Ravi-

2-20-92

This project has come to us in the past few months. Other than receiving copies of all correspondence, City of Hayward has not been involved with overseeing this project.

Recently, I received these report (with separately bound appendix.)

Ron Helm, consultant w/ Lowney + Associates requested a March mtg, but has not set a date.

Any questions?

Pam

a "SLIC" site

PS - Players:
current "owners"?
A.M. Homes
prospective buyers:
Pepsi Co

92 FEB 11 AM 8:35

SOIL AND GROUND WATER QUALITY RECONNAISSANCE, 32-ACRE HAYWARD PARCEL, HAYWARD, CALIFORNIA

DRAFT

LOWNEY ASSOCIATES
ENVIRONMENTAL/GEOTECHNICAL/ENGINEERING SERVICES

405 Clyde Avenue, Mountain View, California 94043
(415) 967-2365 • FAX (415) 967-2785

LOWNEYASSOCIATES
Environmental/Geotechnical/Engineering Services

February 10, 1992
30-718-9, MV052805

AM HOMES
577 Salmar Avenue
Campbell, California 95008

RE: **SOIL AND GROUND WATER QUALITY RECONNAISSANCE,**
32-ACRE HAYWARD PARCEL,
HAYWARD, CALIFORNIA

Attention: Mr. Steve Delva

Gentlemen:

As you requested, we have completed the attached draft report which summarizes our soil and ground water quality investigation for the referenced property. The scope of work performed was discussed with you and described in our letters dated June 19, August 20, September 20, and November 7, 1990, and April 23, and September 20, 1991.

If you have any questions, please call.

Very truly yours,

LOWNEY ASSOCIATES

Stason Foster

Stason I. Foster

Ron L. Helm

Ron L. Helm, R.E.A.

Glenn Romig

Glenn A. Romig, P.E.

Copies: Addressee (4)
Alameda County Health Agency (2)
Attn: Ms. Pamela J. Evans
Hayward Fire Department (2)
Attn: Mr. Hugh Murphy

▼ 405 Clyde Avenue, Mountain View, California 94043 (415) 967-2365 FAX (415) 967-2785

SOIL AND GROUND WATER QUALITY RECONNAISSANCE

For

32-ACRE HAYWARD PARCEL,
Hayward, California

To

AM HOMES
577 Salmar Avenue
Campbell, California 95008

February 1992

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SOIL AND GROUND WATER QUALITY RECONNAISSANCE
32-ACRE HAYWARD PARCEL
HAYWARD, CALIFORNIA

1.0 INTRODUCTION

1.1 Purpose

This report presents the results of our soil and ground water quality reconnaissance at the referenced site, located on Hesperian Boulevard adjacent to Alameda Creek in Hayward, California. The purpose of our investigation was to evaluate soil and ground water quality at the site and has included collection and analysis of selected ground water, surface water, soil and slag samples. A baseline health risk assessment was also performed to evaluate compounds of concern.

1.2 Site Description

The 32-acre property, as shown on Figures 1 and 2, is bordered to the east and south by Alameda Creek flood control channel levees, to the west by Hesperian Boulevard, and to the north by industrial and commercial developments. The site was reportedly used for agricultural purposes until 1969 and left fallow until 1970, when a drive-in movie theater was constructed on the eastern portion of the site. Operation of this theater was discontinued in the mid 1980s and the site has been unoccupied since.

1.3 Previous Investigations

The Phase I studies conducted by Earth Metrics, Incorporated and Harding Lawson Associates (HLA) on May 15, 1987 and October 12, 1989, respectively, identified areas of potential concern.

Site visits conducted by Earth Metrics in 1987 revealed that the eastern portion of the site contained remnants of the abandoned drive-in theater including: two projection screens, paved driveways, concrete slabs, metal speaker posts, and graded parking areas. Household trash, including appliances, mattresses, and newspapers had been dumped along the access road and in former drive-in parking areas. Ponding was observed on-site in May 1987. The undeveloped western portion of the site was covered with numerous mounds consisting of concrete fragments, asphaltic materials, and slag fragments. Dense vegetation covered sections of this area.

Two site visits were conducted by HLA in September 1989. The screens, paved driveways, concrete slabs, and speaker posts had been removed from the drive-in portion of the site and several mounds of household trash were observed. The western undeveloped portion of the site contained mounds of debris consisting of soil, concrete fragments, asphalt, and paving rubble. Several small containers of hazardous materials were observed along the northeastern border of the site, including one 5-gallon metal container of methyl ethyl ketone, five 5-gallon plastic containers of unknown material, seven 5-gallon containers of used oil, one 10-ounce container of malathion, one 24-ounce container of pesticide, and three 10-ounce glass containers of pesticide. The exact locations of these materials were not specified in the report, except that they were located along the northeast border of the site. No evidence of leakage was observed and these materials were reportedly removed from the site by September 20, 1989.

On November 16, 1989, HLA installed five well points along the northeast boundary of the site, to evaluate ground water quality in this vicinity. Well points are not "permanent" wells and likely consisted of collecting a "grab" sample of the ground water using a hydropunch sampler. After the sample is collected, the boring is typically grouted. Ground water was analyzed for total petroleum hydrocarbons (TPH) as gasoline and diesel, motor oil, and benzene, ethylbenzene, toluene, and xylenes (BTEX). TPH diesel concentrations were not detected above the detection limit of 0.05 parts per million (ppm). TPH gas concentrations ranged from 0.08 to 0.15 ppm and motor oil concentrations ranged from 2.1 to 54 ppm. Benzene was detected in one well point (3.8 parts per billion or ppb), ethylbenzene was detected in three well points (1.1 to 2.7 ppb), toluene was detected in four well points (2.1 to 30 ppb), and xylenes were detected in two well points (9 to 13 ppb). In addition, a slight sheen was reportedly observed on ground water in two of the well points.

1.4 Scope of Work

The scope of work performed for this investigation included the following:

- Visiting the site to observe current site conditions and review of aerial photographs to evaluate past site usage.
- Environmental questionnaires were sent to AM Homes to be filled out by the current and previous owner(s) of the site.
- Drilling of four exploratory borings into the uppermost water-bearing stratum and installation of four "permanent" monitoring wells; collection and analysis of selected soil and ground water samples.

- Advancement of 27 exploratory borings to depths of three to four feet; collection and analysis of selected soil samples.
- Collection and analysis of one hydropunch ground water sample and three surface water samples.
- Collection and analysis of six slag samples and twelve composite soil samples from beneath surface slag piles.
- Preparation of a baseline health risk assessment.
- Review of previous reports, evaluation of analytical data and preparation of this report.

2.0 SITE OBSERVATION

2.1 Site Conditions

On July 5 and 6, 1990, our representative walked the site and looked for signs of underground and above ground storage tanks, sumps, transformers, stains, debris, and other materials indicative of a release of hazardous materials. No evidence of chemical usage, storage, disposal, and/or spills was observed on-site.

The generally level site contained numerous mounds of trash on the drive-in portion, primarily consisting of scrap metal, household appliances, mattresses, wood, an abandoned car, plastic, and rubber. The surface gravel fill layer across the drive-in contained numerous fragments of waste metal, asphalt chips, and slag. Slag is generally produced as a by-product in metal foundry or refining operations and was commonly used as granular fill material prior to the 1970s. An area of ponding and associated white stains in low areas were observed on the drive-in parking lot which borders the undeveloped portion of the site.

The undeveloped portion of the site contained several piles of debris consisting of root fragments, concrete blocks, concrete pipes, asphalt, and slag. Several mounds of soil were also observed on the site. Approximately half of this area had been plowed and stripped of vegetation. During subsequent site visits, vegetation consisting of tall grass, thistle, and other weeds was observed to have grown over a large portion of the formerly plowed area.

2.2 Aerial Photograph Review

Aerial photographs of the vicinity were reviewed to evaluate past site usage. The photographs were taken for the United States Department of the Interior and Pacific Aerial Survey between 1958 and 1990. Table 1 below references the aerial photographs reviewed.

TABLE 1. Aerial Photographs Reviewed, Two Hayward Parcels, Hayward, California

Date Taken	Reference Number	Scale
July 21, 1958	GS-VUO 1-83; single	1:20,000
July 7, 1960	GS-VACY 1-64; single	1:15,000
May 14, 1965	ALA 5-48,49; stereo pair	1:12,000
May 16, 1966	BUT-3GG-65,66; stereo pair	1:20,000
October 14,1974	13-24, 25; color stereo pair	1:20,000
September 6, 1979	AV 1750-06-49,51; stereo pair	1:12,000
October 28, 1980	GS-VEZR 1-117,118; stereo pair	1:24,000
June 22, 1981	AV-2040-06046,47; stereo pair	1:12,000
June 21, 1983	AV-2300-06-46,47; stereo pair	1:12,000
May 15 , 1985	AV-2640-06-47,48; stereo pair	1:12,000
March 30,1988	AV-3268-6-49,50; stereo pair	1:12,000
July 17, 1990	ALA AV-3845-16-45,46; stereo pair	1:12,000

The aerial photographs from 1958 and 1960 showed the project site and general vicinity as agricultural land planted with row crops on-site. No sheds, drums, or discolored areas of soil were noted on or near the project site.

The 1965 and 1966 photos also showed the majority of the site in use as agricultural land. A dirt road near Alameda Creek led from Hesperian Boulevard to the far eastern corner of the site. The eastern corner of the site was cleared of vegetation and consisted of a dirt lot with one structure that appeared to be a pump station located on the creek bank. Industrial buildings were present well to the east and south of the site and housing developments were located well to the north.

In the 1974 photo, two drive-in movie theaters had been constructed on the eastern portion of the property. Two projection screens were present and parking areas were graded in a semi-circular pattern surrounding each screen. No discolored areas or drums were observed on the drive-in portion of the site. The western portion of the site was undeveloped but appeared to contain supplies and debris piles from construction of the drive-in. Vegetation was present on the western portion of the site. Bordering properties were primarily agricultural or vacant. However, industrial buildings had been constructed on the adjacent property northeast of the site.

The 1979 aerial photograph showed no significant changes in the site. However, objects which appeared to be storage barrels or drums were noted on the property north of and adjacent to the northeast boundary of the project site.

The 1980 photo showed the site to be relatively unchanged. The area west of the project site was agricultural and undeveloped land existed to the east. Industrial buildings were present north and south of the site.

The 1981 and 1983 photographs showed a large area of ponded water in the parking area of the central theater, at the same location where surface water was observed during our previous site visits. White stained areas associated with ponding of water in low areas were noted at several locations on-site. No barrels were observed on-site, although identification of barrels on aerial photographs is often difficult.

The 1985 photo showed the drive-in theater in deteriorating condition. Ponding and white stained areas were still present, along with numerous piles of trash. The main projection house was torn down and only the foundation remained.

The 1988 and 1990 photos showed the drive-in theater facilities to be further deteriorated. The second projection house had been removed by 1988. By 1990, the trash piles had been pushed into rows and the screens were removed.

2.3 Environmental Questionnaires

Two environmental questionnaires were sent to AM Homes, one for the current owner to fill out and one to be delivered to the previous site owner(s), if possible. The questionnaire to the current owner was filled out and returned to us, and a copy is presented in Appendix D. The questionnaire to the previous owner was not returned to us.

The returned questionnaire indicates that the site is currently owned by Filare Partners, which is a joint corporation consisting of Charles Davidson, Ken Earp, and AM Homes, who have owned the site since 1988. They did not report any knowledge of spraying or dust control operations performed during the operation of the drive-in theater, or storage/use of hazardous materials on-site since the property purchase in 1988.

2.4 Review of Fire Department Files

Files of the Union City Fire Department were reviewed to obtain information concerning an ongoing investigation at the Pacific States Steel Corporation located within four miles of the project site. This investigation addresses an on-site slag issue which is being closely monitored by regulatory agencies. Available information indicates that approximately 50,000 cubic yards of slag, a by-product from steel manufacturing, was stockpiled on this site from 1966 to 1978. Slag depths range to 11 feet and cover an area of approximately 8.5 acres.

Work at the site has included installation of 10 ground water monitoring wells, sampling of slag from 36 test pits, collection of several background soil samples and soil samples from beneath the slag piles, and collection of water and sediment samples from a bordering flood control canal.

Based on analytical results of slag samples, the primary metals of concern are lead and zinc, with copper and cadmium being secondary metals of concern. Concentrations of those metals have exceeded TTLC and/or STLC values, classifying the slag as a California hazardous waste. However, soluble metals analyzed by the toxicity characteristic leaching procedure (TCLP) did not exceed TCLP regulatory values, therefore, the slag is not a RCRA hazardous waste.

Soil analyses indicate that only the upper 0.5 feet of underlying soil (silty clay) has been impacted, as metal concentration slightly above background levels were detected. Analytical results do not indicate that the site has impacted surface water or sediments from the adjacent flood control canal or ground water. Thus, the metals contained in the slag appear to be very immobile.

Interim remedial measures designed to eliminate a zone of perched water located directly above the slag/soil interface have been proposed. However, actual remedial alternatives for the slag and soil have not yet been addressed. We understand that encapsulation of the slag and soil on-site will likely be the preferred remedial alternative.

3.0 SOIL QUALITY EVALUATION

3.1 Exploratory Borings

To investigate near surface soil quality, soil samples were collected at various depths from numerous exploratory borings as shown on the attached site plan. The initial field investigation was completed in July 1990, with the second phase completed in October 1990. A review of the results and consideration of remedial alternatives was subsequently performed. Based on our conclusions, additional field work was conducted in May and December 1991. All exploratory borings were located within the boundaries of the site, ranging to depths of 26.5 feet. Soil samples were obtained in 2.5 inch diameter brass liners which had been thoroughly cleaned with tri-sodium phosphate (TSP) and rinsed with distilled water, or steam cleaned. Copies of all laboratory data sheets along with a discussion of laboratory procedures are included in Appendix E (bound separately).

3.2 Petroleum Hydrocarbon Analyses

Initial soil borings (EB-1, EB-2 and EB-3) were located in areas where petroleum hydrocarbons might be expected due to leaking motor oil. They were collected in low lying, white stained areas where surface water ponding apparently occurred during the rainy season. If hazardous materials were released on the site's surface, water flow would likely transport these substances toward the low lying areas.

Soil samples were also collected from borings AF-1 to AF-4 which, as discussed later, were converted into ground water monitoring wells.

The July 1990 sampling consisted of analysis of eleven near surface samples for TPH as gasoline, BTEX, and oil and grease. The analytical results are shown in Table 2.

TABLE 2. Laboratory Analysis of Near Surface Soil Samples
July 5 and 6, 1990
Two Hayward Parcels, Hayward, California
(concentrations in ppm)

Sample	Total Depth (ft.)	Oil and Grease	TPH Gas	Benzene	Toluene	Ethylbenzene	Xylene
AF-1	0.5-1.0	<30	<1.0	0.0065	<0.0050	<0.0050	0.0083
AF-1	4.5-5.0	<30	<1.0	0.0091	<0.0050	<0.0050	0.0065
AF-2	0.5-1.0	700	<1.0	<0.0050	0.0023	<0.0050	0.012
AF-2	4.5-5.0	<30	<1.0	0.0062	0.0054	<0.0050	0.0094
AF-3	0.5-1.0	<30	<1.0	0.0083	<0.0050	<0.0050	0.0069
AF-3	4.5-5.0	<30	<1.0	0.0062	<0.0050	<0.0050	<0.0050
AF-4	0.5-1.0	6,800	<1.0	<0.0050	0.0060	<0.0050	0.024
AF-4	4.5-5.0	<30	<1.0	<0.0050	<0.0050	<0.0050	0.0056
EB-1	0.5-1.0	1,400	<1.0	<0.0050	1.3	0.014	0.0054
EB-2	0.5-1.0	2,500	<1.0	0.014	0.013	<0.0050	0.0083
EB-3	0.5-1.0	210	<1.0	<0.0050	0.0070	<0.0050	0.0053
Designated Level to Protect Ground Water[1]		**N/A**	**N/A**	**0.7**	**100**	**680**	**620**

---

[1] "Water Quality Goals and Hazardous and Designated Levels for Chemical Constituents", California Regional Water Quality Control Board, Central Valley Region, September 1986

To further characterize near-surface soil quality, fifteen additional soil borings (SS-1 to SS-15) were advanced to depths of four feet in October 1990. These borings were located in a grid pattern to provide coverage of the entire site. However, six borings were located near the northeastern border of the site where HLA had previously noted small containers of hazardous materials. In addition, one boring (SS-3) was located in an area where extensive amounts of slag were observed. Analytical results of these samples for total oil and grease are presented below in Table 3.

To evaluate the leachability of oil detected at the site, soil samples HS-4, HS-5, and HS-9 to HS-12 were subsequently collected in May 1991. Analyses for soluble oil and grease were performed using Soluble Threshold Limit Concentration (STLC) extraction techniques. This technique generally involves the use of a buffered citric acid solution (pH of 5.0) in which the sample is agitated for several days to simulate exposure to a typical landfill leachate environment. To simulate natural site conditions, deionized water was used instead of the acid solution in this analysis. The pH of the soil sample was also evaluated. These analytical results are also presented below in Table 3.

Figures 3, 4, and 5 show the concentrations of total oil and grease detected at three different depth intervals.

TABLE 3. Laboratory Analysis of Soil Samples for Total Oil & Grease, Soluble Oil & Grease, and pH, October 3, 1990 and May 1, 1991, Two Hayward Parcels, Hayward, California (concentrations in ppm)

	Depths in feet							
Sample	0.0 - 0.5	0.5 - 1.0	1.0 - 1.5	1.5 - 2.0	2.0 - 2.5	2.5 - 3.0	3.0 - 3.5	3.5 - 4.0
SS-1	390	180	<30					
SS-2	2,700	3,400	5,200	100	<30	<30	<30	190
SS-3	<30	380	460	<30	49	300		
SS-4	210	90	<30					
SS-5	120	<30	<30					
SS-6	260	40	<30					
SS-7	340	<30	<30					
SS-8	2,600	250	<30					
SS-9	1,700	980	360	<30	<30	<30	<30	<30
SS-10	1,300	<30	<30					
SS-11	<30	<30	<30					
SS-12	620	250	<30					
SS-13	4,000	260	<30					
SS-14	67	<30	<30					
SS-15	<30	<30	<30					
HS-4, pH = 8.8		130 (<5)						
HS-5, pH = 8.4		780 (<5)						
HS-9, pH = 12		370 (<5)						
HS-10, pH = 9.6		41 (<5)						
HS-11, pH = 10		<30						
HS-12, pH = 8.6		2[illegible]0 (<5)						

( ) Soluble Oil and Grease concentrations; STLC analysis conducted using deionized water at pH = 7.0.

Five soil samples collected from the upper six inches were sent to a laboratory specializing in hydrocarbon analysis to evaluate the different types of oil present in the samples collected. The five samples analyzed were selected due to their relatively high concentrations of oil (390 to 4,000 ppm) and their locations across the site. Two samples were selected from the undeveloped portion of the site (SS-1 and SS-2), and three samples were selected from the drive-in portion of the site (SS-8, SS-10, and SS-13).

Initial characterization (using thin layer chromatography or TLC) of three samples (SS-2, SS-10, and SS-13) displayed chromatograms similar to asphaltic oil. The TLC characterization for the other two samples (SS-1 and SS-8) displayed chromatograms similar to motor oil. However, a more detailed scan with capillary gas chromatography suggested the presence of motor oil in only sample SS-8.

To further evaluate soil quality in the vicinity of SS-8, soil sample SS-8A was collected from near SS-8 and four additional samples (SS-8B through SS-8E) were collected in a radial pattern around SS-8 at a distance of approximately 10 feet. The five additional samples were collected in December 1991 from the 0.5 to 1.0 foot depth interval. Laboratory analysis for total petroleum oil (Standard Method 5520EF) did not detect concentrations above detection limits. In our opinion, this data indicates that the extent of motor oil in the vicinity of SS-8 was very limited and is not a significant concern.

3.3 EPA Priority Pollutant Analyses

Analyses for selected EPA priority pollutant compounds were performed on two composite samples collected in October 1990. Each composite sample consisted of four individual samples from the 0.5 to 1.0 foot depth interval. One composite was taken from the undeveloped portion and the other from the drive-in portion of the site. Two samples from the "drive-in" composite (SS-6 and SS-11) were collected near the northeastern property line where hazardous materials containers were previously observed by Harding Lawson Associates. Laboratory analysis of both composite samples for volatile organic compounds, semi-volatile organic compounds, polychlorinated biphenyls (PCBs) and organochlorine pesticides, asbestos, cyanide, TPH gas, diesel and BTEX did not detect concentrations above detection limits.

Analytical results of the composite samples for EPA priority pollutant metals by Atomic Absorption (AA) are shown below in Table 4. Total Threshold Limit Concentrations (TTLC) and Soluble Threshold Limit Concentrations (STLC) are levels at which a solid is classified as a hazardous waste (as defined by Title 22 of the California Code of Regulations) for purposes of treatment, storage, or disposal.

TABLE 4. Analytical Results of Composite Soil Samples for EPA Priority Pollutant Metals, Two Hayward Parcels, Hayward, California (concentrations in ppm)

			Composite SS-1, 2, 3, 5 (Undeveloped Area)		Composite SS-6, 7, 8, 11 (Drive-In Area)	
Metal	TTLC Limit	STLC Limit	TTLC Result	STLC Result	TTLC Result	STLC Result
Antimony	500	15	<0.25	<0.0050	<0.25	<0.0050
Arsenic	500	5	7.5	0.095	7.8	0.049
Beryllium	75	0.75	<0.50	<0.010	<0.50	<0.010
Cadmium	100	1	4.6	<0.010	2.7	<0.010
Total Chromium	2,500	560	290	0.8	110	0.84
Copper	2,500	25	380	1.3	43	0.55
Lead	1,000	5	300	7.2	46	0.39
Mercury	20	0.2	0.089	<0.00020	0.082	<0.00020
Nickel	2,000	20	76	0.4	73	0.39
Selenium	100	1	0.37	<0.0050	<0.25	<0.0050
Silver	500	5	<0.50	<0.010	<0.50	<0.010
Thallium	700	7	<0.25	<0.0050	<0.25	<0.0050
Zinc	5,000	250	1,100	39	170	4.2

As shown above, elevated levels of soluble lead were detected in the composite from the undeveloped portion of the site. To further evaluate lead levels, analyses were performed for TTLC and STLC lead on the eight individual samples. In addition, samples HS-1, HS-2 and HS-3 were collected in May 1991 from borings located near sample SS-3. Results of lead analyses are shown in Table 5. In our opinion, the fluctuations in lead levels are due to varying quantities of slag contained in the samples.

TABLE 5. Analytical Results for TTLC and STLC Lead
From Individual Samples,
October 31, 1990 and May 1, 1991,
Two Hayward Parcels, Hayward, California,
(concentrations in ppm)

Sample.	Depth (Feet)	TTLC Result	TTLC Limit	STLC Result	STLC Limit
SS-1	0.5 - 1.0	140	1,000	3.6	5
SS-2	0.5 - 1.0	42	1,000	0.72	5
SS-3	0.5 - 1.0	270	1,000	9.9	5
SS-5	0.5 - 1.0	24	1,000	0.32	5
SS-9	0.5 - 1.0	180	1,000	1.7	5
SS-11	0.5 - 1.0	7.9	1,000	0.24	5
SS-12	0.5 - 1.0	390	1,000	0.70	5
SS-15	0.5 - 1.0	27	1,000	0.34	5
HS-1	0.5 - 1.0	1,700	1,000	4.6	5
HS-2	0.5 - 1.0	390	1,000	3	5
HS-3	0.5 - 1.0	500	1,000	1.2	5

4.0 SLAG EVALUATION

To evaluate the source of metals detected in soil, an evaluation of the slag was performed. The slag present on-site is a hard refuse, rock-like material and is likely associated with metal foundry or smelting operations. Historically, slag was commonly used as granular fill material. As shown on Figure 6, slag was observed in various quantities over approximately 50 percent of the undeveloped portion of the site. Slag depths vary widely; however, depths of 1.0 to 2.5 feet are common. This slag was also observed to be scattered throughout the gravel used for parking areas on the drive-in portion of the site. The slag/gravel mixture was observed to depths of roughly 1.0 feet and is underlain by native silty clays.

Visual examination indicated that several variations of slag, some appearing very dense while others very porous and of differing color, were present on-site. To evaluate metal content of the slag, samples of four predominant types of slag (A, B, D and F) as well as two samples of the slag/gravel mixture (C and E) used in parking areas, were collected. A brief description of the slag type is discussed below.

Type A

Dark gray, dull appearance, highly vesiculated, minor inclusions of a light brown mineral. Present in field as fine to coarse gravel. Cobbles up to several inches in diameter are also present.

Type B

Dark gray to black, metallic appearance, very dense and brittle, slightly magnetic, with minor vesicles. Present in field as fine to coarse gravel. Commonly interspersed with Type A.

Type C

Light brown to light gray, fine to coarse gravel/soil matrix. Forms the swales in the drive-in areas.

Type D

Light gray, highly vesiculated, similar in composition to Type A slag but less dense.

Type E

Dark gray and brown gravel, fine to medium grained, heterogeneous composition of Types A and B slag with quartz and chert fragments. Located over surface of drive-in areas.

Type F

Light to dark gray, compositionally similar to Type C but forms a more cohesive mass.

4.1 Slag TTLC Metal Analyses

As presented below in Table 6, these samples were analyzed for 17 toxic metals listed in Title 22 of the California Code of Regulations. In addition, an analysis to distinguish hexavalent chromium was performed on Type D in which the highest total chromium level was detected. Following proper sample preparation techniques, the slag was crushed prior to analysis. The analyses were performed using inductively coupled plasma (ICP) techniques.

TABLE 6. Laboratory Analysis of Slag Samples
for Total (TTLC) Metal Concentrations,
Two Hayward Parcels, Hayward, California
(concentrations in ppm)

Metal	Slag Type A	Slag Type B	Slag Type C	Slag Type D	Slag Type E	Slag Type F	TTLC Limit
Antimony	66.8	<0.08	58.9	59.0	38.9	50.4	500
Arsenic	59.3	<0.06	56.3	59.0	35.9	47.4	500
Barium	5,100	<0.001	236.0	336.0	91.6	159.0	10,000
Beryllium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	75
Cadmium	7.06	0.88	5.4	4.8	2.4	4.5	100
Total Chromium	311.2	3.4	251.3	349.0	201.0	319.4	2,500
Chromium VI	NA	NA	NA	<0.5	NA	NA	500
Cobalt	8.43	<0.006	8.71	7.4	6.1	6.9	8,000
Copper	4,600	7,000	111.2	86.0	37.2	93.7	2,500
Lead	361.2	<0.044	252.0	269.4	48.3	324.3	1,000
Mercury	13.5	<0.024	11.9	12.9	1.9	10.3	20
Molybdenum	137.4	<0.008	132.8	139.0	78.4	108.3	3,500
Nickel	28.8	16.6	48.9	22.1	13.1	26.5	2,000
Selenium	39.3	<0.06	33.6	33.6	19.8	29.8	100
Silver	5.8	<0.006	3.91	5.16	2.9	3.9	500
Thallium	46.7	<0.054	40.8	45.1	25.9	36.1	700
Vanadium	42.5	<0.01	32.9	44.5	24.7	27.3	2,400
Zinc	25,000	4.3	15,800	24,000	294.0	15,700	5,000

4.2 Slag STLC Metal Analyses

To evaluate soluble metal concentrations and contaminant behavior under site conditions, the slag was additionally analyzed (by ICP) using modified STLC extraction techniques.

The actual average pH of soil and ponded water at the site has been shown to be approximately 9.5 and 9.0, respectively. Therefore, to simulate actual on-site conditions, the soluble metal analyses were performed using an extraction solution with a pH of 9.0. The slag was additionally analyzed for soluble metals using deionized water at a neutral pH, and acidic extraction solutions at a pH of 1.5. These analyses were conducted to simulate neutral on-site conditions and conditions within the human digestive system, respectively. After extraction, the pH of the neutral extraction solution was measured to further evaluate the behavior of soil, water and metals at the site. These results are presented below in Table 7.

TABLE 7. Laboratory Analysis of Slag Samples for Soluble (STLC) Metal Concentrations, Two Hayward Parcels, Hayward, California

(concentrations in ppm)

Metal	pH 7.0 Slag Type A	pH 9.0 Slag Type A	pH 1.5 Slag Type A	pH 7.0 Slag Type B	pH 9.0 Slag Type B	pH 1.5 Slag Type B	STLC Limit
Antimony	<0.040	0.20	1.2	--	--	--	15
Arsenic	<0.030	0.27	2.2	--	--	--	5.0
Barium	0.33	4.30	35.6	--	--	--	100
Beryllium	<0.010	<0.010	<0.010	--	--	--	0.75
Cadmium	<0.003	<0.003	<0.003	--	--	--	1.0
Total Chromium	<0.003	0.10	5.0	--	--	--	560
Cobalt	<0.003	0.60	0.20	--	--	--	80
Copper	<0.003	0.60	<0.003	0.11	105	330	25
Lead	0.01	1.1	0.73	--	--	--	5.0
Mercury	<0.010	0.13	0.52	--	--	--	0.2
Molybdenum	<0.008	1.60	5.8	--	--	--	350
Nickel	<0.008	0.30	0.5	--	--	--	20
Selenium	<0.150	0.16	1.2	--	--	--	1.0
Silver	<0.005	0.70	<0.005	--	--	--	5
Thallium	0.22	0.12	1.8	--	--	--	7.0
Vanadium	<0.006	0.34	1.7	--	--	--	24
Zinc	<0.004	0.88	31.4	--	--	--	250
Final pH*	10.3			7.9			

Metal	pH 7.0 Slag Type C	pH 9.0 Slag Type C	pH 1.5 Slag Type C	pH 7.0 Slag Type D	pH 9.0 Slag Type D	pH 1.5 Slag Type D	STLC Limit
Antimony	<0.040	<0.040	2.53	<0.040	<0.040	3.43	15
Arsenic	<0.030	0.13	2.80	<0.030	0.05	3.65	5.0
Barium	0.20	4.3	8.33	<0.006	3.1	31.8	100
Beryllium	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.75
Cadmium	<0.003	<0.003	0.20	<0.003	<0.003	0.16	1.0
Total Chromium	<0.003	0.30	26.8	0.02	0.30	28.1	560
Cobalt	<0.003	<0.003	0.45	<0.003	<0.003	0.35	80
Copper	<0.003	0.52	0.49	0.55	0.40	<0.003	25
Lead	<0.044	0.12	1.40	<0.044	0.88	1.4	5.0
Mercury	<0.010	<0.010	0.71	<0.010	<0.010	0.96	0.2
Molybdenum	1.03	0.42	9.30	<0.008	1.64	10.5	350
Nickel	<0.008	<0.008	2.42	<0.008	<0.008	1.80	20
Selenium	<0.150	<0.150	1.64	<0.150	<0.150	2.30	1.0
Silver	<0.005	<0.005	0.68	0.81	<0.005	0.09	5
Thallium	<0.060	0.02	1.95	<0.060	0.01	2.60	7.0
Vanadium	<0.006	0.36	2.5	<0.006	0.72	6.60	24
Zinc	0.35	1.01	193.0	0.03	1.44	0.314	250
Final pH*	10.1			9.5			

TABLE 7. Laboratory Analysis of Slag Samples for Soluble (STLC) Metal Concentrations, Two Hayward Parcels, Hayward, California
CONTINUED

Metal	pH 7.0 Slag Type E	pH 9.0 Slag Type E	pH 1.5 Slag Type E	pH 7.0 Slag Type F	pH 9.0 Slag Type F	pH 1.5 Slag Type F	STLC Limit
Antimony	0.860	<0.040	0.99	<0.040	0.90	<0.040	15
Arsenic	<0.030	<0.030	1.7	<0.030	0.51	<0.030	5.0
Barium	0.85	1.5	4.7	0.89	1.19	16.8	100
Beryllium	<0.010	<0.010	0.01	<0.010	<0.010	<0.010	0.75
Cadmium	<0.003	<0.003	0.17	<0.003	<0.003	<0.003	1.0
Total Chromium	<0.003	<0.003	27.1	<0.003	0.04	28.0	560
Cobalt	<0.003	<0.003	0.3	<0.003	<0.003	0.12	80
Copper	0.43	0.55	0.05	0.49	0.71	0.57	25
Lead	<0.044	<0.044	0.97	<0.044	1.04	0.93	5.0
Mercury	<0.010	<0.010	0.69	<0.010	0.21	0.41	0.2
Molybdenum	<0.008	<0.008	3.5	<0.008	0.99	7.80	350
Nickel	<0.008	<0.008	0.84	<0.008	<0.008	2.32	20
Selenium	<0.150	<0.150	1.19	<0.150	0.47	1.13	1.0
Silver	<0.005	<0.005	0.25	<0.005	<0.005	0.02	5
Thallium	<0.060	<0.060	1.63	<0.060	0.16	3.70	7.0
Vanadium	0.19	0.28	1.55	<0.006	0.58	4.40	24
Zinc	<0.004	<0.004	54.2	<0.004	0.64	220.0	250
Final pH*	11.1			11.1			

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* Following the 48 hour extraction process, the pH of the deionized water solution was measured.

4.3 Hazardous Waste Characterization (Title 22)

To evaluate the slag for hazardous waste characteristics defined by Title 22 of the California Code of Regulations, the two slag samples with the highest metal content were analyzed for corrosivity, ignitability, reactivity and toxicity. As shown below in Table 8, results of these analyses indicate that under these criteria, the slag is non-hazardous. The pH, flashpoint, sulfide and cyanide content, and the 96-hour LC_{50} were all found to be within acceptable ranges. In addition, the slag samples were not found to react dangerously with water.

TABLE 8. Laboratory Analysis of Slag Samples for Title 22 Hazardous Waste Characteristics, Two Hayward Parcels, Hayward, California

Slag Sample	Slag Sample A	Slag Sample D	Hazardous Waste Criteria*
Corrosivity (pH)	10.0	9.9	pH ≤ 2.0 or pH ≥ 12.5
Ignitability (Flashpoint)	>100°C	>100°C	<60°C
Reactivity:			
Sulfide (ppm)	<10	<10	Contains sulfide or cyanide and is dangerous under specific conditions.
Cyanide (ppm)	<1.0	<1.0	
Reaction with water	Negative	Negative	Potentially dangerous when mixed with water.
Toxicity (96-hour LC_{50})	>1,000 ppm	>1,000 ppm	Acute aquatic 96-hr LC_{50}< 500 ppm

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* Specific criteria are listed in Title 22 of the California Code of Regulations

4.4 Underlying Soil Quality

To evaluate the potential impact of the slag on soil at the site, near surface soil samples were collected at twelve locations across the site using a backhoe in December 1991. The backhoe pits were approximately 3 to 5 feet in depth. One of the twelve pits (P-6) was located near sample SS-3, an area where previous elevated lead levels were detected. Two additional pits (P-11 and P-12) were located in areas where no slag was observed. The remaining nine pits were located in areas at which slag was present.

A composite of four soil samples from each backhoe pit was analyzed (by ICP) for total and soluble metals detected at elevated concentrations in the slag, including copper, mercury, selenium, and zinc. The samples were collected using methods described in EPA document SW846 to properly characterize the soil. The samples were collected at a depth of approximately 6 inches below the soil/slag interface, at random distances from the western end of each pit. Selection of distances was accomplished using the random number function on a Sharp EL-506P calculator.

To simulate naturally occurring on-site conditions, the actual pH of each composite soil sample was determined and the STLC analyses were performed using an extraction solution with a similar pH. Analytical results are presented in Tables 9 and 10.

TABLE 9. Laboratory Analysis of Composite Soil Samples From Backhoe Pits for Total (TTLC) Metal Concentrations, Two Hayward Parcels, Hayward, California
(concentrations in ppm)

Sample	Depth (ft.)	Copper	Lead	Mercury	Selenium	Zinc
P-1	2.5	31.2	31.0	11.1	25.0	60.8
P-2	2.5	43.9	41.8	17.7	39.8	73.8
P-3	2.0	30.1	30.9	19.2	37.3	57.0
P-4	2.0	49.1	41.3	20.3	37.8	84.3
P-5	2.5	46.5	44.5	14.1	34.4	89.8
P-6	3.0	49.1	44.4	18.2	41.6	77.2
P-7	1.5	30.9	31.4	10.3	25.0	55.2
P-8	3.0	40.6	44.1	12.9	34.4	73.9
P-9	2.0	40.8	43.7	14.1	34.7	94.8
P-10	2.0	33.6	34.8	12.4	32.1	63.1
P-11	1.5	23.1	29.4	8.63	28.8	51.8
P-12	1.5	29.1	30.8	10.8	26.7	52.3
TTLC Limit		2,500	1,000	20	100	5,000

TABLE 10. Laboratory Analysis of Composite Soil Samples From Backhoe Pits for Soluble (STLC) Metal Concentrations and pH, Two Hayward Parcels, Hayward, California
(concentrations in ppm)

Sample	Depth (ft.)	Copper	Lead	Mercury	Selenium	Zinc	pH
P-1	2.5	0.33	<0.044	0.19	0.19	0.13	6.83
P-2	2.5	0.38	<0.044	0.25	0.36	0.09	7.07
P-3	2.0	0.26	<0.044	0.26	0.30	0.09	6.82
P-4	2.0	0.32	<0.044	0.15	0.20	0.13	7.19
P-5	2.5	0.52	0.21	0.11	<0.150	0.11	6.96
P-6	3.0	0.31	<0.044	0.13	<0.150	<0.004	8.34
P-7	1.5	0.37	<0.044	0.16	0.21	0.09	7.45
P-8	3.0	0.36	<0.044	0.17	<0.150	<0.004	9.13
P-9	2.0	0.59	<0.044	0.13	0.21	0.45	9.01
P-10	2.0	0.29	<0.044	0.15	0.23	0.12	8.57
P-11	1.5	0.30	<0.044	0.11	0.17	<0.004	8.83
P-12	1.5	0.58	0.24	0.22	0.47	0.79	3.75
STLC Limit		25	5.0	0.2	1.0	250	

As shown above, mercury levels detected in several soil samples were near or exceeded the TTLC or STLC values. Our discussions with several analytical laboratories indicated that ICP analytical techniques often produce inaccurate results for certain metals including mercury, selenium, and arsenic. To confirm the presence of mercury in soil, samples P-2 and P-3 were additionally analyzed for total and soluble mercury using an atomic absorption (AA)/cold vapor process. To additionally evaluate the precision of ICP methods for total arsenic and selenium, slag sample A, in which the highest levels of arsenic and selenium were detected, was also reanalyzed for these metals using atomic absorption. Atomic absorption is the preferred analytical method for detecting these metals.

These analyses did not detect total or soluble mercury above the detection limit of 0.01 ppm. As discussed on the attached laboratory data sheets, the false positive results previously obtained were likely caused by matrix affects associated with the ICP method.

The atomic absorption results for arsenic and selenium also showed a significant reduction in concentrations. Originally detected by ICP at concentrations of 59.3 and 39.3 ppm, these metals were found at only 5.5 and 4.1 ppm, respectively, by atomic absorption.

In our opinion, elevated levels of mercury, arsenic, and selenium reported by ICP in soil and/or slag are not accurate. These original results were likely biased due to analytical limitations. The results obtained by AA are more representative of actual concentrations, in our opinion.

4.5 Statistical Analysis (SW846)

The analytical results of soil samples collected from beneath slag piles were statistically analyzed using methods discused in EPA document SW846 to establish the maximum concentration of each metal of concern at a 95 percent confidence level. Analytical data was input to a Microsoft QuickBASIC program developed by Lowney Associates. Statistical results are shown below in Table 11 and copies of data output files are included in Appendix F.

TABLE 11. Statistical Results (SW846)
Metal Concentrations in Soil at 95 Percent Confidence Level,
Two Hayward Parcels, Hayward, California
(concentrations in ppm)

	Copper	Lead	Mercury	Selenium	Zinc
TTLC Concentration	41.87	40.67	16.14	35.95	77.25
TTLC Limit	2,500	1,000	20	100	5,000
STLC Concentration	0.443	0.110	0.196	0.282	0.286
STLC Limit	25	5.0	0.2	1.0	250

As shown above, total and soluble concentrations of each metal of concern in soil, at a 95 percent confidence level, are below the respective TTLC and STLC levels. The results for mercury were calculated using the original elevated concentrations. However, as discussed, subsequent analyses did not detect mercury in selected samples, indicating that the elevated levels were due to inaccuracies in analytical methods. Therefore, mercury levels would be significantly lower than presented above and not an environmental concern to the subject site.

5.0 GROUND WATER QUALITY EVALUATION

5.1 Installation of Monitoring Wells

Four of the exploratory borings (AF-1 to AF-4) were drilled on July 5 and 6, 1990 and converted to "permanent" ground water monitoring wells in accordance with Alameda County Flood Control and Water Conservation District guidelines. Ground water was encountered at depths ranging from 14 to 18 feet below grade. The wells were terminated at depths ranging from 20.0 to 26.5 feet. Boring logs and details regarding our field investigation are included in Appendix B. Permits and well installation details are presented in Appendices A and C, respectively.

The locations of the monitoring wells were selected based upon the following considerations: (1) to provide coverage of the entire site; (2) to detect contaminants flowing to the site from off-site sources; (3) to evaluate the northeastern border of site where hazardous materials containers were previously observed.

5.2 Hydropunch Samples

To provide additional information on ground quality and further evaluate the northeastern portion of the site, one hydropunch ground water sample (HP-13) was collected on October 3, 1990. Three additional attempts were made to obtain hydropunch samples at other on-site locations, but the uppermost aquifer did not produce a sufficient volume of ground water to facilitate sampling or analysis.

5.3 Ground water Petroleum Hydrocarbon Results

Ground water samples collected from the four on-site monitoring wells in July, September, and October 1990, and December 1991, were analyzed for petroleum hydrocarbons. Analytical results are summarized below in Table 12.

TABLE 12. Laboratory Analysis of Ground Water Samples, For Petroleum Hydrocarbons, Two Hayward Parcels, Hayward, California, (concentrations in ppb)

Well, Date	Total Oil and Grease	TPH Diesel	TPH Gas	Benzene	Toluene	Ethylbenzene	Xylene
AF-1							
7/7/90	<5,000	---	<30	<0.30	<0.30	<0.30	<0.30
9/7/90	<5,000	---	---	---	---	---	---
10/4/90	---	<50	<30	<0.30	<0.30	<0.30	<0.30
12/6/91	<5,000	---	---	---	---	---	---
AF-2							
7/7/90	<5,000	---	<30	<0.30	<0.30	<0.30	<0.30
9/7/90	6,000	---	---	---	---	---	---
10/4/90	---	<50	<30	<0.30	<0.30	<0.30	<0.30
12/6/91	<5,000	---	---	---	---	---	---
AF-3							
7/7/90	<5,000	---	<30	<0.30	<0.30	<0.30	<0.30
9/7/90	15,000	---	---	---	---	---	---
10/4/90	---	<50	<30	<0.30	<0.30	<0.30	<0.30
10/11/90	<5,000	---	<30	<0.30	<0.30	<0.30	<0.30
12/6/91	<5,000	---	---	---	---	---	---
AF-4							
7/7/90	<5,000	---	<30	<0.30	<0.30	<0.30	<0.30
9/7/90	<5,000	---	---	---	---	---	---
10/4/90	---	<50	<30	<0.30	<0.30	<0.30	<0.30
12/6/91	<5,000	---	---	---	---	---	---

As shown, TPH gasoline, diesel, and BTEX have not been detected in ground water at the site. Oil and grease was detected in ground water from wells AF-2 and AF-3 during the September 1990 sampling round. However, oil and grease were not detected during previous nor subsequent sampling rounds. Therefore, in our opinion, the September 1990 results are probably spurious.

5.4 Ground Water EPA Priority Pollutant Results

In September 1990, ground water from the on-site wells was analyzed for selected EPA priority pollutant compounds. No levels above laboratory detection limits were reported for the following analyses: volatile organics, pesticides, PCB's, cyanide, and asbestos.

Low levels of unidentified semi-volatile organic compounds were detected in wells AF-2 and AF-4, at concentrations of 0.300 and 0.330 ppb, respectively.

As shown in Table 13, analysis of ground water samples for 13 EPA priority pollutant metals detected several metals at levels above drinking water standards. Since the levels detected may have been partially due to suspended particulate matter within the ground water samples, the wells were resampled in December 1991. The samples were filtered prior to being analyzed for 18 toxic metals, including Chromium VI, listed in Title 22 of the California Code of Regulations. Analytical results of the filtered samples are enclosed in parentheses.

In general, metal concentrations detected in the filtered samples were lower than previous results. All concentrations detected were well below STLC limits; however, levels of arsenic, barium, chromium III, and lead were detected at concentrations slightly above drinking water standards in water from well AF-1.

An evaluation of total dissolved solids (TDS) indicated that the highest level was in samples AF-1, and TDS levels correspond closely with metal concentrations. In our opinion, metal concentrations detected in ground water are naturally occurring background levels.

TABLE 13. Laboratory Analysis of Ground Water Samples For Metals, September 7, 1990, and December, 1991, Two Hayward Parcels, Hayward, California. (concentrations in ppb)

Analytes	AF-1	AF-2	AF-3	AF-4	Primary[1] MCL	STLC[2] Max Limit
Antimony	<500 (<50)	<500 (<25)	<500 (<25)	<500 (<25)	NA	15,000
Arsenic	180 (56)	58 (<25)	120 (<25)	99 (<25)	50	5,000
Barium	– (1,000)	– (<100)	– (460)	– (<100)	1,000	100,000
Beryllium	<10 (<10)	<10 (<10)	<10 (<10)	<10 (<10)	NA	750
Cadmium	<10 (<10)	<10 (<10)	<10 (<10)	<10 (<10)	10	1,000
Chromium (III)	190 (200)	62 (<10)	190 (92)	230 (25)	100	560,000
Chromium (VI)	– (41)	– (<5)	– (16)	– (39)	50	5,000
Cobalt	– (<50)	– (<50)	– (<50)	– (<50)	NA	80,000
Copper	92 (110)	24 (27)	120 (63)	90 (23)	NA	25,000
Lead	<50 (23)	<50 (5.7)	<50 (12)	25 (14)	15	5,000
Mercury	<0.2 (<0.2)	<0.2 (<0.2)	<0.2 (<0.2)	<0.2 (<0.2)	2	200
Molybdenum	– (53)	– (90)	– (71)	– (70)	NA	20,000
Nickel	<50 (220)	94 (<50)	190 (110)	350 (<50)	NA	20,000
Selenium	100 (<50)	<50 (<25)	63 (<25)	55 (<25)	10	1,000
Silver	<10 (18)	<10 (<10)	<10 (<10)	<10 (<10)	50	5,000
Thallium	<500 (<50)	<500 (<25)	<500 (<25)	<500 (<25)	NA	7,000
Vanadium	– (190)	– (<50)	– (96)	– (<50)	NA	24,000
Zinc	200 (290)	64 (100)	250 (180)	280 (90)	NA	250,000
Total Dissolved Solids, 12/91(ppm)	45,000	23,000	33,000	31,000		

NA Not Available.

[1] "New and Proposed Drinking Water Standards and Proposition 65 Water Quality Criteria", California Regional Water Quality Control Board, Central Valley Region, September 1989.

[2] California Code of Regulations, Title 22, Section 22-66699.

( ) Results of samples which were filtered prior to analysis. (December, 1991)

5.5 Hydropunch Sampling Analyses

The hydropunch sample (HP-13) , located near the northern boundary of the site, was analyzed for motor oil by gas chromatography (GC), oil and grease by EPA test method 503AE, TPH gas and BTEX. Ground water from well AF-3 was also analyzed by the same methods to provide a comparison. As shown in Table 14, concentrations were not found above detection limits.

TABLE 14. Laboratory Analysis of Hydropunch Ground Water Samples,
For Petroleum Hydrocarbons,
October 11, 1990,
Two Hayward Parcels, Hayward, California.
(concentrations in ppb)

Well	Total Oil and Grease	Motor Oil by GC	TPH Gas	Benzene	Toluene	Ethylbenzene	Xylene
AF-3	<5,000	<50	<30	<0.30	<0.30	<0.30	<0.30
HP-13	<5,000	<50	<30	<0.30	<0.30	<0.30	<0.30

5.6 Surface Water Quality

In May 1991, water samples (HP-1, 2, and 3) were collected from three areas of ponded water at the site. Laboratory analysis of these samples for oil and grease did not detect levels above the detection limit of 5.0 ppm. Analyses for pH indicated values of 8.9, 9.5, and 8.7, respectively.

6.0 REGIONAL GEOLOGY AND HYDROGEOLOGY

6.1 Geology

The project site is located at the eastern boundary of the Bay Plain physiographic province near the San Leandro and Niles Cones. The sediments underlying the site are Quaternary alluvial deposits derived from Mesozoic marine sediments and intrusives and Pleistocene volcanics of the Diablo Range. The sediments are composed of unconsolidated gravel, sand, silt, and clay deposits. These sediments were deposited as alluvial fans by streams draining the highlands.

Underlying the Quaternary alluvium is the Santa Clara Formation of Plio-Pleistocene age. It consists of unconsolidated to semi-consolidated continental deposits of gravel, sand, silt, and clay. The combined thickness of the Santa Clara Formation and the Quaternary alluvium in the site area is approximately 500 feet. The Santa Clara Formation is underlain by non-water-bearing bedrock generally composed of Jurassic to Pliocene marine sediments, serpentine, quartz diorite, and rhyolite.

The site is located approximately 3 miles southwest of the Hayward fault, a regional, right lateral, strike-slip fault trending northwest-southeast. The valley floor slopes gently in this area toward San Francisco Bay, located approximately 3.5 miles to the west-southwest (California Department of Water Resources, 1967).

6.1.1 Subsurface Materials

Based on the findings of our subsurface exploration program, the soils at the site can be roughly grouped into five strata as described below.

Stratum A*f*: (Fill) Sandy Gravel (GP), Gravelly Clay (CL), and Silty Sand (SM).

Stratum A*f* consists of gray, well graded, sandy gravel (GP); gray, well graded gravelly clay (CL); and red-brown, well graded, silty sand (SM). This stratum extends from the surface to a depth of 3.0 feet in boring AF-2, however, was not present in borings AF-1, AF-3, and AF-4. Water contents ranged from 2 to 16 percent.

Stratum A: Silty Clay (CL,CH), Sandy Clay (CL,CH), Clayey Sand (SC), and Clayey Silt (ML).

Stratum A consists of brown, gray, and black, soft to very stiff, low to high plasticity, silty clay (CL, CH); brown to gray, stiff to very stiff, low to high plasticity, sandy clay (CL,CH); brown, well graded, clayey sand (SC); and black, firm, low to moderate plasticity clayey silt (ML). This stratum was encountered from the surface or below Stratum A*f* to a maximum depth of 19 feet. Water contents ranged from 5 to 42 percent.

Stratum B: Sand (SW, SP), and Clayey Sand (SC).

Stratum B consists of brown, loose, well graded and poorly graded, sand (SW,SP); and brown, stiff to medium dense, well graded, clayey sand (SC). This stratum was encountered in all borings except AF-2 at a depth of roughly 19 feet. This stratum ranged in thickness from 1 to 6 feet and water contents ranged from 15 to 23 percent.

Stratum C: Silty Clay (CL/CH), Sandy Clay (CL,CL/CH), and Clay (CH).

Stratum C consists of brown, moderate plasticity, silty clay (CL/CH); brown, low to moderate plasticity, firm to very stiff, sandy clay (CL); and gray, high plasticity, firm to stiff, clay (CH). This stratum was encountered in all borings, except AF-2, at depths of 20 to 25 feet. Water contents ranged from 23 to 42 percent.

Stratum D: Clayey Sand (SC) and Silt (ML).

Stratum D consists of brown, well graded, loose, clayey sand (SC); and brown, low plasticity, firm silt. This stratum was encountered in boring AF-1 between 24.5 and 25.0 feet, and in boring AF-4 between 23.5 to 24.0 feet. Water contents ranged from 26 to 28 percent.

6.2 Hydrogeology

The project site is located along the northern boundary of the Niles subarea of the Fremont Ground Water Area. Shallow ground water is contained in sand and clayey sand lenses interbedded with deposits of silty clay and silt. Shallow ground water at the site is generally contained in semi-confined to confined aquifers ranging in depth from approximately 7 to 25 feet below ground surface. Ground water at depth in this area is generally confined within a series of flat-lying gravel aquifers separated by relatively low permeability clay aquicludes. The Newark aquifer, lying directly beneath the Newark aquiclude, is the shallow "potable aquifer" and is present at depths ranging from 60 to 140 feet below ground surface. The thicker clay deposits beneath the site act as partial barriers to the vertical movement of ground water from one aquifer to another (California Department of Water Resources, 1967). The City of Hayward does not use any ground water for drinking water purposes. However, a 320 foot deep water well located near the intersection of Industrial and Hesperian, approximately 1/4 mile northwest of the project site, is reportedly used for construction purposes (City of Hayward Water Department, 1991).

The regional ground water flow is towards the San Francisco Bay to the west-southwest. The closest surface water is Alameda Creek, forming the south-southeast boundary of the site. Alameda Creek provides the primary source of surface recharge to the alluvium east of the Hayward fault (California Department of Water Resources; 1967).

6.2.1 Ground Water Elevations

Stabilized ground water levels measured during well installation ranged from approximately 6.0 to 11.0 feet below grade. As shown in Table 15, below, fluctuations in ground water elevations of generally less than 0.5 feet have been observed between July 1990 and January 1992. These fluctuations are likely due to seasonal variations in rainfall and/or other factors not in evidence at the time measurements were made.

TABLE 15. Ground Water Elevations, Two Hayward Parcels, Hayward, California (relative elevation/feet)

Well	Date Measured	Initial Depth to Ground Water Below Present Grade (feet)	Static Depth to Ground Water Below Present Grade (feet)	Static Depth to Ground Water Below Top of Casing (feet)	Relative* Ground Water Elevation (feet)
AF-1	7/5/90	18.0	11.0	--	--
	7/11/90		11.01	13.89	-5.72
	7/26/90		11.14	14.02	-5.85
	9/7/90		11.39	14.27	-6.10
	10/4/90		11.46	14.34	-6.17
	1/10/92		10.87	13.75	-5.58
AF-2	7/5/90	14.0	6.0	--	--
	7/11/90		6.17	9.07	-4.50
	7/26/90		6.25	9.15	-4.58
	9/7/90		6.26	9.55	-4.59
	10/4/90		6.88	9.78	-5.21
	1/10/92		6.08	8.98	-4.41
AF-3	7/5/90	15.0	7.5	--	--
	7/11/90		7.75	8.21	-5.11
	7/26/90		7.83	8.29	-5.19
	9/7/90		8.06	8.52	-5.42
	10/4/90		8.11	8.57	-5.47
	1/10/92		7.70	8.25	-5.15
AF-4	7/5/90	17.0	6.0	--	--
	7/11/90		6.08	8.98	-4.10
	7/26/90		6.10	9.00	-4.12
	9/7/90		6.32	9.22	-4.34
	10/4/90		6.41	9.31	-4.43
	1/10/92		6.01	8.91	-4.03

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* Wells surveyed to a relative elevation of 7.5 feet at top of casing for monitoring well AF-5

6.2.2 Ground Water Flow

Ground water levels measured in on-site wells has revealed the site ground water flow direction to be to the north, which is in contrast to the regional flow direction of west-southwest. This difference may be caused by natural variations in ground water flow directions or by ground water extraction in the vicinity. The average linear velocity of ground water movement below the site may be established using Darcy's Law with knowledge of soil hydraulic conductivity, porosity, and the hydraulic gradient. The hydraulic gradient across the site during July 1990 was measured to range from 0.0015 to 0.0030 based on the ground water level readings measured in the surveyed monitoring wells. Average soil hydraulic conductivity beneath the site was estimated from correlations from several sources based on the soil samples obtained from the borings and our experience.

The average linear velocity for the sand and clayey sand water bearing strata encountered at the site is estimated at 1 to 80 feet per year. As the above is based on average values of soil hydraulic conductivity, we expect that at many locations ground water movement will actually be much faster or slower than estimated velocities, corresponding to natural variations in permeability expected in soil deposits of this type and variations in the hydraulic gradient. In a study such as this, with soil permeability estimated from correlations based on visual classification of a limited number of soil samples, and not from in-situ permeability and/or pump test data, an average permeability value may only be considered approximate. Estimations of soil permeability are often in error by a factor of 10 or more. This is also true of ground water velocity based on estimated permeability values.

7.0 QUALITY CONTROL

Quality Control (QC) checks were employed to evaluate the accuracy and precision of laboratory analyses and to provide checks on field, transport, and storage procedures. Both field and laboratory QC procedures were used. Analytical results for the soil and ground water QC samples are presented below in Table 16.

One rinsate blank was collected during the July sampling round. After the sampling equipment had been cleaned, the sampling bailer was rinsed again with distilled water. This water was decanted into VOA bottles and handled with the rest of the ground water samples. Rinsate blanks check potential volatile migration after cleaning procedures have been completed. The rinsate blank was labeled AF-6 and analyzed by Sequoia Analytical for TPH gas and BTEX.

Split soil and ground water samples were sent to Anametrix, Inc. to be analyzed for total oil and grease by EPA Test Method 503DE. Split samples are used to check laboratory precision or the repeatability of laboratory results.

Laboratory blanks are volatile organic analysis (VOA) bottles filled with distilled water in the lab. One lab blank was taken into the field during the July sampling round, handled with the other samples, and returned to the lab with the rest of the samples. Laboratory blanks check potential volatile migration through the septa from more contaminated to less contaminated samples, ambient or residual contamination, or problems with laboratory analytic procedures and VOA bottle preparation procedures. The laboratory blank was analyzed for TPH gas and BTEX.

TABLE 16. Laboratory Analysis of Quality Control Samples
Two Hayward Parcels, Hayward, California
(concentrations in ppm)

SOIL	Oil and Grease	TPH Gas	BTEX
July Anametrix Sample EB-2, 0.5-1.0	660	NT	NT
July Sequoia Sample EB-2, 0.5-1.0	2,500	NT	NT
October Anametrix Sample SS-5, 0.5-1.0	40	NT	NT
October Sequoia Sample SS-5, 0.5-1.0	120	NT	NT
GROUND WATER			
September Anametrix Sample AF-3	<5	NT	NT
September Sequoia Sample AF-3	15	NT	NT
July Anametrix Sample AF-3	<5	NT	NT
July Sequoia Sample AF-3	<5	NT	NT
July Rinsate Blank	NT	<30 ppb	<0.3 ppb
July Travel Blank	NT	<30 ppb	<0.3 ppb

NT = Not Tested

A comparison of results for duplicate ground water samples from well AF-3 shows that similar values were reported by the two laboratories. However, Sequoia did detect a low level of oil and grease near the detection limit in September that was not detected by Anametrix.

A comparison of duplicate soil samples shows variation in the results reported by the two labs, which, in our opinion, is because the samples were obtained from two separate, adjacent borings. Soils tend to be quite heterogeneous even over short distances, and may have a significant affect on concentrations of oil and grease. In addition, analytical techniques and instruments may vary slightly between different labs.

Analysis of the rinsate and travel blanks did not detect TPH gas or BTEX compounds.

8.0 ENVIRONMENTAL THREAT ASSESSMENT

As outlined in the Interim Guidance for Preparation of a Preliminary Endangerment Assessment Report (California Department of Health Services, June 22, 1990), an evaluation of environmental impacts should be performed for all sites where there has been a release of hazardous substances/wastes.

The metals and asphaltic oil detected on-site have been shown to be relatively immobile under site conditions and analytical results indicate that significant migration to underlying soil and ground water has not occurred.

Therefore, in our opinion, the following environmental resources have not, nor are likely to be impacted by substances detected on-site. The environmental resources include: 1) sensitive, endangered, or threatened species, 2) sensitive ecosystems, 3) wildlife, 4) flora and fauna, 5) national/state parks or reserves, 6) historic or landmark sites, 7) prime agricultural lands, and 8) designated scenic areas.

9.0 BASELINE HEALTH RISK ASSESSMENT

9.1 Procedures

To assess the potential human health impacts associated with metals detected at the site, a human health risk assessment was performed. This risk assessment was prepared in general conformance with guidelines presented in Risk Assessment Guidance for Superfund (EPA 1989a). Although future industrial use of the property is planned, risks associated with both industrial and residential uses were evaluated.

The basic framework for this risk assessment included the following five steps:

- Selection of potential chemicals of concern: For this assessment metals detected in slag or ground water (or both) were evaluated.
- Identification of potential exposure pathways and estimation of exposure point concentrations for detected metals
- Estimation of human intake for each complete exposure pathway.
- Toxicity assessment: Hazard identification and dose-response assessment were estimated.

- Risk characterization: The theoretical carcinogenic risk and non-carcinogenic health effects are estimated for each metal by combining exposure and toxicity information.

To evaluate the potential risks to human health associated with proposed industrial land-use and hypothetical residential land-use, the concentrations of metals in relevant environmental media were used to calculate the chronic daily intakes (CDIs) for noncarcinogens and lifetime average daily doses (LADDs) for carcinogens. A CDI for a compound is the amount of substance taken into the body per unit body weight per unit time (e.g., 30 years for residential exposure and 25 years for occupational exposure), and a LADD is the average daily dosage received over a certain period of time (e.g., 30 years), but normalized over a 70 year lifetime.

For this risk assessment, oral, dermal (skin contact), and inhalation exposure pathways were assumed to be complete. Noncarcinogenic and carcinogenic risks were calculated from the oral/inhalation/dermal CDI and LADDs, respectively, for both residential and industrial land use scenarios.

9.2 Data Used

To conservatively evaluate risks, the highest metal concentrations detected in slag were used. As presented in Table 5, an unrepeated maximum lead concentration of 1,700 ppm was detected in soil/slag samples during initial sampling phases. However, statistical analysis of lead results presented in Table 5 revealed an upper 95 percent confidence level for lead of approximately 315 ppm. Since lead levels subsequently detected in individual slag samples ranged up to 361.2 ppm, this higher value was used in risk calculations. Metal concentrations detected in soil from backhoe pits were significantly lower than those found in slag, therefore, they were not considered in evaluating health risks.

For the residential land use scenario, it was conservatively assumed that shallow ground water is used as a water source for a person residing on the property. Analytical results of filtered ground water samples (shown in Table 13) were used for these calculations.

9.3 Risk Assumptions

This assessment was based on very conservative "worst case" assumptions regarding metal concentrations, toxicity, and routes and durations of exposure. These assumptions are discussed in detail in the attached risk assessment (Appendix G).

In general, for the residential land use scenario, it was assumed that a residential development was constructed on the slag and the inhabitants resided on the site for a period of 30 years and used the shallow ground water as a water source. The occupational exposure scenario assumed that an on-site worker would come in contact with the slag 8 hours a day for 25 years. Bioavailability (the fraction of a dose available for absorption) for the oral and inhalation routes was conservatively assumed to be 100 percent. For the dermal route, inorganic substances are assumed to be 10 percent bioavailable according to EPA guidelines. Furthermore, it was assumed that concentrations of inorganic substances present in inhaled dust are the same as detected in the slag.

9.4 Noncarcinogenic Health Effects

Noncarcinogenic effects are evaluated by the calculation of a hazard index (HI) for each compound of concern. The HI is obtained by dividing the exposure level for a compound by the level of that compound above which adverse health effects may occur. Any single compound with a HI greater than one may pose a potential health concern. In the case of exposure to multiple compounds, each individual HI is added to yield a total HI for the site. Therefore, the total HI can exceed unity even though no single compound exceeds it's acceptable level.

The assumption that the total HI for the site is the summation of each individual HI is most properly applied to compounds that induce the same effect by the same mechanism (EPA, October 1986). Consequently, the addition of HIs of compounds that are not expected to induce the same types of effects could overestimate the potential health risk.

9.4.1 Noncarcinogenic Health Effects (Occupational Setting)

As shown in Table 8 of the attached risk assessment report, the HI values for each individual metal do not exceed unity, indicating that adverse noncarcinogenic health effects associated with an individual metal would not be a significant problem for occupational use of the property.

The total hazard index for noncarcinogenic effects is 2.06 for an occupational exposure scenario, indicating that the combined effects of each metal may pose a minimal risk. However, the majority of the total HI is comprised of the sum of individual HI values for copper and thallium. Since these metals do not have similar potential health effects, the total HI, in our opinion, does not indicate that the site poses an unacceptable health risk for occupational use.

9.4.2 Noncarcinogenic Health Effects (Residential Setting)

The total HI for the residential exposure scenario was calculated to be 18.02. Therefore, there is a potential noncarcinogenic risk for a hypothetical inhabitant of the unremediated site. A large portion of the noncarcinogenic risk is due to exposure to compounds in ground water. Since ground water consumption at the site is an unrealistic assumption, this is a significant overestimation of potential risk, in our opinion.

9.5 Carcinogenic Risks

For potential carcinogens, risks are estimated as probabilities. The carcinogenic risk is calculated by multiplying each pathway-specific LADD for each compound by the appropriate carcinogenic potency factor (CPF). The CPF values convert estimated exposure intakes directly to incremental risk. Therefore, if the exposure assessment is conservative, the resultant risk is an upper-bound estimate. Consequently, estimated risk may overestimate the actual risk at the site (EPA, October 1986).

The EPAs target carcinogenic risk range is 10^{-4} to 10^{-6} with 10^{-6} (one-in-a-million) being considered an insignificant risk. The acceptability of higher risk values is dependent on site specific conditions. The CRWQCB has divided what they consider acceptable risks into three categories which are dependant upon the classification of the compound of concern. Under CRWQCB guidelines for the South Bay Multi-Site Cooperative Superfund Program (CRWQCB, June 1990), acceptable risks for Class A, Class B, and Class C carcinogens are one-in-a-million, one-in-one-hundred thousand, and one-in-ten-thousand, respectively. These risk limits are typically used to generate acceptable or target remedial cleanup levels.

Potential carcinogenic metals detected at the site include arsenic, cadmium, and lead. Of these metals only arsenic is a known Class A human carcinogen. Cadmium and lead are both "probable" (Class B) human carcinogens.

9.5.1 Carcinogenic Risks (Occupational Setting)

As shown in Table 6 of the risk assessment, risks via an inhalation pathway for each individual compound, for an occupational exposure scenario, are well below the desired one-in-a-million level.

Of the risks associated with individual metals, only arsenic via an oral pathway exceeds the desired levels at 1.8 in-a-million. For an oral exposure pathway, risks associated with cadmium and lead are well below the CRWQCB target risk for Class B carcinogens of one-in-one hundred thousand.

As with the calculation of noncarcinogenic HIs, the pathway-specific carcinogenic risks for each compound are summed to obtain a total carcinogenic risk value for the site of 2.4 in-a-million. As stated in the risk assessment, this value is not significantly different from the target risk levels of one-in-a-million and is well within the EPA's target risk range of 10^{-4} to 10^{-6}. In our opinion, since this risk is based on "worst case" (often unrealistic) assumptions, and therefore an upper-bound estimation of actual risk, it is acceptable for occupational use of the property. Recommended remedial measures, as discussed in section 11.2 of this report, would further reduce or eliminate potential health risks by effectively eliminating exposure pathways.

9.5.2 Carcinogenic Risks (Residential Setting)

As shown in Table 11 of the risk assessment, the theoretical upper-bound carcinogenic risk for an on-site residential receptor is 11 in-ten thousand. As shown, virtually all of this risk is associated with the unrealistic assumption that ground water is consumed by inhabitants of the site. The theoretical carcinogenic risk associated with slag is 8.4 in-a-million, which is well within the EPA's target risk range of 10^{-4} to 10^{-6}.

It is emphasized that all estimates of non-carcinogenic and carcinogenic risk are dependant on numerous, often unrealistic, "worst case" assumptions. Consequently, the risk assessment results should not be considered a characterization of absolute risk. An important use of the results is to highlight potential areas or sources of concern so that they may be effectively dealt with in the remedial process.

10.0 CONCLUSIONS

The purpose of this investigation was to evaluate soil and ground water at a 32-acre parcel located in Hayward, California. Because the site was previously used a agricultural land as well as a drive-in theater, chemicals of concern included pesticides and petroleum fuels and oils that may have leaked from vehicles parked on-site. In addition, slag was observed on the western portions of the site. Thus, the metal content of the slag as well as the metal content of the site's soil and ground water were also evaluated.

10.1 Soil Quality (Pesticides)

Row crops were planted on-site during the late 1950s. However, pesticides have not been detected in the on-site soil; thus, they are not an environmental concern for the site.

10.2 Soil Quality (Petroleum Hydrocarbons)

Petroleum oil has been documented across the site, predominantly in the upper 0.5 feet of soil. Fuel fingerprinting of five soil samples indicated that the oil present was asphaltic oil in three samples, motor oil in one sample, and an unconfirmed identification in one sample. Subsequent analyses to evaluate the extent of motor oil impacted soil did not detect petroleum oil. The testing performed therefore indicates that the extent of impacted soil is very limited.

In our opinion, the majority of oil detected is non-hazardous, heavy, solid phase hydrocarbons contained in the asphaltic material used in the construction of roads and parking areas for the drive-in. During our site visits, asphaltic chips were observed mixed in the gravel fill used for the drive-in portion of the site. Broken asphalt was also observed dumped in various locations on the undeveloped site areas. Because of the solvents used during the extraction process, leaching of solid phase petroleum hydrocarbons from asphaltic fragments will occur during laboratory analyses. Thus, the reported results do not represent actual solute concentrations in on-site soils.

Analyses for soluble petroleum oil using STLC extraction techniques showed that the oil is confined and will not migrate downward to ground water under neutral pH conditions. In addition, analysis of the ponded water, which is in direct contact with asphalt containing surface materials. did not detect concentrations of total petroleum oil.

These results indicate that oil detected in soil at the site is relatively immobile and likely confined to asphaltic chips. It is not expected to leach into the soil matrix.

Soil and ponded water pH at the site is predominantly from 7 to 9, however higher and lower pH values were detected. This indicates that basic conditions prevail at the site. Nonetheless, in our opinion, an STLC test with a neutral solution is more representative of site conditions than an STLC test with an acidic solution.

Asphaltic oil in soil should not require remedial action and is not an environmental concern at the site. Asphalt is not considered a hazardous waste by the State of California.

10.3 Soil/Slag Quality (Metals)

Our site reconnaissance revealed slag scattered throughout the gravel in the drive-in portion of the site and over approximately 50 percent of the undeveloped portion of the site. Four different types of slag and two samples of slag intermixed with gravel were evaluated for total metal content. Of the 17 toxic metals and hexavulent chromium listed in Title 22 of the California Code of Regulations only copper and zinc exceeded TTLC values. Lead, although well below the TTLC, was also elevated. In addition, arsenic, mercury and selenium levels appeared slightly higher than typical background concentrations. However, the reported levels of these metals are likely inaccurate due to the analytical method used.

Laboratory analysis of the slag samples for soluble metals using modified STLC extraction techniques indicated that only mercury and selenium occasionally exceeded the STLC limit. These two metals generally exceeded the STLC when analyzed with a buffered citric acid solution with a pH of 1.5, and on one occasion, with a pH of 9.0. Soluble copper, lead, and zinc concentration were not elevated. In addition, analyses of the two slag samples with the highest metal content for hazardous waste characteristics including corrosivity, ignitability, reactivity, and toxicity showed the slag to be non-hazardous.

The potential impact of the slag on soil at the site was also evaluated. Total and soluble levels for five metals of concern (copper, lead, zinc, mercury and selenium), which were occasionally detected at levels above the TTLC and/or STLC limits during the slag analysis, were evaluated. These analyses showed that elevated concentrations of copper, lead, and zinc detected in slag have not migrated to the underlying soil. Only mercury was occasionally detected above the TTLC and STLC limits. Selenium levels also appeared slightly elevated.

As previously discussed, soil and/or slag samples, in which the highest levels of arsenic, mercury, and selenium were detected, were reanalyzed using atomic absorption spectrometry. These analyses indicated that results for these metals originally obtained by ICP techniques are not accurate. Much lower or non-detectable concentrations were found using AA techniques. Our discussions with several analytical laboratories have indicated that AA is the preferred analytical method due to the greater degree of precision obtained. Therefore, in our opinion, these metals are not a significant concern in soil or slag at the site.

In summary, the metal content of the slag consists primarily of total copper, lead, and zinc. However, these metals were not detected at significant levels in underlying soil and do not appear to be highly soluble under typical on-site conditions.

10.4 Ground Water Quality (Petroleum Hydrocarbons)

Low levels of total petroleum oil were detected in wells AF-2 and AF-3 during the September 1990 sampling round, but not during prior nor subsequent sampling rounds.

In our opinion, these results indicate that the concentrations of petroleum oil present in these wells are very near the detection limit or no longer present. The petroleum oil detected may have been associated with an isolated slug of oil present in the ground water or laboratory error since similar results have not been repeated. The unidentified semi-volatile organic compounds detected in wells AF-2 and AF-4 during the September 1990 sampling round are likely components of petroleum oil.

Although low levels of TPH as gasoline and BTEX compounds were previously detected in well point samples collected by HLA in November 1989, these compounds were not detected in ground water from on-site wells during any of the sampling rounds. Since collection and laboratory analysis of ground water samples from permanent monitoring wells is regarded as more credible, in our opinion, data obtained from prior well point samples is spurious. The ground water samples obtained from the well points may have been contaminated from improperly cleaned drilling or sampling equipment, during performance of field work. Alternatively, laboratory contamination may have resulted in false positive results.

The hydropunch sample obtained in this investigation (HP-13) was located near well point WP-4 installed by HLA. Analytical results for HP-13 did not detect petroleum oil, TPH gas, or BTEX; whereas results from well point WP-4 detected 54 ppm petroleum oil, 0.13 ppm TPH gas, and low levels of ethylbenzene, toluene, and xylenes. The differences in analytical results are likely due to different methods of obtaining ground water samples. Modern hydropunch sampling techniques are superior to many methods previously used in that only a clean stainless steel rod and temporary screen are advanced into the aquifer. Augers, which can become contaminated from overlying soil, are not advanced into the water-bearing stratum.

10.5 Ground Water Quality (Metals)

The levels of metals detected in ground water, in our opinion, represent natural baseline conditions. Filtering of samples prior to analysis to remove suspended particulate matter generally resulted in a reduction of metal concentrations compared to previous unfiltered sample results. In general, the metal concentration detected in ground water from the on-site wells were well below drinking water standards. However, arsenic, barium, chromium III, and lead were detected in water from well AF-1 at or slightly above drinking water standards. Total dissolved solids concentrations from the wells corresponded closely with metal levels with the highest concentration also occurring in well AF-1. In our opinion, this indicates that metal concentrations detected may still be partially due to suspended particulate matter in the water even though the samples were filtered prior to analysis. All metal levels detected in ground water were well below STLC values.

It is not unusual for shallow ground water to naturally exceed drinking water standards for a variety of constituents. Municipal ground water wells typically draw from much deeper aquifers. In order to obtain cleaner water, such wells may be drilled to depths of several hundred feet. We understand that ground water in the site vicinity is not used for potable purposes (City of Hayward Water Department, 1991) and hence, in our opinion, the metal concentrations detected in the ground water would not present a health or environmental concern at the site.

In our opinion, virtually no exchange of ground water is expected between the shallow zone and the deeper Newark aquifer because an extensive clay layer, the Newark Aquiclude, separates these two zones. Thus, any contaminants impacting the shallow aquifer are not expected to migrate to the deeper Newark aquifer.

10.6 Risk Assessment

Based on the proposed future industrial use of the property, the risk assessment concluded that the site, in it's current state, would pose only a minimal noncarcinogenic risk. The carcinogenic risk for industrial land use is extremely low and not significant in view of the numerous conservative assumptions upon which the risk assessment is based.

For a hypothetical residential land use scenario, the risk assessment concluded that the site may pose a moderate noncarcinogenic risk. However, this basically assumes that a residential development is constructed directly on top of the slag, which, in our opinion, is unrealistic. The carcinogenic risk for residential use was found to be largely due to assumed ground water use by inhabitants of the site. Carcinogenic risks associated with the slag are substantially lower and well with in the EPA's target risk range.

11.0 RECOMMENDATIONS

11.1 Petroleum Hydrocarbons

Remedial action for asphaltic oil at the site will not be required. Asphalt is not considered a hazardous material and is extensively used for roads and parking areas.

A limited amount of motor oil may be present on-site due to small leaks from automobiles during the operation of the drive-in theater. Because these leaks will be very difficult to impossible to locate, we recommend no further action. In addition, the oil, if present, does not appear highly mobile since petroleum oil was not detected in ponded water located in parking areas of the drive-in.

11.2 Metals

Metals associated with slag are present on-site. As evaluated by the risk assessment, these metals would not present a significant health concern for future industrial use of the property. In our opinion, on-site encapsulation of the slag would reduce the limited health risk even more. Placing slag beneath on-site pavements and building slabs during construction of the proposed industrial/warehouse complex, would effectively eliminate exposure pathways and significantly reduce or eliminate potential health risks. In addition, the leaching of metals from the slag under site conditions is very unlikely. Thus, impact to the site's ground water will not occur, in our opinion.

To minimize exposure of workers and residents in the nearby vicinity to airborne particulates that may be generated by remediation/construction activities, adequate dust control procedures should be followed during the proposed on-site construction and remediation. We also recommend that air monitoring be conducted during future construction activities to document potential impacts, if any, on air quality.

If encapsulation of the slag beneath on-site pavements and/or building slabs is performed, geotechnical design recommendations should be developed for slabs, foundations, and pavements to be constructed over the encapsulated material.

In addition, we understand that a significant quantity of imported fill material will be placed on-site prior to development. Since utility trenches may extend below fill depths, we recommend that the planned trench locations be cleared of slag prior to placement of fill, thereby avoiding unneeded excavation of the slag during utility installation and repair.

12.0 LIMITATIONS

Soil deposits and rock formations may vary in type, strength, and many other important properties across any geologic area. The study that we have made assumes that the data obtained in the field and laboratory are reasonably representative of field conditions and that the subsurface conditions are reasonably susceptible to interpolation and extrapolation between borings.

The accuracy and reliability of geo- or hydrochemical studies are a reflection of the number and type of samples taken and the extent of the analysis conducted, and is thus inherently limited and dependent upon the resources expended. Our sampling and analytical plan was designed using accepted environmental engineering principles and our judgement for the performance of a reconnaissance ground water quality investigation, and was based on the degree of investigation desired by you. It is possible to obtain a greater degree of certainty, if desired, by implementing a more rigorous soil sampling program or by installation of a higher density of monitoring wells.

This report was prepared for the use of AM Homes in evaluating the environmental setting and ground water quality at the referenced site at the time of this study. We make no warranty, expressed or implied, except that our services have been performed in accordance with hydrogeological and environmental engineering principles generally accepted at this time and location. The hydrochemical and other data presented in this report can change over time and are applicable only to the time this study was performed.

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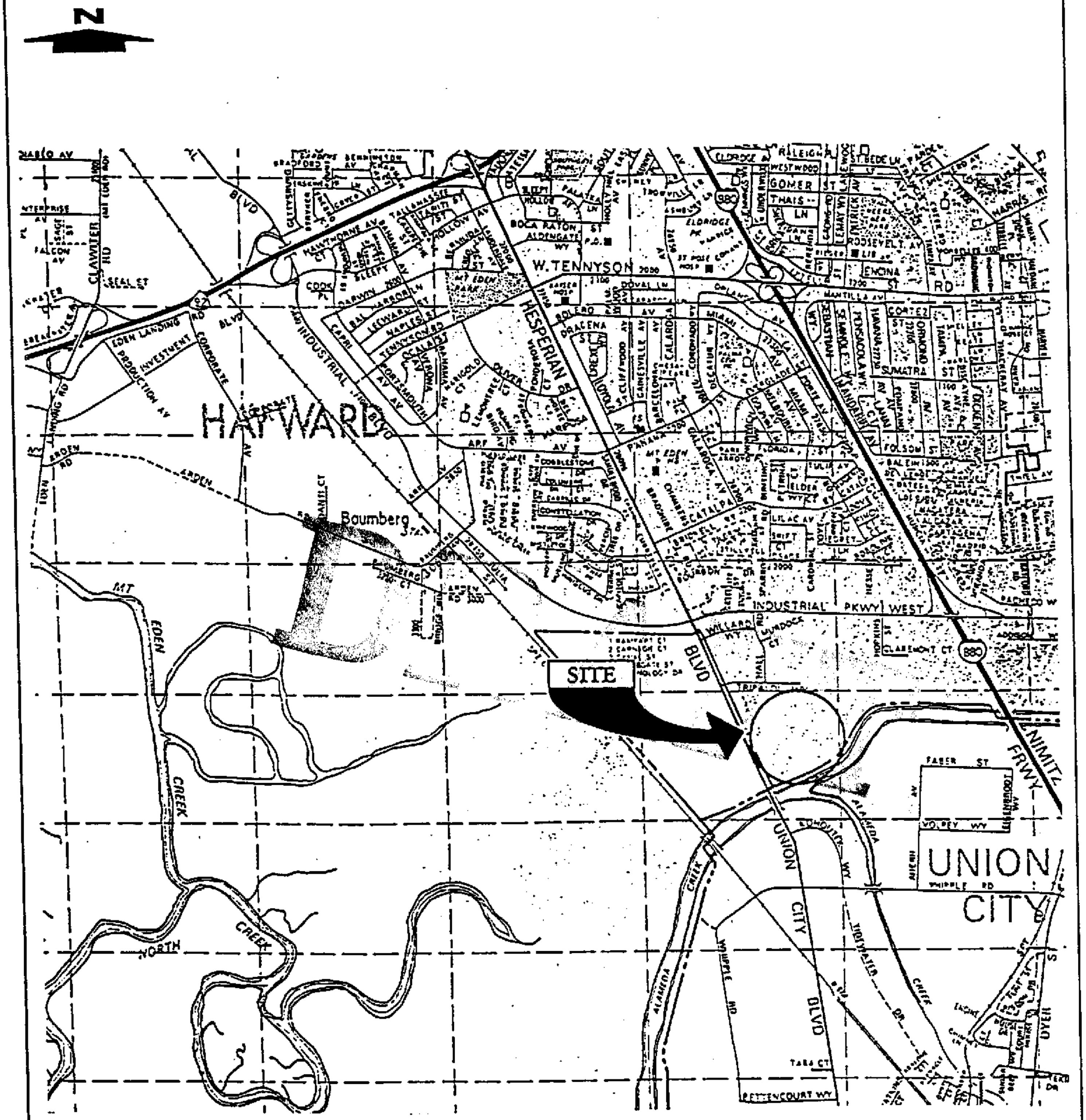

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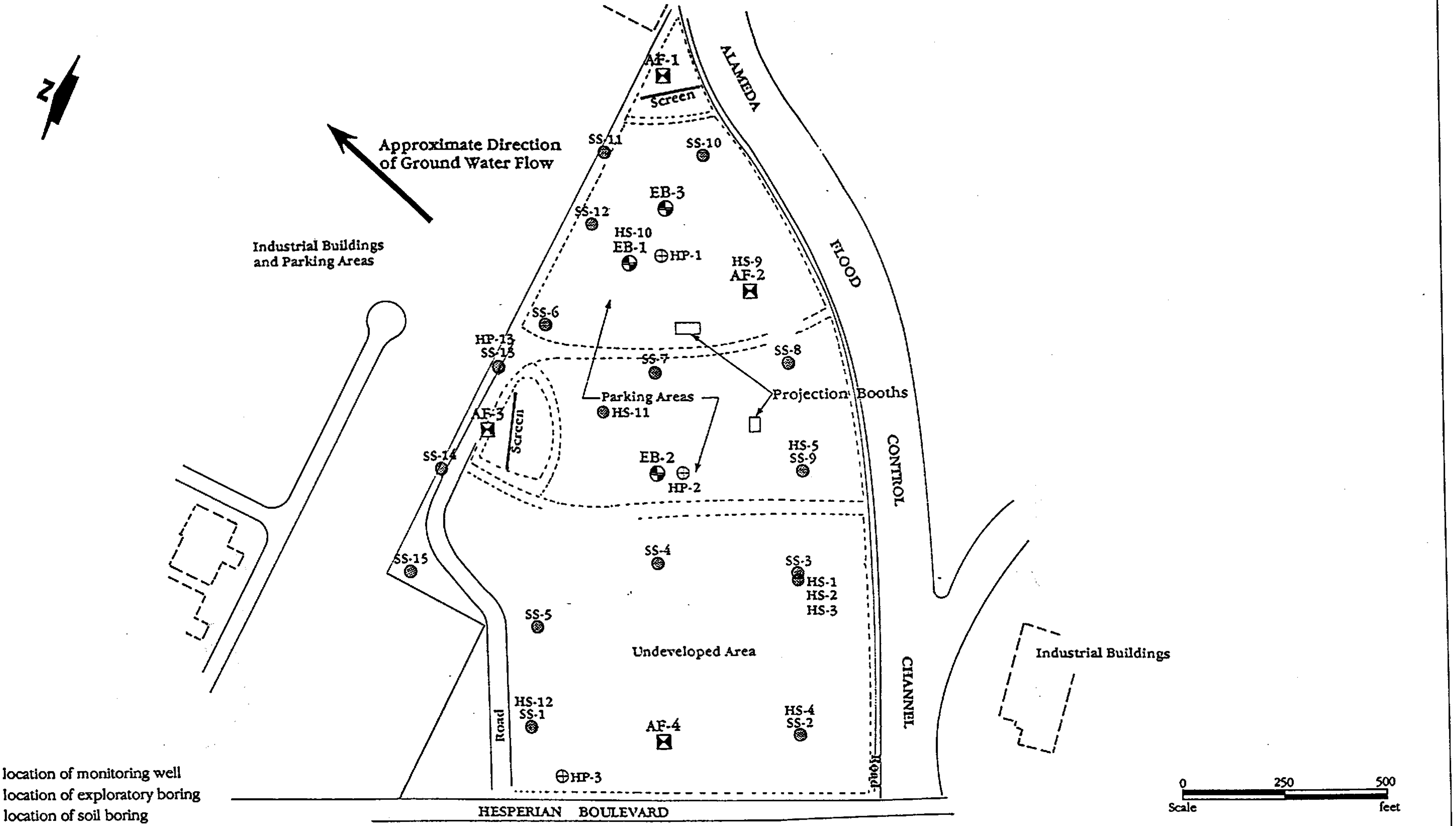
718-9,7/19 PMLe*JC

VICINITY MAP

TWO HAYWARD PARCELS
Hayward, California

LOWNEYASSOCIATES
Environmental/Geotechnical/Engineering Services

FIGURE 1
718-9D, February 1992



LEGEND

☒ - Approximate location of monitoring well

◐ - Approximate location of exploratory boring

● - Approximate location of soil boring

⊕ - Approximate location of surface water sample

AF - Alameda Flood Control (monitoring well); installed July 1990

EB - Exploratory boring; drilled July 1990

SS - Soil Sample; drilled October 1990

HS - Hayward Soil Sample; drilled May 1990

HP - Hydropunch ground water sample (HP-13) & Hayward parcel surface water sample (HP-1,2 & 3)

Base by Aerial Photo, dated 1981.

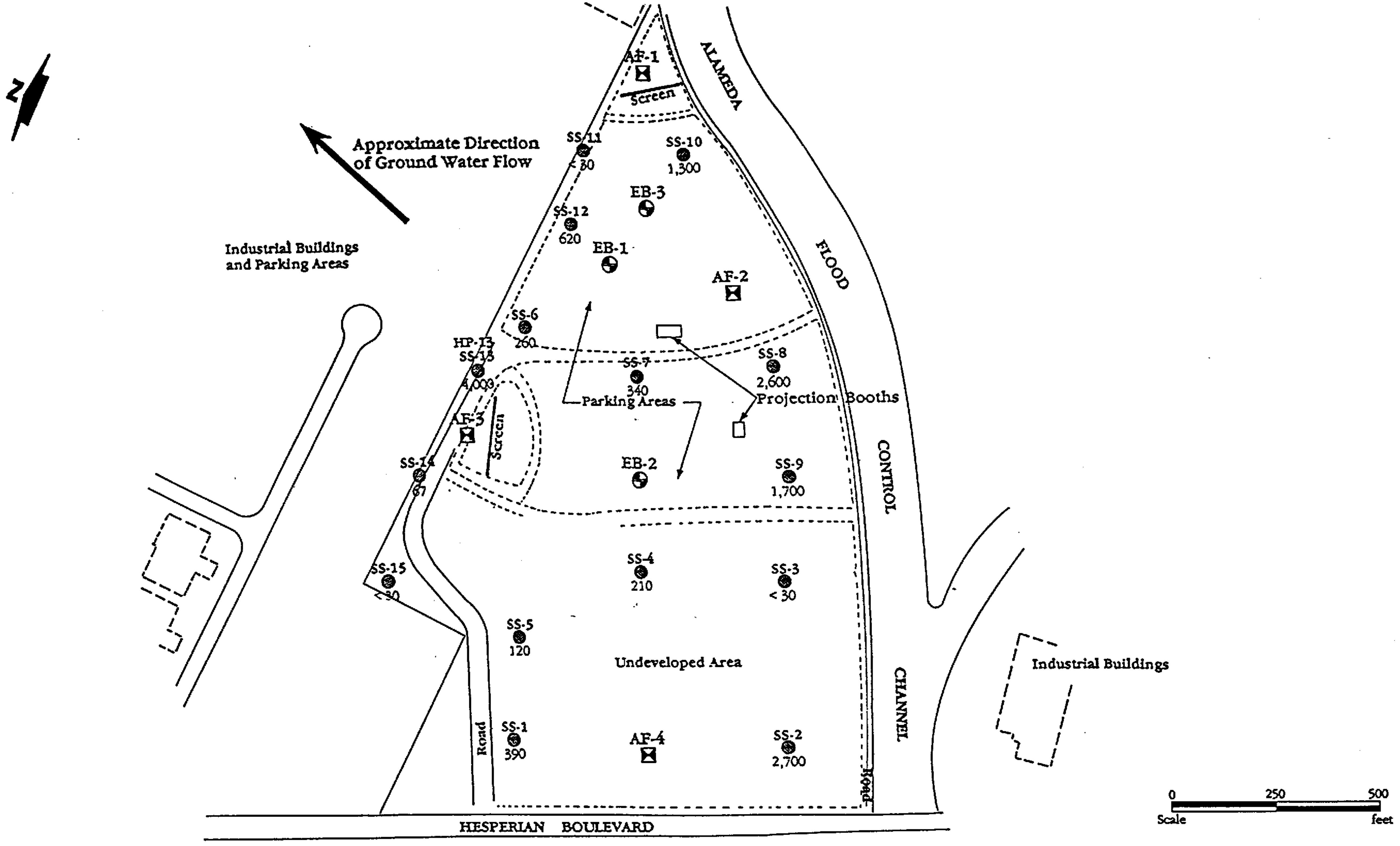
718-9,11/5 PMLe*JC

SITE PLAN

TWO HAYWARD PARCELS
Hayward, California

LOWNEYASSOCIATES
Environmental/Geotechnical/Engineering Services

FIGURE 2
718-9D, February 1992



LEGEND

☒ - Approximate location of monitoring well

⊕ - Approximate location of exploratory boring

● - Approximate location of soil boring

Base by Aerial Photo, dated 1981.

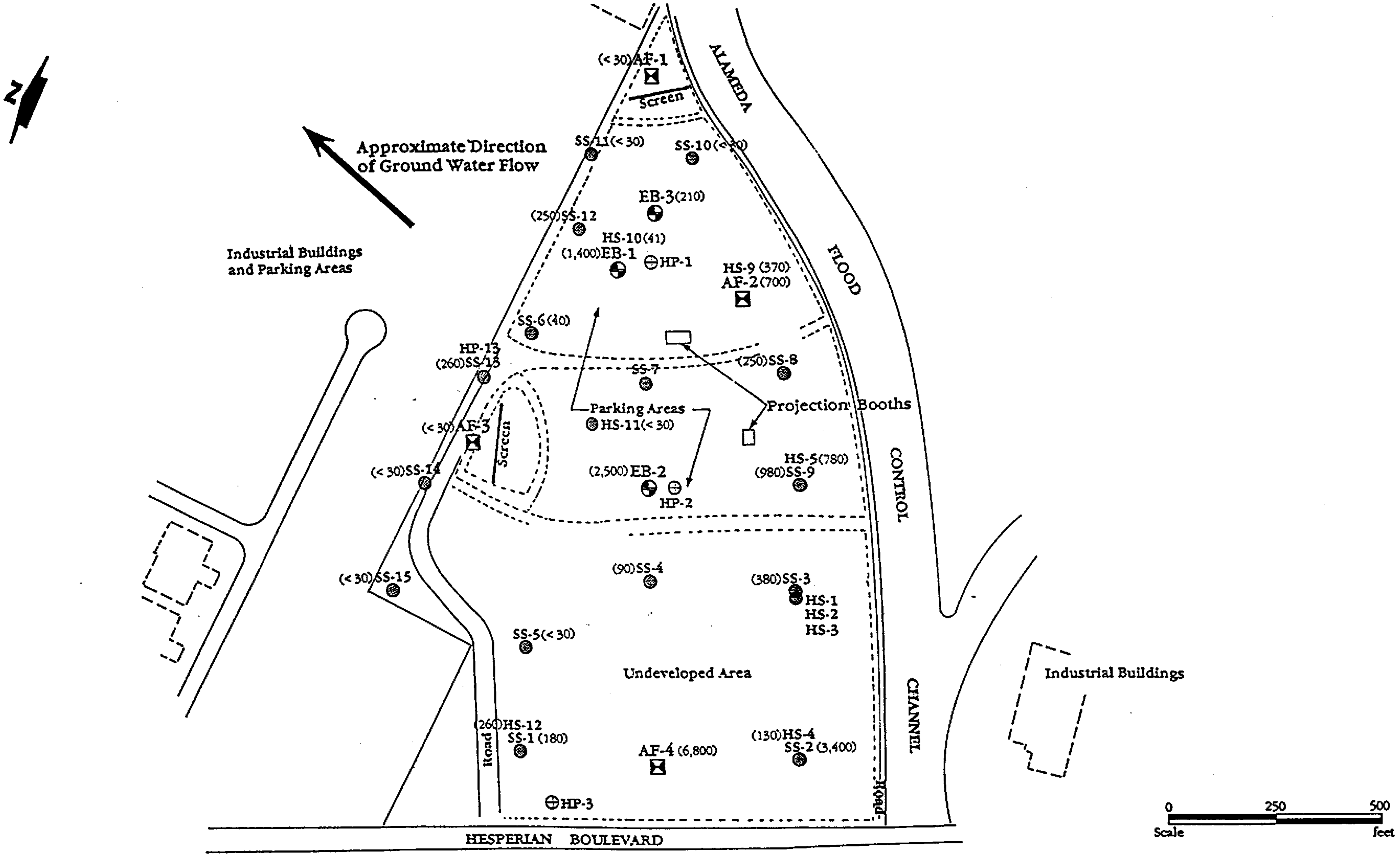
TOTAL OIL AND GREASE CONCENTRATIONS AT THE 0.0 TO 0.5 FOOT DEPTH INTERVAL (in ppm)

TWO HAYWARD PARCELS
Hayward, California

LOWNEYASSOCIATES
Environmental/Geotechnical/Engineering Services

FIGURE 3
718-9D, February 1992

718-9,11/5 PML*JC



LEGEND

- ☒ - Approximate location of monitoring well
- ◐ - Approximate location of exploratory boring
- ● - Approximate location of soil boring

Base by Aerial Photo, dated 1981.

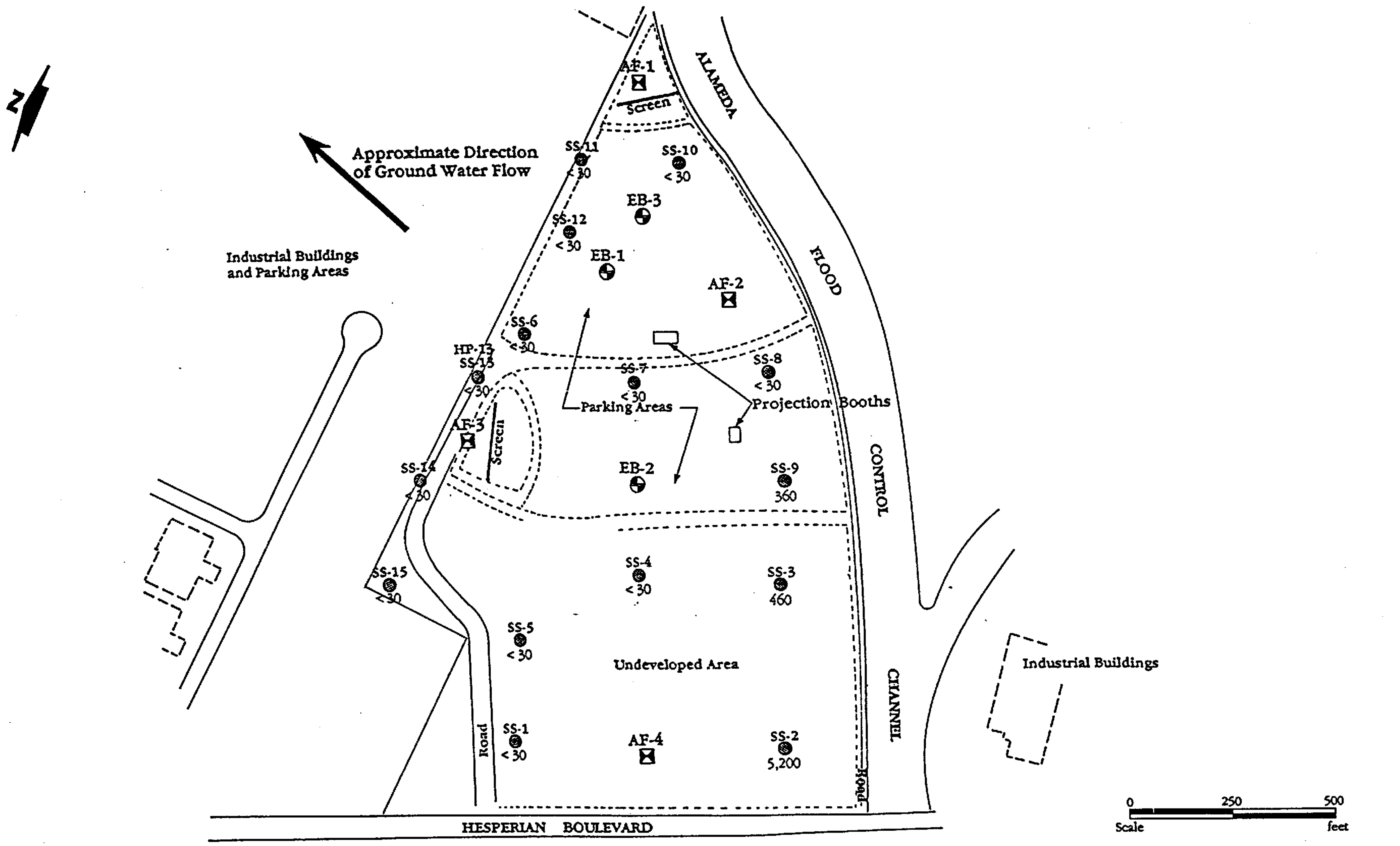
TOTAL OIL AND GREASE CONCENTRATIONS AT THE 0.5 TO 1.0 FOOT DEPTH INTERVAL (in ppm)

TWO HAYWARD PARCELS
Hayward, California

LOWNEY ASSOCIATES
Environmental / Geotechnical / Engineering Services

FIGURE 4
718-9D, February 1992

718-8.11/5 PMLs*JC



LEGEND

- ☒ - Approximate location of monitoring well
- ⊕ - Approximate location of exploratory boring
- ● - Approximate location of soil boring

Base by Aerial Photo, dated 1981.

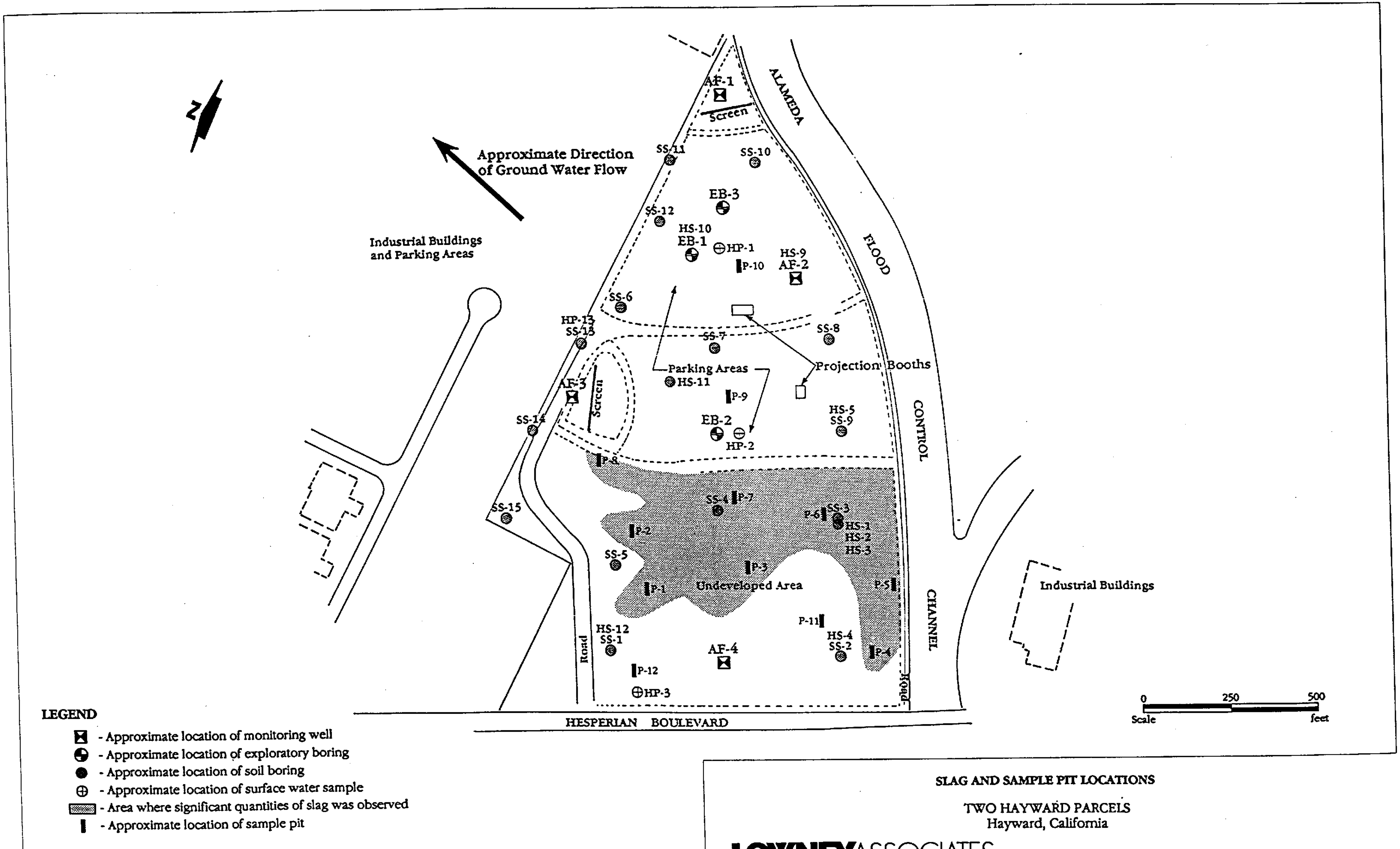
TOTAL OIL AND GREASE CONCENTRATIONS AT THE 1.0 TO 1.5 FOOT DEPTH INTERVAL (in ppm)

TWO HAYWARD PARCELS
Hayward, California

LOWNEYASSOCIATES
Environmental/Geotechnical/Engineering Services

FIGURE 5
718-9D, February 1992

718-9,11/5 PML*JC



Base by Aerial Photo, dated 1981.

718-9,11/6 PMLs*JC

SLAG AND SAMPLE PIT LOCATIONS

TWO HAYWARD PARCELS
Hayward, California

LOWNEYASSOCIATES
Environmental/Geotechnical/Engineering Services

FIGURE 6
718-9D, February 1992

APPENDIX A - PERMITS

The construction of monitoring wells at the site comes under the guidelines established by the Alameda County Flood Control and Water Conservation District. Construction of the monitoring wells was performed by a driller with a valid State Water Well Contractor's License (C57) from the firm Exploration Geo Services, San Jose, California. A copy of the permit is attached.

→ Ron H

ALAMEDA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
5997 PARKSIDE DRIVE • PLEASANTON, CALIFORNIA 94566 • (415) 484-2600

3 July 1990

OC.
JUL 5 1990

J.V. Lowney & Associates
145 Addison Avenue
Palo Alto, CA 94301

Gentlemen:

Enclosed is Groundwater Protection Ordinance permit 90393 for a monitoring well construction project at the intersection of Hesperian Boulevard and Alameda Creek in Hayward for AM Homes.

Please note that permit condition A-2 requires that a well construction report be submitted after completion of the work. The report should include drilling and completion logs, location sketch, and permit number.

If you have any questions, please contact Wyman Hong or Craig Mayfield at 484-2600.

Very truly yours,

Mun J. Mar
General Manager

By
J. Killingstad, Chief
Water Resources Engineering

WH:mm
Enc.

MAR 31 1988

ALAMEDA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

5997 PARKSIDE DRIVE • PLEASANTON, CALIFORNIA 94566 • (415) 484-2600

GROUNDWATER PROTECTION ORDINANCE PERMIT APPLICATION

FOR APPLICANT TO COMPLETE

OCATION OF PROJECT Intersection of Hesperian Blvd.
nd Flood Control Channel, Hayward, CA

LIENT
ame AM Homes
ddress 577 Salmar Ave Phone
ity Campbell, CA Zip 95008

PPLICANT
ame J. V. Lowney & Associates
ddress 145 Addison Ave. Phone 415-328-6920
ity Palo Alto, CA Zip 94301

ESCRIPTION OF PROJECT
ater Well Construction X Geotechnical
athodic Protection Well Destruction

ROPOSED WATER WELL USE
omestic Industrial Irrigation
unicipal Monitoring X Other

ROPOSED CONSTRUCTION
rilling Method:
ud Rotary Air Rotary Auger X
able Other Hollow Stem

ELL PROJECTS
Drill Hole Diameter 8 in. Depth(s) 25-30 ft.
Casing Diameter 2 in. Number
Surface Seal Depth 25 ft. of Wells 5
Driller's License No. C57-484288

EOTECHNICAL PROJECTS
Number
Diameter in. Maximum Depth ft.

STIMATED STARTING DATE 7/3/90
STIMATED COMPLETION DATE 7/5/90

I hereby agree to comply with all requirements of this permit and Alameda County Ordinance No. 73-68.

PPLICANT'S
IGNATURE Date 6/22/90

FOR OFFICE USE

PERMIT NUMBER 90393
LOCATION NUMBER

Approved Wyman Hong Date 25 Jun 90
Wyman Hong

PERMIT CONDITIONS

Circled Permit Requirements Apply

(A.) GENERAL
1. A permit application should be submitted so as to arrive at the Zone 7 office five days prior to proposed starting date.
2. Notify this office (484-2600) at least one day prior to starting work on permitted work and before placing well seals.
3. Submit to Zone 7 within 60 days after completion of permitted work the original Department of Water Resources Water Well Drillers Report or equivalent for well projects, or bore hole logs and location sketch for geotechnical projects. Permitted work is completed when the last surface seal is placed or the last boring is completed.
4. Permit is void if project not begun within 90 days of approval date.

(B.) WATER WELLS, INCLUDING PIEZOMETERS
1. Minimum surface seal thickness is two inches of cement grout placed by tremie, or equivalent.
2. Minimum seal depth is 50 feet for municipal and industrial wells or 20 feet for domestic, irrigation, and monitoring wells unless a lesser depth is specially approved.

C. GEOTECHNICAL. Backfill bore hole with compacted cuttings or heavy bentonite and upper two feet with compacted material.

D. CATHODIC. Fill hole above anode zone with concrete placed by tremie, or equivalent.

E. WELL DESTRUCTION. See attached.

ALAMEDA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
5997 PARKSIDE DRIVE • PLEASANTON, CALIFORNIA 94566 • (415) 484-2600

24 September 1990

J.V. Lowney & Associates
145 Addison Avenue
Palo Alto, CA 94301

Gentlemen:

Enclosed is Groundwater Protection Ordinance permit 90576 for a contamination investigation at Hesperian Boulevard and Alameda Creek in Hayward for AM Homes.

If you have any questions, please contact Todd Wendler or Craig Mayfield at 484-2600.

Very truly yours,

Jim Dixon
General Manager

By
J. Killingstad, Chief
Water Resources Engineering

TW:mm
Enc.

J. V. LOWNEY ASSOC.
SEP 25 1990
RECEIVED

ALAMEDA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

5997 PARKSIDE DRIVE ♦ PLEASANTON, CALIFORNIA 94566 ♦ (415) 484-2600

GROUNDWATER PROTECTION ORDINANCE PERMIT APPLICATION

FOR APPLICANT TO COMPLETE

ATION OF PROJECT Intersection of Hesperian
lvd, and Flood Control Channel,
ayward, CA

IENT
ne AM Homes
dress 577 Salmar Ave. Phone ___
ty Campbell, CA Zip 95008

LICANT
ne J.V. Lowney + Associates
dress 145 Addison Ave Phone 415-328-6920
ty Palo Alto, CA Zip 94301

E OF PROJECT
l Construction — Geotechnical Investigation
athodic Protection ___ General ___
ater Supply ___ Contamination ___
onitoring ___ Well Destruction ___
Hydropunch and Soil Borings

POSED WATER SUPPLY WELL USE
estic ___ Industrial ___ Other N/A
icipal ___ Irrigation ___

LLING METHOD:
Rotary ___ Air Rotary ___ Auger X
le ___ Other Hollow Stem

LLER'S LICENSE NO. C57-484288

L PROJECTS 3 Hydropunch Borings (15-20 ft.) 15 Soil Borings (4 ft.)
Drill Hole Diameter ___ in. Maximum
Casing Diameter ___ in. Depth ___ ft.
Surface Seal Depth ___ ft. Number ___

TECHNICAL PROJECTS
Number of Borings ___ Maximum
Hole Diameter ___ in. Depth ___ ft.

IMATED STARTING DATE 10/4/90
IMATED COMPLETION DATE 10/5/90

ereby agree to comply with all requirements of this
mit and Alameda County Ordinance No. 73-68.

LICANT'S
NATURE Date 9.15.90

FOR OFFICE USE

PERMIT NUMBER 90576
LOCATION NUMBER ___

PERMIT CONDITIONS

Circled Permit Requirements Apply

A. GENERAL
[✓ 1.] A permit application should be submitted so as t arrive at the Zone 7 office five days prior t proposed starting date.
2. Submit to Zone 7 within 60 days after completic of permitted work the original Department c Water Resources Water Well Drillers Report c equivalent for well projects, or drilling log and location sketch for geotechnical projects.
[✓ 3.] Permit is void if project not begun within 9 days of approval date.

B. WATER WELLS, INCLUDING PIEZOMETERS
1. Minimum surface seal thickness is two inches c cement grout placed by tremie.
2. Minimum seal depth is 50 feet for municipal ar industrial wells or 20 feet for domestic anc irrigation wells unless a lesser depth i specially approved. Minimum seal depth fc monitoring wells is the maximum depth practicab or 20 feet.

[✓ C.] GEOTECHNICAL. Backfill bore hole with compacted cu tings or heavy bentonite and upper two feet with cor pacted material. In areas of known or suspecte contamination, tremied cement grout shall be used place of compacted cuttings.

D. CATHODIC. Fill hole above anode zone with concre placed by tremie.

E. WELL DESTRUCTION. See attached.

Approved Todd N. Wendler Date 19 Sep 9

12198

APPENDIX B - SUBSURFACE INVESTIGATION

A subsurface investigation was performed on July 5 and 6, 1990, using a B-40 Mobile drill rig equipped with an 8-inch hollow-stem auger. Four borings (AF-1 to AF-4) were advanced into the uppermost water-bearing sediments to depths ranging from 20.0 to 26.5 feet. The four borings were completed as monitoring wells. Soil samples were collected at 5-foot intervals and logged using the Unified Soil Classification System (ASTM D-2487). Boring logs, as well as a key to the classification of the soil (Figure B-1), are included as part of this appendix.

All sampling equipment was thoroughly cleaned with a tri-sodium phosphate and distilled water solution or steam cleaned. Soil samples were collected using a 2.5-inch O.D. California Modified drive sampler in the soil above the water table and a 2.0-inch O.D. Terzaghi drive sampler in the soil beneath the water table. Upon collection from the California drive sampler, the ends of the brass liner were covered with aluminum foil and then sealed with a plastic cap at each end. The caps were taped airtight and labeled appropriately. These samples were then immediately placed in an ice-cooled chest for transport to a certified analytical laboratory. Samples retrieved from the Terzaghi drive sampler were placed in glass bottles, sealed with a screw-on aluminum cap and labeled.

The standard penetration resistance blow counts were obtained by dropping a 140-pound hammer through a 30-inch free fall. The blows per foot recorded on the boring logs represent the accumulated number of blows required to drive the sampler the last 12 inches of the interval indicated.

The attached boring logs and related information depict subsurface conditions only at the locations indicated and at the particular date designated on the logs. Subsurface conditions at other locations may differ from conditions occurring at these boring locations. The passage of time may result in a change in the subsurface conditions due to environmental changes. In addition, any stratification lines on the logs represent the approximate boundary between soil types and the transition may be gradual.

PRIMARY DIVISIONS			SOIL TYPE	LEGEND	SECONDARY DIVISIONS
COARSE GRAINED SOILS MORE THAN HALF OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVELS MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS (LESS THAN 5% FINES)	GW	▒	Well graded gravels, gravel-sand mixtures, little or no fines.
			GP	▒	Poorly graded gravels or gravel-sand mixtures, little or no fines.
		GRAVEL WITH FINES	GM	▥	Silty gravels, gravel-sand-silt mixtures, non-plastic fines.
			GC	▨	Clayey gravels, gravel-sand-clay mixtures, plastic fines.
	SANDS MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS (LESS THAN 5% FINES)	SW	░	Well graded sands, gravelly sands, little or no fines.
			SP	░	Poorly graded sands or gravelly sands, little or no fines.
		SANDS WITH FINES	SM	▥	Silty sands, sand-silt mixtures, non-plastic fines.
			SC	▨	Clayey sands, sand-clay mixtures, plastic fines.
FINE GRAINED SOILS MORE THAN HALF OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS LIQUID LIMIT IS LESS THAN 50%		ML	▥	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
			CL	▨	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	▥	Organic silts and organic silty clays of low plasticity.
	SILTS AND CLAYS LIQUID LIMIT IS GREATER THAN 50%		MH	▥	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	▨	Inorganic clays of high plasticity, fat clays.
			OH	▨	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS			Pt	≋	Peat and other highly organic soils.

DEFINITION OF TERMS

U.S. STANDARD SERIES SIEVE — 200, 40, 10, 4
CLEAR SQUARE SIEVE OPENINGS — 3/4", 3", 12"

SILTS AND CLAY	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		

GRAIN SIZES

▥	TERZAGHI SPLIT SPOON STANDARD PENETRATION
▥	MODIFIED CALIFORNIA
▥	SHELBY TUBE PITCHER TUBE

SAMPLERS

SAND AND GRAVEL	BLOWS/FOOT*
VERY LOOSE	0 - 4
LOOSE	4 - 10
MEDIUM DENSE	10 - 30
DENSE	30 - 50
VERY DENSE	OVER 50

RELATIVE DENSITY

SILTS AND CLAYS	STRENGTH‡	BLOWS/FOOT*
VERY SOFT	0 - 1/4	0 - 2
SOFT	1/4 - 1/2	2 - 4
FIRM	1/2 - 1	4 - 8
STIFF	1 - 2	8 - 16
VERY STIFF	2 - 4	16 - 32
HARD	OVER 4	OVER 32

CONSISTENCY

* Number of blows of 140 pound hammer falling 30 inches to drive a 2 inch O.D. (1-3/8 inch I.D.) split spoon (ASTM D-1586).

‡ Unconfined compressive strength in tons/sq. ft. as determined by laboratory testing or approximated by the standard penetration test (ASTM D-1586), pocket penetrometer, torvane, or visual observation.

KEY TO EXPLORATORY BORING LOGS
Unified Soil Classification System (ASTM D - 2487)

TWO HAYWARD PARCELS
Hayward, California

LOWNEYASSOCIATES
Environmental/Geotechnical/Engineering Services

FIGURE B - 1
718-9D, January 1992

DRILL RIG: Mobile B-40

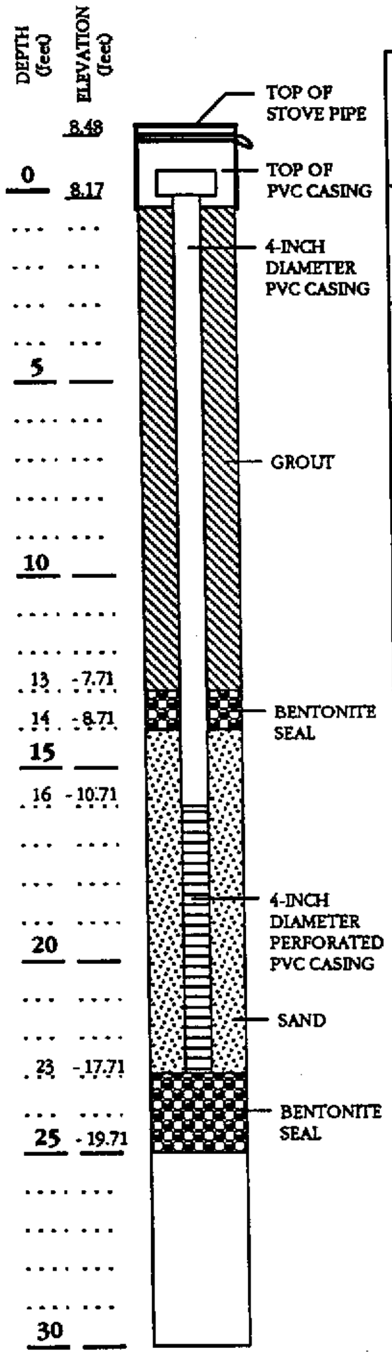
SURFACE ELEVATION: 5.29 feet

LOGGED BY: PMLe/SF

DEPTH TO GROUNDWATER: 11.14 feet
(From Surface Elevation)

BORING DIAMETER: 8 inches

DATE DRILLED: 7/15/90



DESCRIPTION	SYMBOL	CONSISTENCY	SOIL TYPE	LEGEND	DEPTH (feet)	SAMPLER	WATER CONTENT (%)	PENETRATION RESISTANCE (BLOWS/FT.)	ORGANIC VAPORS (ppm)
Brown silty clay, moderate to high plasticity, dry, few rootlets.	A	Very stiff	CH	▨		▓ ▓	9 11	19 28	
Brown sandy clay, low to moderate plasticity, slightly moist, fine to coarse subangular to subrounded sand.	A	Very stiff	CL	▨	5	▓	12	28	
Brown clayey sand, fine sand, slightly moist, well graded.	A	Medium dense	SC	▨					
Black silty clay, moderate to high plasticity, moist.	A	Very stiff	CH	▨	10	▓ ▓	23 ▼ - final 21	12 22	
Gray silty clay with trace sand, moderate to high plasticity, moist.	A	Very stiff	CH	▨	15				
Brown sandy clay, fine to medium sand, moderate plasticity, moist.	A	Very stiff	CL/CH	▨			▽ - initial		
Brown clayey sand, fine to coarse sand, well graded, saturated.	B	Medium dense	SC	▨	20	▓	22	24	
Brown sandy clay, fine sand, wet, well graded, moderate plasticity.	C	Very stiff	CL/CH	▨					
Brown clayey sand, fine sand, wet, well graded.	D	Loose	SC	▨	25	▓	28	10	
Bottom of Boring = 25.0 feet NOTE: The stratification lines represent the approximate boundary between the soil types. The transition may be gradual.					30				

718-9,7/19 PMLe*JC

MONITORING WELL LOG - AF-1

TWO HAYWARD PARCELS
Hayward, California

LOWNEYASSOCIATES
Environmental/Geotechnical/Engineering Services

DRILL RIG: Mobile B-40

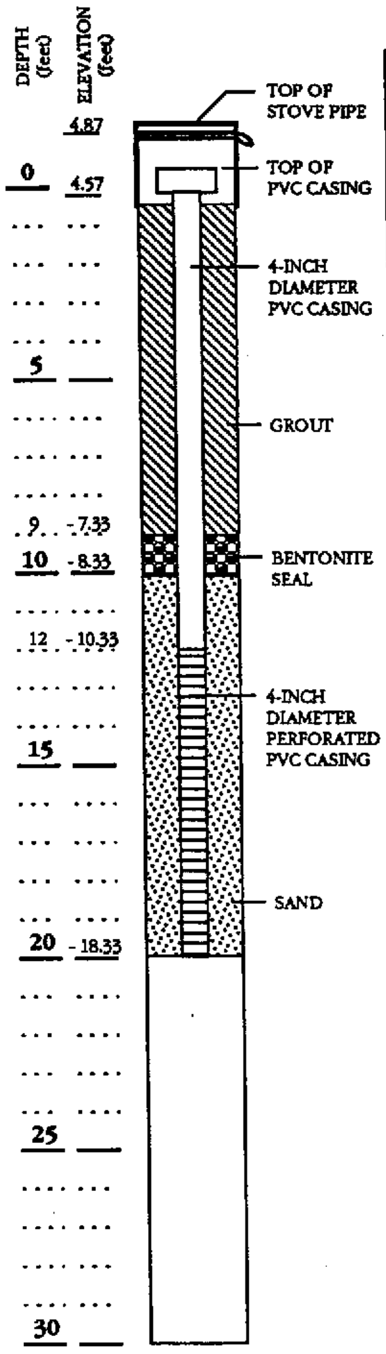
SURFACE ELEVATION: 1.67 feet

LOGGED BY: PMLe/SF

DEPTH TO GROUNDWATER: 6.25 feet
(From Surface Elevation)

BORING DIAMETER: 8 inches

DATE DRILLED: 7/15/90



DESCRIPTION	SYMBOL	CONSISTENCY	SOIL TYPE	LEGEND	DEPTH (feet)	SAMPLER	WATER CONTENT (%)	PENETRATION RESISTANCE (BLOWS/FT.)	ORGANIC VAPORS (ppm)
(Fill) Gray sandy gravel, fine to coarse sand and fine gravel, well graded, subangular sand and gravel, dry.	AF	Loose	GP				2	8	
(Fill) Gravelly clay with sand, fine to coarse sand and fine gravel, subangular sand and gravel, well graded, moist.	AF	Stiff Soft	CL CH		5		16 33	9 4	
Gray silty clay, moderate to high plasticity, moist to wet, trace fine sand.	A	Stiff	CH				▼ - final		
Black silty clay, high plasticity, moist, trace fine to medium grained sand.	A				10		27	12	
Brown sandy clay, moderate to highly plastic, moist, fine grained sand.	A	Stiff	CH		15 20		▽ - initial 21 26	13 7	
Bottom of Boring = 20.0 feet NOTE: The stratification lines represent the approximate boundary between the soil types. The transition may be gradual.					25 30				

718-9,7/19 PMLe*JC

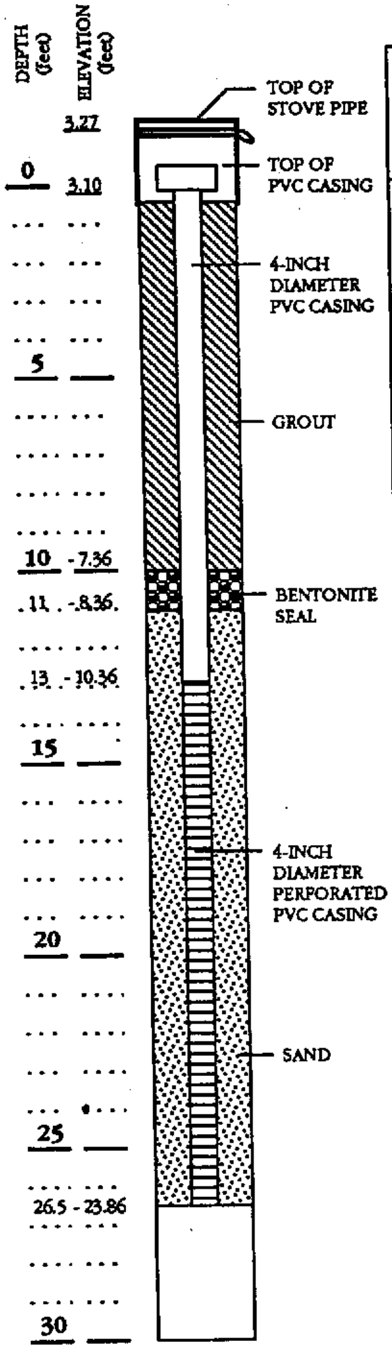
MONITORING WELL LOG - AF-2

TWO HAYWARD PARCELS
Hayward, California

LOWNEYASSOCIATES
Environmental/Geotechnical/Engineering Services

DRILL RIG: Mobile B-40
SURFACE ELEVATION: 2.64 feet
LOGGED BY: PMLe/SF

DEPTH TO GROUNDWATER: 7.83 feet
(From Surface Elevation)
BORING DIAMETER: 8 inches
DATE DRILLED: 7/15/90



DESCRIPTION	SYMBOL	CONSISTENCY	SOIL TYPE	LEGEND	DEPTH (feet)	SAMPLER	WATER CONTENT (%)	PENETRATION RESISTANCE (BLOWS/FT.)	ORGANIC VAPORS (ppm)
Brown gravelly clay, moderate plasticity, fine to coarse gravel, angular, dry.	A	Very stiff	CL/CH				7 5 9	26 34 20	
Brown silty clay, moderate to highly plastic, slightly moist, roots present.	A	Very stiff	CH		5				
Dark brown silty clay, highly plastic, moist.	A	Stiff	CH		10		▼ - final 33	14	
Gray sandy clay, moderate plasticity, slightly moist, fine to coarse grained sand, angular to subangular sand.	A	Very stiff	CL/CH		15		21 ▽ - initial	17	
Brown clayey sand, well graded, fine to medium sand, saturated.	B	Stiff	SC		20		19	9	
Brown sand, medium to coarse grained, rounded, saturated, well graded.	B		SW		25		15		
Brown silty clay, moderately plastic, moist.	C		CL/CH				23		
Bottom of Boring = 26.5 feet NOTE: The stratification lines represent the approximate boundary between the soil types. The transition may be gradual.					30				

718-9,7/19 PMLe*JC

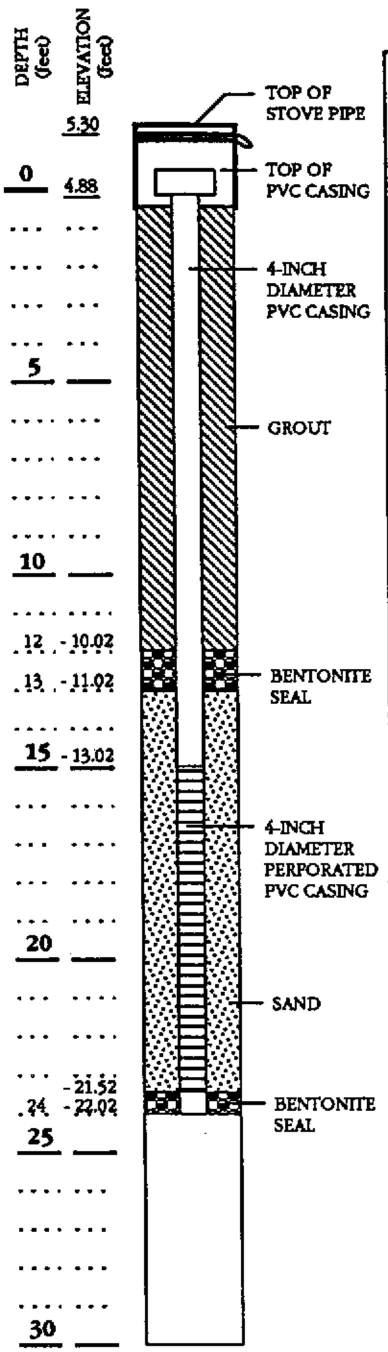
MONITORING WELL LOG - AF-3

TWO HAYWARD PARCELS
Hayward, California

LOWNEYASSOCIATES
Environmental/Geotechnical/Engineering Services

DRILL RIG: Mobile B-40
SURFACE ELEVATION: 1.98 feet
LOGGED BY: PMLe/SF

DEPTH TO GROUNDWATER: 6.20 feet
(From Surface Elevation)
BORING DIAMETER: 8 inches
DATE DRILLED: 7/15/90



DESCRIPTION	SYMBOL	CONSISTENCY	SOIL TYPE	LEGEND	DEPTH (feet)	SAMPLER	WATER CONTENT (%)	PENETRATION RESISTANCE (BLOWS/FT.)	ORGANIC VAPORS (ppm)
Brown silty clay, moderate plasticity, slightly moist, few rootlets.	A	Very stiff	CL/ CH				15 11	22 25	
Moderate to high plasticity.			CH		5		19 ▼ - final	17	
Gray silty clay, moderate to high plasticity, wet.	A	Stiff	CH		10		42	10	
Brown silty clay with trace fine sand, moderate plasticity, moist.	A	Very stiff	CL/ CH		15		22 ▽ - initial	32	
Brown clayey sand, fine sand, saturated, well graded.	B	Medium dense	SC		20		23	22	
Brown sandy clay, very fine sand, wet, low plasticity.	C	Firm	CL						
Brown silt with minor fine sand, wet, low plasticity.	D	Firm	ML				26	10	
Bottom of Boring = 24.0 feet					25 30				

NOTE: The stratification lines represent the approximate boundary between the soil types. The transition may be gradual.

718-9,7/19 PMLe*JC

MONITORING WELL LOG - AF-4

TWO HAYWARD PARCELS
Hayward, California

LOWNEYASSOCIATES
Environmental/Geotechnical/Engineering Services

APPENDIX C - MONITORING WELL INSTALLATION, DEVELOPMENT, SAMPLING AND SURVEYING

The borings advanced into the uppermost water-bearing sediments were converted to "permanent" monitoring wells with the installation of PVC casing. The casing used for the wells was 2-inch I.D., threaded, flush-jointed, PVC Schedule 40 casing with sections containing perforated 0.02-inch slots installed in the lower portion of the wells. After the casing was installed, a filter pack composed of Lone Star number 3 sand was placed in the 3-inch diameter annulus to approximately 2 feet above the slotted casing. A 1-foot seal composed of bentonite pellets topped by cement was placed in the annulus above the sand pack to the surface. The wells were completed with locked stove pipes fitted over the PVC casing approximately two to three feet above grade. In addition, the PVC well casing was fitted with a watertight seal at the surface. Well construction details are shown on the boring logs.

Each well was developed by pumping such that a representative ground water sample was obtained and fine-grained material was flushed from the well and surrounding soil. Approximately 24 hours after well development, the static water level was measured. A one-liter capacity, Teflon bailer with new nylon rope was then used to purge three well casing volumes of water. Conductivity, pH, dissolved oxygen, and temperature measurements were recorded. All well developing and sampling equipment was cleaned with an aqueous tri-sodium phosphate solution and distilled water prior to entering the well.

A well development record for each well was maintained by Lowney Associates. A copy of this record is attached.

After the well development phase, the ground water was sampled. The one-liter bailer was lowered into the well below the water surface. After retrieving the bailer, the ground water was decanted into appropriate sample bottles, labeled, and immediately refrigerated until delivered to an analytical laboratory certified by the CDHS for chemical analysis of drinking water and hazardous waste. Carried along with the ground water samples was a chain of custody form that was maintained for all well samples.

The locations of the monitoring wells were approximately determined. A two-person crew using a Lietz level and an engineers' graduated rod determined the elevations of the monitoring wells. Elevations were recorded to the nearest hundredth of a foot. The monitoring wells were surveyed to a relative elevation of 7.5 feet at the top of casing for monitoring well AF-5.

RECORD OF WELL DEVLOPMENT/SAMPLING
J.V. LOWNEY & ASSOCIATES

Project Number: 718-9 Project Name: 2 Hayward Parcels

Date: 7/11/90

Field Geologist/Engineer: PMLe / SF

Well Number: AF-1 Well T.D. (completed): 25.72 (feet)

Well Location:

Perforated Interval: ______ to ______ (feet)

Casing Diameter: ______ (inches) Well Diameter: 2 (inches)

Ground Elevation: ______ (feet)

Static Water Level Prior to Developing Well (depth to water): 13.89

Static Water Level After Recovery (depth to water): 14.44

Height of Datum Above (Below) Ground: ______ (feet)

Water Level Measured From:
☒ Top of Casing
☐ Top of Box

Water Elevation: ______ (feet MSL) Well Volume: 7 (liters)

Three Well Volumes: 21 (liters) Production Time: 20 (minutes)

Total Volume Produced: 24 (liters) Number of Well Volumes: 4

Production Rate: ______ (liters per minute) Drawdown Rate: ______ (feet)

Development Method:

Sampling Method:

Sample Description:

Depth Where Sample Collected:

Where/When Sample Delivered:

Comments:
Well Development-
pumped out ≈30 gallons
went dry after 15-20
gallons & slowly recharged

No. of Well Volumes	pH	Conductivity µmhos/cm³ X10	Temp °C	DOx (ppm)
1	5.95	6130	20.4	2.04
2	5.90	6250	19.2	1.92
3	5.96	0270/6210	19.0	1.32
4	6.17	6300	18.5	1.84
5				
6				
7				
8				
9				
10				

RECORD OF WELL DEVLOPMENT/SAMPLING
J.V. LOWNEY & ASSOCIATES

Project Number: 718-9 Project Name: 2 HAYWARD PARCELS
Date: 7/11/90
Field Geologist/Engineer: PMLe / SF
Well Number: AF-2 Well T.D. (completed): 22.8 (feet)
Well Location:
Perforated Interval: ______ to ______ (feet)
Casing Diameter: ______ (inches) Well Diameter: ______ (inches)
Ground Elevation: ______ (feet)
Static Water Level Prior to Developing Well (depth to water): 9.07
Static Water Level After Recovery (depth to water): 10.97
Height of Datum Above (Below) Ground: ______ (feet)

Water Level Measured From:
☐ Top of Casing
☐ Top of Box

Water Elevation: ______ (feet MSL) Well Volume: 9 (liters)
Three Well Volumes: 27 (liters) Production Time: 20 (minutes)
Total Volume Produced: 27 (liters) Number of Well Volumes: 3
Production Rate: ______ (liters per minute) Drawdown Rate: ______ (feet)

Development Method:
Sampling Method:
Sample Description:
Depth Where Sample Collected:
Where/When Sample Delivered:

Comments:
Well Development-
Pumped out ≈ 30-35
gallons total. Went dry
after 5 gallons + slowly
recharged

80% AT 11.8ft

No. of Well Volumes	pH	Conductivity µmhos/cm³ X10	Temp °C	DOx (ppm)
1	6.61	3670	23.6	3.22
2	6.56	3510	21.5	2.19
3	6.57	3510	21.1	2.11
4				
5				
6				
7				
8				
9				
10				

RECORD OF WELL DEVLOPMENT/SAMPLING
J.V. LOWNEY & ASSOCIATES

Project Number: 718-9 Project Name: 2 Hayward Parcels

Date: 7/11/90

Field Geologist/Engineer: PMLe / SF

Well Number: AF-3 Well T.D. (completed): 24.59 (feet)

Well Location:

Perforated Interval: ______ to ______ (feet)

Casing Diameter: 2 (inches) Well Diameter: 2 (inches)

Ground Elevation: ______ (feet)

Static Water Level Prior to Developing Well (depth to water): 8.21

Static Water Level After Recovery (depth to water): 8.55

Height of Datum Above (Below) Ground: ______ (feet)

Water Level Measured From:
☒ Top of Casing
☐ Top of Box

Water Elevation: ______ (feet MSL) Well Volume: 10 (liters)

Three Well Volumes: 30 (liters) Production Time: 20 (minutes)

Total Volume Produced: 30 (liters) Number of Well Volumes: ______

Production Rate: ______ (liters per minute) Drawdown Rate: ______ (feet)

Development Method:

Sampling Method:

Sample Description:

Depth Where Sample Collected:

Where/When Sample Delivered:

Comments: Well Development - pumped out ≈ 30 gallons total. Recharges quickly

No. of Well Volumes	pH	Conductivity µmhos/cm³	Temp °C	DOx (ppm)
1	6.41	4000	19.8	1.31
2	6.42	5180	18.5	3.01
3	6.68	4480	18.1	10.70
4				
5				
6				
7				
8				
9				
10				

RECORD OF WELL DEVLOPMENT/SAMPLING
J.V. LOWNEY & ASSOCIATES

Project Number: 718-9 Project Name: 2 Hayward Parcels

Date: 7/11/90

Field Geologist/Engineer: PMLe / SF

Well Number: AF-4 Well T.D. (completed): 25.65 (feet)

Well Location:

Perforated Interval: ______ to ______ (feet)

Casing Diameter: 2 (inches) Well Diameter: 2 (inches)

Ground Elevation: ______ (feet)

Static Water Level Prior to Developing Well (depth to water): 8.98

Static Water Level After Recovery (depth to water): 9.50

Height of Datum Above (Below) Ground: ______ (feet)

Water Level Measured From:
☒ Top of Casing
☐ Top of Box

Water Elevation: ______ (feet MSL) Well Volume: 10 (liters)

Three Well Volumes: 30 (liters) Production Time: 20 (minutes)

Total Volume Produced: 30 (liters) Number of Well Volumes: 3

Production Rate: ______ (liters per minute) Drawdown Rate: ______ (feet)

Development Method:

Sampling Method:

Sample Description:

Depth Where Sample Collected:

Where/When Sample Delivered:

π(200)(.016)
≈ 10.05

Comments:
Well Development -
pumped out 35 gallons
total. Recharges quickly.

No. of Well Volumes	pH	Conductivity µmhos/cm³	Temp °C	DOx (ppm)
1	6.40	3880	20.7	5.52
2	6.37	4160	19.9	5.19
3	6.44	4240	19.4	4.44
4				
5				
6				
7				
8				
9				
10				

RECORD OF WELL DEVLOPMENT/SAMPLING
J.V. LOWNEY & ASSOCIATES

Project Number: P3723 Project Name: Two Hayward
Date: 9/7/90
Field Geologist/Engineer: PMLe/SF
Well Number: AF-1 Well T.D. (completed): 25.75 (feet)
Well Location:
Perforated Interval: ______ to ______ (feet)
Casing Diameter: 2 (inches) Well Diameter: 8 (inches)
Ground Elevation: ______ (feet)
Static Water Level Prior to Developing Well (depth to water): 14.27
Static Water Level After Recovery (depth to water): 15.60

Water Level Measured From:
☒ Top of Casing
☐ Top of Box

Height of Datum Above (Below) Ground: ______ (feet)
Water Elevation: ______ (feet MSL) Well Volume: 7 (liters)
Three Well Volumes: 21 (liters) Production Time: 15 (minutes)
Total Volume Produced: 21 (liters) Number of Well Volumes: 3
Production Rate: ______ (liters per minute) Drawdown Rate: ______ (feet)

Development Method:
Sampling Method:
Sample Description:
Depth Where Sample Collected:
Where/When Sample Delivered:

$\pi(137.8)(.016)$
≈ 6.9

Comments:

(x10)

No. of Well Volumes	pH	Conductivity µmhos/cm³	Temp °C	DOx (ppm)
1	5.95	5630	21.4	11.35
2	6.08	5750	20.9	10.69
3	6.20	5840	18.9	14.59
4				
5				
6				
7				
8				
9				
10				

RECORD OF WELL DEVLOPMENT/SAMPLING
J.V. LOWNEY & ASSOCIATES

Project Number: P3723 Project Name: Two Hayward

Date: 9/7/90

Field Geologist/Engineer: PMLe /SF

Well Number: AF-2 Well T.D. (completed): 22.80 (feet)

Well Location: ____

Perforated Interval: ____ to ____ (feet)

Casing Diameter: 2 (inches) Well Diameter: 8 (inches)

Ground Elevation: ____ (feet)

Static Water Level Prior to Developing Well (depth to water): 9.55

Static Water Level After Recovery (depth to water): 11.2

Height of Datum Above (Below) Ground: ____ (feet)

Water Level Measured From:
☒ Top of Casing
☐ Top of Box

Water Elevation: ____ (feet MSL) Well Volume: 8 (liters)

Three Well Volumes: 24 (liters) Production Time: 15 (minutes)

Total Volume Produced: 24 (liters) Number of Well Volumes: 3

Production Rate: ____ (liters per minute) Drawdown Rate: ____ (feet)

Development Method: ____

Sampling Method: ____

Sample Description: ____

Depth Where Sample Collected: ____

Where/When Sample Delivered: ____

$\pi(159)(.016)$

≈ 8

Comments: ____

X10

No. of Well Volumes	pH	Conductivity µmhos/cm³	Temp °C	DOx (ppm)
1	6.45	3520	23.5	2.79
2	6.50	3260	22.8	2.35
3	6.47	3680	22.7	2.37
4				
5				
6				
7				
8				
9				
10				

RECORD OF WELL DEVLOPMENT/SAMPLING
J.V. LOWNEY & ASSOCIATES

Project Number: P3723 Project Name: Two Hayward

Date: 9/7/90

Field Geologist/Engineer: PMLe/SF

Well Number: AF-3 Well T.D. (completed): 24.55 (feet)

Well Location:

Perforated Interval: to (feet)

Casing Diameter: 2 (inches) Well Diameter: 8 (inches)

Ground Elevation: (feet)

Static Water Level Prior to Developing Well (depth to water): 8.52

Static Water Level After Recovery (depth to water): 8.82

Water Level Measured From:
☒ Top of Casing
☐ Top of Box

Height of Datum Above (Below) Ground: (feet)

Water Elevation: (feet MSL) Well Volume: 10 (liters)

Three Well Volumes: 30 (liters) Production Time: 15 (minutes)

Total Volume Produced: 30 (liters) Number of Well Volumes: 3

Production Rate: (liters per minute) Drawdown Rate: (feet)

Development Method:

Sampling Method:

Sample Description:

Depth Where Sample Collected:

Where/When Sample Delivered:

π (192.4)(.016)
= 9.7

Comments:

(x 10)

No. of Well Volumes	pH	Conductivity µmhos/cm³	Temp °C	DOx (ppm)
1	6.90	3860	19.0	13.54
2	6.81	4850	17.3	15.49
3	6.85	4950	17.6	10.08
4				
5				
6				
7				
8				
9				
10				

RECORD OF WELL DEVLOPMENT/SAMPLING
J.V. LOWNEY & ASSOCIATES

Project Number: P3723 Project Name: 2 - HAYWARD

Date: 9/7/90

Field Geologist/Engineer: PmLe/ SF

Well Number: AF-4 Well T.D. (completed): 24.9 (feet)

Well Location: ______

Perforated Interval: ______ to ______ (feet)

Casing Diameter: ______ (inches) Well Diameter: 2 (inches)

Ground Elevation: ______ (feet)

Static Water Level Prior to Developing Well (depth to water): 9.22

Static Water Level After Recovery (depth to water): 9.75

Height of Datum Above (Below) Ground: ______ (feet)

Water Level Measured From:
☒ Top of Casing
☐ Top of Box

Water Elevation: ______ (feet MSL) Well Volume: 10 (liters)

Three Well Volumes: 30 (liters) Production Time: ______ (minutes)

Total Volume Produced: 30 (liters) Number of Well Volumes: 3

Production Rate: ______ (liters per minute) Drawdown Rate: ______ (feet)

Development Method: ______

Sampling Method: ______

Sample Description: ______

Depth Where Sample Collected: ______

Where/When Sample Delivered: ______

Comments: ______

No. of Well Volumes	pH	Conductivity µmhos/cm³	Temp °C	DOx (ppm)
1	6.84	4140	19.7	2.05
2	6.91	4470	18.5	2.37
3	6.90	4490	18.5	2.30
4				
5				
6				
7				
8				
9				
10				

RECORD OF WELL DEVLOPMENT/SAMPLING
J.V. LOWNEY & ASSOCIATES

Project Number: 718-9A Project Name: 2 - HAYWARD

Date: 10-4-90

Field Geologist/Engineer: SF

Well Number: AF-1 Well T.D. (completed): 25.5 (feet)

Well Location: ______

Perforated Interval: ______ to ______ (feet)

Casing Diameter: ______ (inches) Well Diameter: ______ (inches)

Ground Elevation: ______ (feet)

Static Water Level Prior to Developing Well (depth to water): 14.34

Static Water Level After Recovery (depth to water): 19.80

Height of Datum Above (Below) Ground: ______ (feet)

Water Level Measured From:
☒ Top of Casing
☐ Top of Box

Water Elevation: ______ (feet MSL) Well Volume: 7 (liters)

Three Well Volumes: 21 (liters) Production Time: ______ (minutes)

Total Volume Produced: 21 (liters) Number of Well Volumes: ______

Production Rate: ______ (liters per minute) Drawdown Rate: ______ (feet)

Development Method: ______

Sampling Method: ______

Sample Description: ______

Depth Where Sample Collected: ______

Where/When Sample Delivered: ______

Comments: 11:00

No. of Well Volumes	pH	Conductivity µmhos/cm³	Temp °C	DOx (ppm)
1	6.73	6610		5.43
2	6.67	5540		5.46
3	6.68	6570		5.49
4				
5				
6				
7				
8				
9				
10				

RECORD OF WELL DEVLOPMENT/SAMPLING
J.V. LOWNEY & ASSOCIATES

Project Number: 718-9A Project Name: 2-HAYWARD
Date: 10-4-90
Field Geologist/Engineer: SF
Well Number: AF-2 Well T.D. (completed): 22.78 (feet)
Well Location:
Perforated Interval: ______ to ______ (feet)
Casing Diameter: ______ (inches) Well Diameter: ______ (inches)
Ground Elevation: ______ (feet)
Static Water Level Prior to Developing Well (depth to water): 9.78
Static Water Level After Recovery (depth to water): 11.2
Height of Datum Above (Below) Ground: ______ (feet)

Water Level Measured From:
☒ Top of Casing
☐ Top of Box

Water Elevation: ______ (feet MSL) Well Volume: 8 (liters)
Three Well Volumes: 24 (liters) Production Time: ______ (minutes)
Total Volume Produced: 24 (liters) Number of Well Volumes: ______
Production Rate: ______ (liters per minute) Drawdown Rate: ______ (feet)

Development Method:
Sampling Method:
Sample Description:
Depth Where Sample Collected:
Where/When Sample Delivered:

Comments: 17:00

No. of Well Volumes	pH	Conductivity µmhos/cm³ (x10)	Temp °C	DOx (ppm)
1	7.11	3830		5.47
2	7.08	3570		5.53
3	7.05	3610		5.53
4				
5				
6				
7				
8				
9				
10				

RECORD OF WELL DEVLOPMENT/SAMPLING
J.V. LOWNEY & ASSOCIATES

Project Number: 718 - 9A Project Name: 2-HAYWARD

Date: 10-9-90

Field Geologist/Engineer: SF

Well Number: AF-3 Well T.D. (completed): 24.55 (feet)

Well Location:

Perforated Interval: to (feet)

Casing Diameter: (inches) Well Diameter: (inches)

Ground Elevation: (feet)

Static Water Level Prior to Developing Well (depth to water): 8.57

Static Water Level After Recovery (depth to water): 8.81

Height of Datum Above (Below) Ground: (feet)

Water Level Measured From:
☒ Top of Casing
☐ Top of Box

Water Elevation: (feet MSL) Well Volume: 10 (liters)

Three Well Volumes: 30 (liters) Production Time: (minutes)

Total Volume Produced: 30 (liters) Number of Well Volumes:

Production Rate: (liters per minute) Drawdown Rate: (feet)

Development Method:

Sampling Method:

Sample Description:

Depth Where Sample Collected:

Where/When Sample Delivered:

Comments: 9:30

X10

No. of Well Volumes	pH	Conductivity μmhos/cm^3	Temp °C	DOx (ppm)
1	7.18	4170		5.29
2	7.04	4790		5.30
3	7.03	4910		5.31
4				
5				
6				
7				
8				
9				
10				

RECORD OF WELL DEVLOPMENT/SAMPLING
J.V. LOWNEY & ASSOCIATES

Project Number: 718-9A Project Name: 2-Hayward
Date: 10-4-90
Field Geologist/Engineer: SF
Well Number: AF-4 Well T.D. (completed): 24.78 (feet)
Well Location:
Perforated Interval: ______ to ______ (feet)
Casing Diameter: ______ (inches) Well Diameter: ______ (inches)
Ground Elevation: ______ (feet)
Static Water Level Prior to Developing Well (depth to water): 9.31
Static Water Level After Recovery (depth to water): 9.70
Height of Datum Above (Below) Ground: ______ (feet)

Water Level Measured From:
☒ Top of Casing
☐ Top of Box

Water Elevation: ______ (feet MSL) Well Volume: 10 (liters)
Three Well Volumes: 30 (liters) Production Time: ______ (minutes)
Total Volume Produced: 30 (liters) Number of Well Volumes: ______
Production Rate: ______ (liters per minute) Drawdown Rate: ______ (feet)

Development Method:
Sampling Method:
Sample Description:
Depth Where Sample Collected:
Where/When Sample Delivered:

Comments: 1:15

No. of Well Volumes	pH	Conductivity µmhos/cm^3 X10	Temp °C	DOx (ppm)
1	6.40	3650		5.27
2	6.42	3910		5.60
3	6.50	4000		5.59
4				
5				
6				
7				
8				
9				
10				

LOVNEY ASSOCIATES RECORD OF WELL DEVELOPMENT/SAMPLING

Project Number 718-9D

Date 12-6-91

Project Name TWO HAYWARD

Field Geologist/Engineer SF

Well Number AF-1

Perforated Interval ______ (feet)

Well Total Depth (completed) 25.7 (feet)

Casing Diameter 2 (inches)

Ground Elevation ______ (feet)

Boring Diameter 8 (inches)

Well Location ______

Static Water Level Prior to Developing Well (depth to water) ≃14.04

Static Water Level After Recovery (depth to water) 14.33

Water Level Measured From Top of Casing ☐ Top of Box ☐

Height of Datum Above (Below) Ground ______ (feet)

Water Elevation ______ (feet MSL)

Three Well Volumes ______ (liter/gal)

Well Volume 7 ([✓ liter]/gal)

Total Volume Produced ______ (liter/gal)

Number of Well Volumes ______

Production Rate ______ (__ /min)

Production Time ______ (min)

Drawdown Rate ______ (feet)

Development Method/Volume ______

Sampling Method ______

Sample Description ______

Sample Deliver ☐ Pick-Up ☐ When ______

Where ______

Comments

Well Volumes	pH	Conductivity µSx10	Temp °F
1	7.09	6870	61
2	7.07	6860	62
3	7.07	6870	62
4			
5			
6			
7			
8			
9			
10			

LOVNEY ASSOCIATES RECORD OF WELL DEVELOPMENT/SAMPLING

Project Number 718-9D   Date 12-6-91

Project Name Two Hayward

Field Geologist/Engineer SF

Well Number AF-2   Perforated Interval ______ (feet)

Well Total Depth (completed) 22.8 (feet)   Casing Diameter 2 (inches)

Ground Elevation ______ (feet)   Boring Diameter 8 (inches)

Well Location ______

Static Water Level Prior to Developing Well (depth to water) 9.30   Static Water Level After Recovery (depth to water) 9.51

Water Level Measured From   Top of Casing ☒   Top of Box ☐

Height of Datum Above (Below) Ground ______ (feet)   Water Elevation ______ (feet MSL)

Three Well Volumes ______ (liter/gal)   Well Volume 9 ([✓ liter]/gal)

Total Volume Produced ______ (liter/gal)   Number of Well Volumes ______

Production Rate ______ (__ /min)   Production Time ______ (min)

Drawdown Rate ______ (feet)

Development Method/Volume ______

Sampling Method ______

Sample Description ______

Sample   Deliver ☐   Pick-Up ☐   When ______

Where ______

Comments

Well Volumes	pH	Conductivity µSx10	Temp °F
1	7.40	3910	62
2	7.39	3840	62
3	7.35	3850	62
4			
5			
6			
7			
8			
9			
10			

LOVNEYASSOCIATES RECORD OF WELL DEVELOPMENT/SAMPLING

Project Number 718-9D Date 12-6-91

Project Name TWO HAYWARD

Field Geologist/Engineer SF

Well Number AF-3 Perforated Interval ______ (feet)

Well Total Depth (completed) 24.5 (feet) Casing Diameter 2 (inches)

Ground Elevation ______ (feet) Boring Diameter 8 (inches)

Well Location ______

Static Water Level Prior to Developing Well (depth to water) ≃ 8.49 Static Water Level After Recovery (depth to water) 8.71

Water Level Measured From Top of Casing ☒ Top of Box ☐

Height of Datum Above (Below) Ground ______ (feet) Water Elevation ______ (feet MSL)

Three Well Volumes ______ (liter/gal) Well Volume 10 ([✓ liter]/gal)

Total Volume Produced ______ (liter/gal) Number of Well Volumes ______

Production Rate ______ (__ /min) Production Time ______ (min)

Drawdown Rate ______ (feet)

Development Method/Volume ______

Sampling Method ______

Sample Description ______

Sample Deliver ☐ Pick-Up ☐ When ______

Where ______

Comments

Well Volumes	pH	Conductivity µSx10	Temp °F
1	7.12	4860	62
2	7.08	4890	62
3	7.06	4880	62
4			
5			
6			
7			
8			
9			
10			

LOWNEY ASSOCIATES

RECORD OF WELL DEVELOPMENT/SAMPLING

Project Number 718-9D
Date 12-6-91
Project Name TWO HAYWARD
Field Geologist/Engineer SF

Well Number AF-4
Perforated Interval ______ (feet)
Well Total Depth (completed) 24.9 (feet)
Casing Diameter 2 (inches)
Ground Elevation ______ (feet)
Boring Diameter 8 (inches)
Well Location ______
Static Water Level Prior to Developing Well (depth to water) = 9.15
Static Water Level After Recovery (depth to water) 9.98

Water Level Measured From Top of Casing ☒ Top of Box ☐

Height of Datum Above (Below) Ground ______ (feet)
Water Elevation ______ (feet MSL)
Three Well Volumes ______ (liter/gal)
Well Volume 10 ([✓ liter]/gal)
Total Volume Produced ______ (liter/gal)
Number of Well Volumes ______
Production Rate ______ (__ /min)
Production Time ______ (min)
Drawdown Rate ______ (feet)

Development Method/Volume ______
Sampling Method ______
Sample Description ______
Sample Deliver ☐ Pick-Up ☐ When ______
Where ______

Comments

Well Volumes	pH	Conductivity µSx10	Temp °F
1	6.85	4210	62
2	6.84	4220	61
3	6.87	4220	61
4			
5			
6			
7			
8			
9			
10			

ENVIRONMENTAL QUESTIONNAIRE FOR OWNERS

Project Name: TWO HAYWARD PARCELS, INTERSECTION OF HESPERIAN BLVD. AND ALAMEDA FLOOD CONTROL CHANNEL, HAYWARD,CA

Project Numbers: 718-9A

J. V. LOWNEY ASSOC.
NOV 7 1990
RECEIVED

Please return to:

J. V. LOWNEY & ASSOCIATES
145 Addison Avenue
Palo Alto, California 94301
415-328-6920

Attention: Peter M. Leffler

Please fill in and attach your business card if possible.

Name: AM HOMES INC

Address: 577 SALMAR AVE
CAMPBELL, CA 95008
ATTN: TOM QUAGLIA

Business Phone Number: 408-370-1166

Best time to contact you: M-F 8:30AM - 5:30PM

The project site (32 acres) is owned by Filare Partners, a joint venture corporation consisting of Charles Davidson, Ken Earp (OAKWOOD PROP) and AM Homes.

Please use additional sheets if space provided is not adequate.

1. Which site(s) do you own?

32 acre ~~vac~~. former movie theater site

2. How long have you owned this site(s)?

1988

3. Describe present and past usage of the property to the best of your knowledge. Is there any history of past site usage involving the use, storage or disposal of hazardous materials onsite? If "YES," please describe.

Past usage is as a movie theater drive-in site. Prior to drive-in the site ~~would~~ was cultivated for various agricultural crops. Since purchase the site has sat vacant.

4. Describe present and past usage of properties adjacent to or in close proximity of your property.

Southern boundary is Alameda County flood channel. Northern boundary is the Tripaldi Industrial Park. Across Hesperian to west is ag land.

5. Do your current or past tenant(s) have a hazardous material management plan? If the answer is "NO," you can skip questions 6 and 7. If "YES," please attach a copy of it..

No current tenants. We have ~~[illegible]~~ no knowledge of such a plan for previous tenants.

6. Has your current tenant(s)' or past tenant(s)' hazardous material management plan been provided to any government agencies? If "YES," please provide name(s) and address(es).

—

7. What is the name, address and phone number of the person(s) who can provide a copy of the hazardous material management plan?

—

8. What types and quantities of chemicals are being used, or have been used on your property?

Chemical Type (name)	Quantity
None by AM Homes / Fibre Partners since purchase in 1988	

9. What types and quantities of wastes are being or have been generated on your property? Are these wastes corrosive? Must the wastes be treated or disposed of quickly? Does reactivity increase over time?

Waste Type (name)	Waste Characteristics	Quantity
NA		

10. How are these wastes currently managed on your property?

NA

11. How were and/or are these wastes disposed? Onsite or offsite? If onsite: exactly where; does your tenant have a permit for onsite disposal; and what type of permit? If offsite: how are they collected; transported; and how often? Please provide name and address of disposal facility, as well as name and quantity of disposed wastes.

NA

12. Does your present or past tenant(s) store any wastes generated before disposal? Please thoroughly describe any storage method practiced on your property and the likelihood of spillage or leakage. Does the particular type of storage system(s) chosen adequately protect against the particular hazard of the waste (corrosivity, reactivity, ignitability)? How often is your tenant(s)' storage system(s) checked? What is the capacity of your tenant(s)' storage system(s)?

NA

13. Have any hazardous materials been spilled on your property? If "YES," describe any spill incident(s) that occurred on or adjacent to your property. Please provide date(s) of occurrence(s), types (name), and quantities of chemical(s) spilled, whether the spill was reported to any government agency, when it was reported, and whether any remedial action was taken or was necessary.

NA

14. How are health and the environment protected while wastes are stored at your property?

NA

15. Are any of the following located within the site's boundaries? Please describe.

    a) Auto Service Center (with or without gas pump):

    b) Loading/Unloading Areas:

    c) Floor Drains:

    d) Tands (above or below ground):

    e) Boilers:

    VACANT SITE

    f) Emergency Generators:

    g) Air/Water Pollution Control Equipment:

    h) Manufacturing/Processing Equipment:

    i) Transformer/Heat Transfer Equipment:

16. Have any ground water monitoring wells been installed on or near the site? If "YES," where, and by whom?

    YES: by Harding Lawson and Associates in 1989 and JV Lowney and Associates in 1990

17. Do you have any knowledge of spraying or dust control operations performed during operation of the drive-in theater? If "YES" please give details.

    NO: Just hear-say.

```
PROJECT NUMBER 718-9E
01-20-1992      14:59:10
STATISTICAL ANALYSIS FOR 32-ACRE HAYWARD PARCEL

TOTAL (TTLC) COPPER CONCENTRATIONS

The data distribution is negative binomial.
An arcsin transformation was performed

SAMPLE CONCENTRATION      TRANSFORMED CONCENTRATION
-------------------------------------------------------------
      31.2  ppm                .0031200202476111
      43.9  ppm                .0043900564033387
      30.1  ppm                .0030100181806501
      49.1  ppm                .0049100789144181
      46.5  ppm                .0046500670301849
      49.1  ppm                .0049100789144181
      30.9  ppm                .0030900196691423
      40.6  ppm                .0040600446158313
      40.8  ppm                .0040800452784341
      33.6  ppm                .0033600252887897
      23.1  ppm                .0023100082176072
      29.1  ppm                .0029100164281558


DATA ANALYSIS SUMMARY
-------------------------
UNTRANSFORMED DATA
   Mean= 37.333333333333 ppm
    Variance= 76.580606060636 ppm
TRANSFORMED DATA
   Mean= 37.333645930479 ppm
    Variance= .0076584998472355 ppm
    Standard Deviation= 8.7512844155302 ppm
    Standard Error of the Mean= 2.5262785021174 ppm
    Regulatory Threshold= 2500 ppm
   Student's T Value= 1.796
    Concentration at  95  percent upper confidence interval= 41.870806550234 ppm
    Minimum number of samples needed= 3.9860522819213D-05
```

```
PROJECT NUMBER 718-9E
01-20-1992      15:00:48
STATISTICAL ANALYSIS FOR 32-ACRE HAYWARD PARCEL

TOTAL (TTLC) LEAD CONCENTRATIONS

The data distribution is negative binomial.
An arcsin transformation was performed

SAMPLE CONCENTRATION      TRANSFORMED CONCENTRATION
-----------------------------------------------------
        31  ppm                 .0031000198607239
        41.8  ppm               .0041800486900099
        30.9  ppm               .0030900196691423
        41.3  ppm               .0041300469635716
        44.5  ppm               .0044500587477657
        44.4  ppm               .0044400583526011
        31.4  ppm               .0031400206394903
        44.1  ppm               .0044100571777476
        43.7  ppm               .0043700556359541
        34.8  ppm               .0034800280962301
        29.4  ppm               .0029400169415
        30.8  ppm               .0030800194787968


DATA ANALYSIS SUMMARY
-----------------------
UNTRANSFORMED DATA
   Mean= 37.341666666667 ppm
   Variance= 41.095378787909 ppm
TRANSFORMED DATA
   Mean= 37.341955093351 ppm
   Variance= .0041097682268 ppm
   Standard Deviation= 6.410746964117 ppm
   Standard Error of the Mean= 1.850623358917 ppm
   Regulatory Threshold= 1000 ppm
   Student's T Value= 1.796
   Concentration at  95  percent upper confidence interval= 40.665649367726 ppm
   Minimum number of samples needed= 1.4255310625842D-04
```

```
PROJECT NUMBER 718-9E
01-20-1992      15:02:06
STATISTICAL ANALYSIS FOR 32-ACRE HAYWARD PARCEL

TOTAL (TTLC) MERCURY CONCENTRATIONS

The data distribution is negative binomial.
An arcsin transformation was performed

SAMPLE CONCENTRATION      TRANSFORMED CONCENTRATION
----------------------------------------------------
      11.1  ppm                 .0011100009117544
      17.7  ppm                 .0017700036968255
      19.2  ppm                 .0019200047185972
      20.3  ppm                 .0020300055769583
      14.1  ppm                 .0014100018688151
      18.2  ppm                 .0018200040190494
      10.3  ppm                 .0010300007284849
      12.9  ppm                 .0012900014311267
      14.1  ppm                 .0014100018688151
      12.4  ppm                 .0012400012710832
      8.63  ppm                 8.6300042849053D-04
      10.8  ppm                 .0010800008398083


DATA ANALYSIS SUMMARY
----------------------
UNTRANSFORMED DATA
   Mean= 14.144166666667 ppm
    Variance= 14.797953787882 ppm
TRANSFORMED DATA
   Mean= 14.144184750409 ppm
    Variance= .0014798086012473 ppm
    Standard Deviation= 3.8468279507314 ppm
   Standard Error of the Mean= 1.1104836015466 ppm
   Regulatory Threshold= 20 ppm
   Student's T Value= 1.796
    Concentration at  95  percent upper confidence interval= 16.138611013347 ppm
   Minimum number of samples needed= 1.392009506174
```

```
PROJECT NUMBER 718-9E
01-16-1992       16:06:04
STATISTICAL ANALYSIS FOR 32-ACRE HAYWARD PARCEL

TOTAL SELENIUM (TTLC) CONCENTRATIONS

The data distribution is Poisson.
A square root transformation was performed.

SAMPLE CONCENTRATION       TRANSFORMED CONCENTRATION
--------------------------------------------------------------
        25.0 ppm                  5.0
         39.8 ppm                   6.308724118235
         37.3 ppm                   6.107372593841
         37.8 ppm                   6.148170459576
         34.4 ppm                   5.865151319446
         41.6 ppm                   6.449806198639
        25.0 ppm                  5.0
         34.4 ppm                   5.865151319446
         34.7 ppm                   5.8906705900095
         32.1 ppm                   5.665686189686
         28.8 ppm                   5.3665631459995
         26.7 ppm                   5.1672042731055


DATA ANALYSIS SUMMARY
------------------------
UNTRANSFORMED DATA
    Mean= 33.133333333333 ppm
     Variance= 32.224242424273 ppm
TRANSFORMED DATA
    Mean= 32.904086242243 ppm
     Variance= .062543875564379 ppm
     Standard Deviation= .25008773573366 ppm
     Standard Error of the Mean= .020840644644473 ppm
     Regulatory Threshold= 100 ppm
    Student's T Value= 1.796
  Concentration at 95 percent upper confidence  interval=
    35.945829653996 ppm
     Minimum number of samples needed= .044372419460608
```

```
PROJECT NUMBER 718-9E
01-20-1992       15:04:56
STATISTICAL ANALYSIS FOR 32-ACRE HAYWARD PARCEL

TOTAL (TTLC) ZINC CONCENTRATIONS

The data distribution is negative binomial.
An arcsin transformation was performed

SAMPLE CONCENTRATION       TRANSFORMED CONCENTRATION
------------------------------------------------------------
      60.8  ppm                   .0060801498388029
      73.8  ppm                   .0073802679692262
      57  ppm                     .0057001234632034
      84.3  ppm                   .0084303993932523
      89.8  ppm                   .0089804827788731
      77.2  ppm                   .0077203067385826
      55.2  ppm                   .005520112132097
      73.9  ppm                   .0073902690600206
      94.8  ppm                   .0094805679962404
      63.1  ppm                   .0063101674950613
      51.8  ppm                   .0051800926619672
      52.3  ppm                   .0052300953712273


DATA ANALYSIS SUMMARY
------------------------
UNTRANSFORMED DATA
  Mean= 69.5 ppm
   Variance= 223.17090909091  ppm
TRANSFORMED DATA
   Mean= 69.501969518439 ppm
    Variance= .022321814239609 ppm
    Standard Deviation= 14.940481127076 ppm
    Standard Error of the Mean= 4.3129468711044 ppm
    Regulatory Threshold= 5000 ppm
    Student's T Value= 1.796
    Concentration at  95  percent upper confidence interval= 77.24781362371 ppm
    Minimum number of samples needed= 2.6974398583548D-05
```

```
PROJECT NUMBER 718-9E
01-16-1992      16:53:14
STATISTICAL ANALYSIS FOR 32-ACRE HAYWARD PARCEL

SOLUBLE (STLC) COPPER CONCENTRATIONS

SAMPLE CONCENTRATION
---------------------
        .33 ppm
        .38 ppm
        .26 ppm
        .32 ppm
        .52 ppm
        .31 ppm
        .37 ppm
        .36 ppm
        .59 ppm
        .29 ppm
        .3 ppm
        .58 ppm

DATA ANALYSIS SUMMARY
-----------------------
Mean= .38416666666667 ppm
Variance= .013081060606064 ppm
Standard Deviation= .11437246436998 ppm
Standard Error of the Mean= .033016486545945 ppm
Regulatory Threshold= 25 ppm
Student's T Value= 1.796
Concentration at 95 percent upper confidence interval= .44346427650319 ppm
Minimum number of samples needed= 6.9634832765044D-05
```

```
PROJECT NUMBER 718-9E
01-16-1992      16:40:11
STATISTICAL ANALYSIS FOR 32-ACRE HAYWARD PARCEL

SOLUBLE LEAD (STLC) CONCENTRATIONS

SAMPLE CONCENTRATION
---------------------
        .043 ppm
        .043 ppm
        .043 ppm
        .043 ppm
        .21 ppm
        .043 ppm
        .043 ppm
        .043 ppm
        .043 ppm
        .043 ppm
        .043 ppm
        .24 ppm

DATA ANALYSIS SUMMARY
-----------------------
Mean= .0733333333333333  ppm
Variance= .005059696969697  ppm
Standard Deviation= .071131546937325  ppm
Standard Error of the Mean= .02053390888607 ppm
Regulatory Threshold= 5 ppm
Student's T Value= 1.796
Concentration at  95  percent upper confidence interval= .11021223369272 ppm
Minimum number of samples needed= 6.7240481278623D-04
```

```
PROJECT NUMBER 718-9E
01-16-1992      16:34:07
STATISTICAL ANALYSIS FOR 32-ACRE HAYWARD PARCEL

SOLUBLE MERCURY (STLC) CONCENTRATIONS

SAMPLE CONCENTRATION
----------------------
     .19 ppm
     .25 ppm
     .26 ppm
     .15 ppm
     .11 ppm
     .13 ppm
     .16 ppm
     .17 ppm
     .13 ppm
     .15 ppm
     .11 ppm
     .22 ppm

DATA ANALYSIS SUMMARY
------------------------
Mean= .16916666666667 ppm
Variance= .0026083333333336 ppm
Standard Deviation= .05107184482015 ppm
Standard Error of the Mean= .014743171677462 ppm
Regulatory Threshold= .2 ppm
Student's T Value= 1.796
Concentration at  95  percent upper confidence interval= .19564540299939 ppm
Minimum number of samples needed= 8.8498273893378
```

```
PROJECT NUMBER 718-9E
01-16-1992      16:41:50
STATISTICAL ANALYSIS FOR 32-ACRE HAYWARD PARCEL

SOLUBLE SELENIUM (STLC) CONCENTRATIONS

SAMPLE CONCENTRATION
---------------------
       .19 ppm
       .36 ppm
       .3 ppm
       .2 ppm
       .14 ppm
       .14 ppm
       .21 ppm
       .14 ppm
       .21 ppm
       .23 ppm
       .17 ppm
       .47 ppm

DATA ANALYSIS SUMMARY
-----------------------
Mean= .23 ppm
Variance=  .010054545454545  ppm
Standard  Deviation=  .10027235638273  ppm
Standard  Error  of  the  Mean=  .028946135974924  ppm
Regulatory  Threshold=  1  ppm
Student's  T  Value=  1.796
Concentration  at   95   percent  upper  confidence  interval=  .28198726021096  ppm
Minimum  number  of  samples  needed=  .054700797252333
```

```
PROJECT NUMBER 718-9E
01-16-1992       16:43:57
STATISTICAL ANALYSIS FOR 32-ACRE HAYWARD PARCEL

SOLUBLE ZINC (STLC) CONCENTRATIONS

SAMPLE CONCENTRATION
----------------------
      .13 ppm
      .09 ppm
      .09 ppm
      .13 ppm
      .11 ppm
      .003 ppm
      .09 ppm
      .003 ppm
      .45 ppm
      .12 ppm
      .003 ppm
      .79 ppm

DATA ANALYSIS SUMMARY
-----------------------
Mean= .167416666666667 ppm
Variance= .052262446969697 ppm
Standard Deviation= .2286098138088 ppm
Standard Error of the Mean= .065993968770951 ppm
Regulatory Threshold= 250 ppm
Student's T Value= 1.796
Concentration at  95  percent upper confidence interval= .2859418345793 ppm
Minimum number of samples needed= 2.7008735210335D-06
```

DRAFT BASELINE HEALTH RISK ASSESSMENT

Two Hayward Parcels

HAYWARD, CALIFORNIA

Prepared for:

Lowney Associates
Mountain View, CA

Prepared by:

Western Environmental Health Associates, Inc.
Davis, CA

Lee R. Shull

Lee R. Shull, Ph.D., President/Senior Toxicologist

Date prepared: February 5, 1992

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1.0 INTRODUCTION

This report, which has been prepared on behalf of Lowney and Associates, Inc., presents the findings a quantitative health risk assessment (HRA) associated with inorganic substances that have been detected in slag and groundwater at the Hayward property parcels (Lowney, 1992). The referenced site is a 32-acre parcel located on Hesperian Blvd adjacent to Alameda Creek in Hayward, CA. As indicated in Lowney (1992), the site was reportedly used for agricultural purposes until 1959 and left fallow until 1970, when a drive-in movie theatre was contructed on the eastern portion of the site; the movie theatre has since been removed. Site investigation work at the site, which has been conducted in various stages since 1987, has more recently been focused on two environmental media: surficial "slag"located predominantly on the undeveloped western portion of the site, and shallow ground water. Samples of slag and ground water were collected in 1990 and 1991 and analyzed for a wide range of organic and inorganic substances

In order to achieve the overall goal of this HRA, which is to identify and assess any existing or future hypothetical impacts to human health that may exist at the site due to the presence of these inorganic residues in surface slag and ground water, the specific objectives are:

1. To identify potential future human receptors (e.g., onsite workers, residential inhabitants) that to the metals detected in on-site soil and groundwater;

2. To identify potential routes of human exposure to metals detected in on-site soil and groundwater,

3. To estimate the amount (dosage) of chemicals absorbed by the potential human receptors,

4. To characterize the risks to human health resulting from the estimated exposure to the metals detected in soil and groundwater.

2.0 METHODS AND PROCEDURES USED

2.1 Guidance Documents Used

Although this HRA report cannot be characterized as a detailed risk assessment, it generally follows the basic procedures outlined in:

> *Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual (Interim Final), Office of Emergency and Remedial Response, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. 20460.*

According to EPA, this guidance document (referred to herein as EPA, 1989a) is intended "...to provide a framework for developing the risk information necessary to assist decision-making at remedial sites. Specific objectives of the process are to:

- provide an analysis of baseline risks and help determine the need for action at sites;
- provide a basis for determining levels of chemicals that can remain onsite and still be adequately protective of public health;
- provide a basis for comparing potential health impacts of various remedial alternatives; and
- provide a consistent process for evaluating and documenting public health threats at sites." (EPA, 1989a).

Other guidance documents that were consulted during the course of preparing this HRA are:

Superfund Exposure Assessment Manual. December 1988. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 20460.

Exposure Factors Handbook. July 1989. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 20460. EPA/600/8-89/043.

Exposure Factors Handbook Supplement. March 1991. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 20460. EPA/600/8-89/043.

Multi-Pathway Health Risk Assessment Input Parameters Guidance Document. June 1988. South Coast Air Quality Management District. Prepared by Clement Associates, Inc. William J. Dennison.

Risk Assessment Guidelines: Air Toxics "Hots Spots" Program. January 1991. Prepared by: California Air Pollution Control Officers Association (CAPCOA).

2.2 Basic Procedures Used

EPA (1986a, 1989a) suggests the following five steps as a basic framework for a baseline HRA: (1) selection of chemicals of potential concern (i.e., indicator chemicals), (2) estimation of exposure point concentrations of chemicals of potential concern associated with complete or potentially complete exposure pathways, (3) estimation of human intake of chemicals of potential concern for potentially complete exposure pathways, (4) toxicity assessment of chemicals of potential concern, and (5) risk characterization. Each of the five steps is briefly discussed below in the context of this report.

1. Selection of chemicals of potential concern. Chemicals of potential concern are selected from among the inventory of chemicals that have been detected in environmental media (e.g., slag, ground water) at the site. In this HRA, the selection procedure incorporates chemical toxicity information, determinants of environmental fate (e.g., physicochemical properties), and extent of chemical distribution in soil at the site.

2. Estimation of exposure point concentrations of indicator chemicals. This step is comprised of three basic elements:

    a. Identification of potential pathways by which human receptors of potential concern (actual or hypothetical) at the site might be exposed to chemicals of potential concern;

    b. Identification of the location and biological characteristics of maximally-exposed individuals (MEI), either actual or theoretical, for each potentially significant exposure pathway at the site;

    c. Estimation of exposure point concentrations of chemicals of potential concern in environmental transport media (e.g., soil, air) judged as potentially significant for the MEIs at the site.

3. Estimation of human intake. For each exposure pathway that is judged as complete in step 2 (i.e., humans are exposed to one or more environmental media containing a quantifiable concentration of one or more indicator chemicals), the intake of the chemical(s) is calculated and expressed as the amount of the substance taken into the body per unit body weight per unit time. Total intake is called the Chronic Daily Intake (CDI) and is calculated for each chemical of potential concern. The total CDI is the sum of intakes of a substance across all exposure routes (oral, respiratory, dermal) that might be applicable.

CDIs for potentially carcinogenic chemicals and non-carcinogenic chemicals are calculated differently, as follows:

a. Carcinogens. CDI estimates are based on chronic lifetime exposure extrapolated over the estimated average 70-year lifetime (EPA, 1989a). This is done to be consistent with cancer potency factors, which are based on chronic lifetime exposures in either human subjects or test animals. Therefore, the CDI for carcinogens is a Lifetime Average Daily Dose (LADD) over 70 years regardless of the actual exposure duration.

b. Non-carcinogens. CDI estimates are averaged over the estimated exposure period (e.g., 30 years for residential exposure durations, 25 years for worker exposure durations).

4. Toxicity assessment. In order to characterize the risk associated with complete exposure pathways, toxicity information for each of the chemicals of potential concern is evaluated as follows:

a. Hazard identification: For each chemical of potential concern, International (International Agency for Research on Cancer, IARC), Federal (EPA) and State (Cal EPA) assessments and weight-of-evidence classifications are evaluated to determine whether a chemical should be treated as a carcinogen or only as a non-carcinogen.

b. Dose-response assessment: For chemicals that have been established as potentially carcinogenic in humans by appropriate Federal or State agencies, EPA-derived cancer potency factors (CPF, q1*) are used to estimate theoretical carcinogenic risk. For estimating theoretical noncarcinogenic health impacts, EPA-derived reference dosages (RfDs) are employed if available and applicable to this HRA.

5. Risk characterization. Theoretical carcinogenic and noncarcinogenic health impacts are estimated for individual chemicals of potential concern by combining exposure and toxicity information developed in steps 1 through 4.

2.3 Definition of "Significant" and "Insignificant"

These terms will appear periodically in certain sections of this HRA. Whereas the terms "significant" and "insignificant" are generally applied in conjunction with a statistical analysis of data, not every situation can or needs to be quantitatively or statistically evaluated to judge whether it is or is not "significant". Statistical analyses of scientific data are generally conducted when interpretation of the information is not obvious. For example, in decision-making on the potential for adverse health impacts associated with hazardous materials, non-mathematical assessments are regularly used when scientific judgement indicates an either obvious probability or improbability of an adverse impact under a specific set of conditions.

In some sections of this HRA, scientific judgement rather than some statistical analysis is used for drawing conclusions as to questions of "significance." EPA (1989a) provides for this scientific latitude with the statement that "...while the manual provides a logical series of analytical procedures, these procedures are not intended to substitute for a well-reasoned thought process or scientific judgement" (page 5).

3.0 SUMMARY OF CHEMICAL RESIDUES AT THE SITE

Five separate onsite sampling programs have been conducted at the site (Lowney, 1992):

1. July 1990 initial investigation. Fifteen near-surface samples collected and analyzed for TPH as gasoline, oil and grease, and BTEX (benzene, toluene, ethylbenzene, xylene). Five of the exploratory borings (AF-1 to AF-5) were converted to ground water monitoring wells. Wells were terminated at depths ranging from 11.5 feet to 26.5 feet. Ground water samples were collected and analyzed for petroleum hydrocarbons.

2. September, 1990 investigation. The five monitoring wells were sampled and analyzed for total oil and grease, and 13 EPA priority pollutant metals.

3. October 1990 investigation. Fifteen soil borings were advanced to depths of four feet and samples (mixture of soil and slag) were analyzed for total oil and grease. Composite samples were also analyzed for priority pollutant metals. TTLC and STLC lead (Pb) analyses were also conducted on certain samples. One additional (hydropunch) ground water sample was collected at the northeastern portion of the property. The five monitoring wells were sampled and analyzed for petroleum hydrocarbons (total oil and grease, TPH diesel, TPH gasoline, and BTEX).

4. May 1991 investigation. Four samples were collected for the purpose of evaluating the leachability of oil from soil. TTLC and STLC lead (Pb) analyses were also conducted on certain samples.

5. December 1991 investigation. Five samples were collected at depths of 0.5 to 1.0 feet and analyzed for total petroleum oil. Six different types of slag were identified at the site; samples were collected of each type of slag and analyzed for 17 priority metals (plus hexavalent chromium) listed in Title 22 of the California Code of Regulations; both STLC and TTLC concentrations measured. In addition, soil (not slag) samples were collected from twelve backhoe pits (3-5 feet in depth); a composite of four soil samples from each pit was analyzed (both TTLC and STLC) for copper, lead, mercury, selenium, and zinc. The five monitoring wells were sampled and analyzed for petroleum hydrocarbons and 13 EPA priority pollutant metals

These investigations have resulted in the finding of residual concentrations of various organic and inorganic substances in soil, slag and ground water at the site. The findings from these investigations have been summarized in a series of tables in Lowney (1992). A more general summary of residual concentrations of substances in soil, ground water and slag are presented herein in Tables 1, 2 and 3, respectively.

Soil

As shown in Table 1, residues of organic substances (mainly oil and grease) were detected in approximately 50% of the soil samples collected at the range of concentrations shown. Residues of oil and grease are confined predominately to the upper 0.5 feet of soil (Lowney, 1992). Soil samples did not contain TPH gas above the detection limit. Fuel fingerprinting of five soil samples confirmed asphaltic oil in three samples, motor oil in one sample, and an unconfirmed identification in one sample (Lowney , 1992). Lowney (1992) concluded that the majority of the oil detected at the site is due to non-hazardous heavy solid phase hydrocarbons contained in the asphaltic material used in the construction of roads and parking areas for the former drive-in theatre. The STLC extraction analysis showed that the oil is confined within the soil and will not migrate downward to the ground water under neutral pH conditions (Lowney, 1992). Except for one detection of toluene (1.3 ppm), BTEX constituents were detected at very low concentrations. At these low concentrations, none of the BTEX constituents would be expected to adversely impact ground water.

Ground Water

Depth to ground water varies, but was encountered at depths ranging from 6 feet to 18 feet (Lowney, 1992). As indicated in Table 2, ground water was found to contain oil and grease residues, but did not contain detectable residues of BTEX constituents. In regards to inorganic substances, almost all metals were detected in upper aquifer ground water at the site. Concentrations of arsenic, barium, chromium III, and lead were detected in filtered samples at concentrations above drinking water standards (Lowney, 1992). Lowney (1992) indicated that shallow ground water in the vicinity of the site is not used for potable purposes. They also expressed their belief that virtually no exchange of ground water between the shallow zone and the Newark aquifer (deeper aquifer) would be expected.

Slag

Residual concentration data for inorganic substances in all six types of slag are summarized collectively in Table 3. This slag is spread unevenly over approximately 50% of the undeveloped portion of the site. Lowney (1992) described this slag as a hard refuse, metal containing material. As shown in Table 6 of Lowney (1992), the metal content of the six different types of slag varied greatly. The degree to which metals in the slag have leached and impacted underlying soil was investigated by Lowney (1992); their findings indicated no elevated concentrations in underlying soil of the four metals analyzed for (copper, lead, mercury, selenium, zinc; see Table 9 of Lowney, 1992).

4.0 SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Health risk assessments of sites containing potentially hazardous materials, such as the subject site, generally are based on "chemicals of potential concern" rather than every individual chemical ever detected in environmental media at a site. The selection of such chemicals is based primarily on their measured concentrations in the media that have been investigated (e.g., soil and ground water) and their inherent toxicities (EPA, 1986a). Additional factors to be considered include physical and chemical characteristics related to the chemicals, such as environmental mobility and persistence, as well as biological characteristics such as bioaccumulation. The U.S. EPA (1986a) instituted the use of the chemicals of potential concern approach as a practical matter to avoid unnecessary effort in assessing risk at sites where multiple chemicals exist. EPA stated that only those chemicals considered to represent the most "toxic, mobile, and persistent at the site, as well as those present in the largest amounts (i.e., the highest risk chemicals)" should be chosen for risk assessment purposes (EPA, 1986a; 1989a).

The two principal elements of this process are (1) the qualitative and quantitative chemical analytical data that have been collected in the Study Area, and (2) the selection criteria.

Section 3.0 above presented the inventory of chemicals that have been detected in slag, soil and ground water at the site. For the purposes of this HRA, selection is based on all of the monitoring data that have been collected at the site (Tables 1, 2 and 3).

Selection of chemicals of potential concern for this HRA was based on EPA's suggested criteria and "best scientific judgement." Selection criteria included consideration of: (1) the areal distribution and concentrations of residues in environmental media (slag, ground water) at the site, (2) the potential for human exposure to chemical residues (includes mobility and persistency in soil), and (3) published toxicologic data in mammals.

Chemicals Selected as Chemicals of Potential Concern

For the purposes of this HRA, 17 inorganic substances that have been detected in slag and/or ground water, regardless of concentrations present, are selected as chemicals of potential concern. These substances are listed in Table 4. As shown, all of these substances have been detected in slag , but only 11/17 have been detected in ground water.

Chemicals Excluded as Chemicals of Potential Concern

Although the frequency of detection of organics in soil is relatively high (>10%) for oil and grease and BTEX compounds (see Table 1), all of the organic substances (e.g., oil, grease, etc.) are excluded as chemicals of potential concern. As discussed in Section 3.0, Lowney (1992) concluded that the majority of the oil detected at the site is due to non-hazardous heavy solid phase hydrocarbons contained in the asphaltic material used in the construction of roads and parking areas for the former drive-in theatre. Furthermore, the STLC extraction analysis showed that the oil is confined within the soil and will not migrate downward to the ground water under neutral pH conditions (Lowney, 1992). BTEX constituents generally selected as chemicals of concern for hydrocarbon mixtures such as oil and grease were detected at very low concentrations in soil (see Table 1). None of the BTEX compounds have been detected in ground water (see Table 2).

Summary: Chemicals of Potential Concern

Seventeen inorganic substances are selected as chemicals of potential concern for this HRA. Theoretical carcinogenic and noncarcinogenic risk associated with theoretical exposure of receptors of concern (see Section 5.0 below) are estimated for these substances, individually and collectively.

5.0 EXPOSURE ASSESSMENT

5.1 Objectives and Procedures

The overall goal of this exposure assessment is to estimate the nature and magnitude of theoretical human exposures to chemicals of potential concern present in slag and ground water at the site. In accordance with EPA (1989a) and described in Section 2.2 of this HRA, the exposure assessment procedure is comprised of three basic elements:

1. Identification of both current and future hypothetical complete human exposure pathways. According to EPA (1989a), a complete exposure pathway consists of "four necessary elements: (1) a source and mechanism of chemical release to the environment, (2) an environmental transport medium (e.g., air, ground water) for a released chemical, (3) a point of potential human contact with the contaminated medium (referred to as the exposure point), and (4) a human exposure route (e.g., drinking water ingestion) at the contact point." This evaluation includes characteristics of maximally-exposed individuals (MEI) for each potentially complete exposure pathway, and environmental fate characteristics of the chemicals, to determine whether there is significant current exposure and significant potential for future exposure to the chemicals of concern present in slag and ground water at the site.

2. Estimation of exposure point concentrations of chemicals of concern associated with each of the actual or potentially significant exposure pathways identified in the first step. Exposure point concentrations (e.g., concentrations present in a transport medium such as air, soil, food at the point of human contact) are based on monitoring data.

3. Estimation of actual (current land use) or assumed (future hypothetical land use) human exposures (intakes) of chemicals of concern. Chemical-specific intakes are estimated (i.e., calculation of mg/kg body weight/day) for each significant exposure pathway identified in step 2, using equations that include variables for exposure point concentration, contact rate, exposure frequency, exposure duration, body weight, and exposure averaging time (EPA, 1989a).

5.2 Underlying Approaches and Assumptions

For the purposes of this HRA, two potential future land-uses are addressed herein:

- Commercial/industrial use. No particular industrial usage has been specified. In keeping with the baseline nature of this HRA, it is assumed that the site remains unremediated (i.e., the slag currently present at the site remains onsite). Under this land-use condition, the potential human receptor of potential concern is the onsite worker who would be expected to occupy the site during normal business hours.

- Residential land use. This land use represents the most conservative land use whereby human receptors might be exposed to chemicals of potential concern. It is assumed that the on-site area is converted into a residential neighborhood consisting of single family homes typical of those found in the East San Francisco Bay Region. It is also assumed that the site is not remediated (i.e., residues of chemicals of concern currently present remain in slag and ground water).

These factors and assumptions are considered realistic for assessing theoretical baseline human exposure to chemicals of potential concern at the site. Theoretical maximally exposed individuals (MEIs) associated with these land uses are assumed and their theoretical exposures assessed quantitatively.

5.3 Evaluation of Potential Exposure Pathways

5.3.1 Industrial/Commercial Land Use

Potentially Complete Exposure Pathways

Based on the physical environment at the site and the projected human activity patterns associated unspecified industrial/commercial operations, the following are exposure pathways of potential significance:

- Incidental ingestion of slag;
- Incidental dermal contact with slag;
- Inhalation of dust generated from slag. Occupational exposure is conservatively assumed to occur entirely outdoors.

Pathways Considered Not Complete

Ground water is not considered a potentially complete exposure pathway for the hypothetical onsite worker, therefore is not included in this HRA. The municipal water supply is currently used in the vicinity of site to supply industrial/commercial needs (Lowney, 1992).

5.3.2 Residential Land Use

Potentially Complete Exposure Pathways

Based on the physical environment at the site and the projected human activity patterns associated with hypothetical residential habitation of the site, the following exposure pathways are considered to be potentially significant and are addressed in this HRA:

1. Pathways associated with slag:
   - Incidental ingestion of slag;
   - Incidental dermal contact with slag;
   - Inhalation of dust generated from slag, including dust in both indoor and outdoor air.
2. Pathways associated with water:
   - Use of ground water containing detected levels of the chemicals of concern for domestic purposes. Theoretical exposure routes include ingestion and dermal contact. Inclusion of ground water as a theoretically complete exposure pathway is considered an overly conservative assumption, in view of the fact that the shallow ground water in the vicinity of the site is not used for domestic purposes because of poor quality (Lowney, 1992). t is assumed that potable water in the occupational setting will come from some source other then the groundwater underlying the site.

Pathways Considered Not Complete

Because this HRA is conducted with the assumption that the site is not remediated, there are no complete exposure pathways associated with food-chain transfer of constituents from slag into homegrown plant produce. The slag material at the site is not suited for backyard gardening or support of other food-producing plants (e.g., fruit trees). Lowney (1992) reported an observation from their site visit that virtually no vegetation was found to be growing on the slag. Clearly, if the slag were to become mixed/diluted with soil, food-chain transfer of toxic constituents in the slag does constitute a potentially complete pathway.

Although the mother's milk pathway is potentially complete under the assumption of an onsite residential setting, this pathway is not addressed in this HRA.

5.4 Exposure Point Concentrations for Potentially Complete Exposure Pathways

An exposure point concentration is the amount of the chemical in the environmental medium (soil, air, water) of a complete exposure pathway at the point of human contact. In this assessment , the potential exposure points are the slag, and the groundwater underlying the site. When several samples have been taken, EPA (1989a) recommends that the upper 95% percent confidence limit of the average concentration be used as the exposure point concentration. When the data are not normally or log-normally distributed, as is the case in this instance, the upper 95th percent confidence limit of the mean generally exceeds the highest detected concentration. In such instances, EPA recommends that the highest detected concentrations be used as the exposure point concentration. For the purposes of this HRA, the exposure point concentrations for individual chemicals of concern are:

- Slag: The highest detected concentrations of the 17 inorganics in the six different types of slag (Lowney, 1992) were conservatively used as representative of the exposure point concentrations for slag. These concentrations, which are tabulated in Table 4, are used as exposure point concentrations in slag for both the onsite worker receptor and the onsite residential receptor.

- Dust: No air samples have been taken at the site for the purpose of during the concentration of particulate matter (PM10) in air. Furthermore, it was not deemed necessary to model fugitive dust generation for the purposes of this HRA. Therefore, it was conservatively assumed that the PM10 content in air in the vicinity of the site originates at the site. The 1990 annual average PM10 concentration as reported by the Bay Area Air Quality Management District (BAAQMD) for the Fremont area (closest BAAQMD monitoring station to Hayward) is 27.0 $\mu g/m^3$ (BAAQMD, Public Information Office, January 1992). This PM10 concentration was used as the dust concentration at the site. It was further assumed that the concentration of inorganic substances in this dust is the same as the slag.

- Ground water: The highest detected concentrations of the 17 inorganics in the filtered water samples were conservatively used as representative of the water pathway. Since six of the inorganic constituents were not detected in ground water, no concentrations were assumed to be present; these six substances were not included in the ground water pathway. Exposure point concentrations associated with ground water are given in Table 4.

5.5 Estimation of Theoretical Intakes of Chemicals of Concern

Oral Ingestion of Slag/Dust

Oral ingestion of substances in slag can result from direct ingestion of slag and from the swallowing of inhaled dust particles, which are deposited in the lungs and removed by the mucociliary escalator. EPA (1989a) has suggested that calculating a 30-year exposure to oral ingestion of soil/dust be divided into 2 parts. First, a six-year exposure duration for young children is evaluated which accounts for a period of the highest soil ingestion rate (200 mg/day) combined with a lower body weight (15 kg). Second, a 24-year exposure duration is assessed for older children and adults using a lower soil ingestion rate (100 mg/day) and higher body weight (70 kg). In order to simplify the calculations, the chronic daily intake (CDI) for soil ingestion was calculated as a single step using time-weighted values for both soil ingestion and body weight based on 6/30 years of the total for the CDI for children, and 24/30 years for the CDI in older children and adults. The CDI for inorganic substances of concern associated with the ingestion of slag is calculated using the following equation:

$$\mathrm{CDI} = \frac{\mathrm{Cs} \times \mathrm{IR} \times \mathrm{ABS} \times \mathrm{EF} \times \mathrm{ED} \times \mathrm{CF}}{\mathrm{BW} \times \mathrm{LT} \times 365} \qquad \text{(Equation 1)}$$

where:

Cs = Concentration of contaminant in slag (μg/kg) (Table 4).
IR = Rate of soil ingestion (mg/day).
ABS = Fraction of ingested contaminant that is absorbed.
EF = Exposure frequency (days/year).
ED = Exposure Duration (years).
CF = Conversion factor (10^{-3} mg/μg).
BW = Average body weight (kg).
LT = Lifetime (years).
365 = Conversion factor (days/year).

Default values for both the residential and onsite worker receptors for these factors are given in Table 5. CDI (noncarcinogenic effects) and LADD (carcinogenic effects) are given for the occupational worker receptor in Tables 8 and 9, respectively. Similarly, CDI (noncarcinogenic effects) and LADD (carcinogenic effects) are given for the residential receptor in Tables 10 and 11, respectively.

Dermal Contact with Slag

The CDI (mg/kg/day) for dermal contact with contaminated soil is calculated using the following equation:

$$\mathrm{CDI} = \frac{\mathrm{Cs \times IR \times ABS \times EF \times ED \times CF}}{\mathrm{BW \times LT \times 365}} \qquad \text{(Equation 2)}$$

where:

Cs = Concentration of contaminant in slag (μg/kg) (Table 4).
SA = Skin surface area available for contact (cm^2)
AF = Soil-to-skin adherence factor (mg/cm^2)
ABS = Fraction of ingested contaminant that is absorbed (%).
EF = Exposure frequency (days/year).
ED = Exposure Duration (years).
CF = Conversion factor (10^{-3} mg/μg).
BW = Average body weight (kg).
LT = Lifetime (years).
365 = Conversion factor (days/year).

Default values for both the residential and onsite worker receptors for these factors are given in Table 5. CDI (noncarcinogenic effects) and LADD (carcinogenic effects) associated with dermal exposure are combined with the slag oral exposure pathway, and are given for the occupational worker receptor in Tables 8 and 9, respectively. Similarly, CDI (noncarcinogenic effects) and LADD (carcinogenic effects) are given for the residential receptor in Tables 10 and 11, respectively.

Inhalation of Particulates from Slag

The CDI (μg/kg-day) for the inhalation of particulates is calculated as:

$$CDI = \frac{IR \times PC \times RF \times C \times ED \times 10^{-9}\ kg/\mu g}{BW \times LT \times 365} \qquad \text{(Equation 3)}$$

where:

IR = Inhalation rate (m^3/hr).
PC = Particulate concentration in air ($\mu g/m^3$) (27.0 $\mu g/m^3$; BAAQMD, 1990).
RF = Respirable fraction of particulates (percent, taken as 100%).
C = Concentration of contaminant on particulate ($\mu g/kg$) (Table 4).
ED = Exposure duration (hours).
BW = Average body weight (kg).
LT = Average lifetime (years).
365 = Conversion factor (days/year).

Default values for both the residential and onsite worker receptors for these factors are given in Table 5. CDI (noncarcinogenic effects) and LADD (carcinogenic effects) are given for the occupational worker receptor in Tables 8 and 9, respectively. Similarly, CDI (noncarcinogenic effects) and LADD (carcinogenic effects) are given for the residential receptor in Tables 10 and 11, respectively.

Oral Ingestion of Groundwater.

The CDI resulting from the ingestion of groundwater is calculated using the following equation:

$$CDI = \frac{Cw \times IR \times EF \times ED}{BW \times LT \times 365} \qquad \text{(Equation 4)}$$

where:

Cw = Concentration of contaminant in water (mg/L) (Table 4).
IR = Ingestion rate (L/day).
ED = Exposure duration (hours).
BW = Average body weight (kg).
LT = Average lifetime (years).
365 = Conversion factor (days/year).

Default values for both the residential and onsite worker receptors for these factors are given in Table 6. CDI (noncarcinogenic effects) and LADD (carcinogenic effects) are given for the residential receptor in Tables 10 and 11, respectively.

6.0 TOXICITY ASSESSMENT

In this section, critical toxicity criteria are presented for each of the chemicals of potential concern. These criteria, which are used to assess theoretical carcinogenic and noncarcinogenic risk, have been developed for evaluation of health impacts in humans as a consequence of exposure to these chemicals.

For purposes of assessing potential impacts on human health, chemicals are standardly separated into toxicologic categories, depending on their toxicodynamic behavior in biological systems. The primary basis of categorization is whether a chemical exhibits noncarcinogenic or carcinogenic impacts. For potentially carcinogenic chemicals, EPA assumes that there is no level of exposure below which cancer will not occur in some individuals (i.e., there is no threshold dose for carcinogenic effects). For noncarcinogenic chemicals, it is believed that organisms have protective mechanisms that must be overcome before a toxic endpoint is produced (i.e., there is a threshold dose for a response to a toxicant). Thus, it is believed that a range of exposures up to a defined threshold can be tolerated by an organism without appreciable risk of causing the toxic effect. Presented in the following sections is a brief discussion of the toxicity criteria used in this HRA.

Toxicity Criteria for Estimating Potential Noncarcinogenic Effects

Reference doses (RfDs), which are standard health effects criteria developed by EPA's RfD Work Group, are used for assessing noncarcinogenic health impacts (i.e., RfDs provide a benchmark against which human intakes of chemicals in environmental media may be compared). An RfD is an estimate of the maximum human chronic daily intake (CDI) that can occur without appreciable risk of adverse effect. They are chemical-specific and route-specific (e.g., oral, inhalation), and are standardly expressed in units of mg/kg of body weight/day (mg/kg/day). Although dose-response data from human studies are preferable for deriving RfDs (e.g., workplace exposures), they typically are based on animal studies because of a lack of human data. RfDs are generally reported by EPA in their on-line database called Integrated Risk Information System (IRIS), or in their Health Effects Assessment Summary Tables (HEAST).

RfD values for the chemicals of concern are listed in Table 8. As shown, EPA has reported oral RfDs (RfD_o) for all of the chemicals of concern except cobalt. Inhalation RfDs (RfD_i) are lacking for most of the chemicals of concern. In the absence of RfD_i values, RfD_o values were used as surrogate RfD_i values in estimating noncarcinogenic risk in this HRA. No adjustments were made of the RfD_o values used for assessing inhalation risk.

EPA typically does not report dermal RfD values. To estimate noncarcinogenic risk for the dermal pathway, RfDo values were extrapolated in accordance with EPA procedures (EPA, 1990). Consequently, RfD_o values were adjusted by conservatively assuming that 5% of the oral dose administered during the oral toxicity study would be absorbed if administered via dermal exposure.

Toxicity Criteria for Estimating Potential Carcinogenic Effects

EPA assigns weight-of-evidence classifications to potential human carcinogens. Chemicals are placed in either Group A, Group B1, Group B2, Group C, Group D or Group E. For chemicals placed in Group A, EPA has determined that there is sufficient evidence to support the causal association between exposure in humans and cancer. Chemicals assigned Group B1 and B2 status are considered by EPA as "probable carcinogens"; there is limited (B1) or inadequate (B2) evidence of carcinogenesis from human studies, but sufficient evidence of carcinogenesis from animal studies. Chemicals assigned to Group C are considered by EPA to be "possible carcinogens"; there is limited evidence of carcinogenesis in animals and no evidence of carcinogenesis in humans. Chemicals given Group D status by EPA are not classified as to human carcinogenesis because of inadequate evidence in both humans and animals, or because virtually no data are available.

Table 7 lists EPA's weight-of-evidence classifications for the 17 substances of potential concern. As shown, two of the inorganics, arsenic and chromium VI, have been assigned Group A status and two have been assigned Group B status by EPA. Table 7 also lists route-specific cancer potency factors (CPFs) for each of the carcinogenic substances. Cadmium and chromium VI are considered by EPA as carcinogenic only by the inhalation pathway. As shown, both CPF_o and CPF_i values are available for oral and inhalation pathways except for lead; EPA has not established a CPF_i value. Since no EPA-established CDF_i has been established for lead, inhalation carcinogenic risk for lead was not calculated.

Similar to the dermal RfD values, EPA does not report dermal CPF values. To estimate carcinogenic risk for the dermal pathway, CPF_o values were extrapolated in accordance with EPA procedures (EPA, 1990), and as described above.

Other Pertinent Toxicology Information

In addition to the toxicodynamic information (e.g., carcinogenic weight of evidence, RfDs, CPFs), toxicokinetic information may be directly pertinent to this HRA. The most pertinent toxicokinetic information is the bioavailability (fraction of a dose available for absorption) of chemicals via the routes of exposure (oral, dermal and inhalation) from different environmental media (soil, air). For the purposes of this HRA, bioavailability of substances for the oral and inhalation routes is assumed to be 100% (i.e., it is conservatively assumed that the degree of absorption of the substances, which are likely to be adsorbed to soil particles, is the same as if the substances were not adsorbed to soil particles). For the dermal route, inorganic substances are assumed to be 10% bioavailable (EPA, 1990).

7.0 RISK CHARACTERIZATION

7.1 Quantitative Health Risk Assessment Methodology

To quantitatively assess the potential risks to human health that are associated with the two future hypothetical land uses considered in this assessment (onsite industrial/commercial, onsite residential), the concentrations of inorganic substances in relevant environmental media (slag, ground water, air) were used to calculate the chronic daily intakes (CDIs) for noncarcinogens and lifetime average daily doses (LADDs) for carcinogens. A CDI for a chemical is the amount of substance taken into the body per unit body weight per unit time, expressed as mg/kg/day, and a LADD is the dosage daily dosage received over a certain period of time (e.g., 30 years), but normalized over a lifetime (70 years). Noncarcinogenic and carcinogenic risk are calculated from the oral/inhalation/dermal CDI and oral/inhalation/dermal LADDs, respectively.

Noncarcinogenic Risk Characterization

Potential noncarcinogenic risk is assessed by evaluating the ratio of the CDI to the pathway-specific reference dose (RfD) (i.e., CDI:RfD), which is also known as the Hazard Index (EPA, 1989a). In general, if the HI is less than unity (i.e., if the CDI is below the health-based criterion), the chemical is considered unlikely to be associated with any significant health risks. Therefore, chemicals and exposure pathways with HIs ≤ 1.0 are projected to be less likely to be of regulatory concern than chemicals and pathways with HIs >1.0.

In accordance with EPA guidance (1989a), HIs are summed across exposure pathways for the same chemical, and across chemicals that have similar toxic endpoints in the human body. These total HIs produce an estimate of total noncarcinogenic risk. If the HI is less than one, the combined intakes of substances by the exposure routes under consideration are not likely to a pose health risk.

Carcinogenic Risk Charaterization

Carcinogenic risk is quantified for the carcinogenic chemicals of concern for the oral, dermal and inhalation routes of exposure. Cancer risk for each chemical is estimated by multiplying each pathway-specific and chemical-specific LADD by the appropriate route-specific CPF. According to EPA (1989a), this approach is appropriate for theoretical upperbound cancer risks of less than 1×10^{-2}.

Under the land-use conditions assumed in this HRA, exposure to the potentially carcinogenic chemicals can potentially occur via a combination of the oral, inhalation and dermal pathways.

Consistent with EPA's guidance procedure for chemical mixtures (EPA, 1986b), incremental risks associated with each pathway are considered additive. The total theoretical upperbound lifetime excess cancer risk for the combined exposures derived in this HRA are compared to EPA's range for health protectiveness at hazardous waste sites. According to Agency policy (EPA, 1987), the total target carcinogenic risk resulting from exposures may range from 10^{-4} to 10^{-7}.

7.2 Risk Characterization for the Industrial/Commercial Land Use

Noncarcinogenic Risk

As indicated in Table 8, the total Hazard Index for the exposure pathways addressed for onsite worker sums to 2.06, which exceeds the target risk level of an HI ≤ 1.0. Therefore, under the assumptions of this HRA, a potential noncarcinogenic risk to the onsite workers exists. The majority of the noncarcinogenic risk is associated with oral exposure to the substances of concern. Moreover, essentially 50% of the HI is contributed by copper. The remainder of the oral risk is predominately contributed by thallium, lead, antimony and barium.

Carcinogenic Risk

As indicated in Table 9, the total theoretical upperbound carcinogenic risk for the onsite worker sums to 2.4×10^{-6}, which is equivalent to 2.4 new theoretical cases of cancer per 1,000,000 exposed individuals. This level of risk is well within EPA's target carcinogenic risk range of 10^{-4} to 10^{-6}, and should be considered di minimis in view of the numerous conservative assumptions that were assumed in this analysis.

The majority of risk (96%) is contributed by arsenic. Of the arsenic risk, approximately 80% is associated with the oral pathway. As indicated above, it should be clearly understood that these carcinogenic risks are upperbound, based on many overly conservative assumptions. The contribution of these various assumptions (i.e., sources of uncertainty) are discussed in Section 7.4 below. For example, the conservative assumption was made in the exposure assessment that hypothetical onsite workers would come into contact with the slag 8 hours a day for 25 years.

7.3 Risk Characterization for the Residential Land Use

Noncarcinogenic Risk

As indicated in Table 9, the total Hazard Index for the hypothetical onsite residential receptor sums to 18.02, which exceeds the target risk level of an HI ≤ 1.0. Therefore, there is a potential noncarcinogenic risk to humans who might inhabit a hypothetical residential area developed at the site. As shown in Table 9, potential exposure to substances in slag accounts for approximately 70% of the total HI; the remainder is associated with assumed exposure to substances in ground water. The substances contributing the greatest to the total noncarcinogenic risk are copper, chromium, thallium, arsenic and barium.

Carcinogenic Risk

Theoretical upperbound probabilities of new cases of cancer associated with theoretical exposure to each of the carcinogenic substances under the hypothetical residential land use condition are given in Table 11. As shown, the total theoretical upperbound carcinogenic risk for the onsite residential receptor sums to 1.1 x 10^{-3}, which is equivalent to 11 new theoretical cases of cancer per 10,000 exposed individuals. As shown, virtually all of this risk is associated with arsenic in ground water. The theoretical carcinogenic risk associated with slag is 8.4 x 10^{-6}, which is well within EPA's target risk range of 10^{-4} to 10^{-6}. As stated earlier, it should be clearly understood that these carcinogenic risks are upperbound, based on many overly conservative assumptions. The contribution of these assumptions (i.e., sources of uncertainty) are discussed in Section 7.4 below.

7.4 Uncertainty Analysis

Because of the many overly conservative factors and assumptions incorporated into health risk assessment methodologies, the theoretically plausible estimates of both carcinogenic and noncarcinogenic risks presented in this HRA are likely to produce a significant overestimations of actual risk. In general, there are three primary sources of uncertainty in this risk assessment:

- Sampling and analyses of environmental samples,
- Assumptions and factors used in deriving theoretical human intake levels, and
- Assumptions and factors associated with the use of toxicological data.

There are numerous sub-sources of uncertainty inherent in each of these primary sources, some of which may overestimate (OE), underestimate (UE), or either over- or underestimate actual risk (O/UE). The magnitude of each of these sources of uncertainty is judged (professional judgement) as either low, moderate, or high.

Sampling and Analyses of Environmental Samples

- The number of samples taken at the site may not be sufficient to fully characterize the actual areal distribution of chemical residues in soil. In fact, most of the onsite soil samples were collected in areas which were known to contain chemical residues. These concentrations were used in the HRA as representative of larger assumed areas of contamination. .... low OE

- The use of the maximum detected concentrations of some chemicals in some areas because the sampling data were found to not fit a normal or log normal distribution is likely to overly exaggerate concentrations present. .... moderate OE

Assumptions and Factors Used in Deriving Theoretical Human Intake Levels

- The standard assumptions for body weight, life expectancy, consumption rates (e.g., inhalation rates, soil consumption rates, etc.) may not be representative of the actual human receptors that may reside or work at the site.. .... moderate OE

- The probability that all of the various upperbound assumptions used in the exposure assessment occurring at the receptor location is extremely low. .... moderate OE

- The frequency and duration of exposure to environmental media of concern generally represent the 95% upper confidence limit of the value used. This will generally result in an overestimation of the exposure and the consequent daily intake of the substance... moderate OE

- In assessing the daily intakes resulting from inhalation of particulates, it was assumed that the concentration of dust in indoor air was the same as that in outdoor air .... low OE

- The amount of media intake (i.e., consumption rates), which are assumed to be constant over time, may not be constant over time or representative of the human populations in the area. .... low OE

Assumptions and Factors Associated With the Use of Toxicological Data

- The cancer potency factors (CPF) used for the animal carcinogens are the 95th percent upperbound confidence limit derived from the linearized multistage model using animal chronic bioassay data, which tends to greatly overestimate carcinogenic risk in humans.

The linearized multistage model ignores many known factors that have been documented to protect humans against the carcinogenic actions of chemicals, such as DNA repair and immunosurveillence. ....high OE

- Some of the carcinogenic chemicals of concern are known to cause cancer in humans. Therefore, assuming that these various chemicals are human carcinogens greatly overestimates actual carcinogenic risk ....moderate OE

- Cancer potency factors are extrapolated from animal data, in which the animals were exposed to relatively high intakes. Likely errors are inherent in the extrapolation of data from animals to humans, as well as from high to low doses. Moreover, test rodents typically used in carcinogenesis bioassays tend to be more sensitive to carcinogenic effects of chemicals than other mammals, including humans.........................moderate OE

- For non-carcinogenic effects, acceptable exposure levels, generally called reference doses (RfDs) are used. An RfD, which is generally derived from animal data, is the quotient of the No-Observable-Adverse-Effect-Level (NOAEL) or Lowest-Observed-Adverse-Effect-Level (LOAEL) divided by an uncertainty factor. An uncertainty factor is the product of multiple of 10 , which are typically incorporated to offset assumed sources of uncertainty such as extrapolating subchronic to chronic durations of exposure, extrapolating from LOAELs to NOAELs, protection of the most sensitive individuals in the population, etc. RfD values are typically based on the most sensitive toxic endpoints in the most sensitive species, which may be greatly over-protective of human health. Also, the use of uncertainty factors tend to be very conservative...................moderate OE

- Toxicity data used in deriving RfDs are from controlled animal studies, designed to determine the effects of individual chemicals. The mixture of chemicals present in the emissions from the site may or may not act synergistically (either antagonistically or potentiatively)...low O/UE

As indicated above, there are numerous sources of uncertainty that are likely to affect estimations of risk in this HRA. Most of the factors listed as subsources of uncertainty contribute to an over-estimation of risk. No factors are listed that are believed to produce a significant underestimation of risk. Therefore, it is highly likely that the actual risks posed by substances at the site are substantially lower than the estimated risks presented in this report.

In accordance with EPA guidance (EPA, 1989a), this HRA incorporates numerous conservative factors and assumptions. Therefore, the actual risks posed by chemical residues in soil at the site under the land-use conditions addressed are highly unlikely to be greater and are highly likely to be lower than those presented in this HRA.

7.5 Conclusion

Based on a future hypothetical use of the subject property for industrial/commercial purposes, and based on numerous hypothetical conditions and conservative assumptions associated with this land use, this HRA finds that the subject property may pose a minimal noncarcinogenic risk to theoretical onsite workers; the Hazard Index (HI) of 2.06 exceeds the target HI of 1.0. However, the total theoretical upperbound carcinogenic risk for the onsite worker summed to 2.4 x 10^{-6}, which is not significantly different from the target risk level of 1 x 10^{-6} and is well within EPA's target risk range of 10^{-4} to 10^{-6}.

Under an assumed future use of the subject property for residential purposes, and also based on numerous hypothetical conditions and conservative factors associated with this land use, this HRA finds that the subject property may pose a moderate noncarcinogenic risk to theoretical residential receptors; the Hazard Index (HI) of 18.02 significantly exceeds the target HI of 1.0. Similarly, the total theoretical upperbound carcinogenic risk summed to 1.1 x 10^{-3}, which exceeds EPA's target risk range of 10^{-4} to 10^{-6}. Virtually all of this theoretical carcinogenic risk was found to be contributed by arsenic in ground water.

These conclusions are based on site-specific data interpreted conservatively to provide a safety margin to address uncertainty inherent in health risk assessment. The methods used to estimate carcinogenic risk and Hazard Indices used herein are based predominately on upperbound (reasonable maximum) variables and assumptions and are health-conservative in nature. Conservative factors and assumptions were intentionally used to ensure that potential health impacts would not be underestimated. The result of this approach is that the upper limits of risk are predicted. That is to say, any actual risks due to chemical residues in soil at the subject property are not expected to be any higher than the predicted risks herein and are highly likely to be substantially lower, even approaching zero. This health conservative approach in assessing risk is the adopted approach of the U.S. EPA and Cal EPA.

8.0 REFERENCES

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TABLE 1

SUMMARY OF CHEMICAL IN SOIL

Chemical	Number of Samples Analyzed	No. Detects/ No. Samples	Frequency of Detection (%)	Range of Detected Concentrations (μg/kg)	Detection Limit (μg/kg)	Location of Maximum
Organics						
Oil and grease	75	38 / 75	51	40-6800	30	AF-4, 0.5-1.0
TPH Gas	11	0 / 11	0	N/A	1	N/A
Benzene	11	6 / 11	55	0.0062-0.014	0.005	EB-2, 0.5-1.0
Toluene	11	6 / 11	55	0.0023-1.3	0.005	EB-1, 0.5-1.0
Ethylbenzene	11	1 / 11	9	0.014	0.005	EB-1, 0.5-1.0
Xylene	11	10 /11	91	0.0053-0.024	0.005	AF-4, 0.5-1.0
Inorganics						
Copper	12	12/12	100	23.1–49.1	NA	P-6, 3 ft.
Lead	12	12/12	100	29.4–44.5	NA	P-5, 2.5 ft.
Mercury[a]	–	–	–	–	–	–
Selenium	12	12/12	100	25.0–41.6	NA	P-6, 3 ft.
Zinc	12	12/12	100	51.8–94.8	NA	P-9, 2 ft.

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[a] Samples were analyzed by ICP; results are considered suspect, therefore are not given here.

TABLE 2

SUMMARY OF CHEMICALS IN GROUNDWATER[a]

Chemical	Number of Samples Analyzed	No. Detects/ No. Samples	Frequency of Detection (%)	Range of Detected Concentrations (μg/kg)	Detection Limit (μg/kg)	Location of Maximum
Inorganics						
Antimony	4	0/4	0	NA	25-50	NA
Arsenic	4	1/4	25	56	25	AF-1
Barium	4	2/4	50	460-1000	100	AF-1
Beryllium	4	0/4	0	NA	10	NA
Cadmium	4	0/4	0	NA	10	NA
Chromium (III)	4	3/4	75	25-200	10	AF-1
Chromium(VI)	4	3/4	75	16-41	5	AF-1
Cobalt	4	0/4	0	NA	50	NA
Copper	4	4/4	100	23-110	--	AF-1
Lead	4	4/4	100	5.7-23	--	AF-1
Mercury	4	0/4	0	NA	0.2	NA
Molybdenum	4	4/4	100	53-90	50	AF-2
Nickel	4	2/4	50	110-220	50	AF-1
Selenium	4	0/4	0	NA	25-50	NA
Silver	4	1/4	25	18	10	AF-1
Thallium	4	0/4	0	NA	25-50	NA
Vanadium	4	2/4	50	96-190	50	AF-1
Zinc	4	4/4	100	90-290	NA	AF-1

TABLE 2
(con't)

SUMMARY OF CHEMICALS IN GROUNDWATER

Chemical	Number of Samples Analyzed	No. Detects/ No. Samples	Frequency of Detection (%)	Range of Detected Concentrations (μg/kg)	Detection Limit (μg/kg)	Location of Maximum
Organics						
Total Oil & Grease	13	2 / 13	15.4	6000-15000	5000	AF-3
TPH Diesel	4	0/4	0	NA	50	NA
TPH Gas	9	0 /9	0	NA	30	NA
Benzene	9	0 / 9	0	NA	0.3	NA
Toluene	9	0 / 9	0	NA	0.3	NA
Ethylbenzene	9	0 / 9	0	NA	0.3	NA
Xylene	9	0 / 9	0	NA	0.3	NA

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[a] All inorganic water samples were filtered prior to analysis.

TABLE 3

SUMMARY OF INORGANIC SUBSTANCES IN SLAG SAMPLES

Chemical	Number of Samples Analyzed	No. Detects/ No. Samples	Frequency of Detection (%)	Range of Detected Concentrations (mg/kg)	Detection Limit (mg/kg)	Location of Maximum
Antimony	6	5 / 6	83.3	38.9-66.8	0.08	TypeA
Arsenic	6	5 / 6	83.3	5.5	0.06	TypeA
Barium	6	5 / 6	83.3	91.6-5100	0.001	TypeA
Beryllium	6	0 / 6	0.0	NA	0.001	NA
Cadmium	6	6 / 6	100.0	0.88-7.06	0.003	TypeA
Σ Chromium	6	6 / 6	100.0	3.4-349	0.006	TypeD
Chromium VI	1	0 / 1	0	NA	0.5	NA
Cobalt	6	5 / 6	83.3	6.1-8.71	0.006	TypeC
Copper	6	6 / 6	100	37.2-7000	0.002	TypeB
Lead	6	5 / 6	83.3	48.3-361.2	0.044	TypeA
Mercury	6	5 / 6	83.3	1.9-13.5	0.024	TypeA
Molybdenum	6	5 / 6	83.3	78.4-139.0	0.008	TypeD
Nickel	6	6 / 6	100	13.1-48.9	0.008	TypeC
Selenium	6	5 / 6	83.3	19.8-39.3	0.06	TypeA
Silver	6	5 / 6	83.3	2.9-5.8	0.006	TypeA
Thallium	6	5 / 6	83.3	25.9-46.7	0.054	TypeA
Vanadium	6	5 / 6	83.3	24.7-44.5	0.01	TypeD
Zinc	6	6 / 6	100	4.3-25000	0.004	TypeA

TABLE 4

SOIL AND WATER CONCENTRATION OF INORGANICS USED IN THE RISK ASSESSMENT

Chemical	Soil (Slag) (mg/kg)	Groundwater (μg/L)
Antimony	66.8	<50[a]
Arsenic	5.5	56
Barium	5100	1000
Cadmium	7.06	<10
∑Chromium	349	200
Chromium VI	<0.5	41
Cobalt	8.73	<50
Copper	7000	110
Lead	361.2	23
Mercury	13.5	<.2
Molybdenum	139	90
Nickel	48.9	220
Selenium	4.1	<50
Silver	5.8	18
Thallium	46.7	<50
Vanadium	44.5	190
Zinc	25000	290

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[a] Values indicated as less than (<) are considered not detected (ND) and the value shown is the detection limit.

TABLE 5

DEFAULT VALUES ASSOCIATED WITH SOIL EXPOSURE PATHWAYS

	Exposure Scenario	
Oral Ingestion	**Residential**	**Occupational**
Ingestion Rate(mg-soil/day)[a]	120[b]	100
Absorption (%)	100	100
Exposure Frequency (days/year)[a]	350	250
Exposure Duration (years)	30[a]	25[a]
Average Body Weight	59[b]	70
Lifetime (years)[a]	70	70
Dermal Contact		
Surface Area (cm^2)[a,c]	4211	4211
Adherence Factor (mg/cm^2)[d]	0.5	0.5
Absorption (%)	10	10
Exposure Frequency (days/year)[a]	350	250
Exposure Duration (years)[a]	30	25
Average Body Weight[a]	59	70
Lifetime (years)[a]	70	70

TABLE 5
(con't)

DEFAULT VALUES ASSOCIATED WITH SOIL EXPOSURE PATHWAYS

	Exposure Scenario	
Indoor Inhalation of Particulates	**Residential**	**Occupational**
Inhalation Rate(m^3/hr)[a]	0.89	0.89
Repirable Fraction of Particulates (%)	75	75
Exposure Duration (hrs)[a]	189,000[e]	0[f]
Average Body Weight[a]	70	70
Lifetime (years)[a]	70	70
Outdoor Inhalation of Particulates		
Inhalation Rate(m^3/hr)	1.4	1.4
Repirable Fraction of Particulates (%)	75	75
Exposure Duration (hrs)	63,000[h]	50,000[i]
Average Body Weight	70	70
Lifetime (years)	70	70

TABLE 5
(con't)

DEFAULT VALUES ASSOCIATED WITH SOIL EXPOSURE PATHWAYS

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a EPA, 1989

b Weighted average soil ingestion rates for small children and adults. See Section 5.4.4.1 for an explanation of the assumption used in these calculations.

c Total exposed surface area for hands, lowwer and upper arms, and the head.

d CAPCOA, 1991.

e Assumes 18 hrs/day indoors for 350 days/year for 30 years.

f All occupational exposure is assumed to occur outdoors.

h Assume 6 hrs/day spent outdoors, 350 days/year, for 30 years.

i 8 hrs/day, 250 days/yr, for 25 years.

TABLE 6

DEFAULT VALUES ASSOCIATED WITH WATER INGESTION PATHWAYS

	Exposure Scenario	
Oral Ingestion	Residential	Occupational
Ingestion Rate(L/day)[a]	2[b]	0
Absorption (%)	100	100
Exposure Frequency (days/year)[a]	350	0
Exposure Duration (years)	30[a]	0
Average Body Weight	70[b]	70
Lifetime (years)[a]	70	70

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[a] EPA, 1989

[b] Weighted average soil ingestion rates for small children and adults.

TABLE 7

TOXICITY CRITERIA FOR CHEMICALS OF CONCERN[a]

Chemical	RfD Inhalation mg/kg/day	RfD Oral mg/kg/day	Class/CPF Inhalation $(mg/kg/day)^{-1}$	Class/CPF Oral $(mg/kg/day)^{-1}$
Antimony	–	0.0004	–	–
Arsenic	–	0.001	A/5.0	A/1.7
Barium	0.01	0.05	–	–
Cadmium	–	0.0005	B1/6.1	–[b]
Chromium	0.00000057	1.0	–	–
Chromium VI	0.00000057	0.005	A/41	–[b]
Colbalt	–	–	–	–
Copper	–	0.005	–	–
Lead	0.0043[c]	0.0014	B2/0.027[c]	B2/ND[d]
Mercury	–	0.0003	–	–
Molybdenum	–	0.004	–	–
Nickel	–	0.02	–	–
Selenium	0.001[c]	0.003[c]	–	–
Silver	–	0.003	–	–
Thallium	–	0.00007	–	–
Vanadium	–	0.007	–	–
Zinc	–	0.2	–	–

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[a] All values obtained from the Health Effects Summary Tables (HEAST), 1991, unless otherwise noted.

[b] There is inadequate evidence for carcinogenicity via the oral route (EPA, 1991).

[c] CAPCOA, 1991.

[d] No data available.

TABLE 8

SUMMARY OF NON-CARCINOGENIC EFFECTS
HYPOTHETICAL LAND-USE: OCCUPATIONAL EXPOSURE

	Soil Pathways				
Chemical	CDI Inhalation mg/kg/day	CDI Oral mg/kg/day	CDI:RfD Ratio Inhalation	CDI:RfD Ratio Oral	Total
Antimony	3.86×10^{-7}	4.77×10^{-5}	0.001	0.12	0.12
Arsenic	3.18×10^{-8}	3.93×10^{-6}	0.00003	0.004	0.004
Barium	2.95×10^{-5}	3.64×10^{-3}	0.03	0.07	0.10
Cadmium	4.08×10^{-8}	5.04×10^{-6}	0.00004	0.01	0.01
ΣChromium	2.02×10^{-6}	2.49×10^{-4}	0	0.003	0.003
Chromium VI	0	0	0	0	0
Copper	4.05×10^{-5}	5.00×10^{-3}	0.0085	1.00	1.01
Lead	2.09×10^{-6}	2.58×10^{-4}	0.005	0.18	0.18
Mercury	7.81×10^{-8}	9.64×10^{-6}	0.0003	0.03	0.03
Molybdenum	8.04×10^{-7}	9.93×10^{-5}	0.0002	0.02	0.02
Nickel	2.83×10^{-7}	3.49×10^{-5}	0.000001	0.002	0.002
Selenium	2.37×10^{-8}	2.93×10^{-6}	0.00002	0.001	0.001
Silver	3.36×10^{-8}	4.14×10^{-6}	0.00001	0.001	0.001
Thallium	2.70×10^{-7}	3.34×10^{-5}	0.004	0.48	0.48
Vanadium	2.57×10^{-7}	3.18×10^{-5}	0.00004	0.004	0.004
Zinc	1.45×10^{-4}	1.79×10^{-2}	0.0007	0.09	0.09
				Total	2.06

TABLE 9

SUMMARY OF CARCINOGENIC RISKS
HYPOTHETICAL FUTURE LAND-USE: OCCUPATIONAL EXPOSURE

	Slag Pathways[a]				
Chemical	LADD Inhalation[b] mg/kg/day	LADD Oral[c] mg/kg/day	Risk Inhalation	Risk Oral	Total
Arsenic	9.45×10^{-8}	2.93×10^{-6}	4.7×10^{-7}	1.8×10^{-6}	2.3×10^{-6}
Cadmium	9.99×10^{-9}	3.76×10^{-6}	6.1×10^{-8}	–[d]	6.1×10^{-8}
Lead	1.91×10^{-8}	1.92×10^{-4}	5.2×10^{-10}	–[e]	5.2×10^{-10}
				Total	2.4×10^{-6}

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a Exposure point concentrations are given in Table 4.

b Calculated using Equation 3. Default values are given in Table 5.

c Calculated using Equation 1 for oral exposure and Equation 2 for dermal wxposure; LADD values given are the sum of oral and dermal exposure. Default values are given in Table 5.

d Not considered an oral carcinogen by EPA (see Table 7).

e No oral CPF is available (see Table 7).

TABLE 10

HYPOTHETICAL LAND-USE: RESIDENTIAL EXPOSURE

SUMMARY OF NON-CARCINOGENIC EFFECTS

	Slag Pathways				Water Pathways		
Chemical	CDI Inhalation mg/kg/day	CDI Oral mg/kg/day	CDI:RfD Ratio Inhalation	CDI:RfD Ratio Oral	CDI mg/kg/day	CDI:RfD Ratio	Total
Antimony	4.72×10^{-7}	1.89×10^{-4}	0.0012	0.47	ND	ND	0.47
Arsenic	3.89×10^{-8}	1.17×10^{-5}	0.00004	0.01	0.0015	1.50	1.51
Barium	3.6×10^{-5}	4.45×10^{-2}	0.035	0.89	0.927	0.55	1.48
Cadmium	4.99×10^{-8}	1.49×10^{-5}	0.00005	0.03	ND	ND	0.03
∑Chromium	2.47×10^{-6}	1.01×10^{-3}	4.33	0.001	0.0055	0.006	4.34
Chromium VI	ND	ND	ND	ND	0.0012	0.24	0.24
Copper	4.95×10^{-5}	2.03×10^{-2}	0.01	4.06	0.003	0.60	4.67
Lead	2.55×10^{-6}	7.64×10^{-4}	0.006	0.55	0.006	0.43	0.99
Mercury	9.54×10^{-8}	3.92×10^{-5}	0.0003	0.13	ND	ND	0.13
Molybdenum	9.82×10^{-7}	4.03×10^{-4}	0.0002	0.10	0.0026	0.65	0.75
Nickel	3.46×10^{-7}	5.25×10^{-4}	0.00001	0.026	0.006	0.30	0.33
Selenium	2.90×10^{-8}	1.19×10^{-5}	0.00001	0.004	ND	ND	0.004
Silver	4.10×10^{-8}	1.69×10^{-5}	0.00001	0.006	ND	ND	0.006
Thallium	3.29×10^{-7}	1.35×10^{-4}	0.0001	1.92	ND	ND	1.92
Vanadium	3.14×10^{-7}	1.29×10^{-4}	0.00004	0.02	0.005	0.74	0.76
Zinc	1.77×10^{-4}	7.26×10^{-2}	0.001	0.36	0.008	0.40	0.40
		Total	4.38	8.58	Total	6.60	
			Total (Slag)	12.96			
						Total HI	18.02

TABLE 11

HYPOTHETICAL LAND-USE: RESIDENTIAL EXPOSURE
SUMMARY OF CARCINOGENIC RISKS

	Slag Pathways[a]				Water Pathways[a]		
Chemical	LADD Inhalation[b] mg/kg/day	LADD Oral[c] mg/kg/day	Risk Inhalation	Risk Oral	LADD[d] mg/kg/day	Risk	Total
Arsenic	1.60×10^{-8}	4.80×10^{-6}	7.9×10^{-8}	8.2×10^{-6}	6.55×10^{-4}	1.1×10^{-3}	1.1×10^{-3}
Cadmium	2.04×10^{-8}	6.41×10^{-6}	1.2×10^{-7}	_[e]	6.00×10^{-5}	_[e]	1.2×10^{-7}
Lead	1.06×10^{-6}	3.15×10^{-4}	2.9×10^{-8}	_[f]	2.69×10^{-4}	_[f]	2.9×10^{-8}
		Total	2.3×10^{-7}	8.2×10^{-6}			
		Total (Slag)	8.4×10^{-6}			Total Water	1.1×10^{-3}
						Total Risk (Slag and Water)	1.1×10^{-3}

TABLE 11
(con't)

HYPOTHETICAL LAND-USE: RESIDENTIAL EXPOSURE
SUMMARY OF CARCINOGENIC RISKS

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[a] Exposure point concentrations are given in Table 4.

[b] Calculated using Equation 3.

[c] Calculated using Equation 1 for oral exposure and Equation 2 for dermal exposure; valus given are the sum of oral and ddermal exposures.

[d] Calculated using Equation 4.

[e] Not considered by EPA to be an oral carcinogen (see Table 7).

[f] No oral CPF is available (see Table 7).