04.08-05/25/88-00204

REMEDIAL ACTION
ALTERNATIVES ANALYSIS
FOR SUBSTATION 2,
SITE 15
U.S. NAVAL STATION ROOSEVELT ROADS

CONFIRMATION STUDY TO DETERMINE POSSIBLE DISPERSION AND MIGRATION OF SPECIFIC CHEMICALS
U.S. NAVAL STATION ROOSEVELT ROADS

Contract No. N62470-85-B-7972

ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
Sacramento, California

FEBRUARY 1988

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1.0 BACKGROUND

This report presents the remedial action alternatives analysis for the polychlorinated biphenyl (PCB)-contaminated soil at Substation 2, Site 15 at Naval Station (NAVSTA) Roosevelt Roads, Puerto Rico. This analysis includes an evaluation of four remedial action alternatives. The alternatives analysis is based on the results of the Characterization sampling and analysis, and risk assessment. Several clean-up levels for the PCB-contaminated soil are addressed in the remedial action alternatives analysis. The clean-up criteria eventually used are those which have been established by the Environmental Protection Agency (EPA) in the Toxic Substance Control Act (TSCA) policy for the clean-up of spilled PCBs. This policy establishes requirements for the clean-up of spills resulting from the release of materials containing PCBs at concentrations of 50 parts per million (ppm) or more. The requirements in this policy are based upon the Agency's evaluation of the potential routes of exposure and potential risks associated with PCB spills, as well as the cost of clean-up of these spills.

The Characterization of Site 15 was performed as part of the Confirmation Study for NAVSTA Roosevelt Roads. The objective of this Study is to determine if specific toxic or hazardous materials have contaminated the environment at the Navy activities and may include consideration of various remedial alternatives. The Study is part of the Navy Assessment and Control of Installation Pollutants (NACIP) program designed to identify contamination of Navy lands resulting from past operations and to institute corrective measures, as needed.

The NACIP program consists of three distinct phases:

- o Initial Assessment Study (IAS)--record searches and personnel interviews to collect and evaluate all evidence supporting the existence of a contamination problem at an installation.
- o Confirmation Study--on-site investigations including physical and analytical monitoring to confirm or refute the existence of contamination, and if necessary recommending both interim and long-term corrective measures.
- o Corrective Measures--institution of needed interim and/or long-term remedial measures to control and mitigate contamination.

The IAS phase of the NACIP for NAVSTA Roosevelt Road was conducted in 1984. Results of the IAS for Substation 2, Site 15, showed that sufficient evidence existed to indicate the potential presence of PCB contaminants in the soil that might pose an imminent health or environmental threat on or off the Naval facility. It has been estimated that 3,000 gallons of PCB-containing oil were discharged on the site from 1964 to 1979. In this period, Site 15 was used by the Public Works Department-Power Distribution Shop for the repair of pole-mounted distribution electrical transformers. Oil was drained from the transformers to repair the inner cores and coils and was subsequently poured onto the ground. It is suspected that the drained oil contained PCBs because the transformers were serviced with PCB-based dielectric fluids.

Because of recommendations made during the IAS, Site 15 is being further investigated in the Confirmation Study of the

NACIP program. The Confirmation Study is performed in sequential efforts, termed Steps, which are defined below.

Step	Description
IA	Verification of existence of contamination.
IB	Characterization of extent and rate of migration of contaminants, geohydrological, geophysical, and other factors.
II	Evaluation of alternatives to achieve compliance, preparation of cost estimates, and project effectiveness of alternatives.
III	Preparation of site operation and draft Government project documentation with cost estimate(s) satisfactory for project funding requests.

Verification Step sampling and analysis for Site 15 was completed in May 1986. This sampling program consisted of the collection and analysis of soil samples for PCBs. Because of the PCB contamination detected in the soil during the Verification Step, the study proceeded to the Characterization Step (Step IB). The Characterization sampling and analysis of Site 15 was completed in January 1988, and the results were used in performing the remedial alternatives analysis for the site.

Section 2.0 of this report presents the results of Verification sampling which led to the Characterization Study of Site 15. The results of the Characterization Step sampling are presented in Section 3.0 and the risk assessment is detailed in Section 4.0. The remedial alternatives analysis is given in Section 5.0

2.0 VERIFICATION STEP RESULTS

During the Verification Step (Step IA) for the NAVSTA Roosevelt Roads Confirmation Study, 16 soil samples were collected at Site 15 and analyzed for PCBs. Eight samples were collected from the area surrounding Substation 2, and eight samples were collected from the storage area located directly southeast of Substation 2 across Valley Forge Road. Each of the samples was a composite of the soil in the 0- to 1-foot (ft) depth interval. The analytical data for these soil samples show that PCB contamination exists in the area surrounding Substation 2; no PCB contamination was detected in the soil in the storage yard. The Verification Step sampling locations around Substation 2 are shown in Figure 2-1. The number by each sampling point is the PCB concentration for that location in ppm.

Based on results from the Verification Step sampling, Site 15 was recommended for additional soil sampling and analysis to delineate the extent of PCB contamination. This additional soil sampling and analysis was performed as the Characterization Step of the Confirmation Study.

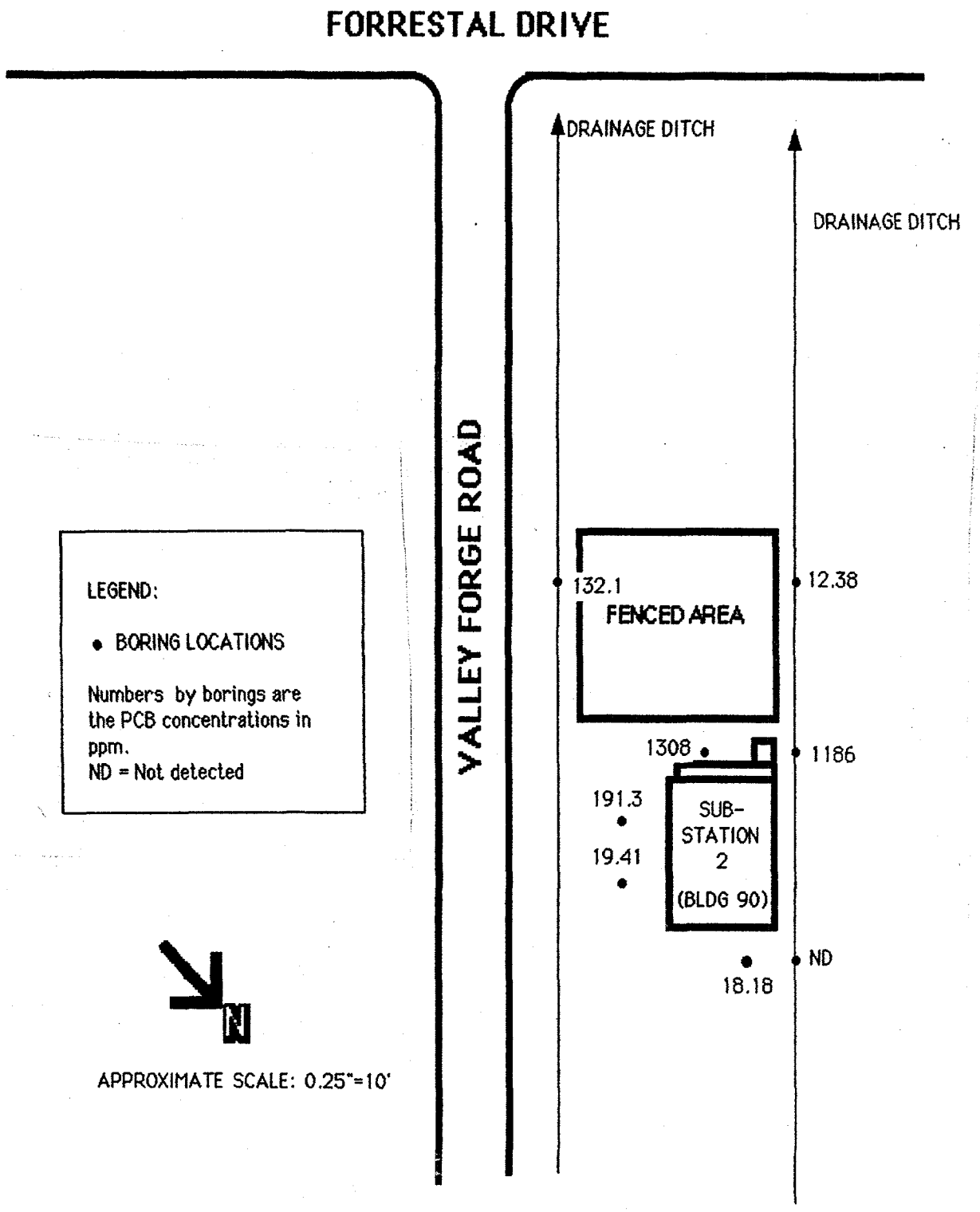

FIGURE 2-1
VERIFICATION SAMPLING LOCATIONS AND RESULTS AT SITE 15, SUBSTATION 2

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3.0 CHARACTERIZATION STUDY

The work plan for the Characterization of Site 15 specified the drilling of 33 hand-augured soil borings. Borings were to be drilled to a depth of 3 ft with soil samples to be collected from the 0- to 1-ft depth, the 1- to 2-ft depth, and the 2- to 3-ft depth. The work plan specified that a total of 99 soil samples were to be collected for PCB analysis. However, during the field sampling coral was found generally at a depth of 9 to 12 inches which halted hand augering to greater depths. Consequently, only one soil sample was collected from all but two of the sampling locations. The two sampling locations where hand augering was performed to depths greater than 1 ft were located northeast of Substation 2 (Building 90).

A total of 36 soil samples were collected from the 33 sampling locations, 30 of which were collected from the 0- to 1-ft depth interval. All of the samples were extracted for PCB analysis, and the PCB analyses of the soils were performed in two batches. The first batch of samples consisted of those located in and nearest to the contaminant source area (area between Building 90 and the fenced area). The second batch of samples selected for PCB analyses was selected based on the results of the first batch. With this phased approach, a total of 15 samples were analyzed for PCBs.

The results of the Characterization sampling and analysis for Site 15 are presented in Figure 3-1. The numbers by the sampling points are the PCB concentrations in ppm for those locations. The numbers in parentheses are the PCB

concentrations detected in the preceding Verification Step of the study.

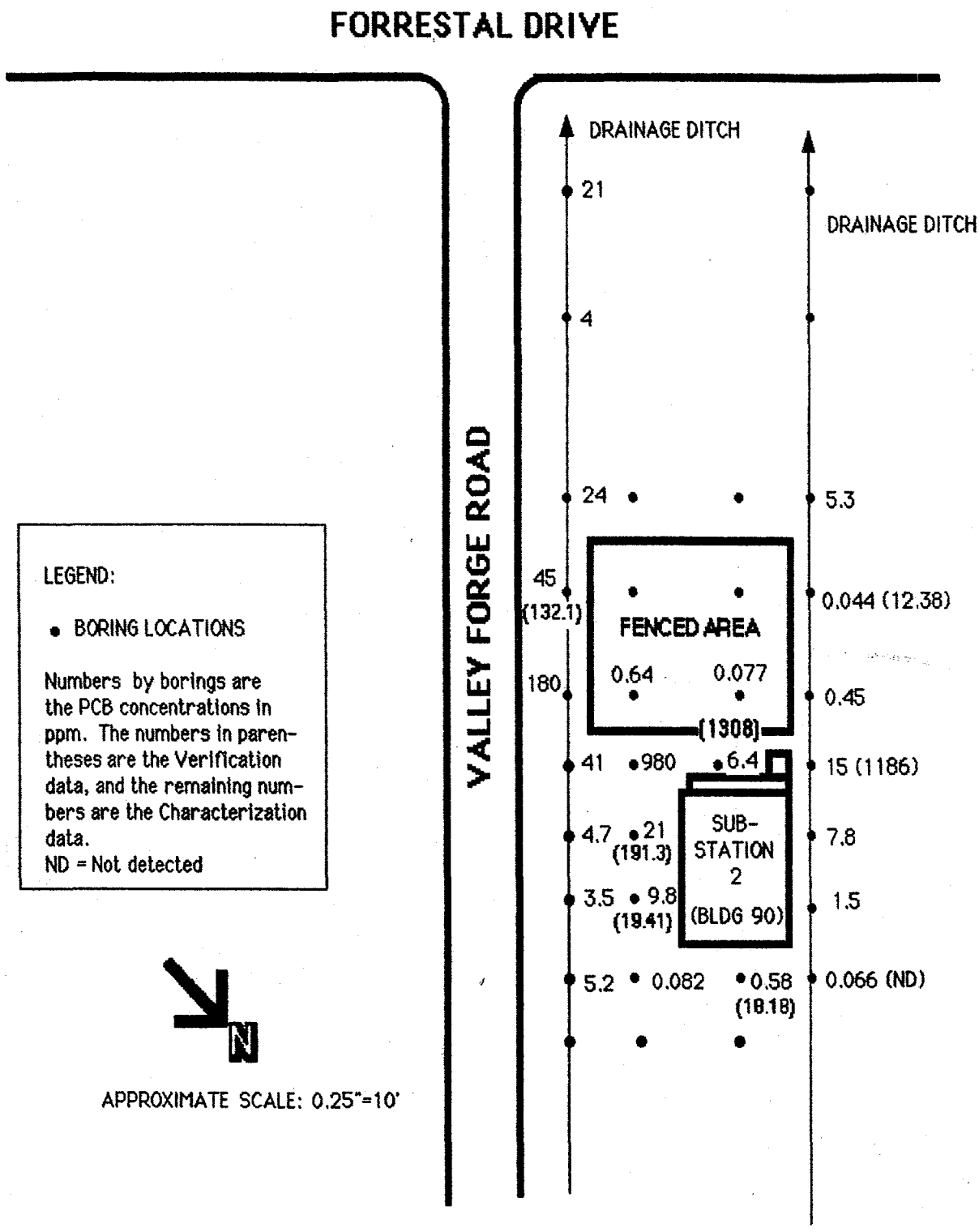

FIGURE 3-1
CHARACTERIZATION STEP SAMPLING LOCATIONS AND RESULTS AT SITE 15, SUBSTATION 2

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4.0 RISK ASSESSMENT

The objective of this section is to determine whether the levels of PCBs in the soil at Site 15 pose a threat to human health and/or the environment. In this section a soil criterion will be developed that represents a safe level of residual PCB contamination. The development of the PCB soil criterion involved the evaluation of the PCB clean-up requirements set forth by EPA in the TSCA policy to determine their applicability to Site 15, and the performance of a site specific risk assessment. In the TSCA policy, EPA has established criteria to be used in determining the adequacy of the clean-up of spills resulting from the release of materials containing PCBs at concentrations of 50 ppm or greater occurring after May 4, 1987. This policy requires clean-up of PCB-contaminated soil to different levels depending upon the spill location, potential for exposure to residual PCBs remaining after clean-up, the concentration of the PCBs initially spilled, and the nature and size of the population potentially at risk of exposure. For PCB spill areas where there is a greater potential for human exposure to the PCB contamination, the policy requires more stringent clean-up standards. The TSCA PCB regulations are presented below by spill location description.

Spill Location Description	PCB Criterion
(1) Spills at outdoor electrical substations with restricted access	25-50 ppm

(2)	Spills at other restricted access locations other than electrical substations	25 ppm
(3)	Spills at nonrestricted access areas	10 ppm

Because the soil contamination at Site 15 exists in an open area with nonrestricted access to lawn maintenance and other station personnel, the 10 ppm clean-up standard would be applicable to the site.

To further evaluate the appropriateness of the 10 ppm clean-up standard for Site 15, a site specific risk assessment was performed. The objective of the risk assessment was the development of a safe level of residual PCB contamination (termed target concentration) based on site specific conditions.

The first step in determining target concentrations is the identification of actual and potential exposure pathways. Only complete exposure pathways are considered for the purpose of developing target concentrations. If any of these components is not present, then the exposure pathway is incomplete and would not be expected to contribute to the total exposure from the site.

A complete exposure pathway has four components:

1. A source of chemical release,
2. An environmental transport medium,

3. A point where human or environmental receptors could be exposed, and
4. A likely exposure route.

A screening of current and potential exposure pathways was conducted to determine which pathways are most significant for the site in terms of human exposure to contaminants. This screening step serves to eliminate from consideration those exposure scenarios in which contaminants may be released from the site but for which there is little or no potential for human contact. This screening also identifies those exposure pathways that are complete and will require detailed quantitative analysis to estimate the extent of human exposure. Environmental receptors were eliminated from further consideration because the contaminated area is too small to support significant populations.

The following routes of exposure have been identified for Site 15 based on the pathway screening analysis:

1. Exposure of workers or the public through dermal absorption of contaminated surface soil,
2. Exposure of workers or the public through incidental ingestion of contaminated surface soil,
3. Exposure of workers or the public through ingestion of contaminated drinking water, and
4. Exposure of workers or the public through inhalation of contaminated dusts and/or vapors.

The following paragraphs describe the rationale for selection or exclusion of the various exposure pathways for developing a target PCB concentration for Site 15.

Exposure Of Workers Or The Public Through Dermal Absorption Of Contaminated Surface Soil--The access to Site 15 by lawn maintenance crews and other station personnel could result in direct contact with soil on exposed skin surfaces and subsequent percutaneous absorption of contaminants. This exposure to soil through dermal absorption represents a complete pathway and, therefore, was included in subsequent analysis of a target PCB concentration.

Exposure Of Workers Or The Public Through Incidental Ingestion Of Contaminated Surface Soil--As a result of persons coming into direct contact with soil contaminants at Site 15, contaminated soil may be accidentally ingested. Persons who have been exposed to soil contaminants through direct contact may consume food items with soiled hands or otherwise ingest soil as a result of unintentional hand-to-mouth contact. Through these mechanisms, persons may actually ingest small quantities of contaminated soil from the site. Because this pathway is considered to be complete, it was included in the development of a target PCB concentration for the site.

Exposure Of Workers Or The Public Through Ingestion Of Contaminated Drinking Water--There are no drinking water wells on or near the site, and it is unlikely that significant leaching and migration of PCBs to the ground water, by infiltrating rainwater, is occurring because of the low solubility of PCBs in water. Because no exposure point has been identified and environmental transport is unlikely, this pathway is classified as incomplete and is eliminated from further consideration.

Exposure Of Workers Or The Public Through Inhalation Of Contaminated Dusts Or Vapors--Field investigations of Site 15 have indicated that some of the area is thinly vegetated. Consequently, dispersion of airborne PCB-contaminated dust during lawn mowing is a likely transport mechanism. However, migration via volatilization is an unlikely transport mechanism because PCBs are not very volatile and are not expected to volatilize from the soil. Therefore, dust inhalation, but not vapor inhalation, is considered a complete pathway and was included in development of a target PCB concentration for Site 15.

Based on this exposure pathways analysis, it appears likely that the worst case scenario involves dermal absorption, incidental ingestion, and dust inhalation of residual soil contaminants. Maximum conditions of exposure correspond to a worker performing ground maintenance 2 hours per day for 26 days out of the year. These assumptions were used to modify the dermal adsorption factor of 38 milligrams per day (mg/day) developed by Hawley (1985) to yield an annualized average dermal human intake factor of 0.226 milligrams (mg) of soil per day using the following equation:

$$38 \text{ mg/day} \times \frac{26 \text{ workdays/year}}{365 \text{ days/year}} \times \frac{2 \text{ hours/workday}}{24 \text{ hours/day}} = 0.226 \text{ mg/day}$$

The same level of activity was used to modify the lifetime average soil ingestion rate of 100 mg/day and the average inhalation rate for doing moderately heavy work of 2.8 cubic meters per hour (m^3/hour), both suggested by EPA (1986a). This yields an annualized average incidental soil ingestion

human intake factor of 0.594 mg/day and an annualized average inhalation exposure factor of 0.0166 m^3/day.

According to EPA policy, a total carcinogenic risk level of 10^{-6} is an acceptable risk for exposure of an individual to a hazardous waste site. The EPA approach (1986a) is to apportion an equal level of risk to each potential carcinogen at the site. But, because PCBs are the only observed carcinogen at the site, the PCB target risk level is the same as the total carcinogen risk level.

The target PCB oral chronic daily intake (CDI) at the site was then determined by dividing the target risk level of 10^{-6} by the oral route cancer potency factor of 4.34 $(mg/kg/day)^{-1}$ yielding a value of 2.30×10^{-7} mg/kg/day [kg = kilograms].

The target PCB inhalation CDI was calculated in a similar manner. However, because an inhalation route cancer potency factor for PCBs was not available in the technical literature, an assumed inhalation factor was used. In general, the inhalation factor is about an order of magnitude less than the oral route cancer potency factor, which is 4.34 $(mg/kg/day)^{-1}$ for PCBs. Threfore, an inhalation factor of 0.4 $(mg/kg/day)^{-1}$ was used to yield a target PCB inhalation CDI of 0.25×10^{-5} mg/kg/day.

Using Pathway Preliminary Pollutant Limit Values (PPLV) methodology, significant source-to-receptor pathway is quantified and the effects combined to ensure that an exposed individual will not receive an unacceptably large dose. Intermediate results of the method are referred to as single-pathway preliminary pollutant limit values (SPPPLVs) and

represent residual levels of contamination that would be safe if only that single pathway were operating. Several pathways are combined by the following equation:

$$PPLV = \frac{1}{\frac{1}{SPPPLV,1} + \frac{1}{SPPPLV,2} + \ldots}$$

The dermal absorption exposure pathway is defined as:

$$SPPPLV_{(D)} = B_W/W_S \times CDI$$

where: B_W = body weight of an adult (70 kg)
W_S = annualized average dermal human intake factor (0.226 mg/day)
CDI = 2.30×10^{-7} mg/kg/day

$$SPPPLV_{(D)} = \frac{70\ kg}{2.26 \times 10^{-7}\ kg/day} \times 2.30 \times 10\text{-}7\ mg/kg/day$$

$$= 71.2\ mg/kg$$

The incidental soil ingestion exposure pathway is defined as:

$$SPPPLV_{(I)} = B_W/W_{Si} \times CDI$$

where: B_W = body weight of an adult (70 kg)
W_{Si} = annualized average incidental soil ingestion human intake factor (0.594 mg/day)
CDI = 2.30×10^{-7} mg/kg/day

$$SPPPLV_{(I)} = \frac{70\ kg}{5.94 \times 10^{-7}\ kg/day} \times 2.30 \times 10\text{-}7\ mg/kg/day$$

$$= 27.1\ mg/kg$$

The dust inhalation exposure pathway is defined as:

$$SPPPLV_{(R)} = \frac{B_W \times CDI}{RB \times C_{SS}}$$

where:
- B_W = body weight of an adult (70 kg)
- RB = annualized average inhalation exposure factor (0.0166 m^3/day)
- C_{SS} = concentration of suspended particles in the air (assume 4×10^{-1} mg/m^3)
- CDI = 0.25×10^{-5} mg/kg/day

$$SPPPLV_{(R)} = \frac{70\ kg \times 0.25 \times 10\text{-}5\ mg/kg/day}{0.0166\ m^3/day \times 4 \times 10^{-1}\ mg/m^3}$$

$$= 0.0264\ kg/kg \text{ or } 2.64 \times 10^4\ mg/kg$$

The soil PCB PPLV criterion, i.e., the target residual PCB soil concentration, was developed assuming an average, representative scenario, where the same worker is exposed to contaminated soils through each of the 3 exposure routes. This PPLV is defined as follows:

$$PPLV = \frac{1}{\frac{1}{SPPPLV_{(D)}} \quad \frac{1}{SPPPLV_{(I)}} \quad \frac{1}{SPPPLV_{(R)}}}$$

The calculated PPLV for PCBs is 20 mg/kg. Therefore, based on the site specific risk assessment, the calculated PCB clean-up level is 20 mg/kg or ppm. However, the more conservative TSCA clean-up standard of 10 ppm will be used to provide an added degree of protection to human health in the clean-up of Site 15. This clean-up standard, along with the identified contaminant routes of exposure form the basis for development of the remedial action alternatives.

5.0 ALTERNATIVES ANALYSIS

The four remedial alternatives developed for Site 15 are described below and illustrated in Figures 5-1 through 5-4, respectively. These alternatives were developed based on the contaminant routes of exposure and clean-up level identified in the previous section. The four alternatives vary in the degree to which they address the PCB contamination problem at the site. For example, Alternative 1 applies the least stringent requirements for clean-up while Alternative 4 applies the most stringent.

Alternative 1 is the "no action" alternative. In this alternative a 6-foot (ft) high, galvanized chain link fence is to be installed around the site. The fence is to encompass all areas of the site confirmed to have PCB concentrations above 10 ppm. The fence is to be 542 linear feet (L.F.) long, enclosing a total area of 688 square yards (S.Y.).

In Alternative 2 a single-layered asphalt cap is to be installed over the site. This cap is to consist of 4 inches of base material and 1 inch of bituminous paving. The cap is to cover areas of the site confirmed to have PCB concentrations above 10 ppm. The cap is to have an area of 688 S.Y.

Alternative 3 specifies both partial excavation and capping. In this alternative site areas confirmed to have PCB concentrations above 25 ppm are to be excavated. A total of 96 cubic yards (C.Y.) of PCB-contaminated soil are to be removed by excavating an area of 288 S.Y. to a depth of 1 ft. The excavated areas are then to be backfilled with clean soil,

which is defined by EPA as containing less than 1 ppm PCBs. Futhermore, site areas confirmed to have PCB concentrations between 10 and 25 ppm are to be capped with a single-layered asphalt cap. This cap is to cover an area totaling 400 S.Y. The cap is to meet the same specifications as those specified in Alternative 2. Excavated material is to be disposed of by incineration in an incinerator permitted for PCB incineration.

Alternative 4 is the most stringent in meeting PCB clean-up criteria. In this alternative site areas confirmed to have PCB concentrations exceeding 10 ppm are to be excavated. A total of 229 C.Y. of PCB-contaminated soil are to be removed by excavating an area of 688 S.Y. to a depth of 1 ft. The excavated area is then to be backfilled with clean soil. Excavated material is to be disposed of by incineration.

Table 5-1 presents the estimated costs to implement each of the four remedial action alternatives, and Appendix A contains the detailed cost estimates for each alternative. Most of the cost estimates for these alternatives were performed using Mean Site Work Cost Data 1987. The exceptions are the hauling and disposal costs for the PCB-contaminated soil. These figures were obtained from ENSCO, the firm that operates the PCB-permitted incinerator nearest to Site 15, which is located in El Dorado, Arkansas. Hauling costs include freight charges from Site 15 to this location in Arkansas.

As shown in Table 5-1, the lowest cost alternatives are Alternative 1, which involves the construction of a fence around the area with a PCB concentration exceeding 10 ppm, and Alternative 2, capping. The costs for Alternatives 3 and 4 are significantly higher than those for Alternatives 1 and 2

because of the high costs associated with hauling and incineration of the contaminated soil.

The disadvantage of Alternatives 1 and 2 is that although the fencing/capping eliminates the human exposure pathways, these alternatives do not accomplish any reduction in toxicity or volume of the contamination. Likewise, Alternative 3, which provides treatment and destruction of a portion of the contaminated soil, only provides partial reduction of waste volume. The highest cost alternative, Alternative 4, provides treatment and destruction of all of the contaminated soil with a PCB concentration exceeding 10 ppm.

TABLE 5-1 SUMMARY OF COST ESTIMATES FOR REMEDIAL ACTION ALTERNATIVES FOR SITE 15, SUBSTATION 2

Alternative	Capital Cost ($)	Annual O&M Cost ($/YR)	Total Cost ($)*
1	$8,400	$50	$8,800
2	$2,900	$50	$3,300
3	$242,300	$50	$242,700
4	$574,000	0	$574,000

* Total Cost = Sum of capital cost and present worth of annual O&M cost assuming a period of 20 years at 10 percent interest rate.

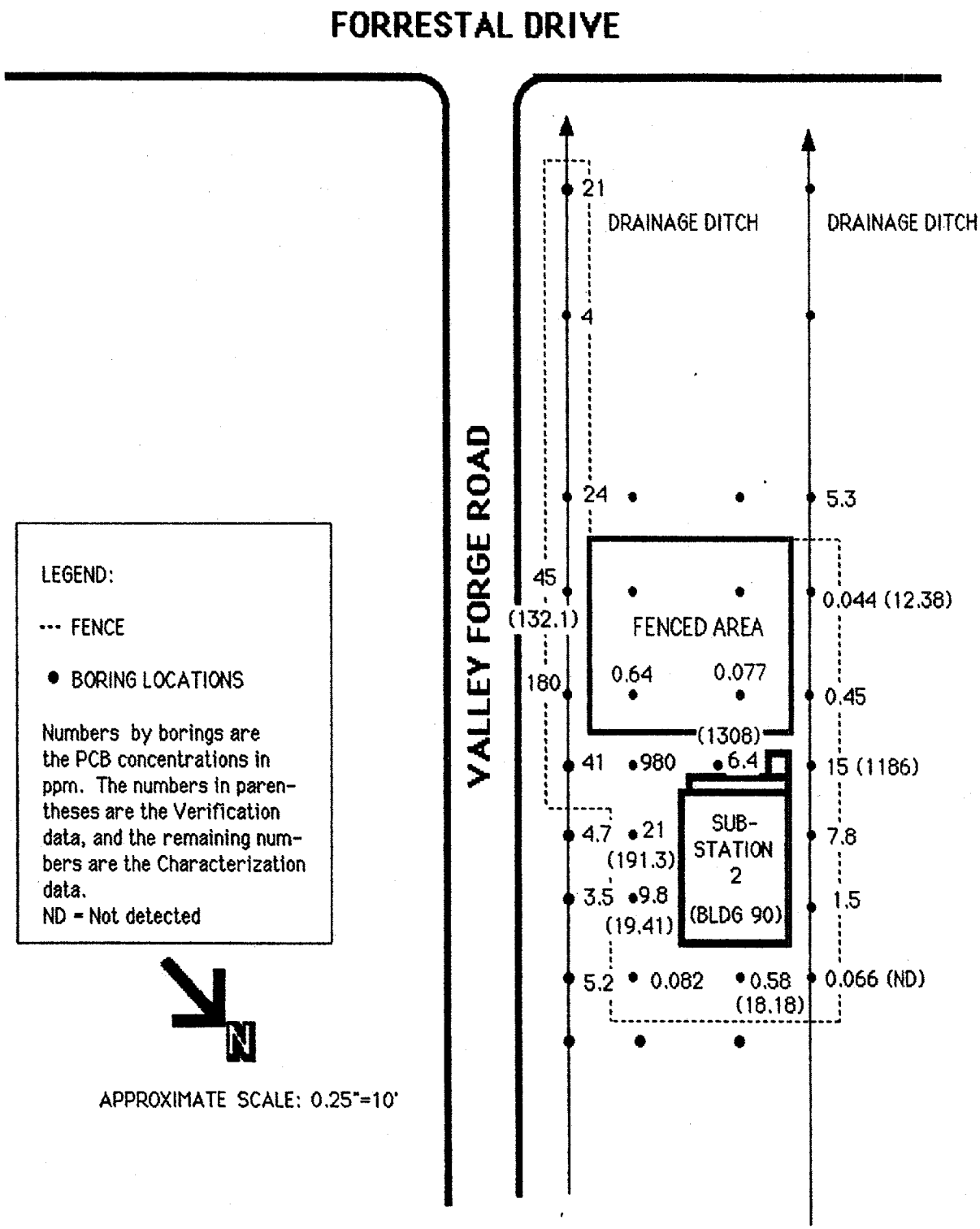

FIGURE 5-1
ALTERNATIVE 1, NO ACTION,
SITE 15, SUBSTATION 2

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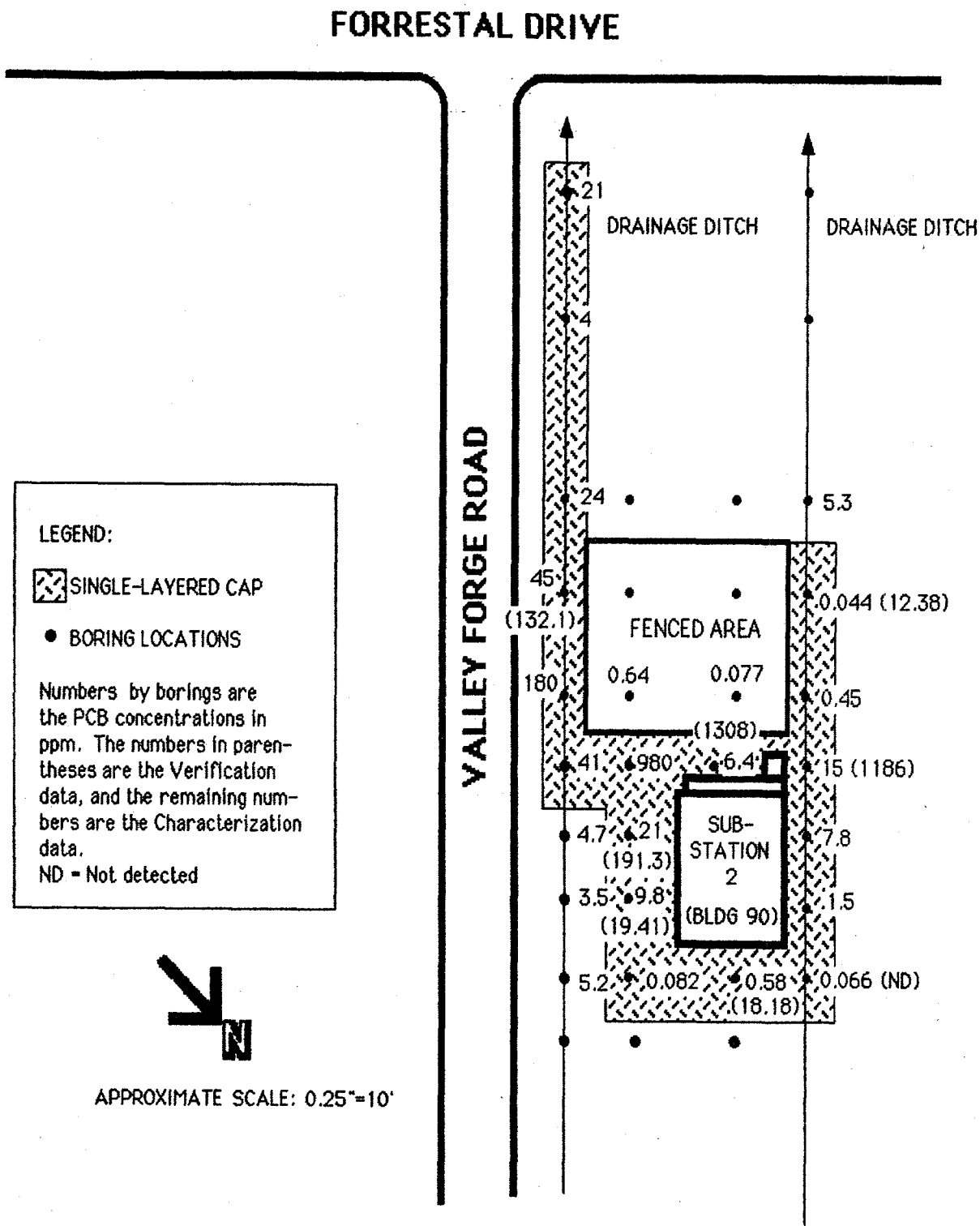

FIGURE 5-2
ALTERNATIVE 2, CAPPING,
SITE 15, SUBSTATION 2

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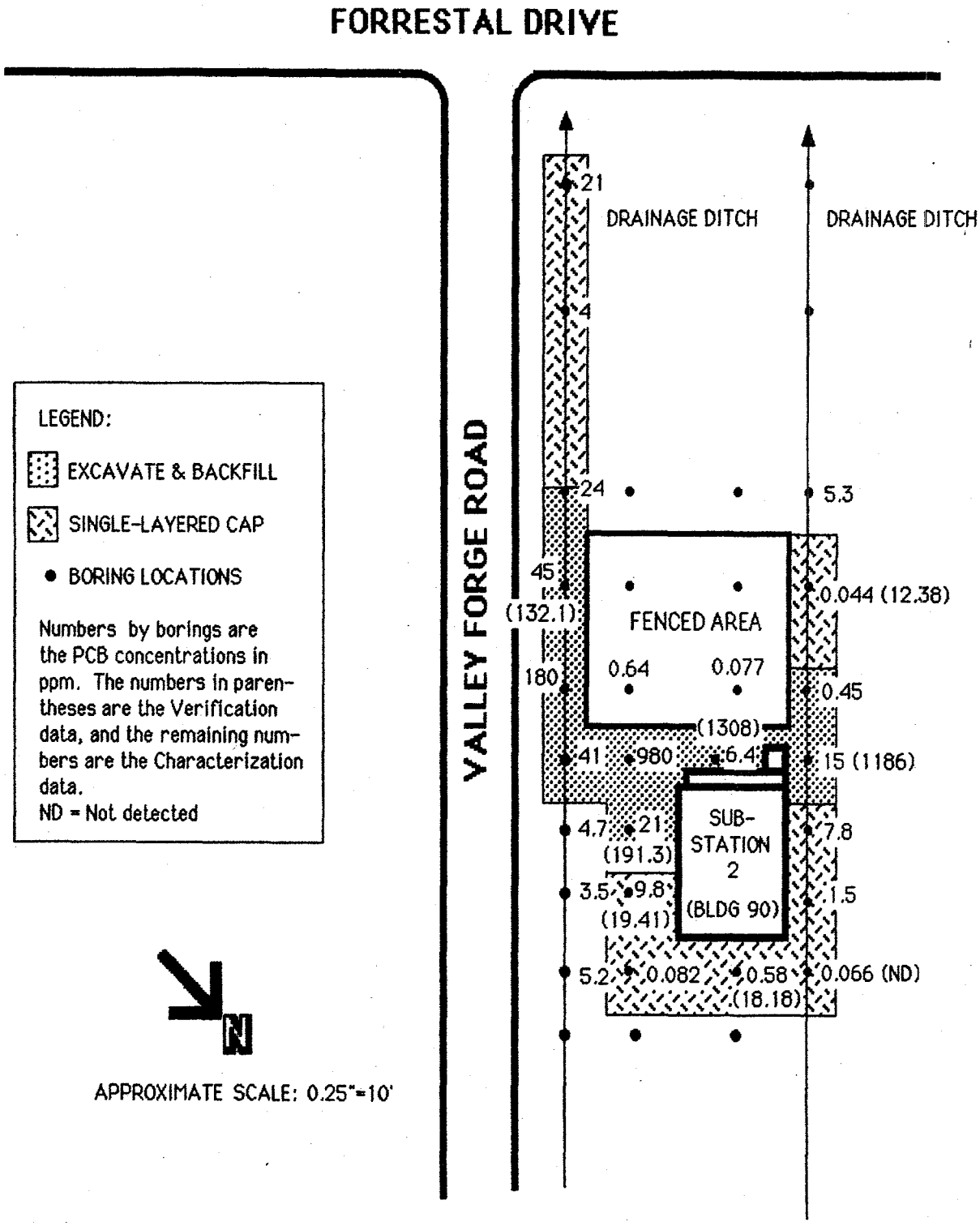

FIGURE 5-3
ALTERNATIVE 3, PARTIAL EXCAVATION AND CAPPING, SITE 15, SUBSTATION 2

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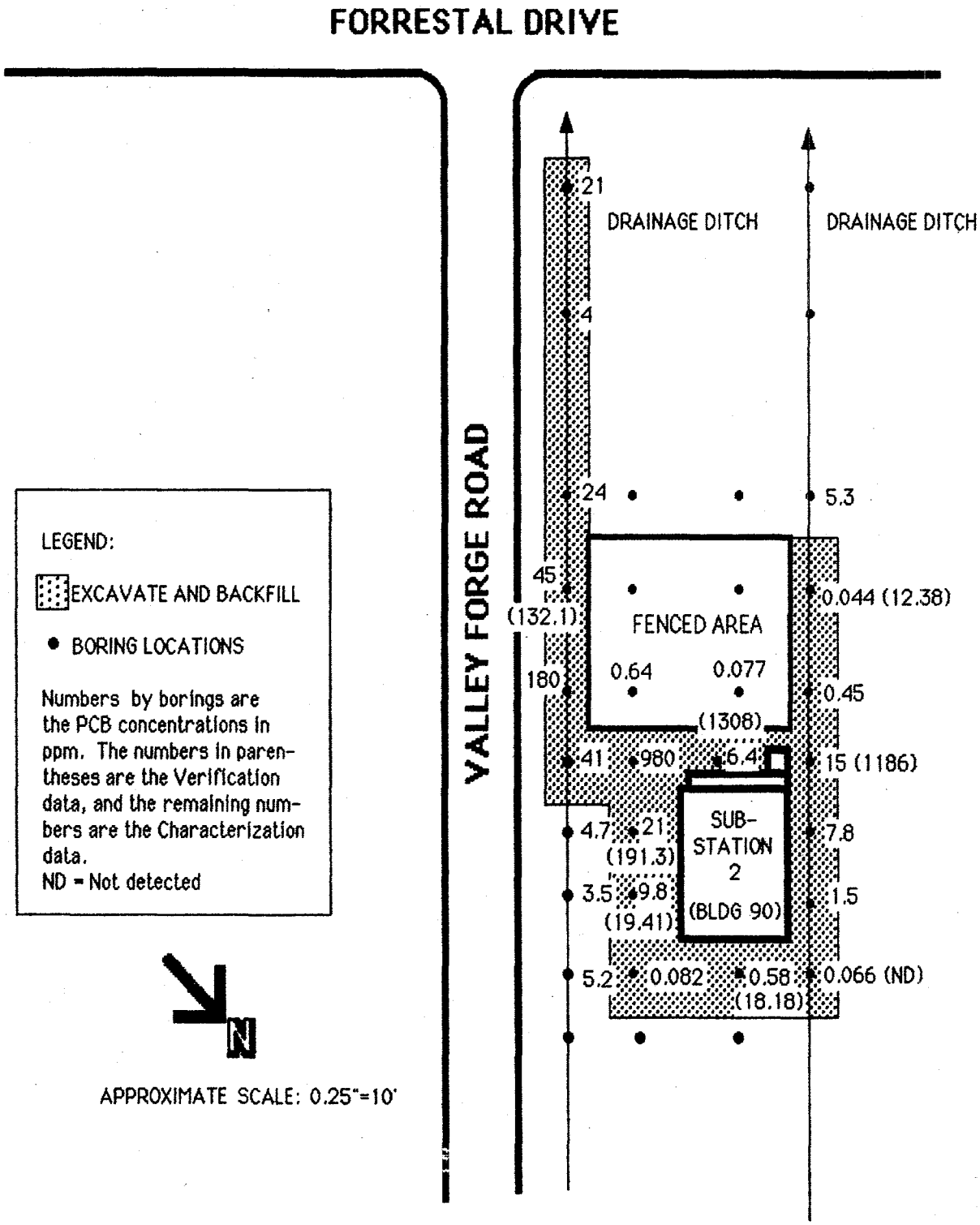

FIGURE 5-4
ALTERNATIVE 4, EXCAVATION,
SITE 15, SUBSTATION 2

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6.0 REFERENCES

Hawley, J.K. 1985. Assessment of Health Risk from Exposure to Contaminated Soil. Risk Analysis, 5(4).

U.S. Environmental Protection Agency (EPA). 1986a. Superfund Public Health Evaluation Manual. Office of Emergency and Remedial Response, Washington, DC.

U.S. Environmental Protection Agency (EPA). 1986b. Verified Reference Doses (RFDs) of the U.S. Environmental Protection Agency. EPA, Cincinnati, OH. Environmental Criteria and Assessment Office.

U.S. Environmental Protection Agency (EPA). 1986c. Guidelines for the Health Risk Assessment of Chemical Mixtures. Federal Register 51(185):34014-34025.

U.S. Environmental Protection Agency (EPA). 1987a. "Update No. 2 to "Quality Criteria For Water 1986". Office of Water Regulation and Standards Criteria and Standards Division. May, 1987.

U.S. Environmental Protection Agency (EPA). 1987b. Draft, CERCLA Compliance With Other Laws Manual, Volume I: Overview and RCRA Requirements. Office of Emergency and Remedial Response. Office of Solid Waste and Emergency Response. June, 1987

U.S. Environmental Protection Agency (EPA). 1987c. Code of Federal Regulations, Title 40, July, 1987.

APPENDIX A
COST ESTIMATES FOR REMEDIAL ACTION ALTERNATIVES

ALTERNATIVE 1 NO ACTION

CAPITAL COST

FENCE, CHAIN LINK INDUSTRIAL 6' HIGH PLUS 3 STRANDS BARBED WIRE, 2" LINE POST @ 10' O.C. 1 - 5/8" TOP RAIL

6 GA WIRE, GALV. STEEL		
542 L.F. X $11.90/L.F.	=	$6,450
CORNER POSTS, 3" DIA GALV. STEEL		
7 POSTS X $66 EA	=	$462
BRACES, GALV. STEEL		
14 BRACES X $23 EA	=	$322
GATE		
1 X $90		$90
SUBTOTAL		$7,324
CONTINGENCY (15%)		$1,099
TOTAL CAPITAL COST		$8,423

ANNUAL O&M COST

ASSUME $50/YR

ALTERNATIVE 2 CAPPING

CAPITAL COST

BITUMINOUS CAP, 1" THICK PAVING, 4" GRAVEL BASE

BORROW	76 CY X $7.30/CY	=	$555
COMPACTION	76 CY X $3.24/CY	=	$246
BITUMINOUS CAP	688 SY X $2.55/SY	=	$1,754
SUBTOTAL			2,555
CONTINGENCY (15%)			383
TOTAL CAPITAL COST			$2,938

ANNUAL O&M COST

ASSUME $50/YR

ALTERNATIVE 3 PARTIAL EXCAVATION & CAPPING

CAPITAL COST

EXCAVATION & BACKFILL

EXCAVATION	96 CY X $2.83/CY	=	$272
BORROW	96 TONS X $1.98/TON	=	$190
HAUL BACKFILL	96 CY X $6.95/TON	=	$667
BACKFILL & COMPACTION	96 CY X $2.82/CY	=	$271
REVEGETATION	288 SY X $3.24/SY	=	$933

HAULING & INCINERATION

CONTAINERIZATION	96 CY X $251.46/CY	=	$24,140
FREIGHT SOIL	96 CY X $237.50/CY	=	$22,800
INCINERATION SOIL	96 CY X $1666.25/CY	=	$159,960

CAP

BORROW	44 CY X $7.30/CY	=	$321
COMPACTION	44 CY X $3.24/CY	=	$143
CAP	400 SY X $2.55/SY	=	1,020
SUBTOTAL			$210,717
CONTINGENCY			$31,608
TOTAL CAPITAL COST			$242,325

ANNUAL O&M COST

ASSUME $50/YR

ALTERNATIVE 4 EXCAVATION

CAPITAL COST

EXCAVATION & BACKFILL

EXCAVATION	229 CY X $2.83/CY	=	$648
BORROW	229 TONS X $1.98/TON	=	$453
HAUL BACKFILL	229 CY X $6.95/TON	=	$1,592
BACKFILL & COMPACTION	229 CY X $2.82/CY	=	$646
REVEGETATION	688 SY X $3.24/SY	=	$2,229

HAULING & INCINERATION

CONTAINERIZATION	229 CY X $251.46/CY	=	$57,584
FREIGHT	229 CY X $237.50/CY	=	$54,388
INCINERATION	229 CY X $1666.25/CY	=	$381,571
SUBTOTAL			$499,111
CONTINGENCY (15%)			$74,867
TOTAL CAPITAL COST			$573,978

ANNUAL O&M COST = 0