Raymark 3.6 #11501

RI990246DF

DRAFT FINAL
AREA II
REMEDIAL INVESTIGATION

VOLUME I OF II
TEXT, TABLES, AND FIGURES

RAYMARK-FERRY CREEK-OPERABLE UNIT 3
STRATFORD, CONNECTICUT

RESPONSE ACTION CONTRACT (RAC), REGION I

For
U.S. Environmental Protection Agency

By
Tetra Tech NUS, Inc.

EPA Contract No. 68-W6-0045
EPA Work Assignment No. 002-RICO-01H3
TtNUS Project No. N7491

November 2000

TETRA TECH NUS, INC.

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ACRONYMS AND ABBREVIATIONS USED IN THE REMEDIAL INVESTIGATION REPORT

ABS	Absorption Factor
ARARs	Applicable or Relevant and Appropriate Requirements
ARCS	Alternative Remedial Contracting Strategy
AST	aboveground storage tank
ATSDR	Agency for Toxic Substances and Disease Registry
AVS/SEM	acid volatile sulfide/simultaneously extractable metals
AWQC	Ambient Water Quality Criteria
bgs	below ground surface
B&RE	Brown & Root Environmental
°C	degree Celsius
CDM	Camp Dresser and McKee
CERCLA	The Comprehensive Environmental Response, Compensation, and Liability Act of 1980. Amended by SARA in 1986. Also called the Superfund Law.
cc	cubic centimeter
cf	cubic foot
cfm	cubic foot per minute
cfs	cubic foot per second
CFR	Code of Federal Regulations
CLP	(EPA) Contract Laboratory Program
cm	centimeter
cm/sec	centimeter per second
COC	Contaminant of Concern
COPC	Contaminant of Potential Concern
CPF	Carcinogenic Potency Factor
CSF	Carcinogenic Slope Factor
CSI	Comprehensive Site Investigation
CT-AWQ	Connecticut Ambient Water Quality Criteria
CT DEC	Connecticut Direct Exposure Criteria
CT DEP	Connecticut Department of Environmental Protection
CT DHS	Connecticut Department of Health Services
CT DOH	Connecticut Department of Health
CT DOT	Connecticut Department of Transportation
CT DPHAS	Connecticut Department of Public Health and Addiction Services
CTE	Central Tendency Exposure
CT PMC	Connecticut Pollutant Mobility Criteria
CWA	Clean Water Act
CY	cubic yard
DAS	Direct Analytical Services
DDT	Dichloro diphenyl trichloroethane
dia	diameter
DNAPL	dense non-aqueous phase liquid
EE/CA	Engineering Evaluation/Cost Analysis
ELI	Environmental Laboratories, Inc.
EM	Electromagnetic
EPA	U.S. Environmental Protection Agency

ERA	ecological risk assessment
ERL	effects range low
ESI	Expanded Site Inspection
°F	degree Fahrenheit
FEMA	Federal Emergency Management Agency
FID	flame ionization detector
Foster Wheeler	Foster Wheeler Environmental Corporation
FS	Feasibility Study
ft	foot
ft^2/day	square foot per day
ft^3/day	cubic foot per day
g	gram
g/day	grams per day
GA/GAA	State of Connecticut classification for drinking water sources
gal	gallon
GB	State of Connecticut classification for non-drinking water sources
gpd	gallon per day
gpm	gallon per minute
GPR	Ground Penetrating Radar
GPS	Global Positioning System
HBC	Housatonic Boat Club
HEAST	EPA's Health Effects Assessment Summary Tables
HI	Hazard Index
HNUS	Halliburton NUS Corporation
hr	hour
HQ	Hazard Quotient
i	hydraulic index
ID	inner diameter
IEUBK	EPA's Integrated Exposure Uptake and Biokinetic Model for lead exposure
ILCR	Incremental Lifetime Cancer Risk
in.	inch
IDW	Investigation-Derived Waste
IRIS	EPA's Integrated Risk Information System Database
K	Hydraulic conductivity
K_d	Adsorption coefficient
kg	kilogram
kg/day	kilogram per day
K_{oc}	Adsorption partitioning coefficient
K_{ow}	Octanol-water partitioning coefficient
l	liter
lb	pound
LDR	land disposal restriction
LOAEL	Lowest Observed Adverse Effect Level
m	meter
µ	micro (prefix)
µg/dL	micrograms per deciliter
µg/kg	microgram per kilogram

µg/l or µg/L	microgram per liter
MATC	maximum allowable tissue concentrations
MCL	Federal Safe Drinking Water Act maximum contaminant level. The primary MCL is health-based; the secondary is aesthetic-based.
MCLG	Federal Safe Drinking Water Act maximum contaminant level goal.
MEP	Multiple Extraction Procedure
MFL	million fibers per liter
mg	milligram
mg/cm^2	milligrams per square centimeter
mg/kg	milligram per kilogram
mg/l or mg/L	milligram per liter
mi	mile
ml	milliliter
mph	miles per hour
MSL	mean sea level
NAPL	non-aqueous phase liquid
NCP	National Oil and Hazardous Substances Contingency Plan
NESHAP	National Emission Standards for Hazardous Air Pollutants
NGVD	National Geodetic Vertical Datum
NOAA	National Oceanic Atmospheric Administration
NOAEL	No Observed Adverse Effect Level
NPDES	National Pollutant Discharge Elimination System
NTCRA	Non-Time Critical Removal Action
OSHA	Occupational Safety and Health Administration
OSWER	(EPA's) Office of Solid Waste and Emergency Response
OU2	Operable Unit No. 2
OU3	Operable Unit No. 3
PAH	polynuclear aromatic hydrocarbon
PCA	principal components analysis
PCB	polychlorinated biphenyl
PCDD	Polychlorinated dibenzo dioxins
PCDF	Polychlorinated dibenzo furans
PCE	Tetrachloroethene
pH	hydrogen-ion concentration
PID	photoionization detector
ppb	part per billion
ppm	part per million
ppt	part per thousand
PRG	Preliminary Remediation Goal
PRP	Potentially Responsible Party
psi	pound per square inch
QA/QC	Quality Control/Quality Assurance
RAO	Remedial Action Objective
Raymark Facility	Raymark Industries, Inc. Facility
RBC	Risk Based Concentration
RRCs	EPA Region III Risk-based Calculation
RCP	reinforced concrete pipe
RCRA	Resource Conservation and Recovery Act

Removal Action	Action taken by EPA to address immediate danger to public health and the environment
RfC	Reference Concentration
RfD	Reference Dose
RFI	RCRA Facility Investigation
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RME	Reasonable Maximum Exposure
ROD	(EPA's) Record of Decision. Documents the selection of a cost-effective Superfund remedy.
RSRs	State of Connecticut Remediation Standard Regulations
SAIC	Science Applications International Corporation
SARA	Superfund Amendments and Reauthorization Act of 1986. Amended CERCLA. Also known as the Superfund law.
SB/SC	State of Connecticut Classification for Coastal and Marine Surface Water
SCT	Salinity-Conductivity-Temperature
SCV	Secondary Chronic Values
SDWA	Safe Drinking Water Act
SPLP	Synthetic Precipitation Leaching Procedure
SPT	Standard Penetration Testing
sq ft	square foot
sq in.	square inch
sq yd	square yard
SSL	EPA's generic soil screening levels
SVOC	Semivolatile Organic Compound
TAL	(CLP) Target Analyte List for Inorganics
TAT	Technical Assistance Team
TBC	To Be Considered
TC	Toxicity Characteristic
TCB	Trichlorobiphenyl
TCDD	2,3,7,8 – tetrachlorodibenzo-p-dioxin
TCE	Trichloroethene
TCL	(CLP) Target Compound List for Organics
TCLP	Toxicity Characteristic Leaching Procedure
TEF	Toxicity Equivalence Factor
TEL	threshold effect level
TEQ	Toxicity Equivalency
TERC	Total Environmental Restoration Contract
TOC	Total Organic Carbon
TOX	Total Organic Halides
TPH	Total Petroleum Hydrocarbons
TPY	ton per year
TRV	Toxicity Reference Value
TRW	Technical Review Workgroup
TSCA	Toxic Substances Control Act
TSD	(RCRA) Treatment, Storage, and Disposal
TtNUS	Tetra Tech NUS, Inc.
UCL	Upper Confidence Limit

USACE	U.S. Army Corps of Engineers
USCS	Unified Soils Classification System
USDOI	U.S. Department of the Interior
USGS	U.S. Geological Survey
UST	underground storage tank
VOC	Volatile Organic Compound
VSP	Vertical Sampling Program
Weston	Roy F. Weston, Inc.
WQC	State of Connecticut water quality criteria
WQS	State of Connecticut water quality standards
XRF	x-ray fluorescence
1,1-DCA	1,1-Dichloroethane
1,1,1-TCA	1,1,1-Trichloroethane
1,2-DCE	1,2-Dichloroethene
1,1-DCE	1,1-Dichloroethene
2,4-D	2,4-dichlorophenoxyacetic acid

1.0 INTRODUCTION

This source control Remedial Investigation (RI) Report defines the nature and extent of soil and sediment contamination within Area II resulting from past disposal practices at the Raymark Industries, Inc. Facility (Raymark Facility), located in Stratford, Connecticut (Figure 1-1). This report was prepared by Tetra Tech NUS, Inc. (TtNUS), for the U.S. Environmental Protection Agency (EPA) under RAC Work Assignment No. 002-RICO-01H3, Contract No. 68-W6-0045, to partially fulfill the requirements for Operable Unit No. 3 (OU3), Raymark - Ferry Creek. A Draft RI was developed in June 1998 for eight areas affected by Raymark soil-waste. However, when EPA determined additional information was needed for some of these areas, a decision was made to separate the areas into three source control investigations, Area I, Area II, and Area III. Each of these 3 areas are comprised of sub-areas as described below. Groundwater investigations are not included as groundwater contamination beneath and downgradient of the former Raymark Facility is being investigated by TtNUS under Raymark – a different Operable Unit (OU2). However, the OU2 investigation only includes the northern section of Area II.

Area I, the northernmost portion of OU3, is comprised of Areas A-1, A-2, and A-3. It is located just south of Interstate 95 and is bounded to the south by Broad Street. Area II, the focus of this report is comprised of Areas B, C, and F. Its northern boundary is Broad Street, and it primarily includes wetlands and open water around lower Ferry Creek and its confluence with the Housatonic River (Area B), the wetlands south of the Housatonic Boat Club (Area C), and Selby Pond (Area F). Area III, the southernmost portion of OU3, includes Areas D and E. Area D is the area surrounding the Beacon Point boat launch area and Area E is the wetland area along Elm Street just west of Area D. Refer to Figure 1-2 for the locations of each Area.

The soils of the Housatonic Boat Club have been evaluated in an Engineering Evaluation/ Cost Analysis (EE/CA) (TtNUS 1999a), developed to support selection of a non-time critical removal action for that area. The Housatonic Boat Club is not included as part of Area C.

As requested by EPA, this report incorporates information collected for OU3 from 1997 to 1999, with data previously compiled in the *Final Technical Memorandum, Compilation of Existing Data, Raymark - Ferry Creek* (B&RE, February 1997) under this work assignment and

the *Draft Phase III Technical Memorandum, Remedial Investigation, Selby Pond* (HNUS, 1997a) under ARCS Work Assignment No. 42-1LH3, Contract No. 68-W8-0117. This RI Report was developed based on the approved Work Plan and Work Plan Amendments.

This Area II RI Report was prepared in accordance with the *Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA, 1988). It is consistent with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986; and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This Area II RI is consistent with the State of Connecticut's applicable and relevant environmental laws and regulations.

Soils and sediments as discussed in this RI report for Areas B, C, and F have been defined as follows. Soils are defined as solid matrix samples collected from relatively dry areas located outside designated wetland boundaries and not associated with creeks, creek beds, or the Housatonic River. Wetland soils are defined as solid matrix samples collected from within designated wetland boundaries. Sediments are defined as solid matrix samples collected from creeks, creek beds, or the Housatonic River.

1.1 Purpose of Report

This Area II RI Report documents the nature and extent of contamination, and associated public health and environmental risks within Ferry Creek, other ecological areas, and adjacent properties associated with the Raymark Facility. (Figure 1-2 identifies the study area.) The overall objectives of this RI are to:

- Compile and evaluate all available data needed to characterize the Area II conditions and to determine the nature and extent of contamination in the surface water, sediment, soil, and biota within Area II,

- Assess the risks to human health and the environment within Area II,

- Serve as the data resource for developing, screening, and evaluating a range of potential alternative remedial actions that will address the contamination within Area II, and support the Feasibility Study.

1.2 Report Organization

This RI Report comprises two volumes. Volume I presents the text and discussion of investigation activities, results, interpretations, and references. Volume I also includes the tables and figures referenced in the text. Volume II presents the appendices. Appendix A contains the boring logs and sediment sample log sheets from the TtNUS sampling efforts; Appendix B contains a disk, which contains all the analytical data used to produce this RI report; Appendix C is the Hydraulic Assessment prepared by the U.S. Army Corps of Engineers (USACE); Appendix D contains the backup tables and calculations for the ecological risk evaluation, the Ecological Risk Assessment prepared by the National Oceanic and Atmospheric Administration (NOAA), and the Ecological Risk Assessment supplements prepared by Science Applications International Corporation (SAIC). Appendix E contains the supplemental Evaluation of Contaminant Fate and Transport; and Appendix F is the backup tables and calculations for the Human Health Risk Assessment.

This RI Report is organized as follows:

- Section 1.0, Introduction, discusses the purpose and scope of the RI, summarizes the background and history of the Raymark Facility, and describes the Area II study area.

- Section 2.0, Study Area Investigations, presents a summary of the field investigation activities conducted both within and outside Area II.

- Section 3.0, Physical Characteristics of the Study Area, presents descriptions of surface features and land uses, geology, hydrogeology, surface water hydrology, and meteorology.

- Section 4.0, Nature and Extent of Contamination, discusses the potential sources, contaminant presence, and contaminant distribution within the biota, the soils, surface water, and sediment in Area II.

- Section 5.0, Contaminant Fate and Transport, presents an interpretation of potential contaminant migration pathways and transport mechanisms.

- Section 6.0, Baseline Human Health Risk Evaluation, includes identification of human receptors and exposure pathways, selection of contaminants of concern (COCs), and a discussion of the human health effects associated with the COCs. The results of the evaluation are used to characterize human health risk.

- Section 7.0, Ecological Evaluation, presents a summary of the environmental setting and identifies areas of potential ecological concern. The results are used to characterize ecological risk.

- Section 8.0, Summary and Conclusions, summarizes the nature and extent of contamination, the fate and transport of contaminates, and the risks to human health and the environment associated with Area II.

1.3 Study Area Background

This section summarizes the history of the Raymark Facility, describes the study area, and identifies other activities associated with the Raymark Facility. Refer to *the OU1 Final Remedial Investigation Report* (HNUS, 1995) for further details on Facility operating history, environmental activities, permits, and compliance history.

1.3.1 History of the Raymark Facility

The Raymark Facility, formerly named Raybestos - Manhattan Company, was located at 75 East Main Street in Stratford, Fairfield County, Connecticut at latitude 41°12′02.5″N and longitude 73°07′14.0″W (see Figure 1-1). The Raymark Facility operated from 1919 until 1989, when the plant was shut down and permanently closed. The facility was demolished

and a cap was placed over the contaminated areas on the property in 1996 and 1997. Based on Stratford tax map information, the facility occupied 33.4 acres and manufactured friction materials containing asbestos and non-asbestos components, metals, phenol-formaldehyde resins, and various adhesives. Primary products were gasket material, sheet packing, and friction materials including clutch facings, transmission plates, and brake linings. As a result of these activities, soils at the facility became contaminated primarily with asbestos, lead, and polychlorinated biphenyl compounds (PCBs).

Between 1919 and 1984, low-lying portions of the Raymark Facility were filled with manufacturing waste materials from various plant operations. The filling of those areas occurred over the life of the facility operations, and progressed essentially from north to south, across the Raymark Facility. New buildings and parking areas were constructed over these filled areas as the manufacturing facility expanded.

The Raymark Facility was underlain by an extensive drainage system network. This network collected water and wastes from the manufacturing operations and diverted it into the facility drainage system. The system also collected stormwater runoff. These liquids were transported through the drainage system network, mixed with lagoon wastewaters, and discharged to Ferry Creek.

During peak operations at the Raymark Facility, approximately 2 million gallons of water were used for plant processes each day. Municipal water was used for both contact and non-contact cooling water. To supplement this source, Raymark installed an additional on-site supply well. The well, located in the northeastern corner of the facility, was used for non-contact cooling water. Facility water was recirculated, with some percentage reinjected into the on-site well; the remaining water and municipal water were discharged through the facility drainage system. Wastewater from facility operations was collected and discharged to a series of four settling lagoons located in the southwestern corner of the facility, and along the southern property boundary near Longbrook Avenue and the Barnum Avenue Cutoff. The wastewater consisted of wastewater from the acid treatment plant, wet dust collection, paper making processes, non-contact cooling water, and wastewater from solvent recovery plant operations. The lagoons also received stormwater drainage and surface water runoff.

Solids were allowed to settle in Lagoon Nos. 1, 2, and 3 prior to discharge of clarified wastewater and unsettled solids to Lagoon No. 4, that in turn discharged directly into Ferry Creek. Discharge of wastewater to Lagoon Nos. 1, 2, and 3 ceased in 1984. These lagoons were closed in December 1992 and January 1993. After 1984 only stormwater drainage was discharged from the facility (through Lagoon No. 4). During the fall of 1994, stormwater drainage that exited the Raymark Facility through Lagoon No. 4 was diverted around this lagoon and connected directly to the storm sewer, which ultimately discharges to Ferry Creek. Lagoon No. 4 was closed in early 1995.

During the operation of the lagoons, the settled material in the lagoons was periodically removed by dredging. During the facility's 70 years of operation, it was common practice to dispose of both this dredged lagoon waste and other manufacturing waste as "fill" material (referred to as "Raymark soil-waste/fill" in this RI) both at the Raymark Facility and at various locations in Stratford. Several of these locations that received Raymark soil-waste/fill are included within Area II (Figure 1-2).

A number of the off-the-facility "locations" where Raymark soil-waste/fill was disposed, were contaminated with asbestos, lead, and polychlorinated biphenyls (PCBs) at levels that posed a threat to public health. To abate the potential health threat to residential properties, residential properties were remediated under EPA CERCLA time-critical removal actions during 1993 to 1996. The excavated material from these residential locations was stored and ultimately placed under the cap at the Raymark Facility. Waste from one municipal property, Wooster Middle School, was also excavated, stored, and ultimately placed under the cap at the Raymark Facility.

1.3.2 Study Area Description and Setting

The Area II study area includes lower Ferry Creek and adjacent wetland properties (Area B), the wetlands surrounding the Housatonic Boat Club property (Area C), and Selby Pond and the surrounding wetlands (Area F). Originally, the OU3 area was defined as the commercial properties (Morgan Francis, Spada, and the Housatonic Boat Club) where Raymark soil-waste/fill was known to have been deposited. Based on analytical results of surface water and

sediment sampling (Figure 1-2), the OU3 area was expanded to include Ferry Creek, Selby Pond, and surrounding wetlands.

Ferry Creek is located approximately 500 feet west of and parallel to the Housatonic River. It flows south under the Interstate 95 overpass, through the Morgan Francis Property, under East Broadway Street and Ferry Boulevard, through the Spada Property, to the non-functioning flood control barrier (spring-loaded sluice gate system that is stuck partially open by debris) at Broad Street, and discharges into the Housatonic River. The OU3 Area II also includes "other ecological areas impacted by Raymark soil-waste", which are defined by the delineated wetland boundaries along Ferry Creek; the delineated wetland boundaries along the Housatonic River, the Housatonic Boat Club and Beacon Point Road (north and south of the boat launch); the wetland located adjacent to and south of 1260 Elm Street, Lot K; and the Selby Pond Site located south of the intersection of Stratford Avenue and Lockwood Avenue. Wetlands have been delineated throughout OU3.

Because more information was needed on certain areas of these parcels, EPA decided to separate the OU3 areas into three study areas. This RI contains information on Area II, which includes Areas B, C, and F. These locations are downgradient of the former Raymark Facility and may have been affected by wastewater discharge, stormwater drainage, surface water runoff, Raymark soil-waste/fill direct deposition, and groundwater contaminant migration. The name designations used for locations and properties in this report are those that have become convention for the study area, as established by EPA. Area II is comprised of the following properties:

- **Area B (Lower Ferry Creek)** is located approximately 50 feet south of Area A-2. It is bounded by Broad Street to the north, the Housatonic River to the east, Ferry Boulevard and Lockwood Avenue to the west, residential properties along Stratford Avenue to the southwest, and a public boat launch area at the end of Stratford Avenue to the south. It includes undeveloped wetlands, Ferry Creek, and a small portion of the Housatonic River. Area B covers approximately 18 acres, including approximately 3.2 acres of wetlands, of which approximately 2.7 acres are open water in the creek channel at high tide. The remaining 14.8 acres includes Ferry Creek, a small portion of the Housatonic River, small areas of grass and vegetation, and a man-made ridge or dike composed of fill debris that

runs along the edge of wetlands along Lockwood Avenue and Ferry Creek. Samples for this area include soils, sediment, surface water, and biota.

- **Area C (Housatonic Boat Club Wetlands Area)** is located to the south and adjacent to Area B. It is bounded by Shore Road to the west, the Housatonic River to the east, Tide Harbours Condominium Complex to the south, and a public boat launch area at the end of Stratford Avenue to the north. It includes undeveloped wetlands that are tidally influenced by the Housatonic River. The Housatonic Boat Club (HBC) property was originally part of Area C and evaluated in the Draft OU3 RI report dated June 1998. However, since then the soils within the HBC property have been evaluated in an EE/CA (TtNUS 1999a) developed to support selection of a non-time critical removal action. Area C now only includes approximately 8.1 acres of wetlands. All samples presented in this report for this area are sediment and surface water samples.

- **Area F (Selby Pond Site)** is located approximately 500 feet south of Ferry Creek and 400 feet west of the Housatonic River, south of the intersection of Stratford Avenue and Lockwood Avenue. It includes open water (Selby Pond) and surrounding vegetated wetlands. It is bordered primarily by residential properties to the west, north, and east, and by the American Shakespeare Theater property to the south. Selby Pond and the neighboring American Shakespeare Theater property are currently owned by the State of Connecticut. Portions of the wetland are located on residential properties. It is assumed that tidal flow is exchanged between Ferry Creek and Selby Pond through a reinforced concrete pipe and tidal creek channel. The pipe outlet at Ferry Creek has not been observed at low tide because it is situated below the low tide water elevation. Area F covers approximately 6.4 acres, with approximately 2 acres of wetlands, approximately 2.1 acres of open water, and approximately 2.3 acres of grass and vegetation surrounding the wetlands. Samples for this area are sediment, surface water, and biota.

1.3.3 Other On-Going Activities

Activities undertaken in the vicinity of the study area that are related to the investigations conducted to support this RI include:

- ***OU1*** **- Cleanup of the source at the OU1-Raymark Facility is complete.** EPA completed a Remedial Investigation and Feasibility Study for controlling sources of waste at the 33-acre Raymark Facility in 1995 describing the type and location of wastes, the risks posed by those wastes, and discussed possible cleanup solutions. After receiving public comments, EPA decided to consolidate Raymark wastes excavated from the residential areas and the Wooster Middle School at the OU1-Raymark Facility and cap the property. EPA documented this decision in a ROD in June 1995. Once the approach was selected, EPA began the actual cleanup. This included demolition of 15 acres of buildings, consolidation of over 100,000 cubic yards of off-site Raymark waste and the placement of an impermeable cap with a soil gas collection system over the entire property. Solvents, called dense non-aqueous phase liquids (DNAPLs), in the underlying groundwater and gases beneath the cap are treated at facilities onsite. Final construction was completed in November 1997. The site is now operated and maintained by the CT DEP.

- ***OU2*** **- Groundwater Remedial Investigation Activities** - The Remedial Investigation/Feasibility Study is in progress. This groundwater investigation focuses on a 500-acre study area largely downgradient of the OU1-Raymark Facility that has become contaminated with volatile organic compounds (VOCs) and metals, presumably from the activities conducted on the property. The study area includes businesses that have handled or continue to handle hazardous materials, but investigations are focused on groundwater contaminants that appear to be attributable to the OU1-Raymark Facility. Currently, groundwater in this operable unit is not used as a drinking water supply. In some portions of the study area, contaminants in the groundwater appear to be volatilizing, or discharging to surface water, which may pose a threat to human health or the environment.

  EPA intends to issue a Final Remedial Investigation in 2001 describing contamination and potential health risks for this operable unit. EPA also plans to release a Feasibility Study, analyzing potential cleanup solutions for the area, in 2001/2002. Possible remediation alternatives include no action; limited pumping and treating; and in-situ groundwater treatment.

- ***OU4* - Raybestos Ballfield Remedial Investigation Activities** – The Remedial Investigation is complete, and the Feasibility Study is in progress. This area, a former ball field and park, was built using waste fill from the Raymark Facility (see Figure 1-2). In 1992, EPA fenced this area, sampled and removed drummed wastes, and placed a soil cover over contamination at the site. EPA released a final Remedial Investigation in June 1999 that described the nature and extent of contamination at this area.

  EPA plans to release a Feasibility Study in 2001. EPA will select and document its chosen cleanup solution once the Feasibility Study has been reviewed by state and local officials and the public. Cleanup options currently being evaluated for this operable unit include capping existing wastes in place; excavation of all wastes for off-site disposal; treatment of wastes; consolidation of up to 155,000 cubic yards of Raymark wastes from other operable units with existing wastes at OU4 (affording possible reuse of the property); and consolidation of up to 422,000 cubic yards of Raymark wastes from other operable units with existing wastes at OU4 (possibly preventing reuse of the property).

- ***OU5* - Shore Road Activities** - This area is a roughly 4-acre section of Shore Road near the Housatonic Boat Club and the former Shakespeare Theater that borders on the Housatonic River (see Figure 1-2). As a temporary measure, contamination in this area was covered with an interim plastic fabric barrier and wood chips by the CT DEP in 1993. The area was sampled extensively in 1998/1999 and high levels of contamination were present in the surface soils. As the area is contaminated, and because the plastic barrier was beginning to wear and the wood chips were beginning to erode, EPA accelerated cleanup. An Engineering Evaluation/Cost Analysis (EE/CA), completed in June, 1999, presented cleanup alternatives. In September 1999, following the public comment period, EPA released an Action Memorandum documenting its cleanup strategy.

  The Action Memorandum stated that EPA will test waste stabilization techniques that could minimize the release of waste dust during the excavation of Shore Road wastes. It also stated that wastes from the Shore Road Study Area will be deposited in a temporary storage facility within Stratford. During the public comment period on the EE/CA, EPA discussed the Raybestos Memorial Ballfield and/or the Contract Plating Company property as potential temporary storage facilities for the approximately 35,000 cubic yards of soil.

Based on the negative public support for waste storage at either location, EPA decided to suspend final remedial action at the study area. Instead an interim removal action was planned. This action included limited temporary capping of contaminated hot spots, relocation of utilities, repair of existing stone riprap revetment, restoration of the western shoulder and embankment cover along Shore Road, and placement of sheet piling to prevent erosion of materials.

EPA began these excavation and cleanup activities in November, 1999 and completed the interim action in July, 2000. As EPA completes investigations for other Raymark operable units in Stratford, it will decide on a final remedy for this study area that is compatible with the other operable units.

- ***OU6* - Commercial Properties Activities** - A Remedial Investigation is in progress. This 48-acre area encompasses approximately 22 commercial properties, many along Ferry Creek that received Raymark wastes as fill (see Figure 1-2). Additional properties may be added to the list in the future. These areas are being investigated separately by EPA because commercial landowners face a unique set of issues related to site cleanups under Superfund.

  The type and extent of contamination at these sites will be described in the Remedial Investigation scheduled for release in 2001. A Feasibility Study examining cleanup options for this area is also planned for 2001. The particular cleanup approaches for these properties will vary by property depending on the extent of contamination and the risks to human health and the environment at each property. Cleanup options may include addressing portions of each property containing Raymark wastes through excavation, consolidation, treatment, or capping.

- ***OU7 Activities/OU3 Area II*** - A Draft Final Remedial Investigation has been completed. This area includes approximately 36 acres of wetlands roughly in the center of the Raymark Industries, Inc. Superfund Site (see Figure 1-2). Interim measures for this operable unit have included placement of signs at Selby Pond warning people not to eat eels caught in the pond, and placement of signs warning of contamination within the wetlands. EPA has also excavated contamination from a residential area abutting Selby

Pond. EPA sampled these water bodies that make up OU7 in which Raymark wastes have been deposited through dumping and erosion.

A Feasibility Study for these areas is planned to be released in 2001. This area contains approximately 315,000 cubic yards of contaminated soils and fill and approximately 50,000 cubic yards of contaminated sediment. Possible cleanup approaches for this operable unit include capping in place, treatment, excavation, and dredging with wetland restoration.

- ***OU8 Activities/OU3 Area III*** - A Draft Final Remedial Investigation has been completed. This 21-acre area is the southernmost operable unit of the Raymark Industries, Inc. Superfund site, and includes the Beacon Point boat launch area and wetlands along Elm Street (see Figure 1-2). EPA removed contaminated soil from several acres of an Elm Street residential property within this area in 1994. This soil was consolidated and capped at the Raymark Facility. EPA recently completed sampling for these areas.

  The Feasibility Study for these areas is also anticipated in 2001. This area contains approximately 200,000 cubic yards of contaminated soils and fill, and 18,000 cubic yards of sediment. Possible cleanup approaches include capping in place, treatment, excavation, and dredging with wetland restoration.

1.3.4 Previous Investigations

A substantial number of field investigations relating to soil, sediment, surface water, biota, and groundwater have been conducted at the Raymark Facility and its environs. A discussion of investigations pertinent to the study area is included in Section 2.0.

2.0 STUDY AREA INVESTIGATIONS

This section presents a brief description of each investigation performed to characterize the impacts to ponds, wetlands, and other properties resulting from past disposal of Raymark Facility soil-waste/fill materials. Previous investigations relevant to Area II are presented in Section 2.1; and investigations relevant to the entire OU3 study area are summarized on Table 2-1. Information collected from these investigations was used to meet the Remedial Investigation objectives presented in Section 1.1.

Additional investigations performed at the Raymark Facility to characterize the on-site materials and facility setting are summarized in the *Final RCRA Facility Investigation Report, Raymark Industries, Inc.* (ELI, 1995) and the *Final Remedial Investigation Report, Raymark Industries, Inc. Facility* (HNUS, 1995). Further evaluation of groundwater contamination beneath and migrating downgradient of the Raymark Facility is currently being conducted.

Investigation of properties potentially affected by Raymark soil-waste/fill have been conducted since 1992 (see Table 2-1 and sections below). The information is presented below in chronological order. Many dates overlap because contractors were hired by a variety of entities (EPA, State of Connecticut, and the Army Corps of Engineers) to perform specific tasks. In addition, many investigations were conducted on properties both within and outside Area II. These investigations are included in this section. There have been investigations conducted for other Raymark investigations that do not impact Area II. These investigations have not been included.

2.1 Surface Water and Sediment Investigations (1992 - 1994)

Surface water and sediment sampling was conducted at the Raymark Facility and environs by EPA, its contractors, and the various contractors hired by Raymark Industries Inc., from 1992 through 1994 in order to determine whether site contaminants were migrating off the property. The sampling assessed a series of four lagoons located at the Raymark Facility in the southwestern corner and along the southern property boundary near Longbrook Avenue and the Barnum Avenue Cutoff. These lagoons, frequently referred to as settling basins or ponds, received stormwater drainage, surface water runoff, and wastewater from various on-site

operations. Solids were allowed to settle in Lagoon Nos. 1, 2, and 3 prior to discharge of clarified wastewater and unsettled solids into Lagoon No. 4, which discharged into a culverted tributary that directly discharged into Ferry Creek. Ferry Creek ultimately discharges to the Housatonic River, which includes Area B, C, and F wetlands.

2.1.1 Sediment at Raymark Facility and along Ferry Creek/Housatonic River (1992 - 1995)

In 1992, sediment samples were collected as part of an EPA Site Inspection for Raymark Industries. Fifteen samples were collected along Ferry Creek and the Housatonic River. Samples were submitted to EPA-approved laboratories for analysis of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), PCBs, metals, cyanide, dioxins/furans, and asbestos. Numerous site-related organic and inorganic contaminants were detected at elevated levels. The sampling locations and analytical results are summarized in Weston's Final Site Inspection Report (Weston, 1993).

2.1.2 Surface Water at Raymark Facility (1993)

Five surface water samples were collected in July 1993 to characterize both the quantity and quality of drainage discharges into and out of Lagoon No. 4. After installation of the surface stormwater drainage diversion system around Lagoon No. 4, the outlet to this lagoon (Station No. 5) was resampled in October 1993. Samples were submitted for laboratory analysis of VOCs, SVOCs, PCBs, metals, cyanide, sulfide, chlorinated herbicides, organophosporous pesticides, dioxin/furan, and asbestos (ELI, 1994). These sampling rounds confirmed that the site had discharged contaminated materials/water into Ferry Creek. Results from subsequent sampling indicated that similar contaminants were detected both on-site and in the creek sediments (HNUS, 1994/1995 sediment and surface water sampling results). Ferry Creek ultimately discharges to the Housatonic River, which includes Area B, C, and F wetlands.

2.2 Fish, Shellfish, and Eel Sampling (1993)

In October 1993, the EPA and CT DEP sampled fish and shellfish from various water bodies around Stratford. The CT DEP collected shellfish samples from the Housatonic River and Ferry

Creek. The EPA collected fish samples from five ponds within Stratford, including Selby Pond. The shellfish and Selby Pond fish sample information is included in the Stratford Data Base, and is included in the Area B and Area F discussions on biota. Another 1993 study, prepared by Connecticut Department of Public Health and Addiction Services (CT DPHAS) under cooperative agreement with the Agency for Toxic Substance and Disease Registry (ATSDR), found elevated levels of PCBs, particularly Aroclor 1262 which is a Raymark soil-waste/fill indicator, in eels from Selby Pond. As a result of the study, an eel fish consumption health advisory was issued, recommending that consumption of eels from Selby Pond be limited to not more than one meal per month.

2.3 Soil Sampling (1993)

Numerous properties were sampled around Stratford to identify the extent of soil contamination resulting from disposal of Raymark soil-waste/fill. Residential properties were sampled and evaluated, and waste was excavated when appropriate. Commercial and wetland properties were sampled, but no cleanup has occurred to date. The sample results from the commercial and wetland properties in and around Areas B, C, and F are included in this RI.

2.4 Phase I Remedial Investigation (1993 - 1995)

The Phase I Remedial Investigation was conducted from 1993 through 1995. This investigation consisted of treatability studies, and field work. This investigation was conducted by HNUS under EPA Contract No. 68-W8-0117, ARCS Work Assignment No. 42-1LH3. The activities conducted as part of the field investigation included a soil boring and sampling program, a salinity survey, a ground penetration radar (GPR) survey, and a topographic survey. The investigation also included advancing soil borings for groundwater monitoring well installations. Pertinent activities conducted as part of the environmental sampling program included four rounds of surface water and sediment sampling. These activities are described below.

2.4.1 Surface Water and Sediment Sampling (1994 - 1995)

Four rounds of surface water and sediment sampling were conducted at selected locations to evaluate potential contaminant migration from the Raymark Facility. In the course of the four sampling rounds, 140 locations were sampled from streams, ponds, wet areas, and leachate outbreaks identified by EPA from within the original study area. Based on sampling results and discussions with EPA, the study area was further refined; 96 of these 140 sampling locations are located within the limits of the OU3 study area as currently defined (Areas A-1, A-2, A-3, B, C, D, E, and F). Surface water samples were collected and submitted to EPA-approved laboratories for analysis of target compound list (TCL) VOCs, TCL SVOCs, TCL pesticides/PCBs, and target analyte list (TAL) metals. Field measurements included pH, temperature, specific conductivity, dissolved oxygen, and salinity. Sediment samples were submitted to EPA-approved laboratories for analysis of TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, TAL metals, asbestos, dioxin/furans, total organic carbon (TOC), and grain size. In the fourth sampling round, some sediment samples were also submitted for acid volatile sulfide/simultaneously extractable metals (AVS/SEM) analysis.

This work provided information on the extent of contamination. The information was used to define the Area II study area.

2.4.2 Salinity Survey (1994)

A salinity survey was performed in June 1994. The survey was conducted along the length of Ferry Creek from just south of the flood control barrier/hydraulic sluice gate system at Broad Street, north to the confluence of Ferry Creek and Long Brook Creek. The survey was designed to define the saline/freshwater interface within Ferry Creek.

Fifteen survey/sampling locations were established along Ferry Creek. The survey involved measuring in-situ water temperature and salinity using a YSI Model 33 Salinity-Conductivity-Temperature (SCT) meter. In-situ temperature and salinity measurements were recorded for each station during both high and low tides. Sediment samples were also collected from each station during the low tide salinity/temperature survey, using a stainless steel trowel and/or hand auger advanced into the sediment to a depth of approximately 3 inches. The interstitial

fluid of the sediment samples was then analyzed for salinity by the EPA Narragansett Bay Laboratory (HNUS, 1994).

2.5 Comprehensive Site Investigation Sampling Program (1994 - 1995)

Using data developed by others, Comprehensive Site Investigation (CSI) reports were prepared in 1994 and 1995 for properties under investigation as part of the Stratford Superfund Sites program. The purpose of the CSIs was to determine the extent and magnitude of lead, PCB, and asbestos contamination associated with Raymark soil-waste/fill Facility waste disposal in surface and subsurface soils. The CSI reports were designed to provide site-specific data necessary to proceed with the Stratford Superfund Sites Removal Action Program. The information contained in the reports was based on the subsurface samples collected during the vertical sampling program (1993).

Sample locations were selected based on a systematic grid approach for each property investigated. Grid intersections were set at 25-foot intervals and sampling was conducted at each grid intersection. Surface soil samples were collected from depths of 0 to 12 inches bgs using a stainless steel trowel. Subsurface soil samples were obtained from depths of 1 to 12 feet bgs using a hand-operated Geoprobe® slide-hammer piston rod apparatus advanced hydraulically using a Terraprobe® truck-mounted unit. Soil samples from each boring were visually classified and logged. Constituents of all soils were characterized using the Burmister soil classification ranges, and soil color was described using Munsell color charts. Samples were composited from 1-foot intervals and screened at the on-site laboratory for asbestos, lead, and PCBs. Approximately 10 percent of the samples were submitted for confirmatory analysis at an off-site laboratory.

Site-specific data for numerous properties have been generated through the CSI program. CSIs have been conducted on properties adjacent or closely proximate to portions of Areas B, C, and F properties. Final CSI Reports for these applicable properties were completed in 1995, and report sections relevant to OU3 were presented in *the Final Technical Memorandum, Compilation of Existing Data, RI/FS, Raymark - Ferry Creek* (B&RE, 1997a). This information served as a resource for additional data collection and in data interpretation for this RI Report.

2.6 Removal Actions Post-Excavation Program (1994 - 1996)

Specific site property excavations were performed based on the results of the CSI sampling program discussed in Section 2.5. Upon completion of the excavations, samples were collected to ensure that the contaminated materials were removed. Removal action soil sample locations were selected based on a systematic grid approach for each property excavated. Grid intersections were set at 15-foot intervals; samples were collected at depths of 0 to 3 inches from each exposed wall, base, and perimeter of an excavated grid using a pre-cleaned iron shovel or hand trowel. Samples were composited from each exposed surface and screened at the on-site laboratory for asbestos, lead, and PCBs. Approximately 10 percent of the samples were submitted for confirmatory analysis at an off-site laboratory. Once the contaminated materials were removed, the areas were backfilled with clean materials and seeded.

Post-Excavation Record Plans were prepared for these properties. As stated in the *Final Technical Memorandum, Compilation of Existing Data, RI/FS, Raymark - Ferry Creek* (B&RE, 1997a), data and information from Post-Excavation Record Plans adjacent or closely proximate to portions of Areas B, C, and F were completed between 1994 and 1996. The Post-Excavation Record Plans documented the soil removal action clean-up activities conducted at each property and showed that the established clean-up criteria had been achieved.

2.7 Ecological Risk Assessment (1996 - 1999)

An Ecological Risk Assessment report was prepared for EPA Region I by NOAA and its contractor (NOAA, 1998). This assessment addressed the risks to ecological receptors posed by contaminants present in Ferry Creek, portions of the Housatonic River, and associated wetlands. A Phase III Ecological Risk Assessment was completed by SAIC (SAIC 1999b) to assess the ecological impacts of contaminants on wetland, intertidal, marsh, and freshwater habitats of Areas B, C, and F, as well as Areas D and E. Areas D and E will be addressed in the Area III RI Report. The information from these reports is evaluated and summarized in Section 7.0. Both reports are presented in their entirety in Appendix D.

2.8 Selby Pond Investigation and Sampling (1996)

Based on the results of two rounds of surface water and sediment sampling conducted at Selby Pond as a part of the Phase I RI, (see discussion in Section 2.5.2), additional investigations were carried out at Selby Pond in three phases, as detailed below.

2.8.1 Selby Pond - Phase I

The Phase I investigation was performed by HNUS from September 3, 1996 through September 6, 1996. The objective of Phase I activities was to obtain information related to the depth and physical composition of the sediment material within Selby Pond and the surrounding wetlands. The results of the Phase I investigation were used to direct the subsequent field sampling under Phase II (HNUS, 1997).

2.8.2 Selby Pond - Phase II

The Phase II investigation was performed by HNUS from November 5, 1996 through November 16, 1996. The objective of the Phase II activities was to define the nature and extent of contamination within the Selby Pond site. Activities included collecting surface water samples, surficial sediment samples, and deep-sediment core samples. The samples were analyzed using EPA-approved laboratories for TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, and TAL metals. Sediment samples were also analyzed for dioxins/furans and asbestos. Sample locations were surveyed by HNUS using global positioning system (GPS).

2.8.3 Selby Pond - Phase III

Based on an evaluation of the data from Phases I and II and qualitative evaluations of human health and ecological considerations, an evaluation was conducted by HNUS to determine whether a non-time-critical removal action (NTCRA) at Selby Pond was warranted. No additional field sampling was conducted to support this assessment. However, previous data collected by the EPA, the CT DEP, and the CT DPHAS under cooperative agreement with the ATSDR were reviewed to support the evaluation (see Section 2.2). The Phase III assessment concluded that a separate non-time-critical removal action was not warranted. The report

recommended the inclusion of Selby Pond in the overall assessment of the area. Thus, Selby Pond was added as Area F (B&RE 1997) and included in this Draft RI report.

2.9 Phase II Site Investigation (1997)

A review of all the data from 1992 through 1996 identified data gaps. These data gaps indicated the need to collect additional field data to finalize the RI and support the FS for the OU3 study area. Data gaps were identified for each area, except for the Selby Pond site (Area F), which had been investigated previously to determine the need for a NTCRA. Field investigations and sample collection were conducted by HNUS during July and August 1997. Field activities included advancing soil borings and collecting soil samples, and collecting surficial soil and sediment samples. These activities are described in the sections below.

2.9.1 Soil Borings and Soil Sampling

Additional soil borings were collected to further determine the nature and extent of the contamination.

Soil borings were advanced, and surficial and subsurface soils were collected throughout the OU3 area, including Area B. Individual boring locations were selected based on previously identified data gaps, and as a result of meetings between TtNUS, EPA, and CT DEP. Approximately 35 soil borings were advanced to depths of 16 feet using hollow-stem auger methods. The intent was to advance the boring until "natural" soil was encountered. At the direction of EPA, no borings were advanced to depths greater than 16 feet.

Continuous split-barrel sampling was conducted throughout the advancement of each boring, and soil samples were field screened using a portable photoionization detector (PID) or flame ionization detector (FID). Based on PID or FID field screening results, selected samples were sent for laboratory analysis of VOCs. Soils from each sampled interval were sent to the Connecticut Department of Health (CT DOH) laboratory for analysis of asbestos. Soil samples were also sent to an off-site laboratory for screening of lead and copper using x-ray fluorescence (XRF). Based on the XRF screening results, an average of two samples were selected from each borehole for analysis at EPA-approved laboratories. Analyses included

TCL VOCs, TCL SVOCs, TAL metals, dioxin/furans, and/or TCL pesticides/PCBs (plus Aroclor 1262 and 1268). Selected soil samples were also analyzed for Synthetic Precipitation Leaching Procedure (SPLP) metals, based on the amount of soil recovered from the sampled interval, direction from EPA in the field, and the XRF field screening results.

2.9.2 Sediment Sampling

Additional sediment samples were collected to further determine the nature and extent of contamination. Samples were collected from stream channels, wetland areas, and estuarine shore locations to evaluate the nature and extent of contamination, and the physical/geotechnical properties of the sediment. Sediment samples were collected throughout the OU3 area, including Areas (B and C) from depths of up to 6 feet bgs.

Samples submitted for chemical analysis were collected using vibratory coring or grab sampling techniques. Sediment samples were field screened using a portable PID or FID. Selected samples were submitted to EPA-approved laboratories for analysis of TCL VOCs, TCL SVOCs, TCL pesticides/PCBs (plus Aroclor 1262 and 1268), TAL metals, dioxins/furans, TOC, and/or grain size. Selected samples were also submitted to the CT DOH laboratory for analysis of asbestos. An additional 10 percent of the pesticide/PCB samples were also analyzed for PCB homologues and PCB congeners. Selection of samples for analysis of TCL VOCs was determined based on PID or FID screening results.

Also in Areas C and D, sediment samples were collected from predetermined depths, based on existing data gaps, using a piston-core sampler or hand auger. Sediment samples from Area B were collected from the Ferry Creek channel from up to three units (representing the soft, consolidated, and firm bearing sediment layers), when present within the predetermined sampling depths. Sediment samples from Area B were collected using vibracore techniques.

3.0 PHYSICAL CHARACTERISTICS OF THE STUDY AREA

This section summarizes the physical characteristics of the study area and region in which Area II is situated. The surface features and land uses are described in Section 3.1. Discussions of related geology, hydrogeology, surface water hydrology, and meteorology are presented in Sections 3.2 through 3.5, respectively.

3.1 Surface Features and Land Use

Area II is part of the Housatonic River Basin, a tidally influenced drainage system. Area II covers approximately 44 acres including approximately 17 acres of wetlands and/or open water; portions of commercial properties; and Ferry Creek, the Housatonic River, Selby Pond and their associated wetlands. A description of Area II is included in Section 1.3.2.

As most of Area II is wetlands and open water, its topography is relatively flat. A man-made ridge or dike approximately 3 to 6 feet high runs along the edge of the Area B wetlands beside Lockwood Avenue and Ferry Creek. This feature, composed of fill debris including asphalt shingles and tile fragments, is believed to be a flood control structure. Based on a review of USGS topographic maps, the majority of Area II lies at topographic elevations below 10 feet National Geodetic Vertical Datum (NGVD) 1929.

Area II is located within the 100-year floodplain, as observed from Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps for Stratford, Connecticut (FEMA, 1992), and as presented in the U.S. Army Corps of Engineers Hydrologic Evaluation of the study area. The Hydraulic Evaluation is included in Appendix C. The 100-year frequency base flood elevation is 10.1 feet NGVD; the 10-year frequency flood elevation is 8.5 feet NGVD (USACE, 1998).

State or federally listed threatened species reported to exist in the vicinity of Area II include the least tern, the Atlantic sturgeon, the piping plover, and occasional transient bald eagles and peregrine falcons (NOAA, 1998; CT DEP, 1997b; US DOI, 1997).

The principal industries within the Stratford community include manufacturing of aircraft, air conditioning, chemicals, plastic, paper, rubber goods, electrical and machine parts, and toys. The Stratford Town Clerk reported the latest (September, 1999) estimate for the population of the Town of Stratford as 47,230 people within the 19.9 square miles (12,736 acres) of the town. This is a decrease from the 1990 census when the population was listed as 49,389.

3.2 Geology

This section provides a brief overview of the geology of the region and Area II. A more detailed evaluation of the geologic/hydrogeologic data including geologic cross sections, groundwater contour maps, and bedrock surface contour maps will be presented in the OU2 groundwater RI. However, the OU2 study area does not include the entire Area II area. The description of both the regional and Area II geology includes a general discussion of soils (natural deposits and artificial fill deposits) and bedrock encountered in on-site borings, with an emphasis on surficial soils (fill and thickness of fill maps). For purposes of this report, fill is included within the category of a soil. The definitions used in this section:

Glacial till, deposited by glacier ice, is variable in thickness, forming a discontinuous mantle over bedrock. The till consists of a non-stratified, poorly sorted mixture of coarse (pebbles/cobbles/boulders) and fine (sand/silt/clay) fractions, with the coarse fraction generally not exceeding 20 percent.

Ice-contact stratified drift includes sand, gravel, silt, and clay, frequently poorly sorted with abrupt changes in grain size. These deposits were formed during glaciation in streams and local ephemeral lakes in close relation to melting glacier ice, and often grade into outwash sediments.

Glacial outwash deposits are predominant in the stream valleys, and consist of highly stratified sand, silty sand, and gravelly sand. Beds are not persistent, and individual lenses attain thicknesses of tens of feet, and thin out or are truncated over short distances. Glacio-fluvial outwash units in the vicinity of the study area generally consist of sands with up to 50 percent gravel, grading up-valley (northward).

Swamp and marsh deposits are present in lowlands and in proximity to the Housatonic River. Tidal marshes are also present in this area. Swamp and marsh deposits consist of silt, sand, and clay-sized particles interbedded with organic fragments and peat deposits. The oldest marshes in the western coastal area of Connecticut (2,000 to 4,000 years old) have peat deposits of approximately 10 feet (Dreyer, 1995).

A large portion of the Stratford, Connecticut region is composed of manmade fill according to the quadrangle map created by Flint, 1968. Fill deposits are often found in lowland areas of the region and are often overlying swamp and marsh deposits. Fill deposits also overlie stratified drift and ice contact deposits such as sands and gravels.

Fill deposits of variable thickness are a result of manmade activities. Fill materials frequently include manufacturing, household, and construction debris usually mixed with natural materials such as silty sand and gravel. Natural materials include various amounts of clay, silt, sand, and gravel. Manmade materials consist of charcoal, asphalt, metal brick, tile, glass, and other miscellaneous manmade materials, including manufacturing debris. Other fill materials that do not contain visual evidence of manmade debris are present throughout the Stratford, Connecticut region, generally consisting of sands with varying amounts of silt and gravel. This fill is frequently more difficult to distinguish from natural/native deposits.

3.2.1 Regional Geology

The discussion of the regional geology is based on data collected during previous subsurface investigations and is also summarized in the *Final Remedial Investigation Report, Raymark Industries, Inc. Facility* (HNUS, 1995). Discussion of the regional geology is divided into two subsections: overburden and bedrock. The overburden is defined as unconsolidated deposits of sand, silt, gravel, clay, and peat. Bedrock consists of metamorphic rocks that are mainly schist and gneiss, overlain by overburden deposits.

3.2.1.1 Regional Overburden Geology

The State of Connecticut has been covered by glacial ice at least twice in geologic time. During the last retreat, glaciers deposited a thin mantle of till overlying bedrock. Glacio-fluvial

outwash deposits formed thicker, highly stratified sequences of silty sand to gravelly sand that overlaid the till and filled bedrock valleys. Windblown sand and silt were also deposited on valley floors, however, these deposits are indistinguishable from present day organic topsoil deposits.

Area II is generally located in the Stratford outwash plain, on the western Housatonic River valley floor. Natural overburden deposits in the vicinity of Stratford consist of glacial deposits (outwash sediments, ice-contact stratified drift, and till) and younger swamp and marsh deposits (Flint, 1968). More recent activity and changes have placed fill in some of the former swamp and marsh areas in addition to re-grading activities for development purposes.

3.2.1.2 Regional Bedrock Geology

Area II is located in the Connecticut Valley Synclinorium of Connecticut's Western Uplands, according to the "Bedrock Geological Map of Connecticut" (CT GNHS, 1985). The regional bedrock setting consists of a series of meta-sedimentary and meta-volcanic rocks of the Early and Middle Paleozoic Era, generally foliated, with foliation trending northeast-southwest, in a large syncline. These rocks are mainly schists, gneisses, and granites. The sequence was tightly folded and subjected to progressive regional metamorphism, ranging from chlorite to kyanite grade. A high angle fault is mapped approximately 1 mile to the southeast of Area II, across the Housatonic River, generally trending southwest to northeast (CT GNHS, 1985). The implication of this fault and any related splay faulting to local geology and contaminant transport was not evaluated. Bedrock does not outcrop (occur at the surface) within Area II.

3.2.2 Site Geology

The discussion of Area II geology is divided into two subsections: overburden and bedrock geology. These subsections are based on overburden and bedrock data collected during soil boring activities conducted during several previous investigations as summarized in Section 2.0.

3.2.2.1 Study Area Surficial Geology and Fill Thickness

The surficial deposits that occur at and within the shallow subsurface of Area II are mapped as Stratford outwash sediments, fill deposits, and swamp/marsh deposits (Flint, 1968). Based on borings advanced in or near Area II, the surficial and overburden deposits are characterized primarily by a variety of locally derived glacial outwash deposits and ice contact deposits, alluvial deposits, swamp and marsh deposits, and fill materials. Glacial till may be present locally, but is discontinuous. Overburden consists of a complex sequence of alluvial and outwash deposits (sand and gravel) ranging from silty sands to coarse gravels. Peat/organic silt deposits in the Area II study area frequently underlie fill materials.

An estimated thickness-of-fill contour map was prepared for Area B (Figure 3-1). The thickness of fill is based on visual descriptions of soil samples collected from borings within Area II. Ferry Boulevard and East Broadway are assumed to have been built prior to fill deposition based on historical aerial photographs.

Fill was also mapped in the study area by the Connecticut State Geological and Natural History Survey *Surficial Geology of the Ansonia and Milford quadrangles in 1968.* In this report fill is mapped only "where it is known or judged to be at least 5 feet thick" (Flint, 1968).

Fill consists of both natural and artificial materials placed as a result of human activity. Fill materials include manufacturing, household, and construction debris. This debris is mixed with natural materials such as silty sand and gravel. These artificial materials were generally present in a matrix of silty to gravelly sand, with varying amounts of silt and gravel. Other fill materials that do not contain visual evidence of man-made debris are present throughout the Area II area, generally consisting of sands with varying amounts of silt and gravel. This re-worked native fill is frequently more difficult to distinguish from natural/native non-disturbed deposits. The boring logs, located in Appendix A, contain detailed descriptions of the fill and natural soils. Identification of fill was done by visual descriptions of soil and sediment samples collected during the field investigation. The focus of this report is to identify fill that occurs within Area II. Roads that form the boundaries for Area B of Area II are included in the fill thickness map, as the fill thickness map only includes Area B (Figure 3-1). Roads that are expected to contain some road-base material or fill were built before the filling activities

occurred in the wetland areas (based on historical aerial photographs) that are the subject of this RI. No differentiation was made between Raymark soil-waste/fill and other types of fill on the fill thickness maps.

Area II overburden geology is discussed below. Area designations are described in Section 1.3.2 and on Figure 1-2.

Area B (Lower Ferry Creek)

The description of overburden geologic materials presented below is based on ten soil borings. B2-SB01 – B2-SB09 were advanced in Area B to depths of 16 feet below grade by HNUS, as part of the 1997 Phase II Site Investigation (described in Section 2.9.1). MW-312B was advanced to 123 feet bgs in Area B in January 1999 as part of the OU2 RI. Boring locations are presented on Figure 3-1. Boring logs are in Appendix A. All sample locations are shown on Figure 4-1.

Fill was identified in six of the nine borings to depths ranging from approximately 6.8 feet below grade (B2-SB4) to approximately 14.3 feet below grade (B2-SB2). The fill thickness generally increases with distance from the nearby roadways (Ferry Boulevard, Lockwood Avenue, and Stratford Avenue), and generally increases toward the Ferry Creek channel. No fill was noted at B2-SB6, B2-SB7, B2-SB9, or MW-312. In Area B, the fill matrix was generally comprised of silt, organic silt, or silty sand. Artificial materials observed within the fill in Area B included asbestos fibers and tiles/boards, asphalt-like shingles, glass, and concrete.

In most of the borings advanced in Area B, the fill materials are underlain by coastal wetlands deposits comprised of silt or organic silt with trace to some fine sand, with peat interlayered at some locations. In the southern portion of Area B, at borings B2-SB4, -SB6, and -SB7, sand, with varying amounts of gravel is more prevalent underlying the upper fill and silt or silty sand horizons. Deeper overburden materials noted at MW-312B consist of glacial outwash sand and gravel with varied silt content.

Nine sediment core samples were collected using a boat mounted vibracore unit at locations in lower Ferry Creek (downstream of the Broad Street tide gate) and at the confluence of Ferry

Creek and the Housatonic River. These nine vibracore locations, B2-SD01, B2-SD02, B2-SD04 through B2-SD10, are indicated on Figure 3-1 with the thickness of fill deposits noted at each location. The fill thickness contours do not extend to these locations for two reasons: 1) the variable conditions found in this tidal estuary; and 2) the varied sample compression noted with the vibracore sampling method that make the accuracy of the observed thicknesses uncertain. Fill materials were identified at depths ranging from approximately 5.0 to 8.5 feet bgs in eight of the nine sediment cores. The fill deposits consisted primarily of fine grained sediment, such as silt and organic debris which includes asbestos fibers, sludge materials and petroleum odor, staining and sheen as noted during the field investigation.

Area C (Housatonic Boat Club Wetlands Area)

The description of overburden geologic materials presented below is limited due to the lack of subsurface data. Sediment samples were collected in 1994 in Area C from the upper 6 to 8 inches. These hand-auger boring locations are presented on Figure 4-8.

Sediments in Area C generally consisted of varying amounts of silty sand, organic silt or silt. Sediment locations closer to Shore Road and inside the higher energy flow areas or channels throughout the wetlands are composed of silty sands (HB02, HB4A, HB6). The interior wetlands locations or lower energy environments such as HB8A, HB16, and HB18 were composed of silt and organic silt/muck. A small quantity of man-made debris such as glass and plastic was noted at the ground surface in the small northern wetland portion of Area C. This debris appears to be flotsam from high tide or flow events and not a product of active fill activities. Fill materials were not identified visually in these sediment samples. Sample logs with soil descriptions are in Appendix A. There are no fill thickness maps for Area C.

Area F (Selby Pond)

Field investigation activities included collecting sediment cores within Selby Pond. The thickness of organic deposits (peat) present under the open water and in the wetlands of Selby Pond was found to range from approximately 6.5 feet to 14.0 feet, consistent with regional peat thicknesses. These peat deposits were probably developed over the last 2,000 to 4,000

years (HNUS, 1997a). A solid substrate bottom (sand, silt, rock) was not encountered in any of the borings conducted in Selby Pond. Fill materials were not detected in any of the borings.

Observations made during sediment coring at Selby Pond support the hypothesis that an ancient freshwater floating bog is present beneath the peat layer. Selby Pond is a glacial kettle pond formed prior to marine transgression and area salt marsh development. Supporting observations are the presence of a woody root layer observed in several of the sediment cores; the *Sphagnum* (a freshwater moss) above the root layer at location SP16; the apparent low-strength material beneath the root layer (as indicated by no recovery); and the lack of a hard substrate bottom (sand, silt, etc.). The highly organic, low-strength material found in Selby Pond is typical of freshwater shrub bog deposits (HNUS, 1997a). Vibracore sediment logs are supplied in Appendix A. All sample locations are shown on Figure 4-15.

There are no fill thickness maps for Area F.

3.2.2.2 Study Area Bedrock Geology

Area II bedrock geology is based on referenced geologic maps and a review of the boring log for the one boring that was cored into bedrock within the Area B. Three monitoring wells were installed at one location (MW-312B) along Lockwood Avenue, within Area B. The top 30 feet of bedrock was cored at this location and is described below. No borings or monitoring wells were cored into bedrock in Areas C and F.

Bedrock does not outcrop (occur at the ground surface) within Area II. The nearest bedrock outcrop is located approximately 4,200 feet north of Area II. The bedrock surface elevation data from all bedrock borings used in OU2 (groundwater) investigations indicate that the bedrock surface is highly variable throughout the area. The depth to bedrock at MW-312B is 90.5 feet bgs.

Bedrock underlying Area II is mapped as the Derby Hill Schist, a mainly medium- to fine-grained, thinly laminated, greenish-gray to medium dark-gray chloritic muscovite schist, which is Lower to Middle Ordovician in age. This rock type is composed mainly of quartz, muscovite, chlorite, and sodium plagioclase, with accessory minerals (Fritts, 1968). The boring

log from MW-312B describes the observed rock core as a foliated, quartz, mica, mafic gneiss, which graded into a mica-rich schist. High angle foliation and schistosity was observed to be common; weathered horizontal and high angle to vertical fractures were also noted.

3.3 Hydrogeology

Regional hydrogeologic units consist of unconsolidated overburden deposits, including till, stratified outwash, swamp and marsh deposits, and an upper fractured bedrock unit. Regional groundwater flow in the OU3 area appears to be influenced by Ferry Creek. The wetland's hydrology and flow is generally toward the Housatonic River (HNUS, 1995).

Groundwater levels for Area II vary from approximately 8.0 feet to less than 1.0 foot below ground surface (bgs). These groundwater levels are approximate and are based on observations made in the field and recorded on the boring logs for Area II. Because no shallow overburden monitoring wells are present in Area II, definite water levels could not be measured. It appears that groundwater flow direction within the shallow overburden aquifer is south and southeasterly toward the surface water bodies, Ferry Creek, Selby Pond, and the Housatonic River (HNUS, 1995). Groundwater appears to be hydrologically connected to the surface water bodies, resulting in groundwater discharge into the surface water bodies and adjacent wetlands. The surface water bodies and adjacent wetlands are tidally influence as further discussed in Section 3.4, Surface Water Hydrology. However, the extent of tidal influence on groundwater was not investigated in this RI. As previously discussed, only one boring, MW-312, was cored to bedrock, and therefore groundwater depth and flow through bedrock can not be assessed for Area II.

Groundwater in the vicinity of Area II is classified as GB (unsuitable for drinking without treatment) by the CT DEP. All drinking water for Area II is supplied by the Bridgeport Hydraulic Company. The supply source of public drinking water is Trapp Falls Reservoir located in Shelton, Connecticut, approximately 5 miles from the study area.

3.4 Surface Water Hydrology

Area II is located in the Housatonic Main Stem Regional Drainage Basin. Long Island Sound receives the area's entire surface drainage via the Housatonic River. Ferry Creek is the major surface water feature that lies wholly or partially within Area II. Large areas of wetlands are also included in Area II, as detailed in Section 1.3.2.

Ferry Creek, Selby Pond, the Housatonic River and the Area II wetlands are tidally influenced. The Housatonic is tidally influenced to the Derby Dam in Derby, Connecticut, 11 miles upstream of the mouth of Ferry Creek (Weston, 1993). Although tide gates are present at the Broad Street crossing of Ferry Creek, these gates do not prevent backwater from high tides from passing upstream into Ferry Creek (USACE, 1998). Selby Pond is influenced by a pipe and open channel connection from the Area B wetlands. The pond and wetland water level rise and fall approximately 1 to 2 feet each tide cycle. The water level variation in Ferry Creek during this same cycle is typically 5 to 7 feet.

The Housatonic River is listed as Class SC/SB (coastal and marine surface water that does not meet the criteria for marine life habitat, recreation or industrial use) with an average discharge of 3,400 cubic feet per second at its mouth (Weston, 1993). Ferry Creek is listed as Class B/A, potential drinking water supply; fish and wildlife habitat; recreational use; agricultural and industrial supply; and other legitimate uses including navigation (CT DEP, 1997a).

Additional detailed hydrologic information on delineation of drainage areas for each area and elevations within each watershed area, discussion of storm drain networks, overland flow, tidal hydraulics, and rainfall runoff analysis is presented in Appendix C.

3.5 Climate and Meteorology

Area II is located in a temperate-humid climate, characterized by highly changeable weather and large daily and annual temperature variations. The most pronounced topographical effect is the land-sea breeze, an occurrence generally associated with the spring through early autumn months. Mean monthly temperatures during the summer average 3 to 5 degrees lower

than nearby inland locations. Temperatures during the fall and winter months are moderated because of the proximity of Long Island Sound. Winter snowfall is generally around 10 inches less than areas a few miles inland, also due to the proximity of Long Island Sound.

Low-lying areas are subject to flooding during periods of high tide. Tides 3 to 5 feet higher than normal may be encountered in the presence of slow-moving, deepening low pressure systems.

Area II is highly impacted by storm events, as the area is located within a storm surge zone. Hurricanes, gale storms, and rain storms frequently occur and contribute to the flooding events within Area II.

The local NOAA Climatological Station is located at the Bridgeport-Sikorsky Airport which is within close proximity to Area II. For the past 30 years, data from this station have been used to describe the general climate in the area.

July is the warmest month with an average temperature of 73.4° F. The coldest month is January with an average temperature of 28.7° F. The maximum temperature observed between 1939-1998 was 103° F. The minimum temperature observed during this period was -7° F. Normal annual precipitation for the region is 42.6 inches, with between 3 and 4 inches of rain or water equivalent falling monthly. The area has an average annual snowfall of 25.8 inches which generally occurs between November and April. Most snowfall occurs in January and February. Averages for these 2 months are 7.4 inches and 7.6 inches, respectively.

Wind speed in the region varies between 9.3 and 13.0 mph with an average of 11.4 mph. In the warmer months the prevailing wind direction is southwest. In the colder, months the prevailing direction is west to northwest.

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6.0 Baseline Human Health Risk Evaluation
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Sections:
7.0 Ecological Evaluation
8.0 Summary and Conclusions
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