N61165.AR.004226
CNC CHARLESTON
5090.3a

CORRECTIVE MEASURES STUDY WORK PLAN SOLID WASTE MANAGEMENT UNIT 17 (SWMU 17) ZONE H CNC CHARLESTON SC
1/1/2001
CH2M HILL

CORRECTIVE MEASURES STUDY WORK PLAN

Solid Waste Management Unit 17, Zone H

Charleston Naval Complex
North Charleston, South Carolina

SUBMITTED TO
U.S. Navy Southern Division
Naval Facilities Engineering Command

PREPARED BY
CH2M-Jones

E012001001GNV

January 2001

Revision 0
Contract N62467-99-C-0960

CORRECTIVE MEASURES STUDY WORK PLAN

Solid Waste Management Unit 17, Zone H

Charleston Naval Complex
North Charleston, South Carolina

SUBMITTED TO
U.S. Navy Southern Division
Naval Facilities Engineering Command

PREPARED BY
CH2M-Jones

E012001001GNV

January 2001
158814.ZH.03

Revision 0
Contract N62467-99-C-0960

Certification Page for Corrective Measures Study Work Plan for SWMU 17, Zone H

I, Dean Williamson, certify that this report has been prepared under my direct supervision. The data and information are, to the best of my knowledge, accurate and correct, and the report has been prepared in accordance with current standards of practice for engineering.

South Carolina

Temporary Permit No. T2000342

Dean Williamson

Dean Williamson, P.E.

1/4/2001

Date

SOUTH CAROLINA
CH2M HILL, INC.
No. C00201
CERTIFICATE OF AUTHORIZATION

Contents

Acronyms and Abbreviations

µg/kg	microgram per kilogram
µg/L	microgram per liter
°C	100 degrees ° Celsius
AST	above-ground storage tank
BEQ	Benzo(a)pyrene equivalents
CA	corrective action
CFR	Code of Federal Regulations
CMS	corrective measures study
CNC	Charleston Naval Complex
COC	chemical of concern
COPC	chemical of potential concern
DAF	dilution attenuation factor
DNAPL	dense nonaqueous phase liquid
DPT	direct push technology
EPA	U.S. Environmental Protection Agency
FBM	Fleet Ballistic Missile
ft bgs	feet below ground surface
HI	hazard index
LNAPL	light nonaqueous phase liquid
MCL	maximum contaminant level
MCS	media cleanup standard
mg/kg	milligram per kilogram
NAPL	nonaqueous phase liquid
NAVBASE	Naval Base
NAVFACENGCOM	Southern Division Naval Facilities Engineering Command
ORC™	oxygen release compound
PAH	polycyclic aromatic hydrocarbon
PCA	tetrachloroethane

PCB	polychlorinated biphenyl
ppb	parts per billion
PRG	Preliminary Remediation Goal
RAO	remedial action objective
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RFI	RCRA facility investigation
RGO	remedial goal option
SCDHEC	South Carolina Department of Health and Environmental Control
SSL	soil screening level
SVE	soil vapor extraction
SVOC	semi-volatile organic compound
SWMU	Solid Waste Management Unit
TEQs	TCDD (dioxin isomer) equivalents
TV	transformer vault
USBP	U.S. Border Patrol
UST	underground storage tank
VOC	volatile organic compound

SECTION 1.0

Introduction

1.0 Introduction

In 1993, Naval Base (NAVBASE) Charleston was added to the list of bases scheduled for closure as part of the Defense Base Realignment and Closure Act, which regulates closure and transition of property to the community. The Charleston Naval Complex (CNC) was formed as a result of the dis-establishment of the Charleston Naval Shipyard and NAVBASE on April 1, 1996.

CNC corrective action (CA) activities are being conducted under the Resource Conservation and Recovery Act (RCRA). The South Carolina Department of Health and Environmental Control (SCDHEC) is the lead agency for CA activities at the site. All RCRA CA activities are performed in accordance with the Final Permit (Permit No. SC0 170 022 560). In April 2000, CH2M-Jones was awarded a contract to provide environmental investigation and remediation services at CNC. This Corrective Measures Study (CMS) Work Plan has been prepared by CH2M-Jones to identify and evaluate the potential remedial alternatives for the soil and groundwater at Solid Waste Management Unit (SWMU) 17 in Zone H at the CNC .

1.1 Regulatory Background

CH2M HILL has prepared this CMS Work Plan on behalf of the Southern Division Naval Facilities Engineering Command (NAVFACENGCOM) to comply with the RCRA Hazardous and Solid Waste Amendments Permit requirements for closure of CNC. A RCRA Facility Investigation (RFI), a baseline risk assessment, and an RFI Addendum prepared by EnSafe have been completed for SWMU 17 and submitted to SCDHEC for review. SCDHEC comments on the RFI Addendum are currently being resolved and addressed. An RFI work plan addendum is being developed for collection of additional soil and groundwater samples to complete the delineation of the extent of contamination (and to address the majority of SCDHEC's comments). However, the overall nature and extent of contamination has been generally well-established for the majority of the site.

The next step in the RCRA CA program for SWMU 17 is the CMS process, which consists of this CMS Work Plan, the CMS, the CMS report, and implementation of the selected corrective measure alternative. This CMS Work Plan discusses the remedial action objectives and media cleanup standards to be used for protecting human health.

1.2 CMS Work Plan Organization

This CMS Work Plan consists of the following four sections:

1.0 Introduction — Presents the purpose of the work plan and background information necessary to understand the CMS objectives. Accordingly, this section includes a general site description and a description of the nature and extent of contamination in soils and groundwater at SWMU 17.

2.0 Risk Assessment Results and COC Identification — Discusses the risk assessment performed for SWMU 17 and direct and indirect exposure scenarios identified as needing further evaluation.

3.0 Corrective Measures Study Approach – Presents the results of the baseline risk assessment, describes the remedial action objectives, and proposes media cleanup standards for the site.

4.0 Project Management Plan — Describes the overall project management approach, including roles and responsibilities, communication plan, project schedule, and project deliverables.

5.0 References – Includes any documents cited in the previous three sections.

Tables are embedded in the text of this work plan as they are referenced; figures are found at the end of the sections in which they are referenced.

1.3 Site Background and History

SWMU 17 is located at Building FBM 61 within Zone H at the CNC. FBM 61 is a former Fleet Ballistic Missile Training Center that was used by the Navy from 1962 until June 1996. It is leased by the U.S. Border Patrol (USBP) and is used as a law enforcement training facility.

The zoning for SWMU 17, as applied by the City of North Charleston, is B-2, a zoning type that allows for various commercial business activities but does not provide for long-term or permanent residential use. The CNC Reuse Plan designates the future land use of this area for government offices and a training campus. The USBP's use of this area for law enforcement training is compatible with the zoning and future land use provided for in the Reuse Plan.

There are four known sources of contamination at SWMU 17. These four source areas (designated as A through D) are described below and shown in Figure 1-1.

A: In June 1987, a leak occurred in a boiler fuel oil line that runs underneath a storage addition on the north side of FBM 61. Approximately 14,355 gallons of #5 diesel fuel oil leaked, of which approximately 7,300 gallons were recovered.

B: In September 1997, a 250-gallon steel underground storage tank (UST) was removed because holes in the tank had allowed #2 diesel fuel oil to leak into the ground. This UST was located next to transformer vault (TV) 1.

C: In 1984, a line pole capacitor ruptured and spilled polychlorinated biphenyl (PCB) oils at the northern end of the paved courtyard. The Navy cleaned up the PCB oils.

D: Soil samples collected in 1982 confirmed the presence of PCB-containing soils beneath the drains at TV1. There is no information as to whether samples were collected from the soils near TV2, a second TV at the site. PCBs were also detected in oily soil samples collected during the cleanup of source A, above. Both PCB-filled transformers were removed in the early 1990s.

In addition to the four known sources described above, the possibility was presented in the EnSafe RFI Addendum (EnSafe, 2000) that another UST exists beneath the floor of FBM 61. The presence of this UST has not been confirmed.

1.4 Summary of Site Investigation Activities to Date

Site investigation activities have occurred in five separate phases since 1994. Table 1-1 briefly summarizes these activities. Soil sample collection and groundwater monitoring well installation methods are described in detail in EnSafe/Allen & Hoshall, 1996.

TABLE 1-1
Summary of Site Investigation Activities at SWMU 17, Zone H

Date	Soils	Groundwater
1994	34 surface soil samples (0-1 feet below ground surface [ft bgs])	Wells 017001 to 017004 installed Wells 017005 and 017006 installed later to determine northern extent of

TABLE 1-1
Summary of Site Investigation Activities at SWMU 17, Zone H

Date	Soils	Groundwater
	32 subsurface soil samples (3-5 ft bgs)	groundwater contamination
June 1997	6 soil borings in paved courtyard to investigate oil/water separators (performed as part of Zone L RFI)	
June 1998	--	Wells 017007 – 017010 installed; Deep well 01702D installed to investigate full stratigraphic section
1999 Addendum activities	6 surface soil samples 10 subsurface soil samples (direct push technology [DPT]) 16 saturated soil samples (collected below the water table using DPT)	27 temporary wells

A total of 36 surface soil samples were collected from the top foot of the soil interval in 1994-1995, and 33 subsurface soil samples were collected in 1994 and 1995 at a depth of approximately 3 to 5 feet below ground surface (ft bgs). Generally, these samples were analyzed for the full suite of analytes (volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, PCBs, metals, and cyanide). Tables 2.5.12 and 2.5.13 in the RFI Addendum (EnSafe, 2000) list the analyses performed for each of the samples collected.

Six surface, 10 subsurface, and 16 saturated soil samples were also collected in 1999 using direct push technology (DPT). The saturated zone samples were collected to provide a comparison to groundwater samples in areas of the site with light non-aqueous phase liquids (LNAPL) and dense non-aqueous phase liquids (DNAPL). Saturated soil samples were analyzed for VOCs, SVOCs, pesticides, PCBs, metals and cyanide. Figure 1-2 shows surface and subsurface soil sample locations.

A total of 10 shallow groundwater monitoring wells were installed in 1994 and 1998 to a typical depth of about 15 ft bgs. In 1998, one deep monitoring well was installed to a depth of 44 ft bgs at SWMU 17. In 1999, 27 temporary wells were installed to a depth of approximately 15 ft bgs using DPT. These wells were installed to investigate other potential sources of contamination at SWMU 17 and to better delineate the extent of specific contaminants in groundwater. Figure 1-3 shows groundwater monitoring wells and DPT locations.

Soil samples collected from SWMU 17 borings indicate that the site geology consists of unconsolidated coastal sediments. Four cross-sections of the site, provided in the RFI Addendum, Figures 2.5.62 and 2.5.63 (EnSafe, 2000), illustrate the interbedded nature of these sediments, which consist of silty sands and marsh clays. The water table is approximately 5 ft bgs at SWMU 17, and the aquifer materials consist of interbedded sands and clays that range from 5 to 15 feet in thickness. Beneath this aquifer lies an organic clayey silt (Q_{m1}) that appears to be laterally continuous at SWMU 17 since it is detected in the bottom portions of all of the groundwater wells installed at the site. This clay unit is approximately 15 feet thick in the one well that fully penetrated it, and may provide an effective barrier in preventing shallow groundwater contamination from reaching the deeper aquifer that lies beneath the clay.

As described earlier, surface soil samples, subsurface soil samples and groundwater samples were collected at the site and analyzed for VOCs, SVOCs, PCBs/pesticides, and metals. The RFI Addendum (EnSafe, 2000) contains 53 figures showing the lateral extent of these chemicals across the site and 10 tables listing the concentrations of the chemicals detected in the samples. Because of data gaps at the conclusion of this multi-event sampling program, limited additional sampling is needed to address the full extent of the contamination in the soil and groundwater. These samples will be collected as an RFI Addendum activity and addressed separately from this document. At the current time, enough is known about the nature and extent of contamination to initiate the CMS process. The early stages of the CMS process can be carried out concurrently with the activities related to the additional sampling event.

To develop a list of chemicals of potential concern (COPCs), concentrations of chemicals in soil and groundwater samples were compared to site background concentrations, risk-based concentrations (RBCs), soil screening levels (SSLs) or maximum contaminant levels (MCLs), as appropriate (EnSafe, 2000). RBCs for surface soils were developed by EnSafe and are documented in the RFI Addendum (EnSafe, 2000); SSLs for subsurface soils and RBCs for groundwater are based on U.S. Environmental Protection Agency Region IX Preliminary Remediation Goals (PRGs) (EPA, 2000) and are listed in Table 2.5.36 in the RFI Addendum. MCLs are the federal drinking water standards that were promulgated by EPA (Title 40 of the *Code of Federal Regulations* Part 264 (40 CFR 264). Figures 1-4 through 1-6 illustrate the extent of contamination in surface soil, subsurface soil, and groundwater, relative to SSLs and RBCs. For these figures, the chemical that has the greatest lateral extent across the site has been selected for each media; Aroclor-1260 for soils and chlorobenzene for groundwater. Additional figures will be presented in Section 2 to better illustrate the extent of contamination in each of the impacted media at the site.

After the COPCs were identified by the screening process described above, a risk assessment for SWMU 17 was conducted by EnSafe. The risk assessment identified a preliminary set of chemicals of concern (COCs) that significantly contribute to a pathway in a use scenario for a specific receptor. Section 2 describes the results of the risk assessment and the final set of COCs that were identified for SWMU 17.

1.5 Summary of Conclusions from RFI Addendum

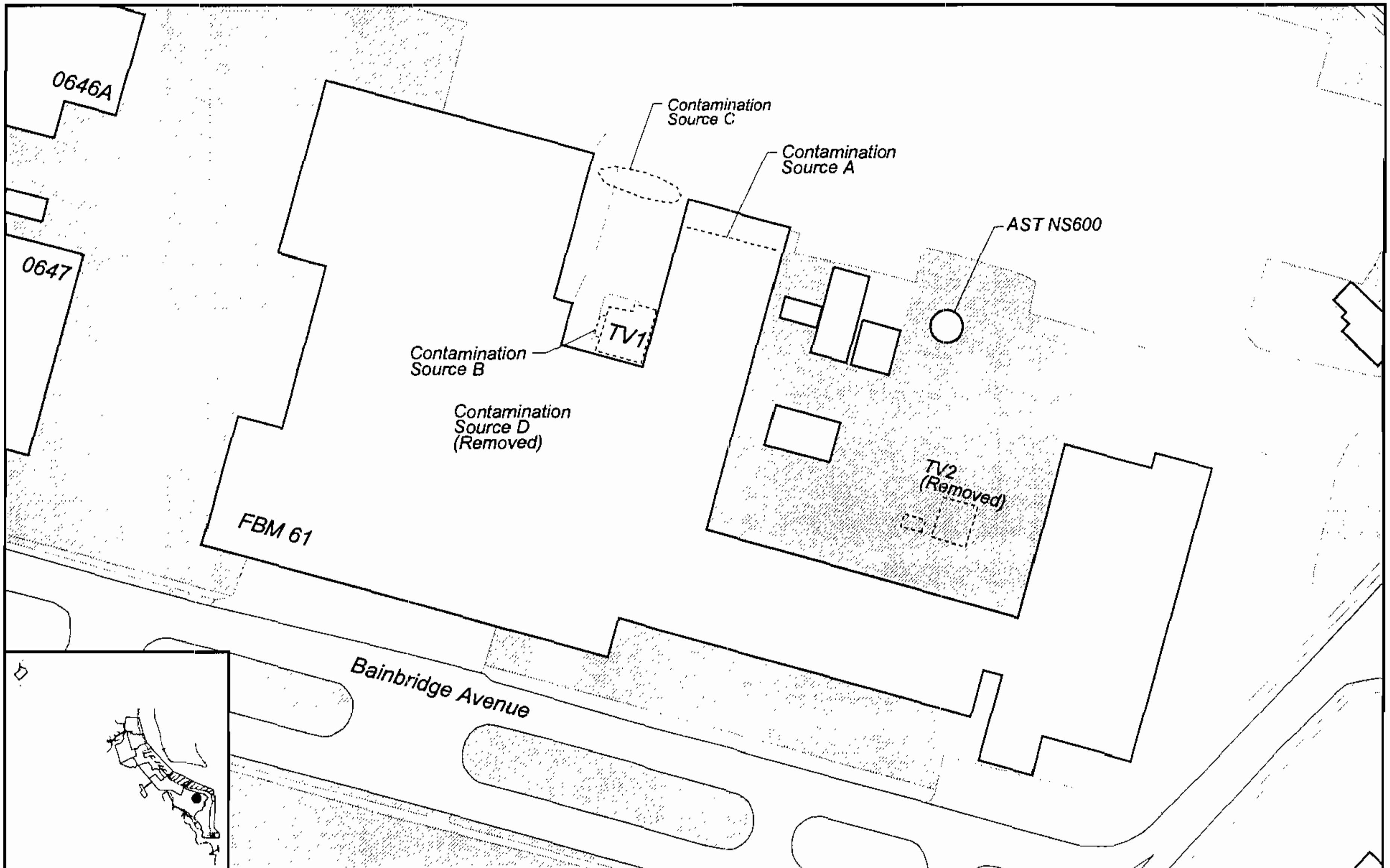
The RFI Addendum (EnSafe, 2000) included the following summary of the general origins and extent of key contaminants, which serves as an overall conceptual site model regarding sources of contamination and current status.

> *PCB and diesel fuel oil from activities in and around FBM 61 have entered soil and groundwater at the site. PCB contamination is the result of transformer fluid leaks in the paved courtyard area on the north side of the building. Aroclor-1260 is the main PCB contaminant exceeding screening levels in soil. Chlorinated benzenes are also present as contaminants associated with the leaking transformer dielectric fluid. Leaking transformer fluids pooled on the surface or in pavement subgrade materials northwest of what is now the storage area, and migrated vertically until accumulating in the saturated zone as a DNAPL in the area immediately surrounding well 017002. The DNAPL found at well 017002 is persistent but not great in thickness (0.10 ft, 01/00). The DNAPL accumulation appears static but is a continuing source of dissolved phase constituents such as the chlorinated benzene compounds. Although there have been some PCB detections in groundwater, chlorobenzene is the most widespread contaminant in groundwater related to the dielectric fluid and has migrated north and south of the building area.*

> *Diesel fuel leaking from UST FBM 61-1 and the buried boiler fuel pipeline likely contributed to the spread of PCB contaminants in soil. Residual diesel fuel from the pipeline leak is present as LNAPL in the storage addition area. LNAPLs at FBM 61 have not migrated from the source area and are relatively immobile under existing site groundwater gradients. However, the LNAPLs continue to be a source of dissolved phase constituents. Soluble phase fuel constituents are present in shallow groundwater beneath the paved*

courtyard and storage addition, and in the area around the pipeline between the storage addition and the boiler fuel storage AST [above-ground storage tank]. *Moderate pumping of the temporary wells during development and sampling created a noticeable increase in LNAPL measured in SWMU 17 wells. This implies that the LNAPLs may be induced to move by low pumping of the aquifer.*

The low permeability clayey sediments of Qm_1 *effectively isolate the basal sand (*Qs_1*) of the surficial aquifer beneath SWMU 17 which has not been impacted by contaminants in near surface soils and shallow groundwater.*



LEGEND

Non-paved Surfaces

Existing Structure

Contamination Source

N

0 75 150 Feet

Figure 1-1
Sources of Contamination
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\cnc-egis-DEN.apr, Date: 20 Nov 2000 10:53, User: GHALL

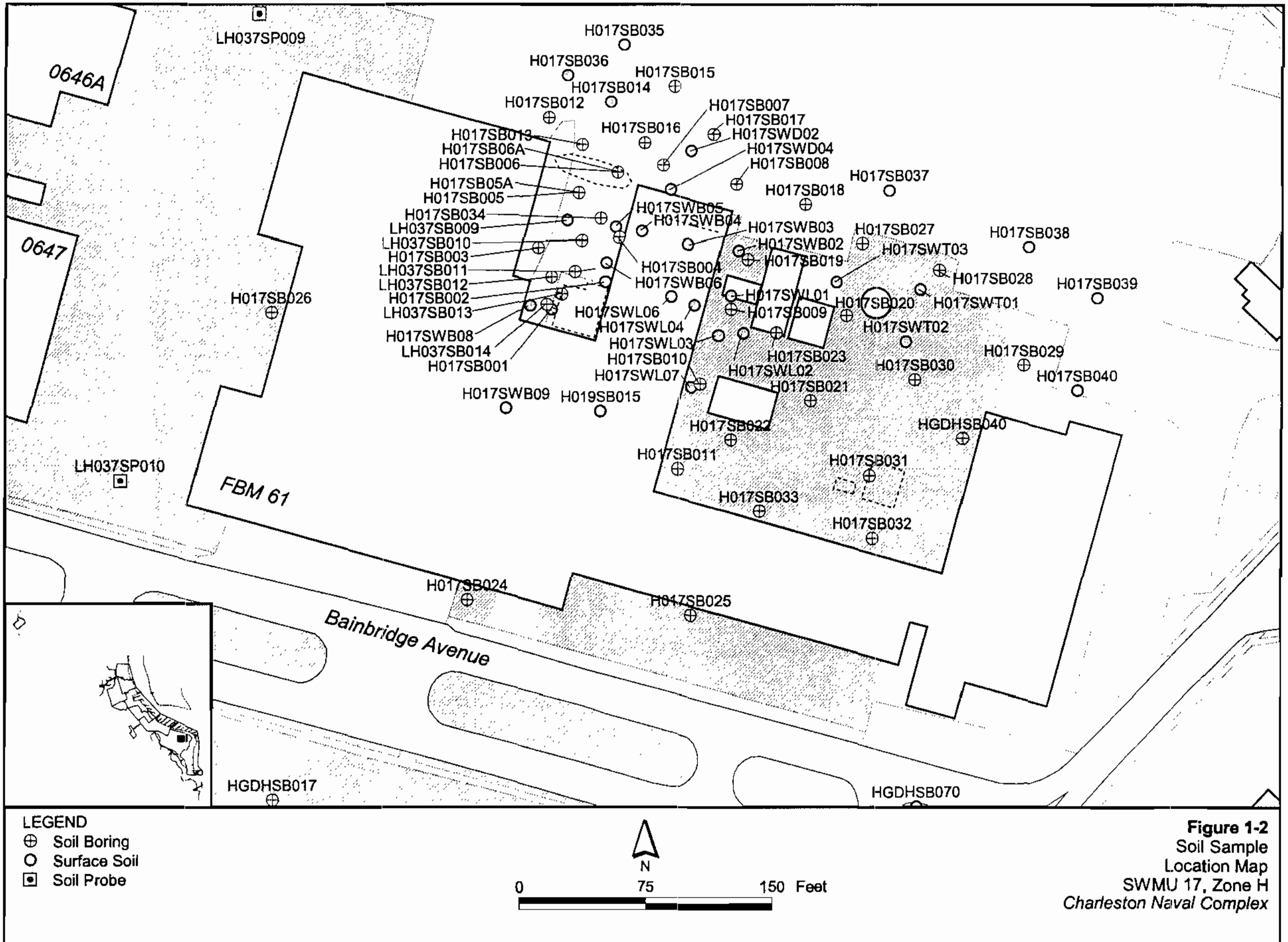
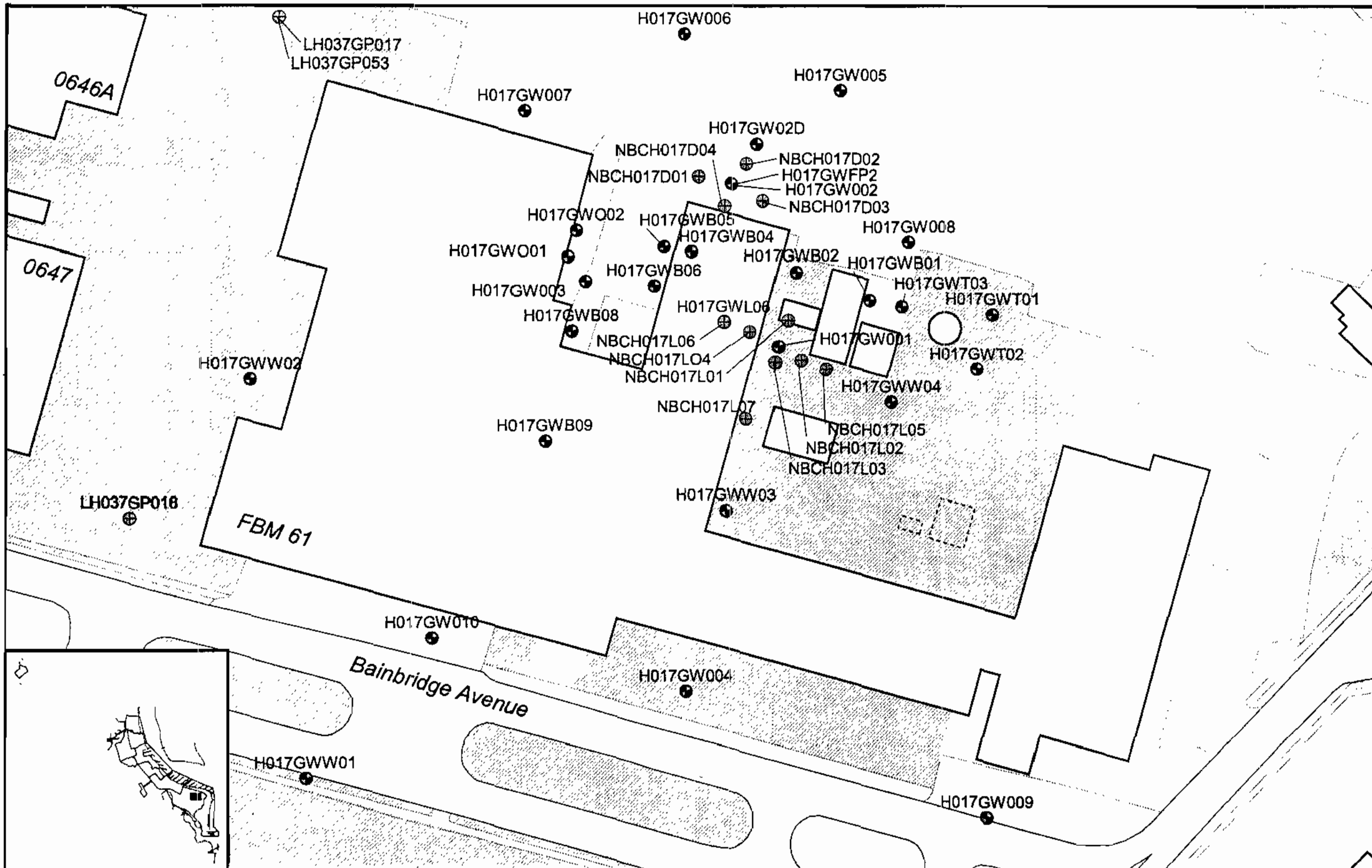


Figure 1-2
Soil Sample
Location Map
SWMU 17, Zone H
Charleston Naval Complex

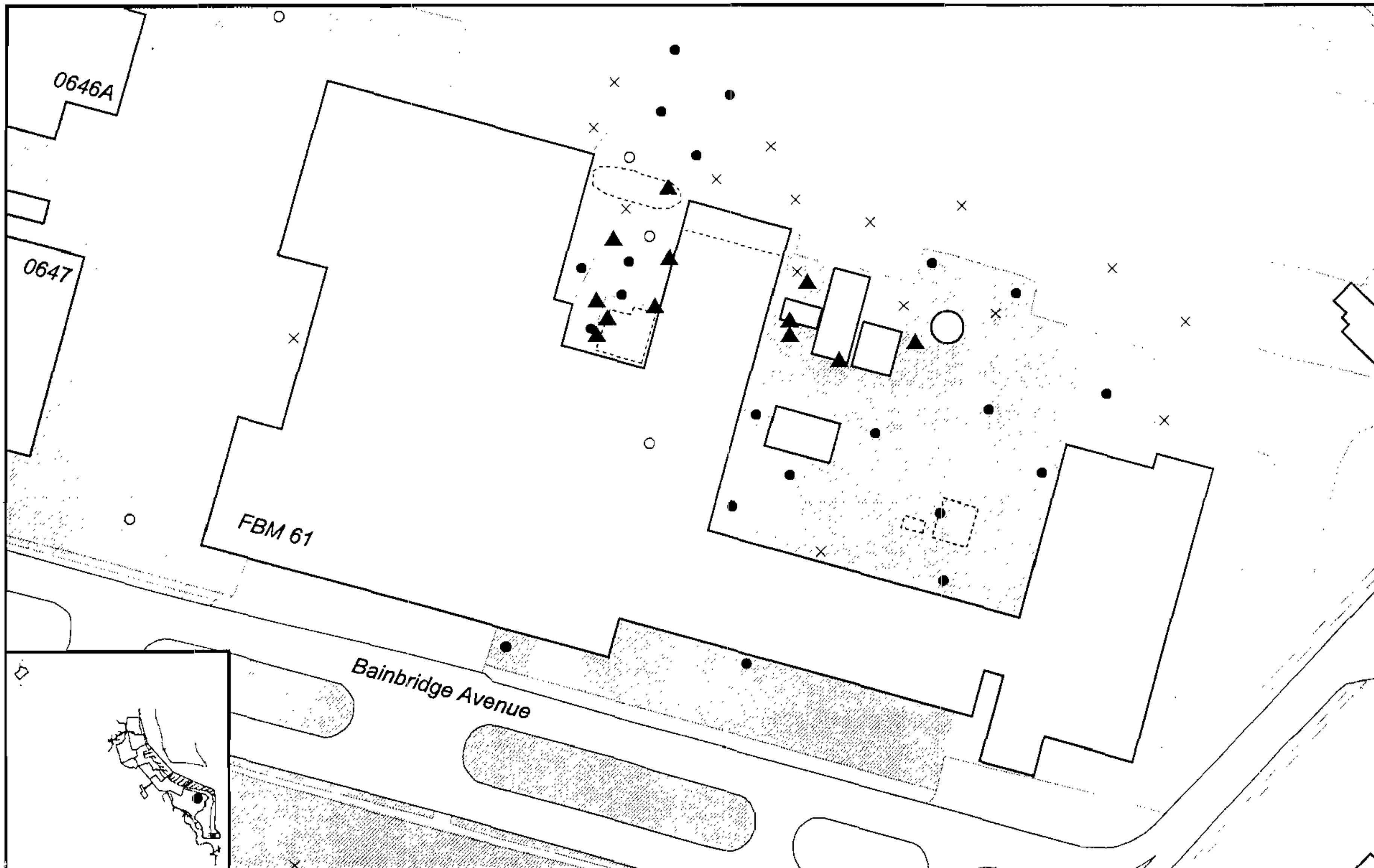
File Path: C:\18gis\CNC\cnc-egis-DEN.apr, Date: 20 Nov 2000 10:58, User: GHALL



LEGEND
- Groundwater Probe
- Groundwater Well

Figure 1-3
Groundwater Sample
Location Map
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\cnc-egis-DEN.apr, Date: 20 Nov 2000 11:01, User: GHALL



LEGEND
○ Not Sampled
× ND
● ≤ 0.999 (mg/kg)
▲ ≥ 1.0 (mg/kg)

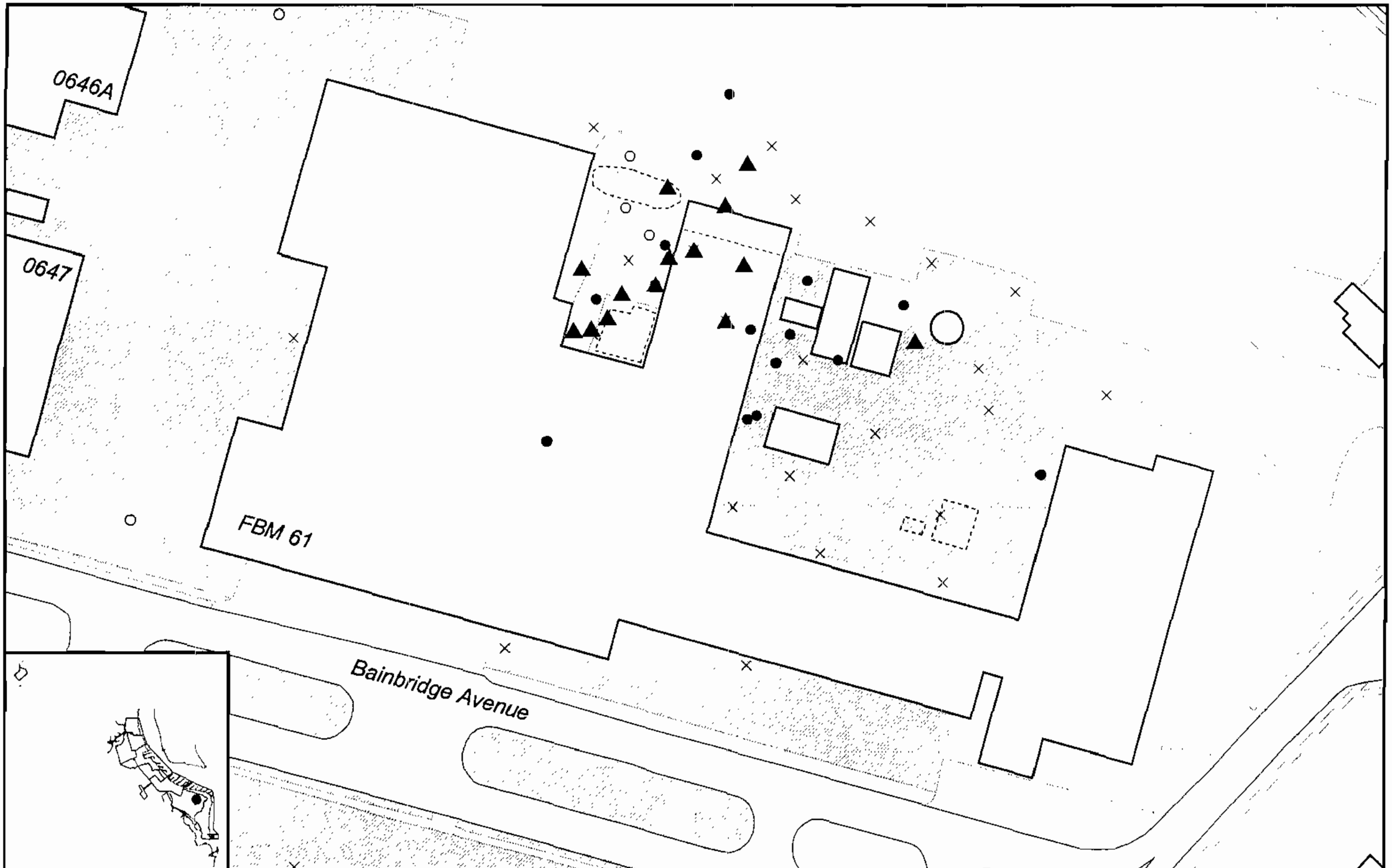
Note: RBC = 1.0 mg/kg.

N

0 75 150 Feet

Figure 1-4
Extent or Aroclor-1260
in Surface Soils
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\cnc-egis-DEN.apr, Date: 22 Dec 2000 10:34, User: GHALL



LEGEND
○ Not Sampled
× ND
● ≤ 0.999 (mg/kg)
▲ ≥ 1.0 (mg/kg)

Note: SSL = 1.0 mg/kg.

N

0 75 150 Feet

Figure 1-5
Extent of Aroclor-1260
in Subsurface Soils
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\cnc-egis-DEN.apr, Date: 22 Dec 2000 10:37, User: GHALL

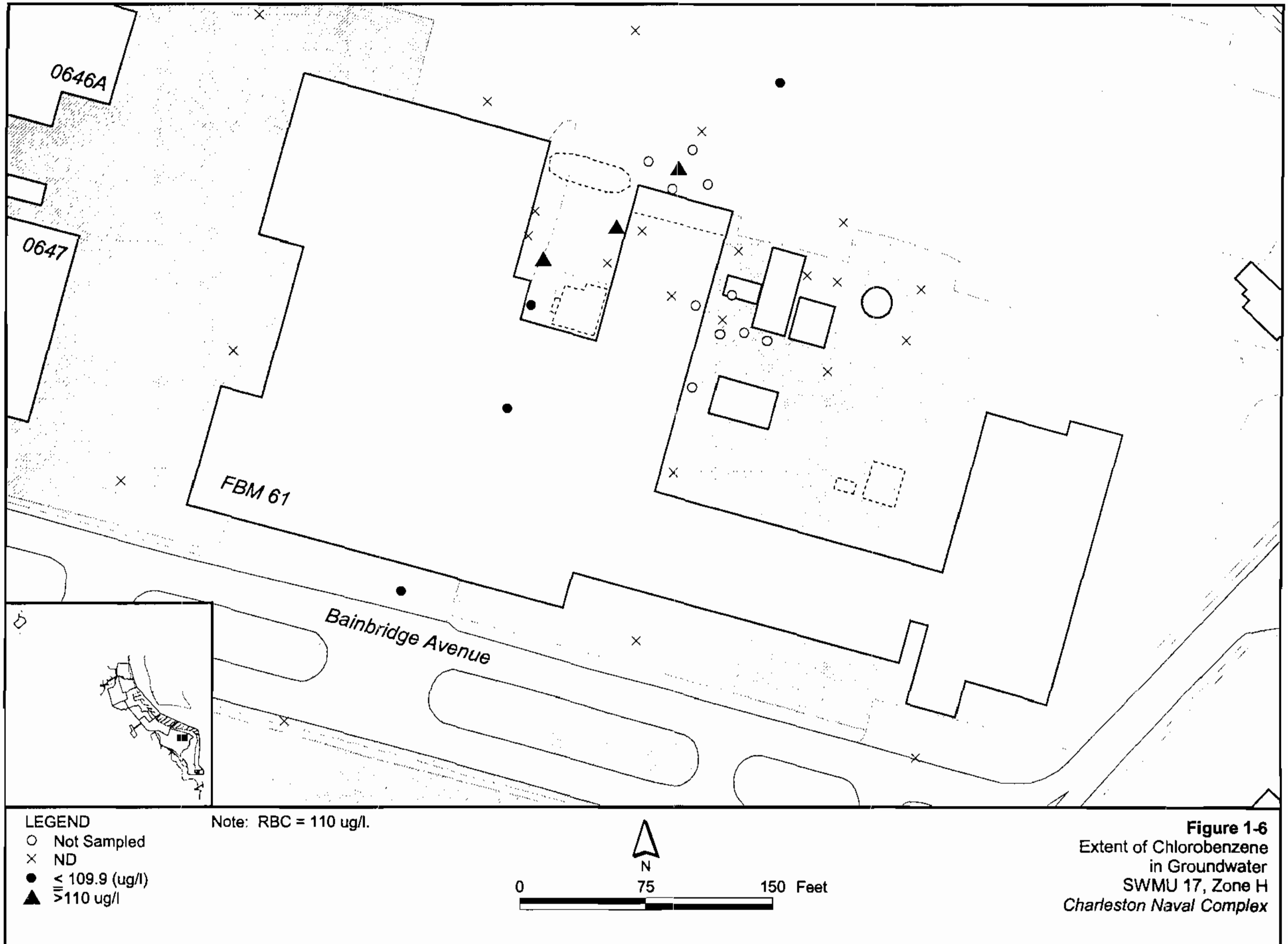


Figure 1-6
Extent of Chlorobenzene
in Groundwater
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\cnc-egis-DEN.apr, Date: 20 Nov 2000 15:28, User: GHALL

SECTION 2.0

Risk Assessment Results and COC Identification

2.0 Risk Assessment Results and COC Identification

This section of the CMS Work Plan discusses the risk assessment performed for SWMU 17 and documented in the Zone H RFI Addendum (EnSafe, 2000), and direct and indirect exposure scenarios identified as needing further evaluation in this CMS. This section also presents the preliminary COCs identified in the RFI and a COC refinement process to select a final set of COCs per medium for the CMS. In addition, proposed remedial action objectives (RAOs), media cleanup standards (MCSs) and remedial goal options (RGOs) are presented for use in the alternatives evaluation in the CMS.

A risk assessment for SWMU 17 was performed and documented in the Zone H RFI Addendum (see Volume II of IV, Sections 2.5 to 4.0) for COPCs identified in the preliminary screening process. According to the RFI and risk assessment, environmental media at SWMU 17 that have been excessively impacted include surface and subsurface soils and groundwater. Potential offsite impacts were evaluated as part of the fate and transport analysis; it was concluded that offsite sediment or surface water impacts are not occurring at the present time and are not anticipated in the future. There are no sediments or surface water associated with this SWMU; therefore these media do not need to be remediated or considered in the CMS.

Preliminary COCs that were identified in the RFI for soils and groundwater are further refined in the following sections to selected final COCs for the SWMU 17 CMS.

2.1 Surface Soil COC Evaluation

Table 2-1 presents a risk assessment summary for surface soils for both residential and industrial land use. Conclusions from the risk assessment regarding these COCs include the following:

- Aroclor-1260 and benzo(a)pyrene equivalents (BEQs) were identified as COCs for a residential scenario, while the only COC identified for a general worker scenario is Aroclor-1260. No COCs were identified for noncarcinogenic effects.
- For Aroclor-1260, the unrestricted (residential) scenario risk (1E-06) RBC was exceeded in 12 of the 39 sampling locations, and an industrial worker scenario

TABLE 2-1
Summary of Surface Soil Risks for SWMU 17

Preliminary COC from RFI	Max. Concentration (mg/kg)	Incremental Lifetime Cancer Risk		Final COC for CMS Work Plan?	
		Industrial Land Use	Residential Land Use	Industrial	Residential
PCB Aroclor-1260	180	2×10^{-05}	7×10^{-05}	Yes	Yes
Dioxins (TEQs)[a]	0.00012	7×10^{-06}	3×10^{-05}	No	No
BEQs[b]	0.28	1×10^{-06}	3×10^{-06}	No	No
Total Risk		$\mathbf{3 \times 10^{-05}}$	$\mathbf{1 \times 10^{-04}}$		

NC Not a carcinogen

HIs were less than 1.0 for all scenarios.

The majority of the risks are from inhalation of dust pathway.

[a] Detected dioxins (max = 0.12 parts per billion [ppb]) were below the SCDHEC and EPA action level of 1 ppb. In addition, background TEQs are not established for CNC although TEQs are ubiquitous in urban soils.

[b] BEQs were below background levels and below typical detection limits (e.g., 0.33 mg/kg).

(1E-05) RBC value was exceeded in 6 of 39 locations for general workers. The highest concentration of 180 milligrams per kilogram (mg/kg) occurred at 017SB020, which is located within the secondary containment wall around AST NS600 (see Figure 1-1 for location). It was noted in the RFI Addendum that if this single high value is removed from the data set, the *exposure point concentration,* the likely concentration for a receptor exposure, decreases from 11.9 mg/kg to 4.0 mg/kg, indicating that this location is a significant "hot spot."

- For BEQs, the highest concentration of 0.28 mg/kg was detected at 017SB002, next to the newer extension of building FBM 61, within the asphalt paved area. The detected BEQs are above the unrestricted use risk level (1E-06) RBC value of 0.088 mg/kg, but all are below an industrial scenario (1E-05) RBC of 0.78 mg/kg. The CNC and Zone H-wide BEQ background levels are higher than the maximum detected BEQs within SWMU 17.
- The action level for TCDD equivalents (TEQs) is 1 microgram per kilogram (µg/kg). None of the detected TEQs were above this criterion, although they were above residential and industrial RBCs.

Surface Soil Risk Results and Uncertainty

Surface soil risks for workers are within 1 to 100 in a million-risk range, and HI was below 1.0. Risks to a future resident are at the upper limit for acceptable risk range, while HIs are below 1.0. The calculated risks resulted primarily from the inhalation of dust. Typically, the inhalation pathway contributes to significantly less dose/risk than ingestion and dermal pathways. Because of the assumptions used in the risk assessment, the inhalation pathway risks were higher to a worker, reported at 2×10^{-5}. The ingestion and dermal pathway risks were 6×10^{-6} and 1×10^{-6}, respectively, indicating that risks to a future industrial worker from these pathways is well within acceptable risk limits. Residential scenario risks from inhalation were at 4×10^{-5}, compared to ingestion pathway risks at 5×10^{-5} and dermal pathway risks at 1×10^{-5}. Thus the cumulative risks from ingestion and dermal pathway to a resident are likely to be 5×10^{-5}, which is within EPA's acceptable risk range, although it is above the SCDHEC's point of departure risk of 1 in a million for a future resident. However, HIs were below a value of 1.0. The risks will be further discussed by COC below.

BEQs — The maximum detected concentration for polycyclic aromatic hydrocarbon (PAH) (BEQ) of 0.28 mg/kg in surface soil is well below the typical detection limit value of 0.33, as well as the established CNC reference or background level (1304 ug/kg). The overall cumulative risk contribution from BEQs is also low. Therefore, BEQs are not recommended for further evaluation as a COC in the remedial alternatives analysis of this CMS.

TEQs — TEQs have an established action level of 1 part per billion (ppb) at CNC. None of the detected TEQs reported exceeded these limits. Although no site-specific anthropogenic background levels for TEQs were established for CNC, they are known to occur in the background of the urban environment (ATSDR, 1997). Therefore, TEQs are not recommended for further evaluation as a COC in the remedial alternatives analysis of this CMS.

PCBs — Aroclor-1260 was reported in surface soil at concentrations ranging between 0.036 to 180 mg/kg concentration, contributing a risk of 2 x 10-5 for industrial land use, and 7 x 10-5 for residential land use. Because Aroclor-1260 exceeded these criteria, appears to be site-related, and is a contributor to the cumulative risk, it will be carried through remedial alternatives analysis as a COC.

Summary of Surface Soil COCs

Based on the RFI and risk assessment as well as the preceding discussion, Aroclor-1260 is the only surface soil COC that needs further evaluation for remediation in the CMS to protect human health and the environment at SWMU 17.

2.2 Subsurface Soil COC Evaluation

Subsurface soils are not a direct exposure concern under normal industrial operation conditions or residential use. However, subsurface contaminants may indirectly influence other media through migration over time. Therefore, they were evaluated for the potential to migrate downward to shallow groundwater and the potential to volatilize into air.

Subsurface Soil Leachability to Groundwater

Based on the fate and transport evaluations conducted during the RFI, the chemicals listed in Table 2-2 were identified as COPCs since they exceeded the default EPA soil SSLs for leachability to groundwater, with a dilution attenuation factor of 1.0 (DAF=1) (see Section 2.5.6 of RFI Addendum, EnSafe, 2000). Most of the contaminated subsurface soils are located under the asphalt pavement and the newer extension of Building FBM 61, although some of the contaminated subsurface soils are in the unpaved area and areas with fractured pavement.

TABLE 2-2
Summary of Subsurface Soil COPCs and COCs Based on Groundwater Protection

COPCs from RFI (>SSL at DAF=1)	Detected Concentration Range (mg/kg)	SSLs (at DAF=1)	Site-Specific SSLs[a] (at DAF=15.3) (mg/kg)	Detected in Groundwater at >RBC/MCL?	COC (>SSL at DAF=15.3 and Detected in Groundwater)
Aroclor-1260	0.035-6200	1[b]	1[b]	Yes	**Yes**
Benzene	0.042-7.2	0.002	0.031	Yes	**Yes**
Benzo(a)anthracene	0.026-3.1	0.08	1.53	No	No
Benzo(a)pyrene	0.021-1.6	0.4	6.13	No	No
Benzo(b)fluoranthene	0.023-0.79	0.2	3.82	No	No
Chlorobenzene	0.0035-790	0.07	1.07	Yes	**Yes**
Ethylbenzene	2.6-5.3	0.7	10.7	No	No
1,2-dichlorobenzene	0.22-1.8	0.9	13.78	No	No
1,3-dichlorobenzene[c]	0.167-22	0.1	1.5	Yes	**Yes**

TABLE 2-2
Summary of Subsurface Soil COPCs and COCs Based on Groundwater Protection

COPCs from RFI (>SSL at DAF=1)	Detected Concentration Range (mg/kg)	SSLs (at DAF=1)	Site-Specific SSLs[a] (at DAF=15.3) (mg/kg)	Detected in Groundwater at >RBC/MCL?	COC (>SSL at DAF=15.3 and Detected in Groundwater)
1,4-dichlorobenzene	0.315-40	0.1	1.5	Yes	**Yes**
1,2-dichloroethene, total	0.26-0.27	0.02	0.31	No	No
Hexachlorobenzene	0.285-1.3	0.1	1.53	No	No
Naphthalene	0.043-26	4	61	No	No
Styrene	0.59	0.2	3.06	No	No
1,2,4-trichlorobenzene	0.1-410	0.3	4.59	Yes	**Yes**
1,1,2,2-tetrachloroethane	3.8	0.0002	0.002	No	No

[a] The leachability criteria or soil screening levels are selected from EPA Region IX PRG tables (EPA 2000), with a site-specific DAF calculated at 15.3 (see Appendix).

[b] Aroclor-1260 is assigned a PRG of 1 mg/kg.

[c] 1,4 dichlorobenzene SSL value is used for 1,3-dichlorobenzene.

Site-Specific DAF Calculation

In the RFI, a generic, overly conservative DAF of 1 was used in the SSL calculation. Therefore, a site-specific DAF value was estimated as described in the Appendix. The site specific DAF calculated for SWMU 17 is 15.3. This assumes that about 25 percent of the area is unpaved or otherwise available for leaching/percolation. The input assumptions to this calculation are considered conservative since much of the subsurface contamination is underneath the asphalt-paved parking lot and underneath the newer extension of the building FBM 61. Thus, leachability is limited for these subsurface soils, and is likely to be less than the assumed 25 percent.

Chemicals Above SSLs but Not in Groundwater Above Criteria

Several chemicals in Table 2-2 that were detected in subsurface soil above the SSL (based on a DAF=1) were not detected in groundwater at the site. These chemicals are discussed in the following paragraphs.

PAHs — Highly insoluble PAHs are not expected to pose a leaching hazard or become dissolved in the groundwater. PAHs are largely associated with the presence of LNAPL. Removal of LNAPL will be specifically addressed during the evaluation of remedial alternatives, and it is anticipated that PAHs in the soil may be reduced in concentration as part of this effort. Because of their low solubilities, these chemicals were not detected in groundwater at SWMU 17. Consequently, the three PAHs listed in Table 2-2 — (benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene) are not proposed as COCs.

Methylnaphthalene and Ethylbenzene — These two chemicals were reported in subsurface soil samples within and near the LNAPL-containing area. Subsurface soil concentrations for these chemicals were also below the revised SSL. These chemicals are not proposed as COCs for subsurface soil.

Hexachlorobenzene — This chlorinated aromatic hydrocarbon is relatively immobile and has not been detected in groundwater. It was detected in only 2 of the 34 soil samples (see Figure 2.5.27 of the RFI Addendum, EnSafe, 2000). Because it is limited in area of occurrence and is not above the site-specific SSL, hexachlorobenzene is not proposed as a COC for subsurface soil.

Styrene — Styrene was detected in only 1 of the 20 subsurface soil samples, and the detected concentration was below the site-specific SSL. It was not detected in any groundwater samples. Therefore, it is not proposed as a COC for subsurface soil.

1,1,2,2-Tetrachloroethane (PCA) — 1,1,2,2-PCA was reported in only one subsurface soil sample at 3.8 mg/kg, above its SSL value. However it was not detected in groundwater in the vicinity. Considering the time that has likely passed since the subsurface release, this highly soluble chemical would have reached groundwater if it was present in significant volume and at greater than the SSL. Because of the infrequency of detection and because it is not present in the groundwater, it is not proposed as a COC for subsurface soil.

Summary of Subsurface Soil COCs for Protection of Groundwater

Based on the discussion above, the following COCs are proposed for subsurface soil, to protect groundwater from the leaching of contaminants from soil:

- PCB – Aroclor-1260
- Benzene
- Chlorobenzene
- 1,3-dichlorobenzene

- 1,4-dichlorobenzene
- 1,2,4-trichlorobenzene

Evaluation of Potential Subsurface Soil Releases to Air

Because several of the subsurface soil COPCs are volatile, they could migrate from the subsurface environment into ambient air and into the indoor air of buildings above or adjacent to the contaminated area. A screening evaluation for such potential was conducted by comparing maximum and average detected subsurface soil concentrations with SSLs for air releases from several state environmental agencies. These maximum and mean concentrations were compared with industrial land use-based SSL-air values (see Table 2-3 for summary). Of the VOCs and SVOCs detected in the subsurface soils, only chlorobenzene and benzene exceed their SSL-air values. Therefore, chlorobenzene and benzene are COCs for the air migration pathway.

TABLE 2-3
SWMU 17 Subsurface Soil COC - Evaluation of Potential for Air Emissions from Subsurface Soil COPCs

	Concentration		RBC (SSL-Air) - Industrial		
COPC	Maximum (mg/kg)	Average (mg/kg)	Virginia (mg/kg)	Connecticut (mg/kg)	Industrial – Air (COC?)
Benzene	7.2	2	1.1	113	**Yes**
Chlorobenzene	790	159	14	106	**Yes**
1,2-dichloroethene (total)	0.270	0.265	NA	22[a]	No
1,2-dichlorobenzene	1.8	1.6	330	818	No
1,3 dichlorobenzene	22	10	NA	818	No
1,4 dichlorobenzene	40	11	1200	3270	No
1,2,4-trichlorobenzene	410	93	980	NA	No
Ethylbenzene	5.3	3.6	610	5672	No
Styrene	0.59	0.59	1500	28	No
1,1,2,2-tetrachloroethane	3.8	NA	0.77	1	No[b]
Tetrachloroethene	1	NA	14	27	No
Toluene	5.5	3.2	180	2615	No
Xylene (total)	21	18.5	NA	1702	No

[a] Value is from Michigan Department of Environmental Quality (MI-DEQ) Part 201, June 2000- for cis- and trans-DCE.
[b] 1122-PCA was detected in only one sample.

Virginia - Virginia Voluntary Remediation Regulations (9VAC 20-160-0)

TABLE 2-3
SWMU 17 Subsurface Soil COC - Evaluation of Potential for Air Emissions from Subsurface Soil COPCs

	Concentration		RBC (SSL-Air) - Industrial		
COPC	Maximum (mg/kg)	Average (mg/kg)	Virginia (mg/kg)	Connecticut (mg/kg)	Industrial – Air (COC?)

Connecticut - State of Connecticut Department of Environmental Protection guidance tables (Appendix E to Sections 22a-133k-1 through 22a-133k, of Regulation of Connecticut State Agencies Volatilization Criteria for Groundwater).

Summary of Subsurface Soil COCs

Based on the previous discussion, the following COCs are proposed for subsurface soil, to protect groundwater from the leaching of contaminants from soil and to protect industrial workers from exposure to COCs that may volatilize into air:

- PCB – Aroclor-1260
- Benzene
- Chlorobenzene
- 1,3-dichlorobenzene
- 1,4-dichlorobenzene
- 1,2,4-trichlorobenzene

In addition, LNAPL, DNAPL, and associated saturated soil at the site will also be addressed as COCs, as part of the subsurface soil and groundwater remedial planning and alternatives.

2.3 Groundwater COC Evaluation

Table 2-4 presents the groundwater COPCs with a significant level of occurrence, which contributed most to the overall risk from assumed ingestion of groundwater. For noncarcinogenic effects, these include 1,3-dichlorobenzene, and chlorobenzene; for carcinogenic effects, only Aroclor-1260 is included. The DNAPL/LNAPL detected in groundwater will be addressed in the CMS. These COPCs are discussed further in this section.

TABLE 2-4
Summary of COPCs for Groundwater at SWMU 17

Groundwater	Max GW Conc. (µg/L)	Detected in Groundwater Frequently, Recently?	RBC (µg/L)	MCL (µg/L)	GW RBC for Air (µg/L) (based on residential land use)	COC
Benzidine	56	No	0.00029	NA	NA	No
Aroclor-1260	62	Yes	0.034	0.5	45	Yes
Benzene	130	Yes	0.41	5	5,600	Yes
1,4-dichlorobenzene	2,700	Yes	0.5	75	16,000	Yes
Chlorobenzene	6,900	Yes	110	NA	210,000	Yes
2-chlorophenol	180	Yes	30	NA	NA	Yes
1,2-dichloroethene	54	No	61	70 [a]	85,000	No
1,2-dichlorobenzene	280	Yes	370	600	160,000	No
1,3-dichlorobenzene	1,400	Yes	5.5	NA	NA	Yes
Naphthalene	33	Yes	6.2	NA	31,000	Yes
1,2,4-trichlorobenzene	1,200	Yes	190	70	30,000	Yes

[a] 1,2-DCE is assumed to be all *cis*-isomer.

To assess the potential for indoor air migration, the maximum detected groundwater concentrations were compared to groundwater RBCs for air emissions. These criteria were selected from State of Connecticut Department of Environmental Protection guidance tables (Appendix E to Sections 22a-133k-1 through 22a-133k, of Regulation of Connecticut State Agencies Volatilization Criteria for Groundwater). The results indicate that the groundwater concentrations are below these criteria for all COPCs except Aroclor-1260; thus, the remainder of the COPCs do not appear to be of concern for migration from groundwater to air.

Groundwater concentrations were compared with MCLs and RBCs, assuming potable use. Because the groundwater is classified as GB-2, comparing site grondwater concentrations against MCLs and RBCs is a conservative protective evaluation of the water quality.

Uncertainty Discussion

Although benzidine was included as a COPC for the risk assessment, it was detected in only 1 out of 17 samples. It was detected in the first sampling round in well 017GW005, but was not detected in two subsequent rounds of re-sampling of that well. Therefore, it is reported as an incomplete exposure and migration pathway in the fate and transport section of the RFI Addendum (Section 2.5.6.2, EnSafe, 2000). Based on a review of the site data, it appears that this chemical is not present at the site; therefore, the chemical is not selected as a COC for the CMS.

Summary of Groundwater COCs for CMS

Based on the previous discussions, the following are COCs for the CMS at SWMU 17:

- Aroclor-1260
- Benzene
- Chlorobenzene
- 1,3-dichlorobenzene
- 1,4-dichlorobenzene
- Naphthalene
- 1,2,4-trichlorobenzene
- 2-chlorophenol

2.4 Remedial Action Objectives

RAOs are medium-specific goals that the remedial actions are designed to accomplish in order to protect human health and environment by preventing or reducing exposures under current and future land use conditions. The following RAOs have been identified for the media at SWMU 17.

- **Surface Soils — Protection of Onsite Industrial Workers:** The RAOs for surface soils are to prevent ingestion, direct dermal contact, or exposure by inhalation of contamination via vapors or soil particulates with unacceptable carcinogenic or non-carcinogenic risk.

- **Subsurface Soils — Protection of Groundwater and Indoor Air Quality:** The RAOs for subsurface soils are to prevent migration of contamination from soil into groundwater in excess of drinking water standards or tap water RBCs, and to control volatile emissions of contaminants into buildings such that indoor air concentrations do not pose an unacceptable risk to onsite industrial workers.

- **Groundwater — Protection and Restoration of Beneficial Use:** The RAOs for groundwater are to prevent ingestion and direct/dermal contact with groundwater having unacceptable carcinogenic or non-carcinogenic risk, and to restore the aquifer to beneficial use.

2.5 Remedial Goal Options and Proposed Media Cleanup Standards

Throughout the process of remediating a hazardous waste site, a risk manager uses a progression of increasingly acceptable site-specific media levels in considering remedial alternatives. Remedial goal options (RGOs) and media cleanup standards (MCSs) under RCRA are developed at the end of the risk assessment in the RFI/RI/State programs.

RGOs can be based on a variety of criteria, such as specific incremental cancer risk levels (e.g., 1E-04, 1E-05, or 1E-06), Hazard Index (HI) levels (e.g., 0.1, 1.0, 3.0), or site background concentrations. For a particular RGO, specific MCSs can be determined as target concentration values. Achieving these MCSs is accepted as demonstrating that RGOs and RAOs have been achieved. Achieving these goals should promote the protection of human health and the environment, while achieving compliance with applicable state and federal standards.

Preliminary MCSs and RGOs were selected from EPA Region IX PRG tables (EPA, 2000), established drinking water MCLs, and other available guidance for chemicals of concern (COCs). The exposure media of concern for SWMU 17 are surface and subsurface soils and groundwater. Because SMWU 17 is located within a highly developed area of the CNC and there are no surface water bodies in the immediate vicinity of the site, ecological exposures were not considered necessary for evaluation

As previously indicated, a variety of criteria can be used to develop target options, such as incremental carcinogenic risks of 10E-06, 10E-05, and 10E-04; target HIs of 0.1, 1, and 3; or background concentrations. It is also important to specify the assumed land use and exposure conditions in the RGOs.

Surface Soil MCSs/RGOs

Aroclor-1260 was the only COC identified for surface soil. Table 2-5 presents RGOs and MCSs for the associated target risk level for Aroclor-1260. Although residential use is not planned for this site, for purposes of comparison Table 2-5 presents RGOs for residential use. Figure 2-1 illustrates the extent of Aroclor-1260 in surface soils at concentrations greater than 1 mg/kg. During the CMS, the feasibility of achieving an

TABLE 2-5
Remedial Goal Options - Surface Soil at SWMU 17

				Residential RGOs/MCSs Based on Carcinogenic Risks			Industrial RGOs/MCSs Based on Carcinogenic Risks		
	Minimum detection	Maximum detection	COC	1E-6	1E-5	1E-4	1E-6	1E-5	1E-4
COC	(mg/kg)	(mg/kg)		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Aroclor-1260	0.036	180	Yes	0.2	2	20	1	10	100

MCS of 1 mg/kg or 10 mg/kg for PCB in surface soil will be evaluated. Either of these values may be an acceptable MCS.

Subsurface Soil MCSs

Compounds identified as COCs in subsurface soil were based on leachability to groundwater, with two COCs identified on the basis of exceeding SSL-air values. The target concentrations based on release to air are much higher than the leachability groundwater. Therefore, the lower of these two values, the SSL-leachability to groundwater, was included as the MCSs in Table 2-6. Table 2-6 includes the MSCs/RGOs as the target subsurface soil concentrations estimated on the basis of site-specific SSLs (DAF=15.3) alternatives analysis in the CMS.

TABLE 2-6
Subsurface Soil - MCSs/RGOs for SWMU 17

Chemical	Detected Concentration Range (mg/kg)	MCS[a] (mg/kg)
PCB – Aroclor-1260	0.035-6200	1
Benzene	0.002-7.2	0.031
Chlorobenzene	0.004-790	1.07
1,3-dichlorobenzene	0.058-22	1.5[b]
1,4-dichlorobenzene	0.024-40	1.5
1,2,4-trichlorobenzene	0.32-410	4.59

[a] All the criteria are leachability to groundwater-based SSLs. The SSLs are selected from EPA Region IX PRG tables, (EPA, 2000), with a site-specific DAF calculated as 15.3 (see Appendix).

[b] 1,4 dichlorobenzene SSL value is used for 1,3-dichlorobenzene.

Figures 2-2 through 2-7 illustrate the extent of each of these COCs in subsurface soils at concentrations greater than their respective MCSs.

Groundwater MCSs

The groundwater has MCLs and MCLGs applied to public water supply wells, which are typically completed in deeper aquifers. Contamination at SWMU 17 is detected mostly in the shallow groundwater (2 to 5 feet in depth). The groundwater flow gradients are relatively flat, indicating limited offsite migration potential. Therefore, the applicability of MCLs should be evaluated as part of the risk management decision. Table 2-7 provides a preliminary list of groundwater MCSs.

TABLE 2-7
Groundwater MCSs/RGOs for SWMU 17

						RGOs Based on Noncarc. Risks		
	Min. Conc.	Max. Conc.	Proposed MCS	MCL	Explanation	HI=0.1	HI=1	HI=3
COC	(µg/L)	(µg/L)	(µg/l)	(µg/L)		(µg/L)	(µg/L)	(µg/L)
Aroclor-1260	2.3	520	0.5	0.5	MCL is proposed cleanup goal.	NA	NA	NA
2-chlorophenol	5	18	30	NA	Not a carcinogen; cleanup goal for HI=1 is 30 µg/L.	3	30	90
1,3-dichlorobenzene	2	1,400	600	600#	MCL is proposed cleanup goal.	0.6	6	17
1,4-dichlorobenzene	1	2,700	75	75	MCL is proposed cleanup goal.	NA	NA	NA
1,2,4-trichlorobenzene	1	1,400	70	70	MCL is proposed cleanup goal.	19	190	570
Benzene	2	130	5	5	MCL is proposed cleanup goal.	NA	NA	NA
Chlorobenzene	.78	6,900	110	NA	Not a carcinogen; cleanup goal for HI=1 is 110 µg/L.	11	110	330
Naphthalane	6	33	6.2	NA	Not a carcinogen; cleanup goal for HI=1 is 6.2 µg/L.	0.62	6.2	19

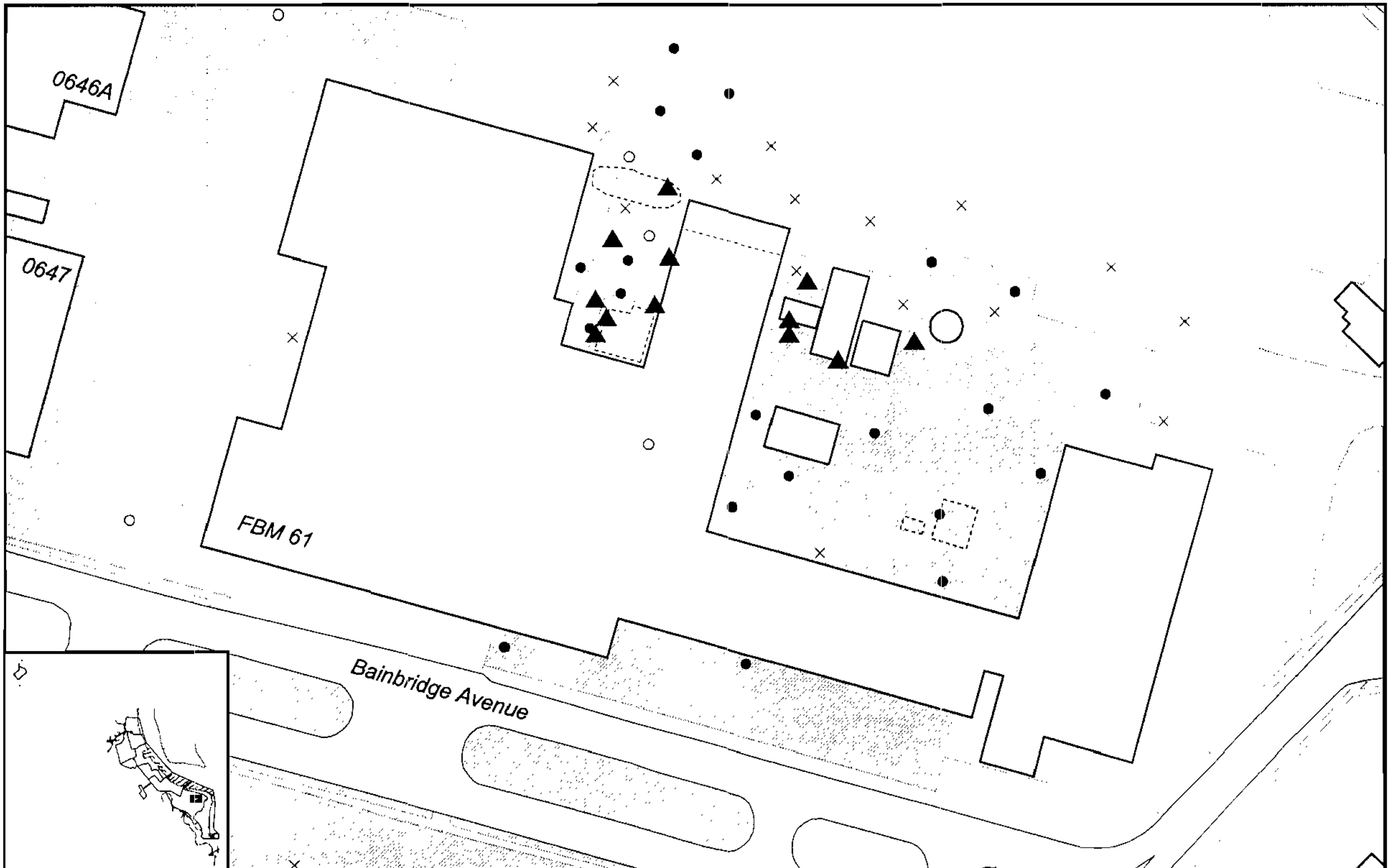
NA Not applicable (not a carcinogen)

Value for 1,3-dichlorobenzene is based on 1,2-dichlorobenzene.

Figures 2-8 through 2-15 illustrate the extent of each of the COCs listed in Table 2-7 relative to their respective MCSs.

2.6 Potential CMS Field Investigation

Once MCSs have been determined for each COC, corrective measure technologies will be identified in the CMS. The technologies will be evaluated on the basis of various criteria, including effectiveness in attaining the MCSs, and cost. Preferred technologies will be advanced to the design phase. To reduce the uncertainty associated with the performance, implementation and cost of certain technologies, it may be necessary to collect additional data on contaminant extent, soil properties, or NAPL properties. Additional data may also be required for the design. The types of data that may be needed are uncertain at this time, but will be determined when corrective measure technologies are identified and are in the process of evaluation.



LEGEND
○ Not Sampled
× ND
● ≤ 0.999 (mg/kg)
▲ ≥1.0 mg/kg

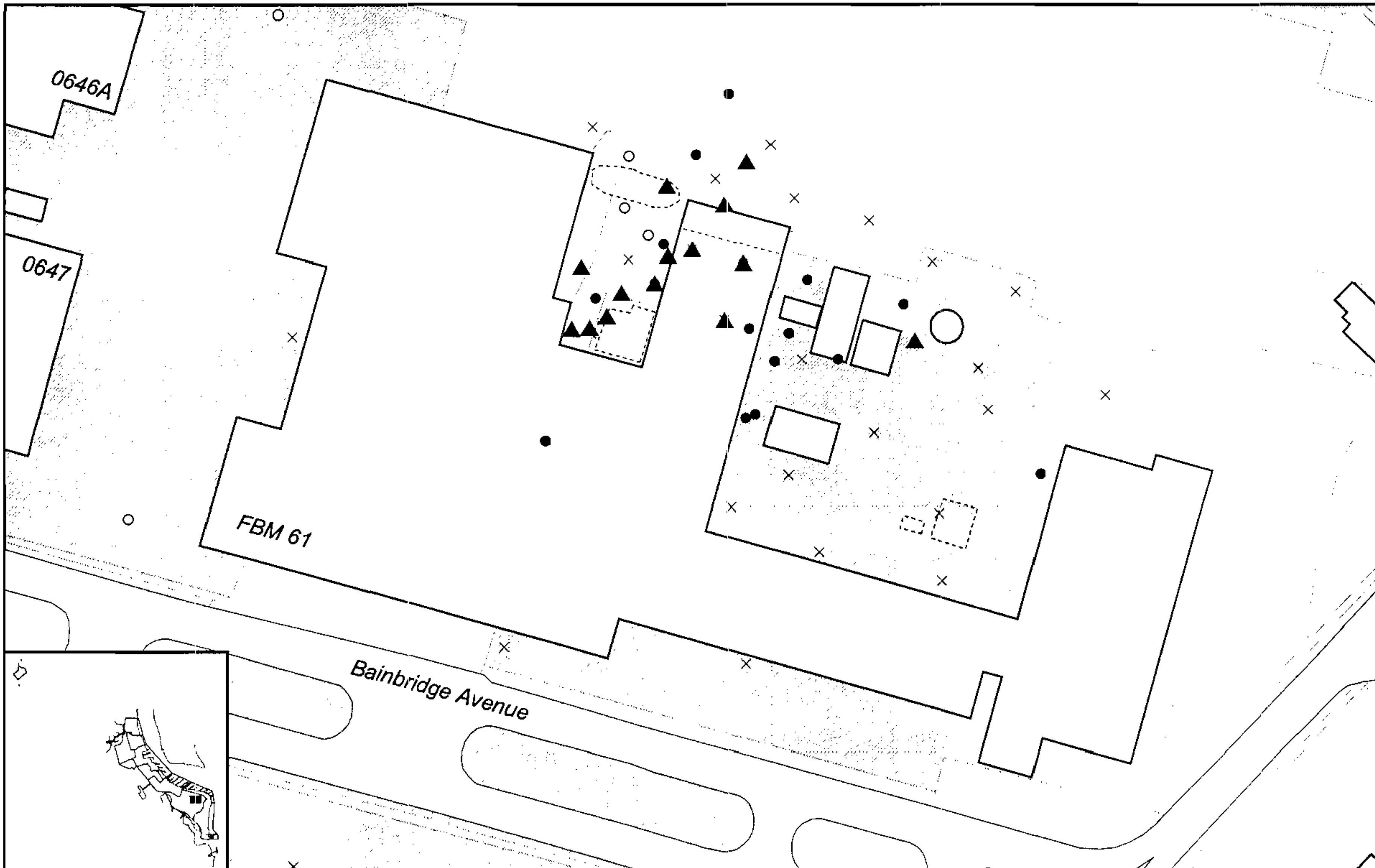
Note: MCS = 1.0 mg/kg.

N

0 75 150 Feet

Figure 2-1
Extent of Aroclor-1260
in Surface Soils
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\cnc-egis-DEN.apr, Date: 20 Nov 2000 10:02, User: GHALL



LEGEND
○ Not Sampled
× ND
● ≤ 0.999 (mg/kg)
▲ ≥1.0 (mg/kg)

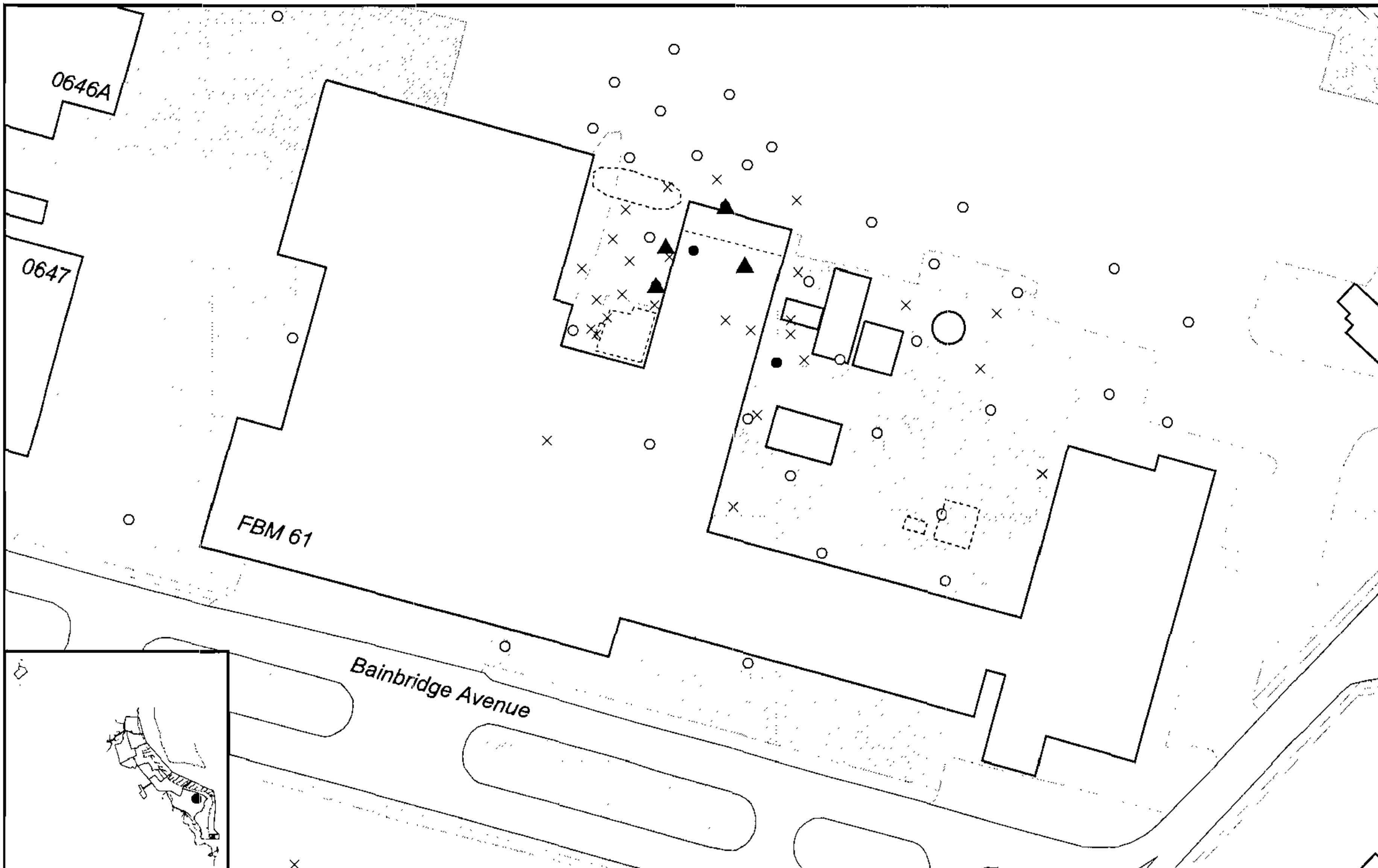
Note: MCS = 1.0 mg/kg.

N

0 75 150 Feet

Figure 2-2
Extent of Aroclor-1260
in Subsurface Soils
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\cnc-egis-DEN.apr, Date: 20 Nov 2000 11:16, User: GHALL

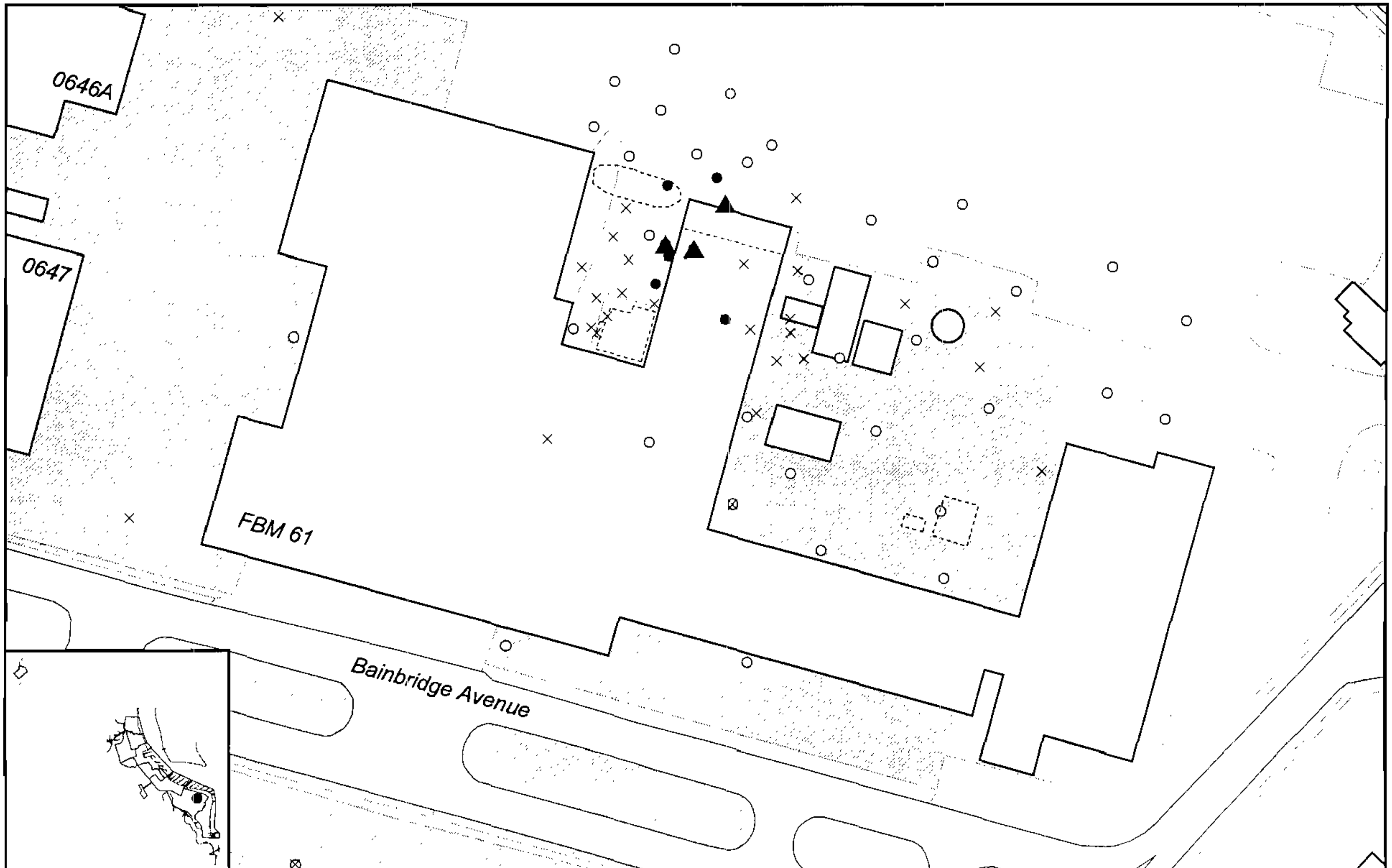


LEGEND
○ Not Sampled
× ND
● ≤ 0.0309 (mg/kg)
▲ ≥ 0.031 (mg/kg)

Note: MCS = 0.031 mg/kg

Figure 2-3
Extent of Benzene
in Subsurface Soils
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\cnc-egis-DEN.apr, Date: 21 Dec 2000 15:01, User: GHALL



LEGEND
○ Not Sampled
× ND
● 0 - 1.069 (mg/kg)
▲ ≥ 1.07 (mg/kg)

Note: MCS = 1.07 mg/kg

N

0 75 150 Feet

Figure 2-4
Extent of Chlorobenzene
in Subsurface Soils
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\cnc-egis-DEN.apr, Date: 21 Dec 2000 14:17, User: GHALL

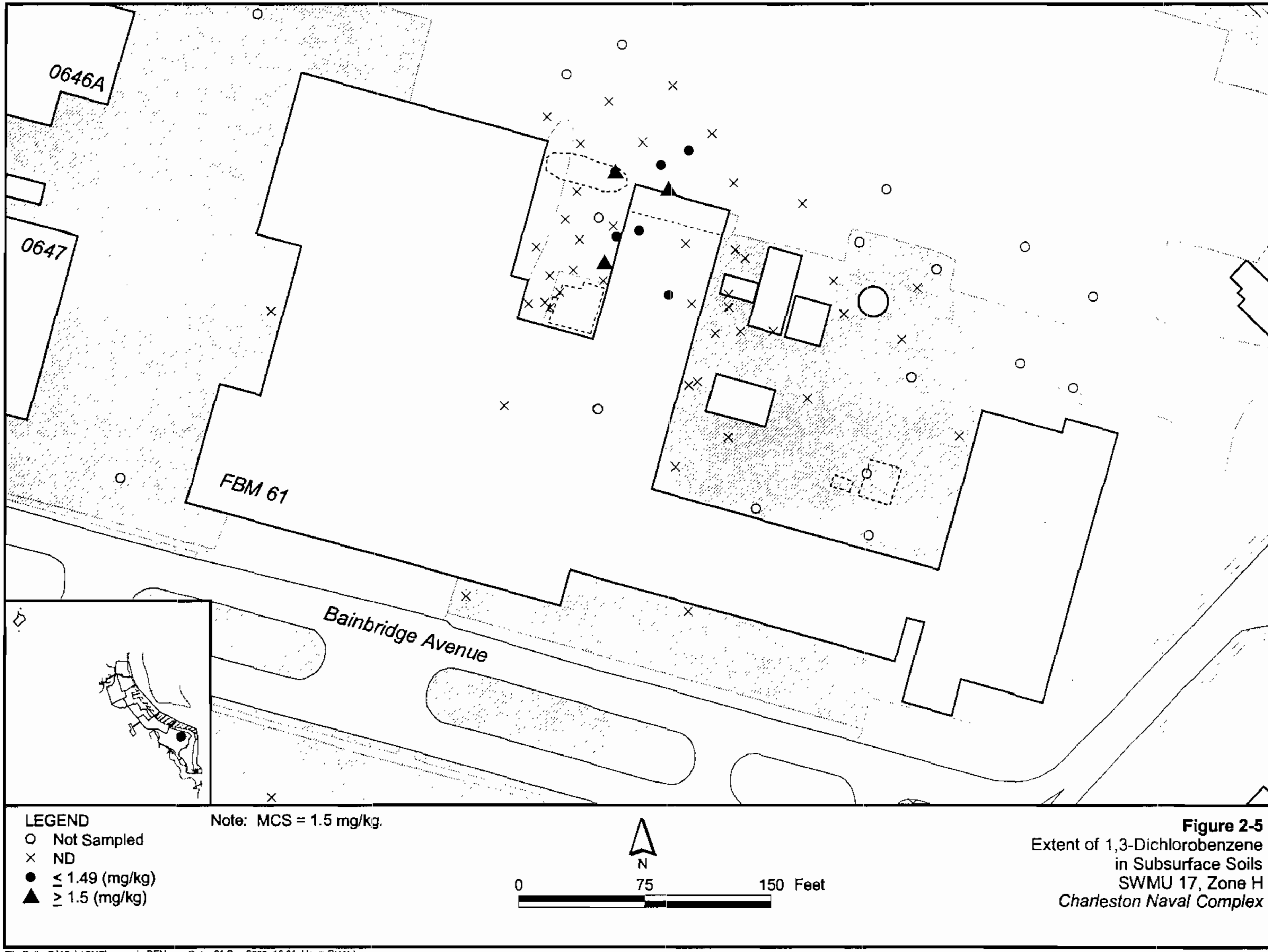


Figure 2-5
Extent of 1,3-Dichlorobenzene
in Subsurface Soils
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\cnc-egis-DEN.apr, Date: 21 Dec 2000 15:31, User: GHALL

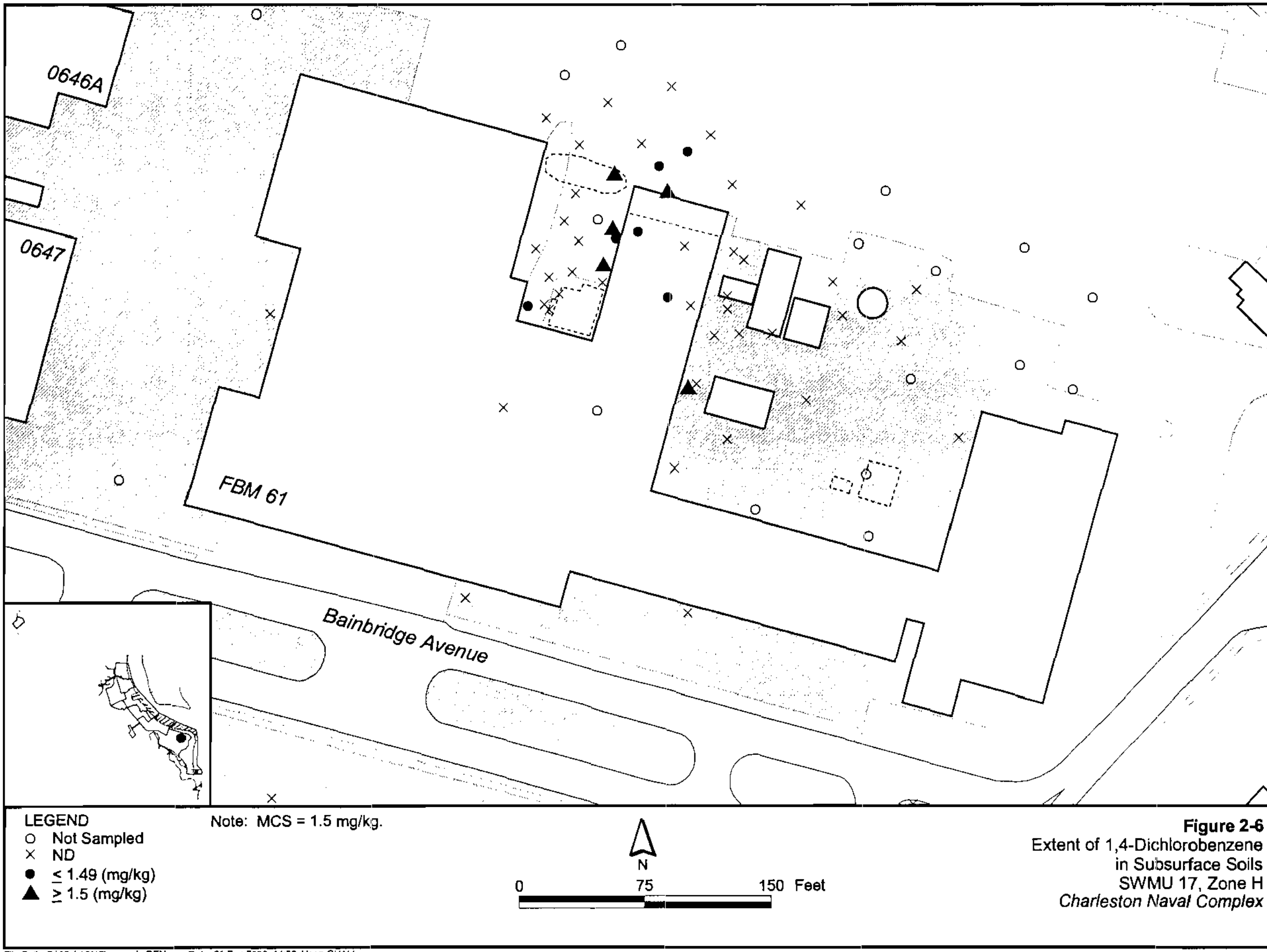
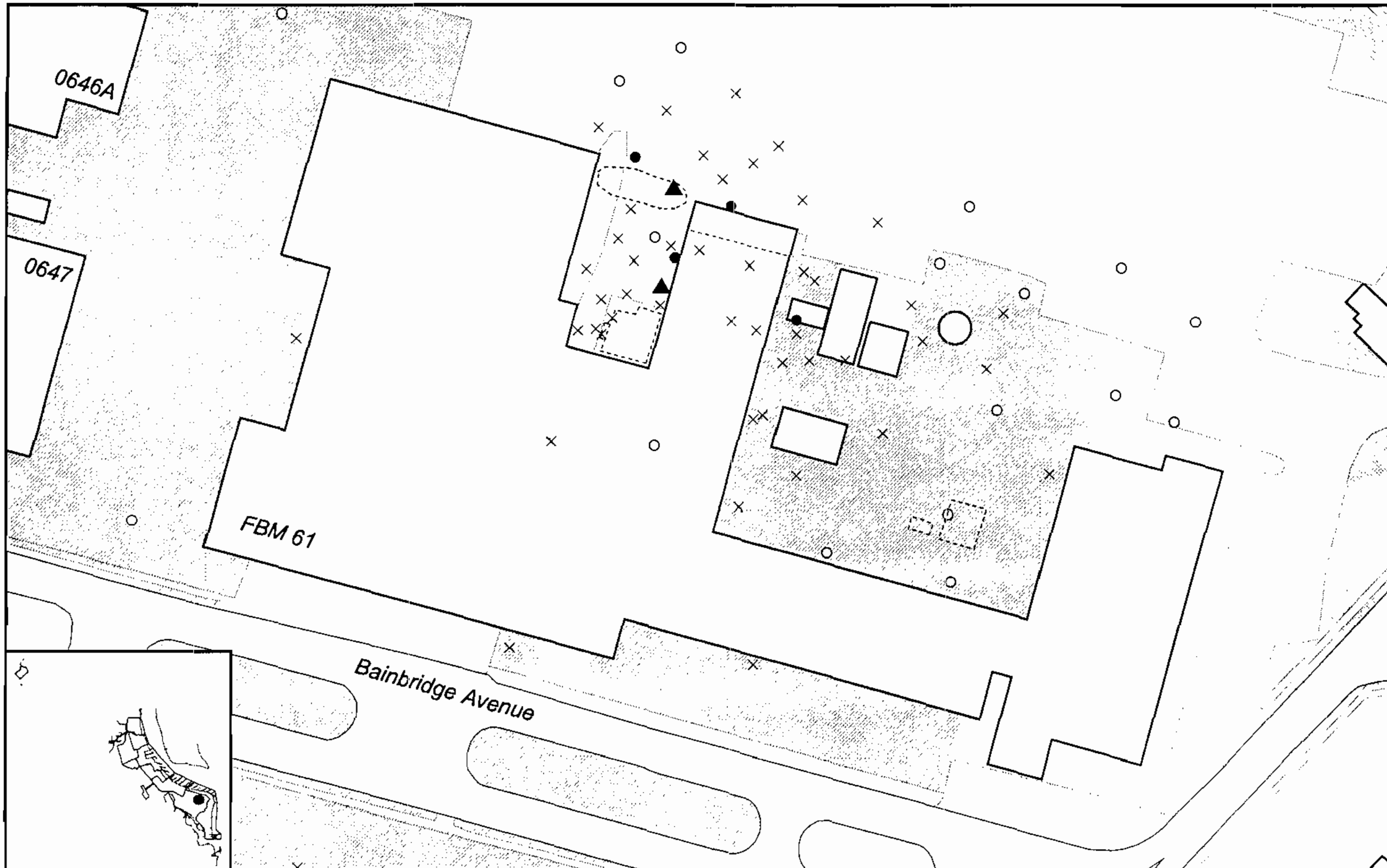


Figure 2-6
Extent of 1,4-Dichlorobenzene
in Subsurface Soils
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\cnc-egis-DEN.apr, Date: 21 Dec 2000 14:30, User: GHALL

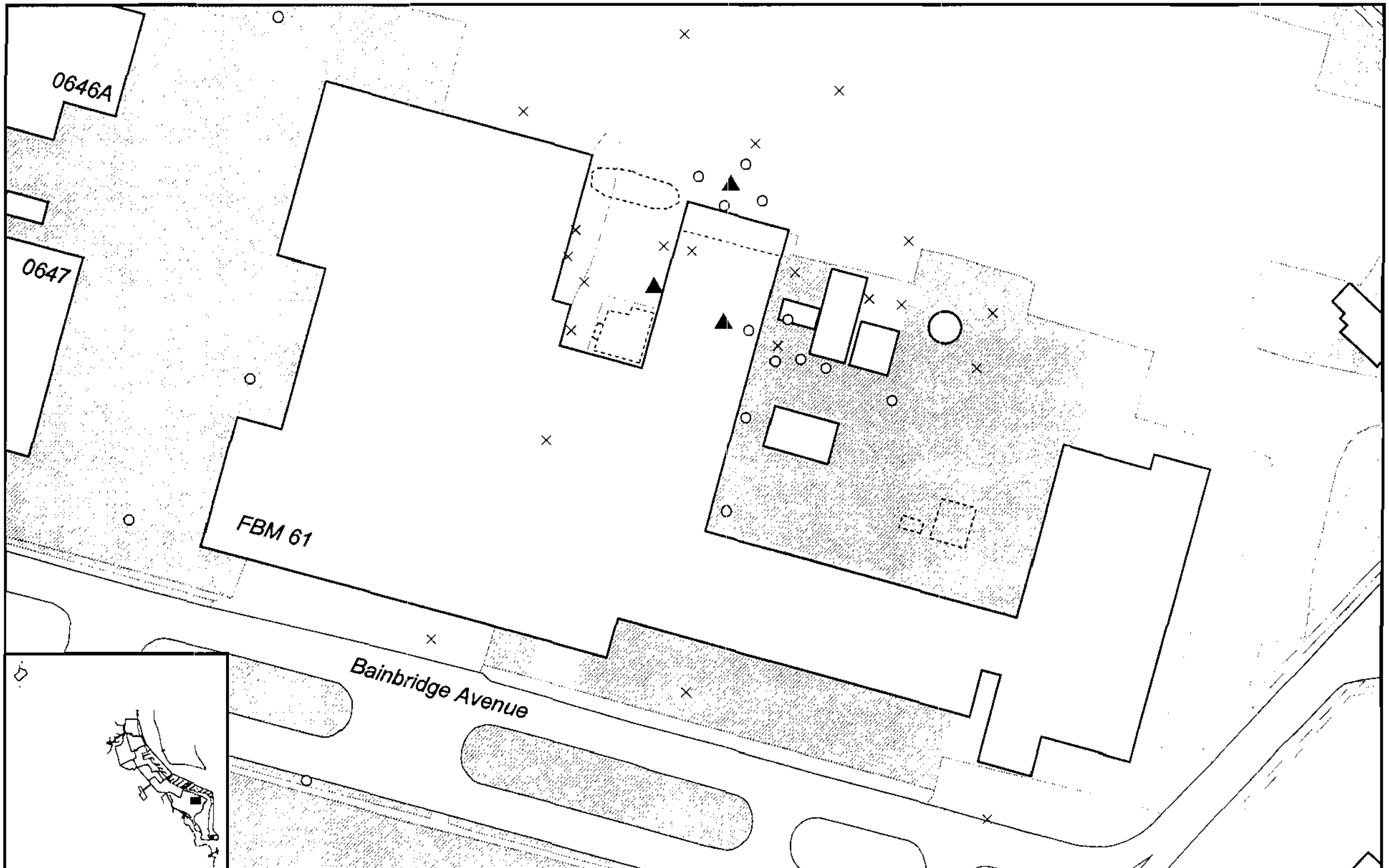


LEGEND
- ○ Not Sampled
- × ND
- ● ≤ 4.58 (mg/kg)
- ▲ ≥ 4.59 (mg/kg)

Note: MCS = 4.59 mg/kg

Figure 2-7
Extent of 1,2,4-Trichlorobenzene
in Subsurface Soils
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\cnc-egis-DEN.apr, Date: 21 Dec 2000 15:51, User: GHALL



LEGEND
- ○ Not Sampled
- × ND
- ● ≤ 0.49 (ug/l)
- ▲ ≥ 0.5 ug/l

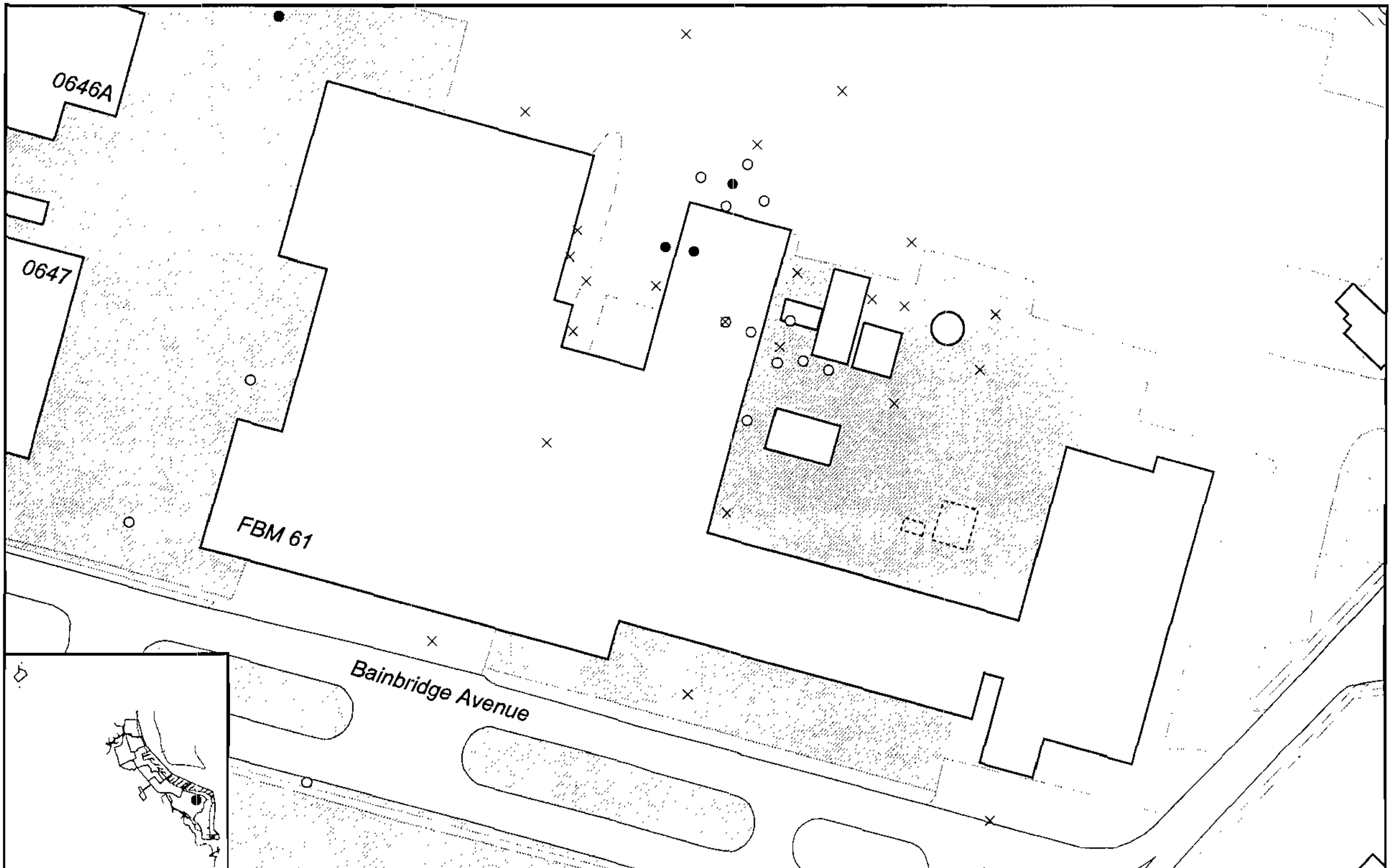
Note: MCS = 0.5 ug/l

N

0 75 150 Feet

Figure 2-8
Extent of Aroclor-1260
in Groundwater
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\cnc-egis-DEN.apr, Date: 20 Nov 2000 15:51, User: GHALL



LEGEND
- ○ Not Sampled
- × ND
- ● 0.001 - 29.9 (ug/l)
- ▲ ≥ 30 (ug/l)

Note: MCS = 30 ug/l

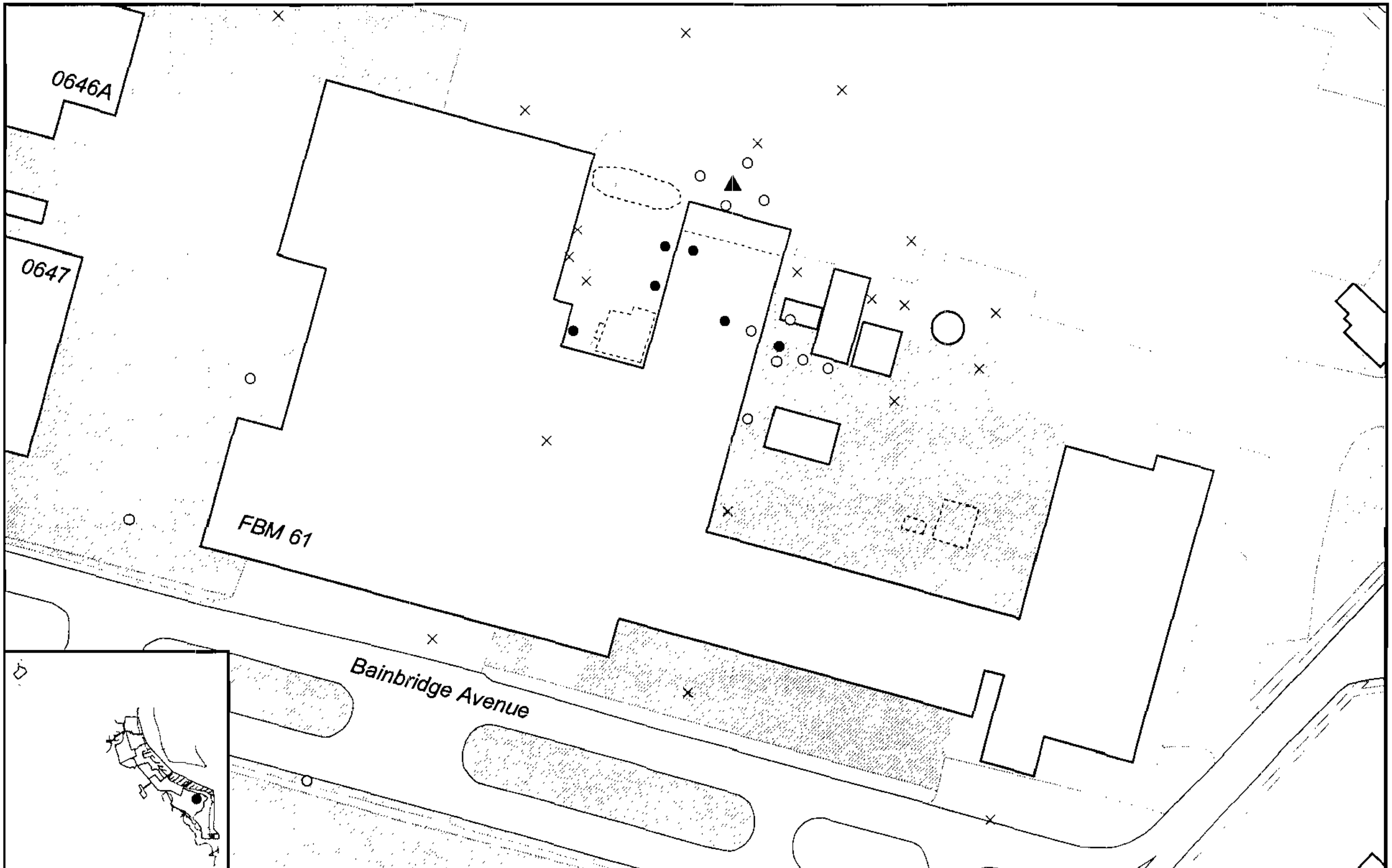
N

0 75 150 Feet

DRAFT
For Discussion Only

Figure 2-9
Extent of 2-Chlorophenol
in Groundwater
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\cnc-egis-DEN.apr, Date: 22 Dec 2000 7:06, User: GHALL



LEGEND
○ Not Sampled
× ND
● ≤ 599 (ug/l)
▲ ≥ 600 (ug/l)

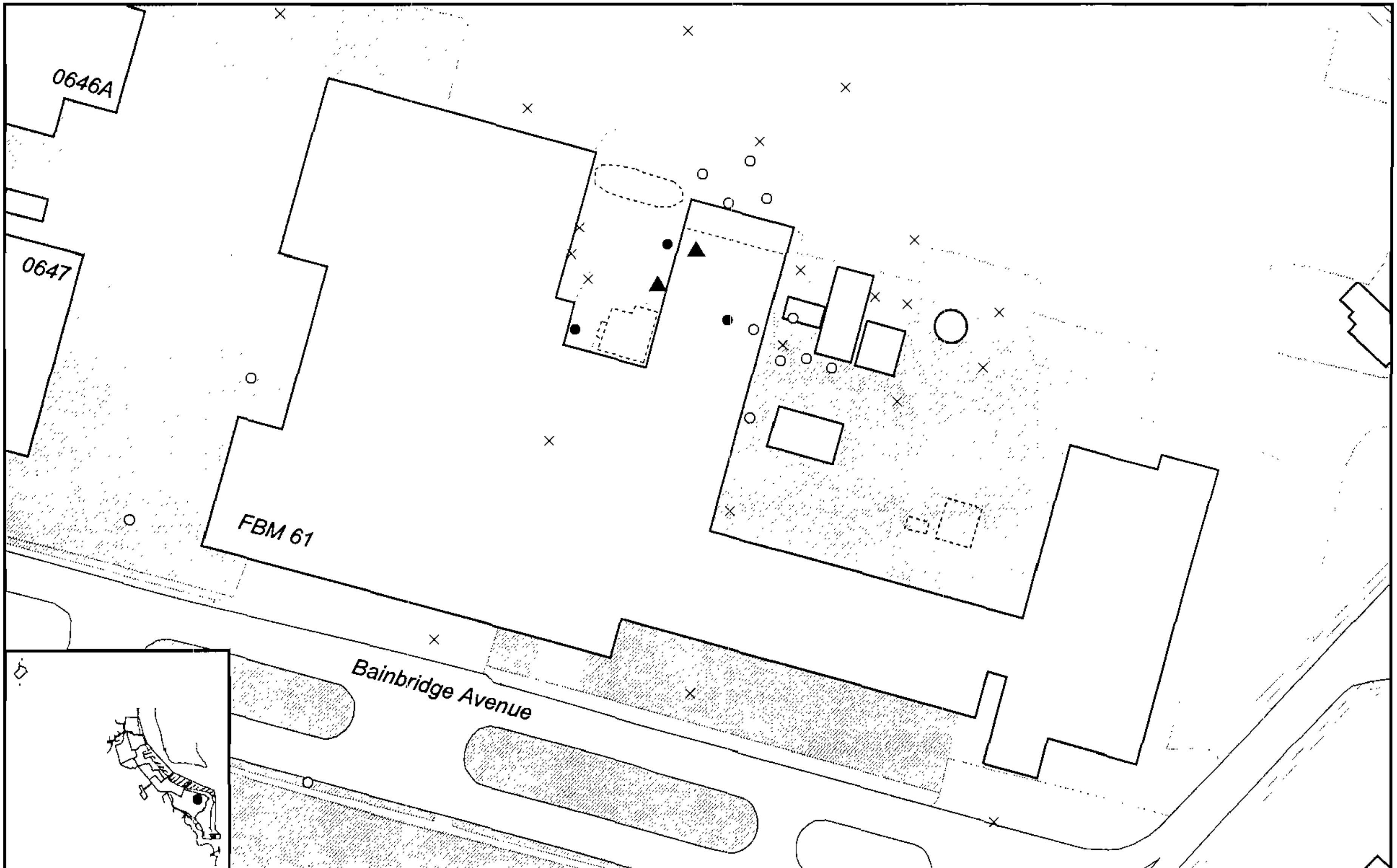
Note: MCS = 600 ug/l

N

0 75 150 Feet

Figure 2-10
Extent of 1,3-Dichlorobenzene
In Groundwater
SWMU17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\cnc-egis-DEN.apr, Date: 22 Dec 2000 6:38, User: GHALL



LEGEND
○ Not Sampled
× ND
● ≤ 74.9 (ug/l)
▲ ≥ 75 (ug/l)

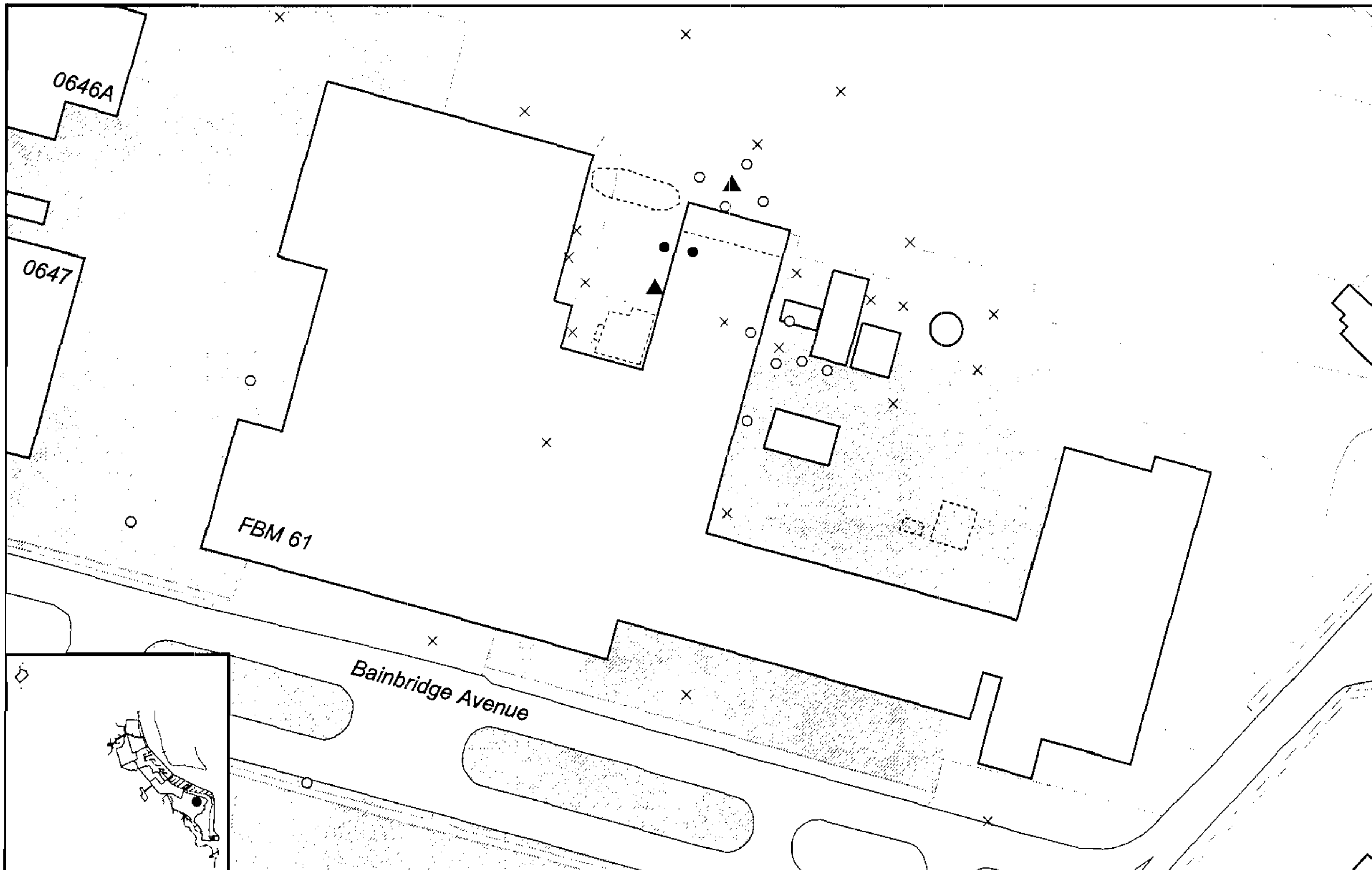
Note: MCS = 75 ug/l

N

0 75 150 Feet

Figure 2-11
Extent of 1,4-Dichlorobenzene
in Groundwater
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\cnc-egis-DEN.apr, Date: 22 Dec 2000 7:23, User: GHALL



LEGEND
○ Not Sampled
× ND
● ≤ 69.9 (ug/l)
▲ ≥ 70 (ug/l)

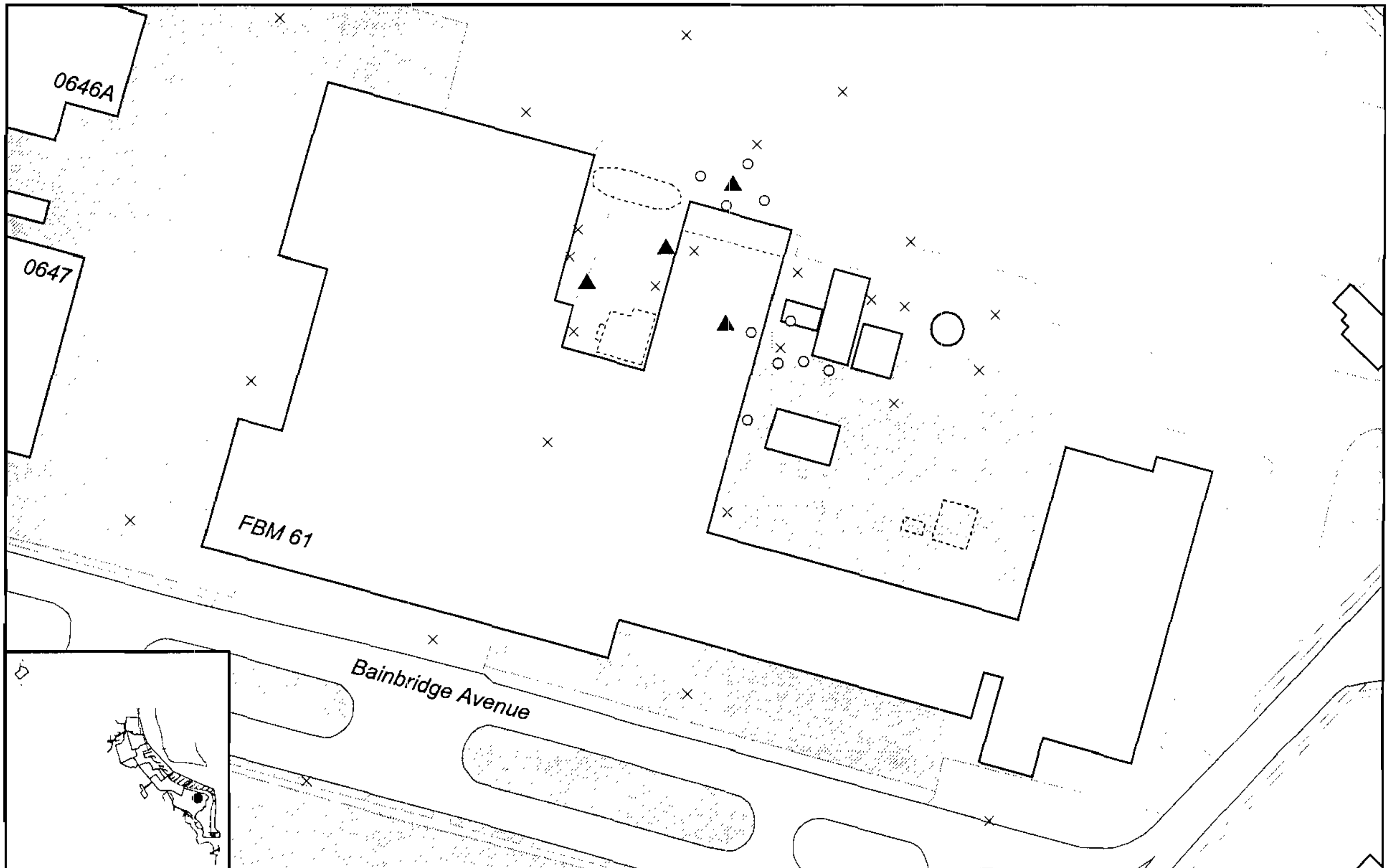
Note: MCS = 70 ug/l

N

0 75 150 Feet

Figure 2-12
Extent of 1,2,4-Trichlorobenzene
in Groundwater
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\cnc-egis-DEN.apr, Date: 22 Dec 2000 7:39, User: GHALL

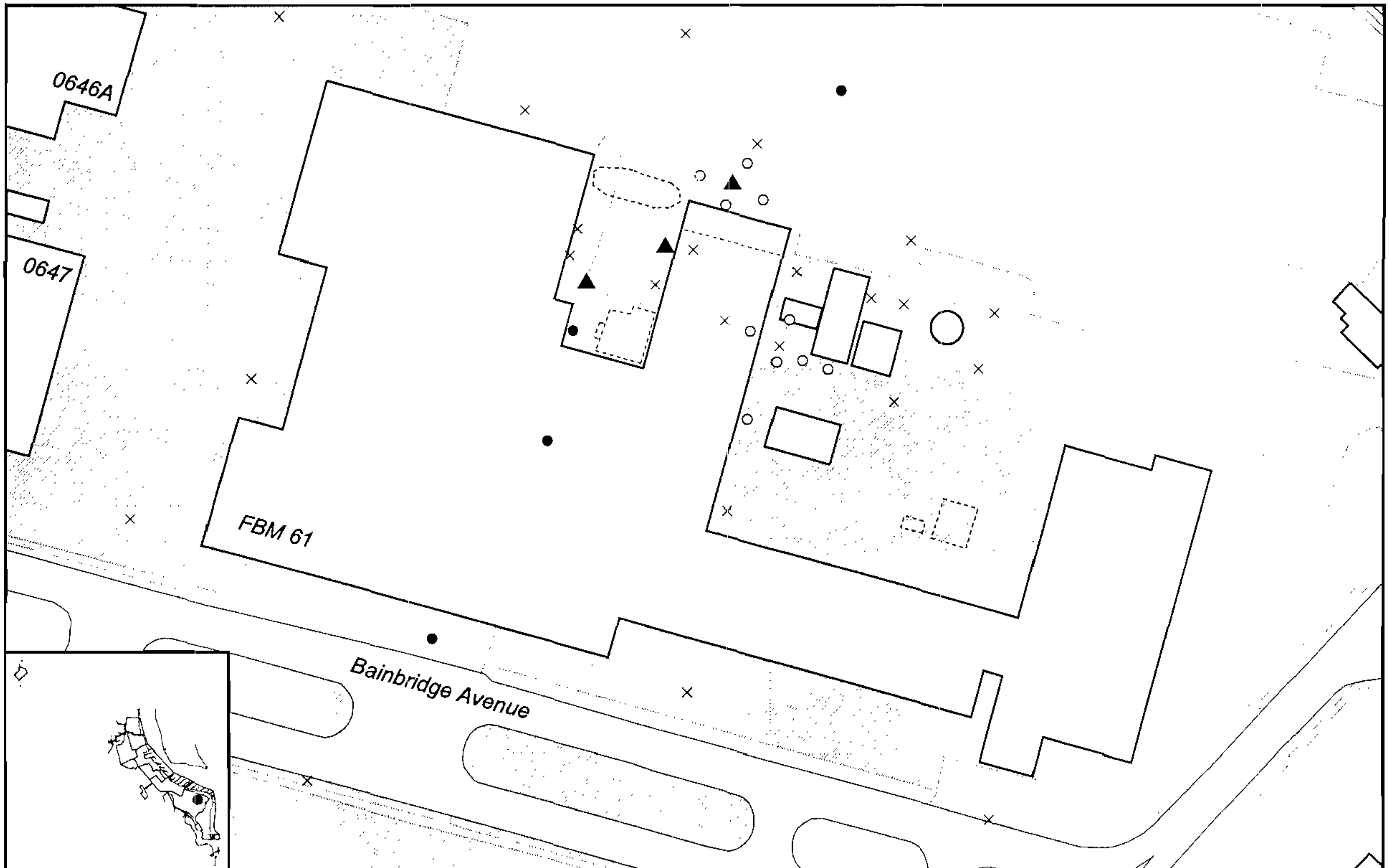


LEGEND
- ○ Not Sampled
- × ND
- ● ≤ 4.9 (ug/l)
- ▲ ≥ 5 (ug/l)

Note: MCS = 5 ug/l

Figure 2-13
Extent of Benzene
in Groundwater
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\cnc-egis-DEN.apr, Date: 22 Dec 2000 7:50, User: GHALL



LEGEND
○ Not Sampled
× ND
● ≤ 109.0 (ug/l)
▲ ≥ 110 (ug/l)

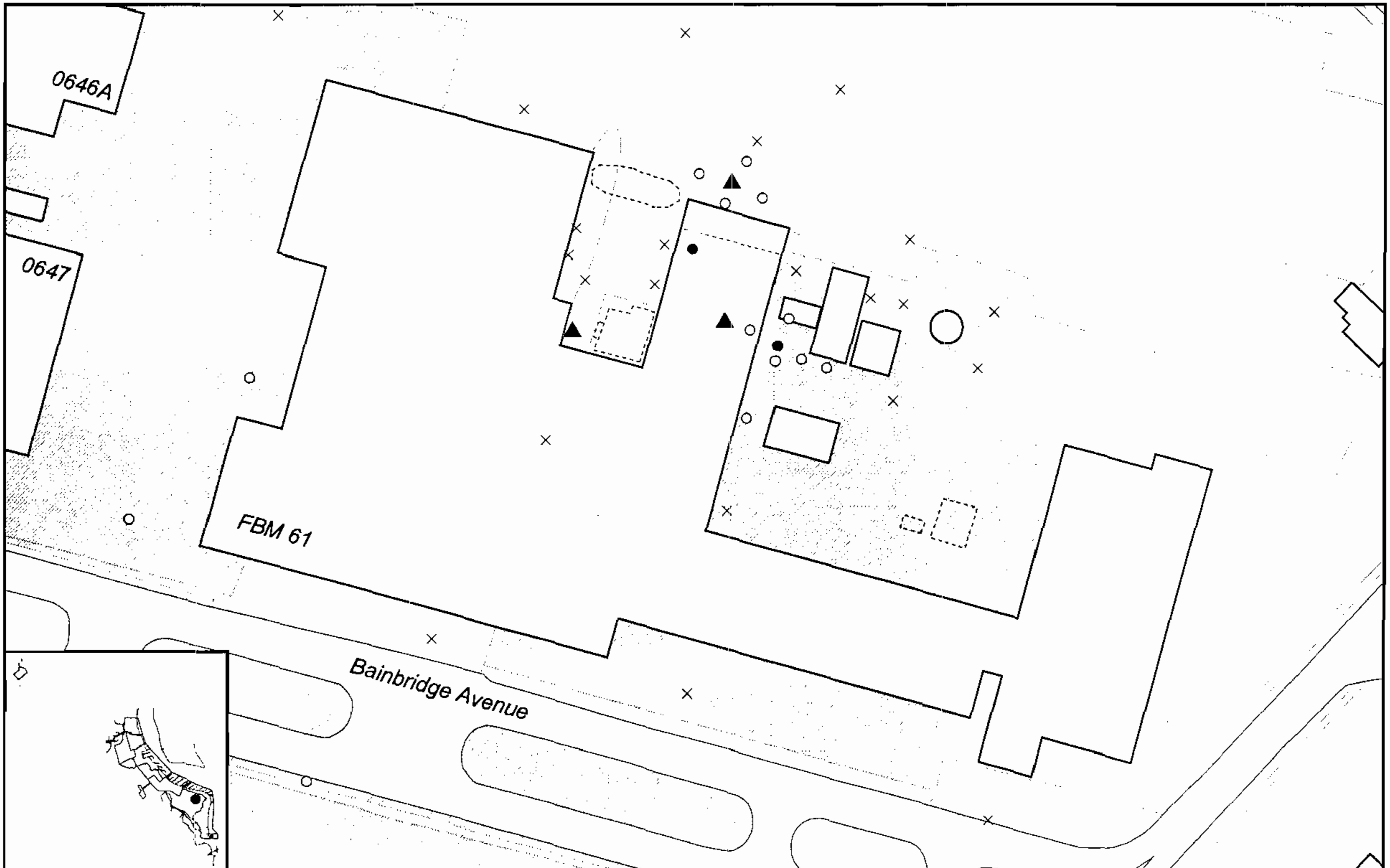
Note: MCS = 110 ug/l

N

0 75 150 Feet

Figure 2-14
Extent of Chlorobenzene
in Groundwater
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\cnc-egis-DEN.apr, Date: 22 Dec 2000 8:11, User: GHALL



LEGEND
○ Not Sampled
× ND
● ≤ 6.19 (ug/l)
▲ ≥ 6.2 (ug/l)

Note: MCS = 6.2 ug/l

Figure 2-15
Extent of Napthalene
in Groundwater
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\cnc-egis-DEN.apr, Date: 22 Dec 2000 8:22, User: GHALL

SECTION 3.0

Corrective Measures Study Approach

3.0 Corrective Measures Study Approach

The CMS will consist of the following tasks that will be performed in the order presented below:

1. Corrective measure technologies will be identified to address the soil and groundwater contamination at the site.
2. Corrective measure technologies will be grouped together into alternatives, which will consist of one or more technologies that are well-suited to treat contamination in all media at the site.
3. Corrective measure alternatives will be screened, using several criteria and decision factors.
4. A preferred corrective measure alternative will be selected.
5. The CMS and preferred corrective measure alternative will be documented in the CMS report.

The approach used to identify and screen technologies and alternatives is described in the following sections.

3.1 Identification of Corrective Measure Technologies

Corrective measures technologies, which have the potential to eliminate, control, and/or reduce unacceptable risk to human health or the environment to acceptable levels, will be identified and screened. A preliminary list of technologies, described below, was developed on the basis of the list of COCs and RGOs discussed earlier:

- **Excavation** — This technology involves excavation of surface and/or subsurface soils with appropriate disposal or treatment, and backfilling of the excavation.
- **Soil Cap** — This technology involves the installation of an impermeable or semi-permeable barrier on top of the surface soils to reduce the potential for exposure of humans to COCs, and to reduce additional leaching of contaminants from surface and subsurface soils to groundwater.

- **Six-Phase Heating** — This technology involves electrodes placed in the ground and electrical current run between the electrodes to generate heat due to the natural resistance of the soil/groundwater. Contaminants with boiling points lower than the achievable temperature (100 degrees ° Celsius [° C]) are volatilized, collected in the vadose zone, and treated above ground.

- **Soil Vapor Extraction (SVE) and Bioventing** — This technology involves vapor extraction wells installed to strip the volatile compounds from the subsurface (vadose zone) soils and to provide oxygen to support biodegradation.

- **Air-Sparging/SVE** — This technology involves the injection of air below the water table to strip out volatile contaminants from the groundwater and saturated soils. SVE wells are used to collect the vapors, which are treated above ground. The process also transfers oxygen to the groundwater, which promotes biodegradation.

- **Hydraulic Containment through Groundwater Extraction** — This technology involves strategically placed groundwater extraction wells to provide hydraulic control so that the contamination does not migrate offsite.

- **In-situ Aerobic Biodegradation** — This technology involves the injection of oxygen release compound (ORC™) to enhance aerobic biodegradation. The ORC is injected with direct push methods. It slowly releases oxygen that promotes biodegradation.

- **Monitored Natural Attenuation** — This technology involves monitoring to evaluate naturally occurring processes, such as biodegradation, dispersion, adsorption, and dilution, that may be adequate to prevent the migration of contamination away from SWMU 17.

- **Multi-Phase Extraction** — This technology involves the simultaneous removal of NAPL, groundwater, and soil vapors from extraction wells. The groundwater table is lowered in the process, allowing SVE and bioventing to occur in what was formerly saturated soil.

- **In Situ Oxidation** — This technology involves the injection of oxidizing agents (hydrogen peroxide or potassium permanganate) to promote abiotic in-situ oxidation of organic compounds in the groundwater, saturated soil, and unsaturated soil.

- **Free Product Skimming** — This technology involves the removal of free product (mobile NAPL) by using skimming pumps in extraction wells.

These and other technologies will be screened on the basis of their effectiveness, implementability, and cost.

3.2 Approach to Evaluating Corrective Measure Alternatives

Corrective measure technologies that pass the initial screening will be assembled into alternatives. According to the RCRA permit issued by SCDHEC (SCDHEC, 1998), the alternatives will be evaluated with the following five standards:

1. Protect human health and the environment.
2. Attain media cleanup standards (RGOs).
3. Control the source of releases to minimize future releases that may pose a threat to human health and the environment.
4. Comply with applicable standards for the management of wastes generated by remedial activities.
5. Other factors include (a) long-term reliability and effectiveness; (b) reduction in toxicity, mobility, or volume of wastes; (c) short-term effectiveness; (d) implementability; and (e) cost.

Each of the five standards is defined in more detail below:

1. *Protect human health and the environment.*

The alternatives will be evaluated on the basis of their ability to protect human health and the environment. The ability of an alternative to achieve this standard may or may not be independent on its ability to achieve the other standards. For example, an alternative may be protective of human health, but may not be able to attain the media cleanup standards if the media cleanup standards are not directly tied to protecting human health.

2. *Attain media cleanup standards (RGOs).*

The alternatives will be evaluated on the basis of their ability to achieve RGOs. The RGOs were defined in Section 2 of this work plan. Since there is some uncertainty with this evaluation, this uncertainty will be qualitatively characterized. Another aspect of this standard is the time frame to achieve the RGOs. Estimates of the time frame for the alternatives to achieve RGOs will be provided.

3. *Control the source of releases.*

This standard deals with the control of releases of contamination from the source (the area in which the contamination originated). There are four known sources of contamination at SWMU 17 that were the result of accidental releases of contaminants. This standard will apply to NAPL- and contaminated soils at the site, which if left unaddressed, may continue to act as sources of contaminants to groundwater.

4. *Comply with any applicable standards for management of wastes.*

This standard deals with the management of wastes derived from implementing the alternatives; for example, groundwater from pump and treatment operations. Alternatives will be designed to comply with all standards for management of wastes. Consequently, this standard will not be explicitly included in the detailed evaluation presented in the CMS.

5. *Other factors*

Five other factors are to be considered if an alternative is found to meet the four standards described above. These other factors are as follows:

5a. Long-term reliability and effectiveness

Alternatives will be evaluated on the basis of their reliability, and the potential impact should the alternative fail. In other words, a qualitative assessment will be made of the chance of the alternative failing and the consequences of that failure. An assessment also will be made of the useful life of the technologies in the alternative.

5b. Reduction in the toxicity, mobility, or volume of wastes

Alternatives with technologies that reduce the toxicity, mobility, or volume of the contamination will generally be favored over those that do not. Consequently, a qualitative assessment of this factor will be made for each alternative.

5c. Short-term effectiveness

Alternatives will be evaluated on the basis of the risk they create during the implementation of the remedy. Factors that may be considered include fire, explosion, and exposure of workers to hazardous substances.

5d. Implementatiblity

The alternatives will be evaluated for their implementability by taking into account any difficulties associated with constructing the systems (such as the construction disturbances they may create), operation of the alternatives, and the availability of equipment and resources to implement the technologies making up the alternatives.

5e. Cost

A net present value of each alternative will be developed. These cost estimates will be used for the relative evaluation of the alternatives, not to bid or budget the work. The estimates will be based on information available at the time of the CMS and on a conceptual design of the alternative. They will be "order-of-magnitude" estimates with a generally expected accuracy of -50 percent to +50 percent for the scope of action described for each alternative. The estimates will be divided into capital costs and operations and maintenance costs for each alternative.

In addition to the criteria described above, the alternatives will be evaluated for the ability to achieve all contractual obligations of CH2M-Jones and the Navy.

3.3 Corrective Measures Study Report

The CMS report will be prepared to present the identification, development, and evaluation of potential corrective measures for SWMU 17. A proposed outline of the report, as shown in Table 3-1, provides an example of the report format and content organization.

TABLE 3-1
Example Outline of CMS Report
SWMU 17
CNC, Charleston, South Carolina

Executive Summary

1.0 Introduction

- 1.1 Corrective Measures Study Purpose and Scope
- 1.2 Report Organization
- 1.3 Background Information
  - 1.3.1 Facility Description
  - 1.3.2 Site History and Background
    - 1.3.2.1 Geology and Hydrology
    - 1.3.2.2 Nature and Extent of Contamination
    - 1.3.2.3 Contaminant Fate and Transport
    - 1.3.2.4 Summary of Risk Assessment

2.0 Identification and Screening of Technologies

- 2.1 Remedial Goal Objectives
- 2.2 Identification and Screening of Technologies
  - 2.2.1 Identification and Initial Screening of Technologies
  - 2.2.2 Evaluation of Technologies
  - 2.2.3 Selection of Technologies
- 2.3 Summary

3.0 Development and Screening of Alternatives

- 3.1 Development of Preliminary Alternatives
  - 3.1.1 Alternative 1
  - 3.1.2 Alternative 2
  - 3.1.3 Alternative 3
  - <<Additional alternatives will be developed as found necessary>>
- 3.2 Screening of Preliminary Alternatives
  - 3.2.1 Screening Criteria
  - 3.2.2 Alternative 1
  - 3.2.3 Alternative 2
  - 3.2.4 Alternative 3

<<Additional alternatives will be screened as found necessary>>

3.3 Summary of Screening Alternatives

4.0 Detailed Analysis of Alternatives

4.1 Approach

4.2 Evaluation Criteria

4.3 Description of Alternatives

4.3.1 Alternative 1

4.3.2 Alternative 2

4.3.3 Alternative 3

<<Additional alternatives will be described as found necessary>>

4.4 Detailed Analysis of Alternatives

4.4.1 Alternative 1

4.4.2 Alternative 2

4.4.3 Alternative 3

<<Additional alternatives will be analyzed as found necessary>>

4.5 Comparative Analysis of Alternatives

5.0 Recommended Remedial Alternative

6.0 References

Appendices

A Technology Specific Documentation

B Contaminant Fate and Transport Calculations (if needed)

C Corrective Measure Alternative Cost Estimates

<<Additional appendices will be added, if necessary>>

List of Tables

List of Figures

SECTION 4.0

Project Management Plan

4.0 Project Management Plan

This project management plan has been prepared to define the project organization, to identify key personnel and their responsibilities, and to establish reporting requirements and lines of communication for the performance of the CMS and the preparation of the CMS report for SWMU 17. The plan also includes the proposed project schedule and the project deliverables required during the CMS. The plan has been developed to maintain consistency in procedures and communications during execution of the CMS.

4.1 Project Organization and Responsibilities

The organizations that will participate in completing the CMS for SWMU 17 have specific functions according to their project responsibilities, as described below:

- **Lead Regulatory Agency** — SCDHEC, the lead regulatory agency, will assign a lead engineer and hydrogeologist for the review and completion of the CMS for the site.
- **Support Regulatory Agency** — EPA is the support regulatory agency with Dann Spariosu as EPA contact person for this project.
- **Owner/Operator** — The U.S. Navy is the Owner/Operator for the site, and Tony Hunt with the Navy is the primary contact for SCDHEC and EPA. The Navy is ultimately responsible for completing the CMS and implementing the agency-approved CA.
- **Owner's Contractor** — CH2M-Jones, the Navy's contractor, is responsible for completing this project for the Navy. Dean Williamson is the primary point of contact for the CH2M-Jones team, and will be assisted by Ms. Rebecca Carovillano, who will serve as the alternate point of contact and task leader for the CMS.

4.2 Project Schedule

The project schedule for completing the CMS for SWMU 17 is presented in this subsection. The schedule presented in Table 4-1 includes the following:

- CMS tasks and associated subtasks
- Anticipated start and end dates for each subtask

- Project milestones, including completion for each work item

The project schedule will be finalized on the basis of the input from the reviewers of this document.

4.3 Project Deliverables

The project deliverables consist of the CMS report, which will be prepared in draft and final versions. The comments on the draft CMS report that are received from the Navy, EPA, and SCDHEC will be incorporated into the final CMS report.

TABLE 3-1
Project Schedule

Activity	Start Date	End Date
Comment Period for CMS Work Plan	1/8/2001	2/7/2001
Revisions to CMS Work Plan	2/8/2001	2/23/2001
Implementation of CMS Work Plan	2/23/2001	5/1/2001
Submission of Revision 0 CMS Report	5/1/2001	5/1/2001
Comment Period for CMS Report	5/1/2001	6/1/2001
Submission of Revision 1 CMS Report	6/1/2001	7/1/2001

SECTION 5.0

References

5.0 References

Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological Profile for Chlorinated Dibenzo-p-Dioxins. Draft for Public Comment (update). September 1997.

EnSafe/Allen & Hoshall. Final RCRA Facility Investigation Report for Zone H Naval Base Charleston. Prepared for the Department of the Navy, Southern Division Naval Facilities Engineering Command: Charleston, SC. Contract N62467-89-D0318. July 1996.

EnSafe. *RCRA Facility Investigation Addendum.* NAVBASE Charleston. 2000.

South Carolina Department of Health and Environmental Control (SCDHEC). RCRA Permit SC0 170 022 560. Charleston Naval Complex, Charleston, South Carolina. August 17, 1988.

U.S. Environmental Protection Agency (EPA
http://www.epa.gov/region09/waste/sfund/prg/
November 1, 2000.

APPENDIX

Calculation of Site-Specific DAF, SWMU 17

APPENDIX A

DAF Calculations for SWMU 17

Site(s)	Hydraulic Conductivity K (m/yr)	Hydraulic Gradient I (m/m)	Aquifer Thickness da (m)	Source Length Sw (m)	Infiltration Rate I' (m/yr)	Mixing Zone d (m)	DAF	Generic SSLs DAF 1	Generic SSLs DAF 20	Site Specific SSLs (Calculated from Calculated DAF)
PCB - Aroclor-1260	96.01	0.01	5.8	27.4	0.00762	3.1	15.3	Preliminary Remediation Goal of 1 mg/kg		
Benzene	96.01	0.01	5.8	22.9	0.00762	2.6	15.3	0.002	0.03	0.023
Benzo(a)anthracene[a]	96.01	0.01	5.8	22.9	0.00762	2.6	15.3	0.08	2	1.53
Benzo(a)pyreneb	96.01	0.01	5.8	22.9	0.00762	2.6	15.3	0.4	8	6.13
Benzo(b)fluoranthene[a]	96.01	0.01	5.8	22.9	0.00762	2.6	15.3	0.2	5	3.82
Chlorobenzene	96.01	0.01	5.8	27.4	0.00762	3.1	15.3	0.07	1	0.77
Ethylbenzene	96.01	0.01	5.8	22.9	0.00762	2.6	15.3	0.7	13	9.97
1,2-dichlorobenzene	96.01	0.01	5.8	27.4	0.00762	3.1	15.3	0.9	17	13.03
1,3-dichlorobenzene[b]	96.01	0.01	5.8	27.4	0.00762	3.1	15.3	0.1	2	1.53
1,4-dichlorobenzene	96.01	0.01	5.8	27.4	0.00762	3.1	15.3	0.1	2	1.53
Hexachlorobenzene[a]	96.01	0.01	5.8	27.4	0.00762	3.1	15.3	0.1	2	1.53
Naphthalene	96.01	0.01	5.8	22.9	0.00762	2.6	15.3	4	84	64.29
Styrene[a]	96.01	0.01	5.8	27.4	0.00762	3.1	15.3	0.2	4	3.06
1,2,4-trichlorobenzene	96.01	0.01	5.8	27.4	0.00762	3.1	15.3	0.3	5	3.84
1,1,2,2-tetrachloroethane	96.01	0.01	5.8	27.4	0.00762	3.1	15.3	0.0002	0.003	0.002

[a] chemicals were detected in subsurface soil, but not in site groundwater.

[b] A generic SSL was not available for 1,3-dichlorobenzene; therefore, SSL for 1,4-dichlorobeneze was used.

K is based on the slug test performed at 017001(0.863 feet/day ~ 96.01 m/yr, Table 3.4, Zone H RFI).
I is based on groundwater elevation differences and distance (47') between 017B04 (6.36') and 017D03 (5.89') (Figure 2.5.7A, Zone H RFI Addendum).
da is based on depth to water and bottom of screened interval of 017D04 (19 feet ~ 5.8m, Figure 2.5.5B, Zone H RFI Addendum).
I' is based on 25 percent (heavily paved area) of the simulated recharge rate (0.10 ft/yr ~ 0.03048 m /yr x 25% = 0.00762 m/yr, USGS, 1999).
Sw is based on benzene, ethylbenzene, and naphthalene base on northeast GW flow direction and area depicted in Fig 22.9 m, Zone H RFI Addendum).
Sw for all other constituents is based on northeast GW flow direction and area depicted in Figure 2.5.24 (90 feet ~ 27.4 m, Zone H RFI Addendum).