United States Environmental Protection Agency
Office of Emergency and Remedial Response
EPA/ROD/R09-91/074
September 1991

EPA

Superfund Record of Decision:

Signetics (Advanced Micro Devices 901) (TRW Microwave), CA

50272-101

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15. Supplementary Notes

16. Abstract (Limit: 200 words)

The Signetics site is an active semiconductor manufacturing facility in Sunnyvale, Santa Clara County, California. The site is part of a larger study area that includes four Operable Units (OUs): the Signetics site, the 3-acre Advanced Micro Devices (AMD) 901/902 site, the 1-acre TRW Microwave site, and a 100-acre offsite contaminated ground water plume. Land use in the area is predominantly commercial and industrial. Residential property lies to the north and west of the main facilities and overlies portions of the offsite ground water OU. Six aquifers are associated with the study area including a deeper aquifer confirmed only at the TRW and Signetics sites. Currently, the contaminated ground water is not used as a drinking water supply, but the State considers several of the aquifers to be potential drinking water sources. From 1964 to the present, Signetics used its portion of the study area for manufacturing semiconductors with organic solvents, acids, and metals. These substances also were used in semiconductor manufacturing at the AMD and TRW sites from 1969 to the present and from 1974 to 1986, respectively. As a result of a leakage from an underground waste solvent storage tank at the Signetics site, a number of investigations were conducted that revealed extensive

(See Attached Page)

17. Document Analysis a. Descriptors

Record of Decision - Signetics (Advanced Micro Devices 901) (TRW Microwave), CA
First Remedial Action - Final
Contaminated Media: soil, gw
Key Contaminants: VOCs (PCE, TCE)

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) None	21. No. of Pages 114
	20. Security Class (This Page) None	22. Price

(See ANSI-Z39.18) *See Instructions on Reverse* OPTIONAL FORM 272 (4-77) (Formerly NTIS-35) Department of Commerce

Abstract (Continued)

contamination of onsite soil and ground water. Leakage from the acid neutralization system at AMD and responses to an information questionnaire regarding an underground tanks investigation at TRW resulted in a number of investigations that also revealed extensive contamination of onsite soil and ground water at both of these sites. Several initial remedial measures were conducted at the Signetics OU. From 1982 to present, ground water has been pumped from various site locations and treated using air stripping and carbon adsorption, followed by air stripping to control off-gases and reuse of the treated water in industrial processes. Contaminated soil has been removed from three separate locations, including 4,720 cubic yards of soil from a waste solvent storage tank area in 1983. In 1989, three vapor extraction wells were installed to treat contaminated soil. Several initial remedial measures also have been conducted at the AMD OU. In 1983 and 1984, acid neutralization sumps and about 217 cubic yards of contaminated soil were removed. From 1984 to 1988, remediation of ground water was implemented using extraction wells and dewatering sumps. Several initial remedial measures also have been conducted at the TRW OU. From 1983 to 1984, an underground waste solvent storage tank and 120 cubic yards of onsite contaminated soil were removed. From 1984 to present, ground water has been pumped and treated using air stripping, followed by onsite discharge to surface water. In addition, two ground water extraction systems pump contaminated ground water from the 100-acre offsite plume. The extracted water is treated at a neighboring AMD facility using air stripping, followed by liquid phase granular activated carbon polisher , with onsite discharge to surface water or reuse by the facility. This Record of Decision (ROD) collectively addresses final remediation of soil and ground water in the four separate OUs within the study area. The primary contaminants of concern affecting the soil and ground water are VOCs including PCE and TCE.

The selected remedial action for this site includes separate remedies for the four different OUs. The remedy for the Signetics OU includes expanding the onsite soil vapor extraction system; and continuing onsite pumping and treatment of ground water using air stripping, followed by aqueous-phase carbon polishing, reuse of the treated water, and vapor-phase carbon treatment of the effluent air stream. The remedy for the AMD OU includes excavating 37 cubic yards of onsite contaminated soil, followed by offsite incineration and/or disposal, and backfilling the excavation with clean soil; continuing onsite pumping and treatment of ground water using air stripping and carbon adsorption of off-gases, followed by reuse of the treated water. The remedy for the TRW OU includes continuing onsite pumping and treatment of ground water using air stripping, followed by onsite discharge of treated water to surface water. The remedy for the offsite ground water OU includes continuing and expanding the pumping and treatment system for contaminated ground water using air stripping and aqueous-phase carbon adsorption, followed by reuse of the treated water or onsite discharge to surface water, and offsite regeneration of spent carbon. Each OU also will involve continuing ground water monitoring, and implementing institutional controls including deed and ground water use restrictions. The estimated present worth cost for the remedial action for all OUs is $11,900,000, which includes an estimated annual O&M cost of $236,000 for the Signetics OU; $225,000 for the AMD OU; and $255,000 for the offsite ground water OU. No annual O&M cost was provided for the TRW OU.

PERFORMANCE STANDARDS OR GOALS: Chemical-specific soil clean-up goals have been set at background or total VOCs 1 mg/kg based on State policy. Chemical-specific ground water clean-up goals are based on State and Federal MCLs, and include PCE 5 ug/l (State) and TCE 5 ug/l (State).

RECORD OF DECISION

ADVANCED MICRO DEVICES #901/902
SIGNETICS
TRW MICROWAVE

COMBINED SUPERFUND SITES

SUNNYVALE, CALIFORNIA

September 11, 1991

U.S. ENVIRONMENTAL PROTECTION AGENCY

REGION 9

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PART I. DECLARATION

1.0 SITE NAMES AND LOCATIONS

Advanced Micro Devices
901/902 Thompson Place
Sunnyvale, CA 94088

Signetics, Inc.
811 East Arques Avenue
Sunnyvale, CA 94088

TRW (FEI) Microwave
825 Stewart Drive
Sunnyvale, CA 94088

2.0 STATEMENT OF BASIS AND PURPOSE

This Record of Decision ("ROD") presents the selected remedial actions for the Advanced Micro Devices 901/902, Signetics and TRW Microwave Superfund sites in Sunnyvale, California. This group of sites has been divided into four operable units (OUs). This document was developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 U.S.C. Section 9601 et. seq., and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan, 40 C.F.R. Section 300 et. seq., ("NCP"). The attached administrative record indices (Attachment B) identify the documents upon which the selection of the remedial actions are based. The State of California concurs with the selected remedies.

3.0 ASSESSMENT OF THE SITE

Actual or threatened release of hazardous substances from these sites, if not addressed by implementing the response actions selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

4.0 DESCRIPTION OF THE REMEDY

Remedies have been selected for each operable unit. The remedy for the AMD 901/902 operable unit consists of soil excavation followed by offsite incineration/disposal, continued groundwater extraction followed by treatment of the extracted groundwater with the existing air stripper, and reuse of the treated water. The air stripper includes air emissions control and is regulated by the Bay Area Air Quality Management District (BAAQMD). Additional contaminated soils and structures were removed as part of interim remedial actions.

The remedy for the Signetics operable unit consists of vapor extraction for soil remediation with continued groundwater extraction, treatment of contaminated water with the existing air stripper and reuse of the treated water. The groundwater treatment system uses multiple air strippers. The initial air stripper includes air emissions control and the second set of air strippers are not controlled. All air strippers meet the requirements of the BAAQMD regulations. Aqueous phase carbon is utilized as a final treatment and serves as a backup system to the air stripping systems. Additional contaminated soils and structures were removed as part of interim remedial actions.

The remedy for the TRW operable unit consists of continued groundwater extraction, treatment of contaminated water with the existing air stripper and discharge of the treated groundwater to surface water under an NPDES permit. The required goal for water reuse is 100%. The groundwater treatment system uses an air stripper to remove chemicals from the groundwater. The air effluent from the air stripper is not controlled. The air stripper meets the requirements of the BAAQMD regulations and air emission control will be added to the system if required by BAAQMD.

The remedy for the offsite operable unit consists of continued groundwater extraction. The contaminated groundwater is piped to the AMD facility at 915 DeGuigne Drive for treatment by an air stripper, followed by reuse or discharge of the treated groundwater to surface water under an NPDES permit. The required goal for water reuse is 100%. The groundwater treatment system uses an air stripper to remove chemicals from the groundwater. The air effluent from the air stripper is not controlled. The air stripper meets the requirements of the BAAQMD regulations and air emission control will be added to the system if required by BAAQMD. Additional contaminated soils and structures were removed as part of interim remedial actions.

These remedial actions address the principal risks remaining within a study area defined by four operable units including the area from approximately Arques Avenue on the south and north to Lake Haven Drive and bounded on the east by DeGuigne Avenue and Fair Oaks Avenue on the West. These risks are addressed by removing the contaminants from ground water, thereby significantly reducing the toxicity, mobility or volume of hazardous substances. These response actions will greatly reduce the possibility of contamination of existing potable water supplies and potential future water supplies.

5.0 DECLARATION

The selected remedies are protective of human health and the environment, comply with federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and are cost-effective. These remedies utilize permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable and satisfy the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element.

Because the remedies will result in hazardous substances remaining on-site above health-based levels, a five-year review, pursuant to CERCLA Section 121, 42 U.S.C. Section 9621, will be conducted at least once every five years after initiation of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

John Wise (signature) — 9.11.91

John Wise
Deputy Regional Administrator

Date

PART II. DECISION SUMMARY

This Decision Summary provides an overview of the problems posed by the Advanced Micro Devices, Signetics, TRW Microwave Superfund sites and an "offsite" area where groundwater contaminant plumes have become commingled ("the Study Area"), the remedial alternatives, and the analysis of the remedial alternatives. This Decision Summary explains the rationale for remedies selected at the three areas and how the selected remedies satisfy the statutory requirements.

1.0 SITE NAME, LOCATION, AND DESCRIPTION

1.1 SITE NAME AND LOCATION

As referenced above this ROD includes three separate Superfund sites and an offsite area located in Sunnyvale, Santa Clara County, California (Figure 1). These areas have been combined into a large study area (Figure 2). Each of the three Superfund sites and their commingled plume have been considered separately as one of four operable units (OUs) within the larger study area. A detailed discussion of each operable unit is presented in the sections below.

1.1.1 AMD 901/902 Operable Unit

The Advanced Micro Devices facility (Figure 3) located at 901/902 Thompson Place, Sunnyvale California (AMD 901/902) consists of two low rise buildings connected by a common foyer and entrance. This is located in an area of low to flat relief about 3 miles south of the southern extension of the San Francisco Bay in an area broadly bounded by the Bayshore, Central, and Lawrence Expressways and Fair Oaks Avenue. This is an industrial park setting dominated by low rise industrial buildings common in the electronics industry of Santa Clara County. The industrial park area is dominated by electronics manufacturers. Mixed commercial and light industrial use is common immediately surrounding the industrial park area. No residential property is in the immediate vicinity of the AMD 901/902 operable unit. Some residential property lies to the west and south of the industrial park. The area to the north of the AMD 901/902 operable unit is part of the industrial park and includes the TRW operable unit. Land use immediately north of the industrial park area is mixed commercial property, followed by a predominately residential area further north.

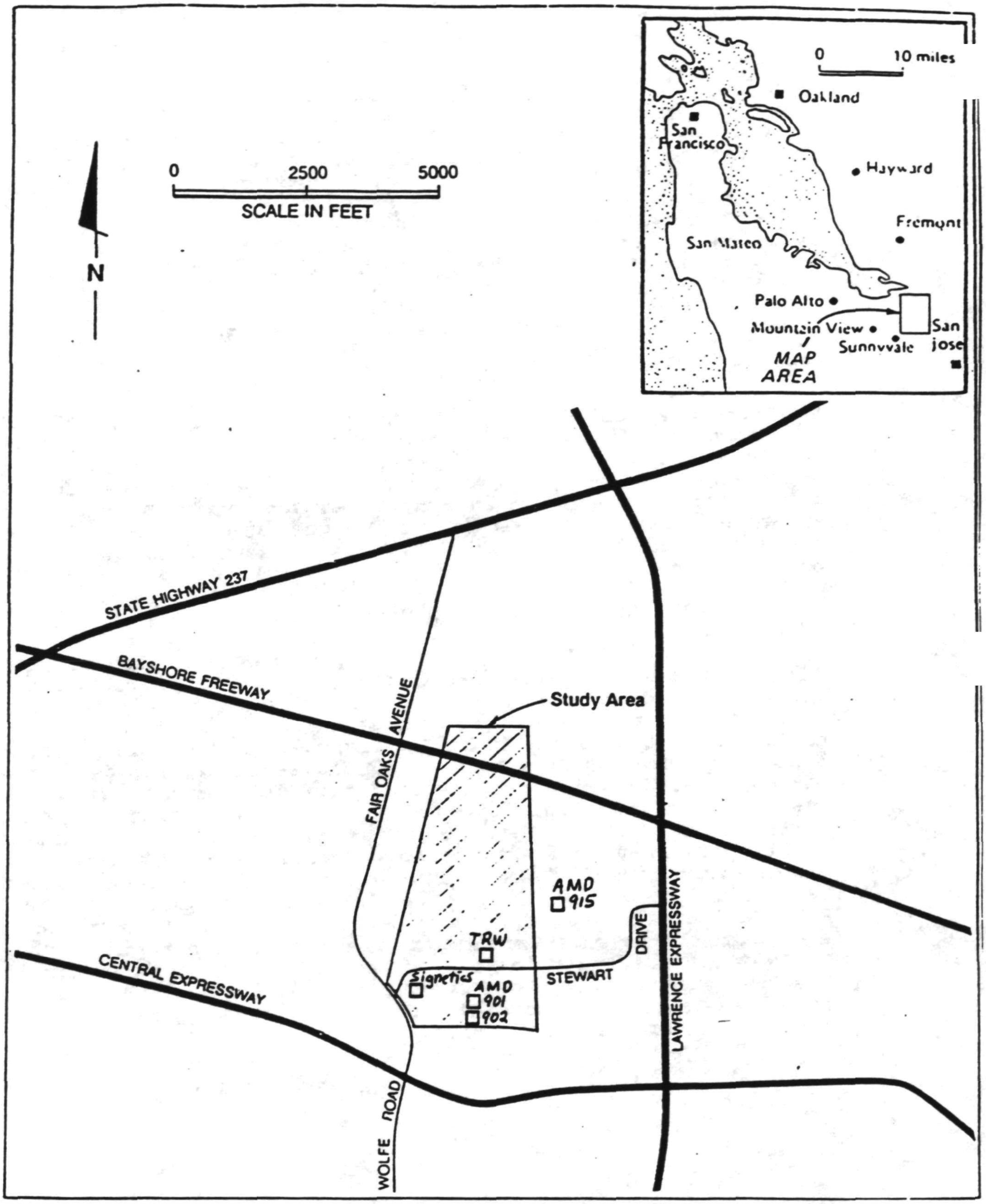

Figure 1. Location Map of the Study Area including: AMD 901/902, Signetics, and TRW Microwave

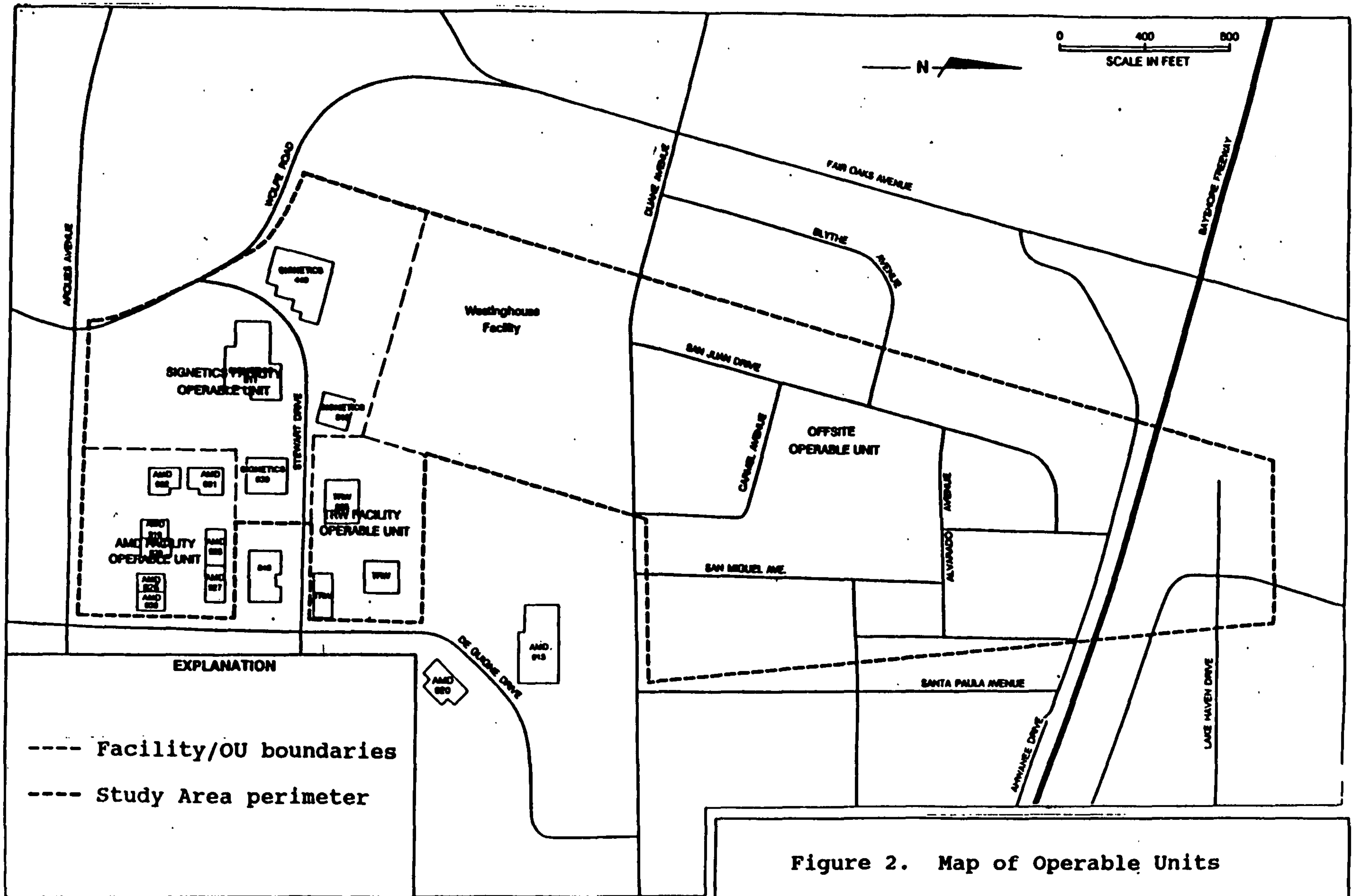

Figure 2. Map of Operable Units

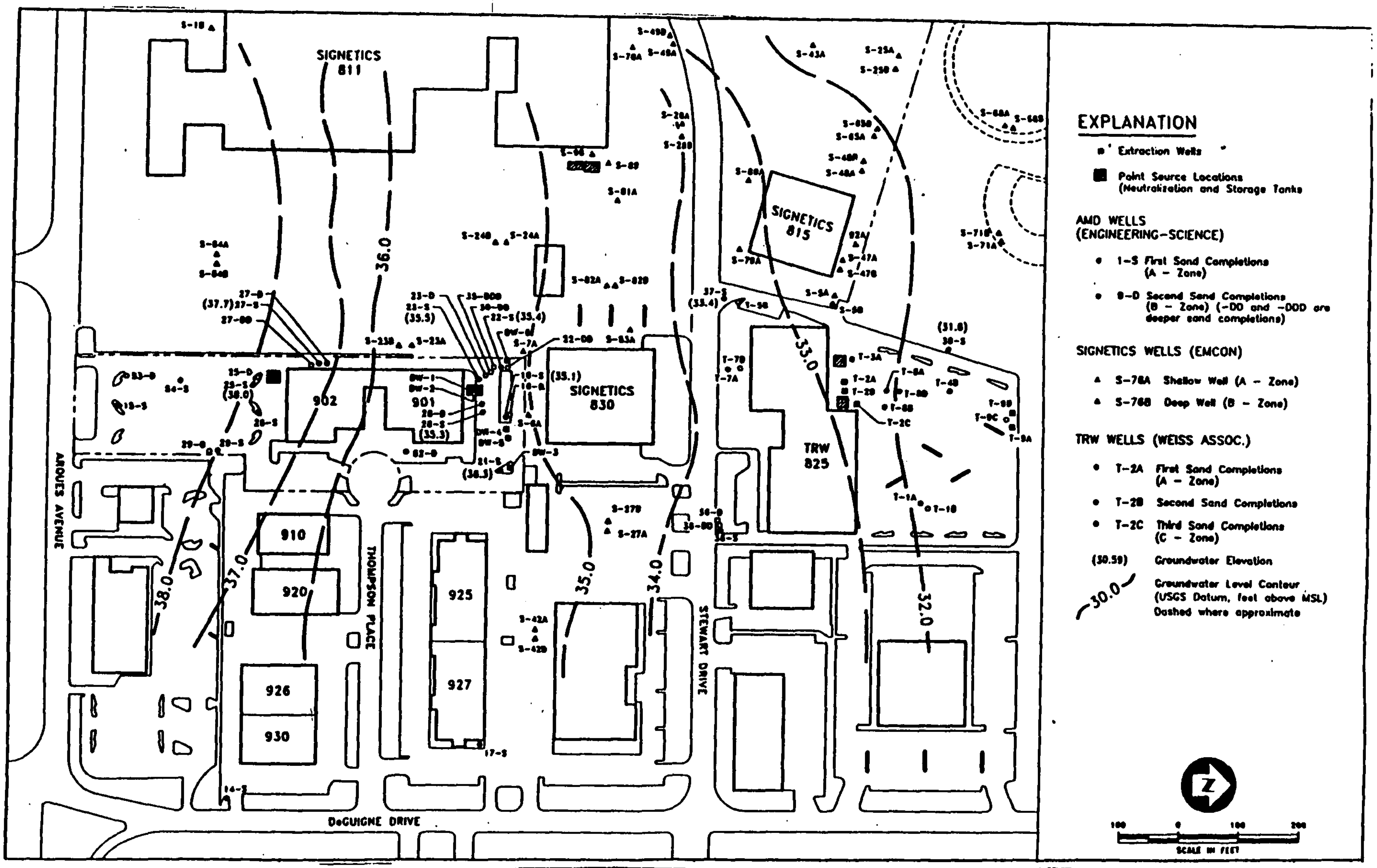

Figure 3. AMD 901/902 Site Map

1.1.2 Signetics Operable Unit

Signetics owns and operates a facility located at 811 East Arques Avenue, in Sunnyvale. This location is part of a larger complex of facilities operated by Signetics, including 440 Wolfe and several facilities along Stewart Drive (Figure 4). This is an area of Santa Clara County developed as an industrial park, dominated by low rise buildings. The major business activity of the area is semiconductor manufacture and research and development. The Signetics' facilities are representative of property development in this area.

This is an area of low topographic relief in the southern portion of the Santa Clara Valley. Surface drainage in the area is to the north, toward San Francisco Bay. Vegetation is limited to grass and shrubs. Residential development has occurred in the area south of the Signetics facility within the last two years. The area immediately west of the Signetics OU is park land. The area immediately north of the Signetics OU is the former Sunnyvale High School property, which is currently used as an electronics research and development facility. This area includes a track and ball field for recreational use by employees.

1.1.3 TRW Microwave Operable Unit

The former TRW Microwave facility (TRW) is located at 825 Stewart Drive, Sunnyvale, Santa Clara County. Aerotech Industries and this site were wholly acquired by TRW Microwave in 1974 and was operated by TRW Microwave from July 1974 to August 1986. The property was purchased by Tech Facility 1, Inc. in 1987. Some assets at this site were acquired by FEI Microwave, Inc. in July 1987. The manufacturing facility is currently operated by FEI Microwave, Inc. This location is near the intersection of the Lawrence Expressway and Route 101 (Figure 5). This is an area of the Santa Clara Valley of low topographic relief. The drainage in the area is toward the north to San Francisco Bay. The facility is located in an industrial park setting dominated by low buildings separated by paved parking lots, fields and streets, with some landscaping. The dominant activity in this area is related to the semiconductor industry, though the industrial park is bordered by residential property particularly to the north.

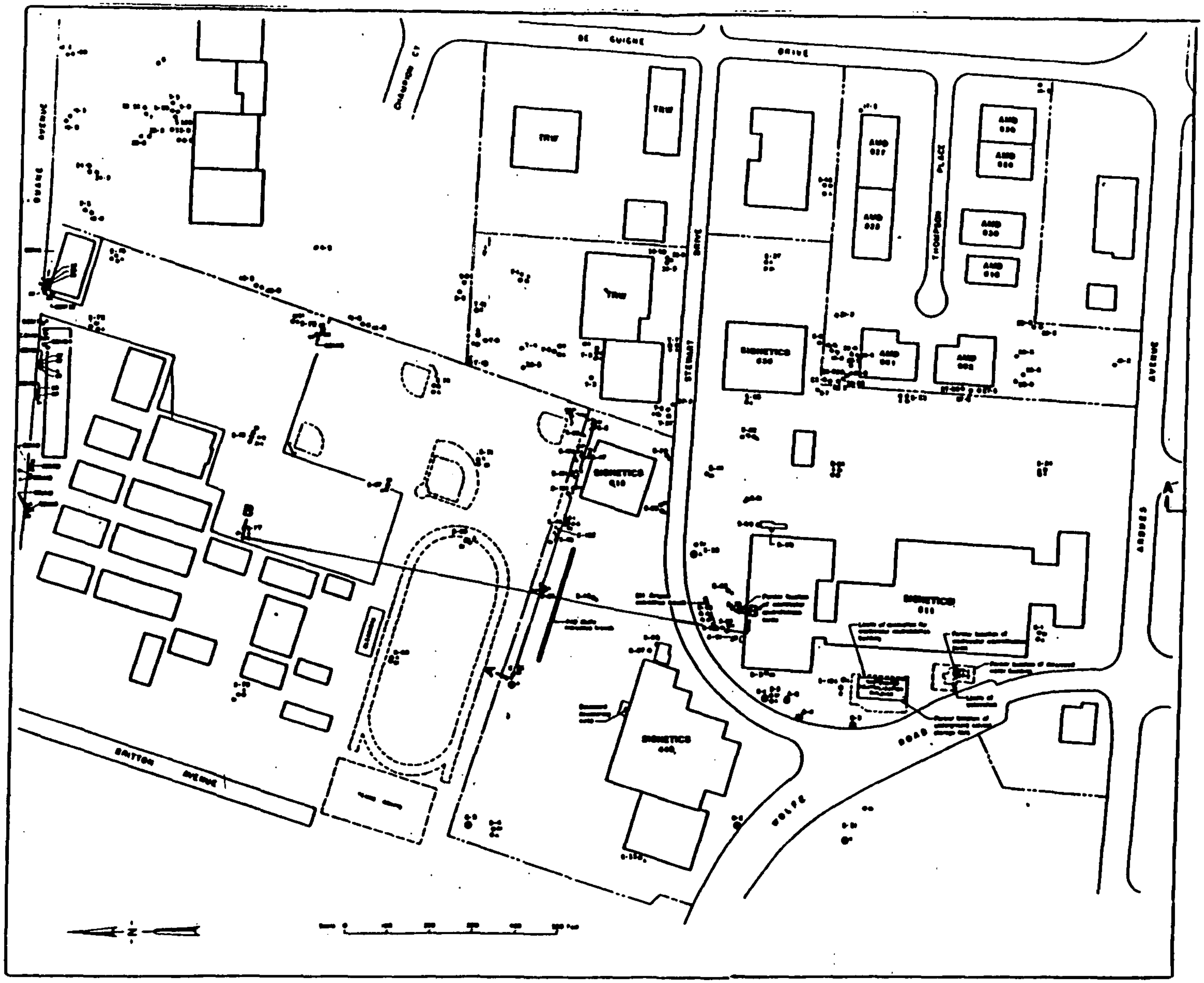

Figure 4. Signetics Site Map

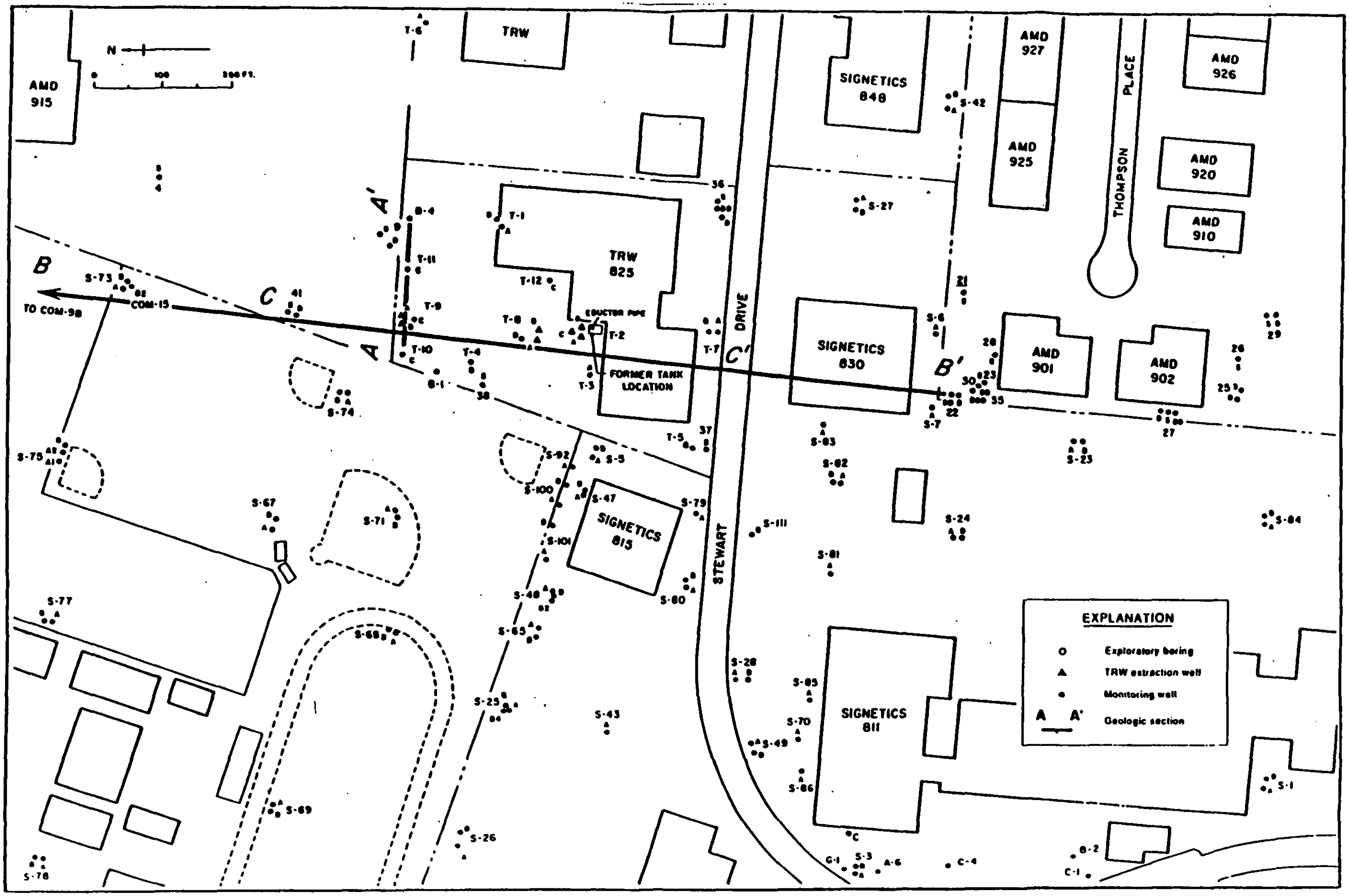

Figure 5. TRW Microwave Site Map

1.1.4 Offsite Operable Unit

The study area for the offsite operable unit begins north of the Signetics operable unit (Figure 2) and extends north of Duane Avenue in an area bounded approximately by the Sunnyvale East Drainage Channel on the west and Santa Paula Avenue on the east. The study area extends north of Highway 101 to just north of Lakehaven Drive. The actual offsite operable unit is loosely defined as the area inside the 5 $\mu g/l$ (Figure 6) isopleth for TCE in groundwater. This covers an area of about 100 acres and includes commercial and residential property. The area south of Duane Avenue is industrial property and includes the former Sunnyvale High School Buildings currently used as an industrial research and development facility. Commercial and retail property is mixed with multiple unit residential property along the north side of Duane Avenue. The remainder of the offsite area is residential property, including approximately 600 single family residential units and the former San Miguel Elementary School. The Elementary School currently is used as a daycare facility for the community and houses a Headstart Program for Sunnyvale.

1.2 REGIONAL TOPOGRAPHY

The Study Area is located in the Santa Clara Valley which is a gently-sloping alluvial plain, flanked by the Diablo Range to the east-southeast and the Santa Cruz Mountains to the west-southwest. The Study Area is located toward the center of the valley. The Santa Cruz Mountains are located several miles southwest of the Study Area. The San Francisco Bay is located approximately 4 miles north of the Study Area.

1.3 ADJACENT LAND USE

The study area site is a broad area extending to just north of the Bayshore Freeway, bounded on the south by the Central Expressway, and bounded east to west by the Lawrence Expressway and Fair Oaks Drive (see Figure 1). The facility is located in an industrial park setting bordered by residential areas. The area to the east is dominantly commercial and retail space. The area immediately to the west of the study area is mostly residential property. The land to the north of the study area is a mix of multiple and single family residential property including several large trailer park developments and retail centers.

Approximately 60% of the study area acreage is devoted to industrial and commercial use. The former San Miguel School facility accounts for about 5% of the study area with the remainder used as residential property. The recreational facilities within the surrounding areas include a park along Fairoaks which includes ball fields and tennis courts.

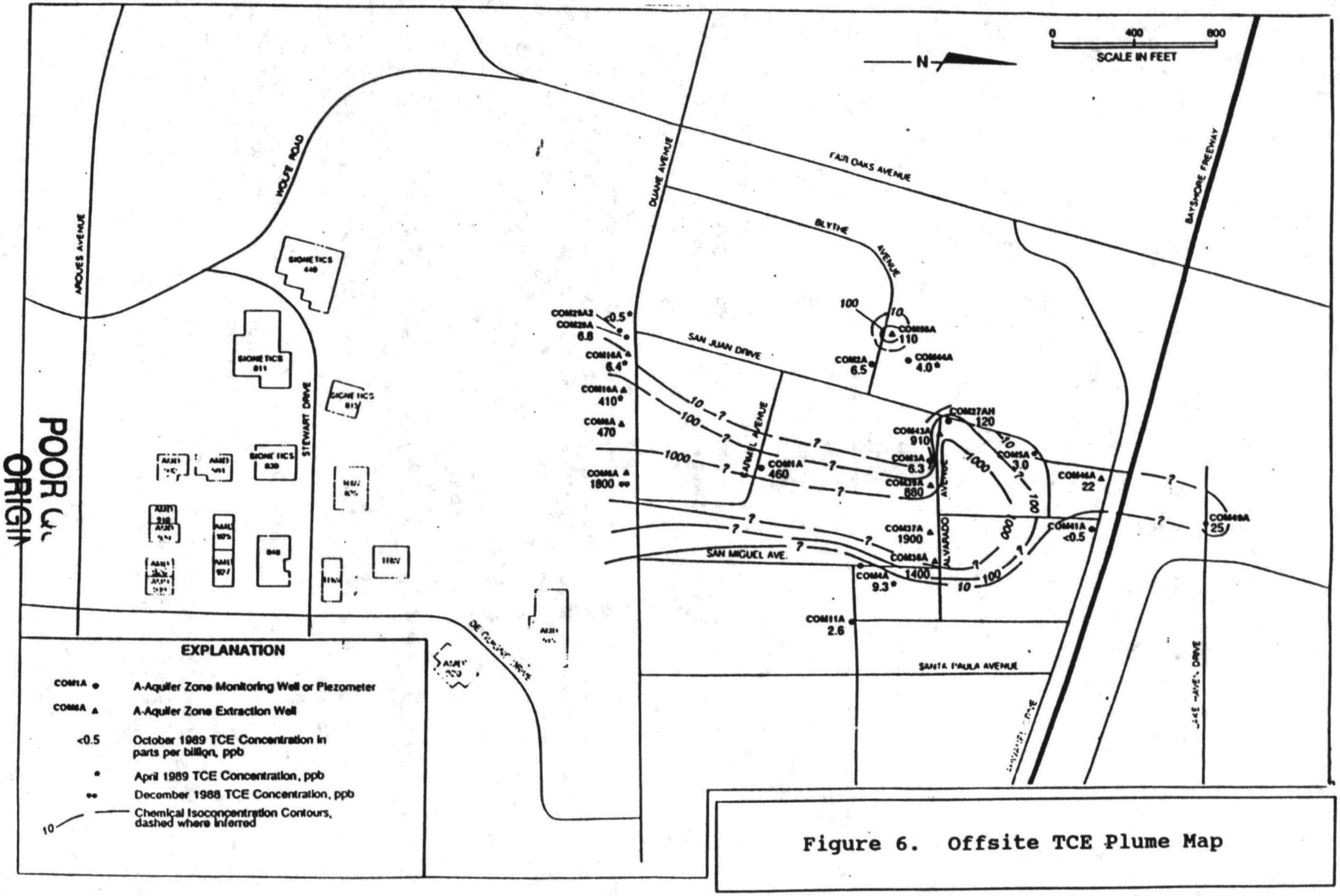

Figure 6. Offsite TCE Plume Map

1.4 HISTORICAL LAND USE

Land use in Santa Clara County, until the late 60's, was agricultural, predominantly commercial fruit orchards. Development of light industrial manufacturing facilities began in the late 50's. As the area developed a reputation as a center of the micro-electronics industry, development accelerated through the 70's. This, along with increased demand for residential property related to the increased industrialization, has limited agriculture to isolated locations and the fringes of the Santa Clara Basin.

All of the industrial facilities within the study area were built on land that had previously been used for agriculture and all were designed and built as electronics manufacturing plants. While manufacturing processes have varied among the facilities and through time, the manufacturing processes at these sites have involved the use of solvents, caustics, metals, and acids. The current trend is a decline in the importance of manufacturing and increased emphasis on research and development activities.

1.5 HYDROGEOLOGY

Stratigraphy in the valley surrounding the study area is characterized by interbedded and interfingering sands, silts and clays. These sediments were deposited in complex patterns by fluvial-alluvial systems draining the uplands to the south with sediments deposited as the streams flowed north toward the Bay.

The nomenclature applied to the water bearing units in the study area is representative of the hydrogeology within the Santa Clara Groundwater Basin. A number of shallow water bearing units are separated from deeper aquifers by a thick persistent aquitard. The shallow units may be subdivided into a variety of zones depending upon depth, lithology and lateral persistence. These zones are frequently labeled as A and B zones (Figure 7). The deeper aquifer is commonly referred to as the C aquifer and the clay layer separating the upper and lower water-bearing zones is commonly referred to as the B-C aquitard. The aquitard has been reported to be between 50 and 100 feet thick in Santa Clara Valley.

Six local aquifers have been identified through the investigation in the study area and the deeper, B-C aquitard (Figure 7) has been confirmed at both the TRW and Signetics operable units. Regional investigation has indicated that deeper aquifers do exist in the Santa Clara Valley Groundwater Basin and are probably present in the project area. The shallowest water bearing zone has been designated the A zone and generally occurs from 6 to 25 feet below the ground surface. This is the most persistent, permeable unit near 825 Stewart Drive and generally contains from 1 to 19 feet of permeable material. The next unit has been designated as the B1 aquifer and generally occurs from 25 to 55 feet below ground

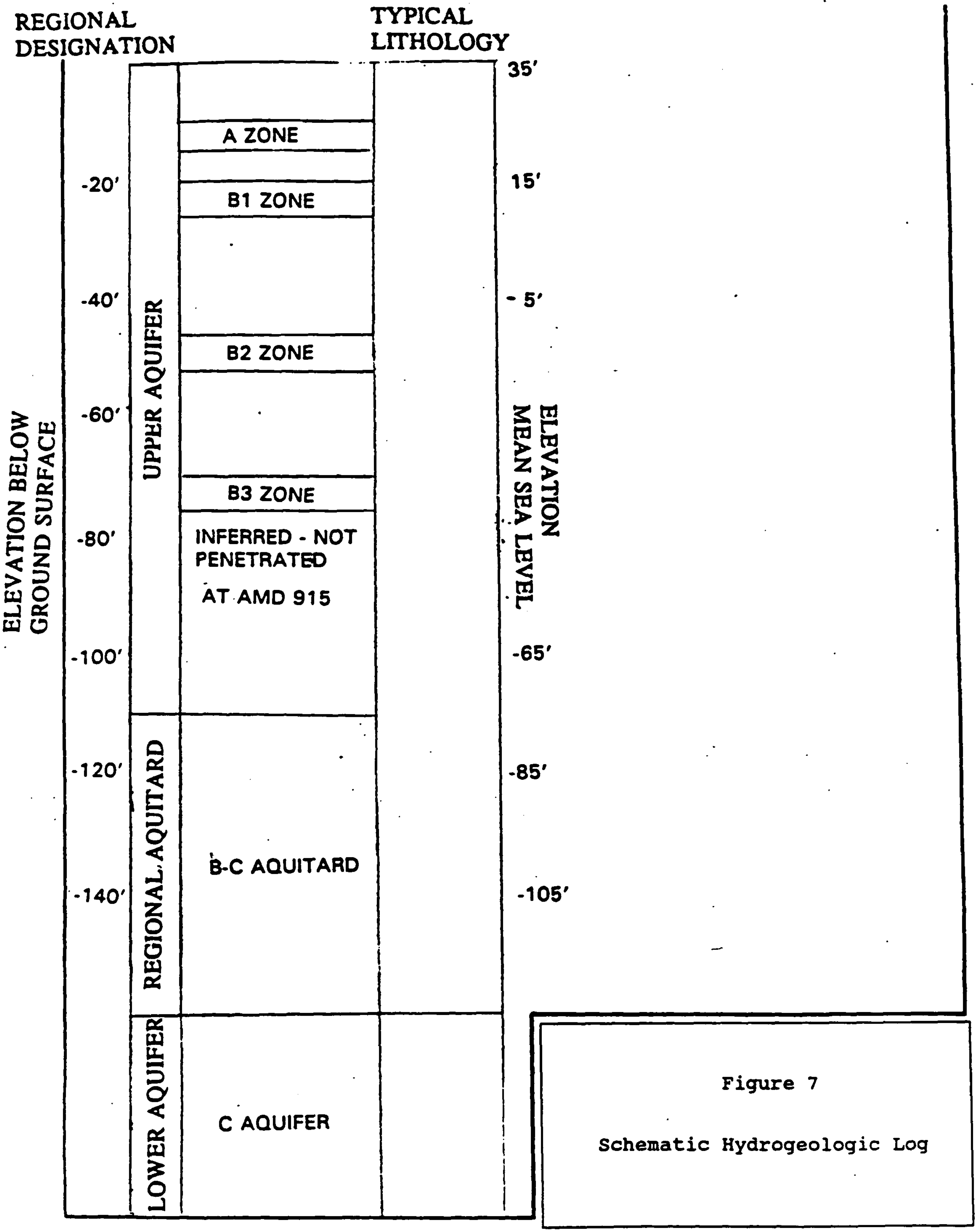

Figure 7

Schematic Hydrogeologic Log

surface and contains 0.5 to 15 feet of permeable materials. The next unit has been designated as the B2 aquifer and occurs from 45 to 55 feet below the ground surface. It generally contains from 6 to 8 feet of permeable material. The next unit, the B3, is relatively thin and only encountered in a few borings at the TRW site. It consists of from 1 to 5 feet of permeable material. The next unit, B4, begins from 82 to 86 feet below ground surface and contains 1 to 4 feet of permeable material. The deepest unit identified at the TRW site is aquifer B5. This aquifer occurs from 116 to 123 feet below ground surface and contains 5 to 7 feet of permeable material.

The static groundwater flow direction within the study area is to the north-northeast in all aquifers. The vertical gradient has been documented to be upward under normal conditions in the study area. The flow direction and vertical hydraulic gradient may be reversed locally in the vicinity of groundwater extraction wells operating in the A, B1, B2, and B3 aquifers.

1.6 WATER USE

Currently, groundwater from this basin provides up to 50% of the municipal drinking water for the 1.4 million residents of the Santa Clara Valley. In 1989, groundwater accounted for approximately 128,000 of the 315,000 acre feet of drinking water delivered to Santa Clara Valley Water District customers. This water is produced from the C aquifer. Groundwater contamination is limited to the shallow A and B water bearing zones (see Section 1.5 above).

Prior to the conversion of agricultural land throughout the Santa Clara Valley to industrial use in the late 1960's and early 1970's, groundwater in this area was used as irrigation supply and for other agricultural purposes. No supply wells completed in the contaminated shallow aquifers have been identified. On March 30, 1989, the Regional Board incorporated the State Board Policy of "Sources of Drinking Water" into the Basin Plan. The policy provides for a Municipal and Domestic Supply designation for all waters of the State with some exceptions. Groundwaters of the State are considered to be suitable or potentially suitable for municipal or domestic supply with the exception of: 1) the total dissolved solids in the groundwater exceed 3000 mg/L, and 2) the water source does not provide sufficient water to supply a single well capable of producing an average, sustained yield of 200 gallons per day. Based on data submitted as part of the Remedial Investigation report, the RWQCB has determined that neither of these two exceptions apply to the A and B zones in the study area. Thus, the A and B zones are considered to be potential sources of drinking water by RWQCB. EPA agrees with this determination.

AMD 901/902, TRW Microwave and Signetics were proposed for inclusion on the National Priorities List (NPL) (see Section 2.3) primarily because of the potential threat from past chemical releases to the quality of this valuable resource. The major concern at the site stems from the potential migration of contaminants in the Upper Aquifer Zone down to the Lower Aquifer Zone through abandoned or poorly sealed wells or natural conduits through aquitard material. Municipal water supply wells are generally perforated in the Lower Aquifer Zone. All water supply wells located within an approximate one mile radius of the study area are perforated from 190 to 390 feet below ground surface.

Currently, the nearest municipal drinking water supply well downgradient of the study area is a Santa Clara Valley Water District well, which is located more than 1000 feet north of the site. No pollutants have been found in this well to date. Currently, there are no known users of ground water from the Upper Aquifer Zone. The Regional Water Quality Control Board (RWQCB) has identified potential beneficial uses of the shallow ground water underlying and adjacent to the study area. These beneficial uses include industrial process water supply, industrial service water supply, municipal and domestic water supply and agricultural water supply. These are the same as the existing and potential beneficial uses of the ground water in the Lower Aquifer Zone.

A well search for abandoned wells in a 3350 acre area encompassing the study area was completed in December 1986. This includes over one mile in all directions and over three miles in the downgradient direction. The focus of the well search was to identify wells that potentially may form migration pathways to the deeper aquifer. The search identified 177 possible well locations. Of these wells 76 are identified as destroyed. Only four wells that might act as potential migration conduits to deeper aquifers were identified. One of these wells is a Santa Clara Valley Water District (SCVWD) well more than 1000 feet downgradient of the site. Testing of the well has shown no evidence of contamination. Of the remaining three wells, two wells are listed as destroyed in SCVWD records. The remaining well is a cathodic protection well maintained by Pacific Gas & Electric. This type of well is frequently installed to inhibit rust in underground pipelines. These wells are typically shallow (i.e. pipeline depth) and cased with steel. No additional data was available on the other well and attempts to field check the well location were unsuccessful.

Two municipal supply wells were identified by the potential conduit study. Well ID number 1845 is a City of Sunnyvale water supply well. This well is over 3000 feet upgradient of the known groundwater contamination plume. Well ID number T6SR1WS29N2 T6SR1WS29 is also upgradient of the groundwater pollution plume and is shown in Santa Clara Valley Water District records as destroyed.

1.7 SURFACE AND SUBSURFACE STRUCTURES

Surface and subsurface structures involving the use of chemicals is limited to the AMD 901/902, Signetics and TRW Microwave operable units. These are the only areas were chemical use has been documented. The structures are similar within each operable unit, however the number and location is different enough to warrant a discussion focused on each operable unit.

1.7.1 AMD Operable Unit

The surface area included in the AMD 901/902 operable unit is approximately 3 acres with the physical surface structures covering about 0.6 acres. Subsurface structures at the AMD 901/902 facility include both structures installed in vaults below engineered grade and structures installed directly into native soils. These structures include waste solvent tanks and acid neutralization systems (ANS). One above grade waste solvent tank in the Pad II area (Figure 8) was installed in 1972 or earlier. This tank was removed in 1982 and replaced with a 1000 gallon below grade steel unit. This new tank, installed in a coated concrete vault, is still in use.

Separate acid neutralization systems were maintained for each fabrication facility (901 and 902). The acid neutralization system for the 901 facility was installed in the Pad I area (Figure 8) in 1968 and removed in 1982. The ANS for AMD 902 was installed in the Pad II area in 1972. This system was excavated and removed in 1984. Each system consisted of a single coated concrete tank of about 2000 gallon capacity.

New acid neutralization systems were installed in 1982. The A-system for AMD 901 and the B-system for AMD 902. Both systems are fiberglass reinforced tanks installed in below grade coated vaults. Each system consists of three tanks with a total capacity of 2000 gallons.

1.7.2 Signetics Operable Unit

Above ground structures at the Signetics facility include the 811 East Arques building, a building at 440 Wolfe and buildings at 830 and 815 Stewart Drive (Figure 2). The remedial investigation has included groundwater monitor wells, soil samples and/or soil gas studies near all four buildings. The investigation has focused on underground structures and the primary source of contamination at the 811 East Arques building.

In general underground structures at the Signetics facility can be grouped into three categories; diesel tanks, waste solvent storage, and waste water storage or treatment tanks. A waste solvent tank located on the west side of the 811 E. Arques building was removed in 1982 (Figure 9). Waste water treatment tanks located north of the 811 building were removed in 1984.

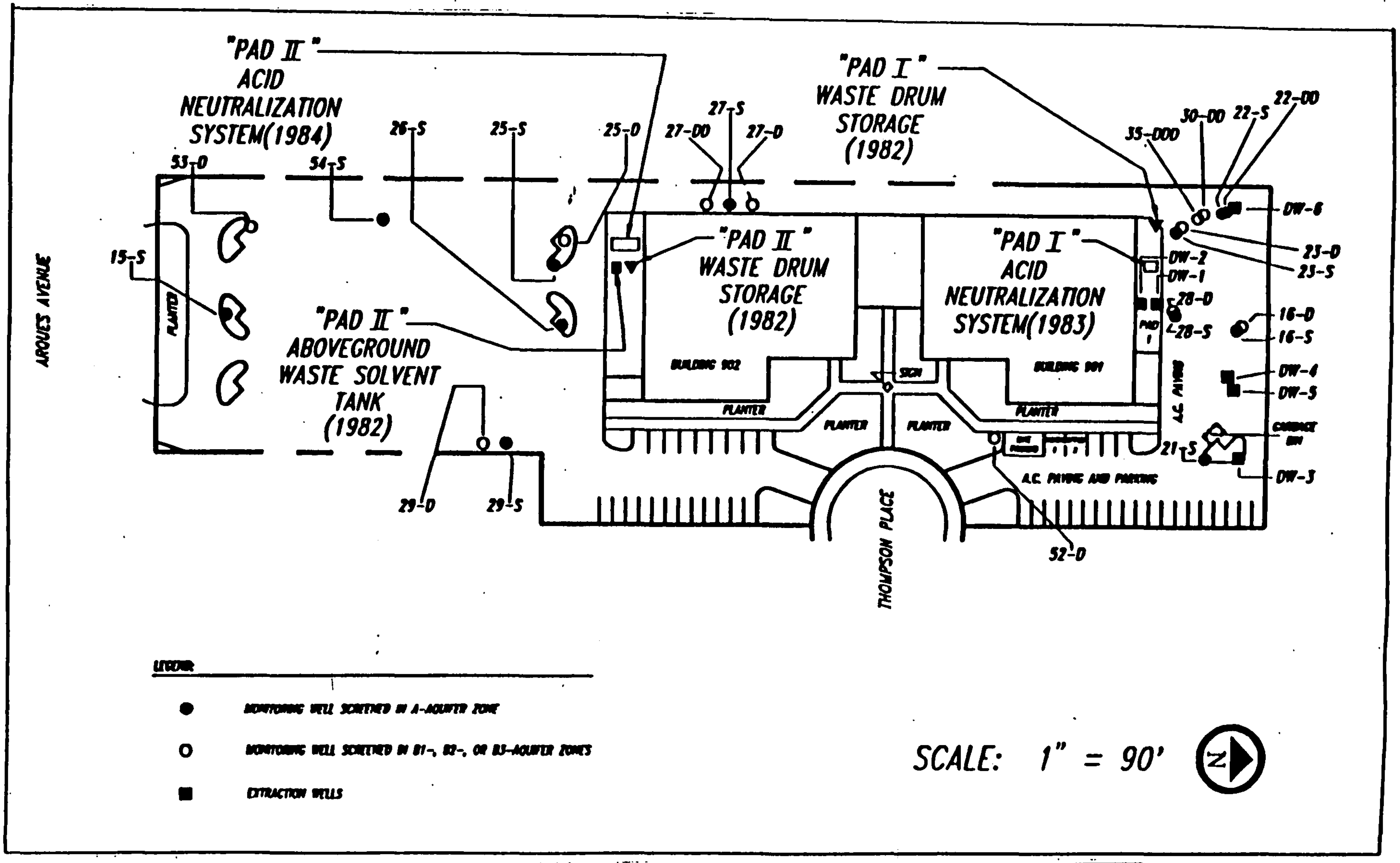

Figure 8. Historical Waste Storage Locations at AMD 901/902 (with removal dates in parentheses)

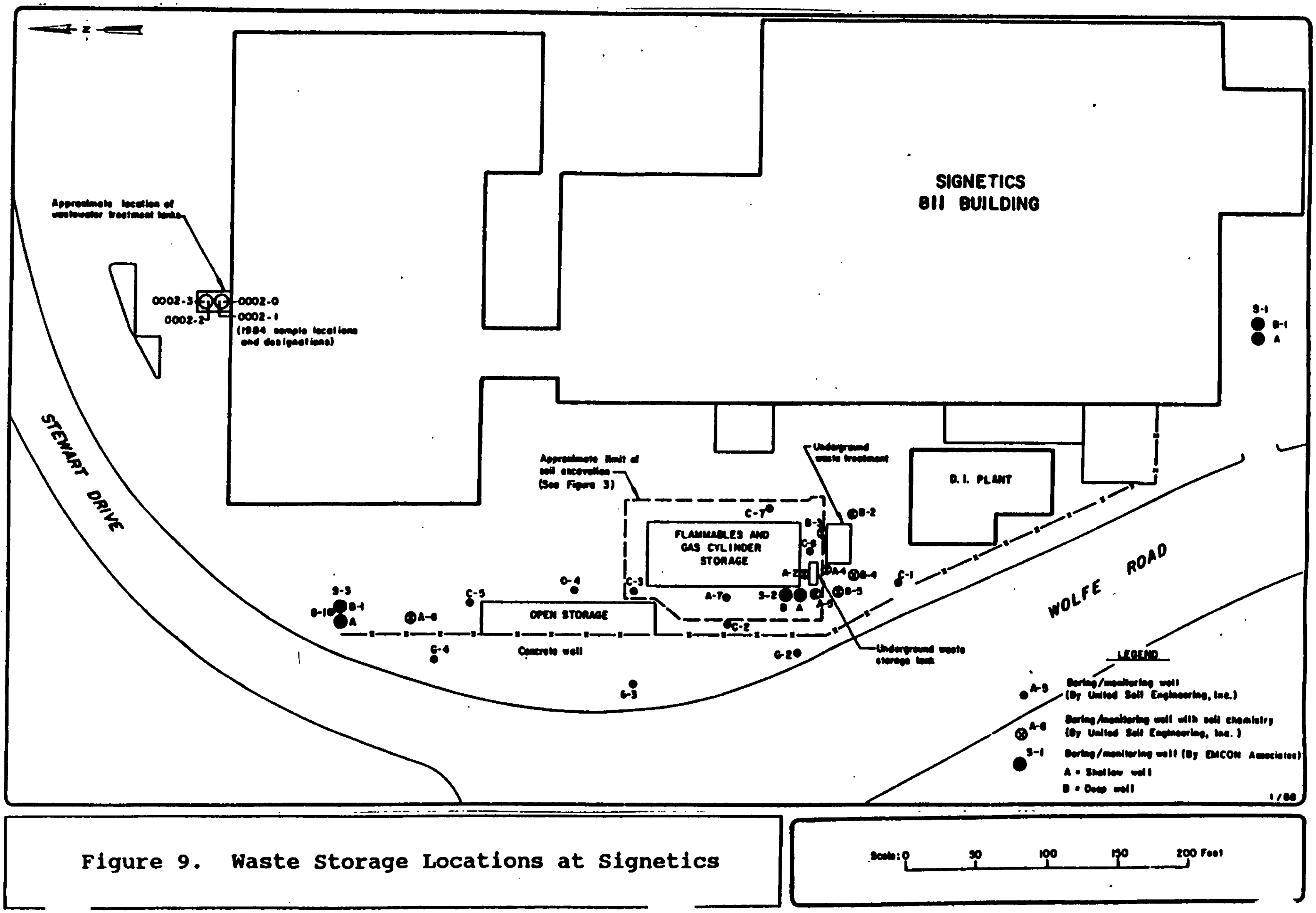

Figure 9. Waste Storage Locations at Signetics

Currently four underground diesel fuel tanks are in place on the west side of the 440 Wolfe building and one underground diesel tank is in place on the east side of the 811 E. Arques building. Groundwater monitor wells located downgradient of the diesel tanks are monitored quarterly. Two underground waste solvent tanks are located on the west side of the 811 East Arques facility near the waste water treatment plant. The facilities on the east side of the 811 East Arques building are located in concrete vaults. Two waste water equalization tanks are located at the northeast corner of the 811 East Arques and two additional waste water neutralization tanks are located at the northeast corner of the 440 Wolfe facility. Groundwater monitoring wells are also located downgradient of these tanks.

1.7.3 TRW Operable Unit

The former TRW Microwave facility at 825 Stewart Drive is one of three structures on an approximately 1 acre site. The investigation has been focused on the 825 Stewart Drive building. Two below ground facilities have been documented at the TRW site. These include an acid neutralization system north of the building and a waste solvent storage tank (Figure 10). The acid neutralization system was installed in 1968 when the facility began operation. The first tank in a series of four underground waste solvent tanks was installed in 1970 and was replaced sequentially in 1973, 1976, and 1980. The final underground solvent tank was removed in 1983. The acid neutralization system was removed in 1986 and replaced by a three tank above ground system.

1.7.4 Offsite Operable Unit

Structures within the offsite operable unit are primarily retail or residential. The exceptions to this is the former Sunnyvale High School site just north of the Signetics 440 Wolfe facility (Figure 2) and the San Miguel School site located near the corner of San Miguel and Alvarado Avenues (Figure 2).

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

Separate Orders have been prepared by the RWQCB for each onsite Operable Unit (AMD, Signetics and TRW) with joint tasks for the Offsite OU unit. This course has been taken due to the commingling of the groundwater plume in the offsite area. The Companies are encouraged to submit joint reports when feasible. A joint RI/FS was completed and served to further define the groundwater contaminant plume. If joint reports are not coordinated and submitted, each company is still individually responsible for the joint tasks in these Board Orders.

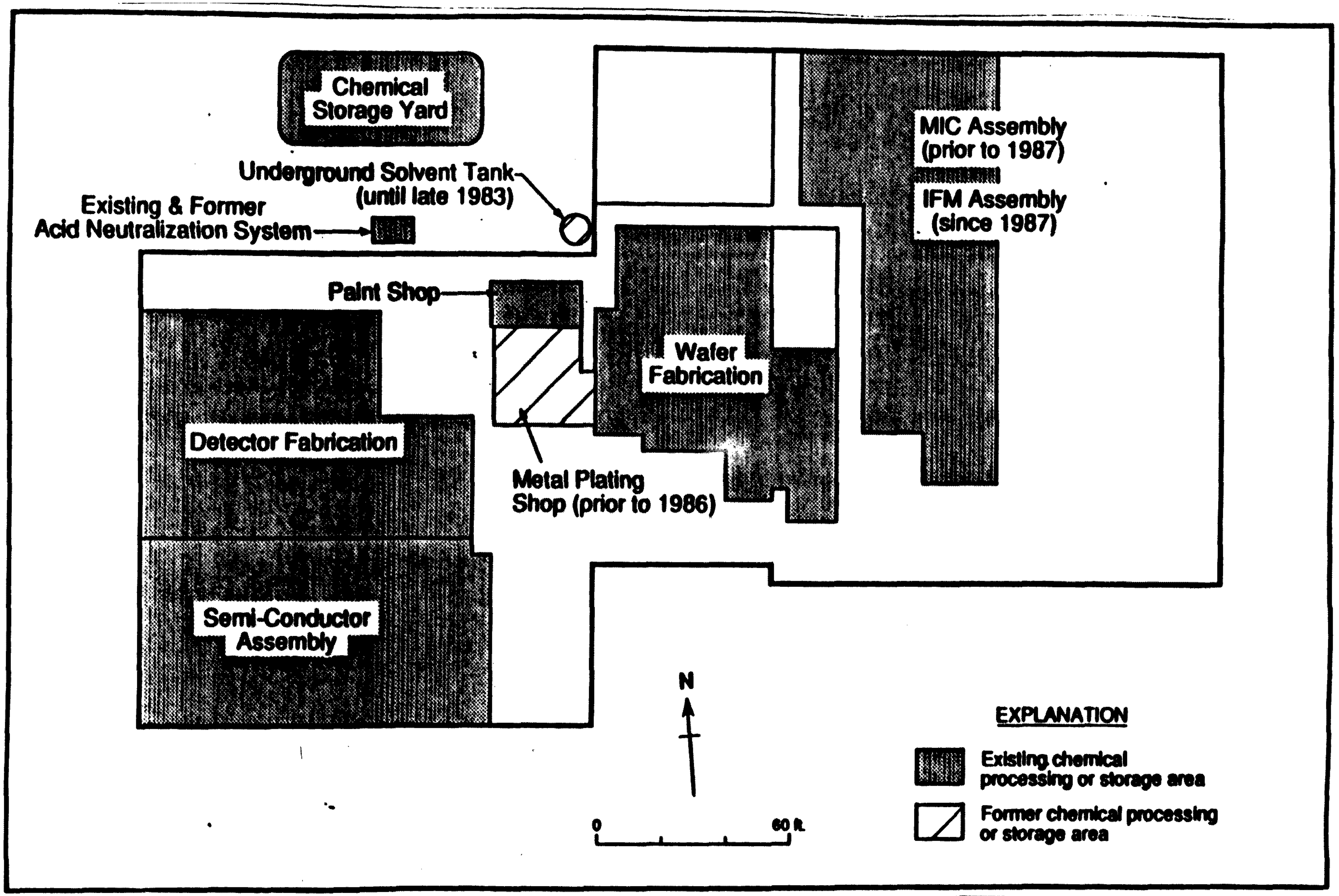

Figure 10. Chemical Storage and Processing Locations at TRW Microwave

2.1 HISTORY OF SITE ACTIVITIES

As discussed above, conversion of the agricultural land in the Santa Clara Valley to industrial use began in the late 50's and escalated in the 60's and 70's with the establishment of Santa Clara as a center of the electronics industry. The three industrial facilities included in this ROD have been a part of this pattern of development.

2.1.1 AMD Operable Unit

AMD 901 has been used as a semiconductor manufacturing facility since 1969 to the present. Manufacturing operations at AMD 902 began in 1972 and are still active. The manufacturing process at these two facilities involved the use of solvents for cleaning and degreasing, acids for etching, caustics for acid neutralization and some arsine and chromium in the manufacturing process.

Initial investigation at the AMD 901/902 site began in 1982 with the investigation of leakage from an acid neutralization system near AMD 901. This leakage was investigated and the acid neutralization system was removed during 1983. In 1984 the investigation expanded to include the acid neutralization system at AMD 902. Polluted soils were found near both acid neutralization systems.

The polluted soils were identified as point sources that had resulted in groundwater pollution with volatile organic chemicals (VOCs). Further investigation and interim remedial actions followed the soils investigation.

The original development of the property was begun by Johnson and Mape. The property at 901 Thompson Place was acquired from Johnson and Mape by B/G Management in 1977. The property at 902 Thompson Place was acquired from Johnson and Mape by Mr. and Mrs. Edwin Rosenthal in 1974. Partial interest in the 902 property was sold by Mr. and Mrs. Rosenthal in 1982. The remaining interest was sold in 1984. The purchase of these interests was converted into two undivided 50% interests in the property at 902 Thompson Place for Research Group 82-1 and Thompson Place 2, limited partnerships. These are the current property owners of record for AMD 901/902. AMD has been the sole tenant and operator of the facilities and has assumed responsibility for the cleanup actions at the site.

2.1.2 Signetics Operable Unit

Signetics has operated a semiconductor manufacturing facility at the 811 E. Arques Avenue since 1964. The manufacturing processes employed at this location have utilized various organic solvents, acids, corrosives, and metals. Current chemical usage is similar to past patterns, with the exception of the closure of the plating operation at 811 E. Arques, which has eliminated some potential sources of metal pollution, and the elimination of chemicals containing chromium, phenol, trichloroethylene (TCE), and perchloroethylene (PCE).

Initial investigation at the site began in February 1982 with the detection of a leak in an underground waste solvent storage tank. The presence of contaminated soil was verified during the tank removal. Following additional investigation of the Signetics main campus facility (440 Wolfe, 815 Arques, 830 Arques) the waste solvent tank area has been identified as the principal source of contaminants on the Signetics site.

All storage and treatment facilities have been updated and either relocated above ground or doubly contained. Hazardous materials from other nearby Signetics facilities are stored at the 811 E. Arques site, under the authority of the Resource Conservation and Recovery Act (RCRA), prior to offsite disposal at an appropriate commercial disposal facility. Recent facility inspections and reporting indicate that the facility is in compliance with the requirements of its RCRA permit.

2.1.3 TRW Operable Unit

Initial operation as an industrial facility began in 1968 when Aerotech Industries began assembling and testing microwave components at this site. The first semiconductor manufacturing began in 1970. Aerotech Industries and this site were acquired by TRW Microwave in 1974 and was operated by TRW Microwave from July 1974 to August 1986. The property was purchased by Tech Facility 1, Inc. in 1987. Some assets at this site were acquired by FEI Microwave, Inc. in July 1987. The manufacturing facility is currently operated by FEI Microwave, Inc.

While processes have varied throughout the history of the site, chemical usage has remained relatively constant. Solvents, metals, and acids have been involved in the manufacturing process. FEI Microwave is currently manufacturing electronic components at the facility.

As a result of responses to an information questionnaire regarding underground tanks investigation of pollution at the 825 Stewart Drive site was initiated 1983 at the request of Board Staff. The initial phase of investigation produced evidence of soil pollution with a variety of volatile organic chemicals (VOCs). Investigation at the site has focused on the location of an underground solvent storage tank and acid neutralization system.

Additional soil work was completed in 1983 and initial groundwater investigation began in July 1983. In addition to VOCs, metals were detected in soil near the acid neutralization system. A more comprehensive soil investigation was completed in 1988 to address possible polluted soil that might still remain near the identified point sources. All underground storage and treatment systems for solvents and acids have been removed and replaced with above ground systems.

2.2 HISTORY OF SITE INVESTIGATIONS

Initial investigations at all three industrial sites were initiated as a result of an information questionnaire regarding underground tanks. This questionnaire was mailed by the RWQCB to over 2000 industrial facilities in Santa Clara County as a follow-up to the discovery of groundwater contamination at other sites in Santa Clara County.

The sites were proposed for inclusion on the National Priority List or Superfund list between 1984 and 1988. As required by Superfund proposed final Remedial Investigation and Feasibility Study reports (RI/FS) were submitted on behalf of AMD, TRW, and Signetics (the Companies) in January 1991. Final RI/FS reports were submitted in March 1991. The Regional Water Quality Control Board (RWQCB) adopted an Order approving the joint RI/FS and a final Remedial Action Plan that will encompass cleanup at the four Operable Units including AMD, Signetics, TRW Microwave and the offsite area.

2.2.1 AMD Operable Unit

Two possible sources of pollution have been identified at the AMD 901/902 OU. These include acid neutralization systems south of the AMD 902 building and north of AMD 901 (Figure 8). Soil pollution was the highest near the AMD 901 acid neutralization system. During removal of the system, soil with up to 186,000 μg/kg of trichloroethylene (TCE) was excavated. Due to proximity of the building not all of the polluted soil could be removed from the southern portion of the excavation.

Additional investigation of source area soil was completed in 1988. This investigation confirmed the presence of polluted soil beneath the excavation for the acid neutralization system removed near the AMD 901 building. The maximum concentrations detected in soil include 242,000 μg/l of 1,2-dichlorobenzene (DCB), 35,000 μg/l of tetrachloroethylene (PCE), 80,000 μg/l of TCE, and 72 μg/l of 1,1-dichloroethylene (1,1-DCE). The estimated volume of soil remaining in this area containing levels of total VOCs higher than 1 ppm is 37 cubic yards.

An acid neutralization system was also removed from the vicinity of AMD 902 in 1984. The maximum concentration of soil pollution detected during the investigation of the neutralization system was 1200 μg/kg of TCE, directly beneath the former tank location. No other soil pollution above 100 μg/kg was detected during this removal action. Based on analysis of soil following the excavation and concentrations of pollutants in groundwater in the area of the excavation no additional investigation of the AMD 902 source area was required.

2.2.2 Signetics Operable Unit

Initial investigation at the site began in February 1982 with the detection of a leak in an underground waste solvent storage tank. The presence of contaminated soil was verified during the tank removal. Following additional investigation of the Signetics main campus facility (440 Wolfe, 815 Arques, 830 Arques) the waste solvent tank area has been identified as the principal source of soil and groundwater contaminants on the Signetics site.

Following the discovery of the leak in the waste solvent tank west of the 811 E. Arques building a systematic review of potential source areas was completed. Five possible source areas were investigated in detail and a more wide ranging soil gas survey was completed in an attempt to locate a possible unknown source. The areas investigated include the former underground waste solvent storage tank, the 440 Wolfe facility, Main Campus diesel tanks, Main Campus wastewater neutralization tanks, and the former location of wastewater neutralization tanks north of the 811 Arques facility (Figure 9). In addition a soil gas survey was completed in the vicinity of the 815 Stewart Drive building.

The results of these investigations have identified two probable source areas of volatile organic chemicals (VOCs) within the Signetics OU, the former underground waste solvent tank area and the former 811 Arques wastewater neutralization tank area. Based on the results of these investigations other source areas are not anticipated.

2.2.3 TRW Operable Unit

As a result of responses to an information questionnaire regarding underground tanks circulated by the RWQCB, investigation of pollution at the 825 Stewart Drive site was initiated in 1983 at the request of Board Staff. The initial phase of investigation produced evidence of soil pollution with a variety of volatile organic chemicals (VOCs). Investigation at the site has focused on the location of an underground solvent storage tank and acid neutralization system (Figure 10).

Additional soil work was completed in 1983 and initial groundwater investigation began in July 1983. In addition to VOCs, metals were detected in soil near the acid neutralization system. A more comprehensive soil investigation was completed in 1988 to address possible polluted soil that might still remain near the identified point sources. The excavation was expanded to the limits allowed by the proximity of the building. This area was identified as a point source for chemicals that resulted in groundwater pollution.

Additional investigation was completed in 1988, as required under RWQCB Order 88-015, since some contaminated soil was left in place near the former location of the underground waste solvent storage tank. The maximum concentration of total VOCs detected in the vadose zone near the solvent storage tank was about 4 ppm. The maximum concentration of total VOCs in saturated zone soil in this area was approximately 34 ppm. Based on these estimates, and making liberal assumptions regarding concentration and volume, it is estimated that the vadose and saturated soils in this area contain at most three pounds of TCE.

Soil investigation near an underground, acid neutralization system (ANS) was also carried out during the closure of the system in 1986. Some soil samples contained elevated levels of metals, however no elevated levels of VOCs were detected during this investigation. This area is not considered a source area for pollutants currently detected in the groundwater. Extraction tests on soil from the ANS excavation area indicate that the inorganics would not be expected to impact groundwater.

2.3 HISTORY OF ENFORCEMENT ACTIONS

The three industrial sites have been proposed or included on the National Priorities List (NPL) and have been regulated by Regional Board Orders as separate entities, as indicated herein:

2.3.1 AMD Operable Unit

a.	October 1984	Site proposed for inclusion on the National Priorities List (NPL)
b.	September 1985	Waste Discharge Requirements Adopted
c.	June 1986	Site formally added to the NPL
d.	December 1987	Site Cleanup Requirements Adopted
e.	April 1989	RWQCB Order #89-56, Revised Site Cleanup Requirements Adopted, approving RI/FS workplan and associated tasks,
f.	June 1991	RWQCB Order #91-102, Revised site cleanup requirements, approving the RI/FS and proposed plan adopted.

2.3.2 Signetics Operable Unit

a.	April 16, 1983	Waste Discharge Requirements Adopted,
b.	October 1984	Site proposed for inclusion on the National Priorities List (NPL),
c.	September 18, 1985	Waste Discharge Requirements Adopted,
d.	December 16, 1987	Site Cleanup Requirements Adopted,
e.	July 20, 1988	Waste Discharge Requirements Adopted approving RI/FS workplan and related tasks,
f.	April 1989	RWQCB Order #89-058 Revised Site Cleanup Requirements Adopted, approving RI/FS workplan and related tasks.
g.	July 1989	Waste Discharge Requirements Amended,
h.	October 1989	EPA drops proposal to include Signetics on the NPL,
i.	June 1991	RWQCB Order #91-104, Revised site cleanup requirements, approving the RI/FS and proposed plan adopted.

2.3.3 TRW Operable Unit

a.	June 1984	Cleanup and Abatement Order Issued
b.	October 1985	Waste Discharge Requirements Adopted
c.	January 1988	Site Cleanup Requirements Adopted
d.	June 1988	Site proposed for inclusion on the National Priorities List (NPL).

e.	April 1989	RWQCB Order #89-057 Revised Site Cleanup Requirements Adopted, approving RI/FS workplan and related tasks.
f.	September 1989	Reissued Waste Discharge Requirements Adopted
g.	February 1990	Site formally added to the NPL
h.	June 1991	RWQCB Order #91-103, Revised site cleanup requirements, approving the RI/FS and proposed plan adopted.

3.0 COMMUNITY RELATIONS

3.1 Community Involvement

An aggressive Community Relations program has been ongoing for all Santa Clara Valley Superfund sites, including AMD 901/902, Signetics and TRW Microwave. The Board published a notice in the San Jose Mercury News on March 13, 20, and 27, 1991, announcing the proposed final cleanup plan and opportunity for public comment at the Board Hearing of March 20, 1991 in Oakland, and announcing the opportunity for public comment at an evening public meeting to be held at the Westinghouse Auditorium, Britton at East Duane Avenue, in the City of Sunnyvale on Thursday March 28, 1991. Based on community response the 30 day comment period from March 20, 1991 through April 19, 1991 was extended an additional 30 days through May 20, 1991.

In response to comments received at the March 20, 1991 meeting, an additional meeting was held in early May. The initial focus of this meeting was on parents of children utilizing the San Miguel School facilities. After further discussion with other community members the focus of the meeting was broadened to include the surrounding community. Following this meeting several additional informal meetings were held with community members and groups during the extended public comment period.

Additional comments regarding the proposed cleanup plan were received at the RWQCB meeting June 19, 1991. These comments emphasized citizens concern regarding vapor emission in the offsite area and the impact of the Superfund status of the offsite area on local property values.

3.2 Fact Sheets

Fact Sheets were mailed to interested residents, local government officials, and media representatives. Fact Sheet 1, mailed in

December 1989, summarized the pollution problem, the results of investigations to date, and the interim remedial actions. Fact Sheet 2, mailed in March 1991, described the cleanup alternatives evaluated, explained the proposed final cleanup plan, announced opportunities for public comment at the Board Hearing of March 20, 1991 in Oakland and the Public Meeting of March 28, 1991 in Sunnyvale and described the availability of further information at the City of Sunnyvale Library and the Regional Board offices.

Fact Sheet 3, a summary and refinement of Fact Sheet 2, was hand delivered to all residences in the offsite area in early May to announce the May 7 meeting at the San Miguel School. Fact Sheet 4 describing the final proposed plan and containing a summary of responses to key community issues was hand delivered to all residences in the offsite area and mailed to a 400 person mailing list in early June.

4.0 SCOPE AND ROLE OF THE RESPONSE ACTION

4.1 SCOPE OF THE RESPONSE ACTION

The remedies selected and described in this ROD include the existing interim remedial measures. The interim remedial measures have included the removal of leaking underground tanks, acid neutralization systems, and some contaminated soils, containment and extraction of contaminated groundwater, and treatment of extracted groundwater. The remedies selected and interim remedial measures to date are explained by operable unit in the following sections.

4.1.1 AMD Operable Unit

4.1.1.1 AMD Interim Remedial Measure

Onsite interim remedial actions began in 1983 with the removal of the acid neutralization sump and about 103 cubic yards of soil at AMD 901. Not all of the polluted soil was removed due to possible structural damage to AMD 901. In 1984, the acid waste neutralization sump and about 114 cubic yards of soil were removed from the vicinity of Building 902.

Remediation of the groundwater began in 1984 with the installation of two dewatering sumps and one extraction well to contain the onsite pollution. One sump extracts water from the shallow A Aquifer; the other two systems extract water from the B1 Aquifer. Three additional extraction wells were installed in 1988 to enhance the containment of the groundwater pollution in the B2 Aquifer. The extracted groundwater is treated by an air stripper with vapor-phase GAC emission control, and all of the effluent is reused as process water at the AMD 901/902 facility. Figure 11 shows the layout of the groundwater extraction and treatment system.

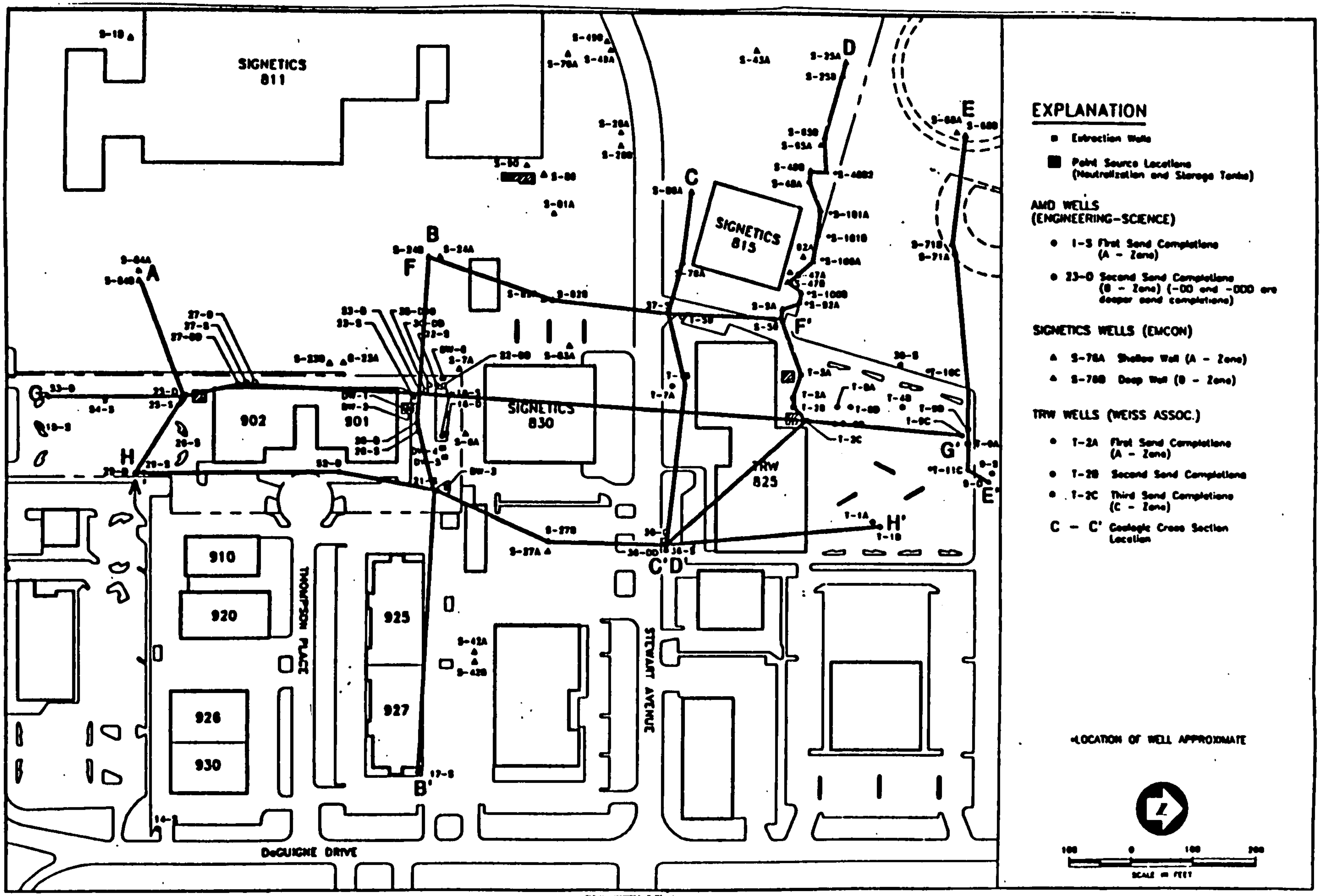

Figure 11. AMD 901/902 Groundwater Extraction System

4.1.1.2 AMD Selected Remedy

Excavation and offsite treatment and disposal is the selected remedy for the 37 cubic yards of contaminated soil that remains beneath AMD Building 901. The selected remedy for the AMD onsite groundwater is the continuation of the present groundwater extraction and treatment system involving air stripping with carbon adsorption of the offgas as permitted by the BAAQMD.

The treated groundwater is currently reused as process water by the manufacturing facility. All industrial process water is discharged to the sanitary sewer, and thus indirectly to the publicly owned treatment works (POTW). This discharge is controlled by a permit from the POTW and is subject to EPA pretreatment regulations. The discharge to surface water from the POTW is also controlled by an NPDES permit. The POTW has operated within all limits set by the NPDES permit.

The manufacturing operation will be eliminated at the AMD 901/902 facility in the near future and AMD has applied for an NPDES permit for the discharge of the treated effluent from the groundwater treatment system. No permit has been issued and discharge limits have not been established. It is probable that the discharge limits will be similar to those recently established for the AMD 915 facility included in this ROD as Table 3. A deed restriction will be included in the remedy to prohibit the installation of onsite wells until the groundwater remediation is completed.

4.1.2 Signetics Operable Unit

4.1.2.1 Signetics Interim Remedial Measure

Contaminated soil has been removed from three separate locations, an underground solvent storage tank located west of the 811 E. Arques building, a waste water neutralization tank area, also north of the 811 E. Arques building, and soil removed during the construction of the extraction trench at Signetics' 440 Wolfe facility. Approximately 4,720 cubic yards of soil was removed from the area of the waste solvent storage tank area in 1983. The volume removed from the wastewater tank area is unknown, however, based on analyses of soil from the excavation, it appears that all soil above 1 ppm total VOCs was removed from this area. The soil removed from the area of the 440 Wolfe trench is insignificant and does not represent soil removal from a source area.

Previous soil investigations have not documented a source area for the elevated levels of contaminants detected in wells north of the 811 Arques building. Based on results of a 1988 soil vapor extraction test, three additional vapor extraction wells were installed in 1989 and the system continues to operate.

Signetics operates six separate groundwater extraction systems in the vicinity of 811 E. Arques (Figure 12). In 1982, initial extraction of groundwater in the A aquifer began shortly after the discovery of pollution. This was accomplished with the basement dewatering sumps surrounding the 440 Wolfe Building, downgradient of 811 E. Arques. Similar systems also operate in the northern portion of the 811 Building and the wastewater treatment building.

Three other extraction systems were designed and installed specifically to contain polluted groundwater to the Signetics property. An extraction trench system was installed in the A aquifer north of 440 Wolfe Road in 1984 and operation began in 1985. Operation of this trench has been continuous with the exception of maintenance. Due to low water levels resulting from the drought and long term groundwater withdrawal, the system has been operating cyclically.

An extraction trench was installed in the A Aquifer north of the 811 E. Arques Building in 1984. The intent of this trench was to intercept polluted groundwater that may have come in contact with the polluted soil remaining in place at the 811 site. After an initial period of effective recovery of polluted groundwater, this trench became ineffective. This is again an effect of the low water levels resulting from the current drought.

The third groundwater extraction system consists of a series of six wells north of the Signetics facility at 815 E. Stewart Drive. This system was intended to prevent further migration of polluted groundwater downgradient to the north across the Signetics property boundary. The system consists of three A Aquifer wells, one B1 Aquifer well, and two B2 Aquifer wells. Operation of this system began in 1987 and, with the exception of downtime for maintenance operation, has been continuous to date. Extraction rates from the B2 Aquifer were increased in 1990.

All extracted groundwater is treated by a common treatment system utilizing air stripping and carbon adsorption on air stripper offgas and as final polish on the water. The treatment system is located at the 440 Wolf Road Building. The treated groundwater is currently 100% reused as industrial process water or for nonpotable uses. In the event of temporary plant shutdown the water will be discharged to surface waters following treatment under an NPDES discharge permit.

4.1.2.2 Signetics Selected Remedy

The selected remedy for the Signetics property combines soil and groundwater cleanup measures and expands the existing interim remedial measure's systems. Groundwater extraction from the A and B Aquifers will be enhanced by the installation of some additional extraction wells and an increased pumping rate at the 440 Wolf extraction trench. The soil vapor extraction system will also be

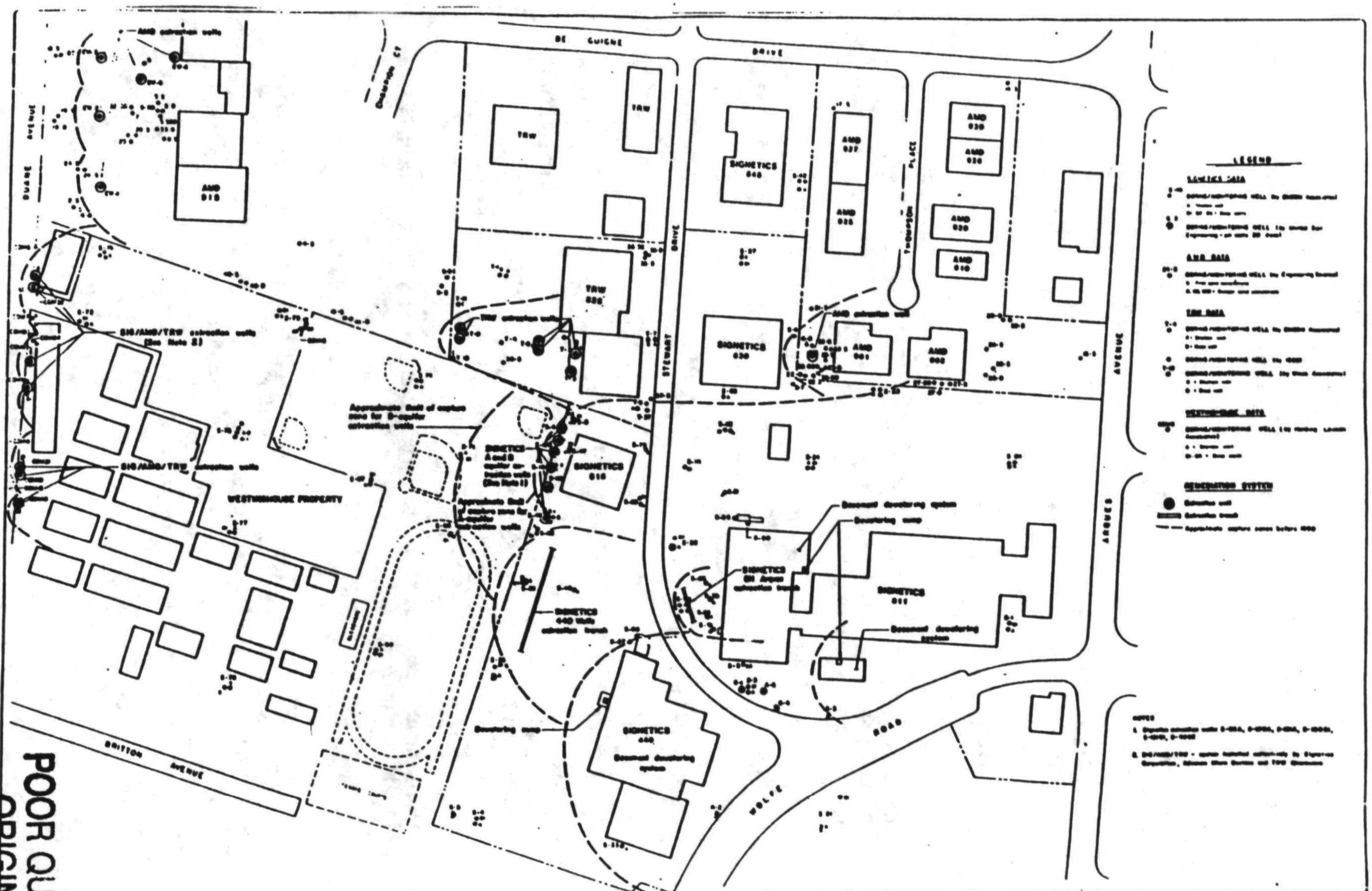

Figure 12. Signetics Groundwater Extraction System

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expanded by the addition of at least four more vapor extraction wells. The vacuum pumps and the carbon treatment units would be expanded to accommodate the additional wells. Deed restrictions will prohibit the installation of drinking water wells until the remediation is completed.

The discharge to surface water is controlled by NPDES Permit No. CA0028720. The limits for this discharge includes instantaneous maximum limits for specific contaminants and limits for receiving waters including pH, nitrogen and dissolved oxygen. This permit includes limits for the discharge of two waste streams, one from a reverse osmosis treatment system used in the manufacturing process (Waste 1) and the other (Waste 2) the discharge from the groundwater treatment system. The discharge limits were established following EPA guidance and represent the best available technology. A complete list of discharge limits is included as Table 1.

TABLE 1 - NPDES DISCHARGE LIMITS, SIGNETICS

Waste 001

Constituent	Instantaneous Maximum Limit (mg/l)
Total dissolved solids	2000
Chlorine	0.0

Waste 002

Constituent	Instantaneous Maximum Limit (μg/l)
Trichlorofluoromethane	5
1,1,1-trichloroethane	5
Tetrachloroethylene	5
Trichloroethylene	5
Ethylbenzene	5
Dichlorobenzene	5
1,1 Dichloroethylene	5
Xylenes	5

4.1.3 TRW Operable Unit

4.1.3.1 TRW Interim Remedial Measure

Interim actions to deal with soil pollution began in 1983 with the removal of the underground waste solvent storage tank and some associated polluted soil. Additional soil was removed from this same area in 1984. All the polluted soil could not be removed due to the proximity of the foundation of the 825 Stewart building to the excavation. The total soil removed for offsite disposal from the solvent tank areas was 120 cubic yards. Soil pollution near the waste solvent tank was investigated again in 1988 to determine what levels of soil pollution remain in place near 825 Stewart. The highest levels of soil pollution sampled in the unsaturated zone by this investigation were 4 ppm total VOCs. Levels of VOCs found in the saturated zone were as high as 34 ppm.

Investigations in the area of the underground acid neutralization system and its associated piping system were completed in 1985 and 1986. No VOCs were detected in either area, however some areas of possible metals pollution were located.

Initial actions to deal with groundwater pollution at the TRW operable unit began in 1984 with the installation of an eductor in the waste solvent tank excavation. Additional extraction wells were created in 1984 by the conversion of some existing monitoring wells. Groundwater extraction currently involves seven extraction wells, three A Zone wells, three B1 Aquifer wells, and one B2 extraction well (Figure 13).

The extracted groundwater is treated by an air stripping system at the 825 Stewart site. Uncontrolled air emissions are currently regulated by a BAAQMD permit for this site. After treatment, the water is released to Calabazas Creek under an NPDES permit.

4.1.3.2 TRW Selected Remedy

The selected remedy for the onsite plume at TRW consists of continuing with the present groundwater extraction and air stripper treatment system. If air emissions exceed those levels permitted by the BAAQMD, air emissions control technology will be added to the air stripper. Treated effluent will continue to be discharged to Calabazas Creek under an NPDES permit.

The discharge to surface water is controlled by NPDES Permit No. CA0028886. The limits for this discharge includes instantaneous maximum limits for specific contaminants and limits for receiving waters including pH, nitrogen and dissolved oxygen. The discharge limits were established following EPA guidance and represent the best available technology. A complete list of discharge limits is included as Table 2.

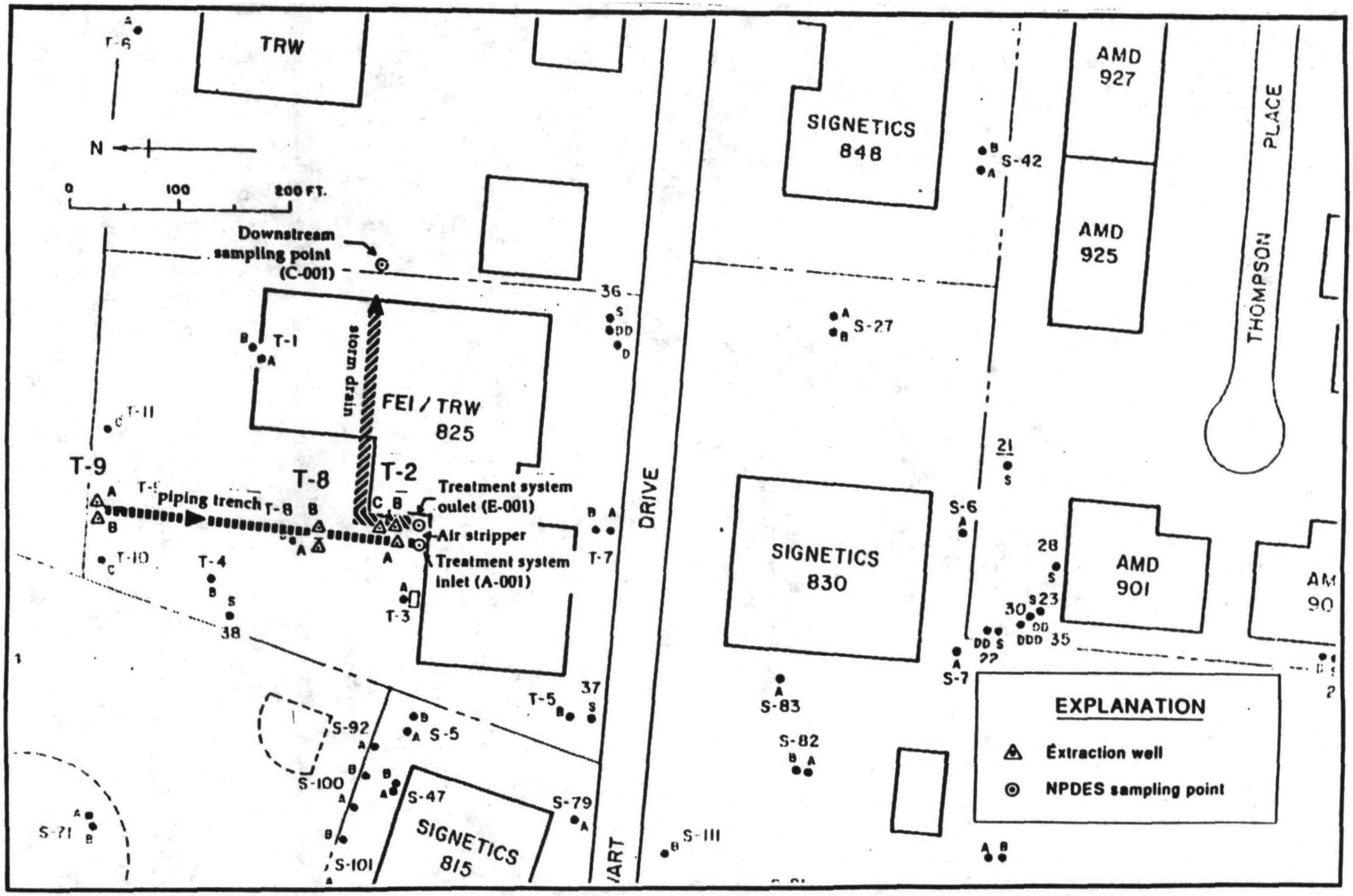

Figure 13. TRW Groundwater Extraction System

TABLE 2 - NPDES DISCHARGE LIMITS, TRW

Constituent	Instantaneous Maximum Limit (μg/l)
VOC's	
Trichlorofluoromethane	5.0
1,1,1-trichloroethane	5.0
Tetrachloroethylene	4.0
Trichloroethylene	5.0
1,1 Dichloroethylene	5.0
Vinyl Chloride	0.5
1,2-Dichloroethylene	6.0
Methylene Chloride	5.0
Total VOC's	25.0[1]
AROMATICS	
Ethylbenzene	5.0
Dichlorobenzene	5.0
Xylenes	5.0
Total Petroleum Hydrocarbons	50.0
METALS	
Arsenic	20.0
Cadmium	10.0
Chromium (VI)	11.0
Copper	20.0
Cyanide	25.0
Lead	5.6
Mercury	1.0
Nickel	7.1
Silver	2.3
Zinc	58.0

1. The pH of the discharge shall not exceed 8.5 nor be less than 6.5.

2. Toxicity: The survival of rainbow trout in 96-hour bioassays of the effluent as discharged shall be a median of 90% survival and a 90 percentile value of not less than 70%

[1]The total VOC limit is the sum of all EPA 601 compounds.

4.1.4 Offsite Operable Unit

4.1.4.1 Offsite Interim Remedial Measure

Two offsite groundwater containment extraction systems have been installed (Figure 14). The Duane Avenue Extraction system, consisting of nine extraction wells, is located just south of Duane Avenue, approximately 1200 to 2100 feet downgradient (north) of AMD, Signetics, and TRW facilities. This extraction system was installed and began operation in 1986. The Duane Avenue system extracts water from the A, B1, B2, B3, and B4 Aquifers.

A second extraction system consisting of fourteen wells, along Alvarado Avenue, approximately 2700 to 4300 feet downgradient (north) of the AMD, Signetics and TRW facilities, was completed in 1988. Operation of the Alvarado Avenue system began in October 1988. This system extracts water from the A, B1 and B2 Aquifers.

All extracted groundwater is transferred by a piping system to the AMD 915 DeGuigne facility where the water is treated by an air stripper followed by a liquid-phase GAC polisher. About 30% of the treated water is used as process make-up water by the AMD 915 facility and the remainder is released to a storm drain tributary to Calabazas Creek under an NPDES permit. Uncontrolled air emissions are currently regulated by a BAAQMD permit.

4.1.4.2 Offsite Selected Remedy

The selected remedy for the offsite commingled plume involves the expansion of the current extraction system with some additional wells and a continuation of the current air stripper treatment system. The air stripper will include air emissions control if emissions exceed levels permitted by the BAAQMD. Treated effluent will continue to be reused as much as possible with the balance being released to Calabazas Creek under an NPDES permit.

The discharge to surface water is controlled by NPDES Permit No. CA0028797. The limits for this discharge includes instantaneous maximum limits for specific contaminants and limits for receiving waters including pH, nitrogen and dissolved oxygen. The discharge limits were established following EPA guidance and represent the best available technology. A complete list of discharge limits is included as Table 3.

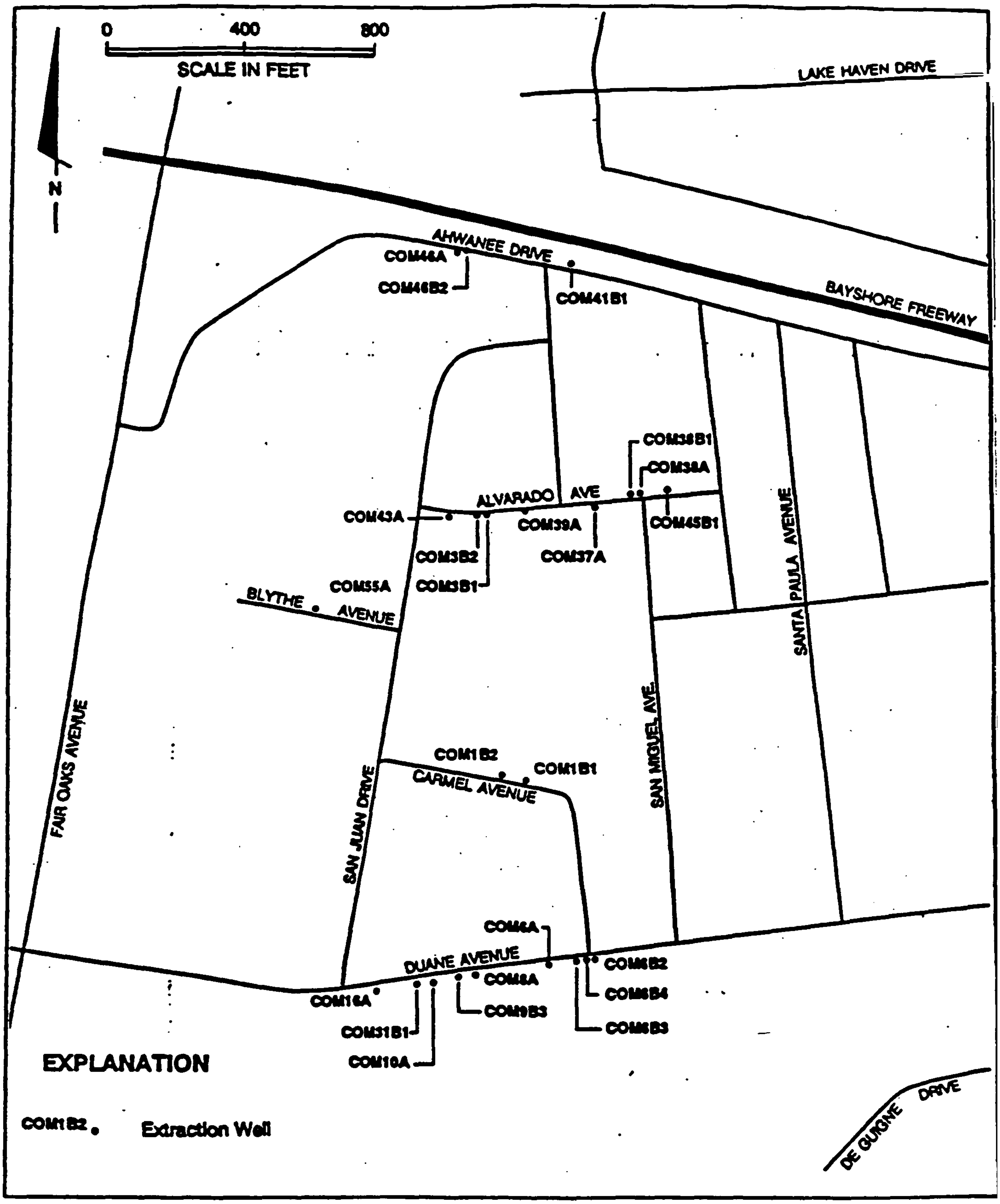

Figure 14. Offsite Groundwater Extraction System

TABLE 3 -NPDES DISCHARGE LIMITS, OFFSITE

Constituent	Instantaneous Maximum Limit (µg/l)
VOC's	
Trichlorofluoromethane	5.0
1,1,1-trichloroethane	5.0
Tetrachloroethylene	5.0
Trichloroethylene	5.0
1,1 Dichloroethylene	5.0
Vinyl Chloride	0.5
cis-1,2-Dichloroethylene	5.0
trans-1,2-Dichloroethylene	5.0
Methylene Chloride	5.0
Total VOC's	10.0[2]
AROMATICS	
Ethylbenzene	5.0
Dichlorobenzene	5.0
Trichlorobenzene	5.0
Xylenes	5.0
Total Petroleum Hydrocarbons	50.0
INORGANICS	
Arsenic	20.0
Cadmium	10.0
Chromium (VI)	11.0
Copper	20.0
Cyanide	25.0
Lead	5.6
Mercury	1.0
Nickel	7.1
Silver	2.3
Zinc	58.0

[2]Total of constituents for EPA 601 analytes

4.2 ROLE OF THE RESPONSE ACTION

The purpose of the actions at AMD/Signetics/TRW is to control the migration of polluted groundwater from the sites and to capture and remediate existing contaminated groundwater. The intent of these actions is to expedite cleanup of groundwater at these sites and to prevent further movement of contaminated groundwater downgradient and potential vertical migration into aquifers that currently serve as drinking water sources.

The IRMs for groundwater have contained the groundwater contamination plume to the sites and greatly limited the leading edge in the offsite area. Vertical migration has been limited and the toxicity, mobility, and volume of contaminants have been reduced. The final goal of this response action is to allow the future use of the shallow groundwater as a possible source of drinking water.

5.0 SUMMARY OF SITE CHARACTERISTICS

5.1 SOURCES OF CONTAMINATION

5.1.1 AMD Source Investigation

Two possible sources of pollution have been identified at the AMD 901/902 OU. These include acid neutralization systems south of the AMD 902 building and north of AMD 901 (Figure 8). Additional investigation of source area soil was completed in 1988. This investigation confirmed the presence of polluted soil beneath the excavation for the acid neutralization system removed near the AMD 901 building. The maximum concentrations detected in soil include 242,000 µg/l of 1,2-dichlorobenzene (DCB), 35,000 µg/l of tetrachloroethylene (PCE), 80,000 µg/l of TCE, and 72 µg/l of 1,1-dichloroethylene (1,1-DCE). The estimated volume of soil remaining in this area containing levels of total VOCs higher than 1 ppm is 37 cubic yards.

An acid neutralization system was also removed from the vicinity of AMD 902 in 1984. The maximum concentration of soil pollution detected during the investigation of the neutralization system was 1200 µg/kg of TCE, directly beneath the former tank location. No other soil pollution above 100 µg/kg was detected during this removal action. Based on analysis of soil following the excavation and concentrations of pollutants in groundwater in the area of the excavation no additional investigation of the AMD 902 source area was required.

A soil gas survey was completed around the AMD 901/902 buildings in October 1989 to estimate the possible extent of soil contamination and to attempt to locate any undocumented source areas. TCE was the predominant contaminant in vadose zone soil gas ranging as a high as 350 μg/l and averaging 63 μg/l in 19 out of 20 sample locations. The distribution of soil gas contamination was not indicative of additional source areas.

5.1.2 Signetics Source Investigation

Following the discovery of the leak in the waste solvent tank west of the 811 E. Arques building a systematic review of potential source areas was completed. Five possible source areas were investigated in detail and a more wide ranging soil gas survey was completed in an attempt to locate a possible unknown source. The areas investigated include the former underground waste solvent storage tank, the 440 Wolfe facility, Main Campus diesel tanks, Main Campus wastewater neutralization tanks, and the former location of wastewater neutralization tanks north of the 811 Arques facility. In addition a soil gas survey was completed in the vicinity of the 815 Stewart Drive building.

The results of these investigations have identified two probable source areas of volatile organic chemicals (VOCs) within the Signetics OU, the former underground waste solvent tank area and the former 811 Arques wastewater neutralization tank area (Figure 9). Based on the results of these investigations other source areas are not anticipated.

5.1.3 TRW Source Investigation

Two possible sources of pollution have been identified at TRW. These include an acid neutralization system and an underground solvent storage tank area (Figure 10). Initial soil pollution investigations focused on the area near the underground solvent waste storage tank in 1983. Additional soil samples were collected in July of 1984; the soil in these samples contained a variety of VOCs including trichloroethylene (TCE), tetrachloroethylene (PCE), and 1,2-dichloroethylene (1,2-DCE). The waste solvent storage tank and some associated soil was removed in 1983. Additional soil removal was completed in 1984. The excavation was expanded to the limits allowed by the proximity of the building. This area was identified as a point source for chemicals that resulted in groundwater pollution.

Additional investigation was completed in 1988, as required under RWQCB Order 88-015, since some contaminated soil was left in place near the former location of the underground waste solvent storage tank. The maximum concentration of total VOCs detected in the vadose zone near the solvent storage tank was about 4 ppm.

5.2 DESCRIPTION OF CONTAMINATION

5.2.1 SOIL INVESTIGATIONS

5.2.1.1 AMD Operable Unit

Soil pollution was the highest near the AMD 901 acid neutralization system. During removal of the system, soil with up to 186,000 μg/kg of trichloroethylene (TCE) was excavated. Due to proximity of the building not all of the polluted soil could be removed from the southern portion of the excavation.

An acid neutralization system was also removed from the vicinity of AMD 902 in 1984. The maximum concentration of soil pollution detected during the investigation of the neutralization system was 1200 μg/kg of TCE, directly beneath the former tank location. No other soil pollution above 100 μg/kg was detected during this removal action. Based on analysis of soil following the excavation and concentrations of pollutants in groundwater in the area of the excavation no additional investigation of the AMD 902 source area was required.

5.2.1.2 Signetics Operable Unit

Initial investigation of soil pollution began in 1982 following the report of a leak in an underground solvent storage tank. Analyses of soil samples from this initial phase of investigation indicated that onsite soil was polluted with up to 8100 ppb TCE, 16,400 ppb 1-,1-,1-trichloroethane (TCA), 18,100 ppb xylene, and 79,000 ppb butyl acetate.

Soil samples were collected from the base of the excavation at various times in 1982. This follow-up investigation of polluted soil remaining in place after the removal of the solvent storage tank detected a variety of organic solvents. The greatest concentrations detected were for TCE at 63,000 ppb, TCA at 1,700,000 ppb and PCE at 1,000,000 ppb.

The initial tank excavation was utilized as part of a larger excavation for the installation of a new subsurface wastewater treatment plant. Prior to beginning the larger excavation, a series of borings was made throughout the planned excavation area. The borings extended through the vadose zone into the saturated zone at depths of 18 to 19.5 feet. Several soil "hotspots" were identified. The maximum contamination that was detected was in boring S-54 with 6,700 ppb of TCE, 12,000 ppb of TCA, and 23,000 ppb of PCE. The excavation removed soil into the saturated zone, at a depth of about 20 feet. Based on the analysis of soil samples from the borings this excavation should have removed all vadose zone soil containing VOCs greater than 1 ppm total VOCs. However, based on the absence of verification samples from the construction excavation, additional A zone groundwater monitor wells were installed in 1989 downgradient of the excavation. Low levels of VOCs (19 ppb TCE) have been detected in these wells. These levels are probably not indicative of remaining soil contamination in this area.

5.2.1.3 TRW Operable Unit

Initial soil pollution investigations focused on the area near the underground solvent waste storage tank in 1983. Additional soil samples were collected in July of 1984; the soil in these samples contained a variety of VOCs including trichloroethylene (TCE), tetrachloroethylene (PCE), and 1,2-dichloroethylene (1,2-DCE). The waste solvent storage tank and some associated soil was removed in 1983. Additional soil removal was completed in 1984. The excavation was expanded to the limits allowed by the proximity of the building. This area was identified as a point source for chemicals that resulted in groundwater pollution.

Additional investigation was completed in 1988, as required under RWQCB Order 88-015, since some contaminated soil was left in place near the former location of the underground waste solvent storage tank. The maximum concentration of total VOCs detected in the vadose zone near the solvent storage tank was about 4 ppm. The maximum concentration of total VOCs in saturated zone soil in this area was approximately 34 ppm. Based on these estimates, and making liberal assumptions regarding concentration and volume, it is estimated that the vadose and saturated soils in this area contain at most three pounds of TCE.

Soil investigation near an underground, acid neutralization system (ANS) was also carried out during the closure of the system in 1986. Some soil samples contained elevated levels of metals, however no elevated levels of VOCs were detected during this investigation. This area is not considered a source area for pollutants currently detected in the groundwater. Extraction tests on soil from the ANS excavation area indicate that the inorganics would not be expected to impact groundwater.

The remaining soil contamination is minimal and occurs at depths greater than ten feet. The maximum vadose zone contamination is about 4 ppm. With current technology it is not possible to separate the higher levels of soil contamination in the saturated zone soil from the groundwater contamination. However the remaining soil contamination does not present any known impacts that will not be remediated by the groundwater extraction system.

5.2.2 GROUNDWATER INVESTIGATIONS

5.2.2.1 AMD Operable Unit

The initial groundwater monitor wells were installed in 1983 following the excavation of the AMD 901 ANS. Additional wells have been installed each year through 1989. Currently there are 30 monitoring wells and 6 extraction wells at the AMD 901/902 site. Sampling of the AMD 901/902 well field was monthly from March 1985 through February 1986, and bimonthly until 1988. The sample plan has called for quarterly monitoring of selected wells since 1988.

Based on this groundwater data TCE is the most common pollutant and has been used as an indicator for groundwater pollution at AMD 901/902. Initial levels of groundwater pollution at this site were as high as 100 ppm of TCE with total VOCs as high as 1000 ppm prior to the point source removal in 1983. The highest current levels of groundwater pollution are about 1 ppm TCE for the onsite area. Currently the onsite pollution extends to a depth of up to 65 feet.

5.2.2.2 Signetics Operable Unit

Groundwater pollution by VOCs was detected during the initial investigation in 1982. Monitoring has been continuous for selected wells on at least a quarterly basis since 1982. Groundwater pollution has spread through the upper four aquifers. Additional wells were installed in 1989 to provide additional characterization of the extent of vertical pollution. The total number of monitor wells installed in five water bearing zones at the Signetics OU is 96. The downgradient and lateral extent of contamination of groundwater contamination at the Signetics OU is difficult to quantify due to the commingling both laterally and downgradient.

The highest initial concentrations of TCE detected in the A aquifer was 34,000 μg/l in 1982 in well S049A. The highest concentration of TCE in the A aquifer in October 1990 was 22,000 μg/l in well S091A with groundwater from well S049A containing 12,000 μg/l TCE. The concentration in well S091A is an historic low for TCE in groundwater from that well.

The highest initial concentration of TCE in the B1 aquifer was 2600 μg/l in 1982 in well S048B1 and 25,000 μg/l in 1983 in well S075B1. Currently the highest concentration of TCE in the B1 aquifer is 20,000 μg/l at well S065B1. The highest concentration of TCE in the B2 aquifer was 13,000 μg/l at well S048B2 in 1986, 20,000 μg/l in 1988, and 8800 μg/l at the same well. The highest initial concentration of TCE in the B3 aquifer was 25,000 μg/l of TCE in well S101B3 in 1986. Currently the highest concentration of TCE in the B3 is 740 μg/l, also measured in well S101B3. The maximum concentration in October 1990 in an onsite B4 aquifer well at 811 E. Arques was 13 μg/l. This is the first occurrence of a chemical of concern above drinking water standards in an onsite B-4 aquifer well.

The current volume of contaminated groundwater in the A aquifer is estimated to be 1,353,600 cubic feet (10,125,631 gallons) and 10,516,500 cubic feet (78,668,883 gallons) in the B aquifer. This estimate is based on the surface area of the Signetics OU and average saturated thicknesses for the individual aquifer zones.

5.2.2.3 TRW Operable Unit

The initial groundwater monitor wells were installed at this site by TRW in 1983, with additional wells installed in 1984, 1986 and 1989. There are twenty-five monitoring wells located within the TRW operable unit. This includes wells installed by AMD and Signetics as part of the RI. Monitoring of water levels and contamination has been carried out on at least a quarterly basis for selected wells since at least 1986. Based on this data the dominant VOC in the groundwater is TCE, although 1,2-DCE, Freon 113, and PCE are also frequently detected.

The highest initial levels of TCE in the groundwater were detected in well T-2A. The highest concentrations of VOCs in the A aquifer in 1990 were measured in groundwater from wells T-9A and T-7A (see Appendix 1, figure 4), with the most recent concentrations being approximately 2,300 and 1,700 μg/l, respectively. Contaminant concentrations in these wells may be influenced by migration from offsite sources. Therefore these wells may not be representative of A zone contamination at the TRW OU. Well T-2A (Figure 13), an extraction well downgradient of the source area, detected about 100 μg/l of TCE and 200 μg/l of total VOCs in the October 1990 sampling. Groundwater pollution in the deeper aquifers was originally the most concentrated in well T-2B. Currently the highest TCE concentration in onsite wells is in well T-2B an extraction well in aquifer B1, with a concentration of 19,000 μg/l. High levels of vinyl chloride (7800 μg/l) are also detected in well T-2B.

5.2.2.4 Offsite Operable Unit

It was determined in 1984 that groundwater pollution had migrated north, downgradient from point sources at TRW (FEI) Microwave, 825 Stewart, and Signetics 811 Arques facilities. Initial investigation began in September 1984. Several phases of investigation including two soil gas surveys and the installation of 83 monitor wells, 23 extraction wells, and 22 piezometers. Additional pilot and soil borings were also completed.

Offsite the pollution extends downgradient to the north for approximately 4000 feet and to a maximum lateral extent of about 1600 feet. Contaminants have been detected to a depth of up to 100 feet in the B4 zone. Additional monitor wells will be required at the distal edge of the plume to define the current extent of the contamination plume. The pattern of vertical contamination generally represents the standard model for contaminants that are heavier than water, in that the depth of contamination increases with distance from the source area.

The current volume of contaminated groundwater in the A aquifer in the Offsite OU is estimated to be 1,490,600 cubic feet (11,145,974 gallons) and 41,140,000 cubic feet (307,748,571 gallons) in the B aquifer. This estimate is based on the surface area of the Offsite OU and average saturated thicknesses for the individual aquifer zones.

5.2.3 AIR INVESTIGATIONS

5.2.3.1 AMD 901/902 Operable Unit

As part of the interim remedial action for groundwater, an air stripper is in place at the AMD 901/902 OU. This air stripper has a carbon unit filtering the air effluent. Current air emissions are very limited and approximately 4.6 X 10^{-3} pounds per day of TCE is released into the ambient air. In reviewing the original permit application in 1985 the BAAQMD estimated the risk related to the chemical releases from the AMD air stripper to be 1.6 X 10^{-6}. It is unclear if this evaluation was made with the activated carbon treatment of the air effluent in place. What is certain is that effluent concentration has declined since the original permit to operate was issued in 1986. This decline would result in decreased emission from the air stripper with an attendant decrease in risk. The spent carbon is removed for offsite treatment and disposal.

Volatilization of groundwater contaminants from the subsurface was not investigated for the AMD 901/902 OU since no current residential property exists above or adjacent to the plume within this operable unit. The site is completely paved or covered by structures with active ventilation systems. The paving may limit the migration of contaminants and the active ventilation systems will limit the concentration of contaminants in indoor air. A review of this exposure pathway will be conducted to determine the impact on future potential residents at the five year review period.

Consideration of worker safety in the 901 facility due to the possible off-gassing of VOCs from contaminated soil beneath the AMD 901 building was investigated due to agency comments (Appendix A). This was not part of the RI/FS and these concerns are considered more appropriate for regulation and evaluation by California Occupational Health and Safety Association (CAL-OSHA).

Modeling that was done to estimate migration of vapors from groundwater in the offsite OU would not apply to exposures in the 901 facility for several reasons. The model assumes that the structure has a basement, crawl space, or a perimeter crack to allow infiltration of the vapors. The AMD 901 is constructed on a concrete slab and no extensive cracking of the slab has been observed. Another component of the model is that 100% infiltration is assumed and a limited number of air exchanges per hour occurs in the average home. These two factors are major components in the process of releases of contaminants from soil possibly getting trapped and concentrated in indoor air.

As part of the facility operation all areas of the building have active ventilation systems which result in a greatly increased air exchange rates and positive pressure. The active ventilation would result in the removal of contaminants as they enter the indoor space and the positive pressure would reduce the infiltration rate. These two factors in combination would act to limit the possibility of the vapors entering or becoming concentrated in indoor air in a semiconductor manufacturing facility. Active ventilation systems, sealing of slabs or below ground portions of structure, and maintenance of positive pressure are major components of systems designed for remediation of indoor air contamination.

In response to agency concern AMD sampled air in the interior of the 901 facility with a photoionization detector (PID). PIDs are not chemical specific, in that they will not indicate what chemical is being detected, only an approximate concentration of chemicals in vapor. The detection limit for this method is between 0.5 part per million (ppm) and 1 ppm. All readings were below the detection limit. To confirm these results summa canisters of indoor and outdoor ambient air were collected and analyzed. These results indicate that the chemicals present at high concentrations in the contaminated soil, 1,1-Dichloroethylene (DCE), Trichlorethylene (TCE), Tetrachloroethylene (PCE) and Dichlorobenzene (DCB), are not present above 0.25 part per billion (ppb). The worker safety regulations include allowable exposure for these chemicals from 25 to 200 ppm. These above factors all contribute to the conclusion that worker exposure to indoor air contaminated by vapors migrating from contaminated soil is not a significant risk at the AMD 901 facility.

5.2.3.2 Signetics Operable Unit

As part of the interim remedial action for groundwater three air strippers are in place at the Signetics OU. The air strippers are operated in sequence with the total flow being fed to one large diameter stripping tower, the water is then captured and the volume is split between the two remaining towers. The first air stripper in the sequence has two parallel lines of eleven 150-pound drums of granular activated carbon. It is estimated that the primary air stripper removes about 99% of the total VOCs in the influent. The vapor phase carbon system reduces air emission risk by over 90%. The second set of air strippers reduces the remaining 1% of the VOCs by an additional 88% to about 1 $\mu g/l$ in the treated groundwater effluent. Under regulation of a BAAQMD permit to operate, the air stripper system is limited to a maximum release of 0.52 pounds per day of VOCs to the atmosphere. The spent vapor phase carbon is removed for offsite treatment and disposal.

The risk related to this release from the air strippers was evaluated after the completion of the FS. This risk was evaluated using a screening level model. The maximum concentration predicted by the model was 0.434 μg/l. This would result in an estimated increased cancer risk of approximately 1 X 10^{-6}. Non-carcinogenic effects were also evaluated for this release and none would be predicted from the exposure to the maximum concentrations resulting from the air stripper discharge.

Volatilization of groundwater contaminants from the subsurface was not investigated for the Signetics OU since no current residential property exists above or adjacent to the plume within this operable unit. The site is completely paved or covered by structures with active ventilation systems. The paving may limit the migration of contaminants and the active ventilation systems will limit the concentration of contaminants in indoor air. A review of this exposure pathway will be conducted to determine the impact on future potential residents at the five year review period.

5.2.3.3 TRW Operable Unit

As part of the interim remedial action for groundwater an air stripper is in place at the TRW OU. The air stripper air effluent is uncontrolled, however due to the combination of low groundwater effluent concentration and low extraction rate, the air emissions from the air stripper are limited. It is estimated that the air stripper releases about 0.84 pounds of VOCs per day. About 90% of this total discharge is TCE. This release of contaminant is regulated and permitted by the BAAQMD, however the BAAQMD did not require risk screening at the time this permit to operate was issued (1985). Evaluation of the risk included in the FS predicts that the maximum concentration of VOCs released by the air stripper at the TRW operable unit is 9.24 X 10^{-3} mg/m^3. Since TCE is a carcinogen and is the dominant chemical in the stripper influent and stripper air emissions, the cancer risk related to this air discharge was evaluated for TCE. The maximum concentration as estimated by the model would occur at 0.191 kilometers from the air stripper. Assuming that an individual was exposed to this concentration for a period of thirty years would result in an excess cancer risk estimate for this air emissions of 1.79 X 10^{-5}.

5.2.3.4 Offsite Operable Unit

As part of the interim remedial action for groundwater in the offsite area groundwater is extracted and piped for treatment to the Advanced Micro Devices facility at 915 DeGuigne Drive in Sunnyvale. The groundwater is treated by an air stripper followed by aqueous phase granular activated carbon. The air effluent from the air stripper is uncontrolled. It was estimated in the FS that the air stripper releases about one and one-half pounds per day of VOCs to the ambient air. The release from this air stripper system was re-evaluated in September 1991. The influent volume and concentration had declined. Mass balance estimates based on the current flow rate and concentration indicate that VOC emission has declined to about 300 pounds per year or 0.82 pounds per day. Based on a model prepared by the California Air Pollution Control Officers Association the risk related to this release is less than 1×10^{-5}. This release of contaminant is regulated and permitted by the BAAQMD.

The baseline public health evaluation indicated that volatilization of chemicals from groundwater could reach the surface. The risk from this exposure pathway was evaluated based an modeling of the transport of VOCs from groundwater through soil to the surface and eventually entering residential buildings through cracks in concrete slabs. This evaluation predicted a possible excess cancer risk of 1×10^{-4}.

Although the predicted risk was within the risk range allowed by the NCP it was determined that additional investigation of this pathway was warranted. The decision to proceed with additional data collection was based on several considerations; this was the only current pathway that had a high probability of being complete, the groundwater plume is beneath a residential area including a child care facility (San Miguel School), and modeling of vapor transport is poorly developed and relatively speculative.

Additional data was collected through the use of a field flux chamber. This provides a measure of the gross emission rate for a known surface area of soil. The intent using this measurement technique was to eliminate the modeling of vapor transport in the vadose zone from the estimate. This would still require the estimation of infiltration rate into structures and the fate of the contaminants upon entering a structure. The other option considered was the direct measurement of indoor air from selected structures. This approach was rejected due to a lack of sampling protocol for indoor air and the possible contamination of indoor air by indoor sources.

Three sampling events for field flux measurements have occurred. Two separate transects across the known groundwater plume were included in the field sampling (Figure 15). One transect was in the near source area in open fields. The second transect was near the San Miguel School. The first transect was intended to provide a "worst case" estimate of the field flux rate since it crossed the groundwater plume where concentrations were the highest. The second transect was intended to be representative of the flux rate in the residential area.

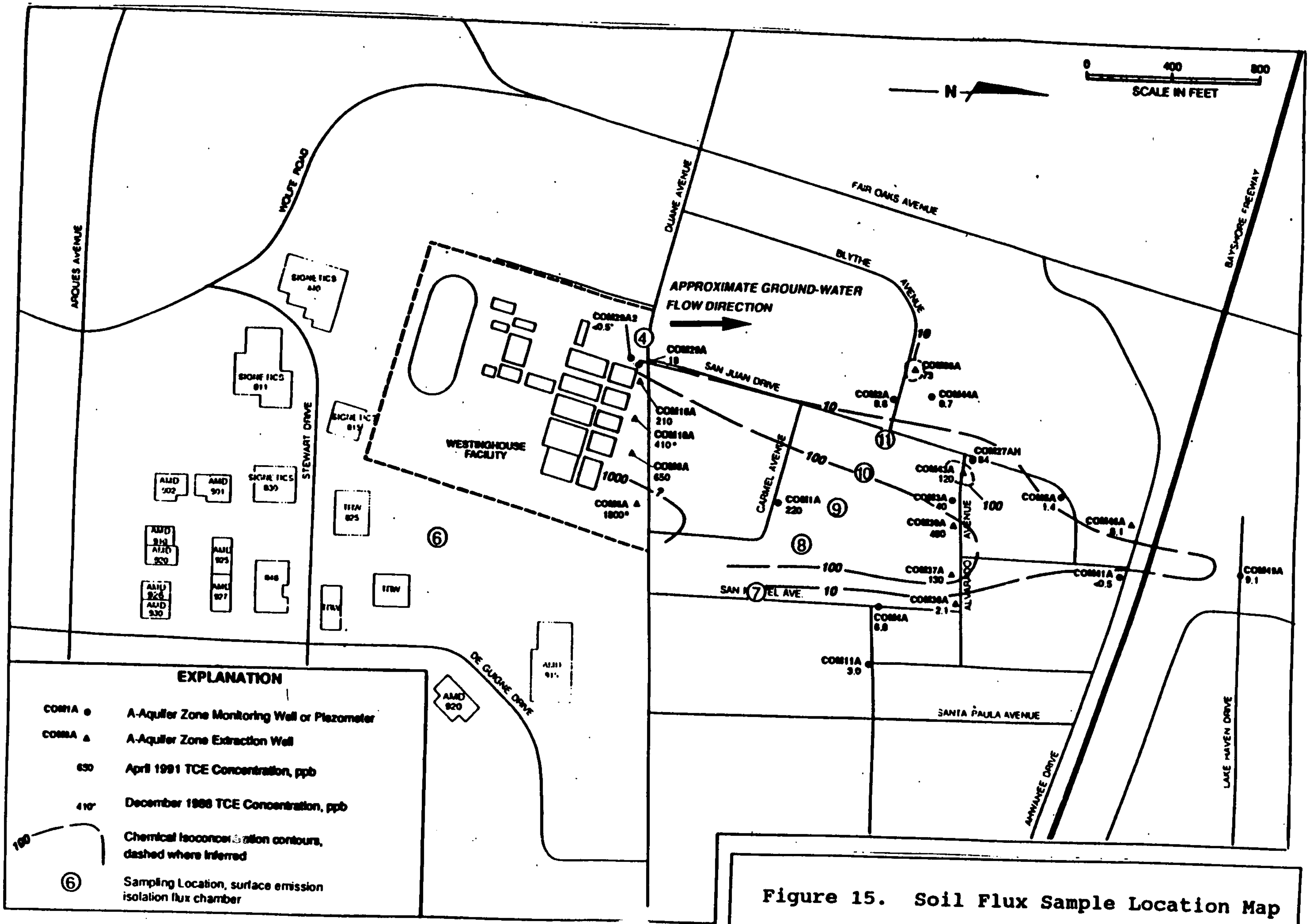

Figure 15. Soil Flux Sample Location Map

Field flux data has measured very low concentrations of VOC's. The scenario was not as expected, in that TCE has been detected in the offsite area and not in the near source area. Vinyl chloride was detected in one of three sampling events at location 6 (Figure 15) in the near source area. TCE has been detected in one sample (location 9) from the offsite area in two sample events and at location 8 in the most recent sampling. Other chemicals, most notably 1,1,1-TCA and Freon 113, are frequently detected in soil flux gas samples. Correlation between the occurrence of these chemicals and groundwater is difficult since these chemicals do not occur frequently or at high concentrations in groundwater.

The possible exposure to chemicals as a result of air emissions from groundwater will be evaluated as part of the five year review for all four operable units (TRW (FEI) Microwave, Signetics, AMD 901/902 and the associated offsite operable unit). This is a relatively new exposure scenario and assumptions related to this pathway are not well established. In addition, appropriate field sampling methodologies are not well established. It is anticipated that additional data and techniques will be available at the five year review.

6.0 SUMMARY OF SITE RISKS

6.1 TOXICITY ASSESSMENT

A baseline public health evaluation (BPHE) is completed for every Superfund site. As part of this assessment the occurrence of chemicals at a site is investigated to identify those chemicals whose occurrence and toxicity should be considered in the cleanup of the site. Groundwater data collected after 1988 and all shallow soil data was utilized in this evaluation. The BPHE did not consider the groundwater data on the basis of operable unit where the data was collected. Rather, since the groundwater is connected throughout the operable units, geometric mean and maximum concentration data was applied to the overall site regardless of location of occurrence.

Based on very conservative assumptions regarding concentration, distribution, toxicity, analytical data, and potential routes of exposure, the BPHE for these three combined sites identified twenty-eight "chemicals of potential concern" (Table 4) from this database. This included seventeen organic chemicals and eleven inorganic chemicals. The assignment of a chemical as a carcinogen in Table 4 is based on its classification as a carcinogen by an EPA Carcinogen Risk Assessment Verification Endeavor (CRAVE) workshop. In addition to the criteria outlined above some of the 28 chemicals were included based on detection in soil and mobility in the environment though they have never been detected in groundwater.

TABLE 4
AMD 901, SIGNETICS, TRW DATA SUMMARY

		GROUNDWATER		SOIL	
Chemical	CRAVE	Max Value (µg/l)	#Det/#Anal	Max Value (µg/kg)	#Det/#Anal
Antimony		120	6/13	12	3/6
Arsenic	A	40	7/13	4.6	4/6
Barium	D	100	2/5	300	6/6
Benzene	A	NS	NA	4,000	1/5
Cadmium	B1	38	4/13	6.9	4/7
Chloroform	B2	140	12/316	7	3/14
Chromium(Total)	A[1]	160	7/13	59	11/11
Copper	D	97	7/13	190	7/7
1,2-Dichlorobenzene	D	330	17/76	240,000	11/14
1,1-Dichloroethane	B2	600	25/556	NS	NA
1,1-Dichloroethene	C	740	49/556	NS	NA
cis-1,2-Dichloroethene	D	8000	104/154	460	11/14
trans-1,2-Dichloroethene	D	1800	11/154	73	1/14
Ethylbenzene	D	NS	NA	2,000	1/5
Freon 113	D	78,000	209/556	NS	NA
Lead	B2	710	8/13	66	5/7
Methylene Chloride	B2	520	1/76	26	4/10
Nickel	D	280	9/13	250	7/7
Silver	D	24	3/13	NS	NA
Tetrachloroethene	B2	610	88/670	35,000	11/31
Thallium	D	160	8/13	3.8	2/6
Toluene	D	NS	NA	3,000	1/5
1,1,1-Trichloroethane	D	1,000	144/670	NS	NA
Trichloroethene	B2	290,000	618/670	80,000	23/31
Trichlorofluoromethane	D	1.2	4/126	NS	NA
Vinyl Chloride	A	32,000	67/670	ND	0/5
Xylenes	D	NS	NA	4,000	1/5
Zinc	E	1,100	10/13	67	7/7

NS = Not Sampled
NA = Not Applicable
A = Known Human Carcinogens
B1 = Probable Human Carcinogen (limited human evidence, adequate evidence from animals)
B2 = Probable Human Carcinogen (inadequate human evidence, adequate evidence from animals)
C = Possible Human Carcinogen (limited evidence of carcinogenicity, animal studies only)
D = Not Classified as to Human Carcinogenicity (inadequate animal and human data or no data)
E = Not a Human Carcinogen (adequate evidence of non-carcinogenicity in adequate animal or human studies)

[1] Chromium VI inhalation only

As part of risk management, further evaluation of the groundwater data in the FS has resulted in the reduction of the number of organic chemicals to ten chemicals of concern. All of the inorganics were removed from the list of chemicals of concern based on additional groundwater sampling that was not available when the BPHE was completed and the fact that some of the inorganics detected in soil were not used as part of the process at the operable unit where the BPHE included the inorganics as chemical of concern.

This final list of "chemicals of concern" includes (shaded in Table 4) 1,2-Dichlorobenzene (1,2-DCB), 1,1-Dichloroethane (1,1-DCA), 1,1-Dichloroethylene (1,1-DCE), cis-1,2-Dichloroethylene (cis-1,2-DCE), trans-1,2-Dichloroethylene (trans-1,2-DCE), Freon 113, Tetrachloroethylene (PCE), 1,1,1-Trichloroethane (1,1,1-TCA), TCE, and vinyl chloride.

The rational for selecting these remaining ten chemicals as chemicals of concern is as follows:

1. 1,1-Dichloroethane (1,1-DCA), 1,1-Dichloroethylene (1,1-DCE), Tetrachloroethylene (PCE), and TCE are probable or possible human carcinogens.

2. 1,2-DCB, Freon 113, PCE, 1,1,1-TCA TCE and Vinyl Chloride are detected in groundwater at a greater than 10% frequency.

3. 1,1-DCA, 1,1-DCE, cis-1,2-DCE, and trans-1,2-DCE, are detected in more than 5% of groundwater samples or are breakdown products of one of the other chemicals of concern and therefore might reasonably be expected to occur in increased frequency, distribution or concentration.

4. 1,1-DCA, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, Freon 113, PCE, 1,1,1-TCA, TCE, and vinyl chloride possess physicochemical properties (relatively high water solubility and relatively low soil sorption) which promote their dispersion in groundwater. In addition all of these chemicals are volatile and can easily be dispersed into soil gas and possibly the atmosphere.

5. 1,2-DCB, 1,1-DCE, Freon 113, PCE, 1,1,1-TCA, and TCE, have been used on site as part of the manufacturing process. Soil sampling has documented the presence of most of these chemicals as contaminants in soil from source area excavations.

6. TCE has been used as an indicator chemical throughout the study area. This is based on the reasons stated above. TCE is also the chemical most frequently detected in soil and groundwater. TCE has been detected in groundwater at the greatest concentration of any of the chemicals of concern, has

the most widespread occurrence and has the highest concentration in groundwater samples.

6.2 RISK CHARACTERIZATION

A Baseline Public Health Evaluation (BPHE) is conducted at every Superfund site to evaluate the risk posed by the site in its existing condition. The BPHE examines the chemicals present at the site (see Section 6.1) and the possible routes of exposure to humans and animals.

Using similarly conservative assumptions, the BPHE also developed future and current exposure scenarios. For the hypothetical future exposure scenarios, it was assumed that the onsite areas of the site would be developed for residential use and that the groundwater in the A- and B-aquifers would be used for domestic water supply purposes. The potential current exposure scenario considered in the BPHE evaluated inhalation of VOC vapors originating from the offsite groundwater plume.

Fugitive dust emission or incidental ingestion of soil by construction workers during hypothetical future construction on the site were not evaluated as exposure pathways at these sites. This choice was made because the documented contaminated soil is all at depths greater than eight to ten feet. Fugitive dust emission is not a concern in this circumstance. Standard construction practices in this portion of the Santa Clara Valley would not result in excavations of this depth.

According to the BPHE, **potential future exposure** routes at the Companies site may include ingestion of groundwater containing the chemicals of potential concern, inhalation of VOC vapors from groundwater during showering or other domestic uses, and inhalation of VOC vapors originating from the groundwater. Based on the absence of known soil "hot-spots", other than those well below ground surface and beneath buildings, direct contact exposure to chemicals of concern was not considered further in the exposure evaluation.

In addition to the above, the BPHE also assumed that the current cleanup actions would be discontinued and cleanup measures would not be implemented at any time in the future. Using these assumptions, the BPHE concluded that the only **average exposure scenario** for which there would be a potential health risk or an increased cancer risk greater than 1 in 10,000 was the hypothetical future domestic use of contaminated shallow groundwater. The most crucial of these assumptions is that cleanup activity in the study area would cease. This implies that current concentrations in groundwater would persist into the future.

The only **current exposure scenario** identified in the BPHE is indoor exposure to vapors migrating from the contaminated groundwater in the offsite area. This pathway was evaluated for two separate populations, residents of the offsite area and children attending the San Miguel school. These cancer risks and health hazard assessments are based on estimates of the indoor air concentrations of the chemicals of concern predicted by mathematical models. The predicted carcinogenic risk for the average case is estimated to be about 4 in 100,000,000 for schoolchildren and about 1 in 10,000 for residents. The model does not predict any toxic effects from this exposure. This is within the risk range that would be allowable under EPA guidance after cleanup. EPA methodology will be applied to reassess this exposure within each of the four operable units at the five year review.

The **future use scenario** considered by the BPHE is domestic use of shallow groundwater beneath the site. This would expose residents to contaminated groundwater through ingestion of water and inhalation during domestic use (showering, cooking, etc.). The greatest potential carcinogenic risk related to the average exposure through these pathways is approximately 2 in 1000.

Domestic use is a hypothetical case since shallow groundwater in the A- and B-aquifers is not currently used for water-supply purposes and local ordinances prohibit such practice. Currently, there are no plans to use the A- and B-aquifer groundwater as a drinking water supply.

6.2.1 Soil

6.2.1.1 AMD 901/902 Soil

No shallow (less than 2 feet) contaminated soil is remaining since the interim remedial actions for soil was effective in removing shallow soil. Contaminated soil that remains in place is greater than ten feet in depth. The exposure to contaminated soil through the dermal contact route was not evaluated since it is unlikely that contact with the chemicals of concern at AMD 901/902, VOCs, would occur. Possible exposure of workers to the contaminants remaining in soil in place at the AMD 901 facility as a result of volatilization was investigated and will be discussed below under risk from air pathways.

6.2.1.2 Signetics Soil

The interim remedial action of excavation and offsite disposal was effective in removing contaminated soil from the Signetics operable unit. No additional contaminated soil has been documented, therefore risk due to direct contact or fugitive dust emission was not evaluated.

6.2.1.3 TRW Soil

No shallow (less than 2 feet) contaminated soil is remaining since the interim remedial actions for soil was effective in removing shallow soil. Contaminated soil that remains inplace is greater than ten feet in depth. The exposure to contaminated soil through the dermal contact route was not evaluated since it is unlikely that contact with the chemicals of concern at TRW, VOCs and metals, would occur. Additionally, should dermal contact occur the VOCs would volatilize into the air prior to significant subcutaneous adsorption and subcutaneous adsorption of metals is not significant.

6.2.1.4 Offsite Soil

No source areas have been located or are suspected in the offsite operable unit. Soil contamination would only occur at contact between the soil and groundwater, which occurs at depths greater than twelve feet. Concentrations are assumed to be minimal due to the constant partitioning of chemicals from water to soil and soil to water. Risk due to direct contact or fugitive dust emission was not evaluated.

6.2.2 Air

6.2.2.1 AMD 901/902

The risk from the air stripper emissions was evaluated by the BAAQMD in 1985 prior to providing AMD with a permit to operate the air stripper. The risk related to the chemical releases from the AMD 901/902 air stripper was estimated by BAAQMD personnel to be 1.6×10^{-6}. Flow rate and influent concentration was higher in 1985 than now therefore maximum air concentration and the related risk would also be lower than that projected in 1985.

The potential for volatilization of chemicals from groundwater to the surface was evaluated in the BPHE for the hypothetical case that the "onsite" industrial property at the AMD 901/902, Signetics and TRW operable units was converted to residential property. This evaluation was based strictly on modeling of transport from groundwater into residences and assuming current groundwater concentrations for chemicals of concern. The excess cancer risk estimate, based on this model is 4×10^{-5} for the average case and 8×10^{-4} for the maximum case. The non-carcinogenic cancer index for both the average and maximum cases is much less than one.

The portion of the groundwater contaminant plume that currently beneath the AMD 901/902 operable unit does not represent a current risk since no residences overlay the plume. The manufacturing facilities that overlay the plume all utilize active ventilation systems which would act in two ways to reduce this potential risk, first the ventilation system, by pumping air into the structure, creates positive pressure thus reducing the rate of infiltration of contaminants into the structure and secondly the continued influx of air dilutes any contaminants that enter the structure.

In response to agency concerns regarding the presence of contaminated soil remaining below the AMD 901 facility, AMD sampled air in the interior of the 901 facility with a photoionization detector (PID). PIDs are not chemical specific, in that they will not indicate what chemical is being detected, only an approximate concentration of chemicals in vapor. The detection limit for this method is between 0.5 part per million (ppm) and 1 ppm. All readings were below the detection limit. To confirm these results discrete samples indoor and outdoor ambient air were collected in summa canisters and analyzed. This sampling protocol allows much lower detection limits. These results indicate that the chemicals present at high concentrations in the contaminated soil, 1,1-Dichloroethylene (DCE), Trichlorethylene (TCE), Tetrachloroethylene (PCE) and Dichlorobenzene (DCB), are not present above 0.25 part per billion (ppb).

Worker safety regulations include allowable exposure for these chemicals from 25 to 200 ppm. The worker allowable worker exposures are risk based, however the assumptions used in assessing worker exposure are significantly different from the assumptions used in the BPHE. The comparison of the non-detectable levels of the chemicals of concern to the allowable levels would still indicate that exposure to indoor air contaminated by vapors migrating from contaminated soil or other sources is probably not a significant risk at the AMD 901 facility.

6.3.2.2 Signetics

As part of the interim remedial action three air strippers are present at the Signetics 440 Wolfe facility. The air strippers operate in sequence, with the first air stripper removing over 99% of the VOCs from the influent water. This initial stripper does include control of the air emissions with capture by vapor phase carbon. The total release of VOCs by all three air strippers is limited to 0.52 pounds per day by a BAAQMD Permit to Operate. The risk from the release from the air strippers was evaluated after the completion of the FS. The maximum concentration predicted by the model was 0.434 $\mu g/l$. This would result in an estimated increased cancer risk of approximately 1×10^{-6}. Non-carcinogenic effects were also evaluated for this release and none would be predicted from the exposure to the maximum concentrations resulting from the air stripper discharge. The model assumed minimum stack height, maximum predicted concentration and minimum distance to the receptors at the property boundary.

The risk related to volatilization of chemicals, primarily VOCs from groundwater, was evaluated for all three "onsite" operable units for a hypothetical future scenario of conversion to residential property as discussed above in section 6.3.2.1.

6.3.2.3 TRW

As part of the interim action and as part of the proposed remedy an air stripper has been operating at the former TRW Microwave facility since 1985. The emissions from this air stripper are estimated to be 0.84 pounds per day. TCE accounts for over 90% of this emission. While vinyl chloride is detected routinely in one of the onsite TRW wells it is not detected in the influent to the treatment system. This is a function of dilution of the vinyl chloride by mixing with groundwater from other extraction wells. Therefore the cancer risk related to this release was evaluated for TCE. The maximum concentration of VOCs estimated by the California Air Resources Board PTPLU model is 9.24×10^{-3} mg/m^3. The excess cancer risk related to release of TCE to the ambient air at this concentration for a 75 year lifetime exposure is estimated to be 1.79×10^{-5}.

The risk related to volatilization of chemicals, primarily VOCs from groundwater, was evaluated for all three "onsite" operable units for a hypothetical future scenario of conversion to residential property as discussed above in section 6.3.2.1.

6.3.2.4 Offsite

The only documented emissions within the offsite operable unit is from the shallow soil. This may be from the volatilization of groundwater chemicals into ambient air or may represent deposition in the shallow soil from ambient air. Volatilization of chemicals from the groundwater was modeled in the BPHE and investigated as detailed in section 5.2.3.4 above.

Due to the dispersive action of the wind and the low contaminant concentrations estimated and measured, the risk related to this exposure pathway in ambient air is nil. The risk from this pathway was initially estimated based on a two stage model as described above. Additional risk estimates were made for a maximum and an average case based on measured, field flux data rather than flux data estimated by a mathematical transport model. The indoor air concentration is still based on a conservative box model that assumes a low rate of indoor air exchange and a maximal area of infiltration. The maximum case assumes exposure for 30 years with the indoor air concentration modeled from the maximum field flux rate measured. The average case assumes a 9 year exposure with the indoor air concentration modeled from the mean of the measured field flux rates. The estimated risk for the maximum case is 5.75×10^{-5} and 9.1×10^{-7} for the average case. In each scenario the only observed carcinogenic chemical of concern was TCE.

The risk related to the operation of air strippers at the AMD 915 site, where the offsite groundwater is treated, was evaluated after the completion of the FS. Offgas from the air strippers was collected and analyzed for cis-1,2-DCE, trans-1,2-DCE, TCE, 1,1,1-TCA and vinyl chloride in September 1991. This data was then used in a screening level model developed by the California Air Pollution Control Officers Association. This model uses average area wide meteorological conditions, minimum release point height, maximum toxicity or carcinogenicity values, and minimum receptor distances. This model would predict a cancer risk of less than 1 X 10^{-5} and no non-carcinogenic health effects.

6.3.3 Groundwater

Possible exposure to contaminated groundwater as a result of using this groundwater as a source of domestic water supply was evaluated. This evaluation considered both direct ingestion of the groundwater and exposure to contaminants through the inhalation pathway as a result of showering and other domestic use. The evaluation was not considered separately for the operable units. It was assumed that the potential for the migration of the contaminants to a water supply well in the shallow aquifer were equal.

The evaluation of the this scenario assumes that no further actions would occur and that the current contaminant concentrations in groundwater would be present at the time a domestic well began to draw water from the shallow water bearing zones. This scenario was evaluated for both the A and B zone waters, but the numbers presented here are for the A zone which represents the greater risk and hazard. The non-carcinogenic hazard ratio and the carcinogenic cancer risk was considered for two cases, the average case and the maximum case. The average case assumes a 9 year exposure including ingestion of 1.4 liters of water per day contaminated with the chemicals of concern as represented by the geometric mean concentration in data from 1988 through 1989. The maximum case assumes a 30 year exposure to these chemicals at the maximum concentration detected in this same database. This scenario assumes ingestion of 2 liters of contaminated water per day for this 30 year period.

The excess cancer risk for the average or representative case based on the combination of ingestion and inhalation exposure is 2 X 10^{-3} (Table 5). The excess cancer risk for the maximum case is 5 X 10^{-1}. The potential cancer risk was evaluated, under the guidance of EPA Region IX toxicologist, without the inclusion of 1,1-DCE as a carcinogen. Under this guidance modified reference dose was used in the calculation of the hazard ratio for 1,1-DCE. However, based on guidance from EPA (Risk Assessment Guidance for Superfund), since the hazard index is greater than one it is not appropriate to consider 1,1-DCE only as a non-carcinogen since this would require evaluation of the potential non-carcinogenic effects by target organ and might not correctly represent the potential carcinogenic effects of 1,1-DCE. Therefore, the appropriate cancer risk related to the ingestion of groundwater is 2 X 10^{-3} for the average case and 5 X 10^{-1} for the maximum case.

TABLE 5
ADULT CARCINOGENIC RISK
AMD 901/902, SIGNETICS, AND TRW

CHEMICAL	CONCENTRATION µg/l	REPRESENTATIVE EXPOSURE			CONCENTRATION µg/l	MAXIMUM EXPOSURE		
		INGESTION	INHALATION	TOTAL		INGESTION	INHALATION	TOTAL
1,1-DCA	18	6×10^{-6}	NA	6×10^{-6}	600	6×10^{-4}	NA	6×10^{-4}
1,1-DCE	9.5	2×10^{-5}	4×10^{-5}	6×10^{-5}	63	4×10^{-4}	9×10^{-4}	1×10^{-3}
PCE	610	2×10^{-6}	1×10^{-7}	2.1×10^{-6}	610	4×10^{-4}	2×10^{-6}	4×10^{-4}
TCE	560	2×10^{-6}	3×10^{-6}	5×10^{-6}	200,000	2×10^{-2}	4×10^{-2}	6×10^{-2}
VINYL CHLORIDE	240	2×10^{-3}	2×10^{-4}	2.2×10^{-3}	18,000	4×10^{-1}	6×10^{-2}	5×10^{-1}
TOTAL		2×10^{-3}	3×10^{-4}	2×10^{-3}		4×10^{-1}	1×10^{-1}	5×10^{-1}
TOTAL W/O 1,1-DCE		2×10^{-3}	2×10^{-4}	2×10^{-3}		4×10^{-1}	1×10^{-1}	5×10^{-1}

The hazard index for the representative case is greater than one and is much greater than one for the maximum case. This indicates that non-carcinogenic health effects would be expected. Since the hazard index is greater than one the actual health hazard would require further evaluation on a target organ basis. Since the water is not currently used as a source of drinking water and is not used without treatment this was not pursued.

It should be emphasized that the shallow groundwater is not currently used for local drinking water; local ordinances require the installation of a sanitary seal through at least the upper 50 feet of the shallow water bearing zones. This would limit use of the most contaminated groundwater for drinking water. In addition, the assumption that all cleanup actions will be discontinued is intended only to provide a baseline for comparison, and does not reflect the current situation or future plans within the study area.

6.3 PRESENCE OF SENSITIVE HUMAN POPULATIONS

The study area is located in predominantly industrial area however, the groundwater contamination plume does extend downgradient to the north, beneath a residential area. The extension of the groundwater contamination plume North of Duane Avenue (offsite operable unit) may result in as many as 600 residences overlying the groundwater plume. This includes the San Miguel School, which currently houses a daycare center and a Headstart Program.

Since the contaminated groundwater has not affected the drinking water supply the only possible current exposure is through the inhalation pathway. This exposure pathway was evaluated for children attending programs at the San Miguel school facility. The excess cancer risk for both the average and maximum cases was less than 1×10^{-6}. The hazard ratio for both the average and maximum cases was less also less than one. The average case assumed the children were present for four hours per day for two years. The maximum case assumed the children were present for eight hours per day for four years.

6.4 PRESENCE OF SENSITIVE ECOLOGICAL SYSTEMS

Two endangered species are reported to use South San Francisco Bay, located approximately three miles north of the Study Area. The California clapper rail and the salt marsh harvest mouse are reported to exist in the tidal marshes of the Bay and bayshore. The endangered California brown pelican is occasionally seen in the Bay Area, but does not nest in the South Bay. Ranges of the endangered American peregrine falcon and southern bald eagle include the Bay Area. The southern bald eagle does not use bay and bayshore habitats. The peregrine falcon is making a strong recovery and may be downgraded from endangered to threatened status in specific areas, including California, in the near future. Nesting peregrines have been noted in the northern bay area, including the Golden Gate Bridge and Bay Bridge, however nesting peregrine falcons have not been reported in the South Bay.

The AMD site Study Area does not constitute critical habitat for endangered species nor does it include or impact any "wetlands."

6.5 CONCLUSION

Actual or threatened releases of hazardous substances from the Advanced Micro Devices, 901/902 Thompson Place, Signetics, 811 East Arques, and former TRW Microwave facility, 825 Stewart Drive Superfund sites, if not addressed by implementing the response action selected in this ROD may present an imminent and substantial endangerment to the public health, welfare or environment. Based on the fact that a variety of the VOCs detected in the Study Area pose significant health risks as carcinogens or as noncarcinogens and complete exposure pathways exist, EPA has determined that remediation is warranted.

7.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)

Under Section 121(d)(1) of CERCLA, remedial actions must attain a degree of clean-up which assures protection of human health and the environment. Additionally, remedial actions that leave any hazardous substance, pollutant, or contaminant on-site must meet a level or standard of control that at least attains standards, requirements, limitations, or criteria that are "applicable or relevant and appropriate" under the circumstances of the release. These requirements, known as "ARARs", may be waived in certain instances, as stated in Section 121(d)(4) of CERCLA.

"Applicable" requirements are those clean-up standards, standards of control and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant or contaminant, remedial action, location, or other circumstance at a CERCLA site. "Relevant and appropriate" requirements are clean-up standards, standards of control and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site. For example, requirements may be relevant and appropriate if they would be "applicable" but for jurisdictional restrictions associated with the requirement. (See the National Contingency Plan, 40 C.F.R. Section 300.6, 1986).

The determination of which requirements are "relevant and appropriate" is somewhat flexible. EPA and the State may look to the type of remedial actions contemplated, the hazardous substances present, the waste characteristics, the physical characteristics of the site, and other appropriate factors. It is possible for only part of a requirement to be considered relevant and appropriate. Additionally, only substantive requirements need be followed. If no ARAR covers a particular situation, or if an ARAR is not sufficient to protect human health or the environment, then non-promulgated standards, criteria, guidance, and advisories must be used to provide a protective remedy.

7.1 TYPES OF ARARS

There are three types of ARARs. The first type includes "contaminant specific" requirements. These ARARs set limits on concentrations of specific hazardous substances, pollutants, and contaminants in the environment. Examples of this type of ARAR are ambient water quality criteria and drinking water standards. The second type of ARAR includes location-specific requirements that set restrictions on certain types of activities based on site characteristics. These include restriction on activities in wetlands, floodplains, and historic sites. The third type of ARAR includes action-specific requirements. These are technology-based restrictions which are triggered by the type of action under consideration. Examples of action-specific ARARs are Resource Conservation and Recovery Act ("RCRA") regulations for waste treatment, storage, and disposal.

ARARs must be identified on a site-specific basis from information about specific chemicals at the site, specific features of the site location, and actions that are being considered as remedies.

7.2 CONTAMINANT-SPECIFIC ARARS AND TBCS

Section 1412 of the Safe Drinking Water Act, 42 U.S.C. Section 300G-1

Under the authority of Section 1412 of the Safe Drinking Water Act, Maximum Contaminant Levels Goals (MCLGs) that are set at levels above zero, shall be attained by remedial actions for ground or surface water that are current or potential sources of drinking water, where the MCLGs are relevant and appropriate under the circumstances of the release based on the factors in §300.400 (g)(2).

The appropriate remedial goal for each indicator chemical in ground water is the MCLG (if not equal to zero), the federal MCL, or the State MCL, whichever is most stringent.

California's Resolution 68-16

California's "Statement of Policy With Respect to Maintaining High Quality of Waters in California," Resolution 68-16, affects remedial standards. The policy requires maintenance of existing water quality unless it is demonstrated that a change will benefit the people of the State, will not unreasonably affect present or potential uses, and will not result in water quality less than that prescribed by other State policies.

The FS evaluated groundwater cleanup to background or non-detect levels. Cleanup to non-detect levels would increase estimated groundwater cleanup times by over 50% and add significantly to cost. The FS also evaluated cleanup levels necessary to achieve a 1 in 1,000,000 excess cancer risk from future ingestion of the groundwater. This is highly impractical due to the presence of arsenic. The arsenic concentration would have to be reduced to 1.5 μg/l to approach the 1 in a 1,000,000 excess cancer risk. This is far below the current MCL for arsenic of 50 μg/l and is probably below the naturally occurring background of arsenic in groundwater in Santa Clara County.

In addition, cleanup of groundwater to below the MCL for the chemicals of concern may not be achievable due to the technical difficulties in restoring aquifers by the removal of low concentrations of any VOC. This is due to the slow desorption of VOCs adsorbed to the inner pore spaces of soil particles which make up the aquifer material and VOCs adsorbed to clays and organic matter in the aquitard. Cleanup to MCL levels would protect the primary beneficial use of the groundwater as a potential source of drinking water. For these reasons, MCLs were accepted as concentrations that meet the intent of Resolution No. 68-16.

7.3 ACTION SPECIFIC ARARS AND TBCS

National Pollutant Discharge Elimination System (NPDES)

NPDES substantive permit requirements and/or RWQCB Waste Discharge Requirements (WDRs) are potential ARARs for effluent discharges. The effluent limitations and monitoring requirements of an NPDES permit or WDRs legally apply to point source discharges such as those from a treatment system with an outfall to surface water or storm drains. The RWQCB established effluent discharge limitations and permit requirements based on Water Quality Standards set forth in the San Francisco Bay Regional Basin Plan or best available technology standards.

EPA Office of Solid Waste and Emergency Response (OSWER) Directive 9355.0-28

OSWER Directive 9355.0-28 "Control of Air Emissions from Superfund Groundwater Air Strippers at Superfund Groundwater Sites" applies to future remedial decisions at Superfund sites in ozone non-attainment areas. Future remedial decisions include Records of

Decisions (RODs), Significant Differences to a ROD and Consent Decrees. The four operable units are in an ozone non-attainment area. This directive requires such sites to control total volatile organic compound emissions from air strippers and soil vapor extractors to fifteen pounds per day per facility. This directive is not an ARAR, but is a TBC. ARARs with more stringent requirements take precedence over the directive.

Bay Area Air Quality Management District (BAAQMD) Regulation 8, Rule 47

Bay Area Air Quality Management District Board of Directors adopted Regulation 8, Rule 47. This rule is entitled "Air Stripping and Soil Vapor Extraction Operations" and applies to new and modified operations. The rule consists of two standards:

- o Individual air stripping and soil vapor extraction operations emitting benzene, vinyl chloride, perchloroethylene, methylene chloride and/or trichloroethylene are required to control emissions by at least ninety percent by weight. Operations emitting less than one pound per day of these compounds are exempt from this requirement if they pass a District risk screen.

- o Individual air stripping and soil vapor extraction operations emitting greater than fifteen pounds per day of organic compounds other than those listed above are required to control emissions by at least ninety percent by weight.

Regulation 8, Rule 47 is an ARAR for the implementation of the remedy at all four operable units.

Bay Area Air Quality Management District (BAAQMD) Regulation 8, Rule 40

Bay Area Air Quality Management District Board of Directors adopted Regulation 8, Rule 40, July 1986. This rule is entitled "Aeration of Contaminated Soil and Removal of Underground Storage Tanks". The purpose of this Rule is to limit the emission of organic compounds from soil that has been contaminated by organic or petroleum chemical leaks or spills; to describe an acceptable soil aeration procedure; and to describe an acceptable procedure for controlling emissions from underground storage tanks during replacement or removal. This rule includes standards for aeration, reporting requirements and a manual of procedures.

- o Uncontrolled aeration (8-40-301) is limited by a combination of organic content and volume.

- o Controlled aeration (8-40-302) requires that the emissions of organic compounds to the atmosphere be reduced by at least 90% by weight.

Regulation 8, Rule 40 would be an ARAR for the implementation of any remedy that includes soil aeration or removal of any soil containing greater than 50 ppm by weight organic content.

Resource Conservation Recovery Act (RCRA) Land Disposal Restrictions

The contaminated ground water contains two spent solvents that are RCRA listed wastes. TCE is an F001 listed waste, and TCA is an F002 listed waste. Adsorbents and other materials used for remediation of groundwater VOCs, such as activated carbon, chemical-adsorbing resins, or other materials used in the treatment of ground water or air will contain the chemicals after use. RCRA land disposal restrictions are not applicable but are relevant and appropriate to disposal of treatment media due to the presence of constituents which are sufficiently similar to RCRA wastes.

Clean Water Act

Under these provisions, discharges of treated groundwater to the local sanitary sewer must comply with local POTW pretreatment programs. Discharges of treated groundwater to the sanitary sewer at AMD 901/902 must meet the substantive standards of the City of Sunnyvale.

7.4 LOCATION-SPECIFIC ARARS

Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act is an applicable requirement for the locations adjacent to Calabazas Creek, Guadelupe Slough and other tributary streams and marshes.

8.0 DESCRIPTION OF ALTERNATIVES

8.1 REMEDIAL ACTION OBJECTIVES

Cleanup of groundwater contamination at the AMD/Signetics/TRW sites focuses on the following remedial objectives:

1. Prevention of the near-term and future exposure of human receptors to contaminated groundwater and soil;

2. Restoration of the contaminated groundwater for future use as a potential source of drinking water;

3. Control of contaminant migration;

4. Monitoring of contaminant concentrations in groundwater to observe the control of contaminant migration and the progress

of cleanup.

8.2 CLEANUP STANDARDS

8.2.1 Cleanup Standards

Even though shallow groundwater affected by these sites is not currently being used for drinking water, it is a potential drinking water source and must be protected as such. Therefore, the cleanup standards have been set at state and federal Maximum Contaminant Levels (MCLs) for drinking water. The cleanup standards for nine of the ten chemicals of concern for these sites are the California MCLs for drinking water (Table 6). The exception is 1,2-DCB for which California has not established an MCL. The cleanup standard for 1,2-DCB will be the recently promulgated Federal MCL, which becomes effective July 1992. Setting the cleanup standards at these levels fulfills the ARARs and also achieves a risk level within the EPA acceptable risk range.

For the study area, the carcinogenic risk at the cleanup standards for all chemicals listed in Table 6 associated with the potential future use scenario of groundwater ingestion and inhalation of VOCs from groundwater would be 3.7 X 10-4 (Tables 7 & 8). This risk is based on all the chemicals in Table 6 being present in the groundwater any place within the study area. This estimate is based on assumptions similar to the probable maximum case in the BPHE, except it assumes a 70 year rather than a 30 year exposure used to estimate the probable maximum risk scenario in the BPHE.

These assumptions are probably overly conservative, especially the assumption regarding the occurrence of all chemicals. Table 6 shows which chemicals occur or would be reasonably expected to occur in which operable unit. Based on these chemicals only, the estimated excess carcinogenic risk after cleanup is 6 X 10-6 for the AMD operable unit and 4 X 10-5 for Signetics, TRW, and the offsite commingled plume (Table 8). In cleaning up TCE to the 5 ppb cleanup standard it is quite likely that the concentrations of other VOCs will be reduced to levels below the 5 ppb range. These risk values represent the maximum residual risk that would be probable following cleanup.

In addition, these values include 1,1-DCE which is classified by EPA as a possible human carcinogen. The classification of 1,1-DCE as a carcinogen is based on a single positive result out of seventeen studies and, based on guidance of EPA region IX toxicologist, it is acceptable to exclude 1,1-DCE as a

TABLE 6
CLEANUP STANDARDS FOR THE CHEMICALS OF CONCERN IN GROUNDWATER

AMD 901/902, Signetics, and TRW
Sunnyvale, California

COMPOUND	FEDERAL MCLG[a]	FEDERAL MCL[b]	CALIFORNIA MCL	APPLICABLE OPERABLE UNITS
1,2- Dichlorobenzene	(600)	(600)	NA	AMD, TRW
1,1-Dichloroethane[c]	NA	NA	5	ALL
1,1-Dichloroethene[d]	7	7	6	ALL
cis-1,2-Dichloroethene	(70)	(70)	6	ALL
trans-1,2-Dichloro-ethene	(100)	(100)	10	ALL
Freon 113	NA	NA	1,200	ALL
Tetrachloroethene[c]	(0)	(5)	5	AMD, TRW, OFFSITE
1,1,1-Trichloroethane	200	200	200	ALL
Trichloroethene[c]	0	5	5	ALL
Vinyl Chloride[c]	0	2	0.5	AMD, TRW, Signetics

Shaded criteria are the selected cleanup standards

(a) MCLG = maximum contaminant level goal. Concentrations in micrograms per liter.

(b) MCL = maximum contaminant level. Concentrations in micrograms per liter.

(c) Potential or probable human carcinogen.

(d) Possible human carcinogen.

NA = Not available.

( ) Criteria in parentheses, effective July 1992 carcinogen. If 1,1-DCE is not included as a carcinogen, a modified reference dose is used in the evaluation of the non-carcinogenic hazard quotient. If it is excluded, the estimated risk at cleanup standards decreases to 6 X 10-6 for Signetics and TRW and 3 X 10-6 for the offsite commingled plume.

The non-carcinogenic hazard index at the cleanup standards, for all of the chemicals shown in Table 6 associated with the potential future use scenario of groundwater ingestion and inhalation of VOCs is 0.44 (Table 7). If only those chemicals that might be reasonable expected to occur within any operable unit are considered then the hazard index for this scenario is 0.44 for AMD and Signetics operable unit, 0.1 for the TRW operable unit, and 0.2 for the offsite commingled plume (Table 7).

Cleanup standards for the treated effluent from the air stripper are set by RWQCB in the NPDES permit process. Cleanup standards for the air stripper offgas are established by the BAAQMD permit process. All of the treatment systems, except for the groundwater treatment system at AMD 901/902, are currently permitted by the RWQCB and BAAQMD. The groundwater treatment system at AMD 901/902 does have a permit to operate from the BAAQMD, however since the water is reused as industrial process water and indirectly discharged to the sanitary sewer system apermit from the RWQCB is not required.

Operation of the AMD 901/902 site as a production facility by AMD will cease sometime in late 1991 or early 1992. This will preclude the indirect discharge of the treated groundwater under local POTW regulations. An NPDES permit will be required for discharge of this water, however the discharge limits have not been established at this time.

There are currently no ARARs established for cleanup levels in contaminated soil. However, a RWQCB policy of cleanup to background or 1 ppm total VOCs for soils is a TBC criteria and has been set as the soil cleanup standard for these sites. Experience at other sites has shown that this level will prevent recontamination of groundwater.

8.2.2 Compliance Boundaries

The compliance boundary for contaminated groundwater includes all groundwater within the plume boundaries indicated in Figures 16 and 17, all groundwater monitored in existing wells, and any contaminated groundwater identified by additional monitoring wells installed upon RWQCB or EPA request for the purpose of monitoring potential vertical or horizontal migration of the plumes currently located in the A and B Aquifers.

TABLE 7, HAZARD INDEX AT CLEANUP STANDARDS, AMD 901/902, Signetics, TRW

CONCENTRATION (Cw) SET AT ARARs

HAZARD INDEX = CDI/RfD | CDI = Chronic Daily Intake | RfD = Reference Dose

Cw = ARARs, TBCs, or cleanup goals

No.	CHEMICAL	Cw µg/l	WOE	ORAL RfD	CDI	HI	Inhalation RfD	Inhalation HI	TOTAL HI
1	1,2-DICHLOROBENZENE	0.100	MCL\B2	0.01	2.86e-03	2.86e-01	NA	0.00	2.86e-01
2	1,1-DCA	0.005	CA MCL\B2	0.100	1.43e-04	1.43e-03	0.1	1.43e-03	2.86e-03
3	1,1-DCE	0.006	CA MCL\C	0.009	1.71e-04	1.90e-02	NA	0.00	1.90e-02
4	cis-1,2-DCE	0.006	CA MCL\D	0.02	1.71e-04	8.57e-03	NA	0.00	8.57e-03
5	trans-1,2-DCE	0.010	CA MCL\D	0.02	2.86e-04	1.43e-02	NA	0.00	1.43e-02
6	FREON 113	1.200	CA MCL\D	3	3.43e-02	1.14e-02	NA	0.00	1.14e-02
7	PCE	0.005	MCL\B2	0.01	1.43e-04	1.43e-02	NA	0.00	1.43e-02
8	1,1,1-TCA	0.200	MCL\D	0.09	5.71e-03	6.35e-02	0.3	1.90e-02	8.25e-02
9	TCE	0.005	MCL\B2	NA	1.43e-04	0.00	NA	0.00	0.00
10	VINYL CHLORIDE	0.0005	CA MCL\A	NA	1.43e-05	0.00	NA	0.00	0.00
				TOTAL HAZARD INDEX =		.42e00		.20e-01	.44e+00

IRIS = IRIS ORAL REFERENCE DOSE

DWHA = DRINKING WATER HEALTH ADVISORY

WQC = NATIONAL AMBIENT WATER QUALITY CRITERIA FOR PUBLIC HEALTH

MCL = FEDERAL MCL

CA MCL = CALIFORNIA MCL

WOE = WEIGHT OF EVIDENCE = SOURCE OF DATA

A = KNOWN HUMAN CARCINOGENS

B1 = PROBABLE HUMAN CARCINOGEN (limited human evidence, adequate evidence from animals)

B2 = PROBABLE HUMAN CARCINOGEN (inadequate human evidence, adequate evidence from animals)

C = POSSIBLE HUMAN CARCINOGEN (limited evidence of carcinogenicity, animal studies only)

TABLE 8, CANCER RISK AT CLEANUP STANDARDS

AMD 901/902, Signetics and TRW		CHEMICAL CONCENTRATION SET TO CLEANUP STANDARDS						
DETERMINATION OF EXCESS LIFETIME CANCER RISK FOR CARCINOGENS								
EXCESS LIFETIME CANCER RISK = CDI x q*								
q* = CANCER POTENCY FACTOR (MG/KG/DAY)-1			CDI = Chronic Daily Intake (MG/KG)					
Cw = ARARs, TBCs, or cleanup goals								
CHEMICAL	Cw MG/L	WOE\CLASS OF CARCINOGEN	ORAL q*	CDI	RISK	INHALATION q*	INHALATION RISK	TOTAL RISK
1,1-DCA	0.005	CA MCL\B2	9.10e-02	1.43e-04	1.30e-05	NA	0.00	1.30e-05
1,1-DCE	0.006	CA MCL\C	6.00e-01	1.71e-04	1.03e-04	1.20e+00	2.06e-04	3.09e-04
PCE	0.005	MCL\B2	5.10e-02	1.43e-04	7.29e-06	3.30e-03	4.71e-07	7.76e-06
TCE	0.005	MCL\B2	1.10e-02	1.43e-04	1.57e-06	1.70e-02	2.43e-06	4.00e-06
VINYL CHLORIDE	0.0005	CA MCL\A	2.30e+00	1.43e-05	3.29e-05	2.95e-01	4.21e-06	3.71e-05
			EXCESS CANCER RISK		1.58e-04		2.13e-04	3.71e-04
		EXCESS CANCER RISK W/O 1,1-DCE			2.78e-05		7.11e-06	3.49e-05
WOE = WEIGHT OF EVIDENCE = SOURCE OF DATA								
MCL = FEDERAL DRINKING WATER MAXIMUM CONTAMINANT LEVEL								
CAMCL = CALIFORNIA DRINKING WATER MAXIMUM CONTAMINANT LEVEL								
A = KNOWN HUMAN CARCINOGENS								
B1 = PROBABLE HUMAN CARCINOGEN (limited human evidence, adequate evidence from animals)								
B2 = PROBABLE HUMAN CARCINOGEN (inadequate human evidence, adequate evidence from animals)								
C = POSSIBLE HUMAN CARCINOGEN (limited evidence of carcinogenicity, animal studies only)								

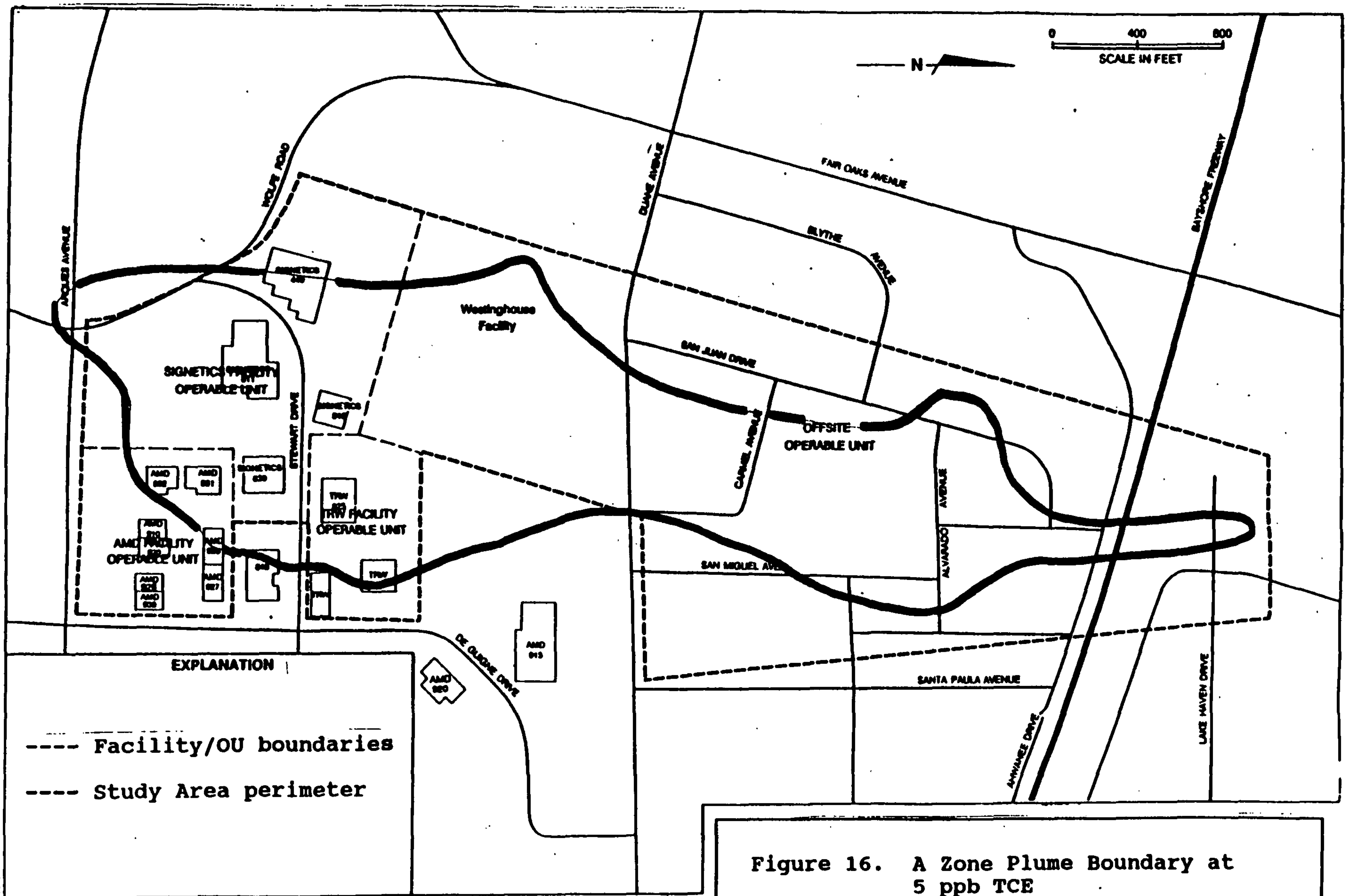

Figure 16. A Zone Plume Boundary at 5 ppb TCE

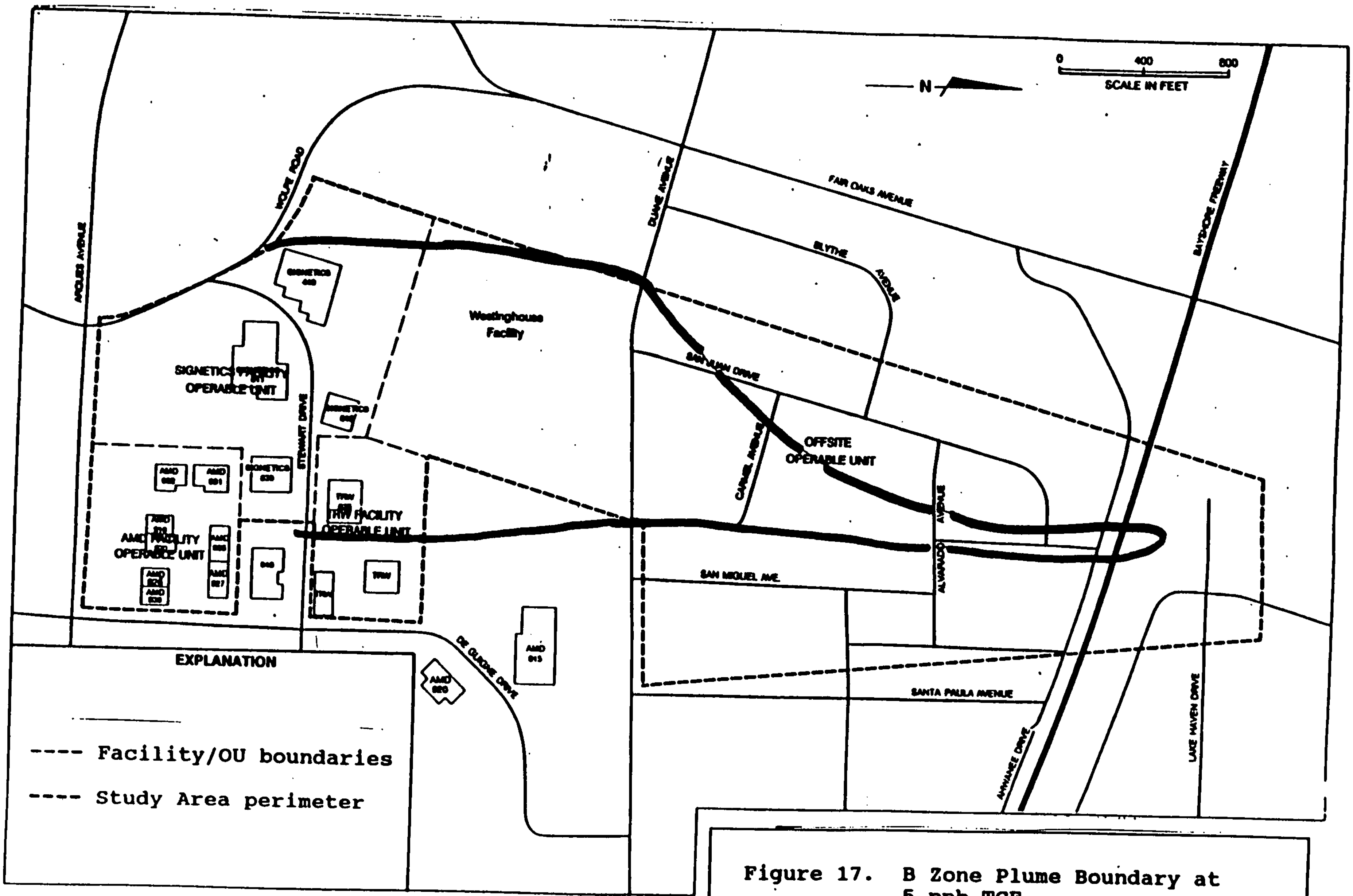

Figure 17. B Zone Plume Boundary at 5 ppb TCE

8.3 REMEDIAL ACTION ALTERNATIVES

Initially, a large number of cleanup methods (technologies) were screened with respect to their effectiveness, implementability, and order-of-magnitude cost. The methods which passed this initial screening were then combined into cleanup alternatives most applicable to each Operable Unit and evaluated in detail.

8.3.1 AMD Operable Unit

Approximately 37 cubic yards of residual contaminated soil is located in the unsaturated zone upgradient of the groundwater extraction and treatment system. Alternative 1 applies to both soil and groundwater. Alternatives 2 through 7 specifically address the soil, and Alternatives 8 through 10 address groundwater.

<u>AMD Alternative 1: No Action - Monitoring</u> The no action alternative includes completely stopping operation of the existing groundwater treatment system which has been operating for the last 6 years. No additional soil remediation would be performed. Groundwater monitoring would continue. Time for the groundwater to achieve compliance with ARARs is unknown with best estimates in the range of hundreds of years. The present worth cost is projected to be $1.5 million.

<u>AMD Alternative 2: Soil Flushing</u> In this alternative, water would be percolated through contaminated soil to solubilize VOCs adsorbed to the soil and flush them into the groundwater. Groundwater would then be treated by an activated carbon treatment system. This procedure would reduce the residual concentrations in the soil and increase the soluble concentrations in the groundwater. It is estimated this alternative would take hundreds of years to reduce concentrations of VOCs in soil to the 1 ppm level. The present worth cost of this alternative is estimated to be $2.8 million.

<u>AMD Alternative 3: Soil Aeration</u> This alternative consists of excavating the contaminated soil and transporting it to an appropriate treatment area. The soil would be spread out to a predetermined depth, usually 1 to 3 feet, and mechanically mixed on a regular basis. The contaminants would volatilize and be released to the air. Again, it is estimated this alternative would take hundreds of years to reduce concentrations of VOCs in soil to the 1 ppm level. The present worth cost of this alternative is estimated to be $2.7 million.

AMD Alternatives 4 through 6: Vacuum Extraction (VE); VE with Heated Air Assist; VE with Steam Assist These three alternatives involve in situ vacuum extraction whereby VOCs are removed from the soil by mechanically drawing or venting air through the unsaturated soil layer. The soil would be gradually treated as the VOCs are released from the soil particles. Extraction of the VOC-containing vapors could be enhanced by using heated air or steam. VOC-laden air would then be treated with an appropriate treatment system. Again, it is estimated this alternative would take hundreds of years to reduce concentrations of VOCs in soil to the 1 ppm level. The present worth cost of these alternatives ranges from $2.8 to $3.5 million.

AMD Alternative 7: Excavation and Offsite Disposal/Treatment In this alternative, the contaminated soil would be excavated, the building reinforced as needed, and the excavation backfilled. The excavated soil would be treated most likely by incineration and/or disposed offsite. The concentrations of VOCs in soil can be reduced to the 1 ppm level during the duration of the excavation. The present worth cost of this alternative is estimated to be $2.7 million.

AMD Alternative 8: Extraction - Air Stripping with Carbon Adsorption of the Offgas This alternative comprises the current interim remedial treatment system for the groundwater (extraction wells, air stripper, and carbon adsorption of the offgas). Air stripping as a stand-alone technology is very effective in removing VOCs from groundwater at the AMD Operable Unit. Carbon adsorption of the stripper vapor exhaust provides additional treatment. This alternative is modeled to achieve cleanup standards in 18 years at a present value cost of $2.6 million.

AMD Alternative 9: Extraction - Carbon Adsorption Alternative This alternative consists of extraction of groundwater using the current well system. The extracted groundwater could then be passed directly through granular activated carbon for adsorption of VOCs. Use of the air stripper would be discontinued. This alternative would not change the time to achieve ARARs (18 years) however the present value cost would increase to $4.6 million.

AMD Alternative 10: Augmented Extraction with Enhanced Treatment This alternative involves installing additional wells on the AMD OU to extract additional groundwater. The groundwater would be treated in the existing air stripper system. An additional carbon adsorption unit would be installed to provide additional capacity to treat the air stripper offgas. The increased number of wells would not result in an increased rate of groundwater extraction, therefore the estimated time to achieve ARARs remains at 18 years. The estimated present value cost of this alternative is $2.8 million.

AMD Treated Groundwater Disposal For all three groundwater remediation alternatives (8 through 10), discharge options for treated groundwater include: discharge to a publicly owned treatment works (POTW), discharge to storm drain, and industrial process applications. Currently, AMD reuses all of the treated groundwater in onsite facility uses.

8.3.2 Signetics Operable Unit

Alternatives 1 through 4 combine soil and groundwater remedial alternatives for the Signetics property.

Signetics Alternative 1: No Action In this alternative, no action would be taken to remediate soil or groundwater and the existing soil-vapor vacuum extraction system would be shut down. The estimated present value cost of this alternative is $1.5 million.

Signetics Alternative 2: No Additional Groundwater or Vacuum Extraction Alternative 2 comprises the interim remedial system currently in operation. Groundwater is extracted using two extraction trenches, six extraction wells, and three basement dewatering sumps. The existing soil-vapor vacuum extraction system would continue to operate. Extracted groundwater would continue to be treated by air stripping followed by carbon polishing of the effluent water. In addition, vapor-phase carbon would continue to be used to remove residual VOCs from the effluent air stream from the air strippers. The estimated present value cost of this alternative is $3.9 million.

Signetics Alternative 3: Enhanced Groundwater Extraction This alternative consists of improving the extraction system to compensate for declining water levels; these declines have resulted in decreases in contaminant removal rates and apparent increases in downgradient VOC concentrations. The existing soil-vapor vacuum extraction system would continue to operate. The proposed improvements to the groundwater extraction system are:

- Increase pumping rate at the 440 Wolfe extraction trench to decrease the water levels in the trench

- Install a series of A-aquifer extraction wells north of the 811 Arques Avenue building

- Install piezometers along and north of the 815 Stewart Drive property boundary to assess the current capture zones

- Install additional A-aquifer extraction wells immediately north of the 815 Stewart building, unless declining water levels preclude extraction

- Resume pumping from an existing B1/B2-aquifer extraction well (S-100B1)

- Initiate groundwater extraction from the B3-aquifer if onsite VOC concentrations increase significantly.

The present value cost of this alternative is $3.9 million.

Signetics Alternative 4: Enhanced Groundwater (A- and B-Aquifers) and Vacuum Extraction (A-Aquifer) This alternative is similar to Alternative 3 except that both the groundwater and vacuum extraction systems are expanded. The expanded vacuum extraction system would include four additional vapor extraction wells and an upgrade of the blowers and carbon adsorption system. The present value cost of this alternative is $4.1 million.

8.3.3 TRW Operable Unit

Alternatives for remediation of soil have been incorporated into comprehensive groundwater remediation alternatives for the TRW property.

TRW Alternative 1: No Action Alternative 1 is a no further action alternative. All current remedial activities would be stopped. The present value cost of this alternative is $1.0 million.

TRW Alternative 2: Current Groundwater Extraction System With Alternative 2, groundwater extraction from the 7 well/1 eductor system, groundwater treatment by air stripping, and groundwater discharge under an NPDES permit would continue. No additional remedial technology would be required, although the present system would be upgraded as part of normal maintenance and replacement. This alternative would also include deed restrictions on the use of groundwater in the A- and B-aquifers.

The FS estimates that this alternative would require at least 7 years of operation to reach compliance with applicable, relevant, and appropriate requirements (ARARs) and eleven years to approach non-detect levels of organic chemicals. The estimated present worth cost of this alternative is $0.8 million to achieve ARARs and $1.1 million to approach background levels.

TRW Alternative 3: Soil Flushing and Groundwater Extraction Alternative 3 combines the components for Alternative 2 with flushing of source area soils. Soil flushing should increase water saturation of, and circulation through, soils, and might increase the potential for VOC desorption from soils to groundwater, thus reducing the time for VOC removal from the subsurface soil.

The FS estimates that this alternative would require at least 7 years of operation to reach compliance with ARARs and eleven years to approach non-detect levels of organic chemicals. The estimated present worth cost of this alternative is $0.8 million to achieve ARARs and $1.2 million to approach background levels.

TRW Alternative 4: Partial Excavation and Groundwater Extraction Alternative 4 consists of excavating the most highly contaminated soils north and west of the former tank area, dewatering the entire excavated area, and backfilling the excavation with clean material. This alternative would also include deed restrictions on the use of groundwater in the A- and B-aquifers and continued pumping, treatment, and discharge of groundwater from existing and two new extraction wells. This alternative would require significant engineering controls prior to and during excavation, as well as relocation of operational equipment.

The FS estimates that this alternative would require at least 7 years of operation to reach compliance with ARARs and eleven years to approach non-detect levels of organic chemicals. The estimated present worth cost of this alternative is $1.6 million to achieve ARARs and $2 million to approach background levels.

8.3.4 Offsite Operable Unit

Remedial alternatives for soil were not addressed for the Offsite OU because contaminant sources in soil are limited to the facility properties.

Offsite Alternative 1: No Action The no action alternative involves no further action to treat, contain, or remove any of the contaminated groundwater. To implement this alternative, planned and existing remedial measures would be discontinued. Groundwater monitoring would continue. Time for the groundwater to achieve compliance with ARARs is unknown with best estimates in the range of hundreds of years. The present worth cost is projected to be $1.9 million.

Offsite Alternative 2: Expanded Extraction, Air Stripping, and Carbon Adsorption: This alternative consists of continued operation of the existing offsite extraction and treatment system. The system currently extracts groundwater from 23 extraction wells. The extracted groundwater is conveyed through an underground piping system to the AMD Building 915 treatment facility; the groundwater is treated by air stripping followed by aqueous carbon adsorption. Currently, about 30% of the treated groundwater is reused at the AMD facility, with the remainder discharged under NPDES permit CA0028797 to the storm drain system. The spent carbon is removed and regenerated offsite as needed, approximately every 1.5 years.

The hydraulic performance evaluation of the extraction system indicated that because of declining water levels, hydraulic capture is not being fully maintained in the A- and B2-aquifers. It is estimated that 5 new A-aquifer extraction wells (or an extraction trench) and 3 new B2-aquifer wells may be needed to maintain adequate capture. Based on results of a simplified model it is estimated that this alternative could meet groundwater ARARs in 36 years. The present worth cost for this alternative is estimated at $4.4 million.

Offsite Alternative 3: Extraction and Carbon Adsorption This alternative consists of pumping groundwater from the upgraded offsite extraction systems and treatment of the water by carbon adsorption. The treated groundwater would be reused and/or discharged under NPDES permit CA0028797 to the storm drain system. This alternative differs from Alternative 2 in that VOC removal is accomplished by means of a carbon adsorption unit only, rather than by use of a combined air stripping/carbon adsorption system. The estimated time to achieve cleanup is 36 years, the same as Alternative 2. The present worth cost for this alternative is estimated at $10 million.

9.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section provides an explanation of the nine criteria used to select the remedy, and an analysis of the remedial action alternatives in light of these criteria, highlighting the advantages and disadvantages of each alternative.

9.1 NINE CRITERIA

The alternatives were evaluated using nine component criteria. These criteria, which are listed below, are derived from requirements contained in the National Contingency Plan (NCP) and CERCLA Sections 121(b) and 121(c).

1. Overall protection of human health and the environment.

2. Short term effectiveness in protecting human health and the environment.

3. Long-term effectiveness and permanence in protecting human health and the environment.

4. Compliance with ARARs (ARARs are detailed in Section 7.0).

5. Use of treatment to achieve a reduction in the toxicity, mobility or volume of the contaminants.

6. Implementability.

7. State acceptance/Support Agency acceptance.

8. Community acceptance.

9. Cost.

9.2 ANALYSIS OF ALTERNATIVES

The analysis for two of the nine criteria, State acceptance and Community acceptance, generally apply equally to all of the alternatives. Their analysis will be provided at the beginning of this section.

STATE ACCEPTANCE AND COMMUNITY ACCEPTANCE

The Feasibility Study and the Proposed Plan Fact Sheet were reviewed by the RWQCB and they concur with EPA's preferred alternatives, thus providing State acceptance. Based on questions raised by the community and discussed in the Responsiveness Summary (Appendix A), there appears to be community acceptance for the selected remedies in so far as the remedies address the groundwater and soil at the AMD, Signetics, and TRW properties.

There is significant community concern about the potential for VOCs to volatilize from the offsite groundwater and then migrate through the soil gas and eventually become concentrated in confined spaces of buildings in the residential area. Groundwater extraction that proceeds as rapidly as possible is the selected remedy at all of the sites and addresses this potential volatilization problem by reducing the concentrations of contaminants in the groundwater, which, in turn, reduces the potential for significant levels of VOCs to reach buildings at the surface. Actual field measurements of the vapor flux at the soil surface have not indicated a significant problem. Field measurements will continue and a reassessment of the problem will be initiated at the 5 year review period, unless the need for earlier reassessment is indicated by future field measurements.

At this time, EPA and RWQCB do not believe that selection of an additional remedial action (e.g., ventilation aids placed in buildings) will be necessary. For the time being, the community appears to have accepted this strategy for addressing the potential volatilization problem.

9.2.1 AMD Operable Unit

Of the ten alternatives evaluated for the cleanup of the AMD property, Alternatives 2 through 7 specifically address the contaminated soil. Alternatives 8 through 10 specifically address the contaminated groundwater. Alternative 1 is the no action alternative for both the soil and the ground water.

9.2.1.1 AMD Soils

AMD Soil: PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Alternatives 5, 6, and 7 are protective of human health and the environment because they remove the soil contaminants from the site either by enhanced vacuum extraction or excavation followed by offsite treatment and disposal. Only Alternative 7 is protective in a reasonable time frame. Alternatives 5 and 6 would require hundreds of years to reach the cleanup standard of 1 ppm total VOCs because of the physical properties of some chemicals of concern, notably DCB and PCE, that make their removal from soil extremely difficult. Upon implementation, Alternative 7 will immediately prevent the soil from acting as a further source of groundwater contamination and will prevent soil contaminants from volatilizing into the soil gas and eventually migrating into confined spaces of dwellings at the surface.

Without the advantages of heated air or steam assistance (Alternatives 5 and 6), the vacuum extraction of Alternative 4 would not be effective enough to eliminate the risk from PCE and DCB. As is the case with Alternatives 4, 5, and 6, Alternative 3 depends on the transfer of chemicals from the soil to vapor. PCE and DCB are bound too tightly to the soil to be effectively removed by simple aeration. In addition, the time to reach the cleanup standards for offsite disposal of the extracted soils in Alternative 3 would require hundreds of years. Similar physical chemical properties of PCE and DCB prevent Alternative 2 from effectively removing these contaminants from the soil by using soil flushing as a form of enhanced groundwater treatment.

Alternative 1 is not protective of human health and the environment because it would leave all VOC contaminants in place in the soil.

AMD Soil: COMPLIANCE WITH ARARS

Alternative 7 is the only soil remediation alternative that will comply with all pertinent ARARs identified in Section 7 in a reasonable amount of time. It would comply with the RCRA land disposal restriction by first treating the excavated soil offsite with an appropriate technology before disposal. The current treatment technology for removal of the majority of VOCs in soil is incineration, which would result in permanent destruction of the chemicals of concern. The actual treatment technology will be determined by LDRs at the time of removal.

Due to the difficulty in implementation of Alternative 7, AMD will be given up to two years from the adoption of the RWQCB Order (June 1991) to complete the Alternative 7 soil remedy. All other alternatives would not comply with soil ARARs for hundreds of years.

Alternatives 3 through 6 involve air emissions that come under regulation by BAAQMD. Emissions from the vapor extraction alternatives would comply with air ARARs, but Alternative 3 emissions from onsite soil aeration may not meet BAAQMD requirements. Alternative 3 would attain the UIC ARAR for injected water.

Because of the difficulty in removing DCB and PCE from soil under native conditions, compliance with TBCs is questionable for all of the Alternatives except Alternative 7 due to the length of time required to reach the soil cleanup criteria of 1 ppm. Heated air or steam injection (Alternatives 5 and 6) may enhance the removal rates, however neither is a proven technology and the same physical limits may still apply. Alternative 7 would achieve the soil cleanup criteria by removing all soil that contains above 1 ppm total VOCs.

Alternatives 3 and 7 would also be required to comply with BAAQMD Rule 8, Regulation 40.

AMD Soil: REDUCTION OF TOXICITY, MOBILITY, OR VOLUME OF CONTAMINANTS THROUGH TREATMENT

Alternative 7 provides the greatest reduction in toxicity mobility and volume of soil contaminants through excavation followed by contaminant destruction from an incineration technology. All other treatment alternatives do not affect the toxicity of the soil contaminants, but they do reduce their mobility and volume in the soil.

Like Alternative 7, Alternative 3 reduces soil contaminant mobility by excavation. Unlike Alternative 7, the mobility and volume of the contaminants then increases as aeration of the soils emits the contaminants into the air.

Air emissions from the vapor extraction remedies would be controlled by adsorption of the contaminants onto vapor-phase carbon. Regeneration of the carbon by an incineration technology would destroy the contaminants, thus providing the maximum reduction in toxicity, mobility, and volume for those contaminants removed from the soil. Because of physical and chemical limitations, it would require hundreds of years to remove enough contaminants from the soils by vapor extraction or aeration to reduce the total VOCs down to 1 ppm.

Alternative 1 provides no reduction in toxicity, mobility, or volume.

AMD Soil: LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternative 7 provides the best long-term effectiveness of all the alternatives for soil cleanup because the soil contaminants are removed from the site and eventually destroyed at an offsite treatment and disposal facility. Removal will prevent the soil from acting as a further source of groundwater contamination and will prevent soil contaminants from volatilizing into the soil gas and eventually migrating into confined spaces of dwellings at the surface.

Alternative 3 is a reliable way of eliminating the soil as a source of groundwater contamination, although it would leave contaminants onsite during the aeration process. However, the time to reach the cleanup standard for offsite disposal is estimated to be hundreds of years. This is a function of the physical properties of some chemicals of concern, notably DCB and PCE, that makes their removal from soil difficult.

Alternatives 4 through 6 are all dependent upon the transfer of chemicals from soil to vapor, as is Alternative 3. Alternative 4 would not effectively remove PCE or DCE. Alternatives 5 and 6 are evolving technologies and pilot tests at the site would be needed to determine their effectiveness. They would remove volatile contaminants but might leave elevated levels of DCB in the soil.

Vapor exhaust for Alternatives 4 through 6 would be controlled by carbon adsorption which is an adequate and reliable technology.

Contaminant residues on the carbon would be destroyed during regeneration of the carbon by an incineration technology.

Alternative 2, soil flushing, would take an excessively long time to reach the proposed cleanup level of 1 ppm for total VOCs. This is exacerbated by the low solubilities of some of the chemicals of concern, particularly DCB.

Alternative 1 provides no long-term effectiveness.

AMD Soil: <u>SHORT-TERM EFFECTIVENESS</u>

Alternatives 1 and 2 do not increase the risk to the community because downgradient monitoring would alert the community to possible VOC migration to leading edge wells. The plume would continue to migrate under Alternative 1.

Alternatives 4 through 6 would cause a minor increased risk exposure to workers during the construction activities necessary to install the vapor extraction system.

Alternatives 3 and 7 involve soil excavation which would increase the chances of exposure of workers and the community to contaminated dust and volatilized contaminants in the air near the site.

Due to the difficulty in implementation of Alternative 7, AMD will be given up to two years from the adoption of the RWQCB Order (June 1991) to complete the soil remedy. This possible delay is still protective of human health and the environment on the short-term because, at this time, the majority of soil in question is protected from infiltrating surface water by concrete. This soil is also prevented from coming into direct contact with the water table by operation of the AMD 901 groundwater extraction system. This extraction system also controls the migration of contaminated water from the site. This alternative can achieve Board guidance of 1 ppm total VOCs immediately upon completion of the removal action.

AMD Soil: <u>IMPLEMENTABILITY</u>

Alternative 1 would be easiest to implement since it requires no action.

Treatment Alternatives 4 through 6 would be easiest to implement because they involve in situ technologies. Alternatives 5 and 6 might be slightly more difficult to implement than Alternative 4 because they represent evolving variations of simple vacuum extraction and pilot tests would be necessary. Permit requirements can be readily attained.

Alternatives 3 and 7 are not easily implemented because they would require that operations in the building be temporarily halted, and adequate construction controls (including dust minimization) would be needed. Due to the difficulty in implementation, AMD will be given up to two years from the adoption of the RWQCB Order (June 1991) to complete the soil remedy. Permit requirements should be readily attained.

Like Alternative 7, Alternative 3 is not easily implemented because it will require that operations in the building be temporarily halted, and adequate construction controls (including dust minimization) would be needed. It is unlikely that BAAQMD permit requirements could be met.

Alternative 2 would be very difficult to implement because reinjection of the groundwater would be required. The clay soil structure at this site would tend to channel the injected water and, thus it may not be possible to implement soil flushing effectively.

AMD Soil: <u>COST</u>

The FS provided cost figures for the soil remedies as if groundwater monitoring and groundwater extraction and treatment would continue for 18 years without any changes to the present system at AMD 901. The 18-year present worth cost of these groundwater activities is $2.6 million based on an annual O&M of $225,000. The following discussion of costs for soil remedies has subtracted out the groundwater costs since they are dealt with in the analysis of groundwater remedies for AMD 901 in Section 9.2.1.2.

Alternative 1 would leave the soil in place without any treatment or other action. It thus has no costs associated with the soil portion of the Alternative. Groundwater monitoring would continue and the associated costs are discussed with the groundwater remedies.

The least expensive soil remedies involve excavation and either offsite treatment and disposal (Alternative 7) or onsite treatment and disposal (Alternative 3). While Alternative 3 has a lower capital cost of $27,000 compared to $47,000 for Alternative 7, the $6,000 annual O&M cost makes Alternative 3 twice as expensive as Alternative 7, which has no O&M costs. The 18-year present worth costs of Alternatives 3 and 7 are $96,000 and $47,000, respectively. Alternative 7 is the most cost effective of all the treatment alternatives.

Alternatives 2 and 4 have nearly identical present worth costs at, $224,000 and $225,000, respectively. Like Alternative 3, neither of these two alternatives is effective enough to adequately address the contaminated soil. Alternative 2 has a capital cost of $86,000 and an annual O&M cost of $12,000, while Alternative 4 has a capital cost of $63,000 and an annual O&M cost of $14,000.

The most expensive alternatives involve enhancements of the pure vacuum extraction offered in Alternative 4. The hot air assist in Alternative 5 and the steam assist in Alternative 6 have present worth costs of $327,000 and $943,000, respectively.

Alternative 5 has a capital cost of $73,000 and an annual O&M cost of $22,000. The capital cost and annual O&M cost for Alternative 6 are $122,000 and $71,000, respectively. The cost estimates for these alternatives are based on 18 years of O&M, although effective cleanup of the soils by these alternatives would take much longer than 18 years.

9.2.1.2 AMD Groundwater

AMD GW: <u>PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT</u>

Alternatives 8, 9, and 10 basically provide equal protection of human health and the environment because they both extract groundwater that contains contaminants at concentrations above drinking water standards and capture the contaminants on either vapor-phase or liquid-phase carbon followed by their destruction during carbon regeneration. Extraction prevents further migration of the plume. Deed restrictions protect against use of the aquifers before cleanup is completed. After cleanup, these alternatives are estimated to result in a reduced cancer risk range, as discussed in Section 8.2.1, of 3.7×10^{-4} to 6×10^{-6} and a reduced HI of 0.44. All treated water is reused before ultimate discharge to the sanitary sewer.

Air emissions from Alternatives 8 and 10 are considered sufficiently protective since they meet BAAQMD permit requirements while the calculated worst case cancer risk is 1.6×10^{-6} and the HI is less than 1.

Alternative 1 provides little reduction of risk since natural attenuation of groundwater contaminant concentrations could require more than 100 years compared to the approximately 18 year cleanup time for Alternatives 8, 9 and 10. While future use of the contaminated groundwater may be unlikely, a future user of the contaminated groundwater would be exposed to a cancer risk of 5×10^{-1} and an HI much greater than 1. Finally, Alternative 1 is least protective of human health and the environment because it does not include deed restrictions and thus, greatly increases the chances that an individual will install a well into a migrating plume.

AMD GW: <u>COMPLIANCE WITH ARARS</u>

Alternatives 8, 9 and 10 would attain all pertinent ARARS identified in Section 7. The Safe Drinking Water Act MCLs and California Department of Health Services DWALs would be achieved by extracting groundwater contaminated above these levels. The Fish and Wildlife Coordination Act would not be an ARAR for these alternatives because the groundwater extraction system would prevent the plume from reaching surface waters or wet lands and the treatment system would ensure that discharged water was protective of human health and the environment.

The RCRA land disposal restrictions would apply to the spent carbon from Alternative 8, 9 and 10. The spent carbon would be treated before reuse or disposal by an incineration process.

Only Alternatives 8 and 10 would need to comply with OSWER Directive 9355.0-28 and BAAQMD Regulation 8, Rule 47 because of the air stripper emissions. These ARARs are addressed by the BAAQMD permitting process, and the air strippers have emissions control.

The drinking water ARARS would not be attained by Alternative 1 since contamination would be left in place. The Fish and Wildlife Coordination Act would become an ARAR if the plume migrated to Guadelupe Slough and other tributary streams and marshes. California's resolution 68-16 would not be achieved since the groundwater contaminants would unreasonably affect the present and potential uses of the upper aquifers. RCRA land disposal restrictions, BAAQMD Regulation 8, and OSWER Directive 9355.0-28 would not apply to Alternative 1 since it does not use treatment.

AMD GW: <u>REDUCTION OF TOXICITY, MOBILITY, OR VOLUME OF CONTAMINANTS THROUGH TREATMENT</u>

Alternatives 8, 9 and 10 reduce the toxicity, mobility, and volume of groundwater contaminants by removing greater than 99% of the contaminants from the extracted groundwater. They concentrate the contaminants onto granular activated carbon, which would then be regenerated or properly disposed at a landfill. Contaminants could potentially be destroyed during carbon regeneration, making any future release of the removed contaminants impossible.

Alternative 1 does not reduce toxicity, mobility, or volume since the groundwater contaminants are allowed to continue migrating.

AMD GW: <u>LONG-TERM EFFECTIVENESS AND PERMANENCE</u>

Alternatives 8, 9 and 10 include groundwater extraction which is intended to reduce the level of contamination in the A and B Aquifer Zones to the cleanup standards indicated in Section 8.2. Thus, potential risks to the community currently posed by the site in its present condition are minimized. To ensure that the magnitude of residual risks are minimized, the performance of the groundwater extraction system will be carefully monitored on a regular basis and adjusted as warranted by the performance data collected during operation.

The potential future risk from long-term exposure to volatilized contaminants that are emitted from the soil and accumulate inside residences is addressed by the groundwater extraction system in Alternatives 8, 9 and 10. Groundwater extraction reduces the amounts of contaminants that could volatilize into the soil gas and eventually into surface air. Furthermore, deed restrictions will prevent the installation of wells in the on-site portion of the plume until it is cleaned up. Finally, this newly recognized potential problem will be much better understood by the time the first five-year review occurs. Fans or other active or passive ventilation aids could be provided to any affected buildings in addition to continuation of deed restrictions.

Treatment by air stripping provided by Alternatives 8 and 10 is reliable for the long-term removal of VOCs from the groundwater. Treatment residuals are expected to be negligible based on the high volatility of the compounds present in the groundwater and their capture by the vapor-phase carbon after air stripping.

Treatment by aqueous phase granular activated carbon provided by Alternative 9 is reliable for the removal of VOCs from the groundwater. Treatment residuals are expected to be negligible since they will be concentrated on a relatively small amount of carbon that will either be properly disposed in a landfill or regenerated by a destructive technology. If vinyl chloride is produced as a degradation product from TCE or DCE, it will not be effectively trapped on the carbon employed in any of the treatment alternatives.

Alternative 1 provides no long-term effectiveness.

AMD GW: <u>SHORT-TERM EFFECTIVENESS</u>

The short-term impact to the health of workers and the community will be very minimal for Alternatives 8, 9 and 10 because the groundwater extraction system is already in place as the interim remedial action at the site. There would be no current additional risks since the plume is already contained and the treatments are protective. Groundwater cleanup time is estimated to require about 18 years.

Alternative 1 does not include the implementation of treatment remedies; therefore, there are no additional risks to the community. Risks associated with the contaminant plume would remain at the site for over 100 years until natural attenuation reduces the contaminant concentrations down to the cleanup standards.

AMD GW: <u>IMPLEMENTABILITY</u>

Alternatives 8 and 9 include the same extraction system which is already in place. Alternative 10 would augment the extraction system by the installation of additional extraction wells and emissions-control carbon canisters. These alternatives provide groundwater treatment with either an air stripper or carbon adsorption. Both methods are proven technologies and there are no technical considerations that prohibit the use of either of these technologies. In addition, these alternatives are administratively feasible using existing permits for air emissions.

Alternative 8 is the easiest to implement since it is already implemented as the interim remedy at the site. Alternatives 9 and 10 would require modifications to the present extraction and/or treatment system, but their implementation would still be relatively easy. Institutional controls required in Alternatives 8, 9, and 10 are administratively feasible.

There are no technical concerns regarding the implementability of Alternative 1.

AMD GW: COST

Based on an estimated 18 years to cleanup the A Aquifer and 9 years for the B Aquifer, costs of Alternatives 8, 9 and 10 are significantly greater than the 30 years of groundwater monitoring in Alternative 1. Alternative 8 is the most cost effective since it will meet all cleanup requirements for a present worth cost of 2.6 million dollars compared to the 2.8 million dollar present worth cost of Alternative 10 and the 4.6 million dollar present worth cost of Alternative 9. Alternative 1 has a present worth cost of 1.5 million dollars, but would be ineffective for cleanup.

Alternatives 1 and 8 have no capital costs while Alternatives 9 and 10 have capital costs of 37 and 53 thousand dollars, respectively.

The annual O&M costs for Alternatives 8 and 10 are nearly identical at 225 and 239 thousand dollars, respectively. The large amount of carbon for Alternative 9 gives it an annual O&M cost of 382 thousand dollars. Alternative 1 represents the annual cost of groundwater monitoring at 100 thousand dollars.

9.2.2 Signetics Operable Unit

Signetics: PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Alternatives 2, 3, and 4 basically provide equal protection of human health and the environment because they all extract groundwater that contains contaminants at concentrations above drinking water standards, they all extract contaminants from soil gas using vapor extraction, and they all capture the contaminants on vapor-phase carbon followed by contaminant destruction during carbon regeneration. Groundwater extraction prevents further migration of the plume. Deed restrictions protect against use of the aquifers before cleanup is completed. After cleanup, as discussed in Section 8.2.1, these alternatives are estimated to result in a reduced cancer risk range of 3.7×10^{-4} to 6×10^{-6} and a reduced HI of 0.44. All treated water is reused before ultimate discharge to the sanitary sewer or irrigated landscape.

Air emissions from Alternatives 2, 3 and 4 are considered sufficiently protective since they meet BAAQMD permit requirements while the calculated worst case cancer risk is 1.5×10^{-6} and the HI is less than 1. Air stripper emissions are greatly reduced by the vapor-phase carbon control units. Emissions from the soil vapor extraction system are captured by carbon control units. Emissions to ambient air are essentially nil and do meet BAAQMD requirements

Alternative 1 provides little reduction of risk since natural attenuation of groundwater contaminant concentrations could require more than 100 years compared to the approximately 24-36 year cleanup time for Alternatives 2, 3 and 4. While future use of the contaminated groundwater may be unlikely, a future user of the contaminated groundwater would be exposed to a cancer risk of 5×10^{-1} and an HI much greater than 1. Finally, Alternative 1 is least protective of human health and the environment because it does not include deed restrictions and thus, greatly increases the chances that an individual will install a well into a migrating plume.

Signetics: COMPLIANCE WITH ARARS

Alternatives 2, 3 and 4 would attain all pertinent ARARS identified in Section 7. The Safe Drinking Water Act MCLs and California Department of Health Services DWALs would be achieved by extracting groundwater contaminated above these levels. The Fish and Wildlife Coordination Act would not be an ARAR for these alternatives because the groundwater extraction system would prevent the plume from reaching surface waters or wet lands and the treatment system would ensure that discharged water was protective of human health and the environment.

The RCRA land disposal restrictions would apply to the spent carbon from Alternative 2, 3 and 4. The spent carbon would be treated before reuse or disposal by an incineration process.

Alternatives 2, 3 and 4 would need to comply with OSWER Directive 9355.0-28 and BAAQMD Regulation 8, Rule 47 because of the air stripper emissions. These ARARs are addressed by the BAAQMD permitting process and the air strippers have emissions control.

The drinking water ARARS would not be attained by Alternative 1 since contamination would be left in place. The Fish and Wildlife Coordination Act would become an ARAR if the plume migrated to Guadelupe Slough and other tributary streams and marshes. California's resolution 68-16 would not be achieved since the groundwater contaminants would unreasonably affect the present and potential uses of the upper aquifers. RCRA land disposal restrictions, BAAQMD Regulation 8, and OSWER Directive 9355.0-28 would not apply to Alternative 1 since it does not use treatment.

Signetics: <u>REDUCTION OF TOXICITY, MOBILITY, OR VOLUME OF CONTAMINANTS THROUGH TREATMENT</u>

Alternatives 2, 3 and 4 reduce the toxicity, mobility, and volume of groundwater contaminants by removing greater than 99% of the contaminants from the extracted groundwater. They concentrate the contaminants onto granular activated carbon, which would then be regenerated or properly disposed at a landfill. Contaminants could potentially be destroyed during carbon regeneration, making any future release of the removed contaminants impossible.

Alternative 1 does not reduce toxicity, mobility, or volume since the groundwater contaminants are allowed to continue migrating.

Signetics: <u>LONG-TERM EFFECTIVENESS AND PERMANENCE</u>

Alternatives 2, 3 and 4 include groundwater extraction which is intended to reduce the level of contamination in the A and B Aquifer Zones to the cleanup standards indicated in Section 8.2. Thus, potential risks to the community currently posed by the site in its present condition are minimized. To ensure that the magnitude of residual risks are minimized, the performance of the groundwater extraction system will be carefully monitored on a regular basis and adjusted as warranted by the performance data collected during operation.

The potential future risk from long-term exposure to volatilized contaminants that are emitted from the soil and accumulate inside residences is addressed by the groundwater extraction and soil vapor extraction systems in Alternatives 2, 3 and 4. These extractions reduce the amount of contaminants that could volatilize into the soil gas and eventually into surface air. Furthermore, deed restrictions will prevent the installation of wells in the on-site portion of the plume until it is cleaned up. Finally, this newly recognized potential problem will be much better understood by the time the first five-year review occurs. Fans, other ventilation aids, or passive ventilation aids could be provided to any affected buildings in addition to the above deed restrictions.

Treatment by air stripping provided by Alternatives 2, 3 and 4 is reliable for the long-term removal of VOCs from the groundwater.

Treatment residuals are expected to be negligible based on the high volatility of the compounds present in the groundwater and their capture by the vapor-phase carbon after air stripping. If vinyl chloride is produced as a degradation product from TCE or DCE, it will not be effectively trapped on the carbon employed in any of the treatment alternatives.

Alternative 1 provides no long-term effectiveness.

Signetics: <u>SHORT-TERM EFFECTIVENESS</u>

The short-term impact to the health of workers and the community will be very minimal for Alternative 2 because the groundwater extraction and soil vapor extraction systems are already in place as the interim remedial action at the site. Alternatives 3 and 4 would involve the installation of some additional wells at only a very minor risk from drilling activities to the drillers. For all of these alternatives there would be no current additional risks since the plume is already contained and the treatments are protective. Groundwater cleanup time is estimated to require about 24-36 years.

Alternative 1 does not include the implementation of treatment remedies; therefore, there are no additional risks to the community. Risks associated with the contaminant plume would remain at the site for over 100 years until natural attenuation reduces the contaminant concentrations down to the cleanup standards.

Signetics: <u>IMPLEMENTABILITY</u>

Alternative 2 includes the same extraction system which is already in place. Alternatives 3 and 4 would augment the extraction system by the installation of additional extraction wells and emissions-control carbon canisters. These alternatives provide groundwater treatment with an air stripper followed by vapor-phase carbon adsorption. Both methods are proven technologies and there are no technical considerations that prohibit the use of either of these technologies. In addition, these alternatives are administratively feasible using existing permits for air emissions.

Alternative 2 is the easiest to implement since it is already implemented as the interim remedy at the site. Alternatives 3 and 4 would require modifications to the present extraction system, but their implementation would still be relatively easy. Institutional controls required in Alternatives 2, 3, and 4 are administratively feasible.

There are no technical concerns regarding the implementability of Alternative 1.

Signetics: <u>COST</u>

Based on an estimated 13 years to cleanup the A Aquifer and 36 years for the B Aquifer using Alternative 2 and based on an estimated 8 years to cleanup the A Aquifer and 24 years for the B Aquifer using Alternatives 3 or 4, total costs for treatment alternatives are significantly greater than the 30 years of cost for groundwater monitoring in Alternative 1. Alternative 4 is the most cost effective since it will most rapidly meet all cleanup requirements for a present worth cost of 4.1 million dollars compared to the 3.9 million dollar present worth costs of Alternatives 2 and 3. Essentially, the additional 0.2 million dollar cost of Alternative 4 supports the accelerated remediation of hot spots. Alternative 1 has a present worth cost of 1.5 million dollars, but would be ineffective for cleanup.

Alternatives 1 and 2 have no capital costs while Alternatives 3 and 4 have capital costs of 252 and 351 thousand dollars, respectively.

The annual O&M costs for Alternatives 2, 3, and 4 are nearly identical at 236, 236 and 246 thousand dollars, respectively. Alternative 1 represents the annual cost of groundwater monitoring at 95 thousand dollars.

9.2.3 TRW Operable Unit

TRW: <u>PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT</u>

Alternatives 2, 3 and 4 are protective of human health and the environment to roughly the same degree because they extract groundwater that contains contaminants at concentrations above drinking water standards. Extraction prevents further migration of the plume. Deed restrictions protect against use of the aquifers before cleanup is completed. After cleanup, as discussed in Section 8.2.1, all three alternatives are estimated to result in a reduced cancer risk range of 3.7×10^{-4} to 6×10^{-6} and a reduced HI range of 0.44 to 0.1 related to domestic use of groundwater. Any un-recycled treated effluent would meet NPDES discharge requirements which are protective of human health and the environment.

Alternatives 3 and 4, which take a more active role in addressing the contaminated soil in the saturated A Zone, would not provide significantly greater protection of human health and the environment since the location of the contaminated soil is downgradient from contaminated groundwater at the AMD 901/902 property and would likely be recontaminated until the upgradient contamination is cleaned up.

Alternatives 2,3 and 4 all would use air-stripping to treat the extracted groundwater. The use of an air-stripper is considered to be sufficiently protective since it does satisfy BAAQMD requirements which is the appropriate ARAR and would result in an estimated increased cancer risk of about 1.79 X 10^{-5}.

Alternative 1 provides no reduction in risk because it allows the contaminated groundwater to continue migrating. Natural attenuation of the groundwater contaminant concentrations could require more than 100 years compared to the approximately 7 year cleanup time for the other alternatives. While future use of the contaminated groundwater may be unlikely, a future user of the contaminated groundwater would be exposed to a maximum cancer risk of 5 X 10^{-1} and an HI much greater than 1. Alternative 1 is thus the least protective of human health and the environment.

TRW: COMPLIANCE WITH ARARS

Alternatives 2, 3 and 4 would attain all pertinent ARARS identified in Section 7. The Safe Drinking Water Act MCLs and the California Department of Health Services DWALs would be achieved in approximately 7 years by extracting groundwater contaminated above these levels. NPDES permit requirements would be met by proper design and operation of the treatment system. Closure requirements would be met by achieving MCLs in the groundwater. The Fish and Wildlife Coordination Act would not be an ARAR for these three alternatives because the groundwater extraction system would prevent the plume from reaching surface waters or wet lands and the treatment system would ensure that any discharged water was protective of human health and the environment.

The RCRA land disposal restrictions would apply to the spent carbon from Alternatives 2, 3 and 4 in the event that it became necessary to implement air stripper emissions control involving gas-phase activated carbon. The spent carbon could be treated before reuse or disposal by an incineration process.

Alternatives 2, 3 and 4 would need to comply with OSWER Directive 9355.0-28 and BAAQMD Regulation 8 Rule 47 because of the air stripper emissions. These ARARS are addressed by the BAAQMD permitting process. If permit modifications become necessary, emissions could be captured and destroyed by available technology. Alternative 4 might also be required to comply with mass emission standards in BAAQMD Rule 40, Regulation 8.

Alternative 1 would not comply with drinking water ARARS for at least 100 years since contamination would be free to migrate. The Fish and Wildlife Coordination Act would become an ARAR if the plume migrated to a surface water or other tributary streams and marshes. California's resolution 68-16 would not be achieved since the groundwater contaminants would unreasonably affect the present and potential uses of the upper aquifers. RCRA land disposal restrictions, NPDES requirements, BAAQMD Regulation 8, and OSWER Directive 9355.0-28 would not apply to Alternative 1 since it does not use treatment.

TRW: REDUCTION OF TOXICITY, MOBILITY, OR VOLUME OF CONTAMINANTS THROUGH TREATMENT

Alternatives 2, 3 and 4 reduce the toxicity, mobility, and volume (TMV) of groundwater contaminants by removing greater than 99% of the contaminants from the extracted groundwater. However, these alternatives transfer the groundwater contaminants to the air where their toxicity, mobility and volume as air contaminants actually increases. In addition, some of the VOCs are ozone precursors. The current air stripper is operating under a BAAQMD permit that does not require emissions control.

Alternative 3 may provide slightly less reduction in VOC mobility because possible loss of complete hydraulic control as a result of soil flushing may increase the mobility of the VOCs. Alternative 4 may provide slightly greater reduction in TMV if the small volume of extracted soil is treated with a destructive technology prior to disposal. Alternative 1 provides no reduction in TMV.

TRW: LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternatives 2, 3 and 4 include groundwater extraction which is intended to reduce the level of contamination in the A and B Aquifer Zones to the cleanup standards indicated in Section 8.2. Thus, potential risks to the community currently posed by the site in its present condition are minimized. To ensure that the magnitude of residual risks are minimized, the performance of the groundwater extraction system will be carefully monitored on a regular basis and adjusted as warranted by the performance data collected during operation. Although soil flushing in Alternative 3 is a proven technology, effectiveness at this site is uncertain.

The potential future risk from long-term exposure to volatilized contaminants that are emitted from the soil and accumulate inside residences is addressed by the groundwater extraction system in Alternatives 2, 3 and 4. Groundwater extraction that proceeds as rapidly as possible addresses this potential volatilization problem by reducing the concentrations of contaminants in the groundwater, which, in turn, reduces the potential for significant levels of VOCs to reach buildings at the surface. Actual field measurements of the vapor flux at the soil surface have not indicated a significant problem. Field measurements will continue and a reassessment of the problem will be initiated at the 5 year review period, unless the need for earlier reassessment is indicated by future field measurements. Fans or other ventilation aids could be provided to any affected buildings. Furthermore, deed restrictions will prevent the installation of wells in the onsite portion of the plume until it is cleaned up.

Treatment by air stripping provided by Alternatives 2, 3, and 4 is reliable for the long-term removal of VOCs from the groundwater. Treatment residuals are expected to be negligible based on the high volatility of the compounds present in the groundwater.

Alternative 1 would provide long-term effectiveness after more than 100 years that would be necessary for natural attenuation. Offsite monitoring may not be reliable for detecting further downgradient migration. Alternative 1 provides very little long-term effectiveness in comparison to the other three alternatives.

TRW: SHORT-TERM EFFECTIVENESS

The short-term impact to the health of workers and the community will be very minimal for the groundwater portion of Alternatives 2, 3 and 4 because the extraction and treatment system is already in place as the interim remedial action at the site. There would be no current additional risks since the plume is already contained and the treatments are protective. Groundwater cleanup is estimated to require about 7 years.

Alternative 4 is slightly less effective on the short-term than Alternatives 2 and 3 because of the increased dust containing VOCs and VOC emissions during excavation of the small volume of contaminated soil in the saturated zone.

Alternative 1 doesn't include the implementation of a treatment remedy; therefore, there are no additional risks to the community. Risks associated with the contaminant plume would remain at the site for over 100 years until natural attenuation reduces the contaminant concentrations down to the cleanup standards.

TRW: IMPLEMENTABILITY

Alternatives 2, 3 and 4 are easily implemented for the groundwater extraction and treatment system since it is already implemented with the required permits in place. Additional permits would be required for soil flushing in Alternative 3, but should be readily obtainable. Institutional controls required in Alternatives 2, 3 and 4 are administratively feasible.

Excavation is a proven technology, however excavation near a building poses severe logistical problems for FEI Microwave, the current occupants of the TRW onsite area. This significantly lowers the implementability of the soil portion of Alternative 4.

In Alternatives 2 and 3, the soil is addressed by the groundwater extraction and treatment system. There are no technical concerns regarding the implementability of Alternative 1.

TRW: COST

Alternatives 2 and 3 have nearly identical costs. Alternative 2 is slightly less expensive with a present worth cost of $750,379 compared to $827,379 for Alternative 3. Due to the difficulty of the soil excavation near a building, Alternative 4 is dramatically more expensive with a present worth cost of 1.6 million dollars. Alternative 1 is the second most expensive alternative because groundwater monitoring would be needed well beyond the 7 year cleanup time estimated for the other alternatives. For a 30 year monitoring period, the present worth cost would be $984,893.

9.2.4 Offsite Operable Unit

Offsite: PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Alternatives 2 and 3 basically provide equal protection of human health and the environment because they both extract groundwater that contains contaminants at concentrations above drinking water standards. Extraction prevents further migration of the plume and continually reduces the contaminant concentrations, thus continually decreasing the potential for volatilized VOCs to reach significant concentrations inside surface dwellings. After cleanup, as discussed in Section 8.2.1, both Alternatives 2 and 3 are estimated to result in a reduced cancer risk range of 3.7×10^{-4} to 3×10^{-6} and a reduced HI range of 0.44 to 0.2. Water discharged or reused following treatment would meet NPDES requirements which are protective of human health and the environment.

Alternative 3 could be considered slightly more protective than Alternative 2 since it would not involve the transfer of groundwater contaminants to the air and would involve the destruction of the contaminants by regeneration of the granular activated carbon. Air emissions from Alternative 2 are considered sufficiently protective, however, since they meet BAAQMD permit requirements, while the calculated worst case cancer risk less than 1×10^{-5} and the HI is less than 1.

Alternative 1 provides far less reduction in risk because it would allow the contaminated groundwater to continue migrating and natural attenuation of groundwater contaminant concentrations could require more than 100 years compared to the approximately 36 year cleanup time for Alternatives 2 and 3. While future use of the contaminated groundwater may be unlikely, a future user of the contaminated groundwater would be exposed to a cancer risk of

5 X 10^{-1} and an HI much greater than 1. Alternative 1 is least protective of human health and the environment, because it does not include deed restrictions, and thus greatly increases the chances that an individual will install a well into a migrating plume.

Offsite: <u>COMPLIANCE WITH ARARS</u>

Both Alternatives 2 and 3 would attain all pertinent ARARS identified in Section 7. The Safe Drinking Water Act MCLs and California Department of Health Services DWALs would be achieved by extracting groundwater contaminated above these levels. NPDES permit requirements would be met by proper design and operation of either treatment system. The Fish and Wildlife Coordination Act would not be an ARAR for Alternatives 2 and 3 because the groundwater extraction system would prevent the plume from reaching surface waters or wet lands and the treatment system would ensure that discharged water was protective of human health and the environment.

The RCRA land disposal restrictions would apply to the spent carbon from Alternative 3 and would also apply to Alternative 2 in the event that it became necessary to implement air stripper emissions control involving gas-phase activated carbon. The spent carbon could be treated before reuse or disposal by an incineration process.

Only Alternative 2 would need to comply with OSWER Directive 9355.0-28 and BAAQMD Regulation 8, Rule 47 because of the air stripper emissions. These ARARs are addressed by the BAAQMD permitting process. If permit modifications become necessary, emissions could be captured and destroyed by available technology.

The drinking water ARARS would not be attained by Alternative 1 since contamination would be left in place for at least 100 years. The Fish and Wildlife Coordination Act would become an ARAR if the plume migrated to Guadelupe Slough and other tributary streams and marshes. California's resolution 68-16 would not be achieved since the groundwater contaminants would unreasonably affect the present and potential uses of the upper aquifers. RCRA land disposal restrictions, NPDES requirements, BAAQMD Regulation 8, and OSWER Directive 9355.0-28 would not apply to Alternative 1 since it does not use treatment.

Offsite: <u>REDUCTION OF TOXICITY, MOBILITY, OR VOLUME OF CONTAMINANTS THROUGH TREATMENT</u>

Both Alternatives 2 and 3 reduce the toxicity, mobility, and volume of groundwater contaminants by removing greater than 99% of the contaminants from the extracted groundwater. Alternative 3 concentrates the contaminants onto granular activated carbon, which would then be regenerated or properly disposed at a landfill. Contaminants could potentially be destroyed during carbon regeneration, making any future release of the removed contaminants impossible.

Alternative 2 transfers the groundwater contaminants to the air where their toxicity, mobility, and volume as air contaminants actually increases. In addition, some of the VOCs are ozone precursors. The current air stripper is operating under a BAAQMD permit that does not require emissions control. A very tiny fraction of the groundwater contaminants will be captured on the carbon polisher and would be destroyed during regeneration or treated before disposal at a proper landfill.

Alternative 1 does not reduce toxicity, mobility, or volume of the groundwater contaminants because they are allowed to continue migrating.

Offsite: <u>LONG-TERM EFFECTIVENESS AND PERMANENCE</u>

Alternatives 2 and 3 include groundwater extraction which is intended to reduce the level of contamination in the A and B Aquifer Zones to the cleanup standards indicated in Section 8.2. Thus, potential risks to the community currently posed by the site in its present condition are minimized. To ensure that the magnitude of residual risks are minimized, the performance of the groundwater extraction system will be carefully monitored on a regular basis and adjusted as warranted by the performance data collected during operation.

The potential future risk from long-term exposure to volatilized contaminants that are emitted from the soil and accumulate inside residences is addressed by the groundwater extraction system in Alternatives 2 and 3. Groundwater extraction reduces the amounts of contaminants that could volatilize into the soil gas and eventually into surface air. The RWQCB has required the PRPs to continue measuring soil vapor emissions from selected points along a plume cross-section on a semi-annual basis for at least two years. This newly recognized potential problem will be much better understood by the time the first five-year review occurs. If necessary, more refined air sampling could be conducted at that time. Fans or other ventilation aids could be provided to any affected buildings.

Treatment by air stripping provided in Alternative 2 is reliable for the long-term removal of VOCs from the groundwater. Treatment residuals are expected to be negligible based on the high volatility of the compounds present in the groundwater.

Treatment by aqueous phase granular activated carbon provided in Alternative 3 is reliable for the removal of VOCs from the groundwater. Treatment residuals are expected to be negligible since they will be concentrated on a relatively small amount of carbon that will either be properly disposed in a landfill or regenerated by a destructive technology.

Alternative 1 provides no long-term effectiveness.

Offsite: <u>SHORT-TERM EFFECTIVENESS</u>

The short-term impact to the health of workers and the community will be very minimal for Alternatives 2 and 3 because the groundwater extraction system is already in place as the interim remedial action at the site. There would be no current additional risks since the plume is already contained and the treatments are protective. Groundwater cleanup time is estimated to require about 36 years. Uncontrolled air emissions from Alternative 2 make it slightly less effective in protecting health and the environment than Alternative 3 in the short-term.

Alternative 1 does not include the implementation of treatment remedies; therefore, there are no additional risks to the community. Risks associated with the contaminant plume would remain at the site for over 100 years until natural attenuation reduces the contaminant concentrations down to the cleanup standards.

Offsite: <u>IMPLEMENTABILITY</u>

Alternatives 2 and 3 include the same extraction system which is already in place. Both alternatives provide groundwater treatment with either an air stripper or carbon adsorption. Both methods are proven technologies and there are no technical considerations that prohibit the use of either of these technologies. In addition, both alternatives are administratively feasible using existing permits for discharge or air emissions.

Institutional controls required in Alternatives 2 and 3, are administratively feasible. There are no technical concerns regarding the implementability of Alternative 1.

Offsite: <u>COST</u>

Based on an estimated 21 years to cleanup the A Aquifer and 36 years for the B Aquifer, costs of Alternatives 2 and 3 are significantly greater than the 30 years of groundwater monitoring in Alternative 1. Alternative 2 is the most cost effective since it will meet all cleanup requirements for a present worth cost of 4.4 million dollars compared to the 10 million dollar present worth cost of Alternative 3. Alternative 1 has a present worth cost of 1.9 million dollars, but would be ineffective for cleanup.

The annual O&M costs for Alternatives 1, 2, and 3 are 124, 255, and 637 thousand dollars, respectively. The capital cost of Alternatives 1, 2, and 3 are 56, 208, and 411 thousand dollars, respectively.

9.3 THE SELECTED REMEDY

9.3.1 Basis of Selection

The selected remedies addressing contaminated groundwater all basically entail the continuation of the current IRM, groundwater extraction followed by air stripping. In some cases, minor modifications will be made in the form of additional extraction wells and increased water reuse. These remedies met all of the nine criteria and adequately addressed the remedial action objectives. Implementability and cost effectiveness distinguished these alternatives from other alternatives that also met the nine criteria and remedial action objectives. The selected remedies are relatively easy to implement and, in most cases, easier to implement than competing alternatives. Except for the Signetics remedy, the selected remedies were the least expensive of the competing alternatives and always the most cost effective. The Signetics remedy costs 0.2 million dollars more than its two competing alternatives, but is more cost effective because the accelerated hot spot remediation increases the overall effectiveness of the groundwater cleanup.

Remedies and alternatives with either liquid-phase or vapor-phase carbon treatment are advantageous because they involve the destruction of the adsorbed VOCs during carbon regeneration, thus providing the maximum reduction in toxicity, mobility, and volume. Liquid-phase carbon treatment was evaluated as an alternative for the AMD onsite unit, but it was not selected because the existing air stripper remedy contains equally effective vapor-phase carbon emission control at half the present worth cost. Only the TRW onsite and the offsite commingled plume air strippers do not contain GAC air emission control.

Despite the slight advantages in contaminant destruction offered by the carbon treatment alternative for the offsite commingled plume, the existing air stripper without emissions controls was selected because of several advantages. These advantages include the fact that the air stripper costs less than carbon adsorption and is already installed and operating in accordance with current permits. In addition, residuals from the air stripper could potentially be captured and destroyed by available emissions control technology if permit modifications become necessary. This last point is also true of the TRW air stripper remedy, which was selected without comparison to a liquid-phase carbon treatment alternative.

The relatively small volume of contaminated soil in the saturated zone at TRW is best addressed by the present groundwater extraction and treatment system. The two alternatives that were not selected as the remedy are either dramatically more expensive and difficult to implement or not significantly more effective.

For AMD soils, the selected remedy is excavation followed by offsite treatment (incineration) and disposal. While some of the in situ alternatives are easier to implement, the selected remedy is the only alternative that will meet ARARs in a reasonable amount of time. It is also the most cost effective alternative and involves destruction of the contaminants, thus providing the greatest reduction in toxicity, mobility, and volume.

9.3.2 Features of the Remedies

The groundwater remedies selected for each of the AMD/Signetics/TRW sites involve institutional controls, continued groundwater monitoring, and continued groundwater extraction and treatment with the air strippers that are currently in place. Existing NPDES permitted discharge of treated water to Calabazas Creek and existing BAAQMD permitted air emissions will continue. Basically, these remedies are already implemented and operating with acceptance form the community and federal, state, and local agencies. In some cases, minor modifications will be made in the form of additional extraction wells and increased water reuse. The total combined cost for the remedies has a present worth of 12 million dollars. The features of these remedies are described below along with specific soil remedies for some of the sites.

1. Institutional Controls

   Deed and well-permit restrictions will protect humans from exposure to contaminated groundwater below the AMD, Signetics, and TRW properties during the cleanup period.

2. Groundwater Monitoring

   Continued groundwater monitoring and soil flux monitoring will verify plume containment, determine current plume boundaries, follow the decrease in VOC concentrations as the cleanup progresses, and verify compliance with RWQCB orders.

3. Groundwater Extraction

   Continued groundwater extraction from a total of 19 A Aquifer wells, 2 extraction trenches and multiple building dewatering sumps which extract from the A zone and 23 B Aquifer wells distribute a total flow of approximately 225 gpm among four different treatment system locations. Existing and new well locations and pumping rates contain the plume and will prevent further migration of the VOC-contaminated groundwater. The cancer risk of 5×10^{-1} for a future use of drinking water contaminated with vinyl chloride, TCE and DCE will be continually reduced over an estimated 36-year cleanup period to a maximum risk of 3.7×10^{-4}. Thus, groundwater extraction until drinking water standards are achieved will attain ARARs and permanently restore the contaminated aquifers to their maximum beneficial uses.

Enhanced groundwater extraction at the Signetics property will focus on two areas: improved control of contaminant migration laterally in the A zone and, improved control of vertical migration of contaminants from the B1 and B2 zones to B3 and B4 zones. The enhancement may include modification of existing equipment, installation of new wells or trenches and increased rates of groundwater withdrawal from the deeper aquifers.

Modification of the Alvarado and Duane Avenue offsite extraction systems and continued groundwater extraction from these modified systems would focus on improving control of the A zone plume under the current drought conditions.

4. Air Stripping

Existing air strippers will remove more than 99% of the VOCs from the extracted groundwater. In addition, air stripper effluents from the Signetics property and the offsite commingled plume are polished with liquid-phase carbon. These treatments allow the effluent to be either reused or discharged under existing NPDES permits to Calabazas Creek without degrading this surface water or presenting a significant risk to human health and the environment.

The AMD and Signetics property air strippers contain vapor-phase carbon to control air emissions, while the TRW and offsite strippers do not currently contain emissions control. Emissions from the air strippers are considered safe by the BAAQMD under existing permits. The TRW and offsite strippers will include air emissions control if emissions exceed levels permitted by the BAAQMD.

The spent carbon from the liquid and vapor phase control units is transferred to a licensed facility where it is regenerated by the use of a rotary kiln. Thus, a significant amount of the VOCs are ultimately destroyed, further reducing the toxicity, mobility, and volume of the original contamination.

5. Water Reuse

Currently, more than 50% of the treated effluents are reused as process makeup water, cooling tower water, irrigation, or other uses. This percentage will increase dramatically as reuse of effluent from the offsite air stripper located at AMD

915 increases from 35% to 65% by the end of 1991. The required goal is 100% reuse of the 150 to 200 gpm treated effluent at AMD/Signetics/TRW as soon as possible.

6. Soil Remediation

The 37 cubic yards of contaminated soil at the AMD property will be excavated and transported offsite for treatment and disposal. The treatment will likely involve an incineration technology resulting in destruction of the VOC contaminants. This remedy prevents human exposure to the contaminants and prevents recontamination of the groundwater.

The existing soil vapor extraction system at the Signetics property will be enhanced by increasing the number of vapor extraction wells and the volume of vapor-phase carbon units for emissions control.

There is no current exposure pathway for the small volume of contaminated soils at the TRW site. These soils will be decontaminated by natural soil flushing. The resulting contaminated groundwater will be captured and treated by the current groundwater extraction and treatment system.

9.3.3 Uncertainty in the Remedy

The groundwater remediation remedy for each of the AMD/Signetics/TRW sites involves groundwater extraction followed by treatment with air strippers. The goal of this remedial action is to restore the ground water to its beneficial use, which is, at these sites, a potential source of drinking water. Based on information obtained during the RI and on a careful analysis of all remedial alternatives, EPA and the RWQCB believe that the selected remedy will achieve this goal. It may become apparent, during implementation or operation of the groundwater extraction system and its modifications, that contaminant levels have ceased to decline and are remaining constant at levels higher than the cleanup standards over some portion of the plume. In such a case, the system performance standards and/or the remedy may be reevaluated by EPA.

The selected remedy will include groundwater extraction for an estimated period of 12 to 38 years, during which the system's performance will be carefully monitored on a regular basis and adjusted as warranted by the performance data collected during operation. Modifications may include any or all of the following:

a) at individual wells where cleanup goals have been attained, pumping may be discontinued;

b) alternating pumping at wells to eliminate stagnation points;

c) pulse pumping to allow aquifer equilibration and to allow adsorbed contaminants to partition into ground water; and

d) installation of additional extraction wells to facilitate or accelerate cleanup of the contaminant plume.

To ensure that cleanup goals continue to be maintained, the aquifer will be monitored at those wells where pumping has ceased on an occurrence of every 5 years following discontinuation of groundwater extraction.

10.0 STATUTORY DETERMINATIONS

The selected remedies will comply with Section 121 of CERCLA. The selected remedies protect human health and the environment through extraction and treatment of the VOC-contaminated ground water and the removal of contaminated soils. The reductions in risk are summarized in Section 9.3.2 of this ROD. There are no short-term or long-term threats associated with the selected remedies that cannot be readily controlled. In addition, no adverse cross-media affects are expected from the remedies.

The selected remedies will comply with all of the identified chemical, action, and location specific ARARs that are described in Section 7 of this ROD. In the event that it becomes apparent that the drinking water ARARs may not be achievable as described in Section 9.3.3 of this ROD, the system performance standards and/or the particular groundwater remedy may be reevaluated.

The present worth cost of the selected remedies total $11.9 million dollars for the AMD/Signetics/TRW sites. This total is the sum of $2.65 million for AMD onsite, $4.11 million for Signetics onsite, $0.75 million for TRW onsite, and $4.39 million for the offsite commingled plume. These remedies are the least costly of the alternatives which are equally protective of human health and the environment. The selected remedies are already installed for the most part and are operating in accordance with current permits for water discharge and air emissions.

The selected remedies use permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable and satisfy the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element. In addition, the remaining toxicity, mobility, and volume of contaminants emitted from the TRW onsite and the offsite commingled plume air strippers could be potentially captured and destroyed by available emissions control technology if permit modifications become necessary. Section 9.3.2 of this ROD summarizes the key features of the selected remedies.

Because the remedies will result in hazardous substances remaining onsite above health-based levels, a five-year review, pursuant to CERCLA Section 121, 42 U.S.C. Section 9621, will be conducted at least once every five years after initiation of the remedial actions to ensure that the remedies continue to provide adequate protection of human health and the environment.

11.0 DOCUMENTATION OF SIGNIFICANT CHANGES

There were no significant changes between the proposed plan and this Record of Decision.

PART III. RESPONSIVENESS SUMMARY

1.0 INTRODUCTION

This responsiveness summary reviews comments and questions regarding the Remedial Investigation/Feasibility Study (RI/FS) and Proposed Final Cleanup Plan (proposed plan) for Advanced Micro Devices facilities at 901/902 Thompson Place (AMD 901/902) and 915 DeGuigne Drive (AMD 915), the former TRW Microwave at 825 Stewart Drive (TRW) the Signetics facility at 811 E. Arques, all in Sunnyvale. A single responsiveness summary was prepared for this group of Superfund sites because actions at all sites potentially impact the same local community. The study area that encompasses AMD 901/902, Signetics, and TRW has been divided into four area-specific operable units. Separate proposed plans have been developed for each of these four operable units and for AMD 915.

This summary includes comments received during the 60 day period from the opening of public comment at the Board meeting of March 20, 1991 through the close of public comment on May 20, 1991. All comment during this period was received by the RWQCB. Additional opportunity for comment was given to the public at the RWQCB meeting on June 19, 1991. This Record of Decision does not include any significant changes to the proposed plan presented at the community meeting of March 27, 1991 and does not differ significantly from the plan adopted by the RWQCB

2.0 REGIONAL WATER QUALITY CONTROL BOARD RESPONSES

Since RWQCB is the lead agency for AMD 901/902, Signetics, and TRW Microwave and received all comments, RWQCB prepared the Responsiveness Summary (Attachment A). EPA, as the support agency, has reviewed and concurs with the RWQCB responses.

Written comments were received from Santa Clara Valley Water District (SCVWD); Supervisor Ron Gonzales, Santa Clara County Board of Supervisors; Santa Clara County Office of Education; Silicon Valley Toxics Coalition (SVTC); San Miguel Homeowners Association; California Department of Health Services, Environmental Epidemiology and Toxicology Branch (EETB); and two community members, Gary Holton and John Schwartz. Specific comments received at the community meeting held at the Westinghouse Auditorium in Sunnyvale, March 28, 1991, general comments from an informal meeting held May 7, 1991 at the San Miguel School site in Sunnyvale and verbal comments received by telephone during the comment period and two meetings with the San Miguel Homeowners Association, May 23 and May 30, 1991, will also be outlined and addressed separately. The comments by SCVWD and Gary Holton were supportive of the proposed plan, as outlined above, and as such will not require a specific response.

The attached Responsiveness Summary is divided into two parts; Part I provides a summary of the major issues raised by commentors and focuses on the concerns of the local community; Part II is a more technical response to all significant comments.