic Log	MP Casing Log	Serial No. Batch No.	Final Packer Pressure/Volume	Comments	Joint Tests joint	Joint Tests pass
500	ZONE 2		6	3046		70psi 14:25	✓	✓
			5			90psi 14:19	✓	✓
510		509.4 SCREEN	4	5269	512.6'	90psi 14:15	✓	✓
520		519.4	3	2736 3047	522.6'	90psi 14:11	✓	✓
			2	5266 QA1	527.6'	90psi 14:06	✓	✓
530								
			1		✓	90psi 14:01	✓	✓
540								
						90psi 13:51 Inflation tool valve	✓	✓
550						set at 150psi Set supply @ 240psi		
560				BOTTOM	OF 4"	STEEL 559.6'		
570								
580								
590								
600					TD OF HOLE	= 605 ft.		

Regular MP Casing | MP Packer | Settlement Casing | Measurement Port Coupling | Pumping Port Coupling | Regular Coupling

APPENDICES

COMPLETION REPORT

NASA JET PROPULSION LABORATORY SITE

PASADENA, CALIFORNIA

MONITORING WELL MW-3 AND MW-4 EQUIPPED

WITH THE WESTBAY MP SYSTEM.

Ebasco Subcontract No. 7708-90S-2068

Prepared By:

Westbay Instruments Inc.

March 23, 1990

Westbay Ref.: WB650-90

Distribution List:

Ebasco Services Incorporated Mr. Dan Melchior - 1 copy

Appendix A

MW-3 Casing Length Measurement Record - 3 Sheets
MW-3 Packer Inflation Record - 10 Sheets
MW-4 Casing Length Measurement Record - 3 Sheets
MW-4 Packer Inflation Record - 10 Sheets

Casing Length

Westbay Instruments Inc.

Project: NASA JET PROPULSION LABORATORY/EBASCO Date: FEB. 10/90 Project No.: WB 650

Location: PASADENA, CALIFORNIA Drillhole No.: MW-3 Nominal B.O.H.: 720'

Casing Size/Type: Plastic 1.5" MP Measured by: T° = 63°F ER/KS Checked by: —

from top of MP

Section No.	Serial No.	Description	Nominal Length, ft. m.	Measured Length, ft. m.	Cummulative Length, ft. m.	Meas. Temp. C	Centralizers	Magnetic Collars
1		10+R		10.01	-.433			
2		10+M		~~9.98~~ -.002	-.435			
3		5+P		+.002	-.437.			
4		10+M		+.001	-.438			
5		5+R		-.08	-.358			
6		P+R		+.005	-.363			
7		10+M		+.008	-.371			
8		10+R		+.005	-.376			
9		10+R		+.001	-.377			
10		10+R		+.000	-.377			
11		10+R		+.001	-.378			
12		10+R		+.008	-.386			
13		10+R		+.008	-.394			
14		P+P		+.001	-.395			
15		10+M		+.005	-.400			
16		5+R		-.08	-.320			
17		P+R		+.008	-.328			
18		10+M		+.01	-.329			
19		10+R		-.005	-.324			
20		10+R		—	-.324			
21		10+R		—	-.324			
22		10+R		—	-.324			
23		10+R		+.009	-.332			
24		10+R		+.003	-.335			
25		10+R		+.008	-.343			
26		10+R		—	-.343			
27		10+R		—	-.343			
28		10+R		+.002	-.345			
29		10+R		+.001	-.346			
30		10+R		+.010	-.356			

Westbay Instruments Inc.

Casing Length

Project: NASA JET PROPULSION LABORATORY Date: Feb 10/90 Project No.: WB-650

Location: PASADENA, CALIFORNIA Drillhole No.: MW-3 Nominal B.O.H.: 720'

Casing Size/Type: Plastic 1.5" MP Measured by: ER/KS Checked by: ———

Section No.	Serial No.	Description	Nominal Length, ft. m.	Measured Length, ft. m.	Cummulative Length, ft. m.	Meas. Temp. C	Centralizers	Magnetic Collars
31		10+R		+.010	-.366			
32		10+R		-.002	-.364			
33		10+R		+.002	-.366			
34		10+R		+.009	-.375			
35		10+R		+.002	-.377			
36		2+R		—	-.377			
37		5+R		-.075	-.302			
38		P+P		+.010	-.303			
39		10+M		+.010	-.304			
40		5+R		-.076	-.228			
41		P+R		+.005	-.233			
42		10+R		+.001	-.234			
43		10+R		—	-.234			
44		10+R		—	-.234			
45		10+R		+.002	-.236			
46		5+R		—	-.236			
47		2+R		—	-.236			
48		2+R		-.069	-.167			
49		10+R		—	-.167			
50		10+R		—	-.167			
51		P+P		+.002	-.169			
52		10+M		+.001	-.170			
53		5+R		-.078	-.092			
54		P+R		+.001	-.093			
55		10+M		—	-.093			
56		10+R		-.005	-.088			
57		10+R		-.001	-.087			
58		10+R		—	-.087			
59		10+R		—	-.087			
60		5+R		-.078	-.049			

Westbay Instruments Inc.

Casing Length

Project: NASA JET PROPULSION LABORATORY Date: Feb 10/90 Project No.: WB-650

Location: PASADENA CALIFORNIA. Drillhole No.: MW-3 Nominal B.O.H.: 720'

Casing Size/Type: Plastic 1.5" MP Measured by: ER/KS Checked by: —

Section No.	Serial No.	Description	Nominal Length. ft. m.	Measured Length. ft. m.	Cummulative Length. ft. m.	Meas. Temp. C	Centralizers	Magnetic Collars
61		P+P		+.008	-.057			
62		10+M		+.001	-.058			
63		5+R		-.072	+.014			
64		P+R		+.010	+.004			
65		10+R		+.001	+.003			
66		10+R		-.002	+.005			
67		10+R		—	+.005			
68		10+R		—	+.005			
69		10+R		—	+.005			
70		10+R		—	+.005			
71		10+R		-.002	+.007			
72		10+R		—	+.007			
73		10+R		—	+.007			
74		10+R		—	+.007			
75		10+R		+.008	-.001			
76		10+R		—	-.001			
77		10+R		-.010	+.009			
78		10+R		—	+.009			
79		10+R		-.007	+.016			
80		10+R		+.010	+.006			
81		5+R			—			
82		2+R		+.006	Top of casing			
		Cumulative length	is with	respect	to top of coupling		on same	line
		apositive number	is Further	below	top of MP casing	than	nominal	lengths
		indicate						

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Westbay Instruments Inc.

MP Packer Inflation Record

Project: NASA JPL / EBASCO
Completed By: Kurt Seedhouse

Location: PASADENA CALIFORNIA
Date Completed: Feb. 15, 1990

Hole No.: MW-3
Date Inflated: Feb. 11, 1990

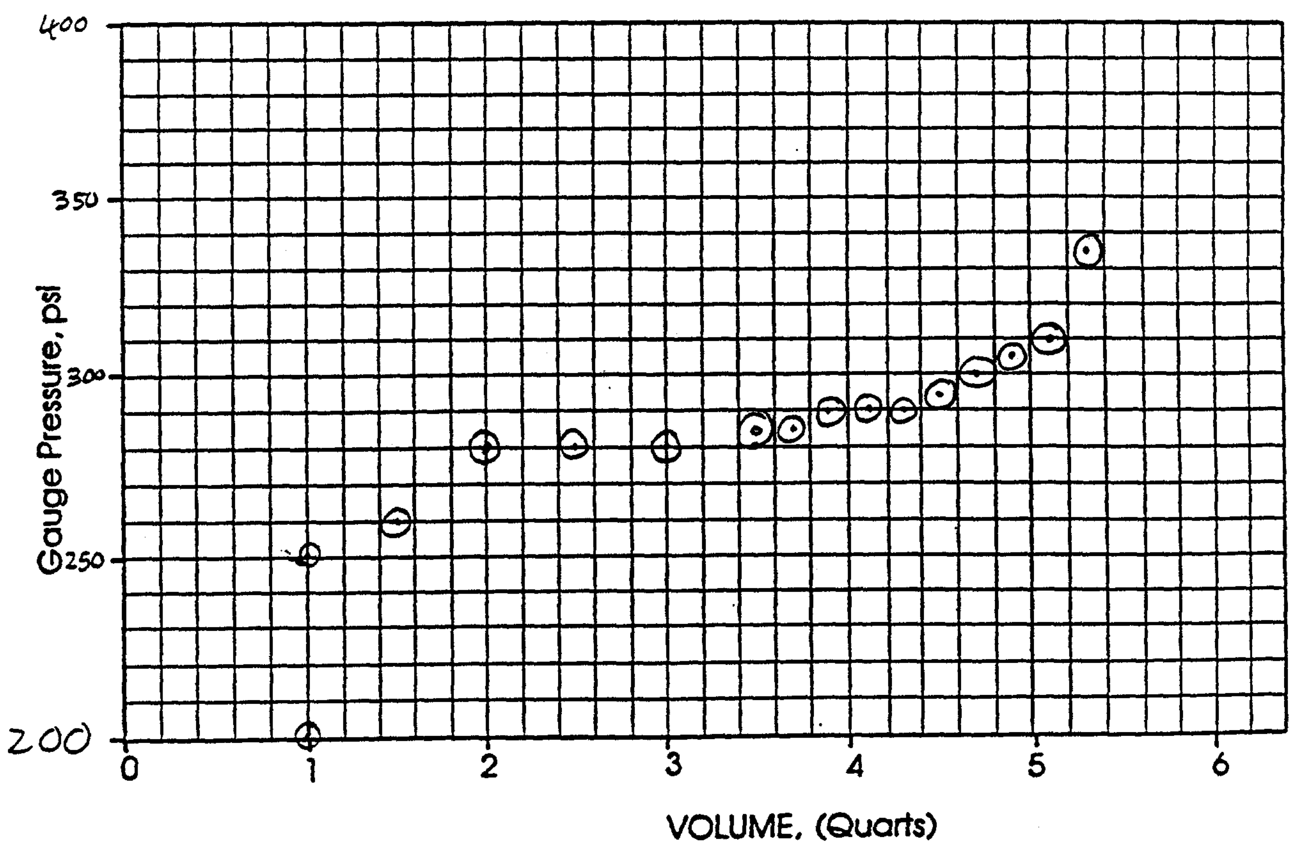
Packer No.: CASING #3
Depth (ft.) 664' – 667'

Inflation Tool Setting (psi) 280 psi @ 1.0 min.
Depth to Water Table (ft.) 131'

Volume Quarts	1.0	1.5	2.0	2.5	3.0	3.5	3.7	3.9	4.1	4.3	4.5
Pressure Psi	250	260	280	280	280	285	285	290	290	290	295
Quarts	4.7	4.9	5.1	5.3	4.4						
Psi	300	305	310	335	Ø						

Readings taken at 1 minute from line isolation

Plot of Gauge Pressure (psi) vs. Volume (Quarts)



Westbay Instruments Inc.

MP Packer Inflation Record

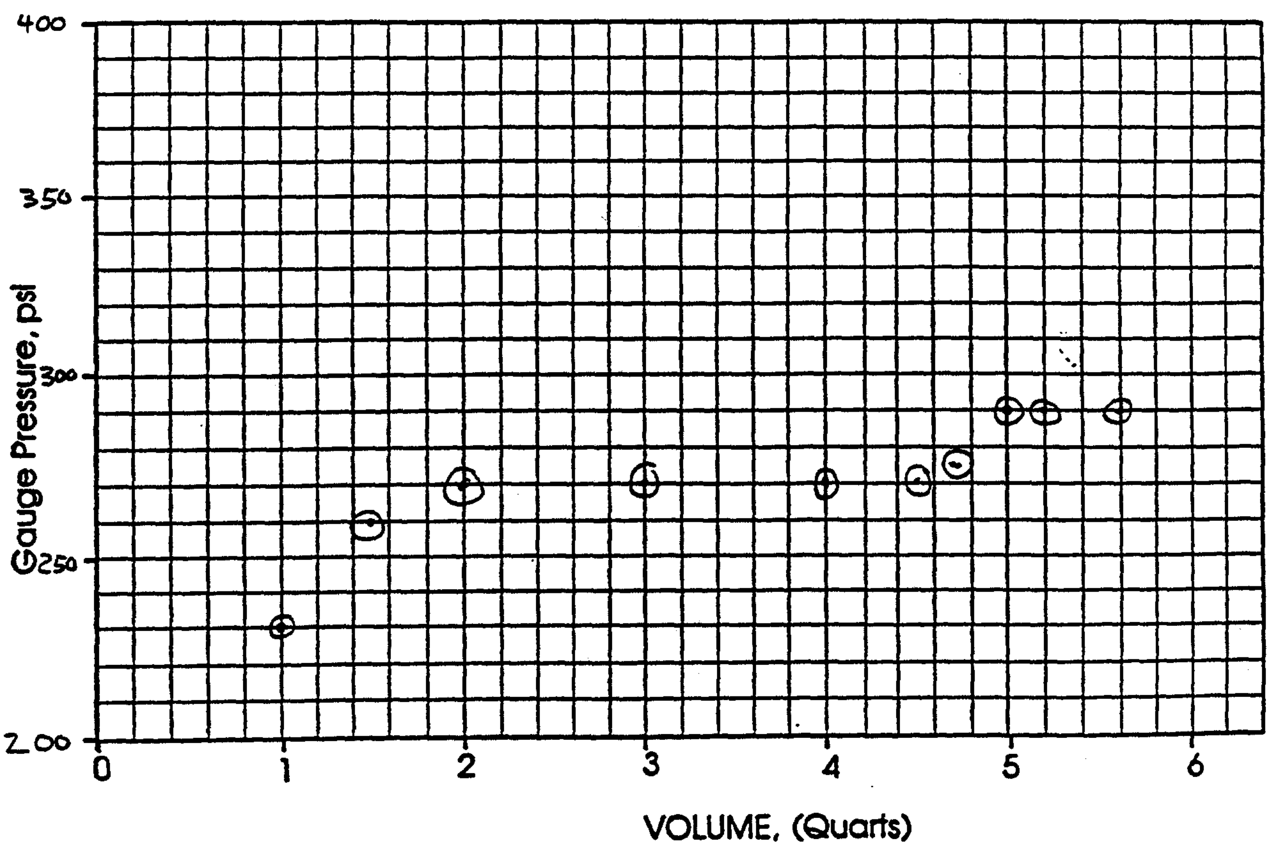
Project: NASA JPL /EBASCO
Completed By: K. Seedhouse
Location: PASADENA CALIFORNIA
Date Completed: Feb 15, 1990
Hole No.: MW-3
Date Inflated: Feb 11, 1990
Packer No.: CASING ELEMENT #6
Depth (ft.) 644' – 647'
Inflation Tool Setting (psi) 280 psi @ 1 min.
Depth to Water Table (ft.) 131'

Readings taken at 1 min. from line isolation

Volume Quarts	1.0	1.5	2.0	3.0	4.0	4.5	4.7	5.0	5.2	5.4
Pressure Psi	230	260	270	270	280	280	285	290	290	290

5.6	4.8	
290	Ø	

Plot of Gauge Pressure (psi) vs. Volume (Quarts)



Westbay Instruments Inc.

MP Packer Inflation Record

Project: NASA JPL /EBASCO

Completed By: K Seedhouse

Location: PASADENA CALIFORNIA

Date Completed: Feb 15 1990

Hole No.: MW-3

Date Inflated: Feb 11 1990

Packer No.: CASING ELEMENT #14

Depth (ft.) 569' - 572'

Inflation Tool Setting (psi) 280psi @ 1min.

Depth to Water Table (ft.) 131'

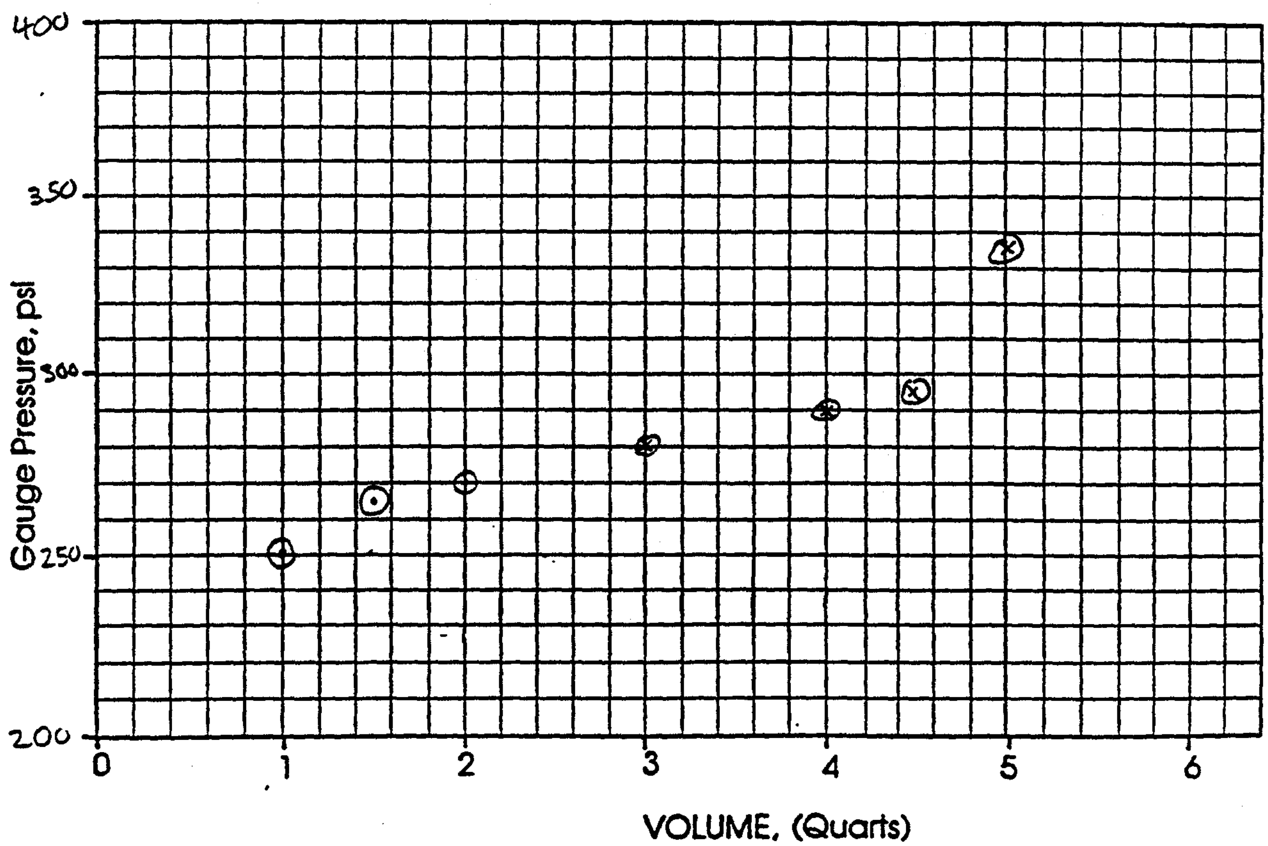
Pump @ 50psi
5:15p.m.

Volume Quarts	1.0	1.5	2.0	3.0	4.0	4.5	5.0	5.5	4.7	
Pressure Psi	250	265	270	280	290	295	300	335	0	

Readings taken 1minute after line isolation

Return 0.8 l

Plot of Gauge Pressure (psi) vs. Volume (Quarts)



Westbay Instruments Inc.

MP Packer Inflation Record

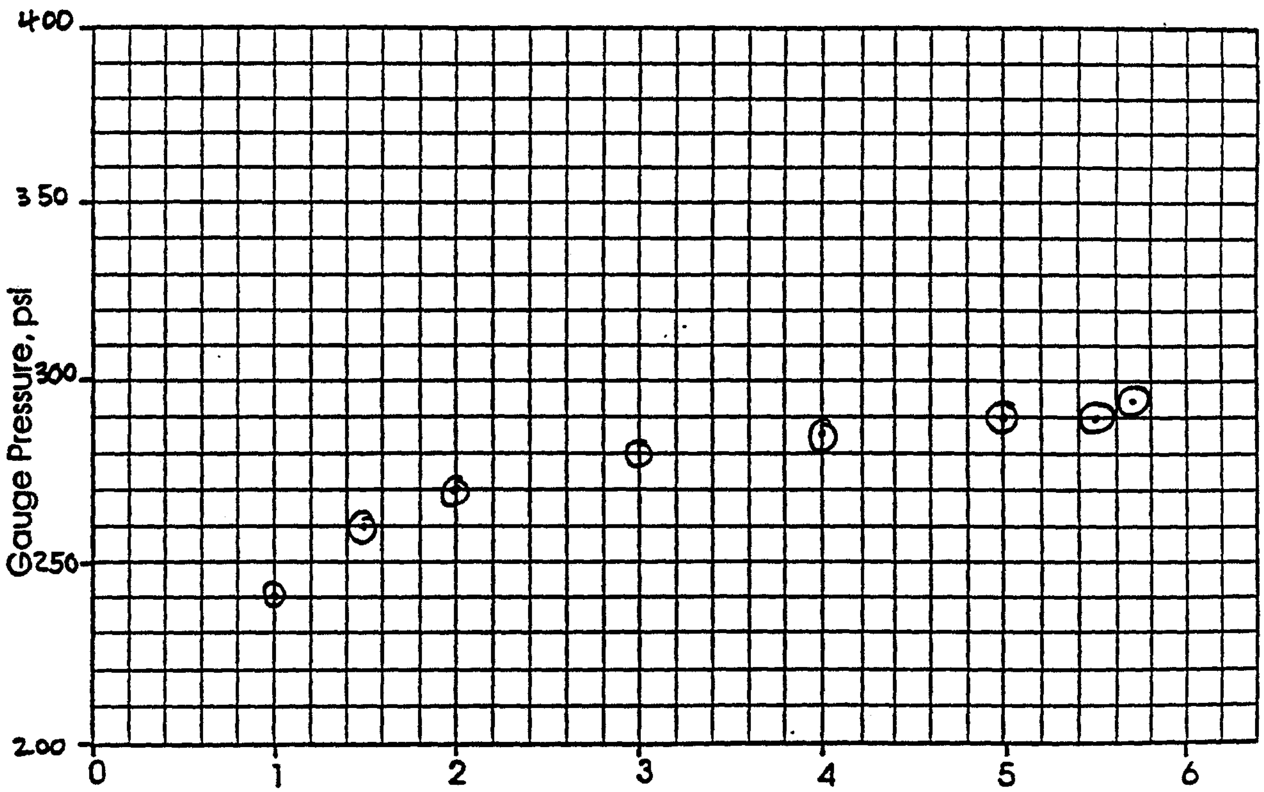
Project: NASA JPL / EBASCO
Completed By: K Seedhouse
Location: PASADENA CALIFORNIA
Date Completed: FEB 11/90
Hole No.: MW-3
Date Inflated: Feb. 11, 1990
Packer No.: CASING ELEMENT # 17
Depth (ft.) 549' – 552'
Inflation Tool Setting (psi) 280 psi @ 1 min.
Depth to Water Table (ft.) 131'

6:05 p.m.

Volume Quarts	1.0	1.5	2.0	3.0	4.0	4.5	5.0	5.5	5.7	0.8 RETURN
Pressure Psi	240	260	270	280	285	285	290	290	295	0

Readings taken 1 minute after line isolation

Plot of Gauge Pressure (psi) vs. Volume (Quarts)



Westbay Instruments Inc.

MP Packer Inflation Record

Project: NASA JPL /EBASCO
Completed By: K Seedhouse

Location: PASADENA CALIFORNIA
Date Completed: FEB 11/90

Hole No.: MW-3
Date Inflated: Feb 11, 1990

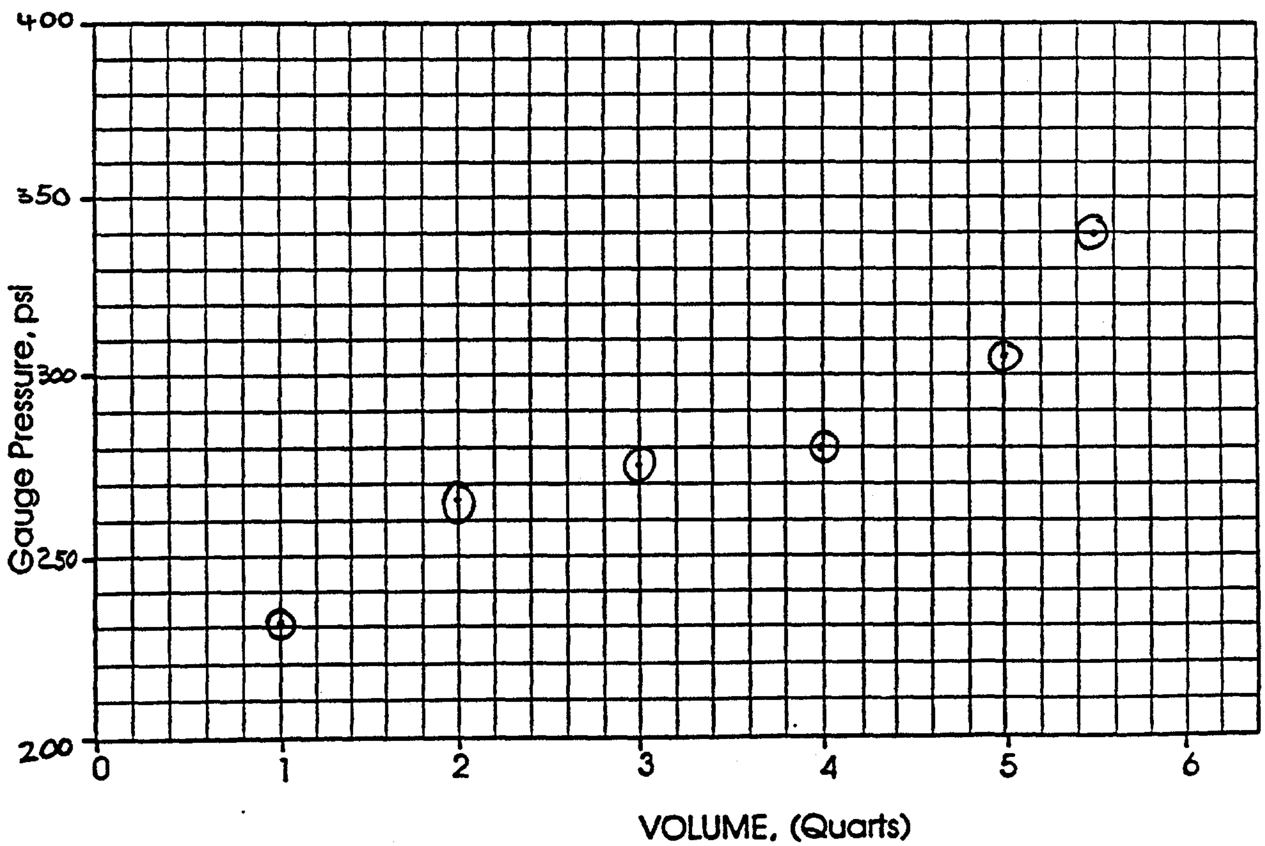
Packer No.: CASING ELEMENT # 38
Depth (ft.) 357' - 360'

Inflation Tool Setting (psi) 280 psi @ 1 min
Depth to Water Table (ft.) 131'

Volume Quarts	1.0	2.0	3.0	4.0	5.0	5.5	0.8			
Pressure Psi	230	265	275	280	305	340	0			

Readings taken @ 1 min. from time line isolated.

Plot of Gauge Pressure (psi) vs. Volume (Quarts)



Westbay Instruments Inc.

MP Packer Inflation Record

Project: NASA JPL / EBASCO

Completed By: K Seedhouse

Location: PASADENA CALIFORNIA

Date Completed: FEB 11/90

Hole No.: MW-3

Date Inflated: Feb 11, 1990

Packer No.: CASING ELEMENT #41

Depth (ft.) 337' - 340'

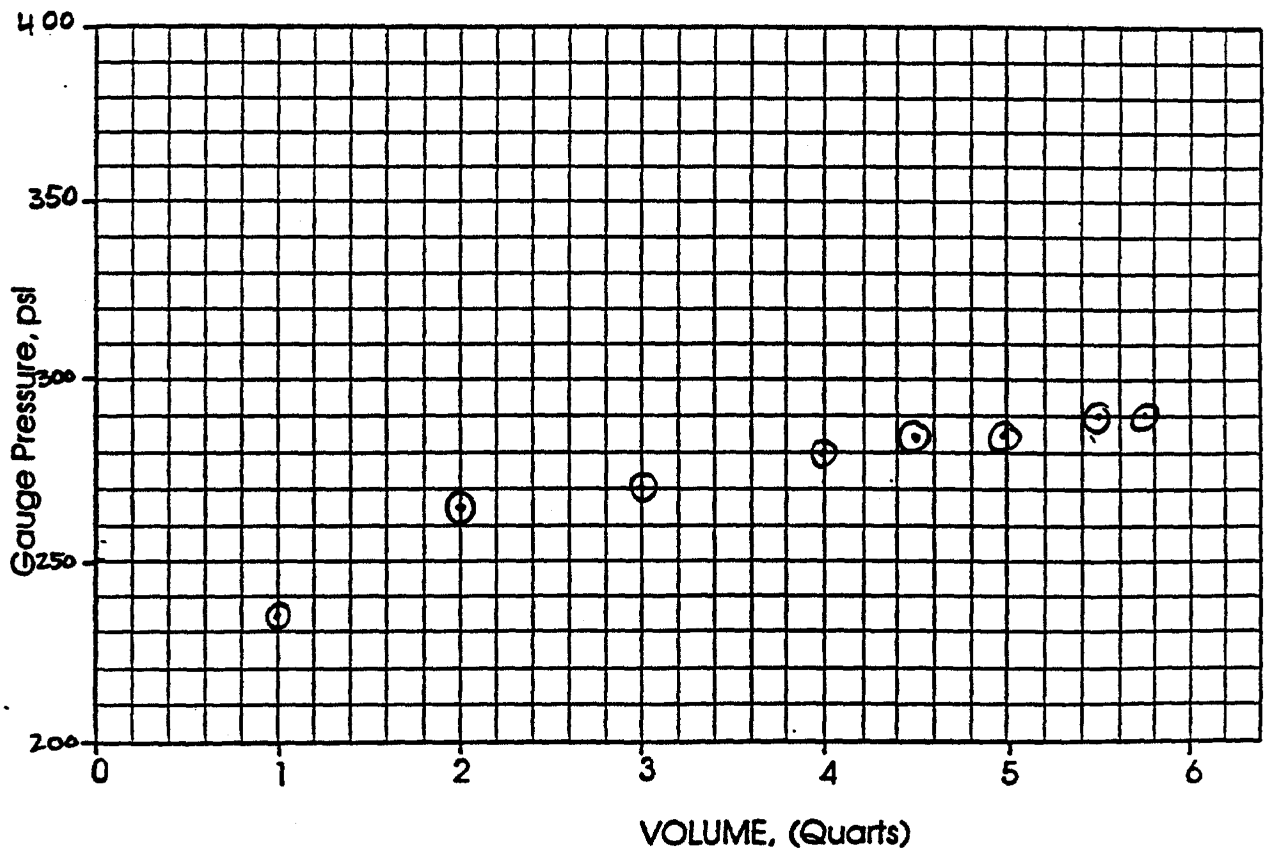
Inflation Tool Setting (psi) 280 psi @ 1 min

Depth to Water Table (ft.) 131'

Volume Quarts	1.0	2.0	3.0	4.0	4.5	5.0	5.25	5.5	5.75	0.8l RETURN
Pressure Psi	235	265	270	280	285	285	285	290	290	0

Readings taken at 1 minute from line isolation

Plot of Gauge Pressure (psi) vs. Volume (Quarts)



Westbay Instruments Inc.

MP Packer Inflation Record

Project: NASA JPL / EBASCO

Completed By: K Seedhouse

Location: PASADENA CALIFORNIA

Date Completed: FEB 11/90

Hole No.: MW-3

Date Inflated: Feb 11, 1990

Packer No.: CASING ELEMENT 51

Depth (ft.) 263' - 266'

Inflation Tool Setting (psi) 280psi @ 1min.

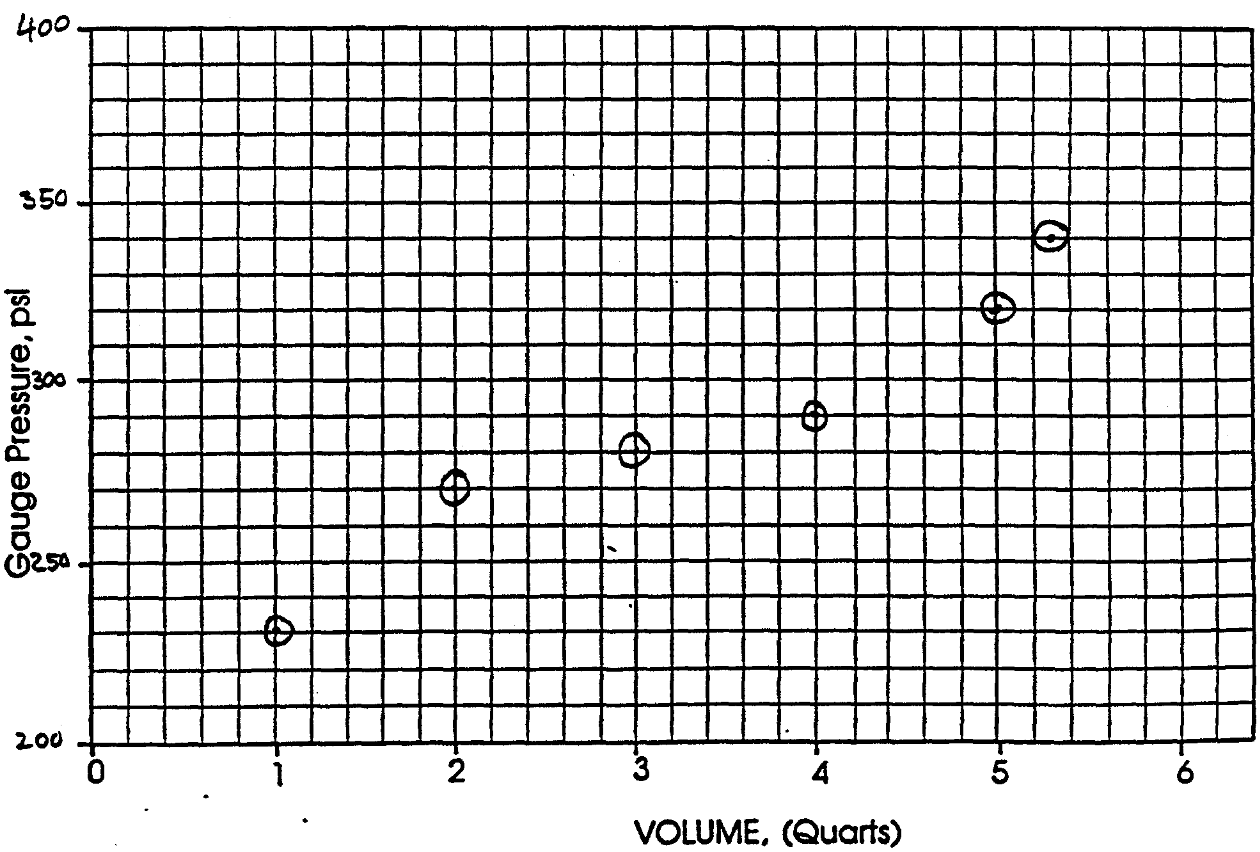
Depth to Water Table (ft.) 131'

9:20 P.M.

Volume Quarts	1.0	2.0	3.0	4.0	5.0	5.3	~0.8l RETURN			
Pressure Psi	230	270	280	290	320	340	0			

Readings taken 1minute from line isolation

Plot of Gauge Pressure (psi) vs. Volume (Quarts)



Westbay Instruments Inc.

MP Packer Inflation Record

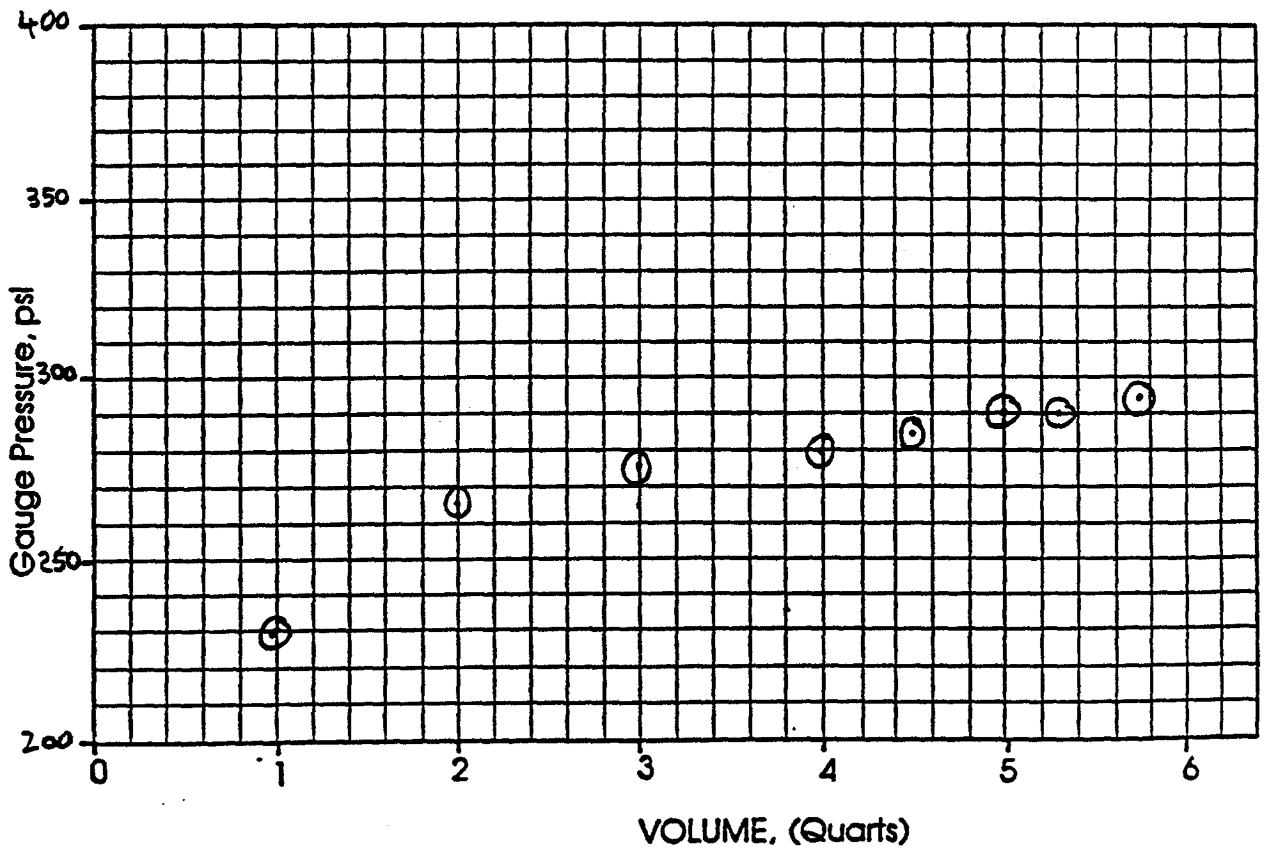
Project: NASA - JPL /EBASCO | Completed By: K Seedhouse
Location: PASADENA CALIFORNIA | Date Completed: Feb. 15 1990
Hole No.: MW-3 | Date Inflated: Feb 11 1990
Packer No.: CASING ELEMENT #54 | Depth (ft.) 243' - 246'
Inflation Tool Setting (psi) 280 psi at 1min. | Depth to Water Table (ft.) 131'

8:00 p.m.

Volume Quarts	1.0	2.0	3.0	4.0	4.5	5.0	5.3	5.75	~0.2 Return	
Pressure Psi	230	265	275	280	285	290	290	295	0	

Readings Taken 1minute from line isolation

Plot of Gauge Pressure (psi) vs. Volume (Quarts)



Westbay Instruments Inc.

MP Packer Inflation Record

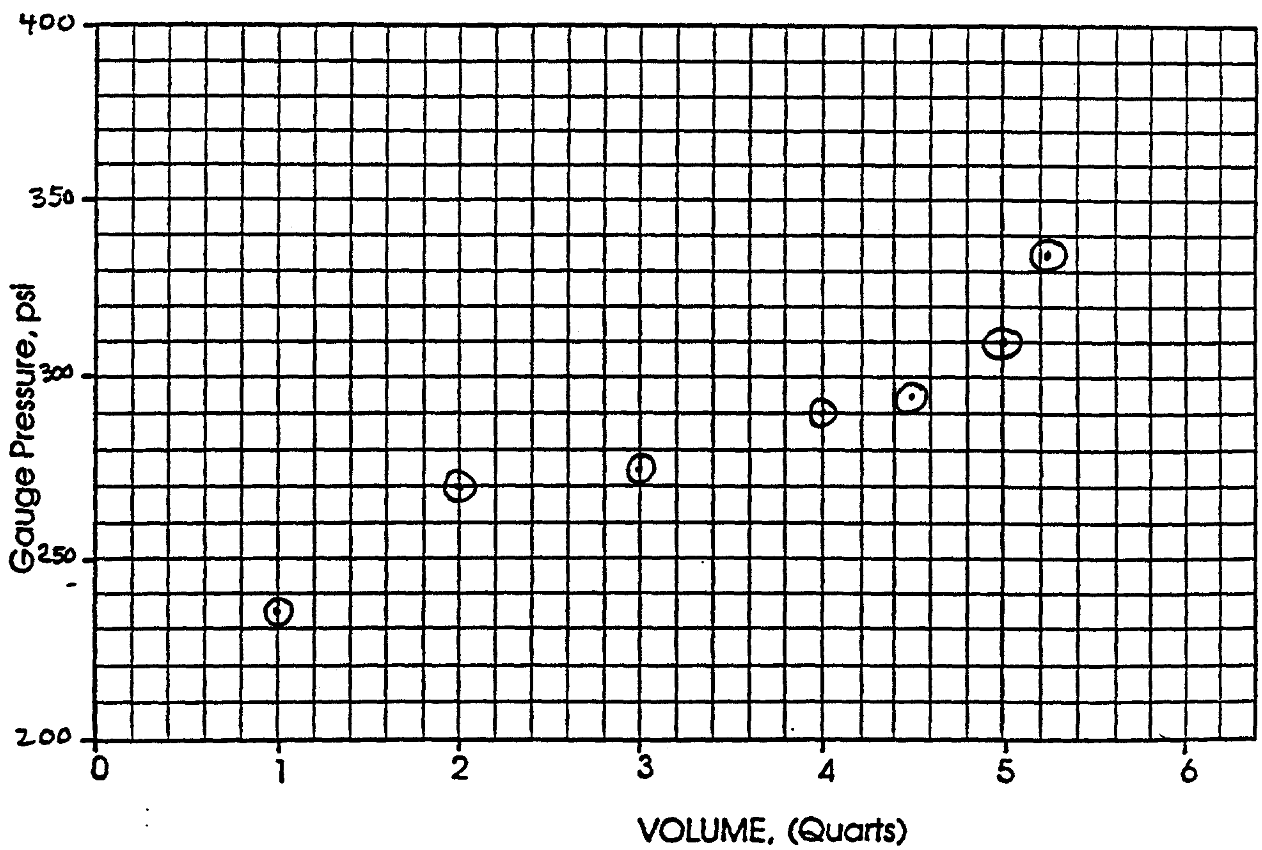
Project: NASA JPL /EBASCO
Completed By: ER /KS / MARK CUTLER
Location: PASADENA CALIFORNIA
Date Completed: FEB 11/90
Hole No.: MW-3
Date Inflated: Feb. 11, 1990
Packer No.: CASING ELEMENT # 61
Depth (ft.) 183' - 186'
Inflation Tool Setting (psi) 280 psi @ 1 min.
Depth to Water Table (ft.) 131'

8:07 p.m.

Volume Quarts	1.0	2.0	3.0	4.0	4.5	5.0	5.25	~0.8 l RETURN		
Pressure Psi	235	270	275	290	295	310	335	0		

Readings taken @ 1 minute from line isolation

Plot of Gauge Pressure (psi) vs. Volume (Quarts)



Westbay Instruments Inc.

MP Packer Inflation Record

Project: NASA JPL /EBASCO
Completed By: K Seedhouse

Location: PASADENA CALIFORNIA
Date Completed: FEB 11/90

Hole No.: MW-3
Date Inflated: Feb 11/90

Packer No.: CASING ELEMENT #64
Depth (ft.) 163' - 166'

Inflation Tool Setting (psi) 275 psi @ 1 min
Depth to Water Table (ft.) 131'

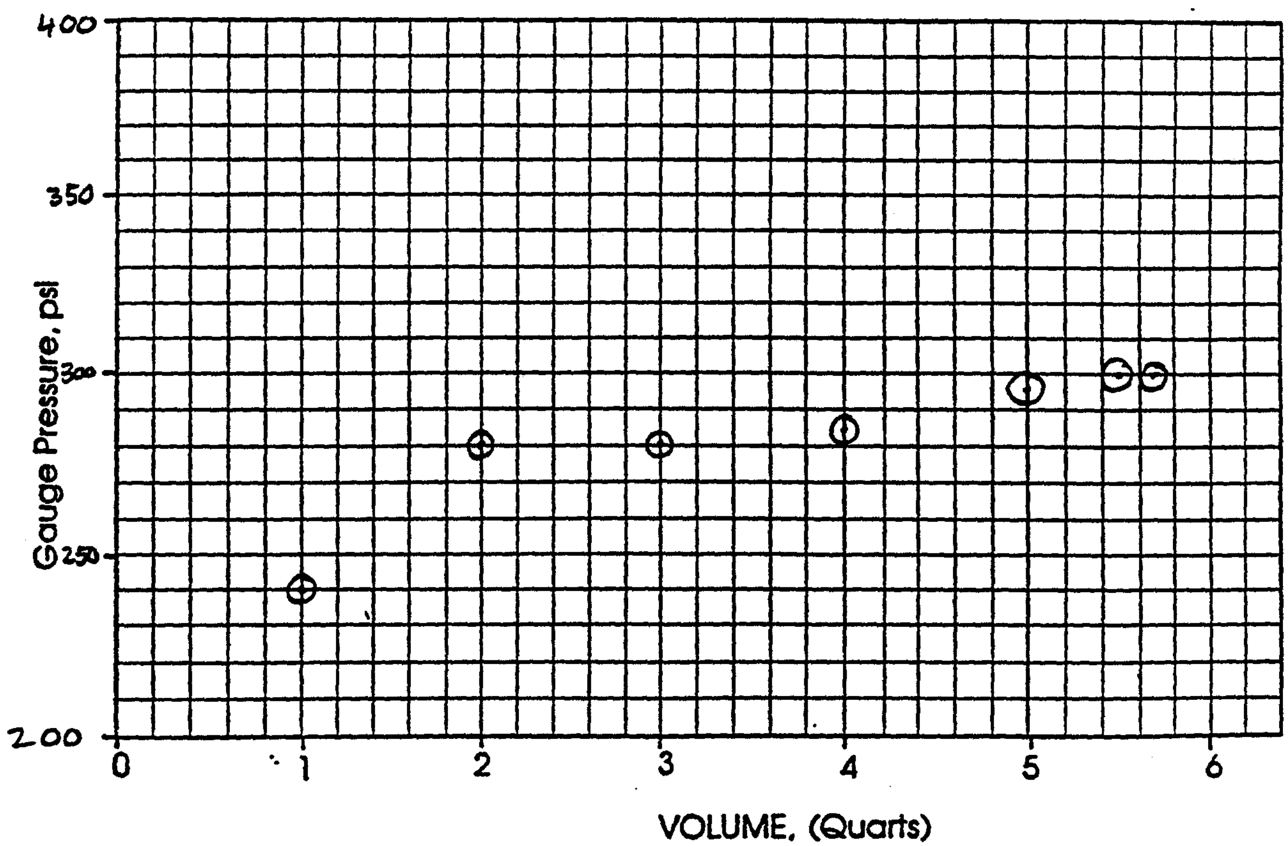
8=20pm.

Volume Quarts	1.0	2.0	3.0	4.0	5.0	5.5	5.7	~0.8 l RETURN.		
Pressure Psi	240	280	280	285	295	300	300	0		

Readings taken 1 minute from line Isolation

8=30 p.m. /INFLATION TOOL TEST @ SFC = 275 psi

Plot of Gauge Pressure (psi) vs. Volume (Quarts)



Westbay Instruments Ltd.

Casing Length Measurement Record

Project: JPL / EBASCO Date: FEB. 15, 1990 Project No.: WB 650

Location: PASADENA, CALIFORNIA Drillhole No.: MW-4 Nominal B.O.H.: 605'

Casing Size/Type: MP -1.5" Measured by: E. REHTLANE Checked by: —

Section No.	Serial No.	Description	Nominal Length, ft	Measured Length, ft	Cummulative Length, ft	Meas. Temp, C	Centralizers	Magnetic Collars
1		10+R		-.003				
2		10+M		-.005				
3		P+P		+.010				
4		10+M		+.001				
5		5+R		+.002				
6		P+R		+.010				
7		10+M		+.001				
8		10+R		+.001				
9		10+R.		+.002				
10		10+R		—				
11		10+R		+.002				
12		10+R		—				
13		10+R		+.004				
14		10+R		—				
15		2+R						
16		2+R						
17		2+R		+.020				
18		10+R		+.002				
19		5+P		+.005				
20		10+M		—				
21		5+R		+.005				
22		P+R		+.008				
23		10+M		—				
24		10+R		—				
25		10+R		-.002				
26		10+R		-.002				
27		5+R		+.001				
28		P+P		+.01				
29		10+M		+.005				
30		5+R		+.004				

Westbay Instruments Ltd.

Casing Length Measurement Record

Project: JPL / EBASCO Date: FEB 15, 1990 Project No.: WB 650

Location: PASADENA, CALIFORNIA Drillhole No.: MW-4 Nominal B.O.H.: 605'

Casing Size/Type: MP-1.5" Measured by: E. REHTRANE Checked by: —

Section No.	Serial No.	Description	Nominal Length, ft	Measured Length, ft	Cummulative Length, ft	Meas. Temp. C	Centralizers	Magnetic Collars
31		P+R		+.005				
32		10+M		+.002				
33		10+R		+.005				
34		10+R		+.002				
35		10+R		—				
36		10+R		—				
37		5+R						
38		2+R		+.012				
39		P+P		—				
40		10+M		—				
41		5+R		+.010				
42		P+R		+.002				
43		10+M		—				
44		10+R		+.006				
45		10+R		—				
46		10+R		+.008				
47		10+R		-.007				
48		10+R		—				
49		5+R		+.002				
50		P+P		+.006				
51		10+M		—				
52		5+R		+.008				
53		P+R		+.007				
54		10+R		-.006				
55		10+R		-.002				
56		10+R		-.002				
57		10+R		—				
58		10+R		—				
59		10+R		—				
60		10+R		—				

Westbay Instruments Ltd.

Casing Length Measurement Record

Project: JPL / EBASCO Date: FEB. 15, 1990 Project No.: WB650

Location: PASADENA, CALIFORNIA Drillhole No.: MW-4 Nominal B.O.H.: 605'

Casing Size/Type: MP - 1.5" Measured by: E. REHTLANE Checked by: —

Section No.	Serial No.	Description	Nominal Length, ft	Measured Length, ft	Cummulative Length, ft	Meas. Temp. C	Centralizers	Magnetic Collars
61		10+R		-.002				
62		10+R		—				
63		10+R		—				
64		10+R		+.001				
65		10+R		—				
66		10+R		+.001				
67		10+R		—				
68		2+R		+.002				
			550	+0.139				
		∴ THE TOTAL LENGTH OF MP CASING IS MEASURED TO BE 550.139' IN LENGTH.						
		NOTE: Casing #67 and #68 Removed and Replaced With:						
67		5+R		—				
68		2+R		—				
69		2+R		—				
			547'					

Westbay Instruments Inc.

MP Packer Inflation Record

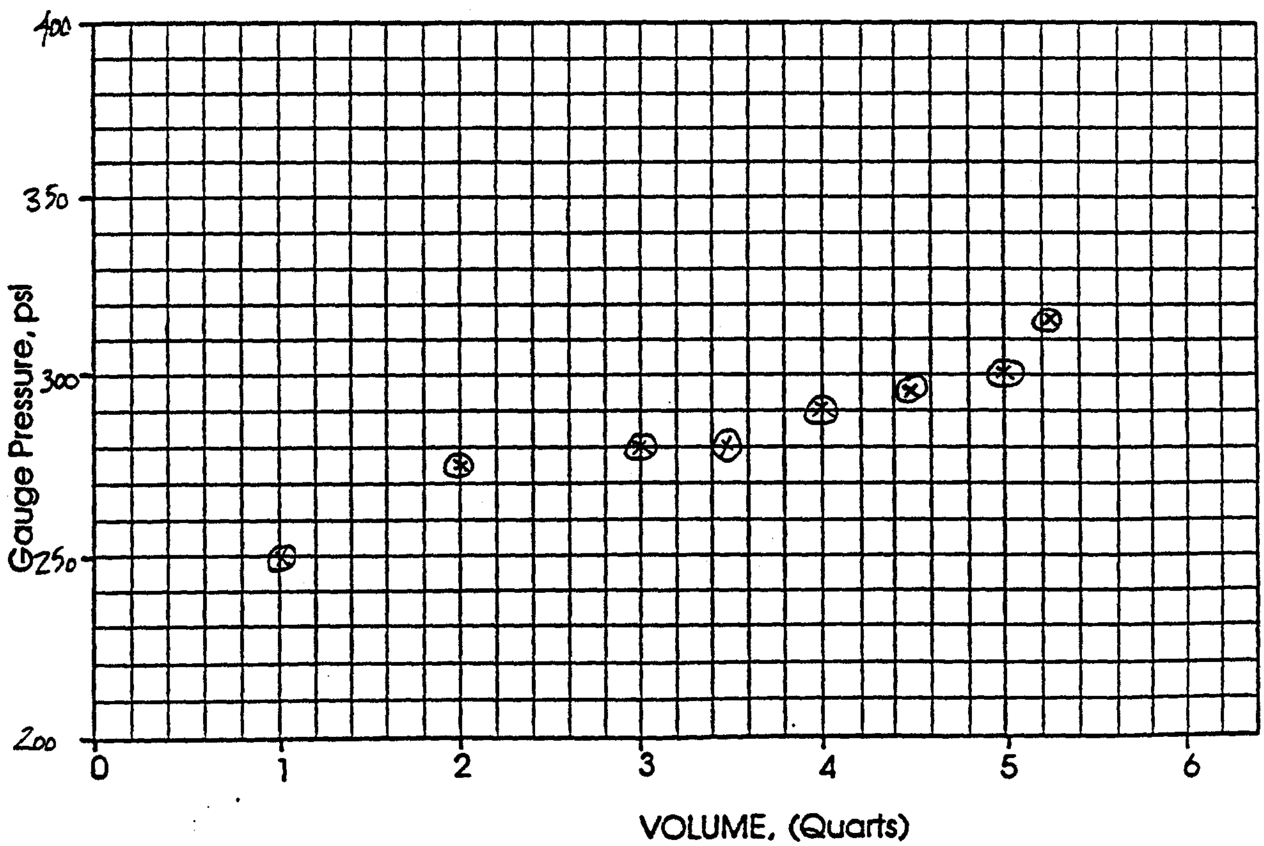
Project: NASA/EBASCO - JPL
Completed By: E. REHTLANE
Location: PASADENA, CALIFORNIA
Date Completed: FEB 17, 1990
Hole No.: MW-4
Date Inflated: FEB 17, 1990
Packer No.: 3
Depth (ft.) 522'-527'
Inflation Tool Setting (psi) 260 psi
Depth to Water Table (ft.) ≈110'

11:02 a.m.

Volume Quarts	1.0	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.25	0.7 l RETURN
Pressure Psi	250	275	275	280	280	290	295	300	315	0

1 minute pressure stabilization times.

Plot of Gauge Pressure (psi) vs. Volume (Quarts)



Westbay Instruments Inc.

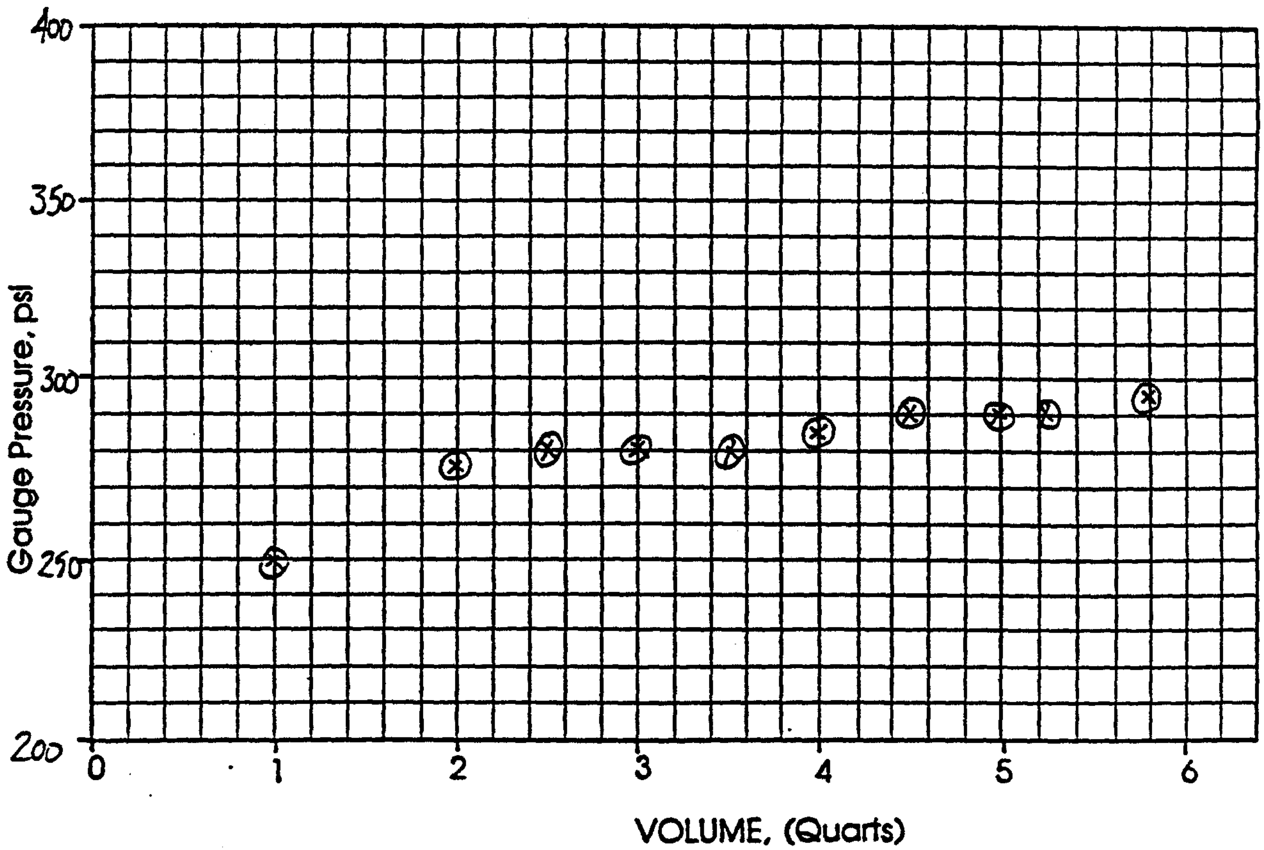
MP Packer Inflation Record

Project: NASA/EBASCO/ JPL
Completed By: E. REHTLANE
Location: PASADENA, CALIFORNIA
Date Completed: FEB. 17, 1990
Hole No.: MW-4
Date Inflated: FEB 17, 1990
Packer No.: #6
Depth (ft.) 502'-507'
Inflation Tool Setting (psi) 260 psi
Depth to Water Table (ft.) ≈110'

11:24 a.m.

Volume Quarts	1.0	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.3	5.8	0.7
Pressure Psi	250	275	280	280	280	285	290	290	290	295	∅

Plot of Gauge Pressure (psi) vs. Volume (Quarts)



Westbay Instruments Inc.

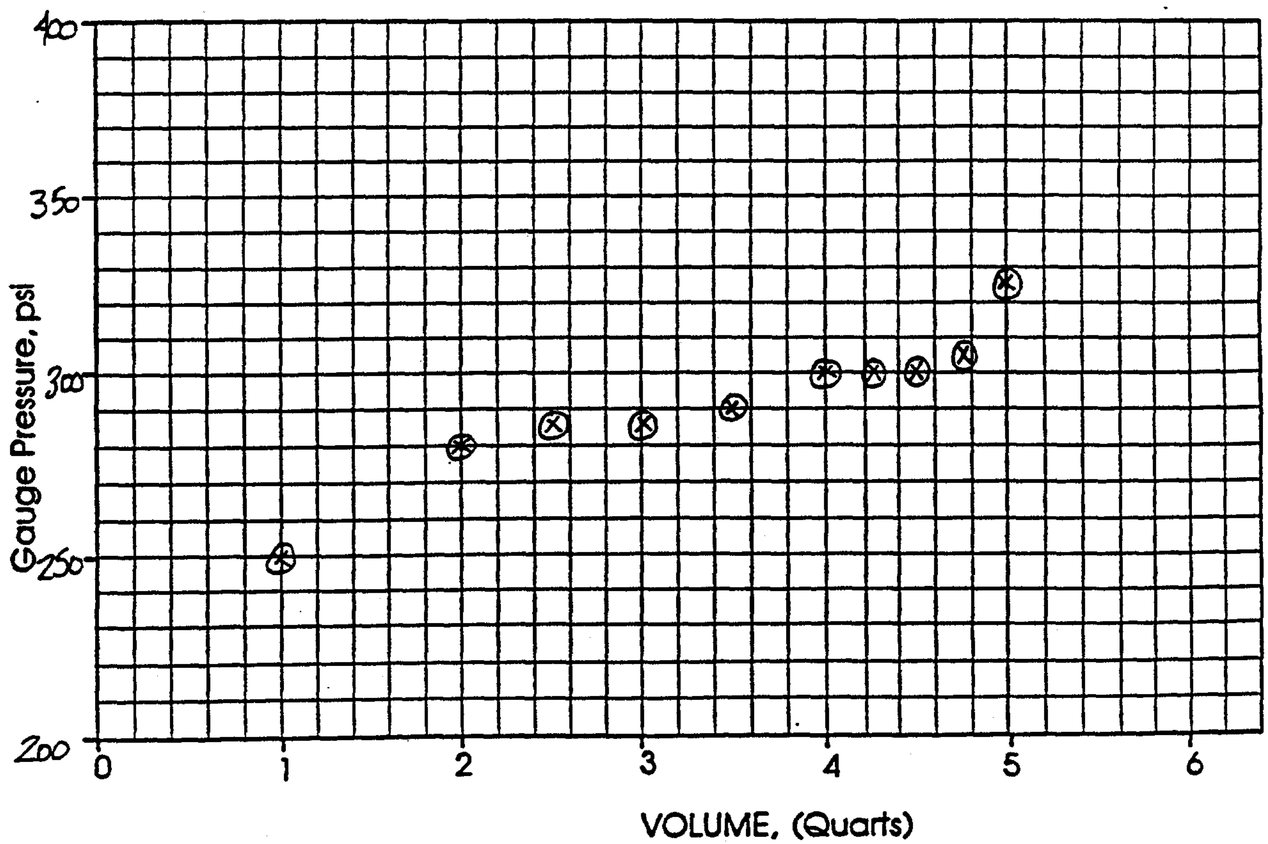
MP Packer Inflation Record

Project: NASA JPL / EBASCO | Completed By: ER / KS / MARK CUTLER
Location: PASADENA, CALIFORNIA | Date Completed: FEB 17, 1990
Hole No.: MW-4 | Date Inflated: FEB 17, 1990
Packer No.: #19 | Depth (ft.) 401'-406'
Inflation Tool Setting (psi) 260psi | Depth to Water Table (ft.) ≈10'

11:48 am.

Volume Quarts	1.0	2.0	2.5	3.0	3.5	4.0	4.25	4.5	4.75	5.0	0.7 l
Pressure Psi	250	280	285	285	290	300	300	300	305	325	0

Plot of Gauge Pressure (psi) vs. Volume (Quarts)



Westbay Instruments Inc.

MP Packer Inflation Record

Project: NASA JPL / EBASCO

Completed By: E. REHTLANE

Location: PASADENA, CALIFORNIA

Date Completed: FEB. 17, 1990

Hole No.: MW-4

Date Inflated: FEB. 17, 1990

Packer No.: #22

Depth (ft.) 381'-386'

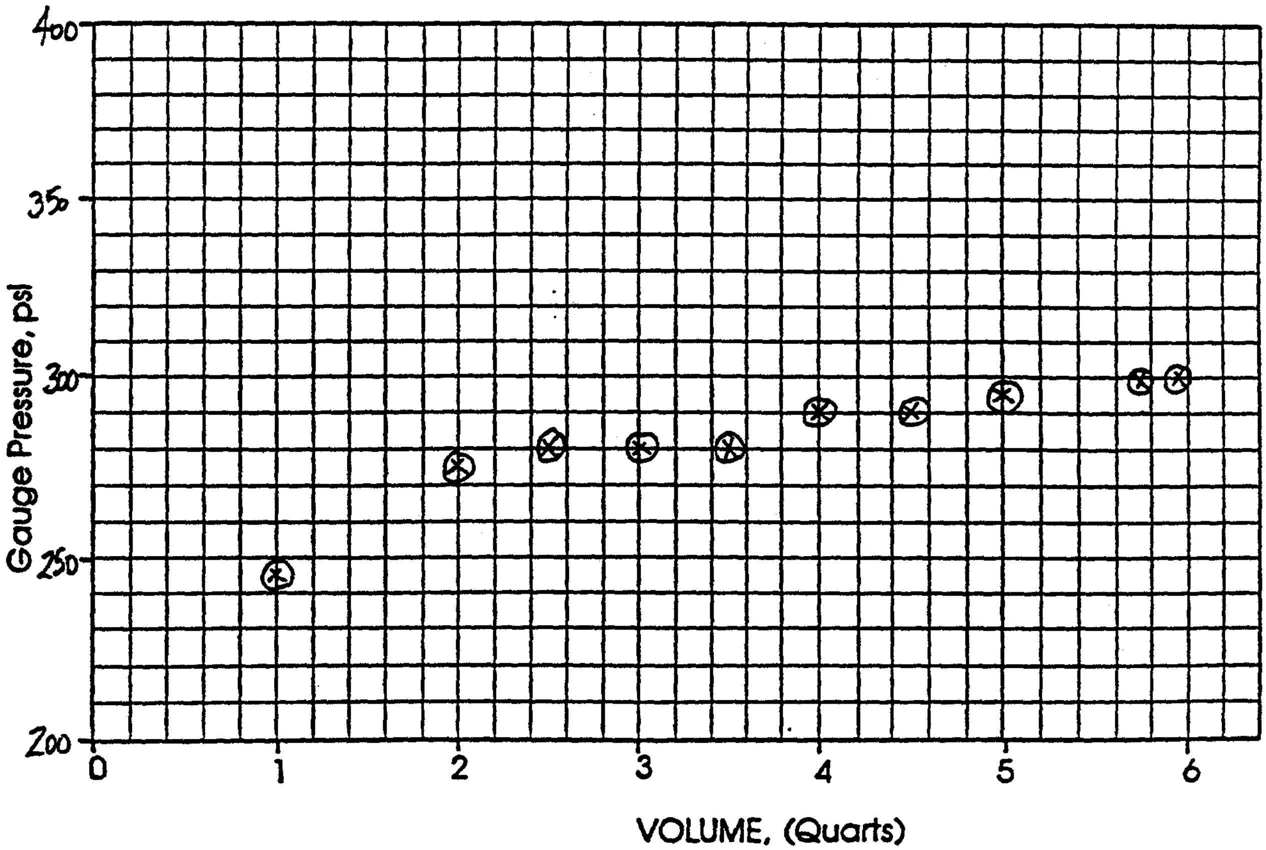
Inflation Tool Setting (psi) 260 psi

Depth to Water Table (ft.) ≈110'

12=06

Volume Quarts	1.0	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.75	5.9	0.7 L RETU..V
Pressure Psi	245	275	280	280	280	290	290	295	300	300	ϕ

Plot of Gauge Pressure (psi) vs. Volume (Quarts)



Westbay Instruments Inc.

MP Packer Inflation Record

Project: NASA JPL / EBASCO

Completed By: ERIK REHTLANG

Location: PASADENA, CALIFORNIA

Date Completed: FEB 17, 1990

Hole No.: MW-4

Date Inflated: FEB 17, 1990

Packer No.: # 28

Depth (ft.) 331' - 336'

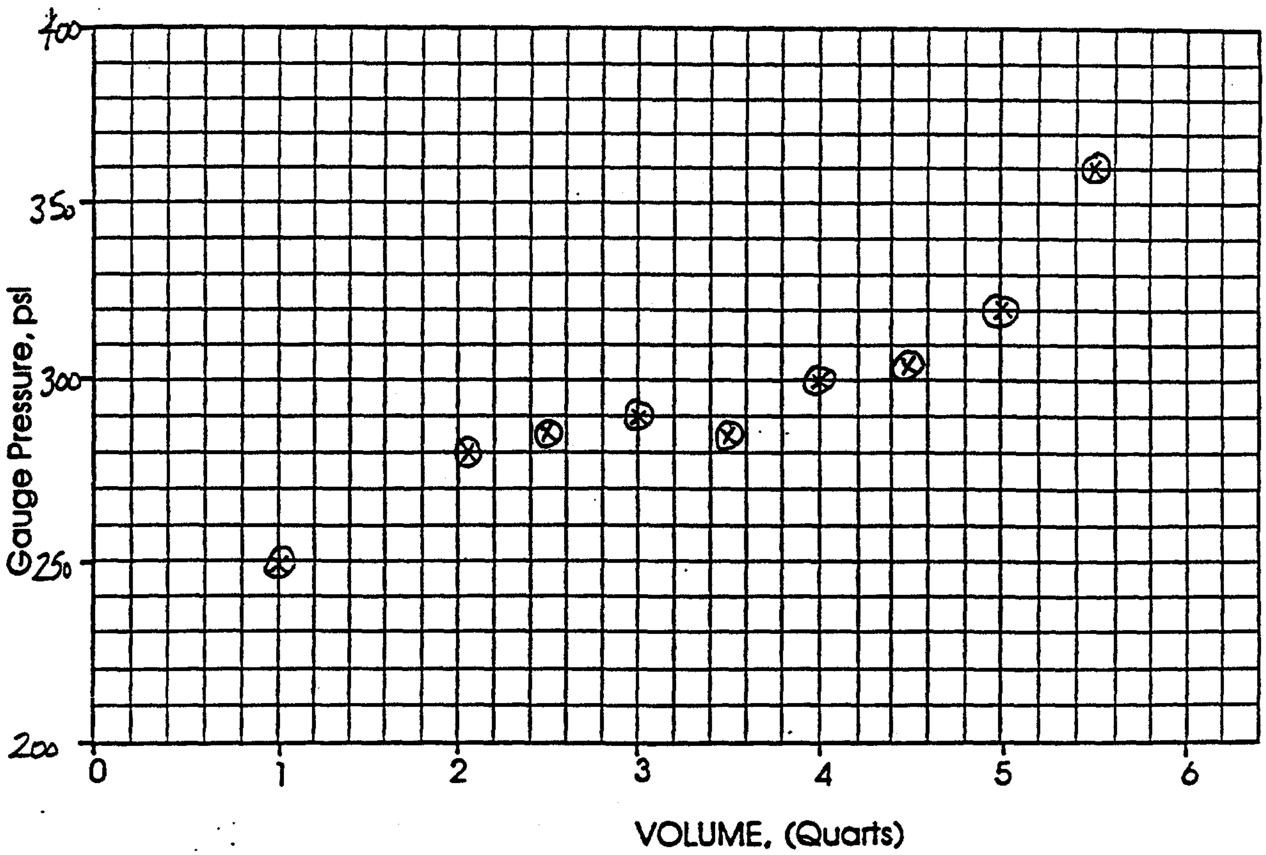
Inflation Tool Setting (psi) 260 psi

Depth to Water Table (ft.) ≈110'

12:34

Volume Quarts	1.0	2.1	2.5	3.0	3.5	4.0	4.5	5.0	5.5	.7	
Pressure Psi	250	280	285	290	295	300	305	320	360	ϕ	

Plot of Gauge Pressure (psi) vs. Volume (Quarts)



Westbay Instruments Inc.

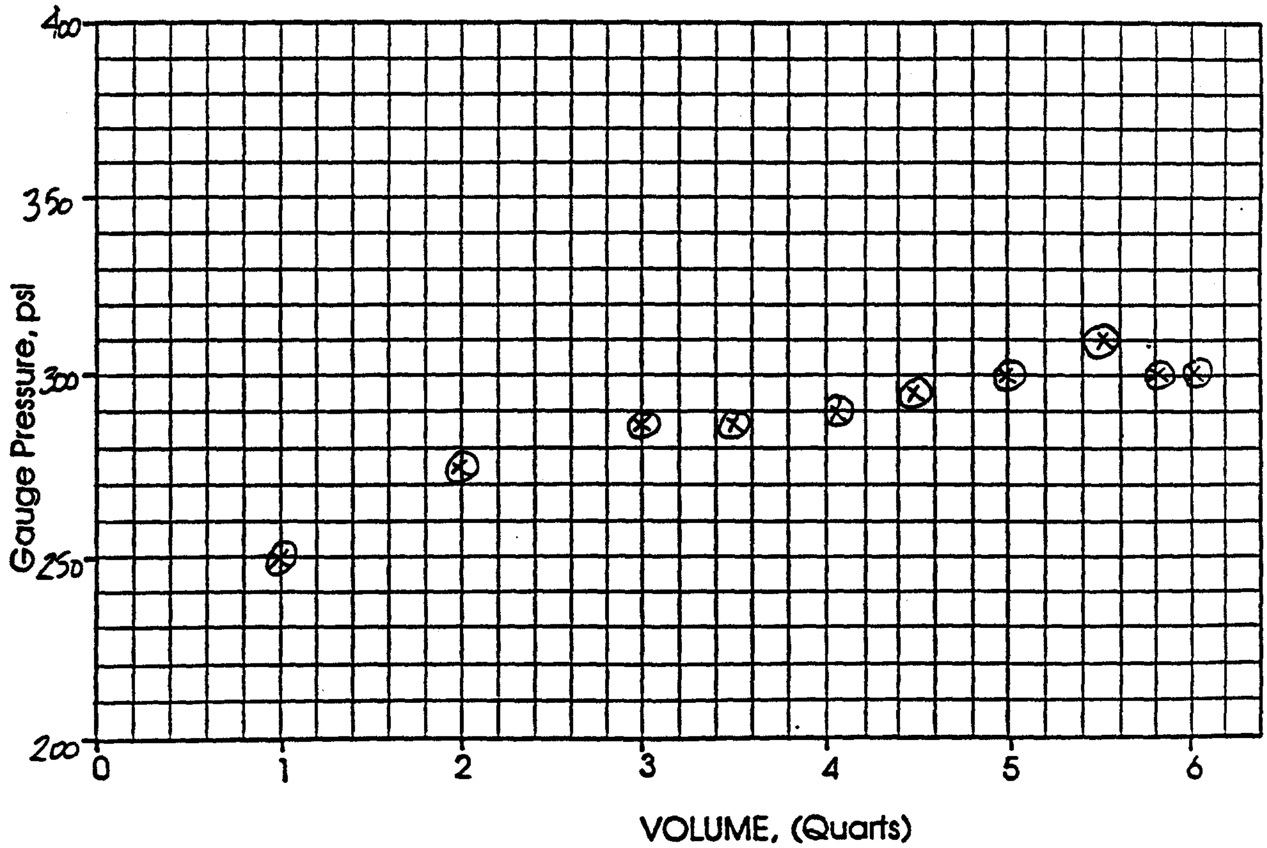
MP Packer Inflation Record

Project: NASA : JPL /EBASCO
Completed By: E. REHTLANE
Location: PASADENA, CALIFORNIA
Date Completed: FEB 17, 1990
Hole No.: MW-4
Date Inflated: FEB 17, 1990
Packer No.: #31
Depth (ft.) 311'-316'
Inflation Tool Setting (psi) 260 psi
Depth to Water Table (ft.) ≃110'

12:55

Volume Quarts	1.0	2.0	3.0	3.5	4.1	4.5	5.0	5.5	5.8	6.0
Pressure Psi	250	275	285	285	290	295	300	310	300	300

Plot of Gauge Pressure (psi) vs. Volume (Quarts)



Westbay Instruments Inc.

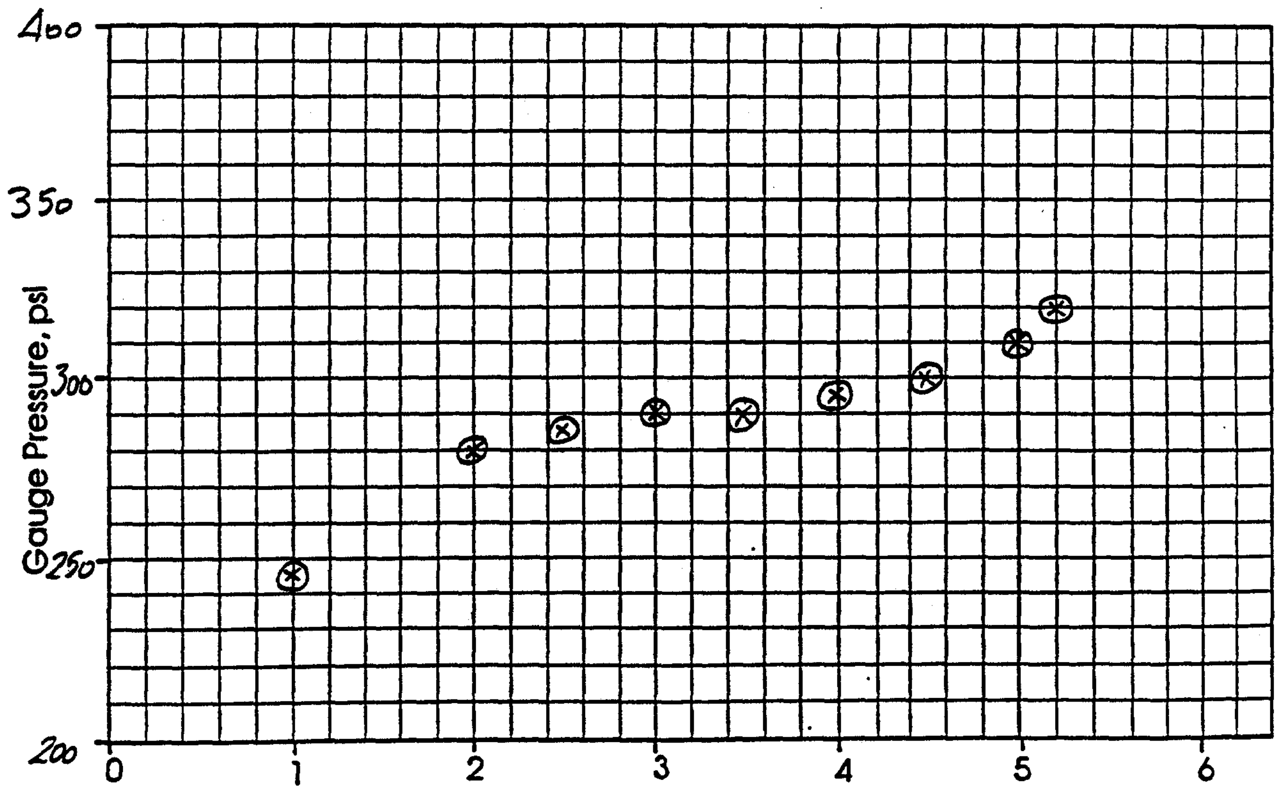
MP Packer Inflation Record

Project: NASA JPL / EBASCO	Completed By: E. REHTLANE
Location: PASADENA, CALIFORNIA	Date Completed: FEB. 17, 1990
Hole No.: MW-4	Date Inflated: FEB. 17, 1990
Packer No.: #39	Depth (ft.) 249'–254'
Inflation Tool Setting (psi) 260 psi	Depth to Water Table (ft.) ≈110'

1:15 p.m.

Volume Quarts	1.0	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.2	0.7L RETURN
Pressure Psi	245	280	285	290	290	295	300	310	320	0

Plot of Gauge Pressure (psi) vs. Volume (Quarts)



Westbay Instruments Inc.

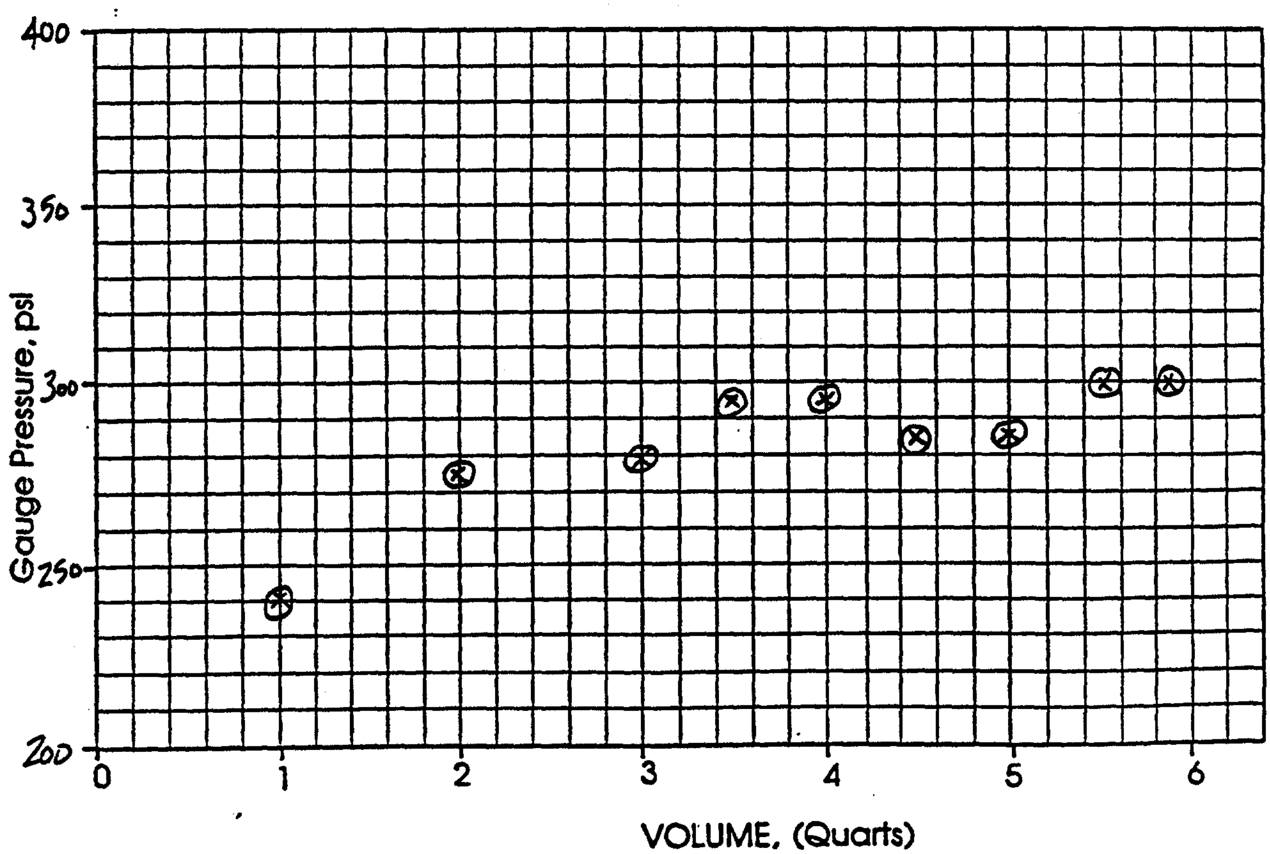
MP Packer Inflation Record

Project: NASA - JPL / EBASCO
Completed By: E. REHTLANE
Location: PASADENA, CALIFORNIA
Date Completed: FEB 17/90
Hole No.: MW-4
Date Inflated: FEB 17/90
Packer No.: #42
Depth (ft.) 229' - 234'
Inflation Tool Setting (psi) 260
Depth to Water Table (ft.) ≈110'

1=35am.

Volume Quarts	1.0	2.0	3.0	3.5	4.0	4.5	5.0	5.5	5.8	0.7l
Pressure Psi	240	275	280	295	295	285	285	300	300	RETURN φ

Plot of Gauge Pressure (psi) vs. Volume (Quarts)



Westbay Instruments Inc.

MP Packer Inflation Record

Project: NASA - JPL / EBASCO

Completed By: E. REHTLANE

Location: PASADENA, CALIFORNIA

Date Completed: FEB 17, 1990

Hole No.: MW-4

Date Inflated: FEB 17, 1990

Packer No.: #5

Depth (ft.) 159 - 164'

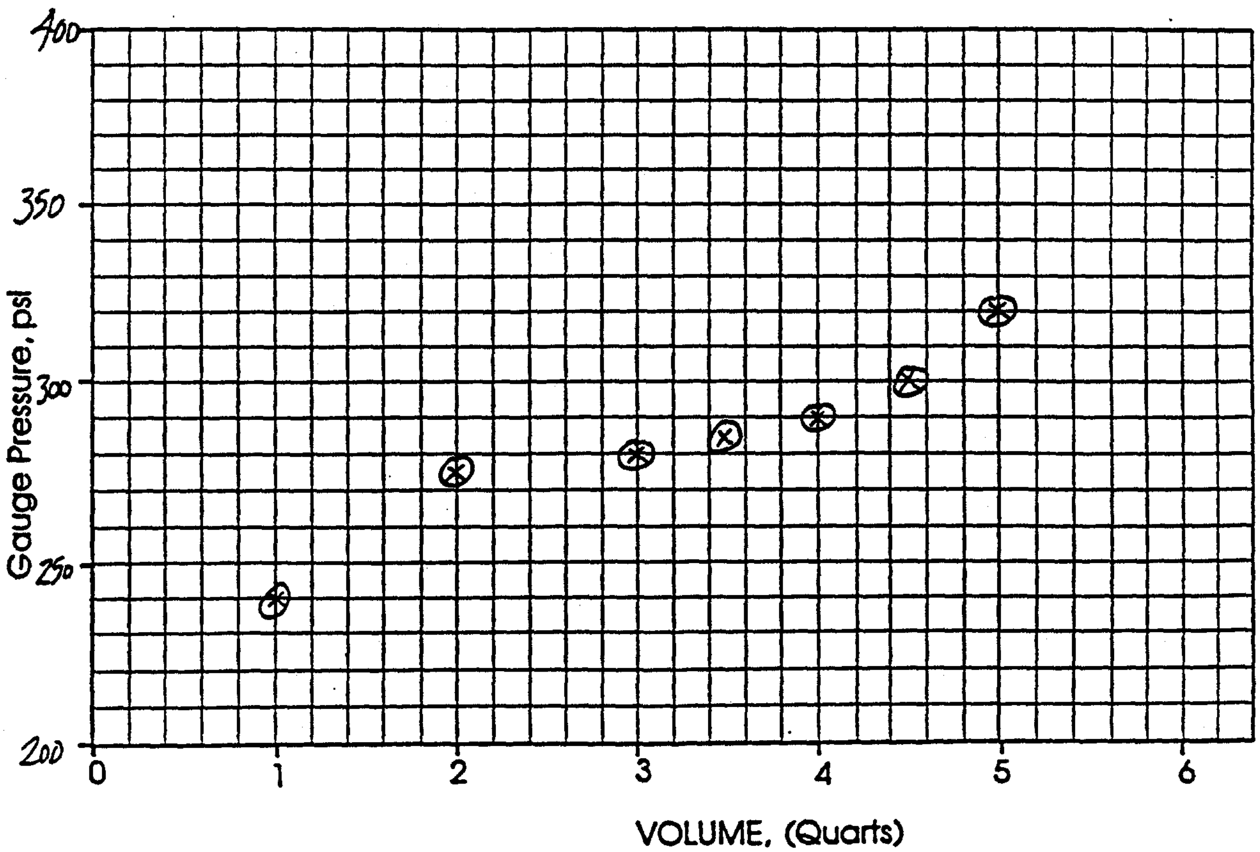
Inflation Tool Setting (psi) 250 psi

Depth to Water Table (ft.) ≅110'

1:55 p.m.

Volume Quarts	1.0	2.0	3.0	3.5	4.0	4.5	5.0	0.7 l Return		
Pressure Psi	240	275	280	285	290	300	320	0		

Plot of Gauge Pressure (psi) vs. Volume (Quarts)



Westbay Instruments Inc.

MP Packer Inflation Record

Project: NASA JPL / EBASCO

Completed By: E. REHTLANE

Location: PASADENA, CALIFORNIA

Date Completed: FEB 17, 1990

Hole No.: MW-4

Date Inflated: FEB 17, 1990

Packer No.: #53

Depth (ft.) 149'-154'

Inflation Tool Setting (psi) 270 psi @ 14:33

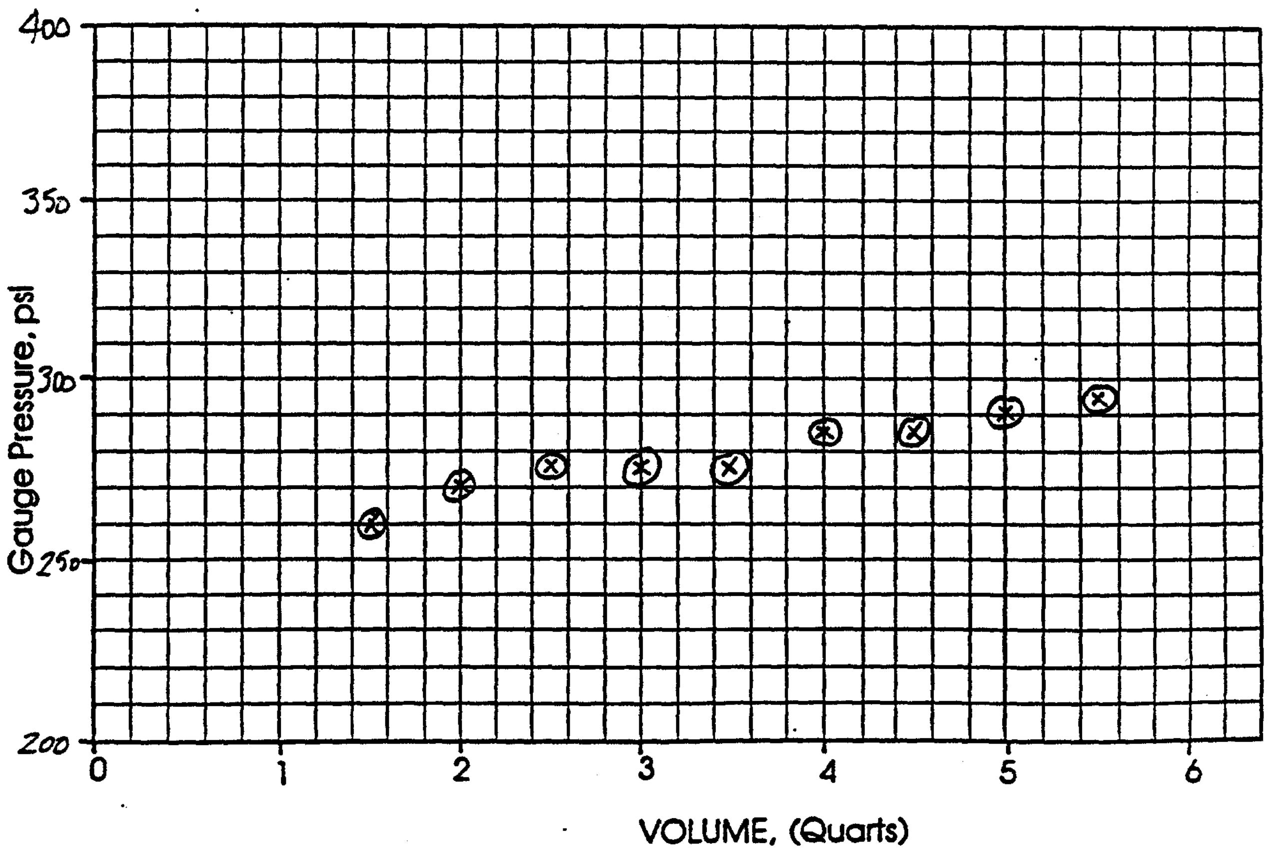
Depth to Water Table (ft.) ≈ 110'

2=10 p.m.

Value setting end of Inflation

Volume Quarts	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	≈0.7 l RETURN
Pressure Psi	260	270	275	275	275	285	285	290	295	0

Plot of Gauge Pressure (psi) vs. Volume (Quarts)



Appendix B

MW-3 Hydraulic Conductivity Test Field Records
- 5 Sheets

Plots of Normalized Head Ratios vs. Time, MW-3, Zones 2,4,6,8,10
- 3 Sheets

MW-4 Hydraulic Conductivity Test Field Records
- 5 Sheets

Plots of Normalized Head Ratios vs. Time, MW-4, Zones 2,4,6,8,10
- 3 Sheets

Westbay Instruments Ltd.

HYDRAULIC CONDUCTIVITY TEST

FIELD DATA SHEET

Page____ of____

Datum: —　　Probe Type: Electric　　Date: FEB 12, 1990　　Job No.: 650

Elev. Ground Sfc: —　　Serial No.: EE172　　Monitoring Well No.: MW-3

Height MP Casing above Ground Sfc: —　　Range: 0 to 500 psi　　Project: NASA JPL / ERASCO

Elev. top of MP Casing: —　　Riser Diameter 1.495" 3.8cm　　Test Zone No. 2

Test Type: Rising Head　　Test Zone Diameter: 9.875" 25.1cm　　Test Zone Interval 615'-679'

Operator ER/KS/ HANS PAPENGUTH.　　Test Zone Length (L) 64' = 1951cm.

Initial Head Difference(Ho) 59.8 psi　　Initial Test Reading (h) 45.Ø psi

Calculated Hydraulic Conductivity (k) —　　Analysis Method Hvorslev

Attached Analysis Sheets or Graphs —　　Comments —

Clock Time	Elapsed Time min. sec.	Test Readings* (h) ft. m psi	Normalized Test Readings	Clock Time	Elapsed Time min. sec.	Test Readings* (h) ft. m psi	Normalized Test Readings
14:46:55	0	45.0	1.00				
14:46:57	Ø	45.2	1.00				
14:46:58	1	49.7	.92				
14:47:27	30	74.9	.50				
14:47:58	61	89.6	.25				
14:48:27	90	97.5	.12				
14:48:57	120	101.8	.050	$H_f = 104.8$ psi			
14:49:27	150	103.8	.017	$H_o = 104.8 - 45.0 = 59.8$ psi			
14:49:57	180	104.6	.00				
14:50:15	198	104.8	—	$K(est) = \frac{d^2 \ln\left(\frac{2L}{D}\right)}{8L(t_2 - t_1)} \ln\left(\frac{H_1}{H_2}\right)$			
Above is selected data from file ZONE2K.PRO collected Feb 12 1990				$t_1 = 30$ sec	$H_1 = 74.9 - 104.8 =$		-29.9
				$t_2 = 90$ sec	$H_2 = 97.5 - 104.8 =$		-7.3
				$d = 3.8$ cm		$D = 25.1$ cm	
				$L = 64' =$	1951cm		
				$\therefore K(est) = 1.1 \times 10^{-4}$			

*READINGS UNCORRECTED FOR VARIATIONS IN BAROMETRIC PRESSURE

070788

HYDRAULIC CONDUCTIVITY TEST

Westbay Instruments Ltd.

FIELD DATA SHEET

Page____ of____

Datum: ____ Probe Type: Electric Date: Feb. 13 1990 Job No.: 650

Elev. Ground Sfc: — Serial No.: EE172 Monitoring Well No.: MW-3

Height MP Casing above Ground Sfc: — Range: 0 to 500 psi Project: NASA JPL/EBASCO

Elev. top of MP Casing: — Riser Diameter 3.8 cm Test Zone No. 4

Test Type: Rising Head Test Zone Diameter: 25.1cm Test Zone Interval 542'-581'

Operator K Seedhouse Test Zone Length (L) 39' 1189 cm.

Initial Head Difference(Ho) 9.0 psi Initial Test Reading (h) 22.2 psi

Calculated Hydraulic Conductivity (k) — Analysis Method Hvorslev

Attached Analysis Sheets or Graphs — Comments —

Clock Time	Elapsed Time min.	sec.	Test Readings* (h) ft. m psi	Normalized Test Readings	Clock Time	Elapsed Time min.	sec.	Test Readings* (h) ft. m psi	Normalized Test Readings
15:11:14		∅	22.2	1.∅					
15:11:16		2	23.5	∅.86					
15:11:18		4	24.7	.72					
15:11:20		6	25.8	.60					
15:11:22		8	26.6	.51	$K\ (est) = \dfrac{d^2 \ln\left(\frac{2L}{D}\right) \ln\left(\frac{H_1}{H_2}\right)}{8L(t_2-t_1)}$				
15:11:24		1∅	27.∅	.47					
15:11:29		15	28.4	.31					
15:11:34		2∅	29.3	0.21	$t_1 = 2$	sec	$H_1 =$	23.5 − 31.2	= −7.7
15:11:39		25	29.9	.14	$t_2 = 20$	sec	$H_2 =$	29.3 − 31.2	= −1.9
15:11:44		3∅	3∅.3	.10	$d = 3.8$	cm	D =	25.1cm	
					L = 1189	cm			
Final Pressure			31.2psi	∅					
Selected data from file ZONE4K.PRO					K(est) =		5.4	X10^{-4} cm	sec
collected Feb. 13 1990									

*READINGS UNCORRECTED FOR VARIATIONS IN BAROMETRIC PRESSURE

070788

Westbay Instruments Ltd.

HYDRAULIC CONDUCTIVITY TEST

FIELD DATA SHEET

Page ____ of ____

Datum: — Probe Type: EE Date: Feb. 15 1990 Job No.: WB-650

Elev. Ground Sfc: — Serial No.: EE172 Monitoring Well No.: MW-3

Height MP Casing above Ground Sfc: — Range: 0 to 500 psi Project: NASA JPL / EBASCO

Elev. top of MP Casing: — Riser Diameter 3.8 cm Test Zone No. 6

Test Type: RISING HEAD Test Zone Diameter: 9.875" 25.1 cm Test Zone Interval 320' - 366'

Operator K Seedhouse Test Zone Length (L) 46' 1402 cm.

Initial Head Difference(Ho) 32.1 - 24.0 = 8.1 psi Initial Test Reading (h) 24.0 psi

Calculated Hydraulic Conductivity (k) — Analysis Method Hvorslev

Attached Analysis Sheets or Graphs — Comments —

Clock Time	Elapsed Time min. sec.	Test Readings* (h) ft. m psi	Normalized Test Readings	Clock Time	Elapsed Time min. sec.	Test Readings* (h) ft. m psi	Normalized Test Readings
14:59:49	Ø	24.0	1.0				
14:59:59	10	25.0	.88				
15:00:17	28	26.0	.75				
15:00:36	47	27.0	.63				
15:01:02	73	28.0	.51	$K(est) = \frac{d^2 \ln\left(\frac{2L}{D}\right)}{8L(t_2 - t_1)} \ln\left(\frac{H_1}{H_2}\right)$			
15:01:32	103	29.0	.38				
15:02:11	142	30.0	.26				
15:03:09	200	31.0	.14	$t_1 = 10$ sec.	$H_1 =$	25.0 - 32.1	= -7.1
15:03:54	245	31.5	.0741	$t_2 = 200$ sec.	$H_2 =$	31.0 - 32.1	= -1.1
15:05 36	347	32.0	.0123	L = 1402 cm	d =	3.8cm	
15:06:16	387	32.1	Ø	D = 25.1 cm			
Selected Data from file ZONE6.PRO				∴ K(est) =	6.0	$\times 10^{-5}$	cm/sec
Collected Feb. 14, 1990							

*READINGS UNCORRECTED FOR VARIATIONS IN BAROMETRIC PRESSURE

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Westbay Instruments Ltd.

HYDRAULIC CONDUCTIVITY TEST

FIELD DATA SHEET

Page ____ of ____

Datum: — Probe Type: Electric Date: Feb. 15, 1990 Job No.: 650

Elev. Ground Sfc: — Serial No.: EE172 Monitoring Well No.: MW-3

Height MP Casing above Ground Sfc: — Range: 0 to 500 psi Project: NASA JPL / EBASCO

Elev. top of MP Casing: — Riser Diameter 3.8 cm Test Zone No. 8

Test Type: RISING HEAD Test Zone Diameter: 25.1 cm Test Zone Interval 223' - 270' BGS

Operator K Seedhouse Test Zone Length (L) 47' 1433 cm.

Initial Head Difference (Ho) 9.8 psi Initial Test Reading (h) 21.9 '

Calculated Hydraulic Conductivity (k) — Analysis Method Hvorslev

Attached Analysis Sheets or Graphs — Comments —

Clock Time	Elapsed Time min. sec.	Test Readings* (h) ft. m psi	Normalized Test Readings	Clock Time	Elapsed Time min. sec.	Test Readings* (h) ft. m psi	Normalized Test Readings
11:50:14	Ø	21.9	1.0				
11:50:16	2	23.3	.86				
11:50:18	4	24.7	.71				
11:50:19	5	26.0	.58				
11:50:21	7	27.0	.48	$K(est) = \frac{d^2 \ln\left(\frac{2L}{D}\right)}{8L(t_1 - t_2)} \ln\left(\frac{H_1}{H_2}\right)$			
11:50:23	9	28.0	.38				
11:50:27	13	29.1	.27				
11:50:30	16	30.0	.17	$t_1 = 2$	$H_1 = 23.3 - 31.7 = -8.4$		
11:50:38	24	31.0	.071	$t_2 = 28$	$H_2 = 31.3 - 31.7 = -.4$		
11:50:42	28	31.3	.041	L = 1433 cm.	D = 25.1 cm		
11:50:53	39	31.6	.010	d = 3.8 cm.			
11:51:22	66	31.7	Ø				
				$\therefore K(est) = 7.0 \times 10^{-4}$			

*READINGS UNCORRECTED FOR VARIATIONS IN BAROMETRIC PRESSURE

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Westbay Instruments Ltd.

HYDRAULIC CONDUCTIVITY TEST

FIELD DATA SHEET

Page___of___

Datum: — Probe Type: Electric Date: Feb. 16 1990 Job No.: WB-650

Elev. Ground Sfc: — Serial No.: EE172 Monitoring Well No.: MW-3

Height. MP Casing above Ground Sfc: — Range: 0 to 500.0 psi Project: NASA-JPL

Elev. top of MP Casing: — Riser Diameter 3.8 cm Test Zone No. 10

Test Type: Rising Head Test Zone Diameter: 25.1cm Test Zone Interval 155' - 192'

Operator K Seedhouse Test Zone Length (L) 37' 1128 cm

Initial Head Difference(Ho) 9.1 psi Initial Test Reading (h) 23.3 psi

Calculated Hydraulic Conductivity (k) — Analysis Method Hvorslev

Attached Analysis Sheets or Graphs — Comments —

Clock Time	Elapsed Time min. sec.	Test Readings* (h) ft. m psi	Normalized Test Readings	Clock Time	Elapsed Time min. sec.	Test Readings* (h) ft. m psi	Normalized Test Readings
9:25:15	Ø	23.3	1.0				
9:25:16	1	23.4	.99				
9:25:17	2	24.8	.84				
9:25:18	3	25.5	.76				
9:25:19	4	26.3	.67				
9:25:20	5	27.1	.58				
9:25:22	7	28.2	.46				
9:25:24	9	29.4	.33				
9:25:27	12	30.0	.26				
9:25:31	16	31.0	.15				
9:25:39	24	32.0	.04				
9:25:47	32	32.3	.01				
9:25:52	37	32.4	—				

$$K(est) = \frac{d^2 \ln\left(\frac{2L}{D}\right)}{8L(t_2-t_1)} \ln\left(\frac{H_1}{H_2}\right)$$

$t_1 = 1$ sec. $H_1 = 23.4_{psi} - 32.4_{psi} = -9.0_{psi}$

$t_2 = 16$ sec. $H_2 = 31.0_{psi} - 32.4_{psi} = -1.4_{psi}$

$d = 3.8$ cm $D = 25.1$ cm

$L = 1128$ cm

$K(est) = 8.9 \times 10^{-4}$ cm/sec

*READINGS UNCORRECTED FOR VARIATIONS IN BAROMETRIC PRESSURE

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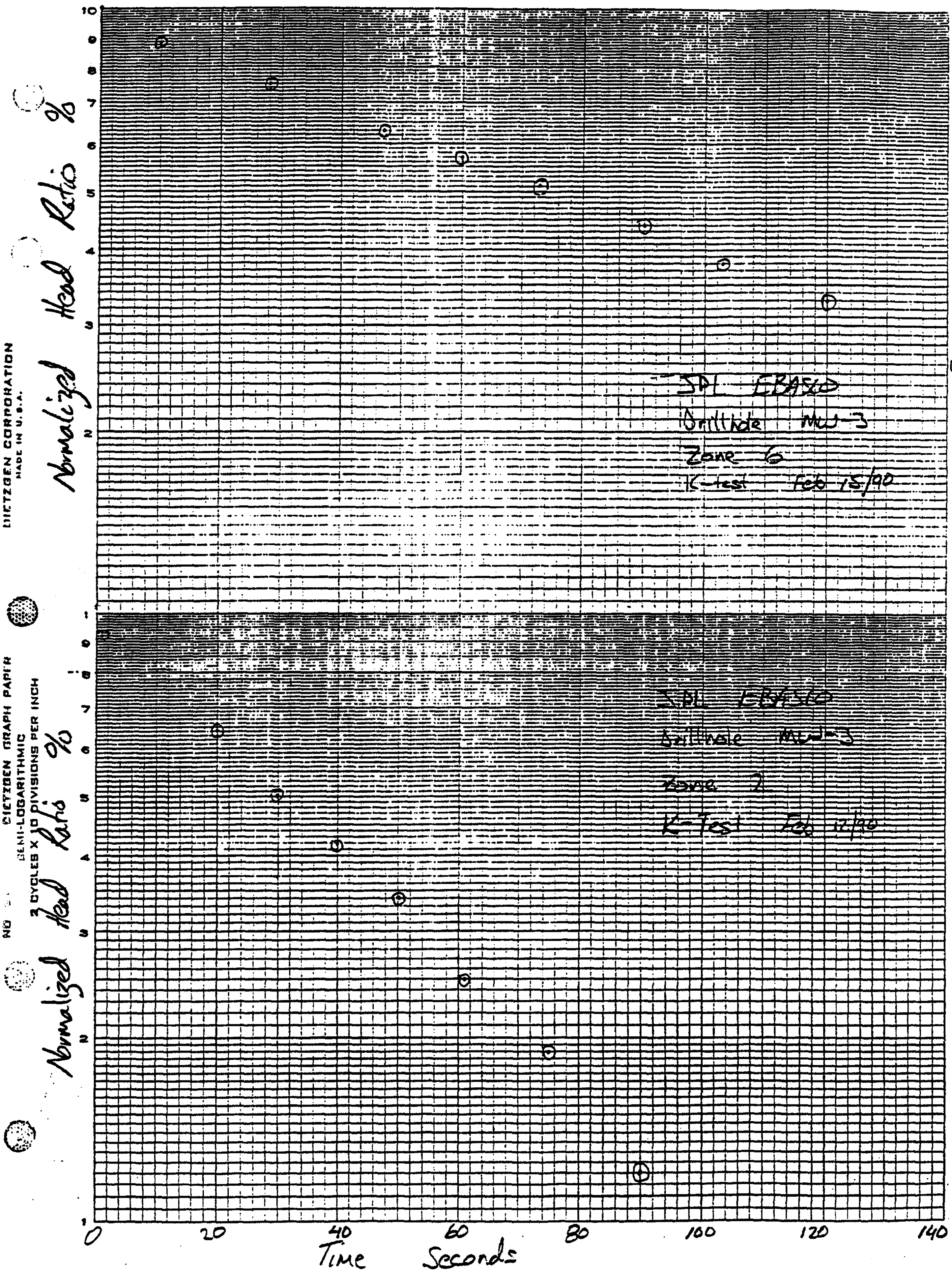
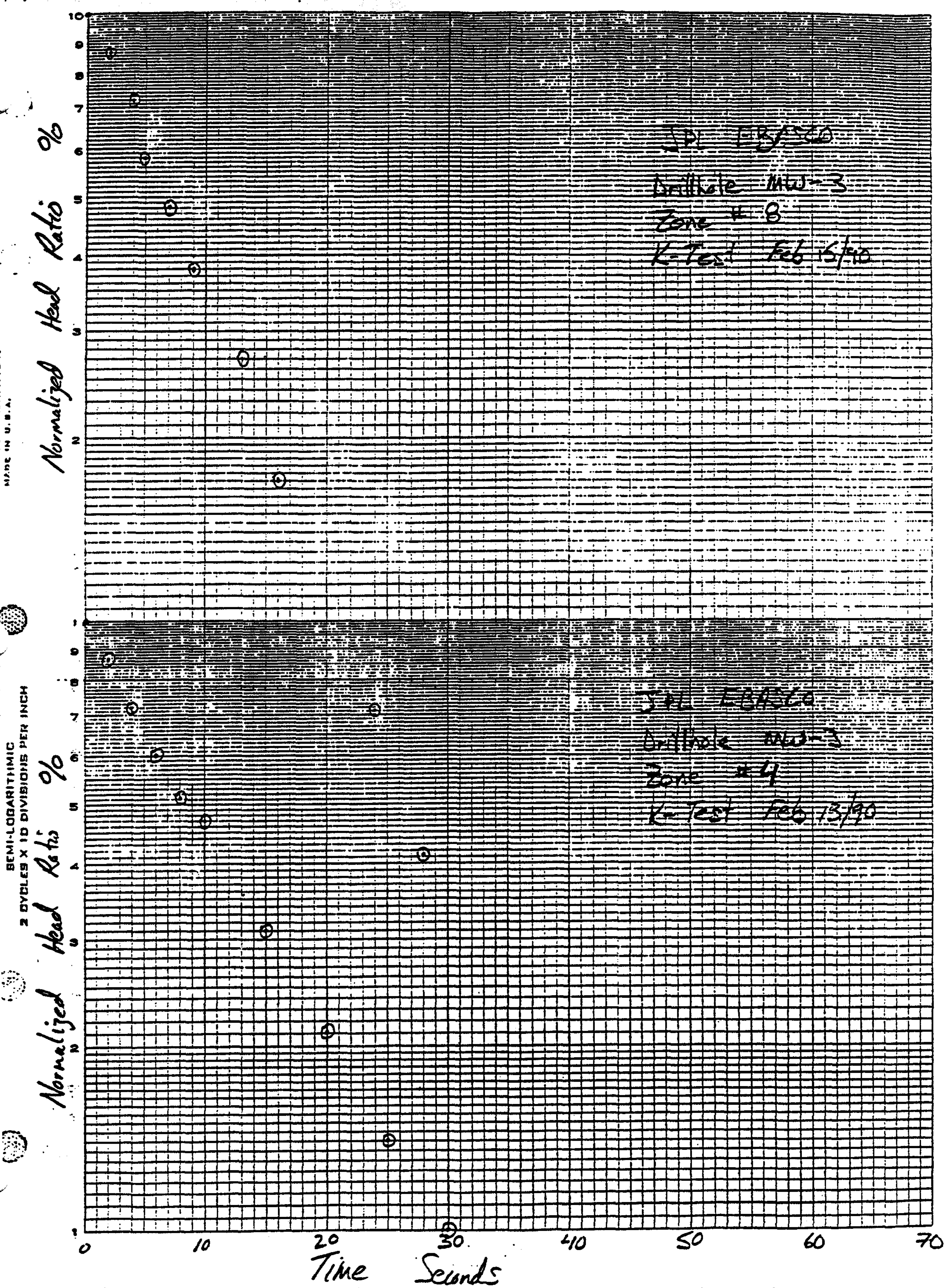
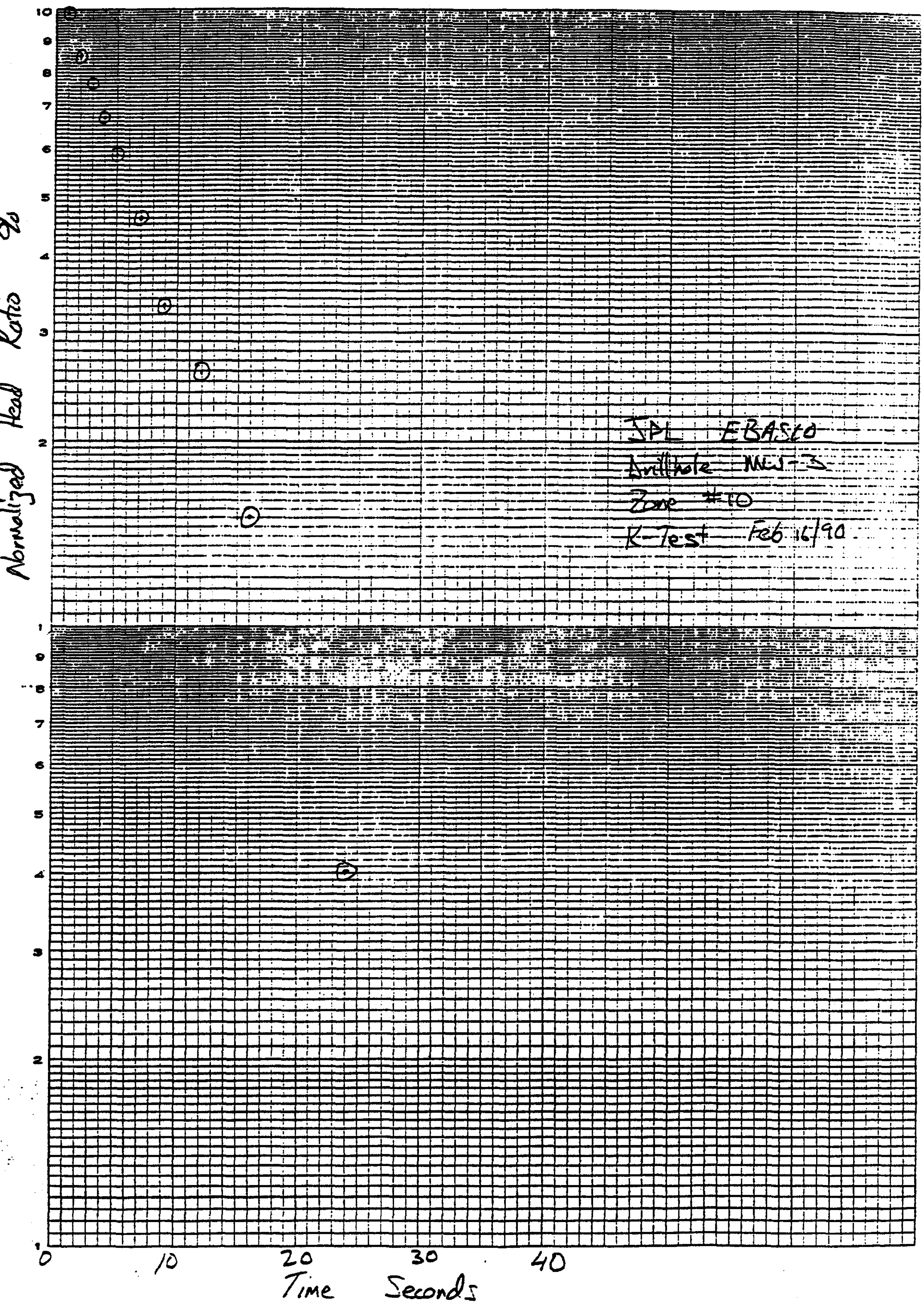


DIETZGEN CORPORATION
MADE IN U.S.A.
NO
DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
3 CYCLES X 10 DIVISIONS PER INCH
Normalized Head Ratio %
JPL EBASCO
Drillhole MW-3
Zone 6
K-test Feb 15/90
Normalized Head Ratio %
JPL EBASCO
Drillhole MW-3
Zone 2
K-Test Feb 12/90
0
20
40
60
80
100
120
140
Time Seconds



J&L EBASCO
Drillhole MW-3
Zone # 8
K-Test Feb 15/90
J&L EBASCO
Drillhole MW-3
Zone # 4
K-Test Feb 13/90
Normalized Head Ratio %
Normalized Head Ratio %
Time Seconds
0
10
20
30
40
50
60
70
SEMI-LOGARITHMIC
2 CYCLES X 10 DIVISIONS PER INCH
MADE IN U.S.A.


Normalized Head Ratio %
Time Seconds
0
10
20
30
40
JPL EBASCO
Drillhole MW-3
Zone #10
K-Test Feb 16/90

Westbay Instruments Ltd.

HYDRAULIC CONDUCTIVITY TEST

FIELD DATA SHEET

Page ____ of ____

Datum: —
Probe Type: EE
Date: Feb 22/90
Job No.: 650

Elev. Ground Sfc: —
Serial No.: EE 172
Monitoring Well No.: MW-4

Height MP Casing above Ground Sfc: —
Range: 0 to 500 psi
Project: NASA JPL / EBASCO

Elev. top of MP Casing: —
Riser Diameter: 3.8 cm
Test Zone No. 2

Test Type: Rising head
Test Zone Diameter: 31.1
Test Zone Interval: 480' - 532'

Operator: K.S./E.R./A.[illegible]
Test Zone Length (L): 56' = 1707 cm

Initial Head Difference (Ho): 13.2 PSI
Initial Test Reading (h): 16.6 PSI

Calculated Hydraulic Conductivity (k): —
Analysis Method: Hvorslev

Attached Analysis Sheets or Graphs: —
Comments: —

Clock Time	Elapsed Time min. sec.	Test Readings* (h) ~~ft. m~~ psi	Normalized Test Readings	Clock Time	Elapsed Time min. sec.	Test Readings* (h) ft. m psi	Normalized Test Readings
15:29:46	—	16.6	1.0				
15:28:47	01	17.0	.97				
15:28:50	04	20.0	.74				
15:28:54	08	21.5	.63				
15:28:59	13	23.0	.52	$K(est) = \frac{d^2 \ln\left(\frac{2L}{D}\right) \ln\left(\frac{H_1}{H_2}\right)}{8L\,(t_2-t_1)}$			
15:29:03	17	24.3	.42				
15:29:08	22	25.2	.35				
15:29:13	27	26.0	.29	$t_1 = 4$ sec	H_1	$= 29.8 - 20$	$= 9.9$
15:29:19	33	27.0	.21	$t_2 = 33$ sec	H_2	$= 29.8 - 27$	$= 2.8$
15:29:29	43	28.0	.14	$d = 3.8$ cm	$D =$	31.1 cm	
15:29:44	58	29.0	.061	$L = 1707$ cm.			
15:30:05	1 09	29.5	.023				
Final Pressure		29.8		$\therefore K(est)$	$= 1.1 \times 10^{-4}$	cm/sec	
					↳	2.1×10^{-4} cm/sec	

*READINGS UNCORRECTED FOR VARIATIONS IN BAROMETRIC PRESSURE

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Westbay Instruments Ltd.

HYDRAULIC CONDUCTIVITY TEST

FIELD DATA SHEET

Page____of____

Datum: — Probe Type: EE Date: Feb 23/90 Job No.: 650

Elev. Ground Sfc: — Serial No.: EE172 Monitoring Well No.: MW-4

Height MP Casing above Ground Sfc: — Range: 0 to 500 psi Project: NASA JPL / EBASCO

Elev. top of MP Casing: — Riser Diameter (d) 3.8 ~~in.~~ cm Test Zone No. 4

Test Type: Rising Head Test Zone Diameter: 31.1 Test Zone Interval 370'-426'

Operator K.S./E.R./D.Mc. Test Zone Length (L) 56' = 1707 cm.

Initial Head Difference(Ho) 13.9 PSI Initial Test Reading (h) 17.9 PSI

Calculated Hydraulic Conductivity (k) — Analysis Method Hvorslev

Static Water Level in Test Zone — ft. m psi. Comments —

Clock Time	Elapsed Time min. sec.	Test Readings* (h) ~~ft.~~ ~~m~~ psi	Normalized Test Readings	Clock Time	Elapsed Time min. sec.	Test Readings* (h) ft. m psi	Normalized Test Readings
13:19:28	—	17.9	1.0				
13:19:29	01	18.0	.99				
13:19:30	02	19.0	.93				
13:19:32	04	20.9	.78				
13:19:34	06	21.9	.71	$K(est) = \dfrac{d^2 \ln\left(\frac{2L}{D}\right) \ln\left(\frac{H_1}{H_2}\right)}{8L(t_2 - t_1)}$			
13:19:36	08	23	.63				
13:19:38	10	24.1	.55				
13:19:40	12	25.5	.45	$t_1 = 4$ s	$H_1 =$	$31.8 - 20.9 = 10.9$	
13:19:44	16	26.4	.39	$t_2 = 27$ s	$H_2 =$	$31.8 - 29.1 = 2.7$	
13:19:47	19	27.3	.32	$d = 3.8$ cm	$D =$	31.1 cm	
13:19:51	23	28.3	.25	$L = 1707$ cm			
13:19:55	27	29.1	.19				
13:20:02	34	30.0	.13				
13:20:14	46	31.0	.058	∴ K(est) = 3.0	$\times 10^{-4}$	cm/s	
13:20:29	61	31.5	.022				
Final Pressure		31.8					

*READINGS UNCORRECTED FOR VARIATIONS IN BAROMETRIC PRESSURE

070788

Westbay Instruments Ltd.

HYDRAULIC CONDUCTIVITY TEST

FIELD DATA SHEET

Page ___ of ___

Datum: — Probe Type: EE Date: Feb 24/90 Job No.: 650

Elev. Ground Sfc: — Serial No.: EE 172 Monitoring Well No.: MW-4

Height MP Casing above Ground Sfc: — Range: 0 to 500 psi Project: NASA JPL /EBASCO

Elev. top of MP Casing: — Riser Diameter (d) 3.8 cm Test Zone No. 6

Test Type: Rising head. Test Zone Diameter: 31.1 cm Test Zone Interval 306'- 348'

Operator K.S./E.R./D.Mc Test Zone Length (L) 42' = 1280 cm.

Initial Head Difference(Ho) 11.3 PSI Initial Test Reading (h) 20.7 PSI

Calculated Hydraulic Conductivity (k) — Analysis Method Hvorslev

Static Water Level in Test Zone — ft. m psi Comments —

Clock Time	Elapsed Time min. sec.	Test Readings* (h) psi	Normalized Test Readings	Clock Time	Elapsed Time min. sec.	Test Readings* (h) ft. m psi	Normalized Test Readings
8:49:48	—	20.7	1.0				
8:49:50	02	21.7	.91				
8:49:52	04	23.5	.75				
8:49:54	06	25.0	.62				
8:49:57	09	26.3	.50	$K(est) = \frac{d^2 \ln(\frac{2L}{D})}{8L}$		$\frac{\ln(\frac{H_1}{H_2})}{(t_2 - t_1)}$	
8:49:59	11	27.0	.41				
8:50:03	15	28.0	.35				
8:50:07	19	29.0	.27	$t_1 = 6$ sec	$H_1 =$	32.0 - 25.0 = 7.0	
8:50:13	25	30.0	.18	$t_2 = 25$ sec	$H_2 =$	32.0 - 30.0 = 2.0	
8:50:22	34	31.0	.088	$d = 3.8$ cm	$D =$	31.1 cm.	
8:50:32	44	31.5	.044	$L = 1280$ cm			
8:52:31	163	32.0	—				
Final Pressure		32.0		∴ K(est)	= 4.1 x	10^{-4} cm/sec	

*READINGS UNCORRECTED FOR VARIATIONS IN BAROMETRIC PRESSURE

070788

Westbay Instruments Ltd.

HYDRAULIC CONDUCTIVITY TEST

FIELD DATA SHEET

Page____of____

Datum: — Probe Type: EE Date: Feb 24/90 Job No.: 650

Elev. Ground Sfc: — Serial No.: EE 172 Monitoring Well No.: MW-4

Height MP Casing above Ground Sfc: — Range: 0 to 500 psi Project: NASA JPL /EBASCO

Elev. top of MP Casing: — Riser Diameter (d) 3.8 ~~in.~~ cm Test Zone No. 8

Test Type: Rising Head Test Zone Diameter: 31.3 cm Test Zone Interval 203'-257'

Operator K.S./E.R./D.Mc Test Zone Length (L) 54' = 1646 cm

Initial Head Difference(Ho) 13.4 PSI Initial Test Reading (h) 18.4 PSI

Calculated Hydraulic Conductivity (k) — Analysis Method Hvorslev

Static Water Level in Test Zone — ft. m psi. Comments —

Clock Time	Elapsed Time min. sec.	Test Readings* (h) ~~ft.~~ ~~m~~ psi	Normalized Test Readings	Clock Time	Elapsed Time min. sec.	Test Readings* (h) ft. m psi	Normalized Test Readings
13:53:15	—	18.4	1.0				
13:53:17	02	19.8	.90				
13:53:20	05	22.1	.72				
13:53:22	07	23.5	.63				
13:53:26	11	25.3	.47	K(est) =	d^2	$\ln\left(\frac{2L}{D}\right)$	$\ln\left(\frac{H_1}{H_2}\right)$
13:53:28	13	26.6	.39		8L	(t_2-t_1)	
13:53:31	16	27.3	.34				
13:53:34	19	28.1	.27	$t_1 = 2$	$H_1 =$	31.8 − 19.8	= 12.0
13:53:39	24	29.2	.19	$t_2 = 24$	$H_2 =$	31.8 − 29.2	= 2.6
13:53:45	30	30.0	.13	d = 3.8 cm	D =	31.1 cm	
13:53:56	41	31.0	.060	L = 1646 cm			
13:54:11	56	31.5	.022				
				K(est) =	3.6 x 10^{-4}	cm/sec	
Final Pressure		31.8					

*READINGS UNCORRECTED FOR VARIATIONS IN BAROMETRIC PRESSURE

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HYDRAULIC CONDUCTIVITY TEST

Westbay Instruments Ltd.

FIELD DATA SHEET

Page____of____

Datum: —
Probe Type: EE
Date: Feb 26/90
Job No.: 650

Elev. Ground Sfc: —
Serial No.: EE172
Monitoring Well No.: MW-4

Height MP Casing above Ground Sfc: —
Range: 0 to 500 psi
Project: NASA JPL /EBASCO

Elev. top of MP Casing: —
Riser Diameter (d) 3.8 ~~in~~ cm
Test Zone No. 10

Test Type: Rising Head
Test Zone Diameter: 31.1 cm
Test Zone Interval 121' - 169'

Operator K.S. /E.R. /D.Mc.
Test Zone Length (L) 48' = 1463 cm.

Initial Head Difference (Ho) 13.7 PSI
Initial Test Reading (h) 19.9 PSI

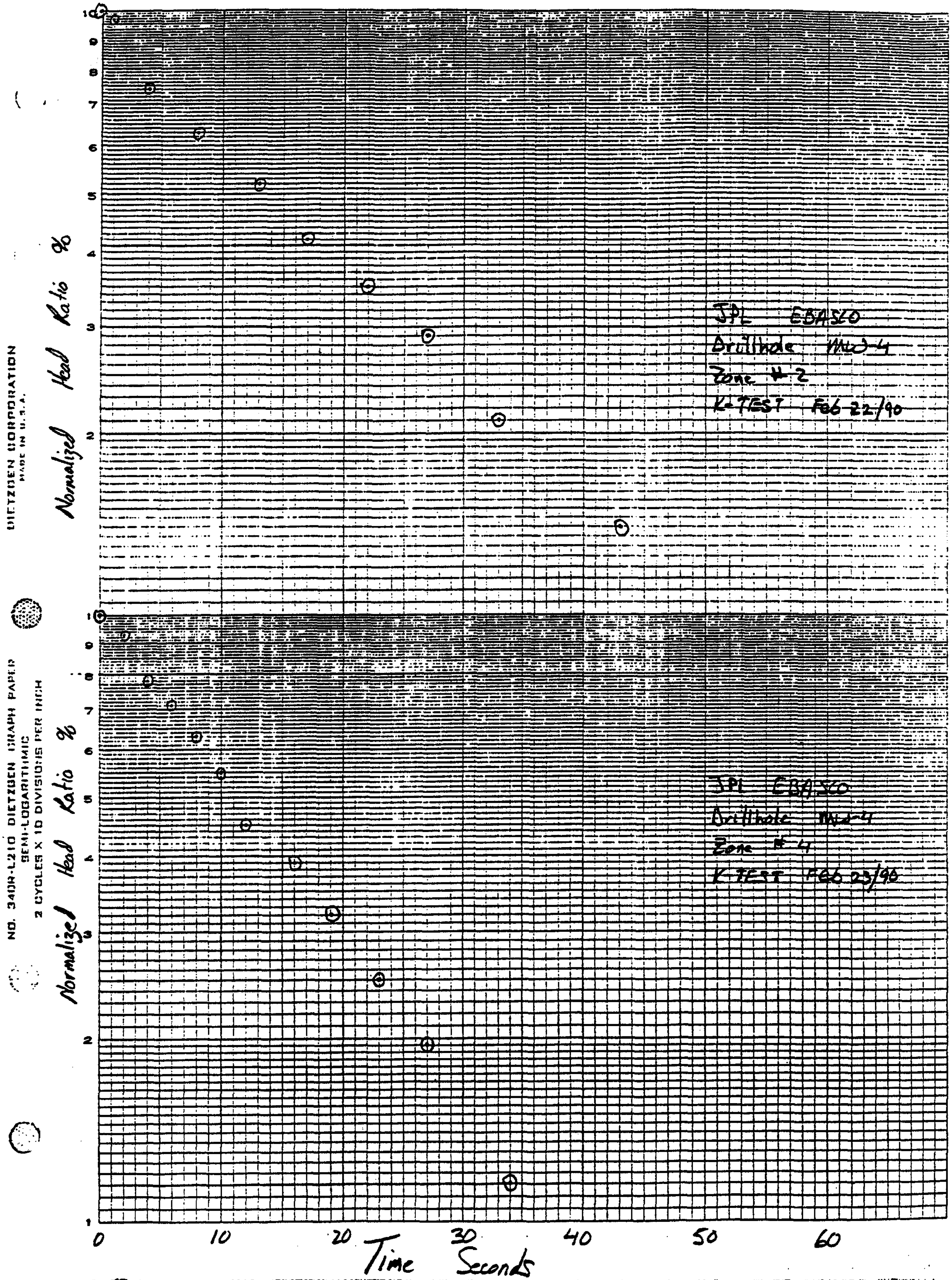
Calculated Hydraulic Conductivity (k) —
Analysis Method Hvorslev

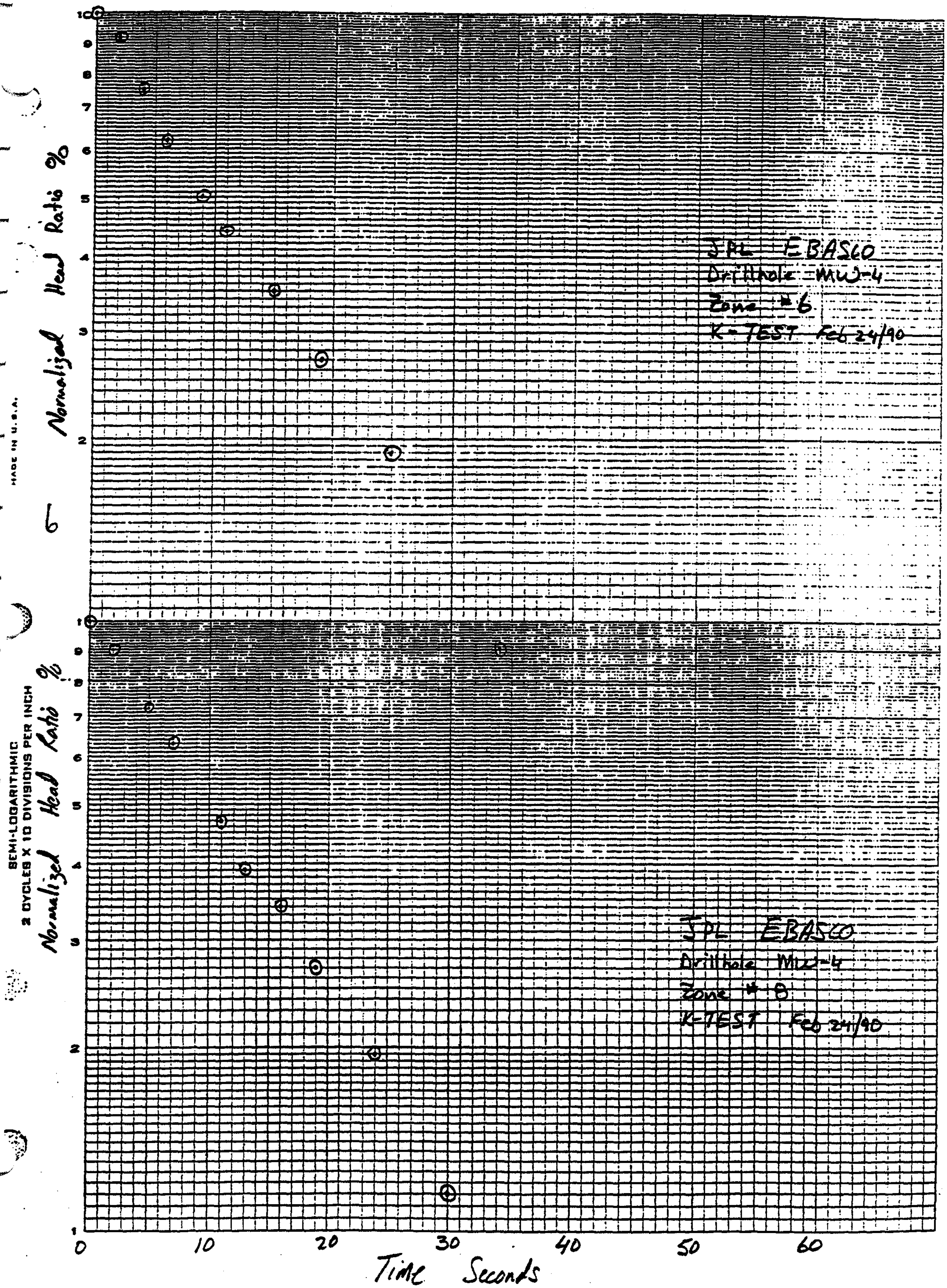
Static Water Level in Test Zone — ft. m psi. Comments —

Clock Time	Elapsed Time min. sec.	Test Readings* (h) ~~ft.~~ ~~m~~ psi	Normalized Test Readings	Clock Time	Elapsed Time min. sec.	Test Readings* (h) ft. m psi	Normalized Test Readings
	—	19.9	1.0				
	02	23.7	.72				
	03	24.7	.65				
	04	25.5	.59				
	06	26.9	.49				
	07	28.2	.39				
	09	29.6	.29	K (est) =	d^2 / 8L	$\ln(\frac{2L}{D})$ / $(t_2 - t_1)$	$\ln(\frac{H_1}{H_2})$
	11	30.3	.24				
	13	31.2	.18				
	16	32.2	.10	T_1 = 2 sec	H_1 =	33.6 - 23.7	= 9.9
	21	33.0	.044	T_2 = 13 sec	H_2 =	33.6 - 31.2	= 2.4
	28	33.5	.007	d = 3.8 cm	D =	31.1 cm	
	41	33.6	—	L = 1463 cm			
Final Pressure		33.6					
				K (est) =	7.2×10^{-4}	cm/s	

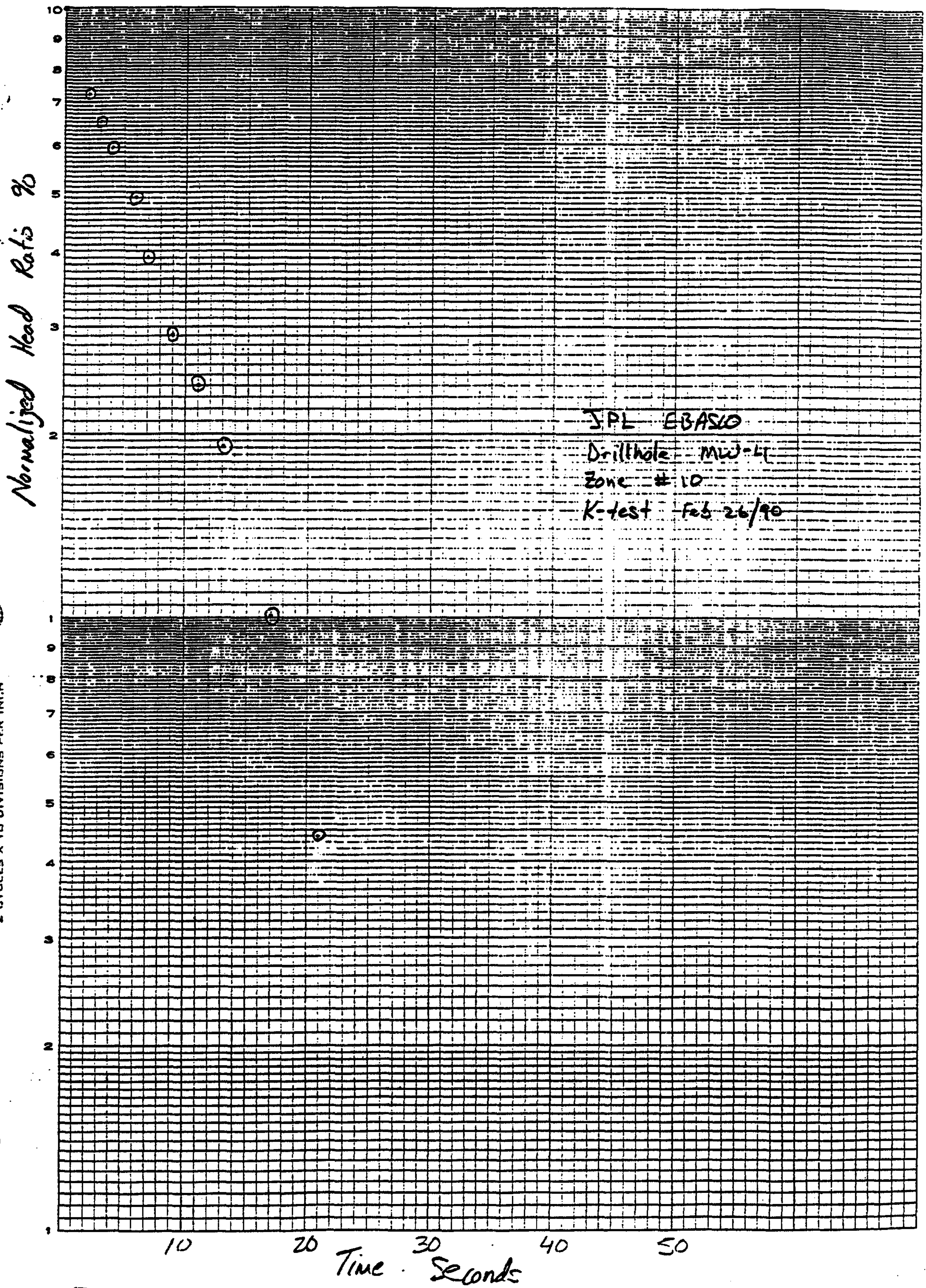
*READINGS UNCORRECTED FOR VARIATIONS IN BAROMETRIC PRESSURE

070788


DIETZGEN CORPORATION
MADE IN U.S.A.
NO. 340R-L210 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
2 CYCLES X 10 DIVISIONS PER INCH
Normalized Head Ratio %
JPL EBASCO
Drillhole MW-4
Zone # 2
K-TEST Feb 22/90
Normalized Head Ratio %
JPL EBASCO
Drillhole MW-4
Zone # 4
K-TEST Feb 23/90
0
10
20
30
40
50
60
Time Seconds



Normalized Head Ratio %
6
JPL EBASCO
Drillhole MW-4
Zone #6
K-TEST Feb 24/90
Normalized Head Ratio %
JPL EBASCO
Drillhole MW-4
Zone #8
K-TEST Feb 24/90
0
10
20
30
40
50
60
Time Seconds
MADE IN U.S.A.
SEMI-LOGARITHMIC
2 CYCLES X 10 DIVISIONS PER INCH


JPL EBASCO
Drillhole MW-4
Zone #10
K-test Feb 26/90
Normalized Head Ratio %
Time Seconds
10
20
30
40
50
10
9
8
7
6
5
4
3
2
1
9
8
7
6
5
4
3
2
1

Appendix C

MP System Well History, MW-3 - 2 Sheets
Pumping Log and Pumping History, MW-3/Zone 2 - 2 Sheets
Pumping Log and Pumping History, MW-3/Zone 4 - 1 Sheet
Pumping Log and Pumping History, MW-3/Zone 6 - 1 Sheet
Pumping Log and Pumping History, MW-3/Zone 8 - 1 Sheet
Pumping Log and Pumping History, MW-3/Zone 10 - 1 Sheet

Westbay Instruments Inc.

Sheet 1 of 2

MP System Well History

Project: NASA JPL / EBASCO WB Ref: 650

Location: PASADENA CALIFORNIA Well No: MW-3 Installed by: E.R. K.S.

Hole Depth: 720 ft. MP Depth: 688 ft Well Diameter: 9 7/8"/4" steel Date Installed: Feb. 12, 1990

Measurement Datum: Top of 7.5" steel Datum Elevation:

DATE	DEPTH TO WATER BELOW MP START 7½"	DEPTH TO WATER BELOW MP FINISH 7½"	COMMENTS: ZONES PURGED/DATE, ZONES SAMPLED/DATE, PUMPING PORT STATUS/DATE, PRESSURE PROFILE/DATE ZONES K TESTED/DATE ETC.
Feb11/90			Install MP and inflate all Packers
Feb12/90			Pressure Profile of well all measurement Ports
			KTest Zone 2 615' to 679' Pumping Port
			Casing element #3 opened at 14:47 (Zone 2)
Feb13/90		133.02'	Close Pumping Port element #3
	124.42	124.29	Hydraulic Integrity test FROM 7½"
	157.5'		KTest Zone 4 FROM 7½"
Feb14/90			Purge zone 4 to cloudy H_2O
		132.33	Close Pumping Port Zone 4
	11:43 123.09	11:50 123.06	Hydraulic Integrity Test
			Open Pumping Port Zone 6 Ktest
			Purging Zone 6
Feb15/90		130.57'	Purge Zone 6 CLOSE PUMPING PORT ZONE 6
	10:28		ADD H_2O TO MP CASING
10:30am	125.54		
10:32	125.42		
10:36		125.36	ZONE 6 ∴ PUMPING PORT SEALED.
11:45			Open Pumping Port Zone 8
			KTest Zone 8 PURGE ZONE 8
Feb16/90	Below 7.5"	130.98'	CLOSE PORT 8 7/8" to 7.0" 1 7/8" movement
8:08		126.35'	Hydraulic Integrity Test Add H_2O to casing
8:24		126.21'	∴ PP SEALED @ ZONE 8
~9:40			OPEN PUMPING PORT IN ZONE 10 FOR RISING HEAD TEST / PURGING.
9:52		129.86'	BELOW 7½" CASING
Feb20/90			@ 13:10 Finish purging Zone 10 total 277 l removed
		129.31'	13:34 Close Pumping Port Zone 10
			Hydraulic Integrety Test Add H_2O to casing
		123.38'	13:43
		123.33'	13:48 ∴ PP Sealed at Zone 10
		123.32'	13:52 "
Feb21/90	41.54'		Casing Flushed with ≈110 gallons Tap water Feb20/90

Westbay Instruments Inc.

MP System Well History

Project: NASA JPL / EBASCO WB Ref: 650

Location: PASADENA CA Well No: MW-3 Installed by: ER KS

Hole Depth: 720 ft. MP Depth: 688' Well Diameter: 9 7/8" / 4" STEEL Date Installed: Feb 12 1990

Measurement Datum: Top of 7.5" steel Datum Elevation:

DATE	DEPTH TO WATER BELOW MP START	DEPTH TO WATER BELOW MP FINISH	COMMENTS: ZONES PURGED/DATE, ZONES SAMPLED/DATE, PUMPING PORT STATUS/DATE, PRESSURE PROFILE/DATE ZONES K TESTED/DATE ETC.
Feb21/90	41.54'	162.91'	H_2O Level in casing bailed down below Zone Levels
FEB21/90			SET OF FLUID PRESSURE READINGS TAKEN IN MONITORING AND QA ZONES.
FEB26/90			SET OF FLUID PRESSURE READINGS TAKEN
FEB27/90	161.10'	161.55'	SAMPLING ACTIVITY AT ZONE 10
FEB28/90	161.55'		SAMPLING ACTIVITY AT ZONE 8
		165.32'	SAMPLING ACTIVITY AT ZONE 6
MARCH 1/90	165.21'		SAMPLING ACTIVITY AT ZONE 4
		166.37'	SAMPLING ACTIVITY AT ZONE 2
MAR 2/90	166.31'	167.98	SAMPLING ACTIVITY AT ZONE 2
MAR3/90	167.87'	167.82'	SET OF FLUID PRESSURE READINGS TAKEN IN MONITORING AND QA ZONES

Westbay Instruments Ltd.

PUMPING LOG
MP System Pumping Ports

1/2

Client: NASA JPL /EBASCO

Job No.: WB-650

Project/Location: PASADENA CA

Technician(s): K.S. E.R

Borehole No.: MW-3

Date: FEB. 12 1990

Drill Type: MUD ROTARY

BAROID PRODUCT - QUICK-GEL DRISPACK

Drill Fluid: BENTONITE MUD

Zone No.: 2

Interval Length: SCREEN 650-660' BGS

Hole Size: 9 7/8" MUD ROTARY

Interval Depth: SAND 615'-679'

Elevation Head(wrt G.S.): —

Recommended Minimum Extraction: —

Date/Time Pumping Port Opened: Feb 12, 1990 14:47 Closed: FEB 13, 1990 13:30

Pump Type: AIR LIFT (NITROGEN)

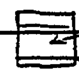
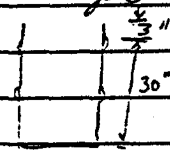
Pumping History

Date	Time	Volume Pumped	Cumulative Volume	Pumping Rate	ΔH	Comments
Feb 12, 1990	15:50	start	∅			
	16:00	8 l	8 l			Cloudy LIGHT BROWN
	16:06	8 l	16 l			16.5°C pH 7.4 Sc 610 μmhos
		7 l	23 l			
	16:15	8 l	31 l			16.2°C pH 7.5 Sc 600 μmhos
	16:20	9 l	40 l	2 l/min		
	16:25	9 l	49 l			16.9°C pH 7.6 Sc 600 μmhos
	16:28	8 l	57 l			slightly Hazy
	16:32	9 l	66 l			
	16:36	8 l	74 l			
		8 l	82 l			
	16:45	10 l	92 l			JAR LEFT FOR ~5 min; LIGHT BROWN; VERY DARK BROWN (LIKE DRILLING MUD)
Feb 13/90	07:21	7 l	99			
	7:25	9 l	108			
	7:30	8 l	116			
		8 l	124			VERY MURKY (BROWN)
		8 l	132			VERY MURKY, BROWN
		8 l	140			VERY MURKY, BROWN
	8:05	8 l	148		Sc = 378 μS	VERY MURKY, BROWN pH = 7.6 T = 13.
	8:	8 l	156			
	8:19	9 l	165			

Apparent Transmissivity: T =

Westbay Instruments Ltd.

Pumping History

Date	Time	Volume Pumped	Cumulative Volume	Pumping Rate	ΔH	Comments
Feb13/90	8:22	7l	172l			Zone 2
	8:29	8l	180l			
		8l	188l			
	845	8l				HAZY (LIGHT BROWN)
	849	5l				VERY DARK BROWN (LIKE DRILLING MUD) AFTER 5 min
		drain	50 gal			
Note =	55gal	over 30"	 1/3" 30"			28" from Rim
				0.54 "/gal.		
29" to 30 FROM TOP AT START	9=27					
	10:02	28"-17"=11"				Less Dark TRACE MUD AFTER 5 min
		= +20gals U.S.			Temp	17.9C pH 8.0 431 µmho
	10:33	+6"				Cloudy
	↓	+11 gals U.S.			Temp	17.4C pH 8.0 430 µmhos
						Salinity Ø
	11:08	+5.5"				
		+10gals			Temp	17.0 pH 8.3 420 µmhos
				Recalibrate	pH meter	pH=7.9
Empty Barrel						
Start	11:37	H_2O 30.5"	from rim of	barrel		
	12:08	H_2O 22.5"	from rim			
		8" = 15gals			Temp. 18.	4 pH 7.3 422 µmhos
						cloudy
	12:45	H_2O 12" from Rim				Hazy
		9.5" = 18gals				
Total	5 1/4 hours		74 gal.			

Westbay Instruments Ltd.

PUMPING LOG
MP System Pumping Ports

1/1

Client: NASA JPL/EBASCO
Job No.: WB 650
Project/Location: PASADENA, CALIFORNIA
Technician(s): ER/KS/MIKE BARNES
Borehole No.: MW-3
Date: FEB 13/90
Drill Type: ROTARY
Drill Fluid: MUD ROTARY

$\pi r^2 h$ $r_1 = 4\frac{1}{2}"$ $r_2 = 9\frac{7}{8}"$

Zone No.: 4
Interval Length: 39'
Hole Size: 9 7/8"
Interval Depth: 542–581'
Elevation Head (wrt G.S.): —

Recommended Minimum Extraction: —
Date/Time Pumping Port Opened: FEB 13 1990 Closed: Feb 14, 1990
Pump Type: Air Lift

Pumping History

Date	Time	Volume Pumped	Cumulative Volume	Pumping Rate	ΔH	Comments 55 U.S.
FEB 13/90	3:51				H_2O	AT START 31" FROM TOP OF BARREL
	4:10	11 gal.	24" FROM RIM	HAZY		
	↓					pH 7.2 T 16.3°C / 410 µmho
				LIGHT BROWN		
	4:45		15¼" FROM RIM (28 gal.)			
FEB 14/90	7:30 a.m.					START PURGING
	7:56		9" from RIM			
			(39 gal)			CLOUDY, LIGHT BROWN
	8:10	20 l		ph = 6.7, Sc = 372,	T°: 11.8	Drain Barrel
	8:15	+ 4 l				
	8:22	+ 7 l				DARK BROWN, VERY MUDDY
	8:27	+ 7 l	(49 gal)			24" from Rim DARK BROWN VERY MUDDY TRACE SETTLED OUT
	8:36	21" from Rim				DARK BROWN, VERY MUDDY TRACE SETTLED OUT
		~~+55 gal~~		ph = 7.3, Sc = 371,	T° = 12.0	CLEANER THAN ZONE 2
	9:07	13" from Rim				MURKY, LIGHT BROWN
		~~+15 gal~~		ph = 7.4, Sc = 388,	T° = 11.6	
	9:37	7" FROM RIM	+8l + 7l + 9 + 9 + 10	DRAW BARREL		MURKY, LIGHT BROWN
			+10 + 8 + 8			CLOUDY, LIGHT BROWN
	10:15	30" FROM RIM 29" FROM RIM		ph = 7.4, Sc = 390,	T°: 14.0	SLIGHT ORGANIC VAPOR ODOUR DETECTED IN BARREL
	10:35	+ 9 l				OVA DOESN'T PICK UP ANYTHING
		+ 4 l	(96 gal)			CLOUDY, LIGHT BROWN.

Apparent Transmissivity: T =

Westbay Instruments Inc.

PUMPING LOG
MP System Pumping Ports

VI

Client: JPL /EBASCO

Job No.: WB 650

Project/Location: PASADENA, CALIFORNIA

Technician(s): E.R./K.S./MIKE BARNES

Borehole No.: MW-3

Date: FEB 14, 1990

Drill Type: —

Drill Fluid: —

Zone No.: 6

Interval Length: 46'

Hole Size: 9 7/8"

Interval Depth: 320'-366'

Elevation Head (wrt G.S.): —

Recommended Minimum Extraction: —

Date/Time Pumping Port Opened: FEB 14/90

Closed: 10:30 Feb 15/90

Pump Type: NITROGEN LIFT

55gal barrel .54"/U.S.gal.

Pumping History

Date	Time	Volume Pumped	Cumulative Volume	Pumping Rate	ΔH	Comments
FEB. 14/90	3:49 p.m.					2'8" TOP OF BARREL TO H_2O
	4:19 p.m.	23" TO H_2O FROM TOP		ph=7.1, Sc=352, T°=13.8		MURKY, LIGHT BROWN
	4:50 p.m.	15½" TO H_2O TOP +8l		ph=7.2, Sc=310 T°=13.8		MURKY, LIGHT BROWN, TRACE SILT
FEB 15/90	7:21am	15" TO Rim				
	7:58am	(14gal) 12¼" To Rim				Murky
	8:17	(5gal) 4.5" To Rim		pH 7.2 Sc 309		T 13°C
	8:24	+4l				cloudy
	8:32	+7l		pH 7.3 Sc 280		T 12.4°C
	8:37	+7l				Less Cloudy
	8:41	+5l 30" To Rim		pH 7.4 Sc 287		T 13.6°C TRACE OF SILT
	9:12	+11gal 24" To Rim				Cloudy
				pH 7.3 Sc 291 T		13.9°C
	9:36	+6.5gal 20½" To Rim				Cloudy TRACE OF SILT
			Total 57.5 gal			

Apparent Transmissivity: T =

Westbay Instruments Inc.

PUMPING LOG

MP System Pumping Ports

1/1

Client: NASA JPL / EBASCO

Job No.: 650

Project/Location: PASADENA CA

Technician(s): ER / KS

Borehole No.: MW-3

Date: Feb 15/90

Drill Type: —

Drill Fluid: —

Zone No.: 8

Interval Length: 47'

Hole Size: 9 7/8"

Interval Depth: 223'-270'

Elevation Head (wrt G.S.): —

Recommended Minimum Extraction:

Date/Time Pumping Port Opened: 11:45 Feb15/90 Closed: FEB 16/90 8:01

Pump Type: Air Lift

Pumping History

Date	Time	Volume Pumped	Cumulative Volume	Pumping Rate	ΔH	Comments
Feb 15/90	12:30	∅ 19¼" TO RIM	∅			
	13:04	(8 gal) 15½" TO RIM		T°=17.2 ph=7.2, Sc	362	CLOUDY, LIGHT BROWN MINOR SEDIMENT
	14:00	9" to Rim		T=17.0 Ph 6.9	Sc	373 Mucky Brown
	14:27	6" TO RIM	24.5 gals	T= 17.0 Ph 7.1	Sc	358 Mucky to Cloudy
	14:32	+4 l		T=16.9 Ph 7.1	Sc	368 Cloudy
	14:37	+6 l				
	14:42	+9 l				
	14:46	6 l				
	14:47	28" TO RIM				
	15:00	7.5 gal 24" TO RIM		T=16.9 Ph	7.0 Sc	372 Cloudy
	15:30	7.5 gal 20" TO RIM				
			46 gal			

Apparent Transmissivity: T =

Westbay Instruments Inc.

PUMPING LOG
MP System Pumping Ports

1/1

Client: NASA JPL/EBASCO
Project/Location: PASADENA, CA.
Borehole No.: ~~MW-4~~ MW-3 WB
Drill Type: —
Drill Fluid: —

Job No.: 650
Technician(s): ER/KS
Date: FEB 20/90

Zone No.: 10
Hole Size: 9 7/8"
Elevation Head (wrt G.S.): —

Interval Length: 37'
Interval Depth: 155'-192'

Recommended Minimum Extraction: —
Date/Time Pumping Port Opened: FEB 16, 1990 Closed: Feb 20, 1990
Pump Type: Nitrogen Gas lift

Pumping History

55 gallon drum .54"/gal

Date	Time	Volume Pumped	Cumulative Volume	Pumping Rate	ΔH	Comments
Feb 20/90	7:51	28" to Rim				240' Eductor 210' air line Purge air max 150 psi
	8:11	25" to Rim				Cloudy
	8:24	24" to Rim	7.5 gal	T 13°C Sc 355 µmhos		Murky Grey Brown
—	—	—	—	pH 7.6		
	9:04	19½" To Rim		pH 8.12 Sc 390 µmho		13.2°C Cloudy
	—	—				Trace of silt
	9:42	13½" To Rim		pH 8.17 Sc 400 µmho		T-14.0°C Cloudy
						Less silt
	9:56	12" To Rim				Try Constant flow Purge
	10:08	9.5" To Rim				
	10:22	7" To Rim	39 gal 147 l	pH 7.98 Temp	15.0°C	Sc 410 µmhos Hazy
	—	—				10:22 data after constant
	—	—				airflow airlift
	10:46	2 3/4" To Rim				
	10:50	2" To Rim		pH 8.17 Temp	15.2°C	Sc 405 µmhos
						Hazy - clearing No silt
	11:22	27½" To Rim				
	12:26	9" To Rim.	177 l	pH 7.99	17.0°C	Sc 420 µmhos
		34 gal	73 gal			hazy - no silt.
		130 l				

Apparent Transmissivity: T =

Appendix D

MP System Well History, MW-4 - 2 Sheets
Pumping Log and Pumping History, MW-4/Zone 2 - 1 Sheet
Pumping Log and Pumping History, MW-4/Zone 4 - 1 Sheet
Pumping Log and Pumping History, MW-4/Zone 6 - 1 Sheet
Pumping Log and Pumping History, MW-4/Zone 8 - 1 Sheet
Pumping Log and Pumping History, MW-4/Zone 10 - 1 Sheet

Westbay Instruments Inc.

Sheet 1 of 2

MP System Well History

Project: NASA JPL /EBASCO WB Ref: 650

Location: PASADENA CALIFORNIA Well No: MW-4 Installed by: E.R/K.S.

Hole Depth: 605' MP Depth: 547' Well Diameter: 12¼"/4" steel Date Installed: Feb. 16/90

Measurement Datum: TOP OF MP STICK-UP AT THE TIME Datum Elevation:

DATE	DEPTH TO WATER BELOW MP START	DEPTH TO WATER BELOW MP FINISH	COMMENTS: ZONES PURGED/DATE. ZONES SAMPLED/DATE. PUMPING PORT STATUS/DATE. PRESSURE PROFILE/DATE ZONES K TESTED/DATE ETC.
FEB 16/90		311.40'	MP CASING LOWERED INTO MW-4 (OPEN HOLE DTW ≈110' FROM G.S.)
FEB 17/90	311.43'		ALL MP PACKERS INFLATED IN MW-4
FEB 19/90	294'	250.95'	SET OF PRESSURE READINGS TAKEN IN MONITORING AND QA ZONES
FEB 21	251.03'		SUPPLEMENTARY PACKER SEAL TESTING
FEB 22			OPEN PUMPING PORT ZONE 2, CONDUCT RISING HEAD TEST.
Feb 23		117.84'	Casing element #3 closed at 11:20 AM (ZONE 2)
12:26	134.98'		Hydraulic Integrity Test Water bailed below outside piezometric level
12:36		134.98'	Tested Positive
			Open casing element #19 (Zone 4)
			K-Test Zone #4, PURGE ZONE 4.
Feb 24/90			Close Port Zone #4 Hydraulic Integrity test OK
		134.85'	K Test Zone #6, Purge Zone 6, Close Port Zone 6
			Hydraulic Integrity Test
			K Test Zone #8 Purge Zone 8
Feb 26/90			Close Port Zone #8
	131.92	131.88	
	@ 8:14	@ 8:26	Hydraulic Integrity Test
		131.88 @ 8:36	:- PUMPING PORT IS CLOSED
FEB 26			K TEST ZONE 10, PURGE ZONE 10, CLOSE PP IN
			ZONE 10
		148.95'	FLUSH INTERIOR MP CASING W/ PASADENA CITY TAP WATER
Mar 2	148.57		Pressure Profile (TEST ZONES ONLY), SAMPLE ZONE 8, 6
		147.60'	FROM TOP OF TEMP. MP 17½" ABOVE MIDDLE #69
MAR 3	147.70'	148.12'	SAMPLE ZONE 6, ZONE 10
Mar 5	148.21		DTW 15¼" above Center of top coupling / Sample Zones 4, 2
		152.19'	Casing Stub 1.00' above Center of Top Coupling
			PRESSURE Profile of Well TAKEN

Westbay Instruments Inc.

MP System Well History

Project: NASA JPL WB Ref: 650

Location: PASADENA, CALIFORNIA Well No: MW-4 Installed by: ER/KS

Hole Depth: 605' MP Depth: 547' Well Diameter: 12¼" / 4" STEEL Date Installed: FEB 16/90

Measurement Datum: TOP OF MP STICK-UP AT THE TIME Datum Elevation:

DATE	DEPTH TO WATER BELOW MP START	DEPTH TO WATER BELOW MP FINISH	COMMENTS: ZONES PURGED/DATE, ZONES SAMPLED/DATE, PUMPING PORT STATUS/DATE, PRESSURE PROFILE/DATE ZONES K TESTED/DATE ETC.
Mar 6/90	151.87'	@ 8:45	All P Ports Closed. - Sampling complete.
	@		QA Test all QA Zones - show positive seal by Packers
	@ 10:52	128.25'	End of Test, FINAL WATER LEVEL INSIDE MP TAKEN
			FROM TOP OF TEMPORARY MP CASING (1.0' ABOVE MIDDLE
			OF COUPLING NUMBER 69).

Westbay Instruments Inc.

PUMPING LOG
MP System Pumping Ports

1/1

Client: NASA JPL / EBASCO

Job No.: WB 650

Project/Location: PASADENA, CALIFORNIA.

Technician(s): ER/KS

Borehole No.: MW - 4

Date: FEB 23/90

Drill Type: —

Drill Fluid: —

Zone No.: 2

Interval Length: 52'

Hole Size: 31.1 cm

Interval Depth: 480' - 532'

Elevation Head (wrt G.S.): 112.5'

Closed by measuring differential movement
O.C. Tool start 3½"
end 1 3/8"

Recommended Minimum Extraction: —

Date/Time Pumping Port Opened: FEB 22, 1990

Closed: Feb 22/1990 at 11:30 AM

Pump Type: NITROGEN GAS LIFT

EDUCTOR TO 210'
AIRLINE TO 170'
NITROGEN CONSTANT PRESSURE @ ~30psi

55 gallon drum 0.54"/gal (us)

Pumping History

Date	Time	Volume Pumped	Cumulative Volume	Pumping Rate	ΔH	Comments
FEB 23	7:36am					DTW IN DRUM = 31" FROM RIM
	7:50		5.5 gal			CLEAR 28" FROM RIM.
	8:07am	24¾" From Rim	11.5 gal	TEMP		CLEAR ph = 8.03, T° = 17°C Sc = 620 umhos
	8:36	21½" From Rim	17.5 gal	READINGS NOT VALID		CLEAR ph = 7.74, T° = 17°C, Sc = 600 umhos.
	9:07	16" From Rim	27.7 gal			SLIGHTLY HAZY ph = 7.8, T° = 17°, Sc = 545 umhos
	9:35	11" "	37.0 gal			SLIGHT HAZY ph = 8.3, T° = 21.8 Sc = 449 µmohs
—	Change	Nitrogen Bottles				
	9:40	11" From Rim.	37.0 gal			
	10:10	5" From Rim	48.1 gal			slightly HAZY/CLEAR ph = 8.25, T° = 19.7, Sc = 500 µmhos
		2 gallon	50.1 gal			2 gallons collected while pumping
	10:20	21½" From Rim				pumped drum to 21½" From Rim
	10:40	13½ From Rim	63.1 gal			Clear ph = 8.10, T° = 19.4, Sc 500
	Hydraulic	Integrety	Test bailed	water from	117.84'	
				to	134.98	at 12:26
			No Water	Leaked =>	134.98	at 12:36

Apparent Transmissivity: T =

Westbay Instruments Inc.

PUMPING LOG
MP System Pumping Ports

Client: NASA JPL /EBASCO
Job No.: WB 650
Project/Location: PASADENA CALIFORNIA
Technician(s): ER/DMc
Borehole No.: MW - 4
Date: Feb 23/90
Drill Type: —
Drill Fluid: —

Zone No.: 4
Interval Length: 56'
Hole Size: 31.1 cm
Interval Depth: 370' - 426'
Elevation Head (wrt G.S.): —

Recommended Minimum Extraction: —
Date/Time Pumping Port Opened: Feb 23/90
Closed: 7:50 a.m. FEB 24/90
Pump Type: Nitrogen Gas Lift

BEFORE CLOSING 4½" TOP MP TO "T" HANDLE
AFTER CLOSING 2⅝" TOP MP TO "T" HANDLE.
HYDRAULIC TEST (BAIL DOWN). ∴ SEALED.
130.65 8:2:
130.65/8=35a

55 gal drum ⇒ 0.54"/gal (US)

Pumping History

Date	Time	Volume Pumped	Cumulative Volume	Pumping Rate	ΔH	Comments
Feb 23/90	2:23	28" from Rim				
	2:59	17½" " "	19.4 gal			cloudy ph=7.99, T°=21.9, Sc=468 umhos
	3:30	11" " "	31.5 gal			cloudy ph=8.16, T°=21.0, Sc=400 umohs
	3:54	7½" " "	37.2 gal	Trace Silt Brown		pump 55 gal drum
	4:05					cloudy ph=8.19 T°=20.3, Sc=401 umohs
	4:09	30" " "				start new drum
	4:31	22½" " "	51.1 gal			Hazy ph=8.20, T°=20.1, Sc=395 umohs
	5:02	19 " "	57.6 gal			clear ph=8.21, T=19.1, Sc=390 umohs
	5:24	15 " "	65.0 gal			clear ph=8.19 T=19.3 Sc=389

Apparent Transmissivity: T =

Westbay Instruments Inc.

PUMPING LOG
MP System Pumping Ports

1/1

Client: NASA JPL / EBASCO
Job No.: WB650
Project/Location: PASADENA, CA.
Technician(s): ER/KS/DMC
Borehole No.: MW-4
Date: FEB 24/90
Drill Type: —
Drill Fluid: —

Zone No.: 6
Interval Length: 42'
Hole Size: 31.1 cm
Interval Depth: 306'-348'
Elevation Head (wrt G.S.): —

Recommended Minimum Extraction: —
Date/Time Pumping Port Opened: ~9:13 a.m. FEB 24/90 Closed: 12:50 p.m. FEB 24/90
Pump Type: NITROGEN LIFT - 3/4 EDUCTOR TO 210', AIRLINE TO 170'.

CLOSE PP = INITIAL MEASUREMENT 3 1/2"
= FINAL MEASUREMENT 1 1/2"

NOTE = EBASCO STAFF TAKE T°, Sc, ph READINGS

0.54"/gal (US)

Pumping History

HYDRAULIC TEST = 1:24 p.m. → 134.87'
1:44 p.m. → 134.85' } O.K.

Date	Time	Volume Pumped	Cumulative Volume	Pumping Rate	ΔH	Comments
FEB 24	9:35 a.m.	30" FROM RIM				START PURGING.
	10:05 a.m.	22" FROM RIM	14.8 gal			LIGHT RED-BROWN, VERY CLOUDY OVA READING - NO KICK
						ph = 7.87, T° = 19.4, Sc = 352 µmhos
	10:36	12 1/2 "	32.4 gal			light Brown/cloudy ph = 7.91 T = 20.8° Sc = 351 µmhos
	11:03	7 "	42.6 gal			light Brown/cloudy ph = 7.56 T = 20.9 Sc = 360 µmhos
	11:17	25" "				Pump drum
	11:37	20" "	51.9 gal			hazy/cloudy ph = 8.39 T = 20.6° Sc = 363 µmhos
	12:01	14 1/2" "	63.9 gal			clear ph = 7.98 T = 21.5° Sc = 359 µmhos
	12:38	6 "	77.8 gal			clear ph = 7.99 T = 21.5 Sc = 370 µmhos

Apparent Transmissivity: T =

Westbay Instruments Inc.

PUMPING LOG
MP System Pumping Ports

Client: NASA JPL/ EBASCO

Job No.: WB 650

Project/Location: PASADENA, CA.

Technician(s): ER/KS/DMC.

Borehole No.: MW - 4

Date: FEB 24/90

Drill Type: —

Drill Fluid: —

Zone No.: ZONE 8

Interval Length: 54'

Hole Size: 31.1 cm

Interval Depth: 203' - 257'

Elevation Head (wrt G.S.): —

Recommended Minimum Extraction: —

Date/Time Pumping Port Opened: 1:50 PM Feb 24/90 Closed: 7:40 a.m. FEB 26/90

Pump Type: NITROGEN LIFT - 3/4" EDUCTOR TO 210', AIRLINE TO 190'

CLOSING PP = BEFORE CLOSING 8 1/4" 'T' HANDLE TO TOP MP (3' TEMP. S/U)
AFTER 6 3/8"
HYDRAULIC TEST = BAIL H_2O OUT OF MP (6 l)
DTW = 131.92' @ 8:14
131.88 @ 8:26
131.88 @ 8:36 ∴ PP SEALED

Pumping History

Date	Time	Volume Pumped	Cumulative Volume	Pumping Rate	ΔH	Comments
FEB 24	2:30 p.m.	28 1/2" TO RIM				BEGIN PURGING
	2:58 pm	23 1/2" TO RIM	9.3 gal			mud red Brown ph=7.29 T=21.1 Sc: 555 µmho.
	3:30 PM	17" TO RIM	21.3 gal	ph= 7.84 T°=20.1		SLIGHTLY HAZY Sc = 550 µmh.
	4:00 pm	12" TO RIM	30.5 gal			SLIGHTLY HAZY ph= 7.78, T°=20 Sc= 545 µmhos
	4:38	7" TO RIM	40 gal			VERY SLIGHT HAZE
		+9 l				ph= 7.83, T°= 19.8, Sc= 554 µmhos
		+9 l				
		+9 l				
	5:00 pm.	32" TO RIM				ph= 7.76, T°=19.9, Sc = 540 µmh
	5:33 pm	26" TO RIM				CLEAR ph= 7.75, T°=19.8°C
		+8 l	59 gal			Sc=535 µmhos

Apparent Transmissivity: T =

Westbay instruments inc.

PUMPING LOG
MP System Pumping Ports

Client: NASA JPL / EBASCO
Job No.: WB 650
Project/Location: Pasadena California
Technician(s): E. Rehtlane KS/DMC
Borehole No.: MW-4
Date: FEB. 26/90
Drill Type: —
Drill Fluid: —

Zone No.: Zone # 10
Interval Length: 48'
Hole Size: 31.1 cm
Interval Depth: 121'-169'
Elevation Head (wrt G.S.):

Recommended Minimum Extraction: —
Date/Time Pumping Port Opened: Feb 26/90
Closed: 1:30p.m. / FEB 26/90
Pump Type: NITROGEN GAS LIFT

CLOSING PP: BEFORE 5½" AFTER 3½"

HYDRAULIC TEST. ADD 6L TO MP CASIN DTW = 90.0' STABLE FOR 1 MINUTE ∴ PP IN Z10 SEALED.

55gal. drum 1usgal/.54"

Pumping History

Date	Time	Volume Pumped	Cumulative Volume	Pumping Rate	ΔH	Comments
Feb 26/90	9:30	32" to Rim				
	10:03	25½" to Rim				ph: 7.33, T°=17.2 Sc= 405 µmhos Hazy
	10:32	18" TO RIM				ph: 7.36, T°=17.1 Sc= 403 µmhos. CLEAR
	10:45					OVA READING - NO KICK (ACTUALLY GOI BELOW)
	11:04	11½" TO RIM.		PH 7.34	17.2°C	Sc 410 µmhos
	11:46	6¾" TO RIM	46.7 US. GAL			
	12:02p.m.	2¾" TO RIM				
	12:11	+17 l				EMPTY 55gal DRUM
		+9 l				
		+9 l				
	12:32	+9 l	65 gal			

Apparent Transmissivity: T =

Appendix E

MW-3 Piezometric Pressures/Levels, Field Data Record, Feb 12,1990
MW-3 Piezometric Pressures/Levels, Field Data Record, Feb 21,1990
MW-3 Piezometric Pressures/Levels, Field Data Record, Mar 3, 1990

Westbay Instruments Inc.

PIEZOMETRIC PRESSURES/LEVELS

FIELD DATA AND CALCULATION SHEET

Datum: — Pressure Probe Type ELECTRIC Date: FEB 12, 1990 Job No.: 650

Elev. Ground Sfc: — Serial No.: EE172 Drillhole No.: MW-3

Height MP Casing above Ground Sfc: — Range: 0 to 500 psi Client: NASA JPL / EBASCO

Elev. top of MP Casing: — Weather: HAZY, SUNNY Casing Size/Type: MP - 1.5"

Reference Elev. Steel Casing: — Barometric Pressure: — Operator: ER/KS

Ambient Reading (Pressure/Temperature/Time): Start 13.1 /292.4/10:08 Finish 13.9/292.6/11:45

(COUNTER ZEROED @ TOP OF #82 (TEMP. 2' MP).

Depth to Meas. Port Valve, ft, m		Elev. Meas. Port ft, m	Fluid Pressure Readings psi			Trans. Temp., K	Time, H:M:S	Press. Head Outside Port, ft, m	Piez. Level Outside Port, ft, m	Comments
From Log	From Cable		Inside Casing	Outside Casing	Inside Casing					
	~176'									1ST MAG COLLAR
	~250									2ND MAG COLLAR
	~342'									3RD MAG COLLAR
	~558'									4TH MAG COLLAR
	~649'									5TH MAG COLLAR
	684'11"									TOUCH BOTTOM
1 (QA)	668'4"		157.1			296.7	10:18			
	(668)		157.2			297.4	10:20			
			157.2			297.7	10:22			
			157.2			298.2	10:29			
			157.2			298.3	10:34			
			157.2				10:35:30			
				283.9			10:36			
				283.8			10:36:30			
				283.8			10:37		45.1	
					157.2/3	298.3	10:38			
2	653'6"		150.8				10:42:30			
	(653)			239.3			10:43			
				239.3			10:44			
				239.3		297.9	10:45			

270789

PIEZOMETRIC PRESSURES/LEVELS

Westbay Instruments Inc.

FIELD DATA AND CALCULATION SHEET

Datum: — Pressure Probe Type EE Date: FEB 12, 1990 Job No.: 650

Elev. Ground Sfc: — Serial No.: EE172 Drillhole No.: MW-3

Height MP Casing above Ground Sfc: — Range: 0 to 500 psi Client: NASA JPL / EBASCO

Elev. top of MP Casing: — Weather: Sunny Casing Size/Type: 1.5" MP

Reference Elev. Steel Casing: — Barometric Pressure: — Operator: ER/KS

Ambient Reading (Pressure/Temperature/Time): Start 13.1/292.4/10:08 Finish 13.9/292.6/11:45

Depth to Meas. Port Valve, ft, m		Elev. Meas. Port ft, m	Fluid Pressure Readings psi			Trans. Temp., K	Time, H:M:S	Press. Head Outside Port, ft, m	Piez. Level Outside Port, ft, m	Comments
From Log	From Cable		Inside Casing	Outside Casing	Inside Casing					
2 (Cont.)				239.3					132.8	
					150.7	297.8	10:46:30			
3 (QA)	633'9"		142.0				10:48:30			
	(633)			258.4		297.7	10:49			
				258.4			10:50			
				258.3			10:51		69.0	
			142.0		142.0					
				256.7			10:51:30			2ND ACTIVATION
				256.7			10:52			
					142.0					
4	559'1"		109.4			297.4	10:56:30			
	(558)			198.5		297.2	10:57			
				198.6			10:58			
				198.6			10:59			
				198.6		296.1	11:00		131.7	
					109.6		11:00:30			
			109.6	198.6	109.6	295.6				2ND ACTIVATION
5 (QA)	539'3"		100.9				11:04:30			
	(538)			196.8			11:05:00			
				196.8		295.4	11:06		115.8	
					100.8		11:06:30			

270789

Westbay Instruments Inc.

PIEZOMETRIC PRESSURES/LEVELS

FIELD DATA AND CALCULATION SHEET

Datum: — Pressure Probe Type: EE Date: FEB 12, 1990 Job No.: 650

Elev. Ground Sfc: — Serial No.: EE 172 Drillhole No.: MW-3

Height MP Casing above Ground Sfc: — Range: 0 to 500 psi Client: NASA JPL / EBASCO

Elev. top of MP Casing: — Weather: Sunny Casing Size/Type: 1.5" MP

Reference Elev. Steel Casing: — Barometric Pressure: — Operator: ER / KS

Ambient Reading (Pressure/Temperature/Time): Start 13.1 / 297.4 / 10:08 Finish 13.9 / 292.6 / 11:45

Depth to Meas. Port Valve, ft, m		Elev. Meas. Port ft, m	Fluid Pressure Readings psi			Trans. Temp., K	Time, H:M:S	Press. Head Outside Port, ft, m	Piez. Level Outside Port, ft, m	Comments
From Log	From Cable		Inside Casing	Outside Casing	Inside Casing					
5(8A)(cont.)			100.8				11:06:45			2nd Activation
				195.6			11:07:15			
				195.6			11:07:45			
					100.8					
6	348'2"		17.1				11:11:30			
	(346')			107.5		295.2	11:12:00			
				107.5			11:13:00			
				107.6/5		294.8	11:14:00			
				107.6/5			11:15:00		129.6	
					17.2		11:16:00			
			17.2				11:16:15			2nd Activation
				107.5			11:16:45			
				107.5/6			11:17:15			
					17.2					
7(9A)	328'4"		13.8				11:19:45			
	(326)			103.5			11:20:15			
				103.5		294.1	11:20:45			
				103.5			11:21:45		119.1	
					13.8					
			13.8				11:22:30			2nd Activation
				102.8			11:23			

102.8 13.8 11:24

Westbay Instruments Inc.

PIEZOMETRIC PRESSURES/LEVELS

FIELD DATA AND CALCULATION SHEET

Datum: — Pressure Probe Type ELECTRIC Date: FEB 12, 1990 Job No.: 650

Elev. Ground Sfc: — Serial No.: EE172 Drillhole No.: MW-3

Height MP Casing above Ground Sfc: — Range: 0 to 500 psi Client: NASA JPL / EBASCO

Elev. top of MP Casing: — Weather: Sunny Casing Size/Type: 1.5" MP

Reference Elev. Steel Casing: — Barometric Pressure: — Operator: ER

Ambient Reading (Pressure/Temperature/Time): Start 13.1/292.4/10:08 Finish 13.9/292.6/11:45

Depth to Meas. Port Valve, ft, m		Elev. Meas. Port ft, m	Fluid Pressure Readings psi			Trans. Temp., K	Time, H:M:S	Press. Head Outside Port, ft, m	DTW Piez. Level Outside Port, ft, m	Comments
From Log	From Cable		Inside Casing	Outside Casing	Inside Casing					
8	254'10"		13.7				11:27:00			
	(252)			66.6/5		294.0	11:27:30			
				66.5			11:28:30			
				66.6		293.7	11:29:30			
				66.6			11:30:30			
					13.8		11:31		130.2	
			13.8				11:31:15			2nd Activation
				66.6	13.8		11:31:45			
9(8A)	235'0"		13.8				11:33:30			
	(232)			82.1		293.3	11:34			
				82.1			11:35			
				82.1		293.1	11:36			
					13.9		11:36:30		74.7	
			13.9				11:36:45			2nd Activation
				81.4			11:37:15			
				81.4	13.9		11:38:15			
10	174'5"		13.8			292.6	11:40:30			
	(172')			32.5			11:41:00			
				32.5	13.9		11:42:00		129.1	
			13.9	32.5						2nd Activation
				32.5	13.9					1 minute

270789

WESTBAY INSTRUMENTS (C) 1989

— File Header Information —

COMPANY........WESTBAY INST
TECH......... ERIK REHTLANE
PROJECT...... EBASCO/JPL
PROBE INFO... EE172 0-500
MISC INFO.... MW3 PREADINGS
TEMP UNITS...   (K)
PRES UNITS...   PSI
TEMP MULT.... 0.100000
PRES MULT.... 0.100000
TEMP OFFSET.. 0

1/2

Equivalent Depths To Water in Brackets.

DATE	WELL	ZONE	MODE	INSIDE		OUTSIDE		ATMOSPHERIC		
Thu Jan 01 -5:00:00	0	0								
Wed Feb 21 09:46:52	0	0	SEMI-AUTO							FILE CLOSED - PROGRAM QUIT
Wed Feb 21 10:12:09	1	1	SEMI-AUTO					13.500	291.700	
Wed Feb 21 10:38:05	1	1	SEMI-AUTO	232.300	295.500					TEMPERATURE STABILIZATION
Wed Feb 21 10:38:25	1	1	SEMI-AUTO	232.200	295.700					
Wed Feb 21 10:39:49	1	1	SEMI-AUTO	232.300	296.400					
Wed Feb 21 10:40:02	1	1	SEMI-AUTO	232.300	296.500					
Wed Feb 21 10:42:38	1	1	SEMI-AUTO	232.400	297.200					
Wed Feb 21 10:44:27	1	1	SEMI-AUTO	232.500	297.600					
Wed Feb 21 10:46:12	1	1	SEMI-AUTO	232.500	297.800					
Wed Feb 21 10:48:05	1	1	SEMI-AUTO	232.500	298.000					
Wed Feb 21 10:49:34	1	1	SEMI-AUTO	263.400	298.100					
Wed Feb 21 10:49:38	1	1	SEMI-AUTO			242.400	298.100			
Wed Feb 21 10:49:46	1	1	SEMI-AUTO			234.600	298.100			
Wed Feb 21 10:49:53	1	1	SEMI-AUTO			233.300	298.000			
Wed Feb 21 10:50:01	1	1	SEMI-AUTO			232.700	298.100			
Wed Feb 21 10:50:09	1	1	SEMI-AUTO			232.500	298.100			
Wed Feb 21 10:50:54	1	1	SEMI-AUTO			232.400	298.000			
Wed Feb 21 10:51:27	1	1	SEMI-AUTO			232.300	298.100			
Wed Feb 21 10:51:53	1	1	SEMI-AUTO			232.300	298.100			[164.0']
Wed Feb 21 10:52:26	1	1	SEMI-AUTO	232.400	298.100					
Wed Feb 21 10:53:55	1	2	SEMI-AUTO	228.200	298.200					ZONE 1 DATA MISLOCATED
Wed Feb 21 10:55:29	1	2	SEMI-AUTO			239.400	298.200			
Wed Feb 21 10:55:50	1	2	SEMI-AUTO			239.500	298.200			
Wed Feb 21 10:56:32	1	2	SEMI-AUTO			239.500	298.200			
Wed Feb 21 10:57:06	1	2	SEMI-AUTO			239.500	298.200			[132.6']
Wed Feb 21 10:57:33	1	2	SEMI-AUTO	228.200	298.200					
Wed Feb 21 10:58:47	1	3	SEMI-AUTO	219.600	298.200					
Wed Feb 21 10:59:02	1	3	SEMI-AUTO	219.500	298.200					
Wed Feb 21 10:59:34	1	3	SEMI-AUTO			231.300	298.200			
Wed Feb 21 11:00:05	1	3	SEMI-AUTO			231.300	298.100			
Wed Feb 21 11:00:33	1	3	SEMI-AUTO			231.300	298.100			[131.5']
Wed Feb 21 11:01:02	1	3	SEMI-AUTO	219.500	298.100					
Wed Feb 21 11:02:25	1	4	SEMI-AUTO	186.900	298.100					
Wed Feb 21 11:02:46	1	4	SEMI-AUTO	186.900	298.000					
Wed Feb 21 11:03:45	1	4	SEMI-AUTO			198.600	297.800			
Wed Feb 21 11:04:34	1	4	SEMI-AUTO			198.600	297.600			[131.9']
Wed Feb 21 11:05:22	1	4	SEMI-AUTO			198.600	297.500			
Wed Feb 21 11:06:22	1	4	SEMI-AUTO	186.900	297.300					
Wed Feb 21 11:06:41	1	4	SEMI-AUTO	187.000	297.300					
Wed Feb 21 11:07:46	1	5	SEMI-AUTO	178.400	297.100					
Wed Feb 21 11:07:54	1	5	SEMI-AUTO	178.300	297.100					
Wed Feb 21 11:08:23	1	5	SEMI-AUTO	178.300	297.100					
Wed Feb 21 11:08:55	1	5	SEMI-AUTO			187.900	297.000			
Wed Feb 21 11:09:25	1	5	SEMI-AUTO			187.900	297.000			
Wed Feb 21 11:09:58	1	5	SEMI-AUTO			187.800	296.900			[136.8']
Wed Feb 21 11:10:48	1	5	SEMI-AUTO	178.300	296.900					
Wed Feb 21 11:15:16	1	6	SEMI-AUTO	94.700	296.300					
Wed Feb 21 11:15:52	1	6	SEMI-AUTO	94.700	296.100					

2/2

Wed Feb 21 11:16:[illegible]	1	6	SEMI-AUTO			107.600	295.900	
Wed Feb 21 11:17:08	1	6	SEMI-AUTO			107.700	295.800	
Wed Feb 21 11:17:48	1	6	SEMI-AUTO			107.700	295.600	[129.6']
Wed Feb 21 11:18:09	1	6	SEMI-AUTO	94.700	295.600			
Wed Feb 21 11:18:28	1	6	SEMI-AUTO	94.700	295.600			
Wed Feb 21 11:19:29	1	7	SEMI-AUTO	86.000	295.400			
Wed Feb 21 11:20:05	1	7	SEMI-AUTO	86.000	295.300			
Wed Feb 21 11:21:06	1	7	SEMI-AUTO			97.200	295.100	
Wed Feb 21 11:21:46	1	7	SEMI-AUTO			97.200	295.000	
Wed Feb 21 11:22:41	1	7	SEMI-AUTO			97.100	295.000	[134.1']
Wed Feb 21 11:23:12	1	7	SEMI-AUTO	86.000	295.000			
Wed Feb 21 11:23:42	1	7	SEMI-AUTO	86.000	294.900			
Wed Feb 21 11:25:25	1	8	SEMI-AUTO	53.800	294.700			
Wed Feb 21 11:25:46	1	8	SEMI-AUTO	53.800	294.600			
Wed Feb 21 11:26:24	1	8	SEMI-AUTO			66.900	294.300	
Wed Feb 21 11:27:02	1	8	SEMI-AUTO			66.900	294.100	
Wed Feb 21 11:27:32	1	8	SEMI-AUTO			66.900	293.800	[129.7']
Wed Feb 21 11:27:48	1	8	SEMI-AUTO	53.900	293.700			
Wed Feb 21 11:28:03	1	8	SEMI-AUTO	53.900	293.600			
Wed Feb 21 11:28:58	1	9	SEMI-AUTO	45.200	293.300			
Wed Feb 21 11:29:17	1	9	SEMI-AUTO	45.200	293.200			
Wed Feb 21 11:29:38	1	9	SEMI-AUTO			58.700	293.100	
Wed Feb 21 11:30:12	1	9	SEMI-AUTO			58.600	292.800	
Wed Feb 21 11:30:50	1	9	SEMI-AUTO			58.500	292.600	
Wed Feb 21 11:31:19	1	9	SEMI-AUTO			58.400	292.400	
Wed Feb 21 11:33:09	1	9	SEMI-AUTO			58.100	291.900	[130.3']
Wed Feb 21 11:33:57	1	9	SEMI-AUTO			58.000	291.800	
Wed Feb 21 11:34:27	1	9	SEMI-AUTO		Inside	45.200	291.700	WEAK ACTIVATION PROBE LOOSE
Wed Feb 21 11:35:10	1	9	SEMI-AUTO		Readings	45.200	291.600	
Wed Feb 21 11:35:52	1	9	SEMI-AUTO	45.300	291.300			
Wed Feb 21 11:36:15	1	9	SEMI-AUTO			57.800	291.500	
Wed Feb 21 11:36:55	1	9	SEMI-AUTO			57.700	291.400	
Wed Feb 21 11:37:14	1	9	SEMI-AUTO			57.600	291.400	WEAK ACTIVATION
Wed Feb 21 11:37:40	1	9	SEMI-AUTO			57.600	291.400	[131.2']
Wed Feb 21 11:38:53	1	10	SEMI-AUTO	19.100	291.200			
Wed Feb 21 11:39:04	1	10	SEMI-AUTO	19.100	291.200			
Wed Feb 21 11:39:42	1	10	SEMI-AUTO			33.000	291.000	
Wed Feb 21 11:40:13	1	10	SEMI-AUTO			33.100	290.800	
Wed Feb 21 11:40:49	1	10	SEMI-AUTO			33.100	290.600	[127.7']
Wed Feb 21 11:41:08	1	10	SEMI-AUTO	19.300	290.500			WEAK ACTIVATION
Wed Feb 21 11:42:47	1	10	SEMI-AUTO					13.900 290.100
Wed Feb 21 11:43:52	0	0	SEMI-AUTO					FILE CLOSED - PROGRAM QUIT

1/

WESTBAY INSTRUMENTS (c) 1989
-- File Header Information --
COMPANY........WESTBAY INST
TECH......... ER/KS
PROJECT...... EBASCO/JPL
PROBE INFO... EE172 0-500
MISC INFO.... MW3 MARCH3/90
TEMP UNITS... (K)
PRES UNITS... PSI
TEMP MULT.... 0.100000
PRES MULT.... 0.100000
TEMP OFFSET.. 0

DATE	WELL	ZONE	MODE	INSIDE		OUTSIDE		ATMOSPHERIC		Equivalent Depth to Water In Brackets
Sat Mar 03 07:10:51	1	1	SEMI-AUTO					13.700	292.200	MW3 DTW 7:05 AM 167.87FT FROM 7.5CSN 6
Sat Mar 03 07:12:23	1	1	SEMI-AUTO					40.000	292.000	IN WATER ON WAY DOWN
Sat Mar 03 07:21:54	1	1	SEMI-AUTO	234.300	295.900					
Sat Mar 03 07:23:04	1	1	SEMI-AUTO	234.400	296.400					DTW 163.69 FROM 7.5
Sat Mar 03 07:32:45	1	1	SEMI-AUTO	234.600	298.100					DTW 163.69 FT Inside Casing
Sat Mar 03 07:33:52	1	1	SEMI-AUTO			256.100	298.100			30 SECOND READINGS
Sat Mar 03 07:34:22	1	1	SEMI-AUTO			256.300	298.100			
Sat Mar 03 07:34:51	1	1	SEMI-AUTO			256.400	298.200			
Sat Mar 03 07:35:23	1	1	SEMI-AUTO			256.400	298.200			[111.9']
Sat Mar 03 07:35:50	1	1	SEMI-AUTO	234.400	298.200					
Sat Mar 03 07:37:47	1	2	SEMI-AUTO	227.900	298.300					DTW 163.71 FT Inside Casing
Sat Mar 03 07:38:36	1	2	SEMI-AUTO			242.200	298.300			
Sat Mar 03 07:39:06	1	2	SEMI-AUTO			242.200	298.300			
Sat Mar 03 07:39:35	1	2	SEMI-AUTO			242.200	298.300			
Sat Mar 03 07:40:07	1	2	SEMI-AUTO			242.200	298.300			[129.6']
Sat Mar 03 07:40:36	1	2	SEMI-AUTO	227.900	298.300					
Sat Mar 03 07:41:37	1	3	SEMI-AUTO	223.700	298.300					DTW163.75 FT Inside Casing
Sat Mar 03 07:42:36	1	3	SEMI-AUTO			294.900	298.200			
Sat Mar 03 07:43:05	1	3	SEMI-AUTO			294.800	298.200			
Sat Mar 03 07:43:35	1	3	SEMI-AUTO			294.600	298.200			
Sat Mar 03 07:44:06	1	3	SEMI-AUTO			294.400	298.200			
Sat Mar 03 07:44:36	1	3	SEMI-AUTO			296.400	298.200			
Sat Mar 03 07:45:05	1	3	SEMI-AUTO			296.200	298.200			WEAK ACTIVATION
Sat Mar 03 07:45:44	1	3	SEMI-AUTO	223.900	298.200					
Sat Mar 03 07:46:20	1	3	SEMI-AUTO			292.500	298.200			
Sat Mar 03 07:46:28	1	3	SEMI-AUTO			292.500	298.200			
Sat Mar 03 07:46:45	1	3	SEMI-AUTO			292.500	298.200			
Sat Mar 03 07:46:53	1	3	SEMI-AUTO			292.500	298.200			
Sat Mar 03 07:47:23	1	3	SEMI-AUTO			292.400	298.200			Mislocated
Sat Mar 03 07:47:52	1	3	SEMI-AUTO	223.500	298.200					DTW 163.75 FT Inside Casing
Sat Mar 03 07:51:33	1	4	SEMI-AUTO	186.300	298.000					DTW 164.13FT
Sat Mar 03 07:52:21	1	4	SEMI-AUTO			200.900	297.900			
Sat Mar 03 07:52:50	1	4	SEMI-AUTO			200.900	297.800			
Sat Mar 03 07:53:19	1	4	SEMI-AUTO			200.900	297.700			[129.6]
Sat Mar 03 07:53:51	1	4	SEMI-AUTO			200.900	297.600			
Sat Mar 03 07:54:16	1	4	SEMI-AUTO	186.400	297.600					DTW 164.10FT Inside Casing
Sat Mar 03 08:02:02	1	5	SEMI-AUTO	177.400	297.000					164.22 FT
Sat Mar 03 08:03:35	1	5	SEMI-AUTO			192.000	296.900			
Sat Mar 03 08:04:06	1	5	SEMI-AUTO			192.100	296.900			
Sat Mar 03 08:04:34	1	5	SEMI-AUTO			192.100	296.900			
Sat Mar 03 08:05:05	1	5	SEMI-AUTO			192.200	296.900			
Sat Mar 03 08:05:35	1	5	SEMI-AUTO			192.200	296.900			GAS MISLOCATION?
Sat Mar 03 08:06:04	1	5	SEMI-AUTO			192.200	296.900			[129.2']
Sat Mar 03 08:06:38	1	5	SEMI-AUTO	177.500	296.900					
Sat Mar 03 08:11:41	1	6	SEMI-AUTO	93.200	296.300					C344.9
Sat Mar 03 08:12:52	1	6	SEMI-AUTO			109.400	296.000			

[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			
Sat Mar 03 08:14:20	1	6	SEMI-AUTO			109.400	295.700			[126.6'] 2/o
Sat Mar 03 08:14:51	1	6	SEMI-AUTO	93.200	295.600					
Sat Mar 03 08:15:25	1	6	SEMI-AUTO	93.200	295.500					DTW 165.07FT Inside Casing
Sat Mar 03 08:17:14	1	7	SEMI-AUTO	84.500	295.200					C324.8FT
Sat Mar 03 08:18:31	1	7	SEMI-AUTO	84.400	295.100					
Sat Mar 03 08:19:19	1	7	SEMI-AUTO			99.700	295.000			
Sat Mar 03 08:19:55	1	7	SEMI-AUTO			99.800	295.000			
Sat Mar 03 08:20:23	1	7	SEMI-AUTO			99.800	294.900			
Sat Mar 03 08:20:52	1	7	SEMI-AUTO			99.800	294.900			
Sat Mar 03 08:21:21	1	7	SEMI-AUTO			99.800	294.900			[128.7']
Sat Mar 03 08:22:08	1	7	SEMI-AUTO	84.500	294.900					DTW 165.08 FT Inside Casing
Sat Mar 03 08:24:56	1	8	SEMI-AUTO	52.100	294.500					C251.1FT
Sat Mar 03 08:26:33	1	8	SEMI-AUTO			68.400	293.800			
Sat Mar 03 08:27:04	1	8	SEMI-AUTO			68.400	293.600			
Sat Mar 03 08:27:32	1	8	SEMI-AUTO			68.300	293.400			
Sat Mar 03 08:28:03	1	8	SEMI-AUTO			68.300	293.200			
Sat Mar 03 08:28:33	1	8	SEMI-AUTO			68.300	293.100			[127.2']
Sat Mar 03 08:29:03	1	8	SEMI-AUTO	52.200	292.900					DTW 165.40 FT Inside Casing
Sat Mar 03 08:30:40	1	9	SEMI-AUTO	43.400	292.500					C231.3 FT
Sat Mar 03 08:32:34	1	9	SEMI-AUTO			59.300	291.900			
Sat Mar 03 08:33:05	1	9	SEMI-AUTO			59.300	291.800			
Sat Mar 03 08:33:33	1	9	SEMI-AUTO			59.300	291.700			
Sat Mar 03 08:34:04	1	9	SEMI-AUTO			59.400	291.600			
Sat Mar 03 08:34:34	1	9	SEMI-AUTO			59.400	291.600			
Sat Mar 03 08:35:01	1	9	SEMI-AUTO			59.400	291.500			[127.5']
Sat Mar 03 08:35:35	1	9	SEMI-AUTO	43.400	291.400					DTW 165.49FT Inside Casing
Sat Mar 03 08:38:52	1	10	SEMI-AUTO	17.200	290.800					C171.7FT
Sat Mar 03 08:40:32	1	10	SEMI-AUTO			34.700	290.300			
Sat Mar 03 08:41:03	1	10	SEMI-AUTO			34.700	290.100			
Sat Mar 03 08:41:33	1	10	SEMI-AUTO			34.800	290.000			
Sat Mar 03 08:42:02	1	10	SEMI-AUTO			34.800	289.900			
Sat Mar 03 08:42:32	1	10	SEMI-AUTO			34.800	289.800			
Sat Mar 03 08:43:03	1	10	SEMI-AUTO			34.800	289.700			[124.0']
Sat Mar 03 08:43:37	1	10	SEMI-AUTO	17.200	289.600					DTW 165.70 FT Inside Casing
Sat Mar 03 08:50:05	0	0	SEMI-AUTO							FILE CLOSED - PROGRAM QUIT
Sat Mar 03 08:59:20	1	3	SEMI-AUTO	218.500	294.400					C631.1 FT
Sat Mar 03 09:01:03	1	3	SEMI-AUTO			232.800	295.500			
Sat Mar 03 09:01:32	1	3	SEMI-AUTO			232.800	295.800			
Sat Mar 03 09:02:04	1	3	SEMI-AUTO			232.900	296.000			
Sat Mar 03 09:02:31	1	3	SEMI-AUTO			232.900	296.200			[129.4']
Sat Mar 03 09:03:36	1	3	SEMI-AUTO	218.600	296.600					DTW 163.54 FT Inside Casing
Sat Mar 03 09:18:04	1	3	SEMI-AUTO					13.900	291.800	AT SURFACE
Sat Mar 03 09:19:57	0	0	SEMI-AUTO							FILE CLOSED - PROGRAM QUIT

Appendix F

MW-4 Piezometric Pressures/Levels, Field Data Record, Feb 19,1990
MW-4 Piezometric Pressures/Levels, Field Data Record, Mar 2, 1990
MW-4 Piezometric Pressures/Levels, Field Data Record, Mar 5, 1990

PIEZOMETRIC PRESSURES/LEVELS

Westbay Instruments Inc.

FIELD DATA AND CALCULATION SHEET

Datum: —

Pressure Probe Type ELECTRIC

Date: FEB 19, 1990

Job No.: WB 650

Elev. Ground Sfc: —

Serial No.: EE 172

Drillhole No.: MW-4

Height MP Casing above Ground Sfc: —

Range: 0 to 500 psi

Client: NASA JPL / EBASCO

Elev. top of MP Casing: —

Weather: CLEAR, COOL

Casing Size/Type: MP - 1.5" ID

Reference Elev. Steel Casing: —

Barometric Pressure:

Operator: ER / KS

Ambient Reading (Pressure/Temperature/Time): Start 13.7 / 287.5 / 10:03 Finish —

PROTOTYPE TRIPOD (NOTE COUNTER READS BACKWARDS). BELOW GS.

Depth to Meas. Port Valve, ft, m: From Log	From Cable	Elev. Meas. Port ft, m	Fluid Pressure Readings psi: Inside Casing	Outside Casing	Inside Casing	Trans. Temp., K	Time, H:M:S	Press. Head Outside Port, ft, m	Piez. Level Outside Port, ft, m	Comments
QA 1	9472'2"		116.4			292.6	10:11			
			116.6			295.3	10:16			
			116.7			296.5	10:22			
			116.7			296.7	10:27			
				192.7			10:32:30			
				192.7			10:33			
				192.8			10:33:30			
				192.7		296.7	10:34		~~113.8~~	114.7' JMc Mar 19, 19
					116.7					
			116.7				10:35			
				192.6			10:35:30			2ND ACTIVATION
				192.6	116.7	296.8	10:36			
ZONE 2	9487'2"		110.5			295.9	10:44			
				186.9			10:44:30			
				186.8			10:45			
				186.8	110.5		10:45:30		112.5	113.3' JMc Mar 19,
			110.5				10:46			2ND ACTIVATION
				186.8			10:46:30			
				186.8			10:47			
					110.5		10:47:30			

270789

Westbay Instruments Inc.

PIEZOMETRIC PRESSURES/LEVELS

FIELD DATA AND CALCULATION SHEET

Datum: —
Pressure Probe Type ELECTRIC
Date: FEB 19, 1990
Job No.: WB 650

Elev. Ground Sfc: —
Serial No.: EE 172
Drillhole No.: MW4

Height MP Casing above Ground Sfc: —
Range: 0 to 500 psi
Client: NASA JPL/EBASCO

Elev. top of MP Casing: —
Weather: CLEAR, COOL
Casing Size/Type: MP - 1.5" I.D.

Reference Elev. Steel Casing: —
Barometric Pressure: —
Operator: ER/KS

Ambient Reading (Pressure/Temperature/Time): Start 13.7/287.5/10:03 Finish —

Depth to Meas. Port Valve, ft, m		Elev. Meas. Port ft, m	Fluid Pressure Readings psi			Trans. Temp., K	Time, H:M:S	Press. Head Outside Port, ft, m	Piez. Level Outside Port, ft, m	Comments
From Log	From Cable		Inside Casing	Outside Casing	Inside Casing					
A ZONE3	9507		101.7				10:50			
				179.5		294.5	10:50:30			Dnlc Mr 19/90
				179.5	101.6		10:51		~~109.3~~	110.1'
			101.6				10:51:30			2ND ACTIVATION
				178.5		294.6	10:52			
				178.5	101.6		10:52:30			
ZONE 4	9608' 3"		57.5				10:55			
				135.7		294.9	10:55:30			
				135.7			10:56			
				135.7			10:56:30		109.3'	
					57.6		10:57			
			57.6	135.7			10:57:30			2ND ACTIVATION
				135.7			10:58			
					57.6		10:58:30			
ZONE 5	9628' 6"		48.8				11:01			
				126.8			11:01:30			
				126.8		294.8	11:02			Dnlc Mr 19/90
				126.8	48.8/.9		11:02:30		~~109.9~~	110.7'
			48.8/.9	126.3			11:03			2ND ACTIVATION
				126.4			11:03:30			
					48.8/.9		11:04			

PIEZOMETRIC PRESSURES/LEVELS

Westbay Instruments Inc.

FIELD DATA AND CALCULATION SHEET

Datum: —   Pressure Probe Type ELECTRIC   Date: FEB 19, 1990   Job No.: WB 650

Elev. Ground Sfc: —   Serial No.: EE 172   Drillhole No.: MW 4

Height MP Casing above Ground Sfc: —   Range: 0 to 500 psi   Client: NASA JPL / EBASCO

Elev. top of MP Casing: —   Weather: CLEAR, COOL   Casing Size/Type: MP - 1.5" ID.

Reference Elev. Steel Casing: —   Barometric Pressure: —   Operator: ER / KS

Ambient Reading (Pressure/Temperature/Time): Start 13.7/287.5/10:03   Finish —

Depth to Meas. Port Valve, ft, m — From Log	Depth to Meas. Port Valve, ft, m — From Cable	Elev. Meas. Port ft, m	Fluid Pressure Readings psi — Inside Casing	Fluid Pressure Readings psi — Outside Casing	Fluid Pressure Readings psi — Inside Casing	Trans. Temp., K	Time, H:M:S	Press. Head Outside Port, ft, m	Piez. Level Outside Port, ft, m	Comments
	RAISE PROBE ~1/2" ACTIVATE ~10 SECOND, DEACTIVATE, LOWER AND ACTIVATE IN QA 5									
				125.7						
				125.7	48.9		11:07			
	RAISE ~3/4" ACTIVATE ~3 minutes, DEACTIVATE, LOWER AND ACTIVATE IN QA 5									
			50.0	64.7			11:11			
				68.6			11:11:30			
				74.2			11:12:15			
				76.8	50.0		11:12:30			
ZONE 6	9678' 8"		28.3				11:17			
				105.6		294.4	11:17:30			
				105.6			11:18			D.M. Mar 19/90
				105.6	28.4		11:18:30		~~108.8~~	109.6'
			28.4	105.6			11:19			2ND ACTIVATION
				105.6	28.4	293.9	11:19:30			
QA ZONE 7	9698' 8"		19.6			293.6	11:25			
				96.6			11:25:30			
				96.6		293.7	11:26			D.M. Mar 19/90
				96.6	19.6		11:26:30		~~109.5~~	110.4'
			19.6	96.2		293.8	11:27			2ND ACTIVATION
				96.2			11:27:30			

PIEZOMETRIC PRESSURES/LEVELS

Westbay Instruments Inc.

FIELD DATA AND CALCULATION SHEET

Datum: —   Pressure Probe Type ELECTRIC   Date: FEB 19, 1990   Job No.: WB 650

Elev. Ground Sfc: —   Serial No.: EE 172   Drillhole No.: MW-4

Height MP Casing above Ground Sfc: —   Range: 0 to 500 psia kg a/cm²   Client: NASA JPL/EBASCO

Elev. top of MP Casing: —   Weather: COOL, CLEAR   Casing Size/Type: MP - 1.5" I.D.

Reference Elev. Steel Casing: —   Barometric Pressure: —   Operator: ER/KS

Ambient Reading (Pressure/Temperature/Time): Start 13.7/287.5/10:03   Finish —

Zone No.	Depth ft. m.	Fluid Pressure Readings psia kg a/cm² Inside Casing	Outside Casing	Inside Casing	Trans. Temp., K	Time, H:M:S	Depth to Water in MP ft. m.	Calibration check psia kg a/cm²	Piez. Level Outside Port, ft. m.	Comments
		RAISE PROBE ~3/4" @ 11:29 a.m.				, ACTIVATE, LEAVE FOR 2 minute, DEACTIVATE LOWER.				
QA ZONE 7		20.5				11:41				
			76.7/.8			11:41:15				
			77.4			11:41:30				
			78.4			11:42				
			79.2	20.5		11:42:30				
ZONE 8	976'0"	13.6			294.3	11:49				
			69.9			11:49:30				
			69.9			11:50				
			69.9		294.1	11:50:30				DM Mar 19/90
			69.9	13.7		11:51			~~109.4~~	110.4
		13.7	69.9			11:51:30				2ND ACTIVATION
			69.9			11:52				
			69.9	13.7		11:52:30				
QA ZONE 9	978'0"	13.7			293.7	11:55				
			61.1			11:55:30				
			61.1			11:56				DM Mar 19/90
			61.1	13.7		11:56:30			~~109.7~~	110.3'
		13.7	60.4			11:57				2ND ACTIVATION
			60.4/5			11:57:30				
				13.7						

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Westbay Instruments Inc.

PIEZOMETRIC PRESSURES/LEVELS

FIELD DATA AND CALCULATION SHEET

Datum: ——

Pressure Probe Type ELECTRIC Date: FEB 19, 1990 Job No.: WB 650

Elev. Ground Sfc: ——

Serial No.: EE 172 Drillhole No.: MW-4

Height MP Casing above Ground Sfc: ——

Range: 0 to 500 psia kg a/cm^2 Client: NASA JPL / EBASCO

Elev. top of MP Casing: ——

Weather: COOL, CLEAR Casing Size/Type: MP - 1.5" I.D.

Reference Elev. Steel Casing: ——

Barometric Pressure: —— Operator: ER / KS

Ambient Reading (Pressure/Temperature/Time): Start 13.7 / 287.5 / 10:03 Finish ——

Zone No.	Depth ft. m.	Fluid Pressure Readings psia: Inside Casing	Fluid Pressure Readings psia: Outside Casing	Fluid Pressure Readings kg a/cm^2: Inside Casing	Trans. Temp., K	Time, H:M:S	Depth to Water in MP ft. m.	Calibration check psia kg a/cm^2	Piez. Level Outside Port, ft. m.	Comments
RAISE PROBE 3/4", ACTIVATE FOR 2 MINUTES, DEACIVATE, LOWER										
QA ZONE 9 (CONT.)		13.7				12:03 p.m.				
			23.7			12:03:15				
			23.7			12:03:30				
			23.7			12:04				
			23.7	13.7		12:04:30				
ZONE 10	9851'3"	13.7			292.9	12:08				
			31.7			12:08:30				
			31.7			12:09				S.M. Mar 19/90
			31.7	13.7		12:09:30			~~107.5~~	108.1'
		13.7	31.7			12:10				2ND ACTIVATION
			31.7			12:10:30				
			31.7			12:11				
QA ZONE 1	9471'8"	123.0				12:23				
			192.7			12:23:15				
			192.7			12:24				SAME AS BEFORE
			192.7	123.0		12:24:30				
RAISE PROBE ~3/4", ACTIVATE FOR 2 MIN., DEACTIVATE AND LOWER										
		125.8				12:25				
			174.9			12:25:15				
			176.1			12:25:45				

Westbay Instruments Inc.

PIEZOMETRIC PRESSURES/LEVELS

FIELD DATA AND CALCULATION SHEET

Datum: — Pressure Probe Type ELECTRIC Date: FEB 19, 1990 Job No.: WB 650

Elev. Ground Sfc: — Serial No.: EE 172 Drillhole No.: MW-4

Height MP Casing above Ground Sfc: — Range: 0 to 500 psia kg a/cm² Client: NASA JPL / EBASCO

Elev. top of MP Casing: — Weather: CLEAR, COOL Casing Size/Type: MP-1.5"

Reference Elev. Steel Casing: — Barometric Pressure: — Operator: ER/KS

Ambient Reading (Pressure/Temperature/Time): Start 13.7/287.5/10:03 Finish —

Zone No.	Depth ft. m.	Fluid Pressure Readings psia kg a/cm² Inside Casing	Outside Casing	Inside Casing	Trans. Temp., K	Time, H:M:S	Depth to Water in MP ft. m.	Calibration check psia kg a/cm²	Piez. Level Outside Port, ft. m.	Comments
			177.3			12:26				
			179.1			12:26:30				
			180.7			12:27				
			182.1			12:27:30				
			183.2			12:28				
			184.2			12:28:30				
			185.1			12:29				
			185.9			12:29:30				
			187.2	125.7		12:30:30				
ZONE 2	9486'	119.5			296.3	12:36				
			186.9			12:36:30				
			186.9			12:37				
ZONE 3	9505		177.40			12:38:05				
			177.30			38:35				
			177.40	110.7		39:05				
		110.7				12:46:44				
			175.60			12:47:03				
			175.70			12:47:35				
			175.7	110.7		12:47:41				

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PIEZOMETRIC PRESSURES/LEVELS

Westbay Instruments Inc.

FIELD DATA AND CALCULATION SHEET

Datum: —
Pressure Probe Type ELECTRIC
Date: FEB 19, 1990
Job No.: WB 650

Elev. Ground Sfc: —
Serial No.: EE 172
Drillhole No.: MW-4

Height MP Casing above Ground Sfc: —
Range: 0 to 500 psia kg a/cm²
Client: NASA JPL/EBASCO

Elev. top of MP Casing: —
Weather: CLEAR, COOL
Casing Size/Type: MP - 1.5" I.D.

Reference Elev. Steel Casing: —
Barometric Pressure: —
Operator: ER / KS

Ambient Reading (Pressure/Temperature/Time): Start 13.7/287.5/10:03 Finish —

Zone No.	Depth ft. m.	Fluid Pressure Readings psia kg a/cm² Inside Casing	Outside Casing	Inside Casing	Trans. Temp., K	Time, H:M:S	Depth to Water in MP ft. m.	Calibration check psia kg a/cm²	Piez. Level Outside Port, ft. m.	Comments
	RAISE	PROBE	3/4" AND	ACTIVATE,		LEAVE FOR 3 min,	DEACTIVATE,		LOWER	
		121.8				12:56				
			153.1			12:56:30				
			153.8			12:57				
			154.5		295.8	12:57:30				
			154.9			12:58				
			155.7			12:59				
			156.0			12:59:30				
				121.2		1:00				
ZONE 4	9608	77.1/.2			296.1	1:03				
			135.8			1:03:15				
			135.8	77.1/.2	295.7	1:03:30				
			REMOVE	TOOL	FROM	MONITORING	WELL			

27078

1/1

WESTBAY INSTRUMENTS (c) 1989
-- File Header Information --
COMPANY........WESTBAY INST
TECH......... DMC
PROJECT...... EBASCO/JPL
PROBE INFO... EE172 0-500
MISC INFO.... MW4 MAR02
TEMP UNITS...   (K)
PRES UNITS...   PSI
TEMP MULT.... 0.100000
PRES MULT.... 0.100000
TEMP OFFSET.. 0

DATE	WELL	ZONE	MODE	INSIDE		OUTSIDE		ATMOSPHERIC		Equivalent Depth To Water In Brackets
Fri Mar 02 10:33:21	4	2	SEMI-AUTO	175.100	295.500					TEMPERATURE STABILIZATION
Fri Mar 02 10:36:06	4	2	SEMI-AUTO	175.100	295.800					
Fri Mar 02 10:37:06	4	2	SEMI-AUTO	175.100	295.800					DTW 144.81FT FROM MP 36.25 IN A
69										Inside Casing
Fri Mar 02 10:39:37	4	2	SEMI-AUTO	175.100	295.900					
Fri Mar 02 10:40:15	4	2	SEMI-AUTO			188.200	295.900			
Fri Mar 02 10:40:46	4	2	SEMI-AUTO			188.300	295.900			
Fri Mar 02 10:41:16	4	2	SEMI-AUTO			188.300	295.900			[112.0']
Fri Mar 02 10:41:47	4	2	SEMI-AUTO	175.200	296.000					
Fri Mar 02 10:45:12	4	4	SEMI-AUTO	122.200	296.100					DTW 145.32 FT Inside Casing
Fri Mar 02 10:46:05	4	4	SEMI-AUTO	137.200	296.100					
Fri Mar 02 10:46:41	4	4	SEMI-AUTO	137.100	296.100					
Fri Mar 02 10:47:02	4	4	SEMI-AUTO			137.100	296.100			
Fri Mar 02 10:47:36	4	4	SEMI-AUTO			137.200	296.100			
Fri Mar 02 10:48:03	4	4	SEMI-AUTO			137.200	296.100			[108.3']
Fri Mar 02 10:48:37	4	4	SEMI-AUTO		Inside	122.200	296.100			
Fri Mar 02 10:50:44	4	6	SEMI-AUTO		Reading	91.600	296.000			
Fri Mar 02 10:50:53	4	6	SEMI-AUTO	91.600	296.000					DTW 145.64 FT Inside Casing
Fri Mar 02 10:52:31	4	6	SEMI-AUTO			106.800	295.800			
Fri Mar 02 10:53:00	4	6	SEMI-AUTO			106.800	295.700			
Fri Mar 02 10:53:30	4	6	SEMI-AUTO			106.800	295.700			[108.0']
Fri Mar 02 10:54:01	4	6	SEMI-AUTO	91.600	295.600					
Fri Mar 02 10:56:43	4	8	SEMI-AUTO	55.700	295.300					146.02 FT Inside Casing
Fri Mar 02 10:57:47	4	8	SEMI-AUTO			71.100	295.000			
Fri Mar 02 10:58:14	4	8	SEMI-AUTO			71.200	294.800			
Fri Mar 02 10:58:46	4	8	SEMI-AUTO			71.100	294.700			[108.3']
Fri Mar 02 10:59:18	4	8	SEMI-AUTO	55.800	294.600					
Fri Mar 02 11:02:11	4	10	SEMI-AUTO	16.600	293.500					
Fri Mar 02 11:02:17	4	10	SEMI-AUTO	16.500	293.500					
Fri Mar 02 11:02:23	4	10	SEMI-AUTO	16.600	293.400					
Fri Mar 02 11:02:25	4	10	SEMI-AUTO	16.600	293.400					DTW 146.01 FT Inside Casi
Fri Mar 02 11:03:31	4	10	SEMI-AUTO			33.900	292.800			
Fri Mar 02 11:04:00	4	10	SEMI-AUTO			33.900	292.500			
Fri Mar 02 11:04:30	4	10	SEMI-AUTO			34.000	292.300			[103.7']
Fri Mar 02 11:04:59	4	10	SEMI-AUTO	16.700	292.000					
Fri Mar 02 11:05:22	4	10	SEMI-AUTO					14.100	291.900	JUST OUT OF WATER
Fri Mar 02 11:06:07	0	0	SEMI-AUTO							FILE CLOSED - PROGRAM QUIT

1/2

WESTBAY INSTRUMENTS (c) 1989
-- File Header Information --
COMPANY........WESTBAY INST
TECH......... ER/KS
PROJECT...... EBASCO/JPL
PROBE INFO... EE172 0-500
MISC INFO.... MW4 MARCH5/90
TEMP UNITS...   (K)
PRES UNITS...   PSI
TEMP MULT.... 0.100000
PRES MULT.... 0.100000
TEMP OFFSET.. 0

DATE	WELL	ZONE	MODE	INSIDE		OUTSIDE		ATMOSPHERIC	Equivalent Depth To Water In Brackets.
Mon Mar 05 15:47:56	4	1	SEMI-AUTO	176.600	295.900				TRANSDUCER STABILIZATION
Mon Mar 05 15:48:12	4	1	SEMI-AUTO	176.600	295.800				
Mon Mar 05 15:51:44	4	1	SEMI-AUTO	176.600	296.100				
Mon Mar 05 15:52:13	4	1	SEMI-AUTO	176.600	296.200				
Mon Mar 05 15:56:28	4	1	SEMI-AUTO	176.700	296.400				
Mon Mar 05 15:57:47	4	1	SEMI-AUTO	176.700	296.500				
Mon Mar 05 16:00:21	4	1	SEMI-AUTO	176.700	296.500				DEPTH TO WATER 148.50 FEET TOP OF M
P9									
Mon Mar 05 16:01:30	4	1	SEMI-AUTO	176.700	296.500				TOP OF STUB MP CASING IS 15.25 INCH
EL									
Mon Mar 05 16:01:32	4	1	SEMI-AUTO	176.800	296.600				
Mon Mar 05 16:02:19	4	1	SEMI-AUTO	176.800	296.600				
Mon Mar 05 16:02:59	4	1	SEMI-AUTO	254.900	296.600				
Mon Mar 05 16:03:06	4	1	SEMI-AUTO			256.700	296.600		WRONG LOCATION
Mon Mar 05 16:03:43	4	1	SEMI-AUTO	176.800	296.600				
Mon Mar 05 16:06:39	4	2	SEMI-AUTO	172.500	296.600				DTW 148.55 FEET BELOW TOP OF MP
Mon Mar 05 16:07:02	4	2	SEMI-AUTO	172.500	296.600				COUPLING DEPTH 512 FEET
Mon Mar 05 16:07:52	4	2	SEMI-AUTO	172.500	296.600				In[illegible] Casing
Mon Mar 05 16:08:23	4	2	SEMI-AUTO			188.100	296.500		
Mon Mar 05 16:08:42	4	2	SEMI-AUTO			188.100	296.500		
Mon Mar 05 16:09:03	4	2	SEMI-AUTO			188.100	296.500		[112.0']
Mon Mar 05 16:09:24	4	2	SEMI-AUTO	172.500	296.500				
Mon Mar 05 16:12:15	4	3	SEMI-AUTO	163.700	296.400				DTW 148.60 FEET Inside Casing
Mon Mar 05 16:12:38	4	3	SEMI-AUTO	163.700	296.400				COUPLING AT 492 FEET
Mon Mar 05 16:13:01	4	3	SEMI-AUTO			163.600	296.500		
Mon Mar 05 16:13:28	4	3	SEMI-AUTO			177.500	296.500		
Mon Mar 05 16:13:47	4	3	SEMI-AUTO			177.500	296.500		
Mon Mar 05 16:14:06	4	3	SEMI-AUTO			177.500	296.500		[116.0']
Mon Mar 05 16:14:37	4	3	SEMI-AUTO	163.800	296.500				
Mon Mar 05 16:14:42	4	3	SEMI-AUTO	163.700	296.500				
Mon Mar 05 16:18:45	4	4	SEMI-AUTO	119.500	296.600				DTW 149.00 FEET CIOPLING DEPTH 391'
Mon Mar 05 16:19:19	4	4	SEMI-AUTO	119.500	296.500				Inside Casing
Mon Mar 05 16:19:42	4	4	SEMI-AUTO			137.000	296.500		
Mon Mar 05 16:20:03	4	4	SEMI-AUTO			137.000	296.400		
Mon Mar 05 16:20:22	4	4	SEMI-AUTO			137.000	296.400		
Mon Mar 05 16:20:41	4	4	SEMI-AUTO			137.000	296.400		[108.2']
Mon Mar 05 16:21:50	4	4	SEMI-AUTO	119.500	296.300				
Mon Mar 05 16:21:57	4	4	SEMI-AUTO	119.500	296.300				
Mon Mar 05 16:23:30	4	5	SEMI-AUTO	110.800	296.200				DEPTH TO WATER 149.06 FEET COUPLING
T									Inside Casing
Mon Mar 05 16:23:36	4	5	SEMI-AUTO	110.300	296.200				
Mon Mar 05 16:24:52	4	5	SEMI-AUTO	110.800	296.100				
Mon Mar 05 16:25:15	4	5	SEMI-AUTO			127.600	296.100		
Mon Mar 05 16:25:36	4	5	SEMI-AUTO			127.600	296.000		
Mon Mar 05 16:25:55	4	5	SEMI-AUTO			127.600	296.000		
Mon Mar 05 16:26:16	4	5	SEMI-AUTO			127.600	296.000		[109.7']
Mon Mar 05 16:26:36	4	5	SEMI-AUTO	110.800	296.000				

Mon Mar 05 16:29:16	4	6	SEMI-AUTO	88.900	295.900					DEPTH TO WATER 149.29 FEET COUPLI
T										Inside Casing
Mon Mar 05 16:29:52	4	6	SEMI-AUTO	88.900	295.800					2/2
Mon Mar 05 16:30:11	4	6	SEMI-AUTO			106.700	295.800			
Mon Mar 05 16:30:40	4	6	SEMI-AUTO			106.700	295.700			
Mon Mar 05 16:31:10	4	6	SEMI-AUTO			106.700	295.600			[107.6']
Mon Mar 05 16:31:33	4	6	SEMI-AUTO	88.900	295.600					
Mon Mar 05 16:35:36	4	7	SEMI-AUTO	80.200	295.300					DTW 149.35 FEET COUPLING DEPTH 30.
T										Inside Casing
Mon Mar 05 16:36:09	4	7	SEMI-AUTO	80.200	295.300					
Mon Mar 05 16:36:26	4	7	SEMI-AUTO			95.700	295.200			
Mon Mar 05 16:37:00	4	7	SEMI-AUTO			95.700	295.200			
Mon Mar 05 16:37:29	4	7	SEMI-AUTO			95.800	295.200			
Mon Mar 05 16:38:13	4	7	SEMI-AUTO	80.200	295.200					
Mon Mar 05 16:38:49	4	7	SEMI-AUTO			94.800	295.100			SECOND ACTIVATION
Mon Mar 05 16:39:03	4	7	SEMI-AUTO			94.800	295.100			
Mon Mar 05 16:39:29	4	7	SEMI-AUTO			94.800	295.100			
Mon Mar 05 16:39:50	4	7	SEMI-AUTO			94.900	295.000			[114.8']
Mon Mar 05 16:40:51	4	7	SEMI-AUTO			94.900	295.000			
Mon Mar 05 16:43:49	4	8	SEMI-AUTO	53.100	294.900					DEPTH TO WATER 149.57 FEET COUPLING
T										Inside Casing
Mon Mar 05 16:44:18	4	8	SEMI-AUTO	53.100	294.900					
Mon Mar 05 16:44:45	4	8	SEMI-AUTO			71.000	294.700			
Mon Mar 05 16:45:15	4	8	SEMI-AUTO			71.100	294.600			
Mon Mar 05 16:45:46	4	8	SEMI-AUTO			71.100	294.500			[107.4']
Mon Mar 05 16:46:18	4	8	SEMI-AUTO			71.100	294.400			
Mon Mar 05 16:46:43	4	8	SEMI-AUTO	53.100	294.400					
Mon Mar 05 16:46:49	4	8	SEMI-AUTO	53.100	294.300					
Mon Mar 05 16:48:27	4	9	SEMI-AUTO	44.400	294.100					DEPTH TO WATER 149.62 FEET COUPLI
T										Inside Casing
Mon Mar 05 16:48:58	4	9	SEMI-AUTO	44.400	294.000					
Mon Mar 05 16:49:21	4	9	SEMI-AUTO			62.100	293.900			
Mon Mar 05 16:49:50	4	9	SEMI-AUTO			62.200	293.900			
Mon Mar 05 16:50:22	4	9	SEMI-AUTO			62.200	293.800			
Mon Mar 05 16:50:49	4	9	SEMI-AUTO			62.200	293.700			[107.9']
Mon Mar 05 16:51:29	4	9	SEMI-AUTO	44.400	293.600					
Mon Mar 05 16:51:35	4	9	SEMI-AUTO	44.400	293.600					
Mon Mar 05 16:51:35	4	9	SEMI-AUTO	44.400	293.600					
Mon Mar 05 16:55:32	4	10	SEMI-AUTO					13.800	292.700	
Mon Mar 05 16:55:41	4	10	SEMI-AUTO	13.800	292.600					COUPLING AT 149 FEET
Mon Mar 05 16:56:06	4	10	SEMI-AUTO	13.800	292.500					
Mon Mar 05 16:56:27	4	10	SEMI-AUTO			33.800	292.200			
Mon Mar 05 16:56:59	4	10	SEMI-AUTO			33.800	292.000			
Mon Mar 05 16:57:28	4	10	SEMI-AUTO			33.800	291.800			[103.7']
Mon Mar 05 16:58:02	4	10	SEMI-AUTO	13.900	291.600					
Mon Mar 05 16:58:12	4	10	SEMI-AUTO	13.900	291.600					
Mon Mar 05 16:58:19	4	10	SEMI-AUTO					13.900	291.500	END OF PROFILE ZONE 1 NOT ACCESSE
Mon Mar 05 16:58:50	4	10	SEMI-AUTO					13.900	291.500	
Mon Mar 05 16:58:54	4	10	SEMI-AUTO					13.900	291.400	
Mon Mar 05 16:59:22	0	0	SEMI-AUTO							FILE CLOSED - PROGRAM QUIT

Appendix G

MW-3 Groundwater Sampling Field Data Sheets - 6 pages.
MW-4 Groundwater Sampling Field Data Sheets - 6 pages.

Westbay Instruments Inc.

Groundwater Sampling

FIELD DATA SHEET

Project NASA JPL/EBASCO Location PASADENA, CALIFORNIA Depth 172' Date FEB 27/90

Drillhole No. MW-3 Sampling Zone No. 10 Starting Time 9:00 a.m Finishing Time 3:30 p.m.

Technicians ER/KS/DMC / MARK CUTLER

Water Level Inside MP Casing (Beginning of Session) 161.10' FROM TOP OF 7½" (End of Session) 161.55'

Sampler Probe Preparation - See Sampling Plan Collection Bottle Preparation - See Sampling Plan

Reel Counter 51.2 m at Mag Collar

	SURFACE FUNCTION CHECKS					SAMPLE COLLECTION CHECKS					
Run No.	Activation	Vacuum Check Valve Closed	Valve Open	Evacuate Container ≈ 20" Hg	Valve Closed	Water Level in MP (ft, m) From top of 7½"	Valve Open Time	Valve Closed Time	Water Level in MP (ft, m) From top of 7½"	Volume Retrieved (l)	Sample Container Type All collected with 4 x 250ml SS bottles
1	✓	✓	✓	✓	✓	153.33	9:20:30	9:23:30	153.34	>0.9	Field Parameters
2	✓	✓	✓	✓	✓	153.38	10:04:00	10:06:30	153.38	1.0	4x VOA 1 S x 500ml
3	✓	✓	✓	✓	✓	153.41	10:35:45	10:38:00	153.41	1.0	2 x 500 ml
4	✓	✓	✓	✓	✓	153.45	11:02:00	11:04:30	153.45	1.0	
5	✓	✓	✓	✓	✓	153.49	11:23:00	11:25:30	153.50	1.0	
6	✓	✓	✓	✓	✓	153.50	11:54:45	11:57:15	153.52	.9+	
7	✓	✓	✓	✓	✓	153.52	12:18:00	12:20:30	153.53	.9+	
8	✓	✓	✓	✓	✓	153.58	12:39:30	12:42:00	153.58	.9+	
9	✓	✓	✓	✓	✓	153.62	13:21:30	13:24:00	153.62	.9+	
10	✓	✓	✓	✓	✓	153.63	13:44:00	13:46:30	153.65	.9+	
11	✓	✓	✓	✓	✓	153.67	14:25:30	14:28:00	153.67	.9+	'O' RING FELL OFF PROBE FACE SEAL - REPLACE.
12	✓	✓	✓	✓	✓	153.69	14:47:15	14:50:15	153.70	.9+	
13	✓	✓	✓	✓	✓	153.72	15:13:00	15:16:00	153.72	.9+	
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											
24											
25											

Total Volume :

FIELD DETERMINATIONS (APPEARANCE, pH, S.C. , etc.) 9:35 pH 7.01 Temp 15.4 Sc 430

3:15 pH 7.03 Temp 17.9 Sc 450

270789

Westbay Instruments Inc.

Groundwater Sampling

FIELD DATA SHEET

Project NASA JPL/EBASCO Location PASADENA, CALIFORNIA Depth 252' Date FEB 28/90

Drillhole No. MW-3 Sampling Zone No. 8 Starting Time 7:45 a.m. Finishing Time 13:00

Technicians ER/KS/DMC

Water Level Inside MP Casing (Beginning of Session) 161.55' @ 7:35 a.m. (End of Session) SEE ZONE 6 SHEET.

Sampler Probe Preparation - See Sampling Plan Collection Bottle Preparation - See Sampling Plan

SURFACE FUNCTION CHECKS						SAMPLE COLLECTION CHECKS (All Collected With 4 x 250 ml. S.S. Sample Bottles)					
Run No.	Activation	Vacuum Check Valve Closed	Valve Open	Evacuate Container	Valve Closed	Water Level in MP (ft, m)	Valve Open Time	Valve Closed Time	Water Level in MP (ft, m)	Volume Retrieved (l)	Sample Container Type
1	✓	✓	✓	✓	✓	153.48	8:41:00	8:44:00	153.47	≈ 1.0	Field Parameters
2	✓	✓	✓	✓	✓	153.51	9:11:30	9:13:30	153.50		
3	✓	✓	✓	✓	✓	155.85	Valve Open on way		down to zone.		Decontaminate
4	✓	✓	✓	✓	✓		Sampler and Sample		Bottles.		
5	✓	✓	✓	✓	✓	156.12	10:26:30	10:29:00	156.13		
6	✓	✓	✓	✓	✓	156.20	10:52:00	10:54:30	156.18		
7	✓	✓	✓	✓	✓	156.23	11:14:30	11:17:00	156.23		
8	✓	✓	✓	✓	✓	156.29	11:37:00	11:39:30	156.30		
9	✓	✓	✓	✓	✓	156.35	12:00:00	12:02:30	156.35	~ 1.0 l	
10	✓	✓	✓	✓	✓	156.41	12:22:30	12:25:00	156.41		
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											
24											
25											

Total Volume :

FIELD DETERMINATIONS (APPEARANCE, pH, S.C. , etc.) 8:50 pH 7.15 Temp 16.6°C Sc 390

12:30 pH 7.11 Temp 20.0°C Sc 411

270789

Westbay Instruments Inc.

Groundwater Sampling

FIELD DATA SHEET

Project NASA / JPL EBASCO Location Pasadena California Depth 346' Date Feb 28/90

Drillhole No. MW-3 Sampling Zone No. 6 Starting Time 13:14 Finishing Time 5:30 PM

Technicians ER/KS/DMc

Water Level Inside MP Casing (Beginning of Session) SEE ZONE 8 SHEET. (End of Session) 165.32'

Sampler Probe Preparation - See Sampling Plan Collection Bottle Preparation - See Sampling Plan SAMPLES: 2 x 40 ml VOA'S.

Counter on Reel = 104 m

	SURFACE FUNCTION CHECKS					SAMPLE COLLECTION CHECKS (All Collected with 4x250 ml SS. Bottles)					
Run No.	Activation	Vacuum Check Valve Closed	Valve Open	Evacuate Container	Valve Closed	Water Level in MP (ft, m)	Valve Open Time	Valve Closed Time	Water Level in MP (ft, m)	Volume Retrieved (l)	Sample Container Type
1	✓	✓	✓	✓	✓	156.09'	13:25:00	13:27:30	156.08	≈1.0	
2	✓	✓	✓	✓	✓	156.17'	13:53:00	13 55:30	156.15	~1.0	
3	✓	✓	✓	✓	✓	156.21'	14:19:00	14:21:30	156.22	~1.0	
4	✓	✓	✓	✓	✓	156.26'	14:44:00	14:46:30	156.28	~1.0	
5	✓	✓	✓	✓	✓	156.35'	15:10:15	15:13:00	156.35	~1.0	
6	✓	✓	✓	✓	✓	156.40'	15:35:30	15:37:50	156.41	~1.0	
7	✓	✓	✓	✓	✓	156.47'	REJECT	RUN - SAMPLE	VALVE MOMENTARILY	OPENED PRIOR TO	ACTIVATION
8	✓	✓	✓	✓	✓	156.68'	16:33:40	16:36:10	156.69	~1.0	
9	✓	✓	✓	✓	✓	156.78'	17:02:30	17:05:00	156.78	~1.0	
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											
24											
25											

Total Volume :

FIELD DETERMINATIONS (APPEARANCE, pH, S.C., etc.) Hazy 13:30 pH 8.6 Temp 18.6°C Sc 400
17:15 pH 8.4 Temp 16.8°C Sc 325

270789

Continue

Westbay Instruments Inc.

Groundwater Sampling

FIELD DATA SHEET

Project NASA JPL / EBASCO Location Pasadena California Depth 558' Date Mar 1/90

Drillhole No. MW-3 Sampling Zone No. 4 Starting Time 7:55 AM Finishing Time 12:35

Technicians KS / AMc

Water Level Inside MP Casing (Beginning of Session) 165.21' at 7:40 AM. (End of Session)

Sampler Probe Preparation - See Sampling Plan Collection Bottle Preparation - See Sampling Plan

SURFACE FUNCTION CHECKS						Activate SAMPLE COLLECTION CHECKS All Collected With 4x250 ml. S.S. Bottles					
Run No.	Activation	Vacuum Check Valve Closed	Valve Open	Evacuate Container	Valve Closed	Water Level in MP (ft, ~~m~~)	Valve Open Time	Valve Closed Time	Water Level in MP (ft, ~~m~~)	Volume Retrieved (l)	Sample Container Type
1	✓	✓	✓	✓	✓	155.99	8:08:30	8:11:00	155.96	≃ 1.0	
2	✓	✓	✓	✓	✓	156.02	8:45:30	8:48:00	156.01	>1.0	
3	✓	✓	✓	✓	✓	156.09	9:21:30	9:24:00	156.07	No Sample	Vaccume only
4	✓	✓	✓	✓	✓	156.12	9:58:15	9:59:00	156.11	≃1.0	Sulpher Odour.
5	✓	✓	✓	✓	✓	156.16	10:31:15	10:33:45	156.17		
6	✓	✓	✓	✓	✓	156.24	11:07:05	11:09:40	156.24		Brown 1l
7	✓	✓	✓	✓	✓	156.30	11:42:45	11:45:30	156.30		Brown 1l
8	✓	✓	✓	✓	✓	156.35	12:17:15	12:19:47	156.34		2xVOA
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											
24											
25											

Total Volume :

FIELD DETERMINATIONS (APPEARANCE, pH, S.C. , etc.) Cloudy light brown. Same as Purge Water.
8:25 pH 7.22 Temp 15.5°C Sc=392 µmohs
" ? got CLEARER DURING SAMPLING.