DVIADEC95

c 1/3 t.3

SA/AOC Grp
57 — 2
73 — AREC
29 — 8
61B } AREE
61AU
44 — 3
— 3
52 — 3
38
61X, 61AA, 69AN, 69AT, 69AS,
61D, 61AV, 61AX, 61AX, 69F, 63S } AREE

U.S. Army Environmental Center

FORT DEVENS
FEASIBILITY STUDY
FOR GROUP 1A SITES

LOWER COLD SPRING BROOK
SITE INVESTIGATION REPORT
DATA ITEM A009

CONTRACT DAAA15-91-D-0008

U.S. ARMY ENVIRONMENTAL CENTER
ABERDEEN PROVING GROUND, MARYLAND

DECEMBER 1995

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LOWER COLD SPRING BROOK
SITE INVESTIGATION REPORT
DATA ITEM A009

CONTRACT NO. DAAA15-91-D-0008
TASK ORDER NUMBER 0004

Prepared for:

U.S. Army Environmental Center
Aberdeen Proving Ground, Maryland

Prepared by:

ABB Environmental Services, Inc.
Portland, ME
Project No. 07005-15

DECEMBER 1995

LOWER COLD SPRING BROOK
SITE INVESTIGATION REPORT

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EXECUTIVE SUMMARY

This Site Investigation (SI) report summarizes field observations, laboratory analytical data, and interpretation of data gathered during the Lower Cold Spring Brook SI and several other investigations conducted along lower Cold Spring Brook and associated stormwater outfalls. The purposes of this report are to present available data collected at the stormwater outfalls and areas downgradient of the outfalls along lower Cold Spring Brook, assess the presence and distribution of contamination, present a preliminary risk evaluation, and make recommendations concerning future actions. This SI was conducted by ABB Environmental Services, Inc. (ABB-ES), at the direction of the U.S. Army Environmental Center (USAEC) under Contract No. DAAA15-91-D-0008, Delivery Order 0004.

Cold Spring Brook originates in the central part of the Main Post at Fort Devens. Its headwaters are formed by runoff and groundwater discharge in the vicinity of the magazine area and the Cold Spring Brook landfill. Further downstream, it flows north through woodlands and wetlands and passes beneath the Boston & Maine Railroad (B&MRR) right-of-way at Barnum Road. From that point, the brook collects runoff from the industrial area along Barnum Road as it flows northeast off Fort Devens property. This latter length of brook which collects runoff from the Barnum Road industrial area has been named lower Cold Spring Brook for SI purposes. The Army has designated lower Cold Spring Brook as Study Area (SA) 73.

Previous field investigations identified several stormwater outfalls and associated drainage ditches along Barnum Road that were considered potential contributors to contamination in lower Cold Spring Brook. Data from these investigations revealed the presence of contaminants, predominantly semivolatile organic compounds (SVOCs) and inorganics in drainage ditches/swales at the outfalls and in lower Cold Spring Brook. As a result, SI sampling was conducted in September 1994 to establish baseline conditions, confirm sources, and evaluate potential effects of exposure to contaminated surface water and sediments.

During the SI, surface water and sediment samples were collected from 23 locations in lower Cold Spring Brook and 11 locations in storm drain ditches and swales. The surface water samples were analyzed for Project Analyte List (PAL)

SVOCs; total and dissolved inorganics; and the water quality parameters total suspended solids, chloride, sulfate, total hardness, and alkalinity. The sediment samples were analyzed for PAL SVOCs, PAL inorganics, total organic carbon, total petroleum hydrocarbons (TPHCs), grain size distribution, and percent solids. In addition, sediment samples from six locations adjacent to and downgradient of an historical fuel oil spill were analyzed for volatile organic compounds (VOCs). To supplement the 1994 SI data, additional surface water and sediment samples (four and five samples, respectively) were collected in the vicinity of one of the storm drain systems in 1995.

The macroinvertebrate community was characterized at 10 of the sediment sampling stations, and sediment samples from those stations were subjected to laboratory toxicity testing. Surface water and sediment samples from these 10 bioassay stations were also analyzed for pesticides and polychlorinated biphenyls (PCBs).

A Preliminary Risk Evaluation (PRE) was performed as a screening-level evaluation of the actual and potential risks that environmental contaminants may pose to ecological receptors in the vicinity of lower Cold Spring Brook. The PRE included benchmark screening of data for eight storm drain systems and associated drainage ditches/swales that discharge to lower Cold Spring Brook, lower Cold Spring Brook itself, and Storm Drain System No. 5, which drains north into Grove Pond. Habitat in ditches/swales downgradient of four of the storm drain systems more closely resembles terrestrial habitat than aquatic habitat and does not support aquatic life; data for these areas were screened against surface soil benchmarks. Remaining soil/sediment data were screened against sediment benchmarks. Surface water data for samples collected from storm drain system outfalls and ditches were evaluated in one data set rather than on an outfall-by-outfall basis. Lower Cold Spring Brook surface water data were evaluated for upstream and downstream subsections.

The conclusions drawn from the data evaluation and the ecological PRE for lower Cold Spring Brook are:

- No evidence exists that analytes in surface water pose risks to aquatic receptors in the lower Cold Spring Brook watershed. Although lead exceeds its AWQC, it is unlikely that it poses a risk to aquatic receptors in lower Cold Spring Brook.

- Aquatic habitat quality tends to be low at the storm drain system discharge areas relative to habitat quality in lower Cold Spring Brook. The slow stream velocity and sand and mud substrate of lower Cold Spring Brook contribute to its poor aquatic habitat quality rating.

- In general, within individual storm drain systems, surface soil and sediment samples from locations nearest the outfall pipes are more contaminated than locations further downgradient, in the Cold Spring Brook floodplain. In Systems No. 2/3/4, contamination (polynuclear aromatic hydrocarbons [PAHs], inorganics, and TPHC) is generally found near the storm drain outlet. Contaminants (PAHs, inorganics and TPHC) in System No. 7 appear to be associated with runoff from Barnum Road. The Study Area (SA) 57 marsh contained sediments contaminated with VOCs, semivolatile organic compounds (SVOCs), pesticides, PCBs, and inorganics. Sediments downgradient of System No. 9 appear adversely affected by upgradient sources other than system No. 9.

- No ecological risks were identified from exposure to contaminated media in Storm Drain Systems No. 1/2, System No. 5, System No. 6, and System No. 8.

- Based on benchmark screening of sediment contaminant concentrations, limited ecological risks may be associated with Storm Drain Systems No. 2/3/4, Storm Drain System No. 7, the SA 57 marsh, and an upstream subsection of lower Cold Spring Brook.

- Site-specific toxicity tests indicate that aquatic and benthic organisms are generally not adversely affected by exposure to sediments from lower Cold Spring Brook. Limited growth and survival effects were observed in sediments from the upstream section of Cold Spring Brook located near Storm Drain System No. 9, downgradient from System No. 7, and at a downstream station not closely associated with a specific storm drain system.

- Based on the results of laboratory toxicity testing, use of literature-based sediment quality guidelines for benchmark screening appears to over-estimate receptor risk in lower Cold Spring Brook. Aquatic toxicity studies did not demonstrate a widespread or severe toxicity response.

- An ecological characterization field program to characterize ecological receptors at lower Cold Spring Brook concluded that signs of stressed vegetation were limited to one small (400 square feet) area in the Storm Drain Systems No. 2/3/4 drainage ditch. Whether the stress resulted from chemical contaminants or from physical stress associated with stormwater flow and ponding was unclear.
- Samples collected in the vicinity of the Storm Drain System No. 9 outfall suggest that the area northwest of the Saratoga Street and Dakota Street intersection may have contributed PAH contamination to lower Cold Spring Brook. Available data suggest that this area may have had a greater influence on lower Cold Spring Brook than Storm Drain System No. 9.

Based on the above conclusions, recommendations for lower Cold Spring Brook are:

- No further study or remedial action is recommended for areas downstream of the outfalls at Storm Drain Systems No. 1/2, System No. 5, System No. 6, System No. 8, and System No. 9.
- Remedial activities are not recommended for the upstream pond where sediment analysis (CSD-94-02X) and benchmark screening suggest potential adverse biological effects. Laboratory toxicity testing indicates that sediments from this area do not adversely affect test organisms.
- Remedial activities are not recommended for the area of lower Cold Stream Brook from sample location CSD-94-03X to location CSD-94-08X where limited toxicity was observed in laboratory studies. The toxicity studies did not identify a specific toxicant on which to base remedial actions, and field observations indicate habitat in this area is comparable to or better than the reference station.

Remedial activities within the brook channel and floodplain would likely adversely affect the brook and marsh which provides good habitat to wildlife and aquatic receptors.

- Because benchmark screening appears to overestimate receptor risk, it is recommended that no remedial activities based wholly on benchmark screening results be undertaken in the isolated marsh area north of Saratoga Street (sample location SSD-95-09K). Benchmark screening was not an accurate predictor of biological effects at marsh location CSD-94-02X.
- Potential contaminant sources and migration in the vicinity of SA 57 should be investigated further.
- Remedial activities at Storm Drain Systems No. 2/3/4 and System No. 7 should focus on source controls and hot spot removal of contaminated sediments in ditches.

1.0 INTRODUCTION

ABB Environmental Services, Inc. (ABB-ES), prepared this Site Investigation (SI) report in accordance with U.S. Army Environmental Center (USAEC, formerly the U.S. Army Toxic and Hazardous Materials Agency) Contract DAAA15-91-D-0008, Delivery Order 0004, for conducting environmental investigations at Group 1A sites at Fort Devens, Massachusetts. This SI report summarizes field observations and laboratory chemical data from SI activities performed to collect information on the distribution of contaminants in sediment and surface water potentially affected by stormwater outfalls draining industrial areas along Barnum Road. The Army has designated lower Cold Spring Brook as Study Area (SA) 73.

Previous field investigations along Barnum Road identified several stormwater outfalls that are potential contributors to contamination in lower Cold Spring Brook. These previous investigations included the 1992 SI for Group 3 SAs, the 1993 SA 57 SI (ABB-ES, 1993a and 1993b, respectively), and an Arthur D. Little, Inc. (A.D. Little) Base Realignment and Closure Environmental Evaluation (BRAC EE) entitled *Final Storm Sewer System Evaluation (Area Requiring Environmental Evaluation [AREE] 70)* (A.D. Little, 1994a). Results of these investigations prompted an SI for lower Cold Spring Brook which was performed in 1994. After completion of the SI field activities, ABB-ES prepared a Lower Cold Spring Brook SI Data Package (ABB-ES, 1995a). This data package presented the results of the SI and provided preliminary evaluations of the absence or presence of contamination, the potential pathways of contaminant migration, and potential risk to ecological receptors.

1.1 PURPOSE AND SCOPE

The purposes of this SI report are to present available data collected at the stormwater outfalls and areas downgradient of the stormwater outfalls at SA 73, assess the presence and distribution of contamination, present a Preliminary Risk Evaluation (PRE), and make recommendations for future actions. The contamination assessment in this SI report provides the interpretive link between the tabulated chemical data, field observations, and the hydrological and physical environment.

This report is based on data collected from the previous investigations (ABB-ES, 1993a; ABB-ES, 1993b; and A.D. Little, 1994a), data collected during the Lower Cold Spring Brook SI (ABB-ES, 1995a), and data from additional sampling in the vicinity of Storm Drain System No. 9 by A.D. Little in 1995 (A.D. Little, 1995).

1.2 SITE DESCRIPTION AND HISTORY

Cold Spring Brook originates in the central part of the Main Post at Fort Devens. Its headwaters are formed by runoff and groundwater discharge in the vicinity of the magazine area and the Cold Spring Brook landfill. Further downstream, it flows north through woodlands and wetlands, and passes beneath the Boston & Maine Railroad (B&MRR) right-of-way at Barnum Road. From that point, the brook collects runoff from the industrial area along Barnum Road as it flows northeast off Fort Devens property (Figure 1-1). The brook ultimately discharges to Grove Pond. Descriptions of the storm drain systems, as well as other potential sources of contamination to the brook, located in or near the industrial area along Barnum Road are provided in the following paragraphs. Figure 1-2 shows the location of each storm drain system.

Storm Drain Systems No. 1/2. System No. 1 drains an area located to the west of Building 3769 (the Armory) near the Northeast Gate (Barnum Gate) on Barnum Road. System No. 1 discharges from a headwall just east of Barnum Road into a drainage swale that runs southeast and discharges to lower Cold Spring Brook. The eastern half of System No. 2, which empties into the same drainage swale as System No. 1, drains a small area on the eastern side of Barnum Road adjacent to System No. 1. Aerial photographs from 1943 indicate that the area west of Building 3769 was once occupied by a large railyard. From 1952 to the present, the area has been used for vehicle storage. The entire area is currently occupied by the Massachusetts Army National Guard. There are no AREEs or SAs associated with Storm Drain Systems No. 1/2.

Storm Drain Systems No. 2/3/4. System No. 3 and the western half of System No. 2 were evaluated concurrently because the two systems discharge to the same headwall location. System No. 3 drains a large area around Building 259, a vehicle maintenance shop occupied by the Massachusetts Army National Guard. Runoff is collected from this area and from an area west of Barnum Road, where large lots are used for vehicle storage. The runoff flows southeast under Barnum Road and is discharged through a headwall into a drainage swale that leads to lower Cold Spring Brook. This swale also accepts flow from System No. 4, which discharges from a headwall further upslope. AREEs 61B and 61AU, Areas of Contamination (AOCs) 44 and 52, and SA 38 are associated with System No. 3; AREEs 61X and 69AU and AOCs 44 and 52 are associated with System No. 4.

Storm Drain System No. 5. System No. 5 collects stormwater drained from the western section of the land occupied by the Massachusetts Army National Guard to the west of Barnum Road, near Buildings 3702 and 3703, and from paved areas around these buildings. The collected runoff flows northeast under the road leading to Grove Pond and discharges into a wooded area on the southeast side of Grove Pond. AOCs 44 and 52 are associated with this system.

Storm Drain System No. 6. System No. 6 collects runoff from the area around Buildings 3712 and 3713, which includes vehicle storage areas and an unpaved area of railroad track. The system initially drains to the southwest, but turns to the southeast before passing under Barnum Road and discharging into a drainage swale that leads to lower Cold Spring Brook. Historical land use near System No. 6 included a former commissary and, as interpreted from aerial photographs, a vehicle storage/maintenance facility. During a previous investigation, it was determined that System No. 6 received a spill of approximately 3,000 gallons of No. 4 fuel oil from an overfilled underground storage tank in 1978. The old commissary (Building 3712) is currently leased to the B&MRR.

System No. 6 also carried the discharge of a fuel spill associated with SA 57 Area 1 and the floor drain at SA 38. The AREEs and SAs associated with System No. 6 are 61X, 61AA, 69AN, 69AT, 69AS, SA 38, and SA 57.

Storm Drain System No. 7. System No. 7 drains a small wooded area located south of System No. 6 near Barnum Road and lower Cold Spring Brook. With the exception of a culvert under Barnum Road, the system is an open ditch from a road along the western edge of the Barnum Road industrial area to its confluence with lower Cold Spring Brook. Historical land use near System No. 7 included a driver training facility to the northwest. Railroad tracks lie to the west. There are no AREEs, SAs, or AOCs associated with this system.

SA 57/Area 2. In addition to the storm drain outfalls, Area 2 of SA 57 is a potential source of contaminants to lower Cold Spring Brook. During the SI for Groups 2 & 7, the investigation of Area 2 at SA 57 revealed petroleum-related contaminants in surface soil collected from a drainage swale that leads toward lower Cold Spring Brook. The swale meets Cold Spring Brook downstream of the System No. 6 drainage swale, and upstream of a containment dam installed during the 1978 No. 4 fuel oil recovery effort. The Groups 2 & 7 SI concluded that the contaminants discovered in the Area 2 swale (currently interpreted as originating from crank-case oil) were related to past maintenance of military equipment stored nearby. A remedial investigation (RI) is underway to investigate evidence that the contaminants have migrated downslope toward lower Cold Spring Brook.

Bowers Brook. The Bowers Brook watershed is considered a potential additional source of contaminants to lower Cold Spring Brook from off-site agricultural activities. Bowers Brook enters lower Cold Spring Brook from the southeast downstream of the No. 4 fuel oil containment dam.

Storm Drain System No. 8. Storm Drain System No. 8 drains a wooded area within the curve of Barnum Road east of the B&MRR right-of-way. Runoff flows from the northwest to the southeast, crossing under Barnum Road and continuing through a marsh area before discharging to Cold Spring Brook. There are no AOCs, SAs, or AREEs associated with this system. Historically, land use in the area has included railroad activities; undeveloped woodlands lie to the west of System No. 8.

Storm Drain System No. 9. Storm Drain System No. 9 is an extensive system that drains paved residential areas, railroad tracks, and unpaved storage yards near the intersection of Bates Service Road and Cavite Street. The system runs underground and east along Cavite Street, then south along Saratoga Street before discharging to a culvert that passes under Patton Road at the junction of Patton Road, Saratoga Street, and Barnum Road. The combined discharge of Storm Drain System No. 9 and surface water collected west of Saratoga Street and Patton Road mixes with flow from lower Cold Spring Brook about 100 feet east of the culvert outlet.

A railyard located to the north and east of System No. 9 has been in place since 1942. The northwestern part of System No. 9 is occupied by housing units that were constructed in the 1950s. An historical blacksmith shop, lumber yard, and dispatch office located in the center of System No. 9 are currently occupied by the electric shop, hazardous waste storage area, and heating shop. The AREEs associated with System No. 9 include 61D(AP), 61AV, 61AX, 61AY, 69F, and 63S. SA 29 is also located in the vicinity of System No. 9.

1.3 PREVIOUS FIELD INVESTIGATION ACTIVITIES

The following subsections summarize previous investigation activities in the vicinity of lower Cold Spring Brook.

1.3.1 1992 Group 3 Study Areas and 1993 Study Area 57 Site Investigations

The 1992 Group 3 SA SI gathered information on surface water and sediment contamination upstream of, and within, areas where contaminants may have entered lower Cold Spring Brook (ABB-ES, 1993a). Laboratory analysis on both the surface water and sediment samples consisted of Project Analyte List (PAL) volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), inorganic analytes, and total petroleum hydrocarbons (TPHC). In addition, surface water samples were analyzed for PAL water quality parameters and total suspended solids (TSS). Sediment samples were also analyzed for total organic carbon (TOC) and grain-size distribution.

During the 1993 SA 57 SI, ABB-ES sampled sediment in two ditches leading to lower Cold Spring Brook, surface water and sediment within the brook to investigate the distribution of contamination in sediment within Area 1 and Area 2 of SA 57, and surface water and sediment in lower Cold Spring Brook upstream and downstream of SA 57 (ABB-ES, 1993b). Laboratory analysis of the sediment in the ditches consisted of PAL SVOCs, TPHC, TOC, oil fingerprinting, and grain-size distribution. Two rounds of lower Cold Spring Brook surface water and sediment data were collected. During the first round, surface water samples were analyzed for PAL SVOCs, TPHC, and PAL water quality parameters, while the sediment samples were analyzed for PAL SVOCs, TPHC, TOC, and grain-size distribution. During the second round, surface water samples were analyzed for PAL VOCs, SVOCs, inorganics, TPHC, and TOC. Unsafe winter field conditions prevented the collection of a sediment sample from sample location 57D-92-02X during the second round.

Samples collected during the 1992 Group 3 SA SI and the 1993 SA 57 SI included: one round of sediment samples from six sampling locations (57S-92-01X through 57S-92-06X); one round of surface water and sediment samples from three sampling locations (G3D-92-01X through G3D-92-03X); two rounds of surface water and sediment samples from a tenth sampling location (57D-92-01X); and two rounds of surface water and a single round of sediment from an eleventh sampling location (57D-92-02X). Sample locations are shown in Figure 1-3.

The data summary in this SI considers the analytical results for the three sediment samples collected from the ditch in Area 1 of SA 57, along with the analytical results for all six sediment samples collected from lower Cold Spring Brook. The data summary does not evaluate analytical results for surface water collected during the 1992 Group 3 SA SI and the 1993 SA 57 SI because the more recent analytical results for surface water collected during the 1994 Lower Cold Spring Brook SI are considered a better representation of surface water quality. The analytical results for sediment samples collected from the ditch in Area 2 will be presented in a separate RI report for SA 57, to be issued at a later date.

1.3.2 AREE 70 Evaluation

The AREE 70 evaluation gathered information on 55 storm drain systems and three surface water bodies, and identified potential sources of contamination not identified previously (A.D. Little, 1994a). Included in the AREE 70 evaluation were Storm Drain Systems No. 1 through No. 9 and lower Cold Spring Brook. Laboratory analysis on both the surface water and sediment samples consisted of PAL VOCs, SVOCs, inorganic analytes, and TPHC. In addition, the surface water samples were analyzed in the field for pH, temperature, conductivity, and turbidity. Sediment samples were also analyzed for TOC.

Analytical results for sediment samples collected from 13 AREE 70 locations are considered in the SI data summary. Twelve of these AREE 70 sample locations, designated as SSW/SSD-93-XXX, are shown in Figure 1-3. Sample location SSW/SSD-93-92C was upstream of a Patton Road culvert, approximately 1,000 feet south of the intersection of Patton Road and Barnum Road. This location is too far south to be shown on Figure 1-3. The data summary does not evaluate analytical results for surface water collected during the AREE 70 evaluation because surface water quality can change relatively quickly and the recent analytical results for surface water collected during the 1994 Lower Cold Spring Brook SI are considered a better representation of current surface water quality.

1.4 PREVIOUS FIELD INVESTIGATION CONCLUSIONS

Data from the previous field investigations revealed the presence of contaminants, predominantly SVOCs and inorganics, at the outfalls and in Cold Spring Brook. The AREE 70 Addendum 1 (A.D. Little, 1994b) concluded that target analytes increased in concentration downstream with the boundary of the industrial area on Barnum Road. The AREE 70 Report (A.D. Little, 1994a) identified Storm Drain Systems No. 1, 2, 3, 6, and 7 as systems of concern based upon analytical results. In addition, the Groups 2 & 7 SI identified Area 2 of SA 57 as a potential source of petroleum-related contaminants to Cold Spring Brook (see Subsection 1.2).

No clear correlation between most of the contaminant concentrations found in the outfalls and the contaminant concentrations found in Cold Spring Brook was observed in the data obtained during the AREE 70 investigations. However, the data did suggest that there may be a positive correlation between elevated concentrations of metals and SVOCs in the outfall location and the stream sample location at System No. 3. With this exception, it could be inferred from the current data that the outfalls are the single or primary source of the contamination detected in Cold Spring Brook. In general, analyte concentrations increased downstream from the confluence of the System No. 7 drainage swale and Cold Spring Brook, which corresponds to the general location of the Fort Devens industrial area. The storm drain outfalls were considered the most likely non-point sources contributing to contamination in lower Cold Spring Brook,

As a result of these previous investigations, an SI was conducted to establish baseline conditions, confirm sources, and evaluate potential effects of exposure to contaminated surface water and sediments from the industrial areas along Barnum Road that have been identified as potential contributors to contamination in Cold Spring Brook.

1.5 REPORT ORGANIZATION

This SI report consists of six sections. Section 1 provides a brief description of lower Cold Spring Brook as well as the storm drain systems and other potential sources of contamination to the brook. Section 1 also summarizes the results of the previous field investigations.

Section 2 describes SI activities, including the field program, analytical program, chemical data management, and handling of investigation derived waste. Section 3 describes site physical characteristics.

Section 4 presents the results of laboratory chemical analysis and assesses the presence and distribution of site contamination. Section 5 presents an ecological PRE based on data from the previous investigations and the Lower Cold Spring Brook SI. Section 6 contains SI conclusions and recommendations based on SI results.

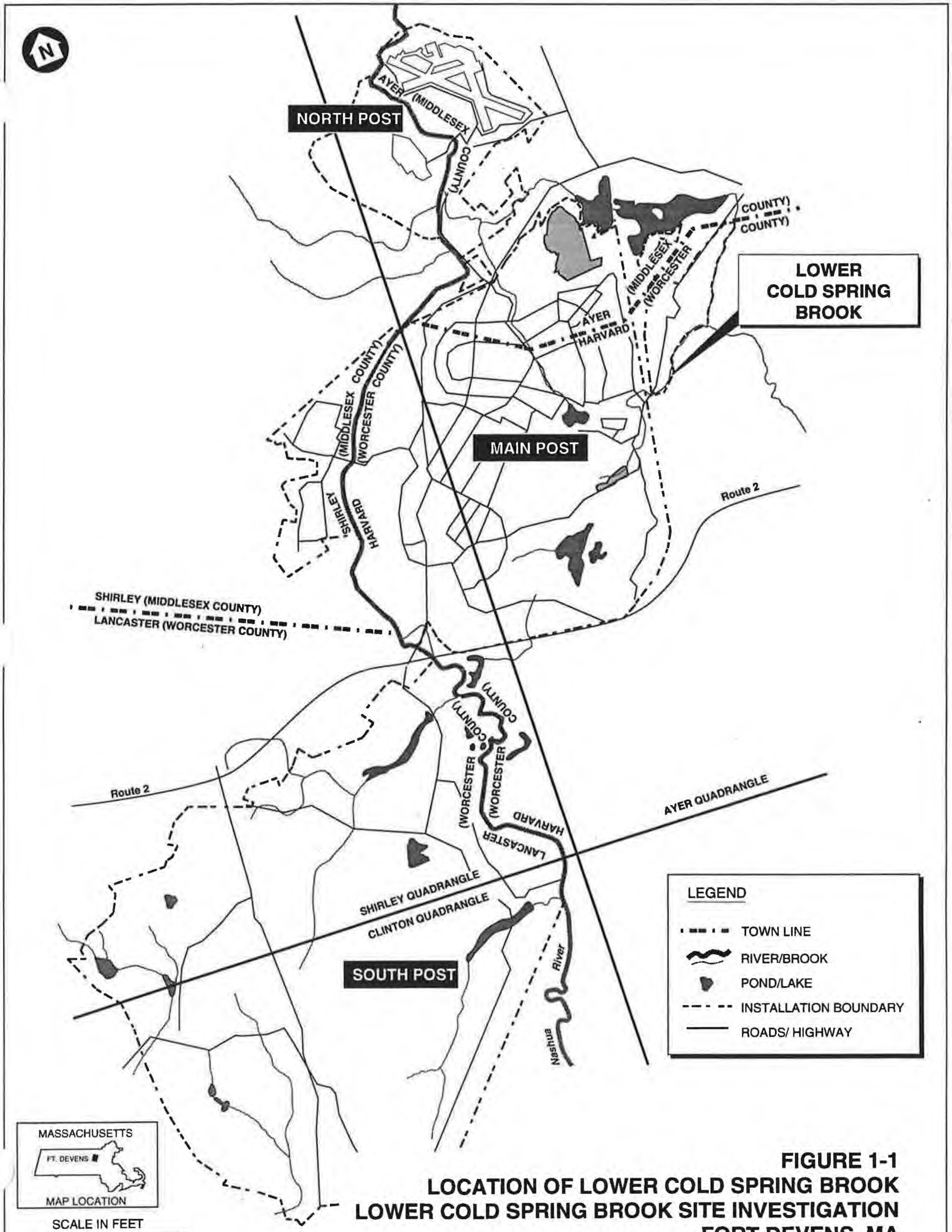

FIGURE 1-1
LOCATION OF LOWER COLD SPRING BROOK
LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ABB Environmental Services, Inc.

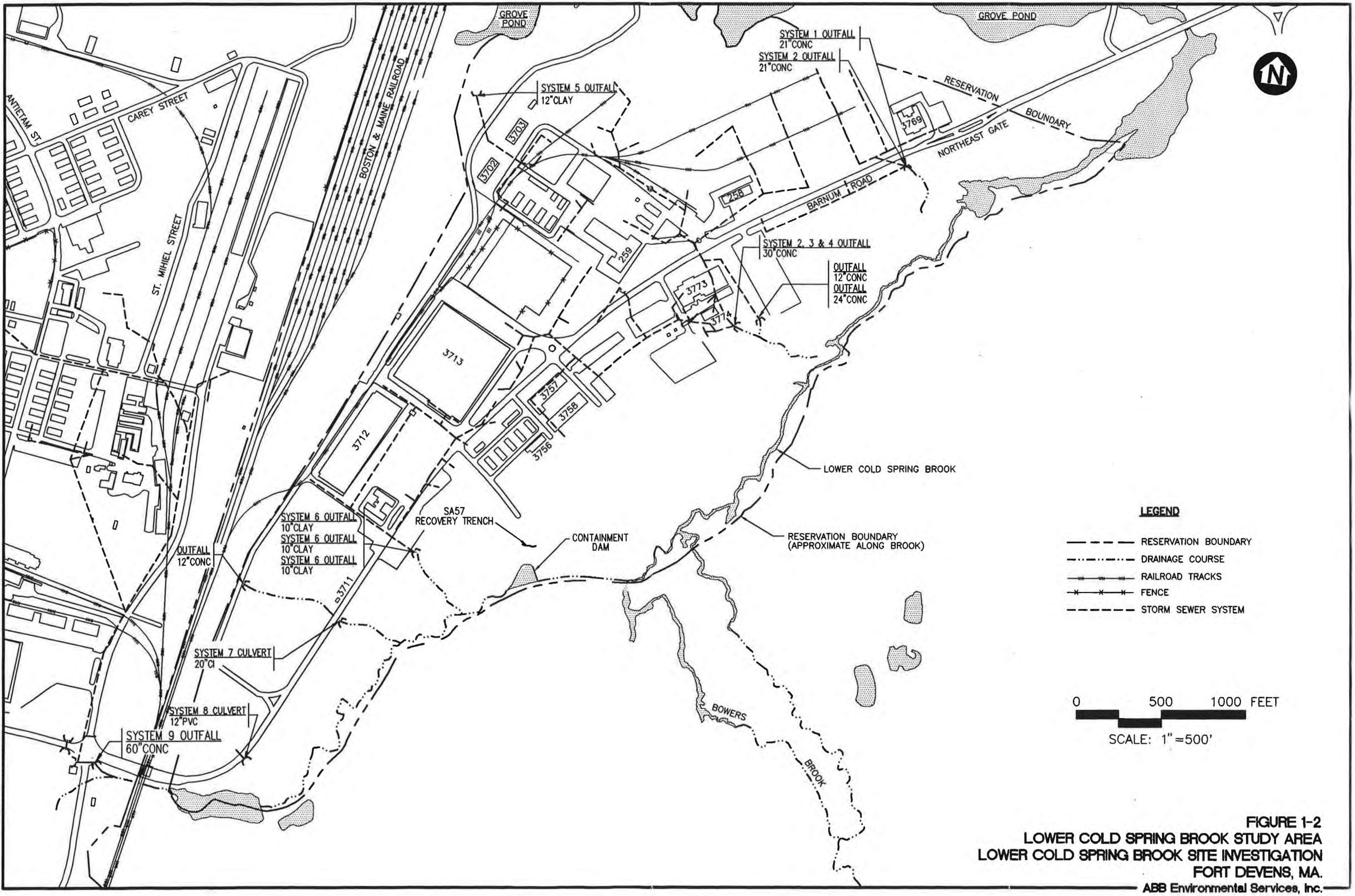

FIGURE 1-2
LOWER COLD SPRING BROOK STUDY AREA
LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ABB Environmental Services, Inc.

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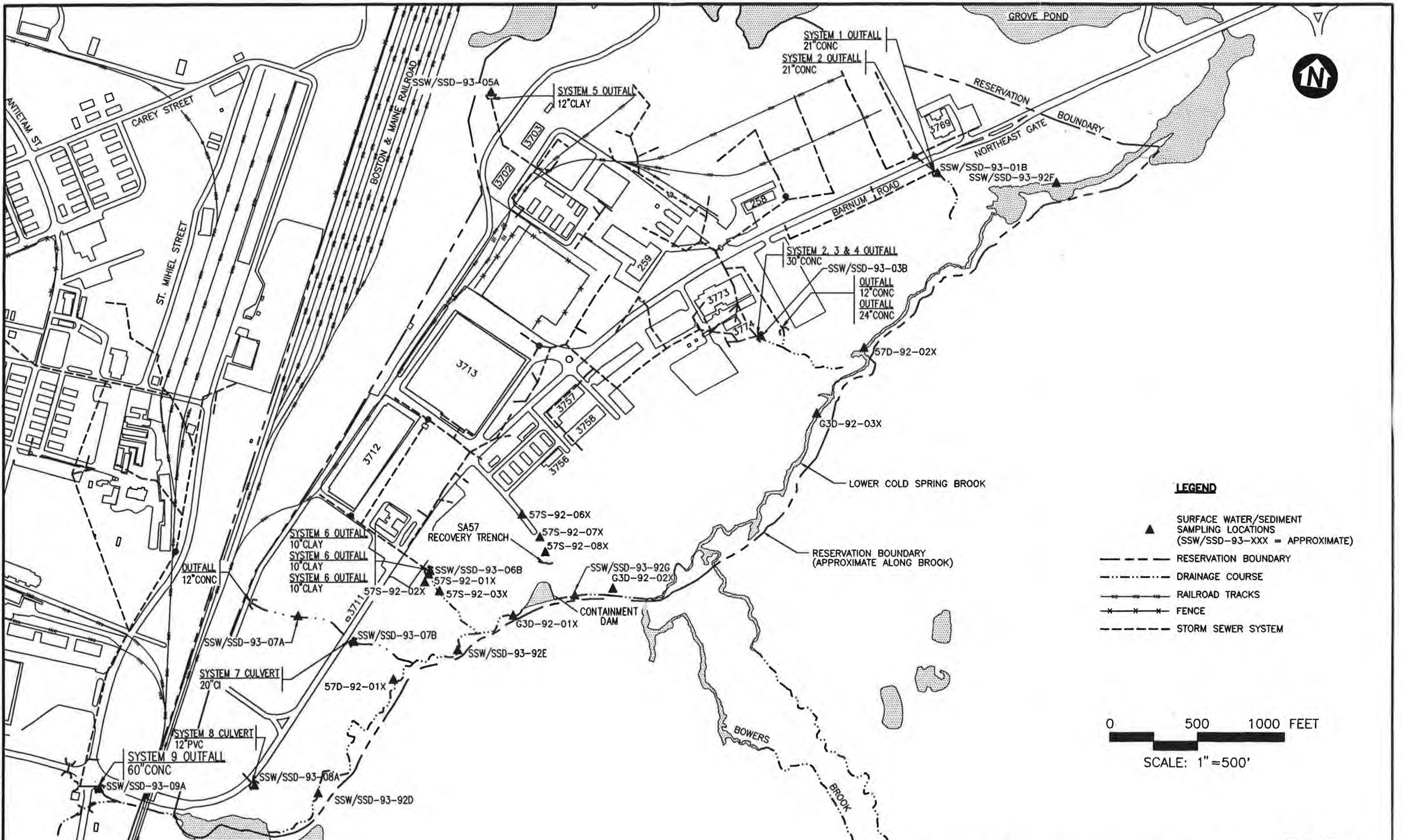


FIGURE 1-3
PREVIOUS SURFACE WATER AND SEDIMENT SAMPLE LOCATIONS
LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ABB Environmental Services, Inc.

2.0 SITE INVESTIGATION ACTIVITIES

This section summarizes the 1994 (surface water and sediment sampling) and 1995 (ecological characterization field program) activities performed by ABB-ES. Included are discussions pertaining to sampling rationale, the laboratory analytical program, chemical data management, and handling of investigation derived waste. This section also includes 1995 post SI data from sampling performed by A.D. Little, Inc. in the vicinity of Storm Drain System No. 9.

2.1 SITE INVESTIGATION FIELD PROGRAM SUMMARY

The SI at lower Cold Spring Brook was undertaken in accordance with the Final Cold Spring Brook SI Work Plan (ABB-ES, 1994) and in conformance to the provisions of the Project Operations Plan (POP) (ABB-ES, 1993e). The SI was conducted to further characterize the distribution of contaminants associated with both storm drain system and non-point source releases, as well as to evaluate the overall ecological effects of the contaminants on lower Cold Spring Brook.

Sediment samples were collected from 23 locations in lower Cold Spring Brook, and 11 locations in drainage ditches/swales and other potential source areas. Surface water samples were collected in conjunction with sediment samples whenever possible; however, lack of standing water prevented this at several locations. Sample locations are shown in Figure 2-1. Table 2-1 lists brook and drainage-way sample locations. Two of the surface water and sediment pairs were collected from the outflow of Storm Drain System No. 5, which drains toward Grove Pond (see Figure 2-1). The surface water samples were analyzed for PAL SVOCs, total and dissolved inorganics, and the water quality parameters TSS, chloride, sulfate, total hardness, and alkalinity. In addition, the surface water samples were analyzed in the field for pH, dissolved oxygen, conductivity, and temperature. The sediment samples were analyzed for PAL SVOCs, PAL inorganics, TOC, TPHC, grain size distribution, and percent solids. Grain size distribution reports are included in Appendix A. In addition, sediment samples from six locations (CSD-94-13X, -14X, -17X, -19X, -20X, and -35X) adjacent to SA 57 and downgradient of an historical fuel oil spill were analyzed for VOCs (see Figure 2-1). The macroinvertebrate community was characterized at 10 sampling stations, and sediment samples from those stations were subjected to toxicity testing. Surface water and sediment samples from these 10 bioassay stations were also analyzed for pesticides and polychlorinated biphenyls (PCBs).

A field survey was conducted by ABB-ES ecologists on August 30, 1995 to determine whether observable vegetative impacts were associated with ditch contamination. The survey focussed on outfall areas where Storm Drain Systems No. 2/3/4, 7, 8, and 9 discharge into lower Cold Spring Brook. In addition, a survey was conducted in the brook itself in the vicinity of SA 57. At each area, wildlife observations and characteristic plant species were noted, and evidence of vegetative stress and/or phytotoxicity sought. Observations were recorded in a bound field notebook and photographs were taken to document existing conditions.

With the exception of one location within Storm Drain Systems No. 2/3/4, no evidence of vegetative stress or phytotoxicity was observed during the survey. Vegetative stress was noted in the vicinity of CSD-94-23X, which is located in Storm Drain System No. 2/3/4 approximately 1,000 feet above its confluence with lower Cold Spring Brook (see Figure 2-1). A 400 square foot portion of storm drain channel in the vicinity of CSD-94-23X was devoid of vegetation. Although the lack of vegetative growth in this area may be attributable to contaminant-related phytotoxicity, it is also possible that episodic surges of storm water may prevent plants from becoming established in this area. CSD-94-23X is also located immediately above a road culvert and the lack of vegetation in this area may be due to periodic ponding conditions during periods when this culvert becomes obstructed.

2.2 STORM DRAIN SYSTEM NO. 9 SUPPLEMENTAL SAMPLING

The SI Data Package (ABB-ES, 1995a) concluded that additional sampling should be performed in the vicinity of the Storm Drain System No. 9 outfall to further assess contamination in that area. As a result, USAEC directed A.D. Little, Inc. to collect surface water and sediment samples from three Cold Spring Brook locations and two locations in the drainage ditch/swale whose flow combines with that of System No. 9 at the Barnum Road intersection (A.D. Little, 1995). These samples are listed below.

SSW-95-09H and SSD-95-09H:	Surface water and sediment samples from pond downstream of the B&MRR right-of-way
SSW-95-09I and SSD-95-09I:	Surface water and sediment samples from Cold Spring Brook below confluence with drainage from System No. 9
SSW-95-09J and SSD-95-09J:	Surface water and sediment samples from Cold Spring Brook upstream of System No. 9
SSW-95-09K and SSD-95-09K:	Surface water and sediment samples from drainage ditch/swale north of Dakota Street upstream of System No. 9
SSD-95-09L:	Sediment/soil sample at discharge end of culvert at end of access road leading to Commissary (Building 1410); surface water not available for sampling at this location

All samples were analyzed for SVOCs, pesticides and PCBs, inorganics, TOC, and TPHC. In addition, surface water samples were analyzed for dissolved inorganics, TSS, chloride, sulfate, total hardness, and alkalinity.

2.3 ANALYTICAL PROGRAM

Water, sediment, and surface soil samples collected during the Lower Cold Spring Brook SI were submitted to the USAEC performance demonstrated laboratory Environmental Science and Engineering, Inc. (ESE) to quantify contaminants that were expected, based on available information, to be present. Analytical parameters were selected from the Fort Devens PAL (Appendix B), and analyses were performed in accordance with the USAEC Quality Assurance (QA) Program (USATHAMA, 1990) or standard U.S. Environmental Protection Agency (USEPA) methodologies (USEPA, 1983; USEPA, 1986c).

The performance demonstrated analytical methods used for PAL organics, inorganics, and explosives are similar to USEPA Contract Laboratory Program (CLP) Routine Analytical Services and support USEPA Level III data quality. The following subsections summarize the laboratory quality assurance/quality control (QA/QC) program.

2.3.1 Laboratory Performance Demonstration

In accordance with the USAEC QA Program, laboratories must provide a satisfactory performance demonstration for certain analytical methods conducted in association with site investigations (USATHAMA, 1990). Laboratories demonstrate performance by first submitting data from analysis of calibration standards and then data from analysis of performance samples sent to the laboratory by USAEC. The concentrations of the analytes in these samples are unknown by the laboratory. The data are sent to USAEC where the precision and accuracy of the analyses are determined. Approval is either awarded to or denied the laboratory based on this performance. An analytical method code is assigned to each method and reported with results. Certified Reporting Limits (CRLs) are also determined from this process.

Some methods such as alkalinity, TOC, and TSS do not require performance demonstration. The USAEC recognizes standard USEPA protocols or internal laboratory methods for these parameters. Laboratories are required to submit information on procedures for analyzing samples using these methods to the USAEC Chemistry Branch before they are implemented.

Performance demonstrated analytical methods which were used during the Lower Cold Spring Brook SI are listed with a brief description in Table C-1 of Appendix C, and CRLs are listed in Tables C-2 through C-6. A list of USEPA methods and associated reporting limits is presented in Table C-7.

2.3.2 Laboratory Methods Quality Control

ESE, the laboratory used for this study, organizes all submitted samples into lots that are assigned a three or four character code using letters of the alphabet. Each lot consists of the maximum number of samples, including QC samples that can be processed through the rate limiting step of the method during a single time period (not exceeding 24 hours). Lots may consist of samples from multiple installations, provided the data quality objectives are the same. The rate limiting step is usually determined by time or equipment limitations.

Laboratory control samples are associated with each lot. Control samples are spikes of both high and low concentrations of specific analytes that help monitor laboratory precision and accuracy. The recoveries of these spikes are plotted on control charts generated by the laboratory and submitted to USAEC. Data generated from the performance demonstration process are used to calculate a mean recovery value. Control and warning limits are statistically generated by the USAEC Chemistry Branch to help measure laboratory data quality.

Method blanks are also run at the laboratory to evaluate the potential for target analytes to be introduced during the processing and analysis of samples. One method blank is included in each analytical lot. Method blank results for the Lower Cold Spring Brook SI are presented in Appendix C.

2.4 DATA REDUCTION AND EVALUATION

Initial responsibility for accuracy and completeness of data packages rests with the analytical laboratory. All data submissions to USAEC must first undergo a laboratory review process. This review includes checks that evaluate completeness of laboratory data, accuracy of reporting limits, compliance with quality control (QC) limits and holding times, and correlation of laboratory data to associated laboratory tests.

Laboratories review the following items before submitting data to USAEC:

- chain of custody records;
- instrument printouts, to check if these agree with handwritten results;
- calibration records, to ensure a particular lot is associated with only one calibration;
- chromatograms and explanations for operator corrective actions (such as manual integrations);

- standard preparation and documentation of source;
- calculations on selected samples;
- notebooks and sheets of paper, to ensure all pages are dated and initialed, and explanations of procedure changes;
- gas chromatograph/mass spectrograph library search of unknown compounds; and
- transfer files and records, to ensure agreement with analysis results.

To document the data review and evaluation process, a data review checklist is submitted as part of the data package.

2.5 DATA REPORTING

Once the data have undergone review by the laboratory, they are encoded for transmission to the USAEC Installation Restoration Data Management Information System (IRDMIS) as Level 1 data. Once in IRDMIS, the data are subjected to a group and records check.

Data are then transferred to an Army data management contractor. During this phase the data are considered to be Level 2. Another group and records check is performed, and data are reviewed by the USAEC Chemistry Branch. If errors are identified, the data are returned to the laboratory for correction. Once data have been reviewed by the USAEC Chemistry Branch, the determination is made on a lot by lot basis whether the data are acceptable. The data that are accepted are then elevated to Level 3. Level 3 data are available to USAEC personnel and contractors by modem to a main frame computer.

2.6 FIELD QUALITY CONTROL SAMPLES

QC samples collected in the field include matrix spike (MS) samples, matrix spike duplicate (MSD) samples, field duplicates, rinsate blanks, and trip blanks.

MS/MSD samples were collected at a rate of one set per twenty samples. Site investigators designated the samples to be used as MS/MSDs. This was noted on the chain of custody forms submitted to the laboratory. The samples designated as MS/MSDs were spiked at the laboratory with the analytes requested for the regular field samples to assess what matrix effects may have occurred on the target analytes. MS/MSD results are presented in Appendix C.

Field duplicate samples were also collected at the rate of one per 20 samples. They were submitted to the laboratory to be analyzed for the same analytes as the corresponding field samples. The purpose of submitting these samples was to assess sample collection and laboratory analytical precision for the sampled media. Duplicate sample results are presented in Appendix C.

Rinsate blanks were collected and analyzed for inorganics, VOCs, SVOCs, pesticides/PCBs and other parameters including alkalinity, total hardness, TPHC, TOC and TSS. They were collected by rinsing sampling apparatus with "chemically pure" deionized water and collecting the water in sample containers. Analysis of rinsates provided information to evaluate the potential for sample contamination during sample collection. The results also determined whether decontamination of the sampling equipment was thorough. Rinsate blanks were collected at a rate of one per 20 samples per decontamination event.

A trip blank accompanied samples that were analyzed for VOCs to determine if cross contamination occurred during the shipment and handling of field samples.

2.7 EVALUATION OF POTENTIAL FIELD OR LABORATORY INTRODUCED CONTAMINATION

Analytical laboratory data reported during lower Cold Spring Brook soil sampling were evaluated for possible laboratory or sampling-related contamination. This evaluation did not include validation by USEPA guidelines. Sample results were not adjusted for reported analytes that were also detected at similar concentrations in blanks associated with that sample. Action levels were not established and the 10X rule was not applied to compounds considered to be common laboratory contaminants by the USEPA. These contaminants included the VOCs acetone, methylene chloride, and toluene, and SVOC phthalate esters (e.g., bis(2-ethylhexyl) phthalate). Action levels for other analytes using the 5X rule application were not established. Analytes that would have been below these action levels were not removed from the data, as they would have been in the USEPA data validation process.

General trends relating to blank and sample contamination were examined. A comparison of blank data with results from the entire data set is presented in Appendix C. Assessments were made based on analyte detection in blanks, the frequency of this detection, and the concentrations of these analytes.

2.8 CHEMICAL DATA MANAGEMENT

Chemical data were managed by ABB-ES' Sample Management System and the USAEC IRDMIS. These systems are described in the following subsections.

2.8.1 Sample Tracking System

ABB-ES used its computerized Sample Management System to track environmental samples from field collection to shipment to the laboratory. ABB-ES also tracked the status of analyses and reporting by the laboratory.

Each day, the field sampling teams carried computer-generated sample labels into the field which stated the sample control number, sample identification, size and type of container, sample preservation summary, analysis method code, and sample medium. The labels also provided space for sampling date and time and the collector's initials to be added at the time of collection.

Samples were temporarily stored in the ABB-ES field office refrigerator. They were logged-in on a computer, along with the collector's initials and the sampling date and time. The system would then indicate the sample status as "COLLECTION IN PROGRESS."

When the samples were prepared for shipment, they were "RELEASED" by the sample management system. Upon request, the system printed an Analysis Request Form and a chain of custody form, which were signed and included with the samples in the shipment. The system would then indicate the sample status as "SENT TO LAB."

This system substantially reduced the time required for preparation of sample tracking documentation, and provided an automated record of sample status.

After shipment of samples to the laboratory, ABB-ES continued to track and record the status of the samples, including the date analyzed (to establish actual holding times), the date a transfer file was established by ESE, and the date the data were sent to IRDMIS.

2.8.2 Installation Restoration Data Management Information System

IRDMIS is an integrated system for collection, validation, storage, retrieval, and presentation of data of the USAEC Installation Restoration and Base Closure Program. The system uses personal computers, a UNIX-based minicomputer, printers, plotters, and communications networks to link these devices.

For each sample lot, ABB-ES developed a "provisional" map file for the sample locations, which was entered into IRDMIS by Potomac Research Institute (PRI), the USAEC data management contractor.

Following analysis of the sample lot, ESE created chemical files using data codes provided by ABB-ES, and entered the analytical results (Level 1) on a personal computer in accordance with the User's Manual (PRI, 1993). For each sample lot, a hard copy was printed, reviewed, and checked by the ESE Laboratory Program Manager. ESE created a transfer file from accepted records that was then sent to ABB-ES (Level 2). ABB-ES performed a group and record check and sent approved records in a chemical transfer file to PRI. PRI checked the data and, if accepted, entered it into the IRDMIS minicomputer (Level 3). Level 3 chemical data are used for evaluating site conditions and are the data used in reports and decision-making.

2.9 SURVEY OF SAMPLING LOCATIONS

The horizontal location of sediment and surface soil sample points was surveyed by a Massachusetts licensed land surveyor following completion of field sampling activities. In addition, the surveyor surveyed the location of Storm Drain System outfalls and measured the ground surface elevation at surface soil sample locations. Horizontal locations are referenced to the Massachusetts Planar

Coordinate System. Elevations are referenced to the National Vertical Geodetic Datum of 1929. Appendix D presents the survey data.

2.10 INVESTIGATION DERIVED WASTE

Wastes generated during the SI in association with sampling and decontamination were handled in accordance with Section 4 of the POP (ABB-ES, 1993e).

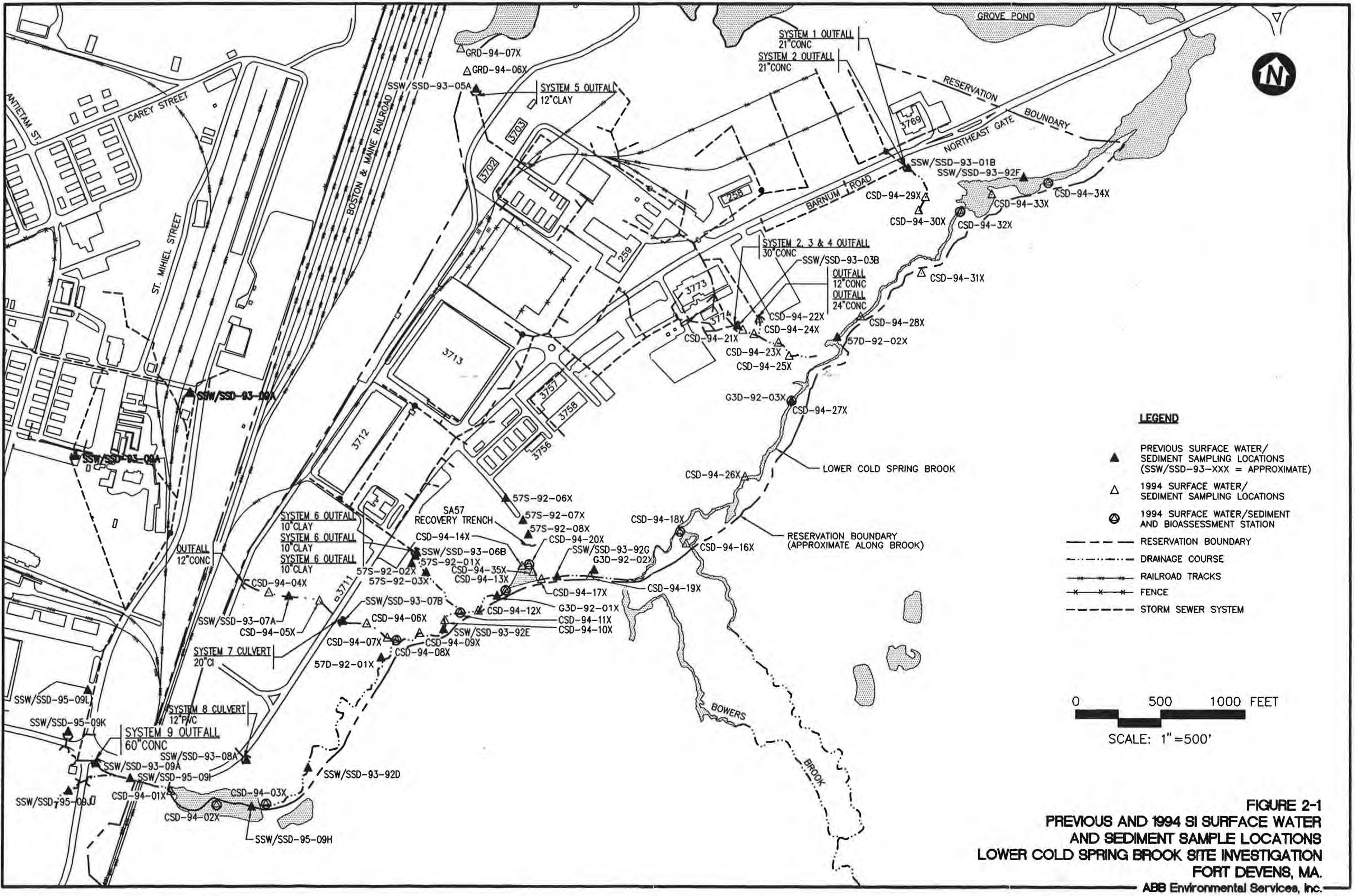


FIGURE 2-1
PREVIOUS AND 1994 SI SURFACE WATER
AND SEDIMENT SAMPLE LOCATIONS
LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ABB Environmental Services, Inc.

TABLE 2-1
BROOK AND DRAINAGE-WAY SAMPLE LOCATIONS

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

BROOK SURFACE WATER/SEDIMENT	DRAINAGE-WAY SURFACE WATER/SEDIMENT
CSW/CSD-94-01X	CSW/CSD-94-04X
CSW/CSD-94-02X	CSW/CSD-94-05X
CSW/CSD-94-03X	CSW/CSD-94-06X
CSW/CSD-94-08X	CSW/CSD-94-07X
CSW/CSD-94-09X	CSW/CSD-94-21X
CSW/CSD-94-10X	CSD-94-22X
CSW/CSD-94-11X	CSD-94-23X
CSW/CSD-94-12X	CSW/CSD-94-24X
CSW/CSW-94-13X	CSD-94-25X
CSW/CSD-94-14X	CSD-94-29X
CSW/CSD-94-16X	CSW/CSD-94-30X
CSW/CSD-94-17X	
CSW/CSD-94-18X	
CSW/CSD-94-19X	
CSW/CSD-94-20X	
CSW/CSD-94-26X	
CSW/CSD-94-27X	
CSW/CSD-94-28X	
CSW/CSD-94-31X	
CSW/CSD-94-32X	
CSD/CSW-94-33X	
CSW/CSD-94-34X	
CSW/CSD-94-35X	

3.0 PHYSICAL CHARACTERISTICS

This section describes the physical characteristics at Fort Devens and lower Cold Spring Brook. Discussions of the climate, vegetation, ecology, physiography, soils, surficial and bedrock geology, and regional hydrogeology are included.

3.1 FORT DEVENS

Fort Devens is located in the towns of Ayer and Shirley (Middlesex County) and Harvard and Lancaster (Worcester County), approximately 35 miles northwest of Boston, Massachusetts. It lies within the Ayer, Shirley, and Clinton map quadrangles (7½-minute series). The installation occupies approximately 9,260 acres and is divided into the North Post, the Main Post, and the South Post (see Figure 1-1).

More than 6,000 acres at Fort Devens are used for training and military maneuvers, and more than 3,000 acres are developed for housing, buildings, and other facilities; the installation has been reported as the largest undeveloped land holding under a single owner in north-central Massachusetts (USFWS, 1992).

The South Post is located south of Massachusetts Route 2 and is largely undeveloped. The Main Post and North Post primarily contain developed lands, including recreational areas (e.g., a golf course and Mirror Lake), training areas, and an airfield. Group 1A sites are located on the main post.

The following subsections describe the history and physical setting of Fort Devens.

3.1.1 Fort Devens History

Camp Devens was created as a temporary cantonment in 1917 for training soldiers from the New England area. It was named after Charles Devens - a Massachusetts Brevet Major General in the Union Army during the Civil War who later became Attorney General under President Rutherford Hayes. Camp Devens, served as a reception center for selectees, as a training facility, and, at the end of World War I, as a demobilization center (Marcoa Publishing Inc., 1990). At Camp Devens the 1918 outbreak of Spanish influenza infected 14,000 people, killed 800, and caused the installation to be quarantined (McMaster et al., 1982). Peak military strength during World War I was 38,000. After World War II, Fort Devens became an installation of the U.S. Army Field Forces, CONARC in 1962 and the U.S. Army Forces Command (FORSCOM) in 1973 (Biang et al., 1992).

In 1921, Camp Devens was placed in caretaker status. During summers from 1922 to 1931, it was used as a training camp for National Guard troops, Reserve units, Reserve Officer Training Corps (ROTC) cadets, and the Civilian Military Training Corps (CMTC). In 1929, Dr. Robert Goddard used Camp Devens to test his early liquid-fuel rockets, and there is a monument to him on Sheridan Road near Jackson Gate (Fort Devens Dispatch, 1992).

In 1931, troops were again garrisoned at Camp Devens. It was declared a permanent installation, and in 1932 it was formally dedicated as Fort Devens. During the 1930s, there was a limited building program, and beautification projects were conducted by the Works Progress Administration (WPA) and Civilian Conservation Corps (CCC).

In 1940, Fort Devens became a reception center for New England draftees, and was expanded to more than 10,000 acres. Approximately 1,200 wooden buildings were constructed, and two 1,200-bed hospitals were built. In 1941, the Army Airfield was constructed by the WPA in of 113 days (Fort Devens Dispatch, 1992). In 1942, the Whittemore Service Command Base Shop for motor vehicle repair (Building 3713) was built, and at the time it was known as the largest garage in the world (U.S. Army, 1979). The installation's current wastewater treatment plant was also constructed in 1942 (Biang et al., 1992).

During World War II, more than 614,000 inductees were processed. Fort Devens' population reached a peak of 65,000. Three Army divisions and the Fourth Women's Army Corps trained at Fort Devens, and it was the location of the Army's Chaplain School, the Cook & Baker School, and a basic training center for Army nurses. A prisoner-of-war camp for 5,000 German and Italian soldiers was operated from 1944 to 1946. At the end of the war, Fort Devens again became a demobilization center, and in 1946 it reverted to caretaker status.

Fort Devens was reactivated in July 1948 and again became a reception center during the Korean Conflict. It has been an active Army facility since that time.

Currently, the mission at Fort Devens is to command and train its assigned duty units; operate the South Boston Support Activity in Boston; the Sudbury Training Annex and the Hingham USAR Annex; and to support the 10th Special Forces Group (A), the U.S. Army Intelligence School, Fort Devens; the U.S. Army Reserves; Massachusetts Army National Guard; and ROTC Training Programs. No major industrial operations occur at Fort Devens, although several small-scale industrial operations are performed under (1) the Directorate of Plans, Training, and Security; (2) the Directorate of Logistics; and (3) the Directorate of Engineering and Housing. The major waste-producing operations by these groups are photographic processing and maintenance of vehicles, aircraft, and small engines. Past artillery fire, mortar fire, and waste explosive disposal at Fort Devens are potential sources for explosives contamination (USAEC, 1993).

Under Public Law 101-510, the Base Realignment and Closure (BRAC) Act of 1990, Fort Devens has been identified for closure by July 1997. Four thousand six hundred acres are to be retained to establish a Reserve Component enclave and regional training center.

3.1.2 Fort Devens Physical Setting

The climate, vegetation, ecology, physiography, soils, surficial and bedrock geology, and regional hydrogeology of Fort Devens are described in the subsections that follow.

3.1.2.1 Climate. The climate of Fort Devens is typical of the northeastern United States, with long cold winters and short hot summers. Climatological data were reported for Fort Devens by the U.S. Department of the Army (1979), based in part on a 16-year record from Moore Army Airfield (MAAF).

The mean daily minimum temperature in the coldest months (January and February) is 17 degrees Fahrenheit (°F), and the mean daily maximum temperature in the hottest month (July) is 83°F. The average annual temperature is 58°F. There are normally 12 days per year when the temperature reaches or exceeds 90°F and 134 days when it falls to or below freezing.

The average annual rainfall is 39 inches. Mean monthly precipitation varies from a low of 2.3 inches (in June) to a high of 5.5 inches (in September). The average annual snowfall is 65 inches, and snowfall has been recorded in the months of September through May (falling most heavily from December through March).

Wind speed averages 5 miles per hour, ranging from the highest monthly average of 7 mph (March-April) to the lowest monthly average of 4 miles per hour (September).

Average daytime relative humidities range from 71 percent (January) to 91 percent (August), and average nighttime relative humidities range from 46 percent (April) to 60 percent (January).

3.1.2.2 Vegetation. The Main and North Posts at Fort Devens are characterized primarily by urban and developed cover types. Approximately 56 percent of that area is covered by developed lands, the golf course, the airfield, and the wastewater infiltration beds. Early successional forest cover types (primarily black cherry-aspen hardwoods) encompass approximately 2 percent of the area, mixed oak-red maple hardwoods approximately 20 percent, and white pine-hardwood mixes approximately 11 percent. The rest of the North and Main Posts are characterized by various coniferous species, shrub habitat, and herbaceous cover types.

Much of the South Post is undeveloped forested land. The area includes approximately 8 percent early successional forest (black cherry, red birch, grey birch, quaking aspen, red maple); 26 percent mixed oak hardwoods; and 9 percent coniferous forest (white pine, pitch pine, red pine). Four percent of the area comprises a mixed shrub community. The 200-acre Turner Drop Zone is maintained as a grassland that represents a "prairie" habitat. Vegetative cover in the large "impact area" of the central South Post has not been mapped in detail. It is dominated by fire-tolerant species such as pitch pine and scrub oak.

Extensive sandy glaciofluvial soils are found in the Nashua River Valley, particularly in the South and North Post areas of Fort Devens. Extensive accumulations of these soils are unusual in Massachusetts outside of Cape Cod and adjacent areas of southeastern Massachusetts, and they account for some of the floral and faunal diversity at the installation.

3.1.2.3 Ecology. Fort Devens encompasses numerous terrestrial, wetland, and aquatic habitats in various successional stages. Floral and faunal diversity is strengthened by the installation's close proximity to the Nashua River; the amount, distribution, and nature of wetlands; and the undeveloped state and size of the South Post (USFWS, 1992). Much of Fort Devens was formerly agricultural land and included pastures, woodlots, orchards, and cropped fields. Existing habitat types reflect this agrarian history, ranging from abandoned agricultural land to secondary growth forested regions. Fort Devens is generally reverting back to a forested state.

There are 1,313 acres of wetlands at Fort Devens. The wetlands are primarily palustrine, although riverine and lacustrine types are also found. Forested palustrine floodplain wetlands associated with the Nashua River and its tributary Nonacoicus Brook are located on Fort Devens' Main and North Posts. These include 191 acres of flooded areas, emergent marsh, and shrub wetlands. Also present are 245 acres of isolated regions of palustrine wetlands and lacustrine systems. On the South Post, there are 877 acres of wetlands, consisting of deciduous forested wetlands, deciduous shrub swamps, emergent marsh, open lacustrine waters in ponds, and open riverine waters (USFWS, 1992).

Approximately half of Fort Devens' land area abuts the northern boundary of the Oxbow National Wildlife Refuge (NWR), a federal resource administered as part of the Great Meadows NWR (USFWS, 1992).

Fort Devens supports an abundance and diversity of wildlife. Identified taxa include 771 vascular plant species, 538 species of butterflies and moths, eight tiger beetle species, 30 vernal pool invertebrates, 15 amphibian species (six salamanders, two toads, seven frogs), 19 reptile species (seven turtles, 12 snakes), 152 bird species, and 42 mammal species. The status of fish populations in Fort Devens aquatic systems has not been fully defined (ABB-ES, 1993d).

Rare and endangered species at Fort Devens include the federally listed (endangered) bald eagle and peregrine falcon (both occasional transients); the state-listed (endangered) upland sandpiper, ovoid spike rush, and Houghton's flatsedge; the state-listed (threatened) Blanding's turtle, cattail sedge, pied-billed grebe, and northern harrier; and the state-listed (special concern) blue-spotted salamander, grasshopper sparrow, spotted turtle, wood turtle, water shrew, blackpoll warbler, American bittern, Cooper's hawk, sharp-shinned hawk, and Mystic Valley amphipod. Also state-listed as rare or endangered are three Lepidoptera (butterfly and moth) species identified at Fort Devens.

The Massachusetts Natural Heritage Program (MNHP) has developed Watch Lists of unprotected species that are uncommon or rare in Massachusetts. From the Watch Lists, 14 plant species, two amphibian species, and 15 bird species have been observed at Fort Devens.

Additional detail concerning the ecological characteristics of lower Cold Spring Brook can be found in Section 5.

3.1.2.4 Physiography. Fort Devens is in a transitional area between the coastal lowland and central upland regions of Massachusetts. All of the landforms are products of glacial erosion and deposition on a crystalline bedrock terrain. Glacial erosion was superimposed on ancient bedrock landforms that were developed by the erosional action of preglacial streams. Generally, what were bedrock hills and ridges before the onset of Pleistocene glaciation were only moderately modified by glacial action, and they remain bedrock hills and ridges today. Similarly, preglacial bedrock valleys are still bedrock valleys. In post-glacial time, streams have locally modified the surficial glacial landforms, but generally have not affected bedrock.

The predominant physiographic (and hydrologic) feature in the Fort Devens area is the Nashua River. It forms the eastern installation boundary on the South Post, where its valley varies from a relatively narrow channel (at Still River Gate), to an extensive floodplain with a meandering river course and numerous cutoff meanders (at Oxbow NWR). The Nashua River forms the western boundary of much of the Main Post, and there its valley is deep and comparatively steep-sided with extensive bedrock outcroppings on the eastern bank. The river flows through the North Post in a well-defined channel within a broad forested floodplain.

Terrain at Fort Devens falls generally into three types. The least common is bedrock terrain, where rocks that have been resistant to both glacial and fluvial erosion remain as topographic highs, sometimes thinly veneered by glacial deposits. Shepley's Hill on the Main Post is the most prominent example.

A similar, but more common terrain at Fort Devens consists of materials (tills) deposited directly by glaciers as they advanced through the area or as the ice masses wasted (melted). These landforms often conform to the shape of the underlying bedrock surface. They range from areas of comparatively low topographic relief (such as near Lake George Street on the Main Post) to elongated hills (drumlins) whose orientations reflect the direction of glacier movement (such as Whittemore Hill on the South Post).

The third type of terrain was formed by sediment accumulations in glacial-meltwater streams and lakes (glaciofluvial and glaciolacustrine deposits). This is the most common terrain at Fort Devens, comprising most of the North and South Posts and much of the Main Post. Its form bears little or no relationship to the shape of the underlying bedrock surface. This terrain includes extensive flat uplands such as the hills on which MAAF and the wastewater infiltration beds are located on the North Post. Those are large remnants of what was once a continuous surface that was later incised and divided by downcutting of the Nashua River. Another prominent glacial meltwater feature is the area around Cranberry Pond and H-Range on the South Post. This is classic kame-and-kettle topography formed by sand and gravel deposition against and over large isolated ice blocks, followed by melting of the ice and collapse of the sediments. The consistent elevations of the tops of these ice-contact deposits are an indication of the glacial-lake stage with which they are associated. Mirror Lake and Little Mirror Lake on the Main Post occupy another conspicuous kettle.

3.1.2.5 Soils. Fort Devens lies within Worcester County and Middlesex County in Massachusetts (see Figure 1-1). The soils of Worcester County have been mapped by the Soil Conservation Service (SCS) of the U.S. Department of Agriculture (USDA). Mapping of the soils of Middlesex County has not been completed. However, an interim report (USDA, 1991), field sheet #19 (USDA, 1989), and an unpublished general soil map (USDA, undated) are available.

Soil mapping units ("soil series") that occur together in intricate characteristic patterns in given geographic areas are grouped into soil "associations." Soils in the Worcester County portions of Fort Devens consist generally of three associations. Three associations also have been mapped in the Middlesex County portions of Fort Devens. Although the mapped associations are not entirely the same on both sides of the county line, the differences reflect differences in definition and the interim status of Middlesex County mapping. The general distributions of the soil associations are shown in Figure 3-1, and descriptions of the soil series in those associations are provided below.

WORCESTER COUNTY (USDA, 1985)

Winooski-Limerick-Saco Association:

Winooski Series. Very deep; moderately well drained; slopes 0 to 3 percent; occurs on floodplains; forms in silty alluvium.

Limerick Series. Very deep; poorly drained; slopes 0 to 3 percent; occurs on floodplains; forms in silty alluvium.

Saco Series. Very deep; very poorly drained; slopes 0 to 3 percent; occurs on floodplains; derived mainly from schist and gneiss.

Hinckley-Merrimac-Windsor Association:

Hinckley Series. Very deep; excessively drained; slopes 0 to 35 percent; occurs on stream terraces, eskers, kames, and outwash plains.

Merrimac Series. Very deep; excessively drained; slopes 0 to 25 percent; occurs on stream terraces, eskers, kames, and outwash plains.

Windsor Series. Very deep; moderately well drained; slopes 0 to 3 percent; occurs on floodplains.

Paxton-Woodbridge-Canton Association:

Paxton Series. Very deep; well drained; slopes 3 to 35 percent; occurs on glacial till uplands; formed in friable till overlying firm till.

Woodbridge Series. Very deep; moderately well drained; slopes 0 to 15 percent; occurs on glacial till uplands; formed in firm till.

Canton Series. Very deep; well drained; slopes 3 to 35 percent; occurs on glaciated uplands; formed in friable till derived mainly from gneiss and schist.

MIDDLESEX COUNTY (USDA, 1991)

Hinckley-Freetown-Windsor Association (This is a continuation of the Hinckley-Merrimac-Windsor Association mapped in Worcester County):

> Hinckley Series. Deep; excessively drained; nearly level to very steep; occurs on glacial outwash terraces, kames, and eskers; formed in gravelly and cobbley coarse-textured glacial outwash.
>
> Freetown Series. Deep; very poorly drained; nearly level, organic; occurs in depressions and on flat areas of uplands and glacial outwash plains.
>
> Windsor Series. Deep; excessively drained; nearly level to very steep; occurs on glacial outwash plains, terraces, deltas, and escarpments; formed in sandy glacial outwash.

Quonset-Carver Association:

> Quonset Series. Deep; excessively drained; nearly level to very steep; occurs on glacial outwash plains, terraces, eskers, and kames; formed in water-sorted sands derived principally from dark phyllite, shale, or slate.
>
> Carver Series. Deep; excessively drained; nearly level to steep; occurs on glacial outwash plains, terraces, and deltas; formed in coarse, sandy, water-sorted material.

Winooski-Limerick-Saco Association (This is a continuation of the same association mapped along the Nashua River floodplain in Worcester County).

3.1.2.6 Surficial Geology. Fort Devens lies in three topographic quadrangles: Ayer, Clinton, and Shirley. The surficial geology of Fort Devens has been mapped only in the Ayer quadrangle (Jahns, 1953) and Clinton quadrangle (Koteff, 1966); the Shirley quadrangle is unmapped.

Unconsolidated surficial deposits of glacial and postglacial origin comprise nearly all of the exposed geologic materials at Fort Devens. The glacial units consist of till, deltaic deposits of glacial Lake Nashua, and deposits of glacial meltwater streams.

The till ranges from unstratified gravel to silt, and it is characteristically bouldery. Jahns (1953) and Koteff (1966) recognize a deeper unit of dense, subglacial till, and an upper, looser material that is probably a slightly younger till of englacial or superglacial origin. Till is exposed in ground-moraine areas of the Main Post (such as in the area of Lake George Street) and on the South Post at and south of Whittemore Hill. It also underlies some of the water-laid deposits (Jahns, 1953). Till averages approximately 10 feet in thickness, but reaches 60 feet in drumlin areas (Koteff, 1966).

Most of the surficial glacial units in the Nashua Valley are associated with deposition in glacial Lake Nashua, which formed against the terminus of the Wisconsinan ice sheet as it retreated northward along the valley. Successively lower outlets were uncovered by the retreating glacier, and the lake level was correspondingly lowered. Koteff (1966) and Jahns (1953) recognize six lake levels (stages) in the Fort Devens area, distinguished generally by the elevations and distribution of their associated deposits. The stages are, in order of development: Clinton Stage; Pin Hill Stage; Old Mill Stage; Harvard Stage; Ayer Stage; and Groton Stage.

The glacial lake deposits consist chiefly of sand and gravelly sand. Coarser materials are found in topset beds of deltas built out into the lakes and in glacial streambeds graded to the lakes. Delta foreset beds are typically composed of medium to fine sand, silt, and clay. Lake-bottom deposits, which consist of fine sand, silt, and clay, are mostly covered by delta deposits and are seldom observed in glacial Lake Nashua deposits. One of the few known exposures of glacial lake-bottom sediments in the region is on the South Post near A- and C-Ranges. There, a section of more than 14 feet of laminated clay was mined for brick-making in the early part of this century (Alden, 1925, pp. 70-71). The general physical characteristics of glacial lake deposits are the same regardless of the particular lake stage in which the deposits accumulated (Koteff, 1966; Jahns, 1953). Although glaciofluvial and glaciolacustrine sediments are typically well stratified, correlations between borings are difficult because of laterally abrupt changes characteristic of these generally high-energy depositional environments.

Postglacial deposits consist mostly of river-terrace sands and gravels; fine alluvial sands and silts beneath modern floodplains; and muck, peat, silt, and sand in swampy areas.

Jahns (1953) also observed a widespread veneer of windblown sand and ventifacts above the glacial materials (and probably derived from them in the brief interval between lake drainage and the establishment of vegetative cover).

3.1.2.7 Bedrock Geology. Fort Devens is underlain by low-grade metasedimentary rocks, gneisses, and granites. The rocks range in age from Late Ordovician to Early Devonian (approximately 450 million to 370 million years old). The installation is situated approximately 2 miles west of the Clinton-Newbury-Bloody Bluff fault zone, which developed when the ancestral European continental plate collided with and underthrust the ancestral North American plate. The continents reseparated in the Mesozoic to form the modern Atlantic Ocean. Fort Devens is located on the very eastern edge of the ancestral North American continental plate. A piece of the ancestral European continent (areas now east of the Bloody Bluff fault) broke off and remained attached to North America.
Preliminary bedrock maps (at scale 2,000 feet/inch) are available for the Clinton quadrangle (Peck, 1975 and 1976) and Shirley quadrangle (Russell and Allmendinger, 1975; Robinson, 1978). Bedrock information for the Ayer quadrangle is from the Massachusetts state bedrock map (at a regional scale of 4 miles/inch) (Zen, 1983) and in associated references (Robinson and Goldsmith, 1991; Wones and Goldsmith, 1991). Among these sources, there is some disagreement about unit names and stratigraphic sequence; however, there is general agreement about the distribution of rock types.

In contrast to the high metamorphic grade and highly sheared rocks of the Clinton-Newbury zone, the rocks in the Fort Devens area are low grade metamorphics (generally below the biotite isograd) and typically exhibit less brittle deformation. Major faults have been mapped, however, including the Wekepeke fault exposed west of Fort Devens (in an outcrop 0.25 mile west of the old Howard Johnson rest stop on Route 2).

Figure 3-2 is a generalized summary of the bedrock geology of Fort Devens. It is compiled from Peck (1975), Robinson (1978), Russell and Allmendinger (1975), and Zen (1983), and it adopts the nomenclature of Zen (1983). Because of limited bedrock exposures, the locations of mapped contacts are considered approximate, and the mapped faults are inferred. Rock units strike generally northward to northeastward, but vary locally. The bedrock units underlying Fort Devens are as follows:

DSw **WORCESTER FORMATION** (Lower Devonian and Silurian) Carbonaceous slate and phyllite, with minor metagraywacke to the west (Zen, 1983; Peck, 1975). Bedding is typically obscure because of a lack of compositional differences. It is relatively resistant to erosion and forms locally prominent outcrops. The abandoned Shaker slate quarry on the South Post is in rocks of the Worcester Formation. The unit corresponds to the "DSgs" and "DSs" units of Peck (1975) and the "e3" unit of Russell and Allmendinger (1975).

So **OAKDALE FORMATION** (Silurian) Metasiltstone and phyllite. It is fine-grained and consists of quartz and minor feldspar and ankerite, and it is commonly deformed by kink banding (Zen, 1983; Peck, 1975; Russell and Allmendinger, 1975). In outcrop it has alternating layers of brown siltstone and greenish phyllite. The Oakdale Formation crops out most visibly on Route 2 just east of the Jackson Gate exit. It corresponds to the "DSsp" unit of Peck (1975), the "e2" unit of Russell and Allmendinger (1975), and "ms" unit of Robinson (1978).

Sb **BERWICK FORMATION** (Silurian) Thin- to thick-bedded metamorphosed calcareous metasiltstone, biotitic metasiltstone, and fine-grained metasandstone, interbedded with quartz-muscovite-garnet schist and feldspathic quartzite (Zen, 1983; Robinson and Goldsmith, 1991). In areas northwest of Fort Devens, cataclastic zones have been observed (Robinson, 1978).

Dcgr **CHELMSFORD GRANITE** (Lower Devonian) Light-colored and gneissic, even and medium grained, quartz-microcline-plagioclase-muscovite-biotite, pervasive ductile deformation visible in elongate quartz grains aligned parallel to mica. It intrudes the Berwick Formation and Ayer granite (Wones and Goldsmith, 1991).

AYER GRANITE

Sacgr **Clinton facies** (Lower Silurian) Coarse-grained, porphyritic, foliated biotite granite with a nonporphyritic border phase; it intrudes the Oakdale and Berwick Formations and possibly the Devens-Long Pond Facies (Zen, 1983; Wones and Goldsmith, 1991).

SOad **Devens-Long Pond facies** (Upper Ordovician and Lower Silurian) Gneissic, equigranular to porphyoblastic biotite granite and granodiorite. Its contact relationship with the Clinton facies is unknown (Wones and Goldsmith, 1991). Observations of mapped exposures of this unit on Fort Devens indicate that it may not be intrusive.

Bedrock is typically unweathered to only slightly weathered at Fort Devens. Glaciers stripped away virtually all of the preglacially weathered materials, and there has been insufficient time for chemical weathering of rocks in the comparatively brief geologic interval since glacial retreat.

3.1.2.8 Regional Hydrogeology. Fort Devens is in the Nashua River drainage basin, and the Nashua River is the eventual discharge locus for all surface water and groundwater flow at the installation.

The water of the Nashua River has been assigned to Class B under Commonwealth of Massachusetts regulations. Class B surface water is "designated for the uses of protection and propagation of fish, other aquatic life and wildlife, and for primary and secondary contact recreation" (314 CMR 4.03).

The principal tributaries of the north-flowing Nashua River at Fort Devens are Nonacoicus Brook and Walker Brook on the North Post; Cold Spring Brook (which is a tributary of Nonacoicus Brook) on the Main Post; and Spectacle Brook and Ponakin Brook (tributaries of the North Nashua River), Slate Rock Brook, and New Cranberry Pond Brook on the South Post. There are two ponds on Fort Devens' South Post that are called Cranberry Pond. For the purpose of this report, the isolated kettle pond located east of H-Range is referred to as Cranberry Pond, and the pond impounded in the 1970s, 0.5-mile west of the Still River gate, is referred to as New Cranberry Pond.

Glacial meltwater deposits constitute the primary aquifer at Fort Devens. In aquifer tests performed as part of the Groups 2 and 7 SI (ABB-ES, 1993b), measured hydraulic conductivities in meltwater deposits were comparatively high - typically $1\text{x}10^{-3}$ to $1\text{x}10^{-2}$ centimeters per second (cm/sec). In till and in clayey lake-bottom sediments, measured hydraulic conductivities were lower and ranged generally from $1\text{x}10^{-6}$ to $1\text{x}10^{-4}$ cm/sec. Groundwater also occurs in the underlying bedrock; however, flow is limited because the rocks have very little primary porosity and water moves primarily in fractures and dissolution voids.

Groundwater in the surficial aquifer at Fort Devens has been assigned to Class I under Commonwealth of Massachusetts regulations. Class I consists of groundwaters that are "found in the saturated zone of unconsolidated deposits or consolidated rock and bedrock and are designated as a source of potable water supply" (314 CMR 6.03). The transmissivity of an aquifer is the product of its hydraulic conductivity and saturated thickness, and as such it is a good measure of groundwater availability. Figure 3-3 shows aquifer transmissivities at Fort Devens, based on the regional work of Brackley and Hansen (1977). Transmissivities in the meltwater deposits range from 10 square feet per day (ft^2/day) to more than 4,000 ft^2/day. Aquifer transmissivities between 10 and 1,350 ft^2/day correspond to potential well yields generally between 10 and 100 gallons per minute (gpm); transmissivities from 1,350 to 4,000 ft^2/day typically yield from 100 to 300 gpm; and where transmissivities exceed 4,000 ft^2/day, well yields greater than 300 gpm can be expected. (Most domestic wells in the area are drilled 100 to 200 feet into bedrock and yield less than 10 gpm. Higher yields are associated with deeper bedrock wells.)

In Figure 3-3, the zones of highest transmissivity are found in areas of thick glacial meltwater deposits on the North and Main Posts, and these encompass the Sheboken, Patton, and McPherson production wells and the largely inactive Grove Pond wellfield. The zones of lowest transmissivity are associated with exposed till and bedrock and are located on the Main Post surrounding Shepley's Hill and between Jackson Gate and the parade ground, and on the South Post at Whittemore Hill and isolated areas to the north and west.

A regional study of water resources in the Nashua River basin was reported by Brackley and Hansen (1977). A digital model of groundwater flow at Fort Devens is available in a report by Engineering Technologies Associates, Inc. (1995).

According to Engineering Technologies Associates, Inc. (1995), in the absence of pumping or other disturbances, groundwater recharge occurs in upland areas (e.g., the high ground on the Main Post between Queenstown, Givry, and Lake George Streets, and on the South Post the area around Whittemore Hill). The groundwater flows generally from the topographic highs to topographic lows. It discharges in wetlands, ponds, streams, and directly into the Nashua River. Groundwater discharge maintains the dry-weather flow of the rivers and streams.

3.2 LOWER COLD SPRING BROOK

Cold Spring Brook originates in the central part of the Main Post at Fort Devens. Its headwaters are formed by runoff and groundwater discharge in the vicinity of the magazine area and the Cold Spring Brook landfill. Further downstream, it flows north through woodlands and wetlands and passes beneath the B&MRR right-of-way at Barnum Road. From there, the brook collects runoff from the industrial area along Barnum Road as it flows northeast off Fort Devens property (see Figure 1-2). The brook ultimately discharges to Grove Pond. For the purpose of this SI, lower Cold Spring Brook is considered to be the portion of the brook that is located southeast of Barnum Road.

3.2.1 Lower Cold Spring Brook Geology

The following subsections describe the surficial and bedrock geology of the lower Cold Spring Brook area.

3.2.1.1 Surficial Geology. Lower Cold Spring Brook lies within the Ayer topographic quadrangle. The surficial geology of the Ayer quadrangle was mapped in 1941 by Jahns (Jahns, 1953). Soils in the Barnum Road Area are part of the Hinckley-Merrimack (Freetown)-Windsor Association and are associated with deposition in glacial Lake Nashua, which formed against the terminus of the Wisconsinan ice sheet. Soils in this association are characterized as being very deep, moderately well to excessively drained, and having slopes of 0 to 35 percent.

Mapped surficial units in the Barnum Road area consist of sands and pebble- to boulder-gravels of glacial streams, and muck and peat swamp deposits (postglacial) near Cold Spring Brook. Till is known to discontinuously underlie some of the water-laid deposits. The till locally ranges from unstratified gravel to silt, its consistency varies from loose to compact, and it is characteristically bouldery (Jahns, 1953).

Grain size distribution analyses were run on surface soil samples collected from near the edge of the Cold Spring Brook swamp during the 1993 SI at SA 57.

Analyses indicate that the soils may be fill or reworked glacial outwash. Soil types range from well graded sand to silty sand, with fines ranging from 1.6 to 20.2 percent and gravel from 0.7 to 37.9 percent. Grain size distribution analyses were also run on two sediment samples from Cold Spring Brook and found to be indicative of a sandy silt and a silty sand.

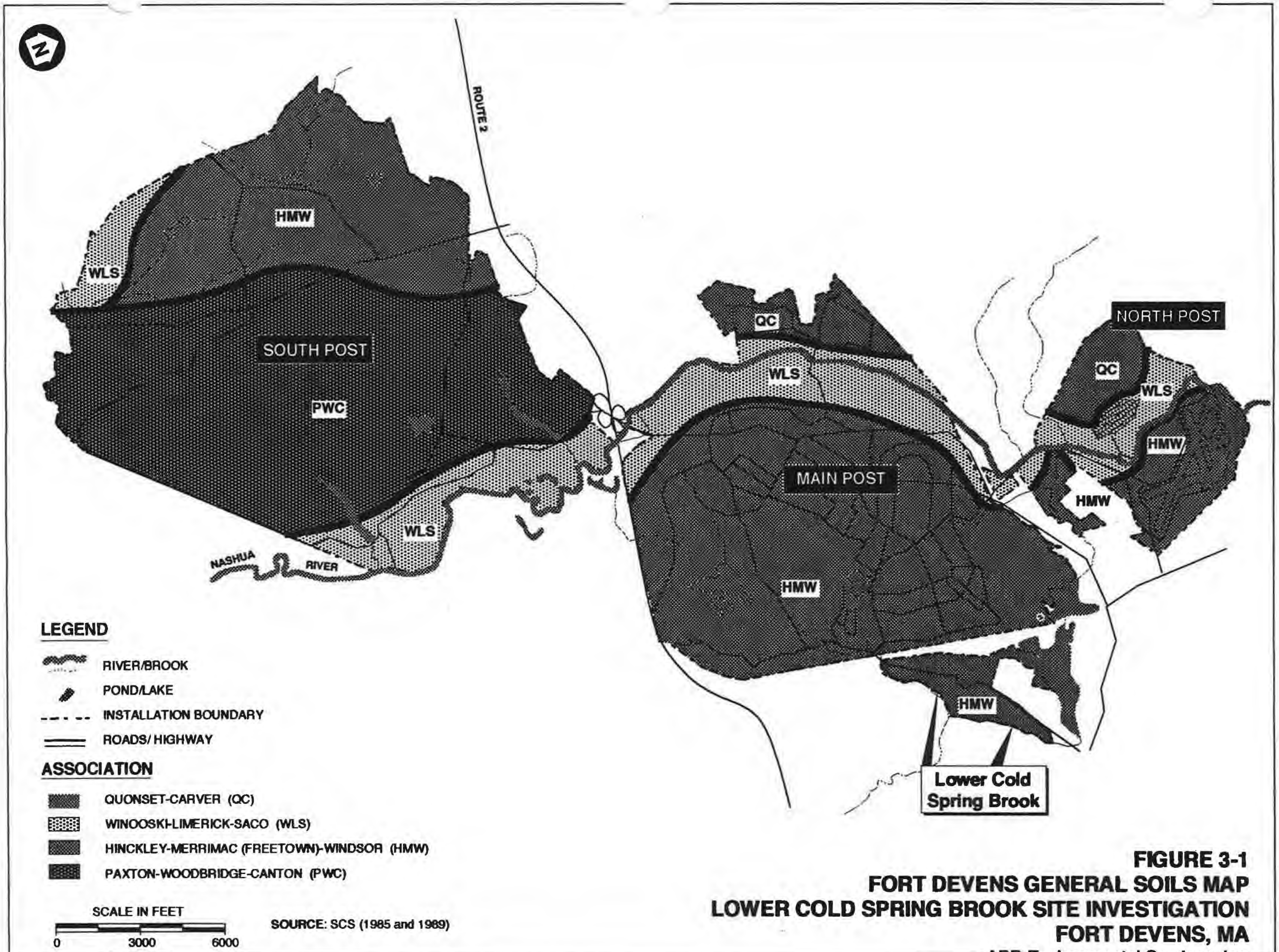
Grain size distribution analyses run on sediment samples for the 1995 Lower Cold Spring Brook SI revealed soil types ranging from well-graded sand to silt/clay. Results for specific locations are detailed in Section 4.0. Grain size distribution reports are provided in Appendix A.

3.2.1.2 Bedrock Geology. Bedrock is not exposed at or near lower Cold Spring Brook and has not been encountered during site investigations. Bedrock in this portion of the installation has been mapped as the generally northeast-striking Berwick Formation (Silurian), consisting of calcareous and biotitic metasiltstone and fine-grained metasandstone, interbedded with small amounts of quartz-muscovite-garnet schist and feldspathic quartzite.

3.2.2 Lower Cold Spring Brook Area Hydrogeology

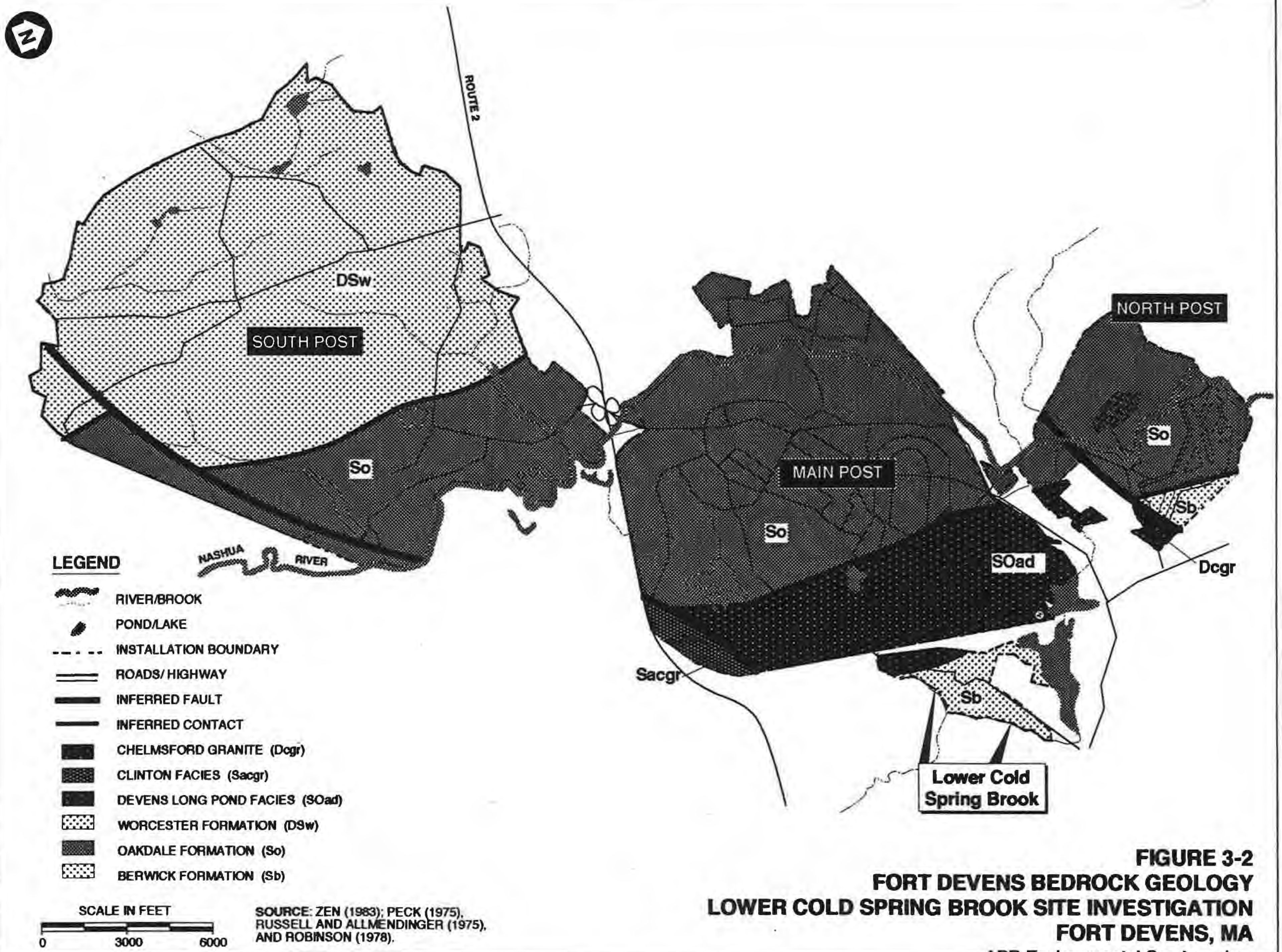
No monitoring wells were installed during the SI for lower Cold Spring Brook. However, monitoring wells from Groups 3, which is located along the Barnum Road, show that groundwater flows generally southeastward, eastward and northeastward from the Building 3713 area towards Cold Spring Brook. Water in Cold Spring Brook flows into Grove Pond, Plow Shop Pond, Nonacoicus Brook, and the Nashua River.

As previously discussed under Regional Hydrogeology, the surficial aquifer at Fort Devens has been assigned to Class I under Commonwealth of Massachusetts regulations (314 CMR 6.03). Based on a report by Camp Dresser & McKee (CDM), the area between Barnum Road and Cold Spring Brook also falls within the Zone II area of influence of the Town of Ayer water supply wells located along the south side of Grove Pond (CDM, 1993). The Zone II area is defined in the report as the conceptual zone of contribution to the wells under a specific set of conditions which simulates the most severe pumping and recharge conditions that can be realistically anticipated.



SOURCE: SCS (1985 and 1989)

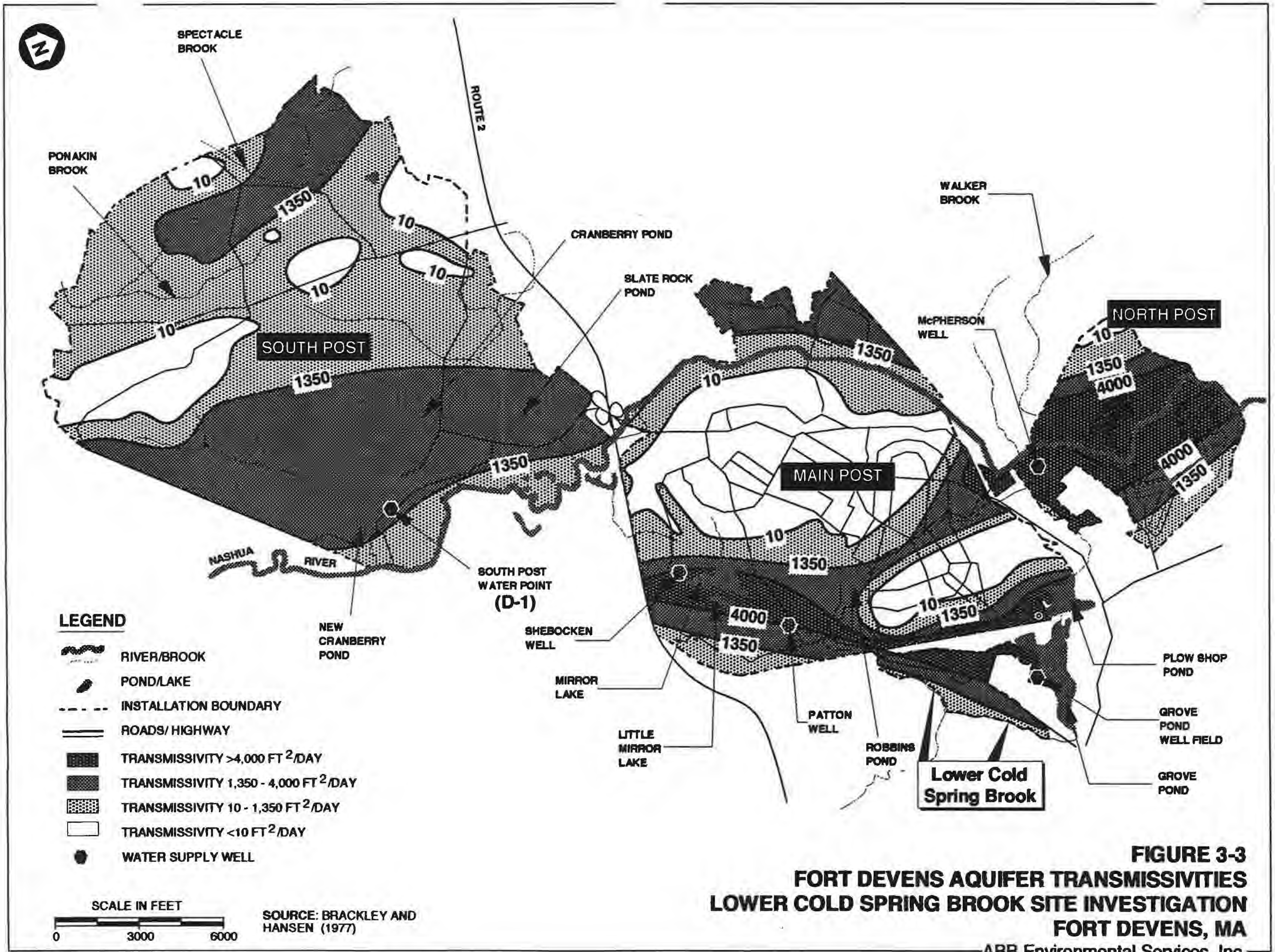
FIGURE 3-1
FORT DEVENS GENERAL SOILS MAP
LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA
ABB Environmental Services, Inc.



SOURCE: ZEN (1983); PECK (1975), RUSSELL AND ALLMENDINGER (1975), AND ROBINSON (1978).

FIGURE 3-2
FORT DEVENS BEDROCK GEOLOGY
LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ABB Environmental Services, Inc.



SOURCE: BRACKLEY AND HANSEN (1977)

FIGURE 3-3
FORT DEVENS AQUIFER TRANSMISSIVITIES
LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA
ABB Environmental Services, Inc.

4.0 PRESENCE AND DISTRIBUTION OF CONTAMINATION

Analytical data used in this contamination assessment include data for the surface water and sediment samples collected from the vicinity of lower Cold Spring Brook during the 1994 SI, and surface water and sediment samples collected by A.D. Little, Inc. in 1995 in the vicinity of Storm Drain System No. 9.

This data assessment also considers the analytical results from the 1992 Group 3 SA SI (ABB-ES, 1993a) and the 1993 SA 57 SI (ABB-ES, 1993b) which were previous investigations performed in the vicinity of lower Cold Spring Brook. Included are analytical results for three sediment samples collected from the ditch in Area 1 of SA 57, along with analytical results from six sediment samples collected from lower Cold Spring Brook.

This contamination assessment also considers the analytical results for sediment samples collected from 13 locations during the AREE 70 Evaluation (A.D. Little, 1994a, 1994b), a previous investigation that included areas along lower Cold Spring Brook (see Figure 1-3).

The data summary does not evaluate analytical results for surface water collected during the 1992 Group 3 SA SI, the 1993 SA 57 SI, or the AREE 70 evaluation because of the potential for surface water quality in lower Cold Spring Brook to vary both seasonally and over longer time periods. The analytical results for surface water collected during moderate flow conditions in lower Cold Spring Brook in the fall of 1994 are considered more representative of current surface water quality. Samples collected during the above programs were analyzed for the parameters summarized in Table 4-1.

4.1 SEDIMENT LABORATORY RESULTS

The following subsections summarize the results of laboratory analyses of sediment. To better assess the affects of each potential source area on lower Cold Spring Brook, the tables and supporting text in this subsection are organized so that analytical results from sample locations in each potential source area are presented with analytical results from selected sample locations in lower Cold Spring Brook. Sample locations in the brook were selected to represent conditions upstream and downstream of the confluence with runoff from each potential source area. Analytical results from the upstream sample location(s) represent "background" conditions relative to the point of confluence and analytical results from the downstream locations represent potentially "affected" conditions. Analytical results associated with Storm Drain System No. 5, which discharges to Grove Pond, are presented in a separate table.

4.1.1 Storm Drain Systems No. 1/2

Sample locations in the potential source area, or "ditch", associated with Storm Drain Systems No. 1/2 are SSD-93-01B, CSD-94-29X, and CSD-94-30X. The upstream sample location in lower Cold Spring Brook is CSD-94-31X, and the downstream sample locations are CSD-94-32X, CSD-94-33X, and CSD-94-34X. The sample locations are shown on Figure 4-1, and the analytical results are presented in Table 4-2.

4.1.1.1 Total Organic Carbon and Grain Size Distribution Results. TOC concentration in the ditch samples ranged from 30,000 to 58,400 micrograms per gram ($\mu g/g$), while TOC concentration in lower Cold Spring Brook ranged from 24,600 to 67,400 $\mu g/g$.

Grain size distribution analysis was not performed on the ditch samples, but was performed on two of the brook samples: CSD-94-32X and CSD-94-34X. The analyses indicate that the sediment at these locations is a silty fine sand.

4.1.1.2 Volatile Organic Compound Results. Although Table 4-2 does not present VOC results, the SSD-93-01B sample was analyzed for VOCs. No VOCs were detected.

4.1.1.3 Semivolatile Organic Compound and Total Petroleum Hydrocarbon Results. Fourteen SVOCs were detected in the SSD-93-01B sample. This sample also had the highest concentration of total SVOCs, at 181 $\mu g/g$. The highest individual SVOC concentrations reported in SSD-93-01B were 30 $\mu g/g$ each for fluoranthene, phenanthrene, and pyrene. The concentrations of all the SVOCs decrease significantly in the CSD-94-30X sample, the most downgradient of the ditch samples collected. Only fluoranthene, phenanthrene, and pyrene were detected in the CSD-94-30X sample, at a total concentration of 16 $\mu g/g$. Fluoranthene (2 $\mu g/g$) and pyrene (2 $\mu g/g$) were the only SVOCs detected in the

CSD-94-32X sample collected downstream of the confluence with lower Cold Spring Brook. A comparison of the analytical results for the upstream CSD-94-31X sample and the downstream CSD-94-32X and CSD-94-34X samples indicates a slight increase in the concentrations of fluoranthene and pyrene downstream of the confluence. The downstream CSD-94-33X sample is an exception to this observation, as no SVOCs were detected in this sample.

The concentration of TPHC in ditch samples ranged from 239 to 281 μg/g. Unlike SVOC concentrations in the ditch samples, TPHC concentrations in the ditch samples did not significantly decrease downgradient of the outfall at Systems No. 1/2. A moderate increase in TPHC concentration from upstream to downstream sample locations in lower Cold Spring Brook can be observed in Table 4-2.

4.1.1.4 Pesticide and Polychlorinated Biphenyl Results. Pesticide and PCB analyses were not performed on sediment samples collected from the ditch, but were performed on two samples collected from lower Cold Spring Brook downstream of Systems No. 1/2: CSD-94-32X and CSD-94-34X. Only 2,2-bis(para-chlorophenyl)-1,1-dichloroethane (DDD) was detected in these samples: 0.024 μg/g in the CSD-94-32X sample and 0.0537 μg/g in the CSD-94-34X sample.

4.1.1.5 Inorganic Results. Review of Table 4-2 does not reveal a correlation between inorganic concentrations in ditch samples and distance downgradient from the Systems No. 1/2 outfall. While the concentrations of some inorganics decreased with increasing distance from the outfall, the concentrations of other inorganics appeared to increase. Table 4-2 also indicates that inorganic concentrations in the lower Cold Spring Brook upstream sample (CSD-94-31X) are generally higher than inorganic concentrations in downstream samples CSD-94-32X through CSD-94-34X. Exceptions to this observation are concentrations of lead, manganese, and zinc which are higher in downstream sample CSD-94-32X, and arsenic, cobalt, copper, lead, selenium, and zinc which are higher in downstream sample CSD-94-34X. However, the overall distribution pattern for inorganics does not indicate that Systems No. 1/2 have been a source of inorganic contamination to lower Cold Spring Brook.

4.1.2 Storm Drain Systems No. 2/3/4

Sample locations in the potential source area, or "ditches," associated with Storm Drain Systems No. 2/3/4 are SSD-93-03B and CSD-94-21X through CSD-94-25X. The upstream sample locations in lower Cold Spring Brook are G3D-92-03X and CSD-94-27X. The downstream sample locations in lower Cold Spring Brook are 57D-92-02X and CSD-94-28X. The sample locations are shown on Figure 4-2, and the analytical results are presented in Table 4-3.

4.1.2.1 Total Organic Carbon and Grain Size Distribution Results. TOC concentrations in the ditch samples ranged from 4,490 to 154,000 $\mu g/g$, while TOC concentrations in lower Cold Spring Brook ranged from 19,700 to 219,000 $\mu g/g$. Scientific evidence suggests that high TOC concentrations in sediment typically indicate that the sediment has a greater potential to adsorb organic and inorganic contaminants. Therefore, localized areas of relatively high TOC concentration, such as at the CSD-94-24X and G3D-92-03X sample locations, could contribute to isolated "hot spots" of contamination.

Grain size distribution analysis was not performed on the ditch samples, but was performed on three of the brook samples: G3D-92-03X, CSD-94-27X, and 57D-92-02X. The analyses indicate that the sediment at these locations ranges from a silt to a silty sand.

4.1.2.2 Volatile Organic Compound Results. The SSD-93-03B sample was the only ditch sample analyzed for VOCs. Tetrachloroethylene was detected at 0.24 $\mu g/g$. The G3D-92-03X sample was the only brook sample analyzed for VOCs. No VOCs were detected in this sample.

4.1.2.3 Semivolatile Organic Compound and Total Petroleum Hydrocarbon Results. A significant disparity between SVOC concentrations reported for the two upstream samples, G3D-92-03X and CSD-94-27X, can be observed in Table 4-3. A potential contributing factor to the relatively high SVOC concentrations in G3D-92-03X is the high TOC concentration (219,000 $\mu g/g$) reported in that sample. Because the TOC concentration in G3D-92-03X is an order of magnitude higher than the other three brook samples, this sample was not considered when comparing SVOC and TPHC concentrations in upstream and downstream samples.

Fifteen SVOCs were detected in the SSD-93-03B sample. This sample also had the highest concentration of total SVOCs at 854 $\mu g/g$. The highest individual SVOC concentration reported in SSD-93-03B was 200 $\mu g/g$ of pyrene. Review of Table 4-3 indicates that the sediment at the SSD-93-03B sample location has more SVOCs at higher concentrations than sediment associated with the outfall at the CSD-94-22X location. The total concentration of SVOCs decreases to 106 $\mu g/g$ in the CSD-94-21X sample collected approximately 50 feet downgradient from the SSD-93-03B sample location. Only fluoranthene (20 $\mu g/g$), phenanthrene (7 $\mu g/g$), and pyrene (20 $\mu g/g$) were detected in the CSD-94-25X sample, the most downgradient of the ditch samples collected.

Thirteen SVOCs were detected in the 57D-92-02X sample collected downstream of the confluence with lower Cold Spring Brook. The total SVOC concentration, however, was only 7.2 $\mu g/g$. A comparison of the analytical results between upstream CSD-94-27X and downstream 57D-92-02X and CSD-94-28X samples shows little, if any, increase in the concentration of most SVOCs downstream of the confluence.

The concentration of TPHC in ditch samples ranged from 625 to 5,490 $\mu g/g$. The ditch sample location with the highest TPHC concentration was CSD-94-24X, located approximately 100 feet downgradient from the SSD-93-03B sample location. A review of Table 4-3 indicates a general correlation between TPHC and TOC concentrations.

A decrease in TPHC from upstream to downstream sample locations can also be observed in Table 4-3. Considering the relatively high TPHC concentration in ditch sediment, it appears that Systems No. 2/3/4 have no greater effect on lower Cold Spring Brook than do Storm Drain Systems No. 1/2, where relatively low TPHC concentration is present in ditch sediment.

4.1.2.4 Pesticide and Polychlorinated Biphenyl Results. Pesticide and PCB analyses were not performed on sediment samples collected from the ditches, but were performed on one sample collected from lower Cold Spring Brook: CSD-94-27X. No pesticides or PCBs were detected in this sample.

4.1.2.5 Inorganic Results. A review of Table 4-3 does not reveal a correlation between inorganic concentrations in ditch sediment and distance downgradient from the Systems No. 2/3/4 outfall. However, comparison of the trends in inorganic concentrations and TPHC concentration in the ditch samples indicates a correlation between the concentrations of inorganics and TPHC. The CSD-94-24X sample, which had the highest TPHC concentration of the ditch samples, also had the highest concentrations of inorganics. Table 4-3 also indicates that the inorganic concentrations in lower Cold Spring Brook upstream sample CSD-94-27X are generally higher than inorganic concentrations in the downstream CSD-94-28X sample. The data do not indicate that Storm Drain Systems No. 2/3/4 were a source of inorganic contamination to the brook.

4.1.3 Bowers Brook

The sample location in Bowers Brook is CSD-94-16X. The upstream sample location in lower Cold Spring Brook is G3D-92-02X and the downstream sample locations are CSD-94-18X and CSD-94-26X. The sample locations are shown on Figure 2-1, and the analytical results are presented in Table 4-4.

4.1.3.1 Total Organic Carbon and Grain Size Distribution Results. The TOC concentration in the Bowers Brook sample (CSD-94-16X) was 104,000 $\mu g/g$, while TOC concentration in lower Cold Spring Brook ranged from 18,500 to 166,000 $\mu g/g$.

Grain size distribution analysis was not performed on the sample from Bowers Brook, but was performed on two of the samples from lower Cold Spring Brook: G3D-92-02X and CSD-94-18X. The analyses indicate that the sediment at these locations is a silt/clay.

4.1.3.2 Volatile Organic Compound Results. The upstream G3D-92-02X sample was the only sample analyzed for VOCs. Acetone was detected in this sample at 0.49 $\mu g/g$. The source of this VOC is undetermined.

4.1.3.3 Semivolatile Organic Compound and Total Petroleum Hydrocarbon Results. Five SVOCs were detected in the CSD-94-16X sample. This sample had a total SVOC concentration of 7.7 $\mu g/g$. The highest individual SVOC concentration reported in CSD-94-16X was 2.6 $\mu g/g$ of pyrene. Pyrene (1 $\mu g/g$) was the only SVOC in the CSD-94-18X sample collected at the confluence with lower Cold Spring Brook and no SVOCs were detected in the CSD-94-26X sample located downstream of the confluence. A comparison of the analytical results for the upstream sample G3D-92-02X to the downstream samples

CSD-94-18X and CSD-94-26X indicates that Bowers Brook is contributing little, if any, contamination to lower Cold Spring Brook sediment. The decrease in SVOC concentrations from upstream to downstream sample locations can be observed in Table 4-4.

The concentration of TPHC in the CSD-94-16X sample was 192 μg/g. Similar to the trend in SVOC concentrations, the TPHC concentration from upstream to downstream sample locations in lower Cold Spring Brook appears to decrease.

4.1.3.4 Pesticide and Polychlorinated Biphenyl Results. Pesticide and PCB analyses were not performed on the CSD-94-16X sample, and were performed on only one sample collected from lower Cold Spring Brook: CSD-94-18X. Only DDD at 0.0498 μg/g was detected in this sample.

4.1.3.5 Inorganic Results. A review of Table 4-4 indicates that the inorganics concentrations in the upstream G3D-92-02X sample are generally higher than the inorganic concentrations in downstream samples CSD-94-18X and CSD-94-26X.

4.1.4 Study Area 57 Marsh

Sample locations in the potential source area, or "marsh", are CSD-94-20X, CSD-94-14X, CSD-94-35X, and CSD-94-17X. A duplicate sample was taken from the CSD-94-20X location. The upstream sample location in lower Cold Spring Brook is CSD-94-13X and the downstream sample locations are SSD-93-92G and CSD-94-19X. The sample locations are shown on Figure 4-3, and the analytical results are presented in Table 4-5.

4.1.4.1 Total Organic Carbon and Grain Size Distribution Results. The TOC concentrations in the marsh samples ranged from 56,700 to 266,000 μg/g, while TOC concentration in lower Cold Spring Brook ranged from 124,000 to 170,000 μg/g.

Grain size distribution analysis was performed on one marsh sample (CSD-94-20X) and one brook sample (CSD-94-13X). The analysis indicates that the sediment at both these locations is a silt/clay.

4.1.4.2 Volatile Organic Compound Results. All of the marsh samples were analyzed for VOCs. Three VOCs were detected in the CSD-94-20X and

CSD-94-35X samples: acetone, toluene, and trichlorofluoromethane. Trichlorofluoromethane was detected in all the marsh samples, with the highest concentration (0.35 μg/g) detected in the CSD-94-14X sample. Upstream and downstream brook samples were also analyzed for VOCs. Acetone, toluene, and trichlorofluoromethane were detected in the upstream CSD-94-13X and downstream CSD-94-19X samples. No VOCs were detected in the SSD-93-92G downstream sample. The highest total VOC concentration (0.76 μg/g) was detected in the CSD-94-19X sample, as was the highest individual VOC concentration: 0.66 μg/g of acetone. A comparison of the analytical results between the upstream CSD-94-13X and downstream CSD-94-19X samples indicates a negligible overall increase in the concentration of VOCs downstream of the confluence.

4.1.4.3 Semivolatile Organic Compound and Total Petroleum Hydrocarbon Results. Five SVOCs were detected in the CSD-94-17X sample. The total SVOC concentration in this sample was 9 μg/g and the highest individual SVOC concentrations were 3 μg/g of fluoranthene and 3 μg/g of pyrene. The CSD-94-20X sample was the only other marsh sample where SVOCs were detected; the SVOCs were fluoranthene at 1 μg/g, phenanthrene at 0.8 μg/g, and pyrene at 2 μg/g. Four SVOCs, benzo(a)anthracene, fluoranthene phenanthrene, and pyrene were detected in the downstream samples. Total SVOC concentration in the SSD-93-92G sample was 5.4 μg/g.

A relatively high total SVOC concentration of 16 μg/g was detected in the upstream sample CSD-94-13X, indicating a potential upstream source. This is consistent with the SVOC distribution pattern discussed for the segment of lower Cold Spring Brook associated with Storm Drain System No. 6. Samples from that brook segment show relatively high SVOC concentrations in brook sediments downstream of Storm Drain System No. 6 and upstream of sample location CSD-94-13X.

The concentration of TPHC in marsh samples ranged from 251 to 2,700 μg/g. The highest TPHC concentration was detected in the CSD-94-20X sample, the most upgradient sample location relative to Area 2 of SA 57. Relatively low TPHC concentrations were detected in the more downgradient CSD-94-35X and CSD-94-17X sample locations.

An increase in TPHC from the upstream CSD-94-13X sample location to the downstream SSD-93-92G sample location can be observed in Table 4-5. TPHC concentration in sediment further downstream (CSD-94-19X) appears to significantly decrease.

4.1.4.4 Pesticide and Polychlorinated Biphenyl Results. Pesticide and PCB analyses were performed on all the marsh samples. Six pesticides and the PCB Aroclor 1260 were detected in the CSD-94-20X sample and its duplicate. Total pesticide concentration in the slightly more contaminated duplicate sample was approximately 0.239 μg/g and Aroclor 1260 was detected at 0.309 μg/g. Pesticides and PCBs were not detected in the other marsh samples.

Three pesticides and Aroclor 1260 were detected in the upstream sample and two pesticides were detected in a downstream sample. The total pesticide concentration in the upstream CSD-94-13X sample was approximately 0.685 μg/g and Aroclor 1260 was detected at 0.0392 μg/g. The total pesticide concentration in the downstream SSD-93-92G sample was approximately 0.04 μg/g.

4.1.4.5 Inorganic Results. A review of Table 4-5 indicates that higher concentrations of inorganics tend to be in upstream sample CSD-94-13X and marsh samples CSD-94-14X, CSD-94-20X, and CSD-94-35X, and lower concentrations tend to be in downstream samples CSD-94-17X, SSD-93-92G, and CSD-94-19X. The lowest concentrations tend to be in the sample from CSD-94-19X, the most downstream of the samples listed in Table 4-5. This pattern of contaminant distribution is consistent with the pattern discussed in Subsection 4.1.5 for Storm Drain System No. 6. Samples collected in the vicinity of Storm Drain System No. 6 show increasing concentrations of inorganics in lower Cold Spring Brook as sample locations get closer to the SA 57 Marsh.

4.1.5 Storm Drain System No. 6

Sample locations in the potential source area, or "ditch", associated with Storm Drain System No. 6 are SSD-93-06B and 57S-92-01X through 57S-92-03X. A duplicate sample was taken from the SSD-93-06B sample location. The upstream sample location in lower Cold Spring Brook is CSD-94-10X, and the downstream sample locations are CSD-94-11X, CSD-94-12X, and G3D-92-01X. The sample locations are shown on Figure 4-4, and the analytical results are presented in Table 4-6.

4.1.5.1 Total Organic Carbon and Grain Size Distribution Results. TOC concentrations in the ditch samples ranged from 18,400 to 75,000 μg/g, while TOC concentration in lower Cold Spring Brook ranged from 4,250 to 223,000 μg/g.

Grain size distribution analysis was performed on three of the ditch samples (57S-92-01X through 57S-92-03X) and on two of the brook samples (CSD-94-11X and G3D-92-01X). The analysis indicates that the sediment in the ditch ranges from a well-graded sand to a silty sand and the sediment in the brook is a silt/clay.

4.1.5.2 Volatile Organic Compound Results. VOC analysis was not performed on sediment samples collected from the ditch, but was performed on one downstream sample (G3D-92-01X) collected from lower Cold Spring Brook. Acetone was the only VOC analyte reported in this sample, at a concentration of 0.657 μg/g. Acetone is considered a common laboratory contaminant by USEPA, and the low concentration of acetone reported in this sample may have been introduced during laboratory handling.

4.1.5.3 Semivolatile Organic Compound and Total Petroleum Hydrocarbon Results. Seventeen SVOCs were detected in the SSD-93-06B sample. This sample also had the highest concentration of total SVOCs, at approximately 59.8 μg/g. The highest individual SVOC concentration reported in SSD-93-06B was 9.3 μg/g of di-n-butyl phthalate. With the exception of benzo(k)fluoranthene, chrysene, fluoranthene, and pyrene, concentrations of SVOCs appear to decrease significantly in the most downgradient ditch sample (57S-92-03X). However, the use of relatively high detection limits in samples 57S-92-02X and 57S-92-03X complicates a direct comparison to the upgradient SSD-93-06B sample.

A comparison of the analytical results for the upstream and the downstream brook samples indicates an increase in some SVOC concentrations downstream of the confluence. Benzo(k)fluoranthene, chrysene, fluoranthene, phenanthrene, and pyrene were detected in downstream CSD-94-11X sample at a total concentration of 34 μg/g.

The concentrations of TPHC in ditch samples ranged from 1,410 to 3,500 μg/g. A moderate increase in TPHC concentration from upstream to downstream sample locations in lower Cold Spring Brook can be observed in Table 4-6.

4.1.5.4 Pesticide and Polychlorinated Biphenyl Results. Pesticide and PCB analyses were not performed on sediment samples collected from the ditch, but were performed on one downstream sample (CSD-94-11X) collected from lower Cold Spring Brook. Four pesticides were detected in this sample, at a total concentration of 0.769 μg/g.

4.1.5.5 Inorganic Results. Only two ditch samples were analyzed for inorganics: SSD-93-06B and the SSD-93-06B duplicate. All four brook samples were analyzed for inorganics. A review of Table 4-6 indicates that the concentration of each of the inorganic analytes, except manganese, are higher in the downstream CSD-94-11X sample than in the upstream CSD-94-10X sample. Inorganic concentrations tended to be greatest in sample G3D-92-01X collected furthest downstream. This is consistent with the inorganic distribution pattern observed at the SA 57 Marsh.

4.1.6 Storm Drain System No. 7

Sample locations in the potential source area, or "ditch", associated with Storm Drain System No. 7 are CSD-94-04X, SSD-93-07A, CSD-94-05X, SSD-93-07B, CSD-94-06X, and CSD-94-07X. A duplicate sample was taken from the CSD-94-05X location. The upstream sample location in lower Cold Spring Brook is 57D-92-01X and the downstream sample locations are CSD-94-08X, CSD-94-09X, and SSD-93-92E. The 57D-92-01X location was sampled twice: August 1992 and January 1993. The sample locations are shown on Figure 4-5, and the analytical results are presented in Table 4-7.

4.1.6.1 Total Organic Carbon and Grain Size Distribution Results. TOC concentrations in the ditch samples ranged from 9,600 to 199,000 μg/g, while TOC concentration in lower Cold Spring Brook ranged from 34,800 to 170,000 μg/g.

Grain size distribution analysis was not performed on the ditch samples, but was performed on two of the brook samples: 57D-92-01X and CSD-94-08X. The analysis indicates that the sediment at these locations ranges from a silt to medium sand.

4.1.6.2 Volatile Organic Compound Results. Although Table 4-7 does not present VOC results, SSD-93-07A and SSD-93-07B samples were analyzed for

VOCs. No VOCs were detected in these samples. VOC analyses were performed on one upstream sample (57D-92-01X) and one downstream sample (SSD-93-92E) collected from lower Cold Spring Brook. Acetone was reported in the 57D-92-01X sample at 0.44 μg/g. Acetone is considered a common laboratory contaminant by USEPA, and the low concentration of acetone reported in this sample may have been introduced during laboratory handling. No VOCs were detected in the SSD-93-92E sample.

4.1.6.3 Semivolatile Organic Compound and Total Petroleum Hydrocarbon Results. Eight SVOCs were detected in the SSD-93-07A sample. The concentration of total SVOCs in this sample was 11.6 μg/g. The concentrations of most of these SVOCs decreased in downgradient ditch samples until the culvert beneath Barnum Road. The SSD-93-07B sample collected near the culvert outlet had the highest individual SVOC concentration of the ditch samples: di-butyl phthalate at 22 μg/g. The concentrations of benzo(k)fluoranthene, chrysene, fluoranthene, phenanthrene, and pyrene increased slightly in samples collected downgradient from the SSD-93-07B sample location. These same SVOCs were detected in the CSD-94-08X sample collected at the confluence with lower Cold Spring Brook. Similar concentrations were detected in the CSD-94-09X sample collected further downstream. Although no SVOCs were detected in the upstream 57D-92-01X sample collected in 1993, fluoranthene, phenanthrene, and pyrene were detected in the 57D-92-01X sample collected in 1992. A comparison of the analytical results between the 57D-92-01X (1992) sample and the downstream samples indicates a slight increase in the concentrations of these three SVOCs, in addition to detectable concentrations of benzo(a)anthracene and chrysene.

The concentration of TPHC in ditch samples ranged from 219 to 2,320 μg/g. Similar to SVOC concentrations, the concentration of TPHC also increased downgradient from the SSD-93-07B sample location. The highest TPHC concentration of the ditch samples was detected in the CSD-94-06X sample. A moderate increase in TPHC concentration from upstream to downstream sample locations can be observed in Table 4-7.

4.1.6.4 Pesticide and Polychlorinated Biphenyl Results. Pesticide and PCB analyses were not performed on sediment samples collected from the ditch, but were performed on two samples collected from lower Cold Spring Brook: CSD-94-08X and SSD-93-92E. DDD and

2,2-bis(para-chlorophenol)-1,1,1-trichloroethane (DDT) were detected at a total concentration of approximately 0.072 μg/g in the CSD-94-08X sample. DDD and endosulfan sulfate were detected at a total concentration of approximately 0.073 μg/g in the SSD-93-92E sample.

4.1.6.5 Inorganic Results. A review of Table 4-7 indicates that there is no general increase or decrease in inorganic concentrations along the ditch, other than a notable peak in the concentration of some inorganics at the SSD-93-07B sample location. The concentrations of aluminum, barium, cobalt, iron, and manganese are significantly greater at this sample location than at the other sample locations in the ditch. Table 4-7 also indicates no significant overall difference in the concentration of inorganics from upstream sample locations to downstream sample locations.

4.1.7 Storm Drain System No. 8

The sample location in the potential source area, or "ditch", associated with Storm Drain System No. 8 is SSD-93-08A. The upstream sample location in lower Cold Spring Brook is CSD-94-03X and the downstream sample location is SSD-93-92D. The sample locations are shown on Figure 2-1, and the analytical results are presented in Table 4-8.

4.1.7.1 Total Organic Carbon and Grain Size Distribution Results. The TOC concentration in the ditch sample was 66,000 μg/g, while TOC concentrations in lower Cold Spring Brook were 22,000 μg/g in the CSD-94-03X sample and 50,000 μg/g in the SSD-93-92D sample.

Grain size distribution analysis was not performed on the ditch sample, but was performed on one of the brook samples: CSD-94-03X. The analysis indicates that the sediment at this location is a fine sand.

4.1.7.2 Volatile Organic Compound Results. The SSD-93-08A sample was analyzed for VOCs. No VOCs were detected. VOC analyses were performed on the downstream sample (SSD-93-92D) collected from lower Cold Spring Brook. The only VOC detected in this sample was 1,1,1-trichloroethane, at a concentration of 0.28 μg/g.

4.1.7.3 Semivolatile Organic Compound and Total Petroleum Hydrocarbon Results. Five SVOCs were detected in the SSD-93-08A sample at a total SVOC concentration of approximately 4 μg/g. A comparison of the analytical results between the upstream and downstream brook samples indicates that System No. 8 is contributing little, if any, SVOC contamination to lower Cold Spring Brook. The decrease in SVOC concentrations from upstream to downstream sample locations can be observed in Table 4-8.

The concentration of TPHC in the SSD-93-08A sample was 780 μg/g. Similar to the trend in SVOC concentrations, the TPHC concentration from upstream to downstream sample locations in lower Cold Spring Brook appears to decrease.

4.1.7.4 Pesticide and Polychlorinated Biphenyl Results. Pesticide and PCB analyses were not performed on the SSD-93-08A sample, but were performed on both samples collected from lower Cold Spring Brook. DDT, DDD, and 2,2-bis(para-chlorophenol)-1,1-dichloroethene (DDE) were detected in the CSD-94-03X sample at a total concentration of 0.068 μg/g. No pesticides or PCBs were detected in the SSD-93-92D sample.

4.1.7.5 Inorganic Results. A review of Table 4-8 indicates that, contrary to the trend observed for SVOCs, TPHC, and pesticides, the concentrations of inorganics show increases from the upstream CSD-94-03X sample to the downstream SSD-93-92D sample. Several fold increases in the concentrations of aluminum, barium, iron, manganese, and vanadium can be observed in Table 4-8.

4.1.8 Storm Drain System No. 9

Nine samples are used to evaluate contamination in the vicinity of the Storm Drain System No. 9 outfall. These include two upstream samples in Cold Spring Brook, SSD-93-92C and SSD-95-09J; three potential source area samples, SSD-93-09A, SSD-95-09K, and SSD-95-09L; and four downstream sample locations, SSD-95-09I, CSD-94-01X, CSD-94-02X, and SSD-95-09H. These sample locations are shown on Figure 4-6.

The source area sample point SSD-95-09L was located downgradient of the outlet of a culvert that passes beneath the driveway to the Commissary. Source area sample point SSD-95-09K was at the upstream end of the culvert beneath Dakota Street, just west of its intersection with Saratoga Street. Source area sample SSD-

93-09A was collected downstream of the 60-inch diameter culvert/outfall on the east side of Patton Road, upstream of the confluence with Cold Spring Brook. As shown on Figure 4-6, this outfall location receives not only storm sewer flow from Storm Drain System No. 9, but also overland flow from areas north and south of Dakota Street, and west of Saratoga Street and Patton Road. The analytical results for samples in association with Storm Drain System No. 9 are presented in Table 4-9.

4.1.8.1 Total Organic Carbon and Grain Size Distribution Results. The TOC concentration in the source area samples ranged from 1,490 μg/g at SSD-95-09K to 125,000 μg/g at location SSD-95-09L, while TOC concentrations in the upstream portion of lower Cold Spring Brook ranged from 9,600 to 36,600 μg/g, and concentrations in downstream samples ranged from 2,080 μg/g at CSD-94-01X to 120,000 μg/g at CSD-94-02X. Sample CSD-94-02X was collected from within the shallow pond and wetland downstream of the B&MRR, and its high TOC concentration may reflect organically rich sediments resulting from plant decomposition. Scientific evidence suggests that sediments with high TOC concentrations typically have greater potential to adsorb organic and inorganic contaminants than less organically rich sediments. Localized areas of relatively high TOC concentration, such as at the CSD-94-02X sample location, could contribute to isolated "hot spots" of contamination.

Grain size distribution analysis was not performed on the ditch samples, but was performed on two of the brook samples: CSD-94-01X and CSD-94-02X. The analysis indicates that the sediment in these locations ranges from a silt/clay to medium sand.

4.1.8.2 Volatile Organic Compound Results. Although Table 4-9 does not present VOC results, SSD-93-09A and SSD-93-92C samples were analyzed for VOCs. However, no VOCs were detected.

4.1.8.3 Semivolatile Organic Compound and Total Petroleum Hydrocarbon Results. Review of the SVOC data in Table 4-9 indicates that only two SVOCs were detected in the SSD-93-09A sample: benzo(a)anthracene at 2 μg/g and chrysene at 3 μg/g. In comparison, 8 SVOCs were reported in sample SSD-95-09L, and 16 SVOCs were reported in sample SSD-95-09K. With the exception of bis(2-ethylhexyl) phthalate, a common laboratory and field introduced contaminant, concentrations in sample SSD-95-09L were relatively low (total

SVOCs of 4.6 μg/g, excluding bis(2-ethylhexyl) phthalate and blank contaminants), while those in sample SSD-95-09K were relatively high (total SVOCs of 84 μg/g, excluding blank contaminants).

A comparison of analytical results for upstream and downstream samples in lower Cold Spring Brook shows an increase in SVOC concentrations in the downstream samples. The increase is most evident in sample SSD-95-09I (total SVOCs of 61.1 μg/g compared to 6.2 μg/g or less in upstream samples), and to a lesser extent in sample CSD-94-02X (total SVOCs of 14 μg/g).

This leads to the conclusion that a source in the vicinity of the Saratoga Street/Barnum Road intersection may have contributed SVOCs to brook sediments at sample location SSD-95-09I. Available data suggest that surface runoff from the area north of Dakota Street was a more likely source than Storm Drain System No. 9. This interpretation is made, however, with the caveat that the evaluated samples were collected as part of three separate sampling events spanning approximately two years; no data is available on the concentration of SVOCs at the location of sample SSD-93-09A (collected in 1993) at the time that samples SSD-95-09K and SSD-95-09I were collected in 1995. Possible sources of SVOC contamination in runoff tributary to location SSD-095-09K include street and parking lot runoff and a fire at Warehouse No. 17 (Building T-1423) on Saratoga Street in the summer of 1994.

Because the TOC concentration in the CSD-94-02X sample was more than one order of magnitude higher than the other two brook samples, it is possible that the high TOC concentration contributed to relatively high SVOC concentrations in this sample.

The concentration of TPHC in the source area samples ranged from 270 to 965 μg/g, while the concentration in the upstream Cold Spring Brook sample was 77.8 μg/g and concentrations in downstream samples ranged from 61 to 2,120 μg/g. Similar to the trend in SVOC concentrations, the TPHC concentration appears to increase from upstream to downstream sample locations in lower Cold Spring Brook.

4.1.8.4 Pesticide and Polychlorinated Biphenyl Results. Pesticide and PCB analyses were not performed on the SSD-93-09A sample, but were performed on the 1995 samples (SSD-95-XX) and the lower Cold Spring Brook downstream sample CSD-94-02X. Endosulfan II, DDT, DDD, DDE, and Dieldrin were detected at a total concentration of less than 1 μg/g in most of the samples. Sample CSD-94-02X had a reported gamma-chlordane concentration of 0.0716 μg/g, and the highest total pesticide concentration, 0.94 μg/g.

4.1.8.5 Inorganic Results. Review of Table 4-9 indicates that among source area samples, sample SSD-95-09L, the most upstream sample, typically had the highest inorganic concentrations. Sample SSD-95-09K, from the intermediate sample location, typically had the lowest concentrations. None of the concentrations appear extraordinary, however, and considering the relatively low concentrations at the intermediate sample location SSD-95-09K, it seems unlikely that surface runoff from the area near SSD-95-09L contributed significantly to inorganic concentrations at SSD-93-09A.

Comparison of inorganics concentrations for upstream and downstream samples in lower Cold Stream Brook reveals, with the exception of sample CSD-94-02X, relatively consistent concentrations with little if any increase in downstream concentrations. Inorganic concentrations at CSD-94-02X were typically several fold to an order of magnitude greater than the other downstream locations evaluated in association with Storm Drain System No. 9. The reason for this has not been identified. Slow stream velocity would seem to favor sediment deposition at both location CSD-94-02X and SSD-95-09H, and similar surface water chemistry that could influence precipitation of inorganics would be expected at the two locations. Thus greater consistency would be expected between these two samples. It is possible that the relatively high TOC concentrations at CSD-094-02X may have influenced sediment chemistry by increased sorption of inorganics.

4.1.9 Storm Drain System No. 5

Sample locations in the potential source area, or "ditch", are SSD-93-05A, GRD-94-06X, and GRD-94-07X. No sediment samples were collected from Grove Pond during the Lower Cold Spring Brook SI. The sample locations are shown on Figure 2-1, and the analytical results are presented in Table 4-10.

4.1.9.1 Total Organic Carbon and Grain Size Distribution Results. TOC concentrations in the ditch samples ranged from 55,000 to 428,000 μg/g. No grain size distribution analyses were performed on the ditch samples.

4.1.9.2 Volatile Organic Compound Results. Although Table 4-10 does not present VOC results, the SSD-93-05A sample was analyzed for VOCs. However, no VOCs were detected.

4.1.9.3 Semivolatile Organic Compound and Total Petroleum Hydrocarbon Results. Thirteen SVOCs were detected in the SSD-93-05A sample, with a total SVOC concentration of approximately 74.3 μg/g. The concentrations of many of these SVOCs appear to increase further downgradient in the ditch. The GRD-94-06X sample had a total SVOC concentration of approximately 123 μg/g. However, only one SVOC (pyrene) was detected in the GRD-94-07X sample, the most downgradient sample.

The concentration of TPHC ranged from 1,570 to 3,200 μg/g. TPHC concentration does not appear to significantly decrease in downgradient ditch samples.

4.1.9.4 Pesticide and Polychlorinated Biphenyl Results. Pesticide and PCB analyses were not performed on the ditch samples.

4.1.9.5 Inorganic Results. A review of Table 4-10 indicates an overall decrease in the concentrations of inorganics downgradient from the Storm Drain System No. 5 outfall. The only exceptions to this trend are the concentrations of aluminum, selenium, and sodium, which have their highest concentrations in the GRD-94-07X sample.

4.2 SURFACE WATER LABORATORY RESULTS

The results of laboratory analyses of surface water samples collected during the lower Cold Spring Brook SI and supplemental sampling at Storm Drain System No. 9 are summarized in the following subsections. The tables present analytical results for samples collected in potential source areas, or "ditches," associated with storm drain systems separately from analytical results for samples collected in lower Cold Spring Brook. Table 4-11 presents analytical results for lower Cold Spring Brook surface water, and Table 4-12 presents analytical results for storm drain system surface water. Sample locations are shown on Figure 2-1 and Figure 4-6 (supplemental samples at Storm Drain System No. 9).

4.2.1 Lower Cold Spring Brook

Review of Table 4-11 shows relatively high concentrations of inorganics in unfiltered surface water samples from three locations: CSW-94-14X, CSW-94-31X, and CSW-94-33X. Further review indicates, however, that this does not represent localized surface water degradation. The unfiltered surface water samples from these locations had relatively high concentrations of aluminum, arsenic, iron, barium, lead, manganese, and zinc compared to unfiltered upstream samples (CSW-94-13X and CSW-94-31X). Review of data for filtered samples, however, shows much lower concentrations that are consistent with concentrations in both upstream samples and other lower Cold Spring Brook surface water samples. This and relatively high TSS concentrations in the unfiltered samples lead to the conclusion that the high concentrations of inorganics resulted from nonfilterable material (i.e., TSS) in these samples.

The water quality parameters alkalinity, chloride, and total hardness varied within a relatively small range for most of the surface water samples with little apparent trend. Alkalinity values ranged within an approximate factor of two (27,000 to 51,000 μg/L) in all samples except three from the SA 57 marsh (CSW-94-14X, 13,000 μg/L; CSW-94-20X, 22,000 μg/L; and CSW-94-35X, 19,000 μg/L) and the upstream sample SSW-95-09I (70,800 μg/L). Chloride concentrations ranged from 33,000 to 66,000 μg/L. Total hardness ranged from 50,400 to 71,600 μg/L in al samples except one from the SA 57 marsh (CSW-94-35X, 31,600 μg/L) and three sample collected in 1995 in the upstream subsection of lower Cold Spring Brook (SSW-95-09H, 73,900 μg/L; SSW-95-09I, 89,500 μg/L; and SSW-95-09J, 82,000 μg/L). Sulfate was reported at 10,100 to 14,000 μg/L in the three samples SSW-95-09H, SSW-95-09I, and SSW-95-09J

Pesticides not reported in any of the ten 1994 surface water samples in which they were target analytes. A total of ten pesticides were reported at low concentrations in the 1995 samples; however, only two were confirmed. These were DDD in SSW-95-09I (0.00833 μg/L) and alpha-BHC in SSW-95-09H and SSW-95-09I (0.0182 and 0.021 μg/L, respectively). As discussed in Appendix C, these reported concentrations are considered estimated.

Other than bis(2-ethylhexyl)phthalate, which is a suspected laboratory contaminant, no SVOCs were detected in lower Cold Spring Brook surface water.

4.2.2 Storm Drain Systems

Review of data in Table 4-12 and comparison with data in Table 4-11, shows that analyte concentrations in unfiltered samples are generally comparable to those in lower Cold Spring Brook surface water, although perhaps a little more variable. Review of the data for filtered samples shows that the higher concentrations contributing to the observed variability appear associated with nonfilterable material in the unfiltered samples. This is especially evident in the sample from location CSW-94-30X which had high inorganic concentrations and very high TSS concentrations in the unfiltered sample, but low concentrations in the filtered sample. Exceptions to this generalization exist for sample locations CSW-94-21X and CSW-94-24X where slightly elevated concentrations of zinc were not reduced by filtration. It is noted that concentrations of calcium are typically lower, and concentrations of magnesium and manganese typically higher, in surface water samples from drainage ditches than in samples from lower Cold Spring Brook. Surface water samples collected downstream of the storm drain system outfalls do not appear to be significantly degraded by inorganics.

Measured values for the water quality parameters of alkalinity (13,000 to 53,100 μg/L), chloride (18,700 to 39,000 μg/L), and sulfate (5,640 μg/L) tended to be lower than in lower Cold Spring Brook and do not suggest that storm drainage increased the concentration of these parameters in the brook. Total hardness ranged from 20,000 to 48,000 μg/L in all but one ditch surface water sample. A total hardness value of 92,400 μg/L was reported for sample CSW-94-30X; this value may have been influenced by very high TSS (3,950,000 μg/L) in the sample, however.

Only the surface water sample SSW-95-09K was analyzed for pesticides. The pesticide alpha-BHC was confirmed in the primary sample, but not its duplicate, and DDD was confirmed in the duplicate, but not the primary sample. For this reason, as discussed in Appendix C, the reported concentrations are considered estimated, and the actual presence of DDD and alpha-BHC is suspect.

Other than bis(2-ethylhexyl)phthalate, which is a suspected laboratory contaminant, no SVOCs were detected in storm drain system surface water.

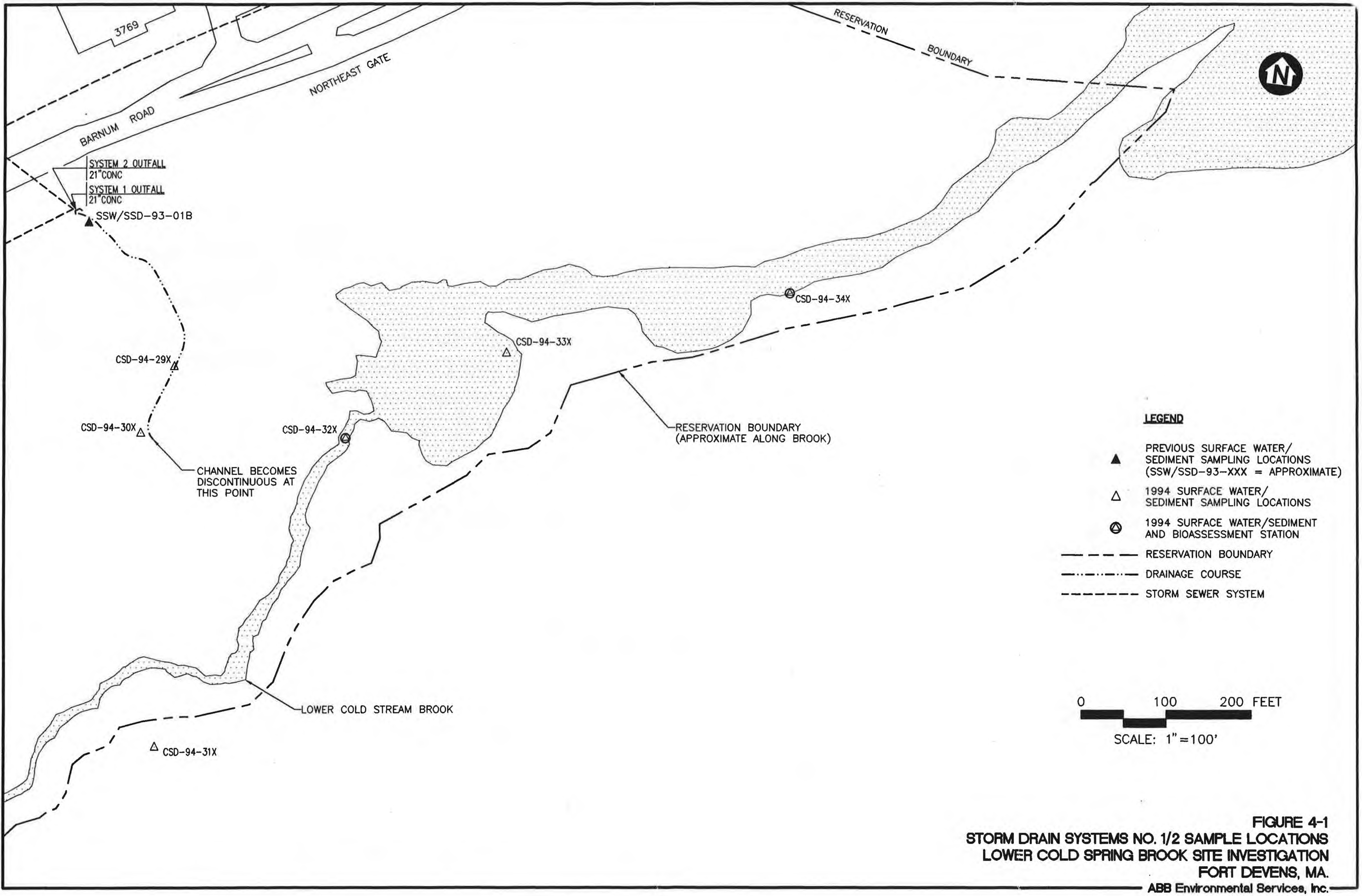


FIGURE 4-1
STORM DRAIN SYSTEMS NO. 1/2 SAMPLE LOCATIONS
LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ABB Environmental Services, Inc.

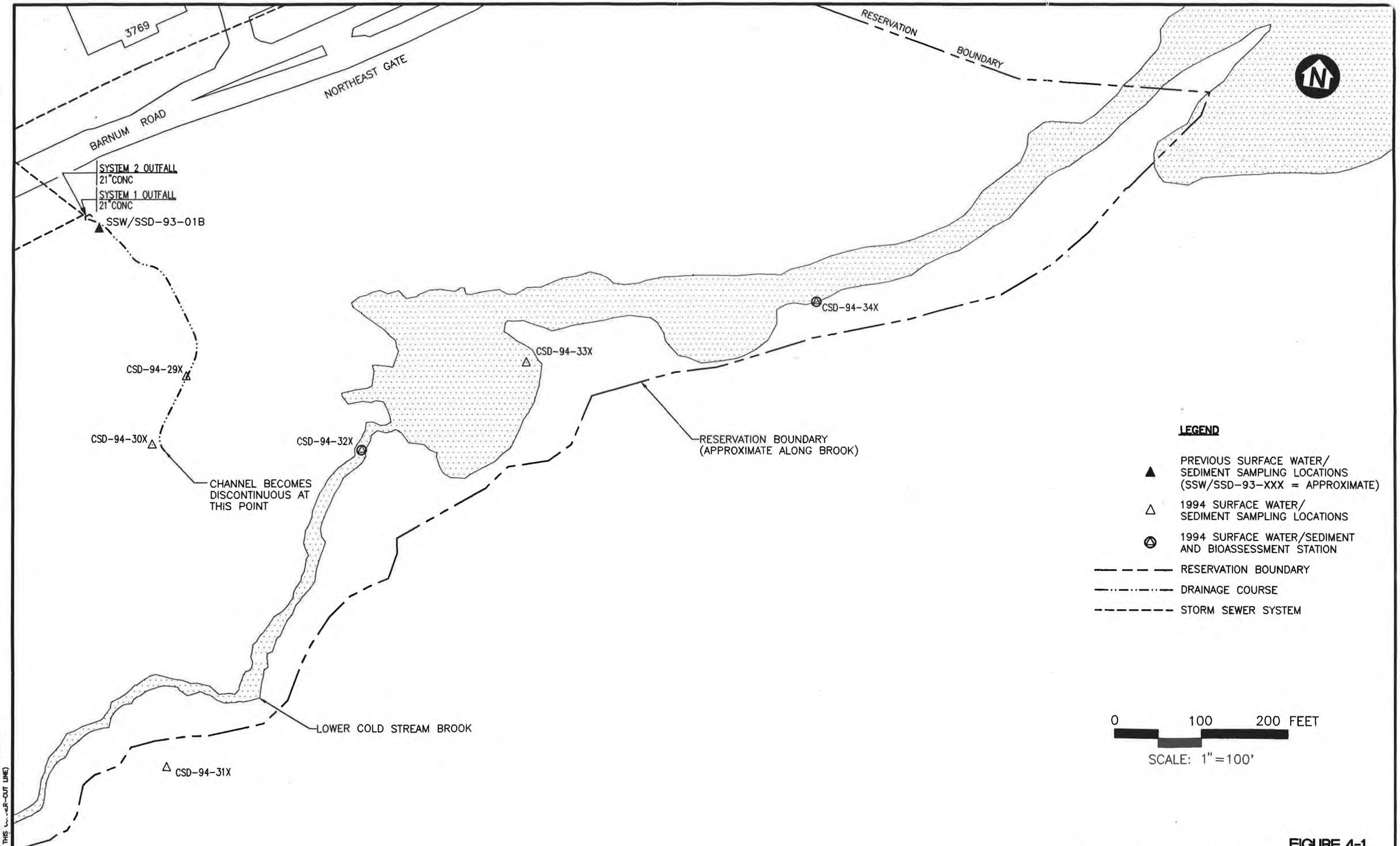


FIGURE 4-1
STORM DRAIN SYSTEMS NO. 1/2 SAMPLE LOCATIONS
LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ABB Environmental Services, Inc.

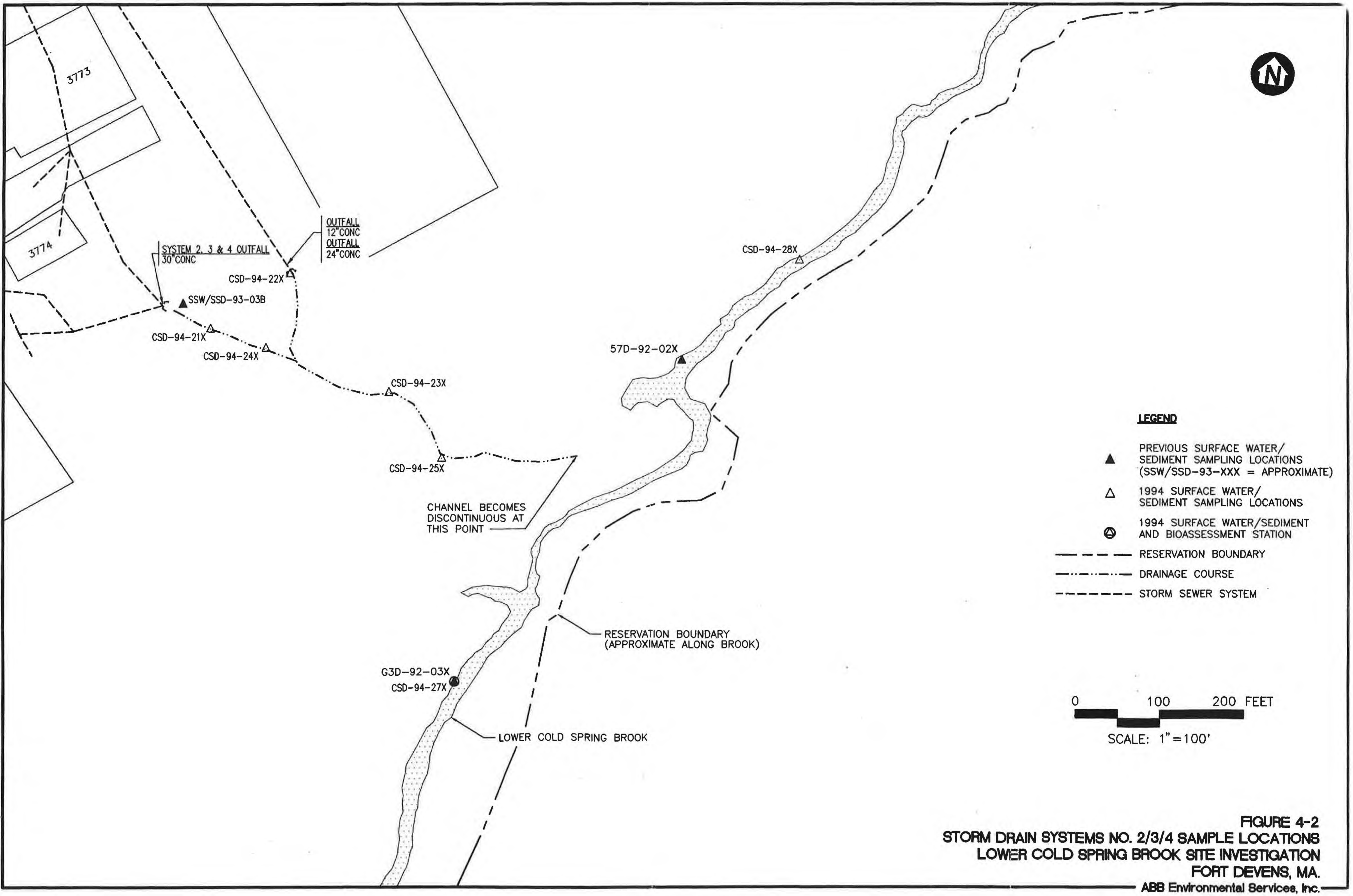


FIGURE 4-2
STORM DRAIN SYSTEMS NO. 2/3/4 SAMPLE LOCATIONS
LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ABB Environmental Services, Inc.

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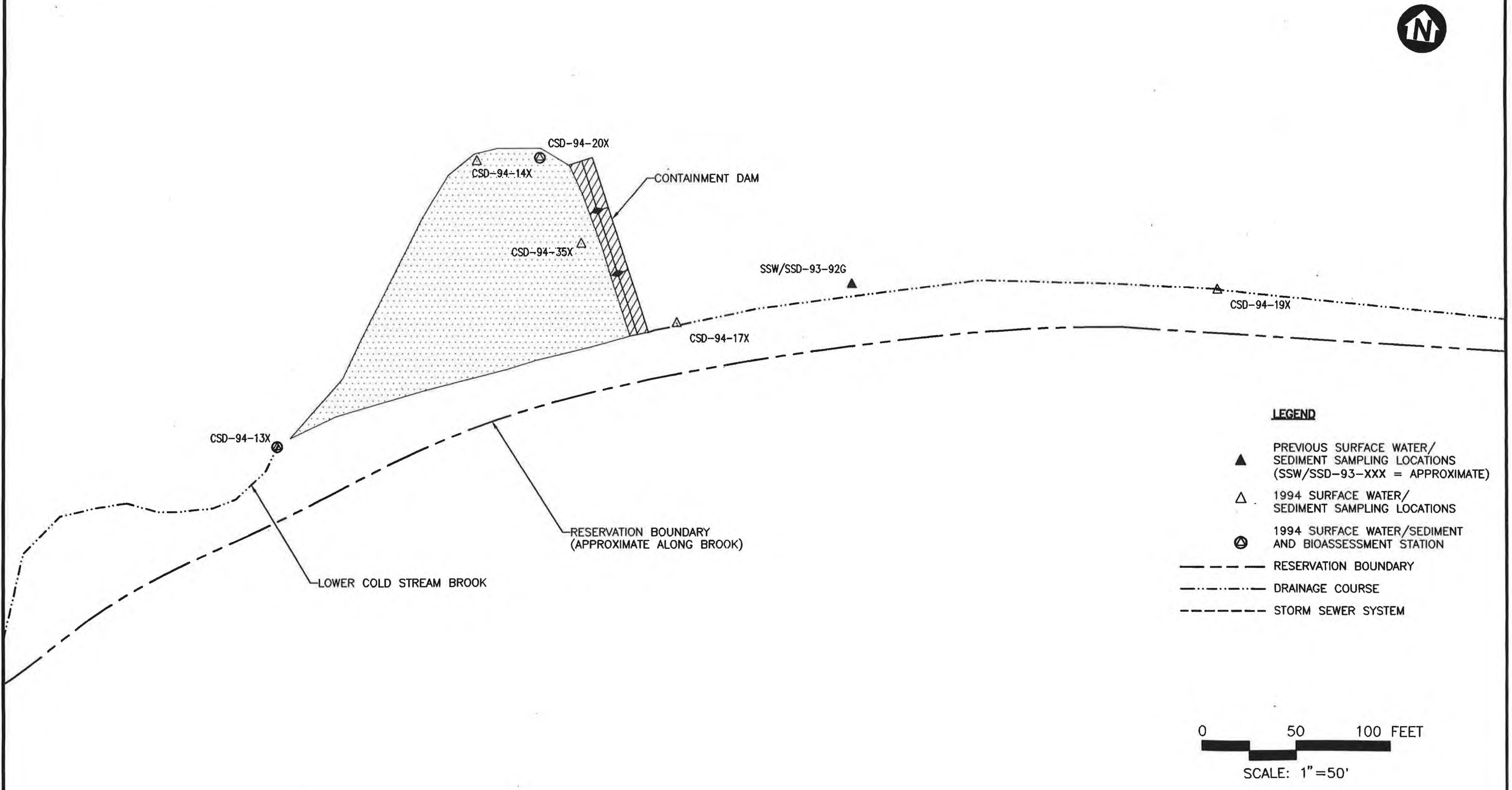

FIGURE 4-3
SA 57 MARSH SAMPLE LOCATIONS
LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ABB Environmental Services, Inc.

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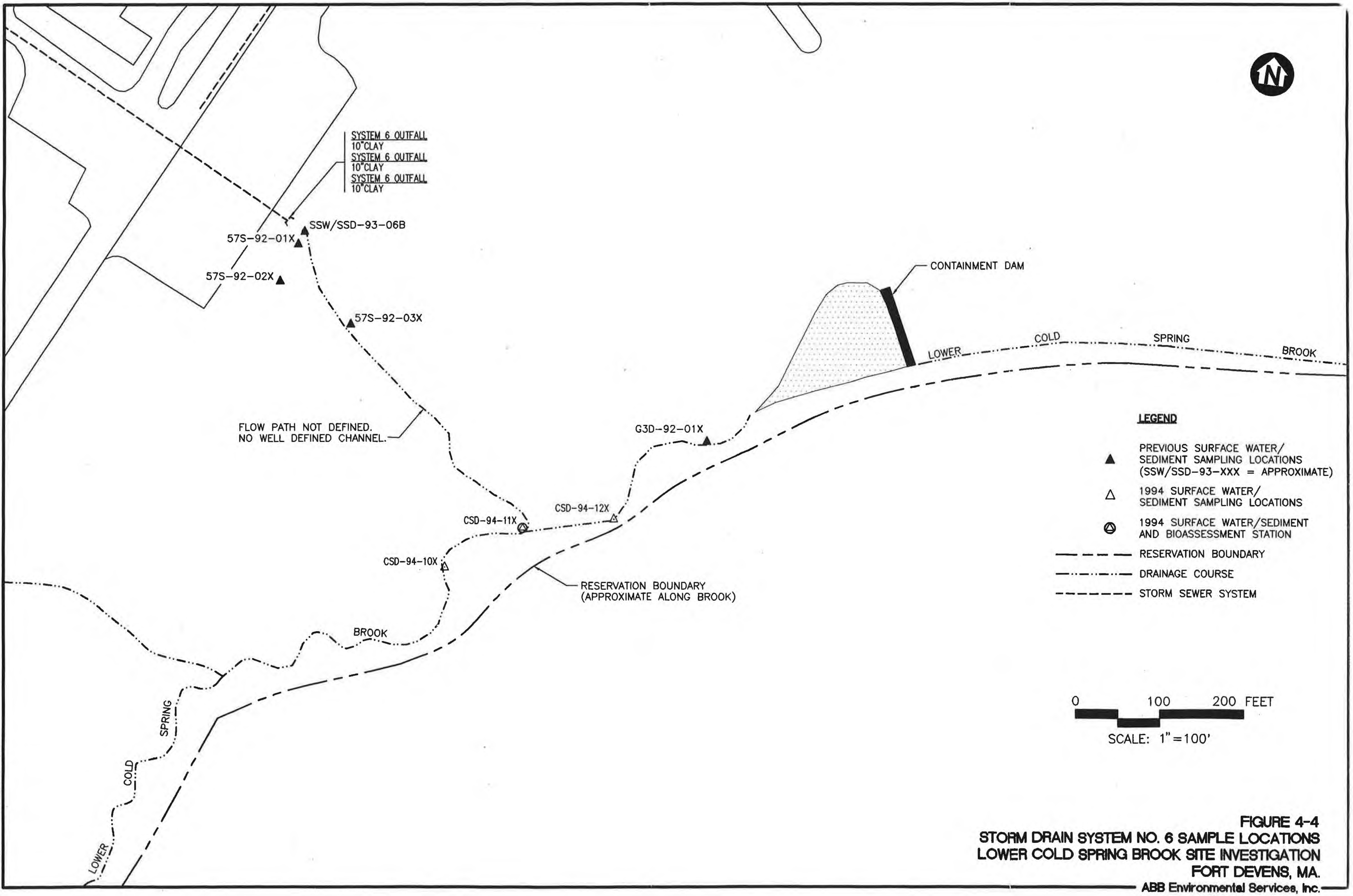

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FIGURE 4-4
STORM DRAIN SYSTEM NO. 6 SAMPLE LOCATIONS
LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.
ABB Environmental Services, Inc.

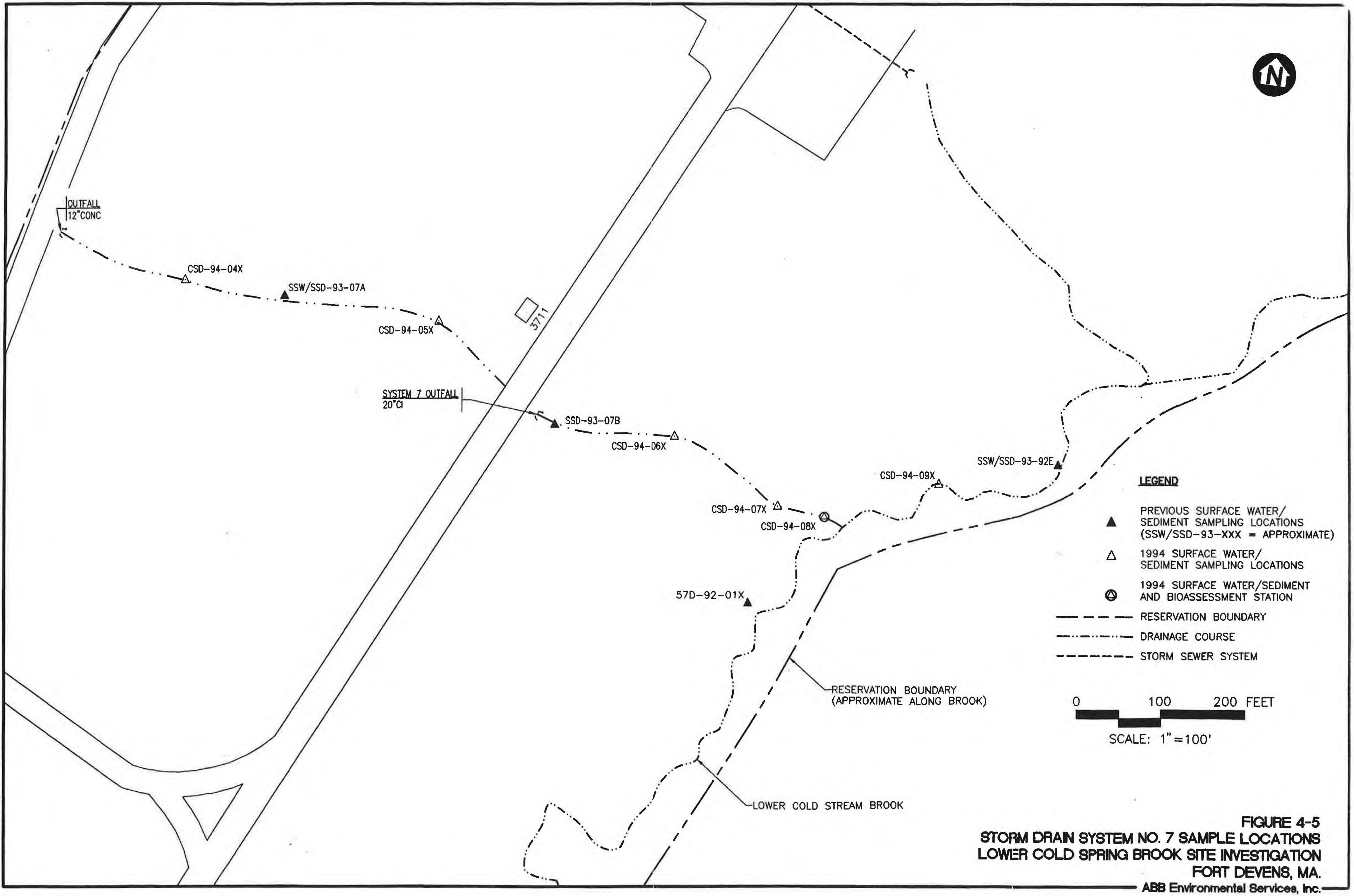

FIGURE 4-5
STORM DRAIN SYSTEM NO. 7 SAMPLE LOCATIONS
LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ABB Environmental Services, Inc.

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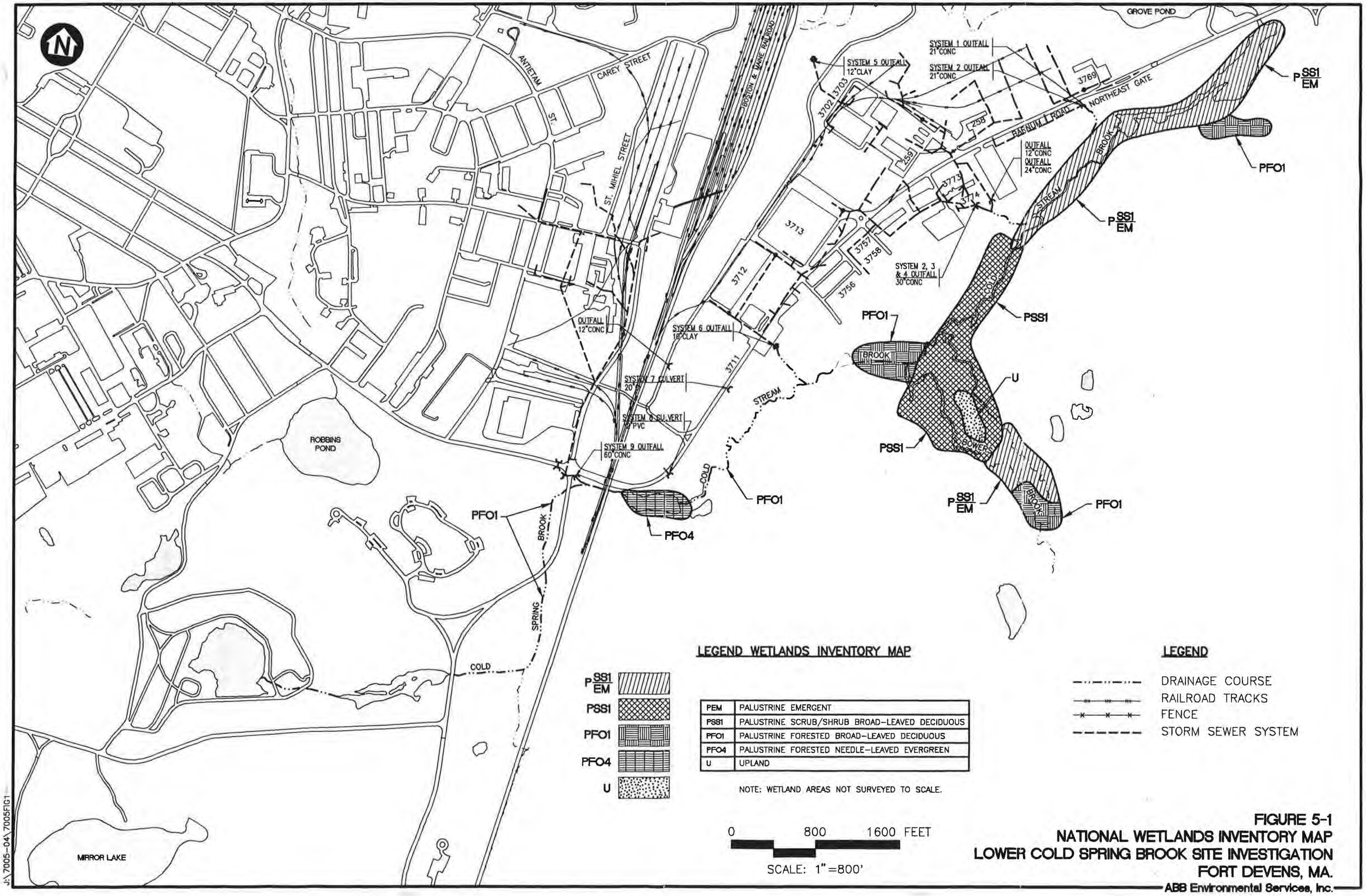

LEGEND WETLANDS INVENTORY MAP

P SS1/EM ▨
PSS1 ▦
PFO1 ▤
PFO4 ▥
U ░

PEM	PALUSTRINE EMERGENT
PSS1	PALUSTRINE SCRUB/SHRUB BROAD-LEAVED DECIDUOUS
PFO1	PALUSTRINE FORESTED BROAD-LEAVED DECIDUOUS
PFO4	PALUSTRINE FORESTED NEEDLE-LEAVED EVERGREEN
U	UPLAND

NOTE: WETLAND AREAS NOT SURVEYED TO SCALE.

FIGURE 5-1
NATIONAL WETLANDS INVENTORY MAP
LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ABB Environmental Services, Inc.

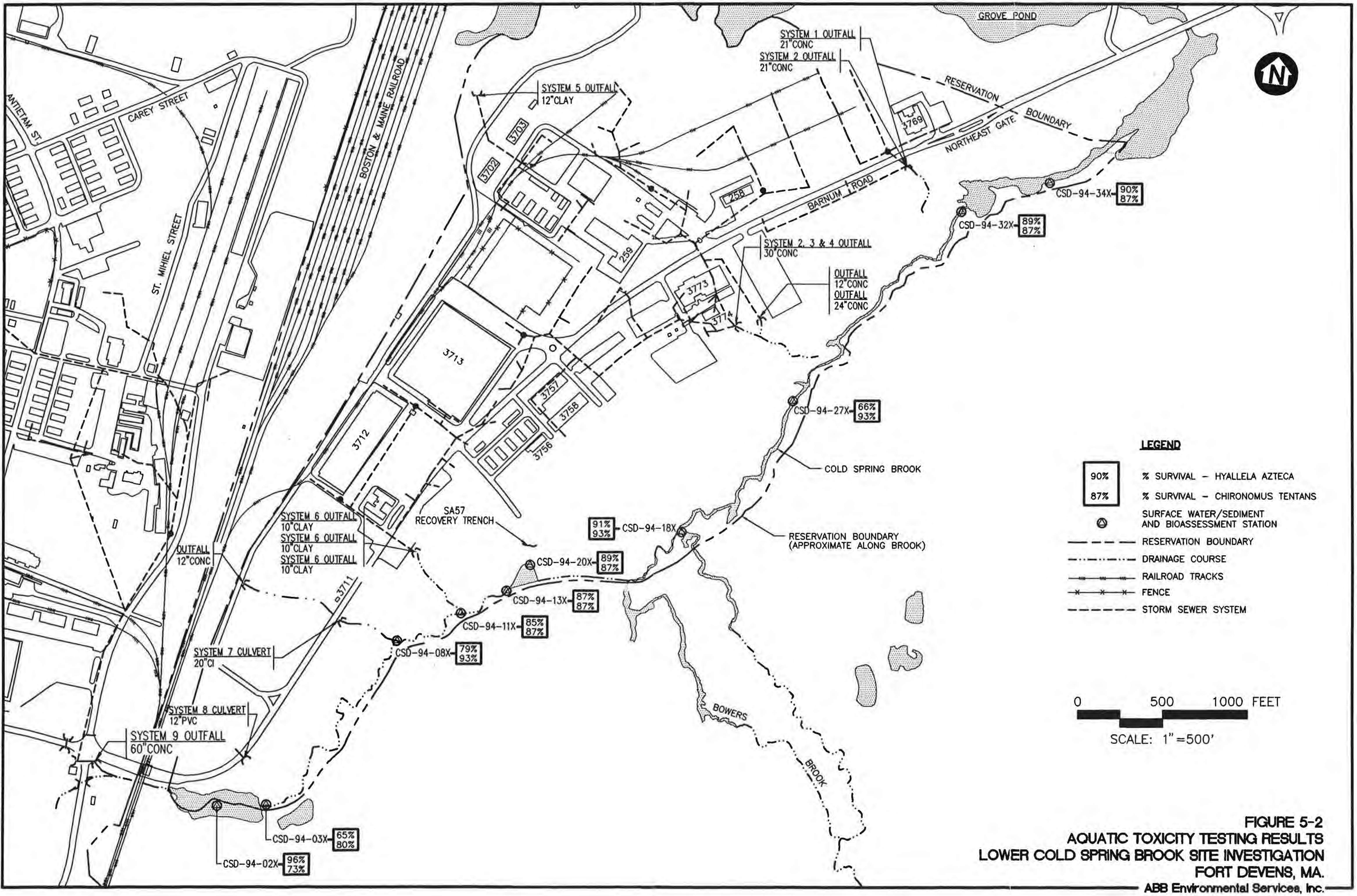

FIGURE 5-2
AQUATIC TOXICITY TESTING RESULTS
LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ABB Environmental Services, Inc.

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TABLE 5-1
BENTHIC MACROINVERTEBRATE COMMUNITY METRICS

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MASSACHUSETTS

METRIC	DESCRIPTION
otal taxa (number of nvertebrate taxa)	Defines species richness. Richness generally increases with increasing water quality, habitat diversity, and/or habitat suitability (U.S. Environmental Protection Agency [USEPA], 1990).
ilsenhoff Biotic Index HBI)	Developed to summarize overall pollution tolerance of the benthic arthropod community. Similar in concept to the Florida index, but incorporates abundance and a slightly different weighing factor for tolerance. Tolerance values are assigned ranging from 0 to 10 (10 signifying the most tolerant). The 0-10 scale was modified to include non-arthropod species. The HBI index decreases in value with increasing water resource integrity. Although it may be applicable for other types of pollutants, use of the HBI in detecting non-organic pollution effects has not been thoroughly evaluated (USEPA, 1990).
Scraper/Filterer Ratio	Reflects the riffle/run community food base and provides insight into the nature of potential disturbance factors. Predominance of a feeding type may indicate an unbalanced community responding to an overabundance of a particular food source. Filtering collectors are sensitive to toxicants bound to fine particulate organic material and may decrease in abundance when exposed to sources of such bound toxicants (USEPA, 1990).
Ephemeroptera-plecoptera-trichoptera (EPT) Index	The percent EPT taxa indicates whether a substantial portion of the community is comprised of taxa sensitive to environmental stress. The insect orders of the mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) are considered intolerant of most forms of pollution, and populations are often low in stressed environments.
EPT/Chironomidae Ratio	The EPT index measures species intolerant to contaminant stress, while the midge family Chironomidae represent pollution tolerant benthic taxa. Communities with good biotic condition are characterized by a fairly even distribution among EPT and chironomids (USEPA, 1990).
Percent dominant taxon	Calculated as the ratio of the taxonomic group with the most individuals (dominant) to the total number of organisms. Percent dominance should remain low to reflect a healthy biotic condition (Plafkin et al., 1989).
Community Loss Index	Measures the loss of benthic taxa as compared to a reference station. Values increase as the degree of dissimilarity with the reference station increases.

TABLE 5-2
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SURFACE SOIL[1]
STORM DRAIN SYSTEM NO. 1/2

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ANALYTE	Frequency of Detection [2]	Range of Detection Limits	Range of Detected Concentrations	Average of all Concentrations [3]	Background Screening Value [4]	Maximum Exceeds Background?
PAL METALS (μg/g)						
Arsenic	3/3	NA	15.5 to 23.3	18.3	21	YES
Calcium	3/3	NA	819 to 2,470	1,370	1,400	YES
Chromium	3/3	NA	15.9 to 32.2	24.2	31	YES
Cobalt	3/3	NA	4.7 to 6.54	5.7	ND	NA
Copper	3/3	NA	15.9 to 46.7	35.7	8.39	YES
Iron	3/3	NA	10,400 to 16,700	13,367	15,000	YES
Lead	3/3	NA	43 to 78.7	55	34.4	YES
Nickel	3/3	NA	15.6 to 24.5	19.4	14	YES
Sodium	3/3	NA	76.6 to 1,000	532	131	YES
Zinc	3/3	NA	53.9 to 83.5	66.8	35.5	YES
PAL SEMIVOLATILE ORGANICS (μg/g)						
2-Methylnaphthalene	1/3	1 to 2	0.21 to 0.21	0.57	NA	NA
Acenaphthylene	1/3	0.7 to 2	5.8 to 5.8	2.4	NA	NA
Anthracene	1/3	0.7 to 2	7.1 to 7.1	2.8	NA	NA
Benzo (a) anthracene	1/3	3 to 8	16 to 16	7.2	NA	NA
Benzo (a) pyrene	1/3	5 to 10	8.4 to 8.4	5.3	NA	NA
Benzo (b) fluoranthene	1/3	4 to 10	11 to 11	6	NA	NA
Benzo (g,h,i) perylene	1/3	5 to 10	11 to 11	6.2	NA	NA
Benzo (k) fluoranthene	1/3	1 to 3	6.3 to 6.3	2.8	NA	NA
Chrysene	2/3	2 to 2	10 to 14	8.3	NA	NA
Fluoranthene	3/3	NA	6 to 30	15	NA	NA
Fluorene	1/3	0.7 to 2	2.3 to 2.3	1.2	NA	NA
Indeno (1,2,3-cd) pyrene	1/3	6 to 10	8.9 to 8.9	5.6	NA	NA
Phenanthrene	3/3	NA	3 to 30	12	NA	NA
Pyrene	3/3	NA	7 to 30	16	NA	NA
TOTAL PETROLUEM HYDROCARBONS (μg/g)						
Total Petroleum Hydrocarbons	3/3	NA	239 to 281	253	NA	NA
OTHER (μg/g)						
Total Organic Carbon	3/3	NA	30,000 to 58,400	40,300	NA	NA

TABLE 5-2
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SURFACE SOIL[1]
STORM DRAIN SYSTEM NO. 1/2

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ANALYTE	Vertebrate Screening Value[5]	Maximum Exceeds Ecological Screening Value?	Phytotoxicity Screening Value[6]	Maximum Exceeds Phytotoxicity Screening Value?	Invertebrate Screening Value[7]	Maximum Exceeds Invertebrate Screening Value?
PAL METALS (µg/g)						
Arsenic	65	NO	NA	NA	100	NO
Calcium	NA	NA	NA	NA	NA	NA
Chromium	15,000	NO	NA	NA	50	NO
Cobalt	46	NO	25	NO	NA	NA
Copper	1,000	NO	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA
Lead	190	NO	NA	NA	1,190	NO
Nickel	410	NO	25	NO	400	NO
Sodium	NA	NA	NA	NA	NA	NA
Zinc	240	NO	NA	NA	130	NO
PAL SEMIVOLATILE ORGANICS (µg/g)						
2-Methylnaphthalene	214	NO	NA	NA	34	NO
Acenaphthylene	214	NO	NA	NA	34	NO
Anthracene	214	NO	NA	NA	34	NO
Benzo (a) anthracene	214	NO	NA	NA	34	NO
Benzo (a) pyrene	214	NO	NA	NA	34	NO
Benzo (b) fluoranthene	214	NO	NA	NA	34	NO
Benzo (g,h,i) perylene	214	NO	NA	NA	34	NO
Benzo (k) fluoranthene	214	NO	NA	NA	34	NO
Chrysene	214	NO	NA	NA	34	NO
Fluoranthene	214	NO	NA	NA	34	NO
Fluorene	214	NO	NA	NA	34	NO
Indeno (1,2,3-cd) pyrene	214	NO	NA	NA	34	NO
Phenanthrene	214	NO	NA	NA	34	NO
Pyrene	214	NO	NA	NA	34	NO
TOTAL PETROLUEM HYDROCARBONS (µg/g)						
Total Petroleum Hydrocarbons	NA	NA	NA	NA	NA	NA
OTHER (µg/g)						
Total Organic Carbon	NA	NA	NA	NA	NA	NA

NOTES:

[1] Based on analytical data from the following three sampling locations: CSD-94-29X, CSD-94-30X, and SSD-93-01B.

[2] Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples.

[3] The average of all concentrations assigns a value of 1/2 the detection limit to all non-detects.

[4] Background values from RI Addendum Report for Group 1A Sites (ABB-ES, 1993c).

[5] Screening values are Protective Contaminant Levels (PCLs) from Table B-5, and are derived as described in Appendix B. The value presented represents the lowest PCL for the shrew, woodcock, fox, or hawk.

[6] Phytotoxicity Screening Values from Suter et al., 1993 unless otherwise noted. The screening value is the lowest Lowest Observed Effect Level (LOEL) from among plant growth studies conducted in solid media.

[7] Invertebrate Screening Value from Neuhauser et al., 1985 unless otherwise noted. For organic compounds, the screening value is the lowest LC_{50} (14-day soil test on *Eisenia foetida*) from among chemicals in the same chemical class; a conservative factor of 0.2 was applied and the resultant value should be protective of 99.9% of the population from acute effects (USEPA, 1986b).

NA = Not available/Not applicable

ND = Not detected

µg/g = micrograms per gram

TABLE 5-3
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SEDIMENT[1]
STORM DRAIN SYSTEM NO. 2/3/4

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ANALYTE	Frequency of Detection [2]	Range of Detection Limits	Range of Detected Concentrations	Average of all Concentrations [3]	Upgradient Screening Value [4]	Maximum Exceeds Upgradient?
PAL METALS ($\mu g/g$)						
Aluminum	6/6	NA	5,000 to 29,500	11,953	3,080	YES
Antimony	3/6	1.09 to 19.6	3.48 to 18.8	7.30	ND	YES
Arsenic	6/6	NA	8.4 to 60	22.2	13.1	YES
Barium	6/6	NA	12.7 to 155	54.1	7.85	YES
Cadmium	5/6	0.7 to 0.7	0.947 to 27.7	6.88	ND	YES
Calcium	6/6	NA	686 to 3,850	2,233	482	YES
Chromium	6/6	NA	19.7 to 142	53.4	6.24	YES
Cobalt	6/6	NA	3.86 to 15.7	7.98	ND	YES
Copper	6/6	NA	12.2 to 145	49.9	ND	YES
Iron	6/6	NA	11,100 to 42,400	20,450	6,440	YES
Lead	6/6	NA	18 to 410	166	6.31	YES
Magnesium	6/6	NA	2,430 to 14,900	6,137	1,370	YES
Manganese	6/6	NA	172 to 572	354	214	YES
Mercury	1/6	0.05 to 0.05	0.0751 to 0.0751	0.0334	ND	YES
Nickel	6/6	NA	15 to 82.1	33.1	3.94	YES
Potassium	6/6	NA	552 to 4,610	1,631	ND	YES
Sodium	6/6	NA	108 to 1,650	650	ND	YES
Vanadium	6/6	NA	14.2 to 91.4	36.2	4.09	YES
Zinc	6/6	NA	41 to 573	188	18.1	YES
PAL VOLATILE ORGANICS ($\mu g/g$)						
Tetrachloroethylene	1/1	NA	0.24 to 0.24	0.24	NA	NA
PAL SEMIVOLATILE ORGANICS ($\mu g/g$)						
2-Methylnaphthalene	1/6	0.5 to 5	2.1 to 2.1	1.1	NA	NA
2-Methylphenol	1/6	0.3 to 3	0.35 to 0.35	0.52	NA	NA
4-Methylphenol	1/6	2 to 20	2.2 to 2.2	3.9	NA	NA
Acenaphthene	2/6	0.4 to 4	1 to 3.6	1.4	NA	NA
Acenaphthylene	1/6	0.3 to 3	30 to 30	5.6	NA	NA
Anthracene	4/6	2 to 3	0.6 to 30	6.0	NA	NA
Benzo (a) anthracene	4/6	8 to 20	2 to 60	15	NA	NA
Benzo (a) pyrene	2/6	2 to 20	10 to 60	15	NA	NA
Benzo (b) fluoranthene	4/6	10 to 20	6 to 60	19	NA	NA
Benzo (g,h,i) perylene	1/6	2 to 20	30 to 30	8.5	NA	NA
Benzo (k) fluoranthene	4/6	3 to 7	1 to 70	14	NA	NA
Chrysene	4/6	6 to 10	6 to 90	21	NA	NA
Dibenzo(a,h) anthracene	1/6	2 to 20	1.7 to 1.7	3.6	NA	NA
Dibenzofuran	2/6	0.4 to 4	1 to 2.6	1.2	NA	NA
Fluoranthene	6/6	NA	8 to 100	36	NA	NA

TABLE 5-3
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SEDIMENT[1]
STORM DRAIN SYSTEM NO. 2/3/4

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ANALYTE	Frequency of Detection [2]	Range of Detection Limits	Range of Detected Concentrations	Average of all Concentrations [3]	Upgradient Screening Value [4]	Maximum Exceeds Upgradient?
Fluorene	2/6	0.3 to 3	2 to 8.1	2.2	NA	NA
Naphthalene	1/6	0.4 to 4	3.6 to 3.6	1.3	NA	NA
Phenanthrene	6/6	NA	5 to 100	27	NA	NA
Pyrene	6/6	NA	7 to 200	51	NA	NA
TOTAL PETROLEUM HYDROCARBONS (µg/g)						
Total Petroleum Hydrocarbons	6/6	NA	625 to 5,490	1,943	NA	NA
OTHER (µg/g)						
Total Organic Carbon	6/6	NA	4,490 to 154,000	49,852	NA	NA

TABLE 5-3
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SEDIMENT[1]
STORM DRAIN SYSTEM NO. 2/3/4

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ANALYTE	USEPA SQC[5]	NOAA, 1990 ER-L[6]	NYSDEC Guidelines[7]	Ontario LEL[8]	Range of Ecological Screening Values	Maximum Exceeds Minimum Screening Value?	Maximum Exceeds Maximum Screening Value?
PAL METALS (µg/g)							
Aluminum	NA	NA	NA	NA	NA to NA	NA	NA
Antimony	NA	2	NA	NA	2 to 2	YES	YES
Arsenic	NA	33	5	6	5 to 33	YES	YES
Barium	NA	NA	NA	NA	NA to NA	NA	NA
Cadmium	NA	5	0.8	0.6	0.6 to 5	YES	YES
Calcium	NA	NA	NA	NA	NA to NA	NA	NA
Chromium	NA	80	26	26	26 to 80	YES	YES
Cobalt	NA	NA	NA	50	50 to 50	NO	NO
Copper	NA	70	19	16	16 to 70	YES	YES
Iron	NA	NA	24,000	20,000	20,000 to 24,000	YES	YES
Lead	NA	35	27	31	27 to 35	YES	YES
Magnesium	NA	NA	NA	NA	NA to NA	NA	NA
Manganese	NA	NA	428	460	428 to 460	YES	YES
Mercury	NA	0.15	0.11	0.2	0.11 to 0.2	NO	NO
Nickel	NA	30	22	16	16 to 30	YES	YES
Potassium	NA	NA	NA	NA	NA to NA	NA	NA
Sodium	NA	NA	NA	NA	NA to NA	NA	NA
Vanadium	NA	NA	NA	NA	NA to NA	NA	NA
Zinc	NA	120	85	120	85 to 120	YES	YES
PAL VOLATILE ORGANICS (µg/g)							
Tetrachloroethylene	NA	NA	NA	NA	NA to NA	NA	NA
PAL SEMIVOLATILE ORGANICS (µg/g)							
2-Methylnaphthalene	6.5	0.065	NA	NA	0.065 to 6.5	YES	NO
2-Methylphenol	NA	NA	NA	NA	NA to NA	NA	NA
4-Methylphenol	NA	NA	NA	NA	NA to NA	NA	NA
Acenaphthene	6.5	NA	36.5	NA	6.5 to 36.5	NO	NO
Acenaphthylene	6.5	NA	NA	NA	6.5 to 6.5	YES	YES
Anthracene	6.5	0.085	NA	NA	0.085 to 6.5	YES	YES
Benzo (a) anthracene	65.85	0.23	NA	NA	0.23 to 65.85	YES	NO
Benzo (a) pyrene	53.15	0.4	NA	NA	0.4 to 53.15	YES	YES
Benzo (b) fluoranthene	6.5	NA	NA	NA	6.5 to 6.5	YES	YES
Benzo (g,h,i) perylene	6.5	NA	NA	NA	6.5 to 6.5	YES	YES
Benzo (k) fluoranthene	6.5	NA	NA	NA	6.5 to 6.5	YES	YES
Chrysene	6.5	0.4	NA	NA	0.4 to 6.5	YES	YES
Dibenzo(a,h) anthracene	6.5	0.06	NA	NA	0.06 to 6.5	YES	NO
Dibenzofuran	NA	NA	NA	NA	NA to NA	NA	NA
Fluoranthene	31	0.6	NA	NA	0.6 to 31	YES	YES

TABLE 5-3
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SEDIMENT[1]
STORM DRAIN SYSTEM NO. 2/3/4

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ANALYTE	USEPA SQC [5]	NOAA, 1990 ER-L [6]	NYSDEC Guidelines [7]	Ontario LEL [8]	Range of Ecological Screening Values	Maximum Exceeds Minimum Screening Value?	Maximum Exceeds Maximum Screening Value?
Fluorene	6.5	0.035	NA	NA	0.035 to 6.5	YES	YES
Naphthalene	6.5	0.34	NA	NA	0.34 to 6.5	YES	NO
Phenanthrene	9	0.225	6.95	NA	0.225 to 9	YES	YES
Pyrene	65.55	0.35	NA	NA	0.35 to 65.55	YES	YES
TOTAL PETROLEUM HYDROCARBONS (µg/g)							
Total Petroleum Hydrocarbons	NA	NA	NA	NA	NA to NA	NA	NA
OTHER (µg/g)							
Total Organic Carbon	NA	NA	NA	NA	NA to NA	NA	NA

NOTES:

[1] Based on analytical data from the following six sampling locations: CSD-94-21X through CSD-94-25X; SSD-93-03B.

[2] Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples.

[3] The average of all concentrations assigns a value of 1/2 the detection limit to all non-detects.

[4] Upgradient sediment sample location includes: SSD-93-92C from A.D. Little (1994).

[5] Organic carbon normalized mean values from USEPA (1988 and 1993a,b,c,d) Sediment Quality Criteria (SQC), using 5 % total organic carbon in sediments. Value for acenaphthene was used as a conservative surrogate for all PAHs that do not have published values.

[6] Effects range-low (ER-L) values from Long and Morgan (1990).

[7] New York State Department of Environmental Conservation ([NYSDEC], 1989), organics normalized to 5 % total organic carbon in sediment.

[8] Lowest Effect Level (LEL) values reported in "Guidelines for the Protection and Mangement of Aquatic Sediment Quality in Ontario" (Persaud et al., 1992).

NA = Not available/Not Applicable

ND = Not detected

µg/g = micrograms per gram

TABLE 5-4
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SEDIMENT[1]
SA 57 MARSH

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ANALYTE	Frequency of Detection [2]	Range of Detection Limits	Range of Detected Concentrations	Average of all Concentrations [3]	Upgradient Screening Value [4]	Maximum Exceeds Upgradient?
PAL METALS (µg/g)						
Aluminum	4/4	NA	5,160 to 21,600	10,855	3,080	YES
Arsenic	4/4	NA	11.5 to 26.7	21.5	13.1	YES
Barium	3/4	5.18 to 5.18	37.1 to 84.2	48.9	7.85	YES
Cadmium	1/4	0.7 to 0.7	2.96 to 3	1.01	ND	YES
Calcium	4/4	NA	2,840 to 13,000	7,951	482	YES
Chromium	3/4	4.05 to 4.05	14.6 to 56.7	25.8	6.24	YES
Cobalt	3/4	1.42 to 1.42	5.15 to 10.4	6.0	ND	YES
Copper	4/4	NA	16.2 to 93	48.9	ND	YES
Iron	4/4	NA	5,790 to 22,800	11,913	6,440	YES
Lead	4/4	NA	95 to 248	173	6.31	YES
Magnesium	4/4	NA	1,590 to 5,690	2,796	1,370	YES
Manganese	4/4	NA	41.7 to 473	237	214	YES
Nickel	3/4	1.71 to 1.71	15.3 to 37.2	18.4	3.94	YES
Potassium	3/4	100 to 100	427 to 1,620	663	ND	YES
Selenium	4/4	NA	0.924 to 9.46	3.54	ND	YES
Sodium	4/4	NA	819 to 5,930	2,515	ND	YES
Vanadium	3/4	3.39 to 3.39	16.9 to 41.2	20.4	4.09	YES
Zinc	4/4	NA	124 to 209	169	18.1	YES
PAL VOLATILE ORGANICS (µg/g)						
Acetone	2/4	0.017 to 0.017	0.035 to 0.11	0.043	NA	NA
Toluene	2/4	0.0008 to 0.0008	0.0016 to 0.0047	0.0016	NA	NA
Trichlorofluoromethane	4/4	NA	0.031 to 0.35	0.13	NA	NA
PAL SEMIVOLATILE ORGANICS (µg/g)						
Benzo (k) fluoranthene	1/4	0.3 to 0.7	1 to 1	0.5	NA	NA
Chrysene	1/4	0.6 to 1	1 to 1	0.6	NA	NA
Fluoranthene	2/4	0.7 to 0.7	1 to 3	1.2	NA	NA
Phenanthrene	2/4	0.3 to 0.3	0.8 to 1	0.5	NA	NA
Pyrene	2/4	0.3 to 0.3	2 to 3	1.2	NA	NA
PAL PESTICIDES/PCBs (µg/g)						
DDD	1/1	NA	0.04 to 0.041	0.041	NA	NA
DDE	1/1	NA	0.0338 to 0.035	0.034	NA	NA
DDT	1/1	NA	0.083 to 0.09	0.087	NA	NA
Aroclor-1260	1/1	NA	0.243 to 0.309	0.276	NA	NA
Chlordane-alpha	1/1	NA	0.0123 to 0.013	0.013	NA	NA
Chlordane-gamma	1/1	NA	0.0276 to 0.0298	0.029	NA	NA
Dieldrin	1/1	NA	0.0298 to 0.0311	0.031	NA	NA

TABLE 5-4
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SEDIMENT[1]
SA 57 MARSH

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ANALYTE	Frequency of Detection [2]	Range of Detection Limits	Range of Detected Concentrations	Average of all Concentrations [3]	Upgradient Screening Value [4]	Maximum Exceeds Upgradient?
TOTAL PETROLEUM HYDROCARBONS ($\mu g/g$)						
Total Petroleum Hydrocarbons	4/4	NA	251 to 2,700	1,059	NA	NA
OTHER ($\mu g/g$)						
Total Organic Carbon	4/4	NA	56,700 to 266,000	133,138	NA	NA

TABLE 5-4
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SEDIMENT[1]
SA 57 MARSH

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ANALYTE	USEPA SQC[5]	NOAA, 1990 ER-L[6]	NYSDEC Guidelines[7]	Ontario LEL[8]	Range of Ecological Screening Values	Maximum Exceeds Minimum Screening Value?	Maximum Exceeds Maximum Screening Value?
PAL METALS (µg/g)							
Aluminum	NA	NA	NA	NA	NA to NA	NA	NA
Arsenic	NA	33	5	6	5 to 33	YES	NO
Barium	NA	NA	NA	NA	NA to NA	NA	NA
Cadmium	NA	5	0.8	0.6	0.6 to 5	YES	NO
Calcium	NA	NA	NA	NA	NA to NA	NA	NA
Chromium	NA	80	26	26	26 to 80	YES	NO
Cobalt	NA	NA	NA	50	50 to 50	NO	NO
Copper	NA	70	19	16	16 to 70	YES	YES
Iron	NA	NA	24,000	20,000	20,000 to 24,000	YES	NO
Lead	NA	35	27	31	27 to 35	YES	YES
Magnesium	NA	NA	NA	NA	NA to NA	NA	NA
Manganese	NA	NA	428	460	428 to 460	YES	YES
Nickel	NA	30	22	16	16 to 30	YES	YES
Potassium	NA	NA	NA	NA	NA to NA	NA	NA
Selenium	NA	NA	NA	NA	NA to NA	NA	NA
Sodium	NA	NA	NA	NA	NA to NA	NA	NA
Vanadium	NA	NA	NA	NA	NA to NA	NA	NA
Zinc	NA	120	85	120	85 to 120	YES	YES
PAL VOLATILE ORGANICS (µg/g)							
Acetone	NA	NA	NA	NA	NA to NA	NA	NA
Toluene	NA	NA	NA	NA	NA to NA	NA	NA
Trichlorofluoromethane	NA	NA	NA	NA	NA to NA	NA	NA
PAL SEMIVOLATILE ORGANICS (µg/g)							
Benzo (k) fluoranthene	16.9	NA	NA	NA	16.9 to 16.9	NO	NO
Chrysene	16.9	0.4	NA	NA	0.4 to 16.9	YES	NO
Fluoranthene	80.6	0.6	NA	NA	0.6 to 80.6	YES	NO
Phenanthrene	23.4	0.225	18.1	NA	0.225 to 23.4	YES	NO
Pyrene	170	0.35	NA	NA	0.35 to 170	YES	NO
PAL PESTICIDES/PCBs (µg/g)							
DDD	0.108	0.002	6.5	0.008	0.002 to 6.5	YES	NO
DDE	0.108	0.002	6.5	0.005	0.002 to 6.5	YES	NO
DDT	0.108	0.001	6.5	0.008	0.001 to 6.5	YES	NO
Aroclor-1260	2.5	NA	NA	0.005	0.005 to 2.5	YES	NO
Chlordane-alpha	NA	0.0005	0.0008	0.007	0.0005 to 0.007	YES	YES
Chlordane-gamma	NA	0.0005	0.0008	0.007	0.0005 to 0.007	YES	YES
Dieldrin	1.43	0.00002	2.535	0.002	0.00002 to 2.5	YES	NO

VOLAT
Acetone
Toluene
Trichloro

SEMIV(
Benzo (k'
Chrysene
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Phenanth
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PESTIC
4,4'-DD
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4,4'-DD
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TABLE 5-4
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SEDIMENT[1]
SA 57 MARSH

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ANALYTE	USEPA SQC [5]	NOAA, 1990 ER-L [6]	NYSDEC Guidelines [7]	Ontario LEL [8]	Range of Ecological Screening Values	Maximum Exceeds Minimum Screening Value?	Maximum Exceeds Maximum Screening Value?
TOTAL PETROLEUM HYDROCARBONS (µg/g)							
Total Petroleum Hydrocarbons	NA	NA	NA	NA	NA to NA	NA	NA
OTHER (µg/g)							
Total Organic Carbon	NA	NA	NA	NA	NA to NA	NA	NA

NOTES:

[1] Based on analytical data from the following four sampling locations: CSD-94-14X, CSD-94-17X, CSD-94-20X, and CSD-94-35X. Pesticides/PCBs were analyzed at CSD-94-20X (and a duplicate) only.

[2] Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples.

[3] The average of all concentrations assigns a value of 1/2 the detection limit to all non-detects.

[4] Upgradient sediment sample location includes: SSD-93-92C from A.D. Little (1994).

[5] Organic carbon normalized mean values from USEPA (1988 and 1993a,b,c,d) Sediment Quality Criteria (SQC), using 13 % total organic carbon in sediments. Value for acenaphthene was used as a conservative surrogate for all PAHs that do not have published values.
Value for DDT used for DDD and DDE.

[6] Effects range-low (ER-L) values from Long and Morgan (1990).

[7] New York State Department of Environmental Conservation ([NYSDEC], 1989), organics normalized to 13 % total organic carbon in sediment.
Value for DDT used for DDD and DDE.

[8] Lowest Effect Level (LEL) values reported in "Guidelines for the Protection and Mangement of Aquatic Sediment Quality in Ontario" (Persaud et al., 1992).

NA = Not available/Not Applicable

ND = Not detected

µg/g = micrograms per gram

TABLE 5–5
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SURFACE SOIL[1]
STORM DRAIN SYSTEM NO. 6

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ANALYTE	Frequency of Detection [2]	Range of Detection Limits	Range of Detected Concentrations	Average of all Concentrations [3]	Background Screening Value [4]	Maximum Exceeds Background?
PAL METALS (µg/g)						
Barium	1/1	NA	24 to 69	46.5	42.5	YES
Cadmium	1/1	NA	3.82 to 3.82	2.21	2	YES
Calcium	1/1	NA	1,190 to 1,760	1,475	1,400	YES
Chromium	1/1	NA	27.1 to 64.6	45.9	31	YES
Cobalt	1/1	NA	4.23 to 7.39	5.81	ND	YES
Copper	1/1	NA	40.7 to 105	72.9	8.39	YES
Iron	1/1	NA	14,900 to 21,800	18,350	15,000	YES
Lead	1/1	NA	140 to 420	280	34.4	YES
Manganese	1/1	NA	184 to 320	252	300	YES
Nickel	1/1	NA	14.1 to 22.8	18.5	14	YES
Sodium	1/1	NA	76.2 to 138	107	131	YES
Tin	1/1	NA	13.5 to 13.5	8.61	NE	YES
Vanadium	1/1	NA	16.8 to 36.8	26.8	28.7	YES
Zinc	1/1	NA	83.1 to 189	136	35.5	YES
PAL SEMIVOLATILE ORGANIC COMPOUNDS (µg/g)						
2–Methylnaphthalene	1/4	1 to 2	0.15 to 0.19	0.67	NA	NA
Acenaphthene	1/4	0.7 to 1	0.18 to 0.22	0.39	NA	NA
Acenaphthylene	1/4	0.7 to 1	2.7 to 3.2	1.1	NA	NA
Anthracene	1/4	0.7 to 1	2.5 to 3	1.03	NA	NA
Benzo (a) anthracene	1/4	3 to 7	2.7 to 3.5	2.9	NA	NA
Benzo (a) pyrene	1/4	5 to 10	3.1 to 4.1	4.0	NA	NA
Benzo (b) fluoranthene	1/4	4 to 8	3.5 to 4.9	3.6	NA	NA
Benzo (g,h,i) perylene	1/4	5 to 10	3.1 to 4.9	4.1	NA	NA
Benzo (k) fluoranthene	3/4	1 to 1	3 to 4	2.95	NA	NA
Bis(2–ethylhexyl)phthalate	1/4	10 to 20	1.4 to 1.4	6.5	NA	NA
Chrysene	3/4	2 to 2	3.3 to 5	3.7	NA	NA
Dibenzo(a,h) anthracene	1/4	4 to 8	0.83 to 0.83	2.6	NA	NA
Di–n–butylphthalate	1/4	1 to 2	6.2 to 9.3	2.2	NA	NA
Fluoranthene	3/4	1 to 1	4 to 10	6.03	NA	NA
Fluorene	1/4	0.7 to 1	0.61 to 0.61	0.42	NA	NA
Phenanthrene	3/4	0.7 to 0.7	3.2 to 4.6	3.1	NA	NA
Pyrene	3/4	0.7 to 0.7	4.6 to 10	6.4	NA	NA

TABLE 5-5
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SURFACE SOIL[1]
STORM DRAIN SYSTEM NO. 6

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ANALYTE	Frequency of Detection [2]	Range of Detection Limits	Range of Detected Concentrations	Average of all Concentrations [3]	Background Screening Value [4]	Maximum Exceeds Background?
TOTAL PETROLUEM HYDROCARBONS (µg/g)						
Total Petroleum Hydrocarbons	4/4	NA	1,410 to 3,500	2,133	NA	NA
OTHER (µg/g)						
Total Organic Carbon	4/4	NA	18,400 to 75,000	35,650	NA	NA

TABLE 5-5
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SURFACE SOIL[1]
STORM DRAIN SYSTEM NO. 6

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ANALYTE	Vertebrate Screening Value[5]	Maximum Exceeds Ecological Screening Value?	Phytotoxicity Screening Value[6]	Maximum Exceeds Phytotoxicity Screening Value?	Invertebrate Screening Value[7]	Maximum Exceeds Invertebrate Screening Value?
PAL METALS (µg/g)						
Barium	6,500	NO	500	NO	NA	NA
Cadmium	2.9	YES	2	YES	50	NO
Calcium	NA	NA	NA	NA	NA	NA
Chromium	15,000	NO	NA	NA	50	YES
Cobalt	46	NO	25	NO	NA	NA
Copper	1,000	NO	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA
Lead	190	YES	NA	NA	1,190	NO
Manganese	5,700	NO	500	NO	NA	NA
Nickel	410	NO	25	NO	400	NO
Sodium	NA	NA	NA	NA	NA	NA
Tin	31	NO	NA	NA	NA	NA
Vanadium	200	NO	NA	NA	NA	NA
Zinc	240	NO	NA	NA	130	YES
PAL SEMIVOLATILE ORGANIC COMPOUNDS (µg/g)						
2-Methylnaphthalene	214	NO	NA	NA	34	NO
Acenaphthene	214	NO	NA	NA	34	NO
Acenaphthylene	214	NO	NA	NA	34	NO
Anthracene	214	NO	NA	NA	34	NO
Benzo (a) anthracene	214	NO	NA	NA	34	NO
Benzo (a) pyrene	214	NO	NA	NA	34	NO
Benzo (b) fluoranthene	214	NO	NA	NA	34	NO
Benzo (g,h,i) perylene	214	NO	NA	NA	34	NO
Benzo (k) fluoranthene	214	NO	NA	NA	34	NO
Bis(2-ethylhexyl)phthalate	750	NO	200	NO	630	NO
Chrysene	214	NO	NA	NA	34	NO
Dibenzo(a,h) anthracene	214	NO	NA	NA	34	NO
Di-n-butylphthalate	2,691	NO	200	NO	630	NO
Fluoranthene	214	NO	NA	NA	34	NO
Fluorene	214	NO	NA	NA	34	NO
Phenanthrene	214	NO	NA	NA	34	NO
Pyrene	214	NO	NA	NA	34	NO

TABLE 5–5
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SURFACE SOIL[1]
STORM DRAIN SYSTEM NO. 6

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ANALYTE	Vertebrate Screening Value [5]	Maximum Exceeds Ecological Screening Value?	Phytotoxicity Screening Value [6]	Maximum Exceeds Phytotoxicity Screening Value?	Invertebrate Screening Value [7]	Maximum Exceeds Invertebrate Screening Value?
TOTAL PETROLUEM HYDROCARBONS (µg/g)						
Total Petroleum Hydrocarbons	NA	NA	NA	NA	NA	NA
OTHER (µg/g)						
Total Organic Carbon	NA	NA	NA	NA	NA	NA

NOTES:

[1] Based on analytical data from the following four sampling locations: 57S–92–01X through 57S–92–03X, and SSD–93–06B. Inorganics were analyzed in SSD–93–06B and a duplicate only.

[2] Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples.

[3] The average of all concentrations assigns a value of 1/2 the detection limit to all non–detects.

[4] Background values from RI Addendum Report for Group 1A Sites (ABB–ES, 1993c).

[5] Screening values are Protective Contaminant Levels (PCLs) from Table B–5, and are derived as described in Appendix B. The value presented represents the lowest PCL for the shrew, woodcock, fox, or hawk.

[6] Phytotoxicity Screening Values from Suter et al., 1993 unless otherwise noted. The screening value is the lowest Lowest Observed Effect Level (LOEL) from among plant growth studies conducted in solid media.

[7] Invertebrate Screening Value from Neuhauser et al., 1985 unless otherwise noted. For organic compounds, the screening value is the lowest LC_{50} (14–day soil test on *Eisenia foetida*) from among chemicals in the same chemical class; a conservative factor of 0.2 was applied and the resultant value should be protective of 99.9% of the population from acute effects (USEPA, 1986b).

NA = Not available/Not applicable

ND = Not Detected

µg/g = micrograms per gram

TABLE 5-6
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SEDIMENT[1]
STORM DRAIN SYSTEM NO. 7

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ANALYTE	Frequency of Detection [2]	Range of Detection Limits	Range of Detected Concentrations	Average of all Concentrations [3]	Upgradient Screening Value [4]	Maximum Exceeds Upgradient?
PAL METALS (µg/g)						
Aluminum	6/6	NA	2,670 to 20,900	9,366	3,080	YES
Arsenic	6/6	NA	9.75 to 41.6	21.4	13.1	YES
Barium	6/6	NA	9.65 to 545	134	7.85	YES
Beryllium	2/6	0.427 to 0.5	3.37 to 8.35	1.85	ND	YES
Cadmium	2/6	0.7 to 1.2	6.43 to 10.6	2.61	ND	YES
Calcium	6/6	NA	1,020 to 6,910	3,668	482	YES
Chromium	4/6	4.05 to 4.05	9.64 to 40.5	17.2	6.24	YES
Cobalt	6/6	NA	4.32 to 298	68.6	ND	YES
Copper	6/6	NA	7.31 to 36.2	19.0	ND	YES
Iron	6/6	NA	4,790 to 67,800	23,229	6,440	YES
Lead	6/6	NA	17 to 212	94.1	6.31	YES
Magnesium	6/6	NA	817 to 4,600	2,217	1,370	YES
Manganese	6/6	NA	189 to 25,000	5,267	214	YES
Nickel	6/6	NA	13.7 to 145	51.4	3.94	YES
Potassium	3/6	100 to 131	544 to 1,290	486	ND	YES
Selenium	1/6	0.25 to 0.449	2.18 to 2.18	0.33	ND	YES
Sodium	6/6	NA	67.2 to 1,980	648	ND	YES
Vanadium	5/6	3.39 to 3.39	10.8 to 27.4	15.7	4.09	YES
Zinc	6/6	NA	46.9 to 604	186	18.1	YES
PAL SEMIVOLATILE ORGANICS (µg/g)						
Acenaphthylene	1/6	0.033 to 0.3	0.36 to 0.36	0.11	NA	NA
Benzo (a) anthracene	1/6	0.041 to 2	0.64 to 0.64	0.37	NA	NA
Benzo (k) fluoranthene	3/6	0.066 to 0.7	0.48 to 3	0.74	NA	NA
Chrysene	3/6	0.032 to 1	0.84 to 3	0.82	NA	NA
Di-n-butylphthalate	2/6	0.061 to 0.6	5.5 to 22	4.7	NA	NA
Fluoranthene	6/6	NA	0.27 to 6	2.0	NA	NA
Phenanthrene	5/6	0.032 to 0.032	0.16 to 3	1.2	NA	NA
Pyrene	5/6	0.083 to 0.083	0.28 to 5	1.7	NA	NA

TABLE 5–6
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SEDIMENT[1]
STORM DRAIN SYSTEM NO. 7

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ANALYTE	Frequency of Detection [2]	Range of Detection Limits	Range of Detected Concentrations	Average of all Concentrations [3]	Upgradient Screening Value [4]	Maximum Exceeds Upgradient?
TOTAL PETROLEUM HYDROCARBONS (µg/g)						
Total Petroleum Hydrocarbons	6/6	NA	219 to 2,320	859	NA	NA
OTHER (µg/g)						
Total Organic Carbon	5/5	NA	9,600 to 199,000	56,920	NA	NA

TABLE 5-6
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SEDIMENT[1]
STORM DRAIN SYSTEM NO. 7

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ANALYTE	USEPA SQC[5]	NOAA, 1990 ER-L[6]	NYSDEC Guidelines[7]	Ontario LEL[8]	Range of Ecological Screening Values	Maximum Exceeds Minimum Screening Value?	Maximum Exceeds Maximum Screening Value?
PAL METALS (µg/g)							
Aluminum	NA	NA	NA	NA	NA to NA	NA	NA
Arsenic	NA	33	5	6	5 to 33	YES	YES
Barium	NA	NA	NA	NA	NA to NA	NA	NA
Beryllium	NA	NA	NA	NA	NA to NA	NA	NA
Cadmium	NA	5	0.8	0.6	0.6 to 5	YES	YES
Calcium	NA	NA	NA	NA	NA to NA	NA	NA
Chromium	NA	80	26	26	26 to 80	YES	NO
Cobalt	NA	NA	NA	50	50 to 50	YES	YES
Copper	NA	70	19	16	16 to 70	YES	NO
Iron	NA	NA	24,000	20,000	20,000 to 24,000	YES	YES
Lead	NA	35	27	31	27 to 35	YES	YES
Magnesium	NA	NA	NA	NA	NA to NA	NA	NA
Manganese	NA	NA	428	460	428 to 460	YES	YES
Nickel	NA	30	22	16	16 to 30	YES	YES
Potassium	NA	NA	NA	NA	NA to NA	NA	NA
Selenium	NA	NA	NA	NA	NA to NA	NA	NA
Sodium	NA	NA	NA	NA	NA to NA	NA	NA
Vanadium	NA	NA	NA	NA	NA to NA	NA	NA
Zinc	NA	120	85	120	85 to 120	YES	YES
PAL SEMIVOLATILE ORGANICS (µg/g)							
Acenaphthylene	6.5	NA	NA	NA	6.5 to 6.5	NO	NO
Benzo (a) anthracene	65.9	0.23	NA	NA	0.23 to 66	YES	NO
Benzo (k) fluoranthene	6.5	NA	NA	NA	6.5 to 6.5	NO	NO
Chrysene	6.5	0.4	NA	NA	0.4 to 6.5	YES	NO
Di-n-butylphthalate	NA	NA	NA	NA	NA to NA	NA	NA
Fluoranthene	31	0.6	NA	NA	0.6 to 31	YES	NO
Phenanthrene	9	0.225	6.95	NA	0.225 to 9	YES	NO
Pyrene	65.6	0.35	NA	NA	0.35 to 66	YES	NO

TABLE 5-6
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SEDIMENT[1]
STORM DRAIN SYSTEM NO. 7

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ANALYTE	USEPA SQC [5]	NOAA, 1990 ER-L [6]	NYSDEC Guidelines [7]	Ontario LEL [8]	Range of Ecological Screening Values	Maximum Exceeds Minimum Screening Value?	Maximum Exceeds Maximum Screening Value?
TOTAL PETROLEUM HYDROCARBONS (µg/g)							
Total Petroleum Hydrocarbons	NA	NA	NA	NA	NA to NA	NA	NA
OTHER (µg/g)							
Total Organic Carbon	NA	NA	NA	NA	NA to NA	NA	NA

NOTES:

[1] Based on analytical data from the following six sampling locations: CSD-94-04X through CSD-94-07X; SSD-93-07A and SSD-93-07B.

[2] Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples.

[3] The average of all concentrations assigns a value of 1/2 the detection limit to all non-detects.

[4] Upgradient screening concentration is sample location SSD-93-92C from A.D. Little (1994).

[5] Organic carbon normalized mean values from USEPA (1988 and 1993a,b,c,d) Sediment Quality Criteria (SQC), using 5 % total organic carbon in sediments. Value for acenaphthene was used as a cons surrogate for all PAHs that do not have published values.

[6] Effects range-low (ER-L) values from Long and Morgan (1990).

[7] New York State Department of Environmental Conservation ([NYSDEC], 1989), organics normalized to 5 % total organic carbon in sediment.

[8] Lowest Effect Level (LEL) values reported in "Guidelines for the Protection and Mangement of Aquatic Sediment Quality in Ontario" (Persaud et al., 1992).

NA = Not available/Not Applicable

ND = Not detected

µg/g = micrograms per gram

TABLE 5-7
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SURFACE SOIL[1]
STORM DRAIN SYSTEM NO. 8

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ANALYTE	Frequency of Detection [2]	Detection Limits	Detected Concentrations	Background Screening Value [3]	Concentration Exceeds Background?
PAL METALS (µg/g)					
Barium	1/1	NA	49.2	42.5	YES
Beryllium	1/1	NA	0.945	0.347	YES
Calcium	1/1	NA	1,510	1,400	YES
Chromium	1/1	NA	38	31	YES
Cobalt	1/1	NA	13.8	ND	NA
Copper	1/1	NA	26	8.39	YES
Iron	1/1	NA	19,200	15,000	YES
Lead	1/1	NA	110	34.4	YES
Manganese	1/1	NA	595	300	YES
Nickel	1/1	NA	17.9	14	YES
Zinc	1/1	NA	190	35.5	YES
PAL SEMIVOLATILE ORGANICS (µg/g)					
Chrysene	1/1	NA	0.4	NA	NA
Di-n-butylphthalate	1/1	NA	2.1	NA	NA
Fluoranthene	1/1	NA	0.53	NA	NA
Phenanthrene	1/1	NA	0.48	NA	NA
Pyrene	1/1	NA	0.45	NA	NA
TOTAL PETROLUEM HYDROCARBONS (µg/g)					
Total Petroleum Hydrocarbons	1/1	NA	780	NA	NA
OTHER (µg/g)					
Total Organic Carbon	1/1	NA	66,000	NA	NA

TABLE 5-7
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SURFACE SOIL[1]
STORM DRAIN SYSTEM NO. 8

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ANALYTE	Vertebrate Screening Value [4]	Concentration Exceeds Ecological Screening Value?	Phytotoxicity Screening Value [5]	Concentration Exceeds Phytotoxicity Screening Value?	Invertebrate Screening Value [6]	Concentration Exceeds Invertebrate Screening Value?
PAL METALS (µg/g)						
Barium	6,500	NO	500	NO	NA	NA
Beryllium	220	NO	10	NO	NA	NA
Calcium	NA	NA	NA	NA	NA	NA
Chromium	15,000	NO	NA	NA	50	NO
Cobalt	46	NO	25	NO	NA	NA
Copper	1,000	NO	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA
Lead	190	NO	NA	NA	1,190	NO
Manganese	5,700	NO	500	YES	NA	NA
Nickel	410	NO	25	NO	400	NO
Zinc	240	NO	NA	NA	130	YES
PAL SEMIVOLATILE ORGANICS (µg/g)						
Chrysene	214	NO	NA	NA	34	NO
Di-n-butylphthalate	2,691	NO	200	NO	630	NO
Fluoranthene	214	NO	NA	NA	34	NO
Phenanthrene	214	NO	NA	NA	34	NO
Pyrene	214	NO	NA	NA	34	NO
TOTAL PETROLUEM HYDROCARBONS (µg/g)						
Total Petroleum Hydrocarbons	NA	NA	NA	NA	NA	NA
OTHER (µg/g)						
Total Organic Carbon	NA	NA	NA	NA	NA	NA

NOTES:

[1] Based on analytical data from the following sampling location: SSD-93-08A.

[2] Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples.

[3] Background values from RI Addendum Report for Group 1A Sites (ABB-ES, 1993c).

[4] Screening values are Protective Contaminant Levels (PCLs) from Table B-5, and are derived as described in Appendix B. The value presented represents the lowest PCL for the shrew, woodcock, fox, or hawk.

[5] Phytotoxicity Screening Values from Suter et al., 1993 unless otherwise noted. The screening value is the lowest Lowest Observed Effect Level (LOEL) from among plant growth studies conducted in solid media.

[6] Invertebrate Screening Value from Neuhauser et al., 1985 unless otherwise noted. For organic compounds, the screening value is the lowest LC_{50} (14-day soil test on *Eisenia foetida*) from among chemicals in the same chemical class; a conservative factor of 0.2 was applied and the resultant value should be protective of 99.9% of the population from acute effects (USEPA, 1986b).

NA = Not available/Not applicable

ND = Not Detected

µg/g = micrograms per gram

TABLE 5–8
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SEDIMENT[1]
STORM DRAIN SYSTEM NO. 9

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ANALYTE	Frequency of Detection [2]	Detection Limits	Detected Concentrations	Upgradient Screening Value [3]	Concentration Exceeds Upgradient?
PAL METALS (µg/g)					
Aluminum	1/1	NA	5,850	3,080	YES
Arsenic	1/1	NA	17.5	13.1	YES
Barium	1/1	NA	19.5	7.85	YES
Calcium	1/1	NA	1,080	482	YES
Chromium	1/1	NA	17.4	6.24	YES
Cobalt	1/1	NA	3.14	ND	NA
Copper	1/1	NA	11.1	ND	NA
Iron	1/1	NA	14,200	6,440	YES
Lead	1/1	NA	53	6.31	YES
Magnesium	1/1	NA	3,030	1,370	YES
Manganese	1/1	NA	108	214	NO
Nickel	1/1	NA	13.6	3.94	YES
Potassium	1/1	NA	672	ND	NA
Sodium	1/1	NA	98	ND	NA
Vanadium	1/1	NA	12.6	4.09	YES
Zinc	1/1	NA	43.6	18.1	YES
PAL SEMIVOLATILE ORGANICS (µg/g)					
Benzo (a) anthracene	1/1	NA	2	NA	NA
Chrysene	1/1	NA	3	NA	NA
TOTAL PETROLEUM HYDROCARBONS (µg/g)					
Total Petroleum Hydrocarbons	1/1	NA	270	NA	NA
OTHER (µg/g)					
Total Organic Carbon	1/1	NA	51,000	NA	NA

TABLE 5–8
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SEDIMENT[1]
STORM DRAIN SYSTEM NO. 9

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ANALYTE	USEPA SQC [4]	NOAA, 1990 ER–L [5]	NYSDEC Guidelines [6]	Ontario LEL[7]	Range of Ecological Screening Values	Concentration Exceeds Minimum Screening Value?	Concentration Exceeds Maximum Screening Value?
PAL METALS (µg/g)							
Aluminum	NA	NA	NA	NA	NA to NA	NA	NA
Arsenic	NA	33	5	6	5 to 33	YES	NO
Barium	NA	NA	NA	NA	NA to NA	NA	NA
Calcium	NA	NA	NA	NA	NA to NA	NA	NA
Chromium	NA	80	26	26	26 to 80	NO	NO
Cobalt	NA	NA	NA	50	50 to 50	NO	NO
Copper	NA	70	19	16	16 to 70	NO	NO
Iron	NA	NA	24,000	20,000	20,000 to 24,000	NO	NO
Lead	NA	35	27	31	27 to 35	YES	YES
Magnesium	NA	NA	NA	NA	NA to NA	NA	NA
Manganese							
Nickel	NA	30	22	16	16 to 30	NO	NO
Potassium	NA	NA	NA	NA	NA to NA	NA	NA
Sodium	NA	NA	NA	NA	NA to NA	NA	NA
Vanadium	NA	NA	NA	NA	NA to NA	NA	NA
Zinc	NA	120	85	120	85 to 120	NO	NO
PAL SEMIVOLATILE ORGANICS (µg/g)							
Benzo (a) anthracene	65.9	0.23	NA	NA	0.23 to 65.9	YES	NO
Chrysene	6.5	0.4	NA	NA	0.4 to 6.5	YES	NO
TOTAL PETROLEUM HYDROCARBONS (µg/g)							
Total Petroleum Hydrocarbons	NA	NA	NA	NA	NA to NA	NA	NA
OTHER (µg/g)							
Total Organic Carbon	NA	NA	NA	NA	NA to NA	NA	NA

NOTES:

[1] Based on analytical data from the following sampling location: SSD–93–09A.

[2] Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples.

[3] Upgradient sediment sample location includes: SSD–93–92C from A.D. Little (1994).

[4] Organic carbon normalized mean values from USEPA (1988 and 1993a,b,c,d) Sediment Quality Criteria (SQC), using 5 % total organic carbon in sediments. Value for acenaphthene was used as a conser surrogate for all PAHs that do not have published values.

[5] Effects range–low (ER–L) values from Long and Morgan (1990).

[6] New York State Department of Environmental Conservation ([NYSDEC], 1989), organics normalized to 5 % total organic carbon in sediment.

[7] Lowest Effect Level (LEL) values reported in "Guidelines for the Protection and Mangement of Aquatic Sediment Quality in Ontario" (Persaud et al., 1992).

NA = Not available/Not Applicable

ND = Not detected

µg/g = micrograms per gram

TABLE 5-9
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SEDIMENT[1]
UPSTREAM SECTION OF COLD SPRING BROOK

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ANALYTE	Frequency of Detection[2]	Range of Detection Limits	Range of Detected Concentrations	Average of all Concentrations[3]	Background Concentration[4]	Maximum Exceeds Background?
SEMIVOLATILE ORGANIC COMPOUNDS (µg/g)						
2-Methylnaphthalene	1/5	0.032 to 0.5	0.2 to 0.2	0.1	NA	NA
Acenaphthylene	2/5	0.033 to 0.3	0.12 to 0.9	0.2	NA	NA
Anthracene	1/5	0.033 to 1	0.19 to 0.19	0.24	NA	NA
Benzo (a) anthracene	2/5	0.041 to 2	1 to 7	2	NA	NA
Benzo (a) pyrene	1/5	0.25 to 2	0.74 to 0.74	0.69	NA	NA
Benzo (b) fluoranthene	2/5	0.21 to 2	0.68 to 10	2.4	NA	NA
Benzo (g,h,i) perylene	1/5	0.18 to 2	0.38 to 0.38	0.36	NA	NA
Benzo (k) fluoranthene	3/5	0.13 to 0.7	0.15 to 4	1	NA	NA
Carbazole	1/3	0.1 to 1	0.28 to 0.28	0.28	NA	NA
Chrysene	3/5	0.032 to 1	0.25 to 8	2	NA	NA
Fluoranthene	4/5	0.032 to 0.032	0.29 to 9	3	NA	NA
Fluorene	2/5	0.033 to 0.3	0.16 to 2	0.5	NA	NA
Hexadecanoic acid	2/2	NA to NA	2 to 4	3	NA	
Indeno (1,2,3-cd) pyrene	1/5	0.29 to 5	0.4 to 0.4	1.1	NA	NA
Naphthalene	1/5	0.037 to 1	0.073 to 0.073	0.232	NA	NA
Octadecanoic Acid	1/1	NA to NA	0.81 to 0.81	0.81	NA	
Phenanthrene	4/5	0.032 to 0.032	0.15 to 10	3.0	NA	NA
Pyrene	4/5	0.083 to 0.083	0.4 to 10	3.8	NA	NA
PESTICIDES/PCBs (µg/g)						
4,4'-DDD	4/4	NA to NA	0 to 0.56	0.18	NA	NA
4,4'-DDE	3/4	0.0027 to 0.0027	0 to 0.16	0.05	NA	NA
4,4'-DDT	3/4	0.0035 to 0.0035	0 to 0.15	0.05	NA	NA
gamma-Chlordane	1/2	0.005 to 0.005	0.0716 to 0.0716	0.0371	NA	NA
Dieldrin	1/4	0.0016 to 0.0063	0.0135 to 0.0135	0.0051	NA	NA
Endosulfan II	1/4	0.0007 to 0.0066	0.0031 to 0.0031	0.0025	NA	NA
INORGANICS (µg/g)						
Aluminum	5/5	NA to NA	1,720 to 13100	5,050	3080	YES
Arsenic	5/5	NA to NA	9 to 62	22	13.1	YES
Barium	4/5	5.18 to 5.18	11 to 117	32.6	7.85	YES

TABLE 5-9
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SEDIMENT[1]
UPSTREAM SECTION OF COLD SPRING BROOK

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ANALYTE	Frequency of Detection[2]	Range of Detection Limits	Range of Detected Concentrations	Average of all Concentrations[3]	Background Concentration[4]	Maximum Exceeds Background?
Calcium	5/5	NA to NA	408 to 6780	1,929	482	11 NA
Chromium	4/5	4.05 to 4.05	5.51 to 48	16	6.24	YES
Cobalt	3/5	1.42 to 2.5	3 to 23.2	7.55	ND	YES
Copper	4/5	2.84 to 2.84	3 to 48.8	13.7	ND	YES
Iron	5/5	NA to NA	3450 to 28700	10,818	6440	YES
Lead	5/5	NA to NA	5.48 to 241	68.4	6.31	YES
Magnesium	5/5	NA to NA	637 to 4130	1,952	1370	[11] NA
Manganese	5/5	NA to NA	62 to 861	404	214	YES
Mercury	1/5	0.05 to 0.05	0.247 to 0.247	0.0694	ND	YES
Nickel	5/5	NA to NA	4.12 to 33.5	16.5	3.94	YES
Potassium	5/5	NA to NA	194 to 1380	499	ND	[11] NA
Selenium	1/5	0.25 to 0.449	2 to 1.78	0.496	ND	YES
Sodium	3/5	38.7 to 38.7	409 to 1900	570	ND	[11] NA
Vanadium	4/5	3.39 to 3.39	3.31 to 34.3	11.1	4.09	YES
Zinc	5/5	NA to NA	15.2 to 332	94	18.1	YES
TOTAL PETROLEUM HYDROCARBONS (µg/g)						
Total Petroleum Hydrocarbons	5/5	NA to NA	61 to 2120	627	NA	NA
OTHER (µg/g)						
Total Organic Carbon	5/5	NA to NA	2080 to 120000	35,136	NA	NA

TABLE 5-9
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SEDIMENT[1]
UPSTREAM SECTION OF COLD SPRING BROOK

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ANALYTE	USEPA SQC[5] (mg/kg)	NOAA, 1990 ER-L[6] (mg/kg)	NOAA, 1993 ER-L[6] (mg/kg)	NYSDEC Guidelines[7] (mg/kg)	Ontario LEL[8] (mg/kg)	Range of Ecological Screening Values	Maximum Exceeds Minimum Screening Value?	Maximum Exceeds Maximum Screening Value?
SEMIVOLATILE ORGANIC COMPOUNDS (µg/g)								
2-Methylnaphthalene	4.55	0.065	0.07	NA	NA	0.065 to 4.55	YES	NO
Acenaphthylene	4.55	NA	0.044	NA	NA	0.044 to 4.55	YES	NO
Anthracene	4.55	0.085	0.0853	NA	NA	0.085 to 4.55	YES	NO
Benzo (a) anthracene	46.095	0.23	0.261	NA	NA	0 to 46.095	YES	NO
Benzo (a) pyrene	37.205	0.4	0.43	NA	NA	0.4 to 37.205	YES	NO
Benzo (b) fluoranthene	4.55	NA	NA	NA	NA	4.55 to 4.55	YES	YES
Benzo (g,h,i) perylene	4.55	NA	NA	NA	NA	4.55 to 4.55	NO	NO
Benzo (k) fluoranthene	4.55	NA	NA	NA	NA	4.55 to 4.55	NO	NO
Carbazole	NA	NA	NA	NA	NA	NA to NA	NA	NA
Chrysene	4.55	0.4	0.384	NA	NA	0.384 to 4.55	YES	YES
Fluoranthene	21.7	0.6	0.6	NA	NA	0.6 to 21.7	YES	NO
Fluorene	4.55	0.035	0.019	NA	NA	0.019 to 4.55	YES	NO
Hexadecanoic acid	NA	NA	NA	NA	NA	NA to NA	NA	NA
Indeno (1,2,3-cd) pyrene	4.55	NA	NA	NA	NA	4.6 to 4.55	NO	NO
Naphthalene	4.55	0.34	0.16	NA	NA	0.16 to 4.55	NO	NO
Octadecanoic Acid	NA	NA	NA	NA	NA	NA to NA	NA	NA
Phenanthrene	6.3	0.225	0.24	4.865	NA	0.225 to 6.3	YES	YES
Pyrene	45.885	0.35	0.665	NA	NA	0.35 to 45.885	YES	NO
PESTICIDES/PCBs (µg/g)								
4,4'-DDD	[9] 0.029	0.002	NA	1.75	0.008	0 to 1.75	YES	NO
4,4'-DDE	[9] 0.029	0.002	0.0022	1.75	0.005	0 to 1.75	YES	NO
4,4'-DDT	0.02898	0.001	NA	1.75	0.008	0 to 1.75	YES	NO
gamma-Chlordane	NA	0.0005	NA	0.00021	0.007	0.00021 to 0.007	YES	YES
Dieldrin	0.385	0.00002	NA	0.6825	0.002	0.00002 to 0.6825	YES	NO
Endosulfan II	NA	NA	NA	[10] 0.001	NA	0.001 to 0.0011	YES	YES
INORGANICS (µg/g)								
Aluminum	NA	NA	NA	NA	NA	NA to NA	NA	NA
Arsenic	NA	33	8.2	5	6	5 to 33	YES	YES
Barium	NA	NA	NA	NA	NA	NA to NA	NA	NA

TABLE 5-9
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SEDIMENT[1]
UPSTREAM SECTION OF COLD SPRING BROOK

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ANALYTE	USEPA SQC[5] (mg/kg)	NOAA, 1990 ER-L[6] (mg/kg)	NOAA, 1993 ER-L[6] (mg/kg)	NYSDEC Guidelines[7] (mg/kg)	Ontario LEL[8] (mg/kg)	Range of Ecological Screening Values	Maximum Exceeds Minimum Screening Value?	Maximum Exceeds Maximum Screening Value?
Calcium	NA	NA	NA	NA	NA	NA to NA	NA	NA
Chromium	NA	80	81	26	26	26 to 81	YES	NO
Cobalt	NA	NA	NA	NA	50	50 to 50	NO	NO
Copper	NA	70	34	19	16	16 to 70	YES	NO
Iron	NA	NA	NA	24000	20000	20000 to 24000	YES	YES
Lead	NA	35	46.7	27	31	27 to 46.7	YES	YES
Magnesium	NA	NA	NA	NA	NA	NA to NA	NA	NA
Manganese	NA	NA	NA	428	460	428 to 460	YES	YES
Mercury	NA	0.15	0.15	0.11	0.2	0.11 to 0.2	YES	YES
Nickel	NA	30	20.9	22	16	16 to 30	YES	YES
Potassium	NA	NA	NA	NA	NA	NA to NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA to NA	NA	NA
Sodium	NA	NA	NA	NA	NA	NA to NA	NA	NA
Vanadium	NA	NA	NA	NA	NA	NA to NA	NA	NA
Zinc	NA	120	150	85	120	85 to 150	YES	YES
TOTAL PETROLEUM HYDROCARBONS (µg/g)								
Total Petroleum Hydrocarbons	NA	NA	NA	NA	NA	NA to NA	NA	NA
OTHER (µg/g)								
Total Organic Carbon	NA	NA	NA	NA	NA	NA to NA	NA	NA

TABLE 5-9
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SEDIMENT[1]
UPSTREAM SECTION OF COLD SPRING BROOK

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

Notes:

[1] Based on analytical data from the following sampling locations: CSD-94-01X, CSD-94-02X, CSD-94-03X, SSD-95-09H, and SSD-95-09I.

[2] Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples.

[3] The average of all concentrations assigns a value of 1/2 the detection limit to all non-detects.

[4] The background sediment sample location is SSD-93-92C. Two times the upstream concentration is calculated for inorganics only.

[5] Organic carbon normalized mean values from USEPA (1988) Sediment Quality Criteria (SQC), using 3.5 % total organic carbon in sediments. Value for acenaphthene used as a surrogate for all PAHs that do not have published values.

[6] Effects range-low (ER-L) values from Long and Morgan (1990, 1993).

[7] New York State Department of Environmental Conservation ([NYSDEC], 1989), organics normalized to 3.5 % total organic carbon in sediment.

[8] Lowest Effect Level (LEL) values reported in "Guidelines for the Protection and Mangement of Aquatic Sediment Quality in Ontario" (Persaud et al., 1992).

[9] Value for 4,4'-DDT used for 4,4'-DDD and 4,4'-DDE.

[10] Value for endosulfan used for all endosulfan compounds.

[11] Analyte is an essential nutrient and is not considered toxic except at high concentrations.

NA = Not available/Not Applicable

ND = Not detected

Shading indicates the exceedance of a guideline value.

TABLE 5–10
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SEDIMENT[1]
LOWER COLD SPRING BROOK

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ANALYTE	Frequency of Detection [2]	Range of Detection Limits	Range of Detected Concentrations	Average of all Concentrations [3]	Upgradient Screening Value [4]	Maximum Exceeds Upgradient?
PAL METALS (µg/g)						
Aluminum	23/23	NA to NA	3,410 to 20,100	10,435	3,080	YES
Arsenic	23/23	NA to NA	5.87 to 120	44	13.1	YES
Barium	23/23	NA to NA	23.3 to 188	82	7.85	YES
Beryllium	1/23	0.427 to 0.5	4.37 to 4.37	0.42	ND	YES
Calcium	23/23	NA to NA	898 to 17,000	5,771	482	YES
Chromium	17/23	4.05 to 4.05	8.5 to 50.7	23	6.24	YES
Cobalt	21/23	1.42 to 2.5	4.87 to 36	13	ND	YES
Copper	23/23	NA to NA	2.34 to 63.7	24	ND	YES
Iron	23/23	NA to NA	4,800 to 37,200	17,903	6,440	YES
Lead	23/23	NA to NA	6.9 to 350	134	6.31	YES
Magnesium	23/23	NA to NA	1,340 to 11,000	3,213	1,370	YES
Manganese	23/23	NA to NA	242 to 3,150	1,155	214	YES
Nickel	23/23	NA to NA	8.67 to 55.1	27	3.94	YES
Potassium	18/23	100 to 100	173 to 3,830	771	ND	YES
Selenium	11/23	0.25 to 0.449	0.9 to 3.01	1.0	ND	YES
Sodium	21/23	38.7 to 100	91 to 2,570	1,102	ND	YES
Vanadium	20/23	3.39 to 3.39	8.45 to 72.5	25	4.09	YES
Zinc	23/23	NA to NA	19.9 to 479	191	18.1	YES
PAL VOLATILE ORGANICS (µg/g)						
1,1,1–Trichloroethane	1/9	0.0044 to 0.2	0.28 to 0.28	0.0548	NA	NA
Acetone	5/9	0.017 to 3.3	0.22 to 0.66	0.8251	NA	NA
Toluene	2/9	0.0008 to 0.1	0.0033 to 0.0043	0.0177	NA	NA
Trichlorofluoromethane	2/9	0.0059 to 0.23	0.096 to 0.1	0.0614	NA	NA
PAL SEMIVOLATILE ORGANICS (µg/g)						
Acenaphthylene	2/25	0.033 to 0.3	0.075 to 4.37	0.239	NA	NA
Anthracene	3/25	0.033 to 0.71	0.1 to 4.42	0.2952	NA	NA
Benzo (a) anthracene	6/25	0.041 to 2	0.27 to 18.1	1.1514	NA	NA
Benzo (a) pyrene	2/25	0.25 to 2	0.51 to 22.9	1.3534	NA	NA
Benzo (b) fluoranthene	2/25	0.21 to 2	0.67 to 32.7	1.6848	NA	NA
Benzo (g,h,i) perylene	2/25	0.18 to 2	0.34 to 18.9	1.1254	NA	NA
Benzo (k) fluoranthene	8/25	0.066 to 0.7	0.47 to 33.2	1.9352	NA	NA
Bis(2–ethylhexyl) phthalate	1/25	0.48 to 6	1.5 to 1.5	1.1416	NA	NA
Carbazole	1/22	0.033 to 1	4.68 to 4.68	0.3778	NA	NA
Chrysene	8/25	0.032 to 1	0.67 to 47.1	2.6559	NA	NA
Fluoranthene	19/25	0.032 to 0.3	0.62 to 59.4	4.4567	NA	NA
Fluorene	1/25	0.033 to 0.3	0.086 to 0.086	0.0699	NA	NA
Indeno (1,2,3–cd) pyrene	2/25	0.29 to 3	0.33 to 20.3	1.3678	NA	NA
Phenanthrene	17/25	0.032 to 0.3	0.25 to 19.8	1.8874	NA	NA
Pyrene	20/25	0.033 to 0.2	0.47 to 53.1	4.6516	NA	NA

TABLE 5–10
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SEDIMENT[1]
LOWER COLD SPRING BROOK

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ANALYTE	Frequency of Detection [2]	Range of Detection Limits	Range of Detected Concentrations	Average of all Concentrations [3]	Upgradient Screening Value [4]	Maximum Exceeds Upgradient?
PAL PESTICIDES/PCBs (µg/g)						
DDD	8/10	0.0027 to 0.00826	0.0106 to 0.49	0.1156	NA	NA
DDE	5/10	0.0077 to 0.0077	0.0041 to 0.2	0.0412	NA	NA
DDT	3/10	0.00707 to 0.0035	0.0202 to 0.0923	0.0187	NA	NA
Chlordane–gamma	2/7	0.005 to 0.005	0.0392 to 0.0663	0.0169	NA	NA
Dieldrin	1/10	0.0016 to 0.00629	0.0192 to 0.0192	0.0043	NA	NA
Endosulfan sulfate	2/10	0.0005 to 0.00763	0.0027 to 0.0112	0.0041	NA	NA
TOTAL PETROLEUM HYDROCARBONS (µg/g)						
Total Petroleum Hydrocarbons	22/25	28 to 28.2	23 to 1,800	353	NA	NA
OTHER (µg/g)						
Total Organic Carbon	24/24	NA to NA	4,250 to 223,000	94,819	NA	NA

TABLE 5-10
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SEDIMENT[1]
LOWER COLD SPRING BROOK

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ANALYTE	USEPA SQC[5]	NOAA, 1990 ER-L[6]	NYSDEC Guidelines[7]	Ontario LEL[8]	Range of Ecological Screening Values	Maximum Exceeds Minimum Screening Value?	Maximum Exceeds Maximum Screening Value?
PAL METALS (µg/g)							
Aluminum	NA	NA	NA	NA	NA to NA	NA	NA
Arsenic	NA	33	5	6	5 to 33	YES	YES
Barium	NA	NA	NA	NA	NA to NA	NA	NA
Beryllium	NA	NA	NA	NA	NA to NA	NA	NA
Calcium	NA	NA	NA	NA	NA to NA	NA	NA
Chromium	NA	80	26	26	26 to 80	YES	NO
Cobalt	NA	NA	NA	50	50 to 50	NO	NO
Copper	NA	70	19	16	16 to 70	YES	NO
Iron	NA	NA	24,000	20,000	20,000 to 24,000	YES	YES
Lead	NA	35	27	31	27 to 35	YES	YES
Magnesium	NA	NA	NA	NA	NA to NA	NA	NA
Manganese	NA	NA	428	460	428 to 460	YES	YES
Nickel	NA	30	22	16	16 to 30	YES	YES
Potassium	NA	NA	NA	NA	NA to NA	NA	NA
Selenium	NA	NA	NA	NA	NA to NA	NA	NA
Sodium	NA	NA	NA	NA	NA to NA	NA	NA
Vanadium	NA	NA	NA	NA	NA to NA	NA	NA
Zinc	NA	120	85	120	85 to 120	YES	YES
PAL VOLATILE ORGANICS (µg/g)							
1,1,1-Trichloroethane	NA	NA	NA	NA	NA to NA	NA	NA
Acetone	NA	NA	NA	NA	NA to NA	NA	NA
Toluene	NA	NA	NA	NA	NA to NA	NA	NA
Trichlorofluoromethane	NA	NA	NA	NA	NA to NA	NA	NA
PAL SEMIVOLATILE ORGANICS (µg/g)							
Acenaphthylene	11.7	NA	NA	NA	11.7 to 11.7	NO	NO
Anthracene	11.7	0.085	NA	NA	0.085 to 11.7	YES	NO
Benzo (a) anthracene	119	0.23	NA	NA	0.23 to 119	YES	NO
Benzo (a) pyrene	95.7	0.4	NA	NA	0.4 to 95.7	YES	NO
Benzo (b) fluoranthene	11.7	NA	NA	NA	11.7 to 11.7	YES	YES
Benzo (g,h,i) perylene	11.7	NA	NA	NA	11.7 to 11.7	YES	YES
Benzo (k) fluoranthene	11.7	NA	NA	NA	11.7 to 11.7	YES	YES
Bis(2-ethylhexyl) phthalate	NA	NA	10.8	NA	10.8 to 10.8	NO	NO
Carbazole	NA	NA	NA	NA	NA to NA	NA	NA
Chrysene	11.7	0.4	NA	NA	0.4 to 11.7	YES	YES
Fluoranthene	55.8	0.6	NA	NA	0.6 to 55.8	YES	YES
Fluorene	11.7	0.035	NA	NA	0.035 to 11.7	YES	NO
Indeno (1,2,3-cd) pyrene	11.7	NA	NA	NA	14 to 11.7	YES	YES
Phenanthrene	16.2	0.225	12.5	NA	0.225 to 16.2	YES	YES
Pyrene	118	0.35	NA	NA	0.35 to 118	YES	NO

TABLE 5-10
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SEDIMENT[1]
LOWER COLD SPRING BROOK

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ANALYTE	USEPA SQC [5]	NOAA, 1990 ER-L [6]	NYSDEC Guidelines [7]	Ontario LEL[8]	Range of Ecological Screening Values	Maximum Exceeds Minimum Screening Value?	Maximum Exceeds Maximum Screening Value?
PAL PESTICIDES/PCBs (μg/g)							
DDD	0.075	0.002	4.5	0.008	0.002 to 4.5	YES	NO
DDE	0.075	0.002	4.5	0.005	0.002 to 4.5	YES	NO
DDT	0.075	0.001	4.5	0.008	0.001 to 4.5	YES	NO
Chlordane-gamma	NA	0.0005	0.00054	0.007	0.0005 to 0.007	YES	YES
Dieldrin	0.99	0.00002	1.76	0.002	0.00002 to 1.76	YES	NO
Endosulfan sulfate	NA	NA	0.0027	NA	0.0027 to 0.0027	YES	YES
TOTAL PETROLEUM HYDROCARBONS (μg/g)							
Total Petroleum Hydrocarbons	NA	NA	NA	NA	NA to NA	NA	NA
OTHER (μg/g)							
Total Organic Carbon	NA	NA	NA	NA	NA to NA	NA	NA

NOTES:

[1] Based on analytical data from the following 25 sampling locations: 57D-92-01X (twice) and 57-92-02X; CSD-94-08X through CSD-94-13X, CSD-94-16X, CSD-94-18X, CSD-94-19X, CSD-94-26X through CSD-94-28X, CSD-94-31X through CSD-94-34X; G3D-92-01X through G3D-92-03X; and SSD-93-92D, SSD-93-92E, and SSD-93-92G.

[2] Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples.

[3] The average of all concentrations assigns a value of 1/2 the detection limit to all non-detects.

[4] Upgradient sediment sample location includes: SSD-93-92C from A.D. Little (1994).

[5] Organic carbon normalized mean values from USEPA (1988 and 1993a,b,c,d) Sediment Quality Criteria (SQC), using 9 % total organic carbon in organic sediments. Value for acenaphthene was used as a conservative surrogate for all PAHs that do not have published values.
Value for DDT used for DDD and DDE.

[6] Effects range-low (ER-L) values from Long and Morgan (1990).

[7] New York State Department of Environmental Conservation ([NYSDEC], 1989), organics normalized to 9 % total organic carbon in sediment.
Value for DDT used for DDD and DDE.
Value for endosulfan used for endosulfan sulfate.

[8] Lowest Effect Level (LEL) values reported in "Guidelines for the Protection and Mangement of Aquatic Sediment Quality in Ontario" (Persaud et al., 1992).

NA = Not available/Not Applicable
ND = Not detected
μg/g = micrograms per gram

TABLE 5-11
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SURFACE SOIL[1]
STORM DRAIN SYSTEM NO. 5

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ANALYTE	Frequency of Detection [2]	Range of Detection Limits	Range of Detected Concentrations	Average of all Concentrations [3]	Background Screening Value [4]	Maximum Exceeds Background?
PAL METALS (µg/g)						
Aluminum	3/3	NA	10,700 to 42,200	27,767	15,000	YES
Arsenic	3/3	NA	5.35 to 43	23	21	YES
Barium	2/3	5.18 to 5.18	57 to 99	53	42.5	YES
Beryllium	1/3	0.5 to 0.5	1.62 to 1.62	0.707	0.347	YES
Cadmium	2/3	0.7 to 0.7	0.931 to 4.59	1.96	2	YES
Calcium	3/3	NA	591 to 6,960	3,127	1,400	YES
Chromium	2/3	4.05 to 4.05	36.9 to 163	67.3	31	YES
Cobalt	2/3	1.42 to 1.42	13.1 to 28.8	14.2	ND	YES
Copper	3/3	NA	47.3 to 65.6	58.6	8.39	YES
Iron	3/3	NA	2,200 to 48,700	22,400	15,000	YES
Lead	3/3	NA	160 to 356	225	34.4	YES
Magnesium	2/3	100 to 100	4,080 to 17,500	7,210	5,600	YES
Manganese	3/3	NA	43.2 to 2,410	1,251	300	YES
Mercury	1/3	0.05 to 0.05	0.0961 to 0.0961	0.0487	0.22	NO
Nickel	2/3	1.71 to 1.71	25.3 to 82	36	14	YES
Potassium	2/3	100 to 100	755 to 5,950	2,252	1,700	YES
Selenium	2/3	0.449 to 0.449	0.67 to 8.64	3.18	ND	YES
Sodium	3/3	NA	270 to 5,310	2,009	131	YES
Vanadium	2/3	3.39 to 3.39	48.8 to 88.6	46.4	28.7	YES
Zinc	2/3	8.03 to 8.03	63.7 to 301	123	35.5	YES
PAL SEMIVOLATILE ORGANICS (µg/g)						
Acenaphthene	1/3	0.036 to 2	0.21 to 0.21	0.41	NA	NA
Acenaphthylene	2/3	0.033 to 0.033	3 to 3.8	2.3	NA	NA
Anthracene	1/3	0.033 to 2	4.5 to 4.5	1.8	NA	NA
Benzo (a) anthracene	1/3	0.17 to 8	5.9 to 5.9	3.3	NA	NA
Benzo (a) pyrene	1/3	0.25 to 10	5.8 to 5.8	3.6	NA	NA
Benzo (b) fluoranthene	2/3	0.21 to 0.21	6.9 to 20	9.0	NA	NA
Benzo (g,h,i) perylene	1/3	0.25 to 10	5 to 5	3.4	NA	NA
Benzo (k) fluoranthene	2/3	0.066 to 0.066	6.2 to 10	5.4	NA	NA
Chrysene	2/3	0.12 to 0.12	7.4 to 20	9.2	NA	NA
Fluoranthene	2/3	0.068 to 0.068	7.3 to 30	12	NA	NA
Fluorene	1/3	0.033 to 2	0.91 to 0.91	0.64	NA	NA
Phenanthrene	2/3	0.033 to 0.033	8.4 to 10	6.1	NA	NA
Pyrene	3/3	NA	0.66 to 30	14	NA	NA

TABLE 5–11
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SURFACE SOIL[1]
STORM DRAIN SYSTEM NO. 5

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ANALYTE	Frequency of Detection [2]	Range of Detection Limits	Range of Detected Concentrations	Average of all Concentrations [3]	Background Screening Value [4]	Maximum Exceeds Background?
TOTAL PETROLUEM HYDROCARBONS (µg/g)						
Total Petroleum Hydrocarbons	3/3	NA	1,570 to 3,200	2,657	NA	NA
OTHER (µg/g)						
Total Organic Carbon	3/3	NA	55,000 to 428,000	191,867	NA	NA

TABLE 5-11
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SURFACE SOIL[1]
STORM DRAIN SYSTEM NO. 5

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ANALYTE	Vertebrate Screening Value[5]	Maximum Exceeds Ecological Screening Value?	Phytotoxicity Screening Value[5]	Maximum Exceeds Phytotoxicity Screening Value?	Invertebrate Screening Value[6]	Maximum Exceeds Invertebrate Screening Value?
PAL METALS (µg/g)						
Aluminum	15,000	YES	NA[7]	NA	NA	NA
Arsenic	107	NO	NA	NA	100	NO
Barium	6,395	NO	500	NO	NA	NA
Beryllium	216	NO	10	NO	NA	NA
Cadmium	2	YES	2	YES	50	NO
Calcium	NA	NA	NA	NA	NA	NA
Chromium	15,349	NO	NA	NA	50	YES
Cobalt	46	NO	25	YES	NA	NA
Copper	662	NO	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA
Lead	220	YES	NA	NA	1,190	NO
Magnesium	NA	NA	NA	NA	NA	NA
Manganese	6,646	NO	500	YES	NA	NA
Mercury						
Nickel	414	NO	25	YES	400	NO
Potassium	NA	NA	NA	NA	NA	NA
Selenium	1	YES	NA	NA	NA	NA
Sodium	NA	NA	NA	NA	NA	NA
Vanadium	195	NO	NA	NA	NA	NA
Zinc	251	YES	NA	NA	130	YES
PAL SEMIVOLATILE ORGANICS (µg/g)						
Acenaphthene	214	NO	NA	NA	34	NO
Acenaphthylene	214	NO	NA	NA	34	NO
Anthracene	214	NO	NA	NA	34	NO
Benzo (a) anthracene	214	NO	NA	NA	34	NO
Benzo (a) pyrene	214	NO	NA	NA	34	NO
Benzo (b) fluoranthene	214	NO	NA	NA	34	NO
Benzo (g,h,i) perylene	214	NO	NA	NA	34	NO
Benzo (k) fluoranthene	214	NO	NA	NA	34	NO
Chrysene	214	NO	NA	NA	34	NO
Fluoranthene	214	NO	NA	NA	34	NO
Fluorene	214	NO	NA	NA	34	NO
Phenanthrene	214	NO	NA	NA	34	NO
Pyrene	214	NO	NA	NA	34	NO

TABLE 5-11
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SURFACE SOIL[1]
STORM DRAIN SYSTEM NO. 5

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ANALYTE	Vertebrate Screening Value [5]	Maximum Exceeds Ecological Screening Value?	Phytotoxicity Screening Value [5]	Maximum Exceeds Phytotoxicity Screening Value?	Invertebrate Screening Value [6]	Maximum Exceeds Invertebrate Screening Value?
TOTAL PETROLUEM HYDROCARBONS (µg/g)						
Total Petroleum Hydrocarbons	NA	NA	NA	NA	NA	NA
OTHER (µg/g)						
Total Organic Carbon	NA	NA	NA	NA	NA	NA

NOTES:

[1] Based on analytical data from the following three sampling locations: GRD-94-06X and GRD-94-07X; and SSD-93-05A.

[2] Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples.

[3] The average of all concentrations assigns a value of 1/2 the detection limit to all non-detects.

[4] Background values from RI Addendum Report for Group 1A Sites (ABB-ES, 1993c).

[5] Screening values are Protective Contaminant Levels (PCLs) from Table B-5, and are derived as described in Appendix B. The value presented represents the lowest PCL for the shrew, woodcock, fox, or hawk.

[5] Phytotoxicity Screening Values from Suter et al., 1993 unless otherwise noted. The screening value is the lowest Lowest Observed Effect Level (LOEL) from among plant growth studies conducted in solid media.

[6] Invertebrate Screening Value from Neuhauser et al., 1985 unless otherwise noted. For organic compounds, the screening value is the lowest LC_{50} (14-day soil test on *Eisenia foetida*) from among chemicals in the same chemical class; a conservative factor of 0.2 was applied and the resultant value should be protective of 99.9% of the population from acute effects (USEPA, 1986b).

[7] The screening value for this analyte is less than the background screening value. Phytotoxic effects are not expected at background concentrations.

NA = Not available/Not applicable

ND = Not Detected

µg/g = micrograms per gram

TABLE 5-11
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SURFACE SOIL[1]
STORM DRAIN SYSTEM NO. 5

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ANALYTE	Frequency of Detection [2]	Range of Detection Limits	Range of Detected Concentrations	Average of all Concentrations [3]	Background Screening Value [4]	Maximum Exceeds Background?
PAL METALS (µg/g)						
Aluminum	3/3	NA	10,700 to 42,200	27,767	15,000	YES
Arsenic	3/3	NA	5.35 to 43	23	21	YES
Barium	2/3	5.18 to 5.18	57 to 99	53	42.5	YES
Beryllium	1/3	0.5 to 0.5	1.62 to 1.62	0.707	0.347	YES
Cadmium	2/3	0.7 to 0.7	0.931 to 4.59	1.96	2	YES
Calcium	3/3	NA	591 to 6,960	3,127	1,400	YES
Chromium	2/3	4.05 to 4.05	36.9 to 163	67.3	31	YES
Cobalt	2/3	1.42 to 1.42	13.1 to 28.8	14.2	ND	YES
Copper	3/3	NA	47.3 to 65.6	58.6	8.39	YES
Iron	3/3	NA	2,200 to 48,700	22,400	15,000	YES
Lead	3/3	NA	160 to 356	225	34.4	YES
Magnesium	2/3	100 to 100	4,080 to 17,500	7,210	5,600	YES
Manganese	3/3	NA	43.2 to 2,410	1,251	300	YES
Nickel	2/3	1.71 to 1.71	25.3 to 82	36	14	YES
Potassium	2/3	100 to 100	755 to 5,950	2,252	1,700	YES
Selenium	2/3	0.449 to 0.449	0.67 to 8.64	3.18	ND	YES
Sodium	3/3	NA	270 to 5,310	2,009	131	YES
Vanadium	2/3	3.39 to 3.39	48.8 to 88.6	46.4	28.7	YES
Zinc	2/3	8.03 to 8.03	63.7 to 301	123	35.5	YES
PAL SEMIVOLATILE ORGANICS (µg/g)						
Acenaphthene	1/3	0.036 to 2	0.21 to 0.21	0.41	NA	NA
Acenaphthylene	2/3	0.033 to 0.033	3 to 3.8	2.3	NA	NA
Anthracene	1/3	0.033 to 2	4.5 to 4.5	1.8	NA	NA
Benzo (a) anthracene	1/3	0.17 to 8	5.9 to 5.9	3.3	NA	NA
Benzo (a) pyrene	1/3	0.25 to 10	5.8 to 5.8	3.6	NA	NA
Benzo (b) fluoranthene	2/3	0.21 to 0.21	6.9 to 20	9.0	NA	NA
Benzo (g,h,i) perylene	1/3	0.25 to 10	5 to 5	3.4	NA	NA
Benzo (k) fluoranthene	2/3	0.066 to 0.066	6.2 to 10	5.4	NA	NA
Chrysene	2/3	0.12 to 0.12	7.4 to 20	9.2	NA	NA
Fluoranthene	2/3	0.068 to 0.068	7.3 to 30	12	NA	NA
Fluorene	1/3	0.033 to 2	0.91 to 0.91	0.64	NA	NA
Phenanthrene	2/3	0.033 to 0.033	8.4 to 10	6.1	NA	NA
Pyrene	3/3	NA	0.66 to 30	14	NA	NA

TABLE 5-11
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SURFACE SOIL[1]
STORM DRAIN SYSTEM NO. 5

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ANALYTE	Frequency of Detection [2]	Range of Detection Limits	Range of Detected Concentrations	Average of all Concentrations [3]	Background Screening Value [4]	Maximum Exceeds Background?
TOTAL PETROLUEM HYDROCARBONS (µg/g)						
Total Petroleum Hydrocarbons	3/3	NA	1,570 to 3,200	2,657	NA	NA
OTHER (µg/g)						
Total Organic Carbon	3/3	NA	55,000 to 428,000	191,867	NA	NA

TABLE 5-11
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SURFACE SOIL[1]
STORM DRAIN SYSTEM NO. 5

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ANALYTE	Vertebrate Screening Value[5]	Maximum Exceeds Ecological Screening Value?	Phytotoxicity Screening Value[5]	Maximum Exceeds Phytotoxicity Screening Value?	Invertebrate Screening Value[6]	Maximum Exceeds Invertebrate Screening Value?
PAL METALS (µg/g)						
Aluminum	1,500	YES	NA[7]	NA	NA	NA
Arsenic	65	NO	NA	NA	100	NO
Barium	6,500	NO	500	NO	NA	NA
Beryllium	220	NO	10	NO	NA	NA
Cadmium	2.9	YES	2	YES	50	NO
Calcium	NA	NA	NA	NA	NA	NA
Chromium	15,000	NO	NA	NA	50	YES
Cobalt	46	NO	25	YES	NA	NA
Copper	1,000	NO	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA
Lead	190	YES	NA	NA	1,190	NO
Magnesium	NA	NA	NA	NA	NA	NA
Manganese	5,700	NO	500	YES	NA	NA
Nickel	410	NO	25	YES	400	NO
Potassium	NA	NA	NA	NA	NA	NA
Selenium	1.1	YES	NA	NA	NA	NA
Sodium	NA	NA	NA	NA	NA	NA
Vanadium	200	NO	NA	NA	NA	NA
Zinc	240	YES	NA	NA	130	YES
PAL SEMIVOLATILE ORGANICS (µg/g)						
Acenaphthene	214	NO	NA	NA	34	NO
Acenaphthylene	214	NO	NA	NA	34	NO
Anthracene	214	NO	NA	NA	34	NO
Benzo (a) anthracene	214	NO	NA	NA	34	NO
Benzo (a) pyrene	214	NO	NA	NA	34	NO
Benzo (b) fluoranthene	214	NO	NA	NA	34	NO
Benzo (g,h,i) perylene	214	NO	NA	NA	34	NO
Benzo (k) fluoranthene	214	NO	NA	NA	34	NO
Chrysene	214	NO	NA	NA	34	NO
Fluoranthene	214	NO	NA	NA	34	NO
Fluorene	214	NO	NA	NA	34	NO
Phenanthrene	214	NO	NA	NA	34	NO
Pyrene	214	NO	NA	NA	34	NO

TABLE 5-11
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SURFACE SOIL[1]
STORM DRAIN SYSTEM NO. 5

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ANALYTE	Vertebrate Screening Value [5]	Maximum Exceeds Ecological Screening Value?	Phytotoxicity Screening Value [5]	Maximum Exceeds Phytotoxicity Screening Value?	Invertebrate Screening Value [6]	Maximum Exceeds Invertebrate Screening Value?
TOTAL PETROLUEM HYDROCARBONS (μg/g)						
Total Petroleum Hydrocarbons	NA	NA	NA	NA	NA	NA
OTHER (μg/g)						
Total Organic Carbon	NA	NA	NA	NA	NA	NA

NOTES:

[1] Based on analytical data from the following three sampling locations: GRD-94-06X and GRD-94-07X; and SSD-93-05A.

[2] Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples.

[3] The average of all concentrations assigns a value of 1/2 the detection limit to all non-detects.

[4] Background values from RI Addendum Report for Group 1A Sites (ABB-ES, 1993c).

[5] Screening values are Protective Contaminant Levels (PCLs) from Table B-5, and are derived as described in Appendix B. The value presented represents the lowest PCL for the shrew, woodcock, fox, or hawk.

[5] Phytotoxicity Screening Values from Suter et al., 1993 unless otherwise noted. The screening value is the lowest Lowest Observed Effect Level (LOEL) from among plant growth studies conducted in solid media.

[6] Invertebrate Screening Value from Neuhauser et al., 1985 unless otherwise noted. For organic compounds, the screening value is the lowest LC_{50} (14-day soil test on *Eisenia foetida*) from among chemicals in the same chemical class; a conservative factor of 0.2 was applied and the resultant value should be protective of 99.9% of the population from acute effects (USEPA, 1986b).

[7] The screening value for this analyte is less than the background screening value. Phytotoxic effects are not expected at background concentrations.

NA = Not available/Not applicable

ND = Not Detected

μg/g = micrograms per gram

TABLE 5-12
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SURFACE WATER[1]
STORM DRAIN SYSTEMS

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ANALYTE [1]	Frequency of Detection[2]	Range of Detection Limits	Range of Detected Concentrations	Average of all Concentrations[3]	Background Concentration[4]	Maximum Exceeds Background?	USEPA Chronic Water Quality Criteria (1991)[5]	Maximum Exceeds Screening Criteria?
SEMIVOLATILES (µg/L)								
Bis (2-Ethylhexyl) phthalate	3/7	4.8000 to 4.8000	4.5 to 10	4.05	NA	YES	160	NO
FILTERED INORGANICS (µg/L)								
Antimony	1/7	3.0300 to 3.0300	3.66 to 3.66	1.82	ND	YES	30	NO
Arsenic	3/7	2.5400 to 2.5400	3.09 to 11.4	3.91	ND	YES	6 190	NO
Barium	7/7	NA to NA	12 to 47.1	26.8	7.28	YES	NA	NA
Calcium	7/7	NA to NA	7,290 to 14400	10804	15100	[7,8] NO	NA	NA
Iron	6/7	38.8000 to 38.8000	107 to 3060	753	138	YES	1000	YES
Lead	3/7	1.2600 to 1.2600	1.41 to 2.93	1.20	ND	YES	9 1.0	YES
Magnesium	7/7	NA to NA	517 to 2570	1412	2520	[8] NA	NA	NA
Manganese	7/7	NA to NA	195 to 973	457	53.6	YES	NA	NA
Potassium	7/7	NA to NA	1,250 to 2250	1698	ND	[8] NA	NA	NA
Sodium	7/7	NA to NA	15,000 to 22300	18979	24300	[7,8] NO	NA	NA
Zinc	2/7	21.1000 to 21.1000	42.9 to 277	53.2	ND	YES	9 50	YES
WATER QUALITY PARAMETERS (mg/L)								
Alkalinity	7/7	NA to NA	13,000 to 30000	19000	NA	NA	20000	YES
Chloride	7/7	NA to NA	18,700 to 33000	29343	NA	NA	230000	NO
Total Hardness	7/7	NA to NA	20,000 to 92400	40514	NA	NA	NA	NA
Total Suspended Solids	7/9	4000.0000 to 4000.0000	9,000 to 3950000	451722	NA	NA	NA	NA

NOTES:

[1] Sample locations include: CSW-94-04X, CSW-94-05X (plus duplicate), CSW-94-06X, CSW-94-07X, CSW-94-21X, CSW-94-24X, and CSW-94-30X.

[2] Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples.Q

[3] The average of all concentrations assigns a value of 1/2 the detection limits to all non-detects.

[4] The background sample location is SSW-93-92C. Two times the upstream concentration is calculated for inorganics only.

[5] USEPA Ambient Water Quality Criteria (1991).

[6] Criterion for the trivalent species of arsenic.

[7] Maximum analyte concentration is less than two times the average upstream concentration for inorganic compounds.

[8] Analyte is an essential nutrient, and is not considered toxic except at high concentrations.

[9] Hardness dependent criterion based on site-specific hardness concentration (41 mg/L as $CaCO_3$).

NA = Not Available

ND= Not Detected

TABLE 5-13
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SURFACE WATER
SA 57 MARSH

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ANALYTE [1]	Frequency of Detection[2]	Range of Detection Limits	Range of Detected Concentrations	Average of all Concentrations[3]	Background Concentration[4]		Maximum Exceeds Background?	USEPA Chronic Water Quality Criteria (1991)[5]	Maximum Exceeds Screening Criteria?
					Average	2X Average			
FILTERED INORGANICS (µg/L)									
Antimony	2/4	3.0300 to 3.0300	2.95 to 4.11	2.5225		ND	YES	30	NO
Barium	4/4	NA to NA	8.28 to 16.5	11.1875		7.28	YES	NA	NA
Calcium	4/4	NA to NA	7300 to 22800	15600		15100	[6]NA	NA	NA
Iron	3/4	38.8000 to 38.8000	172 to 249	158.85		138	YES	1,000	NO
Lead	1/4	1.2600 to 1.2600	1.41 to 1.41	0.825		ND	YES	[7] 1.5	NO
Magnesium	4/4	NA to NA	611 to 3270	2000.25		2520	[6]NA	NA	NA
Manganese	4/4	NA to NA	7.88 to 108	61.245		53.6	YES	NA	NA
Potassium	4/4	NA to NA	801 to 2160	1490.25		ND	6NA	NA	NA
Sodium	4/4	NA to NA	20600 to 46200	28150		24300	6NA	NA	NA
WATER QUALITY PARAMETERS (mg/L)									
Alkalinity	4/4	NA to NA	13,000 to 47000	25250		NA	YES	20,000	YES
Chloride	4/4	NA to NA	33,000 to 66000	46750		NA	YES	230,000	NO
Total Hardness	4/4	NA to NA	31,600 to 67200	54400		NA	YES	NA	NA
Total Suspended Solids	3/4	4000.0000 to 4000.0000	9,000 to 212000	88750		NA	YES	NA	NA

NOTES:

[1] Sample locations include: CSW-94-14X, CSW-94-17X, CSW-94-20X, and CSW-94-35X.

[2] Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples.Q

[3] The average of all concentrations assigns a value of 1/2 the detection limits to all non-detects.

[4] The background sample location is SSW-93-92C. Two times the upstream concentration is calculated for inorganics only.

[5] USEPA Ambient Water Quality Criteria (1991).

[6] Analyte is an essential nutrient, and is not considered toxic except at high concentrations.

[7] Hardness dependent criterion based on site-specific hardness concentration (54 mg/L as $CaCO_3$).

NA = Not Available

ND = Not Detected

TABLE 5-14
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SURFACE WATER
UPSTREAM SUBSECTION OF LOWER COLD SPRING BROOK

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ANALYTE [1]	Frequency of Detection[2]	Range of Detection Limits	Range of Detected Concentrations	Average of all Concentrations[3]	Background Concentration[4] Average	Maximum Exceeds Background?	USEPA Chronic Water Quality Criteria (1991)[5]	Maximum Exceeds Screening Criteria?
PESTICIDES/PCBs (µg/L)								
alpha-BHC	2/4	0.0385 to 0.0385	0.018 to 0.021	0.019	NA	YES	6 0.08	NO
gamma-BHC (Lindane)	1/4	0.0025 to 0.0507	0.003 to 0.003	0.014	NA	YES	0.080	NO
4,4-DDD	1/4	0.0081 to 0.0233	0.008 to 0.008	0.0089	NA	YES	7 0.001	YES
Heptachlor	2/4	0.0423 to 0.0423	0.003 to 0.004	0.012	NA	YES	0.004	NO
FILTERED INORGANICS (µg/L)								
Arsenic	4/5	2.3500 to 2.3500	3.09 to 4.98	3.28	ND	YES	8 190	NO
Barium	4/5	5.0000 to 5.0000	7.38 to 18.3	10.5	7.3	YES	NA	NA
Beryllium	1/5	1.1200 to 5.0000	1.39 to 1.39	1.89	NA	YES	5.3	NO
Calcium	5/5	NA to NA	23100 to 29000	24,880	15,100	9 NA	NA	NA
Iron	5/5	NA to NA	82.8 to 1830	516	138	YES	1,000	YES
Magnesium	5/5	NA to NA	3240 to 3610	3,392	2,520	9 NA	NA	NA
Manganese	5/5	NA to NA	10.1 to 489	138	54	YES	NA	NA
Potassium	3/5	1240.0000 to 1240.0000	1490 to 1690	1,188	ND	9 NA	NA	NA
Sodium	5/5	NA to NA	20500 to 31800	23,260	24,300	9 NA	NA	NA
Zinc	1/5	18.0000 to 21.1000	18.7 to 18.7	11.9	ND	YES	10 80	NO
WATER QUALITY PARAMETERS (mg/L)								
Alkalinity	3/3	NA to NA	47000 to 49000	48,000	NA	NA	20,000	YES
Chloride	5/5	NA to NA	33000 to 66000	46,200	NA	NA	230,000	NO
Sulfate	2/2	NA to NA	10100 to 13000	11,550	NA	NA	NA	NA
Total Hardness	5/5	NA to NA	69600 to 89500	75,000	NA	NA	NA	NA
Total Organic Carbon	2/2	NA to NA	3430 to 3650	3,540	NA	NA	NA	NA
Total Suspended Solids	1/5	4.0000 to 4000.0000	4000 to 4000	1,601	NA	NA	NA	NA

NOTES:

[1] Sample locations include: CSW-94-01X through CSW-94-03X, SSW-95-09H, and SSW-95-09I.

[2] Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples.

[3] The average of all concentrations assigns a value of 1/2 the detection limits to all non-detects.

[4] The background sample location is SSW-93-92C. Two times the upstream concentration is calculated for inorganics only.

[5] USEPA Ambient Water Quality Criteria (1991).

[6] Criterion for gamma-BHC (Lindane).

[7] Criterion for 4,4'-DDT.

[8] Criterion for the trivalent species of arsenic.

[9] Analyte is an essential nutrient, and is not considered toxic except at high concentrations.

[10] Hardness dependent criterion based on site-specific hardness concentration (mg/L as $CaCO_3$).

NA = Not Available
ND = Not Detected

TABLE 5-15
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SURFACE WATER LOWER COLD SPRING BROOK

LOWER COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA.

ANALYTE[1]	Frequency of Detection[2]	Detection Limits	Range of Detected Concentrations	Average of all Concentrations[3]	Upgradient Screening Value[4]	Maximum Exceeds Upgradient?	USEPA Chronic Water Quality Criteria[5]	Maximum Exceeds Screening Criteria?
PAL METALS (µg/L) – filtered								
Antimony	9/16	3.03	2.77 to 4.11	2.52	ND	YES	30	NO
Arsenic	5/16	2.54	3.3 to 4.05	2.01	ND	YES	190 [1]	NO
Barium	16/16	NA	6.81 to 12.5	8.4	7.28	YES	NA	NA
Calcium	16/16	NA	15,500 to 24,000	19,138	15,100	YES	NA	NA
Iron	16/16	NA	105 to 873	234	138	YES	1,000	NO
Lead	2/16	1.26	2.06 to 10.6	1.34	ND	YES	1.7 [2]	YES
Magnesium	16/16	NA	2,660 to 3,460	3,049	2,520	YES	NA	NA
Manganese	16/16	NA	56.4 to 442	166	53.6	YES	NA	NA
Potassium	16/16	NA	1,410 to 2,540	1,813	ND	YES	NA	NA
Sodium	16/16	NA	19,000 to 32,800	22,775	24,300	YES	NA	NA
PAL SEMIVOLATILES (µg/L) – unfiltered								
Bis (2-ethylhexyl) phthalate	2/16	4.8	4.5 to 11	3.1	NA	NA	360	NO
CATIONS/ANIONS (µg/L) – unfiltered								
Chloride	16/16	NA	33,000 to 66,000	44,688	ND	NA	230,000	NO
WATER QUALITY PARAMETERS (µg/L) – unfiltered								
Alkalinity	16/16	NA	27,000 to 51,000	39,063	NA	NA	20,000	NO[6]
Total Hardness	16/16	NA	50,400 to 71,600	61,000	NA	NA	NA	NA

NOTES:

[1] Sample locations include: CSW-94-08X through CSW-94-13X, CSW-94-16X, CSW-94-18X, CSW-94-19X, CSW-94-26 through CSW-94-28X, and CSW-94-31X through CSW-94-34X.

[2] Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples.

[3] The average of all concentrations assigns a value of 1/2 the detection limits to all non-detects.

[4] Upgradient surface water sample location: SSW-93-92C from A.D. Little (1994).

[5] USEPA Ambient Water Quality Criteria (1986a and 1990).

[1] Criterion for the trivalent species of arsenic.

[2] Hardness dependent criterion based on site-specific hardness concentration of 61 mg/L as $CaCO_3$.

[6] The standard for this parameter is a minimum criterion.

NA = Not Available

ND = Not Detected

µg/l = micrograms per liter

6.0 CONCLUSIONS AND RECOMMENDATIONS

This section summarizes the conclusions from the lower Cold Spring Brook SI. The conclusions are followed by recommendations for the site.

6.1 CONCLUSIONS

- No evidence exists that analytes in surface water pose risks to aquatic receptors in the lower Cold Spring Brook watershed. Although lead exceeds its AWQC, it is unlikely that it poses a risk to aquatic receptors in lower Cold Spring Brook.
- Aquatic habitat quality tends to be low at the storm drain system discharge areas relative to habitat quality in lower Cold Spring Brook. The slow stream velocity and sand and mud substrate of lower Cold Spring Brook contribute to its poor aquatic habitat quality rating.
- In general, within individual storm drain systems, surface soil and sediment samples from locations nearest the outfall pipes are more contaminated than locations further downgradient, in the Cold Spring Brook floodplain. In Systems No. 2/3/4, contamination (polynuclear aromatic hydrocarbons [PAHs], inorganics, and TPHC) is generally found near the storm drain outlet. Contaminants (PAHs, inorganics and TPHC) in System No. 7 appear to be associated with runoff from Barnum Road. The Study Area (SA) 57 marsh contained sediments contaminated with VOCs, semivolatile organic compounds (SVOCs), pesticides, PCBs, and inorganics. Sediments downgradient of System No. 9 appear adversely affected by upgradient sources other than system No. 9.
- No ecological risks were identified from exposure to contaminated media in Storm Drain Systems No. 1/2, System No. 5, System No. 6, and System No. 8.

- Based on benchmark screening of sediment contaminant concentrations, limited ecological risks may be associated with Storm Drain Systems No. 2/3/4, System No. 7, the SA 57 marsh, and an upstream subsection of lower Cold Spring Brook.
- Maximum concentrations of PAHs, pesticides, and several inorganics detected in lower Cold Spring Brook sediments exceeded PRE screening values. However, many of these maximum concentrations were detected in samples collected in 1992; analytical results for samples collected at nearly the same locations in 1994 were much lower and were often less than or only slightly exceeded screening values. Giving weight to the more recent data, benchmark screening indicates that aquatic and benthic receptors are possibly at risk from exposure to pesticides in sediments from isolated areas of lower Cold Spring Brook, and from PAHs, TPHC, and some metals in the vicinity of SA 57.
- Site-specific toxicity tests indicate that aquatic and benthic organisms are generally not adversely affected by exposure to sediments from lower Cold Spring Brook. Limited growth and survival effects were observed in sediments from the upstream section of Cold Spring Brook, from the confluence of the System No. 7 ditch and lower Cold Spring Brook, and at a downstream station not closely associated with a specific storm drain system.
- Use of literature-based sediment quality guidelines for benchmark screening appears to over-estimate the risk in lower Cold Spring Brook. Aquatic toxicity studies did not demonstrate a widespread or severe toxicity response.
- An ecological characterization field program to characterize ecological receptors at lower Cold Spring Brook concluded that signs of stressed vegetation were limited to one small (400 square feet) area in the Storm Drain Systems No. 2/3/4 drainage ditch. It was unclear whether the stress resulted from chemical contaminants or from physical stress associated with stormwater flow and ponding.

- Samples collected in the vicinity of the Storm Drain System No. 9 outfall suggest that the area northwest of the Saratoga Street and Dakota Street intersection may have contributed PAH contamination to lower Cold Spring Brook. Available data suggest that this area may have had a greater influence on lower Cold Spring Brook than Storm Drain System No. 9.

6.2 RECOMMENDATIONS

- Based on the results of the analytical program, ecological characterization field program, the PRE, and laboratory toxicity testing, no further study or remedial action is recommended for areas downstream of the outfalls at Storm Drain Systems No. 1/2, System No. 5, System No. 6, System No. 8, and System No. 9.

- Remedial activities are not recommended for the upstream pond where sediment analysis (CSD-94-02X) and benchmark screening suggest potential adverse biological effects. Laboratory toxicity testing indicates that sediments from this area do not adversely affect test organisms.

- Remedial activities are not recommended for the area of lower Cold Stream Brook from sample location CSD-94-03X to location CSD-94-08X where limited toxicity was observed in laboratory studies. The toxicity studies did not identify a specific toxicant on which to base remedial actions, and field observations indicate habitat in this area comparable to or better than the reference station. Remedial activities within the brook channel and floodplain would likely adversely affect the brook and marsh which provides good habitat to wildlife and aquatic receptors.

- Because benchmark screening appears to overestimate receptor risk, it is recommended that no remedial activities based wholly on benchmark screening results be undertaken in the isolated marsh area north of Saratoga Street (sample location SSD-95-09K). Benchmark screening was not an accurate predictor of biological effects at marsh location CSD-94-02X.

- Potential contaminant sources and migration in the vicinity of SA 57 should be investigated further.

- Remedial activities at Storm Drain Systems No. 2/3/4 and System No. 7 should focus on source controls and hot spot removal of contaminated sediments in ditches.

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

ABB-ES	ABB Environmental Services, Inc.
AOC	Area of Contamination
AREE	Area Requiring Environmental Evaluation
AWQC	Ambient Water Quality Criteria
B&MRR	Boston & Maine Railroad
BRAC	Base Realignment and Closure
BRAC EE	Base Realignment and Closure Environmental Evaluation
CCC	Civilian Conservation Corps
CLP	Contract Laboratory Program
cm/sec	centimeters per second
CMTC	Civilian Military Training Corps
COPCs	Chemicals of Potential Concern
CRL	certified reporting limit
DDD	2,2-bis(para-chlorophenyl)-1,1-dichloroethane
DDE	2,2-bis(para-chlorophenyl)-1,1-dichloroethene
DDT	2,2-bis(para-chlorophenyl)-1,1,1-trichloroethane
EPT	Ephemeroptera-Plecoptera-Trichoptera Index
ER-L	effects range-low
ESE	Environmental Science and Engineering, Inc.
°F	degrees Fahrenheit
ft^2/day	square feet per day
gpm	gallons per minute
IRDMIS	Installation Restoration Data Management Information System
LC_{50}	lethal concentration with 50% mortality
LOEL	lowest observed effect level
MAAF	Moore Army Airfield
mg/kg	milligrams per kilogram
MADEP	Massachusetts Department of Environmental Protection

MNHP	Massachusetts Natural Heritage Program
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NOAA	National Oceanic and Atmospheric Administration
NWR	National Wildlife Refuge
NYSDEC	New York State Department of Environmental Conservation
ORNL	Oak Ridge National Laboratory
PAH	polynuclear aromatic hydrocarbon
PAL	Project Analyte List
PC	personal computer
PCB	polychlorinated biphenyl
PCL	Protective Contaminant Level
POP	Project Operations Plan
PRE	Preliminary Risk Evaluation
PRI	Potomac Research Institute
PSQG	Provincial Sediment Quality Guidelines
QA	Quality Assurance
QC	Quality Control
RI	Remedial Investigation
RBP	Rapid Bioassessment Protocol
ROTC	Reserve Officer Training Corps
SA	Study Area
SCS	Soil Conservation Service
SI	Site Investigation
SQC	Sediment Quality Criteria
SQL	Sample Quantitation Limit
SVOC	semivolatile organic compound
TOC	total organic carbon
TPHC	total petroleum hydrocarbon
TSS	total suspended solids

μg/g	micrograms per gram (equivalent to part per million)
μg/L	micrograms per liter (equivalent to part per billion)
USAEC	U.S. Army Environmental Center
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VOC	volatile organic compound
WPA	Works Progress Administration

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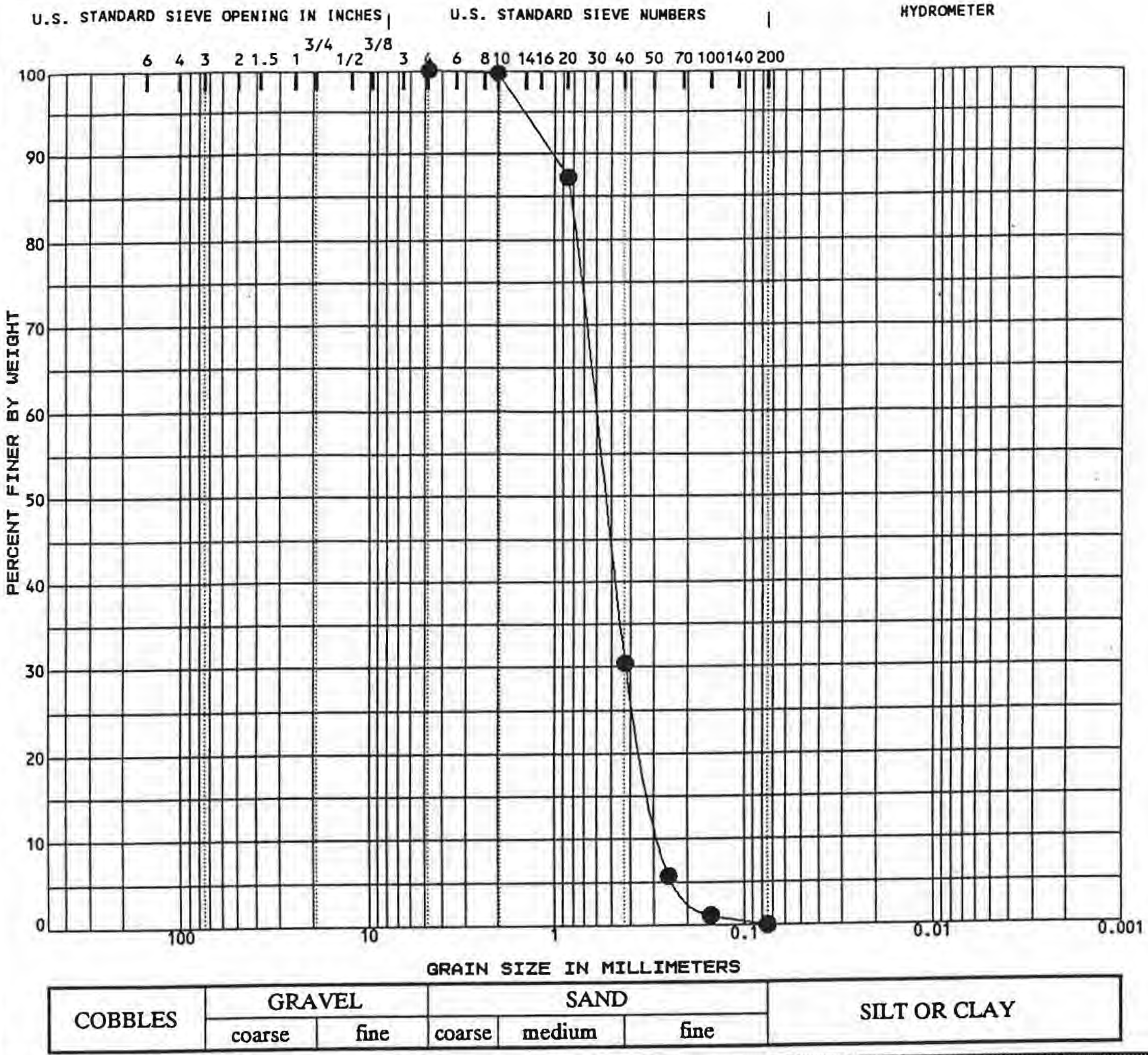
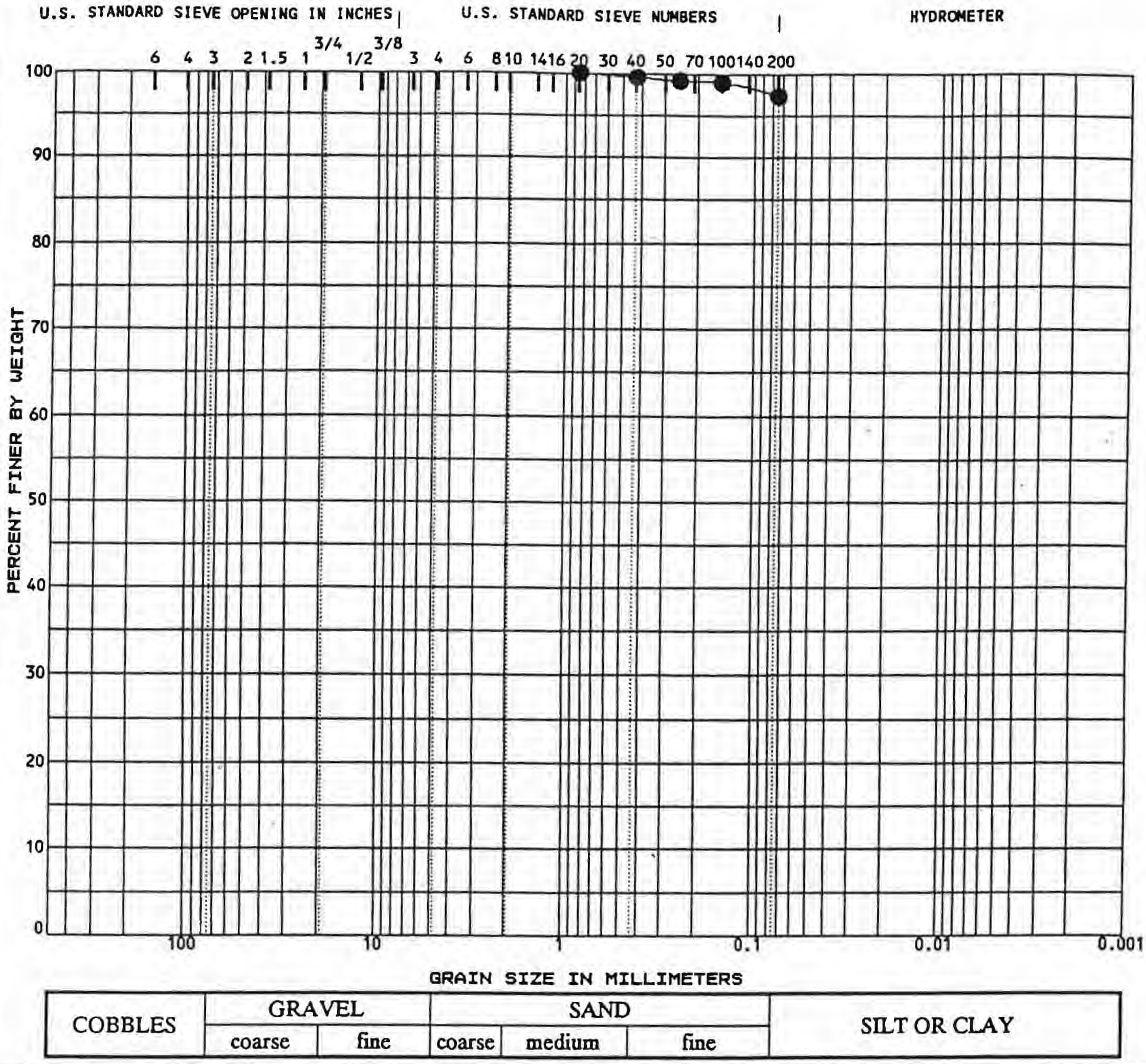


	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	CSD-01X	1.0	Medium to Fine SAND; trace coarse sand					1.06	2.2

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	CSD-01X	1.0	4.75	0.61	0.421	0.2742	0.0	100.0	0.0	

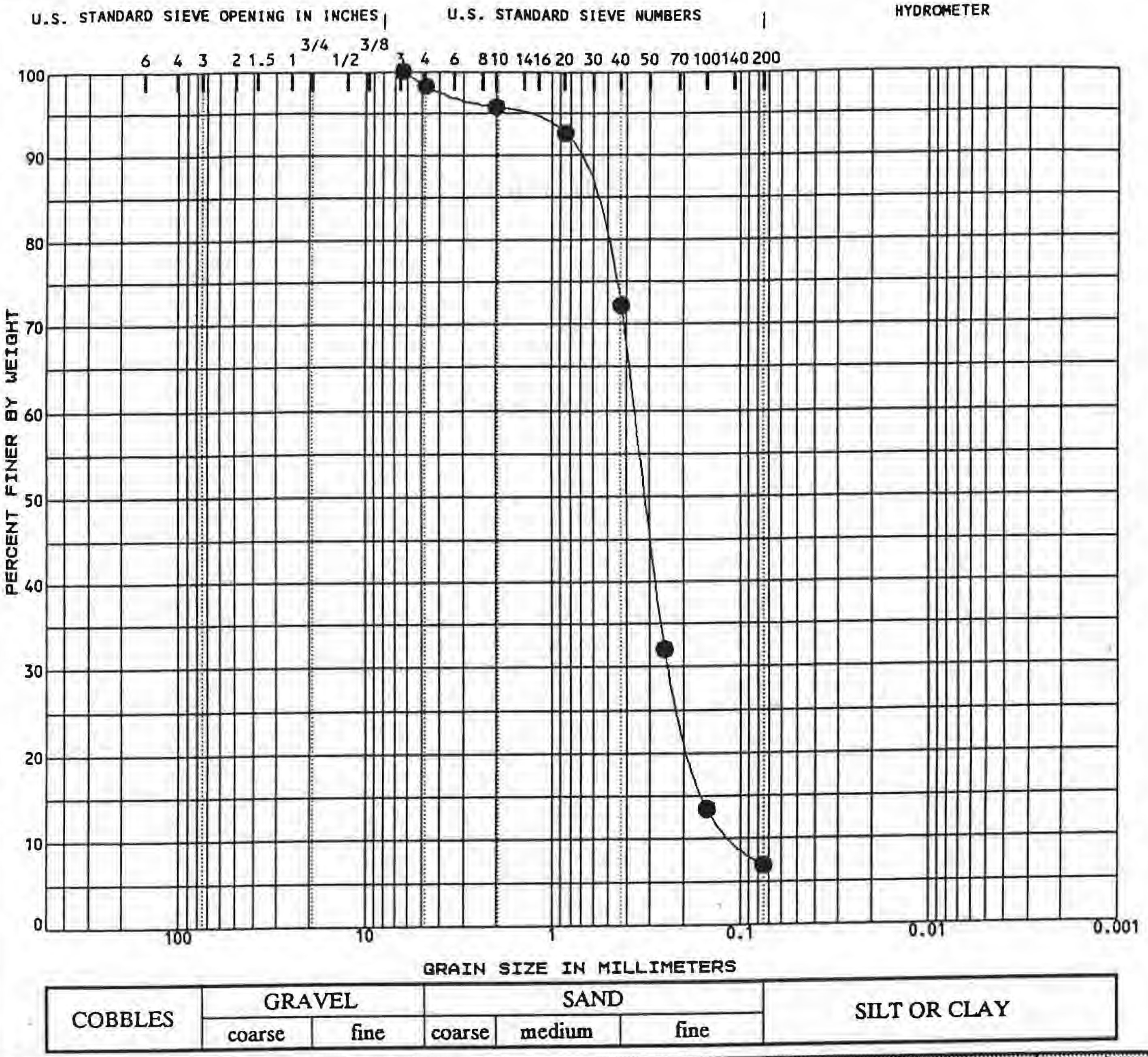
Project **Fort Devens**	Location **Cold Spring Brook**
Area	Notes
Date **March 1995**	**GRADATION CURVES**



	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	CSD-02X	1.0	SILT/CLAY; trace fine to medium sand						

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	CSD-02X	1.0	0.85				0.0	2.7	97.3	

	Project **Fort Devens**	Location **Cold Spring Brook**
	Area	Notes **ALMOST ALL ORGANICS**
	Date **March 1995**	**GRADATION CURVES**



Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● CSD-03X 1.0	Fine SAND; some medium sand; trace silt, coarse sand, and fine gravel					1.49	3.5

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● CSD-03X 1.0	6.30	0.36	0.237	0.1039	1.8	91.3	6.9	

Project **Fort Devens**

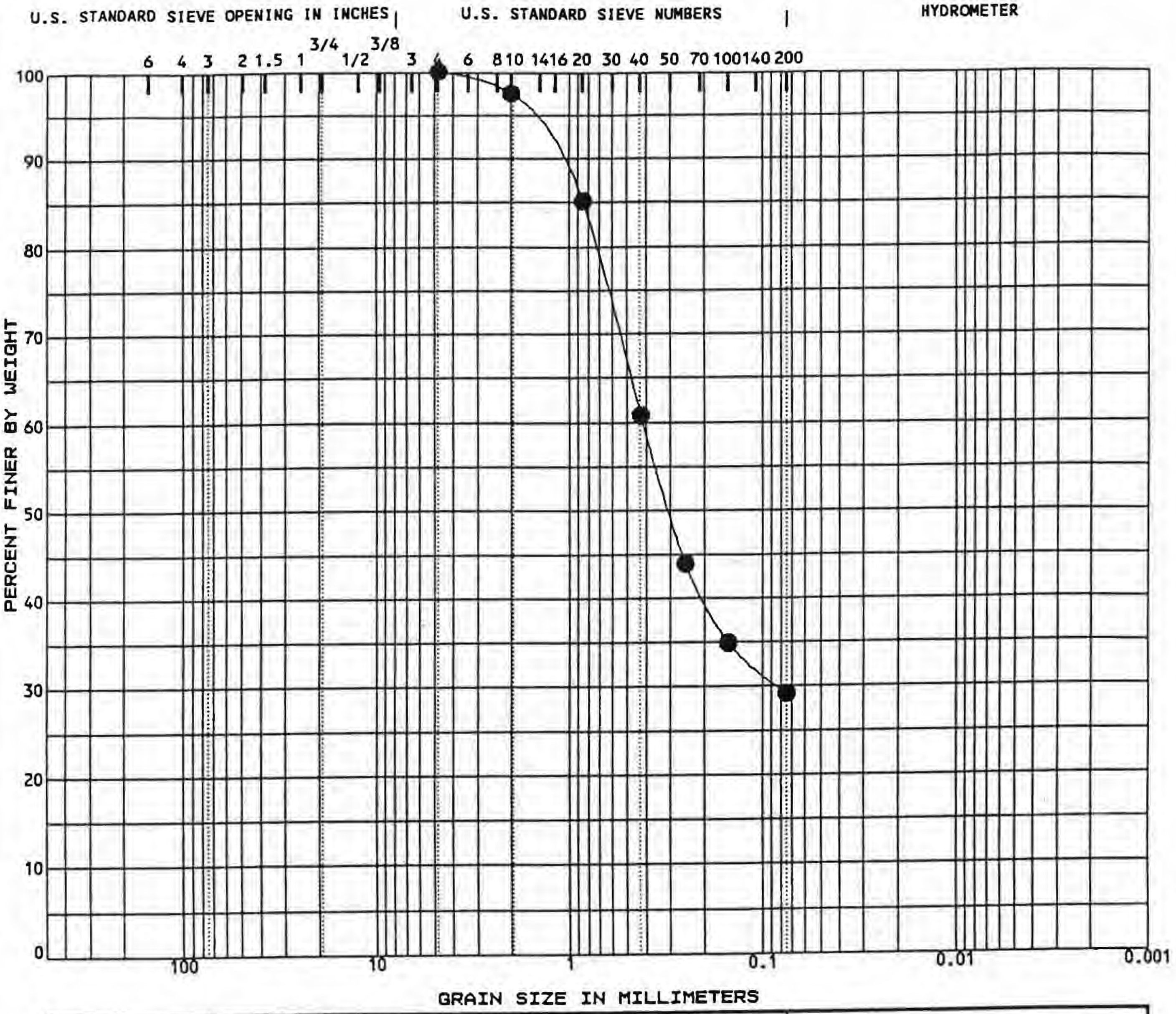
Area

Date **March 1995**

Location **Cold Spring Brook**

Notes

GRADATION CURVES

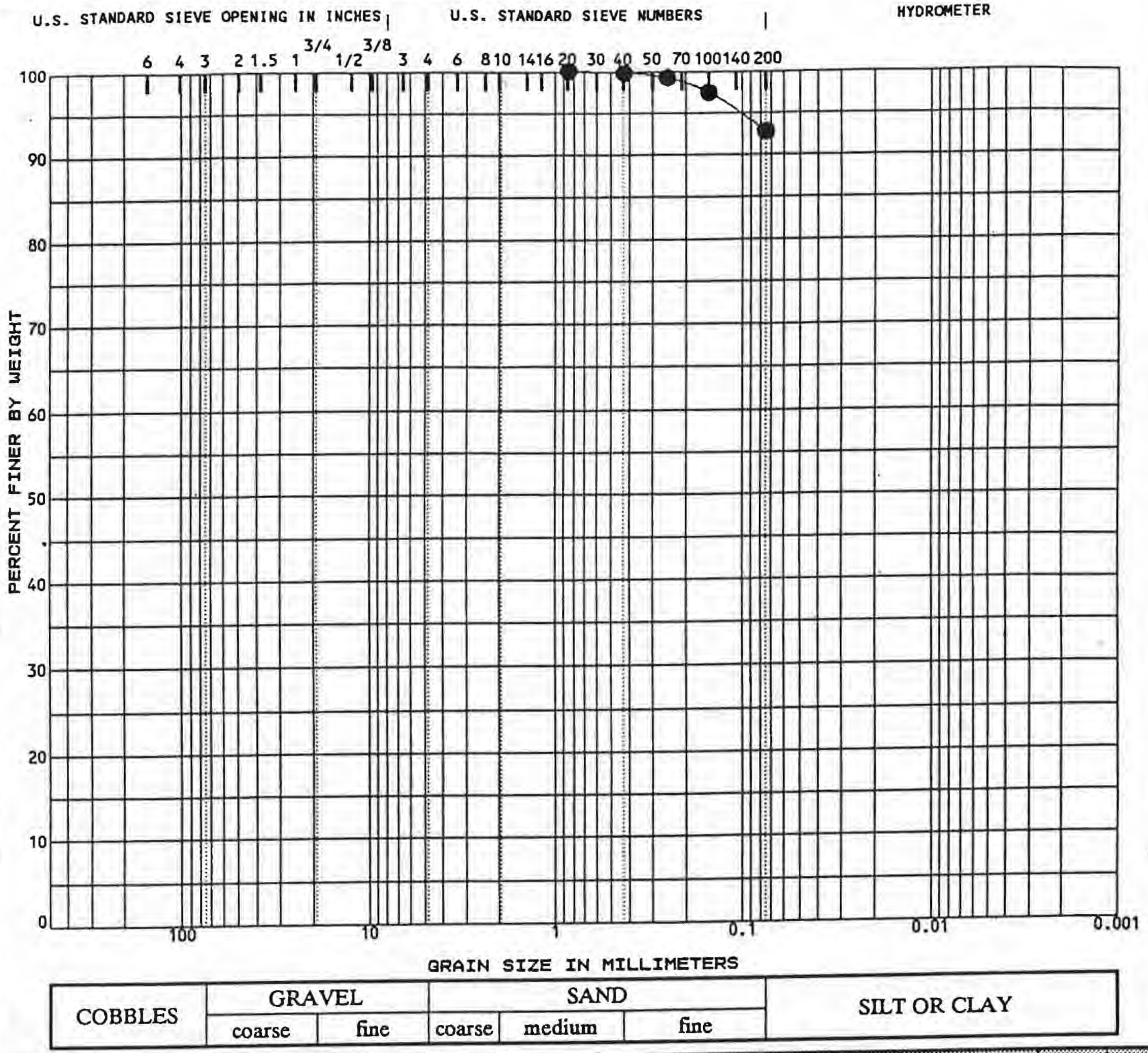


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● CSD-08X 1.0	**Medium to Fine SAND; some silt;**						
	trace coarse sand						

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● CSD-08X 1.0	4.75	0.41	0.083		0.0	70.8	29.2	

Project	**Fort Devens**	Location **Cold Spring Brook**
Area		Notes **ALOT OF ORGANICS**
Date	**March 1995**	**GRADATION CURVES**



Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
● CSD-11X	1.0	SILT/CLAY; trace fine to medium sand						

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● CSD-11X	1.0	0.85				0.0	7.3	92.7	

Project Fort Devens

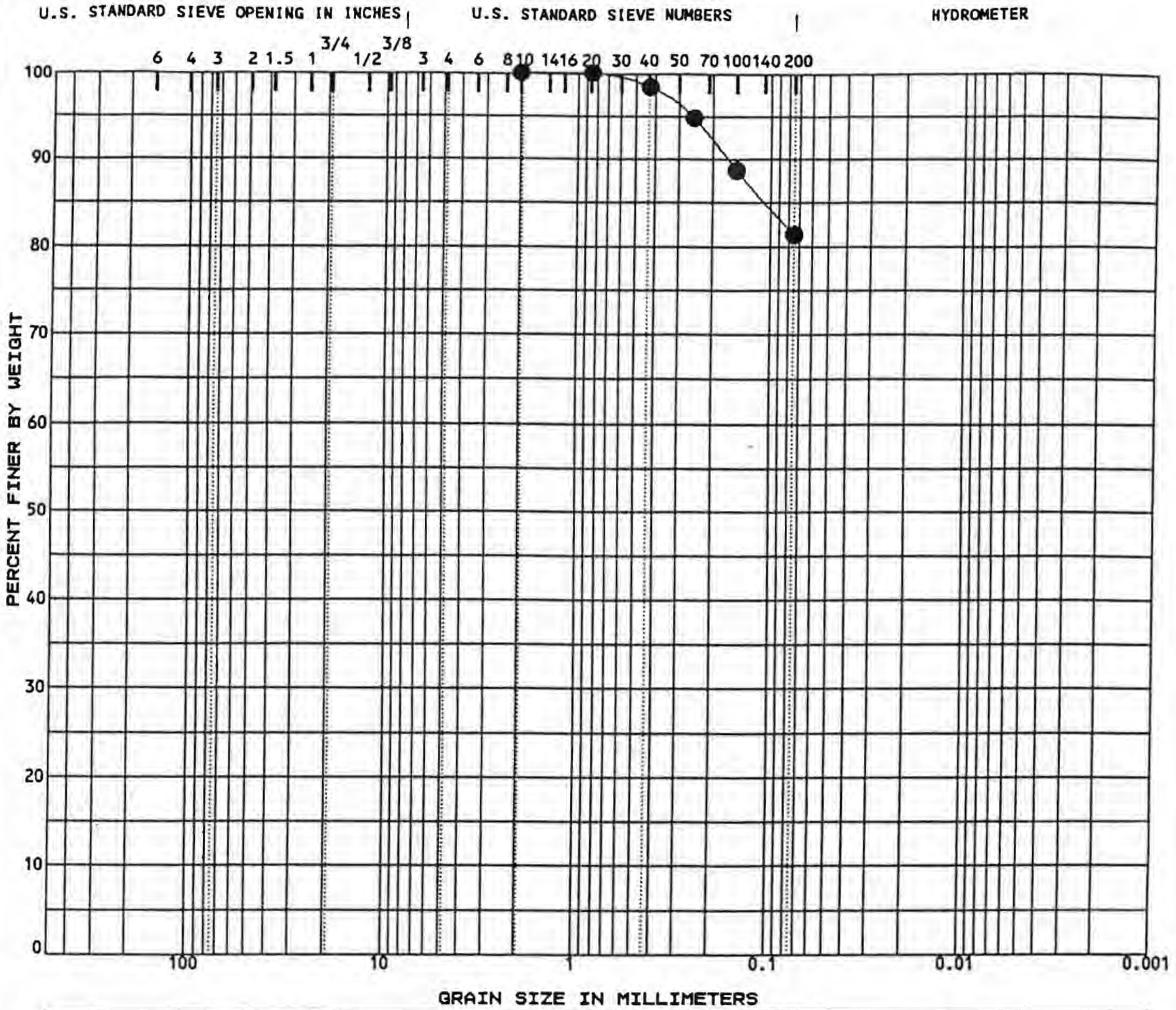
Area

Date March 1995

Location Cold Spring Brook

Notes

GRADATION CURVES

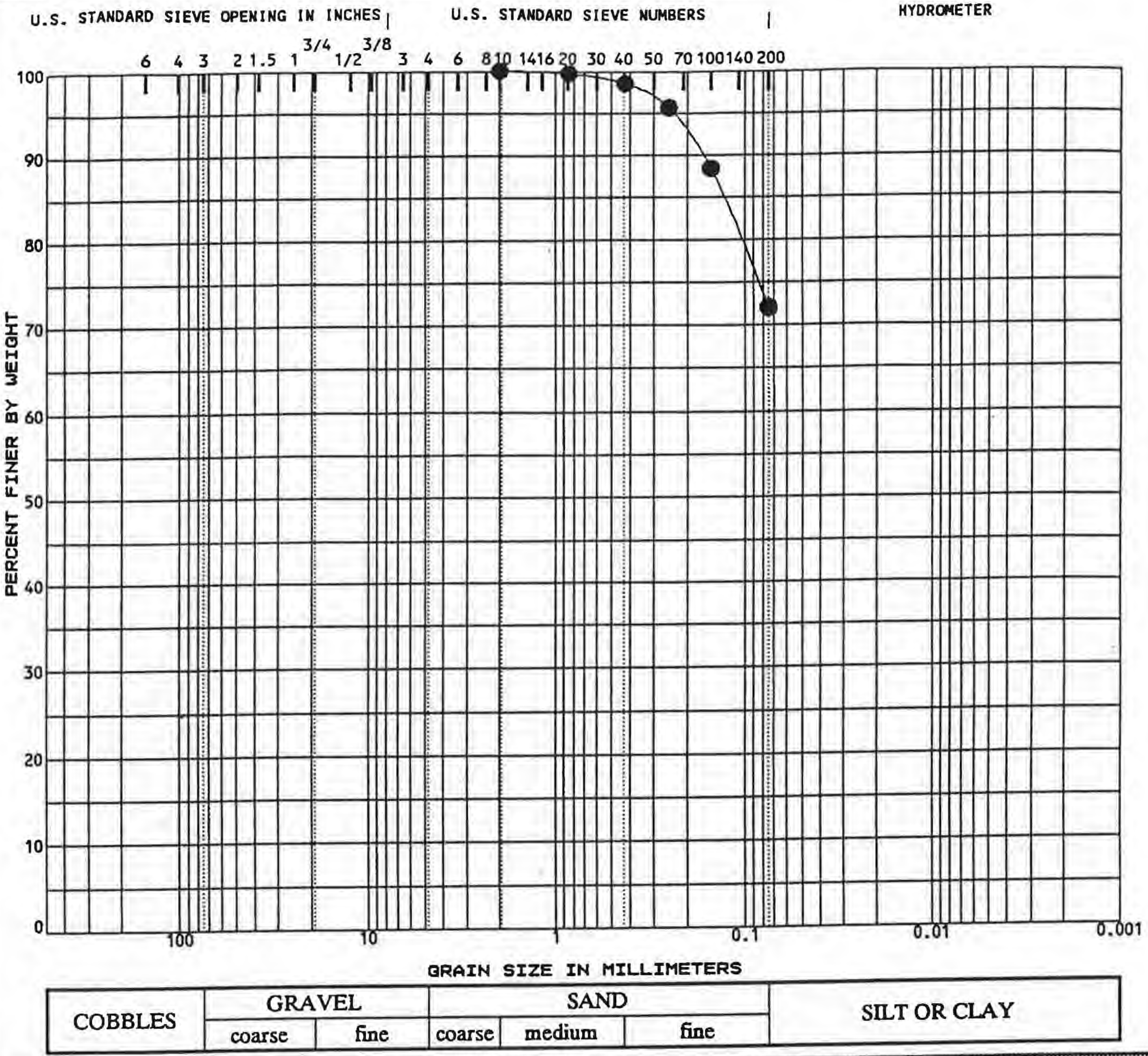


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
● CSD-13X	1.0	SILT/CLAY; little fine sand; trace medium sand						

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● CSD-13X	1.0	0.85				0.0	18.7	81.3	

Project	Fort Devens	Location	Cold Spring Brook
Area		Notes	
Date	March 1995	**GRADATION CURVES**	



	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	CSD-18X	1.0	SILT/CLAY; some fine sand; trace medium sand						

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	CSD-18X	1.0	2.00				0.0	28.0	72.0	

Project Fort Devens

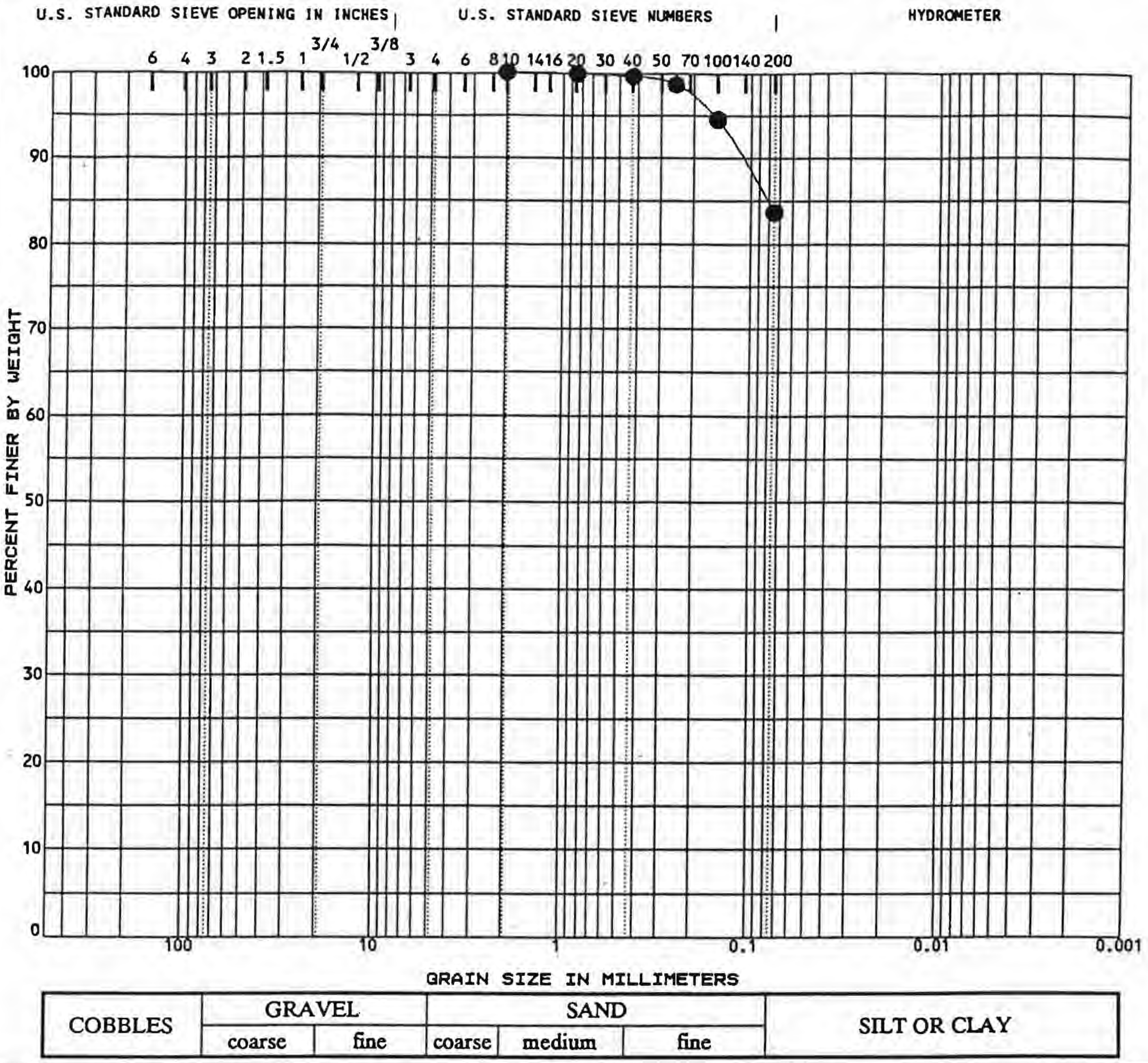
Area

Date March 1995

Location Cold Spring Brook

Notes

GRADATION CURVES



Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
● CSD-20X	1.0	SILT/CLAY; little fine sand; trace medium sand						

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● CSD-20X	1.0	2.00				0.0	16.3	83.7	

Project **Fort Devens**

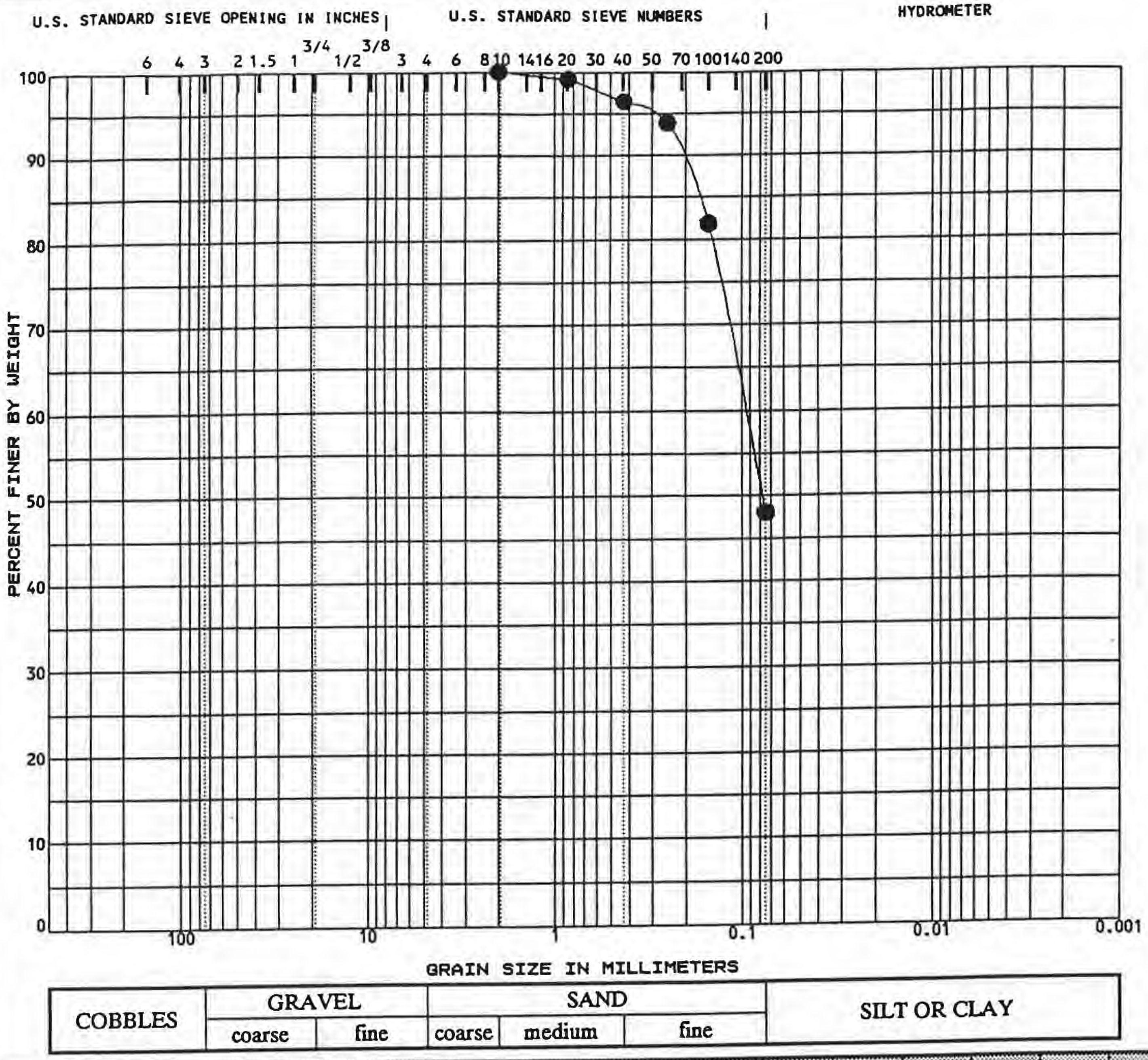
Location **Cold Spring Brook**

Area

Notes

Date **March 1995**

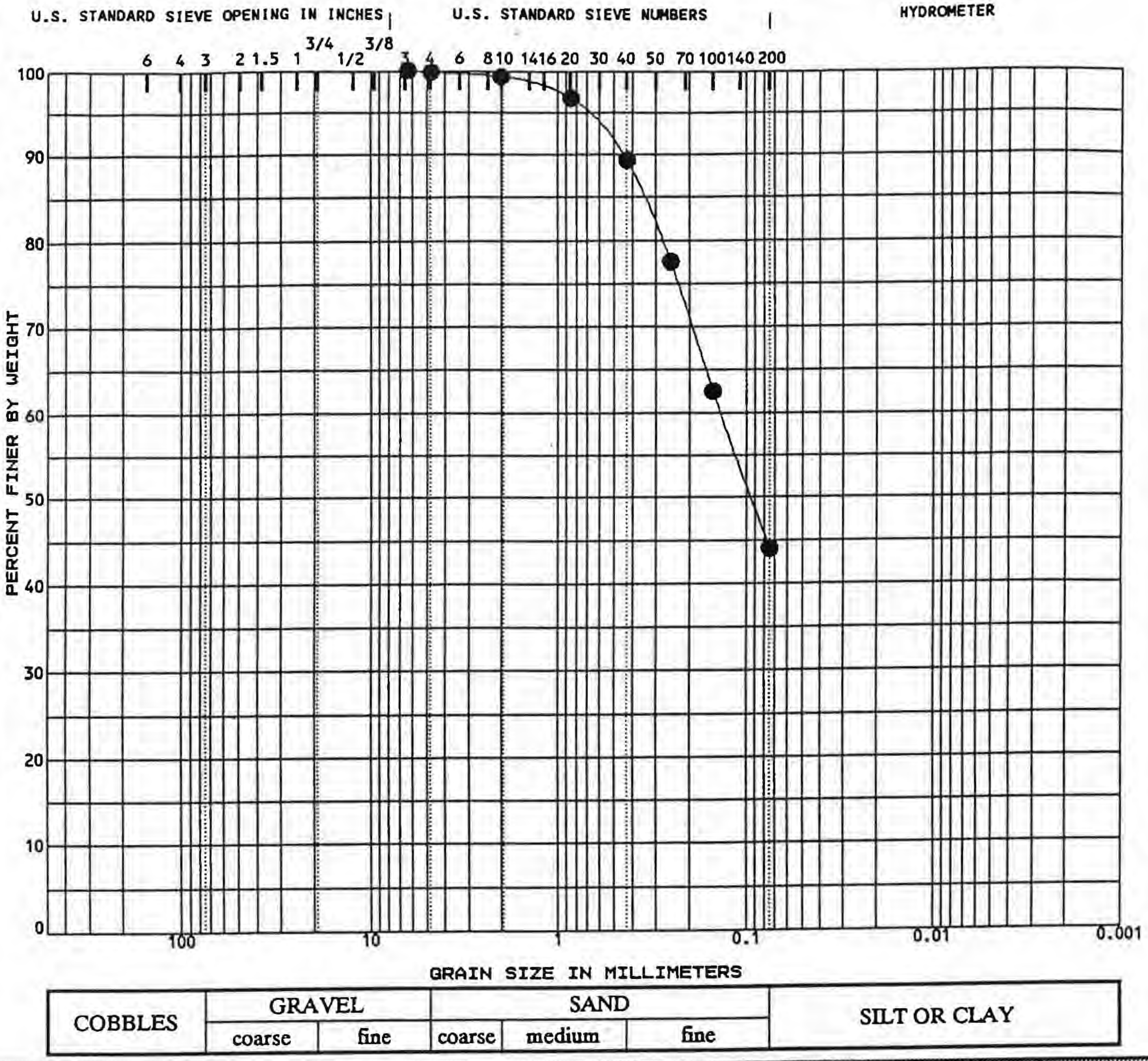
GRADATION CURVES



Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● CSD-27X 1.0	FINE SANDY SILT/CLAY; trace medium sand						

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● CSD-27X 1.0	2.00	0.10			0.0	52.0	48.0	

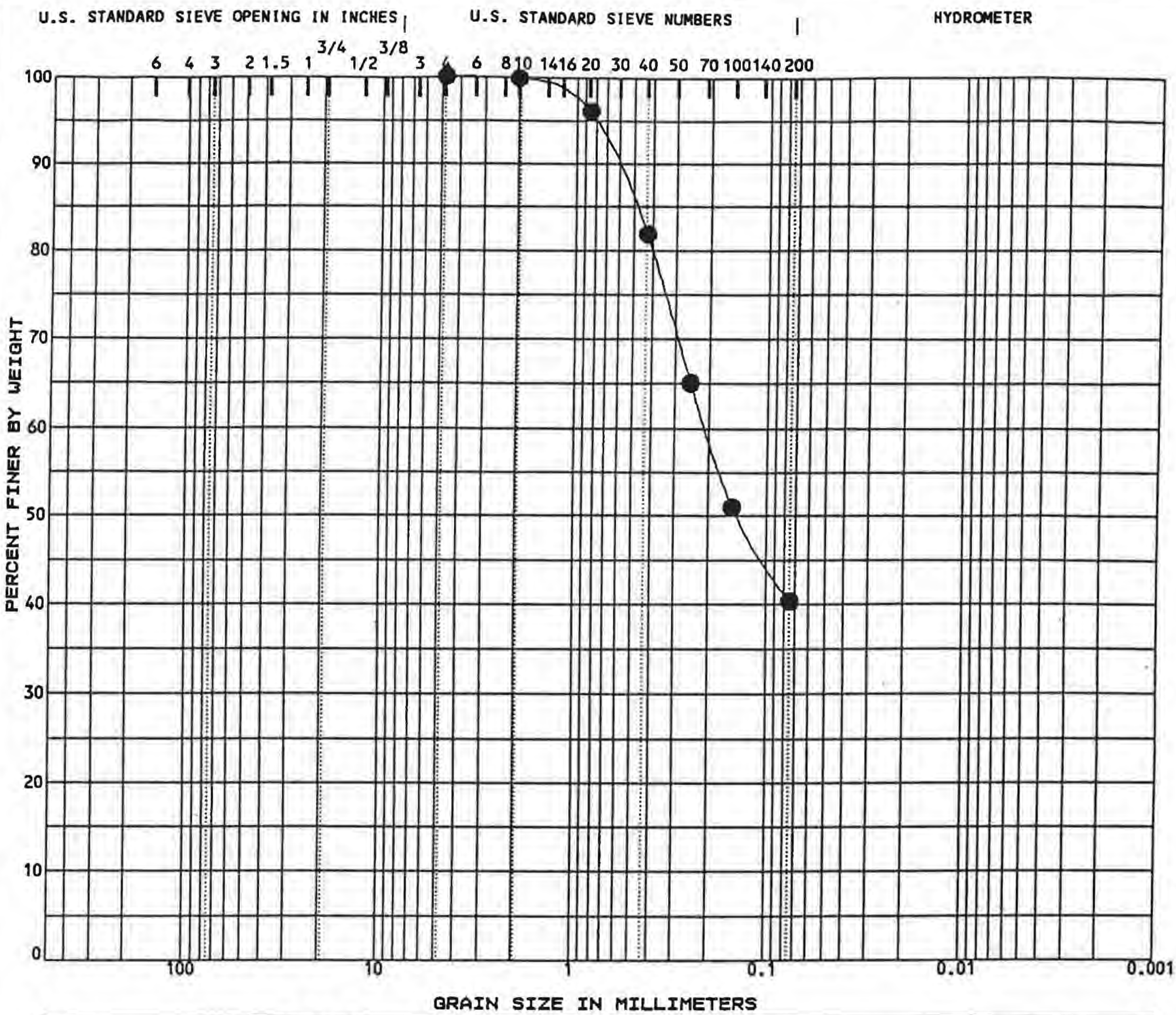
	Project **Fort Devens**	Location **Cold Spring Brook**
	Area	Notes
	Date **March 1995**	**GRADATION CURVES**



Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● CSD-32X 1.0	SILTY FINE SAND; trace medium to coarse sand						

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● CSD-32X 1.0	6.30	0.14			0.2	55.8	44.0	

Project Fort Devens	Location Cold Spring Brook
Area	Notes
Date March 1995	**GRADATION CURVES**



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● CSD-34X 1.0	**SILTY FINE SAND; little medium sand; trace coarse sand**						

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● CSD-34X 1.0	4.75	0.21			0.0	59.7	40.3	

Project **Fort Devens**

Location **Cold Spring Brook**

Area

Notes

Date **March 1995**

GRADATION CURVES

FORT DEVENS PROJECT ANALYTE LIST

FORT DEVENS PROJECT ANALYTE LIST

Project Analyte List Inorganics

AL	ALUMINUM
SB	ANTIMONY
AS	ARSENIC
BA	BARIUM
BE	BERYLLIUM
CD	CADMIUM
CA	CALCIUM
CR	CHROMIUM
CO	COBALT
CU	COPPER
FE	IRON
PB	LEAD
MG	MAGNESIUM
MN	MANGANESE
HG	MERCURY
NI	NICKEL
K	POTASSIUM
SE	SELENIUM
AG	SILVER
NA	SODIUM
TL	THALLIUM
V	VANADIUM
ZN	ZINC

Project Analyte List Explosives

135TNB	1,3,5-TRINITROBENZENE
13DNB	1,3-DINITROBENZENE
246TNT	2,4,6-TRINITROTOLUENE
24DNT	2,4-DINITROTOLUENE
26DNT	2,6-DINITROTOLUENE
HMX	CYCLOTETRAMETHYLENETETRANITRAMINE
NB	NITROBENZENE
RDX	CYCLONITE
TETRYL	NITRAMINE
NG	NITROGLYCERINE
PETN	PENTAERYTHRITOL TETRANITRATE

Project Analyte List Anions/Cations

HCO3	BICARBONATE
CL	CHLORIDE
SO4	SULFATE
NO_3	NITRATE
CA	CALCIUM
K	POTASSIUM
MG	MAGNESIUM

Project Analyte List Water Quality Parameters

CL	CHLORIDES
N2KJEL	TOTAL NITROGEN
NIT	NO_3-N
SO4	SULFATES
TPO4	TOTAL PHOSPHORUS
--	HARDNESS
ALK	ALKALINITY
TSS	TOTAL SUSPENDED SOLIDS
DO	DISSOLVED OXYGEN
	COLIFORM

Project Analyte List Organics

Volatile Organic Compounds:

111TCE	1,1,1-TRICHLOROETHANE
112TCE	1,1,2-TRICHLOROETHANE
11DCE	1,1-DICHLOROETHYLENE / 1,1-DICHLOROETHENE
11DCLE	1,1-DICHLOROETHANE
12DCE	1,2-DICHLOROETHYLENES, TOTAL (CIS AND TRANS ISOMERS)
12DCLE	1,2-DICHLOROETHANE
12DCLP	1,2-DICHLOROPROPANE
ACET	ACETONE
BRDCLM	BROMODICHLOROMETHANE
C2AVE	ACETIC ACID, VINYL ETHER/VINYL ACETATE
C2H3CL	CHLOROETHENE / VINYL CHLORIDE
C2H5CL	CHLOROETHANE
C6H6	BENZENE
CCL4	CARBON TETRACHLORIDE
CH3BR	BROMOMETHANE
CH3CL	CHLOROMETHANE
CHBR3	BROMOFORM

C13DCP	CIS-1,3-DICHLOROPROPYLENE C+S-1,3-DICHLOROPROPENE
CHCL3	CHLOROFORM
CL2CH2	DICHLOROMETHANE/METHYLENE CHLORIDE
CLC6H5	CHLOROBENZENE
CS2	CARBON DISULFIDE
DBRCLM	DIBROMOCHLOROMETHANE
ETC6H5	ETHYLBENZENE
MEC6H5	TOLUENE
MEK	METHYLETHYL KETONE / 2-BUTANONE
MIBK	METHYLISOBUTYL KETONE
MNBK	METHYL-N-BUTYL KETONE / 2-HEXANONE
STYR	STYRENE
T13DCP	TRANS-1,3-DICHLOROPROPENE
TCLEA	1,1,2,2-TETRACHLOROETHANE
TCLEE	TETRACHLOROETHYLENE / TETRACHLOROETHENE
TRCLE	TRICHLOROETHYLENE / TRICHLOROETHENE
TXYLEN	XYLENES, TOTAL COMBINED

Project Analyte List Organics

Semivolatile Compounds:

124TCB	1,2,4-TRICHLOROBENZENE
12DCLB	1,2-DICHLOROBENZENE
13DCLB	1,3-DICHLOROBENZENE
14DCLB	1,4-DICHLOROBENZENE
245TCP	2,4,5-TRICHLOROPHENOL
246TCP	2,4,6-TRICHLOROPHENOL
24DCLP	2,4-DICHLOROPHENOL
24DMPN	2,4-DIMETHYLPHENOL
24DNP	2,4-DINITROPHENOL
24DNT	2,4-DINITROTOLUENE
26DNT	2,6-DINITROTOLUENE
2CLP	2-CHLOROPHENOL
2CNAP	2-CHLORONAPHTHALENE
2MNAP	2-METHYLNAPHTHALENE
2MP	2-METHYLPHENOL / 2-CRESOL
2NANIL	2-NITROANILINE
2NP	2-NITROPHENOL
33DCBD	3,3'-DICHLOROBENZIDINE
3NANIL	3-NITROANILINE
46DN2C	4,6-DINITRO-2-CRESOL / METHYL-4,6-DINITROPHENOL
4BRPPE	4-BROMOPHENYLPHENYL ETHER

4CANIL	4-CHLOROANILINE
4CL3C	4-CHLORO-3-CRESOL / 3-METHYL-4-CHLOROPHENOL
4CLPPE	4-CHLOROPHENYLPHENYL ETHER
4MP	4-METHYLPHENOL / 4-CRESOL
4NANIL	4-NITROANILINE
4NP	4-NITROPHENOL
ANAPNE	ACENAPHTHENE
ANAPYL	ACENAPHTHYLENE
ANTRC	ANTHRACENE
B2CEXM	BIS (2-CHLOROETHOXY) METHANE
B2CIPE	BIS (2-CHLOROISOPROPYL) ETHER
B2CLEE	BIS (2-CHLOROETHYL) ETHER/2,2´-OXYBIS(1-CHLOROPROPANE)
B2EHP	BIS (2-ETHYLHEXYL) PHTHALATE
BAANTR	BENZO [A] ANTHRACENE
BAPYR	BENZO [A] PYRENE
BBFANT	BENZO [B] FLUORANTHENE
BBZP	BUTYLBENZYL PHTHALATE
BGHIPY	BENZO [G,H,I] PERYLENE
BKFANT	BENZO [K] FLUORANTHENE
BZALC	BENZYL ALCOHOL
CARBAZ	CARBAZOLE
CHRY	CHRYSENE
CL6BZ	HEXACHLOROBENZENE
CL6CP	HEXACHLOROCYCLOPENTADIENE
CL6ET	HEXACHLOROETHANE
DBAHA	DIBENZ [A,H] ANTHRACENE
DBZFUR	DIBENZOFURAN
DEP	DIETHYL PHTHALATE
DMP	DIMETHYL PHTHALATE
DNBP	DI-N-BUTYL PHTHALATE
DNOP	DI-N-OCTYL PHTHALATE
FANT	FLUORANTHENE
FLRENE	FLUORENE
HCBD	HEXACHLOROBUTADIENE
ICDPYR	INDENO [1,2,3-C,D] PYRENE
ISOPHR	ISOPHORONE
NAP	NAPHTHALENE
NB	NITROBENZENE
NNDNPA	N-NITROSO DI-N-PROPYLAMINE
NNDPA	N-NITROSO DIPHENYLAMINE
PCP	PENTACHLOROPHENOL
PHANTR	PHENANTHRENE
PHENOL	PHENOL
PYR	PYRENE

Project Analyte List Organics

Pesticides and PCBs:

ABHC	ALPHA-BENZENEHEXACHLORIDE / ALPHA-HEXACHLOROCYCLOHEXANE
ACLDAN	ALPHA CHLORDANE
AENSLF	ALPHA-ENDOSULFAN / ENDOSULFAN I
ALDRN	ALDRIN
BBHC	BETA-BENZENEHEXACHLORIDE / BETA-HEXACHLOROCYCLOHEXANE
BENSLF	BETA-ENDOSULFAN / ENDOSULFAN II
DBHC	DELTA-BENZENEHEXACHLORIDE / DELTA-HEXACHLOROCYCLOHEXANE
DLDRN	DIELDRIN
ENDRN	ENDRIN
ENDRNA	ENDRIN ALDEHYDE
ENDRNK	ENDRIN KETONE
ESFSO4	ENDOSULFAN SULFATE
GCLDAN	GAMMA-CHLORDANE
HPCL	HEPTACHLOR
HPCLE	HEPTACHLOR EPOXIDE
LIN	LINDANE / GAMA-BENZENEHEXACHLORIDE / GAMMA-HEXACHLOROCYCLOHEXANE
MEXCLR	METHOXYCHLOR
PCB016	PCB 1016
PCB221	PCB 1221
PCB232	PCB 1232
PCB242	PCB 1242
PCB248	PCB 1248
PCB254	PCB 1254
PCB260	PCB 1260
PPDDD	2,2-BIS (PARA-CHLOROPHENYL)-1,1-DICHLOROETHANE
PPDDE	2,2-BIS (PARA-CHLOROPHENYL)-1,1-DICHLOROETHENE
PPDDT	2,2-BIS (PARA-CHLOROPHENYL)-1,1,1-TRICHLOROETHANE
TXPHEN	TOXAPHENE