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United States Environmental Protection Agency

Environmental Sciences Division
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Las Vegas, NV 89193-3478

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August 1998

Research and Development

EPA

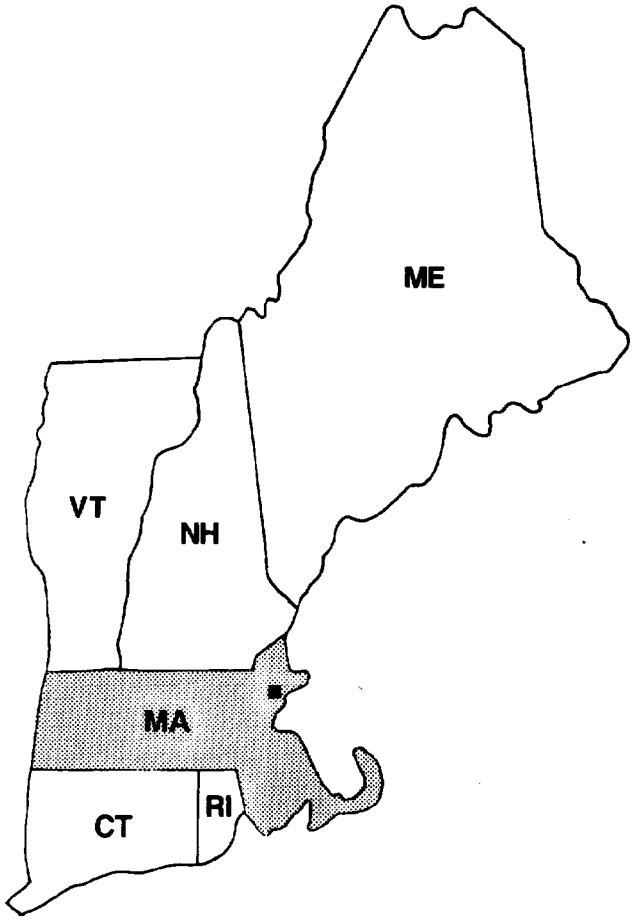
AERIAL PHOTOGRAPHIC ANALYSIS INDUSTRI-PLEX SITE AND STUDY AREA

Woburn, Massachusetts

Volume 1

25872

EPA Region 1



SUPERFUND RECORDS CTR
Site: Industriplex
Break: 12.4
Other:

FINAL GROUNDWATER/SURFACE WATER INVESTIGATION PLAN (GSIP) STATEMENT OF WORK (SOW)

INTRODUCTION

The purpose of this Final GSIP SOW is to address EPA's GSIP Phase 1 and Phase 2 comments and satisfy the obligations of the ROD and Consent Decree. The information gathered in the Final GSIP SOW shall be incorporated into a Final Comprehensive GSIP Report. All applicable, relevant and appropriate data from the GSIP Phase 1 and Phase 2 Reports shall be incorporated into this Final Comprehensive GSIP Report, as well as any other relevant and appropriate data such as the 1993 Geraghty & Miller groundwater data, MIT data, etc. The previous GSIP Phase 1 and 2 human health and ecological risk assessments shall be revised based upon the data generated from the Final GSIP SOW and any applicable, relevant and appropriate data generated since the GSIP Phase 2 Report. The revised human health and ecological risk assessments will comply with current EPA guidance/ policy requirements and be incorporated into the final section of the Final Comprehensive GSIP Report. The work outlined in this Final GSIP SOW is being required under the Industri-Plex Superfund Site, Woburn, MA, Consent Decree (US EPA Civil Action # 89-0195-MC) lodged April 24, 1989. EPA will conduct field oversight of the Final GSIP SOW investigation activities.

Section 1.0 <u>On-Site Investigations</u>

Section 1.1 Source Areas (Southern Atlantic Avenue/Vining Property, West Hide Pile)

The approach outlined in ISRT's November 11, 1997 Source Area Scope of Work appropriately evaluates the West Hide Pile and Southern Atlantic Avenue /Vining Property. Attached EPA has provided specific comments to this work plan. These comments must be satisfactorily addressed and incorporated into the revised work plan. The investigation will determine the condition of the benzene and toluene source contamination and evaluate possible removal of the source. This approach agrees with EPA's requirement to assess the impact of source areas and is consistent with EPA's March 6, 1998 Draft SOW. EPA will provide field oversight of the investigation activities. Consistent with the November 1997 Commerce Way Source Area Investigation, ISRT, EPA, and their respective contractors will maintain direct communication.through-out the investigation, and evaluate any modifications associated with anomalies or unanticipated events.

Section 1.2 Groundwater Flow Path

Section 1.2.1 Buried Aquifer Conditions (Hide Piles to HBHA Pond)

Additional investigation work will be accomplished in a 2-step approach.

Step 1

OPTION A:
Collect low-flow groundwater samples from the shallow, intermediate and deep portions of the overburden aquifer at the 45 sampling locations delineated on Figure 1. The Figure illustrates 9 transects with five sampling locations per transect. These samples will be analyzed for "Plume Delineation Parameters" illustrated on Table 1. A total of 135 samples will be collected plus QA/QC samples (trip blanks, duplicates, equipment blanks). If the total arsenic analysis shows concentrations greater than 50 mg/l then the laboratory will be instructed to continue analysis to determine arsenic speciation.

All samples will be collected with a peristaltic pump following EPA-Region 1 Low Flow Sampling Standard Operation Procedures (SOP). Metals and Arsenic Speciation Samples should be properly preserved in accordance with EPA/ISRT April/May 1998 discussions [1) samples are to be stored at the temperature they were collected at; 2) HCl will be used as a preservative, 3) amber bottles will be used and samples will be kept in the dark].

OPTION B:

Collect low-flow groundwater samples from shallow, intermediate and deep portions of the overburden aquifer at the 45 sampling locations delineated on Figure 1. The Figure illustrates 9 transects with five sampling location per transect. These samples will be analyzed in the field through "Field Screening Parameters" illustrated on Table 2. A total of 135 samples will be collected in the field. If the total arsenic analysis shows concentrations greater than 50 mg/l then the sample will be sent off-site to a certified laboratory for total arsenic and arsenic speciation.

All samples will be collected with a peristaltic pump following EPA-Region 1 Low Flow Sampling Standard Operation Procedures (SOP). In order to check the accuracy and precision of the field analysis, 15% of the samples (approximately 20 samples) shall be analyzed for the Chemical Parameters listed in Table 2 Field Groundwater Analytical Parameters. All metal and Arsenic Speciation Samples for laboratory analysis should be properly preserved in accordance with EPA/ISRT April/May 1998 discussions [1) samples are to be stored at the temperature they were collected at; 2) HCl will be used as a preservative, 3) amber bottles will be used and samples will be kept in the dark].

Step 2

Based on these data, the core of the plume will be mapped both vertically and horizontally. One sampling location will be selected at each of the nine transects, based upon the highest concentrations of arsenic, benzene, and toluene observed in Step 1. The decision for selecting the sampling location should also take into consideration the field geo-chemistry data and

their impact on the plumes. Three samples will be collected from each sampling location (shallow, intermediate and deep) and analyzed for "Plume Geochemistry Parameters" illustrated on Table 1. A total of 30 samples will be collected plus QA/QC samples (trip, blanks, duplicates, equipment blanks, etc). Samples will be collected using EPA Region I low-flow techniques and analyzed by a certified laboratory.

Section 1.2.2 Bedrock Aquifer

The potential for bedrock contamination and migration have not been thoroughly evaluated at the Site. Although, EPA is willing to consider ISRT's current evaluation of bedrock, which suggests that the bedrock does not significantly contribute to flow in the overburden aquifer or to the HBHA Pond and HBHA Wetlands. However, if new groundwater data collected in the overburden suggests that the above is not accurate, then additional bedrock data may be required. See related work under Section 2.2.

Section 2.0 Off-Site Investigations

Section 2.1 Source Areas

Other sources may also be contributing to the release of site-related contaminants (e.g. arsenic) in groundwater. These source areas include the western and eastern portion of the Boston Edison ROW Number 9, which were was remediated as part of the remedial action, the former Mishawum Lake bed sediments containing high concentrations of metals, and HBHA Wetland sediments. All of these areas contain site related COCs, and organic materials which may generate geochemical conditions in groundwater that may cause the mobilization of site related metals. Groundwater data collected in 1993 show high arsenic concentrations in groundwater being released from the western portion of BECO ROW, which contains site-related animal hide waste materials. These same releases are expected to be occurring at the eastern portion of the ROW, which also contains site-related animal hide waste materials. Through precipitation and erosion events and possible contaminant groundwater discharge, the Mishawum Lake bed sediments and HBHA sediments also received site related contaminants. The following investigations will be required at each potential source area:

Section 2.1.1 Source Plume Delineation

Section 2.1.1.1 Western and Eastern BECO ROW Section

Three groundwater monitoring transects (transect #s 3, 4 and 5) containing a total of thirteen sample locations, as shown on Figure 2, shall be located immediately downgradient of this area to evaluate the source. Low flow groundwater samples will be collected from each of three vertical horizons of the aquifer (shallow, intermediate, and deep) at each location and analyzed for Table 1 "Plume Delineation Parameters". A total of 39 samples will be collected plus QA/QC samples (trip blanks, duplicates,

equipment blanks). All samples will be collected with a peristaltic pump following EPA-Region 1 Low Flow Sampling Standard Operation Procedures. See GW Notes 1 and 2 below.

Section 2.1.1.2 Former Mishawum Lake Groundwater

One groundwater monitoring transect (transect # 2) containing five (5) sampling locations, as shown on Figure 2, shall be located immediately downgradient of this area to evaluate the source. Low flow groundwater samples will be collected at each locations at a vertical frequency of no-less-than every 10 feet, and analyzed for Table 1 "Plume Delineation Parameters". It is estimated that the saturated thickness of the overburden aquifer is 80 feet. In preparation of cost information, it is estimated that a total of 40 samples will be collected plus QA/QC samples (trip blanks, duplicates, equipment blanks). All samples will be collected with a peristaltic pump following EPA-Region 1 Low Flow Sampling Standard Operation Procedures. See GW Notes 1 & 2 below.

Section 2.1.2 Comprehensive Source Core/Maximum Concentration Delineation

Based upon the results of Section 2.1.1 and Section 2.2, 26 samples (approximately 20% of the total samples) will be collected from the four areas (Western BECO ROW, Eastern BECO ROW, Former Mishawum Lake, HBHA Pond Buried Valley) and be analyzed for "Plume Geochemistry Parameters" illustrated on Table 1. Samples will be selected from each transect based upon the maximum concentrations site-related contaminates. A minimum of 50% of the samples (13 samples) will be proportionately collected from each transect within the four areas, in an attempt to map the core of the plume(s). As appropriate (where no plume core exists), other samples may be selected based upon maximum concentrations. In addition, appropriate QA/QC samples (trip blanks, duplicates, equipment blanks) will be collected. All samples will be collected with a peristaltic pump following EPA-Region 1 Low Flow Sampling Standard Operation Procedures.

Section 2.1.3 Potable Drinking Water Supply (Interstate 95)

One groundwater monitoring transect (transect # 1) containing seven (7) sampling locations shall be located just north of Interstate 95 as illustrated on Figure 2 to evaluate the sources. Low flow groundwater samples will be collected at each locations at a vertical frequency of no-less-than every 10 feet, and analyzed for Table 1 "Plume Geo-Chemistry Parameters". It is estimated that the saturated thickness of the overburden aquifer is 80 feet. In preparation of cost information, it is estimated that a total of 56 samples will be collected plus QA/QC samples (trip blanks, duplicates, equipment blanks, etc). All samples will be collected with a peristaltic pump following EPA-Region 1 Low Flow Sampling Standard Operation Procedures. See GW Notes 1 & 2 below.

Section 2.1.4 Mishawum Lake Bed Sediments

Twenty soil borings shall be located within and adjacent to the Former Mishawum Lake boundary to determine the presence of site-related contaminants. Borings will be located on an approximate 300 to 400 foot grid as shown on Figure 3. One composite sample will be collected from a 2-foot interval that spans the original lake bed sediment/peat layer and analyzed for TAL metals. If field X-Ray Fluorescence can detect metal compounds to MCP and Consent Decree Soil action levels (such as, As=30 ppm, Cr=1,000 ppm, Pb=300 ppm, Hg = 20 ppm, etc.), then the technology should be utilized in the field with 20% of the samples being submitted to a certified laboratory for confirmatory analysis. In addition, the samples will also be analyzed for site related semi-volatile contamination (Bis(2-ethylhexyl)phthalate, Diethylphthalate, PAHs, 4-Methyl-2-pentanone, and 4-methylphenol). The results of this work will be applied to future human exposure pathways (e.g. construction worker).

GW NOTE 1: Horizontally, the sample locations shall be located approximately 150 - 200 feet apart, as illustrated on the Figures.

GW NOTE 2: Hydro-punch monitoring well techniques (e.g. micro-wells, geo-probes, etc.) are considered the most cost effective means at obtaining low-flow groundwater information; however, field conditions or equipment limitations may cause other monitoring well techniques to be more cost effective. ISRT and EPA should discuss these other monitoring well techniques when field conditions or equipment limitation issues arise. Where applicable, these other techniques may be implemented.

Section 2.2 HBHA Pond Buried Valley Groundwater Flow Paths

Two groundwater monitoring transects containing thirteen (13) sampling locations shall be installed at the southern end of HBHA Pond and south of the HBHA Pond as shown on Figure 4 to evaluate the plumes migration . Low flow groundwater samples will be collected at each locations at a vertical frequency of no-less-than every 10 feet, and analyzed for Table 1 "Plume Delineation Parameters". It is estimated that the saturated thickness of the overburden aquifer is 40 feet. In preparation of cost information, it is estimated that a total of 52 samples will be collected plus QA/QC samples (trip blanks, duplicates, equipment blanks). All samples will be collected with a peristaltic pump following EPA-Region 1 Low Flow Sampling Standard Operation Procedures. See GW Notes 1 and 2 below.

GW NOTE 1: Horizontally, the sample locations shall be located approximately 150 - 200 feet apart, as illustrated on the Figures.

GW NOTE 2: Hydro-punch monitoring well techniques (e.g. micro-wells, geo-probes, etc.) are considered the most cost effective means at obtaining low-flow groundwater information; however, field conditions or equipment limitations may cause other monitoring well techniques to be more cost effective. ISRT and EPA should discuss these other monitoring well techniques when field conditions or equipment limitation issues arise. Where applicable, these other techniques may be implemented.

Section 2.3 Ecological and Human Health Impact

Section 2.3.1 Toxicological Surface Water and Sediment Sampling

EPA is requiring that comprehensive sediment and surface water toxicity data be collected for the site to properly assess ecological impacts related to site-related contaminated sediments and surface water. EPA's triad sediment sampling analysis approach shall be applied for each of the thirteen sediment samples collected from locations shown on Figure 5. Analytical parameters for sediment samples will be VOCs, metals, and SVOCs, as well as PCBs and pesticides. In addition, macro-invertebrate samples shall be collected at each of these sediment locations and analyzed qualitatively for species and quantitatively for contaminant concentrations. Qualitative analysis will identify type of organisms/species, and number of organisms/species at each of the 13 sediment sample locations. Quantitative benthic analysis will also be conducted at each of the 13 sediment sampling locations, and analyzed for metals at a experienced, certified laboratory. Acute and chronic toxicity testing will be performed on hyalella and chironomids as the indicator species at each of the 13 sediment sampling locations. A copy of the chronic toxicity Standard Operating Procedures for hyalella is attached. The data collected will be applied to human health and ecological risk assessments, and utilized in food chain models to evaluate the impact to the mallard duck.

Section 2.3.2 Fish Sampling

Additional fish samples shall be collected to further evaluate the impacts to fish from the site-related contaminants qualitatively and quantitatively. Previous fish sampling activities have illustrated a depleted fish population in the HBHA Pond. This depletion appears to be associated with the presence of site related contaminants in the HBHA Pond and contaminant plume discharges into the HBHA Pond. This additional sampling will be conducted in four ponds near the Site (two downgradient and two upgradient) and the data will be applied to the human health and ecological risk assessments. These Ponds are identified as North Pond, Phillips Pond, HBHA Pond, and HBHA Wetland pond 3 at Mishawum Road. See Figure 5 for fish sampling locations.

The fish samples collected at the reference stations should reflect species collected at the downgradient ponds (HBHA Pond and HBHA Wetland Pond 3). Therefore, fish should be collected from the downgradient ponds first. All fish sampling activities shall comply with EPA's "Guidelines for Fish Tissue Preparation and Analyses" (1995).If possible, a minimum of five fish from each of three trophic species (predator, forager, bottom feeder) should be collected. The variety of species should be representative of different trophic levels. Prior to preparing the fish for tissue analysis, the fish will be examined for histological effects from potential contaminant exposure. The USFWS, with assistance from the Contractor, will collect the fish species, and assist in documenting qualitative fish observations (species; number of fish collected of each species; age; length; weight; visual observation, such as

tumors, sores lesions, etc; fish collection technique; other environmental observations surrounding sampling area; etc.,). Documentation will also include photographing the fish species. A log will be kept by the USFWS and the Contractor to document these observations. The Contractor shall quantitatively prepare the fish for laboratory analysis. The fish will be analyzed for tissue analysis as follows:

small fish:	analyze whole fish for metals
medium fish:	analyze offal and fillet for metals
large fish:	analyze target organs (liver and kidneys) for metals

The USFWS and contractor will also evaluate the four ponds ability to provide a sustainable fish population that supports recreational fishing. This evaluation will be considered in the human health risk assessment.

Section 2.4. Downgradient Transport

Section 2.4.1 Sediments

The purpose of this work is to determine the hydraulic characteristics of the HBHA (Pond and Wetlands) over a range of discharge scenarios; to identify sediment physical characteristics to quantify entrainment shear stresses, transport mechanisms, and depositional dynamics; and to quantify sediment loading, retention, and export budgets for HBHA under normal and high-flow conditions.

The objectives will be accomplished by:

1) Obtaining the HEC-2 data deck used in the 1980 FEMA study to evaluate velocity and discharge profiles through HBHA. Note: This study should consider that significant changes to the surface water conditions at/surrounding the site have occurred since the 1980 FEMA study.)

2) Collecting depth integrated stream sediment samples and concurrent velocity and depth measurements at all HBHA inflows and outflows.

3) Determining the volume, chemical composition, and physical characteristics of fine-grained sediments in HBHA.

4) Completing investigations to determine sediment contaminant flux migration, contaminant migration under storm conditions, and sediment migrations mechanisms.

5) Determining the storm size required to mobilize and transport HBHA Pond sediments downstream.

6) Completing a hydraulic and sediment fate and transport modeling analysis of the HBHA.

See related work under Section 2.4.2.

Section 2.4.2 Surface Water

To understand sediment transport and impacts to surface water, the following investigation will be conducted in 2 steps:

Step 1

- Using depth integrated samplers, TSS samples will be collected from nine sampling locations to determine the optimum sampling depths. The nine sampling locations will include:

  - Halls Brook discharge into HBHA Pond;
  - Atlantic Avenue Drainway discharge into HBHA Pond;
  - Unnamed tributary draining BECO ROW 9 and discharging into HBHA Pond;
  - Discharge from HBHA Pond;
  - Discharge from HBHA Wetland; and
  - 4 Culverts draining areas west of the commuter rail tracks and discharging into HBHA Wetland (samples may need to be collected as grab samples).

Step 2

- Determine the stage response and use the information to set the proper sample depth of the ISCO sampler units.

- Install storm-activated ISCO samplers at each of the nine sampling locations. If Step 1 indicates that the data from the four western culverts is inconsequential, then the ISCO samplers may be located at the five sampling locations along HBHA. Grab samples may be collected where ISCO samplers are not implemented.

  1. Collect time interval TSS samples during base flow and two storm flow periods during the spring, and pond turn over periods (mid summer/ early fall and late fall/winter) at the 9 locations (listed above).

  2. Prepare 81 flow weighted composite samples (three seasons, 3 sampling events per seasons and 9 sampling locations); analyze each sample for TSS, total Arsenic, Dissolved Arsenic, (determine suspended arsenic by difference), total chromium, total lead, total mercury, Bis(2-ethylhexyl)phthalate, Diethylphthalate, PAHs, 4-Methyl-2-pentanone, and 4-methylphenol.

3. Prepare 9 flow weighted composite samples of the discharge from HBHA Pond (3 seasons and three sampling events per season); analyze the samples for TCL VOCs, TCL SVOCs, and TAL metals.

4. Prepare 9 flow weighted composite samples of the discharge from HBHA Wetland (3 seasons and three sampling events per season) analyze the samples for TCL VOCs and TCL SVOCs and TALS metals.

- Collect stage discharge relationship data during rain events from each of the nine sampling locations.

- Collect discharge measurements from each of the nine sampling locations .

See related work under Section 2.3.1 and Section 2.4.1.

Section 2.4.3 Monthly Surface Water Monitoring

The contractor shall collect monthly surface-water samples for one year (12 months) at the HBHA Pond outlet and HBHA Wetland (Mishawum Road) outlet, and analyze these samples for toluene, benzene, arsenic (total and dissolved), chromium (total), lead (total), mercury (total), iron (total) and geochemistry parameters. As necessary, vertical profiling and/or cross-sectional surface water samples may need to be collected from each outlet to determine adequate sampling/monitoring locations. This effort can be combined with additional surface water sampling efforts outlined under Section 2.4.2.

Section 2.5 Risk Assessments

Section 2.5.1 Human Health Risk Assessment*

The human health risk assessment must be revised based upon the new analytical data, and comply with EPA guidance documents and GSIP comments. Groundwater exposure scenarios are to include the commercial or industrial use of groundwater, VOC vapor intrusions into building spaces, and construction worker exposure to groundwater. Surface water exposure scenarios are to include wading and swimming in HBHA and ingestion of fish. The surface water exposure scenario must also consider contaminated groundwater discharging to surface water. Soil exposure scenarios are to include construction worker exposure to contaminated soils/sediments as seen at the former Mishawum Lake bed sediments.

Section 2.5.2 Ecological Risk Assessment*

The ecological risk assessment must be revised based upon the new analytical data, and comply with EPA guidance documents and GSIP comments.

* EPA has included a copy of EPA Region 1, New England, Risk Updates (Numbers 1 - 4). Also, on December 17, 1997, EPA released "Risk Assessment Guidance for Superfund (RAGS) Volume 1 - Human Health Evaluation Manual (part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments) (Interim)". Please reference these documents, as well as any other applicable guidance documents, when preparing the risk assessments.

TABLE 1
Groundwater Analytical Parameters*

Plume Delineation Parameters

Field Parameters: Eh, pH, temperature, Specific Conductance, Dissolved Oxygen, Ferrous Iron, Sulfide

Laboratory: Low-Flow Sampling - Unfiltered Samples; Alternatively, Unfiltered and Filtered Samples

Benzene
Toluene
Total Arsenic
Arsenic Species**
Total Iron
Total Chromium
Total Lead
Total Mercury

Plume Geochemistry Parameters

Field Parameters: Eh, pH, temperature, Specific Conductance, Dissolved Oxygen, Ferrous Iron, Sulfide

Laboratory:

TCL VOCs	(Low-Flow Sampling - Unfiltered Samples; Alternatively, Unfiltered and Filtered Samples)
TAL Metals	Low-Flow Sampling - Unfiltered Samples; Alternatively, Unfiltered and Filtered Samples)
TCL SVOCs	(Low-Flow Sampling - Unfiltered Samples; Alternatively, Unfiltered and Filtered Samples)

Arsenic Species**
Nitrate, Nitrite, Sulfate, Bicarbonate/Carbonate and Phosphate
Ammonia
DOC

* In addition to the groundwater samples, the contractor shall collect appropriate Quality Assurance and Quality Control (QA/QC) samples for laboratory analysis. This includes trip blanks, duplicates, equipment blanks, etc.

** Arsenic Speciation will be conducted only when Total Arsenic concentrations are greater than 50 ppb.

TABLE 2
Field Groundwater Analytical Parameters*

Field Screening Parameters

Geochemistry Parameters: Eh, pH, temperature, Specific Conductance, Dissolved Oxygen, Ferrous Iron, Sulfide

Chemical Parameters: On-Site GC, or similar field instrument; Low-Flow Sample Collection

Benzene
Toluene
Total Arsenic
Arsenic Species**
Total Iron
Total Chromium
Total Lead
Total Mercury

* In addition to the groundwater samples, the contractor shall collect appropriate Quality Assurance and Quality Control (QA/QC) samples for laboratory analysis. This includes trip blanks, duplicates, equipment blanks, etc.

** Arsenic Speciation will be conducted only when Total Arsenic concentrations are greater than 50 ppb.

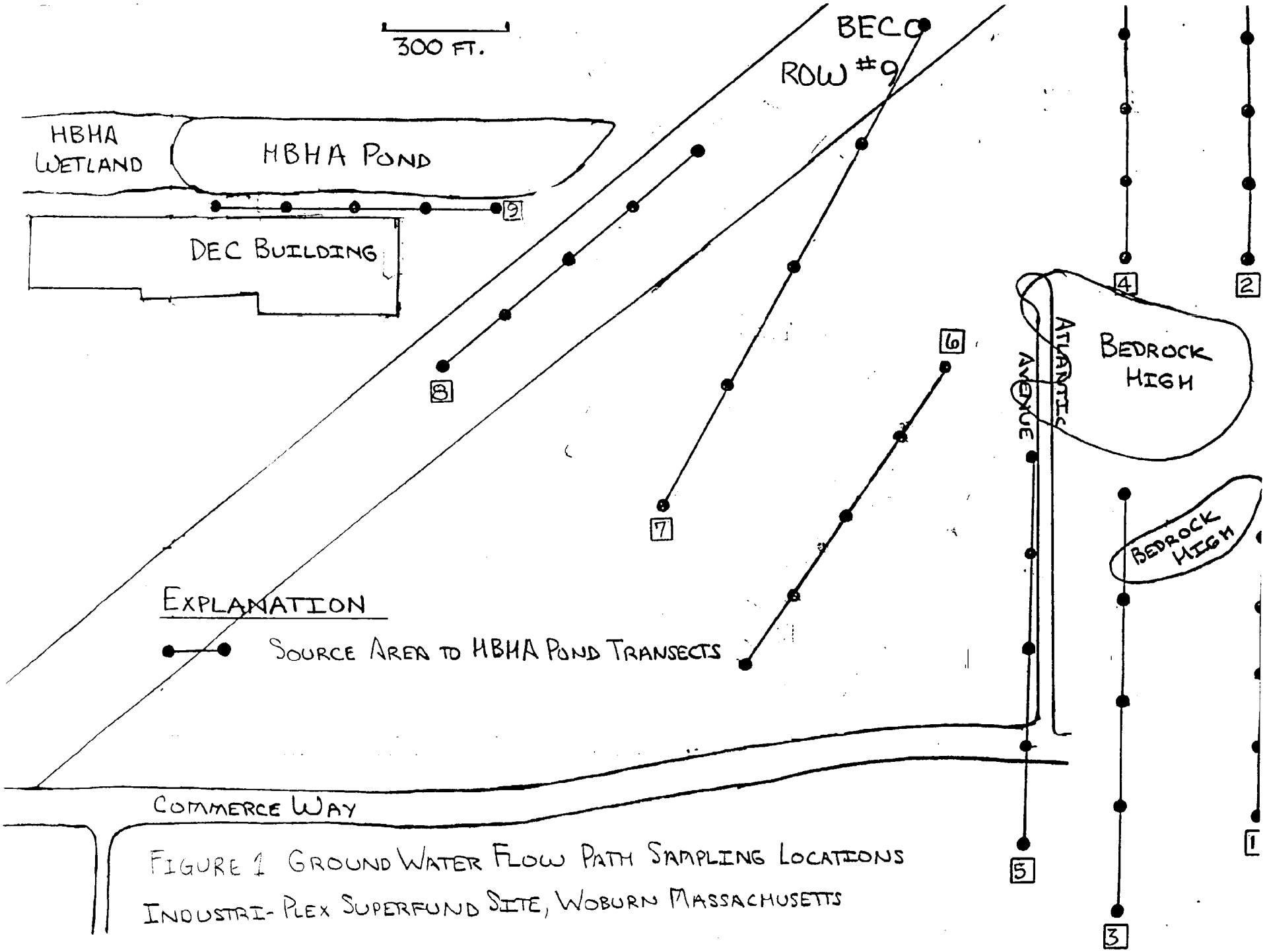
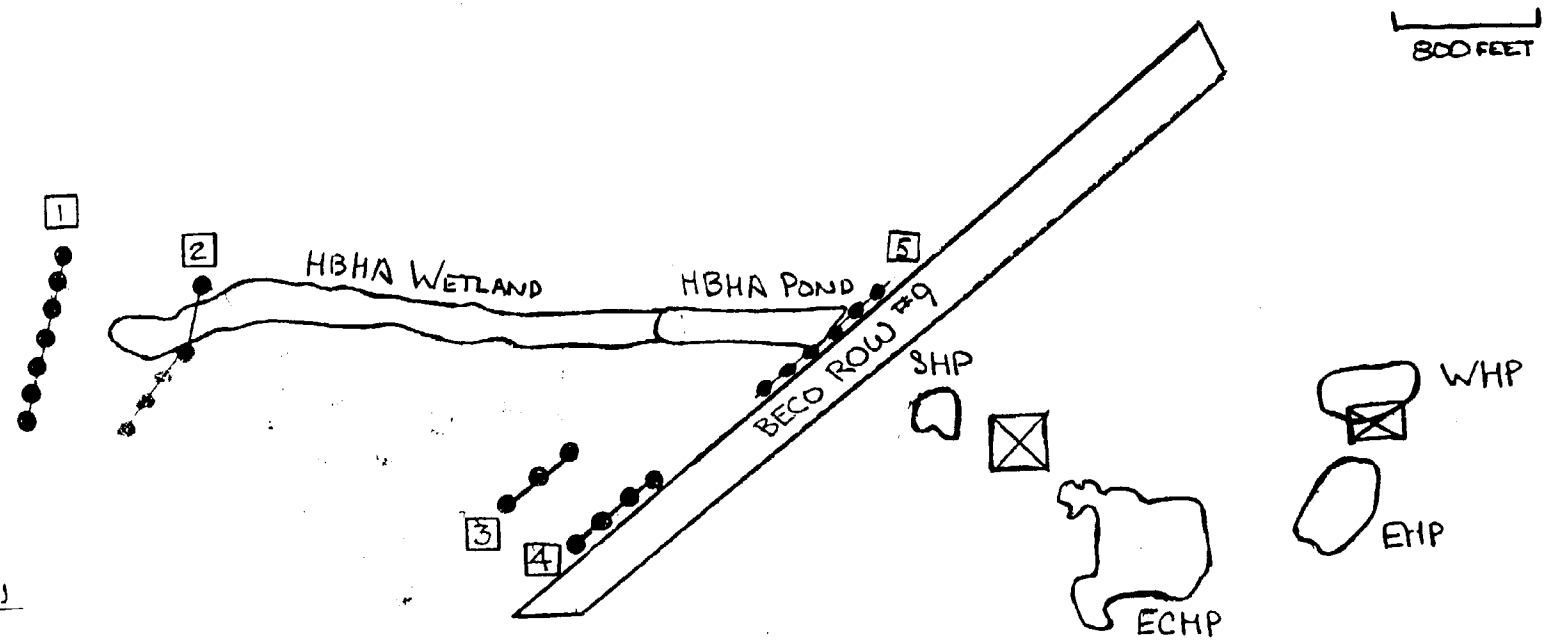


FIGURE 1 GROUND WATER FLOW PATH SAMPLING LOCATIONS
INDUSTRI-PLEX SUPERFUND SITE, WOBURN MASSACHUSETTS



EXPLANATION

⊠ BENZENE/TOLUENE SOURCE AREA INVESTIGATION

GEOPROBE®/MICROWELL® TRANSECT

1 TRANSECT 1 - MIGRATION TO GW-1 AQUIFER

2 TRANSECT 2 - MIGRATION FROM LAKE MISHAWUM

3 TRANSECT 3 - MIGRATION FROM EAST END BECO ROW #9

4 TRANSECT 4 - MIGRATION FROM EAST END BECO ROW #9

5 TRANSECT 5 - MIGRATION FROM WEST END BECO ROW #9

FIGURE 2. SOURCE AREA SAMPLING LOCATIONS (GROUND WATER) INDUSTRI-PLEX SITE, WOBURN, MA

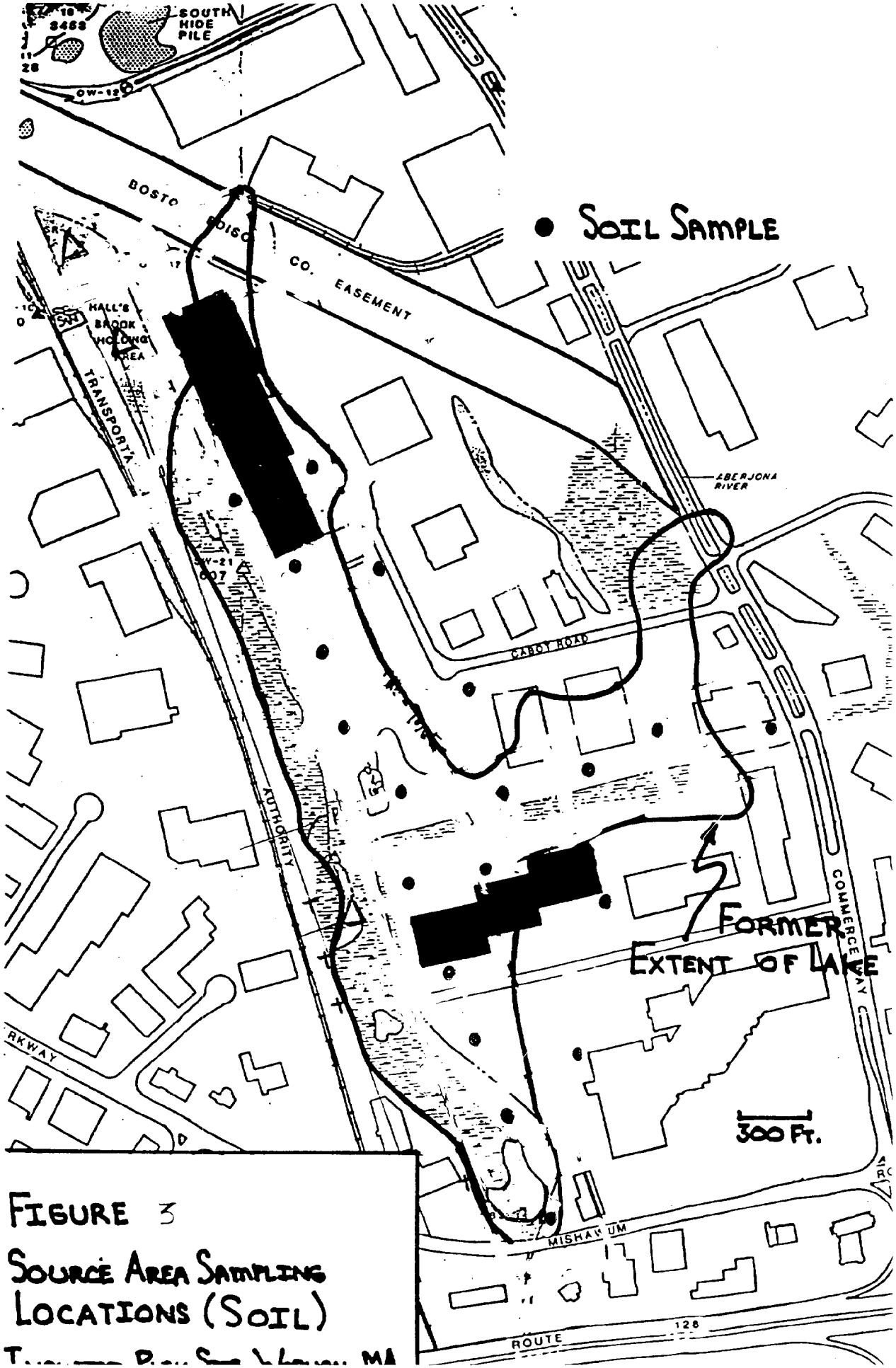


FIGURE 3

SOURCE AREA SAMPLING LOCATIONS (SOIL)

Tyco Plastics Site Woburn, MA

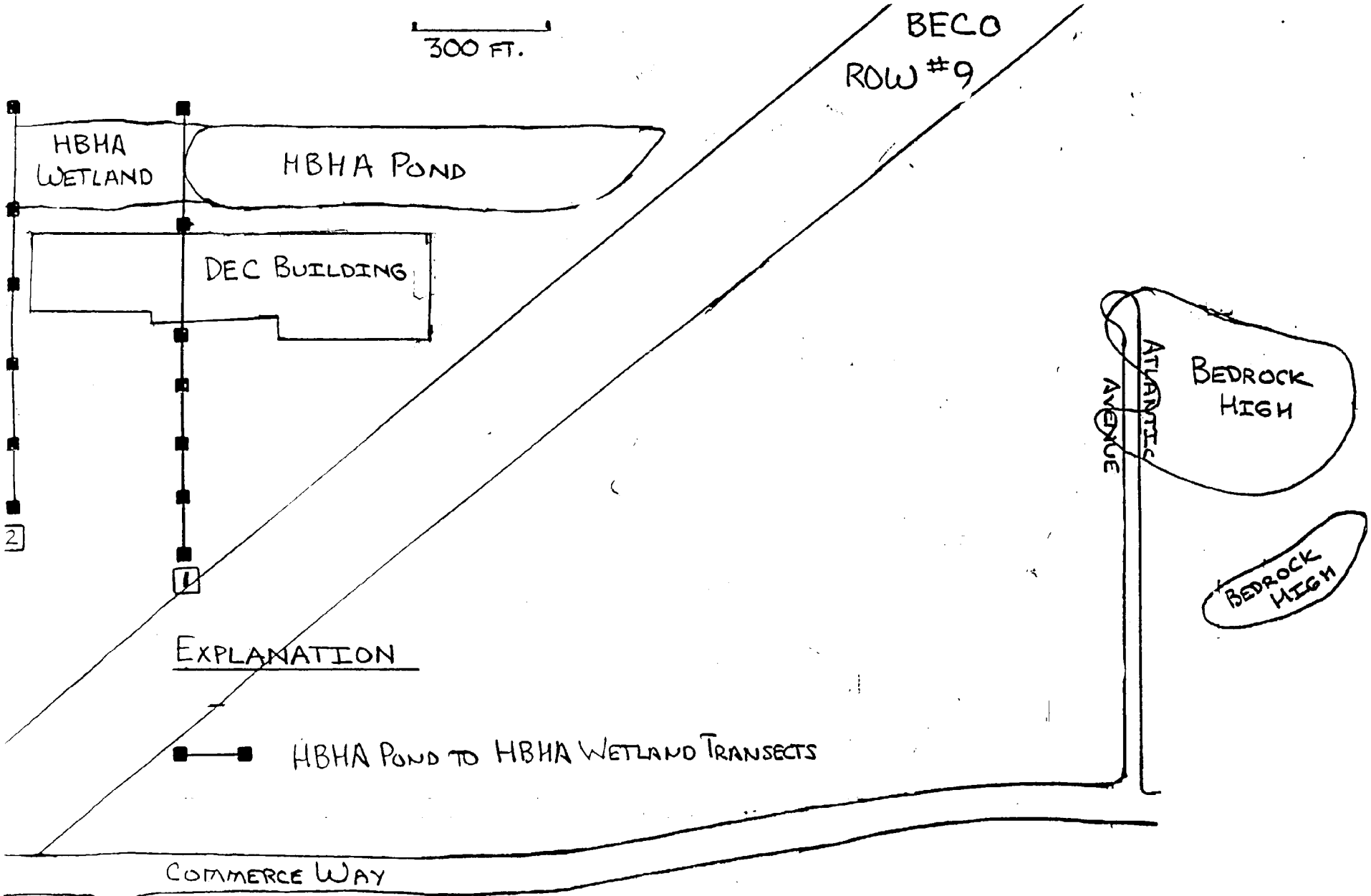
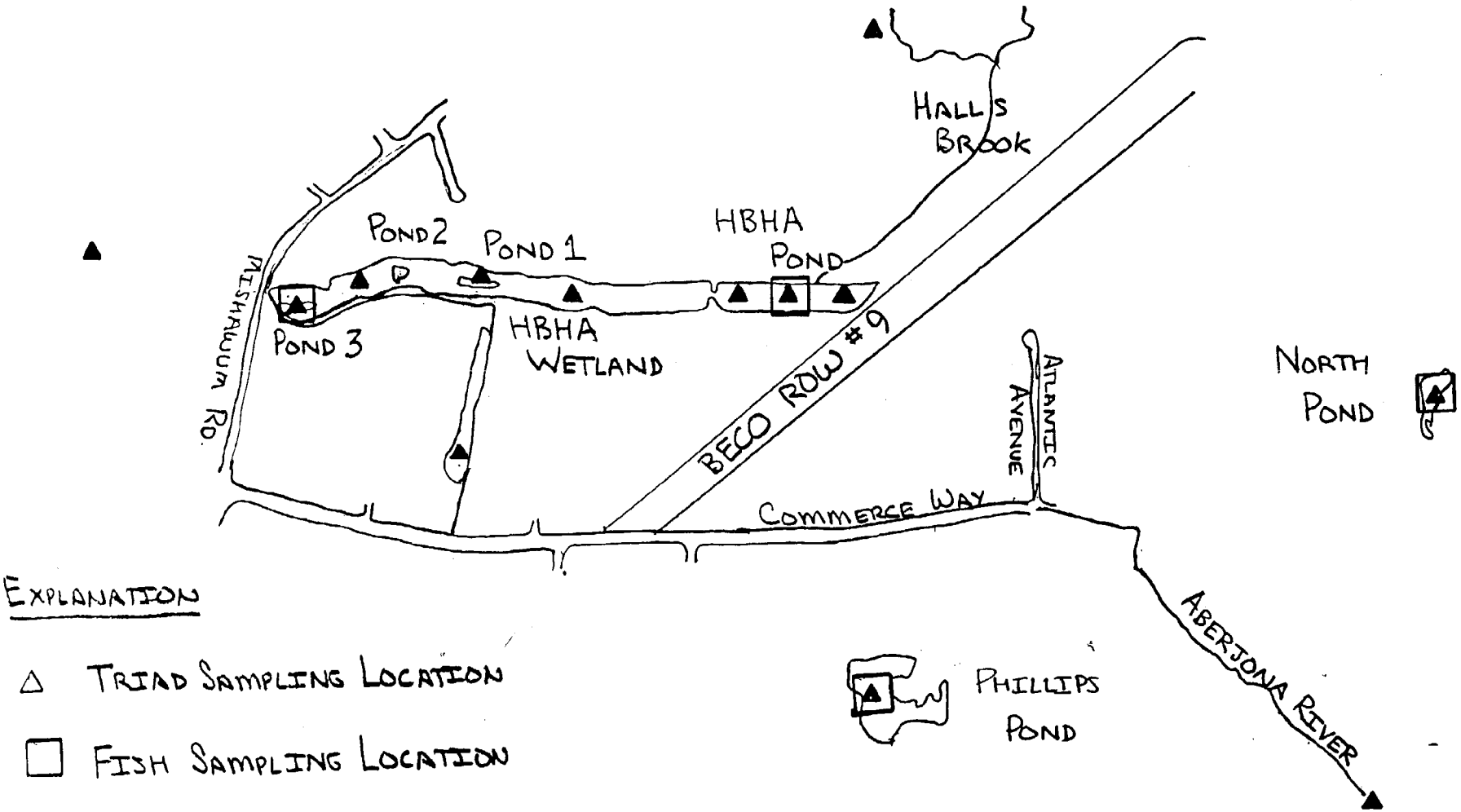


FIGURE 4 GROUND WATER FLOW PATH SAMPLING LOCATIONS
INDUSTRI-PLEX SUPERFUND SITE, WOBURN MASSACHUSETTS



EXPLANATION

△ TRIAD SAMPLING LOCATION

□ FISH SAMPLING LOCATION

FIGURE 5

ECOLOGICAL IMPACT SAMPLING LOCATIONS

INDUSTRI-PLEX SITE, WOBURN, MA

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August 1998

AERIAL PHOTOGRAPHIC ANALYSIS
INDUSTRI-PLEX SITE AND STUDY AREA

Woburn, Massachusetts

Volume 1

by

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NOTICE

This document has undergone a technical and quality control and assurance review and approval by personnel of the U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, Landscape Ecology Branch at Las Vegas, Nevada, and is for internal Agency use and distribution only.

ABSTRACT

This report presents the findings from a historical site analysis and a wetlands and drainage analysis of the Industri-plex site and the surrounding study area in Woburn, Massachusetts. These analyses were performed using archival aerial photographs. The site and surrounding study area were analyzed to detect evidence of waste disposal and other activities of environmental significance at the request of Region 1 of the U.S. Environmental Protection Agency (EPA). Findings from the analyses are presented in two volumes; Volume 1 contains text and Volume 2 contains digitally produced photographic prints with accompanying analysis overlays.

The two aerial photographic analyses, the historical site analysis and the wetlands and drainage analysis, presented in this report focused on the 1938 through 1995 time frame using aerial photographs from 1938, 1952, 1963, 1970, 1971, 1975, 1978, 1980, 1985 and 1995. The objective of the historical site analysis was to identify potential sources of contaminants on the site and in the study area. The objective of the wetlands and drainage analysis was to delineate historical changes to wetlands, surface bodies, and streams on the site and within the study area.

The historical site analysis identified major fill areas that were placed on the Industri-plex site during the study period. In addition, industrial impoundments and deposition of waste materials were noted on the site. The historical analysis of the Industri-plex study area documented significant environmental activity and features at 20 previously identified and at two previously unidentified sites of potential source contaminants. The wetlands and drainage analysis of the Industri-plex study area revealed significant loss of wetland habitat and alteration of natural drainage patterns primarily from 1970 through 1995 when the northern and southern portions of the study area were being developed.

The U.S. Environmental Protection Agency, Environmental Sciences Division, Landscape Ecology Branch in Las Vegas, Nevada, prepared this report for the EPA Region 1, Office of Site Remediation and Restoration in Boston, Massachusetts and the EPA Office of Emergency and Remedial Response in Washington, D.C.

CONTENTS

VOLUME 1

	Page
Abstract	iii
Introduction	1
Methodology	4
Historical Photographic Analysis	
Industri-plex site	8
Industri-plex study area	12
Wetlands and Drainage Analysis	32
Glossary	34
References	35

VOLUME 2

FIGURES

Number		
1	Study area location map, Massachusetts	1
2	Local study area location map, Boston North and Reading, Massachusetts	2
3	Industri-plex site, December 16, 1938	3
4	Industri-plex site, October 12, 1952	3
5	Industri-plex site, April 29, 1963	3
6	Industri-plex site, October 29, 1970	3
7	Industri-plex site, July 3, 1971	4
8	Industri-plex site, December 28, 1975	4
9	Industri-plex site, April 23, 1978	4
10	Industri-plex site, November 6, 1980	5
11	Industri-plex site, July 24, 1985	5
12	Industri-plex site, March 29, 1995	5

13 Industri-plex study area, December 16, 1938 6
14 Industri-plex study area, October 12, 1952 7
15 Industri-plex study area, April 29, 1963 8
16 Industri-plex study area, October 29, 1970 9
17,18 Industri-plex study area, July 3, 1971 10,11
19,20 Industri-plex study area, December 28, 1975 12,13
21 Industri-plex study area, April 23, 1978 14
22-24 Industri-plex study area, November 6, 1980 15,16,17
25 Industri-plex study area, July 24, 1985 18
26 Industri-plex study area, March 29, 1995 19

INTRODUCTION

This report presents the findings from a historical site analysis and a wetlands and drainage analysis of the Industri-plex site and the surrounding study area in Woburn, Massachusetts (Figure 1). These analyses were performed using archival aerial photographs. The Industri-plex site (CERCLIS ID# MAD076580950) is located along New Boston Road. The Industri-plex study area surrounds the site and is roughly defined by Interstate Highway 93 on the east, Interstate Highway 95 on the south, a railroad on the west, and Eames Road to the north (Figure 2). Findings from the analyses are presented in two volumes; Volume 1 contains text and Volume 2 contains digitally produced photographic prints with accompanying analysis overlays.

The Industri-plex site was used for manufacturing chemicals such as arsenic insecticide, acetic acid, and sulfuric acid for the textile, leather, and paper manufacturing industries. Phenol, benzene, and toluene were also manufactured at the site (EPA 1998).

Region 1 of the U.S. Environmental Protection Agency (EPA) requested a historical analysis to document waste disposal activities and other activities of environmental significance at the Industri-plex site. The historical analysis of the Industri-plex study area was performed to document the development of previously identified potential sources of environmental contamination (HNUSC 1997) and to locate any previously unidentified potential sources of contamination. Known potential contaminant sites are identified in the document "Preliminary Multiple Source Groundwater Response Plan Report, Industri-plex Site, Woburn, Massachusetts". The site identification numbers used in that document (EPA Work Assignment No. 11-1L07) are used in this historical analysis. Two sites (Sites 1 and 2) that are previously unidentified potential sources of contamination are analyzed in this historical analysis. Finally, a wetlands and drainage analysis was performed to delineate historical changes to wetlands, surface water bodies, and streams within the site and study area.

Aerial photographs of the Industri-plex site and study area were obtained for the 1938 through 1995 time frame. Aerial photographs from 1938, 1952, 1963, 1970, 1971, 1975, 1978, 1980, 1985, and 1995 were used for the site, study area, and wetlands and drainage analyses.

The historical site analysis identified major fill areas that were located on the Industri-plex site during the study period. In addition, industrial impoundments and deposition of waste materials were noted on the site. The historical analysis of the study area surrounding the Industri-plex site documented significant environmental activity at 20 previously identified and at 2 previously unidentified sites of potential source contaminants. The wetlands and drainage analysis of the Industri-plex study area revealed significant loss of wetland habitat and alteration of natural drainage patterns primarily from 1970 through 1995 when the northern and southern portions of the study area were being developed.

Findings are described in text form and shown on overlays to digitally produced prints. Historical aerial photographs used in the analysis of this site have been digitally scanned and plotted for use in this report. A transparent overlay with interpretative data is affixed to each of the digital plots. See the Methodology section for a discussion of the scanning and plotting procedures. Findings from the wetland and drainage analysis are annotated on overlays to a set of large prints (1938 through 1995). Findings from the historical analysis of the Industri-plex study area are annotated onto a second overlay to the set of large prints. Findings for the historical analysis of the Industri-plex site are annotated on overlays to a set of small prints (1938 through 1995). In the historical analyses, identified features or conditions that are not associated with a numbered site are annotated on the overlays to the prints but are not discussed in the text. To diminish clutter on the overlays the approximate site location numbers of sites analyzed in the Industri-plex study area are presented on the wetlands and drainage overlays.

A glossary, defining features or conditions identified in this report, follows the analysis section. Sources for all maps, aerial photographs, and collateral data used in the production of this report are listed in the References section. A list of all aerial photographs that were identified and evaluated for potential application to this study can be obtained by contacting the EPA Work Assignment Manager.

The U.S. Environmental Protection Agency, Environmental Sciences Division, Landscape Ecology Branch in Las Vegas, Nevada, prepared this report for the EPA Region 1 Office of Site Remediation and Restoration in Boston, Massachusetts, and the EPA Office of Emergency and Remedial Response in Washington, D.C.

METHODOLOGY

This report was prepared using a standard methodology that includes the following steps:

- data identification and acquisition,
- photographic analysis and interpretation, and
- graphics and text preparation.

These steps are described below. Subsections also address details related to specific kinds of analyses that may be required to identify environmental features such as surface drainage and wetlands. All operational steps and processes used to perform this work (including data identification and acquisition, photographic analysis and interpretation, and graphics and text preparation) adhere to strict QA/QC guidelines and standard operating procedures (SOPs). These guidelines and procedures are documented in the Master Quality Assurance Project Plan (QAPP) prepared for Remote Sensing Technical Support Contract No. 68-C5-0065 (LESAT 1998).

Data identification and acquisition included a search of government and commercial sources of historical aerial film for the study area. Photographs with optimal spatial and temporal resolution and image quality were identified for acquisition. In addition, U.S. Geological Survey (USGS) topographic maps were obtained to show the study area location and to provide geographic and topographic context.

To conduct this analysis, the analyst examined diapositives (transparencies) of historical aerial photographs showing the study area. Diapositives are most often used for analysis instead of prints because the diapositives have superior photographic resolution. They show minute details of significant environmental features that may not be discernible on a paper print.

A photographic analyst uses a stereoscope to view adjacent, overlapping pairs of diapositives on a backlit light table. In most cases, the

stereoscope is capable of various magnifications up to 60 power. Stereoscopic viewing involves using the principle of parallax (observing a feature from slightly different positions) to observe a three-dimensional representation of the area of interest. The stereoscope enhances the photo interpretation process by allowing the analyst to observe vertical as well as horizontal spatial relationships of natural and cultural features.

The process of photographic analysis involves the visual examination and comparison of many components of the photographic image. These components include shadow, tone, color, texture, shape, size, pattern, and landscape context of individual elements of a photograph. The photo analyst identifies objects, features, and "signatures" associated with specific environmental conditions or events. The term "signature" refers to a combination of components or characteristics that indicate a specific object, condition, or pattern of environmental significance. The academic and professional training, photo interpretation experience gained through repetitive observations of similar features or activities, and deductive logic of the analyst as well as background information from collateral sources (e.g., site maps, geologic reports, soil surveys) are critical factors employed in the photographic analysis.

The analyst records the results of the analysis by using a standard set of annotations and terminology to identify objects and features observed on the diapositives. Significant findings are annotated on overlays attached to the photographic or computer reproduced prints in the report and discussed in the accompanying text. Annotations that are self-explanatory may not be discussed in the text. The annotations are defined in the legend that accompanies each print and in the text when first used.

Objects and features are identified in the graphics and text according to the analyst's degree of confidence in the evidence. A distinction is made between certain, probable, and possible identifications. When the analyst believes the identification is unmistakable (certain), no qualifier is used. Probable is used when a limited number of discernible characteristics allow the analyst to be reasonably sure of a particular identification. Possible is used when only a few characteristics are discernible, and the analyst can only infer an identification.

The prints in this report have been reproduced, either by photographic or computer methods, from the original film. Reproductions are made from the original film and may be either contact (the same size) prints or enlargements, depending on the scale of the original film. Any computer-produced prints used in this report are generated from scans of the film at approximately 1,300 dots per inch (dpi) and printed at 720 dpi. Although the reproductions allow effective display of the interpretive annotations, they may have less photographic resolution than the original film. Therefore, some of the objects and features identified in the original image and described in the text may not be as clearly discernible on the prints in this report.

Study area boundaries shown in this report were determined from aerial photographs or collateral data and do not denote legal property lines or ownership.

Surface Drainage

The surface drainage analysis produced for this report identifies the direction and potential path that a liquid spill or surface runoff would follow based on the topography of the terrain and the presence of discernible obstacles to surface flow. The analyst determines the direction of surface drainage by stereoscopic analysis of the aerial photographs and by examining USGS topographic maps. Site-specific surface drainage patterns are annotated on the map or photo overlay. Where the direction of subtle drainage cannot be determined, an indeterminate drainage line symbol is used. Regional surface flow is ascertained from the USGS topographic maps.

Wetland Analysis

The most general type of wetland analysis involves differentiating wetland and nonwetland areas. An analyst utilizes aerial photographs, soil surveys, hydric soils data, National Wetland Survey maps, and other available data to identify wetland boundaries and drainage networks within a study area. More detailed analyses are conducted using the Cowardin Classification System (Cowardin 1979) to provide information regarding vegetation types and hydrologic regimes. Analyses of photography from several years can be

compiled to assess changes in wetland areas and measurements can be conducted to quantify results. Field checking of final products can confirm and refine mapping results and aid in compliance with jurisdictional and legal requirements. Results of a wetlands analysis are presented on clear acetate overlays attached to photographs or USGS topographic maps.

Color Infrared Photographs

Some photographs used for this analysis were made from color infrared film. Normal color film records reflected energy in the blue, green, and red portions of the electromagnetic spectrum. Color infrared film differs in that it is sensitive not only to reflected blue, green, and red energy, but also to reflected energy in the infrared portions of the electromagnetic spectrum; however, the blue energy is filtered out and only the green, red, and infrared energy is recorded. When color infrared film is processed, it displays "false" colors that do not correspond with the true colors of the features photographed. For example, features that are highly reflective in the infrared portion of the spectrum, such as healthy vegetation, appear red to magenta on color infrared film. The false color displayed by a feature is produced in accordance with the proportions of green, red, and infrared energy it reflects. These portions are referred to as the "spectral reflectance characteristics" of the feature. To interpret the true color of a particular feature accurately from color infrared film, a knowledge of the spectral reflectance characteristics of that feature is required. This information is not readily available for the majority of features identified in this report. Therefore, unless otherwise indicated, no attempt has been made to interpret the true colors of the features identified on the color infrared film analyzed for this report.

HISTORICAL PHOTOGRAPHIC ANALYSIS

INDUSTRI-PLEX SITE

1938 (Figure 3) - An industrial facility is operating on the site. The main facility building on the site is joined to the railroad line that lies to the east by two railroad spurs. A smokestack west of the main facility building is probably part of the facility's incinerator. The smokestack is present on the site throughout the remainder of this study and will no longer be discussed or annotated. Several auxiliary buildings (not annotated) are located nearby. Three liquid-filled impoundments, located south of the main facility building, are probably used for industrial liquid waste disposal. A probable outfall, discharging into the adjacent drainageway, is noted east of the largest of these impoundments. Another impoundment is located across the railroad tracks west of the main facility building. There are 5 vertical tanks on the site. The vertical tank east of the main facility building is linked to the building by a overhead pipeline (not annotated). Six possible vertical tanks, aligned in a row, are noted northeast of the main facility building at the end of an access road. Dark-toned and light-toned material (possibly waste material) has been deposited on the surface of areas north and south of the main facility building. A mound of course-textured, light-toned probable raw materials is noted along the railroad spur.

1952 (Figure 4) - The industrial facility remains in operation. The large impoundment south of the main facility building appears to have been reconfigured. The impoundment now consists of a network of smaller interconnected impoundments. The drainageway east of the impoundment has been channelized; the probable outfall is no longer visible. Atop the embankment east of the channelized drainageway are 4 manmade circular objects (annotated as "unidentified objects"), two of which appear to have pipes (not annotated) extending from them into the drainageway. The resolution of the 1952 photographs does not allow for identification of the 4 objects. Another channelized drainageway leads to the large impoundment from the vicinity of the two small impoundments located north of the large impoundment. A network

of access roads (not annotated), leading to fill areas and areas of deposited dark- and light-toned material, and possible dark-toned material, is now in place east of the main facility building. Two areas that contained light-toned material in 1938 have begun to revegetate. The mounds of dark-toned material, located south and southeast of the main facility building in 1938, have been removed. Two piles of probable raw material, a mound of dark-toned fine-textured material, and a mound of course-textured, light-toned material are noted along the railroad spur north of the main facility building. There are 9 vertical tanks and four possible tank pads on the site.

1963 (Figure 5) - The industrial facility continues to be in operation. The three impoundments south of the main facility building continue to contain liquid. A small building located between the large and two small impoundments has been removed. A building foundation remains. Probable raw material is again noted adjacent to the north side of the main facility building. During the intervening years between 1958 and 1963 it appears that fill material has continued to be deposited east of the main facility. Three fill areas are noted on the site. On the southernmost fill area are three liquid-filled probable impoundments. Nearby are three stains on the slope of the fill area. The flow-shaped stains appear to be the result of probable liquid waste disposal. A nearby truck, noted adjacent to one of three flow-shaped stains, is probably discharging waste liquid. There are 9 vertical tanks on the site. The 4 unidentifiable objects noted east of the large impoundment in 1952 are no longer on the site.

1970 (Figure 6) - There are containers stored in open storage areas adjacent to the main facility. The two small impoundments south of the main facility building and the impoundment across the railroad tracks west of the site have been filled in. A new impoundment is located between the two former lagoon locations. The new impoundment is possibly connected to the larger impoundment located to the south via a drainageway. These remaining two impoundments are partially filled with liquid. The top floor of the southern section of the main facility building has been removed. The fill areas, located east of the main facility building, appear to have received more material since 1963. The three separate fill areas noted in 1963 now form one large fill area that covers the low hills east of the site. A portion of the fill area located east of the large impoundment in 1963 has

revegetated. The 2 probable impoundments noted on the southernmost fill area in 1965 have been filled in. Uncovered probable solid waste is noted along an access road (not annotated) in the southern section of the fill area. There are 8 vertical tanks on the site.

1971 (Figure 7) - Two piles of solid waste have been deposited south of the main facility building. Uncovered solid waste is noted in the southern section of the fill area. There are 9 vertical tanks on the site. No other significant change is noted on the site.

1975 (Figure 8) - The site has undergone significant change since 1971. The fill area east of the main facility building has been expanded and reconfigured. In addition to this large fill area, there are now 3 other fill areas located near the main facility building. Mounds of variously colored material have been deposited around the main facility building. A new building has been built in an area that has been filled and leveled southeast of the main facility building. The construction of a new railroad spur that leads to the building has resulted in a reconfiguration of the southwest corner of the large impoundment. In addition, the impoundment has been expanded into the channelized drainageway to the east. Solid waste is again noted around the small impoundment and probable solid waste is noted in the southern section of the large fill area. There are 3 vertical tanks on the site.

1978 (Figure 9) - Much of the southern section of the large fill area located east of the main facility building in 1975 has been. New buildings, part of an industrial park, have been built on this fill area. The southernmost section of the fill area, however, remains much as it was in 1975. There are now 5 fill areas around the main facility building. The small impoundment south of the main facility building has been filled in. There are now 2 vertical tanks on the site.

1980 (Figures 10) - The main facility building has been removed. Mounds of solid waste, probably debris from the main facility building demolition, are noted throughout the site. An open storage area, located northwest of the former main facility building, contains cases, crates, and truck trailers (not annotated). The relatively high resolution of this year of film allows

for identification of a perimeter fence encircling this area of the site. The surfaces of all of the fill areas noted in 1978 are now mostly vegetated with the exception of the fill area located in the northeast portion of the site. The unvegetated fill area, unlike the vegetated fill areas, is probably still active. The impoundments noted south of the main facility building in 1978 are no longer operational. A drainage channel has been dug through the impoundment area. A new building has been built east of the former main facility building. A new paved road south of the new building leads to a gated access to the area around the former main facility building. There are now 2 vertical tanks on the site. The northern railroad spur leading onto the site is no longer visible.

1985 (Figure 11) - The open storage area, noted northwest of the former main facility building in 1980, remains in operation. Truck trailers are parked at the location of the former main facility building (not annotated) and to the west. A Quonset hut has been built at the location of the former main facility building. The mounds of solid waste noted on the site in 1980 are relatively unchanged. None of the fill areas (not annotated) appear to be active. There are now 2 vertical tanks on the site.

1995 (Figure 12) - A new building is noted at the location of the southern section of the former main facility building. The areas north and east of this new building have undergone change since 1985. North of the new building multiple rows of mounded material now stand where truck trailers were parked in 1985. Three rectangular-shaped liquid-filled impoundments are noted north of the mounded material. Mounded material is also stored northeast and south of the new building. Standing liquid (probably collected rainwater) is noted in the derelict impoundments located in the southern section of the facility. A new channelized drainageway has been built east of the former impoundments. The 2 northernmost fill areas appear to have been capped. The fill area northeast of the new building is active. This fill area is unvegetated and a large mound of fine-textured material has been placed on it. The fill area east of the derelict impoundments remains vegetated and has not changed significantly. The other fill areas south and west of the derelict impoundment are capped or partially-capped.

HISTORICAL PHOTOGRAPHIC ANALYSIS

INDUSTRI-PLEX STUDY AREA
(Figures 13 through 26)

SITES IDENTIFIED IN COLLATERAL DATA:

AREA A - Sites north of the Industri-plex site

Site A1: Fuel Transfer & Storage Facility

1938 - The chief land cover and land uses on and around the site are residential and woodlands.

1952 - The residences have been removed.

1963 - A rectangular-shaped open storage area, containing probable cases and crates and probable drums, has been placed on the site. Two buildings (not annotated) are on the site.

1970 - The open storage, containing probable drums and probable crates and cases, has been expanded to the south.

1971 - Open storage of containers continues on the site. The area surrounding the two facility buildings (not annotated) is covered with stacked drums and cases and crates. Another collection of stacked drums is noted south of the buildings. Trailers (not annotated) are parked on the site.

1975 - Open storage of containers continues on the site. Cases and crates, trailers, and drums are stored on the site. Off the site and adjacent to the northwest corner of the site is another open storage area; it contains cases and crates and 3 horizontal tanks. A railroad spur has been built across the site.

1978 - The inventory of containers on the site has increased. The adjacent off-site open storage area remains in use.

1980 - Cases and crates, trailers, and drums (not annotated) continue to be stored on the site. The offsite open storage area, adjacent to the northern border of the site, is now used for truck parking (not annotated). The area south of the site is also used for truck parking. Scattered containers similar in appearance to those stored on the site are visible amongst some of the trucks (not annotated).

1985 - Only the section of the site north of the railroad track that bisects the site is still used for open storage of cases and crates, trailers, and drums (not annotated). The area south of the track is empty.

1995 - Two new buildings have been built on the site south of the railroad spur that crosses the site. The area north of the railroad spur continues to be used for the open storage of cases and crates as well as probable drums. The adjacent off-site open storage area remains in use.

Site A2: Undercoverwear--Lots 4 and 4A

1938 - The site is wooded.

1952 - No significant change on the site.

1963 - No significant change on the site.

1970 - No significant change on the site.

1971 - No significant change on the site.

1975 - No significant change on the site.

1978 - No significant change on the site.

1980 - No significant change on the site.

1985 - No significant change on the site.

1995 - A new building has been built on the site. The ground surface surrounding the building has been filled and leveled.

Site A3: Industrial Property

1938 - The site is wooded.

1952 - No significant change is noted on the site.

1963 - No significant change is noted on the site.

1970 - A warehouse-type building has been built on the site. An open storage area containing possible drums (not annotated) is adjacent to the north side of the building.

1971 - The open storage area (not annotated) now contains cases and crates.

1975 (not depicted on Figure 20) - The building has been extended to the north. The open storage area is no longer being used.

1978 - No significant change is noted on the site.

1980 - No significant change is noted on the site.

1985 - No significant change is noted on the site.

1995 - No significant change is noted on the site.

Site A4: Olin Chemical

1938 - The land cover and land uses on and around the site are woodlands and cleared woodland fields.

1952 - No significant change is noted on the site.

1963 - An industrial plant has been built on the site. Twelve buildings (not annotated), seven of which are connected by an overhead pipeline, comprise the facility. Four impoundments have been constructed in the southwestern section of the facility. The northernmost is partially filled with liquid and the other 3 impoundment are empty. The impoundments appear to be unlined. On the west side of the facility is an open storage area containing probable drums and probable crates and cases. One vertical tank and 6 horizontal tanks are on the site.

1970 - The industrial plant remains in operation. Fifteen buildings are now part of the facility. The southwest section of the facility has had fill (not annotated) added to it, extending it southward. A building near the impoundments in this section of the facility has been expanded. Two of the impoundments located in this section in 1963 have been dismantled. Two new impoundments are now noted at this location. The other 2 impoundments noted in 1963 remain; a total of 4 impoundments are on the facility. All 4 impoundments contain liquid. The open storage area contains probable drums (not annotated). A new railroad spur enters the site from the west. Four new horizontal tanks have been added to the east side of the facility. There are now 10 horizontal tanks and 1 vertical tank on the site. Probable standing liquid (not annotated) is adjacent to the vertical tank. Standing liquid is also noted near the railroad spur. Dark-toned material has been placed on the surface in two places in the eastern section of the site.

1971 - Probable cases and crates (not annotated) are visible in the open storage area on the west side of the site and in two other areas. The westernmost impoundment (not annotated) visible in 1970 no longer appears operative. The remaining 3 impoundments contain liquid. There are 9 horizontal tanks and 8 vertical tanks on the site.

1975 - The open storage on the west side of the site contains crates and cases. Two other open storage areas (not annotated) are noted in the southeast section of the site; a crane (not annotated) is operating nearby. A flow-shaped stain pattern (not annotated) leads from this area down slope to the east. The impoundments on the west side of the site have been filled and leveled. The drainage way along the western edge of the facility has been channelized. The 3 impoundments on the south side of the site have been

replaced by 2 larger impoundments that now sit atop the former impoundment location. The eastern new impoundment is empty and the western new impoundment appears to be partially filled with soil; a green liquid (not annotated) partially covers the bottom of the western impoundment. A possible outfall is noted on the south side of the impoundments. There are 11 horizontal tanks and 8 vertical tanks on the site. Standing liquid is visible adjacent to the cluster of 5 horizontal tanks and one vertical tank in the southeast corner of the site.

1978 - The facility remains operational. Open storage areas on the west side and in the southeast section of the site contain crates and cases. The two impoundments on the southeast side of the site do not contain liquid. There are 10 horizontal and 6 vertical tanks on the site. The possible outfall noted in 1975 is no longer visible.

1980 - The facility remains operational. The open storage areas noted on the site in 1978 continue to be used for the storage of crates and cases. The westernmost impoundment contains liquid; the other impoundment is empty. Erosion rills (not annotated) are on a cleared area in dense vegetation south of the easternmost impoundment. The cleared area and erosion rills lead down a slope to a natural drainage channel. There are 11 horizontal tanks and 15 vertical tanks on the site.

1985 - The facility remains operational. The open storage areas on the west side of the site and southeast section of the site continue to be used for the storage of crates and cases. The area of open storage located in the southeast section of the site has expanded to the south. A possible vertical tank and 2 possible horizontal tanks (not annotated) are on the expanded southern section of this open storage area. The westernmost impoundment contains liquid; the other impoundment is empty. There are 11 horizontal tanks and 13 vertical tanks on the site (all the tanks are not annotated).

1995 - The facility is no longer operational. Many of the buildings and associated infrastructure on the site in 1985 have been removed. Three buildings and 5 vertical tanks remain on the site. The 2 impoundments, in the southern section of the site, have been removed. This area and the surrounding area have been backfilled and graded (not annotated).

Site A5: Ritter Trucking (former)

1938 - The site is part of a woodlands.

1952 - No significant change on the site.

1963 - A tractor trailer depot has been built on the site.

1970 - The depot remains in operation. A fill area extends from the northeast section of the facility.

1971 - The depot remains in operation. Probable waste material has been deposited on the north side of the fill area noted in 1970.

1975 - The depot remains in operation. Probable waste material is again noted on the site in the same area as in 1971.

1978 - The depot remains in operation. Probable waste material is again noted on the site in the same area as was noted in 1975.

1980 - The depot remains in operation. A new building, with an associated parking lot (not annotated), has been built north of the site. The parking lot covers the area that contained probable waste material in 1978.

1985 - The depot remains in operation.

1995 - The depot remains in operation.

AREA B - Sites northwest and west of the Industri-Plex site

Site B1: Blox/Brussard

1938 - A main facility building, surrounded by support buildings (not annotated), is noted on the site. East of the building are possible stock pens.

1952 - The main facility building has been expanded. A drainage ditch extends from the vicinity of the main facility building eastward to a series of small possible liquid waste lagoons. A new support building has been built north of the main facility building. Only the foundation remains of one of the support buildings noted in 1938.

1963 - No significant change is noted at the site.

1970 - The possible lagoons and drainage ditch are no longer on the site. Three of the support buildings have been removed. A fill area extends eastward from the main facility to partially cover the possible stock pens.

1971 - The last support building has been removed. No other significant change is noted at the site.

1975 - Possible equipment is stored on a concrete pad north of the main facility. No other significant change is noted at the site.

1978 - The possible equipment stored on a concrete pad north of the main facility is no longer visible. No significant change is noted at the site.

1980 - No significant change is noted at the site.

1985 - No significant change is noted at the site.

1995 - An open storage area, adjacent to the north side of the main facility building, contains probable case and crates and probable drums.

Site B2: Woburn Sanitary Landfill

1938 - The chief land cover and land use on and around the site are wetlands and woodlands. An access road runs through the site.

1952 - A probable piggery has been built along the access road.

1963 - An extraction operation now covers much of the site.

1970 - Extraction operations have ceased. The site appears to be used as a landfill. Piles of probable waste material have been deposited at two locations on the site. Dark-toned material has been graded across the surface of an area west of the probable waste material. An access road from New Boston Road leads onto the site from the east.

1971 - Landfill operations appear to have continued on the site. The landfill has expanded in both horizontal and vertical extent. Probable waste material is piled at three locations on the landfill.

1975 - Landfill operations have continued. The landfill has expanded in both horizontal and vertical extent. Mounds of material located in the southern section of the landfill are probable fill material to be used for landfill covering operations.

1978 - Landfilling operations have continued. The landfill has expanded in both horizontal and vertical extent. A new access road leads on to the landfill from the south. Mounded material at the terminus of the access road in probable fill material to be used for landfill covering operations.

1980 - Landfilling operations have continued. The landfill has expanded in both horizontal and vertical extent. An active fill face is noted in the center of the site. A bulldozer (not annotated) is operating in this area.

1985 - Landfilling operations have continued. The landfill has expanded in both horizontal and vertical extent. A possible bulldozer (not annotated) is located in the center of the site.

1995 - Landfilling operations have continued. The landfill has expanded in both horizontal and vertical extent. Two areas containing mounds of material located in the southern section of the landfill are probable fill material used for capping the landfill. A depression containing standing liquid (not annotated) has been created in the center area on the landfill.

AREA C- Sites southwest of the Industri-plex site

Site C1: North Woburn Industrial Park

1938 - The chief land cover and land use on and around the site are agricultural fields and a piggery.

1952 - An extraction operation has begun to operate in the area.

1963 - No significant change on the site.

1970 - A warehouse-type building, part of a new industrial park, has been built on the site. The extraction operation and the piggery are no longer in place.

1971 - No significant change is noted on the site.

1975 - No significant change is noted on the site.

1978 - No significant change is noted on the site.

1980 - No significant change is noted on the site.

1985 - No significant change is noted on the site.

1995 - No significant change is noted on the site.

Site C2: Globe Ticket Company

1938 - The chief land cover and land use on and around the site is an extraction operation.

1952 - The surface of much of the extraction operation has begun to revegetate, indicating inactivity.

1963 - The extraction operation associated with Site C1 has been expanded northward onto the site. No other significant change is noted on the site.

1970 - A new road is being constructed along the east side of the site. No other significant change is noted on the site.

1971 - The site has been partially filled and leveled. A building is being constructed on the site.

1975 - The building under construction in 1971 has been completed. The ground surface surrounding the building has been completely filled and leveled.

1978 - No significant change is noted on the site.

1980 - No significant change is noted on the site.

1985 - No significant change is noted on the site.

1995 - No significant change is noted on the site.

Site C3: 3-C Company

1938 - The chief land cover and land use on and around the site are an extraction operation and a piggery.

1952 - The surface of much of the extraction operation has begun to revegetate, indicating inactivity. The piggery is still in operation.

1963 - The piggery is no longer in operation. An access road leads east from New Boston Road across the site and ends on a large mound of material. Possible solid waste material has been placed atop the mounded material.

1970 - A new road is under construction along the west side of the site. The surface of the site has revegetated. There is no evidence of waste disposal on the site.

1971 - No significant change is noted on the site.

1975 - A new building has been built on the site. The ground surface surrounding the building has been filled and leveled.

1978 - No significant change is noted on the site.

1980 - No significant change is noted on the site.

1985 - No significant change is noted on the site.

1995 - No significant change is noted on the site.

Site C4: Ace Disposal Service

1938 - The chief land cover and land use on and around the site are open fields and woodlands. A ground scar is also noted nearby.

1952 - No significant change is noted on the site.

1963 - No significant change is noted on the site.

1970 - No significant change is noted on the site.

1971 - A new building has been built adjacent to the south side of the ground scar.

1975 - The building is surrounded by a parking lot (not annotated) containing vehicles and empty dumpsters (not annotated).

1978 - No significant change is noted on the site.

1980 - Vehicles, including garbage trucks (neither are annotated), are parked around the main facility building in the southern section of the site. Empty waste disposal bins are stored around the building in the northern section of the site. The ground surface in this area is hummocky. Light-toned possible waste material is noted in an excavation depression. Three filled dumpsters are located nearby.

1985 - The surface of the site north of the main facility building, characterized as hummocky in 1980, has been leveled. The excavation depression noted in 1980 has been filled in. Vehicles and probable waste disposal bins (not annotated) are on the site.

1995 - The parking lot surrounding the main facility building is empty. Probable waste dumpsters are stored northeast of the main facility building.

Site C5: Atlantic Plywood

1938 - The chief land cover and land use on and around the site are an extraction operation and a piggery.

1952 - The surface of much of the extraction operation has begun to revegetate, indicating inactivity.

1963 - The site appears to be used for waste disposal. A large mound of material has been placed in the center of the inactive extraction area. Probable waste material is noted atop the mound and scattered across the surface of the remainder of the site (not annotated).

1970 - There is no evidence of waste disposal activity on the site. A new road is under construction along the west side of the site.

1971 - A small pile of possible waste material and an extraction operation are noted on the site.

1975 - Heavy machinery is visible leveling future building sites.

1978 - Four new buildings have been built on the site.

1980 - Four new buildings have been built on the site.

1985 - No significant change is noted on the site.

1995 - No significant change is noted on the site.

Site C6: (Keramas) Property

1938 - The chief land cover and land use on and around the site are an extraction operation and a piggery.

1952 - The surface of much of the extraction operation has begun to revegetate, indicating inactivity. The piggery in still in operation.

1963 - The piggery is no longer in operation.

1970 - A new road is being constructed along the east side of the site. A new building is being constructed in an area of the site that has been filled and leveled.

1971 - The building, under construction in 1970, has been completed.

1975 - Mounded material, probably fill material, has been placed in a depression southwest of the building.

1978 - No significant change is noted on the site.

1980 - The depression southwest of the building has been filled in. Mounded material, probably fill material, is in this area.

1985 - Two new buildings have been built on the fill area.

1995 - No significant change is noted on the site.

AREA D - Sites southeast of the Industri-plex site

<u>Site D1: Marshall's</u>

1938 - The site is wooded.

1952 - An extraction operation is operating south of the site.

1963 - An extraction operation is now on the site.

1970 - The surface of the extraction operation has partially revegetated (not annotated), indicating lack of activity.

1971 - No significant change is noted on the site.

1975 - The surface of the site has been leveled. A new building has been constructed on the site. Construction activity (not annotated) is visible in the area adjacent to the new building.

1978 - There are now 4 buildings on the site. A vertical tank is noted adjacent to one of the buildings.

1980 - No significant change is noted on the site.

1985 - No significant change is noted on the site.

1995 - No significant change is noted on the site.

Site D2: Chomerics

1938 - The land cover and land use on and around the site are woodlands and agricultural fields.

1952 - An extraction operation is operating west of the site.

1963 - An extraction operation is now on the site. Three areas that have had possible waste materials deposited on them are noted.

1970 - The possible waste materials are no longer visible on the site. Three new buildings have been built on a section of the site that has not be disturbed by the extraction operations.

1971 - Extraction operations adjacent to the site have ceased. No other significant change is noted on the site.

1975 - The extraction operations adjacent to the site are once again underway. No significant change is noted on the site.

1978 - Extraction operations adjacent to the site have ceased. Phillip's Pond is now adjacent to the site.

1980 - No significant change is noted on the site.

1985 - Building construction is noted adjacent to Interstate 93.

1995 - A new building has been built on the site.

AREA E - Sites south of the Industri-plex site

Site E1: Industrial Property

1938 - The site is comprised of a wooded area near Mishawum Lake and part of Mishawum Lake.

1952 - The extraction operation at Site E2 has been expanded towards the site.

1963 - No significant change is noted on the site.

1970 - No significant change is noted on the site.

1971 - Mishawum Lake is no longer in place. No significant change is noted on the site.

1975 - Although the site is relatively unchanged, the area around it has been leveled in preparation for future construction.

1978 - Building construction has continued around the site. There is, however, no significant change noted on the site.

1980 - There is no significant change is noted on the site.

1985 - A new building has been built on the site.

1995 - There is no significant change is noted on the site.

Site E2: Woburn Mall, Wetlands Area

1938 - An extraction area is located in this area.

1952 - The extraction operation has expanded northward.

1963 - The extraction operation continues to expand.

1970 - The extraction operations continue on the site.

1971 - No significant change is noted on the site.

1975 - Extraction operations have ceased. The surface of the site has been leveled in preparation for future construction.

1978 - A shopping mall (not annotated) has been built on the site.

1980 - No significant change is noted on the site.

1985 - No significant change is noted on the site.

1995 - No significant change is noted on the site.

AREA F - Sites outside the vicinity of the Industri-plex site

<u>Site F1: MBTA Property</u>

1938 - An extraction area is noted south of Mishawum Road.

1952 - The extraction area is inactive and has begun to revegetate. An access road leads south from Mishawum Road onto a two-tiered fill area. Probable waste has been deposited along the face of the fill area.

1963 - The fill area has been expanded and leveled. A facility comprised of two buildings and an open storage area has built atop the fill area. The open storage area contains cases and crates (not annotated).

1970 - No significant change is noted on the site.

1971 - No significant change is noted on the site.

1975 - Possible waste material has been placed on the east side of the site. No other significant change is noted on the site.

1978 - The site is no longer being used for open storage. An access road leads from the northeast corner of the former open storage area to a mound of material.

1980 - The site has been almost completely cleared. All buildings except for a residential-style building (not annotated) along Mishawum Road have been removed from the site. A commuter parking lot is on the site.

1985 - No significant change is noted on the site.

1995 - No significant change is noted on the site.

Site F2: Commercial Property

1938 - An extraction area is noted south of Mishawum Road.

1952 - The extraction area is inactive and has begun to revegetate.

1963 - A commercial building has been built on the site. West of the building, a building foundation and probable demolition debris are noted. Small mounds of fine-grained light- and dark-toned material have been placed east of the building.

1970 - West of the commercial building two other commercial buildings have been built. The area to the east has revegetated (not annotated).

1971 - An open storage area containing a crane, mounds of fine-textured material, and possible transportable open storage bins (not annotated) is on the site. In the center of the open storage area is a mound of possible waste material.

1975 - No significant change is noted on the site.

1978 - No significant change is noted on the site.

1980 - No significant change is noted on the site.

1985 - No significant change is noted on the site.

1995 - The building on site since 1963 has been replaced with a new building.

Site F3: Mobile Station

1938 - No significant activity is noted on the site.

1952 - A gasoline service station is noted north of West Street

1963 - No significant change is noted on the site.

1970 - No significant change is noted on the site.

1971 - No significant change is noted on the site.

1975 - A probable automotive repair building has been built north of the gasoline station. No other significant change is noted on the site.

1978 - No significant change is noted on the site.

1980 - The probable automotive repair building has been removed.

1995 - No significant change is noted on the site.

Additional Sites Identified Through Photographic Analysis:

Site 1: Automotive Junkyard (located north of Mishawum Road):

1938 - The site is wooded.

1952 - A automotive junkyard is noted north of Mishawum Road.

1963 - The automotive junkyard has been expanded.

1970 - No significant change is noted on the site.

1971 - The inventory of junked vehicles has significantly decreased. Vehicles on the site have been paced into neat rows, the site appears to be used for vehicle storage.

1975 - No significant change is noted on the site.

1978 - The inventory of vehicles on the site has increased.

1980 - No significant change is noted on the site.

1985 - No significant change is noted on the site.

1995 - The automotive junkyard/vehicle storage has been removed and a motel has been built on the site.

Site 2: Open Storage Area/Automotive Junkyard (located east of Route 38):

1938 - The land cover and land use on and around the site are woodlands.

1952 - A piggery has been established near the site. No significant change on the site.

1963 - A probable automotive junkyard and a storage area, containing probable trailers, and probable cases and crates, are on the site.

1970 - An automotive junkyard covers the site.

1971 - No significant change is noted on the site.

1975 - No significant change is noted on the site.

1978 - No significant change is noted on the site.

1980 - The site is used as automotive junkyard and for vehicle storage. Mounded material, probable fill material, has been placed on the east edge of the site.

1985 - The site is used for as automotive junkyard and for vehicle storage. Trailers (not annotated) are parked in the area that had contained mounded material in 1980.

1995 - No significant change is noted on the site.

WETLANDS AND DRAINAGE ANALYSIS
INDUSTRI-PLEX SITE AND STUDY AREA

Wetland Analysis

The most general type of wetland analysis involves differentiating wetland and nonwetland areas. An analyst utilizes aerial photographs, soil surveys, hydric soils data, National Wetland Survey maps, and other available data to identify wetland boundaries and drainage networks within a study area. In this analysis, wetlands were delineated on the photographs from 1938 and 1995. The Wetlands Change Overlay on the 1995 enlargement presents the change (gain and loss) of wetlands from 1938 to 1995.

Most losses of wetland habitat occurred in the Industri-plex facility area and portions of the study area that have been highly developed. Gains in wetland habitat were primarily observed in those areas where hydrologic modification, resulting from study area development, took place.

Surface Drainage

A Surface Drainage and Ponded Liquid Overlay was produced for each enlargement from 1938 to 1995. For each successive year after 1938, new drainageways are depicted with dotted lines as contrasted with dashed lines of previously existing drainageways. Ponded liquids were also identified and mapped. Modifications in these features were caused by progressive development within the study area and natural fluctuations in ponded liquid levels due to seasonal changes.

From 1938 through 1952 (Figures 13 and 14) few changes were noted in surface drainage patterns within the study area. By 1963 (Figure 15) drainage of the North and South Branches of the Aberjona River was altered somewhat due to construction of U.S. Interstate 93. By 1970 (Figure 16) other drainage patterns were altered in the northern, southern, and western

portions of the study area due to construction of new buildings. In 1975 (Figure 19) development continued in the study area, particularly south of the Industri-plex site. The remaining portions of Lake Mishawum were converted into the Hall's Brook Holding Area (HBHA) that receives drainage from the entire study area. By 1978 (Figure 21) new surface drainageways were noted (1) between the impoundment south of the Industri-Plex site and the HBHA and (2) east of the large landfill area in the northwest portion of the study area. The Atlantic Avenue Drainageway (AAD), which flows from South Pond to the HBHA, was constructed by 1995 (Figure 26). One other new drainageway visible in 1995 flows into Phillip's Pond from a wetland to the north.

GLOSSARY

Access Road - A paved or unpaved route of vehicular access.

Auto Junkyard - A yard for the collection, storage, and resale of junked vehicles and parts of vehicles.

Channelized Drainage - A man-made or altered drainage route.

Cleared Area (CA) - An area from which man has removed trees, shrubs, or other natural vegetative cover.

Dark-, Medium-, or Light-Toned - Tones of features in question are compared with the darkest and lightest tones of gray (if using B&W photography) on the print.

Disturbed Ground (DG) - A rough area where the ground surface has been dug up or overturned.

Drums (DR) - Metal cylinders used for the storage, transportation, or disposal of materials.

Face - The wall or slope of a mine, extraction, excavation, landfill, or fill area at which work is progressing (e.g., working face, fill face).

Fill (FL) - Earth, stones, or other material that is used to build up the level of an area of ground.

Graded Area - An area where the surface of the ground has been leveled or altered by a vehicle pulling or pushing a wide blade.

Impoundment (IM) - A liquid containment area that appears to be related to activity on a site but does not appear to be used for waste storage, disposal and/or treatment.

Mounded Material (MM) - Piles of raw or waste materials on or in the vicinity of the site.

Open Storage Area - An area of open-air (outdoor) storage of containerized, raw or waste materials, within industrial or manufacturing sites.

Outfall (OF) - The place where an effluent is discharged into the environment.

Pond - A small body of liquid, natural or man-made (e.g., farm pond), that does not appear to be directly related to disposal or treatment activity on the site.

Solid Waste (SW) - Any garbage, refuse, or sludge from a waste treatment, water supply treatment plant, or air pollution control facility, and other discarded material, including solid or semi-solid material resulting from industrial, commercial, mining, and agricultural operations, and from community activities; does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges.

Stain (ST) - A residue or discoloration resulting from a spill, discharge, or removed/dispersed materials.

Standing Liquid (SL) - A small, shallow, temporary collection of liquid, not necessarily waste. Not to include liquid contained in impoundments, trenches, pits, etc.

Tanks - Vertical tanks (VT), horizontal tanks (HT), pressure tanks (PT), tank farms, and solid waste management units. A large receptacle, container, or structure for holding liquid or gas.

REFERENCES

MAPS

Source[a]	Figure	Name	Scale	Date
USGS	1	United States	1:2,500,000	1972
USGS	2	Boston North, MA	1:25,000	1985
USGS	2	Reading, MA	1:25,000	1985

COLLATERAL INFORMATION

EPA. 1998. Background information provided by Region 1 Remote Sensing Request Form and site maps.

LESAT (Lockheed Environmental Systems & Technologies Co.). 1998. Master Quality Assurance Project Plan. Prepared for EPA Environmental Sciences Division. Contract 68-C5-0065. Las Vegas, Nevada.

HNUSC (Halliburton NUS Corporation). 1997. Preliminary Multiple Source Groundwater Response Plan Report, Industri-Plex Site, Woburn, Massachusetts. EPA Work Assignment No. 11-1L07.

AERIAL PHOTOGRAPHS

Photo source[a]	Figure	Date of acquisition	Original scale	Film type[b]	Mission I.D.	Source frame #
USGS	3,13	12-16-38	1:24,000	B&W	GSF9	205
ASCS	4,14	10-12-52	1:12,000	B&W	DPQ13K	99,100
USGS	5,15	04-29-63	1:24,000	B&W	GSVAQ2	78
ASCS	6,16	10-29-70	1:38,000	B&W	DPQ-5LL	64
ASCS	7,17,18	07-03-71	1:20,000	B&W	DPQ-3MM	125,126,176,177
AIRMAP	8,19,20	02-28-75	1:16,000	CC	723115	3-1,3-3
USGS	9,21	04-23-78	1:24,000	B&W	GS-SWJS	1-105
EPA	10,22-24	11-06-80	1:9,000	CC	80-099	3038-3040, 3058-3060
UMASS	11,25	07-24-85	1:24,000	CIR	4390	1745,1746
USGS	12,26	03-29-95	1:40,000	B&W	8358	2

[a]AIRMAP Airmap America, Braintree, Massachusetts
ASCS U.S. Department of Agriculture, Agricultural Stabilization and Conservation Service, Salt Lake City, Utah
EPA U.S. Environmental Protection Agency, Environmental Sciences Division, Las Vegas, Nevada
UMASS University of Massachusetts, Amherst, Massachusetts
USGS U.S. Department of Interior, U.S. Geologic Survey, Washington, D.C.
[b]B&W Black-and-white
CIR Color Infrared
CC Conventional Color