

**DETERMINATION OF THE CONCENTRATION
OF LEAD IN SEDIMENTS IN MONTEREY
HARBOR, CALIFORNIA**

Prepared for

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March 11, 1993

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High levels of lead were discovered in samples of marine mussels (*Mytilus californianus*) near Monterey Harbor by the State of California Mussel Watch Program between 1981 and 1983 (Wilder and Jagger, 1988). An isotopic lead study, conducted in 1984, indicated that an onshore slag pile (Figure 1) was the source of the lead found in the mussels near Monterey Harbor (Flegal, 1986). In 1988 the California Regional Water Quality Control Board, Central Coast Region conducted an additional study to define the boundaries of the lead contamination in the sediment in Monterey Harbor (Wilder and Jagger, 1988). The results of the study revealed concentrations of total lead in the surface sediment up to 5800 mg/kg (Figure 2) and up to 1400 mg/kg (Figure 3) in the sediment approximately one-foot beneath the surface.

In addition to determining the concentrations of total lead in the surface and subsurface sediments in Monterey Harbor, Wilder and Jagger (1988) developed cleanup boundaries and discussed various cleanup strategies. The threshold limits for lead established by Title 22 of the California Administrative Code were utilized to develop cleanup boundaries. The total threshold limit concentration (TTLC) for lead is 1000 mg/kg (ppm) and the soluble threshold limit concentration (STLC) is 5 mg/l. Samples were analyzed by the Waste Extraction Test to estimate soluble levels of lead to determine a value for lead in Monterey Harbor that would correspond to the STLC waste limit of 5 mg/l. It was estimated that a cleanup level of 75 to 200 mg/kg (TTLC) would correspond to a hazardous waste limit of 5 mg/l (STLC). A conservative cleanup goal of 75 mg/kg was chosen to ensure that all hazardous material would be removed (Wilder and Jagger, 1988).

Southern Pacific removed the lead-contaminated soil onshore in 1991 in compliance with Cleanup and Abatement Order 91-095 of the California Regional Water Quality Control Board, Central Coast Region. On September 17, 1992 Cleanup and Abatement Order 92-124 of the California Regional Water Quality Control Board, Central Coast required Southern Pacific Transportation Company to delineate the vertical and horizontal extent of the lead contamination in Monterey Harbor offshore from the former slag pile.

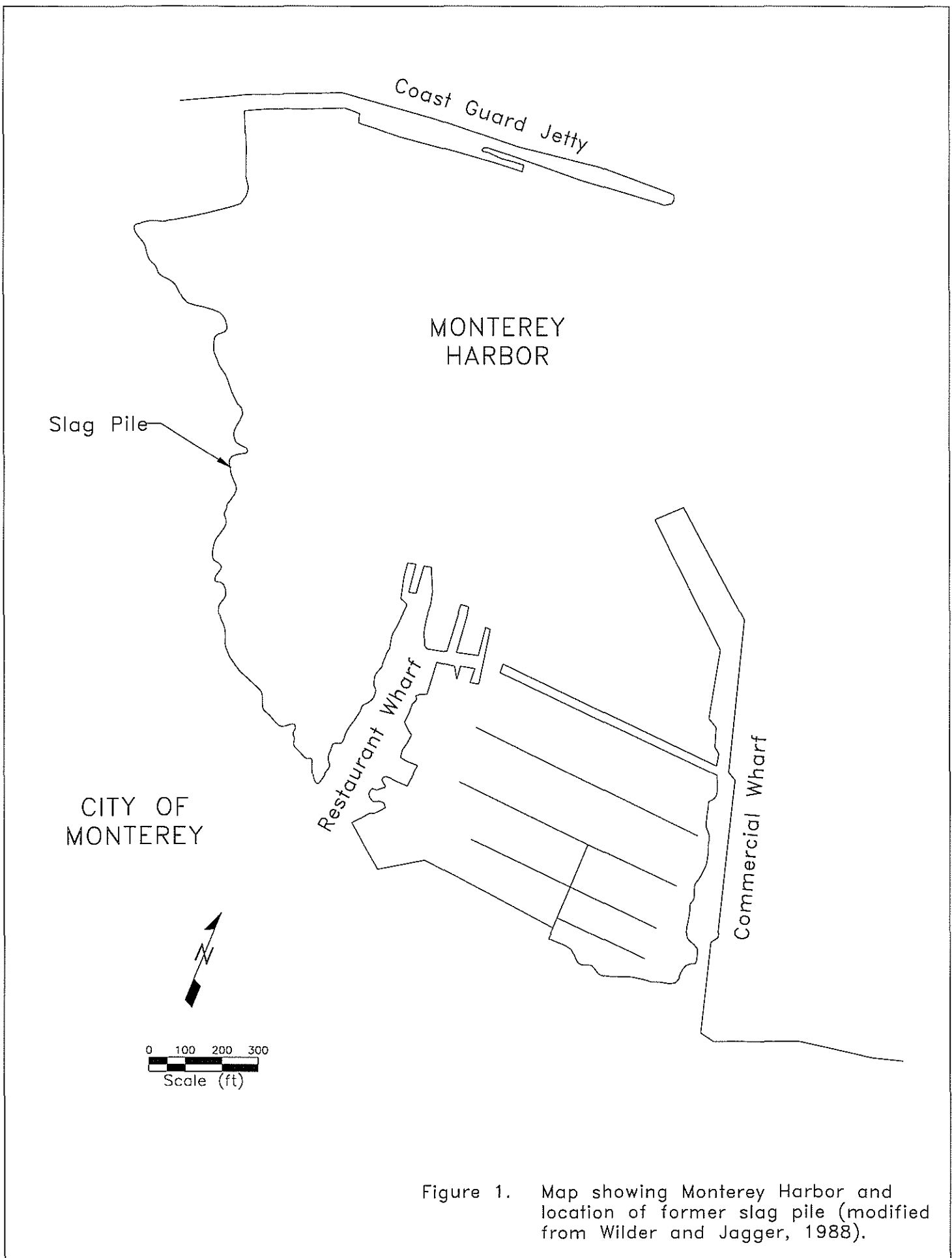


Figure 1. Map showing Monterey Harbor and location of former slag pile (modified from Wilder and Jagger, 1988).

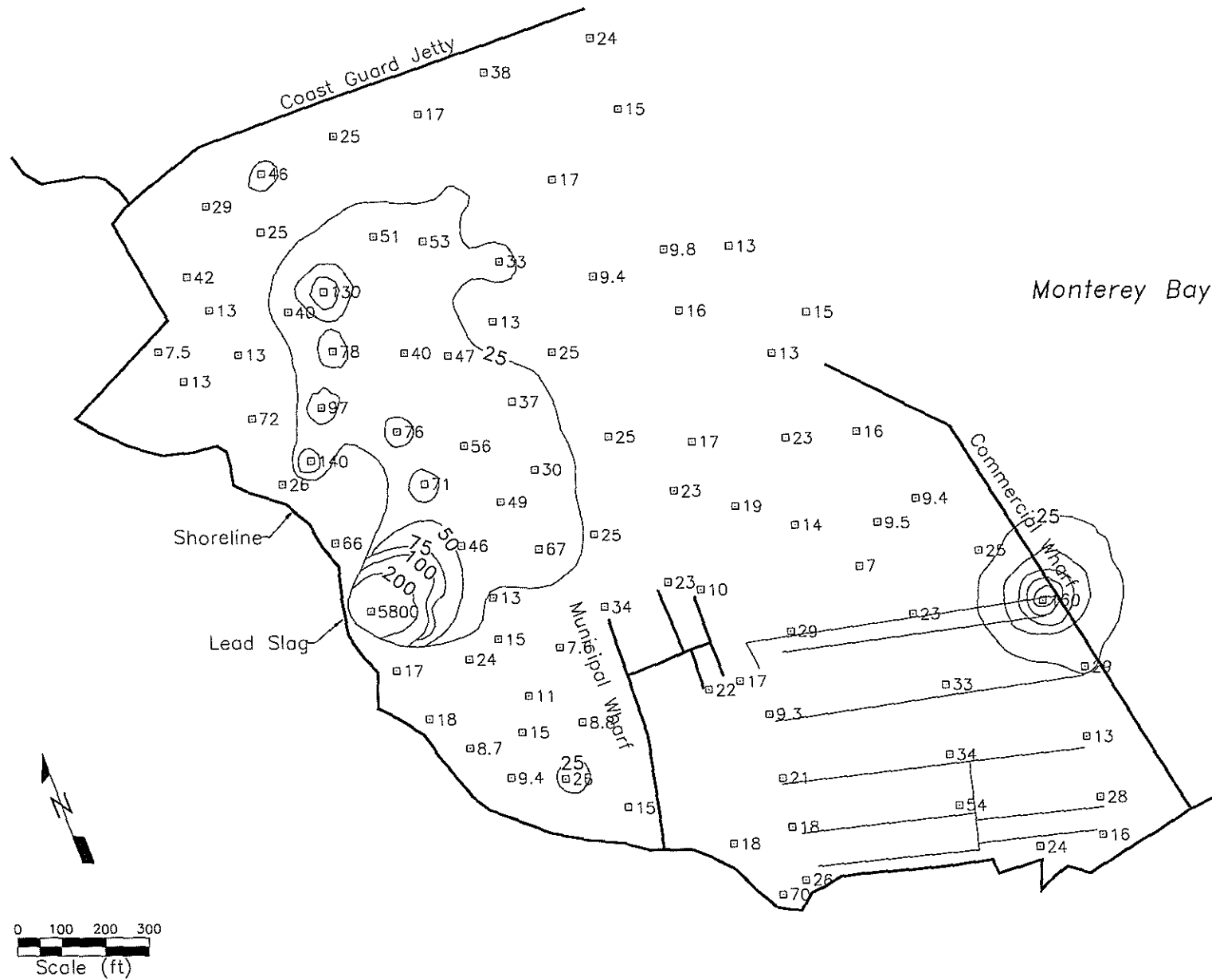


Figure 2. Concentration of lead (mg/kg) in surface sediment in Monterey Harbor offshore of lead slag pile (from Wilder and Jagger, 1988)

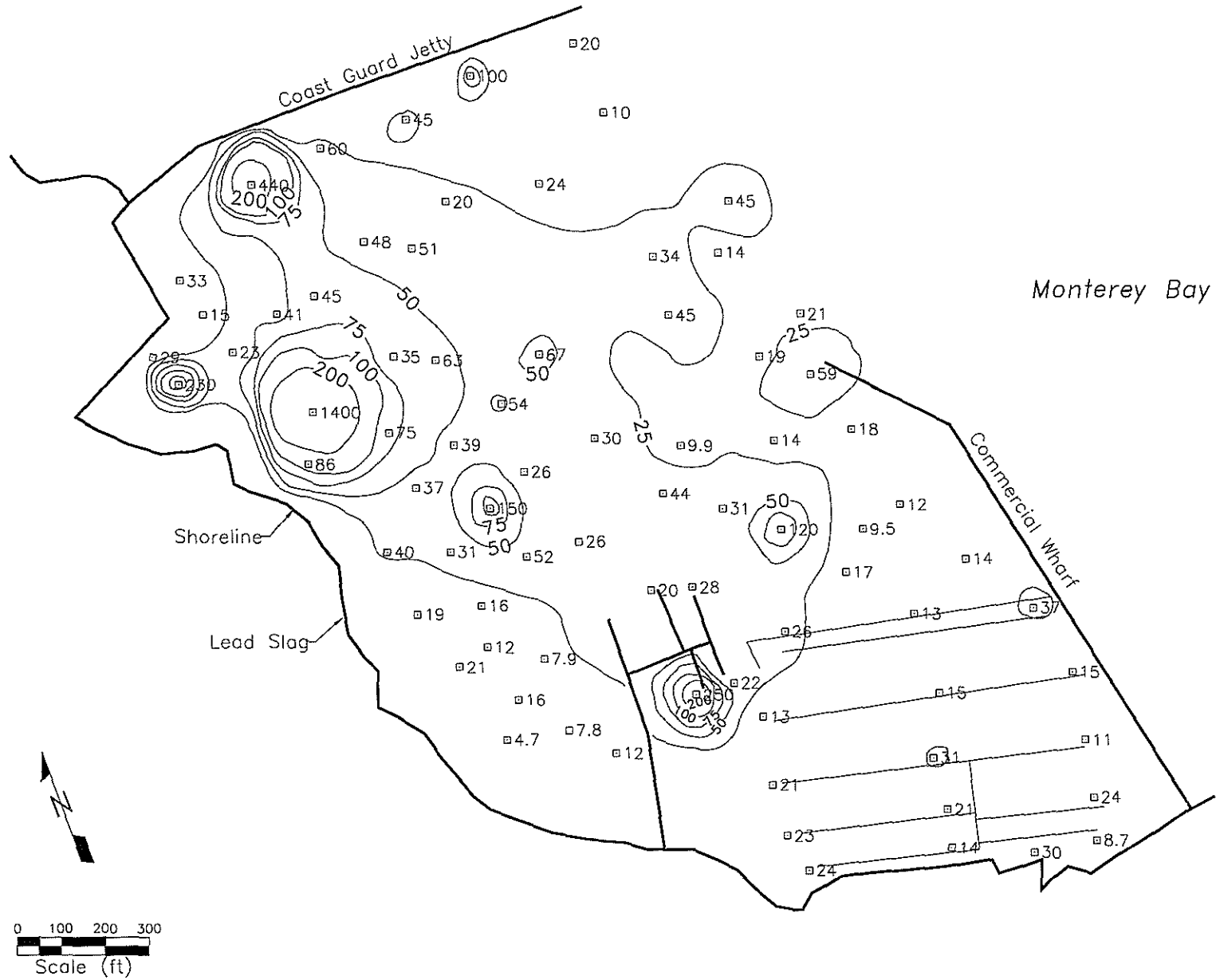


Figure 3. Concentration of lead (mg/kg) in sediment one foot below the surface in Monterey Harbor offshore of lead slag pile (from Wilder and Jagger, 1988).

A study, including a field sampling program on January 8, 1993, was conducted by ENTRIX, Inc. to determine the present concentrations of total lead in the sediment at the surface and at a depth of approximately one foot below the sediment surface in areas that had concentrations of lead above 75 mg/kg in 1988 (Wilder and Jagger, 1988) (Figure 4). The results of this investigation are presented below.

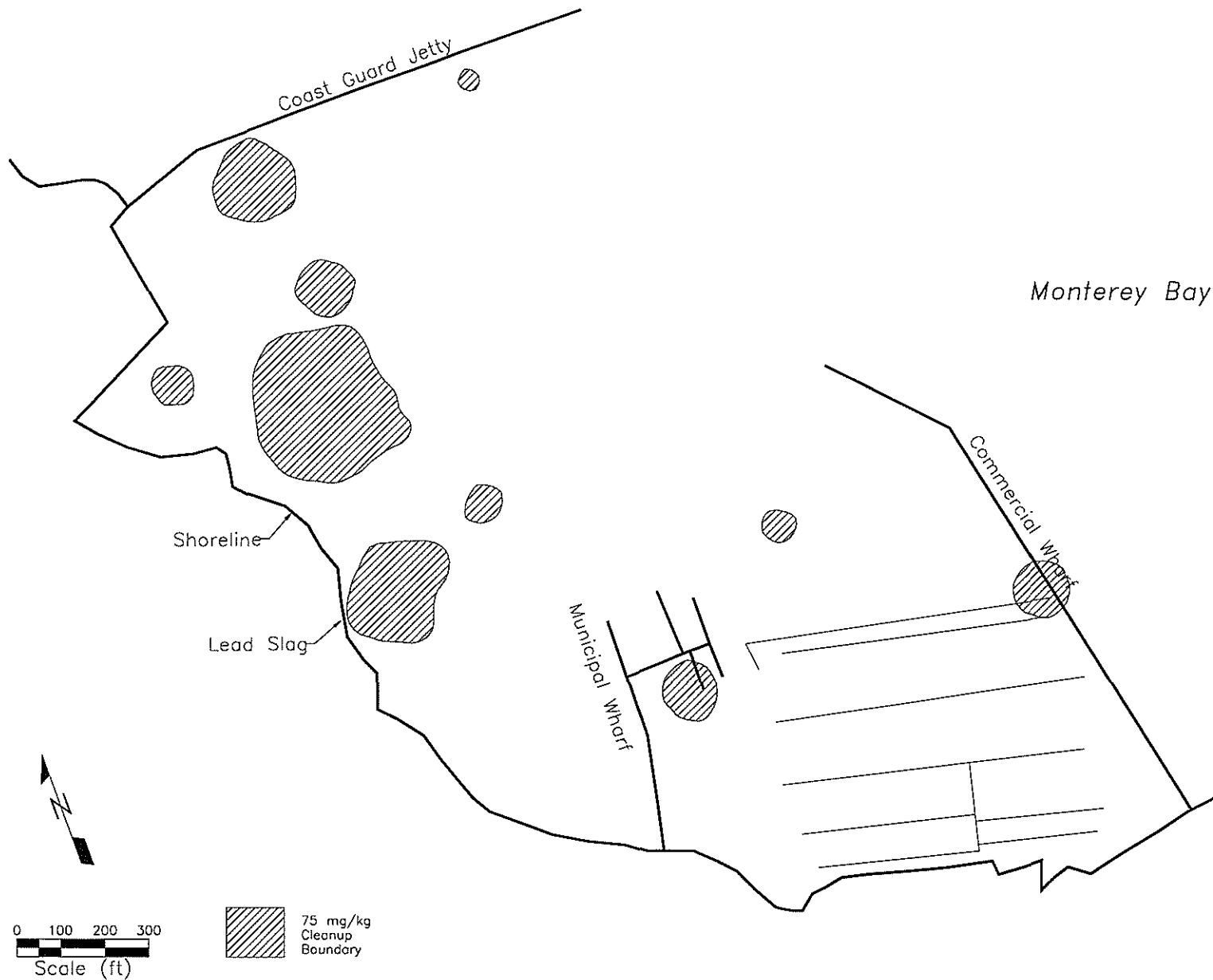


Figure 4. Map showing area in Monterey Harbor with concentrations of lead in the sediment greater than 75 mg/kg, established by Wilder and Jagger (1988) as a cleanup boundary.

Sampling locations were chosen (Figure 5) in areas that were shown to have concentrations of lead in the sediment greater than 75 mg/kg in 1988 by Wilder and Jagger (1988) (see Figures 2, 3 and 4 of this report). The proposed sampling points A to K were converted to latitude and longitude with the use of NOAA chart No. 18685, since no coordinates were provided in the previous study (Wilder and Jagger, 1988). These coordinates were used by a surveying company, Sea Surveyor, to locate the sampling sites with an E.S.P. laser range-azimuth navigation system. The laser navigation system was established on the U.S. Coast Guard pier and utilized the following U.S. Army Corps of Engineering survey monuments:

<u>Monument</u>	<u>Easting</u>	<u>Northing</u>	<u>MLLW Elevation</u>
200	1,151,464.29'	477,293.04'	31.59'
203	1,151,154.37'	477,034.84'	34.01'
204	1,151,976.96'	477,089.57'	31.33'

The surveyor guided the sampling vessel to the proposed sampling locations. Some of the sampling locations were moved due to the presence of rocky substrate, which prevented the penetration of the coring tube to a depth of one-foot. The surveyor revised the coordinates for the sampling locations, as necessary. The coordinates and location of the actual sample collection sites are shown in Table 1 and Figure 6. The sample number, sample type, location of sample collection, time of collection, and depth of water column is shown in Table 2. On January 8, 1993, a team of two divers using SCUBA equipment collected sediment samples at the surface and at a depth of one foot using a 2" diameter PVC coring tube. After the sample was collected, both ends of the coring tube were capped and brought to the surface in the upright position. The sample was stored in an ice chest containing blue ice to maintain a temperature of approximately 4°C. Duplicate sediment samples were collected for 15% of the samples.

After the completion of sample collection, the top two inches and bottom two inches of sediment in the coring tube was transferred to a separate precleaned 8-oz. glass jar labeled with the following information: sample location, sample number, date, collector, time of collection, and analysis to be performed. Chain-of-custody forms were completed and signed prior to transporting the samples to the analytical laboratory [National Environmental Testing, Inc. (NET)]. The sediment was analyzed for the presence of lead using EPA method 7421

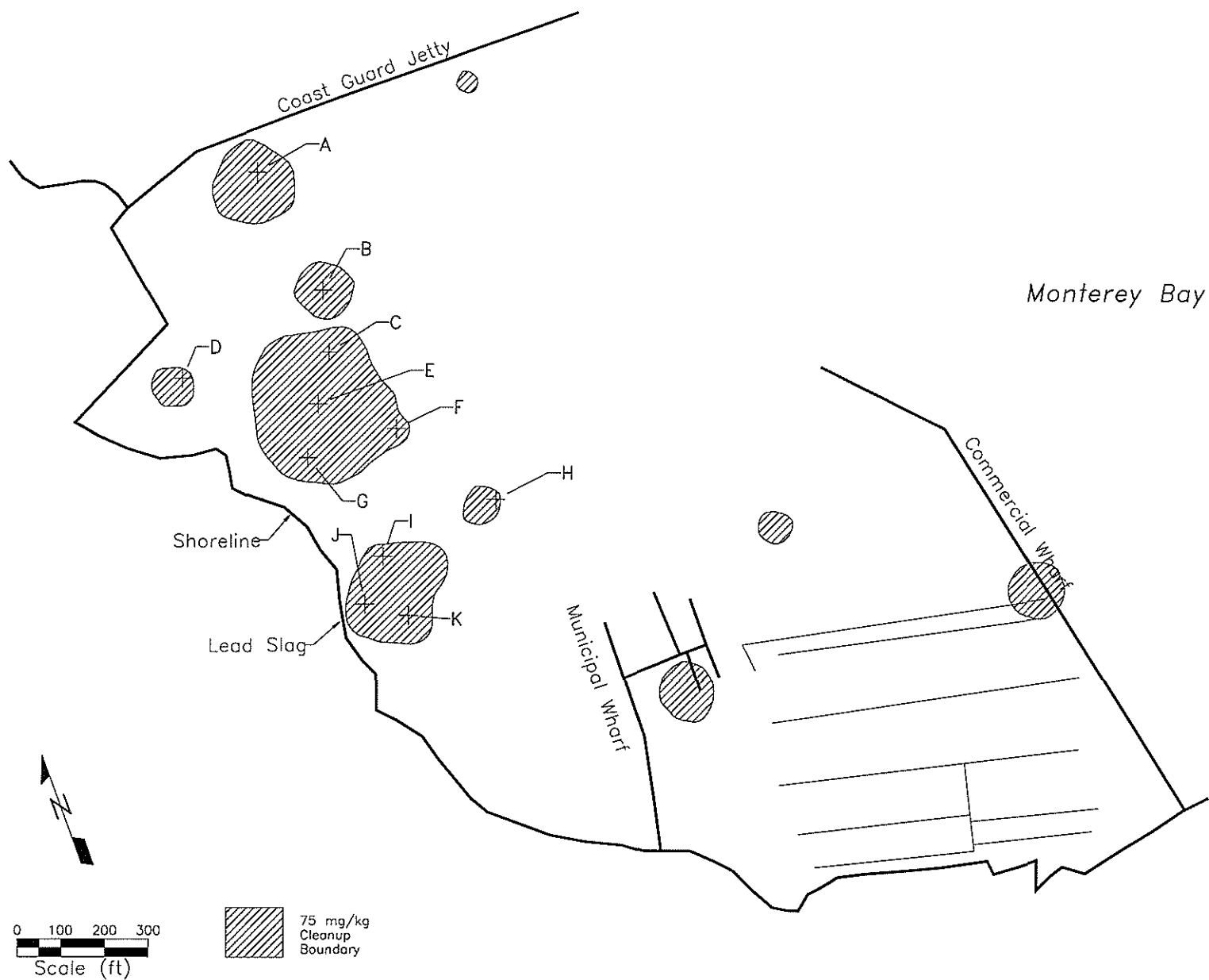


Figure 5. Proposed sites for collection of sediment at the surface and at a depth of one foot in Monterey Harbor in January, 1993.

Table 1. Location of Sediment Sampling Stations A to K in LAMBERT* Coordinates.

<u>STATION</u>	<u>EASTING</u>	<u>NORTHING</u>
A	1,151,551'	477,155'
B	1,151,500'	476,812'
C	1,151,428'	476,747'
D	1,151,141'	476,894'
E	1,151,336'	476,589'
F	1,151,429'	476,474'
G	1,151,307'	476,481'
H	1,151,485'	476,216'
I	1,151,170'	476,323'
J	1,151,130'	476,179'
K	1,151,124'	476,081'

* California State Coordinate System.

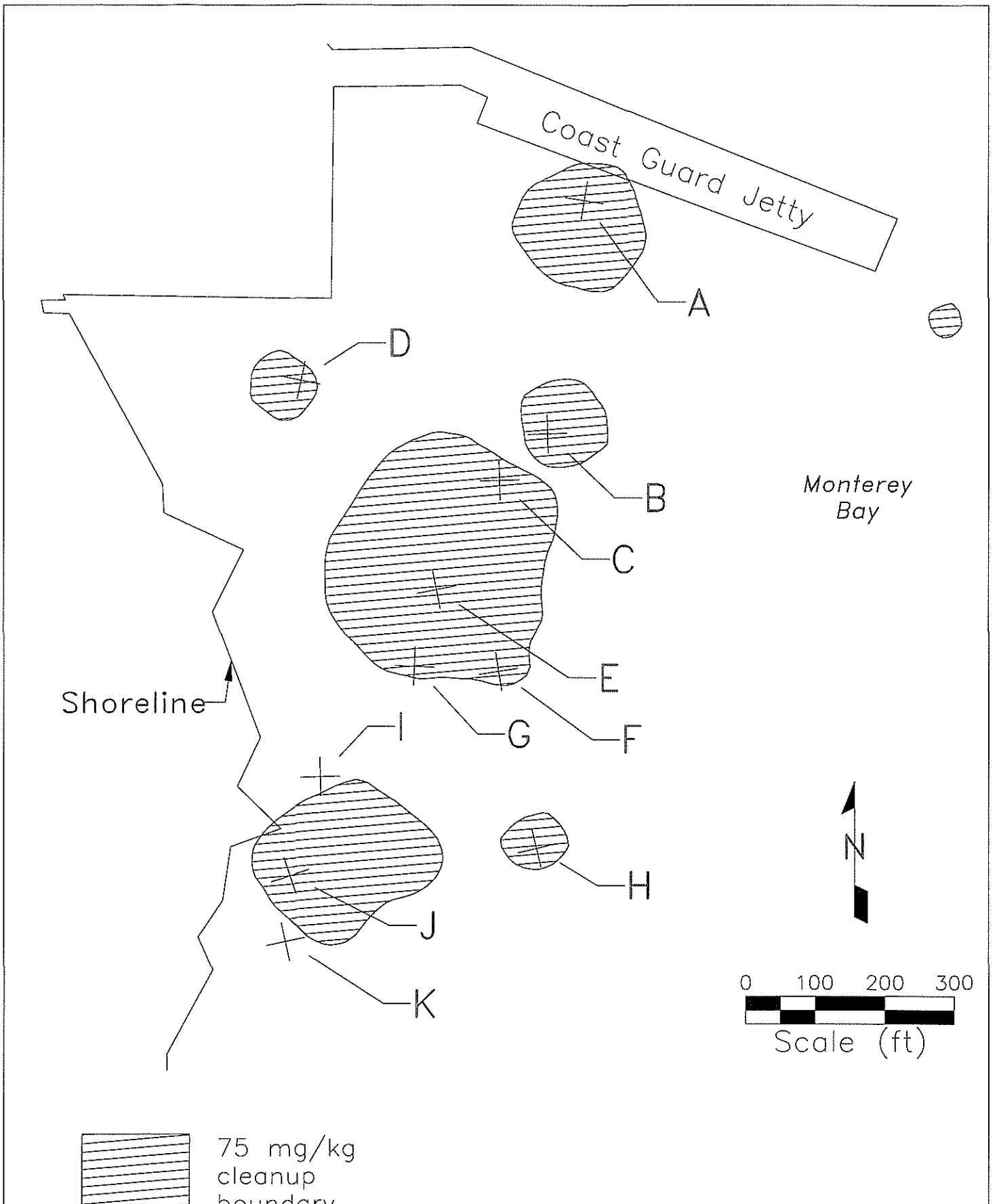


Figure 6. Map showing actual locations of sediment sampling in Monterey Harbor on January 8, 1993. Note: Some stations were moved due to obstructions.

Table 2. Sample Identification Numbers, Station Designation and Other Information about Sediment Samples Collected for Lead Determination on January 8, 1993.

<u>SAMPLE</u>	<u>TYPE</u>	<u>STATION NAME</u>	<u>TIME(AM)</u>	<u>DEPTH(FT.)</u>	
1	Surface	A	9:00	42	
2	1 Ft. depth	A	9:00	42	
3	Surface	A	9:00	42	Duplicate
4	Surface	B	9:15	36	
5	1 Ft. depth	B	9:15	36	
6	Surface	C	9:30	30	
7	1 Ft. depth	C	9:30	30	
8	1 Ft. depth	C	9:30	30	Duplicate
9	Surface	D	9:45	15	
10	1 Ft. depth	D	9:45	15	
11	Surface	E	9:57	24	
12	1 Ft. depth	E	9:57	24	
13	Surface	F	10:00	25	
14	1 Ft. depth	F	10:00	25	
15	Surface	F	10:15	25	Duplicate
16	Surface	G	10:15	20	
17	1 Ft. depth	G	10:15	20	
18	Surface	H	10:28	29	
19	1 Ft. depth	H	10:28	29	
20	Surface	I	10:35	14	
21	1 Ft. depth	I	10:35	14	
22	Surface	J	10:45	10	
23	1 Ft. depth	J	10:45	10	
24	Surface	K	10:52	10	
25	1 Ft. depth	K	10:52	10	
26	1 Ft. depth	K	10:52	10	Duplicate

The diver observations recorded at each sampling location are presented in Table 3. The results of analysis of the sediment samples collected in Monterey Harbor for the presence of total lead are shown in Appendix A. A comparison of the results from the 1988 and 1993 studies is shown in Table 4.

In 1988 the maximum level of lead in the surface sediment was 5800 mg/kg at sample location J; in 1993, the maximum concentration of lead in the surface sediment was 190 mg/kg at that same location. At a depth of one foot, the highest concentration of lead reported in 1988 in the sediment was 1400 mg/kg at sampling location E. In 1993 the amount of lead reported at that location was 14 mg/kg. The highest amount of lead reported in the sediment at a depth of one foot in 1993 was 170 mg/kg at sampling location J. All of the values of lead in the sediment in 1993 are less than the upper end of the threshold range of 75 to 200 mg/kg for cleanup described by Wilder and Jagger (1988). The data also show that in 1993 the concentration of lead in the surface sediment is above 75 mg/kg at only two out of the 11 sampling locations (three locations if the duplicate sample values are not averaged). In 1988 eight surface sediment samples contained lead at a concentration greater than 75 mg/kg. At the one-foot depth, three of 11 sediment samples in 1993 contained lead above a concentration of 75 mg/kg (4 locations if the values of a duplicate sample are not averaged). In 1988 a total of eight sediment samples contained lead concentrations above 75 mg/kg.

Thus, within five years since 1988 the concentration of lead in the surface sediment has decreased from a high of 5800 mg/kg in the surface sediment to 190 mg/kg at Station J and from 1400 mg/kg to 19 mg/kg at the one-foot depth at Station E. These decreases could be the result of scouring of the bottom resulting from storms, currents, and tidal action. It is probable that further reductions in the concentrations of lead in the sediment will continue in the future as a result of these and other natural processes.

Table 3. Observations Recorded at Sediment Sampling Stations A to K in Monterey Harbor on January 8, 1993.

- Station A: - Located approximately 20 ft. south of U.S. Coast Guard pier. Algae, squid eggs and debris present on sea floor. Fine compacted sand bottom; dark gray black subsurface about 1-2" below surface.
- Station B: - Located between two permanent docks; approximately 25 ft. east of the entrance of the channel to the docks. *Cerianthus* and deep burrowing polychaete tubes and mounds abundant. No algae and debris. Fine compacted sand.
- Station C: - Moved slightly to the mouth of the third berth from the east of the southernmost permanent dock. A few clam and polychaete burrows, two *Cerianthus*, and paper debris. Fine compacted sand.
- Station D: - Located 20 ft. west of permanent dock. Two to three foot high sand waves with coarse sand on top of waves, scattered rocks and reefs. Rocky reef present approximately 50 ft. from sample. One *Aplysia*, some *Olivella* and *Olivella* shells with hermit crabs.
- Station E: - Located at the mouth of second berth (southwest corner). Smooth bottom of fine sand with a few polychaete worm burrows.
- Station F: - Smooth, fine sandy bottom. Lots of *Hermisenda* with eggs, a few polychaete holes and one *Aplysia*.
- Station G: - Moved (approximately 25 ft.) due to rocky substrate underlying 1-2" of fine to coarse sand. Substrate sampled to a depth of 8 or 9". Core could not penetrate further due to hard packed shell/clay layer. Smooth, flat, fine sand bottom, consolidated shell and hardpack clay at about 8-9" deep. A few worm tubes as well as burrows.
- Station H: - Moved approx. 20 ft. due to rocky substrate underlying 2-3" sand layer. Substrate sampled at a depth of 9", core could not penetrate further. Scattered rocks on a sandy bottom. A few polychaete tubes and scattered bits of algae and small pebbles.
- Station I: - Patches of coarse and fine sand with occasional rocks protruding. Also scattered rocks that may be fill material, rather than native rock. Several *Aplysia*, numerous *Olivella*.
-

Table 3. Observations Recorded at Sediment Sampling Stations A to K in (concluded) Monterey Harbor on January 8, 1993.

- Station J: - Moved approximately 30 ft. Patches of coarse and fine sand and "fill material." Substrate sampled to a depth of 8 or 9" before reached hardpacked clay and shell. Many *Aplysia* and *Olivella*.
- Station K: - Patches of coarse and fine sand plus fill material. Substrate to a depth of 8 or 9" before hardpacked clay and shell. Many *Aplysia* and *Olivella*.
-

Table 4. Results of Lead Analysis of Sediment Samples Collected in Monterey Harbor at the Surface and Depth of One Foot in 1988* and 1993.

Sampling Location	<u>SURFACE</u> (mg/kg)		<u>ONE FOOT DEPTH</u> (mg/kg)	
	1988	YEAR 1993	1988	YEAR 1993
A	46	33	200	56
A(dup.)		80		
B	130	41	45	57
C	78	58	75	53
C(dup.)				81
D	13	4.9	230	11
E	97	39	1400	19
F	76	40	75	76
F(dup.)		64		
G	140	96	100	120
H	49	50	150	57
I	100	60	40	63
J	5800	190	<25	170
K	200	37	19	38

*1988 sample results from data in Figures 3 and 4 in Wilder and Jagger "Monterey Harbor Lead Study", September 1988.

1. Concentrations of lead in the surface sediment in Monterey Harbor have decreased from a maximum of 5800 mg/kg at Station J in 1988 to 190 mg/kg in 1993.
2. Concentrations of lead in the sediment at a depth of one foot have decreased from a maximum of 1400 mg/kg at Station E to 170 mg/kg at Station J in 1993.
3. Further reduction of the levels of lead in the sediment can be expected over time.

Flegal R. A. 1986. State Water Resources Control Board, Monterey Harbor Special Lead Study, 1986. Water Quality Monterey Report No. 86-1WQ.

Wilder M. and P. Jagger, 1988. Monterey Harbor Lead Study, September 1988, A Cleanup and Abatement Study Analyzing Cleanup Boundaries, Feasibility, and Costs. California Regional Water Quality Control Board, Central Coast Region.

APPENDIX A



NATIONAL
ENVIRONMENTAL
TESTING, INC.®

FEB 01 1993
NET Pacific, Inc.
435 Tesconi Circle
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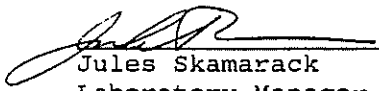
Date: 01/26/1993
NET Client Acct No: 34600
NET Pacific Job No: 93.00022
Received: 01/12/1993

Client Reference Information

Monterey Harbor, Project No: 364400 0000

Sample analysis in support of the project referenced above has been completed and results are presented on following pages. Please refer to the enclosed "Key to Abbreviations" for definition of terms. Should you have questions regarding procedures or results, please feel welcome to contact Client Services.

Approved by:


Jules Skamarack
Laboratory Manager

Enclosure(s)



Client Acct: 34600
Client Name: ENTRIX, Inc.
NET Job No: 93.00022

Date: 01/26/1993
Page: 2

Ref: Monterey Harbor, Project No: 364400 0000

ANALYTE: Lead (GFAA)
METHOD: EPA 7421
REPORTING LIMIT: 0.2 mg/Kg

Lab No.	Descriptor	Date Taken	Results	Units
148739	1	01/08/1993	33	mg/Kg
148740	2	01/08/1993	56	mg/Kg
148741	3	01/08/1993	80	mg/Kg
148742	4	01/08/1993	41	mg/Kg
148743	5	01/08/1993	57	mg/Kg
148744	6	01/08/1993	58	mg/Kg
148745	7	01/08/1993	53	mg/Kg
148746	8	01/08/1993	81	mg/Kg
148747	9	01/08/1993	4.9	mg/Kg
148748	10	01/08/1993	11	mg/Kg
148749	11	01/08/1993	39	mg/Kg
148750	12	01/08/1993	19	mg/Kg
148751	13	01/08/1993	40	mg/Kg
148752	14	01/08/1993	76	mg/Kg
148753	15	01/08/1993	64	mg/Kg
148754	16	01/08/1993	96	mg/Kg
148755	17	01/08/1993	120	mg/Kg
148756	18	01/08/1993	57	mg/Kg
148757	19	01/08/1993	50	mg/Kg
148758	20	01/08/1993	60	mg/Kg
148759	21	01/08/1993	63	mg/Kg
148760	22	01/08/1993	190	mg/Kg
148761	23	01/08/1993	170	mg/Kg
148762	24	01/08/1993	37	mg/Kg
148763	25	01/08/1993	38	mg/Kg
148764	26	01/08/1993	28	mg/Kg



Client Acct: 34600
Client Name: ENTRIX, Inc.
NET Job No: 93.00022

Date: 01/26/1993
Page: 3

Ref: Monterey Harbor, Project No: 364400 0000

QUALITY CONTROL DATA

<u>Parameter</u>	<u>Reporting Limits</u>	<u>Units</u>	<u>Cal Verf Stand % Recovery</u>	<u>Blank Data</u>	<u>Spike % Recovery</u>	<u>Duplicate Spike % Recovery</u>	<u>RPD</u>
Lead	0.2	mg/Kg	100	ND	98	95	1.6



KEY TO ABBREVIATIONS and METHOD REFERENCES

- < : Less than; When appearing in results column indicates analyte not detected at the value following. This datum supercedes the listed Reporting Limit.
- * : Reporting Limits are a function of the dilution factor for any given sample. To obtain the actual reporting limits for this sample, multiply the stated Reporting Limits by the dilution factor (but do not multiply reported values).
- ICVS : Initial Calibration Verification Standard (External Standard).
- mean : Average; sum of measurements divided by number of measurements.
- mg/Kg (ppm) : Concentration in units of milligrams of analyte per kilogram of sample, wet-weight basis (parts per million).
- mg/L : Concentration in units of milligrams of analyte per liter of sample.
- mL/L/hr : Milliliters per liter per hour.
- MPN/100 mL : Most probable number of bacteria per one hundred milliliters of sample.
- N/A : Not applicable.
- NA : Not analyzed.
- ND : Not detected; the analyte concentration is less than applicable listed reporting limit.
- NTU : Nephelometric turbidity units.
- RPD : Relative percent difference, $100 \text{ [Value 1 - Value 2] / mean value}$.
- SNA : Standard not available.
- ug/Kg (ppb) : Concentration in units of micrograms of analyte per kilogram of sample, wet-weight basis (parts per billion).
- ug/L : Concentration in units of micrograms of analyte per liter of sample.
- umhos/cm : Micromhos per centimeter.

Method References

Methods 100 through 493: see "Methods for Chemical Analysis of Water & Wastes", U.S. EPA, 600/4-79-020, rev. 1983.

Methods 601 through 625: see "Guidelines Establishing Test Procedures for the Analysis of Pollutants" U.S. EPA, 40 CFR, Part 136, rev. 1988.

Methods 1000 through 9999: see "Test Methods for Evaluating Solid Waste", U.S. EPA SW-846, 3rd edition, 1986.

SM: see "Standard Methods for the Examination of Water & Wastewater, 17th Edition, APHA, 1989.



NATIONAL ENVIRONMENTAL TESTING, INC.

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1 of 2

1625

CHAIN OF CUSTODY RECORD

COMPANY ENTRIX
 ADDRESS 590 YGNACIO VALLEY ROAD SUITE 200
 PHONE (510) 935-9920 FAX (510) 935-5368
 PROJECT NAME/LOCATION MONTEREY HARBOR
 PROJECT NUMBER 36400 0000
 PROJECT MANAGER MARION FISCHEL

SAMPLED BY MARTY GESLAK
 (PRINT NAME)
Gordon Rubilicard
 (PRINT NAME)

Marty Geslak
 SIGNATURE
Gordon Rubilicard
 SIGNATURE

ANALYSES

TURNAROUND TIME _____ DAY (S)

DATE	TIME	SAMPLE ID/DESCRIPTION	GRAB	COMP	# OF CONTAINERS	MATRIX	PRESERVED (Y/N)	LEAD	ANALYSES	COMMENTS
1/13/93		1	✓		1	Sand	N			extraction of all samples by EPA method 3050 analysis by EPA method 7420
		2								
		3								
		4								
		5								
		6								
		7								
		8								
		9								
		10								
		11								
		12								
		13								
		14								
		15								

RESULTS TO: Dr. Marion Fischel

INVOICE TO: Dr. Marion Fischel

RELINQUISHED BY: JR Retell DATE/TIME: 1/11/93 1407
 RECEIVED BY: Kurt Holman

RELINQUISHED BY: Kurt Holman DATE/TIME: 1/11/93 1900
 RECEIVED BY: _____

RELINQUISHED BY: _____ DATE/TIME: _____
 RECEIVED BY: _____

RELINQUISHED BY: _____ DATE/TIME: 1/12/93 0800
 RECEIVED FOR LABORATORY BY: J. Lopez

METHOD OF SHIPMENT _____

REMARKS: _____
seals intact - AL
(Kurt Holman)
STUDY SEALED





NATIONAL ENVIRONMENTAL TESTING, INC.

1625

CHAIN OF CUSTODY RECORD

SANTA ROSA DIVISION, 435 TESCONI CIRCLE, SANTA ROSA, CA 95401
(707) 526-7200 PHONE (707) 526-9623 FAX

2 of 2

COMPANY ENTRIX
 ADDRESS 590 Ygnacio Valley Road
 PHONE (510) 935-9920 FAX (510) 935-5368
 PROJECT NAME/LOCATION MONTEREY HARBOR
 PROJECT NUMBER 364400 0006
 PROJECT MANAGER MARION FISCHER

SAMPLED BY
MARTY GESLAK
 (PRINT NAME)
Gordon Robillard
 (PRINT NAME)

Marty Geslak
 SIGNATURE
Gordon Robillard
 SIGNATURE

ANALYSES

TURNAROUND TIME _____ DAY(S)

DATE	TIME	SAMPLE ID/DESCRIPTION	GRAB	COMP	# OF CONTAINERS	MATRIX	PRESERVED Y/N	ANALYSES	COMMENTS
1/16/93	16		✓		1	soil	N	<div style="border: 1px solid black; padding: 5px; transform: rotate(-45deg); display: inline-block;"> LEAD </div>	
	17								
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								
	26								

RESULTS TO:

INVOICE TO:

RELINQUISHED BY: <u>X. Pickett</u>	DATE/TIME: <u>1/11/93 1407</u>	RECEIVED BY: <u>Kurt Holman</u>
RELINQUISHED BY:	DATE/TIME:	RECEIVED BY:

RELINQUISHED BY: <u>Kurt Holman</u>	DATE/TIME: <u>1/11/93 1900</u>	RECEIVED BY:
RELINQUISHED BY:	DATE/TIME: <u>1/12/93 0800</u>	RECEIVED FOR LABORATORY BY: <u>A. Lopez</u>

METHOD OF SHIPMENT

REMARKS:

(CUSTODY SEALED) 1/11/93
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