Pacific Gas and Electric Company

One California Street, Room F-235
San Francisco, CA 94106
415/973-5615

July 13, 1992

Mr. Britt Johnson
Hazardous Materials Specialist
Alameda County Health Agency
Division of Hazardous Materials
Department of Environmental Health
80 Swan Way, Room 350
Oakland, CA 94621

Subject: Lead Contamination
4930 Coliseum Way
Oakland, CA 94610

Dear Mr. Johnson:

Pacific Gas and Electric Company is submitting for you review, 2 copies of a Pre-Remediation Health Risk Assessment for the above site. This Assessment has been prepared consistent with the scope of work submitted to you on May 20, 1992 and previously discussed with Dr. Ravi Arulananthanam.

Your letter dated May 7, 1992 required from us preparation of the Health and Safety Plan. The Plan was prepared and submitted to you together with the scope of work for the Assessment.

On June 29, 1992, I contacted Cal EPA Department of Toxic Substances Control, Berkeley Regional Office and was informed the Cal EPA does not have any additional permit requirements regarding this matter.

Please review the attached document, and let me know if you have any concerns with its content.

The capping design is currently progressing, and will be ready for your review about July 20, 1992.

If you have any concerns with the Health and Safety Plan, possibly we could get together and discuss them.

Please do not hesitate to call me at (415) 973-5615, if you have any questions.

Sincerely,
PG&E

Wally A. Pearce
Staff Safety Engineer

WAP/blw
Enclosures

cc: Tom Burton w/Attachment
Brian Hoffer
Mike Kunz
Ernie Wong

DRAFT 1.0

Pre-Remediation Human Health Risk Assessment

for

PG&E
ENCON-GAS Transmission and Distribution Construction Yard
Former Gas Holder Tank Area
4930 Coliseum Way
Oakland, California

Submitted to:

Alameda County Health Care Services Agency
Department of Environmental Health
Division of Hazardous Materials

Prepared by:

Aqua Resources Inc.
a wholly owned subsidiary of The Earth Technology Corporation
2030 Addison Street, Suite 500
Berkeley, CA 94704

July 1992

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1.0 INTRODUCTION

This report presents the Pre-Remediation Human Health Risk Assessment for soils containing elevated concentrations of lead in an area near a former Gas Holder Tank located at the Pacific Gas and Electric Company ENCON-Gas Transmission and Distribution Construction Yard at 4930 Coliseum Way, Oakland, California (the "site"). The general location of the site is shown in Figure 1.1: Site Location Map. This report is prepared by Aqua Resources Inc. (ARI), a wholly owned subsidiary of The Earth Technology Corporation, and evaluates three scenarios of human exposure at several mean concentrations of lead in soil.

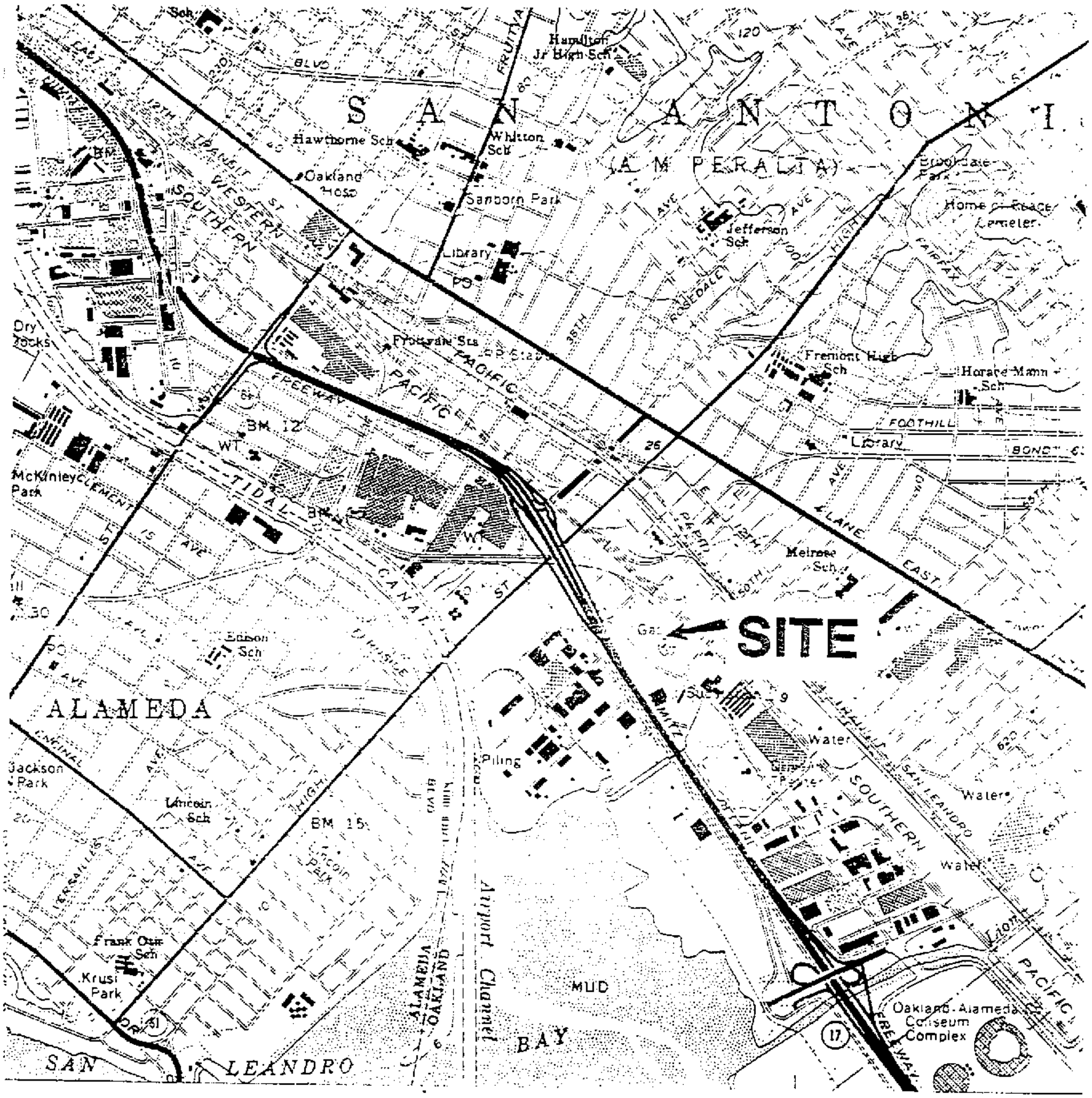
1.1 STATEMENT OF PURPOSE

The purpose of this report is to assess the potential adverse health effects resulting from exposure to soils containing elevated concentrations of lead at the site. Potential human exposure to lead from the site by combined inhalation and ingestion of the lead bearing soils at the site is considered. The conclusions of this report demonstrate the need for lead mitigation at the site, and suggest a concentration of lead in soil which may be left unmitigated without causing significant adverse health effects.

1.2 REPORT ORGANIZATION

The Pre-Remediation Human Health Risk Assessment consists of the following elements:

- Site background
- Environmental fate and transport of lead at the site
- Exposure analyses for resident children, adults and onsite workers
- Conclusions and recommendations



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Source: United States Geological Survey, 1959, photorevised 1980, Oakland East 7.5 minute topographic quadrangle.

AQUA RESOURCES, INC.
BERKELEY, CALIFORNIA

PG & E ENCON-Gas T & D Construction Yard

Site Location Map

JOB NO. **90262**	**Figure 1.1** DATE: July 23, 1991

2.0 SITE BACKGROUND

2.1 SITE DESCRIPTION

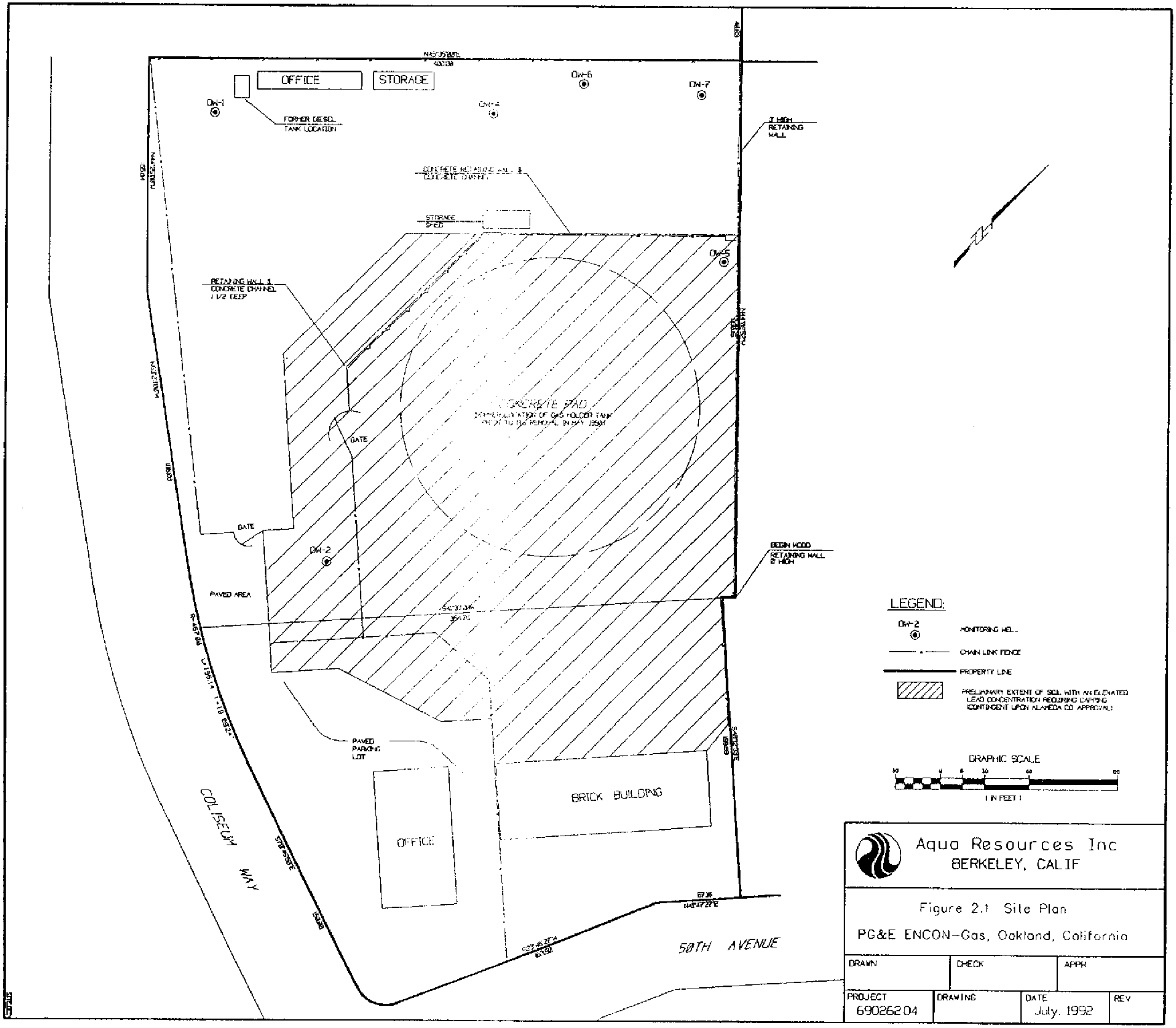
The T&D Construction Gas Yard is wholly owned by PG&E and is used as a vehicle, materials, and equipment storage and distribution facility. Historically, the site was also used as a vehicle service center and aboveground natural gas storage facility.

The site is surrounded by industrial properties. Immediately to the northeast of the site is a junkyard and metal recycling operation; to the northwest is a plaster casting company, a pattern company and a metal foundry; to the west and southwest (across Coliseum Way) are two motels and a recreational vehicle sales facility; to the southeast (across 50th Street) is a trucking facility.

Figure 2.1 shows the site layout including the location of a circular concrete pad which formerly supported an above-ground gas holder tank (GHT). This former tank is considered to be the source of lead paint chips which cause elevated lead concentrations in the surrounding soils. Two office buildings, and various material storage buildings are currently located on the site. The vicinity of the former GHT is enclosed by fences on all sides and is bound to the northwest and northeast by a retaining wall. The ground elevation is about 3 to 4 feet higher on the other side of the retaining wall at the northern corner of the GHT area. The surface of the former GHT area consists of native soil with an occasional thin top layer of coarse gravel. Except for an asphalt parking lot and an asphalt paved area extending from the northern property corner southeast to the retaining wall and southwest to the small storage shed, the remainder of the site is covered in gravel.

2.2 SITE HISTORY

The earliest aerial photographs made available to ARI at the California Division of Mines and Geology (DMG) photo library that cover the site area were taken in August of 1939. These photos showed that the area was already heavily developed. Very large commercial



LEGEND:

OW-2 ◉	MONITORING WELL
———•———	CHAIN LINK FENCE
━━━━━━	PROPERTY LINE
▨	PRELIMINARY EXTENT OF SOIL WITH AN ELEVATED LEAD CONCENTRATION REQUIRING CAPPING (CONTINGENT UPON ALAMEDA CO. APPROVAL)

GRAPHIC SCALE

(IN FEET)

Aqua Resources Inc
BERKELEY, CALIF

Figure 2.1 Site Plan

PG&E ENCON-Gas, Oakland, California

DRAWN	CHECK	APPR	
PROJECT 69026204	DRAWING	DATE July, 1992	REV

industrial buildings existed along both sides of San Leandro Street between High Street and 50th Avenue. A large round tank, the former GHT, was in place on the PG&E site; however, the shadow of the tank prevented our determining if any structures existed on the site of the present-day scrap metal business. There were large buildings east of the railroad track and west of San Leandro Street. There were no large buildings at 4700-4800 Coliseum Way. Some small buildings were in place around Coliseum Way and 46th Avenue. The East Creek Slough drainage penetrated farther inland to the south and east of the site than it does at present. The only other aerial photograph available for this area was taken in March of 1984. It showed the former GHT and the site in approximately the same condition as it is at present.

Historical topographic maps for the Oakland East Quadrangle were also reviewed at the DMG. These maps were dated 1949, 1959, and 1968 (photo revision of 1959 map). Each of these maps used a pink coloration to designate a developed area, rather than showing individual buildings. The only structure at the site shown on these maps was the GHT.

The above ground low-pressure GHT stood for over 50 years before it was dismantled in May of 1990. Presently, only the circular concrete foundation and 24 tank tie-down boxes remain from the GHT. The entire tank was originally painted with a red lead or lead-based primer. Reportedly, before each of the regular tank painting episodes, the old paint was removed by sand blasting. Inspection of paint chips from the former GHT show at least two layers of red paint separated by a layer of green paint. It is believed that the sandblasting and final dismantling of the GHT generated paint chips which are the source of elevated lead levels in the surrounding soil.

2.3 REGIONAL AND SITE GEOLOGY AND HYDROGEOLOGY

2.3.1 Regional Geology

Geologic maps of the region prepared by the DMG (1961) and by Goldman (1969) show the site is underlain by Quaternary marine and marsh deposits. These sediments consist predominantly of highly plastic, blue-grey Bay Mud inter-bedded with grey, organic-rich silty sands and clayey marsh deposits.

2.3.2 Site Geology

The area near the removed GHT consists of native soil with an occasional thin top layer of added coarse gravel. It is lower in elevation and separated from the storage shed area to the northwest by a concrete retaining wall. The subsurface materials observed in borings at the site typically consist of 2-1/2 to 3-1/2 feet of silty clay with a small percentage of sand and gravel. Underlying this unit is 2 to 3 feet of gravelly sandy clay. This is typically underlain by about 4 feet of sand or an approximately 50/50 mixture of clay/sand and gravel. The lowest unit consists of inter-bedded sandy and silty clays, observed to the deepest boring depth of 17 feet in the former GHT area.

A sieve analysis was performed on a composite sample of surface soils collected from around the perimeter of the GHT pad. The grain size distribution is summarized in Table 2.1 and a detailed materials testing report is included in Appendix A. The mode of this grain size distribution, or most common grain diameter, falls in the medium sand range between the number 10 (2 mm) and number 40 (0.42 mm) sieves.

Table 2.1 Grain Size Distribution of Surface Soils Near Former GHT

Sieve Screen Size	Weight Held on Screen (gm)	Cumulative Wt% Passing
2"	0	100
1.5"	97	95.0
1"	25	93.8
0.75"	37	91.9
0.50"	211	81.2
0.375"	108	75.8
No. 4	142	68.6
No. 10	196	58.7
No. 40	516	32.6
No. 200	321	16.4
Pan	325	0

2.3.3 Site Hydrogeology

The topography of the area in the vicinity of the site is relatively flat. Regional surface water flow is to the southwest (toward San Leandro Bay). Inspection of the site indicates that site runoff also flows toward the San Leandro Bay. The surface water bodies nearest the site include the San Leandro Bay (located approximately one third of a mile south of the site) and a canal that extends north from San Leandro Bay (located about one half of a mile west of the site).

The potentiometric surface of the uppermost groundwater bearing zone beneath the site was found in December, 1991 to be 4-1/4 feet below the ground surface in monitoring well OW-5, which lies nearest the former GHT location. At the end of a wet March, 1992, the water level was observed to be several tenths of a foot below the ground surface in this same well.

In a number of borings saturated soils have been initially encountered at depths below those observed in nearby monitoring wells. This comparison of the stabilized groundwater level to the depth of first encounter in borings indicates some degree of confinement. The zone of most permeable materials appears to be the clayey sands and gravels observed in well OW-5 at a depth of 6 to 10 feet below the ground surface.

Six groundwater monitoring wells are currently in place on the site, completed to an approximate depth of 20 feet below ground surface. Their locations were shown in Figure 2.1. Quarterly groundwater surface elevation measurements from OW-1, OW-2, and OW-5 indicate that the general regional groundwater flow direction is to the southwest across the site at a gradient of about 0.0038 ft/ft. However, groundwater elevations in OW-3, later replaced by OW-6, and OW-4 are anomalously high and may indicate the presence of a perched zone or artificial water source, such as a leaking pipe, in this area. Water samples collected from four wells constructed on-site showed typical conductivity levels of 1,000 to 1,500 microsiemen per centimeter (uS/cm). There is a relation between conductivity and Total Dissolved Solids (TDS): ½ conductivity (uS/cm) ≈ TDS (mg/L). The TDS values estimated from conductivity are consistent with a laboratory measured value of 780 mg/L TDS for a water sample collected from well OW-3.

3.0 ENVIRONMENTAL FATE AND TRANSPORT OF LEAD

Human exposure to lead from the PG&E site may occur by inhalation and ingestion of lead contaminated soils, either singly or in combination. Ingestion of lead from ingested on-site soils by non-PG&E workers is made unlikely under the site's present use by the fact that the area is surrounded by a high perimeter security fence. Ingestion of lead through water ingestion of contaminated surface water or groundwater is also unlikely. Land usage between the PG&E site and San Leandro Bay is commercial/industrial. Lead analyses have been performed at two separate times on groundwater samples collected from the shallow on-site monitoring wells and each set of analyses reported concentrations of lead in groundwater below the method detection limits (MDLs). The MDL for the first water samples was 0.05 mg/L, while the MDL for the most recent set of samples was 0.003 mg/L. The Maximum Contaminant Level (MCL) for drinking water is 0.05 mg/L for both the Federal and the State of California standards.

The rate of solubilization of lead is a complex function of the groundwater pH, the oxidation state of lead, and the soil chemistry of the site. Field measurements of groundwater pH for monitoring well OW-5 have been near neutral, reducing the possibility of mobilizing lead as Pb^{2+} or $Pb(OH)_4^-$ ions. Lead bound in paint chips is not expected to be readily soluble, and the absence of lead in the groundwater indicates that little lead if any is being transported by the groundwater flow. This lead absence, in spite of the presence of lead in the soils at this site for many years, is evidence of the low potential for future groundwater contamination at this site. Proposed capping of the site will even further reduce this chance.

Inhalation of wind borne dust is recognized as a potential pathway of human exposure to lead at this site. Airborne dust particles are dislodged, or eroded, from the surface of the soil by the forces of wind and are transported and dispersed downwind. Unlike groundwater transport, where concentrations of lead in the groundwater are the cumulative result of years of leaching, wind borne dust concentrations are transient and are assumed to be a function of the current wind velocity. The concentration of lead in air at the site has been evaluated for consideration in the Exposure Assessment by two methods: average ambient air lead concentrations were measured over a 6 hour period, and air concentrations were estimated using an air emission and dispersion model based on an average soil lead concentration and mean annual wind velocity conditions.

When evaluating the ingestion route of exposure, and estimating lead concentrations in air, the assumed concentration of lead in soil was considered to be the arithmetic mean of all soil samples above four feet in depth collected in the former GHT area. This average soil concentration of lead is about 3287 mg/kg.

4.0 EXPOSURE ANALYSIS

4.1 INPUT AIRBORNE LEAD PARTICULATE CONCENTRATIONS

In order to evaluate lead exposure through the inhalation route, an estimate of the concentration of lead in air was required. Two methods were used to arrive at the estimate. First an air emission and dispersion model was used which predicts air particulate concentration based upon site specific input parameters. Next field measurements were made of the upwind, downwind and crosswind concentrations of lead in the ambient air. The most conservative of these two estimates was then used in the exposure evaluation.

4.1.1 Model Estimate of Airborne Lead Particulate Concentrations

Airborne concentrations of respirable lead contaminated particulate matter were estimated using analytic techniques presented in the California Site Mitigation Decision Tree Manual (CSMDTM, California DHS, 1986). The CSMDTM techniques are modified from an approach developed by C. Cowherd et al (EPA, 1984) whose based their work on field studies of wind erosion. The model itself is conservative in that it assumes that the soil particles are highly erodible and that they are in an unlimited supply.

The average annual emission rate of respirable lead particles was estimated from the following equation (California DHS, 1986):

$$Q = 0.036\ f\ A\ (1\text{-}V)\ (U/U_t)^3\ [F(x)] \qquad \text{Eqn. 1}$$

where Q = emission rate (gm/hr)

f = weight fraction of lead on/in soil particulate emissions with a particle diameter smaller than 10 microns.

A = surface area of site (m^2)

V = fraction of exposed contaminate area which is vegetated (for bare soil, $V = 0$)

U = mean annual wind speed (m/s)

U_t = threshold wind velocity (m/s)

F(x) = function plotted in Figure 8.8 of CSMDTM where $x = 0.886\ (U_t / U)$

All of these parameters were calculated according to the methods outlined in the CSMDTM. The parameter U_t is function of D, the mode of the soil particulate size distribution and a roughness height parameter, Z_o, which is a measure of the size and spacing of surface irregularities which affect wind flow such as trees and buildings.

From the sieve analysis results presented in Section 3.3.2, a value for D of 0.42 mm was determined, and a value of 200 cm was used for Z_o. This value of Z_o is representative of an intermediate roughness height for urban areas and is believed to be conservative because, while the site lies in urban Oakland, the size of buildings at the site is smaller and their spacing is larger than the typical urban setting. Smaller, more widely spaced buildings give a smaller value of Z_o, which in turn gives a larger U_t and a smaller emissions rate.

The mean annual wind speed assumed was 7.5 mph (3.35 m/s), which was the reported mean wind speed from over 87,000 readings taken at the Oakland Airport from 1951 to 1960 (provided by the U.S. Department of Commerce, National Weather Service). This value was selected since it is more conservative than the mean annual wind speed reported at the Oakland Airport from 1974 to 1979 of 4.4 mph (California Air Resources Board, provided by National Weather Service).

The area of lead contaminated soil was estimated as 8900 m^2 and a value of V = 0.3 was calculated to account for the fraction of this area which is presently covered in concrete by the former GHT's pad. The arithmetic average of lead concentration in soil was used for the weight fraction f, or 0.003287. Using this set of values a lead emission rate of 17.7 gm/hr was estimated.

The concentration of lead in air due to dispersion of the lead emitted from the source area was estimated using the Gaussian area source air dispersion model described in the CSMDTM. This model calculates the lead concentration in air as:

$$C = 16\,Q / [\pi\, L_v\, (2\,\pi)^{0.5}\, \sigma_z\, U] \qquad \text{Eqn. 2}$$

where C = concentration of lead in air (gm/m^3)
Q = emission rate (gm/s)
U = wind speed (m/s)
σ_z = standard deviation of the plume concentration in the vertical direction (m)
L_v = $L + L'$
L = distance from the site center to the receptor, which must be at least 2.5 times the cross-wind width of the site, (m)
L' = distance from the site center to the virtual upwind point source and is given by 2.5 times the cross-wind width of the site, (m)

A value of 250 meters was used for both L and L'. A standard deviation of 10.0 was estimated from guidance given in the CSMDTM. The same average wind speed, 3.35 m/s (7.5 mph), was used and the emission rate calculated in Eqn. 1 was used as input to Eqn. 2, once corrected for units consistency. The resultant air lead concentration was estimated as 0.0006 mg/m^3.

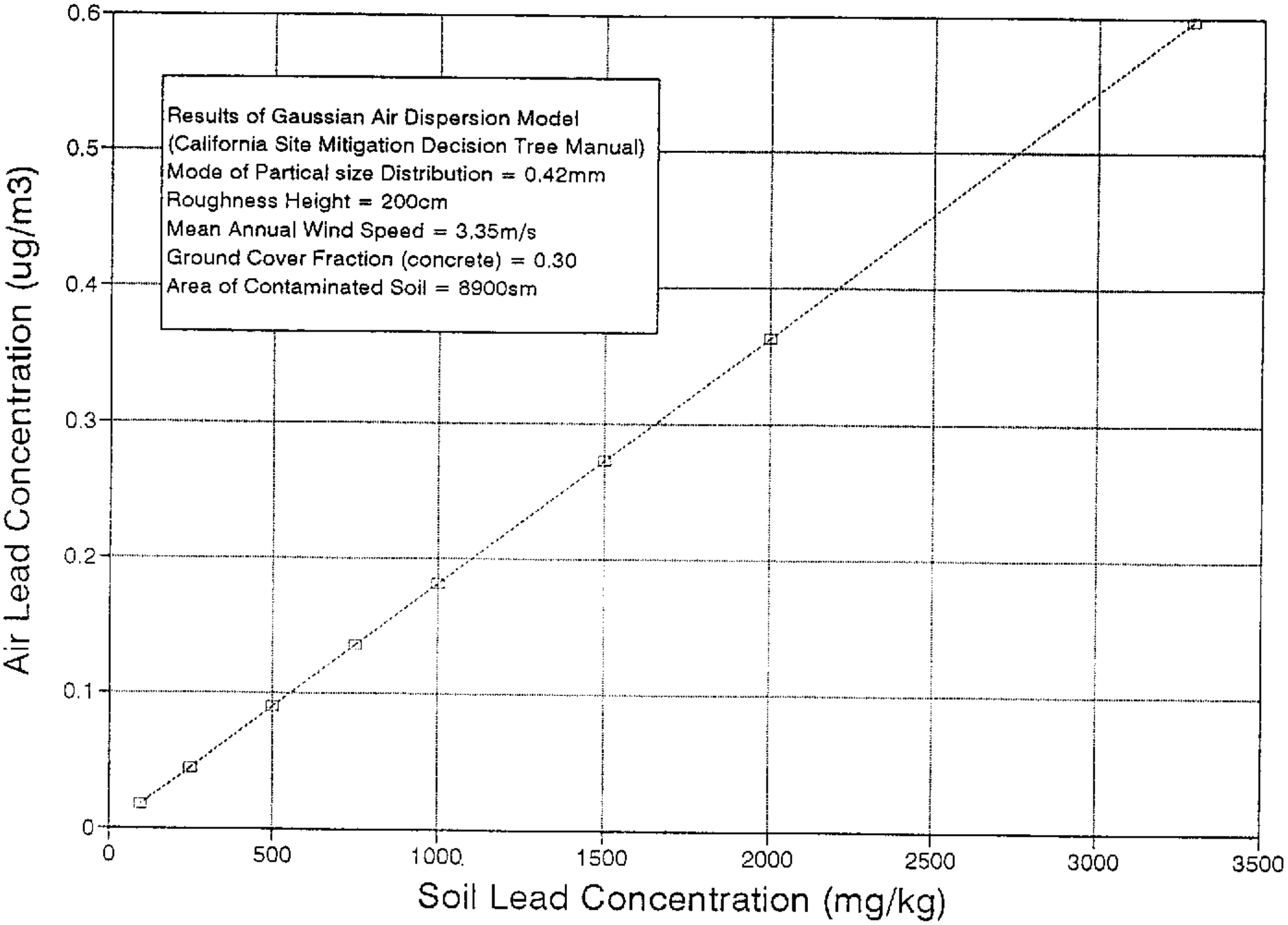
By varying the soil lead concentration input to Eqn. 1, an estimated relationship between the surface soil lead concentration and the resultant air lead concentration was developed. This relationship is presented in Figure 4.1, Estimated Concentration of Lead in Air Versus Soil Lead Concentration. This data was used for evaluating exposures following mitigation to various remaining soil lead concentrations.

4.1.2 Measurement of Airborne Lead Particulate Concentrations

On June 1, 1992, three air monitors, each consisting of a particulate air filter and pump, were placed at three locations around the perimeter of the site: upwind, downwind and crosswind. Each of the pumps was calibrated to draw ambient air at a constant rate of 5 liters/minute. The pumps worked for a period of over 6 hours, beginning at about 10 am, until a total of

Figure 4.1

Estimated Concentration of Lead in Air Versus Soil Lead Concentration



Results of Gaussian Air Dispersion Model
(California Site Mitigation Decision Tree Manual)
Mode of Partical size Distribution = 0.42mm
Roughness Height = 200cm
Mean Annual Wind Speed = 3.35m/s
Ground Cover Fraction (concrete) = 0.30
Area of Contaminated Soil = 8900sm

2,000 liters of air had been passed through each filter. Wind velocity measurements taken at the beginning and end of the sampling period averaged 5 mph with occasional gusts to 9 mph. The wind direction was from due West. Each filter was then detached from its pump and submitted for analysis for lead by method NIOSH 7300. A travel blank, consisting of an open filter cartridge which travelled with the active sample filters, was also submitted for analysis. The result for the three samples and the travel blank sample are summarized in Table 4.1. A copy of the laboratory results is included in Appendix A.

Table 4.1 Results of Air Monitoring Samples

Sample ID	Sample Location	Total Lead Collected (μg)	Air Lead Concentration (mg/m^3)
AM-1	Upwind	< 1.0	< 0.0005
AM-2	Crosswind	< 1.0	< 0.0005
AM-3	Downwind	< 1.0	< 0.0005
BLANK	Travel Blank	< 1.0	Not Applicable

Since each monitoring station indicated concentrations of lead in air which were less than 0.0005 mg/m^3, the more conservative value of 0.0006 mg/m^3 estimated by the air dispersion model was used as the base case for the exposure assessment, representing no mitigation action was taken.

4.2 EXPOSURE OF RESIDENT CHILDREN TO SITE LEAD

The first risk scenario considered the case where children were in residence at or near the site. The computer Uptake/Biokinetic Model (UBK), version 0.4 (developed by EPA, 1990) was used to predict the blood lead levels in resident children near the site resulting from total lead uptake. Diet, ingestion, and inhalation of soil and dust are modelled in this program as lead exposure routes for infants and children. The model is intended to evaluate the effects of regulatory decisions concerning each medium on blood lead levels and potential health effects. The maternal contribution to infant blood lead levels at birth is also considered in the model.

In the current application of the UBK model, all default values were used for the model parameters except: the soil and dust concentrations were varied (assumed equivalent), and the air concentration input was that concentration corresponding to the input soil concentration as was shown in Figure 4.1. The default drinking water lead concentration is 4.0 µg/L and the maternal blood concentration is 7.5 µg/dl. Indoor air is assumed to have 0.3 of the outdoor air lead concentration as a default. For each set of input parameters the model generated a frequency distribution for blood lead levels in children aged 0 to 7 years. The default geometric standard deviation was 1.42. The distribution was then compared to a cutoff unacceptable blood lead level of 10 µg/dl to determine the percentage of children, at each soil and corresponding air lead concentration, whose blood lead level lies below the cutoff.

Figure 4.2 shows the results of a series of model runs. In these runs, the soil concentration and corresponding air concentration given in Figure 4.1 were varied to determine the soil concentration which ensures that 95% of the resident children have blood lead levels below the cutoff. This soil concentration was found to be slightly less than 500 ppm of lead. If children were residing in the near vicinity of the site at its current average soil concentration of 3278 ppm, the model predicts that they would have a mean blood lead level concentration of 25.34 µg/dl with only 0.65% of them having blood lead levels below the cutoff of 10 µg/dl. The probability density function for this exposure is shown in Figure 4.3.

4.3 EXPOSURE OF RESIDENT ADULTS TO SITE LEAD

The second risk scenario considered the case where adults were in residence at or near the site. Resident adults were considered to experience exposure to lead through ingestion of contaminated soil and inhalation of soil and dust. Empirical studies were used to relate the amount of lead ingested and inhaled to a predicted incremental increase in blood lead concentration due to exposure to lead at the site.

The relationship between blood lead and air lead concentration has been studied by numerous researchers. The most reliable and relevant studies consistently yield a relationship slope factor typically in the range of 1.3 to 2.0 µg/dl per µg/m^3, with a weighted

Figure 4.2

Percentage of Children with Blood Lead Conc. below Cutoff vs. Soil Lead Conc.

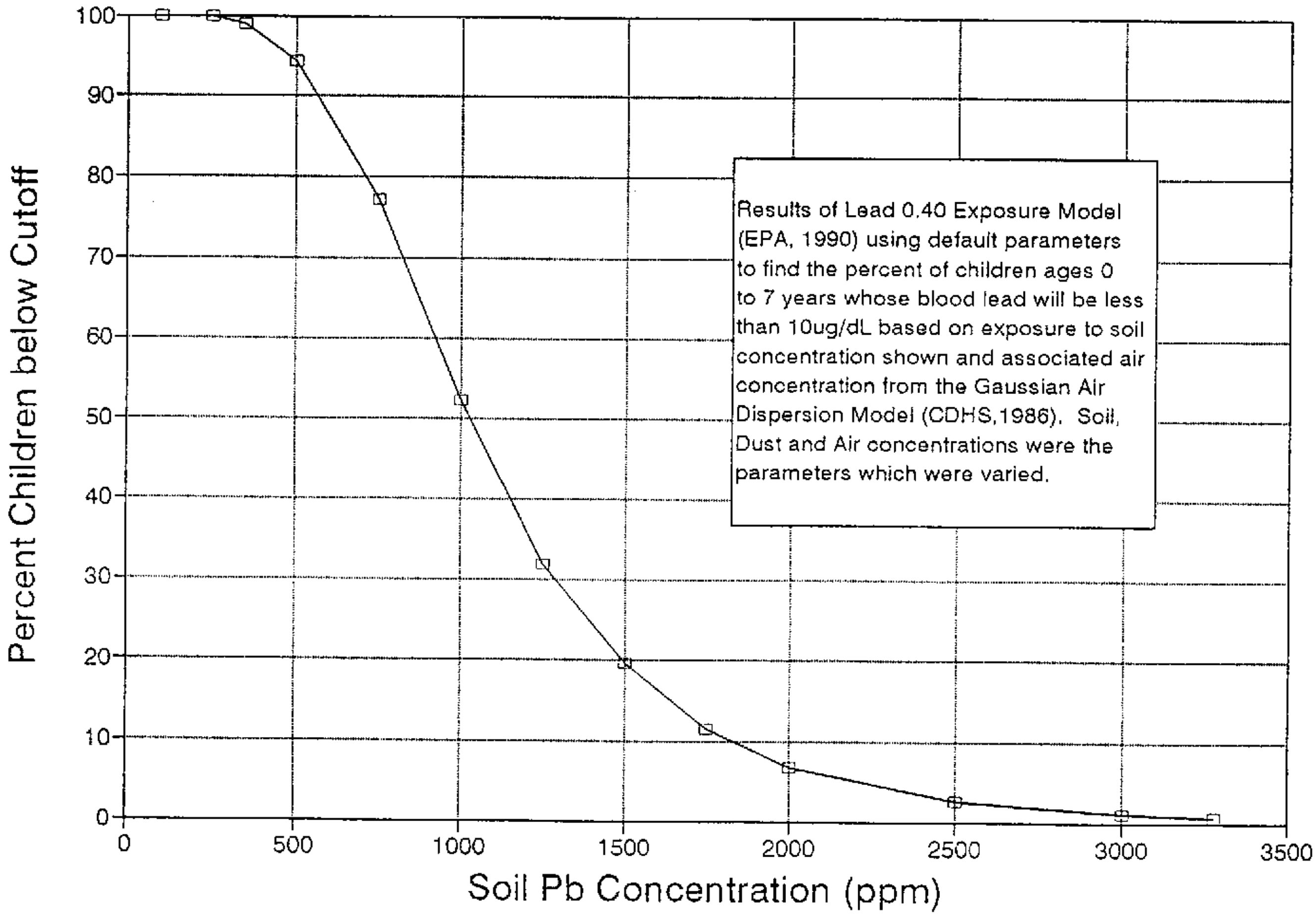

Results of Lead 0.40 Exposure Model (EPA, 1990) using default parameters to find the percent of children ages 0 to 7 years whose blood lead will be less than 10ug/dL based on exposure to soil concentration shown and associated air concentration from the Gaussian Air Dispersion Model (CDHS,1986). Soil, Dust and Air concentrations were the parameters which were varied.

Figure 4.3 Probability Density Function of Children's Blood Lead Resulting from Residential Exposure to the Site Once Lead is Mitigated to Below 500 mg/kg in Soil

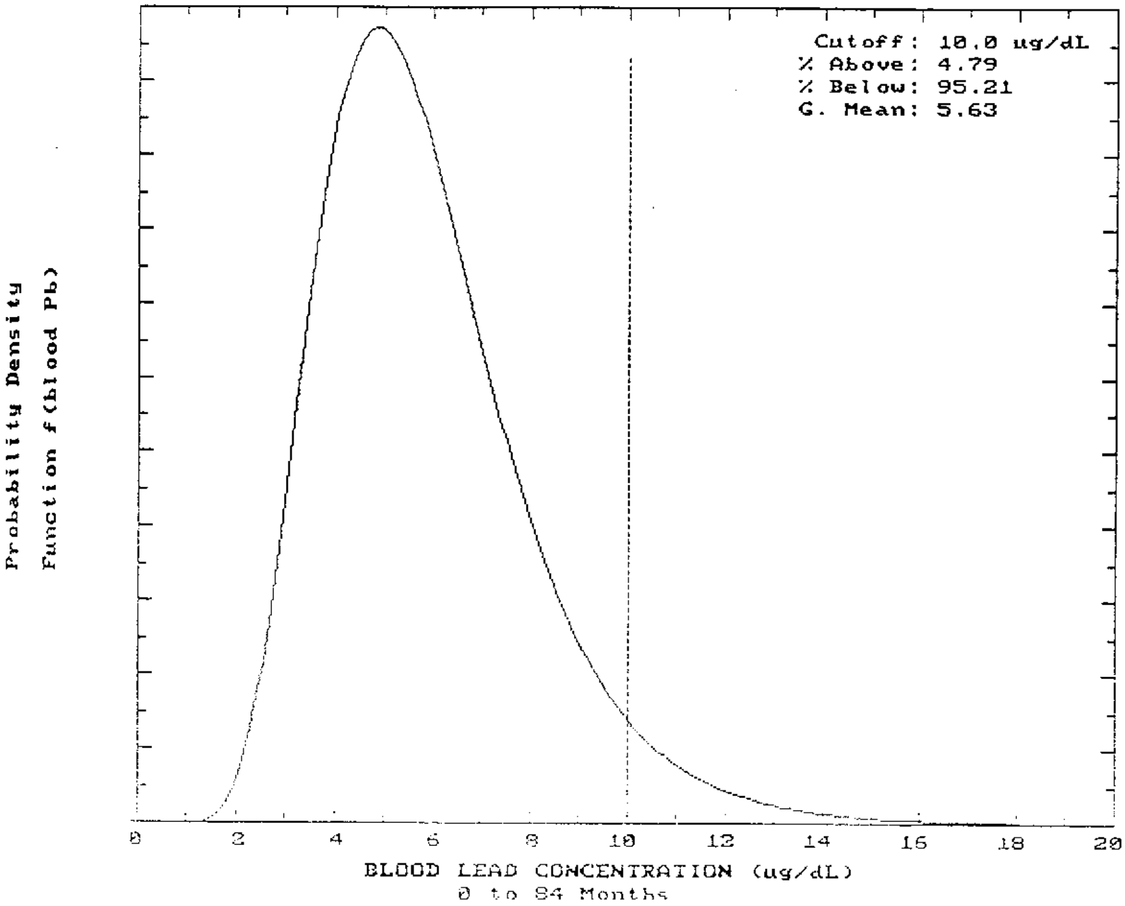
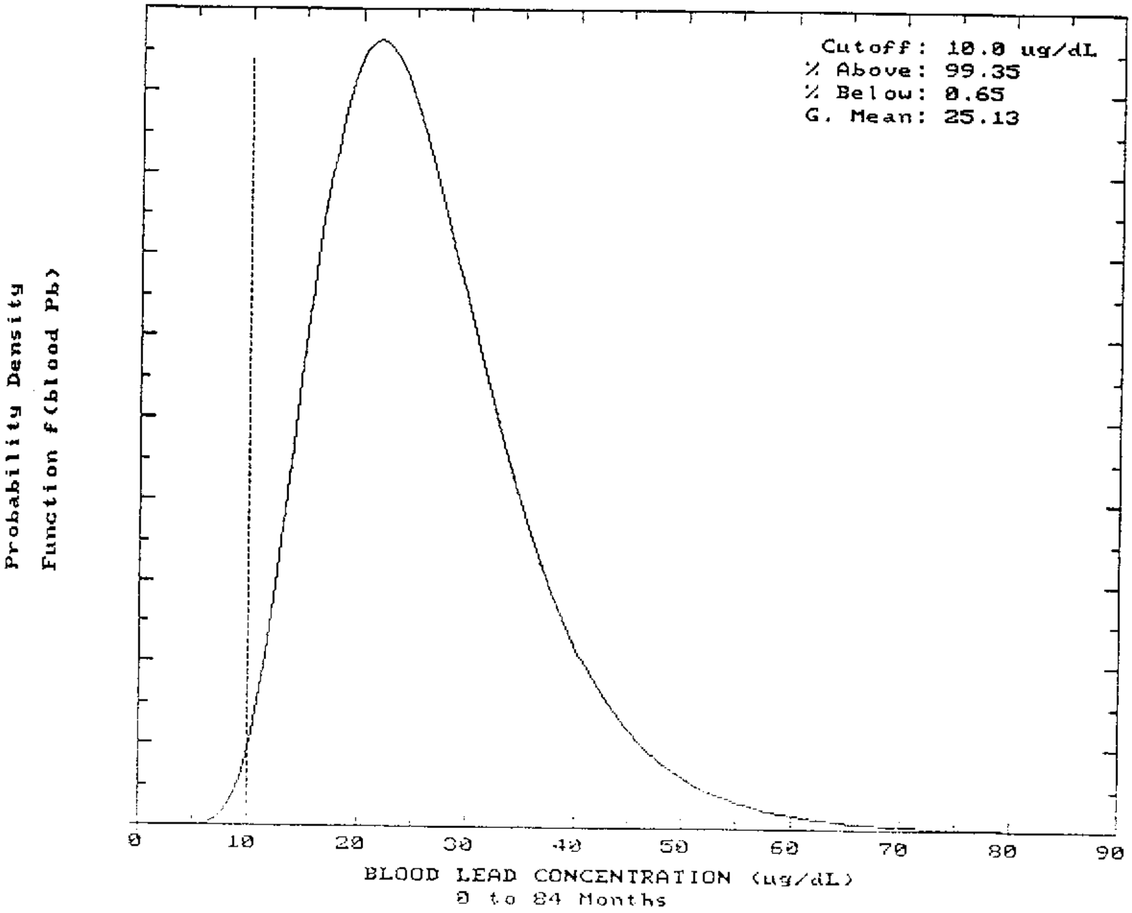


Figure 4.4 Probability Density Function of Children's Blood Lead Resulting from Residential Exposure to the Site at its Current Lead Concentration



slope of 1.4 (EPA, 1989 - Review of the National Ambient Air Quality Standard to Lead: Exposure Analysis Methodology and Validation). An additional factor should be used to account for possible re-entry of lead into the blood from bone or other long-term storage compartments. The EPA has recommended a factor of 1.3 to account for storage, which results in a blood lead/air lead inhalation slope of (1.4 * 1.3 =) 1.8 μg/dl per $\mu g/m^3$. The assumed relationship between the air lead concentration, C_{air} ($\mu g/m^3$), and the resulting increase in blood lead concentration, C_{blood} (μg/dl), is given by:

$$C_{blood} = 1.8\ C_{air} \qquad \text{Eqn. 5.1}$$

Studies examining the relationship between blood lead and ingested soil lead in adults were not found. Based upon the studies which investigated the relationship between blood lead and dietary lead intake are available, however. The Air Quality Management Division, Office of Air Quality Planning and Validation (EPA 1989) suggests that a slope value of 0.032 μg/dl per μg/day lead intake can be used for intake levels below 40 μg/day. Several studies indicate non-linear blood lead responses at high exposures but a linear relationship at relatively low intake levels. To account for this the NAAQS suggests using a different slope value of 0.009 μg/dl per μg/day is suggested for the portion of lead intake above 40 μg/day.

In calculating the increase in blood lead concentration due to ingested soil, it was necessary to assume a soil ingestion rate. Calabrese *et al.* (1990) in their study of adult soil ingestion rates, suggest a mean soil consumption rate of 50 mg/day. Using this value, the rate of lead consumed, Pb in mg/day, by a resident adult is estimated as

$$Pb = 50 * f_{lead}. \qquad \text{Eqn. 5.2}$$

Where f_{lead} is the fraction of lead in the consumed soil. If the rate of lead ingestion is less than 40 μg/day then the estimated increase in blood lead concentration in μg/dl resulting from soil consumption is given as

$$C_{blood} = 0.032\ Pb. \qquad \text{Eqn. 5.3}$$

If the rate of lead ingestion is greater than 40 µg/day then the relationship to blood lead concentration is given by

$$C_{blood} = 0.032 * 40 + 0.009\ (Pb - 40). \qquad \text{Eqn. 5.4}$$

Using Eqns. 5.1 through 5.4, the increase in blood lead concentration for resident adults was estimated in Table 4.2 for both the present average lead concentration at the site and for a scenario where lead at the site was mitigated to a lead concentration of 500 mg/kg.

Table 4.2 Incremental Increase in Blood Lead Concentration to Resident Adults

	Base Case	Theoretical Cleanup Case
Soil Lead Concentration (mg/kg)	3287	500
Contribution to Blood Lead from Soil Ingestion (µg/dl)	2.40	0.80
Air Lead Concentration ($\mu g/m^3$)	0.6	0.09
Contribution to Blood Lead from Soil/Dust Inhalation (µg/dl)	1.08	0.16
Total Estimated Increase in Adult Blood Lead Concentration (µg/dl)	3.48	0.96

In order to evaluate the human health impact of the estimated increases in blood lead concentration due to the presence of lead at the site, it is useful to first discuss the background blood lead levels in urban populations in the United States. The National Center for Health Statistics has provided the most comprehensive picture of blood lead levels among U.S. residents as part of the second National Health and Nutrition Examination Study (NHANES II) conducted from February 1976 to February 1980. In all, 5,841 adults aged 18 to 74 years were examined. The geometric mean of the sample population who lived in an area described as urban, but with a population less than 1 million, was 15.7 µg/dl for men and 11.0 µg/dl for women. The blood lead data from the NHANES II study demonstrated a significant downward trend over time for nationwide blood lead levels in the U.S. Using regression model-predicted blood lead levels, a 31 to 42% drop was found over the duration of the study. The most reasonable explanation for this trend appears to be concurrent reductions in the amount of lead released into the environment and diet, e.g. from decreased use of leaded gasoline, decreased used of lead solder in cans, etc. The EPA (EPA 1989) has derived a model which takes into account adjustments for leaded gasoline phasedown, dietary lead reductions and reductions in maternal exposure. The EPA used this model to predict 1990 "Baseline" average blood lead levels. The drop in blood lead levels between 1978 and those predicted for 1990 was about 64% for women and about 71% for men. Using these estimates for blood lead decline the expected blood lead level in urban areas, with populations of less than 1 million, in 1990 is 4.6 µg/dl for men and 4.0 for women.

At the current concentration of lead in soil at the site, a resident adult was estimated to experience a 3.48 µg/dl increase in blood lead concentration. This represents a 76% and an 87% increase in the blood lead concentration of men and women respectively over the expected 1990 background level. Their expected total blood lead concentrations, however, are still below the mean found in the NHANES study for 1976 through 1980. If lead at the site were mitigated to 500 mg/kg in soil, the expected blood lead increase of 0.96 µg/dl would represent only a 21 to 24% increase in the estimated background blood lead concentration of adults. These results are summarized in Table 4.3.

Table 4.3 Summary of Blood Lead Levels Expected in Resident Adults

	Men	Women
Estimated background blood lead conc. (µg/dl)	4.6	4.0
Estimated blood lead conc. for residents prior to mitigation action (µg/dl)	8.08	7.48
Percent increase over background	76%	87%
Estimated blood lead conc. for residents following mitigation of soil lead to 500 mg/kg (µg/dl)	5.56	4.96
Percent increase over background	21%	24%

The lead-induced health effects of concern in adults with blood lead levels ≤ 20 µg/dl are: aminolevulinic acid dehydrase (ALA-D) inhibition; erythrocyte protoporphyrin (EP) elevation in females; and elevated blood pressure in middle aged men (aged 40-59).

Low-level lead exposure is associated with inhibition of erythrocyte ALA-D activity. The inverse correlation of blood lead level with ALA-D is seen at very low blood lead levels (down to the lowest observed blood lead values of approximately 3 to 5 µg/dl) and occurs in adults as well as children. This suggests that the LOAEL (lowest observable adverse effect level) for ALA-D and interference with heme synthesis possibly occurs at blood lead levels < 10 µg/dl. The evidence thus far indicates no apparent threshold. The possible health impact at the blood levels predicted is not known.

Accumulation of EP occurs at thresholds of approximately 25-30 µg/dl of lead in men and approximately 15 to 20 µg/dl in women. These threshold values are based on the evaluation by the EPA of studies of occupationally exposed persons and the general population. Since blood lead concentrations in theoretical adult site residents are not expected to exceed 10 µg/dl, accumulation of EP is not expected.

An evaluation of various studies suggests a small but significant direct association between blood lead levels and blood pressure in middle-aged men (40 to 59 years old). The evidence indicates no apparent threshold through < 10 µg/dl of lead. Quantitatively, the relationship appears to hold across a wide range of blood lead values, extending possibly down to as low as 7 µg/dl for middle-aged man (EPA 1990). An estimated mean increase of about 1.5-3.0 mm Hg in systolic blood pressure appears to occur for every doubling of blood lead concentration in adult males. The effect on diastolic blood pressure was not significant. The blood lead concentrations of the subjects evaluated in the studies reviewed by EPA generally had higher blood lead concentrations than those predicted here. Sharp *el al.* (1988) reported the relationship between blood pressure and the logarithm of blood lead concentration utilizing multiple regression analysis on data gathered in bus drivers (mean blood Pb 6.4 µg/dl, range 2-15 µg/dl). Covariants included age, body mass index, sex, race, and caffeine intake. The largest regression coefficients relating systolic blood pressure and blood lead and diastolic blood pressure and blood lead were 1.8 mm Hg/ln(µg/dl) and 2.55 mm Hg/ln(µg/dl), respectively.

Using the relationships reported by Sharp *et al.*, residential exposure to lead at the site without any mitigation would be expected to lead to increased systolic and diastolic blood pressures of 2.2 and 3.1 mm Hg, respectively. These values are consistent with the relationships estimated by EPA (EPA 1990). The implication of lead-induced blood pressure increases with regard to potential increased risk for other more serious cardiovascular outcomes still remains to be delineated. Many factors contribute to the development of increased blood pressure or "hypertension" including hereditary traits, nutritional factors, and environmental agents. Essentially, any increase in blood pressure causes an increased risk (albeit small) for stroke, heart attack, and/or associated mortality. At this time, sufficient information does not exist for quantifying this risk.

After completion of mitigation, no increase in blood pressure is expected.

The conclusion of the adult residential exposure assessment indicates that were the site left in its present state, resident adults would be expected to experience an increase of 3.48 µg/dl in their blood lead concentration above the expected background. Their blood lead levels however would still be expected to lie below the mean blood lead concentration of urban adults in the period of 1976 to 1980, when leaded gasoline and lead soldered cans were more prevalent. Associated with the expected increase in blood lead concentration, the following adverse health effects might be noted: inhibition of erythrocyte ALA-D activity and interference with heme synthesis, and increased blood pressures of about 2 to 3 mm Hg. After completion of mitigation and reducing average lead concentration to 500 mg/kg, ALA-D inhibition might still be present. However, no elevated blood pressure would be expected.

4.4 EXPOSURE OF ON-SITE WORKERS TO LEAD

The final risk scenario considered the case where on-site workers are exposed to the elevated lead concentrations found at the site for 40 hours each week. It was assumed that the results found for on-site residential adults could be used once scaled to account for the portion of the time workers are on-site. The scale factor used was 0.24 (40 hours/week/[7 days/week * 24 hours/day]). A summary of the estimated incremental increase in blood lead concentration and expected blood lead levels in on-site workers can be found in Tables 4.4 and 4.5.

Table 4.4 Incremental Increase in Blood Lead Concentration to On-site Workers

	Base Case	Case After Mitigation is Completed
Soil Lead Concentration (mg/kg)	3287	500
Contribution to Blood Lead from Soil Ingestion (μg/dl)	0.57	0.19
Air Lead Concentration (μg/m^3)	0.6	0.09
Contribution to Blood Lead from Soil/Dust Inhalation (μg/dl)	0.26	0.04
Total Estimated Increase in Adult Blood Lead Concentration (μg/dl)	0.83	0.23

Table 4.5 Summary of Blood Lead Levels Expected in On-site Workers

	Men	Women
Estimated background blood lead conc. (μg/dl)	4.6	4.0
Estimated blood lead conc. for workers prior to mitigation action (μg/dl)	5.43	4.83
Percent increase over background	18%	21%
Estimated blood lead conc. for workers following mitigation of soil lead to 500 mg/kg (μg/dl)	4.83	4.23
Percent increase over background	5%	6%

As was noted in the residential adult exposure scenario, inhibition of erythrocyte ALA-D activity and interference with heme synthesis has been associated with blood lead concentrations down to the lowest observed lead values (in the range 3 to 5 μg/dl). One would anticipate that given the small increase in blood lead (i.e., over background) the health impact would be negligible.

Since the blood lead concentrations of theoretical on-site workers is less than 10 μg/dl, accumulation of EP is not expected. Sharp *et al.*'s relationship to blood pressure also indicates that for both the present and theoretical cleanup case, no observable increase in on-site worker blood pressure would be expected.

5.0 CONCLUSIONS

This Pre-Remediation Human Health Risk Assessment considers three exposure scenarios: that of children residing at the site or in its vicinity, that of adults residing at the site or in its vicinity, and finally that of on-site workers. The greatest impact to human health was found for the residential children scenario. It was estimated that mitigating the mean soil lead concentration at the site from its current value of 3287 mg/kg to less than 500 mg/kg, would be protective of child and adult human health. The conclusions of this assessment are summarized below.

- The lead present at the site is found at an average concentration in soil of 3287 mg/kg, and has not been detected in groundwater.

- The average annual concentration of lead in air at the site is estimated from a wind erosion/dispersion model as 0.6 $\mu g/m^3$.

- The concentration of lead in air around the perimeter of the site was measured to be less than the method detection limit of 0.5 $\mu g/m^3$.

- Ingestion of site soils and inhalation of soil and dust from the site are considered to be the routes of exposure for the human health risk assessment.

- The scenario of resident children at the site indicated that the children's blood lead level would be at an average of 25.34 μg/dl during residential exposure to lead at the site in its present condition.. Exposure modelling indicates that reducing the mean soil concentration to about 500 mg/kg would result in a 95% statistical confidence that resident children's blood lead levels would be below an acceptable cutoff of 10 μg/dl.

- The site lead-induced health effects of concern for adults are expected to be ALA-D inhibition and elevation of blood pressure.

- The scenario of resident adult exposure at the site indicated that adult blood lead concentrations would be increased over their expected background concentration (from other sources) of 4.0 to 4.6 µg/dl, to an expected concentration of 7.5 to 8.1 µg/dl due to exposure to the current lead concentrations at the site. The expected exposure related rise in blood pressure is estimated as about 2 to 3 mm Hg.

- No rise in blood pressure is predicted for resident adults if the mean concentration of lead in soil at the site is mitigated to less than 500 mg/kg.

- The scenario of on-site worker exposure indicated that their blood lead concentration would increase over their expected background of 4.0 to 4.6 µg/dl, to an expected concentration of 4.8 to 5.4 µg/dl due to exposure to the current lead concentrations at the site. No rise in blood pressure is expected due to this exposure.

- No blood pressure rise is predicted for on-site workers if the mean concentration of lead in soil at the site is mitigated to less than 500 mg/kg.

6.0 REFERENCES

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APPENDIX A
LABORATORY RESULTS

pace
INCORPORATED
THE ASSURANCE OF QUALITY

REPORT OF LABORATORY ANALYSIS

June 11, 1992

Mr. Aaron Stessman
Earth Technology Corporation
2030 Addison Street
Suite 500
Berkeley, CA 94704

RE: PACE Project No. D20603.505
Client Reference: IH Analysis

Dear Mr. Stessman:

Enclosed is the report of laboratory analyses for samples received June 03, 1992.

If you have any questions concerning this report, please feel free to contact us.

Sincerely,

R. Paul Dugas
Project Manager

Enclosures

5930 McIntyre Street
Golden, CO 80403
TEL: 303-278-3400
800-878-3434
FAX: 303-278-2121

Offices Serving: Minneapolis, Minnesota
Tampa, Florida
Iowa City, Iowa
San Francisco, California
Kansas City, Missouri
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Denver, Colorado

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REPORT OF LABORATORY ANALYSIS

Earth Technology Corporation
2030 Addison Street
Suite 500
Berkeley, CA 94704

June 11, 1992
PACE Project Number: D20603505

Attn: Mr. Aaron Stessman

Client Reference: IH Analysis

PACE Sample Number:			65 0107426	65 0107434	65 0107442
Client Sample ID:			AM-1	AM-2	AM-3
Parameter	Method	Units			
FIELD ANALYSIS					
AIR VOLUME / SAMPLE TIME					
Air Sample Volume		Liters	2000	2000	2000
INORGANIC ANALYSIS					
LEAD (NIOSH 7300)					
Total		ug	LT 1	LT 1	LT 1
Air Concentration		mg/m3	LT 0.0005	LT 0.0005	LT 0.0005

LT Less than.

Mr. Aaron Stessman
Page 2

June 11, 1992
PACE Project Number: D20603505

Client Reference: IH Analysis

PACE Sample Number: 65 0107450
Client Sample ID: BLANK

Parameter	Method	Units	
INORGANIC ANALYSIS			
LEAD (NIOSH 7300)			
Total		ug	LT 1

LT Less than.

These data have been reviewed and are approved for release.

Steven Ignelzi
Analytical Services Manager

The Earth Technology Corporation

Chain of Custody Record

job no.

Date 6/1/92

Page 1 of 1

Laboratory PACE INC.

Address 5930 McIntyre St.
Golden, CO 80403
(800) 373-3434

Client PG+E

Address Coliseum Way
Oakland, CA

Project Name / Number 690262.04

Contract / Purchase Order / Quote

Method of Shipment: Fed. Ex.

Shipment No. 1

Project Manager V. Bajsarowicz

Telephone No. (510) 540-6954

Fax. No. (510) 540-7496

Samplers: (Signature)

Field Sample Number	Location/ Depth	Date	Time	Sample Type	Type/Size of Container	Preservation Temp.	Preservation Chemical	Filtered √	No. of Containers	Analysis Required: NIOSH #7300 (LEAD)							Remarks
AM-1	Site	6/1/92	[illegible] day	[illegible]	37mm [illegible] Filter	—	—		1	X							Lead by ICP
AM-2	"	"	"	"	"	—	—		1	X							"
AM-3	"	"	"	"	"	—	—		1	X							"
BLANK	—	"	"	"	"	—	—		1	X							"

Relinquished by:
Signature
Printed Aaron N. Slessman
Company Aqua Resources/TETC
Reason Mailed for Analysis
Date 6/2
Time 12:10

Received by:
Signature
Printed
Company
Reason
Date
Time

Relinquished by:
Signature
Printed
Company
Reason
Date
Time

Received by:
Signature
Printed
Company
Reason
Date
Time

Comments: • 5 working days turnaround per conv with Paul Dugas. • 2000 ℓ air volume passed through AM samples.
• Blank: left open and travelled with samples
• FAX results to VOYTEK (510) 540-7496.

Relinquished by:
Signature
Printed
Company
Reason
Date
Time

Received by:
Signature
Printed
Company
Reason
Date
Time

DISTRIBUTION: White to Laboratory, Canary to Earth Technology Project File, Pink to Courier, Golden to Field File

F1000
2/15/91

CMT CONSTRUCTION MATERIALS TESTING, INC.

Job Name: 4930 COLISEUM WAY
Job No. 90856
Sample Description: DK BR SI SO W/GRAVEL
Sample No: 1
Source: SITE
Date: 5-27-92
Client No: AQUA RESOURCES 690262.04
Sampled: JO Tested: G

COMPACTION CURVE

% Retained on 3/4": ______ ASTM D1557 A (4" mold) ASTM D1557 B C or D (6" mold)

Trial No.	+100	+150	+200	+250
Wet Wt.	2066	2125	2105	2061
Wet Den.				
Dry Wt.	1953	1973	1917	1849
Moisture				
% Moisture				
Dry Den.				

Group Symbol:

4" MOLD

Wet Den. = .06614 x Wet Wt.

$$\text{Dry Den.} = \frac{\text{Wt Den.}}{100 + \% H_2O}$$

6" MOLD

Wet Den. = .02939 x Wet Wt.

$$\text{Dry Den.} = \frac{\text{Wt Den.}}{100 + \% H_2O}$$

Sample

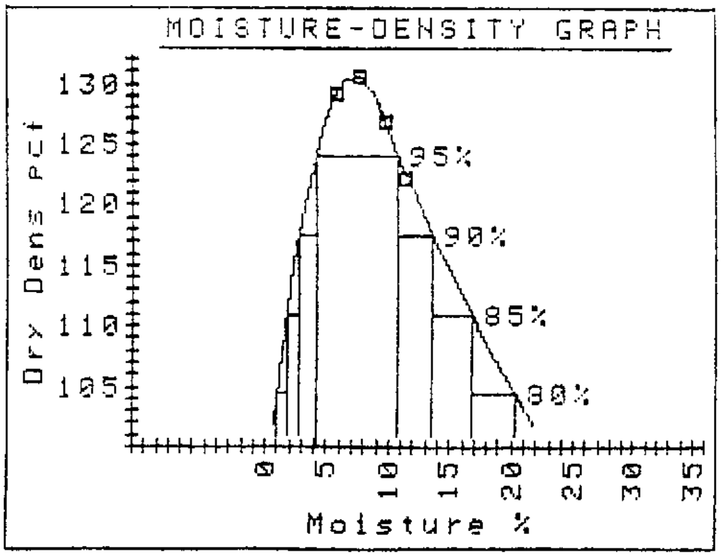
Maximum Dens.: 130.6 pcf
Optimum Mois.: 7.3 %

MOISTURE RANGE

	low	high
95%	4.1	10.8
90%	2.8	13.6
85%	1.8	16.7
80%	-	20.2

LAB DATA

	dens	mois
1.	129.2	5.8
2.	130.5	7.7
3.	126.8	9.8
4.	122.3	11.5

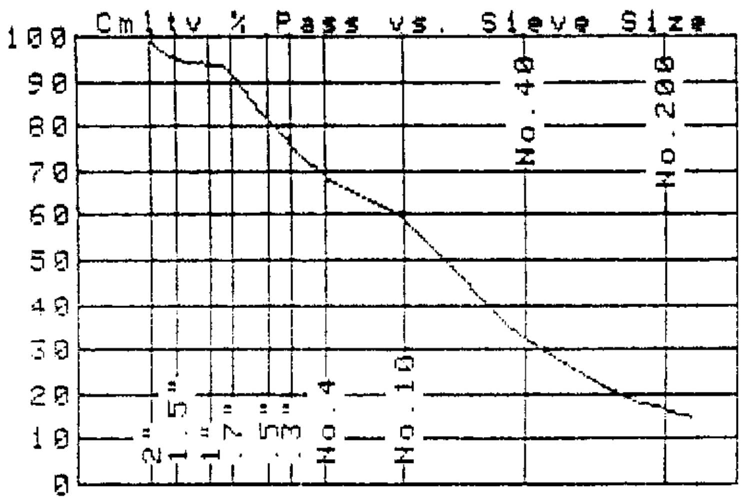


JOB NO.______
LE______

CMT CONSTRUCTION MATERIALS TESTING, INC.

Job Name:	4930 COLISEUM WAY	Job No.	90856
Sample Description	DK BR SI SD w/ GRAVEL	Sample No:	
Source:	SITE	Date:	5-27-92
Client No:	AQUA RESOURCES 690262.04	Sampled:	Tested:

SIEVE ANALYSIS



SIEVE	WT(g)	CUM. % PASSING
2"	0	100 %
1.5"	97	95 %
1"	25	93.8 %
.750"	37	91.9 %
.500"	211	81.2 %
.375"	108	75.8 %
No.4	142	68.6 %
No.10	196	58.7 %
No.40	516	32.6 %
No.200	321	16.4 %
pan	325	
total	1978	

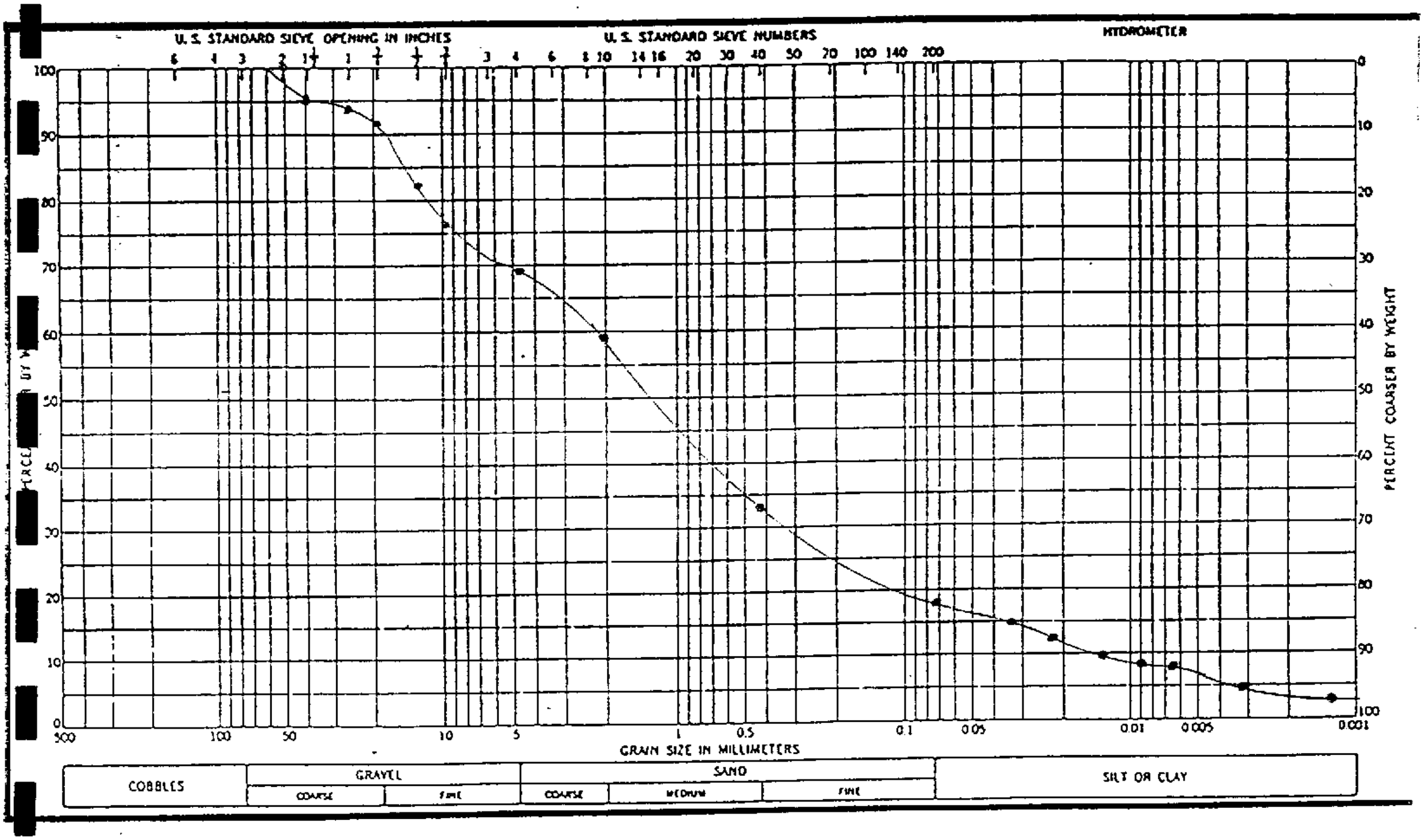
REMARKS:

CMT CONSTRUCTION MATERIALS TESTING, INC.

Job Name: 4930 COLISEUM WAY
Sample Description: Dk Br Si SD w/ GRAVEL
Source: SITE
AQUA RESOURCES 690262.04

Job No.: 90856
Sample No.: 1
Date: 5-27-92
By:

HYDROMETER ANALYSIS
ASTM D-422



Remarks:

1000-U Detroit Avenue . Concord, California 94518 . Telephone (415) 825-2840

CONSTRUCTION MATERIALS TESTING, INC.

Job Name: 4930 COLISEUM WAY
Sample Description: DK BR SI SD W/GRAVEL
Source: SITE
AQUA RESOURCES 690262.4

Job No.: 90 856
Sample No.: 1
Date: 5-27-92
By:

HYDROMETER ANALYSIS
ASTM D-422

Date	Actual Time	Elapse Time (min.)	R/H	Temp. C	C	% Pass	L	K	Dia.
5/27	9:35	2	23	22	5.8	15.0	12.5	.01332	.0333
	9:38	5	19	"	"	11.5	13.2	"	.0216
	9:48	15	17	"	"	9.8	13.5	"	.0126
	10:03	30	15	"	"	8.0	13.8	"	.0090
	10:33	60	14	23	5.7	7.2	14.0	.01317	.0064
	1:43	250	11	"	"	4.6	14.5	"	.0032
5/28	9:33	1440	9	22	5.8	2.8	14.8	.01332	.0014

Dry Weight of Soil 114.59 Assumed Specific Gravity 2.65

Remarks: