CAMBRIA

April 9, 1998

Mr. Bob Gondek
Chevron Products Company
6001 Bollinger Canyon Road, Building L
San Ramon, California 94583-0804

Re: **Report of Field Activities and Bioremediation Monitoring**
Former Chevron Bulk Fuels Facility #100-1425
302 Main Street
Craig, Alaska
Cambria Project #31-718

Dear Mr. Gondek:

Cambria Environmental Technology, Inc. (Cambria) is pleased to present this report summarizing sampling and remediation system operation and maintenance (O&M) activities at the above-referenced site. Site activities were conducted in conjunction with AIG Environmental Management, Inc. (AIGEM) investigation field activities. Presented below is a site summary, our scope of work, and our conclusions.

SITE SUMMARY

This former Chevron Facility is located on Main Street in Craig, Alaska, on the western shoreline of Prince of Wales Island (Figure 1). Records indicate that Chevron Products Company (Chevron) constructed the site bulk fuels facility in the 1930's, and operated the facility until 1986. The facility has been operated by various organizations since, and is now operated by Harbor Enterprises d.b.a. Petro Marine.

Site History: Various site investigations have been conducted, including the installation of twelve monitoring wells and numerous soil borings. A vapor extraction system operated on site from 1989 to 1992. In 1989, a water treatment unit consisting of an oil/water separator and an air stripper were also installed to treat ground water draining from the tank farm area. In 1989, separate phase hydrocarbons were noted in one monitoring well. Benzene and total recoverable petroleum hydrocarbons have been detected in ground water at up to 12,000 parts per billion (ppb) and 35,000,000 ppb, respectively.

Hydrogeologic Setting: The site subsurface is reported to consist of poorly graded gravel and sand. The site topography slopes north, from the tank farm toward Bucareli Bay. Ground water flow direction is anticipated to follow the site topography, and historical data reports ground water lying approximately 2 to 8 ft below grade.

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SCOPE OF WORK

Our objective was to investigate and halt a leaking drainage pipe feeding into the site remediation system. In addition, Cambria was to sample selected temporary monitoring wells installed by AIGEM and install locking caps on the existing site wells. Mr. Bergstrom of Cambria conducted site activities September 10, 11, 13, and 14, 1997.

Site Maintenance: The leaking pipe was a conveyance pipe (3-inch diameter schedule 40 PVC) which carried water from a French drain within the southern (older) containment area to a water storage tank for the air stripper. The pipe runs below grade for all but the lowest six feet, nearest the air stripper. The leak was from a valve, located in front of the storage tank. The other end of the pipe, within the southern containment area, could not be uncovered and plugged because the screened area at the top of the pipe was too large and was buried under a significant volume of rock and soil.

After draining water from the pipe, the leaking valve was removed and a capping assembly was placed on the pipe, stopping any further leaking. The drained water was stored in drums on site with AIGEM's purge water, to be included in the site operator's waste water treatment system. Additional water was drained into the remediation system holding tank. A 4"x4" wood support was installed to support the lowest end of the pipe. The leak was stopped using available pipe and fittings (a 3-inch hubless coupler, a 4-inch hubless coupler, a length of 4-inch ABS pipe, a 4-inch ABS female adaptor, and a 4-inch ABS male plug), and those fittings are expected to remain secure for several years. We recommend eventually removing those fittings and solvent welding a 3-inch PVC slip end cap to the end of the pipe. This would provide a more permanent solution, but would require draining the conveyance line and French drain again.

Water Sampling: Cambria sampled site wells in accordance with the "Protocol for Monitoring Intrinsic Bioremediation in Ground Water" published in 1995 by Chevron Research and Technology Company, Health, Environment, and Safety Group. Cambria's ground water data is presented in Table 1. The AIGEM ground water data is included as Attachment 1.

All monitoring wells sampled were purged manually using hand bailers. During purging, the ground water temperature, pH, conductivity, dissolved oxygen (DO), and oxidation-reduction potential (ORP) were measured. These measurements were taken ex situ for monitoring wells, and were not taken on temporary wells since AIG purged these wells prior to Cambria's sampling.

Due to the combination of a 48-hour hold time on some samples' analyses and the remoteness of the site, all wells were sampled on two consecutive days. On the first day, alkalinity, sulfate, and ferrous iron samples were collected. Nitrate samples were collected during the second day of sampling.

Locking Cap Installation: Locking well head caps were placed on all monitoring wells located, and locked with standard Chevron padlocks. Wells MW-1C, MW-2, MW-8, and MW-9 were not located. Although a cap and lock were placed on well MW-1, the top of the casing was cracked, preventing a secure seal. Due to a lack of survey equipment, the well head was not modified.

RESULTS

Using Cambria's and AIGEM's data, we have assembled isoconcentration maps for TPHd in soil, TPHg in soil, TPHd in ground water, TPHg in ground water, nitrate, sulfate, and ORP. These are presented as Figures 2 through 8, respectively.

Extent of Petroleum Hydrocarbons: The highest concentrations of TPHd in soil are located in the two above ground storage tanks (AST) containment areas and the soils immediately down slope (north) of the AST's. Decreasing concentrations extend approximately 150 ft in the presumed ground water flow direction (north), toward Bucareli Bay. This is consistent with the tank farm being the source area, and a dissolved plume having migrated slightly down gradient. From this map, we estimate that within 100 ft downgradient of the tank farm soil concentrations of TPHd fall below 200 parts per million (ppm). The upgradient extent of the TPHd plume (above 200 ppm) is defined by the September, 1997 data.

AIGEM reported low concentrations of TPHg in soil samples taken from three soil borings. These samples were all from locations on the northern edge of the southern (older) containment area (Figure 3). The extent of TPHg in soil samples collected in September 1997 is confined to the vicinity of AST containment areas.

The highest concentrations of TPHd in ground water correspond to the areas with the highest concentrations of TPH d in soil (Figure 4). Concentrations of TPHd decrease in the downgradient direction. Although not delineated in the up- or crossgradient direction in this round of sampling, previous ground water sampling has provided delineation to the west (B95-3) and decreasing concentration in the upgradient direction (B95-1).

Concentrations of TPHg in ground water are limited to the two AST containment areas and an area immediately down slope (north) of Tank 11 (Figure 5). TPHg was not detected in samples to the north, south, east, and west of the dissolved TPHg plume.

Biological Parameters: Isoconcentration maps for nitrate, sulfate, and oxygen reduction potential (ORP) are presented as Figures 6 through 8, respectively. Interpretation of these maps is presented below. Nitrates and sulfates were analyzed as indicators of anaerobic biodegradation of the hydrocarbon plume. ORP was analyzed to assess how oxidizing the subsurface environment was through a cross section of the hydrocarbon plume.

Nitrates: Nitrates serve as both nutrients and electron acceptors for subsurface bacteria. Typically present at concentrations of a few ppm, nitrates in shallow ground water originate from human and animal wastes, the decay of organic materials, and artificially applied fertilizers. In areas of little biological activity, nitrate concentrations remain fairly uniform in both the down- and crossgradient directions. When nitrate containing ground water flows through a biologically active zone, the nitrates are consumed as nutrients (building blocks of the biomass) and as electron acceptors. As shown in Figure 6, the nitrate isoconcentration map, dissolved nitrates in ground water are lower within the petroleum hydrocarbon plume than in areas further downgradient and lateral from the source area. These maps also indicate that nitrate and sulfate are being reintroduced to the nitrate- and sulfate-deficient ground water at relatively high concentrations.

Sulfates: Sulfates also serve as both nutrients and electron acceptors for subsurface bacteria. The distribution of sulfates typically parallels that of nitrates for the same reasons stated above - they are consumed within the biologically active area of the plume. Figure 7 shows greatly decreased sulfate concentrations (more than 100-fold) in the areas of highest TPH concentrations in soil and ground water. Sulfate concentrations partially rebound downgradient of the plume (presumably due to mixing of desulfated ground water present with ground water which passed to the sides of the hydrocarbon plume). Sulfates measured at 522 ppm in well TW-1 are assumed to reflect minerals present in seawater and were not contoured.

Oxygen Reduction Potential: Both oxidizing and reducing processes occur in the subsurface, depending on soil chemistry, contaminates, and, especially, biological activity. Reducing conditions, yielding negative ORP values, may indicate areas where anaerobic biodegradation is occurring. All of the measured ORP levels were positive, indicating oxidizing conditions. However, the ORP isoconcentration map shows lower ORP levels in and near the plume than levels further from the plume. This small decrease in ORP is consistent with the small decrease in DO (discussed below) and indicates that biodegradation is occurring primarily aerobically, rather than anaerobically.

Dissolved Oxygen: DO was measured in ground water within and outside of the hydrocarbon plume. Concentrations of DO were about 1 ppm lower in the center of the plume (MW-1), but high in all ground water measured. This indicates that while DO is being consumed with the hydrocarbon plume, it is not a limiting factor for biological activity at this site with shallow ground water. The shallow depth to water allows a greater rate of oxygen diffusion into the ground water than at deeper sites. Also, the relatively cold ground water has a greater ability to dissolve oxygen.

CONCLUSION

The September 1997 field work, sampling and subsequent analysis have accomplished the following:

- Stopped the leak in piping which led from the French drain in the southern AST containment area;
- Documented the biological activity occurring in the center of the hydrocarbon plume; and
- Identified the parameters currently limiting the rate of biodegradation of petroleum hydrocarbons.

CLOSING

We appreciate the opportunity to provide consultant services to Chevron. Please call if you have any questions or comments.

Sincerely,
Cambria Environmental Technology, Inc.

David B. Thomas

David B. Thomas
Senior Engineer

Attachments:

Figure 1 - Site Plan
Figure 2 - Ground Water Benzene Isoconcentration Map
Figure 3 - Ground Water TPHg Isoconcentration Map
Figure 4 - Ground Water TPHd Isoconcentration Map
Figure 5 - Soil Benzene Isoconcentration Map
Figure 6 - Soil TPHg Isoconcentration Map
Figure 7 - Soil TPHd Isoconcentration Map
Figure 8 - Dissolved Nitrate Sulfate Isoconcentration Map
Figure 9 - Dissolved Sulfate Isoconcentration Map
Figure 10 - Oxidation-Reduction Potential Isoconcentration Map
Table 1 - Field and Laboratory Bioremediation Parameters
Attachment A - AIGEM Analytical Data

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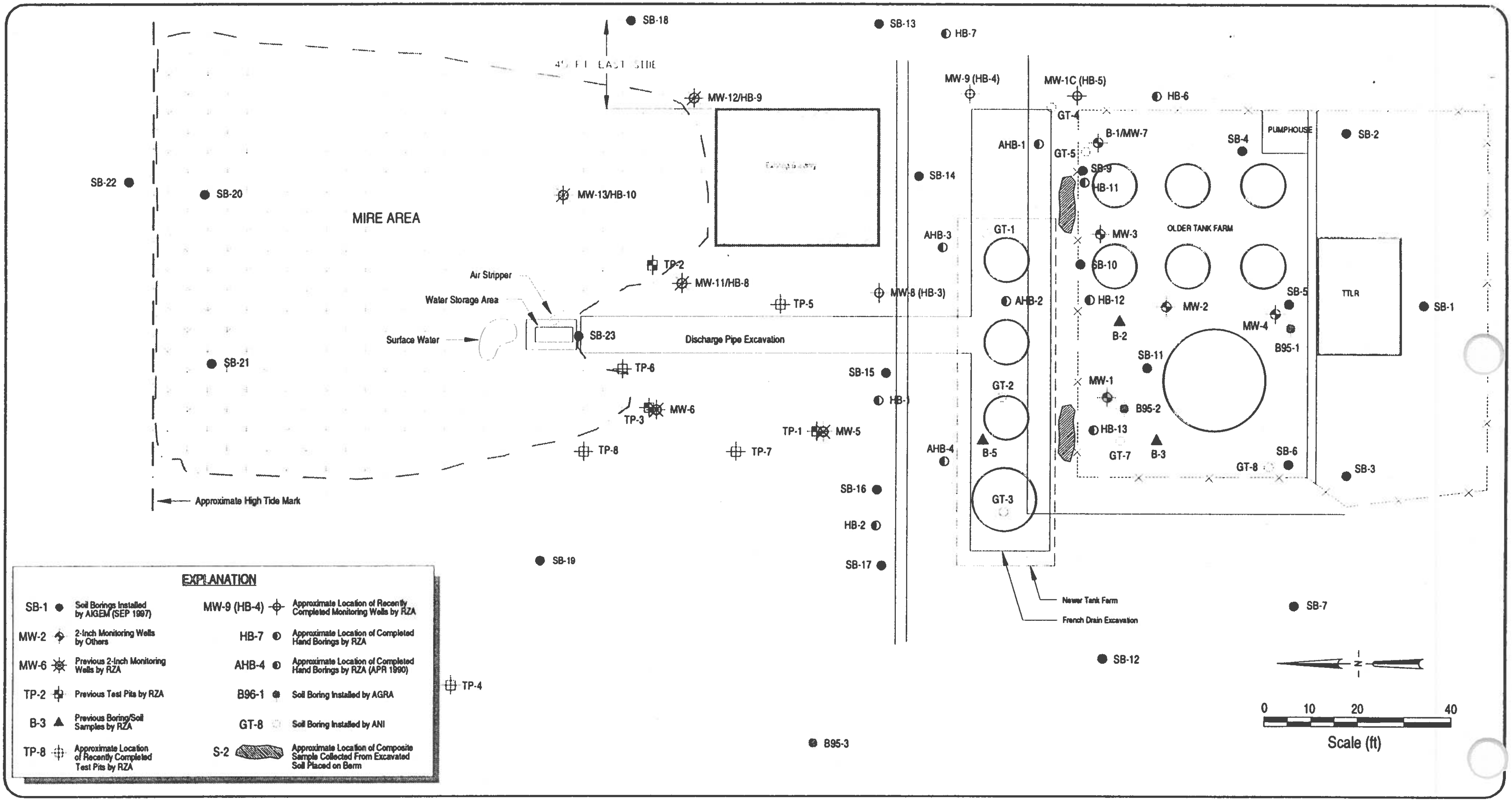

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Bulk Fuel Facility
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Craig, Alaska

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Site Plan

September, 1997

FIGURE
1

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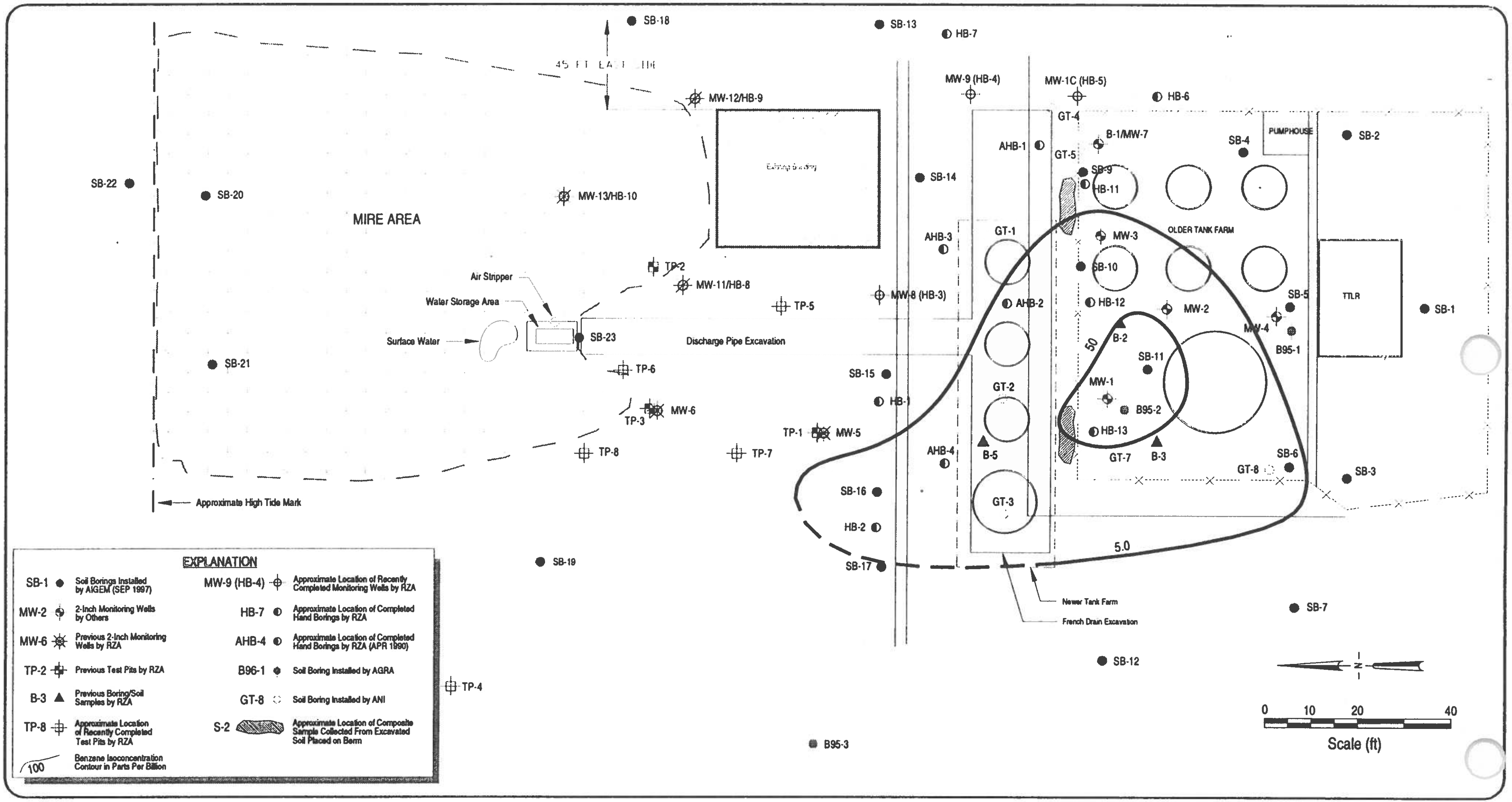

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Ground Water Benzene
Isoconcentration Map
September, 1997

FIGURE
2

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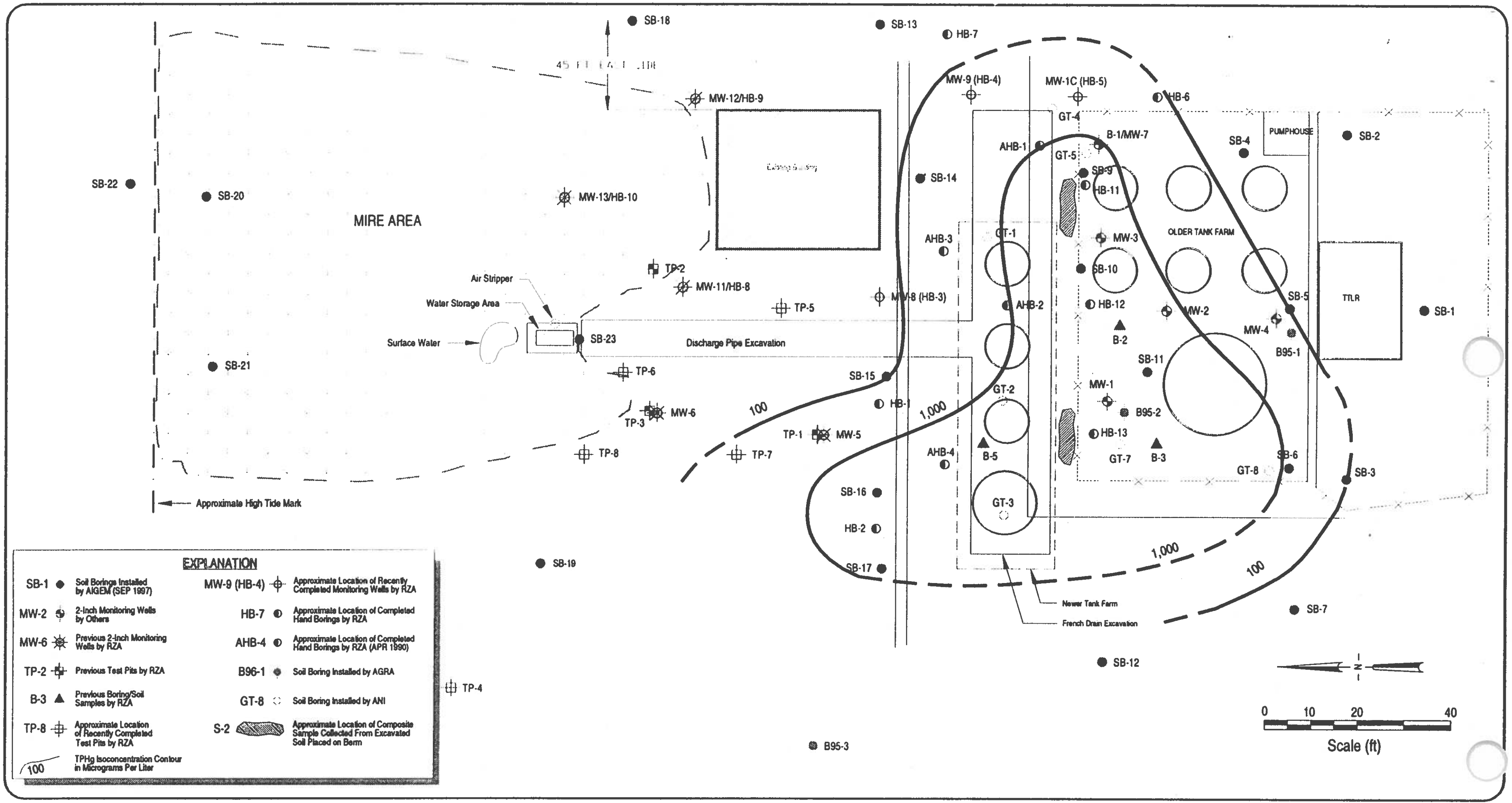

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Ground Water TPHg
Isoconcentration Map
September, 1997

FIGURE
3

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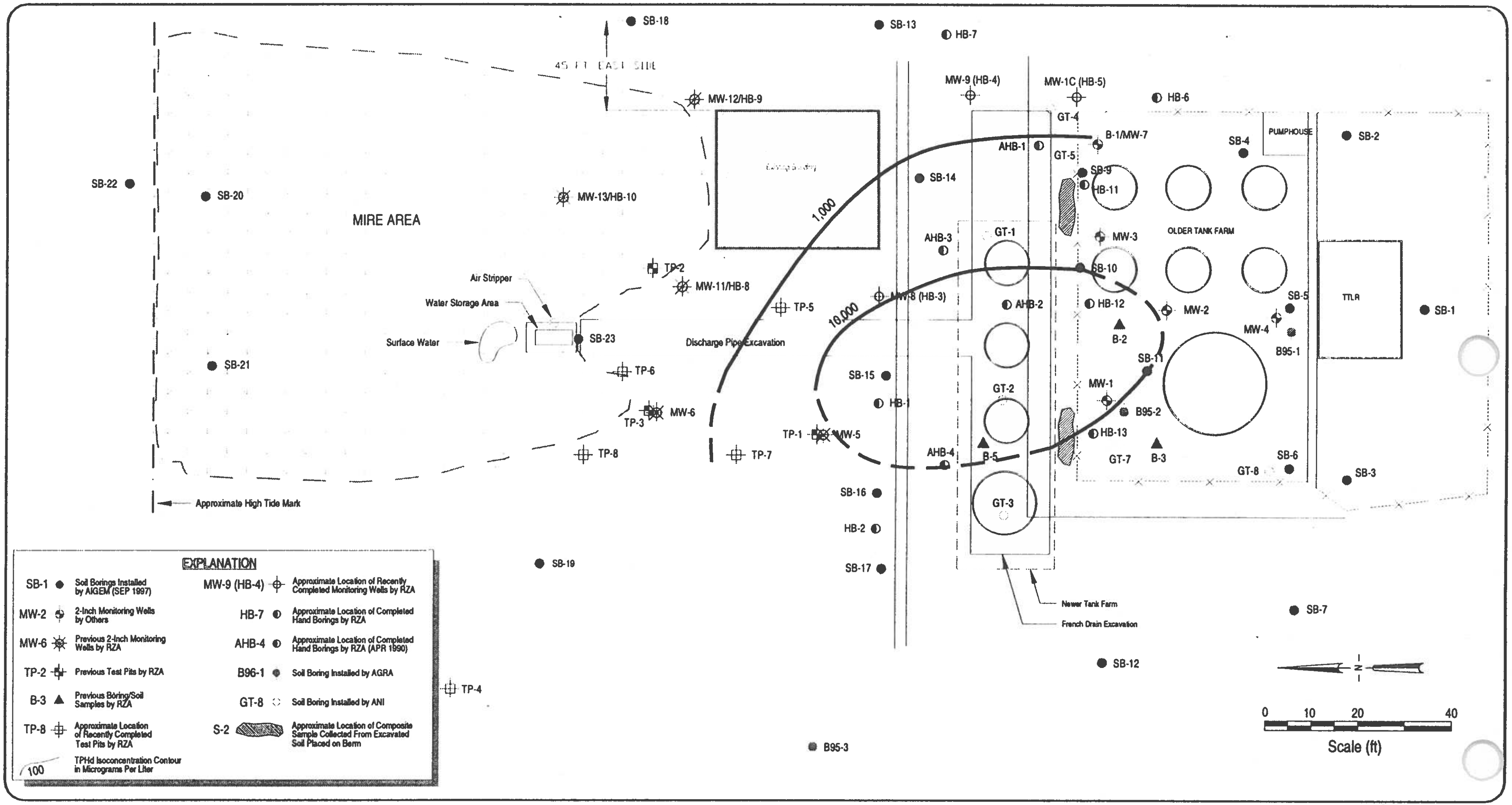

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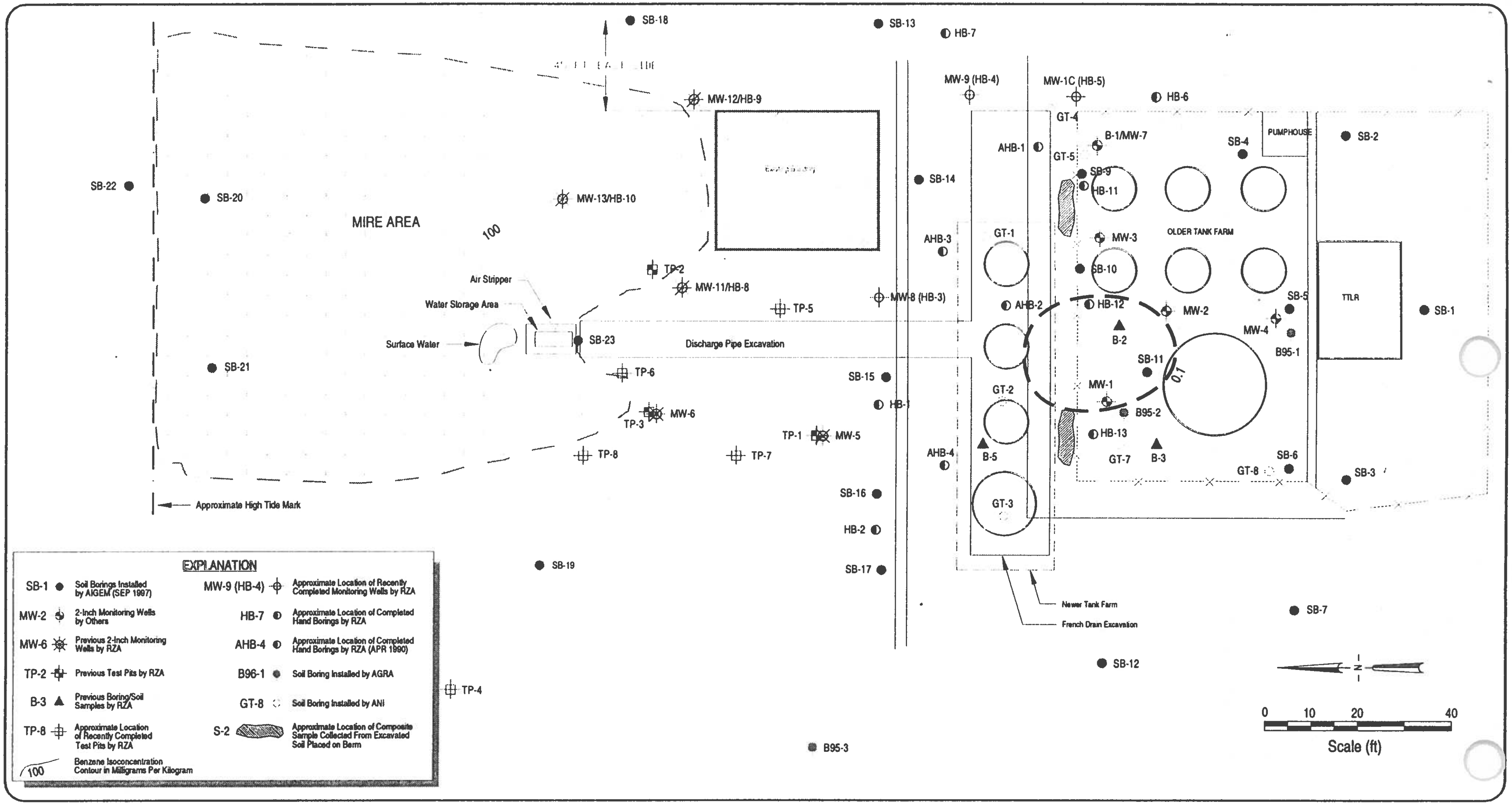
Ground Water TPHd
Isoconcentration Map
September, 1997

FIGURE
4

03/11/98



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Soil Benzene Isoconcentration Map

September, 1997

FIGURE
5

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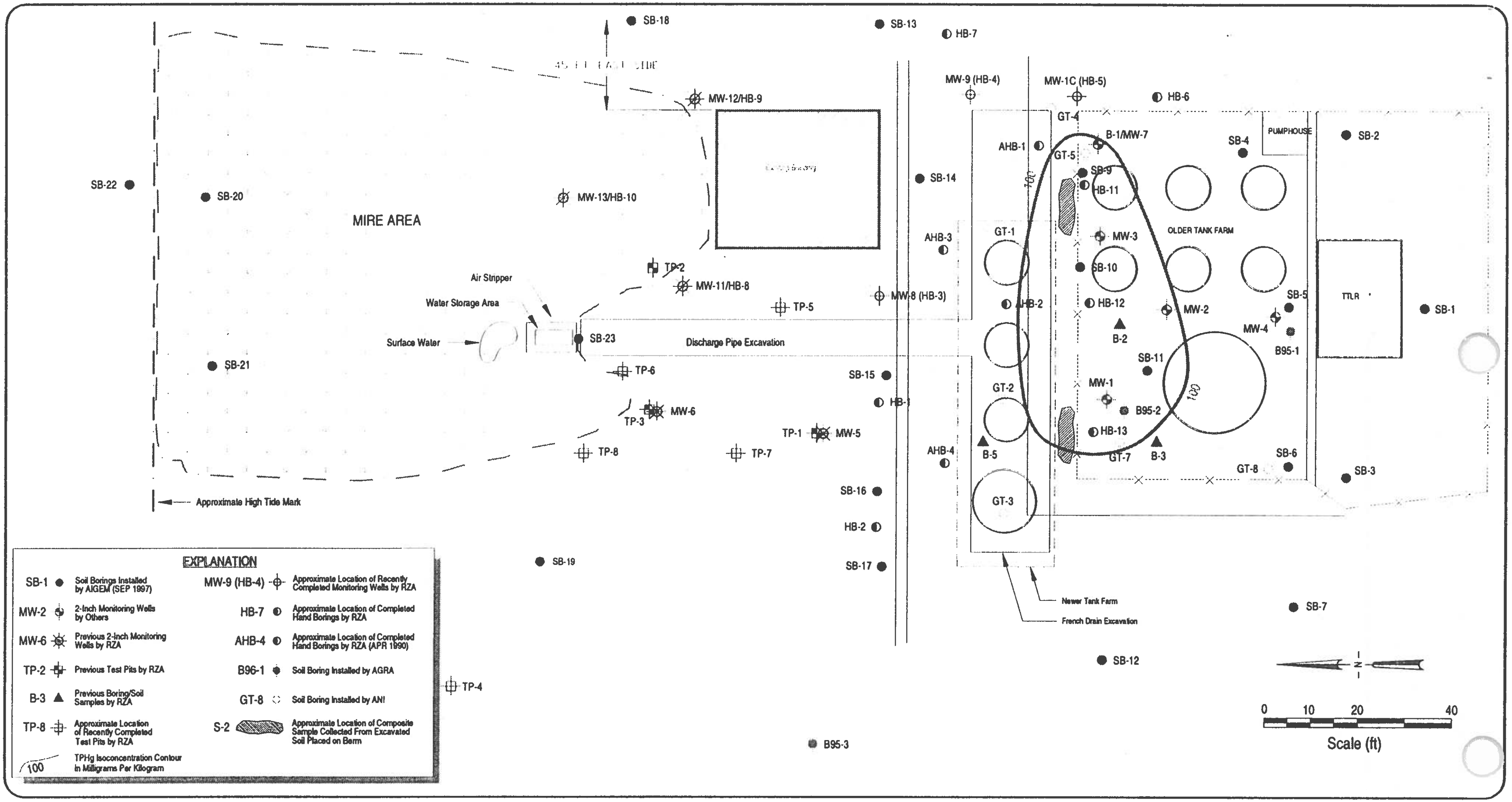

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Soil TPHg
Isoconcentration Map
September, 1997

FIGURE
6

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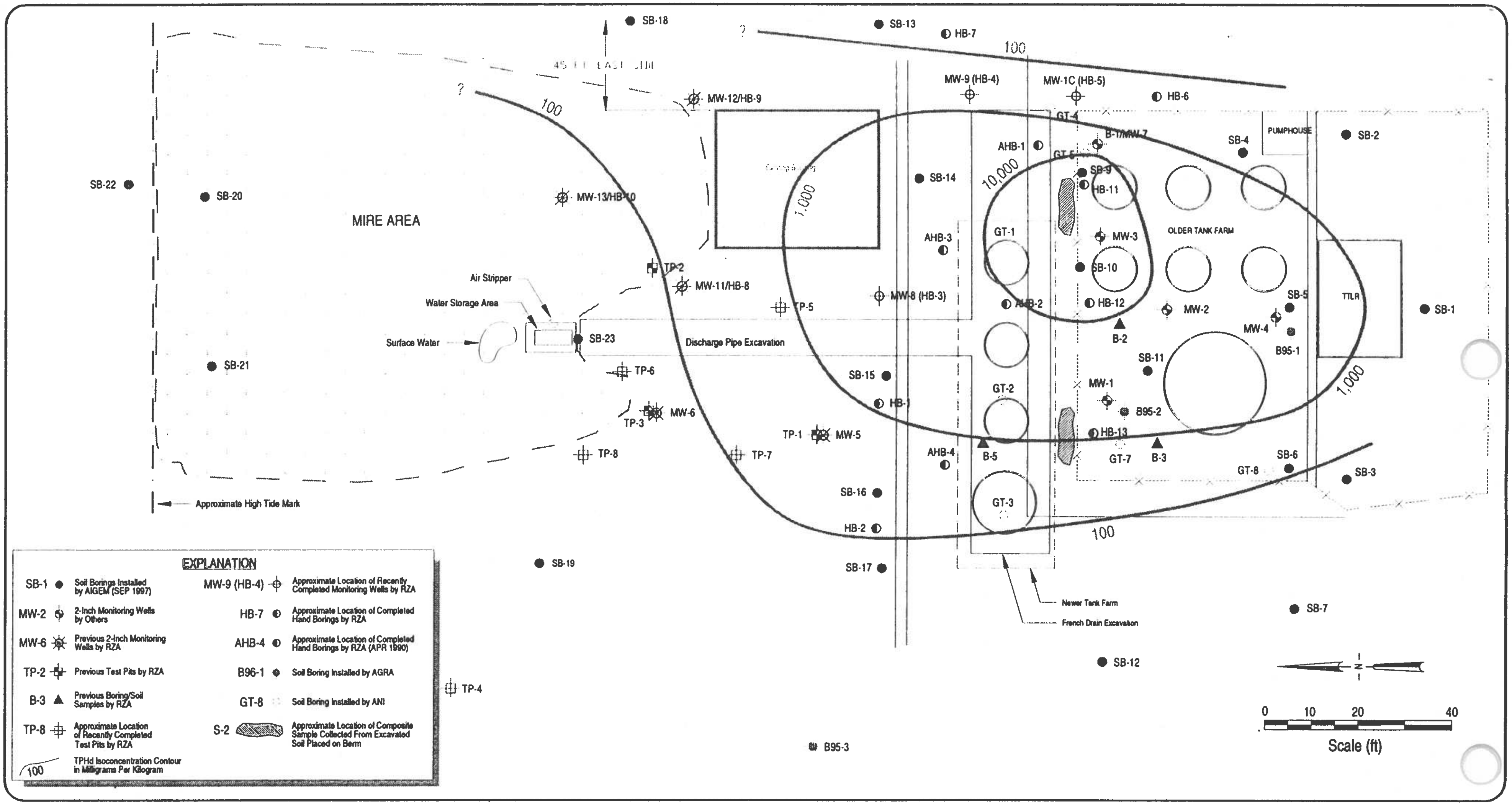

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Soil TPHd
Isoconcentration Map
September, 1997

FIGURE
7

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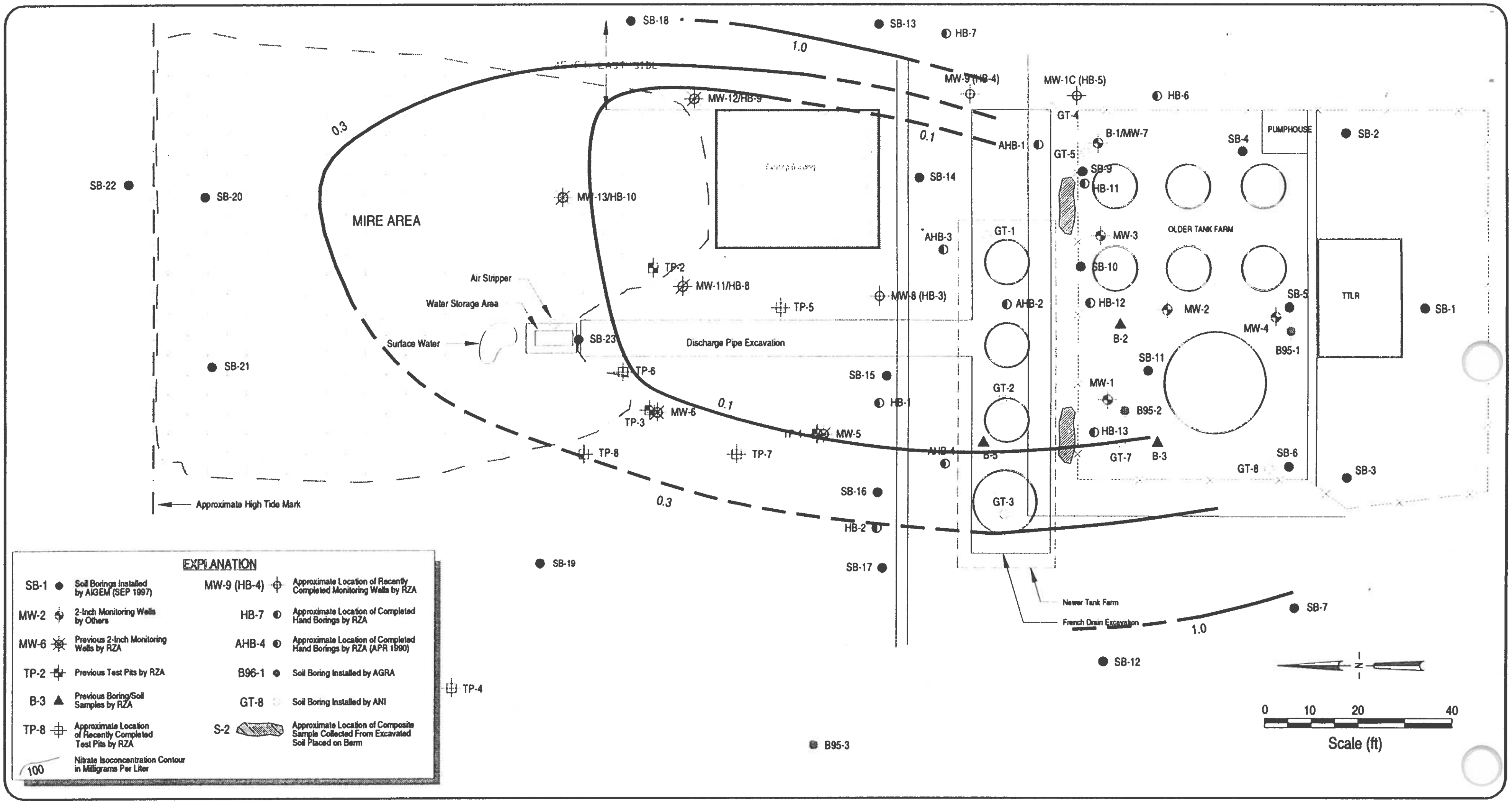

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Dissolved Nitrate
Isoconcentration Map
September, 1997

FIGURE
8

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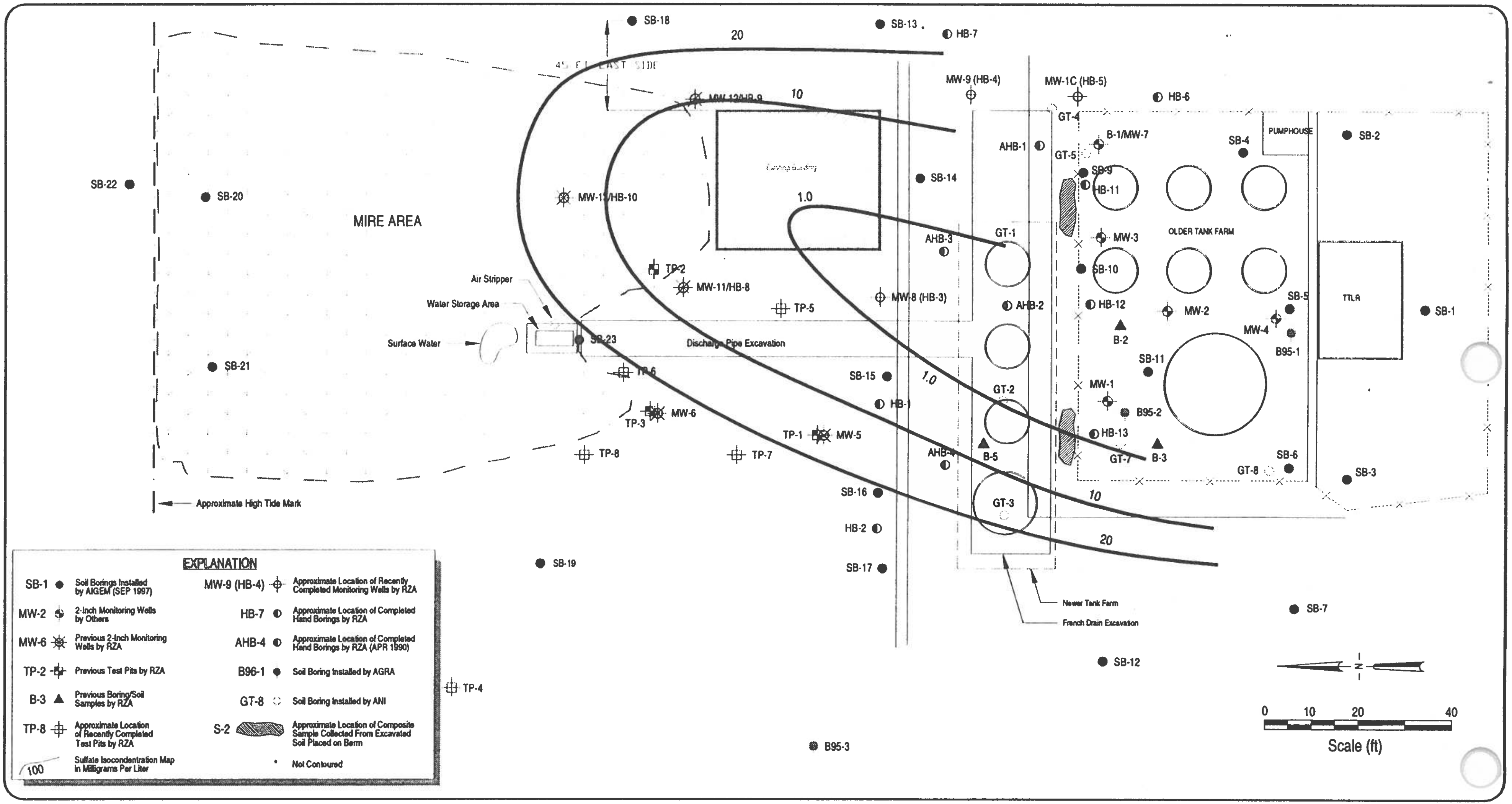

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Dissolved Sulfate
Isoconcentration Map
September, 1997

FIGURE
9

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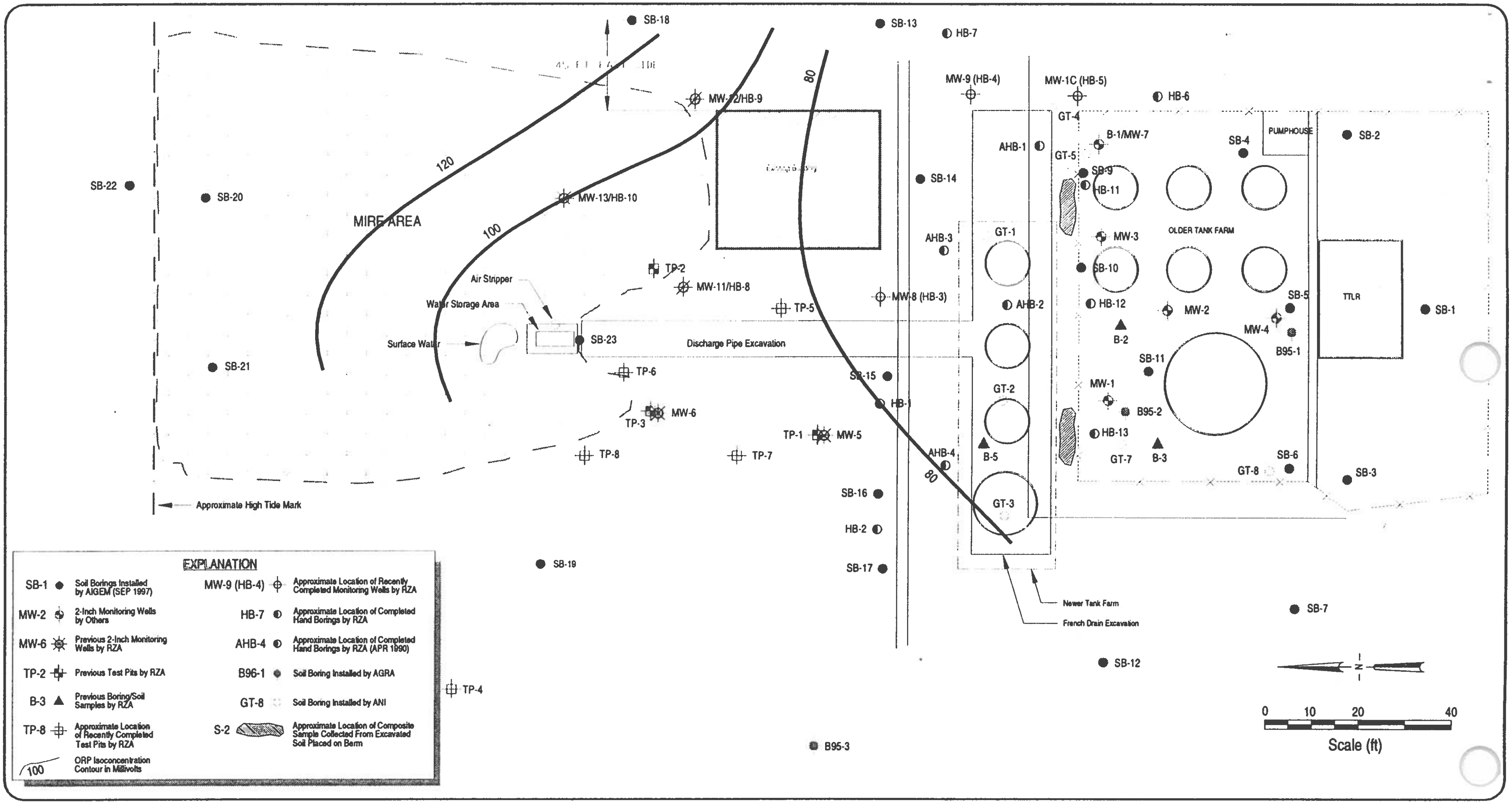

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Oxidation-Reduction Potential
Isoconcentration Map
September, 1997

FIGURE
10

03/20/98

Field and Laboratory Bioremediation Parameters - Former Chevron Bulk Fuels Facility 1001425, Wards Cove Packing Company, Former Chevron Bulk Fuels Facility, Craig, Alaska

WHERE ARE THESE POINTS?

Sample ID	Date Sampled	Pre-Purge DO (mg/L)	Post-Purge DO (mg/L)	Pre-Purge ORP (mV)	Post-Purge ORP (mV)	Alkalinity (mg/L)	Ferrous Iron (mg/L)	Sulfate (mg/L)	Nitrate-Nitrogen (mg/L)
TW-1	9/14/97	---	13.65	---	191	216	<0.00500	522	0.770
TW-2	9/11/97	---	14.79	---	73	275	<0.00500	92.8	1.16
TW-3	9/11/97	---	15.01	---	59	155	<0.00500	51.2	2.73
MW-1	9/11/97	15.99	13.89	40	42	110	0.0101	<0.100	<0.0500
MW-5	9/14/97	13.8	15.05	125	87	149	0.0198	11.9	0.0910
MW-6	9/11/97	4.73	15.88	70	35	177	<0.00500	22.7	0.127
MW-12	9/14/97	14.55	14.99	146	115	139	<0.00500	5.65	0.0520

Abbreviations/Notes:

DO = dissolved oxygen
ORP = oxidation-reduction potential
mg/L = milligrams per liter
mV = millivolts
--- = not measured

Samples analyzed by North Creek Analytical Services

Attachment A

AIGEM Analytic Data

Table 1: Groundwater Monitoring Data
Wards Cove Tank Farm Facility, Craig, Alaska

Well	Date Monitored	Depth to Groundwater	Temperature (Fahrenheit)	Conductivity (a)	pH	Comments
SB-4	10-Sep-97	2.70	56	110	7.6	Sheen observed
SB-5	10-Sep-97	2.20	55	290	7.8	Sheen observed
SB-6	10-Sep-97	2.00	61	176	6.2	Sheen observed
SB-7	10-Sep-97	2.10	57	213	7.9	
SB-9	10-Sep-97	2.20	59	185	6.9	Sheen observed
SB-10	10-Sep-97	2.20	56	186	7.5	Sheen observed
SB-11	10-Sep-97	3.00	56	288	7.5	Sheen observed
SB-12	10-Sep-97	--	--	--	--	No groundwater yield
SB-13	10-Sep-97	5.00	55	303	8.4	
SB-14	10-Sep-97	--	--	--	--	No groundwater yield
SB-15	10-Sep-97	4.40	56	131	7.5	Sheen observed
SB-16	10-Sep-97	4.65	55	212	7.6	Sheen observed
SB-17	10-Sep-97	--	--	--	--	No groundwater yield
SB-18	10-Sep-97	1.60	58	21	6.7	
SB-19	10-Sep-97	--	--	--	--	No groundwater yield
SB-20	10-Sep-97	--	--	--	--	No groundwater yield
SB-21	10-Sep-97	--	--	--	--	No groundwater yield
MW-11	11-Sep-97	NM	NM	NM	NM	
MW-13	11-Sep-97	NM	NM	NM	NM	

(a) microsiemens per centimeter
NM Not measured
-- Well did not yield sufficient groundwater to monitor or sample

Table 2: Soil Laboratory Analytical Results
Wards Cove Bulk Fuel Facility, Craig, Alaska

Sample	Collected	TPH-D	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	MTBE
SB1: 0'-0.5'	11-Sep-97	**190**	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB2: 0'-0.5'	11-Sep-97	**170**	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB3: 0'-0.5'	11-Sep-97	**44**	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB4: 0.5'-1'	10-Sep-97	**590**	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB4: 2.5'-3'	10-Sep-97	**390**	ND<10	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1
SB5: 0.5'-1'	10-Sep-97	**350**	ND<10	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1
SB5: 2.5'-3'	10-Sep-97	**6,800**	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB6: 0.5'-1'	10-Sep-97	**630**	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB6: 2.5'-3'	10-Sep-97	**49**	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB7: 2.5'-3'	10-Sep-97	**35**	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB9: 0.5'-1'	10-Sep-97	**11,000**	**100**	ND<0.1	ND<0.1	ND<0.1	**2.9**	ND<0.1
SB9: 2.5'-3'	10-Sep-97	**14,000**	**200**	ND<0.1	**0.3**	**0.6**	**11**	ND<0.1
SB10: 0.5'-1'	10-Sep-97	**14,000**	**500**	ND<0.1	**0.5**	**0.3**	**2.4**	ND<0.1
SB10: 2.5'-3'	10-Sep-97	**7,800**	**100**	ND<0.1	ND<0.1	**0.1**	**0.8**	ND<0.1
SB11: 0.5'-1'	10-Sep-97	**2,800**	**80**	ND<0.1	ND<0.1	**0.2**	**1**	ND<0.1
SB11: 2.5'-3'	10-Sep-97	**4,400**	**500**	**0.2**	ND<0.1	**1.5**	**8.8**	ND<0.1
SB12: 2.5'-3'	10-Sep-97	**ND<10**	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB13: 3'-3.5'	9-Sep-97	**ND<10**	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB14: 0'-0.5'	9-Sep-97	**3,800**	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB14:4.5'-5'	10-Sep-97	**110**	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB15: 3.5'-4'	9-Sep-97	**1,300**	ND<10	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1
SB16: 4'-4.5'	9-Sep-97	**300**	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB17: 3.5'-4'	9-Sep-97	**88**	ND<10	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1
SB18: 2.5'-3'	10-Sep-97	**320**	ND<10	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1
SB19: 2.5'-3'	10-Sep-97	**ND<10**	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB20: 2.5'-3'	10-Sep-97	**55**	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB21: 2.5'-3'	10-Sep-97	**33**	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB23: 0.5'-1'	11-Sep-97	**ND<10**	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005

Table 2: Soil Laboratory Analytical Results
Wards Cove Bulk Fuel Facility, Craig, Alaska

TPHG = Total petroleum hydrocarbons as gasoline
TPHD = Total petroleum hydrocarbons as diesel
All results in milligrams per kilogram
NA = Not analyzed
ND = Not detected
TPHG and BTEX analysis by USEPA Method 8260 and GC/MS combination
TPHD analysis by GC/MS combination (extracted by USEPA Method 3510)
TPHD analytical range is C8-C40
Samples analyzed by Zymax Envirotechnology in San Luis Obispo, California

Table 3: Groundwater Laboratory Analytical Results
Wards Cove Bulk Fuel Facility, Craig, Alaska

Sample	Collected	TPHD	TPHG	Benzene	Toluene	Ethylbenzene	Xylenes	MTBE*
SB4	10-Sep-97	**NA**	ND<50	ND<0.5	ND<0.5	ND<0.5	**2.8**	ND<0.5
SB5	10-Sep-97	**NA**	ND<100	ND<1.0	ND<1.0	ND<1.0	ND<1.0	ND<1.0
SB6	10-Sep-97	**3,100**	**1,000**	**7.3**	**3.9**	**1.4**	**7.1**	**3.1**
SB7	10-Sep-97	NA	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5
SB9	10-Sep-97	NA	**2,000**	**2.9**	**13**	**25**	**240**	ND<2.0
SB10	10-Sep-97	NA	**3,000**	**32**	**29**	**9.9**	**58**	ND<2.0
SB11	10-Sep-97	**10,000**	**5,000**	**160**	**9.3**	**41**	**210**	ND<2.0
SB13	10-Sep-97	ND<100	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5
SB15	10-Sep-97	**48,000**	ND<100	ND<1.0	ND<1.0	ND<1.0	ND<1.0	ND<1.0
SB16	10-Sep-97	NA	**10,000**	**13**	**2.4**	**4**	**21**	ND<2.0
SB18	10-Sep-97	**280**	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5
SB21	10-Sep-97	NA	ND<50	ND<0.5	**0.7**	ND<0.5	ND<0.5	ND<0.5
SB22	11-Sep-97	**150**	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5
SB23	11-Sep-97	**250**	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5
MW-11	11-Sep-97	**130**	ND<50	ND<0.5	**1.1**	ND<0.5	ND<0.5	ND<0.5
MW-13	11-Sep-97	**160**	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5
Air Stripper Piping	9-Sep-97	**910**	**210**	**4.6**	**0.5**	**0.9**	**0.9**	ND<0.5
Surface Water Air Stripper	9-Sep-97	**1,100**	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5

TPHD = Total petroleum hydrocarbons as diesel
TPHG = Total petroleum hydrocarbons as gasoline
All results in micrograms per liter
ND = Not detected
NA = Not analyzed because sample destroyed in transit to laboratory
TPHG and BTEX analysis by USEPA Method 8260 and GC/MS combination
TPHD analysis by GC/MS combination (extracted by USEPA Method 3550)
MTBE = Methyl-t-Butyl Ether
Samples analyzed by Zymax Envirotechnology in San Luis Obispo, California

Table 4: **Breakdown of Soil Analytical Results by Carbon Chain Ranges**
Wards Cove Bulk Fuel Facility, Craig, Alaska

Sample Number	Date Collected	C6-C10 TPH	C6-C10 Aliphatic	C6-C10 Aromatic	C10-C25 TPH	C10-C25 Aliphatic	C10-C25 Aromatic	C25-C36 TPH	C25-C36 Aliphatic	C25-C36 Aromatic	PNAs
SB5: 2.5'-3'	10-Sep-97	ND<10	ND<10	ND<10	6,680	5,344	**2,672**	120	108	36	ND
SB9: 0.5'-1'	10-Sep-97	100	70	50	10,500	8,400	**4,200**	500	450	150	ND
SB9: 2.5'-3'	10-Sep-97	200	140	100	**13,500**	**10,800**	**5,400**	500	450	150	8.9 (a)
SB10: 0.5'-1'	10-Sep-97	500	350	**250**	**13,800**	**11,040**	**5,520**	200	180	60	ND
SB10: 2.5'-3'	10-Sep-97	100	70	50	7,710	6,168	**3,084**	90	81	27	ND
SB11: 0.5'-1'	10-Sep-97	80	56	40	2,760	2,208	**1,104**	40	36	12	ND
SB11: 2.5'-3'	10-Sep-97	500	350	**250**	4,350	3,480	**1,740**	50	45	15	ND
SB14: 0'-0.5'	9-Sep-97	ND<10	ND<10	ND<10	3,260	2,608	**1,304**	540	486	162	ND
SB15: 3.5'-4'	9-Sep-97	20	14	ND<10	1,230	984	**492**	70	63	21	ND

Shaded concentrations are those that exceed ADEC Soil Cleanup Standards (Table B from Draft Cleanup Standards dated 11/12/97 assuming migration to groundwater and over 40 inches annual rainfall)

All results in milligrams per kilogram
TPH = Total petroleum hydrocarbons
PNAs = Polynuclear aromatic hydrocarbons
ND = Not detected (listed with laboratory method detection limit)
Results reported by Zymax Envirotechnology in San Luis Obispo, California
(a) Naphthalene

The following percentages were used to break down the TPH into aliphatic and aromatic composition:

Carbon Range	Percent Aliphatic	Percent Aromatic
C6-C10	70	50
C10-C-25	80	40
C25-C36	90	30

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Phone #		Co.	
Fax # 907 465 5262		Phone #	
		Fax #	

Environmental Management
A Division of AIG Consultants, Inc.
3090 South Bristol Street, Suite 600
Costa Mesa, California 92626
Direct Dial: (714) 435-6654
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A Member Company of American International Group, Inc.

December 2, 1999

Mr. Jan Supler
Wards Cove Packing Company
98 E. Hamlin Street
Seattle, Washington 98105-0030

RE: Review of Cambria Environmental Technology, Inc.'s Report of Field Activities and Bioremediation Monitoring dated April 9, 1998 for Craig, Alaska Site.

Dear Mr. Supler:

At the request of Wards Cove Packing Company (Wards Cove), AIG Consultants, Inc.-Environmental Management Division (AIGC-EM) performed a review of the Cambria Environmental Technology, Inc. (Cambria) document referenced above (Attachment 1). Presented below are AIGC-EM's comments regarding the document and the potential for effective in-situ bioremediation at the Wards Cove site in Craig, Alaska.

EVALUATION OF GROUNDWATER CHEMISTRY AND POTENTIAL ONGOING IN-SITU BIOREMEDIATION IN THE GROUNDWATER

A variety of indigenous organisms that live in the subsurface can convert contaminants to less toxic byproducts. In aerobic respiration, microbes transform organic contaminants to carbon dioxide by transferring electrons from the contaminant (oxidizing it) to oxygen (reducing it) or to a less-favored electron acceptor. Dissolved oxygen (DO) is the most thermodynamically-favored electron acceptor used in the biodegradation of petroleum hydrocarbons, which are readily biodegradable under aerobic conditions. Ideally, aerobic biodegradation of petroleum hydrocarbons occurs when DO concentrations are greater than 2 milligrams per liter (mg/L). During aerobic biodegradation, DO levels are reduced as aerobic respiration occurs.

Bioremediation parameter results from the September 1997 sampling event, including DO concentrations, are presented in Table 1 of Attachment 1. During that event, DO concentrations (post purging) ranged from 13.65 mg/L to 15.88 mg/L. Cambria states that the data indicates that DO is being consumed by the hydrocarbon plume; however, this is a weak argument due to the relatively small difference between DO concentrations within and outside of the plume. AIGC-EM does concur with Cambria that the shallow depth to groundwater allows a greater rate of oxygen diffusion into the groundwater than at deeper sites. The most favorable assessment of the data with respect to potential for aerobic biodegradation at the site would be that the high DO concentrations suggest that future aerobic biodegradation is not limited by the availability of oxygen.

Under oxidizing conditions, the oxidation-reduction (redox) potential of groundwater is positive and reducing conditions are characterized by negative readings; therefore the redox potential of groundwater within the contaminant plume should be less than that measured outside the plume. Cambria presents redox potential levels in and near the plume that are lower than levels further downgradient of the plume, which may indicate that some level of aerobic biodegradation is occurring within the plume.

After DO has been depleted in the microbiological treatment zone, nitrate may be used as an electron acceptor during anaerobic biodegradation. In the process of denitrification, nitrate is reduced to nitrite, and then to nitrogen, which tends to leave the system as a gas. Nitrate concentrations detected during the September 1997 sampling event are slightly lower within the plume than in areas further downgradient and lateral from the source area. This may be indicative of denitrification processes that have occurred during natural attenuation.

After DO and nitrate have been depleted, sulfate may be used as an electron acceptor for anaerobic biodegradation. Fluctuation of sulfate concentrations across a contaminant plume is used as an indicator of anaerobic degradation of fuel compounds. Sulfate concentrations in groundwater samples collected on June 1, 1995, ranged from less than 0.01 mg/L to 522 mg/L. The sulfate ranges detected during the event indicate that sulfate is available as an electron acceptor for anaerobic biodegradation and that bioactivity is reducing sulfate concentrations in portions of the contaminant plume. Cambria assumes that the concentration of 522 mg/L detected in well TW-1 reflects minerals present in seawater, which may be a reasonable assumption.

Ferric iron may be used as an electron acceptor during anaerobic biodegradation of petroleum hydrocarbons. In this process, ferric iron is reduced to ferrous iron which may be soluble in water. The detection of ferrous iron concentrations is used as an indicator of anaerobic degradation of petroleum hydrocarbons. Ferrous iron was not detected in five of the seven wells sampled during the September 1997 event. Concentrations of ferrous iron in the remaining 2 wells were 0.0101 mg/L and 0.0198 mg/L, indicating that ferric iron in the subsurface is not being significantly reduced by anaerobic biodegradation processes. Cambria did not comment on ferrous iron concentrations in its report.

CONCLUSIONS

Given that DO is the most thermodynamically-favored electron acceptor used in the biodegradation of petroleum hydrocarbons, it would be expected that the decrease in DO concentrations within the contaminant plume as compared to those outside of the plume would be greater than that observed during the September 1997 event. A more-indicative trend is observed where sulfate concentrations within the plume are more than 100 times less than those outside of the plume, which is the strongest evidence of ongoing anaerobic (not aerobic) biodegradation at this site. It is AIGC-EM's opinion that while subsurface conditions appear to be conducive for biodegradation of petroleum hydrocarbons at this site, data indicates that the current rate of biodegradation will not effectively reduce contaminant concentrations to groundwater cleanup levels in a timely manner.

In the only two wells within the tank farm that were sampled by Cambria in July 1999 (MW-1 and MW-7), the concentration of total petroleum hydrocarbons as diesel (TPHD) in MW-1 was 66.5 mg/L as compared to 7.5 µg/L during the previous sampling event in July 1998; and, the concentration of TPHD in MW-7 was 284 mg/L (far exceeding the ADEC Section 1.2.3 Table C Draft Guidance Cleanup Level of 1.5 mg/L) (Well MW-7 had not been previously analyzed for TPHD). Similar results are reflected in Well MW-12 (located downgradient of the tank farm). The concentration of TPHD in MW-12 was 6.72 mg/L as compared to 0.213 mg/L during the previous event in July 1998. As stated above, this indicates that the current rate of biodegradation will not effectively reduce contaminant concentrations to groundwater cleanup levels in a timely manner. Given that DO concentrations in the groundwater are already high, it is unlikely that enhancement of aerobic bioremediation, such as the addition of oxygen-releasing compounds to the groundwater, would increase the rate of biodegradation at this site.

If you have any questions regarding this document, please do not hesitate to contact me at (714) 435-6654.

Sincerely,
AIG Consultants, Inc.
Environmental Management Division

Darryl Snow
Senior Environmental Consultant

Attachment 1: Copy of Cambria's Report of Field Activities and Bioremediation Monitoring Dated April 9, 1998

ATTACHMENT 1
COPY OF CAMBRIA'S REPORT OF FIELD ACTIVITIES AND BIOREMEDIATION MONITORING
DATED APRIL 9, 1998

CAMBRIA

April 9, 1998

Mr. Bob Gondek
Chevron Products Company
6001 Bollinger Canyon Road, Building L
San Ramon, California 94583-0804

Re: **Report of Field Activities and Bioremediation Monitoring**
Former Chevron Bulk Fuels Facility #100-1425
302 Main Street
Craig, Alaska
Cambria Project #31-718

Dear Mr. Gondek:

Cambria Environmental Technology, Inc. (Cambria) is pleased to present this report summarizing sampling and remediation system operation and maintenance (O&M) activities at the above-referenced site. Site activities were conducted in conjunction with AIG Environmental Management, Inc. (AIGEM) investigation field activities. Presented below is a site summary, our scope of work, and our conclusions.

SITE SUMMARY

This former Chevron Facility is located on Main Street in Craig, Alaska, on the western shoreline of Prince of Wales Island (Figure 1). Records indicate that Chevron Products Company (Chevron) constructed the site bulk fuels facility in the 1930's, and operated the facility until 1986. The facility has been operated by various organizations since, and is now operated by Harbor Enterprises d.b.a. Petro Marine.

Site History: Various site investigations have been conducted, including the installation of twelve monitoring wells and numerous soil borings. A vapor extraction system operated on site from 1989 to 1992. In 1989, a water treatment unit consisting of an oil/water separator and an air stripper were also installed to treat ground water draining from the tank farm area. In 1989, separate phase hydrocarbons were noted in one monitoring well. Benzene and total recoverable petroleum hydrocarbons have been detected in ground water at up to 12,000 parts per billion (ppb) and 35,000,000 ppb, respectively.

Hydrogeologic Setting: The site subsurface is reported to consist of poorly graded gravel and sand. The site topography slopes north, from the tank farm toward Bucareli Bay. Ground water flow direction is anticipated to follow the site topography, and historical data reports ground water lying approximately 2 to 8 ft below grade.

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SCOPE OF WORK

Our objective was to investigate and halt a leaking drainage pipe feeding into the site remediation system. In addition, Cambria was to sample selected temporary monitoring wells installed by AIGEM and install locking caps on the existing site wells. Mr. Bergstrom of Cambria conducted site activities September 10, 11, 13, and 14, 1997.

Site Maintenance: The leaking pipe was a conveyance pipe (3-inch diameter schedule 40 PVC) which carried water from a French drain within the southern (older) containment area to a water storage tank for the air stripper. The pipe runs below grade for all but the lowest six feet, nearest the air stripper. The leak was from a valve, located in front of the storage tank. The other end of the pipe, within the southern containment area, could not be uncovered and plugged because the screened area at the top of the pipe was too large and was buried under a significant volume of rock and soil.

After draining water from the pipe, the leaking valve was removed and a capping assembly was placed on the pipe, stopping any further leaking. The drained water was stored in drums on site with AIGEM's purge water, to be included in the site operator's waste water treatment system. Additional water was drained into the remediation system holding tank. A 4"x4" wood support was installed to support the lowest end of the pipe. The leak was stopped using available pipe and fittings (a 3-inch hubless coupler, a 4-inch hubless coupler, a length of 4-inch ABS pipe, a 4-inch ABS female adaptor, and a 4-inch ABS male plug), and those fittings are expected to remain secure for several years. We recommend eventually removing those fittings and solvent welding a 3-inch PVC slip end cap to the end of the pipe. This would provide a more permanent solution, but would require draining the conveyance line and French drain again.

Water Sampling: Cambria sampled site wells in accordance with the "Protocol for Monitoring Intrinsic Bioremediation in Ground Water" published in 1995 by Chevron Research and Technology Company, Health, Environment, and Safety Group. Cambria's ground water data is presented in Table 1. The AIGEM ground water data is included as Attachment 1.

All monitoring wells sampled were purged manually using hand bailers. During purging, the ground water temperature, pH, conductivity, dissolved oxygen (DO), and oxidation-reduction potential (ORP) were measured. These measurements were taken ex situ for monitoring wells, and were not taken on temporary wells since AIG purged these wells prior to Cambria's sampling.

Due to the combination of a 48-hour hold time on some samples' analyses and the remoteness of the site, all wells were sampled on two consecutive days. On the first day, alkalinity, sulfate, and ferrous iron samples were collected. Nitrate samples were collected during the second day of sampling.

Locking Cap Installation: Locking well head caps were placed on all monitoring wells located, and locked with standard Chevron padlocks. Wells MW-1C, MW-2, MW-8, and MW-9 were not located. Although a cap and lock were placed on well MW-1, the top of the casing was cracked, preventing a secure seal. Due to a lack of survey equipment, the well head was not modified.

RESULTS

Using Cambria's and AIGEM's data, we have assembled isoconcentration maps for TPHd in soil, TPHg in soil, TPHd in ground water, TPHg in ground water, nitrate, sulfate, and ORP. These are presented as Figures 2 through 8, respectively.

Extent of Petroleum Hydrocarbons: The highest concentrations of TPHd in soil are located in the two above ground storage tanks (AST) containment areas and the soils immediately down slope (north) of the AST's. Decreasing concentrations extend approximately 150 ft in the presumed ground water flow direction (north), toward Bucareli Bay. This is consistent with the tank farm being the source area, and a dissolved plume having migrated slightly down gradient. From this map, we estimate that within 100 ft downgradient of the tank farm soil concentrations of TPHd fall below 200 parts per million (ppm). The upgradient extent of the TPHd plume (above 200 ppm) is defined by the September, 1997 data.

AIGEM reported low concentrations of TPHg in soil samples taken from three soil borings. These samples were all from locations on the northern edge of the southern (older) containment area (Figure 3). The extent of TPHg in soil samples collected in September 1997 is confined to the vicinity of AST containment areas.

The highest concentrations of TPHd in ground water correspond to the areas with the highest concentrations of TPH d in soil (Figure 4). Concentrations of TPHd decrease in the downgradient direction. Although not delineated in the up- or crossgradient direction in this round of sampling, previous ground water sampling has provided delineation to the west (B95-3) and decreasing concentration in the upgradient direction (B95-1).

Concentrations of TPHg in ground water are limited to the two AST containment areas and an area immediately down slope (north) of Tank 11 (Figure 5). TPHg was not detected in samples to the north, south, east, and west of the dissolved TPHg plume.

Biological Parameters: Isoconcentration maps for nitrate, sulfate, and oxygen reduction potential (ORP) are presented as Figures 6 through 8, respectively. Interpretation of these maps is presented below. Nitrates and sulfates were analyzed as indicators of anaerobic biodegradation of the hydrocarbon plume. ORP was analyzed to assess how oxidizing the subsurface environment was through a cross section of the hydrocarbon plume.

Nitrates: Nitrates serve as both nutrients and electron acceptors for subsurface bacteria. Typically present at concentrations of a few ppm, nitrates in shallow ground water originate from human and animal wastes, the decay of organic materials, and artificially applied fertilizers. In areas of little biological activity, nitrate concentrations remain fairly uniform in both the down- and crossgradient directions. When nitrate containing ground water flows through a biologically active zone, the nitrates are consumed as nutrients (building blocks of the biomass) and as electron acceptors. As shown in Figure 6, the nitrate isoconcentration map, dissolved nitrates in ground water are lower within the petroleum hydrocarbon plume than in areas further downgradient and lateral from the source area. These maps also indicate that nitrate and sulfate are being reintroduced to the nitrate- and sulfate-deficient ground water at relatively high concentrations.

Sulfates: Sulfates also serve as both nutrients and electron acceptors for subsurface bacteria. The distribution of sulfates typically parallels that of nitrates for the same reasons stated above - they are consumed within the biologically active area of the plume. Figure 7 shows greatly decreased sulfate concentrations (more than 100-fold) in the areas of highest TPH concentrations in soil and ground water. Sulfate concentrations partially rebound downgradient of the plume (presumably due to mixing of desulfated ground water present with ground water which passed to the sides of the hydrocarbon plume). Sulfates measured at 522 ppm in well TW-1 are assumed to reflect minerals present in seawater and were not contoured.

Oxygen Reduction Potential: Both oxidizing and reducing processes occur in the subsurface, depending on soil chemistry, contaminates, and, especially, biological activity. Reducing conditions, yielding negative ORP values, may indicate areas where anaerobic biodegradation is occurring. All of the measured ORP levels were positive, indicating oxidizing conditions. However, the ORP isoconcentration map shows lower ORP levels in and near the plume than levels further from the plume. This small decrease in ORP is consistent with the small decrease in DO (discussed below) and indicates that biodegradation is occurring primarily aerobically, rather than anaerobically.

Dissolved Oxygen: DO was measured in ground water within and outside of the hydrocarbon plume. Concentrations of DO were about 1 ppm lower in the center of the plume (MW-1), but high in all ground water measured. This indicates that while DO is being consumed with the hydrocarbon plume, it is not a limiting factor for biological activity at this site with shallow ground water. The shallow depth to water allows a greater rate of oxygen diffusion into the ground water than at deeper sites. Also, the relatively cold ground water has a greater ability to dissolve oxygen.

CONCLUSION

The September 1997 field work, sampling and subsequent analysis have accomplished the following:

- Stopped the leak in piping which led from the French drain in the southern AST containment area;
- Documented the biological activity occurring in the center of the hydrocarbon plume; and
- Identified the parameters currently limiting the rate of biodegradation of petroleum hydrocarbons.

CLOSING

We appreciate the opportunity to provide consultant services to Chevron. Please call if you have any questions or comments.

Sincerely,
Cambria Environmental Technology, Inc.

David B. Thomas

David B. Thomas
Senior Engineer

Attachments:
Figure 1 - Site Plan
Figure 2 - Ground Water Benzene Isoconcentration Map
Figure 3 - Ground Water TPHg Isoconcentration Map
Figure 4 - Ground Water TPHd Isoconcentration Map
Figure 5 - Soil Benzene Isoconcentration Map
Figure 6 - Soil TPHg Isoconcentration Map
Figure 7 - Soil TPHd Isoconcentration Map
Figure 8 - Dissolved Nitrate Sulfate Isoconcentration Map
Figure 9 - Dissolved Sulfate Isoconcentration Map
Figure 10 - Oxidation-Reduction Potential Isoconcentration Map
Table 1 - Field and Laboratory Bioremediation Parameters
Attachment A - AIGEM Analytical Data

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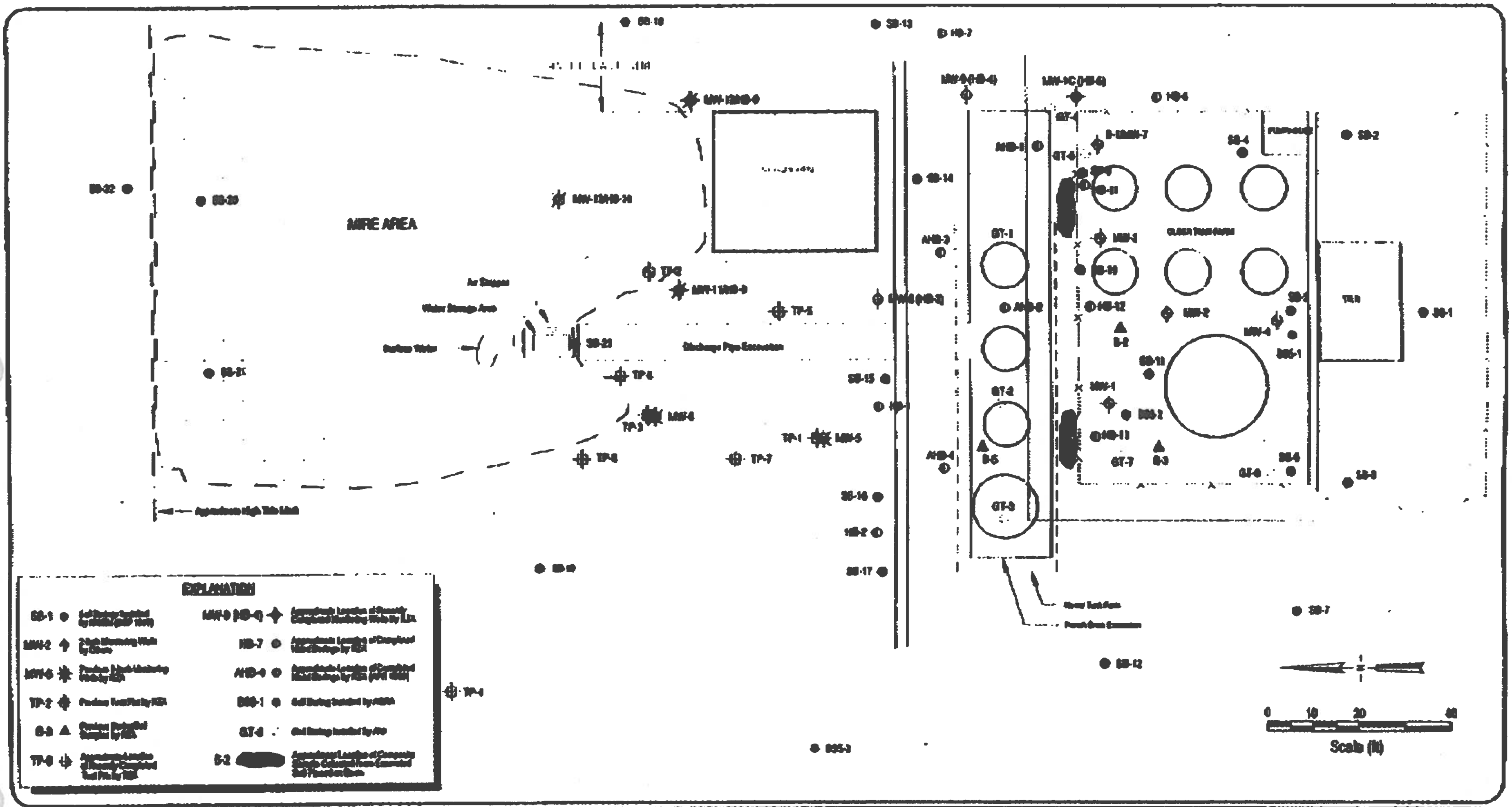

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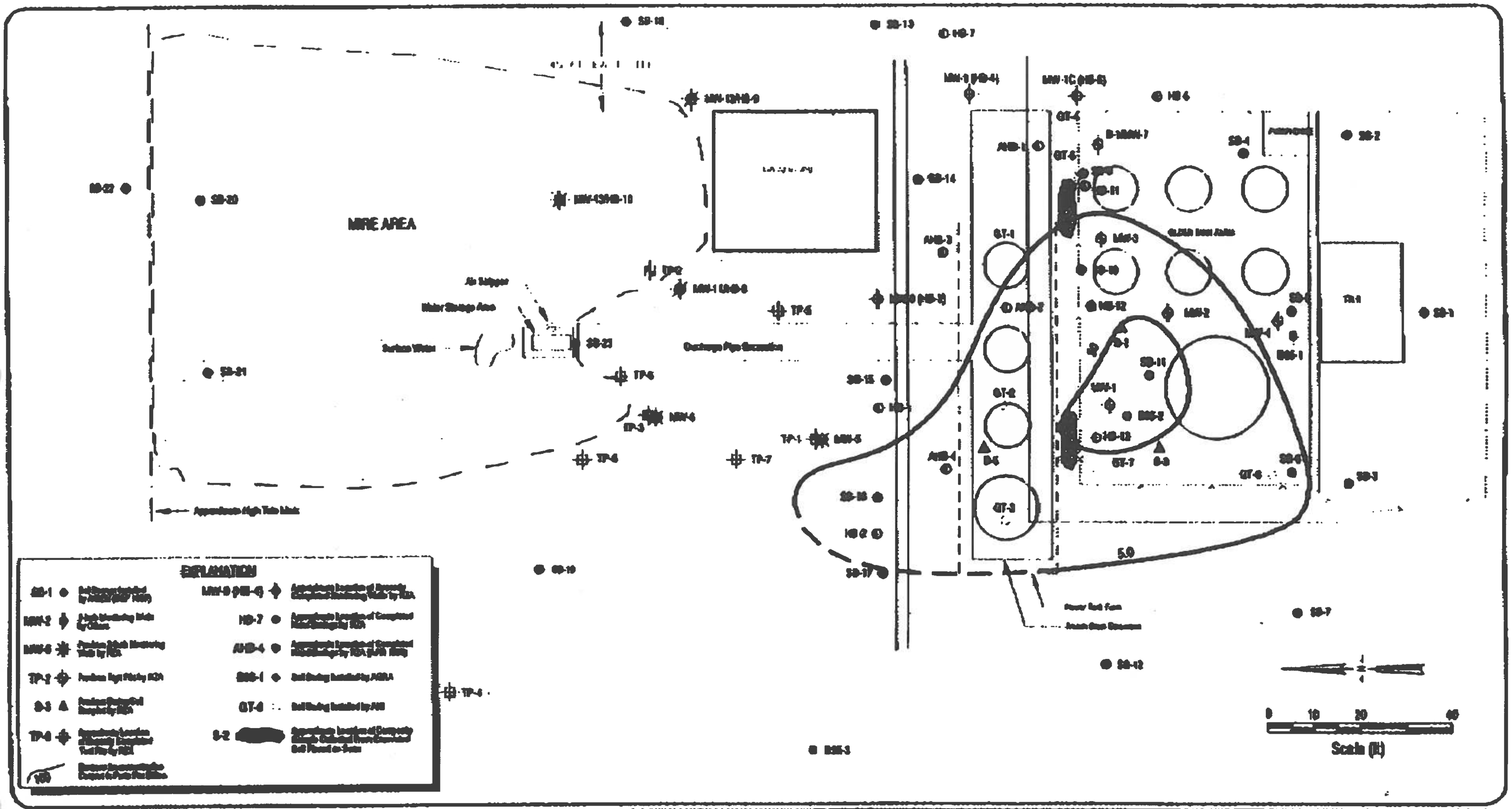
Environmental Technology, Inc.

Bulk Fuel Facility
302 Main Street
Craig, Alaska

Site Plan

September, 1997

FIGURE
1



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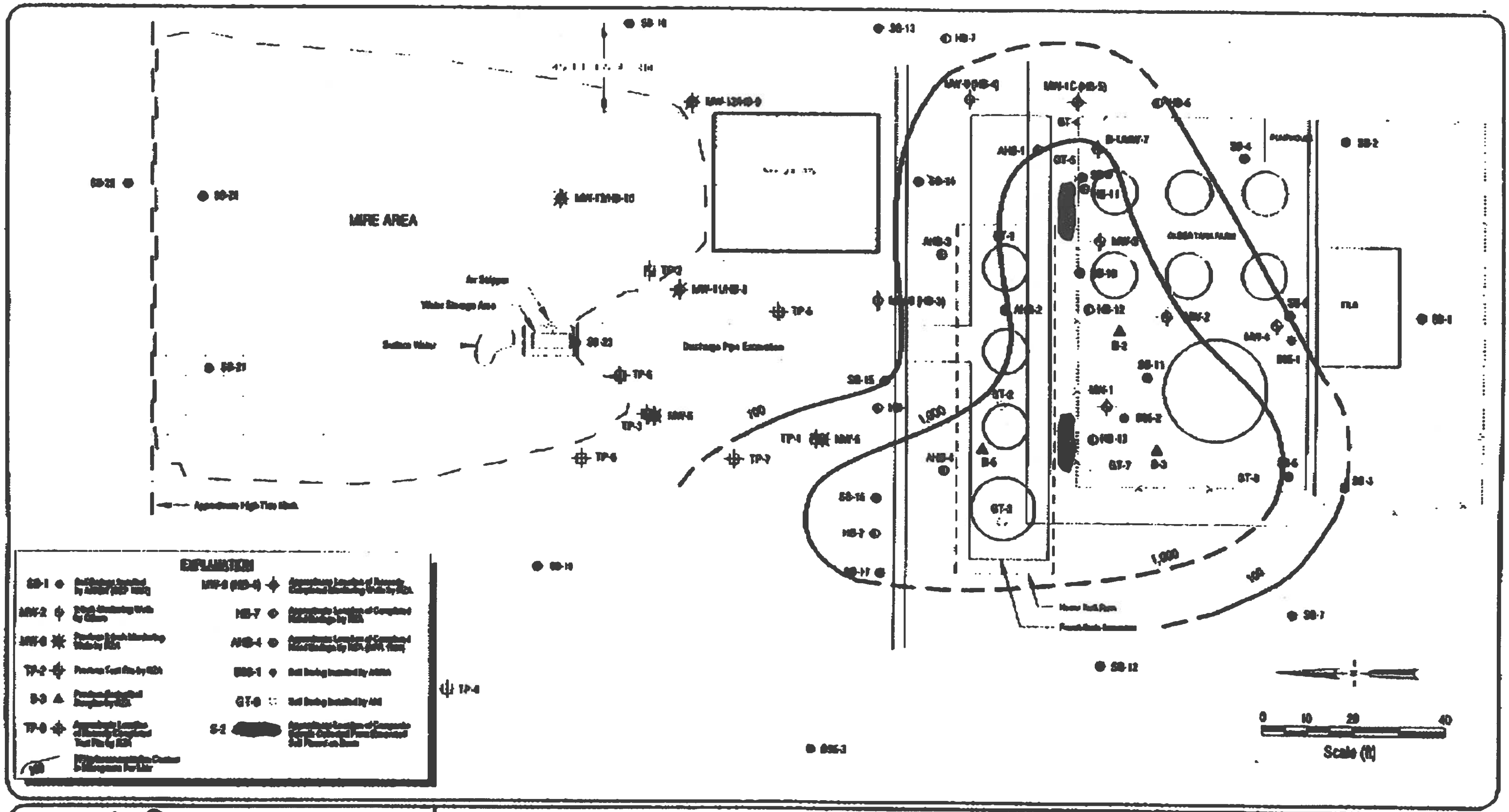
Craig, Alaska

Ground Water Benzene
Isoconcentration Map
September, 1997

FIGURE
2



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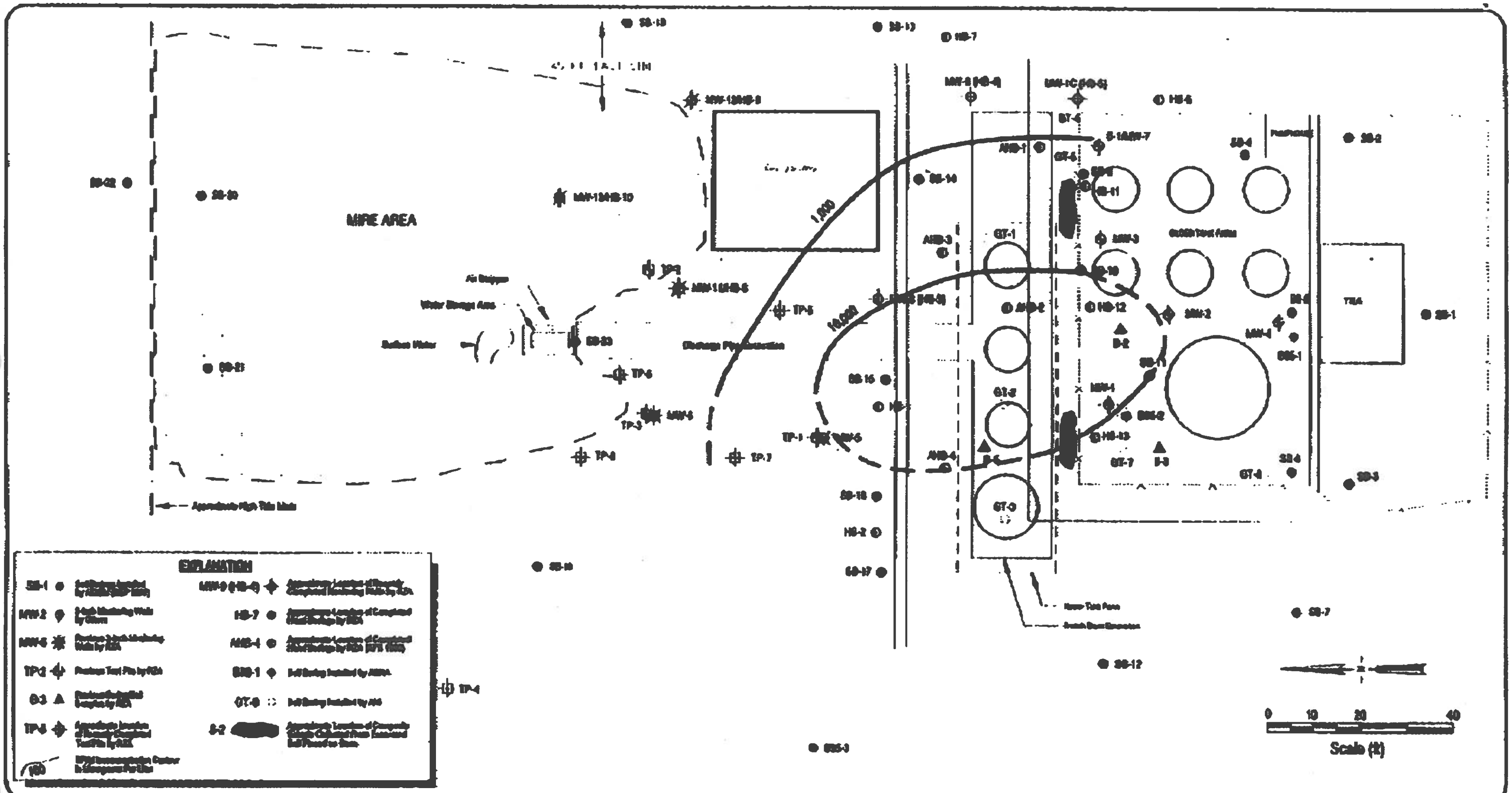
Craig, Alaska

Ground Water TPHg
Isoconcentration Map
September, 1997

FIGURE
3



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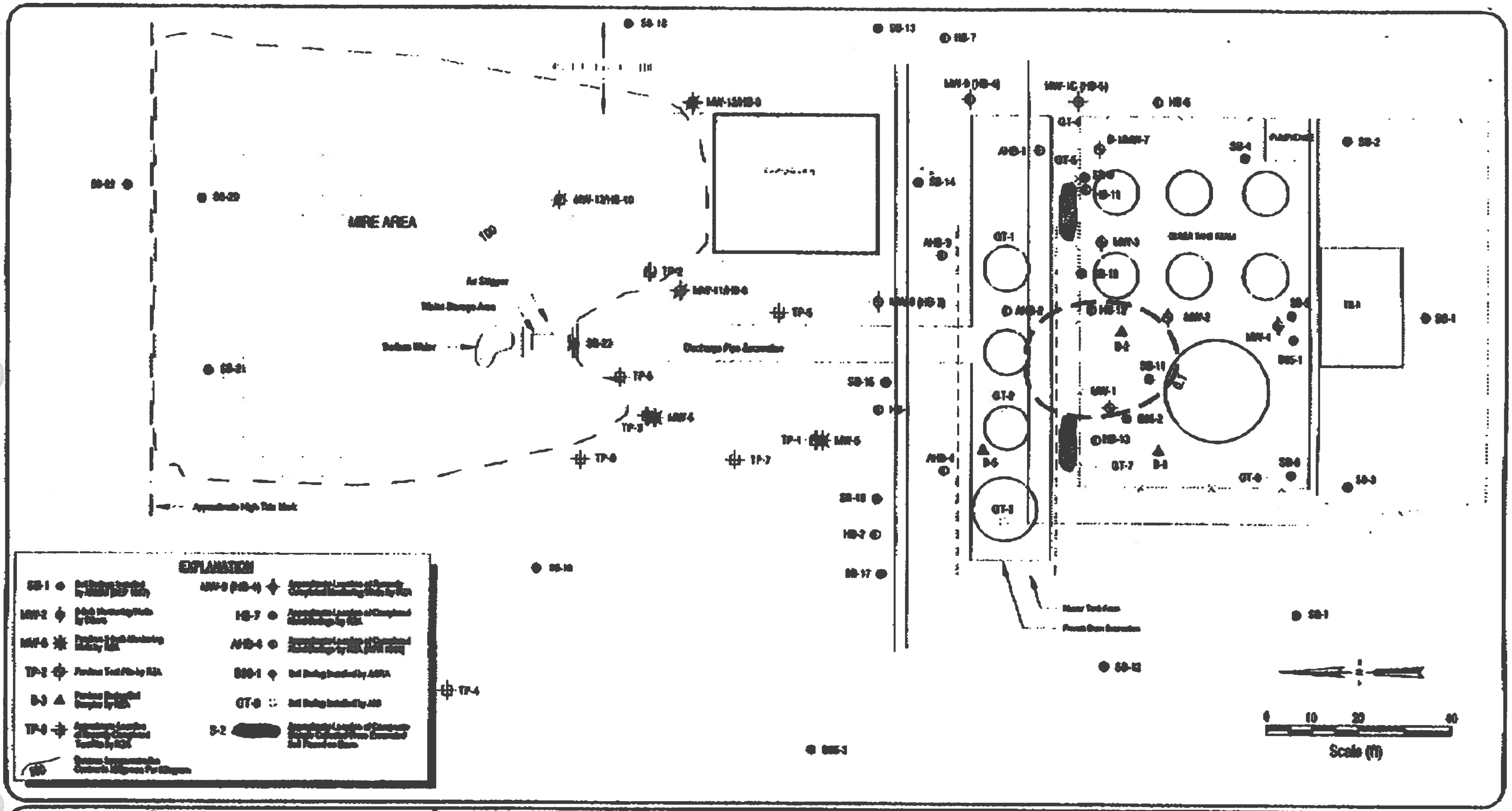
Ground Water TPHd
Isoconcentration Map
September, 1997

FIGURE
4



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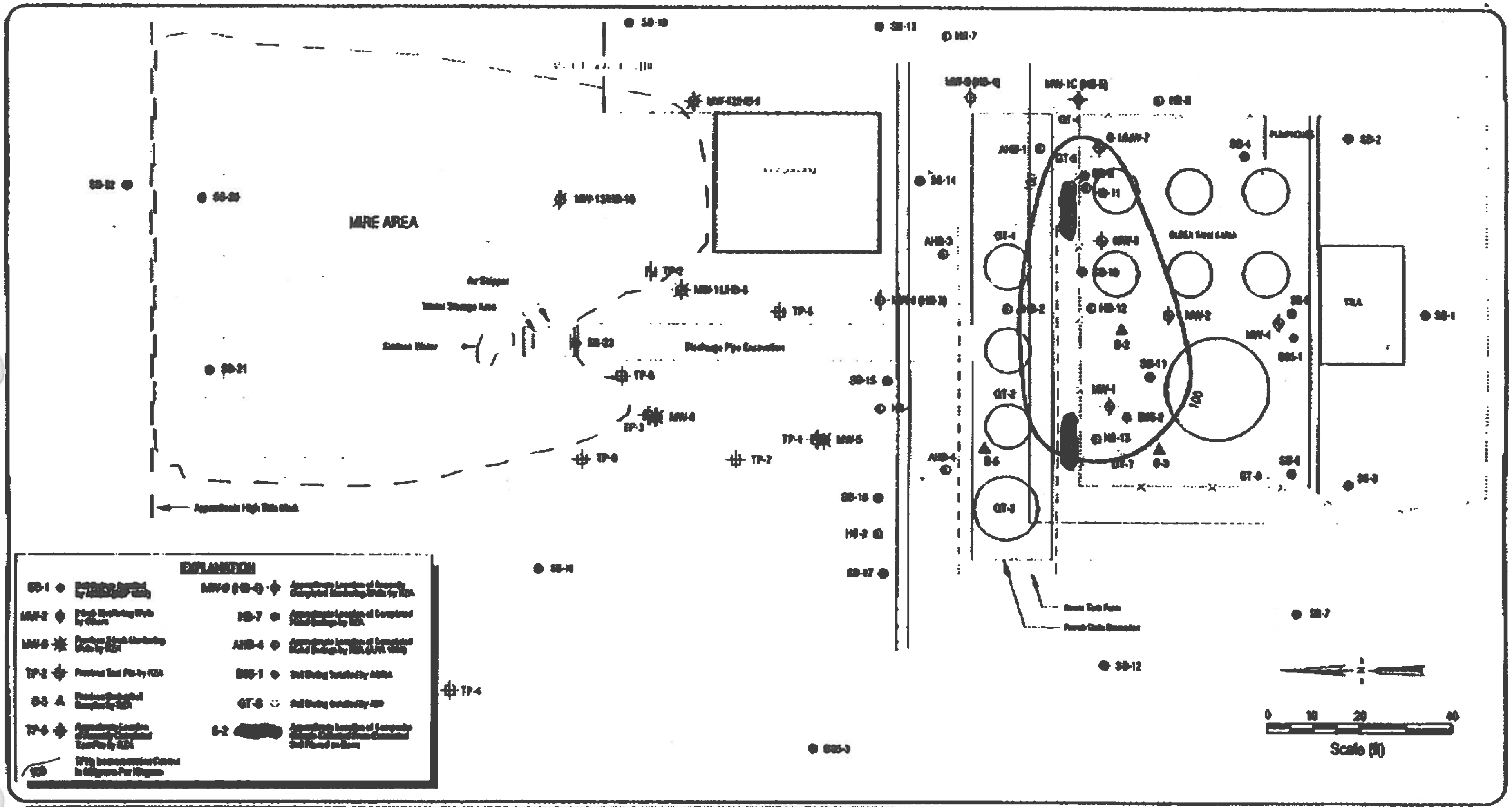
Craig, Alaska

Soil Benzene Isoconcentration Map

September, 1997

FIGURE
5



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Wards Cove Bulk Fuel Facility
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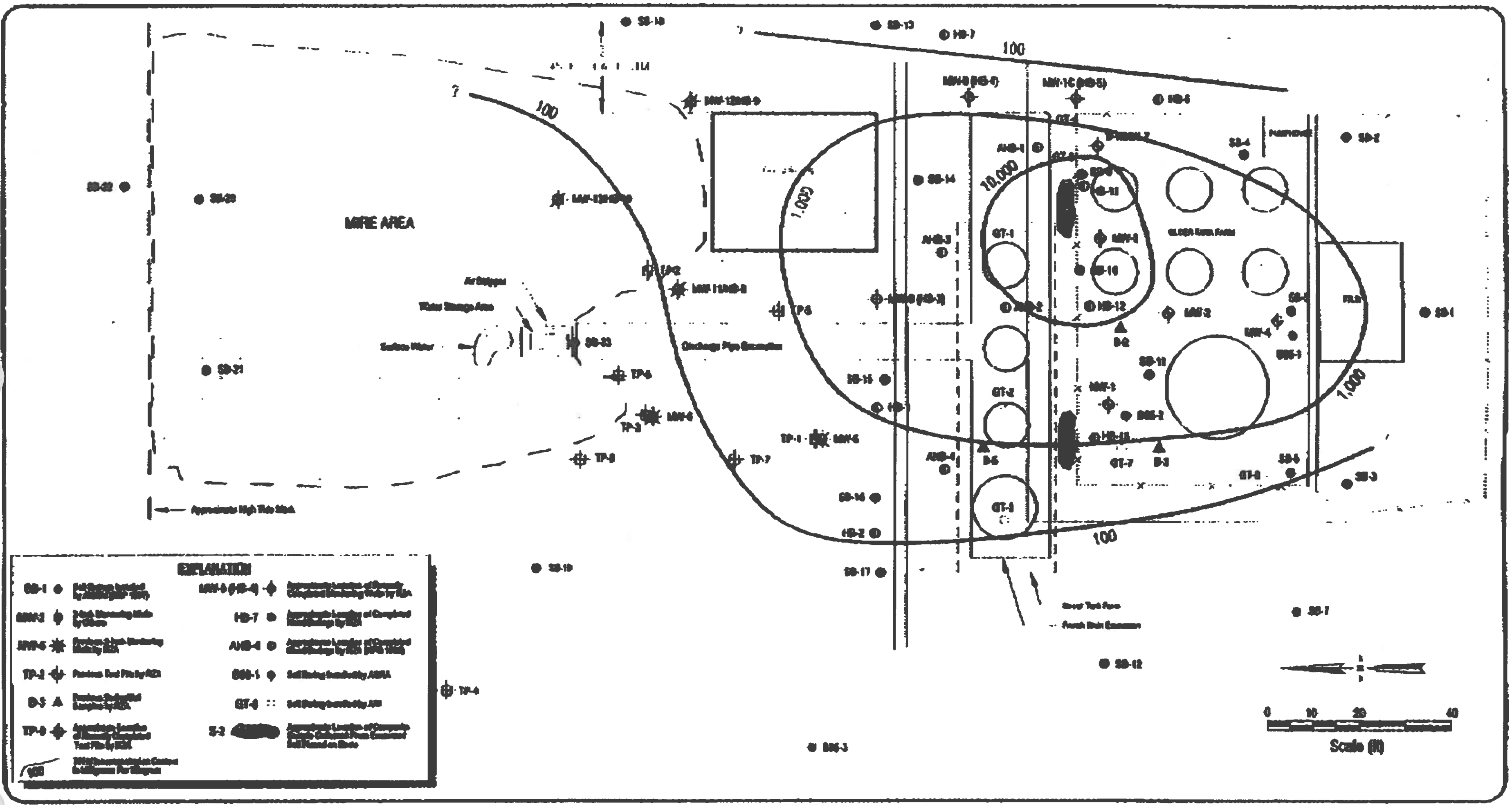
Craig, Alaska

Soil TPHg
Isoconcentration Map
September, 1997

FIGURE
6



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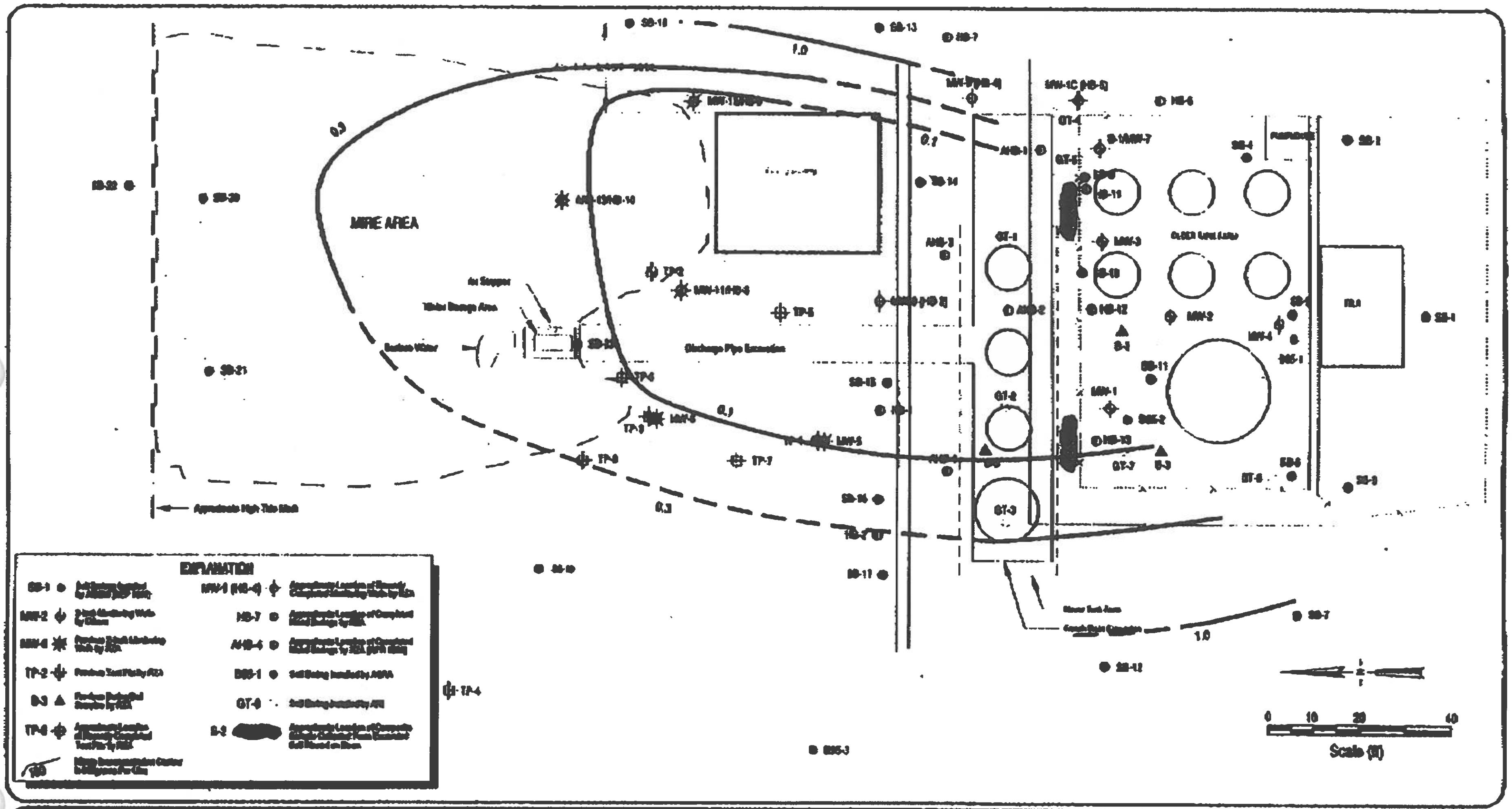
Wards Cove Bulk Fuel Facility
302 Main Street
Craig, Alaska

Soil TPHd
Isoconcentration Map
September, 1997

FIGURE
7



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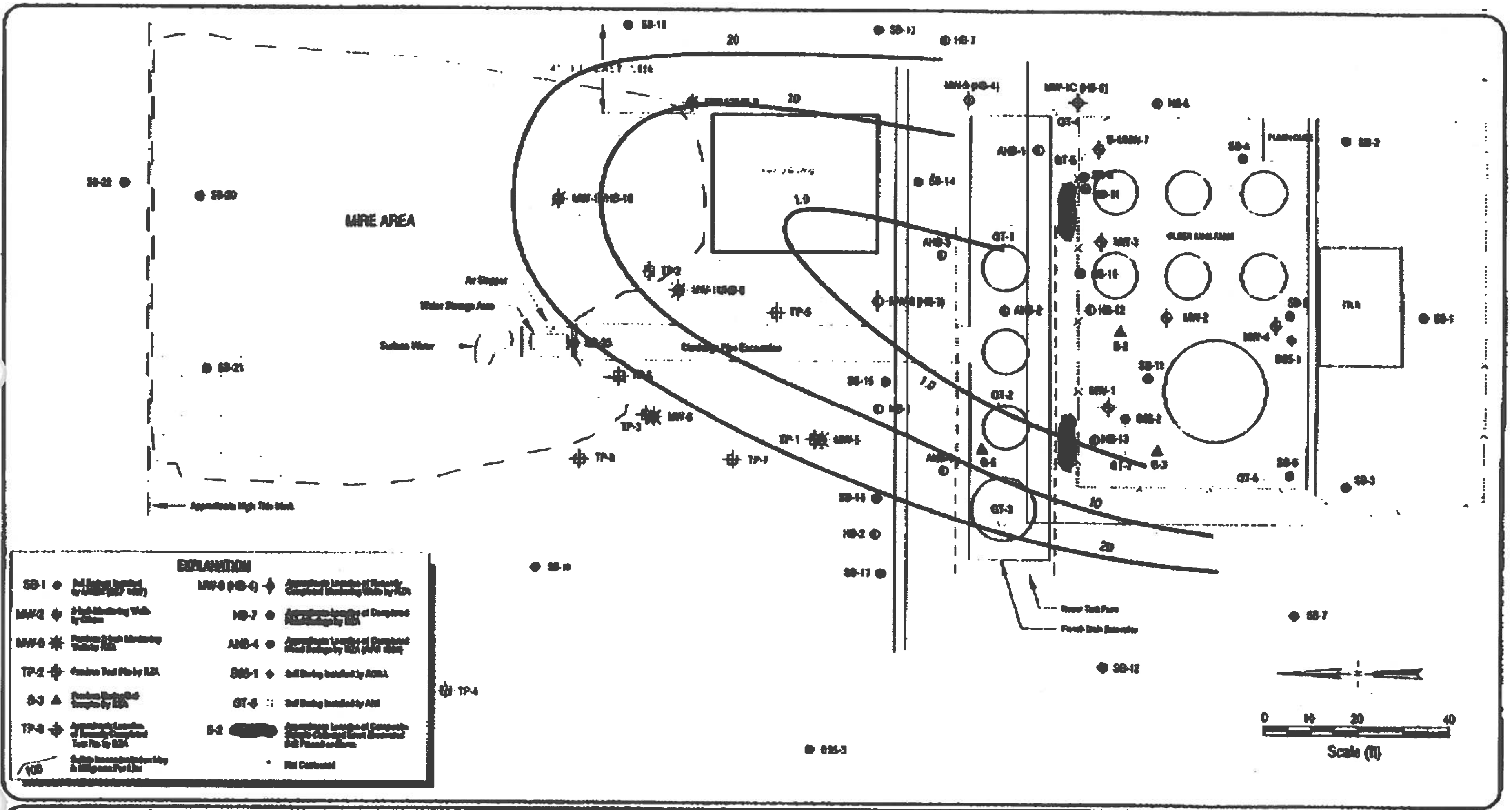
Wards Cove Bulk Fuel Facility
302 Main Street
Craig, Alaska

Dissolved Nitrate
Isoconcentration Map
September, 1997

FIGURE
8



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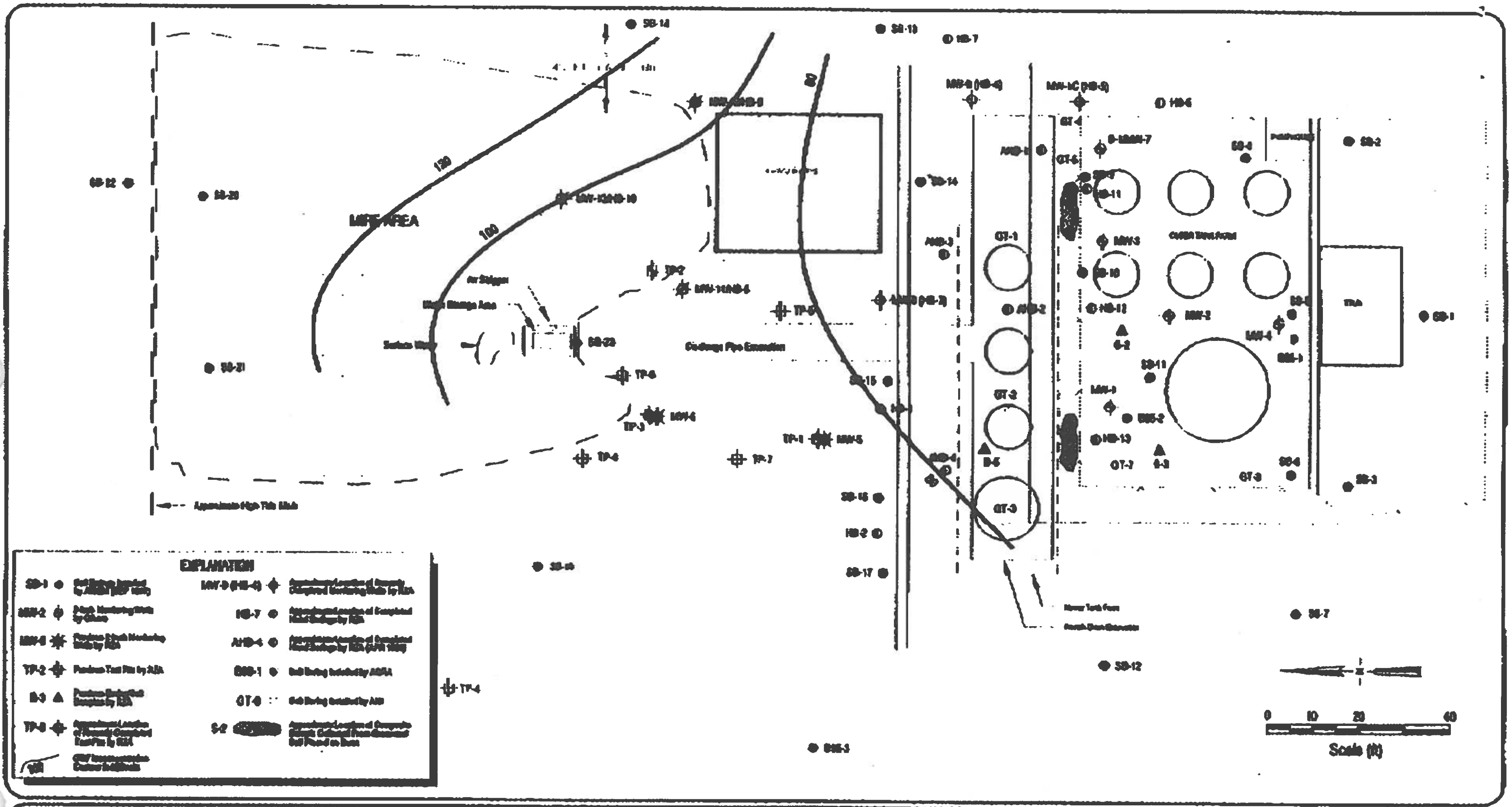
Wards Cove Bulk Fuel Facility
302 Main Street
Craig, Alaska

Dissolved Sulfate
Isoconcentration Map
September, 1997

FIGURE
9



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Wards Cove Bulk Fuel Facility
302 Main Street
Craig, Alaska

Oxidation-Reduction Potential
Isoconcentration Map
September, 1997

FIGURE
10

Field and Laboratory Bioremediation Parameters - Former Chevron Bulk Fuels Facility 1001425, Wards Cove Packing Company, Former Chevron Bulk Fuels Facility, Craig, Alaska

Sample ID	Date Sampled	Pre-Purge DO (mg/L)	Post-Purge DO (mg/L)	Pre-Purge ORP (mV)	Post-Purge ORP (mV)	Alkalinity (mg/L)	Ferrous Iron (mg/L)	Sulfate (mg/L)	Nitrate-Nitrogen (mg/L)
TW-1	9/14/97	---	13.65	---	191	216	<0.00500	522	0.770
TW-2	9/11/97	---	14.79	---	73	275	<0.00500	92.8	1.16
TW-3	9/11/97	---	15.01	---	59	155	<0.00500	51.2	2.73
MW-1	9/11/97	15.99	13.89	40	42	110	0.0101	<0.100	<0.0500
MW-5	9/14/97	13.8	15.05	125	87	149	0.0198	11.9	0.0910
MW-6	9/11/97	4.73	15.88	70	35	177	<0.00500	22.7	0.127
MW-12	9/14/97	14.55	14.99	146	115	139	<0.00500	5.65	0.0520

Abbreviations/Notes:

DO = dissolved oxygen
ORP = oxidation-reduction potential
mg/L = milligrams per liter
mV = millivolts
--- = not measured

Samples analyzed by North Creek Analytical Services

Attachment A

AIGEM Analytic Data

Table 1: **Groundwater Monitoring Data**
Wards Cove Tank Farm Facility, Craig, Alaska

Well	Date Monitored	Depth to Groundwater	Temperature (Fahrenheit)	Conductivity (a)	pH	Comments
SB-4	10-Sep-97	2.70	56	110	7.6	Sheen observed
SB-5	10-Sep-97	2.20	55	290	7.8	Sheen observed
SB-6	10-Sep-97	2.00	61	176	6.2	Sheen observed
SB-7	10-Sep-97	2.10	57	213	7.9	
SB-9	10-Sep-97	2.20	59	185	6.9	Sheen observed
SB-10	10-Sep-97	2.20	56	186	7.5	Sheen observed
SB-11	10-Sep-97	3.00	56	288	7.5	Sheen observed
SB-12	10-Sep-97	--	--	--	--	No groundwater yield
SB-13	10-Sep-97	5.00	55	303	8.4	
SB-14	10-Sep-97	--	--	--	--	No groundwater yield
SB-15	10-Sep-97	4.40	56	131	7.5	Sheen observed
SB-16	10-Sep-97	4.65	55	212	7.6	Sheen observed
SB-17	10-Sep-97	--	--	--	--	No groundwater yield
SB-18	10-Sep-97	1.60	58	21	6.7	
SB-19	10-Sep-97	--	--	--	--	No groundwater yield
SB-20	10-Sep-97	--	--	--	--	No groundwater yield
SB-21	10-Sep-97	--	--	--	--	No groundwater yield
MW-11	11-Sep-97	NM	NM	NM	NM	
MW-13	11-Sep-97	NM	NM	NM	NM	

(a) microsiemens per centimeter
NM Not measured
-- Well did not yield sufficient groundwater to monitor or sample

Table 2: **Soil Laboratory Analytical Results**
Wards Cove Bulk Fuel Facility, Craig, Alaska

Sample	Collected	TPH-D	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes	MTBE
SB1: 0'-0.5'	11-Sep-97	190	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB2: 0'-0.5'	11-Sep-97	170	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB3: 0'-0.5'	11-Sep-97	44	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB4: 0.5'-1'	10-Sep-97	590	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB4: 2.5'-3'	10-Sep-97	390	ND<10	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1
SB5: 0.5'-1'	10-Sep-97	350	ND<10	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1
SB5: 2.5'-3'	10-Sep-97	6,800	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB6: 0.5'-1'	10-Sep-97	630	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB6: 2.5'-3'	10-Sep-97	49	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB7: 2.5'-3'	10-Sep-97	35	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB9: 0.5'-1'	10-Sep-97	11,000	100	ND<0.1	ND<0.1	ND<0.1	2.9	ND<0.1
SB9: 2.5'-3'	10-Sep-97	14,000	200	ND<0.1	0.3	0.6	11	ND<0.1
SB10: 0.5'-1'	10-Sep-97	14,000	500	ND<0.1	0.5	0.3	2.4	ND<0.1
SB10: 2.5'-3'	10-Sep-97	7,800	100	ND<0.1	ND<0.1	0.1	0.8	ND<0.1
SB11: 0.5'-1'	10-Sep-97	2,800	80	ND<0.1	ND<0.1	0.2	1	ND<0.1
SB11: 2.5'-3'	10-Sep-97	4,400	500	0.2	ND<0.1	1.5	8.8	ND<0.1
SB12: 2.5'-3'	10-Sep-97	ND<10	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB13: 3'-3.5'	9-Sep-97	ND<10	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB14: 0'-0.5'	9-Sep-97	3,800	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB14:4.5'-5'	10-Sep-97	110	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB15: 3.5'-4'	9-Sep-97	1,300	ND<10	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1
SB16: 4'-4.5'	9-Sep-97	300	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB17: 3.5'-4'	9-Sep-97	88	ND<10	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1
SB18: 2.5'-3'	10-Sep-97	320	ND<10	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1
SB19: 2.5'-3'	10-Sep-97	ND<10	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB20: 2.5'-3'	10-Sep-97	55	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB21: 2.5'-3'	10-Sep-97	33	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005
SB23: 0.5'-1'	11-Sep-97	ND<10	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	ND<0.005

Table 2: **Soil Laboratory Analytical Results**
Wards Cove Bulk Fuel Facility, Craig, Alaska

TPHG = Total petroleum hydrocarbons as gasoline
TPHD = Total petroleum hydrocarbons as diesel
All results in milligrams per kilogram
NA = Not analyzed
ND = Not detected
TPHG and BTEX analysis by USEPA Method 8260 and GC/MS combination
TPHD analysis by GC/MS combination (extracted by USEPA Method 3510)
TPHD analytical range is C8-C40
Samples analyzed by Zymax Envirotechnology in San Luis Obispo, California

Table 3: Groundwater Laboratory Analytical Results
Wards Cove Bulk Fuel Facility, Craig, Alaska

Sample	Collected	TPHD	TPHG	Benzene	Toluene	Ethylbenzene	Xylenes	MTBE*
SB4	10-Sep-97	NA	ND<50	ND<0.5	ND<0.5	ND<0.5	2.8	ND<0.5
SB5	10-Sep-97	NA	ND<100	ND<1.0	ND<1.0	ND<1.0	ND<1.0	ND<1.0
SB6	10-Sep-97	3,100	1,000	7.3	3.9	1.4	7.1	3.1
SB7	10-Sep-97	NA	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5
SB9	10-Sep-97	NA	2,000	2.9	13	25	240	ND<2.0
SB10	10-Sep-97	NA	3,000	32	29	9.9	58	ND<2.0
SB11	10-Sep-97	10,000	5,000	160	9.3	41	210	ND<2.0
SB13	10-Sep-97	ND<100	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5
SB15	10-Sep-97	48,000	ND<100	ND<1.0	ND<1.0	ND<1.0	ND<1.0	ND<1.0
SB16	10-Sep-97	NA	10,000	13	2.4	4	21	ND<2.0
SB18	10-Sep-97	280	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5
SB21	10-Sep-97	NA	ND<50	ND<0.5	0.7	ND<0.5	ND<0.5	ND<0.5
SB22	11-Sep-97	150	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5
SB23	11-Sep-97	250	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5
MW-11	11-Sep-97	130	ND<50	ND<0.5	1.1	ND<0.5	ND<0.5	ND<0.5
MW-13	11-Sep-97	160	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5
Air Stripper Piping	9-Sep-97	910	210	4.6	0.5	0.9	0.9	ND<0.5
Surface Water Air Stripper	9-Sep-97	1,100	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5

TPHD = Total petroleum hydrocarbons as diesel
TPHG = Total petroleum hydrocarbons as gasoline
All results in micrograms per liter
ND = Not detected
NA = Not analyzed because sample destroyed in transit to laboratory
TPHG and BTEX analysis by USEPA Method 8260 and GC/MS combination
TPHD analysis by GC/MS combination (extracted by USEPA Method 3550)
MTBE = Methyl-t-Butyl Ether
Samples analyzed by Zymax Envirotechnology in San Luis Obispo, California

Table 4: Breakdown of Soil Analytical Results by Carbon Chain Ranges
Wards Cove Bulk Fuel Facility, Craig, Alaska

Sample Number	Date Collected	C6-C10 TPH	C6-C10 Aliphatic	C6-C10 Aromatic	C10-C25 TPH	C10-C25 Aliphatic	C10-C25 Aromatic	C25-C36 TPH	C25-C36 Aliphatic	C25-C36 Aromatic	PNAs
SB5: 2.5'-3'	10-Sep-97	ND<10	ND<10	ND<10	6,680	5,344	2,672	120	108	36	ND
SB9: 0.5'-1'	10-Sep-97	100	70	50	10,500	8,400	4,200	500	450	150	ND
SB9: 2.5'-3'	10-Sep-97	200	140	100	13,500	10,800	5,400	500	450	150	8.9 (a)
SB10: 0.5'-1'	10-Sep-97	500	350	250	13,800	11,040	5,520	200	180	60	ND
SB10: 2.5'-3'	10-Sep-97	100	70	50	7,710	6,168	3,084	90	81	27	ND
SB11: 0.5'-1'	10-Sep-97	80	56	40	2,760	2,208	1,104	40	36	12	ND
SB11: 2.5'-3'	10-Sep-97	500	350	250	4,350	3,480	1,740	50	45	15	ND
SB14: 0'-0.5'	9-Sep-97	ND<10	ND<10	ND<10	3,260	2,608	1,304	540	486	162	ND
SB15: 3.5'-4'	9-Sep-97	20	14	ND<10	1,230	984	492	70	63	21	ND

Shaded concentrations are those that exceed ADEC Soil Cleanup Standards (Table B from Draft Cleanup Standards dated 11/12/97 assuming migration to groundwater and over 40 inches annual rainfall)

All results in milligrams per kilogram
TPH = Total petroleum hydrocarbons
PNAs = Polynuclear aromatic hydrocarbons
ND = Not detected (listed with laboratory method detection limit)
Results reported by Zymax Envirotechnology in San Luis Obispo, California
(a) Naphthalene

The following percentages were used to break down the TPH into aliphatic and aromatic composition:

Carbon Range	Percent Aliphatic	Percent Aromatic
C6-C10	70	50
C10-C-25	80	40
C25-C36	90	30

Table 5: Breakdown of Groundwater Analytical Results by Carbon Chain Ranges
Wards Cove Bulk Fuel Facility, Craig, Alaska

Sample Number	Date Collected	C6-C10 TPH	C6-C10 Aliphatic	C6-C10 Aromatic	C10-C25 TPH	C10-C25 Aliphatic	C10-C25 Aromatic	C25-C36 TPH	C25-C36 Aliphatic	C25-C36 Aromatic	PNAs
SB6	10-Sep-97	1,000	700	500	2,850	2,280	1,140	250	225	75	ND<2
SB9	10-Sep-97	2,000	1,400	1,000	NA	NA	NA	NA	NA	NA	NA
SB10	10-Sep-97	3,000	2,100	1,500	NA	NA	NA	NA	NA	NA	NA
SB11	10-Sep-97	5,000	3,500	2,500	9,800	7,840	3,920	200	180	60	(a)
SB15	10-Sep-97	ND<100	ND<100	ND<100	44,600	35,680	17,840	3,400	3,060	1,020	ND<20
SB16	10-Sep-97	10,000	7,000	5,000	NA	NA	NA	NA	NA	NA	ND<2.0
Air Stripper Piping	9-Sep-97	ND<50	ND<50	ND<50	810	648	324	100	90	30	ND<2
Surface Water Air Stripper	9-Sep-97	ND<50	ND<50	ND<50	590	472	236	510	459	153	ND<2

Shaded concentrations are those that exceed ADEC Groundwater Cleanup Standards (Table C from Draft Cleanup Standards dated 11/12/97).

All results in micrograms per liter
TPH = Total petroleum hydrocarbons
PNAs = Polynuclear aromatic hydrocarbons
ND = Not detected (listed with laboratory method detection limit)
NA = Not analyzed (sample destroyed in transit to laboratory)
Results reported by Zymax Envirotechnology in San Luis Obispo, California
(a) Concentrations of fluorene, naphthalene, and phenanthrene detected at 2.5, 12, and 5 micrograms per liter, respectively

Carbon Range	Percent Aliphatic	Percent Aromatic
C6-C10	70	50
C10-C-25	80	40
C25-C36	90	30