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INSTALLATION RESTORATION PROGRAM

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For Site Investigation at the
142nd Fighter Interceptor Group
Oregon Air National Guard
Portland International Airport
Portland, Oregon



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• Oak Ridge, Tennessee 37831

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TABLE OF CONTENTS

	<u>Page</u>
1.0 EXECUTIVE SUMMARY.....	1
1.1 Site 1 - Central Hazardous Waste Storage Area.....	1
1.2 Site 2 - Civil Engineering Hazardous Material Storage Area.....	3
1.3 Site 3 - Hush House Area.....	3
1.4 Site 4 - Main Drainage Ditch.....	4
1.5 Site 5A - AGE Maintenance Shop (Motor Pool Fenceline Area).....	5
1.6 Site 5B - AGE Maintenance Shop (UST Pit Area).....	6
1.7 Site 7 - Burn Pit Area.....	7
1.8 Site 8 - Sanitary Landfill.....	8
2.0 INTRODUCTION.....	10
2.1 Restoration Process and Purpose of Site Investigation.....	10
2.2 Project Location and Site Layout.....	11
2.3 Historical Site Ownership and Operation.....	14
2.4 Contaminant Release and Site Remediation Activities to Date....	17
3.0 ENVIRONMENTAL SETTING.....	19
3.1 Land Use and Ecology.....	19
3.2 Climate.....	20
3.3 Surface Water.....	20
3.4 Geology and Hydrogeology.....	23
3.4.1 Physiographic Setting.....	23
3.4.2 Soils.....	23
3.4.3 Stratigraphy.....	25
4.0 SITE DESCRIPTIONS.....	30
4.1 Central Hazardous Waste Storage Area (Site 1).....	30
4.2 Civil Engineering Hazardous Material Storage Area (Site 2).....	34
4.3 Hush House Area (Site 3).....	36
4.4 Main Drainage Ditch (Site 4).....	38
4.5 AGE Maintenance Shop (Site 5).....	39
4.6 Burn Pit Area (Site 7).....	41
4.7 Sanitary Landfill (Site 8).....	43
5.0 HYDROGEOLOGIC FINDINGS.....	46
5.1 Field Methods and Well Construction.....	46
5.2 Lithology.....	50
5.3 Hydrogeology.....	53
5.3.1 Hydrostratigraphy.....	53
5.3.2 Occurrence and Movement of Ground Water.....	53
5.4 Aquifer Mechanics.....	64
5.4.1 Hydraulic Conductivity.....	64
5.4.2 Local Horizontal Ground Water Velocity.....	66
5.5 Potential for Contaminant Migration in Ground Water.....	67

TABLE OF CONTENTS (cont'd)

	<u>Page</u>
6.0 SITE CHARACTERIZATION.....	70
6.1 Sampling Methods.....	70
6.1.1 Soil and Sediment Sampling.....	71
6.1.2 Ground Water Sampling.....	71
6.1.3 Soil Gas Surveys.....	72
6.1.4 Management of SI-Derived Wastes.....	72
6.2 Analytical Methods.....	73
6.3 Sampling Program and Analytical Results.....	73
6.3.1 Site 1 - Central Hazardous Waste Storage Area.....	75
6.3.2 Site 2 - Civil Engineering Hazardous Material Storage Area.....	88
6.3.3 Site 3 - Hush House Area.....	95
6.3.4 Site 4 - Main Drainage Ditch.....	99
6.3.5 Site 5 - AGE Maintenance Shop.....	105
6.3.6 Site 7 - Burn Pit Area.....	113
6.3.7 Background Conditions.....	120
6.3.8 Site 8 - Sanitary Landfill.....	122
7.0 PRELIMINARY RISK ASSESSMENT.....	132
7.1 Introduction.....	132
7.2 Hazard Identification.....	132
7.3 Applicable or Relevant and Appropriate Requirements (ARARs).....	134
7.3.1 Identification of Federal ARARs.....	135
7.3.2 Comparison with Federal ARARs.....	137
7.3.3 Identification of non-Federal ARARs.....	140
7.3.4 Comparison with non-Federal ARARs.....	147
7.4 Exposure Assessment.....	151
7.4.1 Exposure Assumptions for the Ground Water Ingestion Pathway.....	152
7.4.2 Exposure Assumptions for the Surface Soil/ Sediment Ingestion Pathway.....	153
7.4.3 Exposure Assumptions for the Subsurface Soils.....	154
7.5 Toxicity Assessment.....	154
7.6 Risk Characterization.....	156
7.6.1 Site 1: Central Hazardous Waste Storage Area.....	156
7.6.2 Site 2: Civil Engineering Hazardous Material Storage Area.....	158
7.6.3 Site 3: Hush House Area.....	160
7.6.4 Site 4: Main Drainage Ditch.....	160
7.6.5 Site 5A: AGE Maintenance Shop - Fenceline Area.....	160
7.6.6 Site 5B: AGE Maintenance Shop - UST Area.....	163
7.6.7 Site 7: Burn Pit Area.....	167
7.7 Summary of Prior Risk Assessment for Site 1 Soils Unit.....	167

TABLE OF CONTENTS (cont' d)

	<u>Page</u>
8.0 QUALITY ASSURANCE AND QUALITY CONTROL EVALUATION.....	172
8.1 Laboratory QA/QC Program.....	172
8.1.1 QA/QC Review.....	172
8.1.2 Data Qualification for Laboratory Blanks.....	172
8.2 Field QA/QC Program.....	174
8.2.1 Analytical Results for Field QA/QC Blanks.....	178
8.2.2 Data Qualification for Field QA/QC Blanks.....	183
8.2.3 Field Duplicates.....	184
9.0 DISCUSSION OF FINDINGS AND RECOMMENDATIONS.....	191
9.1 Site 1 - Central Hazardous Waste Storage Area.....	191
9.1.1 Ground Water Unit.....	191
9.1.2 Soils Unit.....	192
9.2 Site 2 - Civil Engineering Hazardous Material Storage.....	194
9.3 Site 3 - Hush House Area.....	195
9.4 Site 4 - Main Drainage Ditch.....	196
9.5 Site 5A - AGE Maintenance Shop (Motor Pool Fenceline Area).....	198
9.6 Site 5B - AGE Maintenance Shop (UST Pit Area).....	200
9.7 Site 7 - Burn Pit Area.....	201
9.8 Site 8 - Sanitary Landfill.....	203
9.9 Summary of Recommendations.....	205
10.0 REFERENCES.....	207
11.0 ACRONYMN LIST.....	213
APPENDIX A - Chemical Analytical Results	
APPENDIX B - Monitoring Well Installation Logs and Borehole Logs	
APPENDIX C - Slug Test Data and Derived Coefficients	
APPENDIX D - Soil Gas Survey Report	
APPENDIX E - Field GC Analytical Report	
APPENDIX F - Geophysical Survey Report	
APPENDIX G - Public Health Risk Evaluation Process	
APPENDIX H - Hazard Ranking System Score Sheets	
APPENDIX I - Environmental Sensitivity Scores to Establish PHC Cleanup Levels	
APPENDIX J - Laboratory QA/QC Data Validation Report	
APPENDIX K - Field Change Forms	
APPENDIX L - Chain of Custody Forms	

LIST OF TABLES

<u>Table</u>	<u>Title</u>	<u>Page</u>
4-1	Summary of Previous Findings at Potential Hazardous Waste Sites.....	31
5-1	Construction Details of Monitoring Wells.....	49
5-2	Survey Coordinates for Monitoring Wells.....	51
5-3	Ground Water Level Measurements.....	54
5-4	Hydraulic Conductivities for Monitoring Wells.....	65
6-1	Summary of Environmental Sampling Activities at Site 1.....	77
6-2	Analytical Results for Fast-Track (December 1988) Sampling Episode - Site 1.....	79
6-3	Soil/Slurry Sample Depths - Site 1 (Expanded SI Episode - January 1989).....	83
6-4	Analytical Results for Expanded SI (January 1989) Sampling Episode - Site 1 (Field GC Headspace Analyses).....	84
6-5	Analytical Results for Expanded SI (January 1989) Sampling Effort - Site 1 (Offsite Laboratory Analyses).....	85
6-6	Summary of Environmental Sampling Activities at Site 2 (Civil Engineering Hazardous Materials Storage Area).....	91
6-7	Analytical Results for Site 2 (Civil Engineering Hazardous Material Storage Area).....	94
6-8	Summary of Environmental Sampling Activities at Site 3 (Hush House Area).....	98
6-9	Analytical Results for Site 3 (Hush House Area).....	100
6-10	Summary of Environmental Sampling Activities at Site 4 (Main Drainage Ditch).....	102
6-11	Analytical Results for Site 4 (Main Drainage Ditch).....	104
6-12	Summary of Environmental Sampling Activities at Site 5A (AGE Maintenance Shop - Fenceline Area).....	108
6-13	Analytical Results for Site 5A (AGE Maintenance Shop - Fenceline Area).....	109
6-14	Summary of Environmental Sampling Activities at Site 5B (AGE Maintenance Shop - Former UST Area).....	111
6-15	Analytical Results for Site 5B (AGE Maintenance Shop - Former UST Area).....	114
6-16	Summary of Environmental Sampling Activities at Site 7 (Burn Pit Area).....	116
6-17	Analytical Results for Site 7 (Burn Pit Area).....	121
6-18	Summary of Environmental Sampling Activities at Background Location..	123
6-19	Analytical Results for the Background Location.....	125
7-1	Water Quality ARARs and Drinking Water Health Advisories for Identified Chemicals at Oregon ANG Portland.....	138
7-2	Comparison of Ground Water Concentrations with ARARs at Site 1.....	139
7-3	Comparison of Ground Water Concentrations with ARARs at Site 2.....	141
7-4	Comparison of Ground Water Concentrations with ARARs at Site 5A (Fenceline Area).....	142

LIST OF TABLES (cont'd)

<u>Table</u>	<u>Title</u>	<u>Page</u>
7-5	Comparison of Ground Water Concentrations with ARARs at Site 7.....	143
7-6	Comparison of Site 4 Sediment Concentrations with WDOE Interim Sediment Quality Standards.....	149
7-7	Toxicity Measures for Waste Site Evaluation: Ingestion and Inhalation Pathways.....	155
7-8	Risk Characterization for Site 1: Exposure to Ground Water....	157
7-9	Risk Characterization for Site 2: Exposure to Ground Water....	159
7-10	Risk Characterization for Site 4: Exposure to Sediments.....	161
7-11	Risk Characterization for Site 5A: Exposure to Ground Water (Fenceline Area).....	162
7-12	Risk Characterization for Site 5A: Exposure to Surface Soils (Fenceline Area).....	164
7-13	Risk Characterization for Site 5A: Exposure to Full Soil Column (Fenceline Area).....	165
7-14	Risk Characterization for Site 5B: Exposure to Full Soil Column (Former UST Area).....	166
7-15	Risk Characterization for Site 7: Exposure to Ground Water....	168
7-16	Risk Characterization for Site 7: Exposure to Surface Soils....	169
8-1	Laboratory Blank Qualification Results for Soil Samples.....	175
8-2	Laboratory Blank Qualification Results for Ground Water Samples.....	177
8-3	Field QA/QC Samples Cross-Reference Chart.....	179
8-4	Summary of Trip Blanks, Field Blanks, and Equipment Rinses Analytical Results.....	181
8-5	Field Blank Qualification Results for Environmental Samples....	185
8-6	Summary of Field Duplicate Analytical Results.....	188

LIST OF FIGURES

<u>Figure</u>	<u>Title</u>	<u>Page</u>
2-1	Regional Vicinity Map for Oregon ANG Portland.....	12
2-2	Location of Potential Hazardous Waste Sites at Oregon ANG Portland Facility.....	13
2-3	Public and Private Wells in the Vicinity of ANG Portland.....	15
2-4	Location of the Portland Well Field.....	16
3-1	Drainage System and Ditches at ANG Portland.....	21
3-2	Upper and Lower Reaches of Columbia Slough.....	22
3-3	Geologic Map of the ANG Portland Facility and Vicinity.....	24
3-4	Geologic Cross Section - Eastern Portion of the Portland Well Field.....	26
4-1	Site 1: Central Hazardous Waste Storage Area Previous Sampling Locations.....	33
4-2	Site 2: Civil Engineering Hazardous Material Storage Area Previous Sampling Locations.....	35
4-3	Site 3: Hush House Area Previous Sampling Locations.....	37
4-4	Site 5: AGE Maintenance Shop Previous Sampling Locations.....	40
4-5	Site 7: Burn Pit Area.....	42
4-6	Location of Burn Pit Area (Site 7).....	44
4-7	Site 8: Sanitary Landfill.....	45
5-1	Schematic Diagram of Well Construction.....	48
5-2	Location of Monitoring Wells.....	52
5-3	Site 1: Ground Water Elevations - August 1989.....	56
5-4	Site 2: Ground Water Elevations - August 1989.....	57
5-5	Site 3: Ground Water Elevations - August 1989.....	58
5-6	Site 5A: Ground Water Elevations - August 1989.....	59
5-7	Site 5B: Ground Water Elevations - August 1989.....	60
5-8	Site 7: Ground Water Elevations - August 1989.....	61
5-9	Background Ground Water Elevations - August 1989.....	62
5-10	Ground Water Table Contour at ANG Portland (Summer Conditions).....	63
6-1	Site 1: Central Hazardous Waste Storage Area Sampling Locations.....	76
6-2	Site 2: Civil Engineering Hazardous Material Storage Area Sampling Locations.....	90
6-3	Site 2: Civil Engineering Hazardous Material Storage Area TCE Concentrations and Soil Gas Contours.....	93
6-4	Site 3: Hush House Area Sampling Locations.....	97
6-5	Site 4: Main Drainage Ditch Sample Locations.....	101
6-6	Site 5A: AGE Maintenance Shop - Fenceline Area Sampling Locations.....	106
6-7	Site 5B: Excavation Pit and Sampling Locations for Former Underground Storage Tank.....	112
6-8	Site 7: Burn Pit Area Sampling Locations.....	117
6-9	Site 7: Burn Pit Area - Total Hydrocarbons Concentrations in Soil Gas.....	119
6-10	Background Sample Locations.....	124
6-11	Location of Geophysical Survey Grid.....	129
6-12	Location of Unexplained Anomalous Region.....	131

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1.0 EXECUTIVE SUMMARY

This report describes Site Investigation (SI) activities accomplished under the Department of Defense Installation Restoration Program (IRP) at the 142nd Fighter Interceptor Group (FIG) Oregon Air National Guard facility located near the Portland International Airport in Portland, Oregon (hereinafter referred to as "ANG Portland" or "the Base"). Eight individual sites were identified in a Preliminary Assessment (PA) report as locations where contaminants may be potentially present and may pose a threat to human health, public safety, or the environment. These eight sites were:

- Site 1 - Central Hazardous Waste Storage Area
- Site 2 - Civil Engineering Hazardous Material Storage Area
- Site 3 - Hush House Area
- Site 4 - Main Drainage Ditch
- Site 5 - AGE Maintenance Shop
- Site 6 - Wash Rack West of Building 1355
- Site 7 - Burn Pit Area
- Site 8 - Sanitary Landfill

The PA evaluation resulted in a recommendation of no further action for Site 6. Site Investigation activities were conducted for the remaining seven sites.

The major objective of the Site Investigation program was to collect sufficient field and other data to determine whether contamination is present or absent at each site, to determine impact to the environment and/or human health, and to recommend further investigations where required. A secondary objective was to obtain preliminary information regarding the extent and migration of any contamination found to be present. The technical approach, major findings, and recommendations of the SI program for each site are summarized in the following sections. The risk assessment results discussed below were based on conservative estimates for "reasonable maximum exposure scenarios."

1.1 SITE 1 - CENTRAL HAZARDOUS WASTE STORAGE AREA

This site was used for storage of miscellaneous wastes including drums of hazardous materials and electrical gear. Contaminant types suspected to be present at the site included waste oils, fuels and solvents, shop wastes, and

transformer fluids. Since many of the wastes stored at the site were derived from petroleum-based products, analyses included petroleum hydrocarbons (PHCs), volatile organics (VOCs), and semi-volatile organics (SVOCs or BNAs). To check for possible dielectric fluid leakage from electrical equipment, polychlorinated biphenyls (PCBs) analyses were also performed. Because of the wide variety of wastes stored at the site, the ground water was also checked for the presence of five common metals (cadmium, total chromium, lead, nickel, and zinc).

Low concentrations of VOCs, PCBs, or PHCs were found in many of the soil samples collected at the site from the unsaturated zone. The contaminants present in the unsaturated soils do not appear to pose a significant threat to human health or the environment based on the results of risk assessment, comparison with potential ARARs (applicable or relevant and appropriate requirements), and comparison with other "to be considered" (TBC) environmental guidelines. On this basis, no further investigation appears to be necessary for the Site 1 unsaturated soils.

High concentrations of bromochloromethane and methylene chloride were detected in the ground water and saturated soils underlying the site. Contamination appears to be limited to two areas which are associated with former spill locations. Preliminary risk characterization for the ground water showed a very high combined exposure Hazard Index value (more than 3,000 times the acceptable value). The detected concentrations for these compounds were more than 10,000 times greater than the federal water quality criteria (FWQC), adjusted for drinking water only.

In view of these very high projected risks, it is recommended that the Site 1 ground water be investigated further in the RI/FS. Further site characterization efforts should include hydrogeological characterization of deeper soils and delineation of the extent of contamination in the vicinity of the two spill areas identified in the SI program. Particular emphasis should be placed on determining the extent of vertical migration of dense chlorinated hydrocarbons in the ground water and saturated soils, which could be present as non-aqueous phase liquids that tend to sink in the saturated zone.

1.2 SITE 2 - CIVIL ENGINEERING HAZARDOUS MATERIAL STORAGE AREA

Site 2 is defined by the location of a former solvent storage shed. A former paint storage building was also located near the site. Suspected contaminants included methyl ethyl ketone and other solvents and thinners. Soil, ground water and soil gas sampling were undertaken to assess potential contamination. Analyses included VOCs, PHCs, and five metals.

Trichloroethene (TCE) and dichloroethenes (DCEs) were detected in ground water at concentrations which greatly exceeded the FWQC and the federal maximum contaminant levels (MCLs) for drinking water. Other chlorinated hydrocarbons appear to be present based on the soil gas survey results.

Because of the high concentrations of TCE confirmed in ground water which far exceeded potential ARARs, the undefined extent of the TCE plume, and the presence of other chlorinated hydrocarbons observed at the site, it is recommended that Site 2 be investigated further in the RI/FS. Further site characterization efforts should include additional ground water sampling to determine the extent of contamination, with emphasis on installation of deeper monitoring wells to assess the vertical migration of the dense chlorinated hydrocarbons detected in ground water. Additional soil gas surveys appear to be appropriate to aid in defining the extent of the plume and in locating potential sources, with additional soil sampling to confirm any source areas identified.

1.3 SITE 3 - HUSH HOUSE AREA

Waste oil, solvent, and fuel contamination was suspected at Site 3 due to spills, rainwater runoff, and washdown which may have occurred from the Hush House facility. In addition to the jet engine testing activity at the Hush House, the site had been formerly used for drum storage. The potential for contamination at this site was assessed by analyzing soil and ground water samples for VOCs and PHCs.

No significant PHC, VOC, or BTEX (benzene, toluene, ethylbenzene, and xylenes) contamination was detected in any of the samples analyzed in the SI program.

Data from a prior soil sampling investigation were compared with pertinent TBC guidelines, showing all PHC concentrations to be far less than State of Oregon cleanup standards for motor fuel and heating oil.

Based on the absence of significant PHC, VOC, or BTEX contamination in the media sampled, and the results of the TBC comparison, no further investigation of this site is deemed necessary.

1.4 SITE 4 - MAIN DRAINAGE DITCH

The Base main drainage ditch was suspected to have been impacted by miscellaneous wastes due to runway spillage, contamination which may have occurred elsewhere on the ANG facility and directed to the ditch via the storm drainage system and sewers, or contamination which may have migrated to the ditch via shallow ground water discharge from nearby sites.

Potential contamination was assessed by collecting surficial soil/sediment samples within the drainage ditch. The samples were analyzed for petroleum hydrocarbons and VOCs to test for contaminant residues from possible past releases of petroleum-based liquids (fuels, oils, solvents). Analysis for five common metals was also performed as indicators of potential contamination from petroleum-based materials or other possible releases of wastes such as discussed for the other IRP sites.

PHCs, lead, and other metals were detected in all of the seven sediment samples tested. The concentrations were generally higher in the samples taken from the upstream portions of the ditch.

The preliminary risk assessment for sediments concluded that no adverse carcinogenic or noncarcinogenic effects would be expected under the assumed exposure scenario for human receptors. The risk calculations did not consider PHCs, since PHC results are not chemical-specific and toxicity measures are not available. Additional chemical analyses are needed to assess the potential risks of specific compounds associated with the PHC contamination.

Comparison was made with state of Washington marine sediment quality standards for metals which, in the absence of better criteria, were deemed to be pertinent as TBC guidelines for preliminary evaluation of remediation requirements at this site. These standards were not exceeded by any of the metal concentrations detected in the sediment samples.

In spite of the low risks projected for human receptors by the risk characterization, further investigation of this site is recommended in the RI/FS because of the presence of PHCs in a water environment, the need for more complete characterization of the extent and chemical nature of the PHC contamination, and the absence of established criteria for estimating ecological impacts from non-chemical-specific PHC data. Further investigation might also include evaluation of impacts to surface or ground water, depending on the results of more detailed chemical characterization of the sediments.

1.5 SITE 5A - AGE MAINTENANCE SHOP (MOTOR POOL FENCELINE AREA)

Contamination was suspected along the motor pool fence line of Site 5 due to reported and suspected disposal/spillage of AGE Maintenance Shop wastes in this area such as spent battery acid, solvents and automotive fluids. To assess potential environmental contamination due to these releases, soil and ground water samples were collected and analyzed. Analyses included VOCs, BNAs, six metals, and sulfate. The sulfate analysis was included because of potential impact from drainage of sulfuric acid from the spent batteries.

The analyses indicated several contaminants to be present at relatively low concentrations: TCE, sulfate, lead, and other metals. The presence of sulfate and lead may be due to past drainage of batteries at the site.

Preliminary risk characterization indicated no adverse carcinogenic or noncarcinogenic effects would be expected under the assumed exposure scenarios for ground water, surficial soils, and subsurface soils. However, the concentration of TCE detected in ground water slightly exceeded potential ARARs (MCL and FWQC).

Although the risks associated with TCE in the ground water were projected to be insignificant and the potential ARAR concentrations were only slightly exceeded, these conclusions are based on very limited sampling of ground water at the site. It is possible that the TCE detected in the monitoring well sample represents the edge of a plume and that more significant contamination is located nearby, particularly since TCE was detected at several other sites on the Base. Therefore, it is recommended that ground water at and near the site be further characterized in the RI/FS to confirm the presence or absence of this compound and determine its distribution. Additional investigation of the site soils may be needed to delineate sources, depending on the outcome of the ground water investigation.

1.6 SITE 5B - AGE MAINTENANCE SHOP (UST PIT AREA)

At least minor leakage of diesel fuel (No. 2 heating oil) is known to have occurred from a former underground storage tank (UST) located near the AGE Maintenance Shop. The leaking tank was excavated and removed in late 1988. Ground water and soil samples were collected and analyzed from within and near the excavation pit in order to provide preliminary data regarding the extent and degree of contamination. Analyses included PHCs and VOCs to test for the presence of organic compounds commonly found in heating oil.

No petroleum hydrocarbons or volatile aromatics were detected in the ground water sample. PHCs were detected in all the soil borings except for the boring on the apparent upgradient side of the pit. Common fuel components (benzene, ethylbenzene, and xylenes - or BEX compounds) were detected in samples from the center of the pit as well as in downgradient soil samples.

The data suggest that diesel fuel from the former leaking UST has migrated downgradient beyond the walls of the excavation pit. PHC and BEX concentrations were greatest at the soil/groundwater interface horizon, suggesting that downward migration may be impeded by the ground water table. Another possibility is that contaminants may have been absorbed in the soils and have not yet leached to the ground water table.

Comparison was made with Oregon's UST cleanup criteria and rules for PHCs in soils, which were recently adopted and were identified as potential ARARs for Site 5B. The UST cleanup standard applicable for this site was greatly exceeded by the high PHC concentration (11,300 ppm) found in the sample taken from beneath the bottom of the pit prior to the SI program. In addition, the ground water sampling and analyses conducted at Site 5B were not sufficient to demonstrate the absence of impacts to ground water at the site, which is required by the Oregon UST Cleanup Rules.

Further investigation at Site 5B is required. At the suggestion of EPA reviewers, further investigation and cleanup of this Site was performed outside of the IRP program (i.e., under the Spill and Immediate Response (SIR) program following the state's UST regulations).

1.7 SITE 7 - BURN PIT AREA

For 21 years, Site 7 site was used to burn several thousand gallons per year of waste fuel, POL (petroleum, oil, and lubricants), and solvents. In order to evaluate the presence and approximate horizontal extent of residual fuels and incomplete combustion products at the site, a soil gas survey and soil and ground water sampling were conducted. Analyses included VOCs and BNAs, as well as PHCs (alkanes) and lead as indicators of the expected contaminants.

The soil gas results indicated the presence of a variety of chlorinated hydrocarbons in the immediate vicinity of the former pit and in the western half of the surveyed zone, including methylene chloride, bromochloromethane, TCE, carbon tetrachloride, chloroform, 1,1,1-trichloroethane, and tetrachloroethene. Benzene, toluene, and xylenes were also detected in soil gas samples.

The soil gas data established the general extent of apparent widespread hydrocarbon contamination at the site, with the plume centered at the former burn pit location. The presence of PHCs was confirmed in soil samples collected near the center of the pit. The presence of contamination in ground water was not confirmed.

Preliminary risk assessment calculations showed that no adverse carcinogenic or noncarcinogenic effects would be expected under the assumed exposure scenarios for ground water, surficial soils, and subsurface soils. Comparison was made with Oregon's UST cleanup criteria for PHCs in soils, which were deemed pertinent as TBC guidelines for assessment of site remediation requirements. The applicable PHC cleanup standard for this site was not exceeded in any of the three samples analyzed.

Although the soil gas sampling indicated the approximate extent of contamination, the significance of this contamination remains undefined due to the limited soil sampling and analytical program conducted. In spite of the low risks projected for human receptors by the risk characterization and the favorable comparison with the Oregon UST cleanup criteria, further investigation of this site is recommended in the RI/FS because of the wide-spread presence of numerous chlorinated hydrocarbons at the site as confirmed by the soil gas survey results, and the need for more complete characterization of the extent and chemical nature of the hydrocarbon contamination in soils at the site. Chemical analyses are needed to determine concentrations of specific hydrocarbon compounds, rather than generic PHC results, in order to perform risk assessment calculations.

Further investigation might also include evaluation of impacts to surface or ground water, depending on the results of more detailed chemical characterization of the soil media.

1.8 SITE 8 - SANITARY LANDFILL

The existence, location, history and use of a sanitary landfill at Site 8 were based on the recollections of one individual interviewed during the Preliminary Assessment. During the SI, the former Deputy Civil Engineer of the Base was interviewed to confirm the location of Site 8 given in the Preliminary Assessment report and to obtain additional details describing the former landfill area. He described the area to include 3 to 6 trenches in random orientation, located 5 to 20 ft apart from each other, with dimensions about 6 ft deep, 10 ft wide, and 60 to 70 ft long.

A records search was performed to identify aerial photographs of the Base taken during the period of reported landfill activity. Pertinent photographs were examined for visual evidence of landfill activity. Some of the photographs showed that the land surface was disturbed several times in the Site 8 area during the period of interest. Although the disturbances did not have the appearance of landfill trenches, it was decided to conduct geophysical surveys to provide additional evidence regarding the potential existence of the sanitary landfill.

Electromagnetic (EM) conductivity and total field magnetic surveys were conducted over a 250-by-500-foot gridded area at Site 8. Due to the construction of a new facility on the northern portion of the site, the grid could not encompass 100 percent of the Site 8 area. No EM or magnetic anomalies were observed in the data that appeared attributable to the suspected landfill trenches, as described above.

Neither the aerial photograph study nor the geophysical survey revealed evidence of landfilling activity matching the description given by the former Base Deputy Civil Engineer. However, since this investigation was conducted at Site 8, the aerial photographs mentioned above were reviewed by the former Deputy Civil Engineer of the Base. His comments indicated that only a portion of the area he recollected as being the former waste disposal area was included in the geophysical survey. Based on this information and the inability to conduct the geophysical survey over the area of new construction, further investigation of this site is necessary to determine the possible existence and location of the sanitary landfill and to prepare a decision document.

2.0 INTRODUCTION

2.1 RESTORATION PROCESS AND PURPOSE OF SITE INVESTIGATION

This report describes Site Investigation (SI) activities accomplished under the Department of Defense Installation Restoration Program (IRP) at the 142nd Fighter Interceptor Group (FIG) Oregon Air National Guard facility located near the Portland International Airport in Portland, Oregon (hereinafter referred to as "ANG Portland" or "the Base").

As a result of the 1986 Superfund Amendments and Reauthorization Act (SARA) to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Department of Defense (DOD) has adopted the EPA/Superfund terminology and procedures for conducting its Installation Restoration Program. The CERCLA/SARA (Superfund) methodology prescribes the following steps in the restoration process:

1. Preliminary Assessment
2. Site Inspection
3. Remedial Investigation
4. Feasibility Study
5. Remedial Action

The Phase I Records Search completed in 1987 (HMTG, 1987) fulfills the requirements and objectives of the Preliminary Assessment (PA) step by identifying and evaluating sites at ANG Portland where environmental contamination was suspected and which might require further field investigation.

This IRP Site Investigation (SI) corresponds with the CERCLA Site Inspection phase, in which chemical and hydrogeologic field data are to be gathered at the suspected sites. The overall purpose of the Site Investigation phase is to collect data to verify and characterize the presence of contamination at the sites identified in the PA phase and to evaluate the potential human health/environmental risk posed by contaminants which are found.

For sites where contamination was confirmed, further studies (Remedial Investigations and Feasibility Studies) may be performed to determine the extent of contamination and gather sufficient characterization information to further assess risks and to develop and evaluate possible remedial responses. These investigations are beyond the scope covered by this document.

The Site Investigation (SI) work for this project followed appropriate EPA guidance documents relative to CERCLA, including Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (U.S. EPA, October 1988b).

2.2 PROJECT LOCATION AND SITE LAYOUT

The ANG Portland facility is located on the south side of the Portland International Airport in Portland, Oregon (Figure 2-1). The airport is located northeast of the city situated between the Columbia River to the north and the Columbia Slough to the south.

The current ANG Portland boundary (Figure 2-1) occupies approximately 245 acres which is leased from the Port of Portland. The ANG boundary formerly included an additional 150 acres along the western edge which was transferred back to the Port of Portland in January 1986. A former burn pit site located outside the northeastern ANG boundary was included in the current investigation since the military previously used the site for fire training exercises which included waste burning (refer to Site 7 in Figure 2-2).

A drainage system consisting of drainpipes and open ditches routes ANG facility surface runoff to the Columbia Slough. Drinking water is supplied to the facility via a City of Portland water main. The principal City water source is Bull Run Watershed; this is augmented by a municipal well field (discussed below). There are no known supplemental ground water supply wells located on-site. The ANG Portland facility is served by a sanitary sewer system; gravity sewer and pressure sewer lines route domestic wastes to a Port of Portland pumping station.

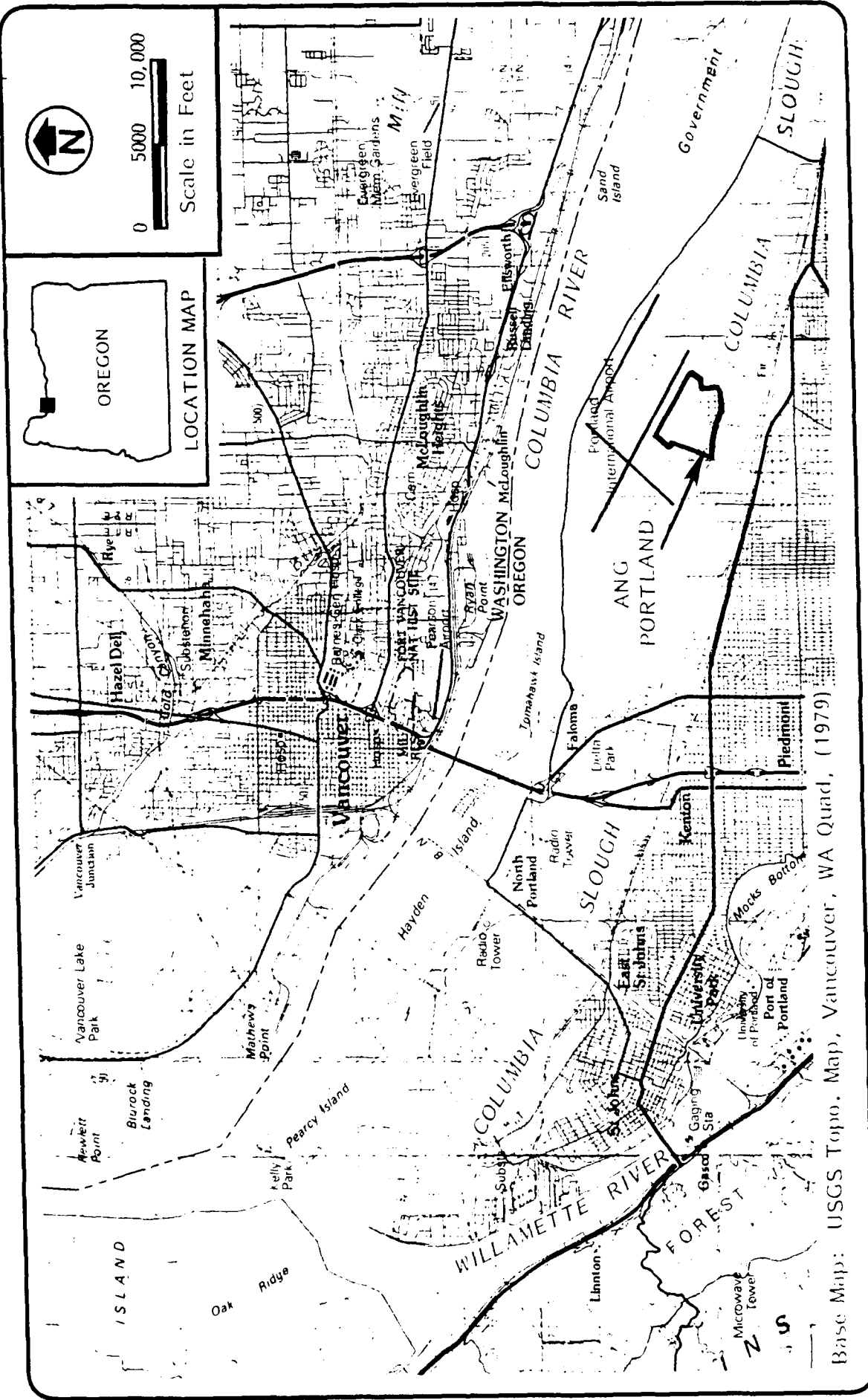
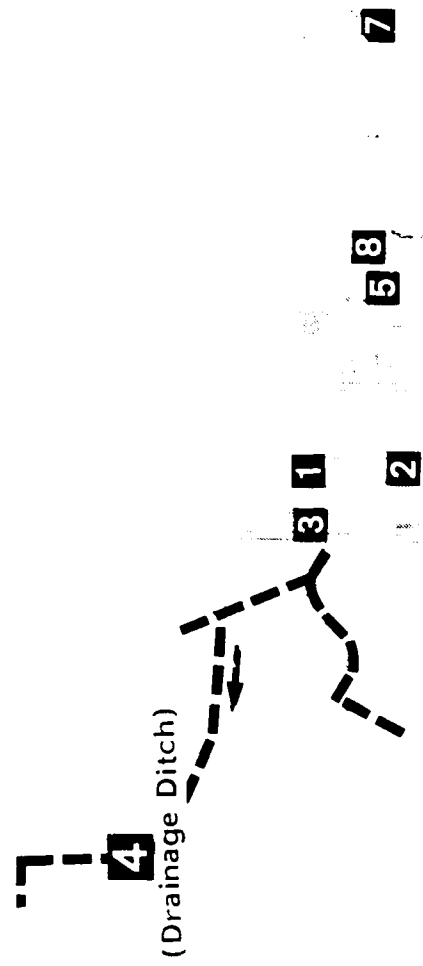


Figure 2-1

REGIONAL VICINITY MAP FOR OREGON ANG PORTLAND
 PORTLAND IAP, PORTLAND, OREGON

Base Map: USGS Topo. Map, Vancouver, WA Quad, (1979)

BASE MAP: USGS 15' QUADRANGLE, MOUNT TABOR, OR (1978)



A north arrow pointing upwards, enclosed in a circle with the letter 'N'. Below it is a scale bar with markings at 0, 500, and 1000 feet. The text 'Scale in Feet' is written vertically to the right of the scale bar.

Figure 2-2
LOCATION OF POTENTIAL HAZARDOUS WASTE SITES
AT OREGON ANG PORTLAND FACILITY
PORTLAND IAP, PORTLAND, OREGON

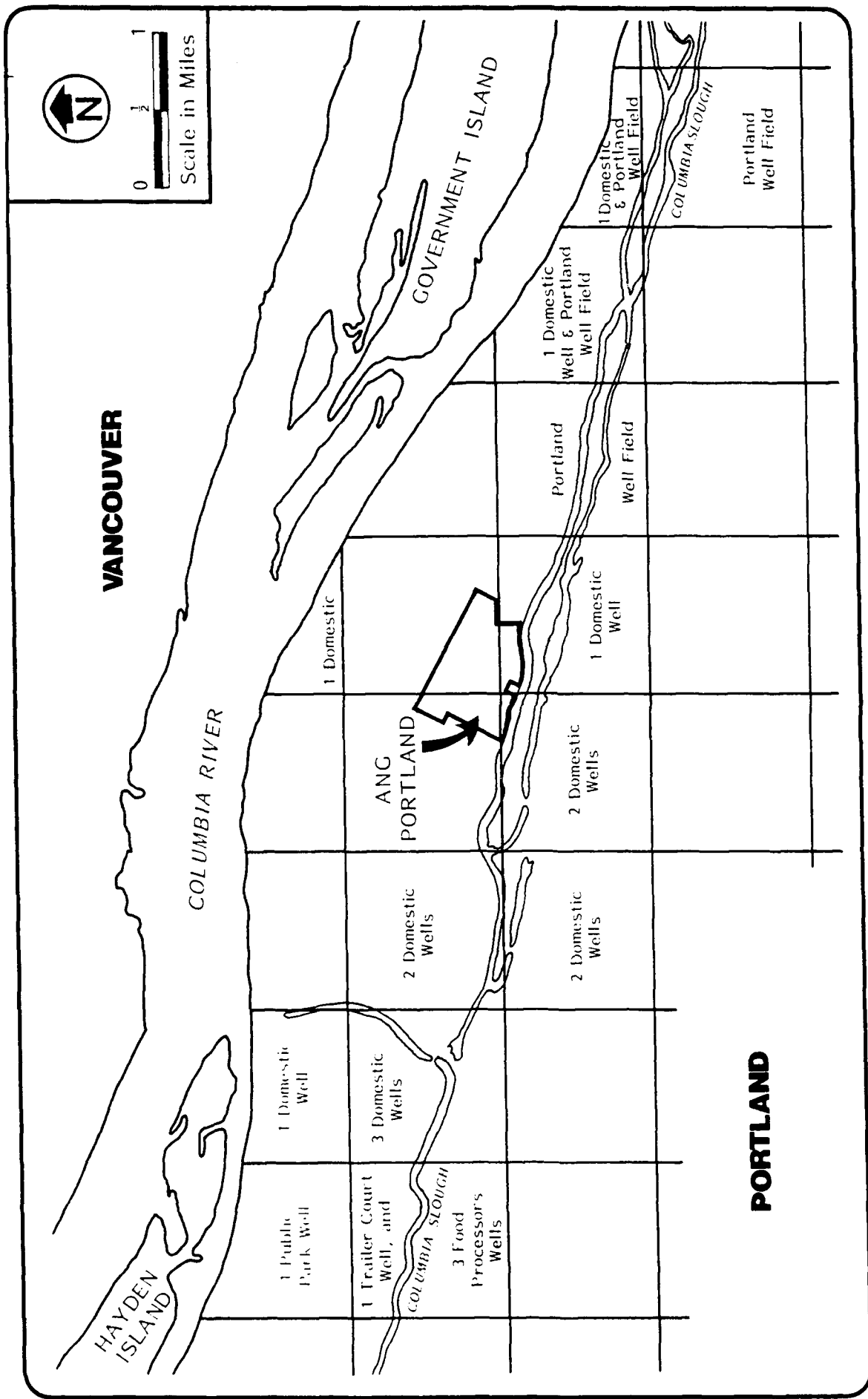
A search has been performed to identify and locate public and private wells in the vicinity of ANG Portland which have potential for human consumption (e.g., drinking water or food processing uses). The Portland office of U.S. Geological Survey had records of eight domestic wells located within about one mile of ANG Portland. Six additional domestic wells, one public park well, one trailer court well, and three food processor wells were also identified to be within a three mile radius (see Figure 2-3).

In addition to the wells identified above, there exists a major well field beginning about one mile east of the ANG Portland boundary (Figure 2-4). Known as the Portland Well Field, it is one of the nation's largest ground water developments. In times of drought, emergency, or peak demand, it serves as a supplemental supply of water for the City of Portland's municipal system. Water rights applications have been filed for more than 40 production wells with a combined yield of over 150 million gallons per day. At least 20 wells have been constructed (Hoffstetter, 1984). The well field has been used for extensive periods in summer months.

The development of this resource has been coupled with an increased level of concern and attention by local citizens and agencies regarding water quality issues in the vicinity of the well field. For example, stringent plans and development standards have been implemented by the City of Portland for a light-industrial zoned area (designated as the Columbia South Shore Plan District of the Columbia Corridor). These standards are designed with protection of the well field in mind, and include requirements for containment of any hazardous materials that may be associated with proposed developments. In addition, studies have been initiated by the city to characterize existing water quality in Columbia Slough and identify potential sources of hazardous substance inputs to the slough; these studies also have protection of the well field as a primary objective.

2.3 HISTORICAL SITE OWNERSHIP AND OPERATION

The history of the ANG Portland facility was described in the IRP Phase I Records Search (HMTC, 1987). ANG Portland was opened in 1941 and operated as an Army Air



SI Report
 Revision 3
 17 May 1991
 15 of 214

Figure 2-3
 PUBLIC AND PRIVATE WELLS IN THE VICINITY OF ANG PORTLAND
 PORTLAND IAP, PORTLAND, OREGON

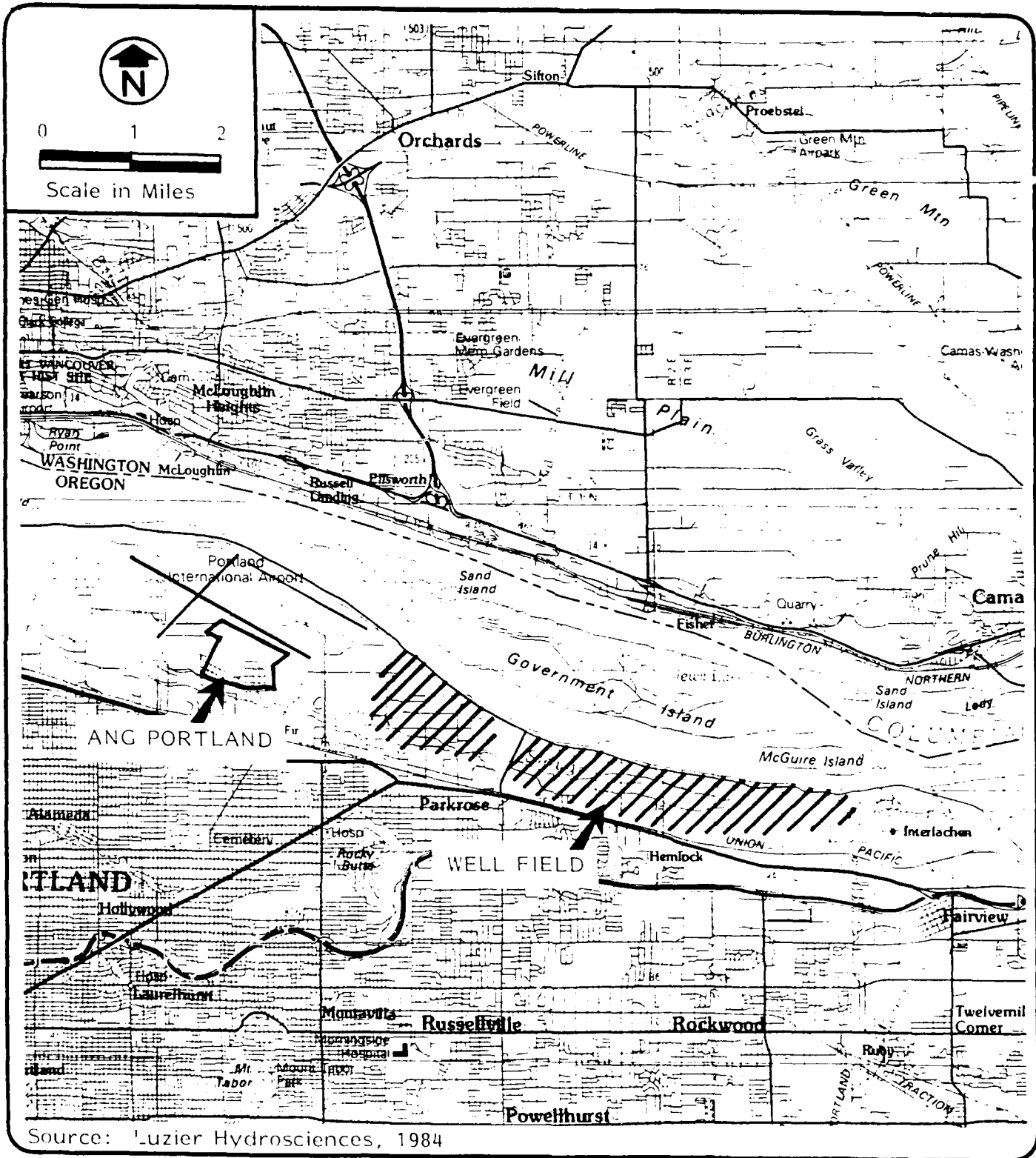


Figure 2-4
LOCATION OF THE PORTLAND WELL FIELD
OREGON AND PORTLAND
PORTLAND IAP, PORTLAND, OREGON

Base until 1945. Following World War II, most of the Base was converted to operation as an Air National Guard facility. Between 1950 and 1964 it became an active Air Force Base, then converted back to an Air National Guard facility and has maintained this status to the present time.

2.4 CONTAMINANT RELEASE AND SITE REMEDIATION ACTIVITIES TO DATE

There has been only limited site-specific study of the ANG Portland, Oregon facilities with respect to characterization or remediation of possible environmental contamination. The IRP Phase I Records Search report cited below constitutes the best source of information regarding past practices and conditions at the sites of interest.

- Installation Restoration Program Phase I Records Search for Portland International Airport (ANG) Portland, Oregon and North Bend Air National Guard Station, North Bend, Oregon (Hazardous Materials Technical Center, August 1987).

This document (hereinafter referred to as the Preliminary Assessment Report, or "PA Report") evaluated eight sites and ranked six of them according to the USAF HARM (Hazard Assessment Rating Methodology) protocol. The eight sites were named as follows:

- Site 1 - Central Hazardous Waste Storage Area
- Site 2 - Civil Engineering Hazardous Material Storage Area
- Site 3 - Hush House Area
- Site 4 - Main Drainage Ditch
- Site 5 - AGE Maintenance Shop
- Site 6 - Wash Rack West of Building 1355
- Site 7 - Burn Pit Area
- Site 8 - Sanitary Landfill

The PA evaluation resulted in a recommendation of no further action for Site 7 and hence this site was not scored. Site 8 (Sanitary Landfill) was identified and evaluated in the PA report, but not given a HARM score due to insufficient data. All sites except Site 6 were investigated further during the SI phase of the IRP.

The following documents describe field sampling activities and analytical results for some of the sites which were performed subsequent to the PA report.

- Report on Limited Investigation of Soils Contamination, Oregon Air National Guard Base, Portland, Oregon (SRH Associates, Inc., October 21, 1988).
- Letter from Captain R.C. Rein (Oregon ANG) to Lauren Garner (Oregon Department of Environmental Quality), Re: LPUST Reporting, 12 December 1988.

The sampling and characterization data available from these documents are discussed for each site in Section 4.0.

Additional information pertinent to the individual sites was obtained in discussions with ANG personnel at an Initial Coordination Meeting and site visits held November 8-9, 1988. This supplemental information has been incorporated into the discussion in Section 4.0 for each site.

A number of environmental studies have been conducted relative to existing and proposed activities and facilities in the general vicinity of the Portland International Airport. These are listed in the reference section of this report, and include assessments of local geology, wildlife, hydrology, water quality, etc., in relation to projects such as development of the nearby Portland Well field, a major proposed street extension (Airport Way) and associated commercial development of land just southeast of the airport, and water quality assessment studies for the Columbia Slough located south of the airport. The area of land along the Columbia River between its shore and the Columbia Slough is known as the Columbia Corridor. A number of studies have been performed or are in progress for the Columbia Corridor and portions thereof, due to concern for development of the area and for water quality and natural resource issues. Information from these references has been incorporated into pertinent sections of this report.

3.0 ENVIRONMENTAL SETTING

3.1 LAND USE AND ECOLOGY

The Oregon ANG Portland facility is mostly cleared of vegetation and developed. The majority of land surrounding the facility is currently zoned M3 (Light Manufacturing). The Master Drainageway Plan for Multnomah County Drainage District No. 1 identified land uses within various sub-basins along the Columbia River near the airport (Century West, 1988). For the sub-basin which includes the seven sites in the present SI study, existing land uses are either industrial or open space, with no agricultural acreage. For a large sub-basin adjacent to the eastern boundary of Oregon ANG Portland, the Drainageway Plan identified industrial, open space, and agricultural land uses.

The IRP Phase I study (HMTC, 1987) states there are no endangered or threatened fauna/flora within one mile of the project site. A recent natural resource inventory (Bureau of Planning, 1988) identified large open space grassland areas associated with the Portland International Airport complex which provide some habitat for wildlife. The wildlife included small mammals, songbirds, and raptors (hawks, owls, falcons). Raptors have been observed along the drainage ditches and slough area of the ANG facility (Rein, 1988). Contamination of the food chain with persistent or bioaccumulative pollutants could potentially impact these higher-order predators. Peregrine falcons and bald eagles are considered transitory in the study area, while the red-tailed hawk is considered a resident raptor which may utilize trees near open areas as perches (Hwang, 1988). A 107-acre wetland complex exhibiting very good quality wildlife habitat is located less than one mile west of the ANG facility.

Surface drainage from the Oregon ANG Portland facility eventually discharges to the Upper Columbia Slough. The slough acts as a wildlife corridor connecting major wetland areas, resulting in high interspersion and overall value (Bureau of Planning, 1988). It provides food, water, and shelter for a variety of birds, small mammals and other kinds of wildlife. Fishery habitat in the slough is generally limited, due to channel cleaning/maintenance operations and low flow

characteristics. Predominant fish species in the Slough channels are sticklebacks and black crappies; game species include largemouth black bass, bluegill, crappie, and brown bullhead.

3.2 CLIMATE

The Portland area has a moderate temperate climate characterized by mild rainy winters and warm to hot dry summers. The average annual precipitation is 37.39 inches (NOAA, 1982), with approximately 88 percent of the annual total falling during the period October through May. That part of precipitation which leaves the study area as direct surface runoff or which recharges the ground water (defined as net precipitation) has been calculated to be 13.81 inches per year (HMTG, 1987).

Temperature varies from an average of between 40-50°F during winter to 60-67°F during summer. The annual mean temperature is 53°F. Surface winds normally average about 8 mph from the southwest.

3.3 SURFACE WATER

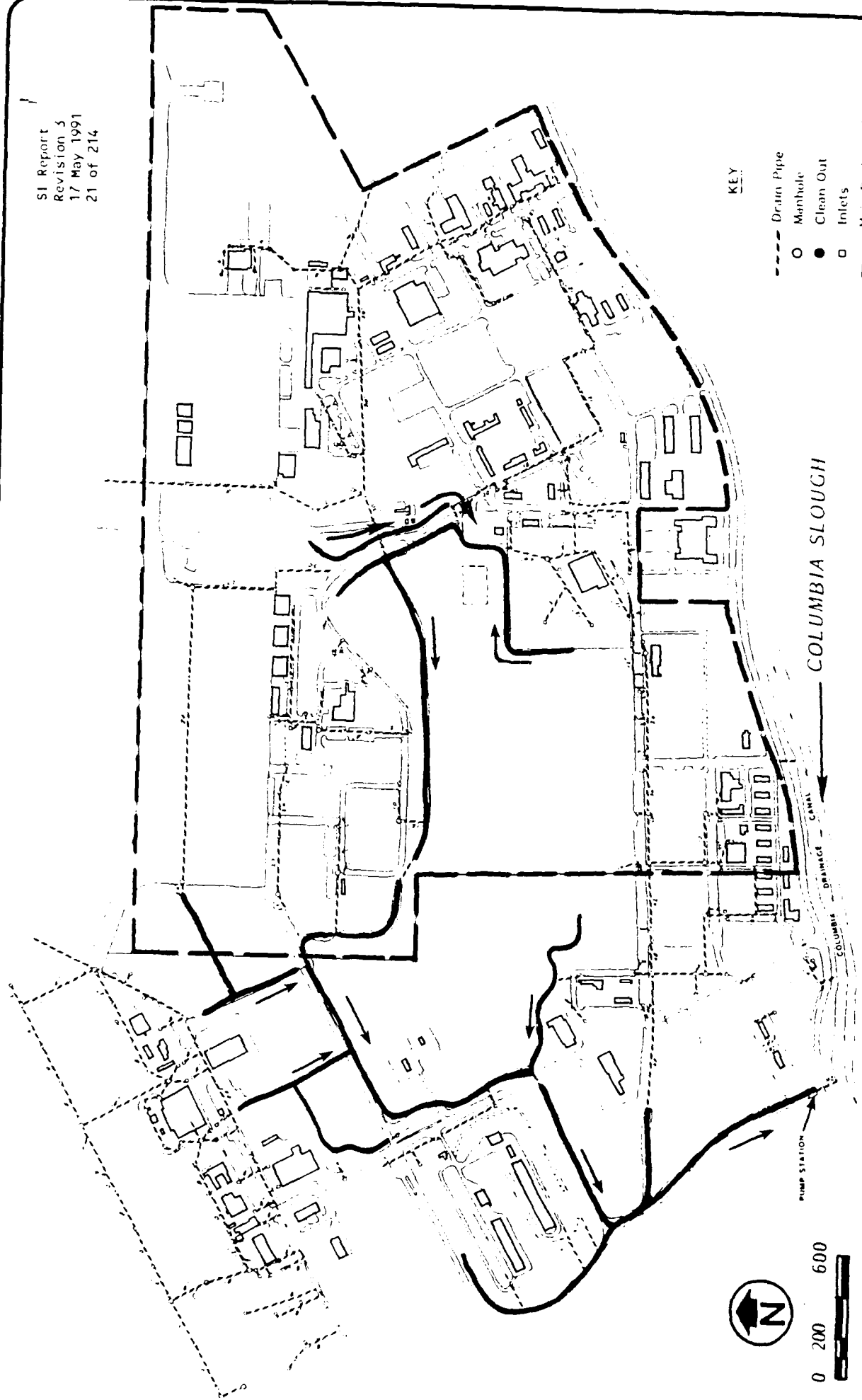
Surface runoff at the Oregon ANG Portland facility is directed into a main drainage ditch which eventually crosses the western boundary of the facility and then discharges directly into the Upper Columbia Slough (refer to Figure 3-1). Running water flows through the main drainage ditch system only during periods of precipitation. As part of the Site Investigation, the drainage ditch was evaluated as a potential hazardous waste site (refer to Site 4 discussion).

The receiving water (Upper Columbia Slough) is hydraulically isolated from the lower slough and the Columbia River (Bureau of Environmental Services, 1988). Under normal flow conditions, all flow from the upper slough either passes over a weir or is pumped to the lower slough, which ultimately discharges directly to the Willamette River near the confluence with the Columbia River (refer to Figure 3-2).

SI Report
 Revision 5
 17 May 1991
 21 of 214

KEY

- Drain Pipe
- Manhole
- Clean Out
- Inlets
- Main Drainage Ditch
- Surface Flow Direction
- - - New Base Boundary



0 200 600
 Scale in Feet

BASE MAP: PORTLAND ANG COMPREHENSIVE PLAN, 12/20/85

Figure 3-1
 DRAINAGE SYSTEM AND DITCHES AT ANG PORTLAND
 PORTLAND IAP, PORTLAND, OREGON

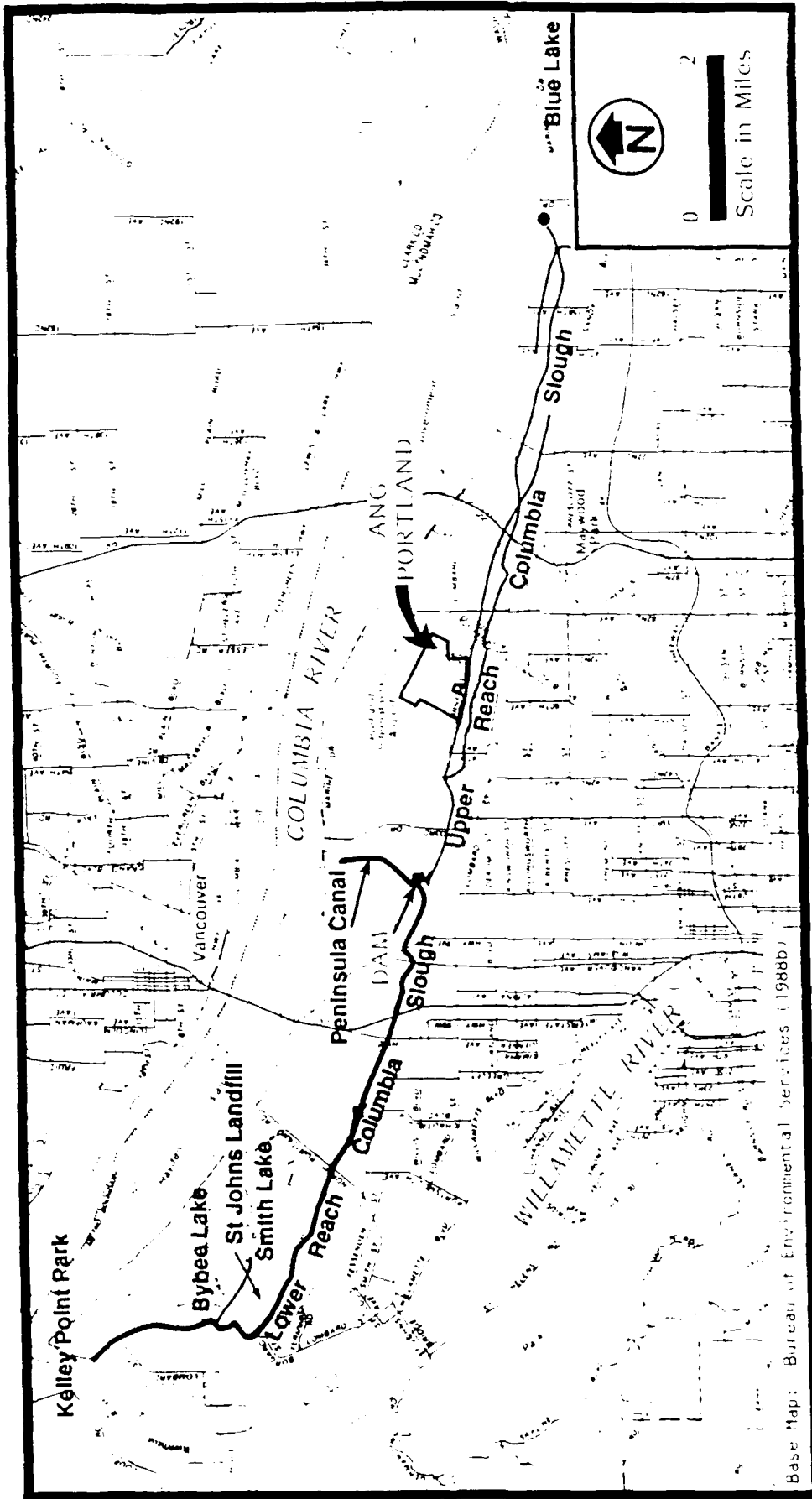


Figure 3-2
UPPER AND LOWER REACHES OF COLUMBIA SLOUGH
OREGON ANG PORTLAND
PORTLAND IAP, PORTLAND, OREGON

The 100-year flood plain elevation for the primary drainageway (Columbia Slough) is 14 feet mean sea level (MSL) based on unobstructed hydraulic flow conditions. The average maintained water level of the upper slough is 8 feet MSL with a minimum continuous flow estimated to be 70 cfs (U.S. Army Corp of Engineers, 1976). Surface elevation of the Oregon ANG Portland facility varies from 13 to 20 feet MSL. The Columbia Slough has been primarily used for flood control and agricultural irrigation. Multnomah County Drainage District No. 1 provides flood control for the slough system. During major storm events flow is pumped directly from the eastern end of the upper slough into the Columbia River, under the management of the drainage district.

3.4 GEOLOGY AND HYDROGEOLOGY

3.4.1 Physiographic Setting

The Portland Air National Guard facility is located on the Columbia River Floodplain which is composed of alluvial and fluviolacustrine deposits, as shown in Figure 3-3. This area is characterized by a relatively level surface approximately 20 feet above sea level. In the past, the floodplain was often flooded during high stage flow of the Columbia River but is now protected by dikes and engineered drainage. The area currently occupied by Oregon ANG Portland was partially covered by shallow lakes and marshy areas that were filled with dredge materials before development (HMTG, 1987; Hogenson and Foxworthy, 1965). The facility is bounded on the south by the Columbia Slough which provides some drainage for the area. The floodplain is bounded by the Columbia River, one mile north of the ANG facility, and the escarpment of the Portland Terraces region, approximately 2000 feet to the south of the Columbia Slough.

3.4.2 Soils

Soils at Oregon ANG Portland include Pilchuck and Sauvie-Rafton Series. Pilchuck soils underlie most of the facility and can be characterized as dark grayish brown to dark brown soils with high permeabilities. The southeastern corner of the base is underlain by Sauvie-Rafton soils. These soils are very poorly drained silt loams. The surface soil layer is approximately 15 inches thick and is underlain by dark gray-brown silty clay loam to a depth of 60 inches or more.

Qa1

Younger Alluvium

Gravel, sand, silt, and clay, slightly stratified. Mostly well sorted beneath flood plains of larger rivers; less sorted near smaller streams. Thickness generally a few feet near small streams, about 20 or 30 feet along Sandy and Clackamas Rivers, and as much as 200 feet along Columbia River. Layers of well-sorted gravel and sand yield large amounts of water to wells, less sorted and finer grained materials yield smaller amounts.

Qf1

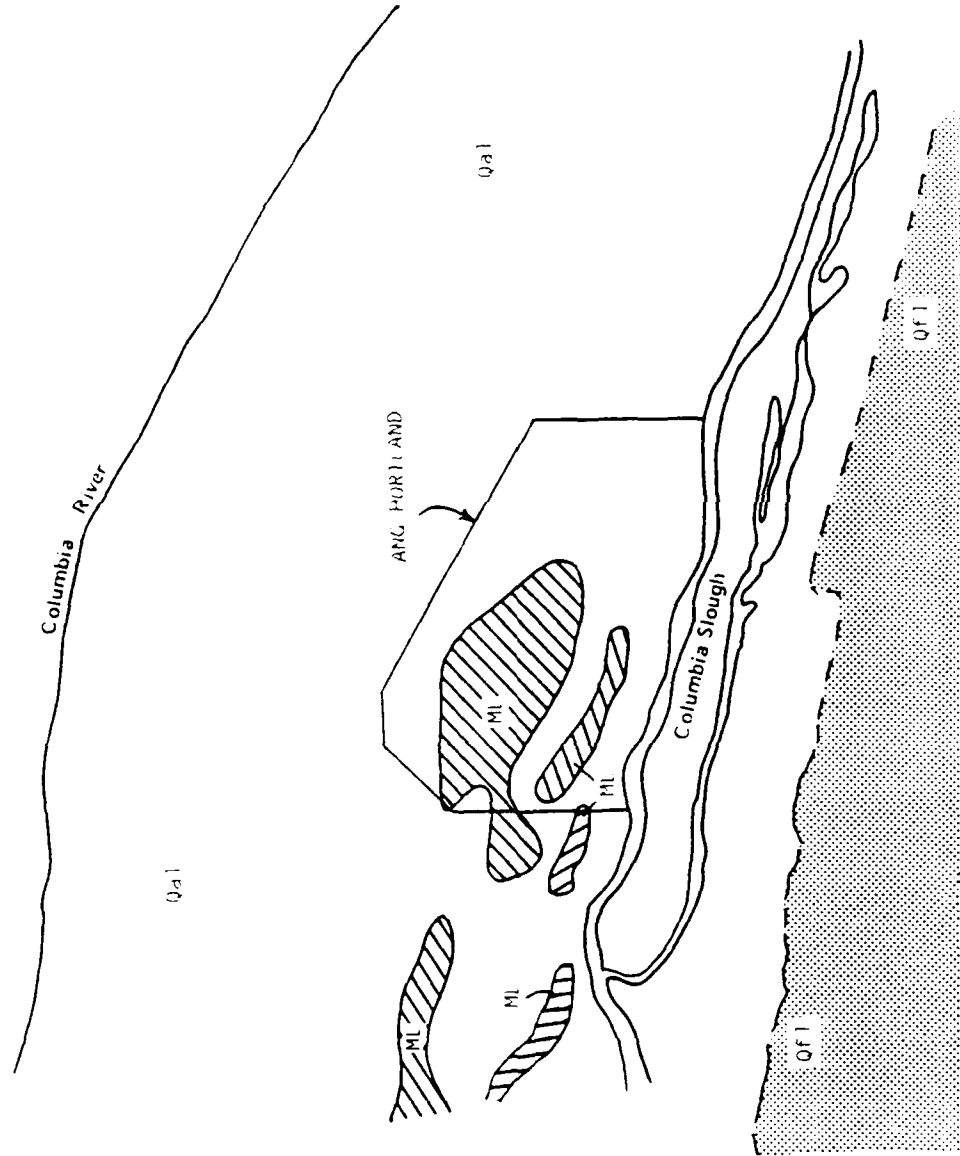
Fluvio-lacustrine Deposits

Unconsolidated gravel, sand, silt, and clay; slightly stratified. Generally bouldery and coarser grained to the east and progressively finer grained to the west side of the area, but contains some gravel layers throughout most of the area. Thickness generally less than 100 feet; locally, it may be as great as 150 feet. Gravel and sand beds are permeable but are mostly above regional water table and are unsaturated or yield only small amounts to wells from perched water. Where permeable beds extend below the regional water table, they yield moderate to large quantities to wells.

M1

Made Land

Former swamp and lake areas of the Columbia River Floodplain filled with dredge material.



(adapted from Hogenson and Foxworthy, 1965)

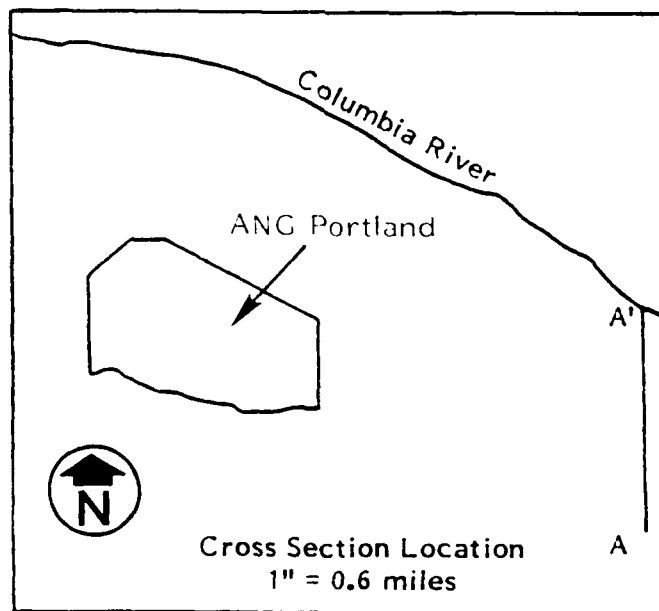
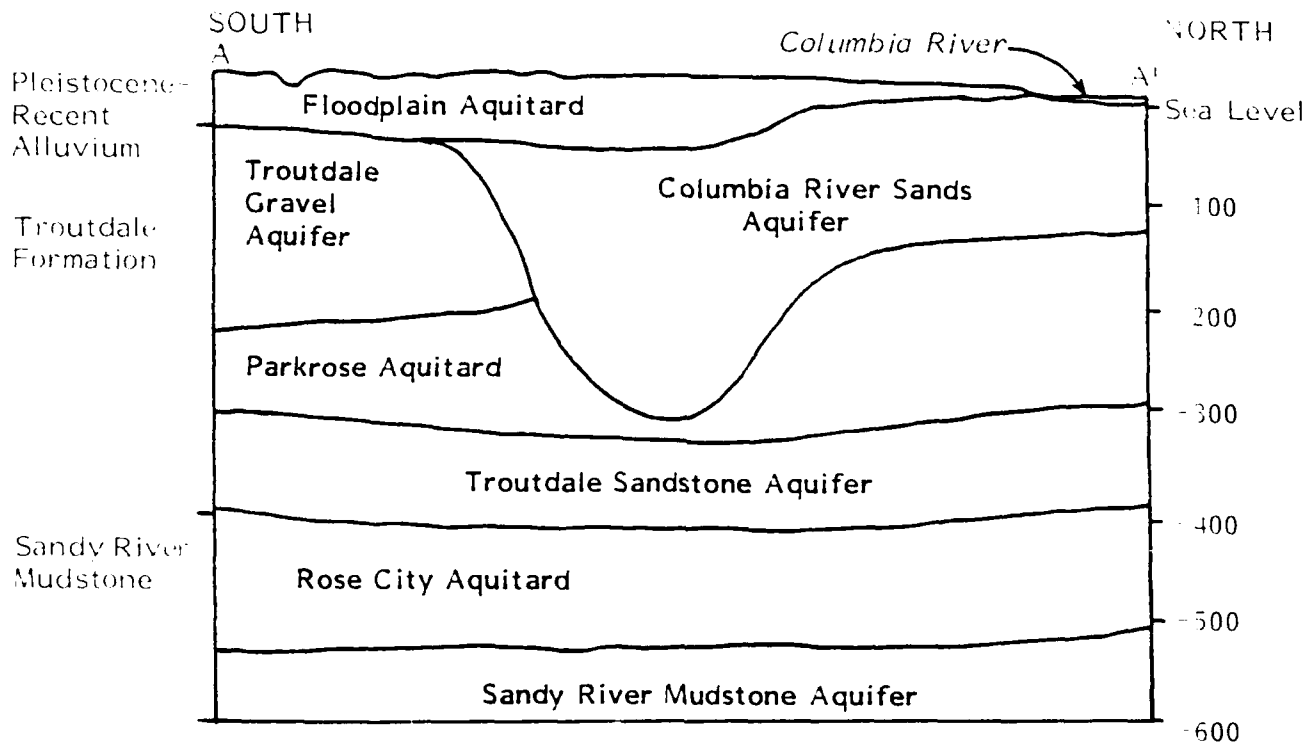
Figure 3-3
 GEOLOGIC MAP OF THE ANG PORTLAND FACILITY AND VICINITY
 PORTLAND IAP, PORTLAND, OREGON

The hydraulic conductivity of the sandy soils is approximately 10^{-2} cm/sec, while the silty soils often have conductivities less than 10^{-4} cm/sec (HMTG, 1987). Throughout most of the area, the land surface has been elevated by the addition of several feet of fill materials. The fill material is often comprised of dredged river sediments and floodplain soils that include silty clay with some cobbles.

3.4.3 Stratigraphy

The north Portland area is underlain by a thick sequence of Tertiary and Quaternary sedimentary and volcanic deposits. Formations present in the area include: Eocene to Miocene marine sedimentary rocks, Columbia River Basalt, Sandy River Mudstone, Troutdale Formation Pleistocene-Recent Alluvium (Hogenson and Foxworthy, 1965). The marine strata underlying the Columbia River Basalt do not crop out in the area and have been penetrated by deeper water wells. These formations have contributed saline water to production wells completed in the Columbia River Basalt at the city of Gladstone (Hogenson and Foxworthy, 1965). Regional stratigraphic relationships are shown in Figure 3-4. Specific features about each deposit are discussed in ascending order in the following sections.

Columbia River Basalt: The Columbia River Basalt is comprised of a sequence of basaltic lavas that extends over most of southern Washington and northern Oregon. The basalt is exposed in the Willamette River channel north of the mouth of the Clackamas River, and extends eastward beneath the north Portland area underlying younger sedimentary deposits. The properties of the basalt are often controlled by the geometry of individual lava flows within the unit. The top and bottom of flows are often comprised of brecciated scoriaceous material, while the interior portions are often massive or exhibit columnar jointing. Where the basalt is fractured it may have significant hydraulic conductivity, and it often serves as a water supply in the region. The basalt is not used for water supplies in the vicinity of ANG Portland. The thickness of the basalt in the area is unknown. The basalt thickness is highly variable in the region, as basalt flows inundated the existing topography and infilled valleys during early Miocene time (Hogenson and Foxworthy, 1965; Mundorff, 1964).



Source: Willis, 1975

Figure 3-4

GEOLOGIC CROSS SECTION - EASTERN PORTION OF THE PORTLAND WELL FIELD
 ANG PORTLAND, PORTLAND IAP, PORTLAND, OREGON

Sandy River Mudstone: This unit is comprised of indurated sedimentary deposits of Pliocene age which unconformably overlie the Columbia River Basalt (Hogenson and Foxworthy, 1965). The thickest known occurrence of this unit is in the southwestern corner of T1N R1E (southwest of ANG Portland), where a well penetrated a 900 foot thick interval of Sandy River Mudstone. The lower 300 feet of the interval at this location contains significant sand and gravel, and the coarser-grained fraction appears to increase to the north (Brown and Caldwell, 1986; Willis, 1975). Because of their differing hydraulic properties, the upper fine-grained portion of the unit is known as the Rose City Aquitard and the lower portion as the Sandy River Mudstone Aquifer (Brown and Caldwell, 1986). Willis (1975) reported a transmissivity of 2.32×10^{-5} to 6.13×10^{-5} m²/sec for the Sandy River Mudstone. Radiometric dating of water samples from the Sandy River Mudstone has indicated an age of 1300 ± 130 years for waters at the Portland Well Field (Willis, 1975). Pumping tests have also indicated hydraulic communication between the Sandy River Mudstone Aquifer and the overlying Troutdale Aquifer.

Troutdale Formation: The Troutdale Formation is comprised of a sequence of slightly cemented to well-lithified sands and gravels that are used as a major water supply in the region. The unit is approximately 200 to 350 feet thick in the vicinity of Oregon ANG Portland (Hogenson and Foxworthy, 1965). The sands and gravels were deposited by westward flowing streams that deposited volcanic debris in the area during Pliocene time. The Troutdale Formation also includes intervals of clay and mudstone that probably represent floodplain and lacustrine deposits. Locally, the Troutdale has been subdivided into the upper Troutdale Gravel Aquifer, a middle unit of fine-grained deposits known as the Parkrose Aquitard and the lower Troutdale Sandstone Aquifer. Both the sand and gravel aquifers yield large quantities of water and are considered significant water resources in the Portland area. Hydraulic conductivities derived from pumping tests for the Troutdale Gravel range from 1.89×10^{-3} m/sec (Brown and Caldwell, 1986) to 5.29×10^{-4} m/sec (Luzier, 1984). Hydraulic conductivity values for the Troutdale Sand have been reported from 1.18×10^{-4} m/sec (Brown and Caldwell, 1986) to 2.29×10^{-4} m/sec (Luzier, 1984). The Troutdale Gravel Aquifer is hydraulically interconnected with the Columbia River Sands as the Columbia River Sands unconformably overlie and truncate the Troutdale Gravel beneath the Columbia River floodplain (see Figure 3-4).

Columbia River Sands: The Columbia River Sands fills a Pleistocene Columbia River Valley and is composed of late Pleistocene and Holocene sand. The unit is estimated to be between 200 and 300 feet thick. The Columbia River Sands consists of medium sand, with occasional layers of silt, clay, and gravelly zones. The sand composition is quartzose, while the gravel is composed of basalt, andesite, dacite, and quartzite (Hoffstetter, 1984). Pump tests conducted on a pilot well completed in this unit determined a specific capacity of 98 gpm/ft, a transmissivity of 150,000 gpd/ft, and a storage coefficient of 0.0009 (Willis, 1975). Although this unit is capable of yielding significant quantities of water, its use as a water resource has been minimal because of poor water quality.

Pleistocene-Recent Alluvium

During Pleistocene time, the ancestral Columbia River eroded a major valley along the approximate course of the modern Columbia River. This occurred in response to lowered base levels during glacial events. After the glaciation, the river deposited a thick (up to 300 feet) sequence of sand and gravels in this valley (Hogenson and Foxworthy, 1965). Point and braid bar deposits have accumulated to form a sequence of lenticular beds of unconsolidated sands and gravels with high conductivities. In recent times, flood events have deposited a thin (0 to 70 feet) sequence of overbank floodplain deposits that mantle the current floodplain. This unit serves as a local aquitard that inhibits the downward migration of ground water through the subsurface. The aquitard sediments consist of low permeability silts and clays. The floodplain aquitard may be absent in some places due to facies changes to sand deposition, or erosion during flood events. The lateral discontinuity of the floodplain deposits has been noted in studies of the Portland Well Field (Brown and Caldwell, 1986). Surface soils at ANG Portland also include areas of made land created when dredgings from the Columbia River were used as material to fill low lying areas (Moore, 1988).

Shallow ground water from the floodplain deposits may discharge to the underlying aquifer, or to local surface waters such as Columbia Slough. If the Slough extends into the alluvial aquifer, any dense contaminants that reach this water body would tend to sink and could find a preferential pathway to the aquifer. Although the unit is thin and does not directly constitute a water resource, the

floodplain sequence is important to any investigation of contaminant migration. The variable lithologies of these deposits may cause complex migration patterns in the subsurface which must be carefully examined due to the discontinuous nature. Two borings installed for geotechnical investigations at Oregon ANG Portland have encountered floodplain deposits to a thickness of 34 feet.

4.0 SITE DESCRIPTIONS

The following sections describe the known history of waste management activities and results of prior studies at the seven Oregon ANG Portland sites. Table 4-1 summarizes the findings of previous investigations for each site.

4.1 CENTRAL HAZARDOUS WASTE STORAGE AREA (SITE 1)

Site 1 is an area about 50 x 250 feet located to the north of Building 1131 (see Figure 4-1). Starting in 1970, this site was used for storage of miscellaneous wastes including 55-gallon drums of waste oil, solvents, fuels, Stoddard solvent, diesel fuel, shop wastes, transformers, and capacitors. The area was unpaved and had no containment structures. A new street (Hampshire Boulevard) has recently been constructed through part of the site. Although there have been no major spills recorded for this site, contamination is suspected due to the nature of past storage activity, the variety of wastes stored, and the observance by previous investigators of stained soil and gravel in the area.

Several underground utilities cross the eastern portion of the site, including a new storm sewer parallel with Hampshire Boulevard. Surface water that does not infiltrate probably drains off-site to a storm drain inlet to the north or west toward the drainage ditch along Hannis Street. In either case, the surface water would eventually drain into the main base drainage ditches which are ultimately pumped into Columbia Slough (see Site 4).

The only previous chemical characterization at this site consisted of four surface soil samples taken in September, 1988 by SRH Associates, Inc. and analyzed for total petroleum hydrocarbons (TPH), PCBs, and various common solvents. Analytical procedures used were EPA-600/4-79-020 Method No. 418.1 for TPH, EPA SW 846 Method No. 8080 for PCBs, and an unspecified GC/FID technique for solvents. Soil samples were taken from four test pits dug with a backhoe, at two depths (0.5 ft and 3.5 ft) in each pit. All shallow samples were composited, then analyzed. All deep samples were composited, then analyzed. Compositing could dilute the concentration of contaminants in a given sample by a factor of four. Results of analyses showed 594 mg/kg TPH in the shallow composite and 12

Table 4-1

SUMMARY OF PREVIOUS FINDINGS
AT POTENTIAL HAZARDOUS WASTE SITES
OREGON AND PORTLAND
PORTLAND IAP, PORTLAND, OREGON

SITE 1 - CENTRAL HAZARDOUS WASTE STORAGE AREA

- Contamination was suspected (petroleum, solvents, PCBs, metals) due to past storage of miscellaneous wastes and electrical gear at the site.
 - Soil sampling at 0.5 ft and 3.5 ft depths have shown total petroleum hydrocarbon concentrations of 594 mg/kg in a shallow composite and 12 mg/kg in a deeper composite. The same samples were analyzed for PCBs and various common solvents with none being detected.
 - Visual observation of stained soil areas up to 8 ft across, with vertical penetration of stain only into the upper 3 inches of the soil column.
-

SITE 2 - CIVIL ENGINEERING HAZARDOUS MATERIAL STORAGE AREA

- Contamination was suspected due to past storage of solvents such as methyl ethyl ketone and observations of stained surface gravels at the site.
 - Soil sampling at 0.5 ft and 3.5 ft depths have shown total petroleum hydrocarbon concentrations of 4 mg/kg in a shallow composite and 35 mg/kg in a deeper composite. The same samples were analyzed for various common solvents including MEK with none being detected.
-

SITE 3 - HUSH HOUSE AREA

- Contamination (fuels, oils, solvents) was expected due to apparent spillage and washdown of petroleum products from Hush House operations, as well as potential spillage from former drum storage activity.
- Soil sampling at 0.5 ft and 3.5 ft depths have shown total petroleum hydrocarbon concentrations of 5 mg/kg in a shallow composite and 17 mg/kg in a deeper composite. The same samples were analyzed for polynuclear aromatic hydrocarbons (PAHs), with only pyrene and fluorene being detected.

Table 4-1 (Continued)

SUMMARY OF PREVIOUS FINDINGS
AT POTENTIAL HAZARDOUS WASTE SITES
OREGON ANG PORTLAND
PORTLAND IAP, PORTLAND, OREGON

SITE 4 - MAIN DRAINAGE DITCH

- Petroleum, solvent and metals contamination was expected due to likely spillage of products and waste materials along runways and in other locations throughout the ANG facility which are directed by the storm drainage systems to the main drainage ditch.
 - There have been no sampling or analyses performed relative to the main drainage ditch within ANG boundaries.
-

SITE 5 - AGE MAINTENANCE SHOP

- Petroleum, solvent and metals contamination was expected due to reported past practices of draining batteries and buckets of waste oils and solvents, as well as a known release of heating oil from a recently removed underground storage tank.
 - Total petroleum hydrocarbon concentrations of up to 11,000 ppm were found in soil sampled near the base of the pit after removal of the underground storage tank. No other previous chemical analyses were available for this site.
-

SITE 7 - FORMER BURN PIT AREA

- Residues from fire suppressants and partially combusted petroleum, solvents, and oily wastes are expected due to past long-term use of the site as a fire training facility.
 - No previous chemical analyses are available for samples from this site.
-

SITE 8 - SUSPECTED LANDFILL AREA

- The existence, location, and extent of this area was in doubt. There is no real evidence that hazardous materials were disposed of in this area.

SI Report
Revision 3
17 May 1991
33 of 214

KEY
● Soil/Sediment Boring

Parking

(FORMER) HAMPSHIRE AVE.

FUTURE STREET

Hush House Area

Boundary of Site #1 Area per PA Report (shaded)

General Limits of Former Storage Yard

Previous Soil Sampling Locations

Bldg. 1131

FUTURE STREET

HAMPSHIRE BLD.

Former Storage Bins

O'CONNOR WAY

Parking

16

14

16

14

16



Scale in Feet

Base Map: Guthrie/Slusarenko Assoc., October, 1986

Figure 4-1

SITE 1: CENTRAL HAZARDOUS WASTE STORAGE AREA PREVIOUS SAMPLING LOCATIONS
ANG PORTLAND, PORTLAND IAP, PORTLAND, OREGON

mg/kg in the deeper composite. PCBs and solvents were not detected: detection limits were 1 mg/kg for PCBs and ranged from 4 to 45 mg/kg for the various solvents tested. Visual observations noted during this sampling program included several stained surface areas measuring up to 8 ft across. Vertical penetration of oil stains in the test pits appeared to be confined to only the top three inches of soil.

4.2 CIVIL ENGINEERING HAZARDOUS MATERIAL STORAGE AREA (SITE 2)

Site 2 is located east of Building 1109 (see Figure 4-2). The site is defined by the former location of a solvent storage shed south of Building 1123. The shed has since been removed from the area. The PA report showed the site to be adjacent to and northeast of the shed. During the Initial Coordination Meeting, ANG personnel determined that the HMTG location was poorly defined and may have been in error, and that the most likely location for Site 2 was beneath the shed itself. The shed had open walls for ventilation and a gravel floor. Methyl ethyl ketone was stored in or near the shed in drums laid horizontally on a rack elevated above the ground surface. Previous investigations have reported drum leakage and discolored gravel in the storage area. A paint storage building (Building 1123) formerly existed just north of the shed. A new street was constructed just east of the site in 1988. A second street is planned for construction in the near future which would pass just west of the site.

Topography at the site is level. Infiltration is slow as evidenced by pools of standing water at the site following rains. Some surface water may drain off-site via the base drainage system, although the nearest storm drain inlets are fairly distant: 300 ft to the west along Hannis Street and 500 ft to the southeast along Chin Street. Both of these storm drains eventually discharge into the main base drainage ditches which are ultimately pumped into Columbia Slough (see Site 4). Prior to the recent construction, when the solvent shed was in active use, infiltration may have been less restricted due to the presence of gravel at the site. Underground utilities near the site include a new storm sewer along the west side of the newly paved Hampshire Boulevard, and a sanitary sewer along its east side.

KEY
● Soil/Sediment Boring

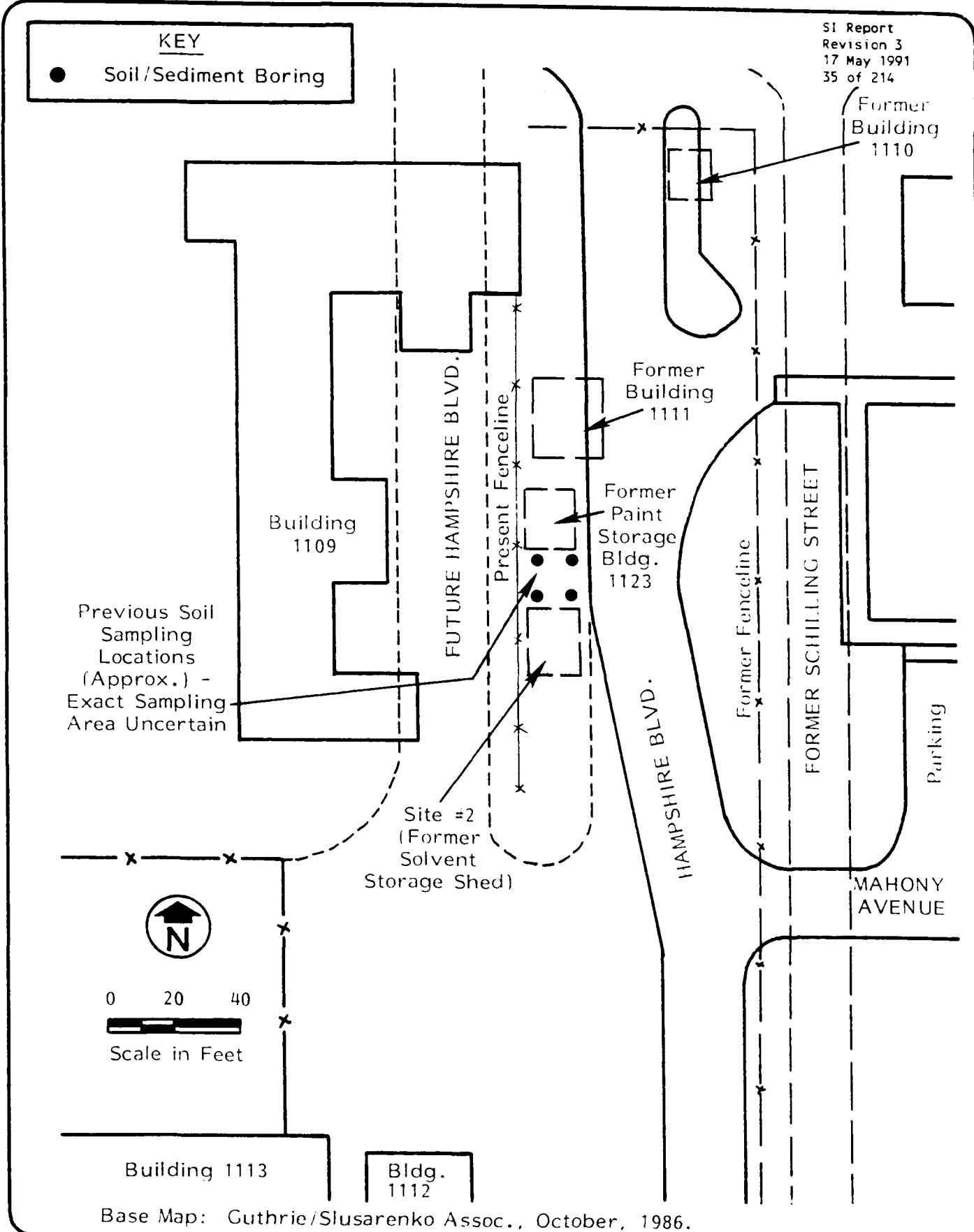


Figure 4-2

SITE 2: CIVIL ENGINEERING HAZARDOUS MATERIAL STORAGE AREA
PREVIOUS SAMPLING LOCATIONS
ANG PORTLAND, PORTLAND IAP, PORTLAND, OREGON

Some previous chemical characterization data are available for this site. Two soil samples were taken from each of four test pits in September, 1988 by SRH Associates, Inc. and analyzed for total petroleum hydrocarbons (TPH) and a variety of solvents including methyl ethyl ketone. The samples were taken just after construction of the new street mentioned above. The surface soils at the site had been disturbed and graded due to the construction activity; it was also reported that at least 6 inches of topsoil had been removed from the site. One shallow composite and one deep composite were created and analyzed using the sampling and analytical methods as described earlier for Site 1. The analytical data showed 4 mg/kg TPH in the shallow composite and 35 mg/kg TPH in the deeper composite. No solvents were detected; detection limits ranged from 4 to 45 mg/kg for solvents tested. The lower TPH result for the shallow sample may be attributable to the topsoil removal during construction.

4.3 HUSH HOUSE AREA (SITE 3)

A Hush House, currently used to test jet engine performance twice daily, is located at Site 3. (The proper terminology for the Hush House is "Jet Engine Test Stand;" however, to maintain consistency with other reports the term "Hush House" will be used.) Site 3 is located along the west and south edges of the concrete pad associated with the Hush House (see Figure 4-3). Waste oils and fuels may have contaminated these soils due to spills, rainwater runoff and washdown from the Hush House facility. The unpaved surface at the southwest corner of the Hush House apron was formerly used for storage of unknown fluids in 55-gallon drums (likely to be waste oils, fuels, or solvents). Soil contamination is expected due to the runoff, washdown, and storage activities, in addition to surface stains observed in the area. It is planned to take the Hush House facility out of service once a new Hush House facility is operable (construction of the new facility began in 1989).

The Hush House facility and its concrete pad are built on slightly elevated soils, a few feet higher than the surrounding land. Site 3 is located on this elevated portion of soil next to the pad. Adjacent topography slopes sharply down to the south and east away from the pad, and toward a ditch along the east

KEY
● Soil/Sediment Boring

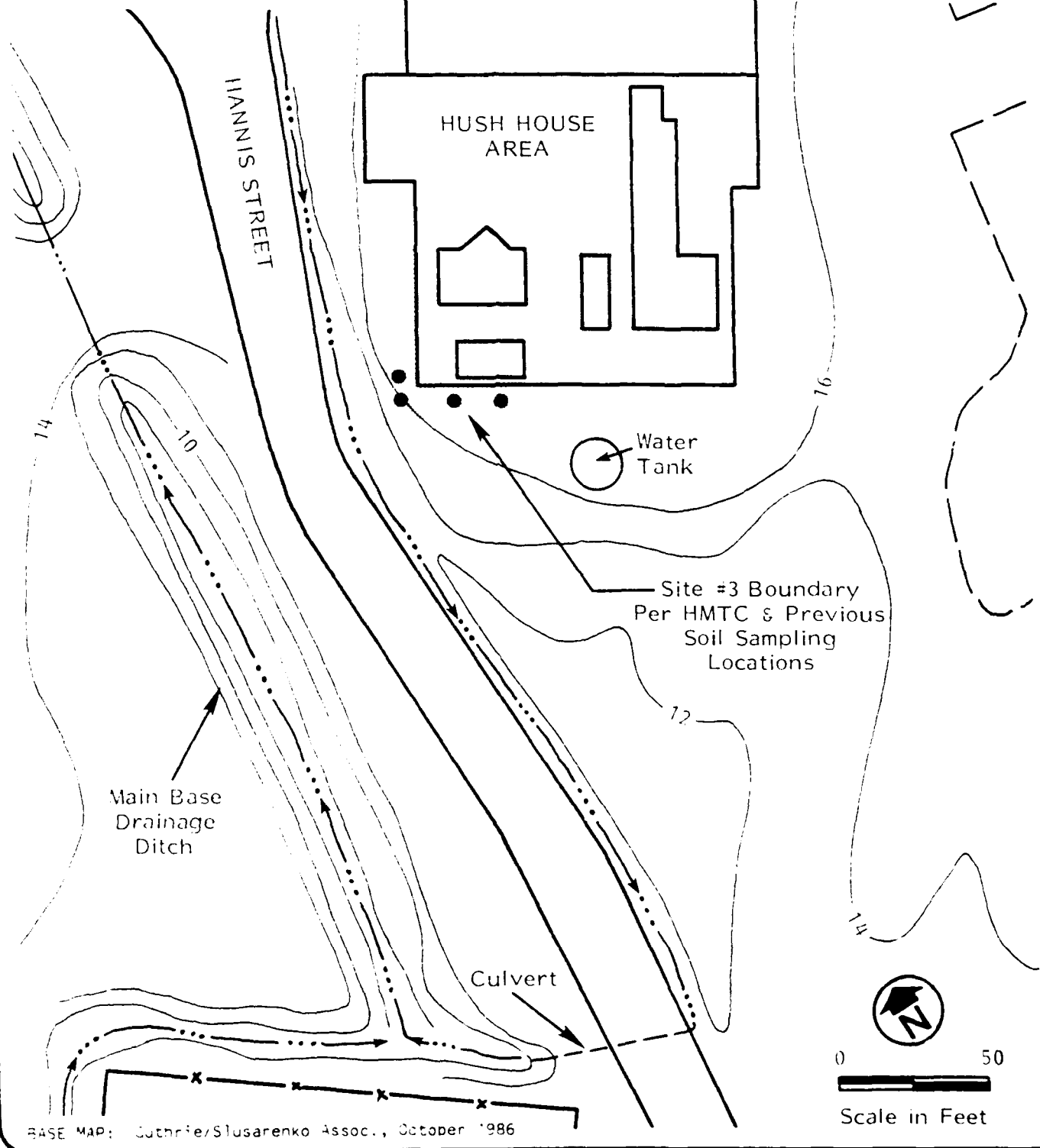


Figure 4-3

SITE 3: HUSH HOUSE AREA PREVIOUS SAMPLING LOCATIONS
ANG PORTLAND, PORTLAND IAP, PORTLAND, OREGON

side of Hannis Street. Surface water in this ditch enters a culvert passing under Hannis Street south of the site and discharges to the main base drainage ditches which are ultimately pumped into Columbia Slough (see Site 4). There is an oil/water separator located downhill from the site about 100 ft to the south. It is an active unit which is not included in the present investigation.

The only previous chemical characterization data available for this site consisted of a composite of shallow soil samples and a composite of deeper soil samples taken from four test pits by SRH Associates, Inc. in September, 1988. The soil samples were analyzed for total petroleum hydrocarbons (TPH) and polycyclic aromatic hydrocarbons (PAHs). PAHs were analyzed per EPA SW 846 Method No. 8100; otherwise sampling and analytical methodology was the same as described for Site 1. The analytical results revealed low levels of TPH (5 mg/kg in the shallow composite and 17 mg/kg in the deep composite). Among the PAHs, only pyrene and fluorene were detected (these results were reported as $\mu\text{g/L}$ in extract, so actual concentrations in soil are uncertain).

4.4 MAIN DRAINAGE DITCH (SITE 4)

The main drainage ditch (see Figure 3-1) has the potential to receive hazardous waste constituents from surface spills, indirect discharges, and stormwater runoff. The drainage system consists of drainpipes and open ditches which route water across the western boundary of the ANG facility and ultimately into Upper Columbia Slough. Oregon ANG Portland personnel indicated that numerous fuel spills have occurred at this site over the past five years, and fuel and oil have been evident in the drainage ditches downstream from the apron area (HMTC, 1987). JP-4, AVGAS, diesel and any other hazardous waste/material from runways, aprons, and other paved areas could end up in the drainage ditch. Since water flows in the ditch only during periods of precipitation, it is possible that small spills and industrial discharges could result in sediment accumulation of contaminants close to the point of discharge.

There has been no environmental sampling of the drainage ditch within the current ANG boundary. Some limited sediment and water sampling was conducted in the drainage ditch outside the western boundary of the ANG facility (R.N. Smith

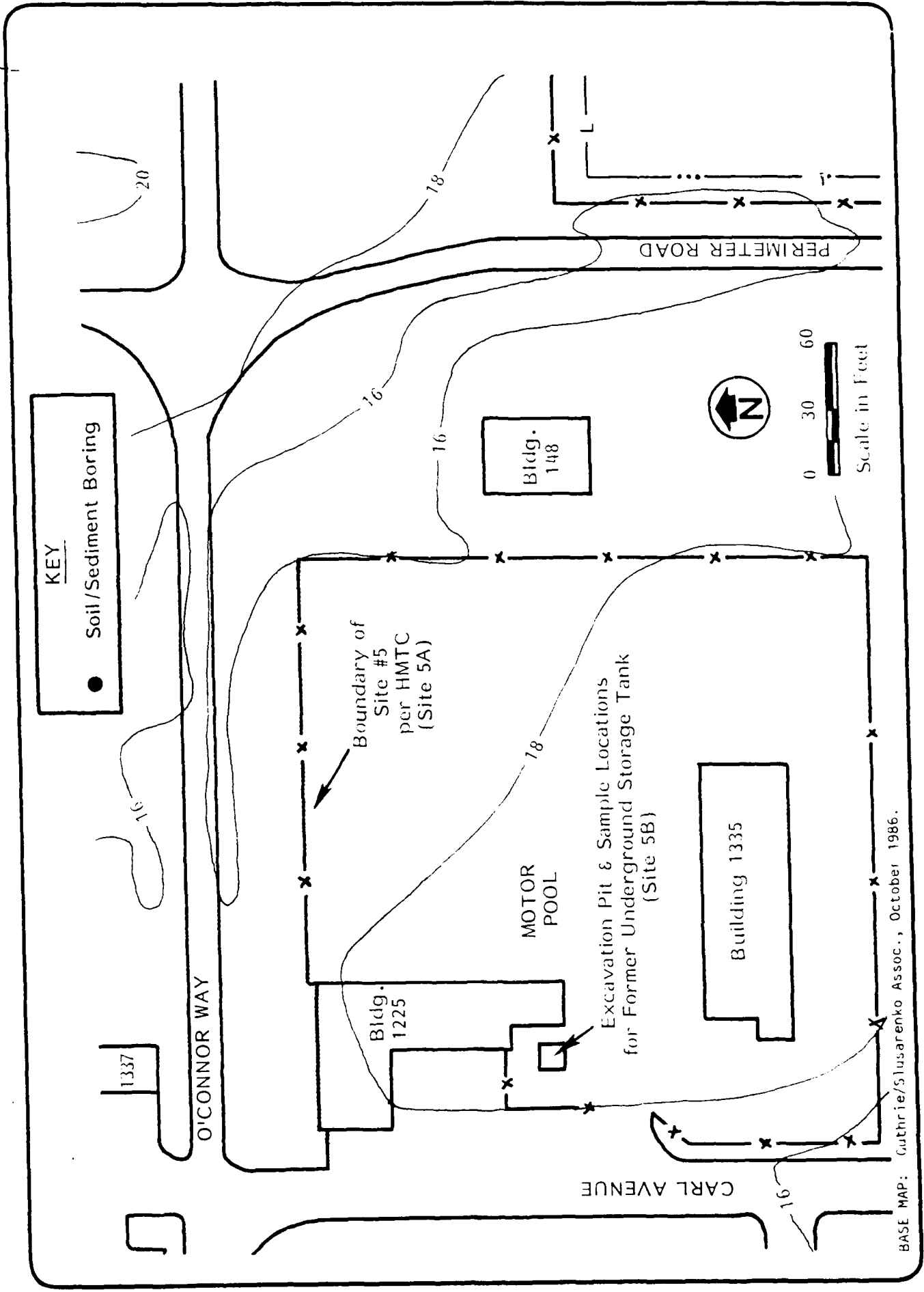
Associates, 1987). Results indicated elevated sediment metal levels (particularly lead) adjacent to a former fleet maintenance facility (Diesel, Oil and Lubrication Shop). Sediment lead concentrations ranged from 32 to 2,700 mg/kg. According to the R.N. Smith report, the likely source of the metals was probably related to the diesel, oil and lubrication function and other maintenance operations involving solvents or generating petroleum wastes which may have been improperly stored and/or disposed.

The IRP Records Search (HMTTC, 1987) noted that pollutants might enter the drainage ditch near Building 729 through a pipe from an area to the north of the ANG facility. This pipe discharges into the drainage ditch at a point downstream and outside the current western boundary of the ANG facility. This claim was not investigated in the Site Investigation, since any contaminants contributed from this source would be attributable to activities other than those of Oregon ANG Portland.

4.5 AGE MAINTENANCE SHOP (SITE 5)

The Preliminary Assessment (PA) report identified this site to be along the fence line south of O'Connor Way, including the northern side of Building 1225 (see Figure 4-4). The adjacent area served as a motor pool until 1972. Contamination is expected due to acid-lead storage batteries and buckets of waste oil and solvent which were reportedly drained in the vicinity of the fence. It is possible that other wastes associated with the motor pool, such as lubricants, antifreeze, and cleaning solutions, may have been disposed of or spilled in the area as well. The PA survey team observed discolored soil and stressed vegetation along the fence near the northeast corner of Building 1225. Stained soil was also observed by SAIC staff in this area during a site tour held November 9, 1988. No prior sampling or chemical analyses have been reported in the area along the fence line. The area along the fenceline, as identified in the PA Report, is referred to in the present SI report as Site 5A.

In November and December, 1988, Building 1225 and an adjacent petroleum underground storage tank (UST) were removed from the site. About this time, the UST pit was added to the SI program and is referred to herein as Site 5B. The



BASE MAP: Guthrie/Slusarenko Assoc., October 1986.

Figure 4-4
SITE 5: AGE MAINTENANCE SHOP PREVIOUS SAMPLING LOCATIONS
AND PORTLAND, PORTLAND IAP, PORTLAND, OREGON

underground storage tank was in active use until its removal (approximate age: 35 years). Its former location is shown in Figure 4-4 near the southwest corner of Building 1225. The UST stored diesel fuel (No. 2 heating oil) and had a capacity of 675 gallons. The tank contents were emptied before the tank was excavated. After removal, ANG personnel found an estimated 10 gallons of free oil product at the bottom of the excavation (approximate depth of 8-9 ft). The free product was cleaned up using absorbent pads and drummed for proper disposal off-base. The tank was observed to be badly corroded with numerous holes. The holes appeared to comprise about one to two percent of the total tank surface area. During a site visit on December 9, 1988, SAIC staff observed an oil sheen on the water surface at the bottom of the pit; the source of the water was probably ground water.

In conjunction with the UST removal, ANG personnel sampled the soil near the bottom of the pit at two locations to test for hydrocarbon contamination. Analytical results showed total petroleum hydrocarbon concentration to be 500 ppm in a sample taken at 6-inch depth, and 11,000 ppm in the second sample, which was taken from soil about two feet below the bottom of the pit.

Topography at the site is generally flat, with slight slopes toward the east and perhaps northward. The area near the UST may drain southward. The nearest storm drain inlets are (1) at the east end of the site on the south edge of O'Connor Way, and (2) south of the site on the east side of Carl Avenue. The storm sewers all drain to the main drainage ditch near Site 3. The water in the main ditches is eventually pumped into Columbia Slough (see Site 4). Numerous underground utilities exist near the site. These include a storm sewer and water line along the east side of Carl Avenue, another storm sewer crossing O'Connor Way at the eastern edge of the site, and sanitary sewer and power lines which pass just north of where Building 1225 used to be.

4.6 BURN PIT AREA (SITE 7)

The former burn pit area is located just outside the ANG boundary in the northeast corner (see Figure 4-5). Between 1957 and 1978, the burn pit was used solely by the military as a fire training exercise area. Permission to use the

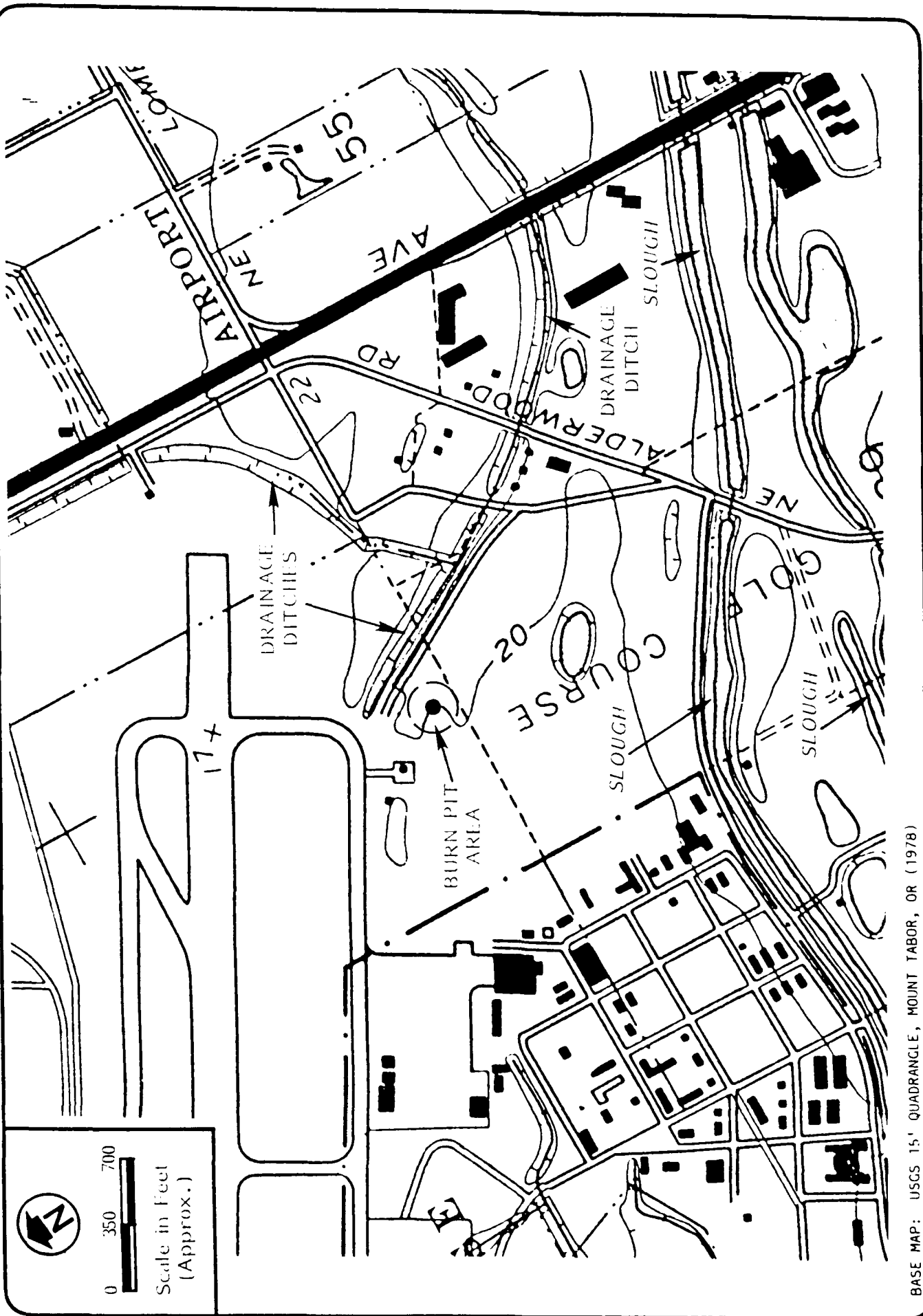


Figure 4-5

SITE 7: BURN PIT AREA
ANG PORTLAND, PORTLAND IAP, PORTLAND, OREGON

pit was granted by the landholder (Port of Portland). It is estimated that several thousand gallons of flammable liquids may have been disposed of in the pit each year, including waste fuel, JP-4, oils and solvents (HMTC, 1987). The PA survey team noted that there were no visible containment structures or berms installed at the site, and there had been no environmental monitoring to date (HMTC, 1987).

The burn pit is no longer in use and the area is currently covered by a layer of gravel. No visible evidence of the former burn pit remains. However, the location of the former pit is precisely known from photographic records. The location of the former pit, as evident in Figure 4-6, is different from that indicated in Figure 3-D of the Preliminary Assessment report (HMTC, 1987).

The topography at the site is relatively flat with drainage swales and ditches located to the northwest and northeast. The ditch to the northwest eventually discharges via the ANG storm drainage system to the main drainage ditches (Site 4). The ditch to the northeast is shown in Figure 4-6 and drains about two miles eastward toward a small lake.

4.7 SANITARY LANDFILL (SITE 8)

The Preliminary Assessment report (HMTC, 1987) described this site as a former sanitary landfill, located in the vicinity of the junction of O'Connor Way and Perimeter Road to the east of Building 1225 adjacent to Site 5 (see Figure 4-7). The existence, location, and possible extent of this site were based on the recollections of a single member of the Air Guard, since retired and living out of town. Landfill activity was reported to have occurred from 1950 to 1964 due to Air Force operations, and then up to the mid-1970's due to Air Guard operations. The Oregon Department of Environmental Quality and the Portland office of EPA have no records of landfill activities at this site.

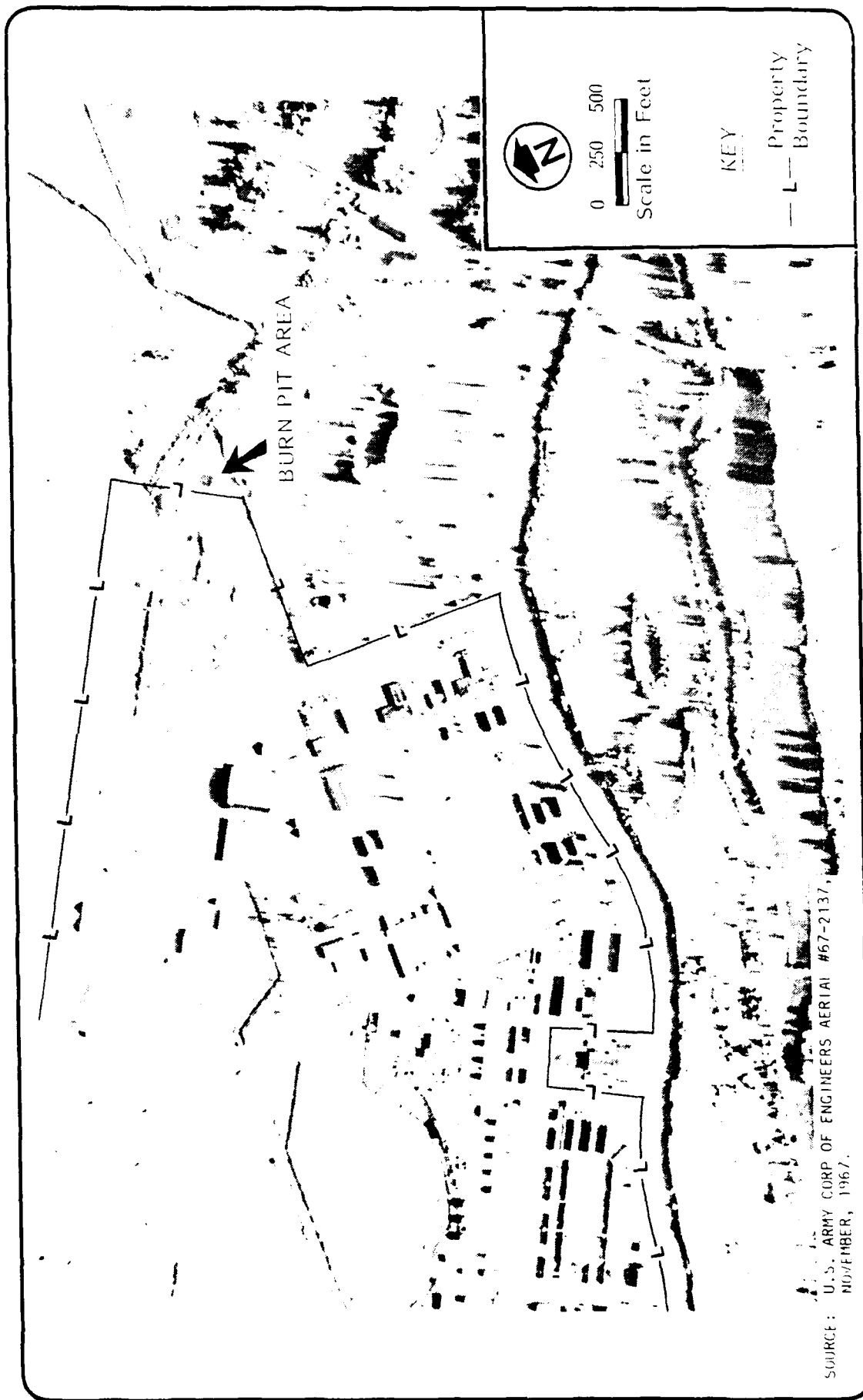


Figure 4-6

LOCATION OF BURN PIT AREA (SITE 7)
ANG PORTLAND, PORTLAND IAP, PORTLAND, OREGON

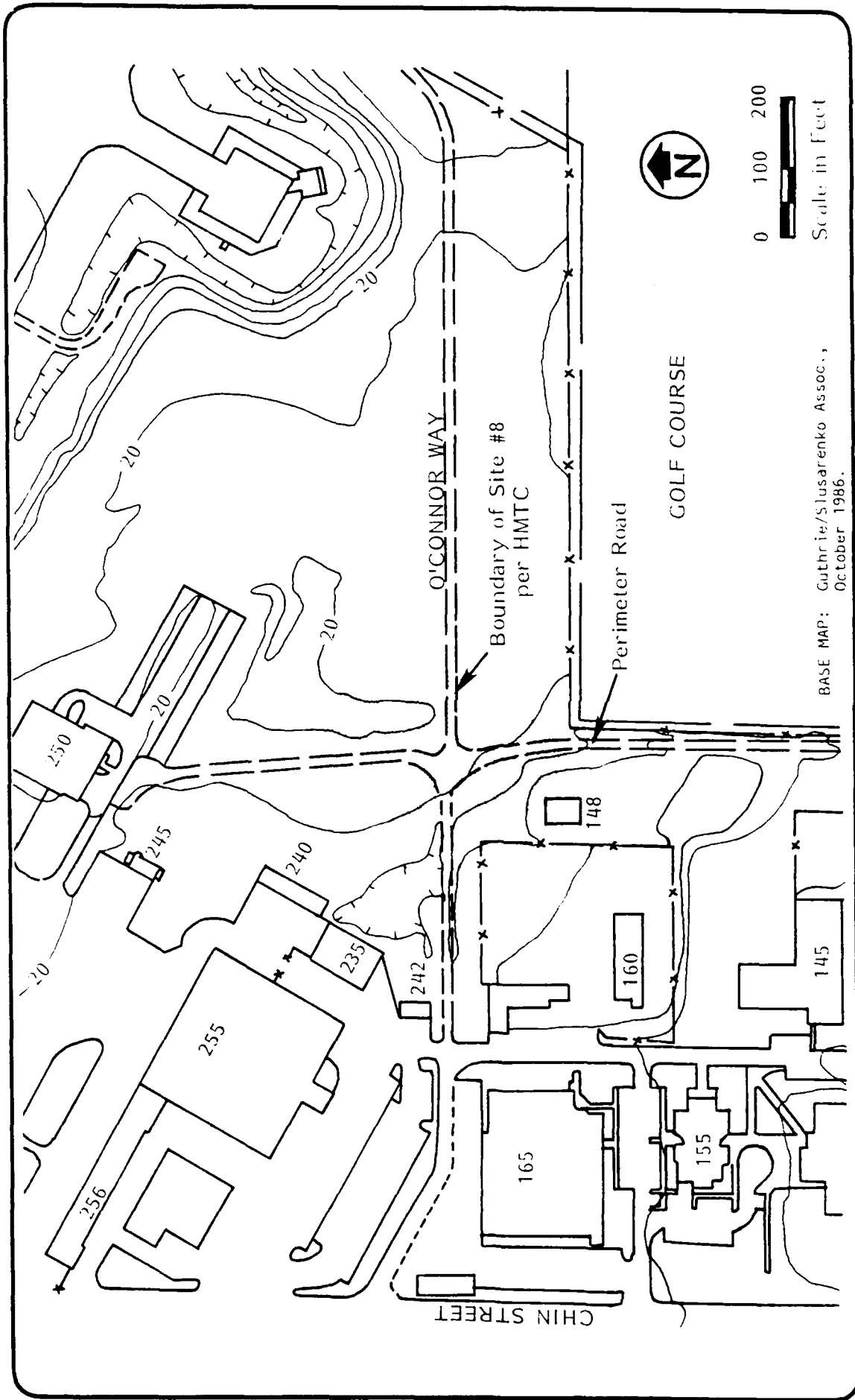


Figure 4-7

SITE 8: SANITARY LANDFILL.
ANG PORTLAND, PORTLAND IAP, PORTLAND, OREGON

5.0 HYDROGEOLOGIC FINDINGS

This section discusses the subsurface hydrogeologic information obtained from the installation of boreholes and monitoring wells during the ANG Portland Site Investigation. Slug tests and water level measurements conducted at each monitoring well provided information on hydraulic characteristics of water bearing sediments and ground water flow velocities. This local hydrogeologic information is evaluated in terms of the regional hydrogeology and potential contaminant migration pathways via ground water.

5.1 FIELD METHODS AND WELL CONSTRUCTION

Twelve monitoring wells were installed at five of the sites by a drilling subcontractor. An SAIC geologist was present for oversight of the drilling operations and well installation procedures, logging the borehole, taking soil samples for subsequent laboratory analysis, and determining the appropriate depth to place the well screen.

Boreholes were installed using a Mobil B-61 hollow stem auger drilling rig equipped with 6-inch I.D. and 11-inch O.D. hollow stem auger. Soil samples for lithologic logging were collected at five-foot intervals using a split-spoon sampler driven with a 140-lb. hammer falling a distance of 30 inches. Soil samples for chemical analysis were also obtained by this method at Site 3 and the Background monitoring well.

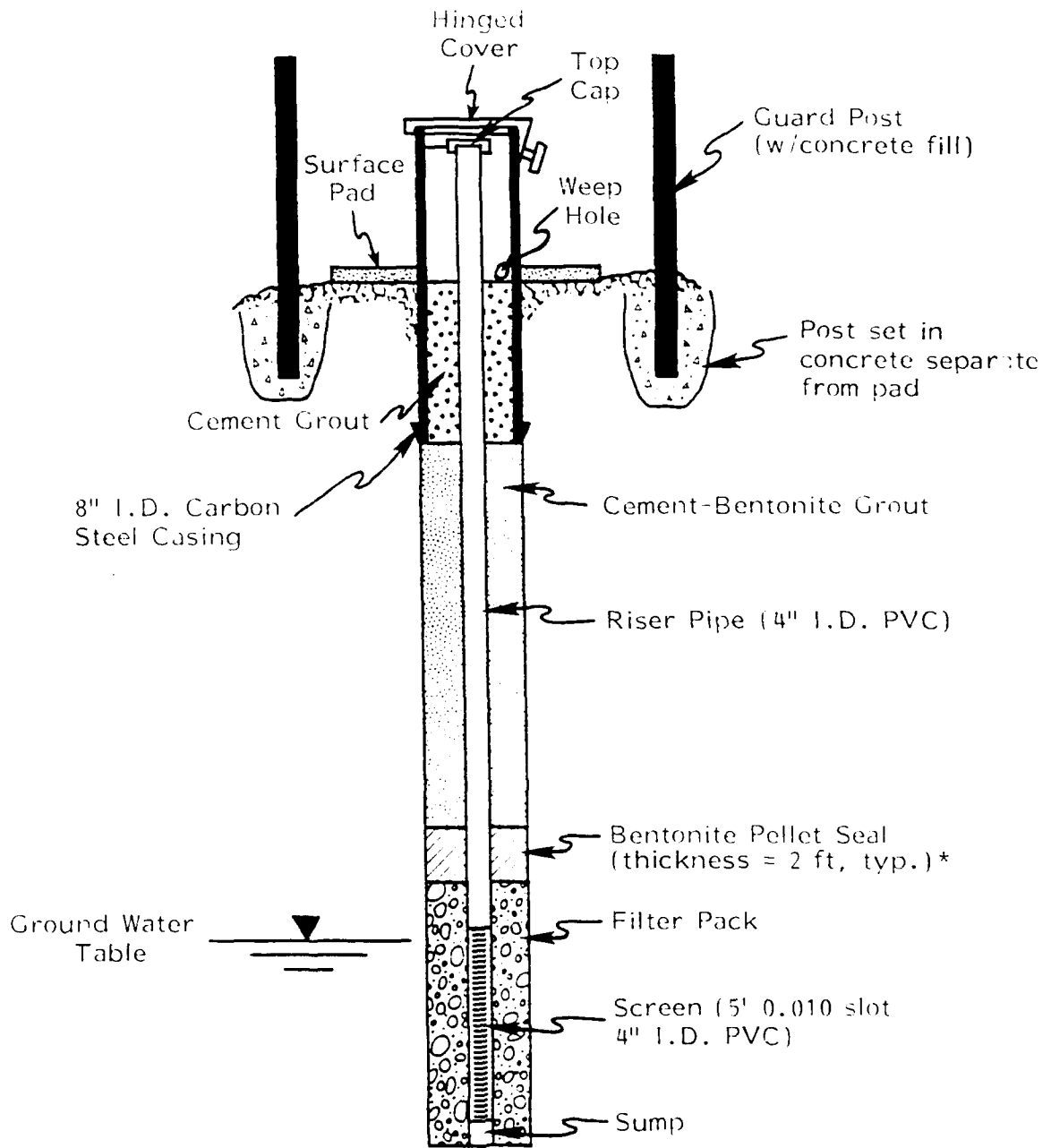
Monitoring wells were planned to be constructed with the top of the well screen approximately even with the water table so as to intersect any potential floating contaminants. However, the top of the well screens were usually installed one to two feet below the water table for reasons discussed below. The water table fluctuates seasonally by several feet and it was desirable that wells installed during the winter not become dry during the summer. In addition, the very fine-grained sediments made it very difficult to determine the precise elevation of the water table prior to well installation based on observation of the drill cuttings; the water table was often several feet higher than the point where saturated drill cuttings were first encountered. It was decided that it was

preferable to have well screens set deeper than planned rather than risk having wells go dry in summer. Therefore, some of the wells were completed with the top of the screens a few feet below the winter water table (e.g., MW2-1, MW3-1, MW7-1).

Monitoring wells were constructed of 4-inch O.D., flush thread, Schedule 40 PVC pipe with five-foot long PVC well screens having 0.010-inch slots. Five-foot well screens were selected in lieu of 10-foot screens to preferentially pump from near the water table. In general, the monitoring wells were difficult to keep from pumping dry and it was necessary to pump from as deep in the well as possible. Sediments were found to coarsen with depth and water would be preferentially removed from the most permeable interval (assumed to be near the bottom of the well screen). A 10-foot screen would have made it very difficult to remove water from near the water table. Figure 5-1 presents a diagrammatic sketch of a typical completed monitoring well installation. Completion depths of the monitoring wells ranged from 12 to 24 feet. Monitoring well construction details are shown in Table 5-1.

Monitoring wells were developed following completion. Wells installed in December 1988 and January 1989 were developed using a submersible pump; wells installed during August 1989 were developed using centrifugal pumps. Valves were installed in the pump discharge lines to limit the discharge rate in order to keep the wells from being pumped dry. The submersible pump was decontaminated prior to use in each well. Suction tubing dedicated to each well was used with the centrifugal pump to eliminate having to decontaminate between wells. Wells were developed until the discharge water was relatively clear and measurements of pH, conductivity, and temperature had stabilized.

Monitoring wells were installed during each of three separate field sampling episodes (December 1988, January 1989, and August 1989). Static water levels were measured simultaneously for all the wells installed prior to and during a given episode, several days after installation and developing activities had been completed. It was necessary to delay the measurements because most of the wells were installed in fine-grained soils which slowed water level recovery rate. Water levels were measured using a Yellow Springs Instrument Company, Inc.



* In cases of shallow ground water, bentonite seal was not always 2 ft. thick.

Figure 5-1

SCHEMATIC DIAGRAM OF WELL CONSTRUCTION
ANG PORTLAND, PORTLAND IAP, PORTLAND, OREGON

Table 5-1

CONSTRUCTION DETAILS OF MONITORING WELLS
AT OREGON ANG PORTLAND
PORTLAND IAP, PORTLAND, OREGON

Well ID Number	Casing Elevation ^a (ft)	Casing Diameter (in)	Date Installed	Bore Depth ^b (ft)	Well Depth ^b (ft)	Depth to Bottom of Screen ^b (ft)
MW1-1	17.886	4	12/14/88	15	13	12
MW1-2	16.323	4	1/26/89	15	14	13
MW2-1	16.450	4	12/16/89	13.5	11	10
MW2-2	16.840	4	8/23/89	16	16	15
MW3-1	18.123	4	12/15/88	15	13	12
MW5-1	19.228	4	12/17/88	15	12	11
MW5-2	20.261	4	12/17/88	12	12	11
MW7-1	26.702	4	8/23/89	26.5	22	21
MW7-2	20.966	4	8/24/89	19.5	19	18
MW7-3	25.220	4	8/24/89	24	24	23
MW7-4	23.803	4	8/25/89	20	19.5	18.5
MWBG	25.587	4	8/22/89	21.5	20	19

^a Vertical Datum = NGVD 1947 Adjustment (Department of Defense Station 10734, Elev. 5.602 m).

^b Depth below land surface.

Temperature-Level-Conductivity meter and recorded to the nearest 0.01 feet. Water table elevations were obtained by subtracting depth to water from the elevation of the top of the well casing. At the close of each episode of the field program, a subcontractor conducted a horizontal and vertical survey of each newly completed well. The survey point was the highest edge on the north side of the casing. The surveys were referenced to Port of Portland monuments using the State of Oregon coordinate system. The survey specifications required vertical closure of 0.01 feet and horizontal closure of 0.1 feet. Surveyed coordinates are given in Table 5-2.

Slug tests were conducted at each well near the close of the August 1989 field program using an Instrumentations Northwest™ pressure transducer, data logger, and integrated software with a laptop personal computer. A centrifugal pump and dedicated tubing were used to evacuate the water column to a point just above the pressure transducer. Drawdown and recovery rate level data were recorded by the datalogger and later transferred to a standard 3.5-inch disk for storage and analysis.

5.2 LITHOLOGY

Lithologic information was obtained from borings completed during this investigation. Monitoring well locations are shown on Figure 5-2; detailed lithologic logs are presented in Appendix B.

In general, fill and floodplain deposits were the only sediments encountered in the borings. It was difficult to distinguish between fill and floodplain deposits because dredged floodplain deposits (i.e., dredgings from the Columbia River) have been used extensively over the years for fill material in the ANG Portland area (Moore, 1988). No distinct stratigraphic units were recognized in the borings; however, they typically showed the following general sequence:

- 0 - 5 ft.: Moist, poorly draining sandy silt and clay, probably fill. Some gravel encountered at Site 3 and Background location.
- 5 - 10 ft.: Sandy silt and clay grading downward to very fine sandy silt with increasing proportion of fine sand. No gravel was observed in this interval.

Table 5-2

SURVEY COORDINATES FOR MONITORING WELLS
INSTALLED AT OREGON ANG PORTLAND
PORTLAND IAP, PORTLAND, OREGON

WELL I.D.	OREGON STATE COORDINATE SYSTEM	
	NORTHING	EASTING
MW1-1	703,996.599	1,463,980.897
MW1-2	704,040.704	1,464,138.141
MW2-1	703,482.864	1,464,050.581
MW2-2	703,433.304	1,464,042.453
MW3-1	704,095.274	1,463,670.422
MW5-1	703,623.905	1,464,911.848
MW5-2	703,497.070	1,464,870.209
MW7-1	703,599.308	1,466,282.086
MW7-2	703,636.949	1,466,414.519
MW7-3	703,730.526	1,466,179.866
MW7-4	703,514.117	1,466,064.447

Horizontal Datum = Oregon North Coordinate
System (Port of Portland monuments).

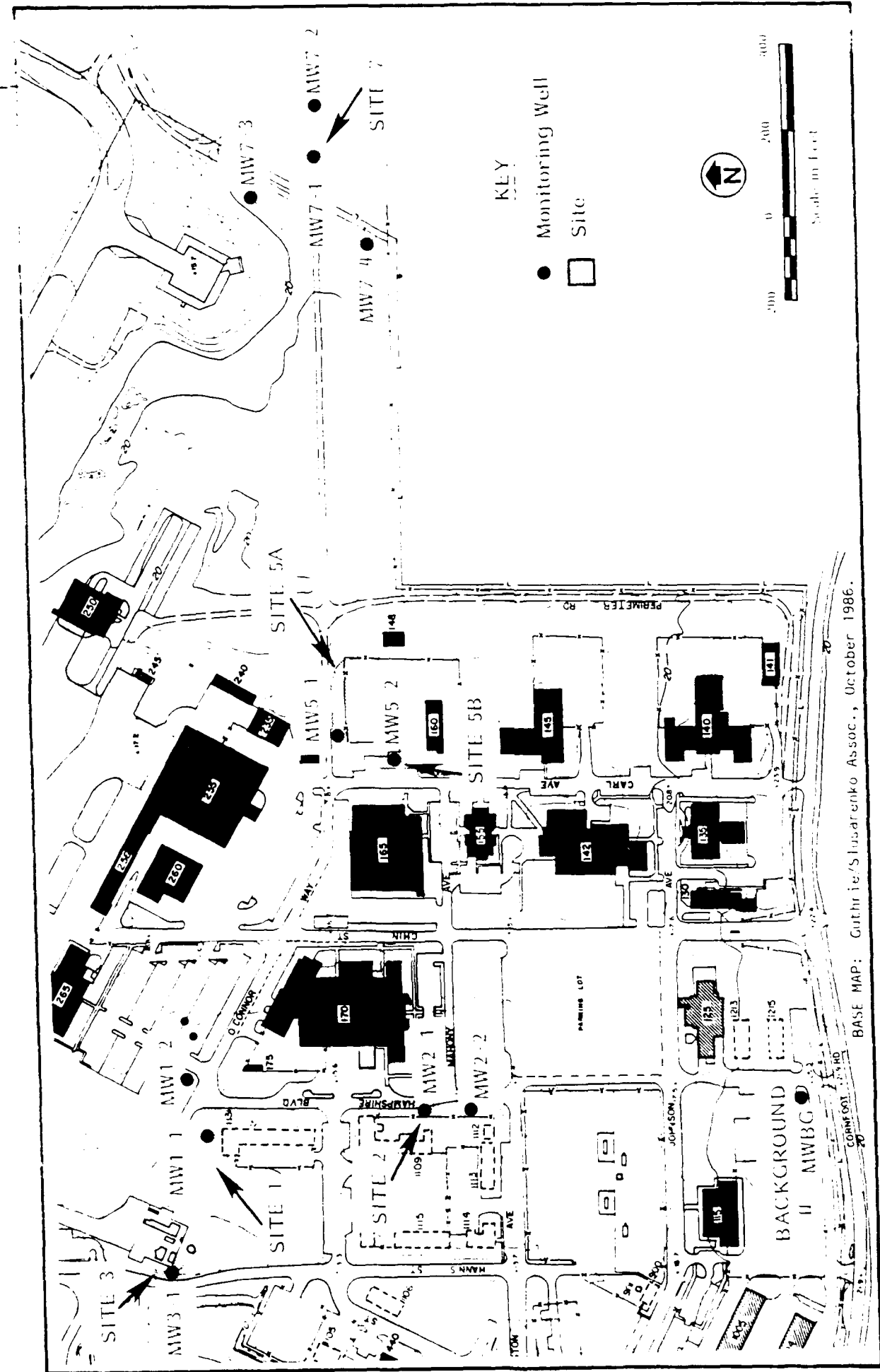


Figure 5-2
LOCATION OF MONITORING WELLS
AT PORTLAND, PORTLAND IAP, PORTLAND, OREGON

- 10 - 25 ft.: Sandy silt, usually coarser than the unit described above. A layer (1 to 2 feet thick) of medium to coarse sand was encountered in wells MW7-2 and MW7-4 between 15 and 20 feet, and in well MW7-3 between 20 and 25 feet.

The sand unit found in three of the Site 7 wells is potentially important because it could provide a relatively permeable conduit for contaminant transport, particularly if it is continuous across the Base. However, the sand unit was not encountered in any other well drilled to depths greater than 15 feet (i.e., MWBG and MW7-1). Therefore, the unit may not be continuous across the Base (or even locally such as at Site 7), and any permeable pathways due to the sand unit appear to be limited to localized areas.

5.3 HYDROGEOLOGY

5.3.1 Hydrostratigraphy

The sediments encountered in this study to depths of 25 feet belong to the Floodplain Aquitard (see Section 3.3 and Figure 3-4). In the area of the Base, the Floodplain Aquitard consists of interbedded sand and silty sands to depths approximately 60 to 80 feet below land surface where they grade into the Columbia River Sands Aquifer (Willis, 1975). Based on the lithologic results, the Columbia River Sands Aquifer was not encountered in any of the borings performed for the Site Investigation monitoring wells.

5.3.2 Occurrence and Movement of Ground Water

The water table was found to occur at depths of less than 15 feet below land surface in monitoring wells installed as part of this study (Table 5-3). The water table elevation declined by approximately 1.5 feet between measurements made on January 10, 1989 and August 29, 1989. Seasonal fluctuations are probably predominantly influenced by precipitation. However, the water table in the Floodplain Aquitard may also be influenced to some extent by the potentiometric surface of the Columbia River Sands Aquifer and by the level of the Columbia River. The river levels are subject to both seasonal (runoff) and diurnal (tidal) variations. Any effect the river may have on water levels in the Floodplain Aquitard would be indirect (the Columbia River is in direct hydraulic communication with the Columbia River Sands and Troutdale Gravel Aquifers) and

Table 5-3

GROUND WATER LEVEL MEASUREMENTS
 OREGON ANG PORTLAND
 PORTLAND IAP, PORTLAND, OREGON

Well ID Number	Top of Casing (MSL)	PAD Elevation (MSL)	1/27/89		8/29/89		1/21/89		8/29/89	
			Depth to Water Table (BLS)	Water Table Elevation (MSL)	Depth to Water Table (BLS)	Water Table Elevation (MSL)	Depth to Water Table (BLS)	Water Table Elevation (MSL)	Depth to Water Table (BLS)	Water Table Elevation (MSL)
MW1-1	17.89	15.62	5.32	10.34	6.83	8.79	10.34	8.48	8.48	
MW1-2	16.32	15.02	NM*	NM*	6.54	8.48	NM*	8.48	8.48	
MW2-1	16.45	14.84	4.52	10.32	5.50	9.34	10.32	9.34	9.34	
MW2-2	16.84	15.25	NM	NM	5.86	9.39	NM	9.39	9.39	
MW3-1	18.12	15.95	6.17	9.78	7.71	8.24	9.78	8.24	8.24	
MW5-1	19.23	17.18	5.68	11.50	6.42	10.76	11.50	10.76	10.76	
MW5-2	20.26	18.21	6.69	11.52	7.67	10.54	11.52	10.54	10.54	
MW7-1	26.70	24.97	NM	NM	14.75	10.22	NM	10.22	10.22	
MW7-2	20.97	19.18	NM	NM	9.52	9.66	NM	9.66	9.66	
MW7-3	25.22	23.73	NM	NM	13.45	10.31	NM	10.31	10.31	
MW7-4	23.80	22.24	NM	NM	11.42	10.82	NM	10.82	10.82	
MWBG	25.59	24.65	NM	NM	13.48	11.17	NM	11.17	11.17	

* NM = No measurement taken; monitoring well not installed at the time.

BLS - below land surface

MSL - mean sea level (see Table 5-1 for datum).

All measurements are in feet.

may be subject to a significant lag in observed water levels because of the low sediment permeabilities associated with the Floodplain Aquitard.

Water table elevations measured in August 1989 are shown on individual site maps presented on Figures 5-3, 5-4, 5-5, 5-6, 5-7, 5-8, 5-9, and 5-10. Inferred water table elevation contours, based on August 28, 1989 measurements, are shown in Figure 5-10. These contours indicate ground water movement to be generally in a northerly direction towards the Columbia River. The contours in Figure 5-10 indicate two distinct areas with differing ground water flow directions and hydraulic gradients:

- 2×10^{-3} in a north-northwesterly direction for the area encompassed by Sites 1, 2, 3, 5, and Background, and
- 5×10^{-3} in a northeasterly direction for the area of the Site 7 wells.

The contours in the Site 7 area suggest that the ground water flow direction might be influenced in this location by the drainage ditch northeast of the site. However, surface topography slopes downward from Site 7 to the northeast, and this could also explain the apparent ground water flow direction in this area.

The ground water level measurements taken in January 1989 provide some indication of the seasonal variability in ground water flow direction. Based on these data, the direction of ground water flow in winter appears to be northwesterly or westerly in the area of the Base encompassing Sites 1, 2, 3, and 5, compared with the north-northwesterly and northeasterly (Site 7 area) direction stated above for the summer data. Although the direction of ground water flow may be expected to have seasonal variations, the northwesterly or westerly direction found in winter should be used with caution since it is based on data from fewer wells than the summer measurements. It is also possible that local influences such as drainage ditches and building foundations may affect observed ground water flow directions at the sites. These local ground water flow directions may or may not be indicative of the regional flow pattern of the Floodplain Aquitard.

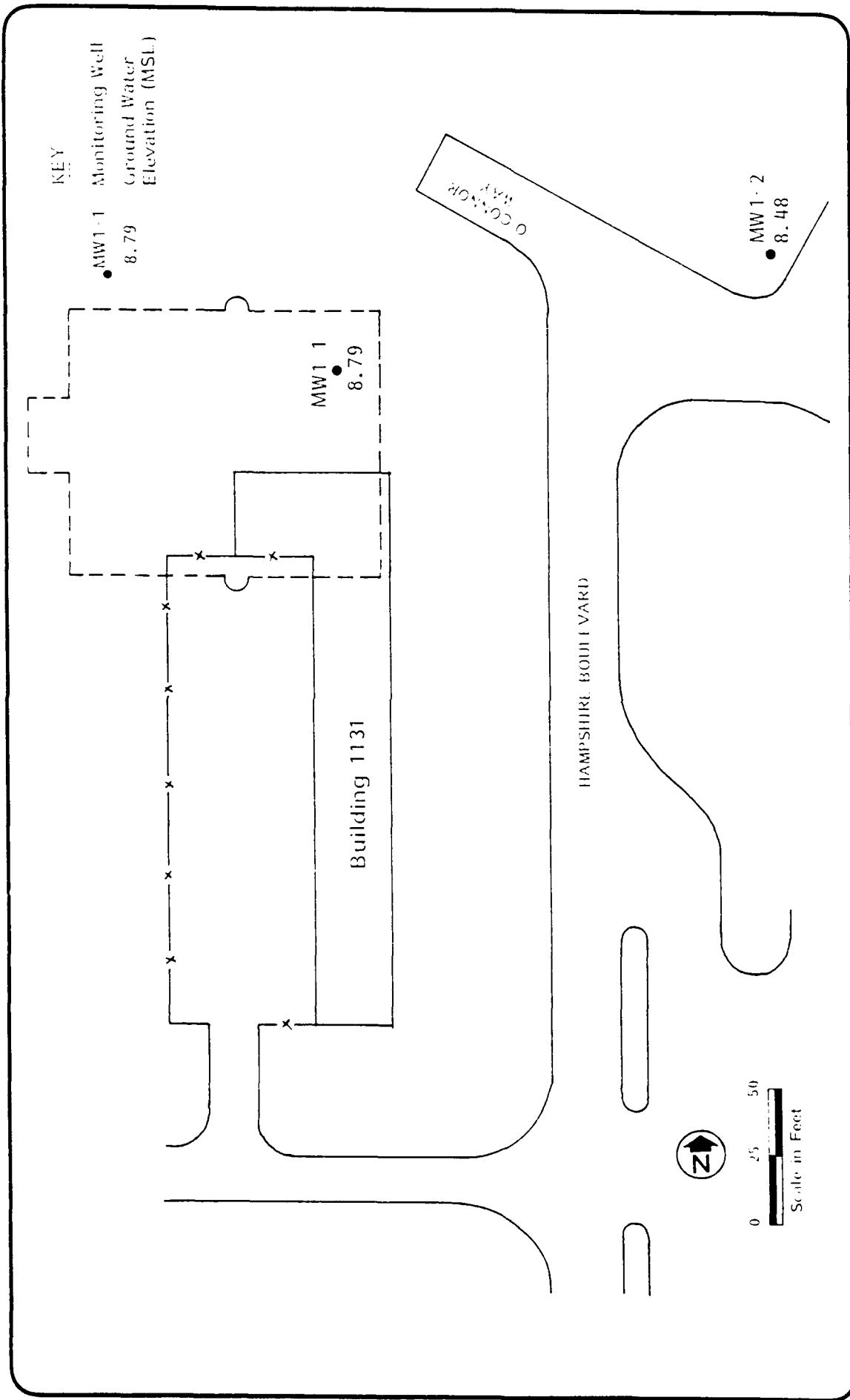


Figure 5-3
SITE 1: GROUND WATER ELEVATIONS - AUGUST 1989
OREGON ANG PORTLAND
PORTLAND IAP, PORTLAND, OREGON

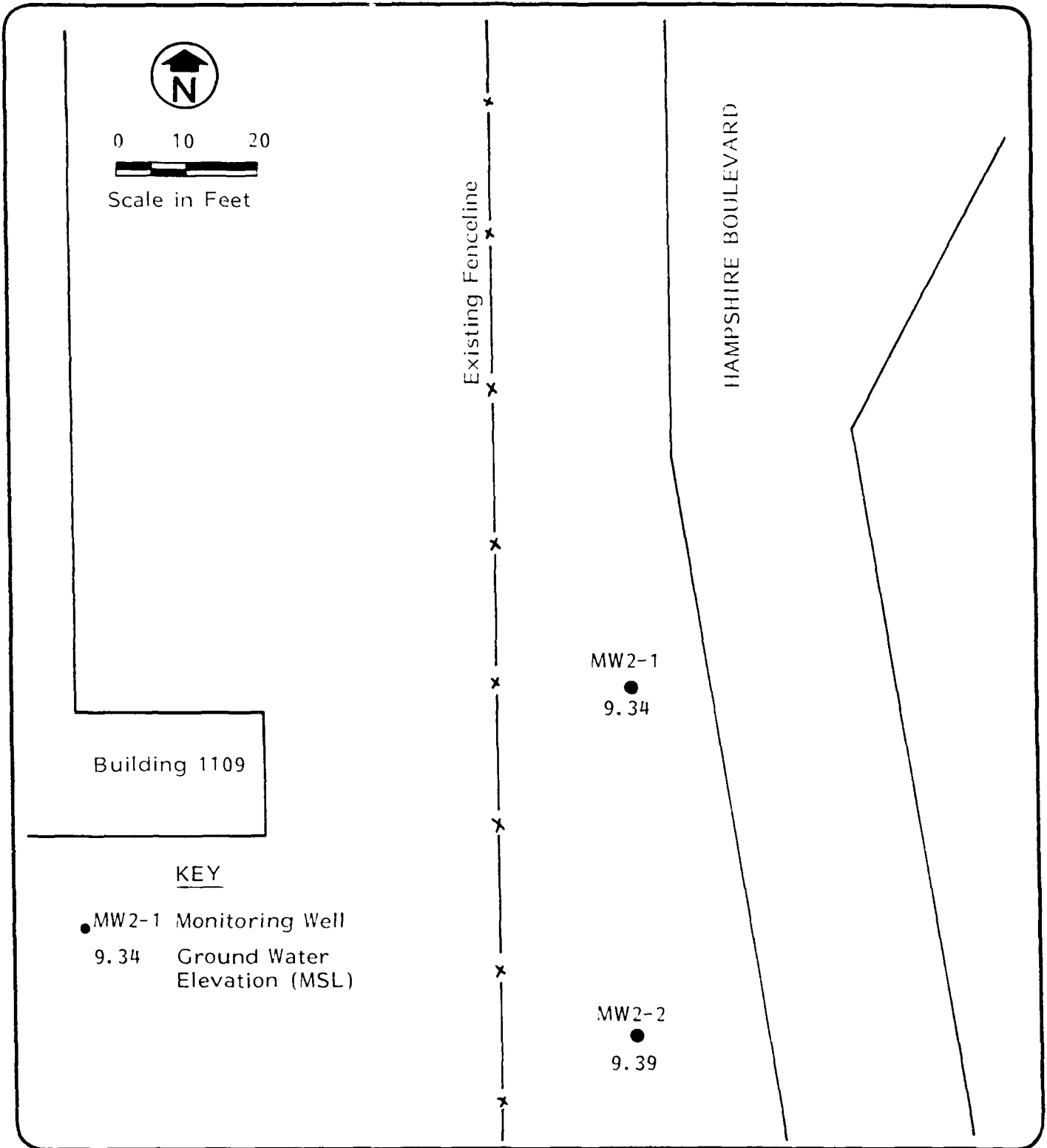


Figure 5-4

SITE 2: GROUND WATER ELEVATIONS - AUGUST 1989
OREGON ANG PORTLAND
PORTLAND IAP, PORTLAND, OREGON

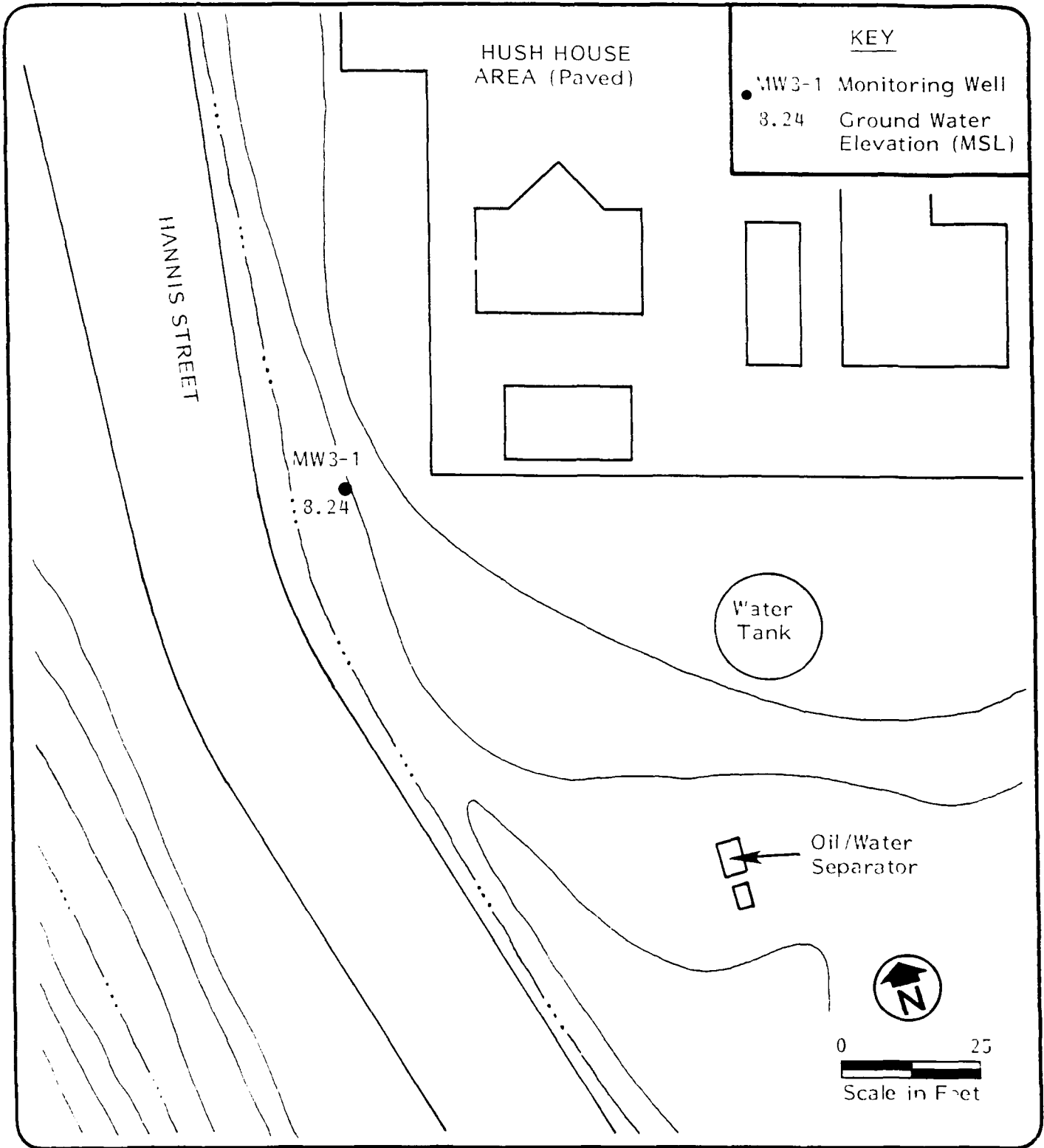


Figure 5-5

SITE 3: GROUND WATER ELEVATION - AUGUST 1989
OREGON ANG PORTLAND
PORTLAND IAP, PORTLAND, OREGON

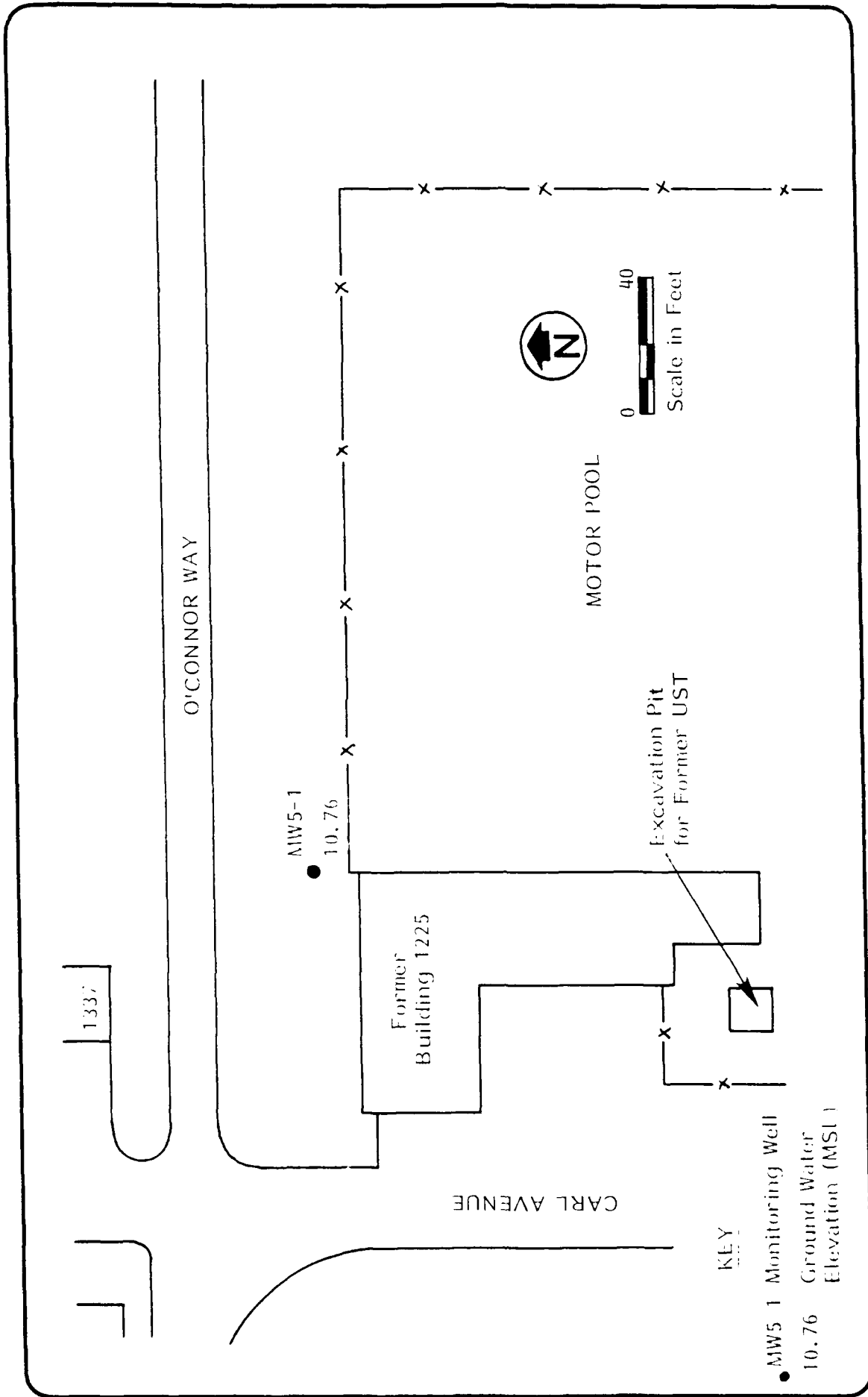


Figure 5-6
SITE 5A: GROUND WATER ELEVATION - AUGUST 1989
OREGON ANG PORTLAND
PORTLAND IAP, PORTLAND, OREGON

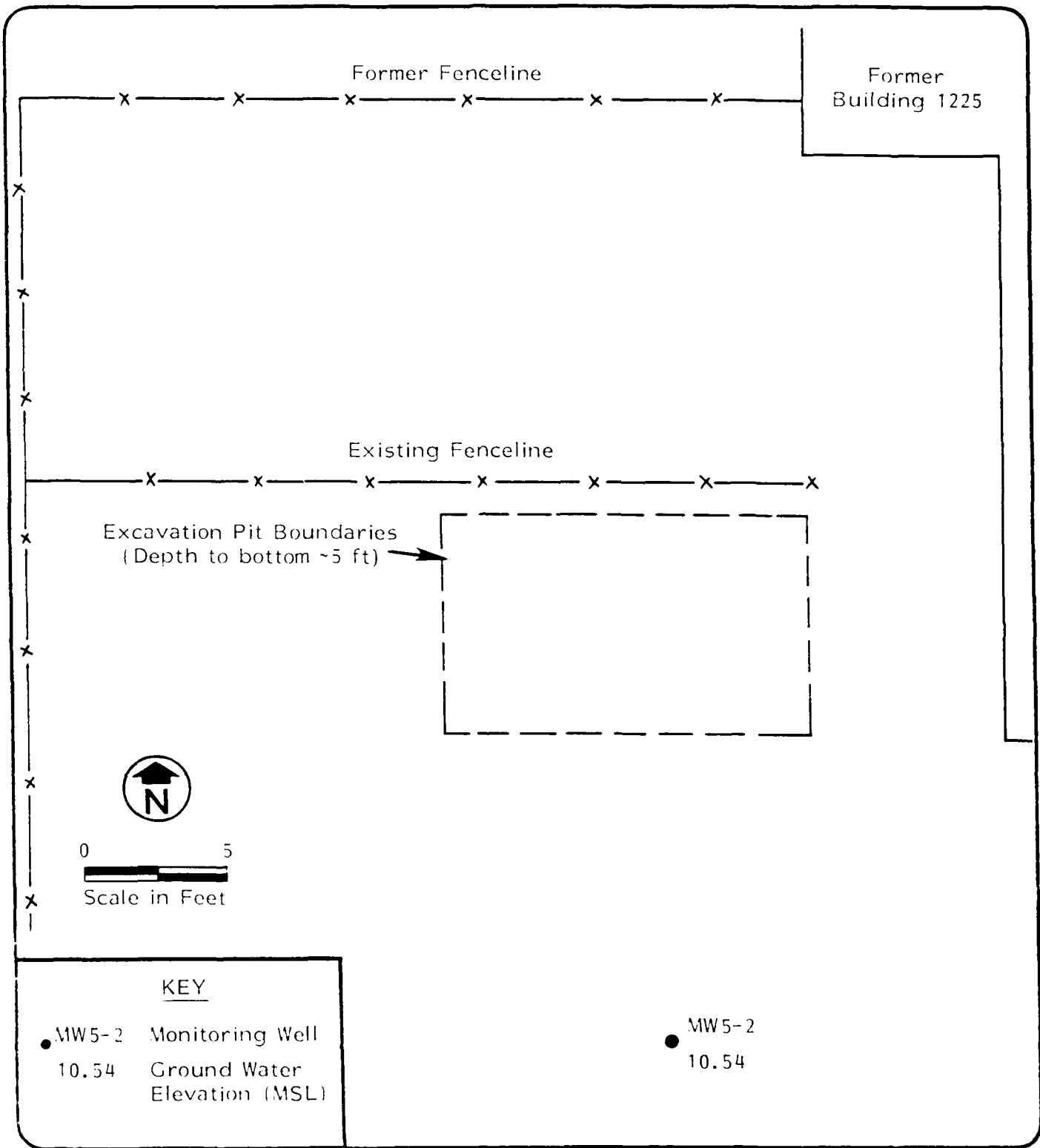


Figure 5-7

SITE 5B: GROUND WATER ELEVATION - AUGUST 1989
OREGON ANG PORTLAND
PORTLAND IAP, PORTLAND, OREGON

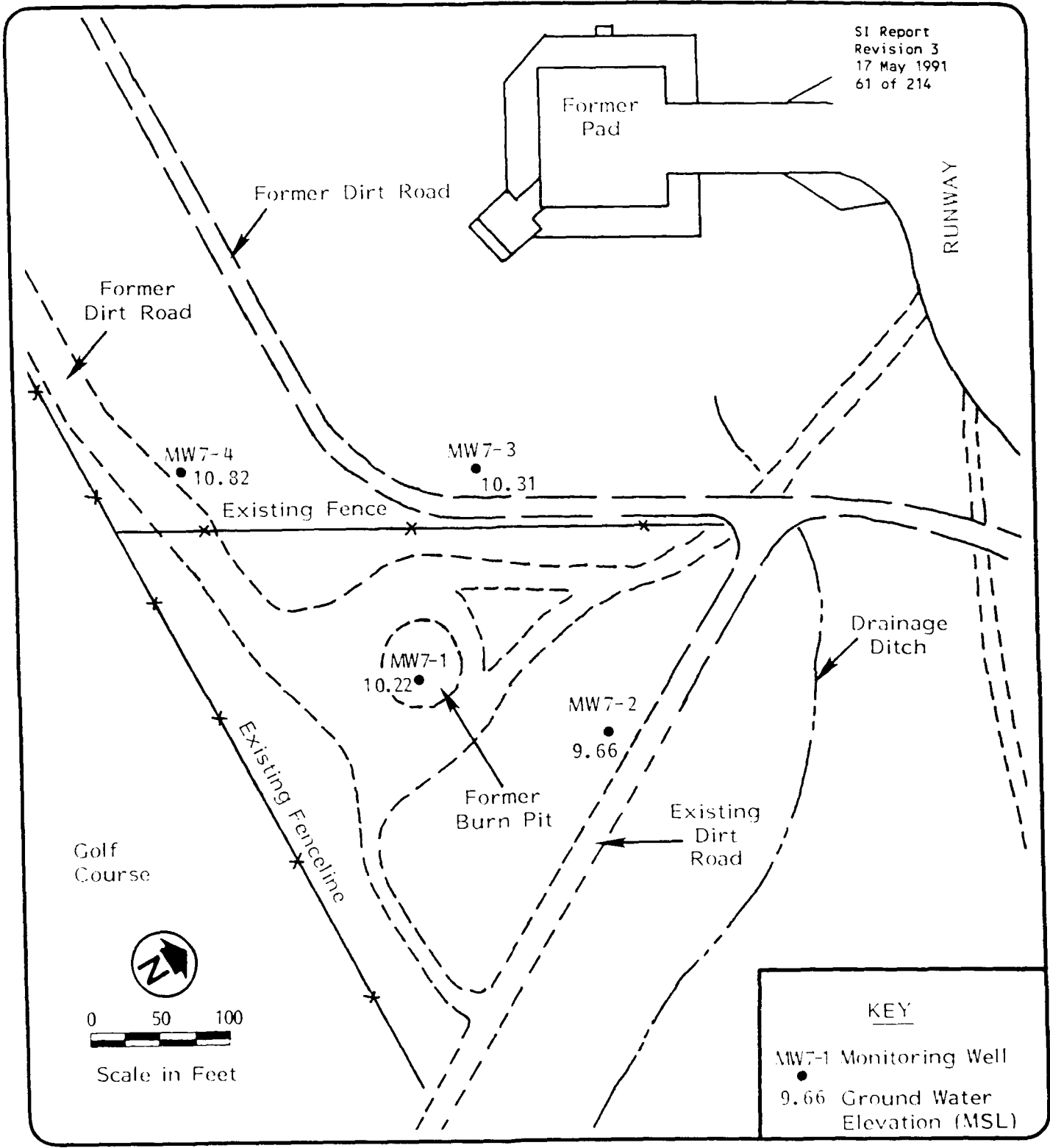


Figure 5-8

SITE 7: GROUND WATER ELEVATIONS - AUGUST 1989
OREGON ANG PORTLAND
PORTLAND IAP, PORTLAND, OREGON

JOHNSON AVENUE

SJ Report
Revision 3
17 May 1991
62 of 214

KEY

- MWBG Monitoring Well 11.17
- Ground Water Elevation (MSL)

Building 125

Building 1213

Building 1215

Guard House at Main Entrance

MWBG

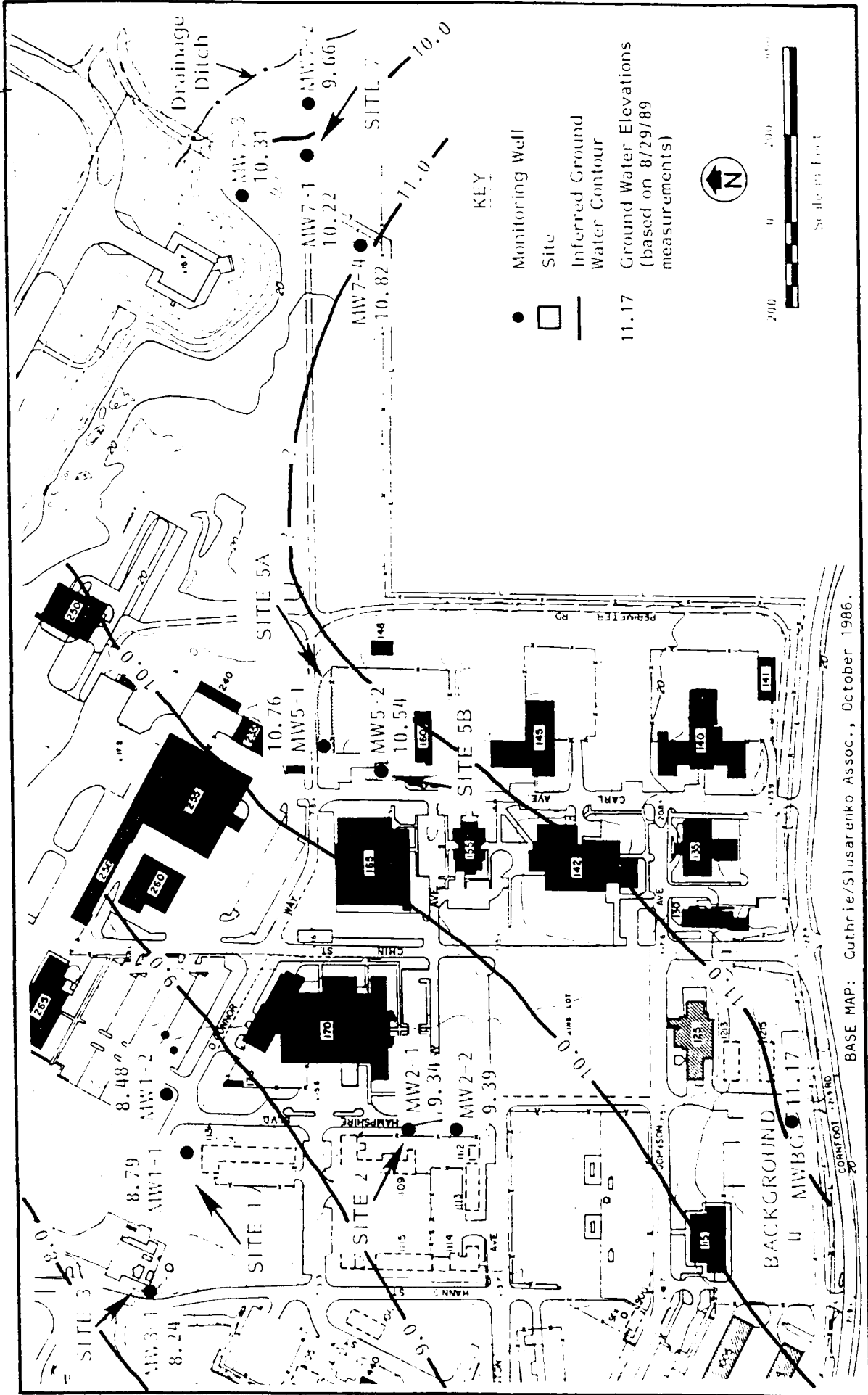
11.17

CORNFOOT DRIVE



0 30 60
Scale in Feet

Figure 5-9



BASE MAP: Guthrie/Shusarenko Assoc., October 1986.

Figure 5-10
 GROUND WATER TABLE CONTOUR AT ANG PORTLAND
 (Summer Conditions)
 PORTLAND IAP, PORTLAND, OREGON

5.4 AQUIFER MECHANICS

5.4.1 Hydraulic Conductivity

Hydraulic conductivities for the sediments in the immediate vicinity of each well screen were determined by conducting slug tests in each well at the close of the August 1989 program. The slug test data were interpreted using the method of Hvorslev (Hvorslev, 1951) including the necessary time lag corrections. The data reduction curves and derived coefficients are presented in Appendix C.

Due to the relatively large difference in permeability between the well screen sand pack and the generally low permeability, fine-grained sediments comprising the aquitard, a significant time lag must be accounted for in reducing the slug test data. This time lag represents the time required for complete equalization of the head difference if the original rate of inflow were maintained (Hvorslev, 1951). The term "original" is somewhat misleading, as the literature and practical application of this concept have used "original" to mean that portion of the flow which is believed to be representative of flow through the aquifer, as opposed to the initial flow obtained from dewatering the sand pack. The time lag is accounted for in the Hvorslev method for reducing the data and does not affect subsequent calculations for determining hydraulic conductivities.

Calculated hydraulic conductivities are listed in Table 5-4 for each monitoring well. The calculated conductivity values encompass three orders of magnitude, and are in agreement with the observed soil lithologies:

- Monitoring wells completed in clays and silts were determined to have hydraulic conductivities of 10^{-5} cm/s. These wells were difficult to develop and purge, since they could not sustain continuous pumping even at very low rates (e.g., less than 0.5 gpm).
- Monitoring wells completed in fine sandy silt generally exhibited a hydraulic conductivity near 10^{-4} cm/s. These wells were often able to sustain a pumping rate of 0.5 GPM during development and purging.
- Hydraulic conductivities calculated for Site 7 wells were in the 10^{-3} cm/s range. These wells were able to sustain a pumping rate of at least 1 GPM during development and purging. Monitoring wells MW7-1 and MW7-2 exhibited the highest hydraulic conductivities. These wells were partially completed in the thin layer of coarse sand described in Section 5.2.

Table 5-4

HYDRAULIC CONDUCTIVITIES FOR MONITORING WELLS
AT OREGON ANG PORTLAND
PORTLAND IAP, PORTLAND, OREGON

<u>Well ID</u>	<u>Hydraulic Conductivity</u> (cm/s)	<u>Hydraulic Conductivity</u> (ft/day)	<u>Average Linear Velocity</u> (ft/day)
MW1-1	9.29×10^{-4}	2.63	5.26×10^{-3}
MW1-2	1.37×10^{-4}	0.39	7.80×10^{-4}
MW2-1	3.61×10^{-5}	0.10	2.04×10^{-4}
MW2-2	1.90×10^{-4}	0.54	1.08×10^{-3}
MW3-1	6.5×10^{-4}	1.84	3.68×10^{-3}
MW5-1	5.27×10^{-5}	0.15	3.0×10^{-4}
MW7-1	4.64×10^{-3}	13.1	6.55×10^{-2}
MW7-2	9.75×10^{-3}	27.6	0.138
MW7-3	1.16×10^{-3}	3.29	1.64×10^{-2}
MW7-4	1.48×10^{-3}	4.19	2.10×10^{-2}
MWBG	4.43×10^{-5}	0.13	2.6×10^{-4}

10^{-5} cm/s

10^{-4} cm/s

10^{-3} cm/s

MW2-1
MW5-1
MWBG

MW1-1
MW1-2
MW3-1

MW7-1
MW7-2
MW7-4

NOTE: Site 7 ground water velocities were calculated using a hydraulic gradient of 5×10^{-3} . All other velocities were calculated using a hydraulic gradient of 2×10^{-3} .

5.4.2 Local Horizontal Ground Water Velocity

The horizontal ground water flow velocity in the shallow saturated sediments beneath ANG Portland may be estimated using the following variation of Darcy's Law:

$$v = Ki/n$$

where: v = ground water travel time in ft/day
 K = hydraulic conductivity in ft/day
 i = hydraulic gradient (dimensionless)
 n = porosity (volume fraction)

Velocity estimates were calculated for each of the two areas which exhibited distinctly differing hydraulic gradients (i.e., 5×10^{-3} ft/day for wells at Site 7, and 2×10^{-3} ft/day for wells at the remaining sites).

As discussed in Section 5.3.2, hydraulic gradients at the Base range from 5×10^{-3} (for wells at Site 7) to 2×10^{-3} (for wells at the remaining sites). Hydraulic conductivities of the various wells range from 0.13 to 27.6 ft/day (Table 5-4). A porosity of 30 percent was assumed for the generally coarser sediments of the Site 7 wells and a porosity of 40 percent was assumed for the generally finer sediments of the remaining wells, based on typical values given in Freeze and Cherry (1979).

Using the above assumptions and ranges, the sand unit encountered at Site 7 was calculated to have an average linear velocity range of 0.14 to 1.6×10^{-2} ft/day. On the other hand, average linear velocities of 7.8×10^{-4} to 1×10^{-3} ft/day were calculated for the sandy silt and clay layers present throughout the rest of the Base. These calculated velocities are estimated values applicable to the ground water near each well.

These estimates of average linear velocity encompass four orders of magnitude. This wide range is primarily a function of the variability of hydraulic conductivities which, in turn, are dependent upon soil lithology. Wide ranges in hydraulic conductivity are typical of complex, interbedded fluvial deposits. The interbedded nature of the sediments at the ANG Portland sites suggests that

the entire range of calculated horizontal ground water velocities should be considered for potential contaminant transport.

Nested monitoring wells were not installed as part of this study. Therefore, the vertical velocity component of ground water flow cannot be estimated. In most instances the vertical velocity is several orders of magnitude less than the horizontal velocity. However, with small horizontal velocities, such as those reported above, gravity flow may become important, particularly if dense-phase contaminants are present. Small horizontal velocities can increase the importance of vertical migration for light-phase contaminants as well, since dispersion transport rates become relatively more significant.

5.5 POTENTIAL FOR CONTAMINANT MIGRATION IN GROUND WATER

The information presented in Sections 2.0 and 3.0 describes the following water resources or features in the vicinity of ANG Portland:

- Columbia River, which is about one mile north of the Base.
- Columbia Slough (immediately south of the Base), which flows to the Willamette River and is sometimes pumped to the Columbia River.
- Main Base drainage ditch (e.g., Site 4), which is pumped into Columbia Slough.
- Drainage ditch near Site 7, which extends eastward two miles from the Base.
- The Columbia River Sands Aquifer, which underlies the Floodplain Aquitard. (The surface soils at the Base belong to the Floodplain Aquitard; the Columbia River Sands Aquifer is one of several aquifers utilized by the City of Portland Well Field for supplemental municipal water supply).

Each of these features has some possibility of being impacted by migration of contaminants from the IRP sites simply due to its proximity to the Base. The hydrogeologic investigation at ANG Portland has provided some information pertinent to evaluation of potential contaminant migration via local ground water pathways. The data suggest that surface water drainage ditches, such as those adjacent to Sites 3 and 7, receive some ground water discharge. However, it is

unlikely that the ditches influence ground water flow on much more than a very localized level.

The overall movement of ground water appears to be toward the Columbia River (and away from Columbia Slough). Hence any ground water contaminant plumes which exist at the sites would be expected to be migrating generally northward (including northwestward or northeastward). However, since most of the shallow soils encountered in this investigation were fine-grained sediments with low hydraulic conductivity, and base-wide hydraulic gradients appear small, rates of migration via ground water advection should not be very great. Since average linear ground water velocities across the Base appear small (with the exception of the velocities encountered at Site 7, which appear to have a limited area of influence), contaminant migration may be significantly influenced by dispersion, in both horizontal and vertical directions. In addition, other site-specific factors could greatly affect migration pathways and rates, such as the presence of highly permeable conduits (e.g., utilities trenches, or the coarse sand found at Site 7 and at the Background location), or attenuation/removal mechanisms (e.g., volatilization, adsorption, and biological degradation).

The degree of vertical hydraulic communication with the Columbia River Sands Aquifer or deeper aquifers of the Portland Well Field (such as the Parkrose Gravel Aquifer, Troutdale Sandstone Aquifer, or the Rose City Aquifer) cannot be determined from the limited data obtained from the shallow monitoring wells installed during this investigation, none of which extended below the Floodplain Aquitard. It is very likely that the Floodplain Aquitard is in hydraulic communication with the Columbia River Sands Aquifer. If contaminants reach the Columbia River Sands Aquifer, they would be expected to experience greater migration rates in this unit than in the Floodplain sediments.

In view of the low permeability of the Floodplain Aquitard and the considerable distances from the IRP sites to the Columbia River and the City of Portland Well Field (e.g., one mile), it seems unlikely that contaminants would have migrated from the Base to near these resources. In addition, the Portland Well Field appears to be generally upgradient of the Base and the aquifers drawn from in the well field lie at a much greater depth than where contamination was detected in

the Floodplain Aquitard. However, as discussed in the next section, presently available information is very limited with regards to the horizontal and vertical extent of contamination at the IRP sites. The small gradients, wide range of hydraulic conductivities, and the possible existence of highly permeable buried stream channels could give rise to an eastward flow vector during pumping of the Portland Well Field. Further chemical and hydrogeological investigation is needed in order to determine whether contamination is present to a great extent and whether there is any threat to water resources such as private wells or the municipal well field.

6.0 SITE CHARACTERIZATION

This section describes the field program and results obtained for characterization of potential contamination at each of the IRP sites at ANG Portland. Included are discussions of the sampling and analytical methodology, sampling locations and rationale for analyses performed, analytical results, and geophysical survey techniques and findings.

6.1 SAMPLING METHODS

Samples were collected for chemical analyses of soil, sediment, and ground water. Standard sampling methods and sample handling procedures were employed to maintain sample integrity, assure representativeness, and minimize the potential for cross-contamination. The following sections summarize the techniques used to collect the samples. Additional details of the methods employed can be found in the Sampling and Analysis Plan (SAIC, 1989a). Additional discussion of sample handling procedures is provided below.

After sealing and labeling the sampling containers as required in the Sampling and Analysis Plan, soil, sediment, and water samples were stored in coolers prior to and during shipment. The samples from each event were counted to ensure that all samples were collected, and the chain of custody forms were completed in preparation for shipping and analysis. The samples were placed in Ziploc™ bags, wrapped in "bubble wrap", and then placed in ice chests. The samples were packed in ice to maintain a temperature of 4°C in the cooler. The completed chain of custody document was placed in a sealed plastic bag and taped to the inside lid of the cooler. Custody seals were secured to the cooler opening and the ice chest was sealed with strapping tape. Samples were transported by courier (Federal Express) on the same day of collection to SAIC's Analytical Laboratory in La Jolla, California. The samples and sealed coolers were kept in view and possession of the sampling team until acceptance by the courier. Upon arrival at the lab, the laboratory staff inventoried samples against accompanying chain of custody and examined them for breakage or other loss of sample integrity. The

laboratory signed the chain of custody and returned it to SAIC in Bothell, Washington to confirm sample receipt and the commencement of analysis. Copies of the chain of custodies are provided in Appendix L.

6.1.1 Soil and Sediment Sampling

Soil samples were collected by two methods. A bucket-type hand auger was used whenever possible to collect the soil samples. If difficult soil conditions (such as the presence of cobbles) precluded effective use of the hand auger, samples were collected using a hollow stem auger drilling rig with a split-spoon sampling attachment. The hand auger method was also used to collect all the Site 4 sediment samples, as well.

The hand auger was decontaminated by scrubbing with an Alconox™-water solution, followed by a tap water rinse, deionized water rinse, pesticide-grade methanol rinse, and finally a pesticide-grade hexane rinse. The auger was then allowed to air-dry before a borehole was started. The auger was turned to the appropriate sampling level and the contents of the bucket were emptied onto a sheet of aluminum foil. Samples for volatile organic analysis were collected first, followed by semivolatile samples, petroleum hydrocarbons, and lastly, inorganics. This procedure was followed for the collection of samples at each borehole and sediment sampling station.

At Site 3 and the Background location, a gravel layer was encountered which required the use of the hollow stem auger drilling rig to collect the samples. The samples were collected using a stainless steel split-spoon attached to the end of drilling rods. The split-spoon was filled with soil by driving it with a 140-lb hammer dropped a distance of 30 inches. Sample containers were filled for each analyte required in the order given above. The split-spoon was decontaminated prior to the collection of each sample in a manner identical to the sequence described above.

6.1.2 Ground Water Sampling

Prior to the collection of ground water samples, all monitoring wells were purged to ensure that the water in the well was representative of ground water in the

formation. The monitoring wells installed in December 1988 and January 1989 were purged using a submersible pump. The wells were purged until measured values for pH, specific conductance, and temperature stabilized. Upon completion of purging, the submersible pump and hose were decontaminated before purging of the next well commenced. The wells installed in August 1989 were purged using a centrifugal pump and dedicated suction tubing, thus eliminating the need for decontamination of purging equipment between wells.

Ground water samples were collected from each well using a Teflon™ bailer. The bailer was decontaminated according to the sequence described above prior to the collection of each sample. The bailer was attached to nylon line and slowly lowered down the monitoring well until it was just below the water surface. After filling, the bailer was brought up from the well and sample containers were filled in the following order: VOCs, SVOCs, PHCs, and inorganics. After filling the containers, the nylon line was discarded and the bailer was decontaminated before proceeding with sampling at the next station.

6.1.3 Soil Gas Surveys

The soil gas sampling and analyses were conducted by a subcontractor (Tracer Research Corporation), with oversight by the SAIC field operations manager. Sample stations were staked by SAIC. A steel pipe sample probe was hydraulically driven to a depth of 4-5 ft at each station. The sample was collected after drawing several liters of soil gas through the probe with a vacuum pump. Sample collection was accomplished using a glass syringe inserted through a silicone rubber tubing segment of the evacuation line while the pump was running. The sample was immediately injected into the field gas chromatograph (GC) for analysis. Additional details of the techniques and operating procedures used in the soil gas surveys are presented in Appendix D.

6.1.4 Management of SI-Derived Wastes

Secondary wastes were generated during the SI as a result of the field activities. These included drill cuttings (soils) and water from development and purging of the monitoring wells. These SI-derived secondary wastes were containerized in drums, labeled, inventoried, and stored at the Base until

results were available from analysis of the associated environmental samples. After analytical results were available for the environmental samples, these data were evaluated to determine which of the corresponding secondary wastes were potentially contaminated. Those drummed secondary wastes assessed to be potentially contaminated were then sampled and analyzed to determine whether the material exhibited hazardous waste characteristics or other contamination as detected in the associated environmental samples. After analytical results were available for the secondary wastes, recommendations were made to the Base Environmental Coordinator regarding disposition for each drum and appropriate transportation labeling and waste manifest information.

6.2 ANALYTICAL METHODS

Samples sent to the off-site laboratory were analyzed in accordance with EPA SW 846 procedures (EPA 1986d), EPA drinking water methods (EPA, 1983), or standard methods prescribed by the American Society for Testing and Materials (ASTM). The specific methods employed for each sample are identified in the sampling activities tables for each site in Section 6.3. A description of each analytical method is given in Section 8.1.

Samples analyzed by field GC using headspace techniques were accomplished in conformance with EPA SW Method No. 3810 with modification of the bath temperature. This method was used only for Site 1 samples. Analysis was performed for specific target compounds that had previously been detected at Site 1 and Site 2 nearby. These were bromochloromethane, methylene chloride, 1,2-dichloroethene, and trichloroethene. Further details of these procedures for the head space analyses are given in Appendix E.

Samples collected during the soil gas surveys were analyzed using field GC instrumentation equipped with flame ionization and electron capture detectors. The procedures employed are detailed in Appendix D.

6.3 SAMPLING PROGRAM AND ANALYTICAL RESULTS

The environmental field efforts were conducted in three separate sampling episodes: December 1988, January 1989, and August 1989. The field activities

were split into separate episodes because of ANG desire to proceed with construction of new buildings or facilities at several of the sites.

ANG Portland had planned and scheduled potential construction activity for 1989 at Sites 1, 2, and 3. To minimize construction delays, SAIC was directed to conduct field activities for these sites under an accelerated program. The first sampling episode was termed the Fast-track program, and was initiated on December 7, 1988 and concluded on December 21, 1988. Fast-track work was conducted at Sites 1, 2, 3, and 5. Site 5 was included in order to broaden the initial study area to improve the usefulness of ground water level measurements from the Fast-track wells.

The second round of sampling was added to the Site Investigation because high concentrations of volatile organic compounds were detected in the Fast-track ground water sample from Site 1, for which proposed construction was most critical. The second sampling episode was termed the Expanded SI program and was begun on January 19, 1989. Its purpose was to characterize the extent of contamination at the site to determine whether remedial action was necessary and how it could be expedited so that construction could commence as soon as possible. The Expanded SI field effort was completed by January 27, 1989.

The third episode included the remainder of the planned Site Investigation environmental sampling activities. It was conducted between August 4, 1989 and August 29, 1989.

The field work was conducted in accord with the activities and procedures described in the project work plans (SAIC, 1989a), with the exception of several field changes which were necessary to accommodate field conditions or other factors. These changes are described in the field change forms provided in Appendix K.

Analytical results for environmental samples are presented in the following sections for each site. The tabulated results are footnoted ("flagged") to indicate any data which were qualified as a result of the analytical data validation process. These "qualifiers" indicate that the particular chemical

concentration is suspect or is an estimate because of a variety of problems that can be encountered during the sampling and/or analytical process. The data qualifiers are briefly explained in the footnotes of the table. A more detailed explanation of the data validation process and the meaning of the qualifiers is presented in Section 8.0.

6.3.1 Site 1 - Central Hazardous Waste Storage Area

Fast-track Sampling Episode (December 1988)

Field Sampling Activities. Field work was performed at Site 1 during the Fast-track episode because construction of a new Avionics building was scheduled for 1989 which would impact a portion of the site. In order to assess potential contamination from spills, leaks, or disposal of hazardous waste constituents which may have occurred in the past, samples were collected for analysis from one monitoring well near the center of the site and a total of 12 soil sampling stations spaced over the site. Samples were taken from two depths at each soil station (one near the surface and one at 3-5 ft depth). The sample station locations are shown in Figure 6-1. The sampling and analytical schedule is given in Table 6-1.

The rationale for the sampling and analysis program was as follows:

- Beginning in 1970, Site 1 was used for storage of miscellaneous wastes including 55-gallon drums of waste oil, solvents, fuels, Stoddard solvent, diesel fuel, shop wastes, transformers, and capacitors. Suspected spills and leaks could have occurred anywhere within the storage area. The area was unpaved and had no containment structures. The shaded area in Figure 6-1 indicates the site boundary as identified in the PA Report.
- Since many of the wastes stored at the site were derived from solvents or other petroleum-based products, the soil and ground water samples were tested for petroleum hydrocarbons (C₁₀-C₂₄ alkanes) and volatile organics (aromatics and halocarbons).
- To check for possible dielectric fluid leakage from electrical equipment, polychlorinated biphenyls (PCBs) analysis was performed on all of the surface soil samples. Since PCBs generally exhibit low mobility in soils, only two of the deeper soil samples were tested for PCBs.

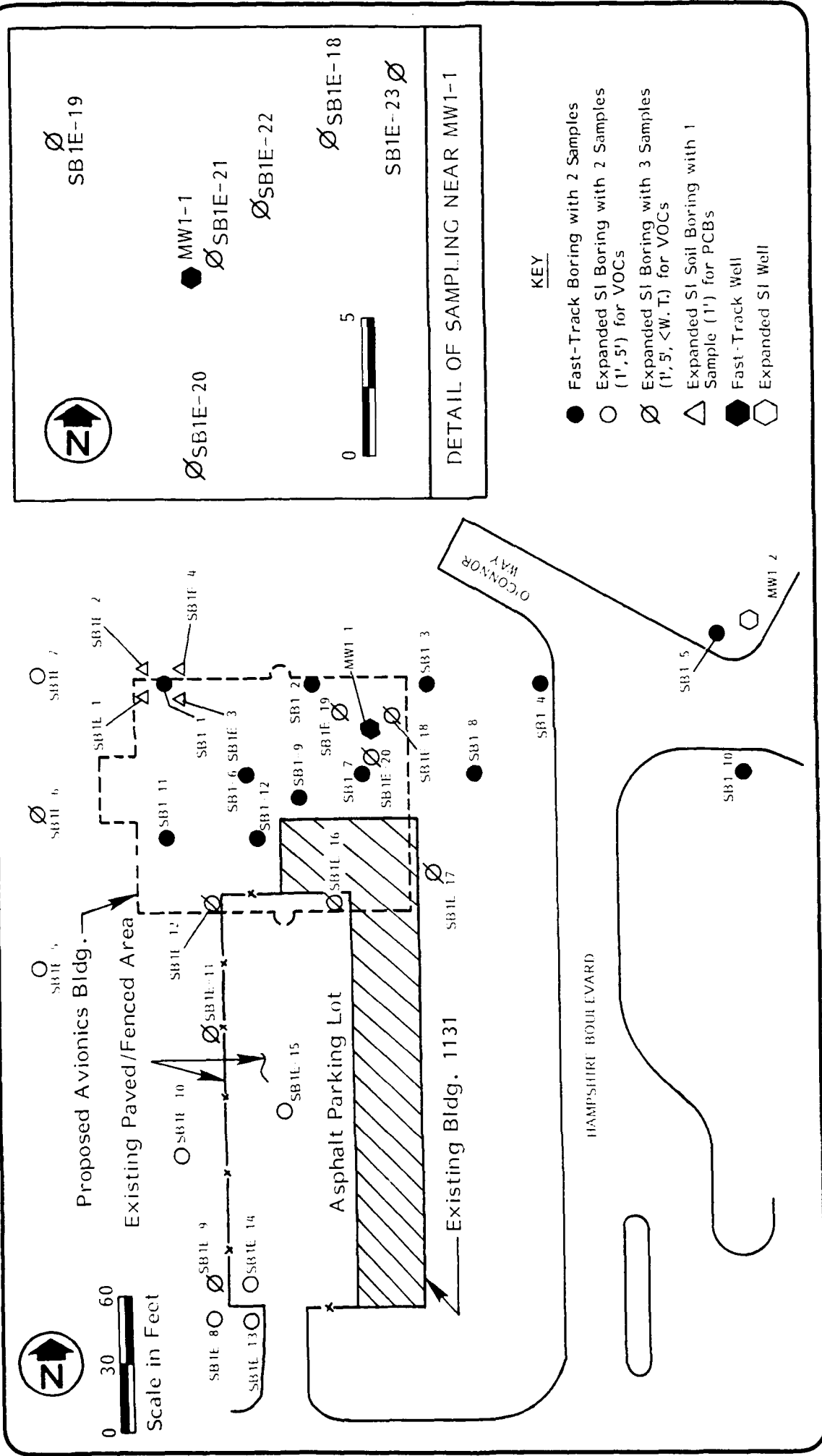


Figure 6-1
 SITE 1: CENTRAL HAZARDOUS WASTE STORAGE AREA SAMPLING LOCATIONS
 ANG PORTLAND, PORTLAND IAP, PORTLAND, OREGON

Table 6-1

SUMMARY OF ENVIRONMENTAL SAMPLING ACTIVITIES AT SITE 1
[CENTRAL HAZARDOUS WASTE STORAGE AREA]
[FAST-TRACK EPISODE - DECEMBER 1988]
OREGON AND PORTLAND
PORTLAND IAP, PORTLAND, OREGON

<u>Matrix/Analysis</u>	<u>Analytical Method</u>	<u>Depth Collected (ft)</u>	<u>Sampling Method</u>	<u>No. of Field Samples</u>
<u>Soils/Sediments</u>				
Volatile Organics	SW5030/8240	1, 3-5	HA	24
PCBs	SW3550/8080	1, 2@ 3-5	HA	14
Petroleum Hydrocarbons (C ₁₀ -C ₂₄ alkanes)	ASTM D3328	1, 3-5	HA	24
Percent Moisture	E160.3	1, 3-5	HA	24
<u>Ground Water</u>				
Volatile Organics	SW5030/8240	--	B	1
Base/Neutral/Acid Extractables	SW3520/8270	--	B	1
PCBs	SW3520/8080	--	B	1
<u>Metals (dissolved):</u>				
Cadmium	SW3020/7131	--	B	1
Chromium	SW3005/6010	--	B	1
Lead	SW3020/7421	--	B	1
Nickel	SW3005/6010	--	B	1
Zinc	SW3005/6010	--	B	1
pH	E150.1/Fld.*	--	B	1
Temperature	E170.1/Fld.*	--	B	1
Specific Conductance	E120.1/Fld.*	--	B	1

ASTM = American Society for Testing and Materials Methods.
SW = SW 846 Methods (EPA, 1986).
E = EPA Drinking Water Methods (EPA, 1983).
HA = Hand Auger
B = Bailer
* Field Measurement

- The monitoring well was installed near the center of the site to determine whether ground water beneath the site had been impacted.
- Because of the wide variety of wastes stored at the site, the ground water sample was characterized for a wide spectrum of possible contaminants by analyzing for volatile organics, PCBs, semi-volatile organics (base/neutral-acid extractions) and for five common metals (cadmium, total chromium, lead, nickel, and zinc).

Fast-track Episode Results. The analytical results for the Fast-track samples are presented in Table 6-2. There were no volatile organic compounds detected in any of the soil samples during the Fast-track episode. PCBs were detected in one of the soil samples (0.34 S,M mg/kg in SB1-1-1). (Note: S and M are data qualifiers; see Table 6-2 for explanation of qualifiers.) It is likely that the petroleum hydrocarbons (PHCs) also found in this sample were present as residual dielectric oils associated with the PCBs. PHCs were detected at low concentrations in 4 of the remaining 23 soil samples.

Two volatile organic compounds (bromochloromethane and methylene chloride) were detected at high concentrations (120,000 I $\mu\text{g/L}$ and 510 S,C $\mu\text{g/L}$, respectively) in the ground water sample from MW1-1. Metals (zinc and iron) were present at concentrations similar to those found in the background samples. No other compounds were detected in the ground water sample.

Expanded SI Sampling Episode (January 1989)

Field Sampling Activities. Since significant concentrations of bromochloromethane (BCM), methylene chloride, and PCBs were found in some of the Fast-track samples, the construction of the Avionics building was postponed. Detection of these contaminants prompted initiation of the Expanded SI sampling episode, which was designed to further define the contaminated areas and provide sufficient information to determine whether the site could be quickly remediated so the planned construction efforts could be resumed.

During planning of the Expanded SI program, the ANG Portland Fire Chief was interviewed concerning historical use of fire extinguishers at the Base, since BCM was commonly used for this purpose. It was learned that a number of

Table 6-2

ANALYTICAL RESULTS FOR FAST-TRACK (DECEMBER 1988) SAMPLING EPISODE - SITE 1
 OREGON ANG PORTLAND
 PORTLAND IAP, PORTLAND, OREGON

CLASS AND COMPOUND	GROUND WATER (µg/L)		SOIL BORINGS (mg/kg)						All Other Samples Analyzed
	MW1-1	Detection Limit	SB1-1-1	SB1-5-2	SB1-7-2	SB1-10-1	SB1-12-2		
<u>Volatiles Organics</u>									
Acetone	ND	10	ND C	ND	ND	ND	ND C	≤0.19 U ^a ,C	24
Bromochloromethane	120,000 I	20	ND	ND	ND	ND	ND	ND	24
Methylene Chloride	510 S,C	5	0.013U ^a ,C	0.027U ^a ,C	0.013U ^a ,C	0.055U ^a ,C	0.023U ^a ,C	≤0.072U ^a ,C	24
All other volatiles	ND US,C	5-100	ND C	ND C	ND C	ND C	ND C	ND C	24
<u>Polychlorinated Biphenyls (PCBs)</u>									
Arochlor 1254	ND S	0.5	0.34 S,M	NA	NA	NA	NA	NA	14
All other PCBs	ND US	0.5	ND US	NA	NA	NA	NA	NA	14
<u>Petroleum Hydrocarbons</u>									
C ₁₀ - C ₂₈ Alkanes	NA	NA	43 M	11	10	12 M	12	ND	24
<u>Base-Neutral/Acid Organics (BNAs)</u>									
bis(2-ethylhexyl)phthalate	14 B,S	10	NA	NA	NA	NA	NA	NA	NA
Other BNAs	ND	10-50	NA	NA	NA	NA	NA	NA	NA
<u>Metals and Inorganics</u>									
Iron	1,200	9.6	NA	NA	NA	NA	NA	NA	NA
Zinc	14	4.1	NA	NA	NA	NA	NA	NA	NA
Cd, Cr, Pb, Ni	ND	0.3-26	NA	NA	NA	NA	NA	NA	NA

* Compound is a common laboratory contaminant and was detected at a concentration close to the detection limit. Based on customary data validation guidelines for common laboratory contaminants, the concentration in the environmental sample is considered to be not significant. The value shown is the concentration reported by the laboratory for the environmental sample.

• Compound was detected in an associated QA/QC blank. Based on data validation criteria (Section 8.0), the concentration in the environmental sample is considered to be not significant. The value shown is the concentration reported by the laboratory for the environmental sample.

• Except for SB1-1-1 which had 22 mg/kg detection limit, and SB1-3-1 which had a detection limit of 21 mg/kg.

ND Not detected (below detection limit).
 NA Not analyzed.
 N/A Not applicable.

Table 6-2 (cont'd)

ANALYTICAL RESULTS FOR FAST-TRACK (DECEMBER 1988) SAMPLING EPISODE - SITE 1
OREGON ANG PORTLAND
PORTLAND IAP, PORTLAND, OREGON

DATA FLAGS ARE DEFINED AS FOLLOWS:

- A = analysis by method of standard additions.
- B = analyte was detected in the associated method blank.
- C = SPCC or CCC results were outside the Relative Response Factor (RRF) or Percent Difference (2 σ) limits, respectively, per "Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses," February 1, 1988.
- E = reported concentration exceeded the calibration range; dilution was not run.
- HB = analyte was detected in the associated holding blank.
- HT = holding time was exceeded for sample extraction and/or analysis.
- I = estimated concentration due to use of external instead of internal standard.
- J = estimated concentration.
- M = matrix spike/matrix spike duplicate results were outside QC limits, or were very low.
- S = surrogate recoveries were outside QC control limits.
- U = reported as not detected by the laboratory.
- X = analysis data sheet was missing from the lab data report; refer to lab report narrative.

Halonfire extinguishers containing BCM had been stored and decommissioned near Site 1 several years ago. The Fire Chief recalled that a small spill had occurred during decommissioning near the southwest corner of the paved area adjacent to the west side of Building 1131 (see Figure 6-1). While conducting the Expanded SI field work, it was learned from other Base personnel that another spill of fire extinguishing agent had also occurred during decommissioning near monitoring well MW1-1. This second spill occurred during transfer of the agent into drums, and was estimated to have been at least 100 gallons. Methylene chloride is chemically similar to BCM, and hence may be an impurity in the fire extinguishing agent.

The following field activities and objectives were addressed under the Expanded SI program:

- Monitoring well MW1-1 was resampled and analyzed for volatile organics (VOCs) to confirm the presence of BCM and methylene chloride.
- To determine if additional PCB soil contamination existed in the vicinity of boring SB1-1-1, four near-surface soil samples were collected for PCB analysis. Sample locations were on a 10-ft radius from boring SB1-1 (see sample stations SB1E-1 through SB1E-4 in Figure 6-1).
- Soil borings were performed and samples analyzed to determine if additional BCM or methylene chloride contamination existed (see stations SB1E-5 through SB1E-23 in Figure 6-1). Soil samples were taken from locations near the two reported spill areas described above. Soil borings SB1E-10, SB1E-11, and SB1E-15 were located adjacent to and inside the fenced area west of Building 1131 to investigate potential contaminants that may have run-off or seeped through the paved area. The other sample locations were selected to provide soil characterization of the area covered by the footprint and perimeter of the proposed Avionics facility.
- Except for samples SB1E-1 through SB1E-4, each soil and slurry sample was analyzed for BCM, methylene chloride, trichloroethene, and trans-1,2-dichloroethene target compounds using a headspace analytical method employing a field gas chromatograph (GC). These target compounds were chosen since they had been found in the Fast-track samples from Site 1 or the nearby Site 2. Selected samples, totaling approximately 10 percent of all samples collected, were split and sent to the offsite laboratory for confirmatory VOC and BCM analysis.

- Soil samples were collected from various depths (see Table 6-3). Samples were taken below the water table at some of the soil stations. These samples consisted of a soil-water slurry, and were selected to assess possible contamination of soils below the water table (i.e., due to migration of BCM in ground water).
- An additional monitoring well (MW1-2) was installed near the site to ascertain whether a potential source of BCM contamination is located away from Site 1 (see well location in Figure 6-1). The ground water was sampled for VOC and BCM analysis by the offsite laboratory. Based on ground water level measurements available at the time, this well was installed in the apparent upgradient direction from MW1-1 (see Figure 5-3). However, subsequent ground water table elevation measurements suggest that well MW1-2 is probably not upgradient from MW1-1. Five soil/slurry samples were collected during the drilling using a split-spoon sampler.
- All offsite laboratory analyses were performed using EPA SW 846 methods (Method No. 8080 for PCBs and Method No. 8240 for VOCs). BCM was included as a target compound for all of the VOC analyses.

Expanded SI Episode Results. Table 6-4 presents the analytical results for the soil/slurry samples analyzed by the field GC headspace techniques. Bromochloromethane was detected in eight of the 53 samples analyzed, at concentrations ranging from 56 to 12,000 $\mu\text{g}/\text{kg}$. Methylene chloride was detected in three of the samples, at concentrations ranging from 35 to 110 $\mu\text{g}/\text{kg}$. Trichloroethene and 1,2-dichloroethene were not detected in any of the samples. Some non-target peaks were noted during the analyses, but these were estimated as having concentrations of 100 $\mu\text{g}/\text{kg}$ or less (see Appendix E).

In agreement with measurements by the field GC headspace technique, the offsite laboratory VOC analyses (Table 6-5) confirmed the absence of volatile organic compounds in soil samples SB1E-16-2, SB1E-17-2, SB1E-21-2, and SMW1E-2-5. For soil sample SB1E-11-1, however, the offsite laboratory analysis detected no VOCs, whereas the field GC headspace technique found 250 $\mu\text{g}/\text{kg}$ BCM in that sample. The field GC analyst reported that he suspected cross-contamination may have occurred between sample SB1E-14-2 (which had a high concentration of BCM) and four other samples (SB1E-11-1, SB1E-11-2, SB1E-15-1, and SB1E-15-2). Cross-contamination was suspected because these four samples were all analyzed in the same batch, had been stored together with sample SB1E-14-2 in a cooler overnight prior to analysis, and each of the four suspected samples had similar analytical results.

Table 6-3

SOIL/SLURRY SAMPLE DEPTHS - SITE 1
[EXPANDED SI EPISODE - JANUARY 1989]
OREGON AND PORTLAND
PORTLAND IAP, PORTLAND, OREGON

Sample ID (SB1E-):	Depth of Collection, ft	Below Water Table
1-1 through 4-1	1	No
5-1	1	No
5-2	5	Yes
6-1	4	Yes
6-2	4	Yes
7-1	1	No
7-2	5	Yes
8-1	1	No
8-2	5	Yes
9-1	1	No
9-2	5	Yes
9-3	7	Yes
10-1	4	Yes
10-2	6	Yes
11-1	4	Yes
11-2	6	Yes
12-1	1	No
12-2	5	Yes
12-3	7	Yes
13-1	1	No
13-2	5	Yes
14-1	1	No
14-2	5	Yes
15-1	3	No
15-2	5	Yes
16-1	1	No
16-2	5	No
16-3	7	Yes
17-1	1	No
17-2	5	No
17-3	7	Yes
18-1	1	No
18-2	5	No
18-3	7	Yes
19-1	1	No
19-2	5	No
19-3	7	Yes
20-1	1	No
20-2	5	No
20-3	7	yes
21-1	1	No
21-2	5	No
22-1	1	Yes
22-2	5	No
22-3	7	Yes
23-1	1	No
23-2	5	No
23-3	7	Yes

NOTE: Six soil/slurry samples were taken at 3 ft intervals during drilling of monitoring well MW1-2 (samples SMW1E-2-1 through SMW1E-2-6).

Table 6-4

ANALYTICAL RESULTS FOR EXPANDED SI (JANUARY 1989) SAMPLING EPISODE - SITE 1
[Field GC Headspace Analyses]
OREGON AND PORTLAND
PORTLAND IAP, PORTLAND, OREGON

Sample ID	CONCENTRATION IN SOIL OR SLURRY SAMPLE (ug/kg)			
	MeCl ₂	1,2-DCE	BCM	TCE
SB1E-11-1*	<10	<10	250 ^a	<10
SB1E-11-2*	<10	<10	200 ^a	<10
SB1E-14-2*	99	<10	12,000	<10
SB1E-15-1	<10	<10	340 ^a	<10
SB1E-15-2*	<10	<10	380 ^a	<10
SB1E-18-1	<10	<10	190	<10
SB1E-19-3*	<10	<10	56	<10
SB1E-20-3*	110	<10	1,900	<10
SB1F-23-1	35	<10	<20	<10
All Other Samples (44 additional) ^b	<10	<10	<20	<10

1,2-DCE = 1,2-Dichloroethene, detection limit = 10 ug/kg
BCM = Bromochloromethane, detection limit = 20 ug/kg
TCE = Trichloroethene, detection limit = 10 ug/kg
MeCl₂ = Methylene Chloride, detection limit = 10 ug/kg

* Sample taken from below the water table (i.e., sample was a slurry).

^a Reported concentrations appear to be representative of cross contamination (see text for explanation).

^b All samples shown in Table 6.3 were analyzed by the field GC headspace technique except for samples SB1E-1-1 through SB1E-1-4.

Table 6-5

ANALYTICAL RESULTS FOR EXPANDED SI (JANUARY 1989) SAMPLING EPISODE - SITE 1
[Offsite Laboratory Analyses]
OREGON AND PORTLAND
PORTLAND IAP, PORTLAND, OREGON

CLASS AND COMPOUND =====	GROUND WATER (µg/L) =====			SOIL BORINGS (mg/kg) =====		
	Detection Limit	(Resample) MW1E-1	MW1E-2	Samples Analyzed	All Samples	Detection Limit
<u>Volatile Organics</u>						
Bromochloromethane	10	140,000 I ^a	ND	5	ND	0.014-0.015
Methylene Chloride	5	1,500 S	ND	5	≤0.079U ^b	0.007-0.008
All other volatiles	5-100	ND US,C	ND C	5	ND US,C	0.007-0.015
<u>Polychlorinated biphenyls (PCBs)</u>						
Arochlor 1254	NA	NA	NA	4	ND	0.21-0.23
All other PCBs	NA	NA	NA	4	ND	0.21-0.23

^a See Table 6-2 for a list of data qualifiers and their meanings.

^b Compound is a common laboratory contaminant and was detected at a concentration close to the detection limit. Based on customary data validation guidelines for common laboratory contaminants, the concentration in the environmental sample is considered to be not significant. The value shown is the concentration reported by the laboratory for the environmental sample.

ND = Not detected (below detection limits)

NA = Not analyzed

Note: The above results were performed by offsite laboratory. The following soil borings were analyzed for purgeable halocarbons and aromatics: SMW1E-2-5, SB1E-11-1, SB1E-16-2, SB1E-17-2, and SB1E-21-2. The following soil borings were analyzed for PCBs: SB1E-1-1, SB1E-2-1, SB1E-3-1, SB1E-4-1.

for BCM. The suspicion of cross-contamination was not discovered until after the drilling rig had left the field, so additional sampling at these boring locations was not practical (hand augering could not be used in these locations due to difficulties such as presence of gravel). The field GC laboratory QA/QC runs associated with this batch did not reveal any problems with the BCM analytical data for the suspected samples. The cause of the cross-contamination, if it occurred, is uncertain. However, since the confirmatory sample SB1E-11-1 sent for offsite laboratory analysis showed the absence of VOCs, the values of contaminants reported in Table 6-4 for the four suspected samples are in question. It is clear, though, that contaminant concentrations in the four suspected samples were no greater than the values given in Table 6-4. Cross-contamination was not suspected for any of the other samples analyzed by the field GC laboratory.

Four soil samples (SB1E-1 through SB1E-4) were collected to further define the extent of PCB contamination in the vicinity of Fast-track sample SB1-1-1 (where Arochlor 1254 was detected). PCBs were not detected in any of the four samples (Table 6-5).

Resampling of monitoring well MW1-1 confirmed BCM and methylene chloride to be present at concentrations of 140,000 I $\mu\text{g/L}$ and 1,500 S $\mu\text{g/L}$, respectively (Table 6-5). These results are similar to those obtained for the earlier Fast-track sample (Table 6-2).

No volatile organic compounds (including BCM) were detected in the ground water sampled from MW1-2 (Table 6-5). The five soil/slurry samples taken during the boring of MW1-2 also had no detectable volatile organic compounds or BCM as analyzed by the field GC headspace technique and confirmed for sample SMW1E-2-5 by the offsite laboratory VOC analysis.

Summary of Findings and Extent of Contamination at Site 1

Ground Water Findings - The Fast-track program revealed the ground water at the site to have significant concentrations of bromochloromethane (BCM) and methylene chloride at monitoring well MW1-1 (>100,000 I $\mu\text{g/L}$ BCM, >500 S,C $\mu\text{g/L}$ methylene

chloride). Resampling MW1-1 in the Expanded SI episode confirmed these high concentrations. Additional sampling of the saturated soils (i.e., below the water table) in the Expanded SI revealed significant concentrations of these compounds (e.g., 12,000 $\mu\text{g}/\text{kg}$ BCM, 99 $\mu\text{g}/\text{kg}$ methylene chloride) in ground water at a second location (sample SB1E-14-2 at the southwest corner of the paved/fenced area west of Building 1131). Both this location and MW1-1 are close to areas where ANG personnel have recalled spills of Halon fire extinguisher chemical (BCM) to have occurred in recent years. Methylene chloride is very similar to BCM in chemical structure and was likely an impurity in the Halon product. Lower concentrations of these compounds were found in the Expanded SI in saturated soils just south and northwest of MW1-1 (<2000 $\mu\text{g}/\text{kg}$ in SB1E-19 and SB1E-20). Low concentrations of BCM may also be present in the vicinity of the paved/fenced area (<400 $\mu\text{g}/\text{kg}$ in borings SB1E-11 and SB1E-15).

Analysis of ground water and soil samples from monitoring well MW1-2 showed the absence of volatile organics including BCM and methylene chloride. These results provide evidence that ground water contamination present at Site 1 is apparently not due to an offsite source and is more likely attributable to isolated spills which have occurred at the site. This conclusion is supported by the absence of BCM in the saturated soil samples taken from borings surrounding but not immediately adjacent to MW1-1 (i.e., SB1E-5, SB1E-6, SB1E-7, SB1E-12, SB1E-16, and SB1E-18). However, MW1-1 is not immediately upgradient of known areas of ground water contamination, and additional monitoring wells and ground water data are needed to define the extent of contamination.

The full extent of ground water contamination has not been defined at Site 1. In addition to the high concentrations of BCM and methylene chloride found in well MW1-1, saturated soils near the southwest corner of the paved/fenced area adjacent to Building 1131 were also found to contain these compounds. Saturated soils along the west side of the paved/fenced area may also be contaminated with BCM. Insufficient data were obtained for assessment of the vertical extent of the ground water contaminants.

Soil Findings - A major objective of the Expanded SI program was to determine whether significant contamination is present in the unsaturated soils at the

site, including areas to be impacted by the proposed Avionics building. In the Fast-track program, PCBs had been found at low concentration (<1 SM mg/kg) in only one surface sample among 12 boring stations spaced across the site. Four additional samples taken near this station contained no PCBs, indicating that the contamination is likely an isolated spill of limited extent.

The VOC results obtained for unsaturated soil samples showed that relatively low concentrations of BCM and methylene chloride (i.e., ≤ 0.34 mg/kg) are present in soils near monitoring well MW1-1 and perhaps in the vicinity of the paved/fenced area west of Building 1131. Volatile organic compounds were not detected in any of the other unsaturated soil samples, which were taken at about 40-50 ft intervals over the site. As found for the ground water, these results appear indicative of residual unsaturated soil contamination associated with two known spill areas.

The extent of PCB contamination in the unsaturated soils at this site appears to be limited to a relatively small area near SB1-1. For VOCs, contamination appears limited to the immediate vicinity of MW1-1 and perhaps a second area within the paved/fenced area west of Building 1131. These areas are both associated with prior known spill events of BCM. A total of nine soil borings were performed within a 30 ft radius of MW1-1, with BCM not being detected in any of the unsaturated soil samples except SB1E-18-1.

6.3.2 Site 2 - Civil Engineering Hazardous Material Storage Area

Field Sampling Activities

Site 2 is defined by the location of a former solvent storage shed (Building 1123). The shed had open walls for ventilation and a gravel floor. Methyl ethyl ketone was stored in or near the shed in drums and previous investigations have reported drum leakage and discolored gravel in the storage area. In order to assess potential contamination from spills, leaks, or disposal of hazardous waste constituents which may have occurred in the past, samples were collected for analysis from eight soil gas stations, two ground water monitoring wells, and four soil stations near the former shed location. Samples were taken from two

depths at each soil station. The sample station locations are shown in Figure 6-2. The sampling and analytical schedule is given in Table 6-6.

A portion of the work at Site 2 was performed during the Fast-track sampling episode, because the road construction was planned in 1989 adjacent to Site 2.

The Fast-track (December 1988) work included all of the soil samples and one monitoring well (MW2-1) located close to the site. The soil gas survey was not conducted during the Fast-track episode because poor results were expected during winter conditions (i.e., interference from moisture during the rainy season). The soil gas survey and the second well (MW2-2) were completed during the August 1989 sampling program.

The rationale for the sampling and analysis program consisted of the following:

- The soil gas survey was performed as a means to locate potential volatile hydrocarbon contamination of the soils or underlying ground water and to identify lateral extent. The survey technique was used to help to find potential contamination since the former storage area no longer exists and the location of former spillage is presently uncertain (see Section 4.2 discussion). Since site history involved potential spillage of solvents and thinners, the soil gas analysis included the following common aromatic and halogenated hydrocarbons:

methylene chloride	total hydrocarbons (screen)
bromochloromethane	methyl ethyl ketone
trans-1,2-dichloroethene	benzene
trichloroethene	toluene
carbon tetrachloride	xylenes

- Analyze the soil and ground water samples for purgeable halocarbons and purgeable aromatics (volatile organics) to check for the presence of any solvents or thinners which may have been stored and spilled at the site.
- Further characterize the ground water by analysis for petroleum hydrocarbons and five common metals (which might be present due to use of paint in the area). Analysis for a wider range of contaminants in the ground water than in the soil samples was done in order to allow a conclusion of negative impact if no contaminants were found, and to allow comparison with ground water quality in other nearby monitoring wells.

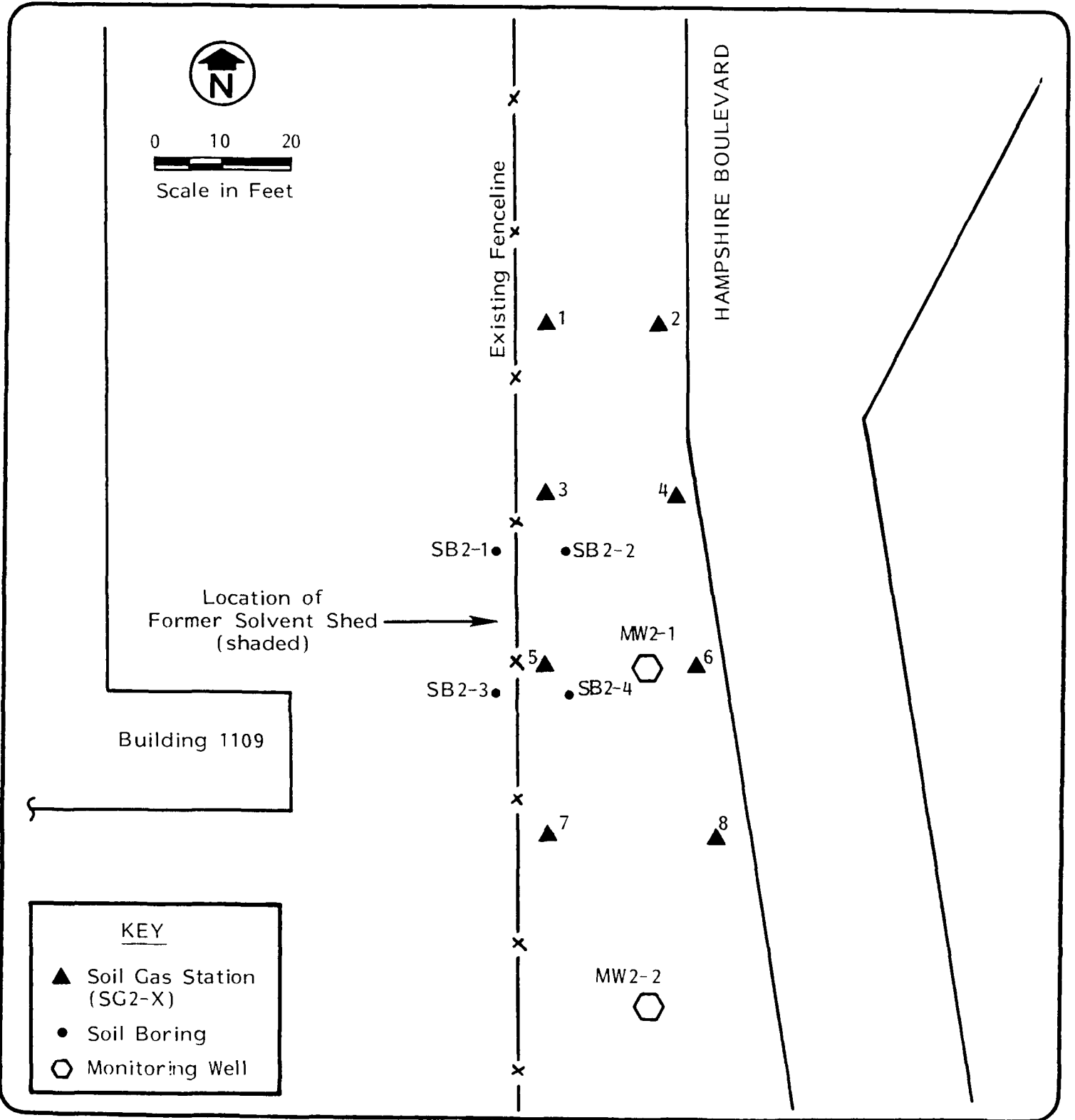


Figure 6-2

SITE 2: CIVIL ENGINEERING HAZARDOUS MATERIAL
STORAGE AREA SAMPLING LOCATIONS
ANG PORTLAND, PORTLAND IAP, PORTLAND, OREGON

Table 6-6

SUMMARY OF ENVIRONMENTAL SAMPLING ACTIVITIES AT SITE 2
[CIVIL ENGINEERING HAZARDOUS MATERIALS STORAGE AREA]
OREGON AND PORTLAND
PORTLAND IAP, PORTLAND, OREGON

<u>Matrix/Analysis</u>	<u>Analytical Method</u>	<u>Depth Collected (ft)</u>	<u>Sampling Method</u>	<u>No. of Field Samples</u>
<u>Soils/Sediments</u>				
Volatile Organics	SW5030/8240	3, 5-6	HA	8
Percent Moisture	E160.3	3, 5-6	HA	8
<u>Ground Water</u>				
Volatile Organics	SW5030/8240	--	B	2
Petroleum Hydrocarbons (C ₁₀ -C ₂₄ alkanes)	ASTM D3328	--	B	2
<u>Metals:</u>				
Cadmium	SW3020/7131	--	B	2
Chromium	SW3010/6010	--	B	2
Lead	SW3020/7421	--	B	2
Nickel	SW3010/6010	--	B	2
Zinc	SW3010/6010	--	B	2
pH	E150.1/Fld.*	--	B	2
Temperature	E170.1/Fld.*	--	B	2
Specific Conductance	E120.1/Fld.*	--	B	2

ASTM = American Society for Testing and Materials Methods.
SW = SW 846 Methods (EPA, 1986).
E = EPA Drinking Water Methods (EPA, 1983).
HA = Hand Auger
B = Bailer
* Field Measurement

- Since the surface soils had been disturbed by recent road and sewer construction and soil sampling activity at this site, soil samples were collected from each boring at depths of 3 feet and 5-6 feet (rather than immediately near the surface).
- Monitoring well MW2-1 was installed during the Fast-track program close to the center of the former storage shed in order to check the most likely spot for possible ground water contamination. The second monitoring well (MW2-2) was planned to help define plume extent if contaminants were detected in the Fast-track program. The results of the soil gas survey were used in locating MW2-2.

Findings and Extent of Contamination at Site 2

Trichloroethene (TCE) was detected in all eight of the soil gas survey stations, as shown in Figure 6-3. None of the other nine target compounds were detected in the soil gas analyses. The soil gas chemist noted a large non-target peak during the GC runs, which he tentatively identified as tetrachloroethene (also known as perchloroethene, or PCE). Smaller non-target peaks were also observed, with tentative identification as chloroform and 1,1,1-trichloroethane (TCA). Total hydrocarbons were also detected, as determined by screening with a flame ionization detector (see Appendix D for these data).

Sampling and analysis of two monitoring wells confirmed the presence of TCE in the ground water (see Table 6-7). TCE was found in high concentrations in ground water samples from both MW2-1 and MW2-2 (up to 710 $\mu\text{g/L}$). Dichloroethenes (DCEs) were also detected in both samples; this is not unexpected since trans-1,2-dichloroethene is often associated with TCE in environmental samples. Cadmium, lead, and zinc were detected in the ground water samples, but at low concentrations close to the detection limits or near concentrations found for the background location (see Table 6-19).

No volatile organic compounds (VOCs) were detected in any of the eight soil samples analyzed during the Fast-track episode (Table 6-7). These samples were taken at the location of the former solvent shed. The soil gas survey also found relatively lower concentrations of TCE in the soil gas samples in this area. Soil samples were not collected from the areas with the highest soil gas TCE concentrations because all the soil sampling planned for the SI program had been performed during the Fast-track episode prior to conducting the soil gas survey.

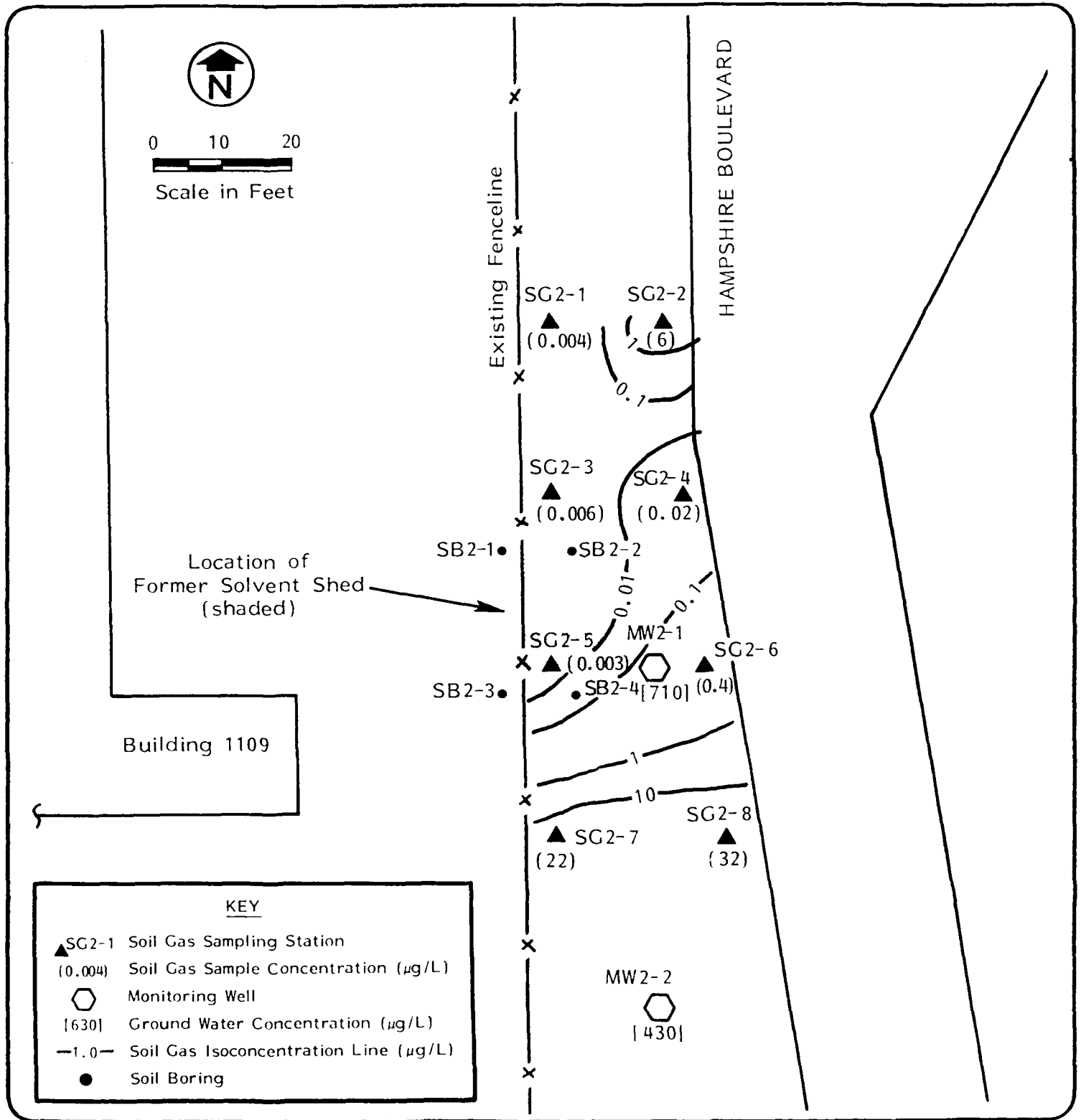


Figure 6-3

SITE 2: CIVIL ENGINEERING HAZARDOUS MATERIAL STORAGE AREA
 TCE CONCENTRATIONS AND SOIL GAS CONTOURS
 ANG PORTLAND, PORTLAND IAP, PORTLAND, OREGON

Table 6-7
ANALYTICAL RESULTS FOR SITE 2
[CIVIL ENGINEERING HAZARDOUS MATERIAL STORAGE AREA]
OREGON AND PORTLAND
PORTLAND IAP, PORTLAND, OREGON

CLASS AND COMPOUND =====	GROUND WATER (µg/L) =====			SOIL BORINGS (mg/kg) =====		
	Detection Limit	MW2-1	MW2-2-1	Samples Analyzed	All Samples	Detection Limit
<u>Volatile Organics</u>			HT ^a			
Trichloroethene	5	710	430	8	ND	0.007
1,2-dichloroethenes	5	130 C	28	8	ND	0.007
Methylene chloride	5	ND	ND	8	≤0.011U ^{b,c}	0.007
All other volatiles	5-100	ND C	ND C	8	ND C	0.007-0.14
<u>Petroleum Hydrocarbons</u>						
C ₁₀ - C ₂₄ Alkanes	13-50	ND	ND	NA	NA	NA
<u>Metals and Inorganics</u>						
Cadmium	0.1-0.3	0.44	0.36U ^c	NA	NA	NA
Lead	1.1	ND	3.7A	NA	NA	NA
Cr, Ni	6-26	ND	ND	NA	NA	NA
Zinc	4-6	10	16U ^c	NA	NA	NA

^a Holding time (HT) was exceeded for water samples MW2-2-1 and D-8 (MW2-2-1 Replicate).

^b Compound is a common laboratory contaminant and was detected at a concentration close to the detection limit. Based on customary data validation guidelines for common laboratory contaminants, the concentration in the environmental sample is considered to be not significant. The value shown is the concentration reported by the laboratory for the environmental sample.

^c Compound was detected in an associated QA/QC blank. Based on data validation criteria (Section 8.0), the concentration in the environmental sample is considered to be not significant. The value shown is the concentration reported by the laboratory for the environmental sample.

ND Not detected (below detection limit).

NA Not analyzed.

NR Not reported.

See Table 6-2 for a list of data qualifiers and their meanings.

The extent of contamination has not been fully defined at Site 2. The distribution of TCE in soil gas is presented in Figure 6-3, with inferred contours indicated. Concentrations of TCE were highest at north and south edges of the survey zone (i.e., sampling locations SG2-2, SG2-7 and SG2-8), suggesting that contamination at the site is not localized to one area. The soil gas probes were driven to within one or two feet of ground water; hence soil gas concentrations are likely related to ground water contamination. Equally high TCE and DCE concentrations were detected in both monitoring wells, which are spaced about 50 ft apart. The soil gas and ground water data indicate there may be a contaminant plume more than 100 ft in extent (from MW2-2 to SG2-2).

Although VOCs were not found in any of the soil samples, the soil gas survey and ground water data indicate that the soil samples may not have been taken from the areas of the site with the most contamination. The soil data are insufficient to determine whether areas of soil contamination exist which may serve as sources for the ground water plume.

6.3.3 Site 3 - Hush House Area

Field Sampling Activities

Waste oils and fuels may have contaminated Site 3 soils due to spills, rainwater runoff, and washdown which may have occurred from the Hush House facility. The unpaved surface at the southwest corner of the Hush House apron was formerly used for drum storage (there are no records of contents, but stored material was likely to include waste oils, fuels, or solvents).

The potential for contamination at this site was assessed by collection and analysis of samples from one shallow monitoring well and four soil boring locations. The soil samples were collected from two horizons in each boring for a total of eight samples. All Site 3 field work was conducted during the Fast-track sampling episode (December 1988). The work was fast-tracked in order to avoid scheduling delays for demolition of the Hush House and construction of new facilities at the site, which had been planned for 1989.

The sample locations are indicated in Figure 6-4. Details of the sampling and analyses program are listed in Table 6-8. The sampling and analytical rationale included:

- All four soil borings were performed within the site boundaries as defined in the Preliminary Assessment Report. This area is adjacent to the Hush House concrete pad, where washdown and runoff of petroleum products from the pad would most likely cause soil contamination. Samples were taken from each boring near the surface and at depth to test for vertical extent of any soil contamination.
- Shallow monitoring well MW3-1 was installed as close to the site as possible to provide confirmation or denial of ground water contamination at the area most likely to have been impacted. The well was installed between the pad and the adjacent ditch, in the apparent downgradient direction based on topographical features.
- Since the suspected contamination is petroleum-based, soils and ground water samples were analyzed for total petroleum hydrocarbons (alkanes) and purgeable aromatics (e.g., benzene, toluene, ethylbenzene, and xylenes, or BTEX). Since solvents may have been present, samples were also checked for purgeable halocarbons (VOC analysis).

Four soil samples obtained from a depth of 1 ft were collected using a hand auger. At 3 ft depth, a layer of cobble-sized gravel was encountered that could not be penetrated by hand auger. Therefore, a hollow stem auger drilling rig was used to reach a depth of approximately 6 ft. A hand auger was used to complete the remaining footage in each boring and collect the four deeper samples.

Findings and Extent of Contamination at Site 3

The results of the Site 3 analyses are presented in Table 6-9. No contaminants were detected in the ground water sample. With the exception of methylene chloride, no purgeable organic compounds were found in any of the eight soil samples. Petroleum hydrocarbons (PHCs) were reported in only one of the soil samples. The reported methylene chloride and PHC concentrations are not considered significant in comparison with concentrations of both these analytes which were detected in associated QA/QC blanks (see Section 8.0).

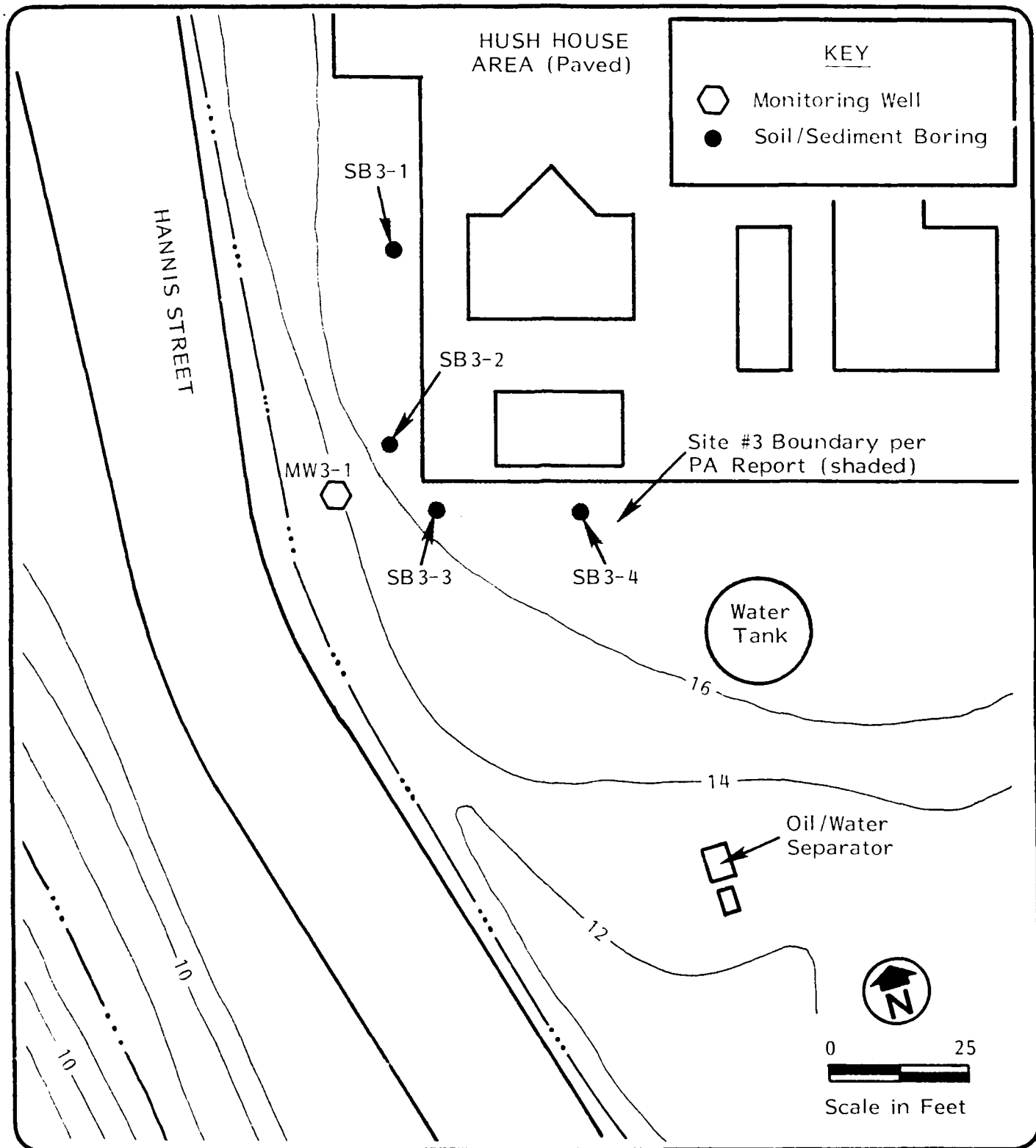


Figure 6-4

SITE 3: HUSH HOUSE AREA SAMPLING LOCATIONS
ANG PORTLAND, PORTLAND IAP, PORTLAND, OREGON

Table 6-8

SUMMARY OF ENVIRONMENTAL SAMPLING ACTIVITIES AT SITE 3 [HUSH HOUSE AREA]
OREGON ANG PORTLAND
PORTLAND IAP, PORTLAND, OREGON

<u>Matrix/Analysis</u>	<u>Analytical Method</u>	<u>Depth Collected (ft)</u>	<u>Sampling Method</u>	<u>No. of Field Samples</u>
<u>Soils/Sediments</u>				
Volatile Organics	SW5030/8240	1, 7-8	HA	8
Petroleum Hydrocarbons (C ₁₀ - C ₂₄ alkanes)	ASTM D3328	1, 7-8	HA	8
Percent Moisture	E160.3	1, 7-8	HA	8
<u>Ground Water</u>				
Volatile Organics	SW5030/8240	--	B	1
Petroleum Hydrocarbons (C ₁₀ - C ₂₄ alkanes)	ASTM D3328	--	B	1
pH	E150.1/Fld.*	--	B	1
Temperature	E170.1/Fld.*	--	B	1
Specific Conductance	E120.1/Fld.*	--	B	1

ASTM = American Society for Testing and Materials Methods.
SW = SW 846 Methods (EPA, 1986).
E = EPA Drinking Water Methods (EPA, 1983).
HA = Hand Auger
B = Bailer
* Field Measurement

These results show that contaminants expected at Site 3 based on past history are not present in the media sampled. The absence of significant PHC or BTEX contamination in soil or ground water indicates that past usage or storage of petroleum products or wastes at the site have led to no apparent impacts in the area of investigation.

6.3.4 Site 4 - Main Drainage Ditch

Field Sampling Activities

The main drainage ditch was suspected to have been impacted by miscellaneous wastes due to runway spillage and any other contamination which may have occurred elsewhere on the ANG facility as directed to the ditch via the storm drainage system and sewers, or which may have migrated from the ditch via shallow ground water from nearby sites (e.g., Site 1 or Site 3). Potential contamination was assessed at this site by collecting surficial soil/sediment samples within the drainage ditch at seven locations depicted in Figure 6-5. The samples were analyzed as shown in Table 6-10, according to the following rationale:

- Particulate-bound contaminants or those with affinity for adsorption in sediments are likely to be concentrated immediately downstream of tributary side channels and storm sewer outfalls. In order to maximize the probability of finding contaminants, most of the sediment samples were taken several feet downstream of sewer discharge pipes. These locations were also designed to allow interpretation of which branches of the drainage system have contributed to any detected contamination.
- Sample stations were confined to portions of the main drainage ditch located within the present ANG boundary (see Figure 3-1). The ditch extends west of the boundary line on land controlled by the Port of Portland.
- The samples were analyzed for petroleum hydrocarbons and VOCs in order to check for contaminant residues from possible releases of petroleum-based liquids (fuels, oils, solvents). Analysis for five common metals was also performed as indicators of potential contamination from petroleum-based materials or other possible releases of wastes such as discussed for the other IRP sites.

Table 6-9

ANALYTICAL RESULTS FOR SITE 3 [HUSH HOUSE AREA]
 OREGON ANG PORTLAND
 PORTLAND IAP, PORTLAND, OREGON

CLASS AND COMPOUND	GROUND WATER (µg/L)		SOIL BORINGS (mg/kg)			
	MW3-1	Detection Limit	SB3-1-2	SB3-3-2	SB3-4-2	All Other Samples Analyzed
<u>Volatile Organics</u>						
Methylene Chloride	ND	5	ND C	0.026U,C	0.017U,C	ND C 8
Benzene	ND	5	ND	ND	ND	ND 8
Ethylbenzene	ND	5	ND	ND	ND	ND 8
Toluene	ND	5	ND	ND	ND	ND 8
Xylenes	ND	5	ND	ND	ND	ND 8
All other volatiles	ND C	5-100	ND C	ND C	ND C	ND C 8
<u>Petroleum Hydrocarbons</u>						
C ₁₀ - C ₂₅ Alkanes	ND	100	2.0U*	ND	ND	ND 8

* Compound was detected in an associated QA/QC blank. Based on data validation criteria (Section 8.0), the concentration in the environmental sample is considered to be not significant. The value shown is the concentration reported by the laboratory for the environmental sample.

ND Not detected (below detection limit).

See Table 6-2 for a list of data qualifiers and their meanings.

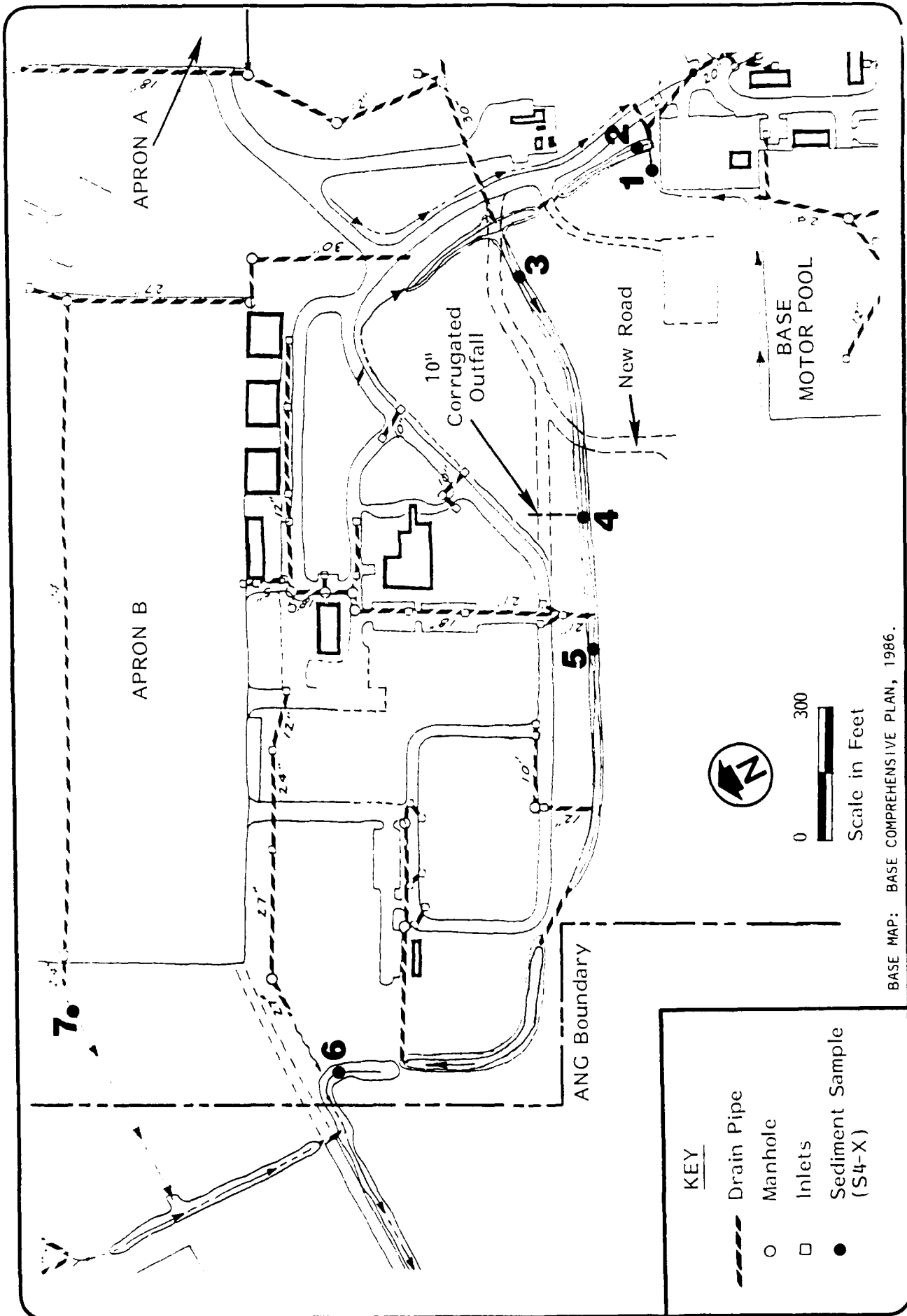


Figure 6-5

SITE 4: MAIN DRAINAGE DITCH SAMPLING LOCATIONS
 ANG PORTLAND, PORTLAND IAP, PORTLAND, OREGON

Table 6-10
SUMMARY OF ENVIRONMENTAL SAMPLING ACTIVITIES AT SITE 4
[MAIN DRAINAGE DITCH]
OREGON ANG PORTLAND
PORTLAND IAP, PORTLAND, OREGON

<u>Matrix/Analysis</u>	<u>Analytical Method</u>	<u>Depth Collected (ft)</u>	<u>Sampling Method</u>	<u>No. of Field Samples</u>
<u>Soils/Sediments</u>				
Volatile Organics	SW5030/8240	surface	HA	7
Petroleum Hydrocarbons (C ₁₀ -C ₂₄ alkanes)	ASTM D3328	surface	HA	7
Metals:				
Cadmium	SW3050/7131	surface	HA	7
Chromium	SW3050/6010	surface	HA	7
Lead	SW3050/7421	surface	HA	7
Nickel	SW3050/6010	surface	HA	7
Zinc	SW3050/6010	surface	HA	7
Percent Moisture	E160.3	surface	HA	7

ASTM = American Society for Testing and Materials Methods.
SW = SW 846 Methods (EPA, 1986).
E = EPA Drinking Water Methods (EPA, 1983).
HA = Hand Auger

Findings and Extent of Contamination at Site 4

As shown in Table 6-11, PHCs were detected in all of the seven sediments sampled. Two of the samples had PHC concentration ≥ 10 HT mg/kg (S4-1 and S4-7). The only reported volatile organic compounds were common laboratory contaminants which were not found in significant concentrations compared with amounts reported in associated QA/QC blanks.

The five metals (cadmium, chromium, lead, nickel, and zinc) were detected in all of the sediment samples. However, chromium and zinc were also detected in the QC blanks associated with some of the samples so the concentration of chromium in S4-4, S4-5 and S4-6, and zinc in S4-4, S4-6 and S4-7 is suspect. The highest metal concentrations were found in samples S4-1 and S4-3. The samples taken further downstream (S4-4, S4-5, and S4-6) had metals concentrations similar to those found in the soil samples from the background location (Table 6-19), except for cadmium and zinc in S4-5.

The extent and nature of contamination in the main drainage ditch is not fully characterized. Significant contamination was found at each of sampling sites except for S4-4 and S4-6. The greatest concentrations of PHCs and metals were found at stations S4-1, S4-3, and S4-7. Lead concentrations, in particular, were also highest for these samples, indicating that contamination could be related to fuel spillage or releases.

Sediment sample S4-1 was collected downstream of a storm water outfall that drained the Base motor pool parking lot (see Figure 6-5). Sample S4-3 was taken downstream of storm sewer outfalls which drained aircraft Aprons A and B, as well as most of the eastern part of the Base. Sample S4-7 was collected near another discharge sewer that drained Apron B. Washdown of spilled fuel and other petroleum products from these paved areas could have contributed to the petroleum hydrocarbon concentrations detected in these samples.

The analytical technique employed for PHCs was designed to quantify the alkanes fraction of hydrocarbons ranging from ten to 24 carbon atoms, in order to provide clear evidence of petroleum contamination. Additional tests would be needed in

Table 6-11
 ANALYTICAL RESULTS FOR SITE 4 [MAIN DRAINAGE DITCH]
 OREGON ANG PORTLAND
 PORTLAND IAP, PORTLAND, OREGON

Soils	Reported Detection Limit	CONCENTRATIONS IN SEDIMENT SAMPLES, mg/kg dry wt basis					S4-7
		S4-1	S4-2	S4-3	S4-4	S4-5	
<u>Volatile Organics</u>							
Acetone	0.013-5.7	ND C ^a	0.26U ^b	0.32U ^b	0.14U ^b	0.26U ^b	ND C
Methylene Chloride	0.006-2.9	ND U ^b	0.008U ^b	0.018U ^b	0.008U ^b	0.011U ^b	ND
Other Volatiles	0.006-5.7	ND C	ND	ND	ND	ND	ND C
<u>Petroleum Hydrocarbons</u>							
C ₁₀ - C ₂₄	0.570-0.920	25.0 S	0.97	6.3	4.6	2.0	0.58
<u>Metals</u>							
Cadmium	0.008-0.013	1.6	0.44	2.9	0.26	0.65	1.1
Chromium, total	2.4-3.7	35	26	28	9.6U ^b	11U ^b	6.4U ^b
Lead	0.042-0.066	41 B	13 B	58 B	7.1 B	6.9 B	4.0 B
Nickel	1.0-1.5	120	24	16	9.3	8.0	5.7
Zinc	5.1-7.7	120	83	330	68U ^b	120	59U ^b

^a See Table 6-2 for a list of data qualifiers and their meanings.

^b Compound was detected in an associated QA/QC blank. Based on data validation criteria (Section 8.0), the concentration in the environmental sample is considered to be not significant. The value shown is the concentration reported by the laboratory for the environmental sample.

ND Not detected (below detection limit).

order to check for the presence of other likely petroleum compounds having environmental significance such as naphthalenes, anthracene, chrysene, and phenanthrene.

6.3.5 Site 5 - AGE Maintenance Shop

Two areas of potential contamination exist at Site 5. As indicated in Figure 6-6, one area lies along the fenceline on the north side of the motor pool near the former location of Building 1224. The other study area involves an excavation pit which remains after removal of a leaking Underground Storage Tank (UST) in late 1988. The sampling program and analytical results for these two areas are discussed separately in the following sections.

The monitoring wells for this site were installed and sampled during the Fast-track episode; this was done mainly to improve triangulation among the Fast-track wells and hence obtain a better preliminary indication of ground water flow direction from the Fast-track level measurements.

Site 5A - Fenceline Area

Field Sampling Activities. Contamination of surface soil was suspected along the motor pool fenceline of Site 5 due to reported and suspected disposal/ spillage of AGE Maintenance Shop wastes in this area, such as spent battery acid, solvents and automotive fluids. To assess potential environmental contamination due to these releases, soil and ground water sampling and analyses were performed as listed in Table 6-12. Sample locations were as illustrated in Figure 6-6. The rationale for the sampling and analysis program was as follows:

- The area of the fence just east of the former Building 1225 location is most suspect due to visual observations of stained surface soil. To test for possible soil contamination, six soil borings were performed along the fenceline, with three of the borings concentrated near the stained area described above. Samples were collected near the surface and at about 3 ft depth in each boring, in order to test for vertical migration of contaminants.
- It had been planned to locate one soil station just north of former Building 1225. However, a pile of debris had been placed in this area from construction activity near the site (see Figure 6-6), so this station was relocated to the fenceline area.

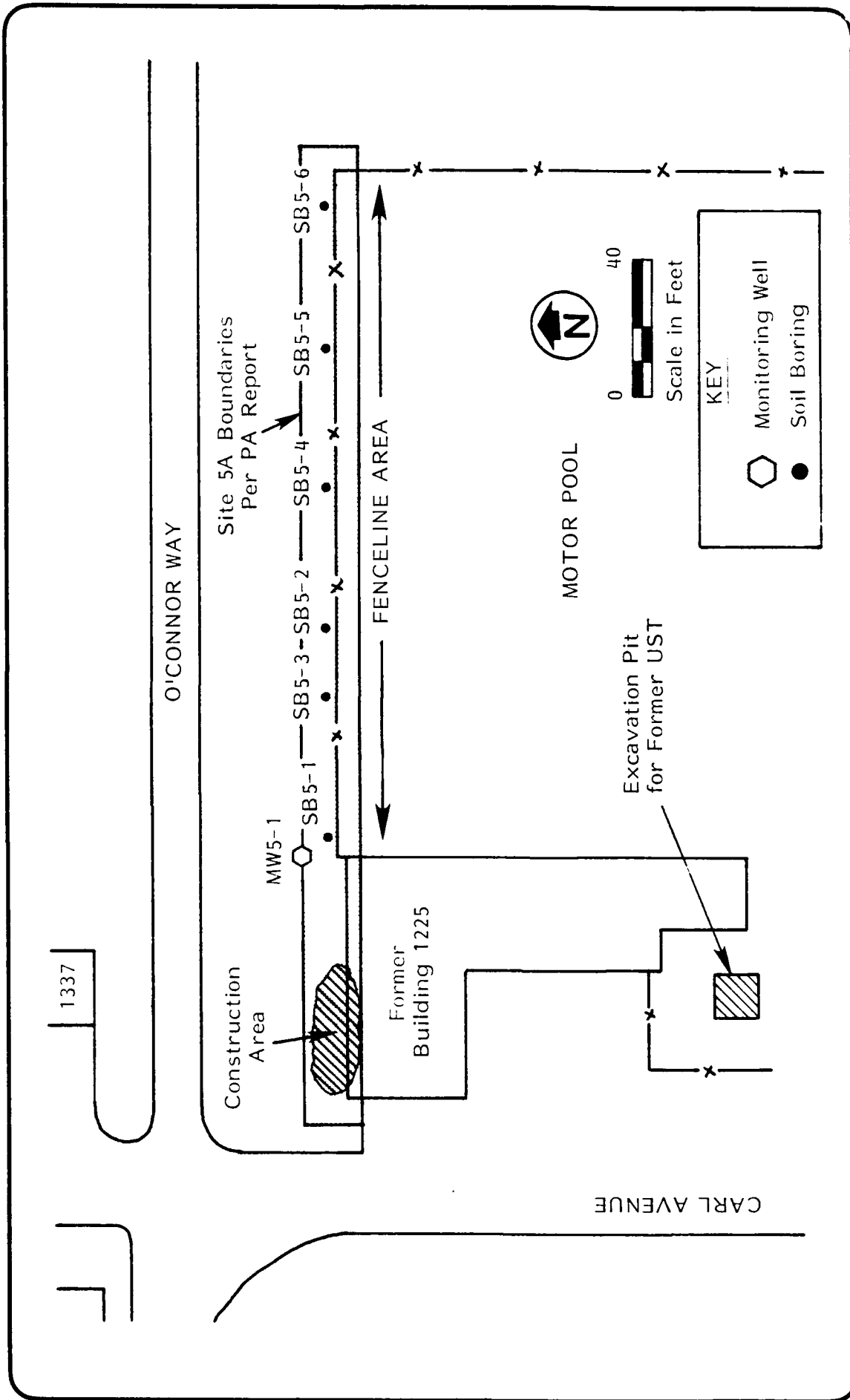


Figure 6-6

SITE 5A: AGE MAINTENANCE SHOP - FENCELINE AREA SAMPLING LOCATIONS
 ANG PORTLAND, PORTLAND IAP, PORTLAND, OREGON

- The soil samples were analyzed for volatile organics and BNAs to check for contamination due to waste oils, solvents, thinners, lubricants, or fuels which may have been disposed. They were also analyzed for lead and five other common metals due to reported drainage of battery acid and possible spillage of other motor pool wastes.
- One shallow monitoring well was installed close to former Building 1225 (the location most likely to be contaminated) to demonstrate whether or not ground water has been impacted.
- The ground water was analyzed for a wide range of potential contaminants since a variety of wastes may have been disposed in the area. Organics analysis included both VOCs and semi-volatiles (SVOCs, or BNAs). Sulfate and lead analyses were performed since lead-acid batteries were drained at the site. Four other common metals were tested for comparison with results from the other monitoring wells; migration of metals may be enhanced at the site as a result of the battery acid drainage. Analysis for iron was included due to the potential acidification of the soils and release of mineral iron.

Findings and Extent of Contamination at Site 5A. The analytical results are shown in Table 6-13. No volatile or semi-volatile organics were reported in the soil samples except common laboratory compounds at insignificant concentrations. Metals (cadmium, chromium, iron, lead, nickel, and zinc) were detected in all 12 soil samples. The detected concentrations for chromium, iron, and nickel were similar to those found in soils at the background location (Table 6-19). Compared with the background results, some of the Site 5A soil samples had elevated concentrations of cadmium (up to 10 times background), lead (up to 5 times background), and zinc (up to 3 times background).

The ground water from well MW5-1 had detectable concentrations of trichloroethene (TCE), cadmium, zinc and sulfate. Except for sulfate, all these results were just slightly greater than the detection limit. The cadmium and zinc concentrations were similar to those found in ground water from the background well (Table 6-19).

The analytical results indicate some contaminants to be present at Site 5A. TCE was measured in shallow ground water at a low concentration (6 $\mu\text{g/L}$). The ground water also has elevated sulfate content (42 mg/L, which is about three times the

Table 6-12

SUMMARY OF ENVIRONMENTAL SAMPLING ACTIVITIES AT SITE 5A
[AGE MAINTENANCE SHOP - FENCELINE AREA]
OREGON ANG PORTLAND
PORTLAND IAP, PORTLAND, OREGON

<u>Matrix/Analysis</u>	<u>Analytical Method</u>	<u>Depth Collected (ft)</u>	<u>Sampling Method</u>	<u>No. of Field Samples</u>
<u>Soils/Sediments</u>				
Volatile Organics	SW5030/8240	1,3	HA	12
Base/Neutral/Acid Extractables	SW3550/8270	1,3	HA	12
Metals:				
Cadmium	SW3050/7131	1,3	HA	12
Chromium	SW3050/6010	1,3	HA	12
Lead	SW3050/7421	1,3	HA	12
Nickel	SW3050/6010	1,3	HA	12
Zinc	SW3050/6010	1,3	HA	12
Percent Moisture	E160.3	1,3	HA	12
<u>Ground Water</u>				
Volatile Organics	SW5030/8240	--	B	1
Base/Neutral/Acid Extractables	SW3520/8270	--	B	1
Inorganics:				
Cadmium	SW3020/7131	--	B	1
Chromium	SW3010/6010	--	B	1
Iron	SW3010/6010	--	B	1
Lead	SW3020/7421	--	B	1
Nickel	SW3010/6010	--	B	1
Zinc	SW3010/6010	--	B	1
Sulfate	SW9038	--	B	1
pH	E150.1/Fld.*	--	B	1
Temperature	E170.1/Fld.*	--	B	1
Specific Conductance	E120.1/Fld.*	--	B	1

ASTM = American Society for Testing and Materials Methods.

SW = SW 846 Methods (EPA, 1986).

E = EPA Drinking Water Methods (EPA, 1983).

HA = Hand Auger

B = Bailer

* Field Measurement

Table 6-13

ANALYTICAL RESULTS FOR SITE 5A [AGE MAINTENANCE SHOP - FENCELINE AREA]
 OREGON AND PORTLAND
 PORTLAND IAP, PORTLAND, OREGON

CLASS AND COMPOUND	GROUND WATER (µg/L)		SOIL BORINGS (mg/kg)					All Other Samples Analyzed		
	MW-1	Detection Limit	SBS-6-1	SBS-2-1	SBS-3-1	SBS-4-1	SBS-5-1			
<u>Volatile Organics</u>										
Acetone	ND	100	0.012-0.014	0.07U*,C	ND C	0.14U*,C	ND C	0.035U*,C	≤0.053U*,C	12
Methylene Chloride	ND	5	0.006-0.007	ND	ND	0.008U*	ND	ND	ND	12
Trichloroethene	6.2	5	0.006-0.007	ND	ND	ND	ND	ND	ND	12
All other volatiles	ND C	5-100	0.006-0.14	ND C	ND C	ND C	ND C	ND C	ND C	12
<u>Base-Neutral/Acid Organics (BNAs)</u>										
bis(2-ethylhexyl)phthalate	98U*	10	0.40-0.46	2.3U*	ND	ND	0.28JU*	ND	≤0.99U*	12
All other BNAs	ND	10-50	0.40-2.2	ND	ND	ND	ND	ND	ND	12
<u>Metals and Inorganics</u>										
Cadmium	0.51	0.3	0.008-0.009	1.4	1.6	0.66	1.9	2.9	≤2.1	12
Chromium, total	ND	12	2.2-2.8	26	30	27	24	24	≤30	12
Iron	ND	9.6	3.3-3.9	28,000	32,000	30,000	29,000	27,000	≤31,000	12
Lead	ND	1.1	0.041-0.058	38 B	34 B	8.6 B	73 B	35 B	≤37 B	12
Nickel	ND	26	0.9-1.1	21	28	23	20	22	≤34	12
Zinc	8	4.1	5.0-5.9	140	160	80U*	110	150	≤130	12
Sulfate	42,000	2,000	NA	NA	NA	NA	NA	NA	NA	NA

* Compound was detected in an associated QA/QC blank. Based on data validation criteria (Section 8.0), the concentration in the environmental sample is considered to be not significant. The value shown is the concentration reported by the laboratory for the environmental sample.

ND Not detected (below detection limit).

See Table 6-2 for a list of data qualifiers and their meanings.

background results). The fenceline area soils contain cadmium, lead, and nickel at slightly elevated concentrations compared with background soils. The presence of sulfate and lead may be due to the drainage of battery acid at the site.

Site 08 - Former Underground Storage Tank (UST) Area

Field Sampling Activities. At least minor leakage of diesel oil (No. 2 heating fuel) is known to have occurred from the former UST located near the motor pool. Ground water and soil samples were collected and analyzed from within and near the excavation pit, as detailed in Table 6-14, in order to provide preliminary data regarding the extent and degree of contamination. The sample locations were as depicted in Figure 6-7.

Sample locations and analyses were selected based on the following:

- Four soil borings were performed to determine the horizontal and vertical extent of soil contamination to aid in remediation of the former UST pit. One boring within the pit and three around its periphery were hand-augered, with samples at two depths in each.
- Peripheral soil samples were taken at a depth about 1 ft below the bottom of the pit to test for horizontal migration and also at 3 ft lower depth to check for vertical movement of oil.
- The soil boring within the pit was sampled at similar elevations as the peripheral samples. These samples served to provide data from the area likely to have the highest contaminant concentrations. The bottom of the pit was dry during the soil sampling episode.
- One shallow monitoring well was installed close to the pit to determine if nearby ground water has been affected. The well was installed and sampled during the December 1988 Fast-track episode in order to obtain an early indication of whether ground water had been impacted by leakage of the former UST.
- All soil and ground water samples were analyzed for purgeable aromatics (VOCs) and petroleum hydrocarbons to test for the presence of organic compounds commonly found in heating oil.

Table 6-14

SUMMARY OF ENVIRONMENTAL SAMPLING ACTIVITIES AT SITE 5B
[AGE MAINTENANCE SHOP - FORMER UST AREA]
OREGON AND PORTLAND
PORTLAND IAP, PORTLAND, OREGON

<u>Matrix/Analysis</u>	<u>Analytical Method</u>	<u>Depth^a Collected (ft)</u>	<u>Sampling Method</u>	<u>No. of Field Samples</u>
<u>Soils/Sediments</u>				
Volatile Organics	SW5030/8240	6, 8-10	HA	8
Petroleum Hydrocarbons (C ₁₀ -C ₂₄ alkanes)	ASTM D3328	6, 8-10	HA	8
Percent Moisture	E160.3	6, 8-10	HA	8
<u>Ground Water</u>				
Volatile Organics	SW5030/8240	--	B	1
Petroleum Hydrocarbons (C ₁₀ -C ₂₄ alkanes)	ASTM D3328	--	B	1
pH	E150.1/Fld.*	--	B	1
Temperature	E170.1/Fld.*	--	B	1
Specific Conductance	E120.1/Fld.*	--	B	1

^a See Figure 6-7 for depths at each boring station.

ASTM = American Society for Testing and Materials Methods.

SW = SW 846 Methods (EPA, 1986).

E = EPA Drinking Water Methods (EPA, 1983).

HA = Hand Auger

B = Bailer

* Field Measurement

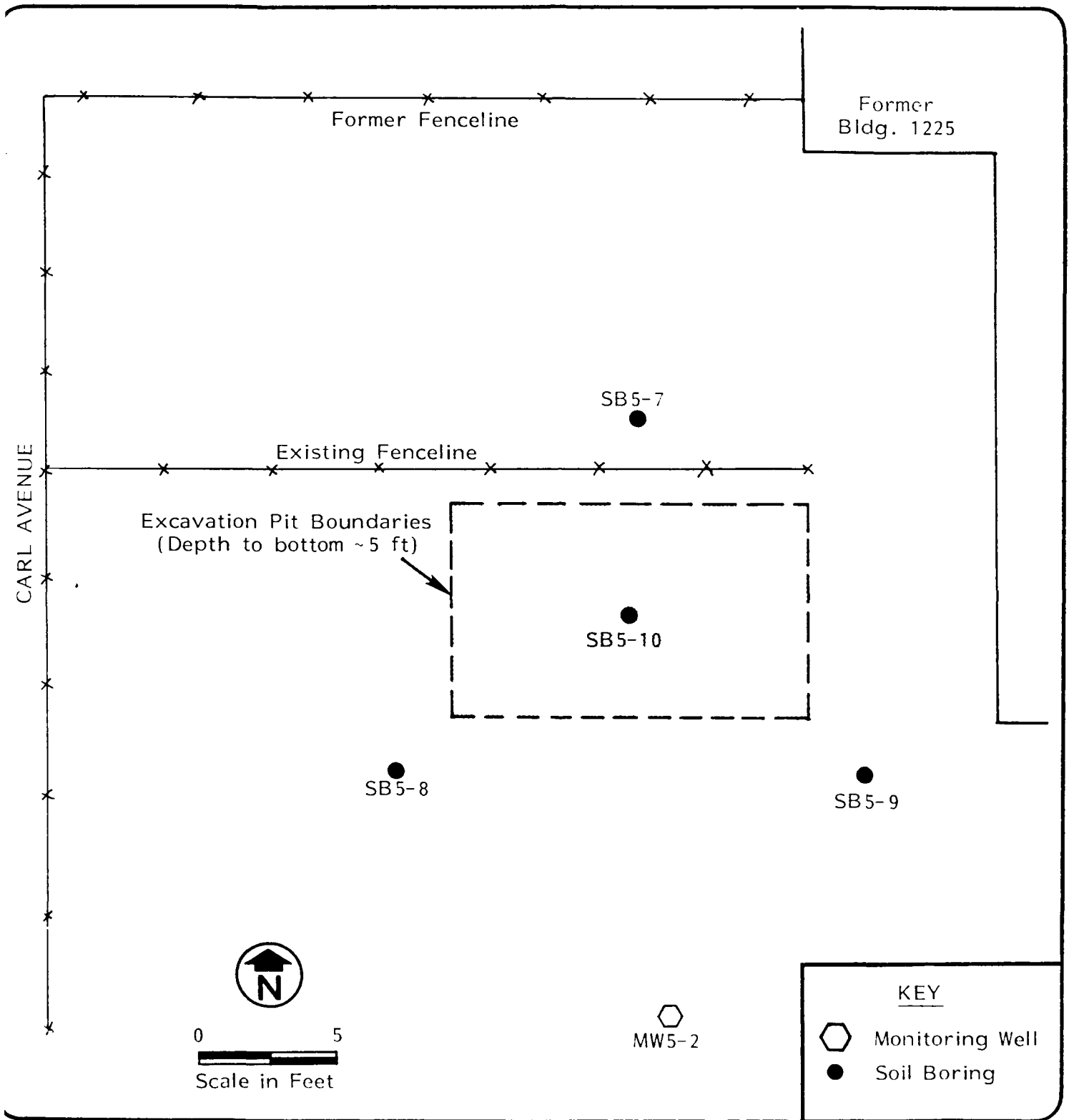


Figure 6-7

SITE 5B: EXCAVATION PIT AND SAMPLE LOCATIONS FOR
FORMER UNDERGROUND STORAGE TANK
ANG PORTLAND, PORTLAND IAP, PORTLAND, OREGON

Findings and Extent of Contamination at Site 5B. Analytical results for the soil samples collected near the former UST pit are shown in Table 6-15. No purgeable aromatics or petroleum hydrocarbons were detected in the ground water sample collected from MW5-2.

PHCs were detected in all the soil borings, except for SB5-9 which was located on the east side of the pit. The highest PHC concentrations (up to 200 S mg/kg) were found in peripheral samples at 6 ft depth from borings on the north and west sides of the pit.

Common fuel components (benzene, ethylbenzene, and xylenes - or BEX) were detected in samples collected from borings SB5-7, SB5-8 and SB5-10. BEX concentrations were greatest in samples collected from the center of the former UST pit (SB5-10), but were also present in borings west and north of the pit.

These results suggest that diesel oil from the former leaking UST has migrated northward and westward from the pit. The fact that soil and ground water immediately south and east of the pit have apparently not been affected. These findings appear consistent with the apparent Base-wide ground water flow direction (northwesterly, see Figure 5-3). PHCs and BEX concentrations were generally higher in samples taken from 6 ft depth than in the deeper samples, suggesting that downward migration may be impeded by the ground water table (depth to ground water was measured at about 7 to 8 ft in MW5-2 during the summer and winter field episodes).

6.3.6 Site 7 - Burn Pit Area

Field Sampling Activities

Site 7 site was used for 21 years to burn several thousand gallons per year of waste fuel, POL (petroleum, oil and lubrication), and solvents. In order to evaluate the presence and approximate horizontal extent of residual fuels and incomplete combustion products at the site, a soil gas survey and soil and ground water sampling was conducted. The soil and ground water sampling program is detailed in Table 6-16, and the sampling locations are presented in Figure 6-8. The sampling and analyses were conducted with the following rationale:

Table 6-15

ANALYTICAL RESULTS FOR SITE 5B [AGE MAINTENANCE SHOP - FORMER UST AREA]
OREGON ANG PORTLAND
PORTLAND IAP, PORTLAND, OREGON

CLASS AND COMPOUND	GROUND WATER (µg/L)		SOIL BORINGS (mg/kg)					All Other Samples Analyzed
	MW5-2	Detection Limit	SBS-7-1	SBS-7-2	SBS-8-1	SBS-10-1	SBS-10-2	
<u>Volatile Organics</u>								
Acetone	ND	100	0.34U ^a , C ^b	0.11U ^a , C	ND C	0.12U ^a , C	0.18U ^a , C	ND C
Methylene Chloride	ND	5	0.058JU ^a	ND	ND	ND	ND	ND
Benzene	ND	5	ND	0.041	ND	0.22	0.069	ND
Ethylbenzene	ND	5	0.033-0.069	0.093	ND	0.86	0.79	ND
Xylenes	ND	5	0.033-0.069	0.087	0.038 C	3.4 E	1.5 E	ND C
All other volatiles	ND C	5-100	0.033-0.14	ND C	ND C	ND C	ND C	ND C
<u>Petroleum Hydrocarbons</u>								
C ₁₀ - C ₄ Alkanes	ND	50	0.59-0.62	36 S	110 S	21 S	15 S	ND
								8

^a Compound was detected in an associated QA/QC blank. Based on data validation criteria (Section 8.0), the concentration in the environmental sample is considered to be not significant. The value shown is the concentration reported by the laboratory for the environmental sample.

^b See Table 6-2 for a list of data qualifiers and their meanings.

ND Not detected (below detection limit).

- The location of the former burn pit is not visually apparent, since gravel has been placed over the area. The center of the former pit was determined based on measurements from aerial photographs (see Figure 4-6) and a survey conducted by ANG Civil Engineering personnel. The survey utilized the centerlines of the nearby runways as reference lines to establish the burn pit centerpoint.
- Because of the uncertainties in liquid fuels disposal practices and completeness of combustion during fire training exercises, as well as potential for airborne dispersion of contaminants, a soil gas survey was conducted over the area to aid in locating residual volatile organic contamination and determine optimum locations for the monitoring wells. The survey grid extended well beyond the edges of the former burn pit and used sample stations on 60 ft centers, as shown in Figure 6-9.

Since site history involved combustion of both fuels and solvents, the soil gas analysis included the following common aromatic and halogenated hydrocarbons:

methylene chloride	total hydrocarbons (FID screen)
bromochloromethane	benzene
trans-1,2-dichloroethene	toluene
trichloroethene	xylenes
carbon tetrachloride	

- One borehole was hand-augered near the center of the former burn pit, with soil samples taken at three depths to obtain data indicative of vertical contaminant migration. The boring was located based on the soil gas survey results.

The soil samples were analyzed for petroleum hydrocarbons (alkanes) and lead as indicators of residual fuel or combustion products.

- Four shallow monitoring wells were installed and sampled to provide information on local hydrogeologic properties and potential contaminant presence/migration. One well was located near the center of the former pit in order to sample ground water from an area most likely to have been impacted by the burn pit activities.

The three remaining wells were installed in a triangular pattern around the pit, as indicated in Figure 6-8. The well locations were selected to be near the edge of the apparent contaminant plume, based on the soil gas survey results.

- One water sample was collected from each well and analyzed for purgeable halocarbons and aromatics (VOCs), base/neutral and acid extractable organics (semivolatiles), and lead. These analyses were designed to check for the suspected presence of residuals from burning of fuels, solvents, and oils.

Table 6-16

SUMMARY OF ENVIRONMENTAL SAMPLING ACTIVITIES AT SITE 7 [BURN PIT AREA]
OREGON AND PORTLAND
PORTLAND IAP, PORTLAND, OREGON

<u>Matrix/Analysis</u>	<u>Analytical Method</u>	<u>Depth Collected (ft)</u>	<u>Sampling Method</u>	<u>No. of Field Samples</u>
<u>Soils/Sediments</u>				
Petroleum Hydrocarbons (C ₁₀ -C ₂₄ alkanes)	ASTM D3328	1,5,10	HA	3
Lead	SW3020/7421	1,5,10	HA	3
Percent Moisture	E160.3	1,5,10	HA	3
<u>Ground Water</u>				
Volatile Organics	SW5030/8240	--	B	4
Base/Neutral/Acid Extractables	SW3520/8270	--	B	4
Lead	SW3050/7421	--	B	4
pH	E150.1/Fld.*	--	B	4
Temperature	E170.1/Fld.*	--	B	4
Specific Conductance	E120.1/Fld.*	--	B	4

ASTM = American Society for Testing and Materials Methods.

SW = SW 846 Methods (EPA, 1986).

E = EPA Drinking Water Methods (EPA, 1983).

HA = Hand Auger

B = Bailer

* Field Measurement

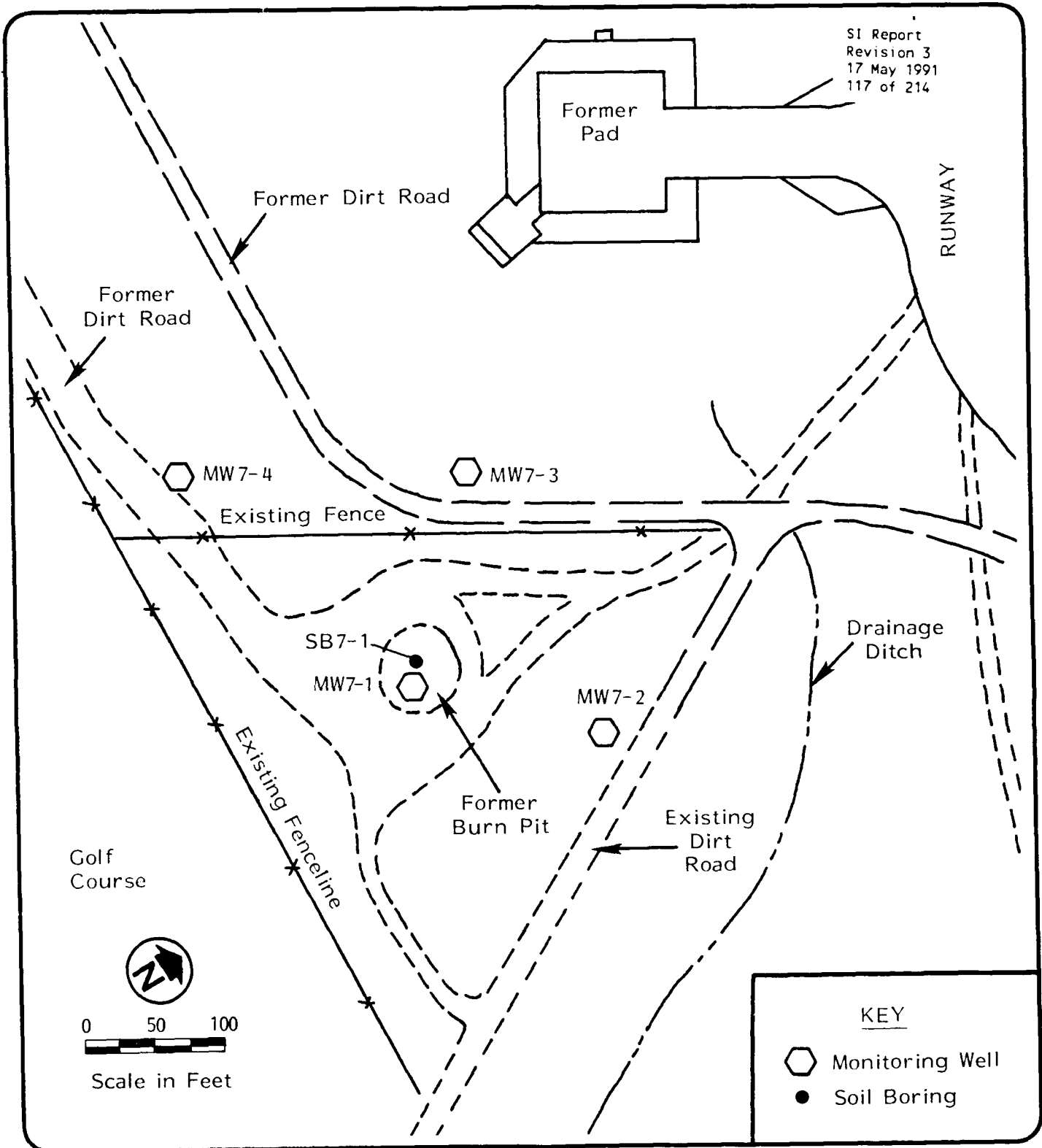


Figure 6-8

SITE 7: BURN PIT AREA SAMPLING LOCATIONS
ANG PORTLAND, PORTLAND IAP, PORTLAND, OREGON

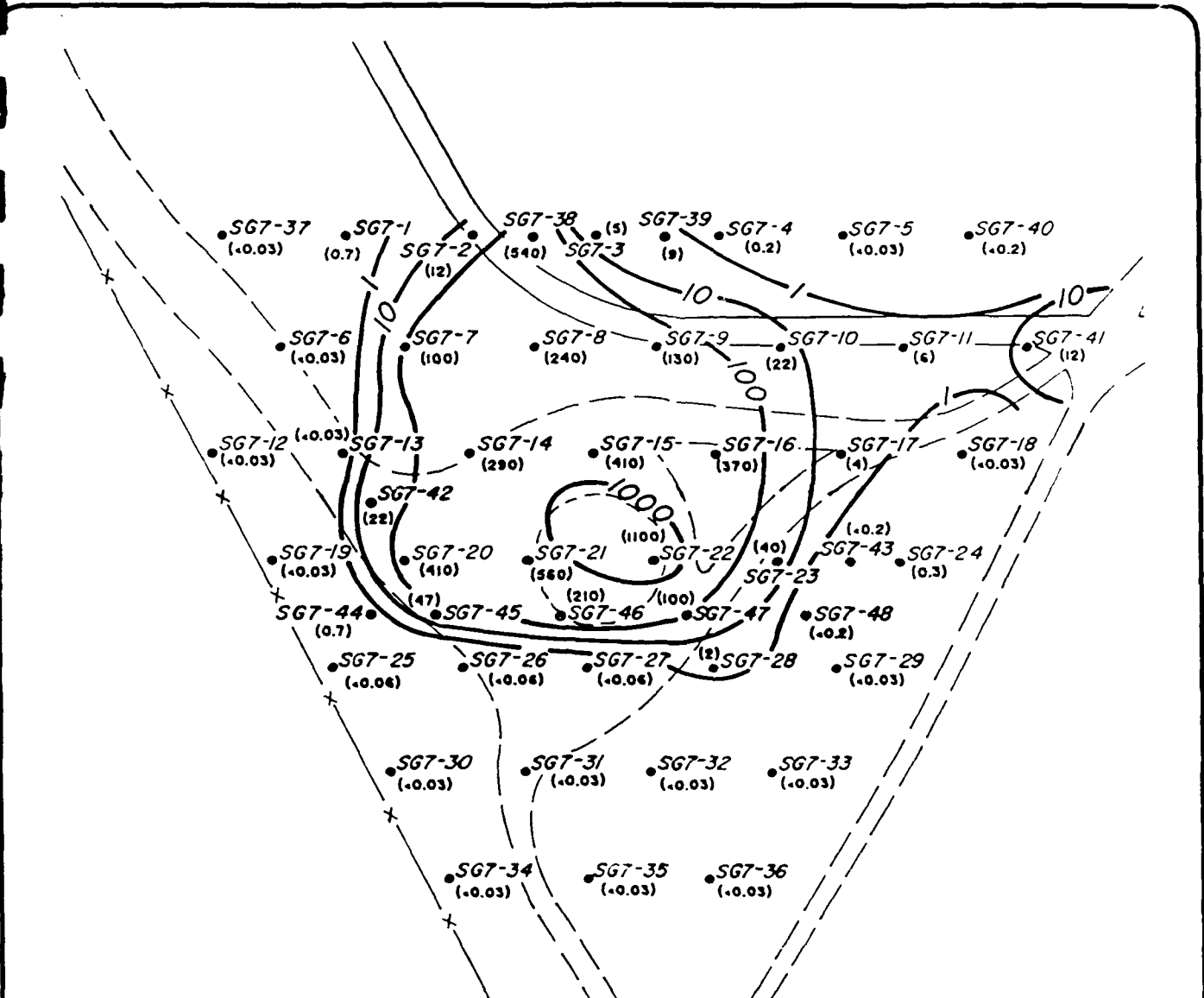
Findings and Extent of Contamination at Site 7

The soil gas survey results for total hydrocarbon are shown in Figure 6-9, with inferred plume contours indicated. The plume is clearly defined with concentrations ranging over several orders of magnitude (i.e., from 0.1 to 1,000 $\mu\text{g/L}$) and centered at the former burn pit location. The contaminant boundary is fairly well defined except to the northwest near sampling location SG7-38 and on the north end of the site near sampling location SG7-41. Concentrations decrease rapidly in an easterly direction moving away from the center of the burn pit. Concentrations also decrease westerly although not as rapidly.

Individual target compounds were detected within the same plume area as shown in Figure 6-9 for the total hydrocarbon results. Detected compounds included methylene chloride, bromochloromethane, TCE, carbon tetrachloride, benzene, toluene, and xylenes. Non-target peaks were also found in many of the samples, tentatively identified by the GC analyst as chloroform, 1,1,1-trichloroethane, and tetrachloroethene. The most prevalent target compounds detected in the soil gas samples were TCE, toluene, and xylenes. These compounds were found in highest concentrations nearest the former burn pit location.

The soil boring was located near the center of the former burn pit at the soil gas sampling point which showed the highest degree of contamination. As shown in Table 6-17, petroleum hydrocarbons (PHCs) were detected in all three soil samples at concentrations up to 72 S mg/kg. Lead was also detected in all three samples, though at concentrations lower than those found in the background samples. The analytical technique employed for PHCs was designed to quantify the alkanes fraction of hydrocarbons ranging from ten to 24 carbon atoms, in order to provide clear evidence of petroleum contamination.

Additional tests would be needed in order to check for the presence of other likely petroleum compounds having environmental significance such as naphthalenes, anthracene, chrysene, and phenanthrene.



EXPLANATION

- SG7-1 SITE #7 SOIL GAS SAMPLING LOCATION
- (0.7) SOIL GAS SAMPLE VALUE (µg/L)
- 10- ISOCONCENTRATION LINE (µg/L)



Figure 6-9

SITE 7: BURN PIT AREA TOTAL HYDROCARBONS CONCENTRATIONS IN SOIL GAS
 ANG PORTLAND, PORTLAND IAP, PORTLAND, OREGON

The analytical results for the ground water samples are shown in Table 6-17. No significant contamination was detected in any of the ground water samples based on the analysis performed (VOCs, BNAs, and lead).

The general extent of apparent hydrocarbon contamination at the site has been established by the soil gas survey results (Figure 6-9). The presence of PHCs was confirmed in soil samples collected near the center of the pit. No significant contamination of ground water was detected. The soil gas results indicate the presence of a variety of chlorinated hydrocarbons in the immediate vicinity of the former pit and in the western half of the surveyed zone.

Contaminants were generally absent in soil gas samples from the eastern portion of the survey zone. The topography slopes downward in this area toward a nearby drainage ditch, so contaminants might have been dissipated by surface water runoff in this part of the site. It is also possible that contaminants have been flushed from this region since a coarse sand unit was encountered in monitoring well MW7-2 (see Section 5.2). Wind dispersion may be another factor causing the observed distributions. Further study would be needed in order to provide better chemical characterization and more complete definition and explanation of contaminant distributions.

6.3.2 Background Conditions

Field Sampling Activities

To establish baseline soil and ground water chemical characteristics, soil and ground water sampling was performed in an area selected to be representative of natural conditions and, to the extent feasible, not influenced by hazardous materials from ANG or non-military airport operations. A background location was chosen along the southern ANG boundary line in the general vicinity of the guard-house. This location is believed to be in an area not impacted by industrial or aircraft operations.

The following sampling/analytical activities were undertaken to establish baseline soil and ground water chemical characteristics:

Table 6-17

ANALYTICAL RESULTS FOR SITE 7 [BURN PIT AREA]
OREGON ANG PORTLAND
PORTLAND IAP, PORTLAND, OREGON

SOIL SAMPLES	REPORTED DETECTION LIMIT (mg/kg)	CONCENTRATION, mg/kg dry wt basis			
		SB7-1-1	SB7-1-2	SB7-1-3	
<u>Petroleum Hydrocarbons</u>					
C ₁₀ - C ₂₄ Alkanes	0.47-0.52	26.0 S ^a	72.0 S	11.0 S	
<u>Lead</u>	0.035-0.036	5.6 B	4.7 B	2.6 B	
<hr/>					
GROUND WATER SAMPLES	REPORTED DETECTION LIMIT (ug/L)	CONCENTRATION, ug/L			
		MW7-1-1	MW7-2-1	MW7-3-1	MW7-4-1
<u>Volatile Organics</u>					
Methylene chloride	5	ND	4JU ^c	3JU ^c	5U ^c
All Other Volatiles	5-10	ND C	ND C	ND C	ND C
<u>Base-Neutral/Acid Organics (BNAs)</u>					
	10-50	ND S	ND S	ND S	ND
<u>Lead</u>	1.1	14AU ^c	1.6U ^c	1.8U ^c	2.0U ^c

^a See Table 6-2 for a list of data qualifiers and their meanings.

^b Holding times (HT) were exceeded for extraction and analysis.

^c Compound was detected in an associated QA/QC blank. Based on data validation criteria (Section 8.0), the concentration in the environmental sample is considered to be not significant. The value shown is the concentration reported by the laboratory for the environmental sample.

ND Not detected (below detection limit).

- Two soil samples were collected from two borings during the Fast-track field episode. The samples were analyzed for purgeable organics, PCBs, and petroleum hydrocarbons.
- Two soil samples were collected from one 3-ft deep soil boring. The soil samples were tested for all analytes investigated at the above sites as shown in Table 6-18.
- Background monitoring well MWBG was located as shown in Figure 6-10. One ground water sample was collected and tested for all analytes investigated at the above sites (see Table 6-18).

Findings at the Background Location

The analytical results of soil and ground water testing for the background location are presented in Table 6-19. No VOCs, BNAs, PHCs, or PCBs were found in the soil samples except for common laboratory contaminants at an insignificant concentration compared with that reported in associated QA/QC blanks. Cadmium, chromium, iron, lead, nickel, and zinc were all detected in the background soil samples. The data show that the soil is iron-rich and contains much lesser concentrations of the other metals.

Iron and sulfate were present in the ground water from the background well. No volatile organics, BNAs, petroleum hydrocarbons, or PCBs were detected in the ground water sample.

It is believed that the concentrations present in the background samples are representative of background conditions at the Base. This is supported by the absence of organic contaminants in both soil and ground water samples. The detected metals concentrations are not atypical for common ranges noted in other studies (EPA, 1983b; Logan and Cassler, 1989).

6.3.8 Site 8 - Sanitary Landfill

The existence, location, history, and use of a sanitary landfill at Site 8 were based on the recollections of an individual interviewed during the Preliminary Assessment. During the SI, this individual (the former Deputy Civil Engineer of the Base) was interviewed to confirm the location of Site 8 given in the

Table 6-18

SUMMARY OF ENVIRONMENTAL SAMPLING ACTIVITIES AT BACKGROUND LOCATION
OREGON ANG PORTLAND
PORTLAND IAP, PORTLAND, OREGON

<u>Matrix/Analysis</u>	<u>Analytical Method</u>	<u>Depth Collected (ft)</u>	<u>Sampling Method</u>	<u>No. of Field Samples</u>
<u>Soils/Sediments</u>				
Volatile Organics	SW5030/8240	1,8	HA	2
Base/Neutral/Acid Extractables	SW3550/8270	1,8	HA	2
PCBs	SW3550/8080	1,8	HA	2
Petroleum Hydrocarbons (C ₁₀ -C ₂₄ alkanes)	ASTM D3328	1,8	HA	2
Metals:				
Cadmium	SW3020/7131	1,8	HA	2
Chromium	SW3010/6010	1,8	HA	2
Iron	SW3010/6010	1,8	HA	2
Lead	SW3020/7421	1,8	HA	2
Nickel	SW3010/6010	1,8	HA	2
Zinc	SW3010/6010	1,8	HA	2
Percent Moisture	E160.3	1,8	HA	2
<u>Ground Water</u>				
Volatile Organics	SW5030/8240	--	B	1
Base/Neutral/Acid Extractables	SW3520/8270	--	B	1
PCBs	SW3520/8080	--	B	1
Petroleum Hydrocarbons (C ₁₀ -C ₂₄ alkanes)	ASTM D3328	--	B	1
Inorganics:				
Cadmium	SW3050/7131	--	B	1
Chromium	SW3050/6010	--	B	1
Iron	SW3050/6010	--	B	1
Lead	SW3050/7421	--	B	1
Nickel	SW3050/6010	--	B	1
Zinc	SW3050/6010	--	B	1
Sulfate	SW9038	--	B	1
pH	E150.1/Fld.*	--	B	1
Temperature	E170.1/Fld.*	--	B	1
Specific Conductance	E120.1/Fld.*	--	B	1

ASTM = American Society for Testing and Materials Methods.
SW = SW 846 Methods (EPA, 1986).
E = EPA Drinking Water Methods (EPA, 1983).
HA = Hand Auger
B = Bailer
* Field Measurement

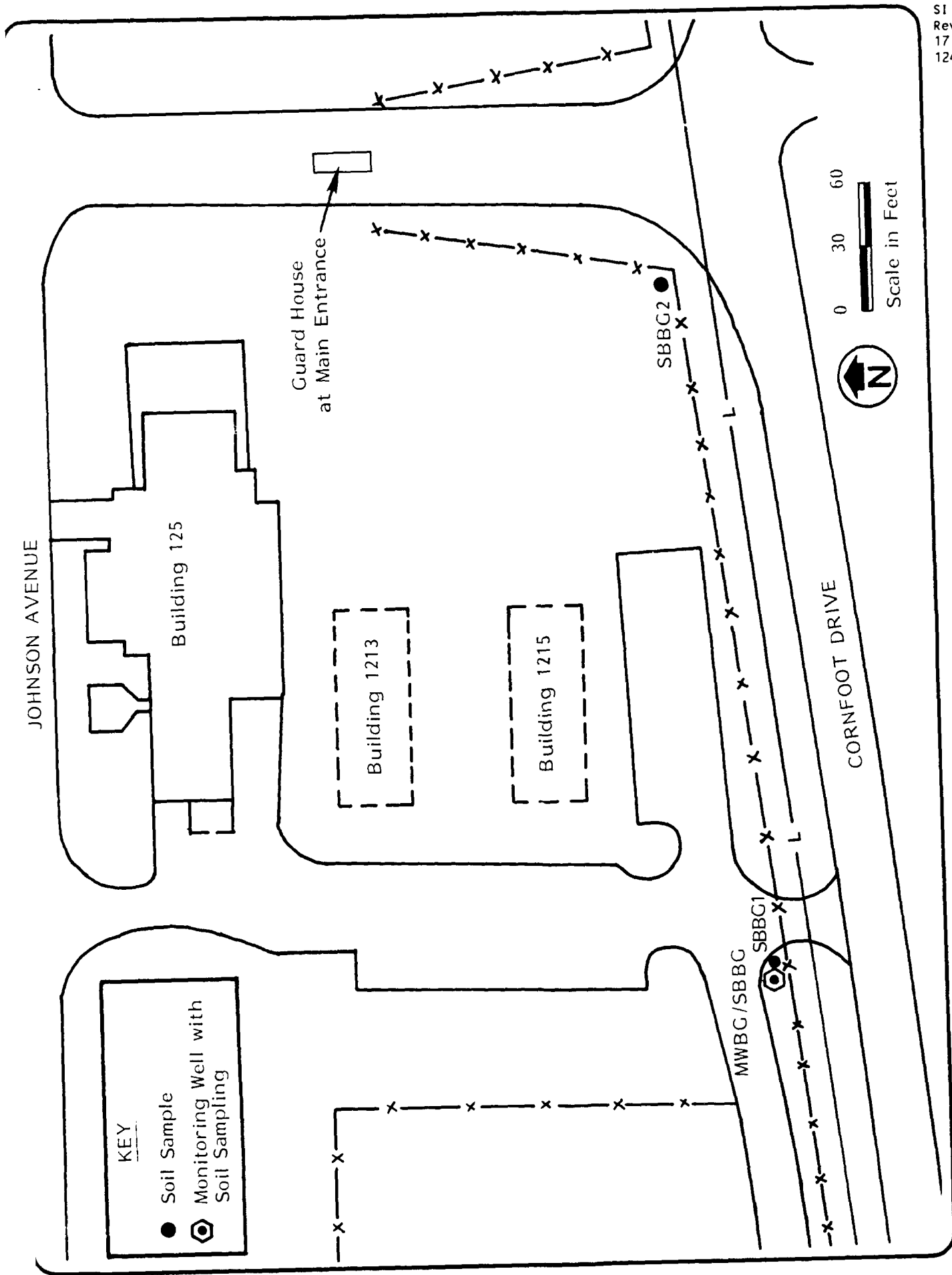


Figure 6-10
BACKGROUND SAMPLE LOCATIONS
ANG PORTLAND, PORTLAND IAP, PORTLAND, OREGON

Table 6-19

ANALYTICAL RESULTS FOR THE BACKGROUND LOCATION
 OREGON ANG PORTLAND
 PORTLAND IAP, PORTLAND, OREGON

CLASS AND COMPOUND	GROUND WATER (µg/L)		SOIL BORINGS (mg/kg)				Samples Analyzed	
	MUBG-1	Detection Limit	SBBG1-1	Dec 88 Samples SBBG1-2	SBBG2-1	SBBG2-2		Aug 89 Samples SBBG-1	SBBG-2
<u>Volatiles Organics</u>	HT*							
Methylene Chloride	ND	5	0.022U ^b , C	0.009U ^b , C	ND C	0.008U ^b , C	NA	NA
All other volatiles	ND C	5-10	ND C	ND C	ND C	ND C	NA	NA
<u>Polychlorinated Biphenyls (PCBs)</u>	ND	0.7-2.5	ND	ND	ND	ND	NA	NA
<u>Petroleum Hydrocarbons</u>								
C ₁₀ - C ₂₄ Alkanes	ND	13	ND	ND	ND	ND	NA	NA
<u>Base-Neutral/Acid Organics (BNAS)</u>								
bis(2-ethylhexyl)phthalate	ND	10	NA	NA	NA	NA	0.43U ^b	ND
All other BNAs	ND	10-50	NA	NA	NA	NA	ND	ND
<u>Metals and Inorganics</u>								
Cadmium	0.86U ^c	0.08	NA	NA	NA	NA	0.19	0.2
Chromium, total	ND	5.9	NA	NA	NA	NA	21	24
Iron	830	12	NA	NA	NA	NA	24,000	25,000
Lead	2.2U ^c	1.1	NA	NA	NA	NA	11 B	14 B
Nickel	ND	14	NA	NA	NA	NA	16	17
Zinc	30U ^c	5.9	NA	NA	NA	NA	54	54
Sulfate	13,000	NR	NA	NA	NA	NA	NA	NA

* Holding time (HT) was exceeded for extraction and analysis of water sample MUBG-1 and D-6 (MUBG-1 Replicate). See Table 6-2 for a list of data qualifiers and their meanings.

^b Compound is a common laboratory contaminant and was detected at a concentration close to the detection limit. Based on customary data validation guidelines for common laboratory contaminants, the concentration in the environmental sample is considered to be not significant. The value shown is the concentration reported by the laboratory for the environmental sample.

^c Compound was detected in an associated QA/QC blank. Based on data validation criteria (Section 8.0), the concentration in the environmental sample is considered to be not significant. The value shown is the concentration reported by the laboratory for the environmental sample.

ND Not detected (below detection limit).
 NA Not analyzed.
 NR Not reported.

Preliminary Assessment report, and to obtain additional details describing the former landfill area (Betcher, 1989). Pertinent details of the interview are given below:

- The Site 8 landfill was operated from approximately 1949 to 1956. After Hangar 255 was built, landfilling was moved to an area just west of the old ammunition storage site on the west end of the Base.
- The landfill approximately covered the area shown in the PA Report (i.e., as shown in Figure 4-7). This area was east of Hangar 255, northwest of the corner of the golf course, and covered about an acre in size.
- Landfilling was done using trenches dug with a bulldozer blade about 10 feet wide, with the depth of the trench determined by the ground water level. The trench depths were about 6 to 8 feet deep. Trenches were generally 60 to 70 feet long. Trenches were dug one at a time (when one was nearly full, they would dig a new trench and use the excavated dirt to cover the old trench). Generally, the cover material was about 3 to 4 feet in thickness.
- The trenches were dug about 5 to 20 feet apart, but not necessarily parallel. Some trenches may have run NE to SW, and some north/south. They would dig a new trench wherever necessary to avoid obstacles, so there was no attempt to make the trenches parallel to each other.
- The wastes deposited in the trenches would have been from the ANG and the Army Guard. The state collected the garbage from the various buildings and shops on the Base and then disposed of them in the Site 8 trenches (the department which collected the garbage could not be recollected).
- The wastes collected and disposed were anything that people would throw away in the shops and buildings. There were probably not any food wastes, except for coffee grounds. During those days, people may have thrown away cans of paint residue, oil residues, batteries, and broken parts. There was also a lot of waste paper from the buildings. If someone cleaned something in one of the shops, the wastes would probably have been tossed into the garbage and gone to the landfill.

Aerial Photographic Study

An aerial photographic study was performed in order to determine if there is visual evidence of landfill activity in the area defined as Site 8 (SAIC, 1989c). Several pertinent aerial photographs of this area for the period of reported

activity were found in the photographic records of the Base and the Army Corps of Engineers. Some of the photographs showed that the land surface was disturbed several times in the Site 8 area during the period of reported landfill activity. Although the disturbances did not have the appearance of landfill trenches, it was decided to conduct geophysical surveys of the area to provide additional evidence regarding the potential existence of the sanitary landfill.

Geophysical Investigation

An electromagnetic (EM) conductivity survey and a total field magnetic survey were conducted at ANG Portland with the objective of locating buried trenches within the Site 8 area as described above. The following subsections summarize the field investigation methods, findings, and conclusions. The geophysical data and additional discussion of methods and findings is given in Appendix F.

Before initiating any geophysical surveys the corners for each site were marked with wood stakes. The grid pattern was designed with 50 foot distances between transects and 50 foot station spacings along each transect. Each station was marked with a wood stake. Transect direction was determined by use of a compass, and all distances were determined to ± 1.0 ft using a surveyor's tape. The geophysical survey area is shown in Figure 6-11.

Because of recent construction near Site 8, the survey could only be extended 250 ft north of the perimeter road instead of 500 ft as had been planned. Also, all utilities were marked and noted with respect to grid locations. These utility locations were used during interpretation to clarify possible anomaly sources.

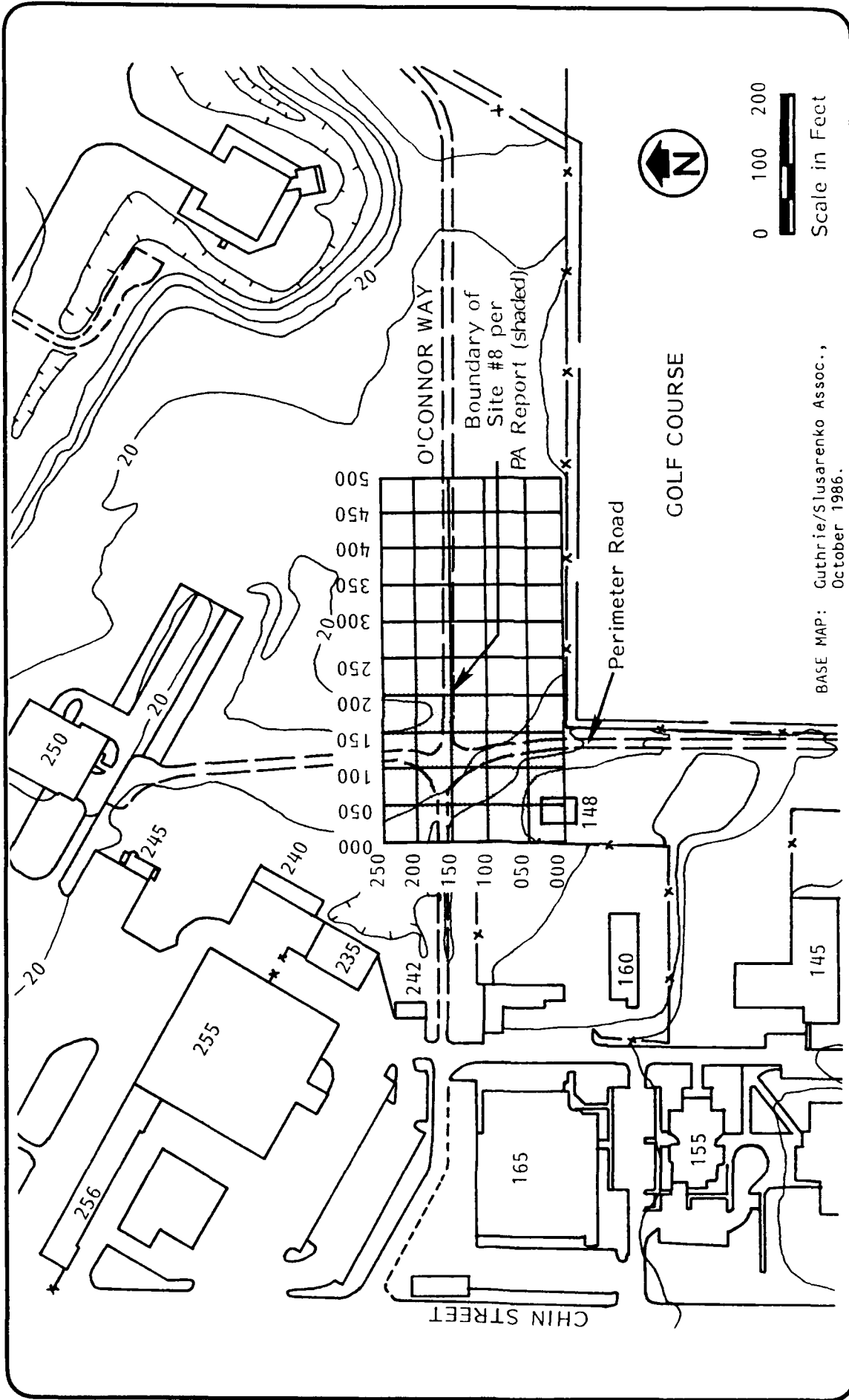
Theory. EM conductivity surveying is a method of obtaining subsurface information by inducing an electric source field into the earth from a surface transmitter coil. The theory developed for EM surveying assumes the ground to be homogeneous, isotropic, and semi-infinite; therefore, surface conductivity measurements are referred to as "apparent conductivity" to discriminate between ground conductivity and measured conductivity (which reflects the cumulative response of subsurface "conductors"). Lateral changes in the electric properties of subsurface materials cause variations or anomalies in the apparent

conductivity. These anomalies are used to interpret subsurface structure. The conductivity of soils or rocks is particularly sensitive to water content and dissolved salts or ions. Accordingly, dry sands and gravels, and massive rock formations have low conductivity, while saturated sands and gravels, most clays, and other materials with high ion content have high conductivity. Landfill areas and buried metal objects often have different conductivity than surrounding terrain, and therefore produce anomalies.

The proton precession magnetometer is an instrument which measures the total magnetic field of the earth. The instrument operates by using a sensing device filled with a proton-source fluid (decane in this case). The sensing device contains a coil which induces a polarizing field approximately normal to the terrestrial field. When the polarizing field is suddenly removed (i.e., the current is stopped in the coil), the protons align with the terrestrial field and precess at an angular velocity known as the Larmor precession frequency. This frequency is proportional to the terrestrial field intensity. Because the proton is a moving charge, it induces a voltage in a pickup coil (located in the sensor) which varies at the precession frequency. The signal from the pickup coil is sent to the instrument where it is amplified, and linearly related to the terrestrial field. Landfills (which often contain high amounts of reinforced concrete and other metal objects) generally have higher magnetic susceptibilities than the surrounding soils and bedrock, therefore causing local anomalies with respect to the natural field.

Summary of Geophysical Survey Findings. Evaluation of the data collected from electromagnetic (EM) and total field magnetic surveys conducted at Site 8 indicated the following:

- The EM survey revealed linear anomaly patterns in the north-south and east-west directions, most of which corresponded with marked utility lines or fences. However, one area was detected on the western portion of the site which exhibited higher conductivities than surrounding areas. The source for this anomaly is unknown.

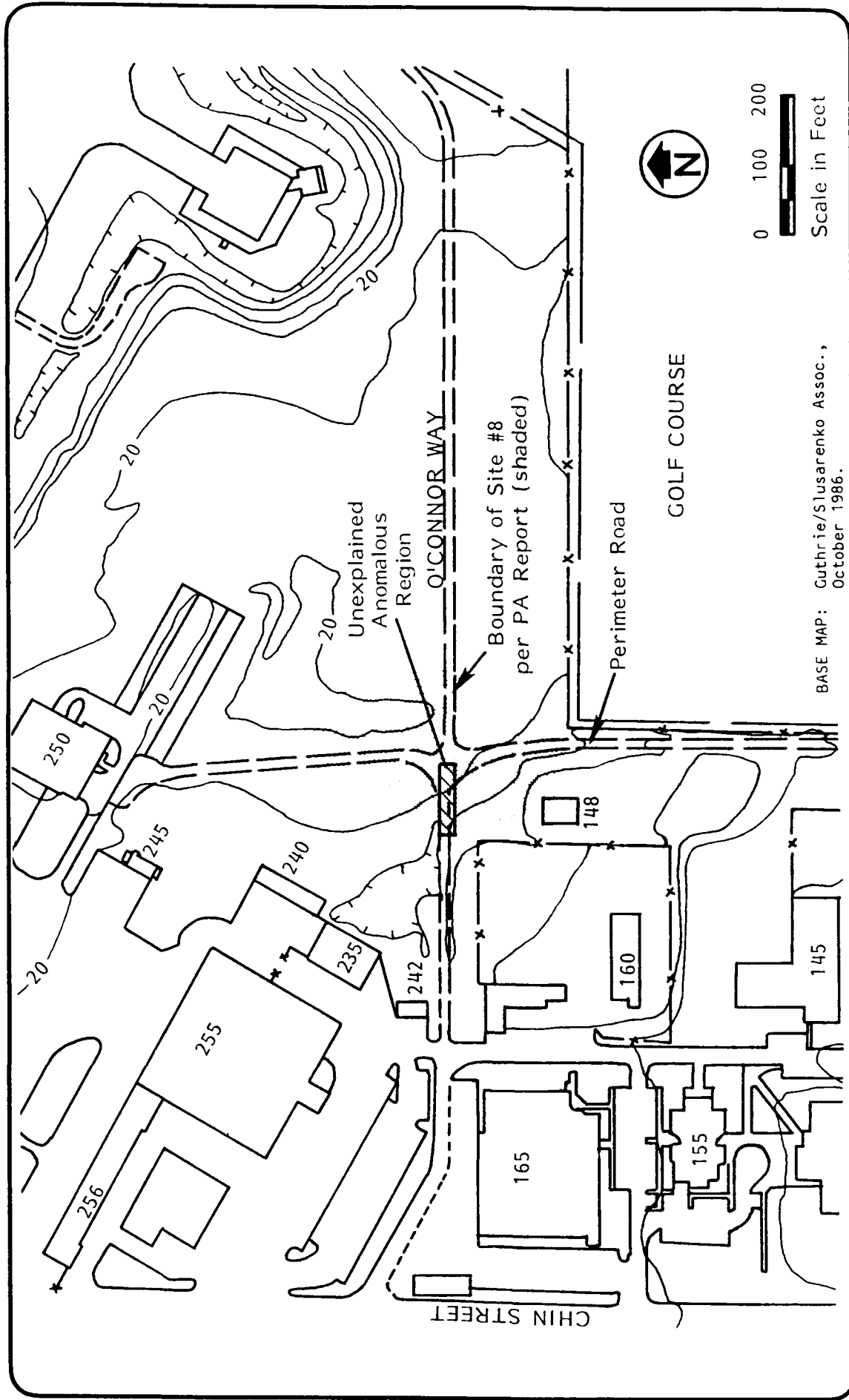


LOCATION OF GEOPHYSICAL SURVEY GRID
ANG PORTLAND, PORTLAND IAP, PORTLAND, OREGON

- The magnetic survey showed anomalies mostly caused by identifiable man-made features, such as utilities, fences, and reinforced concrete structures. One anomalous area observed on the west end of the site, the cause of which is unknown, could be due to buried metallic material. This anomaly is in the same location as the unexplained anomaly in the EM survey data.

Figure 6-12 shows the location of the unexplained anomaly found in both the EM and magnetic surveys. The anomaly appears to trend further west, but predictions of how far west it may extend cannot be made. This anomalous area may be caused by several things including: buried construction debris, unknown utilities, or a buried landfill trench. Construction debris was noted and removed from the surface of this area before the survey commenced. Also, it is possible that a utility exists in this area which was not noted on Base maps nor marked by Base personnel prior to the survey. Furthermore, the addition of another utility in an area already dense with utilities would cause a larger anomaly and possibly explain the data.

Even though the anomaly found in the western part of the site was not explainable by obvious or known sources, it did not match the description of the suspected landfill trenches, since several anomalies of random orientation relatively close to each other should have been observed. In addition, it could have been caused by other phenomena, such as unmarked utilities or complex electromagnetic interactions between two underground power lines which cross each other near the anomaly. It was therefore concluded that none of the anomalies observed in the geophysical data were attributable to the suspected landfill trenches.



BASE MAP: Guthrie/Slusarenko Assoc.,
October 1986.

Figure 6-12

LOCATION OF THE UNEXPLAINED ANOMALOUS REGION
ANG PORTLAND, PORTLAND IAP, PORTLAND, OREGON

7.0 PRELIMINARY RISK ASSESSMENT

This section presents a preliminary risk assessment of exposure to chemicals determined to be present at the ANG Portland IRP sites. The assessment was conducted following the guidelines developed for the federal Superfund program (CERCLA). An overview of the CERCLA risk evaluation process is given in Appendix G. Also included is a discussion of ranking scores for each site based on the CERCLA Hazard Ranking System (EPA, 1984).

7.1 INTRODUCTION

The preliminary risk assessment emphasized evaluation of public health risk. Comparison of site conditions with guidelines for environmental receptors were included where possible. The assessment was conducted for two primary purposes: (1) to evaluate the current and potential risks to human receptors, and (2) to evaluate the need for further action. The preliminary risk assessment evaluated the potential for adverse noncarcinogenic and carcinogenic effects of long-term or chronic exposure to site-related contaminants. The evaluation also incorporated comparison of environmental quality data with chemical-specific ARARs (i.e., applicable or relevant and appropriate requirements). Ecological risk assessment and risk characterization with respect to environmental receptors will need to be addressed in depth during the RI/FS.

Risk assessment, in many instances, must be considered a tool for evaluating the need for site remediation and selecting appropriate remedial actions. Although current exposure to humans may be negligible or even nonexistent, risk assessment may still be warranted to project potential risks of future site or environmental resource use. A projection of hypothetical risks is often developed to obtain a useful measure of the magnitude or significance of site contamination.

7.2 HAZARD IDENTIFICATION

As discussed more fully in Appendix G, the first step in the risk assessment process is to identify all subject chemicals of concern that will serve as the focus of the evaluation. Indicator chemicals are often used to facilitate the risk assessment process when dozens of compounds have been identified at a site.

by narrowing the list of subject chemicals to those that theoretically drive the overall magnitude of the risk. However, there is nothing inherent in the indicator selection process that serves to improve the characterization of risk to human health or the environment.

Since relatively few compounds were detected in the ANG Portland SI sampling program, all chemicals reported to be present in the ground water, soils, and sediments have been included in the preliminary risk assessment. All potentially carcinogenic compounds have been evaluated. Noncarcinogenic effects were considered for all chemicals for which verified reference doses are available, or could be established based on structural and toxicological similarities.

Sampling and analysis of environmental media during the SI at the ANG Portland IRP sites have revealed the presence of various contaminants in ground water, soils, and sediments. Among the compounds reported in the analytical data are common laboratory contaminants - that is, methylene chloride, acetone, and bis(2-ethylhexyl)phthalate - and other compounds which were also detected in various QA/QC blanks associated with the environmental samples. QA/QC validation procedures (Section 8.0) have shown that, in many cases, the reported concentrations in the environmental samples should not be considered significant in view of the blank contamination. Cases where this applies are indicated by footnotes in the tabulated results presented in Section 6.0.

The preliminary risk assessment was performed with the objective of making conservative estimates of risk utilizing reasonable maximum exposure scenarios. Accordingly, *all* chemicals reported by the laboratory above detection limits in the environmental samples have been used in conducting the preliminary risk assessment. This was done in spite of the conclusions of the QA/QC validation process that some of the environmental data should be disregarded as insignificant due to blank contamination. In addition, *all* the reported compounds were used even in cases where environmental concentrations were similar to results for the background location. Using all the reported chemicals in the preliminary risk assessment regardless of the QA/QC qualifiers or comparisons to background data has generally produced a more conservative evaluation than if the qualified and "similar to background" chemicals had been disregarded. The

overall conclusions and recommendations given in this report would not be changed if the preliminary risk assessment had been performed with the qualified or "close to background" chemicals ignored.

2.3 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

CERCLA/SARA requires that remedial response actions must be undertaken in compliance with all ARARs identified during the investigation process (unless one of six statutory waivers is invoked). Under CERCLA methodology, the identification and selection of ARARs is an ongoing and iterative process, beginning at the Site Investigation phase and reaching completion during the Feasibility Study phase. At this point in the assessment of the sites under investigation at Portland, it is appropriate to identify potential chemical-specific ARARs that may be used in determining the need for site remediation.

A chemical-specific criterion or standard becomes an ARAR if it is found to be: (1) applicable, or (2) relevant and appropriate to the particular circumstances at a waste site under investigation. *Applicable* requirements promulgated under federal or state law are those which specifically address a hazardous substance or pollutant, action or location at a hazardous waste (e.g., CERCLA) site. *Relevant and appropriate* requirements are those which, while not *applicable*, address problems or situations sufficiently similar to those encountered at the waste site that their use is well suited to the particular circumstance. EPA guidance on determining whether a requirement is *applicable* or *relevant and appropriate* is provided in CERCLA Compliance with Other Laws Manual (EPA, 1988a, U.S. EPA, 1989d).

These two classes of requirements (i.e., *applicable*, or *relevant and appropriate*) also differ in the amount of discretion allowed in their identification. The revised National Contingency Plan (NCP) notes that *applicable* requirements are identified by a largely objective comparison to the circumstances at the site (EPA, 1988c). A chemical-specific requirement is concluded to be *applicable* if there is a one-to-one correspondence between the requirement and the circumstances at the site. EPA indicates that there is little discretion involved in this determination (EPA, 1988a,c). *Relevant and appropriate*

requirements, however, are determined using best professional judgment as to whether the requirement addresses problems or situations that are generally pertinent to conditions at the site (i.e., relevant) and "well-suited" (i.e., appropriate as a remediation goal).

2.3.1 Identification of Federal ARARs

Federal standards and criteria which have been developed and promulgated for water resources include Maximum Contaminant Levels (MCLs), Maximum Contaminant Level Goals (MCLGs), and Federal Ambient Water Quality Criteria (FWQC). MCLs for toxic chemicals are enforceable EPA standards developed under the Safe Drinking Water Act (SDWA), and represent allowable limits for lifetime exposure to the contaminant in public drinking water supplies. MCLs are established taking into consideration potential health effects and the feasibility of attaining such a concentration given the best available technology, treatment techniques, and costs.

MCLGs are developed as part of the process for developing a final drinking water standard (i.e., MCL). MCLGs are nonenforceable health-based guidelines established at concentrations that are associated with no known or anticipated adverse health effects for chemicals in public drinking water supplies. MCLs are set at concentrations as close to MCLGs as is feasible.

FWQC are guidelines for chemicals in surface waters developed by the EPA Office of Water Regulations and Standards for the protection of aquatic life and human health. Although these are not enforceable standards, they represent scientific data and guidance to be used by the states in developing water quality standards. State water quality standards are those promulgated for the protection of environmental quality, are enforceable when adopted by the state under section 304 of the Clean Water Act, and may be *applicable* or *relevant and appropriate* for evaluating remedial actions at waste sites in that state. The availability of, and numerical values for, these standards vary widely from state to state. If state standards are available, and if these are different from the ARARs proposed by EPA, then EPA guidance specifies that the more stringent of the two standards be used in waste site evaluation (EPA, 1988c).

At the ANG Portland sites under investigation, none of these federal criteria and standards (i.e., MCLs, MCLGs, and FWQC) may be considered *applicable* requirements. The reason is that none of these requirements specifically address the circumstances of observed ground water contamination at the site. The MCLs and MCLGs would be *applicable* if site-related chemicals were observed in a public water supply system, and contamination were present at the tap. (The same reasoning is appropriately used for any state drinking water standards). FWQC were developed for surface water systems and although these may be *relevant and appropriate* for ground water in the absence of MCLs or other standards, they are clearly not *applicable* as remediation guidelines for ground water.

According to EPA, a requirement may be determined to be *relevant and appropriate* if the established health or environmental limit is based on an exposure scenario that is similar to the potential exposure at a hazardous waste site (EPA, 1988a,c). EPA considers this to be the focal point for determining if a requirement is *relevant and appropriate*. The objective of the Safe Drinking Water Act (SDWA) is to ensure that potable water supplies are safe for human consumption. At the ANG Portland IRP sites, a primary regulatory concern is that ground water contamination may preclude use of a potential source of drinking water. With this in mind, the situation at the waste sites is sufficiently similar to the problems addressed by the SDWA that MCLs would be considered *relevant* requirements.

EPA has determined as a matter of policy that MCLs will be *relevant and appropriate* for ground water or surface water that currently is or may in the future be used directly for drinking (EPA, 1988a,c). EPA points out that even though ground water beneath a waste site under investigation may not be a current source of public drinking water and any wells do not belong to a public water system (and therefore do not meet the jurisdictional prerequisites for the SDWA), the water may still be a potential future source of drinking water (provided it is not a Class III aquifer). EPA concludes that because the contaminated ground water could be used directly as a potable supply in the future, MCLs should be identified as a "probable *relevant and appropriate* standard" (EPA, 1988a,c).

MCLs, MCLGs, and FWQC are identified as potential ARARs for the ANG Portland IRP sites. EPA considers MCLGs to be *relevant and appropriate* for evaluating ground water (i.e., as a potential drinking water source) when and if multiple contaminants or pathways may present excess lifetime cancer risks exceeding 10^{-4} (EPA, 1988a,c). FWQC were included as an additional point of comparison for chemicals for which MCLs are not available. EPA indicates that FWQC adjusted for drinking water only may be *relevant and appropriate* under such circumstances.

Table 7-1 lists available federal chemical-specific ARARs for the subject compounds identified at the sites under investigation. Provided in the table is a listing of: (1) EPA primary drinking water standards (MCLs), (2) EPA drinking water maximum contaminant level goals (MCLGs), and (3) EPA Ambient Water Quality Criteria for the protection of human health adjusted for drinking water only (FWQC). Federal Drinking Water Health Advisories are also provided as an additional point of reference. Note that Drinking Water Health Advisories are not ARARs but are considered other values "to be considered" (TBC) in assessing the significance of observed levels of environmental contamination. TBCs are used when ARARs are not available for a certain chemical to aid in establishing appropriate cleanup goals.

7.3.2 Comparison With Federal ARARs

Concentrations of chemicals in ground water at the sites were evaluated by comparing mean and maximum observed levels with potentially *relevant and appropriate* federal ARARs identified above. The evaluation included comparison with proposed as well as existing federal MCLs and MCLGs. It is important to recognize that these proposed values have not been formally promulgated and cannot currently be considered ARARs. Note that promulgated federal ARARs are currently not available for chemicals in soil and for use in evaluating observed levels of contaminants in such media.

Table 7-2 provides a summary of mean and maximum levels of chemicals found in ground water at Site 1 and an indication of any compounds that exceeded potential

Table 7-1

WATER QUALITY ARARS AND DRINKING WATER HEALTH ADVISORIES FOR IDENTIFIED CHEMICALS AT OREGON AND PORTLAND
 PORTLAND TAP, PORTLAND, OREGON

Compound	MCLs ^a (µg/L)	MCLGs ^b (µg/L)	FWQC Adjusted for Drinking Water Only ^c (µg/L)	Oregon State Drinking Water Standards (µg/L)	Federal Drinking Water Health Advisories ^j		
					One-day 10kg ^g (µg/L)	Ten-day 10 kg ^h (µg/L)	Longer-term 70 kg ^h (µg/L)
INORGANICS							
Cadmium	10	5 ^d	10	Same as Federal Primary Drinking Water Standards			
Chromium	50	100 ^d					
Iron	50	0 ^d	50				
Lead			13.4				
Nickel			5000				
Sulfate	250,000 ^e						20 µg/day
Zinc	5000						
ORGANICS							
Acetone							
Benzene	5	0	0.67 ^f 21,000		235	235	
Bis(2-ethylhexyl)phthalate							
Bromochloromethane							
Cis-1,2-Dichloroethene	70 ^d	70 ^d					
Trans-1,2-Dichloroethene	100 ^d	100 ^d					
Ethylbenzene	700 ^d	700 ^d	2400 0.19 ^{f,i}		32,000	3200	N/A
Methylene Chloride	5	0	2.8 ^f				
Trichloroethene	10,000 ^d	10,000 ^d			12,000	7800	27,300
Xylenes							

^a Maximum Contaminant Levels established under the Safe Drinking Water Act.
^b Maximum Contaminant Level Goal established under the Safe Drinking Water Act.
^c Ambient Water Quality Criteria established under the Clean Water Act, adjusted for drinking water only.
^d Proposed MCL or MCLG.
^e Secondary Maximum Contaminant Level (SMCL) established under the Safe Drinking Water Act - NOT AN ARAR.
^f AWQC corresponding to the 10-6 risk level.
^g Drinking Water Health Advisory for a 10 kg child.
^h Drinking Water Health Advisory for a 70 kg adult.
ⁱ FWQC for halomethanes as a class of compounds corresponding to the 10-6 risk level. Methylene chloride (dichloromethane) is a member of this group.
^j Federal Drinking Water Health Advisories are not ARARs but values to be considered (TBC) in evaluating the significance of observed levels of contamination in drinking water supplies. Information obtained from U.S. EPA (1986, 1987a,b,c).

Table 7-2

COMPARISON OF GROUND WATER CONCENTRATIONS WITH ARARS AT SITE 1
OREGON ANG PORTLAND
PORTLAND IAP, PORTLAND, OREGON

CHEMICAL	Mean ^a Concentration in Ground Water (µg/L)	Maximum ^b Concentration in Ground Water (µg/L)	Comparison ^c Mean Concentration vs. ARAR	Comparison ^c Maximum Concentration vs. ARAR
INORGANICS				
Iron	1100.00	1100.00		
Zinc	14.00	14.00		
ORGANICS				
Bis(2-ethylhexyl)phthalate	21.00	21.00		
Bromochloromethane	170,000.00	170,000.00		
Methylene Chloride	1200.00	1200.00	>FWQC (0.19) µg/L	>FWQC (0.19) µg/L

MCL Maximum Contaminant Level, U.S. EPA Primary Drinking Water Standards.

MCLG Maximum Contaminant Level Goal, U.S. EPA health-based guideline used in the development of MCLs.

FWQC Federal Ambient Water Quality Criteria adjusted for drinking water only.

() Indicates FWQC values corresponding to the 10⁻⁶ risk level.

^a Arithmetic mean of sampling set. Not detected results were excluded from analysis and calculation of the arithmetic mean. All detected results were included regardless of associated blank contamination. Field replicate results were averaged and then used as a single value along with the other field sample results to calculate the mean.

^b All detected results were included regardless of associated blank contamination. Field replicate results were averaged and then used as a single value along with the other field sample results to determine the maximum concentration.

^c Results are entered into table only if ARARs are exceeded.

pr Proposed MCL or MCLG.

ARARs. The mean and maximum concentrations of methylene chloride exceeded the federal Ambient Water Quality Criteria (FWQC) adjusted for drinking water only (0.19 $\mu\text{g/L}$).

The comparison with ARARs for Site 2 is presented in Table 7-3. Both mean and maximum levels of TCE are shown to exceed the MCLs (enforceable primary drinking water standard). Both mean and maximum concentrations of 1,2-dichloroethenes exceeded the proposed MCLs. Lead concentrations exceeded the proposed MCLG of 0.0 $\mu\text{g/L}$, although they are considerably less than the current MCL of 50 $\mu\text{g/L}$.

No comparisons with ARARs are shown for Sites 3 and 4. No contaminants were detected at Site 3 except one soil sample with a low concentration of petroleum hydrocarbons, for which there are no pertinent federal ARARs. No ARAR evaluation was conducted for Site 4 since ground water was not sampled at this site and there are no federal ARARs for sediments. Sites 3 and 4 are discussed in the next section concerning potential non-federal guidelines.

Table 7-4 provides the ARAR comparisons for Site 5A (fenceline area). The observed level of TCE in ground water at Site 5A (single sample) exceeds the MCL. No comparisons are given for Site 5B (former UST area) because there were no contaminants detected in ground water and there are no pertinent federal ARARs for the contaminants detected in the soil samples.

The ARAR comparison for Site 7 is given in Table 7-5. Methylene chloride in ground water exceeded the FWQC adjusted for drinking water only (0.19 $\mu\text{g/L}$). Concentrations of lead reported for Site 7 exceeded the proposed MCLG of 0 $\mu\text{g/L}$, although they are considerably below the current MCL of 50 $\mu\text{g/L}$. Note that the QA/QC validation process qualified the lead and methylene chloride data for Site 7 as insignificant compared with concentrations found in associated blanks.

7.3.3 Identification of non-Federal ARARs

The state of Oregon's drinking water standards are the same as the federal limits (e.g., MCLs). No additional standards are included beyond those promulgated by the federal drinking water regulations.

Table 7-3

COMPARISON OF GROUND WATER CONCENTRATIONS WITH ARARS AT SITE 2
OREGON AND PORTLAND
PORTLAND IAP, PORTLAND, OREGON

CHEMICAL	Mean ^a Concentration in Ground Water (µg/L)	Maximum ^b Concentration in Ground Water (µg/L)	Comparison ^c Mean Concentration vs. ARAR	Comparison ^c Maximum Concentration vs. ARAR
INORGANICS				
Cadmium	0.47	0.49		
Chromium	7.00	7.00		
Lead	3.90	3.90	>pr. MCLG 0 µg/L ^d	>pr. MCLG 0 µg/L ^d
Zinc	13.00	15.00		
ORGANICS				
1,2-Dichloroethenes	80.00	130.00	>pr. MCL, 70 µg/L; >pr. MCL, 70 µg/L;	>pr. MCL, 100 µg/L; >pr. MCLG, 100 µg/L;
Trichloroethene	580.00	710.00	>MCL, 5 µg/L; >FWQC, (2.8) µg/L; >MCLG, 0 µg/L	>MCL, 5 µg/L; >FWQC, (2.8) µg/L; >MCLG, 0 µg/L

MCL Maximum Contaminant Level, U.S. EPA Primary Drinking Water Standards.

MCLG Maximum Contaminant Level Goal, U.S. EPA health-based guideline used in the development of MCLs.

FWQC Federal Ambient Water Quality Criteria adjusted for drinking water only.

() Indicates FWQC values corresponding to the 10-6 risk level.

^a Arithmetic mean of sampling set. Not detected results were excluded from analysis and calculation of the arithmetic mean. All detected results were included regardless of associated blank contamination. Field replicate results were averaged and then used as a single value along with the other field sample results to calculate the mean.

^b All detected results were included regardless of associated blank contamination. Field replicate results were averaged and then used as a single value along with the other field sample results to determine the maximum concentration.

^c Results are entered into table only if ARARs are exceeded.

^d Observed concentrations of lead were all less than the present MCL (50 µg/L).

pr Proposed MCL or MCLG.

Table 7-4

COMPARISON OF GROUND WATER CONCENTRATIONS WITH ARARS AT SITE 5A (FENCELINE AREA)
OREGON AND PORTLAND
PORTLAND IAP, PORTLAND, OREGON

CHEMICAL	Mean ^a Concentration in Ground Water (µg/L)	Maximum ^b Concentration in Ground Water (µg/L)	Comparison ^c Mean Concentration vs. ARAR	Comparison ^c Maximum Concentration vs. ARAR
INORGANICS				
Cadmium	0.51	0.51		
Sulfate	42,000.00	42,000.00		
Zinc	8.00	8.00		
ORGANICS				
Bis(2-ethylhexyl)phthalate	98.00	98.00		
Trichloroethene	6.20	6.20	>MCL, 5 µg/L; >FWQC, (2.8) µg/L; >MCLG, 0 µg/L	>MCL, 5 µg/L; >FWQC, (2.8) µg/L; >MCLG, 0 µg/L

MCL Maximum Contaminant Level, U.S. EPA Primary Drinking Water Standards.

MCLG Maximum Contaminant Level Goal, U.S. EPA health-based guideline used in the development of MCLs.

FWQC Federal Ambient Water Quality Criteria adjusted for drinking water only.

() Indicates FWQC values corresponding to the 10-6 risk level.

^a Arithmetic mean of sampling set. Not detected results were excluded from analysis and calculation of the arithmetic mean. All detected results were included regardless of associated blank contamination. Field replicate results were averaged and then used as a single value along with the other field sample results to calculate the mean.

^b All detected results were included regardless of associated blank contamination. Field replicate results were averaged and then used as a single value along with the other field sample results to determine the maximum concentration.

^c Results are entered into table only if ARARs are exceeded.

pr Proposed MCL or MCLG.

Table 7-5

COMPARISON OF GROUND WATER CONCENTRATIONS WITH ARARS AT SITE 7
OREGON AND PORTLAND
PORTLAND IAP, PORTLAND, OREGON

CHEMICAL	Mean ^a Concentration in Ground Water (µg/L)	Maximum ^b Concentration in Ground Water (µg/L)	Comparison ^c Mean Concentration vs. ARAR	Comparison ^c Maximum Concentration vs. ARAR
INORGANICS				
Lead	5.50	14.00	>pr. MCLG, 0 µg/L ^d	>pr. MCLG, 0 µg/L ^d
ORGANICS				
Methylene Chloride	5.00	5.00	>FWQC (0.19) µg/L	>FWQC (0.19) µg/L

NOTE: ALL CONCENTRATIONS IN ENVIRONMENTAL SAMPLES LISTED ABOVE ARE CONSIDERED INSIGNIFICANT IN COMPARISON WITH CONCENTRATIONS DETECTED IN ASSOCIATED BLANK SAMPLES, PER DATA VALIDATION GUIDELINES (SEE SECTION 8.0).

MCL Maximum Contaminant Level, U.S. EPA Primary Drinking Water Standards.

MCLG Maximum Contaminant Level Goal, U.S. EPA health-based guideline used in the development of MCLs.

FWQC Federal Ambient Water Quality Criteria adjusted for drinking water only.

() Indicates FWQC values corresponding to the 10-6 risk level.

^a Arithmetic mean of sampling set. Not detected results were excluded from analysis and calculation of the arithmetic mean. All detected results were included regardless of associated blank contamination. Field replicate results were averaged and then used as a single value along with the other field sample results to calculate the mean.

^b All detected results were included regardless of associated blank contamination. Field replicate results were averaged and then used as a single value along with the other field sample results to determine the maximum concentration.

^c Results are entered into table only if ARARs are exceeded.

^d Observed concentrations of lead were all less than the present MCL (50 µg/L).

pr Proposed MCL or MCLG.

The state of Oregon water quality regulations (OAR 340-41) adopt the FWQC as the state's water quality standards for maximum concentration limits for toxic substances. No standards in addition to the FWQC are included in these regulations.

Several other non-federal requirements and chemical-specific criteria have been identified which appear to be pertinent as potential ARARs or TBC guidelines for determining the need for remediation for the ANG Portland sites. These requirements are discussed in the following sections.

Oregon Environmental Cleanup Law and Rules

As a complement to the federal EPA Superfund program, the state of Oregon's *Environmental Cleanup Law and Cleanup Rules* (ORS 466.540 to 466.590 and OAR 340-122-001 to 340-122-110) provide for state regulation of the investigation and cleanup of sites contaminated by hazardous substances. The state law and rules address contaminated sites not eligible for federal attention (e.g., non-NPL sites), and require phases of an investigation similar to those required under CERCLA (i.e., Preliminary Assessment, Interim Removal Actions, Remedial Investigations, Feasibility Studies, Selection of the Remedial Action, Public Notice and Participation, and Administrative Record). However, the procedures or substantive requirements of the federal CERCLA program have not been specifically adopted.

Although the ANG Portland sites are being studied under a federal program, the cleanup standards prescribed in the Oregon Environmental Cleanup Rules will be applicable to restoration actions. Under these rules, sites must be cleaned up to the background (pre-release) level of any hazardous substances, unless attainment of background levels is not feasible. If cleanup to background is found to be unfeasible, the Director of DEQ must select an alternative remedial action that is both feasible and protective (of public health, safety, welfare, and environment). A protective level, or maximum concentration of hazardous substance which can remain at the site, is then determined based on site-specific risk assessment, site characterization, existing numeric standards, and relevant

scientific information. Risk assessments must be in accord with EPA guidance and must involve exposure scenarios which address present and potential future uses of the environment.

The state cleanup law does not specify any federal ARARs nor does it provide any numerical standards as cleanup guidelines. In the language of the program, the cleanup goal is: "background is best, cleaner is better." The burden for proposing and defending a protective level at a given site rests with the responsible party.

Oregon Cleanup Rules for Leaking Petroleum UST Systems

The state of Oregon has recently established rules and numeric cleanup criteria for releases of petroleum products subject to its underground storage tank (UST) regulatory program (OAR 340-122-205 to 340-122-360). These regulations include a set of rules which define numeric soil cleanup levels for motor fuel and heating oil. The cleanup criteria stipulate permissible concentrations of petroleum hydrocarbons (PHCs) in which can be left in soil after remediation of the leaking UST. The applicable numeric concentration depends on the environmental sensitivity of the particular situation and the type of product released (i.e., gasoline or non-gasoline). A scoring system is used to rank the sensitivity level of a given site; cleanup standards for Level 1 are more stringent than those for Levels 2 and 3 (see Appendix I for scoring example).

The cleanup criteria for gasoline are more stringent than those for non-gasoline products (e.g., 40 ppm PHC for gasoline versus 100 ppm PHC for diesel for Level 1 sites). Gasoline criteria are more stringent because of the greater fraction of BTEX (benzene, toluene, ethylbenzene, and xylenes) normally present in gasoline compared with other types of fuels. DEQ considers the BTEX compounds to comprise those chemicals of greatest environmental concern in petroleum products.

The UST Cleanup Rules specify that the more stringent gasoline PHC cleanup levels must be used to determine if further remediation is required, unless specific analytical testing demonstrates that the contaminant is a non-gasoline fraction

hydrocarbon (e.g., diesel). To qualify as non-gasoline, the analysis must show at least 50% of the hydrocarbon content to consist of compounds with more than 11 carbon atoms. The regulations state that a site is considered sufficiently clean only when all of the sampled areas are analyzed by EPA Method 418.1 (EPA, 1983) to show they have concentrations less than or equal to the required cleanup level.

The UST Cleanup Rules also require that samples be analyzed for benzene, toluene, ethylbenzene, and total xylenes (BTEX). However, regulatory standards for allowable BTEX concentrations in soil have not been established. The significance of the BTEX concentrations in soil and ground water is left to the discretion of DEQ and determined on a case by case basis.

The soil cleanup criteria are only applicable in cases where sampling and analysis have demonstrated no impact to the underlying aquifer. For sites where ground water contamination has been found, more investigation is required and a Corrective Action Plan must be submitted for review by the Oregon Department of Environmental Quality (DEQ). In cases where the magnitude and complexity of a release demands extensive investigation, DEQ may require the remedial investigation and actions to be performed pursuant to Oregon's Environmental Cleanup Law and Rules (described above).

State Sediment Quality Standards

The state of Oregon is currently developing numeric standards for contaminants in sediment that can be used in determining cleanup decisions for fresh water resources. The director of the Oregon DEQ sediment quality program was contacted concerning the status of the program. He indicated that interim standards are forthcoming and that the numeric standards would be comparable to those recently published by the Washington Department of Ecology (WDOE) for the Puget Sound area (Foster, 1990).

The interim standards developed by WDOE include criteria for concentrations of common metals, polar organic compounds (e.g., phenols), and non-polar organic compounds (e.g., PAHs) in sediments (WDOE, 1989). The criteria represent

concentrations in sediments that are predicted to have no adverse effects on biological resources based on a data base developed for Puget Sound. Although the criteria were developed for the marine environment, WDOE has begun using them to evaluate fresh water situations in the absence of criteria specifically derived for fresh water environment (Betts, 1990). Since no better standards are presently available and because forthcoming Oregon fresh water standards are expected to be similar, the WDOE interim sediment standards are considered pertinent as TBC guidance in evaluating remediation requirements for the ANG Portland IRP sites (e.g., Site 4 - Main Drainage Ditch).

3.3.4 Comparison with non-Federal ARARs

Site 3 - Hush House Area

Environmental sampling for this site has provided the following results:

- Prior to the SI, PHCs were detected at concentrations up to 17 mg/kg in soil samples collected in a separate study. These results were not verified by the SI program results even though samples were collected from the same area.
- Petroleum hydrocarbons (PHCs) were just barely detected (2.0 U^a mg/kg) in one of eight soil samples during the SI phase.
- Benzene, toluene, ethylbenzene, and xylenes were not detected in any of the soil or ground water samples.
- PHCs, VOCs, and BTEX compounds were not detected in the ground water.

Site 3 does not involve an underground storage tank and hence is not subject to Oregon's UST cleanup regulations. However, the cleanup criteria contained in these regulations are deemed pertinent as TBC guidelines for assessment of contamination at this site, since PHCs are the contaminants of interest and no other ARARs are available for PHCs in soil media.

Under the UST Cleanup Rules, no cleanup of soils would be necessary for soils shown to have PHC concentrations less than 80 ppm for gasoline-type products or less than 500 ppm for non-gasoline type petroleum products (e.g., diesel fuel). This is based on environmental sensitivity scoring shown in Appendix I, resulting in Level 2 cleanup criteria being applicable. The observed PHC concentrations

in soil samples from the site are all far below this cleanup standard. Even if the most stringent cleanup standards (Level 1) were applicable, the soil PHC concentrations at the site would still be much less than the criteria (i.e., 40 ppm for gasoline, 100 ppm for diesel). This comparison indicates that no further remediation activity should be needed at Site 3.

A Decision Document recommending that no further remedial investigations are necessary at Site 3 was prepared as part of the Fast-track SI efforts. This document was based on the draft version of the UST Cleanup Rules, since the final rules had not yet been promulgated. The draft version contained somewhat different methodology and numerical cleanup standards. Nonetheless, evaluation of Site 3 using the final rules, as described above, does not modify the overall conclusions and recommendations stated in the Decision Document.

Site 4 - Main Drainage Ditch

Sediments sampled from the Base Main Drainage Ditch were analyzed for PHCs and five metals. The analytical results for the metals are compared with the WDOE interim sediment quality chemical criteria in Table 7-6. The comparison shows that the criteria were not exceeded by any of the concentrations detected in the sediment samples. The cadmium concentration in S4-3 came closest to the criterion, but was still almost two times lower than the standard. The WDOE criteria include no numerical standards for assessment of PHC concentrations.

Site 5B - Former UST Area (AGE Maintenance Shop)

This site is clearly subject to the state of Oregon UST Cleanup Rules based on site history and the results of the SI sampling and analysis program. The Base has satisfied the early steps required by these rules by removing the diesel fuel from the tank, removing the tank, cleaning up residual free product in the pit, sampling the soil from the bottom of the pit, and reporting to DEQ.

The analytical results for the samples taken by the Base showed petroleum hydrocarbon (PHC) concentrations as high as 11,300 ppm in soil collected about two feet below the bottom of the pit. Additional sampling by SAIC during the SI included samples from the bottom of the pit as well as its periphery. These

Table 7-6
 COMPARISON OF SITE 4 SEDIMENT CONCENTRATIONS WITH WDOE INTERIM SEDIMENT QUALITY STANDARDS
 OREGON AND PORTLAND
 PORTLAND IAP, PORTLAND, OREGON

Chemical Parameter	WDOE Interim Sediment Quality Standard	METAL CONCENTRATIONS IN SEDIMENTS, mg/kg dry wt basis						
		S4-1	S4-2	S4-3	S4-4	S4-5	S4-6	S4-7
Cadmium	5.1	1.6	0.44	2.9	0.26	0.65	0.27	1.1
Chromium, total	260	35	26	28	9.6	11	6.4	20
Lead	390	41	13	58	7.1	6.9	4.0	42
Nickel	450	120	24	16	9.3	8.0	5.7	12
Zinc	410	120	83	330	68	120	59	76

(mg/kg)

samples were analyzed by a different method than those taken by the Base, and showed generally lower concentrations (up to 200 S mg/kg). All the samples were collected and analyzed prior to development of the UST cleanup regulations; none of the samples were analyzed by the particular analytical method prescribed in these rules. Although diesel fuel was stored in the tank, none of the samples were analyzed to determine the fraction of hydrocarbons larger than eleven carbon atoms and hence demonstrate that the contaminant is a non-gasoline fraction hydrocarbon.

Application of the UST cleanup regulations requires evaluation of the site conditions to determine the appropriate cleanup level based on its environmental sensitivity. As shown in Appendix I, the scoring for Site 5B results in Level 2 cleanup criteria being applicable. For diesel fuel, the Level 2 criterion is 500 ppm PHC. In comparison with this cleanup level, the environmental data indicate that the soil outside the perimeter of the pit walls may not require cleanup, but that the bottom of the pit requires further action.

Ground water sampling was performed near the pit, with analytical results showing no PHCs, BTEX, or VOCs to be present. The well was installed in the apparent upgradient direction from the pit and the fine-grained soils in which it was screened made it difficult to obtain a representative sample of the ground water. For these reasons, the SI analytical data are not sufficient to demonstrate whether or not the ground water at the site has been impacted by the former leaking tank. (Note that it had been intended to install the well downgradient of the pit. However, the well was installed during the first field episode prior to any ground water level measurements being made at the Base; at that time, it was surmised that ground water flowed southward toward Columbia Slough and hence the well was placed south of the pit.)

Sites 1, 2, and 7 - Petroleum Hydrocarbons

Petroleum hydrocarbons (PHCs) were found in soil samples collected from each of Sites 1, 2 and 7, either by the SI sampling program or by prior investigators (see Section 4.0). Following the same reasoning explained above for Site 3, the state UST Cleanup Rules are deemed pertinent as TBC guidance for assessment of

soil PHC contamination at these sites. Environmental sensitivity scoring resulted in Level 2 cleanup criteria being applicable for all three sites (see Appendix I). The Level 2 PHC cleanup levels are 80 ppm for gasoline-type products and 500 ppm for non-gasoline fraction products (e.g., diesel).

For Site 1, the non-gasoline criterion (500 ppm) should apply since BTEX compounds were not detected in the soil or ground water at the site. One of two samples analyzed prior to the SI program had a concentration of 594 mg/kg which slightly exceeds the UST cleanup standard. The other pre-SI sample had a concentration of only 12 mg/kg, which is much less than cleanup level. The high PHC concentration found in the prior investigation was not verified during the SI program, even though 24 samples were collected at the site, including the same area sampled in the prior investigation (Table 6-2). The maximum concentration of PHC reported from the SI program samples was 43 M mg/kg, which is far below the UST cleanup criteria.

PHCs were not detected in significant concentrations in any of the SI program Site 2 soil samples. However, a sampling investigation conducted prior to the SI program reported PHC concentrations up to 35 mg/kg in the soils at Site 2 (see Section 4.0). The UST cleanup criterion for this site would be no greater than 80 ppm for gasoline-type fractions. The maximum PHC concentration reported for Site 2 does not exceed this cleanup level.

BTEX compounds were detected in the soil gas samples at Site 7. Hence the Level 2 cleanup criterion for gasoline-type products should apply (80 ppm). This cleanup standard was not exceeded by any of the PHC concentrations reported in the Site 7 soil samples collected as part of the SI program (Table 6-17).

7.4 EXPOSURE ASSESSMENT

Exposure assessment addresses several major issues: (1) the behavior of site-related contaminants in the environment; (2) identification of receptors at risk and routes of exposure; (3) projecting environmental concentrations of site-related chemicals at points of exposure; and (4) characterizing dose. It is critical that the results of risk assessment be interpreted in the context of

the exposure assumptions/scenarios that form the basis of the evaluation. Much of the uncertainty in the results of risk assessment may be attributed to the assumptions used in the exposure assessment.

Derivation of risk estimates were based on estimates of the "reasonable maximum exposure" of ANG Portland personnel to chemicals in ground water and soils. These estimates are measures of hypothetical risk to a maximally exposed individual. The hypothetical exposures included consideration of both current and potential activity at the sites, including possible future use of the ground water as a drinking water resource. At all sites, risks were characterized separately for exposure to each environmental medium. Combined (i.e., simultaneous) exposure to chemicals originating from more than one site was assumed not to be a concern.

Separate exposure estimates were made for (1) surface soils and (2) surface plus subsurface soils. The latter estimates relate to hypothetical exposure routes due to possible construction activities at the sites in the future. Although there is currently no exposure to the soils below the land surface at the sites under investigation, the risk characterization including subsurface soils was conducted in order to develop a screening-level measure of potential risks for such site activity (e.g., possible future construction and development). The subsurface soil scenario was evaluated for those sites where construction could likely occur (e.g., not evaluated for Site 4 - Main Drainage Ditch).

7.4.1 Exposure Assumptions for the Ground Water Ingestion Pathway

The following assumptions are the basis of the exposure assessment for ground water. These assumptions have been used in developing the chronic dose estimates of hypothetical exposure of human receptors to ground water beneath Sites 1, 2, 5, and 7:

- The receptors hypothetically at risk are 70 kg adults (Base personnel) projected to ingest 2 liters of water per day, 5 days per week, 50 weeks per year, for 20 years of service over a 70 year lifetime. Note that no one at ANG Portland or in the vicinity is known to be currently using water beneath the sites as a source of drinking water.

This hypothetical exposure estimate has been developed for comparative purposes in evaluating the magnitude of ground water contamination at the sites under investigation.

- All chemicals in ground water were considered to be conservative (i.e., they do not transform or degrade over the period of exposure).
- Dose estimates were derived based on mean concentrations (arithmetic mean) of chemicals reported in ground water samples. For samples with field replicates, the replicate results were averaged and used as one sample value along with the remaining samples values to calculate the arithmetic mean for the given media and site.

Samples with analytical results reported by the laboratory as below detection limits were excluded from analysis and calculation of the arithmetic mean. Note that this introduces a very conservative bias into the risk assessment. This is because the estimates of mean concentrations are higher than if the results for all the samples had been included (e.g., assuming chemicals to be present in all samples at a minimum concentration equal to the detection limit or one half the detection limit).

- All chemicals in ground water were considered to be 100% bioavailable for uptake and absorption by humans.

7.4.2 Exposure Assumptions for the Surface Soil/Sediment Ingestion Pathway

The receptors at greatest risk of contact with contaminated surface soils and exposed sediments are the ANG Portland personnel. Given that the facility is fenced, guarded, and isolated, the potential risks to the general population are insignificant in comparison. The pathway that is projected to drive the overall magnitude of the exposure estimate is direct, inadvertent ingestion of soils. The following assumptions were used in the assessment of exposure of personnel at the facility to chemicals in surficial soils or sediments:

- Base personnel are the receptors at primary risk. These receptors are 70 kg adults, projected to inadvertently ingest 0.1 grams of soil 5 days per week, 52 weeks per year, for 20 years of service over a 70 year lifetime.

The ingestion route for sediments presumes that human receptors may ingest sediments via similar routes as assumed for surface soils if and when the water in the ditch recedes or dries up and sediments are exposed (e.g., summer months). Since the ditch is full of water most of the year, the above exposure assumptions are very conservative.

- All chemicals in surficial soils or exposed sediments are considered to be conservative i.e., they do not transform or degrade over the period of exposure.
- Dose estimates are derived based on mean levels of chemicals measured in surface samples i.e., 0 to 3 feet below land surface (BLS). Not-detected results were excluded from the analysis and calculation of the arithmetic means.
- All chemicals in soils and sediments are considered to be 100% bioavailable for uptake and absorption by humans.

7.4.3 Exposure Assumptions for the Subsurface Soils

The same assumptions presented above for surficial soils were adopted for hypothetical exposure to subsurface soils. Inadvertent direct ingestion exposure was assumed to be the pathway of concern. The only difference from the surface soil exposure scenario was in the development of dose estimates. In deriving estimates of long-term dose for the subsurface soil scenario, mean concentrations of contaminants in the full soil column were used instead of the levels in the surficial samples. It was assumed that construction could occur at the site. During this activity, subsurface soils would be uncovered and mixed, and workers could be exposed to chemicals in the full soil column. In addition, long-term exposure of Base personnel to surficial soils *following* construction activity could include concentrations from throughout the entire soil column, due to the uncovering and mixing of the subsurface soils.

7.5 TOXICITY ASSESSMENT

Toxicity measures are required in order to evaluate the results of exposure assessment and derived estimates of chronic dose. The preliminary risk assessment for ANG Portland focused on the potential for long-term effects of exposure to chemicals present in ground water and soils. As discussed in Appendix G, the toxicity measures of greatest importance for evaluating risk to human receptors are the EPA reference doses (RfDs) and carcinogenic potency factors.

Table 7-7 is a listing of available toxicity measures for all chemicals identified at the ANG Portland sites under evaluation. These measures were

Table 7-7

TOXICITY MEASURES FOR WASTE SITE EVALUATION: INGESTION AND INHALATION PATHWAYS
 OREGON AND PORTLAND
 PORTLAND IAP, PORTLAND, OREGON

Compound	Noncarcinogenic Effects		Noncarcinogenic Effects		Source	EPA RfD Chronic Exposure	Noncarcinogenic Effect of Concern	Carcinogenic Potency Factor (q ₁ *) Oral Exposure (mg/kg/day) ⁻¹	Source Carcin. Potency Factor (Oral)	Carcinogenic Potency Factor Inhalation (mg/kg/day) ⁻¹	Source Carcin. Potency Factor (Inhalation)
	RfD-S ^a	RfD-C ^b	RfD-S ^a	RfD-C ^b							
Chromium	...	5.00E-04	...	5.00E-04	d	d,j	Kidney			6.10E+00 (B1)	d
Chromium	2.00E-02	5.00E-03	2.00E-02	5.00E-03	d	d,j	Skin			4.10E+01 (A)	d
Chromium (vi)	2.00E-02	5.00E-03	2.00E-02	5.00E-03	d	d,j	Kidney				
Lead	...	1.40E-03	...	1.40E-03	d,e	d,j	CNS, Kidney				
Nickel	2.00E-02	2.00E-02	0.00E+00	2.00E-02	c,d	c,d,j	Skin, Lung				
Zinc	2.00E-01	2.00E-01	...	2.00E-01	d	d,j	Anemia				
ORGANICS											
Acetone	...	1.00E-01	...	...	d		Liver, Kidney	2.90E-01 (A)	d	2.90E-01 (A)	d
Benzene	...	...	...	...	d,f		Hematopoietic Liver, CNS				
Bromochloromethane	1.00E-02	1.00E-03	...	...					
Bis(2-ethylhexyl) phthalate	2.00E-02	2.00E-02	2.00E-02	2.00E-02	d	d,j	Liver	1.40E-02 (B2)	d	1.40E-02 (B2)	d,m
1,2-Dichloroethene	9.00E-03	9.00E-03	...	...	d,g		Liver, Kidney, CNS				
Ethylbenzene	1.00E+00	1.00E-01	...	...	d		Skin, Liver, Kidney				
Methylene Chloride	6.00E-02	6.00E-02	6.00E-02	6.00E-02	d	d,j	Liver, Kidney, CNS	7.50E-03 (B2)	d	4.70E-07 (B2)	d
Trichloroethene	1.00E-01	1.00E-02	1.00E-01	1.00E-02	d,h	c,k,j	Liver, Kidney, CNS	1.10E-02 (B2)	d	1.70E-02 (B2)	d
xylene	4.00E+00	2.00E+00	7.00E-01	4.00E-01	d	d,m	CNS				

^a RfD = Reference dose for subchronic (short-term) exposure.

^b RfD = Reference dose for chronic (long-term) exposure.

^c IRLS DATA BASE.

^d U.S. EPA GBD Health Effects Assessment Summary Tables (HEAST) FY 1989, or Superfund Public Health Evaluation Manual (1986).

^e Reference doses for lead is under evaluation by EPA. The RfD listed in this table has been used in the absence of a more recent toxicity measure.

^f In the absence of toxicity data, the RfD for bromomethane has been adopted for bromochloromethane.

^g In the absence of toxicity data, the RfD for 1,1-Dichloroethene have been adopted for 1,2-Dichloroethene.

^h In the absence of toxicity data, the RfDs for PCE have been adopted for TCE.

ⁱ RfDs or potency factors for the oral exposure route have been used in the absence of toxicity data for the inhalation route.

^j In the absence of toxicity data, the reference dose for tetrachloroethene is used for trichloroethene.

^k Toxicity measures presented are for mixed xylenes.

obtained primarily from the EPA Integrated Risk Information System (IRIS) on-line data base and the EPA Health Effects Assessment Summary Tables (EPA 1989c). The EPA Superfund Public Health Evaluation Manual (EPA, 1986a) was used as a secondary source. In the absence of toxicity data, RfDs have been assigned to subject chemicals based on structural/toxicological similarities (i.e., similarities to those compounds for which RfDs are available). In addition to the toxicity measures, Table 7-7 provides an indication of the primary noncarcinogenic effect of concern (i.e., the organ system or tissue that is the primary target of the toxic manifestation of the subject chemical).

7.6 RISK CHARACTERIZATION

Risk characterization brings together the results of the toxicity and exposure assessments. Estimates of chronic dose are compared and combined with the selected toxicity measures to develop an indication of the potential for adverse health effects. (See Appendix G for more detailed information on the methods used in risk characterization).

In the following sections, risk characterization results are presented in a summary table for each site and exposure scenario evaluated (see, for example, Table 7-8 for Site 1 ground water). Each table lists the calculated mean concentrations of chemical contaminants observed in the environmental samples. Based on these mean values, estimates of chronic lifetime dose were developed, and the measures used in risk characterization were derived: (1) a hazard index for noncarcinogenic effects; and (2) a measure of the excess lifetime probability of cancer. Risk estimates are shown separately for exposure to each chemical, and then for combined exposure to all chemicals of concern for the given site and scenario.

7.6.1 Site 1: Central Hazardous Waste Storage Area

Table 7-8 presents the results of risk characterization for chemicals in ground water at Site 1. The Hazard Index for this scenario was calculated to be approximately 3×10^4 . The magnitude of this estimate is driven by the very high concentrations of bromochloromethane found in ground water. A verified EPA reference dose is not available for this compound. In the absence of toxicity

Table 7-8

RISK CHARACTERIZATION FOR SITE 1: EXPOSURE TO GROUND WATER
OREGON AND PORTLAND
PORTLAND IAP, PORTLAND, OREGON

Compound	Mean ^a Concentration in Ground Water (µg/L)	Noncarcinogenic Effects ^b (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk ^b (Dose x q1*)
INORGANICS				
Iron	1100.00			
Zinc	14.00	1.37E-03	Anemia	
ORGANICS				
Bis(2-ethylhexyl)phthalate	21.00	2.06E-02	Liver	1.65E-06
Bromochloromethane	170,000.00	3.34E+03	Liver, CNS	
Methylene Chloride	1200.00	3.92E-01	Liver, Kidney, CNS	5.05E-05
Hazard Index: Combined Exposure		3.34E+03		
Excess Lifetime Cancer Risk: Combined Exposure				5.21E-05

^a Arithmetic mean of sampling set. Not detected results were excluded from analysis and calculation of the arithmetic mean. All detected results were included regardless of associated blank contamination. Field replicate results were averaged and then used as a single value along with the other field sample results to calculate the mean.

^b Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated ground water. Exposure assumptions: consumption of 2 liters of water per day, by a 70 kg adult, 5 days per week, 50 weeks per year, for 20 years of a 70-year lifetime.

q₁* Carcinogenic potency factor.

data, the RfD for bromomethane was adopted based on analogous chemical structure. Using this toxicity measure, the risks of adverse noncarcinogenic effects are projected to be unacceptably high for personnel hypothetically exposed to ground water over the assumed 20 year period, and for the other exposure assumptions presented above.

The excess lifetime cancer risk is projected to be approximately 5×10^{-5} for exposure to bis(2-ethylhexyl)phthalate and methylene chloride. This hypothetical risk estimate exceeds the acceptable point of departure value established by EPA for protection of human health and selection of remedial alternatives under the Superfund program (i.e., an excess lifetime cancer risk of 10^{-7} [EPA, 1988b,c, U.S. EPA, 1989a]). The NCP indicates that health advisory or cleanup levels are to be selected such that the total risk of all contaminants falls within the acceptable range of 10^{-4} to 10^{-7} (53 FR 51394).

However, the 10^{-4} level is not intended as an acceptable level for deciding that a given site requires no additional investigation, but rather it may be appropriate as a cleanup level in cases where 10^{-7} levels cannot be achieved. For contaminants found to present in the soils at Site 1, a separate risk assessment was performed in conjunction with Fast-track and Expanded SI sampling episodes described in Section 6.0 (SAIC, 1989b). A summary of this risk assessment is given in Section 7.7.

7.6.2 Site 2: Civil Engineering Hazardous Material Storage Area

Table 7-9 presents the results of risk characterization for chemicals in ground water at Site 2. The Hazard Index is calculated to be approximately 1.4. This value exceeds unity (i.e., 1.0) and reflects a limited potential for adverse noncarcinogenic effects in populations chronically exposed to this ground water as a source of drinking water.

The excess lifetime cancer risk of hypothetical exposure to TCE is projected to be approximately 3.6×10^{-5} . This hypothetical risk estimate exceeds the 10^{-7} point of departure established by EPA under the Superfund program. Although no one is currently using this water as a potable supply, it cannot be considered

Table 7-9

RISK CHARACTERIZATION FOR SITE 2: EXPOSURE TO GROUND WATER
OREGON AND PORTLAND
PORTLAND IAP, PORTLAND, OREGON

Compound	Mean ^a Concentration in Ground Water (µg/L)	Noncarcinogenic Effects ^b (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk ^d (Dose x q1*)
INORGANICS				
Cadmium	0.47	1.84E-02	Kidney	
Chromium	7.00	2.75E-02	Skin	
Lead	3.90	5.47E-02	CNS, Kidney	
Zinc	13.00	1.28E-03	Anemia	
ORGANICS				
1,2-Dichloroethene	80.00	1.74E-01	Liver, Kidney, CNS	
Trichloroethene	580.00	1.14E+00 ^c	Liver, Kidney, CNS	3.58E-05 ^c
Hazard Index: Combined Exposure		1.41E+00		
Excess Lifetime Cancer Risk: Combined Exposure				3.58E-05

^a Arithmetic mean of sampling set. Not detected results were excluded from analysis and calculation of the arithmetic mean. All detected results were included regardless of associated blank contamination. Field replicate results were averaged and then used as a single value along with the other field sample results to calculate the mean.

^b Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated ground water. Exposure assumptions: consumption of 2 liters of water per day, by a 70 kg adult, 5 days per week, 50 weeks per year, for 20 years of a 70-year lifetime.

^c Although calculated risks appear moderate, the TCE concentrations greatly exceed the drinking water MCL of 5 µg/L.

q1* Carcinogenic potency factor.

suitable as a drinking water supply given the projected excess lifetime cancer risk and that the measured TCE concentrations (i.e., 580 $\mu\text{g/L}$) far exceeded the MCL of 5.0.

Chemicals were not detected in soils at Site 2. Therefore, no risk assessment was conducted for exposure to soils.

7.6.3 Site 3: Hush House Area

No specific compounds were detected at Site 3; hence, no risk characterization calculations could be performed. PHCs were detected in prior studies; these results were compared with state ARARs in Section 7.3.4.

7.6.4 Site 4: Main Drainage Ditch

Table 7-10 presents the results of the preliminary risk assessment for hypothetical exposure to surficial sediments of the Main Drainage Ditch (Site 4). Dose estimates were derived for chronic ingestion exposure to Base personnel. As shown in Table 7-10, the Hazard Index was calculated to be approximately 2.5×10^{-2} . No adverse noncarcinogenic effects would be anticipated in personnel inadvertently exposed to these sediments over the projected 20 year exposure period given the exposure assumptions presented above. No carcinogenic compounds (i.e., by the oral route) were found in sediments at the site.

7.6.5 Site 5A: AGE Maintenance Shop - Fenceline Area

Table 7-11 presents the results of risk characterization for chemicals in ground water at Site 5A (Fenceline Area). The Hazard Index for ground water at Site 5A was calculated to be approximately 1.3×10^{-1} . This value is less than unity (i.e., 1.0) and no adverse noncarcinogenic effects would be anticipated in populations chronically exposed to this ground water as a source of drinking water. The excess lifetime cancer risk of hypothetical exposure to ground water is projected to be approximately 8.1×10^{-6} . This hypothetical risk estimate exceeds the acceptable point of departure of 10^{-7} established by EPA under the Superfund program and is based on considering both trichloroethene and bis(2-

Table 7-10

RISK CHARACTERIZATION FOR SITE 4: EXPOSURE TO SEDIMENTS
OREGON AND PORTLAND
PORTLAND IAP, PORTLAND, OREGON

Compound	Mean ^a Concentration in Sediments (mg/kg)	Noncarcinogenic Effects ^b (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk ^d (Dose x q1*)
INORGANICS				
Cadmium	1.00	1.96E-03	Kidney	
Chromium	20.00	3.92E-03	Skin	
Lead	25.00	1.75E-02	CNS, Kidney	
Nickel	28.00	1.37E-03	Skin, Lung	
Zinc	120.00	5.89E-04	Anemia	
ORGANICS				
Acetone	0.25	2.45E-06	Liver, Kidney	
Hazard Index: Combined Exposure		2.54E-02		
Excess Lifetime Cancer Risk: Combined Exposure				

^a Arithmetic mean of sampling set. Not detected results were excluded from analysis and calculation of the arithmetic mean. All detected results were included regardless of associated blank contamination. Field replicate results were averaged and then used as a single value along with the other field sample results to calculate the mean.

^b Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated surficial sediments. Exposure assumptions: inadvertent ingestion of 0.1 grams of sediment per day, by a 70 kg adult, 5 days per week, 50 weeks per year, for 20 years of a 70-year lifetime.

q₁* Carcinogenic potency factor.

Table 7-11

RISK CHARACTERIZATION FOR SITE 5A: EXPOSURE TO GROUND WATER (FENCELINE AREA)
OREGON ANG PORTLAND
PORTLAND IAP, PORTLAND, OREGON

Compound	Mean ^a Concentration in Soils (mg/kg)	Noncarcinogenic Effects ^b (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk ^b (Dose x q1*)
INORGANICS				
Cadmium	0.51	2.00E-02	Kidney	
Sulfate	42,000.00			
Zinc	8.00	7.85E-04	Anemia	
ORGANICS				
Bis(2-ethylhexyl)phthalate	98.00	9.62E-02	Liver	7.69E-06
Trichloroethene	6.20	1.22E-02	Liver, Kidney, CNS	3.82E-07
Hazard Index: Combined Exposure		1.29E-01		
Excess Lifetime Cancer Risk: Combined Exposure				8.07E-06

^a Arithmetic mean of sampling set. Not detected results were excluded from analysis and calculation of the arithmetic mean. All detected results were included regardless of associated blank contamination. Field replicate results were averaged and then used as a single value along with the other field sample results to calculate the mean.

^b Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated ground water. Exposure assumptions: consumption of 2 liters of water per day, by a 70 kg adult, 5 days per week, 50 weeks per year, for 20 years of a 70-year lifetime.

q₁* Carcinogenic potency factor.

ethylhexyl)phthalate. However, the presence of bis(2-ethylhexyl)phthalate is not considered to be significant due to the presence of this compound in an associated QA/QC blank. Disregarding this compound in the risk estimate results in an excess lifetime cancer risk for trichloroethene alone of approximately 3.82×10^{-7} .

Tables 7-12 and 7-13 present the results of preliminary risk assessment for chemicals in soils at Site 5A. The assessment was conducted for hypothetical exposure to both surface and subsurface soils. The Hazard Indices for Site 5A soils were determined to be less than 1.0 for both exposure scenarios (surface soils as well as contaminants in the subsurface environment). No adverse noncarcinogenic effects would therefore be anticipated for hypothetical long-term ingestion exposure. The estimates of excess lifetime carcinogenic risk were below the acceptable range established by EPA under the Superfund Program for both Site 5A soils exposure scenarios. Both of the cancer risk estimates were less than 1×10^{-6} .

7.6.6 Site 5B: AGE Maintenance Shop - UST Area

Preliminary risk assessment results are presented in Table 7-14 for the subsurface soils exposure scenario. The Hazard Index for Site 5B soils was determined to be less than 1.0 for the chemicals observed in subsurface soils. No adverse noncarcinogenic effects would therefore be anticipated for hypothetical long-term ingestion exposure. The estimate of excess lifetime carcinogenic risk was below the acceptable range established by EPA under the Superfund Program for exposure to Site 5B subsurface soils. The cancer risk estimate was less than 1×10^{-6} .

Risk characterization was not conducted for the Site 5B surficial soils since surface soil samples were not collected at this site. Soil contaminants were not expected in these surface soils since the source of contamination was a leaking underground tank.

No chemicals were detected in ground water at Site 5B. For this reason, risk assessment was not performed for ground water at this location.

Table 7-12

RISK CHARACTERIZATION FOR SITE 5A: EXPOSURE TO SURFACE SOILS (FENCELINE AREA)
OREGON AND PORTLAND
PORTLAND IAP, PORTLAND, OREGON

Compound	Mean ^a Concentration in Soils (mg/kg)	Noncarcinogenic Effects ^b (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk ^b (Dose x q ₁ *)
INORGANICS				
Cadmium	1.500	2.94E-03	Kidney	
Chromium	27.000	5.30E-03	Skin	
Iron	29,000.000			
Lead	38.000	2.66E-02	CNS, Kidney	
Nickel	23.000	1.13E-03	Skin, Lung	
Zinc	128.000	6.28E-04	Anemia	
ORGANICS				
Acetone	0.082	8.05E-07	Liver, Kidney	
Bis(2-ethylhexyl)phthalate	1.600	7.85E-05	Liver	6.28E-09
Methylene Chloride	0.008	1.31E-07	Liver, Kidney, CNS	1.68E-11
Hazard Index: Combined Exposure		3.66E-02		
Excess Lifetime Cancer Risk: Combined Exposure				6.30E-09

^a Arithmetic mean of sampling set. Not detected results were excluded from analysis and calculation of the arithmetic mean. All detected results were included regardless of associated blank contamination. Field replicate results were averaged and then used as a single value along with the other field sample results to calculate the mean.

^b Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated surface soil. Exposure assumptions: inadvertent ingestion of 0.1 grams of soil per day, by a 70 kg adult, 5 days per week, 50 weeks per year, for 20 years of a 70-year lifetime.

q₁* Carcinogenic potency factor.

Table 7-13

RISK CHARACTERIZATION FOR SITE 5A: EXPOSURE TO FULL SOIL COLUMN (FENCELINE AREA)
OREGON ANG PORTLAND
PORTLAND IAP, PORTLAND, OREGON

Compound	Mean ^a Concentration in Soils (mg/kg)	Noncarcinogenic Effects ^b (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk ^b (Dose x q1*)
INORGANICS				
Cadmium	1.300	2.55E-03	Kidney	
Chromium	26.000	5.10E-03	Skin	
Iron	30,000.000			
Lead	27.000	1.89E-02	CNS, Kidney	
Nickel	22.000	1.08E-03	Skin, Lung	
Zinc	110.000	5.40E-04	Anemia	
ORGANICS				
Acetone	0.066	6.48E-07	Liver, Kidney	
Bis(2-ethylhexyl)phthalate	1.200	5.89E-05	Liver	4.71E-09
Methylene Chloride	0.008	1.31E-07	Liver, Kidney, CNS	1.68E-11
Hazard Index: Combined Exposure		2.82E-02		
Excess Lifetime Cancer Risk: Combined Exposure				4.73E-09

^a Arithmetic mean of sampling set. Not detected results were excluded from analysis and calculation of the arithmetic mean. All detected results were included regardless of associated blank contamination. Field replicate results were averaged and then used as a single value along with the other field sample results to calculate the mean.

^b Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated surface soil. Exposure assumptions: inadvertent ingestion of 0.1 grams of soil per day, by a 70 kg adult, 5 days per week, 50 weeks per year, for 20 years of a 70-year lifetime.

q1* Carcinogenic potency factor.

Table 7-14

RISK CHARACTERIZATION FOR SITE 5B: EXPOSURE TO FULL SOIL COLUMN (FORMER UST AREA)
OREGON AND PORTLAND
PORTLAND IAP, PORTLAND, OREGON

Compound	Mean ^a Concentration in Soils (mg/kg)	Noncarcinogenic Effects ^b (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk ^b (Dose x q1*)
ORGANICS				
Acetone	0.188	1.84E-06	Liver, Kidney	
Benzene	0.110		Hematopoietic	8.94E-09
Ethylbenzene	0.490	4.81E-06	Skin, Liver, Kidney	
Xylenes	1.100	5.40E-07	CNS	
Hazard Index: Combined Exposure		7.19E-06		
Excess Lifetime Cancer Risk: Combined Exposure				8.94E-09

^a Arithmetic mean of sampling set. Not detected results were excluded from analysis and calculation of the arithmetic mean. All detected results were included regardless of associated blank contamination. Field replicate results were averaged and then used as a single value along with the other field sample results to calculate the mean.

^b Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated surface soil. Exposure assumptions: inadvertent ingestion of 0.1 grams of soil per day, by a 70 kg adult, 5 days per week, 50 weeks per year, for 20 years of a 70-year lifetime.

q1* Carcinogenic potency factor.

7.6.7 Site 7: Burn Pit Area

Ground water and soil contamination were evaluated at the Burn Pit Area. Table 7-15 presents the results for hypothetical exposure to ground water. The Hazard Index was calculated to be approximately 7.9×10^{-2} . This value is less than unity (i.e., 1.0) and no adverse noncarcinogenic effects would be anticipated in populations chronically exposed to this ground water as a source of drinking water. The excess lifetime cancer risk of hypothetical exposure to ground water was projected to be approximately 2.1×10^{-7} . This hypothetical risk exceeds the acceptable point of departure established by EPA under the Superfund program. However, this risk estimate was based solely on the presence of methylene chloride. The concentration of methylene chloride in the environmental sample is not believed to be significant because the compound was detected in an associated QA/QC blank. The preliminary risk assessment for surface soils at Site 7 is presented in Table 7-16. Lead was the only identified chemical of concern in surficial soils. No adverse noncarcinogenic effects would be anticipated for ingestion exposure to soils containing lead at the observed levels. The Hazard Index was calculated to be approximately 4×10^{-3} . The potential for carcinogenic effects is not a concern for ingestion exposure to surface soils at Site 7.

The mean concentrations of contaminants in the full soil column were less than those for the surface soils at the site. Therefore, the risk of exposure to soils during potential construction activities would be less than that calculated for the surface soil exposure scenario.

7.7 SUMMARY OF PRIOR RISK ASSESSMENT FOR SITE 1 SOILS UNIT

A previous risk assessment was prepared in order to assess potential risks associated with chemicals observed in the soil samples collected from the unsaturated zone of the soil profile at Site 1 (SAIC, 1989b). Contamination known to be present in the saturated zone and in ground water at the site were purposely excluded from the evaluation. The identified chemicals of concern addressed in the prior risk assessment were bromochloromethane, methylene chloride, and PCB. The risk assessment was conducted in accordance with appropriate

Table 7-15

RISK CHARACTERIZATION FOR SITE 7: EXPOSURE TO GROUND WATER
OREGON AND PORTLAND
PORTLAND IAP, PORTLAND, OREGON

Compound	Mean ^a Concentration in Ground Water (µg/L)	Noncarcinogenic Effects ^b (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk ^b (Dose x q1*)
INORGANICS				
Lead	5.50	7.71E-02	CNS, Kidney	
ORGANICS				
Methylene Chloride	5.00	1.64E-03	Liver, Kidney, CNS	2.10E-07
Hazard Index: Combined Exposure		7.87E-02		
Excess Lifetime Cancer Risk: Combined Exposure				2.10E-07

^a Arithmetic mean of sampling set. Not detected results were excluded from analysis and calculation of the arithmetic mean. All detected results were included regardless of associated blank contamination. Field replicate results were averaged and then used as a single value along with the other field sample results to calculate the mean.

^b Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated ground water. Exposure assumptions: consumption of 2 liters of water per day, by a 70 kg adult, 5 days per week, 50 weeks per year, for 20 years of a 70-year lifetime.

q1* Carcinogenic potency factor.

Table 7-16

RISK CHARACTERIZATION FOR SITE 7: EXPOSURE TO SURFACE SOILS
 OREGON AND PORTLAND
 PORTLAND IAP, PORTLAND, OREGON

Compound	Mean ^a Concentration in Soils (mg/kg)	Noncarcinogenic Effects ^b (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk ^b (Dose x q1*)
INORGANICS				
Lead	5.60	3.92E-03	CNS, Kidney	
Hazard Index: Combined Exposure		3.92E-03		
Excess Lifetime Cancer Risk: Combined Exposure				

^a Arithmetic mean of sampling set. Not detected results were excluded from analysis and calculation of the arithmetic mean. All detected results were included regardless of associated blank contamination. Field replicate results were averaged and then used as a single value along with the other field sample results to calculate the mean.

^b Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated ground water. Exposure assumptions: inadvertent ingestion of 0.1 grams of soil per day, by a 70 kg adult, 5 days per week, 50 weeks per year, for 20 years of a 70-year lifetime.

q₁* Carcinogenic potency factor.

EPA guidance manuals for endangerment assessments (e.g., EPA, 1985, 1986a). The assessment focused on the following exposure scenarios and routes:

- Short-term exposure to construction workers resulting from a seven month construction period at the site (e.g., to construct a proposed Avionics Building at Site 1)
- Lifetime exposure to Base personnel and surrounding populace
- Exposure to contamination via:
 - Volatilization from soils and inhalation of vapors
 - Inhalation of airborne soil particles with subsequent sorption of soil contaminants within the lungs
 - Ingestion of soil particles
 - Dermal contact and skin sorption.

Exposure assessments were performed for each of the above scenarios and routes and each chemical of concern (bromochloromethane, methylene chloride, and PCB). All positive analytical results reported in soil samples were used in calculating the mean concentrations, regardless of whether the sample was taken above or below the water table, except for the omission of four "questionable" samples among those analyzed by a field GC headspace techniques suspected of cross-contamination (see discussion in Section 6.3.1). Omission of these questionable sample results and inclusion of samples from below the water table resulted in more conservative (higher) mean concentrations for the risk analysis. Exposures and risk characterization were also calculated for a maximum plausible concentration case.

The risk assessment calculations showed the highest exposures for the case of construction workers at the site (hereinafter referred to as the "worst case scenario"). Other routes and scenarios resulted in far less exposures than the worst case scenario. Risks for these worst case exposures were assessed versus guidelines for cancer and non-cancer effects established by EPA for protection of human health and selection of remedial alternatives under the Superfund program (i.e., an excess lifetime cancer risk of 10^{-7} [EPA, 1988b,c, U.S. EPA, 1989a]).

Excess lifetime cancer risks were calculated for carcinogens (methylene chloride and PCB) under the worst case scenario. The combined excess risk was found to be well below the Superfund risk level point of departure of 10^{-7} , even for the plausible maximum concentration case. Risks for noncarcinogenic effects (bromochloromethane, methylene chloride) were assessed by comparing chronic daily intakes (CDIs) to established reference dose (RfD) values for the worst case scenario. Since no RfD value has been established for bromochloromethane, bromomethane was used as a surrogate to estimate risk. The calculated CDIs were well below the RfD values for all compounds of concern, even for the plausible maximum concentration cases (i.e., by a factor of 60 times less). These calculations therefore showed, with conservative assumptions, that the chemicals present in the Site 1 unsaturated soils pose no significant risk for either carcinogenic or non-carcinogenic effects.

8.0 QUALITY ASSURANCE AND QUALITY CONTROL EVALUATION

8.1 LABORATORY QA/QC PROGRAM

8.1.1 QA/QC Review

A comprehensive quality assurance and quality control (QA/QC) program was carried out throughout the Site Investigation to ensure and document the accuracy, precision, representativeness, and overall quality of data obtained. Details of these procedures and methods are described in the Field Sampling and Analysis Plan (SAIC, 1989a). The laboratory analytical data were reviewed and evaluated in accordance with Level C QA/QC validation criteria established under the HAZWRAP Program (DOE, 1988). The results of the QA/QC review are discussed in Appendix J. Data qualifiers resulting from the review are shown as footnotes to the tabulated data presented in Section 6.0.

The data qualifiers concerning the volatile organic compounds analysis of the Site 3 samples are of particular significance, since this data has been used to support a decision document. Difficulties occurred with the initial and continuing calibration of the mass spectrophotometer used to conduct the volatile organics analysis. This resulted in any detected values being considered as estimated. However, because the sensitivity of the mass spectrophotometer was determined to be adequate, the non-detect values are considered valid. Therefore, the data used to support the decision document at Site 3 is of acceptable quality. The problems with the initial and continuing calibrations are discussed fully in Appendix J.

8.1.2 Data Qualification for Laboratory Blanks

Confirmation of the presence of a chemical or analyte in an environmental sample depends, in part, on its detection at a concentration significantly greater than concentrations found in associated blank samples. When a reported concentration for an environmental sample is not much greater than that found in an associated blank, the actual presence of the analyte in the environmental sample is suspect. Data qualification procedures have been developed to account for this concept (EPA, 1988e; DOE, 1988). These criteria generally involve either (1) footnoting

("flagging" or "qualifying") the environmental result or (2) raising the detection limit for the environmental sample and reporting the result as undetected.

The following criteria were used to evaluate the analytical results reported for environmental samples in comparison with results for associated laboratory QA/QC blanks (i.e., method blanks and holding blanks):

- In instances where a blank sample contained common laboratory contaminants, any concentration reported in environmental samples was considered suspect unless it was ten times greater than that detected in any of the associated blank samples. Concentrations reported in environmental samples which were less than ten times the associated blank concentration were footnoted as suspect (i.e., considered to be not significant and not confirmed to be present in the environment).

Common laboratory contaminants were defined for this purpose as acetone, methylene chloride, toluene, 2-butanone, and common phthalate esters such as bis(2-ethylhexyl)phthalate (BEHP).

- For blank samples which contained a constituent of concern other than the common laboratory chemicals listed above, a concentration of five times that detected in the blank was used to evaluate significance in any associated environmental samples. In these cases, concentrations reported in environmental samples which were less than five times the associated blank concentration were footnoted as suspect (i.e., considered to be not significant and not confirmed to be present in the environment).
- For cases where a common laboratory contaminant listed above was reported in an environmental sample but not in any associated blank, the reported result was considered suspect if not greater than ten times the detection limit of the analyte. In these cases, concentrations reported in environmental samples which were less than ten times the corresponding detection limit were footnoted (i.e., considered to be not significant and not confirmed to be present in the environment).

Application of the above criteria is straightforward for environmental samples collected from aqueous media. For non-aqueous ("solid") environmental samples, however, concentrations in the blanks must first be converted from an aqueous concentration (i.e., $\mu\text{g/L}$) to a corresponding concentration applicable to the non-aqueous media (i.e., mg/kg). A concentration in water (e.g., any QA/QC blank) cannot be directly compared to a concentration in a solid (e.g., soil)

sample because of differences in the way the two media are prepared, analyzed, and reported. For example, several grams of wet soil may be weighed for extraction in water or other solvent, the resulting extract weighed, and the results reported for the soil on a dry weight basis; in this case, it is obvious that the detection limit or concentration found in the water or extract is not the same as that reported for the soil.

Aqueous blank concentrations can be converted to corresponding soil concentrations by multiplying the blank concentration by the ratio of the aqueous sample reporting limit to the solid sample reporting limit. For solid samples which require dilution prior to analysis, care must be taken to account for the effect of either (1) the smaller weight of soil sample used in extraction or (2) the diluted concentration of extract analyzed. These calculation methods were employed for the purposes of applying the validation criteria stated above in determining whether concentrations reported in solid environmental samples were significant compared with blank concentrations.

The results of the evaluation process for the laboratory QA/QC blanks are presented in Tables 8-1 and 8-2. These tables show adjusted concentration limits below which a reported concentration in an environmental sample is considered to be insignificant compared with a contaminant concentration detected in the associated blank. These adjusted limits were calculated in accordance with the criteria and methods described above. The analytical results for the environmental samples presented in Section 6.0 have been footnoted where appropriate to reflect these adjusted concentration limits and to indicate reported results that are considered to be suspect.

8.2 FIELD QA/QC PROGRAM

A program of QA/QC procedures was instituted and followed throughout the sampling program. The intent of this QA/QC program was to ensure that collected environmental samples were representative of the study area and that the analytical data obtained accurately describe the concentrations of chemical constituents in the environment. In some instances, contaminants can be introduced in the field during sampling or in the laboratory during analysis.

Table 8-1

LABORATORY BLANK QUALIFICATION RESULTS FOR SOIL SAMPLES
OREGON AND PORTLAND
PORTLAND IAP, PORTLAND, OREGON

METHOD BLANK NUMBER	SAMPLING EPISODE ^a	ANALYTE	CONCENTRATION IN BLANK (µg/L)	ASSOCIATED ENVIRONMENTAL SAMPLES		
				SAMPLE NUMBER	LIMIT ADJUSTMENT FACTOR	ADJUSTED LIMIT FOR SIGNIFICANCE IN ENVIRONMENTAL SAMPLES ^b (mg/kg)
VBDEC19	1	MeCl ₂	24	SB1-4-1	10	0.29
VBDEC19	1	MeCl ₂	24	SB1-5-1	10	0.29
VBDEC19	1	MeCl ₂	24	SB1-6-1	10	0.34
VBDEC19	1	MeCl ₂	24	SB1-6-2	10	0.34
VBDEC19	1	MeCl ₂	24	SB1-7-1	10	0.34
VBDEC19	1	MeCl ₂	24	SB1-7-2	10	0.34
VBDEC27	1	MeCl ₂	17	SB3-3-2	10	0.23
VBDEC27	1	MeCl ₂	17	SB3-4-2	10	0.27
HB29	1	MeCl ₂	8	SB1-1-1	10	0.096
HB29	1	MeCl ₂	8	SB1-1-2	10	0.11
HB29	1	MeCl ₂	8	SB1-2-1	10	0.11
HB29	1	MeCl ₂	8	SB1-2-10	10	0.11
HB29	1	MeCl ₂	8	SB1-11-1	10	0.11
HB29	1	MeCl ₂	8	SB1-11-2	10	0.11
HB29	1	MeCl ₂	8	SB1-12-1	10	0.096
HB29	1	MeCl ₂	8	SB1-12-2	10	0.11
HB28	1	MeCl ₂	15	SB1-3-1	10	0.18
HB28	1	MeCl ₂	15	SB1-3-2	10	0.21
HB28	1	MeCl ₂	15	SB1-4-2	10	0.21
HB28	1	MeCl ₂	15	SB1-5-2	10	0.18
HB28	1	MeCl ₂	15	SB1-8-1	10	0.18
HB28	1	MeCl ₂	15	SB1-8-2	10	0.21
HB28	1	MeCl ₂	15	SB1-9-1	10	0.21
HB28	1	MeCl ₂	15	SB1-9-2	10	0.21
HB28	1	MeCl ₂	15	SB1-9-2R	10	0.21
HB28	1	MeCl ₂	15	SB1-10-1	10	0.18
HB28	1	MeCl ₂	15	SB1-10-2	10	0.21
MB006	1	PHCs	5.8	SB3-1-2	5	34
ALL	1	PCBs	ND ^a			
ALL	2	VOCs	ND			
ALL	2	PCBs	ND			

Table 8-1 (Cont'd)

LABORATORY BLANK QUALIFICATION RESULTS FOR SOIL SAMPLES
OREGON AND PORTLAND
PORTLAND IAP, PORTLAND, OREGON

METHOD BLANK NUMBER	SAMPLING EPISODE ^a	ANALYTE	CONCENTRATION IN BLANK (µg/L)	ASSOCIATED ENVIRONMENTAL SAMPLES		
				SAMPLE NUMBER	LIMIT ADJUSTMENT FACTOR	ADJUSTED LIMIT FOR SIGNIFICANCE IN ENVIRONMENTAL SAMPLES ^b (mg/kg)
MB#2	3	Pb	11	S4-1	5	2.7
MB#2	3	Pb	11	S4-2	5	2.7
MB#2	3	Pb	11	S4-3	5	3.2
MB#2	3	Pb	11	S4-4	5	2.3
MB#2	3	Pb	11	S4-5	5	2.1
MB#2	3	Pb	11	S4-6	5	2.5
MB#2	3	Pb	11	S4-7	5	3.3
MB#2	3	Pb	11	SB5-1-1	5	2.2
MB#2	3	Pb	11	SB5-1-2	5	2.1
MB#2	3	Pb	11	SB5-2-1	5	2.2
MB#2	3	Pb	11	SB2-2-2	5	2.2
MB#2	3	Pb	11	SB5-3-1	5	2.2
MB#2	3	Pb	11	SB5-3-2	5	2.3
MB#2	3	Pb	11	SB5-4-1	5	2.2
MB#2	3	Pb	11	SB5-4-2	5	2.2
MB#2	3	Pb	11	SB5-5-1	5	2.1
MB#2	3	Pb	11	SB5-5-2	5	2.3
MB#2	3	Pb	11	SB5-6-1	5	2.0
MB#2	3	Pb	11	SB5-6-2	5	2.1
MB#2	3	Pb	11	SB7-1-1	5	1.8
MB#2	3	Pb	11	SB7-1-2	5	1.7
MB#2	3	Pb	11	SB7-1-3	5	1.7
MB#2	3	Pb	11	SBBG-1	5	1.8
MB#2	3	Pb	11	SBBG-2	5	2.1
MB#2	3	Pb	11	D-4	5	1.8
MB#2	3	Pb	11	D-5	5	2.1
ALL	3	VOCs	ND			
ALL	3	BNAs	ND			
ALL	3	PHCs	ND			

^a Sampling episodes are: 1 = Fast-track (December 1988)
2 = Expanded SI (January 1989)
3 = August 1989

^b See text for calculation method.

^c Results are not presented above for non-environmental samples such as field blanks.

Table 8-2

LABORATORY BLANK QUALIFICATION RESULTS FOR GROUND WATER SAMPLES
OREGON AND PORTLAND
PORTLAND IAP, PORTLAND, OREGON

METHOD BLANK NUMBER	ANALYTE	SAMPLING EPISODE ^a	CONCENTRATION IN BLANK (µg/L)	LIMIT ADJUSTMENT FACTOR	ADJUSTED LIMIT FOR SIGNIFICANCE IN ENVIRONMENTAL SAMPLES ^b (µg/L)	ASSOCIATED ENVIRONMENTAL SAMPLE NUMBERS ^c
VBDEC27	MeCl ₂	1	17	10	170	MW5-2
MB009A0	BEHP	1	52	10	520	MW1-1, MW5-1, R2
MB007	AR1254	1	0.8	5	4	MW1-1, R2
ALL	PHCs	1	ND			
ALL	Metals	1	ND			
ALL	VOCs	2	ND			
ALL	VOCs	3	ND			
ALL	BNAs	3	ND			
ALL	PHCs	3	ND			
ALL	PCBs	3	ND			

^a Sampling episodes are: 1 = Fast-track (December 1988)
2 = Expanded SI (January 1989)
3 = August 1989

^b See text for calculation method.

^c Results are not presented above for non-environmental samples such as field blanks.

Therefore, analytical data were evaluated in comparison with contaminants detected in associated field blanks to determine if the results of the environmental samples need to be qualified. Such qualification indicates whether a chemical concentration reported in an environmental sample should be questioned due to potentially induced presence of that chemical.

Field QA/QC procedures were undertaken for each site investigated during the SI at ANG Portland. The field QA/QC program included the selection of samples representative of background conditions, sample equipment cleaning procedures, and sample transfer conditions. Included in this program were trip blanks, field blanks, equipment rinse samples, and field duplicate samples; these samples were designed to measure contaminant interference attributable to inadequate sampling technique or interception of airborne contaminants, as well as the reproducibility of the sampling event. Descriptions of the types of field QA/QC samples taken and evaluation of the field QA/QC analytical results are discussed in the following sections.

8.2.1 Analytical Results for Field QA/QC Blanks

Field QA/QC blanks were collected for each site and sampling event in general accordance with the following schedule:

- One trip blank sample for every shipping cooler containing samples collected for VOCs analysis.
- A minimum of one field blank sample collected for each analyte tested during a given field sampling event (an "event" means a sequence of continuous daily sampling activity not interrupted by more than 24 hours of non-sampling activity).
- A minimum of one equipment rinse sample collected per day for each analyte tested on a given day of sampling.

Table 8-3 shows the field QA/QC blanks collected during the SI program and lists the environmental samples associated with each. Analytical results for these blanks are summarized in Table 8-4 and are discussed below.

Table 8-3

FIELD QA/QC SAMPLES CROSS-REFERENCE CHART
 OREGON ANG PORTLAND
 PORTLAND IAP, PORTLAND, OREGON

Sampling Event	QC Sample Date	QC Sample	Environmental Sample Date	Associated Environmental Samples
1	12-8&9-88	EW1-1, TB-1	12-8-88	SB1-11-1, SB1-11-2, SB1-12-1, SB1-12-2, SB1-2-1, SB1-2-1D, SB1-2-2, SB1-1-1, SB1-1-2
1	12-8&9-88	FB1-1, TB-2	12-9-88	SB1-5-2, SB1-10-2, SB1-10-1, SB1-3-1, SB1-3-2, SB1-4-1, SB1-4-2, SB1-5-1, SB1-8-1, SB1-8-2, SB1-7-1, SB1-7-2, SB1-9-1, SB1-9-2, SB1-9-2R, SB1-6-1, SB1-6-2
2	12-13-88	FB2-1, FB3-1, TB-3	12-13-88	SB2-3-1, SB2-3-2, SB2-1-1, SB2-1-2, SB2-2-1, SB2-2-2, SB2-4-1, SB2-4-1R, SB2-4-2, SB3-1-1, SB3-3-1, SB3-4-1, SB3-2-1, SB3-2-1R
2	12-13-88	FB2-1, EW2-1, TB-1, EW3-1	12-14-88	SBBG1-1, SBBG1-2, SBBG2-1, SBBG2-1R, SBBG2-2
3	12-21-88	FB-4, TB-4	12-20-88	SB3-1-2, SB3-2-2, SB3-3-2, SB3-4-2
3	12-21-88	FB-4, TB-4	12-21-88	MW2-1, MW5-1, MW3-1, MW5-2, SB3-1-2, SB3-2-2, SB3-3-2, SB3-4-2, MW1-1, R1, R2, R3
4	1-19-89	FBE-1, EWE-1	1-19-89	SB1E-1-1, SB1E-2-1, SB1E-3-1, RE-1, SB1E-4-1
4	1-20-89	FBE-1, EWE-2, TBE-1	1-20-89	MW1E-1, RE-2

Table 8-3 (cont'd)

FIELD QA/QC SAMPLES CROSS-REFERENCE CHART
 OREGON ANG PORTLAND
 PORTLAND IAP, PORTLAND, OREGON

Sampling Event	QC Sample Date	QC Sample	Environmental Sample Date	Associated Environmental Samples
5	1-24-89	FBE-3, EWE-3 TBE-2	1-24-89	SB1E-17-2
5	1-24&25-89	EWE-4, FBE-3	1-25-89	SMW1E-2-5
5	1-24&26-89	EWE-5, FBE-3 TBE-3	1-26-89	SB1E-11-1, RE-3, SB1E-16-2, SB1E-21-2
5	1-24&27-89	EWE-6, FBE-3 TBE-3	1-27-89	MW1E-2, RE-4
6	8-15-89	FB5, FB6, EW5, TB#01	8-15-89	S4-1, S4-2, S4-3, S4-5, S4-4, S4-6, D1, S4-7
6	8-16-89	FB5, FB6, EW6 TB#02	8-16-89	SB5-1-1, SB5-1-2, SB5-2-1, SB5-2-2, SB5-3-1, SB5-3-2, SB5-4-1, SB5-4-2, SB5-5-1, SB5-5-2, SB5-6-1, SB5-6-2, SB5-7-1, SB5-7-2, SB5-8-1, SB5-8-2, SB5-9-1, SB5-9-2, SB5-10-1, SB5-10-2, D2, D3
6	8-16&17-89	EW7, FB5, FB6	8-17-89	SB7-1-1, SB7-1-2, SB7-1-3, D4
7	8-22-89	FB7, FB8, EW8	8-22-89	SBBG-1, SBBG-2, D5
8	8-28-89	FB8, FB9, EW9, "TRIP-BLANK"	8-28-89	D6, MWBG-1, MW7-2-1, MW7-1-1, MW7-3-1, D7, MW7-4-1, MW2-2-1, D8, DMW1-1

Table 8-4

SUMMARY OF TRIP BLANKS, FIELD BLANKS, AND EQUIPMENT RINSES ANALYTICAL RESULTS (µg/L)
 OREGON ANG PORTLAND
 PORTLAND IAP, PORTLAND, OREGON

SI Report 1
 Revision 3
 17 May 1991
 181 of 214

SAMPLE	METHYLENE CHLORIDE	ACETONE	BIS(2-eh) PHTHALATE	PCBS	PHCS	CADMIUM	CHROMIUM, TOTAL	LEAD	ZINC	SULFATE
<u>Trip Blanks</u>										
TB-1	9 HB	ND	--	--	--	--	--	--	--	--
TB-2	21 HB	ND	--	--	--	--	--	--	--	--
TB-3	ND HT	ND HT	--	--	--	--	--	--	--	--
TB-4	ND HT	ND HT	--	--	--	--	--	--	--	--
Trip Blank #01	ND HT	ND HT	--	--	--	--	--	--	--	--
Trip Blank #02	ND HT	ND HT	--	--	--	--	--	--	--	--
Trip Blank	9 B, HT	ND HT	--	--	--	--	--	--	--	--
TBE-1	ND HT	ND HT	--	--	--	--	--	--	--	--
TBE-2	ND	ND	--	--	--	--	--	--	--	--
TBE-3	ND	ND	--	--	--	--	--	--	--	--
TBE-4	ND	ND	--	--	--	--	--	--	--	--
<u>Field Blanks</u>										
F1-1	11 HB	ND C	--	ND	ND	--	--	--	--	--
FB2-1	ND HT	ND C, HT	--	--	--	--	--	--	--	--
FB3-1	ND HT	ND C, HT	--	--	--	--	--	--	--	--
FB4	ND	ND C	87 B	ND S	ND	ND	ND	ND	ND	ND
FB5	15	ND	--	--	--	0.34	7.0	1.6 A	ND	ND
FB6	30 HT	180 C, HT	99	--	--	ND	ND	NA	ND	ND
FB7	--	--	ND	--	--	ND	ND	NA	ND	ND
FB8	ND HT	ND C, HT	ND	ND	ND	ND	ND	4.8	ND	2,000
FBE-1	--	--	--	--	--	--	--	--	--	--
FBE-2	ND HT	ND C, HT	--	--	--	--	--	--	--	--
FBE-3	ND	ND	--	--	--	--	--	--	--	--
<u>Equipment Rinses</u>										
EW1-1	6.8 HB	ND C	--	ND	ND	--	--	--	--	--
EW2-1	ND HT	ND C, HT	--	--	--	--	--	--	--	--
EW3-1	ND HT	ND C, HT	--	--	--	--	--	--	--	--
EW-4	5 C	ND C	13 B	ND S	245 B	ND	ND	ND	ND	ND
EW-5	12 S, HT	ND US, HT	--	--	0.43	ND	ND	ND	16	--
EW-6	ND HT	ND C, HT	16	--	0.39	ND	ND	5.3	19	--
EW-7	--	--	--	--	ND M	--	--	--	--	--
EW-8	--	--	ND	--	--	0.28	10	NA	ND	--
EW-9	17 HT	90 C, HT	ND	ND	ND	0.39	ND	4.3	8.0	2,000
EWE-1	--	--	--	--	--	--	--	--	--	--
EWE-2	ND HT	ND HT	--	--	--	--	--	--	--	--
EWE-3	ND	ND	--	--	--	--	--	--	--	--
EWE-4	ND HT	ND HT	--	--	--	--	--	--	--	--
EWE-5	ND	ND	--	--	--	--	--	--	--	--
EWE-6	ND	ND	--	--	--	--	--	--	--	--

HB = reported by laboratory in the associated holding blank.
 HT = holding time (HT) exceeded for sample extraction and analysis.
 C = SPCC or CCC results were outside the Relative Response Factor (RRF) or Percent Difference (%D) limits.
 B = analyte was detected in the associated method blank.
 S = surrogate recoveries were outside QC control limits.
 US = compound was reported as not detected and surrogate recoveries were outside QC control limits.

Trip Blank Samples

Trip blanks were prepared by the laboratory and shipped with the other sample bottles to the site. Once at the site, they were stored with unused sample containers and selectively returned along with the collected field samples slated for VOCs analysis. The purpose of a trip blank is to determine whether contamination is introduced during transport of the samples between the site and the laboratory. However, this determination is possible only if any contaminants found in the trip blank were not present in associated field blanks, equipment rinse blanks, or method blanks.

As shown in Table 8-4, the only chemical reported in the trip blank samples was methylene chloride at concentrations of less than 21 HB $\mu\text{g}/\text{L}$. Methylene chloride is a common laboratory contaminant and was also detected in associated method blanks and holding blanks. Hence no cross-contamination appears to have occurred between any of the volatiles samples during shipment and transport.

Field Blank Samples

Field blanks were collected at the site just prior to the commencement of sampling activities on a given day. They were collected by pouring reagent grade water directly into sample containers identical to those used to collect the field samples. After collection they were placed in an ice chest and handled in a manner identical to the field samples. Field blank samples monitor the possibility of introducing airborne contaminants into the sample or sample container at the time of collection. They also check for possible contamination in the reagent grade water used in cleaning of the sampling equipment.

Methylene chloride, acetone, BEHP, cadmium, chromium, lead, and sulfate were found in the various field blanks (see Table 8-4). Introduction of contaminants into field blanks is usually improbable because the reagent grade water is poured directly into the sampling container. The collection of field blanks included no intermediate steps involving contact with any type of equipment other than a pouring funnel used only for this purpose. It is therefore very likely that the source of contaminants was either impure reagent grade water or contaminated

glassware. Glassware used for this sampling program was certified as clean by the distributor. Therefore, it seems the most likely source was impure reagent grade water.

The organics reported in the field blanks are all common laboratory contaminants, so the observed concentrations could have been induced during subsequent analytical steps, as evidenced by the presence of methylene chloride detected in an associated holding blank. Impure field rinse water may have also been a contributing factor.

Equipment Rinse Samples

Equipment rinse samples were collected to verify proper cleaning of sampling equipment between sampling events. The equipment wash samples were taken following cleaning and decontamination of the sampling equipment. They were prepared by collecting reagent grade water poured over and into the equipment. This rinse water was then containerized in the appropriate bottle and handled in a manner identical to the field samples.

As shown in Table 8-4, contaminants identical to those found in the field blanks were also reported in the various equipment rinse samples. In addition, PHCs and zinc were observed in some of the rinse samples. These results indicate that some of the contaminants may have been due to inadequate cleaning of sampling equipment, but that it is also very likely that the contaminants were from the same source as the field blank contamination (e.g., impure reagent grade rinse water). In the case of PHCs, the observed concentration in the equipment wash sample appears to be attributable to laboratory contamination, since PHCs were also found in the associated method blank.

8.2.2 Data Qualification for Field QA/QC Blanks

As discussed in Section 8.1.2, confirmation of the presence of a chemical or analyte in an environmental sample depends, in part, on its detection at a concentration significantly greater than concentrations found in associated blank

samples. When a reported concentration for an environmental sample is not much greater than that found in an associated blank, the actual presence of the analyte in the environmental sample is suspect.

The data qualification procedures and criteria described in Section 8.1.2 were used to review and evaluate the analytical results for environmental samples in the light of contaminants detected in the various field QA/QC blanks (i.e., trip blanks, equipment rinses, and field blanks). Concentrations reported in environmental samples which were less than the qualification criteria were footnoted as suspect (i.e., considered to be not significant and not confirmed to be present in the environment).

The results of the evaluation process for the field QA/QC blanks are presented in Table 8-5. The table shows adjusted concentration limits below which a reported concentration in an environmental sample is considered to be insignificant compared with a contaminant concentration detected in the associated blank. These adjusted limits were calculated in accordance with the criteria and methods described above. The analytical results for the environmental samples presented in Section 6.0 have been footnoted where appropriate to reflect these adjusted concentration limits and to indicate reported results that are considered to be suspect.

8.2.3 Field Duplicates

Field duplicates were collected at a minimum frequency of one in every ten environmental samples taken during a given field sampling event. In addition, at least one field duplicate was generally taken from every site for each media sampled. Duplicates were collected in the field by dividing an environmental sample into equal, representative parts and placing each part into separate sample containers for shipment to the laboratory.

The variability in analytical results between field duplicates serves as a check on the reproducibility of the sampling techniques employed during the field program. Field duplicates also provide insight regarding how representative the analytical results for a given sample are of the actual chemical

Table 8-5

FIELD BLANK QUALIFICATION RESULTS FOR ENVIRONMENTAL SAMPLES
OREGON AND PORTLAND
PORTLAND IAP, PORTLAND, OREGON

SITE	MATRIX OR MEDIA	ANALYTE	BLANK WITH HIGHEST CONCENTRATION	CONCENTRATION IN BLANK (µg/L)	LIMIT ADJUSTMENT FACTOR	ADJUSTED LIMIT FOR SIGNIFICANCE IN ENVIRONMENTAL SAMPLES ^a (µg/L)	AFFECTED SAMPLES ^b
1	Ground Water	MeCl ₂	EW-4	5.4 C	10	54 µg/L	All Fast-Track Samples
1	Soils	MeCl ₂	F1-1	10.5 HB	10	0.15 mg/kg	All Fast-Track Samples
1	All	All	All	ND C,HT	--	NA ^c	All non-Fast-track Samples
2	Ground Water	MeCl ₂	EW-9	17 HT	10	170 µg/L	MW2-2-1 only
2	Ground Water	Zn	EW-9	8	5	40 µg/L	MW2-2-1 only
2	Ground Water	Cd	EW-9	0.39	5	2 µg/L	MW2-2-1 only
2	Soils	All	All	ND C,HT	--	NA	All Samples
3	Ground Water	All	All	ND C,HT	--	NA	All Samples
3	Soils	MeCl ₂	EW-4	5.4 C	10	0.07 mg/kg	All Samples
4	Sediments	MeCl ₂	FB-6	30 HT	10	0.4 mg/kg	For all except S4-1, S4-7
4	Sediments	MeCl ₂	FB-6	30 HT	10	20 mg/kg	S4-1
4	Sediments	MeCl ₂	FB-6	30 HT	10	20 mg/kg	S4-7
4	Sediments	Acetone	FB-6	180 C,HT	10	2.7 mg/kg	For all except S4-1, S4-7
4	Sediments	Acetone	FB-6	180 C,HT	10	135 mg/kg	S4-1
4	Sediments	Acetone	FB-6	180 C,HT	10	135 mg/kg	S4-7
4	Sediments	Lead	FB-5	1.6 A	5	0.36 mg/kg	All samples
4	Sediments	Cd	EW-5	0.43	5	0.26 mg/kg	All samples
4	Sediments	Cr	FB-6	7.0	5	18 mg/kg	All samples
4	Sediments	Zn	EW-5	16	5	81 mg/kg	All samples
5A	Ground Water	BEHP	FB-4	87 B	10	870 µg/L	All samples
5A	Soils	MeCl ₂	FB-6	30 HT	10	0.4 mg/kg	All samples
5A	Soils	Acetone	FB-6	180 C,HT	10	2.3 mg/kg	All samples
5A	Soils	BEHP	FB-6	99	10	42 mg/kg	All samples

Table 8-5 (Cont'd)

FIELD BLANK QUALIFICATION RESULTS FOR ENVIRONMENTAL SAMPLES
OREGON AND PORTLAND
PORTLAND IAP, PORTLAND, OREGON

SITE	MATRIX OR MEDIA	ANALYTE	BLANK WITH HIGHEST CONCENTRATION	CONCENTRATION IN BLANK ($\mu\text{g/L}$)	LIMIT ADJUSTMENT FACTOR	ADJUSTED LIMIT FOR SIGNIFICANCE IN ENVIRONMENTAL SAMPLES ^a ($\mu\text{g/L}$)	AFFECTED SAMPLES ^b
5A	Soils	Cd	EW-6	0.39	5	0.2 mg/kg	All samples
5A	Soils	Pb	EW-6	5.3	5	1.3 mg/kg	All samples
5A	Soils	Zn	EW-6	19	5	81 mg/kg	All samples
5A	Soils	Cr	FB-6	7.0	5	15 mg/kg	All samples
5A	Soils	MeCl ₂	FB-6	30 HT	10	0.4 mg/kg	SB5-6-1,2
5B	Soils	MeCl ₂	FB-6	30 HT	10	4.1 mg/kg	SB5-7-1
5B	Soils	MeCl ₂	FB-6	30 HT	10	2.0 mg/kg	All other samples ^d
5A	Soils	Acetone	FB-6	180 C,HT	10	2.3 mg/kg	SB5-6-1,2
5B	Soils	Acetone	FB-6	180 C,HT	10	25 mg/kg	SB5-7-1
5B	Soils	Acetone	FB-6	180 C,HT	10	12 mg/kg	All other samples ^d
7	Ground Water	MeCl ₂	EW-9	17 HT	10	170 $\mu\text{g/L}$	All samples
7	Ground Water	Pb	FB-8	4.8	5	24 $\mu\text{g/L}$	All samples
BG	Ground Water	Pb	FB-8	4.8	5	24 $\mu\text{g/L}$	All samples
BG	Ground Water	SO ₄	FB-8,EW-9	2,000	5	10,000 $\mu\text{g/L}$	All samples
BG	Ground Water	Cr	FB-6	7.0	5	35 $\mu\text{g/L}$	All samples
BG	Ground Water	Cd	EW-9	0.39	5	1.9 $\mu\text{g/L}$	All samples
BG	Ground Water	Zn	EW-9	8.0	5	40 $\mu\text{g/L}$	All samples
BG	Soils	PHCs	EW3-1	245 B	5	46 mg/kg	All Fast-track Samples
BG	Soils	Pb	FB-8	4.8	5	0.9 mg/kg	August samples
BG	Soils	Cr	EW-8	10	5	18 mg/kg	August samples
BG	Soils	Cd	EW-8	0.28	5	0.14 mg/kg	August samples

^a See text for calculation method.

^b Sampling episodes are: 1 = Fast-track (December 1988)
2 = Expanded 31 (January 1989)
3 = August 1989

^c NA = no adjustments.

^d SB5-7-2, 8-1, 8-2, 9-1, 9-2, 10-1, 10-2.

C = SPCC or CCC results were outside Relative Response Factor (RRF) or Percent Difference (%D) limits, respectively.

HT = holding time (HT) was exceeded for sample extraction. See Appendix A.

composition in the environment at the selected sampling station. Since ground water samples are often homogeneous whereas soil and sediment samples are heterogeneous, more variability is usually exhibited in soil duplicates than in water duplicates. Since field duplicates measure both field sampling and laboratory analytical precision, the field duplicate results often exhibit more variability than lab duplicates which do not include effects due to field sampling.

The precision of duplicates is evaluated by expressing the difference between detected concentrations in each sample as relative percent difference (RPD) values. RPDs are calculated as follows:

$$\text{RPD} = \frac{|C_1 - C_2|}{(C_1 + C_2)/2} \times 100 \text{ percent}$$

where:

C_1 = concentration of the analyte in the sample, and
 C_2 = concentration of the analyte in the duplicate

The results of the field duplicate analyses are shown in Table 8-6. RPD values were calculated for all cases where analytes were detected in both the sample and its duplicate at concentrations considered significant in comparison with concentrations detected in associated blanks. The overall mean value of the calculated RPDs for water matrix samples was 21 percent, while the overall mean value of the calculated RPDs for solid matrix samples was 42 percent.

There are no specific review criteria for evaluation of field duplicate analyses (EPA, 1988e; DOE, 1988). However, based on experience from other projects, the field duplicates exhibited good reproducibility. The results for solid samples were slightly poorer than for the water samples, as expected per the discussion above. There were relatively few samples with calculated RPDs, since not many analyte concentrations were considered significant compared with blank concentrations, so statistical interpretation of the results is not appropriate. The samples with the poorest RPD values were generally those having relatively high concentrations of contamination; matrix interferences likely contributed to poorer reproducibility in these cases.

Table 8-6

Summary of Field Duplicate Analytical Results
ANG Portland, Portland IAP, Portland, Oregon

ANALYTE	Sample Identification		Concentration, ug/L or ug/kg		RPD (%)
	Sample	Field Duplicate	Sample	Field Duplicate	
=====					
WATER SAMPLES:					
=====					
methylene chloride	MW1-1	R2	510 S,D	480 S,D	6
methylene chloride	MW1E-1	RE-2	1,500 S	2,400 S	46
methylene chloride	MW7-3-1	D7	3 J,F,HT	5 U,HT	
bromochloromethane	MW1-1	R2	120,000 I	310,000 I	88
bromochloromethane	MW1E-1	RE-2	140,000 I	110,000 I	24
1,1-dichloroethenes	MW2-2-1	D8	28 HT	29 HT	4
trichloroethene	MW2-2-1	D8	430 HT	470 HT	9
VOCs	MW1E-2	RE-4	5-100 U,D	X D	
VOCs	MWBG-1	D6	5-10 U,D,HT	5-10 U,D,HT	
bis(2-eh)phthalate	MW1-1	R2	14 B,S	27 B,M	
BNAs	MW7-3-1	D7	10-50 US	10-50 US	
BNAs	MWBG-1	D6	10-50 U	10-50 U	
PCBs	MW1-1	R2	0.5 US	1.0 US	
PCBs	MWBG-1	D6	0.7-2.5 U	0.7-2.5 U	
PHCs	MW2-2-1	D8	13 U	13 U,M	
PHCs	MW3-1	R3	100 U	50 U	
PHCs	MWBG-1	D6	13 U	13 U	
cadmium	MW2-2-1	D8	0.36 F	0.61 F	
cadmium	MWBG-1	D6	0.86 F	0.57 F	
chromium, total	MW2-2-1	D8	5.9 U	7.0	
chromium, total	MWBG-1	D6	5.9 U	8.0 F	
iron	MW1-1	R1	1,200	970	21
iron	MWBG-1	D6	830	670	21
lead	MW2-2-1	D8	3.7 A	4.0 A	8
lead	MW7-3-1	D7	1.8 F	7.0 F	
lead	MWBG-1	D6	2.2 F	2.0 F	
nickel	MW2-2-1	D8	14 U	14 U	
nickel	MWBG-1	D6	14 U	14 U	
zinc	MW1-1	R1	14	4 U	
zinc	MW2-2-1	D8	16 F	14 F	
zinc	MWBG-1	D6	30 F	26 F	
sulfate	MW5-1	R1	42,000	42,000	0
sulfate	MWBG-1	D6	13,000	12,000	8
Mean for all Water Samples:					21
=====					

Table 8-6

Summary of Field Duplicate Analytical Results
ANG Portland, Portland IAP, Portland, Oregon

ANALYTE	Sample Identification		Concentration, ug/L or ug/kg		RPD (%)
	Sample	Field Duplicate	Sample	Field Duplicate	
=====					
SOLID SAMPLES:					
=====					
methylene chloride	SB1-2-1	SB1-2-1D	15 H,F,D	12 H,F,D	
methylene chloride	SB1-9-2	SB1-9-2R	32 H,F,D	16 H,F,D	
methylene chloride	SB2-4-1	SB2-4-1R	10 C,D	7 U,D	
methylene chloride	SB3-2-1	SB3-2-1R	7 U,D	41 F,D	
methylene chloride	SBBG2-1	SBBG2-1R	6 U,D	8 C,D	
acetone	SB1-2-1	SB1-2-1D	170 C,D	130 U,D	
acetone	SB5-5-2	D2	23 F,D	92 F,D	
acetone	SB5-10-2	D3	180 F,D	69 U,M,D	
benzene	SB5-10-2	D3	69	35 U,M	
ethylbenzene	SB5-10-2	D3	790	110 M	151
xylenes	SB5-10-2	D3	1,500 E	270 M	139
VOCs	S4-6	D-1	6-13 U,D	6-13 U,D	
VOCs	SB1E-11-1	RE-3	7-15 U,D	7-15 U,D	
bis(2-eh)phthalate	SB5-5-2	D2	760 F	460 U	
bis(2-eh)phthalate	SBBG-2	D5	420 U	16,000 E	
PCBs	SB1-2-1	SB1-2-1D	200 U	210 U	
PCBs	SB1-9-2	SB1-9-2R	86 U	200 U	
PCBs	SB1E-3-1	RE-1	210 U	220 U	
PCBs	SBBG2-1	SBBG2-1R	170 U	160 U	
PHCs	SB1-2-1	SB1-2-1D	2,400 U	2,400 U	
PHCs	SB1-9-2	SB1-9-2R	2,500 U	2,300 U	
PHCs	SB3-2-1	SB3-2-1R	1,800 U	1,800 U	
PHCs	S4-6	D-1	580	570 U	
PHCs	SB5-10-2	D3	15,000 S	190,000 S,M	171
PHCs	SB7-1-2	D4	72,000 S	140,000 S,M	64
PHCs	SBBG2-1	SBBG2-1R	1,900 U	1,900 U	
cadmium	S4-6	D-1	270	290	7
cadmium	SB5-5-2	D2	2,100	2,700	25
cadmium	SBBG-2	D5	200	210	5
chromium, total	S4-6	D-1	6,400 F	7,500 F	
chromium, total	SB5-5-2	D2	28,000	25,000	11
chromium, total	SBBG-2	D5	24,000	26,000	8
iron	SB5-5-2	D2	3.0E+07	2.8E+07 M	7
iron	SBBG-2	D5	2.5E+07	2.9E+07	15
=====					

Table 8-6

Summary of Field Duplicate Analytical Results
ANG Portland, Portland IAP, Portland, Oregon

ANALYTE	Sample Identification		Concentration, ug/L or ug/kg		RPD (%)
	Sample	Field Duplicate	Sample	Field Duplicate	
SOLID SAMPLES (CONT'D):					
lead	S4-6	D-1	4,000 B	3,700 A	8
lead	SB5-5-2	D2	21,000 A,B	22,000 A	5
lead	SB7-1-2	D4	4,700 B	4,900 B	4
lead	SBBG-2	D5	14,000 B	19,000 B	30
nickel	S4-6	D-1	5,700	7,200	23
nickel	SB5-5-2	D2	20,000	18,000	11
nickel	SBBG-2	D5	17,000	21,000	21
zinc	S4-6	D-1	59,000 F	64,000 F	
zinc	SB5-5-2	D2	110,000	120,000	166
zinc	SBBG-2	D5	54,000	59,000	9
Mean for All Solid Samples:					42

DATA FLAGS ARE DEFINED AS FOLLOWS:

- A = analysis by method of standard additions.
- B = analyte was detected in the associated method blank; the reported concentration is not considered significant in comparison with the concentration found in the blank.
- C = analyte is a common laboratory contaminant and was reported at concentration close to the detection limit; the reported concentration is considered to be not significant.
- D = SPCC or CCC results were outside the RRF or %D limits, respectively.
- E = reported concentration exceeded the calibration range; dilution was not run.
- F = analyte was detected in an associated QA/QC blank; the reported concentration is not considered significant in comparison with the concentration found in the blank.
- H = analyte was detected in the associated holding blank; the reported concentration is not considered significant in comparison with the concentration found in the blank.
- HT= holding time was exceeded for sample extraction.
- I = estimated concentration due to use of external instead of internal standard.
- J = estimated concentration.
- M = matrix spike/matrix spike duplicate results were outside QC limits, or were very low.
- S = surrogate recoveries were outside QC control limits.
- U = reported as not detected by the laboratory.
- X = analysis data sheet was missing from the lab data report; refer to lab report narrative.

9.0 DISCUSSION OF FINDINGS AND RECOMMENDATIONS

This section of the report discusses the significance of the physical and chemical findings obtained for each of the ANG Portland IRP sites. The Site Investigation activities were designed with the primary goal of demonstrating either the presence or absence of significant hazardous chemical contamination at each of the sites studied. Limited effort was undertaken to determine the extent of contamination at those sites where contamination was found. Conclusions regarding the need for further investigation, as provided in this section, were based on the extent to which a site has been characterized by this investigation (Section 6.0) and the findings of the chemical-specific ARAR comparisons and preliminary risk assessment conducted for each site (Section 7.0). The preliminary risk assessments were based on conservative estimates for "reasonable maximum exposure scenarios."

9.1 SITE 1 - CENTRAL HAZARDOUS WASTE STORAGE AREA

A total of 35 soil borings were performed at this site, from which 81 soil/slurry samples were collected and analyzed. Ground water samples were collected for analysis from two monitoring wells.

9.1.1 Ground Water Unit

The SI sampling program revealed the ground water at Site 1 to have significant concentrations of bromochloromethane (BCM) and methylene chloride at monitoring well MW1-1 (>100,000 $\mu\text{g/L}$ BCM, >500 S.C $\mu\text{g/L}$ methylene chloride). Resampling confirmed these high concentrations. Sampling and analysis of the saturated soils (i.e., from below the water table) showed significant concentrations of these compounds (e.g., 12,000 $\mu\text{g/kg}$ BCM) in ground water at a second location (just southwest of Building 1131).

Both these locations are associated with past spill areas. The reported spill history and analytical data for the ground water and saturated soil samples indicate that ground water contamination present at Site 1 is probably not due to an offsite source and is more likely attributable to isolated spills. However, the full extent of ground water contamination has not been defined at

Site 1. In addition to the two reported spill locations, the SI data indicate that saturated soils along the west side of the paved/fenced area may also be contaminated with bromochloromethane. The contaminants detected in ground water are relatively soluble organic liquids with high specific gravity, and would be expected to migrate downward in ground water. Insufficient data were obtained for assessment of the vertical extent of the ground water contaminants. Additional ground water data are also needed to define the horizontal extent of contamination.

The results of the preliminary risk characterization and potential ARARs comparison were as follows:

- Due to the high concentrations of bromochloromethane, the risk assessment calculation showed a very high Hazard Index (3.4×10^3). Hence the risks of adverse non-carcinogenic effects are projected to be unacceptably high for the ground water at Site 1.
- The calculation of excess lifetime cancer risk was within the acceptable range established by EPA under the Superfund program (10^{-7} to 10^{-4}).
- The concentration of methylene chloride in ground water was more than 10,000 times greater than the federal water quality criterion (FWQC for drinking water only).

In view of these very high projected risks, it is recommended that the Site 1 ground water unit be investigated further in the RI/FS. Further site characterization efforts should include hydrogeological characterization of deeper soils and better definition of the extent of contamination in the vicinity of the two spill areas identified in the SI program, with particular emphasis on the extent of vertical migration of dense phase chlorinated hydrocarbons in the ground water and saturated soils.

9.1.2 Soils Unit

A major objective of the SI program was to determine whether significant contamination is present in the unsaturated soils at Site 1, including areas to

be impacted by construction of a proposed Avionics building. Hence a comprehensive sampling effort was conducted, covering the entire site as well as focusing on areas where ground water contamination was found.

The extent of PCB contamination in the unsaturated soils at this site appears to be limited to a relatively small area near sampling station SB1-1. For VOCs, contamination appears limited to the immediate vicinity of well MW1-1 and perhaps a second area within the paved/fenced area west of Building 1131. These areas are both associated with prior known spill events of bromochloromethane. A total of nine soil borings were performed within a 30 ft radius of MW1-1, with bromochloromethane being detected in only one of the unsaturated soil samples.

The risk assessment conducted for the chemicals identified in the Site 1 soils unit concluded that the extent of exposure projected for plausible conservative exposure scenarios does not constitute a health risk according to the Superfund guidelines established by EPA.

No chemical-specific potential ARARs were identified for the Site 1 soils. However, comparison was made with PHC cleanup criteria for soils given in the State of Oregon's cleanup rules for leaking underground storage tank (UST) systems, which were deemed pertinent as "to be considered" (TBC) guidelines for assessment of remediation requirements for the ANG Portland IRP sites. PHC concentrations observed in the Site 1 soils were less than the Oregon UST cleanup criterion for all samples except one which was collected and analyzed in a separate study prior to the SI program. The PHC concentration of this prior sample exceeded the criterion by only 20% and was not confirmed by the 24 samples analyzed under the SI program.

Based on the risk assessment results and TBC comparison, the Site 1 soils unit appears to pose no significant threat to human health or the environment, and no further investigation of this unit is deemed necessary.

9.2 SITE 2 - CIVIL ENGINEERING HAZARDOUS MATERIAL STORAGE

Chemical characterization of potential contamination at Site 2 included a soil gas survey with 8 sampling stations, and sampling and analysis of 8 soil samples plus ground water samples from two monitoring wells. No contaminants were detected in the soil at Site 2 as a result of the SI soil sampling program. PHCs had been detected in two soil samples from the site reported in a prior study. The results from the soil gas survey and ground water samples confirmed the presence of significant concentrations of trichloroethene (TCE) and dichloroethenes (DCE) at the site. Other chemicals appear to be present, based on soil gas data, including tetrachloroethene as tentatively identified by the field GC chemist.

The extent of contamination has not been fully defined at Site 2. Concentrations of TCE were highest at the north and south edges of the soil gas survey zone, suggesting that contamination at the site is not localized to one area. High TCE and DCE concentrations were detected in both monitoring wells, which are spaced about 50 ft apart. The soil gas and ground water data indicate the contaminant plume may be more than 100 ft in extent.

Although VOCs were not found in any of the soil samples, the soil gas survey and ground water data indicate that the soil samples may not have been taken from the areas of the site with the most contamination. The soil data are insufficient to determine whether areas of soil contamination exist which may serve as sources for the ground water plume.

The results of the preliminary risk characterization and potential ARARs comparisons were as follows:

- The preliminary risk assessment for ground water resulted in a Hazard Index of 1.4, driven mainly by the presence of TCE. This value reflects a limited potential for adverse noncarcinogenic effects in populations chronically exposed to this ground water as a drinking water source.
- The calculated excess lifetime cancer risk for the ground water was within the acceptable range established by EPA under the Superfund program (10^{-7} to 10^{-4}).

- The concentrations of both TCE and DCE in ground water greatly exceeded the identified potential ARARs (MCLs, FWQC). For example, TCE concentrations were more than 100 times higher than the MCL of 5 µg/L.
- No risk characterization was calculated for Site 2 soils since no specific chemicals were identified in samples from this medium.
- Comparison was made with PHC cleanup criteria for soils given in the state of Oregon's UST cleanup rules which were deemed pertinent as "to be considered" (TBC) guidelines. PHC concentrations for two soil samples reported in a study conducted prior to the SI program were less than the Oregon UST cleanup criterion for both samples.

Because of the high concentrations of TCE confirmed in ground water which far exceed the federal MCL, the undefined extent of the TCE plume, and the presence of other chlorinated hydrocarbons observed at the site, it is recommended that Site 2 be investigated further in the RI/FS. Further site characterization efforts should include additional ground water sampling to determine the extent of contamination, with emphasis on installation of deeper monitoring wells to assess the vertical migration of the dense phase chlorinated hydrocarbons which were detected in the shallow ground water. Additional soil gas surveys appear to be appropriate to aid in defining the extent of the plume and in locating potential sources, with additional soil sampling to confirm any source areas identified.

9.3 SITE 3 - HUSH HOUSE AREA

Under the SI program, eight soil samples and one ground water sample were collected adjacent to the Hush House at Site 3. The samples were analyzed for VOCs and PHCs to check for potential contamination due to past storage and possible spillage of petroleum and solvent products or wastes. The analytical results revealed very little contamination in any of the samples.

No contaminants were detected in the ground water sample. With the exception of methylene chloride, no purgeable organic chemicals were found in any of the eight soil samples. Petroleum hydrocarbons (PHCs) were reported in only one of the soil samples, at a concentration barely above the detection limit. The reported

methylene chloride and PHC concentrations are not considered significant in comparison with concentrations of both these analytes which were detected in associated QA/QC blanks.

These results show that contaminants expected at Site 3 based on past history were not confirmed to be present in the media sampled during the SI program. The absence of significant PHC or BTEX contamination in soil or ground water indicates that past usage or storage of petroleum products or wastes at the site have led to no apparent impacts in the area of investigation.

In a separate study conducted prior to the SI program, two soil samples were collected and analyzed for PHCs. The analyses detected PHCs in both samples at a maximum concentration of 17 mg/kg. As indicated above, the SI program samples did not confirm these results even though samples were taken from the same locations.

Risk characterizations were not calculated for Site 3 because no specific chemicals were detected in the soil and ground water samples. No chemical-specific potential ARARs were identified for Site 3.

Comparison was made with Oregon's UST cleanup criteria for PHCs in soils, which were deemed pertinent as TBC guidelines for assessment of site remediation requirements. Soil PHC concentrations reported as part of the SI program and those from a prior study were all far less than these cleanup criteria for all samples.

Based on the absence of significant VOC or BTEX contamination in the media sampled and the results of the TBC comparison, no further investigation of this site is deemed necessary.

9.4 SITE 4 - MAIN DRAINAGE DITCH

A total of seven sediment samples were collected from the main drainage ditch and analyzed for volatile organics, PHCs, and five metals. PHCs were detected in six of the seven sediments sampled. Two of the samples had PHC concentration ≥ 10

mg/kg. The only reported volatile organic compounds were common laboratory contaminants which were not found in significant concentrations compared with amounts reported in associated QA/QC blanks.

Most of the metals (cadmium, chromium, lead, nickel, and zinc) were detected in all of the sediment samples. The highest metal concentrations were found in two samples from the upstream portion of the ditch. The samples taken further downstream generally had lower metals concentrations, many of which approached those found in the background samples.

The greatest concentrations of PHCs, lead, and other metals were found at three sampling stations located near storm sewer outfalls which drain the Base motor pool parking lot and aircraft aprons. Washdown of spilled fuel and other petroleum products from these paved areas could have contributed to the petroleum hydrocarbon concentrations detected in these samples.

The extent and chemical nature of contamination in the main drainage ditch is not fully characterized. The analytical technique employed for PHCs in sediments was designed to quantify the alkanes fraction of hydrocarbons ranging from ten to 24 carbon atoms, in order to provide clear evidence of petroleum contamination. Additional tests are needed in order to check for the presence in the sediments of other likely petroleum compounds having environmental significance such as naphthalenes, anthracene, chrysene, and phenanthrene.

The results of the preliminary risk characterization and potential ARARs comparisons were as follows:

- The preliminary risk assessment for sediments concluded that no adverse carcinogenic or noncarcinogenic effects would be expected under the assumed exposure scenario. The risk calculations did not consider PHCs, since PHC results are not chemical-specific and toxicity measures are not available.
- No risk characterization was calculated for Site 4 ground water since no samples were collected from this medium.
- No chemical-specific potential ARARs were identified for Site 4.

- Comparison was made with State of Washington marine sediment quality standards for metals which were deemed pertinent as TBC guidelines for preliminary evaluation of remediation requirements at this site. These standards were not exceeded by any of the metals concentrations detected in the sediment samples. This comparison was made in the absence of better criteria. Oregon is presently developing fresh water sediment standards; the Site 4 data could be re-evaluated once these standards are available.

PHC contamination was confirmed in the Site 4 drainage ditch sediment samples. In spite of the low risks projected for human receptors by the risk characterization, further investigation of this site is recommended in the RI/FS because of the presence of PHCs in a water environment, the need for more complete characterization of the extent and chemical nature of the PHC contamination, and the absence of established criteria for estimating ecological impacts from non-chemical specific PHC data. As explained above, further chemical analyses are needed to determine the types and concentrations of specific chemicals likely associated with the PHC contamination so that risk characterization calculations and risk assessments can be made for individual compounds. Further investigation might also include evaluation of impacts to surface or ground water, depending on the results of more detailed chemical characterization of the sediments.

9.5 SITE 5A - AGE MAINTENANCE SHOP (MOTOR POOL FENCELINE AREA)

Twelve soil samples were collected from six borings along the motor pool fence line area. These samples were analyzed for volatile organics, BNAs, and metals. One ground water sample was collected and analyzed for volatile organics, BNAs, sulfates, and metals. No volatile or semi-volatile organics were reported in any of the soil samples except common laboratory compounds at insignificant concentrations.

The analytical results indicate several contaminants to be present at Site 5A. Trichloroethene (TCE) was found in the shallow ground water at a low concentration (6 $\mu\text{g/L}$). The ground water also has elevated sulfate content compared with background results. Some of the fence line area soil samples contained cadmium,

lead, and nickel at elevated concentrations compared with background soils (up to 10 times background for cadmium). The presence of sulfate and lead may be due to the drainage of battery acid at the site.

The results of the preliminary risk characterization and potential ARARs comparisons were as follows:

- The preliminary risk assessment concluded that no adverse carcinogenic or noncarcinogenic effects would be expected under the assumed exposure scenarios for ground water, surficial soils, and subsurface soils.
- The concentration of TCE detected in ground water slightly exceeded the identified potential ARARs (MCL and FWQC).

Further investigation is recommended at this site because TCE was detected in the ground water sample. Although the preliminary risk characterization projected risks to be insignificant and the potential ARAR concentrations were only slightly exceeded, these conclusions are based on very limited sampling of ground water at the site. It is possible that the TCE detected in the monitoring well sample represents the edge of a plume and that more significant contamination is located nearby. It is also possible that the reported TCE concentration is an anomaly since it is barely above the detection limit. However, since TCE was detected at several other sites on the Base and because the concentration reported in the Site 5A ground water sample exceeded the federal MCL, it is recommended that, at a minimum, the monitoring well be resampled and reanalyzed in the RI/FS to confirm the presence or absence of TCE in the ground water. Installation and sampling of additional monitoring wells would also be appropriate in order to demonstrate that the existing well is not on the edge of a nearby plume.

Soil gas analyses could be used in locating any additional wells. A soil gas survey appears to be applicable since there is so far only one monitoring well at the site, and the local ground water flow direction is uncertain. As mentioned in Section 5.0, ground water flow direction at the Base is likely subject to very localized influences such as structures, trenches, pavement, and

local stratigraphy. Further investigation of the soils at the site may be appropriate for identifying sources, depending on the results of the soil gas and ground water investigations.

9.6 SITE 5B - AGE MAINTENANCE SHOP (UST PIT AREA)

The SI program for the UST pit area included analysis of one ground water sample and 8 subsurface soil samples from 4 borings. All samples were analyzed for PHCs and VOCs to assess the extent of contamination from the former leaking tank. No purgeable aromatics or petroleum hydrocarbons were detected in the ground water sample.

PHCs were detected in all the soil samples except for those from the east side of the pit (which is in the apparent upgradient direction). The highest PHC concentrations (up to 2005 mg/kg) were found in peripheral samples at 6 ft depth from borings on the downgradient sides of the pit. Common fuel components (benzene, ethylbenzene, and xylenes - or BEX compounds) were also detected in samples from the center of the pit as well as in the downgradient soil samples. Analytical results from sampling conducted prior to the SI program showed PHC concentrations up to 11,300 ppm in soil collected beneath the bottom of the pit.

The data suggest that diesel fuel from the former leaking UST has migrated downgradient beyond the walls of the excavation pit. Soil and ground water immediately upgradient of the pit had not been affected. PHC and BEX concentrations were greatest at the soil/groundwater interface horizon (i.e., the samples collected at the 6-ft depth), suggesting that downward migration has been impeded by the ground water table.

The results of the preliminary risk characterization and potential ARARs comparisons were as follows:

- The preliminary risk assessment concluded that no adverse carcinogenic or noncarcinogenic effects would be expected under the assumed exposure scenarios for subsurface soils. No risk characterization was performed for surficial soils because this medium was not sampled and was not expected to be contaminated.

- No risk characterization was conducted for ground water because no contaminants were detected in the ground water sample.
- Comparison was made with Oregon's UST cleanup criteria and rules for PHCs in soils, which were recently adopted and were identified as potential ARARs for Site 5B. The applicable UST cleanup standard for this site was greatly exceeded by the high PHC concentration (11,300 ppm) found in the sample taken from beneath the bottom of the pit prior to the SI program.

In addition, the ground water sampling and analyses conducted at Site 5B were not sufficient to demonstrate the absence of ground water impacts due to leakage from the tank. The Oregon UST cleanup standards can only be used to obviate the need for cleanup action if it is demonstrated that ground water at the site has not been impacted. If ground water has been impacted, the rules require further investigation and development of a corrective action plan.

Further investigation at Site 5B is required. At the suggestion of EPA reviewers, further investigation and cleanup of this Site was performed outside of the IRP program (i.e., under the Spill and Immediate Response (SIR) program following the state's UST regulations).

9.7 SITE 7 - BURN PIT AREA

A soil gas survey was conducted over the former burn pit area, with 48 gas samples analyzed. Three soil samples were collected from one soil boring near the center of the former pit. Each soil sample was analyzed for petroleum hydrocarbons and lead. Four monitoring wells were installed with one sample collected from each well. All ground water samples were analyzed for VOCs, BNAs, and lead.

The soil gas results indicated the presence of a variety of chlorinated hydrocarbons in the immediate vicinity of the former pit and in the western half of the surveyed zone, including methylene chloride, bromochloromethane, TCE, and carbon tetrachloride. Benzene, toluene, and xylenes were also detected in soil gas samples. Non-target compounds tentatively identified as present in soil gas included chloroform, 1,1,1-trichloroethane, and tetrachloroethene. Further analyses (e.g., GC/MS) would be needed to confirm the presence of these non-target compounds.

The soil gas data established the general extent of apparent hydrocarbon contamination at the site, with the plume centered at the former burn pit location (Figure 6-9). The presence of PHCs was confirmed in soil samples collected near the center of the pit. PHCs were detected in all three soil samples at concentrations up to 72 S mg/kg. Lead was also detected in the soils, but at concentrations lower than those found in the background samples. The presence of contamination in ground water was not confirmed.

The analytical technique employed for PHCs was designed to quantify the alkanes fraction of hydrocarbons ranging from 10 to 24 carbon atoms, in order to provide clear evidence of petroleum contamination as opposed to compounds such as lipids which are often present in the natural environment. Hence the technique serves as a strong indicator of petroleum contamination, and follow-on tests are needed in order to check for the presence of other likely petroleum compounds having environmental significance such as naphthalenes, anthracene, chrysene, and phenanthrene.

The results of the preliminary risk characterization and potential ARARs comparisons were as follows:

- The preliminary risk assessment concluded that no adverse carcinogenic or noncarcinogenic effects would be expected under the assumed exposure scenarios for ground water, surficial soils, and subsurface soils.
- Methylene chloride was reported in ground water samples at concentrations which exceeded the FWQC. However, these reported methylene chloride data are considered insignificant compared with concentrations found in associated blanks, based on applicable EPA QA/QC data validation criteria.
- Comparison was made with Oregon's UST cleanup criteria for PHCs in soils, which were deemed pertinent as TBC guidelines for assessment of site remediation requirements. The applicable PHC cleanup standard for this site was not exceeded in any of the three samples analyzed.

PHC contamination was confirmed in the Site 7 soil samples. Although the soil gas sampling has indicated the approximate extent of contamination, the significance of this contamination remains undefined due to the limited soil

sampling and analytical program conducted. In spite of the low risks projected for human receptors by the preliminary risk characterization and the favorable comparison with the Oregon UST cleanup criteria, further investigation of this site is recommended in the RI/FS because of the wide-spread presence of numerous chlorinated hydrocarbons at the site as confirmed by the soil gas survey results, and the need for more complete characterization of the extent and chemical nature of the hydrocarbon contamination in soils at the site.

Ground water was deeper at Site 7 than at the other sites, and it is likely that the soil gas measurements did not correspond to volatile emissions released directly from the soil/water interface, since the probes were only driven to depths of 4 to 5 ft. The absence of volatile and semivolatile contaminants in the ground water samples suggests that contaminants may not have migrated to sufficient depth to have entered the saturated zone. Due to the minimal soil sampling information collected, it cannot be determined if a future ground water problem could develop. Vadose soils have not been sufficiently characterized to determine if leaching of contaminants poses a threat to ground water at this site. It is therefore recommended that additional soil sampling be conducted at this site. Analytes should include, among others, all the compounds detected or tentatively identified in the soil gas sampling effort. Further investigation might also include evaluation of impacts to surface or ground water, depending on the results of more detailed chemical characterization of the soil media.

9.8 SITE 8 - SANITARY LANDFILL

The existence, location, history and use of a sanitary landfill at Site 8 were based on the recollections of one individual interviewed during the Preliminary Assessment. During the SI, the former Deputy Civil Engineer of the Base was interviewed to confirm the location of Site 8 given in the Preliminary Assessment report, and to obtain additional details describing the former landfill area. He described the area to include 3 to 6 trenches in random orientation in the location shown in Figure 4-7. The trenches were described as being 5 to 20 ft apart from each other, with dimensions about 6 ft deep, 10 ft wide, and 60 to 70 ft long.

An aerial photographic study was performed in order to determine if there is visual evidence of landfill activity in the area defined as Site 8. Several pertinent aerial photographs of this area for the period of reported activity were found in the photographic records of the Base and the Army Corps of Engineers. Some of the photographs showed that the land surface was disturbed several times in the Site 8 area during the period of reported landfill activity. Although the disturbances did not have the appearance of landfill trenches, it was decided to conduct geophysical surveys of the area to provide additional evidence regarding the potential existence of the sanitary landfill in the Site 8 area.

Electromagnetic (EM) and total field magnetic surveys were conducted over a 250-by-500-foot gridded area at Site 8. The purpose of the geophysical surveys was to locate, if possible, an area of landfill trenches as described above. Both surveys revealed only one anomaly pattern which was not readily attributable to identifiable man-made features or known utilities at the site. The data did not reveal a pattern of anomalies corresponding with the expected pattern of landfill trenches (i.e., several anomalies of random orientation relatively close to each other). It was therefore concluded that none of the anomalies observed in the data were attributable to the suspected landfill trenches.

Neither the aerial photograph study nor the geophysical survey revealed evidence of landfilling activity matching the description given by the former Base Deputy Civil Engineer. However, since this investigation was conducted at Site 8, the aerial photographs mentioned above were reviewed by the former Deputy Civil Engineer of the Base. His comments indicated that only a portion of the area he recollected as being the former waste disposal area was included in the geophysical survey. Based on this information and the inability to conduct the geophysical survey over the area of new construction, further investigation of this site is necessary to determine the possible existence and location of the sanitary landfill and to prepare a decision document.

9.9 SUMMARY OF RECOMMENDATIONS

Based on assessment of the data collected during the Site Investigation, the following recommendations are made for each of the ANG Portland IRP sites:

- Site 1 Soils Unit:

A decision document has been prepared recommending no further action for this unit.

- Site 1 Ground Water Unit:

Due to the confirmed presence of significant bromochloromethane and methylene chloride contamination, the ground water unit should be investigated further during the RI/FS.

- Site 2:

Due to the confirmed presence of significant contamination of ground water by trichloroethene (TCE) and dichloroethenes (DCE), this site should be investigated further during the RI/FS.

- Site 3:

A decision document has been prepared recommending no further action for this site.

- Site 4:

Due to the confirmed presence of PHC contamination in sediments, and the need for more complete site characterization data, the main drainage ditch should be investigated further during the RI/FS.

- Site 5A:

Because of the reported presence of TCE contamination in the ground water, it is recommended that the ground water at and near the site be further characterized in the RI/FS to confirm the presence or absence of this compound. If the presence of significant TCE contamination is confirmed, its source and extent should be defined through additional investigation.

- Site 5B:

Due to the presence of significant PHC contamination in soils, the need for data showing whether downgradient ground water is contaminated, and the need to satisfy particulars of the new state regulations governing cleanup of leaking petroleum UST systems, Site 5B should be investigated further in the RI/FS.

▪ Site 7:

Because of the confirmed presence of PHCs and chlorinated hydrocarbon contamination in widespread distribution at the former burn pit area, and the need for more complete chemical characterization of PHC contamination in the soils, this site should be investigated further during the RI/FS.

▪ Site 8:

A decision document is being prepared for this site.

10.0 REFERENCES

- Betcher, R. M. 1989. Former Base Deputy Civil Engineer, Oregon Air National Guard, Portland, Oregon. Personal Communication.
- Betts, B. 1990. Washington Department of Ecology. Personal communication.
- Breiner, S. 1973. Applications Manual for Portable Magnetometers. EG&G Geometrics Publ.
- Brown and Caldwell. 1986. City of Portland Airport Way Water Quality Study Technical Report.
- Bureau of Environmental Services, City of Portland. 1988. Columbia South Shore Hazardous Materials Containment Facilities Design Handbook.
- Bureau of Environmental Services, City of Portland. 1988 (Draft). Interim Summary Report Columbia Slough Water Quality.
- Bureau of Environmental Services, City of Portland. 1988. Water Quality Report. Columbia Slough Water Quality Management Plan.
- Bureau of Planning, City of Portland. 1988. Inventory and Analysis of Wetlands, Water Bodies, and Wildlife Habitat Areas for the Columbia Corridor: Industrial/Environmental Mapping Project. Four Volumes. October 1988.
- Century West Engineering Corporation. 1988. Draft, Final Report for Master Drainage Plan. Presented to Multnomah County Drainage District No. 1.
- Davis, H.T. 1988. Portland's Design Handbook for Hazardous Materials Containment in the Columbia South Shore.
- Davis, H.T. 1987. Portland's Plan to Protect Groundwater From Hazardous Materials in the Columbia South Shore.
- EG&G Geometrics. 1989. MAGPAC v. 4.1.4 Magnetic Data Processing and Interpretation Programs for the IBM PC Computer User's Manual: EG&G Geometrics Publ.
- Foster, W. 1990. Oregon Department of Environmental Quality. Personal communication.
- Freeze, R.H. and J.A. Cherry. 1979. Groundwater. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.
- Geonics Limited. 1989. DAT31Q v. 2.08 Computer Program Manual (Survey Data Reduction Manual): Geonics Limited Publ.
- Geonics Limited. 1980. Electromagnetic Terrain Conductivity Measurements at Low Induction Numbers. Technical Note 6: Geonics Limited Publ.

10.0 REFERENCES (cont'd)

- Geonics Limited. 1983. EM34-3 Survey Interpretation Techniques, Technical Note 8: Geonics Limited Publ.
- Geonics Limited. 1984. Operating Manual for EM31-D Non-contacting Terrain Conductivity Meter: Geonics Limited Publ.
- Guthrie. 1986. Oregon Air National Guard Master Plan Drawing B-1, Sheet 1 of 1: Base Plan. Guthrie/Slusarenko/Assoc. October, 1986.
- HMTC. 1987. Installation Restoration Program Phase I - Records Search for Portland International Airport (ANG), Portland, Oregon and North Bend Air National Guard Station, North Bend, Oregon. Prepared by Hazardous Materials Technical Center (HMTC).
- Hoffstetter, W.J., Portland Water Bureau. 1984. Geology of the Portland Well Field. Oregon Geology, Volume 46, Number 6.
- Hogenson, G. M. and B. L. Foxworthy. 1965. Ground Water in the East Portland Area Oregon, U.S. Geological Survey Water Supply Paper 1793. 78p.
- Hvorslev, M.J. 1951. Time Lag and Soil Permeability in Groundwater Observations. U.S. Army Corps of Engineers Waterways Exp. Sta. Bull. 36, Vicksburg, Miss.
- Hwang, D. 1988. U.S. Fish and Wildlife Service, Portland, Oregon. Personal communication.
- Integrated Risk Information System. 1989. U.S. Environmental Protection Agency (U.S. EPA) on-line data base of toxicity measures. Office of Research and Development, Environmental Criteria and Assessment Office, Cincinnati, OH. Electronic Mail Account information via Dialcom, Inc. 600 Maryland Ave. SW, Washington, D.C.
- Logan, T.L. and D.E. Cassler. 1989. Correcting Widespread Cadmium Contamination. Water, Environment and Technology (WPCF), Volume 1 (2), October 1989, p. 312.
- Luzier Hydrosiences. 1984. Environmental Consequences of Ground Water Contamination Near the Portland Well Field: A Preliminary Evaluation. Report to the Portland Water Bureau, City of Portland, Oregon.
- McNeill, J.D. 1980. Electrical Conductivity of Soils and Rocks, Technical Note 5: Geonics Limited Publ.
- Moore, M. 1988. U.S. Army Corps of Engineers, Portland, Oregon. Personal communication.

10.0 REFERENCES (cont'd)

- Mundorff, M.J. 1964. Geology and Ground Water Conditions of Clark County, Washington, with a Description of a Major Alluvial Aquifer Along the Columbia River. U.S. Geological Survey Water Supply Paper 1600. 268p.
- National Research Council. 1983. Risk Assessment in the Federal Government: Managing the Process. National Academy Press, Washington, D.C.
- Newton Associates, Inc., David J. 1988. Port of Portland Airtrans Center Drainage Design Project Geotechnical Investigation.
- NOAA. 1982. Monthly Normals of Temperature, Precipitation, and Heating and Cooling Degree Days 1951-1980: Oregon. Climatology of the United States No. 81 (By State). U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), Environmental Data and Information Service, National Climatic Center, Asheville, N.C. September 1982.
- Oregon UST Cleanup Rules. 1989. Oregon Administrative Rules (OAR) 340-122-205 to 340-122-360. In: Cleanup Rules for Leaking Petroleum UST Systems and Numeric Soil Cleanup Levels for Motor Fuel and Heating Oil. Oregon Department of Environmental Quality (DEQ). August 1989.
- Oregon Water Quality Regulations. Oregon Administrative Rules (OAR) 340-41.
- Oregon Environmental Cleanup Law. 1988. Removal or Remedial Action to Abate Health Hazards. Oregon Revised Statutes (ORS) 466.540 to 466.590. In: Oregon's Environmental Cleanup Program: The Environmental Cleanup Law and Rules for Addressing Facilities Contaminated with Hazardous Substances. Oregon Department of Environmental Quality (DEQ). October 1988.
- Oregon Environmental Cleanup Rules. 1988. Oregon Administrative Rules (OAR) 340-122-001 to 340-122-110. In: Oregon's Environmental Cleanup Program: The Environmental Cleanup Law and Rules for Addressing Facilities Contaminated with Hazardous Substances. Oregon Department of Environmental Quality (DEQ). October 1988.
- Rein, R. 1988a. Letter from Captain R.C. Rein (Oregon Air National Guard, Portland IAP, Portland, Oregon) to Lauren Garner (Oregon Department of Environmental Quality), Re: LPUST Reporting. 12 December 1988.
- Rein, R. 1988b. Oregon Air National Guard, Portland, Oregon. Personal communication.
- SAIC. 1989a. Project Management Plan and Sampling and Analysis Plan for Site Investigation at the Oregon Air National Guard, Portland International Airport, Portland, Oregon. Prepared by Science Applications International Corporation (SAIC) under U.S. Department of Energy Contract No. DE-AC05-84OR2140. 26 July 1989.

10.0 REFERENCES (cont'd)

- SAIC. 1989b. Risk Assessment: Site 1 Soils Unit, Central Hazardous Waste Storage Unit; for Site Investigation at the Oregon Air National Guard, Portland International Airport, Portland, Oregon. Prepared by Science Applications International Corporation (SAIC) under U.S. Department of Energy Contract No. DE-AC05-84OR2140. 11 January 1990.
- SAIC. 1989c. Technical Memorandum: Aerial Photographic Investigation, Site 8 - Sanitary Landfill; for Site Investigation at the Oregon Air National Guard, Portland International Airport, Portland, Oregon. Prepared by Science Applications International Corporation (SAIC) under U.S. Department of Energy Contract No. DE-AC05-84OR2140. 31 July 1989.
- Smith Associates, Inc., Roger N. 1987. Characterization of a Landfill Site and Fleet Maintenance Facility at a Former Location of the Oregon Air National Guard. Submitted to Port of Portland Engineering Services.
- SRH. 1988. Report on Limited Investigation of Soils Contamination, Oregon Air National Guard Base, Portland, Oregon. SRH Associates, Inc. October 1988.
- Telford, W.M., L.P. Geldart, R.E. Sheriff, and D.A. Keys. 1976. Applied Geophysics: Cambridge University Press.
- U.S. Army Corps of Engineers. 1976. Revised Draft Environmental Impact Statement, Rivergate-North Portland Flood Control Study. January 1976.
- U.S. Department of Energy (DOE). 1988. Hazardous Waste Remedial Actions Program: Requirements for Quality Control of Analytical Data. Report No. DOE/HWP-65 HZ-RAP-102-1, August 1988.
- U.S. Department of Transportation (DOT), Federal Highway Administration (FHA). 1985. I-205 to I-84 Airport Way, Multnomah County, Oregon. Draft Environmental Impact Statement. IX-9964(I). FHWA-OR-EIS-85-06-85-D.
- U.S. Department of Transportation (DOT), Federal Highway Administration (FHA). 1986. I-206 to I-84 Airport Way, Multnomah County Oregon. Final Environmental Impact Statement. IX-9964(I). FHWA-OR-EIS-85-06-F.
- U.S. Environmental Protection Agency (EPA). 1983a. Methods for Chemical Analysis of Water and Wastes. EPA Report No. 600/4-79-020, March 1983.
- U.S. Environmental Protection Agency (EPA). 1983b. Hazardous Waste Land Treatment. EPA Report No. SW-874. February 1983.
- U.S. Environmental Protection Agency (EPA). 1984. Uncontrolled Hazardous Waste Site Ranking System: A Users Manual. EPA Report No. HW-10.

10.0 REFERENCES (cont'd)

- U.S. Environmental Protection Agency (EPA). 1985. The Endangerment Assessment Handbook. Office of Waste Programs Enforcement. Washington, D.C. August 1985.
- U.S. EPA. 1986a. Superfund Public Health Evaluation Manual. U.S. EPA, Office of Emergency and Remedial Response, Washington, D.C. EPA 540/186/060.
- U.S. EPA. 1986b. Guidelines for Carcinogenic Risk Assessment. Federal Register 51(185):33991-34003.
- U.S. EPA. 1986c. Guidelines for the Health Risk Assessment of Chemical Mixtures. Federal Register 51(185):34014-34025.
- U.S. EPA. 1986d. Test Methods for Evaluating Solid Waste. EPA Report No. SW-846. September 1986.
- U.S. EPA. 1987. Superfund Program: Interim Guidance on Compliance with Other Applicable or Relevant and Appropriate Requirements. Federal Register 52-(166):32496-32499.
- U.S. EPA. 1988a. CERCLA Compliance with Other Laws Manual. U.S. EPA, Office of Emergency and Remedial Response. OSWER Directive 9234.1-01.
- U.S. EPA. 1988b. Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA. U.S. EPA, Office of Solid Waste and Emergency and Remedial Response. OSWER Directive 9335.3-01.
- U.S. EPA. 1988c. National Oil and Hazardous Substances Pollution Contingency Plan (NCP). Federal Register 53(245):51394-51520.
- U.S. EPA. 1988d. Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses. Prepared by the USEPA Data Review Work Group. Compiled by Ruth Bleyler, Sample Management Office, Viar & Company. Prepared for the Hazardous Site Evaluation Division, U.S. Environmental Protection Agency. 1 February 1988.
- U.S. EPA. 1988e. Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses. Prepared by the USEPA Data Review Work Group. Compiled by Ruth Bleyler, Sample Management Office, Viar & Company. Prepared for the Hazardous Site Evaluation Division, U.S. Environmental Protection Agency. 1 July 1988.
- U.S. EPA. 1989a. Risk Assessment Guidance for Superfund: Human Health Evaluation Manual Part A. U.S. EPA, Office of Solid Waste and Emergency and Remedial Response. OSWER Directive 9285.701A.

10.0 REFERENCES (cont'd)

- U.S. EPA. 1989b. Risk Assessment Guidance for Superfund: Volume II Environmental Evaluation Manual. U.S. EPA, Office of Solid Waste and Emergency and Remedial Response. EPA/540/1-89/001.
- U.S. EPA. 1989c. Health Effects Assessment Summary Tables Third Quarter FY 1989. U.S. EPA, Office of Research and Development. OERR 9200.6-303-(89-3).
- U.S. EPA. 1989d. CERCLA Compliance with Other Laws Manual, Part II. U.S. EPA, Office of Emergency and Remedial Response. OSWER Directive 9234.1-01.
- WDOE. 1989. Interim Sediment Quality Evaluation Process for Puget Sound. Washington Department of Ecology. October 1989.
- Willis, R.F. 1975. Pilot Well Study. Conducted for the City of Portland Bureau of Water Works.

11.0 ACRONYM LIST

AGE	Aerospace Ground Equipment
ANG	Air National Guard
ARAR	Applicable or Relevant and Appropriate Requirement
ASTM	American Society for Testing and Materials
AVGAS	Aviation Gasoline
BCM	Bromochloromethane
BEHP	Bis(2-EthylHexyl)Phthalate
BEX	Benzene, Ethylbenzene, and Xylenes
BLS	Below Land Surface
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
BNA	Base-Neutrals/Acids
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CDI	Chronic Daily Intake
CRP	Community Relations Plan
CWA	Clean Water Act
DCE	Dichloroethene
DEQ	Department of Environmental Quality (Oregon)
DOD	Department of Defense
DOE	Department of Energy
DQO	Data Quality Objectives
EM	Electromagnetic
EPA	Environmental Protection Agency
FIG	Fighter Interceptor Group
FS	Feasibility Study
FSP	Field Sampling Plan
FWQC	Federal Water Quality Criteria
GC/FID	Gas Chromatography/Flame-Ionization Detector
HARM	Hazard Assessment Rating Methodology
HAZWRAP	Hazardous Waste Remedial Action Program
HMTC	Hazardous Materials Technical Center
HRS	Hazard Ranking System
HSP	Health and Safety Plan
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
JP-4	Jet fuel
LPUST	Leaking Petroleum Underground Storage Tank
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MMES	Martin Marietta Energy Systems
MOGAS	Motor Gasoline
MSL	Mean Sea Level
NCB	National Guard Bureau
NCP	National Contingency Plan
OSWER	Office of Solid Waste and Emergency Response (EPA)
PA	Preliminary Assessment
PAHs	Polycyclic Aromatic HydroCarbons
PCBs	Polychlorinated Bi-Phenyls

11.0 ACRONYM LIST (cont'd)

PCE	Perchloroethylene (i.e., tetrachloroethene)
PHCs	Petroleum HydroCarbons
POL	Petroleum, Oil and Lubricants
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RA	Remedial Action
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RI	Remedial Investigation
RPD	Relative Percent Difference
SARA	Superfund Amendments and Reauthorization Act
SAIC	Science Applications International Corporation
SDWA	Safe Drinking Water Act
SI	Site Investigation
TBC	"To Be Considered" (non-ARAR environmental guidelines)
TCA	Trichloroethane
TCE	Trichloroethene
TOX	Total Organic Halogen
TPH	Total Petroleum Hydrocarbon
TSCA	Toxic Substances Control Act
UST	Underground Storage Tank
VOC	Volatile Organic Compound
WDOE	Washington Department of Ecology
WP	Work Plan