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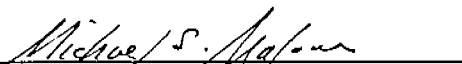
**DRAFT FINAL
BASEWIDE HYDROGEOLOGIC CHARACTERIZATION
FORT ORD, CALIFORNIA
VOLUME I — TEXT AND PLATES**

HLA Project No. 10775 531

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by


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EXECUTIVE SUMMARY

This report presents the results of the Basewide Hydrogeologic Characterization performed at Fort Ord, California. This investigation was conducted by Harding Lawson Associates (HLA) on behalf of the U.S. Army Corps of Engineers (COE), Sacramento District, which has been retained by the Army to conduct the remedial investigation/feasibility study (RI/FS) at Fort Ord.

The purpose of this investigation was to characterize the hydrogeologic conditions at and in the immediate vicinity of Fort Ord. A primary focus of the Basewide Hydrogeologic Characterization was to understand the aquifer systems at Fort Ord in support of the specific RI/FS site investigations being conducted concurrently, and to evaluate the potential for contaminant transport into and within the groundwater system.

METHOD OF INVESTIGATION

HLA compiled available literature, well logs, and groundwater data from previous studies and ongoing groundwater monitoring activities by Fort Ord and other local communities. To supplement these data, HLA performed additional basewide investigations, including: (1) drilling four pilot borings and installing well clusters, (2) drilling a deep aquifer well (to 500 feet); (3) obtaining representative soil and groundwater samples for laboratory analysis; (4) monitoring water levels in selected on- and offbase wells; and (5) geophysically logging the pilot borings and conducting a seismic reflection survey. The data from these activities were then evaluated to characterize the physical conditions of the aquifer systems, pathways between aquifers, regional flow gradients, and groundwater chemistry, and to identify data gaps pertinent to the ongoing RI/FS program.

FINDINGS

Groundwater Resources

Groundwater is the principal source of water supply for Fort Ord and its neighboring communities. Fort Ord is underlain by two groundwater basins, the Salinas basin in the northern part of the base and the Seaside basin in the southern base area. The Salinas basin is large and includes the Main and East Garrison areas, Fritzsche Army Airfield (FAAF), and the city of Marina. This basin extends well beyond the base boundaries. The Seaside basin is comparatively small and includes the Fort Ord Impact Area, Seaside, and Sand City.

The city of Marina and Fort Ord currently obtain water from wells located near the east boundary of Marina and in the East Garrison, respectively. Seaside and the communities immediately south of the base obtain groundwater from Seaside basin wells located immediately west of the Fort Ord Impact Area.

Seawater intrusion has affected wells in the city of Marina and at Fort Ord for several decades. The eastward movement of seawater into the aquifers of the Salinas basin has apparently resulted from overpumping of groundwater. In response to seawater intrusion, Fort Ord has relocated its wells eastward to their current location in the vicinity of the East Garrison. The city of Marina, on the other hand, could only move its wells as far east as the Marina/Fort Ord boundary. Consequently, Marina drilled deeper wells to penetrate aquifers below the zones of seawater intrusion.

Salinas Basin

In the Salinas basin portion of Fort Ord, three aquifers are of primary importance to this investigation:

- The shallow A-aquifer

- The 180-foot aquifer
- The 400-foot aquifer, which underlies the 180-foot aquifer.

The 180-foot and 400-foot aquifer names at Fort Ord are derived from the aquifer names in common usage in the Salinas Valley. The A-aquifer is underlain and separated from the 180-foot aquifer by the Fort Ord-Salinas Valley Aquitard (FO-SVA). The FO-SVA is probably equivalent to the Salinas Valley Aquitard (SVA) of the Salinas Valley proper; however, the nature of the relationship between the FO-SVA and the SVA is uncertain in the east portion of Fort Ord due to apparent elevation differences between these two aquitards.

Two other aquifers are also present, the 900-foot and Aromas-Paso Robles aquifers. Because these are of less importance to the RI/FS investigations, they are not described in detail in this report.

The A-aquifer is not used for water supply. However, due to its proximity to the ground surface and permeable nature, it is vulnerable to contamination transported by infiltrating surface recharge. Groundwater in the A-aquifer is unconfined and perched atop a major aquitard, the FO-SVA. Flow direction is controlled to a large degree by the configuration of this aquitard. Flow diverges toward the northwest and northeast along a north-south groundwater divide approximately coincident with the eastern edge of the Operable Unit 2 (OU2; Main Garrison) landfill. From beneath the landfill, groundwater flows westward until it reaches the west edge of the aquitard, where it appears to cascade into the 180-foot aquifer. Groundwater flowing east from the groundwater divide likely seeps out the bluffs that form the eastern base boundary, with some groundwater probably entering the 180-foot aquifer in the vicinity of the East Garrison.

The distribution of contaminants in the A-aquifer generally reflects the groundwater flow patterns. A trichloroethene (TCE) plume associated with the OU2 landfill is consistent with the flow in the A-aquifer. This plume contains maximum TCE concentrations of approximately 70 micrograms per liter ($\mu\text{g/l}$). At the western edge of the FO-SVA, the plume apparently enters the 180-foot aquifer and reverses flow direction toward the east.

The 180-foot aquifer is a major source of water supply to both Fort Ord and agriculture in the Salinas Valley. This aquifer has two principal water quality issues: seawater intrusion and the potential for chemical contamination. The results of this investigation indicate that groundwater flow in the 180-foot aquifer is eastward from Monterey Bay toward the general vicinity of the Fort Ord supply wells near the East Garrison. Seawater at Fort Ord is believed to have intruded eastward from Monterey Bay to slightly beyond the eastern limits of Marina. Between this location and the Fort Ord supply wells, gradients continue eastward with water-level elevations below sea level, indicating a continuing potential for eastward movement of seawater. The short-term effects of seawater intrusion at Fort Ord could include continued degradation of water quality in the 180-foot and 400-foot aquifers in the Marina-Main Garrison area. However current information on seawater intrusion trends are uncertain due to a general lack of is not current because few relevant water quality data have been collected since GTC performed their seawater intrusion study in 1986. Long-term it is uncertain if pumping at the Fort Ord supply wells is sufficient to induce seawater intrusion from the direction of Marina. It is considered more likely that the Fort Ord supply wells would be affected by seawater intrusion into the 180-foot and 400-foot aquifers of the Salinas Valley proper. North of Fort Ord in the Salinas

Valley, seawater has intruded to within approximately 2.8 miles of the Fort Ord supply well FO-30.

TCE plumes have been identified in two locations affecting the 180-foot aquifer. A TCE plume is associated with the OU2 landfill. This plume appears to have entered the 180-foot aquifer from the A-aquifer near the western edge of the FO-SVA and/or through recently destroyed Fort Ord supply wells. The plume has apparently moved eastward consistent with the eastward flow direction in the 180-foot aquifer. A second TCE plume has been identified in the 180-foot aquifer near RI/FS Site 12. This plume has TCE concentrations up to 230 $\mu\text{g/l}$ and appears to have moved west toward Monterey Bay consistent with local gradients in that area.

The 400-foot aquifer provides significant quantities of water to Marina and Fort Ord. This aquifer is also a major source of drinking and irrigation water in the Salinas Valley. The aquifer is typically confined, but is locally hydraulically connected to the overlying 180-foot aquifer. Data from the 400-foot aquifer are sparse; consequently, the hydraulic continuity and flow directions are only described locally where wells penetrate the aquifer.

The 400-foot aquifer is affected by both seawater intrusion and low levels of organic contaminants. Like the 180-foot aquifer, pumping has resulted in seawater intrusion into the 400-foot aquifer in the area of Marina and the northern Salinas Valley. Low levels of TCE and 1,1-dichloroethene (DCE) (1.0 and 1.2 $\mu\text{g/l}$, respectively) have been detected in the 400-foot aquifer in the vicinity of the OU2 landfill. Beneath the landfill, there appears to be little hydraulic separation between the 180-foot and 400-foot aquifers. Flow patterns in the 400-foot aquifer are poorly defined; however, on the basis of historical movement of seawater and water levels

obtained for this investigation, flow is believed to be in a general eastward direction from the Main Garrison area toward the Fort Ord pumping centers and southward along the axis of the Salinas Valley.

Basin Boundary

Seismic reflection surveys obtained as part of this investigation and previous wells logs indicate a bedrock high separates the Salinas and Seaside groundwater basins. South of the Main Garrison, the bedrock high is composed of the Monterey Formation and is believed to provide hydraulic separation between the two basins. Based on a single well (Huffman), the bedrock high is projected eastward.

Seaside Basin

Three aquifers are recognized in the Seaside basin:

- Uppermost aquifer
- Paso Robles aquifer
- Santa Margarita aquifer.

The Uppermost aquifer is not used for water supply, but the other two aquifers are major water-supply sources. Both the Paso Robles and Santa Margarita formations are considered to contain several water-bearing zones.

This investigation focused principally on the upper water-bearing zones of the Seaside basin because these were considered to be most vulnerable to contamination from surface sources. These zones included the unconfined Uppermost aquifer and the shallow water-bearing zones of the Paso Robles Formation. Unfortunately, much of the Seaside basin within Fort Ord is in the Impact Area, an area of very restricted access.

Similar to previous investigations, access was limited to areas immediately adjacent to the base boundaries and offbase.

The Uppermost aquifer is similar in nature to the A-aquifer of the Salinas basin and consists of sandy, permeable soils. Groundwater within the Uppermost aquifer is unconfined and perched, generally flowing from east to west. The degree of hydraulic communication between the Uppermost and the underlying Paso Robles aquifers is considered relatively low because the upper Paso Robles Formation is poorly sorted, with a-contains considerable fine-grained component. Further, in much of the western portion of the Seaside basin, an extensive clay (the Seaside clay) appears to separate the Uppermost and Paso Robles aquifers.

Pathways from the Uppermost aquifer into the Paso Robles aquifer may exist where sandy strata in the Paso Robles are in contact with the Uppermost aquifer. These pathways are only recognized conceptually and their delineation would require site-specific studies.

The Paso Robles Formation is geologically older than the Uppermost aquifer and the sediments (and aquifer zones) in this formation are believed to be deformed by faulting and folding. This deformation primarily affects the deeper portions of the formation and the faults are considered to act as significant barriers to groundwater flow where they are present. Groundwater in this aquifer is typically confined and flow is influenced to a large degree by pumping from supply wells.

The deepest aquifer in the Seaside basin is the Santa Margarita formation. Groundwater in this aquifer is confined and groundwater flow is strongly influenced by pumping. As in the Paso Robles aquifer, this aquifer is deformed by folding and faulting with faults forming barriers to groundwater flow.

Significant seawater intrusion or groundwater contamination has not been identified in the Seaside basin aquifers.

RECOMMENDATIONS

On the basis of this investigation, the following activities are recommended:

- Evaluate the hydrogeologic conditions between the OU2 landfill and Sites 2 and 12 to:
 - Verify the conceptual flow model between the A- and 180-foot aquifer
 - Evaluate the distribution of contaminants in this potential aquifer pathway
 - Verify and monitor a groundwater mound in the vicinity of Site 12.
- Evaluate upgradient contamination affecting the OU1-FAAF Fire Drill Area.
- Update the status of inactive supply wells as vertical conduits between aquifers based on findings from recent hydrogeologic and contaminant source investigations.
- Perform a groundwater chemistry and water level monitoring program.
- Develop a quantitative groundwater model to:
 - Allow simulation of proposed groundwater extraction systems
 - Assess the potential impact of groundwater reinjection and extraction on contaminant distribution, seawater intrusion, and regional groundwater flow
 - Evaluate the impact of groundwater extraction on the overall water budget for the aquifer system.

1.0 INTRODUCTION

Fort Ord, a U.S. Army base in Monterey County, California, was added to the National Priorities List (NPL) of hazardous waste sites on February 21, 1990 (55 Federal Register 6154). In July 1990, representatives from Fort Ord and the U.S. Army (Army) signed a Federal Facilities Agreement (FFA) with the U.S. Environmental Protection Agency, Region IX (EPA), the California Department of Health Services (DHS), and the California Regional Water Quality Control Board, Central Coast Region (RWQCB). Under this agreement, the Army is required to perform a remedial investigation/feasibility study (RI/FS) at Fort Ord. The Army Corps of Engineers, Sacramento District (COE), is conducting the RI/FS.

This report, prepared by Harding Lawson Associates (HLA) on behalf of the COE, presents the results of the Basewide Hydrogeologic Characterization, which is part of the current investigation program for the Fort Ord RI/FS. The purpose of the Basewide Hydrogeologic Characterization is to evaluate the hydrogeologic conditions in the vicinity of the base in order to understand the hydrogeologic framework of Fort Ord. To fulfill this purpose, the following conditions were characterized: (1) the geologic units that comprise the groundwater aquifers and aquitards at Fort Ord, (2) the groundwater flow conditions, including rates and directions of subsurface flow in and between the identified aquifer units, (3) the existing groundwater extraction from the groundwater basins at Fort Ord, and (4) organic and inorganic groundwater chemistry. This information will be used in the RI/FS to understand hydrogeologic conditions affecting the specific sites, and to assess the potential for contaminant movement into and through the groundwater system.

This document was prepared by HLA at the direction of the COE for the sole use of the COE and the signatories of the FFA, including the Army, EPA, DTSC (formerly, the Toxic Substances Control Program of the DHS), and RWQCB, the only intended beneficiaries of this work. No other party should rely on the information contained herein without prior written consent of the COE and Army. This report and the interpretations, conclusions, and recommendations contained within are based on information presented in other documents that are cited in the text and listed in the references. Therefore, this report is subject to the limitations and qualifications presented in the referenced documents.

Section 2.0 of this report discusses general site conditions. Section 3.0 presents methods used to conduct the study, and Sections 4.0 through 7.0 discuss the results and draw conclusions on the basis of these results. Section 8.0 lists data gaps and proposes a work plan to fill the data gaps. A list of documents used to prepare this report is provided in Section 9.0.

2.0 GENERAL SITE CONDITIONS

2.1 Fort Ord Location and History

Fort Ord is located adjacent to Monterey Bay in northwestern Monterey County, California, approximately 80 miles south of San Francisco (Plate 1). The base comprises approximately 28,000 acres adjacent to the cities of Seaside, Sand City, Monterey, and Del Rey Oaks to the south and Marina to the north. The Southern Pacific Railroad and Highway 1 pass through the western portion of Fort Ord, separating the coastline from the remainder of the base. The Laguna Seca Recreation Area and Toro Regional Park border Fort Ord to the south and southeast, respectively. Land use east of Fort Ord is primarily agricultural.

Since its opening in 1917, Fort Ord has served primarily as a training and staging facility for infantry troops. No permanent improvements were made until the late 1930s, when administrative buildings, barracks, mess halls, tent pads, and a sewage treatment plant were constructed. From 1947 to 1975, Fort Ord was a basic training center. Before 1947 and after 1975, the 7th Infantry Division (Light) occupied Fort Ord.

The three major developed areas within Fort Ord are the Main Garrison, Fritzsche Army Airfield (FAAF), and the East Garrison (Plate 1). The remaining approximately 20,000 acres of undeveloped property are used for training activities. The Main Garrison contains commercial, residential, and light industrial facilities. It was constructed between 1940 and the 1960s, starting in the northwest corner of the base and expanding southward and eastward. During the 1940s and 1950s, there was a small airfield in the central portion of the Main Garrison. This airfield was decommissioned when FAAF was completed, and the airfield facilities were redeveloped as motor pools or for other operations. FAAF, which serves as the general airfield for Fort Ord, is in

the northern portion of the base, adjacent to the city of Marina. FAAF was incorporated into Fort Ord in 1960 and expanded in 1961. The East Garrison occupies 350 acres on the northeast edge of the base and consists of military and industrial support areas, recreational facilities, and recreational open space.

2.2 Climate and Topography

The climate at Fort Ord is characterized as Mediterranean and is typically cool and moist. Coastal fog is common, particularly during the summer months. Temperatures are mild, typically ranging from 40 to 70 degrees Fahrenheit. Temperatures occasionally reach as high as 100 degrees and freezing temperatures are infrequent.

The average annual rainfall is approximately 14 inches with precipitation occurring almost entirely between the months of November and April. Although wind direction is variable, prevailing winds are from the west and northwest.

Elevations at Fort Ord range from approximately 900 feet above mean sea level (MSL) near Impossible Ridge to sea level at the beach. The predominant topography of the area reflects a morphology typical of the dune sand deposits that underlie the western and northern portions of the base. In these areas, the ground surface slopes gently west and northwest, draining toward Monterey Bay. Runoff is minimal due to the high rate of surface water infiltration into the permeable dune sand; consequently, well-developed natural drainages are absent throughout much of this area. Typical of dune topography, closed drainage depressions are common.

The topography in the southeastern third of the base is notably different from the rest of the base. This area has relatively well-defined, eastward-flowing drainages within narrow, moderate to steeply sloping canyons. Runoff is into the Salinas Valley.

2.3 Water Resources

Water supply and water quality are significant environmental issues for Monterey County and its cities. The Monterey Peninsula Water Management District (MPWMD) has the authority to manage water resources for all Monterey Peninsula cities and portions of Monterey County surrounding the peninsula. The California-American Water Company (Cal-Am) is the primary supplier of potable water to the greater Monterey Peninsula, including Seaside, Sand City, and Del Rey Oaks. The MPWMD derives water from three distinct drainage basins: the Carmel Valley basin, the Canyon del Rey basin, and the lower portion of the Seaside basin. Groundwater supplies for Fort Ord and the city of Marina are from aquifers in the Salinas basin; Seaside obtains water from the Seaside basin aquifers.

2.4 Hydrogeology

2.4.1 Regional Geology

Fort Ord is within the Coast Ranges Geomorphic Province. This region consists of northwest-trending mountain ranges, broad basins, and elongate valleys generally paralleling the major geologic structures. Major northwest-trending faults of the active San Andreas fault system have broken the region into a series of tectonic blocks. Fort Ord is west of the San Andreas fault within the Salinian block, a region underlain largely by granitic and metamorphic basement rocks. The King City fault, part of the San Andreas system, is a major structural feature of the northern Salinas Valley and has been interpreted to project northwesterly through or near the northeast boundary of Fort Ord.

In the Coast Ranges, older, consolidated rocks are characteristically exposed in the mountains, buried beneath geologically younger, unconsolidated alluvial fan and

assessment identified (1) no complete exposure pathways for ecological receptors other than soil microbes and invertebrates and (2) no ecological risks, because the detected chemicals are either present beneath pavement and below the depth of plant roots or are beneath buildings in areas not suitable for supporting ecological receptors. Therefore, no additional action is needed to address ecological risks.

portions of the northern Salinas Valley, including Fort Ord, Pleistocene-age sands and gravels represent alluvium deposited when sea level was below its present level.

Extensive clays overlying these coarse-grained sediments represent estuarine conditions during a late Pleistocene interglacial high sea-level stand as discussed by Tinsley (1975).

Older dune sand subsequently covered these estuarine clays. The present elevation of the estuarine clays above sea level indicates some local tectonic uplift has occurred since their deposition during the Pleistocene.

2.4.2 Fort Ord Groundwater Basins

Recent studies of Fort Ord hydrogeology concluded that the base straddles two distinct hydrogeologic basins, the Salinas and Seaside basins (GTC, 1984; SGD, 1987a). Fort Ord includes the southwestern edge of the Salinas basin and the eastern portion of the smaller Seaside basin east of the city of Seaside. As shown on Plates 2 and 3, the Salinas basin underlies the north and southeastern portions of the base; the Seaside basin underlies the south and southwest areas of Fort Ord.

2.4.2.1 Salinas Basin

The Salinas basin is relatively large and extends well beyond the boundaries of Fort Ord. This groundwater basin is composed of several areas referred to as the Arroyo Seco Cone, Forebay Area, East Side, and Pressure Area, as shown on Plate 2 (DWR, 1949). The East Side and Arroyo Seco Cone have little direct effect on the hydrogeologic conditions at Fort Ord and consequently will not be discussed in this report. Fort Ord overlies the southwest corner of the Pressure Area, a portion of the basin characterized as having a series of confined aquifers. Aquifers within the Salinas Valley portion of the Pressure Area have conventionally been named according to their depth below the ground surface in the Salinas Valley. These aquifers include the

180-foot, 400-foot, and 900-foot aquifers. A laterally extensive confining clay traditionally named the SVA overlies much of the Pressure Area within the Salinas Valley. In this area, the SVA is at or near the ground surface, and is generally thought to preclude direct recharge of the underlying aquifers by the Salinas River. Inflows from the Forebay Area aquifers, where the SVA is absent and the Salinas River more directly recharges the underlying aquifers, are believed to recharge the Pressure Area.

At Fort Ord, the Salinas basin is composed of relatively flat-lying to gently dipping, poorly consolidated sediments. Although relatively simple structurally, the sediments are stratigraphically complex, reflecting a variety of depositional environments including eolian, estuarine, fluvial, alluvial fan, and beach deposits. The aquifer and aquitard conditions vary somewhat from those in the Salinas Valley. Most notably, the A-aquifer is present at Fort Ord and absent in the Salinas Valley, and the depths to the 180-foot, 400-foot and 900-foot aquifers are greater at Fort Ord than in the Salinas Valley due to Fort Ord's somewhat higher ground surface elevation.

The A-aquifer is the shallowest aquifer in the Salinas basin portion of Fort Ord. It is composed predominantly of older dune sand and is recharged directly from rainfall and surface water infiltration. An extensive fine-grained sequence (Fort Ord-Salinas Valley Aquiclude [FO-SVA]), generally considered to be related to the SVA of the Salinas Valley, is beneath the A-aquifer. The elevation of the FO-SVA top ranges from approximately 100 to -30 feet MSL. In this report, the FO-SVA is distinguished from the SVA within the Salinas Valley to facilitate the discussion and comparison of these units. The 180-foot aquifer is present beneath the FO-SVA; however, the 180-foot aquifer also extends beyond the FO-SVA lateral limits. Deeper aquifers include the 400-foot and 900-foot aquifers. Continuity between these deeper aquifers

onbase and those offbase in the Salinas Valley has not been well established because only limited deep boring data are available from Fort Ord. However, these aquifer names are used in this report to maintain consistency with historical naming conventions.

At Fort Ord, the ~~otherwise-continuous~~ laterally extensive FO-SVA pinches out near the Main Garrison and along the southern Salinas basin boundary, as do the gravels of the 180-foot aquifer. Beyond the FO-SVA, the distinction between the A- and 180-foot aquifers becomes less well defined and these two aquifers are considered to behave as a single, combined aquifer.

The hills in the southeast portion of Fort Ord are considered to be within the Salinas groundwater basin; however, the geology of that area differs significantly from the geology of the Main Garrison, FAAF, and East Garrison areas. The aquifers in the southeast base area are considered to correlate directly to the geologic formations, the Aromas Sand and the Paso Robles Formation.

2.4.2.2 Seaside Basin

The comparatively small Seaside basin underlies the south and southwest portions of Fort Ord and extends beyond the southern and western boundaries of the base. The Seaside basin has been divided into a Northern and Southern basin, each of which has been further subdivided into a number of subbasins, including the Laguna Seca, Coastal, Fort Ord, and Northern Inland subbasins. These subbasins are shown on Plate 3. In the city of Seaside area, the basin and subbasin boundaries are defined by northwest-trending faults. Elsewhere, subbasin boundaries are uncertain and consequently are not presented on Plate 3. Fort Ord overlies the Northern Inland and Fort Ord subbasins within the Northern Seaside basin and, to a lesser extent, the Laguna Seca subbasin, a part of the Southern Seaside basin.

The Seaside basin is structurally complex and includes several recognized faults and folds. The subdivision of the basin into subbasins is based largely on the presence of these structures and their potential role as barriers to groundwater flow.

The aquifers within the Seaside basin, from ground surface, are referred to as the Uppermost, Paso Robles, and Santa Margarita aquifers.

2.4.2.3 Basin Boundaries

The boundary between the Salinas and Seaside basins is not well defined. A east-west-trending "bedrock high," as defined by the presence of the Monterey Formation described in several water-well logs, is believed to extend from the vicinity of Welch and Grant Ewing ridges eastward to at least Camp Huffman as shown on Plate 3. Based on interpretations of groundwater flow by Muir (1982), the basin boundary then extends southward from Camp Huffman toward Laguna Seca, approximately parallel to Wildcat Ridge. The location of this portion of the boundary is interpretive and remains unconfirmed by subsurface data. Groundwater resource investigations in the Laguna Seca area suggest a possible basin boundary or groundwater divide extending from approximately Laguna Seca northeastward coincident with an anticlinal fold (SGD, 1988b). The approximate location of the basin boundary is depicted on Plate 3.

2.4.2.4 Well Destruction Program

In 1989, 10 inactive Fort Ord water-supply wells were destroyed to eliminate suspected conduits between the A-aquifer and the 180-foot aquifer in the vicinity of the Fort Ord landfills, (designated Operable Unit 2 [OU2]). These wells included FO-11, FO-14, FO-16, FO-17, FO-18, FO-19, FO-21, FO-22, FO-23, and FO-25. FO-24 was not destroyed as part of this program; it is retained by the Army

for emergency water supply. Plate 5 shows the well locations. The inactive wells were destroyed by perforating the casing and injecting the well and annulus with grout. The details of the program are presented in the Destruction Plan and Destruction Record reports (*HLA, 1989a, b*).

3.0 METHODS OF INVESTIGATION

This section describes the methods used to investigate the basewide hydrogeologic conditions at Fort Ord. Data for this investigation were obtained from four sources: literature and well logs from previous investigations, onbase and offbase water supply facilities, wells and borings installed as part of the site-specific RI/FS investigations shown on Plate 4, and wells and boring installed as part of this basewide investigation.

3.1 Literature Review

HLA conducted a literature review of existing information pertinent to basewide hydrogeological conditions. The literature was reviewed to form a conceptual understanding of the base and vicinity with respect to geology, hydrology, groundwater chemistry, and hydraulic parameters. Literature used to prepare this report is listed in Section 409.0.

Well logs for onbase and offbase wells (both active and inactive) were obtained from a variety of sources, including the COE, California Department of Water Resources, Marina County Water District, MPWMD, Monterey County Water Resources Agency, California Water Service Company, Cal-Am, various consultant reports, private land owners, and municipalities (Seaside, Marina, Sand City). Borings and wells used for this investigation are listed in Table 1; well and boring locations are shown on Plate 5. The logs were evaluated for a variety of data, including lithologic and geophysical information, well construction details, specific capacity production test data, and water levels. Together, these well logs were used to develop geologic cross sections, and to scope and implement groundwater sampling and water-level surveying programs.

Chemical data were also obtained from some of these sources, and from the Monterey County Health Department, to further assist in the development of the

groundwater sampling program. Available pumping test data and historical production rates were compiled to provide hydraulic parameters and historic groundwater usage.

3.2 Pilot Boring and Monitoring Well Installation

Pilot borings were drilled and monitoring wells were installed as part of the basewide investigation. The pilot borings were drilled to provide lithologic data and information about the characteristics of the underlying aquifers and to identify appropriate screen intervals for the monitoring wells. Monitoring wells were installed as two or three well clusters near the pilot borings to monitor groundwater chemistry in various aquifers. Each completed monitoring well was horizontally and vertically surveyed to provide control for water-level measurements and well locations. The surveying program included wells installed for the basewide program, and the wells and piezometers installed as part of the RI/FS site-specific investigations.

3.2.1 Pilot Borings

Four pilot borings were completed from January 18 through February 19, 1992. Boring PB-BW-01 was completed at FAAF in the northeast corner of the intersection of Reservation and Blanco roads (Plate 5). This boring was drilled for the well cluster that includes MW-BW-01-A, MW-BW-02-180, and MW-BW-03-400. Borings PB-BW-02, PB-BW-03, and PB-BW-04 were drilled in the southwest portion of the base adjacent to the city of Seaside eastern boundary (Plate 5). Monitoring wells installed in association with these borings are shown on Plate 5.

The pilot borings were drilled by Water Development Corporation (WDC), Woodland, California, using a mud rotary rig equipped with a 6 1/4-inch-diameter drill bit. Soil samples were collected every 20 feet or at significant lithologic changes using a 94-millimeter wireline sampling system or split barrel sampler lined with

2 1/2-inch-diameter stainless steel tubes. Soil samples and borehole cuttings were classified in the field according to ASTM D 2844-90 presented as Plate A1 in Appendix A. Each pilot boring was geophysically logged as described in Section 3.3.2. Pilot boring lithologic and geophysical logs are presented in Appendix A.

3.2.2 Monitoring Well Installation

Ten groundwater monitoring wells were installed as part of the Basewide Hydrogeologic Characterization. The wells were installed from February 15 to April 21, 1992; their locations are shown on Plate 5. Well cluster locations were selected to monitor groundwater quality in the vicinity of the active Fort Ord and Seaside municipal water-supply wells. The locations were also selected investigate data gaps related to stratigraphy and aquifer characteristics in those areas. Soil samples obtained during well drilling were submitted for laboratory analysis to provide background soil chemistry data for the Basewide Background Soil Investigation. Drilling and well construction were performed by WDC. Lithologic logs and well completion details for these wells are presented in Appendix A.

Soil samples for classification and chemical analysis were collected at approximately 10-foot intervals from the unsaturated zone above first groundwater using a drive sampler lined with 2 1/2-inch-diameter stainless steel tubes. Details of the soil sampling intervals, chemical analyses, data validation, and chain of custody are presented in the *Draft Final Basewide Background Soil Investigation* report, dated March 15, 1993.

3.2.3 Well Surveying

Upon completion of basewide and site-specific well installations for the RI/FS program, each of the new onbase wells and piezometer nests were horizontally and

Table 2. Analytical Results for Organic Compounds Detected in Soil Samples
Site 28 - Barracks and Main Garrison Area
Fort Ord, California

Station Number:	SB-28-03	SB-28-04	SB-28-04
Sample Depth(feet):	20.50	5.50	10.50
Sample Number:	SB280320.5	SB28045.5	SB280410.5
Matrix:	SOIL	SOIL	SOIL
Sample Date:	01/06/92	01/05/92	01/05/92
Lab Sample Number:	0621980022SA	0621990010SA	0621990011SA

Test Method/Analyte Name	Units	value	qual	value	qual	value	qual
EPA-8240							
Methylene chloride	ug/kg	2.8	A/Jb	ND(5.2)	AU1/JBb	ND(5.2)	AU1/JBb
Acetone	ug/kg	27	A/b	5.3	A/Jb	ND(10)	A

Notes: Units expressed as micrograms (ug), milligrams (mg) or picograms (pg)
of chemical per kilogram (kg) or gram (g) of soil.

Fecal coliform results reported as Most Probable Number (MPN) per 10 grams for soil samples
and MPN per 100 milliliters for water samples.

NA: Not Analyzed.

ND(): Not Detected at a specific reporting limit. Reporting limit is included in parentheses.

Report Date: Jun 21, 19

Table 2. Analytical Results for Organic Compounds Detected in Soil Samples
Site 28 - Barracks and Main Garrison Area
Fort Ord, California

Station Number:	SB-28-05	SB-28-05	SB-28-05
Sample Depth(feet):	5.50	15.50	20.50
Sample Number:	SB28055.5	SB280515.5	SB280520.5
Matrix:	SOIL	SOIL	SOIL
Sample Date:	01/05/92	01/05/92	01/05/92
Lab Sample Number:	0621990013SA	0621990014SA	0621990015SA

Test Method/Analyte Name	Units	value qual	value qual	value qual
EPA-8240				
Methylene chloride	ug/kg	ND(5.2) AU1/JBb	ND(5.2) A	ND(5.2) A
Acetone	ug/kg	8 A/Jb	ND(10) A	ND(10) A

Notes: Units expressed as micrograms (ug), milligrams (mg) or picograms (pg)
of chemical per kilogram (kg) or gram (g) of soil.

Fecal coliform results reported as Most Probable Number (MPN) per 10 grams for soil samples
and MPN per 100 milliliters for water samples.

NA: Not Analyzed.

ND(): Not Detected at a specific reporting limit. Reporting limit is included in parentheses.

Report Date: Jun 21, 1992

The working cross sections were then simplified and reduced as presented on Plates 6 and 7.

Once the basic stratigraphic framework was established on the cross sections, additional lithologic data from well logs throughout the base were plotted in plan view to map the upper and lower contacts of the FO-SVA. Contours of the top and thickness of the FO-SVA are shown on Plates 8 and 9.

3.5 Groundwater Monitoring

The basewide groundwater monitoring program consisted of four water-level measurement events and two groundwater sampling events. An initial groundwater sampling event at the various RI/FS site wells was performed prior to the basewide program. These data are also included in the basewide groundwater chemistry analysis.

3.5.1 Water-Level Monitoring

The water-level surveys were performed to provide groundwater gradient information for aquifers in the Salinas and Seaside basins. In addition to the RI/FS site wells, these surveys included selected onbase and offbase supply and monitoring wells. The following criteria were used to select wells for water-level monitoring:

- Wells completed in each aquifer provide appropriate areal coverage.
- Each well is constructed in a single aquifer such that its construction isolates it from other aquifers.
- Wells are accessible for periodic monitoring.

The wells selected fulfilled at least two of the above requirements. Due to the limited number of monitoring points in some areas such as the city of Seaside, wells screened in more than one aquifer or with incomplete construction information were

incorporated in the water-level monitoring program; these wells are considered to provide only approximate information about regional water-level conditions.

Water levels in the Salinas basin were measured in wells completed in the A-, 180-foot, and 400-foot aquifers during each of the monitoring events. Only three wells (supply wells Marina 10, 11, and 12) are screened below the 400-foot aquifer. Because these wells operate continuously, accurate water-level measurements could not be obtained. Water levels in the Seaside basin were measured in wells completed in the Uppermost, Paso Robles, and Santa Margarita aquifers. The majority of the Seaside basin underlying Fort Ord is located in the Fort Ord Impact Area (Site 39), an area of restricted access containing only a few wells. Consequently, most of the wells that were monitored in the Seaside basin are located within the city of Seaside beyond Fort Ord's boundaries.

The water-level surveys were completed from January 7 through 9, February 25 through 27, May 20 through 21, and July 7 through 9, 1992; the number of wells surveyed for each round were 109, 126, 152, and 179 wells, respectively. Additional water-level measurements were collected on September 1, 1992, at Fort Ord supply wells FO-29, FO-31, and FO-32. Water levels were measured using graduated steel tapes or electronic water-level sounders according to procedures described in the Sampling and Analysis Plan (SAP; *HLA, 1991b*). Cal-Am provided water levels from their wells at HLA's request for time periods concurrent with the basewide monitoring events.

Details of the four water-level monitoring events are summarized in Table 2. The July 1992 data are the most comprehensive and are considered typical of the other

rounds. Therefore, the July data are used in this report as a basis for describing the general basewide hydraulic conditions.

3.5.2 Groundwater Sampling

The groundwater sampling program consisted of three well-sampling events conducted between March and June 1992. The first sampling event included only wells from the RI/FS site-specific investigations. The second and third events included RI/FS and site characterization wells and the wells selected for the basewide program as described below. The groundwater sampling procedures and quality assurance/quality control (QA/QC) guidelines followed in each sampling event are described in the SAP (HLA, 1991b). Copies of the chain of custody forms completed for the groundwater samples are presented in Appendix D.

Wells were selected for inclusion into the basewide sampling program on the basis of the following criteria:

- Wells cover a broad areal distribution both on the base and around the perimeter of the base.
- Wells are distributed in various aquifers sufficient to identify areal changes in the groundwater chemistry of each aquifer and to characterize chemical differences between aquifers at a specific location.
- Each well is constructed in a single aquifer such that its construction isolates it from other aquifers.
- Wells are accessible for periodic monitoring.

Fifty-seven wells were chosen for the basewide sampling program on the basis of these criteria. The wells included new onbase monitoring wells installed as part of the basewide investigation, existing onbase monitoring wells not included in the current RI/FS site-specific investigations, onbase and offbase groundwater production wells, and offbase monitoring wells. Twelve additional wells from the existing FAAF OU1

Description of Organic Qualifiers Used in Database

HLA Validation Assigned Qualifiers

- A: Sample has undergone routine data validation.
- F: The presence of this compound is due to suspected field contamination.
- J0: Analytical results for this compound are qualified as estimated due to noncompliance with internal area count or retention time criteria.
- J1: Analytical results for this compound are qualified as estimated due to noncompliance with instrument performance criteria.
- J2: Analytical results for this compound are qualified as estimated due to noncompliance with precision.
- J3: Analytical results for this compound are qualified as estimated due to poor spike recoveries.
- J5: Analytical results for this compound are qualified as estimated due to holding time exceedances.
- J6: Analytical results for this compound are qualified as estimated due to field duplicate quality control criteria exceedances.
- J7: Analytical results for this compound are qualified as estimated due to initial and/or continuing calibration problems.
- J8: Analytical results for this compound are qualified as estimated due to detection of the compound above the instrument calibration range.
- J*: Analytical results for this compound are qualified as estimated due to miscellaneous lab errors.
- NQ: Analytical results for this compound have not been qualified.
- N1: Analytical results for this compound are qualified as estimated and presumptively present due to its as a tentatively identified compound.
- N2: Data not qualified due to lack of applicable or relevant criteria. Please refer to data validation or quality text for a discussion of data usability.
- R0: Analytical results for this compound are qualified as rejected due to noncompliance with internal standard area count or retention time criteria.
- R1: Analytical results for this compound are qualified as rejected due to holding time exceedances.
- R2: Analytical results for this compound are qualified as rejected due to poor spike recoveries.
- R3: Analytical results for this compound are qualified as rejected due to noncompliance with instrument performance.
- R5: Analytical results for this compound are qualified as rejected due to incorrect identification.
- R6: Analytical results for this compound are qualified as rejected due to noncompliance with the full CL.
- R7: Analytical results for this compound are qualified as rejected due to initial and/or continuing calibration problems.

- Three nested monitoring wells constructed as part of the basewide investigation (MW-BW-01-A, MW-BW-02-180, and MW-BW-03-400)
- One inactive Fort Ord water-supply well (FO-24)
- Five city of Marina wells, located on the western edge of Fort Ord and FAAF (Marina 02 [180-foot aquifer]; Marina 09 [400-foot aquifer]; and Marina 10, Marina 11, and Marina 12 [900-foot aquifer])
- Three California Water Service active water-supply wells, on the southeastern edge of Fort Ord (Cal Water 33, 39, and 40 [400-foot aquifer])
- Three active irrigation wells in the Salinas Valley east and north of Fort Ord (Wil Ranch, Grainger Farms, and Panziera Ranch [400-foot aquifer]).

The five Marina wells are active water-supply wells operated by the Marina County Water District. Marina 02 is used primarily for irrigation purposes because of water quality concerns related to historical seawater intrusion. Marina 09 is part of the city water supply. Marina 10, 11, and 12 represent the only data points for the 900-foot aquifer in the basewide investigation.

3.5.2.2 Seaside Basin Wells

Thirty wells in the Seaside basin were sampled, including:

- Six monitoring wells constructed as part of previous environmental investigations at Fort Ord (MW-B series).
- Six monitoring wells installed as part of the basewide investigation (MW-BW-04 through MW-BW-09), consisting of three monitoring well pairs adjacent to the city of Seaside/Fort Ord boundary. These wells are screened in the first and second aquifers ~~water-bearing zones~~ (the Uppermost and Paso Robles aquifers) to monitor possible contamination of these uppermost aquifers.
- One active Fort Ord irrigation well (MW-B-32-180).
- Seventeen offbase monitoring or water-supply wells. The PCA, Monterey Sand Company, Plumas, and Ryan Ranch wells are each part of a well pair or nested well group and were selected to help identify chemical differences between the aquifers at specific locations.

The PCA and Monterey Sand Company monitoring wells were originally installed to monitor the effect of groundwater withdrawals at PCA and the Monterey Sand Company, respectively. The wells are owned by the MPWMD and are included in their water-level monitoring program.

The Plumas wells, M-02, 03, and Test 90, monitor the Paso Robles and Santa Margarita aquifers in the Southern Seaside basin. Plumas M-2 is a monitoring well screened in the unconfined portion of the Paso Robles aquifer. Plumas 03 is an active groundwater-supply well operated by Cal-Am and screened in the Paso Robles aquifer both above and below a confining clay. Plumas Test 90 is a monitoring well screened in the Santa Margarita aquifer and was originally installed to determine the effect of groundwater withdrawal from the Paso Robles on the deeper Santa Margarita aquifer. All of the Plumas wells are located on Cal-Am property in the city of Seaside. Plumas M-2 and Test 90 are part of a water-level monitoring program run by MPWMD.

The six Ryan Ranch wells consist of three well pairs located on the southern border of Fort Ord. Ryan Ranch 02, 07, and 10 are active water-supply wells screened in the Santa Margarita aquifer and operated by Cal-Am. Ryan Ranch M2S, M7S, and M8S are monitoring wells screened in the Paso Robles aquifer. These wells were originally installed to study the effect of groundwater withdrawal from the Santa Margarita aquifer on the overlying Paso Robles aquifer.

The Luzern and Seaside 01 wells are active water-supply wells located in the northern Seaside basin. The Luzern well is operated by Cal-Am and is screened in the Paso Robles aquifer. Seaside 01 is operated by the city of Seaside and is screened in the Santa Margarita aquifer.

3.6 Data Validation

The monitoring wells sampled as part of the basewide investigation were divided into onbase (BWMWON) and offbase (BWMWOF) wells. The analytical data from these wells were subjected to data validation. The data validation results are presented in Appendix E; procedures are described in detail in Part 2 of the *Draft Site Characterization, Site 34 - Fritzsche Army Airfield Fueling Facility* report, dated June 2, 1992. The results of the data validation efforts for the site wells are described in the individual RI/FS site investigation reports. Analytical data for the OU2 wells reported by Dames and Moore have not been validated by HLA.

During the course of the detailed validation, some VOC, semivolatile organic compound (SOC) and pesticide/polychlorinated biphenyl (PCB) results and some beryllium results were rejected due to noncompliance with QC criteria. Qualifiers were added to some data by HLA. The remaining data are generally considered valid and technically usable. Intermittent laboratory contamination by methyl ethyl ketone (MEK), methylene chloride, acetone, and bis(2-ethylhexyl)phthalate was observed in the laboratory blanks. As a result, positive detections of these chemicals in the affected samples were qualified by HLA and/or the laboratory to indicate that these detections were attributable to laboratory contamination.

4.0 SALINAS BASIN

4.1. Geology

This section describes the Salinas basin stratigraphy, geologic structure, related offshore geology, and hydrostratigraphy.

4.1.1 Stratigraphy

The principal geologic units of the Salinas basin at Fort Ord are described in this section and are summarized in Table 4. The hydrogeologic map (Plate 3) and geologic cross sections A-A', B-B', and C-C' (Plate 6) should be referred to when reading this section. Detailed lithologic descriptions are presented on the well and boring logs presented in Appendix A. Due to the limited occurrence of recent and older alluvium at Fort Ord, these units are not discussed herein; however, they are described briefly in Table 4.

4.1.1.1 Beach Sand (Qs)

Beach sand is restricted to the coastline and consists of well-sorted, fine- to coarse-grained sand composed largely of quartz and feldspar. Localized concentrations of sand composed largely of heavy mineral constituents and rounded gravels occur sporadically as a result of segregation by wave action. Steep bluffs border much of the landward portion of the beach and at least a portion of the beach sand is derived from erosion of the dunes forming the bluffs.

4.1.1.2 Recent Dune Sand (Qd)

Active and recently active dunes parallel the beach and extend several hundred feet inland. The dunes are composed of typically loose, well-sorted, fine- to medium-grained quartzose sand. Although the dune sand appears similar to the beach sand, it is generally finer-grained. Paleosols, representing former ground surfaces, exist within the dunes. These paleosols indicate that one or more cycles of dune deposition

have occurred with intervening periods of soil development. The paleosols in the dunes bordering the beach indicate older dune sand (Qod) is locally present beneath the recent dune sand.

4.1.1.3 Older Dune Sand (Qod)

This Pleistocene-age sand blankets most of the northern and western portions of Fort Ord and is the most widespread deposit present at the ground surface. Subsurface data indicate that the sand is up to 250 feet thick. This sand is predominantly fine- to medium-grained, ~~with an abundance of~~ with thin gently to moderately dipping laminae (cross bedding). Quartz and feldspar are abundant. Seismic reflectors within the sand and the occasional occurrence of brown, silty strata in borings indicate the presence of paleosols buried within the Qod.

4.1.1.4 Valley Fill Deposits (Qvf)

As used in this report, this Pleistocene-age unit is considered to include two distinct depositional sequences: an estuarine clay (FO-SVA) underlying the Qod, and a sand and gravel fluvial sequence beneath the FO-SVA. From the basal gravels to the fine-grained FO-SVA, the Qvf consists of a fining upward depositional sequence reflecting an episode of marine transgression.

The FO-SVA is limited to the northern portion of the base and ranges up to approximately 100 feet thick (Plate 9). It apparently pinches out and is absent west of the Main Garrison and in the southeast base area (Plate 3). The FO-SVA is composed of blue-gray, plastic clay with abundant shells, thin beds of fine-grained sand, and occasional, very thin layers of peat. This sequence is interpreted to have been deposited in an estuarine and/or lagoonal environment. Age dates obtained from Carbon 14 dating of fossils in the SVA (from the Salinas Valley) range from 16,000 to 6,000 years before

present (*Tinsley, 1975*). These dates may provide an approximate age for the FO-SVA; however, the correlation between the SVA and the FO-SVA has not been conclusively established. Previous studies (*GTC, 1984*) show the FO-SVA continuous with the SVA north of Fort Ord and do not distinguish between these deposits. However, the FO-SVA, at least in the vicinity of the East Garrison, is at a higher elevation than the SVA beneath the Salinas Valley (cross section B-B'). The reason for this elevation difference is uncertain, but it suggests that either age differences exist between the FO-SVA and the SVA, or differential tectonic displacement has occurred between them.

The Valley fill deposits are present beneath the FO-SVA. This sand and gravel sequence extends across much of the northern base area and somewhat beyond the limits of the FO-SVA as shown on cross sections A-A', B-B', and C-C' (Plate 6). These deposits range from approximately 100 to 300 feet thick. The sandy portion of the unit is commonly present immediately below the FO-SVA, and the gravel deposits occur beneath the sand. Numerous thin clays are present throughout. Sandy clay and clayey gravel separate the sandy portion from the gravel deposits in the vicinity of the Fort Ord supply wells. The abundance of rounded gravel, to several inches in diameter, suggest the sand and gravel sequence is of fluvial origin, possibly representing river deposits during a Pleistocene-age low sea level stand.

The gravel is apparently continuous with the 180-foot aquifer of the Salinas Valley (see B-B' [Plate 6] and Boring PB at Building 550A [Appendix A]). However, the gravel is absent in borings drilled southwest of the East Garrison (wells Test 3 and 4). As shown on C-C', Plate 6, the Aromas Sand and Paso Robles Formation, rather than Valley fill deposits, are present in the subsurface at wells Test 3 and 4. A similar condition exists further west, near the west end of Grant Ewing Ridge. As

shown on cross section A-A', the gravel appears to pinch out against the bedrock high which forms the basin boundary.

West of the FO-SVA in the vicinity of the Main Garrison and Highway 1 a significant facies change occurs. In addition to the FO-SVA pinching out, the fluvial gravels and sands underlying the FO-SVA appear to extend only a short distance west beyond the FO-SVA. The subsurface geology in this area is not well defined due to relatively few deep borings. However, a relatively continuous sandy clay and clayey sand aquitard was encountered in wells and borings installed as part of the RI/FS Site 12 investigation and in wells FO-10 and FO-11.

4.1.1.5 Aromas Sand (Qar)

The Aromas Sand is a Pleistocene-age deposit composed of eolian sand and flood-plain deposits. The unit is recognized in the north side of the Salinas Valley in the Moss Landing-Prunedale area. Although definitive correlation is lacking, previous studies indicate that the sand sequence present on the southwest side of the Salinas Valley, in and adjacent to Fort Ord, is also the Aromas Sand (*DWR, 1969*); in this report, the conclusions of the previous studies are assumed to be correct.

The Aromas Sand is exposed throughout the ridge and hilltop areas of the southeast portion of Fort Ord and appears to protrude sporadically above the Qod north and west of that area, apparently representing erosional highs where the Qod was either not deposited or was subsequently eroded. Cemented beds within the Qar are erosion-resistant and contribute to the formation of prominent ridges in the otherwise erodible sands. These ridges typically have abrupt and steep south-facing slopes and gentle northward-facing dip slopes. In much of the southeast portion of the base, the Qar can be observed to dip gently toward the northeast.

Table 3. Analytical Results for Inorganic Compounds Detected in Soil Samples
Site 28 - Barracks and Main Garrison Area
Fort Ord, California

Station Number: SS-28-03
Sample Depth(feet): 0.00
Sample Number: 9333C028003F
Matrix: SOIL
Sample Date: 08/16/93
Lab Sample Number: 0711560003SA

Test Method/Analyte Name	Units	value qual
COLD VAPOR AA		
Mercury	mg/kg	ND(0.053) A/U
FUAA-EPA7421		
Lead	mg/kg	NA
METALS BY ICP		
Beryllium	mg/kg	0.12 A/B
Cadmium	mg/kg	1.2 A
Chromium	mg/kg	13.9 A
Copper	mg/kg	42.4 A
Lead	mg/kg	155 A
Nickel	mg/kg	7.1 A/B
Silver	mg/kg	72.5 A
Zinc	mg/kg	84.4 A
EPA-9045		
pH	pH	NA

Notes: Units expressed as milligrams (mg) of chemical per kilogram (kg) of soil.

NA: Not Analyzed.

ND(): Not Detected at a specific detection limit. Limit of detection is included in parentheses.

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Rico Formation and/or the Purisima Formation (Clark, 1973 and EPA, 1993, Comment 1 Appendix G).

Direct correlation between QTpr surface exposures and subsurface boring data is difficult. However, the proximity of the QTpr at the ground surface near the East Garrison suggests that the clay and sand sequence encountered in Test 3 and 4 below about 60 feet MSL is QTpr. The general similarity between the sand-clay sequence in Test 3 and 4 and geologic materials encountered in the deeper wells of the Main Garrison area suggest the Paso Robles Formation may form portions of the 400-foot aquifer beneath the Main Garrison. Additionally, the irregular nature of the subsurface contact and the zone of red-brown oxidation between the QTpr and the overlying Aromas Sand in the Main Garrison area resemble the Aromas Sand-Paso Robles Formation contact exposed in a roadcut in the southeast portion of the base.

4.1.1.7 Monterey Formation (Tm)

The Miocene-age Monterey Formation does not crop out in the Salinas basin portion of Fort Ord. Well logs from the Gigling, FO-04 (Huffman), and MW-B-26-180 wells at the southern boundary of the basin include lithologic descriptions typical of the shale, mudstone, and sandstone found within the Monterey Formation. The presence of the Monterey Formation in the Gigling well at approximately sea level elevation indicates that the Monterey Formation forms the southern limit of the Qar, QTpr, and the lower portion of the Qvf deposits of the Salinas basin. From this relatively high elevation, the Tm probably slopes downward to the north below the water-supply wells in the Main Garrison and Marina areas with the possible exception of well Marina 10, which appears to penetrate the Tm in its lower portion. Well logs from the deeper Fort Ord and Marina supply wells indicate that the

Monterey Formation, if present in the Main Garrison area, is sufficiently deep to not affect the aquifers of concern in those areas.

4.1.2 Geologic Structure

The King City fault is considered a major structural feature of the Northern Salinas Valley (*Tinsley, 1975*) and has been located using gravity surveys along the west side of the Salinas Valley. Gravity data suggest that the fault forms the Sierra de la Salinas mountain front south of Fort Ord (*Sieck, 1964*); however, the fault's gravity definition becomes vague near Fort Ord so its location in the Fort Ord vicinity is uncertain. The approximate location of the King City fault, as located by the U.S. Geological Survey (USGS), is shown on Plate 3 (*Bowen, 1969*).

Previous studies have suggested that the Gabilan fault (related to the King City fault) crosses west-northwest through the Main Garrison forming a significant groundwater barrier (*DWR, 1969; GTC, 1984*). A number of previous studies have suggested that the Gabilan fault represents the northern extension of the King City fault. This conclusion was based on well logs, which suggested an apparent northeast-downward displacement of the QTpr (*DWR, 1969*). Further, the apparent discontinuity of the Qvf gravel strata (180-foot aquifer) from north to south at Henneken Ranch suggested possible evidence for the fault (*GTC, 1984*).

Two conditions indicate that fault offsets potentially related to the Gabilan fault have not affected late Pleistocene or younger sediments in the Salinas basin portion of Fort Ord. Gently dipping and apparently undisrupted Aromas Sand is exposed in the hills of southeast Fort Ord, and the Valley fill deposits appear to be continuous in the subsurface throughout the Main Garrison-Marina area. Displacement of the Paso Robles Formation is more difficult to assess due to the general absence of recognized marker

strata and adequate subsurface data. However, the apparent vertical offset of the Paso Robles Formation between wells Test 2 and 3, previously suggested as possible evidence for fault offset, could also be explained as the result of fluvial erosion and downcutting during a Pleistocene low sea level stand. Pleistocene-age fluvial downcutting could have formed a bluff or slope along the former Salinas Valley margin, followed by sediment infilling during deposition of the Valley fill deposits. This deposition would have then buried this former valley slope, leaving an apparent "offset" in the subsurface. This bluff or slope is portrayed on cross section C-C', Plate 6.

Except for a broad regional warping, the northern Salinas Valley is believed to have remained relatively undisrupted tectonically since at least the late Pleistocene (*Tinsley, 1975*). On the basis of marine terrace elevations in the northern Salinas Valley, approximately 100 feet of vertical warping is estimated to have occurred since the late Pleistocene between Elkhorn Slough and Santa Cruz (located approximately 8.5 and 23 miles north and northwest of Fort Ord, respectively). This warping is probably continuing (*Tinsley, 1975*). Consistent with this interpretation, the FO-SVA and Valley fill deposit gravels appear to be tilted slightly downward toward the north.

4.1.3 Offshore Geology

Offshore projection of the relatively flat-lying older dune sand and Valley fill deposits indicates that these units would outcrop from near the beach out to approximately 5 miles offshore on the floor of Monterey Bay. The Aromas Sand and Paso Robles Formation are believed to occur at or near the surface in the gently dipping seafloor west of Fort Ord and in the steep south wall of the Monterey Canyon northwest of Fort Ord. Seafloor exposures of these deposits range from near the beach west of the Main Gate to approximately 7 miles offshore of Marina (*Green, 1977*). Nearshore

outcrops of these units are considered to provide potential pathways for seawater into the aquifers at relatively short distances from Fort Ord and Marina production wells.

4.1.4 Hydrostratigraphy

Four aquifers are recognized in the Salinas basin portion of Fort Ord. They include the A-, 180-foot, 400-foot, and 900-foot aquifers. In addition to these aquifers, the southeastern portions of the base appear to include aquifers associated with the Aromas Sand and Paso Robles Formation; possible aquifers in that area are described by their formational names. West of the FO-SVA, the conventional Salinas Valley nomenclature is not directly applicable due to a facies change (see Section 4.1.1.4). The geology and hydrogeology of that area are not yet well understood; in this report, the A- and 180-foot aquifers are considered a combined aquifer and are discussed as part of the 180-foot aquifer.

4.1.4.1 A-Aquifer

The A-aquifer is composed predominantly of fine- to medium-grained, well-sorted sands within the Pleistocene-age older dune sand (Qod). This aquifer is perched and unconfined above the FO-SVA throughout much of the Main Garrison, East Garrison, and FAAF areas. In this report, the A-aquifer is considered to be approximately coincident with the areal extent of the FO-SVA, which forms a major aquitard between the A- and 180-foot aquifers. The depth to the water table in the A-aquifer varies depending on the ground surface topography and depth to the FO-SVA; it typically occurs from approximately 100 to 150 feet bgs in the Main Garrison-Reservation Road area. The saturated thickness of the A-aquifer is typically approximately 20 feet. Recharge to the A-aquifer is primarily the result of infiltration of precipitation and landscape irrigation. The A-aquifer discharges to the 180-foot

aquifer where the FO-SVA is absent and to the surface as seepage from the bluffs along the eastern base boundary.

4.1.4.2 180-Foot Aquifer

The 180-foot aquifer is typically confined and underlies the A-aquifer. The aquifer is unconfined in areas where the FO-SVA is absent and where localized unconfined conditions exist beneath the FO-SVA near Site 10 and in the vicinity of the Fort Ord pumping center. This aquifer is composed of two distinct sequences, an upper sand that includes some gravel, and a lower, predominantly gravel sequence that includes some sand and numerous thin clay lenses. These two sequences are separated locally by fine-grained deposits. The sand unit ranges from approximately 30 to 120 feet thick and appears to pinch out toward the south (A-A', Plate 6). The sand also appears to thin substantially beneath the Salinas Valley (see cross section B-B', Plate 6, east end). The gravelly unit varies from approximately 60 to 170 feet thick. It does not appear to extend south of the "bedrock high" basin boundary nor significantly west of the FO-SVA pinchout. Although these two aquifer subunits appear to be hydraulically connected, lenticular clay beds are common near their contact, particularly near FO-29 as shown on cross sections B-B' and C-C' (Plate 6).

West of the FO-SVA pinchout in the Main Garrison area, a facies change appears to affect the 180-foot aquifer. In this area, the FO-SVA is absent and the 180-foot gravels diminish. The aquifer conditions west of the facies change are not well characterized. A sandy clay encountered at Sites 2 and 12 appears to define two distinct aquifers in that area. However, until the specific conditions are further explored at Sites 2 and 12, aquifers west of the FO-SVA are discussed with the 180-foot aquifer.

The 180-foot aquifer is recharged by subsurface flow from the Salinas Valley and Monterey Bay and from the A-aquifer. The Aromas Sand and Paso Robles Formation probably also recharge the 180-foot aquifer from the area southeast of the Main Garrison. Groundwater gradients indicate much of the 180-foot aquifer discharges at the Fort Ord pumping centers. Some discharge to Monterey Bay may also be occurring near the Main Garrison. Pumping by Marina from the 400-foot aquifer may also induce discharge from the 180-foot aquifer into the 400-foot aquifer.

4.1.4.3 400-Foot Aquifer

The 400-foot aquifer underlies the 180-foot aquifer. Within Fort Ord, the 400-foot aquifer appears to be composed of two different geologic units, including a 150- to 250-foot thick, fine- to medium-grained sand (possibly equivalent to the Aromas Sand) near the OU2 landfill, and a sequence of interbedded sand and clay within the Paso Robles Formation near the Fort Ord supply wells. The upper portion of the 400-foot aquifer is difficult to distinguish locally from the lower portion of the 180-foot aquifer. Well MW-BW-03-400 appears to be screened primarily in the ~~transition-between~~ lower portion of the 180-foot aquifer. As a consequence, data from this well ~~may be influenced by~~ are considered to represent conditions in the 180-foot aquifer.

Water levels in the "Aromas" portion of the 400-foot aquifer (near MW-OU2-06-400) are approximately equivalent to those of the 180-foot aquifer. Water levels in the "Paso Robles" portion of the 400-foot aquifer (near FO-29) are difficult to compare to those of the overlying 180-foot aquifer due to pumping effects from the Fort Ord supply wells.

Subsurface flow from the Salinas Valley and Monterey Bay contribute much of the recharge to the 400-foot aquifer. Subsurface flow from the Paso Robles Formation from the southeastern base area into the 400-foot aquifer beneath the Main Garrison and the Fort Ord supply wells may also contribute to recharge. In addition, poor hydraulic separation between the 400-foot and overlying 180-foot aquifer indicates the 180-foot aquifer potentially provides some recharge to the 400-foot aquifer.

4.1.4.4 900-Foot Aquifer

The 900-foot aquifer is penetrated by several of the Marina supply wells at a depth of approximately 1,000 feet. Available geologic and groundwater information is generally insufficient to characterize this aquifer; however, descriptions from drillers' logs and downhole geophysical logs suggest this confined aquifer is a gently dipping, approximately 100-foot-thick zone of bedded sand and gravel within a predominantly clayey sequence. The presence of shells in well Marina 10 suggests that the aquifer is within marine sediments possibly associated with the Paso Robles Formation or Pliocene deposits such as the Pancho Rico or Purisima Formations.

4.1.4.5 Aquifers of the Southeast Base Area

In the southeast base area, south of the Valley fill deposit contact (Plate 3) the typical aquifer sequence recognized in the Salinas Valley and in the Main Garrison area of Fort Ord is not present. In this portion of the base, the aquifers are described by their geologic names, such as the Aromas Sand and Paso Robles Formation, as shown at the southeast end of cross section C-C' (Plate 6).

4.2 Hydrogeology

Groundwater flow within and between each of the Salinas basin aquifer units is influenced by several factors, including the thickness and geometry of the aquifer and

aquitard/aquiclude units, the spatial variability of the aquifer permeabilities, and locations and magnitudes of groundwater recharge and discharge. This section describes the groundwater flow, including groundwater/surface water interaction, and hydraulic parameter data collected as a part of the basewide field program. Historical groundwater data from wells within and adjacent to the Salinas basin are also presented.

4.2.1 Present Groundwater Flow Conditions

Groundwater elevation data obtained during January, February, May, and July 1992 (Table 2) were plotted and contoured to assess the rates and directions of groundwater flow in and between the A-, 180-foot, and 400-foot aquifers. Comparison of these data indicated the groundwater elevations and flow patterns during the four monthly monitoring periods did not change significantly. Therefore, water-level maps for each aquifer are presented only for July 1992, a representative period. Plates 10 through 13 present contour maps of the July 1992 groundwater elevation data for the A-, 180-foot, and 400-foot aquifers. September 1992 groundwater elevations measured at the Fort Ord water supply Wells FO-29, FO-31, and FO-32 were used to approximate the July 1992 conditions in constructing the contour maps. No 900-foot aquifer wells were measured during July 1992.

4.2.1.1 A-Aquifer

The A-aquifer consists of saturated older dune sand in which groundwater is unconfined and perched over the FO-SVA. Comparison of Plate 8 with the groundwater contours (Plate 10) indicates that flow in the A-aquifer generally conforms to the configuration of the top surface of the FO-SVA. TCE plume distribution (see Section 4.4.2.1) indicates that contaminant distribution is consistent with flow direction,

and that plume movement may be influenced by local variations in groundwater flow related to the FO-SVA surface configuration.

The water-level data for the A-aquifer (Plate 10) indicate that in the OU2 landfill-Main Garrison area, the primary hydraulic gradient direction is west to northwest. There is an apparent north-south groundwater divide coincident with the east edge of the OU2 landfill (Plate 10), where groundwater flow appears to diverge to either the northwest or northeast. The hydraulic gradient in the A-aquifer steepens near the western limit of the FO-SVA. This increased gradient illustrates that groundwater is accelerating or "cascading" off the edge of the FO-SVA and into the 180-foot aquifer. The hydraulic gradient during July 1992 was approximately 0.06 ft/ft to the west between well MW-OU2-04-A and the FO-SVA pinchout. Elsewhere the hydraulic gradients in the A-aquifer are approximately an order of magnitude less than near the FO-SVA pinchout.

Between the East Garrison and FAAF, groundwater in the A-aquifer flows to the northeast. However, water-level data in this area are limited to few widely spaced wells. Localized areas of seepage are present in the bluffs bordering the Salinas Valley. Bluff seepage indicates that surface discharge from the A-aquifer is occurring. The FO-SVA pinchout in the East Garrison area (shown on cross section B-B' [Plate 6]) indicates a potential for flow from the A-aquifer to enter the 180-foot aquifer along the edge of the FO-SVA in that area.

The FO-SVA is absent in the western Main Garrison and Main Gate areas. In these areas, the A- and 180-foot aquifers are considered to behave as a combined aquifer and are discussed in this report as part of the 180-foot aquifer.

The saturated thickness of the A-aquifer is presented on Plate 11. The saturated thickness of the unconfined A-aquifer during July 1992 ranged up to approximately 50 feet, with a typical saturated thickness of approximately 20 feet. Comparison of Plate 11 to Plate 8 suggests that the areas of greatest saturated thickness are associated with low areas in the FO-SVA.

4.2.1.2 180-Foot Aquifer

As described in Section 4.1, the 180-foot aquifer beneath the FO-SVA is composed of sands and gravels occasionally interbedded with silts and clays. Sand predominates in the upper portion of the aquifer, gravel in the lower portion. As shown on Plate 12, the primary flow direction is eastward, toward the Fort Ord water-supply wells, with a slight groundwater mound in the unconfined portion of the aquifer between Highway 1 and the Main Garrison. Water levels in the 180-foot aquifer ranged from several feet above sea level west of the Main Garrison to 30 feet below sea level near supply well FO-31. The horizontal component of the hydraulic gradient varies from approximately 0.006 ft/ft in the Main Garrison area to 0.0006 ft/ft southeast of Marina.

Wells MW-30-01-A, MW-32-01-A, MW-32-02-A, and MW-32-03-A appear to be screened in the Aromas Sand/Paso Robles aquifers; consequently, water levels in these wells are not used to correlate the A- or 180-foot aquifers. The 180-foot aquifer groundwater levels include those measured during September 1, 1992, in active Fort Ord water-supply wells FO-29 and FO-31, and in inactive water-supply well FO-32. Well FO-29 is screened in both the 180-foot and 400-foot aquifers and FO-32 appears to include a small portion of the 400-foot aquifer. Groundwater elevations in wells FO-29 and FO-32 cannot be considered

representative solely of either the 180- or 400-foot aquifer; rather, they are considered a combined water level.

As discussed in Section 4.3, historical groundwater production from 180-foot aquifer wells in Marina has resulted in seawater intrusion and subsequent abandonment of the Marina production wells in the 180-foot aquifer. Groundwater elevations in Wells MW-B-13-180 and MW-OU2-07-180 during July 1992 were slightly higher than those recorded in 1983 when production was occurring (*GTC, 1984*). More significant, the gradient appears to have reversed from the northwest in 1983 to the southeast currently.

In areas where the FO-SVA is absent, such as near the coastline and in the area of the East Garrison, the uppermost A- and 180-foot aquifers are considered to act as a combined unconfined aquifer. West of the FO-SVA pinchout, a sandy clay was encountered during installation of Piezometers PZ-02-01-180-U, -M, -L and PZ-12-01-180-U, -M, -L, suggesting a degree of separation between shallow and deeper groundwater in the 180-foot aquifer at the sites. Water-level information from Site 12 piezometers (PZ-12-01-180-U, -M, and -L) indicates that a significant downward-vertical-gradient (0.17 ft/ft) head difference exists across the clayey sand unit in this area, suggesting. This suggests that it constrains the sandy clay acts as an aquitard within the 180-foot aquifer, impeding the vertical movement of groundwater flow. However, for these preliminary evaluations it was assumed that water levels west of the FO-SVA pinchout represent a combined, unconfined aquifer. Water levels from this area indicate a subdued groundwater mound centered near Site 12 as shown on Plate 12. The source of the mound is uncertain but is tentatively attributed to irrigation

at the Main Garrison. This interpretation indicates divergent flow west from Site 12 (Plate 12) and eastward beneath the FO-SVA.

Near the Main Gate and the basin boundary, the FO-SVA is also absent, and the 180-foot aquifer is considered to be a combined, unconfined aquifer. Groundwater flow in the 180-foot aquifer is toward the north or ~~northwest~~northeast in this area, away from the bedrock high that is presumed to form the Salinas-Seaside basin boundary. The hydraulic gradient in this area during July 1992 was approximately 0.0015 ft/ft.

The 180-foot aquifer is locally unconfined beneath the FO-SVA. Comparison of water levels with the bottom of the FO-SVA, as shown on cross sections A-A' and B-B' (Plate 6), indicate that the 180-foot aquifer is locally unconfined near the southern basin boundary, near Site 10, and east of the OU2 landfill.

The saturated thickness of the 180-foot aquifer is considered equal to the thickness of saturated sand and gravel comprising the 180-foot aquifer from the top of the 400-foot aquifer to the base of the FO-SVA. The saturated thickness of the 180-foot aquifer during July 1992 ranged from approximately 100 to 300 feet.

4.2.1.3 400-Foot Aquifer

Groundwater contours for the 400-foot aquifer are based on relatively few wells as shown on Plate 13. The horizontal component of the hydraulic gradient between well MW-OU2-09-400 and the Fort Ord supply wells was approximately 0.002 ft/ft toward the east to northeast during July 1992.

The degree of hydraulic continuity between the various portions of the 400-foot aquifer is uncertain. The potential that the 400-foot aquifer includes both the Aromas Sand and Paso Robles Formation makes comparison of water levels between these

portions of the 400-foot aquifer somewhat tenuous. Further, due to an absence of marker beds within the Paso Robles, it is difficult to ascertain the degree of hydraulic continuity within the Paso Robles portions of the 400-foot aquifer.

4.2.1.4 Vertical Flow

Plate 14 shows the differences in hydraulic head during July 1992 between the A- and the 180-foot aquifers. Of note are the downward gradients associated with the perched A-aquifer. The maximum difference in hydraulic head between the A- and 180-foot aquifers during July 1992 was approximately 100 feet in the area southeast of the OU2 landfill. In this area, the 180-foot aquifer is locally unconfined, and the A-aquifer has a thin saturated thickness. The difference in hydraulic head generally lessens to the north where the FO-SVA approaches sea level elevation, and east and west, near the FO-SVA pinchout. These data support the concept that divergent regional A-aquifer flow occurs above the FO-SVA, with A-aquifer groundwater descending off the FO-SVA and recharging the 180-foot aquifer.

Plate 15 presents the differences in hydraulic head during July 1992 between the 180- and 400-foot aquifers. In areas where very little if any aquitard material separates the 180- and 400-foot aquifers such as near the OU2 landfill, only very minor head differences were measured. However, in the area of the Fort Ord supply wells, where there is hydraulic separation between the 180- and 400-foot aquifers and pumping is occurring from these aquifers, there are measurable downward gradients from the 180- to the 400-foot aquifer. Further, the presence of clay beds in the 180-foot aquifer near the pumping wells could contribute to downward vertical gradients within the 180-foot aquifer.

No historical 900-foot aquifer hydraulic head information was available to estimate vertical gradients between the 400- and 900-foot aquifers. However, the relatively thick clay beds separating these aquifers suggest hydraulic communication between them is very low.

4.2.1.5 Groundwater/Surface Water Interactions

4.2.1.5.1 Tidal Influence

As a part of the site-specific investigation at Sites 2 and 12, a study was performed to determine the influence of tidal fluctuations on groundwater flow. The study was performed between 2:00 p.m. on December 20 and 4:00 p.m. on December 23, 1991. Groundwater elevation data were collected continuously from three Site 2 wells (MW-02-01-180, MW-02-02-180, and MW-02-03-180) and two Site 12 wells (MW-12-01-180 and MW-12-02-180). These five wells monitor the unconfined portion of the uppermost aquifer, and are located approximately 1,500, 800, 1,000, 2,900, and 3,000 feet from the Monterey Bay shoreline, respectively (Plate 5).

Plate 16 shows the tidal record in Monterey Bay during the study period and the water-level fluctuations in the five wells. Six tidal cycles occurred over the study period, with a maximum tidal fluctuation in Monterey Bay of approximately 8 feet.

The largest tidal effect was observed in well MW-02-02-180, located approximately 800 feet from the Monterey Bay shoreline, where a maximum tidal change of approximately 0.50 foot was observed (Plate 16). A phase lag of approximately 6 hours (the time difference between tidal highs observed in the bay and the well) was observed. In well MW-02-03-180, located approximately 1,000 feet from the bay, a tidal change of approximately 0.25 foot, with a phase lag of approximately 8 hours, was observed during the study period. In well

MW-02-01-180, approximately 1,500 feet from the bay, a minimal tidal change of approximately 0.05 foot was observed. Site 12 Wells MW-12-01-180 and MW-12-02-180 did not show significant tidal fluctuations. These data suggest that, in the Salinas basin, the groundwater levels adjacent to the coast (west of Highway 1) in the unconfined aquifer are affected by tidal fluctuations, but the tidal fluctuations diminish to an insignificant level within Site 12 (east of Highway 1).

The tidal study results were also used to determine a net groundwater flow direction in the area of Sites 2 and 12. The average (arithmetic mean) groundwater elevations measured in the five wells over the 3-day study period were 4.02, 4.17, 3.83, 3.98, and 3.90 for wells MW-02-01-180, MW-02-02-180, MW-02-03-180, MW-12-01-180 and MW-12-02-180, respectively. Analyses of these time-averaged groundwater elevations indicates the net or resultant flow direction at Site 2 was toward the south, while the net or resultant flow direction at Site 12 was to the east. These flow directions are inconsistent with the regional west-southwest flows at Sites 2 and 12. The direction of the tidal flows is based on small head differences during periods of high tidal fluctuation. Groundwater flow directions under extreme tidal conditions are not considered to represent regional conditions.

4.2.1.5.2 Salinas River Interactions

Analysis of limited groundwater elevation data near the Salinas River and review of published water levels from the aquifers beneath the Salinas Valley indicate that the Salinas River is not gaining water from the aquifer system. Since river stage elevations are above sea level, and head levels in the 180-foot aquifer are commonly below sea level, the potential for flow from the river to the 180-foot aquifer groundwater aquifer exists. However, recharge from the Salinas River to all aquifers except the shallow

alluvial sediments of the Salinas Valley is probably minor due to the presence of the SVA throughout the valley area.

4.2.2 Hydraulic Parameters

Aquifer test data were obtained as part of this investigation from a variety of sources including unpublished consultant reports, water purveyors, and regulatory agencies. The test results from the literature were tabulated and are presented in Tables 5, 6, and 7. Aquifer parameters were estimated from the results of three test types: slug tests, specific capacity or single-well tests, and constant-rate pumping tests.

For each reported test, the well construction record was reviewed, and the aquifer tests were categorized into unreliable and reliable aquifer test data. The two criteria used to evaluate the reliability of the tests were (1) whether or not well construction details were available, and (2) whether the well was completed with a single or multiple screened intervals. Aquifer test data were deemed unreliable if they were from a well without documented construction details and/or from a well with multiple screened intervals completed in two or more distinct aquifers. However, aquifer tests of wells completed in both the 180- and 400-foot aquifers were judged reliable where there was no confining layer between the aquifer units. Test results judged unreliable are presented in the tables for the sake of completeness but are not included in the calculation of mean hydraulic parameters.

4.2.2.1 Aquifer Test Descriptions

A total of 42 slug tests, 30 specific capacity tests, and 4 constant-rate pumping tests were judged reliable for the Salinas basin; the results are presented in Tables 5, 6, and 7, respectively. Table 8 summarizes the ranges and average hydraulic conductivities calculated from the reliable data for each of the tests, presented by basin and aquifer.

Transmissivity values were calculated for the specific capacity and constant-rate pumping tests performed. To account for partial aquifer penetration of some wells, and as a means of normalizing transmissivity data for the variable aquifer thicknesses, hydraulic conductivities were calculated from the transmissivity data by dividing the transmissivity by the length of saturated well screen for each well. Hydraulic conductivity values were not calculated for any test results that were judged unreliable. Hydraulic conductivity values were calculated directly during the analysis of the slug test data. It should be noted that well tests, although considered a reliable method to assess aquifer parameters, provide average values of the various strata penetrated by the well. Actual parameters for discrete strata within a test interval can vary considerably from the composite value obtained for the entire test interval.

4.2.2.1.1 Slug Tests

Slug tests, generally performed on low-yield wells, are performed by either adding (slug-in) or removing (slug-out) a known volume to a well and then monitoring the response of the aquifer to the induced water-level change. These data can be used to assess the transmissivity (T) and hydraulic conductivity (K) but not the storage coefficient (S) of an aquifer in the vicinity of the well. Aquifer properties determined from slug tests are generally considered accurate to within an order of magnitude.

Table 5 lists the slug test results.

4.2.2.1.2 Production Tests

Whereas slug tests provide transmissivity and hydraulic conductivity values representative of a relatively small volume of aquifer material in the immediate vicinity of a well, production tests yield transmissivity and hydraulic conductivity values representative of a considerably larger volume of the aquifer. In previous studies, two

types of production tests have been performed on Salinas basin wells, specific-capacity tests and constant-rate tests.

Specific capacity, or single-well production tests, involve pumping a well at a known flow rate and monitoring the water-level drawdown in the pumping well. Specific capacity is defined as the flow rate divided by the drawdown in the well, and is typically reported in units of gallons per minute per foot of drawdown (gpm/ft). T and K values estimated from specific capacity tests are generally considered more representative than slug tests; however, head losses across the gravel pack and well screen can result in underestimation of true aquifer permeabilities. The majority of the available aquifer production test data in the Salinas basin are from specific capacity tests.

For this report, transmissivity values were calculated from the specific capacity data by using a method outlined by Driscoll (1986). For confined aquifers, the specific capacity values in gpm/ft are converted to transmissivity in gallons per day (gpd)/ft by multiplying by 2,000. For unconfined aquifers, the specific capacity values in gpm/ft are multiplied by 1,500 to yield transmissivity in gpd/ft (Driscoll, 1986). Table 6 lists the specific capacity test results.

Constant-rate pumping tests generally provide the best estimate of an aquifer's hydraulic properties, due to the use of observation wells for analysis. Observation wells allow observation of the aquifer behavior without the effects of well loss encountered during specific capacity tests. In addition to transmissivity and hydraulic conductivity, storativity data can also be obtained. Table 7 lists the results of the constant rate pumping tests.

The units used in this analysis were gpm/ft for specific capacity, gpd/ft for transmissivity, gallons per day per square foot (gpd/ft²) for hydraulic conductivity, and dimensionless for storativity or storage coefficient.

The following sections discuss the parameters estimated for the various aquifers as calculated from slug tests, specific capacity tests, and constant-rate aquifer tests performed on wells in the Salinas basin. The test results are summarized in Table 8.

4.2.2.2 A-Aquifer Parameters

Hydraulic conductivity calculated from 13 slug tests ranged from 29 to 711 gpd/ft² with a mean of 305 gpd/ft². Two constant-rate tests performed in the A-aquifer (Wells MW-OU1-07-A and MW-OU2-05-A) resulted in hydraulic conductivities of 20 and 307 gpd/ft². The mean hydraulic conductivity from the combined test types was 286 gpd/ft² (38.2 feet/day).

Storage coefficients calculated from the two constant-rate tests were 0.24 and 0.0082 for Wells MW-OU1-07-A and MW-OU2-05-A, respectively. The 0.24 value from well MW-OU1-07-A is based on drawdown in a discharging well and is therefore considered less reliable than the 0.0082 value from well MW-OU2-05-A. The storage coefficient of 0.0082 is low for an unconfined aquifer and suggests that the A-aquifer may behave as a semi-confined aquifer in the vicinity of well MW-OU2-05-A.

4.2.2.3 180-Foot Aquifer Parameters

Hydraulic conductivities were calculated from 29 slug tests and 22 specific capacity tests. The hydraulic conductivities calculated from the slug tests ranged from 0.3 to 2,326 gpd/ft² with a mean value of 291 gpd/ft². Hydraulic conductivities

calculated from specific capacity tests ranged from 225 to 4,660 gpd/ft². The combined mean hydraulic conductivity was 673 gpd/ft² (90 feet/day).

4.2.2.4 Combined 180-/400-Foot Aquifer Parameters

Three specific capacity tests were performed on wells completed in both the 180- and 400-foot aquifers (Table 8). Specific capacity tests for wells completed in both of these aquifers are considered to provide only general aquifer permeability information. The mean hydraulic conductivity for the three tests is 924 gpd/ft².

4.2.2.5 400-Foot Aquifer Parameters

A single constant-rate pumping test was available to calculate parameters for the 400-foot aquifer. Test results from well Marina 09 produced a hydraulic conductivity of 105 gpd/ft² and a storage coefficient of 0.0042.

4.2.2.6 900-Foot Aquifer Parameters

Hydraulic conductivities in the 900-foot aquifer were calculated from four specific capacity tests and one constant-rate test. The specific capacity test results are listed in Table 7 and the constant-rate test is presented in Hydrocomp (1985). Hydraulic conductivities based on the five tests ranged from 26 to 270 gpd/ft² with a mean value of 79 gpd/ft². The storage coefficient calculated from the single constant-rate test was 0.00155.

4.2.2.7 Spatial Trends in PermeabilityHydraulic Conductivity

The areal distributions of hydraulic conductivities for A-, 180-, and 400-foot aquifers are illustrated in Plates 17 through 19. In the A-aquifer, hydraulic conductivities appear to be significantly higher in the OU2 landfill and Main Garrison areas than in the FAAF and East Garrison areas.

Hydraulic conductivities in the 180-foot aquifer appear to be higher in the northern Main Garrison near the city of Marina southeastern boundary than in the southern Main Garrison area.

The 400-foot aquifer data are considered insufficient to develop conclusions about the spatial distribution of ~~permeability~~hydraulic conductivity.

4.3 Groundwater Production

This section discusses historical and current groundwater production in portions of the Salinas basin in and adjacent to Fort Ord, as well as water-level trends resulting from this production. Groundwater is currently produced from wells at Fort Ord, in the city of Marina, and in the Salinas Valley.

Three groups of water users or purveyors were identified within and immediately adjacent to the Salinas basin portion of Fort Ord; these include Fort Ord, the Marina County Water District, and private, domestic and irrigation well owners in the Salinas Valley. The locations of onbase production wells and selected wells immediately adjacent to the base are shown on Plate 5. Annual production totals for 1980 through 1991 for the Fort Ord and the Marina County Water District wells are summarized in Table 9. For each active well, 1991 production data are presented in Table 10. Additional information for each of the water users is provided below.

A relatively long historical record of groundwater elevation data is available for wells in the Salinas Valley. The historical record dates to the 1910s, when groundwater production was first documented in the Salinas Valley/Castroville area, and the 1940s in the Fort Ord area. In addition, maps of groundwater elevations in the 180- and 400-foot aquifers have been developed for the following periods: 1944 (*DPW, 1946a, b*); 1961 (*Todd, 1961*); 1968 (*GTC, 1984*); 1972 (*DWR, 1973*); 1976, 1979, and 1983

(GTC, 1984; Leedshill-Herkenhoff, 1985); and 1984 (GTC, 1984; MCWRA, 1993).

Typically, the groundwater maps developed over the years show groundwater elevations in the 180-foot aquifer, and reflect the effects of production wells at Fort Ord, the Marina County Water District, and the numerous agricultural, industrial, and private wells in the Salinas Valley. DPW (1946a, b) presented the first discussion of overproduction and the resulting drawdown and seawater intrusion in the Castroville area. In the Fort Ord area, overproduction, excessive drawdown, and seawater intrusion were first observed in the 1960s (GTC, 1984). These conditions have apparently persisted to the present.

4.3.1 Fort Ord Wells

4.3.1.1 Historical Groundwater Production

A detailed discussion of the history of groundwater production at Fort Ord through 1984 is presented in GTC (1984), and is summarized here. Early groundwater production at Fort Ord, although poorly documented, apparently began in the 1920s or 1930s. Five wells (Wells FO-01, FO-04, and FO-05; also known as Gigling, Huffman, and Barloy, respectively) and EG-02 and EG-03 were put into use in the 1930s. Eleven additional wells (FO-06, FO-07A, FO-07B, FO-08, FO-09, FO-10, FO-11, FO-12, FO-14, FO-16, and FO-17), located in the Main Garrison area, were drilled in the 1940s. Around 1950, production ceased in wells FO-06 through FO-10 and in FO-12 because of sanding problems. By 1951, the water supply at Fort Ord was obtained solely from wells FO-11, FO-14, FO-16, and FO-17, centered around the Main Garrison area. Due to increasing water demand, five additional wells (FO-18, FO-19, FO-21, FO-22, and FO-23) were installed just south of Marina in 1952. In the 1960s, wells FO-24 through FO-28, Beach, and Airfield were installed east of

Marina. In 1984, wells FO-29 through FO-32 were installed in the East Garrison area. The historical sequence of well installation and well location was largely related to seawater intrusion. The early production was from wells in the Main Garrison area, but as seawater intrusion advanced inland, wells were located further east.

Table 9 presents the annual production data from 1980 to 1991 for Fort Ord water-supply wells. Groundwater production at Fort Ord between 1985 and 1991 was relatively constant, ranging from 1,522 to 1,853 million gallons. The maximum recorded annual groundwater production at Fort Ord occurred in 1984.

4.3.1.2 Current Groundwater Production

Fort Ord currently produces water from only three water-supply wells (FO-29 through FO-31), located in the East Garrison area (Plate 5). Wells FO-29 and FO-30 are completed in the 180- and 400-foot aquifers; well FO-31 is completed in the 180-foot aquifer. Table 10 presents the total 1991 annual production for each of the current water supply wells.

4.3.2 Marina County Water District Wells

The Marina County Water District currently operates four production wells: Marina 09, 10, 11, and 12 (Plate 5). Marina 09, 10, and 11 are located along the eastern edge of Marina, while Marina 12 is located at the northern edge of Marina (Plate 5). Marina 09 is completed in the 400-foot aquifer, and Marina 10, 11, and 12 are screened in the 900-foot aquifer. Additional wells have been historically operated by the Marina County Water District, but were abandoned due to water quality problems related to seawater intrusion. Most of these wells were completed in the 180-foot aquifer.

Table 9 presents the total annual production from Marina County Water District supply wells from 1987 to 1991; prior production records were not available. Table 10 presents the total 1991 production for each of the wells.

4.3.3 Private, Domestic, and Agricultural Wells

Significant volumes of groundwater are produced from private, domestic, and agricultural wells in the Salinas Valley. Groundwater production from these private wells is regulated by the Monterey County Water Resources Agency. However, specific data regarding these wells were not obtained for this study.

4.3.4 Water-Level Trends

Historically, water levels in the 180-foot aquifer have responded to pumping. Water-level contour maps by GTC (1984) from 1970 through 1983 portray a groundwater trough aligned approximately with the eastern boundary of Marina near the pumping wells. The base of the trough was at approximately -20 feet MSL.

Since 1984, pumping from the 180-foot aquifer has shifted from the Marina area to the Fort Ord supply wells in the East Garrison. As a result, the former trough has disappeared and 180-foot aquifer water levels near Marina have recovered slightly from -20 feet MSL to approximately -14 feet MSL. Although water levels at Marina appear to have recovered somewhat, they have declined east of Marina. Now there is an eastward gradient from Marina toward the current pumping centers near the East Garrison (Plate 12).

Historical water-level data from the 400-foot aquifer are limited; consequently, definitive trends are difficult to assess. A 1984 water-level contour map by GTC indicates water levels as low as -70 feet MSL in Marina and the Main Garrison areas with gradients toward the west. Currently, 400-foot aquifer water levels are at -14

MSL near Marina with an eastward gradient to approximately -30 feet MSL near the Fort Ord supply wells (Plate 13).

4.4 Groundwater Geochemistry

This section presents the groundwater chemical data collected for the Salinas basin during the Fort Ord basewide site investigations. Analytical results are presented in Section 4.4.1, site activities potentially affecting the groundwater chemistry are discussed in Section 4.4.2, and wells representing non-affected (background) conditions are presented in Section 4.4.3.

4.4.1 Salinas Basin Groundwater Chemistry Results

This section presents the results of the groundwater chemical analysis for organic compounds, priority pollutant metals, and general inorganic parameters for the A-, 180-, 400-, and 900-foot aquifers. Complete analytical results obtained during the basewide investigation are provided in Appendix C. Complete analytical results obtained during the investigations of sites 1, 2, 10, 12, 14, 16, 17, 18, 20, 22, 23, 24, 30, 32, and 36 can be found in the site investigation reports, which are currently in preparation.

4.4.1.1 Organic Compounds

The organic compounds detected in groundwater samples in the Salinas basin during the basewide and site-specific investigations are presented in Tables 11 through 14. The organic compounds detected during the Dames and Moore June 1992 sampling round at OU2 are presented in Appendix F and are summarized in Table 15. Part "a" of each table summarizes the results. The following chemicals have been detected in groundwater in the Salinas basin: bromodichloromethane (BDCM), bromoform, carbon disulfide, carbon tetrachloride, chlorobenzene, chloroform, dibromochloromethane (DBCM), 1,2-dichlorobenzene (DCB), 1,4-DCB,

1,1-dichloroethene (DCE), cis- and trans-1,2-DCE, 1,1-dichloroethane (DCA), 1,2-DCA, 1,2-dichloropropane (DCP), tetrachloroethene (PCE), 1,1,1-trichloroethane (TCA), trichloroethene (TCE), trichlorofluoromethane (TCF), benzene, toluene, xylenes, vinyl chloride, and several tentatively identified compounds (TICs).

Laboratory contamination by methylene chloride, acetone, and bis(2-ethylhexyl)phthalate was observed in laboratory blanks and environmental samples. Therefore, these chemicals are not included in the above results. A detailed discussion of laboratory contamination is in Appendix E.

4.4.1.2 Priority Pollutant Metals

The priority pollutant metals detected in groundwater samples in the Salinas basin are presented in Tables 16 through 19. Part "a" of each table summarizes the results. The following metals were detected: antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc.

These results were compared to federal maximum contaminant levels (MCLs) (EPA, 1992h). Antimony, cadmium, chromium, nickel, and thallium exceeded MCLs in some samples (Table 20). However, most of these metals were detected only once in a given well during multiple sampling and analysis rounds, resulting in a low degree of confidence regarding the presence and concentration of these metals in groundwater.

Antimony was detected in three A-aquifer wells, five 180-foot aquifer wells, one 400-foot aquifer well, and one 900-foot aquifer well by EPA Test Method 6010. The EPA Method 6010 detection limit for antimony in groundwater is estimated to be 32 micrograms per liter ($\mu\text{g/l}$; EPA, 1986c), which is above the proposed federal MCL of 6 $\mu\text{g/l}$. Therefore, whenever antimony is detected by this method, the MCL is exceeded. The range of detected values for antimony was 26.4 to 46.9 $\mu\text{g/l}$, and the detected

occurrence of antimony was not confirmed during multiple sampling and analysis rounds at any of the wells. Antimony was detected during the last sampling round at the Wil Ranch and Marina 10 wells; its presence should be evaluated with additional sampling and analysis.

Cadmium was detected in one A-aquifer well and five 180-foot aquifer wells at concentrations ranging from 2.9 to 12.1 $\mu\text{g/l}$. The federal MCL is 5 $\mu\text{g/l}$. The detected occurrence of cadmium not been confirmed during multiple sampling and analysis rounds at any of the wells except MW-14-02-A. Cadmium was detected in this well during three sampling rounds and exceeded the MCL with a concentration of 5.9 $\mu\text{g/l}$ during one round. Cadmium was detected at concentrations exceeding the MCL during the last sampling round at wells MW-02-07-180 and MW-14-03-180 and the presence of cadmium exceeding the MCL at these locations should be confirmed by additional sampling and analysis.

Chromium was detected once above the federal MCL of 50 $\mu\text{g/l}$ in the 180-foot aquifer well MW-02-03-180 at 343 $\mu\text{g/l}$; this was in the last of three sampling and analysis rounds. The relatively high metals concentrations observed in the third sampling event compared to the two previous events at this well may be related to seawater intrusion.

Thallium was detected in three 180-foot aquifer wells ranging from 2 to 9 $\mu\text{g/l}$; the federal MCL is 2 $\mu\text{g/l}$. The presence of thallium has not been confirmed during multiple sampling and analysis rounds. Thallium was detected during the last of three sampling rounds at wells MW-24-02-180 and MW-30-01-180 and the first of three rounds at MW-02-02-180; additional sampling and analysis should be conducted to assess its presence in these wells.

Nickel was detected at concentrations exceeding the federal MCL of 100 $\mu\text{g/l}$ in four A-aquifer wells and twelve 180-foot aquifer wells. Inspection of well construction details for all these wells indicated that they were constructed of stainless steel well screens in combination with either PVC or steel casing. Nickel was detected in 26 of the 30 wells constructed from stainless steel and only twice in wells constructed of PVC. Nickel is a common constituent of stainless steel, and stainless steel well screens have been documented as a source of nickel in groundwater samples (Hewitt, 1992; Parder *et al.*, 1990). Therefore, the presence of nickel was not considered to represent groundwater contamination.

4.4.1.3 General Inorganic Parameters

The detected inorganic parameter results from groundwater in the Salinas basin from the A-, 180-, 400-, and 900-foot aquifers are presented in Tables 21 through 24. Part "a" of each table summarizes the results. The inorganic parameters reviewed during this investigation include major cation and anion concentrations, TDS, and pH. This information was used to aid in interpreting aquifer relationships and flow conditions, and to classify the chemical nature of the groundwater.

The pertinent results are graphically presented on trilinear Piper diagrams (Plates 20 through 23) and Stiff diagrams (Plates 24 through 26). A Piper diagram permits the major anion and cation composition of a water sample to be plotted as a single point on the diagram. All of the water samples from an aquifer are posted on a single Piper diagram from which chemical groupings and trends can be discerned visually. A thorough description of the techniques used for creating and interpreting Piper diagrams can be found in the hydrogeologic literature (Freeze and Cherry, 1979;

Davis and DeWeist, 1967) A Stiff diagram allows visual inspection of the major ion chemistry results from wells in relationship to their location and to each other.

During the preparation of the diagrams, a charge balance error (relative percent difference) between the positive ions and the negative ions was calculated for each sample to evaluate the accuracy of the analytical data. If the charge balance error between positive and negative ions exceeded 15 percent, the results for a sample were considered unreliable and were not used. Missing or anomalous alkalinity data were the most common reasons for charge imbalances. Cation data were generally not available for the OU2 wells, precluding the posting of any OU2 data on either the Stiff or Piper diagrams.

In addition to the Piper and Stiff diagrams, TDS and chloride isoconcentration maps were generated as shown on Plates 27 through 32. Chloride concentration can be a useful indicator of seawater intrusion.

4.4.1.3.1 A-Aquifer

Groundwater in the A-aquifer underlying Fort Ord can be characterized as a sodium-chloride-type water on the basis of the Piper diagram (Plate 20; *Davis and DeWeist, 1967*). The general shape of the Stiff diagrams (Plate 24) also indicates that the A-aquifer groundwater underlying the FAAF is similar to that occurring in the southern portion of the A-aquifer (south and upgradient of the OU2 landfill area), with similar proportions of cations and anions. However, the Stiff diagrams in the FAAF area are narrower than those from the southern portion of the A-aquifer, reflecting the lower TDS concentrations observed in FAAF area (Plate 27). The relatively low TDS observed in the FAAF A-aquifer wells suggests that the source of groundwater in this area is slightly different than that of the Main Garrison Area. The lower

FAAF A-aquifer TDS could be due to mineralogical differences between the older dune sands comprising the aquifers in the two areas, or the result of different groundwater residence times and/or travel paths within the A-aquifer.

4.4.1.3.2 180-Foot Aquifer

The inorganic groundwater chemistry in the unconfined portion of the 180-foot aquifer west of the FO-SVA and in the vicinity of Sites 10 and 20 is very similar to that of the A-aquifer (Plates 21 and 25). This similarity suggests that the groundwater in these two areas came from either the same or similar sources. Both areas are recharged from precipitation infiltrating through relatively homogeneous near-surface geologic materials. The 180-foot aquifer west of the FO-SVA receives recharge from surficial infiltration and from the A-aquifer system.

The area on Plate 2521 designated by the slanted lines represents literature-reported water quality for the 180-foot aquifer in the Salinas Valley (DKT, 1989). It is apparent from the Piper diagram that the water quality of the 180-foot aquifer beneath Fort Ord is distinct from the water quality of the 180-foot aquifer in the Salinas Valley. The water samples from the 180-foot aquifer beneath Fort Ord contain a larger proportion of sodium and chloride than those representative of the 180-foot aquifer beneath the Salinas Valley. The similarity between the A- and the 180-foot aquifer beneath Fort Ord and the dissimilarity between the 180-foot in the Salinas Valley with that of the 180-foot beneath Fort Ord supports the interpretation that water from the A-aquifer contributes to recharge of the 180-foot aquifer beneath Fort Ord. This is considered to be a result of the discontinuous presence of the FO-SVA beneath Fort Ord, which provides localized pathways from the A-aquifer into the 180-foot aquifer.

4.4.1.3.3 400-Foot Aquifer

The inorganic groundwater chemistry in the 400-foot aquifer beneath Fort Ord is distinctly different than that of the overlying A- and 180-foot aquifers (Plates 24-26). The dominant anion and cation in the 400-foot aquifer groundwater are bicarbonate and calcium, respectively. Exceptions to this generalization are well Marina 09, which has chloride as the dominant anion, and wells Cal Water 39 and MW-BW-03-400 (which is screened predominantly in the gravels of the 180-foot aquifer), which have sodium as the dominant cation. The elevated chloride content observed in well Marina 09 appears to be due to seawater intrusion.

The water quality for ~~the~~ Fort Ord water supply wells FO-17, FO-19, ~~FO-24~~,-- FO-28, FO-30, FO-31, and FO-32 is plotted on Plates 21 and 22 using 1985 data provided by the Army (*Fort Ord, 1992b*). With the exception of FO-31, which is screened in the lower portion of the 180-foot aquifer, these Fort Ord wells are screened in both the 180- and the 400-foot aquifers and appear to be more related to the water chemistry of the 400-foot aquifer than to the 180-foot aquifer. The water quality of the 400-foot aquifer Fort Ord water supply wells is very similar to that from the Salinas Valley (Grainger Farm, Panziera Ranch, Wil Ranch, Cal Water 33, and Cal Water 40). This relationship suggests that the 400-foot aquifer contributes much of the water to the Fort Ord wells screened in both the 180- and 400-foot aquifers. Alternatively, water quality in the gravels of the 180-foot aquifer and the 400-foot aquifer may be similar in the vicinity of the Fort Ord supply wells. FO-31 is screened in the gravels of the 180-foot aquifer and its water quality is similar to FO wells screened in both the 180-foot and 400-foot aquifers.

4.4.2 Areas Where Site Activities Affect Groundwater Chemistry

Sites in the Salinas basin where the groundwater quality has been affected by activities at Fort Ord include the following:

- Main Garrison Landfill (OU2); organic compound plume
- Sites 2 and 12 - Main Garrison Sewage Treatment Plant, Lower Meadow, DOL Automotive Yard, and Cannibalization Yard; organic compound plume
- FAAF (OU1); organic compound plume
- Sites 30 and 32 - Driver Training Area and East Garrison Sewage Treatment Plant; elevated TDS
- A small number of other isolated points where organic compounds have been detected.
- Sites 1 and 2; seawater intrusion.

4.4.2.1 Main Garrison Landfill

On the basis of available data for the sites investigated, the Main Garrison Landfill appears to have had the greatest impact on groundwater quality at Fort Ord. A plume associated with the landfill appears to affect the A- and 180-foot aquifers, and possibly extends into the 400-aquifer. Organic compounds in groundwater associated with the landfill include 1,1-DCA, 1,2-DCE, TCA, TCE, PCE, TCF, DBCM, BDCM, 1,4-DCB, 1,2-DCB, 1,2-DCP, vinyl chloride, chloroform, carbon tetrachloride, xylenes, and toluene. Of the detected chemicals, TCE was both the most commonly detected and detected at the highest concentrations relative to MCLs. TCE concentrations observed during this study ranged from 1.2 to 73.0 $\mu\text{g/l}$, commonly exceeding the federal maximum contaminant level of 5 $\mu\text{g/l}$.

Comparison of Plate 10 describing groundwater flow in the A-aquifer to Plate 27 describing the TDS distribution in the A-aquifer indicates that an area of relatively high TDS appears to have originated from the landfill area. Plates 33 and 34

show isoconcentration plots of TCE in the A- and 180-foot aquifers. The TCE plume occurs predominantly west of the landfill, generally coincident with the area of relatively high TDS concentration and consistent with the groundwater gradient in the A-aquifer (Plate 10). The TCE plume appears to reach the edge of the FO-SVA where water from the A-aquifer enters the 180-foot aquifer. The TCE entering the 180-foot aquifer from the A-aquifer appears to have been drawn east under the FO-SVA in the general direction of the Fort Ord supply wells (FO-29, FO-30, and FO-31). This eastward movement is consistent with the groundwater gradient in this portion of the 180-foot aquifer (Plate 12). Vertical leakage of organic compounds from the A- to the 180-foot aquifer may have also occurred as a result of the now destroyed Fort Ord supply wells FO-11, FO-14, FO-16, FO-17, FO-18, FO-19, FO-21, FO-22, FO-23, and FO-25 (*HLA, 1989a, b*). Inadequate well seals between the A- and 180-foot aquifer are believed to have provided a pathway downward from the A- into the 180-foot aquifer.

The detected concentrations of 1,2-DCE and TCE in the 400-foot aquifer at well MW-OU2-07-400 may be associated with the landfill plume. No significant groundwater flow barrier exists between the 180- and 400-foot aquifers in the area of the 180-foot aquifer TCE plume (Plate 6). Further, the city of Marina active supply well Marina 09 is screened in the 400-foot aquifer in the area adjacent to the plume. Pumping of Marina 09 has potentially contributed to flow and contaminant transport in the 400-foot aquifer.

4.4.2.2 Sites 2 and 12

Sites 2 and 12 display the second largest recognized organic contaminant plume, which, similar to OU2, is best defined by the principal contaminant TCE (Plate 34).

Water-level maps and chemical data suggest that this plume extends predominantly to the west. The plume may also extend to the east due to a possible groundwater mound in the 180-foot aquifer beneath Site 12 (Plate 12). However, considerable uncertainty exists with regard to the plume geometry due to the limited information in the area between the OU2 landfill plume and the Sites 2 and 12 plume.

Organic compounds associated with the Sites 2 and 12 plume include 1,1-DCE, 1,2-DCA, 1,2-DCE, 1,1,1-TCA, TCE, PCE, benzene, and chloroform. TCE was the most commonly detected, at concentrations ranging from 0.49 to 230 $\mu\text{g/l}$.

Elevated concentrations of priority pollutant metals were observed in MW-02-07-180. However, these metal concentrations are likely due to cation exchange reactions taking place between the aquifer materials and seawater and are not considered indicative of contamination. The cation exchange reactions are driven by the high ionic strength of the intruding seawater.

Organic compounds including TCE have been detected in wells MW-02-02-180 and MW-02-03-180; MW-02-07-180 has shown no detectable organic compounds. Seawater intrusion has apparently occurred below the organic compound plume present in the upper portion of the 180-foot aquifer. Organic compounds above and west of a well showing seawater intrusion are consistent with the expectation that seawater would be deeper due to its greater density.

4.4.2.3 FAAF Fire Drill Area (OU1)

The FAAF Fire Drill Area (OU1) displays an organic compound plume in the A-aquifer (Plate 33). Organic compounds associated with OU1 consist of carbon disulfide, 1,1-DCA, 1,2-DCE, 1,1,1-TCA, TCE, xylenes, and the tentatively

identified compounds naphthalene and unknown alkanes. TCE was the most commonly detected at concentrations ranging from 4.5 to 41.0 $\mu\text{g/l}$.

Groundwater flow at OU1 is strongly influenced by a groundwater remediation system that extracts contaminated groundwater from the A-aquifer, removes the organic contaminants, and then irrigates an unlined soil treatment area that recharges the A-aquifer.

At OU1, the organic compounds TCE, TCA, PCE, benzene, and toluene have been detected in A-aquifer wells upgradient of the identified source and treatment area (wells MW-OU1-01-A and MW-OU1-02-A) (HLA, 1993a). The detection of TCE at well MW-OU1-01-A represents the highest and most consistent organic compound concentration observed in an upgradient well. The maximum TCE concentration observed at MW-OU1-01-A is 17 $\mu\text{g/l}$ (12/04/90). Detectable concentrations of TCE have been observed in 22 of the 24 sampling events that have occurred at MW-OU1-01-A since August 1988. The source of organic contamination in the A-aquifer upgradient of FAAF Fire Drill Area remains unidentified and warrants further investigation.

No wells are present in the 180-foot aquifer below OU1; however, well MW-B-13-180, located approximately 2,000 feet south of OU1, contained carbon tetrachloride at a concentration of 9.8 $\mu\text{g/l}$. The presence and source of organic contamination in the 180-foot aquifer in this general area is uncertain.

4.4.2.4 Sites 30 and 32

Water quality below Sites 30 and 32, the Driver Training Area and East Garrison Sewage Treatment Plant, appears to reflect groundwater contamination from treatment plant effluent. Elevated TDS, nitrate, and chloride concentrations and unique Stiff and

Piper diagram chemical signatures for wells MW-30-01-180, MW-32-01-A, MW-32-02-A, MW-32-03-A (Table 22, Plates 21 and 25) support this conclusion. Groundwater information in this area is limited to three wells beneath Site 32 (incorrectly identified as A-aquifer wells) and one well to the south beneath Site 30, all of which monitor the 180-foot aquifer.

The TDS concentration of 933 mg/l at well MW-30-01-180 is the second highest observed during this study and is far above what would be expected in this area. Site 30 is being investigated for potential contamination related to a gasoline fueling station, but a fueling station is not considered a likely source for the high TDS conditions observed. The groundwater gradient appears to be in a southeastern direction from Site 32 toward Site 30, suggesting that the high TDS observed at Site 30 could be related to the Site 32. Monitoring well MW-30-01-180 should be resampled and analyzed for constituents consistent with Site 32.

4.4.2.5 Other Sites of Groundwater Contamination

Organic compounds have also been detected in the following locations:

- Sites 17 and 18
- A-aquifer well MW-36-01-A
- 180-foot aquifer wells MW-10-03-180, Marina 02, and MW-B-13-180
- 400-foot aquifer wells MW-OU2-07-400, MW-OU2-06-400, and Wil Ranch.

Site 17 wells MW-17-01-180 and MW-17-02-180 display an apparent organic compound groundwater plume which includes chloroform, carbon tetrachloride, DBCM, bromoform, and PCE. The chemical results from these two wells are inconsistent; chloroform, carbon tetrachloride, and PCE were detected in only one of the

three sampling rounds for these two wells (Table 12). Only bromoform and DBCM were detected consistently in all three sampling rounds from MW-17-01-180. Additional sampling and analysis should be conducted at these wells using EPA Test Methods 8010 and 8020 to verify the existence of the organic compounds at this location.

At Site 18, TCE has been found consistently in well MW-18-03-180 (Table 12). It is not known whether the presence of this compound in Site 18 wells is related to organic compound plume(s) associated with other sites in the vicinity or is associated with Site 18 activities.

The organic compounds observed in the other wells listed above appear to represent unique and isolated low-level occurrences. The presence of these compounds should be confirmed with additional sampling and analyses.

4.4.2.6 Seawater Intrusion

Seawater intrusion into both the 180- and 400-foot aquifers has occurred historically in the Salinas basin. Seawater intrusion is significant because it affects water potability and water treatability during remediation. It will likely be an important consideration when evaluating groundwater extraction as a remedial alternative.

Seawater intrusion occurs when groundwater levels in areas adjacent to a seawater body (e.g., Monterey Bay) are dropped below sea level, creating a gradient inland. The contrasting density of seawater ($\rho=1.025$) to that of typical dilute groundwater ($\rho=1.00$) affects and controls the shape of the intruding mass of seawater. Due to the greater density, intruding seawater moves more rapidly at the base of the zone of intrusion and the intruding seawater body takes the shape of a wedge. The actual interface between the seawater and freshwater is gradational and not sharp due to mechanical and chemical dispersion.

4.4.2.6.1 Historical Seawater Intrusion

180-Foot Aquifer

Seawater intrusion into 180-foot aquifer in the northern Salinas Valley was first observed in the early 1930s (*DPW, 1946a, b*) and consisted of intrusion into the 180-foot aquifer. Seawater intrusion into the Salinas basin appears to be closely related to groundwater withdrawal that lowered the groundwater levels to below sea level. The historical relationship between depressed water levels in the Salinas basin and seawater intrusion has been well documented (*DPW, 1946a, 1946b, 1958, 1963; DWR 1970, 1973, 1975; Leedshill-Herkenhoff, 1985; and GTC, 1984*). Plate 35 shows seawater intrusion, as defined by the chloride 500 mg/l isoconcentration line, steadily migrating inland up the Salinas Valley.

Seawater intrusion into the Salinas basin in the Marina/Main Garrison area was first observed in the 1960s (*GTC, 1984*). Plate 35 portrays the migration of seawater intrusion from 1966 through 1983 in the Marina area. Seawater intrusion into this area has been closely related to groundwater withdrawals by the city of Marina and Fort Ord. Deteriorating water quality forced the city of Marina to discontinue pumping all of its 180-foot aquifer wells by 1978 (*GTC, 1984*) and install water-supply wells into the deeper 400-foot and 900-foot aquifers. In response to seawater intrusion, Fort Ord discontinued pumping in the 180-foot aquifer beneath the Main Garrison area and installed a new well field (FO-29, FO-30, FO-31, and FO-32) near the East Garrison.

400-Foot Aquifer

Seawater intrusion into the 400-foot aquifer has been slower and less extensive than in the overlying 180-foot aquifer. Seawater intrusion into the 400-foot aquifer was first recognized near Castroville in 1959 (*Leedshill-Herkenhoff, 1985*). Plate 36 shows the inland migration of seawater intrusion up the axis of the Salinas Valley.

4.4.2.6.2 Current Conditions

The current extent of seawater intrusion in the Salinas basin aquifers at Fort Ord was assessed from chloride concentration data (Plates 30-32) and water level data (Plates 12 and 13).

Chloride concentrations in the A-aquifer range from 10 to 259 mg/l and do not indicate seawater intrusion into the A-aquifer. All of the water-level data from the A-aquifer are above mean sea level, indicating the potential for seawater intrusion does not exist.

The seawater intrusion effects in the 180-foot aquifer beneath the Main Garrison area appear to have decreased by 1992 (Plate 35). This is supported by historical chloride concentrations at Well FO-24, which have decreased from a high of 550 mg/l in 1981 (*GTC, 1984*) to 93.5 mg/l measured during this investigation. The apparent change in the seawater intrusion trend in this area is likely due to the cessation of groundwater withdrawal by the city of Marina and Fort Ord in this area.

Seawater intrusion appears to be affecting the Site 2 wells MW-02-07-180, MW-02-02-180, and MW-02-03-180. Seawater intrusion effects at these three wells are indicated by the elevated chloride concentrations and the pattern of increasing chloride concentrations with increasing depth of the well screen.

Wells MW-02-02-180, MW-02-03-180 and MW-02-07-180 are adjacent to the coastline at Site 2. Of these three wells, MW-02-07-180 is deepest, screened between -49 and -69 feet mean sea level (MSL), followed by MW-02-03-180 (17 to -24.5 feet MSL), and MW-02-02-180 (16 to -24 feet MSL). Water quality in the deepest well displays the effect of seawater intrusion with elevated TDS of 24,000 mg/l.

Wells MW-02-02-180 and MW-02-03-180 displayed much lower but still elevated TDS concentrations of 794 and 833 mg/l, respectively. Stiff diagrams (Plate 25) indicate

diluted seawater at MW-02-07-180 and suggest diluted seawater is affecting Wells MW-02-02-180 and MW-02-03-180.

The current condition of seawater intrusion in the 400-foot aquifer beneath the city of Marina/Fort Ord Main Garrison area is defined by the water quality of the water supply well Marina 09. The location of the chloride 500 mg/l isoconcentration line is constrained by well Marina 09 and lies to the west of this well.

Chloride concentrations in the 400-foot aquifer range from 16 to 243 mg/l. The wells Marina 09 and MW-OU2-07-400 appear to be slightly affected by seawater intrusion based on these chloride concentrations and water levels.

4.4.3 Background Groundwater Chemistry

Table 25 is a list of wells from the A-, 180-foot, 400-foot, and 900-foot aquifers considered to represent background groundwater chemical conditions at Fort Ord. Tables 26 through 29 list the maximum, minimum, and frequency of detection of the general inorganics and the priority pollutant metals observed in these wells.

Wells were considered to represent background conditions if they were free of organic contaminants, located hydraulically upgradient from site activities, and displayed inorganic chemistry apparently unaffected by site activities. Wells with apparent seawater intrusion or effects from stainless steel well screens were excluded.

5.0 SEASIDE BASIN

The Seaside basin underlies the cities of Seaside and Sand City and the southern part of Fort Ord (Plate 3). The basin comprises an area of approximately 24 square miles bounded by the Pacific Ocean to the west, the Chupines Fault to the south, and, on the basis of limited geologic and hydrologic data, by an elevated subsurface ridge of the Monterey Formation to the north. The eastern basin boundary is uncertain but is assumed to be the elevated area near Impossible Canyon (Plate 3), as originally postulated by Muir (1982). The Seaside basin was subdivided into Southern and Northern Seaside basins (Muir, 1982). The Northern basin has been further subdivided into the Northern Inland, Coastal, and Fort Ord subbasins. The Southern Seaside basin, which is south of the Seaside fault, includes the Laguna Seca subbasin located along the southern base boundary (SGD, 1990f). In the western portions of the Seaside basin, the various basins and subbasins are defined by the Chupines, Seaside, and Ord Terrace faults (Plate 3). The eastern extent of the subbasin is undetermined due to a lack of data from the Fort Ord Impact Area (Site 39).

5.1 Geology

This section describes the Seaside basin stratigraphy, geologic structure, related offshore geology, and hydrostratigraphy.

5.1.1 Stratigraphy

A relative abundance of previous well log data is available for the western portions of the Seaside basin. As a result, the geologic units there are more fully understood than in the Northern Inland and Fort Ord subbasins. The principal geologic units within the Seaside basin at Fort Ord are listed in Table 30 and are described below. Due to the limited occurrence of recent and older alluvium, these units are not

described herein; however, they are described briefly in Table 30. Lithologic descriptions that are common to the Salinas basin are not repeated here but can be found in Section 4.1.1.

5.1.1.1 Beach Sand (Qs)

Beach sand of the Seaside basin is similar in location and lithology to that of the Salinas basin (Section 4.1.1.1).

5.1.1.2 Recent Dune Sand (Qd)

Recent dune sand of the Seaside basin is similar in location and lithology to that of the Salinas basin (Section 4.1.1.2).

5.1.1.3 Older Dune Sand (Qod)

Older dune sand covers much of the western and central portion of the Seaside basin with depths ranging up to approximately 250 feet. In the Site 39 Impact Area (Plate 4), the older dune sand laps unconformably onto the Aromas Sand, while in the western portion of the basin, the Qod appears to overlie the Paso Robles Formation. Previous investigators have portrayed the uppermost deposits within the western Seaside basin as an undifferentiated accumulation of both the Qar and Qod unconformably overlying the Paso Robles Formation (*SGD, 1990f*). The distinction between the Qar and Qod is subtle; the uppermost portion of this undifferentiated sand sequence is commonly fine-grained silty sand, becoming coarse- to medium-grained sand at depth near the contact with the Paso Robles Formation. The coarse-grained sediments indicate fluvial or marine deposition rather than eolian. Despite some fluvial or marine contributions, the sand overlying the Paso Robles Formation in the western Seaside basin is included in the Qod as shown on cross section F-F', Plate 7. The Qod is quartz- and feldspar-rich, similar to the Qod of the Salinas basin.

5.1.1.4 Aromas Sand (Qar)

Surface exposures of the Aromas Sand are mapped at the higher elevations of the eastern Seaside basin as shown on Plate 3 (*Bowen, 1969, Clark et al., 1974, and Dibblee, 1973*). According to Muir (1982), the Qar may range up to 300 feet thick; this is shown on cross section F-F' (Plate 7). Outcrops of Qar become isolated and scattered toward the west and this unit ultimately becomes buried beneath Qod in the western Impact Area and the city of Seaside. Refer to the discussion of the Aromas Sand in Section 4.1.1.5 for additional information about this unit.

5.1.1.5 Paso Robles Formation (QTpr)

Outcrops of the Paso Robles Formation in the eastern Seaside basin have a similar composition to those described in the Salinas basin, i.e., a sequence of lenticular beds of gravel, sand, clay, and silt.

Previous interpretations, based on well logs from the Seaside area, indicate the lower section of the Paso Robles Formation in the western Seaside area has considerable lateral continuity (*Muir, 1982; SGD, 1990f*). Well and geophysical logs from this area indicate the presence of several widespread clays and sands, and of shells indicating a marine origin (*Muir, 1982*) or contact with Pliocene-age marine sediments such as the Pancho Rico and/or Purisima Formations. This contrasts with the poorly sorted and relatively discontinuous nature of the formation in its upper section. Lack of well or boring data from beneath the Fort Ord Impact Area precludes a reliable interpretation of the geology in that area. This absence of subsurface data is evident on the eastern portion of cross section F-F' (Plate 7).

Boring logs from the Coastal subbasin and western portion of the Fort Ord subbasin indicate a clay is present near the older dune sand-Paso Robles contact. The extent of this clay, referred to as the Seaside clay in this report, is shown approximately

on Plate 3 and on cross sections D-D' and F-F' (Plate 7). Although its extent and nature are not well established, the gentle westward slope and stratigraphic position between the Paso Robles and older dune sand suggest this clay may be Pleistocene-age shallow marine sediments (mud) deposited over the Paso Robles Formation.

Lithologic and geophysical logs for PB-BW-02, -03, -04, and MW-BW-09-180 suggest that a similar lithologic sequence is present in the upper portions of these boring locations (see E-E', Plate 7). This correlation across the projected location of the Seaside fault indicates that displacements in the upper QTpr sediments are relatively minor, or that the Seaside fault does not extend upward into this sequence.

5.1.1.6 Santa Margarita Formation (Tsm)

The Miocene-age Santa Margarita Formation, of marine origin, is composed of white or blue-gray, well-sorted, fine- to coarse-grained, quartzose sand and friable sandstone with little clay content and high porosity. Unconformably underlying the Paso Robles Formation in the Seaside basin, the Santa Margarita Formation is reported to interfinger with the shale and diatomaceous members of the Monterey Formation a few miles east of the type section, near the city of Monterey (*Bowen, 1965*). Unlike the Paso Robles and Monterey formations, the Santa Margarita is not continuous throughout the Seaside basin. It apparently thins out in the western part of the Southern Seaside basin beneath the city of Seaside, as shown on Plate 39. The absence of Tsm in the subsurface atop areas where the Monterey Formation is above approximately 100 feet MSL may indicate that the Tsm was removed by past erosion or that the Tsm was never deposited at those locations.

The Santa Margarita Formation was not encountered in wells drilled during this investigation; consequently, little information can be added to the understanding of this unit's hydrogeologic role.

5.1.1.7 Monterey Formation (Tm)

In the Seaside basin, the Miocene-age Monterey Formation is composed primarily of ~~fine-grained~~ shale, mudstone, and diatomaceous shale with lesser amounts of sandstone interbeds. This non-water-bearing unit is assumed to form the base of the Seaside basin water-bearing zones. The following wells penetrate the Monterey Formation in the Seaside basin: Gigling, FO-04 (Huffman), MW-B-26-180, Paralta, MPWMD #01 (D), Monterey Sand Co.-D, and the Seaside 03. There are no surface outcrops in the basin, although the formation is exposed adjacent to the Chupines fault.

5.1.2 Geologic Structure

Unlike the Salinas basin, the Seaside basin is structurally complex and contains several northwest-trending faults and folds. The continuity of these structures into the Fort Ord Impact Area is uncertain due to the absence of adequate subsurface stratigraphic and structural information. Based on well logs, these structures ~~displace~~ deform both the Tm and Tsm. However, the degree of deformation within the Paso Robles Formation is not as well defined as in the Tm and Tsm. Effects of faults on groundwater flow are considered likely to decrease in the upper portions of the QTpr due to minor if any fault offset projecting into the upper QTpr. The degree of folding in the upper portions of the Paso Robles Formation is uncertain, but also considered to be minor. However, folding, followed by erosion prior to deposition of the older dune sand, could have resulted in sandy beds within the Paso Robles Formation being placed in contact with the Uppermost aquifer, thereby providing potential pathways from the

Uppermost aquifer into the Paso Robles Formation. Structural data supporting folding in the Paso Robles Formation is provided in the cited references specifically Muir (1982), SGD (1990) and Greene (1977). Deformation in the Qar is minor, apparently consisting of a slight northward tilting.

The Chupines fault, the only Seaside basin fault evident at the ground surface, forms the southern boundary of the basin, juxtaposing uplifted Monterey Formation on the south against the Santa Margarita Formation, Paso Robles Formation, and Quaternary deposits on the north.

The Seaside fault, together with its eastward projection as an anticlinal fold, defines the boundary between the Northern and Southern Seaside subbasins. Interpretations of seismic records by Greene (1977) indicate the Seaside fault continues offshore into Monterey Bay. Based on well control of the Monterey bedrock surface, SGD (1987a) located the fault approximately as depicted on Plate 3. SGD has also interpreted well data as being indicative of a bedrock high situated along the northeastern portion of this fault.

Relative displacement by the Seaside fault is thought by several authors to be downward to the south (Clark *et al.*, 1974; Muir, 1982; SGD, 1990f), although Thorup (1977) and GTC (1984) offer a contrary interpretation. Stratigraphy at PB-BW-04, located south of the fault, is similar to that at MW-BW-09-180, PB-BW-03, and PB-BW-02, north of the fault. As discussed in Section 5.1.1.5, this indicates that the upper portions of the Paso Robles Formation are offset only slightly, if at all, by this fault. North of the Seaside fault, and south-southeast of well MPWMD #01 (D), a pilot boring installed by HLA (PB-BW-04) failed to reach either the Tm or Tsm. The absence of these units indicates that the bedrock rise seen in MPWMD #01 does not

continue as far south as the fault. Rather, bedrock may descend near the fault (see cross section E-E'; Plate 7). An alternative explanation is that this boring was actually located south of the fault, and the fault location is somewhat north of the location presented by SGD (1990f).

Displacement of the Ord Terrace fault is considered to be of a south-up, north-down sense. On the basis of Cal-Am's Luzern well and Ord Village Well 1, which penetrate the Tm, SGD (1990f) located the Ord Terrace fault approximately as depicted on Plate 3. They concluded that this fault offsets the Tsm and Tm but not the QTpr. Hydrothermal water attributed to either the Seaside or Ord Terrace fault by Geoconsultants (1985) was also used by SGD as a basis to approximate the location of this fault.

5.1.3 Offshore Geology

A series of northwest-trending faults have been mapped offshore from the Seaside basin (Greene, 1977). The Ord Terrace and Seaside faults appear to project offshore. Based on that interpretation, the onshore geologic units would also project some distance offshore. Offshore projection of the onshore geologic conditions would place outcrops of Paso Robles Formation a considerable distance offshore and therefore the point of entry by seawater into that unit would be a considerable distance from the current groundwater production areas. In contrast, the older dune sand (and therefore the Uppermost aquifer) is relatively flat-lying and is probably in contact with seawater in the beach areas. Consequently, seawater intrusion into aquifers within the dune sand could occur rapidly in response to pumping in either the Uppermost aquifer or upper portions of the Paso Robles Formation.

Unfortunately, little definitive geologic data are available offshore and outcrop locations of the various water-producing units are highly interpretive. As a result, the relationship between current groundwater extraction and seawater intrusion is not well established.

5.1.4 Hydrostratigraphy

The Seaside basin has three distinct water-bearing units: the Uppermost, Paso Robles, and Santa Margarita aquifers.

The Uppermost aquifer comprises the saturated portions of the older dune sand and Aromas Sand. This aquifer is composed predominantly of fine- to medium-grained sand, locally coarse-grained in its lower sections, with occasional silt beds. The preponderance of well-sorted sand in this aquifer indicates relatively high vertical and horizontal permeabilities except where limited by silt beds. Recharge to the Uppermost aquifer is primarily the result of infiltrating precipitation and surface water. Seawater intrusion into shallow wells near the beach indicate seawater recharges the aquifer locally in response to pumping.

Except for a few shallow wells near the beach, this aquifer is not used for groundwater supply. The aquifer is unconfined and is typically perched over the finer-grained Paso Robles Formation (QTpr) and/or Seaside clay. Where the QTpr is sandy and in contact with the Uppermost aquifer, hydraulic communication could occur. The Uppermost aquifer appears to be hydraulically connected to the Paso Robles aquifer immediately south of the Seaside/Salinas basin boundary (bedrock high). Water levels in wells MW-B-26-180 and MW-B-28-180, screened in the Uppermost aquifer, are similar to wells MW-B-29-180 and MW-B-27-180, screened in the Paso Robles aquifer.

The aquifers of the Paso Robles Formation are below the Uppermost aquifer. This unit consists of several significant, confined water-producing zones at depth, and numerous small confined zones in discontinuous, lenticular strata in its upper sections. As discussed above, where granular materials are in contact with the Uppermost aquifer, unconfined conditions may occur locally.

If it were continuous, the Seaside clay would form a potentially significant vertical barrier to flow between the Uppermost and Paso Robles aquifers in large portions of the Fort Ord and Coastal subbasins, as shown on Plate 3. However, the continuity of this clay is interpreted from only scattered well data and its role as an aquitard is uncertain. The presence of fine-grained sediments and the lenticular nature of strata in the upper portions of the Paso Robles aquifer indicate relatively low vertical permeabilities.

The degree of offset in the Paso Robles Formation ~~to~~ by the Seaside and Ord Terrace faults is uncertain. However, previous investigations (*SGD, 1990f*) indicate that these faults form significant barriers to flow, at least in the lower portions of the unit. Continuity of marker beds across the Ord Terrace fault reported by *SGD (1990f)*, and apparent continuity of a strata across the Seaside fault, indicate these faults do not form barriers to flow in the upper portions of the Paso Robles Formation.

The Santa Margarita Formation forms the lowermost aquifer in the Seaside basin. This confined aquifer is composed predominantly of quartzose sand with a thoroughgoing clay defining a lower and upper member (*SGD, 1990f*). Wells are typically screened in both members, making an evaluation of their hydraulic relationship unfeasible.

The Santa Margarita aquifer is believed to be absent over localized areas of the basin as shown approximately on cross section E-E' (Plate 7). Both the Seaside and Ord Terrace faults are believed to offset this aquifer and create barriers to flow.

Recharge to the Paso Robles and Santa Margarita formations is believed to be predominantly from subsurface flow (*SGD, 1990f*). The contribution, if any, of recharge by seawater intrusion is unknown because production wells have historically been unimpacted by seawater. Further, the offshore geology and location of seawater pathways into these water-bearing formations is unknown.

5.2 Hydrogeology

This section describes the groundwater flow, including groundwater/surface water interaction, and hydraulic parameter data for the Seaside basin. Information was compiled from several previous studies of groundwater conditions (*Muir, 1982; SGD, 1987a, 1990f*) and a limited amount of additional data were collected during this basewide investigation.

5.2.1 Present Groundwater Flow Conditions

Several nested wells were installed as part of this investigation to monitor groundwater conditions at selected locations in the Uppermost and Paso Robles aquifers. Groundwater elevation data from these and other existing wells were obtained during January, February, May, and July 1992 and are listed in Table 2. Analysis of these data indicate that groundwater elevations during the four monthly monitoring periods did not change significantly. Consequently, water-level maps for the three aquifers are presented only for July 1992, a representative period. Plates 37 through 39 present contour maps of the July 1992 groundwater elevation data for the Uppermost, Paso Robles, and Santa Margarita aquifers.

Water-level elevation data presented by SGD (1990f) indicate that the groundwater production in the Seaside area (from Cal-Am and city of Seaside wells) is causing a depletion in basin storage. SGD estimated the overall rate of decline to be several feet per year from 1960 to 1990.

5.2.1.1 Uppermost Aquifer

The Uppermost aquifer is unconfined and perched within older dune sand and includes the Aromas Sand in the eastern portions of the basin. Although the well groups monitored are at a considerable distance from one another, the water levels indicate a westward flow approximately parallel to topography as shown on Plate 37. The overall hydraulic gradient is approximately 0.015 ft/ft.

Because only limited groundwater elevation data are available, the effects of the faults on shallow groundwater flow are uncertain. However, available geologic information indicates the recognized faults do not offset this unit and therefore are not considered barriers to groundwater flow in the Uppermost aquifer.

5.2.1.2 Paso Robles Aquifer

The Paso Robles aquifer consists of poorly sorted, lenticular beds of gravels, sand, silt, and clay in its upper section, and laterally continuous marine clays and sands at depth. Water-level elevation data for the Paso Robles aquifer indicate that the general flow direction in the Southern Seaside basin is north and northwest as shown on Plate 38. Data do not exist in the Northern Inland subbasin (Impact Area); however, data from wells along the Fort Ord-Seaside boundary (Fort Ord and Coastal subbasins) suggest a poorly defined northward flow with apparent influence from the Ord Grove #2 well (Plate 38). The Seaside fault, separating the Southern Seaside basin from the Coastal subbasin, is assumed to form a barrier to groundwater flow in the Paso

Report Date: Jun 21, 1995

Chemical Data Report - All Chemical Results
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Sample Number	Sample Depth	Station Number	Sample Date	Test Method	Analyte	Units	Value	Date
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	1,1,2,2-Tetrachloroethane	ug/kg	< 5.200	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	1,1,2-Trichloroethane	ug/kg	< 5.200	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	1,1-Dichloroethane	ug/kg	< 5.200	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	1,1-Dichloroethene	ug/kg	< 5.200	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	1,2-Dichloroethane	ug/kg	< 5.200	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	1,2-Dichloroethene (total)	ug/kg	< 5.200	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	1,2-Dichloropropane	ug/kg	< 5.200	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	2-Hexanone	ug/kg	< 10.000	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	4-Methyl-2-pentanone (MIBK)	ug/kg	< 10.000	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	Acetone	ug/kg	< 10.000	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	Benzene	ug/kg	< 5.200	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	Bromodichloromethane	ug/kg	< 5.200	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	Bromoform	ug/kg	< 5.200	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	Bromomethane	ug/kg	< 10.000	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	Carbon disulfide	ug/kg	< 5.200	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	Carbon tetrachloride	ug/kg	< 5.200	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	Chlorobenzene	ug/kg	< 5.200	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	Chloroethane	ug/kg	< 10.000	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	Chloroform	ug/kg	< 5.200	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	Chloromethane	ug/kg	< 10.000	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	Dibromochloromethane	ug/kg	< 5.200	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	Ethylbenzene	ug/kg	< 5.200	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	Hexanal	ug/kg	7.700	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	Methylene chloride	ug/kg	< 5.200	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	Methyl ethyl ketone	ug/kg	< 10.000	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	Styrene	ug/kg	< 5.200	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	Tetrachloroethene	ug/kg	< 5.200	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	Toluene	ug/kg	< 5.200	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	Trichloroethane	ug/kg	< 5.200	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	Vinyl acetate	ug/kg	< 10.000	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	Vinyl chloride	ug/kg	< 10.000	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	Xylenes	ug/kg	< 5.200	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	cis-1,3-Dichloropropene	ug/kg	< 5.200	
SB280315.5	15.50	SB-28-03	01/06/92	EPA8240	trans-1,3-Dichloropropene	ug/kg	< 5.200	
SB280315.5	15.50	SB-28-03	01/06/92	EPA9045	pH	pH	5.700	
SB280320.5	20.50	SB-28-03	01/06/92	EPA8240	1,1,1-Trichloroethane	ug/kg	< 0.0000	
SB280320.5	20.50	SB-28-03	01/06/92	EPA8240	1,1,2,2-Tetrachloroethane	ug/kg	< 0.0000	
SB280320.5	20.50	SB-28-03	01/06/92	EPA8240	1,1,2-Trichloroethane	ug/kg	< 0.0000	
SB280320.5	20.50	SB-28-03	01/06/92	EPA8240	1,1-Dichloroethane	ug/kg	< 0.0000	
SB280320.5	20.50	SB-28-03	01/06/92	EPA8240	1,1-Dichloroethene	ug/kg	< 0.0000	
SB280320.5	20.50	SB-28-03	01/06/92	EPA8240	1,2-Dichloroethane	ug/kg	< 0.0000	
SB280320.5	20.50	SB-28-03	01/06/92	EPA8240	1,2-Dichloroethene (total)	ug/kg	< 5.200	
SB280320.5	20.50	SB-28-03	01/06/92	EPA8240	1,2-Dichloropropane	ug/kg	< 0.0000	
SB280320.5	20.50	SB-28-03	01/06/92	EPA8240	2-Hexanone	ug/kg	< 0.0000	
SB280320.5	20.50	SB-28-03	01/06/92	EPA8240	4-Methyl-2-pentanone (MIBK)	ug/kg	< 10.000	

Notes:

Fecal Coliform results reported as Most Probable Number (MPN) per 10 grams for soil samples and MPN per 100 milliliters for water samples.

ND: Not Detected
 NR: Not Reported
 NA: Not Analyzed

Water-level elevation data for the Santa Margarita aquifer suggest that the primary flow direction in the Southern Seaside basin is from east to west (Plate 39). The overall hydraulic gradient in the Southern Seaside basin (from Ryan Ranch to western Seaside) during July 1992 was approximately 0.006 ft/ft. Steeper gradients near the Ryan Ranch wells are probably related to active pumping of these wells.

Insufficient data were available to contour the Coastal, Fort Ord or Northern Inland subbasins. Water levels shown on Plate 39 are typically within 10 feet above or below MSL with the exception of active Ord Grove #2.

5.2.1.4 Vertical Flow

Plate 40 presents contours of head differences between the Uppermost and Paso Robles aquifers. The head differences during July 1992 show a strong downward gradient; this gradient appears most pronounced near pumping centers in the Paso Robles aquifer, (see Plate 38). The maximum difference in hydraulic head between the two aquifers during July 1992 was approximately 160 feet in Fort Ord near the Seaside boundary.

The water-level data indicate variable slight downward and upward gradients between the Paso Robles and Santa Margarita aquifers. However, because of the limited data available, hydraulic head differences between the Paso Robles and Santa Margarita aquifers were not compared graphically.

5.2.1.5 Tidal Influence

A tidal influence study was performed to determine the effects of tidal fluctuations on shallow groundwater elevations and flow in the Seaside basin. This study was performed over a period of 4 days (June 11 to July 15, 1992) at Fort Ord Site 1, the Ord Village Sewage Treatment Plant (Plate 4). Groundwater elevation data were

collected continuously from Uppermost aquifer wells MW-01-02-180, MW-01-01-180, and MW-01-03-180 (Plate 37). These three wells are located approximately 400, 800, and 1,000 feet, respectively, from the Monterey Bay shoreline and each is screened in the Uppermost aquifer with no significant clay or silt interbeds confining the monitored intervals.

Plate 41 shows the tidal record in Monterey Bay during the study period and the water-level fluctuations in the three wells. Eight tidal cycles occurred over the study period, with a maximum tidal fluctuation in Monterey Bay of approximately 7 feet.

The largest tidal effect was observed in well MW-01-02-180, located closest to the Monterey Bay shoreline, where a tidal fluctuation of approximately 1.35 feet was observed (Plate 41). A phase lag of approximately 3 hours (the time difference between tidal highs observed in the bay and well) was observed at this well. In well MW-01-01-180, a tidal change of approximately 0.28 foot was observed, with a phase lag of approximately 8 hours. In well MW-01-03-180, a minimal tidal change of approximately 0.22 foot was observed. These data confirm that the groundwater-levels in coastal areas of the Seaside basin are affected by tidal fluctuations and that this effect deteriorates rapidly with increasing distance from the coastline.

The tidal study results were also used to determine a net groundwater flow direction in the Site 1 area. The average (arithmetic mean) groundwater elevations measured in the three wells over the 4-day study period were 2.81, 2.75, and 2.83 feet MSL for MW-01-01-180, MW-01-02-180, and MW-01-03-180, respectively. Analysis of these time-averaged groundwater elevations indicates the net or resultant flow direction in the Site 1 area was to the southwest.

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Sample Number	Sample Depth	Station Number	Sample Date	Test Method	Analyte	Units	Value	Detected
SB280410.5	10.50	SB-28-04	01/05/92	EPA8240	Toluene	ug/kg	< 5.200	
SB280410.5	10.50	SB-28-04	01/05/92	EPA8240	Trichloroethene	ug/kg	< 5.200	
SB280410.5	10.50	SB-28-04	01/05/92	EPA8240	Vinyl acetate	ug/kg	< 10.000	
SB280410.5	10.50	SB-28-04	01/05/92	EPA8240	Vinyl chloride	ug/kg	< 10.000	
SB280410.5	10.50	SB-28-04	01/05/92	EPA8240	Xylenes	ug/kg	< 5.200	
SB280410.5	10.50	SB-28-04	01/05/92	EPA8240	cis-1,3-Dichloropropene	ug/kg	< 5.200	
SB280410.5	10.50	SB-28-04	01/05/92	EPA8240	trans-1,3-Dichloropropene	ug/kg	< 5.200	
SB280410.5	10.50	SB-28-04	01/05/92	EPA9045	pH	pH	5.000	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	1,1,1-Trichloroethane	ug/kg	< 5.300	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	1,1,2,2-Tetrachloroethane	ug/kg	< 5.300	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	1,1,2-Trichloroethane	ug/kg	< 5.300	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	1,1-Dichloroethane	ug/kg	< 5.300	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	1,1-Dichloroethene	ug/kg	< 5.300	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	1,2-Dichloroethane	ug/kg	< 5.300	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	1,2-Dichloroethene (total)	ug/kg	< 5.300	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	1,2-Dichloropropene	ug/kg	< 5.300	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	2-Hexanone	ug/kg	< 11.000	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	4-Methyl-2-pentanone (MIBK)	ug/kg	< 11.000	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	Acetone	ug/kg	< 11.000	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	Benzene	ug/kg	< 5.300	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	Bromodichloromethane	ug/kg	< 5.300	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	Bromoform	ug/kg	< 5.300	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	Bromomethane	ug/kg	< 11.000	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	Carbon disulfide	ug/kg	< 5.300	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	Carbon tetrachloride	ug/kg	< 5.300	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	Chlorobenzene	ug/kg	< 5.300	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	Chloroethane	ug/kg	< 11.000	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	Chloroform	ug/kg	< 5.300	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	Chloromethane	ug/kg	< 11.000	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	Dibromochloromethane	ug/kg	< 5.300	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	Ethylbenzene	ug/kg	< 5.300	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	Methylene chloride	ug/kg	< 5.300	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	Methyl ethyl ketone	ug/kg	< 11.000	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	Styrene	ug/kg	< 5.300	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	Tetrachloroethene	ug/kg	< 5.300	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	Toluene	ug/kg	< 5.300	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	Trichloroethene	ug/kg	< 5.300	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	Vinyl acetate	ug/kg	< 11.000	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	Vinyl chloride	ug/kg	< 11.000	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	Xylenes	ug/kg	< 5.300	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	cis-1,3-Dichloropropene	ug/kg	< 5.300	
SB280420.5	20.50	SB-28-04	01/05/92	EPA8240	trans-1,3-Dichloropropene	ug/kg	< 5.300	
SB280420.5	20.50	SB-28-04	01/05/92	EPA9045	pH	pH	5.000	
SB28045.5	5.50	SB-28-04	01/05/92	EPA8240	1,1,1-Trichloroethane	ug/kg	< 5.200	

Notes:

Fecal Coliform results reported as Most Probable Number (MPN) per 10 grams for soil samples and MPN per 100 milliliters for water samples.

ND: Not Detected

NR: Not Reported

NA: Not Analyzed

test data was 166 gpd/ft². Plate 42 shows the test locations and corresponding hydraulic conductivity values for the Paso Robles aquifer.

5.2.2.3 Santa Margarita Aquifer

The mean hydraulic conductivities in the Santa Margarita aquifer, based on one specific capacity and two constant-rate tests, are 600 and 46 gpd/ft², respectively. The average hydraulic conductivity estimated from these three Santa Margarita aquifer tests is 231 gpd/ft³ (Table 8). Plate 43 shows the test locations and corresponding hydraulic conductivity values for the Santa Margarita formation.

5.3 Groundwater Production

Seaside basin supply wells are operated by Cal-Am, the city of Seaside, and the California Water Service Company. Additionally, groundwater is produced from numerous private, domestic, and irrigation wells within the Seaside basin. The locations of the production wells monitored as part of this investigation are shown on Plates 38 and 39. Annual production totals for 1980 through 1991 for the Cal-Am, Seaside, and California Water Service wells are summarized in Table 9. For each active well, 1991 production data are presented in Table 10. Additional historical production data for Seaside basin wells are presented in SGD (1987a and 1990f).

5.3.1 California American Water Company (Cal-Am) Wells

Cal-Am has historically produced water from 11 wells in the Northern Seaside basin and 9 in the Southern Seaside basin. Annual production totals for 1980 through 1991 are summarized in Table 9. The maximum annual production occurred in 1984, when 1,085 million gallons were produced from the Northern basin and 64 million gallons were produced from the Southern basin (Table 9). Table 10 presents the total annual production for 1991 for each of the active Cal-Am wells.

5.3.2 City of Seaside Wells

Three Seaside basin wells are operated by the city of Seaside (Seaside 01, 02, and 03). Annual production totals for 1980 through 1991 are summarized in Table 9. Table 10 presents the total annual production for 1991 for each of the active Seaside wells.

5.3.3 California Water Service Company Wells

California Water Service Company operates five supply wells in the Toro Park area, southeast of Fort Ord. Annual production totals from 1988 through 1991 are summarized in Table 9 (previous records are not available). Table 10 presents the total annual production for 1991 for each of the active wells.

5.3.4 Private, Domestic and Agricultural Wells

Additional groundwater is produced from private, domestic, and agricultural wells in the Laguna Seca and Toro Park areas and in the Salinas Valley. SGD (1990f) reported that an active water-supply well is operated at Mission Memorial Park in the city of Seaside, and Fort Ord operates a water-supply well at the Fort Ord golf course. Inactive private wells include wells historically operated by the Monterey Sand Company, Lonestar (PCA well), and Calabrese Construction.

5.3.5 Water-Level Trends

Historical groundwater elevation data have been evaluated to assess general trends in basin storage. Hydrographs for several production and monitoring wells in the Seaside basin are presented in *Hydrogeologic Update, Seaside Coastal Groundwater Basins* (SGD, 1990f). These hydrographs are for the period 1960 through 1990, and generally show decreases in groundwater elevations over this period. SGD estimated the overall rate of decline in water levels to be several feet per year, with the exception of the Fort Ord subbasin, ~~additional water may be present~~ where it has been estimated that

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Sample Number	Sample Depth	Station Number	Sample Date	Test Method	Analyte	Units	Value	Detec
SB280520.5	20.50	SB-28-05	01/05/92	EPA8240	Chloroform	ug/kg	< 5.200	
SB280520.5	20.50	SB-28-05	01/05/92	EPA8240	Chloromethane	ug/kg	< 10.000	
SB280520.5	20.50	SB-28-05	01/05/92	EPA8240	Dibromochloromethane	ug/kg	< 5.200	
SB280520.5	20.50	SB-28-05	01/05/92	EPA8240	Ethylbenzene	ug/kg	< 5.200	
SB280520.5	20.50	SB-28-05	01/05/92	EPA8240	Methylene chloride	ug/kg	< 5.200	
SB280520.5	20.50	SB-28-05	01/05/92	EPA8240	Methyl ethyl ketone	ug/kg	< 10.000	
SB280520.5	20.50	SB-28-05	01/05/92	EPA8240	Styrene	ug/kg	< 5.200	
SB280520.5	20.50	SB-28-05	01/05/92	EPA8240	Tetrachloroethene	ug/kg	< 5.200	
SB280520.5	20.50	SB-28-05	01/05/92	EPA8240	Toluene	ug/kg	< 5.200	
SB280520.5	20.50	SB-28-05	01/05/92	EPA8240	Trichloroethene	ug/kg	< 5.200	
SB280520.5	20.50	SB-28-05	01/05/92	EPA8240	Vinyl acetate	ug/kg	< 10.000	
SB280520.5	20.50	SB-28-05	01/05/92	EPA8240	Vinyl chloride	ug/kg	< 10.000	
SB280520.5	20.50	SB-28-05	01/05/92	EPA8240	Xylenes	ug/kg	< 5.200	
SB280520.5	20.50	SB-28-05	01/05/92	EPA8240	cis-1,3-Dichloropropene	ug/kg	< 5.200	
SB280520.5	20.50	SB-28-05	01/05/92	EPA8240	trans-1,3-Dichloropropene	ug/kg	< 5.200	
SB280520.5	20.50	SB-28-05	01/05/92	EPA9045	pH	pH	5.300	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	1,1,1-Trichloroethane	ug/kg	< 5.200	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	1,1,2,2-Tetrachloroethane	ug/kg	< 5.200	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	1,1,2-Trichloroethane	ug/kg	< 5.200	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	1,1-Dichloroethane	ug/kg	< 5.200	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	1,1-Dichloroethene	ug/kg	< 5.200	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	1,2-Dichloroethane	ug/kg	< 5.200	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	1,2-Dichloroethene (total)	ug/kg	< 5.200	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	1,2-Dichloropropane	ug/kg	< 5.200	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	2-Hexanone	ug/kg	< 10.000	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	4-Methyl-2-pentanone (MIBK)	ug/kg	< 10.000	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	Acetone	ug/kg	8.000	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	Benzene	ug/kg	< 5.200	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	Bromodichloromethane	ug/kg	< 5.200	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	Bromoform	ug/kg	< 5.200	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	Bromomethane	ug/kg	< 10.000	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	Carbon disulfide	ug/kg	< 5.200	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	Carbon tetrachloride	ug/kg	< 5.200	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	Chlorobenzene	ug/kg	< 5.200	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	Chloroethane	ug/kg	< 10.000	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	Chloroform	ug/kg	< 5.200	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	Chloromethane	ug/kg	< 10.000	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	Dibromochloromethane	ug/kg	< 5.200	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	Ethylbenzene	ug/kg	< 5.200	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	Methylene chloride	ug/kg	< 5.200	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	Methyl ethyl ketone	ug/kg	< 10.000	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	Styrene	ug/kg	< 5.200	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	Tetrachloroethene	ug/kg	< 5.200	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	Toluene	ug/kg	< 5.200	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	Trichloroethene	ug/kg	< 5.200	

Notes:

Fecal Coliform results reported as Most Probable Number (MPN) per 10 grams for soil samples and MPN per 100 milliliters for water samples.

ND: Not Detected
NR: Not Reported
NA: Not Analyzed

Report Date: Jun 21, 1995

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Sample Number	Sample Depth	Station Number	Sample Date	Test Method	Analyte	Units	Value	Detec
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	Vinyl acetate	ug/kg	< 10.000	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	Vinyl chloride	ug/kg	< 10.000	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	Xylenes	ug/kg	< 5.200	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	cis-1,3-Dichloropropene	ug/kg	< 5.200	
SB28055.5	5.50	SB-28-05	01/05/92	EPA8240	trans-1,3-Dichloropropene	ug/kg	< 5.200	
SB28055.5	5.50	SB-28-05	01/05/92	EPA9045	pH	pH	5.600	
* Station Number * SB-28-06 * Matrix Type * SOIL								
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	1,1,1-Trichloroethane	ug/kg	< 5.200	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	1,1,2,2-Tetrachloroethane	ug/kg	< 5.200	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	1,1,2-Trichloroethane	ug/kg	< 5.200	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	1,1-Dichloroethane	ug/kg	< 5.200	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	1,1-Dichloroethane	ug/kg	< 5.200	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	1,2-Dichloroethane	ug/kg	< 5.200	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	1,2-Dichloroethane (total)	ug/kg	< 5.200	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	1,2-Dichloropropane	ug/kg	< 5.200	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	2-Hexanone	ug/kg	< 10.000	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	4-Methyl-2-pentanone (MIBK)	ug/kg	< 10.000	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	Acetone	ug/kg	< 10.000	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	Benzene	ug/kg	< 5.200	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	Bromodichloromethane	ug/kg	< 5.200	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	Bromoform	ug/kg	< 5.200	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	Bromomethane	ug/kg	< 10.000	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	Carbon disulfide	ug/kg	< 5.200	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	Carbon tetrachloride	ug/kg	< 5.200	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	Chlorobenzene	ug/kg	< 5.200	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	Chloroethane	ug/kg	< 10.000	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	Chloroform	ug/kg	< 5.200	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	Chloromethane	ug/kg	< 10.000	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	Dibromochloromethane	ug/kg	< 5.200	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	Ethylbenzene	ug/kg	< 5.200	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	Methylene chloride	ug/kg	< 5.200	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	Methyl ethyl ketone	ug/kg	< 10.000	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	Styrene	ug/kg	< 5.200	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	Tetrachloroethene	ug/kg	< 5.200	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	Toluene	ug/kg	< 5.200	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	Trichloroethane	ug/kg	< 5.200	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	Vinyl acetate	ug/kg	< 10.000	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	Vinyl chloride	ug/kg	< 10.000	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	Xylenes	ug/kg	< 5.200	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	cis-1,3-Dichloropropene	ug/kg	< 5.200	
SB280610.5	10.50	SB-28-06	01/05/92	EPA8240	trans-1,3-Dichloropropene	ug/kg	< 5.200	
SB280610.5	10.50	SB-28-06	01/05/92	EPA9045	pH	pH	5.700	
SB280620.5	20.50	SB-28-06	01/05/92	EPA8240	1,1,1-Trichloroethane	ug/kg	< 5.200	

Notes:

Fecal Coliform results reported as Most Probable Number (MPN) per 10 grams for soil samples and MPN per 100 milliliters for water samples.

ND: Not Detected
 NR: Not Reported
 NA: Not Analyzed

5.4.1.3.1 Uppermost Aquifer

The Piper diagram of six uppermost aquifer wells (Plate 44) suggests that the groundwater in wells MW-BW-04-A, MW-BW-06-A, and MW-BW-08-A is from a common source and consists of a calcium-magnesium-sodium and chloride-bicarbonate type water.

The Stiff diagrams (Plate 47) indicate variable general inorganic chemistry in the Uppermost aquifer. This is likely due to seawater intrusion effects near the coastline and localized chemical variability associated with land uses in this relatively shallow and highly permeable aquifer. The TDS concentrations in the Uppermost aquifer wells ranged from 203 to 2,180 mg/l, with a general increase toward the coastline (Table 38 and Plate 50).

5.4.1.3.2 Paso Robles Aquifer

The Piper diagram of the 15 Paso Robles wells (Plate 45) suggests that the groundwater in this aquifer is predominantly of a calcium-sodium and chloride-bicarbonate type.

The Stiff diagrams (Plate 48) indicate considerable variability in the general inorganic chemistry. Sodium is the dominant cation and chloride is the dominant anion. The TDS concentrations ranged from 190 to 1,050 mg/l and generally increased inland (Table 39 and Plate 51).

5.4.1.3.3 Santa Margarita Aquifer

The Piper diagram of the 10 Santa Margarita wells (Plate 46) indicates that groundwater is predominantly of a calcium-sodium and chloride-bicarbonate type.

The Stiff diagrams (Plate 49) indicate that the general inorganic chemistry in the Santa Margarita aquifer is relatively consistent. Sodium is the dominant cation while chloride and bicarbonate are present in similar amounts as the dominant anions. The

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Sample Number	Sample Depth	Station Number	Sample Date	Test Method	Analyte	Units	Value	Detect
SB28065.5	5.50	SB-28-06	01/05/92	EPA8240	Benzene	ug/kg	< 5.100	
SB28065.5	5.50	SB-28-06	01/05/92	EPA8240	Bromodichloromethane	ug/kg	< 5.100	
SB28065.5	5.50	SB-28-06	01/05/92	EPA8240	Bromoform	ug/kg	< 5.100	
SB28065.5	5.50	SB-28-06	01/05/92	EPA8240	Bromomethane	ug/kg	< 10.000	1
SB28065.5	5.50	SB-28-06	01/05/92	EPA8240	Carbon disulfide	ug/kg	< 5.100	
SB28065.5	5.50	SB-28-06	01/05/92	EPA8240	Carbon tetrachloride	ug/kg	< 5.100	
SB28065.5	5.50	SB-28-06	01/05/92	EPA8240	Chlorobenzene	ug/kg	< 5.100	
SB28065.5	5.50	SB-28-06	01/05/92	EPA8240	Chloroethane	ug/kg	< 10.000	1
SB28065.5	5.50	SB-28-06	01/05/92	EPA8240	Chloroform	ug/kg	< 5.100	
SB28065.5	5.50	SB-28-06	01/05/92	EPA8240	Chloromethane	ug/kg	< 10.000	1
SB28065.5	5.50	SB-28-06	01/05/92	EPA8240	Dibromochloromethane	ug/kg	< 5.100	
SB28065.5	5.50	SB-28-06	01/05/92	EPA8240	Ethylbenzene	ug/kg	< 5.100	
SB28065.5	5.50	SB-28-06	01/05/92	EPA8240	Methylene chloride	ug/kg	< 5.100	
SB28065.5	5.50	SB-28-06	01/05/92	EPA8240	Methyl ethyl ketone	ug/kg	< 10.000	1
SB28065.5	5.50	SB-28-06	01/05/92	EPA8240	Styrene	ug/kg	< 5.100	
SB28065.5	5.50	SB-28-06	01/05/92	EPA8240	Tetrachloroethene	ug/kg	< 5.100	
SB28065.5	5.50	SB-28-06	01/05/92	EPA8240	Toluene	ug/kg	< 5.100	
SB28065.5	5.50	SB-28-06	01/05/92	EPA8240	Trichloroethene	ug/kg	< 5.100	
SB28065.5	5.50	SB-28-06	01/05/92	EPA8240	Vinyl acetate	ug/kg	< 10.000	1
SB28065.5	5.50	SB-28-06	01/05/92	EPA8240	Vinyl chloride	ug/kg	< 10.000	1
SB28065.5	5.50	SB-28-06	01/05/92	EPA8240	Xylenes	ug/kg	< 5.100	
SB28065.5	5.50	SB-28-06	01/05/92	EPA8240	cis-1,3-Dichloropropene	ug/kg	< 5.100	
SB28065.5	5.50	SB-28-06	01/05/92	EPA8240	trans-1,3-Dichloropropene	ug/kg	< 5.100	
SB28065.5	5.50	SB-28-06	01/05/92	EPA9045	pH		6.500	

* Station Number * SG-28-01

* Matrix Type * SOIL GAS

SG28-01-5	5.00	SG-28-01	01/02/92	SOIL GAS	1,1,1-Trichloroethane	ug/l	1.300	
SG28-01-5	5.00	SG-28-01	01/02/92	SOIL GAS	Benzene	ug/l	< 0.010	
SG28-01-5	5.00	SG-28-01	01/02/92	SOIL GAS	Ethylbenzene	ug/l	< 0.010	
SG28-01-5	5.00	SG-28-01	01/02/92	SOIL GAS	Tetrachloroethene	ug/l	< 0.010	
SG28-01-5	5.00	SG-28-01	01/02/92	SOIL GAS	Toluene	ug/l	< 0.010	
SG28-01-5	5.00	SG-28-01	01/02/92	SOIL GAS	Total Hydrocarbons	ug/l	1.100	
SG28-01-5	5.00	SG-28-01	01/02/92	SOIL GAS	Trichloroethene	ug/l	< 0.010	
SG28-01-5	5.00	SG-28-01	01/02/92	SOIL GAS	Vinyl chloride	ug/l	< 0.010	
SG28-01-5	5.00	SG-28-01	01/02/92	SOIL GAS	cis-1,2-Dichloroethene	ug/l	< 0.010	
SG28-01-5	5.00	SG-28-01	01/02/92	SOIL GAS	m,p-Xylenes	ug/l	< 0.010	
SG28-01-5	5.00	SG-28-01	01/02/92	SOIL GAS	o-Xylene	ug/l	< 0.010	
SG28-01-5	5.00	SG-28-01	01/02/92	SOIL GAS	trans-1,2-Dichloroethene	ug/l	< 0.010	

* Station Number * SG-28-02

* Matrix Type * SOIL GAS

SG28-02-5	5.00	SG-28-02	01/02/92	SOIL GAS	1,1,1-Trichloroethane	ug/l	1.600	
SG28-02-5	5.00	SG-28-02	01/02/92	SOIL GAS	Benzene	ug/l	< 0.010	
SG28-02-5	5.00	SG-28-02	01/02/92	SOIL GAS	Ethylbenzene	ug/l	< 0.010	
SG28-02-5	5.00	SG-28-02	01/02/92	SOIL GAS	Tetrachloroethene	ug/l	< 0.010	

Notes:

Fecal Coliform results reported as Most Probable Number (MPN) per 10 grams for soil samples and MPN per 100 milliliters for water samples.

ND: Not Detected
 NR: Not Reported
 NA: Not Analyzed

5.4.2.2 Unconfirmed Contamination

Organic compounds were detected at low concentrations in several of the Seaside basin wells not related to Site 1. In these wells, the detected occurrences were either unconfirmed (i.e., seen in only one of multiple sampling events) or observed at a well that was sampled only once. Organic compounds were detected in 11 of the 32 wells sampled in the Seaside basin; these wells are listed in Table 41 with the detected organic compound(s). Nine of these wells were sampled twice, but only displayed detected organic compounds during one of the sampling rounds. The Plumas Test 90 and Plumas M-02 wells were only sampled once.

All of the wells displaying unconfirmed organic contamination should be resampled and analyzed to confirm or refute the presence of organic compounds in these wells. Wells displaying unconfirmed organic contamination that have been sampled once should be resampled at least two more times to generate a minimum of three sets of results from which to draw conclusions. The well construction details, well access, and pertinent historical information about the well should be collected to evaluate the appropriateness of the use of the well as an organic compound monitoring well.

5.4.3 Background Groundwater Chemistry

Table 42 lists wells from the Uppermost, Paso Robles, and Santa Margarita aquifers considered to represent background chemical conditions at Fort Ord. Tables 43 through 45 describe the maximum, minimum, and detection frequency of the general inorganics and the priority pollutant metals observed in the wells representative of background conditions for the Uppermost, Paso Robles, and Santa Margarita aquifers, respectively.

Wells were considered to represent background conditions if they were free of organic contaminants, located hydraulically upgradient from site activities, and displayed

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Sample Number	Sample Depth	Station Number	Sample Date	Test Method	Analyte	Units	Value	Detect
SG28-04-5	5.00	SG-28-04	01/02/92	SOIL GAS	Vinyl chloride	ug/l	< 0.010	
SG28-04-5	5.00	SG-28-04	01/02/92	SOIL GAS	cis-1,2-Dichloroethene	ug/l	< 0.010	
SG28-04-5	5.00	SG-28-04	01/02/92	SOIL GAS	m-,p-Xylenes	ug/l	< 0.010	
SG28-04-5	5.00	SG-28-04	01/02/92	SOIL GAS	o-Xylene	ug/l	0.690	
SG28-04-5	5.00	SG-28-04	01/02/92	SOIL GAS	trans-1,2-Dichloroethene	ug/l	< 0.010	
* Station Number * SG-28-05 * Matrix Type * SOIL GAS								
SG28-05-5	5.00	SG-28-05	01/01/92	SOIL GAS	1,1,1-Trichloroethane	ug/l	0.670	
SG28-05-5	5.00	SG-28-05	01/01/92	SOIL GAS	Benzene	ug/l	0.020	
SG28-05-5	5.00	SG-28-05	01/01/92	SOIL GAS	Ethylbenzene	ug/l	< 0.010	
SG28-05-5	5.00	SG-28-05	01/01/92	SOIL GAS	Tetrachloroethene	ug/l	< 0.010	
SG28-05-5	5.00	SG-28-05	01/01/92	SOIL GAS	Toluene	ug/l	0.130	
SG28-05-5	5.00	SG-28-05	01/01/92	SOIL GAS	Total Hydrocarbons	ug/l	3.000	
SG28-05-5	5.00	SG-28-05	01/01/92	SOIL GAS	Trichloroethene	ug/l	< 0.010	
SG28-05-5	5.00	SG-28-05	01/01/92	SOIL GAS	Vinyl chloride	ug/l	0.320	
SG28-05-5	5.00	SG-28-05	01/01/92	SOIL GAS	cis-1,2-Dichloroethene	ug/l	< 0.010	
SG28-05-5	5.00	SG-28-05	01/01/92	SOIL GAS	m-,p-Xylenes	ug/l	0.030	
SG28-05-5	5.00	SG-28-05	01/01/92	SOIL GAS	o-Xylene	ug/l	0.030	
SG28-05-5	5.00	SG-28-05	01/01/92	SOIL GAS	trans-1,2-Dichloroethene	ug/l	< 0.010	
* Station Number * SG-28-06 * Matrix Type * SOIL GAS								
SG28-06-5	5.00	SG-28-06	01/01/92	SOIL GAS	1,1,1-Trichloroethane	ug/l	0.760	
SG28-06-5	5.00	SG-28-06	01/01/92	SOIL GAS	Benzene	ug/l	< 0.010	
SG28-06-5	5.00	SG-28-06	01/01/92	SOIL GAS	Ethylbenzene	ug/l	< 0.010	
SG28-06-5	5.00	SG-28-06	01/01/92	SOIL GAS	Tetrachloroethene	ug/l	< 0.010	
SG28-06-5	5.00	SG-28-06	01/01/92	SOIL GAS	Toluene	ug/l	0.050	
SG28-06-5	5.00	SG-28-06	01/01/92	SOIL GAS	Total Hydrocarbons	ug/l	0.730	
SG28-06-5	5.00	SG-28-06	01/01/92	SOIL GAS	Trichloroethene	ug/l	< 0.010	
SG28-06-5	5.00	SG-28-06	01/01/92	SOIL GAS	Vinyl chloride	ug/l	< 0.010	
SG28-06-5	5.00	SG-28-06	01/01/92	SOIL GAS	cis-1,2-Dichloroethene	ug/l	< 0.010	
SG28-06-5	5.00	SG-28-06	01/01/92	SOIL GAS	m-,p-Xylenes	ug/l	< 0.010	
SG28-06-5	5.00	SG-28-06	01/01/92	SOIL GAS	o-Xylene	ug/l	< 0.010	
SG28-06-5	5.00	SG-28-06	01/01/92	SOIL GAS	trans-1,2-Dichloroethene	ug/l	< 0.010	
* Station Number * SG-28-07 * Matrix Type * SOIL GAS								
SG28-07-5	5.00	SG-28-07	01/02/92	SOIL GAS	1,1,1-Trichloroethane	ug/l	1.100	
SG28-07-5	5.00	SG-28-07	01/02/92	SOIL GAS	Benzene	ug/l	< 0.010	
SG28-07-5	5.00	SG-28-07	01/02/92	SOIL GAS	Ethylbenzene	ug/l	< 0.010	
SG28-07-5	5.00	SG-28-07	01/02/92	SOIL GAS	Tetrachloroethene	ug/l	0.030	
SG28-07-5	5.00	SG-28-07	01/02/92	SOIL GAS	Toluene	ug/l	< 0.010	
SG28-07-5	5.00	SG-28-07	01/02/92	SOIL GAS	Total Hydrocarbons	ug/l	18.000	
SG28-07-5	5.00	SG-28-07	01/02/92	SOIL GAS	Trichloroethene	ug/l	< 0.010	
SG28-07-5	5.00	SG-28-07	01/02/92	SOIL GAS	Vinyl chloride	ug/l	< 0.010	

Notes:

Fecal Coliform results reported as Most Probable Number (MPN) per 10 grams for soil samples and MPN per 100 milliliters for water samples.

ND: Not Detected
 NR: Not Reported
 NA: Not Analyzed

6.0 BASIN INTERCONNECTION

6.1 Geology

As described in Sections 4.1 and 5.1, the deeper aquifer materials of the Seaside and Salinas basins appear to be largely separated by the bedrock (Monterey Formation) high located between the Main Garrison and the city of Seaside. Characterization of the geometry and extent of this bedrock high is limited by the relatively few data points in the area. In the FO-04, Gigling, and MW-B-26-180 wells, the contact between the Monterey Formation and overlying unconsolidated aquifer materials appears to occur at approximately 75, -10 and 0 feet above MSL, respectively. These data suggest the bedrock high slopes toward the west and has a relatively flat surface between the Gigling and MW-B-26-180 wells.

6.2 Hydrogeology

Based on extrapolation of water-level elevations in wells on the north and south sides of the bedrock high, the saturated thickness of aquifer materials overlying the bedrock in the vicinity of the Gigling well is relatively thin, as shown on cross sections A-A', D-D', and E-E' (Plates 6 and 7). On the Salinas basin side of the bedrock high, in the area of wells MW-B-22-180 through ~~MW-B-29-180~~ MW-B-23-180, and MW-B-25-180 (Plate 12), groundwater flow in the 180-foot aquifer in July 1992 was to the north or ~~northwest~~ northeast, away from the Gigling well area. On the southern (Seaside basin) side of the bedrock high, flow directions are variable (Plates 37 and 38). However, the elevations of groundwater in both the Uppermost and Paso Robles aquifer that are at approximately the same elevation as the bedrock high indicate that the saturated thickness of material present atop the bedrock high is small. Therefore, it appears that the interconnection of the Salinas and Seaside

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Sample Number	Sample Depth	Station Number	Sample Date	Test Method	Analyte	Units	Value	Detected
SG28-10-5.5	5.50	SG-28-10	01/01/92	SOIL GAS	m-,p-Xylenes	ug/l	0.020	
SG28-10-5.5	5.50	SG-28-10	01/01/92	SOIL GAS	o-Xylene	ug/l	< 0.010	
SG28-10-5.5	5.50	SG-28-10	01/01/92	SOIL GAS	trans-1,2-Dichloroethene	ug/l	< 0.010	
* Station Number * SG-28-11 * Matrix Type * SOIL GAS								
SG28-11-5	5.00	SG-28-11	01/02/92	SOIL GAS	1,1,1-Trichloroethane	ug/l	0.080	
SG28-11-5	5.00	SG-28-11	01/02/92	SOIL GAS	Benzene	ug/l	< 0.010	
SG28-11-5	5.00	SG-28-11	01/02/92	SOIL GAS	Ethylbenzene	ug/l	< 0.010	
SG28-11-5	5.00	SG-28-11	01/02/92	SOIL GAS	Tetrachloroethene	ug/l	0.030	
SG28-11-5	5.00	SG-28-11	01/02/92	SOIL GAS	Toluene	ug/l	0.040	
SG28-11-5	5.00	SG-28-11	01/02/92	SOIL GAS	Total Hydrocarbons	ug/l	1.800	
SG28-11-5	5.00	SG-28-11	01/02/92	SOIL GAS	Trichloroethene	ug/l	< 0.010	
SG28-11-5	5.00	SG-28-11	01/02/92	SOIL GAS	Vinyl chloride	ug/l	< 0.010	
SG28-11-5	5.00	SG-28-11	01/02/92	SOIL GAS	cis-1,2-Dichloroethene	ug/l	< 0.010	
SG28-11-5	5.00	SG-28-11	01/02/92	SOIL GAS	m-,p-Xylenes	ug/l	< 0.010	
SG28-11-5	5.00	SG-28-11	01/02/92	SOIL GAS	o-Xylene	ug/l	< 0.010	
SG28-11-5	5.00	SG-28-11	01/02/92	SOIL GAS	trans-1,2-Dichloroethene	ug/l	< 0.010	
* Station Number * SG-28-12 * Matrix Type * SOIL GAS								
SG28-12-5	5.00	SG-28-12	01/02/92	SOIL GAS	1,1,1-Trichloroethane	ug/l	< 0.010	
SG28-12-5	5.00	SG-28-12	01/02/92	SOIL GAS	Benzene	ug/l	< 0.010	
SG28-12-5	5.00	SG-28-12	01/02/92	SOIL GAS	Ethylbenzene	ug/l	< 0.010	
SG28-12-5	5.00	SG-28-12	01/02/92	SOIL GAS	Tetrachloroethene	ug/l	0.500	
SG28-12-5	5.00	SG-28-12	01/02/92	SOIL GAS	Toluene	ug/l	< 0.010	
SG28-12-5	5.00	SG-28-12	01/02/92	SOIL GAS	Total Hydrocarbons	ug/l	0.520	
SG28-12-5	5.00	SG-28-12	01/02/92	SOIL GAS	Trichloroethene	ug/l	< 0.010	
SG28-12-5	5.00	SG-28-12	01/02/92	SOIL GAS	Vinyl chloride	ug/l	< 0.010	
SG28-12-5	5.00	SG-28-12	01/02/92	SOIL GAS	cis-1,2-Dichloroethene	ug/l	< 0.010	
SG28-12-5	5.00	SG-28-12	01/02/92	SOIL GAS	m-,p-Xylenes	ug/l	< 0.010	
SG28-12-5	5.00	SG-28-12	01/02/92	SOIL GAS	o-Xylene	ug/l	< 0.010	
SG28-12-5	5.00	SG-28-12	01/02/92	SOIL GAS	trans-1,2-Dichloroethene	ug/l	< 0.010	
* Station Number * SG-28-13 * Matrix Type * SOIL GAS								
SG28-13-5	5.00	SG-28-13	01/02/92	SOIL GAS	1,1,1-Trichloroethane	ug/l	< 0.010	
SG28-13-5	5.00	SG-28-13	01/02/92	SOIL GAS	Benzene	ug/l	< 0.010	
SG28-13-5	5.00	SG-28-13	01/02/92	SOIL GAS	Ethylbenzene	ug/l	< 0.010	
SG28-13-5	5.00	SG-28-13	01/02/92	SOIL GAS	Tetrachloroethene	ug/l	0.050	
SG28-13-5	5.00	SG-28-13	01/02/92	SOIL GAS	Toluene	ug/l	< 0.010	
SG28-13-5	5.00	SG-28-13	01/02/92	SOIL GAS	Total Hydrocarbons	ug/l	0.480	
SG28-13-5	5.00	SG-28-13	01/02/92	SOIL GAS	Trichloroethene	ug/l	< 0.010	
SG28-13-5	5.00	SG-28-13	01/02/92	SOIL GAS	Vinyl chloride	ug/l	< 0.010	
SG28-13-5	5.00	SG-28-13	01/02/92	SOIL GAS	cis-1,2-Dichloroethene	ug/l	< 0.010	
SG28-13-5	5.00	SG-28-13	01/02/92	SOIL GAS	m-,p-Xylenes	ug/l	< 0.010	

Notes:

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7.0 CONCLUSIONS

This section presents the current understanding of the hydrogeologic framework of the Salinas and Seaside basins based on the information presented herein.

7.1 Salinas Basin

7.1.1 A-Aquifer

Older dune sand blankets much of the base; this highly permeable sand is directly recharged by precipitation, surface drainage, and other sources of surface infiltration. As a result, the unsaturated portion of this geologic unit and the A-aquifer are considered highly susceptible to contamination resulting from surface activities. Within the older dune sand are occasional silt strata. These fine-grained strata may inhibit vertical unsaturated and saturated flow and encourage lateral flow.

Groundwater in the A-aquifer is not used directly for water supply. However, this aquifer discharges into the underlying 180-foot aquifer, a principal source of drinking and irrigation water, creating a potential contaminant source to the 180-foot aquifer. Extensive fine-grained sediments (predominantly clay of the FO-SVA) form an effective hydraulic separation between the A- and 180-foot aquifers ~~throughout-~~ portions across large areas of Fort Ord. As a consequence, flow from the A- into the 180-foot aquifer appears to be largely restricted to the edges of the FO-SVA, particularly in the Main Garrison area. The perched and unconfined groundwater of the A-aquifer is believed to cascade off the edge of the FO-SVA into the 180-foot aquifer system.

Pathways between the A-aquifer and the 180-foot aquifer may also occur at wells constructed without an adequate seal between the two aquifers. Ten Fort Ord wells near the OU2 landfill were destroyed in 1989 as part of the Army's program to

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Sample Number	Sample Depth	Station Number	Sample Date	Test Method	Analyte	Units	Value	Date
SG28-16-5A	5.00	SG-28-16	01/02/92	SOIL GAS	trans-1,2-Dichloroethene	ug/l	< 0.010	
SG28-16-5B	5.00	SG-28-16	01/02/92	SOIL GAS	1,1,1-Trichloroethane	ug/l	< 0.010	
SG28-16-5B	5.00	SG-28-16	01/02/92	SOIL GAS	Benzene	ug/l	< 0.010	
SG28-16-5B	5.00	SG-28-16	01/02/92	SOIL GAS	Ethylbenzene	ug/l	< 0.010	
SG28-16-5B	5.00	SG-28-16	01/02/92	SOIL GAS	Tetrachloroethene	ug/l	0.050	
SG28-16-5B	5.00	SG-28-16	01/02/92	SOIL GAS	Toluene	ug/l	0.030	
SG28-16-5B	5.00	SG-28-16	01/02/92	SOIL GAS	Total Hydrocarbons	ug/l	1.800	
SG28-16-5B	5.00	SG-28-16	01/02/92	SOIL GAS	Trichloroethene	ug/l	< 0.010	
SG28-16-5B	5.00	SG-28-16	01/02/92	SOIL GAS	Vinyl chloride	ug/l	< 0.010	
SG28-16-5B	5.00	SG-28-16	01/02/92	SOIL GAS	cis-1,2-Dichloroethene	ug/l	< 0.010	
SG28-16-5B	5.00	SG-28-16	01/02/92	SOIL GAS	m,p-Xylenes	ug/l	0.040	
SG28-16-5B	5.00	SG-28-16	01/02/92	SOIL GAS	o-Xylene	ug/l	< 0.010	
SG28-16-5B	5.00	SG-28-16	01/02/92	SOIL GAS	trans-1,2-Dichloroethene	ug/l	< 0.010	
* Station Number * SG-28-17			* Matrix Type * SOIL GAS					
SG28-17-5	5.00	SG-28-17	01/02/92	SOIL GAS	1,1,1-Trichloroethane	ug/l	< 0.010	
SG28-17-5	5.00	SG-28-17	01/02/92	SOIL GAS	Benzene	ug/l	< 0.010	
SG28-17-5	5.00	SG-28-17	01/02/92	SOIL GAS	Ethylbenzene	ug/l	< 0.010	
SG28-17-5	5.00	SG-28-17	01/02/92	SOIL GAS	Tetrachloroethene	ug/l	0.430	
SG28-17-5	5.00	SG-28-17	01/02/92	SOIL GAS	Toluene	ug/l	< 0.010	
SG28-17-5	5.00	SG-28-17	01/02/92	SOIL GAS	Total Hydrocarbons	ug/l	0.240	
SG28-17-5	5.00	SG-28-17	01/02/92	SOIL GAS	Trichloroethene	ug/l	< 0.010	
SG28-17-5	5.00	SG-28-17	01/02/92	SOIL GAS	Vinyl chloride	ug/l	< 0.010	
SG28-17-5	5.00	SG-28-17	01/02/92	SOIL GAS	cis-1,2-Dichloroethene	ug/l	< 0.010	
SG28-17-5	5.00	SG-28-17	01/02/92	SOIL GAS	m,p-Xylenes	ug/l	< 0.010	
SG28-17-5	5.00	SG-28-17	01/02/92	SOIL GAS	o-Xylene	ug/l	< 0.010	
SG28-17-5	5.00	SG-28-17	01/02/92	SOIL GAS	trans-1,2-Dichloroethene	ug/l	< 0.010	
* Station Number * SG-28-18			* Matrix Type * SOIL GAS					
SG28-18-5	5.00	SG-28-18	01/02/92	SOIL GAS	1,1,1-Trichloroethane	ug/l	< 0.010	
SG28-18-5	5.00	SG-28-18	01/02/92	SOIL GAS	Benzene	ug/l	< 0.010	
SG28-18-5	5.00	SG-28-18	01/02/92	SOIL GAS	Ethylbenzene	ug/l	< 0.010	
SG28-18-5	5.00	SG-28-18	01/02/92	SOIL GAS	Tetrachloroethene	ug/l	0.560	
SG28-18-5	5.00	SG-28-18	01/02/92	SOIL GAS	Toluene	ug/l	< 0.010	
SG28-18-5	5.00	SG-28-18	01/02/92	SOIL GAS	Total Hydrocarbons	ug/l	0.340	
SG28-18-5	5.00	SG-28-18	01/02/92	SOIL GAS	Trichloroethene	ug/l	< 0.010	
SG28-18-5	5.00	SG-28-18	01/02/92	SOIL GAS	Vinyl chloride	ug/l	< 0.010	
SG28-18-5	5.00	SG-28-18	01/02/92	SOIL GAS	cis-1,2-Dichloroethene	ug/l	< 0.010	
SG28-18-5	5.00	SG-28-18	01/02/92	SOIL GAS	m,p-Xylenes	ug/l	< 0.010	
SG28-18-5	5.00	SG-28-18	01/02/92	SOIL GAS	o-Xylene	ug/l	< 0.010	
SG28-18-5	5.00	SG-28-18	01/02/92	SOIL GAS	trans-1,2-Dichloroethene	ug/l	< 0.010	
* Station Number * SG-28-19			* Matrix Type * SOIL GAS					

Notes:

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Sample Number	Sample Depth	Station Number	Sample Date	Test Method	Analyte	Units	Value	Detect
SG28-19-5	5.00	SG-28-19	01/02/92	SOIL GAS	1,1,1-Trichloroethane	ug/l	<	0.010
SG28-19-5	5.00	SG-28-19	01/02/92	SOIL GAS	Benzene	ug/l	<	0.010
SG28-19-5	5.00	SG-28-19	01/02/92	SOIL GAS	Ethylbenzene	ug/l	<	0.010
SG28-19-5	5.00	SG-28-19	01/02/92	SOIL GAS	Tetrachloroethene	ug/l	<	1.200
SG28-19-5	5.00	SG-28-19	01/02/92	SOIL GAS	Toluene	ug/l	<	0.010
SG28-19-5	5.00	SG-28-19	01/02/92	SOIL GAS	Total Hydrocarbons	ug/l	<	0.580
SG28-19-5	5.00	SG-28-19	01/02/92	SOIL GAS	Trichloroethene	ug/l	<	0.010
SG28-19-5	5.00	SG-28-19	01/02/92	SOIL GAS	Vinyl chloride	ug/l	<	0.010
SG28-19-5	5.00	SG-28-19	01/02/92	SOIL GAS	cis-1,2-Dichloroethene	ug/l	<	0.010
SG28-19-5	5.00	SG-28-19	01/02/92	SOIL GAS	m,p-Xylenes	ug/l	<	0.010
SG28-19-5	5.00	SG-28-19	01/02/92	SOIL GAS	o-Xylene	ug/l	<	0.010
SG28-19-5	5.00	SG-28-19	01/02/92	SOIL GAS	trans-1,2-Dichloroethene	ug/l	<	0.010
* Station Number * SG-28-20 * Matrix Type * SOIL GAS								
SG28-20-5	5.00	SG-28-20	01/02/92	SOIL GAS	1,1,1-Trichloroethane	ug/l	<	0.070
SG28-20-5	5.00	SG-28-20	01/02/92	SOIL GAS	Benzene	ug/l	<	0.010
SG28-20-5	5.00	SG-28-20	01/02/92	SOIL GAS	Ethylbenzene	ug/l	<	0.010
SG28-20-5	5.00	SG-28-20	01/02/92	SOIL GAS	Tetrachloroethene	ug/l	<	2.600
SG28-20-5	5.00	SG-28-20	01/02/92	SOIL GAS	Toluene	ug/l	<	0.010
SG28-20-5	5.00	SG-28-20	01/02/92	SOIL GAS	Total Hydrocarbons	ug/l	<	1.100
SG28-20-5	5.00	SG-28-20	01/02/92	SOIL GAS	Trichloroethene	ug/l	<	0.010
SG28-20-5	5.00	SG-28-20	01/02/92	SOIL GAS	Vinyl chloride	ug/l	<	0.010
SG28-20-5	5.00	SG-28-20	01/02/92	SOIL GAS	cis-1,2-Dichloroethene	ug/l	<	0.010
SG28-20-5	5.00	SG-28-20	01/02/92	SOIL GAS	m,p-Xylenes	ug/l	<	0.010
SG28-20-5	5.00	SG-28-20	01/02/92	SOIL GAS	o-Xylene	ug/l	<	0.010
SG28-20-5	5.00	SG-28-20	01/02/92	SOIL GAS	trans-1,2-Dichloroethene	ug/l	<	0.010
* Station Number * SS-28-01 * Matrix Type * SOIL								
9333C028001F	0.00	SS-28-01	08/16/93	EPA6010	Beryllium	mg/kg	<	0.100
9333C028001F	0.00	SS-28-01	08/16/93	EPA6010	Cadmium	mg/kg	<	0.610
9333C028001F	0.00	SS-28-01	08/16/93	EPA6010	Chromium	mg/kg	<	27.400
9333C028001F	0.00	SS-28-01	08/16/93	EPA6010	Copper	mg/kg	<	9.800
9333C028001F	0.00	SS-28-01	08/16/93	EPA6010	Lead	mg/kg	<	36.100
9333C028001F	0.00	SS-28-01	08/16/93	EPA6010	Nickel	mg/kg	<	10.000
9333C028001F	0.00	SS-28-01	08/16/93	EPA6010	Silver	mg/kg	<	1.500
9333C028001F	0.00	SS-28-01	08/16/93	EPA6010	Zinc	mg/kg	<	93.500
9333C028001F	0.00	SS-28-01	08/16/93	EPA7061	Antimony	mg/kg	<	0.310
9333C028001F	0.00	SS-28-01	08/16/93	EPA7060	Arsenic	mg/kg	<	1.700
9333C028001F	0.00	SS-28-01	08/16/93	EPA7471	Mercury	mg/kg	<	0.051
9333C028001F	0.00	SS-28-01	08/16/93	EPA7740	Selenium	mg/kg	<	0.840
9333C028001F	0.00	SS-28-01	08/16/93	EPA7841	Thallium	mg/kg	<	0.430
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	1,1,1-Trichloroethane	ug/kg	<	5.100
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	1,1,2,2-Tetrachloroethane	ug/kg	<	5.100

Notes:

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Sample Number	Sample Depth	Station Number	Sample Date	Test Method	Analyte	Units	Value	Dete
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	1,1,2-Trichloroethane	ug/kg	< 5.100	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	1,1-Dichloroethane	ug/kg	< 5.100	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	1,1-Dichloroethene	ug/kg	< 5.100	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	1,2-Dichloroethane	ug/kg	< 5.100	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	1,2-Dichloroethene (total)	ug/kg	< 5.100	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	1,2-Dichloropropane	ug/kg	< 5.100	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	2-Hexanone	ug/kg	< 10.000	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	4-Methyl-2-pentanone (MIBK)	ug/kg	< 10.000	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	Acetone	ug/kg	< 4.400	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	Benzene	ug/kg	< 5.100	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	Bromodichloromethane	ug/kg	< 5.100	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	Bromoform	ug/kg	< 5.100	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	Bromomethane	ug/kg	< 10.000	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	Carbon disulfide	ug/kg	< 5.100	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	Carbon tetrachloride	ug/kg	< 5.100	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	Chlorobenzene	ug/kg	< 5.100	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	Chloroethane	ug/kg	< 10.000	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	Chloroform	ug/kg	< 5.100	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	Chloromethane	ug/kg	< 10.000	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	Dibromochloromethane	ug/kg	< 5.100	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	Ethylbenzene	ug/kg	< 5.100	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	Methylene chloride	ug/kg	< 5.100	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	Methyl ethyl ketone	ug/kg	< 10.000	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	Styrene	ug/kg	< 5.100	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	Tetrachloroethene	ug/kg	< 5.100	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	Toluene	ug/kg	< 5.100	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	Trichloroethene	ug/kg	< 5.100	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	Vinyl acetate	ug/kg	< 10.000	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	Vinyl chloride	ug/kg	< 10.000	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	Xylenes	ug/kg	< 5.100	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	cis-1,3-Dichloropropene	ug/kg	< 5.100	
9333C028001F	0.00	SS-28-01	08/16/93	EPA8240	trans-1,3-Dichloropropene	ug/kg	< 5.100	

* Station Number * SS-28-02

* Matrix Type * SOIL

9333C028002F	0.00	SS-28-02	08/16/93	EPA6010	Beryllium	mg/kg	0.120	
9333C028002F	0.00	SS-28-02	08/16/93	EPA6010	Cadmium	mg/kg	< 0.620	
9333C028002F	0.00	SS-28-02	08/16/93	EPA6010	Chromium	mg/kg	9.600	
9333C028002F	0.00	SS-28-02	08/16/93	EPA6010	Copper	mg/kg	16.100	
9333C028002F	0.00	SS-28-02	08/16/93	EPA6010	Nickel	mg/kg	7.000	
9333C028002F	0.00	SS-28-02	08/16/93	EPA6010	Silver	mg/kg	2.700	
9333C028002F	0.00	SS-28-02	08/16/93	EPA6010	Zinc	mg/kg	59.600	
9333C028002F	0.00	SS-28-02	08/16/93	EPA7041	Antimony	mg/kg	< 0.310	
9333C028002F	0.00	SS-28-02	08/16/93	EPA7060	Arsenic	mg/kg	< 1.300	
9333C028002F	0.00	SS-28-02	08/16/93	EPA7421	Lead	mg/kg	52.600	
9333C028002F	0.00	SS-28-02	08/16/93	EPA7471	Mercury	mg/kg	0.310	

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Sample Number	Sample Depth	Station Number	Sample Date	Test Method	Analyte	Units	Value	Detect
9333C028002F	0.00	SS-28-02	08/16/93	EPA7740	Selenium	mg/kg	<	0.540
9333C028002F	0.00	SS-28-02	08/16/93	EPA7841	Thallium	mg/kg	<	0.430
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	1,1,1-Trichloroethane	ug/kg	<	5.200
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	1,1,2,2-Tetrachloroethane	ug/kg	<	5.200
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	1,1,2-Trichloroethane	ug/kg	<	5.200
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	1,1-Dichloroethane	ug/kg	<	5.200
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	1,1-Dichloroethane	ug/kg	<	5.200
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	1,2-Dichloroethane	ug/kg	<	5.200
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	1,2-Dichloroethane (total)	ug/kg	<	5.200
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	1,2-Dichloropropane	ug/kg	<	5.200
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	2-Hexanone	ug/kg	<	10.000
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	4-Methyl-2-pentanone (MIBK)	ug/kg	<	10.000
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	Acetone	ug/kg	<	10.000
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	Benzene	ug/kg	<	5.200
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	Bromodichloromethane	ug/kg	<	5.200
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	Bromoform	ug/kg	<	5.200
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	Bromomethane	ug/kg	<	10.000
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	Carbon disulfide	ug/kg	<	5.200
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	Carbon tetrachloride	ug/kg	<	5.200
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	Chlorobenzene	ug/kg	<	5.200
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	Chloroethane	ug/kg	<	10.000
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	Chloroform	ug/kg	<	5.200
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	Chloromethane	ug/kg	<	10.000
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	Dibromochloromethane	ug/kg	<	5.200
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	Ethylbenzene	ug/kg	<	5.200
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	Methylene chloride	ug/kg	<	5.200
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	Methyl ethyl ketone	ug/kg	<	10.000
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	Styrene	ug/kg	<	5.200
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	Tetrachloroethane	ug/kg	<	5.200
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	Toluene	ug/kg	<	5.200
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	Trichloroethane	ug/kg	<	5.200
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	Vinyl acetate	ug/kg	<	10.000
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	Vinyl chloride	ug/kg	<	10.000
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	Xylenes	ug/kg	<	5.200
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	cis-1,3-Dichloropropene	ug/kg	<	5.200
9333C028002F	0.00	SS-28-02	08/16/93	EPA8240	trans-1,3-Dichloropropene	ug/kg	<	5.200

* Station Number * SS-28-03

* Matrix Type * SOIL

9333C028003F	0.00	SS-28-03	08/16/93	EPA6010	Beryllium	mg/kg	0.120
9333C028003F	0.00	SS-28-03	08/16/93	EPA6010	Cadmium	mg/kg	1.200
9333C028003F	0.00	SS-28-03	08/16/93	EPA6010	Chromium	mg/kg	13.900
9333C028003F	0.00	SS-28-03	08/16/93	EPA6010	Copper	mg/kg	42.400
9333C028003F	0.00	SS-28-03	08/16/93	EPA6010	Lead	mg/kg	155.000
9333C028003F	0.00	SS-28-03	08/16/93	EPA6010	Nickel	mg/kg	7.100
9333C028003F	0.00	SS-28-03	08/16/93	EPA6010	Silver	mg/kg	72.500

Notes:

Fecal Coliform results reported as Most Probable Number (MPN) per 10 grams for soil samples and MPN per 100 milliliters for water samples.

ND: Not Detected
 NR: Not Reported
 NA: Not Analyzed

Chemical Data Report - All Chemical Results
 Site 28
 Barracks and Main Garrison Area
 Fort Ord, California
 Date Range: 01/01/92-12/10/93

Sample Number	Sample Depth	Station Number	Sample Date	Test Method	Analyte	Units	Value	Date
9333C028003F	0.00	SS-28-03	08/16/93	EPA6010	Zinc	mg/kg	84.400	
9333C028003F	0.00	SS-28-03	08/16/93	EPA7041	Antimony	mg/kg	< 0.320	
9333C028003F	0.00	SS-28-03	08/16/93	EPA7060	Arsenic	mg/kg	< 1.900	
9333C028003F	0.00	SS-28-03	08/16/93	EPA7471	Mercury	mg/kg	< 0.053	
9333C028003F	0.00	SS-28-03	08/16/93	EPA7740	Selenium	mg/kg	< 0.550	
9333C028003F	0.00	SS-28-03	08/16/93	EPA7841	Thallium	mg/kg	< 0.450	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	1,1,1-Trichloroethane	ug/kg	< 5.300	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	1,1,2,2-Tetrachloroethane	ug/kg	< 5.300	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	1,1,2-Trichloroethane	ug/kg	< 5.300	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	1,1-Dichloroethane	ug/kg	< 5.300	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	1,2-Dichloroethane	ug/kg	< 5.300	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	1,2-Dichloroethane (total)	ug/kg	< 5.300	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	1,2-Dichloropropane	ug/kg	< 5.300	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	2-Hexanone	ug/kg	< 11.000	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	4-Methyl-2-pentanone (MIBK)	ug/kg	< 11.000	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	Acetone	ug/kg	< 11.000	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	Benzene	ug/kg	< 5.300	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	Bromodichloromethane	ug/kg	< 5.300	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	Bromoform	ug/kg	< 5.300	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	Bromomethane	ug/kg	< 11.000	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	Carbon disulfide	ug/kg	< 5.300	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	Carbon tetrachloride	ug/kg	< 5.300	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	Chlorobenzene	ug/kg	< 5.300	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	Chloroethane	ug/kg	< 11.000	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	Chloroform	ug/kg	< 5.300	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	Chloromethane	ug/kg	< 11.000	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	Dibromochloromethane	ug/kg	< 5.300	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	Ethylbenzene	ug/kg	< 5.300	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	Methylene chloride	ug/kg	< 5.300	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	Methyl ethyl ketone	ug/kg	< 11.000	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	Styrene	ug/kg	< 5.300	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	Tetrachloroethene	ug/kg	< 5.300	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	Toluene	ug/kg	< 5.300	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	Trichloroethene	ug/kg	< 5.300	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	Vinyl acetate	ug/kg	< 11.000	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	Vinyl chloride	ug/kg	< 11.000	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	Xylenes	ug/kg	< 5.300	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	cis-1,3-Dichloropropene	ug/kg	< 5.300	
9333C028003F	0.00	SS-28-03	08/16/93	EPA8240	trans-1,3-Dichloropropene	ug/kg	< 5.300	

Notes:

Fecal Coliform results reported as Most Probable Number (MPN) per 10 grams for soil samples and MPN per 100 milliliters for water samples.

ND: Not Detected

NR: Not Reported

NA: Not Analyzed

Description of Organic Qualifiers Used in Database

HLA Validation Assigned Qualifiers

A: Sample has undergone routine data validation.

F: The presence of this compound is due to suspected field contamination.

J0: Analytical results for this compound are qualified as estimated due to noncompliance with internal area count or retention time criteria.

J1: Analytical results for this compound are qualified as estimated due to noncompliance with instrument performance criteria.

J2: Analytical results for this compound are qualified as estimated due to noncompliance with precision

J3: Analytical results for this compound are qualified as estimated due to poor spike recoveries.

J5: Analytical results for this compound are qualified as estimated due to holding time exceedances.

J6: Analytical results for this compound are qualified as estimated due to field duplicate quality control criteria exceedances.

J7: Analytical results for this compound are qualified as estimated due to initial and/or continuing calibration problems.

J8: Analytical results for this compound are qualified as estimated due to detection of the compound above the instrument calibration range.

J*: Analytical results for this compound are qualified as estimated due to miscellaneous lab errors.

NQ: Analytical results for this compound have not been qualified.

N1: Analytical results for this compound are qualified as estimated and presumptively present due to its as a tentatively identified compound.

N2: Data not qualified due to lack of applicable or relevant criteria. Please refer to data validation quality text for a discussion of data usability.

R0: Analytical results for this compound are qualified as rejected due to noncompliance with internal area count or retention time criteria.

R1: Analytical results for this compound are qualified as rejected due to holding time exceedances.

R2: Analytical results for this compound are qualified as rejected due to poor spike recoveries.

R3: Analytical results for this compound are qualified as rejected due to noncompliance with instrument

R5: Analytical results for this compound are qualified as rejected due to incorrect identification.

R6: Analytical results for this compound are qualified as rejected due to noncompliance with the full CI

R7: Analytical results for this compound are qualified as rejected due to initial and/or continuing calibration problems.

8.0 DATA GAPS AND WORK PLAN

Sections 8.1 and 8.2 present data gaps identified during the Basewide Hydrogeologic Characterization. Section 8.3 presents a work plan to fill these gaps.

8.1 Salinas Basin

8.1.1 OU2 Landfill - Sites 2 and 12 Area

The Basewide Hydrogeologic Characterization has identified an area between the OU2 landfill and Sites 2 and 12 as a potential pathway between the A- and 180-foot aquifers. The significance of this potential pathway warrants further investigation of the hydrogeologic conditions in the area immediately west of the FO-SVA pinchout.

Data gaps pertaining to the area between OU2 and Sites 2 and 12 are as follows:

- (a) The configuration of the FO-SVA, the reversal of groundwater flow along the western edge of the FO-SVA, and the role of these conditions in transporting contaminants from the A- to the 180-foot aquifer are only generally understood. Specific conditions between OU2 and Sites 2 and 12 have not been verified.
- (b) The distribution of the organic contaminants are only generally defined. Patterns of contaminant movement over time between Site 12 and the OU2 landfill are uncertain.
- (c) A groundwater mound was observed in the Site 12 vicinity but the areal extent, source of recharge, and temporal persistence of this feature are not well defined. The mound is considered to have a potentially significant impact on contaminant transport and seawater intrusion in the unconfined aquifer west of the FO-SVA.

8.1.2 OU1 - FAAF Fire Drill Area

Organic contaminants, apparently unrelated to OU1, have been detected in samples from two upgradient wells at OU1. The upgradient source, location, and extent of contamination have not yet been determined and remain a data gap.

8.1.3 Aquifer Conduits

Ongoing RI/FS investigations have identified additional sources of contamination. Existing inactive supply wells may be adjacent to or downgradient of some of these sources, and have a potential to act as vertical conduits between aquifers. The status of these wells with regard to the current understanding of the hydrogeology and contaminant sources is a data gap.

8.1.4 Groundwater Chemistry and Water-Level Conditions

Several data gaps exist pertaining to groundwater chemistry and groundwater flow patterns. These include:

- (a) The sources of sporadic occurrences of organic contamination detected at several onbase and offbase wells are unknown.
- (b) Temporal variations in groundwater flow and groundwater chemistry are not well characterized.
- (c) Groundwater at the OU2 landfill has not been analyzed for priority pollutant metals.

Observation of groundwater response to artificial sources of recharge and precipitation is limited to relatively short time periods. Water-level monitoring should be performed on an ongoing basis to evaluate the longer-term and seasonal patterns of groundwater response to recharge. This information will facilitate assessing the behavior of contaminant transport and performance of groundwater remediation systems.

8.1.5 Groundwater Remediation

A detailed understanding of the aquifer systems, with particular regard to the impact of extractive remediation systems on seawater intrusion, changes in groundwater extraction and recharge rates, contaminant transport, and the overall water budget, is needed prior to conceptual design of groundwater remediation systems at Fort Ord. Groundwater is the source of water supply at Fort Ord and historically has been

degraded by seawater intrusion as a result of pumping. In addition, groundwater remediation at Sites 2 and 12 and OU2 has the potential to influence seawater intrusion and plume behavior.

Therefore, the following data gaps should be filled prior to conceptual design of groundwater remediation systems:

- (a) The hydrogeologic response to possible future groundwater extraction (and/or recharge) at OU2 and Sites 2 and 12 with regard to contaminant plume behavior, seawater intrusion into the 180-foot aquifer, and regional groundwater flow patterns is uncertain.
- (b) The significance of groundwater extraction on the overall water budget of the aquifer system is uncertain.

8.2 Seaside Basin

Significant groundwater contamination has not been identified in areas of Fort Ord overlying the Seaside basin. However, sporadic occurrences of organic contaminants were detected at a number of on- and offbase wells. Verification of these contaminants has not been performed and remains a data gap.

Ongoing investigation is continuing at several sites in the Seaside basin. If site investigations determine that groundwater contamination has occurred, hydrogeologic data gaps will be filled as part of those site investigations.

8.3 Work Plan

This work plan describes proposed activities for Phase 2 of the Fort Ord Basewide Hydrogeologic Characterization. The objectives of the work plan are to:

- Fill data gaps related to areas of suspected groundwater contamination
- Verify and refine the conceptual model of groundwater flow, particularly in areas where potential contaminant pathways are present

Description of Inorganic Qualifiers Used in Database

Laboratory Assigned Qualifiers

- B: Reported value is less than the CRDL and greater than or equal to the instrument detection limit.
- E: The reported value is estimated because of the presence of interference.
- G: Reporting limit raised due to matrix interference.
- M: Duplicate injection precision not met.
- N: Spiked sample recovery not within control limits.
- R: Reporting limit raised due to high level of analyte present in sample.
- S: The reported value was determined by the Method of Standard Additions (MSA).
- U: Compound was analyzed for but not detected.
- W: Post-digestion spike for furnace AA analysis is outside of control limits.
- *: Duplicate analysis not within control limits.
- +: Correlation coefficient for the MSA is less than 0.995.
- #: Recovery outside QC Limits.

by EPA Test Method 8010 to screen for contaminants characteristic of the OU2 plume. These data will be used to verify plume configuration and assist in selecting monitoring well locations. The Hydropunch samples will be used to evaluate the vertical distribution of organic contaminants.

- Drill and continuously core two pilot borings immediately west of the FO-SVA to evaluate the geologic conditions prior to monitoring well installation. These borings will be up to 250 feet deep. At each boring, up to three Hydropunch samples will be obtained and analyzed by EPA Test Method 8010. A downhole geophysical survey will be performed at the completion of each boring. These surveys will include caliper, gamma, resistivity (point, 16-inch and 64-inch normal) and SP.
- Install two monitoring wells. These wells will be screened in the unconfined aquifer. Water levels and groundwater chemistry will be monitored at each well as part of the Basewide Quarterly Monitoring Program (see Section 8.3.4).

8.3.1.2 Subtask B

The apparent presence of a groundwater mound west of the FO-SVA near Site 12 is a potentially important feature influencing contaminant migration and seawater intrusion. Groundwater remediation at Sites 2 and 12 would potentially affect this mound. To fill data gap (c), Section 8.1.1, the following activities are proposed:

- Drill a pilot boring up to 200 feet deep to evaluate the aquifer relationships and geologic conditions prior to monitoring well installation. Three Hydropunch samples will be obtained and analyzed by EPA Test Method 8010 to evaluate the presence and/or vertical distribution of organic contaminants related to the OU2 or Sites 2/12 plumes. Upon completion of the boring, a downhole geophysical survey will be performed.
- A 150-foot-deep monitoring well will be installed in the unconfined aquifer between Site 12 and OU2 based on the results of the pilot boring. This well will be located west of those proposed in Subtask A above but east of Site 12. Water-level and groundwater quality monitoring will be performed as part of the Basewide Quarterly Monitoring Program (see Section 8.3.4).

8.3.2 Task 2

To fill the OU1 upgradient contaminant source data gap (Section 8.1.2), the basewide program will evaluate potential upgradient sources and identify appropriate

upgradient Hydropunch sampling locations. It is anticipated that three borings will be drilled, with up to two Hydropunch samples obtained from each. Each boring will be approximately 150 feet deep; one of the borings will be geophysically logged as described in Section 8.3.1.1 above. Hydropunch samples will be analyzed by EPA Test Method 8010 for contaminants detected at OU1 wells MW-OU1-01-A and MW-OU1-02-A. Based on the findings from the Hydropunch sampling and analysis, up to two monitoring wells will be installed to monitor water levels and groundwater chemistry to a depth of up to 150 feet. Water levels and groundwater chemistry will be monitored as part of the Basewide Quarterly Monitoring Program (see Section 8.3.4).

8.3.3 Task 3

To address the data gap presented in Section 8.1.3, the Groundwater Well Management Plan (*HLA, 1990b*) will be updated. Wells will be evaluated and prioritized based on new hydrogeologic and contaminant source data collected during recent basewide and site studies.

8.3.4 Task 4

A Basewide Quarterly Monitoring Program is proposed to fill data gaps related to water levels and groundwater chemistry, as presented in Sections 8.1.1, 8.1.2, and 8.1.4. This program will include monitoring and sampling basewide and RI/FS site wells to establish the relationship between precipitation patterns and groundwater fluctuations, to observe temporal changes in groundwater chemistry, to monitor wells near suspected contaminant sources for the presence of contamination, and to monitor wells potentially affected by seawater intrusion. Details of this program will be presented as part of a separate scope of work; an outline of the proposed activities is as follows:

- Sample selected onbase and offbase wells to verify previously detected contamination. Only wells constructed by HLA or those that have been appropriately constructed will be sampled.
- Sample wells within and adjacent to identified groundwater contamination including both up- and downgradient wells. Only analytes detected in previous sampling events or present in nearby sources will be evaluated.
- Perform periodic sampling of field parameters and inorganic chemistry from a selected number of wells to monitor baseline groundwater quality and seawater intrusion conditions.
- Measure water levels quarterly at selected wells to evaluate temporal water-level fluctuations.

8.3.5 Task 5

To fill the data gaps discussed in Section 8.1.5, development of a quantitative groundwater model is proposed. The specific objectives of the modeling are as follows:

- Model the hydrogeologic systems in the vicinity of OU2 and Sites 2 and 12 to allow simulation and testing of proposed extraction systems. The simulated groundwater extraction systems will include evaluating the number of wells, pumping rates, estimated chemical mass removal rates, and estimated capture zones.
- Assess the feasibility of a groundwater reinjection system to recharge treated groundwater, including the number and location of wells, injection rates, and estimated head buildup in the vicinity of injection wells. Evaluate the impact of groundwater reinjection on contaminant distribution and saltwater intrusion.
- Evaluate the impact of groundwater extraction at OU2 and Sites 2 and 12 on the configuration of contaminant plumes relative to the city of Marina and Fort Ord water-supply wells. Evaluate the impact of groundwater extraction at OU2, Sites 2 and 12, the city of Marina, and Fort Ord water-supply wells on regional groundwater flow patterns and future saltwater intrusion.
- Evaluate the impact of groundwater extraction on the overall water budget for the aquifer system.

To achieve these objectives, HLA proposes to develop a three-dimensional finite-difference or finite-element flow and solute transport model, using an existing public-domain groundwater model code. A number of widely used and verified

groundwater models are available and applicable for the Salinas basin at Fort Ord; an evaluation of site-specific issues and model capabilities will be performed prior to selection and development of the model.



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415/892-0821
Telecopy: General: 415/892-0831
Accounting: 415/898-1052

CHAIN OF CUSTODY FORM

Lab: CAL

Samplers: Derek S. Lieberman

Job Number: 07577.750.02

Name/Location: SITE 28 / BLDG. 2353

Project Manager: _____

Recorder: Derek S. Lieberman
(Signature Required)

SOURCE CODE	MATRIX					#CONTAINERS & PRESERV.					SAMPLE NUMBER OR LAB NUMBER			DATE											
	Water	Sediment	Soil	Oil	Unpres.	H ₂ SO ₄	HNO ₃				Yr	Wk	Seq	Yr	Mo	Dy	Time								
50			X		X						5	8	28	04	5	5	9	20	10	5	1	5	1	5	
50			X		X						5	8	28	04	10	5	5	9	20	10	5	1	5	2	5
50			X		X						5	8	28	04	20	5	5	9	20	10	5	1	5	5	0
50			X		X						5	8	28	05	5	5	5	9	20	10	5	1	0	3	5
50			X		X						5	8	28	05	15	5	5	9	20	10	5	1	1	5	5
50			X		X						5	8	28	05	20	5	5	9	20	10	5	1	2	2	0
50			X		X						5	8	28	06	5	5	5	9	20	10	5	1	6	5	0
50			X		X						5	8	28	06	10	5	5	9	20	10	5	1	7	0	5
50			X		X						5	8	28	06	20	5	5	9	20	10	5	1	7	5	5

EPA 601/8010	EPA 602/8020	EPA 624/8240 VOC's	EPA 625/8270	ICP METALS
		X		
		X		
		X		
		X		
		X		
		X		
		X		
		X		
		X		

LAB NUMBER			DEPTH IN FEET	COL MTD CD	QA CODE	MISCELLANEOUS	CHAIN OF CUSTODY REC		
Yr	Wk	Seq					RELINQUISHED BY: (Signature)		RECEIVED BY: (S
							<u>Derek S. Lieberman</u>		<u>Dan J. Ba</u>
							RELINQUISHED BY: (Signature)		RECEIVED BY: (S
							RELINQUISHED BY: (Signature)		RECEIVED BY: (S
							RELINQUISHED BY: (Signature)		RECEIVED BY: (S
							DISPATCHED BY: (Signature)		DATE/TIME
							METHOD OF SHIPMENT		RECEIVE (Signature)
							<u>SEA COURIER / EN COURIER WITH PK</u>		

Laboratory Copy Project Office Copy Field or Office Copy
White Yellow Pink

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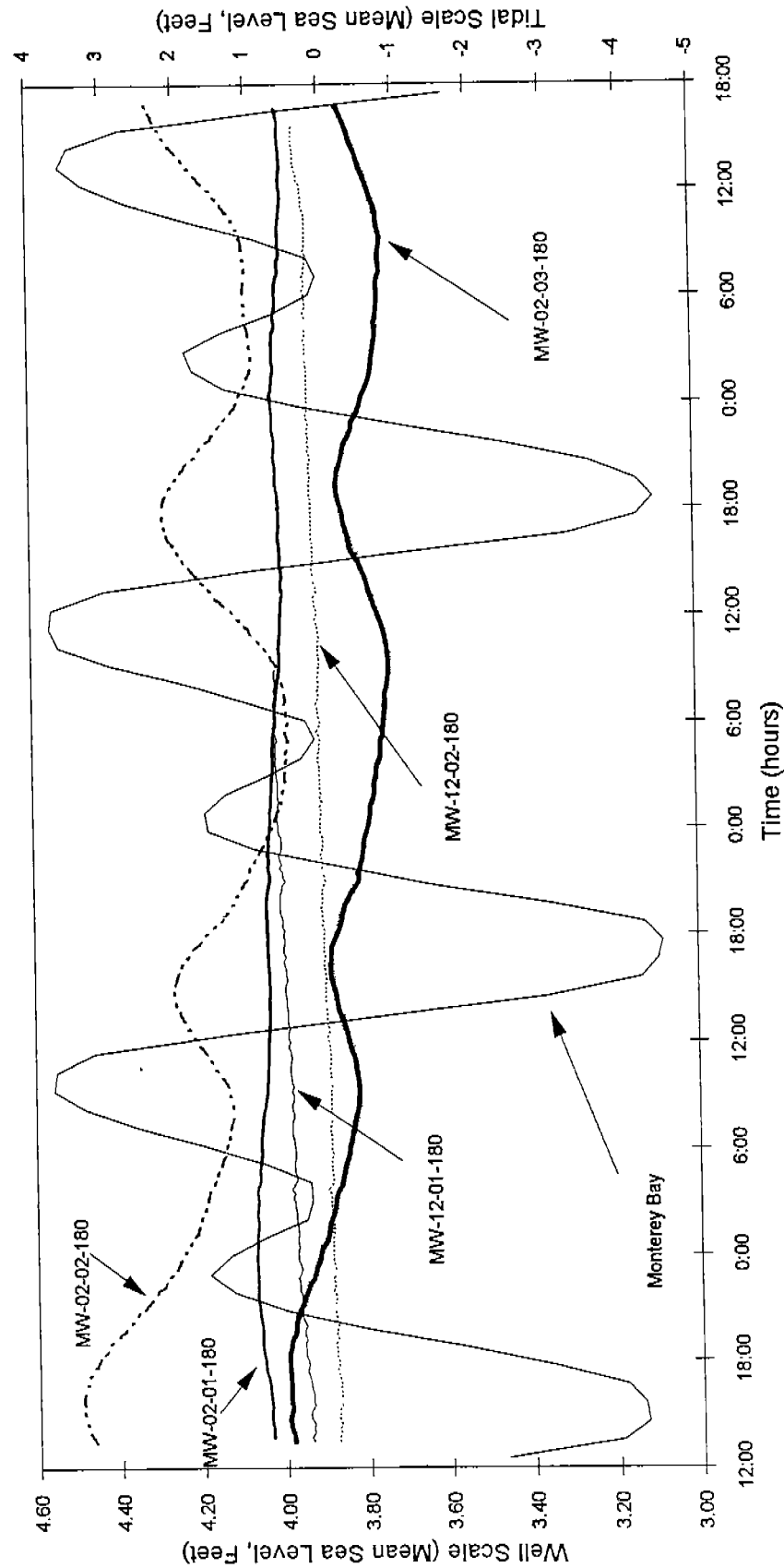
PLATES

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**Fort Ord Tidal Survey
December 20 - 23, 1991**



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PLATE

16



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Sites 2 and 12 Tidal Influence Study December 1991
Basewide Hydrogeologic Characterization
Fort Ord, California

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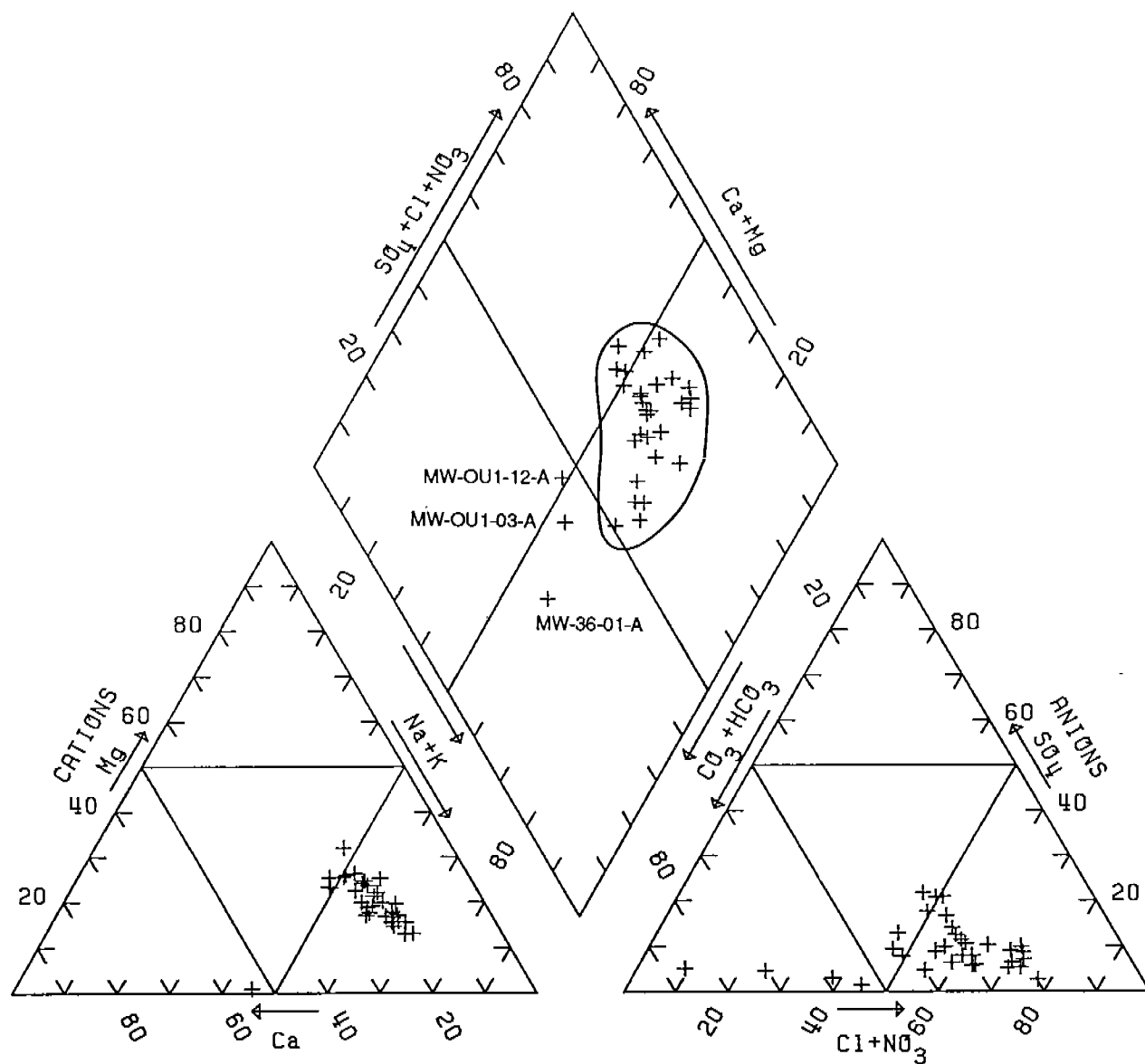
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EXPLANATION

- + A-aquifer Water Sample
- Fort Ord A-aquifer Water Quality

430



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Piper Diagram, A-aquifer
Basewide Hydrogeologic Characterization
Fort Ord, California

PLATE

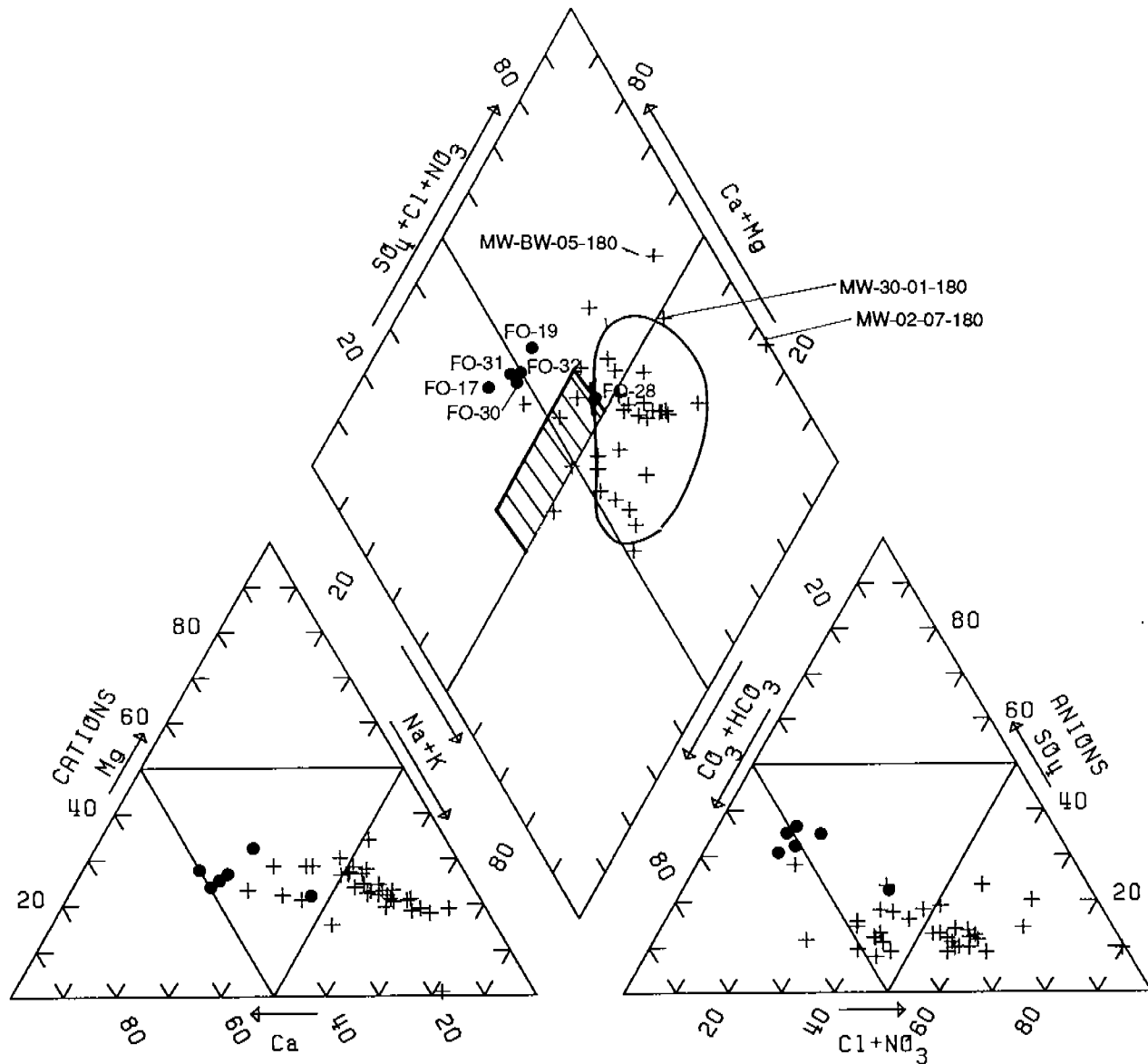
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EXPLANATION

- + 180-foot Aquifer Water Sample (1992 DATA)
- FO-19 Fort Ord Water-Supply Water Sample (1985 DATA)
- Fort Ord A-aquifer Water Quality
- ▨ Salinas Valley 180-foot Aquifer Water Quality (DKT, 1989)

431



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Piper Diagram, 180-foot Aquifer
Basewide Hydrogeologic Characterization
Fort Ord, California

PLATE

21

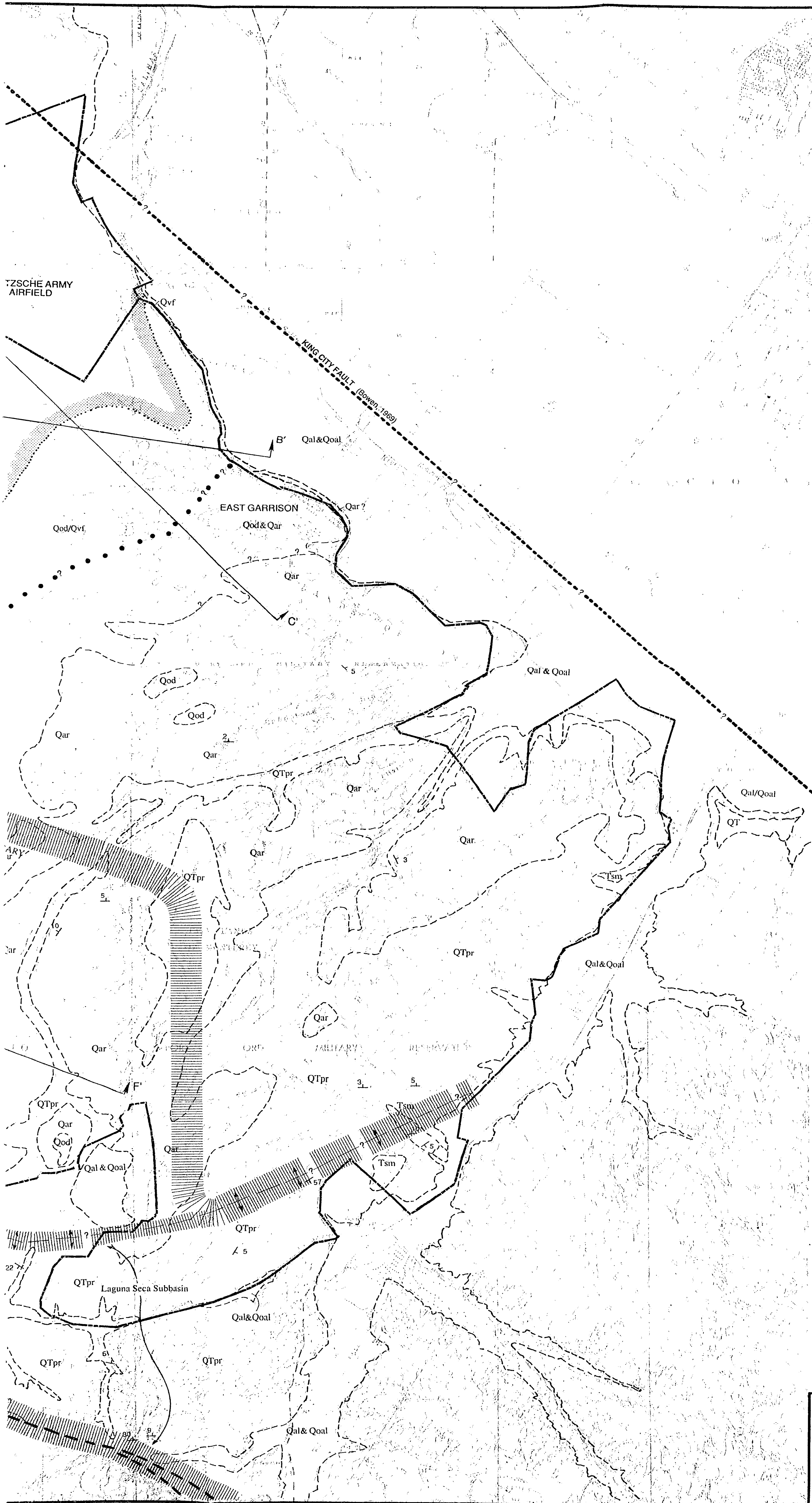
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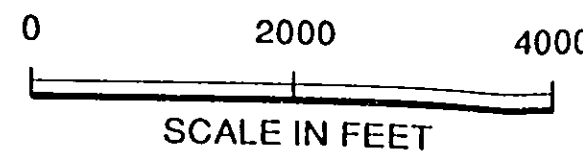


EXPLANATION

GEOLOGIC UNITS	
Qs	Beach sand
Qd	Dune sand
Qal	Alluvium
Qod	Older dune sand
Qoal	Older alluvium, includes stream terrace deposits
Qvf	Valley fill deposits; fluvial and estuarine deposits of clay, sand, and gravel; commonly contains diatomaceous cobbles and shale fragments
Qar	AROMAS SAND; commonly cross-laminated sand of both eolian and floodplain origin
QTpr	PASO ROBLES FORMATION; primarily floodplain and alluvial fan deposits consisting of interbedded sand, silty clay, clay and gravel; may include some marine deposits in the western Seaside and Salinas groundwater basins.
Tsm	SANTA MARGARITA FORMATION; consisting of white to off-white marine sands and sandstone with minor gravel and clay
Tm	MONTEREY FORMATION; consists primarily of siliceous and silty shale and diatomaceous mudstone
/	Indicates geologic unit underlying the surface deposit

GEOLOGIC SYMBOLS

---	Contact, dashed where approximate, queried (?) where uncertain
---	Fault, dashed where approximate, dotted where buried and/or inferred, queried (?) where uncertain
	Bedrock high (Monterey formation at or above sea level)
+	Anticline, showing axis; dashed where approximate, queried (?) where uncertain
...	Southern extent of Qvf, queried (?) where uncertain
	Boundary of FO-SVA and Seaside Clay; queried where uncertain
	Groundwater basin boundary, queried where uncertain
	Groundwater subbasin boundary, queried where uncertain
A A'	Location of cross section with arrows depicting direction of viewing
10	Strike and dip of bedding
B	Seismic Reflection Line Location



Geology after Martin and Emery (1967), Bowen (1969) Dibblee (1973), Clark et al. (1974), with modifications based on aerial photograph interpretation by HLA.

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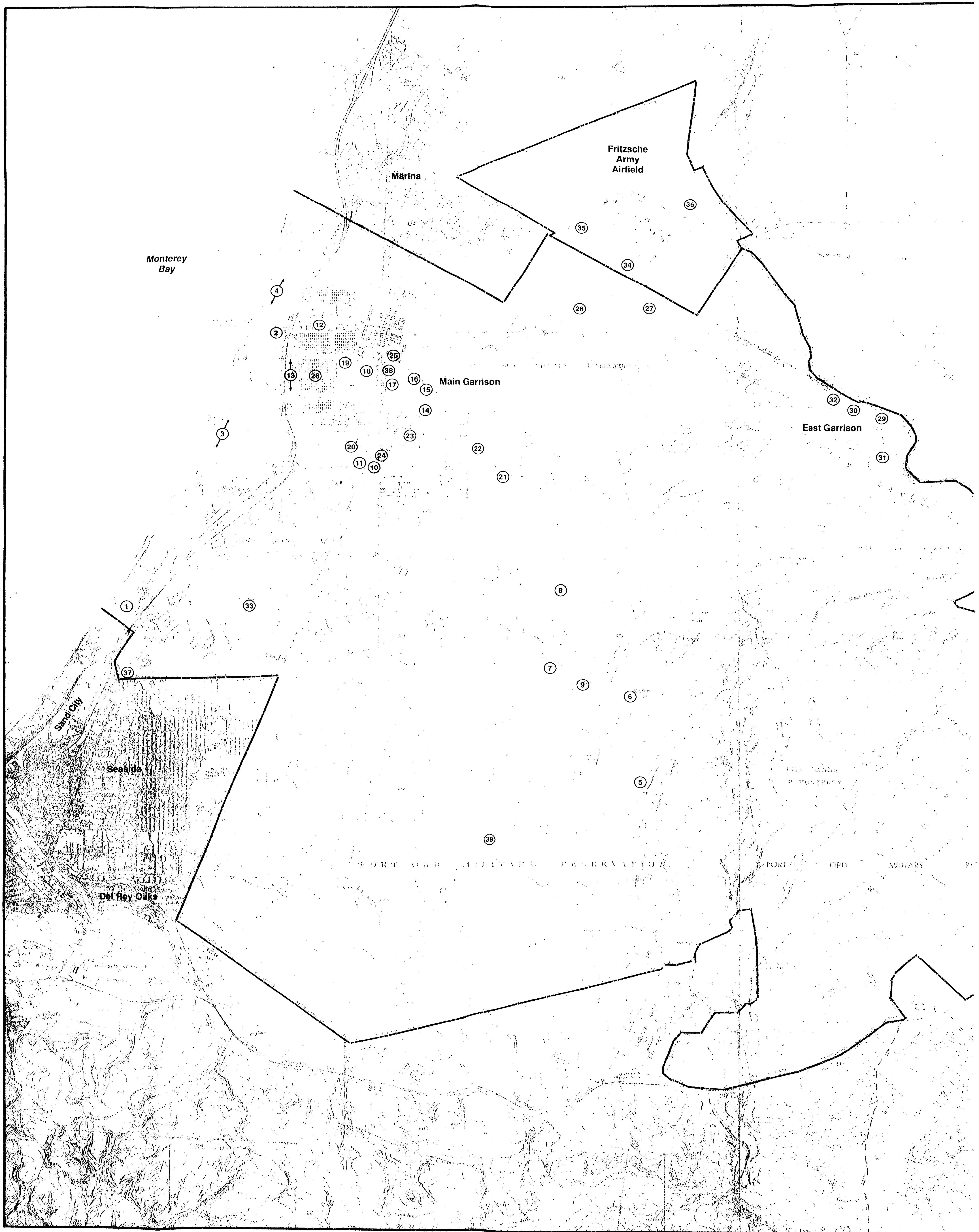


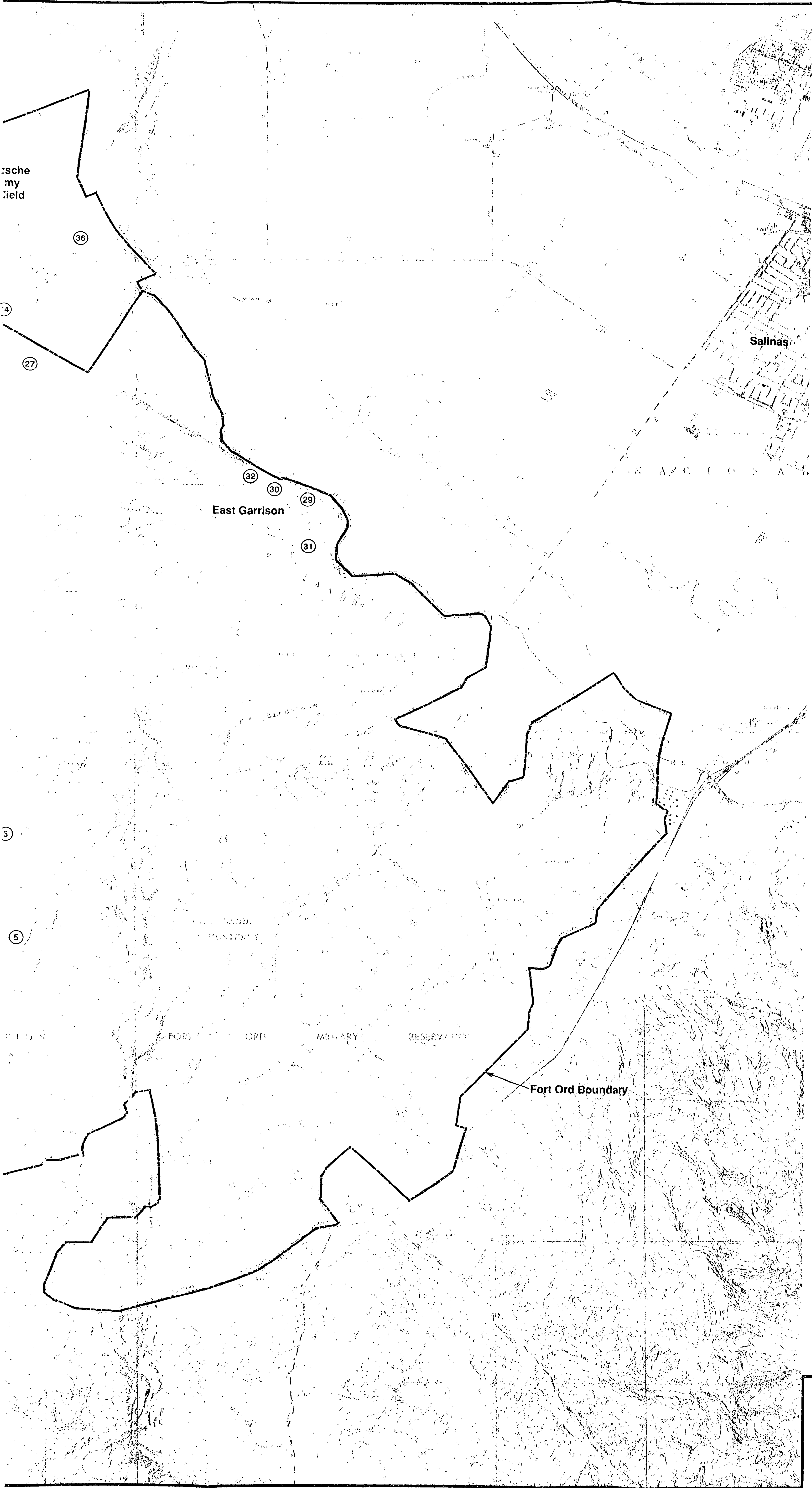
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**Hydrogeologic Map -
Fort Ord and Vicinity
Basewide Hydrogeologic
Characterization
Fort Ord, California**

3

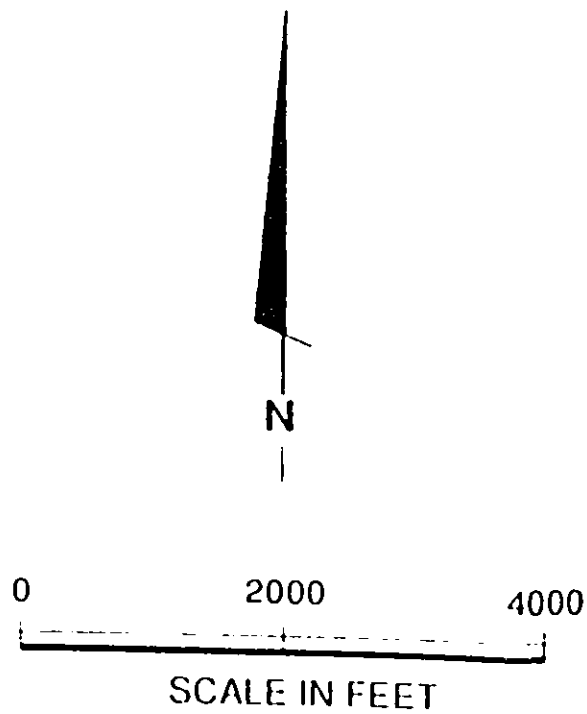
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Fort Ord RI/FS Sites

- | | |
|---|---|
| 1. Ord Village STP | 20. South Parade Ground, 3800 & 519 Motor Pools |
| 2. Main Garrison STP | 21. 4400/4500 Motor Pool - East Block |
| 3. Beach Trainfire Range | 22. 4400/4500 Motor Pool - West Block |
| 4. Beach Stormwater Outfalls | 23. 3700 Motor Pool |
| 5. Range 36A | 24. Old DEH Yard |
| 6. Range 39 (Abandoned Car Dump) | 25. Former DRMO Site |
| 7. Range 40 & 41 (Fire Demonstration Area) | 26. Sewage Pump Stations (Bldgs. 5871 & 6143) |
| 8. Range 49 (Molotov Cocktail Range) | 27. Army Reserve Motor Pool |
| 9. Range 39 (FFE Training Area) | 28. Barracks & Main Garrison Area Facilities |
| 10. Burn Pit | 29. DRMO |
| 11. AAFES Fueling Station | 30. Driver Training Area |
| 12. Lower Meadow (DOL Automotive Yard and Cannibalization Yard) | 31. Former Landfill Site |
| 13. Railroad Right-of-Way | 32. East Garrison STP |
| 14. 707th Maintenance Facility | 33. Golf Course |
| 15. DEH Yard | 34. FAAF Fueling Facility |
| 16. DOL Maintenance Yard and Pete's Pond | 35. Aircraft Cannibalization Yard |
| 17. 1400 Block Motor Pool | 36. FFASTP |
| 18. 1600 Block Motor Pool | 37. Trailer Park Maintenance Shop |
| 19. 2200 Block Facility | 38. AAFES Dry Cleaners |
| | 39. Impact Area |



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Location of 39 RI/FS Sites
Basewide Hydrogeologic
Characterization
Fort Ord, California

PLATE

4

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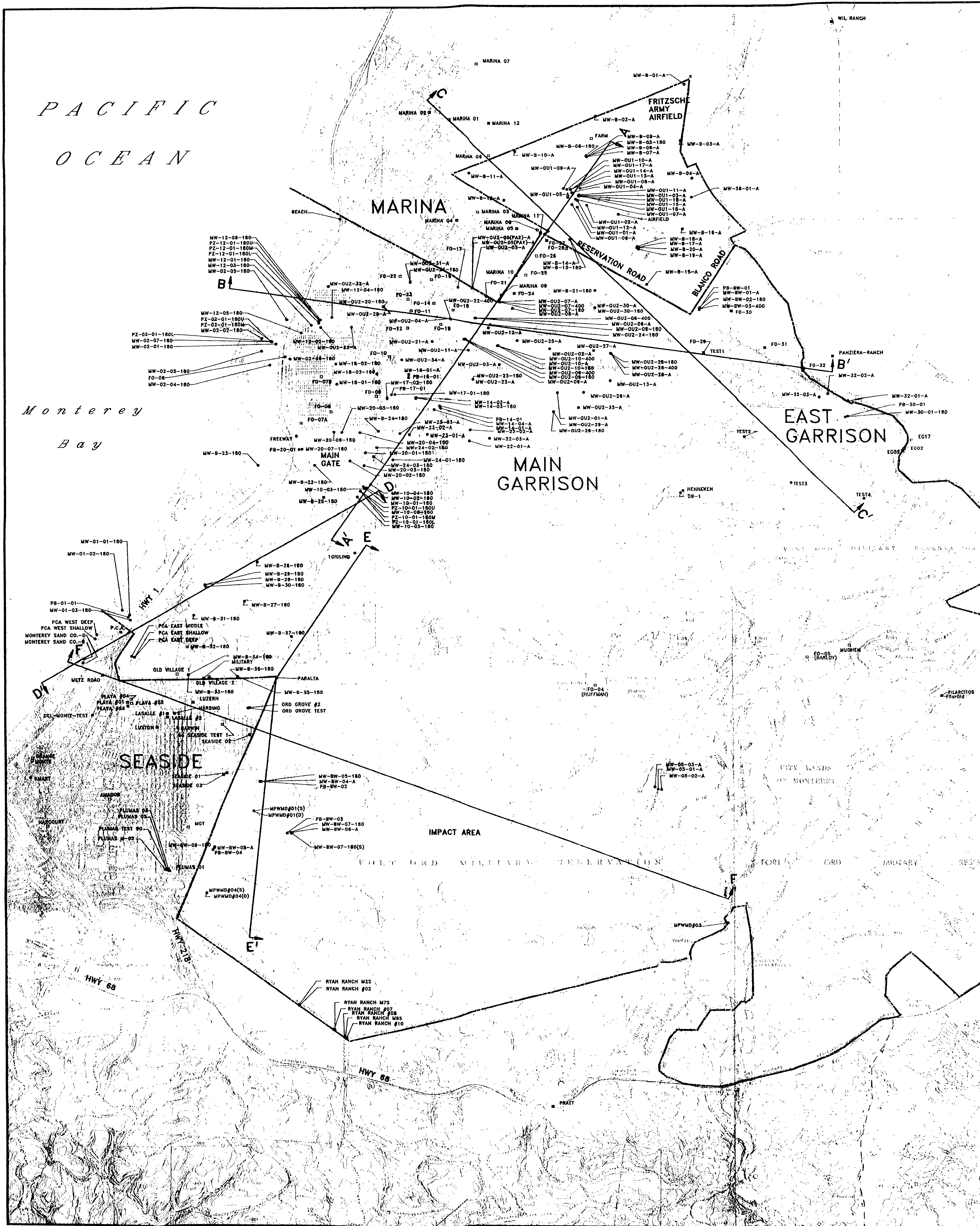
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INTERPRETIVE GEOLOGIC CROSS SECTION A-A'



B WEST

ELEVATION (feet MSL)

VIEW BASELINE (feet)

MONTEREY BAY

HIGHWAY 1

SEISMIC REFLECTION LINE A-A'

INTERSECTION WITH CH...

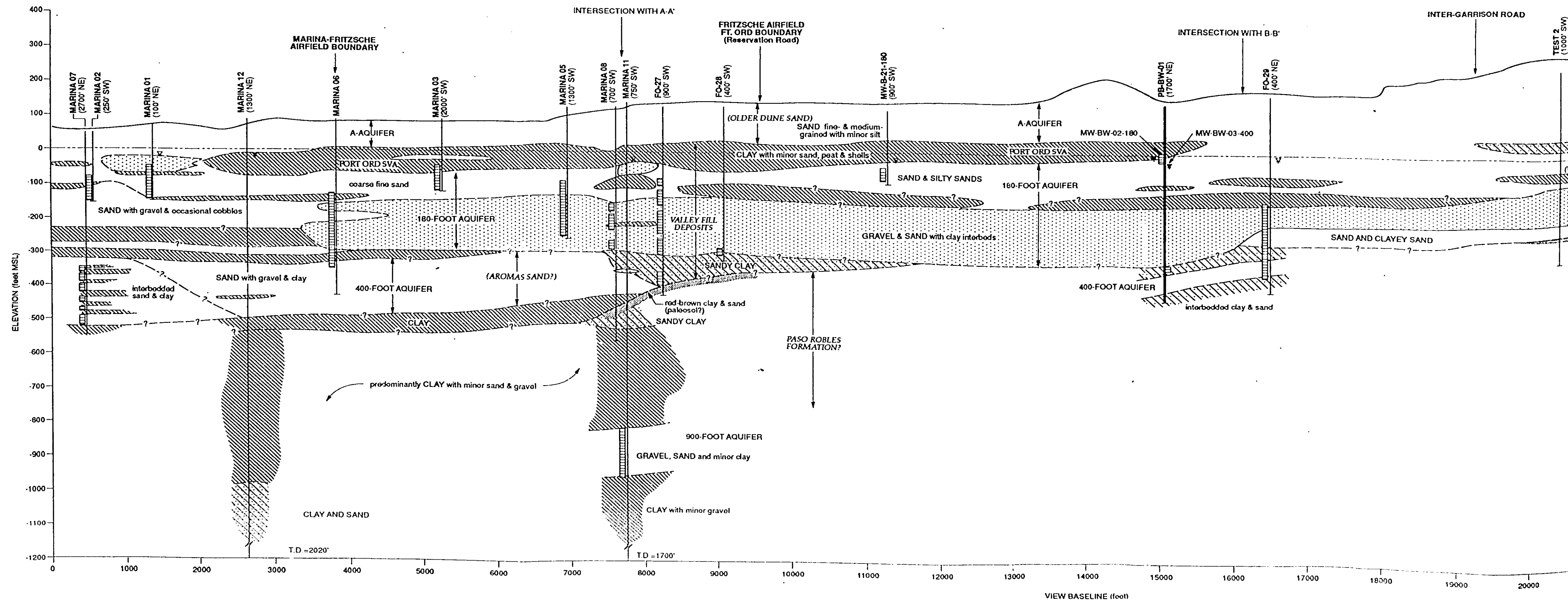
Geological Features and Stratigraphy:

- BEACH SAND**
- RECENT DUNE SAND**
- MONTEREY SAND**
- SAND AND SILTY SAND**
- SANDY CLAY**
- SAND AND SILTY SAND**
- GRAVEL**
- SANDY CLAY**
- CLAY**
- BLUE CLAY & GRAVEL**
- VALLEY FILL DEPOSITS**
- SAND, fine to medium-grained**
- GRAVEL with sand & minor silt**
- AROMAS (AQUICL)**
- 400-FOOT AQUIFER**
- SAND with clay interbeds**
- (PISO ROBLES FORMATION?)**
- SAND**
- CLAY**
- 180-FOOT AQUIFER**
- GRAVEL & cobbles with sand**
- 400 FOOT AQUIFER**
- interbed clay and sand**
- OLDER DUNE SAND**
- SAND, fine to medium-grained**
- gravel sand**
- (TORTOISE SHA)**
- CLAY with minor sand, peat & shells**
- A-AQUIFER**
- SANDS & SILTY SANDS**

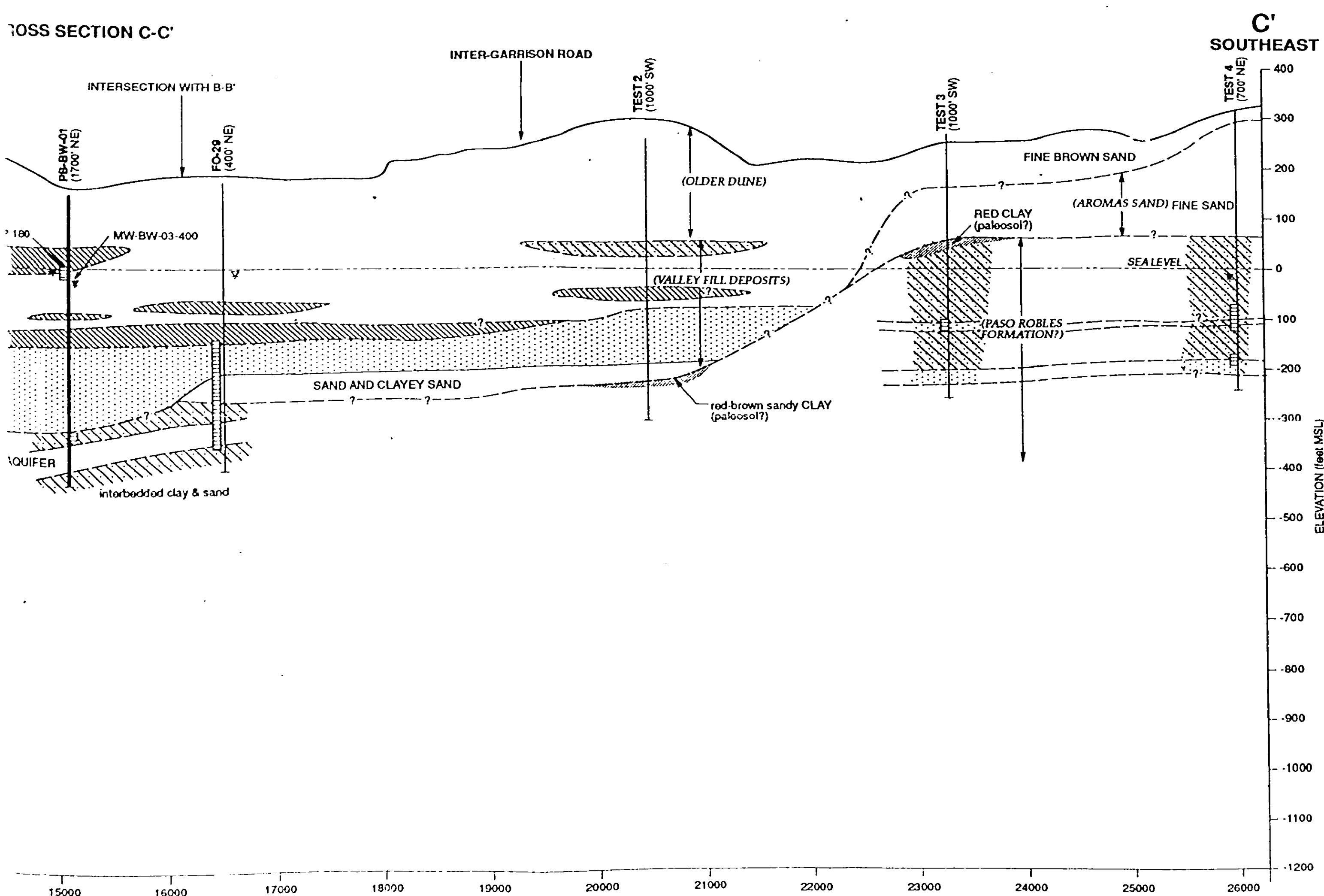
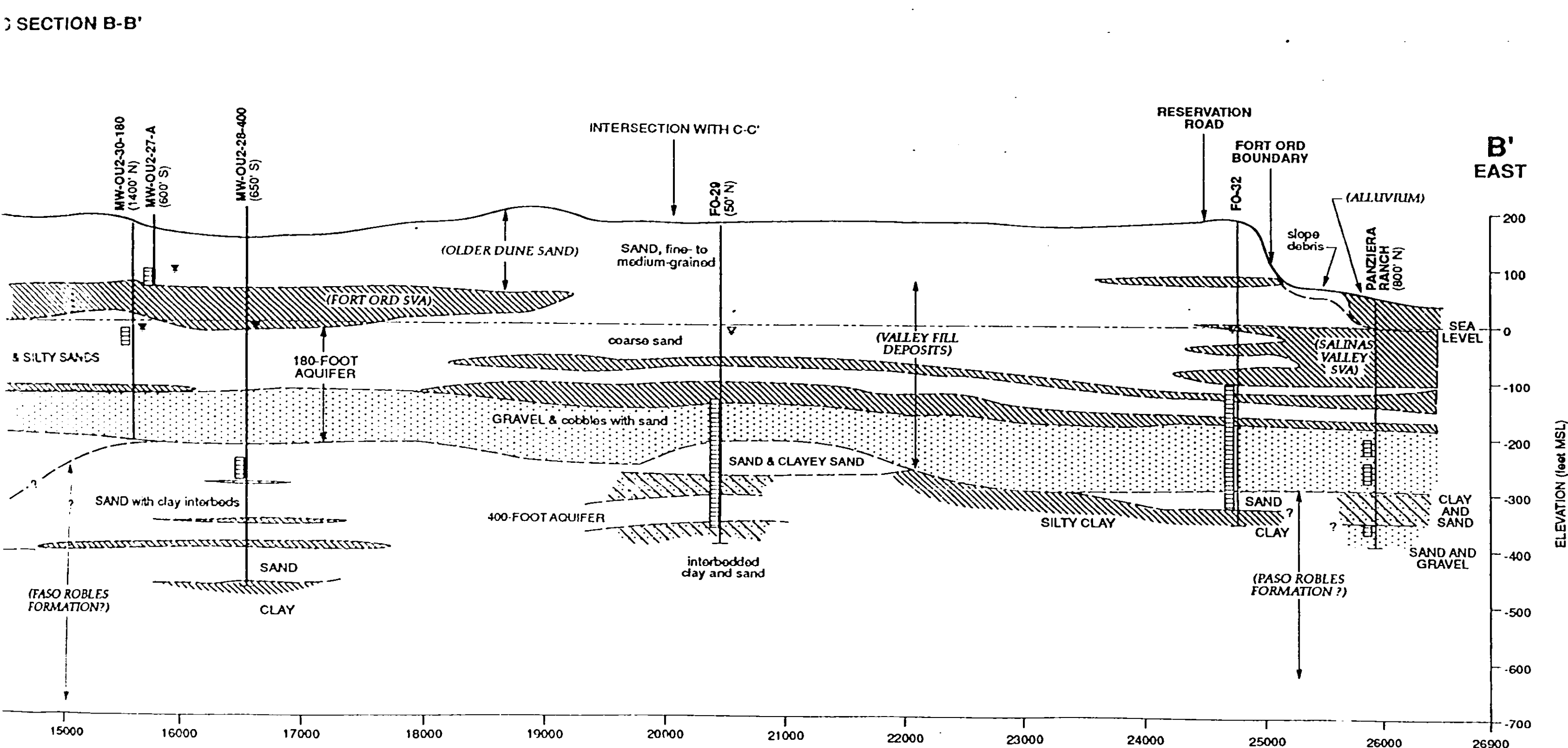
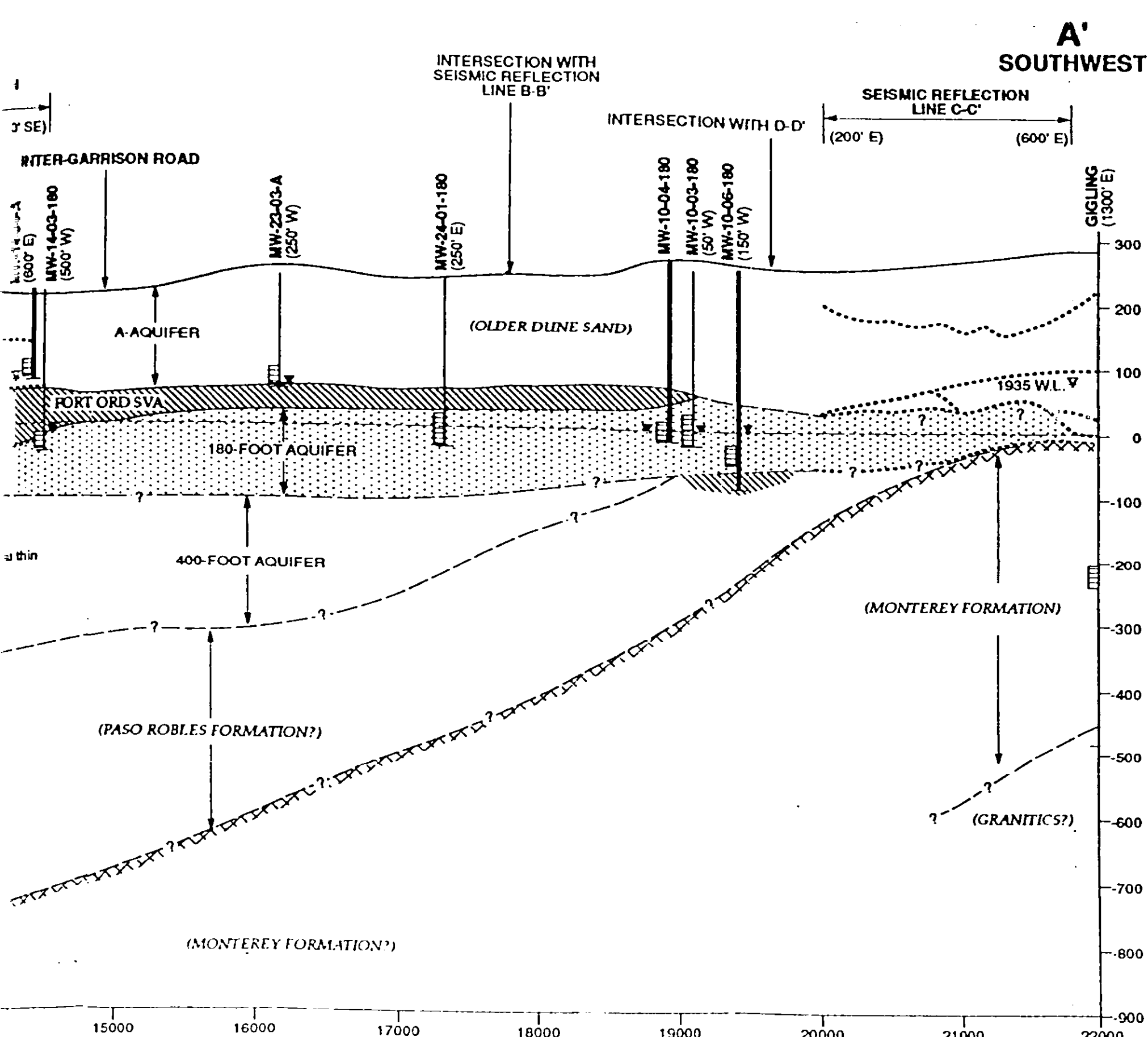
Well Locations and Data:

- MW-02-05-180 (1180' S)
- PZ-12-01-180 (1000' S)
- MW-12-04-180 (750' S)
- MW-02-20-180
- FC-11
- FC-14 (450' N)
- MW-02-22-400
- MW-02-26-400 (22' N)
- MW-02-24-180 (100' S)
- MW-02-25-A (650' S)
- MW-02-25-A (750' S)
- MW-02-30-180 (1400' N)
- MW-02-27-A (600' S)
- MW-02-25-400 (250' S)
- FC-29 (50' N)

INTERPRETIVE GEOLOGIC CROSS SECTION C-C'



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EXPLANATION

Lithologic Patterns:

- Clay
- Sand
- Gravel
- Sandy Clay, Interbedded Clay & Sand

*Patterns are located in areas of borehole control, at distance from borings the absence of a pattern indicates relatively poor subsurface control.

Symbols:

- Geologic Contact, dashed where approximate, queried (?) where uncertain
- Bedrock Surface (Monterey Formation); dashed where approximate, queried (?) where uncertain
- Well/Boring Location Showing Screened Interval
- HLA Well/Boring completed as part of 1991-1992 investigations; shows screened interval
- State Water Level; solid indicates HLA July 1992 level, empty symbol indicates non-HLA pre-July 1992 level
- Seismic Reflector from HLA 1991-1992 seismic reflection survey

Note: Well data projected and interpreted as it would occur approximately at the cross section line.

Vertical Scale: 1" = 200'
Horizontal Scale: 1" = 1000'
(Vertical exaggeration = 5:1)

Note: The cross sections present one interpretation of the lithologic data that were available at the time this report was prepared and are based on the detailed review of the boring logs; other interpretations may be possible.



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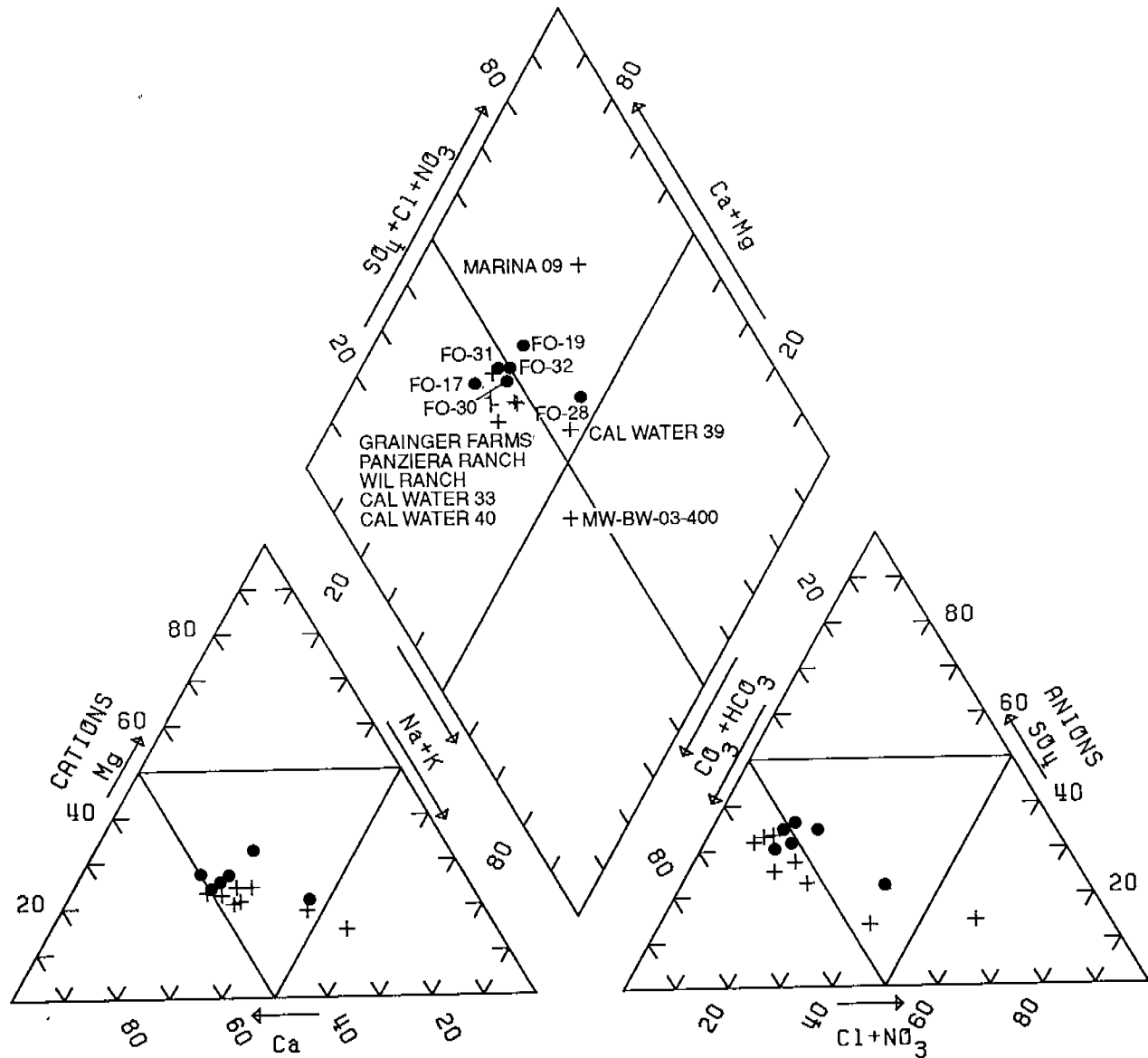
Geologic Cross Sections
A-A', B-B', C-C'
Basewide Hydrogeologic Characterizations
Fort Ord, California

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PLATE
6

30535



EXPLANATION

- + 400-foot Aquifer Water Sample (1992 DATA)
- Ford Ord Water-Supply Water Sample (1985 DATA)
- FO-19

432

PLATE



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Piper Diagram, 400-foot Aquifer
Basewide Hydrogeologic Characterization
Fort Ord, California

22

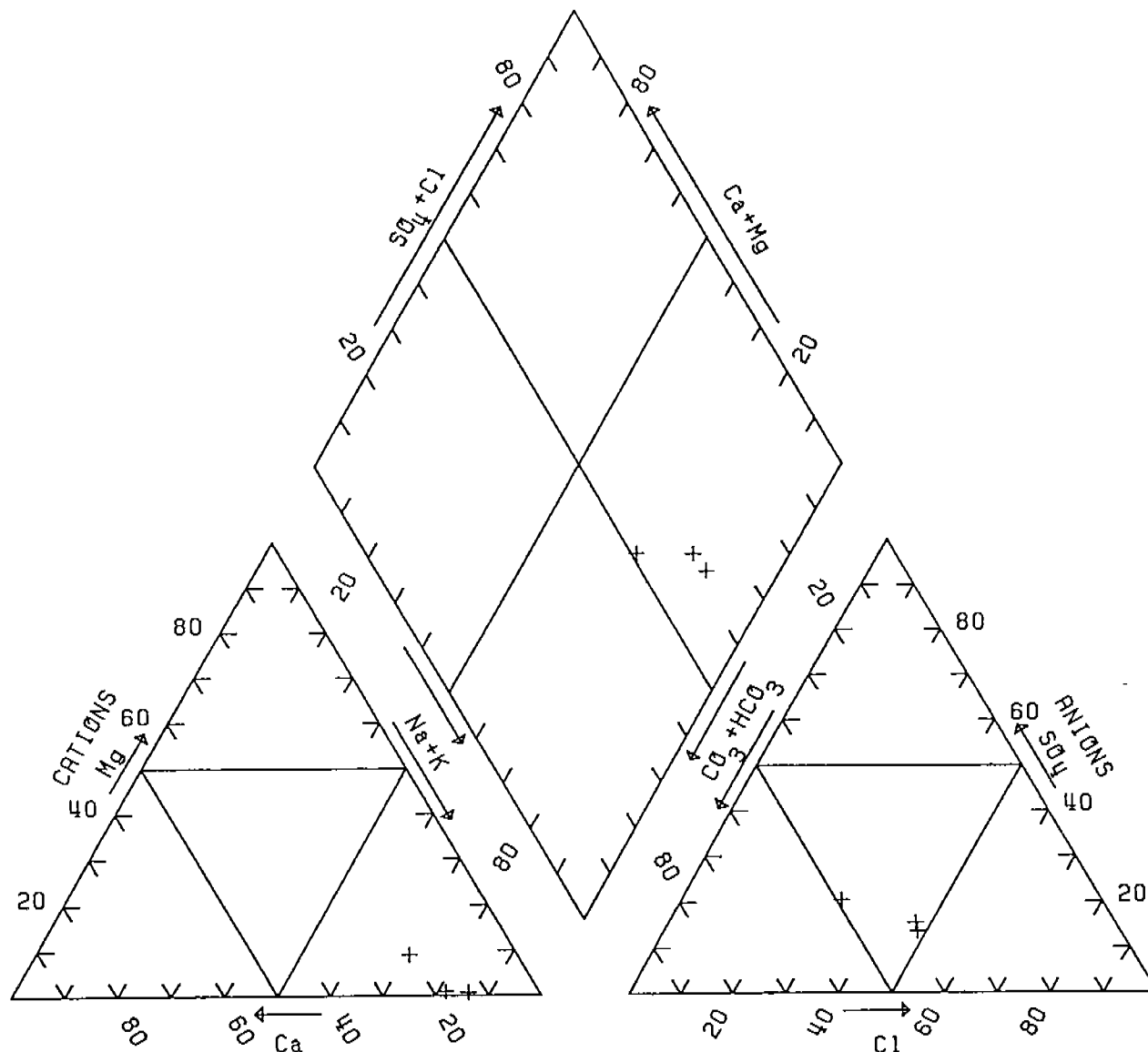
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EXPLANATION

+ 900-foot Aquifer Water Sample



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Piper Diagram, 900-foot Aquifer
Basewide Hydrogeologic Characterization
Fort Ord, California

PLATE

23

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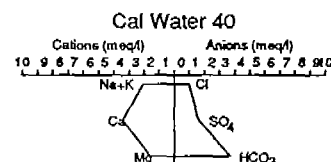
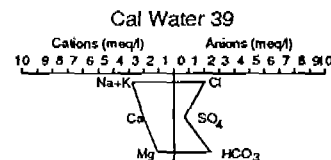
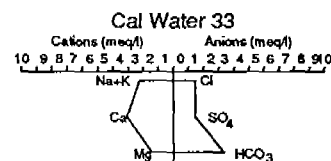
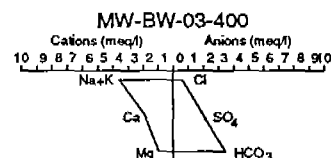
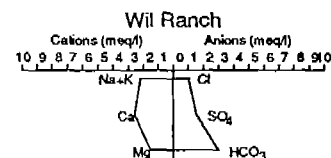
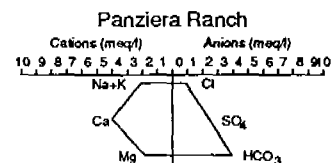
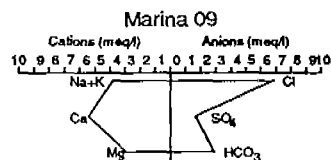
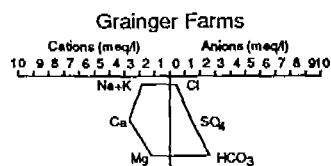
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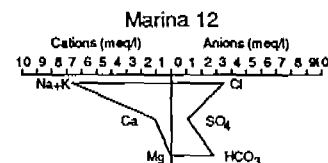
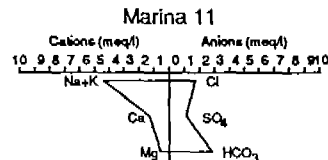
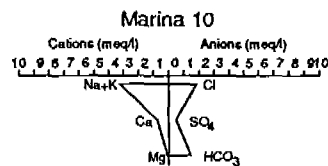
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400-foot Aquifer Wells



900-foot Aquifer Wells



Note: Well locations shown on Plate 5

278



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Stiff Diagrams, 400- and 900-foot Aquifers,
May-June 1992
Basewide Hydrogeologic Characterization
Fort Ord, California

PLATE

26

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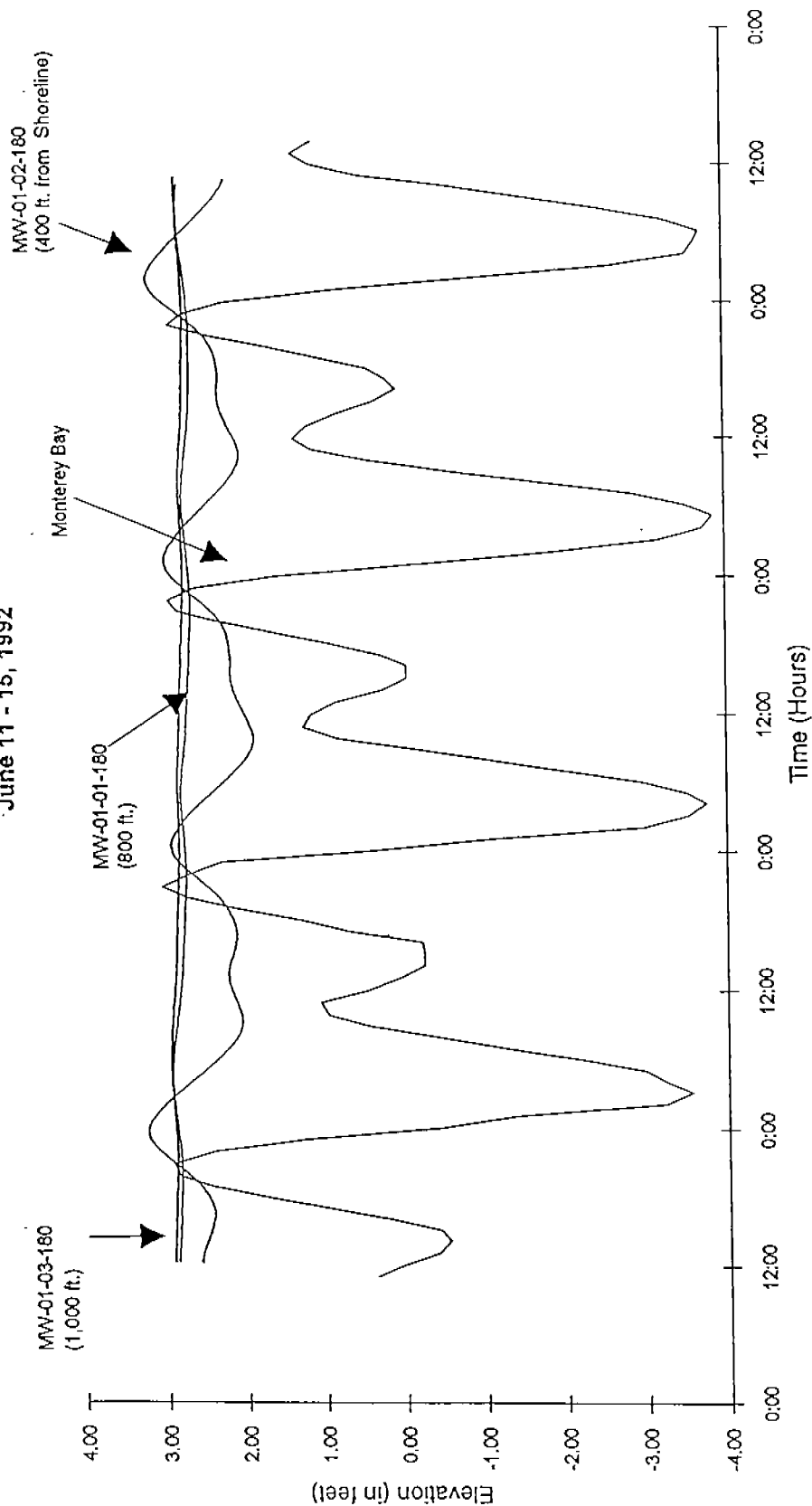
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**Fort Ord Tidal Survey
June 11 - 15, 1992**



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Harding Lawson Associates
Engineering and
Environmental Services

Site 1 Tidal Influence Study June 1992
Basewide Hydrogeologic Characterization
Fort Ord, California

PLATE

41

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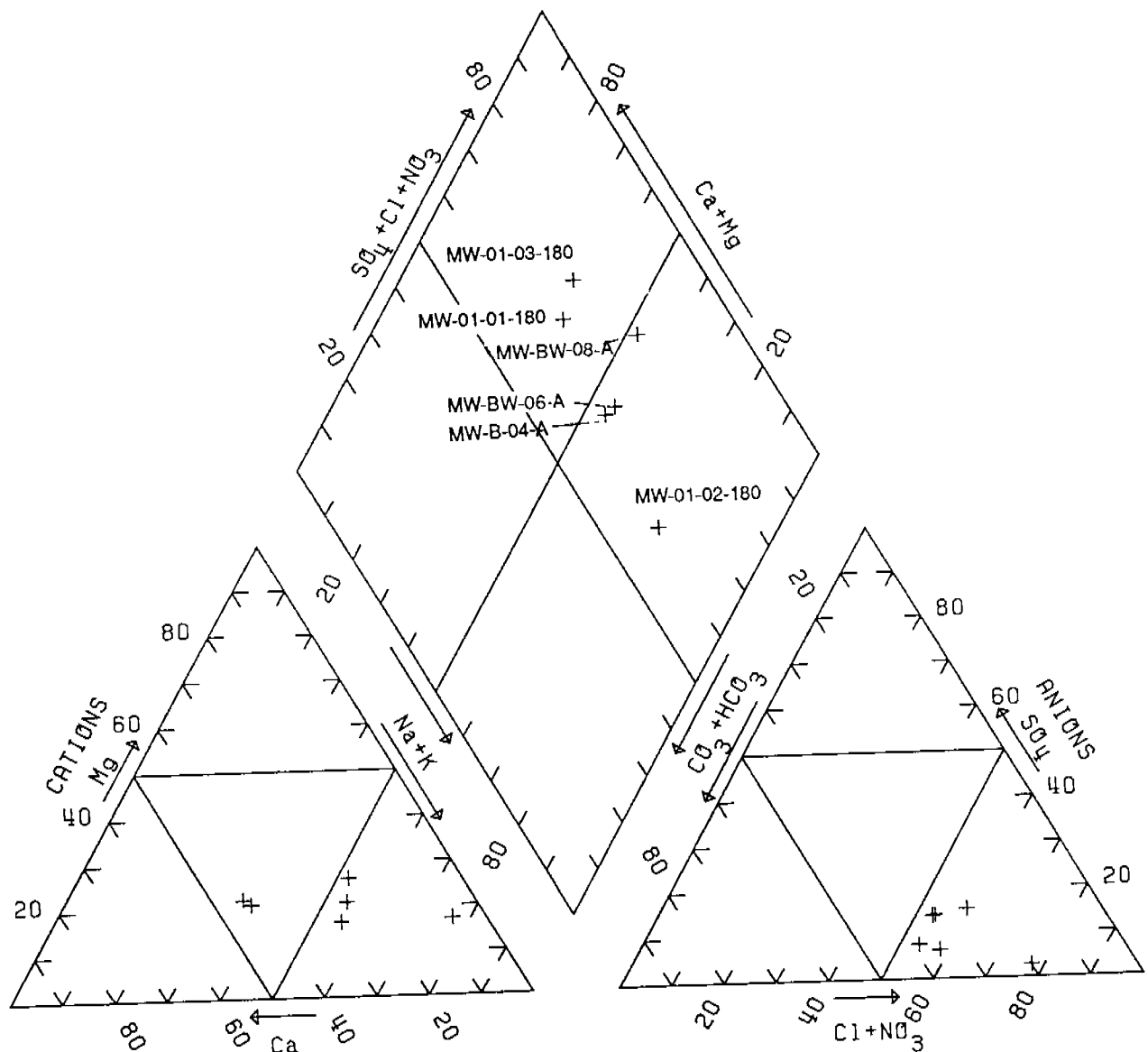
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EXPLANATION

+ Uppermost Aquifer Well



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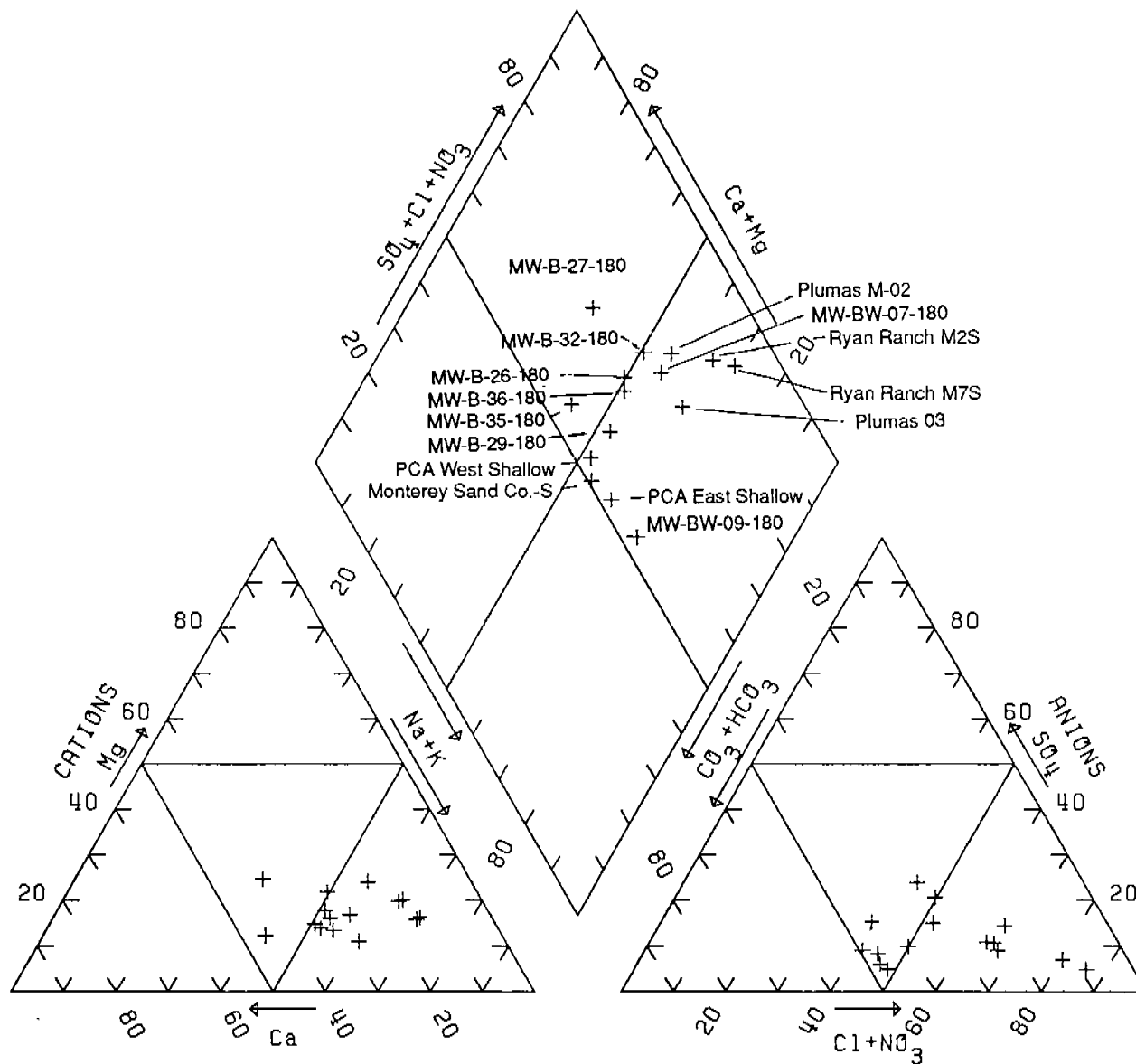
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Piper Diagram, Uppermost Aquifer
Basewide Hydrogeologic Characterization
Fort Ord, California

PLATE

44

454



EXPLANATION

+ Paso Robles Aquifer well

455



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Piper Diagram, Paso Robles Aquifer
Basewide Hydrogeologic Characterization
Fort Ord, California

PLATE

45

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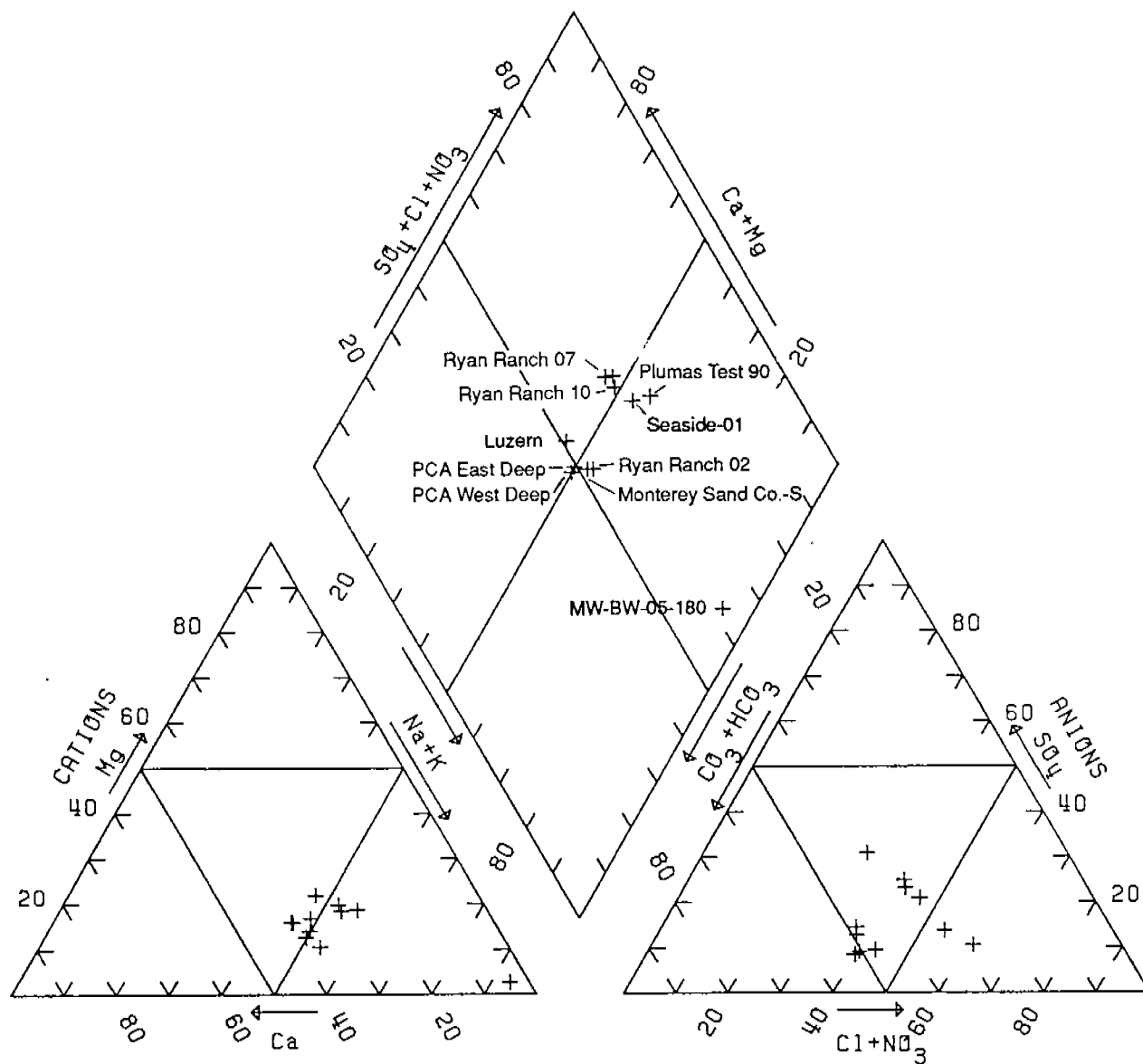
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EXPLANATION

+ Santa Margarita Aquifer well

456



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Piper Diagram, Santa Margarita Aquifer
Basewide Hydrogeologic Characterization
Fort Ord, California

PLATE

46

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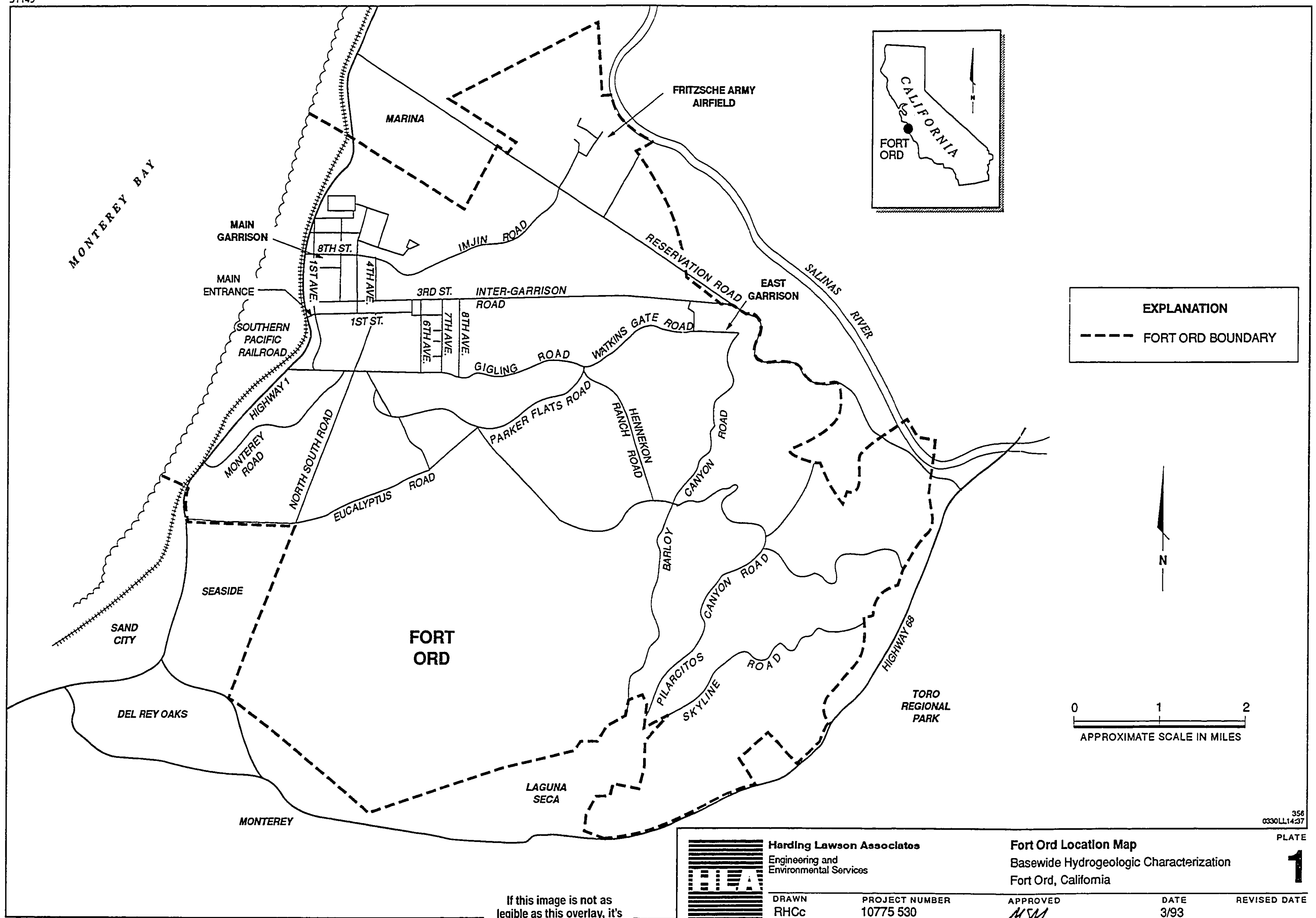
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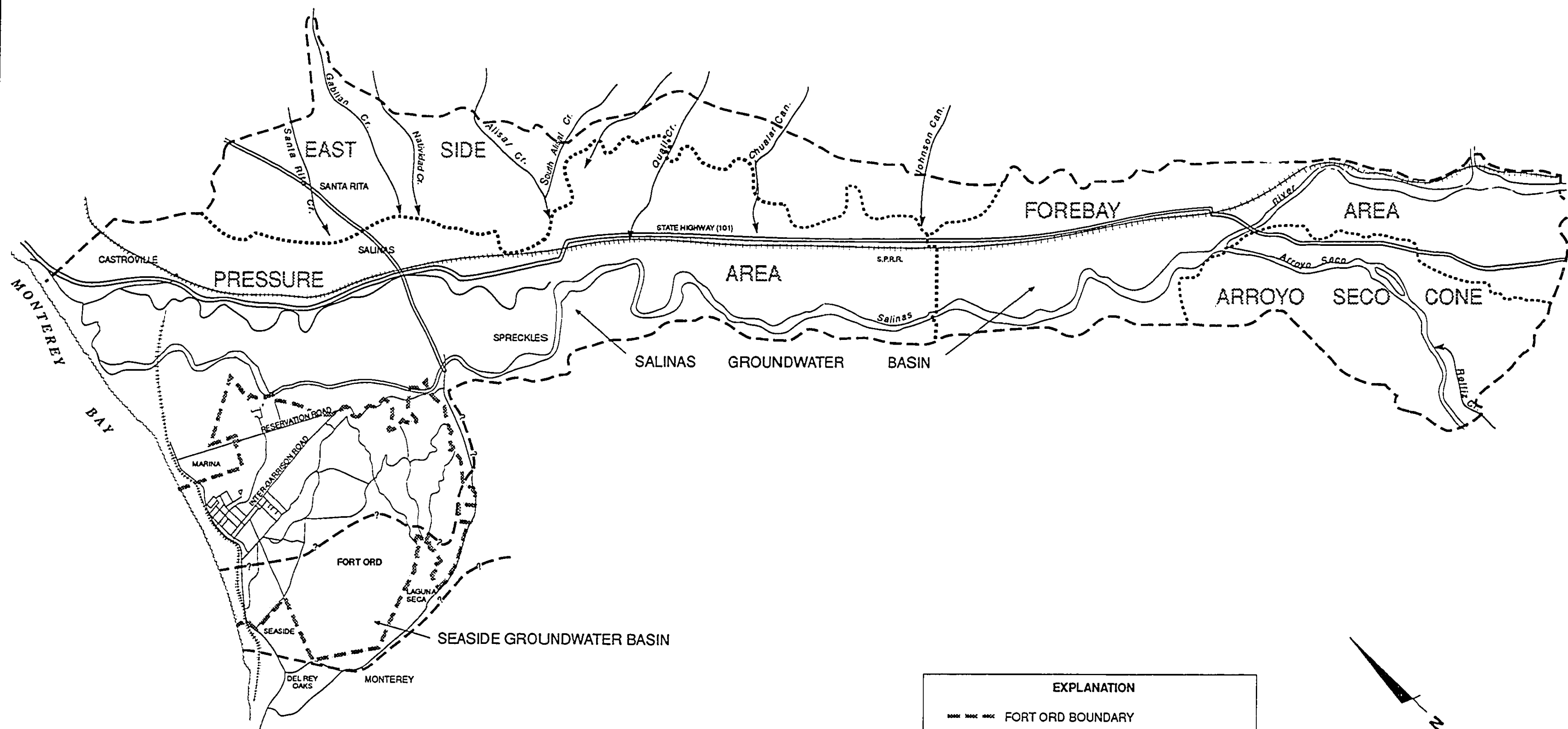
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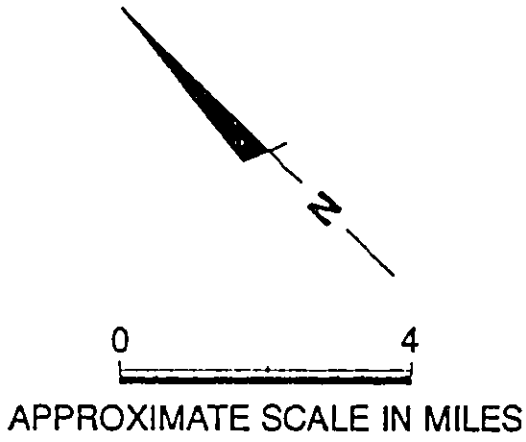


EXPLANATION

--- FORT ORD BOUNDARY

--- GROUNDWATER BASIN BOUNDARY; QUERIED WHERE UNCERTAIN

..... SALINAS BASIN SUBAREA BOUNDARIES



NOTE: Modified from D W R, 1949.

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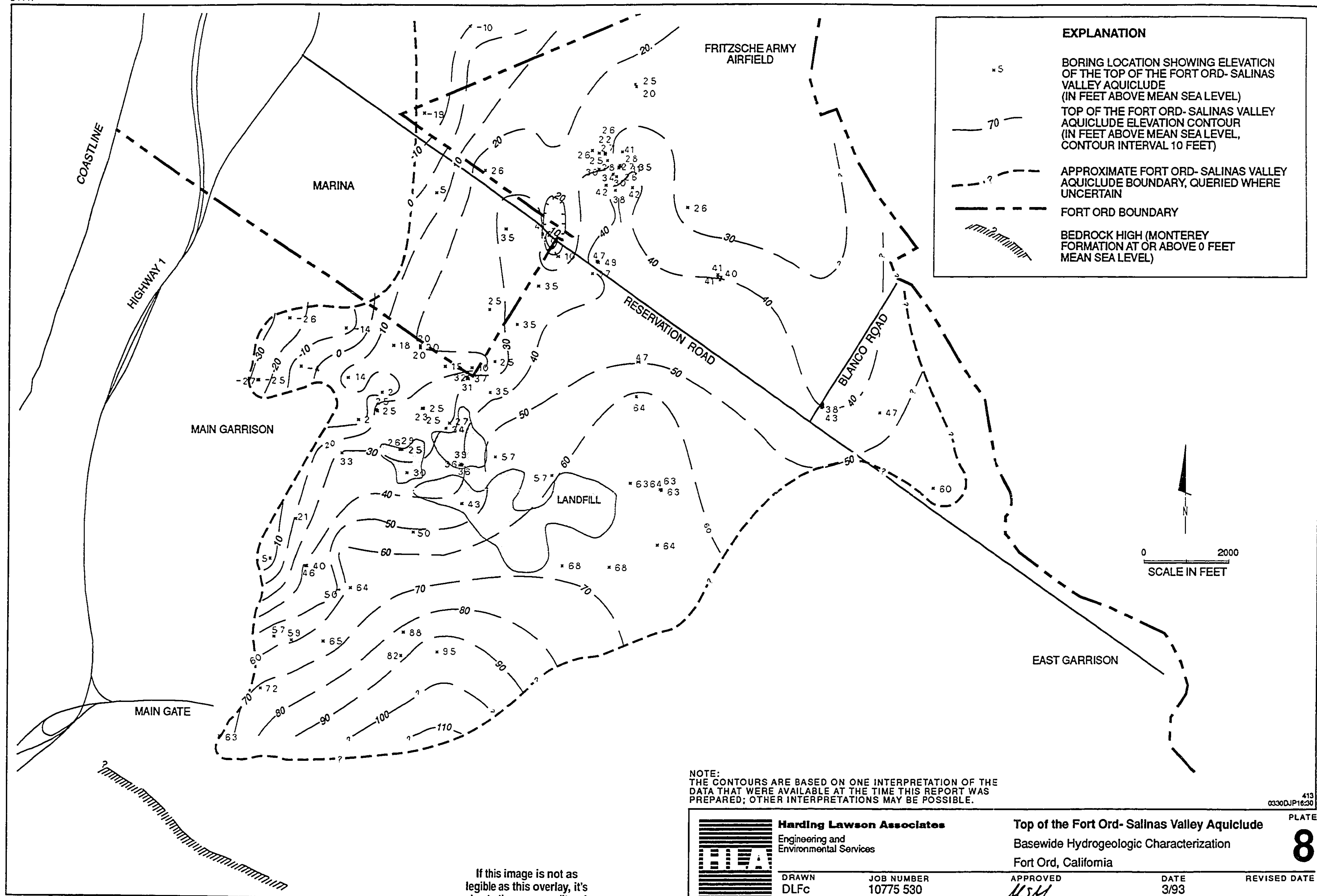


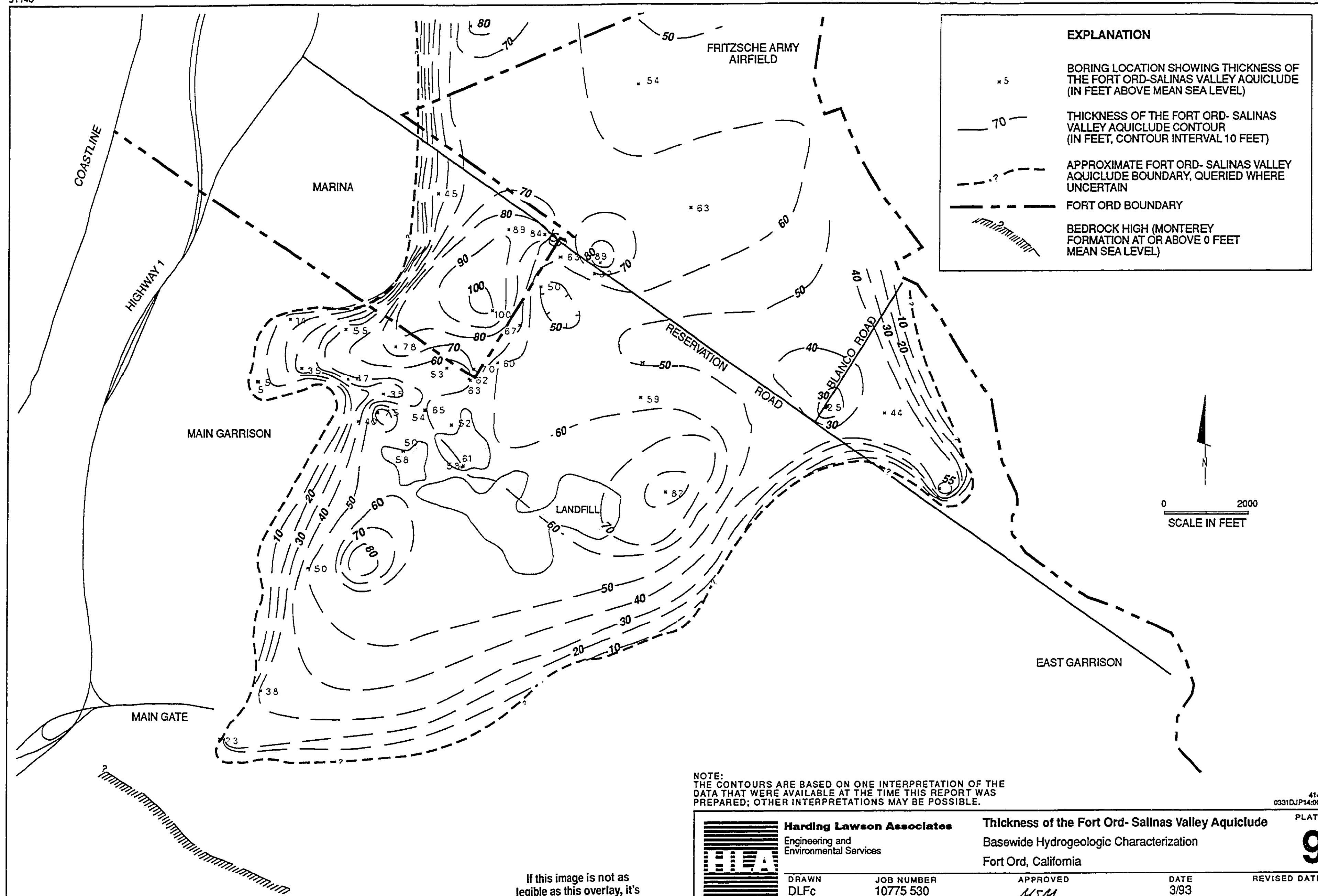
Harding Lawson Associates
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Groundwater Basin Map
Basewide Hydrogeologic Characterization
Fort Ord, California

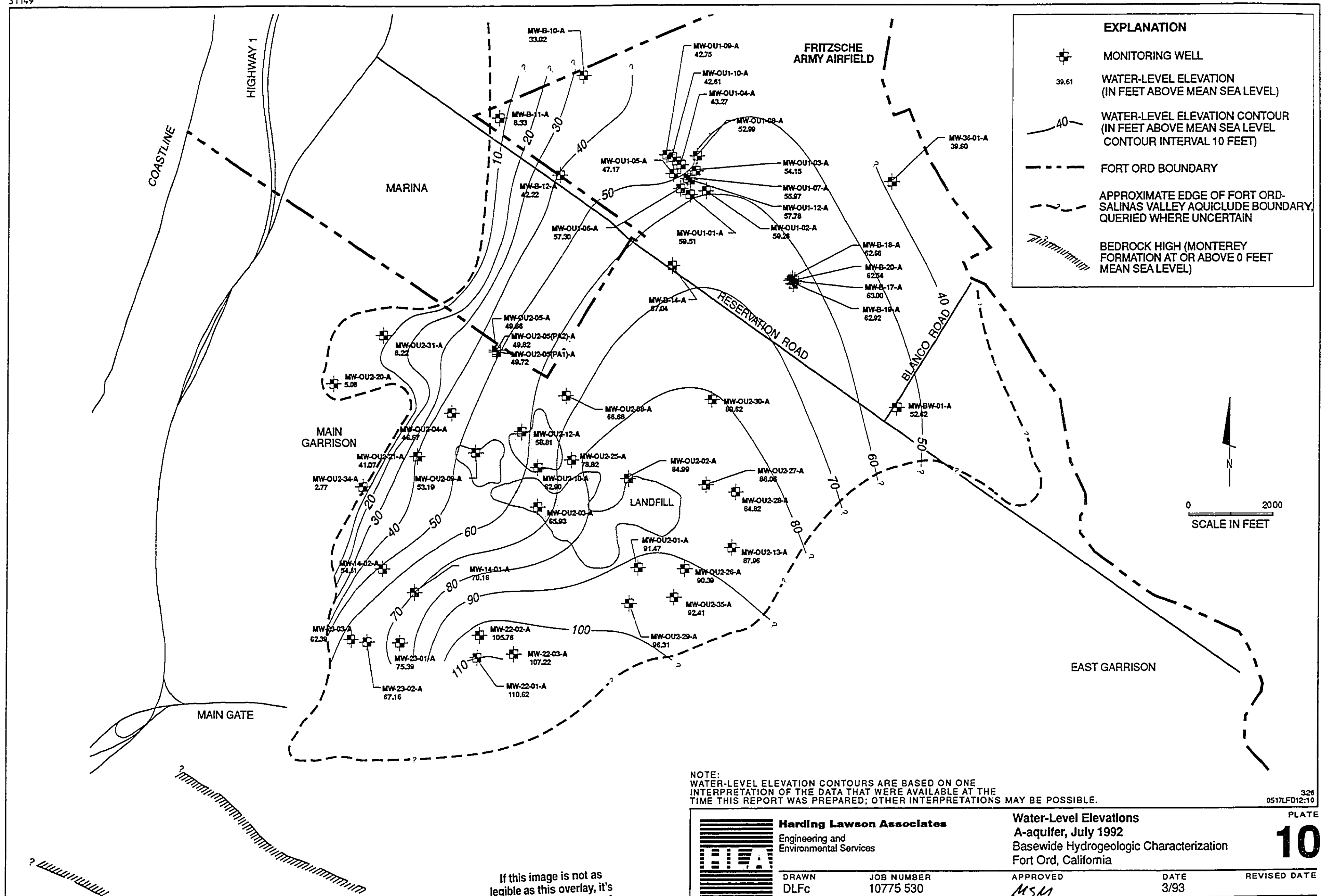
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2

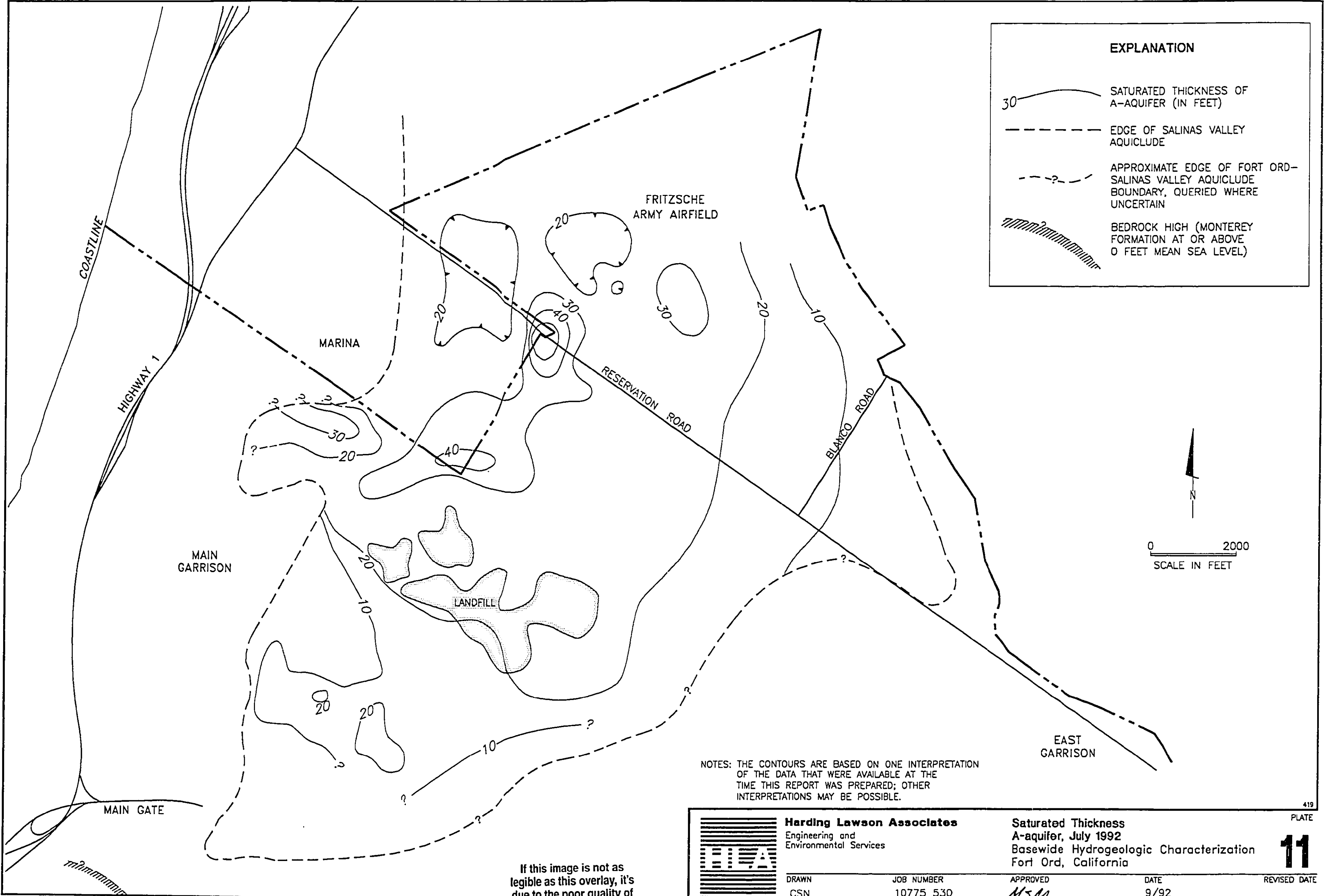
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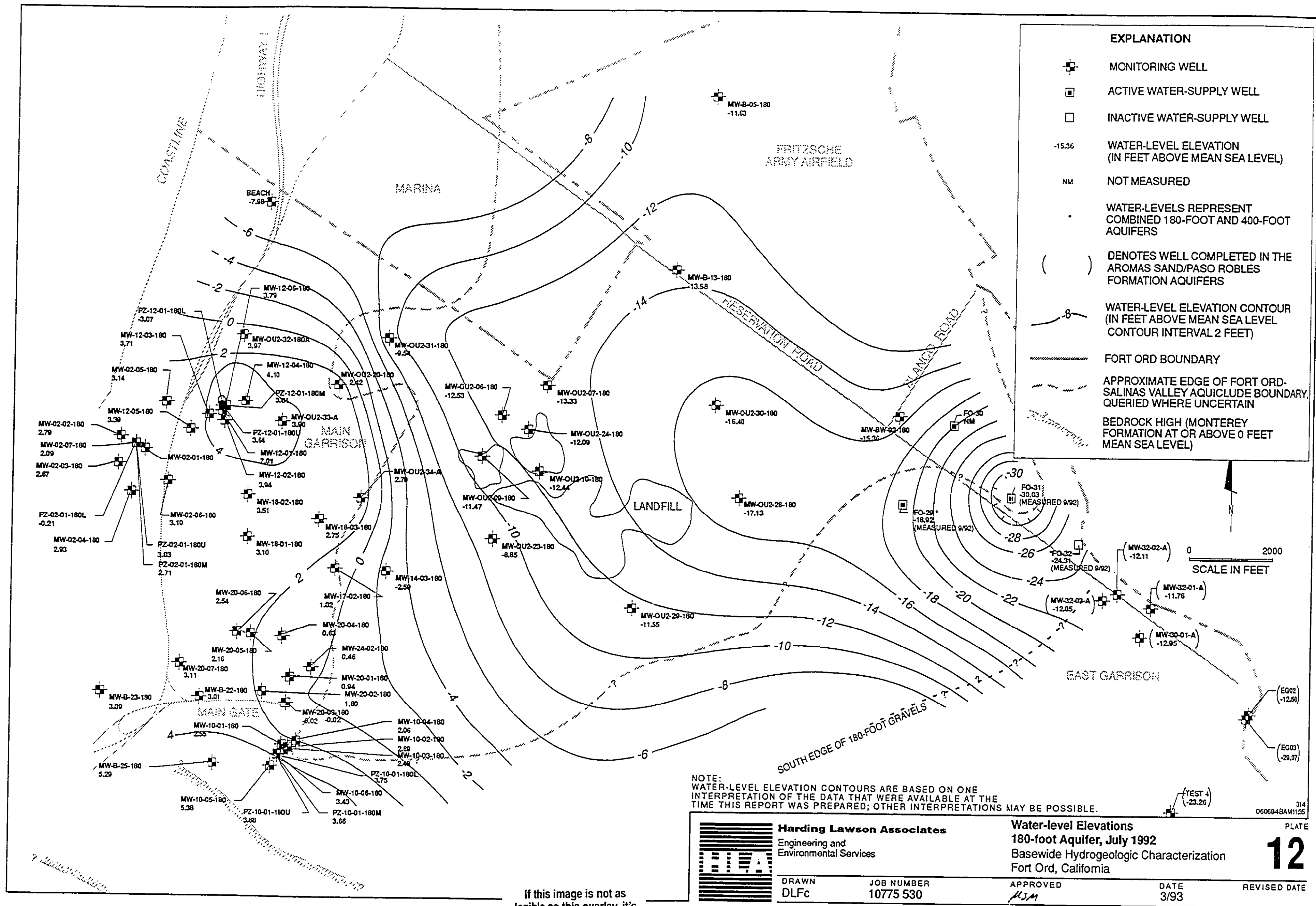
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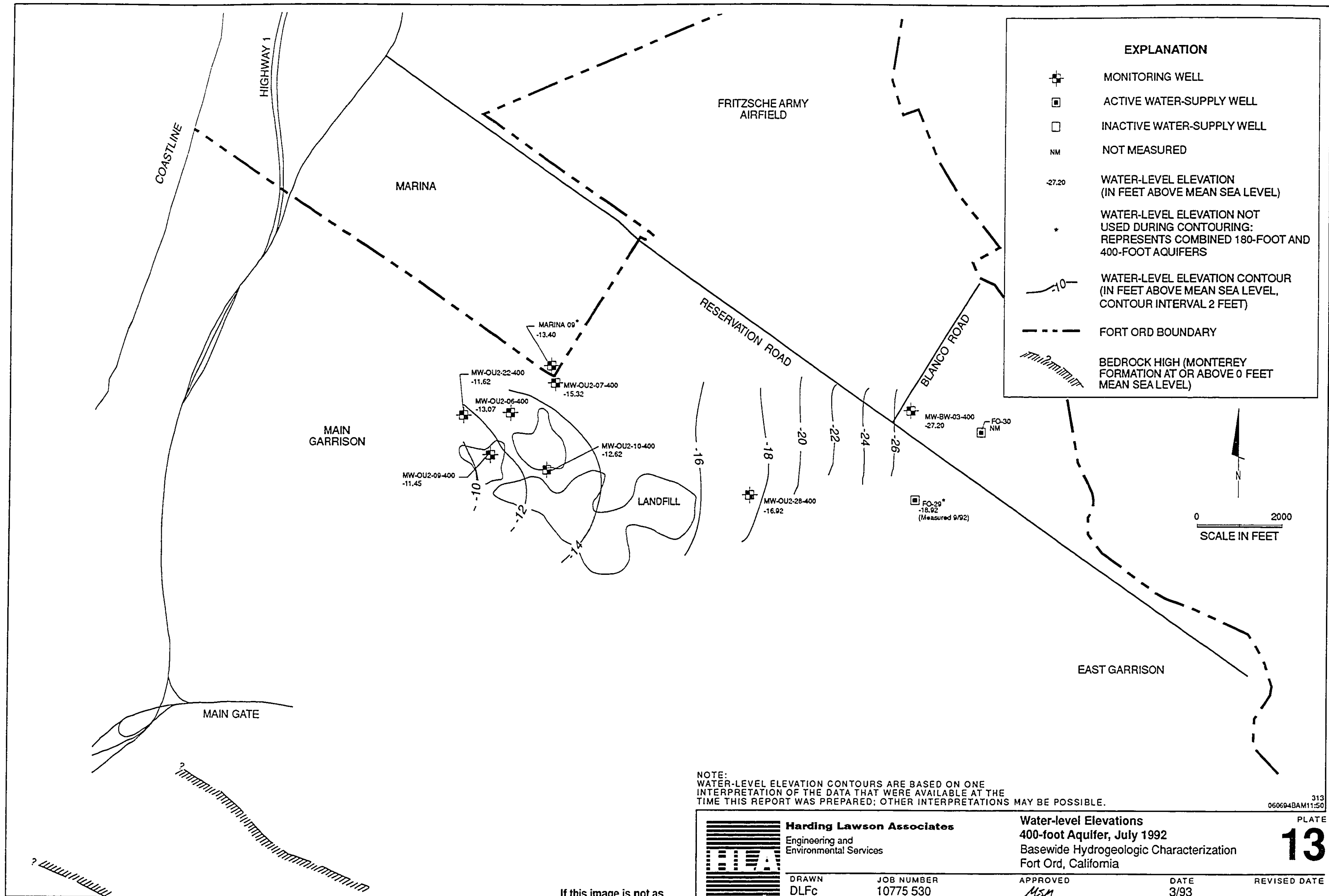
Harding Lawson Associates
Engineering and
Environmental Services

**Saturated Thickness
A-aquifer, July 1992**
Basewide Hydrogeologic Characterization
Fort Ord, California

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
CSN	10775 530	MSM	9/92	



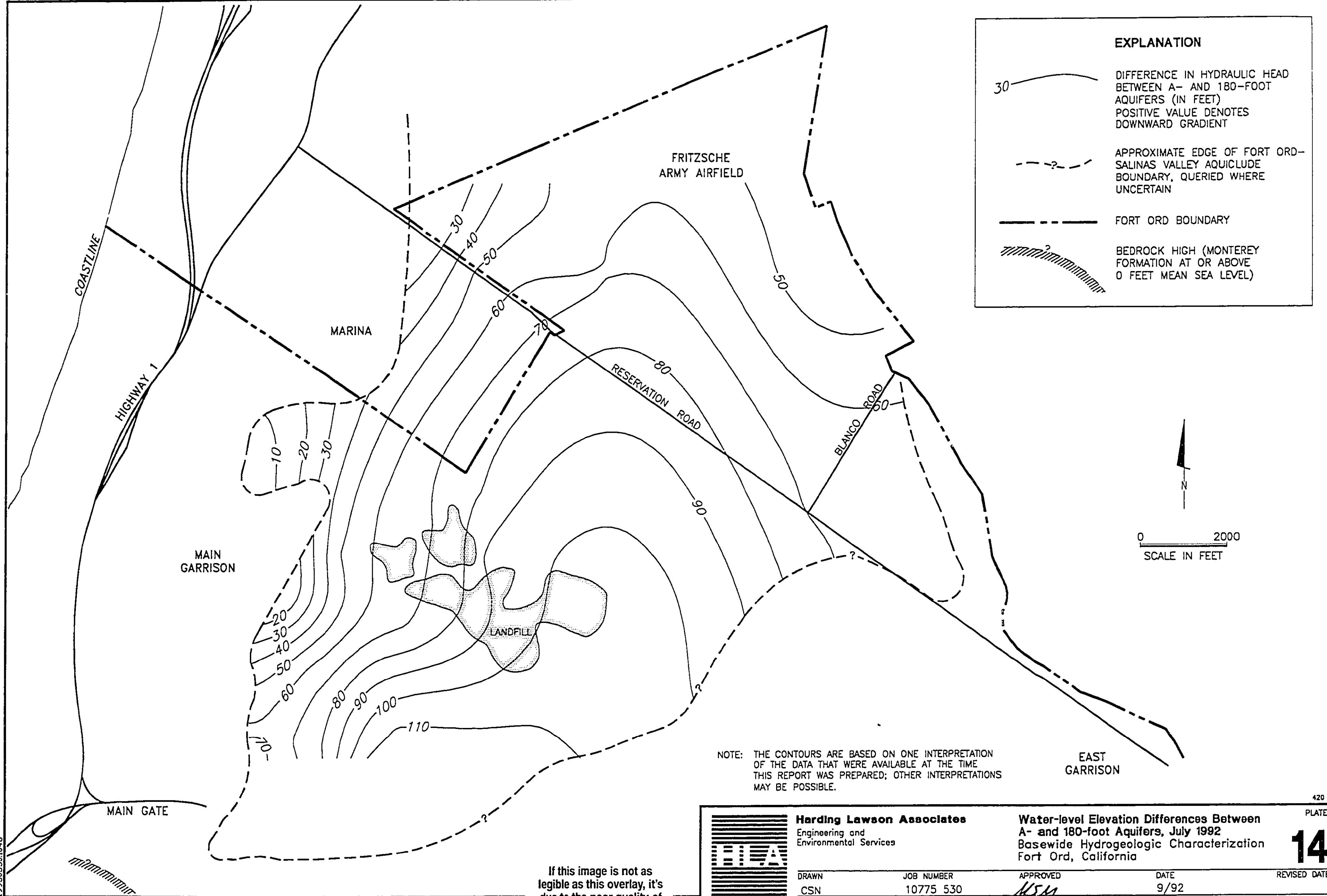
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NOTE:
WATER-LEVEL ELEVATION CONTOURS ARE BASED ON ONE
INTERPRETATION OF THE DATA THAT WERE AVAILABLE AT THE
TIME THIS REPORT WAS PREPARED; OTHER INTERPRETATIONS MAY BE POSSIBLE.

	Harding Lawson Associates		Water-level Elevations		PLATE 13
	Engineering and Environmental Services		400-foot Aquifer, July 1992 Basewide Hydrogeologic Characterization Fort Ord, California		
	DRAWN DLFc	JOB NUMBER 10775 530	APPROVED HSM	DATE 3/93	

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EXPLANATION

30 — DIFFERENCE IN HYDRAULIC HEAD BETWEEN A- AND 180-FOOT AQUIFERS (IN FEET)
POSITIVE VALUE DENOTES DOWNWARD GRADIENT

- - - ? - - - APPROXIMATE EDGE OF FORT ORD-SALINAS VALLEY AQUICLUDE BOUNDARY, QUERIED WHERE UNCERTAIN

———— FORT ORD BOUNDARY

||||| ? ||||| BEDROCK HIGH (MONTEREY FORMATION AT OR ABOVE 0 FEET MEAN SEA LEVEL)

NOTE: THE CONTOURS ARE BASED ON ONE INTERPRETATION OF THE DATA THAT WERE AVAILABLE AT THE TIME THIS REPORT WAS PREPARED; OTHER INTERPRETATIONS MAY BE POSSIBLE.



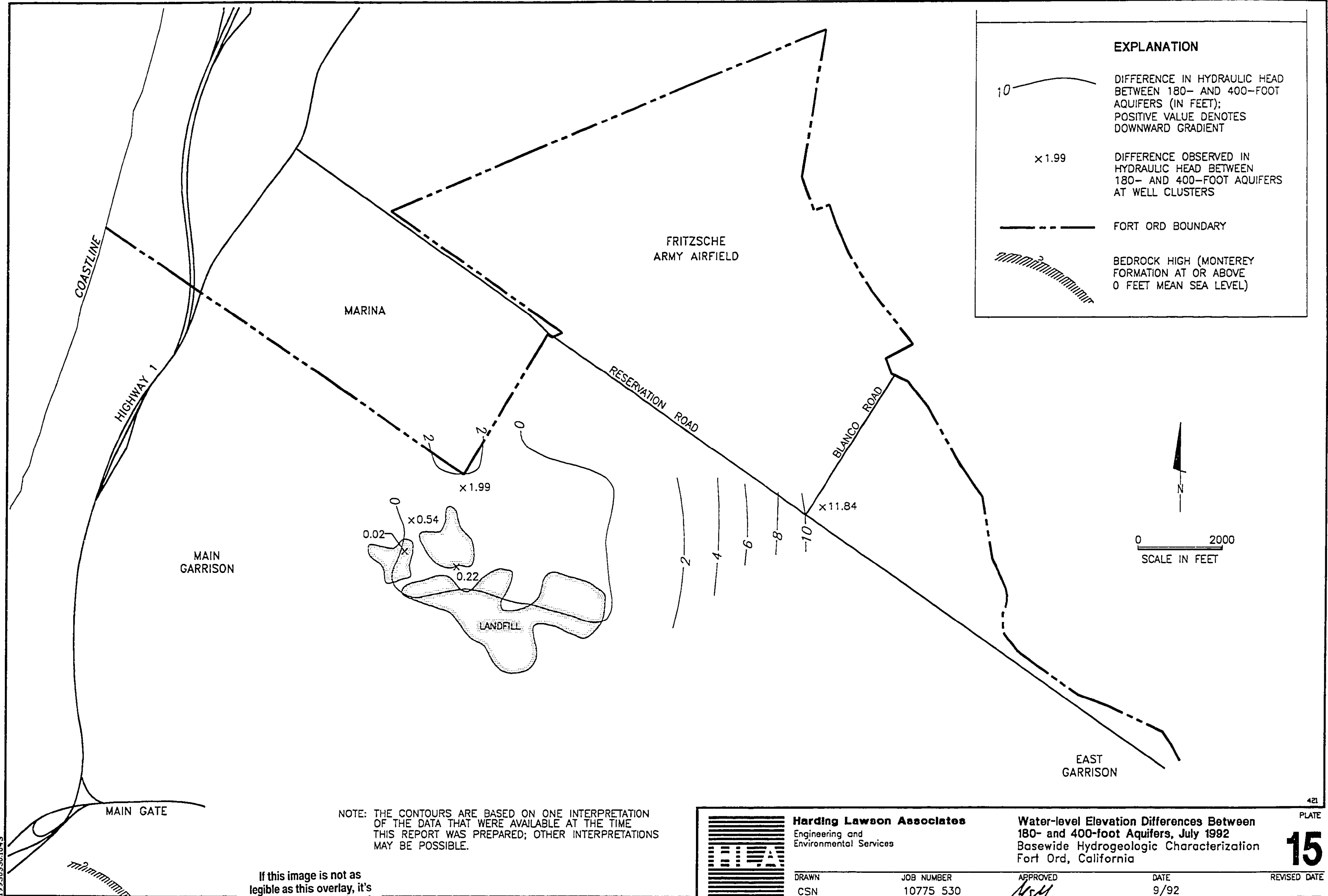
Harding Lawson Associates
Engineering and Environmental Services

Water-level Elevation Differences Between A- and 180-foot Aquifers, July 1992
Basewide Hydrogeologic Characterization Fort Ord, California

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
CSN	10775 530	HLA	9/92	

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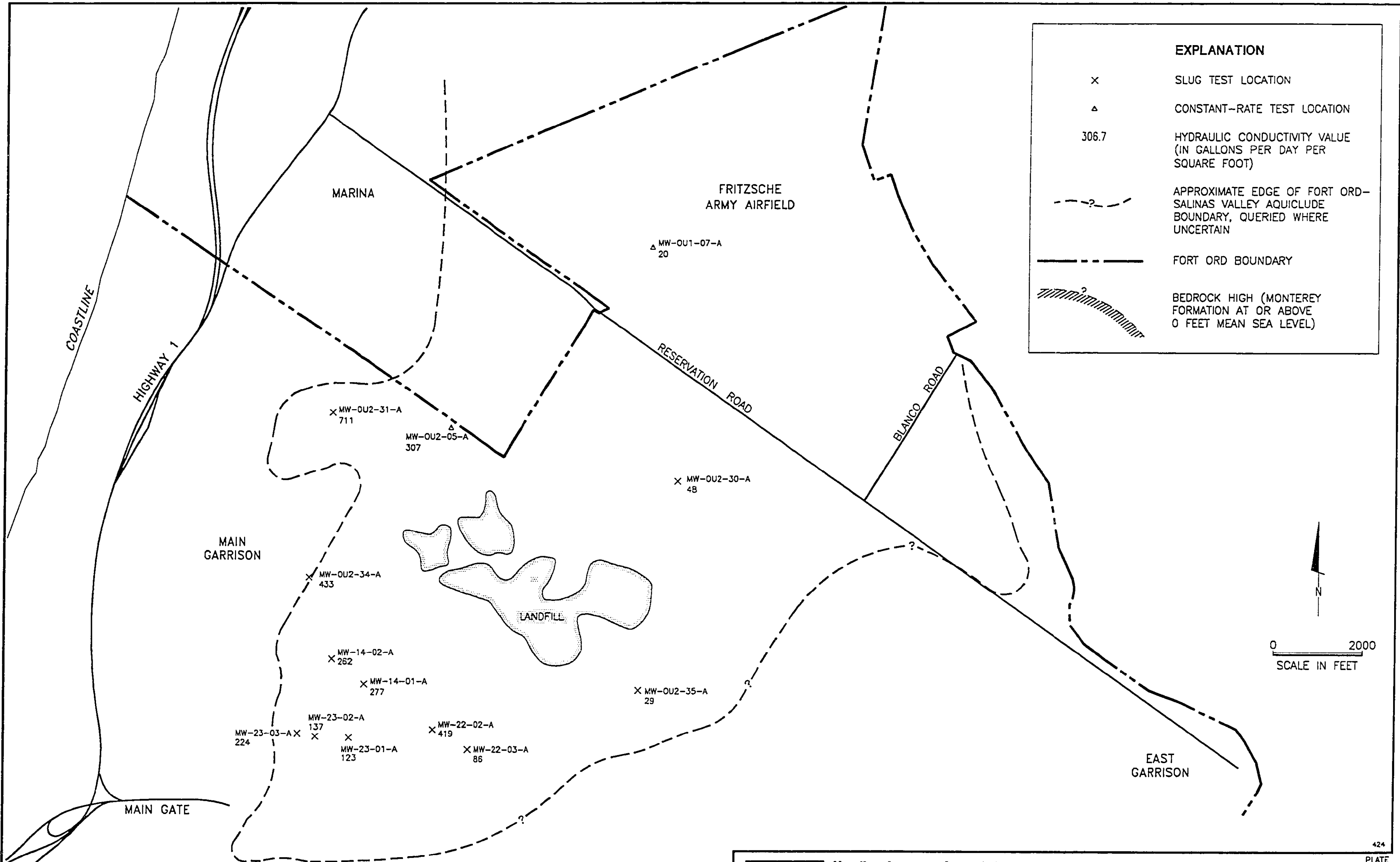
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Page # 141 (3 PGS)

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Document # BW-0608



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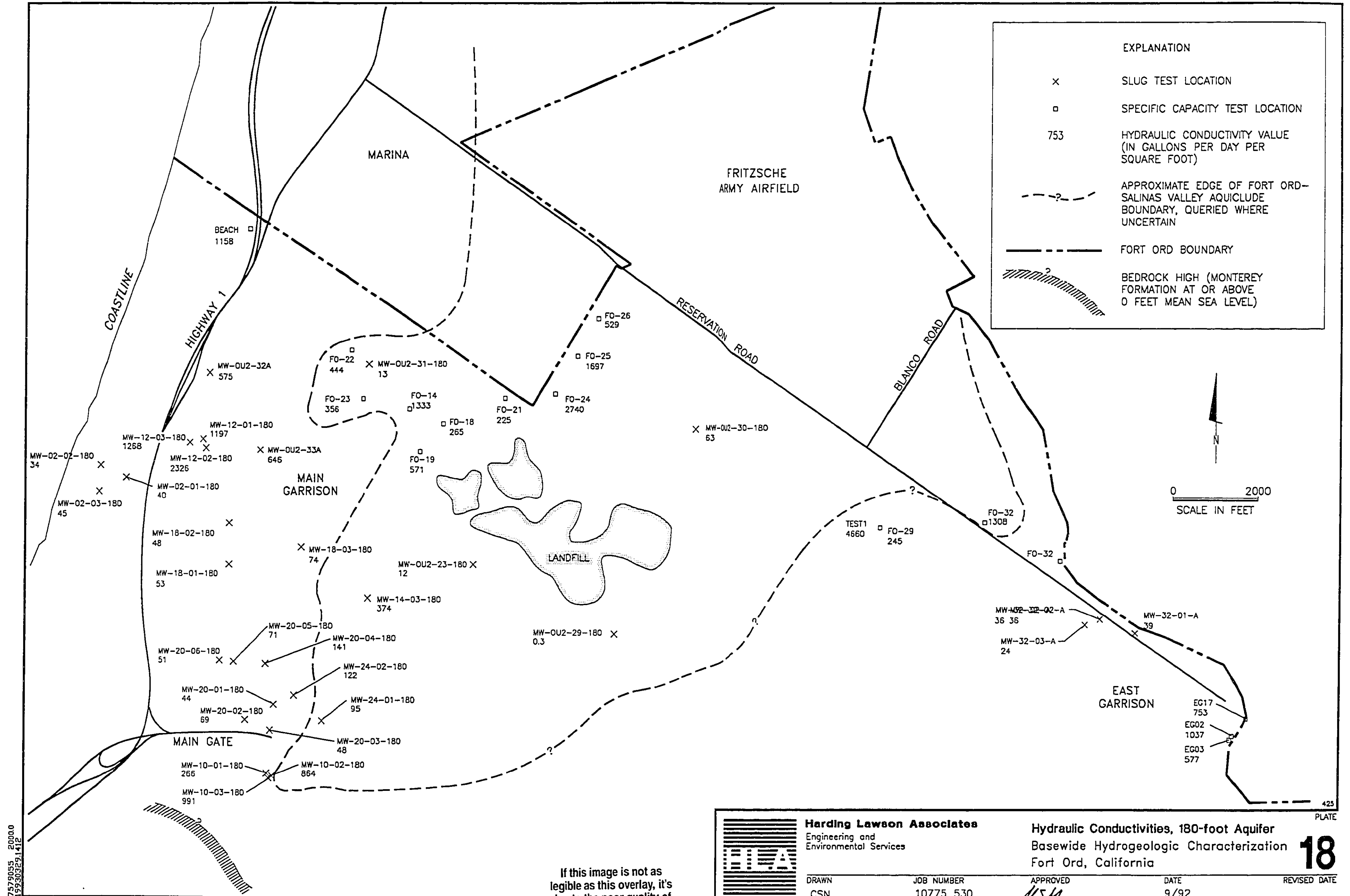
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Harding Lawson Associates
Engineering and Environmental Services

Hydraulic Conductivities, A-aquifer
Basewide Hydrogeologic Characterization
Fort Ord, California

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CSN	10775 530	<i>LSH</i>	9/92	



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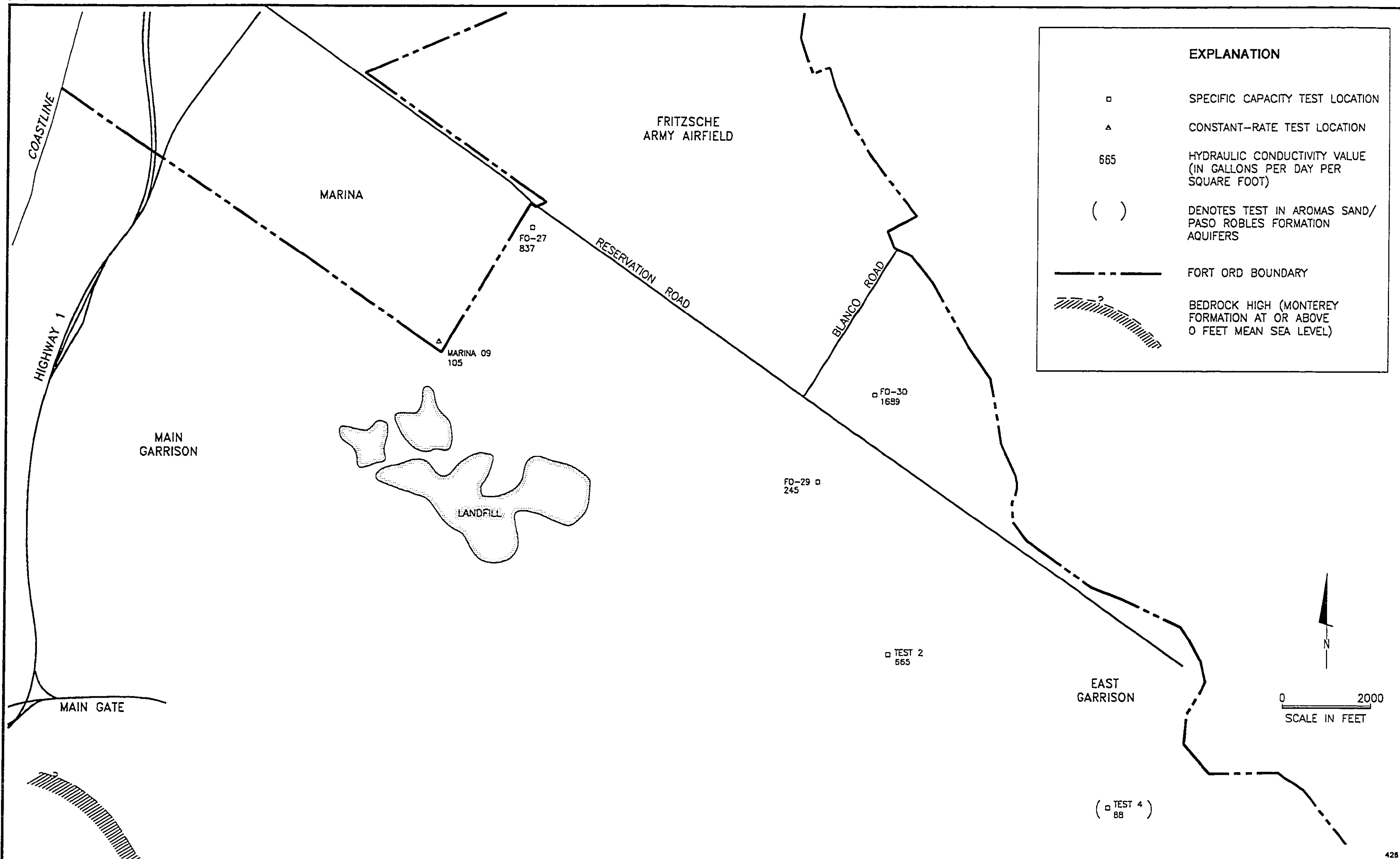


Harding Lawson Associates
Engineering and Environmental Services

Hydraulic Conductivities, 180-foot Aquifer
Basewide Hydrogeologic Characterization
Fort Ord, California

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
CSN	10775 530	11/5/11	9/92	

PLATE



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Harding Lawson Associates
Engineering and
Environmental Services

Hydraulic Conductivities, 400-foot Aquifer
Basewide Hydrogeologic Characterization
Fort Ord, California

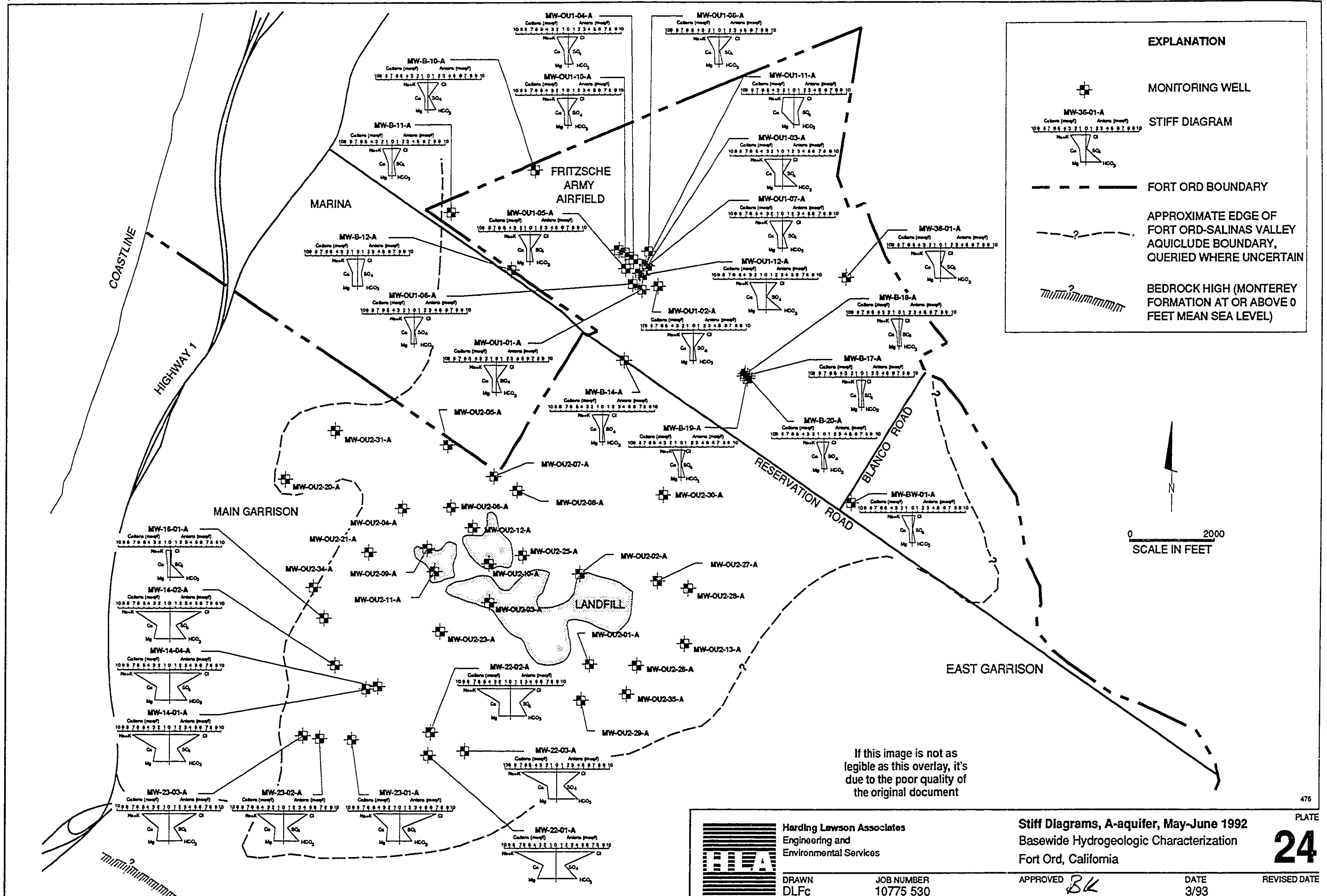
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DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
CSN	10775 530	<i>[Signature]</i>	9/92	

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JOB NUMBER
10775 530

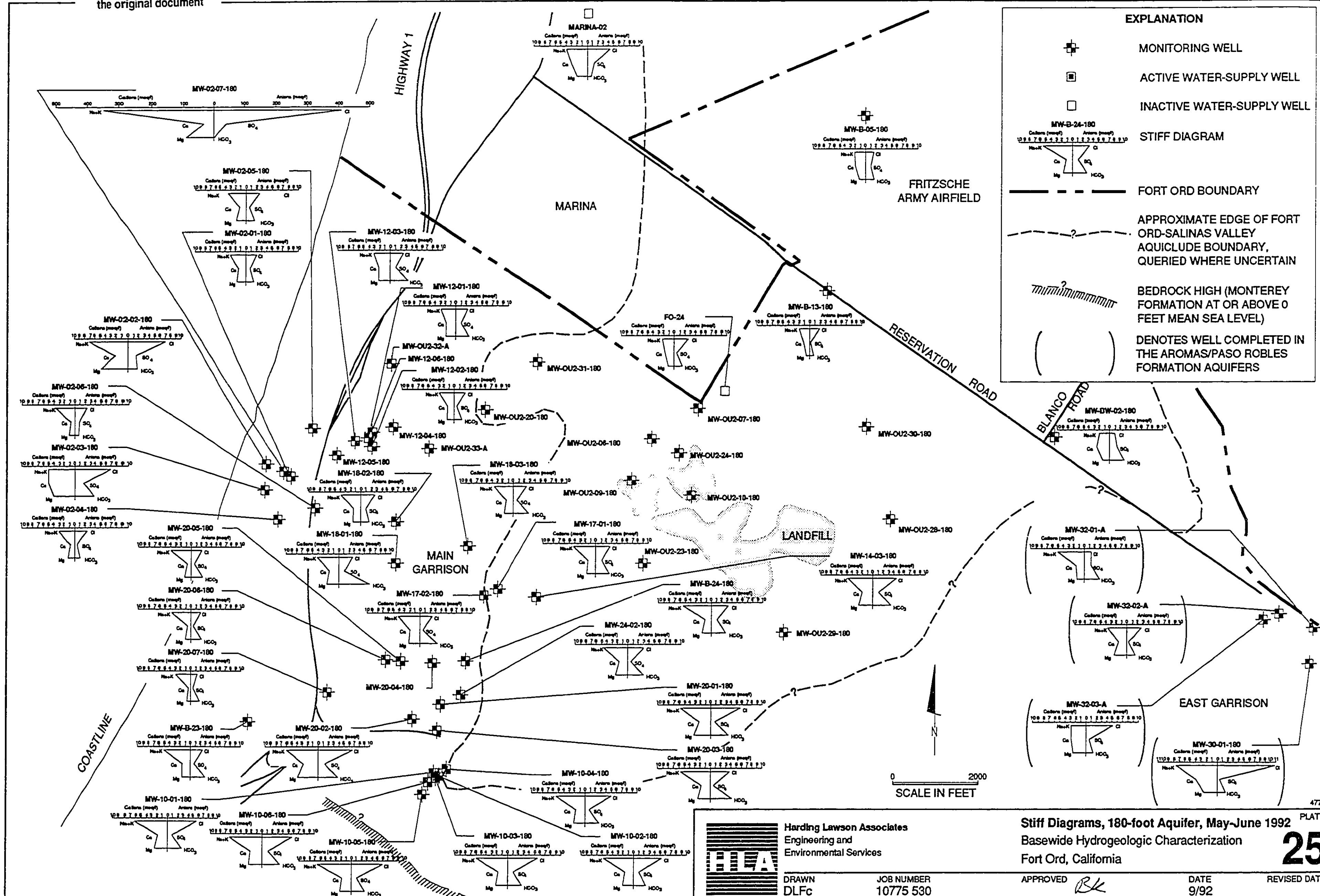
Stiff Diagrams, A-aquifer, May-June 1992
Basewide Hydrogeologic Characterization
Fort Ord, California

APPROVED *BK*

DATE
3/93

REVISED DATE

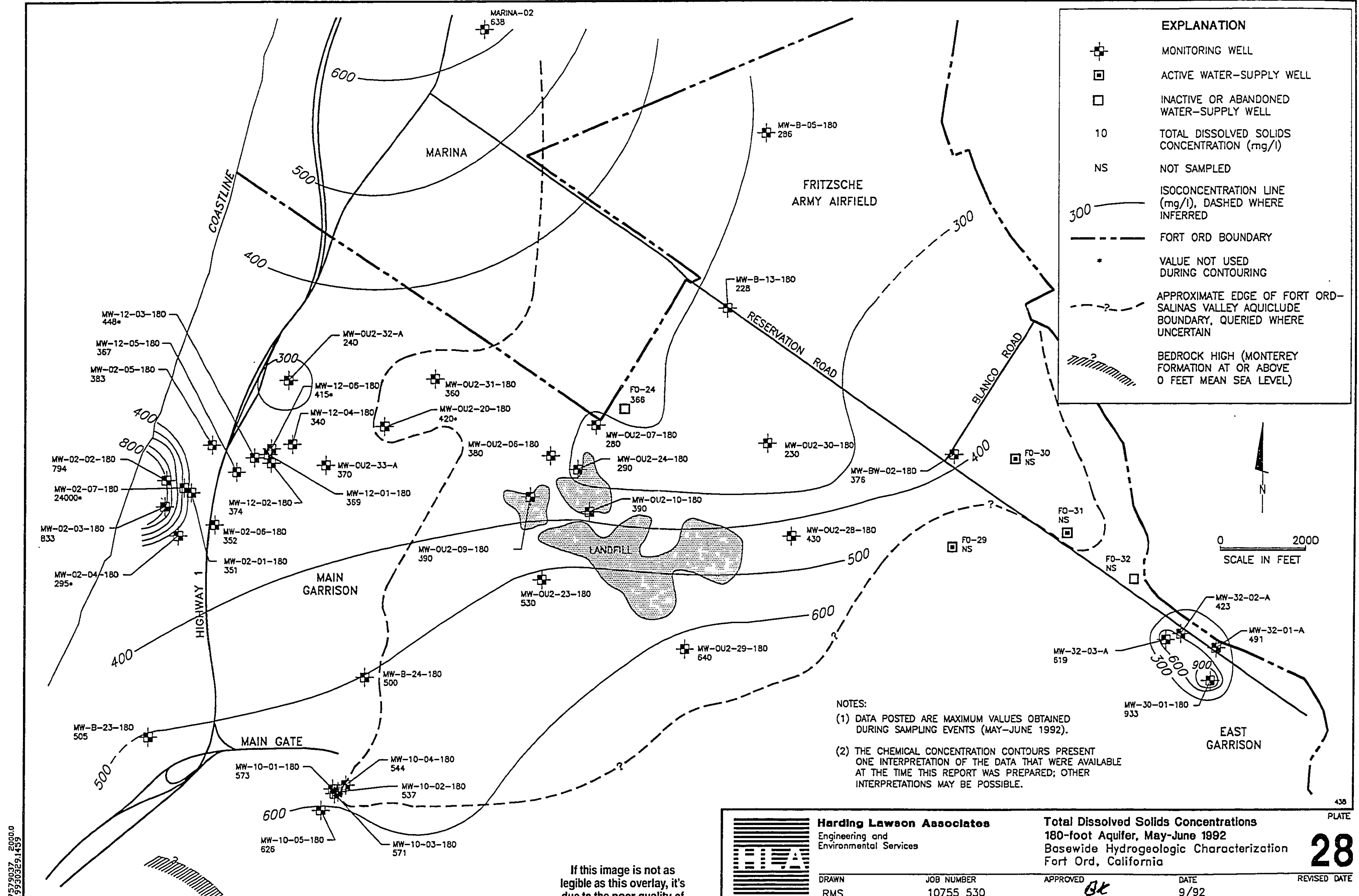
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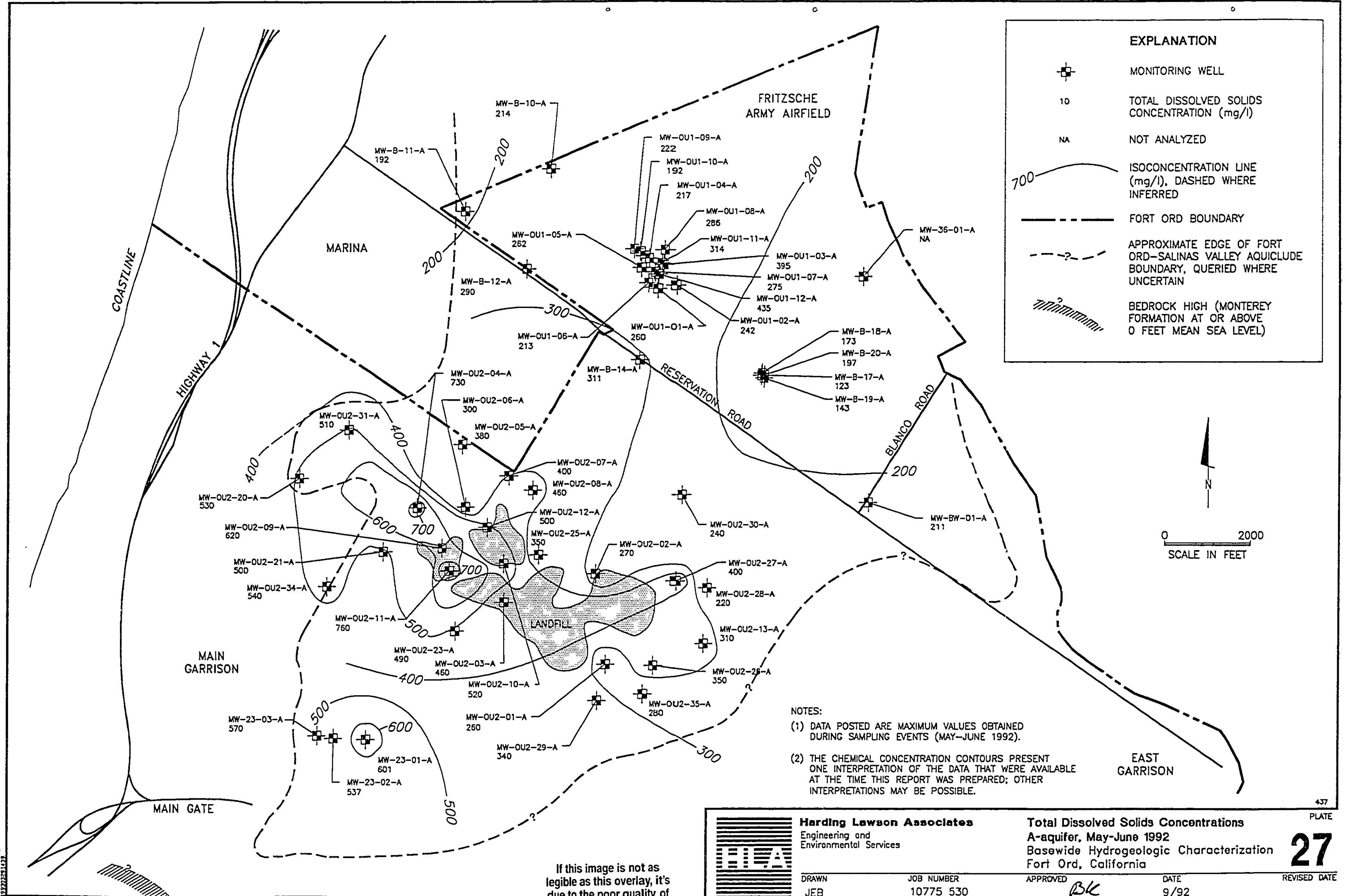
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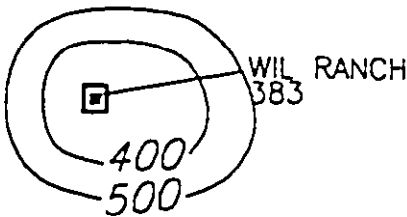
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31164



EXPLANATION

MONITORING WELL

ACTIVE WATER-SUPPLY WELL

INACTIVE WATER-SUPPLY WELL

10

TOTAL DISSOLVED SOLIDS CONCENTRATION (mg/l)

NS

NOT SAMPLED

700

ISOCONCENTRATION LINE (mg/l) DASHED WHERE INFERRED

FORT ORD BOUNDARY

APPROXIMATE EDGE OF FORT ORD-SALINAS VALLEY AQUICLUDE BOUNDARY, QUERIED WHERE UNCERTAIN



0 2000
SCALE IN FEET

NOTES:

- (1) DATA POSTED ARE MAXIMUM VALUES OBTAINED DURING SAMPLING EVENTS (MAY-JUNE 1992).
- (2) THE CHEMICAL CONCENTRATION CONTOURS PRESENT ONE INTERPRETATION OF THE DATA THAT WERE AVAILABLE AT THE TIME THIS REPORT WAS PREPARED; OTHER INTERPRETATIONS MAY BE POSSIBLE.



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**Total Dissolved Solids Concentrations,
400-foot Aquifer, May-June 1992**
Basewide Hydrogeologic Characterization
Fort Ord, California

DRAWN JEB
JOB NUMBER 10775 530

APPROVED *BL*

DATE 9/92

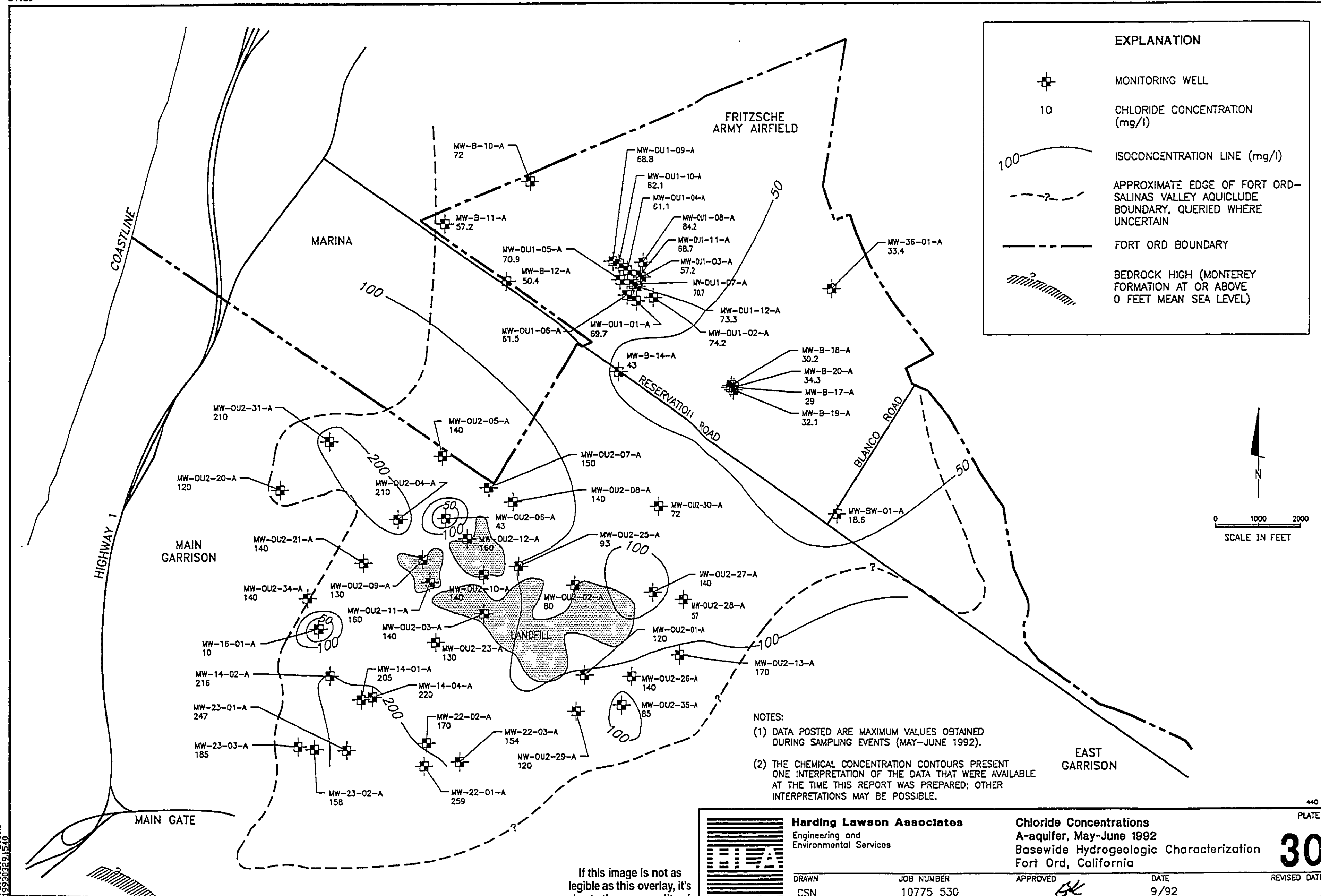
REVISED DATE

439

PLATE

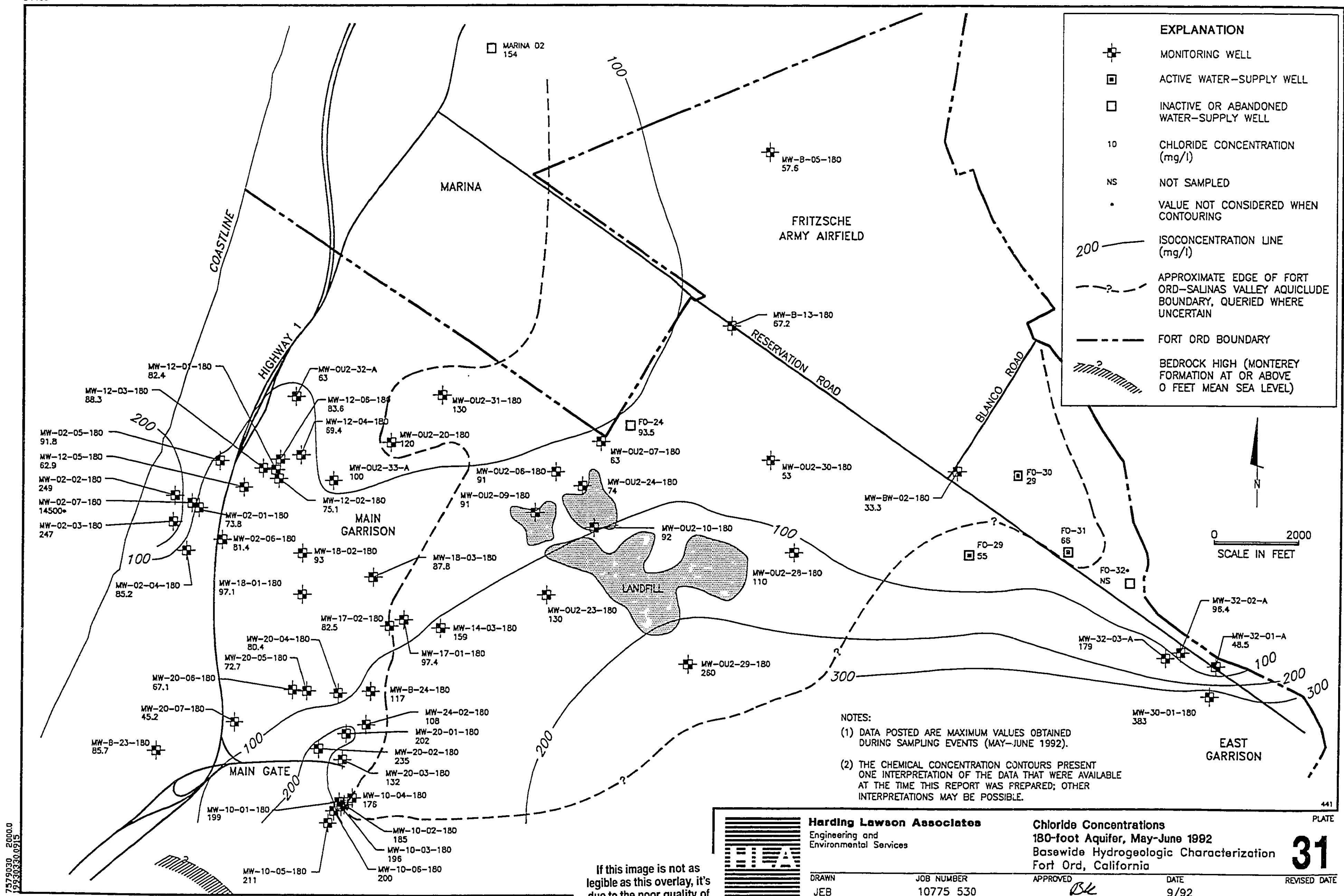
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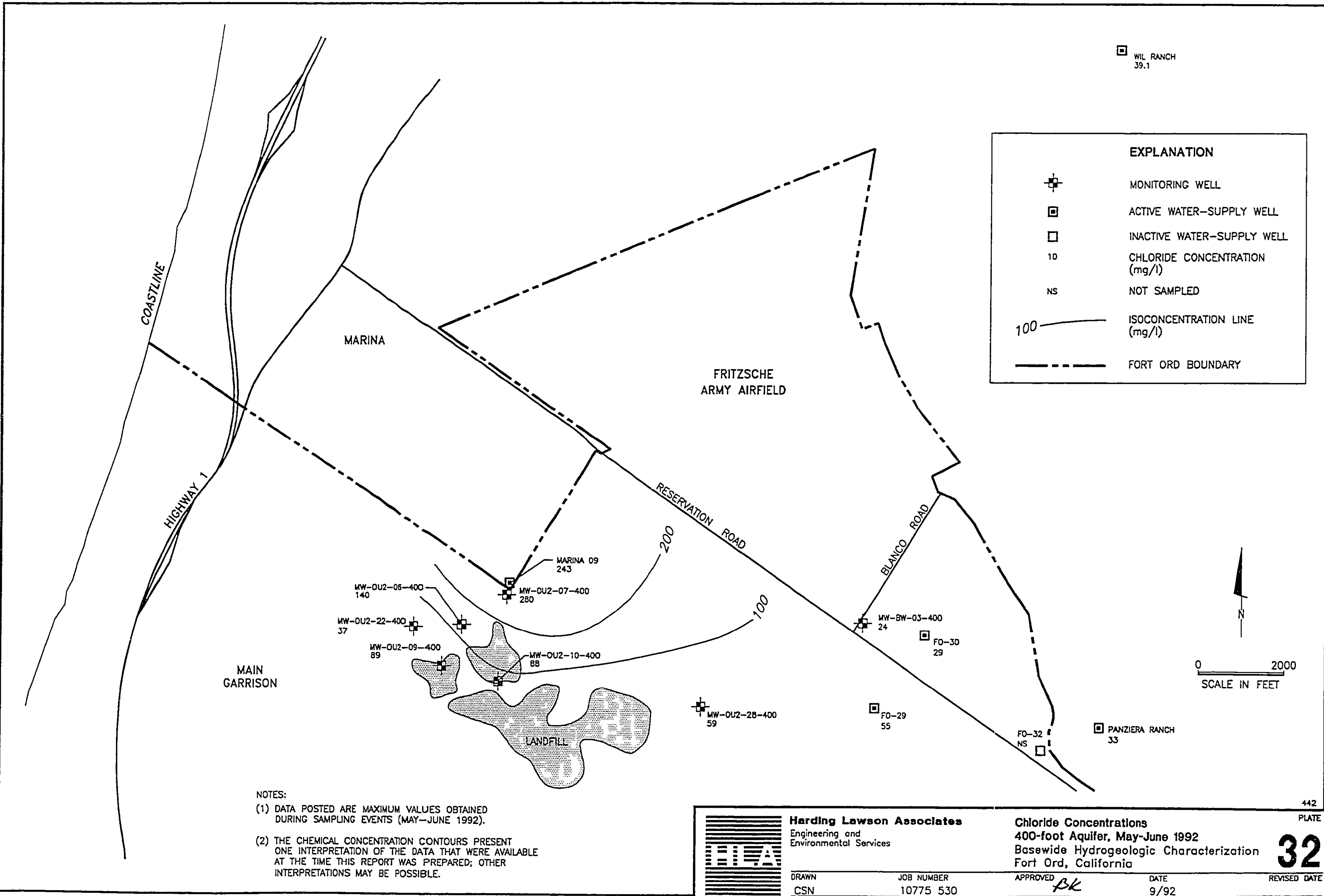
DRAWN CSN JOB NUMBER 10775 530 APPROVED DATE 9/92 REVISED DATE



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31167

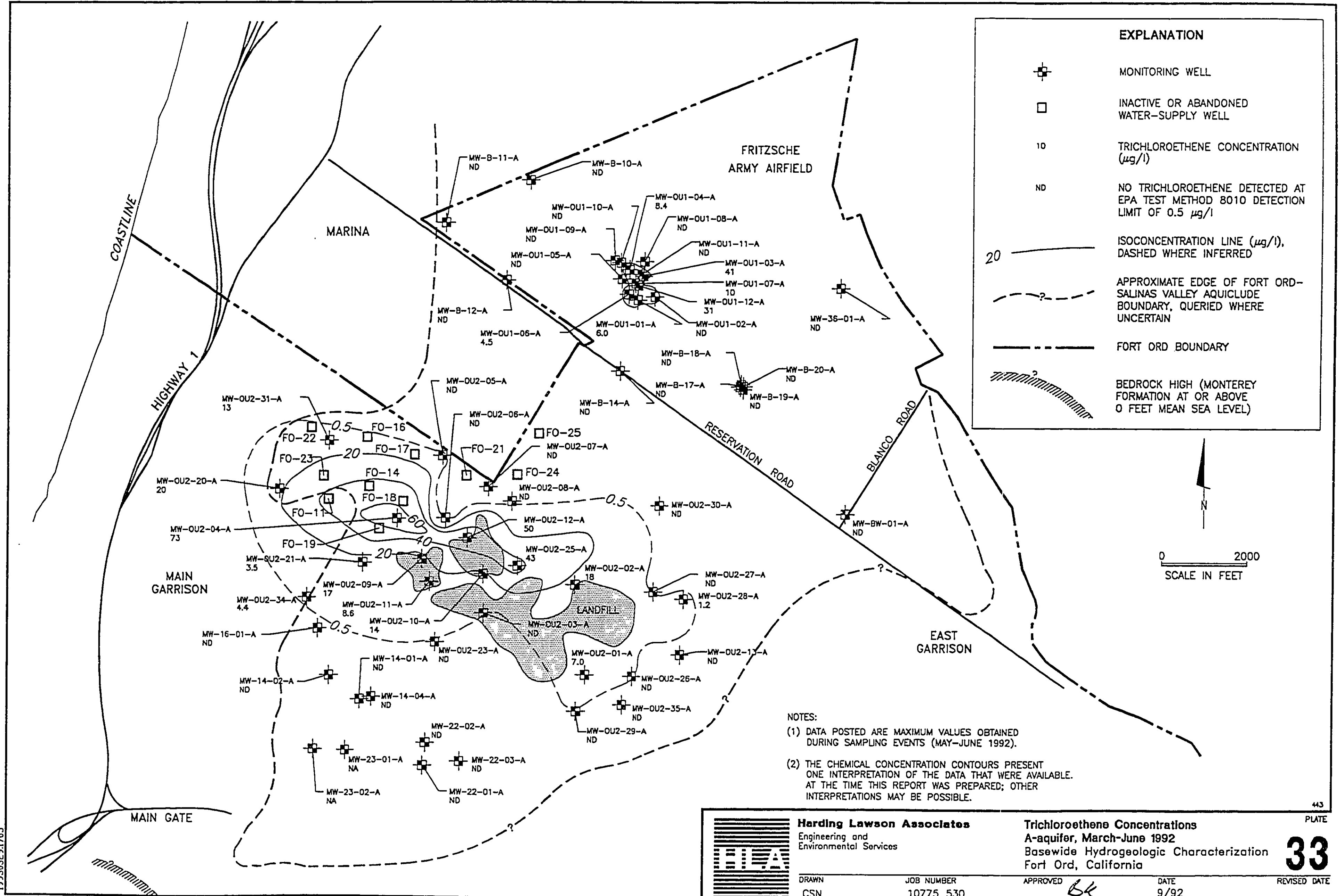


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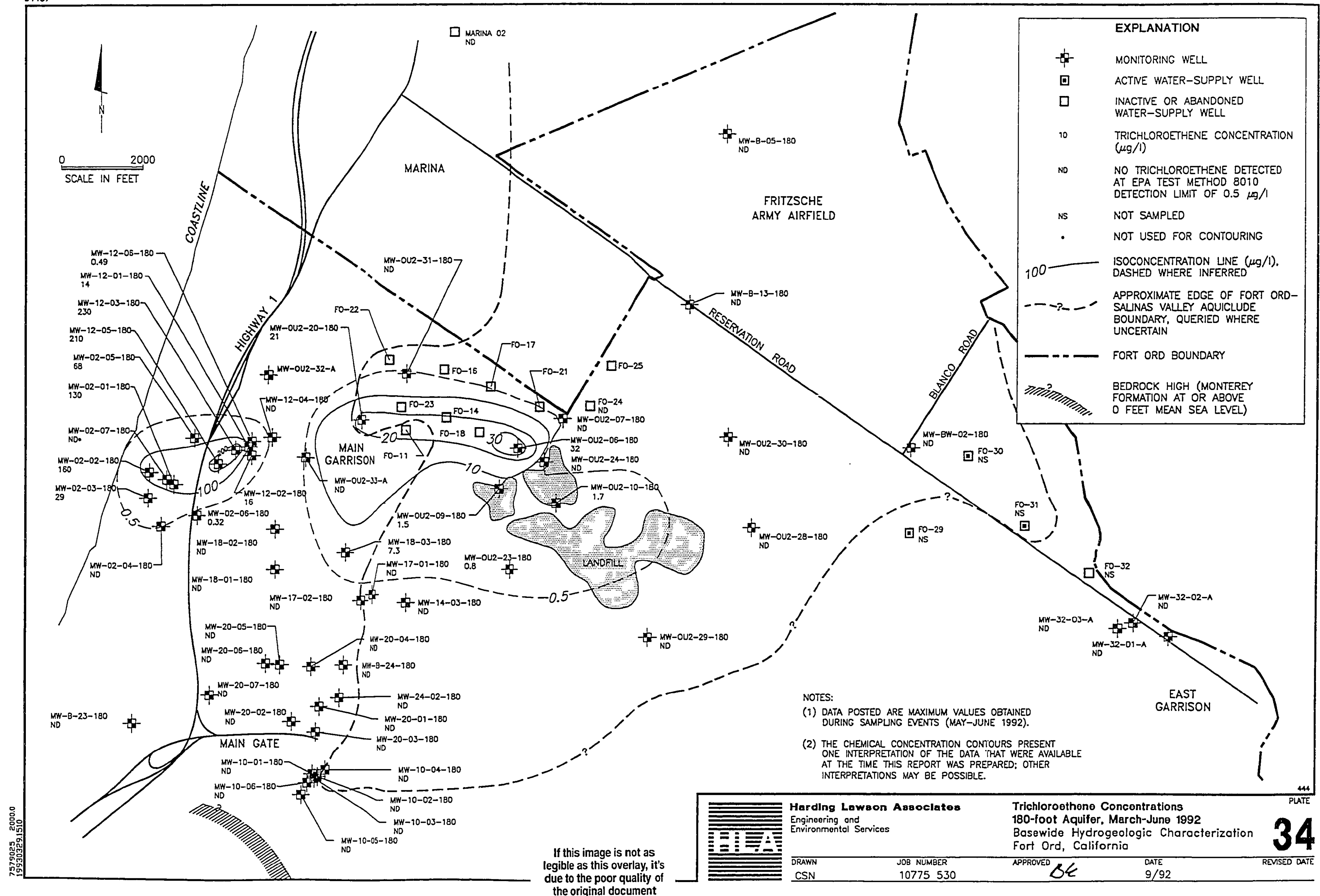
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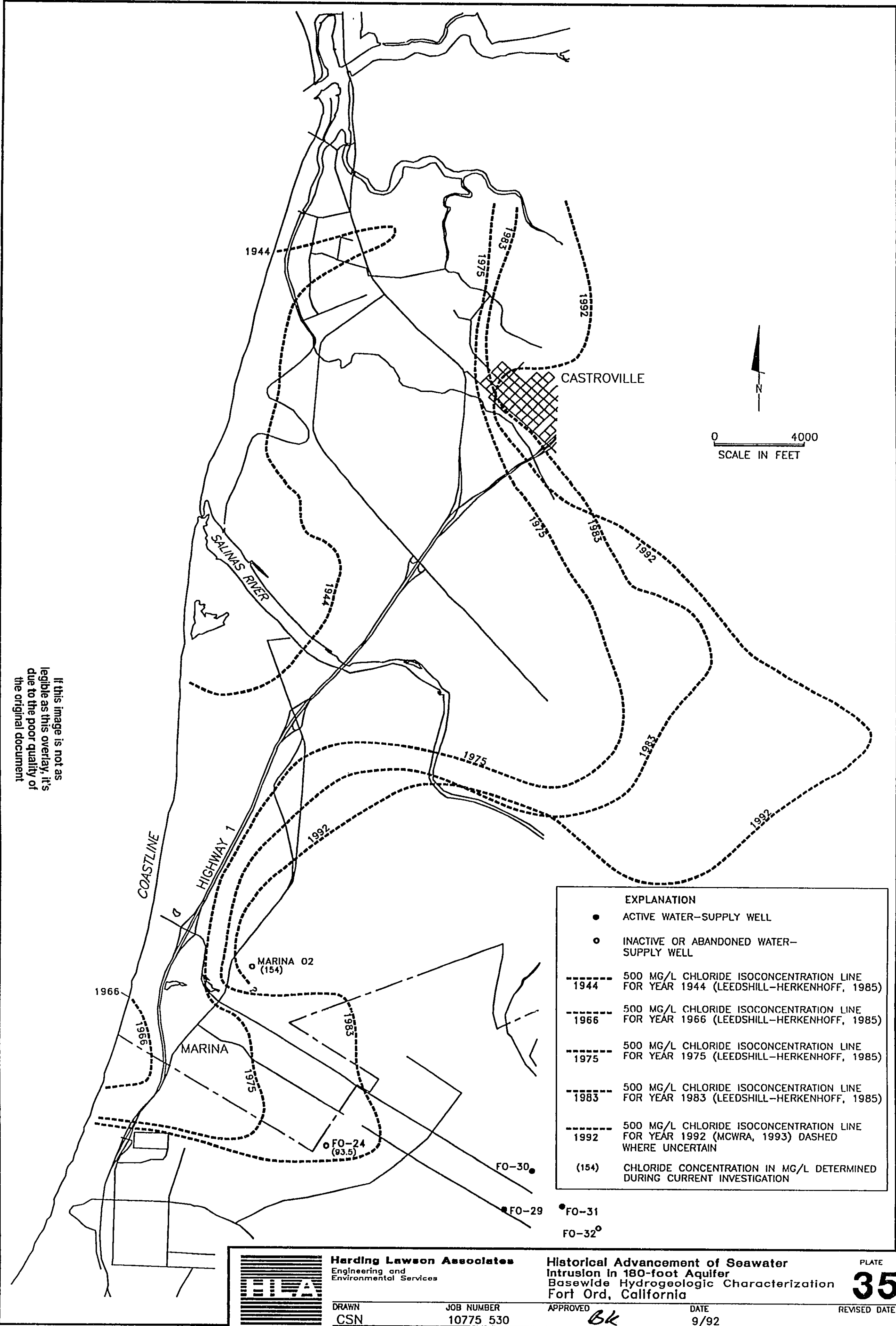
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31168

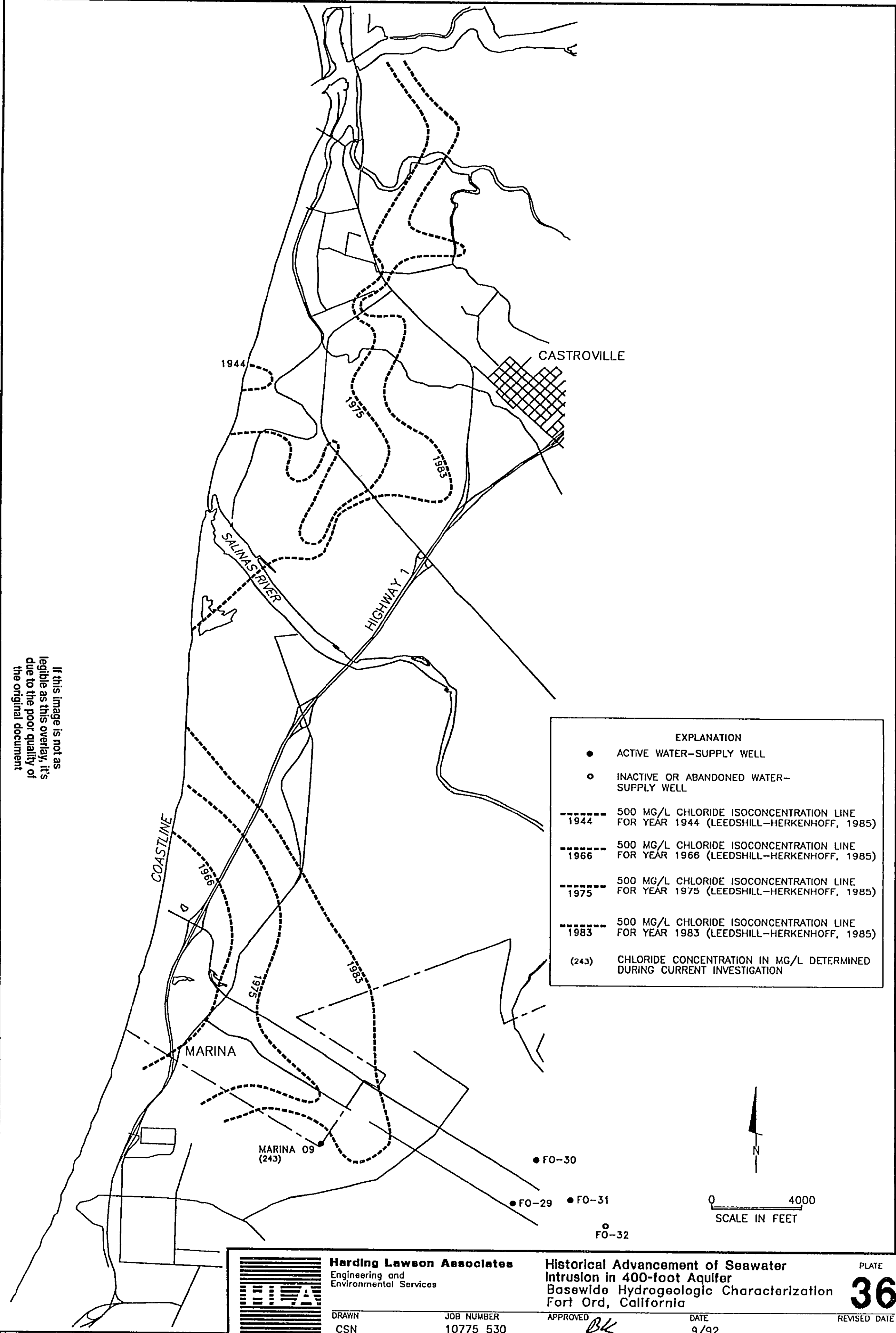


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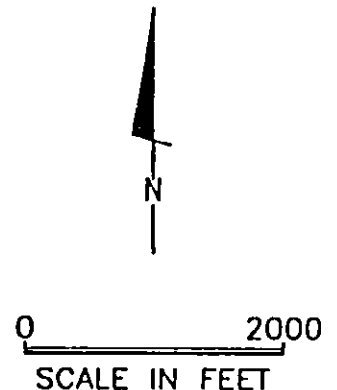
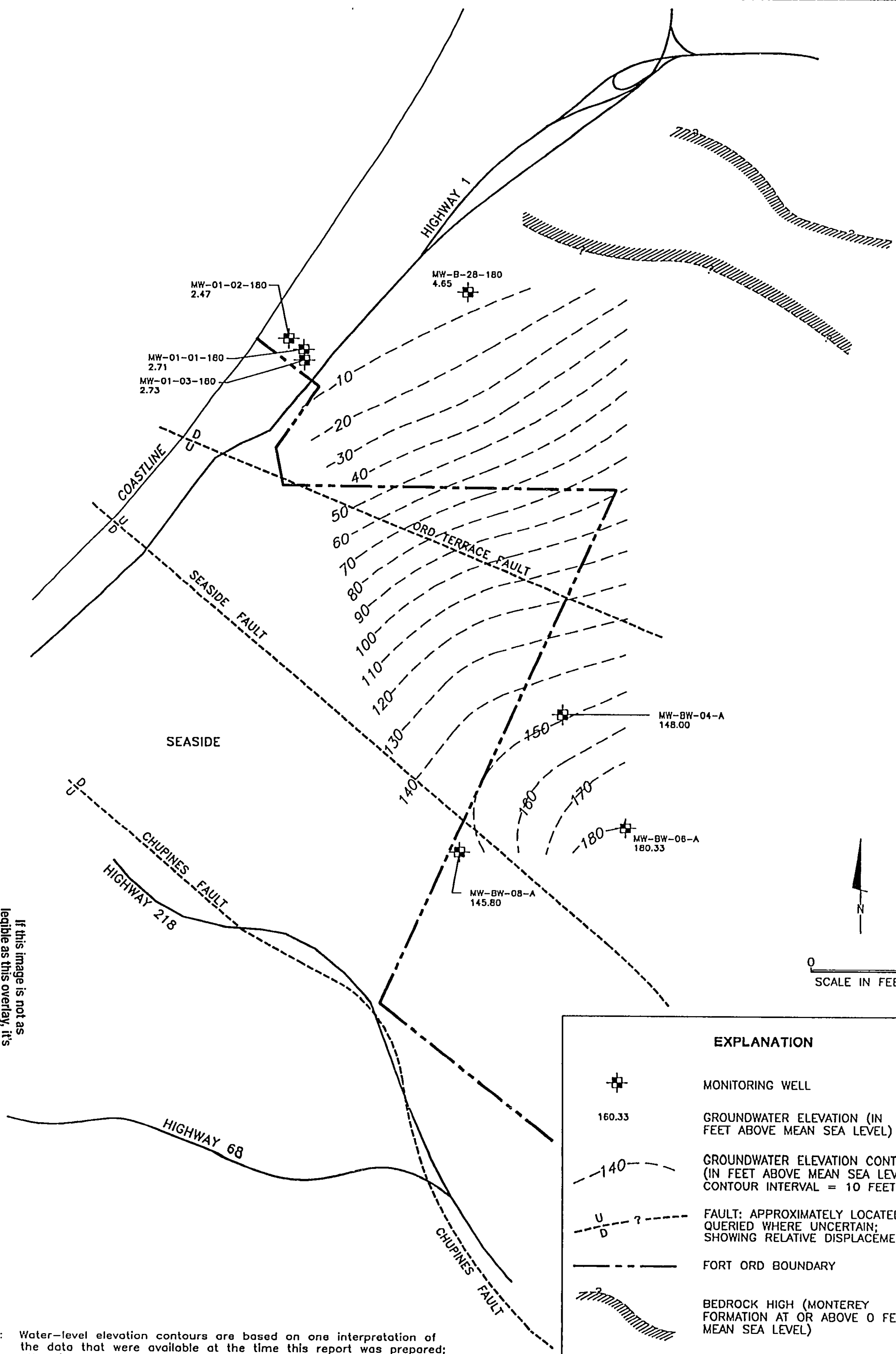
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NOTE: Water-level elevation contours are based on one interpretation of the data that were available at the time this report was prepared; other interpretations may be possible.



EXPLANATION	
	MONITORING WELL
160.33	GROUNDWATER ELEVATION (IN FEET ABOVE MEAN SEA LEVEL)
	GROUNDWATER ELEVATION CONTOUR (IN FEET ABOVE MEAN SEA LEVEL) CONTOUR INTERVAL = 10 FEET
	FAULT: APPROXIMATELY LOCATED; QUERIED WHERE UNCERTAIN; SHOWING RELATIVE DISPLACEMENT
	FORT ORD BOUNDARY
	BEDROCK HIGH (MONTEREY FORMATION AT OR ABOVE 0 FEET MEAN SEA LEVEL)

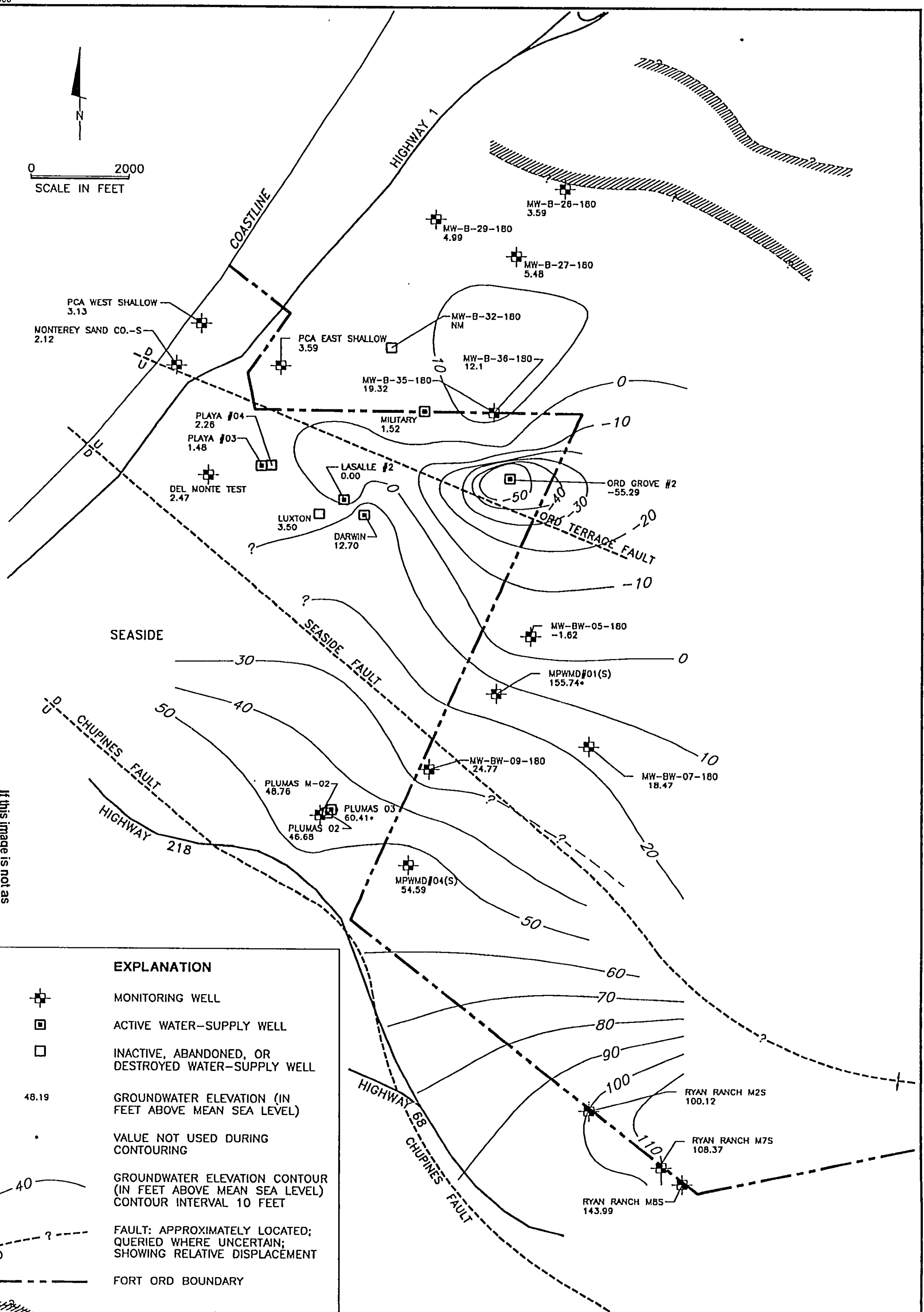
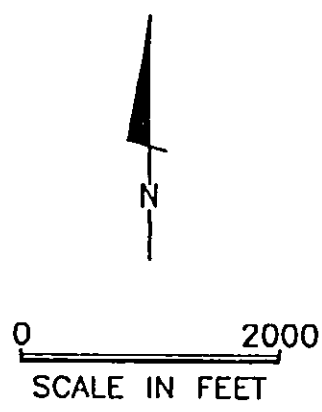


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Water-level Elevations
Uppermost Aquifer, July 1992
Basewide Hydrogeologic Characterization
Fort Ord, California

DRAWN	JOB NUMBER	APPROVED	DATE
CSN	10775 530	<i>MSM</i>	9/92

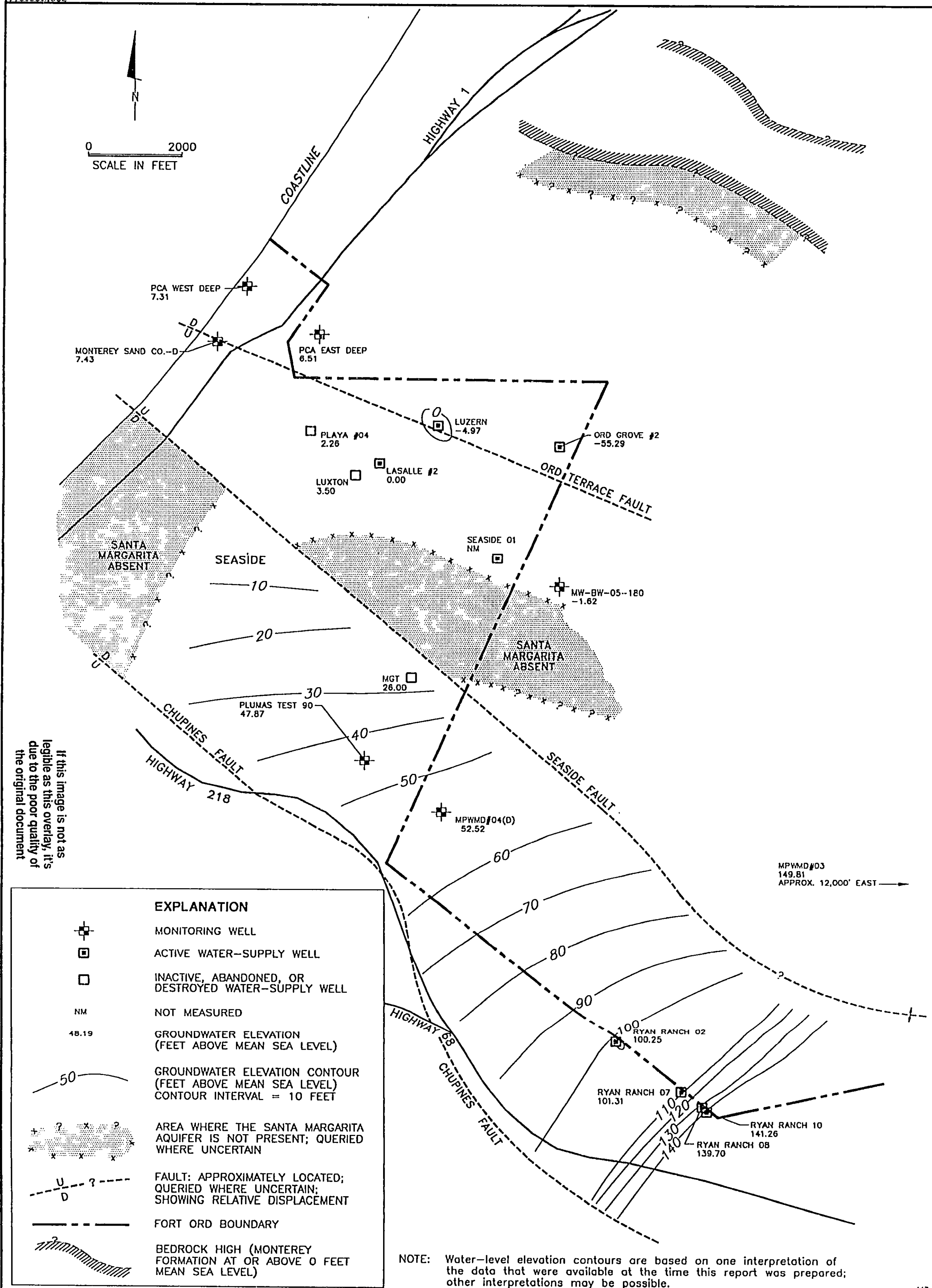
PLATE
37
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EXPLANATION	
	MONITORING WELL
	ACTIVE WATER-SUPPLY WELL
	INACTIVE, ABANDONED, OR DESTROYED WATER-SUPPLY WELL
48.19	GROUNDWATER ELEVATION (IN FEET ABOVE MEAN SEA LEVEL)
.	VALUE NOT USED DURING CONTOURING
40	GROUNDWATER ELEVATION CONTOUR (IN FEET ABOVE MEAN SEA LEVEL) CONTOUR INTERVAL 10 FEET
	FAULT: APPROXIMATELY LOCATED; QUERIED WHERE UNCERTAIN; SHOWING RELATIVE DISPLACEMENT
	FORT ORD BOUNDARY
	BEDROCK HIGH (MONTEREY FORMATION AT OR ABOVE 0 FEET MEAN SEA LEVEL)

NOTE: Water-level elevation contours are based on one interpretation of the data that were available at the time this report was prepared; other interpretations may be possible.

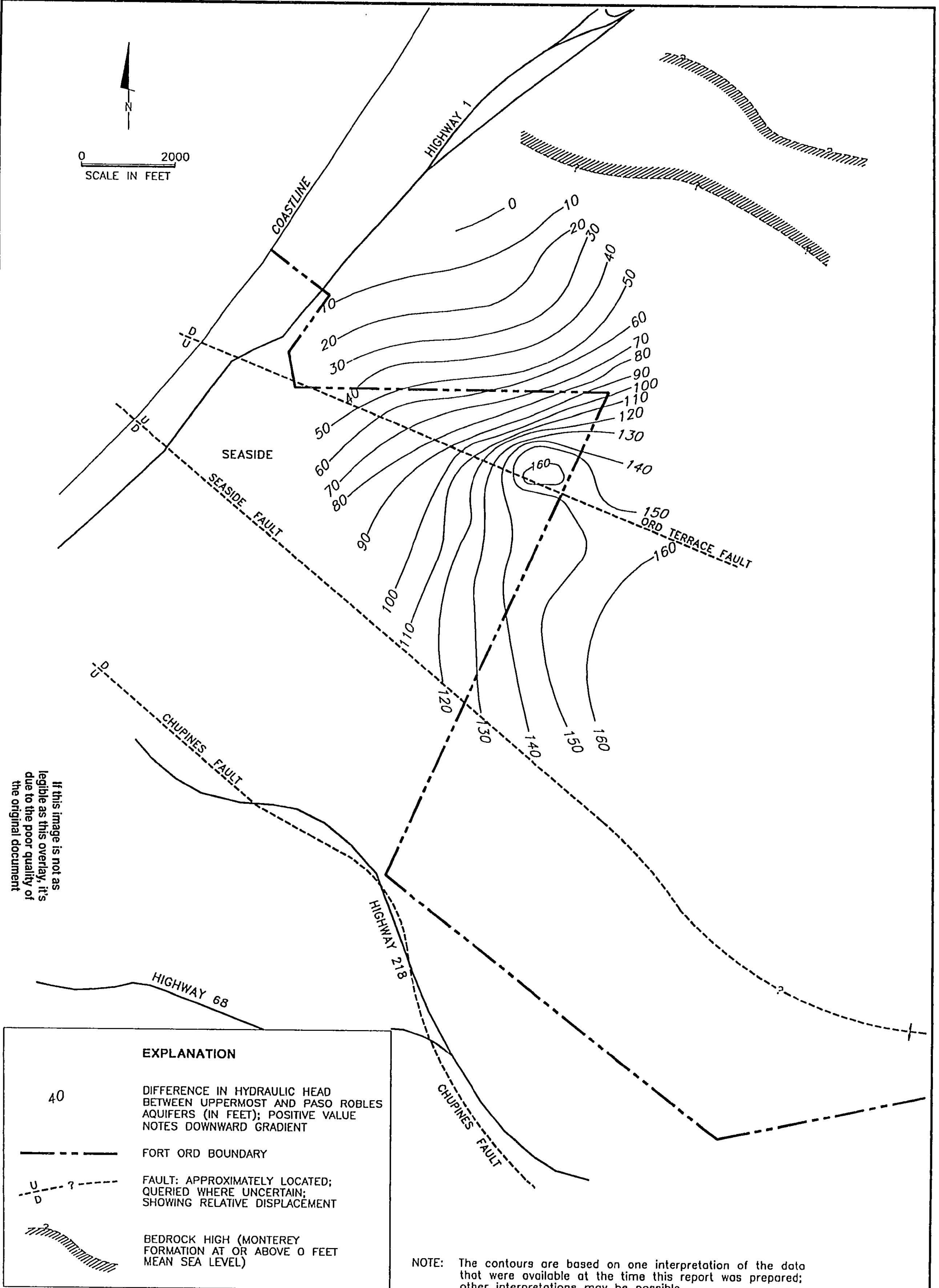
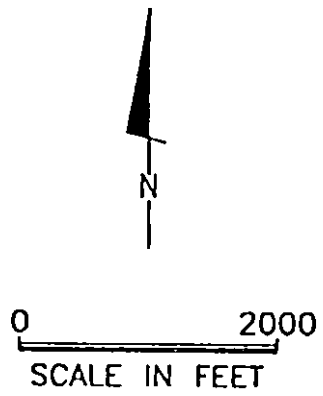


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Water-level Elevations
Santa Margarita Aquifer, July 1992
Basewide Hydrogeologic Characterization
Fort Ord, California

DRAWN	JOB NUMBER	APPROVED	DATE	PLATE
CSN	10775 530	MSM	9/92	39
			REVISED DATE	

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Water-level Elevation Differences Between Uppermost and Paso Robles Aquifer, July 1992
Basewide Hydrogeologic Characterization
Fort Ord, California

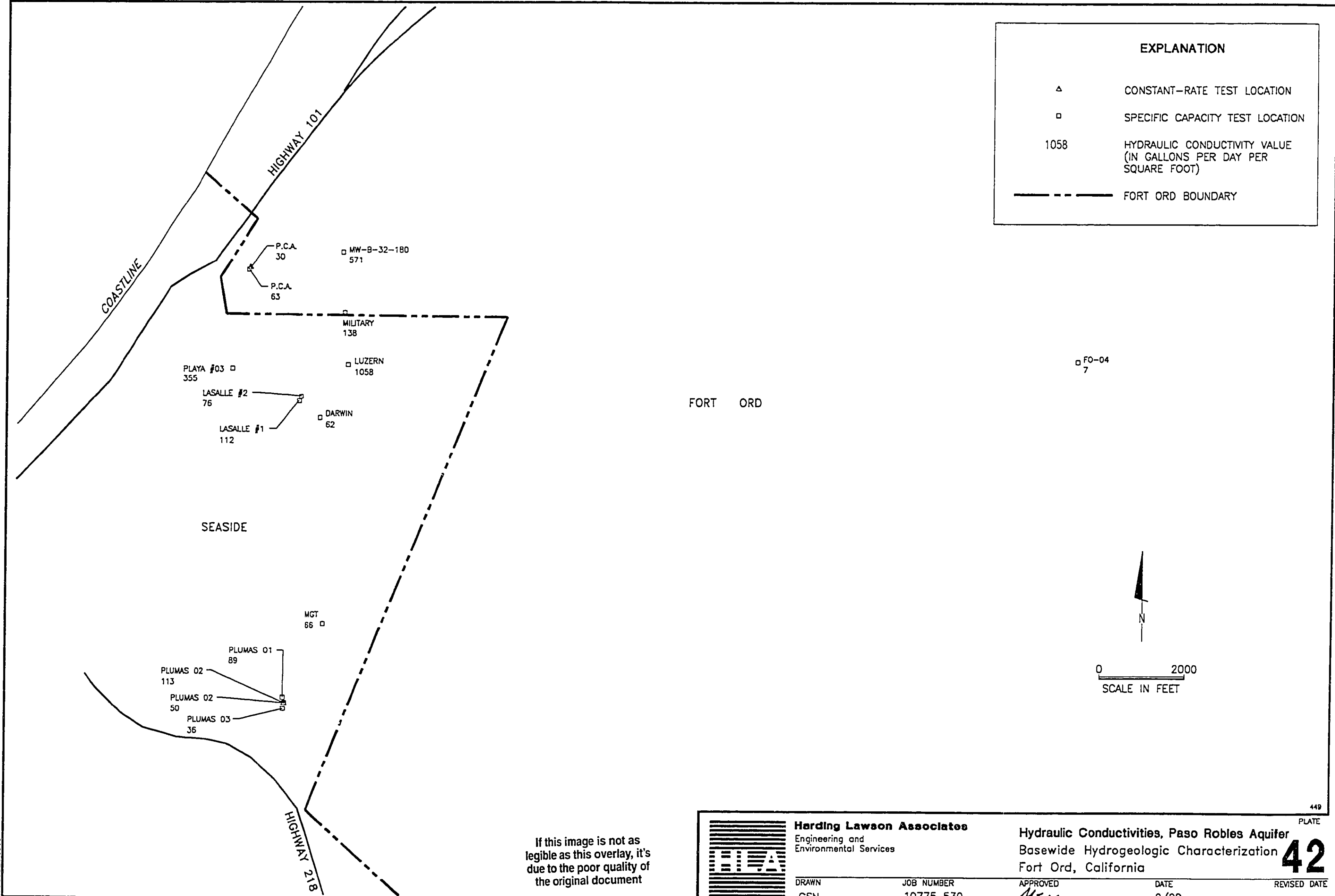
DRAWN CSN	JOB NUMBER 10775 530	APPROVED <i>MSH</i>	DATE 9/92	PLATE 40
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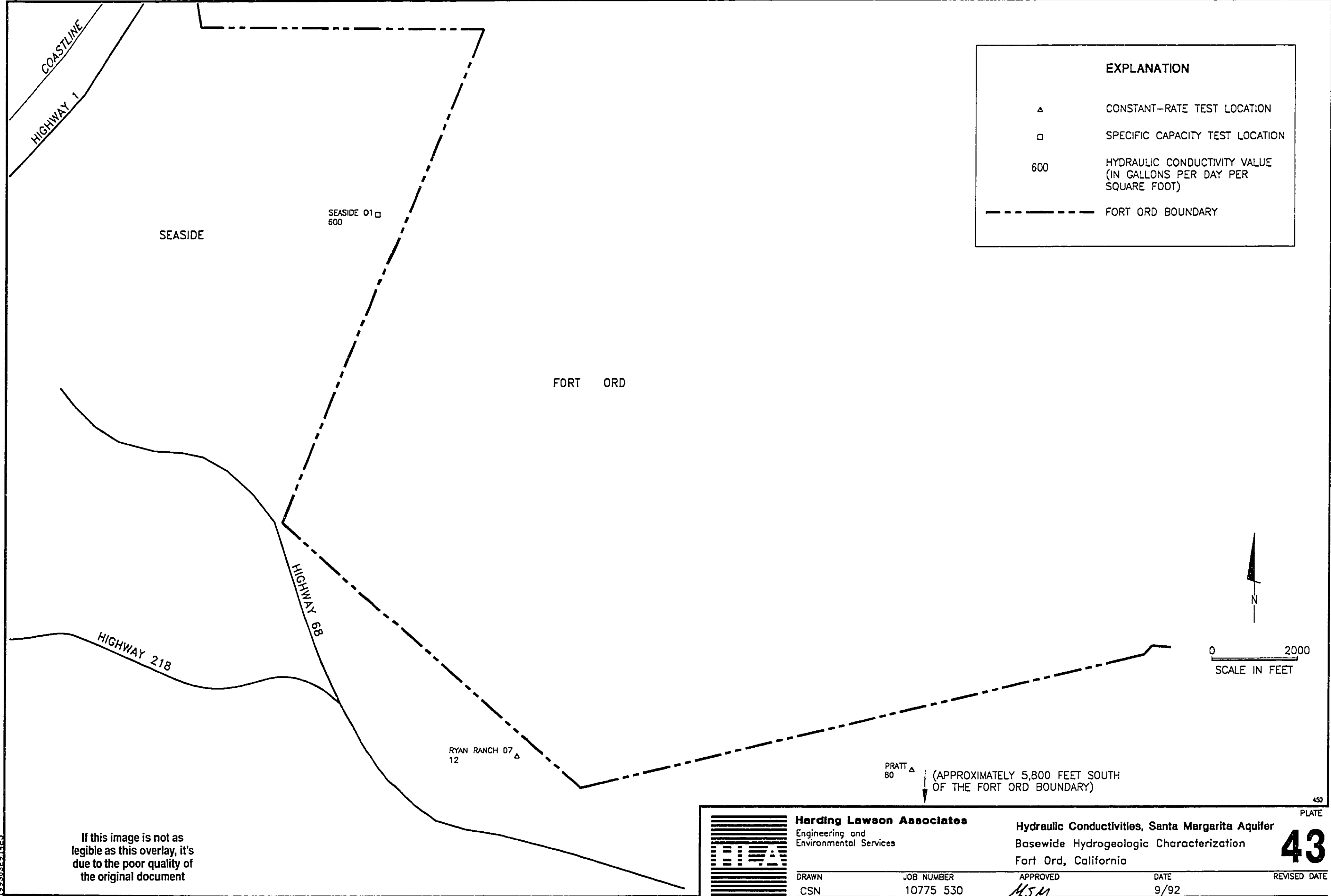
Hydraulic Conductivities, Paso Robles Aquifer
Basewide Hydrogeologic Characterization
Fort Ord, California

449
PLATE

42

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
CSN	10775 530	<i>MSM</i>	9/92	

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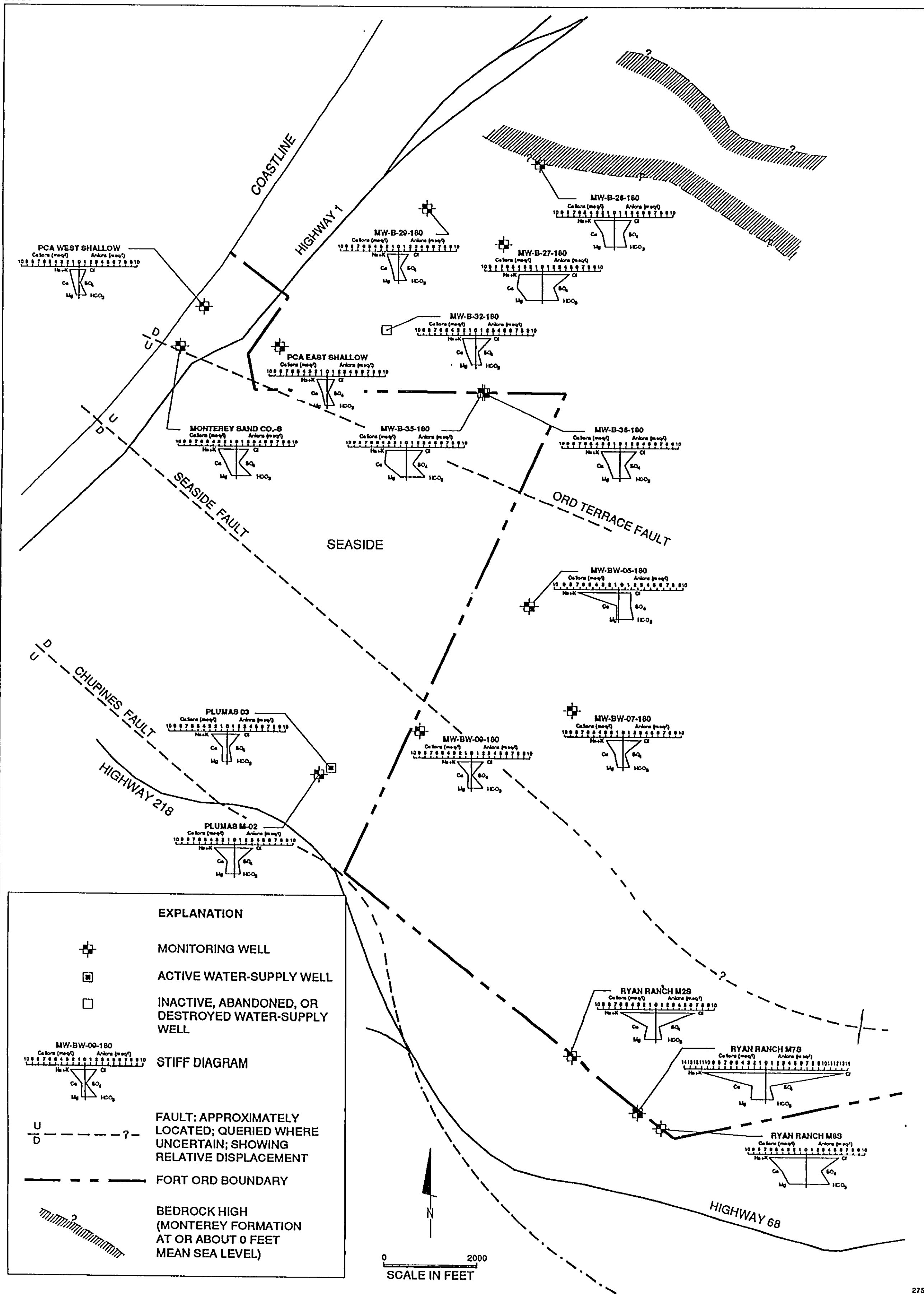
Page # 154 (6 PGS)

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JOB NUMBER
10775 530

Stiff Diagram, Paso Robles Aquifer,
May-June 1992
Basewide Hydrogeologic Characterization
Fort Ord, California

APPROVED
BCE

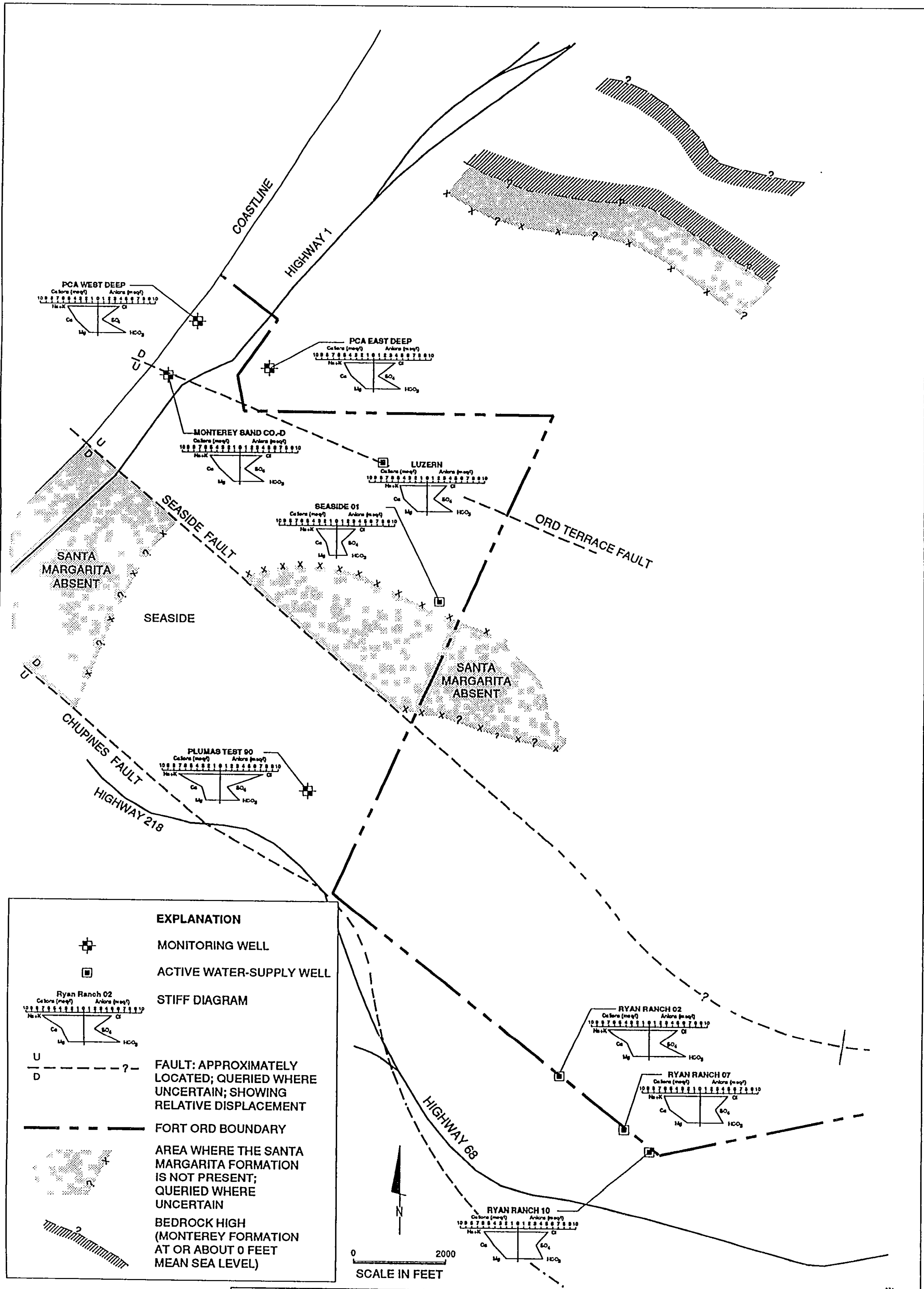
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275
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PLATE

48



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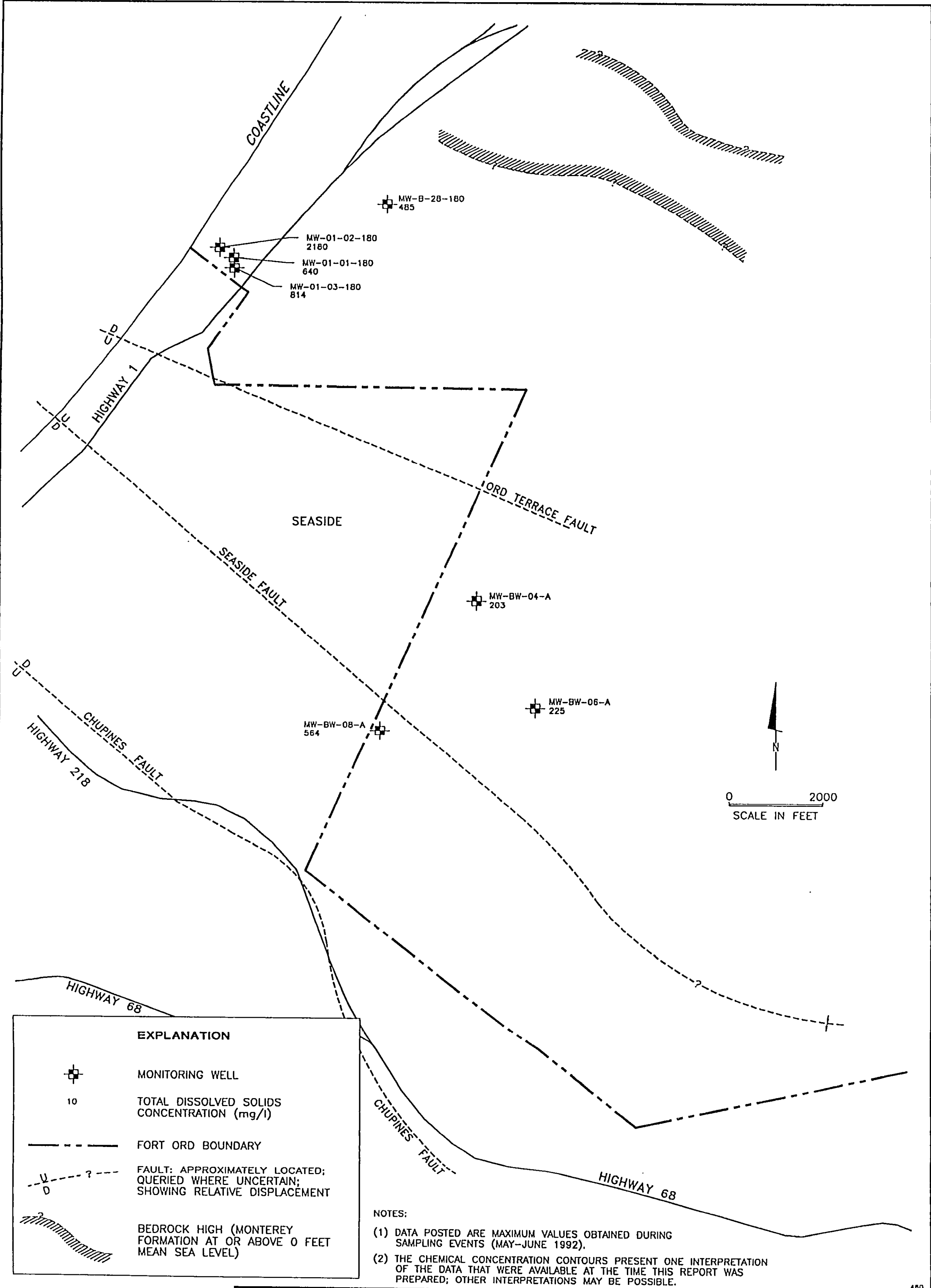
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10775 530

**Stiff Diagrams, Santa Margarita Aquifer,
May-June 1992**
Basewide Hydrogeologic Characterization
Fort Ord, California

APPROVED
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9/92

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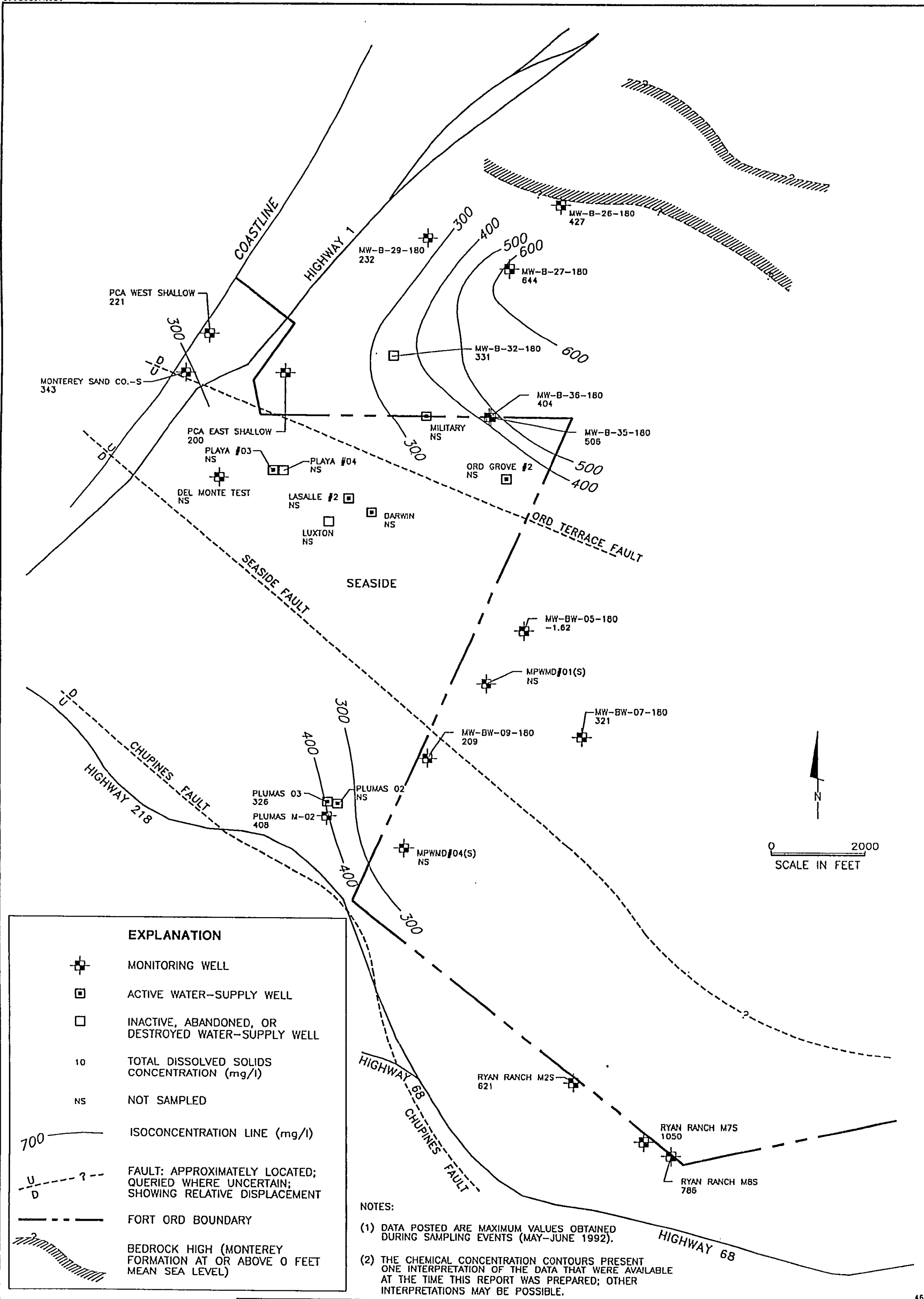
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DRAWN JOB NUMBER
10775 530

**Total Dissolved Solids Concentrations,
Uppermost Aquifer, May-June 1992**
Basewide Hydrogeologic Characterization
Fort Ord, California

APPROVED DATE
9/92

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50
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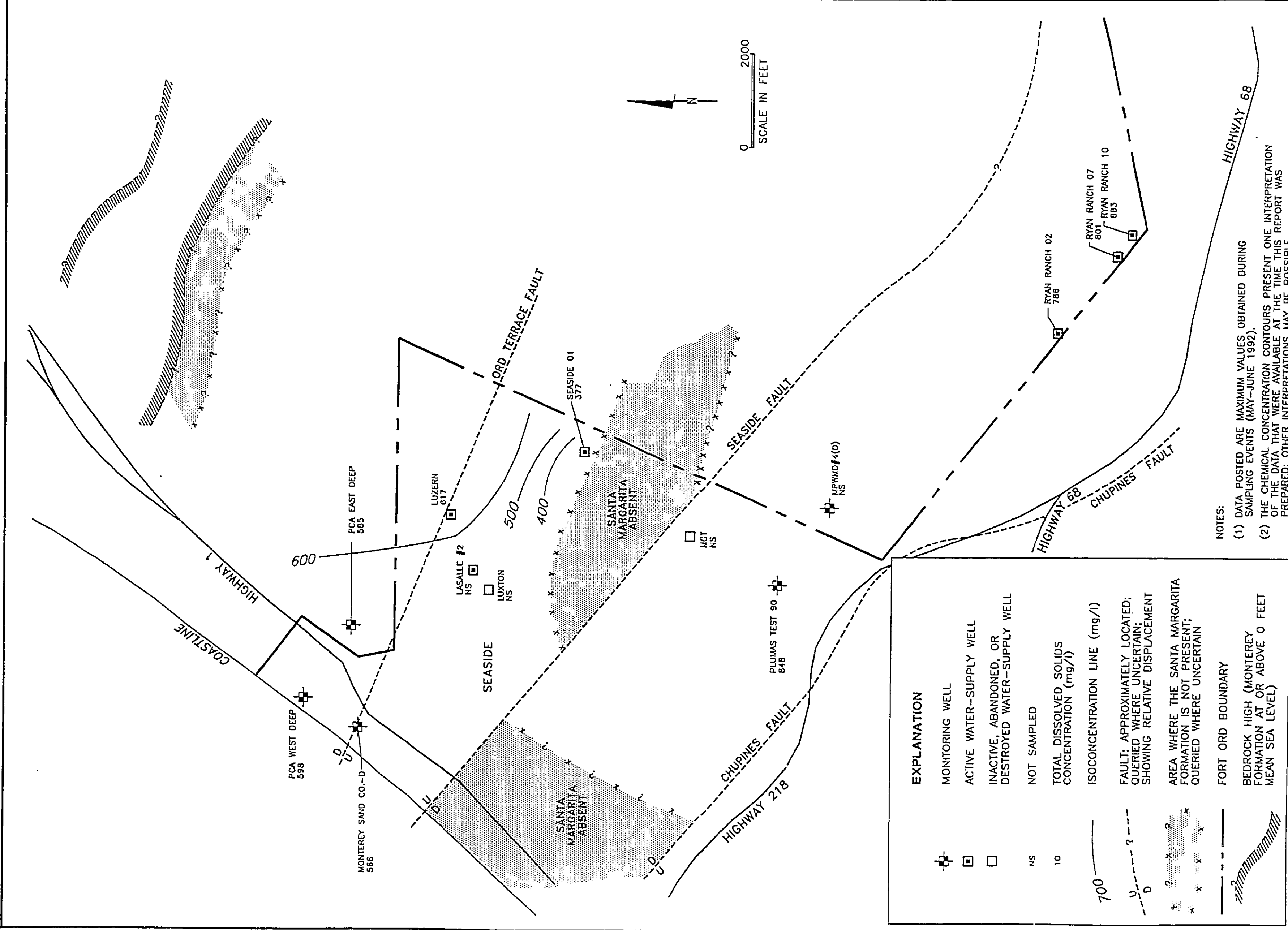


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Total Dissolved Solids Concentrations
Paso Robles Aquifer, May-June 1992
Basewide Hydrogeologic Characterization
Fort Ord, California

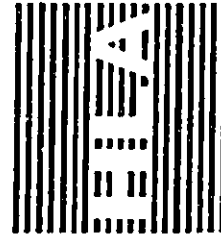
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REVISD DATE



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(2) THE CHEMICAL CONCENTRATION CONTOURS PRESENT ONE INTERPRETATION OF THE DATA THAT WERE AVAILABLE AT THE TIME THIS REPORT WAS PREPARED; OTHER INTERPRETATIONS MAY BE POSSIBLE.

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Total Dissolved Solids Concentrations
Santa Margarita Aquifer, May-June 1992
Basewide Hydrogeologic Characterization
Fort Ord, California

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52
DATE 9/92
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JOB NUMBER 10775 530
DRAWN RMS
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