

Industrial Plant
3, 6
2/15/83

Woburn Environmental Studies

PHASE I REPORT

Volume 2 Appendices—Data/Procedures

Prepared By: Stauffer Chemical Company

Hydrogeologic Assessment By: Roux Associates

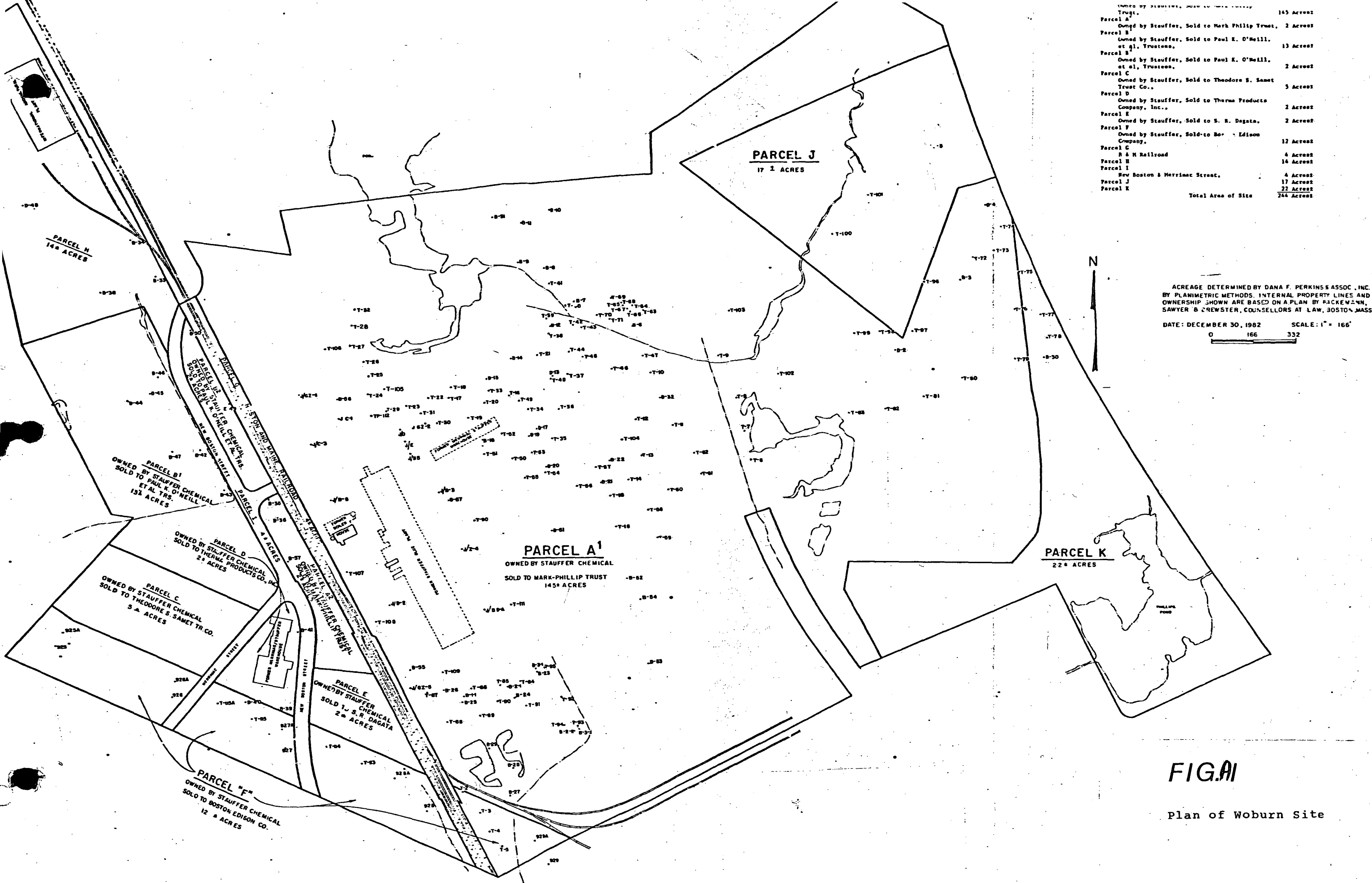
Date: April 1983



SEMS Doc ID 214536

TABLE OF CONTENTS: APPENDIX I

<u>TITLE</u>	<u>PAGE #</u>	<u>REPORT SEC./PAGE #</u>
Fig. 1: Plan of Woburn Site	Append. 1, P. 1	I, PP. I-1, 4, 5, 6, 9, 20
Fig. 2: Plant Layout Merrimac/Monsanto Chemical Plant	Append. 1, P. 2	I, P: I-7
Fig. 3: 1938/63 Dead/Distressed Vegetation	Append. 1, P. 3	I, PP. I-9, 10
Fig. 4: 1938 Dead/Distressed Vegetation	Append. 1, P. 4	I, PP. I-9, 10
Fig. 5: 1963 Dead/Distressed Vegetation	Append. 1, P. 5	I, P. 9



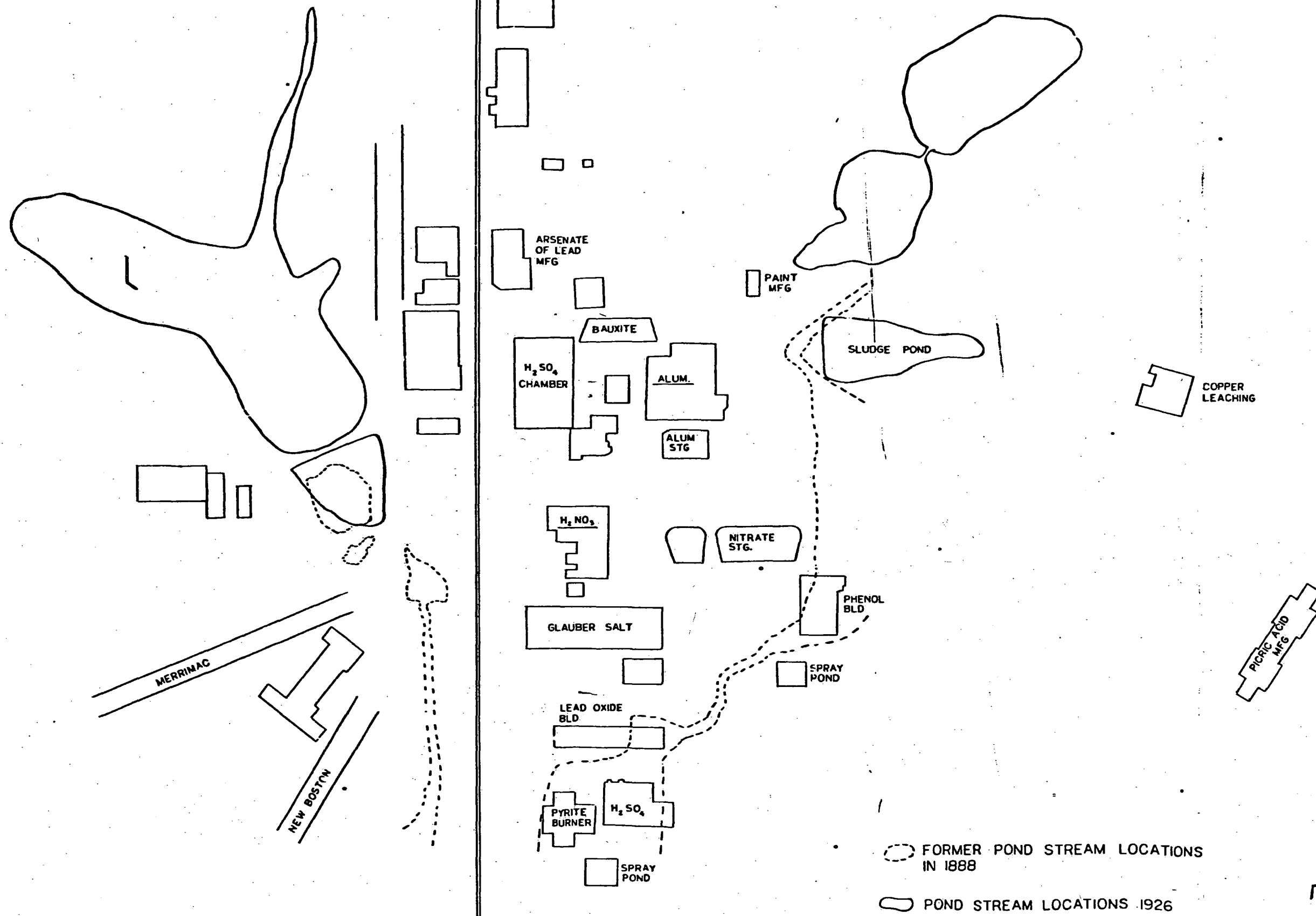


FIG. 2

MERRIMAC/MONSANTO
CHEMICAL PLANT
AT WOBURN MASSACHUSETT

PLANT LAYOUT A COMPOSITE BASED
SANBORN FIRE INSURANCE MAPS OF
1888, 1909, 1910, 1918 AND 1926.

//// AREA WITH APPARENTLY DISTRESSED
VEGETATION NOT DUE TO AND KNOWN
CAUSE

1963 DEAD DISTRESSED VEGETATION

TRACED FROM ENLARGEMENT OF APRIL 29, 1963
PHOTO FROM U.S. GEOLOGIC SURVEY

AREA WITH DEAD OR MISSING VEGETATION
NOT DUE TO ANY KNOWN CAUSE

AREA WITH APPARENTLY DISTRESSED
VEGETATION NOT DUE TO ANY KNOWN
CAUSE

1938 DEAD/DISTRESSED VEGETATION

TRACED FROM ENLARGEMENT OF DECEMBER 21,
1938 PHOTO FROM U.S. NATIONAL ARCHIVES

N

A
FIG. 3

1938/1963 Photo Display of Woburn
Dead/Distressed Vegetation

- Dark areas are probable waste disposal site
- Other areas with dead/distressed vegetation possible waste disposal site

AREA WITH DEAD OR MISSING VEGETATION
NOT DUE TO ANY KNOWN CAUSE

AREA WITH APPRENTLY DISTRESSED
VEGETATION NOT DUE TO ANY KNOWN
CAUSE

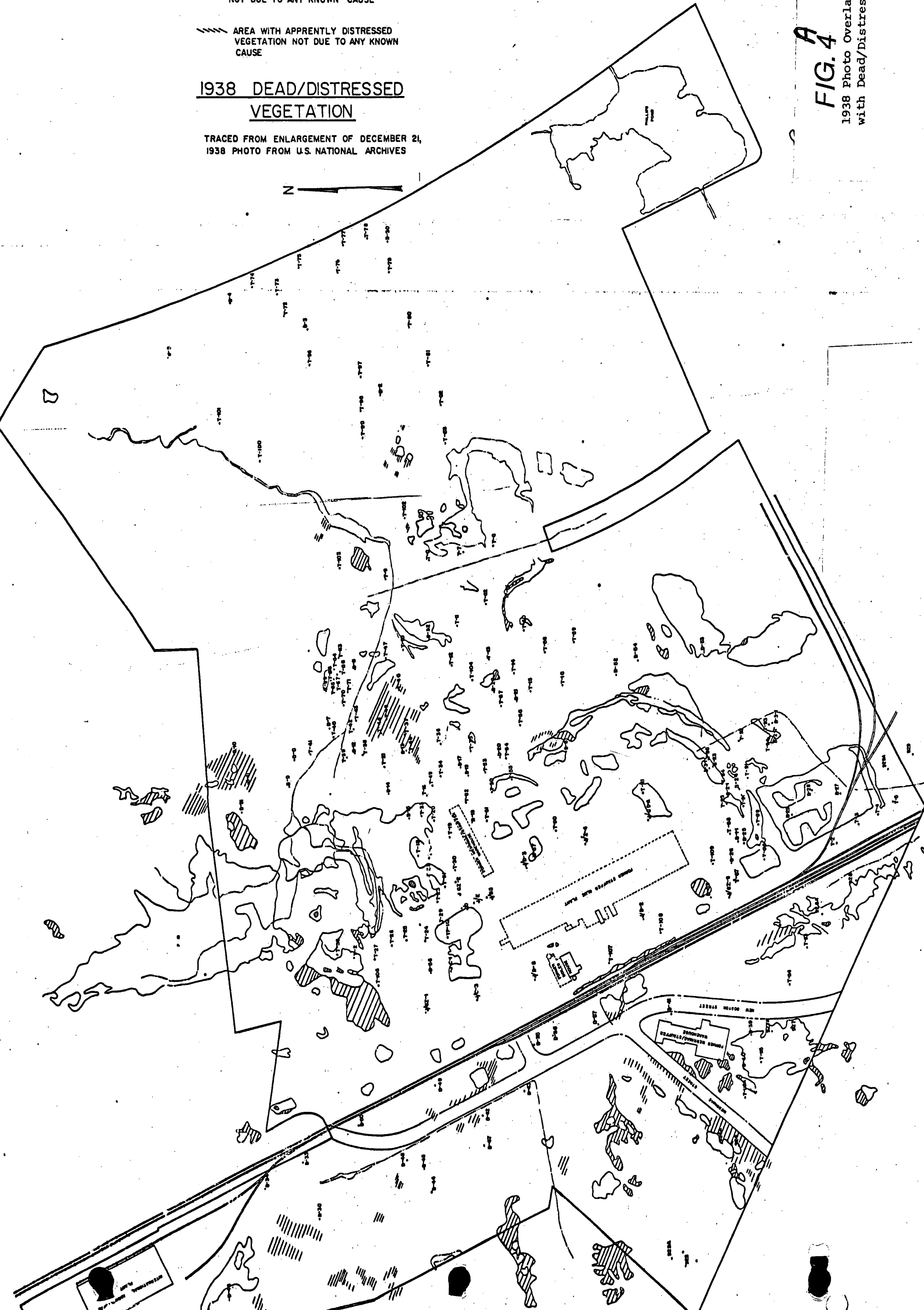
1938 DEAD/DISTRESSED
VEGETATION

TRACED FROM ENLARGEMENT OF DECEMBER 21,
1938 PHOTO FROM U.S. NATIONAL ARCHIVES

N

A
FIG. 4

1938 Photo Overlay of Woburn Site
with Dead/Distressed Vegetation



//// AREA WITH APPRENTLY DISTRESSED
VEGETATION NOT DUE TO AND KNOWN
CAUSE

1963 DEAD DISTRESSED
VEGETATION

TRACED FROM ENLARGEMENT OF APRIL 29, 1963
PHOTO FROM U.S. GEOLOGIC SURVEY





FIG. 5

1963 Photo Overlay of Woburn site
 with Dead/Distressed Vegetation

TABLE OF CONTENTS: APPENDIX I

<u>TITLE</u>	<u>PAGE #</u>	<u>REPORT SEC./PAGE #</u>
Table 1: Woburn Chemical Works Chemical List 1853 - 1963	Append. 1(a), P. 1	I, PP. I-6, 7
Table 2: Merrimac Chemical Company Chemical List		
2.1 - 1888	Append. 1(a), P. 2	I, PP. I-6, 7
2.2 - 1894	Append. 1(a), P. 3	" " " "
2.3 - 1899	Append. 1(a), P. 4	" " " "
2.4 - 1904	Append. 1(a), P. 5	" " " "
2.5 - 1910	Append. 1(a), P. 6	" " " "
2.6.1 - 1918	Append. 1(a), P. 7	" " " "
2.6.2 - 1918 (New England (Manufacturing))	Append. 1(a), P. 8	" " " "
2.7 - Merrimac Chemical	Append. 1(a), P. 9	" " " "
Table 3: Stauffer Chemical Company Chemical List	Append. 1(a), P. 10	I, P. I-11
Table 4: Typical Analysis of Stauffer Waste	Append. 1(a), P. 11	

^A
Table 1

WOBURN CHEMICAL WORKS - CHEMICAL LIST 1853 - 1863

<u>CHEMICAL</u>	<u>OTHER NAME</u>	<u>FORMULA</u>	<u>USE</u>	<u>MISC.</u>
Oil of Vitriol	conc. sulfuric acid	H_2SO_4	textile, paper, tanning, raw material	
Muriatic acid	hydrochloric acid	HCl		
Salt Cake	impure sodium sulfate	Na_2SO_4	paper, tanning	
Glauber Salt	sodium sulfate	$Na_2SO_4 \cdot 10H_2O$	paper, glass	
Soda Ash	---	Na_2CO_3		
Tin crystals	tin chloride	---	dye, textiles	
Blue Vitriol	copper sulfate	---	textiles	

Source: American Chemical Industry: A History, Haynes, Volume I, p. 186

Table ^A 2.1

MERRIMAC CHEMICAL COMPANY - CHEMICAL LIST FEBRUARY, 1888

<u>CHEMICAL</u>	<u>OTHER NAME</u>	<u>FORMULA</u>	<u>USE</u>	<u>MISC.</u>
Alum	generally potassium aluminum sulfate	$K_2Al_2(SO_4)_4 \cdot 24H_2O$	dyeing, tanning, paper industry	from alunite
Silicate of soda	sodium silicate		egg preservation, adhesive, plaster	production started 1859
Salt cake	sodium sulfate	Na_2SO_4	tanning, paper	
Sulphate of soda	sodium sulfate	$Na_2SO_4 \cdot 4H_2O$	paper	
Glauber salts	sodium sulfate	$Na_2SO_4 \cdot 10H_2O$	paper, glass	
Nitrate of soda	sodium nitrate	$NaNO_3$	for nitric acid production	boiled with sulfuric acid
Nitric acid	---	HNO_3	explosives	
Chloride of sulfur		SCl_2	bleaching agent	
Tin crystals	tin chloride	---	dyeing	
Oil of vitriol	sulfuric acid	H_2SO_4		
Muriatic acid	hydrochloric acid	HCl		
Sulphur	sulfur	---	sulfuric acid manufacture	

Source: Sanborn Fire Insurance Map, February 1888

^A
Table 2.2

MERRIMAC CHEMICAL COMPANY - CHEMICAL LIST 1894

<u>CHEMICAL</u>	<u>OTHER NAME</u>	<u>FORMULA</u>	<u>USE</u>	<u>MISC.</u>
Bauxite	aluminum ore		Raw material for alum	
Nitrate of iron				
Pyrites	iron ore	FeS ₂	raw material for sulfuric acid	
Sulfuric acid		H ₂ SO ₄		

Alum.
Silicate of soda
Salt cake
Sulfate of soda
Nitrate of soda
Nitric Acid
Muriatic Acid

} previously mentioned

Source: EPA Files

Table ^A 2.3

MERRIMAC CHEMICAL COMPANY - CHEMICAL LIST 1899

<u>CHEMICAL</u>	<u>OTHER NAME</u>	<u>FORMULA</u>	<u>USE</u>	<u>MISC.</u>
Bisulfate of soda				
Hydrate of aluminum				Intermediate in alum manufacture
Chloride of aluminum	Aluminum chloride	$AlCl_3$		
Paint grinding				

Alum
Sulfuric acid
Sulfate of soda
Bauxite
Pyrites
Muriatic acid
Nitric acid
Nitrate of iron

} previously mentioned

Source: EPA Files

Table 2.4^A

MERRIMAC CHEMICAL COMPANY - CHEMICAL LIST 1904

<u>CHEMICAL</u>	<u>OTHER NAME</u>	<u>FORMULA</u>	<u>USE</u>	<u>MISC.</u>
Carbonizer	aluminum chloride	---	textile mills	started production in 1890
Acetate of soda	sodium acetate	---	dyes in textile mills	Merrimac bought acetate to make acetic acid and acetates for textile industry
Acetic acid				
Hypo acid	---	$\text{Na}_2\text{S}_2\text{O}_4$	photographic	
Bisulfite	hydro sulfide	NaSH	paper making	
Carbonic acid	---	H_2CO_3	paper, tanning	
Oil of vitriol	} previously mentioned			
Muriatic acid				
Nitrate of soda				
Glauber salts				
Tin crystals				
Alum				
Hydrate of aluminum				
Bauxite				
Pyrites				

Source: Sanborn Fire Insurance Map May 1904

Table ^A 2.5

MERRIMAC CHEMICAL COMPANY - CHEMICAL LIST 1910

<u>CHEMICAL</u>	<u>OTHER NAME</u>	<u>FORMULA</u>	<u>USE</u>	<u>MISC.</u>
Arsenate of lead (Arsenite of lead)	---	$Pb_3(AsO_4)_2$ $Pb(AsO_2)_2$	Insecticide	
Sulphuric acid Bisulfide Hypo acid Carbonic acid Alum Hydrates Bauxite Pyrites Tin crystals Muriatic acid Glauber salts Acetic acid Acetate of soda Nitric acid Nitrate of soda	{ previously mentioned			

Source: Sanborn Fire Insurance Map, June 1910

^A
Table 2.6.1

MERRIMAC CHEMICAL COMPANY - CHEMICAL LIST 1918

<u>CHEMICAL</u>	<u>OTHER NAME</u>	<u>FORMULA</u>	<u>USE</u>	<u>MISC.</u>
Acetate of lime				
H acid	---	---	dye	naphthalene derivative production moved to Everett by 1926
Naphahalene	---	---	produce H acid	
Litharge	lead monoxide	---	---	---
Nitre	potassium nitrate or sodium nitrate	---	nitric acid production	
Copper sulfate	---	CuSO ₄		
Mercol.Paint manufacture	alkyl aryl sulfinat paint	---	---	---
Sulfuric acid Muriatic acid Pyrites Bauxite Hydrate Alum Alumina Arsenate of lead Glaubers salt Acetic acid Acetate of soda Bisulfite Carbonic acid Sulphur Nitric acid	} previously mentioned			

Source: Sanborn Fire Insurance Map, May 1918

^A
Table 2.6.2

NEW ENGLAND MANUFACTURING CHEMICAL LIST, May 1918

<u>CHEMICAL</u>	<u>OTHER NAME</u>	<u>USE</u>
Phenol	---	intermediate
Benzol	Benzene	explosives, intermediate, misc.
Picric acid		explosives
Toluene	---	explosives

Source: 1918 Sanborn Fire Insurance Map

^A
Table 2.7

MERRIMAC CHEMICAL COMPANY CHEMICAL LIST May 1926

<u>CHEMICAL</u>	<u>OTHER NAME</u>	<u>FORMULA</u>	<u>USE</u>	<u>MISC.</u>
Merclor	sodium hypochlorite	NaOCl	bleaching for textiles and paper	
Alum				
Hydrate				
Iron sulphate				
Bisulphite				
Pyrites				
Nitre				
Nitric acid				
Paint manufacturing				
Glauber salt	previously mentioned			
Salt cake				
Nitric acid				
Muriatic acid				
Sulfuric acid				
Sulfur				
Nitrate				
Hydro acid				
Acetic acid				
Acetate of lime				

Source: 1926 Sanborn Fire Insurance Map

Table 3

STAUFFER CHEMICAL COMPANY
Chemical List - October 1966

Taken from October 1966 monthly inventory and believed to represent, with minor exceptions, chemicals used from 1934 - 1969 by Stauffer on site.

CHEMICAL	OTHER NAME	FORMULA	USE	OCTOBER USAGE -lb-
Albone	Hydroxide peroxide	H_2O_2	Glue treatment	2,000
Anhydrous ammonia		NH_3	Refrigerant	700
Caustic soda - Flake	Sodium hydroxide	$NaOH$	Hide treatment	2,400
Caustic soda - Liquid 50-S-1	Sodium hydroxide	$NaOH$	Hide treatment	41,000
Chloride of lime			Odor control	4,000
Defoamer-Nopco NZH			Glue treatment	7,426
-Nopco 1719A			Glue treatment	4,386
Epon resin			Glue treatment	0
Epsom salt			Glue treatment	0
Excelsior	Wood shavings		Cooking kettle filter	9,976
Filter aid - Celite 0535	Diatomaceous earth		Filtration	0
Gum arabic			Glue treatment	0
Hygrol			Air conditioning	0
Lime	Unslaked lime	CaO	Hide treatment	68,200
Lime slurry - Dry basis		$Ca(OH)_2$	Hide treatment	375,952
Magnesite	Magnesium carbonate		Hide treatment	24,000
Muriatic acid	Hydrochloric acid	HCl	Hide treatment	0
Rock salt		$NaCl$	Utilities/Safety	2,820
Santobrite; Dow "G"; Chlorophene 665	Sodium pentachloro phenate		Water/glue disinfectant	6,750
Seakem	Sea weed extract		Glue treatment	700
Soda ash	Sodium carbonate	Na_2CO_3	Hide treatment	37,100
Sodium perborate			Glue treatment	7,850
Sugar, granulated			Glue treatment	0
Sulphur dioxide		SO_2	Hide treatment	68,060
Sulphuric acid		H_2SO_4	Hide treatment	591,250
Tomol-SN	Sodium salt of Naptha- lene sulfonic acid		Glue treatment	0
Tri-sodium phosphate		Na_3PO_4	Washing	300
Triethylene glycol			Utilities	0
Zinc Hydrosulphite			Glue treatment	0
Zinc Sulphate		$ZnSO_4$	Water/glue disinfectant	12,250

Definition of Use

1. Hide treatment - Chemicals used to prepare raw hides and any chrome tanned leather for glue cooking; and recover and purify grease.
2. Glue treatment - Chemicals used to brighten, increase viscosity, etc. of finished glue.
3. Water/glue disinfectant - Glue solutions provided almost an ideal media for bacterial growth which degraded or sometimes destroyed glue being processed. Bactericides (Zinc sulfate, Santobrite, Dow "G", etc. were added to clean and disinfect glue pipelines, tanks, equipment, etc.
4. Refrigerant, Odor Control, Air Conditioning, etc. as stated.

Table 4

TYPICAL ANALYSIS OF STAUFFER WASTE

Taken from 9/6/62 analysis by Rohm and Haas

Residue remaining after cooking glue from hide pieces

Contains

1. Water 60 - 75%
2. Residual glue in solution 3% concentration
3. Zinc sulfate. Small amount also Santobrite
4. Grease. Varies from very small to large amount
 - a. Grease consists of varying amounts of:
 1. Olein
 2. Oleic Acid
 3. Stearin
 4. Stearic Acid
 5. Palmitin
 6. Palmitic Acid
 7. Calcium soaps of the above
5. Some residue contains chromium largely as either chrome leather or insoluble $\text{Cr}(\text{OH})_3$
6. Calcium sulfate
7. Small amounts of Fe^{+++} , Mg^{++} , Cl^- , SO_3^{--} , Al^{+++} , CO_2 , etc. in solution
8. Keratin: hair and wool
9. pH varies from around 6 to 8
10. Insoluble proteins present in animal skins, i.e., non-collagen proteins

Table 5 ^A HEAVY METAL CONCENTRATION IN SOIL, SEDIMENT AND SURFACE WATER - ave. (range) mean

2/8/83

Element	Soil			Sediment		Surface Water	
	PPM (g/g)			PPM (g/g)		PPB (g/l)	
(8) U. S.	(9) Worldwide?	Other U. S.	U. S.	Contaminated U. S.	U. S. Fresh	(5) World Rivers	
Ag		.1 (.01-5)					
As		6 (.1-40)	(1) 13(<1-80) (2) 7(.3-38)	(3) (0.1-306)	(3) (4470-66,700)	(3) (<1-1800)*	(.01-3.5) 0.1 (.4-230) .4
Ba	554(15-5000)	500 (100-3000)				(6) (2-340) 3	(9-150) 54
Be	1(<1-7)	6 (.1-40)	(10) 0.6(<1-7)				(.1-1) 1
Cd		.06 (.01-.7)	(10) 1(<1-4)			(6) (1-20) 9.5	0.8
Cr	53(1-1500)	100 (5-3000)	(7) Urban(43-1450) (10) 36(1-100) (4) (<1-30,300)**	(4) (2-288)		(4) (1-112) 10	(.1-80)
Cu	25(<1-300)	20 (2-100)	(10) 13(3-100)			(6) (1-280) 15	(.6-400)
Hg		.03 (.01-.3)	(10) .096(.01-3.4)				0.8
Mn	20(<5-700)	40 (10-1000)	(10) 14(3-700)				(.2-20) 10
Pb	20(<10-700)	10 (2-200)	(5) residential 1636 commercial 2413 (7) Urban(2110-8300) (10) 14(<7-300)			(5) Major U.S. rivers 6.1 Main lakes & rivers 2.3 (.03-115)	(.6-120) 5
Sb		(2-107)					<20
Se		.2 (.01-2)	(10) .39(<.1-1.4)				.02
Ti	0.1						.05-22) 2.6
Zn	54 (<25-2000)	50(10-300)	(7) Urban(460-580)				

(1) The Chemistry & Phytotoxicity of Arsenic in Soil, Contaminated Field Soils. Woolson et al pg. 938-943. SOIL SCI. SOC. AMER. PROC. Vol. 35 1971

(2) Arsenic Distribution in Soils and Its Presence in Certain Plants USDA Tech. Bul #732, July 1940

(3) Arsenic, Natural Academy of Science, Wash. D.C. 1977

(4) Chromium, Reviews of the Environmental Effects of Pollutants, Oak Ridge National Lab. Tenn. U.S. Dept. of Commerce PB-282 796, May 1978

(5) Lead, National Academy of Sciences, Wash. D.C. 1972

(6) Water Quality Criteria. A Report of the Committee on Water Quality Criteria, PB-236 199 U.S. Dep. of Commerce 1972

(7) Distribution of Metals in Streetsweepings, Stormwater Solids and Urban Aquatic Sediments, Wilber, et al, J. Water Poll. Cont. Dec. 1979, Vol. 51, #12, page 2810-2822

(8) Elemental Composition of Surficial Materials in the Conterminous U.S., Shacklette, et al, Geological Survey Professional Paper 574-D 1971

(9) Trace Elements in Biochemistry, Bowen, H.J.M., Academic Press (1966)

(10) Background Geochemistry of some rocks, soils, plants and vegetables in the coterminous U.S. Connor, J.J., & Shacklette, H.T., U.S. Geol. Survey Professional paper 574-F, U.S. Gov. Printing Office, 1975 (Eastern U.S.) taken from EPA publication EPA-600/9-80-010 March 1980.

*Searles Lake, Calif. contains 198,000-243,000

Everglades peat and Okeechobee muck

^A
Table 6 - HEAVY METAL STANDARDS OR GUIDELINES FOR WATER AND AGRICULTURAL SOIL

Element	Guidelines for Addition of Sludge or Waste Containing Heavy Metals to Agricultural Land (lb/acre of heavy metal added)					PPM Increase In Soil conc.(Assume all in top 6" of soil)	Suggested Tolerance Level to Monitor Plants Used For Animal or Human Consumption(PPM)	Water Quality Criteria - g/l (PPB)			
	Ref.1	Ref.2	Ref.3	Ref.4	Ref.5			Drinking Water Std.(6)	Water for Livestock(7)	Marine Aquatic Biota(7)	Fresh Water Aquatic Biota(7)
Ag	180					110		50(max)		5	
As	45-670			110	5.6	3.4-410	2	50(max)	200	50	
Ba							200	1000(max)		1000	
Be				27		16				1500	
Cd	4.5-16.8	5-20	<9	2.7	1.1	0.7-12.2	3	10(max)	50	10	0.4
Cr	450-3570			54	38	23-2185	2	50(max)	1000	100	50
Cu	110-450	125-500	<225	1360	57	35-830	150	1000	500	50	
Hg					0.4	0.2	0.054	2(max)	10	0.1	0.05
Ni	45-180	125-500	<90	110	14.2	8.6-306	3			100	
Pb	450-2680	500-2000	<890	2720	38	23-1665	10	50(max)	100	50	30
Sb	<714					<437		20			
Se				1.1	1.1	0.7	3	10(max)	50	10	
Tl	4.5-8.9					2.8-5.5				100	
Zn	225-890	250-1000	<450	2720	142	87-1665	300	5000	25000	100	

- (1) Design of Land Treatment Systems for Industrial Wastes - Theory & Practice, Overcash, M.R., Pal, D, Ann Arbor Science Pub. Inc.(1979)
- (2) Sludge Treatment and Disposal, Vol 2, EPA-625/4-78-012, October 1978
- (3) Draft of 2nd Ed.- Design Criteria for Municipal Sludge Utilization on Agricultural Land-Technical Policy WPC-3, Illinois EPA(April 1977)
- (4) Land Treatment of Municipal Wastewater Effluents (Design Factors) EPA-625/4-76-010 Vol. 2
- (5) Land Application Guidelines for Sludges Contaminated with Toxic Elements, Garrigan, G.A., Jour W.P.C.F. Dec. 1977, pg. 2380-2388 (Quoted from Ontario Guidelines)
- (6) Environmental Reporter, 132:0102 (thru 47 FR 10998, March 1982)
Environmental Reporter, 132:0301
- (7) Water Quality Criteria 1972, A Report of the Committee on Water Quality,
U. S. Department of Commerce, NTIS PB-236199

January 27, 1983

APPENDIX II

Analytical Data

<u>Page</u> -	Table 1 - Soil Heavy Metal Analysis
	1.1 Summary of Analysis
	1.2 Physical Property Correlation
	1.3 Analysis
	1.4 Old Data
	Table 2 - Soil Organic Screening
	Table 3 - Total Site Sampling & Analysis
	Table 4 - Bore Hole Air Sampling
	Table 5 - Analyte Code & Lower Limit of Detection for Various Media
	Table 6 - Bore Hole Aqueous, TRS & VOC Analysis
	Table 7 - Monitor Well & Leachate Analysis
	7.1 Monitor Well Analysis
	7.2 Leachate Analysis
	Table 8 - Surface Water Analysis
	8.1 Heavy Metal, Suspended Solids, Dissolved Solids Cyanide & Organic Pollutants
	8.2 Standard Water Analysis
	8.3 Previous Water Analysis
	Table 9 - Sediment Analysis
	Figure 1 - Phase I Soil Sampling Locations
	Figure 2 - Bore Hole Sampling Location
	Figure 3 - Surface Water and Sediment Sampling Locations
	Figure 4 - Monitor Well and Leachate Sampling Locations

B
TABLE 1.1

(1)
SUMMARY OF 254 WOBURN SOIL HEAVY METAL ANALYSIS

Element	Number Samples				Concentration - PPM			Maximum
	0-100 PPM	>100 PPM	>500 PPM	>1000 PPM	25 Percentile	50 Percentile	75 Percentile	
Antimony -01	246	8			< 2	2	13	455
Arsenic -02	149	105	51	29	5	23	250	24227
Barium -16	155	99	36	30	<10	45	202	5612
Beryllium -03	254				< 2	2	2	7
Cadmium -04	252	2			< 1	2	3	199
Chromium -05	176	78	41	27	5	18	37	145455
Copper -06	152	102	56	38	8	45	409	29167
Lead -07	101	153	97	74	10	186	1576	89109
Mercury -08	219	4			< 1	< 1		545
Nickel -09	249	6			5	14	23	500
Selenium -10	253	1			< 2	< 2	3	112
Silver -11	252	2			< 2	< 2	5	116
Thallium -12	253	1			<10	< 10	25	258
Zinc -13	111	143	80	63	16	198	903	144330

(1)

This consisted of the following soil analysis

- (21) JANPET
- (7) EPA/DEQE
- (7) Stauffer 4/2/82
- (15) Boston Edison
- (204) Phase I Study

It was assumed JANPET, Boston Edison, EPA/DEQE analyzed for same 14 elements as in the study.

B
TABLE 1.2 - SOIL HEAVY METAL PHYSICAL PROPERTY CORRELATION

(1)

12/16/82

Element	Code #	COLOR										DO/TEXT										DEPTH			
		1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	0-2'	2-6'	6-10'	10-50'
		Samples	25	50	20	20	45	18	13			0	2	36	4	47	30	19	24	24	3	78	72	26	8
		Number Samples >100 ppm										Number Samples >100 ppm										Number Samples >100 ppm			
Antimony	01			1	2		4	1						2	2		3	1							
Arsenic	02		6	17	14	7	37	9	7					29	3	12	15	12	12	11	1	43	41	9	2
Barium	16		4	18	14	7	41	6						29	4	8	15	9	12	12		43	30	11	
Beryllium	03																								
Cadmium	04						1										1					2			
Chromium	05		2	24	7	4	13	3	4					7	1	10	14	5	8	8	1	26	18	6	2
Copper	06		4	20	11	9	39	9	7					31	4	9	17	7	14	14		44	39	9	2
Lead	07		7	22	20	12	42	12	8					36	4	12	22	13	20	14	1	53	50	12	2
Mercury	08																								
Nickel	09						4		1							1			1	1		2	2		
Selenium	10																								
Silver	11						2											2				2			
Thallium	12						1							1								1			
Zinc	13		8	34	15	12	43	9	3					30	4	13	25	14	17	15	1	57	46	12	4

(1)

Restricted to 194 samples collected during study because of uncertainty whether other sample color and texture identification followed same criteria.

B
TABLE 1.3 - SOIL HEAVY METAL ANALYSIS

Page 1 of 6
11-10-82

HEAVY METAL CONCENTRATION - PPM

LOCATION	Ref. #	HEAVY METAL CONCENTRATION - PPM														Depth Ft.	PHYSICAL CHARACTERISTIC			
		3/De	4/Cd	5/Cr	6/Cu	7/Pb	9/Ni	11/Ag	12/Tl	13/Zn	16/Ba	1/Sb	2/As	8/Hg	10/Se		Odor	Color	Dom Tex	Sub Tex
		LLD	1	1	5	2	5	2	1	10	1	10	2	2	1	2				
T-1	73630102				16	11	9	19		18	35		7			3.5	1	1	5	2
B-1	0108				22	17	13	27		38	64		4			7	1	1	5	2
B-2	0117				7	8	6	14		11	40		4			7.75	1	1	5	7
B-3	0114				8	7	8	10		15	36		2			5	1	1	5	5
B-4	0124				5	14	3	16		9	35		5			7	1	1	5	4
B-6	0133		3	280	634	4516	26	16	11	903	420	7	806	4		1	1	5	6	7
B-7	0213		2	68	35	225	12				54		39	6	10	3	1	1	3	7
B-8	0212					7	11	12		14			3			1	2	2	10	7
B-9	0207				637	27	86	15		216	29		118			1	2	1	5	7
"	0216				16	18		12		16			12			3	2	1	5	7
B-10	0209				2105	23	100	13		11	283		126	69		5.4	3	2	7	8
B-11	0201				977	78	188	15			182	220	104			1	3	2	7	8
B-12	0219		15		7	2137	8803	22	46	26	4530	1500	13	1026	2	3	1	2	5	3
"	0224				7	35	11	12			59	10				9	1	5	5	4
B-13	0225				409	95	525	27	3		229	81		194	43	.25	1	1	10	4
"	0230				4	161	1307	503	29	10	20	864	450		281	7	5	5	3	4
B-14	0233				4	112	466	1837	220	3	41	745	130		235	1	5	1	5	5
"	0302				3	16	435	212	20	10	21	1753	260		289		2	3	5	4
B-15	0307				2	20	602	2143	22	15	31	443	560		296	4	15	5	3	4
"	0306				2	19	670	2062	23	12	31	443	400		237	4	7	6.4	3	4
B-19	0310					89	105	765	21	2		231	130		192	79	1	2	1	4
B-20	0312					648	166	451	30			278	200		308	84	1	2	3	4

PHYSICAL CHARACTERISTICS CODE

Odor		Color		Dom Tex (50%) Description		Sub Tex (20%) Description	
1	None	1	Normal	1	Coarse Gravel	1	Coarse Gravel
2	Moderate	2	Black	2	Fine Gravel	2	Fine Gravel
3	Strong	3	White	3	Artificial Components	3	Coarse Sand
		4	Grey		(brick, cement, traprock, etc.)	4	Fine Sand
		5	Red	4	Coarse Sand	5	Silt
		6	Orange	5	Medium Sand	6	Clay
		7	Yellow	6	Fine Sand	7	Organic Matter (roots, grass, etc)
		8	Green	7	Silt	8	Hides, hair particles
		9	Blue	8	Clay	9	Artificial components
		10	Purple	9	Poorly sorted mixture of clay, silt, sand and gravel.	10	Combination of numbers 8 & 9
				10	Topsoil (Organic zone)		

A blank space indicates below LLD level.

SOIL HEAVY METAL ANALYSIS

HEAVY METAL CONCENTRATION - PPM

LOCATION	Ref. #	HEAVY METAL CONCENTRATION - PPM														Depth Ft.	PHYSICAL CHARACTERISTIC				
		3/Ba	4/Cd	5/Cr	6/Cu	7/Pb	9/Ni	11/Ag	12/Tl	13/Zn	16/Ba	17/Sb	2/As	8/Hg	10/Se		Odor	Color	Dom Tex	Sub Tex	
B-21	73630316			11	21	13	11			11			1215			5.5	2	2	7	9	
"	0317			31	40	13	29	3		34	70		210			9.5	2	2	8	3	
B-22	0327		6	4956	81	196	18	2	18	3363	31	3	88	54		7	3	4	7	8	
"	0322			216	21	8	21			61	45		5			8.9	3	2	5	2	
"	0324			42	29	12	35			39	98		5			14.65	2	4	9	6	
B-23	0332		2	1753	398	445	24	5	31	1237	124		237	1	4	1	2	3	3	6	
"	0401		2	36	548	207	21	4	46	36	20		95	1		3	2	7	3	6	
"	0330		2		3145	131	23	3	31	97	23		12			5	2	2	3	6	
B-24	0406		13	6	1856	866	16	17	21	5979	640		11	16	3	1	1	5	3	3	
"	0405		8	16	259	3800	33	7	45	3300	120	13	15	11	35	7	2	4	3	6	
B-25	0412	3	13	135	29167	1875	59	11	31	7396	180		21	5		7	2	2	8	7	
B-26	0419		2	202	281	2018	23	5	18	211	210	5	284	5	15	11	2	2	9	4	
B-27	0432		3	4090	161	555	22	2	10	685	97		64			5	2	2	8	9	
"	0502		4	51	84	45	24		11	2128	43		71		6	21	1	1	8	7	
B-28	0506	4	86	124	3918	4124	47	6	46	6701	100	9	866	17		11	2	2	8	5	
B-29	0525		3	117	409	5631	23	6	39	854	330	17	204	12	15	3	1	7	9	9	
B-30	0523		1	33	26	55	23		10	107	50		5			.9	1	7	9	4	
B-31	0530		2	830	90	126	16			230	45		9	40		3.5	3	2	6	8	
"	0534		2	1170	34	149	18	4	21	216	48		8	43		9.85	3	4	8	7	
B-32	0620		1	688	132	156	22		10	3229	110	2	6			5	2	4	8	8	
"	0619		5	1619	258	385	30	2	29	5714	640	7	6			7	3	2	4	7	
B-33	0702			12	17	70	11			33	45		11			3	2	2	5	4	
"	0633	2		17	26	26	12			32	71		7			5.75	3	4	8	4	
B-34	0714		1	23	26	108	32			43	67					1	1	1	7	4	
"	0630			22	15	15	23			45	33		3			6.35	2	1	2	3	
B-35	0707	2	7	42	340	2857	40	4	20	1735	300	10	1122	9	7	1	1	2	9	4	
"	0711		9	36	367	1152	60	4	10	2020	190	3	133	4	3	2.35	2	4	5	7	
B-36	0811		2	10	437	4660	10	16		359	490	21	1262	4	6	1	1	5	3	5	
"	0808		8		1792	5849	8	32		4151	1700	10	1321	72	4	3	1	5	3	3	
"	0807		9	5	1111	343	6	15	28	6944	1700	13	1944		2	5	1	4	3	3	
"	0804			14	37	123	13		28	70	38		858			7	1	4	5	2	
B-37	0733		5	30	964	540	25	3		1600	160	10	1500	1		3	2	1	3	5	
"	0732	2	20	48	3241	1944	32	5		7685	300	19	204	5	2	9	2	6	8	4	
B-39	0825			6	25	77	7			28	30		12			1	1	1	5	4	

SOIL HEAVY METAL ANALYSIS

HEAVY METAL CONCENTRATION - PPH

LOCATION	Ref. #	HEAVY METAL CONCENTRATION - PPM														Depth Ft.	PHYSICAL CHARACTERISTIC				
		3/Be	4/Cd	5/Cr	6/Cu	7/Pb	9/Mn	11/Ag	12/TL	13/Zn	16/Ba	17/Sb	2/As	8/Hg	10/Se		Odor	Color	Dos	Tex	Sub Tex
B-40	73630834		1	10	262	1010	13	3		465	110	8	19	1	4	1	1	1	6	5	
"	0833			7	8	5	11			89	30				3		1	1	5	4	
"	0832			7	11	6	10			50	30				5		2	1	5	4	
B-41	0901		2	25	127	465	20	4	30	525	160	3	101	4	1		1	5	3	4	
"	0902	2	2	28	147	570	33	4	30	100	300		250	12	3		2	3	3	3	
B-42	0909		2	131	247	1616	11	6	10	505	1000	19	93	3	5	1	1	5	3	5	
"	0911		9		437	5243	9	8		2915	510	39	814	15	16	3	1	5	3	5	
B-43	0914		1	63	30	94	19			280	45		20	47	3	1	1	2	6	4	
"	0915		1	13	114	7476	15	4		214	290	37	1845	54	81	3	1	6	3	4	
"	0917		2	7	270	52	11			140	25		190	40	3	5	2	4	5	4	
B-44	0920		1	18	26	51	21			66	45		14			1	2	1	5	2	
"	0921			11	6	10	11			18			6			7	2	4	5	4	
B-45	1006			6	20	10	13		10	36			184			7	1	1	5	4	
B-46	1001		5		316	21212	9	25	258	1414	1000	141	5960	545		1	2	5	3	4	
B-47	1011		3	63	257	951	44	4	29	767	130		223	2	4	1	1	1	7	2	
"	1009			37	6	10	12			14			5		8	7	2	4	5	3	
B-48	1015			13	19	21	19		21	27	260		10	57		8.3	2	2	8	9	
B-49	1018		12	6	1485	4950	17	16	20	6637	660	5	881	62		.3	1	5	7	4	
"	1017		3	27	808	606	38	7	20	838	190		21			.5	1	7	8	5	
B-50	1023		2	15	55	190	16		20		45		19			1	2	2	7	4	
"	1022			21	42	10	32		10	51	25					2.65	1	1	3	2	
B-51	1030		2	78	59	90	36		30	234	80		19	79		2.35	1	1	5	6	
B-52	1101			6	5	5	13			12			9		3	5	2	4	5	3	
"	1104			7	7	5	14		10	15			10			11	2	2	5	4	
"	1102			9	8		13		10	15			10		3	15	3	2	7	4	
B-53	1107		3	180	169	1160	26	5	45	333	130	5	410	5	9	1	3	4	9	9	
"	1112			7	6	15			20	12						9	2	2	5	4	
B-54	1121		2	110	41	140	19	3	40	137	50		9			1	3	3	6	6	
"	1116			33	15	5	17		10	56	25		3			11	3	2	5	3	
B-55	1127		4	12	12	8200	24	16	50	790	25	13	680	6	9	1	1	5	3	4	
"	1130		4	22	554	871	31	6	20	762	200		782	4	5	5	2	5	3	6	
"	1124		5	19	71	27	15		11	681	89		73			11	2	2	7	7	
B-56	1210		19	68	29	36408	34	32	24	14563	126	78	8932	3		3	1	6	3	4	
"	1202		35	5	2894	76	7	8		32993	132	5	1398			7	1	5	4	4	
B-57	1208		3	187	1818	278	30		15	207	131	5	76			1	3	2	6	3	
"	1205		3	8	94	67	5			1340		4	88			5	2	2	6	6	

SOIL HEAVY METAL ANALYSIS

Table 1.3
Page 4 of 6
11-10-82

LOCATION	Ref. #	HEAVY METAL CONCENTRATION - PPM													Depth Ft.	PHYSICAL CHARACTERISTIC				
		3/Be	4/Cd	5/Cr	6/Cu	7/Pb	9/Ni	11/Ag	12/Tl	13/Zn	16/Ba	17/Sb	2/As	8/Hg		10/Se	Odor	Color	Dom Tex	Sub Tex
T-2	73631410		14	51	2143	4694	20	23	36	4490	673	61	2755	8	4	1.5	1	5	9	9
"	1412		20	22	27	7071	15	45	35	3162	1242	69	8081	4		5.5	1	5	8	7
T-3	1416		4	22	255	7041	10	7	56	342	265	61	1531	34	87	3	1	7	3	9
T-4	1417		12		2913	26699	17	82	29	11165	1282	61	1748	3		.5	2	4	3	1
"	1414		3	29	72	417	9		15	282	49	7	204	1		4.5	1	7	7	1
T-5	1419		5	366	733	4257	40	5	25	2178	337	33	1386	15	2	2	1	3	3	3
T-7	1509		2	25	5	20	5			30		3	7			4.5	2	4	5	5
T-8	1507		2	5	57	3				5		5	4			3	3	2	6	4
T-9	1504		4	28	59	165	20		10	113	50	8	23			3.5	3	6	6	2
"	1505			22	39	25	30		20	50	50	6	7			4.5	2	5	6	2
T-10	1501		5	44444	505	227	10	10	30	374	202	10	10	1	3	unk.	3	5	8	8
"	1503		4	15481	162	396	15	2	20	2840	132	9	8	1		10	3	2	9	8
T-11	1502		3	180	21	15	15			280	50	5	7			unk.	3	3	9	8
T-12	1508			248	1485	30	9			113		5	7			2	3	2	5	4
"	1506		4	15	12	30	10			40		5	10			4.5	2	1	5	2
T-13	1511			10	10		9			34		4	8			2.5	1	6	5	5
T-14	1512	2	6	145455	172	136	20	2	25	11111		9	3	1		4.0	2	2	-	8
"	1518		45	20	5	10			40	50	3	4	4			5	1	4	2	5
T-15	1514			248	32	59	15			198		7	5			3	3	2	-	8
T-16	1510		3	12121	44	253	15				5	32				1	1	3	9	5
"	1519			94	15		6	2		59			50			unk.	1	2	5	4
T-17	1525	3		15	158	1881	30	7	25	188		68	743	16	15	3	1	3	3	9
"	1526		4		840	10400	9	61	55	190	2200	60	1100	2	5	3.5	1	5	4	1
"	1528		5	104	302	1832	295	12	30	1733	337	62	238	2		unk.	2	7	9	6
T-18	1527		5	10	36	1959	21	5	62	2784	515	26	1856	1	2	7.5	1	3	3	9
T-19	1532		5	5	1100	10800	10	59	30	2300	2100	58	950	4	5	unk.	1	5	9	1
T-20	1531	3			157	618	2			70		7	25	4	16	unk.	1	6	8	9
T-22	1601		2	10	41	75	9			25		16	15		2	8.5	1	2	10	7
T-23	1611		5	10	26	290	18	5	55	1800	400	4	11000	1		3.5	1	3	8	9
T-24	1613		6	10	14	109	15	6	64	257	525		9			4.15	1	3	8	9
T-25	1617		199	186	2165	268	36	4	21	144330	103	10	24227			2.0	1	5	6	9
T-26	1622	3	5	179	142	2189	324	2	30	465	129	23	139			2	1	5	8	9
T-27	1624	7	5	260	59	1961	500		49	225	98	15	3			4	1	5	6	9
T-28	1626	3	4	149	26	186	24	3	52	134	103	62	186			2	1	7	8	9
T-29	1609		5	49	922	2353	15	10		3725	98	58	93	1	8	3	2	3	8	9
"	1615		5	29	294	98	9			2549			5882			4	3	2	6	7

SOIL HEAVY METAL ANALYSIS

Table 1.3

11-10-82

LOCATION	Ref. #	HEAVY METAL CONCENTRATION - PPM														Depth Ft.	PHYSICAL CHARACTERISTIC				
		3/Be	4/Cd	5/Cr	6/Cu	7/Pb	9/NI	11/Ag	12/TL	13/Zn	16/Ba	17/Sb	2/As	8/Hg	10/Se		Odor	Color	Dom	Tex	Sub Tex
T-30	73631606		16		990	89109	9	10	50	4554	10	11	16337	594	10	2	1	4	3	4	
T-31	73631608	2	6	110	78	320	205	2	38	1700	280	6	175	1	7	2.5	1	5	5	9	
"	1604		6	12	35	5100	35	5	60	2950	400	35	2050	1		4	1	3	8	9	
T-32	1628		4	64	168	376	18	3	25	198	257	5	129	2	2	2	1	2	6	9	
T-33	1631		4	20	647	3088	15	5	20	1520	98	50	67	2	4	2	1	4	8	9	
T-35	1718		3	1111	45	93	13			359		5	21			1.5	3	2	6	8	
T-36	1717		2	99	14	15	9	16		114		2	8			2	3	2	6	8	
T-38	1632		20	8	2970	14851	18	79	30	8713	297	49	594	1	3	1.5	1	5	5	9	
T-40	1625		26	105	2500	11000	35	50	35	7700	1700	45	5200	2		3	1	7	6	9	
T-42	1721			5	37	176	3			29		4	157			3	2	6	6	5	
T-43	1722		10	346	2424	4646	18	32	28	3838	1010	45	404	2	4	.5	1	5	3	4	
T-45	1724		16	16000	830	2600	62	8	25	29500	720	23	8	6		5.2	2	2	6	9	
"	1726		8	5	2062	5979	9	15	26	3814	742	26	928	1	4	9	1	5	7	9	
T-46	1725		3	396	11	20	9	34		272		4	7			1.15	3	2	6	10	
T-47	1727		4	65	310	3100	15		20	1520	330	35	250		3	3.6	3	2	6	9	
T-48	1732		2	1010	121	30	9			435	101	5	13	1		4	2	2	6	7	
T-50	1733		4		1485	12475	5	72	20	2495	2178	40	40	1	2	1	1	5	9	9	
T-57	1810		2	13000	59	3100	15	5		430	100	17	1450	1	24	2.75	2	2	5	3	
T-59	1813			1750	14	14	10			170		4	8			2	3	2	7	8	
T-60	1812		4	4902	75	88	10		20	11275	490	9	59	1		.8	3	2	7	8	
T-63	1815		2	37	28	888	27	4	28		67	41	1633	13	20	1	1	3	7	9	
"	1818		13		1414	22222	12	96	34	8564	4444	91	5556	4		2.55	1	5	7	9	
T-64	1820		13		1531	26531	14	101	28	6735	5612	102	7959			.4	1	5	7	9	
T-65	1816		5		1287	23762	14	116	41	1089	3762	109	1485	2		.3	1	5	7	9	
T-70	1827		10	97	1900	5100	26	22	41	1900	700	190	1400	6	9	2.5	1	5	7	9	
T-73	1905			7	9		11			16	37	2	3			.7	1	3	6	4	
"	1901				4		8		13	16		4	3			1	1	7	6	5	
T-75	1903		2	58	82	5	55		15	129	65	8	5			2.0	1	4	9	1	
T-79	1907		2	12	19		18		12	24		4	5			1.5	1	6	9	1	
T-81	1909			21	18	10	29		15	51		5	7			.75	1	5	9	1	
T-83	1911			41	41	10	46		20	51	37	8	11			1.5	1	5	9	1	
T-84	1913		4	7	83	360	14	4	41	33	66	54	200			1	1	7	8	9	
T-85	1915		3	75	314	1576	12	6	23	350	365	33	675	4	5	2	1	5	8	9	
"	1916	2	4		653	158	16	2	41	9	37	40	594			5.5	2	3	9	8	
T-86	1918		3	100	1300	2600	14	7	20	390	550	47	1100	5		1.5	1	5	6	9	
T-87	1920		2		745	13725	16	10	54	529	3137	88	588	2		1.5	1	5	9	9	
T-88	1919		6		444	11111	12	13	34	1212	1515	68	778	3		2.25	1	5	9	9	
T-89	1923		4	198	28713	1980	24	7	20	1584	1287	27	941	5	5	2.7	3	2	9	9	
"	1922		4	82	1364	7475	29	9	34	556	323	455	1414	192	5	7.2	3	2	3	8	

SOIL HEAVY METAL ANALYSIS

B
Table 1-3
Page 6 of 6
11-10-82

HEAVY METAL CONCENTRATION - PPM

LOCATION	Ref. #	HEAVY METAL CONCENTRATION - PPM														Depth Ft.	PHYSICAL CHARACTERISTIC			
		3/Be	4/Cd	5/Cr	6/Cu	7/Pb	9/Ni	11/Ag	12/Tl	13/Zn	16/Ba	17/Sb	2/As	8/Hg	10/Se		Odor	Color	Dom Tex	Sub Tex
T-91	1924		4	14	599	1692	29	3	48	92	119	249	796	2	6	3	1	3	8	9
T-93	1930				108		9		13	30		4				2.5	1	6	5	4
T-94	1929		3	2178	1287	218	29		34	525	178	31	743			2	1	6	5	5
T-95	1928		2	303	93	1313	22	2	27	414	182	253	727	5	8	.85	1	3	5	3
"	1927		3	13	624	149	19	2	41	12	149	43	12			1.75	1	6	5	4
"	1926		3	949	152	424	19	6	27	1111	354	24	101		3	4.1	1	5	6	4
T-96	2016				131		12		13	11		5	6			1	1	7	5	3
T-98	2020				4		9			10		7	7			1.5	1	6	5	4
T-100	2024			12	17		19			28	23	11	7			1	1	7	5	2
T-101	2023																1	6	5	9
T-102	2022			10	11		14			20	23	9	8			1	1	6	5	2
T-103	2025			17	19		21			33	23	14	12			.1	1	6	5	4
T-104	2031			1560	8			7		45	51	11	3			3.05	3	2	5	8
T-105	2032		3	39	1000		16	7	13	620	150	15	190		4	3.5	2	2	9	7
T-106	73632033			17	22		20			35	37	8	11			2	1	1	9	3
T-107	2118		9		2500	1500	14	31	20	2200	870	27	290		4	1.8	2	5	6	9
"	2117				48	567	4			78		10	639		6	2.8	1	2	6	9
T-108	2116		8		1400	550	7	16		2400	170	16	120			2	1	5	4	9
T-110	2114			28	32	810	22			120		12	500		6	1	1	6	5	9
"	2112		5	18	11	110	36	5	52	14	200	14	5			unk.	1	3	3	9
T-111	2113			10	4		6			5	23	4				0	1	3	6	4
T-112	2110		5	347	109	412	8	12	10	703	1608	23	48		4	unk.	1	5	6	3
"	2111		2	2300	85	480	9		13	300	210	8	75			unk.	1	3	5	4
T-113	2108		3	4343	1313	8788	24	6	20	778	707	303	14141	111	14	1.5	1	6	5	7
"	2109		14	7	480	160	24		20	1300		32	17000			4.5	1	6	3	9
T-114	2107			7	48	55	17			46	23	7	12		7	1	1	2	3	9
"	2106		3	21	290	4200	36		34	89	120	11	2400	3	5	1.5	1	3	6	9

B
Table 1.4 SOIL HEAVY METAL CONCENTRATION (OLD DATA)

Page 1 of 2
January 24, 1981

Heavy Metal Concentration - PPM																Depth.	Physical Characteristics			
Location	Reference	3/Be	4/d	5/Cr	6 /Cu	7/Pb	9/Ni	11/Ag	12/Tl	13/Zn	16/Na	1/Sb	2/As	8/Hg	10/Se	ft.	Odor	Color	DomTex	SubTex
J/GZ1	00100000			3		210							64			2	1	10	7	3
"	-100010			19		16							57							
J/GZ5	200000			11		14000							270				0			
"	200010			18	14000	1700				1300			2600							
"	200020			12		15							160							
"	200030			14		15							210							
J/C3	300000			450		2100							400			2	0	5	7	3
"	400000			810	830	3200				4300			100							
J/GZ2	500000			360	4200	1100				20000			75			6	0	10	7	8
"	500010			64		5800							160							
"	500020			6		15							13							
J/GZ4	600000			15		870							620			4	0	6	7	3
J/GZ1	700000			64	230	860				49			65			7	0	4	7	0
"	700010			2		120							25							
J/D	800000			650		440							100			0	0	5	10	3
J/E	900000			310		370							29			0	0	10	3	3
J/B-9A	1000000			2		55							8							
J/B-2	1100000			3		1600							69							
J/B-3	1200000			16		3000							55							
J/B-5	1300000			1		470							74							
J/B-6	1400000			12		470							42							
B-1-1	2400000			270	340								70			0.1				
B-1-2	2500000			270	1400								160			0.1				
B-2-1	2600000			340		610							230			0.1				
B-2-2	2700000			510	150								7			0.1				
B-3-1	2800000			0	0								10			0.1				
B-3-2	2900000			30	290								72			1.0				

It is assumed analytical data met basic laboratory quality assurance checks and is acceptable.

HEAVY METAL CONCENTRATION - PPM

Location	Reference #	3/Be	4/Cd	5/Cr	6/Cu	7/Pb	9/Ni	11/Ag	12/Tl	13/Zn	16/Ba	1/Sb	2/As	8/Hg	10/Se	Depth, Physical Characteristics				
																Ft.	Odor	Color	DomTex	SubTex
BE 925	3100000		1	10		5			0		18		14		4	.3				
BE 925A	3200000		1	17		10					17		17		6	99.99				
BE 925A	3300000		2	38		16					45		15		10	1.5				
BE 926A	3400000		2	33		29					47		20		10	1.0				
BE 927	3500000		1	9		52					9		10		2	3.0				
BE 927A	3600000		1	7		92					28		12		3	99.99				
BE 928	3700000		2	605		353					59		104		10	3.0				
BE 928A	3800000		155	2917		2059		32			2		1688	8	112	3.0				
BE 928A	3900000		5	1429		1064				129	1064		246		19	3.0				
BE 928A	4000000		15	2691		865				132	865		266		31	2.5				
BE 929	4100000		3	1477		79				79	79		283		17	99.99				
BE 929	4200000		2	552		136				30	30		47		9	1.0				
BE 929A	4300000		3	1853		625				63	63		194		19	1.5				
BE 929A	4400000		3	2466		272				134	134		164		27	2.0				
BE 929A	4500000		4	1586		1254				82	82		290		19	1.0				

B
Table 2

SOIL ORGANIC SCREENING

Location	Ref. #	Loss on Drying %	Counts/ Gram	Depth ft.	Physical Characteristics			
					Odor	Color	Dom Tex	Sub Tex
B-23	73630330	32.9	30	5	2	2	3	6
B-23	0332	24.3	60	7	1	1	5	2
B-23	0401	35.0	77	3	2	7	3	6
B-24	0405	39.3	270	7	2	4	3	6
B-24	0406	17.1	98	1	1	5	3	3
B-25	0412	62.7	3077	7	2	2	8	7
B-26	0419	20.2	278	11	2	2	9	4
B-27	0432	30.9	773	5	2	2	8	9
B-27	0502	77.6	2791	21	1	1	8	7
B-28	0506	70.2	1510	11	2	6	8	5
B-30	0523	5.2	20	.9	1	7	9	4
B-29	0525	18.3	75	3	1	7	9	9
B-31	0528	-	179	11.25	3	2	8	7
B-31	0530	15.3	241	3.5	3	2	6	8
B-31	0532	-	402	16	3	2	6	6
B-31	0534	26.5	242	9.85	3	4	8	7
B-31	0601	-	67	24	3	2	6	8
B-31	0602	-	401	28	3	2	6	8
B-32	0605		114	1.5	1	2	5	5
B-32	0607		67	3.5	2	2	6	8
B-32	0619	58.1	2459	7	3	2	4	7
B-34	0629	0	759	3	1	1	5	4
B-34	0630	9.3	41	6.35	2	1	2	3
B-34	0631	-	18	10.05	2	1	1	3
B-34	0634	-	153	5	2	1	2	1
B-35	0707	14.3	74	1	1	2	9	4
B-33	0633	51.2	1842	5.75	3	4	8	4
B-33	0702	16.6	148	3	2	2	5	4
B-35	0711	20.2	17,908	2.35	2	4	5	7
B-34	0714	11.5	551	1	1	1	7	4
B-38	0729	12.0	242	1	2	1	7	4
B-37	0732	32.9	763	9	2	6	8	4
B-37	0733	8.8	57	3	2	1	3	5
B-36	0804	10.5	89	7	1	4	5	2
B-36	0807	21.9	77	5	1	4	3	3
B-36	0808	20.8	27	3	1	5	3	5
B-36	0811	14.3	50	1	1	5	3	5
B-39	0819	-	14	11	1	1	5	4
B-39	0823	-	42	5	1	1	5	4
B-39	0825		177	1	1	1	5	4
B-40	0832	16.7	582	5	2	1	5	4
B-40	0833	9.6	11	3	1	1	5	4
B-40	0834	14.5	21	1	1	1	6	5
B-41	0901	6.9	26	1	1	5	3	4
B-42	0909	18.0	252	1	1	5	3	5
B-42	0911	17.1	270	3	1	5	3	5
B-43	0914	26.7	517	1	1	2	6	4
B-43	0917	24.9	341	5	2	4	5	4
B-44	0920	8.5	42	1	2	1	5	2
B-44	0921	17.0	69	7	2	4	5	4
B-46	1001	24.9	107	1	2	5	3	4

SOIL ORGANIC SCREENING

Location	Ref. #	Loss on Drying %	Counts/ Depth Gram ft.		Physical Characteristics			
					Odor	Color	Dom Tex	Sub Tex
B-45	73631006	18.7	166	7	1	1	5	4
B-47	1009	18.2	100	7	2	4	5	3
B-47	1011	8.3	66	1	1	1	7	4
B-48	1015	23.3	3188	8.3	2	2	8	9
B-49	1017	13.9	88	.5	1	7	8	5
B-49	1018	14.9	115	.3	1	5	7	4
B-50	1020	-	32	4.45	1	1	3	2
B-50	1022	2.9	10	2.65	1	1	3	2
B-50	1023	20.0	223	1	2	2	7	4
B-51	1030	8.1	24	2.35	1	1	5	6
B-52	1101	2.3	6	5	2	4	5	3
B-52	1104	19.3	126	11	2	2	5	4
B-53	1112	16.9	91	9	2	2	5	4
B-54	1116	16.7	47	11	3	2	5	3
B-55	1124	26.7	18	11	2	2	7	7
B-56	1127	16.0	199	unk	1	5	3	4
B-55	1130	20.1	32	5	2	5	3	6
B-56	1202	22.1	72	7	1	5	4	4
B-57	1208	15.0	92	1	3	2	6	3
T-2	1410		16	1.5	1	5	9	9
T-5	1411		11	5.5	1	7	9	4
T-2	1412		80	5.5	1	5	8	7
T-4	1414		18	4.5	1	7	7	1
T-3	1415		2	unk	1	2	8	7
T-3	1416		37	3	1	7	3	9
T-4	1417		22	.5	2	4	3	1
T-5	1419		165	2	1	3	3	3
T-11	1502		28	unk	3	3	9	8
T-10	1503		87	10	3	2	9	8
T-9	1505		11	4.5	2	5	6	2
T-12	1506		24	4.5	2	1	5	2
T-8	1507		8	3	3	2	6	4
T-7	1509		6	4.5	2	4	5	5
T-13	1511		17	2.5	1	6	5	5
T-14	1512		61	4	2	2	unk	8
T-15	1514		32	3	3	2	unk	8
?	1519		9	unk	1	2	5	4
T-17	1525		3	3	2	3	3	9
T-17	1528		18	unk	2	7	9	6
T-20	1531		1	unk	1	6	8	9
T-19	1532		11	unk	1	5	9	1
T-22	1601		100	8.5	1	2	10	7
T-30	1606		22	2	1	4	3	4
T-31	1608		8	2.5	1	5	5	9

SOIL ORGANIC SCREENING

Location	Ref.#	Loss on Drying	Counts/ Gram	Depth ft.	Physical Characteristics			
					Odor	Color	Dom Tex	Sub Tex
T-29	73631609		157	3	2	3	8	9
T-29	1615		408	4	3	2	6	7
T-26	1622		8	2	1	5	8	9
T-27	1624		8	4	1	5	6	9
T-40	1625		22	3	1	7	6	9
T-28	1626		13	2	1	7	8	9
T-32	1628		39	2	1	2	6	9
T-33	1631		10	2	1	4	8	9
T-38	1632		9	1.5	1	5	5	9
T-36	1717		10	2	3	2	6	8
T-35	1718		-	1.5	3	2	6	8
T-47	1727		35	3.6	3	2	6	9
T-48	1732		18	4	2	2	6	7
T-50	1733		2	1	1	5	9	9
T-52	1801		5	1.5	1	5	6	5
T-51	1802		10	3.3	1	5	6	2
T-51	1803		46	1	2	2	4	9
T-58	1809		292	2	3	2	7	8
T-57	1810		71	2.75	2	2	5	3
T-60	1812		158	.8	3	2	7	8
T-59	1813		19	2	3	2	7	8
T-70	1827		27	2.5	1	5	7	9
T-73	1901		4	1	1	7	6	5
T-75	1903		3	2	1	4	9	1
T-77	1905		4	.7	1	3	6	4
T-79	1907		9	1.5	1	6	9	1
T-81	1909		29	.75	1	5	9	1
T-83	1911		22	1.5	1	5	9	1
T-85	1916		1	5.5	2	3	8	9
T-89	1922		162	7.2	3	2	3	8
T-89	1923		112	2.7	3	2	9	9
T-91	1924		15	3	1	3	8	9
T-95	1926		6	4.1	1	5	6	4
T-95	1927		2	1.75	1	6	5	4
T-95	1928		9	.85	1	3	5	3
T-94	1929		26	2	1	6	5	5
T-93	1930		5	2.5	1	6	5	4
T-96	2016		2	1	1	7	5	3
T-99	2018		12	1.75	1	6	4	2
T-98	2020		5	1.5	1	6	5	4
T-97	2021		10	1.5	1	1	4	1
T-102	2022		9	1	1	6	5	2
T-101	2023		17	1.5	1	6	5	4
T-100	2024		11	1	1	7	5	2
T-103	2025		5	.1	1	6	5	4
T-102	2026		67	.1	1	2	10	4

SOIL ORGANIC SCREENING

Location	Ref. #	Loss on Counts/		Depth	Physical Characteristics			
		Drying	Gram		Odor	Color	Dom Tex	Sub Tex
T-104	73632031		3	3.05	3	2	5	8
T-105	2032		5.0	3.5	2	2	9	7
T-106	2033		12	2	1	1	9	3
T-114	2107		13	1	1	2	3	9
T-113	2108		127	1.5	1	6	5	7
T-113	2109		23	4.5	1	6	3	9
T-112	2111		12	unk	1	3	5	4
T-111	2113		6	2.8	1	3	6	4
T-110	2114		21	1	1	6	5	9
T-107	2117		19	unk	1	2	6	9

6
Table 4 - BORE HOLE AIR SAMPLING

Location	Depth ft.	Collapsed Depth	Diameter	Date Drilled	Date Sampled			Depth Sampled
					Arsine	TRS	VOC	
AS-1	32'	28'7"	6"	8/17/82	8/24/83 8/27/82 8/27/82	9/14/82 9/14/82 9/14/82	8/24/82 8/24/82 8/24/82	28'
Jan/83 repeat		water at 20'4"					1/24/83	17'
AS-2	18'	11'7"	6"	8/17/82	8/30/82 8/30/82 8/30/82	9/14/82 9/14/82 9/14/82	9/14/82 9/14/82 9/14/82	11'
AS-3	14'	8'1"	6"	8/17/82	8/31/82 8/31/82 8/31/82	9/14/82 9/14/82 9/14/82	9/15/82 9/15/82 9/15/82	7.5'
AS-4	24'	N.A.	6"	8/19/82	8/31/82 8/31/82 9/8/82	9/15/82 9/15/82 9/15/82	9/15/82 9/15/82 9/15/82	23.5'
AS-5	22'	N.A.	6"	8/19/82	9/7/82 9/7/82 9/7/82	9/15/82 9/15/82 9/15/82	9/15/82 9/15/82 9/15/82	21.5'
AS-6	18'	N.A.	6"	8/19/82	9/7/82 9/7/82 9/7/82	9/15/82 9/15/82 9/15/82	9/15/82 9/15/82 9/15/82	17.5'
Jan/83 repeat		9.0'					1/24/83	8.0'
AS-7	6.5'	N.A.	2-4" (2)	9/8/82	9/9/82 9/9/82 9/9/82	9/15/82 9/15/82 9/15/82	9/15/82 9/15/82 9/15/82	6.0'
AS-8	6.5'	N.A.	2-4" (2)	9/8/82	9/9/82 9/9/82 9/9/82	9/15/82 9/15/82 9/15/82	9/15/82 9/15/82 9/15/82	6.0'
B-31	39'	4'9" (1)	6"	8/5/82	8/26/82 8/26/82 8/27/82	9/14/82 9/14/82 9/14/82	9/14/82 9/14/82 9/14/82	4.25"
B-32	21'	2'3" (1)	6"	8/5/82	8/27/82 8/27/82 8/30/82	9/14/82 9/14/82 9/14/82	9/15/82 9/15/82 9/15/82	1.75'

(1) Hole not collapsed but rock blocked at this depth.

Could see further down past rock.

(2) Used 2" handauger, but obstruction caused side movement and enlarged hole.

Table 5

Analyte Codes and Lower Limit of
Detection (LLD) in Various Media

12/16/82

5.1 Heavy Metals (M₁ and M₂)

Compound	Analyte ID Code	LLD in Surface Water	LLD in
		Monitor Wells & Leachate	Sediment
		PPB ($\mu\text{g/l}$)	PPM ($\mu\text{g/g}$)
Antimony (Sb)	01	200	2
Arsenic (As)	02	20	2
Beryllium (Be)	03	5	1
Cadmium (Cd)	04	5	1
Chromium (Cr)	05	50	5
Copper (Cu)	06	20	2
Lead (Pb)	07	50	5
Mercury (Hg)	08	1	1
Nickle (Ni)	09	50	1
Selenium (Se)	10	20	2
Silver (Ag)	11	20	2
Thallium (Tl)	12	100	10
Zinc (Zn)	13	20	1
Barium (Ba)	16	100	10

B

5.2 Organic Pollutents

12/16/82

5.2.1 Volatile Organics (VO)

Compound	Analyte ID Code	LLD in Surface Water, Monitor Wells & Leachate	LLD in Sediment	LLD in Air	
		PPB ($\mu\text{g/l}$)	PPB ($\mu\text{g/g}$)		
Acrolein	01	100 ppb		0.1	PPM
Acrylonitrile	02	100 ppb	All 10 ppb		
Benzene	03	Rest all			
Bis(Chloromethyl) Ether	04	10 ppb			
Bromoform	05				
Carbon Tetrachloride	06				
Chlorobenzene	07				
Chlorodibromomethane	08				
Chloroethane	09				
2-Chloroethylvinyl Ether	10				
Chloroform	11				
Dichlorobromomethane	12				
Dichlorodifluoromethane	13				
1,1-Dichloroethane	14				
1,2-Dichloroethane	15				
1,1-Dichloroethylene	16				
1,2-Dichloropropane	17				
1,3-Dichloropropylene	18				
Ethylbenzene	19				
Methyl Bromide	20				
Methyl Chloride	21				
Methylene Chloride	22				
1,1,2,2-Tetrachloroethane	23				
Tetrachloroethylene	24				
Toluene	25				
1,2-Trans-Dichloroethylene	26				
1,1,1-Trichloroethane	27				
1,1,2-Trichloroethane	28				
Trichloroethylene	29				
Trichlorofluoremethane	30				
Vinyl Chloride	31				
*Arsine	32	NA	NA	0.3	PPM
*Hydrogen Sulfide	33	NA	NA	10	PPM
*Methyl Mercaptan	34	NA	NA	1	PPM
*Dimethyl Sulfide	35	NA	NA	1	PPM
*Dimethyl Disulfide	36	NA	NA	1	PPM

*Listed as volatile organic to simplify data reporting.

B

5.2.2 Base/Neutral Extractibles (BE)

Compound	Analyte ID Code	LLD in Surface Water	LLD in Sediment
		Monitor Wells & Leachate PPB (µg/l) All 10	PPM (mg/l) All 1
Acenaphthene	01		
Acenaphthylene	02		
Anthracene	03		
Benzidine	04		
Benzo(a)Anthracene	05		
Benzo(a)Pyrene	06		
3,4-Benzofluoranthene	07		
Benzo(ghi)Perylene	08		
Benzo(k)Fluoranthene	09		
Bis(2-Chloroethoxy)Methane	10		
Bis(2-Chloroethyl)Ether	11		
Bis(2-Chloroisopropyl)Ether	12		
Bis(2-Ethylhexyl)Phthalate	13		
4-Bromophenyl Phenyl Ether	14		
Butyl Benzyl Phthalate	15		
2-Chloronaphthalene	16		
4-Chlorophenyl Phenyl Ether	17		
Crysene	18		
Dibenzo(a,h)Anthracene	19		
1,2-Dichlorobenzene	20		
1,3-Dichlorobenzene	21		
1,4-Dichlorobenzene	22		
3,3-Dichlorobenzidine	23		
Diethyl Phthalate	24		
Dimethyl Phthalate	25		
Di-N-Butyl Phthalate	26		
2,4-Dinitrotoluene	27		
2,6-Dinitrotoluene	28		
Di-N-Octyl Phthalate	29		
1,2-Diphenylhydrazine	30		
Fluoranthene	31		
Fluorene	32		
Hexachlorobenzene	33		
Hexachlorobutadiene	34		
Hexachlorocyclopentadiene	35		
Hexachloroethane	36		
Indeno(1,2,3-cd)Pyrene	37		
Isophorone	38		
Naphthalene	39		
Nitrobenzene	40		
N-Nitrosodimethylamine	41		
N-Nitrosodi-n-Propylamine	42		
N-Nitrosodiphenylamine	43		
Phenanthrene	44		
Pyrene	45		
1,2,4-Trichlorobenzene	46		

12/16/82

B
5.2.3 Acid Extractibles (AE)

Compound	Analyte ID Code	LLD in Surface Water	LLD in
		Monitor Wells & Leachate	Sediment
		PPB (μ g/l)	PPM (mg/g)
2-Chlorophenol	01	25	All 1
2,4-Dichlorophenol	02	25	
2,4-Dimethylphenol	03	25	
2,6-Dinitro-O-Cresol	04	250	
2,4-Dinitrophenol	05	250	
2-Nitrophenol	06	25	
4-Nitrophenol	07	25	
P-Chloro-M-Cresol	08	25	
Pentachlorophenol	09	25	
Phenol	10	25	
2,4,6-Trichlorophenol	11	25	

B

5.2.4 Pesticide Extractibles (PE)

Compound	Analyte ID Code	LLD in Surface Water	LLD in
		Monitor Wells & Leachate	Sediment
		PPB (μ g/l)	PPM(mg/g)
Aldrin	01	All 10 ppb	All 1
Alpha-BHC	02		
Beta-BHC	03		
Gamma-BHC	04		
Delta-BHC	05		
Chlordane	06		
4,4'-DDT	07		
4,4'-DDE	08		
4,4'-DDD	09		
Dieldrin	10		
Alpha-Endosulfan	11		
Beta-Endosulfan	12		
Endosulfan Sulfate	13		
Endrin	14		
Endrin Aldehyde	15		
Heptachlor	16		
Heptachlor Epoxide	17		
PCB-1242	18		
PCB-1254	19		
PCB-1221	20		
PCB-1232	21		
PCB-1248	22		
PCB-1260	23		
PCB-1016	24		
Toxaphene	25		

B

5.3 Standard Water/Miscellaneous Analysis

12/16/82

Compound	Analyte ID Code	LLD in Surface Water Monitor Wells & Leachate
Ammonia as N	NH	.05 PPM
Specific Conductance	SC	
Dissolved Oxygen	DO	
Temperature	TP	
pH	pH	
Total Suspended Solids	SS	4 PPM
Total Dissolved Solids	DS	5 PPM
Cyanide	CN	20 ppb
Phenol	PN	50 ppb

3
Table 6.1 - Bore Hole Arsine and TRS Analysis

Location	Arsine PPB LLD.3	Hydrogen Sulfide PPM 1	Methyl Mercaptan PPM 1	Dimethyl Sulfide PPM 1	Dimethyl Disulfide PPM 1
AS-1	N.D. N.D. -	13,000 19,000 9,400	470 440 180	5 5 20	N.D. N.D. N.D.
AS-2	N.D. N.D. N.D.	N.D. N.D. N.D.	N.D. N.D. N.D.	N.D. N.D. N.D.	N.D. N.D. N.D.
AS-3	N.D. N.D. -	N.D. N.D. N.D.	N.D. N.D. N.D.	N.D. N.D. N.D.	N.D. N.D. N.D.
AS-4	N.D. N.D. -	N.D. N.D. N.D.	N.D. N.D. N.D.	N.D. N.D. N.D.	N.D. N.D. N.D.
AS-5	.3 .4 N.D.	N.D. N.D. N.D.	N.D. N.D. N.D.	N.D. N.D. N.D.	N.D. N.D. N.D.
AS-6	.5 N.D. N.D.	N.D. N.D. N.D.	N.D. N.D. N.D.	N.D. N.D. N.D.	N.D. N.D. N.D.
AS-7	N.D. N.D. N.D.	N.D. N.D. N.D.	N.D. N.D. N.D.	N.D. N.D. N.D.	N.D. N.D. N.D.
AS-8	.5 N.D. N.D.	N.D. N.D. N.D.	N.D. N.D. N.D.	N.D. N.D. N.D.	N.D. N.D. N.D.
B-31	N.D. N.D. N.D.	47,000 30,000 43,000	20 80 47	2 20 5	N.D. N.D. N.D.
B-32	N.D. N.D. N.D.	N.D. N.D. N.D.	N.D. N.D. N.D.	N.D. N.D. N.D.	N.D. N.D. N.D.

B
 Table 6.2 - Bore Hole & Ambient Air VOC/TRS Analysis
 (Reporting repeat samples collected 1/24/83)

The lower limit of detection (LLD) was estimated at 0.1 PPM for non-sulfur containing compounds and 0.5 PPM for sulfur containing compounds.

<u>Location</u>	<u>Compound</u>	<u>PPM</u>		
		<u>Sample 1</u>	<u>Sample 2</u>	<u>Sample 3</u>
AS-1	Methyl Mercaptan	5.6	8.4	5.9
	Carbon Disulfide	.01	.19	.32
	*Toluene	4.3	.97	2.8
	Dimethyl Disulfide	1.9	4.3	2.6
	*Acetone	1.8	.55	2.2
	Propane thiol	47.	80.	56.
	2-butanone	2.3	N.D.	N.D.
	*Methylene Chloride	1.2	1.2	N.D.
	Methyl Furan	1.2	1.7	1.0
	Methyl propyl disulfide	3.0	4.2	3.6
	Butane thiol	2.9	3.9	2.1
	SO ₂	N.D.	N.D.	0.29
AS-6	*Benzene	.17	N.D	N.D
	*Toluene	1.9	5.2	N.D
	*Acetone	3.0	1.5	N.D
	*Ethyl Acetate	.82	6.6	N.D.
IH (30' from AS-1)	*Toluene	1.9	6.2	2.3
	*Acetone	7.3	5.1	1.4
	*Ethyl Acetate	.44	.47	.29
<u>Field Blank Contamination</u>				
	Methylene Chloride	1.1	N.D.	
	Benzene	N.D.	.19	
	Toluene	1.4	2.1	
	Acetone	.98	1.8	
	Ethyl Acetate	6.0	12.5	

*Assumed due to background contamination found in field blanks.
 The contamination probably results from the analytical standards
 or the air bags.

March 11, 1983

B
TABLE 7.1 MONITOR WELL ANALYSIS

Location	Heavy Metals		pH	Ref. #	Conductivity		Cyanide		Ref. #	Organic Pollutants	
	Ref. #	µg/l			Ref. #	mho/cm	Ref. #	mg/l		Compound	µg/l
OW-1	2925	Cd-7 Zn-20	3222	6.0	3308	100	3009	N.D.	3029,3115,3135		
OW-1A	2927	Cd-5 NI-62 Zn-100	3223	6.0	3309	600	3011	N.D.	3031,3117,3201	bis(pentafluorophenyl) phosphin BE 13	31 14
OW-2	2619	Zn-21	3215	7.0	3301	100	2805	N.D.	2723,2601,2705	VO 22 VO 25 VO 30	15 14 23
OW-3	2621	Cd-6 Zn-30	3216	7.0	3302	900	2807	N.D.	2527,2603,2707	VO 30 BE 13 AE 10	23 34 53
OW-4	2625		3218	7.0	3304	700	2811	N.D.	2729,2607,2711	VO 30	23
OW-5	2627	As-200 Cd-5 Zn-41	3219	7.0	3305	600	2813		2731,2609,2713	VO 3 VO 22 VO 30 BE 13	10 16 26 17
OW-6	2631	Cd-6 Zn-56	3221	7.0	3307	300	2817	N.D.	2735,2613,2717	Carbon disulfide VO 22 Trichloropropane Bromoocyclohexane	90 19 90 36
OW-7	2933	Cd-5 Cu-23 Pb-120 Zn-51	3226	5.0	3312	300	3017	N.D.	3103,3123,3207	Octanoic Acid Nonanoic Acid BE 13	40 14 14
OW-8	2629	Cd-5 Zn-110	3220	7.0	3306	600	2815	N.D.	2733,2611,2715	VO 22 VO 25 VO 30 Tri Decatriene Nitrile BE 13	19 10 11 19 14
OW-9	2623	As-420 Cd-5 Zn-33	3217	9.0	3303	950	2809	N.D.	2605,2727,2709	Carbon disulfide VO 3 VO 22	108 10 17

^B
TABLE 7.1 MONITOR WELL ANALYSIS

Location	Heavy	Metals	pH	Conductivity		Cyanide		Organic Pollutants		
	Ref. #	µg/l	Ref. #	Ref. #	mho/cm	Ref. #	mg/l	Ref. #	Compound	µg/l
OW-10	2931	Cd-28 Cu-1000 Zn-51	3225	6.0	3311	300	3015	N.D.	3101, 3121, 3205	
OW-11	2929	Cd-5 Cu-25 Zn-57	3224	6.0	3310	800	3013	N.D.	3033, 3119, 3203	
									Trichloropropane	66
									Dichlorocyclohexane	13
									Bromocyclohexane	26
									Phthalate	18
									BE 13	63
									BE 29	23
OW-12	3003	Cd-11 Cr-54 Cu-32 Ni-32 Zn-37 Ba-250	3229	7.0	3315	700	3023	N.D.	3109, 3129, 3213	
									Methyl Butanoic Acid	121
									Benzaldehyde	22
									Dihydrotetrazine	102
									Benzene Acetic Acid	1850
									Bis Sulfonfyl Benzene	651
									Sulfur	805
									BE 39	15
OW-13	3001	Zn-40	3228	7.0	3314	1900	3021	N.D.	3107, 3127, 3211	
									Trichloropropane	44
									Bis Sulfonfyl Benzene	39
									Sulfur	233
OW-14	2935	Cu-45 Pb-74 Zn-58	3227	5.0	3313	1100	3019	N.D.	3105, 3125, 3209	

Location	Heavy Metals			pH	Conductivity		Cyanide	Organic Pollutants			
	Ref. #	g/l	Ref. #		Ref. #	μho/cm		Ref. #	mg/l	Ref. #	Compound
L-1	2025	Sb-200 As-300 Cd-7 Zn-24					2033	N.D.	2907,2914,2920	AE 10 Methyl phenol Benzole Acid Piperidinone Benzene Propanoic Acid Bis (Sulfonyl) Benzene Sulfur	860 566 290 62 477 30 221
Spring next to 193 1-93	2023	Cd-6 Pb-62 Zn-36 Ba-110					2031	N.D.	2905,2915,2919	BE 13 VO 22 VO 30	54 29 14

B
TABLE 8.1 SURFACE WATER ANALYSIS

Page 1 of 2
November 29, 1982

Location	Heavy Metals		NH ₃ N mg/l	Cyanide mg/l	Organic Pollutants Compound	mg/l	Suspended Solids	Dissolved Solids
	Ref. #	mg/l					mg/l	mg/l
SW-1	73631319	29.0	N.D.	Aliphatic Amine	20	10	490	
				Ethoxy Ethane	14			
				Phthalate	19			
				BE 13	160			
				BE 29	10			
				Acetone	130			
				Tetrahydrofuran	450			
				Trichlorotrifluoro ethane	83			
				VO 9	10			
				VO 22	49			
				VO 25	93			
				VO 26	62			
				VO 27	17			
				VO 29	66			
SW-4	1326	De 8	4.9	N.D.	BE 13	250	19	490
					BE 29			
					Tetrahydrofuran			
SW-5	1325	16	N.D.	N.D.	BE 13	354	12	327
					BE 29			
					Tetrahydrofuran			
SW-7	1324	De 8	31.0	N.D.	Sulfonyl bis benzene	17	12	510
					BE 13			
					VO 27			
					VO 29			
SW-8	1322	Pb 100	18.0	N.D.	BE 13	145	33	163
					Methyl Ethyl Ketone			
SW-12	1327	35.0	N.D.	N.D.	BE 13	202	12	182
					BE 29			
SW-15	1317	160	9.7	N.D.	Cyclo hexanol	42	47	213
					Chloro cyclo hexene			
					Cyclo hexeneone			
					Trichloropropene			
					Dichlorocyclohexane			
					Bromo cyclohexane			
					BE 13			
					BE 29			

BA1

^B
TABLE B.1 SURFACE WATER ANALYSIS

Location	Heavy Ref. #	Metals mg/l	NH ₃ M mg/l	Cyanide mg/l	Organic Pollutants Compound	mg/l	Suspended Solids mg/l	Dissolved Solids mg/l
SW-16a	1318		7.6	N.D.	Oxabicycloheptane	44	22	216
					trichloro propene	128		
					tetrachloropropene	17		
					dichlorocyclohexene	35		
					Bromo cyclohexene	40		
					Hexadecanoic Acid	17		
					Tridecaatrienenitrile	18		
					BE 13	174		
					BE 26	12		
					~~BE 10~~ AE10	83		
SW-19	1323	Zn 138	12.0	N.D.	BE 13	130	45	362

12/16/02

^B
Table 8.2

Surface Water Analysis

Location	Field Notebook	pH	Temperature °C	Dissolved Oxygen mg/l	Specific Conductivity μ-mho/cm	Comments
SW-1	4966-70	5.03	16	6	700	Flow 230,000 gpd
SW-4	4966-80	6.30	15.5	7.5	800	Flow 386,000 gpd
SW-5	4966-80	6.20	16	7.5	500	
SW-7	4966-79	6.00	16	7.5	600	
SW-8	4966-70	6.06	17.5	8	1500	
SW-12	4966-81	6.00	18	7	200	
SW-15	4966-77	6.63	16	6	300	Flow 283,000 gpd
SW-16	4966-77	6.60	16	7	300	
SW-19	4966-79	6.17	16	8.5	400	

B
Table 8.3 PREVIOUS SURFACE WATER ANALYSIS

Compiled from files received
from R. Loughton, 10/28/82

Collector Location	Approx. Stauffer Location	Date Sampled	Sampler ^a	3/Be	4/Cd	5/Cr	6/Cu	7/Pb	119/1 5/Ni 117/Ag (Pb)	12/Tl	13/Zn	16/Ba	1/Sb	2/As	8/Hg	10/Se
WHS02	1	07/28/80	3								30	30				
HY05	5	12/12/79	1				10				30	40		3	3	
HY05	5	05/13/80	1				10				40	50		2	0.5	
A-1	5	11/07/79	2								340					
HY06	5	12/12/79	1				20				50	180		17	0.3	
HY06	5	05/13/80	1								150	80		15	0.6	2.0
HY07	5	12/12/79	1				20				40	60		3	0.2	
HY07	5	05/13/80	1								80	60		7	0.6	
WHS09	5	07/28/80	3				24					35				
A-1	5	09/13/79	2								110					
A-1	5	10/10/79	2					5			340					
HY10	12	12/12/79	1			40					40	40		19		
HY10	12	05/13/80	1								20	30		6	0.2	
A-4	12	10/10/79	2			17		8			470			12		
A-4	12	11/07/79	2			5	50				140			15		
IP-101	12	10/21/81	5											6		
IP-104	12	10/21/81	5													
A-4	14	09/13/79	2								160					
HY09	14	12/12/79	1								20	30		2		
HY09	14	05/13/80	1								40	30		11		
HY10	15	12/12/79	1								60	50		17		
HY10	15	12/12/79	1			40					40	40		19		
HY10	15	05/13/80	1								40	30		13	0.5	
HY10A	15	07/28/80	3								12	83		200		
HY08	19	05/13/80	3				20				130	40		1	0.6	
HY08	19	07/23/80	5								49			27		
HY08	19	07/28/80	3								49			27		
	19	11/19/80	4			30	30				220					
HY08	19	12/12/81	1					160			280	110		9	0.2	
A-2	19	01/17/79	2								180					
A-2	19	06/29/79	2								240					
A-2	19	09/13/79	2								230					
A-2	19	10/10/79	2				50	14			850					
A-2	19	11/07/79	2				50				240			7		

- ^a 1. Division of Water pollution Control (DMC) Department of Environmental Quality (DEQE)
2. Metropolitan District Commission (MDC)
3. Environmental Protection Agency (EPA) DEQE
4. MDC/Camp, Dresser, McKee
5. DEQE

It was assumed analytical data met basic laboratory quality assurance checks and is acceptable. However, a possible error giving high results was mentioned on page 10 of the October 1981 JANIPET report by GZA. This was in the analytical procedure for determination of metal concentrations in water. GZA noted that EPA's contractor, Ecology and Environment Inc. used at times an analytical method which determined total metals present in water without filtering, instead of dissolved metals. If any of the results reported here were done the same way, then they would include suspended metals.

B
Table 8.4 - Previous Surface Water Analysis - Organics

Page 1 of 2

Collector Location Number	Approx. Stauffer Location	Date Sampled	Sampler**	NI _{AS} N mg/l	CN mg/l	Organic Pollutants Compound	Suspended Solids g/l
MY01A	1	5/13/80	1	0.36	*	*	10
MY01B	1	5/13/80	1	0.54			29
MY01C	1	5/13/80	1	0.25			6.5
WWS02	1	7/28/80	3	*		V014 V026 V027 V028 V029 V031 AE10 BE13 BE43	29 74 20 12 54 36 66 420 170
WWS02	1	7/28/81	5			V014 V026 V027 V028 V029 V031 AE10 BE13 BE43 Freon 113 Methyl Ethyl Ketone	37 300
79-A-6	5	6/17/70	6	90.	0		
79-A-7	5	6/26/79	6	0.64			
79-A-8	5	6/26/79	6	42.			
79-A-9	5	6/26/79	6	21.			
MY05	5	12/12/79	1	0.21			
MY05	5	5/13/80	1	0.17			1.5
MY06	5	12/12/79	1	48			14
MY06	5	5/13/80	1	48			24
MY07	5	12/12/79	1	11			2.0
MY07	5	5/13/80	1	18			10

Compiled from files received
from R. Leighton, 10/28/82

- ** 1. Division of Water Pollution Control (DWPC)/
Department of Environmental Quality (DEQE)
2. Metropolitan District Commission (MDC)
3. Environmental Protection Agency (EPA) DEQE
4. MDC/Camp, Dresser, McKee
5. Dana Perkins and Assoc. Inc.

* Blank spaces means not analyzed.

3
Table 8.4 - Previous Surface Water Analysis - Organics

Page 2 of 2

Collector Location Number	Approx. Stauffer Location	Date Sampled	Sampler**	Mn ₃ as N mg/l	CN mg/l	Organic Pollutants Compounds	Suspended Solids mg/l
WWS09	5	7/28/80	3			V029	15
WWS09	5	7/28/81	1			V029	15
WWS10	5	7/28/80	1		10	V014 V024 V026 V029 BE13 BE13	11 1.0 13 53 21 92
IP-101	10	10/21/81	5				
IP-104	10	10/21/81	5				
MY10A	12	12/12/79	1	38			7.0
MY10A	12	5/13/80	1	4.2			10.0
MY09	14	12/12/79	1	0.09			5.0
MY09	14	5/13/80	1	0.06			6.5
MY10	15	12/12/79	1	37			7
MY10	15	5/13/80	1	4.2			11
MY10A	15	7/28/80	3			AE10	8
MY08	19	7/28/80				Less than detection level	
MY08	19	5/13/80	1	3.4			5.0
MY08	19	12/12/81	1	19			3.0
79-A-5	19	6/26/79	6	11			
7	19	11/19/79	4	0.02		None detected except trifluoro thichloroethane, which was not quantified	

TABLE 9

November 24, 1982

HEAVY METAL CONCENTRATION - PPM																ORGANIC POLLUTANT	
LOCATION	Ref. #	3/De	4/Cd	5/Cr	6/Cu	7/Pb	9/Ni	11/Ag	12/Tl	13/Zn	16/Ba	17/Sb	20/As	8/Hg	10/Se	COMPOUND	PPM
		LLD	1	1	5	2	5	2	1	10	1	10	2	2	.1	2	
1	7J6J12J1		2	470	31	39	18		20	75	82		10			Di Methyl Propane Sulfur Methoxy phenylethenyl benzene Unknown BE BE 13 BE 24 BE 25 BE 26 BE 29 BE 41	5 100 55 69 28 9 53 2 11 2
5	12JJ		2	99	193	270	19		10	250	98		22			Phthalate dioctyl ester hexane diols acid DE 13 DE 26 DE 29	8 27 17 1 3
5a	12J2		1	43	418	299	62		20	289	78		133			Oxybis Ethanol Hexadecanoic Acid DE 13 DE 24 DE 29	230 3 11 1 2
6	1301		3	81	284	636	23	3		606	170		808	3		Subst Ketone Methoxy Ethanol Phthalate Sulfur dioctyl ester hexane diols acid DE 3 DE 13 DE 24 DE 25 DE 26	10 10 6 77 29 2 13 4 8 3
6a	12J4		1	38	223	394	17	3		212	140		548	96		Unknown BE Phthalate Hexadecanoic Acid dioctyl ester hexane diols acid Trideca Triene Nitrile DE 13 DE 26 DE 29 VO 26 VO 29	6 9 5 17 6 7 1 2 25 22

SEDIMENT ANALYSIS

SEDIMENT ANALYSIS

Page 2 of 3
November 24, 1982

HEAVY METAL CONCENTRATION -PPM

LOCATION	Ref. #	HEAVY METAL CONCENTRATION - PPM														ORGANIC POLLUTANT		PPH
		3/Be	4/Cd	5/Cr	6/Cu	7/Pb	9/Hg	11/Ag	12/Tl	13/Zn	16/Ba	17/Sb	2/As	8/Hg	10/Se	COMPOUND		
		LLO	1	1	5	2	5	2	1	10	1	10	2	2	1		2	
7	1304			13	33		17		20	180	25		15			Hexadecanoic Acid	5	
																Sulfur	180	
																Phthalate	29	
																BE 13	77	
																BE 15	3	
																BE 26	2	
																BE 29	28	
8	1230		1	59	27	83	22			100	63					Oxalic Ethanol	20	
																Sulfur	52	
																BE 13	10	
																BE 24	1	
8c	1313		10	66	3366	653	42	4	45	1386	110		129		2	Methyl Naphthalene	4	
																Hexadecanoic Acid	5	
																Sulfur	79	
																Phthalate	35	
																BE 29	26	
																VO 3	320	
8d	1311		2	160	27	66	28			100	50		5					
9c	1314	2	4	141	879	1374	29	3		566	130		131	1	3	Sulfur	119	
																BE 13	41	
																BE 24	2	
																BE 29	36	
																Methyl Ethyl Ketone	140	
12	1310		1	35	55	147	26			167	79		13			Hexadecanoic Acid	10	
																Sulfur	91	
																diethyl ester hexano diol acid	20	
																BE 13	8	
																VO 22	15	

TABLE 9

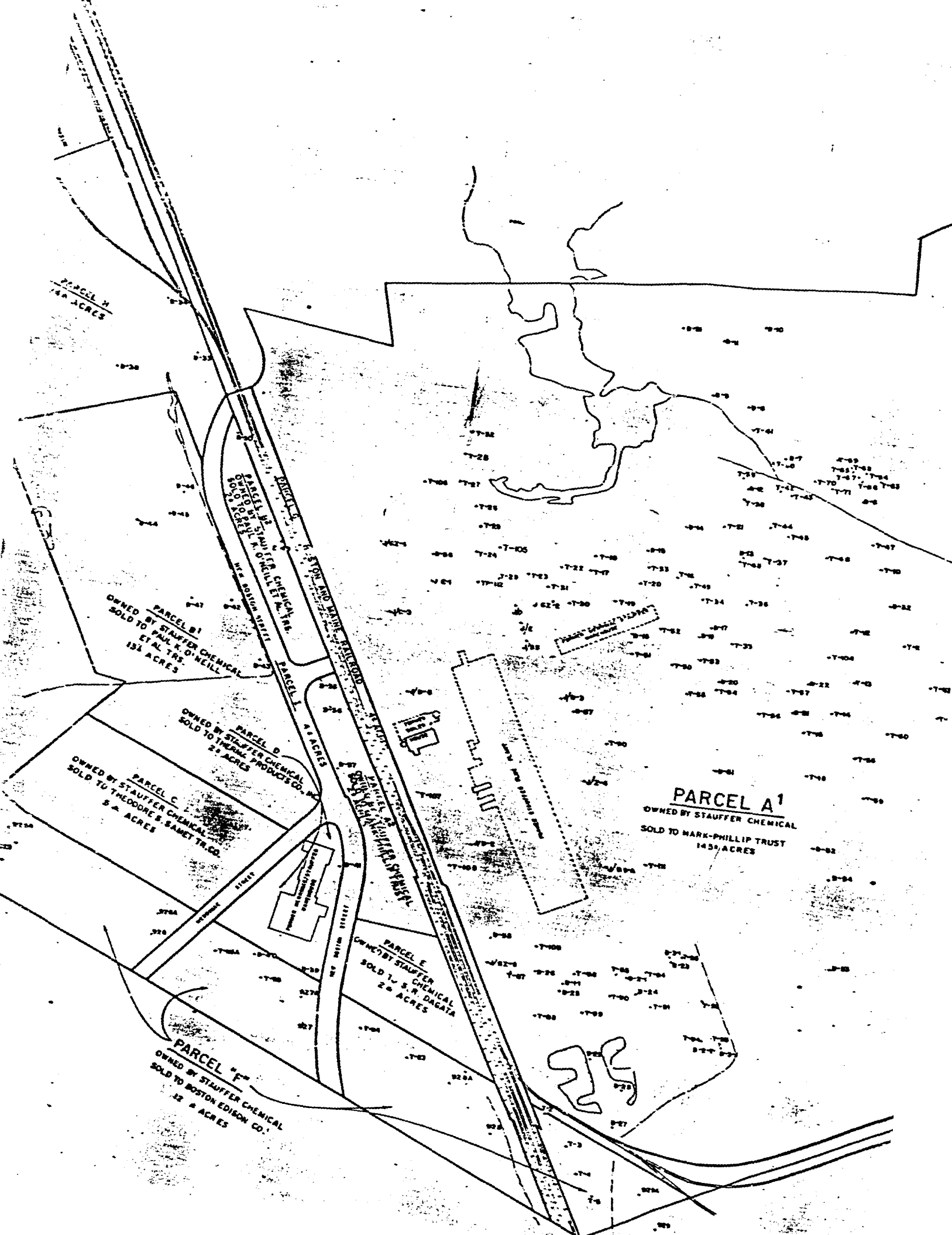
SEDIMENT ANALYSIS

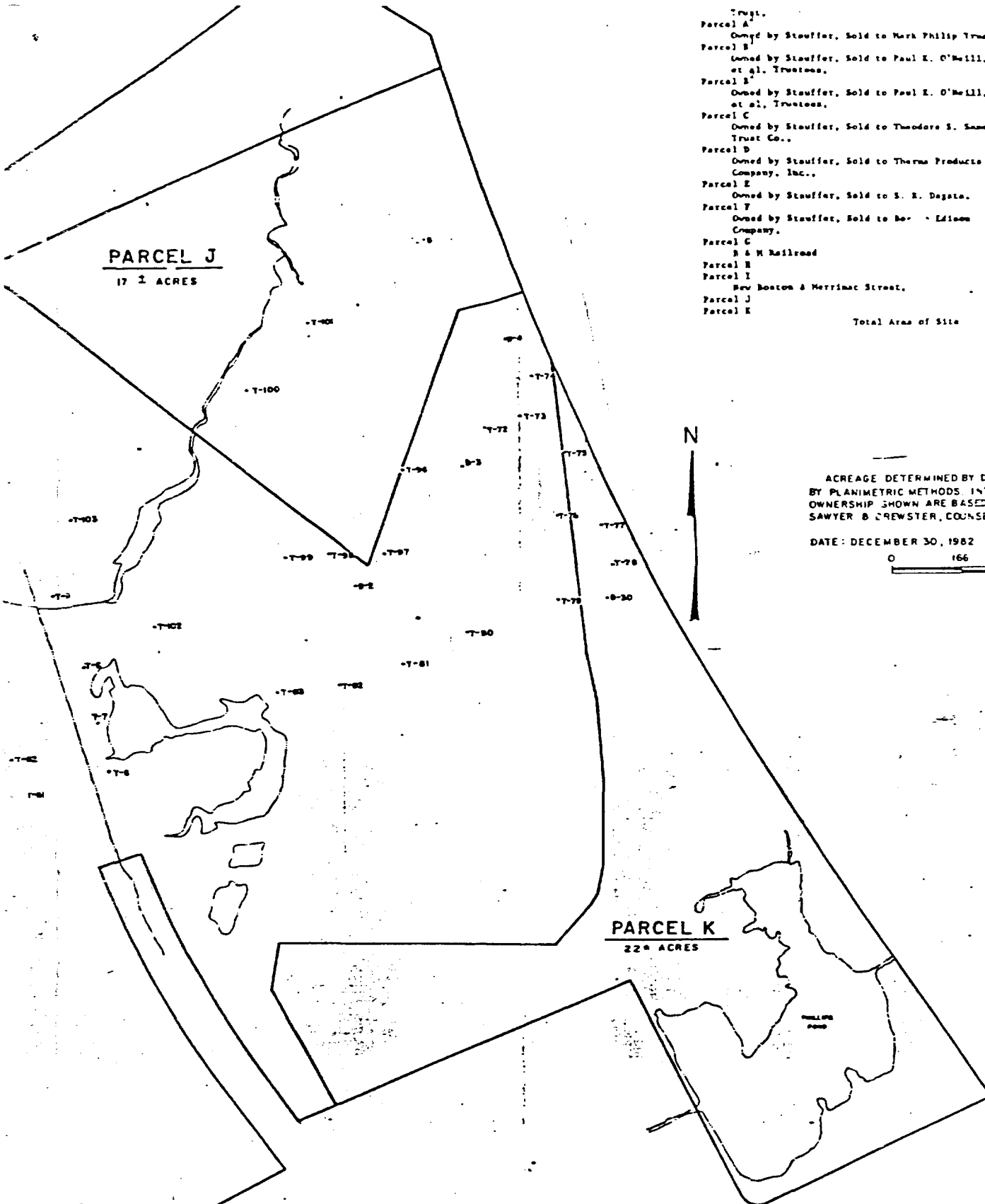
Page 3 of 3

November 24, 1982

HEAVY METAL CONCENTRATION -PPH

HEAVY METAL CONCENTRATION (PPM)																ORGANIC POLLUTANT		
LOCATION	Ref. #	3/Be	4/Cd	5/Cr	6/Cu	7/Pb	9/Hg	11/Ag	12/Tl	13/Zn	16/Ba	17/Sb	2/As	8/Hg	10/Se	COMPOUND	PPH	
		LLD	1	1	5	2	5	2	1	10	1	10	2	2	1	2		
15	1229			43	12	24				10	54	35		2			Oxybis Ethanol Sulfur BE 13 VO 22	5 41 7 16
16	1306			20	31	29	25				72	25		7			Sulfur BE 13 BE 29	18 10 2
17	1307			25	55					20				22	77		2-Propanone Oxybis Ethanol Sulfur BE 13 BE 15 BE 26 BE 29 VO 22	14 21 8 19 6 1 2 15





Parcel A	Owned by Stauffer, Sold to Mark Phillip Trust,	2 Acres
Parcel B	Owned by Stauffer, Sold to Paul E. O'Neill, et al. Trustees,	17 Acres
Parcel C	Owned by Stauffer, Sold to Paul E. O'Neill, et al. Trustees,	2 Acres
Parcel D	Owned by Stauffer, Sold to Theodore S. Smart Trust Co.,	5 Acres
Parcel E	Owned by Stauffer, Sold to Thermo Products Company, Inc.,	2 Acres
Parcel F	Owned by Stauffer, Sold to S. E. Dagata,	2 Acres
Parcel G	Owned by Stauffer, Sold to Bar - Edison Company,	12 Acres
Parcel H	B & M Railroad	4 Acres
Parcel I	New Boston & Merrimack Street,	4 Acres
Parcel J		17 Acres
Parcel K		22 Acres
Total Area of Site		744 Acres

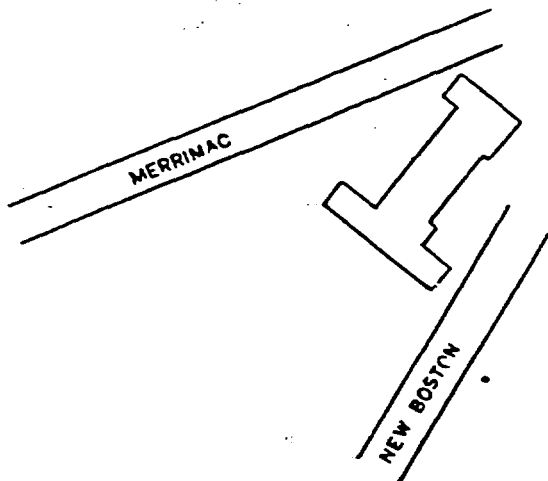
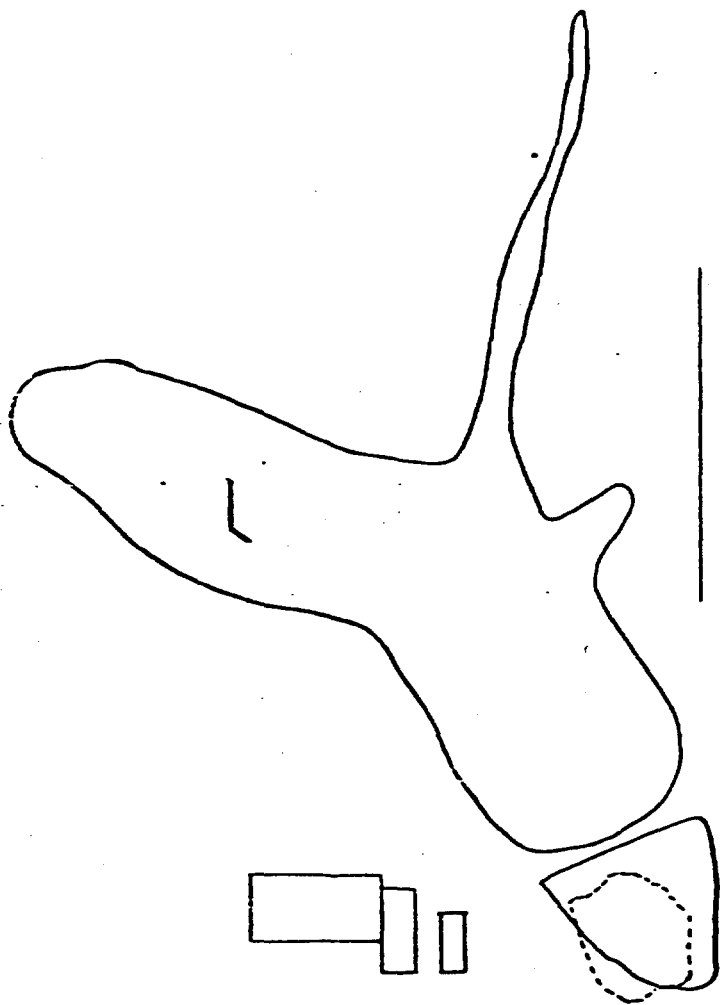
ACREAGE DETERMINED BY DANA F. PERKINS & ASSOC., INC. BY PLANIMETRIC METHODS. INTERNAL PROPERTY LINES AND OWNERSHIP SHOWN ARE BASED ON A PLAN BY FICKELMANN, SAWYER & CREWSTER, COUNSELLORS AT LAW, BOSTON, MASS.

DATE: DECEMBER 30, 1982 SCALE: 1" = 166'

0 166 332

FIG. A1

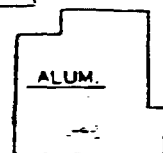
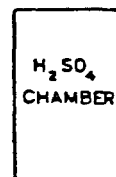
Plan of Woburn Site



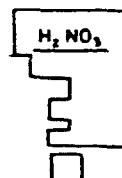
ARSENATE
OF LEAD
MFG



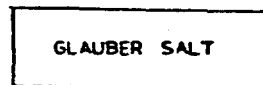
BAUXITE



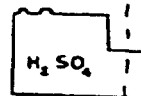
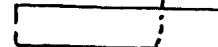
ALUM
STG



NITRATE
STG.



LEAD OXIDE
BLD



SPRAY
POND

PAINT
MFG

SPRA
POND

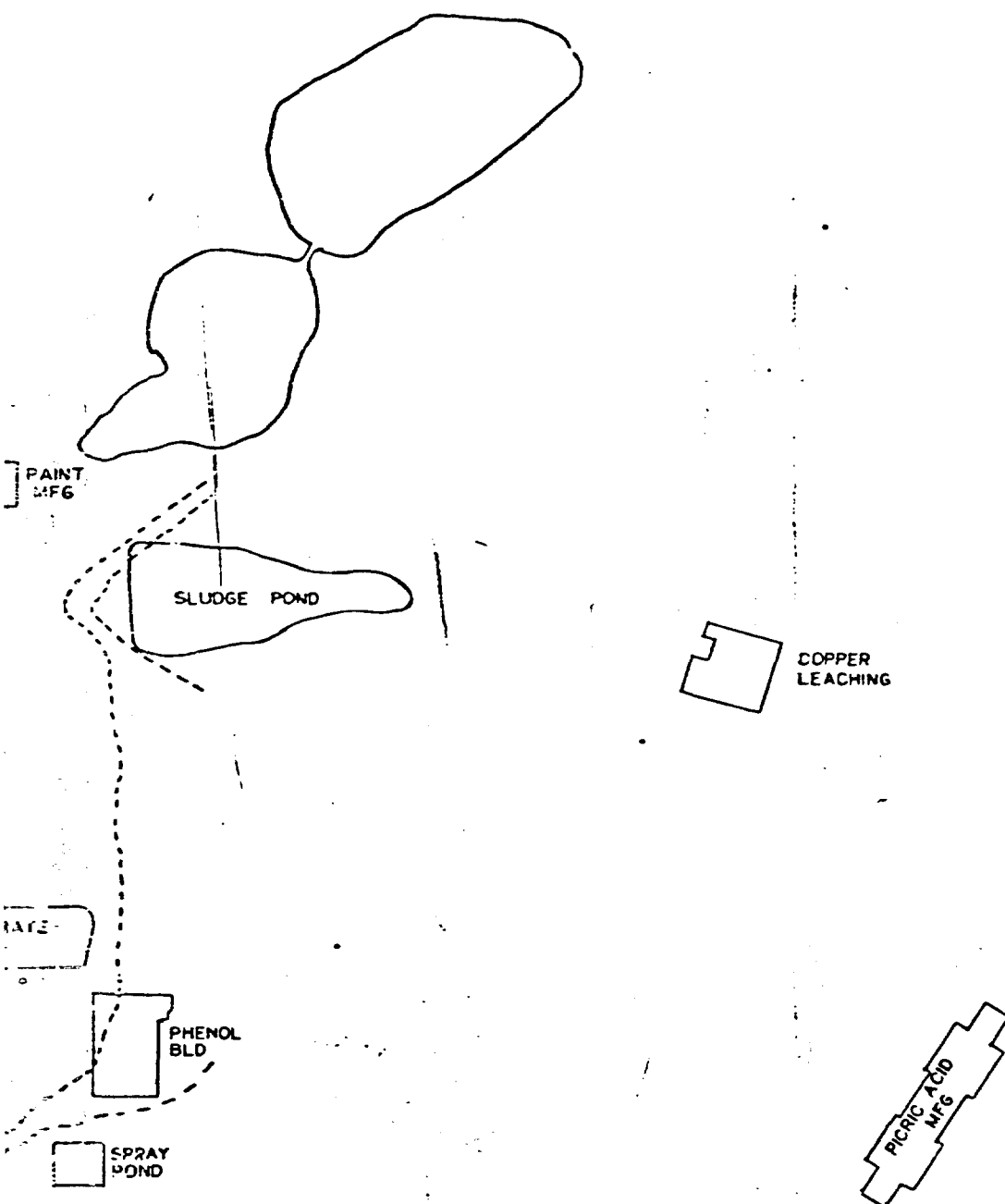
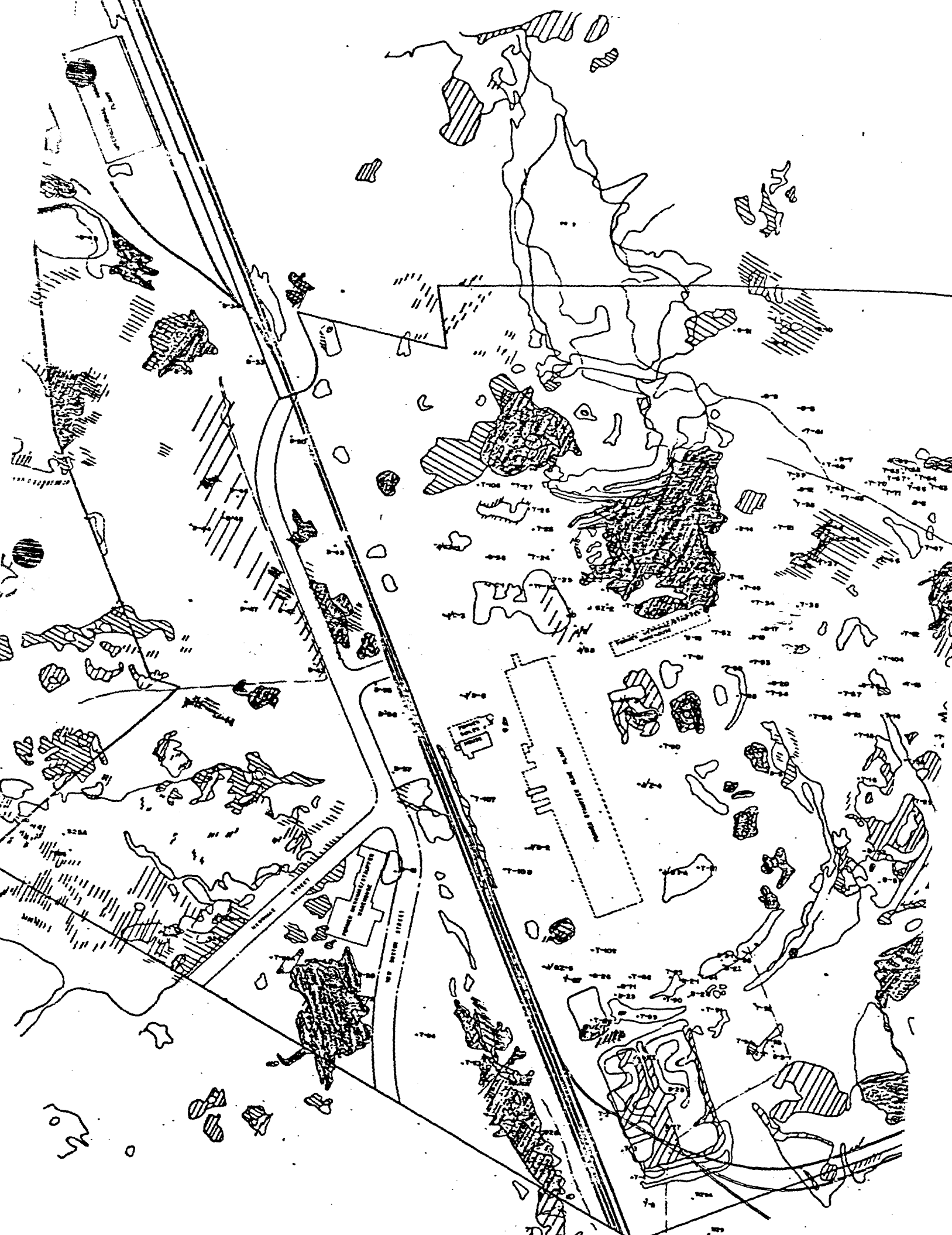


FIG. 2^A

MERRIMAC/MONSANTO
CHEMICAL PLANT
AT WOBURN MASSACHUSETT

PLANT LAYOUT A COMPOSITE BASED
SANBORN FIRE INSURANCE MAPS OF
1888, 1909, 1910, 1918 AND 1926.



////// AREA WITH APPARENTLY DISTRESSED
VEGETATION NOT DUE TO ANY KNOWN
CAUSE

1963 DEAD DISTRESSED VEGETATION

TRACED FROM ENLARGEMENT OF APRIL 29, 1963
PHOTO FROM U.S. GEOLOGIC SURVEY

AREA WITH DEAD OR MISSING VEGETATION
NOT DUE TO ANY KNOWN CAUSE

AREA WITH APPARENTLY DISTRESSED
VEGETATION NOT DUE TO ANY KNOWN
CAUSE

1938 DEAD/DISTRESSED VEGETATION

TRACED FROM ENLARGEMENT OF DECEMBER 21,
1938 PHOTO FROM U.S. NATIONAL ARCHIVES

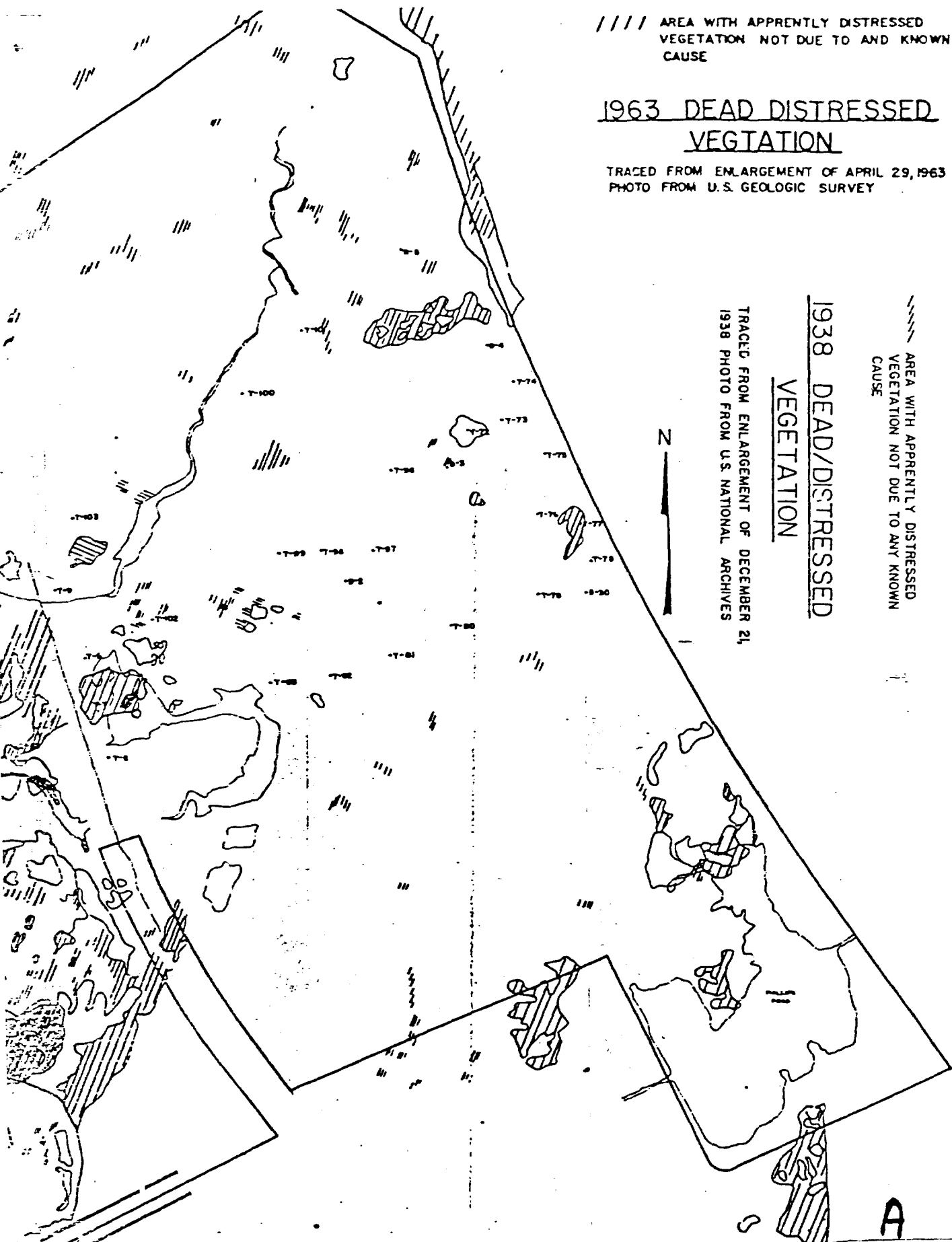
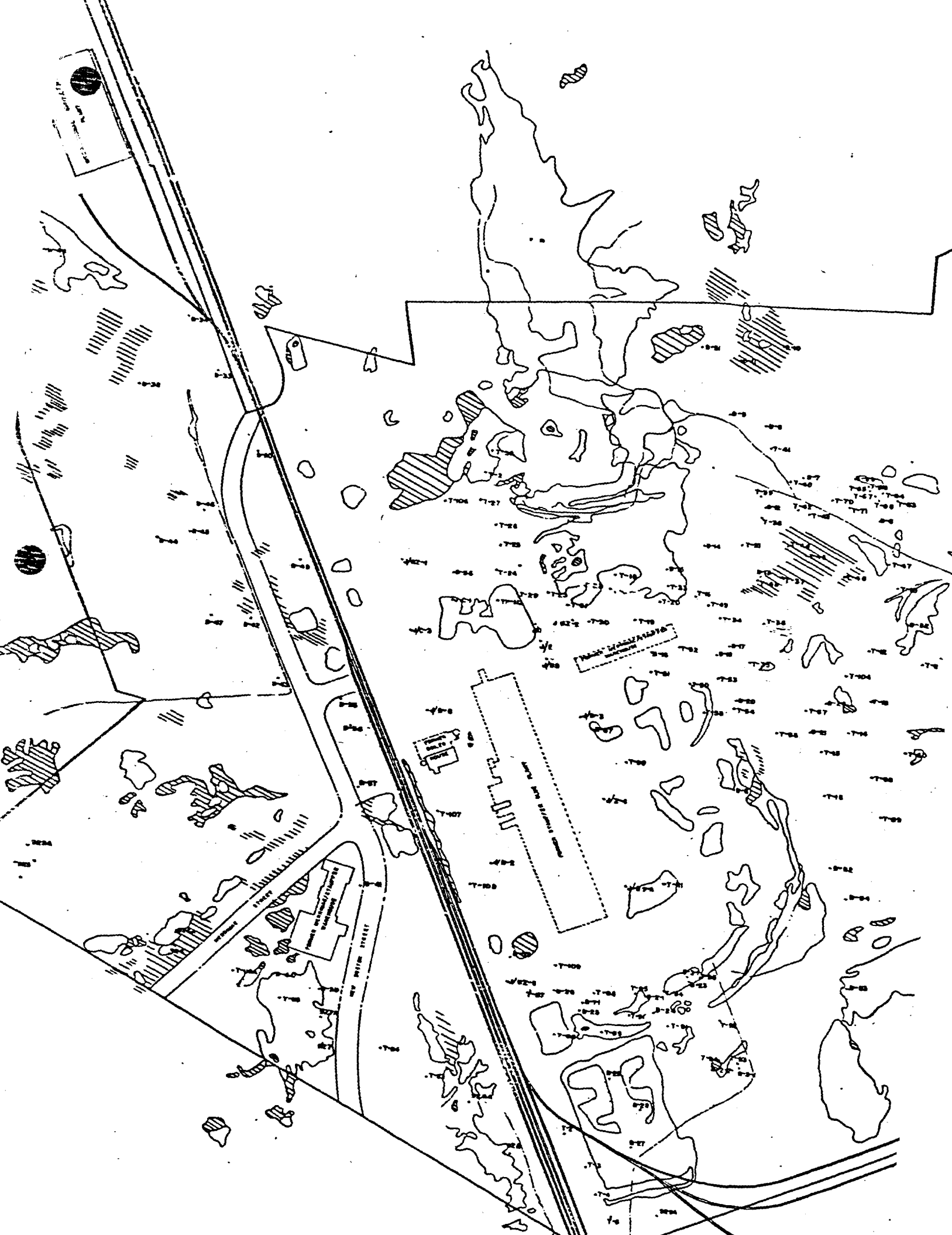


FIG. 3

1938/1963 Photo Display of Woburn
Dead/Distressed Vegetation

- Dark areas are probable waste disposal site
- Other areas with dead/distressed vegetation possible waste disposal



AREA WITH APPARENTLY DISTRESSED
VEGETATION NOT DUE TO ANY KNOWN
CAUSE

1938 DEAD/DISTRESSED
VEGETATION

TRACED FROM ENLARGEMENT OF DECEMBER 21,
1938 PHOTO FROM U.S. NATIONAL ARCHIVES

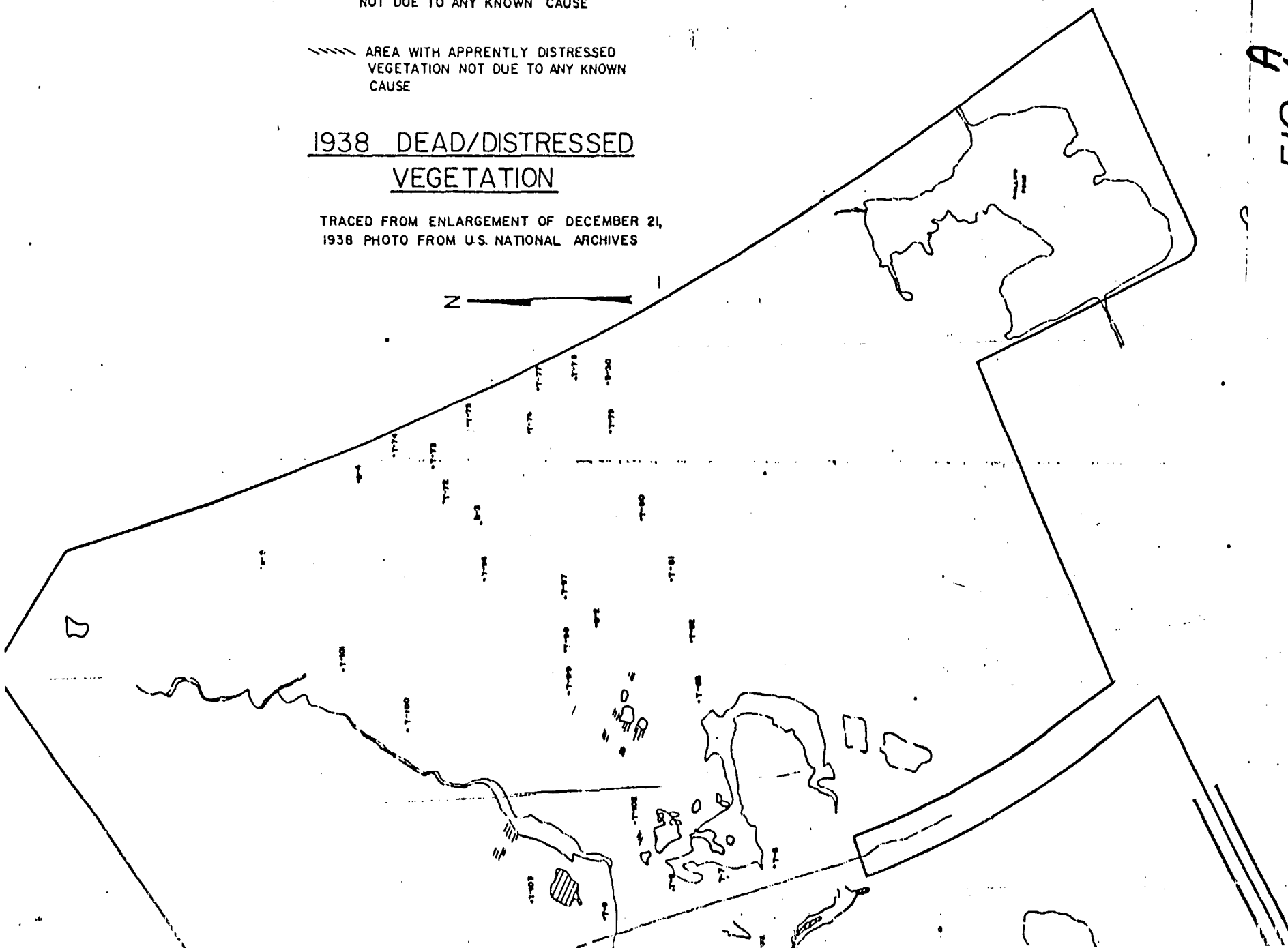
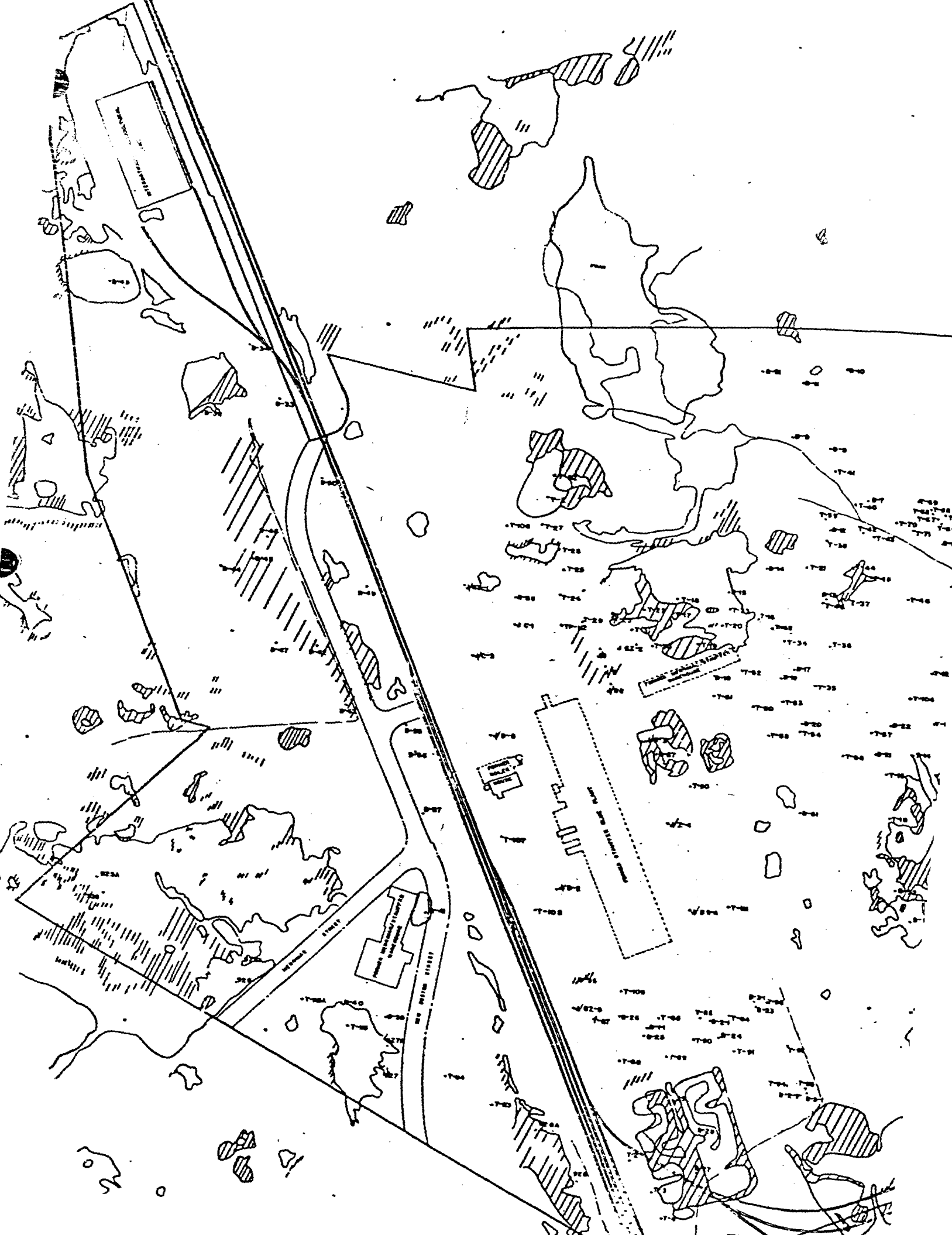


FIG. 4A

1938 Photo Overlay of Woburn Site
with Dead/Distressed Vegetation

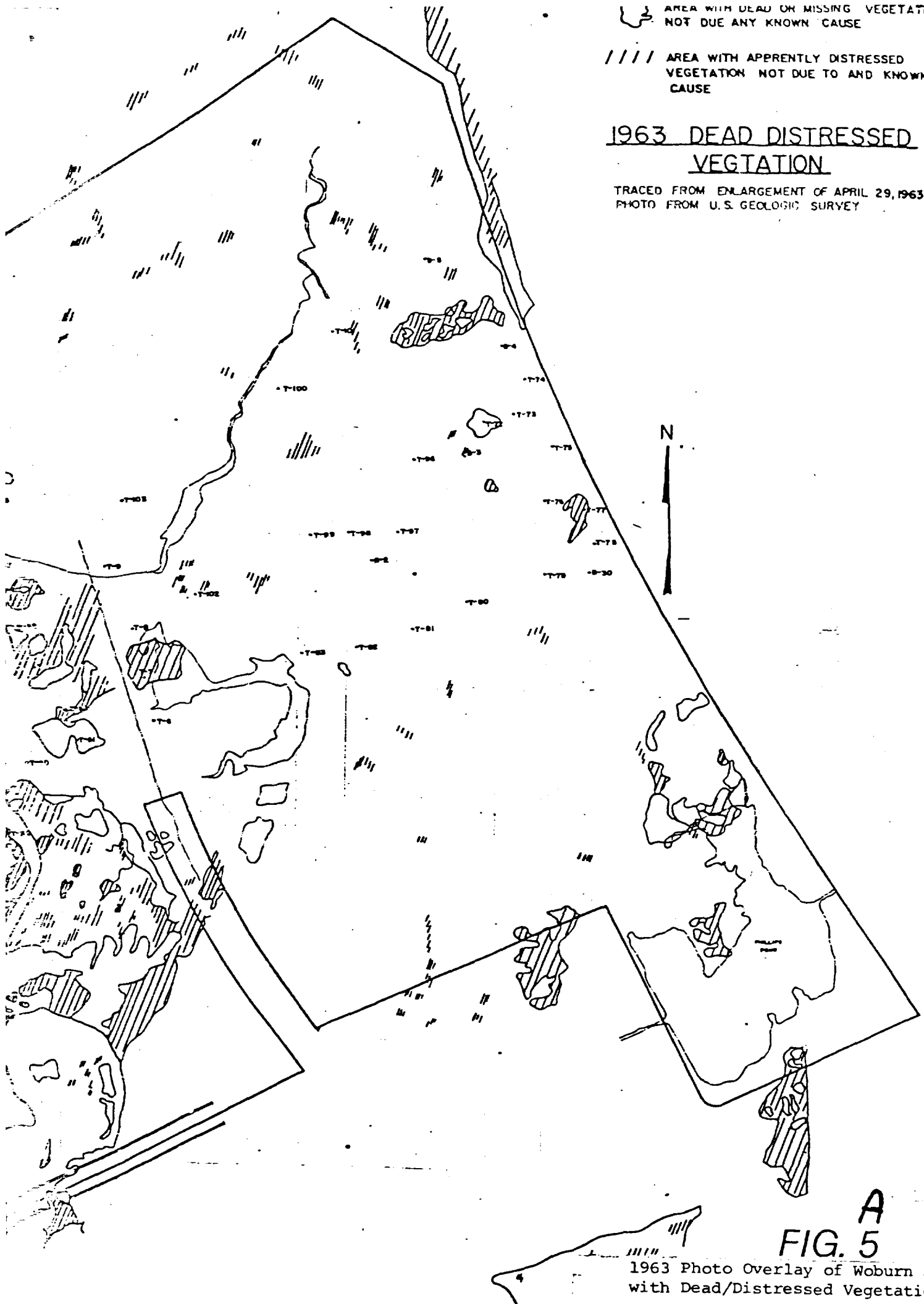


AREA WITH DEAD OR MISSING VEGETATION
NOT DUE ANY KNOWN CAUSE

////// AREA WITH APPARENTLY DISTRESSED
VEGETATION NOT DUE TO AND KNOWN
CAUSE

1963 DEAD DISTRESSED VEGETATION

TRACED FROM ENLARGEMENT OF APRIL 29, 1963
PHOTO FROM U.S. GEOLOGIC SURVEY



A
FIG. 5

1963 Photo Overlay of Woburn site
with Dead/Distressed Vegetation

B
TABLE 10

<u>Drainage Area Figure</u>	<u>Sediment Sample Number</u>	<u>Description of Location</u>	<u>Prominent</u>	
			<u>Metals</u>	<u>Organics</u>
A	5, 5a	Hall's Brook	Lead, Copper	=
B	6, 6a	Chromium Lagoon Ditch by Mayflower Trucking and Railroad Spur	Lead Zinc Arsenic Mercury	=
C	8d	East Waste Pile	Chromium	=
D	8c	West Waste Pile	Copper	Benzene
E	9c	Arsenic Pit/ Pond Finger to West	Lead Copper Zinc Chromium	Methyl ethyl ketone
F	15	Aberjona Onsite	=	=
G	16	Phillips Pond/ Aberjona on Commerce Way	=	=
H	12	Ditch from Pond to Aberjona	Lead	=
I	7	Offsite South Railroad Ditch	=	=
J	19	Aberjona Near Mishawum Road	Mercury	=

50 After Table ^B₉ Page 3 of 3

57 Before Table ^B₁₀

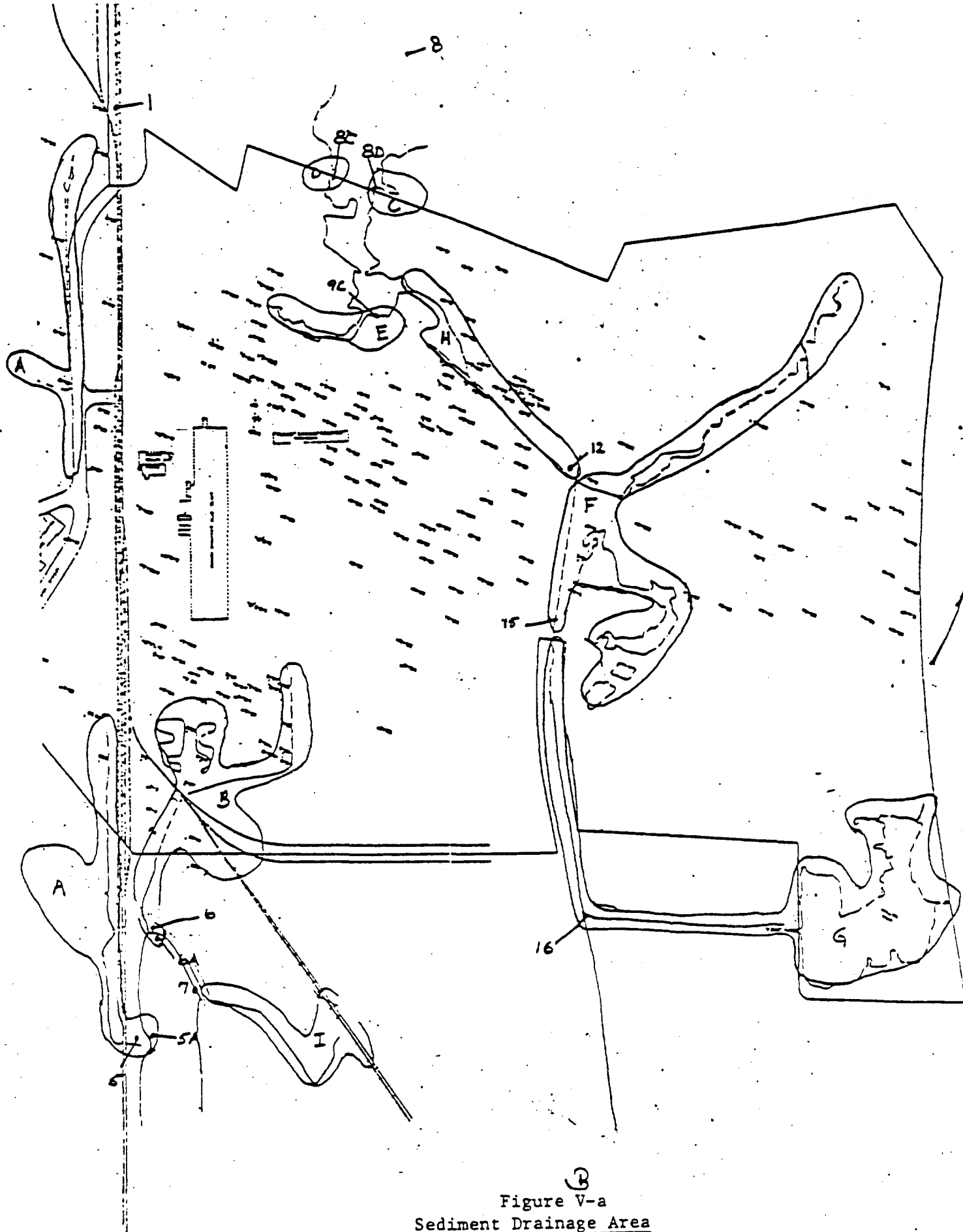
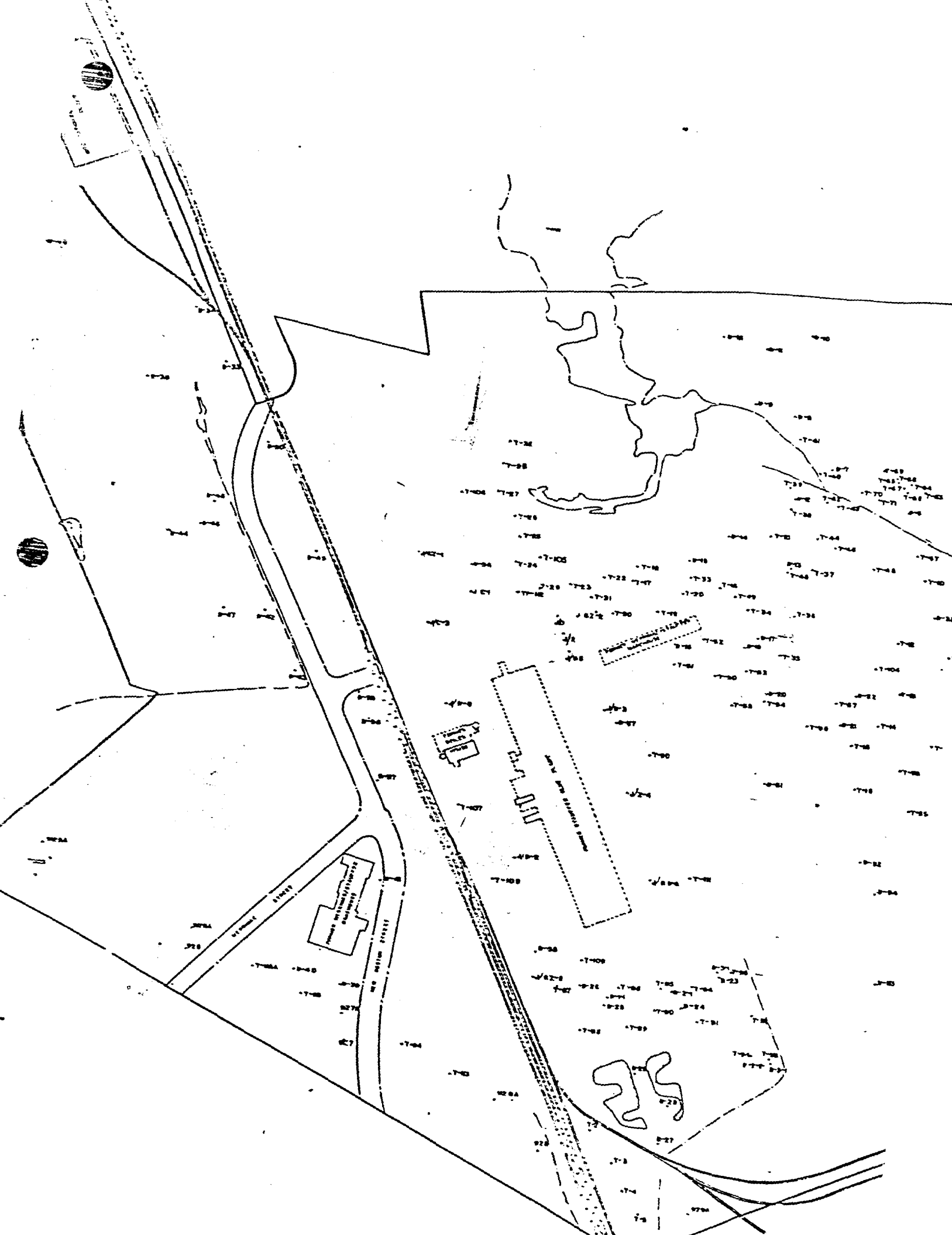


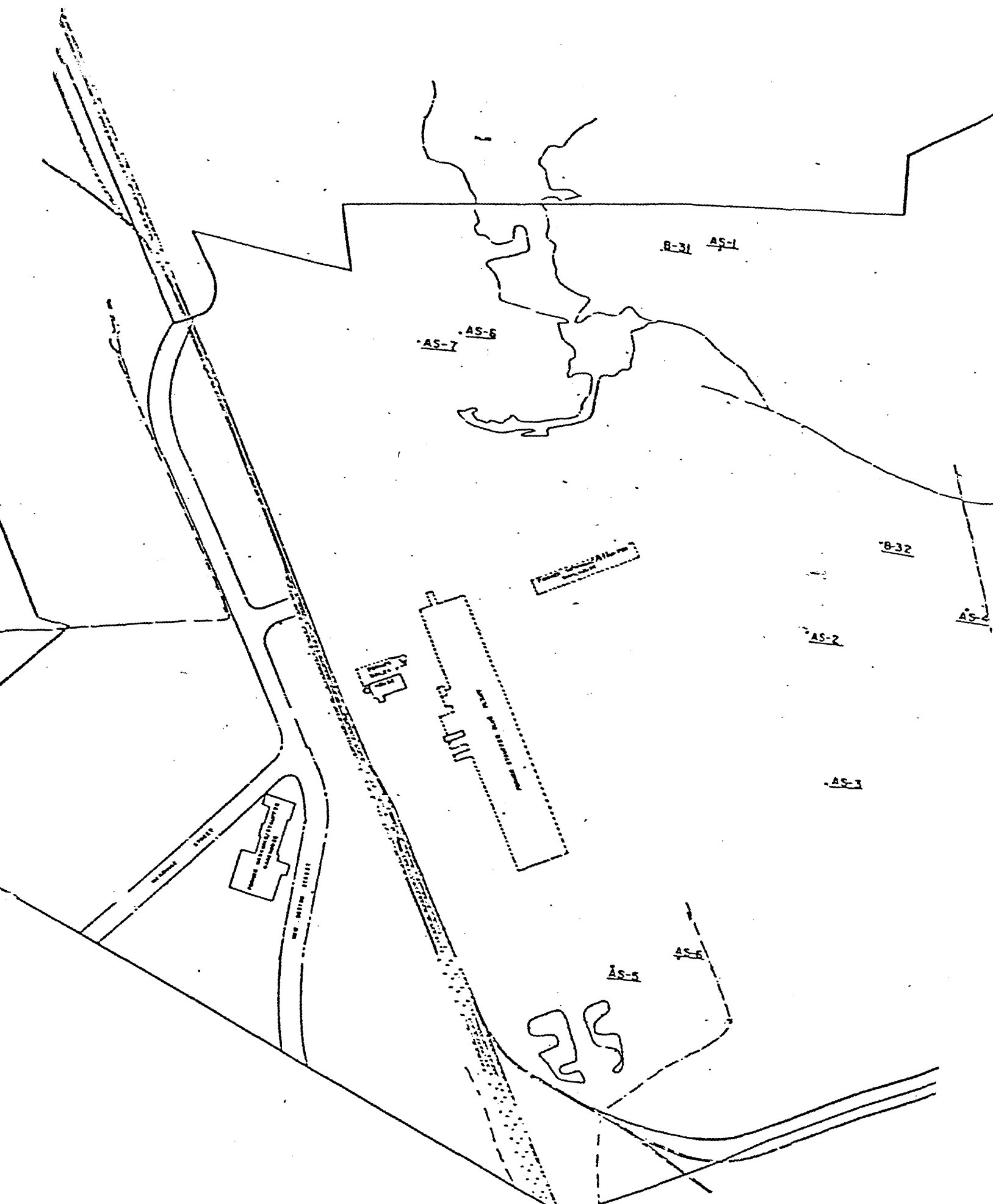
Figure V-a
Sediment Drainage Area

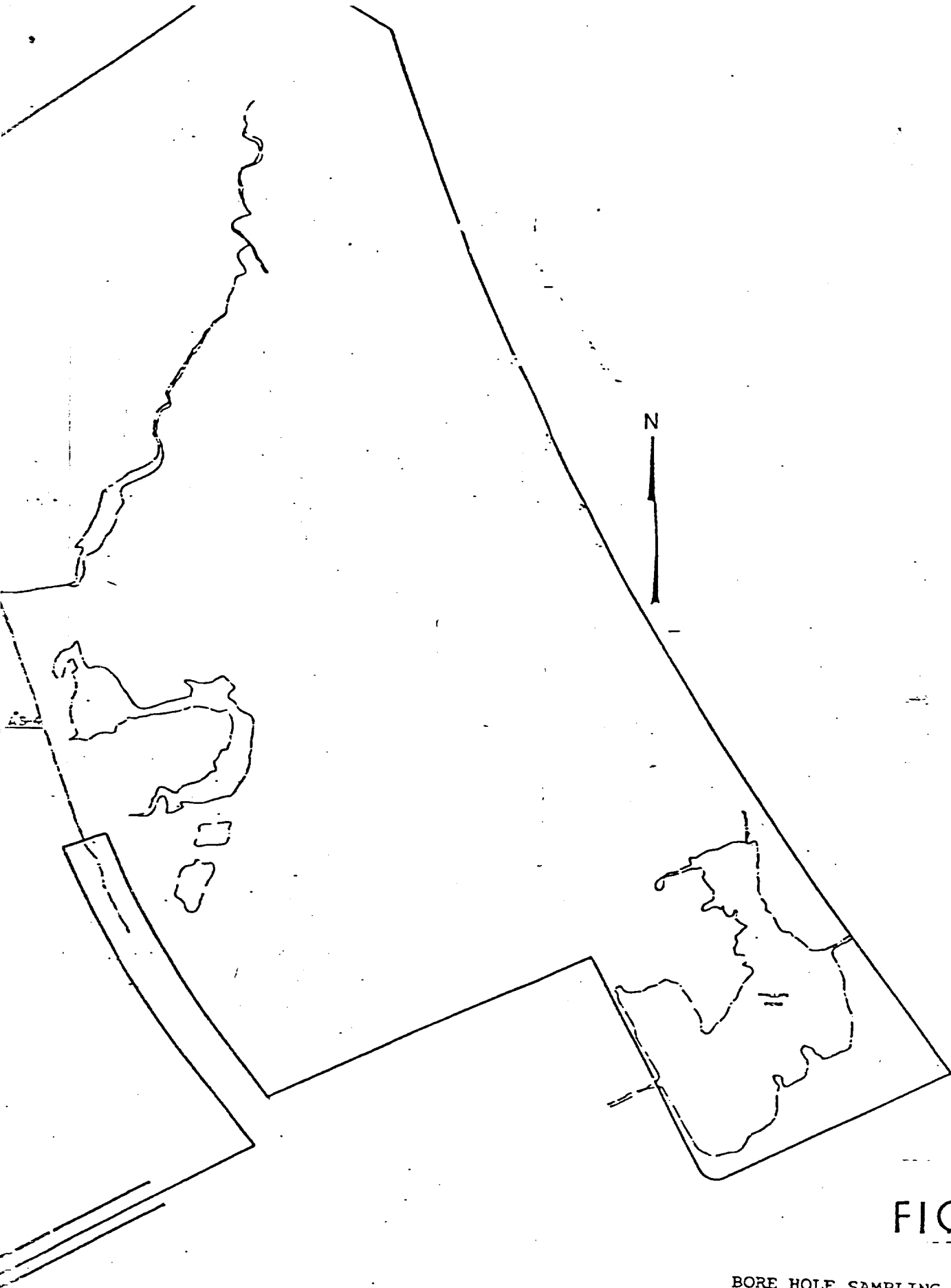
2 After Figure ^B V-a
59 Before Figure ^B 1 11"x17"





T-SOIL SAMPLE COLLECTED WITH BACKHOE
B- " " " " BY BORING
J - SOIL SAMPLES COLLECTED BY JANPET
B-X-X- SOIL SAMPLE COLLECTED BY STAFFER
ON 4/2/82
925- 929- SOIL SAMPLE COLLECTED BY
BOSTON EDISON





^B
FIG. 2

BORE HOLE SAMPLING LOCATIONS

2

Two Figures 11" x 17"

61

Figure ^B₁ and ^B₂

Bibliography

- Anonymous, "Current Developments", Environment Reporter
8-13-82, pg. 496,497; 7-16-82, pg. 369,370
- Archer, McCurley, Rawlings, Source Assessment Pesticide Manufacturing Air Emissions-Overview and Priorization
Monsanto Research Corporation, Dayton, Ohio, March 1978,
EPA-Contract No. 68-02-1874
- Bastian, Robert K., Municipal Study Management: EPA Construction Grants Program, US Environmental Protection Agency,
April 1976, EPA-430/9-76-009
- Boldt, Brody, Delaney, Plan for Investigation of Hazardous Waste Problems: Woburn, MA, Fred C. Hart Ass., Inc.,
New York, N.Y., March 1980, EPA Contract No. 68-01-5815
- Boston Edison Co., Soil Analysis: BECO Right of Way No. 9-
Woburn, MA, Boston Edison Co., Boston, MA, Dec. 1981
- Committee on Biologic Effects of Atmospheric Pollutants,
CHROMIUM, National Academy of Sciences, Washington, D.C.
1974
- Committee on Biologic Effects of Atmospheric Pollutants,
LEAD; Airborne lead in Perspective, National Academy of
Sciences, Washington, D.C., 1972
- Committee on Medical and Biological Effects of Environmental
Pollutants, ARSENIC, National Academy of Sciences,
Washington, D.C., 1977
- Cook, DiNitto, Inventory and Analysis of Existing Well Data
for East and North Woburn, MA, Ecology and Environment,
Inc., Jan. 9, 1981, EPA Contract No. 68-01-6056
- Davis, James A. III; Jacknow, Joel, "Heavy Metals in Wastewater
in Three Urban Areas", Journal WPCF; Vol. 47, No. 9
pg. 2292-2297
- DiNitto, Fucarile, #3 Monitoring of Metal Content in Airborne
Particulate Migrating from Mark Phillip Trust, Ecology and
Environment, Inc., Dec. 29, 1980,
EPA Contact No. 68-01-6056
- Ecology and Environment, Inc., Interim Report on the Geology
and Groundwater of North and East Woburn, MA, Ecology and
Environment, Inc., April 3, 1981,
EPA Contract No. 68-01-6056
- Ecology and Environment, Inc., Interim Report on the Ground-
water Quality: East and North Woburn, MA, Ecology and En-
vironment, Inc., May 6, 1981, EPA Contract No. 68-01-6056
- Environment Protection Agency, Municipal Sludge Management:
Environmental Factors, U.S. EPA, Washington, D.C.,
Oct. 1977, EPA 430/9-77-004
- Environment Protection Agency, Sludge Treatment and Disposal:
Sludge Treatment, Vol. 1, Environmental Research Informa-
tion Center, Cincinnati, Ohio, Oct. 1978
EPA 625/4-78-012
- Environment Protection Agency, Sludge Treatment and Disposal:
Sludge Disposal, Vol. 2, Environmental Research Informa-
tion Center, Cincinnati, Ohio, Oct. 1978
EPA 625/4-78-012
- Fair, Geyer, Okun, Water & Wastewater Engineering, Vol. 2
Water Purification and Wastewater Treatment and Disposal
John Wiley & Sons, Inc., New York, NY, 1968

- Gaynes, Norman I., Formulation of Organic Coatings, D. Van Nostrand Co., Inc., Oct. 1967
- Giordana, May S., Effect of Land Disposal Application of Municipal Wastes on Crop Yields and Heavy Metal Uptake, National Fertilizer Development Center, Muscle Shoals, AL, April 1977, EPA-IAG-D4-0415
- Goldberg-Zoino & Ass., Inc., Hydrogeologic Study: JANPET Ass. Property, Oct. 1981
- JRB Ass., Inc., Manual for Remedial Actions at Waste Disposal Sites, Draft Final Report, June 20, 1980, EPA Contract No. 68-01-4839
- Keeney, Lee, Walsh, Guidelines for the Application of Wastewater Sludge to Agricultural Land in Wisconsin, Technical Bulletin No. 88, Department of Natural Resources, Madison, WI, 1975
- Knezek & Miller, Applications of Sludges and Wastewaters on Agricultural Land: A Planning and Educational Guide, U.S. Environment Protection Agency, Washington, D.C., March 1978
- Leeper, G.W., Reactions of Heavy Metals with Soils with Special Regard to their Application in Sewage Wastes, Department of the Army; Corps of Engineers, Nov. 1972
- Leighton, Chalpin, Simmons, Final Work Plan: Immediate Action and Remedial Investigations, Camp, Dresser, & McKee, Inc. Boston, MA, Nov. 1981
EPA Contract No. 68-03-1612
- Mattiello, Joseph J., Protective and Decorative Coatings: Vol. 2, John Wiley & Sons, Inc., New York, NY, June 1947
- Mertz, Toepfer, Roginski, and Polansky, "Present Knowledge of the Role of Chromium", Federation Proceedings Vol. 33, No. 11, Nov. 1974, pg. 2275-2280
- Metcalf & Eddy, Inc., Wastewater Engineering: Collection, Treatment, Disposal, McGraw-Hill Book Co., New York, NY 1972
- National Academy of Engineering, National Academy of Science, Water Quality Criteria 1972. A Report of the Committee on Water Quality Criteria, US Department of Commerce, Washington, D.C., March 1972
- Nemerow, Nelson L., Theories and Practices of Industrial Waste Treatment, Addison-Wesley Publishing Co., Reading, MA 1963
- Overcash, Pal, Design of Land Treatment Systems for Industrial Wastes-Theory and Practice, Ann Arbor Science, Ann Arbor, MI, 1979
- Schacklette, Hamilton, Boerngen, Bowles, Elemental Composition of Surficial Materials in the Conterminous U.S., US Government Printing Office, Washington, D.C., 1971
- Schultz, David, Disposal of Hazardous Waste: Proceedings of the Sixth Annual Symposium, Municipal Environmental Research Laboratory, US EPA, Washington, D.C., March 1980, EPA-600/9-80-010
- Schultz, David, Treatment of Hazardous Waste: Proceedings of the Sixth Annual Symposium, Municipal Environment Research Laboratory, US EPA, Washington, D.C., March 1980
EPA-600/9-80-011

- Shen, Dr. Thomas T., "Estimating Hazardous Air Emissions from Disposal Sites", Pollution Engineering, Aug. 1981, pg. 31-34
- Towill, Shriner, Drury, Reviews of the Environmental Effects of Pollutants III. Chromium, Information Center Complex, Oak Ridge, Tenn., May 1978, EPA Contract No. IAG-D5-0403
- Walker, John M., Wastewater: Is Muskegon County's Solution Your Solution?, Office of Water Programs Operations, Washington, D.C., March 1977
- Willard, Evans, Schmitt, Closure of Hazardous Waste Surface Impoundments, U.S. EPA, Cincinnati, Ohio, Sept. 1980
EPA Contract No. 68-03-2567

ENDNOTES

1. "Woburn Industries with Personal Sketches", D. L. Sullivant supplement to The News (A Woburn paper), September 27, 1898
2. Dana Perkins & Assoc., letter of December 29, 1982
3. W. C. Bauer, memo of March 11, 1964
4. Interview with W. Huckins, December 28, 1981
5. Melvin W. First, report of November 27, 1972 to Mark Phillips Trust
6. Boston Edison Co., report of March 18, 1982, submitted to William St. Hilaré of DEQE
7. Metcalf & Eddy Memorandum J-7489 of January 20, 1982 to M. Beers
8. Manual for Remedial Action at Waste Disposal Sites. Draft Final Report June 20, 1980. EPA Contract No. 68-01-4839
9. Arsenic, Medical and Biological Effects of Environmental Pollutants National Academy of Science, Washington, D.C. 1977
10. Chromium, Reviews of the Environmental Effects of Pollutants Oak Ridge National Laboratory, Tenn., U.S. Department of Commerce PB-282796, May 1978
11. Lead, Biological Effects of Atmospheric Pollutants, National Academy of Science, Washington, D.C., (1972)

FOOTNOTES

- Footnote 1: Introduction to Organic Chemistry;
Fieser & Fieser,
D.C. Heath & Company, 1957.
- Footnote 2: Protective and Decorative Coating;
Mattiello, J.J. et al,
J. Wiley & Sons, 1947
- Footnote 3: Formulation of Organic Coatings;
Gaynes, N.I. et al,
D. Nostrand, Co., Inc., 1967
- Footnote 4: The Manufacture of Sulfuric Acid and Alkali;
Lunge, George,
D. Nostrand, Co., Inc. 1913
- Footnote 5: Sulfuric Acid Manufacture;
Fairlie, A.M.,
Reinhold Publishing Company, 1936

TABLE OF CONTENTS: APPENDIX III

<u>TITLE</u>	<u>PAGE#</u>	<u>REPORT SEC./PAGE #</u>
Table I: Woburn Environmental Studies/Phase 1 Screening Program	Append. III, PP. 1, 2	VI, P. VI-1
Table II: Accuracy of Fusion-AA Procedure	Append. III, PP. 3-7	VI, P. VI-10
Table III: Lower Limits of Detection for Metals Determination in Soil (ppm)	Append. III, P. 8	VI, P. VI-11

Woburn Environmental Studies

Phase I Screening Program

<u>Analysis Category</u>	<u>Source</u>			
	<u>Surface Water</u>	<u>Sediments</u>	<u>Wells</u>	<u>Leachate</u>
pH	X		X	X
Specific conductance	X		X	X
Dissolved oxygen	X			
Temperature	X		X	
Ammonia (as N)	X			
Total suspended solids	X			
Total dissolved solids (180°C)	X			
Volatile organics ¹	X	X	X	X
Base/neutral extractables ¹	X	X	X	X
Acid extractables ¹	X	X	X	X
Pesticide extractables ¹	X	X	X	X
Metals (Group 1) ²	X	X	X	X
Metals (Group 2) ³	X	X	X	X
Cyanide	X		X	X
Phenol	X		X	X

¹ Set list of Priority Pollutants for each category plus up to twenty (20) additional components.

² Metals (Group 1) are barium, beryllium, cadmium, chromium, copper, nickel, lead, silver, thallium, zinc.

³ Metals (Group 2) are antimony, arsenic, mercury and selenium.

C
TABLE I

(concluded)

Woburn Environmental Studies

Phase I Screening Program

Analysis Category

Source

Test Pit Soil Boring

Bore Hole Ambient Air

Metals (Group 1)
Metals (Group 2)
Organics Screen

X
X
X

Arsine
Hydrogen Sulfide
Methyl Mercaptan
Dimethyl Sulfide
Dimethyl Disulfide
Volatile Organic Compounds "

X
X
X
X
X
X

"VOC result is an unspecified listing of compound(s) and associated concentrations.

C
TABLE II

Accuracy of Fusion-AA Procedure

	NBS-RS-1 ①			NBS-ES-1 ②		
	<u>Certified Value</u>	<u>Result</u>	<u>% Recovery</u>	<u>Certified Value</u>	<u>Result</u>	<u>% Recovery</u>
Arsenic	66 ppm	75 ppm	114	11.6 ppm	8.9 ppm	77
Chromium	2.96%	2.83%	96	76	99	130
Lead	714 ppm	876 ppm	123	28 ppm	ND (<200)	--

① NBS River Sediment

② NBS Estuarine Sediment

C
TABLE II

(continued)

Precision Study for Fusion-AA Procedure

<u>Sample 2-1</u>	<u>µg/g</u>		
	<u>Pb</u>	<u>Cr</u>	<u>As</u>
Trial 1	614	358	232
Trial 2	610	395	237
Trial 3	608	310	213
Trial 4	595	307	227
Average	607	343	227
SD*	± 8	±42	±10
RSD**	1.3%	12%	4.6%

*Standard Deviation

**Relative Standard Deviation

TABLE II

(continued)

Test Results for Lead in Woburn Soils

Pb ($\mu\text{g/g}$)				
<u>Sample</u> ①	<u>XRF</u> ②	<u>XRF</u> ③	<u>XRF</u> ④	<u>AA (PP)</u> ⑤
1-1	510	1600	660	340
1-2	1300	1600	2400	1400
2-1	750	1500	1400	610
2-2	85	1700	0	(55)
3-1	140	650	370	(90)
3-2	150	120	150	(120)
4-1	270	170	950	320
4-2A	250	1100	390	160
4-2B	250	1200	590	210

- ① All soils dried at 105°C, except 4-1, which was dried at 550°C.
- ② Estimated levels obtained using ERC wavelength dispersive instrument. Quantitation based on comparison with NBS River Sediment.
- ③ Results obtained from wavelength dispersive field instrument.
- ④ Results obtained from energy dispersive field instrument.
- ⑤ Atomic absorption (pulse polarography) analysis performed at ERC on fused soil samples.

C
TABLE II

(continued)

Test Results for Chromium in Woburn Soils

Sample ①	Cr (µg/g)			
	XRF ②	XRF ③	XRF ④	AA ⑤
1-1	370	1400	250	270
1-2	220	1100	< 50	270
2-1	320	1200	860	340
2-2	720	2300	1800	510
3-1	84	350	150	88
3-2	23	30	60	30
4-1	15,200	23,800	25,800	16,900
4-2A	130	900	1200	120
4-2B	130	870	1100	140

- ① All soils dried at 105°C, except 4-1, which was dried at 550°C.
- ② Estimated levels obtained using ERC wavelength dispersive instrument. Quantitation based on comparison with NBS Estuarine Sediment.
- ③ Results obtained from wavelength dispersive field instrument.
- ④ Results obtained from energy dispersive field instrument.
- ⑤ Atomic absorption analysis performed at ERC on fused soil samples.

C
TABLE II
(concluded)

Test Results for Arsenic in Woburn Soils

<u>Sample</u> ①	<u>As (μg/g)</u>			
	<u>XRF</u> ②	<u>XRF</u> ③	<u>XRF</u> ④	<u>AA</u> ⑤
1-1	< 200	620	220	70
1-2	< 200	970	600	160
2-1	220	300	390	230
2-2	< 200	1400	43	7
3-1	< 200	10	< 40	10
3-2	< 200	< 10	< 40	72
4-1	< 200	< 10	2900	23
4-2A	< 200	570	180	2
4-2B	< 200	470	240	2

- ① All soils dried at 105°C, except 4-1, which was dried at 550°C.
- ② Estimated levels obtained using ERC wavelength dispersive instrument. Quantitation based on comparison with NBS River Sediment.
- ③ Results obtained from wavelength dispersive field instrument.
- ④ Results obtained from energy dispersive field instrument.
- ⑤ Atomic absorption analysis performed at ERC on fused soil samples.

C
TABLE III

Lower Limits of Detection for
Metals Determination in Soil (ppm)

<u>Analyte</u>	<u>AA*</u>
Antimony	2
Arsenic	2
Barium	10
Beryllium	1
Cadmium	1
Chromium	5
Copper	2
Lead	5
Mercury	1
Nickel	1
Selenium	2
Silver	2
Thallium	10
Zinc	1

*ERT Analytical Method for the Determination of
Selected Metals in Soil

TABLE OF CONTENTS: APPENDIX III

<u>TITLE</u>	<u>PAGE #</u>	<u>REPORT SEC./PAGE #</u>
Attachment I(1): Chain of Custody	Append. III, PP. 1-8	VI, P. VI-2
Attachment I(2): Quality Assurance Protocol	Append. III, PP. 9-13	VI, P. VI-2
Attachment II: Batch Audit Report for Evaluation of Data from ERT	Append. III, PP. 14-16	VI, PP. VI-5, 1
Attachment III: Comparison of Results of Metal Analysis Stauffer Chemical Company/ERT for Selected Soil Samples	Append. III, PP. 17-31	VI, PP. VI-7, 10, 11
Attachment IV: ERT Analytical Method for the Determination of Selected Metals in Soil	Append. III, PP. 32-35	VI, PP. VI-11, 16, 17
Attachment V:	Append. III, P. 36	VI, PP, VI-13, 16
V(1): SCC Method for Screening Volatile Organic Compounds	Append. III, PP. 37-47	
V(2): EPA Method 5020 Head Space Method	Append. III, PP. 48-50	
V(3): EPA Method 8010 Halogenated Volatile Organics	Append. III, PP. 51-60	
V(4): EPA Method 8015 Non-Halogenated Volatile Organics	Append. III, PP. 61-68	
V(5): EPA Method 8020 Aromatic Volatile Organics	Append. III, PP. 69-78	

ATTACHMENT I (1)

1. Chain of Custody Protocol
2. Quality Assurance Protocol

From: "Woburn Environmental Studies
Sampling and Analysis Manual"
Chapter 5 and 6
Stauffer Chemical Co., 1982

I(1)

General Survey RequirementsChain of Custody ProtocolEastern Research Center
Dobbs Ferry, New YorkSection 5.00, Page 1 of 8

It is imperative that written procedures be followed whenever samples are collected, transferred, stored, analyzed or destroyed. The primary objectives of these procedures is to create an accurate written record which can be used to trace the possession and handling of the sample from the moment of its collection to disposal.

A sample is in someone's "custody" if:

1. It is in one's actual physical possession;
2. It is in one's view, after being in one's physical possession;
3. It is in one's physical possession and then locked up so that no one can tamper with it;
4. It is kept in a secured area, restricted to authorized personnel only.

To establish the documentation necessary to trace sample possession from the time of collection, a chain of custody record must be filled out and accompany every sample or

I(1)

General Survey RequirementsChain of Custody ProtocolEastern Research Center
Dobbs Ferry, New YorkSection 5.00, Page 2 of 8

set of samples. The chain of custody record to be used for the Woburn Project is illustrated in Figure 1. The record must contain the following minimum information:

- Collector's sample number
- Signature of collector
- Date and time of collection
- Place of sample collection
- Sample type
- Signatures of persons involved in the chain of possession
- Inclusive dates of possession
- Condition and serial number of Chain of Custody Seals

I(1)

General Survey RequirementsChain of Custody ProtocolEastern Research Center
Dobbs Ferry, New YorkSection 5.00, Page 3 of 8FIGURE 1
(1st side)STAUFFER CHEMICAL COMPANYEASTERN RESEARCH CENTERCHAIN OF CUSTODY RECORD

Sheet No. _____

I. Sample Designation:

- a) Field ID No.(s)
- b) Laboratory ID No.
- c) Collection Site
- d) Type of Samples
- e) Collected By

_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
Signature	Date(s)	Time(s)

II. Sample Shipment:

- a) Shipment Carrier
- b) Type of Service
- c) Shipping Container
- d) Sample Condition
- e) Received By

_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
Signature	Date(s)	Time(s)

III. Sample Receipt:

- a) Location
- b) Container Condition
- c) Sample Condition
- d) Received By

_____	_____	_____
_____	_____	_____
_____	_____	_____
Signature	Date(s)	Time(s)

I(i)

General Survey RequirementsChain of Custody ProtocolEastern Research Center
Dobbs Ferry, New YorkSection 5.00, Page 4 of 8Stauffer Chemical Co.
Eastern Research Center
Chain of Custody RecordFIGURE 1
(2nd side)

Sheet No. _____

IV. Sample Storage:

- a) Location
- b) Sample Condition
- c) Sample Control By

Signature	Date(s)	Time(s)
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

V. Sample Analysis:

- a) Analyses Requested
- b) GAS/RRA Number(s)
- c) Chain of Possession:

Signature	Inclusion Dates	References
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

VI. Sample Disposal:

- a) Method of Disposal
- b) Disposed By:

Signature	Date(s)	Time(s)
_____	_____	_____
_____	_____	_____

I(1)

General Survey RequirementsChain of Custody ProtocolEastern Research Center
Dobbs Ferry, New YorkSection 5.00, Page 5 of 8Security - Sample Custodian

A specific person shall be designated as Sample Custodian. After collection, all field samples are delivered to the Custodian by the collector(s).

The Sample Custodian shall maintain a permanent log book to record, for each sample, the person delivering the sample, the person receiving the sample, date and time received, source of sample, sample identification or log number.

A clean, dry, isolated room or building shall be used as a "staging area". Here samples will be properly handled, stored, and maintained prior to analysis. This area shall be maintained as a secured area.

Upon receipt of a field sample, the Custodian shall be responsible for the following:

1. Log the samples chronologically in a laboratory notebook as stated above.
2. Fill out a chain of custody sheet for each sample.
3. Assign a laboratory number.

I(a)

General Survey RequirementsChain of Custody ProtocolEastern Research Center
Dobbs Ferry, New YorkSection 5.00, Page 6 of 8

4. Secure sample bottle cap with tamper-proof seal.

Sample seals are used to preserve the integrity of the sample from the time of collection until it is opened in the analytical laboratory. The seal must be attached in such a way that it is necessary to break it in order to open the sample container. The seals are over-wrapped with black vinyl electrical tape.

5. Put plastic mesh around glass bottles. This mesh is used for protection from flying glass, should the sample bottle be broken.

6. Store sample in appropriate secured storage container.

Some samples need to be refrigerated or kept in coolers on ice. These containers must be kept locked and secured during sample storage. When samples are being shipped in coolers, these coolers should be equipped with steel tamper-proof seals. Steel seals and coolers will be identified by number.

Samples which do not require refrigeration must be kept in a secured area of the "staging area".

I(1)

General Survey RequirementsEastern Research Center
Dobbs Ferry, New YorkChain of Custody ProtocolSection 5.00, Page 7 of 8

7. When a sample is shipped to an outside laboratory for analysis, it must be packaged in a proper shipping container to avoid leakage and/or breakage.
8. The shipping of samples shall conform to the requirements of the Department of Transportation (DOT).

Internal Audit

In order to maintain an efficient chain of custody program, it is necessary to inspect the documentation procedures of the program.

This inspection will monitor approximately 10% of the chain of custody program. Using the following guidelines, the Site Manager or his representative will perform this inspection:

1. Randomly selected chain of custody forms which constitute 10% of the program will be evaluated.
2. The chain of custody record form will be reviewed to verify that Section I, Sample Designation; Section II, Sample Shipment and Section IV, Sample Storage are properly completed. (See pp 3, 4 of this Section).

I(1)

General Survey RequirementsChain of Custody ProtocolEastern Research Center
Dobbs Ferry, New YorkSection 5.00 , Page 8 of 8

3. From the information supplied in Section IV, the location of the sample can be verified along with sample type, condition, etc.
4. From the sample identification numbers supplied in Section I, recordkeeping documents can be cross referenced.

The field notebook which contains the original sampling data and the Sample Custodian's log book, which is a permanent record of all samples, should be reviewed for completeness.

Eastern Research Center
Dobbs Ferry, New York

The objective of the Quality Assurance (Q.A.) Program is to establish and control the quality of the analytical data resulting from the sampling and analysis program carried out at the Woburn site and at various contract laboratories. Specific objectives of this program are:

- To use sampling and analytical methods capable of meeting the intended needs for precision, accuracy, sensitivity and specificity.
- To reference all sampling and analytical procedures used from the technical/regulatory literature.
- To determine and document the specificity, precision and accuracy of all screening methods to be used (portable x-ray fluorescence, Extraction/GC scan) for the semi-quantitative determination of metals and organic contaminants in environmental samples.
- To maintain a file with all applicable analytical procedures used in meeting the objectives of the program with the Project management.

I(2)

General Survey RequirementsQuality Assurance ProtocolEastern Research Center
Dobbs Ferry, New YorkSection 6.00, Page 2 of 5

The Q.A. Program to be implemented for the Phase I and Phase II Environmental Studies at the Woburn site will be an inherent part of the (1) field sampling program, together with the site screening analyses and (2) the analytical work carried out by contract laboratories.

Q.A. Field Sampling Program

A Q.A. coordinator will be responsible for the implementation of the provisions of the Q.A. Protocol. Q.A. samples are to be added to collected field samples in the following manner:

- a) From each set of ten (10) field samples, one (1) sample will be collected in duplicate and analyzed as the "Sample Duplicate".
- b) For water samples, another sample (taken randomly from each set of ten (10)) will be spiked with the expected analyte(s) at about five (5) times the minimum detectable quantity (MDQ) or at the expected sample concentration level and analyzed as the "Sample Spike". For soil or sediment samples, a previously analyzed high contaminated sample will be resubmitted as the Sample Spike.
- c) A sample of standard non-contaminated soil or sediment (preanalyzed) will also be spiked in the field with the expected analyte(s) at about five (5) times the minimum detectable quantity (MDQ) or at the expected

I(2)General Survey RequirementsQuality Assurance ProtocolEastern Research Center
Dobbs Ferry, New YorkSection 6.00, Page 3 of 5

sample concentration level and analyzed as the "Blank Spike". As an alternative, a previously analyzed, low contaminated sample will be resubmitted as the "Blank Spike".

- d) A sample of organic- and metal-free water preanalyzed, will be used during sampling to monitor potential external contamination and analyzed as the water "Sample Blank".
- e) A sample of standard non-contaminated soil or sediment (preanalyzed) will be used during sampling to monitor potential external contamination and analyzed as the soil/sediment "Sample Blank".

All field Q.A. samples will be submitted as regular "blind" samples to the contractor.

The above detailed steps are designed to assure the continued validity of a sample during collection, pretreatment, preservation and shipment and to test the ability of the contract laboratory to measure specified constituents in the sample matrix at various concentration levels with an acceptable level of precision and accuracy.

I(2)

General Survey RequirementsQuality Assurance Protocol

Eastern Research Center
Dobbs Ferry, New York

Section 6.00 , Page 4 of 5

Q.A. Contract Laboratories

Documentation of laboratory Q.A. programs from commercial laboratories to be contracted for the analysis of metals, organic Priority Pollutants, standard water quality parameters, as well as personnel monitoring samples, will be part of our contract and submitted to the agency under separate cover.

Stauffer Chemical Company has established procedures to monitor the quality of analytical services obtained from commercial laboratories. Separate protocols are in use to evaluate the quality of laboratories to be contracted for either environmental analyses or industrial hygiene monitoring:

- Q.A. samples are submitted to determine (a) general analytical capability, and (b) associated precision, accuracy and turn-around time.
- If favorable results are obtained, the laboratory is visited by a qualified analytical chemist, using a questionnaire developed for this purpose (Appendices 27 and 28).
- Regular samples submitted for analysis includes a minimum of 10% duplicates and 5% spiked samples with

I(2)General Survey RequirementsQuality Assurance Protocol

Eastern Research Center
Dobbs Ferry, New York

Section 6.00, Page 5 of 5

each request and type. The number of Q.A. samples may have to be increased depending on the importance of the data, i.e., compliance analysis.

Results received are judged for data and report quality. Criteria used are those published in the general analytical literature, i.e., ASTM, "US EPA Methods for Chemical Analysis", "Standard Methods for Water and Waste Water" or NIOSH validated methods.

ATTACHMENT II

Batch Audit Report for
Evaluation of Data from ERT

SHIP DATE CATID
8/ 2/1982 - K2

REFE NO TYPE QANAL RES.DATE SCORE
73630102 R 0 9/24/82 75

ANALID LLDAMT RESAMT COMPOUND
2 2 7

REFE NO TYPE QANAL RES.DATE SCORE
73630104 Q 0 9/24/82 75

ANALID LLDAMT ORIGAMT SPIKEAMT RESAMT PROFNO PERCENTR CROSSREF
2 2 5 0 4 3 80 0

REFE NO TYPE QANAL RES.DATE SCORE
73630108 R 0 9/24/82 75

ANALID LLDAMT RESAMT COMPOUND
2 2 4

REFE NO TYPE QANAL RES.DATE SCORE
73630109 Q 0 9/24/82 75

ANALID LLDAMT ORIGAMT SPIKEAMT RESAMT PROFNO PERCENTR CROSSREF
2 2 5 301 398 2 130 0

REFE NO TYPE QANAL RES.DATE SCORE
73630114 R 0 9/24/82 75

ANALID LLDAMT RESAMT COMPOUND
2 2 2

REFE NO TYPE QANAL RES.DATE SCORE
73630117 R 0 9/24/82 75

ANALID LLDAMT RESAMT COMPOUND
2 2 4

REFE NO TYPE QANAL RES.DATE SCORE
73630118 Q 0 9/24/82 75

ANALID LLDAMT ORIGAMT SPIKEAMT RESAMT PROFNO PERCENTR CROSSREF
2 2 120 472 772 2 130 0

REFE NO TYPE QANAL RES.DATE SCORE
73630124 R 0 9/24/82 75

ANALID LLDAMT RESAMT COMPOUND
2 2 5

REFE NO TYPE QANAL RES.DATE SCORE
73630128 Q 0 9/24/82 75

ANALID LLDAMT ORIGAMT SPIKEAMT RESAMT PROFNO PERCENTR CROSSREF
2 2 120 0 62 2 51 0

REFE NO TYPE QANAL RES.DATE SCORE
73630133 R 0 9/24/82 75

2 2 806
8 1 441

REF NO TYPE QANAL RES.DATE SCORE
73630203 R 0 9/24/82 75

ANALID LLDAMT RESAMT COMPOUND
2 2 120

REF NO TYPE QANAL RES.DATE SCORE
73630207 R 0 9/24/82 75

ANALID LLDAMT RESAMT COMPOUND
2 2 118

REF NO TYPE QANAL RES.DATE SCORE
73630209 R 0 9/24/82 75

ANALID LLDAMT RESAMT COMPOUND
2 2 126
8 1 69

REF NO TYPE QANAL RES.DATE SCORE
73630212 R 0 9/24/82 75

ANALID LLDAMT RESAMT COMPOUND
2 2 3

ATTACHMENT III

Comparison of Results of Metal Analyses

Stauffer Chemical Co./ERT

For Selected Soil Samples

TABLE I. AA Determination of Antimony in Woburn Soils by ERC & ERT

<u>Sample</u>	<u>µg/g Sb</u>	
	<u>ERC</u>	<u>ERT</u>
7363-13-01	2.3	ND
7363-13-14	3.1	ND
7363-13-14 dup.	9.3	-
7363-10-01	440	141
7363-10-01 dup.	310	-
7363-16-22	ND ¹	23
7363-16-17	DBLQ ²	10
7363-02-30	DBLQ	ND
7363-17-34	1.1	-
7363-05-15	ND	-
7363-05-16	ND	-

¹ Not detected, ERC lower limit of detection is 0.4 µg/g.

² Detected below limit of quantitation of 1 µg/g.

- Not analyzed.

Quality Assurance Data

<u>Sample</u>	<u>Spiking Level</u>	<u>% Recovery</u>
Reagent Blank	1 µg	115
7363-13-01	25 µg	12

TABLE II. AA Determination of Arsenic in Woburn Soils by ERC & ERT

<u>Sample</u>	<u>µg/g As</u>	
	<u>ERC</u>	<u>ERT</u>
7363-13-01	420*	808
7363-13-14	83	131
7363-13-14 dup.	110	-
7363-10-01	4000*	5960
7363-10-01 dup.	3600*	-
7363-16-22	120	139
7363-16-17	6600*	24227
7363-02-30	250	281
7363-17-34	110	-
7363-05-15	94	-
7363-05-16	14	-

*Quantitation by XRF.

-Not analyzed.

Quality Assurance Data

<u>Sample</u>	<u>Spiking Level</u>	<u>% Recovery</u>
Reagent Blank -	1 µg	100
7363-13-01	1000 µg	98
7363-16-17	25 mg	107

TABLE III. AA Determination of Barium in Woburn Soils by ERC & ERT

<u>Sample</u>	<u>µg/g Ba</u>	
	<u>ERC</u>	<u>ERT</u>
7363-13-01	170	170
7363-13-14	170	130
7363-13-14 dup.	150	-
7363-10-01	540	1000
7363-10-01 dup.	420	-
7363-16-22	160	129
7363-16-17	130	103
7363-02-30	500	450
7363-17-34	400	-
7363-05-15	ND ¹	-
7363-05-16	ND	-

¹ Not detected, ERC lower limit of detection is 100 µg/g.

- Not analyzed.

Quality Assurance Data

<u>Sample</u>	<u>Spiking Level</u>	<u>% Recovery</u>
Reagent Blank	500 µg	92
7363-13-01	200 µg	135

TABLE IV. AA Determination of Beryllium in Woburn Soils by ERC & ERT

<u>µg/g Be</u>		
<u>Sample</u>	<u>ERC</u>	<u>ERT</u>
7363-13-01	ND ¹	ND
7363-13-14	ND	2
7363-13-14 dup.	ND	-
7363-10-01	ND	ND
7363-10-01 dup.	ND	-
7363-16-22	3.9	3
7363-16-17	ND	ND
7363-02-30	ND	ND
7363-17-34	ND	-
7363-05-15	ND	-
7363-05-16	ND	-

¹ Not detected, ERC lower limit of detection is 2 µg/g.

- Not analyzed.

Quality Assurance Data

<u>Sample</u>	<u>Spiking Level</u>	<u>% Recovery</u>
Reagent Blank	150 µg	103
7363-13-01	150 µg	107

TABLE V. AA Determination of Cadmium in Woburn Soils by ERC & ERT

<u>Sample</u>	<u>µg/g Cd</u>	
	<u>ERC</u>	<u>ERT</u>
7363-13-01	2.6	3
7363-13-14	1.8	4
7363-13-14 dup.	1.8	-
7363-10-01	3.0	5
7363-10-01 dup.	2.7	-
7363-16-22	ND ¹	5
7363-16-17	230	199
7363-02-30	2.6	4
7363-17-34	ND	-
7363-05-15	ND	-
7363-05-16	ND	-

¹ Not detected, ERC lower limit of detection is 1.7 µg/g Cd.

- Not analyzed.

Quality Assurance Data

<u>Sample</u>	<u>Spiking Level</u>	<u>% Recovery</u>
Reagent Blank	250 µg	102
7363-13-01	10 µg	100

TABLE VI. AA Determination of Chromium in Woburn Soils by ERC & ERT

<u>Sample</u>	<u>µg/g Cr</u>	
	<u>ERC</u>	<u>ERT</u>
7363-13-01	98	81
7363-13-14	200	141
7363-13-14 dup.	220	-
7363-10-01	ND ¹	ND
7363-10-01 dup.	ND	-
7363-16-22	210	179
7363-16-17	18	186
7363-02-30	260	161
7363-17-34	130	-
7363-05-15	ND	-
7363-05-16	ND	-

¹ Not detected, ERC lower limit of detection is 14 µg/g.

- Not analyzed.

Quality Assurance Data

<u>Sample</u>	<u>Spiking Level</u>	<u>% Recovery</u>
Reagent Blank	50 µg	108
7363-13-01	100 µg	110

TABLE VII. AA Determination of Copper in Woburn Soils by ERC & ERT

<u>µg/g Cu</u>		
<u>Sample</u>	<u>ERC</u>	<u>ERT</u>
7363-13-01	240	284
7363-13-14	790	879
7363-13-14 dup.	780	-
7363-10-01	230	316
7363-10-01 dup.	210	-
7363-16-22	110	142
7363-16-17	1900	2165
7363-02-30	1000	1307
7363-17-34	390	-
7363-05-15	53	-
7363-05-16	59	-

-Not analyzed.

Quality Assurance Data

<u>Sample</u>	<u>Spiking Level</u>	<u>% Recovery</u>
Reagent Blank	250	88
7363-13-01	300	113
7363-16-17	2000	100

TABLE VIII. AA Determination of Lead in Woburn Soils by ERC & ERT

<u>µg/g Pb</u>		
<u>Sample</u>	<u>ERC</u>	<u>ERT</u>
7363-13-01	600	636
7363-13-14	1200	1374
7363-13-14 dup.	1100	-
7363-10-01	21000	21212
7363-10-01 dup.	21000	-
7363-16-22	2100	2189
7363-16-17	230	268
7363-02-30	570	503
7363-17-34	1900	-
7363-05-15	ND ¹	-
7363-05-16	ND	-

¹ Not detected, ERC lower limit of detection is 12 µg/g.

- Not analyzed.

Quality Assurance Data

<u>Sample</u>	<u>Spiking Level</u>	<u>% Recovery</u>
Reagent Blank	250	100
7363-13-01	650	122
7363-16-22	2000	100

TABLE IX. AA Determination of Mercury in Woburn Soils by ERC & ERT

<u>µg/g Hg</u>		
<u>Sample</u>	<u>ERC</u>	<u>ERT (corrected value)</u>
7363-13-01	2.7	263 (2.6)
7363-13-14	1.1	101 (1.0)
7363-13-14 dup.	ND ¹	-
7363-10-01	530	54545 (545)
7363-10-01 dup.	490	-
7363-16-22	ND	ND
7363-16-17	ND	ND
7363-02-30	6.7	734 (7.3)
7363-17-34	ND	-
7363-05-15	ND	-
7363-05-16	ND	-

¹ Not detected, ERC lower limit of detection is 1 µg/g.

² Value given by ERT after computation error had been corrected.

- Not analyzed.

Quality Assurance Data

<u>Sample</u>	<u>Spiking Level</u>	<u>% Recovery</u>
Reagent Blank	200 µg	90
7363-13-01	200 µg	91
7363-02-30	700 µg	103

TABLE X. AA Determination of Nickel in Woburn Soils by ERC & ERT

<u>µg/g Ni</u>		
<u>Sample</u>	<u>ERC</u>	<u>ERT</u>
7363-13-01	13	23
7363-13-14	12	29
7363-13-14 dup.	11	-
7363-10-01	ND ¹	9
7363-10-01 dup.	ND	-
7363-16-22	260	324
7363-16-17	32	36
7363-02-30	16	29
7363-17-34	10	-
7363-05-15	ND	-
7363-05-16	ND	-

¹ Not detected, ERC lower limit of detection is 8 µg/g.

- Not analyzed.

Quality Assurance Data

<u>Sample</u>	<u>Spiking Level</u>	<u>% Recovery</u>
Reagent Blank	250 µg	104
7363-13-01	25 µg	108
7363-16-22	300 µg	96

TABLE XI. AA Determination of Selenium in Woburn Soils by ERC & ERT

<u>Sample</u>	<u>µg/g Se</u>	
	<u>ERC</u>	<u>ERT</u>
7363-13-01	ND ¹	ND
7363-13-14	DBLQ ²	3
7363-13-14 dup.	DBLQ	-
7363-10-01	153	ND
7363-10-01 dup.	172	-
7363-16-22	ND	ND
7363-16-17	ND	ND
7363-02-30	7.4	5
7363-17-34	ND	-
7363-05-15	ND	-
7363-05-16	ND	-

¹ Not detected, ERC lower limit of detection is 0.5 µg/g.

² Detected below lower limit of quantitation of 2 µg/g.

- Not analyzed.

Quality Assurance Data

<u>Sample</u>	<u>Spiking Level</u>	<u>% Recovery</u>
Reagent Blank	1 µg	90
7363-13-01	25 µg	94

TABLE XII. AA Determination of Silver in Woburn Soils by ERC & ERT

<u>Sample</u>	<u>µg/g Ag</u>	
	<u>ERC</u>	<u>ERT</u>
7363-13-01	ND ¹	3
7363-13-14	ND	3
7363-13-14 dup.	ND	-
7363-10-01	63	25
7363-10-01 dup.	62	-
7363-16-22	ND	2
7363-16-17	4	4
7363-02-30	7.9	10
7363-17-34	7.9	-
7363-05-15	ND	-
7363-05-16	ND	-

¹ Not detected, ERC lower limit of detection is 4.0 µg/g.

- Not analyzed.

Quality Assurance Data

<u>Sample</u>	<u>Spiking Level</u>	<u>% Recovery</u>
Reagent Blank	100 µg	100
7363-13-01	20 µg	98

TABLE XIII. AA Determination of Thallium in Woburn Soils by
ERC & ERT

<u>µg/g Tl</u>		
<u>Sample</u>	<u>ERC</u>	<u>ERT</u>
7363-13-01	ND ¹	ND
7363-13-14	ND	ND
7363-13-14 dup.	ND	-
7363-10-01	220	258
7363-10-01 dup.	210	-
7363-16-22	ND	30
7363-16-17	ND	21
7363-02-30	ND	20
7363-17-34	ND	-
7363-05-15	ND	-
7363-05-16	ND	-

¹ Not detected, ERC lower limit of detection is 30 µg/g.

- Not analyzed.

Quality Assurance Data

<u>Sample</u>	<u>Spiking Level</u>	<u>% Recovery</u>
Reagent Blank	350 µg	103
7363-13-01	350 µg	100

TABLE XIV. AA Determination of Zinc in Woburn Soils by ERC & ERT

<u>Sample</u>	<u>µg/g Zn</u>	
	<u>ERC</u>	<u>ERT</u>
7363-13-01	560	606
7363-13-14	330	566
7363-13-14 dup.	310	-
7363-10-01	1200	1414
7363-10-01 dup.	1100	-
7363-16-22	390	465
7363-16-17	98000	144330
7363-02-30	850	864
7363-17-34	780	-
7363-05-15	160	-
7363-05-16	66	-

-Not analyzed.

Quality Assurance Data

<u>Sample</u>	<u>Spiking Level</u>	<u>% Recovery</u>
Reagent Blank	150 µg	109
7363-13-01	600 µg	138
7363-16-17	140 µg	93

ATTACHMENT IV

ERT Analytical Method for the
Determination of Selected Metals in Soil

ANALYTICAL METHOD FOR THE DETERMINATION
OF SELECTED METALS IN SOIL

ACID PARR[®] BOMB TECHNIQUE

Stauffer Chemical

Project No. B667-100

I. Principle

An aliquot of dry, sieved soil is added to a Parr[®] acid digestion bomb and wet ashed with nitric acid. The bomb allows for an enclosed system making optimum use of the oxidation reaction.

II. Reagents/Apparatus/Materials

Nitric Acid, GF Smith double-distilled

Dionized Water, Millipore Mill: Q system with UV irradiation

Filter paper, Whatman 41

Oven, Fisher Model Isotemp 300

Parr[®] bombs, Parr[®] 125 ml capacity acid digestion bombs equipped with Teflon[®] liner and lid.

Jarrell-Ash Model 850 Atomic Absorption Spectrophotometer (AAS), equipped with FLA-100 graphite furnace and IL Model 440 Hydride generator.

III. Digestion

1. A 1 gram sample of soil (submitted in dry, mixed and sieved form by Stauffer) is weighed and transferred to the Teflon[®] liner.
2. A 30.0 ml volume of 8.0 N HNO₃ is added and the bomb assembled and sealed.
3. The bomb is placed in the oven and allowed to equilibrate to 150°C, then heated for an additional 2 hours at 150°C.
4. The bomb is removed from the oven and cooled to room temperature using a flow of ambient air across the bomb.

5. The acid/soil mixture is rinsed into the filter paper using deionized water. Three rinses of the Teflon[®] liner are added to the filter paper.
6. The filtrate is collected into a 100.0 ml volumetric flask and brought to volume.
7. Samples are transferred to polyethylene screw-cap bottles for storage prior to analysis.

IV. Analysis

All AAS analyses are performed strictly according to EPA Methods 200., "Methods for Chemical Analysis of Water and Wastes", EPA-600/4-79-020, March 1979, as specified below:

<u>Analyte</u>	<u>EPA Method</u>	<u>AAS Procedure</u>	<u>Detection* Limit, ug/g</u>
Arsenic	206.3**	Hydride	2.0
Silver	272.1	Flame	1.0
Barium	208.1	Flame	1.0
Beryllium	210.1	Flame	1.0
Cadmium	213.1	Flame	1.0
Chromium	218.1	Flame	5.0
Copper	220.1	Flame	2.0
Mercury	245.1	Cold Vapor	1.0
Nickel	249.1	Flame	2.0
Lead	239.1	Flame	5.0
Antimony	204.2	Graphite	2.0
Selenium	270.3**	Hydride	2.0
Thallium	279.1	Flame	10
Zinc	289.1	Flame	1.0

*Does not necessarily reflect instrument detection limit, may be set by computer input integer restrictions.

**Using IL Model 440 Hydride Generator Adapted Method

V. Standardization

A standard curve using at least three concentrations is prepared each day for each metal, by analyzing analytical standards. After each 8-10 samples, one standard at random is reanalyzed to check instrument stability. At the end of the day, all standards and reagent

50
///

After
Before

V Standardization
VI Quality Assurance

blanks analyzed are put into a linear regression analysis to determine the actual equation for the days curve. The linear regression analysis is used to calculate analytical results of samples. The correlation must be at least 0.98, but preferably 0.99-0.999.

In some cases, if instrument stability is shown to be good by analyzing analytical standards, the concentration mode of the AAS can be used in place of absorbance. In this case, standards are reanalyzed after each 8-10 samples and concentrations taken directly from the digital readout. The instrument uses a two point calibration, so both standards must be reanalyzed each time standards are checked.

VI. Quality Assurance

A separate document specifies the quality assurance program being used for soil metal analyses for project #B667-100. Analyst must be familiar with this document prior to beginning any analyses.

ATTACHMENT V

1. Stauffer Chemical Company
Method for Screening of Volatile
Organic Compounds in Woburn Soils
by Head Space Gas Chromatography
2. EPA Method 5020
Head Space Method
3. EPA Method 8010
Halogenated Volatile Organics
4. EPA Method 8015
Non-Halogenated Volatile Organics
5. EPA Method 8020
Aromatic Volatile Organics

METHOD FOR SCREENING OF VOLATILE ORGANIC
COMPOUNDS IN WOBURN SOILS BY
HEAD SPACE GAS CHROMATOGRAPHY

SCOPE:

This method is designed for the rapid screening of volatile organic compounds in large numbers of soil samples using a static head space gas chromatographic technique. This screening method is based on EPA soil head space Methods No. 5020, 8010, 8015 and 8020. The response of a known quantity of eight standard compounds, chosen from the EPA methods, is compared to the response from the individual soil samples, under identical conditions. Standards chosen to represent several chemical classes with boiling points up to 180°C are: benzene, dichloromethane, methyl ethyl ketone, 1,2-dichloroethane, toluene, methyl isobutyl ketone, chlorobenzene and 1,2-dichlorobenzene. Detection limits for the technique can vary widely depending on the sample matrix. Sensitivity of the screening method will depend on the nature of the compounds present in the sample and their equilibration between the solid and the head space.

PRINCIPLE:

Soil samples are ground at liquid nitrogen temperature to produce a uniform sample. Sub-samples of the ground soil are weighed into crimped-type serum vials and equilibrated at 110°C in the automatic sampler tray of a Perkin Elmer F-45 Automated Head Space Analyzer. A sample of the serum vial head space is analyzed in the GC section of the instrument. Relative amounts of volatile organic compounds (VOC's) in the soil samples are determined by comparison of the normalized total detector response, (total area counts/gram sample). The approximate concentration of total organics is estimated by comparison to the average response of standards chosen from EPA soil head space Methods 8010, 8015 and 8020.

PRECISION AND ACCURACY:

Since the head space technique is used for screening purposes, $\pm 30\%$ relative precision is acceptable for a ground sample. Analysis of standards will yield better relative precision ($< 10\%$). The precision of the technique is affected by the degree of homogeneity of the soil sample and its moisture content. Inhomogeneous samples will contain varying amounts of organics and thereby produce imprecise results in replicate analyses. Moisture was found to increase the sample vial pressure, resulting in an increased amount of organics being injected into the chromatograph. Above 50% moisture, pressure within the sample vial could not be reliably contained, resulting in very irreproducible results.

The accuracy of this method is limited since compounds are not identified by this screening technique. However, care has been taken to choose a variety of organic compounds from the EPA methods which represent a cross section of potential boiling points and chromatographic response factors. These factors allow the method to be used as a realistic screening tool for organics in soils.

APPARATUS:

1. Syringe, 10 μ L capacity, Hamilton 701, or equivalent
2. Hypovials, 15 mL capacity and hand crimper
3. Perkin Elmer F-45 Head Space Analyzer
4. Perkin Elmer Sigma 10 Data System
5. Perkin Elmer Head Space Vials with aluminum-coated silicone septa
6. Spex Liquid Nitrogen Freezer Mill

REAGENTS:

1. 1,2-dichlorobenzene, reagent grade
2. Benzene, reagent grade
3. Dichloromethane, reagent grade
4. Methyl ethyl ketone, reagent grade

5. 1,2-dichloroethane, reagent grade
6. Toluene, reagent grade
7. Methyl isobutyl ketone, reagent grade
8. Chlorobenzene, reagent grade
9. Hydrogen, ultra high purity grade
10. Air, zero grade
11. Nitrogen, ultra high purity grade
12. Nitrogen, liquid

PROCEDURE:

A. Calibration

1. Prepare a mixed calibration standard of approximately two (2) to five (5) grams, weighed to the nearest mg, of each of the following organic compounds, i.e., 1,2-dichlorobenzene, benzene, dichloromethane, methyl ethyl ketone, 1,2-dichloroethane, toluene, methyl isobutyl ketone and chlorobenzene.
2. Accurately weigh a 15.0 mL aliquot of the mixed standard.
3. Calculate the weight of each compound per μL of mixed standard.
4. Inject, in duplicate, 0.4, 0.6, 1.0 and 5.0 μL of the mixed standard into empty head space vials and seal with an Al coated septum. Analyze each sample according to the conditions outlined in Table I.
5. Prepare a calibration curve of total detector response, i.e., total peak area for all eight compounds vs. the total weight of organics injected. Determine the linearity of response and reproducibility of the analysis as outlined in Table II.

B. Sample Determination

1. Add four (4) to five (5)g of chilled (4°C) test sample to the Spex Mill and grind at liquid nitrogen temperature for 2.5 minutes.
2. Weigh two (2), 0.1 to 0.8g sub-samples of the ground sample to the nearest mg and place one each into separate head space vials and seal.
3. Load a calibration standard, prepared by injecting 5.0 μ L of the mixed standard into a head space vial, in the first and last locations of the Perkin Elmer F-45 sample tray. Place soil test samples and quality assurance samples between the standards.
4. Analyze samples in sequence using the conditions noted in Table I. Allow vials to equilibrate for at least 15 minutes prior to starting run.

C. Quality Assurance

1. Quality assurance samples are required for all analyses. For each set of 10 samples analyzed in duplicate, two (2) blank head space vials, two (2) spiked blank head space vials and two (2) spiked samples should be included. Spikes are prepared by directly injecting 5.0 μ L of the mixed standard into the appropriate vials.
2. The reproducibility of the sample analyses should be determined for each duplicate pair. Differences in total area counts/gram should be determined and reported as percent difference.
3. Recovery of spikes, both blank and sample, should be determined relative to the standards run at the beginning and end of each analysis.

CALCULATION:

1. Add all the area counts for the chromatographic peaks eluting within 20 minutes. Calculate the area counts/gram sample using the formula:

$$ACG = \frac{\text{total area counts (R}_t = 0 \text{ to } 20 \text{ min.)}}{\text{weight of sample}}$$

Results reported using this procedure are not corrected for moisture content, but represent the samples as received from the field.

2. Determine the rate of loss of sample components from the heated head space vials due to leakage through the sample vial septum seal by comparing the response from the first standard to the last standard. Calculate a percent loss per vial from the two response factors and normalize the total area counts for each sample in succession in the analyzer tray as illustrated in the sample calculations below:

Correction for loss of sample during run:

Standard No. 1	Area = 3250	Bottle No. 1
Standard No. 2	Area = 2275	Bottle No. 30

% Loss in Standard = 30%

% Loss per Sample Bottle = 1%

Correct each sample area as follows:

$$\text{Corrected Area} = \frac{\text{Area}}{1 - \frac{(\text{Bottle No.}) (\% \text{ Loss/Vial})}{100}}$$

3. Average results of duplicate samples, and report the average if agreement is $\pm 30\%$. If sample results differ by more than $\pm 30\%$, then report the higher value.
4. To determine the approximate concentration of "total volatile organics" in the sample, use the average response factor from Table II and the total area response (ACG) from the sample as follows:

$$\text{Conc. Volatile Organics (ppm)} = \frac{\text{Area Counts/Gram Sample}}{\text{Avg. ACG}}$$

From the data in Table II, the Avg. ACG = 0.645×10^6 . If the test sample's total area = 250 area counts and weighed 0.55 grams then:

$$\begin{aligned} \text{Conc. Volatile Organics} &= \frac{250 \text{ area counts}}{0.55 \text{ gram sample}} \times \\ &\quad \frac{1 \text{ gm organics}}{0.645 \times 10^6 \text{ area counts}} \times \\ &\quad \frac{10^6 \mu\text{g}}{1 \text{ gm}} = 710 \text{ ppm} \end{aligned}$$

DISCUSSION:

Head space gas chromatography was chosen as the screening method to determine approximate levels of organic contaminants in Woburn soils. Since the technique does not provide capabilities for compound identification, eight compounds were chosen from the EPA head space methods 8010, 8015 and 8020 (attached) as standards. The standard compounds represent a range of chemical classes and gas chromatographic detector responses, as would be expected for compounds in the Woburn soils. As a result, a single mixed standard will approximate the range of detector responses expected for unknown compounds in an actual sample, with boiling points up to 180°C.

By modifying the EPA methods as described in this method, it is possible to evaluate large numbers of soil samples for screening purposes in a cost effective manner without performing multiple analyses on each sample.

Several key parameters were studied in the evaluation of the head space screening method. These included:

- linearity of calibration response factors
- effects of sample moisture content
- head space vial seals
- sample equilibration temperature

The linearity of response was checked by analyzing varying volumes of the mixed calibration standard, in duplicate, injected into standard head space vials. Results of the study indicate that all compounds, with the exception of the high boiling chlorobenzene and dichlorobenzene, respond in a linear manner over the range studied. Results are tabulated in Table II.

The temperature of sample equilibration was found to be a critical factor in analysis of Woburn soils. Due to variable moisture contents, temperatures of 130°C and higher were found to cause over pressurization in some sample vials with subsequent loss of sample. Further lowering of the equilibration temperature produced lower responses from the mixed calibration standard. A temperature of 110°C was chosen as optimal for the Phase I screening studies, since it minimized sample loss but maintained sensitivity.

During the temperature study, it was found that the variable moisture content of the Woburn soils produced a marked effect on the standard response. Samples containing high moisture contents (~50% w/w) produced responses approximately 40% higher than dry samples. We believe this phenomenon results from larger injections of samples with vials containing higher pressures. Since it was not possible to dry samples before analysis without losing sample components, results for wet samples are higher than would be expected if the samples were dry. No attempt was made to adjust sample results for moisture content.

Finally, it was noted that a series of standards analyzed during the course of a normal overnight run decreased at a constant rate through the sample tray. The loss was found to be due to the head space vial seal and the length of time the sample remained in the instrument while awaiting analysis (up to 20+ hours). Attempts were made to minimize loss by testing various septums and jars used for sealing sample vials. It was found that aluminum foil-faced silicone septa produced the least amount of loss during the course of the run. Despite this, losses continued at a constant, but slower rate. Results of analyses would be falsely lowered due to the loss of sample. A correction in results was made based on the constant rate of standard loss. This determination was incorporated in the method and was used to adjust sample results accordingly.



D. S. Hackett

DSH/jmr
Attachments

TABLE IPerkin Elmer Model F-45 Head Space AnalyzerOperating Conditions

GC Columns: (1) 6 ft. x 1/8" stainless steel packed with 10% SP-2100 on 100/120 Supelcoport

(2) 10 ft. x 1/8" stainless steel packed with 20% SP-2100 + 1% Carbowax 1500 on 100/120 Supelcoport

<u>Temperatures:</u>	Oven	115°C
	Needle	150°C
	Injection	115°C
	Detector	140°C
	Sample Vial	110°C

<u>Operating Functions:</u>	Pressuration of Vial	fixed time
	Injection Time	5 seconds
	Analyzer Time	20 minutes
	Backflush Time*	21 minutes
	Stabilization Time	3 minutes

<u>Gas Flow:</u>	Hydrogen (FID)	2.5
	Air (FID)	3.6
	Nitrogen (Carrier)	2.4
	Nitrogen (Backflush)	1.8

*Backflush was directed only through column 1 to remove high boiling compounds not chromatographed under these test conditions.

TABLE II

Response Linearity - EPA Head Space Standards
Perkin Elmer Model F-45 Automatic Mode

Compound	Rt (min.)	Amt. Inj. (μ g)	Area Counts	Avg.	Area Counts/Gram (ACG) $\times 10^6$
Methylene Chloride	1.96	49	10, 9	10	0.20
		74	14, 13	14	0.19
		123	23, 23	23	0.19
		615	117, 106, 106	110	0.18
Methyl Ethyl Ketone	2.33	44	33, 29	31	0.70
		67	50, 46	48	0.72
		111	80, 81	81	0.73
		555	410, 377, 374	387	0.70
1,2-Dichloroethane	2.82	72	16, 14	15	0.21
		108	24, 22	23	0.21
		180	38, 39	39	0.22
		900	204, 183, 184	190	0.21
Benzene	3.09	34	43, 40	42	1.24
		50	65, 59	62	1.24
		84	103, 105	104	1.24
		419	534, 480, 481	498	1.19
Methyl Isobutyl Ketone	3.91	46	44, 40	42	0.91
		68	65, 58	62	0.91
		114	99, 102	101	0.89
		570	503, 471, 463	479	0.84
Toluene	4.74	45	48, 46	47	1.04
		67	75, 68	72	1.07
		112	120, 125	123	1.10
		560	676, 589, 598	621	1.11

TABLE II

(concluded)

Response Linearity - EPA Head Space Standards
Perkin Elmer Model F-45 Automatic Mode

Compound	Rt (min.)	Amt. Inj. (μg)	Area Counts	Avg.	Area Counts/Gram (ACG) x 10 ⁶
Chlorobenzene	6.89	45	23, 23	23	0.51
		67	39, 34	37	0.55
		112	66, 68	67	0.60
		560	441, 354, 373	389	0.70
1,2-Dichlorobenzene	17.74	46	10, 11	11	0.24
		68	18, 16	17	0.25
		114	36, 35, 36	36	0.32
		570	291, 204, 230	242	0.42
AVERAGE					0.645

TABLE IIIReproducibility of Head Space Analysis
With EPA StandardConditions:

Equilibration Temperature: 110°C

Standard Vol.: 5 µL

Standard Head Space Vial with Al Coated Silicone Septa

<u>Sample No.</u>	<u>Total Area Counts</u>
1	3674.8
2	3226.9
3	3493.7
4	3106.6
5	3493.8
6	3361.1
Avg.	3392.8
Std. Dev.	205
% Rel. Std. Dev.	6.4

METHOD 5020
HEADSPACE METHOD

1.0 Scope and Application

1.1 Method 5020 is a static headspace technique for extracting volatile organic compounds in pastes, solids, and liquids. It is a simple method that allows large numbers of samples to be analyzed in a relatively short period of time. Because of the large variability and complicated matrices of waste samples in the solid and paste forms, detection limits for this method may vary widely among samples. The method works best for compounds with boiling points of less than 125° C. The sensitivity of this method will depend on the equilibria of the various compounds between the vapor and dissolved phases.

1.2 This method is recommended for use by, or under the supervision of, analysts experienced in the operation of gas chromatographs and in the interpretation of chromatograms.

2.0 Summary of Method

The sample is collected in sealed glass containers and allowed to equilibrate at 90° C. A sample of the headspace gas is withdrawn with a gas-tight syringe for analysis by the appropriate gas chromatographic method (8010, 8015, 8020, or 8030).

3.0 Interferences

Refer to Methods 8010, 8015, 8020, or 8030.

4.0 Apparatus and Materials

4.1 Gas-tight syringe: 5-cc with chromatographic needles.

4.2 Headspace standard solutions: Prepare according to procedures in 8010, 8015, 8020, or 8030 at 50 ng/μl and 250 ng/μl concentrations.

4.3 Vials: 125-ml Hypo-Vials (Pierce Chemical Co., #12995, or equivalent).

4.4 Septa: Tuf-Bond (Pierce #12720, or equivalent).

4.5 Seals: Aluminum (Pierce #13214, or equivalent).

2 / SAMPLE INTRODUCTION TECHNIQUES

4.6 Crimper: Hand (Pierce #13212, or equivalent).

5.0 Reagents

5.1 Refer to Methods 8010, 8015, 8020, or 8030.

6.0 Sample Collection, Preservation, and Handling

6.1 Refer to Methods 8010, 8015, 8020, or 8030.

7.0 Procedure

7.1 Place 10.0 g each of the well-mixed waste sample into three separate 125-ml septum seal vials.

7.2 Dose one sample vial through the septum with 200 μ l of a 50-ng/ μ l standard methanolic solution. Label this "1-ppm spike."

7.3 Dose a separate (empty) 125-ml septum seal vial with 200 μ l of the 50 ng/ μ l standard methanol solution. Label this "1-ppm standard."

7.4 Place the sample, 1-ppm-spike, and 1-ppm-standard vials into a 90° C water bath for 1 hr.

7.5 While maintaining the vials at 90° C, withdraw 2 ml of the headspace gas with a gas-tight syringe and analyze by injecting into a GC, operating under the appropriate conditions for the GC measurement method being used (8010, 8015, 8020, or 8030).

7.6 Analyze the 1-ppm standard and adjust instrument sensitivity to give a minimum response of at least 2x the background. Record retention times (RT) and peak areas of compounds of interest.

7.7 Analyze the 1-ppm spiked sample in the same manner. Record RT's and peak areas.

7.8 Analyze the undosed sample as in Section 7.7.

8.0 Quality Control

8.1 Before processing any samples, the analyst should demonstrate through the analysis of a distilled water method blank that all glassware and reagents are interference-free. Each time a set of samples is extracted or there is a change in reagents, a method blank should be processed as a

safeguard against chronic laboratory contamination. The blank samples should be carried through all stages of the sample preparation and measurement.

8.2 Standard quality assurance practices should be used with this method. Field replicates should be collected to validate the precision of the sampling technique. Laboratory replicates should be analyzed to validate the precision of the analysis. Fortified samples should be carried through all stages of sample preparation and measurement; they should be analyzed to validate the sensitivity and accuracy of the analysis. If the fortified samples do not indicate sufficient sensitivity to detect less than or equal to 1 $\mu\text{g/g}$ of sample, then the sensitivity of the instrument should be increased. Where doubt exists over the identification of a peak on the chromatograph, confirmatory techniques such as mass spectroscopy should be used.

9.0 References

1. Hachenberg, H. and Schmidt, A. 1979. Gas chromatographic headspace analysis. Philadelphia: Hayden & Sons Inc.
2. Friant, S.L. and Suffet, I.H. 1979. Interactive effects of temperature, salt concentration, and pH on headspace analysis for isolating volatile trace organics in aqueous environmental samples. Anal. Chem. 51:2167-2172.

METHOD 8010

HALOGENATED VOLATILE ORGANICS

1.0 Scope and Application

1.1 Method 8010 is used to determine the concentration of various halogenated volatile organic compounds in liquid and solid matrices. Specifically, Method 8010 may be used to detect the following substances:

Benzyl chloride	1,3-Dichlorobenzene
Bis (2-chloroethoxy)methane	1,4-Dichlorobenzene
Bis (2-chloroisopropyl)ether	Dichlorodifluoromethane
Bromobenzene	1,1-Dichloroethane
Bromodichloromethane	1,2-Dichloroethane
Bromoform	1,1-Dichloroethylene (Vinylidene chloride)
Bromomethane	trans-1,2-Dichloroethylene
Carbon tetrachloride	Dichloromethane
Chloroacetaldehyde	1,2-Dichloropropane
Chlorobenzene	1,3-Dichloropropylene
Chloroethane	1,1,2,2-Tetrachloroethane
Chloroform	1,1,1,2-Tetrachloroethane
1-Chlorohexane	Tetrachloroethylene
2-Chloroethyl vinyl ether	1,1,1-Trichloroethane
Chloromethane	1,1,2-Trichloroethane
Chlorotoluene	Trichloroethylene
Dibromochloromethane	Trichlorofluoromethane
Dibromomethane	Trichloropropane
1,2-Dichlorobenzene	Vinyl chloride

1.2 This method is recommended for use by, or under the supervision of, analysts experienced in the operation of gas chromatographs and in the interpretation of chromatograms.

2.0 Summary of Method

2.1 Method 8010 provides chromatographic conditions for the detection of halogenated volatile organic compounds. Waste samples can be analyzed using direct injection, the headspace method (Method 5020) or the purge-and-trap method (Method 5030). A temperature program is used in the gas chromatograph to separate the organic compounds. Detection is achieved by a halide-specific detector (HSD).

2.2 If interferences are encountered, the method provides an optional chromatographic column that may be helpful in resolving the compounds of interest from the interferences.

2 / ORGANIC ANALYTICAL METHODS - GC

3.0 Interferences

3.1 Samples can be contaminated by diffusion of volatile organics (particularly chlorofluorocarbons and methylene chloride) through the sample container septum during shipment and storage. A field sample blank prepared from reagent water and carried through sampling and subsequent storage and handling can serve as a check on such contamination.

3.2 Contamination by carryover can occur whenever high-level and low-level samples are sequentially analyzed. To reduce carryover, the sample syringe or purging device must be rinsed out between samples with reagent water. Whenever an unusually concentrated sample is encountered, it should be followed by an analysis of reagent water to check for cross contamination. For samples containing large amounts of water-soluble materials, suspended solids, high boiling compounds or high organohalide levels, it may be necessary to wash out the syringe or purging device with a detergent solution, rinse it with distilled water, and then dry it in a 105° C oven between analyses.

3.3 Before processing any samples, the analyst should demonstrate daily through the analysis of an organic-free water or solvent blank that the entire analytical system is interference-free. Standard quality assurance practices should be used with this method. Field replicates should be collected to validate the precision of the sampling technique. Laboratory replicates should be analyzed to validate the precision of the analysis. Fortified samples should be analyzed to validate the accuracy of the analyses. Where doubt exists over the identification of a peak on the gas chromatogram, confirmatory techniques such as mass spectroscopy should be used.

3.4 The analyst should maintain constant surveillance of both the performance of the analytical system and the effectiveness of the method in dealing with each sample matrix. This is done by spiking each sample with known amounts of the compounds that the waste is being analyzed for. Using these spiked samples, the sensitivity of the instrument is then readjusted so that 1 µg/g of sample can be readily detected.

4.0 Apparatus and Materials

4.1 Vial with cap: 40-ml capacity screw cap (Pierce #13075 or equivalent). Detergent wash, rinse with tap and distilled deionized water, and dry at 105° C before use.

4.2 Septum: Teflon-faced silicone (Pierce #12722 or equivalent). Detergent wash, rinse with tap and distilled deionized water, and dry at 105° C for 30 min before use. NOTE: Do not heat the TFE seals for extended periods of time (i.e., more than 1 hr) because the silicone layer slowly degrades at 105° C.

4.3 Sample introduction apparatus for Methods 5020 and 5030.

4.4 Gas chromatograph: Analytical system complete with programmable gas chromatograph suitable for on-column injection or purge-and-trap sample introduction and all required accessories, including HSD or FID, column supplies, recorder, and gases. A data system for measuring peak area is recommended.

4.5 GC columns:

Column 1: 8-ft x 0.1-in. I.D. stainless steel or glass column packed with 1% SP-1000 on Carbopac B 60/80 mesh.

Column 2: 6-ft x 0.1-in. I.D. stainless steel or glass column packed with n-octane on Porasil-L 100/120 mesh.

4.6 Detector: Electrolytic conductivity (HSD).

4.7 Syringes: 5-ml glass hypodermic with Luerlok top (2 each).

4.8 Microsyringes: 10, 25, 100 μ l.

4.9 Two-way syringe valve with Luer ends (3 each).

4.10 Syringe: 5 ml, gas-tight with shutoff valve.

4.11 Bottle: 15-ml screw-cap, with teflon cap liner.

5.0 Reagents

5.1 Activated carbon: Filtrasorb 200 (Calgon Corp.) or equivalent.

5.2 Organic-free water: Generated by passing tap water through a carbon filter bed containing about 1 lb of activated carbon. A water purification system (Millipore Super-Q or equivalent) may be used to generate organic-free deionized water. Organic-free water may also be prepared by boiling water for 15 min. Subsequently, while maintaining the temperature at 90° C, bubble a contaminant-free inert gas through the water for 1 hr.

5.3 Stock standard solutions: Stock standard solutions can be prepared from pure standard materials or purchased as certified solutions. Prepare stock standard solutions in methyl alcohol using assayed liquids or gas cylinders as appropriate. Because of the toxicity of many of the compounds being analyzed, primary dilutions of these materials should be prepared in a hood. A NIOSH/MESA-approved toxic gas respirator should be used when the analyst handles high concentrations of such materials.

5.3.1 Place about 9 ml of methyl alcohol into a 10-ml ground-glass-stoppered volumetric flask. Allow to stand about 10 min or until all alcohol-wetted surfaces have dried. Weigh the flask to the nearest 0.1 mg.

5.3.2 Add the assayed reference material

5.3.2.1 Liquids: Using a 100- μ l syringe, immediately add an amount of assayed reference material to the flask, then reweigh. Be sure that the reference material falls directly into the alcohol without contacting the neck of the flask.

5.3.2.2 Gases: To prepare standards from any of the organic compounds that boil below 30° C, fill a 5-ml valved gas-tight syringe with the reference standard to the 5-ml mark. Lower the needle to 5 mm above the methyl alcohol meniscus. Slowly inject the reference standard above the surface of the liquid (the heavy gas will rapidly dissolve into the methyl alcohol).

5.3.3 Reweigh, dilute to volume, stopper, then mix by inverting the flask several times. Calculate the concentration in μ g/ μ l from the net gain in weight. When compound purity is certified at 96% or greater, the weight can be used without correction to calculate the concentration of the stock standard. Commercially prepared stock standards can be used at any concentration if they are certified by the manufacturer or by an independent source.

5.3.4 Transfer the stock standard solution into a Teflon-sealed screw-cap bottle. Store at 4° C and protect from light.

5.3.5 Prepare fresh standards weekly for those compounds whose boiling point is less than or equal to 30° C and for the 2-chloroethyl-vinyl ether. All other standards must be replaced after 1 month, or sooner if comparison with check standards indicate a problem.

5.4 Secondary dilution standards: Using stock standard solutions, prepare secondary dilution standards in methyl alcohol that contain the compounds of interest, either singly or mixed together. The secondary dilution standards should be prepared at concentrations such that the prepared aqueous calibration standards will completely bracket the working range of the analytical system. Secondary dilution standards must be stored with zero headspace and should be checked frequently for signs of degradation or evaporation, especially just prior to preparing calibration standards from them. Quality control check standards, available from the EPA's Environmental Monitoring and Support Laboratory in Cincinnati, can be used to determine the accuracy of calibration standards.

5.5 Calibration standards: In order to prepare accurate aqueous standard solutions, the following precautions must be observed.

5.5.1 Do not inject more than 20 μ l of alcoholic standards into 100 ml of reagent water.

5.5.2 Use a 25- μ l Hamilton 702N microsyringe or equivalent. (Variations in needle geometry will adversely affect the ability to deliver reproducible volumes of methanolic standards into water.)

5.5.3 Rapidly inject the alcoholic standard into the filled volumetric flask. Remove the needle as fast as possible after injection.

5.5.4 Mix aqueous standards by inverting the flask three times only.

5.5.5 Discard the contents contained in the neck of the flask. Fill the sample syringe from the standard solution contained in the expanded area of the flask.

5.5.6 Never use pipets to dilute or transfer samples or aqueous standards.

5.5.7 Aqueous standards are not stable and should be discarded after 1 hr unless preserved, stored, and sealed according to 6.1 and 6.3.

6.0 Sample Collection, Preservation, and Handling

6.1 Grab samples must be collected in glass containers (see Apparatus, Sections 4.1 and 4.2) having a total volume of at least 25 ml. Fill the sample bottles in such a manner that no air bubbles pass through the sample as the bottle is being filled. Seal the bottle so that no air bubbles are entrapped in it. Solid and semisolid samples are to be taken in the same way. Assure that no solid material interferes with sealing of the glass vial. Maintain the hermetic seal on the sample bottle until time of analysis.

6.2 Sample transfer implements: Implements are required to transfer portions of solid, semisolid, and liquid wastes from sample containers to laboratory glassware. The transfer must be accomplished rapidly to avoid loss of volatile components during the transfer step. Liquids may be transferred using a hypodermic syringe with a wide-bore needle attached or with no needle. Solids may be transferred using a conventional laboratory spatula, spoon, or coring device. A coring device that is suitable for handling some samples can be made by using a glass tubing saw to cut away the enclosed end of the barrel of a glass hypodermic syringe.

6 / ORGANIC ANALYTICAL METHODS - GC

6.3 The samples must be iced or refrigerated from the time of collection until extraction. If the sample may contain free or combined chlorine, add sodium thiosulfate preservative (10 mg/40 ml will suffice for up to 5 ppm Cl_2) to the empty sample bottles just prior to shipping to the sampling site, fill with sample just to overflowing, seal the bottle, and shake vigorously for 1 min.

6.4 All samples must be analyzed within 14 days of collection.

7.0 Procedures

7.1 The recommended gas chromatographic columns and operating conditions for the instrument are:

Column 1: Set helium gas flow at 40 ml/min flow rate. Set column temperature at 45° C for 3 min, then program an 8° C/min temperature rise to 220° C and hold for 15 min.

Column 2: Set helium gas flow at 40 ml/min flow rate. Set column temperature at 50° C for 3 min, then program a 6° C/min temperature rise to 170° C and hold for 4 min.

7.2 Calibration

7.2.1 By injecting secondary standards, adjust the sensitivity of the analytical system for each compound being analyzed so as to detect quantities of less than or equal to 1 µg. Calibrate the chromatographic system using either the external standard technique (Section 7.2.2) or the internal standard technique (Section 7.2.3).

7.2.2 External standard calibration procedure

7.2.2.1 Prepare calibration standards at a minimum of three concentration levels for each parameter by carefully adding 20.0 µl of one or more secondary dilution standards to 100, 500, or 1,000 ml of reagent water or the matrix under study. A 25-µl syringe should be used for this operation. One of the external standards should be at a concentration near, but above, the method detection limit and the other concentrations should correspond to the expected range of concentrations found in real samples or should define the working range of the detector. These aqueous standards must be prepared fresh daily.

7.2.2.2 Analyze each calibration standard according to the procedure being used (direct aqueous injection, headspace, or purge-and-trap) and tabulate peak height or area responses against the concentration in the standard. The results can be used to prepare a calibration curve for each compound. Alternatively, if the ratio of response to concentration (calibration factor) is a constant over the working range (less than 10% relative standard deviation), linearity through the origin can be assumed and the average ratio or calibration factor can be used in place of a calibration curve.

7.2.2.3 The working calibration curve or calibration factor must be verified on each working day by the measurement of one or more calibration standards. If the response for any parameter varies from the predicted response by more than $\pm 10\%$, the test must be repeated using a fresh calibration standard. Alternatively, a new calibration curve or calibration factor must be prepared for that compound.

7.2.3 Internal standard calibration procedure. To use this approach, the analyst must select one or more internal standards that are similar in analytical behavior to the compounds of interest. The analyst must further demonstrate that the measurement of the internal standards is not affected by method or matrix interferences. Because of these limitations, no internal standard that would be applicable to all samples can be suggested. The compounds recommended for use as surrogate spikes have been used successfully as internal standards, because of their generally unique retention times.

7.2.3.1 Prepare calibration standards at a minimum of three concentration levels for each parameter of interest as described in Section 7.2.2.1.

7.2.3.2 Prepare a spiking solution containing each of the internal standards using the procedures described in Sections 5.3 and 5.4.

7.2.3.3 Analyze each calibration standard according to appropriate methods (direct injection, 5020, 5030), adding the internal standard spiking solution directly to an aliquot of the sample or, in the case of purge-and-trap, to the syringe. Tabulate peak height or area responses against concentration for each compound and internal standard, and calculate response factors (RF) for each compound as follows:

$$RF = (A_s C_{is}) / (A_{is} C_s)$$

8 / ORGANIC ANALYTICAL METHODS - GC

where:

A_s = Response for the parameter to be measured

A_{is} = Response for the internal standard

C_{is} = Concentration of the internal standard

C_s = Concentration of the parameter to be measured

If the RF value over the working range is a constant (less than 10% relative standard deviation), the RF can be assumed to be invariant and the average RF can be used for calculations. Alternatively, the results can be used to plot a calibration curve of response ratios, A_s/A_{is} against RF.

7.2.3.4 The working calibration curve or RF must be verified on each working day by measuring one or more calibration standards. If the response for any parameter varies from the predicted response by more than +10%, either the test must be repeated using a fresh calibration standard, or a new calibration curve must be prepared for that compound.

7.3 Gas chromatographic analysis

7.3.1 Introduce volatile compounds to the gas chromatograph using direct injection, headspace (Method 5020), or purge-and-trap (Method 5030).

7.3.2 Table 1 summarizes the estimated retention times for a number of organic compounds analyzable using this method. An example of the separation achieved by Column 1 is shown in Figure 1.

7.3.3 Calibrate the system immediately prior to conducting any analysis and recheck for each type of waste. Calibration should be done no less frequently than at the beginning and end of each analysis session.

8.0 Quality Control

8.1 Before processing any samples, the analyst should demonstrate through the analysis of a distilled water method blank that all glassware and reagents are interference-free. Each time a set of samples is extracted or there is a change in reagents, a method blank should be processed as a safeguard against chronic laboratory contamination. The blank samples should be carried through all stages of the sample preparation and measurement.

TABLE 1. ESTIMATED RETENTION TIMES FOR SOME HALOGENATED VOLATILE ORGANICS

Compound	Retention time (min)	
	Col. 1	Col. 2
Bis(2-chloroethoxy)methane		
Bis(2-chloroisopropyl)ether		
Bromobenzene		
Bromodichloromethane		
Bromoform		
Carbon tetrachloride	13.0	14.4
Chloroacetaldehyde		
Chlorobenzene	24.2	18.8
Chloroethane		
Chloroform	10.7	12.1
1-Chlorohexane		
2-Chloroethyl vinyl ether		
Chloromethane	1.50	5.28
Chlorotoluene		
Dibromochloromethane		
Dibromomethane		
1,2-Dichlorobenzene	34.9	12.6
1,3-Dichlorobenzene	34.0	22.4
1,4-Dichlorobenzene	35.4	15.4
Dichlorodifluoromethane		
1,1-Dichloroethane	9.30	12.6
1,2-Dichloroethane	11.4	15.4
1,1-Dichloroethylene	8.0	
trans-1,2-Dichloroethylene		
Dichloromethane	6.5	
1,2-Dichloropropane		
1,3-Dichloropropylene		
1,1,2,2-Tetrachloroethane	21.6	
1,1,1,2-Tetrachloroethane		
Tetrachloroethylene	21.7	15.0
1,1,1-Trichloroethane	12.6	13.1
1,1,2-Trichloroethane	16.5	18.7
Trichloroethylene	15.8	13.1
Trichlorofluoromethane	7.18	
Trichloropropane		
Vinyl chloride	2.67	5.28

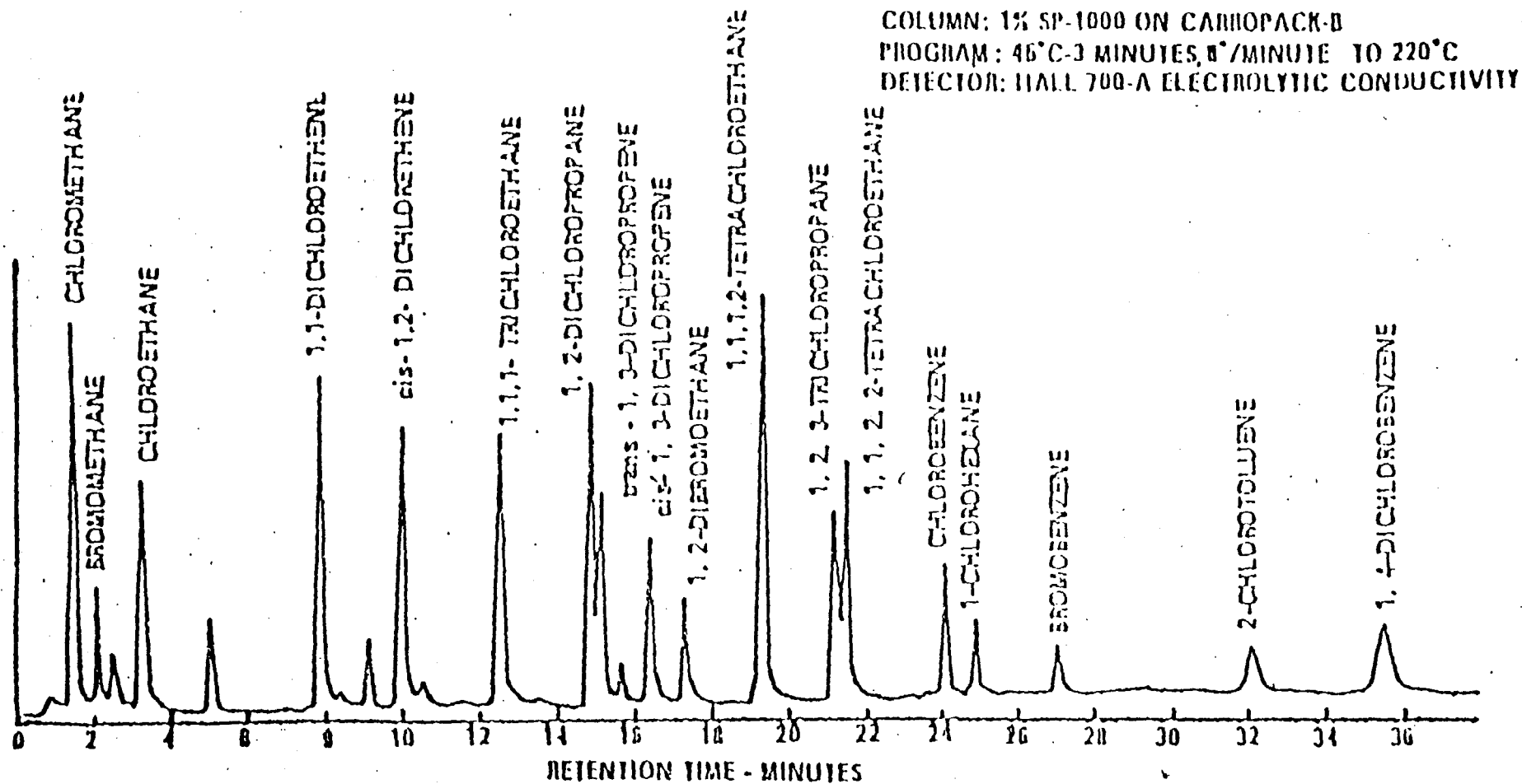


Figure 8.01-1
GAS CHROMATOGRAM OF VOLATILE ORGANICS

8.2 Standard quality assurance practices should be used with this method. Field replicates should be collected to validate the precision of the sampling technique. Laboratory replicates should be analyzed to validate the precision of the analysis. Fortified samples should be carried through all stages of sample preparation and measurement; they should be analyzed to validate the sensitivity and accuracy of the analysis. If the fortified samples do not indicate sufficient sensitivity to detect less than or equal to 1 µg/g of sample, then the sensitivity of the instrument should be increased or the extract subjected to additional cleanup. Where doubt exists over the identification of a peak on the chromatograph, confirmatory techniques such as mass spectroscopy should be used.

9.0 References

1. Bellar, T.A., and J.J. Lichtenberg. 1974. J. Amer. Water Works Assoc. 66(12):739-744.
2. Bellar, T.A., and J.J. Lichtenberg. 1979. Semi-automated headspace analysis of drinking waters and industrial waters for purgeable volatile organic compounds. In: Van Hall (ed.), Measurement of organic pollutants in water and wastewater. ASTM STP 686, pp. 108-129.
3. Development and application of test procedures for specific organic toxic substances in wastewaters. Category 11 - Purgeables and Category 12 - Acrolein, Acrylonitrile, and Dichlorodifluoromethane. Report for EPA Contract 68-03-2635 (in preparation).

METHOD 8015

NONHALOGENATED VOLATILE ORGANICS

1.0 Scope and Application

1.1 Method 8015 is used to determine the concentration of nonhalogenated volatile organic compounds in liquid and solid matrices. Specifically, Method 8015 is used to detect the following substances:

- Acrylamide
- Carbon disulfide
- Diethyl ether
- Methyl ethyl ketone (MEK)
- Methyl isobutyl ketone (MIBK)
- Paraldehyde (trimer of acetaldehyde)

1.2 This method is recommended for use by, or under the supervision of, analysts experienced in the operation of gas chromatographs and in the interpretation of chromatograms.

0 Summary of Method

2.1 Method 8015 provides chromatographic conditions for the detection of certain nonhalogenated volatile organic compounds. Waste samples can be analyzed using direct injection, the headspace method (Method 5020) or the purge-and-trap method (Method 5030). A temperature program is used in the gas chromatograph to separate the organic compounds. Detection is achieved by a flame ionization detector (FID).

2.2 If interferences are encountered, the method provides an optional gas chromatographic column that may be helpful in resolving the compounds of interest from the interferences.

3.0 Interferences

3.1 Samples can be contaminated by diffusion of volatile organics through the sample container septum during shipment and storage. A field sample blank prepared from reagent water and carried through sampling and subsequent storage and handling can serve as a check on such contamination.

3.2 Contamination by carryover can occur whenever high-level and low-level samples are sequentially analyzed. To reduce carryover, the sample syringe or purging device must be rinsed out between samples with reagent water. Whenever an unusually concentrated sample is encountered, it should be followed by an analysis of reagent water to check for cross contamination. For samples containing large amounts of water-soluble materials, suspended

2 / ORGANIC ANALYTICAL METHODS - GC

solids, high boiling compounds or high organohalide levels, it may be necessary to wash out the syringe or purging device with a detergent solution, rinse it with distilled water, and then dry it in a 105° C oven between analyses.

3.3 Before processing any samples, the analyst should demonstrate daily through the analysis of an organic-free water or solvent blank that the entire analytical system is interference-free. Standard quality assurance practices should be used with this method. Field replicates should be collected to validate the precision of the sampling technique. Laboratory replicates should be analyzed to validate the precision of the analysis. Fortified samples should be analyzed to validate the accuracy of the analyses. Where doubt exists over the identification of a peak on the gas chromatogram, confirmatory techniques such as mass spectroscopy should be used.

3.4 The analyst should maintain constant surveillance of both the performance of the analytical system and the effectiveness of the method in dealing with each sample matrix. This is done by spiking each sample with known amounts of the compounds that the waste is being analyzed for. Using these spiked samples, the sensitivity of the instrument is then readjusted so that 1 µg/g of sample can be readily detected.

4.0 Apparatus and Materials

4.1 Vial with cap: 40-ml capacity screw cap vial (Pierce #13075 or equivalent). Detergent wash, rinse with tap and distilled deionized water, and dry at 105° C before use.

4.2 Septum: Teflon-faced silicone (Pierce #12722 or equivalent). Detergent wash, rinse with tap and distilled deionized water, and dry at 105° C for 30 min before use. NOTE: Do not heat the TFE seals for extended periods of time (i.e., more than 1 hr) because the silicone layer slowly degrades at 105° C.

4.3 Sample introduction apparatus for Methods 5020 and 5030.

4.4 Gas chromatograph: Analytical system complete with programmable gas chromatograph suitable for on-column injection or purge-and-trap sample introduction and all required accessories, including FID, column supplies, recorder, and gases. A data system for measuring peak area is recommended.

4.5 GC columns:

Column 1: 8-ft x 0.1-in. I.D. stainless steel or glass column packed with 1% SP-1000 on Carbopac B 60/80 mesh.

Column 2: 6-ft x 0.1-in. I.D. stainless steel or glass column packed with n-octane on Porasil-L 100/120 mesh.

- 4.6 Detector: Flame ionization (FID).
- 4.7 Syringes: 5-ml glass hypodermic with Luerlok top (2 each).
- 4.8 Microsyringes: 10, 25, 100 μ l.
- 4.9 Two-way syringe valve with Luer ends (3 each).
- 4.10 Syringe: 5-ml, gas-tight with shutoff valve.
- 4.11 Bottle: 15-ml screw-cap, with teflon cap liner.

5.0 Reagents

5.1 Activated carbon: Filtrasorb 200 (Calgon Corp.) or equivalent.

5.2 Organic-free water: Generated by passing tap water through a carbon filter bed containing about 1 lb of activated carbon. A water purification system (Millipore Super-Q or equivalent) may be used to generate organic-free deionized water. Organic-free water may also be prepared by boiling water for 15 min. Subsequently, while maintaining the temperature at 90° C, bubble a contaminant-free inert gas through the water for 1 hr.

5.3 Stock standard solutions: Stock standard solutions can be prepared from pure standard materials or purchased as certified solutions. Prepare stock standard solutions in methyl alcohol using assayed liquids. Because of the toxicity of many of the compounds being analyzed, primary dilutions of these materials should be prepared in a hood. A NIOSH/MESA-approved toxic gas respirator should be used when the analyst handles high concentrations of such materials.

5.3.1 Place about 9 ml of methyl alcohol into a 10-ml ground-glass-stoppered volumetric flask. Allow to stand about 10 min or until all alcohol-wetted surfaces have dried. Weigh the flask to the nearest 0.1 mg.

5.3.2 Using a 100- μ l syringe, immediately add an amount of assayed reference material to the flask, then reweigh. Be sure that the reference material falls directly into the methyl alcohol without contacting the neck of the flask.

5.3.3 Transfer the stock standard solution into a Teflon-sealed screw-cap bottle. Store at 4° C and protect from light.

5.3.4 Prepare fresh standards weekly for those compounds whose boiling point is less than or equal to 30° C. All other standards must be replaced after 1 month, or sooner if comparison with check standards indicate a problem.

4 / ORGANIC ANALYTICAL METHODS - GC

5.4 Secondary dilution standards: Using stock standard solutions, prepare secondary dilution standards in methyl alcohol that contain the compounds of interest, either singly or mixed together. The secondary dilution standards should be prepared at concentrations such that the prepared aqueous calibration standards will completely bracket the working range of the analytical system. Secondary dilution standards must be stored with zero headspace and should be checked frequently for signs of degradation or evaporation, especially just prior to preparing calibration standards from them. Quality control check standards, available from the EPA's Environmental Monitoring and Support Laboratory in Cincinnati, can be used to determine the accuracy of calibration standards.

5.5 Calibration standards: In order to prepare accurate aqueous standard solutions, the following precautions must be observed.

5.5.1 Do not inject more than 20 μ l of methanolic standards into 100 ml of reagent water.

5.5.2 Use a 25- μ l Hamilton 702N microliter syringe or equivalent. (Variations in needle geometry will adversely affect the ability to deliver reproducible volumes of methanolic standards into water.)

5.5.3 Rapidly inject the methanolic standard into the filled volumetric flask below the neck. Remove the needle as fast as possible after injection.

5.5.4 Mix aqueous standards by inverting the flask three times only.

5.5.5 Discard the contents contained in the neck of the flask. Fill the sample syringe from the standard solution contained in the expanded area of the flask.

5.5.6 Never use pipets to dilute or transfer samples or aqueous standards.

5.5.7 Aqueous standards are not stable and should be discarded unless stored and sealed as stipulated in Sections 6.1 and 6.3.

6.0 Sample Collection, Preservation, and Handling

6.1 Grab samples must be collected in glass containers (see Apparatus, Sections 4.1 and 4.2) having a total volume of at least 25 ml. Fill the sample bottles in such a manner that no air bubbles pass through the sample as the bottle is being filled. Seal the bottle so that no air bubbles are entrapped in it. Solid and semisolid samples are to be taken in the same way. Assure that no solid material interferes with sealing of the glass vial. Maintain the hermetic seal on the sample bottle until time of analysis.

6.2 Sample transfer implements: Implements are required to transfer portions of solid, semisolid, and liquid wastes from sample containers to laboratory glassware. The transfer must be accomplished rapidly to avoid loss of volatile components during the transfer step. Liquids may be transferred using a hypodermic syringe with a wide-bore needle attached or with no needle. Solids may be transferred using a conventional laboratory spatula, spoon, or coring device. A coring device that is suitable for handling some samples can be made by using a glass tubing saw to cut away the enclosed end of the barrel of a glass hypodermic syringe.

6.3 The samples must be iced or refrigerated from the time of collection until extraction. If the sample contains free or combined chlorine, add sodium thiosulfate preservative (10 mg/40 ml will suffice for up to 5 ppm Cl_2) to the empty sample bottles just prior to shipping to the sampling site, fill with sample just to overflowing, seal the bottle, and shake vigorously for 1 min.

6.4 All samples must be analyzed within 14 days of collection.

7.0 Procedures

7.1 The recommended gas chromatographic column and operating conditions for the instrument are:

Column 1: Set helium gas flow at 40 ml/min flow rate. Set column temperature at 45° C for 3 min, then program an 8° C/min temperature rise to 220° C and hold for 15 min.

Column 2: Set helium gas flow at 40 ml/min flow rate. Set column temperature at 50° C for 3 min, then program a 6° C/min temperature rise to 170° C and hold for 4 min.

7.2 Calibration

7.2.1 By injecting secondary standards, adjust the sensitivity of the analytical system for each compound being analyzed so as to detect quantities of less than or equal to 1 µg. Calibrate the chromatographic system using either the external standard technique (Section 7.2.2) or the internal standard technique (Section 7.2.3).

7.2.2 External standard calibration procedure

7.2.2.1 Prepare calibration standards at a minimum of three concentration levels for each parameter by carefully adding 20.0 µl of one or more secondary dilution standards to 100, 500, or 1,000 ml of reagent water or the matrix under study. A 25-µl syringe should be used for this operation. One of the external standards should be at a concentration near, but above, the method detection

limit and the other concentrations should correspond to the expected range of concentrations found in real samples or should define the working range of the detector. These aqueous standards must be prepared fresh daily.

7.2.2.2 Analyze each calibration standard according to the procedure being used (direct aqueous injection, headspace, or purge-and-trap) and tabulate peak height or area responses against the concentration in the standard. The results can be used to prepare a calibration curve for each compound. Alternatively, if the ratio of response to concentration (calibration factor) is a constant over the working range (less than 10% relative standard deviation), linearity through the origin can be assumed and the average ratio or calibration factor can be used in place of a calibration curve.

7.2.2.3 The working calibration curve or calibration factor must be verified on each working day by the measurement of one or more calibration standards. If the response for any parameter varies from the predicted response by more than $\pm 10\%$, the test must be repeated using a fresh calibration standard. Alternatively, a new calibration curve or calibration factor must be prepared for that compound.

7.2.3 Internal standard calibration procedure. To use this approach, the analyst must select one or more internal standards that are similar in analytical behavior to the compounds of interest. The analyst must further demonstrate that the measurement of the internal standards is not affected by method or matrix interferences. Because of these limitations, no internal standard that would be applicable to all samples can be suggested.

7.2.3.1 Prepare calibration standards at a minimum of three concentration levels for each parameter of interest as described in Section 7.2.2.1.

7.2.3.2 Prepare a spiking solution containing each of the internal standards using the procedures described in Sections 5.3 and 5.4.

7.2.3.3 Analyze each calibration standard according to appropriate methods (direct injection, 5020, 5030), adding the internal standard spiking solution directly to an aliquot of the sample or, in the case of purge-and-trap, to the syringe. Tabulate peak height or area responses against concentration for each compound and internal standard, and calculate response factors (RF) for each compound as follows:

$$RF = (A_s C_{is}) / (A_{is} C_s)$$

where:

A_s = Response for the parameter to be measured

A_{is} = Response for the internal standard

C_{is} = Concentration of the internal standard

C_s = Concentration of the parameter to be measured

If the RF value over the working range is a constant (less than 10% relative standard deviation), the RF can be assumed to be invariant and the average RF can be used for calculations. Alternatively, the results can be used to plot a calibration curve of response ratios, A_s/A_{is} against RF.

7.2.3.4 The working calibration curve or RF must be verified on each working day by measuring one or more calibration standards. If the response for any parameter varies from the predicted response by more than $\pm 10\%$, either the test must be repeated using a fresh calibration standard, or a new calibration curve must be prepared for that compound.

7.3 Gas chromatographic analysis

7.3.1 Introduce volatile compounds to the gas chromatograph using direct injection, headspace (Method 5020), or purge-and-trap (Method 5030).

7.3.2 Calibrate the system immediately prior to conducting any analysis and recheck for each type of waste. Calibration should be done no less frequently than at the beginning and end of each analysis session.

8.0 Quality Control

8.1 Before processing any samples, the analyst should demonstrate through the analysis of a distilled water method blank that all glassware and reagents are interference-free. Each time a set of samples is extracted or there is a change in reagents, a method blank should be processed as a safeguard against chronic laboratory contamination. The blank samples should be carried through all stages of the sample preparation and measurement.

8.2 Standard quality assurance practices should be used with this method. Field replicates should be collected to validate the precision of sampling technique. Laboratory replicates should be analyzed to validate precision of the analysis. Fortified samples should be carried through

8 / ORGANIC ANALYTICAL METHODS - GC

all stages of sample preparation and measurement; they should be analyzed to validate the sensitivity and accuracy of the analysis. If the fortified samples do not indicate sufficient sensitivity to detect less than or equal to 1 µg/g of sample, then the sensitivity of the instrument should be increased. Where doubt exists over the identification of a peak on the chromatograph, confirmatory techniques such as mass spectroscopy should be used.

9.0 References

1. Bellar, T.A., and J.J. Lichtenberg. 1974. J. Amer. Water Works Assoc. 66(12):739-744.
2. Bellar, T.A., and J.J. Lichtenberg. 1979. Semi-automated headspace analysis of drinking waters and industrial waters for purgeable volatile organic compounds. In: Van Hall (ed.), Measurement of organic pollutants in water and wastewater. ASTM STP 686, pp. 108-129.
3. Development and application of test procedures for specific organic toxic substances in wastewaters. Category 11 - Purgeables and Category 12 - Acrolein, Acrylonitrile, and Dichlorodifluoromethane. Report for EPA Contract 68-03-2635 (in preparation).

METHOD 8020

AROMATIC VOLATILE ORGANICS

1.0 Scope and Application

1.1 Method 8020 is used to determine the concentration of various aromatic volatile organic compounds in liquid and solid matrices. Specifically, Method 8020 may be used to detect the following substances:

- Benzene
- Chlorobenzene
- 1,2-Dichlorobenzene
- 1,3-Dichlorobenzene
- 1,4-Dichlorobenzene
- Ethyl benzene
- Toluene
- Xylenes (Dimethyl benzenes)

1.2 This method is recommended for use by, or under the supervision of, analysts experienced in the operation of gas chromatographs and in the interpretation of chromatograms.

2.0 Summary of Method

2.1 Method 8020 provides chromatographic conditions for the detection of aromatic volatile organic compounds. Waste samples can be analyzed using direct injection, the headspace method (Method 5020) or the purge-and-trap method (Method 5030). A temperature program is used in the gas chromatograph to separate the organic compounds. Detection is achieved by a photo-ionization detector (PID).

2.2 If interferences are encountered, the method provides an optional gas chromatographic column that may be helpful in resolving the compounds of interest from the interferences.

3.0 Interferences

3.1 Samples can be contaminated by diffusion of volatile organics through the sample container septum during shipment and storage. A field sample blank prepared from reagent water and carried through sampling and subsequent storage and handling can serve as a check on such contamination.

3.2 Contamination by carryover can occur whenever high-level and low-level samples are sequentially analyzed. To reduce carryover, the sample line or purging device must be rinsed out between samples with reagent water. Whenever an unusually concentrated sample is encountered, it should

2 / ORGANIC ANALYTICAL METHODS - GC

be followed by an analysis of reagent water to check for cross contamination. For samples containing large amounts of water-soluble materials, suspended solids, high boiling compounds or high levels of volatile organics, it may be necessary to wash out the syringe or purging device with a detergent solution, rinse it with distilled water, and then dry it in a 105° C oven between analyses.

3.3 Before processing any samples, the analyst should demonstrate daily through the analysis of an organic-free water or solvent blank that the entire analytical system is interference-free. Standard quality assurance practices should be used with this method. Field replicates should be collected to validate the precision of the sampling technique. Laboratory replicates should be analyzed to validate the precision of the analysis. Fortified samples should be analyzed to validate the accuracy of the analyses. Where doubt exists over the identification of a peak on the gas chromatogram, confirmatory techniques such as mass spectroscopy should be used.

3.4 The analyst should maintain constant surveillance of both the performance of the analytical system and the effectiveness of the method in dealing with each sample matrix. This is done by spiking each sample with known amounts of the compounds that the waste is being analyzed for. Using these spiked samples, the sensitivity of the instrument is then readjusted so that 1 µg/g of sample can be readily detected.

4.0 Apparatus and Materials

4.1 Vial with cap: 40-ml capacity screw cap vial (Pierce #13075 or equivalent). Detergent wash, rinse with tap and distilled deionized water, and dry at 105° C before use.

4.2 Septum: Teflon-faced silicone (Pierce #12722 or equivalent). Detergent wash, rinse with tap and distilled deionized water, and dry at 105° C for 30 min before use. NOTE: Do not heat the TFE seals for extended periods of time (i.e., more than 1 hour) because the silicone layer slowly degrades at 105° C.

4.3 Sample introduction apparatus for Methods 5020 and 5030.

4.4 Gas chromatograph: Analytical system complete with programmable gas chromatograph suitable for on-column injection or purge-and-trap sample introduction and all required accessories, including PID, column supplies, recorder, and gases. A data system for measuring peak area is recommended.

4.5 GC columns:

Column 1: 6-ft x 0.082-in. I.D. #304 stainless steel or glass tubing. Packed with 5% SP-1200 + 1.75% Bentone 34 on 100/120 mesh Supelcoport.

Column 2: 6-ft x 0.1-in. I.D. #304 stainless steel or glass tubing packed with 5% 1,2,3-tris(2-cyanoethoxy)propane on 60/80 mesh Chromosorb W-AW.

- 4.6 Detector: Photoionization (PID).
- 4.7 Syringes: 5-ml glass hypodermic with Luerlok top (2 each).
- 4.8 Microsyringes: 10, 25, 100 μ l.
- 4.9 Two-way syringe valve with Luer ends (3 each).
- 4.10 Syringe: 5-ml, gas-tight with shutoff valve.
- 4.11 Bottle: 15-ml screw-cap, with teflon cap liner.

5.0 Reagents

5.1 Activated carbon: Filtrasorb 200 (Calgon Corp.) or equivalent.

5.2 Organic-free water: Generated by passing tap water through a carbon filter bed containing about 1 lb of activated carbon. A water purification system (Millipore Super-Q or equivalent) may be used to generate organic-free deionized water. Organic-free water may also be prepared by boiling water for 15 min.. Subsequently, while maintaining the temperature at 90° C, bubble a contaminant-free inert gas through the water for 1 hr.

5.3 Stock standard solutions: Stock standard solutions can be prepared from pure standard materials or purchased as certified solutions. Prepare stock standard solutions in methyl alcohol using assayed liquids. Because of the toxicity of many of the compounds being analyzed, primary dilutions of these materials should be prepared in a hood. A NIOSH/MESA-approved toxic gas respirator should be used when the analyst handles high concentrations of such materials.

5.3.1 Place about 9 ml of methyl alcohol into a 10-ml ground-glass-stoppered volumetric flask. Allow to stand about 10 min or until all alcohol-wetted surfaces have dried. Weigh the flask to the nearest 0.1 mg.

5.3.2 Using a 100- μ l syringe, immediately add an amount of assayed reference material to the flask, then reweigh. Be sure that the reference material falls directly into the alcohol without contacting the neck of the flask.

5.3.3 Transfer the stock standard solution into a Teflon-sealed screw-cap bottle. Store at 4° C and protect from light.

4 / ORGANIC ANALYTICAL METHODS - GC

5.3.4 Prepare fresh standards weekly for those compounds whose boiling point is less than or equal to 30° C. All other standards must be replaced after 1 month, or sooner if comparison with check standards indicates a problem.

5.4 Secondary dilution standards: Using stock standard solutions, prepare secondary dilution standards in methyl alcohol that contain the compounds of interest, either singly or mixed together. The secondary dilution standards should be prepared at concentrations such that the prepared aqueous calibration standards will completely bracket the working range of the analytical system. Secondary dilution standards must be stored with zero headspace and should be checked frequently for signs of degradation or evaporation, especially just prior to preparing calibration standards from them. Quality control check standards, available from the EPA's Environmental Monitoring and Support Laboratory in Cincinnati, can be used to determine the accuracy of calibration standards.

5.5 Calibration standards: In order to prepare accurate aqueous standard solutions, the following precautions must be observed.

5.5.1 Do not inject more than 20 µl of alcoholic standards into 100 ml of reagent water.

5.5.2 Use a 25-µl Hamilton 702N microsyringe or equivalent. (Variations in needle geometry will adversely affect the ability to deliver reproducible volumes of methanolic standards into water.)

5.5.3 Rapidly inject the alcoholic standard into the filled volumetric flask. Remove the needle as fast as possible after injection.

5.5.4 Mix aqueous standards by inverting the flask three times only.

5.5.5 Discard the contents contained in the neck of the flask. Fill the sample syringe from the standard solution contained in the expanded area of the flask.

5.5.6 Never use pipets to dilute or transfer samples or aqueous standards.

5.5.7 Aqueous standards are not stable and should be discarded after one hour unless preserved, stored, and sealed according to 6.1 and 6.3.

6.0 Sample Collection, Preservation, and Handling

6.1 Grab samples must be collected in glass containers (see Apparatus, Sections 4.1 and 4.2) having a total volume of at least 25 ml. Fill the

ample bottles in such a manner that no air bubbles pass through the sample as the bottle is being filled. Seal the bottle so that no air bubbles are entrapped in it. Solid and semisolid samples are to be taken in the same way. Assure that no solid material interferes with sealing of the glass vial. Maintain the hermetic seal on the sample bottle until time of analysis.

6.2 Sample transfer implements: Implements are required to transfer portions of solid, semisolid, and liquid wastes from sample containers to laboratory glassware. The transfer must be accomplished rapidly to avoid loss of volatile components during the transfer step. Liquids may be transferred using a hypodermic syringe with a wide-bore needle attached or with no needle. Solids may be transferred using a conventional laboratory spatula, spoon, or coring device. A coring device that is suitable for handling some samples can be made by using a glass tubing saw to cut away the enclosed end of the barrel of a glass hypodermic syringe.

6.3 The samples must be iced or refrigerated from the time of collection until extraction. If the sample may contain free or combined chlorine, add sodium thiosulfate preservative (10 mg/40 ml will suffice for up to 5 ppm Cl_2) to the empty sample bottles just prior to shipping to the sampling site, fill with sample just to overflowing, seal the bottle, and shake vigorously for 1 min.

6.4 Sample preservation: Non-sterile samples containing aromatic hydrocarbons cannot be stored longer than 4 hr because of biological degradation. Samples can be stabilized by adding free chlorine or by adjusting the pH to less than 2 with 1:1 hydrochloric acid. However, free chlorine will react with styrene and 2,3-benzofuran. Therefore, if styrene or 2,3-benzofuran are to be determined in chlorinated water, the sample must be dechlorinated with sodium thiosulfate at the rate of 1 mg/ppm of free chlorine. Once dechlorinated, the sample pH must be adjusted to less than 2 with 1:1 hydrochloric acid. If chemical preservation is employed, the preservative is also added to the blanks.

6.5 All samples must be analyzed within 14 days of collection.

7.0 Procedures

7.1 The recommended gas chromatographic columns and operating conditions for the instrument are:

Column 1: The carrier gas is helium at a flow rate of 30 ml/min. The temperature program sequences are as follows: for lower boiling compounds, operate at 50° C isothermal for 2 min, then program at 6° C/min to 90° C and hold until all compounds have eluted. For a higher boiling range of compounds, operate at 50° C isothermal for 2 min, then program at 3°/min to 110° C and hold until all compounds have eluted. Column 1 provides outstanding separations for a wide variety of aromatic hydrocarbons.

Column 1 should be used as the primary analytical column because of its unique ability to resolve para, meta, and ortho aromatic isomers.

Column 2: The carrier gas is helium at a flow rate of 30 ml/min. The temperature program sequence is as follows: 40° C isothermal for 2 min, then 2°/min to 100° C and hold until all compounds have eluted. Column 2, an extremely high polarity column, has been used for a number of years to resolve aromatic hydrocarbons from alkanes in complex samples. However, since the resolution between some of the aromatics is not as efficient as with Column 1, Column 2 should be used as a confirmatory column.

7.2 Calibration. Assemble necessary gas chromatographic apparatus and establish operating parameters equivalent to those indicated in Section 7.1.

7.2.1 By injecting secondary standards, adjust the sensitivity of the analytical system for each compound being analyzed so as to detect quantities of less than or equal to 1 µg. Calibrate the chromatographic system using either the external standard technique (Section 7.2.2) or the internal standard technique (Section 7.2.3).

7.2.2 External standard calibration procedure

7.2.2.1 Prepare calibration standards at a minimum of three concentration levels for each parameter by carefully adding 20.0 µl of one or more secondary dilution standards to 100, 500, or 1,000 ml of reagent water or the matrix under study. A 25-µl syringe should be used for this operation. One of the external standards should be at a concentration near, but above, the method detection limit and the other concentrations should correspond to the expected range of concentrations found in real samples or should define the working range of the detector. These aqueous standards must be prepared fresh daily.

7.2.2.2 Analyze each calibration standard according to the procedure being used (direct aqueous injection, headspace, or purge-and-trap) and tabulate peak height or area responses against the concentration in the standard. The results can be used to prepare a calibration curve for each compound. Alternatively, if the ratio of response to concentration (calibration factor) is a constant over the working range (less than 10% relative standard deviation), linearity through the origin can be assumed and the average ratio or calibration factor can be used in place of a calibration curve.

7.2.2.3 The working calibration curve or calibration factor must be verified on each working day by the measurement of one or more calibration standards. If the response for any parameter varies from the predicted response by more than ±10%, the test must

be repeated using a fresh calibration standard. Alternatively, a new calibration curve or calibration factor must be prepared for that compound.

7.2.3 Internal standard calibration procedure. To use this approach, the analyst must select one or more internal standards that are similar in analytical behavior to the compounds of interest. The analyst must further demonstrate that the measurement of the internal standards is not affected by method or matrix interferences. Because of these limitations, no internal standard that would be applicable to all samples can be suggested. The compounds recommended for use as surrogate spikes have been used successfully as internal standards, because of their generally unique retention times.

7.2.3.1 Prepare calibration standards at a minimum of three concentration levels for each parameter of interest as described in Section 7.2.2.1.

7.2.3.2 Prepare a spiking solution containing each of the internal standards using the procedures described in Sections 5.3 and 5.4.

7.2.3.3 Analyze each calibration standard according to appropriate methods (direct injection, 5020, 5030), adding the internal standard spiking solution directly to an aliquot of the sample or, in the case of purge-and-trap, to the syringe. Tabulate peak height or area responses against concentration for each compound and internal standard, and calculate response factors (RF) for each compound as follows:

$$RF = (A_S C_{IS}) / (A_{IS} C_S)$$

where:

A_S = Response for the parameter to be measured

A_{IS} = Response for the internal standard

C_{IS} = Concentration of the internal standard

C_S = Concentration of the parameter to be measured

If the RF value over the working range is a constant (less than 10% relative standard deviation), the RF can be assumed to be invariant and the average RF can be used for calculations. Alternatively, the results can be used to plot a calibration curve of response ratios, A_S/A_{IS} against RF.

TABLE 1. RETENTION TIMES FOR SOME AROMATIC VOLATILE ORGANICS

Compound	Retention time (min)
Benzene	3.33
Chlorobenzene	9.17
1,4-Dichlorobenzene	16.8
1,3-Dichlorobenzene	18.2
1,2-Dichlorobenzene	25.9
Toluene	5.75
Ethyl Benzene	
Xylenes	

Column: 6-ft x 1/8-in. column packed with 1.75%
Bentone 34 and 5% SP-2100 on Supercoport 100/200.

9.0 References

1. Bellar, T.A., and J.J. Lichtenberg. 1974. J. Amer. Water Works Assoc. 66(12):739-744.
2. Bellar, T.A., and J.J. Lichtenberg. 1979. Semi-automated headspace analysis of drinking waters and industrial waters for purgeable volatile organic compounds. In: Van Hall (ed.), Measurement of organic pollutants in water and wastewater. ASTM STP 686, pp. 108-129.
3. Dowty, B.J., S.R. Antoine, and J.L. Laseter. 1979. Quantitative and qualitative analysis of purgeable organics by high resolution gas chromatography and flame ionization detection. In: Van Hall (ed.), Measurement of Organic Pollutants in Water and Wastewater. ASTM STP 686, pp. 24-35.
4. Development and application of test procedures for specific organic toxic substances in wastewaters. Category 11 - Purgeables and Category 12 - Acrolein, Acrylonitrile, and Dichlorodifluoromethane. Report for EPA Contract 68-03-2635 (in preparation).

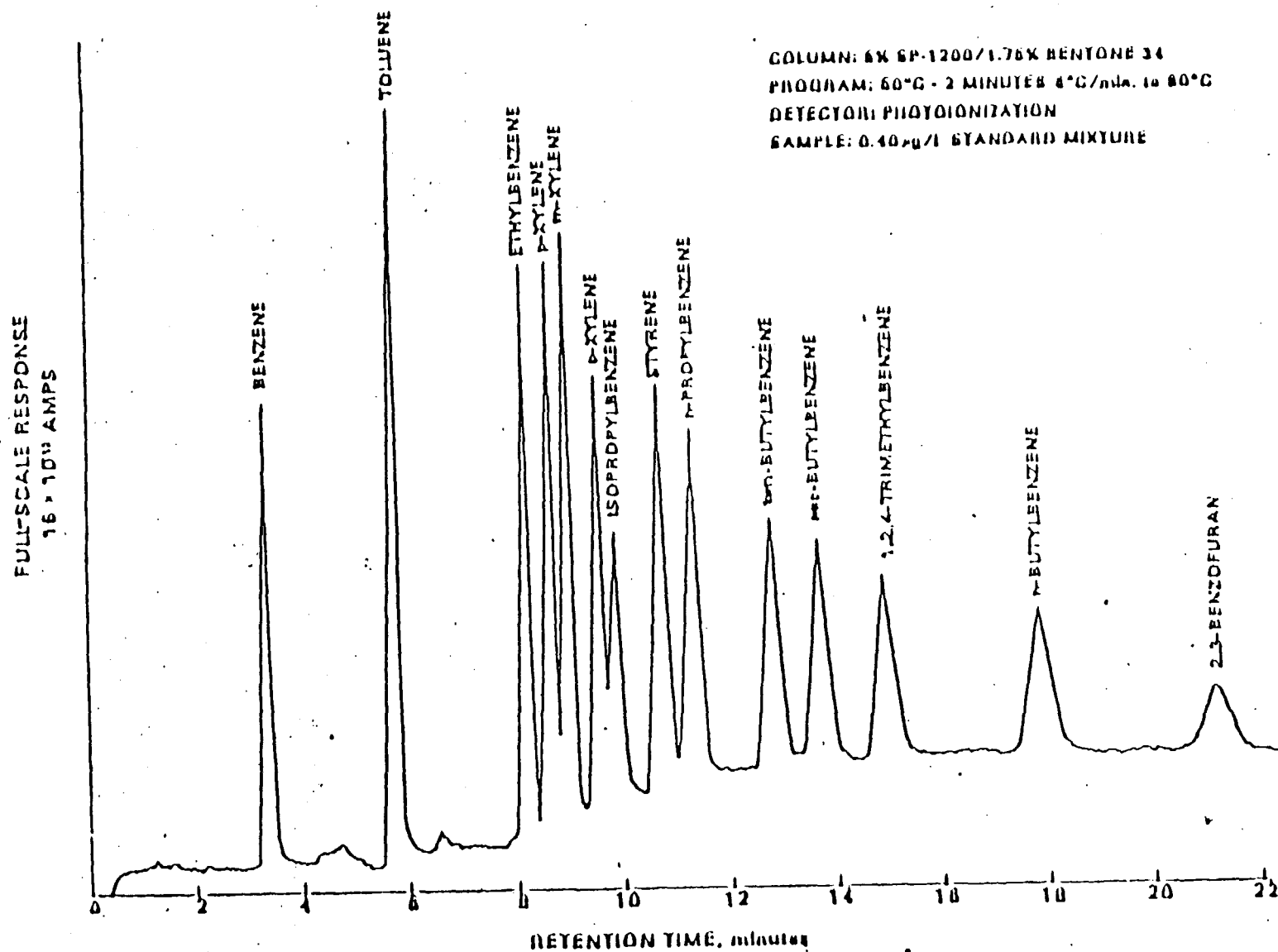


FIGURE 1. CHROMATOGRAM OF TEST MIXTURE AROMATIC VOLATILE ORGANICS
 1/10/82

FULL-SCALE RESPONSE 0.4x10¹⁰ AMPS

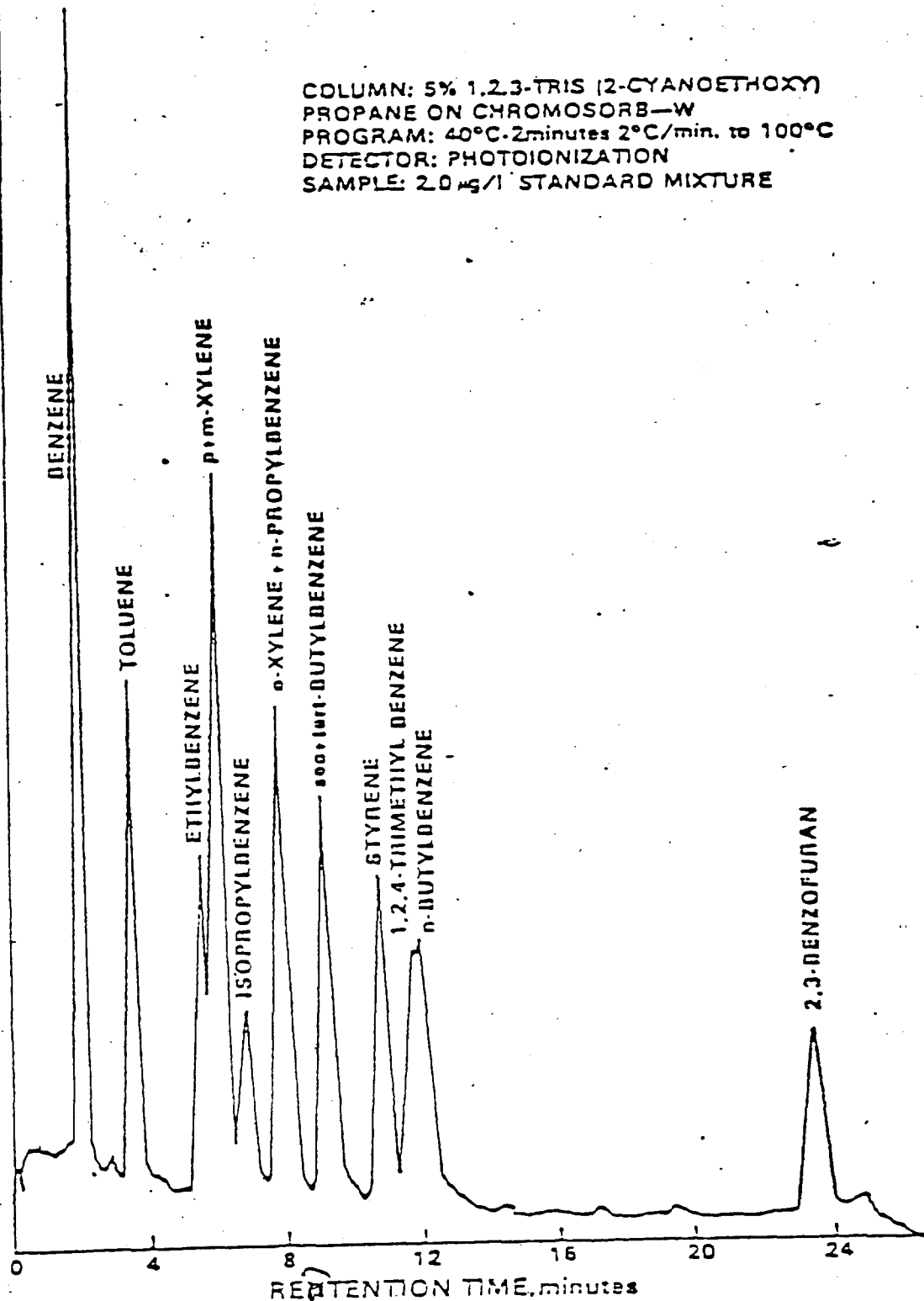


FIGURE 2. CHROMATOGRAM OF TEST MIXTURE

Fig 202012 → AROMATIC VOLATILE ORGANICS

APPENDIX A TO REPORT A
REF CI 82-0411
Date: 4/27/61

TABLE OF CONTENTS: APPENDIX V

<u>TITLE</u>	<u>PAGE #</u>	<u>REPORT SEC./PAGE #</u>
Table 1: Worker Personal Air Sample Results (Filter)		IV, P. IV-2
Table 2: Total Dust Monitoring Results		IV, P. IV-3
Table 3: Vapor/Gas Monitoring Results Draeger Tube Results		IV, P. IV-5
Table 4: Ambient Air Sample Levels of Substances Detected in Bore Hole Samples Volatile Organic Constituents Analysis January, 1983 Sampling		IV, P. IV-6

TABLE 1

WORKER PERSONAL AIR SAMPLE RESULTS (FILTER)

M E T A L R E S U L T S

<u>Sample Number</u>	<u>Sample Duration (Minutes)</u>	<u>Total Particulates mg/m³</u>	<u>Arsenic ug/m³</u>	<u>Lead ug/m³</u>	<u>Total Chromium ug/m³</u>	<u>Type Worker</u>	<u>Sample Date</u>
<u>Presurvey</u>							
W-82-01	422	-	-	-	4	S/H*	6/9/82
W-82-02	423	-	ND<.03	ND<3	-	S/H	6/9/82
W-82-03	422	-	ND<.03	ND<3	-	S/H	6/9/82
W-82-04	423	-	-	-	ND<1	S/H	6/9/82
TD-W-82-01	422	0.1	-	-	-	S/H	
TD-W-82-02	423	0.1	-	-	-	S/H	
<u>Actual Site Work</u>							
AA-154-25	426	0.27	0.11	ND<4.5		Geologist	7/13/82
AA-154-26	425	0.36 mg/m ³	ND<0.11	ND<4.4		Geologist	7/13/82
AA-154-27	179	0.63	ND<0.16	ND<6.3	ND<6.3	Chemist	8/31/82
AA-154-28	130	0.71 mg/m ³	ND<0.36	ND<14		Geologist	7/30/82
AA-154-29	126	6.61	ND<0.41	ND<17		Auger Driller	7/30/82
AA-154-32	436	0.26	ND<2.6	ND<0.065		Geologist (Trenching)	8/31/82
AA-154-33	456	0.13 mg/m ³	ND<2.6	ND<0.064		Backhoe	8/31/82
AA-154-34	333	ND<0.16 mg/m ³	-	-	ND<3.2	Backhoe	9/8/82
AA-154-35	213	ND<.23 mg/m ³	-	-	ND<4.6	Chemist	9/8/82
AA-154-36	309	ND<0.15 mg/m ³	-	-	ND<3.0	Geologist	9/8/82
OSHA LIMITS		15	10	50	100 500 1000	Chromates (as CrO ₃) Chromous Salts, TWA Metal & Insoluble Salts TWA	
TLV-TWA		10	200	150	500 50	(Cr, CrII, CrIII), TWA Cr (VI), TWA	

*S/H-Safety and Health Survey Team Member

V
TABLE 2

TOTAL DUST MONITORING RESULTS

<u>Activity</u>	<u>Number of Readings</u>	<u>Total Dust Concentration</u> (mg/m ³)	
		<u>Range</u>	<u>Arithmetic Average</u>
Resistivity Study	44	.01-1.00 mg/m ³	0.19
<u>Bore Hole</u>			
1. Assembly	2	.03- .25 mg/m ³	0.14
2. Hammering	9	.02- .40 mg/m ³	0.11
3. Augering	12	.01- .23 mg/m ³	0.09
4. Disassembly	6	.04- .16 mg/m ³	0.11
5. Sampling	3	.04- .16 mg/m ³	0.08
6. Shoveling	2	.19-1.70 mg/m ³	0.95
<u>Trenching</u>			
1. Upwind	9	.02- .15 mg/m ³	0.05
2. Downwind	5	.02-2.40 mg/m ³	0.55
3. Digging	18	.02- .81 mg/m ³	0.17
4. Replacing Dirt	7	.07- .82 mg/m ³	0.30
5. Sampling	4	.01- .05 mg/m ³	0.04
6. Backhoe Operator	8	.07- .84 mg/m ³	0.28

Total Dust Concentration
(mg/m³)

<u>Activity</u>	<u>Number Of Readings</u>	<u>Range</u>	<u>Arithmetic Average</u>
<u>Well Drilling</u>			
1. Downwind	3	.10-0.34 mg/m ³ *	.034*
2. Upwind	2	.05- .08 mg/m ³	0.07
3. Drilling	5	.02- .37 mg/m ³	0.10
4. Mixing Cement	3	.15-1.26 mg/m ³	0.69

*Readings to 80 mg/m³ (peak) occurred initially in the immediate down wind area of the worker during the start up of well drilling. Immediate dust control action was initiated and monitoring documented prompt and adequate control (0.34 mg/m³). These initial peak results have been excluded from the table.

The OSHA permissible exposure limit for nuisance dust is 15 mg/m³ (based on total dust and an eight hour time weighted average exposure).

V
TABLE 3

VAPOR/GAS MONITORING RESULTS

DRAEGER TUBE RESULTS

<u>Substance</u>	<u>Date</u>	<u>Location</u>	<u>Result</u> (ppm)
Arsine	6/9/82	G. L. Hide Pile Area	ND<0.05
*Aromatic HC's	6/9/82	G. L. Hide Pile Area	ND<1
Carbon disulfide	6/9/82	G. L. Hide Pile Area	ND<1
Hydrogen Sulfide	6/9/82	G. L. Hide Pile Area	ND<1
Arsine	6/28/82	G. L. Arsenic Pit	ND<0.05
Hydrogen Sulfide	7/29/82	G. L. Hide Pile Area	ND<5
	1/24/83	Bottom AS1	>2000
	1/24/83	Above AS1 (3 ft)	ND<0.5
	1/24/83	15 ft North AS1 (3 ft)	ND<0.5
	1/24/83	15 ft South AS1 (3 ft)	ND<0.5
	1/24/83	Bottom AS6	ND<0.5

*The tube detects aromatic HC's (e.g., benzene, toluene, xylene, ethylbenzene) any of which would have been indicated, if present.

G. L.=Ground level

OSHA permissible exposure limits for arsine, benzene, toluene, xylene, ethylbenzene, carbon disulfide and hydrogen sulfide are 0.05 ppm, 10 ppm, 200 ppm, 100 ppm, 100 ppm, 20 ppm and 20 ppm (ceiling), respectively.

50
161

After	Table $\frac{V}{3}$
Before	Table $\frac{V}{4}$

V
TABLE 4

AMBIENT AIR SAMPLE LEVELS OF SUBSTANCES
DETECTED IN BORE HOLE SAMPLES
VOLATILE ORGANIC CONSTITUENT ANALYSIS
JANUARY, 1983 SAMPLING

	30 Feet Downwind AS-1 (ppm)*
Propyl Mercaptan ¹	N.D. <0.5
Methyl Mercaptan	N.D. <0.5
Methyl Propyl Disulfide ¹	N.D. <0.5
Dimethyl Disulfide	N.D. <0.5
Butyl Mercaptan	N.D. <0.5
Methyl Furan ¹	N.D. <0.1
Carbon Disulfide	N.D. <0.5
2-Butanone ¹ (MEK)	N.D. <0.1
Sulfur Dioxide ¹	N.D. <0.5

N.D. = Not Detected; the lower limit of detection was estimated for non-sulfur containing compounds to be 0.1 ppm and 0.5 ppm for sulfur compounds.

All values are mean values from three samples taken simultaneously downwind, 3 ft. above ground and blank corrected.

¹ The response factors were assumed to be the same as the internal standard (D₆ benzene); all others were calculated.

*Collected approximately 3 ft. above ground.

APPENDIX V

SAFETY AND HEALTH INFORMATION

ATTACHMENT

TITLE

- | | |
|---|---|
| 1 | Safety and Health Plan |
| 2 | Written Respiratory Protection Program |
| 3 | Worker Training Outline and Supplemental Information For Site Workers |
| 4 | Microbiological Consultant's Evaluations |
| 5 | Extract of Environmental References |
| 6 | Detector Tube Information |

✓
ATTACHMENT 1

SAFETY AND HEALTH PLAN

WOBURN PROJECT
SAFETY AND HEALTH PLAN

TABLE OF CONTENTS

- A. Overview and Strategy
- B. Responsibilities
- C. Site Security and Access
- D. Personal Protective Equipment
- E. Exposure Monitoring
- F. Medical Program
- G. Dust Control and Release of Contractor Equipment Off Site
- H. Special Equipment and Health and Safety Facility Requirements
- I. Special Contractor Obligations
- J. General Site Safety Rules
- K. Other Topics
- L. Emergency Response Plan

STAUFFER CHEMICAL COMPANY

WOBURN PROJECT

SAFETY AND HEALTH PLAN

June 28, 1982

W. E. Pickett
Senior Industrial Hygienist
7/2/82

SAFETY AND HEALTH

A. OVERVIEW AND STRATEGY

Activities at the Woburn, MA waste site will be monitored, reviewed and controlled by health and safety personnel to prevent injury and any adverse impact on the health of personnel working on the site and the general public in the surrounding areas. These health and safety responsibilities will transcend all others. Applicable OSHA regulations will be complied with and where OSHA regulation are not applicable, sound industrial hygiene, safety and environmental procedures will be followed. The Stauffer Chemical Company Site Project Engineer is responsible for health and safety. A designated Safety/Health Specialist will assist on a daily basis with the implementation and monitoring of site safety and health programs. This specialist reports directly to the Site Project Engineer on all health/safety matters. Both individuals have initial and continuing access to professional guidance from certified health and safety professionals through Stauffer Corporate Environmental Services and Safety and Loss Control Departments, Westport, CT. The procedures and practices outlined in this protocol are based on a preliminary orientation visit to the site, a review of all available data indicating the waste contaminants of concern, and completion of the initial site Safety and Health Survey. Worker exposure monitoring will be accomplished during Phase I and controls and/or work practices modified to protect workers or public health, as indicated.

Stauffer has engaged a consultant in microbiology to evaluate any potential biological hazards which may be associated with buried animal hides. Interim use of protective equipment for specific tasks associated with investigation of hide piles has been included and will remain in effect until completion of a biohazard survey and as required thereafter.

B. RESPONSIBILITIES (Stauffer Chemical Company Employees)

Site Project Engineer (SPE): In charge of all Phase I site activities and responsible for Safety and Health. Delegated authority and responsibility to stop any activity, as necessary, to protect the workers or the public. Also, responsible for the control of any unanticipated problem or emergency while seeking additional professional expertise as needed.

Safety and Health Specialist (SHS): Reports, on health and safety matters, directly to the Site Project Engineer and on a daily basis assists with the implementation of the health and safety plan and monitors its effectiveness. The health and safety specialist has direct consultant support from certified industrial hygienists and safety professionals through Corporate Headquarters, Stauffer Chemical Company. Duties of the Safety/Health Specialist include:

- Monitor general air contamination levels in work areas.
- Evaluate the skin contamination potential encountered by workers during Phase I.

- Supervise protective clothing and equipment usage during all site activities and monitor the effectiveness of such use.
- Enforce site access procedures.
- Supervise and monitor personal hygiene practices at the site.
- Train all workers in the established safety and health procedures to be followed on-site, proper use of protective equipment, safe work practices, and identified site hazards.
- Document all monitoring, protective clothing/ equipment and training actions taken, to include names of all personnel entering the site, and the exact type of personal protective equipment supplied each individual.
- Brief the Site Engineer on monitoring results, work practices and protective equipment utilization and recommend any changes needed.
- Review environmental sampling results to determine impact on individual hygiene/safety requirements.
- Monitor first aid and other equipment supplies at the site.

Project Health and Safety Professionals: During Phase I, these individuals will be available to the Site Engineer and Safety and Health Specialist on request to review work practices, worker exposure monitoring and protective equipment utilization. In addition, these individuals will make periodic visits to the site to review safety and health programs and recommend any needed changes.

C. SITE SECURITY AND ACCESS

Fenced areas of the hazardous waste site are restricted areas accessible only to the site management team and other authorized personnel involved in evaluative and remedial actions. Personnel under Stauffer Chemical Company control will be allowed on-site only with SPE approval and then protective equipment use and work practices will be as designated by the SHS or SPE. Others having access to the site, but not under Stauffer control (Federal, State, etc.) will be requested to take at least similar precautions and follow site safety and health rules. A record will be kept documenting the names of all workers entering the site. Visitors will be signed in and out of the site. They will be provided with safety equipment and orientation/training necessary for their intended activities, escorted, and will conform to site health and safety rules. Work will generally be accomplished by groups of at least two individuals, except as authorized by the SPE. The existing warning signs and fencing will provide site security and gates will be kept locked for security during non-duty hours. Periodic security surveillance will be maintained during off-duty hours.

SITE SECURITY AND ACCESS (Cont.)

Access control points have been established at one gate for each fenced area to regulate entry and exit. A decontamination station at the gate to the fenced area North of Atlantic Avenue and will be used for equipment decontamination, showering, and change facilities, as indicated. During activities south of Atlantic Avenue, boot and equipment decontamination stations are not required unless otherwise directed by the SPE because of work activities.

The following practices are forbidden within site confines unless the situation is judged by the SPE as permitting less stringent observances.

- Smoking, eating, drinking, chewing gum or tobacco, etc.;
- Entry without specified protective equipment.

The SPE may establish a break area for smoking and drinking in a designated clean area of the site provided hand washing facilities are available and utilized prior to any break activity.

D. PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment encompasses a wide range of respiratory devices and special clothing designed to form an effective barrier between the worker and a potentially hazardous environment. The following table lists general selection criteria for protective clothing (Table I) which will be used in site management decision-making, with the assistance of the SES and Project Safety and Health Professionals.

A written site respiratory protection program has been prepared and is included in the site Industrial Hygiene and Safety Manual. Guidelines on the use of respirators are outlined in Table II.

TABLE 1

PROTECTIVE CLOTHING SELECTION

<u>Criteria</u>	<u>Type</u>	<u>Applicable Site Activity (See Code)</u>
• Potential gross contact with chemicals which are, in vapor form severe skin and eye irritants and/or highly toxic from the standpoint of <u>liquid</u> and vapor skin absorption.	• Fully encapsulated chemical protective suit of impermeable fabric such as butyl rubber, or other material appropriate to the hazard.	1.a
• Moderate to gross contact and/or splash with highly irritating liquids or compounds with high to moderate systemic toxicity via skin absorption.	• Chemical-resistant pants and jacket (rain or splash suit) or disposable coveralls made or coated or laminated (non-breathing) synthetic fabric appropriate to the hazards.	1.b
• Moderate contact or splash with skin irritants and/or materials having systemic toxicity via skin absorption.	• Any of the above types or disposable synthetic coveralls made of noncoated, permeable fabric along with chemical protective apron.	2
• Potential of only slight contact with general organic and inorganic chemicals. General field work in non-hazardous areas.	• Cotton or disposable synthetic coveralls made of breathable fabric. (Synthetic fabrics may provide better chemical splash or contact protection against many organics.)	3
• Potential of flash fire in addition to chemical contact.	• Flame-retardant coveralls or other comparable fire resistant fabric.	
• General hand contact with corrosive, irritating, or systemically toxic chemicals.	• Impermeable chemical protective gloves, e.g., neoprene, nitrile, latex, or butyl rubber.	1,2
• Gross hand contact with liquid chemicals.	• Long-gauntlet chemical protective gloves, e.g., neoprene, nitrile latex, or butyl rubber.	
• General protection against cuts and abrasions. Minimal contact with chemical agents.	• Leather or cloth work gloves. (Leather gloves will be used for excavation activities such as drilling and backhoe work in the known hide pile areas, use of cotton gloves for other activities will be at the direction of the SHS).	3

TABLE 1

PROTECTIVE CLOTHING SELECTION (Cont.)

<u>Criteria</u>	<u>Type</u>	<u>Applicable Site Activity (See Code)</u>
• All work activity in chemical laden waste sites.	• Protective rubber boots and bump camp.	1,2,3*
• Potential liquid splash to facial area (full-face equipment not otherwise specified).	• Face shield plus chemical safety goggles.	1,2*
Worker directly involved with material movement or laboratory work.	• Safety glasses with side shield or safety goggles.	3*

SITE ACTIVITY CODES

1. Handling or moving open, leaking, or deteriorated drums or barrels of materials. Use of code 1.a or 1.b to be approved by SPE, based on the nature of the materials.
2. Sampling of drums, barrels, or unknown pools of organic liquids.
3. General site activities to include visitors, sampling teams and general construction contractor personnel (well drilling, trenching).

More stringent protective equipment will be utilized by contractors if necessary to conform with accepted work practices based on their work activity. (trenching, boring, drilling).

Visitors and anyone not involved in excavating activities in the South fenced area (chromium lagoons) do not require bump camp or safety glasses.

No special requirements exist for areas outside the fence except when drilling or boring through known hide deposits or as otherwise indicated by monitoring data or investigative findings.

- * During material handling operations, sampling, trenching and well drilling contact lenses must not be worn without the site physician's approval.

TABLE II

RESPIRATORY PROTECTION GUIDELINES

AREA	ACTIVITY	RESPIRATORY PROTECTION	MONITORING REQUIREMENTS/ACTIONS
Unfenced Area (Outside of Caution Areas)	1. Walking, Survey Work, Sampling, Without Significant Soil Disturbance (Airborne Dust). 2. Drilling, Trenching and Boring	1. None. 2. None.	1. Initial (7 hr) samples representative of dust conditions analyzed for total dust, arsenic, lead and total chromium. If results indicate levels above action levels or PEL, dust control and/or protection (3M 9913) until sampling indicates adequate exposure control. Periodic real time monitoring of total dust. If total dust results approach 5 mg/m^3 -TWA, increase dust control, monitoring and/or interim respiratory protection, as indicated. 2. Same as 1. above
Unfenced Area (In Arsenic Caution Area)	1. Walking, Survey Work, Sampling (Without Significant Dust Generation). 2. Boring, Drilling and Trenching.	1. None. 2. Initially, 3M 9913.	1. Initial and daily real time spot check of total dust. Respirator (3M 9913) mandatory if total dust concentrations average 300 ug/m^3 at breathing zone. High efficiency 1/2 mask respirator required if real time monitoring indicates Dz concentration of 1 mg/m^3 . 2. Initial 7-hr total dust samples representative of dust conditions analyzed for arsenic and lead. If results are less than 5 ug/m^3 and 30 ug/m^3 , respectively, respiratory protection not required. If results exceed either value, increased dust control measures high efficiency filter respiratory protection until personal monitoring documents control. Daily real time total dust measurements and respiratory protection measures instituted if action levels could be exceeded or 1 mg/m^3 avg. total dust concentrations found.

TABLE II

RESPIRATORY PROTECTION GUIDELINES (Cont.)

REA	ACTIVITY	RESPIRATORY PROTECTION	MONITORING REQUIREMENTS/ACTIONS
dh Fenced Area Wide Pile oution Areas)	1. Walking, Survey Work, Sampling Without Significant Soil Disturbance (Airborne dust) 2. Boring, Drilling and Trenching	1. None. 2. 3M 9913	1. No additional personal samples. Periodic documentation and evaluation of total dust levels (real time measurements). Exposure controls increased at 5 mg/m³ total dust levels. 2. No additional personal samples. Daily documentation and evaluation of total dust levels (real time measurements). Exposure controls increased at 5 mg/m³.
dh Fenced Area Other Caution Areas Such as or Lead)	1. Walking, Survey Work, Sampling (Without Significant Soil Disturbance (Airborne dust) 2. Boring, Drilling and Trenching.	1. None. 2. See Monitoring Requirements	1. Initial and periodic real time spot checks of total dust. Respiratory protection (3M 9913) mandatory if total dust concentration exceeds 1.0 mg/m³ in breathing zone, until personal samples indicate adequate substance control. 2. Initial and daily real time total dust measurements. Mandatory Respiratory Protection (3M 9913) if total dust levels exceed 1.0 mg/m³ in breathing zone until personal samples indicate adequate substance control.

TABLE II

RESPIRATORY PROTECTION GUIDELINES (Cont.)

AREA	ACTIVITY	RESPIRATORY PROTECTION	MONITORING REQUIREMENTS/ACTIONS*
North Fenced Area	1. Walking, Survey Work, Sampling Without Significant Soil Disturbance (Airborne dust) 2. Boring, Drilling and Trenching	1. None. 2. None. Except 3M 9913 in hide pile area. See also monitoring requirements.	1. Initial and periodic real time total dust measurements. 2. Initial personal air samples for total dust, chromium lead and arsenic. Then periodic total dust measurements. Note: Should suspected deposits of toxic chemicals, e.g., lead, arsenic, be discovered, establish caution areas and implement guidelines as indicated for North Fenced Areas.
Commercial & Public Areas	All	None.	None, except as indicated by investigative findings.

E. EXPOSURE MONITORING

Personal breathing zone dust samples will be taken initially during each type of Phase One activity involved with material handling (well drilling, trenching, etc.). Each will be analyzed for total dust, arsenic, lead, and chromium to ensure compliance with applicable OSHA limits. Continued monitoring will be scheduled based on sample results, results of real time dust monitoring, and site activities.

Real time total dust determinations will be made in the breathing zone of workers during operations most likely to produce maximum dust levels. Readings will be based on averaging RAM-1, 32 second integration readings, obtained over a 2 minute period during representative or worst case task conditions. If dust levels approach selected guideline values (Table II), appropriate recommendations will be made by the SHS to the SPE. Excessive readings will trigger intensified dust control efforts such as a fine water spray in the area of activity and more frequent monitoring. If guidelines values are approached in the work area, downwind real time measurements will be made at the site boundary, 3 ft. above the ground. If boundary concentrations are significant, the site project engineer will determine the need for intensified dust control efforts, reduced work activity and/or work stoppage.

Combustible gas meter readings (photoionization meter readings when necessary) will be taken when indicated, such as during well drilling and prior to any trench entry. These measurements may be supplemented with oxygen deficiency measurements and detector tube readings for specific compounds as necessary. Tables II and III summarize the routine sampling anticipated. Additional sampling requirements will be established as needed for unanticipated situations.

Laboratory analyses for industrial hygiene samples will be accomplished by a certified industrial hygiene laboratory using NIOSH recommended methods or their equivalent. Direct reading instruments will be used in accordance with manufacturer instructions. The operation of the photoionization meter and combustible gas meter will be checked against a calibration gas standard prior to each day's use.

AIRBORNE MONITORING PROGRAM

Substance	Type Sample	Frequency	Evaluation of Results
Total Dust (Metals as indicated)	Direct reading, Breathing zone of worker, 2-min. or greater sample time (32 sec. integration)	Initially and as indicated by data or site activity and condition.	Notify Site Engineer and review personal protective equipment and dust control if levels exceed those stated in Table II. If down wind levels approach 5 mg/m ³ contact SPE, reduce site dust generating activities and institute or increase dust control efforts.
	Personal, worker breathing zone, full shift samples. Total mass determination, and lead, arsenic and total Cr. analyses.	Initial sample from individual with max. potential for exposure during well drilling, trenching etc. Additional samples as indicated by data or site activities	If any results are at or above OSHA Action Level or PELs, institute increased dust control practices and require mandatory wear of NIOSH approved respirators during tasks associated with the sample.
	Site boundary, down wind, direct reading 2-min. or greater sample or filter sample (1 hr.) for total dust and metals.	One hour filter sample and/or direct reading sample periodically during periods of max. dust generation or as indicated above.	Individual results reviewed by SPE.
Gas/Vapors	Combustible gas	1. Each morning and afternoon in area of well drilling or trenching. 2. Prior to trench entry.	Results to be individually analyzed. Levels approaching 20% of the LEL represent a potentially dangerous condition. (As indicated by investigative findings, other gas/vapor measurements may be made with suitable instrumentation such as photionization, detection tubes, etc.)
Oxygen Level	Direct Reading	As indicated prior to trench entry	No entry into area less than 19.5% oxygen.

MEDICAL PROGRAM

- Preplacement Physicals:

Personnel who are expected to work 30 or more days within the fenced areas (as determined by Stauffer Chemical Co.) will be required to complete a preplacement medical examination. The scope of the examination will be determined by the Occupational Medicine Department of SCC. Such workers must complete the examination within 15 days of starting work within the fenced areas. Contractors will provide written assurance to the site engineer that designated contractor personnel have completed their examinations. Such SCC employees will not require an additional medical examination, if a current (within 18 months) physical is available through the employee's location medical program. If air sampling or other site conditions should indicate to SCC the need for periodic or additional medical monitoring, site management and contractors will be informed of the actions required.

- Medical Respirator Certification:

Since respiratory protection may be required for certain tasks, Stauffer Chemical Company employees assigned to the site who may need to wear a respirator will be medically certified and will conform to existing Company policies and practices. All employees assigned to tasks requiring respirator wear cannot have facial hair between the sealing surface or hair that interferes with valve operation. Other site personnel (consultants, contractors) who may need to wear a respirator must also be medically qualified. The contractor must provide written assurance to the SPE that this has been accomplished for designated contractor personnel.

- First Aid:

First aid trained personnel will be available when more than 5 workers are on site. Local medical facilities and ambulance services will be advised and utilized as needed for workers injured at the site.

G. DUST CONTROL & RELEASE OF CONTRACTOR EQUIPMENT OFF SITE

The contractor will be expected to provide equipment for and exercise good dust control practices when required during operations such as well drilling and trenching. Trenches will be back filled as soon as possible and, as directed by the SPE, excavated soil stabilized by water spray or tarps. Contractors will be required to visually inspect equipment leaving the site and as directed by the SPE, take appropriate actions so that dirt and debris is not transported off site.

E. SPECIAL EQUIPMENT AND HEALTH AND SAFETY FACILITY REQUIREMENTS

1. Special facilities for health and safety will include:

Storage area for protective equipment.
Clothing change areas, walk through shower facilities.
Boot washing facilities.
Equipment decontamination area and facilities.
IH equipment calibration and storage area.
Administrative areas with telephone.
Site access control point with suitable security provisions.
Training area.

2. Monitoring equipment for health and safety will include:

GCA, Dust Monitor, Model RAM-1
h mu Photoionization Meter, PI-101, 11.7 eV
MSA Combustible Gas Indicator, Model 2A
Du Pont Constant Flow Sampling Pumps, or equivalent
Drager Multi Gas Detector
(arsine, benzene, hydrogen sulfide and oxygen
detector tubes)

Irritant smoke tube, isoamylacetate etc. for respirator fit testing.
Appropriate calibration gases.

3. Personal Protective equipment will include:

Respirators (equivalent to):

MSA Comfo II half-mask; S, M, L - with GMC, high efficiency filters, dust filter and any combination of the above.

MSA Chin - type full face mask with GMC-E canisters (two).

Norton half-mask; S, M, L, with Norton cartridges similar to those described for the MSA Comfo II.

3M 9913 - Odor, dust, mist half-mask.

Self-contained breathing apparatus (2) with 2 spare cylinders.

Clothing

Coveralls
Rain wear
Rubber coated lab apron, 2
Acid resistant coverall M, L
Bump caps - adjustable
Cotton work gloves
Vented safety goggles
Vistor specticals
Rubber boots
Leather work gloves

Misc.

Towels

Soap

Water cooler

Cups

Waste containers-service

Portable eyewash

Stakes and caution signs

Standard first aid kit

Stretcher

Supply of water, ice, and plastic bags suitable for cold packs.

Hose and water for equipment cleaning

Fire extinguisher

I. SPECIAL CONTRACTOR OBLIGATIONS

Contractors will be required to have all workers comply with applicable Federal health and safety regulations, this plan, and any other health and safety requirements set by the SPE.

Contractors must provide assurance that any employees required to wear a respirator meets medical certification requirements.

Contractors will ensure that employees required to use respirators do not have facial hair between the sealing surface of a respirator or facial hair that interferes with respirator valve operation.

Contractors must make their employees available for training at the site and ensure that their employees utilize prescribed protective equipment, conform to the site safety and health rules and follow good work practices.

This plan addresses health and safety concerns unique to the site. Contractors will be expected to determine health and safety requirements unique to their own tasks and institute and conform to sound health and safety practices (i.e., well drilling operations, trenching and work around utility lines).

Contractors will be responsible for providing, as necessary, equipment for dust control and at all times conducting operations in a manner consistent with good dust control practices.

Contractors will instruct workers on site to allow the wear of personal air sampling equipment and follow any instructions provided by the SPE.

Contractors will ensure that their employees abide by site shower requirements.

Contractors will ensure that employees report immediately any injury or illness to the SPE or SHS.

J. GENERAL SITE SAFETY RULES

1. Proper safety equipment must be worn in designated site areas.
2. Smoking and eating is only permitted in designated areas.
3. Report all injuries to the SHS or SPE.
4. Mobile equipment will be operated by authorized employees only.
5. Narcotics, hallucinatory drugs and alcohol are not permitted on the property. People "under the influence" will not be permitted to enter.
6. Willful acts of horseplay, fighting, sabotage, etc. are not permitted.
7. Hands must be washed before utilizing break area facilities.
8. During material handling operations, sampling, trenching and well drilling, contact lenses must not be worn, unless approved by the site physician.

9. Employees shall sign in when arriving at the site, and sign out upon departure.
10. All safety procedures must be followed.
11. Designated employees will be required to shower prior to leaving the site.
12. Items found will not be removed from the site.

X. OTHER TOPICS

1. Drum Handling

Six drums have been identified within the South fenced area (chromium lagoon area). These appear to be associated with the abandoned earth-moving equipment. Drums found will be handled on a case by case basis by the SPE. The site industrial hygiene manual contains general guidance on drum opening and sampling. In Table I and the site written respirator plan guidance is provided regarding respirator and protective equipment requirements.

2. Worker Training

The safety of site workers and avoidance of adverse of health effects will rest ultimately with the worker, and worker awareness of site hazards and commitment to health and safety procedures. The SPE, with the assistance of the SHS, will inform and train all site personnel under their control in established procedures prior to site entry. This will include an overview of suspected hazardous materials onsite, the location of these areas, respirator requirements, and their health effects at expected exposure levels.

Workers will be properly fitted and trained in the usage of all protective and respiratory equipment which they will use at the site, specific site health and safety rules, and actions to be followed in an emergency. For contractors, this training will be conducted on the first day of work and prior to starting any work activity of special concern, as determined by the SPE.

3. Decontamination Procedures:

The need for personnel equipment and/or decontamination will depend on the potential for direct contact with contaminated material. Operations such as walking through designated areas will require only boot washing and removal, protective coverall removal, and the washing of hands and face. In operations in which extensive excavation is performed in a contaminated area, gross contamination of protective clothing and equipment could occur. In this case, a controlled change and shower facility will be utilized and all such field personnel will shower prior to leaving the site. The break area will be used (after boot washing, hand and face washing) for smoking, eating, and restroom facilities. Decontamination of reusable suits (i.e., rain gear) will be accomplished using a soap and water procedure.

4. Working Near High Voltage Power Lines

Heavy equipment should not be used any closer than 15 ft. of power lines. The site engineer will be responsible for notifying Boston Edison, David Von Hein, 617-933-5204, when any heavy equipment is being used within 50 ft. of the centerline of the power lines.

5. Trenching

If the trench is more than 5 ft. deep the walls shall be shored and/or sloped (depending on condition of the soil or OSHA requirements) before anyone enters the trench. Prior to any trench entry a combustible gas test for methane must be completed. Any soil removed from a trench should be placed at least 2 ft. away from the trench.

Trenches should be filled as soon as possible. If any trench is to remain uncovered during off-duty hours it should be marked with stakes and caution signs (within fenced area) or properly barricaded (if outside fenced area).

6. Microbiological Hazard Survey

A detailed plan is being developed by Stauffer's consultant and will be attached when completed.

L. EMERGENCY RESPONSE PLAN

There are five basic types of emergencies; those created by fires, explosion, toxic material releases, natural phenomena and civil disturbances.

Emergency Procedures

1. Immediately notify the SPE, Senior Stauffer representative, or SES of any possible or occurring emergency.
2. All employees, visitors, contractors must report to the administrative trailer. Notification shall be by radio or car horn, or air horn or messenger.
3. An emergency team, designated by the SPE or designee, shall be responsible for rescue or containment.
4. Protective equipment will be used according to guidance in Table 1 and the written respirator program.
5. The SPE or Senior Stauffer representative on site will oversee all operations and decide if local assistance is necessary such as fire department, emergency rescue and/or ambulance. The SPE will also be responsible for dealing with the press or community inquiries.
6. A messenger, or a car horn, or air horn will be used to indicate the situation is controlled.

Natural Phenomena

If weather conditions (thunderstorms, tornado) are threatening worker safety the SPE will be responsible for halting all work and deciding when conditions are favorable for work continuance.

✓
ATTACHMENT 2

WRITTEN RESPIRATORY PROTECTION PROGRAM

Respiratory Protection Program

Woburn Waste Site

June 1982

I. Introduction

Stauffer Chemical Company is committed to provide a safe and healthful work environment for all employees. In addition, OSHA has adopted a mandatory standard covering respiratory protection programs. The Company issued guidelines (October, 1978) to assist Stauffer facilities in preparing specific respiratory protection procedures and programs for their respective operations. Those guidelines provide the basis for the following program for the Woburn site.

POLICY STATEMENT: This respiratory protection program shall be utilized to ensure proper coordination, use and maintenance of respiratory protective equipment as determined necessary to (1) minimize employee exposure to toxic chemical agents; and (2) allow employees to work safely in hazardous work environments.

II. Program Administration

Stauffer Chemical management has designated the site Safety and Health Specialist (SHS), B. Javorek (with assistance from R. Roberson), as the individual responsible for administration of the respiratory protection program. This includes responsibility for:

- A. Supervision of respirator selection, including identification of jobs requiring respirator use;
- B. Establishment of training sessions about respiratory protective equipment for employees;
- C. Establishment of a continuing program of respirator maintenance and inspection;
- D. Designation of proper storage areas for respirators;
- E. Establishment of issuance and accounting procedures for uses of respirators;
- F. Coordination of medical screening program/procedures;
- G. Establishment of a periodic employee exposure evaluation survey to determine changing situations; and
- H. Continuing evaluation of the above aspects to assure their continued functioning and effectiveness.

III. Selection and Use

A. Selection

In all cases, respirators shall be selected on the basis of the hazards to which workers may be exposed and used in accordance with the guidance in the Health and Safety Plan. Respirator selection will consider the following:

1. Nature of the situation encountered,
2. Activities of workers in the hazardous area,
3. Types of inhalation hazard including physical properties, physiological effects on the body, warning properties (e.g., smell or irritation) airborne contaminant concentration, established PELs for toxic materials, and established immediately dangerous to life and health (IDLH) concentration of toxic material.
4. Length of time respirators are to be used. Open-circuit SCBAs provide only 20-25 minutes protection per cylinder.
5. Physical characteristics (i.e., weight) and functional capabilities (i.e., use time) of various respirator types; and
6. Respiratory protection factors.
7. Table I, General Criteria for the Selection of Respiratory Protection Devices.

TABLE I

GENERAL CRITERIA

SELECTION OF RESPIRATORY PROTECTION DEVICES

<u>Criteria</u>	<u>Type</u>	<u>Applicable Site Activity</u>
• Atmospheres that are oxygen deficient (less than 19.5% O ₂) or immediately dangerous to life and health (IDLH) — producing an immediate irreversible or debilitating effect on health.	• Positive pressure closed circuit self-contained breathing apparatus (SCBA); or pressure-demand open circuit SCBA;	
• Atmospheres that may contain high concentrations of unknown substances of contaminant levels exceeding 50X the OSHA PEL for known airborne chemicals, (but are not considered to be IDLH conditions).	• Any of the above types	1
• Atmospheres in which the airborne concentration of all contaminants is known to be less than 50X the respective OSHA PEL and provide good warning properties (taste, smell, and irritation).	• Full-face air purifying cartridge respirator with NIOSH approval for contaminant type or any of above types.	1
• Atmospheres in which the airborne concentration of all contaminants is known to be less than 10X the respective OSHA PEL and provides good warning properties (taste, smell, and irritation).	• Half-mask air purifying cartridge respirator with NIOSH approval for contaminant type.	2
• Odor, no PEL exceedance.	• Disposable combination odor dust/mist mask.	3
• Emergency rescue.	• Positive pressure closed circuit self-contained breathing apparatus (SCBA); or pressure-demand open circuit SCBA.	

SITE ACTIVITY CODES

1. Open, leaking or deteriorated drum or barrel movement/sampling outdoors, type of respirator to be determined by site SHS.
2. As specified by the SHS, a half-mask respirator will be provided as indicated by personal monitoring.
3. Work in areas where odor is objectionable but toxicity not of concern.

B. Use

1. Air Purifying Respirators

Limitations: Air purifying respirators are not for use in atmospheres immediately dangerous to life or health or in atmospheres containing less than 19.5% oxygen; and are not to be worn for protection against organic vapors with poor warning properties or those which generate high heats of reaction with sorbent material in the cartridge.

- a. Half-mask: Reusable half-mask respirators may be used at the Woburn waste site for general protection against organic vapors, acid gases and/or nuisance dusts. The Norton Model 7583, NIOSH approval TC-23C210 with cartridge such as 7500-83 or MSA Comfo II respirator (465 825) with combination filter/cartridge 6MC-H (NIOSH approval TC-23C159 and TC-23C-153), or equivalent, can assure protection against:

- (1) Not more than 1000 ppm organic vapors, 10 ppm chlorine, 50 ppm HCl, 50 ppm sulfur dioxide and/or,
- (2) Dusts, fumes, and mists with a TWA less than 0.05 mg/m^3 and/or,
- (3) Radionuclides

- b. Full-face Mask: MSA Chin Type Gas Mask with Ultravue Facepiece (449261) with Canister 6MR-I (TC-146-106). Protects against:

- (1) 0.5% organic iodides, organic vapors, iodine vapors, and radioactive particulate matter.
- (2) Toxic dusts, mists, and fumes having a TLV less than 0.05 mg/m^3 .

Limitations are similar to those described for the half-mask respirator except for the higher protection factor.

- c. Disposable Dust/Mist/Odor Half-Mask: The 3M Brand Nuisance Odor Respirator (9913) will be used for work in areas where odor is objectionable but vapor/gas toxicity is not of concern. This respirator has a NIOSH dust/mist approval (TC-21C-234) and will also be used for general particulate control as described in the Health and Safety Plan.

2. Supplied Air Respirator

SCBA - Self-Contained Breathing Apparatus: If an area must be entered containing an unknown air contaminant concentration, a pressure demand self-contained breathing apparatus (SCBA), which is specifically designed to maintain positive pressure inside the facepiece, should be used. These units shall also be used for emergency rescue. Only designated emergency team members will be trained in SCBA use:

IV. Medical Certification

When respirator wear is mandatory for Stauffer Chemical Company personnel, they must be medically certified. Contractor personnel required to wear a respirator must be medically certified. This will be accomplished at the time of the preemployment physical (see Safety and Health Plan). If a pre-employment physical has not been required, the contractor will provide written assurance that the individual is medically qualified to use a respirator.

V. Respirator Issuance

Respirators will be issued on a day to day basis according to need. A reasonable inventory of the proper types of respiratory protective devices that may be needed shall be maintained.

VI. Employee Training and Fit Testing

- A. Training: All employees, visitors, and contractors required to wear respirators will receive training in the site, use maintenance and limitations of respirators. This will include training on the nature of the hazard. New employees, visitors, contractors will be trained on their first day at the site. The SHS is responsible for establishing training sessions and maintaining records of all training sessions.

As a minimum, each training session includes the following:

1. Instruction in the nature of the hazard.
2. Discussion of why this is the proper type of unit for the particular purpose.
3. Discussion of device's capabilities and limitations.
4. Instruction and training in actual use (positive/negative pressure tests).

- B. Fit Testing: All employees/workers will be submitted to a "test" atmosphere fit test such as isoamyl acetate and/or irritant smoke to help them select and determine initially which type of available respirator and size provides the best fit. Workers will also be trained in the positive and negative pressure tests which should be followed every time a respirator is used.

Positive Pressure Test - Close the exhalation valve and exhale gently into the facepiece. The facepiece fit is considered satisfactory if a slight positive pressure can be built up inside the facepiece without any evidence of outward leakage of air at the seal. For most respirators, this method of leak testing requires that the wearer first remove the exhalation valve cover and then carefully replace it after the test.

Negative Pressure Test - Close off the inlet opening of the canister or cartridge(s) by covering it with the palm(s). Inhale gently so that the facepiece collapses slightly, and hold the breath for approximately 10 seconds. If the facepiece remains slightly collapsed, the fit of the respirator is considered satisfactory.

- C. Policy: The proper fitting of respiratory protection equipment to the user shall be demonstrated for each employee, using methods recommended by the respirator manufacturer and/or NIOSH. Further, it is the policy of the Company that employees who are obliged to wear respirators must be clean shaven at the respirator sealing surface and any facial hair within the respirator area must be trimmed to avoid interference with valve functions. This policy includes anyone working or visiting at the site who will be required to wear a respirator.

VII. Respirator Maintenance/Inspection

All respirators shall be centrally cleaned, maintained, and inspected at the site after use. In addition, prior to wear workers will inspect respirators. Cartridges will be changed after eight hour usage or whenever breathing resistance is noticed by the wearer or the wearer depicts odor breakthrough. Disposable odor masks will be disposed of after the end of a full shift or as odor breakthrough is noted.

VIII. Program Evaluation

As part of the respiratory protection program, review of work conditions and worker exposure to air contaminants is conducted on a regular basis. This is done by taking personal air samples in the breathing zone of the workers wearing the respirators. Comparing the measured time-weighted average concentration with the maximum use concentration for the respirator is used as a means of checking that the proper respirator has been selected. (See Site Safety and Health Plan.)

Interviews with respirator wearers are conducted periodically to determine how they are using the respirators, comfort, resistance to breathing, fatigue, interference with vision and communication, restriction of movement and interference with job performance, as well as confidence in the respirator's effectiveness.

IX. List of Appendices

The following appendices are included in this manual to provide additional guidance for program implementation:

<u>Appendix</u>	<u>Description</u>
A	Respirator training outline
B	Respiratory Certification of Contractor Employees
C	Respiratory Certification Assurance Form Letter

Appendix A

Respirator Training Outline

1. Hazards in the area
2. Use and limitations of the respirator
3. How to fit the respirator
4. Fit test
5. Areas where respirators are mandatory
6. Care and maintenance of respirators

STAUFFER CHEMICAL COMPANY

SAFETY AND LOSS CONTROL

SAFETY PRACTICES

TITLE: CONTRACTOR SAFETY

Section No. 15
Page 3 of 4
Date Issued 7/15/80
Cancels Page 3 Issued 2/1/79
Effective Date 7/15/80

III. RESPIRATORY CERTIFICATION OF CONTRACTOR'S EMPLOYEES

Before a contract is offered for bids, Plant Management should first determine whether respirators will have to be worn by the contractor's employees for other than escape purposes. If so, this fact, together with the requirement that the contractor's employees be certified to wear respirators, should be clearly spelled out in the Safety Rules for Contractors developed by the plant and included in the bid package.

Employees of contractors who work at Stauffer plants on tasks which, for Stauffer employees, require certification for respirator use must be certified in accordance with the terms of Stauffer's program and conform to Stauffer's safety rules and procedures. It is the contractor's responsibility to obtain and document current annual certification. The Plant Manager must advise the contractor of the requirement for such covered tasks and must assure certifications prior to assignment of contractor employees. Such assurance of certification by a contractor may be obtained by letter from the contractor stating that those individuals who might be required to use respirators have been certified. A typical letter which could be used as one form of assurance is shown as Exhibit B.

STAUFFER CHEMICAL COMPANY

SAFETY AND LOSS CONTROL

SAFETY PRACTICES

TITLE: CONTRACTOR SAFETY

Section No. 15
Page 4 of 4
Date Issued 7/15/80
Cancels Page Issued
Effective Date 7/15/80

IV. OBTAINING COMPLIANCE

Stauffer expects the contractors it employs to:

1. Comply with all applicable local, State and Federal safety, employment and construction laws,
2. Observe safe work practices,
3. Comply with the detailed Stauffer safety rules noted on the attached copy of the Contractor Orientation Checklist.

In order to achieve such compliance, Stauffer should always reserve the right to question and/or demand replacement of unsafe equipment or changes in unsafe practices in all of its contracts with such contractors. If a contractor fails to comply with safety laws or refuses to abide by plant safety rules, Plant Management should use its discretion in exercising one or more of the following options depending upon the seriousness of the violation and the past performance record of the contractor. The options below are listed in increasing order of severity:

1. Submit a "Safety Ticket" (see attached sample, also available through the Forms Depot, Westport) to the contractor describing the unsafe act or condition.
2. Arrange a meeting between the Project Engineer and the contractor to discuss the plant's complaints. This meeting and the points discussed should be documented.
3. Send employee(s) home for a period of time without pay.
4. Contact the Safety & Loss Control or Insurance Department in Westport for suggestions of additional courses of action based on the specifics of the situation.
5. Contact the Law Department, Westport, for advice before stopping the work or terminating a contract.

Respiratory Certification Assurance Form Letter

Re: Contract No. _____

Stauffer Plant: _____

Dear

It has been determined that your employees may be required to wear respirators in the performance of the subject contract. Stauffer Chemical Company requires that any employees of a contractor who might use respiratory equipment must be medically certified for respirator use.

In 29 CFR §1910.134 OSHA has adopted standards regarding respiratory protection including requirements regarding respirator type, use, maintenance and training. Section 1910.134(b)(10) recommends that a local physician determine whether each employee wearing a respirator is physically able to perform the work while using the respiratory equipment.

In order to fulfill Stauffer's requirement regarding medical certification, the statement at the bottom of this letter must be executed and returned. I must receive this assurance of respirator certification before on-site work may proceed under the subject contract.

Very truly yours,

We (I) certify that all employees assigned by the undersigned to work at the referenced Stauffer Chemical Company site in tasks which have been identified as possibly requiring the use of respirators have been medically certified by a local physician on a current basis for use of such equipment.

Company: _____

By: _____

Title: _____

✓
ATTACHMENT 3

WORKER TRAINING OUTLINE AND SUPPLEMENTAL
INFORMATION FOR SITE WORKERS

Worker Training Outline

A. Site Management Organization

1. Site Engineer - name, location.
2. Site Safety and Health Specialist, name, location.
3. Availability of Site Safety and Health Plan and Health & Safety Information.
4. Worker responsibility to follow site rules.
5. Overview using site map - two fenced areas.

B. Occupational Health Concerns at Site

1. Particulates

- Designated areas of chromium, lead, and arsenic. Concentrations in soil generally less than 0.1%. High concentration areas staked with caution signs. Stay out of such areas unless required by work tasks. Then utilize protective equipment/work practices required for the area.
- Keep dust to a minimum during all activities.
- Airborne levels are expected to be below limits established for daily exposures for a working lifetime. Thus, no adverse health effects are expected from these highly toxic substances, including even skin and eye irritation.
- Periodic monitoring will be accomplished to verify airborne levels and protective equipment/work practices will be modified when indicated.
- OSHA applicable information is on file and available for your review.

2. Vapor/Gases

- Odors will be present and may be offensive, especially in or near the hide piles.
- Emissions of vapor/gases have been monitored and do not represent an occupational health hazard.
- Methane (explosive gas) is generated during decomposition of hides. Measurable concentrations have been found within 1/2 inch of the hide pile. No measurable concentrations have been found in the open air above the piles. No smoking rules will be enforced and special safety emphasis is needed during boring/trenching and drilling.

3. Hides:

The buried hides may provide a media for bacterial growth. As indicated, special work practices may be required such as during excavation. Be especially careful and report any injury immediately for prompt cleaning of the wound.

C. Safety Concerns at the Site

1. General: The site safety and health rules are for concerns unique to the site. You are required to also follow good safety and health practices unique to your job (back hoe operator, drilling).
2. Electrical: Boston Edison high voltage power lines cross the area. Do not work with heavy equipment within 15 feet of power lines or staked caution sign area near the power lines.

D. Personal Protective Equipment

1. Inside any fenced area: Rubber boots and if excavation is in progress, the following will be required safety glasses or goggles/bump hat (*coveralls if excavating)
2. Inside North Fenced Area: Boots/Safety glasses or goggles/bump hat coveralls. (Coveralls and boots are to minimize skin contact and facilitate uncontrolled release of materials off site).
3. Other: Other protective requirements will be task specific. Personnel required to wear respirators will be trained and fitted on site. This will be mainly for excavation work if dust levels become high. In addition, showers will be required for some individuals prior to leaving the site (mainly excavation tasks). These facilities may be used on a voluntary basis if desired.

Prior to eating, smoking, or drinking you are required to wash your hands and face. These activities are restricted to designated areas (specify areas).

E. Injury Reporting

Report any injury or illness, however minor, to the site safety and health specialist or site project engineer. Any cut or scrape will require reporting and first aid.

F. Decontamination

1. Equipment leaving the site must be visually clean of site material.
2. Boots must be washed at the boot cleaning station prior to entering the trailer area.

G. Unanticipated Events: If you encounter an unanticipated event, stop and contact the site safety and health representative or site project engineer for guidance. Major concerns could be:

- Discovery of drums or barrels of chemicals.
- Finding of yellow deposit (could be old picric acid - shock sensitive white crystals (could be old phenol highly toxic by skin & inhalation)
- Sudden unexpected emission of any type.

H. Emergency: The site has a limited emergency response capability and plan. Assistance will be called in if needed. In case of a need to have everyone leave the site alternate short and long bursts of a car horn, air horn etc. will be used. Report to the trailer area.

J. Site Safety Rules

I will provide each of you a copy of the Safety Rules which you will be responsible to abide by. We will go through the rules now.

K. General Site Safety/Rules

1. For access to North Fenced Area, workers/visitors will require rubber boots, safety glasses, bump hat, and coveralls. Worker/visitor access to South Fenced Area will require only rubber boots unless excavation operations are in progress.
2. Proper safety equipment must be worn in designated site areas.
3. Smoking and eating are only permitted in designated areas.
4. Report all injuries to the Safety/Health Specialist or Site Engineer.
5. Mobile equipment will be operated by authorized employees only.
6. Narcotics, hallucinatory drugs, and alcohol are not permitted on the property. People "under the influence" will not be permitted to enter.
7. Willful acts of horseplay, fighting, sabotage, etc. are not permitted.
8. Hands should be washed before utilizing break area facilities.
9. Contact lenses will not be permitted at the site (see me for further details if needed).
10. Employees shall sign in when arriving at the site and sign out upon departure.
11. All safety procedures must be followed.
12. Designated employees will be required to shower prior to leaving the si

Woburn Site

Supplemental Health Information for Site Workers

As a worker at the Woburn site, you should be aware of the potentials for chemical exposure. You have been briefed on site safety and health rules which have been developed as part of a comprehensive protection program.

Major concerns are Arsenic, Chromium, Lead, Methane, Hides.

Soil in some areas is contaminated with arsenic, lead, and chromium (generally about 0.1%). Hide piles exist and give off an unpleasant odor and methane (flammable) gas. The hide piles may also be of concern in case of injury and infection. Chemicals from past manufacturing operations (possibly picric acid, toluene, benzene, and phenol) could be discovered and waste from past "midnight" dumpers could also be of concern.

Ambient air levels on site will not adversely effect your health. The site safety and health plan will be used as a basis to control exposures during site activities. Controls will be established to keep exposures below those OSHA limits established for workers exposed daily over a working lifetime. You are expected to follow site safety and health rules. Good personal hygiene must be practiced so that materials are not ingested or a wound contaminated. Coveralls, boots and gloves, when required, will limit physical contact with the chemicals and make clean-up easier.

Exposures on site will be kept below OSHA permissible exposure limits. You are required to know and follow safety and health rules.

A very brief summary about the chemicals mentioned follows. No health effects at anticipated levels of exposure are likely. Effects described are for higher exposures over greater time periods.

Arsenic

OSHA's permissible exposure limit for each 8-hour day is 10 micrograms per cubic meter of air ($\mu\text{g}/\text{m}^3$). A general industry standard exists for the substance and is available for review from the site safety and health specialist. Arsenic compounds on site probably come from the past manufacture of arsenic insecticides/herbicides such as lead arsenate. Arsenic poisoning is rarely seen in industry. Inorganic arsenic compounds are considered a cancer hazard by OSHA. The latest American Conference of Governmental Industrial Hygienist information, however, does not list arsenic and its compounds as carcinogenic. This group does list arsenic trioxide production as a process suspected of having a cancer potential for man.

Chromium

The OSHA daily 8-hour permissible exposure limit is 0.5 milligrams per cubic meter of air (mg/m^3) for soluble chromic and chromous salts and 0.1 mg/m^3 for chromic acid and chromates. The American Conference of Governmental Industrial Hygienists has assigned limits as follows: 0.5 mg/m^3 (Cr II and III compounds) and 0.05 mg/m^3 (Cr VI compounds). Skin irritation has been reported from exposure to chromium IV compounds.

Lead

OSHA's permissible exposure limit for lead is 50 ug/m^3 . A general industry standard exists for this substance and is available for review from the site safety and health specialist (copies of Appendices A & B are attached and contain health hazard data). At anticipated levels of exposure (below the action level) no health effects are expected.

Methane

This is a flammable gas (odorless and colorless). It is a simple odorless asphyxiant and in high concentrations could reduce oxygen content of the air. It is not otherwise a toxic hazard. It has a lower explosive limit (LEL) of 5.3% and upper explosive limit (UEL) of 14.0%. Methane can be given off by the decomposing hide piles.

Hides

An odor comes from the hide piles. No toxic concentrations of chemical substances have been measured, however, even next to the ground. The odor may be offensive. The piles may also provide a media for bacteria growth. Thus, care must be taken with any injury and to prevent infection. In addition, the use of odor, dust, and mist masks may be required to minimize exposures/odors.

Picric Acid

The OSHA daily permissible exposure limit is 0.1 mg/m^3 with a notation that skin exposure is significant. These pale yellow crystals have not been identified but this product may have been produced at one time on the site. Skin irritation can result from exposure. The main concern is discovery of any concentrated deposits which could be dangerous when shocked or exposed to heat. Picric acid is an explosive more powerful than TNT.

Toluene

The OSHA 8-hour daily permissible exposure limit is 200 parts per million (ppm). This substance may have been manufactured on site, however, no significant quantities of toluene are known to exist. Toluene has a typical aromatic hydrocarbon odor. The vapors are irritating to eyes, nose, and throat and can cause headache, dizziness, nausea, and unconsciousness. Even if discovered, the potential for significant exposures is very remote. Toluene is flammable (LEL of 1.27% and UEL of 7.0%)

Benzene

The OSHA 8-hour daily permissible exposure level is 1 part per million (ppm). The American Conference of Governmental Industrial Hygienists classifies benzene as a suspected carcinogen and recommends a 10 ppm limit. Benzene may have been produced on site. Benzene, in high concentration over prolonged periods, can cause blood diseases. The liquid is irritating to skin and eyes. Vapors can cause headache, dizziness, nausea, and unconsciousness. No waste deposits of the substance have been identified. The potential for any significant exposure is remote. If you smell benzene, leave the area and contact site management.

Phenol

The OSHA 8-hour daily permissible exposure level for phenol is 0.1 mg/m³ with a notation that skin exposure is significant. Phenol is a white crystal with a distinctive odor. The substance may have been manufactured at the site in the past. No phenol wastes have been identified. Phenol causes severe burns and all body contact must be avoided. Phenol can be absorbed rapidly through the skin and skin exposure can be fatal. If you smell phenol, leave the area at once and contact the safety and health specialist or site engineer.

If you discover any unusual waste deposit during excavation, stop, leave the work area and consult with site management.

XV. For additional information

Appendix C to Section 1910.1025—Medical Surveillance Guidelines

- I. Medical Surveillance and monitoring requirements for workers exposed to inorganic lead
- II. Adverse health effects of inorganic lead
- III. Medical evaluation
- IV. Laboratory evaluation

Appendix A to Section 1910.1025—Substance Data Sheet For Occupational Exposure to Lead

I. Substance Identification

A. *Substance:* Pure lead (Pb) is a heavy metal at room temperature and pressure and is a basic chemical element. It can combine with various other substances to form numerous lead compounds.

B. *Compounds Covered by the Standard:* The word "lead" when used in this standard means elemental lead, all inorganic lead compounds and a class of organic lead compounds called lead soaps. This standard does not apply to other organic lead compounds.

C. *Uses:* Exposure to lead occurs in at least 120 different occupations, including primary and secondary lead smelting, lead storage battery manufacturing, lead pigment manufacturing and use, solder manufacturing and use, shipbuilding and ship repairing, auto manufacturing, and printing.

D. *Permissible Exposure:* The Permissible Exposure Limit (PEL) set by the standard is 50 micrograms of lead per cubic meter of air ($50 \mu\text{g}/\text{m}^3$), averaged over an 8-hour work-day.

E. *Action Level:* The standard establishes an action level of 30 micrograms per cubic meter of air ($30 \mu\text{g}/\text{m}^3$), time weighted average, based on an 8-hour work-day. The action level initiates several requirements of the standard, such as exposure monitoring, medical surveillance, and training and education.

II. Health Hazard Data

A. *Ways in which lead enters your body.* When absorbed into your body in certain doses lead is a toxic substance. The object of the lead standard is to prevent absorption of harmful quantities of lead. The standard is intended to protect you not only from the immediate toxic effects of lead, but also from the

Appendix A to Section 1910.1025—Substance Data Sheet for Occupational Exposure to Lead

I. Substance Identification

- A. Substance
- B. Compounds Covered by the Standard
- C. Uses
- D. Permissible Exposure
- E. Action Level

II. Basic Health Hazard Data

- A. Ways in which lead enters your body
- B. Effects of overexposure to lead
 - 1. Short-term (acute) overexposure
 - 2. Long-term (chronic) overexposure
- 3. Health protection goal of the standard
- 4. Reporting signs and symptoms of health problems

Appendix B to Section 1910.1025—Employee Standard Summary

- I. Permissible Exposure Limit—paragraph (c)
- II. Exposure Monitoring—paragraph (d)
- III. Methods of Compliance—paragraph (e)
- IV. Respiratory Protection—paragraph (f)
- V. Protective Work Clothing & Equipment—paragraph (g)
- VI. Housekeeping—paragraph (h)
- VII. Hygiene Facilities & Practices—paragraph (i)
- VIII. Medical Surveillance—paragraph (j)
- IX. Medical Removal Protection—paragraph (k)
- X. Employee Information & Training—paragraph (l)
- XI. Signs—paragraph (m)
- XII. Recordkeeping—paragraph (n)
- XIII. Observation of Monitoring—paragraph (o)
- XIV. Effective Date—paragraph (p)

serious toxic effects that may not become apparent until years of exposure have passed.

Lead can be absorbed into your body by inhalation (breathing) and ingestion (eating). Lead (except for certain organic lead compounds not covered by the standard, such as tetraethyl lead) is not absorbed through your skin. When lead is scattered in the air as a dust, fume or mist it can be inhaled and absorbed through your lungs and upper respiratory tract. Inhalation of airborne lead is generally the most important source of occupational lead absorption. You can also absorb lead through your digestive system if lead gets into your mouth and is swallowed. If you handle food, cigarettes, chewing tobacco, or make-up which have lead on them or handle them with hands contaminated with lead, this will contribute to ingestion.

A significant portion of the lead that you inhale or ingest gets into your blood stream. Once in your blood stream, lead is circulated throughout your body and stored in various organs and body tissues. Some of this lead is quickly filtered out of your body and excreted, but some remains in the blood and other tissues. As exposure to lead continues, the amount stored in your body will increase if you are absorbing more lead than your body is excreting. Even though you may not be aware of any immediate symptoms of disease, this lead stored in your tissues can be slowly causing irreversible damage, first to individual cells, then to your organs and whole body systems.

B. Effects of overexposure to lead—(1) Short term (acute) overexposure. Lead is a potent, systemic poison that serves no known useful function once absorbed by your body. Taken in large enough doses, lead can kill you in a matter of days. A condition affecting the brain called acute encephalopathy may arise which develops quickly to seizures, coma, and death from cardiorespiratory arrest. A short term dose of lead can lead to acute encephalopathy. Short term occupational exposures of this magnitude are highly unusual, but not impossible. Similar forms of encephalopathy may, however, arise from extended, chronic exposure to lower doses of lead. There is no sharp dividing line between rapidly developing acute effects of lead, and chronic effects which take longer to acquire. Lead adversely affects numerous body systems, and causes forms of health impairment and disease

which arise after periods of exposure as short as days or as long as several years. (Section 1910.1025, Appendix A(II)(B) (1) corrected at 44 FR 68227, November 30, 1979)

(2) Long-term (chronic) overexposure. Chronic overexposure to lead may result in severe damage to your blood-forming, nervous, urinary and reproductive systems. Some common symptoms of chronic overexposure include loss of appetite, metallic taste in the mouth, anxiety, constipation, nausea, pallor, excessive tiredness, weakness, insomnia, headache, nervous irritability, muscle and joint pain or soreness, fine tremors, numbness, dizziness, hyperactivity and colic. In lead colic there may be severe abdominal pain.

Damage to the central nervous system in general and the brain (encephalopathy) in particular is one of the most severe forms of lead poisoning. The most severe, often fatal, form of encephalopathy may be preceded by vomiting, a feeling of dullness progressing to drowsiness and stupor, poor memory, restlessness, irritability, tremor, and convulsions. It may arise suddenly with the onset of seizures, followed by coma, and death. There is a tendency for muscular weakness to develop at the same time. This weakness may progress to paralysis often observed as a characteristic "wrist drop" or "foot drop" and is a manifestation of a disease to the nervous system called peripheral neuropathy.

Chronic overexposure to lead also results in kidney disease with few, if any, symptoms appearing until extensive and most likely permanent kidney damage has occurred. Routine laboratory tests reveal the presence of this kidney disease only after about two-thirds of kidney function is lost. When overt symptoms of urinary dysfunction arise, it is often too late to correct or prevent worsening conditions, and progression to kidney dialysis or death is possible.

Chronic overexposure to lead impairs the reproductive systems of both men and women. Overexposure to lead may result in decreased sex drive, impotence and sterility in men. Lead can alter the structure of sperm cells raising the risk of birth defects. There is evidence of miscarriage and stillbirth in women whose husbands were exposed to lead

or who were exposed to lead themselves. Lead exposure also may result in decreased fertility, and abnormal menstrual cycles in women. The course of pregnancy may be adversely affected by exposure to lead since lead crosses the placental barrier and poses risks to developing fetuses. Children born of parents either one of whom were exposed to excess lead levels are more likely to have birth defects, mental retardation, behavioral disorders or die during the first year of childhood.

Overexposure to lead also disrupts the blood-forming system resulting in decreased hemoglobin (the substance in the blood that carries oxygen to the cells) and ultimately anemia. Anemia is characterized by weakness, pallor and fatigability as a result of decreased oxygen carrying capacity in the blood.

(3) Health protection goals of the standard. Prevention of adverse health effects for most workers from exposure to lead throughout a working lifetime requires that worker blood lead (PbB) levels be maintained at or below forty micrograms per one hundred grams of whole blood (40 µg/100g). The blood lead levels of workers (both male and female workers) who intend to have children should be maintained below 30 µg/100g to minimize adverse reproductive health effects to the parents and to the developing fetus.

The measurement of your blood lead level is the most useful indicator of the amount of lead being absorbed by your body. Blood lead levels (PbB) are most often reported in units of milligrams (mg) or micrograms (µg) of lead (1 mg = 1000 µg) per 100 grams (100g), 100 milliliters (100 ml) or deciliter (dl) of blood. These three units are essentially the same. Sometime PbB's are expressed in the form of mg% or µg%. This is a shorthand notation for 100g, 100 ml, or dl.

PbB measurements show the amount of lead circulating in your blood stream, but do not give any information about the amount of lead stored in your various tissues. PbB measurements merely show current absorption of lead, not the effect that lead is having on your body or the effects that past lead exposure may have already caused. Past research into lead-related diseases, however, has focused heavily on associations between PbBs and various diseases. As a result, your PbB is an

important indicator of the likelihood that you will gradually acquire a lead-related health impairment or disease.

Once your blood lead level climbs above 40 $\mu\text{g}/100\text{g}$, your risk of disease increases. There is a wide variability of individual response to lead, thus it is difficult to say that a particular PbB in a given person will cause a particular effect. Studies have associated fatal encephalopathy with PbBs as low as 150 $\mu\text{g}/100\text{g}$. Other studies have shown other forms of diseases in some workers with PbBs well below 80 $\mu\text{g}/100\text{g}$. Your PbB is a crucial indicator of the risks to your health, but one other factor is also extremely important. This factor is the length of time you have had elevated PbBs. The longer you have an elevated PbB, the greater the risk that large quantities of lead are being gradually stored in your organs and tissues (body burden). The greater your overall body burden, the greater the chances of substantial permanent damage.

The best way to prevent all forms of lead-related impairments and diseases—both short term and long term—is to maintain your PbB below 40 $\mu\text{g}/100\text{g}$. The provisions of the standard are designed with this end in mind. Your employer has prime responsibility to assure that the provisions of the standard are complied with both by the company and by individual workers. You as a worker, however, also have a responsibility to assist your employer in complying with the standard. You can play a key role in protecting your own health by learning about the lead hazards and their control, learning what the standard requires, following the standard where it governs your own actions, and seeing that your employer complies with provisions governing his actions.

(4) *Reporting signs and symptoms of health problems.* You should immediately notify your employer if you develop signs or symptoms associated with lead poisoning or if you desire medical advice concerning the effects of current or past exposure to lead on your ability to have a healthy child. You should also notify your employer if you have difficulty breathing during a respirator fit test or while wearing a respirator. In each of these cases your employer must make available to you appropriate medical examinations or consultations. These must be provided

at no cost to you and at a reasonable time and place.

The standard contains a procedure whereby you can obtain a second opinion by a physician of your choice. If the employer selected the initial physician. This procedure, however, was delayed by the Court of Appeals in March of 1979, and will not go into effect until after the Court's decision on the overall validity of the standard.

Appendix B to Section 1910.1025— Employee Standard Summary

This appendix summarizes key provisions of the standard that you as a worker should become familiar with.

The appendix discusses the entire standard, but some portions of the standard were temporarily postponed (stayed) by federal court on March 2, 1979. This litigation concerns the validity of the entire lead standard, and a final decision is expected in 1980. Most of the lead standard is currently legally in effect, however. The following discussion in the Appendix notes those few provisions of the standard which have been temporarily stayed.

I. Permissible Exposure Limit (PEL)- paragraph (c)

The standard sets a permissible exposure limit (PEL) of fifty micrograms of lead per cubic meter of air ($50 \mu\text{g}/\text{m}^3$), averaged over an 8-hour work-day. This is the highest level of lead in air to which you may be permissibly exposed over an 8-hour workday. Since it is an 8-hour average it permits short exposures above the PEL so long as for each 8-hour work day your average exposure does not exceed the PEL.

This standard recognizes that your daily exposure to lead can extend beyond a typical 8-hour workday as the result of overtime or other alterations in your work schedule. To deal with this, the standard contains a formula which reduces your permissible exposure when you are exposed more than 8 hours. For example, if you are exposed to lead for 10 hours a day, the maximum permitted average exposure would be $40 \mu\text{g}/\text{m}^3$.

II. Exposure Monitoring-paragraph (d)

If lead is present in the workplace where you work in any quantity, your employer is required to make an initial determination of whether the action level is exceeded for any employee. This initial determination must include

instrument monitoring of the air for the presence of lead and must cover the exposure of a representative number of employees who are reasonably believed to have the highest exposure levels. If your employer has conducted appropriate air sampling for lead in the past year he may use these results. If there have been any employee complaints of symptoms which may be attributable to exposure to lead or if there is any other information or observations which would indicate employee exposure to lead, this must also be considered as part of the initial determination. This initial determination must have been completed by March 31, 1979. If this initial determination shows that a reasonable possibility exists that any employee may be exposed, without regard to respirators, over the action level ($30 \mu\text{g}/\text{m}^3$) your employer must set up an air monitoring program to determine the exposure level of every employee exposed to lead at your workplace.

In carrying out this air monitoring program, your employer is not required to monitor the exposure of every employee, but he must monitor a representative number of employees and job types. Enough sampling must be done to enable each employee's exposure level to be reasonably represented by at least one full shift (at least 7 hours) air sample. In addition, these air samples must be taken under conditions which represent each employee's regular, daily exposure to lead. All initial exposure monitoring must have been completed by May 30, 1979.

If you are exposed to lead and air sampling is performed, your employer is required to quickly notify you in writing of air monitoring results which represent your exposure. If the results indicate your exposure exceeds the PEL (without regard to your use of respirators), then your employer must also notify you of this in writing, and provide you with a description of the corrective action that will be taken to reduce your exposure.

Your exposure must be rechecked by monitoring every six months if your exposure is over the action level but below the PEL. Air monitoring must be repeated every three months if you are exposed over the PEL. Your employer may discontinue monitoring for you if 2 consecutive measurements, taken at

least two weeks apart, are below the action level. However, whenever there is a change in production, process, control, or personnel change at your workplace which may result in new or additional exposure to lead, or whenever there is any other reason to suspect a change which may result in new or additional exposure to lead, your employer must perform additional monitoring.

III. Methods of Compliance—paragraph (e)

Your employer is required to assure that no employee is exposed to lead in excess of the PEL. The standard establishes a priority of methods to be used to meet the PEL. Due to the temporary ruling by the United States Circuit Court of Appeals, your employer will not be legally required to use the preferred engineering and work practice controls. Until the litigation is completed, your employer may meet the PEL by requiring you to wear respirators. Alternatively, the employer may choose to implement engineering and work practice controls even though they are not legally required. Also, OSHA's previous lead standard is still in effect. This does require your employer to use feasible engineering and administrative controls to reduce employee exposure levels, but only to a level of 200 micrograms of lead per cubic meter of air (200 $\mu\text{g}/\text{m}^3$).

IV. Respiratory Protection—paragraph (f)

Your employer is required to provide and assure your use of respirators when your exposure to lead is not controlled below the PEL by other means. The employer must pay the cost of the respirator. Whenever you request one, your employer is also required to provide you a respirator even if your air exposure level does not exceed the PEL. You might desire a respirator when, for example, you have received medical advice that your lead absorption should be decreased. Or, you may intend to have children in the near future, and want to reduce the level of lead in your body to minimize adverse reproductive effects. While respirators are the least satisfactory means of controlling your exposure, they are capable of providing significant protection if properly chosen, fitted, worn, cleaned, maintained, and replaced when they stop providing adequate protection.

Your employer is required to select respirators from the seven types listed in Table II of the Respiratory Protection section of the standard. Any respirator chosen must be approved by the Mine Safety and Health Administration (MSHA) or the National Institute for Occupational Safety and Health (NIOSH). This respirator selection table will enable your employer to choose a type of respirator which will give you a proper amount of protection based on your airborne lead exposure. Your employer may select a type of respirator that provides greater protection than that required by the standard; that is, one recommended for a higher concentration of lead than is present in your workplace. For example, a powered air purifying respirator (PAPR) is much more protective than a typical negative pressure respirator, and may also be more comfortable to wear. A PAPR has a filter, cartridge or canister to clean the air, and a power source which continuously blows filtered air into your breathing zone. Your employer might make a PAPR available to you to ease the burden of having to wear a respirator for long periods of time. The standard provides that you can obtain a PAPR upon request, but this requirement has been stayed as a part of the pending litigation.

Your employer must also start a Respiratory Protection Program. This program must include written procedures for the proper selection, use, cleaning, storage, and maintenance of respirators.

Your employer must assure that your respirator facepiece fits properly. Proper fit of a respirator facepiece is critical. Obtaining a proper fit on each employee may require your employer to make available two or three different mask types. In order to assure that your respirator fits properly and that facepiece leakage is minimized, beginning on March 1, 1980 your employer must give you a "quantitative fit test" if you use a negative pressure respirator. Any respirator which has a filter, cartridge or canister which cleans the work room air before you breathe it and which requires the force of your inhalation to draw air thru the filtering element is a negative pressure respirator. A positive pressure respirator supplies air to you directly. A quantitative fit test uses a sophisticated machine to measure the amount, if any,

of test material that leaks into the facepiece of your respirator.

You must also receive from your employer proper training in the use of respirators. Your employer is required to teach you how to wear a respirator, to know why it is needed, and to understand its limitations.

Until March 1, 1980, your employer must test the effectiveness of your negative pressure respirator initially and at least every six months thereafter with a "qualitative fit test." In this test, the fit of the facepiece is checked by seeing if you can smell a substance placed outside the respirator. If you can, there is appreciable leakage where the facepiece meets your face.

The standard provides that if your respirator uses filter elements, you must be given an opportunity to change the filter elements whenever an increase in breathing resistance is detected. You also must be permitted to periodically leave your work area to wash your face and respirator facepiece whenever necessary to prevent skin irritation. If you ever have difficulty in breathing during a fit test or while using a respirator, your employer must make a medical examination available to you to determine whether you can safely wear a respirator. The result of this examination may be to give you a positive pressure respirator (which reduces breathing resistance) or to provide alternative means of protection.

V. Protective Work Clothing and Equipment—paragraph (g)

If you are exposed to lead above the PEL, or if you are exposed to lead compounds such as lead arsenate or lead azide which can cause skin and eye irritation, your employer must provide you with protective work clothing and equipment appropriate for the hazard. If work clothing is provided, it must be provided in a clean and dry condition at least weekly, and daily if your airborne exposure to lead is greater than 200 $\mu\text{g}/\text{m}^3$. Appropriate protective work clothing and equipment can include coveralls or similar full-body work clothing, gloves, hats, shoes or disposable shoe coverlets, and face shields or vented goggles. Your employer is required to provide all such equipment at no cost to you. He is responsible for providing repairs and replacement as necessary, and also is responsible for the cleaning, laundering

or disposal of protective clothing and equipment. Contaminated work clothing or equipment must be removed in change rooms and not worn home or you will extend your exposure and expose your family since lead from your clothing can accumulate in your house, car, etc. Contaminated clothing which is to be cleaned, laundered or disposed of must be placed in closed containers in the change room. At no time may lead be removed from protective clothing or equipment by any means which disperses lead into the workroom air.

[Section 1910.1025, Appendix B(V) corrected at 44 FR 68827, November 30, 1979]

VI. Housekeeping-paragraph (h)

Your employer must establish a housekeeping program sufficient to maintain all surfaces as free as practicable of accumulations of lead dust. Vacuuming is the preferred method of meeting this requirement, and the use of compressed air to clean floors and other surfaces is absolutely prohibited. Dry or wet sweeping, shoveling, or brushing may not be used except where vacuuming or other equally effective methods have been tried and do not work. Vacuums must be used and emptied in a manner which minimizes the reentry of lead into the workplace.

VII. Hygiene Facilities and Practices-paragraph (i)

The standard requires that change rooms, showers, and filtered air lunchrooms be constructed and made available to workers exposed to lead above the PEL. These requirements have temporarily been delayed by the court of appeals in situations where new facilities must be constructed, or where substantial renovations must be made to existing facilities. When the PEL is exceeded and these facilities are available, however, the employer must assure that food and beverage is not present or consumed, tobacco products are not present or used, and cosmetics are not applied, except in these facilities. Change rooms, showers, and lunchrooms, if available, must be used by workers exposed in excess of the PEL. After showering, no clothing or equipment worn during the shift may be worn home, and this includes shoes and underwear. Your own clothing worn during the shift should be carried home and cleaned carefully so that it does not contaminate your home. Lunchrooms

may not be entered with protective clothing or equipment unless surface dust has been removed by vacuuming, downdraft booth, or other cleaning method. Finally, workers exposed above the PEL must wash both their hands and faces prior to eating, drinking, smoking or applying cosmetics.

All of the facilities and hygiene practices just discussed are essential to minimize additional sources of lead absorption from inhalation or ingestion of lead that may accumulate on you, your clothes, or your possessions. Strict compliance with these provisions can virtually eliminate several sources of lead exposure which significantly contribute to excessive lead absorption.

VIII. Medical Surveillance-paragraph (j)

The medical surveillance program is part of the standard's comprehensive approach to the prevention of lead-related disease. Its purpose is to supplement the main thrust of the standard which is aimed at minimizing airborne concentrations of lead and sources of ingestion. Only medical surveillance can determine if the other provisions of the standard have effectively protected you as an individual. Compliance with the standard's provision will protect most workers from the adverse effects of lead exposure, but may not be satisfactory to protect individual workers (1) who have high body burdens of lead acquired over past years, (2) who have additional uncontrolled sources of non-occupational lead exposure, (3) who exhibit unusual variations in lead absorption rates, or (4) who have specific non-work related medical conditions which could be aggravated by lead exposure (e.g., renal disease, anemia). In addition, control systems may fail, or hygiene and respirator programs may be inadequate. Periodic medical surveillance of individual workers will help detect those failures. Medical surveillance will also be important to protect your reproductive ability—regardless of whether you are a man or woman.

All medical surveillance required by the standard must be performed by or under the supervision of a licensed physician. The employer must provide required medical surveillance without cost to employees and at a reasonable time and place. The standard's medical surveillance program has two parts—

periodic biological monitoring and medical examinations.

Your employer's obligation to offer you medical surveillance is triggered by the results of the air monitoring program. Medical surveillance must be made available to all employees who are exposed in excess of the action level for more than 30 days a year. The initial phase of the medical surveillance program, which includes blood lead level tests and medical examinations, must be completed for all covered employees no later than August 28, 1979. Priority within this first round of medical surveillance must be given to employees whom the employer believes to be at greatest risk from continued exposure (for example, those with the longest prior exposure to lead, or those with the highest current exposure).

Thereafter, the employer must periodically make medical surveillance—both biological monitoring and medical examinations—available to all covered employees.

Biological monitoring under the standard consists of blood lead level (PbB) and zinc protoporphyrin tests at least every 6 months after the initial PbB test. A zinc protoporphyrin (ZPP) test is a very useful blood test which measures an effect of lead on your body, but this test has been temporarily stayed by the Court. Thus biological monitoring under the standard is currently limited to PbB testing. If a worker's PbB exceeds 40 µg/100g the monitoring frequency must be increased from every 6 months to at least every 2 months and not reduced until two consecutive PbBs indicate a blood lead level below 40 µg/100g. Each time your PbB is determined to be over 40 µg/100g, your employer must notify you of this in writing within five working days of his receipt of the test results. The employer must also inform you that the standard requires temporary medical removal with economic protection when your PbB exceeds certain criteria (See Discussion of Medical Removal Protection—Paragraph (k)). During the first year of the standard, this removal criterion is 80 µg/100g. Anytime your PbB exceeds 80 µg/100g your employer must make available to you a prompt follow-up PbB test to ascertain your PbB. If the two tests both exceed 80 µg/100g and you are temporarily removed, then your employer must make successive PbB tests available to you on a monthly basis during the period of your removal.

Medical examinations beyond the initial one must be made available on an annual basis if your blood lead level exceeds 40 µg/100g at any time during the preceding year. The initial examination will provide information to establish a baseline to which subsequent data can be compared. An initial medical examination must also be made available (prior to assignment) for each employee being assigned for the first time to an area where the airborne concentration of lead equals or exceeds the action level. In addition, a medical examination or consultation must be made available as soon as possible if you notify your employer that you are experiencing signs or symptoms commonly associated with lead poisoning or that you have difficulty breathing while wearing a respirator or during a respirator fit test. You must also be provided a medical examination or consultation if you notify your employer that you desire medical advice concerning the effects of current or past exposure to lead on your ability to procreate a healthy child.

Finally, appropriate follow-up medical examinations or consultations may also be provided for employees who have been temporarily removed from exposure under the medical removal selection provisions of the standard (See Part IX, below).

The standard specifies the minimum content of pre-assignment and annual medical examinations. The content of other types of medical examinations and consultations is left up to the sound discretion of the examining physician. Pre-assignment and annual medical examinations must include (1) a detailed work history and medical history, (2) a thorough physical examination, and (3) a series of laboratory tests designed to check your blood chemistry and your kidney function. In addition, at any time upon your request, a laboratory evaluation of male fertility will be made (microscopic examination of a sperm sample), or a pregnancy test will be given.

The standard does not require that you participate in any of the medical procedures, tests, etc. which your employer is required to make available to you. Medical surveillance can, however, play a very important role in protecting your health. You are strongly encouraged, therefore, to participate in a meaningful fashion. The standard

contains a multiple physician review mechanism which would give you a chance to have a physician of your choice directly participate in the medical surveillance program. If you were dissatisfied with an examination by a physician chosen by your employer, you could select a second physician to conduct an independent analysis. The two doctors would attempt to resolve any differences of opinion, and select a third physician to resolve any firm dispute. This multiple physician review mechanism, however, has been temporarily delayed by the Court of Appeals. As a result, generally your employer will choose the physician who conducts medical surveillance under the lead standard—unless you and your employer can agree on the choice of a physician or physicians. Some companies and unions have agreed in advance, for example, to use certain independent medical laboratories or panels of physicians. Any of these arrangements are acceptable so long as required medical surveillance is made available to workers.

The standard requires your employer to provide certain information to a physician to aid in his or her examination of you. This information includes (1) the standard and its appendices, (2) a description of your duties as they relate to lead exposure, (3) your exposure level, (4) a description of personal protective equipment you wear, (5) prior blood lead level results, and (6) prior written medical opinions concerning you that the employer has. After a medical examination or consultation the physician must prepare a written report which must contain (1) the physician's opinion as to whether you have any medical condition which places you at increased risk of material impairment to health from exposure to lead, (2) any recommended special protective measures to be provided to you, (3) any blood lead level determinations, and (4) any recommended limitation on your use of respirators. This last element must include a determination of whether you can wear a powered air purifying respirator (PAPR) if you are found unable to wear a negative pressure respirator.

The medical surveillance program of the lead standard may at some point in time serve to notify certain workers that

they have acquired a disease or other adverse medical condition as a result of occupational lead exposure. If this is true, these workers might have legal rights to compensation from public agencies, their employers, firms that supply hazardous products to their employers, or other persons. Some states have laws, including worker compensation laws, that disallow a worker who learns of a job-related health impairment to sue, unless the worker sues within a short period of time after learning of the impairment. (This period of time may be a matter of months or years.) An attorney can be consulted about these possibilities. It should be stressed that OSHA is in no way trying to either encourage or discourage claims or lawsuits. However, since results of the standard's medical surveillance program can significantly affect the legal remedies of a worker who has acquired a job-related disease or impairment, it is proper for OSHA to make you aware of this.

The medical surveillance section of the standard also contains provisions dealing with chelation. Chelation is the use of certain drugs (administered in pill form or injected into the body) to reduce the amount of lead absorbed in body tissues. Experience accumulated by the medical and scientific communities has largely confirmed the effectiveness of this type of therapy for the treatment of very severe lead poisoning. On the other hand, it has also been established that there can be a long list of extremely harmful side effects associated with the use of chelating agents. The medical community has balanced the advantages and disadvantages resulting from the use of chelating agents in various circumstances and has established when the use of these agents is acceptable. The standard includes these accepted limitations due to a history of abuse of chelation therapy by some lead companies. The most widely used chelating agents are calcium disodium EDTA, (Ca Na₂ EDTA), Calcium Disodium Versenate (Versenate), and D-penicillamine (penicillamine or Cupramine).

The standard prohibits "prophylactic chelation" of any employee by any person the employer retains, supervises or controls. "Prophylactic chelation" is the routine use of chelating or similarly acting drugs to prevent elevated blood levels in workers who are

occupationally exposed to lead, or the use of these drugs to *routinely* lower blood lead levels to predesignated concentrations believed to be 'safe'. It should be emphasized that where an employer takes a worker who has no symptoms of lead poisoning and has chelation carried out by a physician (either inside or outside of a hospital) solely to reduce the worker's blood lead level, that will generally be considered prophylactic chelation. The use of a hospital and a physician does not mean that prophylactic chelation is not being performed. Routine chelation to prevent increased or reduce current blood lead levels is unacceptable whatever the setting.

The standard allows the use of "therapeutic" or "diagnostic" chelation if administered under the supervision of a licensed physician in a clinical setting with thorough and appropriate medical monitoring. Therapeutic chelation responds to severe lead poisoning where there are marked symptoms. Diagnostic chelation involved giving a patient a dose of the drug then collecting all urine excreted for some period of time as an aid to the diagnosis of lead poisoning.

In cases where the examining physician determines that chelation is appropriate, you must be notified in writing of this fact before such treatment. This will inform you of a potentially harmful treatment, and allow you to obtain a second opinion.

[Section 1910.1025, Appendix B(VII) corrected at 44 FR 68827, November 30, 1979]

DL Medical Removal Protection Paragraph (k)

Excessive lead absorption subjects you to increased risk of disease. Medical removal protection (MRP) is a means of protecting you when, for whatever reasons, other methods, such as engineering controls, work practices, and respirators, have failed to provide the protection you need. MRP involves the temporary removal of a worker from his or her regular job to a place of significantly lower exposure without any loss of earnings, seniority, or other employment rights or benefits. The purpose of this program is to cease further lead absorption and allow your body to naturally excrete lead which has previously been absorbed. Temporary medical removal can result from an elevated blood lead level, or a medical opinion. Up to eighteen months of protection is provided as a result of either form of removal. The vast majority of removed workers, however, will return to their former jobs long before this eighteen month period expires. The standard contains special provisions to deal with the extraordinary but possible case where a longterm worker's blood lead level does not adequately decline during eighteen months of removal.

During the first year of the standard, if your blood lead level is 80 $\mu\text{g}/100\text{g}$ or above you must be removed from any exposure where your air lead level without a respirator would be 100 $\mu\text{g}/\text{m}^3$ or above. If you are removed from your normal job you may not be returned until your blood lead level declines to at least 60 $\mu\text{g}/100\text{g}$. These criteria for removal and return will change according to the following schedule:

	Removal blood lead ($\mu\text{g}/100\text{g}$)	Air lead ($\mu\text{g}/\text{m}^3$)	Return blood lead ($\mu\text{g}/100\text{g}$)
After Mar. 1, 1980	70 and above	50 and above	At or below 50.
After Mar. 1, 1981	60 and above	30 and above	At or below 40.
After Mar. 1, 1983	50 and above averaged over six months.	20 and above	At or below 40.

You may also be removed from exposure even if your blood lead levels are below these criteria if a final medical determination indicates that you temporarily need reduced lead exposure for medical reasons. If the physician who is implementing your employers medical program makes a final written opinion recommending your removal or other special protective measures, your employer must

implement the physician's recommendation. If you are removed in this manner, you may only be returned when the doctor indicates that it is safe for you to do so.

The standard does not give specific instructions dealing with what an employer must do with a removed worker. Your job assignment upon removal is a matter for you, your employer and your union (if any) to

work out consistent with existing procedures for job assignments. Each removal must be accomplished in a manner consistent with existing collective bargaining relationships. Your employer is given broad discretion to implement temporary removals so long as no attempt is made to override existing agreements. Similarly, a removed worker is provided no right to veto an employer's choice which satisfies the standard.

In most cases, employers will likely transfer removed employees to other jobs with sufficiently low lead exposure. Alternatively, a worker's hours may be reduced so that the time weighted average exposure is reduced, or he or she may be temporarily laid off if no other alternative is feasible.

In all of these situation, MRP benefits must be provided during the period of removal—i.e., you continue to receive the same earnings, seniority, and other rights and benefits you would have had if you had not been removed. Earnings includes more than just your base wage; it includes overtime, shift differentials, incentives, and other compensation you would have earned if you had not been removed. During the period of removal you must also be provided with appropriate follow-up medical surveillance. If you were removed because your blood lead level was too high, you must be provided with a monthly blood test. If a medical opinion caused your removal, you must be provided medical tests or examinations that the doctor believes to be appropriate. If you do not participate in this follow up medical surveillance, you may lose your eligibility for MRP benefits.

When you are medically eligible to return to your former job, your employer must return you to your "former job status." This means that you are entitled to the position, wages, benefits, etc., you would have had if you had not been removed. If you would still be in your old job if no removal had occurred that is where you go back. If not, you are returned consistent with whatever job assignment discretion your employer would have had if no removal had occurred. MRP only seeks to maintain your rights, not expand them or diminish them.

If you are removed under MRP and you are also eligible for worker compensation or other compensation for

lost wages, your employer's MRP benefits obligation is reduced by the amount that you actually receive from other sources. This is also true if you obtain other employment during the time you are laid off with MRP benefits.

The standard also covers situations where an employer voluntarily removes a worker from exposure to lead due to the effects of lead on the employee's medical condition, even though the standard does not require removal. In these situations MRP benefits must still be provided as though the standard required removal. Finally, it is important to note that in all cases where removal is required, respirators cannot be used as a substitute. Respirators may be used before removal becomes necessary, but not as an alternative to a transfer to a low exposure job, or to a lay-off with MRP benefits.

X. Employee Information and Training—Paragraph (1)

Your employer is required to provide an information and training program for all employees exposed to lead above the action level or who may suffer skin or eye irritation from lead. This program must inform these employees of the specific hazards associated with their work environment, protective measures which can be taken, the danger of lead to their bodies (including their reproductive systems), and their rights under the standard. In addition your employer must make readily available to all employees, including those exposed below the action level, a copy of the standard and its appendices and must distribute to all employees any materials provided to the employer by the Occupational Safety and Health Administration (OSHA).

Your employer is required to complete this training program for all employees by August 28, 1979. After this date, all new employees must be trained prior to initial assignment to areas where there is a possibility of exposure over the action level.

This training program must also be provided at least annually thereafter.

XI. Signs—Paragraph (m)

The standard requires that the following warning sign be posted in work areas where the exposure to lead exceeds the PEL:

LEAD WORK AREA

LEAD WORK AREA NO SMOKING OR EATING

This requirement, however, has been stayed by the Court of Appeals.

XI. Recordkeeping—Paragraph (n)

Your employer is required to keep all records of exposure monitoring for airborne lead. These records must include the name and job classification of employees measured, details of the sampling and analytic techniques, the results of this sampling, and the type of respiratory protection being worn by the person sampled. Your employer is also required to keep all records of biological monitoring and medical examination results. These must include the names of the employees, the physician's written opinion, and a copy of the results of the examination. All of the above kinds of records must be kept for 40 years, or for at least 20 years after your termination of employment, whichever is longer.

Recordkeeping is also required if you are temporarily removed from your job under the medical removal protection program. This record must include your name and social security number, the date of your removal and return, how the removal was or is being accomplished, and whether or not the reason for the removal was an elevated blood lead level. Your employer is required to keep each medical removal record only for as long as the duration of an employee's employment.

The standard requires that if you request to see or copy environmental monitoring, blood lead level monitoring, or medical removal records, they must be made available to you or to a representative that you authorize. Your union also has access to these records. Medical records other than PbB's must also be provided upon request to you, to your physician or to any other person whom you may specifically designate. Your union does not have access to your personal medical records unless you authorize their access.

[Section 1910.1025, Appendix B(XI) corrected at 44 FR 68827, November 30, 1979]

XIII. Observations of Monitoring—Paragraph (o)

When air monitoring for lead is performed at your workplace as required by this standard, your employer must allow you or someone you designate to act as an observer of the monitoring. Observers are entitled to

an explanation of the measurement procedure, and to record the results obtained. Since results will not normally be available at the time of the monitoring, observers are entitled to record or receive the results of the monitoring when returned by the laboratory. Your employer is required to provide the observer with any personal protective devices required to be worn by employees working in the area that is being monitored. The employer must require the observer to wear all such equipment and to comply with all other applicable safety and health procedures.

XIV. Effective Date—Paragraph (p)

The standard's effective date is March 1, 1979, and employer obligations under the standard begin to come into effect as of that date.

XV. For Additional Information

A. Copies of the Standard and explanatory materials can be obtained free of charge by calling or writing the OSHA Office of Publications, Room S-1212, United States Department of Labor, Washington, D.C. 20210; Telephone (202) 523-6138. The following publications are available:

1. The standard and summary of the, statement of reasons (preamble), Federal Register, Volume 43, pp. 52952-53014, November 14, 1978.

2. The full statement of reasons (preamble) Federal Register, vol. 43, pp. 54354-54509, November 21, 1978.

3. Partial Administrative Stay and Corrections to the standard, [44 FR 5446-5448] January 28, 1979.

4. Notice of the Partial Judicial Stay [44 FR 14554-14555] March 13, 1979.

5. Corrections to the preamble, Federal Register, vol. 44, pp. 20680-20681, April 6, 1979.

6. Additional correction to the preamble concerning the construction industry, Federal Register, vol. 44, p. 50338, August 28, 1979.

7. Appendices to the standard, Federal Register, vol. 44, pp. _____, October _____, (1979).

B. Additional information about the standard, its enforcement, and your employer's compliance can be obtained from the nearest OSHA Area Office listed in your telephone directory under United States Government/Department of Labor.

✓
ATTACHMENT 4

MICROBIOLOGICAL CONSULTANT'S EVALUATIONS

Yale University *New Haven, Connecticut 06510*

SCHOOL OF MEDICINE

333 Cedar Street

Department of Laboratory Medicine

July 21, 1982

OCCUPATIONAL MEDICINE

JUL 26 1982

Dr. Herbert Northrop
Stauffer Chemical Company
Westport, Ct. 06880

Dear Dr. Northrop:

I have examined your Safety and Health Plan concerning the Woburn Project in Woburn, Massachusetts and on June 24, 1982 visited the actual site of hyde dumping.

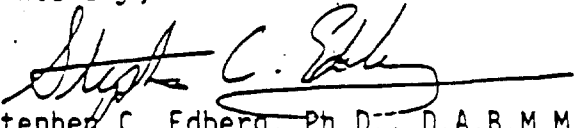
After discussing procedures in animal processing conducted on-site between 1935 and the mid-1970's by the Stauffer Chemical Company I conclude that no practical danger exists from anthrax. Extensive cooking, and at least two separate stages, each alone, should have been sufficient to render this microbe's spores non-viable.

I do believe that a potential theoretical hazard exists from microorganisms, however. First, the environment of the hyde pile may have provided a selective growth medium for a particular organism. While this organism in the wild in low numbers may not pose a hazard for man in a concentrated form a person receiving an extraordinarily high dose may be at risk. Secondly, fungi in high numbers may produce an allergic pneumonitis much like the disease syndrome "Farmer's Lung". Although I believe the danger from either of the possibilities is minimal I feel steps should be taken to obviate the potential hazard prior to sectional excavation. I propose to do this by sampling core material for "predominant microbes" including bacteria and fungi.

In all respects I agree with your report concerning the Woburn Project and the steps you have taken to eliminate possible hazards to the workers and their environment. There is no doubt in my mind, as one certified in "Public Health and Medical Laboratory Microbiology" that you have gone considerably beyond what I would consider to be acceptable procedures.

As we discussed my laboratory will serve as a monitoring station and consultant for this project. I shall be available for testimony for the EPA or any other governmental agency as will my findings.

Sincerely,


Stephen C. Edberg, Ph.D., D.A.B.M.M.
Director, Clinical Microbiology Laboratory
Yale-New Haven Hospital
Associate Professor of Laboratory Medicine
Yale University School of Medicine

50
211

After Yale University letter
Before Madison Bacteriological Laboratories

Madison Bacteriological Laboratories, Inc.

845 East Johnson Street Madison, Wisconsin 53703

608-256-6219

REPORT

OCCUPATIONAL MEDICINE
AUG 18 1982

To: Dr. Herbert Northrup
Stauffer Chemical Co.
Nyala Farm Rd.
Westport, CT 06880

Date: 8/16/82

Date Samples Received:

8/6/82

Sample Description

Test Result

Woburn Waste Site 8/5/82	Anthrax/25g.
43492 New hide pile 6" 0073 8:50 AM	Neg.
43493 New hide pile 6' 0075 9:05 AM	Neg.
43494 Old hide pile 6" 0077 12:20	Neg.
43495 Old hide pile 6' 0079 12:35	Neg.

MADISON BACTERIOLOGICAL LABS., INC.

R. H. Deibel

R. H. DEIBEL PH.D.

18 Aug 82

cc: J. Sheehan

D. McGrade

W. Pickett

Yale University New Haven, Connecticut 06510

SCHOOL OF MEDICINE

333 Cedar Street

Department of Laboratory Medicine

October 6, 1982

Dr. Herbert Northrop
Stauffer Chemical Company
Westport, Ct.

Dear Dr. Northrop:

I have microbiologically analyzed the results of the samples you sent to me from Woburn, Massachusetts. This letter represents a summary of my findings. The individual data sheets, containing a detailed description of the processing of the specimens, are in my files and are available to Stauffer upon request.

Using techniques to isolate both pathogenic and the common soil microbes, your specimens contained no virulent microorganisms. Predominant in the soil samples were fungi of various genera: Mucor, Rhizopus, Penicillium, Aspergillus, Paecilomyces, and Cladosporium. The major genera of bacteria were Azotobacter, Clostridium, Pseudomonas, Acetobacter, and Erwinia. There were other fungi, yeasts, and molds present in small numbers that I did not feel significant.

None of the above mentioned microbes, I feel, were present in sufficient numbers or in relatively high proportions to warrant their being considered a potential hazard for the workers on site.

Sincerely,

Dr. Stephen C. Edberg / dag

Stephen C. Edberg, Ph.D., D.A.B.M.M.
Director, Clinical Microbiology Laboratory
Yale-New Haven Hospital
Associate Professor of Laboratory Medicine
Yale University School of Medicine

SCE:dag

(dictated by Dr. Edberg and signed
in his absence)

✓
ATTACHMENT 5

EXTRACT OF ENVIRONMENTAL REFERENCES

Extract of Specific Environmental

References on Woburn Site

1. EPA; Fact Sheet on Woburn.
2. Ecology and Environment, Inc.; Monitoring of Metal Content in Airborne Particulate Migrating from Mark Phillip Trust (also 5/13/81 Amendment).
3. A. D. Little, Inc.; Draft Report of On-Site and Community Odor Survey at Woburn Massachusetts Hazardous Waste Disposal Site (20 January '82).
4. R. Cleary; Industri-Plex 128, Commerce Way, Woburn, Mass., Notes by Robert Cleary, Surface Water and Leachate Samples.
5. Camp, Dresser and McKee, Inc.; Final Work Plan, Immediate Action and Remedial Investigation - Woburn, Mass. (11/12/81).
6. Goldberg-Ziono & Associates; Hydrogeologic Study (10/82).
7. EPA; Work by EPA, 1979, Surface Soil and Water Samples.
8. Mass. DEQE; Soil, Surface Water and Sedement Samples and Analyses (10/24/79 and 1/7/80).
9. F. C. Hart Associates; Plan for Investigation of Hazardous Waste Problems (March 1980).
10. EPA; Priority Pollutant Survey, EPA and Mass. DEQE (9/28/80).
11. Ecology and Environment, Inc.; Inventory and Analysis of Existing Well Data for East and North Woburn, Mass. (1/9/81).
12. Ecology and the Environment, Inc.; Interim Report on the Geology and Groundwater of North and East Woburn, Mass. (4/3/81).
13. Ecology and the Environment, Inc.; Interim Report on the Groundwater Quality of East and North Woburn, Mass. (5/6/81).
14. Metcalf and Eddy, Inc.; Memorandum to M. Beers (1/2/82) Background Information on Merrimac Chemicals.
15. Chemical Manufacturers Assoc., Inc.; A Hazardous Waste Site Management Plan (1982).
16. Costello and King; Protecting Workers Who Clean Up Hazardous Waste Sites, AIHAJ (1/82).
17. K. J. D'Appolonia; Health Matrix-Toxic Waste Isolation, AIHAJ (1/82).

✓
ATTACHMENT 6

DETECTOR TUBE INFORMATION

1 DRÄGER Tube Arsine 0.05/a (CH 25001)

2 Standard range of measurement 0.05 to 3 ppm arsine
(20°C, 1013 mbar)

3 Number of strokes of the
DRÄGER gas detector pump $n = 20$

4 Relative standard deviation 20 to 15%

5 Description

Scale tube • pale blue precleanse layer, reagent: copper compound
• white indicating layer, reagent: gold compound • colour change to
a weak violet-grey.

6 Reaction principle

AsH_3 + Gold compound $\rightarrow$ Colloidal gold
Arsine weak violet-grey

7 Cross-sensitivity

Phosphine and antimony hydride are also indicated, but with other sensitivity than arsine. Interfering gases (hydrogen sulphide, sulphur dioxide, hydrogen selenide, mercaptans, ammonia and hydrogen chloride) are retained in the precleanse layer.

8 Extension of the range of measurement

8.1 Determination of AsH_3 concentration up to 60 ppm.

The number of strokes can be arbitrarily varied between $n = 1$ and $n = 20$.
With $n = 1$, the range of measurement extends from 1 to 60 ppm.

8.2 Determination of AsH_3 concentrations below 0.05 ppm.

For determination of smaller arsine concentrations, the number of strokes can be increased to a maximum of 200, but it must be ensured that the faint violet-grey discoloration of the white indicating layer does not go beyond the first scale division ("0.05" mark).

Consequently, the number of pump strokes with which the discoloration just reaches the "0.05" mark is to be determined in the measurement. Evaluation is in accordance with the following formula:

$$\text{ppm AsH}_3 = \frac{1}{\text{number of strokes}}$$

The lowest AsH_3 concentration which can be determined with a maximum number of strokes of 200 is 0.005 ppm.

* This restriction is obviously only valid when the air sample is sucked through the tube with more than 20 strokes. It is necessary, since the end of the discoloration becomes diffuse on exceeding the "0.5" mark, complicating the evaluation. To keep as far as possible from this "critical" point, the "0.05" mark is used for evaluation.

1. DRÄGER Tube Benzene 0.5/a

(67 28561)

2 Standard range of measurement 0.5 to 10 ppm benzene
(20°C, 1013 mbar)

3 Number of strokes of the
DRÄGER gas detector pump n = 40 to 2

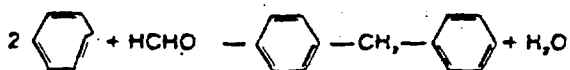
4 Relative standard deviation 30 to 20%

5 Description

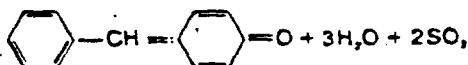
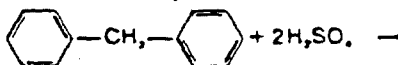
Comparison tube • ampoule, reagent: sulphuric acid • white indicating layer, reagent: formaldehyde • colour change to light brown • light brown colour comparison layer.

6 Reaction principle

According to Feigl (15), probably the following:



Benzene Formaldehyde



p-quinoid compound
(colour: light brown)

7 Cross-sensitivity

Other aromatic compounds (e.g. toluene, xylene, ethyl benzene) are indicated with approximately the same sensitivity as benzene.

1 DRÄGER Tube Hydrogen Sulphide 1/c (67 19001)

2 Standard range of measurement 1 to 20 ppm hydrogen sulphide
(20°C, 1013 mbar) 10 to 200 ppm hydrogen sulphide

2 Number of strokes of the n = 10
DRÄGER gas detector pump n = 1

4 Relative standard deviation 10 to 5%

5 Description

Scale tube • white indicating layer, reagent: lead compound • colour change to pale brown.

6 Reaction principle



7 Cross sensitivity

SO₂ concentrations of up to 20 ppm have no influence on the H₂S indication; in the presence of higher SO₂ concentrations, the H₂S indication is somewhat too high (e. g. a mixture of 5 ppm H₂S and 40 ppm SO₂ gives an indication of about 8 ppm H₂S; a mixture of 10 ppm H₂S and 100 ppm SO₂ gives an indication of about 15 ppm H₂S).
SO₂ alone does not discolour the indicating layer.

8 Extension of the range of measurement

The number of strokes can be increased directly to n = 100, whereby the range of measurement is 0.1 to 2 ppm H₂S.

Concentrations below 0.1 ppm H₂S can also be determined, if the number of strokes is increased above n = 100. Up to 500 strokes are possible, but it must be ensured that the indicating layer does not dry out during the test, since this would lead to diffuse discolorations which are difficult to evaluate.

1 DRÄGER Tube Hydrogen Sulphide D.5/a (67 28041)

2 Standard range of measurement 0.5 to 15 ppm hydrogen sulphide
(20°C, 1013 mbar)

3 Number of strokes of the
DRÄGER gas detector pump $n = 10$

4 Relative standard deviation 10 to 5%

5 Description

Scale tube • white indicating layer, reagent: mercury complex • colour change to pale brown.

6 Reaction principle

H_2S + Hg complex → pale brown sulphide
Hydrogen sulphide

7 Cross sensitivity

As yet, no interference by other gases and vapours has been observed, but investigations are still in progress.

1 DRÄGER Tube Hydrogen Sulphide 100/a (CH 29101)

2 Standard range of measurement 100 to 2,000 ppm hydrogen sulphide.
(20°C, 1013 mbar)

3 Number of strokes of the
DRÄGER gas detector pump $n = 1$

4 Relative standard deviation 10 to 5%

5 Description

Scale tube • white indicating layer, reagent: lead compound • colour
change to brown.

6 Reaction principle



7 Cross-sensitivity

The fact that the H_2S indication may be too high in the presence of sulphur dioxide cannot be excluded, but investigations relative to this are still in progress.