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LOCKHEED PROPULSION COMPANY
BEAUMONT TEST FACILITIES
PRELIMINARY REMEDIAL INVESTIGATION

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1.0 INTRODUCTION

Radian Corporation has performed a detailed review of the site history at two former Lockheed test facilities near Beaumont, California (Radian Corporation, September 1986). These sites, operated by Lockheed Propulsion Company in the 1960's and 1970's were used for the processing, testing, and disposal of solid rocket propellant. Collectively, the sites are referred to as the Beaumont facilities. The larger site is the Beaumont No. 1 facility and was the area where major testing activities were conducted. The smaller facility is located approximately five miles to the northwest and is referred to as Beaumont No. 2.

As part of the site history review, recommendations were made to collect ground-water samples from the thirteen existing Beaumont No. 1 wells (Figure 1-1) and the five existing Beaumont No. 2 wells (Figure 1-2). The purpose of this sampling effort was to make a preliminary evaluation of the ground-water quality at both sites. In October of 1986, nine wells at Beaumont No. 1 and a single well at Beaumont No. 2 were sampled. Although strict sampling protocol was followed throughout this investigation, the analytical data may be limited by the quality of the wells sampled. The existing wells at the site were not designed for ground-water quality monitoring. Because only limited information is available concerning well construction, their applicability for monitoring purposes cannot be accurately assessed. However, the data gathered during this investigation have provided a great deal of information, with relatively little effort, assisting in planning for additional hydrologic investigation. This report presents the results of the sampling activities, and outlines a workplan for continued hydrogeologic investigation at the sites. The results of all analyses are compared to the California Department of Health Services (DHS) Sanitary Engineering Branch Maximum Contaminant drinking water standards. These legally enforceable drinking water standards are used, even though the wells at the Beaumont sites are not considered potable, and are posted as such.

Recommendations were also made to conduct a geophysical investigation to locate the boundaries of the radioactive disposal area, the burn pits, the permitted sanitary landfill, and the Beaumont No. 2 garbage dump. This investigation was performed in October 1986, using ground-penetrating radar, terrain conductivity, and magnetometry techniques. The results of these surveys are presented in this report.

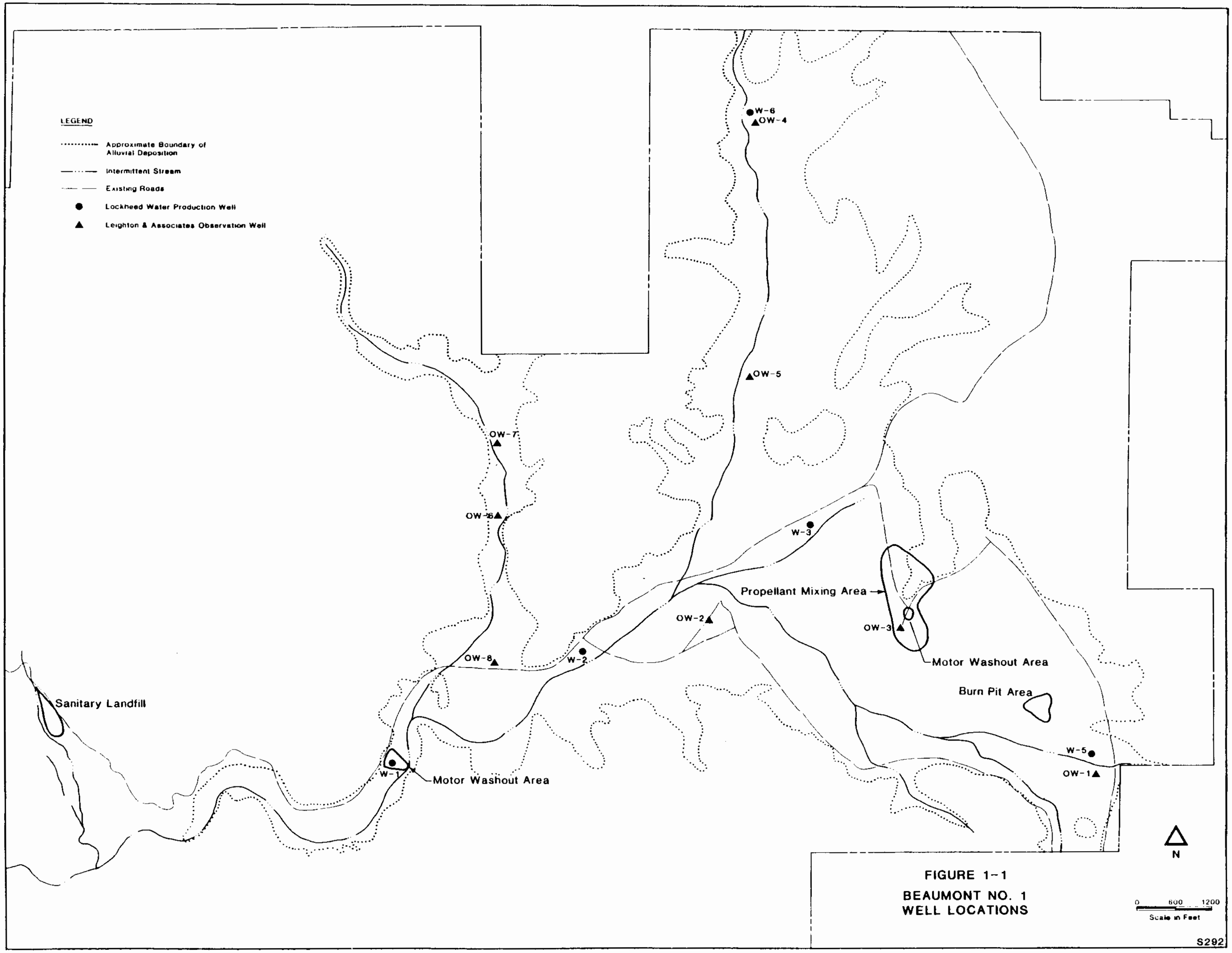


FIGURE 1-1
BEAUMONT NO. 1
WELL LOCATIONS

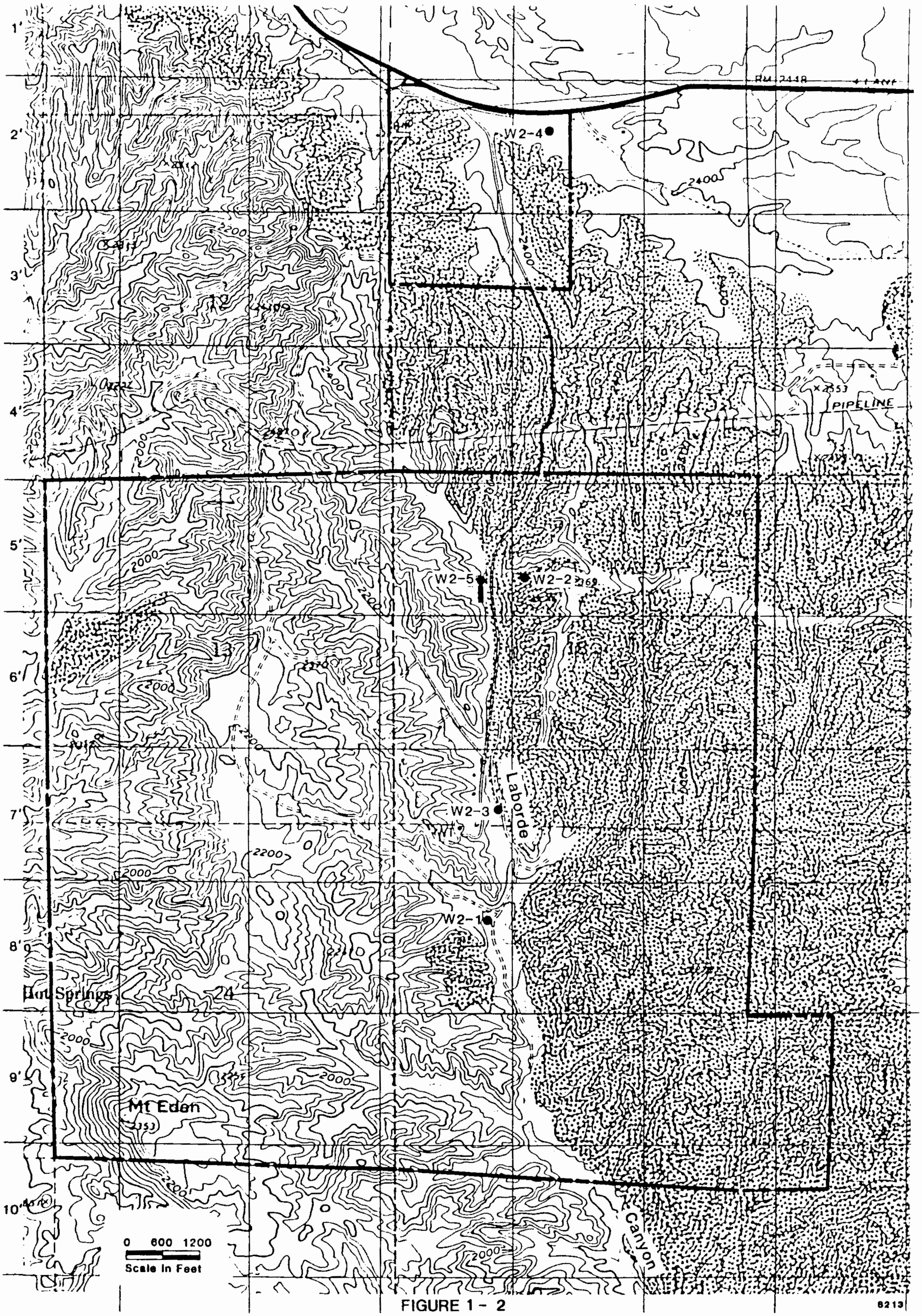


FIGURE 1 - 2
BEAUMONT FACILITY NO. 2
WELL LOCATIONS

2.0 GROUND-WATER INVESTIGATION

2.1 Methodology

The objective of the sampling program was to obtain samples representative of the ground water surrounding each well, and to analyze these samples in a manner which reflects the composition of the ground water as accurately as possible. In order to achieve that objective, all factors which affect the physical and chemical integrity of the sample were controlled as closely as possible before, during, and after sample collection.

The procedures for this sampling program are documented in a Quality Assurance Project Plan (QAPP) which was prepared prior to the initiation of field activities. This QAPP followed the EPA format for such plans, and ensured that proper sampling and analytical protocol were established before samples were collected. The elements of the QAPP are:

- Project description
- Project organization and responsibility
- QA objectives for measurement data precision, accuracy, completeness, representativeness, and comparability
- Sampling procedures
- Sample custody
- Calibration procedures and frequency
- Analytical procedures
- Data reduction, validation, and reporting

- Internal quality control checks
- Performance and system audits
- Preventative maintenance
- Corrective action, and
- Quality assurance reporting.

For easy referral, the complete QAPP document is contained in Appendix A. The information detailed in the QAPP is not repeated in the body of this report, although the actual field procedures used and any deviation from the protocol described in the QAPP are summarized in this section.

Wells Sampled

Nine of the thirteen existing Beaumont No. 1 wells were sampled during this preliminary investigation; no new wells were drilled. The wells which were sampled at Beaumont No. 1 include five former production wells and four observation wells. Two of the production wells were windmill-driven and originally used for irrigation purposes prior to Lockheed acquisition of the site in 1961. The other three production wells were installed by Lockheed to supply water for site operations. One former production well was not located, despite the use of a metal detector, and is assumed to be destroyed either by farming activities or erosion during the spring floods. Eight observation wells (OW) were installed at Beaumont No. 1 by Leighton and Associates in May 1983 as part of an investigation into the water supply capabilities of the upper alluvial aquifer. Presently, three of these wells are dry, and one is located in the far upgradient end of Meeks Creek Canyon where there was no Lockheed activity; these four wells were not sampled. (A well near the mouth of Meeks Canyon was sampled.)

Only one well was sampled at Beaumont No. 2, W2-3, as shown in Figure 1-2. (The W2 designation is used to indicate an existing well at the No. 2 facility.) This well is located at the center of the site.

Prior to sampling the ground water in Wells W-5 and W-6, the old, non-working pumps were removed. In addition, secure well casings were installed around all the wells. These tasks were performed by Beylik Drilling, Inc. under Radian direction. Currently, all wells have protective steel casings with locking covers, as diagramed in Figure 2-1, and all non-working pumps have been removed. Two wells at Beaumont No. 1 have working pumps and are active. Two wells at Beaumont No. 2 have working pumps, but they are not active.

Well Purging

Measurements of the static water level and the total well depth were obtained before purging and sampling a well. An electronic well sounder, decontaminated with distilled water between each hole, was used to obtain measurements to the nearest 0.02 foot. All measurements were made to the top of the steel protective casing with the locking cover off. A mark was inscribed on each casing to indicate the measurement reference point. Data were recorded on ground water gauging sheets, which are included in Appendix C and summarized in Tables 2-1 and 2-2. The elevations of the the top of the steel protective casings were determined by the International Union of Operating Engineers Survey School which trains at the site. This information is also summarized on Tables 2-1 and 2-2, with the surveyors field notes included in Appendix C.

Each monitoring well was purged immediately prior to sample collection in order to ensure that fresh formation water, representative of the surrounding ground water, was sampled. The two active site wells (W-1 and W-3) were purged using the permanently installed pumps that are in the well. The three other old water supply wells (W-2, W-5, and W-6) were purged by the

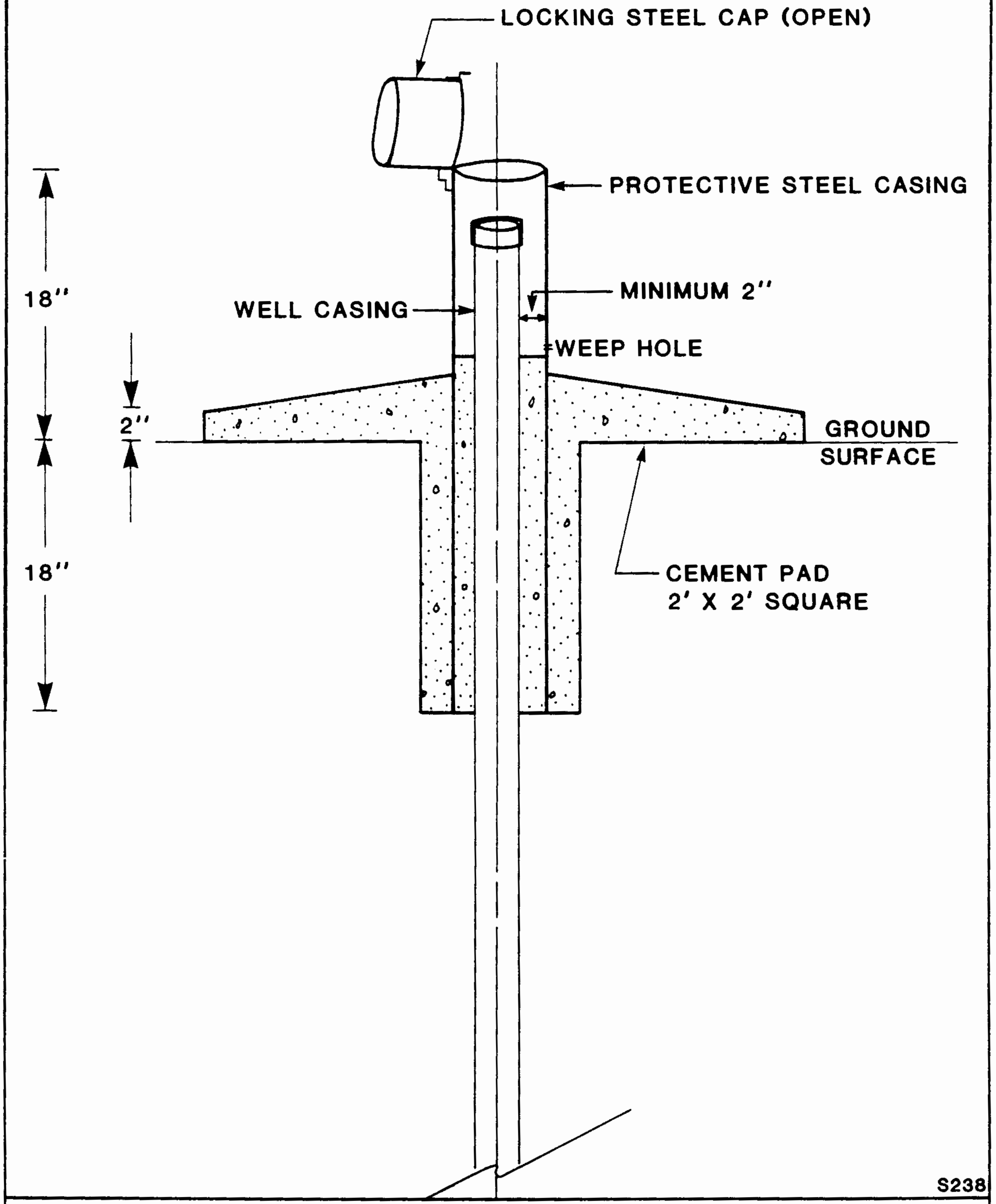


FIGURE 2-1. MONITORING WELL SURFACE COMPLETION

TABLE 2-1. BEAUMONT NO. 1 WELL SAMPLING SUMMARY

Well	Casing Diameter (Inches)	Total Depth (Ft.) 10/86	Depth to Water[1] 11/83	Depth to Water 10/86	Well Casing Elevation (MSL)	Water Table Elevation (MSL)	Analysis Performed 10/86	QA/QC	Comments
Beaumont No. 1									
Leighton and Associates Observation Wells									
OW-1	2	71.30	39	53.81	2202.74	2148.93	601		Upgradient from burn pit area; across wash from W-5.
OW-2	2	22.35	0	0	2076.69	2076.69	601	Lab Duplicate	Lake area - artesian conditions, water flowing out casing.
OW-3	2	57.80	9	31.80	2141.48	2109.68	601, 624, 625, Metals, Ions	Field Duplicate	Downgradient of burn pit area; near SRAM motor wash-out area.
OW-4	2	71.28	Dry	Dry	2239.88	<2168.58	Dry		Upper Aerojet Canyon; near W-6.
OW-5	2	68.42	67	Dry	2158.65	<2090.25	Dry		Southern Aerojet Canyon.
OW-6	2	40.5	36	Dry	2082.54	<2042.54	Dry		Middle of Meeks Canyon, upgradient of site activities.
OW-7	2	50.25	38	48.38	2105.95	2057.57	None		North end of Meeks Canyon, upgradient of site activities.
OW-8	2	63.87	40	49.43	2034.06	1984.63	601		Mouth of Meeks Canyon, downgradient of site activities.
Old Production/Irrigation Wells									
W-1	14		27	33.00	1971.83	1938.83	601		LSM (western) washout area; active well.
W-2	9	250.0	12	26.98	2029.19	2002.21	601		South of Betatron building.
W-3			34	Not Meas.	2124.73		601, 624, 625, Metals, Ions		Pump house well; active.
W-4	--	--	Dry	--	--	--	--		Across wash from W-3; not found and assumed destroyed.
W-5	12.5	124.30	60	75.71	2202.72	2127.01	601, 624, 625, Metals, Ions		South of burn pit bunker.
W-6	10	155.20	--	109.65	2239.97	2130.32	601		Upper Aerojet Canyon near OW-4.

[1] Source: Leighton and Associates, August 23, 1984 (rounded to the nearest foot since vertical datum unknown)

TABLE 2-2. BEAUMONT NO. 2 WELL SAMPLING SUMMARY

Well	Casing Diameter (Inches)	Total Depth (Ft.) 10/86	Depth to Water 11/83	Depth to Water 10/86	Well Casing Elevation (MSL)	Water Table Elevation (MSL)	Analysis Performed 10/86	QA/QC	Comments
Beaumont No. 2									
W2-1									1/3 mile south of W-3, downgradient from garbage disposal site; not located by Radian.
W2-2									Not located.
W2-3	10	208		44.7			601		3/4 mile south of Building 250. Located in middle of the site.
W2-4							None		At northern boundary of site. Not associated with areas of site activity.
W2-5		500					None		Northwest corner of Building 250. Well drilled to deep aquifer.

drilling subcontractor using a submersible pump. All of the two-inch observation wells were purged by hand bailing. At least three times the volume of standing water was purged from each well prior to collection of the sample.

Sample Collection

After purging, ground-water samples were collected using a Teflon\ bailer. Before sampling at each well, the bailer was decontaminated using a laboratory detergent wash and a thorough rinsing with deionized water. The potable water rinse was eliminated because the only sources of water at the site were from wells being sampled in this investigation. These are not considered potable water. Samples were obtained at W-1 and W-3 from the pump outlet after reducing the volume of flow. Bailers would not fit past the well covers and, therefore, could not be used.

All sample containers were obtained from I-Chem Corporation. They were specially cleaned for environmental sampling and had Teflon\ linings in the cover. Table 2-3 summarizes the container, preservation, storage and holding requirements for each analytical method. Labels were prepared and attached to the sampling containers with clear tape before the containers were taken into the field. Container preparation prior to sample collection helped insure that the correct number of samples were taken at each well. It also protected against sample contamination from inks with volatile organic carriers, because no pens were used near the sample collection activities. Proper chain-of-custody protocol, as discussed in Section 5.0 of the QAPP, was followed during sample collection. Completed master sample logs and chain-of-custody forms are included in front of the laboratory data sheets in Appendix D.

Prior to bailing activities, and again before sample collection at each well, new, clean, PVC, surgical-type gloves were put on in order to avoid sample or bottle contamination. Samples brought to the surface in the bailer were transferred directly into the prepared containers with a minimum of

TABLE 2-3. WATER SAMPLE STORAGE AND PRESERVATION METHODS

Parameter	Reference Method	Container(s)[a]	Preservation	Maximum Storage Requirements	Holding Time
Trace Elements (23 Metals)	EPA 200.7	One 500 ml glass or polyethylene jar	HNO_3 to pH <2	Refrigerate at 4°C	6 months
Purgable Halocarbons	EPA 601	Three 40 ml glass vials with Teflon® Seals		Refrigerate at 4°C	14 days
Inorganic Anions	EPA 300.0	One 500 ml glass or polyethylene jar	None	Refrigerate at 4°C	Nitrate-48 hrs. Others-28 days
Purgable Organic Priority Pollutants	EPA 624	Three 40 ml glass vials with Teflon® Seals		Refrigerate at 4°C	14 days
Base/Neutral and Acids	EPA 625	Two 1-Liter glass bottles with Teflon® Seals		Refrigerate at 4°C	7 days until extraction, 40 days after extraction

[a] All containers are pre-treated and cleaned before being purchased by the laboratory.

turbulence by lifting the ball valve using a gloved finger tip. No air bubbles were present in the 40 ml vials submitted for the Method 601 and 624 analyses, but the presence of a small bubble of air in the one liter jars for the Method 625 analysis could not be avoided.

Sample Analysis

Samples were collected from nine wells at Beaumont No. 1 and one from Beaumont No. 2 and analyzed for purgeable halocarbons using EPA Method 601. Method 601 was selected as a screening analysis for all of the wells because it provides excellent detection limits for the chlorinated solvents which were most likely to be encountered at the site. It is also relatively inexpensive when compared to a full suite of priority pollutant analyses.

Additional samples were collected from three of the Beaumont No. 1 wells:

OW-3	Suspected to be downgradient of both the burn pit and propellant mix areas and considered the well most likely to show contamination;
W-3	The major source of water at the site, although not used for drinking purposes, and downgradient of the burn pit area;
W-5	Upgradient of the burn pit area.

Samples obtained from these wells were analyzed for the full suite of priority pollutant analysis, including:

EPA Method 200.7, Trace Elements (ICPES Metals)

EPA Method 300, Inorganic Anions

EPA Method 624, Purgeable Organic Priority Pollutants

EPA Method 625, Base/Neutral and Acid Extractables

These analyses were selected in order to provide a detailed examination of contaminants which may be present in the ground water at the areas of most concern. A summary of the analytical methods is found in Table 2-4. More detailed information, including a summary of the methods, the parameters analyzed for, and their detection limits are found in Section 7.0 of the QAPP, in Appendix A.

Along with the collection of samples from each well, a series of quality control samples were analyzed by the laboratory. These included field blanks and field duplicates, submitted as blind samples which could not be identified by laboratory personnel, and laboratory duplicates, matrix spikes, surrogate spikes, second-column confirmation samples, calibration standards, and reagent blanks for each method. Quality control samples were included as an integral part of this sampling program in order to produce data of known quality. Field duplicates were taken at Well OW-3 and submitted to the laboratory for analysis as Samples OW-3 and WO-3. One field blank was taken and labeled as OWO-1. These data are interpreted in Section 2.4. Further discussion of the internal quality control checks is found in Section 9.0 of the QAPP in Appendix A.

2.2 Occurrence and Movement of Ground Water

Beaumont No. 1

Ground water at the Beaumont No. 1 site is found in two distinct geologic units (Leighton and Associates, 1983a and 1983b). The first water-bearing unit, referred to as the alluvial aquifer, consists of the sandy alluvium which fills the valley bottoms throughout the center of the site. The second water-bearing unit, referred to as the crystalline rock aquifer,

TABLE 2-4. SUMMARY OF ANALYTICAL METHODS PRECISION AND ACCURACY OBJECTIVES

Parameter	Reference Method	Preparation Process	Type of Analysis	Confirmation for Identification	Precision[a]	Accuracy[b]
Trace Elements	EPA 200.7	Digestion by HNO_3	Inductively Coupled Plasma Emission Spectroscopy (ICPES)	--	±60%	±50%
Inorganic Anions	EPA 300.0	--	Ion Chromatography	--	Not specified	Per method QC acceptance criteria
Purgeable Halocarbons	EPA 601	Purge and Trap	Gas chromatography/ Hall Detector	Second-column Confirmation (FID)	±60%	Per method QC acceptance criteria
Purgeable Organic Priority Pollutants	EPA 624	Purge and Trap	Gas Chromatography/ Mass Spectroscopy	Mass Spectral Confirmation	±70%	Per method QC acceptance criteria
Base/Neutrals and Acid Extractables	EPA 625	Methylene Chloride extraction	Gas Chromatography/ Mass Spectroscopy	Mass Spectral Confirmation	±70%	Per method QC acceptance criteria

[a] Percent difference for replicate analyses.
[b] Determined using method QC acceptance criteria for matrix spikes.

consists of fractured portions of the crystalline basement-rock complex. These aquifers are separated by nonwater-bearing units comprised of sediments of late Cenozoic Age.

The alluvial aquifer underlies approximately 800 acres of the alluvial filled valley. The aquifer consists of varying mixtures and lenses of sand, gravel, silt, and clay, and ranges in thickness from 27 to 160 feet across the site. The approximate boundary of the alluvial aquifer is shown on Figure 1-1.

Ground-water recharge to the alluvial aquifer occurs primarily from direct infiltration of on-site rainfall and percolation through stream channels. Recharge from subsurface flow across site boundaries may occur during wet seasons along Potrero Creek at the northeastern corner of the site. Sources of ground-water discharge from the alluvial aquifer include evapo-transpiration, pumping, and deep percolation into underlying fractured bedrock.

The crystalline rock aquifer, located more than 300 feet below ground surface, is composed of moderately to highly fractured Mesozoic quartz diorite, granodiorite, tonalite, and metasedimentary rocks. Recharge to and discharge from the crystalline rock aquifer underlying the site occurs primarily by underflow of ground water across site boundaries. The limited data available suggests that the shallow alluvial aquifer and the deeper crystalline rock aquifer are in poor hydraulic connection (Leighton and Associates, 1983 and 1983b). There are currently no on-site wells that tap the crystalline rock aquifer and recent data are not available to determine ground-water flow. Historic data suggest confined conditions with ground-water flow southward toward the underground Metropolitan Water District San Jacinto Tunnel located near the southeastern corner of the site.

Thirteen wells currently exist at Beaumont No. 1, ranging in total depth from 22 to 250 feet below ground surface (Table 2-1). Five of the wells

(W-1, W-2, W-3, W-4, and W-6) were installed for Lockheed activities or earlier ranching activities. Two of the wells, W-1 and W-3, are still in use today. Construction details of these five wells are unknown. It is uncertain whether or not the Lockheed wells deeper than 160 feet (W-2) are screened in the alluvial aquifer, since the alluvial aquifer is thought to range up to 160 feet in thickness across the site. Eight wells were installed in 1983 by Leighton and Associates as observation wells. They are all under 75 feet in total depth and are assumed to be screened within the alluvial aquifer. Boring logs for the eight observation wells are included in Appendix B, although they do not provide details on screen placement, or well completion.

Water level measurements taken by Radian in October 1986 show that the depth to ground water ranges from ground surface at OW-2 to nearly 110 feet below ground surface at W-6 (see Table 2-1). Three of the 13 wells were dry (OW-4, OW-5, and OW-6). Water table elevations ranged from 1938 to 2149 feet above mean sea level. A plot of the water table elevations (Figure 2-2) indicates that ground-water flow closely follows the surface drainage patterns dominated by Potrero Creek and its tributaries. The pumping activities associated with Wells W-1 and W-3 could cause local deviations in this flow pattern. However, the magnitude of the effect cannot be assessed until additional ground-water and pumping data are obtained.

Water levels in the Beaumont No. 1 wells were monitored by Leighton and Associates during 1983 and 1984. The collected water level data is compiled on Table 2-5. The depth to water ranged to 70 feet below the ground surface. Shallow ground-water conditions were observed at well OW-2 where the water table intersected the ground surface, and at well OW-3 where the depth to water ranged from 4 to 15 feet over the duration of the monitoring program. The water levels exhibited a seasonal fluctuation from less than 1 foot to about 30 feet.

The Leighton water level data cannot be rigorously compared to the Radian measurements since the Leighton elevation reference points are unknown.

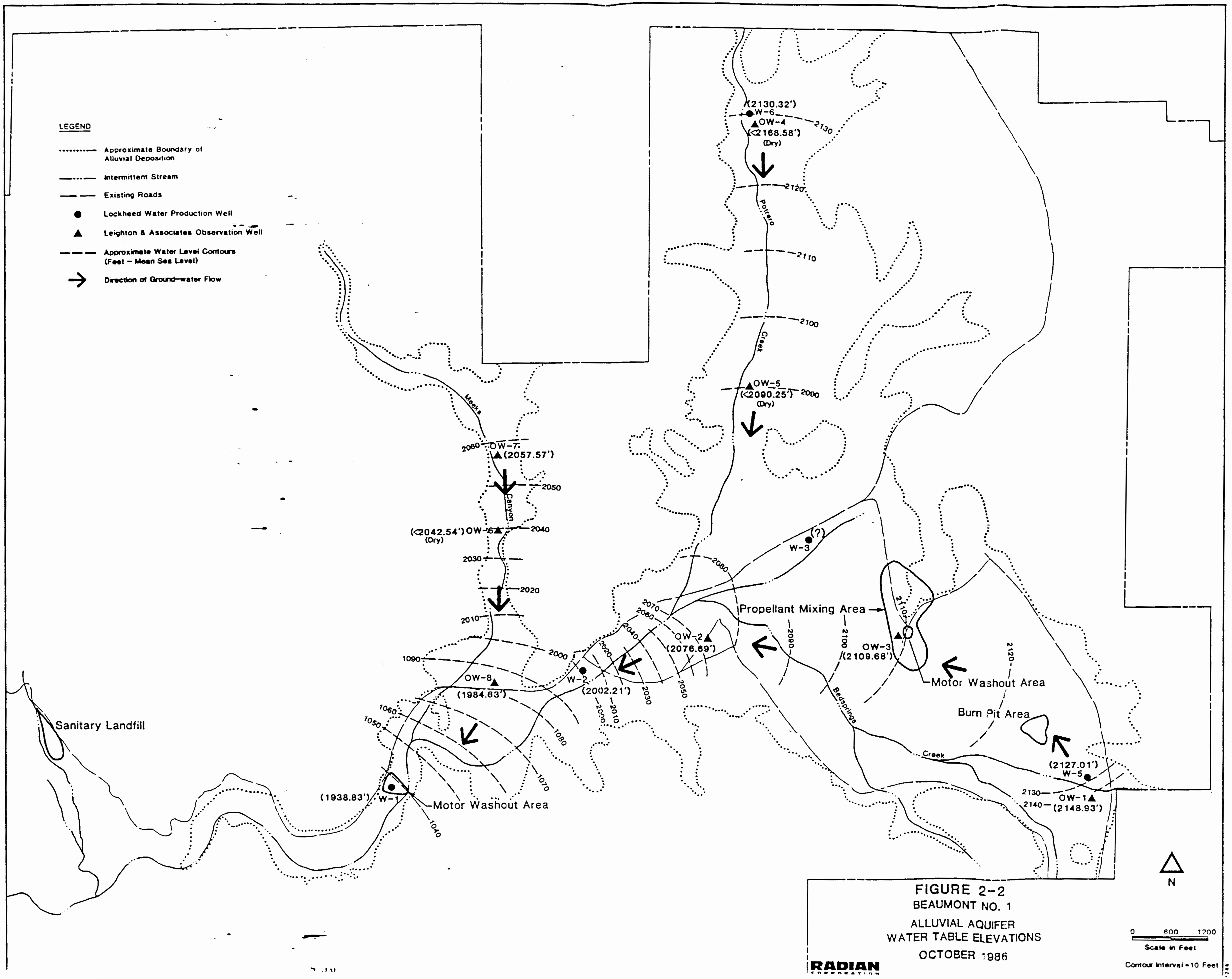


FIGURE 2-2
BEAUMONT NO. 1
ALLUVIAL AQUIFER
WATER TABLE ELEVATIONS
OCTOBER 1986

TABLE 2-5. LEIGHTON AND ASSOCIATES BEAUMONT NO. 1 WATER LEVEL SUMMARY (1983-84) — DEPTH TO GROUND WATER FROM SURFACE (FEET)

Well	DATE													
Number	5/25/83	5/26/83	5/27/83	6/02/83	6/15/83	7/08/83	7/22/83	8/05/83	8/19/83	9/03/83	9/18/83	9/30/83	11/9/83	1/04/84	3/02/84
OW-1	16'			21.33	25.36	31.05	32.72	33.55	34.89	35.64	36.53	37.12	38.62	40.29	44.28
OW-2		Flow 9'	Flow 4 gpm±	Flow	Flow	Flow	Flow	Flow	Flow +1.26	0.19	Flow	Flow	Flow +1.82	Flow +1.33	Flow +0.30
OW-3	9'			4.06	3.88	4.19	4.83	10.23	5.92	6.60	7.05	7.66	9.25	10.81	14.85
OW-4		Dry		Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
OW-5			Dry	Dry	Dry	Dry	Dry	Dry	Dry	86.98	66.98	68.98	66.98	68.98	89.88
OW-6			34'	34.82	34.86	35.04	35.07	35.22	35.45	35.49	35.63	35.70	36.08	36.70	37.43
OW-7			47'	36.03	36.03	36.16	36.30	36.54	38.90	36.99	37.20	37.31	37.78	38.28	38.71
OW-8			36'	36.64	38.38	36.22	38.24	35.50	38.83	40.09	39.13	39.48	39.84	39.53	39.42
W-1				26	25.91	25.92	25.85	28.30	26.20	26.40	26.30	26.29	26.71	27.04	27.13
W-2				6.61	6.16	7.24	6.66	6.87	9.26	10.09	11.16	11.77	11.92	8.53	9.22
W-3							35.90	33.72	33.69	33.80	33.94	34.75	34.50	34.73	34.75
W-4				27.80	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
W-5	(1/25/83) 13.5'			30.75	36.55	45.58	49.50	52.21	54.38	56.10	57.28	58.37	60.40	58.49	61.18
W-6					Dry										

W = Water well
OW = Observation well

Source: Leighton and Associates, October 27, 1983, and Leighton and Associates, August 23, 1984

However, a general comparison of the water level data obtained in November 1983 and that obtained in October 1986 indicates that the water table has dropped an average of about 13 feet. Fluctuations in water table elevations would be expected to occur with yearly fluctuations in rainfall since recharge to the alluvial aquifer occurs primarily from rainfall infiltration. The Riverside County Flood Control District has been monitoring rainfall since 1981 at Potrero Station located at the eastern side of Beaumont No. 1. The cumulative rainfall for each of the five years of monitoring at Potrero Station are:

Year (July to June)	Cumulative Rainfall (Inches)
1981-82	16.93
1982-83	26.15
1983-84	9.16
1984-85	12.91
1985-86	13.60
Average rainfall	16.00

(data from Riverside County Flood Control District)

The average rainfall for the area (based on additional rainfall data from the surrounding region) is reported by the Riverside County Flood Control District to be 16 inches. The rainfall data indicates a high rainfall year in 1982-83 followed by three years of below average rainfall. This would account for the high water table level during the Leighton investigation and the subsequent drop in the water table observed from 1983 to 1986.

Beaumont No. 2

Ground water within the Beaumont No. 2 site is found primarily in Cenozoic alluvial sediments, although these deposits yield little water to wells. A 500-foot well (W2-5) drilled near Building 250 in 1970, as shown on Figure 1-2, produced 10-gpm with 173 feet of drawdown and exhibited a specific capacity of approximately 0.06 gpm/foot of drawdown (Leighton and Associates, 1983b). Currently, electrical power has been disconnected, although the pump and lines are still in place. Four additional wells, of which two have been found (W2-4 and W2-3), are located on site but details regarding their construction are unknown and none are used today.

The depth to ground water was measured by Radian in W2-3, located near the center of the site. The total depth of this well is 208 feet while the depth to water was 44.7 feet. Conclusions regarding ground water flow cannot be made at this time. Additional wells will need to be drilled in further investigations at this site because only one data point exists.

2.3 Ground-Water Quality Results

Ground-water samples were taken from nine wells at the Beaumont No. 1 site and from one well at the Beaumont No. 2 site. Samples from all wells were analyzed for purgeable halocarbons by EPA Method 601. Ground-water samples from three Beaumont No. 1 wells were also analyzed for trace elements (EPA Method 200.7), purgeable organic priority pollutants (EPA Method 624), base/neutral and acid extractable compounds (EPA Method 625), and inorganic anions (EPA Method 300.0). The results of all analyses were compared to the California Department of Health Services (DHS) Sanitary Engineering Branch Maximum Contaminant Level drinking water standards. These are legally enforceable standards created in order to protect human health and welfare. Additional data interpretation was conducted based on calculations of the limits of detection and the limits of quantitation.

Determination of Limits of Detection and Quantitation

Many of the contaminants found in the ground water at Lockheed Beaumont have been detected at levels that approach the limits of laboratory instrument response or detection, where there is a large degree of uncertainty inherent in the measurement process. Because of this uncertainty, Radian has adopted a method for interpreting low-level analytical values based on the guidelines set forth by the American Chemical Society Committee on Environmental Improvement (Keith et al., 1983). This method involves determining a limit of detection and a limit of quantitation when performing analysis for purgeable halocarbons.

The limit of detection (LOD) for an analytical technique is defined as "the lowest concentration level that can be determined to be statistically different from a blank" (Keith et al., 1983). The recommended LOD value is three standard deviations above the mean of each laboratory reagent blank data set. (Reagent blanks are aliquots of organic-free water analyzed at the beginning of each analytical run to determine baseline instrument response.) The LOD is computed for a set of laboratory data by taking the mean value of the laboratory blanks and adding three times the standard deviation of the data set to it.

The limit of quantitation (LOQ) is defined as "the level above which quantitative results may be obtained with a specified degree of confidence" (Keith et al., 1983). The value for limit of quantitation is defined as the mean laboratory reagent blank response plus 10 times the standard deviation of the blank data set. If an uncertainty of ± 30% in the measurement technique and normal Gaussian distribution of the measurements are assumed, the limit of quantitation will be at the 90% confidence level.

For those chemicals not detected in reagent blanks, which include all of the compounds of interest for this investigation, the LOD is accepted as the detection limit reported by the laboratory. These LODs were established by replicate analysis of low-level samples supplied by EPA. These prepared samples contained concentrations of analytes at reported detection limits which were lower than those normally used by the laboratory. The instrument detection sensitivity was adjusted so that chromatographic peaks of the chemicals added to the sample could be distinguished from background levels by the operating chemist. Once LODs had been established by this method, it was necessary to establish LOQ values. In this report, the LOQ for chemicals was determined by dividing the LOD by 3 and multiplying this value by 10, using the principles previously described.

The LODs and LOQs for the Radian laboratory as well as the lowest appropriate regulatory action level are given in the tables for each method. The Committee on Environmental Improvement's article recommends that "Quantitative interpretation, decision-making, and regulatory actions should be limited to data at or above the limit of quantitation" (Keith et al., 1983). Sample data that fall between the limits of detection and quantitation are reported as semiquantitative (SQ) levels, but are not accepted as significant values. These data may be used however, to establish trends, such as direction of plume migration.

The complete set of laboratory data sheets are found in Appendix D, organized by well. These data have been completely summarized by method in Tables 2-6 through 2-16. Any values reported in the data sheets below the LOQ have been replaced with SQ, referring to the fact that the data is semi-quantitative. No correction for the presence of laboratory contamination in blank samples has been made. For ease in interpretation, the complete data sets have been summarized to eliminate all chemicals which were not found in any sample. Also, the non-detected (ND) symbol has been removed, and any values above the action level have been underlined. These summary tables follow the complete data tables for each method in the following discussions.

In order to achieve qualitative results on some contaminated samples, it may be necessary for the laboratory technician to dilute the sample before injection into the instrument. The procedure raises the limit of detection, and subsequently the limit of quantitation, for that particular sample. This is noted in the data tables by a concentration factor greater than one. The LOD and LOQ for a diluted sample can be determined by multiplying the undiluted limit value by the concentration factor.

Purgeable Halocarbons (EPA 601)

The results of the EPA 601 analyses are shown in Table 2-6, and summarized in Table 2-7. Ground-water contamination is observed in the three Beaumont No. 1 wells, OW-2, OW-3, and W-3 (see Figure 2-3), located within one mile downgradient of the burn pit area. These wells all contain concentrations of 1,1-dichloroethene (1,1-DCE) and trichloroethene (TCE) above state action levels while OW-2 also contains 1,2-dichloroethane (1,2-DCA) above the state action level. In addition, concentrations of 1,1-dichloroethane (1,1-DCA) are detected above the limit of quantitation in ground-water samples from the three wells.

Ground-water samples from W-2, located approximately 1.4 miles downgradient of the burn pit area, contain concentrations of 1,1-DCA above the limit of quantitation, and trace concentration of 1,1-DCE and TCE. Wells OW-8 and OW-1, located 0.25 and 0.75 miles downgradient of W-2, respectively, do not exhibit any contamination. This indicates that the downgradient extent of contamination may be in the vicinity of Well W-2.

Ground-water samples taken from the two wells upgradient of the burn pit area, OW-1 and W-5, do not show any contamination. Well W-6, located adjacent to Potrero Creek at the northern boundary of the site, also does not exhibit contamination.

One well at the Beaumont No. 2 site, W2-3, was sampled for EPA 601 analysis. TCE is detected at a concentration above the limit of quantitation but below the state action level.

Methylene chloride and trichlorofluoromethane are detected in several samples, but are also found in the field and reagent blanks. The presence of these chemicals is discussed in Section 2.4 on Quality Control.

TABLE 2-6

EPA METHOD 601
PURGEABLE HALOCARBONS (µg/l)

COMPOUND	ACTION LEVEL[a] (MCL)	LIMIT OF DETECTION OCTOBER 1986 (LOD)	LIMIT OF QUANTITATION OCTOBER 1986 (LOQ)	OW-1 10-86	OW-2 LDA 10-86	OW-2 LDB 10-86	OW-3 FDA 10-86	OW-3 FDB 10-86	OW-8 10-86	W-1	W-2 10-86	W-3 10-86	W-5 10-86	W-6 10-86	W2-3 LDA 10-86	W2-3 LDB 10-86	OWO-1 FIELD BLANK 10-86	REAGENT BLANK 3A 10-22-86	REAGENT BLANK 7A 10-22-86	REAGENT BLANK 7A 10-22-86
1,1,1-trichloroethane	200	0.2	0.67	ND	110	90	190	190	ND	ND	ND	6	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-tetrachloroethane		0.2	0.67	ND	ND	ND	3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-trichloroethane		0.2	0.67	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethane	20	0.1	0.33	ND	4	3.8	10	8.2	ND	ND	1.3	0.68	ND	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethene	6	0.1	0.33	ND	140	120	270	280	ND	ND	SQ	19	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichlorobenzene	130	0.2	0.67	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethane	1	0.1	0.33	ND	2.5	2.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloropropane	10	0.1	0.33	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-dichlorobenzene	130	0.5	1.67	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-dichlorobenzene	130	0.2	0.67	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-chloroethylvinyl ether		2	6.67	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bromodichloromethane	100	0.1	0.33	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bromoform	100	2	6.67	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bromomethane		1	3.33	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
carbon tetrachloride	5	0.2	0.67	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
chlorobenzene	30	0.2	0.67	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
chloroethane		0.5	1.67	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
chloroform	100	0.1	0.33	ND	ND	ND	ND	ND	ND	ND	ND	SQ	ND	ND	ND	ND	ND	ND	ND	ND
chloromethane		0.5	1.67	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,3-dichloropropene	87	0.4	1.33	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
dibromochloromethane	100	0.2	0.67	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
methylene chloride	40	0.4	1.33	1.6	ND	ND	2.8	ND	SQ	SQ	SQ	4.3	ND	1.9	ND	ND	3	ND	ND	SQ
tetrachloroethylene	4	0.1	0.33	ND	ND	ND	ND	ND	ND	ND	ND	SQ	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-dichloroethene	16	0.1	0.33	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,3-dichloropropene		0.4	1.33	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trichloroethene	5	0.2	0.67	ND	180	150	280	240	ND	ND	SQ	18	ND	ND	4.2	3.4	SQ	ND	ND	ND
trichlorofluoromethane	3400	0.1	0.33	0.36	ND	ND	ND	ND	SQ	0.38	ND	0.37	ND	SQ	ND	ND	3	ND	ND	ND
vinyl chloride	2	0.2	0.67	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total 601 Halocarbon:				-	440	370	750	720	-	-	1.3	44	-	-	4.2	3.4	-			
Concentration Factor:			1	1	5	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1

a - Primary Drinking Water Maximum Contaminant Level as established by the Department of Health Services Sanitary Engineering Branch.

NA - Not analyzed.

ND - Not detected.

SQ - Semi-qualitative (between LOD and LOQ).

FD - Field duplicate (A and B).

TABLE 2-7

EPA METHOD 601 SUMMARY
PURGEABLE HALOCARBONS (µg/l)

COMPOUND	ACTION LEVEL (MCL)[a]	LIMIT OF DETECTION (LOD)	LIMIT OF QUANTITATION (LOQ)	OW-1 10-86	OW-2 LDA 10-86	OW-2 LDB 10-86	OW-3 FDA 10-86	WO-3 (WO-3) FDB 10-86	OW-8 10-86	W-1	W-2 10-86	W-3 10-86	W-5 10-86	W-6 10-86	W2-3 LDA 10-86	W2-3 LDB 10-86	OWO-1 FIELD BLANK 10-86	REAGENT BLANK 3A 10-22-86	REAGENT BLANK 7A 10-22-86	REAGENT BLANK 7A 10-22-86
methylene chloride	40	0.4	1.33	1.6			2.8		SQ	SQ	SQ	4.3		1.9			3			SQ
trichlorofluoromethane	3400	0.1	0.33	0.36					SQ	0.38		0.37		SQ			3			
1,1,1-trichloroethane (1,1,1-TCA)	200	0.2	0.67		110	90	190	190				6								
1,1,2,2-tetrachloroethane (1,1,2,2-TCA)		0.2	0.67				3													
1,1-dichloroethane (1,1-DCA)	20	0.1	0.33		4	3.8	10	8.2			1.3	0.68								
1,1-dichloroethene (1,1-DCE)	6	0.1	0.33		140	120	270	280			SQ	19								
1,2-dichloroethane (1,2-DCA)	1	0.1	0.33		2.5	2.5														
chloroform	100	0.1	0.33									SQ								
tetrachloroethylene (PCE)	4	0.1	0.33									SQ								
trichloroethene (TCE)	5	0.2	0.67		180	150	280	240			SQ	18			4.2	3.4	SQ			
Total 601 Halocarbon:				-	440	370	750	720	-	-	1.3	44	-	-	4.2	3.4	-			
Concentration Factor:			1	1	5	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1

a - Primary Drinking Water Maximum Contaminant Level as established by the Department of Health Services Sanitary Engineering Branch.

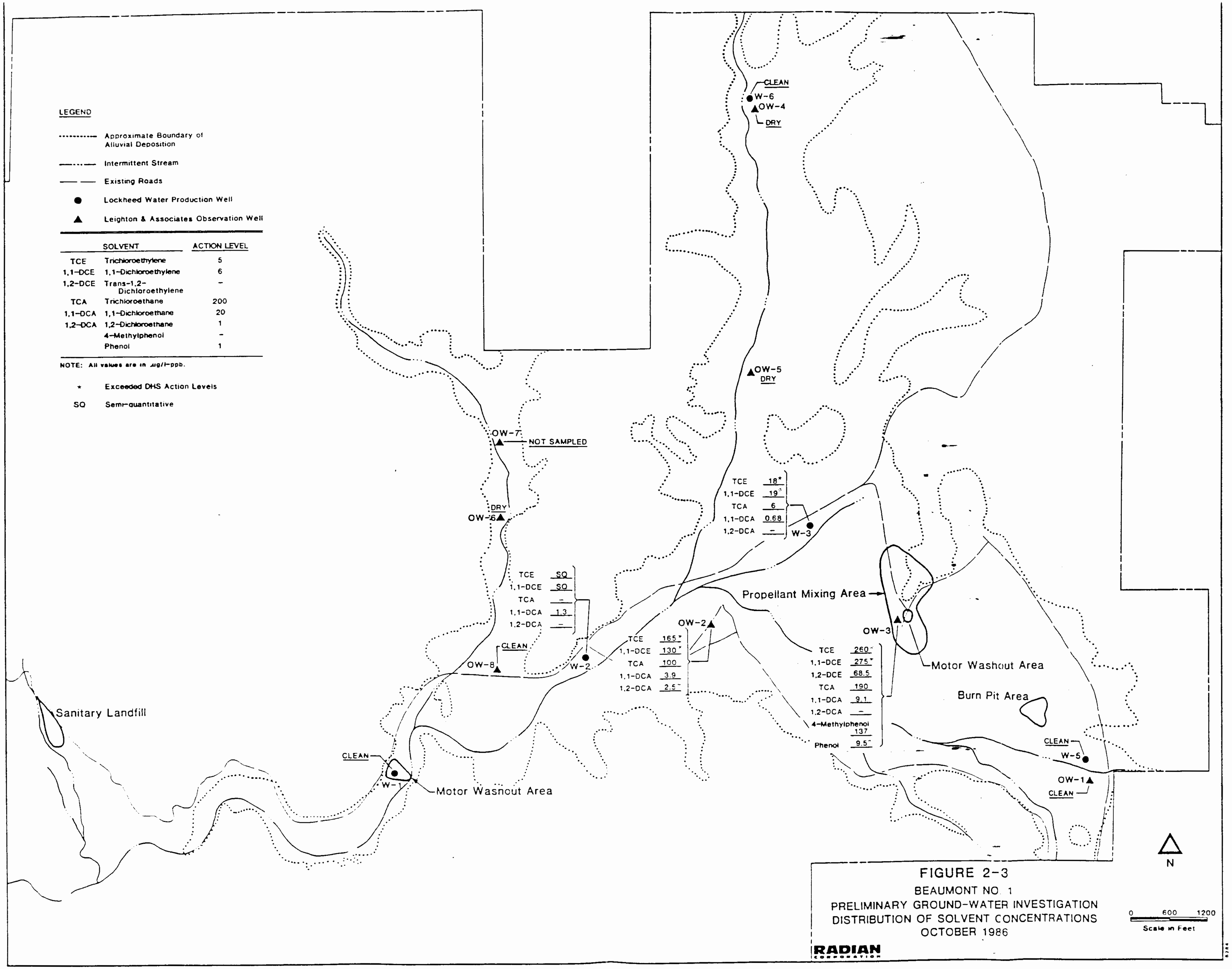
NA - Not analyzed.

ND - Not detected.

SQ - Semi-qualitative (between LOD and LOQ).

FD - Field duplicate (A and B).

Underlined values represent species above the action level.



	SOLVENT	ACTION LEVEL
TCE	Trichloroethylene	5
1,1-DCE	1,1-Dichloroethylene	6
1,2-DCE	Trans-1,2-Dichloroethylene	-
TCA	Trichloroethane	200
1,1-DCA	1,1-Dichloroethane	20
1,2-DCA	1,2-Dichloroethane	1
	4-Methylphenol	-
	Phenol	1

NOTE: All values are in µg/l-ppb.

* Exceeded DHS Action Levels

SQ Semi-quantitative

FIGURE 2-3
BEAUMONT NO. 1
PRELIMINARY GROUND-WATER INVESTIGATION
DISTRIBUTION OF SOLVENT CONCENTRATIONS
OCTOBER 1986

EPA METHOD 624
PURGEABLE ORGANIC PRIORITY POLLUTANTS (ug/l)

COMPOUND	ACTION LEVEL (MCL)[a]	LIMIT OF DETECTION (LOD)	LIMIT OF QUANTITATION (LOQ)	OW-3 FDA 10-86	OW-3 (WO-3) FDB 10-86	W-3 10-86	W-5 LDA 10-86	W-5 LDB 10-86	OWO-1 FIELD BLANK 10-86	REAGENT BLANK 10-28-86	REAGENT BLANK 10-30-86	REAGENT BLANK 10-29-86
1,1,1-trichloroethane	200	3.8	12.67	160	210	7.6	ND	ND	ND	ND	ND	ND
1,1,2,2-tetrachloroethane	7	6.9	23.00	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-trichloroethane	5	5.0	16.67	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethane	20	2.8	9.33	SQ	11	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethene	6	4.7	15.67	160	260	13	ND	ND	ND	ND	ND	ND
1,2-dichloroethane	1	2.8	9.33	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloropropane	10	6.0	20.00	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-butanone		25	83.9	ND	ND	ND	ND	ND	ND	SQ	SQ	SQ
2-chloroethylvinyl ether	10	5.0	16.67	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-hexanone		36	120	ND	ND	ND	ND	ND	ND	ND	SQ	SQ
4-methyl-2-pentanone		46	153.3	ND	ND	ND	ND	ND	ND	ND	ND	SQ
acetone		7.5	25.0	36	SQ	SQ	ND	ND	SQ	SQ	SQ	SQ
benzene	0.7	4.4	14.67	ND	ND	ND	ND	ND	ND	SQ	SQ	SQ
bromodichloromethane	100	2.2	7.33	ND	ND	ND	ND	ND	ND	ND	ND	ND
bromoform	100	4.7	15.67	ND	ND	ND	ND	ND	ND	ND	ND	ND
bromomethane		5.0	16.67	ND	ND	ND	ND	ND	ND	ND	ND	ND
carbon disulfide		1.7	5.67	ND	ND	ND	ND	ND	ND	ND	ND	ND
carbon tetrachloride	5	2.8	9.33	ND	ND	ND	ND	ND	ND	ND	ND	ND
chlorobenzene	30	6.0	20.00	ND	ND	ND	ND	ND	ND	ND	ND	SQ
chloroethane		5.0	16.67	ND	ND	ND	ND	ND	ND	ND	ND	ND
chloroform	100	1.6	5.33	ND	ND	ND	ND	ND	ND	ND	ND	ND
chloromethane		5	16.67	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,3-dichloropropene	87	5.0	16.67	ND	ND	ND	ND	ND	ND	ND	ND	ND
dibromochloromethane	100	3.1	10.33	ND	ND	ND	ND	ND	ND	ND	ND	ND
ethylbenzene		7.2	24.00	ND	ND	ND	ND	ND	ND	ND	ND	ND
methylene chloride	40	2.8	9.33	ND	ND	ND	ND	SQ	ND	SQ	SQ	SQ
styrene		3	10.0	ND	ND	ND	ND	ND	ND	ND	ND	ND
tetrachloroethylene	4	4.1	13.67	ND	ND	ND	ND	ND	ND	ND	ND	ND
toluene	100	6.0	20.00	ND	ND	ND	ND	ND	ND	ND	ND	SQ
trans-1,2-dichloroethene		1.6	5.33	39	98	ND	ND	ND	ND	ND	ND	ND
trans-1,3-dichloropropene		5.0	16.67	ND	ND	ND	ND	ND	ND	ND	ND	ND
trichloroethene	5	1.9	6.33	180	200	13	ND	ND	ND	ND	ND	ND
trichlorofluoromethane		5.0	16.67	ND	ND	ND	ND	ND	SQ	ND	ND	ND
vinyl acetate		6.9	23.0	ND	ND	ND	ND	ND	ND	ND	ND	ND
vinyl chloride	2	5.0	16.67	ND	ND	ND	ND	ND	ND	ND	ND	ND
xylenes (total)		4.6	15.33	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total 624				575	780	34		SQ	SQ	SQ	SQ	SQ
Concentration Factor :			1	5	5	1	1	1	1	1	1	1

a - Primary Drinking Water Maximum Contaminant Level as established by the Department of Health Services Sanitary Engineering Branch.

ND - Not detected.

SQ - Semi-qualitative (between LOD and LOQ).

FD - Field duplicate (A and B).

Purgeable Organic Priority Pollutants (EPA 624)

Analysis for EPA 624 constituents was conducted on ground-water samples from wells most closely associated with the burn pit area, Wells OW-3, W-3, and W-5. Results of these analyses are shown on Table 2-8, and summarized on Table 2-9. As with the EPA 601 results, the 624 analyses show concentrations of 1,1-DCE and TCE above state action levels in Wells OW-3 and W-3. Values for contaminants analyzed by Method 601 will be used in later discussions, since Method 601 provides better detection limits than does Method 624. In addition, Well OW-3 exhibits concentrations of 1,1,1-TCA above the state action level and 1,1-DCA, trans-1,2-DCE, and acetone above the limits of quantitation. Trans-1,2-DCE was not detected in the 601 Analysis, possibly due to isomeric properties of the chemical. Acetone is just above the LOQ and may be a laboratory contaminant. Well W-5 did not exhibit any contamination.

Base/Neutral and Acid Extractables (EPA 625)

Analysis for semi-volatile organic compounds (EPA Method 625) was performed on ground-water samples from wells most closely associated with the burn pit area, Wells OW-3, W-3, and W-5. The results of these analyses are shown on Tables 2-10 and 2-11, and are summarized on Tables 2-12 and 2-13. Phenol and 4-methyl phenol are found in OW-3 at concentrations above the limit of quantitation. The phenol concentration is above the state action level. Phthalates are detected in every sample, including the field and reagent blanks. Their presence is discussed in the section in Quality Control.

Trace Elements (EPA 200.7)

Analysis for metals was conducted on ground-water samples from those wells most closely associated with the burn pit area, wells OW-3, W-3, and W-5. The results of these analyses are shown on Table 2-14, and summarized on Table 2-15. State action levels are not exceeded except in OW-3, when iron and manganese are over the secondary drinking water maximum contaminant level for taste and odor.

RADIAN
CORPORATION

TABLE 2-9

EPA METHOD 624 SUMMARY
PURGEABLE ORGANIC PRIORITY POLLUTANTS (µg/l)

COMPOUND	[a] ACTION LEVEL (MCL)	LIMIT OF DETECTION (LOD)	LIMIT OF QUANTITATION (LOQ)	OW-3 FDA 10-86	OW-3 (WO-3) FDB 10-86	W-3 10-86	W-5 LDA 10-86	W-5 LDB 10-86	OW-1 FIELD BLANK 10-86	REAGENT BLANK 10-28-86	REAGENT BLANK 10-30-86	REAGENT BLANK 10-29-86
1,1,1-trichloroethane (1,1,1-TCA)	200	3.8	12.67	160	210	7.6						
1,1-dichloroethane (1,1-DCA)	20	2.8	9.33	SQ	11							
1,1-dichloroethene (1,1-DCE)	6	4.7	15.67	160	260	13						
acetone		7.5	25.0	36	SQ	SQ			SQ	SQ	SQ	SQ
trans-1,2-dichloroethene (1,2-DCA)		1.6	5.33	39	98							
trichloroethene (TCE)	5	1.9	6.33	180	200	13						
Total 624				575	780	34			SQ	SQ	SQ	SQ
Concentration Factor :			1	5	5	1	1	1	1	1	1	1

a - Primary Drinking Water Maximum Contaminant Level as established by the Department of Health Services Sanitary Engineering Branch.

SQ - Semi-qualitative (between LOD and LOQ).

FD - Field duplicate (A and B).

Underlined values represent species above the action level.

TABLE 2-10

EPA METHOD 625
ACID EXTRACTABLES (ug/l)

COMPOUNDS	ACTION LEVEL (MCL) [a]	LIMIT OF DETECTION (LOD)	LIMIT OF QUANTITATION (LOQ)	OW-3 FDA 10-86	OW-3 (WO-3) FDB 10-86	W-3 LDA 10-86	W-3 LDB 10-86	W-5 10-86	OWO-1 FIELD BLANK 10-86	REAGENT BLANK 10-21-86	REAGENT BLANK 10-21-86
2,4,6-trichlorophenol		2.7	9	ND	ND	ND	ND	ND	ND	ND	ND
2,4-dichlorophenol		2.7	9	ND	ND	ND	ND	ND	ND	ND	ND
2,4-dimethylphenol	400	2.7	9	ND	ND	ND	ND	ND	ND	ND	ND
2,4-dinitrophenol		42	140	ND	ND	ND	ND	ND	ND	ND	ND
2-chlorophenol		3.3	11	ND	ND	ND	ND	ND	ND	ND	ND
2-nitrophenol		3.6	12	ND	ND	ND	ND	ND	ND	ND	ND
4,6-dinitro-o-cresol		24	80	ND	ND	ND	ND	ND	ND	ND	ND
4-methyl phenol		10	33	94	180	ND	ND	ND	ND	ND	ND
4-nitrophenol		2.4	8	ND	ND	ND	ND	ND	ND	ND	ND
pentachlorophenol	30	3.6	12	ND	ND	ND	ND	ND	ND	ND	ND
phenol [b]	1	1.5	5	6.9	12	SQ	SQ	SQ	SQ	ND	ND
p-chloro-m-cresol		3.0	10	ND	ND	ND	ND	ND	ND	ND	ND
Total 625				6.9	12	SQ	SQ	SQ	SQ		
Concentration Factor:			1	1	1	1	1	1	1	1	1

a - Primary Drinking Water Maximum Contaminant Level as established by the Department of Health Services Sanitary Engineering Branch.

NA - Not analyzed.

ND - Not detected.

SQ - Semi-qualitative (between LOD and LOQ).

FD - Field duplicate (A and B).

b - The presence of phenol may be due to laboratory contamination.

TABLE 2-11

EPA METHOD 625
BASE/NEUTRAL EXTRACTABLES (µg/l)

EPA METHOD 625
BASE/NEUTRAL EXTRACTABLE
(ug/l)

COMPOUND	ACTION LEVEL (MCL)	LIMIT OF DETECTION (LOD)	LIMIT OF QUANTITATION (LOQ)	OW-3 FDA 10-86	OW-3 (WO-3) FDB 10-86	W-3 LDA 10-86	W-3 LDB 10-86	W-5 10-86	OWO-1 FIELD BLANK 10-86	REAGENT BLANK 10-21-86	REAGENT BLANK 10-21-86
1,2,4-trichlorobenzene		1.9	6.33	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichlorobenzene	130	1.9	6.33	ND	ND	ND	ND	ND	ND	ND	ND
1,3-dichlorobenzene	130	1.9	6.33	ND	ND	ND	ND	ND	ND	ND	ND
1,4-dichlorobenzene	130	4.4	14.67	ND	ND	ND	ND	ND	ND	ND	ND
2,4-dinitrotoluene		5.7	19.00	ND	ND	ND	ND	ND	ND	ND	ND
2,6-dinitrotoluene		1.9	6.33	ND	ND	ND	ND	ND	ND	ND	ND
2-chloronapthalene		1.9	6.33	ND	ND	ND	ND	ND	ND	ND	ND
3,3-dichlorobenzidine		17	56.67	ND	ND	ND	ND	ND	ND	ND	ND
3,4-benzofluoranthene		4.8	16.00	ND	ND	ND	ND	ND	ND	ND	ND
4-bromophenyl phenyl ether		1.9	6.33	ND	ND	ND	ND	ND	ND	ND	ND
4-chlorophenyl phenyl ether		4.2	14.00	ND	ND	ND	ND	ND	ND	ND	ND
acenaphthene		1.9	6.33	ND	ND	ND	ND	ND	ND	ND	ND
acenaphthylene		3.5	11.67	ND	ND	ND	ND	ND	ND	ND	ND
anthracene	0.7	1.9	6.33	ND	ND	ND	ND	ND	ND	ND	ND
benzidine		44	146.67	ND	ND	ND	ND	ND	ND	ND	ND
benzo(a)anthracene		7.8	26.00	ND	ND	ND	ND	ND	ND	ND	ND
benzo(a)pyrene		2.5	8.33	ND	ND	ND	ND	ND	ND	ND	ND
benzo(g,h,i)perylene		4.1	13.67	ND	ND	ND	ND	ND	ND	ND	ND
benzo(k)fluoranthene		2.5	8.33	ND	ND	ND	ND	ND	ND	ND	ND
benzoic acid		50	166.5	11	32	ND	ND	ND	ND	ND	ND
bis(2-chloroethoxy)methane		5.3	17.67	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-chloroethyl)ether		5.7	19.00	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-chloroisopropyl)ether		5.7	19.00	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-ethylhexyl)phthalate		2.5	8.33	6.1	7.2	5.9	2.6	5.6	5.9	34	34
butyl benzyl phthalate		2.5	8.33	ND	ND	ND	ND	ND	ND	ND	ND
chrysene		2.5	8.33	ND	ND	ND	ND	ND	ND	ND	ND
dibenzo(a.h)anthracene		2.5	8.33	ND	ND	ND	ND	ND	ND	ND	ND
diethyl phthalate		1.9	6.33	ND	ND	ND	ND	ND	ND	ND	ND
dimethyl phthalate		1.6	5.33	ND	ND	ND	ND	ND	ND	ND	ND
di-n-butyl phthalate		2.5	8.33	18	18	27	8.3	31	20	2.1	2.1
di-n-octyl phthalate		2.5	8.33	ND	ND	ND	ND	ND	ND	ND	ND
flourene		1.9	6.33	ND	ND	ND	ND	ND	ND	ND	ND
fluoranthene		2.2	7.33	ND	ND	ND	ND	ND	ND	ND	ND
hexachlorobenzene		1.9	6.33	ND	ND	ND	ND	ND	ND	ND	ND
hexachlorobutadiene		0.9	3.00	ND	ND	ND	ND	ND	ND	ND	ND
hexachlorocyclopentadiene		6.0	20.00	ND	ND	ND	ND	ND	ND	ND	ND
hexachloroethane		1.6	5.33	ND	ND	ND	ND	ND	ND	ND	ND
indeno(1,2,3-cd)pyrene		3.7	12.33	ND	ND	ND	ND	ND	ND	ND	ND
isophorone		2.2	7.33	ND	ND	ND	ND	ND	ND	ND	ND
naphthalene		1.6	5.33	ND	ND	ND	ND	ND	ND	ND	ND
nitrobenzene		1.9	6.33	ND	ND	ND	ND	ND	ND	ND	ND
N-nitrosodimethylamine		10	33.33	ND	ND	ND	ND	ND	ND	ND	ND
N-nitrosodiphenylamine		1.9	6.33	ND	ND	ND	ND	ND	ND	ND	ND
N-nitrosodi-n-propylamine		12	40.00	ND	ND	ND	ND	ND	ND	ND	ND
phenanthrene		5.4	18.00	ND	ND	ND	ND	ND	ND	ND	ND
pyrene		1.9	6.33	ND	ND	ND	ND	ND	ND	ND	ND
Concentration Factor:				1	1	1	1	1	1		

FOOTNOTES: Same as preceding tables.

TABLE 2-12

EPA METHOD 625 SUMMARY
ACID EXTRACTABLES (ug/l)

COMPOUNDS	ACTION LEVEL (MCL) [a]	LIMIT OF DETECTION (LOD)	LIMIT OF QUANTITATION (LOQ)	OW-3 FDA 10-86	OW-3 FDB 10-86	W-3 LDA 10-86	W-3 LDB 10-86	W-5 10-86	OWO-1 FIELD BLANK 10-86	REAGENT BLANK 10-21-8	REAGENT BLANK 10-21-86
4-methyl phenol		10	33	94	180	ND	ND	ND	ND	ND	ND
phenol [b]	1	1.5	5	6.9	12	SQ	SQ	SQ	SQ	ND	ND
Total 625				6.9	12	SQ	SQ	SQ	SQ		
Concentration Factor:			1	1	1	1	1	1	1	1	1

a - Primary Drinking Water Maximum Contaminant Level as established by the Department of Health Services Sanitary Engineering Branch.

NA - Not analyzed.

ND - Not detected.

SQ - Semi-qualitative (between LOD and LOQ).

FD - Field duplicate (A and B).

b - The presence of phenol may be due to laboratory contamination.

Underlined values represent species above the action level.

TABLE 2-13

EPA METHOD 625 SUMMARY
BASE/NEUTRAL EXTRACTABLES (μg/l)

COMPOUND	ACTION LEVEL (MCL)[a]	LIMIT OF DETECTION (LOD)	LIMIT OF QUANTITATION (LOQ)	OW-3 FDA 10-86	OW-3 (WO-3) FDB 10-86	W-3 LDA 10-86	W-3 LDB 10-86	W-5 10-86	OWO-1 FIELD BLANK 10-86	REAGENT BLANK 10-21-86	REAGENT BLANK 10-21-86
bis(2-ethylhexyl)phthalate		2.5	8.33	6.1 BL	7.2 BL	5.9 BL	2.6 BL	5.6 BL	5.9 BL	34	34
di-n-butyl phthalate		2.5	8.33	18 BL	18 BL	27 BL	8.3 BL	31 BL	20 BL	2.1 J	2.1 J
Total 625:											
Concentration Factor:			1	1	1	1	1	1	1	1	1

a - Primary Drinking Water Maximum Contaminant Level as established by the Department of Health Services Sanitary Engineering Branch.

NA - Not analyzed.

ND - Not detected.

SQ - Semi-qualitative (between LOD and LOQ).

FD - Field duplicate (A and B).

TABLE 2-14

EPA METHOD 200.7
TRACE ELEMENTS (mg/l)

COMPOUND	ACTION LEVEL (MCL)[a]	LIMIT OF DETECTION (LOD)	LIMIT OF QUANTITATION (LOQ)	OW-2 QAL 06-83	OW-3 FDA 10-86	OW-3 (WO-3) FDB 10-86	W-3 QAL 06-83	W-3 10-86	W-5 10-86	OWO-1 Field Blank 10-86
aluminum		0.045	0.15	N/A	SQ	SQ	N/A	ND	ND	ND
antimony		0.034	0.11	N/A	ND	ND	N/A	ND	ND	ND
arsenic	0.05	0.053	0.18	<0.005	ND	ND	<0.005	ND	ND	ND
barium	1	0.002	0.01	<0.20	0.068	0.071	<0.20	0.016	0.055	SQ
beryllium		0.0003	0.00	N/A	ND	ND	N/A	ND	ND	ND
boron		0.006	0.02	N/A	0.038	0.038	N/A	0.04	0.034	ND
cadmium	0.01	0.004	0.01	<0.01	ND	ND	<0.01	ND	ND	ND
calcium		0.01	0.03	17.5	47.1	43.9	12	14.6	17.2	0.17
chromium (Total)	0.05	0.007	0.02	<0.01	ND	ND	<0.01	ND	ND	ND
cobalt		0.007	0.02	N/A	ND	ND	N/A	ND	ND	ND
copper	1*	0.006	0.02	<0.01	SQ	SQ	<0.01	0.025	SQ	SQ
iron	.3*	0.007	0.02	0.10	0.655	0.248	0.11	SQ	0.154	SQ
lead	0.05	0.042	0.14	<0.01	ND	ND	<0.01	ND	ND	ND
magnesium		0.03	0.10	4.5	7.96	7.48	2	0.576	3.02	SQ
manganese	0.05*	0.002	0.01	0.01	1.83	1.58	0.01	SQ	0.035	ND
mercury				<0.001	NA	NA	<0.001	NA	NA	NA
molybdenum		0.008	0.03	N/A	ND	ND	N/A	ND	ND	ND
nickel		0.015	0.05	N/A	ND	ND	N/A	ND	ND	ND
potassium		N/A	N/A	N/A	5.04	4.32	N/A	1.47	1.56	<0.05
selenium	0.01	0.075	0.25	<0.002	ND	ND	<0.002	ND	ND	ND
silicon		0.058	0.19	N/A	18	17.2	N/A	12.1	18	0.846
silver	0.05	0.007	0.02	<0.01	ND	ND	<0.01	ND	ND	ND
sodium		0.029	0.10	36	19.5	19.4	80	57.2	13.4	0.496
thallium		0.051	0.17	N/A	ND	ND	N/A	ND	ND	ND
vanadium		0.008	0.03	N/A	ND	ND	N/A	ND	ND	ND
zinc	5*	0.002	0.01	<0.01	SQ	0.01	<0.01	0.013	0.185	0.013

a - Primary Drinking Water Maximum Contaminant Level as established by the Department of Health Services Sanitary Engineering Branch.

* - Secondary Drinking Water Maximum Contaminant Level (taste, odor).

QAL - Previous analysis performed by Quality Assurance Laboratory.

NA - Not analyzed.

ND - Not detected.

SQ - Semi-qualitative (between LOD and LOQ).

FD - Field duplicate (A and B).

TABLE

EPA METHOD .00.7 SUMMARY
TRACE ELEMENTS (mg/l)

COMPOUND	ACTION LEVEL (MCL) [a]	LIMIT OF DETECTION (LOD)	LIMIT OF QUANTITATION (LOQ)	OW-2 QAL 06-83	OW-3 FDA 10-86	OW-3 (WO-3) FDB 10-86	W-3 QAL 06-83	W-3 10-86	W-5 10-86	OWO-1 Field Blank 10-86
aluminum		0.045	0.15		SQ	SQ				
barium	1	0.002	0.01		0.068	0.071		0.016	0.055	SQ
boron		0.006	0.02		0.038	0.038		0.04	0.034	
calcium		0.01	0.03	17.5	47.1	43.9	12	14.6	17.2	0.17
copper	1*	0.006	0.02		SQ	SQ		0.025	SQ	SQ
iron	0.3*	0.007	0.02	0.10	0.655	0.248	0.11	SQ	0.154	SQ
magnesium		0.03	0.10	4.5	7.96	7.48	2	0.576	3.02	SQ
manganese	0.05*	0.002	0.01	0.01	1.83	1.58	0.01	SQ	0.035	
potassium		N/A	N/A		5.04	4.32		1.47	1.56	
silicon		0.058	0.19		18	17.2		12.1	18	0.846
sodium		0.029	0.10	36	19.5	19.4	80	57.2	13.4	0.496
zinc	5*	0.002	0.01		SQ	0.01		0.013	0.185	0.013

a - Primary Drinking Water Maximum Contaminant Level as established by the Department of Health Services Sanitary Engineering Branch.

* - Secondary Drinking Water Maximum Contaminant Level (taste, odor).

QAL - Previous analysis performed by Quality Assurance Laboratory.

NA - Not analyzed.

ND - Not detected.

SQ - Semi-qualitative (between LOD and LOQ).

FD - Field duplicate (A and B).

Underlined values represent species above the action level.

Inorganic Anions (EPA 300)

Analysis for inorganic anions (chloride, fluoride, sulfate, and nitrate) was conducted on ground-water samples from these wells most closely associated with the burn pit area, wells OW-3, W-3, and W-5. The results of these analyses are shown on Table 2-16. State action levels were not exceeded for any anions, although the two-day laboratory holding time for nitrate was exceeded for these samples.

TABLE 2-16

EPA METHOD 300.0
INORGANIC ANIONS (mg/l)

COMPOUNDS	ACTION LEVEL (MCL) [a]	LIMIT OF DETECTION (LOD)	LIMIT OF QUANTITATION (LOQ)	OW-3 FDA 10-86	OW-3 (WO-3) FDB 10-86	W-3 10-86	W-5 10-86	OWO-1 FIELD BLANK 10-86	MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIANCE
chloride	500*	1	3.3	12	12	40	9	ND	12	0	0
fluoride		0.1	0.33	SQ	SQ	SQ	SQ	ND	SQ	0	0
nitrate [b]	45	0.01	0.033	ND	2.6	1.1	1.1	ND	1.3	1.83	141
sulfate	500*	2	6.6	10.2	13	22	22	ND	11.6	1.98	17
Total 300.0											
Concentration Factor:			1	1	1	1	1	1			

a - Primary Drinking Water Maximum Contaminant Level as established by the Department of Health Services Sanitary Engineering Branch.

* - Secondary Drinking Water Maximum Contaminant Level (taste, odor).

NA - Not analyzed.

ND - Not detected.

SQ - Semi-qualitative (between LOD and LOQ).

FD - Field duplicate (A and B).

b - Sample holding time of 48 hours for nitrates was exceeded.

2.4 Quality Control

The purpose of Quality Assurance/Quality Control (QA/QC) procedures is to produce data of known high quality that meets or exceeds the requirements of standard analytical methods, and satisfies the program requirements. The QA/QC program serves to help identify sample bias, determine the limits of precision and accuracy, and validates the reliability of the data set. The following section reports both the field quality control performed during the sampling effort and the analytical quality control required by each method. A summary of precision and accuracy objectives for the analytical methods used is given in Table 2-4.

The sampling and analytical quality control data are presented in Tables 2-17 and 2-18 for field and laboratory duplicates. Comparison of these data to precision and accuracy objectives indicate that most of the data reported meet the specified acceptance criteria for quantitative data. Exceptions are noted in the discussions given below, organized by type of quality control data.

Corrective action was required on the data reported for the Method 300.0 analysis of anions. These samples were analyzed by the laboratory after the hold time of 48 hours for nitrate had been exceeded. It is not known what effect this deviation from procedure has had on these data since levels of nitrates in all wells were low. Corrective action for this situation involves flagging these data in the data base, indicating a violation of sampling handling procedures.

Analysis of Duplicate Samples

Field Duplicates

Analytical precision for each EPA Method was assessed by performing analysis on duplicate samples from the same well. A field duplicate is a second sample collected at the same location as the original sample. The purpose of collecting samples in duplicate is to determine if there is variability in the analytical data due to the combined effects of the laboratory analysis and sample collection processes. Field duplicate (FD) analyses were performed on samples from approximately 10 percent (1 sample) of the wells. The duplicate samples were collected in immediate succession, using identical techniques, and treated in an identical manner during storage, transportation, and analysis.

The well chosen for collection of the single field duplicate was OW-3, suspected as most likely to be contaminated. The duplicate sample was labeled WO-3, and was not identified to the laboratory as a duplicate pair. The results and interpretation of the field duplicate analyses are shown on Table 2-17.

Comparison of duplicate sample pairs is performed using the coefficient of variation (CV) or relative standard deviation.

$$\text{Standard Deviation} = S = \sqrt{\frac{\sum (x-\bar{x})^2}{(n-1)}}$$

and

$$\text{Coefficient of Variation} = CV = (S/\bar{x}) \times 100\%$$

where, x = individual measurement value
$\bar{x}$ = mean
n = number of measurements.

EPA has established recommended acceptance criteria for most methods, as shown in Table 2-4. Although the method of calculating the coefficient of variation is not strictly valid in this investigation because there are only two data sets, these are the formula by which the criteria are determined.

TABLE 2-17

FIELD DUPLICATE QUALITY CONTROL DATA

COMPOUND	LIMIT OF DETECTION (LOD)	LIMIT OF QUANTITATION (LOQ)	OW-3 FDA 10-86	OW-3 (WO-3) FDB 10-86	MEAN $\bar{X}$	STANDARD DEVIATION	COEFFICIENT OF VARIANCE CV
EPA METHOD 601 (ug/l)	METHOD ACCEPTANCE CRITERIA, CV ≤ 60%						
methylene chloride	0.4	1.33	2.8	ND	1.4	2	143*[a]
1,1-dichloroethane (1,1-DCA)	0.1	0.33	10	8.2	9.1	1.3	14
1,1-dichloroethene (1,1-DCE)	0.1	0.33	270	280	275	7.1	2.6
1,1,1-trichloroethane (1,1,1-TCA)	0.2	0.67	190	190	190	0	0
trichloroethene (TCE)	0.2	0.67	280	240	260	28.3	11
1,1,2,2-trichloroethane (1,1,2,2-TCA)	0.2	0.67	3	ND	1.5	2.1	140*
EPA METHOD 624 (ug/l)	Method Acceptance Criteria, CV ≤ 70%						
1,1,1-trichloroethane (1,1,1-TCA)	3.8	12.67	160	210	185	35	19
1,1-dichloroethane (1,1-DCA)	2.8	9.33	SQ	11	9.2	2.5	28
1,1-dichloroethene (1,1-DCE)	4.7	15.67	160	260	210	70.7	34
acetone	7.5	25	36	SQ	25	16	62[a]
trans-1,2-dichloroethene (1,2-DCA)	1.6	5.33	39	98	68.5	42	61
trichloroehtene (TCE)	1.9	6.33	180	200	190	14	7.4
EPA METHOD 625 (ug/l)	Method Acceptance Criteria, CV ≤ 70%						
4-methyl phenol	10	33	94	180	137	61	44
phenol	1.5	5	6.9	12	9.45	3.6	38
bis(2-ethylhexyl)phthalate	2.5	8.33	6.1	7.2	6.65	0.78	12
di-n-butyl phthalate	2.5	8.33	18	18	18	0	0
EPA METHOD 200.7 (mg/l)	Method Acceptance Criteria, CV ≤ 60%						
aluminum	0.045	0.15	SQ	SQ	SQ	0	0
barium	0.002	0.01	0.068	0.071	0.0695	0.0021	3.1
boron	0.006	0.02	0.038	0.038	0.038	0	0
calcium	0.01	0.03	47.1	43.9	45.5	2.3	5
copper	0.006	0.02	SQ	SQ	SQ	0	0
iron	0.007	0.02	0.655	0.248	0.45	0.29	64*
magnesium	0.03	0.1	7.96	7.48	7.73	0.35	4.6
manganese	0.002	0.01	1.83	1.58	1.705	0.18	10
potassium	N/A	N/A	5.04	4.32	4.68	0.51	11
silicon	0.058	0.19	18	17.2	17.6	0.57	3.2
sodium	0.029	0.1	19.5	19.4	19.45	0.071	0.36
zinc	0.002	0.01	SQ	0.01	0.0095	0.0007	7.4
EPA METHOD 300.0 (mg/l)	Method Acceptance Criteria not specified						
chloride	1	3.3	12	12	12	0	0
fluoride	0.1	0.33	SQ	SQ	SQ	0	0
nitrate	0.01	0.033	ND	2.6	1.3	1.83	141
sulfate	2	6.6	10.2	13	11.6	1.98	17

* - Coefficient of variance did not meet the recommended acceptance criteria for the method.

a - Methylene chloride and acetone are suspected laboratory-introduced contaminants.

SQ - Semi-quantitative.

FD - Field duplicate pair.

N/A - Not analyzed.

ND - Non-detected.

All but two of the Method 601 duplicate pairs had CV's well within the 60 percent acceptance criteria for this method, indicating good sampling protocol. The two compounds above the criteria were detected at low levels in one of the two field duplicate samples, and not detected in the other. One of the compounds was methylene chloride suspected to be a laboratory contaminant introduced to one of the sample pairs during analysis as discussed in the Reagent Blank interpretation. No corrective action is recommended.

The other compound is 1,1,2,2 Tetrachloroethane (1,1,2,2 TCA), which is detected at 3 ppb out of a total halocarbon concentration in the sample of 750 ppb. Its presence in the sample was confirmed by second column analysis. This is the only sample of the entire sample set in which 1,1,2,2-TCA was detected. Since it is detected at such a low concentration in the most contaminated sample, and since there is no action level for 1,1,2,2-TCA, no corrective action is recommended.

All duplicate pairs for Methods 624 and 625 had CV's within the 70 percent acceptance criteria for these methods.

All but one of the Method 200.7 duplicate pairs had CV's well within the 60 percent acceptance criteria. Iron had a CV of 64, slightly above acceptable levels. No corrective action is recommended.

Although there is no recommended acceptance criteria for method 300, the CV for Nitrate at 141 is high. The data for this compound been flagged for exceeding holding times.

Laboratory Duplicates

In addition to the field duplicates, approximately 10 percent (2 samples) of the samples were selected for laboratory duplicate analysis (LDA). Laboratory duplicates are a second analysis from the same sample container. The purpose of laboratory duplicate analysis is to determine variability due to the laboratory analytical method or technique. Sample vials for EPA 601 and 624 analyses can be opened only once for sample extraction, so laboratory duplicates were run from each of the separate vials that were submitted.

As shown in Table 2-18, all laboratory duplicate pairs had CVs below the acceptance criteria except for di-n-butyl phthalate in Method 625. This compound is a suspected laboratory contaminant, and no corrective action is recommended. The CV values for Method 601, the most important analysis for this investigation, were exceptionally good.

Matrix Spike

Matrix spikes are quality control analyses where known amounts of several analytes are added to the matrix of a collected sample. The matrix spike is used to determine the accuracy of the analysis by measuring the percent recovery of the spiked analytes. The result includes the amount of spiked analyte plus the amount of the analyte that was originally present in the sample. Matrix effects, found especially in soils, are interferences caused by some inherent property of the material. Percent recovery in matrix spikes for this investigation were generally from 80 to 110 percent within the recommended percent recovery limits for each method, indicative of good analytical accuracy. Only two recoveries were unusually low in the matrix spike analysis performed for Method 601. Chloromethane had a low recovery of 34 percent in one spiked sample but showed 90 percent recovery in the other. Chloromethane was not detected in any well, and is not of concern in this investigation. 1,1-DCE had a low recovery of 44 percent in one spike, and 89 percent in the other. No corrective action is recommended.

Field Blanks and Reagent Blanks

Field blanks (FB) are samples of uncontaminated water which were handled using exactly the same sampling equipment, containers, and procedures used for ground-water samples. Field blanks are used to assess the potential

TABLE 2-18

LABORATORY DUPLICATE QUALITY CONTROL DATA

Acceptance Criteria, CV ≤ 60%

COMPOUND	LIMIT OF DETECTION (LOD)	LIMIT OF QUANTITATION (LOQ)	OW-3 LDA 10-86	OW-3 (WO-3) LDB 10-86	MEAN $\bar{X}$	STANDARD DEVIATION	COEFFICIENT OF VARIANCE CV
EPA METHOD 601 (ug/l)							
1,1,1-trichloroethane (1,1,1-TCA)	0.2	0.67	110	90	2.5	0	0
1,1-dichloroethane (1,1-DCA)	0.1	0.33	4	3.8	3.9	0.14	3.6
1,1-dichloroethene (1,1-DCE)	0.1	0.33	140	120	130	14	11
1,2-dichloroethane (1,2-DCA)	0.1	0.33	2.5	2.5			
trichloroethene (TCE)	0.2	0.67	180	150	100	14	14
			W2-3	W3-2			
trichloroethene (TCE)	0.2	0.67	4.2	3.4	3.8	0.57	15
EPA METHOD 624 (ug/l)							
All target analytes for Method 624 were non-detected							
EPA METHOD 625 (ug/l)							
bis(2-ethylhexyl)phthalate	2.5	8.33	5.9	2.6	4.25	2.3	55
di-n-butyl phthalate	2.5	8.33	27	8.3	18	13.2	73
All target analytes for acid extractables were non-detected or semi-quantitative							
No laboratory duplicate was performed for Method 200.7.							

a - Suspected laboratory contaminant.
LD - Laboratory duplicate pair.
ND - Non-detected.
SQ - Semi-quantitative

introduction of contaminants during sample collection and analysis. In this investigation, blanks were analyzed at a frequency of 10 percent of all samples (1 blank sample for each method). All water used for blanks was deionized/distilled water obtained from the laboratory, boiled for 10 minutes, allowed to cool, and purged with ultra-pure nitrogen for 15 minutes. The purpose of this procedure was to remove all traces of volatile compounds from the water before it was used for blanks. In the field, the blank water was poured into a bailer which had been routinely decontaminated, and transferred to sample bottles in the same way as normal samples. The field blank for this investigation was blind to the laboratory, labeled OWO-1. It was collected in the middle of the sampling activity, immediately following OW-3, the most contaminated well.

Reagent Blanks (RB) are analytical sample runs using only the method reagents but no sample matrix. Reagent blanks allow detection of false positive results due to laboratory contamination. Field blanks and reagent blanks are used in conjunction to determine the source of any contamination.

The field blank results for Method 601 show low concentrations of methylene chloride and trichlorofluoromethane (freon). Methylene chloride was also detected in a reagent blank. Both of these compounds are common laboratory introduced contaminants.

TCE was detected semi-quantitatively in the field blank just above the detection limit. This could be caused by cross-contamination from OW-3 with high levels of TCE, due to an incompletely cleaned bailer. The amount detected is very low, however, and since the field blank followed the most contaminated sample, the results are indicative of good decontamination protocol. No corrective action is recommended.

The field blank results for Method 624 semi-quantitatively indicates the presence of acetone. No acetone was used during field activities. Since acetone was also detected semi-quantitatively in all three reagent blanks, the presence of this compound is probably due to low-level laboratory contamination, possibly improperly dried glassware. The field and reagent blanks for the Method 625 base/neutral extractables indicate the presence of bis [2-ethylhexyl] phthalate and di-n-butyl phthalate. Bis [2-ethylhexyl phthalate is a liquid used in vacuum pumps, and di-n-butyl phthalate is a plasticizer with many uses, found almost universally. Neither compound is of concern in this investigation.

The field blanks for the acid extractables indicate semi-quantitative detection of phenol. No phenol was detected in the reagent blanks. During the time of these analyses, the Radian Sacramento laboratory was experiencing slight phenol contamination due to a reagent contaminated by a degrading phenol-base bottlecap. Since there were two bottles of this reagent, only one of which was found to be contaminated, the reagent blanks may not have shown contamination. The semi-quantitative (SQ) values of phenol in W-3, and W-5, and in the field blank are probably not real. The quantitative values of phenol in OW-3, as well as the values of 4-methylphenol are probably significant, and are indicative of contamination in the well. This is supported by the fact that 4-methylphenol is a surfactant used in metal cleaning and scouring compounds, and might have been used at the washout area near OW-3. Phenol data are flagged as questionable due to possible laboratory contamination.

Field Blank data for Method 200.7 show no significant concentrations of any metals. No corrective action is recommended.

Field Blank data for Method 300.0 show no detectable concentrations of any anions. The nitrate data have been flagged due to exceeded sample holding time.

Surrogate Spike

Surrogate spikes are specially created compounds containing deuterium, which are added to each organic analysis and measured for percent recovery. These are compounds not otherwise found in nature. Surrogate recoveries generally met the recommended acceptance criteria for all analyses.

Second-Column Confirmation

In EPA Method 601, the initial gas chromatographic analysis is performed with a Hall detector (halogen specific). If chemicals are detected, they are confirmed by second-column flame ionization detection. All compounds detected in the 601 analyses were confirmed by second column except for those of W-3. Usually, three 40-ml vials are submitted to the laboratory for 601 analysis. One vial is used for each column analysis, and one vial is extra. Unfortunately, one W-3 vial was broken in transit. The laboratory chose W-3 to perform a matrix spike analysis, using the extra vial, and was unable to perform the second column confirmation, since there was no unopened vial remaining. Since all species detected in other wells were confirmed by second column, the lack of confirmation for the W-3 sample is not thought to be significant.

3.0 GEOPHYSICAL INVESTIGATION

A geophysical investigation was conducted at the Beaumont facilities in order to locate the boundaries of four areas where Lockheed operations were formerly conducted. The objectives of the geophysical investigation were to:

- delineate the perimeter of the burn pit area;
- locate the low level radioactive waste reportedly buried at Beaumont No. 1;
- delineate the perimeter of the Beaumont No. 1 sanitary landfill;
- delineate the perimeter of the Beaumont No. 2 garbage disposal site.

This investigation was conducted by NORCAL Geophysical Consultants, under the direction of Radian Corporation. Section 3.0 summarizes their report, which is included in full as Appendix E.

3.1 Methodology

Geophysical methods sensitive to subsurface electrical and magnetic properties utilized for this investigation and included: ground penetrating radar (GPR), terrain conductivity (TC), and magnetic locator (ML).

Ground penetrating radar is a geophysical survey system that provides a continuous, real-time cross-section of shallow subsurface conditions. GPR uses high frequency radio waves which are reflected back to an antenna on the ground surface when changes occur in subsurface conditions. These reflections may be caused by changes in bedding, cementation, moisture and clay content, voids, fractures, or buried man-made objects. Two antennas, 120 and

500 megahertz (MHz) were used in this investigation. The 120 MHz antenna penetrates to greater depths, but has limited resolution. The 500 MHz antenna provides better resolution, but has a limited range of about five feet in depth.

Terrain conductivity allows measurement of subsurface electrical conductivities. Electric conductivity is a function of the type of subsurface material, its porosity, its permeability, and the fluids which fill the pore space. An EM-31 was used in this investigation to measure lateral change in terrain conductivity.

The magnetic locator is used to detect magnetic anomalies. It produces an audio tone when an anomaly is encountered. A more detailed description of the instrumentation used in this investigation is presented in Appendix A of NORCAL's report.

Burn Pit Area

A 1400-foot by 900-foot survey grid was established at the burn pit area by the International Union of Operating Engineers prior to the investigation. The grid was marked by flagged and labeled stakes on 100-foot centers. Terrain conductivity measurements were obtained at each grid intersection. In anomalous areas, readings were obtained at 10 to 50-foot intervals, determined by pacing between survey markers. All TC measurement stations are shown on Figure 3-1.

The magnetic locator was used at the burn pit area to explore for buried metal objects. Magnetic locator traverses were spaced at 50-foot intervals (Figure 3-1). The locations of anomalies were determined by pacing between the survey markers.

Buried Low Level Radioactive Waste Site

A ground penetrating radar (GPR) survey was performed in three canyons at Beaumont No. 1 to explore for the low level radioactive waste reportedly buried in one of the canyons. The locations of the GPR traverses are shown on Figures 3-2 and 3-5. Two different types of traverses are shown, reconnaissance and calibrated. The dashed lines represent reconnaissance traverses or "scans." These scans were designed to cover a large area in search of possible anomalies. In Canyon No. 1, the scans were performed by towing a 120 MHz antenna behind a vehicle. In Canyon No. 2 and No. 3, a 500 MHz antenna was hand towed. Horizontal control for these scans is approximate. Electronically inscribed event marks were placed on the records at survey markers established along either side and in the middle of Canyon No. 1 and at either side of Canyon No. 3. The length of the scans were determined by a combination by pacing.

The solid lines shown on Figure 3-4 and 3-5 represent calibrated traverses. These traverses were performed in previously suspected burial locations or in anomalous areas delineated by the scans. Calibrated traverses were performed by hand towing either a 120 MHz or 500 MHz antenna along a transect marked by a measuring tape laid out on the ground surface. Horizontal control was established by placing event marks on the records at 5 to 10 feet intervals as determined from the measuring tape.

In Canyon No. 1, GPR data was obtained from 28 scans ranging in length from 90 to 325 feet, and from 29 calibrated traverses which range in length from 80 to 120 feet. In Canyon No. 2, 30 calibrated GPR traverses with lengths of 100 to 130 feet were performed. Finally, in Canyon No. 3, 8 GPR scans were performed which range in length from 20 to 130 feet.

Beaumont No. 1 Sanitary Landfill

Magnetic locator traverses were conducted at the Beaumont No. 1 sanitary landfill to determine the lateral extent of buried metal debris. Measuring tapes were laid out along each traverse and followed while scanning with the magnetic locator. The location of magnetic anomalies were determined from the tape and flagged with survey stakes. Survey stakes were also used to mark the beginning and end of each traverse. The International Union of Operating Engineers surveyed the location of the traverse stakes after the geophysical investigation was conducted.

Beaumont No. 2 Garbage Disposal Site

Magnetic locator traverses were performed at the Beaumont No. 2 garbage disposal site to determine the lateral extent of buried metal debris. The methodology is the same as that used for the Beaumont No. 1 Sanitary Landfill.

3.2 Results

Burn Pit Area

The terrain conductivities measured in the burn pit area range from about 2 to 20 millimhos per meter (mmho/m). Background levels are at about 5 to 6 mmho/m. The TC contours shown on Figure 3-2 depict an area of anomalously high conductivity which occupies a portion of the site between 400 to 800 feet west and extending from 0 to 800 feet south. Most of the magnetic anomalies detected are located within this area. There are, however, a few widely scattered magnetic anomalies that lie outside the conductive zone. These occur in areas where the conductivity is at the background level and therefore probably representative of isolated objects that are too small to resolve with the TC instrumentation.

Although the TC data do not resolve individual trenches, there is a rough alignment of the TC maxima and magnetically anomalous zones along three separate north-south oriented trends. The most predominate of these is along the 600-foot west grid line, extending from about 50 to 700 feet south. This trend is more apparent in the 3-D views of terrain conductivities shown on Figure 3-3. In addition, there are two smaller, more subtle alignments. One is at about 450 feet west, extending from 100 to 300 feet south. The other is at 700 feet west and extends from about 150 to 400 feet south.

The maximum conductivities in the burn pit area were surprisingly low considering the large quantities of metal drums that reportedly were buried there. Some possible explanations for the low values are as follows:

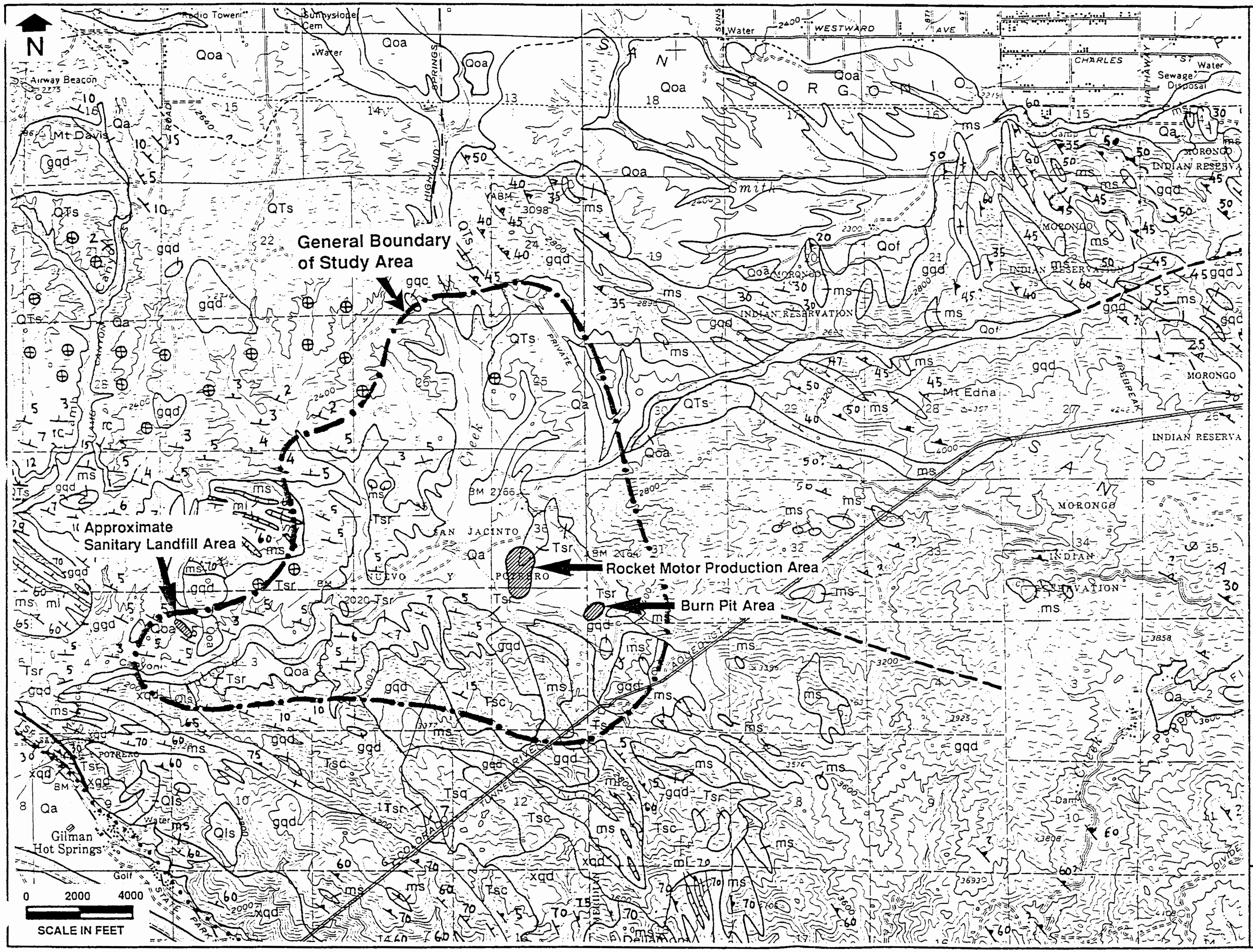
1) The actual amount of metal in the ground may be relatively small since the drums and waste rocket fuel they contained were incinerated prior to being covered by backfill;

2) The residual metal has been in the ground and subject to corrosion and disintegration for more than a decade; and

3) The terrain conductivity measuring instrument samples a hemispherical volume of earth with a radius of 18-20 feet. Since the drums were buried in shallow trenches, they comprise a relatively small source in a large sample volume.

Buried Low Level Radioactive Waste Site

Two different types of GPR anomalies were identified in Canyon No. 1. The first is an irregularity or discontinuity of stratigraphic reflectors that are typically regular and continuous. This type of anomaly could represent disturbed ground and/or backfill, indicating a possible excavation or trench. However, this type of anomaly could also be caused by ground surface irregularities or by natural erosional features. The second type of anomaly



KEY:

Geologic Units in Study Area

Qa	Recent Alluvium (predominantly sand and gravel)
Qoa	Pleistocene Older Alluvium (predominantly sand and gravel)
QTs	Pliocene-Pleistocene San Timeteo Formation terrestrial sediments (interbedded sandstone, siltstone, shale, claystone, and conglomerate)
Tsr	Pliocene-Pleistocene Mount Eden Formation terrestrial sediments (reddish sandstone and clay)
gqd	Mesozoic granodiorite to quartz diorite
ms	Paleozoic or Mesozoic medasedimentary rocks (schist, gneiss)

Symbols

⁓	Geologic contact
– – –	Fault, dashed where approximately located
⟋ 5	Strike & dip of bedding
⊕	Horizontal bedding

Figure 3-3.
Lockheed Beaumont - Geologic Map.

REFERENCE: T.W. Dibblee Jr., 1981.

is a hyperbolic reflection pattern typical of a point source. This type of anomaly could represent a buried object such as a container. Alternatively, point source reflectors could also be caused by boulders, roots, or other natural features.

GPR anomalies were detected in the south central part of Canyon No. 1 and along the east wall near the mouth of the canyon as shown on Figure 3-4. The anomalies in the south part of the canyon align in a northwest-southeast trend suggesting a possible trench. However, these anomalies are in the vicinity of a stream in an area of hummocky ground. Both of these natural features could contribute to the irregularities we identified in this area. The GPR anomalies near the mouth of the canyon roughly align along an east-west trend. The ground surface in this area is relatively smooth and regulator and there are no obvious erosional features in the vicinity. A portion of the canyons' nearby east wall appears to have sloughed, possibly indicating past excavation in the area. Both anomalous zones were investigated using a scintillometer and the magnetic locator. No magnetic or radioactive anomalies were found.

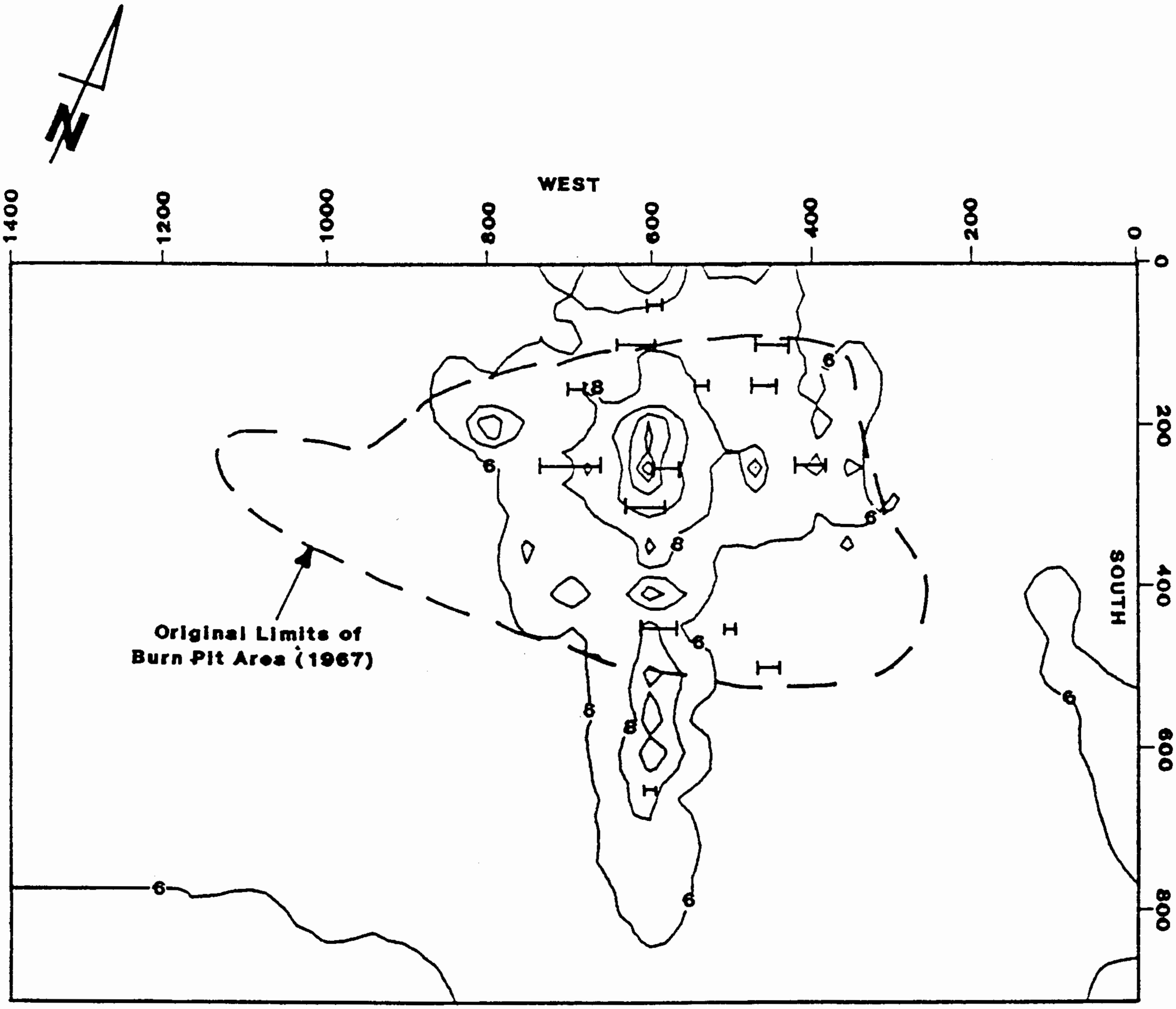
All of the GPR anomalies detected in Canyon No. 2 are the type characterized by irregular or discontinuous stratigraphic reflectors. Except for four anomalies that are closely grouped near the mouth of the canyon as shown in Figure 3-5, the anomalies are all scattered about the central part of the canyon and do not show any obvious trend or alignment. No GPR anomalies were detected in Canyon No. 3.

Beaumont No. 1 Sanitary Landfill

The limits of the Beaumont No. 1 landfill are defined by the distribution of magnetics anomalies as shown on Figure 3-6. These anomalies occupy an area about 350 feet long and 100 to 200 feet wide. However, the outer portions of this area contain isolated and widely scattered anomalies. The landfill proper may actually conform more to the area defined by the closely spaced anomalies located along traverses B, C, and D.

Beaumont No. 2 Garbage Disposal Site

The distribution of magnetic anomalies at the Beaumont No.2 garbage disposal site can be differentiated into two discrete zones as shown on Figure 3-7; an inner zone of concentrated, closely spaced anomalies surrounded by a zone of widely scattered anomalies. The area comprising both zones is about 250 feet wide and 450 feet long. The interior area of concentrated anomalies is about 100 to 200 feet wide and corresponds with the area where metallic debris is visible on the surface. A linear, northwest projecting segment of the outer zone coincides with a narrow canyon. Here, the magnetic anomalies were actually quite closely spaced. The appearance and the nature of the debris visible on the surface in this area suggests that the narrow canyon is an old dump site that may predate Lockheed's Beaumont No. 2 garbage disposal site.



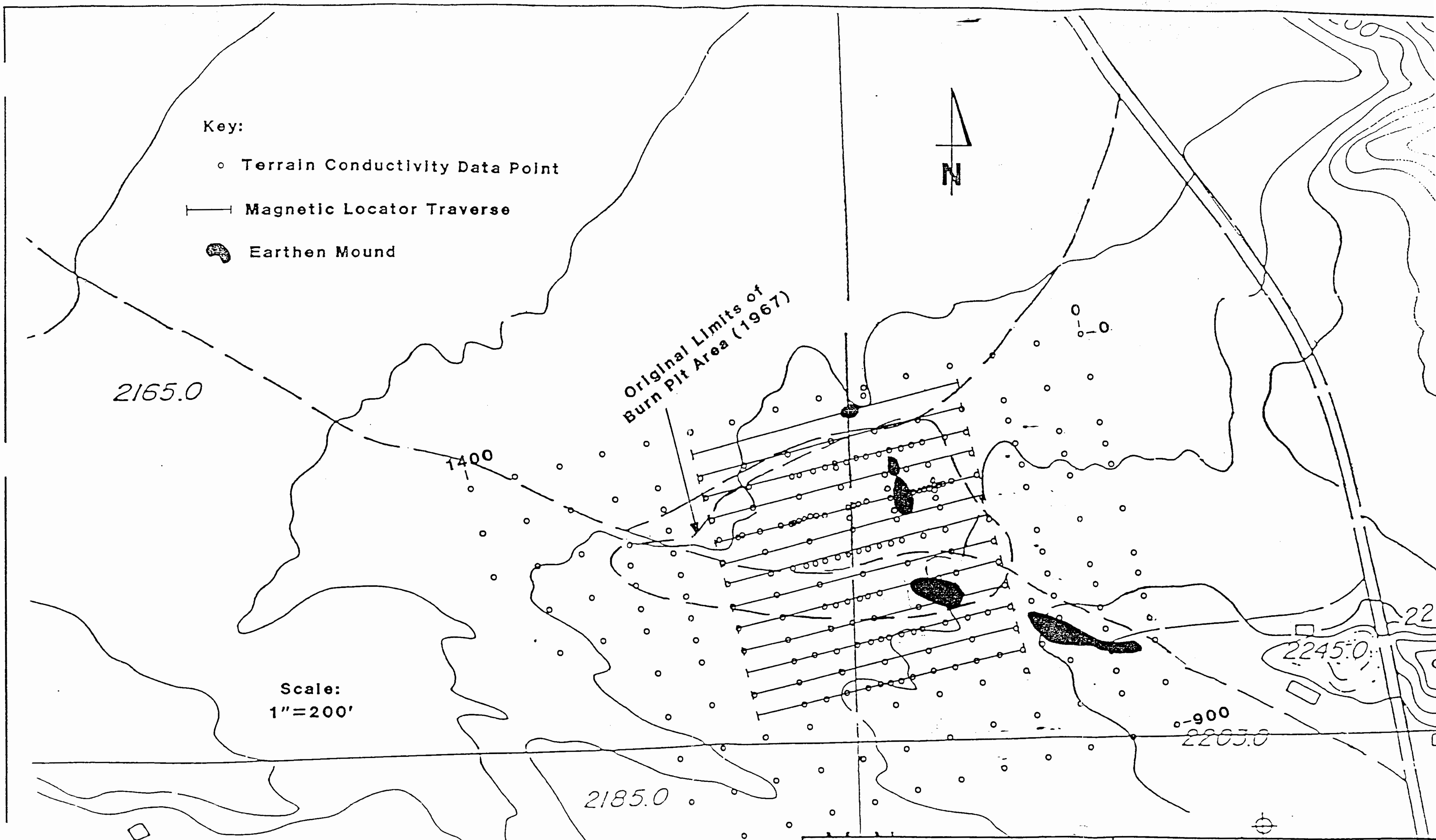
Key:

├─○─┤ **Magnetic Anomaly Location**

╱ **Terrain Conductivity Contour**

Contour Interval: 2 millimhos/meter

NORCAL GEOPHYSICAL CONSULTANTS NORCAL		TERRAIN CONDUCTIVITY CONTOURS AND MAGNETIC ANOMALIES Burn Pit Lockheed Propulsion Company Beaumont, California	PLATE **4**
JOB: 86-138.02	APPR:	DATE: 12/11/86	



NORCAL GEOPHYSICAL CONSULTANTS

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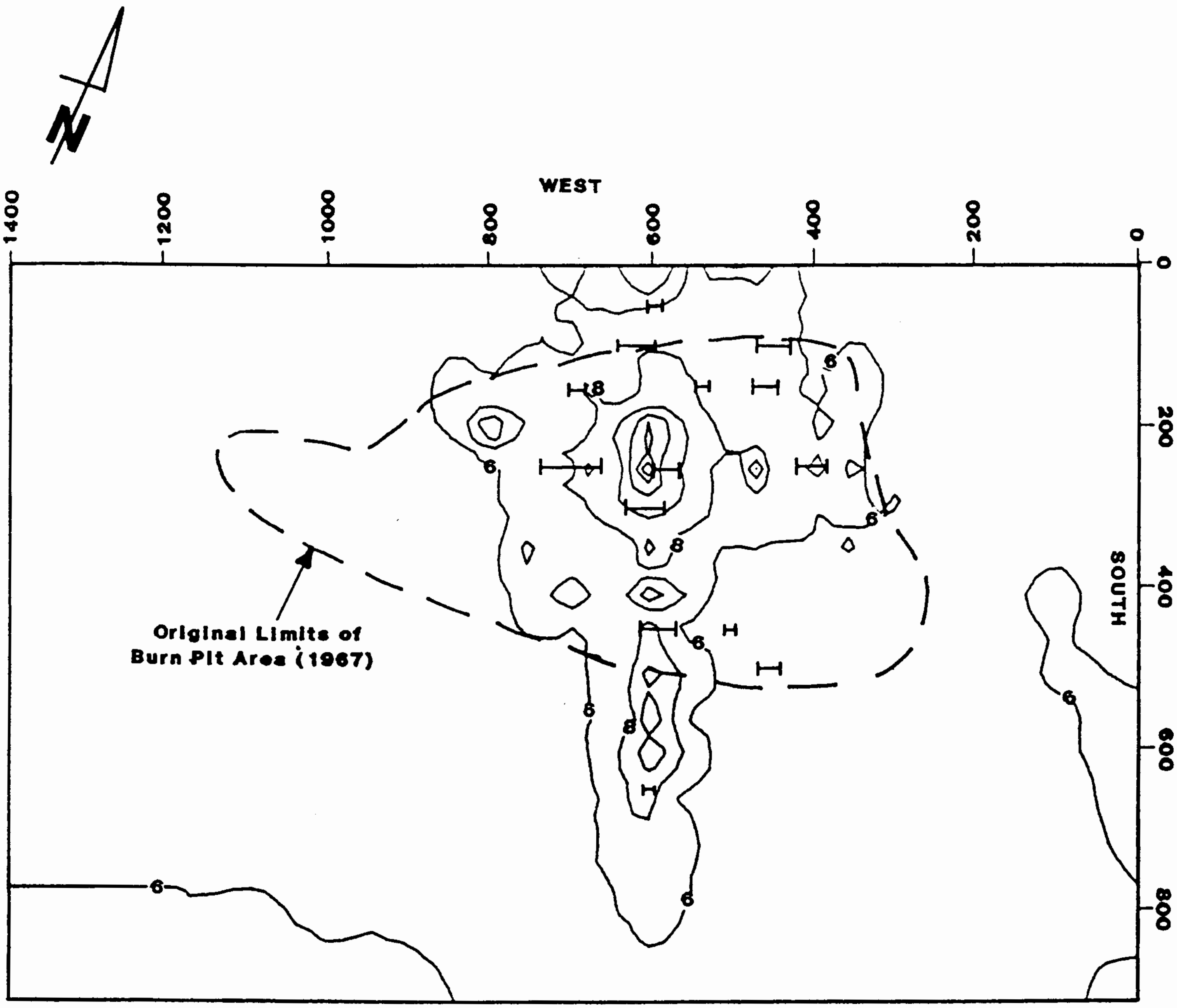
JOB: 86-138.02 | APPR: | DATE: 12/11/86

BURN PIT LOCATION MAP

Lockheed Propulsion Company
Beaumont, California

FIGUR
3-1



Original Limits of Burn Pit Area (1967)

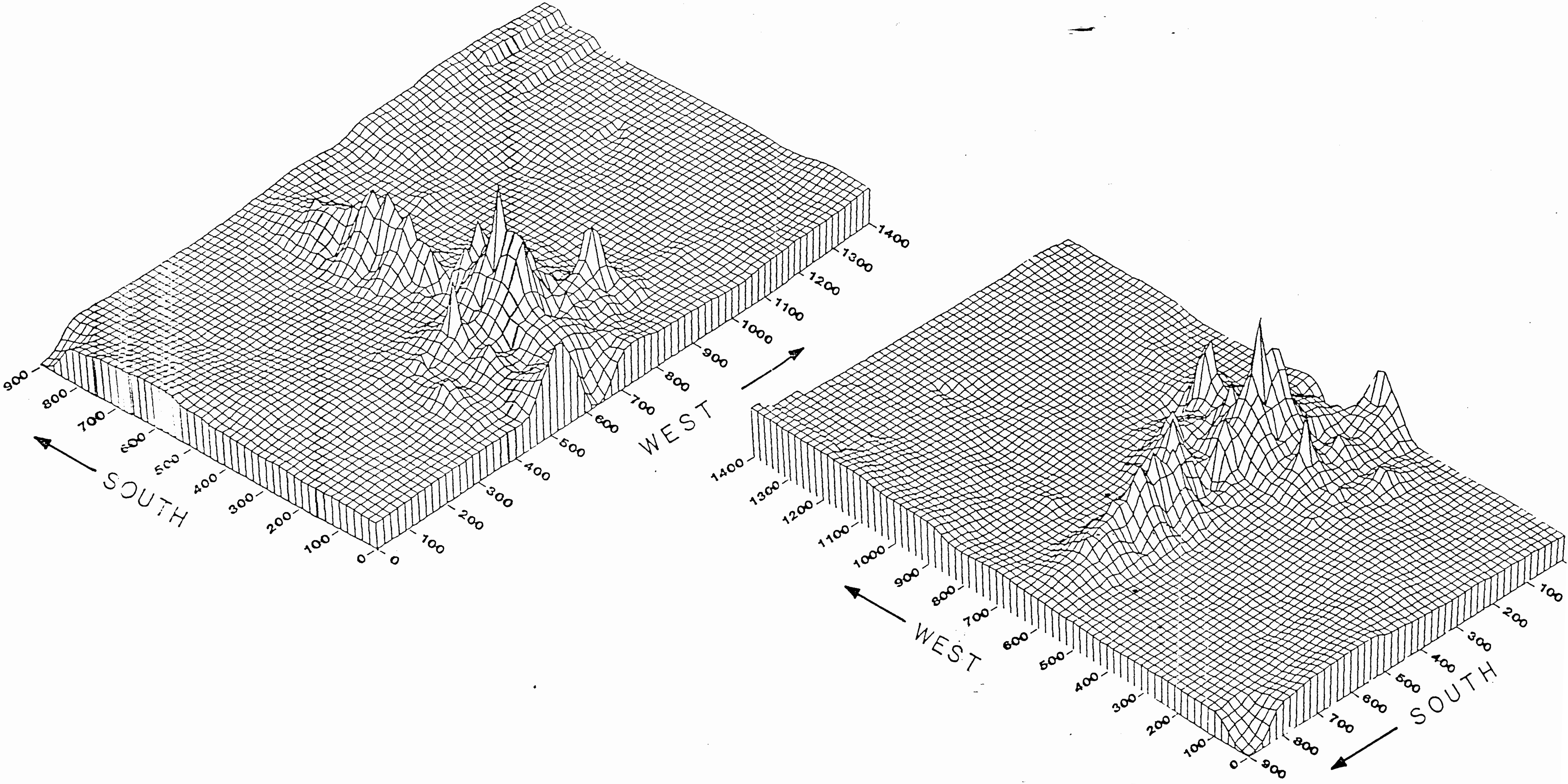
Key:

⊢○⊣ Magnetic Anomaly Location

Terrain Conductivity Contour

Contour Interval: 2 millimhos/meter

NORCAL GEOPHYSICAL CONSULTANTS	TERRAIN CONDUCTIVITY CONTOURS AND MAGNETIC ANOMALIES Burn Pit Lockheed Propulsion Company Beaumont, California	FIGURE 3-2
JOB: 86-138.02 | APPR: | DATE: 12/11/86		



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TERRAIN CONDUCTIVITIES
3 — D Views
Burn Pit
Lockheed Propulsion Company
Beaumont, California

FIG
3

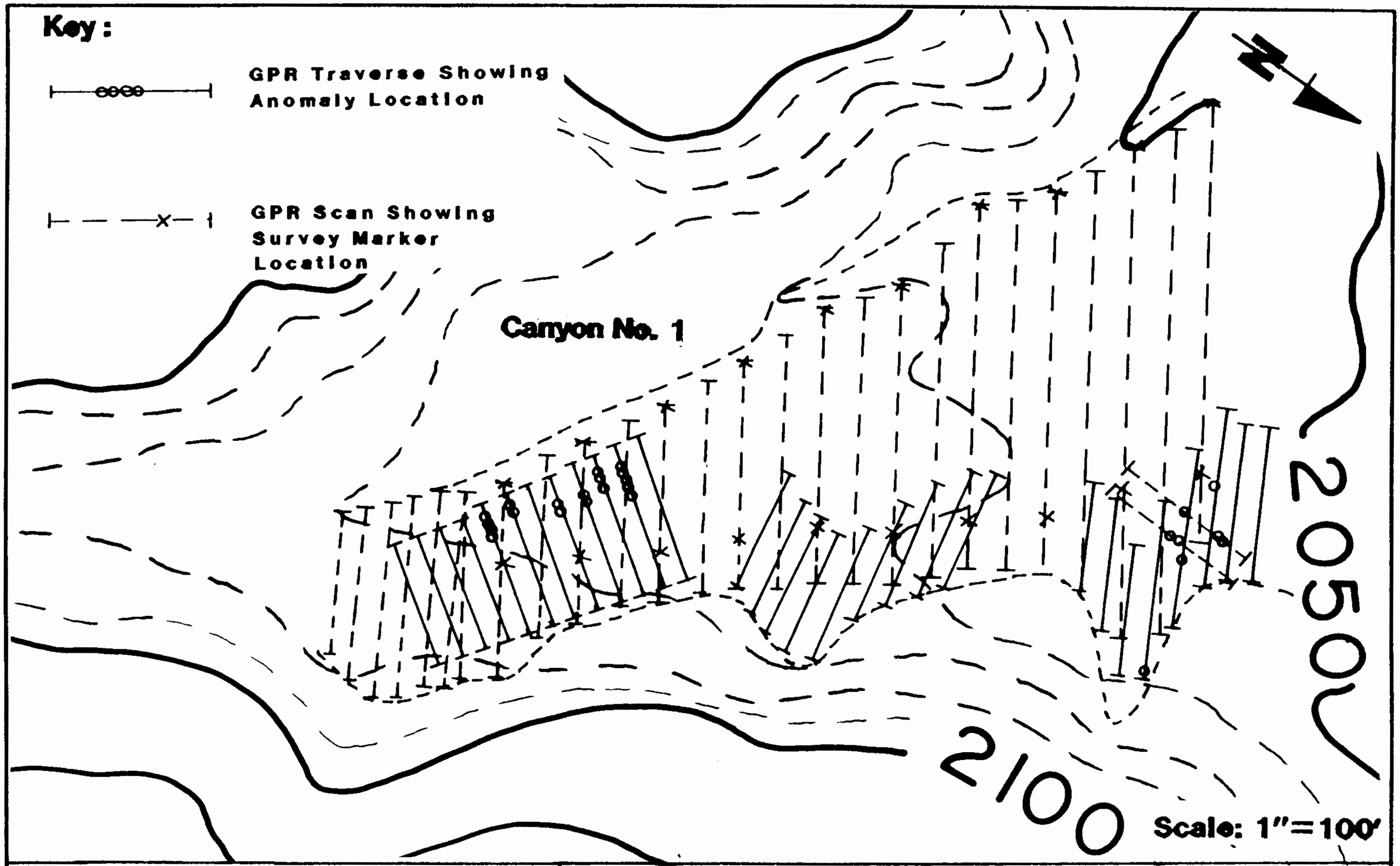

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FIGURE 3-4

GROUND PENETRATING RADAR
LOCATION MAP
CANYON No. 1

Lockheed Propulsion Company
Beaumont, California

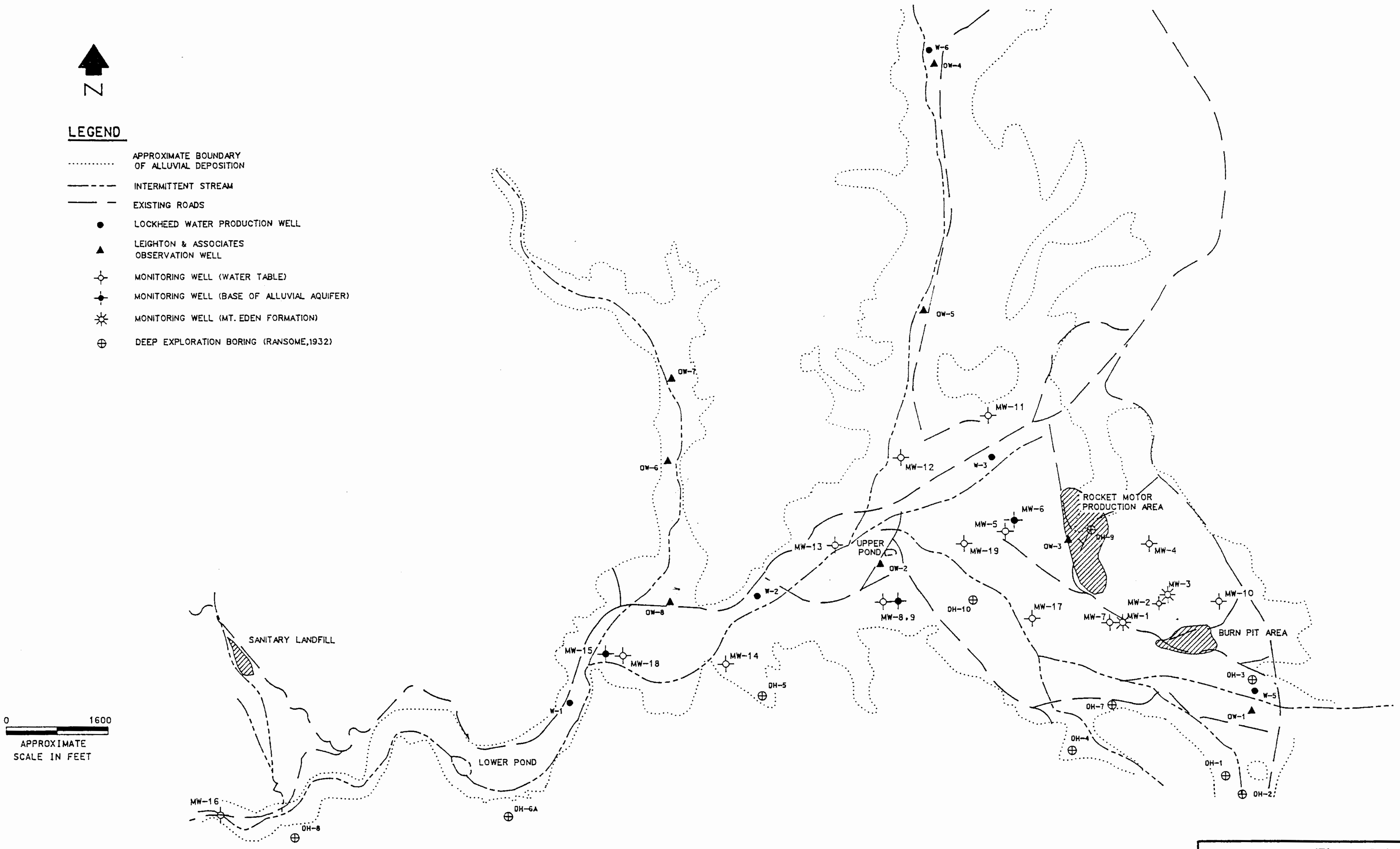
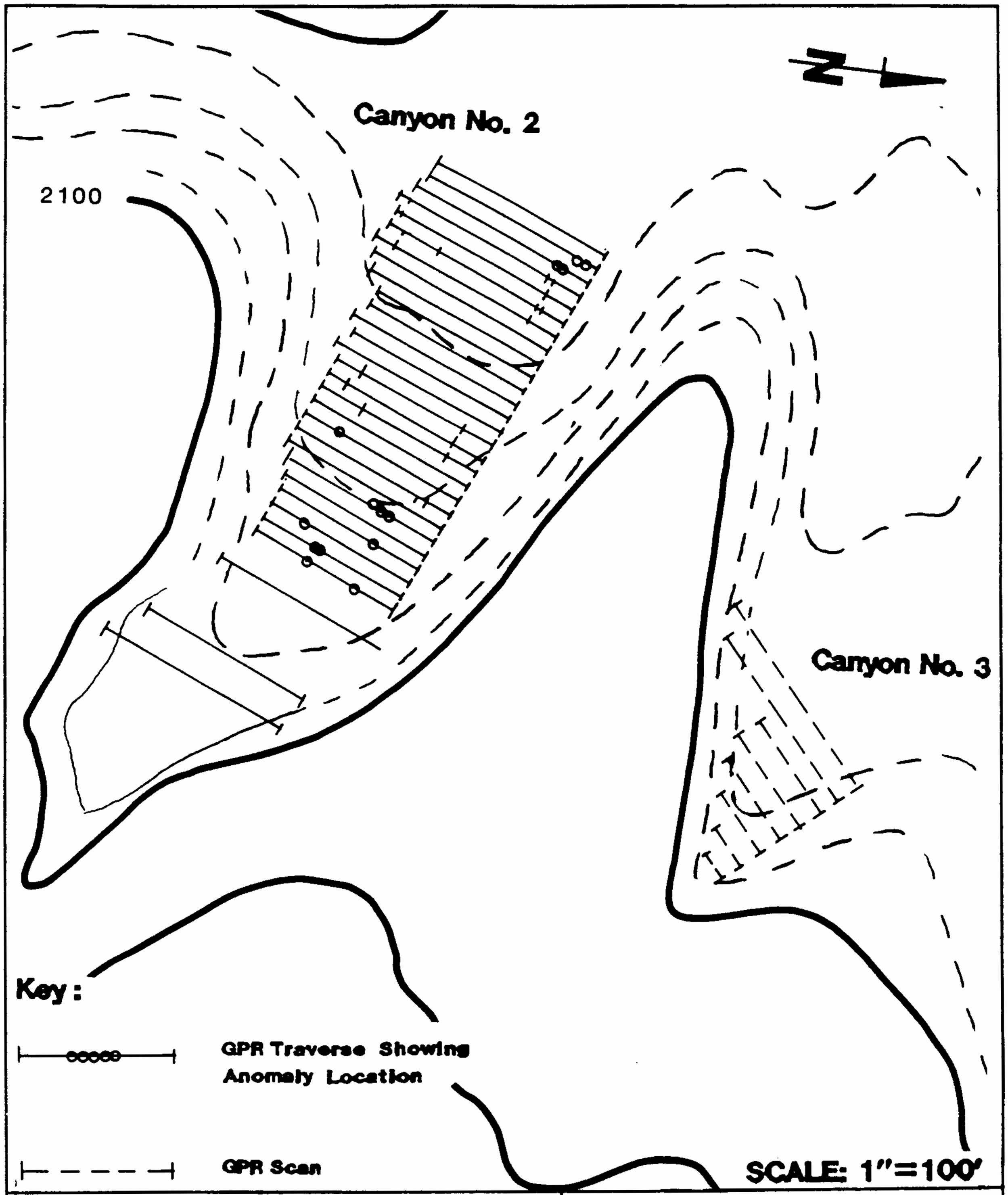


Figure 3-4.
Lockheed Beaumont -
Monitoring Well and Boring Locations.



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DATE: 12/8/86

FIGURE 3-5
GROUND PENETRATING RADAR LOCATION MAP CANYONS NO. 2 & 3
Lockheed Propulsion Company
Beaumont, California

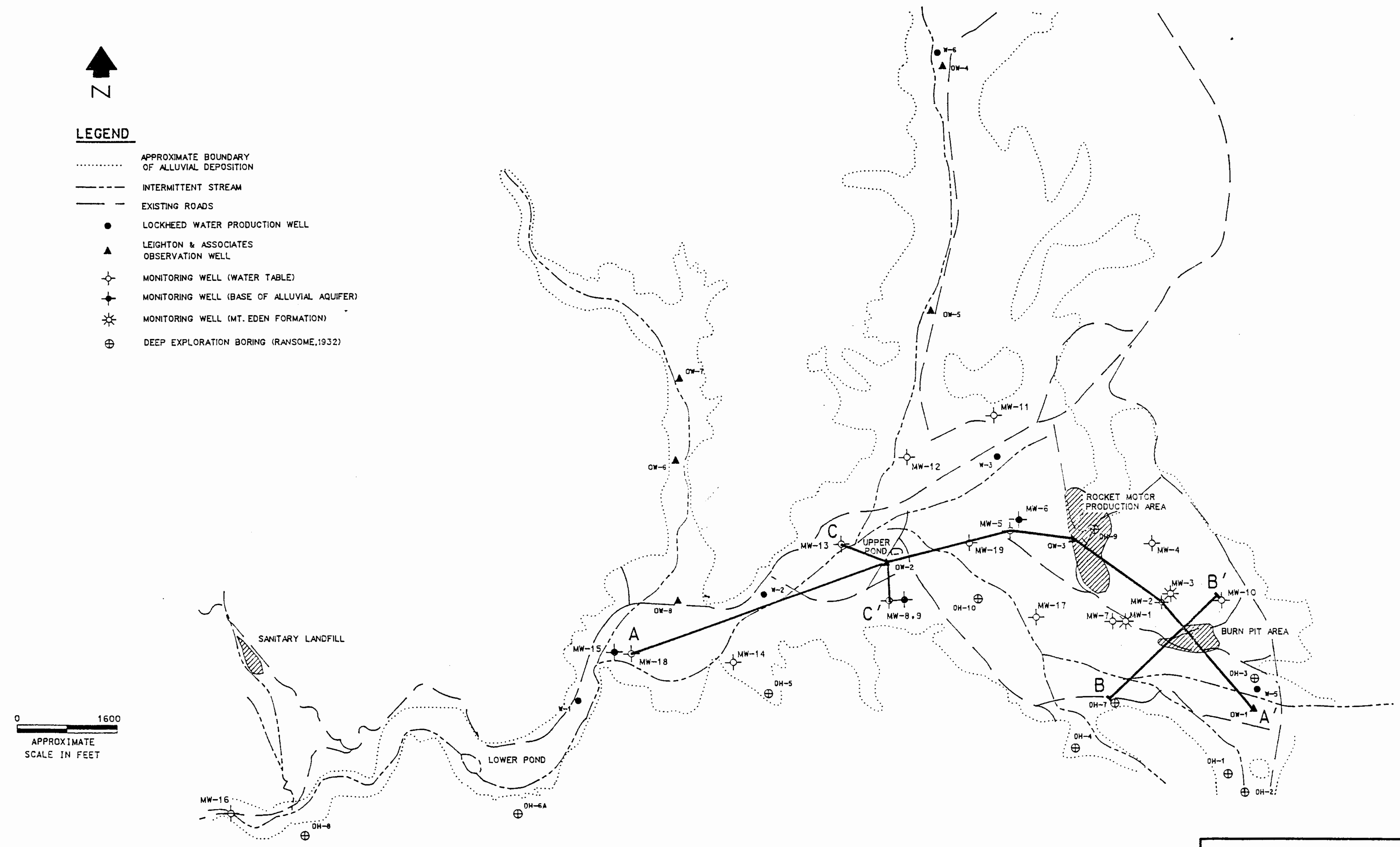

Figure 3-5.
Lockheed Beaumont -
Cross Section Locations.

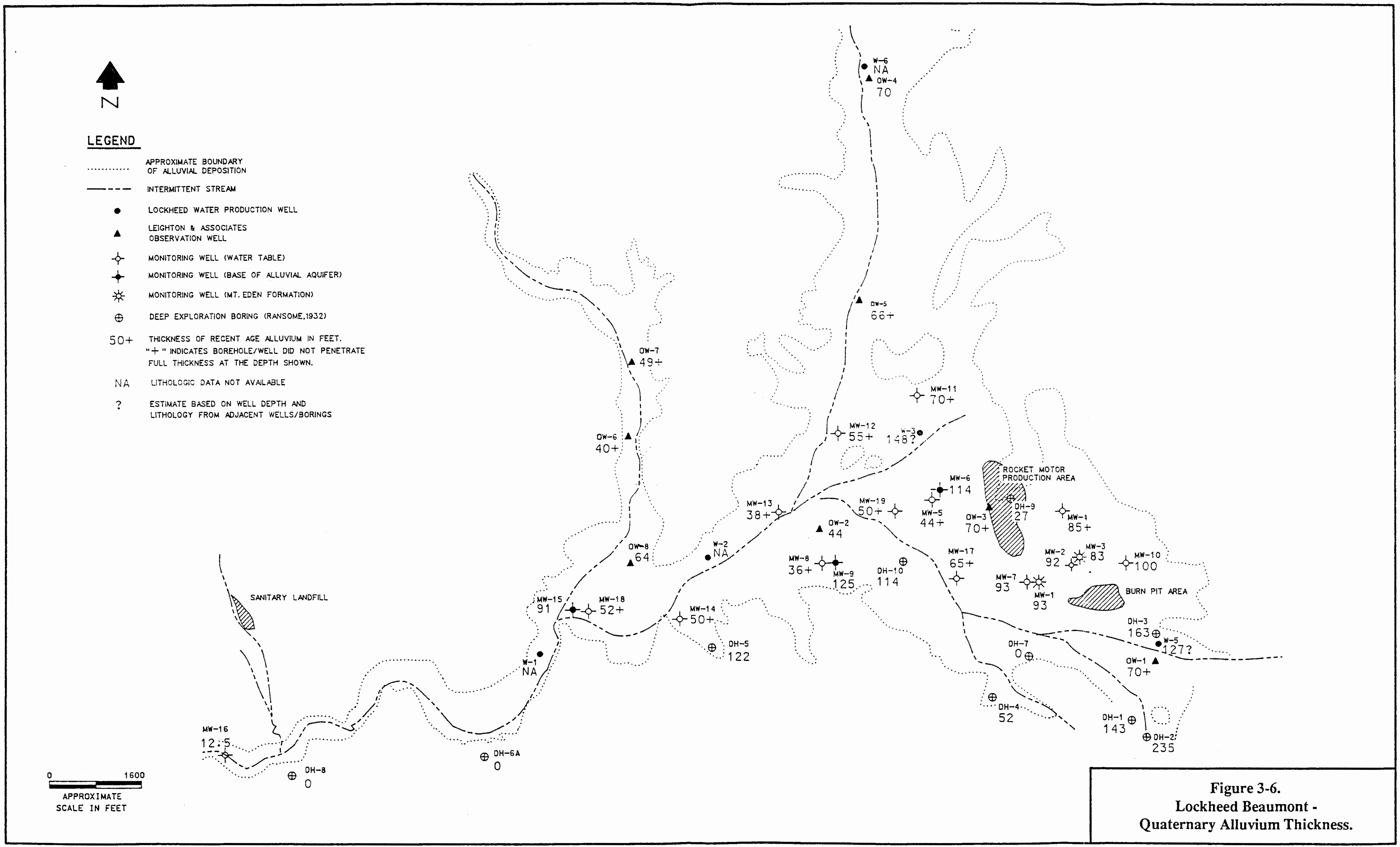

Figure 3-6.
Lockheed Beaumont -
Quaternary Alluvium Thickness.

204-41

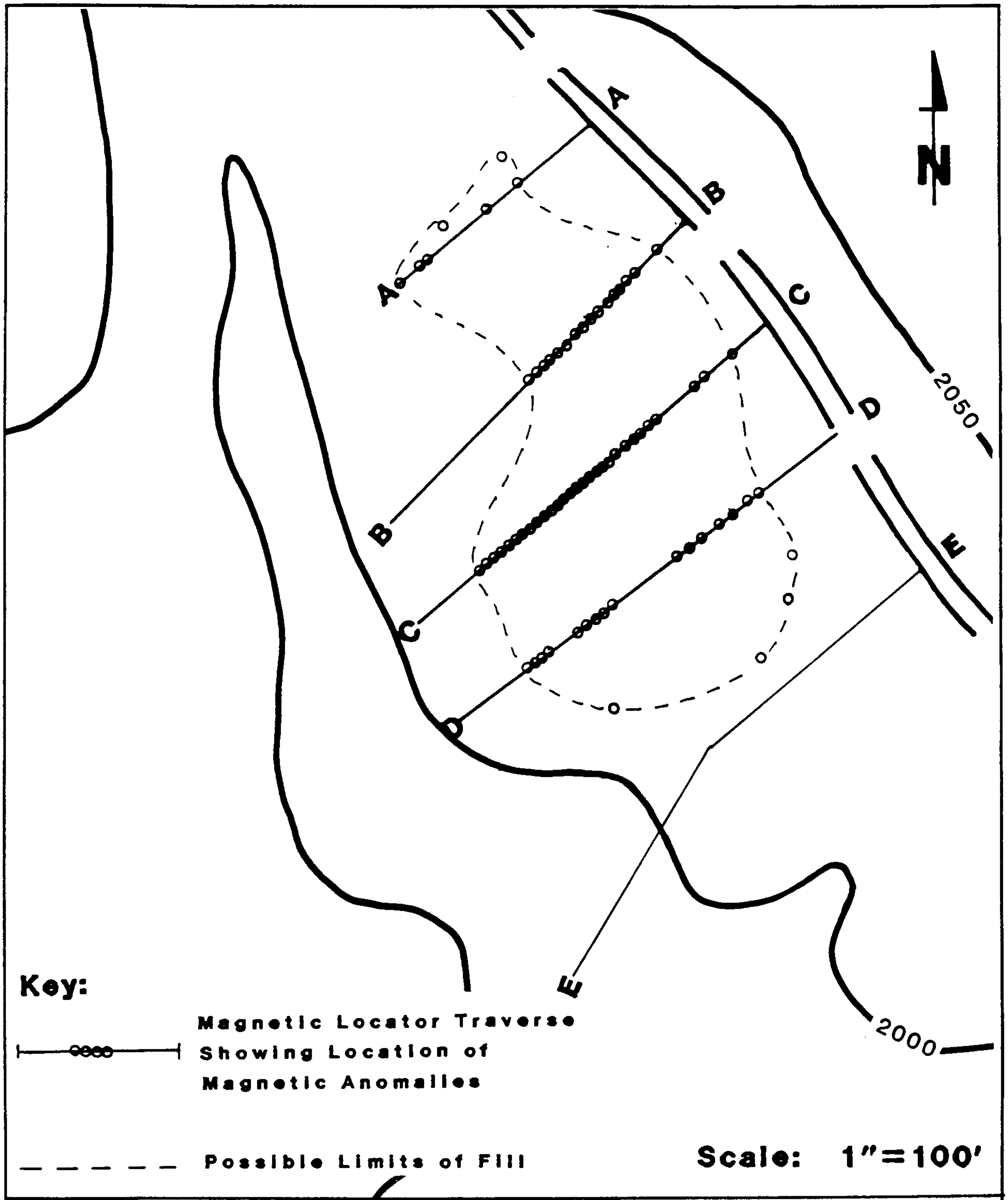

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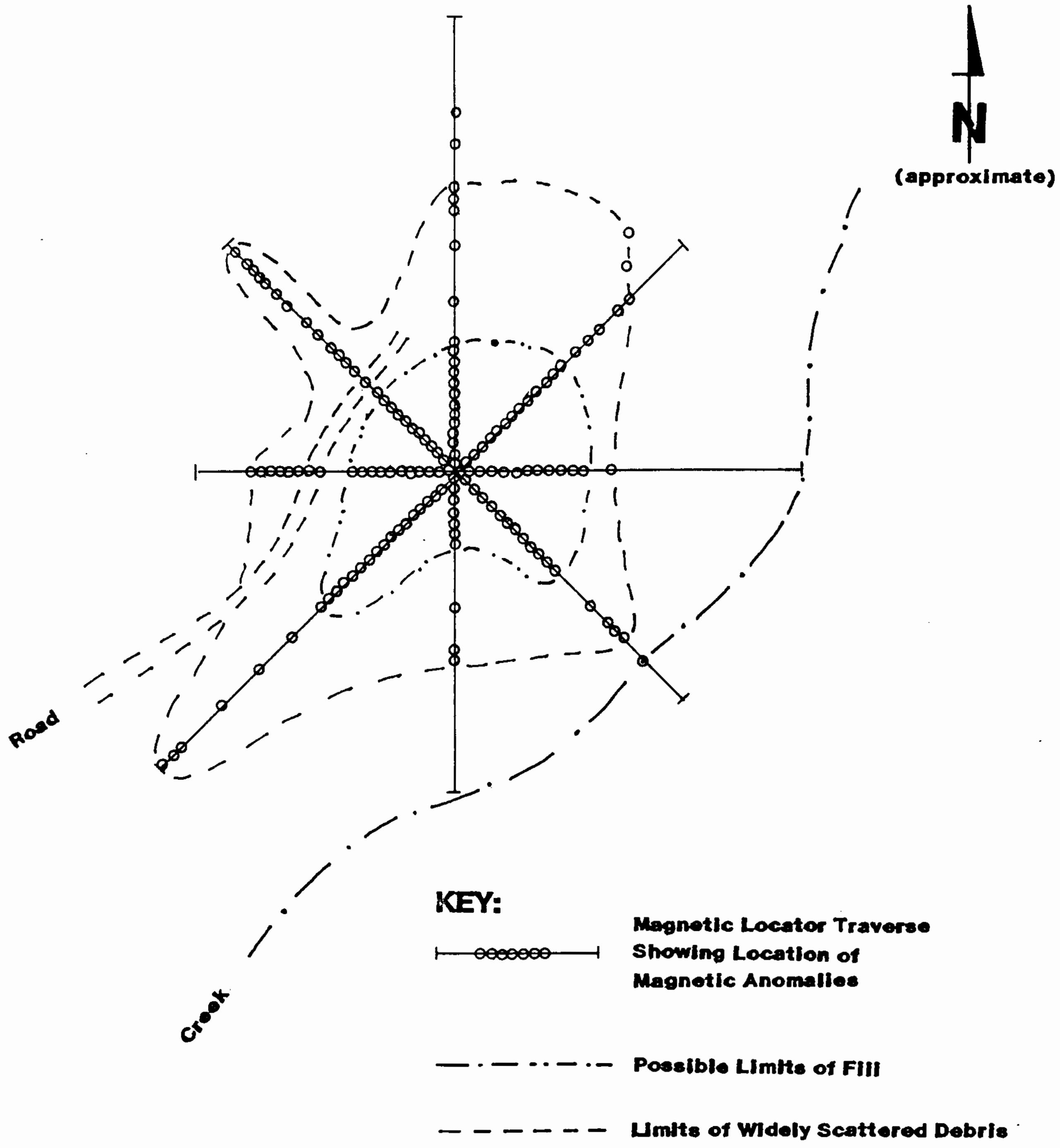
FIGURE 3-6
MAGNETIC ANOMALY LOCATION MAP
BEAUMONT NO. 1 LANDFILL

Lockheed Propulsion Company
Beaumont, California



Scale: 1"=100'

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MAGNETIC ANOMALY LOCATION MAP

BEAUMONT NO. 2 LANDFILL

Lockheed Propulsion Company
Beaumont, California

FIGURE 3-7

4.0 CONCLUSIONS

4.1 Ground-Water Quality

Chlorinated hydrocarbons have been detected in the ground water at Beaumont No. 1 in a plume extending to the northwest of the burn pit and propellant mixing areas. The results of this preliminary ground water study confirm the conclusions of the site history investigation which identified these areas as the primary potential sources of ground-water contamination.

Solvent Transport

The movement of chlorinated hydrocarbons through the ground-water system is governed by several complex processes, making actual prediction of the rate and direction of transport difficult. These processes include advection, dispersion, and a number of chemical and physical reactions occurring within the aquifer.

Advection is a mechanical flow process by which contaminants are carried with the average motion of the flowing ground water. As indicated, the average ground-water motion in the burn pit area is to the northwest. Dispersion involves the mixing and spreading of contaminants in directions both along and normal to the average ground-water motion. Aquifer heterogeneities, associated variation in local ground-water velocities, and molecular diffusion contribute to dispersion, resulting in contaminants occupying a larger portion of the flow system than would be accounted for by advection alone. In order to accurately predict the contaminant transport by advection and dispersion, hydrostratigraphic conditions, aquifer parameters, ground-water gradients, longitudinal and transverse dispersivity values, and sources and rates of contaminant loading must be defined in detail throughout the entire zone of interest.

In addition to the mechanical flow processes, the movement and fate of chlorinated hydrocarbons is affected by adsorption-desorption reactions, biological degradation, and hydrolysis, as well as their densities and the degree to which they dissolve in water (Smith, et al., 1984). Adsorption-desorption is the most important reaction affecting the concentration of dissolved chlorinated hydrocarbons as they move through a soil-water system. Adsorption of contaminants onto the surfaces of organic and mineral soil materials causes contaminant transport to be retarded. The size of the contaminant plume is reduced to some fraction of that which would be expected by advection and dispersion. When contaminant loading to the aquifer has stopped, the reverse process of desorption continues; the organic chemicals are slowly transferred back to the liquid phase as less contaminated water moves through the contaminated zone.

The degree to which chlorinated hydrocarbons are adsorbed depends primarily on the fraction of organic matter in the soil. Chlorinated hydrocarbons partition themselves between the organic matter phase and the water phase as measured by the partition coefficient, K_{oc}. Chemicals with high values of K_{oc} are more strongly distributed to the organic matter phase and therefore, have a lower mobility in ground water. Because of the low percentage of organic matter in the soil of the Beaumont sites, the movement of hydrocarbons is not expected to be greatly retarded by soil adsorption. Values of K_{oc} for some chlorinated organic hydrocarbons are shown on Table 4-1.

Hydrolysis and biological reactions occurring within the aquifer can result in degradation of chlorinated hydrocarbons. The type of microbial activity depends on factors such as pH, temperature, contaminant concentration and the aerobic status of the environment. The products of hydrolysis are usually chlorinated alcohols or carboxylic acids; biological degradation usually results in the replacement of chlorine with hydrogen. Table 4-1 shows some of the degradation products for various chlorinated hydrocarbons. The reaction half-lives for this table were obtained through laboratory

TABLE 4-1.

MOBILITY AND DEGRADATION CHARACTERISTICS OF SOME CHLORINATED ORGANIC SOLVENTS IN GROUND WATER

Chlorinated Organic Solvent	Soil Organic Phase Partition Coefficient, Koc	Water Solubility (mg/L)	Specific Gravity	Reaction	Reaction Half-Life	Reaction Products
Tetrachloroethylene (PCE)	364	200	1.62	Microbial degradation	<2 days	Trichloroethylene 1,2-Dichloroethylene Vinyl chloride
				Hydrolysis	0.73 yr	---[1]
Trichloroethylene (TCE)	126	1,100	1.46	Microbial degradation	0.3 yr at high conc.; minimal at lower conc.	1,2-Dichloroethylene Vinyl chloride
				Hydrolysis	0.9 yr	---[1]
Vinyl chloride or chloroethylene	8.2	2,700	0.91	Hydrolysis	<10 yr	---[1]
1,1,2,2-Tetrachloroethane	118	2,900	--	Microbial degradation	---	1,1,2-Trichloroethylene
1,1,1-Trichloroethane (TCA)				Hydrolysis	0.5 - 0.8 yr	Acetic acid 1,1-Dichloroethylene
	152	720	1.34	Microbial degradation	<2 days	1,1-Dichloroethane 1,2-Dichloroethylene Chloroethane Vinyl chloride
Chloroethane	-	-		Hydrolysis	38 days	Ethanol
Dichloromethane or methylene chloride	8.8	20,000	1.33	Hydrolysis & accompanying oxidation-reduction	1.5- 700 yr	Methyl chloride Methanol Formic acid Formaldehyde

[1] Reaction products not identified.

Source: Smith et al., 1984

studies. Values from field situations may potentially be larger due to varying conditions.

The solubility and density of chlorinated hydrocarbons are important properties affecting their movement and fate in an aquifer. The water solubility of a compound is a measure of how easily it dissolves in ground water. In general, the more chloride substitutions on a hydrocarbon, the less soluble it will be. The chlorinated hydrocarbons found at Beaumont No. 1 have low to moderate water solubilities. If a compound is not completely soluble in water, portions of it will either float on the water table or sink to the bottom of the aquifer. Chlorinated hydrocarbons generally have higher densities than water (specific gravities greater than 1.0) and will, therefore, sink to the bottom of an aquifer. A pool of chlorinated hydrocarbons can form at the bottom of an aquifer, depending on the total amount of contaminant loading to the system.

1,1-Dichloroethene (1,1-DCE), 1-1-dichloroethane (1,1-DCA), 1,1,1-trichloroethane (1,1,1-TCA), and trichloroethene (TCE) comprise the major portion of the contaminants found at Beaumont No. 1. Low or trace levels of chloroform, 1,2-dichloroethane (1,2-DCA), 1,1,2,2-tetrachloroethane and tetra(per)chloroethylene (PCE) were also detected.

Three wells (Wells OW-2, OW-3, and W-3) within one mile downgradient of the burn pit area, and also downgradient of the propellant mix, contained TCE, 1,1-DCE, TCA, and 1,1-DCA. The concentrations of total halogenated hydrocarbons in these wells ranged from 44 to 750 parts per billion (ppb). TCE and 1,1-DCE were detected in Wells OW-3 and OW-2 at levels well above the Department of Health Services action levels for drinking water. Lower levels, although still above action levels, were detected in W-3. 1,2-DCA was above the action level in OW-2, and TCA approached the action level in OW-3. The relative percentages of these contaminants seen in the limited data set for the three wells is:

Compound	% of Total Chlorinated Solvents	Daughter Products
TCE	39	1,1-DCE
1,1 DCE	34	
TCA	25	1,1-DCE; 1,1-DCA
1,1 DCA	.8	
1,2 DCA	.4	

Although there is no conclusive information as to the amounts and types of hydrocarbons used by Lockheed, TCE was generally replaced by TCA in the late 1960's. Lockheed may well have changed solvent type earlier than the general industry, since other records have indicated that they were quite progressive in safety and environmental issues.

The presence of 1,1-DCE, 1,1-DCA, and 1,2-DCA in the ground water at Beaumont No. 1 could represent contaminants in the original TCE or TCA solvents used at the facilities. Alternatively, they could represent reaction, or daughter, products resulting from the biological degradation of TCE and TCA within the aquifer. The high 1,1-DCE concentrations are probably a result of both contamination of the original TCE solvent and the biological degradation of TCE and TCA.

In addition to chlorinated hydrocarbons, 4-methyl phenol was also detected at a single well, OW-3. 4-methyl phenol is used as a surfactant and as a metal cleaning or scouring compound. Although no particular chemicals were referred to during the historical review of the site, one ex-employee did state that surfactants were added to the water used during motor washout activities, which were conducted just upgradient of this well. This use would also be consistent with the metal cleaning and scouring properties of 4-methyl phenol.

Phenol was detected in OW-3 above the state action level for drinking water. The value for phenol is probably significant, although there is a possibility that it is due to laboratory contamination of the sample.

No elevated levels were detected for any metals, or any inorganic anions. Methylene chloride, trichlorofluoromethane, bis [2-ethylhexyl] phthalate, di-n-butyl phthalate, and acetone were detected in various samples. All are common laboratory contaminants, and do not affect this investigation.

The two wells upgradient of the burn pits (OW-1 and W-5), the well at the north end of the eastern Aerojet Canyon (W-6), and the three furthest downgradient wells (W-1, W-2, and OW-8) were free from contamination.

The ground water level measurements taken to date indicate that ground-water flow follows the surface drainage patterns defined by Potrero Creek and its tributaries. In the vicinity of the burn pit area, ground-water flow is to the northwest towards OW-3.

Due to the lack of monitoring wells in optimum locations, it cannot be determined at this time whether the major source of solvent contamination is from the burn pit, propellant mixing or SRAM washout areas. All areas could have experienced solvent disposal. In order to determine the actual source of contamination, further investigation is necessary.

4.2 Geophysical Investigation

A geophysical investigation was conducted using terrain conductivity (TC), Ground Penetrating Radar (GPR), and magnetic locating techniques in four areas of the two Beaumont sites. These areas include the burn pit, the location of the suspected radioactive waste burial, the permitted sanitary landfill, and the garbage dump at Beaumont No. 2. The conclusions of this investigation are summarized by area in the following paragraphs.

In order to determine the limits of the burn pit and, if possible, to resolve individual burial trenches, terrain conductivity (TC) data were obtained and magnetic locator (ML) traverses were performed. The TC data reveal a moderately conductive area that lies mostly within the limits determined by the analysis of historical aerial photography. A rough alignment of TC maxima and magnetic anomaly locations suggest three possible trenches. The most predominate of these extends along survey grid line 600 feet west (from grid line 50 to grid line 700 south). Another possible alignment is located on the 450 feet west grid line, extending from about 100 feet to 300 feet south. A third possible trench alignment is located on the 700 feet west grid line at 150 feet to 400 feet south.

A Ground Penetrating Radar (GPR) survey was performed in three canyons at Beaumont No. 1 to explore for low level radioactive waste reportedly buried in one of the canyons. In the two westernmost canyons, the GPR data reveals several anomalous areas, possibly indicative of excavations. Of these, the most likely burial area is near the mouth of Canyon 1. Here, a sub-linear trend of several anomalies lies below a canyon wall that appears to have been partially excavated. The degree of confidence in this location is not high, however, and excavation must be performed to confirm the presence of any buried materials. This location in Canyon 1 does, however, satisfy the cumulative locating criteria given by the ex-employees who visited the site. The Betatron building is clearly visible, it is up against the bluff on the east side of the canyon, and there is a ditch (creek) in the canyon which would direct water away from the area. Additionally, there appears to be a difference in the existing physical topography and the contour lines representing the bluff on the Lockheed topographic map. This may be due to excavation or natural sloughing of the slope.

No further geophysical investigation is planned or recommended because we feel that the limits of these techniques have been exhausted and further investigation would provide no additional data.

Magnetic Locator traverses at both the Beaumont No. 1 and No. 2 landfill sites defined their fill limits on the basis of buried metallic debris. The extent of these limits has been marked by survey stakes at the site.

5.0 WORKPLAN

The purpose of this section is to outline the scope of work for the Remedial Investigation work to be performed at the Beaumont facilities. This plan is designed to define the environmental effects of contaminants at the sites, and to achieve the following objectives:

- Determine the nature and extent of the chlorinated hydrocarbon-contaminated ground-water and soil-vapor plume.
- Satisfy the intent of the Calderon Bill.
- Define the gradient of the alluvial aquifer.
- Obtain a sample from the lower aquifer in the area most likely to be contaminated.
- Confirm the presence and extent of a confining layer separating the two aquifers.
- Physically locate and sample the buried low-level radioactive liquids using earth-moving equipment.
- Determine the combustibility of both the unburned and burned solid propellant residues found at the site.

The strategy for attaining these goals is presented in the following sections. This is not intended to be a comprehensive document describing the detailed procedures to be used, but more to outline the various procedures, and discuss the rationale for the investigation. A more detailed QAPP will be prepared for the investigation; however, because of the nature of the techniques utilized, many decisions will need to be made in the field.

5.1 Soil-Vapor Investigation

In order to assist in defining the sources of contamination and to evaluate the extent of contaminant migration at the Beaumont facilities, a shallow soil-vapor investigation will be conducted. Because of the large size of the Beaumont sites, soil-vapor surveys will only be conducted in areas where contamination is suspected to occur. These areas include:

Beaumont No. 1

- The burn pit area
- The SRAM washout area
- The LSM washout area
- The permitted sanitary landfill

Beaumont No. 2

- The garbage dump

These areas were selected based on information gathered for the Beaumont Test Facilities Historical Report (Radian, September 1986), combined with the results of the preliminary ground-water investigation discussed in this report. They include all the areas where it could be suspected that hazardous waste had been disposed.

Strategy

The proposed technical approach involves the use of soil-vapor tests to delineate the probable lateral extent of contaminant vapors. Soil-vapor sampling and mapping of volatile contaminant tracer species may help to reduce the time and cost required to delineate subsurface contamination. By plotting the soil-vapor data, and outlining the general aerial extent of contamination, conventional monitoring wells can be efficiently located and used to verify both the presence and extent of subsurface halocarbon contamination.

Additionally, the field analytical equipment can be utilized in conjunction with the drill rig to analyze the ground-water from the borehole before well construction. This will allow the field geologist to make timely evaluation of the water quality, and more effectively locate additional wells. This strategy will maximize the use of the real-time analytical capability to allow field direction of the investigation based on previous sample results. The combination of two monitoring techniques may avoid the need to remobilize drilling equipment to further define the extent of the ground-water plume after the receipt of detailed laboratory results.

In order to best determine the extent of contamination in the vadose zone, a two-step approach will be used to select soil probe locations at each of the investigation areas. The initial probes at each site will be located on a grid system with 100 to 200-foot centers. These data will provide general, unbiased coverage of the whole area. The results of the first phase of analysis will be plotted on a field map, and preliminary contours will be drawn using field computers.

Following the initial appraisal of soil-vapor contamination, additional probes will be installed, if necessary, to more thoroughly define areas of incomplete information. If no contamination is detected, then the investigation for the particular area will be concluded. If contamination is discovered, and ground-water monitoring wells are installed, soil-vapor data from deeper levels will be obtained during drilling in order to supply data of a three-dimensional nature.

In addition to the field analysis of soil-vapor, at least one evacuated stainless steel canister sample will be collected from each investigation area. These canisters will be analyzed at the Radian laboratories in Austin, Texas, using gas chromatographic/multiple detector (GC/MD) techniques. This type of analysis provides detailed speciation for a wide range of compounds. The data will serve to validate the field sampling and analysis, and it will also provide information concerning the presence of any other contaminants in the soil vapor.

Theory of Operation

Volatile organic pollutants evaporate from a contaminant source, or contaminated ground water, into the surrounding soil vapor and move through the soil by molecular diffusion. The tendency of volatile organic pollutants to escape into the soil vapor is a function of their concentration in the source, their aqueous solubility, and their vapor pressure (boiling point). This technology is most effective in mapping low molecular weight halogenated chemicals which readily partition out of the ground water and into the soil vapor due to their high gas/liquid partitioning coefficients. Halocarbons, which are not easily degraded in the soil, tend to establish a relatively predictable concentration gradient that is highest at the source or contaminated water table surface and drops off to essentially zero at the ground surface.

Ideally, the concentration of the contaminant at any given depth in the soil vapor is a function of its concentration in the ground water. In practice, the concentration gradient in the soil vapor between the water table and ground surface may be distorted by hydrologic and geologic variables such as perched water, impermeable materials, or depth to water. However, diffusion of contaminants will generally occur around geologic and hydrologic barriers unless they are of great lateral extent compared to the area of contamination. The principal parameters that enhance diffusive movement of volatile contaminants are high soil permeability and low soil moisture. Diffusion occurs most easily through sand and gravel-type mediums, which exist at the Beaumont sites.

Sampling Procedure

Probes are driven into the ground to a depth of five to six feet below the land surface. The probe is then connected to a vacuum pump using silicone tubing and withdrawn from the ground until a flow of soil vapor is recorded. While soil vapor is being drawn through the probe, a gas sample is taken using a glass syringe inserted through the silicone tubing and into the steel tubing in the adaptor. Vapor samples only contact steel or glass surfaces and shall never be in contact with potentially adsorbing materials (i.e., tubing, hose, pump diaphragm). A vacuum gauge is used to monitor the negative pressure in the evacuation line, assuring that there is no impedance to gas flow caused by clayey or water-saturated soils.

Air samples collected from the sampling probe will be analyzed for chlorinated hydrocarbons, specifically TCE, 1,1,1-TCA, and 1,1-DCE. These compounds will be used as tracer species to determine the extent of any soil-vapor plume. If necessary, field modifications can be made to the analysis as the investigation proceeds.

Soil-vapor data obtained in the field shall be contoured on a base map for each area, delineating the maximum concentration as well as the areal extent of contamination. This contour map will provide the information needed to select the remaining soil-vapor sampling locations, delineating the extent of any existing dissolved halocarbon boundary. These data will be used to select the locations for the monitoring well installation program.

Drilling and well installation will be conducted concurrently with the soil-vapor study. The drilling will provide geological data for definition of soil stratigraphy and water samples for characterization of the liquid hydrocarbon plume.

5.2 Monitoring Well Installation and Ground-Water Sampling Plan

This plan will describe the technical approach intended for the installation of ground-water monitoring wells at Beaumont No. 1 and Beaumont No. 2. The purpose of the ground-water investigation is to determine the horizontal and vertical extent of solvent contamination.

Beaumont No. 1 Well Locations

Fifteen monitoring wells are proposed for Beaumont No. 1, as shown in Figure 5-1 and described in Table 5-1. Thirteen of the proposed wells were selected in order to determine the horizontal and vertical extent of the contaminant plume identified in the preliminary remedial investigation. The remaining two wells are designed to determine the impacts associated with the Beaumont No. 1 sanitary landfill. The proposed locations of the 15 monitoring wells are approximate and subject to change as new information is obtained during the soil vapor investigation.

Proposed wells MW-1, 2, 3, and 4 are located between the burn pit area and the SRAM motor washout/propellant mix area while MWs 5 and 6 are located downgradient of the propellant mix area. These areas are potential sources of the ground-water contamination seen to date. MWs 1, 4, and 5 would allow the relative contributions of each source to be established. The wells will be installed 20 feet below the depth at which water is encountered. Well MW-1 will be drilled first. Soil-vapor phase monitoring will be conducted during drilling to allow for an immediate assessment of contaminant concentrations at MW-1. A sample of groundwater from the well will be analyzed in the field to provide preliminary data. If the monitoring indicates high contaminant concentrations, two additional wells, MWs 2 and 3, will be drilled adjacent to MW-1. MW-2 will be drilled to the bottom of the alluvial aquifer and will allow for the determination of vertical gradients within this aquifer. MW-2 will also provide information as to the existence of a solvent plume that may have settled to the bottom of the alluvial aquifer. MW-3 will

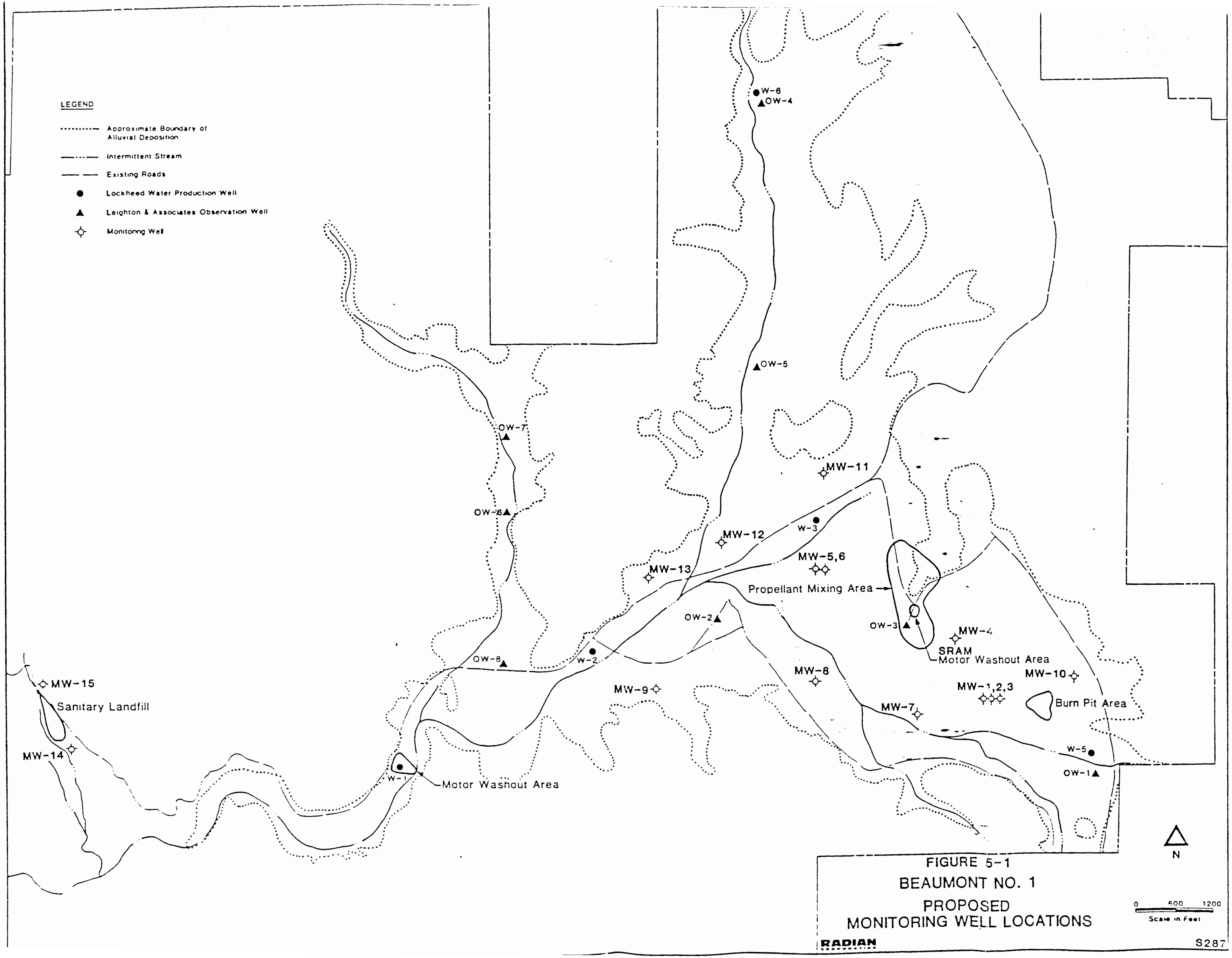


FIGURE 5-1

BEAUMONT NO. 1

PROPOSED MONITORING WELL LOCATIONS

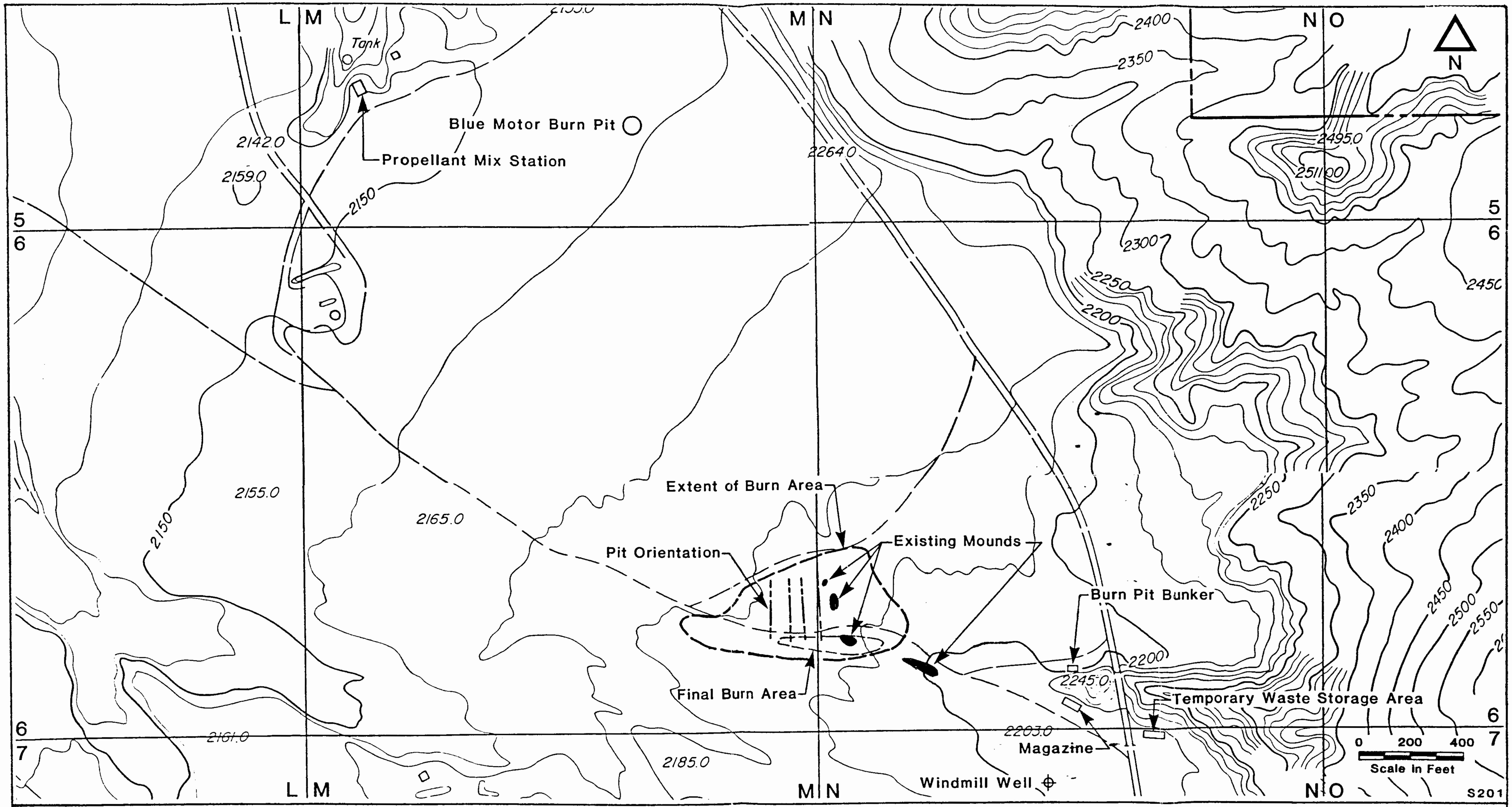


Figure 3-20. Beaumont No. 1, Burn Pit Area, Used From 1961 Through 1974.

TABLE 5-1. BEAUMONT NO. 1 PROPOSED MONITORING WELLS

Proposed Monitoring Well	Approximate Total Depth	Approximate Location	Rationale
MW-1	20 ft. below water table	200-300 ft down-gradient of burn pit area	Determine contamination adjacent to burn pit area; Determine vertical gradients.
MW-2	Bottom of upper aquifer	"	"
MW-3	Lower aquifer	"	"
MW-4	20 ft. below water table	Up-gradient of SRAM washout area	Determine contamination Up-gradient of SRAM washout area.
MW-5	20 ft. below water table	Centered between OW-2, OW-3, and W-3	Determine contamination down-gradient of SRAM washout area.
MW-6	Bottom of upper aquifer	"	"
MW-7	20 ft. below water table	North of Bedsprings Creek	Define southern boundary of plume.
MW-8	20 ft. below water table	South of Bedsprings Creek	Define southern boundary of plume.
MW-9	20 ft. below water table	South of OW-2 and W-2	Define southern boundary of plume.
MW-10	20 ft. below water table	East of burn pit area	Define eastern boundary of plume.
MW-11	20 ft. below water table	North of W-3	define northern boundary of plume.
MW-12	20 ft. below water table	Mouth of Aerojet Canyon	Define northern boundary of plume.
MW-13	20 ft. below water table	Mouth of Aerojet Canyon	Define northern boundary of plume.
MW-14	20 ft. below water table	Down-gradient of sanitary landfill	Determine impacts from sanitary landfill.
MW-15	20 ft. below water table	Up-gradient of sanitary landfill	Proposed if MW-14 is contaminated.

be drilled to the lower confined aquifer. It will allow for the assessment of vertical gradients, and define the location of the confining layer between the two aquifers. MW-6 will be drilled to the bottom of the alluvial aquifer and will be located adjacent to MW-5.

Proposed wells MW-7 through MW-13 were selected to determine the northern and southern extent of any contaminant plume as well as to determine ground-water flow patterns. MWs 7, 8, and 9 will help define the southern extent of contamination while MWs 11, 12, and 13 will help define the northern extent. MW-10 will be drilled east of the burn pit area to define the eastern extent of contamination. Existing well W-2 currently defines the western extent of the plume. These wells will be installed 20 feet below the depth at which water is encountered.

Two wells are proposed in the vicinity of the sanitary landfill. Proposed well MW-14 is downgradient of the landfill. Field analyses of the ground water will be conducted to assess contaminant concentrations at the well. If contamination is indicated, one well, MW-15, will also be drilled upgradient of the sanitary landfill. Both wells will be installed 20 feet below the depth at which water is encountered.

Beaumont No. 2 Well Locations

Seven monitoring wells are proposed for Beaumont No. 2, as shown in Figure 5-2 and summarized in Table 5-2. Four of the proposed wells are designed to determine impacts associated with the garbage disposal site. The remaining three wells are intended to determine the source of contamination found in W2-3 during the preliminary investigation.

Proposed monitoring well MW2-1 is located upgradient of the garbage disposal site while wells MW2-2, MW2-3, and MW2-4 are located downgradient. MW2-4 is in the vicinity of an old well, W2-1, which Radian could not locate. These proposed monitoring wells will be drilled to 20 feet below water table.

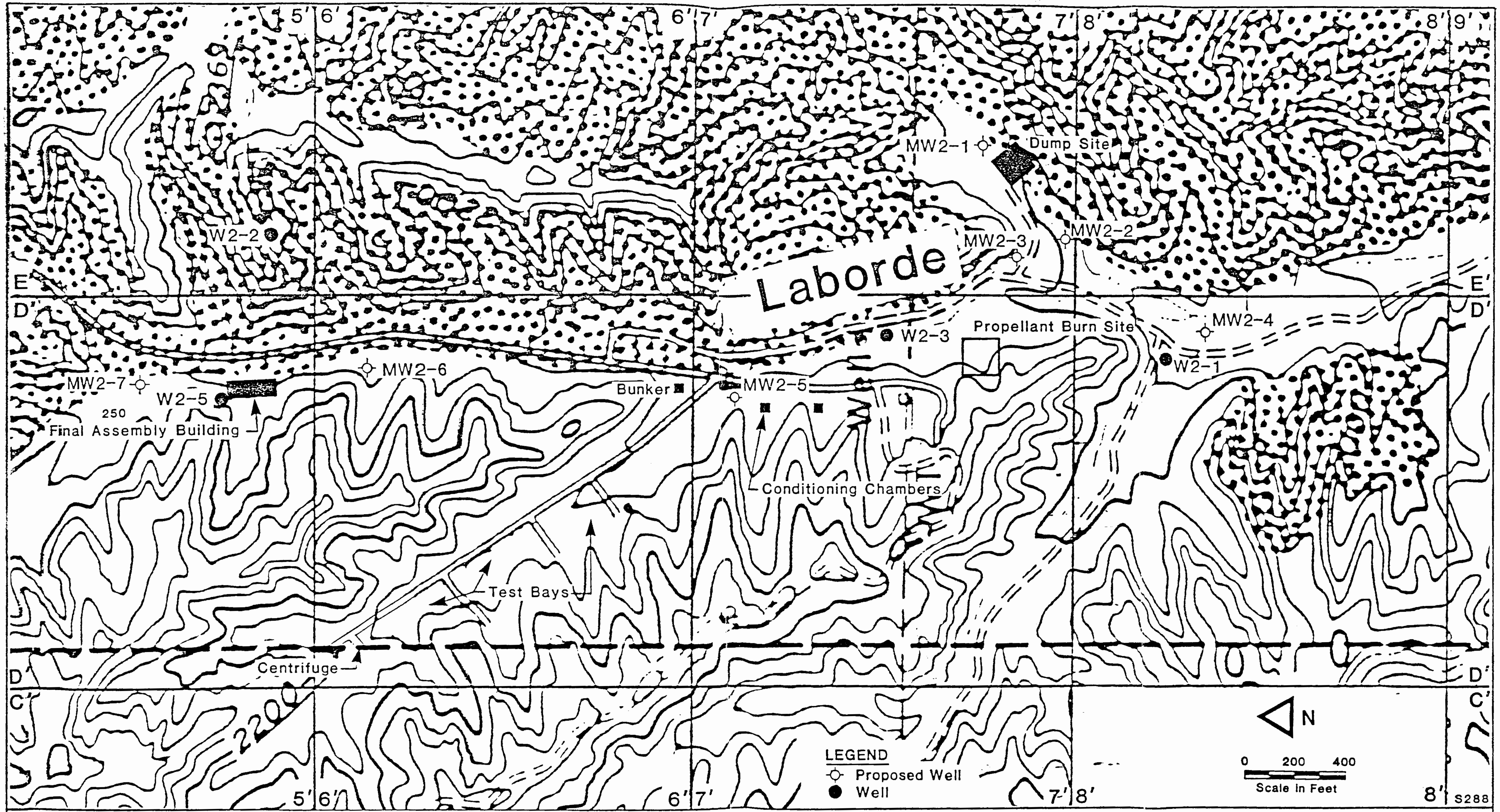
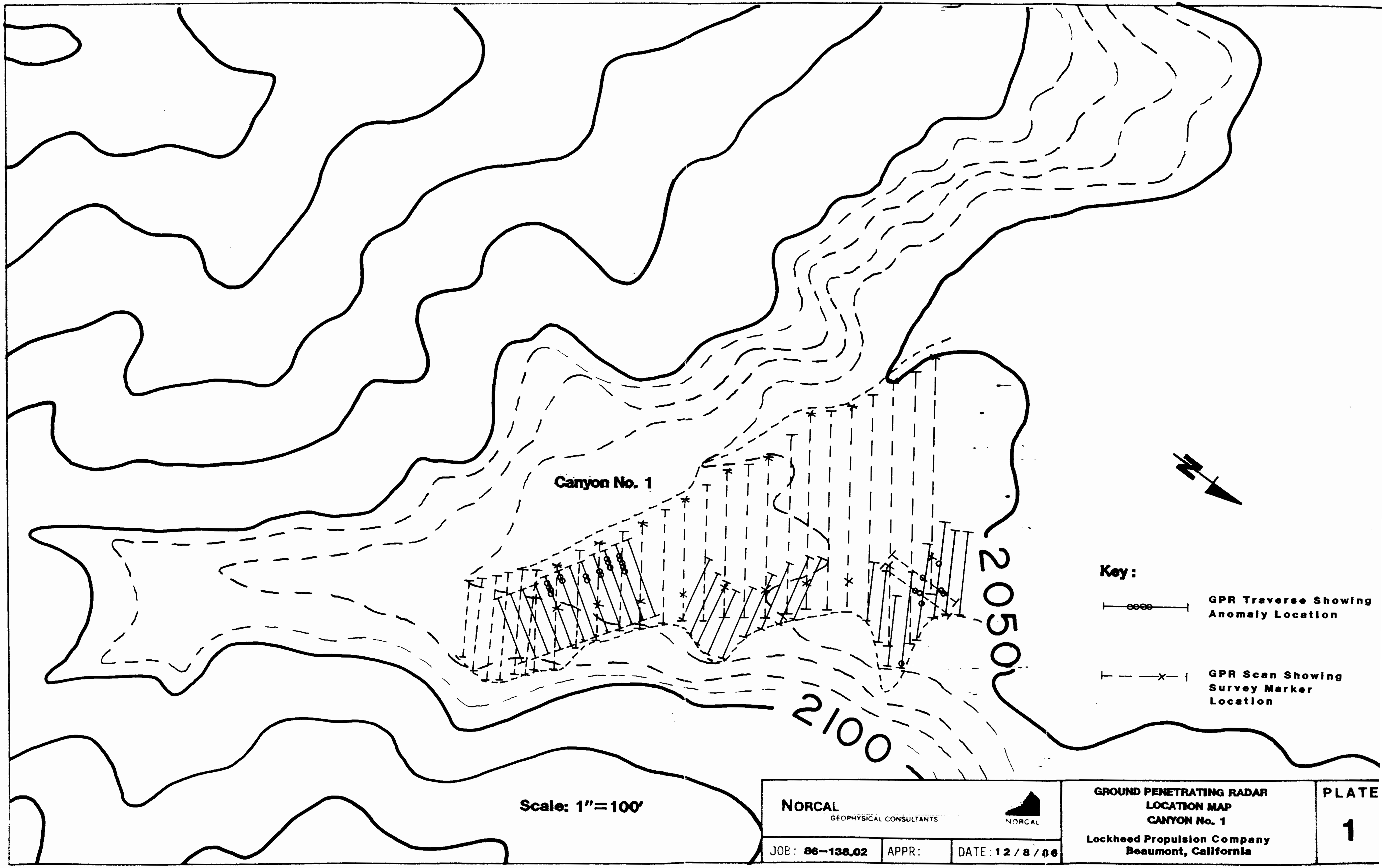


FIGURE 5-2. PROPOSED MONITORING WELL LOCATIONS OF BEAUMONT NO. 2



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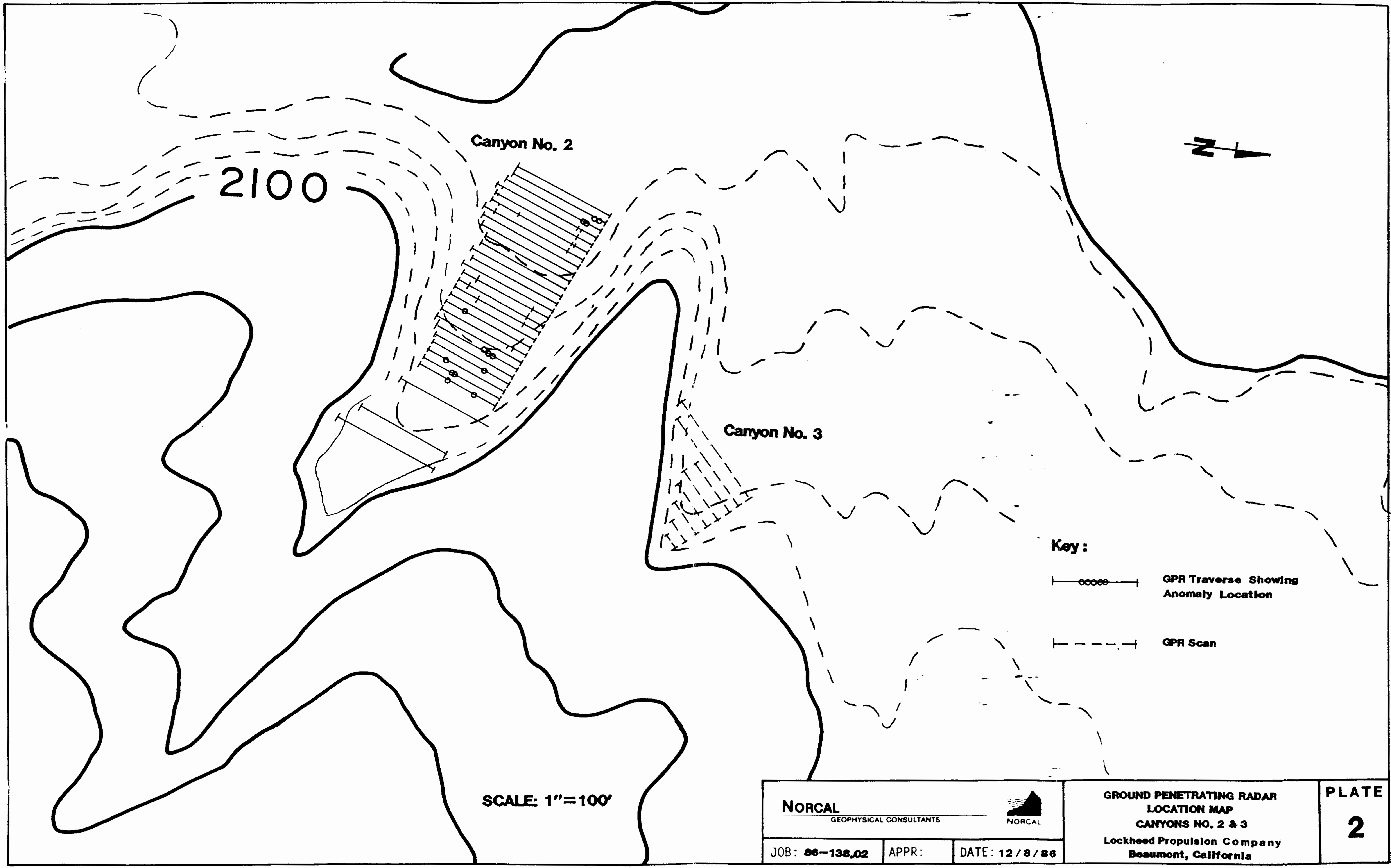
GROUND PENETRATING RADAR
LOCATION MAP
CANYON No. 1

Lockheed Propulsion Company
Beaumont, California

PLATE
1



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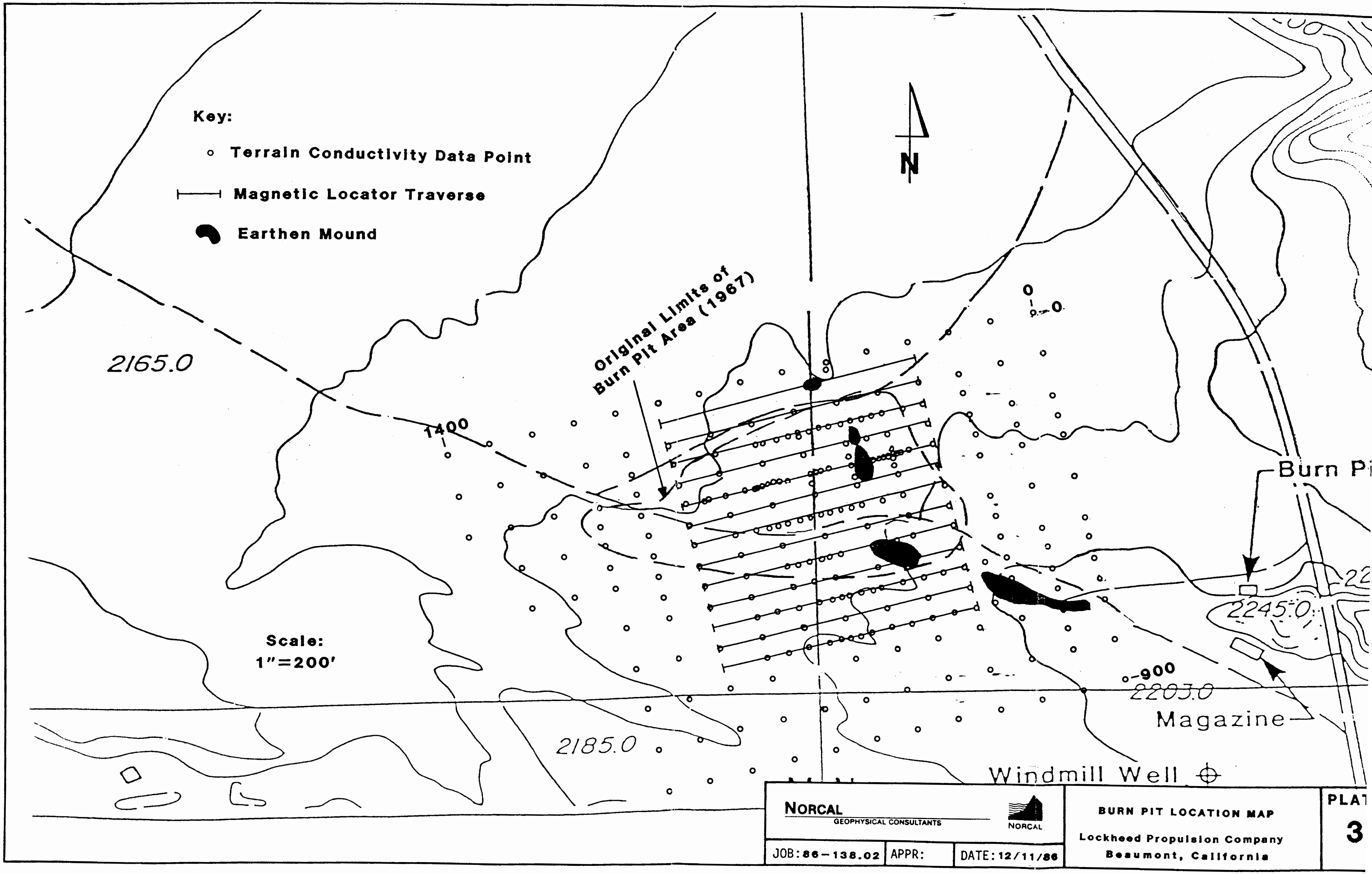
GROUND PENETRATING RADAR
LOCATION MAP
CANYONS NO. 2 & 3
Lockheed Propulsion Company
Beaumont, California

PLATE
2



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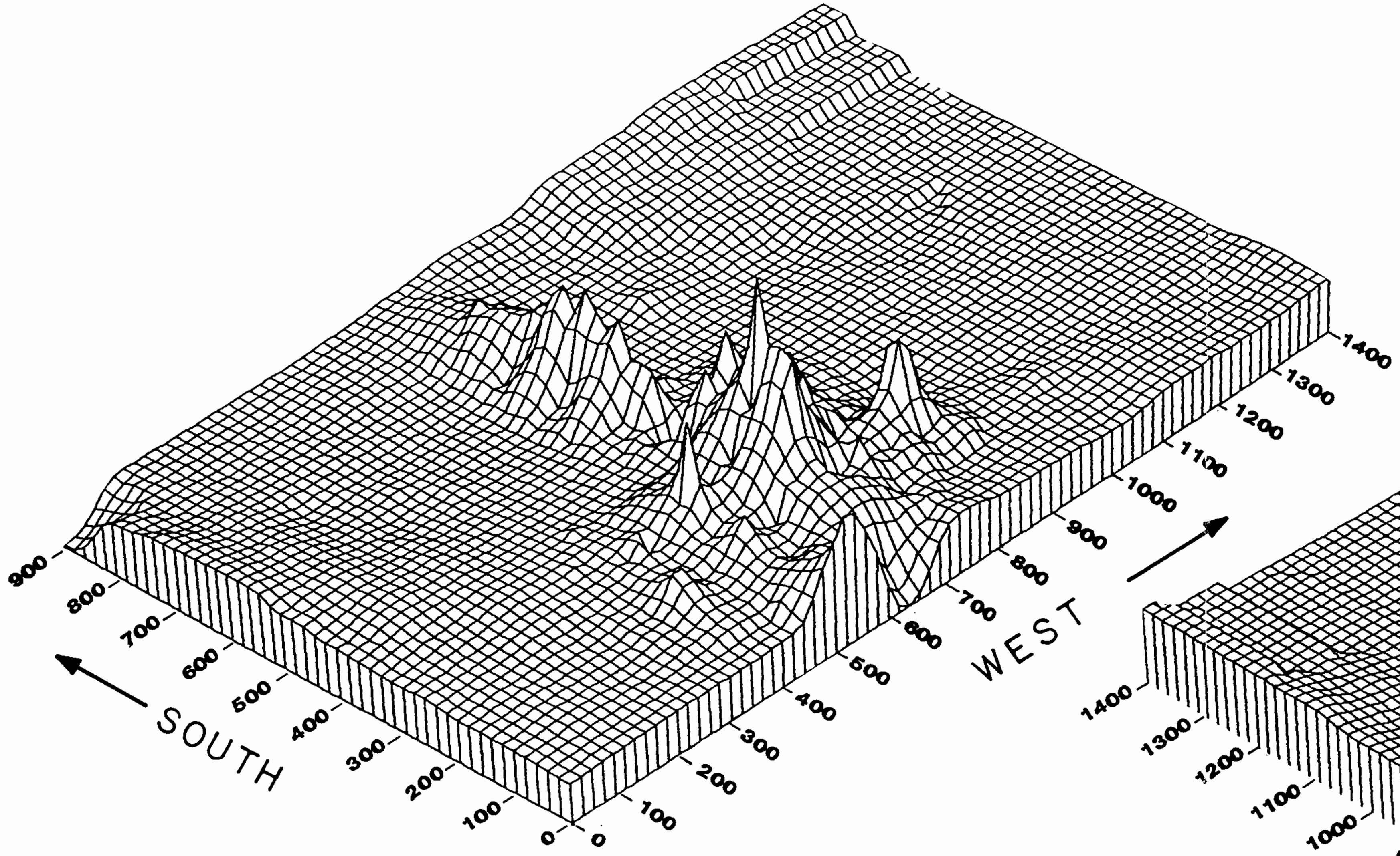
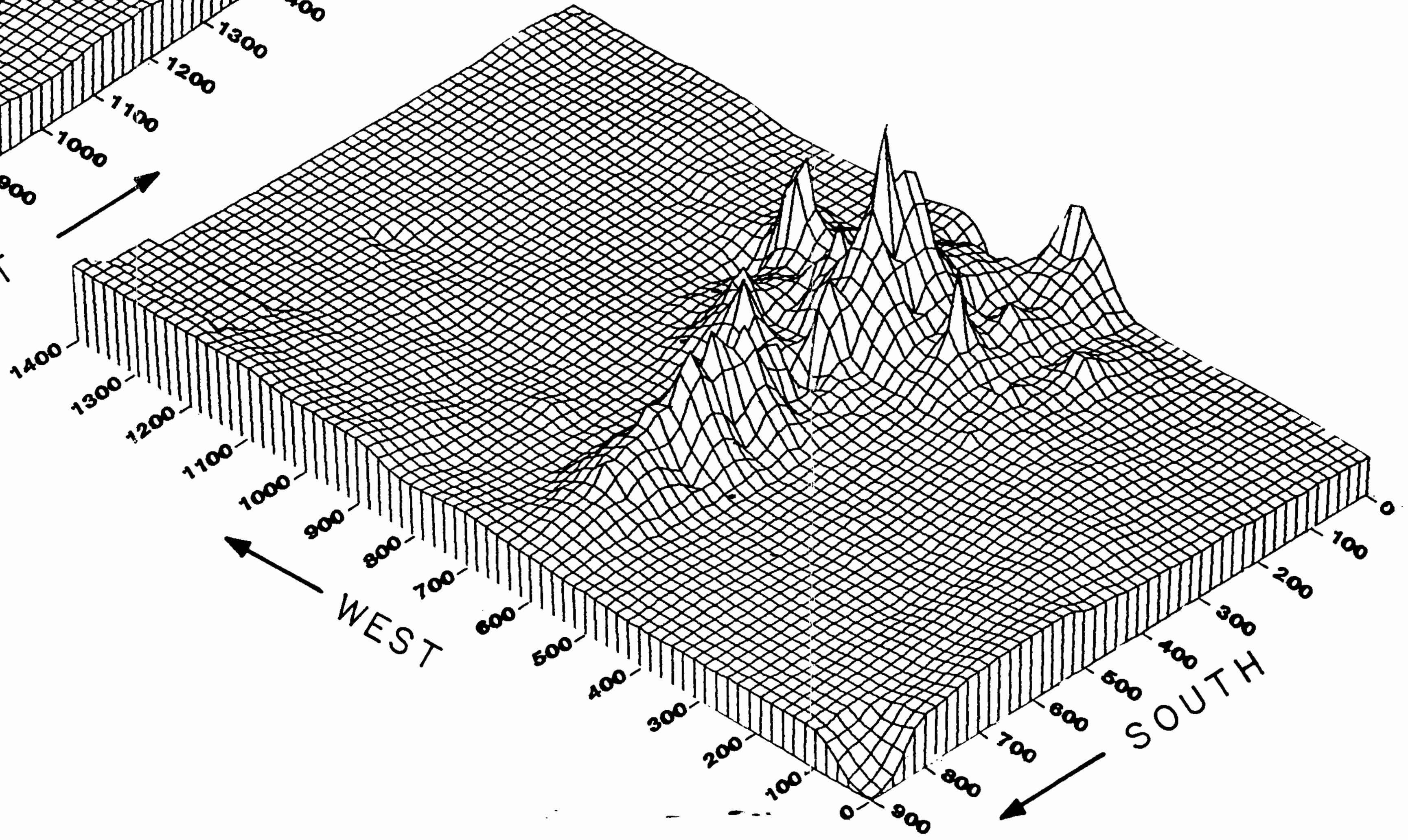
BURN PIT LOCATION MAP

Lockheed Propulsion Company
Beaumont, California

PLAT
3





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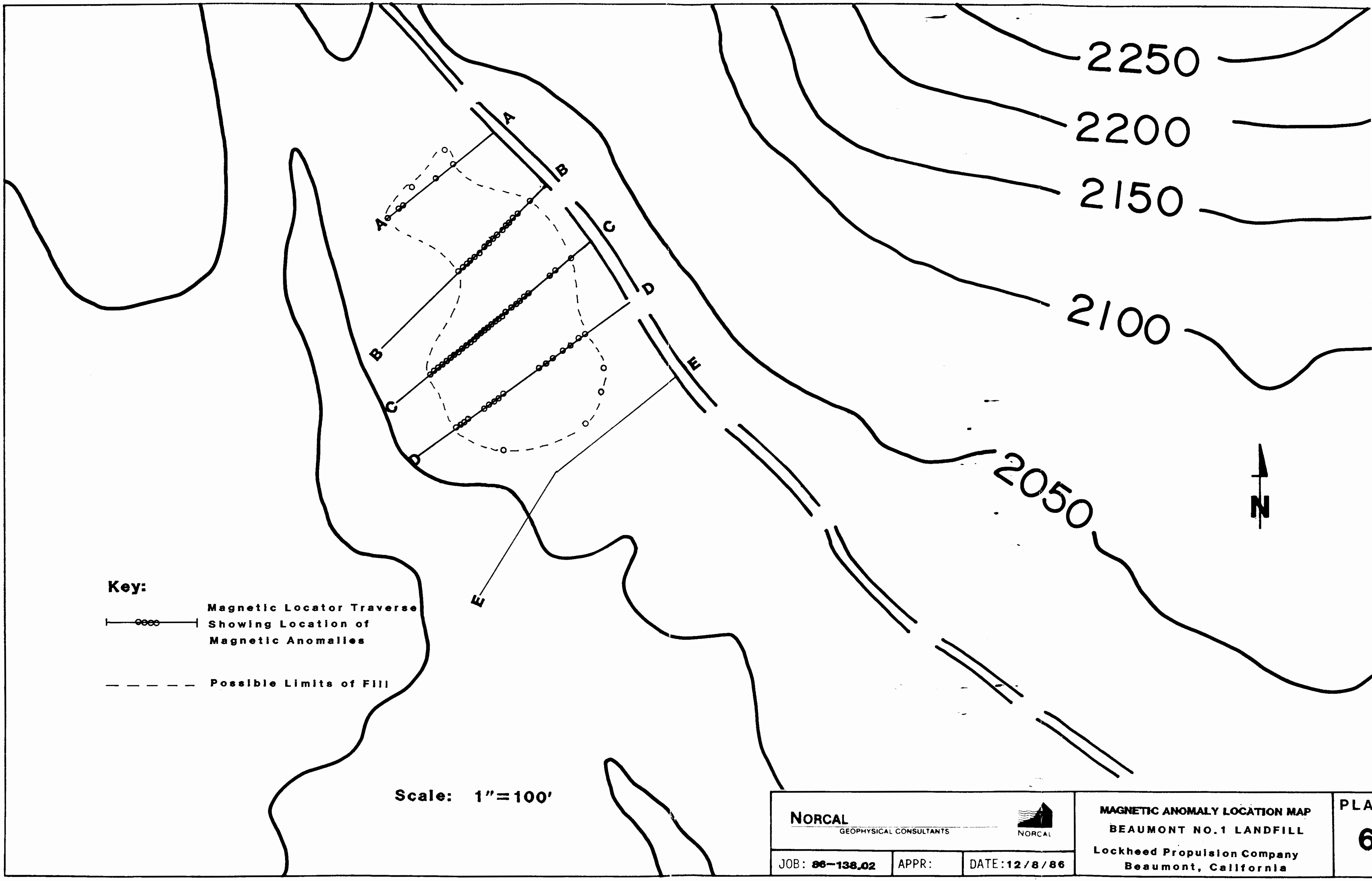
TERRAIN CONDUCTIVITIES
3 - D Views
Burn Pit
Lockheed Propulsion Company
Beaumont, California

PLATE
5



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MAGNETIC ANOMALY LOCATION MAP
BEAUMONT NO.1 LANDFILL
Lockheed Propulsion Company
Beaumont, California

PLA
6

TABLE 5-2. BEAUMONT NO. 2 PROPOSED MONITORING WELLS

Proposed Monitoring Well	Approximate Total Depth	Approximate Location	Rationale
MW2-1	20 ft. below water table	Upgradient of garbage disposal site.	Establish ground-water quality upgradient of the garbage disposal site.
MW2-2	20 ft. below water table	Downgradient of garbage disposal site.	Determine impacts associated with garbage disposal site.
MW2-3	20 ft. below water table	Downgradient of garbage disposal site.	Determine impacts associated with garbage disposal site.
MW2-4	20 ft. below water table	Downgradient of garbage disposal site.	Determine impacts associated with garbage disposal site.
MW2-5	20 ft. below water table	Downgradient of test bays and Building 250.	Determine source of contamination found in W2-3.
MW2-6	20 ft. below water table	South of Building 250.	Determine source of contamination found in W2-3; to be drilled if contaminants are found at MW2-5.
MW2-7	20 ft. below water table	North of Building 250.	To be drilled if contaminants are found at MW2-6; define northern extent of contamination.

The exact locations of the four monitoring wells will be determined in conjunction with the soil vapor investigation to be conducted at the dump.

Proposed monitoring well, MW2-5, will be drilled upgradient of Well W2-3, found to be contaminated during the preliminary investigation. If MW2-5 is also found to be contaminated, MW2-6 and MW2-7 will be drilled in order to define the source and limits of contamination.

Drilling Equipment and Well Construction Procedures

Drilling permits will be obtained from the Riverside County Department of Health before drilling operations begin. Well drilling will be accomplished by dry hollow-stem auger methods, using 6-1/4-inch inside diameter auger flight. The larger auger size is to ensure an annular space between the casing and the auger large enough to accommodate a tremie pipe.

A hollow stem auger drilling rig, capable of drilling to depths of 300 feet in unconsolidated sediments, will be used for shallow monitoring well installation. Deeper wells will probably be drilled using an air-percussion hammer rig, capable of drilling to greater depths with relative ease. On the deeper well, it will be imperative to prevent the possibility of cross-contamination from the upper aquifer. No fluids, gels, oils, grease, etc., will be applied in or on any of the equipment used in the boring. All equipment will be steam-cleaned prior to the commencement of drilling operations for each hole.

All drilling activities will be under the supervision of a qualified Geologist, Geotechnical Engineer, or Professional Engineer. This supervisor will be responsible for the final well construction, along with all documentation of drilling activities.

A continuous corer or split-spoon sampler will be used for sample collection. The continuous corer method increases drilling efficiency and provides a continuous stratigraphic section of the boring for logging and sampling purposes, although some conditions can be more easily sampled using the split-spoon sampler. Representative portions of the samples will be stored for future reference. If unusual soil conditions are observed, samples will be collected for laboratory analysis.

After the total depth of the well has been reached and the location of the screened interval determined by the field geologist, the screen and casing will be set into the borehole through the inside of the hollow stem auger. The screen and casing for the wells consist of Schedule 40 four-inch inside-diameter Polyvinylchloride (PVC). The screen will be 20 feet in length, pre-slotted, with a sealed PVC end cap. The slot size will be compatible with the grain size of sediment in the aquifer and gravel pack. All joints will have flush-joint threaded couplings. No glue, lead shot or lead wool will be used on any part of the screen or casing.

The sand pack will consist of clean silica Monterey sand, placed from the bottom of the boring to at least one foot above the screen. Sand will be poured directly down the auger around the screen and casing with the hollow stem augers acting as a tremie pipe. After a calculated volume of sand has been poured down the hole, the augers will be withdrawn to allow the sand to fill the bottom of the hole. By sounding the level of the sand in the hole, and calculating the length of auger remaining in the hole, the top of the sand and the bottom of the auger should not be separated. This process will be performed slowly, avoiding the buildup of large depths of material in the annular space. This will prevent the compaction and bridging of materials between the well casing and the auger flights. Sounding of the sand level with a measuring tape will also detect any bridging that might occur.

A bentonite seal of at least three feet will be emplaced on top of the sand pack. The bentonite pellets will be poured directly down through the center of the auger unless there is a sufficient amount of water in the well to cause bridging of the bentonite inside of the augers. In this case, the bentonite will be emplaced in the hole through a tremie pipe. A sand-cement grout mix containing three percent bentonite powder by weight will be emplaced into the hole from the top of the bentonite seal to the ground surface.

Approximately two to three feet of well casing will be left above ground after completion of the well. A PVC screw-joint cap will be placed on the top of the stickup casing. A protective steel cover will be placed over the PVC casing and set into a concrete pad. The steel casing will have a locking cap and lock. The concrete pad will be set above ground level and will slope away from the well casing. The ground surface around the well will be sloped away from the casing. The well number will be stenciled on the outside of the protective casing and on the well casing cap.

The general method used for well development will be a combination of bailing, surging, and pumping. Development will be initiated by bailing the well in order to remove sediment and drill cuttings from inside the casing and screen. After bailing, the wells will be surged to pull finer formation materials into the well for removal. A vented surge block will be used in order to comply with the DHS Decision Tree Manual. The vented surge block is a swabbing tool with a flap valve which causes water to move only from the formation into the well. This tool reduces the stress on the well screen during development. After surging, the wells will be bailed again to remove sediment and then pumped until the discharged water is clear and free of sand. All of the wells will be developed for a minimum of four hours of combined bailing, swabbing, and pumping time.

Well Construction Logs

The Geologist or Geotechnical Engineer supervising the drilling procedures will prepare a log of well construction activities. The following information will be included in the drilling, construction, and completion logs:

- Reference elevation for all depth measurements;
- Depth of each change of stratum;
- Thickness of each stratum;
- Identification of the material of which each stratum is composed according to the Unified Soil Classification system, or standard rock nomenclature, as necessary. Identification will also include a description of grain-size, angularity, GSA color, and fining sequence;
- Depth interval from which each formation sample was taken;
- Depth at which ground water is first encountered;
- Depth to the static water level and changes in static water level with well depth;
- Total depth of completed well;
- Reason for terminating drilling;
- Depth or location of any loss of tools or equipment;
- Location of any fractures, joints, faults, cavities or weathered zones;
- Nominal diameter of borings;
- Depth of any grouting or sealing;

- Amount, type, and manufacturer of all materials used in well construction;
- Depth and type of well casing;
- Description (to include length, location, diameter, slot sizes, material, and manufacturer) of well screens;
- Any sealing off of water-bearing strata;
- Method of well development;
- Static water level upon completion of the well and after development;
- Drilling date or dates;
- Construction details of monitoring well as installed.

At the completion of drilling operations, a licensed surveyor registered in the State of California will determine the vertical and horizontal position of the newly installed wells.

The Field Geologist will also be responsible for safety procedures on site, to be described in the Health and Safety Plan. A photoionization detector (PID) will be used for the detection of any volatile contaminants that might be present in the soil or ground water. Air coming from the borehole will be scanned for organic vapors, and every core sample will be scanned along its length as it is taken from the borehole. All OVA or PID readings will be recorded.

Ground-Water Sampling and Analysis

Ground-water samples will be collected from the monitoring wells immediately after they are developed. In addition, the existing wells, sampled during the preliminary investigation, will be resampled at this time. Field staff will be responsible for adhering to the sampling protocol and procedures defined in a Quality Assurance Project Plan (QAPP), which will be similar to the one contained in Appendix A of this report.

Samples from all wells will be submitted for laboratory analysis of purgeable halocarbons by EPA Method 601. Samples from selected wells will also be analyzed for purgeable organic priority pollutants (EPA Method 624), base/neutral and acid extractables (EPA Method 625), metals (EPA Method 200.7) and inorganic anions (EPA Method 300.0).

5.3 Propellant Sampling

In order to determine the combustible properties of both the burned and unburned propellant found at the site, Radian will collect samples for laboratory analysis. Unburned propellant samples will be collected from the burn pit and washout area at Beaumont No. 1, and from the barrel located at Beaumont No. 2. Burned propellant samples will be collected from the surface of the burn pit area at Beaumont No. 1. Samples will be sent to the Hercules Allegheny Ballistics Laboratory for analysis. Results of this analysis will allow characterization of the solid material on the surface at the sites. It will also provide preliminary information for planning further site activities.

5.4 Locating Radioactive Wastes

During the Beaumont site history investigation, it was discovered that several bottles of low-level radioactive waste were buried in a canyon to the south of the Betatron building. Attempts were made to determine the location of these wastes using several methods, including site visits by former Lockheed employees, aerial photographic interpretation, scintillation monitoring with geiger counters, and geophysical surveys of the areas. None were successful in actually locating the wastes; however, suspected locations have been identified. Although the wastes are presumed to be low-level, this cannot be confirmed until they are actually located and sampled.

In order to locate the waste material, Radian believes that it is necessary to physical excavate the overburden soil using heavy construction equipment. Employing a subcontractor, a scraper or road grader will be used to remove the surface soil in one to two inch increments. This activity will be accompanied by close visual observation and radioactive monitoring using geiger counters. A detailed Health and Safety Plan will govern all site activities. Soil removal will begin in the area of Canyon 1, thought most likely to contain the waste, and proceed to Canyon 2 and 3 until the material is found. Once found, the extent of the trench will be located, and a sample of the material will be obtained for laboratory analysis. No additional work will be performed until the situation is discussed with all appropriate agencies, and a detailed plan is formulated.

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Appendix A

QAPP

RADIAN

204-139-05-01

LOCKHEED PROPULSION COMPANY
BEAUMONT TEST FACILITIES
GROUND-WATER SAMPLING
QUALITY ASSURANCE PROJECT PLAN

October 10, 1986

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LOCKHEED BEAUMONT SITES GROUND-WATER SAMPLING:
QUALITY ASSURANCE PROJECT PLAN

QUALITY ASSURANCE PROJECT PLAN

The objective of this ground-water investigation is to perform a preliminary evaluation of ground-water quality at the two Lockheed Beaumont sites. The sampling and analysis of ground water from existing wells will produce scientifically accurate and defensible data which will give a preliminary indication if environmental problems exist at the sites.

The EPA Quality Assurance Project Plan (QAPP) outline has been used to develop this QAPP. The elements of the QAPP are:

- Project description;
- Project organization and responsibility;
- QA objectives for measurement data in terms of precision, accuracy, completeness, representativeness, and comparability;
- Sampling procedures;
- Sample custody;
- Calibration procedures and frequency;
- Analytical procedures;
- Data reduction, validation and reporting;
- Internal quality control checks;
- Performance and system audits;

- Preventative maintenance;
- Corrective action; and
- Quality assurance reporting.

These items are addressed in the following sections.

1.0 Project Description

Radian has completed a detailed review of the site history at two former Lockheed test facilities near Beaumont, California (Radian Corp., September 1986). At the conclusion that study, recommendations were made to collect ground-water samples from selected existing wells that contain water. The purpose of this sampling effort is to allow for a preliminary evaluation of ground-water quality at the two sites.

All samples collected at the two Beaumont sites will be tested for purgeable halocarbons (EPA Method 601). Samples from wells most likely to be contaminated as well as the site production well will also be analyzed for purgeable organic priority pollutants (EPA Method 624), base/neutral and acid extractables (EPA Method 625), metals (EPA Method 200.7), and inorganic anions (EPA Method 300.0). Table 1.1 outlines the sampling and analysis plan for each well. The plan considered such factors as proximity of each well to areas of former site activity, proximity of each well to other wells, and well depth.

TABLE 1-1. BEAUMONT SITES GROUND-WATER SAMPLING PLAN

Well	Location	Total Depth (ft)	Depth to Water 11/83) (ft)	Casing Diameter (inches)	Standing Water Volume (gallons)	Planned Analysis	QA/QC	Comments
OW-1	Beaumont No. 1	70	38.6	2	5	601, 624, 625, Metals, Ions		Up-gradient from burn pit area; near W-5
OW-2	Beaumont No. 1	50	0	2	8	601		Lake area - water at surface
OW-3	Beaumont No. 1	70	9.2	2	10	601, 624, 625, Metals, Ions	Field Duplicates	Down-gradient from burn pit area; near SRAM motor washout area
OW-4	Beaumont No. 1	70	Dry	2	--	601 if not dry		
OW-5	Beaumont No. 1	66	66	2		601		
OW-6	Beaumont No. 1	40	36.1	2	0.6	None		In canyon not associated with, and up-gradient of, site activities
OW-7	Beaumont No. 1	49	37.8	2	1.8	None		In canyon not associated with, and up gradient of, site activities
OW-8	Beaumont No. 1	64	39.8	2	4	601		
W-1	Beaumont No. 1, western washout area		26.7	14		601		At LSM washout area
W-2	Beaumont No. 1 South of Betatron building		11.9	9		601		
W-3	Beaumont No. 1 Pumphouse Well		34.5			601, 624, 625, Metals, Ions		Pump house well
W-4	Beaumont No. 1 across wash from W-3		Dry			--		Not located
W-5	Beaumont No. 1, south of burn pit bunker		60.4	12.5		601		Located next to OW-1

TABLE 1-1. BEAUMONT SITES GROUND-WATER SAMPLING PLAN (Continued)

Well	Location	Total Depth (ft)	Depth to Water 11/83) (ft)	Casing Diameter (inches)	Standing Water Volume (gallons)	Planned Analysis	QA/QC	Comments
W-6	Beaumont No. 1, northern end of eastern Aerojet range	93+		10		None		Located next to OW-4; probably dry
W-1	Beaumont No. 2, 1/3 mile south of W-3					601, 624, 625, Metals Ions		Located down-gradient from garbage disposal site; not located by by Radian
W-2	Beaumont No. 2, across road from Bldg. 250					--		Not located
W-3	Beaumont No. 2, 3/4 mile south of Bldg. 250			10		601		Located in middle of the site
W-4	Beaumont No. 2, at northern boundary of site					None		Not associated with areas of site activity.
W-5	Beaumont No. 2, northwest corner of Bldg. 250	500				None		Well drilled to deep aquifer

2.0 Project Organization and Responsibility

The Radian project team consists of:

- Mr. Robert Vandervort, P.E. -- Program Manager, with ultimate authority for the program, assuring that schedule and budget commitments are met, and that the technical work satisfies project goals.
- Mr. Christopher Koerner, P.E. -- Project Director, responsible for providing technical direction and supervision of the project, and for reporting the study results.
- Ms. Judith Billica -- Civil Engineer, principal investigator for the investigation.

3.0 QA Objectives for Measurement Data in Terms of Precision, Accuracy, Completeness, Representativeness, and Comparability

The purpose of Quality Assurance/Quality Control (QA/QC) procedures is to produce data of known high quality that meets or exceeds the requirements of standard analytical methods, and satisfies the program requirements. The objective of the quality assurance efforts for this program are two-fold. First, they will provide the mechanism for ongoing control and evaluation of measurement data quality throughout the course of the project. Second, quality control data will ultimately be used to define data quality for the various measurement parameters in terms of precision and accuracy. Data quality objectives for the various measurement parameters associated with site characterization efforts are presented in Table 3-1.

Quality control limits for control sample analyses, acceptability limits for replicate analyses, and response factor agreement criteria are based upon precision, in terms of the coefficient of variation (CV), i.e., the relative standard deviation or relative percent difference (RPD). The standard deviation of a sample set is calculated as:

$$S = \text{standard deviation} = \sqrt{\frac{\sum (x-\bar{x})^2}{(n-1)}}$$

where, x = individual measurement
$\bar{x}$ = mean value for the individual measurements
n = number of measurements

The CV is then calculated as:

$$CV = (S/\bar{x}) \times 100\%$$

Precision and accuracy objectives presented in Table 6-1 are not intended to represent data validation criteria. Rather, these values simply

TABLE 3-1. SUMMARY OF ANALYTICAL METHODS PRECISION AND ACCURACY OBJECTIVES

Parameter	Reference Method	Preparation Process	Type of Analysis	Confirmation for Identification	Precision[a]	Accuracy[b]
Trace Elements	EPA 200.7	Digestion by HNO_3	Inductively Coupled Plasma Emission Spectroscopy (ICPES)	--	±60%	±50%
Inorganic Anions	EPA 300.0	--	Ion Chromatography	--	Not specified	Per method QC acceptance criteria
Purgeable Halocarbons	EPA 601	Purge and Trap	Gas chromatography/ Hall Detector	Second-column Confirmation (FID)	±60%	Per method QC acceptance criteria
Purgeable Organic Priority Pollutants	EPA 624	Purge and Trap	Gas Chromatography/ Mass Spectroscopy	Mass Spectral Confirmation	±70%	Per method QC acceptance criteria
Base/Neutrals and Acid Extractables	EPA 625	Methylene Chloride extraction	Gas Chromatography/ Mass Spectroscopy	Mass Spectral Confirmation	±70%	Per method QC acceptance criteria

[a] Percent difference for replicate analyses.

[b] Determined using method QC acceptance criteria for matrix spikes.

represent estimates of the magnitude of uncertainty which might be associated with the data due to measurement error. The QA/QC efforts will focus upon controlling measurement error within these limits and will ultimately provide a data base for estimating the actual uncertainty in the data. It is anticipated that this uncertainty will generally fall within the limits shown in Table 3-1. In terms of impact upon the program objectives, data quality is not equally important for all measurements. Measurements using real-time portable analyzers, for instance, are in most cases used only to provide relative concentration measurements or monitor the working environment as part of the safety program. In these applications, absolute accuracy is of little consequence.

Data representativeness is a function of sampling strategy and is discussed in the appropriate sampling plans. Data comparability will be achieved by using standard units of measure as specified in the methods. The objective for data capture for all measurement parameters will be 90 percent, where completeness is defined as the percentage of valid data in total tests conducted.

4.0 SAMPLE COLLECTION PROTOCOL

The purpose of the sampling protocol is to delineate the procedures which will be used in the collection of ground-water samples from the existing wells at the Lockheed Beaumont sites. The objective of the sampling program is to obtain samples that are representative of the ground water surrounding the well being sampled, and to analyze these samples in a manner which reflects the composition of the ground water as accurately as possible. In order to achieve this objective, all factors which may affect the physical and chemical integrity of the sample must be controlled before, during, and after sample collection.

Water Level and Well Depth Measurements

Prior to the purging or sampling of a well, a static water level measurement and a sounding of the total well depth will be performed. A Fisher M-Scope, or a comparable electronic well sounder, will be used to determine these levels to the nearest 0.01 foot. This instrument utilizes an indicator probe attached by an insulated wire line to an electric meter. When the probe contacts water, an electric circuit is completed, and the meter deflects.

The probe and wire line of this device will be decontaminated between the sounding of the different wells in order to preclude the possibility of cross-contamination. They will be washed with laboratory grade detergent (Alconox), rinsed with potable water, and given a final rinse with distilled water. Particular attention will be paid to the cleaning of the last several feet which actually contact the water. In the event of obvious contamination, the probe and line will be wiped down with acetone to remove the contamination and then washed using the above procedure.

The wire line of the instrument will be calibrated against a steel surveyor's tape at the beginning and end of well sounding activities, and periodically while measurements are being taken. These calibration data will be recorded in the sampler's field notebook.

The static water level will be determined by lowering the probe into the well and obtaining two successive readings which agree to within 0.01 foot. The probe, used as a weighted sounder, will then be lowered to the total depth of the well, where a reading will be taken of the well bottom. All information will be recorded on a form similar to the one shown in Figure 4-1.

All measurements will be referenced to the top of the metal protective casing with the locking cap off. Water level results will be recorded as depth to ground water and will be converted to elevations relative to the USGS benchmarks at the site.

Well Purging

Each monitoring well will be purged immediately prior to sample collection in order to ensure that fresh formation water, representative of the surrounding ground water, is being sampled. The purging operation for shallow wells will be conducted using a Teflon® bailer. A clean submersible pump will be used for the deeper wells.

The bailer and sampling line will be decontaminated prior to use at a well. Bailers will be washed with laboratory-grade detergent (Alconox), rinsed with potable water, and given a final rinse with the liberal use of distilled water.

Each well will be purged by lowering the bailer into the well, allowing it to fill with water, and raising it out of the well. The bailer will not be dropped into the well in order to avoid creating turbulence in the well, causing aeration or degassing of the water. Unnecessary agitation, mixing, or aeration of the well water could possibly affect the sample

GROUND WATER GAUGING DATA SHEET

Parameter Description	Value
SAMPLE CONTROL NUMBER	
DATE	
TIME	
SAMPLER'S INITIALS	
WELL/BORING LOCATION	
WELL/BORING DIAMETER (in)	
ELEVATION OF TOP OF WELL CASING	
REFERENCED TO MEAN SEA LEVEL (MSL)	
GAUGING	
Total Depth (ft)	
Depth to Groundwater (ft)	
CALCULATIONS	
Thickness of Groundwater (ft)	
Well Volume (gallons)	
Purge Volume (gallons)	
NUMBER OF SAMPLE BOTTLES AND TYPE COLLECTED	
pH	
Conductance (umhos)	
Temperature (°C)	

COMMENTS:

Figure 4-1. Ground-Water Gauging Data Sheet.

quality. The well will be purged of a water volume equivalent to three times the water column standing in the casing. If the recharge rate of the well does not permit the withdrawal of three casing volumes, the well will be bailed dry. If the recovery rate is rapid enough, the well will be allowed to refill and the well will be bailed dry a second time. In all cases, the method used and volume of water purged from the well will be recorded. During the purging activity, the equipment and line will not be allowed to lay on the ground or become otherwise contaminated. If contamination inadvertently occurs, the equipment part(s) will be recleaned before the operation is resumed using the aforementioned decontamination procedure.

A five-gallon bucket (or similar container of known capacity) will be used to quantify the amount of water being removed from the well during the purging process. Water produced during purging will be disposed of by discharging to the adjacent ground surface.

Sample Collection

Ground-water samples will be collected with a Teflon® bailer immediately following purging of the well. Prior to sample collection, sampling personnel will re-suit with new, clean, latex, surgical-type gloves in order to avoid sample or bottle contamination.

Containers for sample collection will be obtained from I-Chem Research Corporation, which prepares specially cleaned containers for environmental sampling. All containers have Teflon® linings in the covers.

Ground-water samples will be recovered in a prearranged priority so that all collection and handling takes place as efficiently as possible. Although the actual sample collection protocol will depend on the analyte of interest, it is important to be consistent in general sample collection procedures to facilitate reliable and comparable results. During sample collection, one member of the field team will oversee the operation of field equipment and collection of samples. The other team member will be responsible for entering data into the field logs, container labeling, etc. Such consistency will help minimize any errors which may compromise data validity or promote bias in the analytical results.

The sampling and field handling procedures associated with each analytical method are described below. A description of preservation methods, sample containers, and holding times is presented in Table 4-1.

Purgeable and Halocarbon Organic Compounds (EPA Methods 601 and 624)

EPA Methods 601 and 624 are used to detect purgeable halocarbon and organic compounds in water samples, respectively. Samples for Method 601 analyses should be collected in 40 ml amber glass volatile organic analysis (VOA) vials with Teflon® septa in the screw top cap. Amber glass VOA vials with a minimum capacity of 25 ml should be used for Method 624 samples.

It is extremely important to prevent aeration of ground water samples recovered for EPA 601 and 624 analyses. The Teflon® bailer should be held near the top of the VOA vial and the water allowed to run down the inside of the container. The vial will be filled until a reverse miniscus forms over the top. After the vial has been capped, the bottle will be turned upside down and tapped gently to check for the presence of air in the sample. If any bubbles appear, the sample will be recollected and the above-referenced procedure repeated. Accurate analytical results for VOCs and dissolved gases will be compromised if there is any free air trapped in the sample container.

Base/Neutral and Acid Extractables (EPA Method 625)

Samples collected for base/neutral and acid extractables (EPA Method 625) should be recovered in 1-liter amber glass containers with Teflon®-lined lids. Chemical preservation is not required.

TABLE 4-1. WATER SAMPLE STORAGE AND PRESERVATION METHODS

Parameter	Reference Method	Container(s)[a]	Preservation	Maximum Storage Requirements	Holding Time
Trace Elements (23 Metals)	EPA 200.7	One 500 ml glass or polyethylene jar	HNO_3 to pH <2	Refrigerate at 4°C	6 months
Purgable Halocarbons	EPA 601	Three 40 ml glass vials with Teflon® Seals		Refrigerate at 4°C	14 days
Inorganic Anions	EPA 300.0	One 500 ml glass or polyethylene jar	None	Refrigerate at 4°C	48 hours
Purgable Organic Priority Pollutants	EPA 624	Three 40 ml glass vials with Teflon® Seals		Refrigerate at 4°C	14 days
Base/Neutral and Acids	EPA 625	Two 1-Liter glass bottles with Teflon® Seals		Refrigerate at 4°C	7 days until extraction, 40 days after extraction

[a] All containers are pre-treated and cleaned before being purchased by the laboratory.

Metals

One sample can be recovered from each well for all metals analyses. The sample should be collected in a 500 ml glass or polyethylene jar with a Teflon®-lined lid. Samples scheduled for metals analyses require filtration and preservation with dilute (1:1) nitric acid (HNO_3) to a pH of less than 2. However, preservation should not take place until filtration has been completed. Preservation of samples prior to filtration may leach metals from any sediment into solution, resulting in erroneously high concentration values. In the event that HNO_3 will be used because of shipping restrictions, the sample will be refrigerated to 4°C, shipped immediately, and acidified upon receipt at the laboratory.

Common Ions

Samples collected for ion analyses should be recovered in 500 ml glass or polyethylene jars with Teflon®-lined lids. Nitrate analysis requires samples to be cooled to 4°C.

Specific conductance, pH, and Temperature

Specific conductance, pH, and temperature of water can change over the sample holding time. Consequently, these parameters will be determined in the field. The pH and conductivity probes or cells will be rinsed at least two times with the water to be tested prior to making and recording the measurements. Groundwater temperature will be taken concurrently with pH and conductivity measurements and recorded as degrees Celsius. Values for pH, specific conductance, and temperature will be measured and recorded with a minimum accuracy of ± 0.1 pH unit, ± 10 micromhos, and ± 0.5°C, respectively.

Sample Storage

All samples will be stored at approximately four degrees Celsius (4°C) from immediately after collection until analysis. In the field, samples will be kept in coolers (ice chests) kept cool with ice. Care will be taken to ensure that the samples do not freeze. It should be noted that excessive cold (i.e., packing sample bottles in direct contact with ice) has been attributed to the formation of air bubbles in VOA sample vials, requiring recollection of the samples. Protective foam or styrofoam packing for the containers will protect the samples from excessive cold and minimize the risk of breakage during transport.

5.0 Sample Custody

Samples will be shipped to Radian Analytical Services in Sacramento for analysis. Upon arrival at the laboratory the samples will be inspected, logged into a computer tracking system, and distributed to the laboratory staff by the Radian sample control officer.

When packaging samples for commercial transport, an absorbent material such as vermiculite will be used in case of breakage, and individual bottles will be separated by padded materials. Sample packaging requirements for hazardous materials requiring interstate transport are defined in the Code of Federal Regulations (CFR) 49, Chapter 1, Part 171. These requirements outline in detail the proper classification and procedures for transportation of hazardous materials that will be used for transport of the samples.

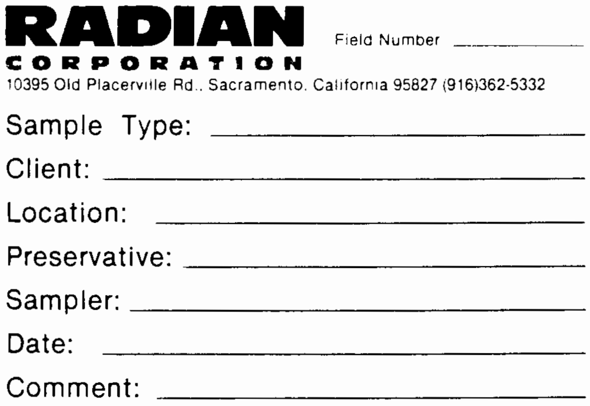
A master sample log will be maintained on-site for all ground water samples collected. Each sample will be assigned a unique identification number; and a full description of the sample, its origin, and disposition will be included in the master log entry. Figure 5-1 is an example of a master sample log entry.

Each sample taken will have a sample label, an example of which is shown in Figure 5-2. Sample labels serve to identify the sample by documenting the sample type, who took it, where it was taken, when it was taken, and the preservation method used. The unique number assigned to each sample is also documented on the sample label. These labels will be filled out using a marker with indelible ink and affixed to the bottles immediately before samples are taken for each individual well. No pens with volatile organic carriers (i.e., Sharpies) will be used in the vicinity of sampling activity in order to prevent possible sample contamination. To ensure future legibility, clear tape will be affixed over the labels.

FIELD INFORMATION

Sample Control No.	Date Sampled	Time Sampled	Sample Location	Sampler's Initials	Matrix	Dup	Analysis	Preservative	Lab ID	Date to Lab	Date from Lab	Comments

Figure 5-1. Example of On-Site Master Sample Log.



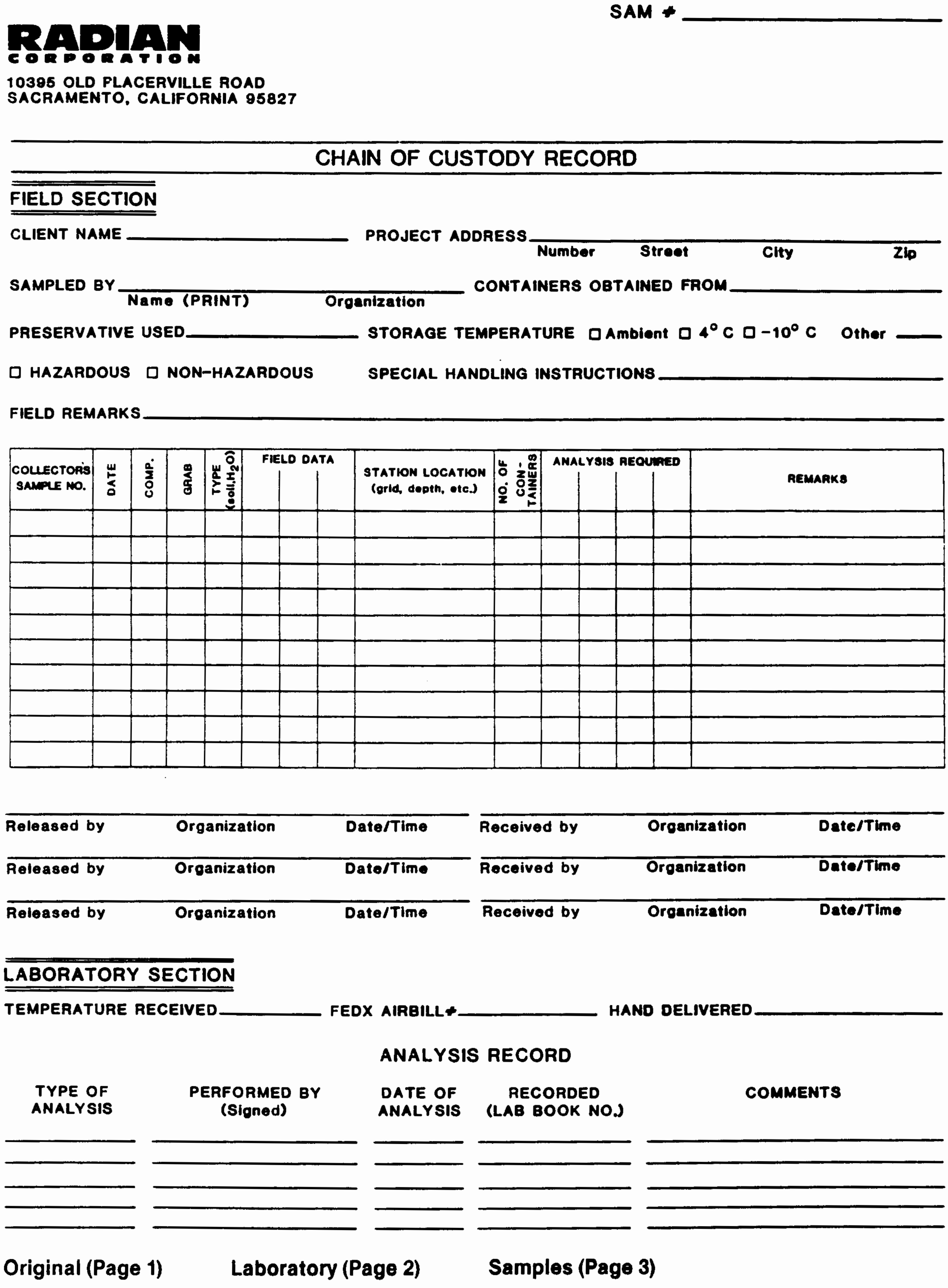
RADIAN
CORPORATION Field Number ____________
10395 Old Placerville Rd., Sacramento, California 95827 (916)362-5332

Sample Type: ______________________
Client: ______________________
Location: ______________________
Preservative: ______________________
Sampler: ______________________
Date: ______________________
Comment: ______________________

3-85-20160

Figure 5-2. Radian sample label.

Chain-of-custody procedures are an integral part of the quality assurance/quality control (QA/QC) program for sampling and analysis. The chain-of-custody record accompanies sealed samples to the laboratory and provides a record of who handled the sample during collection, transportation, and analysis. The chain-of-custody documentation must be kept with the samples at all times. An example of a blank chain-of-custody form is presented in Figure 5-3.



SAM # ______________________

RADIAN
CORPORATION
10395 OLD PLACERVILLE ROAD
SACRAMENTO, CALIFORNIA 95827

CHAIN OF CUSTODY RECORD

FIELD SECTION

CLIENT NAME ______________ PROJECT ADDRESS ______________________
Number Street City Zip

SAMPLED BY ______________________ CONTAINERS OBTAINED FROM ______________
Name (PRINT) Organization

PRESERVATIVE USED ______________ STORAGE TEMPERATURE ☐ Ambient ☐ 4° C ☐ -10° C Other ____

☐ HAZARDOUS ☐ NON-HAZARDOUS SPECIAL HANDLING INSTRUCTIONS ______________

FIELD REMARKS ______________________

COLLECTORS SAMPLE NO.	DATE	COMP.	GRAB	TYPE (soil, H_2O)	FIELD DATA			STATION LOCATION (grid, depth, etc.)	NO. OF CON-TAINERS	ANALYSIS REQUIRED				REMARKS

Released by	Organization	Date/Time	Received by	Organization	Date/Time
Released by	Organization	Date/Time	Received by	Organization	Date/Time
Released by	Organization	Date/Time	Received by	Organization	Date/Time

LABORATORY SECTION

TEMPERATURE RECEIVED __________ FEDX AIRBILL# __________ HAND DELIVERED __________

ANALYSIS RECORD

TYPE OF ANALYSIS	PERFORMED BY (Signed)	DATE OF ANALYSIS	RECORDED (LAB BOOK NO.)	COMMENTS

Original (Page 1) **Laboratory (Page 2)** **Samples (Page 3)**

Figure 5-3. Chain of Custody

6.0 Calibration Procedures and Frequency

Laboratory calibration procedures are conducted according to the prescribed protocols described in each EPA method.

7.0 Analytical Procedures

In assessment monitoring, parameters are carefully selected in order to determine the existence and concentration of specific substances which are known, or suspected, to be present in the ground water. The various EPA methods utilized in this investigation include analysis for purgeable halocarbons, purgeable organics, base/neutral and acid extractables, trace elements (metals), and inorganic anions.

Analytical methods were selected to provide results with a high degree of sensitivity at a cost effective rate. The analytical methods, EPA method numbers, and descriptions of the methods are summarized in Table 3-1. Specific analytes and their detection limits will be discussed later in this section. Table 4-1 lists the sample quantity, sample container, and sample preservation procedures required for each analytical test.

Purgeable Halocarbon Analysis
EPA Method 601

Samples are analyzed for purgeable halocarbons using EPA Method 601. Method 601 is a purge and trap gas chromatographic technique. An inert gas is bubbled through the ground-water sample to transfer volatile purgeable halocarbons from the liquid to the vapor phase. Halocarbons are removed from the inert gas by passing it through a sorbent trap. The halocarbons are then backflushed from the sorbent trap onto a gas chromatographic column to separate and quantify the compounds of interest. The species that can be detected by EPA Method 601 are listed in Table 7.1.

Method 601 provides for a second gas chromatographic column to resolve compounds of interest from interferences that may occur during the analysis. When second-column analysis is performed, retention times on both columns must match. Non-matching chromatographic peaks are considered interference.

TABLE 7-1

EPA METHOD 601

PURGEABLE HALOCARBONS

PARAMETERS AND DETECTION LIMITS

Parameter	Method Detection Limit (ug/liter)
Chloromethane	0.08
Bromomethane	1.18
Dichlorodifluoromethane	1.81
Vinyl Chloride	0.18
Chloroethane	0.52
Methylene Chloride	0.25
Trichlorofluoromethane	ND
1,1-Dichloroethene	0.13
1,1-Dichloroethane	0.07
trans-1,2-Dichloroethene	0.10
Chloroform	0.05
1,2-Dichloroethane	0.03
1,1,1-Trichloroethane	0.03
Carbon Tetrachloride	0.12
Bromodichloromethane	0.10
1,2-Dichloropropane	0.04
cis-1,3-Dichloropropene	0.34
Trichloroethene	0.12
Dibromochloromethane	0.09
1,1,2-Trichloroethane	0.02
trans-1,3-Dichloropropene	0.20
2-Chloroethylvinyl Ether	0.13
Bromoform	0.20
1,1,2,2-Tetrachloroethane	0.03
Tetrachloroethene	0.03
Chlorobenzene	0.25
1,3-Dichlorobenzene	0.32
1,2-Dichlorobenzene	0.15
1,4-Dichlorobenzene	0.24

ND = not determined

Purgeable Halocarbon and Organic Analysis
EPA Method 624

The presence and concentration of purgeable halocarbon and organic compounds can be determined by EPA Method 624. This method (modified for the EPA contract laboratory program) uses a purge and trap gas chromatographic/mass spectrometer (GC/MS) technique. An inert gas is bubbled through the water samples to transfer the purgeable organic compounds from the liquid to vapor phase. The vapor is then swept through a sorbent trap where the purgeables are trapped. The trap is backflushed and heated to desorb the purgeable organics onto a gas chromatographic column where they are separated and then detected with a mass spectrometer. The species which can be detected using EPA Method 624 and their detection limits are listed in Table 7.2.

Base/Neutral and Acid Extractable Organic Analysis
EPA Method 625

Base/neutral and acid extractable analysis is performed using EPA Method 625. This technique quantitatively determines the concentration of a number of semi-volatile organic compounds. Organic compounds are extracted from the sample with methylene chloride at a pH of greater than 11 to obtain base/neutral extractables. Acid extractable compounds are obtained from the sample by extraction with methylene chloride at a pH of 2 or less. Both base/neutral and acid extracts are then concentrated by removal of the methylene chloride through evaporation. Compounds of interest are separated and quantified using a gas chromatograph/mass spectrometer (GC/MS). The compounds that can be detected using EPA Method 625 and their detection limits are listed in Table 7-3.

TABLE 7-2

EPA METHOD 624 (WATER)

PURGEABLE HALOCARBONS AND AROMATICS
PARAMETERS DETECTION LIMITS

Parameter	Detection Limit (ug/1, Water)
Chloromethane	5.0
Bromomethane	5.0
Vinyl chloride	5.0
Chloroethane	5.0
Methylene chloride	2.8
Acetone	7.5
Carbon disulfide	1.7
Trichlorofluoromethane	5.0
1,1-Dichloroethene	4.7
1,1-Dichloroethane	2.8
trans-1,2-Dichloroethene	1.6
Chloroform	1.6
1,2-Dichloroethane	2.8
1,2-Dichloroethane	2.5
1,1,1-Trichloroethane	3.8
Carbon tetrachloride	2.8
Vinyl acetate	6.9
Bromodichloromethane	2.2
1,2-Dichloropropane	6.0
cis-1,3-Dichloropropene	5.0
Trichloroethene	1.9
Benzene	4.4
Dibromochloromethane	3.1
1,1,2-Trichloroethane	5.0
trans-1,3-Dichloropropene	5.0
2-Chloroethylvinyl ether	5.0
Bromoform	4.7
2-Hexanone	
4-Methyl-2-pentanone	
1,1,2,2-Tetrachloroethane	6.9
Tetrachloroethene	4.1
Toluene	6.0
Chlorobenzene	6.0
Ethyl benzene	7.2
Styrene	3.0
Total xylenes	4.6

TABLE 7-3

EPA METHOD 625 (WATER)

BASE/NEUTRAL AND ACID EXTRACTABLE ANALYSIS PARAMETERS AND DETECTION LIMITS

Parameters	Detection Limit (ug/liter)
A. Base/Neutral Extractables	
1,3-Dichlorobenzene	1.9
1,4-Dichlorobenzene	4.4
Hexachloroethane	1.6
bis(2-Chloroethyl) ether	5.7
1,2-Dichlorobenzene	1.9
bis(2-Chloroisopropyl) ether	5.7
Nitrobenzene	1.9
Hexachlorobutadiene	0.9
1,2,4-Trichlorobenzene	1.9
Isophorone	2.2
Naphthalene	1.6
bis(2-Chloroethoxyl) methane	5.3
Hexachlorocyclopentadiene	6.0
2-Chloronaphthalene	1.9
Acenaphthalene	3.5
Acenaphthene	1.9
Dimethyl phthalate	1.6
2,6-Dinitrotoluene	1.9
Fluorene	1.9
4-Chlorophenyl phenyl ether	4.2
2,4-Dinitrotoluene	5.7
Diethylphthalate	1.9
n-Nitrosodiphenylamine	1.9
Hexachlorobenzene	1.9
4-Bromophenyl phenyl ether	1.9
Phenanthrene	5.4
Anthracene	1.9

(Continued)

TABLE 7-3 (Continued)

Parameters	Detection Limit (ug/liter)
A. Base/Neutral Extractables (Continued)	
Alpha-BHC	3.0
Beta-BHC	5.0
Gamma-BHC (lindane)	4.0
Delta-BHC	4.0
Heptachlor	1.9
Aldrin	1.9
Dinbutyl phthalate	2.5
Heptachlor epoxide	2.2
Endosulfan I	6.0
Fluoranthene	2.2
Dieldrin	2.2
4,4'-DDE	5.6
Pyrene	1.9
Endrin	2.5
Endosulfan II	10
4,4'-DDD	2.8
Benzidine	44
4,4'-DDT	4.7
Endosulfan sulfate	5.6
Endrin aldehyde	10
Butyl benzyl phthalate	2.5
bis(2-Ethylhexyl) phthalate	2.5
Chrysene	2.5
Benzo(a)anthracene	7.8
3,3'-Dichlorobenzidine	16.5
Di-n-octyl phthalate	2.5
Benzo(b)fluoranthene	4.8
Benzo(k)fluoranthene	2.5
Benzo(a)pyrene	2.5
Indeno(1,2,3-c,d)pyrene	3.7
Dibenzo(a,h)anthracene	2.5
Benzo(g,h,i)perylene	4.1
2n-Nitrosodimethylamine	10
Gamma chlordane	10
Alpha chlordane	10
PCB (various isomers)	30

(Continued)

TABLE 7-3 (Continued)

Parameters	Detection Limit (ug/liter)
B. Acid Extractables	
2-Chlorophenol	3.3
2-Nitrophenol	3.6
Phenol	1.5
2,4-Dimethylphenol	2.7
2,4-Dichlorophenol	2.7
2,4,6-Trichlorophenol	2.7
4-Chloro-3-methylphenol	3.0
2,4-Dinitrophenol	42
2-Methyl-4,6-dinitrophenol	24
Pentachlorophenol	3.6
4-Nitrophenol	2.4

Trace Elements ICPES (Metals)
EPA Method 200.7

Samples are analyzed for trace elements, or metals, using EPA Method 200.7 for water. Analysis for most metals requires digestion of the sample by nitric acid. This digestion is performed as part of Method 200.7 for water. Following digestion, the trace elements are simultaneously or sequentially determined using inductively coupled argon plasma emission spectroscopy (ICPES). The elements and corresponding detection limits for this method are listed in Table 7.4.

Inorganic Anions
EPA Method 300.0

Samples are analyzed for anions using EPA Method 300.0. This procedure covers the determination of fluoride, chloride, nitrate, and sulfate in water by ion chromatography. Ion chromatography represents a rapid method for separating and analyzing complex solutions of ionic species. The technique employs ion exchange resins to separate individual ions, a patented suppressor column to remove eluent ions, and conductivity cells for the detection of the separated ions.

TABLE 7-4
EPA METHOD 200.7
TRACE ELEMENTS (METALS)
PARAMETERS AND DETECTION LIMITS

Compound	Detection Limits (mg/1)
Aluminum	0.05
Antimony	0.02
Arsenic	0.06
Barium	0.05
Beryllium	0.001
Boron	0.05
Cadmium	0.002
Calcium	0.05
Chromium	0.005
Cobalt	0.006
Copper	0.001
Iron	0.008
Lead	0.08
Magnesium	0.03
Manganese	0.001
Molybdenum	0.002
Nickel	0.003
Potassium	0.05
Selenium	0.08
Silicon	0.02
Silver	0.002
Sodium	0.03
Thallium	0.09
Vanadium	0.003
Zinc	0.003

EPA Method 200.7 has only estimated detection limits for water.

8.0 Data Reduction, Validation, and Reporting

A significant effort will be made to insure that the data meets quality specifications and the reported results are properly qualified. Proper data qualification includes the use of the Radian Analytical Services "Data Export System," evaluation by the analytical task leader, and qualification of data using guidelines established by the American Chemical Society.

The Radian laboratory data will be "exported" to the analytical task leader via hard copy and on floppy disk. Included will be all sampling and analytical quality control information needed to evaluate data quality and method detection limit/apparent detection limit information. The analytical task leader will review these data by batch, compute data qualifying information, and report validated qualifier data. All sample data will be assigned a code indicating the degree of confidence in the sample data. A summary of these codes is given in Table 8-1. Qualifiers such as limit of detection (LOD) and limit of quantitation (LOQ) will be computed using reagent blank data or method detection limits. All sample data will be accompanied with units of measure and the qualifier code indicating quantitative data (above LOD), semi-quantitative data (between limit of detection and quantitation, or in the region of less certainty), or not quantitative (below limit of detection). This code system will resolve any ambiguity in reporting results and provide proper quantification.

If information indicating "possible presence" of a compound is requested, it is possible to report data as below method detection limit (which would typically be below LOD as well). However, this practice is not recommended since data in this region are below reasonable levels of confidence.

Quality control data will be coded and grouped so as not to be confused with results from field samples.

TABLE 8-1

CODING OF SAMPLE/QC DATA

Type of Data	Sample Code	Description
Sample Data	Q	Quantitative - above limit of quantitation.
	SQ (TR)	Semiquantitative (Trace) - between limit of detection and quantitation or in the region of less certainty.
	NQ	Not quantitative - below limit of detection. Can be reported as one-half method detection limit or apparent detection limit.
	NA	Not analyzed.
	NS	Not Sampled.
Quality Control Data	FB	Field blank.
	TB	Trip blank.
	RB	Reagent blank.
	FD	Field duplicate.
	LD	Laboratory duplicate.
	MS	Matrix spike.
	CS	Control Sample.

General reporting practices will include:

- Report header information identifying the information for the sample batch and the analytical method used;
- Sample identification that uniquely identifies the sample analyzed;
- Consistent units of measure per method;
- Consistent significant figures per method;
- Qualification of missing data values (no blank or dashed places reported);
- Qualification of outlier values as to the probability of their existence or the cause for deviation from historical data;
- Consistent treatment of low values using limit of detection/ limit of quantitation criteria; and
- Comparison with regulatory action levels if applicable.

9.0 Internal Quality Control Checks

Quality assurance/quality control (QA/QC) is an integral part of the sampling program for the Lockheed Beaumont sites. The quality assurance (QA) program is a system of quality control (QC) checks which enables validation of data reliability. For example, consistent adherence to sampling protocols, as identified in this plan, represents an important series of QC checks in the overall QA program. Likewise, the recovery of blank, duplicate, and split samples and the use of spikes, laboratory standards, and other control samples during analysis, all serve to help quantify sample bias, determine the limits of precision and accuracy, and validate the reliability of the data set. Such components of the quality assurance program will help to produce data of known quality.

Field Duplicate Samples

A field duplicate sample is a second sample collected at the same location as the original sample. This duplicate sample is analyzed for the purpose of assessing precision due to the combined effects of laboratory analysis and the sample collection process. The duplicate sample will be collected in immediate succession, using identical recovery techniques, and treated in an identical manner during storage, transportation, and analysis. Recovery and analysis of one duplicate sample for every 10 method samples recovered will be performed. The sample containers will be assigned a control number such that they cannot be identified as duplicate samples by laboratory personnel (blind duplicate).

Field Blank/Background Samples

Field blanks/background samples are uncontaminated samples which are collected and processed using the same sampling and handling procedures as other samples. Field blanks in the water matrix are used to assess the potential introduction of contaminants to the samples during sample collection and analysis.

A minimum of one field blank in the water matrix will be collected and analyzed for every 20 method samples. The field blank will consist of distilled water which has been boiled for 10 minutes, allowed to cool, and purged with ultrapure nitrogen for 15 minutes.

Analytical/Laboratory Quality Control

Although field personnel do not implement laboratory QC procedures, it is important to understand laboratory QC protocols when reviewing analytical results. Identifying the introduction of contaminants into data sets as a result of equipment contamination and/or analytical methodologies can greatly affect the representation of the nature and extent of contamination. Laboratory QC is necessary to ensure the validity, and determine the accuracy and precision, of analytical results. The QC checks in the laboratory protocol are specific to the analytical method of interest and generally include the use of:

- Laboratory duplicates;
- Reagent blanks;
- Calibration standards;
- Matrix and surrogate spikes;
- Control samples; and
- Second-column confirmations.

Duplicate, blank, and spike analyses are completed by the laboratory in order to obtain information regarding the accuracy and precision of laboratory equipment and to identify any contaminants which may be introduced to the sample during the analytical procedures. Laboratory duplicates are a second analytical run of the sample collected. Reagent blanks consist of an analytical run without the addition of a sample. A matrix spike is a sample run with a known concentration of certain species of interest added to the sample. Surrogate spikes assess the recovery for key species (volatile, base/neutral, and acid compounds) for every sample analysis. The percentage of the "spiked" species recovered indicates loss or gain of the species due to the analytical equipment or procedures used. One laboratory duplicate and one matrix spike are generally run for every 10 sample analyses performed and one reagent blank is typically completed for every batch of samples analyzed. Control samples are similar to spiked samples in that they are also reported in percent recovery. Distilled water is spiked with the method target analytes. The same control check standard issued by the U.S. EPA is used throughout the project. The control sample is analyzed prior to the sample analyses. All parameters of interest must meet the percent recovery criteria before actual sample analyses occurs. This ensures that the system performance is acceptable.

10.0 Performance and Systems Audit

Radian Analytical Services is a participant in the EPA Contract Laboratory Program (CLP) for organic and inorganic analyses. Within this program, Radian Analytical Services is audited every six months for both organic and inorganic analytical quality. If needed, the results of the CLP audit are available for review. Radian is also involved in the EPA Check Sample Program and is a qualifying laboratory. RAS Sacramento is certified by the State of California Department of Health Services to perform hazardous waste testing and water analysis.

11.0 Preventative Maintenance

The primary objective of a preventative maintenance program is to help ensure the timely and effective completion of a measurement effort. Radian's preventative maintenance program is designed to minimize the down time of crucial sampling and/or analytical equipment due to expected or unexpected component failure. In implementing this program, efforts are focused in three primary areas:

- Establishment of maintenance responsibilities;
- Establishment of maintenance schedules for major and/or critical instrumentation and apparatus; and
- Establishment of an adequate inventory of critical spare parts and equipment.

12.0 Corrective Action

During the course of the program, it will be the responsibility of the Project Director and the sampling team members to see that all measurement and sampling procedures are followed as specified and that measurement data meet the prescribed acceptance criteria. In the event a problem is discovered, prompt and predescribed action will be taken to correct the problem. Corrective action will be initiated, for instance, if QC data are found to exceed acceptability limits. Corrective action may be initiated by the QA Coordinator based upon QC data or audit results, following the flow chart shown in Figure 12-1.

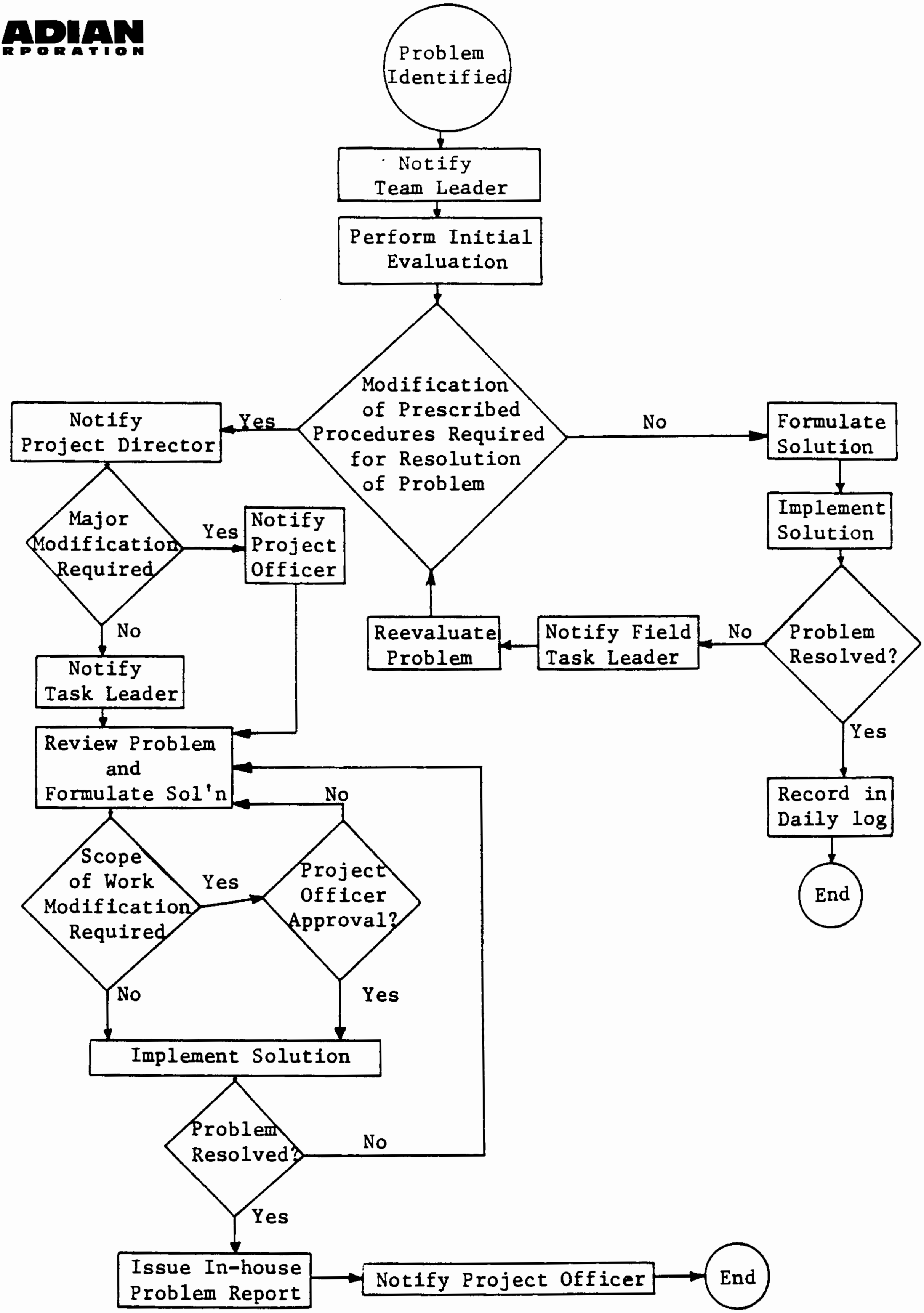


Figure 12-1. Corrective action flow scheme.

13.0 Quality Assurance Reporting

Effective management of a field sampling and analytical effort requires timely assessment and review of field activities. This will require effective interaction and feedback between the field team members, Project Directors, and the QA Coordinator.

The Task Leaders will be responsible for keeping the QA Coordinator and Project Director up to date regarding the status of their respective tasks and results of the QC activities. This will insure that quick and effective solutions can be implemented should any data quality problems arise. The use of frequent status report provides an effective mechanism for ensuring ongoing evaluation of measurement efforts. These status reports will address some or all of the following:

- Summary of activities and general program status;
- Summary of calibration and QC data;
- Summary of unscheduled maintenance activities;
- Summary of corrective action activities;
- Status of any unresolved problems;
- Assessment and summary of data completeness; and
- Summary of any significant QA/QC problems, corrective action and recommended and/or implemented solutions not included above.

Appendix B
Well logs

GEOTECHNICAL BORING LOG

ate 5-25-83 Drill Hole No. OW-1 Sheet 1 of 2

roject Name PORTRERO RANCH Project No. 6820733-02

rilling Co. PIONEER DRILLING Type of Rig AUGER

ole Diameter 8-INCH Drive Weight Drop

Elevation Top of Hole Ref. or Datum

Depth (Feet)	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density (pcf)	Moisture Content (%)	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION Logged By T.O. Sampled By T.O.
10								- MEDIUM TO COARSE MICACEOUS SAND, SLIGHTLY CL
								▽
20								- CLAYEY MEDIUM TO COARSE SAND, TAN
30								- MEDIUM TO VERY COARSE SAND, TAN
40								- FINE TO MEDIUM SAND
50								- GRAVEL
								- GRAVEL

[illegible]

Date 5-25-83 Drill Hole No. OW-1 Sheet 2 of 2

Project Name PORTRERO RANCH Project No. 6820733-02

Drilling Co. PIONEER DRILLING Type of Rig AUGER

ole Diameter 8-INCH Drive Weight Drop

Elevation Top of Hole Ref. or Datum

Depth (Feet)	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density (pcf)	Moisture Content (%)	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION Logged By TO Sampled By TO
0								MEDIUM TO COARSE SAND, DRY
					Bottom 10' heavy perforations.			
70								MEDIUM TO VERY COARSE SAND, DRY (TD.)

GEOTECHNICAL BORING LOG

Date 5/26/83 Drill Hole No. OW-2 Sheet 1 of 2 -

Project A. C. Martin Job No. 6820733-02

Drilling Co. Pioneer Drilling Type of Rig Flight Auger

Hole Diameter 8" Drive Weight 140 lbs Drop 30 in.

Elevation Top of Hole - Ref. or Datum -

Depth Feet	Graphic Log	Type of Test	Tube Sample No.	Blows Per	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION Logged by DS/TO Sampled by DS/TO
0	Alluvium (Qal)	GS SE=54		5 2	97	24	SW-SM	SAND: Medium brown, fine-coarse grained, predominantly medium grained, moderately damp, non-cohesive, micaceous Percent Passing #200 Sieve = 10%
5			Bag	5 8	97	20	CL	SILTY CLAY: Medium-dark brown, sand fine-medium grained. moderately damp, micaceous
	▼	LL=39 PI=12		2 2	-	34	ML	CLAYEY SILT: Dark brown, with fine grained an minor coarse sand, damp, abundant mica, soft
10								
		LL=31 PI= 9		3 4	-	26	CL	SILTY CLAY WITH SAND: Dark brown, medium firm
15								
		LL=32 PI= 4		3 6	-	24	ML	CLAYEY SILT: Dark gray, some interbedded sands root hairs, firm
20								
		LL=37 PI-12		4 5	-	25	ML	CLAYEY SILT: Dark gray, firm
25								
		GS NP		13 19	-	21	SM	SILTY SAND: Gray, dense Percent Passing #200 Sieve = 32%
30								

GEOTECHNICAL BORING LOG

Date 5/26/83 Drill Hole No. OW-2 Sheet 2 of 2 -
Project A. C. Martin Job No. 6820733-02
Drilling Co. Pioneer Drilling Type of Rig Flight Auger
Hole Diameter 8" Drive Weight 140 lbs Drop 30 in.
Elevation Top of Hole - Ref. or Datum -

Depth Feet	Graphic Log	Type of Test	Tube Sample No.	Blows Per	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION Logged by DS/TO Sampled by DS/TO
30	Alluvium							
		LL=37 PI=13	X	11 11	-	33	CL	SILTY CLAY: Gray, micaceous, very firm.
35								
		GS	X	8 22	-	24	SC	CLAYEY SAND: Gray-brown, dense, micaceous Percent Passing #200 Sieve = 33%
40								
		GS	X	13 33	-	24	SM	SILTY SAND: dense, micaceous Percent Passing #200 Sieve = 19%
	Bedrock (TS2)							SANDSTONE: Reddish-brown, hard drilling
45								
		GS	X	100 for 6"	-	15	SM	Percent Passing #200 Sieve = 39%
50								

TOTAL DEPTH 50'
GROUNDWATER ENCOUNTERED @ 9'

(GS)	Indicates Grain Size Analysis
(SE)	Indicates Sand Equivalent Test
(A/L)	Indicates Atterberg Limits Test
(NP)	Indicates Non-Plastic

Date 5-25-83 Drill Hole No. OW-3 Sheet 1 of 2

roject Name PORTRERO RANCH Project No. 652077-02

Drilling Co. PIONEER DRILLING Type of Rig AUGER

Hole Diameter 8-INCH Drive Weight Drop

Elevation Top of Hole Ref. or Datum

Logged By TO

Sampled By TO

Depth (Feet)	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density (pcf)	Moisture Content (%)	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION
10								∇ - FINE TO MEDIUM SAND, TAN
20								- FINE TO MEDIUM SAND SLIGHTLY CLAYEY, TAN
30								- MEDIUM TO COARSE SAND, TAN, DRY
40								- FINE TO MEDIUM SAND, TAN, DRY MICACEOUS
50								- FINE TO MEDIUM CLAYEY SAND TAN, DRY
60								

Date 5-25-83 Drill Hole No. GW-3 Sheet 2 of 2

roject Name PORTRERO RANCH Project No. 682077-02

Drilling Co. PIONEER DRILLING Type of Rig AUGER

Hole Diameter 8-INCH Drive Weight Drop

evation Top of Hole Ref. or Datum

Depth (Feet)	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density (pcf)	Moisture Content (%)	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION Logged By TO Sampled By TO
60								MEDIUM TO COARSE SAND, DRY
70								MEDIUM TO VERY COARSE SAND, TAN (T.D.)

Date 5-26-83 Drill Hole No. OW-4 Sheet 1 of 2

roject Name PORTRERO RANCH Project No. 6820733-02

Drilling Co. PIONEER DRILLING Type of Rig AUGER

ole Diameter 8-INCH Drive Weight Drop

levation Top of Hole Ref. or Datum

GEOTECHNICAL DESCRIPTION

Logged By TO

Sampled By TO

Depth (Feet)	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density (pcf)	Moisture Content (%)	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION
								— FINE TO MEDIUM SAND, TAN
10								
								— SILTY, FINE TO MEDIUM SAND, TAN
20								
								— SILTY, FINE TO MEDIUM SAND, TAN
30								
								— FINE TO COARSE SAND, AVERAGE MEDIUM, TAN
40								
								— FINE SAND, SLIGHTLY MOIST, TAN
50								
								— FINE TO MEDIUM SAND, MOIST
60								

Date 5-26-83 Drill Hole No. OW-4 Sheet 2 of 2

roject Name POTRERO RANCH Project No. 6820733-02

Drilling Co. PIONEER DRILLING Type of Rig AUGER

ole Diameter 8-INCH Drive Weight , Drop

evation Top of Hole Ref. or Datum

Depth (Feet)	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density (pcf)	Moisture Content (%)	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION Logged By TO Sampled By TO
60								
								- FINE TO MEDIUM SAND, MOIST
70								- T.D.

Date 5-27-83 Drill Hole No. OW-5 Sheet 1 of 2

Project Name PORTRERO RANCH Project No. 6820733-02

Drilling Co. PIONEER DRILLING Type of Rig AUGER

Hole Diameter 8-INCH Drive Weight Drop

Elevation Top of Hole Ref. or Datum

GEOTECHNICAL DESCRIPTION

Logged By TO

Sampled By TO

Depth (Feet)	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density (pcf)	Moisture Content (%)	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION
								FINE TO MEDIUM SILTY SAND, BROWN
10								
								CLAYEY FINE TO MEDIUM SAND AND SILT, BROW
20								
								SANDY SILT & CLAY OLIVE BROWN, MOIST
30								
								SANDY SILT, TAN
40								
								CLAYEY MEDIUM TO FINE SAND, OLIVE BROWN
50								
								FINE TO MEDIUM SILTY SAND, TAN
60								

Date 5-27-83 Drill Hole No. OW-5 Sheet 2 of 2

roject Name PORTRERO RANCH Project No. 6820733-02

rilling Co. PIONEER DRILLING Type of Rig

Hole Diameter 8-INCH Drive Weight Drop

evation Top of Hole Ref. or Datum

Depth (Feet)	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density (pcf)	Moisture Content (%)	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION Logged By TC Sampled By TC
60								
								– GRANITIC BEDROCK (TD.) (Probably granitic clasts in Qal or Ts2)
70								

Date 5-27-83 Drill Hole No. OW-6 Sheet 1 of 1

roject Name PORTRERO RANCH Project No. 6820733-02

rilling Co. PIONEER DRILLING Type of Rig AUGER

ole Diameter 8-INCH Drive Weight Drop

vation Top of Hole Ref. or Datum

Depth (Feet)	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density (pcf)	Moisture Content (%)	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION Logged By TO Sampled By TO
								MEDIUM TO VERY COARSE SAND - TAN
10								
								MEDIUM TO VERY COARSE SILTY SAND MOIST, TAN
20								
								FINE TO MEDIUM SAND - MOIST, TAN
30								
								▽
								GRAVEL SEAM
								CLAYEY FINE SAND - GREY
40								GRANITIC BEDROCK (T.D.) (Probably granitic clasts in Qal or Ts_2)
50								

Date 5-27-83 Drill Hole No. OW-7 Sheet 1 of 1

Project Name PORTRERO RANCH Project No. 6820733-02

Drilling Co. PIONEER DRILLING Type of Rig AUGER

Hole Diameter 8-INCH Drive Weight Drop

Elevation Top of Hole Ref. or Datum

Depth (Feet)	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density (pcf)	Moisture Content (%)	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION Logged By TO Sampled By TO
								MEDIUM TO VERY COARSE SAND - TAN
10								
								MEDIUM TO COARSE SAND - TAN
20								
								MEDIUM TO VERY COARSE SAND WITH MINOR FINE PEBBLE GRAVEL - TAN
30								
								CLAYEY FINE TO MEDIUM SAND, MOIST, REDDISH BROWN
40								
								▽
49								GRANITIC BEDROCK (T.D.) (Probably granitic clasts in Qal or Ts_2)
50								

Date 5-27-83 Drill Hole No. OW-8 Sheet 1 of 2

Project Name PORTRERO RANCH Project No. 6820733-02

Drilling Co. PIONEER DRILLING Type of Rig AUGER

Hole Diameter 8-INCH Drive Weight , Drop in

Elevation Top of Hole Ref. or Datum

Depth (Feet)	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density (pcf)	Moisture Content (%)	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION Logged By TO Sampled By TO
								CLAYEY FINE TO MEDIUM SAND, MOIST, TAN
10								
								FINE SAND, TAN
20								
								MEDIUM TO VERY COARSE SAND, TAN - WITH FINE TO MEDIUM PEBBLE GRAVEL
30								
								▽
								MEDIUM TO COARSE SAND, TAN
40								
								SILTY FINE TO VERY FINE SAND, MOIST, BROWN
50								
								FINE TO COARSE SAND, TAN, WET
60								

Date 5-27-83 Drill Hole No. OW-8 Sheet 2 of 2

Project Name PORTRERO RANCH Project No. 6820733-02

rilling Co. PIONEER DRILLING Type of Rig AUGER

Hole Diameter 8-INCH Drive Weight Drop

levation Top of Hole Ref. or Datum

Depth (Feet)	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density (pcf)	Moisture Content (%)	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION Logged By TO Sampled By TO
								— SANDSTONE BEDROCK, RED (T.D.)
70								

Appendix C

Ground-water Field Sheets, Survey Data

LOCKHEED BEAUMONT

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GROUND WATER GAUGING DATA SHEET

Parameter Description	Value
SAMPLE CONTROL NUMBER	
DATE	10/15/86
TIME	8:15 AM
SAMPLER'S INITIALS	JAB / CEK
WELL/BORING LOCATION	OW-4
WELL/BORING DIAMETER (in)	2 inch
ELEVATION OF TOP OF WELL CASING REFERENCED TO MEAN SEA LEVEL (MSL)	
GAUGING	
Total Depth (ft)	71.28 (measured from top of steel casing)
Depth to Groundwater (ft)	–
CALCULATIONS	
Thickness of Groundwater (ft)	0
Well Volume (gallons)	
Purge Volume (gallons)	
NUMBER OF SAMPLE BOTTLES AND TYPE COLLECTED	
pH	
Conductance (umhos)	
Temperature (°C)	

COMMENTS:

- Moist sand at bottom of well
- No samples collected

RADIAN CORPORATION

GROUND WATER GAUGING DATA SHEET

Parameter Description	Value
SAMPLE CONTROL NUMBER	
DATE	10/15/86
TIME	9:15 AM
SAMPLER'S INITIALS	
WELL/BORING LOCATION	W-6
WELL/BORING DIAMETER (in)	9 7/8 ~~12~~ inches CCK
ELEVATION OF TOP OF WELL CASING REFERENCED TO MEAN SEA LEVEL (MSL)	
GAUGING	
Total Depth (ft)	155.2 ft
Depth to Groundwater (ft)	109 ft 7 3/4 inch = 109.65 ft
CALCULATIONS	
Thickness of Groundwater (ft)	45.6 ft
Well Volume (gallons)	268 gal
Purge Volume (gallons)	336 gal
NUMBER OF SAMPLE BOTTLES AND TYPE COLLECTED	
pH	
Conductance (umhos)	
Temperature (°C)	

COMMENTS: Pumped 45 min @ 7 gal/min → dry

shut down 10 min

3 min @ 7 gal/min → 336 total

old windmill pump

20' 11"
11'
14' 8"
16' 6"
33' 3"
21' 1"
21' 3"
21' 0"
21' 2"

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CORPORATION

GROUND WATER GAUGING DATA SHEET

Parameter Description	Value
SAMPLE CONTROL NUMBER	
DATE	10/15/86
TIME	4:00 pm
SAMPLER'S INITIALS	CEK
WELL/BORING LOCATION	W-5
WELL/BORING DIAMETER (in)	12"
ELEVATION OF TOP OF WELL CASING	
REFERENCED TO MEAN SEA LEVEL (MSL)	
GAUGING	
Total Depth (ft)	124'.3
Depth to Groundwater (ft)	75' 8½"
CALCULATIONS	
Thickness of Groundwater (ft)	49'
Well Volume (gallons)	287 gal
Purge Volume (gallons)	
NUMBER OF SAMPLE BOTTLES AND TYPE COLLECTED	EPA 601, 624, 625, 300.0, 200.7
pH	6.6
Conductance (umhos)	150
Temperature (°C)	

COMMENTS: 5.86 gal/ft/in

purged 2 hrs. 5 min at 7 gal/min

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CORPORATION

GROUND WATER GAUGING DATA SHEET

Parameter Description	Value
SAMPLE CONTROL NUMBER	
DATE	10-16
TIME	11:30
SAMPLER'S INITIALS	CGK
WELL/BORING LOCATION	W-3
WELL/BORING DIAMETER (in)	
ELEVATION OF TOP OF WELL CASING	
REFERENCED TO MEAN SEA LEVEL (MSL)	
GAUGING	
Total Depth (ft)	
Depth to Groundwater (ft)	
CALCULATIONS	
Thickness of Groundwater (ft)	
Well Volume (gallons)	
Purge Volume (gallons)	
NUMBER OF SAMPLE BOTTLES AND TYPE COLLECTED	601(3), 624(3), 605(2), 200.7, 300.0
pH	7.1
Conductance (umhos)	325
Temperature (°C)	30.5

COMMENTS: Pumped 1 hr 20 min @

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CORPORATION

GROUND WATER GAUGING DATA SHEET

Parameter Description	Value
SAMPLE CONTROL NUMBER	
DATE	10/16/86
TIME	14:45
SAMPLER'S INITIALS	JAB
WELL/BORING LOCATION	Beaumont #2 W2-3
WELL/BORING DIAMETER (in)	
ELEVATION OF TOP OF WELL CASING REFERENCED TO MEAN SEA LEVEL (MSL)	
GAUGING	
Total Depth (ft)	~~44.7~~ 208'
Depth to Groundwater (ft)	44.7'
CALCULATIONS	
Thickness of Groundwater (ft)	
Well Volume (gallons)	
Purge Volume (gallons)	
NUMBER OF SAMPLE BOTTLES AND TYPE COLLECTED	EPA 601
pH	6.8
Conductance (umhos)	950
Temperature (°C)	-

COMMENTS:

Pumped from 1:30 - 2:30 at 7 gpm

Sample taken with the pump

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GROUND WATER GAUGING DATA SHEET

Parameter Description	Value	
SAMPLE CONTROL NUMBER		
DATE	10·16	
TIME	400	
SAMPLER'S INITIALS	CEK	
WELL/BORING LOCATION	W·2	
WELL/BORING DIAMETER (in)		
ELEVATION OF TOP OF WELL CASING REFERENCED TO MEAN SEA LEVEL (MSL)		
GAUGING		10-17
Total Depth (ft)	250'	
Depth to Groundwater (ft)	27'	26.98
CALCULATIONS		
Thickness of Groundwater (ft)		
Well Volume (gallons)	pumped 1 hr 10 min @ 7 gpm	
Purge Volume (gallons)		
NUMBER OF SAMPLE BOTTLES AND TYPE COLLECTED	601 (3)	
pH	not working	
Conductance (umhos)	540	
Temperature (°C)		

COMMENTS:

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CORPORATION

GROUND WATER GAUGING DATA SHEET

Parameter Description	Value
SAMPLE CONTROL NUMBER	
DATE	10-16-86
TIME	4:30
SAMPLER'S INITIALS	CEK / JAB
WELL/BORING LOCATION	OW-3 Field Dup. WO-3
WELL/BORING DIAMETER (in)	2"
ELEVATION OF TOP OF WELL CASING REFERENCED TO MEAN SEA LEVEL (MSL)	
GAUGING	
Total Depth (ft)	57.80
Depth to Groundwater (ft)	31.80
CALCULATIONS	
Thickness of Groundwater (ft)	26.0'
Well Volume (gallons)	
Purge Volume (gallons)	45 bailers
NUMBER OF SAMPLE BOTTLES AND TYPE COLLECTED	(6) 601, (8) 624, (4) 625, (2) 200.7, (2) 300.0
pH	6.4
Conductance (umhos)	440
Temperature (°C)	19°C

COMMENTS:

RADIAN CORPORATION

GROUND WATER GAUGING DATA SHEET

Parameter Description	Value	
SAMPLE CONTROL NUMBER		
DATE	10·17	
TIME	830	
SAMPLER'S INITIALS	CEK	
WELL/BORING LOCATION	OW-1	
WELL/BORING DIAMETER (in)	2"	
ELEVATION OF TOP OF WELL CASING REFERENCED TO MEAN SEA LEVEL (MSL)		
GAUGING	1st	2nd after 30
Total Depth (ft)	68.70	71.30
Depth to Groundwater (ft)	~~53.81~~ 53.81	70.2
CALCULATIONS		
Thickness of Groundwater (ft)	15'	
Well Volume (gallons)		
Purge Volume (gallons)	30 bailers	
NUMBER OF SAMPLE BOTTLES AND TYPE COLLECTED		
pH	8.8	
Conductance (umhos)	1200	
Temperature (°C)	18.5 °C	

COMMENTS: bailed 27 - dry removed 2.5' silt
ho recovered ~ 4" in 5min -
bailed 4 more bailers - water silty, but not too bad → sampled

RADIAN
CORPORATION

GROUND WATER GAUGING DATA SHEET

Parameter Description	Value	
SAMPLE CONTROL NUMBER		
DATE	10-17-86	
TIME	10:15	
SAMPLER'S INITIALS	CEK	
WELL/BORING LOCATION	OW-2	
WELL/BORING DIAMETER (in)	2"	
ELEVATION OF TOP OF WELL CASING REFERENCED TO MEAN SEA LEVEL (MSL)		
GAUGING	Initial	Final
Total Depth (ft)	16.05	22.35
Depth to Groundwater (ft)	1.85'	1.
CALCULATIONS		
Thickness of Groundwater (ft)		
Well Volume (gallons)		
Purge Volume (gallons)	bailed 125 bailers	
NUMBER OF SAMPLE BOTTLES AND TYPE COLLECTED	601(3)	
pH	6.4	
Conductance (umhos)	190	
Temperature (°C)	18.5°	

COMMENTS:

silty at first- near 16' - bailed silt until would drop further can hear water filling casing - rapid recovery

RADIAN CORPORATION

GROUND WATER GAUGING DATA SHEET

Parameter Description	Value
SAMPLE CONTROL NUMBER	
DATE	10-17
TIME	10:52
SAMPLER'S INITIALS	CEK
WELL/BORING LOCATION	W-1 LSM washout
WELL/BORING DIAMETER (in)	8.5" inside casing
ELEVATION OF TOP OF WELL CASING	
REFERENCED TO MEAN SEA LEVEL (MSL)	
GAUGING	
Total Depth (ft)	
Depth to Groundwater (ft)	
CALCULATIONS	
Thickness of Groundwater (ft)	
Well Volume (gallons)	
Purge Volume (gallons)	
NUMBER OF SAMPLE BOTTLES AND TYPE COLLECTED	601
pH	~~8.6~~ 6.8
Conductance (umhos)	500
Temperature (°C)	20 5°

COMMENTS: Pumped 2hrs @ 10gpm
then
10 min full open

RADIAN
CORPORATION

GROUND WATER GAUGING DATA SHEET

Parameter Description	Value
SAMPLE CONTROL NUMBER	10-17
DATE	11 20
TIME	
SAMPLER'S INITIALS	CEK
WELL/BORING LOCATION	OW-8 Southn canyon
WELL/BORING DIAMETER (in)	2"
ELEVATION OF TOP OF WELL CASING	
REFERENCED TO MEAN SEA LEVEL (MSL)	
GAUGING	
Total Depth (ft)	63.87
Depth to Groundwater (ft)	~~[illegible]~~ 49.43
CALCULATIONS	
Thickness of Groundwater (ft)	
Well Volume (gallons)	
Purge Volume (gallons)	
NUMBER OF SAMPLE BOTTLES AND TYPE COLLECTED	601 (3)
pH	6.2
Conductance (umhos)	900
Temperature (°C)	21.5

COMMENTS: bailed 21 bailers

RADIAN CORPORATION

GROUND WATER GAUGING DATA SHEET

Parameter Description	Value
SAMPLE CONTROL NUMBER	
DATE	10-17
TIME	11:30
SAMPLER'S INITIALS	CEK
WELL/BORING LOCATION	ow-6 middle cyn
WELL/BORING DIAMETER (in)	2"
ELEVATION OF TOP OF WELL CASING REFERENCED TO MEAN SEA LEVEL (MSL)	
GAUGING	
Total Depth (ft)	40.47
Depth to Groundwater (ft)	no water
CALCULATIONS	
Thickness of Groundwater (ft)	
Well Volume (gallons)	
Purge Volume (gallons)	
NUMBER OF SAMPLE BOTTLES AND TYPE COLLECTED	
pH	
Conductance (umhos)	
Temperature (°C)	

COMMENTS:

RADIAN CORPORATION

GROUND WATER GAUGING DATA SHEET

Parameter Description	Value
SAMPLE CONTROL NUMBER	
DATE	10-17
TIME	11:37
SAMPLER'S INITIALS	CEK
WELL/BORING LOCATION	OW-7 north cyn
WELL/BORING DIAMETER (in)	2"
ELEVATION OF TOP OF WELL CASING	
REFERENCED TO MEAN SEA LEVEL (MSL)	
GAUGING	
Total Depth (ft)	50.25
Depth to Groundwater (ft)	48.38
CALCULATIONS	
Thickness of Groundwater (ft)	
Well Volume (gallons)	
Purge Volume (gallons)	
NUMBER OF SAMPLE BOTTLES AND TYPE COLLECTED	
pH	
Conductance (umhos)	
Temperature (°C)	

COMMENTS:

RADIAN
CORPORATION

GROUND WATER GAUGING DATA SHEET

Parameter Description	Value
SAMPLE CONTROL NUMBER	
DATE	10-17
TIME	1200
SAMPLER'S INITIALS	CEK
WELL/BORING LOCATION	W-6 Aerojet Windmill
WELL/BORING DIAMETER (in)	10" casing
ELEVATION OF TOP OF WELL CASING	
REFERENCED TO MEAN SEA LEVEL (MSL)	
GAUGING	
Total Depth (ft)	
Depth to Groundwater (ft)	112.57
CALCULATIONS	
Thickness of Groundwater (ft)	
Well Volume (gallons)	
Purge Volume (gallons)	
NUMBER OF SAMPLE BOTTLES AND TYPE COLLECTED	601
pH	6.8
Conductance (umhos)	400
Temperature (°C)	20.0°

COMMENTS: bailed two days before

RADIAN
CORPORATION

GROUND WATER GAUGING DATA SHEET

Parameter Description	Value
SAMPLE CONTROL NUMBER	
DATE	10-17
TIME	1200
SAMPLER'S INITIALS	CEK
WELL/BORING LOCATION	OW-4 aerojet
WELL/BORING DIAMETER (in)	2"
ELEVATION OF TOP OF WELL CASING	
REFERENCED TO MEAN SEA LEVEL (MSL)	
GAUGING	
Total Depth (ft)	71.25
Depth to Groundwater (ft)	~~71.[illegible]~~ ~~71.25~~ no water
CALCULATIONS	
Thickness of Groundwater (ft)	
Well Volume (gallons)	
Purge Volume (gallons)	
NUMBER OF SAMPLE BOTTLES AND TYPE COLLECTED	
pH	
Conductance (umhos)	
Temperature (°C)	

COMMENTS:

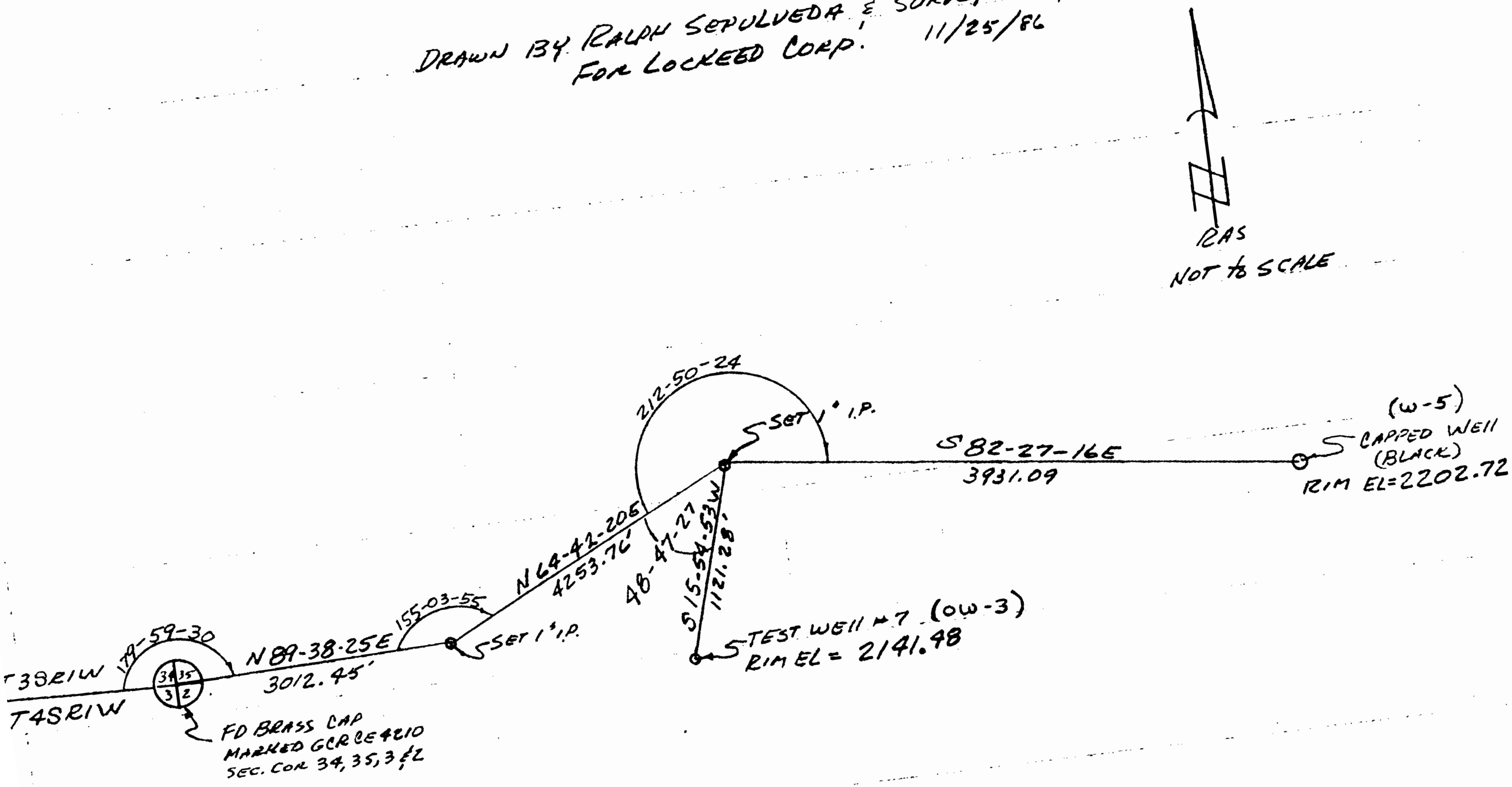
RADIAN
CORPORATION

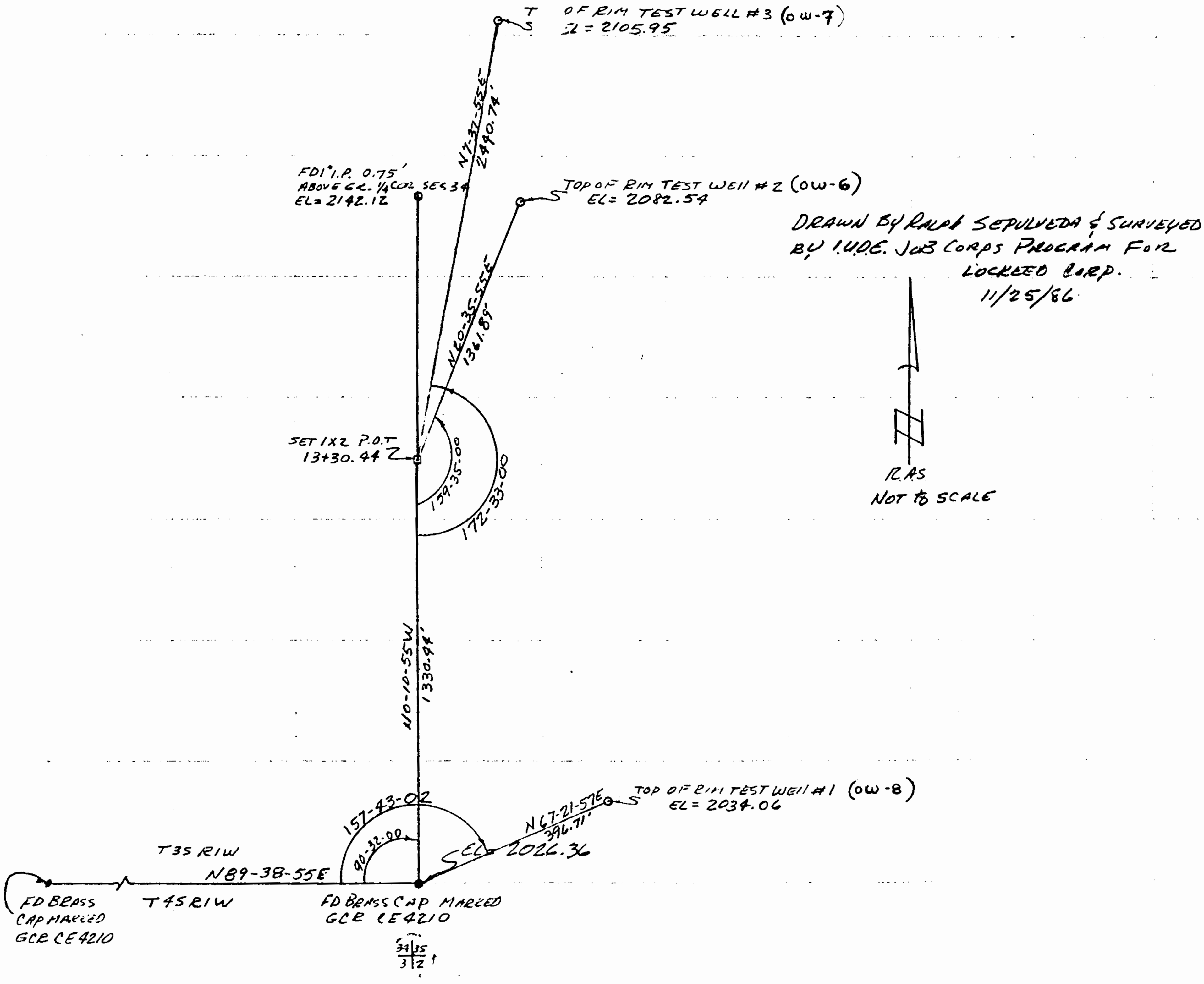
GROUND WATER GAUGING DATA SHEET

Parameter Description	Value
SAMPLE CONTROL NUMBER	
DATE	10-17
TIME	
SAMPLER'S INITIALS	CEK
WELL/BORING LOCATION	OW-5
WELL/BORING DIAMETER (in)	
ELEVATION OF TOP OF WELL CASING	
REFERENCED TO MEAN SEA LEVEL (MSL)	
GAUGING	
Total Depth (ft)	68.42
Depth to Groundwater (ft)	No water
CALCULATIONS	
Thickness of Groundwater (ft)	
Well Volume (gallons)	
Purge Volume (gallons)	
NUMBER OF SAMPLE BOTTLES AND TYPE COLLECTED	
pH	
Conductance (umhos)	
Temperature (°C)	

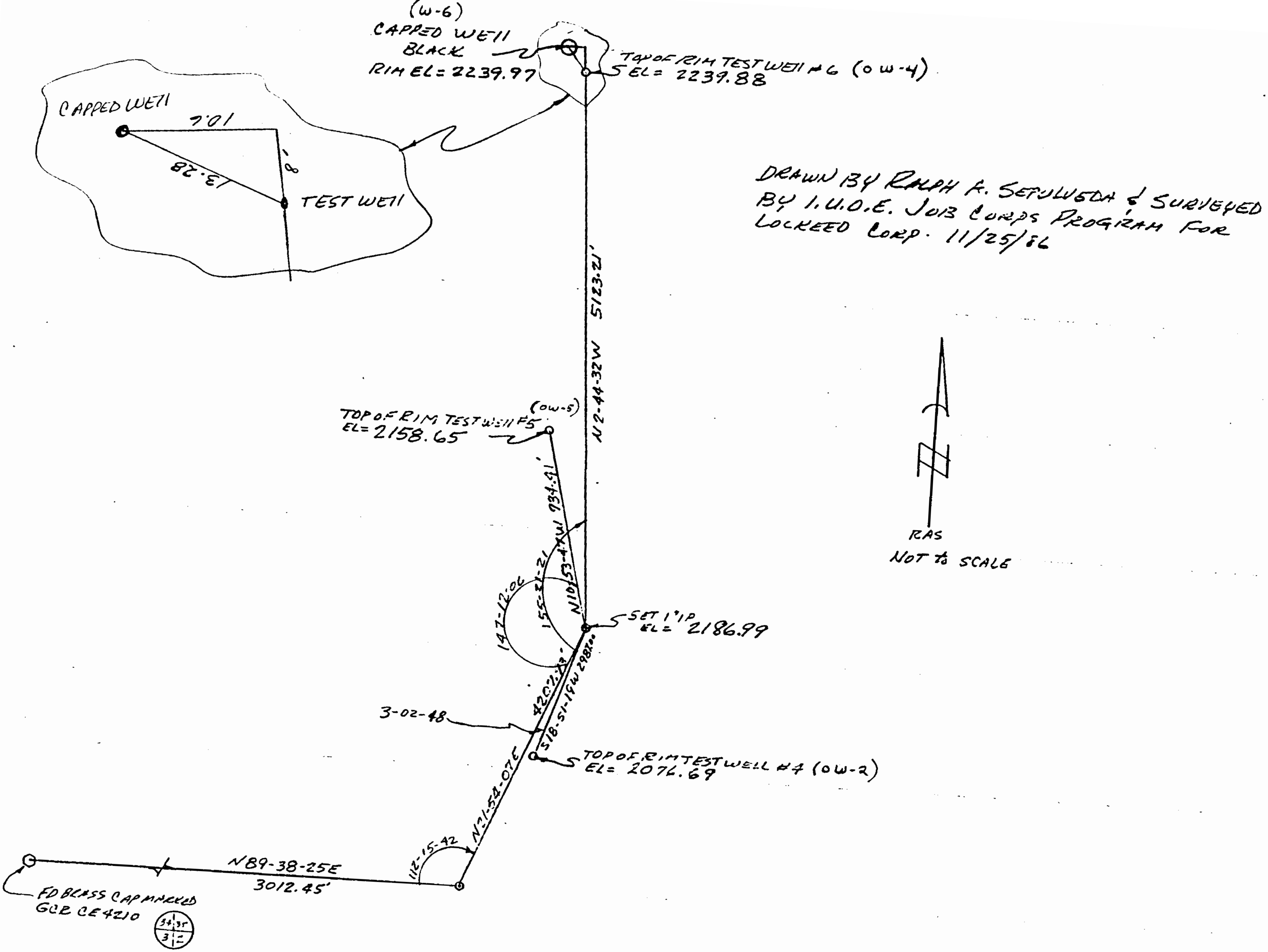
COMMENTS:

DRAWN BY RALPH SEPULVEDA & SURVEYED BY I.U.O.E JOB CORPS PROGRAM
FOR LOCKEED CORP. 11/25/86





DRAWN BY RALPH SEPULVEDA & SURVEYED
BY I.U.O.E. JOB CORPS PROGRAM FOR
LOCKHEED CORP.
11/25/86



DRAWN BY RALPH A. SEPULVEDA & SURVEYED
BY I.U.O.E. JOB CORPS PROGRAM FOR
LOCKEED CORP. 11/25/86

J.O. ______ SURVEY OF LOCKEED CORP. ELEVATIONS DATE 12·4·86

F.B. ___ PAGE ___ PARTY NO AND MEMBERS SEPULVEDA, KARMANU INSTRUCTORS & J.C. STUDENTS

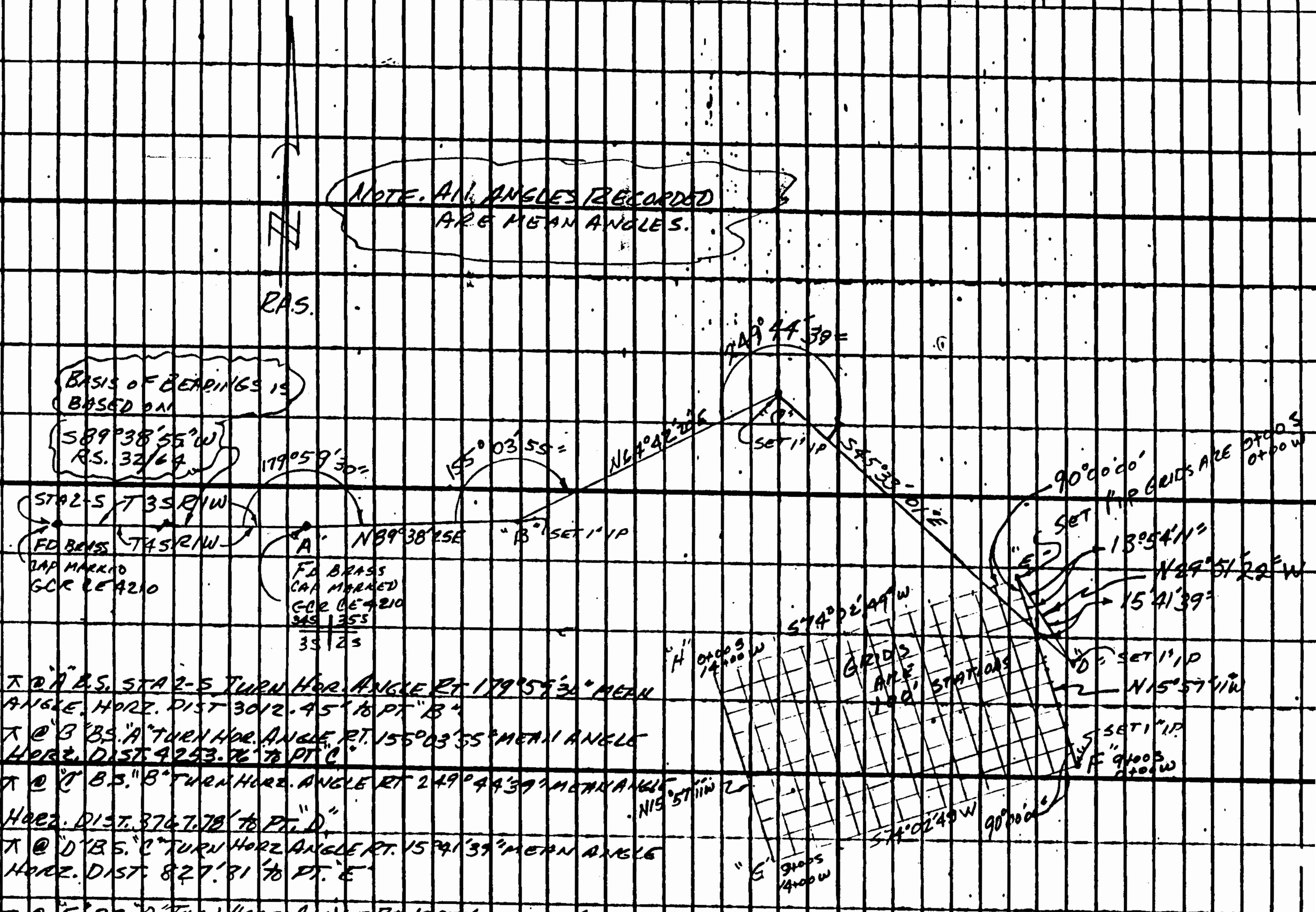
NOTES CALC'D BY CALC'S CHECKED BY MAP NO WEATHER

STATION	B.S	H.I	F.S	ELEVATION		REMARKS
W-1				1971	83	TOP OF RIM (ACTIVE WELL)
OW-1				2202	74	RIM TEST WELL
W-2				2029	19	RIM (WELL ACROSS FROM BETATRON
W-3				2124	73	N/E COR CONC. SLAB NEXT TO
						ROCK CRUSHER.

SURVEY OF BEAUMONT NO.1 BURN PIT AREA

FOR ______ W O No. ______ DATE OCT 10, 1986

SURVEY PARTY RALPH A. SEPULVEDA JOB CORDS REF. ______ B.M. ______



NOTE. ALL ANGLES RECORDED ARE MEAN ANGLES.

BASIS OF BEARINGS IS BASED ON S89°38'55"W R.S. 32/64

⊼ @ "A" B.S. STA 2-5 TURN HOR. ANGLE RT 179°59'30" MEAN ANGLE. HORZ. DIST 3012.45' TO PT "B"

⊼ @ "B" B.S. "A" TURN HOR. ANGLE RT. 155°03'55" MEAN ANGLE HORZ. DIST. 4253.76' TO PT "C"

⊼ @ "C" B.S. "B" TURN HORZ. ANGLE RT 249°44'39" MEAN ANGLE HORZ. DIST. 3767.78' TO PT. "D"

⊼ @ "D" B.S. "C" TURN HORZ ANGLE RT. 15°41'39" MEAN ANGLE HORZ. DIST. 827.81' TO PT. "E"

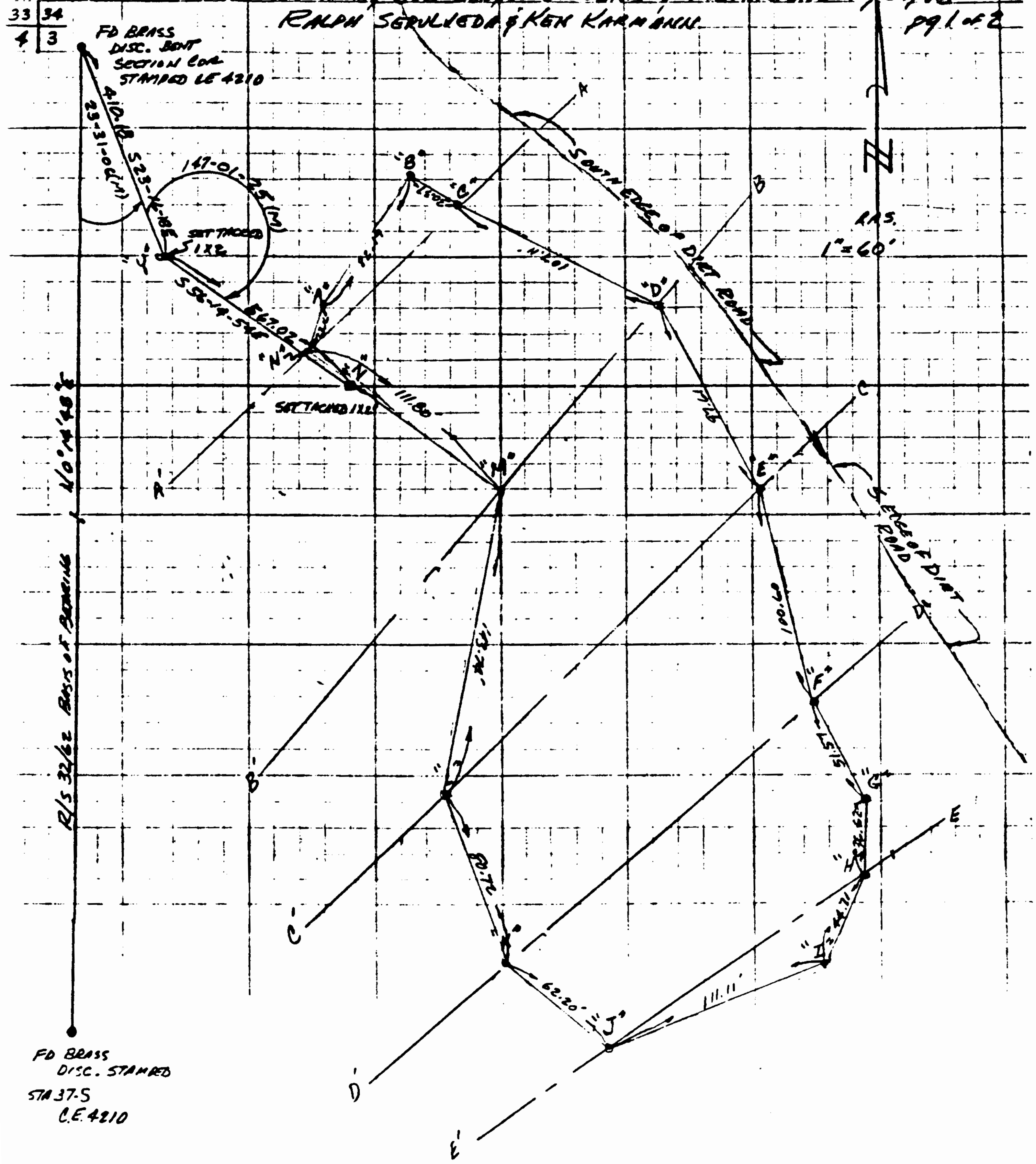
⊼ @ "E" B.S. "D" TURN HORZ ANGLE RT. 13°54'11" MEAN ANGLE HORZ. DIST. 900.00' TO PT "F".

BEAUMONT NO. 1 SANITARY LANDFILL

FIELD WORK BY JOB CORPS STUDENTS & INSTRUCTORS 10/29/86

RALPH SEPULVEDA & KEN KARMANN

pg 1 of 2



BEAUMONT NO.1 SANITARY LANDFILL

FIELD WORK BY JOB CORPS STUDENTS & INSTRUCTORS
RALPH SEPULVEDA & KEN KARMANN

10/29/86
PG 2 OF 2

THE FOLLOWING ARE FIELD ANGLES FROM POINT "Z" TO "A" "B" ETC.

⊼ @ PT "Z" B.S. PT "Y" ALL ANGLES ARE TURNED TO THE RIGHT
SEE PG. 1 OF 2.

STA.	FIELD ANGLE	BEARING	DISTANCE
"A"	37-39-51	N18-35-03W	40.39'
"B"	72-44-51	N16-29-57E	111.89'
"C"	87-54-34	N31-39-40E	99.87'
"D"	132-26-57	N76-12-03E	152.21'
"E"	160-24-24	S75-50-30E	201.06'
"F"	180-08-15	S56-06-39E	263.50'
"G"	184-21-09	S57-53-45E	310.59'
"H"	189-38-33	S46-36-21E	332.09'
"I"	196-32-24	S39-42-30E	349.90'
"J"	215-03-06	S21-11-48E	329.66'
"K"	221-29-24	S14-45-30E	277.56'
"L"	223-46-57	S12-27-57E	194.39'
"M"	181-02-27	S55-12-27E	85.71'
"N"	5-01-20	N51-13-34W	26.14'

Appendix E

Geophysical Report

GEOPHYSICAL INVESTIGATION
BEAUMONT NO. 1 AND BEAUMONT NO. 2
RIVERSIDE COUNTY, CALIFORNIA

A Report Prepared for:

Radian Corporation
10395 Old Placerville Road
Rancho Cordova, California

by

William E. Black

William E. Black
Principal Geophysicist GP-843

Kenneth G. Blom

Kenneth G. Blom
Principal Geophysicist GP-887

NORCAL Geophysical Consultants
921 Transport Way
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Telephone (707) 763-1312

Job No. 84-138.02

December 8, 1986

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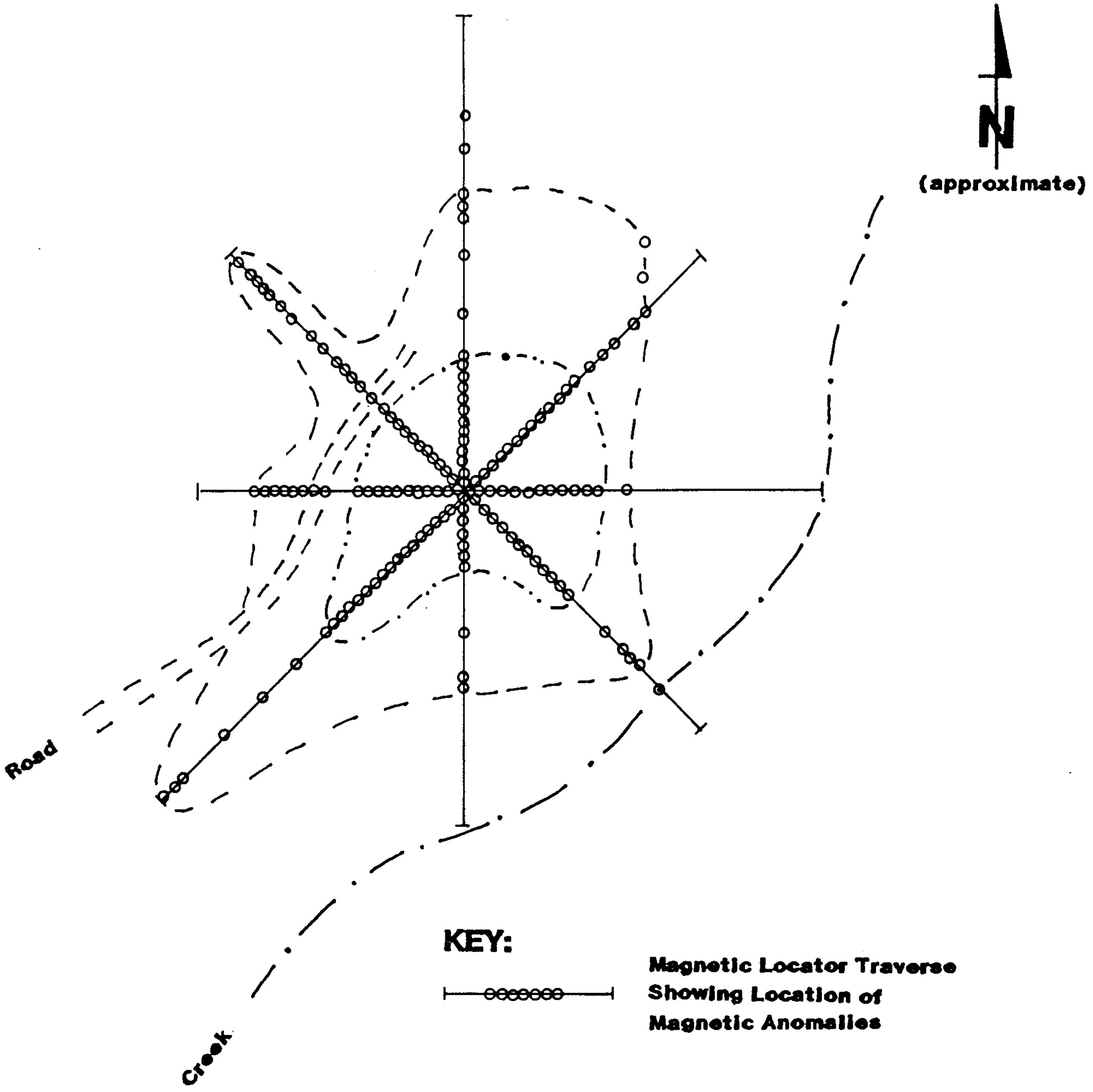

KEY:

├──○○○○○○○──┤	**Magnetic Locator Traverse Showing Location of Magnetic Anomalies**
—·—··—·—	**Possible Limits of Fill**
— — — — — —	**Limits of Widely Scattered Debris**

Scale: 1"=100'

NORCAL
GEOPHYSICAL CONSULTANTS

NORCAL

JOB: 86—138.02 | APPR: | DATE: 12/8/86

MAGNETIC ANOMALY LOCATION MAP

BEAUMONT NO. 2 LANDFILL

Lockheed Propulsion Company
Beaumont, California

PLATE
7

I SUMMARY

A geophysical investigation was performed at two former Lockheed Propulsion Company sites, Beaumont No. 1 and Beaumont No. 2, in southern California.

A Ground Penetrating Radar (GPR) survey was performed in three canyons at Beaumont No. 1 to explore for low level radioactive waste reportedly buried in one of the canyons. In the two westernmost canyons, the GPR data reveals several anomalous areas indicative of possible excavations. Of these, the most likely burial area is near the mouth of Canyon 1. Here, a sub-linear trend of several anomalies lies below a canyon wall that appears to have been partially excavated.

Terrain Conductivity (TC) data were obtained and Magnetic Locator (ML) traverses were performed in the Burn Pit area to determine the limits of the pit and, if possible, to resolve individual burial trenches. The TC data reveal a moderately conductive area that lies mostly within the reported Burn Pit limits. However, a portion of the conductive zone extends 300 ft. south and at least 100 ft. north of these limits. A rough alignment of TC maxima and magnetic anomaly locations suggest three possible trenches. The most predominate of these extends along survey grid line 600 ft. west from 50 ft. to 700 ft. south. Another possible alignment is located on the 450 ft. west grid line, extending from about 100 ft. to 300 ft. south. A third possible trench alignment is located on the 700 ft. west grid line at 150 ft. to 400 ft. south.

Magnetic Locator traverses at both the Beaumont No. 1 and No. 2 landfill sites defined their fill limits on the basis of buried metallic debris.

II INTRODUCTION

This report presents the findings of a geophysical survey performed by NORCAL Geophysical Consultants at two former Lockheed Propulsion Company (LPC) test facilities in southern California. The two sites are located in Beaumont and Potrero and are referred to as Beaumont No. 1 and Beaumont No. 2, respectively. The survey is part of an on-going geotechnical investigation being conducted by Radian Corporation for Lockheed.

The geophysical investigation was performed by NORCAL Geophysicist William E. Black during the period October 13 through October 17, 1986. Mr. Chris Koerner and Ms. Judith Billica of Radian assisted with the data acquisition, provided logistical support and furnished the necessary site maps. The geophysical investigation was authorized under Radian Purchase Order No. 45817.

A. Site Description

The geology, hydrology, climate, biota and physiographic features of the site are described in Radians report on the industrial history of the sites.

B. Purpose

The objectives of the investigation are as follows;

1) Locate buried low level radioactive waste reportedly buried in one of three canyons south of the Bevatron building,

2) Delineate the perimeter of the burn pit where waste rocket fuel was disposed of and,

3) Delineate the perimeters of two landfill sites, one at Beaumont No. 1 and the other at Beaumont No. 2.

C. Previous Work

Previous work performed at the former test facililities consists of Radian's research into the industrial history of each site. The findings of this work are described in their report of September, 1986. The geophysical surveys described herein are an integral part of their recommended scientific investigation designed to define the nature and extent of any environmental impact.

D. Scope of Work

To explore for buried trenches containing radioactive waste and to define the limits of burn pits and land fill areas containing metallic debris we used a suite of geophysical methods which are sensitive to the electrical and magnetic properties of the subsurface. These consist of ground penetrating radar (GPR), terrain conductivity (TC), and magnetic locator (ML) methods.

We obtained GPR data from over 9400 lineal feet of traverse in the three canyons south of the Bevatron building as shown on Plates 1 and 2. We measured terrain conductivities at a total of 258 stations distributed in a grid pattern covering most of the Burn Pit area as shown on Plate 3. In addition, we used the magnetic locator to scan 6000 lineal ft. of traverse in the Burn Pit area, 1300 lin. ft. at the Beaumont No. 1 landfill site, and 1700 lin. ft. at the Beaumont No. 2 landfill site as shown on plates 3, 6 and 7, respectively.

III DATA ACQUISITION

The theory of operation, general procedures, and instrumentation for the three geophysical methods employed in this investigation are discussed in Appendix A, Methodology. The specific procedures we followed in applying these methods to this investigation are discussed below.

A. Ground Penetrating Radar

The locations of the GPR traverses are shown on Plates 1 and 2. Two different types of traverses are shown. The dashed lines represent reconnaisance traverses or "scans". These scans were designed to cover a large area in search of possible anomalies. In Canyon No. 1 we performed the scans by towing a 120 Megaherz (mHz) antenna behind a vehicle. In Canyon No. 3 we hand towed a 500 mHz antenna. Horizontal control for these scans is approximate. Electronically inscribed event marks were placed on the records at survey markers we established along either side and in the middle of Canyon No. 1 and at either side of Canyon No 3. The length of the scans were determined by pacing.

The solid lines shown on Plates 1 and 2 represent calibrated traverses. These traverses were performed in previously suspected burial locations or in anomalous areas delineated by the scans. We performed calibrated traverses by hand towing either a 120 mHz or 500 mHz antenna along a transect marked by a measuring tape laid out on the ground surface. Horizontal control was established by placing event marks on the records at 5 to 10 ft. intervals as determined from the measuring tape.

In Canyon No. 1 we obtained GPR data from 28 scans ranging in length from 90 to 325 ft., and from 29 calibrated traverses which range in length from 80 to 120 ft. In Canyon No. 2 we performed 30 calibrated GPR traverses with lengths of 100 to 130 ft. Finally, in Canyon No. 3 we performed 8 GPR scans which range in length from 20 to 130 ft.

B. Terrain Conductivity

TC data were obtained only in the Burn Pit area. The measurement stations were distributed in a grid pattern as shown on Plate 3. Prior to the investigation a 1400 ft. by 900 ft. survey grid had been established by others. The grid was marked by flagged and labeled stakes on 100 ft. centers and was oriented with it's long axis trending N16E. Our procedure was to obtain TC measurements at each grid intersection, as denoted by the survey markers. In anomalous areas we obtained readings at closer intervals of 10 to 50 ft. as determined by pacing between markers.

C. Magnetic Locator

The magnetic locator was used to explore for buried metal objects along designated traverses in the Burn Pit and the two landfill areas. In the burn pit we scanned traverses spaced at 50 ft. intervals as shown on Plate 3. We determined our location along each traverse by pacing between survey markers. In the two landfill areas we laid out a measuring tape along each traverse and followed the tape while scanning with the magnetic locator. The locations of magnetic anomalies were then determined from the tape. We used flagged survey stakes to mark the beginning and end of each traverse and the limits of the anomalous areas.

IV DATA ANALYSIS

A. Ground Penetrating Radar

Our analysis of the GPR data consisted of a close inspection of the graphical records for anomalous reflection patterns. The anomalies we identified during an on-site inspection of the records were marked in the field and investigated by digging shallow holes, by scanning with a scintillometer (Radian), and/or by more detailed GPR surveying. Unresolved anomalies identified in the field, and additional anomalies identified by a more thorough examination of the records in the office, were plotted in plan view along with the GPR tracklines as shown on Plates 1 and 2.

B. Terrain Conductivity

To obtain TC data we used an electromagnetic induction instrument which measures conductivity directly in units of millimhos per meter (mmho/m). In anomalous areas the readings would often fluctuate with instrument orientation. This is especially common when the source has limited horizontal dimensions. In this situation the reading varies according to the geometry of the object and the orientation of the instruments transmitting and receiving coils relative to that object. The common approach to this phenomenon is to rotate the instrument about its axis and record the average of the minimum and maximum conductivity values. However, this would often result in a value close to the background level in an area where it was obvious from the wide fluctuation that there was buried metal nearby. Therefore, to emphasize the proximity of buried metal, we instead recorded the sum of the maximum value and the difference between the minimum and maximum. The conductivity values recorded in the field were plotted versus their locations in plan view and then computer contoured to form the Terrain Conductivity Map shown on Plate 4. In addition, we used computer processing and graphical techniques to generate the two three-dimensional views of conductivty shown on Plate 5. Both views are computer projections of what the variations in conductivity would look like as viewed in three-dimensions, like topography, from an angle of 45 degrees above the horizontal. The 3-D view on the left is towards the southwest while the 3-D view on the right is looking northwest.

C. Magnetic Locator

Since the magnetic locator produces only an audio tone and has no digital or anolag output, there is no data to reduce or analyze. We did however take note of the location of anomalies identified in the field. We plotted these locations in plan view to indicate the limits of areas containing buried metals as shown on plates 4, 6 and 7.

V RESULTS

The findings of the geophysical investigation are presented on Plates 1 and 2, and 4 through 7, as described above.

A. Canyon No. 1

Two different types of GPR anomalies were identified in Canyon No. 1. One is an irregularity or discontinuity of stratigraphic reflectors that are typically regular and continuous. This type of anomaly could represent disturbed ground and/or backfill, indicating a possible excavation or trench. However, this type of anomaly could also be caused by ground surface irregularities or by natural erosional features. The second type of anomaly is a hyperbolic reflection pattern typical of a point source. This type of anomaly could represent a buried object such as a container. Alternatively, point source reflectors could also be caused by boulders, roots, or other natural features.

We detected GPR anomalies in the south central part of the canyon and along the east wall near the mouth of the canyon as shown on Plate 1. The anomalies in the south part of the canyon align in a northwest-southeast trend suggesting a possible trench. However, these anomalies are in the vicinity of a stream in an area of hummocky ground. Both of these natural features could contribute to the irregularities we identified in this area. The GPR anomalies near the mouth of the canyon roughly align along an east-west trend. The ground surface in this area is relatively smooth and regular and there are no obvious erosional features in the vicinity. However, a portion of the canyon's nearby east wall appears to have been excavated. Both anomalous zones were investigated using a scintillometer and the magnetic locator. No magnetic or radioactive anomalies were found.

B. Canyon No. 2

All of the GPR anomalies detected in Canyon No. 2 are the type characterized by irregular or discontinuous stratigraphic reflectors. Except for four anomalies that are closely grouped near the mouth of the canyon, the anomalies are all scattered about the central part of the canyon and do not show any obvious trend or alignment.

C. Canyon No. 3

No GPR anomalies were detected in Canyon No. 3.

D. Burn Pit

The terrain conductivities measured in the Burn Pit area range from about 2 to 20 millimhos per meter (mmho/m). Background levels are at about 5 to 6 mmho/m. The TC contours shown on Plate 4 depict an area of anomalously high conductivity which occupies a portion of the site between 300 to 900 ft. west and extending from 0 to 800 ft. south. Most of the magnetic anomalies we detected are located within this area. There are however, a few widely scattered magnetic anomalies that lie outside the conductive zone. These occur in areas where the conductivity is at the background level and therefore probably represent small, isolated objects that are too small to resolve with the TC instrumentation.

Although the TC data do not resolve individual trenches, there is a rough alignment of the TC maxima and magnetically anomalous zones along three separate trends. The most predominate of these is along the 600 ft. west grid line, extending from about 50 to 700 ft. south. This trend is more apparent in the 3-D views of terrain conductivities shown on Plate 6. In addition, there are two smaller, more subtle alignments. One is at about 450 ft. west, extending from 100 to 300 ft. south. The other is at 700 ft. west and extends from about 150 to 400 ft. south.

E. Beaumont No. 1 Landfill

The limits of the Beaumont No. 1 landfill are defined by the distribution of magnetic anomalies as shown on Plate 6. These anomalies occupy an area about 350 long and 100 to 200 ft. wide. However, the outer portions of this area contain isolated and widely scattered anomalies. The landfill proper may actually conform more to the area defined by the closely spaced anomalies located along traverses B, C and D.

F. Beaumont No. 2 Landfill

The distribution of magnetic anomalies at the Beaumont No. 2 landfill can be differentiated into two discrete zones; an inner zone of concentrated, closely spaced anomalies surrounded by a zone of widely scattered anomalies. The area comprising both zones is about 250 ft. wide and 450 ft. long. The interior area of concentrated anomalies is about 100 to 200 ft. wide and corresponds with the area where metallic debris is visible on the surface. A linear, northwest projecting segment of the outer zone coincides with a narrow canyon. Here, the magnetic anomalies were actually quite closely spaced. The appearance and the nature of the debris visible on the surface in this area suggests that the canyon is an old dump site that may predate Lockheed's Beaumont No. 2 landfill.

VI DISCUSSION

A. Low Level Radioactive Waste

We believe that the most likely low level radioactive waste burial site is in the vicinity of the GPR anomalies located near the mouth of Canyon 1. This is based on the somewhat linear alignment of the anomalies and their proximity to a portion of the canyon wall that appears to have been excavated. Furthermore, the relatively flat lying area covered by our calibrated lines at this location extends into an area depicted as sloping on the topographic map. This suggests that the topography of this area has been altered.

B. Burn Pit

The maximum conductivities in the Burn Pit area are surprisingly low considering the large quantities of metal drums that reportedly were buried there. Some possible explanations for the low values are as follows:

1) The actual amount of metal in the ground may be relatively small since the drums and waste rocket fuel they contained were incinerated prior to being covered by backfill;

2) the residual metal has been in the ground and subject to corrosion and dissemination for more than a decade;

3) The terrain conductivity measuring instrument samples a hemispherical volume of earth with a radius of 18-20 ft. Since the drums were buried in shallow trenches, they comprise a relatively small source in a large sample volume.

Most of the high conductivity zone is within the original limits of the Burn Pit area as shown on Plate 4. However, a portion of the conductive zone extends about 300 ft. south and at least 100 ft. north of these limits.

This could be due to metallic leachate being carried northward by groundwater flow. It's more likely, however, that the burial area extends beyond the suspected Burn Pit limits.

VII ILLUSTRATIONS

Appendix A

METHODOLOGY

METHODOLOGY

The electrical properties of earth materials vary with different conditions or material types. These properties vary vertically and/or horizontally for a given area or depth according to a material's moisture content, the concentration of dissolved salts or free ions in it's saturating fluids, and according to the quantity of conductive foreign objects buried in it. In the case of saturation, massive rock formations or dry sand are poor conductors because they contain very little moisture. Conversely, fine grained materials are relatively good conductors since they tend to hold moisture and may at times contain naturally occuring free ions. The introduction of ionic fluids or other conductive materials such as metallic debris can significantly increase the electrical conductivity of both coarse and fine grained material.

A. Ground Penetrating Radar

Ground Penetrating Radar (GPR) is a shallow geophysical survey system that provides a continuous real-time cross section of shallow subsurface conditions. The instrumentation used for this investigation is an SIR-3 system manufactured by Geophysical Survey Systems, Inc. The system consists of a radar control unit, signal processing and conditioning circuitry, and a graphical recorder all housed in a single metal case. This unit is connected by a 100 ft. long electrical umbilical cable to a transducer. As the transducer (antenna) is towed along a traverse it transmits radar impulses downwards into the ground. At interfaces where changes in the electrical properties of the subsurface occur, the radar impulse typically undergoes an abrupt change in velocity causing some of the radar energy to be reflected back to the antenna on the ground surface. The amount of energy that is reflected is dependent on the contrast of the respective radar velocity. The time it takes for the radar signal to travel from the antenna to a reflecting interface and back to the antenna, is directly proportional to the depth of the interface. Recording these depth-dependant impulses on a scanning, time-based graphic chart recorder results in a cross-section depicting the longitudinal distribution of subsurface strata and other features over which the radar antenna has passed.

B. Terrain Conductivity

For this survey we used a Geonics Model EM-31 to measure lateral changes in terrain conductivity. The EM-31 consists of a transmitting and a receiving coil that are spaced 12 feet apart. The transmitting coil induces, at a certain frequency, a circular eddy current loop in the earth that is directly proportional to the electrical conductivity of the material it permeates. This current loop, in turn, gives rise to a magnetic field which is proportional to the amount of current flowing within the loop. The receiving coil detects this magnetic field and generates an output voltage that is proportional to its intensity. The instrument is calibrated to display this output voltage, which is linearly related to the terrain conductivity, directly in units of millimhos per meter (mmho/m).

Since the EM-31 transmits its signal into the earth through electromagnetic induction, measurements are taken without direct ground contact. Typically, the instrument is carried at hip level when used. At each station the terrain conductivity is read directly in mmho/m and recorded for later use. At many stations the instrument may be rotated about a vertical axis to check for anomalous lateral variations. In cases where the reading changes significantly as the instrument is rotated, the high and low values are observed and the average reading recorded for that particular station. The effective depth of penetration, which is a function of the instrument height (about 3 feet) and the inter-coil separation (12 feet), is approximately 18 to 20 feet.

C. Magnetic Locator

The instrument we used to detect magnetic anomalies during this investigation is a Model GA-52B Magnetic Locator manufactured by Schonstedt Instrument Company. The instrument responds to differences in the magnetic field between two sensors spaced 20 inches apart. The response consists of a change in frequency of an audible tone emitted by a loud speaker. The greater the difference in the magnetic field between the two sensors, i.e., the steeper the gradient of the magnetic field, the higher the frequency of the tone the unit emits.

Appendix B

BURN PIT

TERRAIN CONDUCTIVITY DATA

BURN PIT
TERRAIN CONDUCTIVITY DATA

SOUTH (FT)	WEST (FT)	CONDUCTIVITY (mmhos/m)
0	0	4.9
100	0	5.1
200	0	5.1
300	0	5.3
400	0	5.5
500	0	5.8
600	0	6.5
700	0	6.3
800	0	5.8
900	0	5.3
900	100	4.9
800	100	5.1
750	100	5.2
700	100	5.5
600	100	5.9
500	100	6.1
400	100	6.1
300	100	5.6
200	100	5.3
100	100	5.3
0	100	5.1
0	200	5.2
100	200	5.1
200	200	5.4
300	200	6.0
400	200	5.9
500	200	5.5
600	200	5.1
700	200	5.1
800	200	4.9
900	200	4.9
900	300	4.9
800	300	4.9
700	300	5.0
600	300	5.2
500	300	5.2
400	300	5.6
300	300	6.0
200	300	5.5
100	300	5.4
0	300	5.2
0	400	5.3
100	400	5.6
200	400	5.4
240	400	6.5
260	400	8.7
280	400	6.1
300	400	5.7
400	400	5.5

BURN PIT
TERRAIN CONDUCTIVITY DATA

SOUTH (FT)	WEST (FT)	CONDUCTIVITY (mmhos/m)
500	400	5.1
600	400	5.0
700	400	5.0
800	400	5.1
900	400	4.9
900	500	5.1
800	500	5.2
700	500	4.9
600	500	4.9
500	500	5.2
450	500	5.6
400	500	5.7
300	500	6.3
280	500	6.8
260	500	7.4
240	500	11.1
230	500	7.1
200	500	6.3
200	450	5.7
100	500	5.9
20	500	6.5
0	500	11.6
0	600	2.5
100	600	8.0
160	600	9.2
200	600	18.0
250	600	20.6
275	600	12.0
300	600	10.0
350	600	7.9
400	600	0.0
450	600	11.6
500	600	12.6
550	600	12.7
600	600	12.8
700	600	8.0
800	600	6.2
900	600	5.4
900	700	5.8
800	700	5.2
700	700	5.0
600	700	5.0
500	700	5.2
500	650	5.3
400	700	10.8
300	700	6.2
200	700	5.5
100	700	5.5
0	700	6.2
0	800	5.6

BURN PIT
TERRAIN CONDUCTIVITY DATA

SOUTH (FT)	WEST (FT)	CONDUCTIVITY (mmhos/m)
100	800	5.3
200	800	13.6
250	800	5.6
300	800	5.5
400	800	5.2
500	800	5.1
600	800	5.0
700	800	5.1
800	800	5.1
900	800	5.6
900	900	6.6
800	900	5.9
700	900	5.0
600	900	4.8
500	900	5.2
400	900	5.2
300	900	5.1
200	900	5.8
100	900	5.4
0	900	5.5
0	1000	5.2
100	1000	5.4
200	1000	5.1
300	1000	5.3
400	1000	5.2
500	1000	5.2
600	1000	4.8
700	1000	5.5
800	1000	5.9
900	1000	6.7
900	1100	7.2
800	1100	6.2
700	1100	5.5
600	1100	5.4
500	1100	5.0
400	1100	5.2
300	1100	5.3
200	1100	5.3
100	1100	5.7
0	1100	5.7
100	1200	5.5
200	1200	5.5
300	1200	5.5
400	1200	5.4
400	1300	5.4
300	1300	5.4
200	1300	5.6
100	1300	5.4
0	1300	5.6
0	1400	5.8

BURN PIT
TERRAIN CONDUCTIVITY DATA

SOUTH (FT)	WEST (FT)	CONDUCTIVITY (mmhos/m)
100	1400	5.9
200	1400	5.5
250	0	5.4
250	100	5.4
250	200	5.8
250	300	5.8
250	400	0.0
250	360	5.5
250	380	6.2
250	390	11.5
250	410	0.0
250	420	11.2
250	430	6.4
250	440	7.6
250	460	5.6
250	475	18.4
250	500	2.4
250	510	7.4
250	550	6.4
250	575	10.0
250	580	16.0
250	585	0.0
250	600	23.0
250	650	6.3
250	670	8.4
250	685	14.0
250	700	0.0
250	710	24.0
250	720	0.0
250	730	5.4
250	750	5.9
250	800	5.9
250	840	3.2
250	850	4.6
250	900	5.4
250	1000	5.3
250	1100	5.4
350	1100	5.4
350	1000	5.4
350	900	5.3
350	800	5.4
350	750	9.6
350	725	6.0
350	700	5.8
350	675	5.7
350	650	5.5
350	625	5.9
350	600	16.4
350	575	5.7
350	550	5.8

BURN PIT
TERRAIN CONDUCTIVITY DATA

SOUTH (FT)	WEST (FT)	CONDUCTIVITY (mmhos/m)
350	525	5.8
350	500	5.8
350	450	5.6
350	400	5.7
350	300	5.8
450	200	5.8
450	300	5.4
450	400	5.3
450	440	5.6
450	445	5.0
450	550	5.6
450	575	4.6
450	600	8.8
450	625	6.4
450	650	5.7
450	675	5.7
450	700	5.7
450	800	5.4
450	900	5.3
450	1000	5.4
150	1000	5.8
150	900	5.6
150	800	5.6
150	700	6.2
150	685	9.2
150	650	5.9
150	625	6.8
150	600	8.6
150	575	8.0
150	550	8.8
150	530	5.4
150	500	6.1
150	475	8.7
150	450	7.5
150	425	5.8
150	400	5.5
150	350	7.9
150	300	5.4
150	200	5.3
650	0	6.4
650	100	5.6
650	200	4.8
650	250	5.0
650	300	4.9
650	350	4.8
650	400	4.8
600	400	4.9
650	450	4.8
650	500	4.9
650	550	4.9

BURN PIT
TERRAIN CONDUCTIVITY DATA

SOUTH (FT)	WEST (FT)	CONDUCTIVITY (mmhos/m)
650	600	9.1
650	575	5.5
650	625	9.3
650	650	5.5
650	700	5.0
650	750	4.9
650	800	5.7
600	800	5.0
550	800	5.0
550	750	5.0
550	700	5.0
550	650	5.2
550	625	6.4
550	600	14.0
550	575	5.4
550	550	5.0
550	525	5.0
550	500	4.9
550	450	4.9
550	400	5.0
550	350	5.2
550	300	5.0
550	250	4.9
550	200	5.3
550	100	5.9
550	0	6.5

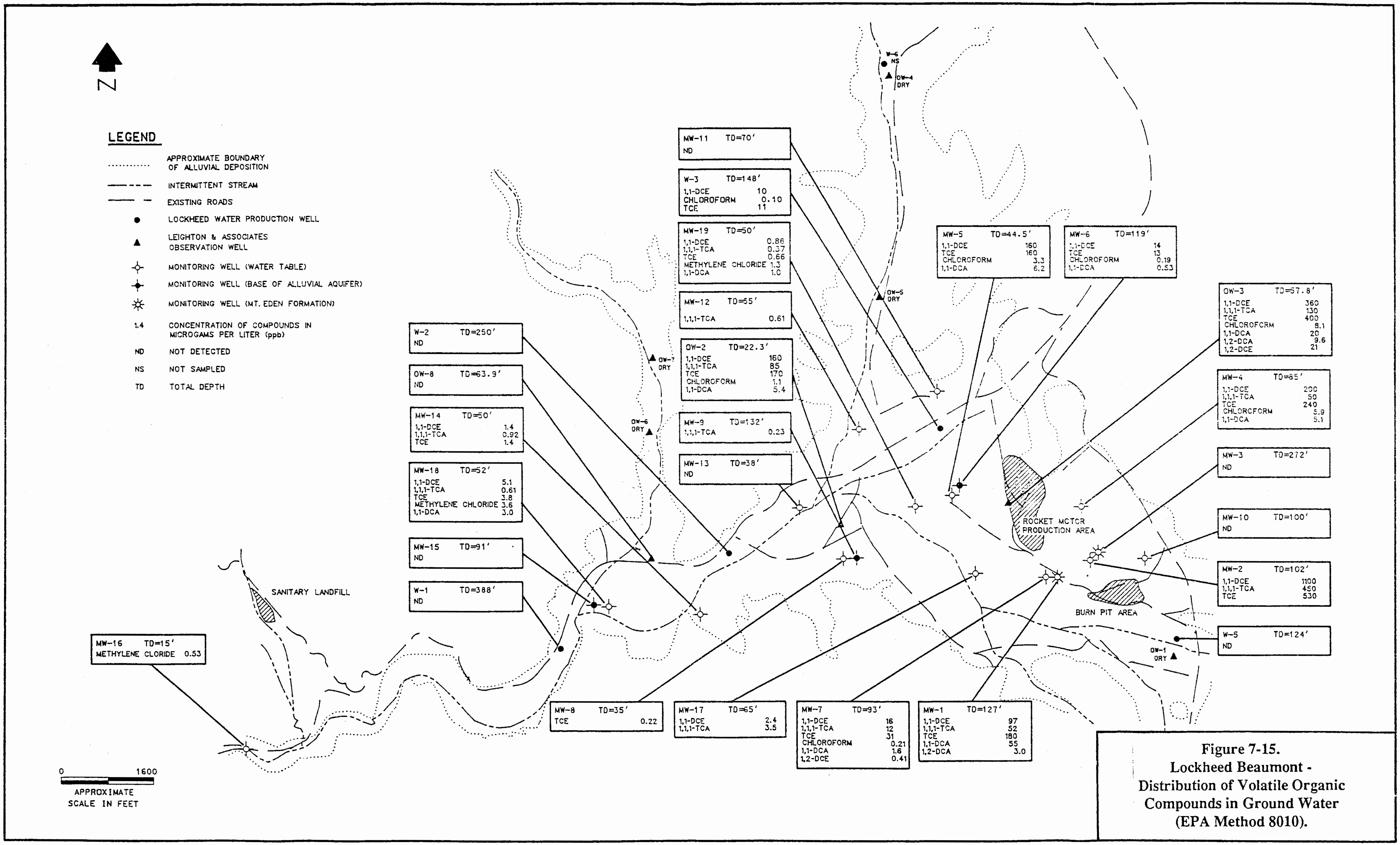

Figure 7-15.
Lockheed Beaumont - Distribution of Volatile Organic Compounds in Ground Water (EPA Method 8010).

204-25

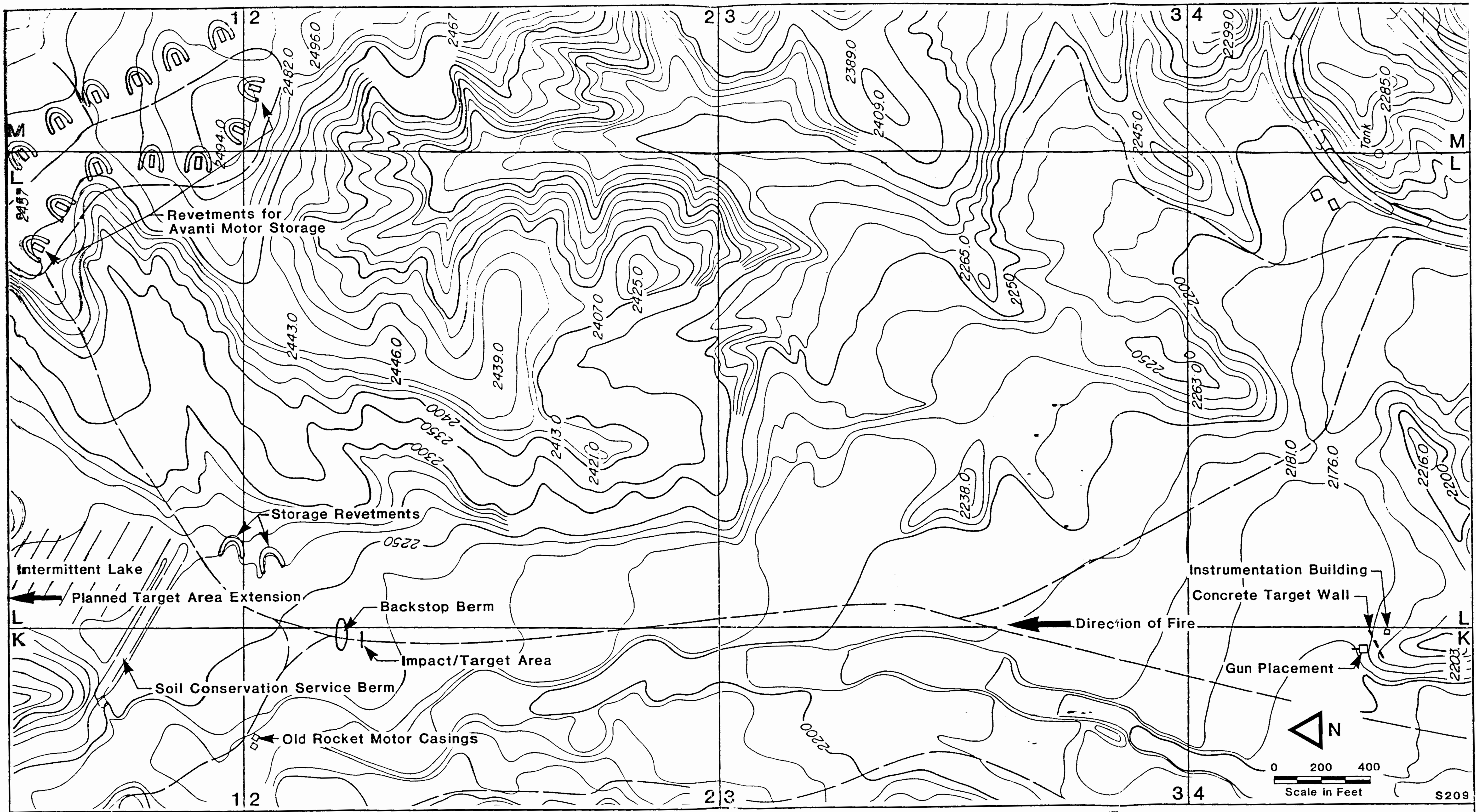

Figure 3-37. Beaumont No. 1, Eastern Aerojet Test Area Used From 1971 to 1973.

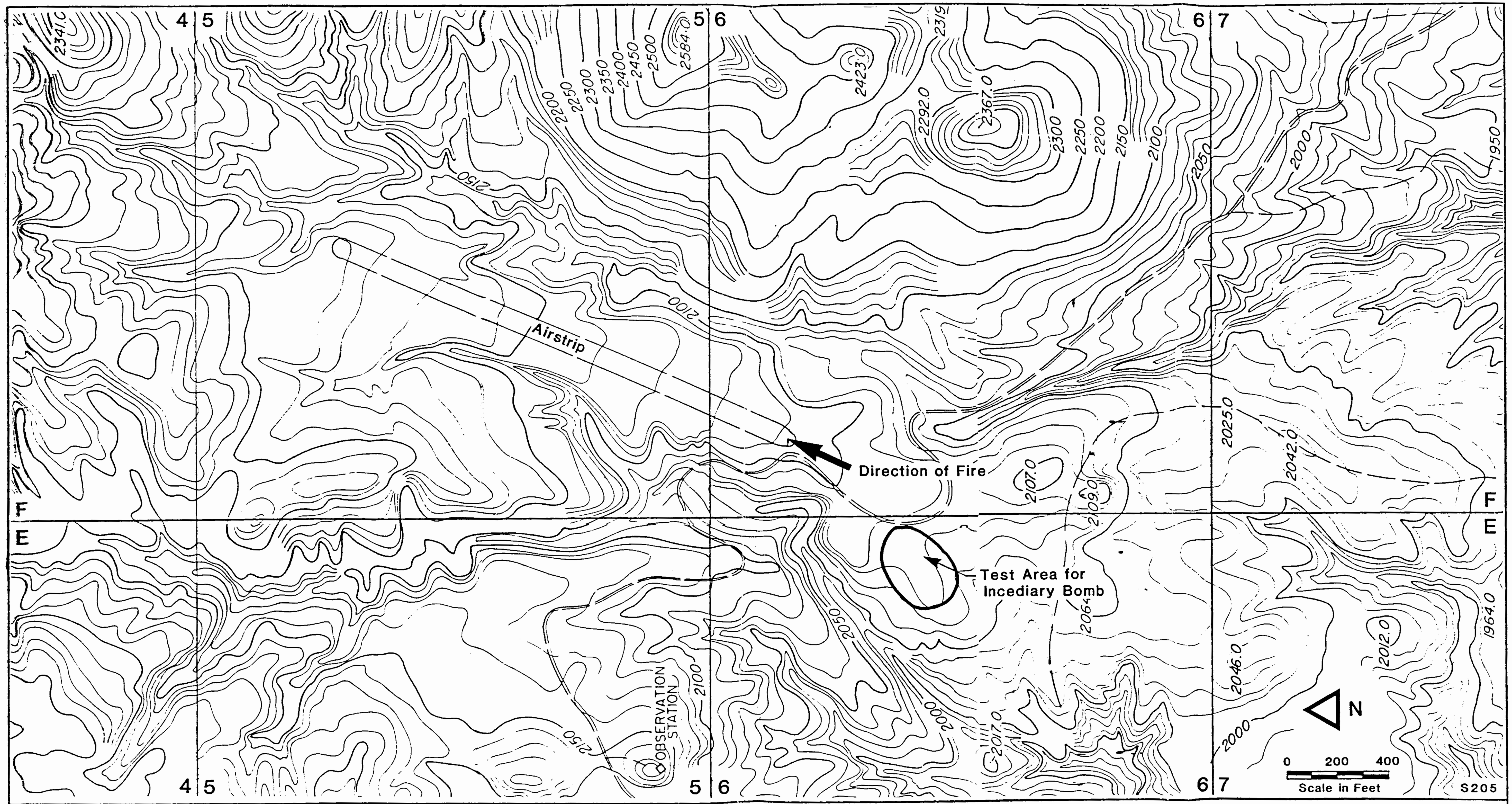

Figure 3-39. Beaumont No. 1, Western Aerojet Test Area.

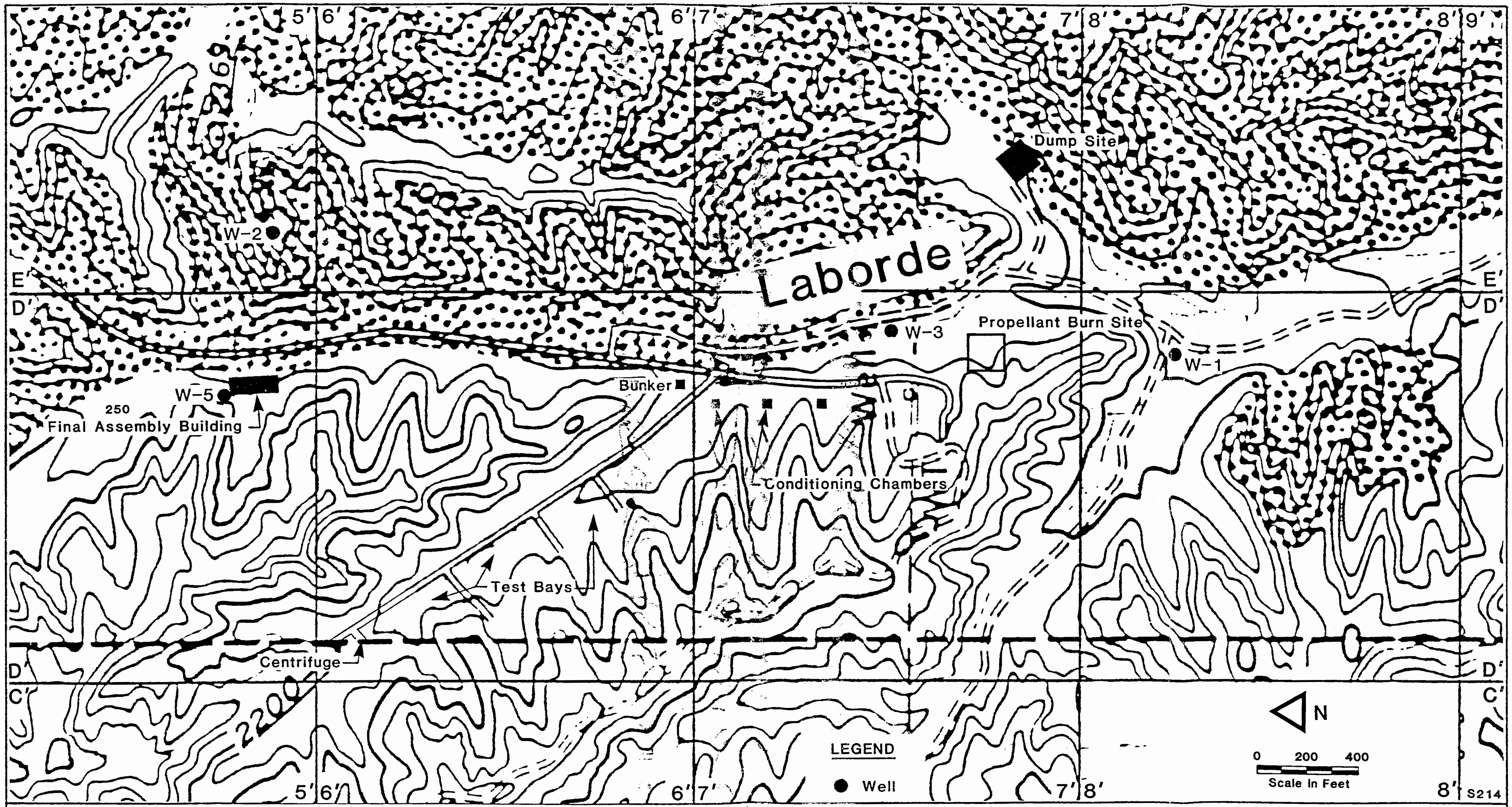

Figure 3-43. Beaumont No. 2, Test Facilities

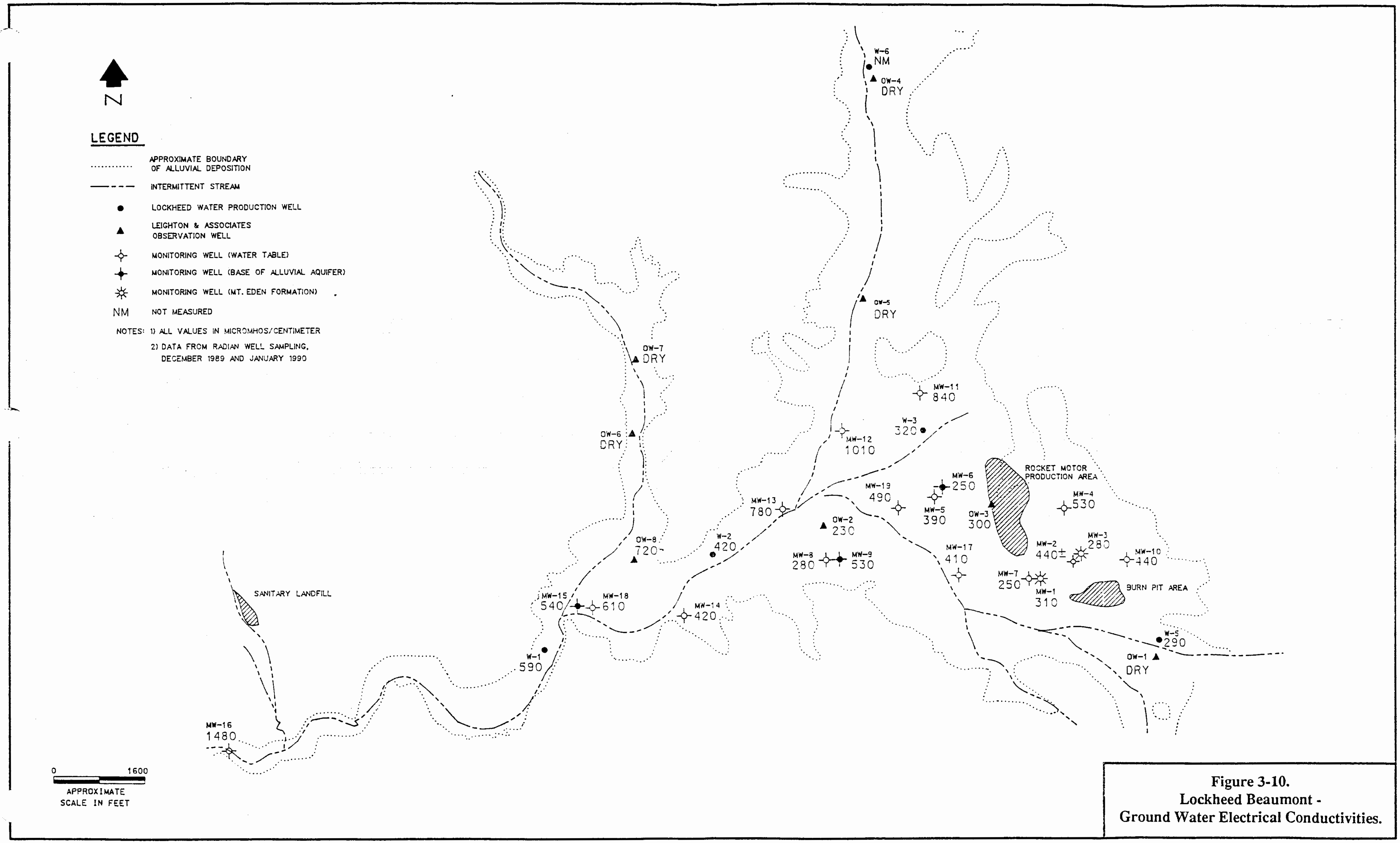

Figure 3-10.
Lockheed Beaumont -
Ground Water Electrical Conductivities.

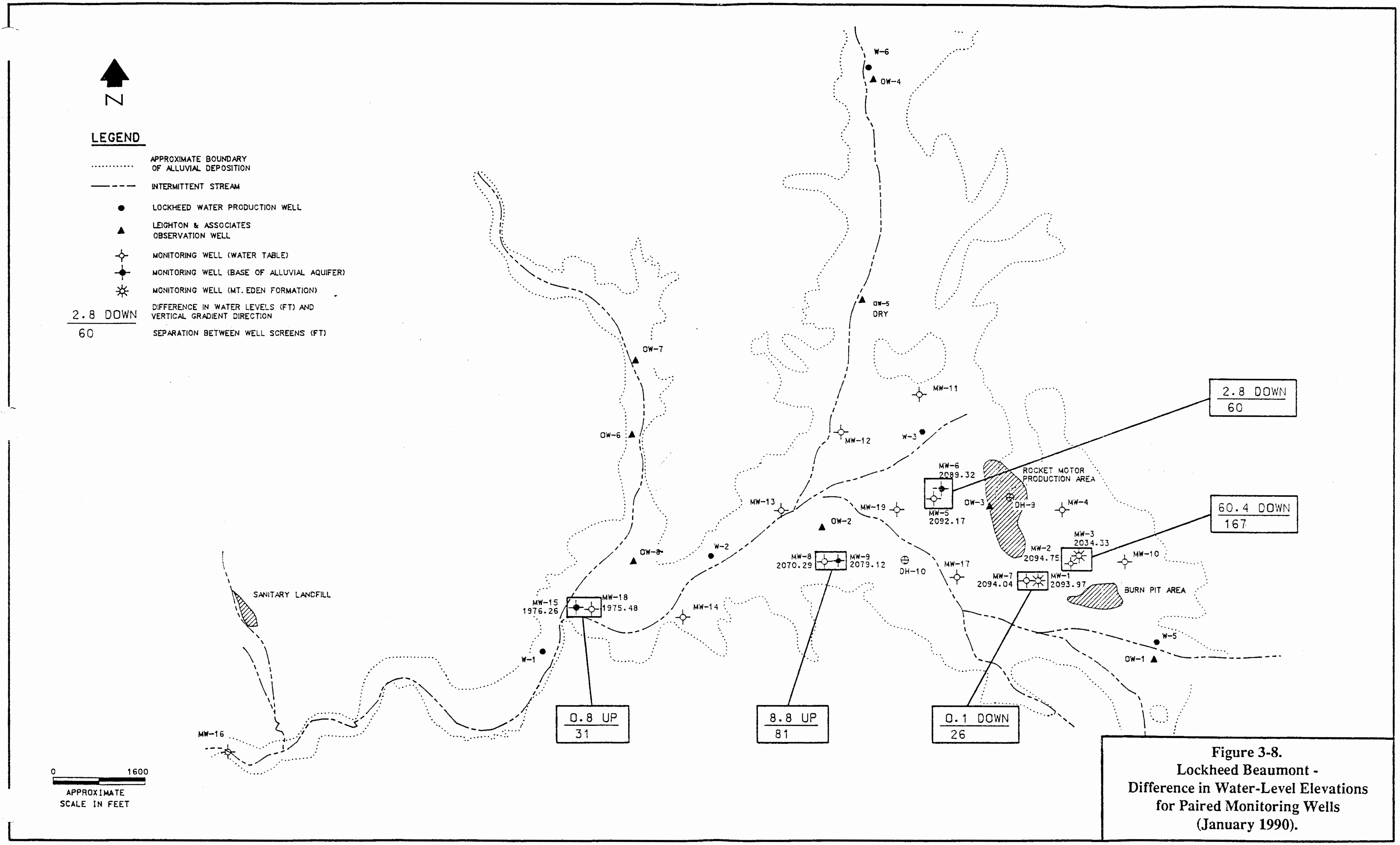

Figure 3-8.
Lockheed Beaumont -
Difference in Water-Level Elevations
for Paired Monitoring Wells
(January 1990).

204-44

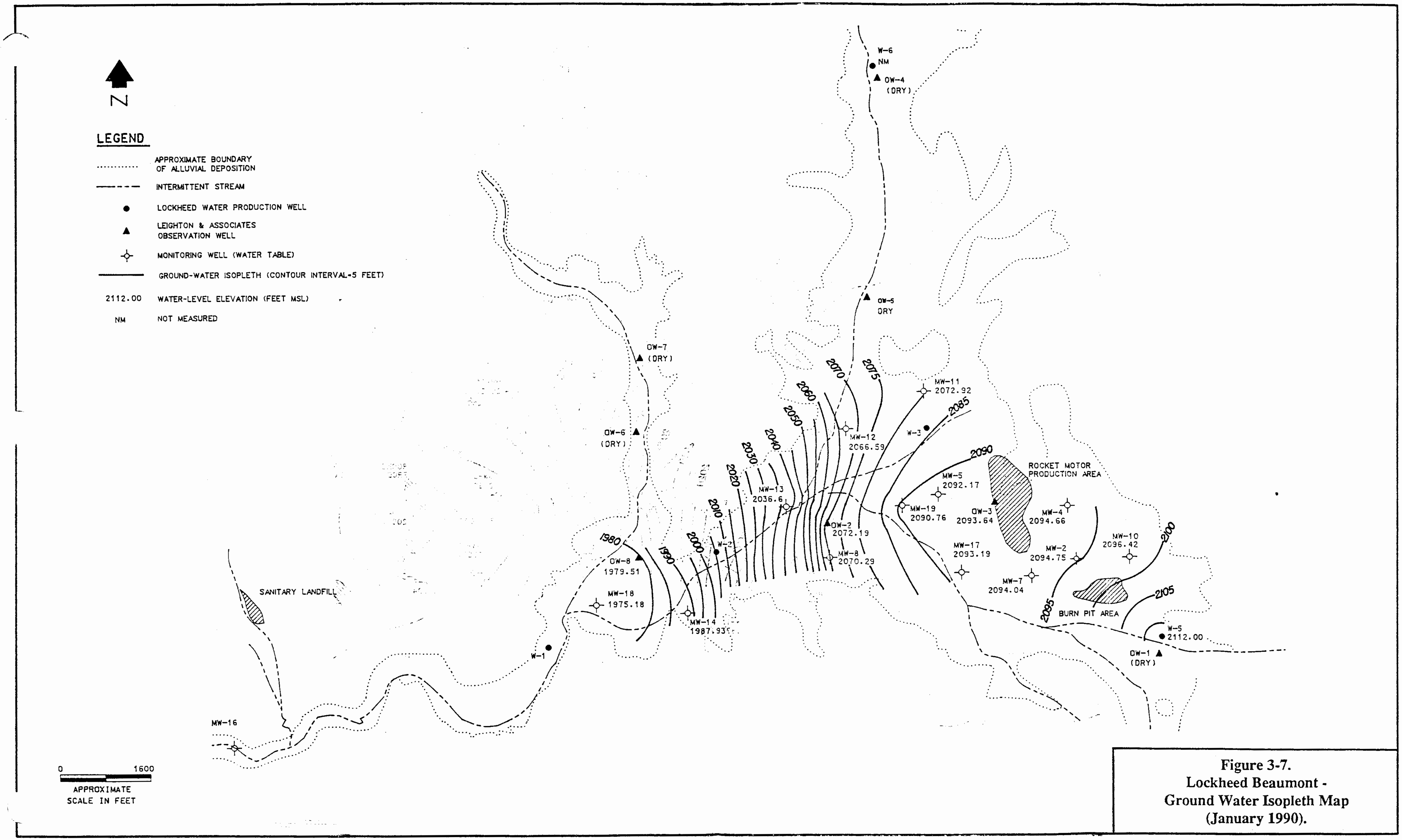

Figure 3-7.
Lockheed Beaumont -
Ground Water Isopleth Map
(January 1990).

204-40