U. S. ENVIRONMENTAL PROTECTION AGENCY REGION I-NEW ENGLAND OFFICE OF ENVIRONMENTAL MEASUREMENT & EVALUATION OFFICE OF ECOSYSTEM ASSESSMENT 60 WESTVIEW STREET, LEXINGTON, MA 02421

MEMORANDUM

DATE: April 19, 1999

- SUBJ: Screening-Level Ecological Risk Assessment, Fort Devens, Ayer, Massachusetts
- FROM: Patti Lynne Tyler PLT Aquatic Biologist/Ecological Risk Assessor
 - TO: Jim Byrne Remedial Project Manager Federal Facilities Superfund Section

Per your request, EPA's Office of Ecosystem Assessment along with the technical assistance of Lockheed Martin's Environmental Services Assistance Team (ESAT) has completed the attached screening-level ecological risk assessment using the analytical results generated from the September 1998 surface water and sampling event that took place within Plow Shop Pond, Grove Pond and Nonacoicus Brook.

Please do not hesitate to contact me should you have any questions and or comments with respect to this assessment.

cc: Peter Nolan Steve Mierzykowski EPA/OEME/ECA USFWS

1A 99041 USAS

Screening-Level Ecological Risk Assessment

Fort Devens

Ayer, Massachusetts

U.S. Environmental Protection Agency Region I New England Office of Environmental Measurement and Evaluation Office of Ecosystem Assessment

April 19, 1999

1A 99041 USAS

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Screening-Level Ecological Risk Assessment

Fort Devens Superfund Site, Ayer, Massachusetts

1.0 INTRODUCTION

This screening level assessment evaluates inorganic data detected from surface water and sediment sampling conducted by EPA's Office of Ecosystem Assessment's Environmental Services Assistance Team (ESAT) during September 1998 on three waterways (i.e., Grove Pond, Plow Shop Pond, and Nonacoicus Brook) associated with the Fort Devens Superfund Site. A detailed description of ESAT's field sampling efforts can be found in *Surface Water and Sediment Sampling for the Fort Devens Superfund Site, Ayer, Massachusetts, September 1998.* This screening-level ecological risk assessment (ERA) has been prepared according to procedures recommended in EPA (1997); *Ecological Risk Assessment Guidance for Superfund, Process for Designing and Conducting Ecological Risk Assessments, Draft Final* (EPA 540/R-97-006). The purpose of this assessment is to compare this surface water and sediment data to ecological benchmarks and to identify chemicals that might pose a potential risk to aquatic organisms. Based on the limited scope of the ERA, background information on the site is only briefly summarized in order to provide a context for subsequent steps.

This ERA consists of a Screening-level Problem Formulation and Ecological Effects Evaluation, and contains the following sections:

- Site history
- Surface water and sediment sampling event, September, 1998
- Environmental setting
- Nature and extent of contamination
- Preliminary exposure pathway analysis
- Screening-level methodology
- Results of the screening-level evaluation
- Discussion and conclusions
- Uncertainty analysis

This screening-level ERA is based on the use of limited site-specific information concerning the presence of ecological receptors and other natural features, therefore some of the

sections listed above contain only a brief summary of the information.

2.0 SITE HISTORY

Fort Devens is a superfund site located in Ayer, Massachusetts. A global positioning system (GPS) map of the site and surrounding environment is provided in Appendix A. The following three waterways have been potentially impacted by the site.

2.1 Plow Shop Pond

The eastern shore of the pond is formed by a railroad causeway which heads south to Hill Yard. Hill Yard is an active railyard operated by the Boston and Maine Railroad (B&MRR). A stone arch culvert under a railroad causeway connects Plow Shop Pond with Grove Pond. An operational railroad roundhouse was located on southern edge of the pond from the period 1900 to 1935. The western and southwestern shores of the pond border the Shepley's Hill Landfill. Historical sources of contamination at Plow Shop Pond include Shepley's Hill Landfill, activities at the railroad roundhouse, activities of the B&MRR, and inflow from Grove Pond. High dissolved concentrations of several inorganics (e.g., arsenic, chromium, lead, and mercury), and an interpreted groundwater flow towards the pond indicate the possibility of contaminant migration from the former tannery site to Plow Shop Pond in groundwater. Surface water from Grove Pond may also have transported contaminants from that pond to downgrading Plow Shop Pond.

2.2 Grove Pond

The pond is bordered on the west by the railroad causeway; on the north by residential, and former industrial areas; and on the south by property owned by Fort Devens, the National Guard, and the Town of Ayer. A tannery, operating between 1854 through 1961, was located on the northwest corner of Grove Pond. The stone arch culvert under the causeway connects the pond with Plow Shop Pond. Waste disposal practices from the tannery operations appear to be a source of contaminants, primarily arsenic, chromium, lead, and mercury, to the ponds. Other potential sources of contamination include inflow from upgradient Cold Spring Brook, inflow from Balch Pond, and runoff from Fort Devens and the Town of Ayer.

2.3 Nonacoicus Brook

Little historical information exists with respect to Nonacoicus Brook. The brook is included in the screening process because it originates with flow from Plow Shop Pond and may have been impacted by site-related chemicals.

3.0 SURFACE WATER AND SEDIMENT SAMPLING EVENT, SEPTEMBER 1998

In September 1998, ESAT collected surface water and sediment samples at 16 locations

associated with the Fort Devens Superfund Site in Ayer, Massachusetts. Sampling was performed to investigate the distribution of metals in surface water and sediment in Plow Shop Pond, Grove Pond, and Nonacoicus Brook, all of which are potentially impacted by the Fort Devens site. Sampling locations in the two ponds were intended to match locations where biological sampling took place during the summer of 1998 (see Appendix B). Specifically, the four locations sampled in each pond corresponded as closely as possible with locations used for emergent insect trap studies performed earlier in the year.

Nonacoicus Brook was sampled because this stream begins as the outfall of Plow Shop Pond, which has been impacted by the Fort Devens site. Prior to this sampling event, there has been little information available with respect to the potential migration of contamination originating from the site. Eight depositional areas were selected along Nonacoicus Brook, representing, to the extent possible, the full course of the Brook from its origin at Plow Shop Pond to its confluence with the Nashua River. Sampling locations were selected for Nonacoicus Brook from its beginning to the point where it passes under Main Street in Ayer. This reach of Nonacoicus Brook is characterized by fairly steeply cut banks, with predominantly coarse sand substrate and occasional shallow riffle areas. Observations in the upper portion of the Brook confirm the presence of freshwater mussels. In addition, numerous sunfish and catfish, and one small pickerel, were observed in this section of the stream. The banks are overhung with red maple, speckled alder, and other trees and shrubs, with occasional heavy growth of grapes. Water depth ranged from less than one inch to as much as two feet in the deepest pools. Surface water was too shallow to be sampled at station NON-5 at the time of the sampling. Although NON-42 is a duplicate sample of NON-4, it was treated as a separate station in the screening process.

At each sampling station, prior to sampling, ESAT measured water quality parameters, including pH, dissolved oxygen, specific conductance, and temperature. ESAT then noted the habitat surrounding the sampling station, recorded the latitude and longitude using Global Positioning System (GPS) (Appendix A), and photographed the station. This information is provided in the field sampling report. Surface water samples were collected for Target Analyte List (TAL) total metals analysis. However both mercury and cyanide were excluded from the analysis. Sediment samples were collected for TAL metals analysis, as well as, grain size and total organic carbon (TOC). A detailed sampling chronology is provided in the field sampling report.

4.0 ENVIRONMENTAL SETTING

The Draft Plow Shop Pond and Grove Pond Sediment Evaluation (ABB Environmental Services, 1995) report lists a number of wildlife species that may be associated with these two ponds. These ponds may provide wildlife habitat for the mink (*Mustela vison*), muskrat (*Ondatra zibethicus*), and beaver (*Castor canadensis*). Bird species include the wood duck (*Aix sponsa*), swamp sparrow (*Melospiza georgiana*), great blue heron (*Ardea herodias*), and red-winged blackbird (*Agelaius phoeniceus*). Green frogs (*Rana clamitans*) and the eastern painted turtle (*Chrysemys picta*) are just two of other reptile and amphibians species which may frequent the watershed. Fish species include largemouth bass (*Micropterus salmoides*),

bluegill (*Lepomis macrochirus*), golden shiner (*Notemigonus crysoleucas*), pumpkinseed (*Lepomis gibbosus*), and the chain pickerel (*Esox niger*).

4.1 Plow Shop Pond

Plow Shop Pond is a shallow, 30 acre pond located outside the installation boundary at the northeastern corner of the Main Post at Fort Devens. A dam located at the northwest corner controls the water elevation. The center of the pond is approximately eight feet deep. The maximum depth is about ten feet in the northeastern section.

The pond is eutrophic, and classified as a floating-leaved deep marsh (E&E,1993). Seasonally, more than 80 percent of the surface area is covered with aquatic macrophytes, which includes sweet water lily (*Nymphaea odorata*) and water shield (*Brasenia schreberi*). Submerged macrophytes, primarily water marigold (*Megalodonta beckii*), seasonally cover more than 75 percent of the submerged portions of the pond. The bottom of the pond consists of highly organic sediments and peat ranging in depth from one to seven feet.

4.2 Grove Pond

Grove Pond is immediately upgradient of Plow Shop Pond. Grove Pond is a shallow, 60 acre pond located in the same general vicinity of Fort Devens as Plow Shop Pond. The pond is eutrophic, and seasonally supports dense growths of both floating-leaved and submerged aquatic macrophytes. Maximum depth is estimated at 5 to 6 feet. The bottom of the pond is similar to Plow Shop Pond, with peat up to several feet thick. At the time of the September 1998 sampling event, aquatic vegetation is prevalent as dense stands of pickerel weed, water lilies, and coontail. The waterfowl were plentiful on this pond as flocks of mallards, wood ducks, Canada geese, cormorants, teal, great blue heron were evident in all areas of the pond.

4.3 Nonacoicus Brook

The Brook and associated wetlands drains Plow Shop Pond. The Brook flows approximately one mile northwest before its confluence with the Nashua River. Nonacoicus Brook starts at a waterfall which is an outlet for Plow Shop Pond. Immediately below the waterfall, there is a wide, shallow pooled area. The Brook leaves this pool in a series of meanders, and passes to the northwest under Scully Street, which is a residential road leading to an industrial park. Immediately beyond Scully Street is a deep pool, approximately ten feet deep in the center. This pool has a fairly hard substrate, and is lined around its edge with large rocks. Beyond the pool, Nonacoicus Brook passes under a railroad track and another residential street, before passing under Main Street and turning to the west toward the Nashua River. At the point where the Brook turns to the west, a tributary joins Nonacoicus Brook from the east. After this point Nonacoicus Brook becomes more depositional, with areas of deep fine sediments and bordering areas of emergent vegetation. The tributary appears to originate near the town center of Ayer, and it passes through a marsh area near the Ayer Public Works Department facilities before joining Nonacoicus Brook.

5.0 NATURE AND EXTENT OF CONTAMINATION

Previous investigations of Grove Pond identified elevated sediment concentrations of inorganics, including arsenic, barium, cadmium, calcium, chromium, copper, iron, lead, manganese, mercury, vanadium, and zinc. The tannery is suspected as the likely source of inorganics to the pond. In a previous ecological Preliminary Risk Evaluation (ABB, 1995), concentrations of arsenic, cadmium, lead, mercury, and several pesticides were found to exceed ecotoxicological benchmarks.

Previous studies conducted at Plow Shop Pond revealed that activities of the tannery, as well as, inflow from Grove Pond has contributed to the contamination in the shallow sediments. Plow Shop Pond also contains elevated sediment concentrations of arsenic, barium, calcium, chromium, copper, lead, and mercury. Additional sources of contamination include the Railroad Roundhouse which may be a source of copper and lead contamination to the sediments; and Shepley's Hill Landfill which has been implicated as a source of arsenic, barium, iron, and manganese along the western shore of the pond. Iron and manganese contributions to the pond is suspected through inflow from Grove Pond (ABB, 1995).

6.0 PRELIMINARY EXPOSURE PATHWAY ANALYSIS

Sediment biota, pelagic biota, and organisms that forage in the ponds and brook may all be exposed to site-related contaminants. This ERA will consider, in a generic manner, risk to benthic invertebrates and aquatic dwelling organisms through the use of benchmarks generally considered to be protective of these organisms. Although not specifically designed for the purpose, conservative sediment and water benchmarks are assumed to be generally protective of organisms that forage in the aquatic system.

7.0 SCREENING-LEVEL METHODOLOGY

This section presents a comparison of surface water and sediment data with benchmarks appropriate to those media. The screening process involves the selection of Contaminants of Potential Concern (COPCs) for each medium. The following three factors were considered in the selection process.

- Comparison with benchmarks. Contaminant concentrations were compared with suitable benchmarks for each medium. If any benchmark was exceeded, the chemical was retained as a COPC.
- Absence of suitable toxicity data. Some contaminants were detected for which widely excepted benchmarks were unavailable. An attempt was made to locate a suitable toxicity values. However, if a toxicity value was not obtained, the contaminant was retained as a COPC.

 Nutrient or low toxicity status. Several chemicals detected in sediments, such as calcium, magnesium, and sodium are nutrients for most organisms, and have low toxicity. These chemicals were eliminated as COPCs.

Surface water analytical results were compared to acute and chronic criteria or benchmarks. Chronic ambient water quality criteria for the metals cadmium, copper, lead, nickel, silver and zinc were adjusted based on site-specific hardness. Site-specific values were obtained from an average of four calcium and magnesium measurements for the Ponds and Brook (Appendix E).

Tables 1 through 6 present the selection of inorganic COPCs for surface water. The benchmarks selected for surface water include, in order of preference, the Federal Ambient Water Quality Criteria, Freshwater Chronic and Acute Values (AWQC); Tier II secondary chronic and acute values (Jones and Tsao, 1996). The lowest chronic values (LCVs) for daphnids from the Suter and Tsao (1996) report were used as benchmarks for calcium, magnesium, potassium, and sodium.

Sediment analytical results were compared to low and high sediment benchmarks. Concentrations exceeding both low and high benchmarks are highlighted in the screening tables. Tables 7 through 12 presents the selection of inorganic sediment COPCs. Inorganic contaminants were evaluated using a variety of benchmarks. Principally, the Ontario Ministry of the Environment (OMOE) sediment quality guidelines (Jaagumagi et al. 1995) were used to evaluate inorganic contaminants in sediment, as these guidelines are applicable to freshwater environments. The Lowest Effect Levels (LELs) and the Severe Effect Levels (SELs) were both presented in the sediment screening tables. NOAA's sediment guidelines, as developed by Long et al. (1995) were used only if OMOE guidelines were unavailable. Additional sediment benchmarks included the Probable Effects Concentrations (PECs) associated with the Assessment and Remediation of Contaminated Sediments (ARCS) Project (EPA 1996), as cited in Jones et al. (1997). Sediment benchmarks were not available from the above listed sources for several inorganic compounds, such as barium, beryllium, cobalt, selenium, thallium, and vanadium. These chemicals were, however, detected in the sediment. Therefore an attempt was made to locate a suitable toxicity value. Potential sources for these inorganics include EPA criteria for non-polluted sediments (EPA, 1977), and British Columbia sediment criteria (BCMOEL, 1994).

In addition to maximum and station-specific concentrations, surface water and sediment concentrations were evaluated by using the arithmetic mean or average concentration which were determined for analytes designated with no data qualifiers as well as data qualifiers such as "U" and "J" or estimated value which is considered approximate due to limitations of the data. In the case of values qualified with a "U", the average was determined by multiplying the value by 0.5. For all other data qualifiers, no manipulations to the data were conducted.

8.0 RESULTS OF THE SCREENING-LEVEL EVALUATION

Tables 1 through 12 display the chemicals which exceed their respective benchmark values. Sediment concentrations of several chemicals exceeded both low and high benchmarks. Since many low benchmarks were exceeded for the sediments, the discussion and subsequent conclusion will focus on sediment concentrations which exceed their respective high benchmarks. The text boxes below highlight those COPCs for their associated aquatic system:

8.1 Plow Shop Pond

The surface water results and the associated screening process for Plow Shop Pond can be found in Tables 1 and 2, and the sediment results in Tables 7 and 8.

8.1.1 Surface Water Results

There were no acute criteria or benchmark exceedances of contaminant concentrations detected in the surface water. Tables 1 and 2 indicate that barium, iron, and manganese were the only three inorganics which exceeded their respective chronic benchmarks. Iron, at 1,600 μ g/L, exceeded its 1,000 μ g/L chronic benchmark in only one of four sample locations (i.e., PSEM-4). Barium, however, exceeded its 4.0 μ g/L Tier II chronic benchmark in all four stations. PSEM-4 had the highest level of barium at 15.3 ug/L. The Tier II chronic value for manganese was exceeded in only one of four sample locations (PSEM-2), at a concentration of 193 μ g/L.

8.1.2 Sediment Results

Based on the screening provided in Tables 7 and 8, nine inorganics are retained as sediment COPCs in Plow Shop Pond. Of these nine COPCs, seven were found in all four sample locations. These include barium, cadmium, chromium, iron, lead, manganese, and zinc. Copper, and nickel were found in three out of four sediment samples above their respective benchmarks. PSEM-1,-2,-3 remained consistent with respect to the number of COPCs per location at nine. Although PSEM-4 had the lowest number of COPCs with seven, more than half were above the high benchmark.

The following metals exceeded their high benchmark values: chromium and lead in PSEM-1; chromium, copper and lead in PSEM-2; cadmium, chromium, copper and lead in PSEM-3; and chromium, iron, lead, and manganese in PSEM-4. Chromium appears to be of particular concern. The range of concentrations are from 2,720 to 5,220 mg/Kg for the four sediment samples. These concentrations are an order of magnitude higher than the high sediment benchmark of 110 mg/Kg. The highest chromium concentrations of 5,220 mg/Kg and 4,820 mg/Kg were found in PSEM-1 and PSEM-4, respectively.

Iron and manganese showed consistent results above low benchmarks for the first three sample locations. However, both metals are markedly higher in PSEM-4, and exceed their

high benchmark values at this location. Three other inorganics exhibited concentrations in excess of their high benchmarks. These inorganics are cadmium, copper, and lead. Lead was approximately twice as high in PSEM-2 than in the other sediment samples, although all sediment concentrations were above the high benchmark of 250 mg/Kg. The highest cadmium concentration was found in PSEM-3 at a concentration of 12.3 mg/Kg, slightly higher than its high benchmark of 10 mg/Kg. High benchmark exceedances for copper were found in PSEM-2 and PSEM-3 at concentrations of 134 and 177 mg/Kg, respectively.

The following is a summary of surface water and sediment COPCs for Plow Shop Pond:

Summ	ary of Surface Water COPCs
•	Barium Iron Manganese
Summ	ary of Sediment COPCs
•••••	Barium Cadmium Chromium Copper Iron Lead Manganese Nickel Zinc

8.2 Grove Pond

The surface water results and associated screening process for Grove Pond can be found in Tables 3 and 4, with sediment results found in Tables 9 and 10.

8.2.1 Surface Water Results

There are no acute exceedances of criteria or benchmarks in the surface water concentrations in this pond. Tables 3 and 4 show that barium and manganese were the only inorganics exceeding their respective chronic benchmark in surface water samples of Grove Pond. Manganese, at a 268 μ g/L concentration exceeded its chronic benchmark of 120 μ g/L in only one of four samples (i.e., GSEM-2). In comparison, barium exceeded it chronic benchmark in all four locations, with the highest level of 11.9 μ g/L occurring in GSEM-2.

8.2.2 Sediment Results

Based on the sediment screening provided in Tables 9 and 10, nine COPCs were identified for sediments in Grove Pond. Six of the nine COPCs were found in all four sediment sample locations. These COPCs include barium, cadmium, chromium, copper, lead, and

zinc. Iron, manganese, and nickel were found at concentrations exceeding their low benchmarks at three of the four stations. The number of COPCs per station remained consistent, ranging from seven (GSEM-3) to nine (GSEM-1,-2). Each station had two metals with concentrations above high benchmarks. Cadmium was above the high benchmark at three locations.

Only three COPCs, cadmium, chromium, and lead exceeded their respected high benchmark values. As with Plow Shop Pond, chromium is of particular concern. Chromium concentrations ranged from 59.7 mg/Kg in GSEM-2 to 33,400 mg/Kg in GSEM-3. With the exception of GSEM-1, all chromium concentrations exceeded its high benchmark of 110 mg/Kg. In fact, the chromium concentration (3,510 mg/Kg) in GSEM-4 was an order of magnitude higher, while the concentration (33,400 mg/Kg) of GSEM-3 was several orders of magnitude higher than the high benchmark value.

The highest concentration of cadmium was found in GSEM-1 at 88.7 mg/Kg, approximately nine times higher than the high benchmark of 10 mg/Kg. With the exception of GSEM-3, cadmium exceeded its high benchmark in all stations sampled. Lead was the only other COPC which showed elevated concentrations above its high benchmark value of 250 mg/Kg. GSEM-1 and GSEM-3 had lead concentrations of 304 and 386 mg/Kg, respectively.

The following is a summary of surface water and sediment COPCs for Grove Pond:

Sumn	nary of Surface Water COPCs	
•	Barium	
•	Manganese	
Sumn	nary of Sediment COPCs	
	Barium	
•	Cadmium	
•	Chromium	
•	Copper	
•	Iron	
•	Lead	
•	Manganese	
•	Nickel	
٠	Zinc	

8.3 Nonacoicus Brook

The surface water results and the associated screening process for Grove Pond can be found in Tables 5 and 6, and sediment results in Tables 11 and 12.

8.3.1 Surface Water Results

There are no acute exceedances of criteria or benchmarks in the surface water concentrations at the locations sampled within Nonacoicus Brook. The screening provided in Tables 5 and 6 identified aluminum, barium, iron, lead and manganese as COPCs for surface water samples in Nonacoicus Brook. Both the average and maximum concentrations of all five COPCs exceeded their respective chronic benchmarks (see Table 6).

Aluminum exceeded its chronic benchmark in four of eight sample locations, with the highest concentration of 275 μ g/L occurring at NON-8. Barium exceeded the chronic benchmark at all nine sample locations. The barium concentrations were similar among the samples taken, ranging from 13 μ g/L (NON-3) to 25.4 μ g/L (NON-8). Iron concentrations were higher than the 1,000 μ g/L chronic benchmark in five of the nine locations, with the highest concentration of 3,200 µg/L found at location NON-2. Lead was undetected at all locations with the exception of NON-8, where a concentration of 11 μ g/L exceeded its chronic benchmark of 3.2 μ g/L. Surface water concentrations of manganese were elevated above its chronic tier II benchmark of 120 μ g/L in every sample taken in Nonacoicus Brook. With the exception of NON-3, manganese concentrations were greater than 500 μ g/L in all other locations, with the highest concentration of 934 μ g/L occurring at NON-8. The surface water sample location NON-8 had the most COPCs (5), and highest surface water concentrations for four of the five COPCs. At least two metals exceed benchmarks at each location sampled on Nonacoicus Brook. It must be noted, however, that there are not any readily apparent trends in upstream/downstream concentrations for the chemicals noted, suggesting that these may be related to natural soil chemistry.

8.3.2 Sediment Results

Ten sediment COPCs have been identified for Nonacoicus Brook. With the exception of silver, all of the other COPCs are also found in Plow Shop and Grove ponds. Tables 11 and 12 identify the COPCs with respect to their location, and associated benchmarks. Except for a few minor low benchmark exceedances, location NON-1 through NON-42 exhibited undetected or low inorganic concentrations. Stations NON-5 through NON-8 appear to be the problem areas for Nonacoicus Brook. A screening of sediment results shows NON-5 with nine COPCs, of which four (i.e., chromium, copper, lead, and zinc) exceeded their respective high benchmarks. On the other hand, NON-8 had ten COPCs, but only two (i.e., cadmium and chromium) exceed their high benchmark value. It should be noted that NON-5 is not part of Nonacoicus Brook. Therefore, downstream locations in Nonacoicus Brook may be partially impacted by sources other than Fort Devens (e.g., urban runoff from the Town of Ayer).

Chromium was the only COPC which exceeded its high benchmark in the last four stations sampled. Sediment concentrations of chromium were an order of magnitude higher than the high benchmark value in NON-6 at 1,090 mg/Kg, and in NON-8 at 1,230 mg/Kg. Copper, lead, and zinc only once exceeded their respective high benchmark value. This occurred at

station NON-5. The only other high benchmark exceedance was that of cadmium at station NON-8, with a concentration of 13.1 mg/Kg.

The following is a summary of surface water and sediment COPCs for Nonacoicus Brook:

Sum	mary of Surface Water CO	PCs
•	Aluminum	
•	Barium	
	Iron	
•	Lead	
•	Manganese	
Sum	mary of Sediment COPCs	
•	Barium	
•	Cadmium	
•	Chromium	
	Copper	
	Iron	
	Lead	
	Manganese	
	Nickel	
•	Silver	
	Zinc	

9.0 DISCUSSION AND CONCLUSIONS

- Hardness-dependent metals for the various waterways were adjusted to site-specific values that ranged from 52 to 62 mg/L, based upon the calcium and magnesium measurements. The criteria for these metals is based on a hardness level of 100 mg/L. Therefore, the lower the hardness of the surface water, the more stringent the criteria becomes. However, based on the results of the surface water analyses, no hardness-dependent metal exceeded its chronic criterion, even when the lower site-specific hardness is incorporated into the equation.
- There are only a few COPCs related to surface water. Screening of the data suggests that these COPCs are more likely to cause chronic than acute effects. Barium and manganese are the two surface water COPCs found in each of the aquatic systems sampled. Barium exceeded its Tier II chronic value at each station sampled in all three ecosystems. It must be noted, however, that the screening benchmark for barium is highly conservative. Also, the data do not suggest any

trends in barium concentrations. Both barium and manganese might be naturally occurring in surface water.

- While the number of surface water COPCs remained fairly constant between the stations in Nonacoicus Brook, sediment COPCs are almost nonexistent between stations NON-1 and NON-4. This is probably due to the higher flow rate through this section of the brook. The organic content in this section is also lower than those of the other stations (i.e. NON-5 through NON-8). The TOC in stations NON-1 through NON-42 range from 2,619 mg/Kg to 13,510 mg/Kg. On the other hand, the TOC for stations NON-5 through NON-8 range from 40,422 mg/Kg to 100,138 mg/Kg.
- In evaluating all three aquatic systems, three sediment COPCs are elevated and potentially pose an aquatic ecological risk. These include cadmium, chromium, and lead. Of these COPCs, chromium requires the greatest attention. Chromium exceeds its high sediment benchmark in 4 of 4 stations in Plow Shop Pond; 3 of 4 locations in Grove Pond; and four of nine locations in Nonacoicus Brook. The highest concentration of 33,400 mg/kg or 3.34% is in found in Grove Pond (GSEM-3). This concentration is several orders of magnitude above the high benchmark value of 110 mg/Kg. Based on four samples, the average concentration of Grove Pond, the maximum and average concentrations are 5,220 and 3,890 mg/Kg, respectively. The highest chromium concentration within Nonacoicus Brook was 1,230 mg/Kg at station NON-8, the furthest station sampled in respect to the two ponds.
- Both maximum and average concentrations of lead in sediments of Plow Shop Pond exceeded the high benchmark. Although the maximum and average concentrations also exceeded the high benchmark in Grove Pond, only two of four stations were responsible for this occurrence. The highest sediment concentration of lead in the stream samples was a detection of 409 mg/Kg at Station NON-5. Station NON-5 is located in the tributary to Nonacoicus Brook, which appears to originate near the town center of Ayer. This tributary may carry some contaminants from urban run-off. No stations within Nonacoicus Brook proper had lead concentrations above the high benchmark. The last three stations (NON-6 through NON-8), had lead concentrations above the low benchmark value.
- The maximum and average cadmium sediment concentrations are as follows:12.3 mg/Kg and 7.85 mg/Kg in Plow Shop Pond; 88.7 mg/Kg and 32.8 mg/Kg in Grove Pond; and 13.1 mg/Kg and 2.96 mg/Kg in Nonacoicus Brook. Clearly, the greatest amount of cadmium contamination exists in Grove Pond.
- Arsenic was a COPC in previous investigations of Plow Shop and Grove ponds. Arsenic was undetected in all surface water and sediment samples analyzed for this particular project. Some of the samples, however, had high detection limits which significantly exceeded the benchmark values.

10.0 UNCERTAINTY ANALYSIS

- The benchmarks employed in this assessment are not site-specific and risk to aquatic life may be over- or under-estimated. For example, the Ontario Ministry of the Environment (OMOE) sediment benchmarks were used in the risk assessment because they are applicable to freshwater ecosystems. However, there are several limitations to these benchmarks. The OMOE benchmarks were derived based on a species "absence" endpoint which is considered insensitive, and therefore may not be adequately protective. Another limitation is that there is no direct cause-and effect relationship is between a single contaminant and benthic organism survival. The OEME values were derived to be applicable to sediment types throughout the province of Ontario; differences between Ontario and U.S. sediments and biota introduce a level of uncertainty.
- Sediment benchmarks were unavailable for several inorganics. These inorganics included barium, beryllium, cobalt, selenium, thallium, and vanadium. A attempt was made to locate a potential effect level for these inorganics. Since these value are not well-established ecological benchmarks, the uncertainty of these values may be high.
- Surface water samples were not filtered. The measured concentrations of some metals may reflect metals bound to suspended soil particles, which would not be readily bioavailable.
- Only four samples were taken in each of the ponds. Only nine samples were taken in Nonacoicus Brook. Therefore, the spatial extent of the contamination is very limited.
- An appropriate background location was not part of the work plan for the Fort Devens sampling. Therefore, COPCs were screened against ecological benchmark values only. Normally, background concentrations are factored into the screening process. Lack of a background location may overestimate risk. Risk attributed to metals such as aluminum, iron, barium, and manganese may be overestimated, since these metals can be naturally present in soils at relatively high concentrations.
- Frequency of detection is normally also part of the screening processing. However, since there were of a limited number of samples taken for each of the aquatic ecosystems, frequency of detection was foregone in the screening of the COPCs.
- Some of the analyses of the sediment samples resulted in elevated detection limits. In these cases, the detection limits are much higher that the benchmark values. Sediments with high detection limits may underestimate risk.
- Mercury was a potential COPCs in past investigations at Fort Devens. Mercury, however, was not included in the sampling regime for this particular investigation. Therefore, the current status of effects from mercury is unknown. Assuming mercury

is still a problem, this would trend to underestimate the overall risk.

11.0 REFERENCES

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Screening of Inorganic Chemicals in Surface Water Samples of Plow Shop Pond Fort Devens Site, Ayer, Massachusetts Surface Water Samples Taken in September 1998

Analyte	PSEM-1		PSEM-2		PSEM-3		PSEM-4		Surface water benchmark chronic (total)	Surface water benchmark acute (total)	Source
Inorganics (ug/L)											
Aluminum	10.0	U	10.0	U	10.0	U	10.0	U	87	750	AWQC
Antimony	5.0	U	5.0	U	5.0	U	5.0	U	30	180	Tier II
Arsenic	10.0	U	10.0	U	10.0	U	20.0	U	190	360	AWQC
Barium	13.5	位归	9.4		8.2	11.	15.3		4.0	110	Tier II
Beryllium	1.0	U	1.0	U	1.0	U	1.0	U	0.66	35	Tier II
Cadmium	1.5	U	1.5	U	1.5	U	1.5	U	0.7 +	1.9 +	AWQC
Calcium	16,200		15,400		14,900		18,600		116,000		LCV
Chromium	3.0	U	3.0	U	3.0	υ	3.0	υ	11 (Cr VI)	16 (Cr VI)	AWQC
Cobalt	1.5	U	1.5	U	1.5	υ	1.5	U	23	1500	Tier II
Copper	1.5	υ	1.5	U	1.5	U	1.5	υ	6.8 +	9.6 +	AWQC
Iron	720		460		230		1,600	1	1000		AWQC
Lead	5.0	U	5.0	U	5.0	U	5.0	υ	1.4 +	36 +	AWQC
Magnesium	3,100		2,600		2,500		3,300		82,000		LCV
Manganese	16.8		193		9.8		81.7		120	2,300	Tier II
Nickel	6.0	U	6.0	U	6.0	U	6.0	U	91 +	816 +	AWQC
Potassium	2,100		1,700		1,400	-	3,000		53,000		LCV
Selenium	20.0	υ	20.0	U	20.0	U	20.0	U	5	20	AWQC
Silver	3.0	U	3.0	U	3.0	U	3.0	U	0.36	1.3 +	Tier II/AWQC
Sodium	25,000		25,100		23,500		25,000	_	680,000		LCV
Thallium	20.0	U	20.0	U	20.0	υ	20.0	U	12	110	Tier II
Vanadium	1.5	υ	1.5	U	1.5	U	1.5	U	20	280	Tier II
Zinc	12.0	U	12.0	U	12.0	U	12.0	U	61 +	67 +	AWQC
# of COPCs per location	1	_	2		1		2				
# exceeding chronic benchmark	1		2		1		2				

Notes:

exceeding acute benchmark

AWQC = Ambient water quality criteria; source documents are the Federal Register; and EPA, 1988 for aluminum.

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Tier II = Secondary Chronic Values based on Great Lakes Tier II methodology; source document is Suter and Tsao (1996 revision).

LCV = Lowest Chronic Value for Daphnids, from Suter and Tsao (1996 revision).

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+ = criterion adjusted to site-specific hadness of 52

= indicates that the contaminant concentration exceeds the chronic criterion or benchmark

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TAB. Screening - Level Ecological Risk Assessment of Inorganic Chemicals in Surface Water Plow Shop Pond - Fort Devens Site, Ayer, Massachusetts

Analyte	Maximum	Location of maximum concentration	Average concentration	# of locations exceeding low benchmark	# of locations exceeding high benchmark	Surface water benchmark chronic (total)	Surface water benchmark acute (total)	Source	Retained as COPCs?	Reason
Inorganics (ug/L)										
Aluminum	U	N/A	5.0	0/4	0/4	87	750	AWQC	No	Analyte not detected
Antimony	U	N/A	2.5	0/4	0/4	30	180	Tier II	No	Analyte not detected
Arsenic	U	N/A	6.25	0/4	0/4	190	360	AWQC	No	Analyte not detected
Barlum	15.3	PSEM-4	11.6	4/4	0/4	4	110	Tier II	Yes	Average/maximum concentratuions exceed chronic benchmark
Beryllium	U	N/A	0.5	0/4	0/4	0.66	35	Tier II	No	Analyte not detected
Cadmlum	υ	N/A	0.75	0/4	0/4	0.7 +	1.9 +	AWQC	No	Analyte not detected
Calcium	18,600	PSEM-4	16,275	0/4		116,000	(<u>417</u>)	LCV	No	Micronutrient, concentrations below chronic value
Chromium	U	N/A	1.5	0/4	0/4	11 (Cr VI)	16 (Cr VI)	AWQC	No	Analyte not detected
Cobalt	U	N/A	0.75	0/4	0/4	23	1500	Tier II	No	Analyte not detected
Copper	U	N/A	0.75	0/4	0/4	6,8+	9.6 +	AWQC	No	Analyte not detected
Iron	1,600	PSEM-4	752.5	1/4		1000	-	AWQC	Yes	Maximum concentration exceeds chronic benchmark
Lead	U	N/A	2.5	0/4	0/4	1,4+	36 +	AWQC	No	Analyte not detected
Magneslum	3,300	PSEM-4	2,875	0/4	-	82,000	-	LCV	No	Micronutrient, concentrations below chronic value
Manganese	193	PSEM-2	75.3	1/4	0/4	120	2300	Tier II	Yes	Maximum concentration exceeds chronic benchmark
Nickel	U	N/A	3,0	0/4	0/4	91 +	816 +	AWQC	No	Analyte not detected
Potassium	3,000	PSEM-4	2,050	0/4	0/4	53,000	-	LCV	No	Micronutrient, concentrations below chronic value
Setenium	U	N/A	10.0	0/4	0/4	5	20	AWQC	No	Analyte not detected
Silver	U	N/A	1.5	0/4	0/4	0.36	1,3 +	Tier II/AWQC	No	Analyte not detected
Sodium	25,100	PSEM-2	24,650	0/4		680,000		LCV	No	Micronutrient, concentrations below chronic value
Thallium	U	N/A	10.0	0/4	0/4	12	110	Tier II	No	Analyte not detected
Vanadium	U	N/A	0.75	0/4	0/4	20	280	Tier II	No	Analyte not detected
Zinc	U	N/A	6.0	0/4	0/4	61+	67 +	AWQC	No	Analyte not detected

Notes:

AWQC = Ambient water quality criteria; source documents are the Federal Register; and EPA, 1988, for aluminum.

Tier II = Secondary Chronic Values based on Great Lakes Tier II methodology; source document is Suter and Tsao (1996 revision).

LCV = Lowest Chronic Value for Daphnids, from Suter and Tsao (1996 revision).

+ = criterion adjusted to site-specific hadness of 58

--- = no benchmark was available for this chemical

N/A = not applicable

= identifies a contaminant as a COPC

Screening of Inorganic Chemic: Jurface Water - Grove Pond Fort Devens, Ayer, Massachusetts

									Surface water benchmark chronic	Surface water benchmark acute	Source
Analyte	GSEM-1		GSEM-2		GSEM-3		GSEM-4		(total)	(total)	
Inorganics (ug/L)	l										
Aluminum	10.0	U	10.0	U	10.0	U	10.0	U	87	750	AWQC
Antimony	5.0	U	5.0	U	5.0	U	5.0	U	30	180	Tier II
Arsenic	10.0	U	10.0	U	10.0	υ	10.0	U	190	360	AWQC
Barium	6.4		11.9		8.8	3	8.8	3	4.0	110	Tier II
Beryllium	1.0	U	1.0	U	1.0	U	1.0	U	0.66	35	Tier II
Cadmium	1.5	U	1.5	U	1.5	U	1.5	U	0.7 +	2.1 +	AWQC
Calcium	18,400		19,700		17,400		17,000		116,000		LCV
Chromium	3.0	U	3.0	U	3.0	U	3.0	U	• 11 (Cr VI)	16 (Cr VI)	AWQC
Cobalt	1.5	U	1.5	U	1.5	U	1.5	U	23	1500	Tier II
Copper	1.5	U	1.5	U	1.5	U	1.5	U	7.4 +	10.6 +	AWQC
Iron	390		270		320		190		1000		AWQC
Lead	5.0	U	5.0	U	5.0	U	5.0	U	1.6 +	41 +	AWQC
Magnesium	3,200	_	3,300		2,800		2,600		82,000		LCV
Manganese	108		268		68.6		20.3		120	2300	Tier II
Nickel	6.0	U	6.0	U	6.0	υ	6.0	U	99 +	895 +	AWQC
Potassium	2,500		1,800		1,400		1,500		53,000		LCV
Selenium	20.0	U	20.0	U	20.0	U	20.0	U	5	20	AWQC
Silver	3.0	U	3.0	υ	3.0	U	3.0	U	0.36	1.6 +	Tier II/AWQC
Sodium	30,500	4	29,400		29,200		22,100		680,000		LCV
Thallium	20.0	U	20.0	υ	20.0	U	20.0	U	12	110	Tier II
Vanadium	1.5	- U	1.5	U	1.5	υ	1.5	U	20	280	Tier II
Zinc	12.0	U	12.0	U	12.0	U	12.0	U	67 +	74 +	AWQC
# of COPCs per location			2	-	1		1 1	_			
# exceeding chronic benchmark	1		2		1		1				

Notes:

exceeding acute benchmark

AWQC = Ambient water quality criteria; source document is the Federal Register; and EPA, 1988 for aluminum

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Tier II = Secondary Chronic Values based on Great Lakes Tier II methodology; source document is Suter and Tsao (1996 revision).

LCV = Lowest Chronic Value for Daphnids, from Suter and Tsao (1996 revision).

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+ = criterion adjusted to site-specific hadness of 58

= indicates that the contaminant concentration exceeds the chronic criterion or benchmark

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TAB⊾ . Screening - Level Ecological Risk Assessment of Inorganic Chemicals in Surface Water Grove Pond - Fort Devens Site, Ayer, Massachusetts

Analyte	Maximum concentration	Location of maximum concentration	Average concentration	# of locations exceeding low benchmark	# of locations exceeding high benchmark	Surface water benchmark chronic (total)	Surface water benchmark acute (total)	Source	Retained as COPCs?	Reason
Inorganies (ug/L)				1						
Aluminum	U	N/A	5.0	0/4	0/4	87	750	AWQC	No	Analyte not detected
Antimony	U	N/A	2.5	0/4	0/4	30	180	Tier II	No	Analyte not detected
Arsenic	υ	N/A	5.0	0/4	0/4	190	360	AWQC	No	Analyte not detected
Barium	11.9	GSEM-2	8.98	4/4	0/4	4	110	Tier II	Yes	Average/maximum concentrations exceed chronic benchmark
Beryllium	U	N/A	0.5	0/4	0/4	0.66	- 35	Tier II	No	Analyte not detected
Cadmium	U	N/A	0,75	0/4	0/4	0.74 +	2.1 +	AWQC	No	Analyte not detected
Calcium	19,700	GSEM-2	18,125	0/4		116,000		LCV	No	Micronutrient, concentrations below chronic value
Chromium	υ	N/A	1.5	0/4	0/4	11 (Cr VI)	16 (Cr VI)	AWQC	No	Analyte not detected
Cobalt	U	N/A	0,75	0/4	0/4	23	1500	Tier II	No	Analyte not detected
Copper	U	N/A	0.75	0/4	0/4	7,4 +	10,6 +	AWQC	No	Analyte not detected
Iron	390	GSEM-1	292,5	0/4	-	1000	-	AWQC	No	Concentrations below benchmark
Lead	U	N/A	2.5	0/4	0/4	1.6 +	41 +	AWQC	No	Analyte not detected
Magnesium	3,300	GSEM-2	2,975	0/4	-	82,000	-	LCV	No	Micronutrient, concentrations below chronic value
Manganese	268	GSEM-2	116.2	1/4	0/4	120	2300	Tier II	Yes	Maximum concetration exceeds chronic benchmark
Nickel	U	N/A	3.0	0/4	0/4	99 +	895 +	AWQC	No	Analyte not detected
Potassium	2,500	GSEM-1	1800	0/4		53,000		LCV	No	Micronutrient, concentrations below chronic value
Selenium	U	N/A	10.0	0/4	0/4	5	20	AWQC	No	Analyte not detected
Sitver	U	N/A	1.5	0/4	0/4	0,36	1.6 +	Tier II/AWQC	No	Analyte not detected
Sodium	30,500	GSEM-1	27,800	0/4		680,000		LCV	No	Micronutrient, concentrations below chronic value
Thallium	U	N/A	10.0	0/4	0/4	12	110	Tier II	No	Analyte not detected
Vanadium	U	N/A	0.75	0/4	0/4	20	280	Tier 11	No	Analyte not detected
Zinc	IJ	N/A	60	0/4	0/4	67 +	74 +	AWOC	No	Analyte not detected

Notes:

AWQC = Ambient water quality criteria; source document is the Federal Register; and EPA, 1988 for aluminum.

Tier II = Secondary Chronic Values based on Great Lakes Tier II methodology; source document is Suter and Tsao (1996 revision).

LCV = Lowest Chronic Value for Daphnids, from Suter and Tsao (1996 revision).

+ = criterion adjusted to site-specific hadness of 58

--- = no benchmark was available for this chemical

N/A = not applicable

= Identifies a contaminant as a COPC

Screening of Inorganic Chemicals in Surface Water Samplo Nonacoicus Brook, Fort Devens, Ayer, Massachusetts Fort Devens Samples Taken September 1998

Analyte	NON-	1	NON-	2	NON-3	5	NON-4	4	NON-42		NON-	6	NON-	7	NON-	8	Surface water benchmark chronic (total)	Surface water benchmark chronic (total)	Source
Inorganics (ug/L)																			
Aluminum	225		51.1		19.0		113		143		21.5		17.5	_	275	178	87	750	AWQC
Antimony	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	30	180	Tier II
Arsenic	10.0	U	10.0	U	10.0	U	10.0	υ	10	U	10	υ	10.0	U	10.0	υ	190	360	AWQC
Barium	14.9	1.20%	19.9	385	13.0		18.6	X	21.1		17.8	204	18.0	1100	25.4		4.0	110	Tier II
Beryllium	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	0.66	35	Tier II
Cadmium	1.5	U	1.5	U	1.5	U	1.5	U	1.5	υ	1.5	U	1.5	U	1.5	υ	0.78 +	2.3 +	AWQC
Calcium	13,300		15,700	-	15,500		15,500		15,600		26,900		27,100		28,000		116,000		LCV
Chromium	3.0	U	3.0	U	3.0	υ	3.0	U	3.0	U	3.0	υ	3.0	υ	10.7		11	16	AWQC
Cobalt	1.5	υ	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	23	1500	Tier II
Copper	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	2.4		7.9 +	11.3 +	AWQC
Iron	2,200		3,200		820	-	1,700	$\langle \mathcal{E}^{(i)} \rangle$	1,900		680		640		1,800	368	1000		AWQC
Lead	5.0	υ	5.0	υ	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	11.0	34.Å	1.7 +	44 +	AWQC
Magnesium	2,300		2,800		2,800		2,800		2,900		4,000		4,000		4,200		82,000		LCV
Manganese	531		590		213	t the	539		640		770	Kina	737		934	S. Sugar	120	2300	Tier II
Nickel	6.0	U	6.0	U	6.0	U	6.0	U	6.0	U	6.0	U	6.0	U	6.0	U	105 +	946 +	AWQC
Potassium	1,600		1,800		1,800		1,700		1,800		2,500		2,400		2,500		53,000		LCV
Selenium	20.0	U	20.0	U	20.0	U	20.0	U	20.0	U	20.0	U	20.0	U	20.0	U	5	20.00	AWQC
Silver	3.0	U	3.0	υ	3.0	- U	3.0	U	3.0	υ	3.0	U	3.0	U	3.0	U	0.36	1.8 +	Tier II/AWQC
Sodium	25,100		26,000		26,000		25,600		25,900		43,400		44,000		42,300		680,000		LCV
Thallium	20.0	U	20.0	U	20.0	U	20.0	U	20.0	υ	20.0	U	20.0	U	20.0	U	12	110	Tier II
Vanadium	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	20	280	Tier II
Zinc	12.0	U	12.0	U	12.0	υ	12.0	υ	12.0	U	12.0	U	12.0	U	12.0	U	71 +	78 +	AWQC
# of COPCs per location	4		3		2		4		4		2		2		5				
# exceeding chronic benchmarks	4		3		2		4		4		2	_	2		5				
# exceeding acute benchmarks	0		0	-	0		0		0		0		0		0		and the second se		

Notes:

AWQC = Ambient water quality criteria; source document is the Federal Register; and EPA, 1988 for aluminum

Tier II = Secondary Chronic Values based on Great Lakes Tier II methodology; source document is Suter and Tsao (1996 revision).

LCV = Lowest Chronic Value for Daphnids, from Suter and Tsao (1996 revision).

+ = criterion adjusted to site-specific hadness of 62

= indicates that the contaminant concentration exceeds the chronic criterion or benchmark

TAI Screening - Level Ecological Risk Assessmenn of Inorganic Chemicals in Surface Water Nonacoicus Brook - Fort Devens Site, Ayer, Massachusetts

Analyte	MaxImum	Location of maximum concentration	Average concentration	# of locations exceeding low benchmark	# of locations exceeding high benchmark	Surface water benchmark chronic (total)	Surface water benchmark acute (total)	Source	Retained as COPCs?	Reason
Inorganics (ug/L)										
Aluminum	275	NON-8	108.14	4/8	0/8	87	750	AWQC	Yes	Average/maximum concentrations exceed chronic benchmark
Antimony	U	N/A	2,5	0/8	0/8	30	180	Tier 11	No	Analyte not detected
Arsenic	U	N/A	5.0	0/8	0/8	190	360	AWQC	No	Analyte not detected
Barium	25,4	NON-8	18,59	8/8	0/8	4	110	Tier I1	Yes	Average/maximum concentrations exceed chronic benchmark
Beryllium	U	N/A	0,50	0/8	0/8	0,66	35	Tier II	No	Analyte not detected
Cadmium	U	N/A	0.75	0/8	0/8	0.78 +	2.3+	AWQC	No	Analyte not detected
Calcium	28,000	NON-8	19,700	0/8	÷	116,000	144	LCV	No	Micronutrient, concentrations below chronic value
Chromium	10.7	NON-8	2,65	0/8	0/8	11 (Cr VI)	16 (Cr VI)	AWQC	No	Concentration below chronic criteria
Coball	U	N/A	0,75	0/8	0/8	23	1500	Tier I!	No	Analyte not detected
Copper	2.4	NON-8	0.96	0/8	0/8	7.9+	11.3 +	AWQC	No	Concentration below chronic criteria
Iron	3,200	NON-2	1,617.5	5/8	0/8	1000		AWQC	Yes	Average/maximum concentrations exceed chronic benchmark
Lead	11.0	NON-B	3.58	1/8	0/8	1.7+	44 +	AWQC	Yes	Average/maximum concentrations exceed chronic benchmark
Magnesium	4,200	NON-8	3,225	0/8	-	82,000		LCV	No	Micronutrient, concentrations below chronic value
Manganese	934	NON-B	619.3	8/8	0/8	120	2300	Tier II	Yes	Average/maximum concentrations exceed chronic benchmark
Nickel	υ	N/A	3.0	0/8	0/8	105 +	946 +	AWQC	No	Analyte not detected
Potassium	2,500	NON-6,-8	2,012,5	0/8		53,000		LCV	No	Micronutrient, concentrations below chronic value
Selenium	U	N/A	10.0	0/8	0/8	5	20	AWQC	No	Analyte not detected
Silver	U	N/A	1,5	0/8	0/8	0.36	1.8 +	Tier II/AWQC	No	Analyte not detected
Sodium	44,000	NON-7	32,287,5	0/8		680,000		LCV	No *	Micronutrient, concentrations below chronic value
Thaillum	U	N/A	10.0	0/8	0/8	12	110	Tier 11	No	Analyte not detected
Vanadium	U	N/A	0.75	0/8	0/8	20	280	Tier II	No	Analyte not detected
Zinc	U	N/A	6.0	0/8	0/8	71+	78 +	AWQC	No	Analyte not detected

Notes:

AWQC = Ambient water quality criteria; source document is the Federal Register; and EPA, 1988 for aluminum.

Tier II = Secondary Chronic Values based on Great Lakes Tier II methodology; source document is Suter and Tsao (1996 revision).

LCV = Lowest Chronic Value for Daphnids, from Suter and Tsao (1996 revision).

+ = criterion adjusted to site-specific hadness of 62

--- = no benchmark was available for this chemical

N/A = not applicable

= identifies a contaminant as a COPC

Ta. Screening of Inorganic Chemicals in Sediment Plow Shop Pond Fort Devens Site, Aver, Massachusetts

Analyte	PSEM-1		PSEM-2		PSEM-3		PSEM-4		Sediment Benchmark (LOW)	Sediment Benchmark (HIGH)	Source
Inorganics mg/Kg d.w.	40.000	- 1	42.000	-	40.000	- 1	40.000			50.020	ADCO
Auminum	12,000		13,000		10,000		10,000			56,030	ARCS
Antimony	/	- 03	0	- 03	5		200		2.0	20	NUAA
Arsenic	300	U	100		100	U	760	U	0		
Barium	115	1.451 2	113	20.400	90.9	THE	/1.4	Mars P	20		EPA, 1997
Beryllium	1.5	disks.	1.5	Charles in	1.4	and the second	1.6	U			
Cadmium	7.0	14.650	3.8	5410	0.400		8.3	1 marting	0.6	10	OMOE
Calcium	4,100		3,900	-	6,400	-	8,900	100.000			
Chromium	3,220	1.0.1	2,720		2,800	and a	4.820		26	110	OMOE
Cobalt	18.9		17.0		19.7	-	26.4		50		OMOE1
Copper	68.2		134		177		80	U	16	110	OMOE
Iron	33,000		28,000		25,000	83	(69,000)		20,000	40,000	OMOE
Lead	258	a an	426		286	5.51	254		31	250	OMOE
Magnesium	1,680		3,100		1,910		1,640				
Manganese	1,030	in the	677	GSN.	645	1.70	4 3 20		460	1,100	OMOE
Nickel	37.5	15	42.2	ALC: E	46.5	1954 B	85	U	16	75	OMOE
Potassium	690		1,450		841		820	_			
Selenium	14.7	U	9.8	U	10.4	U	10.3	U	5		BCMOEL
Silver	2	UJ	2	ŲJ	2	UJ	22	U.	1.0	3.7	NOAA
Sodium	317		381		358		510	1			
Thallium	29.4	U	19.7	U	20.9	U	1,050	U			
Vanadium	36.4		56.3		47.0		41.2				
Zinc	336	in a	558	MAL.	391	1667 <u>16</u>	371		120	820	OMOE
Total organic carbon mg/Kg	219,138		290,390		209,651		207,288				
an a that the state of the				_							
# of COPCs per location	9		9	_	9			-			
# exceeding low benchmark	7		6		5		3				
# exceeding high benchmark	2		3		4		4				

NOTES:

OMOE = Ontario MinIstry of the Environment sediment guidelines; source document is Jaagmagi et al. (1995).

NOAA = National Oceanic and Atmospheric Administration; source document is Long et al. (1995)

ARCS = Assessment and Remediation of Contaminated Sediments Program; source document is Jones et al. (1997 Revision)

BCMOEL = British Columbia Ministry of Environment Lands and Parks (1994)

USEPA (1997) = Guidelines for the Pollutional Classification of Harbor Sediments.

--- = Not Available

Indicates that the chemical exceeds the low benchmark at this station Indicates that the chemical exceeds the hight benchmark at this station

Screening Level Ecological Risk Assessment of Inorganic Chemicals in Sediment Samples of Plow Shop Pond

Fort Devens Site, Ayer, Massachusetts

Analyte	Maximum concentration	Location of maximum concentration	Average concentration	# of locations exceeding low benchmark	# of locations exceeding high benchmark	Sediment Benchmark (LOW)	Sediment Benchmark (HIGH)	Source	Retained as COPCs?	Reason
norganics mg/Kg d.w.										
Aluminum	13,000	PSEM-2	11,250		0/4		58030	ARCS	No	Concentrations below benchmark
Antimony	U	-	34.6	0/4	0/4	2	25	NOAA	No	Analyte not detected
Arsenic	U		175	0/4	0/4	6	33	OMOE	No	Analyte not detected
Barium	115	PSEM-1	99.08	4/4		20	<u>н</u>	EPA, 1977	Yes	Average/maximum concentration exceeds low benchmark
Beryllium	1.5	PSEM-1,-2	1.3		-	F		-	No	No available benchmark
Cadmium	12.3	PSEM-3	7.85	4/4	1/4	0.6	10	OMOE	Yes	Average exceeds low benchmark, maximum exceeds high benchmark
Calcium	8,900	PSEM-4	5,825		-			्याः	No	Micronutrient, no available benchmark
Chromium	5,220	PSEM-1	3,890	4/4	4/4	28	110	OMOE	Yes	Average/maximum concentrations exceed high benchmark
Cobalt	26.4	PSEM-4	20,5	0/4	-	50		OMOE	No	Concentrations below low benchmark
Copper	177	PSEM-3	104.8	3/4	2/4	16	110	OMOE	Yes	Average exceeds low benchmark, maximum exceeds high benchmark
Iron	69,000	PSEM-4	38,750	4/4	1/4	20000	40000	OMOE	Yes	Average exceeds low benchmark, maximum exceeds high benchmark
Lead	428	PSEM-2	308	4/4	4/4	31	250	OMOE	Yes	Average/maximum concentrations exceed high benchmark
Magnesium	3,100	PSEM-2	2,082.5		-			-	No	Micronutrient, no available benchmark
Manganese	4,320	PSEM-4	1,668	4/4	1/4	460	1100	OMOE	Yes	Average/maximum concentrations exceed high benchmark
Nickel	48.5	PSEM-3	42.3	3/4	0/4	16	75	OMOE	Yes	Average/maximum concentrations exceed low benchmark
Potassium	1,450	PSEM-2	950,3		-				No	Micronutrient, no aveilable benchmark
Selenium	U		5.65	0/4		5	-	-	No	Analyte not detected
Silver	υ		3,5	0/4	0/4	1	3.7	NOAA	No	Analyte not detected
Sodium	510	PSEM-4	391,5						No	Micronutrient, no avilable benchmark
Thallium	g U		140					-	No	Analyte not detected
Vanadium	56.3	PSEM-2	45.2						No	No avaitable benchmark
Zinc	558	PSEM-2	414	4/4	0/4	120	820	OMOE	Yes	Average/maximum concentrations exceed low benchmark

NOTES:

OMOE = Ontario Ministry of the Environment sediment guidelines; source document is Jaagmagi et al. (1995).

NOAA = National Oceanic and Atmospheric Administration; source document is Long et al. (1995)

ARCS = Assessment and Remediation of Contaminated Sediments Program; source document is Jones et al. (1997 Revision)

BCMOEL = British Columbia Ministry of Environment Lands and Parks (1994)

USEPA (1977) = Guidelines for the Pollutional Classification of Harbor Sediments.

- = Not Available/Not Applicable

= identifies a contaminant as a COPC

Tab.

Screening of Inorganic Chemicals in Sediment Samples of Grove Pond, Fort Devens, Ayer, Massachusetts Fort Devens Site, Ayer, Massachusetts

Analyte	GSEM-1		GSEM-2		GSEM-3		GSEM-4		Sediment Benchmark (LOW)	Sediment Benchmark (HIGH)	Source
Inorganics mg/Kg d.w.											
Aluminum	14,000		11,000		5,400		21,000			58,030	ARCS
Antimony	5	UJ	5	UJ	5	LU	5	UJ	2.0	25	NOAA
Arsenic	90	U	100	U	50	U	120	U	6	33	OMOE
Barium	115		90.3		170		73.0	and the second	20		EPA, 1997
Beryllium	1.2		1.0	_	0.95		3.1			· · · ·	
Cadmium		2310	28:2		6.8		12.6	1000	0.6	10	OMOE
Calcium	5,700		5,900		215,000		5,100		-	-	
Chromium	59.7		397		33,400	139.5	3.510	1000	26	110	OMOE
Cobalt	34		28.8		3.5		42.5		50		OMOE
Copper	64.5	13.4	43.2	and a	88	13 - 3 - C	52.5	SALE .	16	110	OMOE
tron	22,000	Sal I	21,000	251	8,700		20,000	10.200	20,000	40,000	OMOE
Lead	301		166	State.	386	No.	238	Sad St	31	250	OMOE
Magnesium	3,880		2,240	_	1,650		1,430				
Manganese	789	284	861	To the	1,080	3-46	366		460	1,100	OMOE
Nickel	61.2	Palar .	41.6		15.2		63.1	10.202	16	75	OMOE
Potassium	1,720		1,020		420	U	682		-		
Selenium	10.2	U	10.3	υ	10.4	U	10.1	U	5	-	
Silver	2	UJ	2	UJ	2	UJ	2	UJ	1.0	3.7	NOAA
Sodium	492		485		753		288				
Thallium	20.4	U	20.6	U	20.9	U	20.2	U			
Vanadium	45.4		31.6		53.5		43				
Zinc	632		380	25.478	297		472	10 11 1-1	120	820	OMOE
total organic carbon mg/kg	144,948		172,200		117,043		177,905				

 # of COPCs per location
 9
 9
 7
 8

 # exceeding low benchmarks
 7
 7
 5
 6

 # exceeding high benchmarks
 2
 2
 2
 2

NOTES:

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NOAA = National Oceanic and Atmospheric Administration; source document is Long et al. (1995)

ARCS = Assessment and Remediation of Contaminated Sediments Program; source document is Jones et al. (1997 Revision)

BCMOEL = British Columbia Ministry of Environment Lands and Parks (1994)

USEPA (1997) = Guidelines for the Pollutional Classification of Harbor Sediments.

--- = Not Available



Indicates that the chemical exceeds the low benchmark at this station

Indicates that the chemical exceeds the hight benchmark at this station

Tab. Screening - Level Risk Assessment of Sediments from Grove Pond Fort Devens Site, Ayer, Massachusetts

Analyte	Maximum concentration	Location of maximum concentration	Average concentration	# of locations exceeding lo w benchmark	# of locations exceeding high benchmark	Sediment Benchmark (LCW)	Sediment Benchmark (HIGH)	Source	Retained as COPC?	Reason
norganics mg/Kg d.w.										
Aluminum	21,000	GSEM-4	12,850	-	0/4		58030	ARCS	No	Concentrations below only benchmark
Antimony	U		2.5	0/4	0/4	2	25	NOAA	No	Analyte not detected
Arsenic	U		45	0/4	0/4	6	33	OMOE	No	Analyte not detected
Barlum	170	GSEM-3	112,1	4/4	-	20	-	EPA, 1977	Yes	Average/maximum concentration exceeds low benchmark
Beryllium	3.1	GSEM-4	1.56	-	-	-	-	-	No	No available benchmark
Cadmium	88.7	GSEM-1	32.83	4/4	3/4	0.6	10	OMOE	Yes	Average/maximum concentration exceeds high benchmark
Calcium	215,000	GSEM-3	57,925					NA	No	Micronutrient, no available benchmark
Chromium	33,400	GSEM-3	9,326.7	4/4	3/4	28	110	OMOE	Yes	Average/maximum concentration exceeds high benchmark
Cobalt	42,5	GSEM-4	27.2	0/4	- 1	50	-	OMOE	No	Concentrations below low benchmark
Copper	88	GSEM-3	62.05	4/4	0/4	16	110	OMOE	Yes	Average/maximum concentrations exceeds low benchmark
Iron	22,000	GSEM-1	17,925	3/4	0/4	20000	40000	OMOE	Yes	Maximum concentration exceeds low benchmark
Lead	386	GSEM-3	273.5	4/4	2/4	31	250	OMOE	Yes	Average/maximum concentrations exceed high benchmark
Magnesium	3,880	GSEM-1	2,300					NA	No	Micronutrient, no available benchmark
Manganese	1,080	GSEM-3	774	3/4	0/4	460	1100	OMOE	Yes	Average/maximum concentrations exceed low benchmark
Nickel	63,1	GSEM-4	45.3	3/4	0/4	16	75	OMOE	Yes	Average/maximum concentrations exceed low benchmark
Potassium	1720	GSEM-1	908				-	NA	No	Micronutrient, no available benchmark
Selenium	υ	-	5,13	0/4		5		-	No	Analyte not detected
Silver	U		1.0	0/4	0/4	1	3.7	NOAA	No	Analyte not detected
Sodium	753	GSEM-3	504.5					NA	No	Micronutrient, no avilable benchmark
Thallium	U		10.26		-				No	Analyte not detected
Vanadium	53.5	GSEM-3	43.38	•				-	No	No available benchmark
Zinc	632	GSEM-1	445.3	4/4	0/4	120	820	OMOE	Yes	Average/maximum concentrations exceed low benchmark

NOTES:

OMOE = Ontario Ministry of the Environment sediment guidelines; source document is Jaagmagi et al. (1995).

NOAA = National Oceanic and Atmospheric Administration; source document is Long et al. (1995)

ARCS = Assessment and Remediation of Contaminated Sediments Program; source document is Jones et al. (1997 Revision)

BCMOEL = British Columbia Ministry of Environment Lands and Parks (1994)

USEPA (1977) = Guidelines for the Pollutional Classification of Harbor Sediments.

--- = Not Available/Not Applicable

= identifies a contaminant as a COPC

Screening of Inorganic Chemicals in Sediment Samples of Nonacoicus Brook Fort Devens Site, Ayer, Massachusetts

Analyte Inorganics mg/Kg d.w.	NON-1		NON-2		NON-3		NON-4		(DUP) NON-42		NON-5		NON-6		NON-7		NON-8	Sediment Benchmark (LOW)	Sediment Benchmark (High)	Source
Atuminum	4,700	-	2,900		2,800		3,500		3,200		11,000		6,900		11,000	- and a la	13,000	-	58,030	ARCS
Antimony	5	ŲJ	5	IJ	5	UJ	5	IJ	5	IJ	5	IJ	5	IJ	5	UJ	5 U.	2.0	25	NOAA
Arsenic	25	U	10,0	υ	10.0	υ	20	υ	20	υ	110	υ	30	U	20	U	50 U	6	33	OMOE
Barium	9.1		9.5		9.8		19		16.8		108	20	49.9		46,7	10 1	128	20	-	EPA,1997
Beryflium	0.5	U	0.5	U	0.5	U	0.5	U	0.50	U	0.74		0,56		0.75	-	0.9			NA
Cadmium	23		1.5	U	1.5	U	1.5	U	1.5	U	5.2		3.0	U	3.0	U	1981	0,6	10	OMOE
Calcium	272		397		248		592		566		10,000		341		0.28		5,200	-		NA
Chromium	8.3		20.9	126	10.9		22,4		18.4		601		1000		inc	1	1940	26	110	OMOE
Cobalt	2.3		1.5	υ	1.7		3.0	U	2.3		21.2		5,7		5.0		9.8	50	-	OMOE
Copper	3,0		2.6		2.3		4.5		3.8		otta		22.5	100	14.6		80.2	16	110	OMOE
from	7,700		3,900		5,000		8,100		7,400		32,300	12	9,000		10,000		22,000	20,000	40,000	OMOE
Lead	10,0	U	10.0	υ	10.0	U	10,0	U	9.8	U			U.S.		Sec.		(9) - 21	31	250	OMOE
Magnesium	1,130	_	798	_	956		991		940		3,820		1,890		2,300		2,840	-		NA
Manganese	91.0		133		98.6		179		172		807	13	110		531	1. 11	690	460	1,100	OMOE
Nickel	7.2		6.0	U	6.3		6.0	υ	6.6		37.0		15.9		10,8		24.4	16	75	OMOE
Potassium	400	U	400	υ	400	U	400	υ	400	U	1,760		510		596		948 U	-	-	NA
Selentum	10.0	U	10.0	υ	10.0	U	10,0	υ	9,8	υ	10.6	U	10.5	U	10.2	U	10.2 U	5	-	BCMOEL
Silver	2	u	2	J	2	IJ	2	IJ	2	UJ	2	UJ	2	IJ	2	IJ	3.1 J	1.0	3.7	NOAA
Sodium	200	U	200	U	200	U	200	U	200	U	826		210	U	257		345 U	-		NA
Thattium	19,4	U	20,0	υ	20,0	υ	20.0	υ	19.6	υ	21,1	U	21.0	U	20,4	U	20.5 U		-	NA
Vanadium	5.7		4.3		4.2		5.8		5.3		28,3		10,8		16.2		20.3	-		NA
Zine	11.5		11.2		15.8		21.7		19.4		THOS		99,7		57.2		238	120	820	OMOE
total organic carbon mg/Kg	2,619		3,168		6,844		10,471		13,510		189,087		56,394		40,422		100,138			
# of COPCs per location	1		1		0		0		0	-	9		4		4		10]		
# exceeding low benchmark	1		1		0		0		0		5		3		3		8			
# exceeding high benchmark	0		0		0		0		0		4		1	4	1		2			

NOTES:

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- = Not Available

Indicates that the chemical exceeds the low benchmark at this station

Indicates that the chemical exceeds the hight benchmark at this station

Tal Ecological Risk Assessment of Inorganic Chemicals in Sediment - Nonacoicus Brook Fort Devens Site, Ayer, Massachusetts

Analyte	Maximum Concentration	Location of Maximum Concentration	Average Concentration	# of locations exceeding low benchmark	# of locations exceeding high benchmark	Sediment Benchmark (LOW)	Sediment Benchmark (High)	Source	Retained as COPCs?	Reason
organics mg/Kg d.w.										
Aluminum	13,000	NON-8	6,555.6	0/9	0/9		58,030	ARCS	No	Concentrations below only benchmark
Antimony	U		2.5	0/9	0/9	2.0	25	NOAA	No	Analyte not detected
Arsenic	U		16.4	0/9	0/9	6	33	OMOE	No	Analyte not detected
Barlum	128	NON-8	44.09	4/9		20		EPA,1977	Yes	Average/maximum concentration exceeds low benchmark
Beryllium	0.9	NON-B	0,328	-		-	-	-	No	No available benchmark
Cadmium	13.1	NON-8	2.98	3/9	1/9	0,6	10	OMOE	Yes	Average exceeds low benchmark, maximum exceeds high benchmark
Catcium	10,000	NON-5	1,957.4			-		NA	No	Micronutrient, no benchmark available
Chromium	1,230	NON-B	375.32	5/9	4/9	26	110	OMOE	Yes	Average/maximum concentration exceeds high benchmark
Cobalt	21,2	NON-5	5.58	0/9		50	-	OMOE	No	Concentrations below low benchmark
Copper	112	NON-5	27.28	3/9	1/9	16	110	OMOE	Yes	Average exceeds low benchmark, maximum exceeds high benchmark
Iron	32,300	NON-5	11,711.1	2/9	0/9	20,000	40,000	OMOE	Yes	Maximum concentration exceeds low benchmark
Lead	409	NON-5	88,96	4/9	1/9	31	250	OMOE	Yes	Average exceeds low benchmark, maximum exceeds high benchmark
Magnesium	3,820	NON-5	1,740.6			-		NA	No	Micronutrient, no benchmark available
Manganese	690	NON-8	290.2	3/9	0/9	460	1,100	OMOE	Yes	Maximum concentration exceeds low benchmark
Nickel	37	NON-5	12.69	2/9	0/9	16	75	OMOE	Yes	Maximum concentration exceeds low benchmark
Potassium	1,760	NON-5	482.2				-	NA	No	Micronutrient, no benchmark available
Selenium	U		5.07	0/9	0/9	5	-	NA	No	Analyte not detected
Silver	3.1 J	NON-8	1.34	2/9	0/9	1.0	3,7	NOAA	Yes	Average/maximum concentrations exceed low benchmark
Sodium	826	NON-5	206.7			-		NA	No	Micronutrient, no benchmark available
Thallium	U		10,11	-	-		-	NA	No	Analyte not detected
Vanadium	28.3	NON-5	11,21		-	-	-		No	No avilable benchmark
Zinc	1400	NON-5	208.28	2/9	1/9	120	820	OMOE	Yes	Average exceeds low benchmark, maximum exceeds high benchmark

NOTES:

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USEPA (1977) = Guidelines for the Pollutional Classification of Harbor Sediments.

--- = Not Available/Not Applicable

= identifies a contaminant as a COPC







GSEMI- 3 = ESAT designation, PSEM- 3 = ESAT designation, Surface water/sediment Sampling September 1998

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WINCH SUIENCES DEPT FAX NO. 581 2537

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Pond Sample Locations for Fort Devens, September, 1998

The stations sampled in Grove Pond and Plow Shop Pond were intended to correspond with the emergent insect trap stations established by the U.S. Fish and Wildlife Service during the summer of 1998. The following table show the relationship between the station designations used by ESAT and those used by USFWS.

Grove Pond and Plow Shop Pond Sampling USFWS Stations					
ESAT Designated Sampling Locations	Corresponding USFWS locations				
GSEM -1	Grove Pond Stations 1 and 2				
GSEM-2	Grove Pond Stations 3 and 4				
GSEM-3	Grove Pond Stations 5 and 6				
GSEM-4	Grove Pond Stations 7 and 8				
PSEM-1	Plow Shop Pond Stations 7 and 8				
PSEM-2	Plow Shop Pond Stations 3 and 4				
PSEM-3	Plow Shop Pond Stations 1 and 2				
PSEM-4	Plow Shop Pond Stations 5 and 6				

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY REGION I 60 WESTVIEW STREET, LEXINGTON, MA 02173

PN:

98724

DATE: February 18, 1999

SUBJ: Fort Devens - Metals Results

- FROM: Michael Dowling Chemist
 - TO: James Byrne HBT
- THRU: Dr. William J. Andrade $WM \frac{2}{24}/99$ Senior Chemistry Analytical Specialist

Analytical Reference:

ICP Method 200.7 using ultrasonic nebulization - "Methods for the Determination of Metals in Environmental Samples, Supplement I (EPA 600/R-94/111), May, 1994." (Sample Prep. SOP, 11/98 and ICP-USN SOP, 10/98)

Date Samples Received by Laboratory: 9/11/98

Sample Analysis Starting Date: 10/7/98

File name: 98724WA.USN

Results (ug/L, except where noted)

<u>Parameter</u>	<u>NON-1</u>	<u>NON-2</u>	NON-3	<u>NON-4</u>	<u>NON-42</u>	NON-6
Ag	3.0U	3.0U	3.0U	3.0U	3.0U	3.0U
Al	225	51.1	19.0	113	143	21.5
As	10.0U	10.0U	10.0U	10.0 U	10.0U	10.0U
Ba	14.9	19.9	13.0	18.6	21.1	17.8
Be	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
Ca(mg/L	.) 13.3	15.7	15.5	15.5	15.6	26.9
Cd	1.5U	1.5U	1.5U	1.5U	1.5U	1.5U
Co	1.5U	1.5U	1.5U	1.5U	1.5U	1.5U
Cr	3.0U	3.0U	3.0U	3.0U	3.0U	3.0U
Cu	1.5U	1.5U	1.5U	1.5U	1.5U	1.5U
Fe(mg/L) 2.2	3.2	0.82	1.7	1.9	0.68
K(mg/L)	1.6	1.8	1.8	1.7	1.8	2.5
Mg(mg/	L) 2.3	2.8	2.8	2.8	2.9	4.0
Mn	531	590	213	539	640	770
Na(mg/I	L) 25.1	26.0	26.0	25.6	25.9	43.4
Ni	6.0U	6.0U	6.0U	6.0U	6.0U	6.0U
Pb	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
Sb	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
Se	20.0U	20.0U	20.0U	20.0U	20.0U	20.0U
Tĺ	20.0U	20.0U	20.0U	20.0U	20.0U	20.0U
V	1.5U	1.5U	1.5U	1.5U	1.5U	1.5U
Zn	12.0U	12.0U	12.0U	12.0U	12.0U	12.0U

U = not detected above the reporting limit

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Results (ug/L, except where noted)

Parameter	NON-7	NON-8	GSEM-1	GSEM-2	GSEM-3	GSEM-4
			4		(ave.)	
Ag	3.0U	3.0U	3.0U	3.0U	3.0U	3.0U
Al	17.5	275	10.0U	10.0U	10.0U	10.0U
As	10.0U	10.0U	10.0U	10.0U	10.0U	10.0U
Ba	18.0	25.4	6.4	11.9	8.8	8.8
Be	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
Ca (mg/L)	27.1	28.0	18.4	19.7	17.4	17.0
Cd	1.5U	1.5U	1.5U	1.5U	1.5U	1.5U
Co	1.5U	1.5U	1.5U	1.5U	1.5U	1.5U
Cr	3.0U	10.7	3.0U	3.0U	3.0U	3.0U
Cu	1.5U	2.4	1.5U	1.5U	1.5U	1.5U
Fe (mg/L)	0.64	1.8	0.39	0.27	0.32	0.19
K (mg/L)	2.4	2.5	2.5	1.8	1.4	1.5
Mg (mg/L)	4.0	4.2	3.2	3.3	2.8	2.6
Mn	737	934	108	268	68.6	20.3
Na (mg/L)	44.0	42.3	30.5	. 29.4	29.2	22.1
Ni	6.0U	6.0U	6.0U	6.0U	6.0U	6.0U
Pb	5.0U	11.0	5.0U	5.0U	5.0U	5.0U
Sb	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
Se	20.0U	20.0U	20.0U	20.0U	20.0U	20.0U
Tl	20.0U	20.0U	20.0U	20.0U	20.0U	20.0U
V	1.5U	1.5U	1.5U	1.5U	1.5U	1.5U
Zn	12.0U	12.0U	12.0U	12.0U	12.0U	12.0U

U = not detected above the reporting limit

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Results (ug/L, except where noted)

Ag	3.00	3.0U	3.0U	3.0U	3.0U
Al 1	U0.0U	10.0U	10.0U	10.0U	30.0
As 1	0.0U	10.0U	10.0U	20.0U	10.0U
Ba	13.5	9.4	8.2	15.3	1. 5U
Be	1.0U	1.0 U	1.0U	1.0U	1.0U
Ca (mg/L)	16.2	15.4	14.9	18.6	0.03
Cd	1.5U	1.5U	1.5U	1.5U	1.5U
Co	1.5U	1.5U	1.5U	1.5U	1.5U
Cr	3.0U	3.0U	3.0U	3.0U	3.0U
Cu	5.0U	1.5U	1.5U	1.5U	1.5U
Fe (mg/L)	0.72	0.46	0.23	1.6	0.05
K (mg/L)	2.1	1.7	1.4	3.0	0.59
Mg (mg/L)	3.1	2.6	2.5	3.3	0.01
Mn	16.8	193	9.8	81.7	37.7
Na (mg/L)	25.0	25.1	23.5	25.0	1.0U
Ni	6.0U	6.0U	6.0U	6.0U	6.0U
Pb	5.0U	5.0U	5.0U	5.0U	5.0U
Sb	5.0U	5.0U	5.0U	5.0U	5.0U
Se 2	0.0U	20.0U	20.0U	20.0U	20.0U
Tl 2	20.0U	20.0U	20.0U	20.0U	20.0U
V	1.5U	1.5U	1.5U	1.5U	1.5U
Zn 1	2.0U	12.0U	12.0U	12.0U	12.0U

U = not detected above the reporting limit

Analytical Spike Results

Sample PSEM-2

		Accuracy
<u>Parameter</u>		<u>% Recovery</u>
Ag		107
Al		112
As		108
Ba		101
Be		95
Cd		109
Co		101
Cr		103
Cu	τ.	102
Fe	•:	109
Mn		122
Ni		103
Pb		108
Sb		105
Se		97
Tl		98
v	÷	100
Zn		118

No spike required for Ca, K, Mg and Na

Laboratory Duplicate Results

Sample GSEM-3

	Precision
<u>Parameter</u>	RPD
Ag	T
Al	*
As	*
Ba	0.45
Be	*
Ca	0.57
Cd	*
Со	*
Cr	*
Cu	*
Fe	2.2
K	0.74
Mg	0
Mn	0.44
Na	0
Ni	*
Pb	*
Sb	*
Se	*
T1	*
V	*
Zn	*

* = non detect

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Data Quality Statements

Chemists who reviewed data:	Mike Dowling, Dan Curran
Method modifications:	None
Limitations of data:	None
Comments:	The following samples had a pH of 2-3: PSEM-1, GSEM-1, Equip. Blank.
List of method contaminants:	None
Instrument performance:	Excellent
Matrix spike recovery problems:	None
Unusual visual characteristics:	None
Chain of custody abnormalities:	None

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY REGION I 60 WESTVIEW STREET, LEXINGTON, MA 02173

PN: 98724

DATE:	December 2, 1998
SUBJ:	Fort Devens Sediments - Metals Results
FROM:	Dan Curran Chemist
TO:	James Byrne

THRU: Dr. William J. Andrade WTA 3/10/99 Senior Chemistry Analytical Specialist

Analytical Reference:

ICP Method 200.7 CLP-M - "The U.S. EPA Contract Laboratory Program, Statement of Work for Inorganics Analysis, Doc. #ILM04.0, EPA/540/R95/121." (Sample Prep. SOP, 11/98 and ICP SOP, Rev. #2, 10/98)

Date Samples Received by Laboratory: 9/11/98

Sample Analysis Starting Date: 11/18/98

File name: 98724ICP.wpd

Parameter	GSEM-1	GSEM-2	GSEM-3	GSEM-4
	(ave.)			(ave.)
Ag	2UJ	2UJ	2UJ	2UJ
Al*	1.4	1.1	0.54	2.1
As	90.0U	100U	50.0U	120U
Ba	115	90.3	170	73.0
Be	1.2	1.0	0.95	3.1
Ca*	0.57	0.59	21.5	0.51
Cd	88.7	23.2	6.8	12.6
Со	34.0	28.8	3.5	42.5
Cr	59.7	337	33400	3510
Cu	64.5	43.2	88.0	52.5
Fe*	2.2	2.1	0.87	2.0
Mg	3880	2240	1650	1430
Mn	789	861	1080	366
Ni	61.2	41.6	15.2	63.1
Pb	304	166	386	238
Sb	5UJ	5UJ	5UJ	5UJ
Se	10.2U	10.3U	10.4U	10.1U
Tl	20.4U	20.6U	20.9U	20.2U
V	45.4	31.6	53.5	43.0
Zn	632	380	297	472
Na	492	485	753	288
K	1720	1020	420U	682

U = not detected above the reporting limit

* = concentrations expressed in %, where 1% = 10,000 ppm.

J = approximate

Ag2UJ2J2UJAl*0.470.290.28As25.0U10.0U10.0UBa9.19.59.8Be0.5U0.50U0.50UCa272397248Cd1.5U1.5U1.5U	<u>NON-4</u>
Al*0.470.290.28As25.0U10.0U10.0UBa9.19.59.8Be0.5U0.50U0.50UCa272397248Cd1.5U1.5U1.5U	2UJ
As25.0U10.0U10.0UBa9.19.59.8Be0.5U0.50U0.50UCa272397248Cd1.5U1.5U1.5U	0.35
Ba9.19.59.8Be0.5U0.50U0.50UCa272397248Cd1.5U1.5U1.5U	J 20.0U
Be 0.5U 0.50U 0.50U Ca 272 397 248 Cd 1.5U 1.5U 1.5U	19.0
Ca 272 397 248 Cd 1.5U 1.5U 1.5U	J 0.50U
Cd 1.5U 1.5U 1.5U	592
1.00 1.00 1.00	1.5U
Co 2.3 1.5U 1.7	3.0U
Cr 8.3 26.9 10.9	22.4
Cu 3.0 2.6 2.3	4.5
Fe* 0.77 0.39 0.50	0.81
Mg 1130 798 956	991
Mn 91.0 133 98.6	179
Ni 7.2 6.0U 6.3	6.0U
Pb 10.0U 10.0U 10.0U	J 10.0U
Sb 5UJ 5UJ 5UJ	5UJ
Se 10.0U 10.0U 10.0U	J 10.0U
Tl 19.4U 20.0U 20.0U	J 20.0U
V 5.7 4.3 4.2	5.8
Zn 11.5 11.2 15.8	21.7
Na 200U 200U 200U	200U
K 400U 400U 400U	40011

U = not detected above the reporting limit

* = concentrations expressed in %, where 1% = 10,000 ppm J = approximate

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Parameter	<u>NON-42</u>	NON-5	NON-6	<u>NON-7</u>
Ag	2UJ	2UJ	2UJ	2UJ
Al*	0.32	1.1	0.69	1.1
As	20.0U	110U	30.0U	20.0U
Ba	16.8	108	49.9	46.7
Be	0.50U	0.74	0.56	0.75
Ca	566	10000	341	0.28
Cd	1.5U	5.2	3.0U	3.0U
Со	2.3	21.2	5.7	5.0
Cr	18.4	601	1090	370
Cu	3.8	112	22.5	14.6
Fe*	0.71	3.23	0.90	1.0
Mg	940	3820	1890	2300
Mn	172	607	110	531
Ni	6.6	37.0	15.9	10.8
Pb	9.8U	409	113	56.7
Sb	5UJ	5UJ	5UJ	5UJ
Se	9.8U	10.6U	10.5U	10.2U
Tl	19.6U	21.1U	21.0U	20.4U
V	5.3	28.3	10.8	16.2
Zn	19.4	1400	99.7	57.2
Na	200U	826	210U	257
K	400U	1760	510	596

$\mathbf{U} = \mathbf{not} \ \mathbf{detected} \ \mathbf{above} \ \mathbf{the} \ \mathbf{reporting} \ \mathbf{limit}$

* = concentrations expressed in %, where 1% = 10,000 ppm J = approximate

<u>Parameter</u>	<u>NON-8</u>	PSEM-1	PSEM-2	PSEM-3
Ag	3.1J	2UJ	2UJ	2UJ
Al*	1.3	1.2	1.3	1.0
As	50.0U	300U	160U	160U
Ba	128	115	113	96.9
Be	0.9	1.5	1.50	1.4
Ca*	0.52	0.41	0.39	0.64
Cd	13.1	7.0	3.8	12.3
Co	9.8	18.9	17.0	19.7
Cr	1230	5220	2720	2800
Cu	80.2	68.2	134	177
Fe*	2.2	3.3	2.8	2.5
Mg	2840	1680	3100	1910
Mn	690	1030	677	645
Ni	24.4	37.5	42.2	46.5
Pb	197	258	426	286
Sb	5UJ	7UJ	5UJ	5UJ
Se	10. 2U	14. 7 U	9.8U	10.4U
Tl	20.5U	29.4U	19.7U	20.9U
V	20.3	36.4	56.3	47.0
Zn	238	336	558	391
Na	345U	317	381	358
K	948U	690	1450	841

U = not detected above the reporting limit

* = concentrations expressed in %, where 1% = 10,000 ppm J = approximate

<u>Parameter</u>	PSEM-4
Ag	8UJ
Al*	1.0
As	780U
Ba	71.8
Be	1.6U
Ca*	0.89
Cd	11.2
Со	26.4
Cr	4820
Cu	70.5
Fe*	6.9
Mg	1640
Mn	4320
Ni	33.2
Pb	239
Sb	26UJ
Se	10.3U
T1	103U
V	28.1
Zn	371
Na	510
K	817

$\mathbf{U} = \mathbf{not} \ \mathbf{detected} \ \mathbf{above} \ \mathbf{the} \ \mathbf{reporting} \ \mathbf{limit}$

* = concentrations expressed in %, where 1% = 10,000 ppm J = approximate

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Matrix Spike Results

Sample GSEM2

	Accuracy
<u>Parameter</u>	<u>% Recovery</u>
Ag	< 75
As	112
Ba	94
Be	100
Cd	106
Со	89
Cr	66
Cu	88
Mn	***
Ni	86
Pb	79
Sb	< 75
Se	99
Tl	87
V	88
Zn	67

No spike required for Al, Ca, Fe, Mg Na and K *** = No spike recovery calculated - sample concentration was greater than 4 times spike level.

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Laboratory Duplicate Results

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Sample GSEM-1

Sample GSEM-4

Parameter	Precision <u>RPD</u>		Precision <u>RPD</u>
			مله مله مله مله
Ag	***		****
Al	6.0		5.0
As	***		****
Ba	1.1		2.3
Be	1.4	8. T	3.2
Ca	1.6		1.5
Cd	0.5		5.3
Со	1.0		3.1
Cr	2.1		3.3
Cu	1.2		5.2
Fe	1.6		1.9
Mg	1.4		3.4
Mn	0.8		2.2
Ni	3.2		1.2
Pb	1.8		3.5
Sb	****		****
Se	****		****
TI	****		****
V	3.1		5.9
Zn	1.4		2.9
Na	0.3		3.0
K	13		17

**** = non detect

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Aqueous Laboratory Fortified Blank and Solid Laboratory Control Sample Results

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		% Recovery	
Parameter		<u>LFB</u>	LCS
Ag		36	95
Al		N/A	113
As		94	84
Ba		100	119
Be		100	99
Ca		N/A	114
Cd		124	86
Со		97	97
Cr		98	97
Cu		98	11
Fe		N/A	96
Mg	×.	N/A	90
Mn		105	99
Ni		92	91
Pb		90	94
Sb		92	114
Se		95	114
T1		97	80
V		96	98
Zn		91	96
Na		N/A	N/A
K		N/A	N/A

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Data Quality Statements

Chemists who reviewed data:

Method modifications:

Limitations of data:

Lis of method contaminants:

Instrument performance:

Matrix spike recovery problems:

Unusual visual characteristics:

Chain of custody abnormalities:

Comments:

Mike Dowling, Dan Curran

The volume of hydrochloric acid used in the digestion was doubled.

Ag and Sb results are approximated due to the low MS recoveries.

None

Excellent

Ag, Sb.

None

None

As and Tl reporting limits for sample PSEM-4 are raised due to the high level of interferences.

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Adjustment of Inorganic Criteria Based on Site Specific Hardness

Site specific hardness measured as CaCO3, based on the averaging of four calcium and magnesium measurements.

Plow Shop Pond

Site-specific hardness measured as CaCO3 (mg/L) = 2.497[16.275 mg/L Ca] + 4.118[2.875 mg/L Mg] = 52

Factors for calculating Metals Criteria:

Chronic Criterion = e{mc[ln(hardness)] + bc}; Acute Criterion = e{ma[ln(hardness)] + ba

Cadmium (AWQC chronic criterion) = $e\{0.7852[ln(52)] + (-3.490)\} = 0.68 ug/L$ (AWQC acute criterion) = $e\{1.128[ln(52)] + (-3.828)\} = 1.88 ug/L$

Copper (AWQC chronic) = $e\{0.8545[ln(52)] + (-1.465)\} = 6.76 ug/L$ (AWQC acute) = $e\{0.9422[ln(52)] + (-1.464)\} = 9.57 ug/L$

Lead (AWQC chronic criterion) = $e{1.273[ln(52)] + (-4.705)} = 1.38 ug/L$ (AWQC acute criterion) = $e{1.273[ln(52)] + (-1.460)} = 35.5 ug/L$

Nickel (AWQC chronic criterion) = $e{0.8460[ln(52)] + (1.1645)} = 90.7 ug/L$ (AWQC acute criterion) = $e{0.8460[ln(52)] + (3.3612)} = 815.6 ug/L$

Silver (AWQC acute criterion) = e{1.72[ln(52)] + (-6.52)} = 1.32 ug/L

Zinc (AWQC chronic criterion) = $e\{0.8473[\ln(52)] + 0.7614\} = 60.9 \text{ ug/L}$ (AWQC acute criterion) = $e\{0.8473[\ln(52)] + 0.8604\} = 67.2 \text{ ug/L}$

Grove Pond

Site-specific hardness measured as CaCO3 (mg/L) = 2.497[18.125 mg/L Ca] + 4.118[2.975 mg/L Mg] = 58 Factors for calculating Metals Criteria:

Chronic Criterion = e{mc[ln(hardness)] + bc}; Acute Criterion = e{ma[ln(hardness)] + ba

Cadmium (AWQC chronic criterion) = $e\{0.7852[ln(58)] + (-3.490)\} = 0.74 ug/L$ (AWQC acute criterion) = $e\{1.128[ln(58)] + (-3.828)\} = 2.12 ug/L$

Copper (AWQC chronic) = $e\{0.8545[ln(58)] + (-1.465)\} = 7.4 ug/L$ (AWQC acute) = $e\{0.9422[ln(58)] + (-1.464)\} = 10.6 ug/L$

Grove Pond (cont'd)

Lead (AWQC chronic criterion) = $e\{1.273[ln(58)] + (-4.705)\} = 1.59 ug/L$ (AWQC acute criterion) = $e\{1.273[ln(58)] + (-1.460)\} = 40.8 ug/L$

Nickel (AWQC chronic criterion) = e{0.8460[ln(58)] + (1.1645)} = 99.4 ug/L (AWQC acute criterion) = e{0.8460[ln(58)] + (3.3612)} = 894.6 ug/L

Silver (AWQC acute criterion) = $e\{1.72[\ln(58)] + (-6.52)\} = 1.59 \text{ ug/L}$

Zinc (AWQC chronic criterion) = $e{0.8473[ln(58)] + 0.7614} = 66.8 ug/L$ (AWQC acute criterion) = $e{0.8473[ln(58)] + 0.8604} = 73.8 ug/L$

Nonacoicus Brook

Site-specific hardness measured as CaCO3 (mg/L) = 2.497[19.70 mg/L Ca] + 4.118[3.225 mg/L Mg] = 62

Factors for calculating Metals Criteria:

Chronic Criterion = e{mc[ln(hardness)] + bc}; Acute Criterion = e{ma[ln(hardness)] + ba

Cadmium (AWQC chronic criterion) = $e\{0.7852[ln(62)] + (-3.490)\} = 0.78 ug/L$ (AWQC acute criterion) = $e\{1.128[ln(62)] + (-3.828)\} = 2.29 ug/L$

Copper (AWQC chronic) = $e\{0.8545[ln(62)] + (-1.465)\} = 7.86 ug/L$ (AWQC acute) = $e\{0.9422[ln(62)] + (-1.464)\} = 11.3 ug/L$

Lead (AWQC chronic criterion) = $e\{1.273[ln(62)] + (-4.705)\} = 1.73 ug/L$ (AWQC acute criterion) = $e\{1.273[ln(62)] + (-1.460)\} = 44.4 ug/L$

Nickel (AWQC chronic criterion) = $e{0.8460[ln(62)] + (1.1645)} = 105 ug/L$ (AWQC acute criterion) = $e{0.8460[ln(62)] + (3.3612)} = 946 ug/L$

Silver (AWQC acute criterion) = $e\{1.72[\ln(62)] + (-6.52)\} = 1.78 \text{ ug/L}$

Zinc (AWQC chronic criterion) = $e{0.8473[ln(62)] + 0.7614} = 70.7 ug/L$ (AWQC acute criterion) = $e{0.8473[ln(62)] + 0.8604} = 78.0 ug/L$