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RISK BASED CORRECTIVE ACTIONS ANALYSIS
Montgomery Ward Auto Service Center
and
Enea Properties Sites
Dublin, California

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Project No. 1233

ENVIRONMENTAL AUDIT, INC.®

Planning, Environmental Analyses and Hazardous Substances Management and Remediation

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RISK BASED CORRECTIVE ACTIONS ANALYSIS
MONTGOMERY WARD AUTO SERVICE CENTER
AND
ENEA PROPERTIES SITES
DUBLIN, CALIFORNIA

1.0 INTRODUCTION

This risk based corrective actions analysis has been prepared to address the off-site dissolved phase ground water contamination associated with the Montgomery Ward Auto Service Center, 7575 Dublin Boulevard, Dublin, California (Montgomery Ward Site) (see Figures 1 and 2). The purpose of this analysis is to: 1) determine whether or not the existing levels of dissolved phase petroleum hydrocarbons in the shallow ground water down-gradient and off-site from the Montgomery Ward facility represent a risk to human health or the environment; 2) calculate a risk based clean-up level for the dissolved phase petroleum hydrocarbons in the ground water off-site and down-gradient of the Montgomery Ward Site; and 3) propose additional actions, if necessary, based on the risk based corrective actions analysis.

1.1 MONTGOMERY WARD SITE

In or about November 1988, it was determined that one of the three 10,000-gallon capacity underground storage tanks (USTs) located at the Montgomery Ward Site did not have integrity (see Figure 2). These USTs were located in a common excavation and stored unleaded, premium and regular gasoline. Montgomery Ward ceased using the USTs in November 1988 and retained A.D. Selditch & Associates, Inc. (ADS) to assist them in assessing the extent of petroleum hydrocarbons in the soil and ground water.

1.1.1 Initial Site Assessment

Between December 1, 1988 and February 8, 1989, ADS drilled and sampled eight borings on the Montgomery Ward Site, i.e., borings 5, 6, 7, 8, 9, 10, 12 and 13. These borings were converted into ground water monitoring wells B-5, B-6, B-7, B-8, B-9, B-10, B-12 and B-13, respectively. These borings/wells were installed prior to the removal of the USTs; however, there is no drawing in the ADS report which shows the location of all these wells. Figure 2 shows the location of the wells presently situated on the Montgomery Ward Site.

Selected soil samples from each boring were analytically tested for total petroleum hydrocarbons (TPH) using EPA Method 8015, and benzene, toluene, ethylbenzene, and xylenes (BTEX) using EPA Method 8020. TPH concentrations ranging from below laboratory detection limits to 2,180 milligrams per kilogram (mg/kg) were detected in the soil samples. Benzene was detected in the soil samples and ranged in concentration from 0.18 to 55 mg/kg. Toluene, xylenes and ethylbenzene also were detected. Water samples collected from the wells contained dissolved concentrations of TPH and BTEX. Lead was detected at 2.6 milligrams per liter (mg/l) in the sample collected from well B-13, and well B-12 reportedly contained free-product (see ADS, 1989).

1.1.2 Removal of the USTs

On or about May 18, 1989, the three gasoline USTs and two associated fueling islands were removed from the Montgomery Ward Site. Soils containing petroleum hydrocarbons reportedly were present throughout most of the excavation. The soil excavated in association with removal of the USTs was disposed of off-site and the excavation backfilled with gravel. Wells B-6, B-7, B-8, B-9 and B-13 were destroyed during removal of the USTs (see ADS, 1989). no overexcavation performed

1.1.3 Additional Site Assessment

In August 1989, ADS supervised the installation of two additional ground water monitoring wells (B-15 and B-16) at the Montgomery Ward Site (see Figure 2). A composite soil sample from each boring (i.e., the soil samples collected from each boring at 5, 10, 15 and 20 feet were composited) was tested for TPH and BTEX. TPH concentrations ranged from 6.3 to 10.2 mg/kg and the BTEX concentrations ranged from 0.26 to 6.5 mg/kg. TPH and BTEX also were detected in ground water samples collected from wells B-15 and B-16 (see ADS, 1989).

1.1.4 Ground Water Extraction/Treatment System

In or about the early part of 1990, an ADS designed extraction system began to control the migration of petroleum hydrocarbons in the ground water using a 15-inch diameter ground water extraction well (well B-12) (see Figure 2). The extracted ground water was filtered to remove suspended particles, treated using two 2,500-pound activated carbon canisters connected in series, and discharged to the sanitary sewer system pursuant to a permit issued by the Dublin-San Ramon Services District (see ADS, 1989).

Changes to the ground water extraction and treatment system were made in February 1992. These changes consisted of installing an eight gallon per minute (gpm) rated oil/water separator, product and surge tanks, transfer pump, and filter system.

1.1.5 Ground Water Pumping Tests

Environmental Audit, Inc. (EAI) was retained by Montgomery Ward in 1991 to conduct ground water pumping tests on wells located on the Montgomery Ward Site to determine whether the existing extraction rate was sufficient to capture contaminated ground water located beneath the site. The results of the pumping tests revealed that extraction at a rate of eight gpm from extraction well B-12 should be sufficient to contain ground water beneath the Montgomery Ward Site (see EAI, 1991). However, the hydraulic response of the shallow ground water encountered in the wells on the Montgomery Ward Site was more indicative of a silty sand and sand type lithology rather than the silty clays and clays which were actually encountered during investigation activities.

1.1.6 Quarterly Ground Water Monitoring

Quarterly ground water monitoring activities were initiated by EAI at the Montgomery Ward Site in April 1992. Quarterly ground water monitoring consists of the gauging and sampling of the wells associated with the Montgomery Ward Site, and the analytical testing of the obtained samples (see Table 1).

1.1.7 Supplemental Off-Site Assessment

In May 1993, EAI installed three off-site ground water monitoring wells (MW-100, MW-101 and MW-102) and advanced and sampled eight hydropunches (HP-1 through HP-8) (see Figure 2) (see EAI, 1993). Soil and ground water samples were tested for total petroleum hydrocarbons as gasoline (TPH-G) and BTEX. Table 1 shows the results for ground water samples, and Table 2 the results for soil samples. HP-3 and HP-4 were "hot"

1.1.8 Cone Penetrometer Testing

Cone penetrometer testing (CPT) was conducted on the Montgomery Ward and adjacent Enea Properties sites in July 1994 (see EAI, 1994). Eight CPT soundings which included pore pressure measurements (CPTu), pore pressure dissipation tests (PPDTs), and soil vapor and soil sampling were conducted (see Figure 2). CPTu testing showed that the predominant lithologies present to the depth explored (maximum 52 feet below ground surface [bgs]) were clayey silt, silty clays, and clays. These soils were soft and unconsolidated. PPDTs showed that at location CPT-1 a vertical downward hydraulic gradient exists (-1.2 feet/feet [ft/ft]) and at depths of between approximately 36 and 39 feet bgs, a vertical upward gradient of about 1.45 ft/ft and 2.21 ft/ft exists, respectively.

Vapor and soil sampling also were conducted as part of this CPT investigation. The vapor sampling was inconclusive at depths of nine and eleven feet bgs. Analytical testing of soil samples obtained at approximately 13 and 15 feet bgs showed that TPH-G and BTEX were detected in the soil samples. The TPH-G ranged from below laboratory detection limits to 290 ppm, and the total BTEX ranged from below laboratory detection limits to 52.2 mg/kg. The samples obtained at about 13 feet bgs were believed to be near the top of the water table; the samples obtained at approximately 15 feet were in the water table.

37.0

1.1.9 Efficacy of Ground Water Extraction System

A ground water extraction system is operating at the Montgomery Ward Site to control the migration of dissovled petroleum hydrocarbons in the ground water. The ground water extraction system pump is currently recovering on average of about five gallons per minute which appears to be the long term yield of the extraction well (EAI, 1994a). Interpretation of the ground water elevation map, as contoured based on July 5, 1994 data, suggests that wells B-5, B-10, and B-15 are within the zone of capture of extraction well B-12 (see Figure 3).

1.2 ENEA PROPERTIES

The Enea Properties, described herein as the Enea Plaza site, a commercial shopping center and multi-story office complexes, are situated south of the intersection of Amador Plaza Road and Dublin Avenue (see Figure 2). The Enea Properties are located several hundred feet east of the Montgomery Ward Site and are down-gradient, in respect to ground water flow of the Montgomery Ward Site (see Figure 2).

1.2.1 Records Search/Audits

In May 1988, Earth Metrics Incorporated (EMI) completed for Enea Properties a Preliminary Environmental Screening Analysis of 7460 Dublin Boulevard and 6770 Amador Plaza Road,Dublin, California to determine if there was any known contamination associated with these sites (see EMI, 1988). In August 1991, EMI completed a Level One Environmental Site Assessment of 6700/6766/6780 Amador Plaza Road, Dublin, California and recommended that soil sampling and testing be considered based on the data associated with the Montgomery Ward Site (see EMI, 1991).

1.2.2 Assessment Activities by EMI

In October 1991, EMI drilled and sampled five borings on what will be referred to herein as "Enea Parcel 1" (see Figure 2). Note that the EMI sampling locations are not shown on Figure 2. Temporary monitoring wells were constructed in each boring to allow for the collection of ground water samples. From each boring location, a composite soil sample and ground water samples were tested for TPH-G and BTEX. No TPH-G or BTEX were detected in the composite soil samples; however, TPH-G and BTEX were detected in the ground water samples.

1.2.3 Assessment Activities by Harding Lawson Associates

On January 29, 1993, Harding Lawson Associates (HLA) drilled and constructed ground water monitoring wells MW-1, MW-2, and MW- 3 which were 15, 14, and 16 feet deep, respectively, on Enea Parcel 1 (see Figure 2). Except for boring logs and well construction details, EAI has no other information regarding these wells or the work completed by HLA.

1.2.4 Additional Site Assessment

In August 1993, Epigene International (Epigene) advanced and sampled five hydropunches on Enea Parcels 1 and 2 (HP-1 through HP-5) (see Figure 2). All the samples were analytically tested for TPH-G, total petroleum hydrocarbons as diesel (TPH-D) and BTEX (see Table 3) (see Epigene, 1993).

1.2.5 Installation of Monitoring Well MW-4

In December 1993, monitoring well MW-4 was installed by Epigene (see Figure 2). Except for the boring log and the well construction details, EAI has no other information regarding this well. Table 3 summarizes the testing results made available to EAI associated with ground water samples obtained from the Enea Parcels.

1.2.6 Ground Water Pumping Tests

On February 4, 1994, preparatory to conducting ground water pumping tests, Cypress Environmental (Cypress) installed one extraction well (EW-1) and one piezometer (PZ-1) near Enea monitoring well MW-1 (see Cypress, 1994) (see Figure 2). On February 7 and 8, 1994, using the extraction well and five observation wells (MW-1 through MW-4 and PZ-1), Cypress conducted both a step-discharge and a constant-discharge pumping test. Calculated hydraulic conductivities obtained from the pumping tests for the observation well MW-1 and the piezometer PZ-1 ranged from 0.536 to 0.591 centimeters per second (cm/sec) (or 1,519 to 1,657 ft/day). The pumping well had a calculated hydraulic conductivity of 0.152 to 0.192 cm/sec (or 430 to 544 ft/day). These values are high when compared to the silts, clays, and clayey sands that were identified on the lithologic boring logs for the Enea Properties. Hydraulic conductivities of this range are more typical of clean sands. Higher than anticipated hydraulic conductivities also were observed on the Montgomery Ward Site in relation to the type of soils penetrated by the wells at the site.

2.0 PETROLEUM HYDROCARBON DISTRIBUTION IN SOIL AND GROUND WATER

2.1 DISTRIBUTION IN SOIL

2.1.1 Montgomery Ward Site

Cross sections A-A', B-B', and C-C' show the geologic interpretation of the shallow soils encountered at the Montgomery Ward Site (see Figures 4 through 7). Also shown on the cross sections are the analytical testing results of soil samples obtained to date. These data show that petroleum hydrocarbons were detected in unsaturated and saturated zone soils in borings/wells B-10, B-12, B-15, B-16, and SBCP1 through SBCP4 (see Table 2 and Figures 5 and 7).

2.1.2 Enea Properties Sites

No unsaturated zone soil contamination has been detected to date on the Enea Properties Sites. The east-west geology through the site is interpreted on cross section D-D' (see Figure 8).

2.2 DISTRIBUTION IN GROUND WATER

Dissolved petroleum hydrocarbons as TPH-G and BTEX are present in the ground water beneath the Montgomery Ward and Enea Properties Sites. The presence of dissolved petroleum hydrocarbons (using benzene as the indicator compound) on the Enea Properties Sites appears to be defined in the northerly, southerly, and easterly directions, based on analytical data obtained from water samples collected from Epigene hydropunch locations HP-3 through HP-5, from Enea well MW-2 and EAI hydropunch location HPCP2, and water samples collected from Montgomery Ward wells/hydropunches MW-101, HP-1, HP-2, HP-5 through HP-8 and MW-101 (see EAI, 1993) (see Figure 9). The dissolved benzene in the ground water immediately south of the Montgomery Ward Site is fairly well defined based on analytical data (well MW-102). The northerly extent of dissolved benzene on the Montgomery Ward Site is defined based on well B-15 and EAI hydropunch locations HP-6 and HP-7 (see Figure 9).

What about sewer main acting as conduit?

The analytical data obtained from quarterly monitoring of ground water quality indicate that the concentrations of dissolved TPH-G and BTEX have decreased since commencement of the monitoring program in monitoring wells on the Montgomery Ward and the Enea Properties Site (Tables 1 and 3).

3.0 GEOLOGY AND HYDROGEOLOGY

The City of Dublin is located on the western side of the Livermore Valley, which occupies the northern and eastern portion of the Alameda Creek watershed. The Montgomery Ward and Enea Properties Sites are located in the Dublin sub-basin which is one of the twelve sub-basins of the Livermore Valley Ground Water Basin (see Figure 10). The sub-basins are demarcated based on fault traces and hydrogeologic discontinuities (see CSDWR, 1974). The Dublin sub-basin is drained by San Ramon Creek. To the north is a fault separating the Dublin sub-basin from the Bishop sub-basin, to the east is the

Pleasanton fault, and to the south is the Parks fault. Ground water in the Dublin sub-basin is reported to be both unconfined and confined. The geological units immediately underlying the Montgomery Ward and Enea Properties Sites are reported to be comprised of valley-fill sediment of Holocene age.

The entire Livermore Valley is composed of water-bearing sediments. The oldest water-bearing formation in the Livermore Valley area is reported to be the Tassajara Formation, which is Pliocene in age. These sediments consist of bedded deposits of sandstone, tuffaceous sandstone, tuff and shale. The next youngest geologic unit in the Livermore Valley is the Livermore Formation, which is of Plio-Pleistocene age. This is a significant water-bearing formation which supplies most of the drinking water for the Livermore Valley. Recent surficial valley-fill consists of unconsolidated clay, silt, sand, and gravel which overlie the Tassajara and Livermore Formations.

Aquifer materials within the sub-basin are generally flat lying, multi-layered sediments consisting of an unconfined shallow aquifer overlaying a sequence of leaky or semiconfined aquifers. The regional ground water flow in the area is approximately southeast (see Figure 11).

3.1 REGIONAL GROUND WATER MONITORING NETWORK

The ground water resources in the Livermore-Amador Ground Water Basin are managed by Zone 7 of the Alameda County Flood Control and Water Conservation District in Pleasanton, California (Zone 7). Zone 7 maintains a ground water monitoring well network that provides regional data on basin-wide ground water conditions.

Zone 7 is a wholesaler which sells water to cities throughout the Livermore-Amador Ground Water Basin. The majority of the water for the basin is derived from the California State Water Project (Project) with water from the municipal wells located through out the basin being used as a supplement to water derived from the Project.

Based on the Zone 7 well database, there are fifteen wells within a two-mile radius of the Montgomery Ward Site (see Table 4 and Figure 12). The Water Well Drillers Reports for these wells are presented in Appendix A. The recent chemical analysis of the ground water from several of these wells are contained in Appendix B. Recent ground water elevation data are presented in Appendix C. Based on this information, there are no active water supply wells within this two mile radius. Well 3S/1E/12C2 previously was used as a water supply well, but is now only used for ground water monitoring purposes (Steven J. Ellis, Zone 7, September 26, 1994 personal communication).

3.2 MUNICIPAL WATER SUPPLY WELLS

The nearest municipal water supply wells to the Montgomery Ward and Enea Properties Sites are located approximately 12,000 feet southeast of the sites. These wells are 3S/1E-18A6, 3S/1E- 18A1, 3S/1E-18A5, and 3S/1E-17D2 (see Figure 12). Wells 3S/1E- 18A6,-18A1, and -17D2 are owned by Zone 7 and well 3S/1E-18A5 is owned by the City of Pleasanton. All of these municipal wells are located in the adjacent Bernal sub-basin which is separated from the Dublin sub-basin by a hydraulic discontinuity (Steven J. Ellis, personal communication, 1994).

3.3 WATER QUALITY

3.3.1 Chemical Analyses

The quality of the shallow ground water beneath the Montgomery Ward Site and vicinity varies considerably. Electrical conductivity (Ec) data from ground water monitoring activities at the Montgomery Ward Site indicate that the water quality in terms of total dissolved solids typically ranges from around 750 to 840 mg/l. The conversion factor from Ec units to TDS equivalence is 0.7. Data from wells drilled in the shallow aquifer within the Dublin sub-basin show that TDS ranges from approximately 500 to over 15,000 mg/l (see Appendix B). Wells 3S/1E-6N3 and 3S/1E-6N2 contain the highest TDS values. These wells are located near the wastewater treatment plant which is southeast of the intersection of Interstate 580 and 680 freeways and are located down-gradient of the Montgomery Ward and Enea Properties Sites. The high TDS values are reportedly the result of waste water infiltrating into the ground water from ponds associated with the treatment plant (Steven J. Ellis, Zone 7, personal communication, 1994).

3.3.2 Water Quality Objectives

It is interesting to note that the San Francisco Bay Basin Region 2, Water Quality Control Plan prohibits the discharge to surface or ground water of water which exceeds the ground water quality objective for the basin, i.e., 1,000 mg/l TDS or ambient whichever is lower, unless it can be demonstrated that the application point is in a fringe sub-basin or upland and highland area, and it can be shown that the project, because of its size and location, together with other possible projects in the area, will not cause adverse water quality effects. Based on the high TDS values for water in monitoring wells located adjacent to the wastewater treatment plant, it is apparent that percolating water with high TDS concentrations above the 1,000 mg/l water quality objective in the vicinity of the wastewater treatment plant is impacting the ground water quality in this sub-basin.

3.4 SITE SOILS AND DEPTH TO GROUND WATER

Native soil encountered in the borings drilled on the Montgomery Ward Site predominantly consists of olive brown and gray to dark gray clay with a trace of silt. Ground water encountered in January 1994 in the wells associated with the Montgomery Ward Site ranged from 11 to 12 feet bgs.

CPT showed that these fine grained soils (clayey silt, silty clays, and clays) extend from the surface to depths of at least 52 feet bgs ~~based on~~ the maximum depth explored by the CPT (see EAI, 1994). Similar lithologies are present in the shallow site soils at the Enea Properties Site based on boring logs and CPT data (see EAI, 1994).

4.0 PRESENT LAND USE

The land use in the immediate area where the dissolved phase plume is encountered is commercial. Immediately south of the Montgomery Ward Site is the Crown Chevrolet facility; southeast along Amador Plaza Road are the Enea Properties which includes the Enea Plaza Shopping Center and office buildings; and immediately east are Sanwa Bank and Carroll's Restaurant. East of the intersection of Amador Plaza Road and north of Dublin Avenue are Shamrock Ford and Dublin Honda, both automobile dealerships. The vacant property along Amador Plaza Road will reportedly be developed into an on and off-ramp for Interstate 680 (Dennis Carrington, City of Dublin, personal communication, September 1994).

Dublin Creek is located approximately 1,500 feet south of the Montgomery Ward Site. Dublin Creek is an intermittent stream. The average flow is less than two cubic feet per second (Steven J. Ellis, personal communication, September 1994). Dublin Creek merges with Big Canyon Creek which is east of Interstate 680 and about one half mile east of the Enea Properties Sites. Draining in a southernly direction, the confluence of the two creeks joins Alamo Canal. Alamo Canal then drains into Arroyo De La Laguna which flows into Alameda Creek (Richard Daniels, Alameda County Flood Control District, personal communication, September 1994) (see Figure 1).

5.0 EXPOSURE PATHWAYS

5.1 SOILS

No unsaturated zone soil contamination has been detected to date off-site and down-gradient of the Montgomery Ward Site. Therefore, exposure through ingestion and direct dermal contact with the contaminated soil is non-existent.

5.2 BTEX EMISSIONS

Due to the presence of dissolved BTEX in ground water, exposure to BTEX emissions emanating from the the ground water is possible. Section 7.0 provides a discussion on the risk associated with exposure to BTEX emissions.

5.3 GROUND WATER

Ground water monitoring wells used by Zone 7 exist in the Dublin subbasin (see Sections 3.1 and 3.2). These wells, however, are only used for monitoring purposes (Steven J. Ellis, Zone 7, personal communication, September 1994). The municipal water supply wells in closest proximity to the Montgomery Ward and Enea Properties Sites are over 12,000 feet southeast of the Sites (see Figure 12). These municipal wells are in Bernal sub-basin which is separated from the Dublin sub-basin by a hydraulic discontinuity (see Section 3.0). Due to the presence of this hydraulic discontinuity and the distance to these municipal wells, it is highly unlikely that the dissolved phase petroleum hydrocarbons will significantly impact these wells (see Section 6.0 for a discusion on the fate and transport of these contaminants). Therefore, the probability for exposure to the dissolved phase contaminants through ingestion is very low.

5.4 SURFACE WATER

Dublin Creek, the nearest surface water body, appears to be a recharge source for the shallow ground water table (Richard Daniels, Alameda County Flood Control District, personal communication, 1994). Therefore, exposure to the dissolved phase materials through ingestion or dermal contact with waters from the creek is highly improbable.

5.5 MAN-MADE SUBSURFACE CONDUITS

A utility survey was made in order to determine whether the sewer line located adjacent and south of the Montgomery Ward Site is a possible preferential pathway for subsurface contaminant migration. Figure 13 shows the location and elevations of the ground surface and sewer invert at several points along the sewer line. As shown on this Figure 13, the sewer line invert is located at mean sea elevations (MSL) ranging from 336.15 to 331.15 ft MSL adjacent to the Montgomery Ward Site. Ground water monitoring data shows that the hydrostatic ground water elevations on the Montgomery Ward Site range from 327 and 330 ft MSL which suggests that the sewer trench is possibly not a preferential pathway for migration of contaminants.

Ground water may encounter the sewer line on the eastern portion of the Enea Properties Site (see Figure 13). However, at this time, the ground water monitoring and hydropuch sampling show that the dissolved phase plume has not reached the location of the sewer line on portion of the Enea Properties located east of Amador Plaza Road.

6.0 TRANSPORT AND ATTENUATION OF DISSOLVED PHASE CONTAMINANTS

The major concerns at sites impacted with dissolved phase petroleum hydrocarbons are the continued migration of these contaminants and the potential environmental and health impacts resulting from migration of these contaminants. The specific contaminants of concern for the Montgomery Ward and Enea Properties Sites are purgeable organics (BTEX). In order to predict the migration rates of the dissolved phase hydrocarbons, EAI performed several calculations. The following provides a description of the methodology used.

The rate of movement of ground water can be estimated using Darcy's Law and an equation expressing the conservation of mass, assuming that water is incompressible. These equations are:

Darcy's Law: $Q = KAh/L$

where Q = Flow rate per unit time
K = hydraulic conductivity (feet/unit time)
A = Cross Sectional area through which flow occurs ($feet^2$)
h/L = hydraulic gradient (feet/feet)

The Conservation of Mass equation: $Q = vn_eA$

where v = average velocity of ground water (feet/unit time)
n_e = effective porosity

Combining these two equations results in the equation $v = Kh/n_eL$ (or $v = Ki/n_e$ where i = hydraulic gradient) which gives the average velocity or seepage velocity of the ground water. This is the average velocity at which ground water movement occurs. However, dissolved phase contaminants also are subject to a number of different processes through which they can be removed from ground water. They can be adsorbed onto the surfaces of the aquifer particles, adsorbed by organic carbon that might be present in the also there is dispersion where BTEX can move ahead of GW

aquifer, undergo chemical precipitation, be subject to abiotic degradation as well as biodegradation, and particpate in oxidation-reduction reactions. As a result of these sorption processes, some solutes will move much more slowly through an aquifer than the ground water that is transporting them. This effect is called retardation.

To calculate the retardation effect for solutes, the following equation is used:

$$R = (1 + K_d \rho/\theta)$$

where R = Retardation factor
K_d = distribution coefficient (milliliter/gram)
p = bulk density (gm/cm3)
θ = porosity for saturated media

The average rate of movement of a solute is then computed using the following equation considering only the effects of linear adsorption:

$$v_{d,max} = Ki/(n_e R)$$

where $v_{d,max}$ is the maximum transport rate of the dissolved plume.

In order to compute the minimum time $\theta_{d,min}$ for the a specific portion of a dissolved plume to travel a distance L, the following equation is used:

$$\theta_{d,min} = L/v_{d,max}$$

Using the above equations, EAI has computed the velocity of ground water movement (v), the maximum transport rate of the dissolved plume ($v_{d,max}$), the minimum travel time ($\theta_{d,min}$) for the dissolved plume to reach the municipal water supply wells located approximately 12,000 feet southeast of the Sites. Appendix D presents the associated assumptions and the calculations. Based on the fact that the plume is being contained on the Montgomery Ward Site by the pumping system, EAI assumed for this computation that the maximum concentration migrating off-site from the Montgomery Ward Site is 83 micrograms/liter (ug/l), which is the maximum historical dissolved benzene concentration detected off-site and down-gradient of the Montgomery Ward Site during quarterly ground water monitoring activities. The most recent quarterly monitoring results show that the highest detected benzene concentration off-site of the Montgomery Ward Site is 31 ug/l.

Based on the above calculations, the minimum amount of time $\theta_{d,min}$ for dissolved benzene to reach the municipal water supply wells is approximately 16 years.

Bioattenuation of dissolved phase petroleum hydrocarbons also have been documented in literature (Baker, J.f et. al., 1987; Chiang, C.Y., et. al, 1989; Kemblowski, et. al., 1987; Salanitro, J.P., 1993; and Wilson, B.H., et. al., 1991). If the effects of bioattenuation are taken into account in this analysis, the results show that benzene would biodegrade before reaching the municipal wells (see Appendix D).

7.0 AIR EMISSION CALCULATIONS

The approach used to calculate the air emissions and air quality impacts has been developed by the ASTM in the Draft Guide for Risk Based Corrective Action Applied at Petroleum Release Sites. The assumptions used herein are site specific where data permit. Default assumptions have been developed from references where data are unavailable.

Exposure of individuals to volatile organic compounds released from the USTs would be a result of inhalation of outdoor vapors which originate from dissolved hydrocarbons in ground water located some distance below the ground surface. The goal is to determine the dissolved hydrocarbon Risk Based Screening Level (RBSL) that corresponds to the target RBSL for outdoor vapors in the breathing zone.

A conceptual model for the transport of chemicals from ground water to ambient air is depicted in Figure II-15. The relationship between outdoor air and dissolved ground water concentrations is represented by the volatilization factor (VFwamb) [(mg/m3-air)/(mg/l-water)] which is based on the following assumptions:

A constant dissolved chemical concentration in ground water;

Linear equilibrium partitioning between dissolved chemicals in ground water and chemical vapors at the ground water table;

Steady-state vapor- and liquid-phase diffusion through the capillary fringe and vadose zones to the ground surface;

No loss of chemical as it diffuses towards ground surface, i.e., no biodegradation; and

Steady well-mixed atmospheric dispersion of the emanating vapors within the breathing zone as defined by a "box model" for air dispersion.

The releases from the USTs at the Montgomery Ward Site included BTEX. Benzene is considered to be a carcinogen while toluene, xylenes, and ethylbenzene are considered to be non-carcinogens. RBSL must be developed for both the carcinogens and non-carcinogens. The RBSL for benzene will be based on a risk of 1×10^{-6} or one per million. The RBSL for the non-carcinogens is the chronic reference dose for the specific pollutants.

An occupational exposure of individuals to the volatile organic compounds would occur since the area of the Montgomery Ward Site is a commercial area, i.e., no residential areas are impacted. Therefore, exposure was assumed to occur over a 25 year period per the default assumptions of ASTM.

7.1 BENZENE EMISSION CALCULATIONS

The following emission calculations were completed to determine the RBSL for benzene in ground water using the following equations and assumptions:

$$\text{RBSL (mg/l-H20)} = \frac{\text{RBSLair (ug/m3-air) x 10-3 mg/ug}}{\text{VFwamb}}$$

Where:

RBSLwater	= Risk based screening level - ground water (mg/l-H20)
RBSLair	= Risk based screening level - air (ug/m^3-air)
VFamb	= Volatilization factor (mg/m^3-air)/(mg/l-H20)

RBSLwater $= \dfrac{\text{RBSLair (ug/m}^3\text{-air) x } 10^{-3}\text{ mg/ug}}{\text{VFamb}}$

= 20.65 mg/l-H20 — I get 2.071 — Should be ug/l

RBSLair $= \dfrac{\text{TR x BW x ATc x 365 days/year x } 10^{3}\text{ ug/mg}}{\text{SFo x IRair EF x ED}}$

= 0.493 ug/m^3-air ✓

Where:

TR	= Target excess lifetime cancer risk (1 x 10^{-6})
BW	= Adult body weight (70 kg)
SFo	= Oral cancer slope factor [0.029 (mg/kg-day)-1]
IRair	= Inhalation rate (20 m^3/day)
EF	= Exposure frequency (250 days/year)
ED	= Exposure duration (25 years).
ATC	= 70 years - Averaging time for carcinogens
VFwamb	$= \dfrac{\text{H x } 10^{-3}\text{ l/m}^3}{\left[\dfrac{\text{Uair x AA x Lgw}}{\text{W x Dws}}\right] + 1}$ 10^{+3}?
	= 2.387 x 10^{-5} (mg/m^3-air)/(mg/l-H20)

Where:

H	= Henry's Law Constant [0.22 (cm^3-H20)/(cm^3-air)]
Uair	= Wind speed (estimated to be 2 mph or 894 cm/s)
AA	= Ambient air mixing zone (8 feet or 244 cm)
Lgw	= Depth to ground water (about 2.74 meters or 2,740 cm)
W	= Width of source (about 80 feet or 2438 cm)
Dws	= effective diffusion coefficient between ground water and soil surface (0.0266 cm^2/sec) (calculated below)

Dws $= (\text{hcap} + \text{hv})\left[\dfrac{\text{hcap}}{\text{Dcap}} + \dfrac{\text{hv}}{\text{Ds}}\right]^{-1}$

= 0.0266 cm^2/sec

Where:

cap	= thickness of capillary fringe (5 cm)
hv	= thickness of vadose zone (295 cm)
Dcap	= effective diffusion coefficient through capillary fringe (cm^2/sec) (calculated below)
Ds	= effective diffusion coefficient in soil based on vapor-phase concentration (calculated below)

Dcap	= Dair $\frac{Ocap^{3.33}}{Ot^{3.33}}$ + Dwat(1/H) $\frac{Owcap^{3.33}}{Ot^{3.33}}$	
	= 0.093 cm^2/sec	

Where:

Dair	= 0.093 cm^2/s
Ocap	= Volumetric air content in capillary fringe soils (0.38 cm^3-air/cm^3-soil)
Ot	= Total soil porosity (0.38 cm^3-air/cm^3-soil)
Dwat	= 1.1 x 10-5 cm^2/s
Owcap	= Volumetric water content in capillary fringe soils = 0.342 cm^3-H2O/cm^3-soil
H	= Henry's Law Constant [0.22 (cm^3-H20)/(cm^3-air)]

$$Ds = Dair \frac{Oas^{3.33}}{Ot^{3.33}} + Dw(1/H) \frac{Ows^{3.33}}{Ot^{3.33}}$$

$$= 0.0263\ cm^2/sec$$

Where:

Dair	= 0.093 cm^2/s
Oas	= Volumetric air content in vadose zone soils (0.26 cm^3-air/cm^3-soil)
Ot	= Total soil porosity (0.38 cm^3-air/cm^3-soil)
Dw	= 1.1 x 10-5 cm^2/s
Ows	= Volumetric water content in vadose zone soils (0.12 cm^3-H2O/cm^3-soil)
	= Henry's Law Constant [0.22 (cm^3-H20)/(cm^3-air)]

$$RBSLwater = \frac{BSLair \times 10^{-3}\ mg/ug}{VFwamp}$$

= 20.65 mg/l-water

= 20,650 ug/l-water

Based on these calculations the maximum allowable benzene concentration in ground water that would result in a 1 x 10^{-6} cancer risk level would be 20.65 mg/l.

7.2 RBSL FOR NON-CARCINOGENS

The general assumptions used to calculate the RBSL for non-carcinogens is similar to those developed for carcinogens.

$$RBSL\ (mg/l\text{-}H20) = \frac{RBSLair\ (ug/m^3\text{-}air) \times 10^{-3}\ mg/ug}{VFwamb}$$

Where:

$$RBSLair = \frac{THQ \times RFDi \times BW \times ATn \times 365\ days/year}{IRair \times EF \times ED} \times 10^3\ ug/mg$$

Where:

THQ	= Target hazard quotient - unitless (1.0)
RFDi	= Inhalation chronic reference dose (mg/kg-day)
	= 0.11 for toluene
	= 0.29 for ethylbenzene
	= 2.0 for xylenes
BW	= Adult body weight (70 kg)
ATn	= Averaging time for non-carcinogens (25 years)
IRair	= Daily outdoor air inhalation (20 m^3/day)
EF	= Exposure frequency (250 days/year)
ED	= Exposure duration (25 years)

RBSLair	= 562.1 ug/m^3 for toluene
	= 1,482 ug/m^3 for ethylbenzene
	= 10,220 ug/m^3 for xylene

RBSLw	= 23,548 mg/l-H2O for toluene
	= 62,086 mg/l-H2O for ethylbenzene
	= 428,152 mg/l-H2O for xylene

Based on these calculations the maximum allowable toluene, xylenes, and ethylbenzene concentrations in ground water that would result a hazard quotient greater than 1.0 are orders of magnitude greater than the concentrations of these contaminants in the ground water.

8.0 RISK BASED CLEANUP LEVELS

The exposure pathways were evaluated and the results show the low probability of exposure to the dissolved phase contaminants. The only likely exposure senario is through vapor emissions from the dissolved phase ground water. The risk based screening analysis for exposure to benzene emissions, however, indicate that ground waters could contain a maximum concentration of 20.6 mg/l of benzene before exceeding a cancer risk of 1 in one million or 1×10^{-6} based on site characteristics. The actual maximum detected benzene concentrations in ground water off-site and down-gradient of the Montgomery Ward Site is only 83 ug/l and, consequently, emissions from dissolved phase sources pose very low risk. Therefore, it is EAI's opinion that based on the low probability of exposure to BTEX through the stated pathways that a cancer risk factor of 1×10^{-5} (or 1 in 100,000) for benzene should be used in calculating the risk based clean-up level for this constituent in ground water. ?

The following equation is used to derive the risk based clean-up level for benzene in ground water:

$$RBCLx\ (mg/L) = \frac{TR \times BW \times ATc \times 365\ (days/yr)}{SFo \times IRw \times EF \times ED}$$

Where:

TR	= target excess individual lifetime cancer risk (unitless)
BW	= adult body weight (kg)
ATc	= averaging time for carcinogens (yr)
SFo	= oral cancer slope factor ((mg/kg-day)-1)
IRw	= daily water ingestion rate (liters/day)
EF	= exposure frequency (days/yr)
ED	= exposure duration (yr)

Since the local immediate land use is commercial/industrial, the following defaults were used in the calculations:

BW	= 70 kg
ATc	= for commercial/industrial is 70 yr
SFo	= for benzene = 0.029 kg-day/mg
IRw	= 1 liter/day
EF	= 250 days/yr for commercial/industrial use
ED	= 25 years for commercial/industrial use

This results in a risk based clean-up level for benzene in ground water of 0.0986 mg/l (98.6 ug/l).

For non-carcinogens toluene, xylenes, and ethylbenzene, a similar approach is used:

$$RBCL(mg/l\text{-}H20) = \frac{THQ \times RfDo \times BW \times ATn \times 365\ day/yr}{IRw \times EF \times ED}$$

where THQ	= target hazard quotient for individual constituents (unitless)
RfDo	= oral chronic reference dose (mg/kg-day)

The THQ values for toluene, ethylbenzene, and xylenes are unity. The RfDo values for the above respective non-carcinogens are 0.2 mg/kg-day, 0.1 mg/kg-day, and 2.0 mg/kg-day. The resultant risk based clean-up levels are then calculated at 20 mg/l, 10 mg/l, and 200 mg/l for toluene, ethylbenzene, and xylenes, respectively.

Review of analytical data obtained from ground water monitoring activities (see Table 3) shows that for toluene, xylenes, and ethylbenzene none of these constituent concentrations exceed these risk based clean-up levels. Comparison of actual concentrations detected in ground water during the quarterly monitoring to the applicable or relevant and appropriate requirements (ARARs) (i.e., California Department of Toxic Substances and Control [DTSC] state drinking water maximum contaminant levels (MCLs) or action levels) show that, of these three constituents, none have exceeded their respective MCL or action level since January 1994. Only ethylbenzene exceeded the its respective MCL or action level since monitoring of these off-site wells began in May 1993 (see Tables 1 and 3).

9.0 CONCLUSIONS

Based on the above and data contained in previous reports, the following are concluded with regard to the dissolved plume off-site and down-gradient of the Montgomery Ward Site:

- The analytical data from quarterly ground water monitoring show that the highest concentrations of dissolved benzene ever detected in the ground water down-gradient and off-site of the Montgomery Ward facility was 83 ug/l in well MW-100 which is down-gradient and along the axis of the dissolved phase plume. Currently, the highest concentration of dissolved benzene off-site and down-gradient of the Montgomery Ward site is 31 ug/l in well MW-100, based on July 1994 data.

- The nearest municipal supply wells are located approximately 12,000 feet southeast of the Montgomery Ward and Enea Properties Sites and in the adjacent Bernal subbasin which is separated from the Dublin subbasin by a hydraulic discontinuity.

- No unsaturated petroleum hydrocarbon soil contamination has been detected in soil samples collected and analyzed in the area down-gradient and off-site of the Montgomery Ward Site.

- Ground water is encountered at depths ranging from approximately nine to eleven feet bgs.

- The probability of BTEX exposure through dermal oral contact is very low since there are no pathways for direct ingestion and contact.

- Although BTEX exposure through inhalation is a possibility, calculations shows that a risk of less than 1×10^{-6} is present.

- The concentrations of dissolved constituents in ground water have been documented to be decreasing over time.

- The present concentrations of toluene, xylenes, and ethylbenzene in ground water down-gradient and off-site are less than their respective ARARs and risk based clean-up levels.

- Clean-up of toluene, xylenes, and ethylbenzene in the ground water off-site and down-gradient of the Montgomery Ward Site is not required since the concentrations of these constituents are less than their respective MCLs, action levels, or risk based clean-up levels.

- Use of a cancer risk factor of 1×10^{-5} (1 in 100,000) is appropriate for the dissolved phase plume off-site and down-gradient of the Montgomery Ward Site since the probability of exposure to the chemicals of concern are very low. ← is this acceptable?

- Use of this cancer risk factor of 1×10^{-5} results in a risk based ground water clean-up level of approximately 98.6 ug/l for benzene.

- Present concentrations of benzene in ground water down-gradient and off-site of the Montgomery Ward Site do not exceed the proposed clean up action level and, consequently, remediation of the ground water off-site and down-gradient of the Montgomery Ward Site is not warranted.

- The benzene levels exceeding its proposed risk based clean-up level of 98.6 ug/l are being contained on the Montgomery Ward property by the current ground water extraction system.

10.0 RECOMMENDATIONS

The ground water monitoring data for the dissolved phase plume off-site and down-gradient of the Montgomery Ward Site show that low levels of dissolved purgeable aromatic hydrocarbons are present in the ground water. These levels are less than the risk based clean-up levels proposed herein. It is recommended that two additional ground water monitoring well be installed as shown on Figure 16. This additional ground water monitoring well and the existing wells on the Enea Properties Sites will be used as sentinel wells. These wells will be monitored on a quarterly basis for two years. If the dissolved phase concentration of benzene exceeds its proposed RBCL or toluene, ethylbenzene, or xylenes exceed their MCLs for two consecutive quarters, then additional actions will be considered for the Enea Properties Sites.

If the BTEX concentrations do not exceed the proposed RBCL for benzene or toluene, ethylbenzene, or xylenes respective MCLs during the two years of quarterly monitoring, then no additional actions at the Enea Properties Sites will be necessary, monitoring of the dissolved contaminants off-site and down-gradient of the Montgomery Ward Site will be discontinued, and closure of the Enea Properties Sites should be granted.

11.0 LIMITATION

Our professional services have been performed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable environmental consultants practicing in this or similar localities. No other warranty or representation, expressed or implied, is made as to the professional advice contained in this report.

12.0 REFERENCES

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TABLES

TABLE 1

ANALYTICAL TESTING RESULTS FOR GROUND WATER SAMPLES

Montgomery Ward Site

Parts per billion (ppb)

Well B-5

Compounds	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
04-16-92	4400	670	160	280	320	ND
07-24-92	31000	5400	2600	2200	5800	ND
10-22-92	9100	1100	190	520	740	ND
01-15-93	2300	530	160	300	470	7.9
04-15-93	4900	600	160	470	390	ND
07-14-93	8800	590	210	840	1100	9.9
10-14-93	4500	530	46	490	350	ND
01-13-94	120	15	1.9	12	11	ND
04-04-94	5700	450	39	350	400	ND
07-05-94	2200	69	13	150	95	ND

Well B-10

Compounds	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
04-16-92	7300	1400	640	880	1100	ND
07-24-92	27000	3800	1600	2000	4000	ND
10-22-92	16000	2300	340	1100	1200	ND
01-15-93	10000	1400	310	730	1100	13
04-15-93	8100	580	270	810	580	19
07-14-93	6400	840	120	750	800	7.1
10-14-93	100000	720	120	930	1100	ND
01-13-94	18000	990	180	1300	2400	ND
04-04-94	12000	370	96	900	1800	ND
07-05-94	7800	170	50	550	810	ND

Well B-12

Compounds	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
04-16-92	12000	1300	1100	510	1200	ND
07-24-92	12000	1000	630	520	1000	ND
10-22-92	11000	370	230	400	940	ND
01-15-93	120	2.8	ND	1.6	3.6	11
04-15-93	7100	730	240	350	570	ND
07-14-93	4500	540	97	380	610	ND
10-14-93	11000	710	170	650	1600	ND
01-13-94	6000	330	100	330	620	24
04-04-94	8700	350	58	350	660	ND
07-05-94	8800	250	340	370	920	ND

TABLE 1

ANALYTICAL TESTING RESULTS
FOR GROUND WATER SAMPLES
Montgomery Ward Site

Parts per billion (ppb)

Well B-15

Compounds	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
04-16-92	65	4.4	2.4	6.1	2.8	ND
07-24-92	ND	3.6	1.5	3.1	1.6	ND
10-22-92	ND	1.7	0.89	0.78	0.88	ND
01-15-93	ND	ND	ND	ND	ND	13
04-15-93	ND	2.8	ND	3.0	1.5	ND
07-14-93	ND	ND	ND	0.57	0.74	7.8
10-14-93	ND	0.96	2.6	1.3	3.6	25
01-13-94	ND	ND	0.92	0.70	2	ND
04-04-94	ND	ND	ND	0.56	1	ND
07-05-94	ND	ND	ND	ND	ND	ND

Well B-16

Compounds	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
04-16-92	1300	390	1.7	35	9.3	ND
07-24-92	1600	120	5.7	120	410	ND
10-22-92	1000	76	ND	55	130	ND
01-15-93	160	6.5	0.86	2.3	2.6	5.5
04-15-93	300	65	ND	13	2	ND
07-14-93	170	5.9	ND	4.6	12	ND
10-14-93	390	11	2.4	16	45	21
01-13-94	350	8.7	0.62	25	68	ND
04-04-94	550	8.7	ND	35	81	ND
07-05-94	850	14	5.6	52	130	ND

Well MW-100

Compounds	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
05-13-93	13000	83	ND	960	820	NA
07-14-93	13000	32	ND	1400	790	8
10-14-93	7500	48	16	900	520	0.022
01-13-94	7000	51	ND	590	330	ND
04-04-94	9800	69	ND	540	410	ND
07-05-94	5900	31	8.7	190	190	ND

Well MW-101

Compounds	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
05-13-93	ND	ND	ND	ND	ND	NA
07-14-93	ND	ND	ND	ND	ND	11
10-14-93	ND	0.65	0.89	ND	1.1	ND
01-13-94	ND	ND	ND	ND	ND	28
04-04-94	ND	ND	ND	ND	ND	ND
07-05-94	ND	ND	ND	ND	ND	ND

TABLE 1

ANALYTICAL TESTING RESULTS FOR GROUND WATER SAMPLES

Montgomery Ward Site

Parts per billion (ppb)

Well MW-102

Compounds	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
05-13-93	3600	17	ND	130	63	NA
07-14-93	1500	13	ND	64	4.9	ND
10-14-93	24000	9.6	5.2	60	60	ND
01-13-94	2000	22	ND	26	55	ND
04-04-94	2100	16	2.5	15	35	ND
07-05-94	1300	7	2.9	10	23	ND

5-13-93

Hydropunch ID	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
HP-1	ND	ND	ND	ND	ND	ND
HP-2	ND	ND	ND	ND	ND	ND
HP-3	5700	12	ND	180	50	ND
HP-4	680	6.6	ND	4.1	15	ND
HP-5	ND	ND	ND	ND	ND	ND
HP-6	ND	ND	ND	ND	ND	ND
HP-7	ND	ND	ND	ND	ND	ND
HP-8	ND	ND	ND	ND	ND	ND

ND Not Detected
NA Not Analyzed

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TABLE 2

ANALYTICAL TESTING RESULTS FOR SOIL SAMPLES COLLECTED BY EAI

Montgomery Ward Site

Parts per Million (ppm)

Sample Number	TPH-G	Benzene	Toluene	Ethyl-Benzene	Total Xylenes
B-100 @ 5'	ND	ND	ND	ND	ND
B-100 @ 9'	ND	ND	0.007	ND	ND
B-101 @ 5'	ND	ND	0.68	ND	ND
B-101 @ 9'	ND	ND	0.048	ND	ND
B-102 @ 5'	ND	ND	0.0078	ND	0.006
B-102 @ 9'	ND	ND	ND	ND	ND

ND Not Detected

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TABLE 3

ANALYTICAL TESTING RESULTS FOR GROUND WATER SAMPLES

Enea Plaza Sites

Parts per billion (ppb)

Well MW-1

Compounds	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
10-14-93	5700	76	19	160	460	ND
04-04-94	7000	27	ND	260	49	ND
07-05-94	5100	23	ND	260	50	ND

Well MW-2

Compounds	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
10-14-93	ND	ND	ND	1.1	0.71	21
04-04-94	ND	ND	ND	ND	ND	21
07-05-94	ND	ND	ND	ND	ND	ND

Well MW-3

Compounds	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
10-14-93	2600	26	30	100	130	ND
04-04-94	2600	13	3.4	90	140	ND
07-05-94	3400	15	5	31	48	ND

Well MW-4

Compounds	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
04-04-94	ND	ND	ND	ND	ND	23
07-05-94	ND	ND	0.5	ND	0.62	ND

8-11-93

Hydropunch ID	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	TPH-D
HP-1	98	1.4	ND	ND	ND	51
HP-2	260	0.87	0.64	ND	0.63	69
HP-3	ND	ND	ND	ND	ND	ND
HP-4	ND	ND	ND	ND	0.52	ND
HP-5	ND	ND	ND	ND	ND	81
HP-6 (blank)	ND	ND	ND	ND	ND	140

Note: ENEA samples HP-1 through HP-6 were also analyzed for VOCs using EPA Method 8240. No VOCs were detected.

ND Not Detected
NA Not Analyzed

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TABLE 4

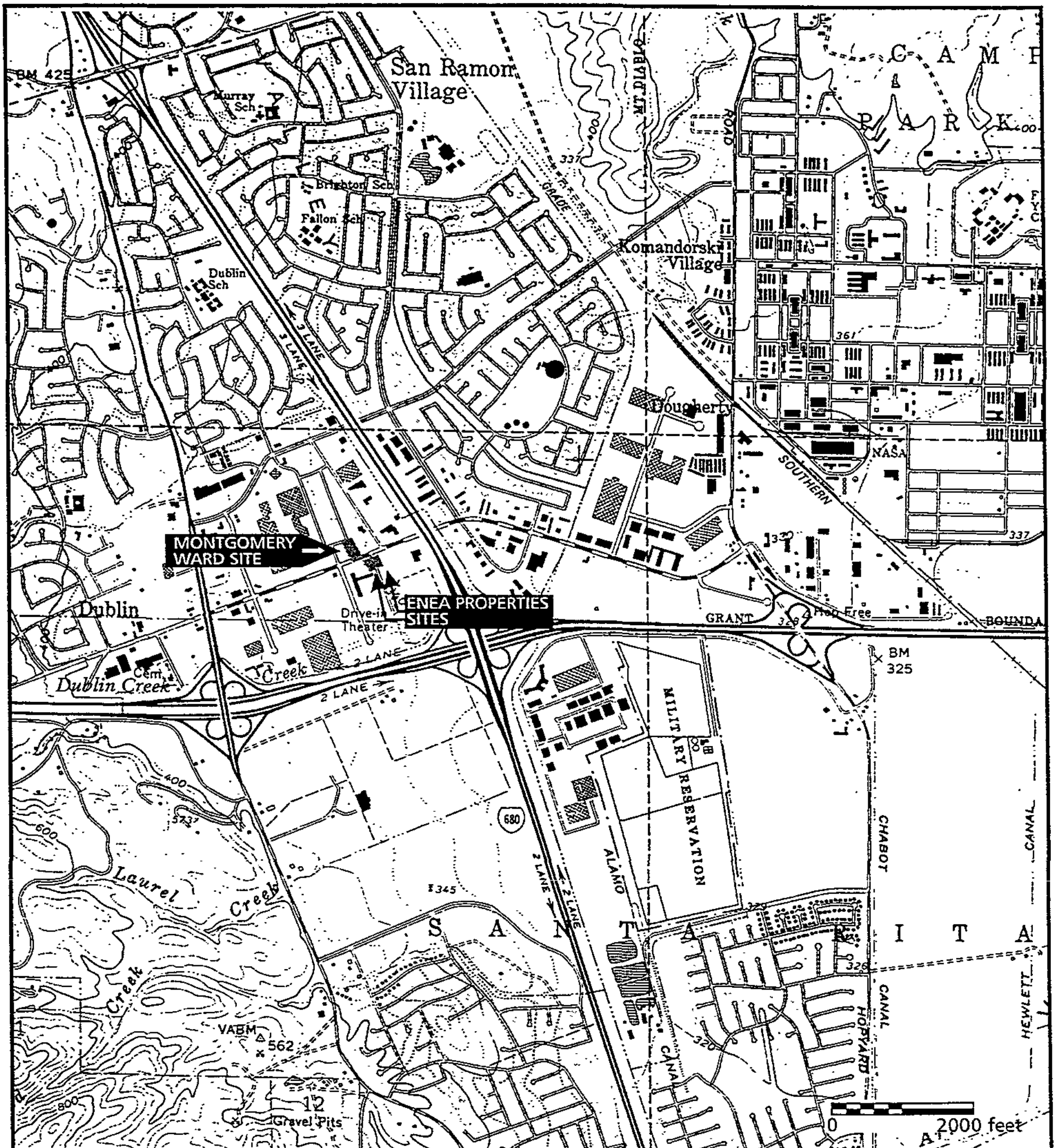
WELLS WITHIN A TWO-MILE RADIUS
MONTGOMERY WARD AUTO SERVICE CENTER
DUBLIN, CALIFORNIA

Well No.	Well Depth	Screen Depth	Zone	Type
2S/1E-32N1	44'	34-39'	CAMP	M
2S/1W-36E3	60'	51-56'	DUBLIN	M
3S/1E-6F3	36'	26-31'	DUBLIN	M
3S/1E-6G5	200'	103-108' 173-178'	DUBLIN	UK
3S/1E-6N2	67'	47-67'	DUBLIN	M
3S/1E-6N3	72'	52-72'	DUBLIN	M
3S/1E-7B2	152'	143-149'	DUBLIN	M
3S/1E-7M2	88'	70-71' 78-85'	DUBLIN	M
3S/1E-18E4	84'	69-79'	BERNAL	M
3S/1W-1B5	112'	97-102'	DUBLIN	M
3S/1W-1J1	70'	47-64'	DUBLIN	M
3S/1W-1J2	37'	15-37'	DUBLIN	M
3S/1W-2A2	47'	37-42'	DUBLIN	M
3S/1W-12C2	48'	UK	DUBLIN	WS
3S/1W-12J1	62'	52-57'	DUBLIN	M

KEY: M = Monitoring Well
WS = Water Supply Well
UK = Unknown

FSM:WORD·1233M2T4.DOC

FIGURES



Environmental Audit, Inc.

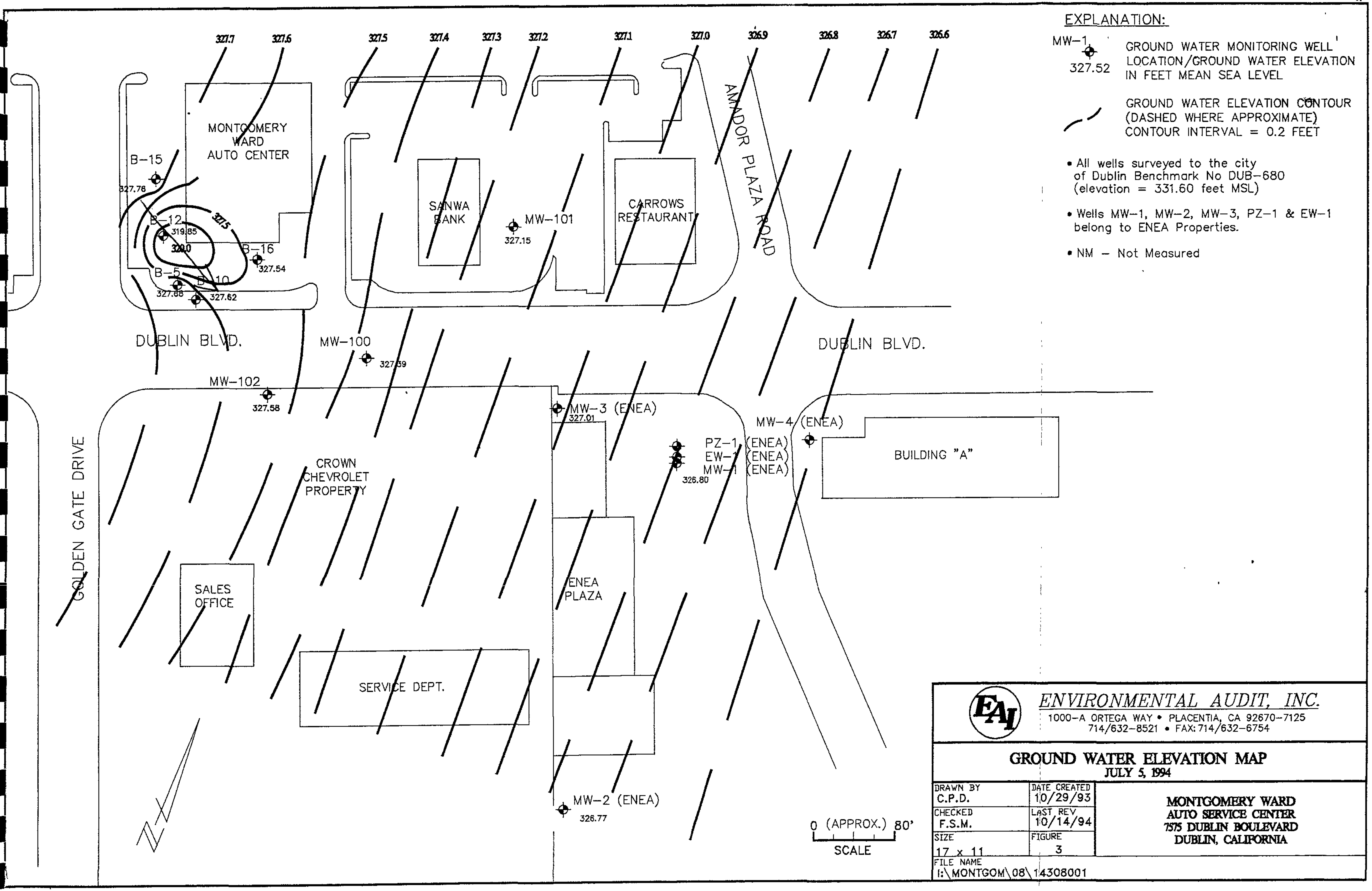
LOCATION MAP
Montgomery Ward Auto Service Center
Enea Properties
Dublin, California

N

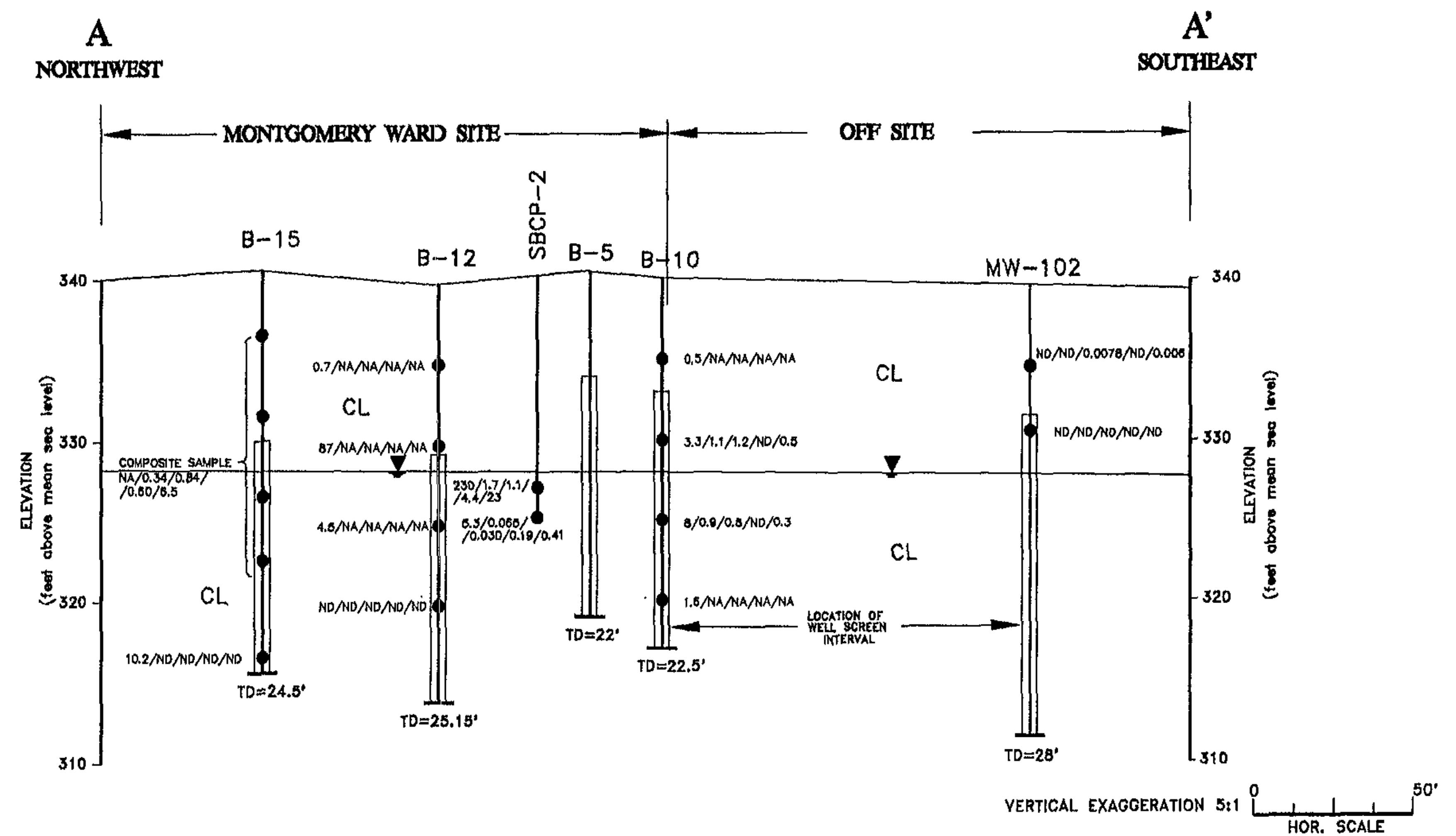
SOURCE: USGS TOPOGRAPHIC 7.5 MINUTE SERIES
DUBLIN, CALIFORNIA QUADRANGLE

Figure 1

Project No. 1233
K:\1233\1233-LM.CDR



EXPLANATION:
MW-1
327.52
GROUND WATER MONITORING WELL LOCATION/GROUND WATER ELEVATION IN FEET MEAN SEA LEVEL
GROUND WATER ELEVATION CONTOUR (DASHED WHERE APPROXIMATE) CONTOUR INTERVAL = 0.2 FEET
• All wells surveyed to the city of Dublin Benchmark No DUB-680 (elevation = 331.60 feet MSL)
• Wells MW-1, MW-2, MW-3, PZ-1 & EW-1 belong to ENEA Properties.
• NM – Not Measured
327.7
327.6
327.5
327.4
327.3
327.2
327.1
327.0
326.9
326.8
326.7
326.6
MONTGOMERY WARD AUTO CENTER
B-15
327.76
B-12
319.85
320.0
B-16
327.54
B-5
327.88
B-10
327.62
SANWA BANK
MW-101
327.15
CARROWS RESTAURANT
AMADOR PLAZA ROAD
DUBLIN BLVD.
MW-100
327.39
MW-102
327.58
DUBLIN BLVD.
MW-3 (ENEA)
327.01
MW-4 (ENEA)
PZ-1 (ENEA)
EW-1 (ENEA)
MW-1 (ENEA)
326.80
BUILDING "A"
GOLDEN GATE DRIVE
CROWN CHEVROLET PROPERTY
SALES OFFICE
SERVICE DEPT.
ENEA PLAZA
MW-2 (ENEA)
326.77
0 (APPROX.) 80'
SCALE
ENVIRONMENTAL AUDIT, INC.
1000-A ORTEGA WAY • PLACENTIA, CA 92670-7125
714/632-8521 • FAX: 714/632-6754
GROUND WATER ELEVATION MAP
JULY 5, 1994
DRAWN BY C.P.D.
DATE CREATED 10/29/93
CHECKED F.S.M.
LAST REV 10/14/94
SIZE 17 x 11
FIGURE 3
FILE NAME I:\MONTGOM\08\14308001
MONTGOMERY WARD AUTO SERVICE CENTER 7575 DUBLIN BOULEVARD DUBLIN, CALIFORNIA



EXPLANATION:

CH	-	CLAY, HIGH PLASTICITY
CL	-	SILTY CLAY, LOW PLASTICITY
ND	-	NOT DETECTED
NA	-	NOT ANALYZED
▼	-	WATER TABLE (01-13-94)
●	-	SOIL SAMPLE LOCATION

CONSTITUENTS SHOWN: TPH/B/T/E/X (parts per million)

TPH	=	TOTAL PETROLEUM HYDROCARBONS
B	=	BENZENE
T	=	TOLUENE
E	=	ETHYLBENZENE
X	=	XYLENES

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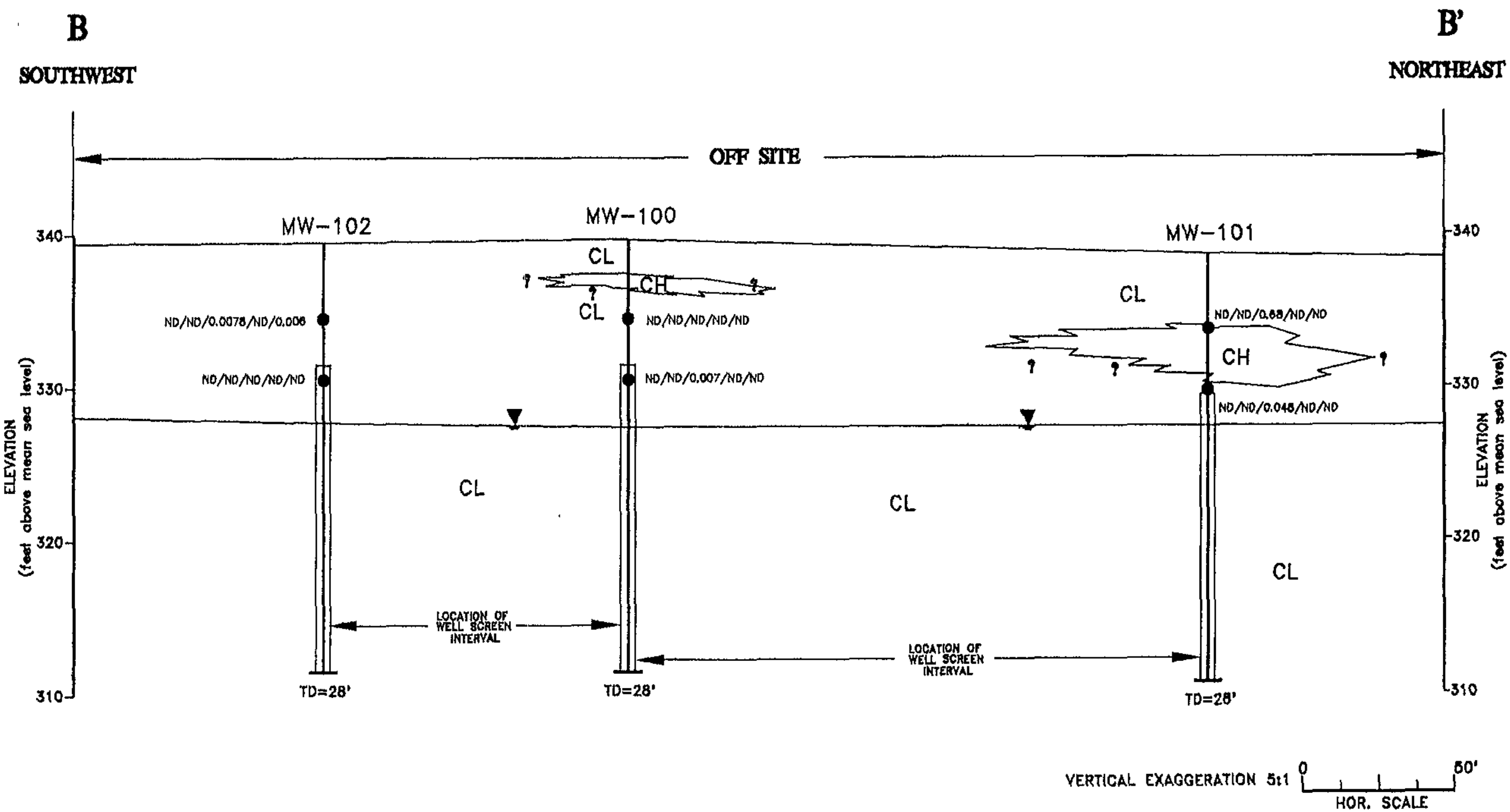
714/632-8521 • FAX: 714/632-6754

CROSS SECTION A-A'

DRAWN BY M.C.	DATE CREATED 03/11/94	MONTGOMERY WARD AUTO SERVICE CENTER DUBLIN, CALIFORNIA
CHECKED B.H.M.	LAST REV 10/10/94	
SIZE 11 x 8.5	FIGURE 5	
FILE NAME I:\MONTGOM\08\14308009		

Job. No. 1233



EXPLANATION:

CH	–	CLAY, HIGH PLASTICITY
CL	–	SILTY CLAY, LOW PLASTICITY
ND	–	NOT DETECTED
▼	–	WATER TABLE (01-13-94)
●	–	SOIL SAMPLE LOCATION

CONSTITUENTS SHOWN: TPH/B/T/E/X (parts per million)

TPH	=	TOTAL PETROLEUM HYDROCARBONS
B	=	BENZENE
T	=	TOLUENE
E	=	ETHYLBENZENE
X	=	XYLENES

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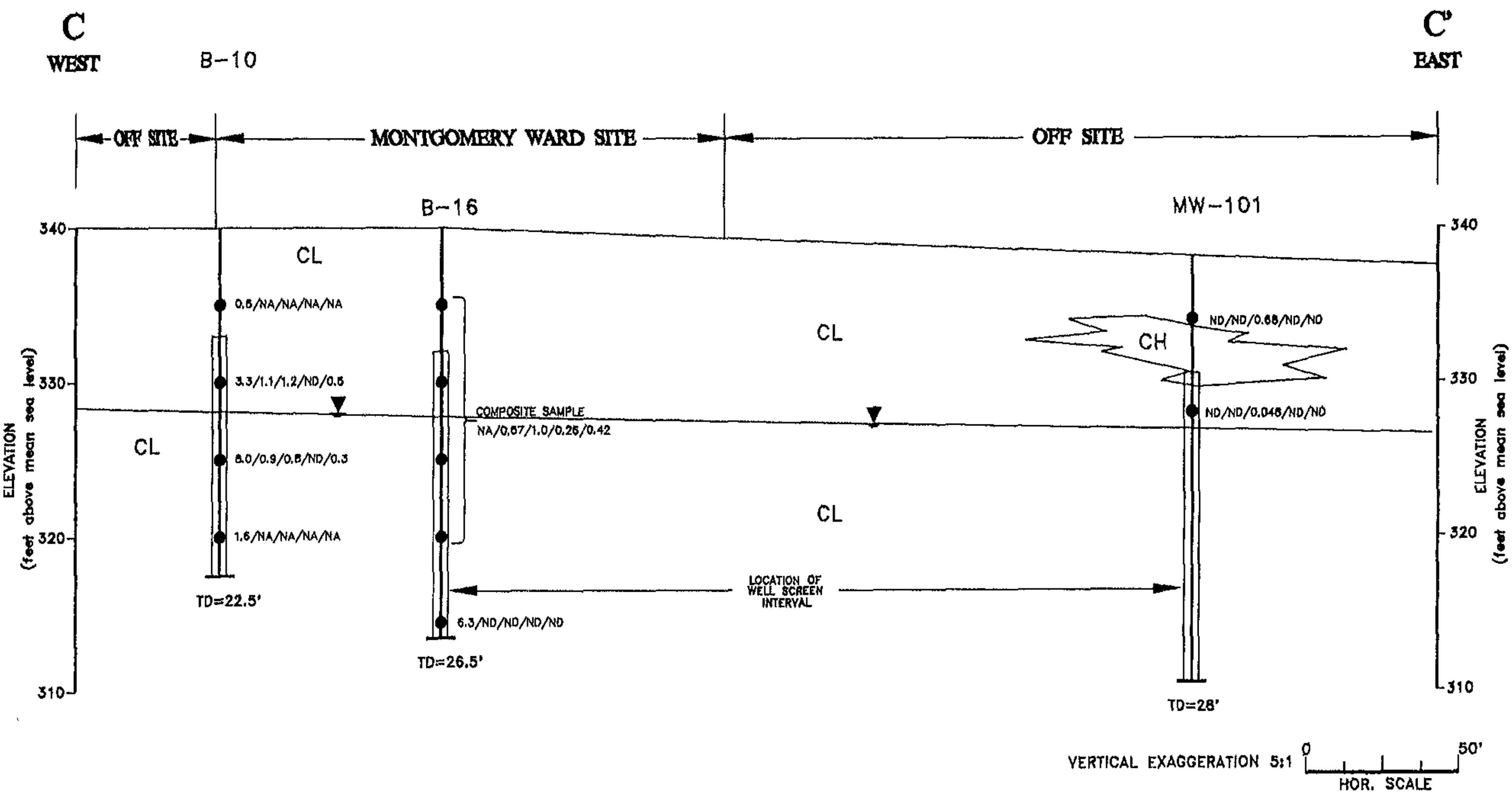
CROSS SECTION B-B'

DRAWN BY M.C.	DATE CREATED 03/14/94	MONTGOMERY WARD AUTO SERVICE CENTER DUBLIN, CALIFORNIA
CHECKED B.H.M.	LAST REV 10/14/94	
SIZE 11 x 8.5	FIGURE 6	
FILE NAME I:\MONTGOM\08\14308008		

Job. No. 1233



EXPLANATION:

CH – CLAY, HIGH PLASTICITY
CL – SILTY CLAY, LOW PLASTICITY
ND – NOT DETECTED
NA – NOT ANALYZED
▼ – WATER TABLE (01-13-94)
● – SOIL SAMPLE LOCATION

CONSTITUENTS SHOWN: TPH/B/T/E/X (parts per million)

TPH = TOTAL PETROLEUM HYDROCARBONS
B = BENZENE
T = TOLUENE
E = ETHYLBENZENE
X = XYLENES

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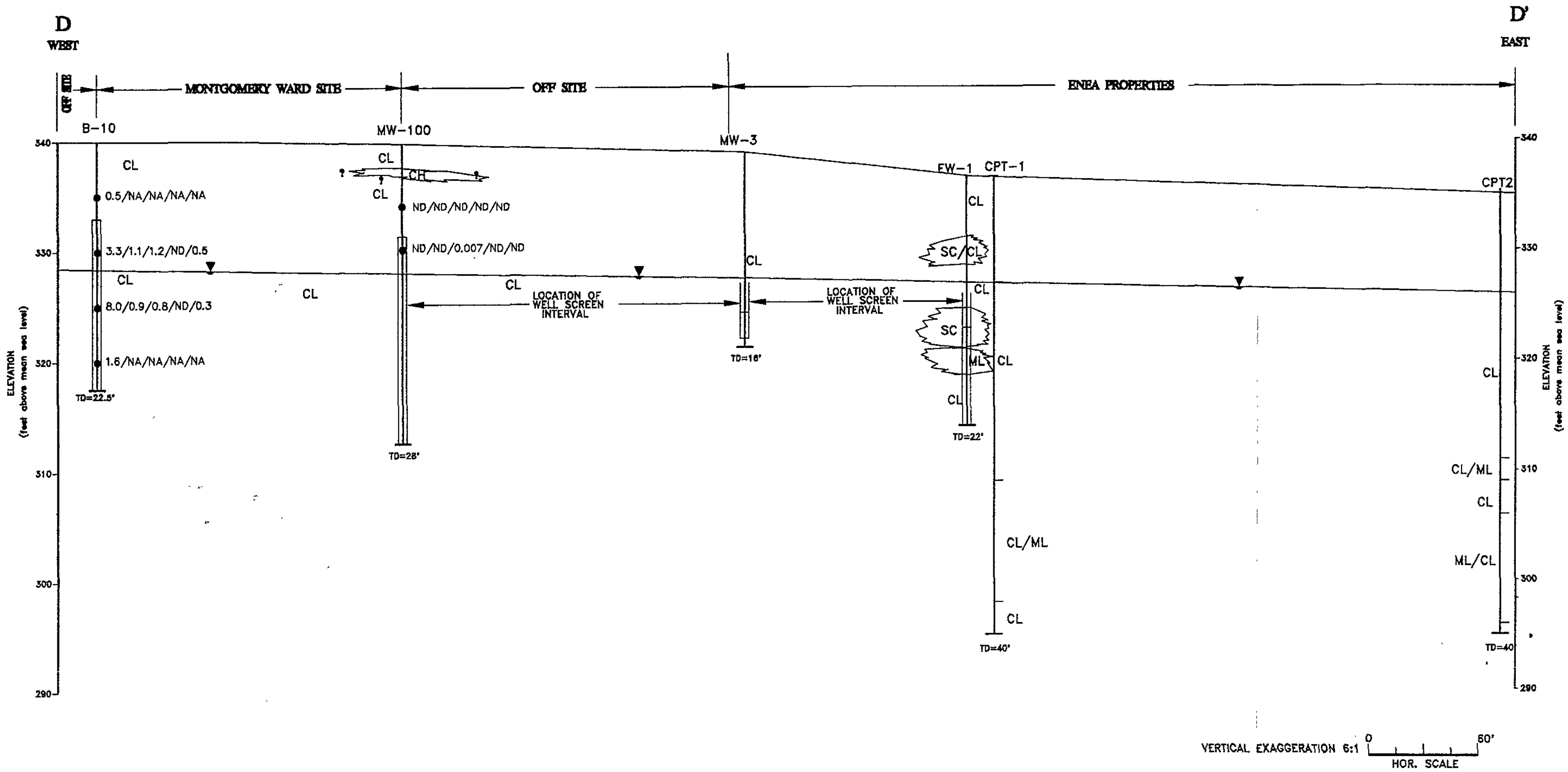
CROSS SECTION C-C'

DRAWN BY M.C.	DATE CREATED 03/14/94	MONTGOMERY WARD AUTO SERVICE CENTER DUBLIN, CALIFORNIA
CHECKED B.H.M.	LAST REV 10/14/94	
SIZE 11 x 8.5	FIGURE 7	
FILE NAME I:\MONTGOM\08\14308010		

Job. No. 1233



EXPLANATION:

CH	–	CLAY, HIGH PLASTICITY
CL	–	SILTY CLAY, LOW PLASTICITY
ND	–	NOT DETECTED
▼	–	WATER TABLE (07-05-94)
●	–	SOIL SAMPLE LOCATION

CONSTITUENTS SHOWN: TPH/B/T/E/X (parts per million)

TPH	=	TOTAL PETROLEUM HYDROCARBONS
B	=	BENZENE
T	=	TOLUENE
E	=	ETHYLBENZENE
X	=	XYLENES

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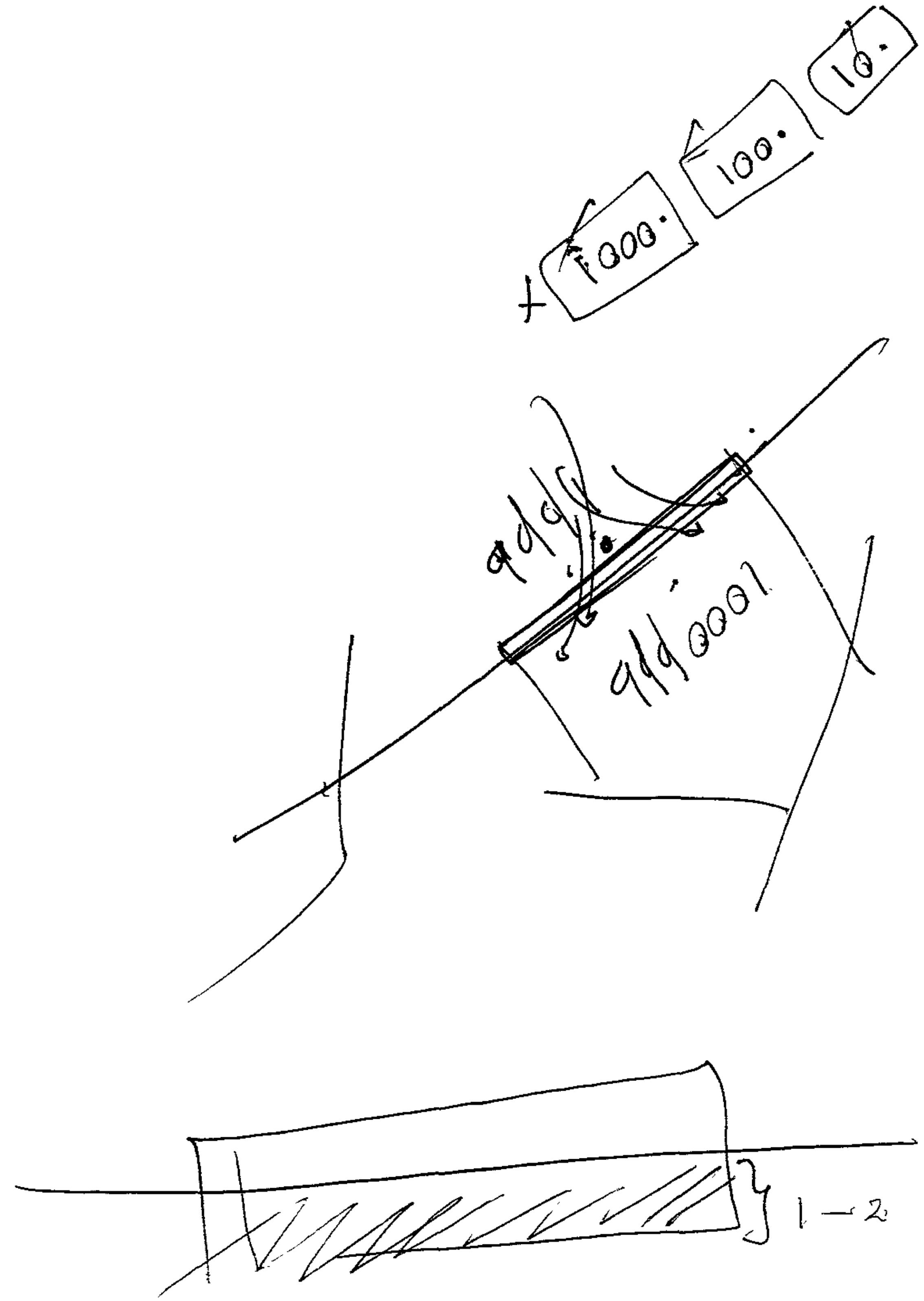
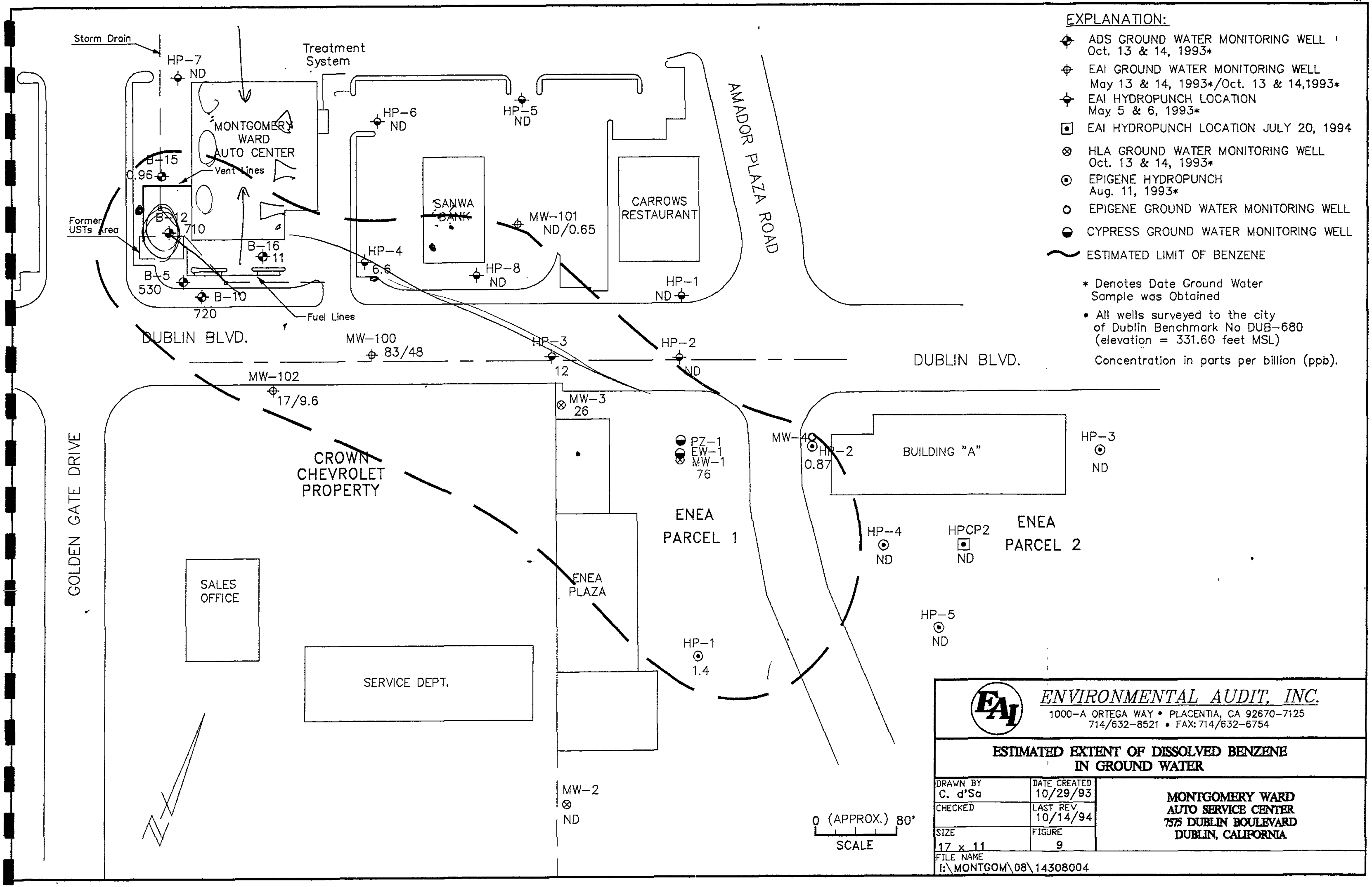
CROSS SECTION D-D'

DRAWN BY	DATE CREATED	
M.C.	10/03/94	MONTGOMERY WARD
CHECKED	LAST REV	AUTO SERVICE CENTER
	10/14/94	DUBLIN, CALIFORNIA
SIZE	FIGURE	
17 x 11	8	
FILE NAME		
I:\MONTGOM\08\14308021		

Job. No. 1233

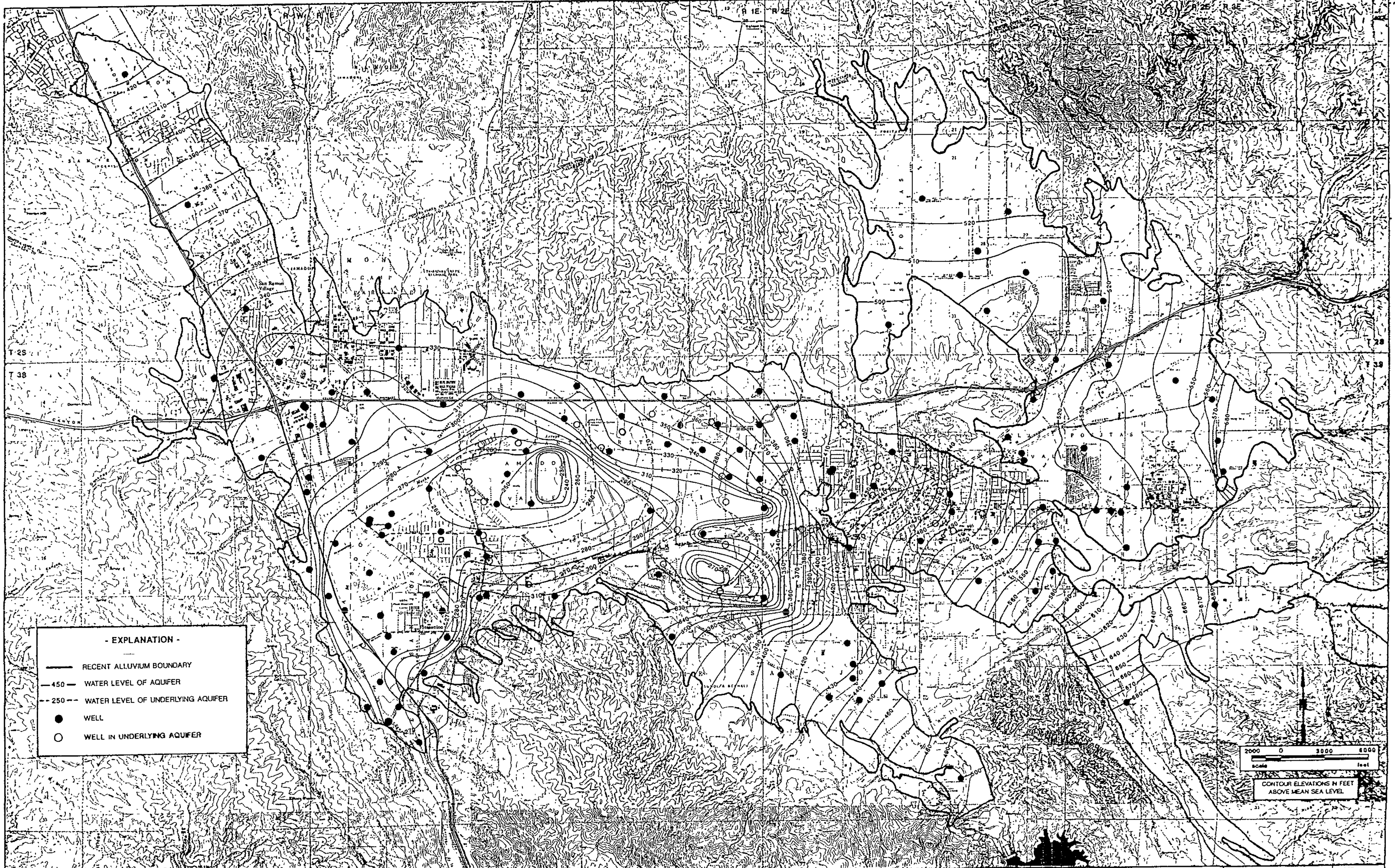

1000.
100.
10.
1 — 2



EXPLANATION:
ADS GROUND WATER MONITORING WELL Oct. 13 & 14, 1993*
EAI GROUND WATER MONITORING WELL May 13 & 14, 1993*/Oct. 13 & 14,1993*
EAI HYDROPUNCH LOCATION May 5 & 6, 1993*
EAI HYDROPUNCH LOCATION JULY 20, 1994
HLA GROUND WATER MONITORING WELL Oct. 13 & 14, 1993*
EPIGENE HYDROPUNCH Aug. 11, 1993*
EPIGENE GROUND WATER MONITORING WELL
CYPRESS GROUND WATER MONITORING WELL
ESTIMATED LIMIT OF BENZENE
* Denotes Date Ground Water Sample was Obtained
• All wells surveyed to the city of Dublin Benchmark No DUB-680 (elevation = 331.60 feet MSL)
Concentration in parts per billion (ppb).
Storm Drain
Treatment System
HP-7 ND
MONTGOMERY WARD AUTO CENTER
Vent Lines
Former USTs Area
B-15 0.96
B-12 710
B-16 11
B-5 530
B-10 720
Fuel Lines
HP-6 ND
HP-5 ND
SANWA BANK
MW-101 ND/0.65
CARROWS RESTAURANT
AMADOR PLAZA ROAD
HP-4 6.6
HP-8 ND
HP-1 ND
DUBLIN BLVD.
MW-100 83/48
HP-3 12
HP-2 ND
DUBLIN BLVD.
MW-102 17/9.6
MW-3 26
PZ-1
EW-1
MW-1 76
MW-4 0.87
HP-2
BUILDING "A"
HP-3 ND
CROWN CHEVROLET PROPERTY
ENEA PARCEL 1
HP-4 ND
HPCP2 ND
ENEA PARCEL 2
GOLDEN GATE DRIVE
SALES OFFICE
ENEA PLAZA
HP-5 ND
HP-1 1.4
SERVICE DEPT.
MW-2 ND
N
0 (APPROX.) 80'
SCALE
EAI
ENVIRONMENTAL AUDIT, INC.
1000-A ORTEGA WAY • PLACENTIA, CA 92670-7125
714/632-8521 • FAX: 714/632-6754
ESTIMATED EXTENT OF DISSOLVED BENZENE IN GROUND WATER
DRAWN BY C. d'Sa
DATE CREATED 10/29/93
CHECKED
LAST REV 10/14/94
SIZE 17 x 11
FIGURE 9
FILE NAME I:\MONTGOM\08\14308004
MONTGOMERY WARD AUTO SERVICE CENTER 7575 DUBLIN BOULEVARD DUBLIN, CALIFORNIA

ZONE 7 ALAMEDA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT	DRAWN GGATES DESIGNED CHECKED DWL APPROVED	WATER RESOURCES ENGINEERING GROUNDWATER MONITORING PROGRAM LIVERMORE VALLEY GROUNDWATER BASIN BOUNDARIES	SCALE 1" = 3000' DATE 17 FEB 1989 FILE NO M-317	SHEET GW

Figure 10



REVISIONS | NUMBER | DESCRIPTION | BY | DATE | APVD

ZONE 7 WATER AGENCY
5997 PARKSIDE DRIVE PLEASANTON CA 94588

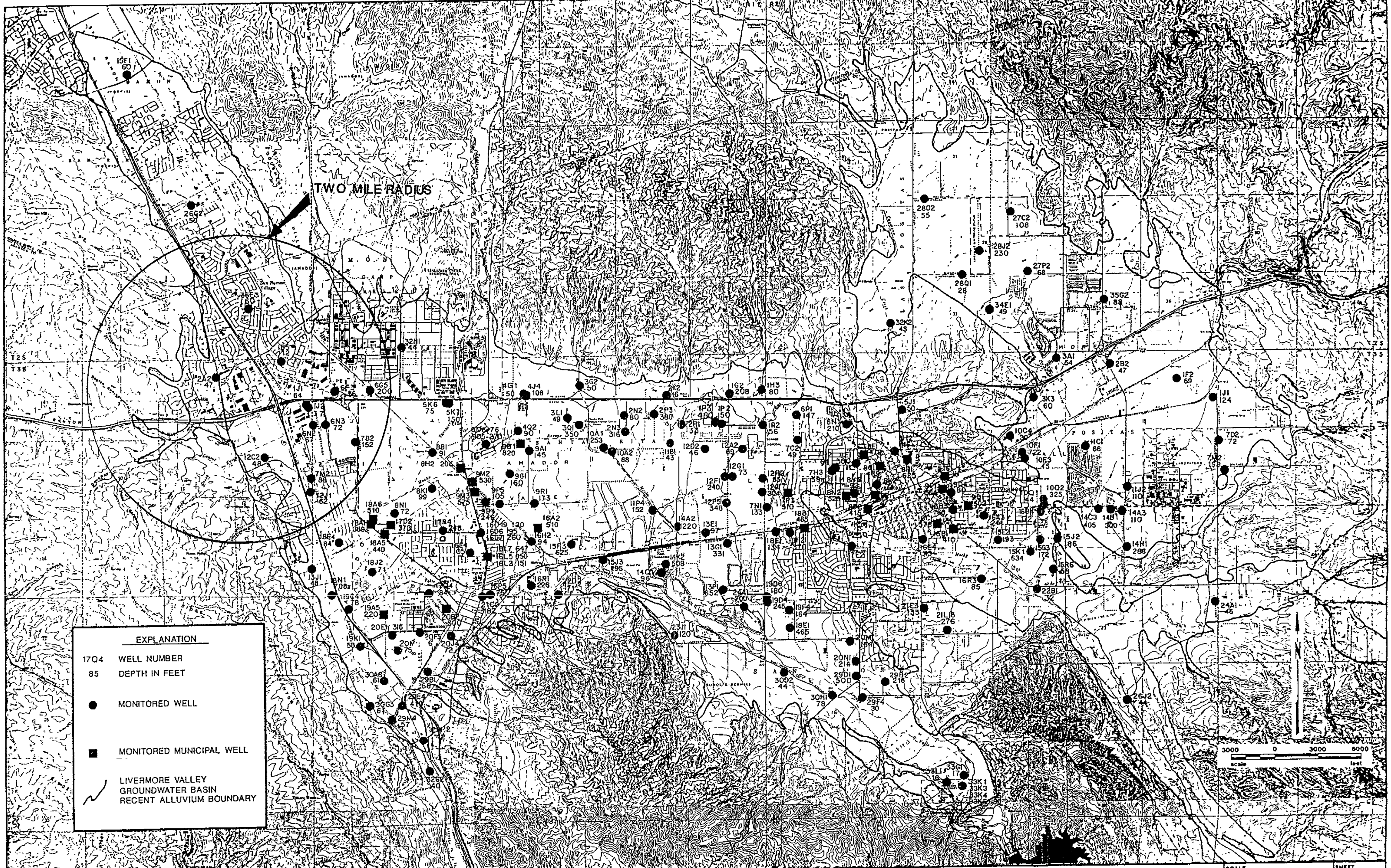
DRAWN G GATES
DESIGNED
CHECKED
APPROVED

WATER RESOURCES ENGINEERING

SPRING 1994
GROUNDWATER LEVEL CONTOURS

SCALE 1"=6000'
DATE 28 MAY 1994
FILE NO. B-334
SHEET OF SHEETS

Figure 11



REVISIONS				
3	ADDED 3S/1E 4G1 REMOVED 3S/1E 29C3 & 3S/1E 29F1			
2	RENUMBERED 3S/1E 9A2 TO 9B1			
1	ADDED 3S/1E 16A2 ADDED DEPTHS FOR 9A2 & 23F1 REVISED TITLE BLOCK AND DEPTH OF 20C3			
	DESCRIPTION	BY	DATE	APPVD

ZONE 7 WATER AGENCY
5997 PARKSIDE DRIVE PLEASANTON CA 94588

DRAWN: [signature]
DESIGNED: David W Lunn
CHECKED
APPROVED

WATER RESOURCES ENGINEERING

LOCATION OF MONITORED WELLS

SCALE: 1" = 6000'
DATE: 11 SEPT. 1991
FILE NO. M-319
SHEET GW OF SHEETS

Figure 12

APPENDIX A

Water Well Drillers Reports

CONFIDENTIAL

STATE OF CALIFORNIA DWR
WELL COMPLETION REPORT
(WELL LOGS)

REMOVED

ZONE 7
WATER RESOURCES ENGINEERING

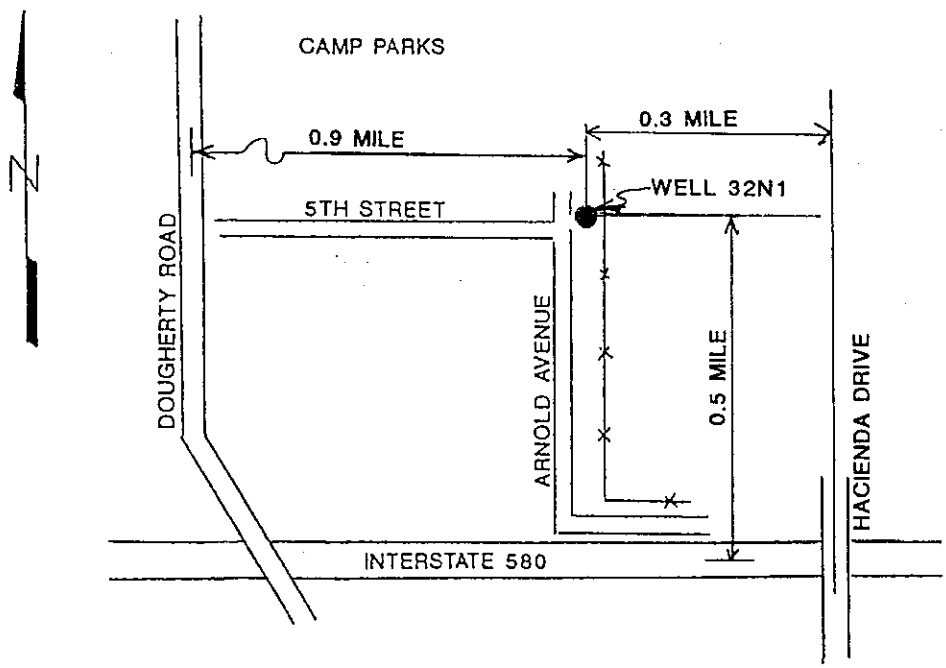
WELL LOCATION DATA

WELL NUMBER 2S / 1E - 32N1

ADDRESS Arnold Avenue and 5th Street, Camp Parks, Dublin	OTHER DESIGNATION
OWNER Zone 7, 5997 Parkside Drive, Pleasanton	PUMP: TYPE
PRIMARY USE: WATER SUPPLY	MAKE
	HP
CATHODIC ___ MONITORING X	METER NUMBER
DRILLER USGS	SOUNDED DEPTH ___ FT
DATE COMPLETED 23 Jun 76	DATE SOUNDED
DEPTH: COMPLETED 45 FT	DATE DESTROYED
DRILLED ___ FT	DATE UNLOCATABLE
DIAMETER 2.5 IN	

REMARKS (Initial and date entry)

LOCATION SKETCH
(Initial and Date)



WH 18 MAY 92

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STATE OF CALIFORNIA DWR
WELL COMPLETION REPORT
(WELL LOGS)

REMOVED

ZONE 7
WATER RESOURCES ENGINEERING

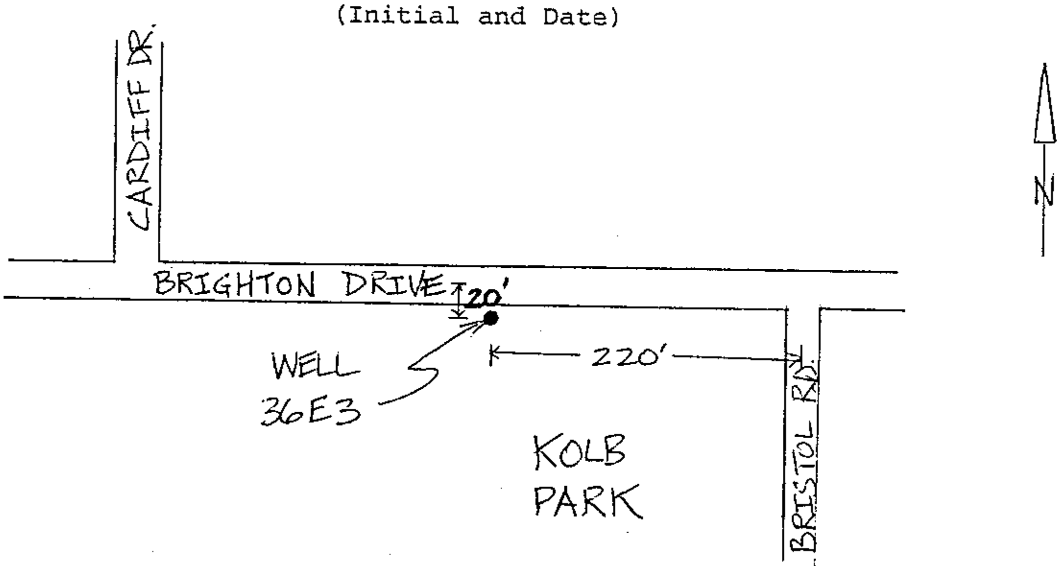
WELL LOCATION DATA

WELL NUMBER 2S / 1W - 36E3

ADDRESS Kolb Park, Brighton Drive, Dublin	OTHER DESIGNATION
OWNER Zone 7	PUMP: TYPE
	MAKE
PRIMARY USE: WATER SUPPLY	HP
CATHODIC MONITORING X	METER NUMBER
DRILLER USGS	SOUNDED DEPTH 58.2 FT
DATE COMPLETED 9-12-77	DATE SOUNDED 12-77
DEPTH: COMPLETED 59 FT	DATE DESTROYED
DRILLED 60 FT	DATE UNLOCATABLE
DIAMETER 3 IN	

REMARKS (Initial and date entry)

LOCATION SKETCH
(Initial and Date)



101985

HH 3 JUL 86

CONFIDENTIAL

STATE OF CALIFORNIA DWR
WELL COMPLETION REPORT
(WELL LOGS)

REMOVED

ZONE 7
WATER RESOURCES ENGINEERING

WELL LOCATION DATA

WELL NUMBER 3S / 1E - 6F3

ADDRESS End of Dublin Court, Dublin

OWNER Zone 7

PRIMARY USE: WATER SUPPLY ____
CATHODIC ____ MONITORING X

DRILLER USGS

DATE COMPLETED 5-17-76

DEPTH: COMPLETED 37 FT
DRILLED 37 FT

DIAMETER 2.5 IN

OTHER DESIGNATION USGS# 374211121542701

PUMP: TYPE ____
MAKE ____
HP ____

METER NUMBER ____

SOUNDED DEPTH ____ FT

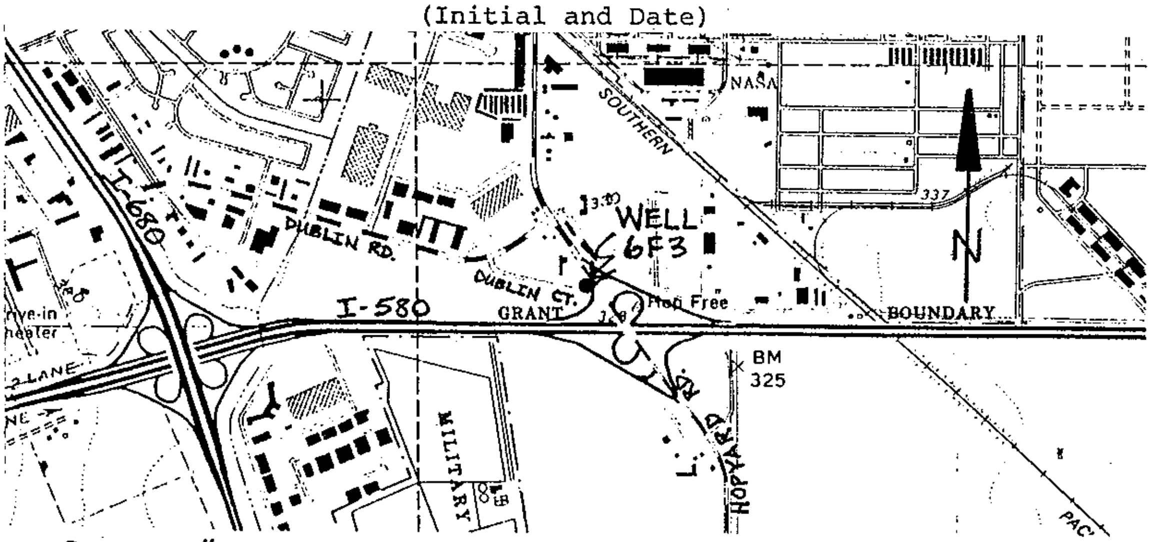
DATE SOUNDED ____

DATE DESTROYED ____

DATE UNLOCATABLE ____

REMARKS (Initial and date entry)

LOCATION SKETCH
(Initial and Date)



SCALE 1" = 2000'

MN 30 MAR 87 101985

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STATE OF CALIFORNIA DWR
WELL COMPLETION REPORT
(WELL LOGS)

REMOVED

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STATE OF CALIFORNIA DWR
WELL COMPLETION REPORT
(WELL LOGS)

REMOVED

ZONE 7
WATER RESOURCES ENGINEERING

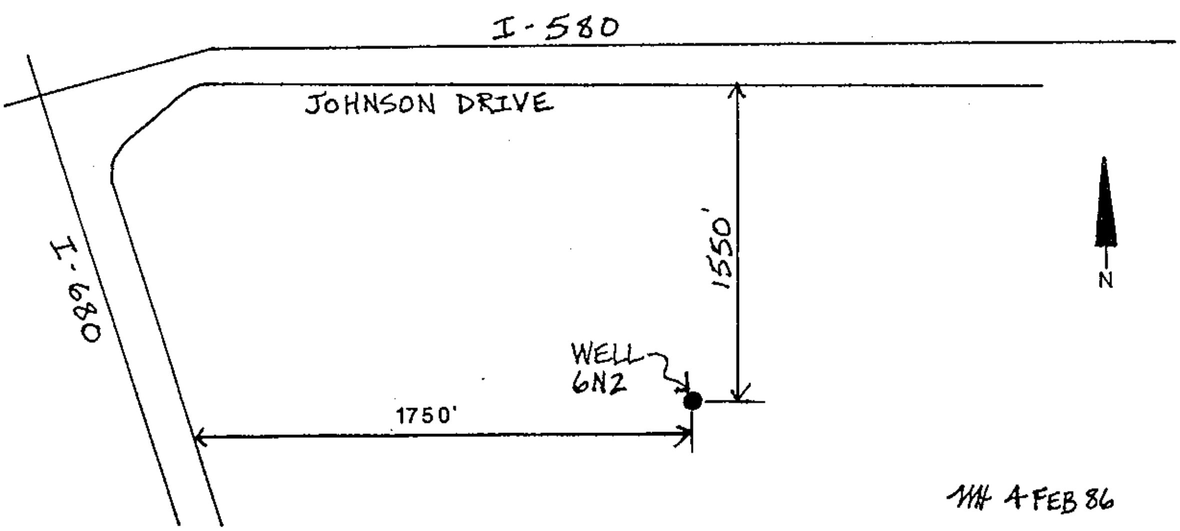
WELL LOCATION DATA

WELL NUMBER 3S / 1E - 6N2

ADDRESS Sludge Ponds, Johnson Dr., Pleasanton. East of Amador Valley Athletic Club	OTHER DESIGNATION MW-3
OWNER DSRSD	PUMP: TYPE
	MAKE
PRIMARY USE: WATER SUPPLY	HP
CATHODIC MONITORING X	METER NUMBER
DRILLER Kleinfelder	SOUNDED DEPTH FT
DATE COMPLETED 12-4-84	DATE SOUNDED
DEPTH: COMPLETED 67 FT	DATE DESTROYED
DRILLED 67 FT	DATE UNLOCATABLE
DIAMETER 4 IN	

REMARKS (Initial and date entry)

LOCATION SKETCH
(Initial and Date)



MH 4 FEB 86

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STATE OF CALIFORNIA DWR
WELL COMPLETION REPORT
(WELL LOGS)

REMOVED

ZONE 7
WATER RESOURCES ENGINEERING

WELL LOCATION DATA

WELL NUMBER 3S / 1E - 6N3

ADDRESS Sludge Ponds, Johnson Dr., Pleasanton. East of Amador Valley Athletic Club

OWNER DSRSD

PRIMARY USE: WATER SUPPLY

CATHODIC MONITORING X

DRILLER J.H. Kleinfelder & Assoc.

DATE COMPLETED 12-4-84

DEPTH: COMPLETED 72 FT

DRILLED 72 FT

DIAMETER 4 IN

OTHER DESIGNATION MW-4

PUMP: TYPE

MAKE

HP

METER NUMBER

SOUNDED DEPTH FT

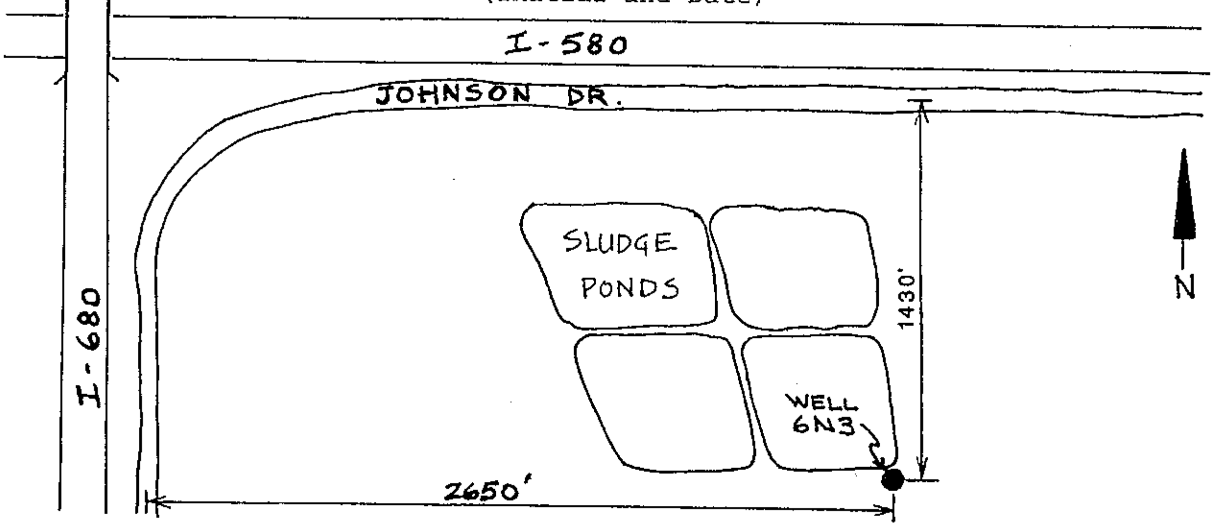
DATE SOUNDED

DATE DESTROYED

DATE UNLOCATABLE

REMARKS (Initial and date entry)

LOCATION SKETCH
(Initial and Date)



MH 31 DEC 85

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STATE OF CALIFORNIA DWR
WELL COMPLETION REPORT
(WELL LOGS)

REMOVED

ZONE 7
WATER RESOURCES ENGINEERING

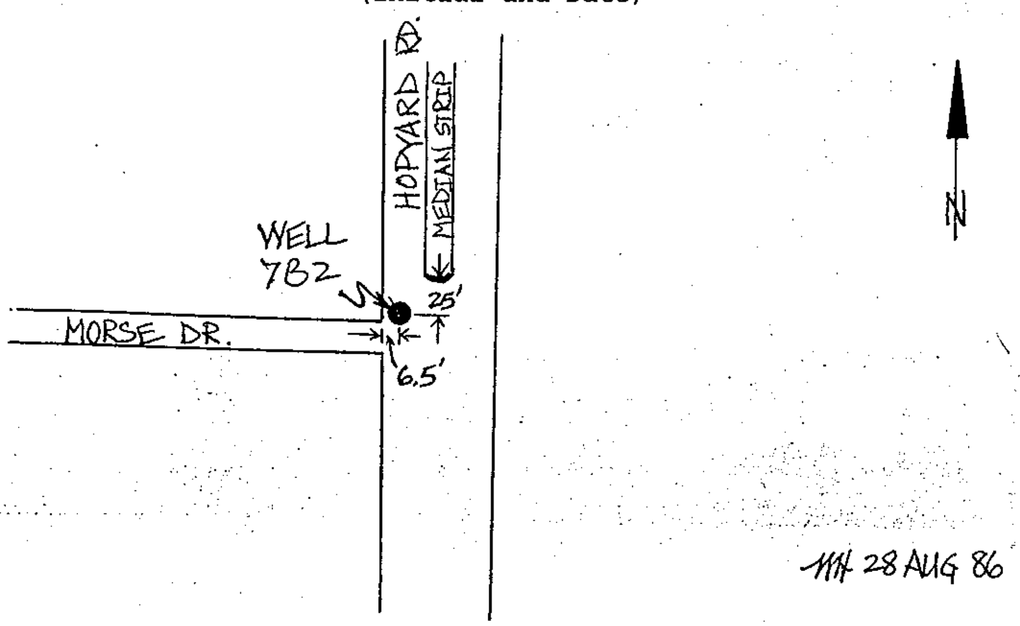
WELL LOCATION DATA

WELL NUMBER 3S / 1E - 7B2

ADDRESS Hopyard Rd. & Morse Dr., Pleasanton.	OTHER DESIGNATION
OWNER Zone 7	PUMP: TYPE
	MAKE
PRIMARY USE: WATER SUPPLY	HP
CATHODIC ___ MONITORING X	METER NUMBER
DRILLER Louis A. Wood Co.	SOUNDED DEPTH ___ FT
DATE COMPLETED 5-15-79	DATE SOUNDED
DEPTH: COMPLETED 151 FT	DATE DESTROYED
DRILLED 152 FT	DATE UNLOCATABLE
DIAMETER 4 IN	

REMARKS (Initial and date entry)

LOCATION SKETCH
(Initial and Date)



MH 28 AUG 86

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STATE OF CALIFORNIA DWR
WELL COMPLETION REPORT
(WELL LOGS)

REMOVED

ZONE 7
WATER RESOURCES ENGINEERING

WELL LOCATION DATA

WELL NUMBER 3S / 1E - 7M2

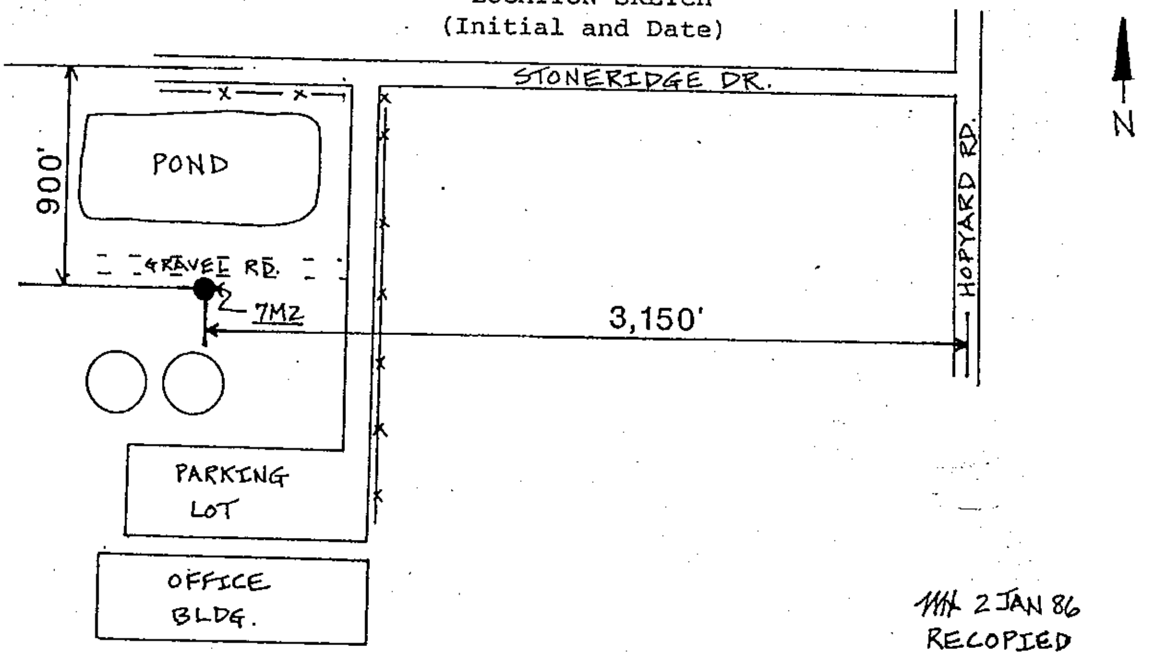
ADDRESS D.S.R.S.D. Sewage Treatment Plant, Stoneridge Dr., Pleasanton
OWNER Zone 7

PRIMARY USE: WATER SUPPLY ___
CATHODIC ___ MONITORING X
DRILLER Louis A. Wood Co.
DATE COMPLETED 5-7-79
DEPTH: COMPLETED 87 FT
DRILLED 87 FT
DIAMETER 4 IN

OTHER DESIGNATION ___
PUMP: TYPE ___
MAKE ___
HP ___
METER NUMBER ___
SOUNDED DEPTH ___ FT
DATE SOUNDED ___
DATE DESTROYED ___
DATE UNLOCATABLE ___

REMARKS (Initial and date entry)

LOCATION SKETCH
(Initial and Date)



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MH 2 JAN 86
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STATE OF CALIFORNIA DWR
WELL COMPLETION REPORT
(WELL LOGS)

REMOVED

ZONE 7
WATER RESOURCES ENGINEERING

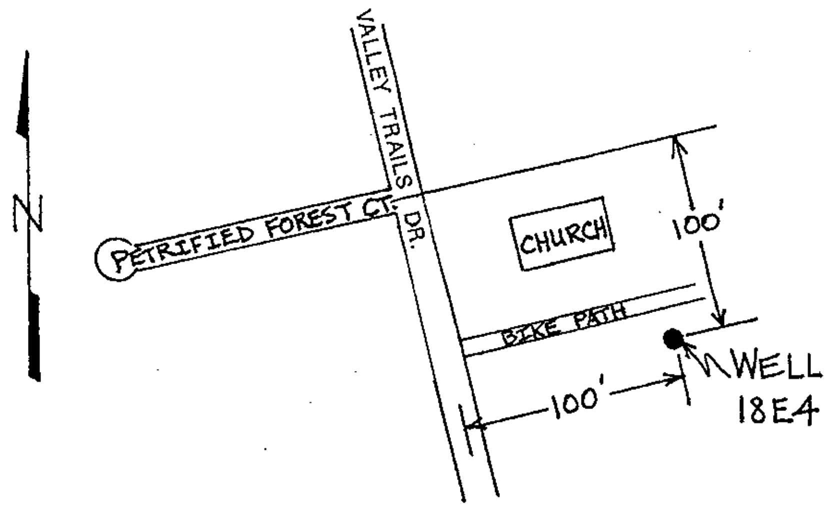
WELL LOCATION DATA

WELL NUMBER 3S / 1E - 18E4

ADDRESS Valley Trails Drive and Petrified Forest Court, Pleasanton	OTHER DESIGNATION
OWNER Zone 7 Water Agency, 5997 Parkside Drive, Pleasanton	PUMP: TYPE
PRIMARY USE: WATER SUPPLY	MAKE
	HP
CATHODIC MONITORING X	METER NUMBER
DRILLER Louis A. Wood Company	SOUNDED DEPTH 79.4 FT
DATE COMPLETED 4 May 79	DATE SOUNDED 28 May 86
DEPTH: COMPLETED 84 FT	DATE DESTROYED
DRILLED 83 FT	DATE UNLOCATABLE
DIAMETER 4 IN	

REMARKS (Initial and date entry)

LOCATION SKETCH
(Initial and Date)



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STATE OF CALIFORNIA DWR
WELL COMPLETION REPORT
(WELL LOGS)

REMOVED

ZONE 7
MONITORING WELL COMPLETION DETAILS

Well No. 3S/1W-1B5

Drilling Method Cable Tool   Date Completed May 10, 1979

Outer Casing

type steel   inner dia. 8"   guage 10   length installed 112'

perforating method Mills Knife

perforated production zones:

Depth	Slot Size	Slots/Row	No. Rows
97-102	~1/4"	4	6

Inner Casing

type plastic   inner dia. 4"   guage sched 40   length installed 108'

perforating method saw cut   final sounded depth 108'

perforated production zones:

Depth	Slot Size	Slots/Row	No. Rows
97-102'	0.05"	20/ft	5 ft

Seal Zones

Depth	Material	Outer Casing Perforated
0-2'	cement grout	No
70-90'	cement grout	yes

Well Development

method(s) compressor-pump   total time 2.3 hr   pump rate: initial 15 gpm, final 15 gpm

draw-down 60'   static water level: initial 9', final 11'   EC: initial 1200, final 950

percent sand & silt: initial 16%, final <<1%   final water color greyish

Remarks (1) outer casing developed (2) grout poured around outer casing from surface

ZONE 7
Monitoring Well Log

Location Maple Ave. at flood control channel crossing, Dublin   Well No. 3S/1W-1B5

Driller Louis A. Wood Co.   Date Drilled Feb. 1979

Cased Depth 112'   Elev. TOC 331.5'   Casing Dia. 8"

Engineer or Technical Rep. C. Lischeske

Material Description	Thick-ness	Depth	Water Bearing	Observed DTW *	SC
Brown silt fill	3'	0-3'	No		
Black clay	7'	3-10'	No		
Yellow clay	6'	10-16'	No		
Yellow sandy clay w/ gravel	4'	16-20'	Yes	10'	4500
Brown-blue clayey sand	8'	20-28'	No		
Blue clay, some sand, salt nodules & streaks at 37'	12'	28-40'	No		
Brown sandy clay, water bearing from 40-42'	14'	40-54'	Partially	N/A	1600
Gravel, avg. dia. 1/4" - 1/2", little clay	2'	54-56'	Yes	12-20'	2000
Brown clayey sand w/ some gravel	4'	56-60'	Yes	20'	2000
Brown sandy clay	2'	60-62'	No		
Blue clay, gravelly and sandy in parts, water bearing gravel at 73'	20'	62-82'	Partly	N/A	1700
Brown clayey sand	3'	82-85'	Yes	N/A	1600
Brown sandy clay	5'	85-90'	No		
Blue sandy clay w/fine gravel	10'	90-100'	Yes	N/A	900
Gravel, avg. dia. 3/4" - 1 1/2"	2'	100-102'	Yes	36'	850
Brown sandy clay	3'	102-105'	No		
Blue sandy clay w/some gravel	6'	105-111'	No		

* Measured during drilling operations - not necessarily static.

ZONE 7
WATER RESOURCES ENGINEERING

WELL LOCATION DATA

WELL NUMBER 3S / 1W - 1B5

ADDRESS Maple Drive and York Drive, Dublin

OWNER Zone 7

PRIMARY USE: WATER SUPPLY

CATHODIC ______ MONITORING X

DRILLER Louis A. Wood Co.

DATE COMPLETED 5-10-79

DEPTH: COMPLETED 108 FT

DRILLED 112 FT

DIAMETER 4 IN

OTHER DESIGNATION USGS# 374234121552001

PUMP: TYPE

MAKE

HP

METER NUMBER

SOUNDED DEPTH FT

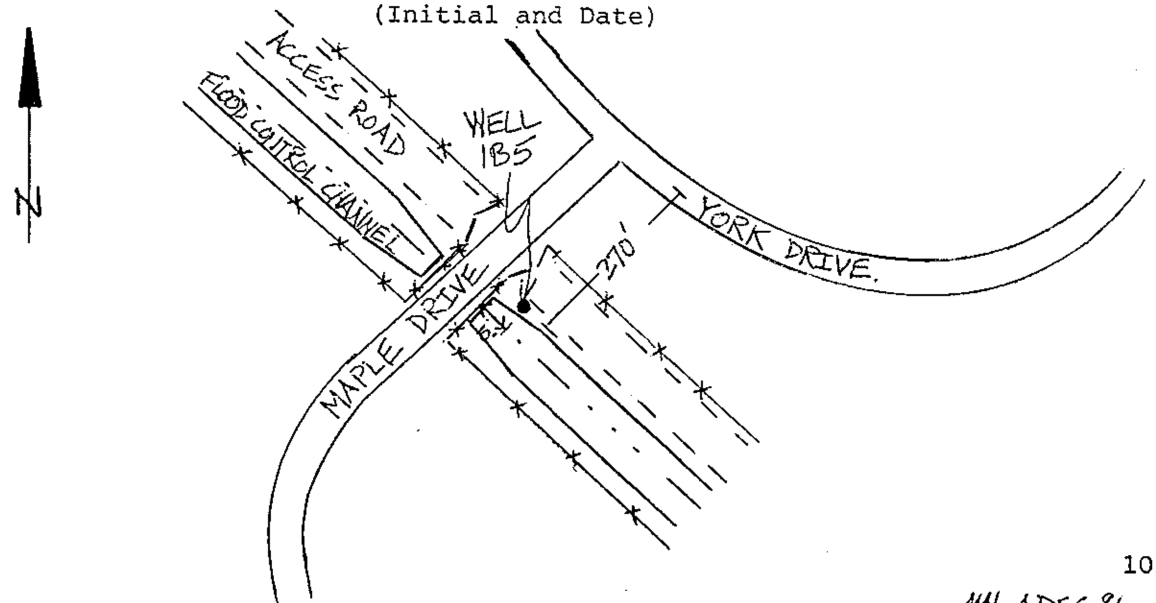
DATE SOUNDED

DATE DESTROYED

DATE UNLOCATABLE

REMARKS (Initial and date entry)

LOCATION SKETCH
(Initial and Date)



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MH 4 DEC 86

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STATE OF CALIFORNIA DWR
WELL COMPLETION REPORT
(WELL LOGS)

REMOVED

Well log continued...

from ft.	to ft.	Formation
44	47	Clay. 45 feet to 46 feet sample. sandy stiff clay, medium bluish gray mottled with minor oxidation stains, trace $CaCO_3$.
47	56	Sand. Driller indicated faster rate of penetration and suggested that drilling in sand at 47 feet. 50 feet to 52 feet sample, clean fine sand with few minor pebbles. Trace $CaCO_3$, light brown. Same as above 55 feet to 56 feet sample, very clean medium sand lens 0.2 feet (subangular grains), medium brown.
56	57	Clay. 56 feet to 57 feet sample, sandy stiff clay, medium brown.
57	70	Sand. 60 feet to 62 feet sample, clayey fine sand, sugary texture, trace $CaCO_3$, light brown. 65 feet to 67 feet sample, interbedded clean medium fine sand and silty stiff dry clay. Trace $CaCO_3$, light brown. 15 feet of sand heaved up augers, sampled to confirm we hit heaving sand.

Original Brown and Caldwell drilling and completion logs were used to prepare this report. The drilling log details are mainly only from samples collected.

WH 26 Jul 90

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STATE OF CALIFORNIA DWR
WELL COMPLETION REPORT
(WELL LOGS)

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WELL COMPLETION REPORT
(WELL LOGS)

REMOVED

ZONE 7
WATER RESOURCES ENGINEERING

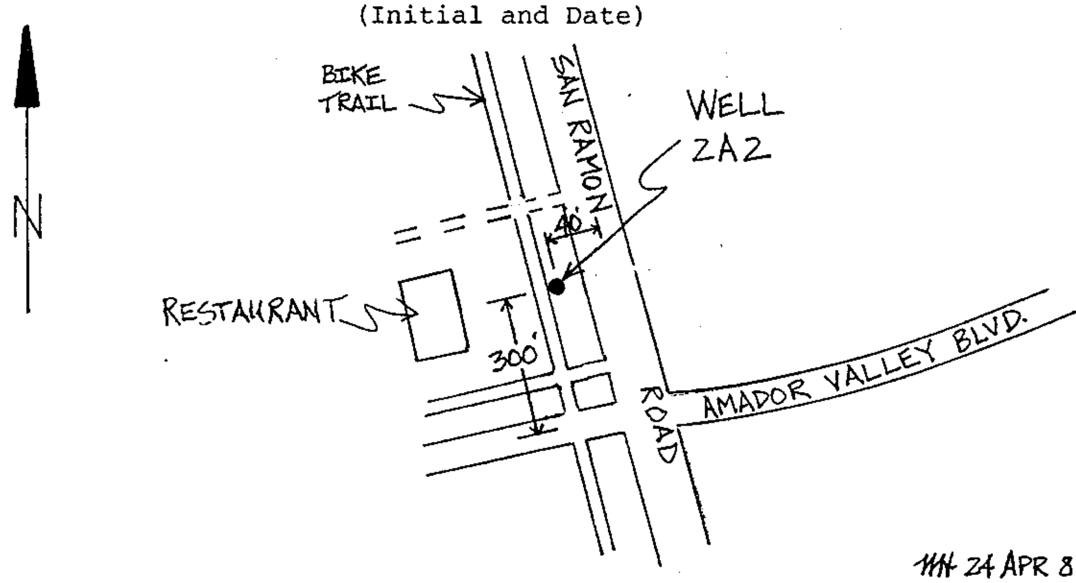
WELL LOCATION DATA

WELL NUMBER 3S / 1W - 2A2

ADDRESS San Ramon Road and Amador Valley Blvd., Dublin	OTHER DESIGNATION
OWNER Zone 7	PUMP: TYPE
	MAKE
PRIMARY USE: WATER SUPPLY	HP
CATHODIC MONITORING X	METER NUMBER
DRILLER USGS	SOUNDED DEPTH FT
DATE COMPLETED 6-18-76	DATE SOUNDED
DEPTH: COMPLETED 47 FT	DATE DESTROYED
DRILLED 47 FT	DATE UNLOCATABLE
DIAMETER 2.5 IN	

REMARKS (Initial and date entry)

LOCATION SKETCH
(Initial and Date)



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ZONE 7
WATER RESOURCES ENGINEERING

WELL LOCATION DATA

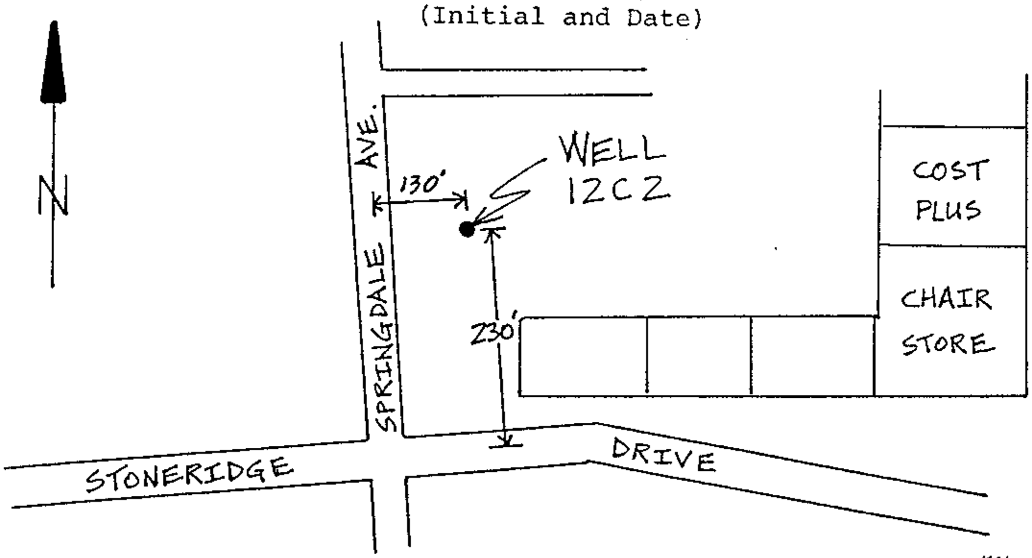
WELL NUMBER 3S / 1W - 12C2

ADDRESS Stoneridge Drive & Springdale Avenue
OWNER
PRIMARY USE: WATER SUPPLY X
CATHODIC ____ MONITORING ____
DRILLER
DATE COMPLETED
DEPTH: COMPLETED 48 FT
DRILLED 48 FT
DIAMETER 8 IN

OTHER DESIGNATION
PUMP: TYPE
MAKE
HP
METER NUMBER
SOUNDED DEPTH 58.5 FT
DATE SOUNDED 12-22-78
DATE DESTROYED
DATE UNLOCATABLE

REMARKS (Initial and date entry)

LOCATION SKETCH
(Initial and Date)



MN 27 APR 87 101985

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STATE OF CALIFORNIA DWR
WELL COMPLETION REPORT
(WELL LOGS)

REMOVED

ZONE 7
WATER RESOURCES ENGINEERING

WELL LOCATION DATA

WELL NUMBER 3S / 1W - 12J1

ADDRESS DSRSD Sewage Treatment Plant, Stoneridge Drive, Pleasanton.

OWNER Zone 7

PRIMARY USE: WATER SUPPLY ____

CATHODIC ____ MONITORING X

DRILLER USGS

DATE COMPLETED 11-14-75

DEPTH: COMPLETED 62 FT

DRILLED 62 FT

DIAMETER 2.5 IN

OTHER DESIGNATION ____

PUMP: TYPE ____

MAKE ____

HP ____

METER NUMBER ____

SOUNDED DEPTH ____ FT

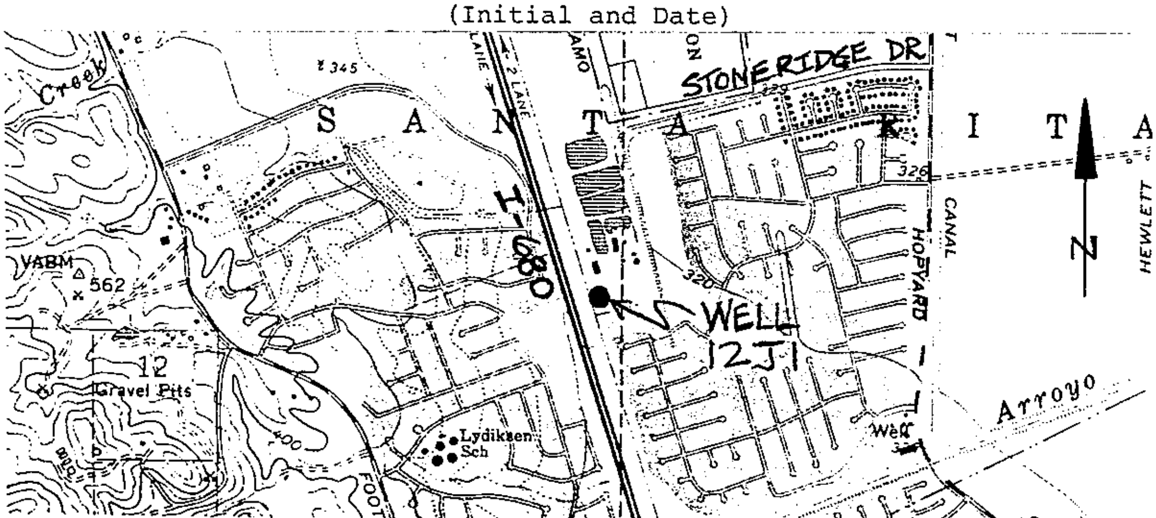
DATE SOUNDED ____

DATE DESTROYED ____

DATE UNLOCATABLE ____

REMARKS (Initial and date entry) ____

LOCATION SKETCH
(Initial and Date)



Scale: 1"=2000'

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APPENDIX B

Recent Water Analyses of Certain Zone 7 Wells

ZONE 7
WATER RESOURCES ENGINEERING
GROUNDWATER QUALITY MONITORING
MAJOR MINERAL SUMMARY
1993 WATER YEAR

SAMPLE	DATE SAMPLED	DEPTH TO WATER IN FEET	WATER TEMP. C	E.C. Micro-Mhos /cm	pH	Ca	Mg	Na	K	HCO3	SO4	Cl	NO3	SiO2	HARD	B	F	Fe	Mn	TDS	PRINCIPAL CATION	PRINCIPAL ANION	PERCENT SODIUM	LAB
						MINERAL CONSTITUENTS IN MILLIGRAMS PER LITER																		
3S/1E 5K 7	07/17/90	48.7	19.0	990	8.5	44	23	140	7	344	134		0	21	203	0.9			0.07	628	Na	HCO3	60	ZONE 7
3S/1E 5K 7	02/21/91	33.2	18.5	870	10.4							43				1.0		0.01		588	Na	SO4	89	ZONE 7
3S/1E 5K 7	06/19/91	33.5	18.8	1240	11.0							54	15			0.8				707	Na	SO4	96	ZONE 7
3S/1E 5K 7	09/10/91	35.4	18.6	1280	10.8							64	4			0.9					Na	SO4	96	ZONE 7
3S/1E 5K 7	01/14/92	36.1	18.6	1130	11.5																			FIELD
3S/1E 5K 7	03/11/92	35.1	20.0	1220	10.5	10	2	205	62	195	121	64	4	3	33	1.0			0.00	665	Na	HCO3	93	ZONE 7
3S/1E 5K 7	03/08/93	32.8	19.0	1650	10.9	2	0	204	63	5	103	65	0	2	6	0.8	0.27		0.00	636		SO4		ZONE 7
3S/1E 5K 7	05/25/93	33.2	18.8	1480	11.7	2	1	206	58	7	113	58	1	3	6	0.8	0.10		0.00	648	Na	SO4	99	ZONE 7
3S/1E 6F 3	09/29/76		18.5	2530	7.1							160	18				0.60			1695				USGS
3S/1E 6F 3	11/18/76		18.0	2620	7.3							150	15				0.70			1755				USGS
3S/1E 6F 3	01/14/77		18.0	2360	7.6	38	28					48	27				1.00			1681				USGS
3S/1E 6F 3	04/21/77		18.0	2310	7.2	40	29	530	1	1300	220	45	32	23			1.00	0.06		1560	Na	HCO3	84	USGS
3S/1E 6F 3	08/30/77		18.5	2490		54	34	550	2	1200	260	120		23			0.70			1634	Na	HCO3	81	USGS
3S/1E 6F 3	10/27/77		17.5	2550		74	39	530	2	1170	300	160								1709	Na	HCO3	77	USGS
3S/1E 6F 3	10/27/77	17.4	18.0	2400	8.3	74	39	530	2	1170	200	160	11	22	340					1614	Na	HCO3	77	DWR
3S/1E 6F 3	02/27/78		18.0	2320		37	28	530	1	1320	200	40		10			1.00			1496	Na	HCO3	85	USGS
3S/1E 6F 3	05/05/78		17.5	2470	7.6	40	33	590	1	1430	230	38	22	19			1.00			1677	Na	HCO3	85	USGS
3S/1E 6F 3	07/18/78		17.5	2400	8.0								21							1570				USGS
3S/1E 6F 3	10/11/78		18.0	2440	7.6	45	30	560	1		210	57	28	19			1.00	0.02	0.28	1635	Na		94	USGS
3S/1E 6F 3	01/22/79		19.0	2100	7.6								27							1370				USGS
3S/1E 6F 3	05/30/79		18.0	2000	7.5	28	170						20							1300				USGS
3S/1E 6F 3	07/02/79		18.5	1990	7.4							14	16							1333				USGS
3S/1E 6F 3	10/15/79		20.0	1940	7.3								17							1280				USGS
3S/1E 6F 3	10/15/79	13.0	20.0	1990	7.9								27							1280				
3S/1E 6F 3	01/08/80		19.0	1740	7.5	20	16	440	1		100	12	16	17			1.40	0.01	0.11	1166	Na		89	USGS
3S/1E 6F 3	05/15/80		18.0	1950																1307				USGS
3S/1E 6F 3	07/16/80		19.0	2090								26	9							1300				USGS
3S/1E 6F 3	10/03/80		18.0	1700								280	3							1139				USGS
3S/1E 6F 3	01/12/81	9.0	17.5	2200		34	25	500	1		280	71	10	19			1.30	0.08	0.23	1400	Na		85	USGS
3S/1E 6F 3	03/12/81	7.2	17.0	1950								50	8							1230				USGS
3S/1E 6F 3	07/27/81		18.0	3160								380	1							2117				USGS
3S/1E 6F 3	12/08/81	6.7	17.0	3290	7.1							180	4							1520				USGS
3S/1E 6F 3	03/04/82		18.0	2860	7.3	91	53	530	1		360	270	0	19			0.80	0.01	0.98	1860	Na		72	USGS
3S/1E 6F 3	05/18/82	5.3	19.5	3130	7.2							360	0							1930				USGS
3S/1E 6F 3	08/10/82	6.5	20.0	3430	7.1							470	0							2120				USGS
3S/1E 6F 3	01/17/83	5.1	18.0	3390	7.2	120	73	560	1		410	410	1	22			0.60	0.02	1.60	2050	Na		67	USGS
3S/1E 6F 3	08/04/83	5.7	18.0	3220	7.2							360	1							1980				USGS
3S/1E 6F 3	12/06/84	4.7	17.0	3570	7.0															2392				RAL
3S/1E 6F 3	04/26/90	6.3	18.1	4700	6.8	304	124	590	4	628	620	1056	0	24	1270	2.7			8.10	3031	Na	Cl	51	ZONE 7
3S/1E 6F 3	09/05/91	7.0	19.7	4500	6.5	314	138	590	5	632	577	1046	4	26	1354	2.9	0.31		4.20	3011	Na	Cl	49	ZONE 7
3S/1E 6F 3	03/09/92	5.3	18.9	4280	7.6	298	157	468	6	633	551	846	3	24	1386	3.9			1.30	2663	Na	Cl	43	ZONE 7

ZONE 7
WATER RESOURCES ENGINEERING
GROUNDWATER QUALITY MONITORING
MAJOR MINERAL SUMMARY
1993 WATER YEAR

SAMPLE	DATE SAMPLED	DEPTH TO WATER IN FEET	WATER TEMP. C	E.C. Micro-Mhos /cm	pH	Ca	Mg	Na	K	HCO3	SO4	Cl	NO3	SiO2	HARD	B	F	Fe	Mn	TDS	PRINCIPAL CATION	PRINCIPAL ANION	PERCENT SODIUM	LAB
						MINERAL CONSTITUENTS IN MILLIGRAMS PER LITER																		
3S/1E 6G 5	08/31/77	67.7		800	7.2			140		320		100			160					544				DWR
3S/1E 6G 5	07/10/79		18.0	910	7.6	34	17	140	1	330	41	100	1		160	1.1				510	Na	BCO3	67	DWR
3S/1E 6G 5	07/20/81		18.0	920	8.3	34	17	134		320		90	0		155					626	Na		66	DWR
3S/1E 6G 8	08/23/83		20.0	890	8.0	33	17	130		320		100	0		150					534	Na		65	DWR
3S/1E 6G 8	09/09/87	13.5	18.0	930	7.6															558				DWR
3S/1E 6N 2	03/20/85	11.5			6.8							10150	0							21950				DSRSD
3S/1E 6N 2	05/09/85	12.0			6.8							9750								22140				DSRSD
3S/1E 6N 2	08/06/85	13.8			6.4							12250								24830				DSRSD
3S/1E 6N 2	08/24/85	12.1			6.9							12500	0							21350				DSRSD
3S/1E 6N 2	01/21/86	14.1			6.9							10500								24300				DSRSD
3S/1E 6N 2	04/09/86	9.6			6.7							9000	1							19400				DSRSD
3S/1E 6N 2	07/15/86	11.0			6.8							8100	0							23000				DSRSD
3S/1E 6N 2	10/13/86	12.0			6.6							8150	0							29400				DSRSD
3S/1E 6N 2	01/21/87	12.0			6.8							9100	1							17880				DSRSD
3S/1E 6N 2	04/02/87	11.0			7.1							7700	0							17360				DSRSD
3S/1E 6N 2	07/28/87	12.0			6.3							10250	0							22070				DSRSD
3S/1E 6N 2	10/06/87	12.0			6.8							9450	1							27480				DSRSD
3S/1E 6N 2	05/17/88	12.0			7.0							9860	1							15870				DSRSD
3S/1E 6N 2	10/12/88	13.0			6.8							9160	1							18460				DSRSD
3S/1E 6N 2	01/19/89	12.0			6.8							9050	1							17972				DSRSD
3S/1E 6N 2	04/19/89	12.0			6.9							9050	1							17936				DSRSD
3S/1E 6N 2	08/11/89	13.0			6.8							9540	0							19110				DSRSD
3S/1E 6N 2	10/04/89	13.0			6.6							8160	1							16640				DSRSD
3S/1E 6N 2	01/02/90	13.0			7.0							8850	1							18550				DSRSD
3S/1E 6N 2	07/03/90	13.0			6.9							8050	0							21300				DSRSD
3S/1E 6N 2	10/03/90	13.0			6.9							10220	0							17305				DSRSD
3S/1E 6N 2	01/03/91	13.0			6.8							7000	1							17940				DSRSD
3S/1E 6N 2	04/05/91	11.7			6.7							9197	0							18730				DSRSD
3S/1E 6N 2	07/04/91	13.2			6.8							9960	0							15370				DSRSD
3S/1E 6N 2	03/04/92	13.0			6.8							9700	2							16510				DSRSD
3S/1E 6N 2	07/31/92	14.0			6.8							9480	0							23150				DSRSD
3S/1E 6N 2	10/26/92	14.5			7.3							9310	1							20406				DSRSD
3S/1E 6N 2	03/29/93	12.4			7.0							8910	0							16150				DSRSD
3S/1E 6N 3	03/20/85	15.0			7.0							4600	1							9990				DSRSD
3S/1E 6N 3	05/09/85	15.0			7.3							3800								8560				DSRSD
3S/1E 6N 3	08/06/85	16.4			6.7							3820	0							9300				DSRSD
3S/1E 6N 3	09/24/85	16.7			7.1							4000	1							7760				DSRSD
3S/1E 6N 3	01/21/86	16.2			7.2							3400								8900				DSRSD
3S/1E 6N 3	04/09/86	14.1			7.0							3800	0							8940				DSRSD
3S/1E 6N 3	07/15/86	16.0			7.1							3500	0							10360				DSRSD

ZONE 7
WATER RESOURCES ENGINEERING
GROUNDWATER QUALITY MONITORING
MAJOR MINERAL SUMMARY
1993 WATER YEAR

SAMPLE	DATE SAMPLED	DEPTH TO WATER IN FEET	WATER TEMP. C	E.C. Micro-Mhos /cm	pH	Ca	Mg	Na	K	HCO3	SO4	Cl	NO3	SiO2	HARD	B	F	Fe	Mn	TDS	PRINCIPAL CATION	ANION	PERCENT SODIUM	LAB
						MINERAL CONSTITUENTS IN MILLIGRAMS PER LITER																		
3S/1E 6N 3	10/13/86	16.0			6.8							3575	2							10900				DSRSD
3S/1E 6N 3	01/21/87	17.0			7.1							3550	2							6840				DSRSD
3S/1E 6N 3	04/02/87	16.0			7.2							3400	0							7370				DSRSD
3S/1E 6N 3	07/28/87	16.0			6.2							3600	0							8140				DSRSD
3S/1E 6N 3	10/06/87	17.0			7.1							3300	0							9180				DSRSD
3S/1E 6N 3	05/17/88	17.0			7.3							3250	2							7940				DSRSD
3S/1E 6N 3	10/12/88	17.5			7.1							3070	4							6530				DSRSD
3S/1E 6N 3	01/19/89	17.0			7.1							3160	0							7387				DSRSD
3S/1E 6N 3	04/19/89	17.0			7.2							3229	0							7869				DSRSD
3S/1E 6N 3	07/06/89	17.0			7.1							3327	0							7741				DSRSD
3S/1E 6N 3	08/11/89	17.0			7.1							3327	0							7741				DSRSD
3S/1E 6N 3	10/04/89	18.0			6.9							2925	1							7630				DSRSD
3S/1E 6N 3	01/02/90	17.0			7.3							3220	1							7340				DSRSD
3S/1E 6N 3	07/03/90	17.0			7.2							2850	1							8510				DSRSD
3S/1E 6N 3	10/03/90	17.0			7.3							3090	0							6575				DSRSD
3S/1E 6N 3	01/03/91	17.0			6.7							2440	0							7010				DSRSD
3S/1E 6N 3	04/05/91	16.9			7.0							2950	2							7140				DSRSD
3S/1E 6N 3	07/04/91	17.7			7.3							2800	0							7390				DSRSD
3S/1E 6N 3	03/04/92	18.0			7.1							2860	0							5640				DSRSD
3S/1E 6N 3	10/26/92	20.0			7.6							2690	2							3860				DSRSD
3S/1E 6N 3	03/23/93	17.4			7.1							2695												DSRSD
3S/1E 7B 2	10/18/79		18.0	790	8.5							110								435				USGS
3S/1E 7B 2	01/30/80		16.0	760	8.2	13	10	130	1		36	110	0	13		0.9	0.40	0.04	0.08	418	Na		79	USGS
3S/1E 7B 2	06/09/80		18.0									100	0							417				USGS
3S/1E 7B 2	08/12/80			800																440				USGS
3S/1E 7B 2	11/13/80		17.0	680								110								374				USGS
3S/1E 7B 2	03/23/81	12.9	19.0	680		8	6	110	1		31	92		11		0.8	0.30	0.09	0.04	372	Na		66	USGS
3S/1E 7B 2	06/30/81	13.0	19.0	675								110	2							386				USGS
3S/1E 7B 2	09/28/81		18.0	690								130	1							380				USGS
3S/1E 7B 2	12/23/81	12.9	15.0	880	9.4							120	0							384				USGS
3S/1E 7B 2	03/18/82		18.0	690	9.3	9	6	130	1		-5	98	0	12		0.9	0.40	0.03	0.03	379	Na		86	USGS
3S/1E 7B 2	06/25/82	10.9	17.0	730	9.0							96	0							375				USGS
3S/1E 7B 2	10/13/82	11.8	18.0	700	8.5							110	0							375				USGS
3S/1E 7B 2	03/22/83		18.0	560	8.6	14	9	100	1		34	58	0	14		0.6	0.40	0.01	0.06	317	Na		76	USGS
3S/1E 7B 2	09/19/83	8.3	18.0	700	8.2							81	0							361				USGS
3S/1E 7B 2	02/28/84		18.0	660	8.9	12	7	136				86			59					317	Na		84	ZONE 7
3S/1E 7B 2	08/13/84		18.0	660	7.8	13	8	114	1	192	40	71	1	14	66	0.8			0.05	357	Na	HCO3	79	ZONE 7
3S/1E 7B 2	09/10/85	8.3	17.0	830	7.9	49	28	68	6	224	93	101	4	21	240	0.5			0.03	479	Na	HCO3	39	ZONE 7
3S/1E 7B 2	08/26/86	8.2	20.0	660	9.3	14	12	99	4	165	34	103	1	11	84	0.3			0.05	358	Na	Cl	72	ZONE 7
3S/1E 7B 2	06/25/87	8.4	19.0	710	8.2	19	12	124	2	212	58	105	0	16	99	0.0			0.08	440	Na	HCO3	74	ZONE 7
3S/1E 7B 2	11/19/87	9.0	17.0	710	8.8	14	7	134	2	193	38	101	0	9	64	0.6			0.04	400	Na	HCO3	82	ZONE 7

ZONE 7
WATER RESOURCES ENGINEERING
GROUNDWATER QUALITY MONITORING
MAJOR MINERAL SUMMARY
1993 WATER YEAR

SAMPLE	DATE SAMPLED	DEPTH TO WATER IN FEET	WATER TEMP. C	E.C. Micro-Mhos /cm	pH	Ca	Mg	Na	K	HCO3	SO4	Cl	NO3	SiO2	HARD	B	F	Fe	Mn	TDS	PRINCIPAL CATION	PRINCIPAL ANION	PERCENT SODIUM	LAB
						MINERAL CONSTITUENTS IN MILLIGRAMS PER LITER																		
3S/1E 7B 2	07/09/90	11.0	19.2	690	9.6	10	5	134	2	199	28	107	0	10	45				0.02	412	Na	HCO3	87	ZONE 7
3S/1E 7B 2	07/22/92	13.4	18.8	730	11.3	12	2	155	3	64	9	91	0	7	39	1.1	0.21		0.01	441	Na	Cl	90	ZONE 7
3S/1E 7M 2	07/25/79		18.2	2620	7.3	290	90	150	3		230	540		27		0.3	0.20			1520	Ca		23	USGS
3S/1E 7M 2	11/14/79		17.0	2210	7.3							470	0							1282				USGS
3S/1E 7M 2	01/04/80		13.5	2420	7.3	270	89	120	2		210	540	0	26		0.2	0.20		1.70	1404	Ca		20	USGS
3S/1E 7M 2	06/11/80		18.0	2640								560	0							1531				USGS
3S/1E 7M 2	08/12/80		18.6	260								480								1420				USGS
3S/1E 7M 2	11/24/80		17.5	1970								400								1143				USGS
3S/1E 7M 2	03/18/81	16.7	17.0	2170		200	70	130	2		150	450		24		0.3	0.20		0.79	1240	Ca		27	USGS
3S/1E 7M 2	06/25/81	18.2	18.0	1900								320								1040				USGS
3S/1E 7M 2	09/04/81		17.0	1660								290	0							963				USGS
3S/1E 7M 2	12/28/81	16.7	17.0	2060	7.4							400	0							1120				USGS
3S/1E 7M 2	03/19/82		18.0	1820	7.3	160	56	120	2		140	340	0	26		0.3	0.20		0.60	1020	Ca		29	USGS
3S/1E 7M 2	06/25/82	15.2	17.0	1440	7.6							250	0							864				USGS
3S/1E 7M 2	10/13/82		18.0	1260	7.3								0							731				USGS
3S/1E 7M 2	03/22/83		17.0	1380	7.6	110	46	110	2		110	180	0	22		0.3	0.30	0.03	0.25	722	Ca		34	USGS
3S/1E 7M 2	09/19/83	14.9	19.0	1250	7.5							130	0							710				USGS
3S/1E 7M 2	02/28/84		18.0	1160	7.5	96	36	100				108			391					573	Ca		36	ZONE 7
3S/1E 7M 2	08/13/84		18.0	1180	7.0	75	34	110	2	410	97	114	1	24	331	0.3			0.34	658	Na	HCO3	42	ZONE 7
3S/1E 7M 2	10/30/84	15.8	18.0	1040	7.4	93	37	90	2	413	92	111		25	385	0.3			0.22	652	Ca	HCO3	34	ZONE 7
3S/1E 7M 2	12/07/84	15.0	17.0	1010	7.1															586				EAL
3S/1E 7M 2	08/13/85	14.9	19.5	1030	7.3	94	34	87	2	424	88	86	2	31	377				0.34	632	Ca	HCO3	34	ZONE 7
3S/1E 7M 2	12/23/85	15.7	17.5	1000	7.4							83	1							626				ZONE 7
3S/1E 7M 2	03/20/86	13.3	20.0	1000	7.1							76	1							605				ZONE 7
3S/1E 7M 2	05/28/86	16.0	19.0	940	7.4					404		66								573				ZONE 7
3S/1E 7M 2	08/26/86	17.1	18.5	970	7.7	82	32	65	2	425	82	67	1	24	338				0.33	583	Ca	HCO3	35	ZONE 7
3S/1E 7M 2	12/10/86	18.0	18.5	940	7.3							69	1							548				ZONE 7
3S/1E 7M 2	03/05/87	16.7	18.0	930	7.4							69								440				ZONE 7
3S/1E 7M 2	05/18/87	16.7	18.5	890	7.7							61	1							520				ZONE 7
3S/1E 7M 2	07/20/87	17.3	19.5	960	7.8	84	17	88	2	410	80	67	0	24	279	0.5			0.26	562	Ca	HCO3	41	ZONE 7
3S/1E 7M 2	12/10/87	18.3	18.0	940	7.4	82	23	86	2	417	84	61	1	24	311	0.0			0.30	571	Ca	HCO3	38	ZONE 7
3S/1E 7M 2	04/30/90	19.6	18.4	1230	7.5	112	29	100	5	409	114	154	1	25	400	0.0			0.35	742	Ca	HCO3	36	ZONE 7
3S/1E 7M 2	09/30/91	22.9	19.1	1070	7.4	65	32	110	20	344	91	105	0	24	294	0.3	0.30		0.00	617	Na	HCO3	45	ZONE 7
3S/1E 7M 2	07/22/92	23.4	19.0	1000	8.7	56	32	106	10	338	94	108	0	16	274	0.2	0.44		0.11	602	Na	HCO3	46	ZONE 7
3S/1E 8B 1	10/03/79		25.0	1690		67	58	190	2		150	250	3	19			0.30	0.02	0.30	1014	Na		51	USGS
3S/1E 8B 1	11/26/79		17.0	1530	7.5							240	2							918				USGS
3S/1E 8B 1	07/01/80		17.0	2180								270	7							1308				USGS
3S/1E 8B 1	08/13/80			1590									1							954				USGS
3S/1E 8B 1	11/13/80			2090								300	8							1220				USGS
3S/1E 8B 1	03/24/81	46.3	17.0	2220		120	110	230	1		250	290	9	26			0.30		0.23	1350	Na		40	USGS

APPENDIX C

Recent Ground Water Elevation Data

ZONE 7
WATER RESOURCES ENGINEERING
GROUNDWATER MONITORING PROGRAM
SEMIANNUAL GROUNDWATER LEVELS IN FEET
SPRING 1994

WELL NUMBER	WELL DEPTH	SUB-BASIN	MEASUREMENT DATE	DEPTH TO WATER	GROUND-WATER ELEVATION	CHANGE IN ELEVATION FALL 1993 TO SPRING 1994	CHANGE IN ELEVATION SPRING 1993 TO SPRING 1994
2S/1E 32N 1	44	CAMP	07-Apr-94	27.6	328.9	-0.5	-1.6
2S/1W 15F 1	60	BISHOP	07-Apr-94	12.0	424.7	0.4	-1.8
2S/1W 26C 2	50	DUBLIN	07-Apr-94	25.9	377.6	-0.6	-4.0
2S/1W 36E 3	60	DUBLIN	07-Apr-94	4.5	339.3	0.7	-1.1
2S/2E 27C 2	108	SPRING	11-Apr-94	17.7	521.8	-0.8	-1.3
2S/2E 27P 2	68	SPRING	11-Apr-94	1.8	501.0	0.6	-1.6
2S/2E 28D 2	55	MAY	11-Apr-94	26.0	525.5	-0.1	-0.4
2S/2E 28J 2	230	MAY	11-Apr-94	3.4	512.8	0.8	-2.1
2S/2E 28Q 1	28	MAY	11-Apr-94	3.9	505.9	1.7	-1.7
2S/2E 32K 2	43	CAYETANO	11-Apr-94	7.8	494.4	-0.9	-2.6
2S/2E 34E 1	49	MAY	11-Apr-94	4.8	492.3	0.2	-0.2
2S/2E 35G 2	88	SPRING	11-Apr-94	8.0	517.6	-0.3	-3.4
* 3S/1E 1G 2	208	MOCHO 2	11-Apr-94	10.8	411.3	14.5	4.3
3S/1E 1H 3	80	MOCHO 2	11-Apr-94	32.3	388.8	2.1	2.0
3S/1E 1P 2	50	AMADOR	11-Apr-94	23.7	363.3	-3.8	-4.7
3S/1E 1P 3	480	AMADOR	11-Apr-94	115.5	276.3	14.9	13.8
3S/1E 1R 2	56	MOCHO 2	30-Mar-94	15.9	380.4	2.3	2.5
3S/1E 2K 2	46	CAMP	11-Apr-94	30.5	363.9	0.5	-2.1
3S/1E 2N 2	80	CAMP	11-Apr-94	18.6	342.0	-0.3	-3.5
3S/1E 2N 3	316	AMADOR	11-Apr-94	101.3	263.7	7.8	10.6
3S/1E 2P 3	380	CAMP	11-Apr-94	96.4	272.6	13.9	15.0
3S/1E 2R 1	33	AMADOR	11-Apr-94	17.3	357.2	2.7	-2.9
3S/1E 3G 2	50	CAMP	08-Apr-94	23.2	328.4	-1.4	-4.0
3S/1E 3L 1	49	CAMP	11-Apr-94	38.5	312.9	-0.6	-2.5
3S/1E 3Q 1	350	AMADOR	11-Apr-94	96.8	256.0	-5.0	-4.0
3S/1E 4G 1	50	CAMP	08-Apr-94	29.3	314.1	-0.2	-2.6
* 3S/1E 4J 4	108	CAMP	08-Apr-94	40.1	304.2	-0.2	-0.5
3S/1E 4Q 2	90	AMADOR	08-Apr-94	66.9	275.1	-0.5	-0.6
3S/1E 5K 6	75	CAMP	08-Apr-94	19.4	324.0	-3.0	-5.2
* 3S/1E 5K 7	150	CAMP	08-Apr-94	32.8	310.8	0.5	0.0
3S/1E 6F 3	36	DUBLIN	07-Apr-94	5.9	321.9	0.3	-0.6
3S/1E 6G 5	200	DUBLIN	07-Apr-94	16.4	313.2	2.0	2.3
3S/1E 6N 2	67	DUBLIN	07-Apr-94	13.1	324.0	0.5	-0.9
3S/1E 6N 3	72	DUBLIN	07-Apr-94	17.6	315.6	0.4	-0.7
3S/1E 7B 2	152	DUBLIN	06-Apr-94	11.9	313.2	0.6	0.2
3S/1E 7M 2	88	DUBLIN	06-Apr-94	21.7	305.9	0.9	0.2
3S/1E 8B 1	148	AMADOR	06-Apr-94	53.3	282.3	-1.0	-0.9
3S/1E 8H 2	205	AMADOR	06-Apr-94	82.1	258.8	9.7	9.5
3S/1E 8K 1	99	AMADOR	06-Apr-94	69.8	259.9	12.6	14.5
3S/1E 8N 1	72	BERNAL	06-Apr-94	57.9	263.1		8.9
3S/1E 9A 1	145	AMADOR	14-Apr-94	83.9	263.7	-0.1	0.1
3S/1E 9B 1	810	AMADOR	11-Apr-94	80.5	267.9	13.1	14.2
3S/1E 9D 5	270	AMADOR	11-Apr-94	78.8	260.7	13.5	11.8
3S/1E 9D 8	76	AMADOR	11-Apr-94				
3S/1E 9G 1	160	AMADOR	06-Apr-94	98.0	251.7	3.0	3.2
3S/1E 9M 2	530	AMADOR	06-Apr-94	83.3	258.6	9.9	10.7
3S/1E 9M 3	575	AMADOR	06-Apr-94	84.8	258.7	9.7	10.5
3S/1E 9P 4	246	AMADOR	06-Apr-94	92.8	252.1	5.2	4.8
3S/1E 9P 5	105	AMADOR	06-Apr-94	96.2	250.5		
3S/1E 9R 1	173	AMADOR	06-Apr-94	108.1	245.9	3.5	21.4

ZONE 7
WATER RESOURCES ENGINEERING
GROUNDWATER MONITORING PROGRAM
SEMIANNUAL GROUNDWATER LEVELS IN FEET
SPRING 1994

WELL NUMBER	WELL DEPTH	SUB-BASIN	MEASUREMENT DATE	DEPTH TO WATER	GROUND-WATER ELEVATION	CHANGE IN ELEVATION FALL 1993 TO SPRING 1994	CHANGE IN ELEVATION SPRING 1993 TO SPRING 1994
3S/1E 10A 1	253	AMADOR	12-Apr-94	94.8	267.2	6.2	7.4
3S/1E 10A 2	88	AMADOR	11-Apr-94	36.0	326.2	1.9	-0.5
3S/1E 11B 1	43	AMADOR	11-Apr-94	31.0	335.7	-0.5	-2.2
3S/1E 11P 4	152	AMADOR	12-Apr-94	98.4	273.6	5.0	3.8
3S/1E 12A 2	69	AMADOR	13-Apr-94	41.0	357.7	2.5	0.8
3S/1E 12D 2	46	AMADOR	13-Apr-94	37.9	343.9		
3S/1E 12F 1	240	AMADOR	31-Mar-94	118.4	281.6	11.8	8.4
3S/1E 12G 1	73	AMADOR	31-Mar-94	65.0	334.9	-0.3	-0.5
3S/1E 12H 2	85	AMADOR	31-Mar-94	61.1	352.9	2.3	-0.2
3S/1E 12J 1	304	AMADOR	31-Mar-94	116.9	303.6	20.2	4.2
3S/1E 12P 5	348	AMADOR	31-Mar-94	120.1	282.8	5.9	14.0
3S/1E 13E 1	97	AMADOR	13-Apr-94	57.4	330.9	-0.3	-10.7
3S/1E 13G 1	332	AMADOR	13-Apr-94	139.6	257.2	-2.5	-9.8
3S/1E 13P 1	652	AMADOR	13-Apr-94	111.2	286.1	12.9	14.9
3S/1E 14A 2	210	AMADOR	12-Apr-94	106.6	274.4	5.0	8.1
3S/1E 14K 2	508	AMADOR	13-Apr-94	113.4	266.6	9.6	12.7
3S/1E 14Q 1	96	AMADOR	12-Apr-94	36.7	325.6	4.4	2.6
3S/1E 15F 3	640	AMADOR					
3S/1E 15J 3	196	AMADOR	06-Apr-94	66.1	275.8	13.9	13.5
3S/1E 16A 2	510	AMADOR	05-Apr-94	91.8	266.4	11.2	12.0
3S/1E 16D 6	195	AMADOR	06-Apr-94	78.0	261.1	10.6	11.3
3S/1E 16D 7	260	AMADOR	06-Apr-94	73.8	265.2	11.9	16.6
3S/1E 16D19	120	AMADOR	06-Apr-94	78.0	261.2	11.7	11.0
3S/1E 16E 4	105	AMADOR	06-Apr-94	77.5	271.5	13.9	13.6
3S/1E 16H 2	94	AMADOR	06-Apr-94				
3S/1E 16L 2	151	AMADOR	05-Apr-94	82.7	271.3	10.6	12.3
3S/1E 16L 5	685	AMADOR	05-Apr-94	79.7	275.7	14.9	14.0
3S/1E 16L 7	647	AMADOR	05-Apr-94	77.8	273.4	12.5	11.9
3S/1E 16P 5	75	AMADOR	06-Apr-94	40.5	311.3	-4.9	-5.6
3S/1E 16R 1	239	AMADOR	06-Apr-94	89.8	270.0	0.3	-0.7
3S/1E 17B 4	248	BERNAL	06-Apr-94	68.8	266.2	13.0	11.3
3S/1E 17D 2	313	BERNAL	06-Apr-94	63.8	263.9	15.0	11.2
3S/1E 17Q 4	84	BERNAL	06-Apr-94	69.2	266.3		
3S/1E 18A 1	389	BERNAL	06-Apr-94	63.7	264.1	14.2	10.1
3S/1E 18A 5	454	BERNAL	05-Apr-94	62.8	264.1	13.5	14.3
3S/1E 18A 6	500	BERNAL	06-Apr-94	60.3	265.2	15.9	12.5
3S/1E 18E 4	83	BERNAL	06-Apr-94	51.6	265.9	5.7	7.1
3S/1E 18J 2	71	BERNAL	06-Apr-94	55.2	264.9	5.2	7.1
3S/1E 18N 1	708	CASTLE	07-Apr-94	55.8	260.9	13.7	12.6
3S/1E 19A 5	220	BERNAL	07-Apr-94	63.7	264.8	12.6	13.6
3S/1E 19C 4	78	BERNAL	08-Apr-94	53.2	266.3	9.1	
3S/1E 19K 1	58	BERNAL	07-Apr-94				
3S/1E 20B 2	500	BERNAL	12-Apr-94	74.9	265.0	14.2	13.3
3S/1E 20E 1	316	BERNAL	07-Apr-94	62.6	264.5	9.6	12.2
3S/1E 20F 5	46	BERNAL	06-Apr-94				
3S/1E 20J 4	72	BERNAL	06-Apr-94	55.6	273.3	4.9	6.6
3S/1E 20M11	71	BERNAL	07-Apr-94	54.3	268.7	9.1	
3S/1E 21C 2	182	AMADOR	06-Apr-94	39.2	312.7	-6.5	-7.4
3S/1E 22D 2	72	AMADOR	06-Apr-94	54.7	311.3	3.9	4.7
3S/1E 23J 1	120	AMADOR	13-Apr-94	76.1	349.4	7.8	21.3

ZONE 7
WATER RESOURCES ENGINEERING
GROUNDWATER MONITORING PROGRAM
SEMIANNUAL GROUNDWATER LEVELS IN FEET
SPRING 1994

WELL NUMBER	WELL DEPTH	SUB-BASIN	MEASUREMENT DATE	DEPTH TO WATER	GROUND-WATER ELEVATION	CHANGE IN ELEVATION FALL 1993 TO SPRING 1994	CHANGE IN ELEVATION SPRING 1993 TO SPRING 1994
* 3S/1E 24A 1	702	AMADOR	13-Apr-94	22.5	382.4	8.0	29.3
3S/1E 29B 1	68	BERNAL	06-Apr-94	19.1	302.9	-0.1	-1.3
3S/1E 29E 4	415	BERNAL	07-Apr-94	44.5	266.0	-0.5	2.8
3S/1E 29M 4	57	CASTLE	07-Apr-94	40.4	267.8	3.0	-1.9
3S/1E 29P 2	42	BERNAL	07-Apr-94	27.7	271.8	0.8	-1.0
3S/1E 30A 8	61	BERNAL	07-Apr-94	48.6	267.1	2.5	-0.8
3S/1E 30G 3	61	CASTLE	07-Apr-94	34.6	298.8	3.9	-6.3
3S/1E 32G 2	40	SUNOL	07-Apr-94				
3S/1W 1B 5	108	DUBLIN	07-Apr-94	8.5	322.9	0.4	0.7
3S/1W 1J 1	70	DUBLIN	07-Apr-94	10.4	321.8	0.5	-1.5
3S/1W 1J 2	37	DUBLIN	07-Apr-94	10.6	321.8	0.3	-1.6
3S/1W 2A 2	47	DUBLIN	07-Apr-94	25.7	341.0	-1.3	-6.5
3S/1W 12C 2	48	DUBLIN	07-Apr-94	21.3	321.7	0.1	-1.7
3S/1W 12J 1	62	DUBLIN	06-Apr-94	21.8	304.8	1.4	0.4
3S/1W 13J 1	48	CASTLE	07-Apr-94	25.9	315.3	3.2	-8.3
3S/2E 1F 2	69	SPRING	12-Apr-94	22.0	545.6	0.1	-0.1
3S/2E 1J 1	124	SPRING	12-Apr-94	39.9	565.7	3.4	1.3
3S/2E 2B 2	46	SPRING	12-Apr-94	9.8	527.6	0.0	-1.6
3S/2E 3A 1	54	SPRING	11-Apr-94	4.5	510.0	0.3	0.2
3S/2E 3K 3	60	MOCHO 1	12-Apr-94	13.7	506.5	2.1	-1.4
* 3S/2E 5J 1	49	NONE					
3S/2E 5N 1	210	MOCHO 2	01-Apr-94	28.3	411.7	13.1	5.9
3S/2E 6P 1	147	MOCHO 2	30-Mar-94	24.1	396.5	5.9	3.9
3S/2E 7C 2	49	MOCHO 2	30-Mar-94	26.1	392.1	2.4	3.6
3S/2E 7H 2	54	MOCHO2	30-Mar-94	26.3	413.9	7.0	7.1
3S/2E 7H 3	59	MOCHO2	30-Mar-94	23.4	412.8	7.7	3.8
3S/2E 7N 1	133	AMADOR	30-Mar-94	118.8	303.4	-5.8	-11.3
3S/2E 7P 3	510	AMADOR	28-Mar-94	148.0	280.8	22.0	22.0
3S/2E 8E 1	300	MOCHO 2	31-Mar-94	32.0	419.9	24.2	7.4
* 3S/2E 8F 1	576	MOCHO 2					
3S/2E 8G 1	465	MOCHO 2	28-Mar-94	39.0	423.4	25.0	6.0
3S/2E 8H 1	625	MOCHO 2	28-Mar-94	47.0	427.5	28.0	16.0
3S/2E 8H 2	46	MOCHO 2	30-Mar-94	33.7	433.3	-4.2	-8.2
3S/2E 8K 2	74	MOCHO 2	30-Mar-94	31.0	431.0	9.9	4.1
* 3S/2E 8N 2	526	MOCHO 2					
3S/2E 8N 5	92	MOCHO 2	31-Mar-94	32.7	423.3	9.6	4.6
3S/2E 8P 1	273	MOCHO 2	28-Mar-94	38.0	427.5	17.0	7.0
* 3S/2E 8P 2	420	MOCHO 2	28-Mar-94	101.0	363.0	-23.0	-11.0
3S/2E 9L 1	516	MOCHO 2	28-Mar-94	56.0	440.7	32.0	27.0
3S/2E 9P 1	515	MOCHO 2	28-Mar-94	69.0	429.6	30.0	13.0
* 3S/2E 9Q 1	572	MOCHO 2					
3S/2E 9Q 4	80	MOCHO 2	31-Mar-94	22.6	479.1	0.0	-2.3
3S/2E 10C 4	30	MOCHO 1	18-Apr-94	16.1	513.9	-0.3	-1.7
3S/2E 10F 1	700	MOCHO 1	12-Apr-94	16.8	517.3	-1.2	-1.9
3S/2E 10F 3	45	MOCHO 1	12-Apr-94	14.2	518.0	-1.4	-2.0
3S/2E 10Q 1	44	MOCHO 2	31-Mar-94	25.7	527.0	-5.0	-9.5
* 3S/2E 10Q 2	325	MOCHO 2	31-Mar-94	29.4	518.0	0.1	-4.3
3S/2E 11C 1	66	MOCHO 1	12-Apr-94	30.0	524.0	0.6	-1.5
3S/2E 11J 2	110	MOCHO 1	12-Apr-94	68.0	527.1	0.5	-1.1
3S/2E 14A 3	110	MOCHO 1	12-Apr-94	72.9	527.0	0.7	-1.6

ZONE 7
WATER RESOURCES ENGINEERING
GROUNDWATER MONITORING PROGRAM
SEMIANNUAL GROUNDWATER LEVELS IN FEET
SPRING 1994

WELL NUMBER	WELL DEPTH	SUB-BASIN	MEASUREMENT DATE	DEPTH TO WATER	GROUND-WATER ELEVATION	CHANGE IN ELEVATION FALL 1993 TO SPRING 1994	CHANGE IN ELEVATION SPRING 1993 TO SPRING 1994
3S/2E 14B 1	300	MOCHO 1	12-Apr-94	65.3	525.4	8.0	-2.0
3S/2E 14C 3	405	MOCHO 1	12-Apr-94	59.9	522.1		-3.0
3S/2E 14H 1	288	MOCHO 1	12-Apr-94	82.5	527.5	0.1	2.1
* 3S/2E 15B 4	172	MOCHO 2	31-Mar-94	36.9	515.1	-1.7	-7.3
3S/2E 15E 2	192	MOCHO 2	31-Mar-94	34.6	510.6	-3.1	-11.5
3S/2E 15G 3	172	MOCHO 2	01-Apr-94	21.6	547.6	-6.7	-13.2
3S/2E 15J 2	186	MOCHO 2	12-Apr-94	34.6	540.7	-11.4	-23.9
* 3S/2E 15K 1	634	MOCHO 2	31-Mar-94	69.8	497.5	8.5	1.1
3S/2E 15R 6	58	MOCHO 2	12-Apr-94	13.3	575.0	0.1	-5.2
3S/2E 16A 3	240	MOCHO 2	31-Mar-94	32.1	492.3	0.0	-4.8
3S/2E 16B 1	410	MOCHO 2	28-Mar-94	76.0	441.6	29.0	13.0
3S/2E 16B 3	97	MOCHO 2	31-Mar-94	27.4	482.7	0.7	-2.6
3S/2E 16C 1	584	MOCHO 2	28-Mar-94	72.0	436.3	54.0	23.0
3S/2E 16E 4	45	MOCHO 2	31-Mar-94	16.4	487.2	0.7	-0.2
3S/2E 16R 3	85	MOCHO2	31-Mar-94	15.2	532.6	-0.2	-1.2
3S/2E 17E 2	94	MOCHO2	31-Mar-94	17.4	447.6	-0.8	-3.2
3S/2E 18B 1	497	AMADOR	28-Mar-94	150.0	285.9	40.0	23.0
3S/2E 18E 1	134	AMADOR	31-Mar-94	82.9	338.3	-6.1	-1.7
* 3S/2E 18F 2	370	AMADOR	31-Mar-94	93.7	333.8	-3.4	12.4
3S/2E 19D 4	245	AMADOR	13-Apr-94	107.9	308.9	23.4	34.9
3S/2E 19D 6	180	AMADOR	13-Apr-94	112.2	301.9	-14.1	-28.0
* 3S/2E 19E 1	465	AMADOR	13-Apr-94	9.8	424.1	2.4	4.4
3S/2E 19F 4	164	AMADOR	13-Apr-94	67.3	361.4	-1.7	4.9
3S/2E 20M 1	184	AMADOR	14-Apr-94	50.0	426.1	14.9	-0.6
3S/2E 20N 1	214	AMADOR	13-Apr-94	56.4	428.4	13.1	0.4
* 3S/2E 21E 3	133	MOCHO 2	13-Apr-94	88.1	442.7	2.6	2.4
* 3S/2E 21L13	276	MOCHO 2	13-Apr-94	122.7	450.3	38.7	42.3
3S/2E 22B 1	32	MOCHO 2	19-Apr-94	16.6	566.6	-1.8	-4.7
3S/2E 24A 1	46	MOCHO 1	12-Apr-94	35.4	679.6	-0.8	-0.5
3S/2E 26J 2	44	MOCHO 2	12-Apr-94	7.1	680.1	3.2	-0.3
3S/2E 29B 2	220	AMADOR	13-Apr-94	30.5	449.5	2.1	-4.7
3S/2E 29D 1	500	AMADOR	13-Apr-94	35.0	432.2	3.3	-3.7
3S/2E 29F 4	36	AMADOR	08-Apr-94	9.7	445.1	-2.5	-2.4
3S/2E 30D 2	44	AMADOR	13-Apr-94	16.4	412.5	-0.1	-0.5
3S/2E 30H 1	78	AMADOR	13-Apr-94	12.9	434.4	4.4	-1.8
3S/2E 33G 1	17	AMADOR	08-Apr-94	7.5	501.6	-0.5	0.7
* 3S/2E 33K 1	15	AMADOR	08-Apr-94	7.5	536.6	2.7	-0.6
* 3S/2E 33K 3	25	AMADOR	08-Apr-94	2.7	538.3	2.4	-0.2
* 3S/2E 33K 4	25	AMADOR	08-Apr-94	4.4	536.6	3.2	-1.7
* 3S/2E 33K 5	30	AMADOR	08-Apr-94	7.8	533.2	1.3	-2.9
* 3S/2E 33L 1	25	AMADOR	08-Apr-94	12.3	539.0	1.2	-0.7
3S/3E 7D 2	74	SPRING	12-Apr-94	46.4	573.7	0.0	-0.1
3S/3E 7M 2	199	SPRING	12-Apr-94	43.5	582.5	0.3	0.2

APPENDIX D

Determination of Aquifer Parameters and Calculations for Fate and Transport Analyses

APPENDIX D

DETERMINATION OF AQUIFER PARAMETERS AND CALCULATIONS FOR FATE AND TRANSPORT ANALYSES

1.0 AQUIFER PARAMETERS

Based on results of the ground water pumping tests conducted at both the Montgomery Ward and Enea Properties Sites, estimates of aquifers parameters such as hydraulic conductivity and transmissivity were determined (see EAI, 1991; Cypress, 1993). The results of the aquifer testing, however, indicated that certain aquifer properties values as determined from the pumping tests were not in agreement with the range of values typical for the type of lithology indicated in both visual logging of soil borings and also geotechnical properties of soils parameters as determined from cone penetrometer testing (CPT). The results of the pumping tests, however, were in direct contrast to the results of the in-situ pore pressure dissipation tests which showed that the response time were slow (> five minutes) and were more representative of clayey soils. Due to the apparent discrepancies between various field tests in deriving aquifer parameters, EAI calculated various transport parameters using conservative assumptions unless otherwise stated.

1.1 Hydraulic Conductivity

The results of the pumping tests at the Enea Properties Site showed that the hydraulic conductivities (k) values for the aquifer ranged from 193 feet/day (ft/day) (determined from distance/drawdown calculations), from 430 ft/day to 544 ft/day (based on pumping well data analyses), and from 1,519 ft/day to 1,657 ft/day (determined from response of aquifer in observation wells) (Cypress, 1993). In comparison, the hydraulic conductivity values from pumping tests conducted on the Montgomery Ward Site ranged from 177 ft/day to 213 ft/day (EAI, 1991). These data, based on short duration pumping tests (less than eight hours), show that there is a tremendous range in values for hydraulic conductivity for the shallow aquifer, even though the soils at the two sites appear lithologically fairly similar based on the visual and geotechnically derived interpretations.

Due to the range in hydraulic conducivity values, EAI also empirically derived a hydraulic conductivity value in order to narrow the range of values for use in the calculations. The following were parameters were used/assumed: 1) maximum distance traveled [740 feet] as measured along the plume axis (see Figure 1); 2) assuming that the release of petroleum hydrocarbons occurred about the time the underground storage tanks were removed (i.e., 1988 or about six years ago [2,190 days]); and the hydraulic gradient, and porosity are approximately 0.0024 and 0.30, respectively. Using these parameters and the following equations:

Darcy's Law: $Q = KAh/L$ (Equation 1)

where:

Q = Flow rate per unit time
K = hydraulic conductivity (feet/unit time)
A = Cross Sectional area through which flow occurs ($feet^2$)

h/L = hydraulic gradient (feet/feet)

The Conservation of Mass equation: $Q = vn_eA$ (Equation 2)

where:

v = average velocity of ground water (feet/unit time)
n_e = effective porosity

Solving equations 1 and 2 for v results in the equation:

$v = Kh/n_eL$ (or $v = Ki/n_e$ where i = hydraulic gradient) (Equation 3)

This equation computes the average velocity or seepage velocity of the ground water. Substituting in the above aquifer parameters results in a hydraulic conductivity value of approximately 90 ft/day. Based on this result, EAI used a hydraulic conductivity value of 544 ft/day for all subsequent calculations. This hydraulic conductivity value is typical of a clean sands and silty sands (Freeze and Cherry, 1979).

1.2 HYDRAULIC GRADIENT

The hydraulic gradient was computed using data obtained from recent quarterly ground water monitoring. The regional hydraulic gradient was computed as 0.0024 feet/feet (ft/ft).

1.3 POROSITY

Effective porosity (n_e) for typical clays range from 0.01 to 0.1. However, EAI has assumed that n_e values for computation purposes is 0.38.

1.4 BULK DENSITY

The bulk density is assumed to be 1.60 grams/cubic centimeter (gm/cm^3) (Freeze and Cherry, 1979).

1.5 RETARDATION EQUATION

The retardation equation is $R = (1 + Kd\ \rho_b/n_e)$ (Equation 4)

where:
Kd = distribution coefficient (ml/gm) (0.183 ml/gm)
ρ_b = bulk density (1.6 mg/cm^3)
n_e = effective porosity (0.38)

Kd, the distribution coefficient, is calculated by the following equation Kd = (Koc)(foc) where Koc is the octanol-water coefficient for a compound and foc is the organic carbon content of the soil. Koc was obtained from literature and is equal to 83.17 ml/gm and foc is 0.0022 which was determined by laboratory analysis of a soil sample obtained (see EAI, 1994). The Retardation Factor is calculated as 1.77.

1.6 CALCULATION OF SEEPAGE VELOCITY

Using Equation 3, one can calculate the seepage velocity. In order to account for the effects of retardation, the following equation is used:

$v_{d,max} = Kh/(n_e LR)$ [or $v_{d,max} = Ki/(n_e R)$]

where i = hydraulic gradient] (Equation 5)

Substituting in the following values (K = 544 ft/day; i= 0.0024 ft/ft; n_e = 0.38; R = 1.77) results in a seepage velocity ($v_{d,max}$) of 1.94 ft/day.

Using the following equation, one is able to calculate the time for a solute to travel a distance L:

$\theta_{d,min} = L/\ v_{d,max}$

where

$\theta_{d,min}$	= time (days)
L	= distance (approximately 12,000 ft to location of municipal supply wells)
$v_{d,max}$	= 1.94 ft/day

The calculated minimum time for a solute to travel 12,000 feet using the $v_{d,max}$ = 1.94 ft/day is 6185.5 days or 16.9 years. Please note that these calculations do not account for the effects of dispersion.

1.7 BIOATTENUATION

The effects of bioattenuation on dissolved phase petroleum hydrocarbons have been documented in literature (Barker, J.F., et. al., 1987; Chiang, C.Y., et. al, 1989; Kemblowski, et. al., 1987; Salanitro, J.P., 1993; and Wilson, B.H., et. al., 1991). These studies show that the dissolved plumes related to accidental release of gasoline are spatially confined due to natural biotransformation mechanisms. Data from research and field studies show that aerobic degradation rates are commonly of a first-order decay rate (Chiang, C.Y., et. al., 1989).

The decay rates for benzene in field studies range from 0.007 day^{-1} to 0.095 day^{-1} (see Barker, J.F., et. al., 1987; Chiang, C.Y., et. al, 1989; Kemblowski, et. al., 1987; Salanitro, J.P., 1993; and Wilson, B.H., et. al., 1991). Assuming a linear decay rate of 0.007 day^{-1}, calculations show that the dissolved benzene concentrations using the maximum detected benzene concentration of 83 parts per billion (ppb) off-site and down-gradient of the Montgomery Ward Site, as measured during quarterly ground water monitoring activities, would be below the DTSC drinking water actions of one ug/l during transport to the nearest muncipal water supply wells located approximately 12,000 feet down-gradient of the Montgomery Ward and Enea Properties Sites (see Table A1).

1.8 DISSOLVED OXYGEN CONTENT IN GROUND WATER

Dissolved oxygen (DO) in ground water was measured using a YSI dissolved oxygen meter on October 3, 1994 during quarterly ground water monitoring activities.

The dissolved oxygen content at approximately one foot into the water column was approximately 11 mg/l and decreasing to approximately 2 mg/l at about four feet into the water column (see Table A2 and Appendix A). Studies have shown that DO content greater than 2 mg/l typically promote biodegradation in ground water containing dissolved petroleum hydrocarbons. The DO results therefore suggest that bioattenuation of the dissolved petroleum hydrocarbons is probably occurring at the Montgomery Ward and Enea Properties Sites.

2.0 REFERENCES

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TABLES

TABLE A1

EFFECTS OF BIOATTENUATION ON BENZENE CONCENTRATIONS IN GROUND WATER*
Montgomery Ward Auto Service Center and Enea Properties Sites

Starting Benzene concentration (mg/l)	Half Life Days at 0.007 days^{-1}
83.0 ug/l	0
41.5 ug/l	143 days
20.8 ug/l	286 days
10.4 ug/l	429 days
5.2 ug/l	572 days
2.6 ug/l	715 days
1.3 ug/l	858 days
0.65 ug/l	1001 days

*Using a half-life of 0.007 day^{-1} and assuming a linear decay, a benzene concentration of 83 milligrams/liter (mg/l) will be attenuated to less than one mg/l in approximately 1000 days or 2.75 years.

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TABLE A2

DEPTH TO GROUND WATER AND DISSOLVED OXYGEN (DO) MEASUREMENTS OBTAINED ON OCTOBER 3, 1994
Montgomery Ward Auto Service Center and Enea Properties Sites

All DO measurements in milligrams/liter (mg/l)

Well I.D.#	DTW*	Dissolved Oxygen at Selected Depths below Water Surface			
		Water Surface	1-foot	2-foot	3-foot
B-5	13.04	14.8	2.9	2.8	2.1
B-10	12.69	4.8	1.8	2.0	1.7
B-12	19.27	8.8	4.4	4.4	4.2
B-15	13.35	6.6	6.2	4.5	3.1
B-16	12.89	3.5	2.4	2.2	2.8
MW-100	12.88	2.0	1.9	1.0	1.6
MW-101	11.98	19.89	19.1	14.6	12.4
MW-102	12.36	16.7	8	4.7	2.2
MW-1	9.66	19.66	10.21	5.82	4.09
MW-2	9.59	14.11	10.89	7.04	2.9
MW-3	10.56	12.96	3.2	2.43	2.03
MW-4	9.77	9.08	2.95	2.32	2.99
EW-1	9.89	10.11	19.98	6.49	3.58

*DTW = Depth to Water in feet
All dissolved oxygen readings were measured with a YSI Dissolved Oxygen Meter.

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APPENDIX A

Field Notes
(Exerpt from EAI's Field Log Book
for the Montgomery Ward Dublin Site)

Q4 1994 10/3/1994 1233

Chris DSa / John Cuinbricz

WELL ID	DTW	O2 ws / 1' bws / 2' / 3'
B-5	13.04	14.8 / 2.9 / 2.8 / 2.1
B-10	12.69	4.8 / 1.8 / 2.0 / 1.7
B-12	19.27	8.8 / 4.4 / 4.4 / 4.2
B-15	13.35	6.6 / 6.2 / 4.5 / 3.1
B-16	12.89	3.5 / 2.4 / 2.2 / 2.8
MW-100	12.88	2 / 1.9 / 1.0 / 1.6
MW-101	11.98	19.8 / 19.1 / 14.6 / 12.4
MW-102	12.36	16.7 / 8.0 / 4.7 / 2.2
MW-1	09.66	19.66 / 10.21 / 5.82 / 4.09
MW-2	09.59	14.11 / 10.89 / 7.04 / 2.90
MW-3	10.56	12.96 / 3.20 / 2.43 / 2.03
MW-4	9.77	9.08 / 2.95 / 2.32 / 2.99
EW-1	9.89	10.11 / 19.98 / 6.49 / 3.58

O_2 at water interface / 1' below water surface (bws) / 2' / 3'

10/3/94