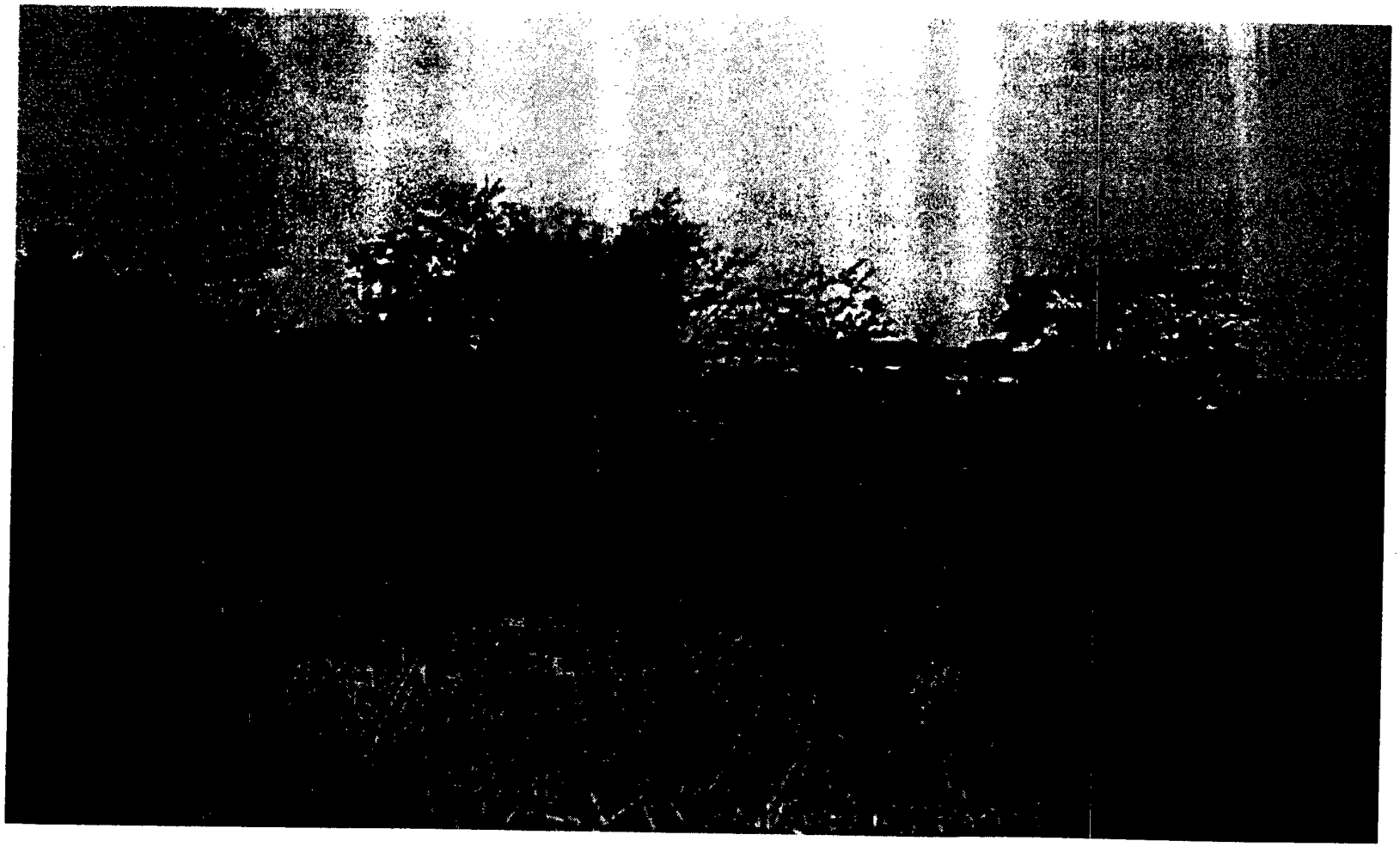
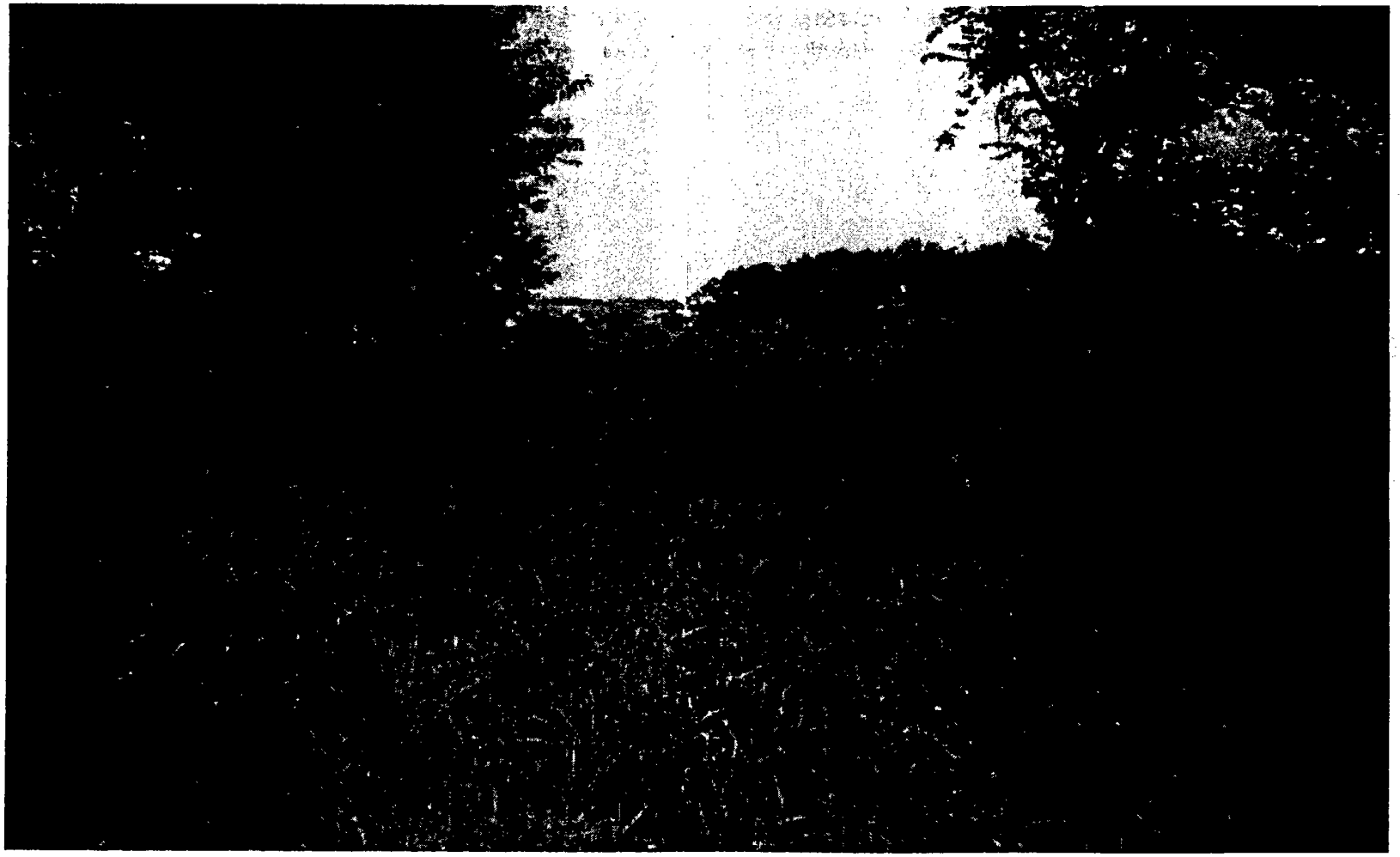
Site 7, 1995

09.04-09/03/98-00 ~~327~~ 345

Site 7 Remedial Action
First Phase

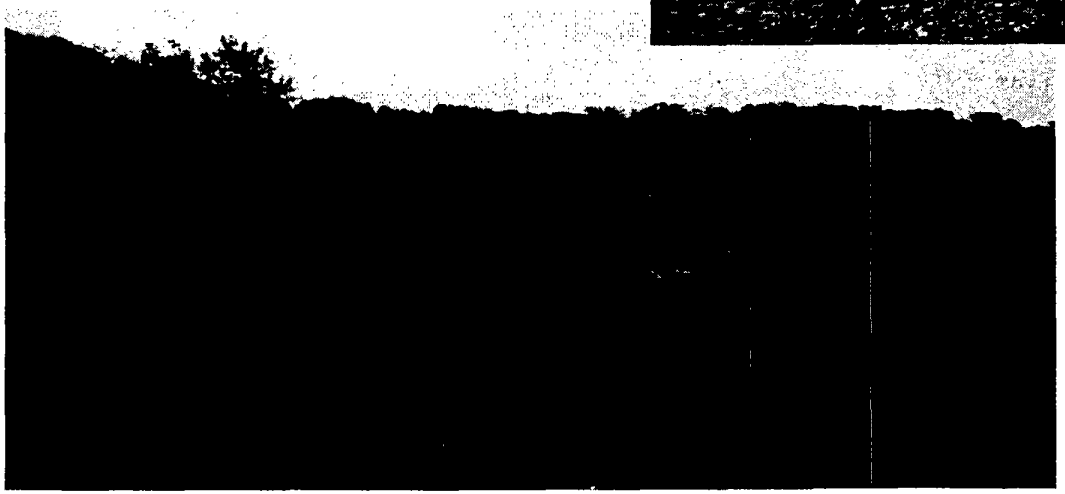


Site 7 Remedial Action
First Phase

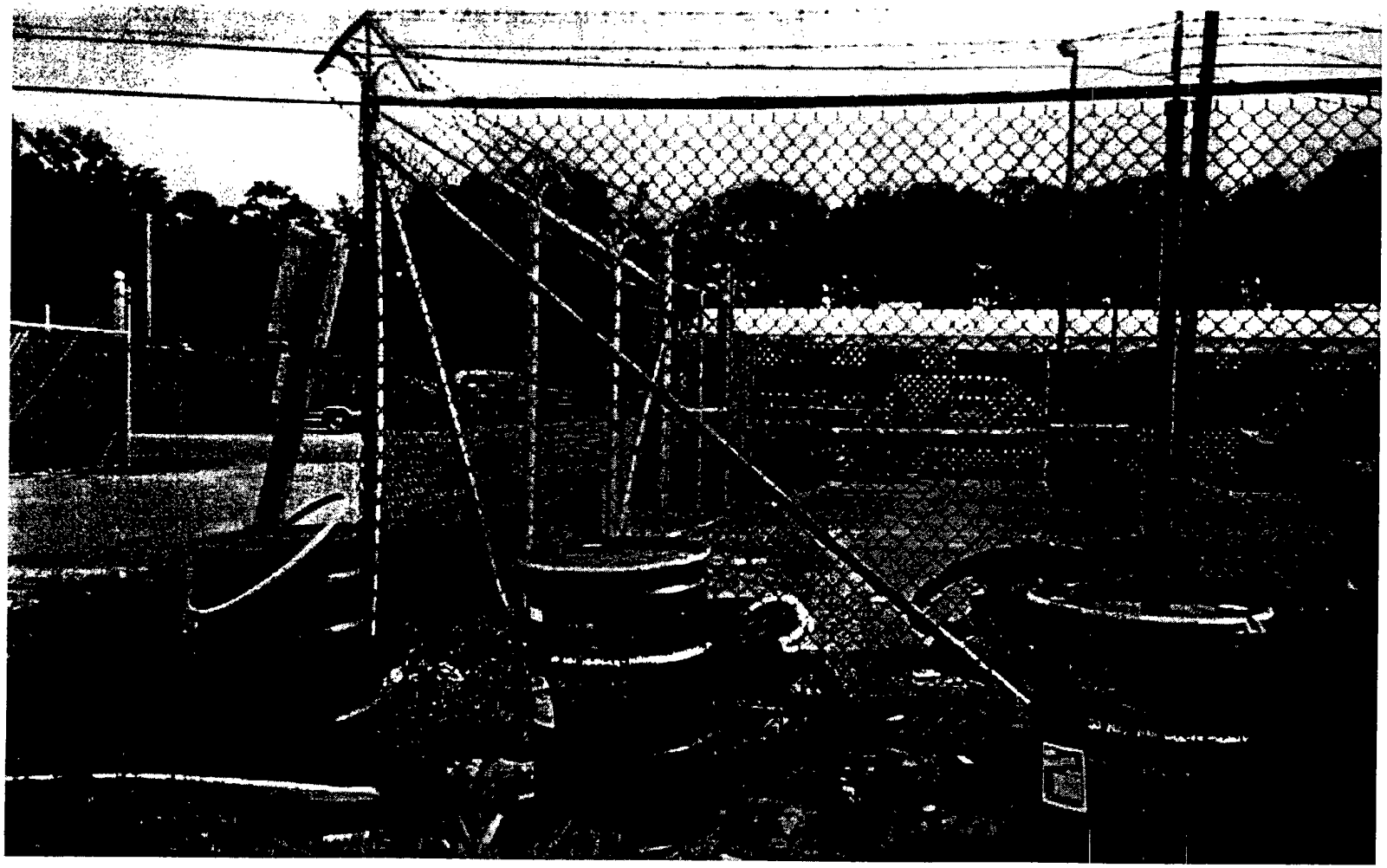


Site 7 Remedial Action
Second Phase

Site 7 Remedial Action
Second Phase



Site 13



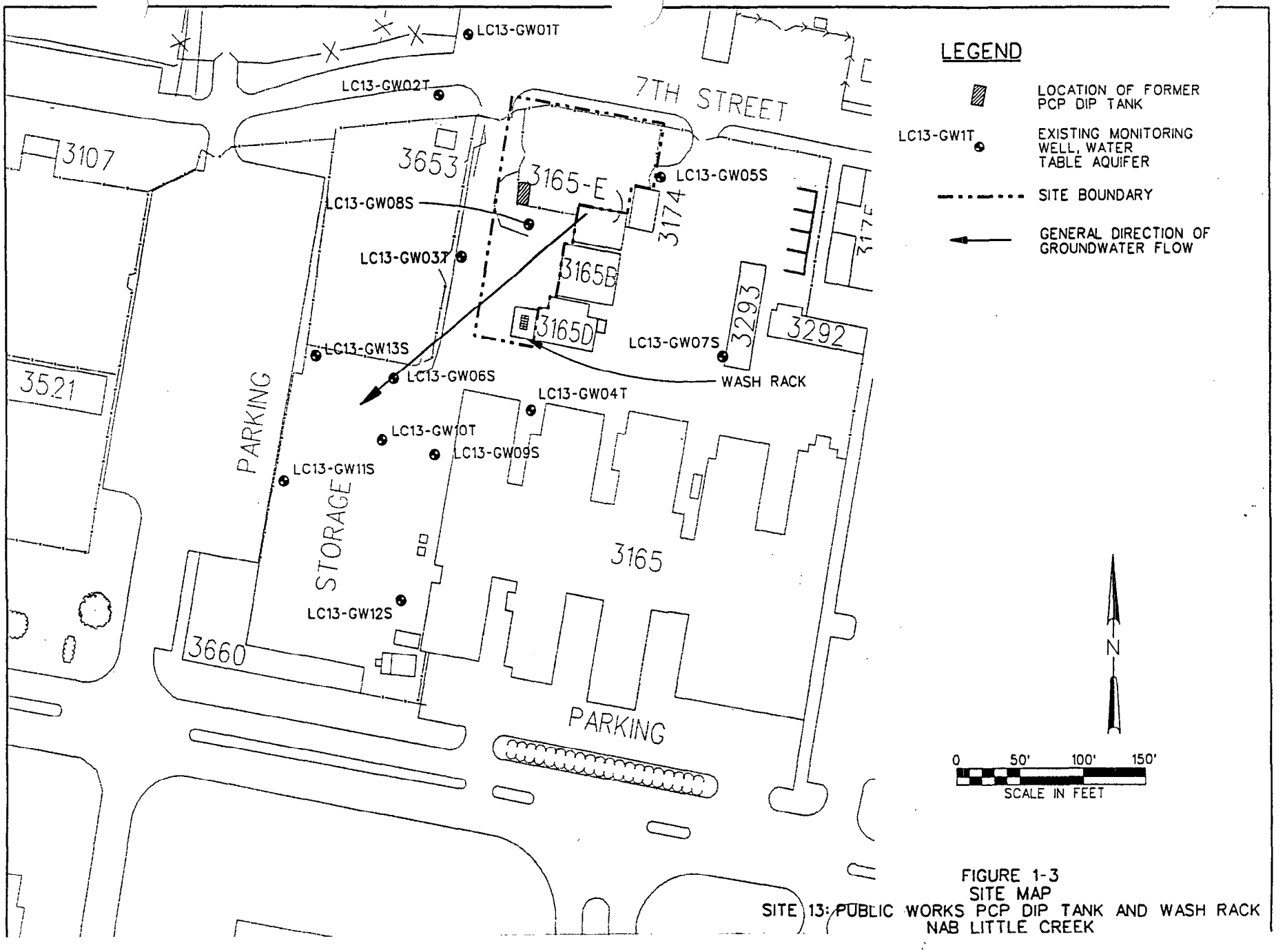


FIGURE 1-3
SITE MAP
SITE 13: PUBLIC WORKS PCP DIP TANK AND WASH RACK
NAB LITTLE CREEK

Table 2-1
Summary of Compounds/Analytes that Exceed Criteria in Soil
Site 13—Public Works PCP Dip Tank and Wash Rack
NAB Little Creek, Virginia Beach, Virginia

Compound/Analyte	Exceedance Criteria (mg/kg)		Number of Exceedances/ Number of Samples	Location of Exceedances		
	RBC Industrial Soil	Leaching-Based		Study	Sample Location (Depth)	Concentration (mg/kg)
Arsenic	3.8	NA	2/3	Phase I SRI	01 (2′ - 4′) 03 (2′ - 4′)	4.0 3.9
Benzo(a)anthracene	7.8	NA	1/26	RI	103 (0 - .5′)	10
Benzo(b)fluoranthene	7.8	NA	1/26	RI	103 (0 - .5′)	13
Benzo(a)pyrene	0.78	NA	2/26	RI	101 (0 - .5′) 103 (0 - .5′)	2.8 6.4
Pentachlorophenol	48	16	8/59	RVS	S3 (4′ - 6′)	79
				RI	GW08 (0 - 2′) GW08 (2 - 4′) GW08 (4 - 6′)	890 30 89
				Phase II SRI	202 (4′ - 6′) 203 (2′ - 4′) 203 (4′ - 6′) 209 (8′ - 10′)	16 67 74 42

NA - Leaching criteria is not applicable because compound has not been detected in the groundwater.
RVS - Round 1 Verification Study
RI - Remedial Investigation
SRI - Supplemental Remedial Investigation

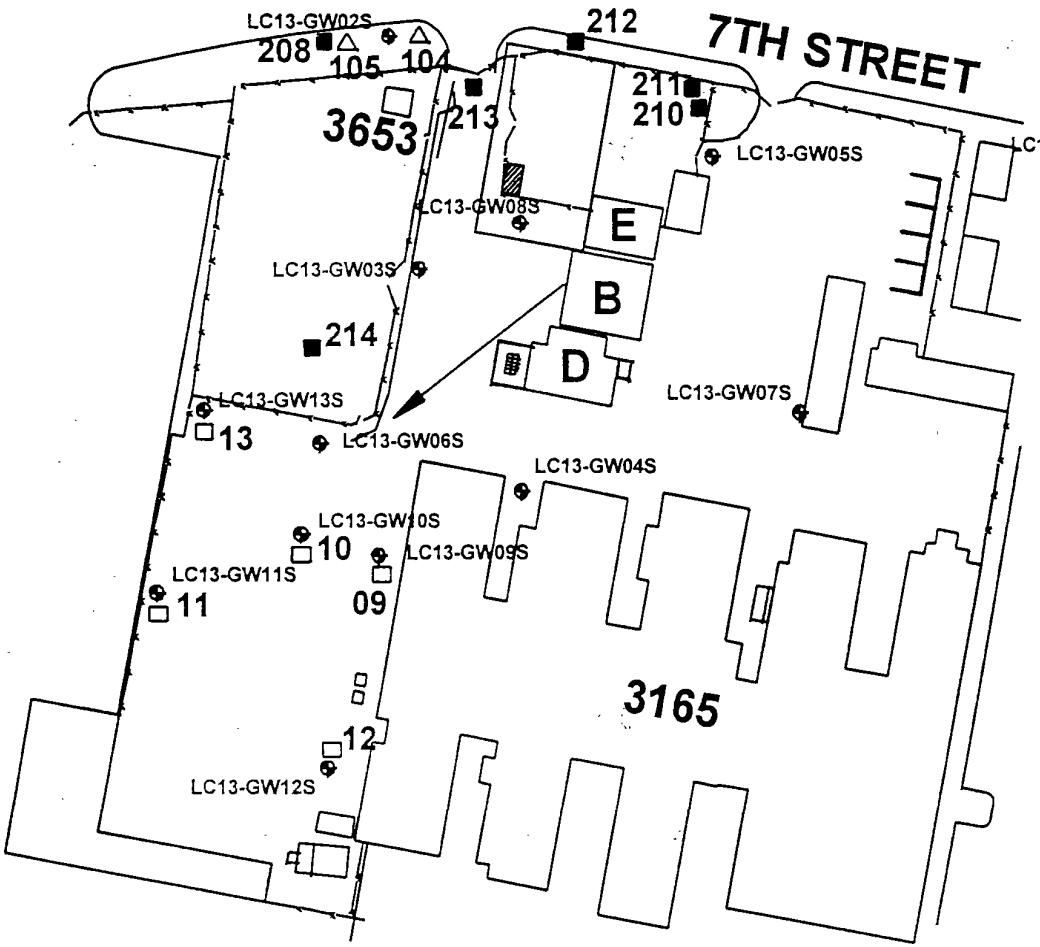
Table 2-2
Summary of Pentachlorophenol Concentrations in Soil (mg/kg)
Site 13—Public Works PCP Dip Tank and Wash Rack
NAB Little Creek, Virginia Beach, Virginia

Study	Round 1 Verification Study (1986)						Remedial Investigation (1993)						Phase I SRI (1995)					
Sample Location	S1	S2	S3	S4	S5	S6	101	102	103	104	105	GW08	01	02	03	04	05	06
Approx. Depth																		
0 - 0.5′	-	-	-	<0.4	<0.4	<0.4	2.4	<1	13	0.5 J	5.5		-	-	-	-	-	-
0.5 - 2′	<0.4	<0.4	-	-	-	-	-	-	-	-	-	890	-	-	-	-	-	-
2′ - 4′	-	-	-	-	-	-	-	-	-	-	-	30	<1	2.7	<1	<1	<1	<1
4′ - 6′	-	-	79	-	-	-	-	-	-	-	-	89	-	-	-	0.4 J	-	-

Study	Phase I SRI (1995)							Phase II SRI (1998)–From On-site Laboratory													
Sample Location	07	08	09	10	11	12	13	201	202	203	204	205	206	207	208	210	211	212	213	214	209*
Approx. Depth																					
0 - 0.5′	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
0.5 - 2′	-	-	-	-	-	-	-	<10	<10	-	<10	<10	<10	<10	<10 (0.16J)	<10 (<0.4)	<10	<10	<10	<10	42.0[a] (65)
2′ - 4′	<1	<1	<1	<1	<1	<1	<1	<10 (<0.39)	6 J (30)	67 (0.15)	<10	<10	<10 (5.7)	<10	<10	-	-	-	-	-	<10[b]
4′ - 6′	-	-	-	<1	-	-	-	7 J	16	74	<10	<10	<10	<10	-	-	-	-	-	-	<10[c] (<0.4)

* Location 209 sampled below water table only (greater than 6 feet deep). Intervals sampled were: [a] 8 - 10 ft.; [b] 12 - 14 ft.; [c] 18 - 20 ft.
\- Not analyzed
J Estimated value
< Below quantitation limit of method. Quantitation limit is shown.
(20) Confirmatory results from offsite lab

Site 13
Previous Soil Sampling



LEGEND

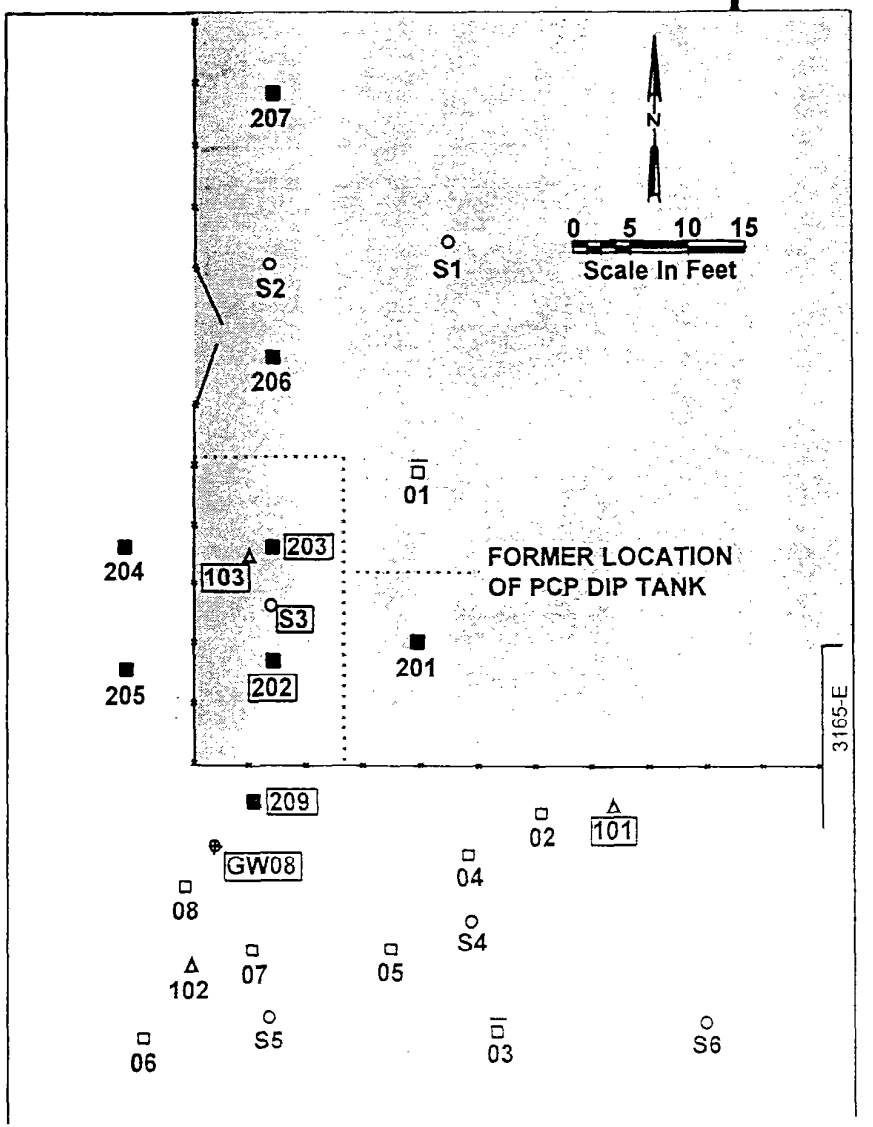
- FORMER PCP DIP TANK
- LC13-GW1S — SHALLOW MONITORING WELL
- GROUNDWATER FLOW
- △ 101-105 — SOIL SAMPLE LOCATION FROM 1993 RI/FS
- □ 01-13 — SOIL SAMPLE LOCATION FROM 1995 PHASE I SRI
- ■ 201-214 — SOIL SAMPLE LOCATION FROM 1998 PHASE II SRI (FIELD ANALYSIS)

N

0 50' 100' 150'

SCALE IN FEET

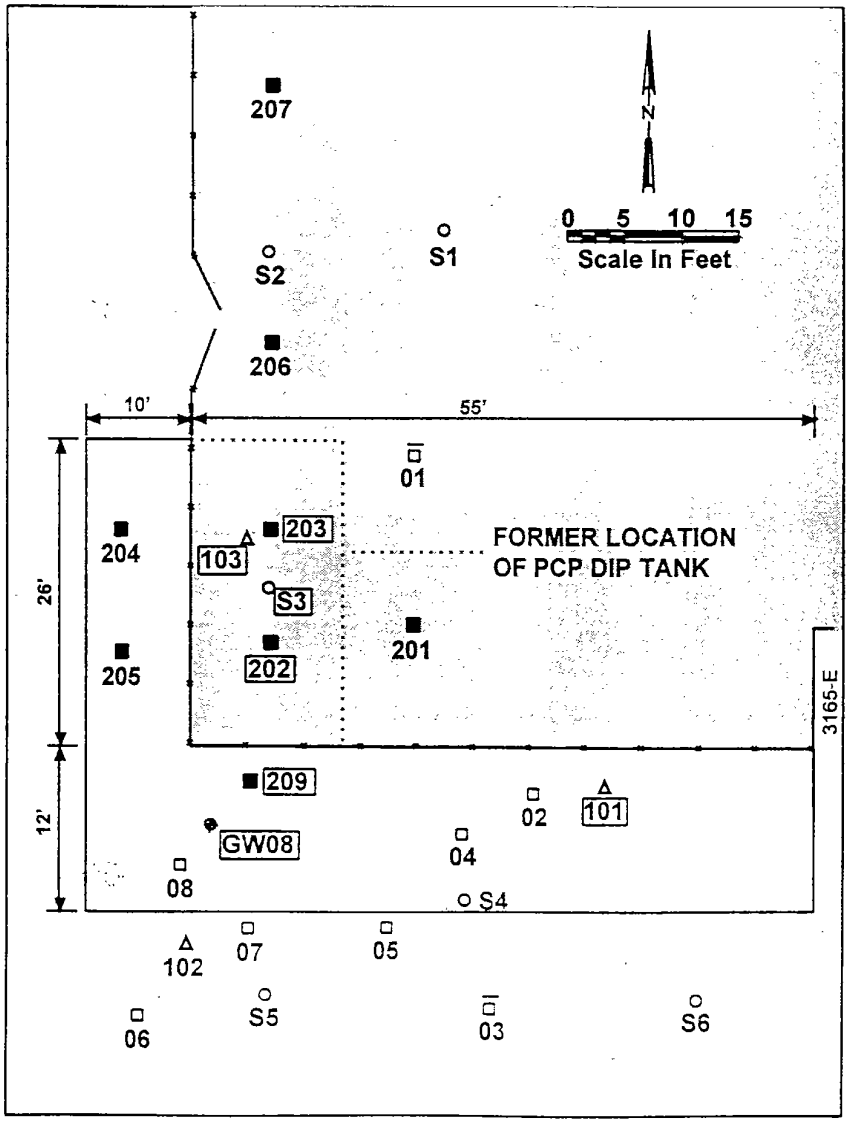
Site 13
Previous Soil Sampling



LEGEND

- FENCE
- S1-S6 — SOIL SAMPLE LOCATION FROM 1986 RVS
- 101-105 — SOIL SAMPLE LOCATION FROM 1993 RI/FS
- 01-13 — SOIL SAMPLE LOCATION FROM 1995 PHASE I SRI
- 201-214 — SOIL SAMPLE LOCATION FROM 1998 PHASE I SRI (FIELD LAB ANALYSIS)
- EXISTING PAVEMENT

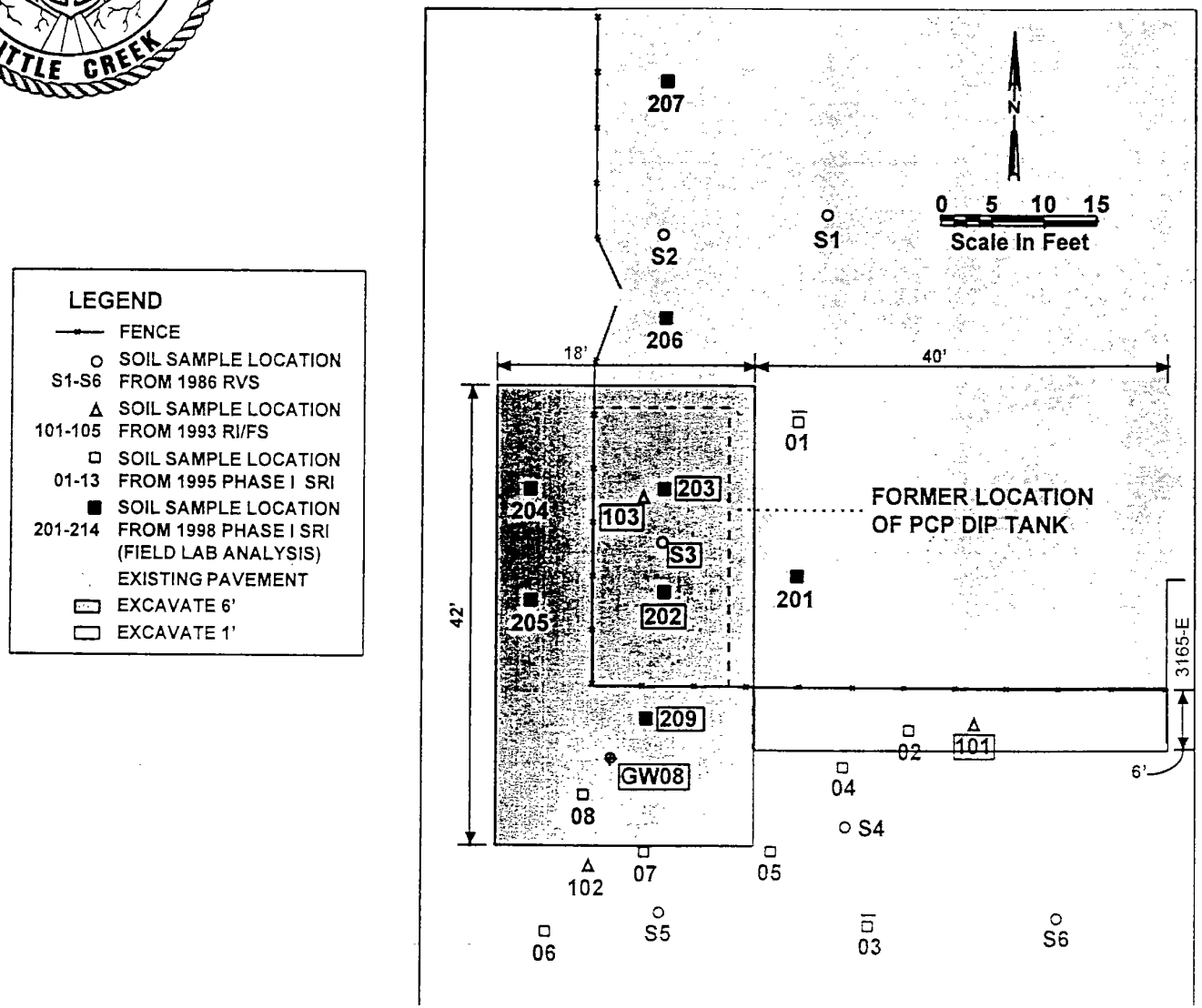
EE/CA for Site 13 RA Alternative 2



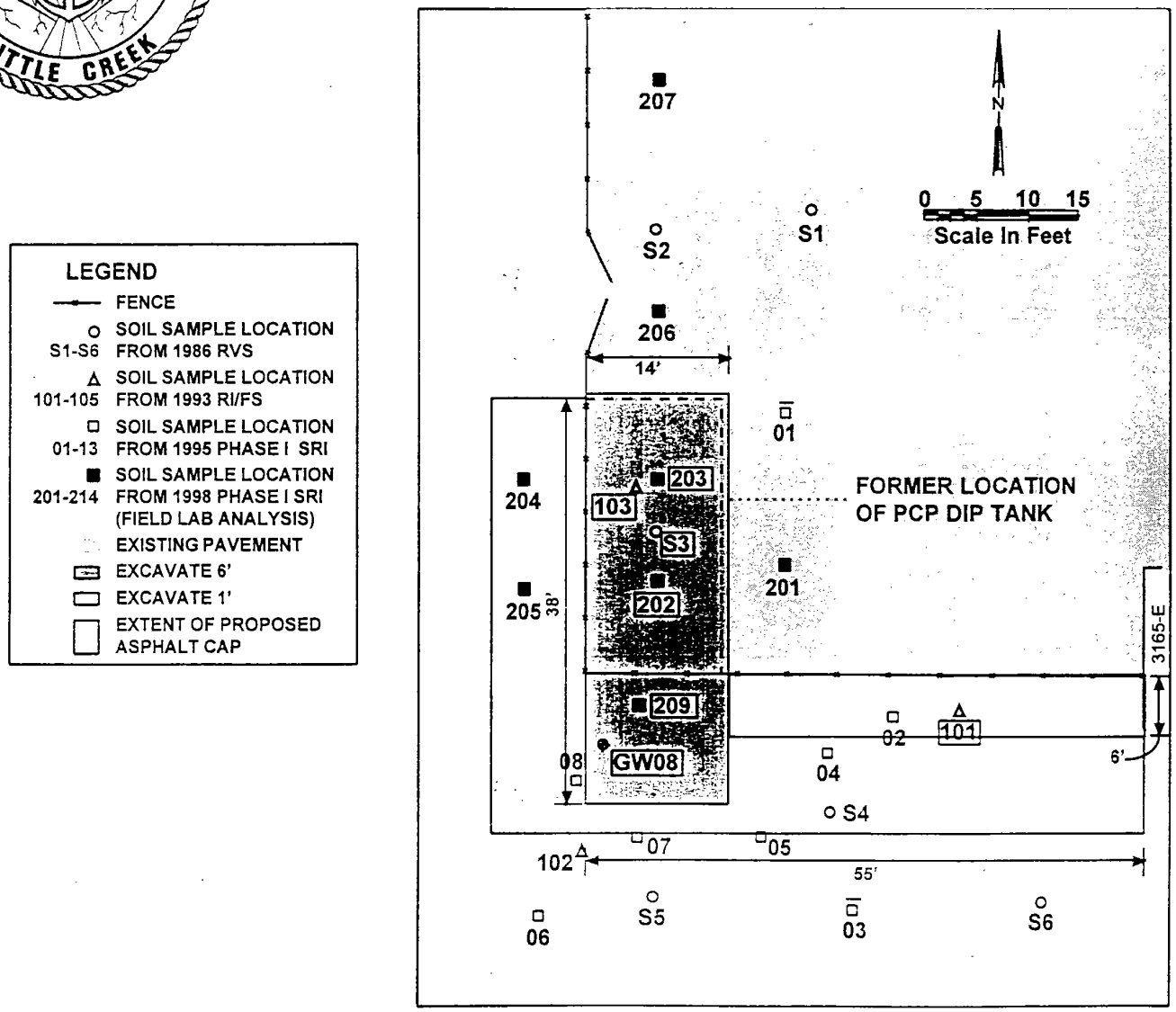
LEGEND

- FENCE
- ○ S1-S6 SOIL SAMPLE LOCATION FROM 1986 RVS
- △ 101-105 SOIL SAMPLE LOCATION FROM 1993 RI/FS
- □ 01-13 SOIL SAMPLE LOCATION FROM 1995 PHASE I SRI
- ■ 201-214 SOIL SAMPLE LOCATION FROM 1998 PHASE I SRI (FIELD LAB ANALYSIS)
- EXISTING PAVEMENT
- EXTENT OF PROPOSED ASPHALT CAP

EE/CA for Site 13 RA Alternative 3



EE/CA for Site 13 RA Alternative 4



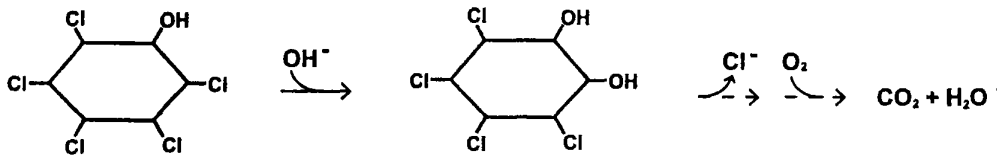
Oxygen Release Compound, ORC®

Remediation of Pentachlorophenol (PCP)

Pentachlorophenol (PCP) is a biocide used widely in the wood preservation industry. Laboratory results have successfully demonstrated bioremediation in soils and groundwater contaminated with pentachlorophenol. In fact, bioremediation has been recommended for implementation at numerous abandoned wood treatment sites (Dasappa, S.M. and R.C. Loehr, 1991). Oxygen Release Compound (ORC®) has been demonstrated to stimulate the rate of pentachlorophenol degradation and offers a unique alternative for PCP remediation.

Biodegradation of Pentachlorophenol

PCP degradation proceeds via a complex series of biochemical reactions beginning with an aerobic step that results in the formation of tetrachlorobenzoquinone (Spain, 1997). Subsequent dechlorination steps yield intermediate compounds susceptible to aerobic ring cleavage. The oxidative sequence ultimately ends in the formation of carbon dioxide.



Pentachlorophenol Tetrachlorobenzoquinone

Laboratory results indicate that PCP degradation occurs rapidly under aerobic conditions with half lives ($T_{1/2}$) less than 48 hours. (Maritinson et.al., 1984). Furthermore, field demonstrations in certain contaminated soils show half lives less than 15 days (Crawford and Hohn, 1985).

Pentachlorophenol Treatment with ORC

ORC provides a slow, steady supply of oxygen that can stimulate the aerobic degradation of pentachlorophenol. Results from a field study at a Region 9 USEPA wood treatment site show that soils amended with ORC achieved a PCP biodegradation half life ($T_{1/2}$) of 37 days compared to the aerobic control (contaminated soils not treated with ORC but exposed to air) which showed a PCP degradation half life of 210 days (Vernalia, et.al., 1997).

A pilot study in which ORC filter socks are being used to enhance the remediation of PCP-contaminated groundwater has produced promising results. The following data were collected after 2.5 months of treatment with ORC.

Well No.	Distance Downgradient	Initial Concentration (ppb)	Concentration after 2.5 Months (ppb)
1	30	400	7
2	5	7	0.3
3	30	54	1.7
4	30	16	1.2

Full scale implementation of enhanced in situ bioremediation with ORC is currently under consideration at several wood treatment facilities with PCP contaminated soils and groundwater. ORC presents a passive, cost effective approach to the remediation of PCP, without the costs associated with highly engineered systems.

ORC Installation Design Parameters

The theoretical mass ratio of oxygen to PCP required for the aerobic degradation of the contaminant is 0.54 to 1.0. Thus, 0.54 pounds of oxygen are required to degrade one pound of PCP.

The sorption coefficient (K_{oc}) for pentachlorophenol is 5.30E+4 ml/g, suggesting that the compound has a stronger tendency to sorb to the aquifer matrix relative to petroleum hydrocarbons (e.g., benzene K_{oc} = 8.30E+01 ml/g). Therefore, when designing groundwater treatment systems employing ORC it is recommended that the aquifer matrix is sampled for PCP concentration. Such considerations will allow for more accurate indications of the oxygen demand imparted by the sorbed fraction of contamination.

References

Crawford, R.L., W.W.Mohn. 1985. Microbial removal of pentachlorophenol from soil using Flavobacterium. Enzyme Microbiol. 45:1122-1125.

Dasappa, S.M. and R.C. Loehr. 1991. Toxicity reduction in contaminated soil bioremediation processes. Water Res. 25:1121-1130.

Martinson, M.M., J.G. Steiert, D.L. Saber, and R.L.Crawford. 1984. Microbiological decontamination of pentachlorophenol in natural waters. In: Biodeterioration Society: Proceedings of the Sixth International Symposium. Ed.: E.E. O'Rear, Commonwealth Agricultural Bureau.

Spain, J. 1997. Synthetic Chemicals with Potential for Natural Attenuation. Bioremediation Journal 1:1-9.

Vernalia, J.L., L.T. LaPat-Polasko, S. Koenigsberg. 1997. Bioremediation of PCP in soil under anaerobic and aerobic conditions. In Situ and On-site Bioremediation 4:469. Eds: Alleman and Lesson. Battelle Press, Columbus, Ohio.

27130A Paseo Espada, Suite 1407, San Juan Capistrano, CA 92675
Phone: 949-443-3136 Fax: 949-443-3140 email: orc@regenesis.com

OXYGEN RELEASE COMPOUND, ORC

Bioremediation

Bioremediation is a process that harnesses microbial metabolism to degrade hazardous substances. M break down a wide variety of organic compounds to obtain energy and materials for growth. Petroleum hydrocarl among the organic compounds that microbes metabolize transforming the compounds into harml products–carbon dioxide and water. All microbes need minerals and water to survive; most microbes are aerc require oxygen.

Oxygen is the Limiting Factor

Oxygen is often the limiting factor for the aerobic microbes that perform bioremediation. Minerals and w generally present in sufficient quantities, however, oxygen is not. Without adequate oxygen, contaminant degr will either cease or may proceed by much slower anaerobic (oxygen-free) processes. Generally, aerobic degr occurs 10 to 100 times faster than anaerobic processes.

ORC—The Technology

Oxygen Release Compound (ORC®) is a patented formulation of magnesium peroxide that slowly releases mc oxygen when hydrated, as shown by the following equation:

$$MgO_2 + H_2O \longrightarrow \tfrac{1}{2}O_2 \uparrow + Mg(OH)_2$$

ORC's unique time release technology delivers oxygen over an extended period of time, lasting about six mon does not require continuous mechanical operation or maintenance.

Oxygen introduced by ORC promotes microbial growth and maximizes the ability of aerobic microbes to contaminants. When strategically applied, ORC treatments can remediate sites faster and lead to more rapid site at substantially lower costs than alternative systems. For example, an ORC treatment is typically two-thirds to the cost of conventional alternatives, and can close the site in as little as one year.

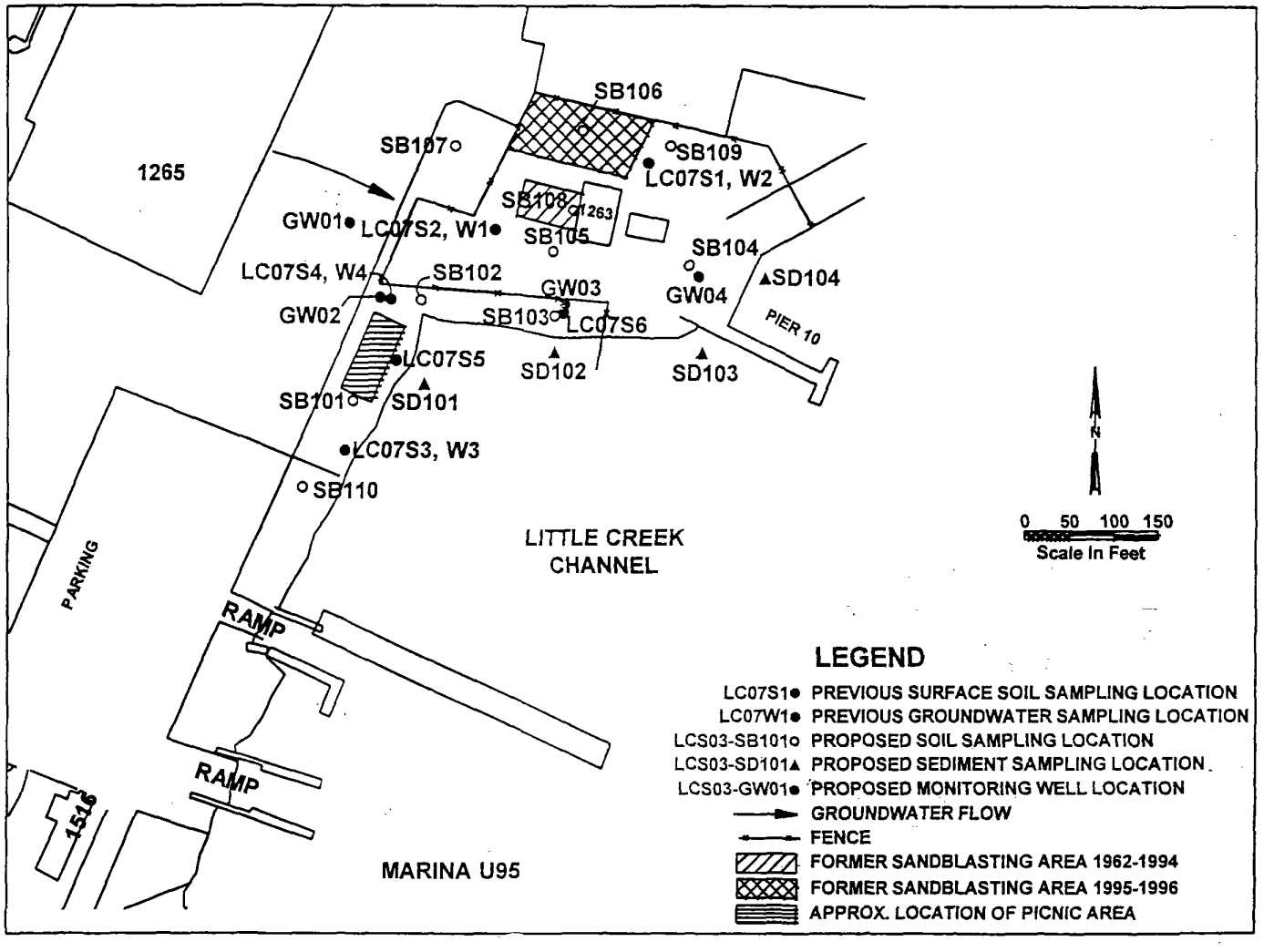
Features	Benefits
• ORC is activated by moisture	• Provides a passive, cost effective, long-term oxygen source
• Patented technology controls and prolongs the release of oxygen without external coating	• Converts to an insoluble, harmless substanc magnesium hydroxide
• Generates higher dissolved oxygen levels than possible with air	• Ideal for in-situ remediation where other methods are impractical
• Moderate pH levels are maintained	• Will not disturb the dimensions of the contami plume or volatilize pollutants
• Long, stable shelf life	

Target Contaminants for ORC

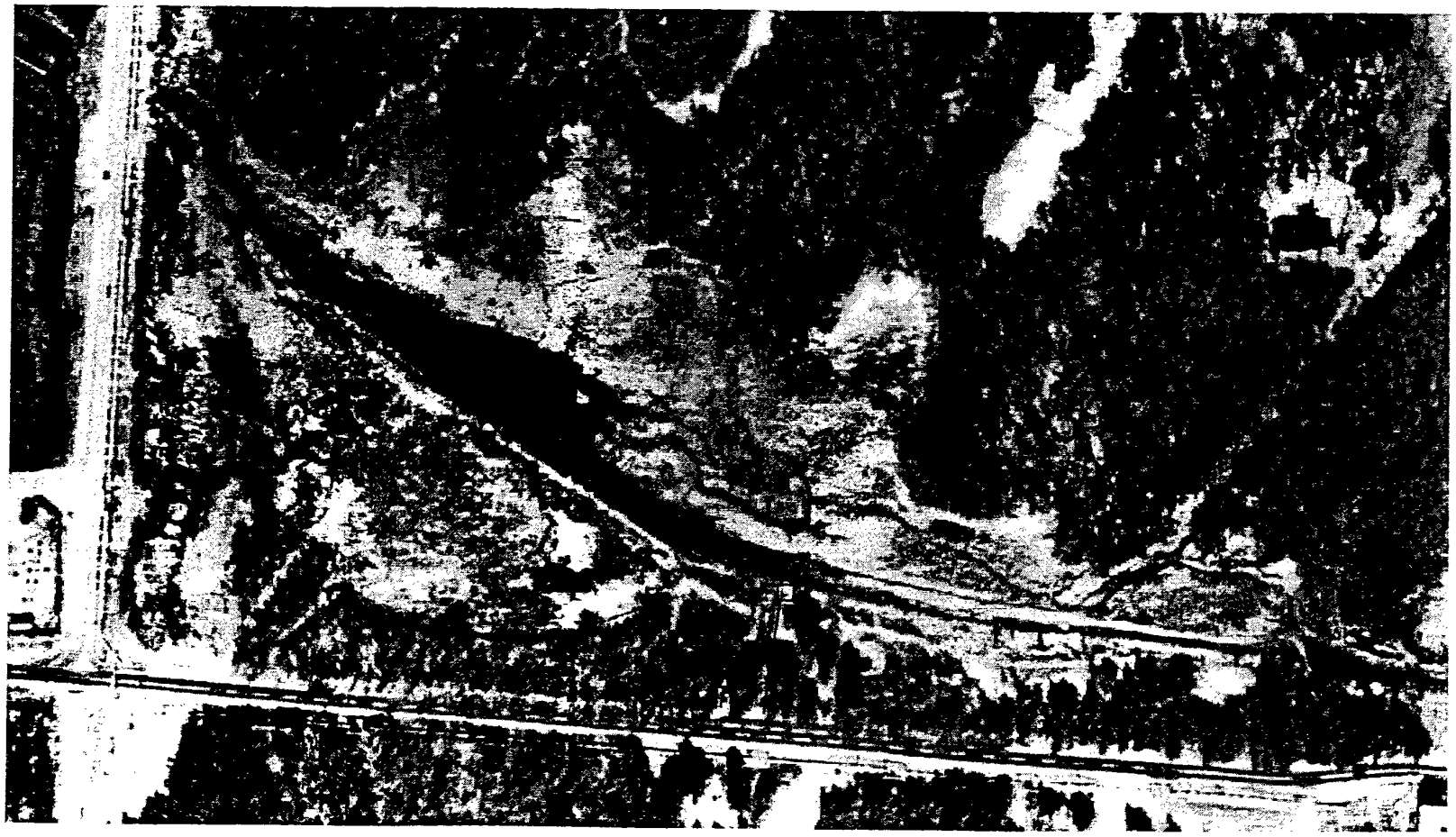
ORC can be used to enhance the bioremediation of any aerobically degradable compounds. These includ gasoline and diesel range organics, PAHs, vinyl chloride, PCP, and MTBE.

ORC® is a registered trademark of REGENESIS Bioremediation Product

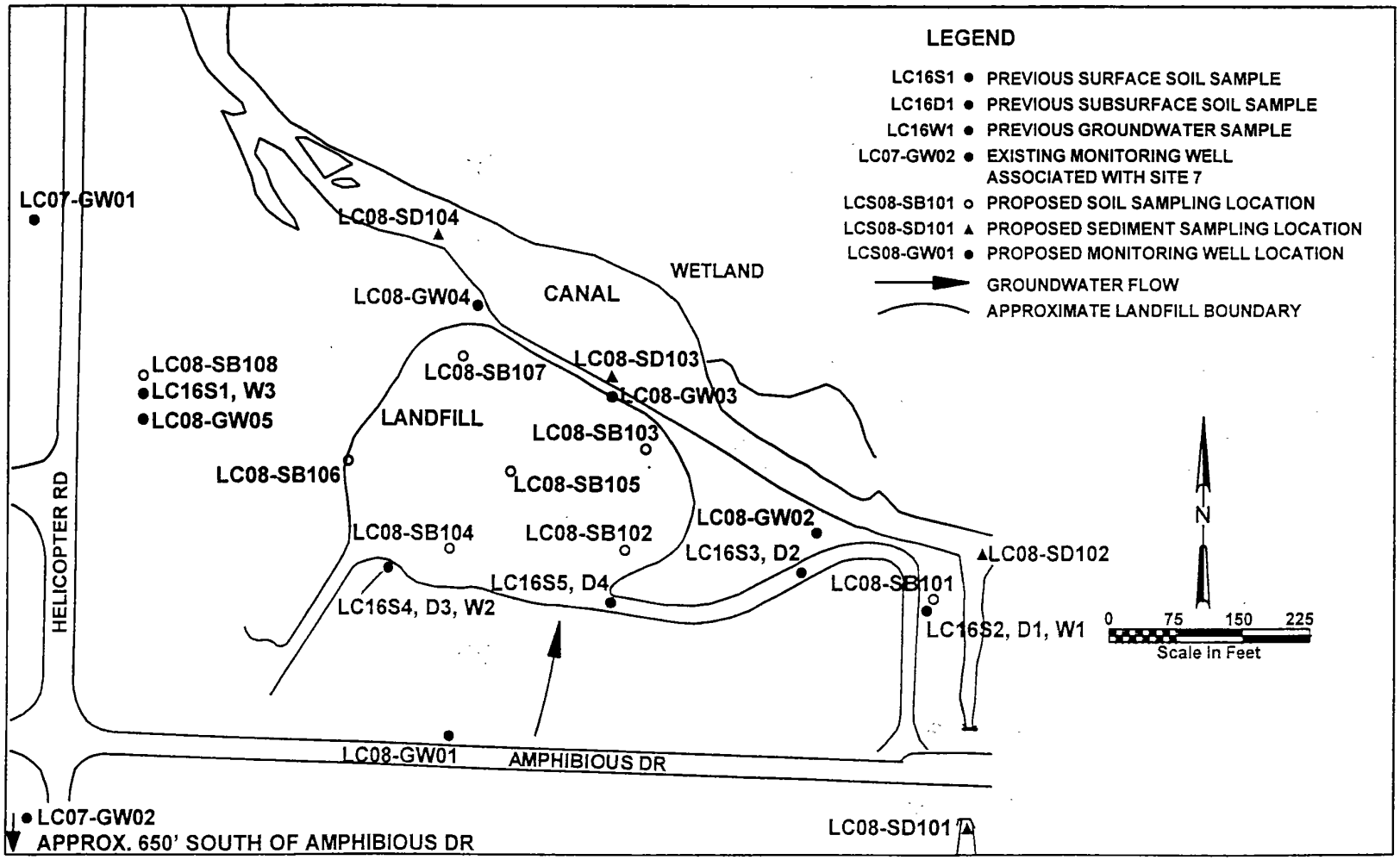
SWMU 3
Proposed Sampling



IR Site 8, 1980



IR Site 8
Proposed Sampling

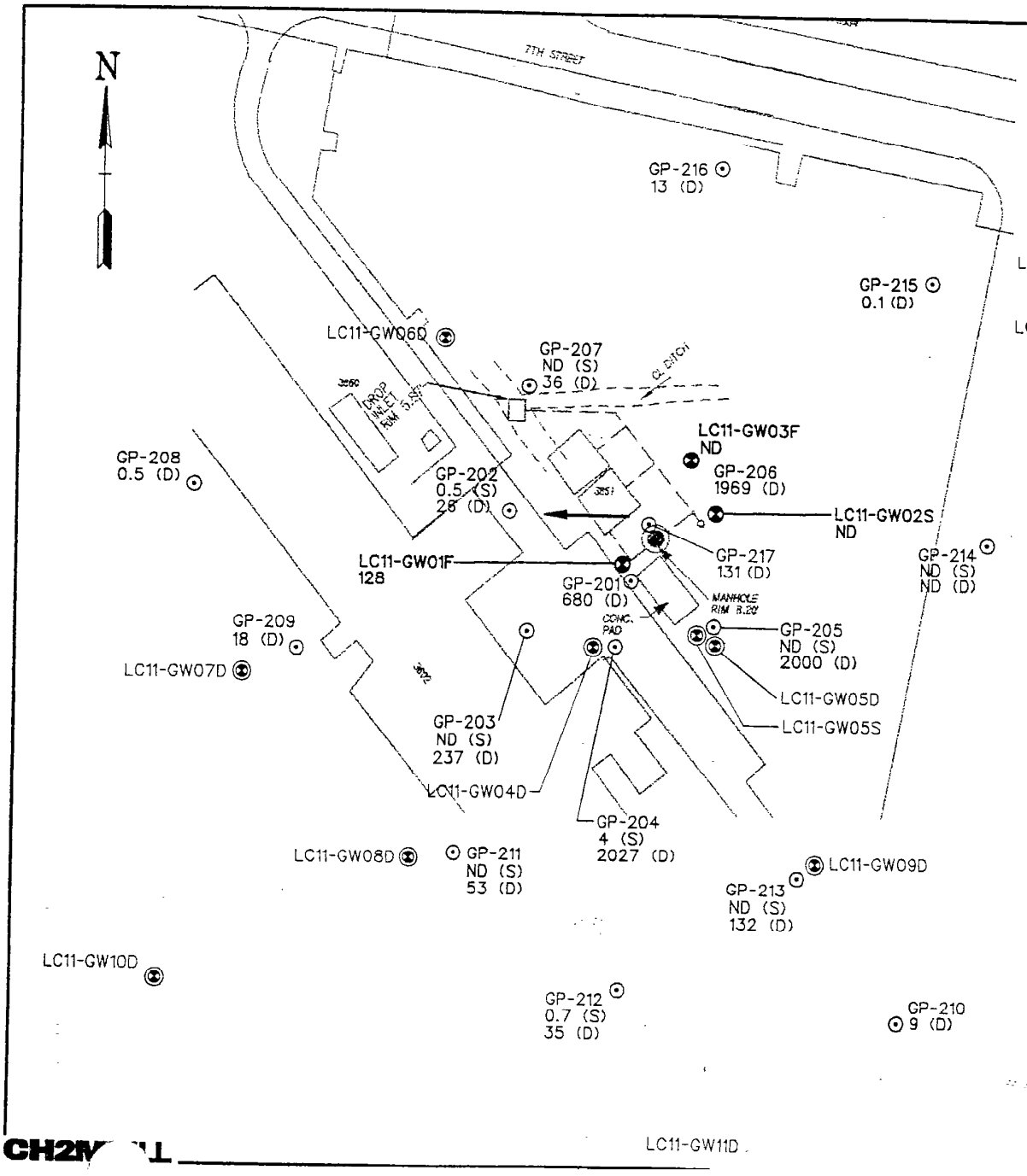


NPL

- To submit comments to the EPA:
  - All comments must be postmarked by Sept 28
  - Submit original and three copies (no facsimiles or tapes) of comments to:
    - Docket Coordinator, Headquarters; U.S. EPA; CERCLA Docket Office; (Mail Code 5201G); 401 M St, SW; Washington, DC 20460; 703-603-9232
    - Express Mail: Docket Coordinator, Headquarters; U.S. EPA; CERCLA Docket Office; 1235 Jefferson Davis Hgwy; Crystal Gateway #1, First Floor; Arlington, VA 22202

NPL

- Submitting comments Cont'd
  - E-Mail: ASCII format only to superfund.docket@epa.gov. Must also send original and three copies by mail or FedEX
  - For further information contact: Terry Keidan (703-603-8852); State, Tribal and Site Identification Center; Office of Emergency and Remedial Response (Mail Code 5204G); U.S. EPA; 401 M St, SW; Washington, DC, 20460
  - Superfund Hotline at 800-424-9346 or 703-412-9810 in the DC area



LEGEND

LC11-GW01F	EXISTING FULLY SCREENED MONITORING WELL
LC11-GW02S	EXISTING SHALLOW MONITORING WELL
— —	STORM SEWER LINES
GP-201	GEOPROBE LOCATIONS
LC11-GW05S	PROVISIONAL LOCATION FOR PROPOSED SHALLOW MONITORING WELL
LC11-GW04D	PROVISIONAL LOCATION FOR PROPOSED DEEP MONITORING WELL
←	DIRECTION OF GROUNDWATER FLOW (DECEMBER 3, 1996)
3	TOTAL CHLORINATED VOCS (PCE, TCE, DCE) IN GROUNDWATER (ug/l) (June-July 1998)
(S)	SHALLOW GROUNDWATER SAMPLE (ug/l)
(D)	DEEP GROUNDWATER SAMPLE (ug/l)
128	TOTAL CHLORINATED VOCS (TCE, TCA, DCE, DCA) IN GROUNDWATER (ug/l) (December 1996)
ND	CONCENTRATIONS OF CHLORINATED VOCS WERE NOT DETECTED

NOTES:

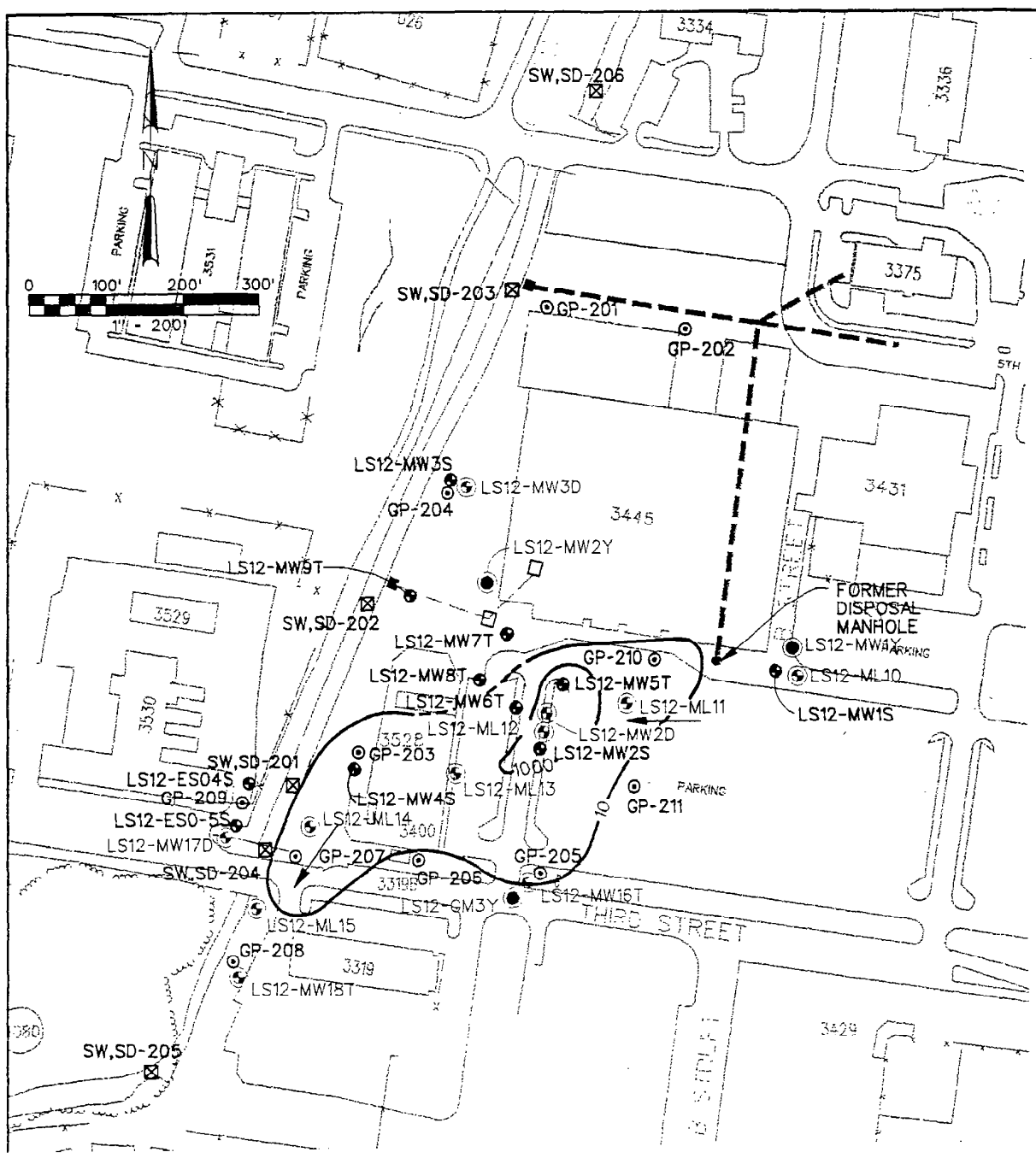
1. MANHOLE, PIPING AND SURROUNDING SOIL HAVE BEEN REMOVED, AND THE SITE HAS BEEN RESTORED.

0 75' 150' 225'

SCALE IN FEET

FIGURE 1-2
CHLORINATED VOCS IN GROUNDWATER
PHASE II SRI SITE 11
NAB LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

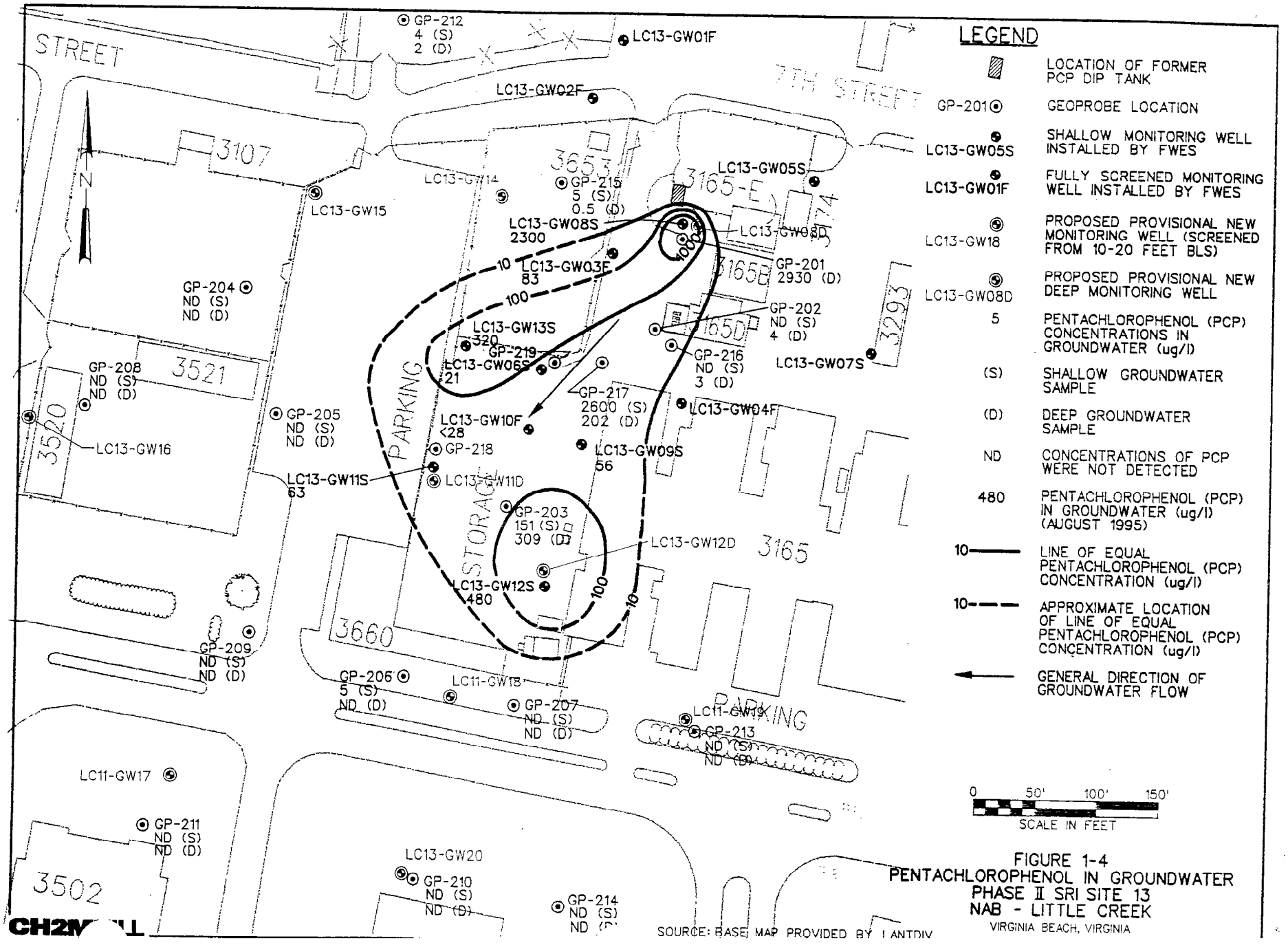
CH2M HILL



LEGEND

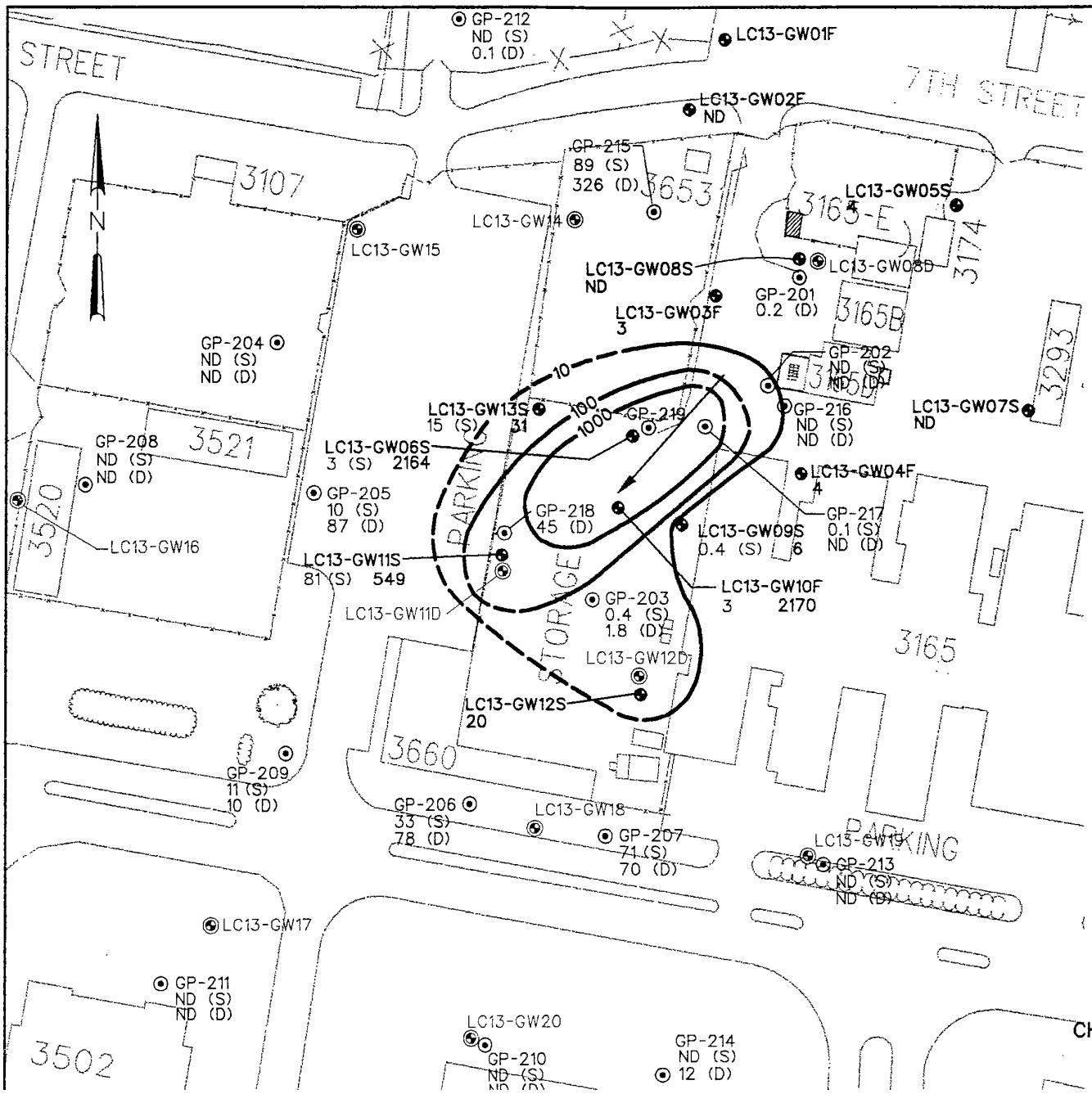
- FORMER STORM SEWER LINE
- LS12-MW1S — SHALLOW WATER TABLE AQUIFER MONITORING WELL (SCREENED ABOVE 15 FT. BLS) INSTALLED BY FWES
- LS12-MW9T — WATER TABLE AQUIFER MONITORING WELL (SCREENED ABOVE AND BELOW 15 FT. BLS) INSTALLED BY FWES
- LS12-ES04S — WATER TABLE AQUIFER UST MONITORING WELL (SCREENED ABOVE 15 FT. BLS) INSTALLED BY ESE
- GP-201 — Phase II SRI GEOPROBE LOCATION
- SW,SD-206 — PHASE II SRI SURFACE WATER AND SEDIMENT SAMPLE LOCATION
- LS12-MW1S — SHALLOW WATER TABLE AQUIFER MONITORING WELL (SCREENED ABOVE 15 FT. BLS) INSTALLED BY CH2M HILL
- LS12-MW1Y — YORKTOWN AQUIFER MONITORING WELL INSTALLED BY CH2M HILL
- LS12-MW16T — WATER TABLE AQUIFER MONITORING WELL (SCREENED ABOVE AND BELOW 15 FT. BLS) INSTALLED BY CH2M HILL
- LS12-MW3D — DEEP WATER TABLE AQUIFER MONITORING WELL (SCREENED BELOW 15 FT. BLS) INSTALLED BY CH2M HILL
- LS12-ML10 — MULTI-LEVEL SAMPLER INSTALLED BY CH2M HILL
- CHLORINATED VOCs IN GROUNDWATER (ug/l)
- GENERAL DIRECTION OF GROUNDWATER FLOW
- LOCATION OF FORMER NORTHERN AND SOUTHERN OUTFALLS

FIGURE 3-2
PROPOSED SAMPLING LOCATIONS
PHASE II SRI SITE 12
NAB - LITTLE CREEK



SOURCE: BASE MAP PROVIDED BY LANTDIV

FIGURE 1-4
PENTACHLOROPHENOL IN GROUNDWATER
PHASE II SRI SITE 13
NAB - LITTLE CREEK
VIRGINIA BEACH, VIRGINIA



LEGEND

	LOCATION OF FORMER PCP DIP TANK
GP-201	GEOPROBE LOCATION
LC13-GW05S	SHALLOW MONITORING WELL INSTALLED BY FWES
LC13-GW01F	FULLY SCREENED MONITORING WELL INSTALLED BY FWES
LC13-GW18	PROPOSED PROVISIONAL NEW MONITORING WELL (SCREENED FROM 10-20 FEET BLS)
LC13-GW08D	PROPOSED PROVISIONAL NEW DEEP MONITORING WELL
10	TOTAL CHLOINATED VOCS (TCE, PCE, DCE) IN GROUNDWATER (ug/l) (June-July 1998)
(S)	SHALLOW GROUNDWATER SAMPLE
(D)	DEEP GROUNDWATER SAMPLE
3	TOTAL CHLORINATED VOCS (TCE, TCA, DCE, DCA) IN GROUNDWATER (ug/l) (August 1995)
ND	CONCENTRATIONS OF CHLORINATED VOCS WERE NOT DETECTED
10	LINE OF EQUAL TOTAL CHLORINATED VOC CONCENTRATION (ug/l)
10	APPROXIMATE LOCATION OF LINE OF EQUAL TOTAL CHLORINATED VOC CONCENTRATION (ug/l)
	GENERAL DIRECTION OF GROUNDWATER FLOW

0 50' 100' 150'
SCALE IN FEET

FIGURE 1-3
CHLORINATED VOCS IN GROUNDWATER
PHASE II SRI SITE 13
NAB - LITTLE CREEK
VIRGINIA BEACH, VIRGINIA