PHASE II
COMPREHENSIVE SITE ASSESSMENT

BARGE B120 SPILL
BUZZARDS BAY, MASSACHUSETTS
RTN 4-17786

Prepared For:

Bouchard Transportation Company, Inc.
58 South Service Road, Suite 150
Melville, New York 11747

Prepared By:

GeoInsight, Inc.
5 Lan Drive, Suite 200
Westford, Massachusetts 01886
Phone: (978) 692-1114
Fax: (978) 692-1115
www.geoinsightinc.com

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ACRONYM AND ABBREVIATION LIST

BaP	Benzo(a)pyrene
CAM	Compendium of Analytical Methods
CSA	Comprehensive Site Assessment
COC	Constituents of Concern
COPEC	Constituents of Potential Ecological Concern
CSM	Conceptual Site Model
ELCR	Excess Lifetime Cancer Risk
EPC	Exposure Point Concentration
EPH	Extractable Petroleum Hydrocarbons
ES	Environmental Screening
ESI	Environmental Sensitivity Index
ESR	Environmentally Sensitive Receptors
ER-L	Effects Range - Low
GC/MS	Gas Chromatographs/Mass Spectrometer
GPS	Global Positioning System
HHRC	Human Health Risk Characterization
HI	Health Index
IRA	Immediate Response Action
IRAC	Immediate Response Action Completion
IRATCGP	Immediate Response Action Treatment and Completion Guideline Plan
ISI	Initial Site Investigation
LSP	Licensed Site Professional
MADEP	Massachusetts Department of Environmental Protection
MADMF	Massachusetts Division of Marine Fisheries
MADPH	Massachusetts Department of Public Health
MCP	Massachusetts Contingency Plan
MSRC	Marine Spill Response Corporation
NAPL	Non-Aqueous Phase Liquid
NHESP	Natural Heritage and Endangered Species Program
NOAA	National Oceanic and Atmospheric Administration
NRDA	Natural Resource Damage Assessment
NSR	No Significant Risk
NST	National Status and Trends
OHM	Oil and/or Hazardous Material
OPA 90	Oil Pollution Act of 1990
PAH	Polynuclear Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PE	Professional Engineer
PH	Professional Hydrologist
RAO	Response Action Outcome
RBTC	Risk-Based Threshold Concentrations
RP	Responsible Party
RPD	Relative Percent Difference
RTN	Release Tracking Number
SCAT	Shoreline Cleanup Assessment Team
SOW	Scope of Work
SVOC	Semi-Volatile Organic Compounds
TPH	Total Petroleum Hydrocarbons
UCLs	Upper Concentration Limits
USCG	United States Coast Guard
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
USFWS	United States Fish and Wildlife Service

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1.0 INTRODUCTION

GeoInsight, Inc. (GeoInsight)[1] and ENTRIX, Inc. (ENTRIX)[2] prepared this Phase II Comprehensive Site Assessment (CSA) Report ("Report") on behalf of Bouchard Transportation Company, Inc. ("Bouchard" or "RP") as part of response actions conducted under the Massachusetts Contingency Plan (MCP), 310 CMR 40.0000 associated with the release of Number 6 (No. 6) fuel oil from Bouchard Barge B120 that occurred on April 27, 2003 in Buzzards Bay (the "Site"). This Phase II CSA has been prepared under the direction of Richard J. Wozmak, P.E., P.H. of EnviroSense, Inc., the Licensed Site Professional (LSP)-of-record for this release. This Phase II CSA (the Report) was prepared following the Massachusetts Department of Environmental Protection (MADEP) approval of the Phase II Scope of Work (SOW) and Updated Conceptual Site Model (Updated CSM) submitted on August 24, 2005. The Phase II SOW was approved by the MADEP on June 27, 2006.

The data and information presented in the Report were derived from comprehensive qualitative and quantitative assessments of the Site, spanning in time from immediately following the release in April 2003 to the Phase II comprehensive response actions completed to date. These assessments include but are not limited to Shoreline Cleanup Assessment Team (SCAT) survey records; Immediate Response Action Completion (IRAC) survey records; Immediate Response Action (IRA) survey records; Phase I and Phase II survey records; analytical data and research; and previous MCP and Natural Resource Damage Assessment (NRDA) reports. The results of these assessments provide an account of:

- properties of the Barge B120 fuel oil and the environmental setting of Buzzards Bay;
- fate and transport of spilled oil; and
- nature, magnitude, and extent of the release.

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[1] *GeoInsight and EnviroSense were retained by Bouchard Transportation Co., Inc. to provide environmental services under the Massachusetts Contingency Plan.*

[2] *ENTRIX are scientific consultants who were retained by Bouchard to advise on scientific issues during the cleanup and removal stage and to advise on natural resource issues during the Natural Resource Damage Assessment (NRDA) conducted under the Oil Pollution Act of 1990 (OPA 90).*

The primary objectives of the Phase II CSA are to:

1. Characterize the magnitude and extent of residual oil using laboratory analytical data and qualitative surveys; and

2. Evaluate if a condition of No Significant Risk (NSR) to human health, public welfare, safety, and the environment is present at each of the remaining 63 segments.

The Report includes data collected from the segments remaining after the Partial Response Action Outcome (RAO) Report submitted to MADEP on May 21, 2004. The Report also includes a Method 3 Risk Characterization, as well as a Stage I Ecological Risk Assessment.

2.0 INCIDENT OVERVIEW

On or about the afternoon of April 27, 2003, an unknown volume of No. 6 fuel oil (estimated to be between 22,000 gallons and 98,000 gallons) was released from Bouchard Barge B120 (which was carrying approximately 4 million gallons of fuel oil) after entering the western approach of Buzzards Bay, Massachusetts. Additional information regarding this release was presented in the Updated CSM dated August 24, 2005. The precise volume of released oil was not determined due to the inherent difficulty of measuring the exact amounts of oil contained in the oil/water mixtures that were offloaded from the ruptured tank, and the unspecified quantity of cargo remaining in the lightering barge and the ruptured tank. The grounding location of the Barge B120 was estimated to be within a ½-mile radius of Buoy G-1, offshore and to the south of Gooseberry Point, Massachusetts. Refer to Figure 1 for the estimated track and approximate grounding location of Barge B120 on April 27, 2003. The RP immediately notified the United States Coast Guard (USCG) upon discovering the release.

On the evening of April 27, 2003, federal and state response agencies arrived on-Site. The federal and state agencies included the USCG, National Oceanic and Atmospheric Administration (NOAA), and the MADEP. Gallagher Marine Systems, Inc. (Gallagher), the firm retained by the RP to manage the emergency response on its behalf, arrived on scene and began to coordinate boom deployment and other immediate response activities to contain the spill and to coordinate cleanup activities. Over 1,500 feet of 16-inch containment boom were initially deployed around the barge's stern to contain the released oil within hours of the release being reported.

By the morning of April 28, 2003, the containment boom was deployed around the barge. The cleanup contractors, Clean Harbors Environmental Services, Inc. (Clean Harbors), the National Response Corporation, and Marine Spill Response Corporation (MSRC), arrived on the scene with cleanup crews, response equipment, and a fleet of vessels. Efforts to recover spilled oil and cleanup oiled shorelines were initiated on April 28, 2003. In general, recovery and cleanup operations included utilizing skimming boats, deployment of boom and sorbent material, power washing, and other manual techniques. Approximately 3,500 gallons of floating oil were removed during initial on-water recovery operations.

The Unified Command, consisting of the USCG (as the Federal On-Scene Coordinator), MADEP (the State On-Scene Coordinator), and the RP, was immediately established to direct and oversee cleanup operations. USCG also obtained input from NOAA representatives regarding cleanup operations and strategies. ENTRIX, the RP's environmental representative, arrived on-scene shortly after the spill event and began to collect environmental data and information for the NRDA process. On September 3, 2003, Unified Command completed cleanup operations specified under its May 23, 2003 Immediate Response Action: Treatment and Completion Guidelines Plan (IRATCGP), and GeoInsight was contracted to provide environmental services for subsequent response actions under the MCP. An IRA Plan was prepared by GeoInsight on September 15, 2003 to continue assessment and cleanup operations under the MCP.

Known information regarding the release, the fate and transport of the released oil, the areas where residual oil impacts may be present, the potential exposure pathways that may exist where residual oil is present, and human and ecological receptors associated with potential exposure pathways are presented in the Updated CSM submitted to MADEP on August 24, 2005. This Updated CSM supplements the initial CSM that was included as part of the May 3, 2004 Phase I Initial Site Investigation (ISI) and CSM Report.

In summary, winds and currents drove the released oil primarily to the north, northwest, and northeast in the days following the spill. The dispersion of oil by wind and current resulted in spotty and varying degrees of shoreline oiling, ranging from trace to relatively heavy amounts. Exposed southwest-facing shorelines generally received the highest degree of relative oiling. Shoreline oiling was unevenly distributed and generally concentrated at exposed points and peninsulas on the northern shore of Buzzards Bay. The Massachusetts municipalities where shorelines were oiled included Westport, Dartmouth, New Bedford, Fairhaven, Gosnold, Mattapoisett, Marion, Wareham, Bourne, and Falmouth. In addition, a few isolated areas of sporadic shoreline oiling were reported in parts of the Elizabeth Islands and Rhode Island (e.g., Little Compton and Block Island). In total, varying degrees of sporadic oiling stretched across approximately 84 miles of the Massachusetts shoreline, and most areas where oiling occurred were only lightly or very lightly oiled. Dozens of miles of shoreline within the general spill area were documented to be unoiled.

3.0 SITE DESCRIPTION

The Site is described primarily in terms of shoreline areas affected by the release and subtidal habitat. This section also includes a description of the physical and chemical properties of oil, sensitive receptors, as well as a description of the geology and hydrogeology of the region.

The oiled areas of shoreline were initially divided into 15 primary geographical divisions to facilitate cleanup operations. The Elizabeth Islands and divisions to the east of the Cape Cod Canal were labeled with an "E" prefix (three divisions), and the divisions to the west of the Cape Cod Canal were labeled with a "W" prefix (12 divisions). The initial divisions were subdivided into individual shoreline segments within the first month of the spill to direct and prioritize cleanup and response efforts, and to separately evaluate individual segments during SCAT reconnaissance visits. The shoreline was divided into a total of 149 shoreline segments that are listed in Table 1.

As described in the February 10, 2004 IRA Status report, 29 segments were documented to be unoiled and not part of the Site. Therefore, the Site was initially composed of 120 shoreline segments and one subtidal segment (i.e., the subtidal zone beneath Buzzards Bay) that were oiled as part of the release. As further described in Section 6.0, a Partial Class A-2 RAO statement was filed in May 2004 for 57 of those 120 shoreline segments where the maximum degree of initial oiling was characterized as "light" or "very light," and three sandy beach segments where the maximum degree of initial oiling was characterized as "moderate." These segments are also included in Table 1 and were conservatively categorized according to the maximum degree of oiling observed on a particular segment. The August 2005 Updated CSM explains in detail the characteristics that were used to develop the degrees of relative oiling. The Partial RAO statement submitted to MADEP on May 21, 2004 applied to the 57 shoreline segments where a Permanent Solution had been achieved pursuant to 310 CMR 40.1036.

The May 2004 Partial RAO statement and the Phase II CSA incorporated shoreline types for each segment as based upon the shoreline composition, public use, and vegetation, as classified by the Unified Command using the scheme presented below.

Shoreline Classification	Shoreline Type
1A	Heavily utilized, public recreational sand beaches
1B	Less utilized, semi-public and private sand beaches
1C	Mixed sand and gravel, gravel (pebble to boulder) and rip rap groins (jetties)
1D	Rip rap seawalls, bulkheads, piers, docks, and pilings
1E	Rocky shorelines
1F	Salt marshes
2	Roseate tern habitat (Ram Island, Bird Island, and Penikese Island, in particular)
3	Piping plover habitat

This site-specific classification was developed using the Environmental Sensitivity Index (ESI) codes, which were developed by NOAA (1999) in response to other oil spills to evaluate shoreline habitat type. This approach for shoreline classification is accepted by the scientific community in assessing and responding to oil spills. Shoreline substrates in the intertidal zone of Buzzards Bay are shown on Figures 2 through 5.

The 63 segments and subtidal zone that were not included in the May 2004 Partial RAO statement were evaluated as part of the Phase II assessment activities. The shoreline segments are listed in Table 2. The Phase II assessment activities also included shallow subtidal areas as further described below.

3.1 CHEMICAL AND PHYSICAL PROPERTIES OF NO. 6 FUEL OIL

No. 6 oil, like other hydrocarbons, is created through distilling crude oil and is composed of thousands of individual hydrocarbon compounds. No. 6 oil is commonly referred to as a heavy fuel oil since it is primarily composed of hydrocarbon compounds with higher boiling points that remain after the more volatile hydrocarbons (e.g., gasoline or No. 2 diesel) are distilled from crude oil. The hydrocarbon compounds remaining in No. 6 fuel oil are generally larger molecules with longer hydrocarbon chain lengths, higher viscosity, lower vapor pressure, and lower solubility. While there may be some overlap in the molecular weight of the individual hydrocarbons that comprise No. 6 and lighter fuels, the differences in general composition significantly influence their transport, fate, and persistence when released into the environment.

3.1.1 Physical Characteristics

The oil carried by the Barge B120 at the time of the release was a blend of relatively light and relatively heavy No. 6 oil, and it is unknown to what degree these two oil types were mixed together in the barge. The specific composition and characteristics of No. 6 fuel oil are variable and are a function of both the refining process used to distill the oil and the chemistry of the crude oil source. The origins and specific characteristics of the individual blends carried by the Barge B120 are unknown.

The oil carried by the Barge B120 was heated during transport (typically No. 6 oil is heated above 130°F to facilitate transport and transfer). The average temperature of the oil after loading was recorded to be 139.6°F. However, the grounding of the barge disabled the heating system and the oil began to cool after the grounding. In general, No. 6 oil has a density similar to seawater, although whether oil floats on seawater is dependent upon a number of factors, including oil and seawater temperature, and salinity. No. 6 oil, when heated, will typically float on seawater over a range of liquid temperatures when the salinity is at or above 15 parts per thousand. Since the average salinity of seawater is typically 35 parts per thousand, No. 6 fuel oil will float on it even after the oil has cooled to ambient temperatures.

3.1.2 Chemical Characteristics

On April 30, 2003, USCG collected eight source oil samples from tanks on the Barge B120 for PAH laboratory analysis. Laboratory analytical results indicate that naphthalenes were the most common PAH in the B120 oil, comprising approximately 30 percent by weight of the oil, with C2-naphthalenes being the predominant hydrocarbon fraction. The B120 oil contained lesser amounts of phenanthrenes and anthracenes, along with pyrenes and chrysenes. The relatively "heavy" (i.e., high molecular weight) PAH, such as benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-c,d)pyrene, were detected at very low concentrations. Other alkylated PAH (e.g, C2-naphthalenes, C1-phenanthrene/anthracenes, C3-fluoranthenes/pyrenes) were also present in the B120 oil. This PAH fingerprint is generally consistent with typical No. 6 oil, and is valuable in assessing the potential behavior and persistence of the oil in the environment as well as distinguishing the B120 oil from other petroleum hydrocarbons and non-petroleum hydrocarbon sources in the environment (i.e., combustion or "pyrogenic" sources). Refer to Section 8 for additional information regarding these non-B120 sources.

3.2 SENSITIVE RECEPTORS

Potential sensitive receptors identified in the spill area include water resources (aquifers, public and private water supply wells), critical habitats, threatened and endangered species, and humans. Information was obtained and reviewed to evaluate potential sensitive receptors in the Buzzards Bay area from the Natural Heritage & Endangered Species Program (NHESP) and Massachusetts Geographic Information Systems (MassGIS).

Review of the MassGIS Map indicated that areas to the east and southeast of the Cape Cod Canal, as well as the Elizabeth Islands to the south, are within a Medium Yield Potentially Productive Aquifer and a United States Environmental Protection Agency (USEPA)-Designated Sole Source Aquifer. A High Yield Potentially Productive Aquifer is located near the Cape Cod Canal. Municipal public supply wells near the shoreline are located in Bourne, Falmouth, Fairhaven, Mattapoisett, and on Cuttyhunk Island (part of the Elizabeth Islands). Non-community public water supplies are located near the shoreline in Westport, Dartmouth, and Wareham. The MassGIS information is summarized on the map identified as the DEP MCP 21E Buzzards Bay Map (MassGIS Map) attached in Appendix A.

The intertidal zone of the shoreline provides habitat for wildlife species, such as shorebirds and marine invertebrates. Information obtained from the NHESP indicated that several threatened or endangered species are present in certain areas of Buzzards Bay. For example, two bird species that utilize the intertidal zone of the shoreline for foraging habitat in this area include the roseate tern (*Sterna dougallii*), an endangered species under Massachusetts and Federal law, and the piping plover (*Charadrius melodus*), a threatened species under Massachusetts and Federal law. Several Buzzards Bay areas are designated as rare and critical habitats according to NHESP information.

Naushon and Pasque Islands (Elizabeth Islands) are designated as areas that may contain rare wetland habitats. Areas west of the Cape Cod Canal may also contain rare wetland habitats as well as Protected Open Spaces[3]. An Area of Critical Environmental Concern[4] is also present near Phinney's Harbor in Bourne.

In addition to wildlife habitats, residents and visitors also use portions of the shoreline for various commercial and recreational purposes. Buzzards Bay is comprised of various public and privately owned shoreline types, including sand beaches, mixed sand/gravel beaches and rocky shorelines. In general, people use the shoreline primarily for seasonal recreational activities, such as swimming, fishing, and walking. Public, semi-public, and private sand beaches are utilized by visitors, local residents, and fishermen. Rocky shorelines are also used for recreational activities, but to a lesser extent. Areas of Buzzards Bay are also utilized for commercial fishing and industrial transportation and production, such as New Bedford Harbor, a popular commercial and industrial port. There are also a number of marinas used for substantial industrial, commercial, and recreational boating.

The majority of residents in the surrounding area receive their potable water from municipal facilities. However, there are some communities surrounding Buzzards Bay that use private well water (e.g., Brandt Island residents in Mattapoisett). The majority of the communities surrounding Buzzards Bay use municipal sewer systems; however, there are existing private septic systems that may ultimately discharge to Buzzards Bay.

The subtidal environment in Buzzards Bay is part of the Site and is identified as a NHESP Estimated Habitat of Rare Wildlife in Wetland Areas. The subtidal zone is home to numerous marine species, including organisms that live in the ocean water, as well as in the subtidal sediment (e.g., clams).

The segment-specific MassGIS and NHESP maps of the remaining 63 shoreline segments are included as part of the data summary packages in Appendix B. The segment-specific MassGIS and NHESP maps of the 57 segments included in the April 2004 Partial Class A-2 RAO are included in that report.

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[3] *Protected Open Space means:*
(a) any federal, state or local government-protected open space, including, but not limited to, parks, forests and watershed lands;
(b) any land used for conservation purposes by a non-profit corporation, such as the Massachusetts Audubon Society, the Trustees of Reservation (excluding land held for its historic value only) and the Nature Conservancy; and
(c) excluding any privately held land associated with a conservation restriction or easement or controlled by a person other than a non-profit corporation or Agency.

[4] *Area of Critical Environmental Concern means an area which has been so designated by the Secretary of Environmental Affairs pursuant to 301 CMR 12.00.*

3.3 CHARACTERIZATION OF GEOLOGY AND HYDROGEOLOGY

3.3.1 Regional Geology

Bedrock geology in the Buzzards Bay area generally consists of crystalline igneous and metamorphic rocks. With the exception of 1E (rocky shorelines) shoreline segments, bedrock does not typically outcrop along Buzzards Bay, and bedrock is not expected to be impacted by this release.

Soil overlying bedrock in the vicinity of Buzzards Bay consists of till and outwash deposits that were deposited during the retreat of the continental ice sheet that was present near Cape Cod and the islands. Glacial till consists of undifferentiated material, ranging in size from clay to boulders. Outwash material is typically better sorted than till and generally consists of sandy material.

In general, the coastal areas of Buzzards Bay currently include inner harbors, small islands, public and private beaches, and marinas, which are comprised of various substrates. The Buzzards Bay shoreline includes beaches, salt marshes, tidal streams, tidal flats, rocky shores, and subtidal habitats. The majority of shorelines in Buzzards Bay are comprised of beaches, consisting of fine to coarse-grained sand and sand mixed with gravel to boulder-size rocks. Salt marshes and man-made structures are present along a sizeable portion of the Buzzards Bay shoreline (to a lesser extent than sand and mixed sand-gravel beaches). The salt marshes are located in intertidal areas typically behind barrier beaches, bordering pools or quiescent water, or along the banks of tidal rivers. Man-made structures within Buzzards Bay include docks, piers, and jetties. Natural rock outcroppings represent a small portion of the shoreline in Buzzards Bay.

The varying shoreline types comprising the coast of Buzzards Bay described above are the result of the interrelationship of the dynamic coastal processes. These coastal processes include wave and tidal action, currents, erosion, sediment transport, and accretion. The primary source of energy for coastal erosion and sediment transport is wave energy and currents. Loose particles, fractured rocks, and unconsolidated or weakly consolidated sediments are susceptible to wave erosion. Additionally, breaking waves also may throw particles against the shore, which leads to abrasion and scouring of shoreline materials. Generally, the majority of shoreline erosion occurs during the winter months by higher energy waves, such as those generated by nor'easter storms. Eroded materials dislodged by wave energy are then transported along the coast by tidal currents. Generally, the current in one direction is usually stronger than in the other resulting in a net one-way transport of sediment. Longshore drift, longshore currents, and tidal currents in combination determine the net direction of sediment transport and areas of deposition or accretion. Sediment accretion typically occurs in the summer months, which are more quiescent than in stormy winter months. Erosion typically occurs during winter storm events, where high-energy storm waves scour the intertidal shoreline sediments onto offshore bars, which provide sediment for shoreline accretion during the summer.

3.3.2 Hydrogeology

Massachusetts is comprised of two physiographic provinces: the Coastal Plain and the New England Upland. The Coastal Plain province includes the southeastern shorelines of Buzzards Bay and is characterized by plains and low hills underlain by a continuous blanket of unconsolidated sediments that cover bedrock. The uppermost 100 feet or more of the sandy sediments form the most productive aquifers in Massachusetts. The New England Upland province which includes the Seaboard Lowlands of the northwestern shorelines of Buzzards Bay is underlain by crystalline metamorphic and igneous rocks that are covered by a discontinuous mantle of till and stratified drift. Stratified drift, which partly fills the valleys of the New England Upland, forms small, isolated, productive aquifers that are scattered throughout the province.

The principal aquifers in Massachusetts can be grouped according to general rock type into stratified glacial drift, sedimentary bedrock, and crystalline bedrock. The southeastern shoreline of Buzzards Bay is comprised of the stratified-drift aquifer. Stratified glacial drift provides water for almost all public supplies that use ground water. The stratified-drift aquifer consists of layered sand and gravel with some silt. This aquifer was deposited over bedrock by glacial meltwaters as the last Wisconsin continental glacier retreated from New England.

The northwestern shorelines of Buzzards Bay are composed of the crystalline-bedrock aquifer. Rural areas rely mostly on the crystalline igneous and metamorphic bedrock aquifer for water supply. Water is present in secondary openings of the impermeable rocks (fractures, joints, and fault or shear zones). The crystalline bedrock aquifer is not used on Cape Cod, Martha's Vineyard and Nantucket because it occurs at great depth, contains saline water, or is overlain by readily accessible water in stratified-drift aquifers.

The Elizabeth Islands overlie a till aquifer that forms a fairly continuous cover over bedrock units. Till generally is not considered to be a source for water supplies except on the sparsely populated Elizabeth Islands because wells have small yields. However, these wells are susceptible to drought and pollution (USGS 1984).

In general, the overall ground water and surface water presumably flows from the mainland and toward Buzzards Bay and the ocean. Tidal fluctuations along the coastline may allow some salt water to migrate a short distance upstream in the mouth of streams and rivers, but in general, the fresh ground water and surface water in this area tends to flow towards the ocean, creating a stratified lens where the fresh water overlies the more dense brackish saltwater.

4.0 SUMMARY OF RESPONSE ACTIONS

A summary of response actions, including cleanup and remedial monitoring activities, are described in greater detail in the Phase I ISI and CSM, the August 2005 Phase II SOW and Updated CSM, and IRA Status Reports. A summary of these activities are presented below to provide an overview of characterization and remediation for the release of No. 6 oil in Buzzards Bay.

4.1 INITIAL CLEANUP ACTIVITIES

Cleanup activities were initiated by Unified Command shortly after the release occurred, and these initial cleanup activities continued until September 3, 2003, when the Incident Command Post was deactivated. Initial response action cleanup procedures and cleanup endpoints were conducted in accordance with the May 23, 2003 IRATCGP. The objectives were to remove as much oil on sandy beaches and mobile or "wipeable" oil from rocky areas as possible to balance the needs of shoreline cleanup for human use along with minimizing impacts to the marine ecosystem (and associated fishing and shellfish industries), and also to reduce impacts to non-marine species such as shorebirds.

The initial response efforts focused primarily on containment, removal, and cleanup of the spilled oil. On-water recovery efforts using skimming boats and deployment of boom and sorbent material were utilized to contain and recover spilled oil prior to stranding on the shoreline. Once oil was ashore, shoreline cleanup activities included manual removal of oiled substrate and material (e.g., wrack and rocks), high-pressure washing, manual wiping, use of sorbents (e.g., snare), substrate excavation, and other manual techniques. Emergency restoration, including re-planting of salt marsh vegetation, was also conducted during this time at several isolated areas. Field teams collected a variety of data during cleanup operations to identify oiled shorelines and prioritize cleanup of the oil. At some locations, Unified Command chose not to remediate small volumes of oil during the emergency phase, particularly on rock surfaces or in marshes where effective cleanup technologies could result in substantial environmental damage to the surrounding ecosystem. In total, approximately 5,341 tons of material were removed during the emergency response phase.

During the first week, daily (or twice daily) overflights were conducted to track the movement of the oil and to direct and prioritize cleanup operations. Overflights provided an opportunity to document the extent of shoreline oiling and were used in conjunction with field inspections to determine the extent of shoreline oiling and appropriate cleanup techniques.

The SCAT surveys were typically composed of representatives from the USCG, MADEP and ENTRIX, with occasional participation by representatives from United States Fish and Wildlife Service (USFWS), Massachusetts Division of Marine Fisheries (MADMF), Clean Harbors, and municipalities (or their designated representatives). The specific functions of the SCAT program included the following:

- Document the location, amount, and type (e.g., tarballs, patties, and splatter) of oil on the shoreline;

- Provide the planning and operations sections of the Unified Command with accurate shoreline oiling information to aid in cleanup operations; and

- Formulate recommendations to Unified Command on appropriate cleanup methods, and identify priorities and identify constraints or limitations (e.g., limited access to a particular area) under the direction of the Unified Command.

Shoreline Inspection forms completed by the SCAT surveys were included in previous GeoInsight submittals, including the September 12, 2003 First Status Report on Response Actions and the November 10, 2003 Second Status Report and Completion Report on Response Actions. Based upon SCAT records, a total of approximately 84 miles of shoreline in Massachusetts were estimated to be oiled to varying degrees. More than two-thirds of the oiled shoreline received only trace or light oiling. More detailed descriptions of shoreline oiling and additional information regarding shoreline characterization and remedial actions conducted by Unified Command are available in the Phase I ISI and CSM.

Unified Command developed cleanup endpoint criteria for each shoreline type (see table below). These criteria were dependent on shoreline type and were used as the basis to determine if the immediate response action was completed (IRAC) for each segment. Qualitative information from field teams were used by Unified Command to determine if each segment passed or failed these criteria.

Shoreline Classification	Shoreline Type	IRAC Cleanup Endpoint Criteria
1A	Heavily utilized, public recreational sand beaches	No visible surface or subsurface oil (not detectable by sight, smell, feel), to the maximum extent possible, as rapidly as possible.
1B	Less utilized, semi-public and private sand beaches	No visible surface, subsurface oil to trace (discontinuous film or spots of oil, an odor, or tackiness), to the maximum extent possible.
1C	Mixed sand and gravel, gravel (pebble to boulder) and rip rap groins (jetties)	No sheen, surface soil does not come off on the finger when touched, subsurface oil to trace (discontinuous film or spots of oil, an odor, or tackiness).
1D	Rip rap seawalls, bulkheads, piers, docks, and pilings	No sheen, oil does not come off on the finger when touched.
1E	Rocky shorelines	No sheen, oil does not come off on the finger when touched.
1F	Salt marshes	No sheen.
2	Roseate tern habitat (Ram Island, Bird Island, and Penikese Island, in particular)	No sheen, residual surface oil on rocky surfaces exposed at low tide does not come off on the finger when touched, intertidal vegetation and associated sediments are free of mobile oil, and intertidal vegetation and associated sediments do not provide a ready source of oil contamination to birds.
3	Piping plover habitat	Case-by-case evaluation and decision points.

When Unified Command agreed that the cleanup endpoint criteria were met for the individual segment or it was infeasible to achieve the specified endpoint criteria based upon the input from the field teams, the immediate response actions were deemed complete for that segment, and the emergency response shoreline cleanup operations ended. Shorelines that did not meet IRAC endpoint criteria generally failed due to very localized small areas of residual oil on rocks that came off to the touch during the inspections. The field teams inspected 106 of the 120 oiled shoreline segments.[5] Of these 106 segments, 91 segments met IRAC endpoint criteria, 10 segments did not meet IRAC endpoint criteria but further treatment was not feasible or not required, and five segments did not meet IRAC endpoint criteria and further treatment was feasible. Additional information regarding IRAC activities are included in the November 10, 2003 Second Status Report and Completion Report on Response Actions.

[5] *Some segments were not inspected during the emergency response (e.g., limited access). These segments were inspected by GeoInsight in the fall of 2003 and spring 2004 after the emergency response phase. In addition, some IRAC inspections were ongoing as part of continued buried oil inspections after September 2003 (e.g., Barney's Joy, East of barbed-wire).*

4.2 MCP IMMEDIATE RESPONSE ACTIONS

After September 3, 2003, evaluation and cleanup activities (if necessary) at shoreline segments transitioned from Unified Command to the LSP-of-Record. Unified Command continued to be involved in response actions related to the Site, and retained authority with regard to cleanup activities. GeoInsight, under the direction of the LSP-of-Record, responded to reports of oil from citizens and state and local officials and continued to conduct shoreline inspections similar to the IRAC inspections.

To continue response actions, an IRA Plan was developed and initiated in accordance with the MCP to address potential Imminent Hazards, if present, and to respond to time-critical conditions. The IRA Plan was divided into three components: 1) evaluate whether MCP IRA objectives were satisfied at segments that had not passed IRATCGP criteria; 2) assess the presence of buried oil; and 3) respond to public concerns and observations of residual oil along the shoreline.

The IRA Plan specifically focused on the potential for oil to mobilize and exacerbate current environmental conditions if not removed immediately. MADEP verbally approved the IRA Plan on September 3, 2003. The initial MCP IRA Plan was submitted on September 15, 2003 to MADEP and an IRA Plan errata sheet was submitted on September 25, 2003 in response to MADEP comments to the IRA Plan.

IRA cleanup activities generally consisted of removing isolated small tarballs (typically less than two inches in diameter) or wrack patties, wiping tacky oil from rocks using sorbent material, and removing small rocks with oil that could not be effectively wiped or cleaned. These activities were conducted by IRA reconnaissance teams during periodic shoreline inspections or in response to public observations reported to GeoInsight. During several IRA cleanup operations, additional personnel from Fleet Environmental Services, Inc. (Fleet) were retained to assist the field teams in cleanups at several segments, including Naushon Island, Brandt Island West, Hoppy's Landing (Long Island), Planting Island Causeway, and Strawberry Point West. In addition, the following IRA Plan Modifications and Proposed IRA Cleanup Activity Letters were submitted to MADEP for segment-specific IRA cleanup.

Report Date	Report Title	Segment Name and Identification
April 23, 2004	Immediate Response Action Plan Modification	Long Island and Causeway South (W2A-10)
June 8, 2004	Immediate Response Action Plan Modification	Long Island and Causeway South (W2A-10)
September 21, 2004	Proposed IRA Cleanup Activities	Brandt Island West (W1F-02)
December 1, 2004	Proposed IRA Cleanup Activities	Strawberry Point West (W1E-03)
August 16, 2005	Immediate Response Action Plan Modification	Harbor View (W2A-02)
November 18, 2005	Immediate Response Action Plan Modification	Long Island and Causeway South (W2A-10)
July 7, 2005	Proposed Additional IRA Cleanup Activities	Brandt Island West (W1F-02)
July 7, 2005	Immediate Response Action Plan Modification	West Island West (W2A-11)
April 5, 2006	Immediate Response Action Plan Modification	Pope's Beach (W2A-03)

MCP IRA cleanup activities resulted in the removal of approximately 13 tons of solid waste between September 3, 2003 and June 30, 2005. Specific information on IRA cleanup activities is summarized in IRA Status Reports dated February 10, 2004, September 16, 2004, March 23, 2005, September 23, 2005, and March 24, 2006.

5.0 CONCEPTUAL SITE MODEL SUMMARY

This section summarizes information pertaining to the fate and transport characteristics of the released oil that was described in the August 24, 2005 Updated CSM. The Updated CSM was developed using three lines of evidence to evaluate the initial movement and distribution of oil in Buzzards Bay and update the extent and magnitude of residual oil following cleanup activities. The lines of evidence consisted of:

- A literature review of information from other releases, including releases with similar oil properties or similar shoreline characteristics;

- A numerical model to evaluate aquatic and shoreline impacts caused by the release and to estimate the movement of floating oil around Buzzards Bay in the days immediately after the release; and

- Field inspections and sediment samples to characterize residual oil remaining after initial cleanup activities and MCP immediate response actions (activities included various sediment and water sampling, and visual shoreline surveys conducted since May 2003).

Based upon the existing literature and knowledge of the ambient conditions in Buzzards Bay, the large majority of No. 6 oil would be expected to float upon release. Small fractions of oil evaporated into the atmosphere or dissolved into the water column within hours of the release, and readily dissipated due to winds and/or currents. Some oil may have adhered to suspended solids on the water surface and sank into the water column as oil globules or tarballs. Heavy oiling on the shoreline tended to thickly adhere to the substrate, and there would be minimal evaporation or dissolution after coming ashore since the readily dissolved fraction or volatile fraction would have already dissolved or volatilized prior to coming ashore.

Natural degradation and natural attenuation over the ensuing months or possibly years would decrease the amount of residual oil remaining in the environment, and the residual oil that did remain would weather into an immobile crust or pavement that would be dry to the touch and generally not biologically-available. Natural attenuation would be greatest along exposed shorelines.

The heaviest oiling occurred on exposed, southwest facing shorelines, such as Barney's Joy and West Island. Minimal amounts of oil sank and formed sporadic tarballs that were highly localized in the vicinity of Barney's Joy during the spring and summer of 2003. By the end of the summer of 2003, there were no reports of substantial tarball occurrences in the Buzzards Bay spill area.

During three years of cleanup and monitoring efforts, a significant amount of oil in the form of semi-solid tarballs, tarmats, and pavement was removed from the Site. In order to target characterization efforts of the Phase II, the results of the three lines of evidence indicated that:

- Highly localized residual oil may be present in some intertidal areas generally as weathered splatter on rocks along relatively unexposed, mixed sand and gravel shorelines where the initial degree of oiling was characterized as moderate or relatively heavy.

- If residual oil were present in the subtidal zone, it would be limited to minimal oiling in the nearshore subtidal zone adjacent to mixed sand and gravel shorelines that were initially moderately to heavily oiled (e.g., Long Island) or in quiescent areas near these shorelines where erosional material may be deposited.

Further evaluation of these areas was conducted as part of the Phase II CSA activities to characterize potential exposure of residual levels of oil-related constituents to human and environmental receptors.

6.0 PHASE II SCOPE OF WORK OVERVIEW

The August 24, 2005 Phase II SOW provided MADEP with a proposed approach for Phase II CSA field work to characterize the remaining 63 shoreline segments and subtidal zone.

6.1 PHASE II CHARACTERIZATION APPROACH

Most of the oil that stranded in the intertidal zone was removed during the initial cleanup conducted under the direction of Unified Command and during subsequent MCP IRA activities. Of the 120 shoreline segments that were initially oiled, a condition of NSR was achieved at 57 segments, as described in the May 2004 Partial RAO report.

The Phase II characterization focused on evaluating residual oil at a subset of the 63 remaining segments that were considered to contain the most residual oil and/or contained sensitive receptors or habitat. This subset of worst-case segments included representative segments from each shoreline classification (e.g., the 1A/1B shoreline classification). The characterization of each shoreline classification would be based upon the characterization of these worst-case segments. Potential subtidal impacts were also characterized using a worst-case approach by focusing on evaluating subtidal areas where residual oil would most likely be present. In focusing upon evaluating potential worst-case conditions, this characterization is considered to be a conservative representation of conditions at the Site.

6.2 INTERTIDAL SHORELINE SEGMENTS

Twelve of the 63 remaining intertidal shoreline segments (approximately 20%) were selected to characterize particular intertidal shoreline classifications. These segments were selected based upon the results of qualitative and quantitative surveys conducted between the date of the initial release and June 2005 using the following criteria:

- the extent and magnitude of residual oil along shoreline segments during the most recent field surveys;
- the results of laboratory analyses of environmental media samples;
- the initial maximum shoreline oiling levels immediately following the release in the spring of 2003;
- the initial oiling index for each shoreline segment; and
- the IRAC status of each shoreline segment.

In addition, information on environmental resources within the Site was reviewed using these additional criteria:

- shoreline classification based upon NOAA's ESI and the Unified Command's IRAC designations;
- salt marsh habitat;
- known presence of threatened or endangered species;
- presence of NHESP priority habitat; and
- public accessibility/expected human use.

The results of this information review were used to develop segment selection criteria for existing residual oil, initial oiling, ecological ranking, and public accessibility. The primary emphasis was on the extent of residual oil in the most recent field surveys since those areas would be the most likely to pose a risk to ecological receptors and humans. The segment field surveys indicated that most of the 63 shoreline segments do not have any evidence of significant residual oil remaining in the intertidal zone. The residual oil in most of those segments where oil was observed consists of highly localized and weathered splatter on a few rocks. Therefore, the segments that had the greatest extent and/or degree of residual oil were selected for further characterization.

As described in the Updated CSM report, characterization of the selected intertidal shoreline segments focused upon mixed sand and gravel (1C) segments and marshes (1F) because the greatest degree of residual oil was expected to be present at these locations. The initial cleanup guidelines established relatively strict cleanup goals for sandy beaches (1A/1B), because these areas were heavily used by the public and residual oil could be easily removed by the cleanup crews. Mixed sand and gravel segments were comparatively difficult to clean, and residual oil on rock surfaces could not be efficiently removed in some locations. Relatively little, if any, residual oil is present at rocky shorelines and segments with manmade structures, such as rip-rap or jetties, because these are typically high-energy environments subject to strong wave action that scours residual oil. Residual oil in some marsh locations (1F) was not removed during the initial cleanup because of concerns that the damage from cleanup operations would outweigh the benefits. Therefore, the number of segments selected for characterization at each shoreline class is as follows.

Primary Shoreline Class	Number of Segments Selected for Phase II Characterization
Sandy Beaches (1A/1B)	2
Mixed Sand and Gravel (1C)	4
Rip Rap Seawalls, Bulkheads, Piers, and Rocky Shores (Bedrock Shores) (1D/1E)	1
Marsh (1F)	5

The following segments were selected to represent worst-case conditions existing at the 63 shoreline segments.

Segment Name	Segment Identification	Town
Aucoot Cove	W1D-01	Mattapoisett
Strawberry Cove	W1E-02	Mattapoisett
Crescent Beach	W1E-04	Mattapoisett
Brandt Island West	W1F-02	Mattapoisett
Mattapoisett Neck West	W1F-05	Mattapoisett
Harbor View	W2A-02	Fairhaven
Pope's Beach	W2A-03	Fairhaven
Long Island and Causeway South	W2A-10	Fairhaven
West Island West	W2A-11	Fairhaven
Round Hill Beach West	W3A-05	Dartmouth
Barney's Joy (West of Barbed Wire)	W3C-03	Dartmouth
Barney's Joy (East of Barbed Wire)	W3C-04	Dartmouth

A summary of the individual segments named above, including shoreline type and degree of oiling classifications, is presented in Table 3.

Visual inspections for residual oil also were conducted at Ram Island (W1G-00), Planting Island Causeway (W1C-02), and Strawberry Point West (W1E-03). Ram Island was initially heavily oiled; however, it is a known nesting site for roseate terns, an endangered species, and was not selected for quantified characterization in the Phase II assessment since periodic visual inspections have indicated that there is minimal oil remaining. The presence of sampling teams could be unnecessarily intrusive to the tern habitat. Visual inspections were also conducted at Planting Island Causeway and Strawberry Point as part of Phase II subtidal sampling field activities.

If the current conditions of these worst-case representative segments[6] support a conclusion that a condition of NSR exists to human health, safety, public welfare, and the environment, then the same conclusion can be applied for the segments with the same shoreline classifications (e.g., sandy beach) but to a lesser degree of oiling and/or environmentally sensitive habitat. Refer to Section 7.0 for further information.

6.3 SUBTIDAL AREAS

The subtidal zone is considered to be a single area for the purpose of Phase II characterization. The subtidal zone was characterized using a variety of methods, including dive surveys, chain drags, lobster pots deployed with absorbent material, numerical modeling, and sediment sampling. These characterization activities were described in the Updated CSM report. Subtidal sampling locations were proposed in the Phase II SOW to validate the Updated CSM, which concluded that significant oiling is

[6] *Portions of two of the above segments, Long Island and Causeway South (W2A-10) and Brandt Island West (W1F-02) are currently undergoing monitoring and/or remedial activities and are not considered representative of other segments.*

not expected to be present in the subtidal zone since no significant oiling was observed in qualitative or quantitative investigations conducted after the summer of 2003. Characterization of subtidal locations focused on areas that would theoretically have the greatest likelihood of residual oil, specifically adjacent to, and downcurrent from, shorelines that were initially heavily oiled or in the vicinity of the grounding site. The Updated CSM indicated that significant residual oil impacts are not expected to be present in the subtidal zone; however, small amounts of residual oil might be present in limited areas, including:

1. areas where the original slick was primarily present (i.e., nearshore subtidal off Barney's Joy);

2. adjacent to moderately or heavily oiled shorelines where natural processes scoured the oil from intertidal surfaces (e.g., Long Island and Causeway South (W2A-10) and West Island West (W1F-02)); and

3. quiescent areas adjacent to moderately oiled or heavily oiled areas where sand-sized particles eroded from the oiled shorelines could have been deposited (e.g., Demarest Lloyd State Park).

The Phase II characterization focused on characterizing the nearshore subtidal zone, which is defined as the marine habitat from mean low water to a depth of approximately 3 feet below mean low water. The subtidal zone is considered to be a single area across Buzzards Bay for the purpose of Phase II characterization. The locations selected for shallow subtidal sampling were adjacent to or in the near vicinity of the following segments.

Segment Name	**Segment Identification**	**Town**
Planting Island Causeway	W1C-02	Marion
Strawberry Cove	W1E-02	Mattapoisett
Strawberry Point West	W1E-03	Mattapoisett
Brandt Island West	W1F-02	Mattapoisett

A summary of the individual segments listed above, including shoreline type and degree of oiling classifications, is presented in Table 4.

7.0 PHASE II ASSESSMENT ACTIVITIES

The Phase II field activities were conducted in August, September, and October 2005 at locations selected to represent current conditions at the remaining 63 segments, as previously discussed in Section 6.0 and the August 2005 Phase II SOW. The field activities consisted of detailed visual inspections for residual oil and sediment sampling for laboratory analysis to characterize the extent and magnitude of residual oil.

Very little residual oil was observed along the shoreline, and the relatively minor residual oil that is present is primarily located in the middle and upper intertidal zones. The oil is typically present as weathered, hardened splatter (ranging from 0.5 inch up to four inches in diameter), and typically does not come off to the touch unless vigorously disturbed. The Phase II field inspection teams removed the small amounts of residual oil encountered during the field inspections, except where the oil was hardened and could not be easily removed, or at locations where additional IRA cleanup activities were considered (e.g., Pope's Beach and Hoppy's Landing). Refer to the IRA Status Reports for additional information regarding IRA cleanup activities.

7.1 FIELD SAMPLING ACTIVITIES AND LABORATORY ANALYSIS

At each sediment sampling location (intertidal, marsh, and subtidal) described in the sections below, a grab sample aliquot was collected from three discrete areas near the sample location (three aliquots per sample location). At the non-marsh intertidal sediment sampling locations, the aliquot sampling locations were oriented parallel to the shoreline and spaced approximately 30 feet apart. Three grab samples were collected from both the upper intertidal zone and lower intertidal zone at these intertidal sampling locations. Samples were collected from the upper intertidal zone and lower intertidal zone at the non-marsh intertidal sampling locations. At the marsh and subtidal sampling locations, the three aliquots were collected within an approximate 15-foot radius around the sample location.

The latitude and longitude of the center of each sediment sampling location was recorded using a hand-held global positioning system (GPS). Samples were collected from the zero- to six-inch depth interval by hand or using pre-cleaned stainless steel sampling implements and laboratory-supplied glassware. A schematic plan depicting the field sampling locations is included as Figure 6.

For each sediment sample location, approximately equal volumes of sediment from each individual aliquot were composited into a single sample by the laboratory for laboratory analysis. Sediment samples collected as part of this Phase II CSA were submitted for laboratory analysis for extractable petroleum hydrocarbons (EPH) fractions using MADEP methods and the 17 PAH target analytes by gas chromatograph/mass spectrometer (GC/MS).

7.2 INTERTIDAL SHORELINE SEGMENTS

Based upon the selection criteria established in the August 2005 Phase II SOW Report, and summarized in Section 6.0 above, 12 of the remaining 63 segments were selected to characterize each shoreline classification (1A/1B-sandy beaches, 1C-mixed sand and gravel, 1D/1E-rip rap seawalls, bulkheads, piers, and rocky shores, and 1F-marshes). Qualitative intertidal inspections were also conducted at two segments, Strawberry Point West (W1E-03) and Planting Island Causeway (W1C-02) as part of subtidal sampling activities. The primary shoreline types at Strawberry Point West and Planting Island Causeway are rocky shoreline (1D) and sand and gravel beaches (1C), respectively. Inspections based upon Phase II criteria for these two segments were conducted; however, this was not included in the Phase II SOW. The Phase II field activities consisted of the following.

- Visually inspecting shoreline segments for residual oil. If residual oil was observed, the field team evaluated the extent and magnitude of residual oil as well as the oil's physical characteristics, including tackiness and exposure potential.

- Collecting composite sediment samples of intertidal sediment for laboratory analysis of EPH fractions and PAH.

- Collecting composite samples of fringing marsh sediment for laboratory analysis of EPH fractions and PAH.

- Visually inspecting marshes and marsh inlets for stressed vegetation and residual oil, and collecting composite samples of marsh sediment at locations where residual oil was observed.

Refer to Table 4 for further detailed Phase II shoreline inspection information for the selected segments.

7.2.1 Sandy Beaches (1A/1B)

Twelve of the remaining 63 segments are characterized as primarily sandy beaches (1A/1B shorelines). Table 5 lists these 12 segments and includes the relative ranking criteria for each segment. Two of these segments, Round Hill Beach West (W3A-05) and Barney's Joy, West of Barbed Wire (W3C-03) were selected for the Phase II assessment activities because these segments were considered to represent the worst-case conditions for this shoreline class based upon initial degree of oiling since no segments formally classified as sandy beaches have continued to have visible residual oil present. Residual oil was not observed at these two segments during the Phase II shoreline inspections.

As part of the Phase II assessment, intertidal sediment samples were collected from three locations at Round Hill Beach West to represent conditions at this shoreline type. Additional intertidal sediment samples were not collected at Barney's Joy West because sediment samples had been collected in January 2004 for the Phase I ISI, and analytical

results indicated the residual oil concentrations were very low. The January 2004 samples represent worst-case conditions at this segment and are considered to be conservative because they represent conditions less than one year after the release where the initial oiling was characterized as heavy, and the degree of weathering at that time was less than the current degree of weathering.

Figure 7 shows the Phase II intertidal sediment sample locations at Round Hill Beach West and the analytical results are included in Table 6. Figure 8 shows the Phase I intertidal sediment sample locations at Barney's Joy West and the Phase I analytical results are included in Table 7.

In summary, residual oil was not observed at these segments, which primarily consisted of sandy beaches. One composite sample,W3A05-P2-LIT-02, collected at Round Hill Beach West, was forensically evaluated because PAH concentrations marginally exceeded an ecological screening benchmark. As described in Section 8.0 below, the relative concentrations and distribution of PAH compounds detected in this sample are attributable to a local condition indicative of a pyrogenic source that is unrelated to the Barge B120 release.

7.2.2 Mixed Sand and Gravel Beaches (1C)

A total of 25 segments of the remaining 63 segments are primarily composed of mixed sand and gravel substrate. Table 8 lists these 25 segments and includes the relative ranking criteria for each segment. West Island West (W2A-11), Barney's Joy, East of Barbed Wire (W3C-04), and Crescent Beach (W1E-04) were selected for additional intertidal sediment sampling and qualitative inspections during Phase II field work to represent the worst-case conditions for this shoreline class. In addition, Phase II activities along the Strawberry Point West (W1E-03) segment consisted of visual inspection of the rocky shoreline and salt marsh portion of the segment, as discussed in Section 7.2.3 and 7.2.4.

It is important to note that, as described in the August 2005 Phase II SOW, residual oil is present at a portion of the Hoppy's Landing area of the Long Island and Causeway South segment (W2A-10) and the degree of this residual oiling is substantially greater than at other 1C shoreline segments. Although Phase II inspection and sampling activities were conducted to characterize this segment, this segment is not considered to be representative of other 1C shoreline segments, and the characterization data from this segment was not used as a proxy for other 1C shoreline segments.

In addition to characterizing the segments that are classified as primarily 1C shoreline types, characterization was also conducted at a mixed sand and gravel portion of a segment that is classified primarily as 1D. Brandt Island West (W1F-02) is classified as primarily a 1D shoreline type due to the causeway to Brandt Island, but the Leisure Shores and Howard's Beach portions of the segment are mixed sand and gravel (1C). Characterization of the mixed sand and gravel portion of this segment is included with the characterization of the other 1C shoreline segments.

With the exception of portions of Hoppy's Landing (part of segment W2A-10) and Leisure Shores (part of segment W1F-02), only trace amounts of residual oil were observed in isolated areas of the 1C shorelines. These trace amounts were in the form of residual splatter on rocks with a typical diameter of about 0.5 inch and either slightly tacky or scoured to a stain. At isolated locations, hardened splatter was observed up to one inch in diameter on rock surfaces. In addition, a single one-inch diameter tarball assumed to be B120 (but was not fingerprinted) was found and removed from Brandt Island West, and areas of residual "pavement" at Crescent Beach and West Island West were observed and removed during the Phase II inspections or shortly after. The areas of residual "pavement" were mixed with sediment and embedded in between cobbles in the middle to upper intertidal zones, was weathered and hardened, and did not come off to the touch unless vigorously disturbed. The areas where residual pavement was encountered ranged between three square inches at West Island West to a 15-foot by five-foot area (discontinuous pavement within this area) at Crescent Beach. These areas of pavement have been removed.

The residual oil observed at portions of Hoppy's Landing and Leisure Shores was different from the residual oil observed at other shoreline segments, and the residual oil at these locations is not characteristic, and therefore, not representative of oil at other 1C shoreline segments. At Hoppy's Landing, most of the residual oil is present as small (generally less than 2 inches in diameter) areas of hardened pavement, but small amounts of tacky oil were observed in sheltered locations beneath rock surfaces, where natural weathering was limited. Sheens have also been observed in tidal pools in areas adjacent to the areas with pavement. IRA remedial activities were conducted in December 2005 (as described in a November 2005 IRA Plan Modification) to expose the tacky oil beneath rocks to natural weathering.

The residual oil observed at Leisure Shores in 2004 and 2005 was primarily present as tiny particles (typically identified as "particles") mixed with the sediment. These particles are not visible on the beach surface, and only appear on the water surface in test pits excavated on the beach. IRA cleanup activities were conducted most recently in July 2005 to expose by roto-tilling and removing these residual oil particles. Additional inspections will be conducted in the summer 2006 whether the subsurface oil particles persist at this location. Weathered oil splatter is also present on occasional cobbles. Refer to IRA Status reports for additional information regarding the oil particles and the cleanup operations.

As part of the Phase II assessment, intertidal sediment samples were collected from the four segments selected to represent conditions at the 1C shoreline type. Two to four designated intertidal sample locations were selected at each segment, as follows.

- West Island West: Intertidal sediment samples were collected at two locations (a total of four composite samples) at this segment to supplement the six intertidal sediment samples that were previously collected as part of the January 2004 Phase I ISI activities. One sample location was adjacent to the location of IRA cleanup activities

that were conducted in July 2005 to remove a small volume of oil-impacted sandy sediment, and the other sample location was near the southern point of West Island.

- Barney's Joy East: Intertidal sediment samples were collected at three locations (composed of one set of upper intertidal grab samples and one set of lower intertidal grab samples). Therefore, there were a total of six composite samples at this segment. The samples were collected from the south-facing side of Barney's Joy where the initial oiling was characterized as relatively heavy.

- Crescent Beach: Intertidal sediment samples were collected at two locations (a total of four composite samples) at this segment to supplement the six intertidal sediment samples that were collected in January 2004.

- Long Island and Causeway South: Intertidal sediment samples were collected at four locations (a total of eight composite samples) at this segment.

- Brandt Island West: Intertidal sediment samples were collected at two locations (a total of four composite samples) in the portion of this segment known as Leisure Shores Beach. Intertidal sediment samples were collected from the segment to supplement the nine grab sediment samples that were collected from Leisure Shores Beach in December 2004.

Intertidal sediment sampling locations at segments West Island West, Barney's Joy East, Crescent Beach, Long Island and Causeway South, and Brandt Island West are shown in Figures 9 through 13, respectively. Tables 9 through 13 summarize the Phase II analytical data at each segment. The sediment sampling laboratory analytical reports are included as Appendix C.

In summary, a trace amount of residual oil was observed at some of the segments characterized as primarily composed of sand and gravel substrate. The splatter is typically 0.5-inch diameter and either slightly tacky or scoured to a stain and does not easily come off to the touch. Low concentrations of EPH and PAH were detected in some of the sediment samples. For reference, EPH and PAH concentrations in the samples collected from the 1C shoreline substrate were not detected above applicable human health and ecological risk benchmarks. Refer to the Risk Characterization summarized in Section 9.0 and attached in Appendix D for additional information regarding the data evaluation.

7.2.3 Rip Rap, Seawalls, Groins, and Bedrock Shorelines (1D/1E)

A total of 14 segments of the remaining 63 segments are classified as having primary shorelines comprised of man-made structures or bedrock shorelines. Table 14 lists these 14 segments, and includes the relative ranking criteria for each segment. Brandt Island West (W1F-02), and portions of Planting Island Causeway (W1C-02) and Strawberry Point West (W1E-03) shown on Figure 13 through 15, respectively, were selected for Phase II assessment activities to represent the worst-case conditions for this shoreline

class. Brandt Island West is primarily a 1D/1E shoreline type; however, the mixed sand and gravel portion of the segment (Leisure Shores and Howard's Beach) were included in the evaluation of the 1C shoreline type, as discussed above in Section 7.2.2. Because these shoreline types typically have little to no intertidal sediment, the characterization focused upon visual inspection of exposed rock surfaces.

Based upon the Phase II inspection at Brandt Island West, a trace amount of residual oil is present on isolated rock surfaces. Residual splatter and small isolated areas of "pavement" were observed. The splatter was typically dime- to quarter-size, but also ranged up to six inches in diameter in some areas. The heaviest concentration of splatter was observed near the southern point of Brandt Island, where small clusters of splatter were observed approximately every five to 15 feet within a 200-foot area. In general, the splatter was located in the middle to upper intertidal zone on boulders and cobbles. The splatter was hardened, difficult to wipe off, and not tacky to the touch. Three small areas of residual "pavement" (up to four inches in diameter) were also found and removed from between cobbles in the middle intertidal zone on the west side of Brandt Island. The residual "pavement" was weathered and hardened, and did not come off to the touch unless broken apart. In addition, some very hard black tarballs (generally up to two inches in diameter) and splatter (generally ranging between dime-size and four inches in diameter) were observed on cobbles and boulders on the west side of Brandt Island. This black substance was much harder than the Barge B120 splatter and "pavement", and was not characteristic of the Barge B120 oil. It is believed that this black substance is remnant oil from a pre-B120 oil spill (based upon hardness and extensive weathered conditions) and is not associated with the Barge B120 release, and this oil was not removed by the field team.

The southern end of the Planting Island Causeway segment and an approximate 2,500 stretch west of Strawberry Point of the Strawberry Point West segment is very rocky, with rocks generally ranging from medium cobbles to boulders. This portion of Planting Island has periodic cement and rock jetties extending into the bay. Access to these areas was restricted (no parking), and terrain was moderately difficult to traverse. Trace amounts of splatter was observed between rocks and boulders primarily in the middle intertidal zone at both segments. The splatter was primarily dime-size; however, several larger deposits, approximately 3 to 4 inches in diameter, were observed. These deposits were no more than a centimeter thick, but could be pressed or scraped with a hard object.[7] The residual oil did not easily come off by touching or pressing the splatter.

7.2.4 Salt Marshes (1F)

Twelve segments of the remaining 63 segments are primarily salt marsh habitat, including fringing marsh (i.e., marshes along the shoreline edge) and back-barrier marshes (i.e., marshes separated from the ocean by a beach or berm). Table 15 lists these 12 segments, and includes the relative ranking criteria for each segment. Pope's Beach (W2A-03), Strawberry Cove (W1E-02), Harbor View (W2A-02), Mattapoisett Neck

[7] *Temperatures during the Phase II inspections of these segments was between 75 and 85 degrees Fahrenheit.*

West (W1F-05), and Aucoot Cove (W1D-01) were selected in the Phase II SOW for Phase II assessment activities to represent the worst-case conditions for this shoreline class. Although the primary shoreline classifications of Crescent Beach (W1E-04), Long Island and Causeway South (W2A-10), Brandt Island West (W1F-02), and Strawberry Point West (W1E-03) are not salt marsh, the fringing salt marshes located in these segments were also included in the evaluation of the salt marsh (1F) shoreline type.

Visual inspection for residual oil was conducted in fringing marshes, marsh inlets, and back-barrier marsh areas. A trace amount of sporadic residual oil was observed on the salt marsh surface, or on rock surfaces located on the marsh in isolated areas at the segments. Specific observations at individual segments are summarized below.

- A small amount of residual splatter was observed in one or two isolated areas on the fringing salt marsh including Strawberry Cove, Crescent Beach, Mattapoisett Neck West, and Aucoot Cove. The splatter was primarily 0.5 inch to two inches in diameter, with the exception of an area where splatter up to four inches in diameter was observed at Strawberry Cove. The splatter was either scoured to a stain or only slightly tacky, and this splatter was not removed during the Phase II inspections.

- Tarballs and tar patties were observed and removed at Aucoot Cove, Harbor View, Pope's Beach, and Strawberry Cove. The majority of tarballs were observed at Harbor View from an area where cleanup activities were conducted approximately two weeks prior to the Phase II inspection. The tarballs observed at this segment (up to four inches in diameter) were present in two peat hummocks in the intertidal zone. No more than one tarball and/or tar patty was found at each of the remaining three segments. The tarballs (ranging one to three inches in diameter) were found in the middle and upper intertidal zones. The tarballs were weathered and hardened, but tacky when pulled apart. The tar patties were tacky and mixed with wrack (up to five inches in diameter) and found on the surface of the salt marsh near the high tide line.

- Residual "pavement" was observed on and removed from the fringing salt marshes at Pope's Beach, Mattapoisett Neck West, Aucoot Cove, and Long Island and Causeway South (Hoppy's Landing) during or shortly after the Phase II inspections. The hardened residual "pavement" was present as discontinuous patches (patches typically less than one foot in diameter) that penetrated the surface marsh sediment up to a few centimeters, and did not easily come off to the touch. A small amount of residual "pavement" (measuring approximately one inch by one inch) observed at Mattapoisett Neck West was removed during the Phase II inspection. Residual "pavement" observed at Pope's Beach (discontinuous patches ranging between one to three inches within a 50-square-foot area) was subsequently removed as part of IRA activities conducted in April 2006. Refer to the forthcoming IRA status report for additional information regarding the cleanup activities at Pope's Beach. Sporadic patches (less than two inches in diameter) of residual "pavement" currently exist on the south-facing fringing marsh of Haskel Island, a small undeveloped island adjacent to Aucoot Cove. Discontinuous patches of residual "pavement" (ranging between less than one inch to five feet in diameter) are also present at Long Island and

Causeway South (Hoppy's Landing). The "pavement" is mostly hard to the touch, but some areas of "pavement" are tacky when pulled apart.

Evidence of oil was not observed in the back barrier salt marshes at Strawberry Point West and Brandt Island West.

The condition and health of the fringing marsh, marsh inlets, and back-barrier marsh areas were noted as part of the Phase II inspection. In general, the inspected salt marshes appeared healthy. The majority of vegetation was green, within the range of normal height, and was found to be growing through some areas of residual "pavement" (e.g., Pope's Beach and Hoppy's Landing). The condition and health of the marsh at each applicable segment are summarized in Table 16.

Naturally-occurring algal mats and erosion scarps, particularly in fringing marshes, were also observed at the above segments. Up to 14 algal mats were observed at each segment during the Phase II inspections. The algal mats were typically black and dark green in appearance and bare of vegetation, and ranged between approximately five feet and 100 feet long and two to 20 feet wide. Vegetation surrounding the algal mats appeared healthy and not stressed. Generally, the presence of algal mats appears to be common along the Buzzards Bay shoreline (including areas unoiled by the release) and not related to B120 oil. In May 2006 GeoInsight prepared a letter responding to the incorrect identification of some of the algal mats as remnant Barge B120 oil. A copy of the May 2006 GeoInsight letter, along with a supporting report prepared by Professor Jim Sears identifying algae in samples collected from these mats, is attached in Appendix E.

Marsh sediment samples were collected from selected segments (Pope's Beach, Strawberry Cove, Harbor View, Mattapoisett Neck West, Aucoot Cove, Long Island and Causeway South, and Brandt Island West) to evaluate the presence and magnitude of EPH fractions and PAH target analytes in the sediment. At each segment, samples were collected from one to six locations in the fringing marsh.

Figures 12, 13, and 16 through 20 show the marsh sediment sampling locations and the analytical results are included in Tables 12, 13, and 17 through 21. EPH and PAH concentrations were not detected above the screening benchmarks in the representative samples, with the exception of the following.

- one composite sample, W2A03-P2-M-03, collected at Pope's Beach; and
- three composite samples, W2A02-P2-M-02, W2A02-P2-M-03, W2A02-P2-M-04, and one grab sample W2A02-92905-01, collected at Harbor View.

As described in Section 8.2, the PAH detected in these samples are derived from local conditions indicative of wood ash or other pyrogenic sources and these PAH are not associated with the Barge B120 release.

7.3 SUBTIDAL AREAS

7.3.1 Subtidal Sediment Sample Collection

Table 22 lists the shoreline segments that are adjacent to the areas where nearshore subtidal sediment samples were collected to characterize sediment quality. A total of nine areas were sampled to characterize potential residual oil in nearshore subtidal sediment. In the summer of 2004, shallow subtidal sediment sampling was completed adjacent to five of the nine segments, including Pope's Beach (W2A-03), Sconticut Neck West (W2A-07), Demarest Lloyd State Park Beach (W3C-05), Barney's Joy East (W3C-04), and Long Island and Causeway South (W2A-10). The analytical results of the 2004 subtidal sediment sampling were included in the Updated CSM. In August and September 2005, Phase II shallow subtidal characterization was conducted adjacent to the remaining four segments: Brandt Island West (W1F-02), Strawberry Cove (W1E-02), Strawberry Point West (W1E-03), and Planting Island Causeway (W1C-02). Adjacent to each segment, one to eight designated sample locations were established in the sandy portions of the shallow subtidal zone. Refer to Table 4 for further detailed Phase II shoreline inspection information for the selected segments.

The nearshore subtidal sampling locations adjacent to Brandt Island West, Planting Island Causeway, Strawberry Point West, and Strawberry Cove are shown on Figures 13, 14, 15 and 17, respectively. Summaries of the Phase II analytical data at Brandt Island West, Strawberry Cove, Strawberry Point West, and Planting Island Causeway are presented in Tables 13, 18, 23, and 24, respectively. The nearshore subtidal sediment sampling laboratory analytical reports are included in Appendix C.

7.3.2 Shellfish Tissue Sample Collection

On April 12, 2006, additional shellfish tissue samples were collected by ENTRIX between Wilbur Point and West Island in Fairhaven, Massachusetts. These tissue samples were not proposed in the Phase II SOW, but were collected in response to a concern relayed to GeoInsight by the Fairhaven Shellfish Constable of unusual shellfish mortality south of Long Island. Details regarding the sample collection and analysis are the Shellfish Survey April 12, 2006 Quahog Tissue Analytical Results prepared by ENTRIX in Appendix F. Oil was not observed on the shells of the shellfish collected for this study, and oil sheens were not observed on the shellfish or dredged material. The analytical results indicated that total PAH concentrations detected in the shellfish tissue samples were less than the average total PAH concentration detected in shellfish from areas unaffected by the Barge B120 oil spill in 2003. ENTRIX concluded that there is no evidence that the Barge B20 oil spill is responsible for increased shellfish mortality.

7.4 DATA QUALITY ASSESSMENT AND EVALUATION

Samples collected during the field investigation were analyzed by the laboratory using MADEP-approved methods. The analytical results were consistent with the required reporting procedures outlined in the MADEP Compendium of Analytical Methods (CAM). The field samples were also collected in accordance with the sample requirements outlined in the CAM.

7.4.1 Data Usability Assessment

ENTRIX performed an independent quality assessment and validation of analytical data using quality control criteria established by the analytical methods and USEPA National Functional Guidelines for the Contract Laboratory Program.

A "Level II" validation was conducted for analyses of EPH and PAH in sediments collected as part of the Phase II assessment. The sediment samples were analyzed by Groundwater Analytical, Inc. in accordance with MADEP methodology for EPH and USEPA SW-846 methodology for PAH: measurement of EPH by MADEP-EPH-98-1 and PAH by 8270C. The data validation found that the samples were extracted and analyzed within the required holding times, that the laboratory quality control surrogate compounds were within acceptable limits, and that the quality assurance/quality control procedures and standards required for the method were substantially achieved. The results of the quality assessment and validation indicated that the laboratory parameters were within acceptable limits and that the data are suitable for use in site characterization and risk assessment.

As part of Phase II sample collection, one to two field duplicates and one to two samples for matrix spike analysis were collected for approximately every 15 samples. A total of six duplicate sediment samples were collected, as summarized below:

Sample Name	Duplicate Name	Segment
DDD-P2-01	W2A11-P2-UIT-02	West Island West (W2A-11)
DDD-P2-02	W2A11-P2-LIT-02	West Island West (W2A-11)
DDD-P2-03	W1E02-P2-M-01	Strawberry Cove (W1E-02)
DDD-P2-04	W3A05-P2-UIT-03	Round Hill Beach West (W3A-05)
DDD-P2-05	W1F05-P2-M-03	Mattapoisett Neck West (W1F-05)
DDD-P2-06	W1F02-P2-M-01	Brandt Island West (W1F-02)

The duplicate samples were collected and submitted for laboratory analysis to evaluate analytical precision. Analytical results for duplicate samples are presented in Table 25. The precision between the two samples is reported as the Relative Percent Difference (RPD), which is calculated using the equation:

$$RPD = \frac{(\text{Sample Concentration} - \text{Duplicate Concentration})}{(\text{Sample Concentration} + \text{Duplicate Concentration}) / 2}$$

The RPD value could only be estimated for one analyte (indeno(1,2,3-cd)pyrene) detected in one sample from Mattapoisett Neck West (W1F-05). The RPD value is 32%. The RPD value could not be calculated for the remainder of the analytes in the other samples because the analyte concentrations in one or both samples were below laboratory detection limits.

In general, RPD values of less than 50% are considered to be acceptable under USEPA data validation guidelines, although it is noted that the precision of testing results decreases as the analyte concentrations approach the laboratory reporting limits. The general rule to properly apply the RPD criteria is that the analyte concentrations should be at least 10 times the reporting limit. Because the detected concentrations in the duplicate samples were well below 10 times the reporting limit, the RPD values should be used with caution.

7.4.2 Data Representativeness Evaluation

As described in the August 2005 Phase II SOW, the Phase II characterization conservatively focused upon evaluating locations that are considered to be "worst-case" where potential residual oil would most likely be present. Therefore, the Phase II data set is conservatively biased because the data set focused upon these worst-case locations. To provide representative coverage in the intertidal zone, intertidal sediment samples were collected from both the upper and lower intertidal zones.

Whole sediment samples (i.e., sediment particulates and associated pore water) were collected at each sampling location and the analytical results are presented on a dry-weight basis. This is consistent with methodology followed during the sediment toxicity studies conducted as part of NOAA's National Status and Trends Program (NOAA NST Program) (Long and Morgan, 1991). ER-Ls were developed in this program using the results of dozens of whole sediment toxicity studies that incorporated sediment samples collected from major water bodies around the U.S. where it was known that a range of chemical contaminants co-occurred in the samples (Long and Morgan, 1991). A variety of benthic infaunal and epibenthic test organisms were used, including various amphipods and bivalve larvae, which are all sensitive to dissolved chemicals in porewater. Because ER-Ls were developed for organisms exposed to whole sediment, including porewater, ER-Ls directly address constituents dissolved in sediment porewater.

Based upon the information presented above, the data collected during the Phase II field investigation is considered to be both useable and conservatively representative to characterize the extent and magnitude of impacts, and for use in human health and ecological risk characterization.

8.0 CHARACTERIZATION OF BACKGROUND AND LOCAL CONDITIONS

Due to other potential sources of petroleum, EPH fractions, and PAH in the vicinity of Buzzards Bay, background concentrations and local conditions (described below) were evaluated as part of the Phase II characterization.

8.1 BACKGROUND CONDITIONS

Samples collected during the Phase II field investigation were used to evaluate background conditions of EPH fractions and PAH in Buzzards Bay sediment. Background is defined in the MCP (310 CMR 40.0006) as:

> *Those levels of oil and hazardous material that would exist in the absence of the disposal site of concern which are either:*
> *(a) ubiquitous and consistently present in the environment at and in the vicinity of the disposal site of concern; and attributable to geologic or ecological conditions, or atmospheric deposition of industrial process or engine emissions;*
> *(b) attributable to coal ash or wood ash associated with fill material;*
> *(c) releases to groundwater from a public water supply system; or*
> *(d) petroleum residues that are incidental to the normal operation of motor vehicles.*

Because the Site is very large (approximately 84 miles of shoreline in Massachusetts were initially oiled to varying degrees by the spill), with multiple uses along the shoreline, it was assumed that while there may be isolated areas of local impacts, there is not a single "background" concentration that would be ubiquitous and consistently present. In contrast to background, "local conditions" (see Section 8.2) are present in a relatively small area when compared to the overall area of a site. Therefore, for the purposes of this report, background concentrations of EPH fractions and PAH in intertidal and subtidal sediment were conservatively assumed to be at or below the laboratory detection limits for these fractions and target analytes. It is important to note that PAH are commonly detected in marine sediment samples collected from around the world.

Analytical results of sediment samples collected during the Phase II data collection indicate that concentrations of EPH fractions and PAH were at or below laboratory detection limits at some intertidal and subtidal sediment sampling locations. These conditions therefore indicate that concentrations of EPH and PAH are at background at these locations.

In addition to sediment samples, samples of shellfish tissue were collected (primarily within the first few months after the spill) for laboratory analysis of PAH. It is important to recognize that while background concentrations of PAH in sediment were assumed to be below laboratory detection limits, detectable PAH concentrations indicative of a non-B120 related "background" concentration was expected to be present in shellfish tissue.

Low concentrations of PAH can be dissolved in the water column or adhered to suspended sediment present in the water column from which the shellfish filter their food. The PAH are derived from non-B120 sources, such as combustion products from boat engines or power plants, incidental minor oil releases from marinas, or ash from burning combustibles (such as wood or coal). Although these PAH concentrations in suspended sediment are typically very low, the PAH accumulate in shellfish tissue because shellfish are not able to metabolize PAH. Over time, shellfish "depurate" or cleanse themselves of foreign matter (such as PAH from a sudden release) but shellfish will have a PAH concentration in their tissue associated with PAH normally present in their environment. Therefore, PAH concentrations in shellfish tissue can be ubiquitous and consistently present in Buzzards Bay (and also in other marine environments in Massachusetts), and the presence of some low concentration of PAH in shellfish tissue constitutes an expected background condition under the MCP. Elevated PAH concentrations in shellfish tissue samples collected from one particular location relative to other locations may indicate the presence of a local condition contributing PAH in excess of the background PAH condition in shellfish tissue.

Shellfish tissue samples were collected from unoiled areas and oiled areas within a week of the B120 oil spill in order to compare pre-spill conditions with those related to the release. While PAH concentrations in shellfish from initially oiled areas were relatively elevated compared to concentrations in shellfish from unoiled areas, PAH concentrations declined rapidly within four months following the spill. By May 2004, PAH concentrations in shellfish had declined to levels similar to unoiled areas, even in shellfish adjacent to the most heavily oiled shorelines.

PAH concentrations in Buzzards Bay shellfish tissue have been monitored by NOAA's Center for Coastal Monitoring and Assessment since the 1980's as part of the Mussel Watch Project. Data from the Mussel Watch website (http://www8.nos.noaa.gov/cit/nsandt/download/mw_monitoring.aspx) indicate that prior to the B120 oil spill, PAH concentrations were detected in shellfish tissue samples annually collected from six locations around the Bay between 1989 and 2002 at concentrations ranging between 75 micrograms of total PAH per kilogram of shellfish tissue (µg/kg) to 1,125 µg/kg, with a mean concentration of 275 µg/kg. For reference, the background PAH concentrations in shellfish tissue samples collected as part of the investigation for the B120 release (i.e., the most recent shellfish tissue samples collected from a particular sampling location that was initially oiled) ranged from 24 to 186 µg/kg, with a mean concentration of approximately 95 µg/kg.

The pre-spill shellfish tissue data collected by NOAA and the samples collected from unoiled areas since the release indicate the presence of non-B120 PAH at concentrations that are typically present in shellfish tissue throughout Buzzards Bay. Concentrations of PAH in shellfish tissue are currently at concentrations similar to or below pre-spill levels, and have been so since at least May 2004. It is important to note that although the most recent PAH concentrations in shellfish tissue samples were considered to be background concentrations (i.e., not associated with the B120 release), the exposure pathway of shellfish tissue ingestion (including these non-B120 PAH) were included in the human

health risk characterization (attached in the Method 3 Risk Characterization summarized in Section 9.0 and included as Appendix D) to be conservative.

8.2 LOCAL CONDITIONS

Local conditions are present in a relatively small area when compared to the overall area of a site, as opposed to background conditions, which are ubiquitous and consistently present across a large geographic area. It is important to recognize that EPH fractions and PAH are present in Buzzards Bay sediments from non-B120 sources. EPH fractions and PAH are found in petroleum products (i.e., petrogenic sources), in combusted material (i.e., pyrogenic sources), and in plant material (i.e., biogenic sources).

8.2.1 Potential Sources of Local Conditions

There are many potential localized sources of petroleum, EPH fractions, and PAH compounds that are present in the vicinity of Buzzards Bay. The communities along Buzzards Bay are diverse, and range from rural, undeveloped areas along the Elizabeth Islands, to relatively small residential communities such as Marion and Mattapoisett, and up to the City of New Bedford, a highly urbanized area, with an active, commercial harbor. Marinas and harbors are present in many of the communities around Buzzards Bay and fishermen and recreational boaters frequent Buzzards Bay daily. The sections below describe some of the local conditions that are present in Buzzards Bay, as well as observations of other potential sources recorded during field inspections.

8.2.1.1 Known Release Sites in the Vicinity of Buzzards Bay

Atlas Tack Corp. Superfund Site. The Atlas Tack Corp. Superfund site is comprised of approximately 24 acres, and was a former manufacturing facility. The facility is located at 83 Pleasant Street in Fairhaven, Massachusetts. From when it was built in 1901 to its closure in 1985, the Atlas Tack Corp. manufactured wire tacks, steel nails, rivets, bolts, and similar items. Operations associated with manufacturing these goods included electroplating, acid-washing, enameling, and painting. For approximately three decades prior to significant environmental legislation, process wastes containing acids, metals such as copper and nickel, and solvents were discharged by that facility to the municipal sewer and on-site lagoon, or were disposed of near the Boys Creek Marsh (USEPA, 2000). Surface drainage from the site discharges directly into Boys Creek along the north portion of the site and indirectly via overland flow into small tributaries and mosquito ditches. This Superfund site is located proximal to and upgradient of both Harbor View and Pope's Beach segments, and may have contributed to the presence of PAH in sediments of both segments.

In July and August 1990, USEPA, USFWS, and NOAA investigated the extent of Atlas Tack constituents of concern in sediments and soils of the streams and wetlands of Boys Creek Marsh. Sediment and soil samples were collected in a proposed near-field reference marsh (Girls Creek Marsh) and far-field reference marsh (West Island Marsh). Sediment samples were collected upstream of initial site boundaries and within Boys

Creek Marsh. Additional sediment sampling for quantitative analysis occurred in 1991 and 1992. The highest concentrations of semi-volatile organic compounds (SVOC), which includes PAH, were detected in upgradient locations, indicating potential runoff from residential and commercial areas. The next highest concentration of SVOC was from a location just south of the hurricane barrier in Boys Creek. Sediment samples contained at least 800 µg/kg (0.8 mg/kg) total SVOC (USEPA, 1995).

It is important to note that field teams observed substantial amounts of coal, slag, and cinders (suspected to be derived from the Atlas Tack Corp. Superfund Site) at both the Harbor View and Pope's Beach segments. Coal, slag, and cinders are indicative of historic combustion processes, and pyrogenic PAH associated with these combustion processes are present at these segments.

New Bedford Harbor Superfund Site. The 18,000-acre New Bedford Superfund Site is an urban tidal estuary with sediments that are contaminated with polychlorinated biphenyls (PCBs) and heavy metals. The Acushnet River discharges into the Harbor, and the degree of sediment contamination declines from north to south. Storm drains, combined sewer overflows, and industrial discharges, as well as smaller brooks and creeks, also discharge directly into the Harbor. Many industries have been located along the shores of New Bedford Harbor throughout the last century, including whaling, textile mills, and the rise of industries, such as Atlas Tack, that used petroleum-based products containing EPH and PAH. At least two manufacturers discharged industrial wastes containing PCBs into the harbor, resulting in the contamination of the harbor sediments from the upper Acushnet River into Buzzards Bay (approximately 6 miles) (Latimer et al. 2003; USEPA 2006). New Bedford Harbor is proximal to Harbor View and Pope's Beach segments.

The Site is divided into three operable units; the upper, lower, and outer harbors according to the degree of contamination and geography. There is little information available about the presence of PAH in New Bedford Harbor sediments, since the primary focus is to remediate the PCB and heavy metals contamination. However, the Army Corps of Engineers (1988) provided average PAH data from the sediment dredging project in the lower harbor, north of Popes Island. Average individual PAH concentrations range from detection limits of less than 1 mg/kg to 3.2 mg/kg (pyrene). Average upper harbor individual PAH concentrations ranged from the detection limit of 4.6 mg/kg to 11.8 mg/kg (benzo[b]fluoranthene and benzo[k]fluoranthene).

These data indicate that although there may not be an individual source of PAH, these compounds are ubiquitous throughout this historically industrialized area, given nearly 200 years of development and population pressure.

Other Release Locations. Petroleum releases have been documented at many locations in the vicinity of Buzzards Bay, particularly at marinas and boat harbors. For example, releases of oil are documented at the Seaport Marina in New Bedford Harbor (RTN 4-17210), Onset Bay Marina in Wareham (RTN 4-15585), and Marion Harbor in Marion (RTN 4-16784). Many of these releases are considered to be adequately regulated (e.g.,

response actions are conducted by USCG) and RAOs have been filed for other releases. However, residual petroleum impacts may remain at some of these release locations, even at locations where an RAO has been submitted. For example, a Class A-2 RAO indicates that while no significant risks are present, the release has not been remediated to background conditions, as defined in the MCP.

8.2.1.2 Documented Marine Releases

Other releases of petroleum to Buzzards Bay have occurred historically, and residual impacts from these hydrocarbons may be present at some locations in Buzzards Bay. These documented marine releases were summarized in the Updated CSM and include:

Incident Name/Vessel Name	Date	Location	Gallons Spilled	Type of Oil/Product
Unknown	1940s	Western Buzzards Bay, Westport	Unknown	No. 2 Fuel Oil
Unknown	1963	Near Nyes Neck (North Falmouth)	Unknown	No. 2 Fuel Oil
Florida	September 16, 1969	Fassets Point (West Falmouth)	189,000	No. 2 Fuel Oil
Barge B65	October 9, 1974	Cleveland Ledge (near canal entrance)	11,000 to 37,000	No. 2 Fuel Oil
Barge B65	January 28, 1977	Cleveland Ledge	81,144	No. 2 Fuel Oil
Bermuda Star	June 10, 1990	Cleveland Ledge	7,500	No. 6 Fuel Oil
Barge B145	June 18, 1990	Cleveland Ledge	100 to 200	Diesel or heating oil
Queen Elizabeth II	August 7, 1992	Sow and Pigs Reef, Cuttyhunk	50	Fuel Oil

The specific shoreline locations impacted by these releases are unknown, and amount of residual petroleum impacts remaining from these releases is also unknown. However, residual oil that is not characteristic of the B120 release and suspected to be from one of these releases was observed at some locations along the Buzzards Bay shoreline.

8.2.1.3 Undocumented Marine Releases

In addition to the documented marine releases described in Section 8.1.2.2 above, evidence of other marine releases not associated with the B120 release were observed along the Buzzards Bay shoreline by the field inspection teams. The differentiation between the B120 release was based primarily upon visual observations of the observed petroleum relative to known B120 oil, supplemented with forensic evaluation of some petroleum samples that had similar visual characteristics as the B120 oil. Refer to the

forensic evaluation report included in Appendix G for additional information. A summary of some of the non-B120 petroleum observed on the shoreline by the field inspection teams is included below.

Elizabeth Islands. During the field inspections conducted on the Elizabeth Islands, large areas of hardened "pavement" (ranging up to approximately 10 by 40 feet and several inches thick) were observed on Naushon, Pasque, Nashaweena, and Weepecket Islands. The pavement appeared to be primarily of gravel-size particles in a hardened petroleum (similar to tar) matrix. When the pavement was broken, the unweathered interior portion appeared to be soft. Some areas of hardened splatter on rock surfaces that appeared to be composed of the same oil were also observed on these islands. This pavement and splatter appeared to be the remnants of an old heavy oil (No. 6 fuel oil or asphalt) spill. The age of the spill is unknown, but is likely several decades old, based upon the hard texture.

Holly Woods, Mattapoisett. In July 2004, GeoInsight received a telephone call from the resident at 8 Holly Woods Road in Mattapoisett, who reported visible globules of "soft, mushy oil and some hardened pancakes of oil" on his private beach at that location. This beach area is located within shoreline segment W1D-04 (Holly Woods/Peases Point). During the initial cleanup activities conducted in the summer 2003 under the Unified Command, MADEP conducted a limited cleanup of this area due to the discovery of old oil that was derived from a previous oil spill and not related to the B120 incident. The resident indicated that the newly observed oil was similar in appearance to the oil that was stranded on his shoreline in 2003 following the B120 oil spill.

Isolated surficial "globs" of liquid oil ranging in size from 6 to 8 inches in diameter were observed on the sand surface in the upper intertidal zone. The oil was black, semi-liquid, and had a potent petroleum odor. Test pit excavations revealed that the oil extended below the surface in the sandy areas, primarily in the upper intertidal zone. Most of the oil was covered with a veneer of sand, and was located on top of a layer of peat. A layer of the same oil was present in an adjacent marsh area. The observed oil in the marsh was located at a depth of 6-12 inches below ground surface (the marsh appeared to have grown over the oil layer) and was soft and tacky.

Based upon the location of the oil (where the marsh had grown over the oil layer, indicating a substantially older release) and forensic evaluation of samples collected from the oil, this oil was not associated with the B120 release and appeared to be some type of asphalt that had stranded ashore during a previous unknown release. MADEP is currently conducting response actions at this location for this unknown release of oil.

Scraggy Neck, Falmouth. During field inspections at Scraggy Neck in Falmouth, the inspection teams observed hardened splatter on some rock surfaces that was substantially harder than the B120 oil. This splatter appeared to be associated with the No. 6 fuel oil release from the *Bermuda Star* in 1990.

Strawberry Point West, Mattapoisett. During a field inspection of Strawberry Point West on October 27, 2004 the inspection team found approximately 20 diesel-soaked absorbent pads on the shoreline. The pads appeared to have washed ashore and were likely dumped into the water from a vessel in Buzzards Bay. The inspection team removed the absorbent pads, but the presence of these pads suggests other marine oil releases (e.g., bilge pumping) that are not reported.

8.2.1.4 Other Potential Sources

There are several other potential non-B120 sources of petroleum, EPH fractions, and PAH that are present in the Buzzards Bay area. For example, normal operations at marinas may release incidental petroleum that is not reportable under the MCP. Fire pits on the shoreline are used by residents and beach goers for a variety of purposes (e.g., clambakes) and PAH derived from wood ash may be present along the immediate shoreline from these fire pits. The inspection teams also observed many other non-B120 sources of EPH fractions and PAH along some areas of the shoreline, including coal, slag, cinders, asphaltic roofing material, engine grease, vegetable oil containers, tires, and roadway pavement.

8.3 FORENSIC EVALUATION OVERVIEW

The presence of coal ash and wood ash, particularly at the Pope's Beach and Harbor View segments (adjacent to the Atlas Tack Corp. Superfund Site) are suspected to contribute to the PAH detected in these samples. Evaluating the presence of coal ash and wood ash in samples was described by the LSP Association in an October 19, 1999 paper titled *Methods for Evaluating Application of the Coal Ash and Wood Ash Exemption Under the Massachusetts Contingency Plan*. This paper includes concentrations of PAH detected in coal ash and wood ash samples selected for study, and presents recommendations for evaluating the presence of pyrogenic sources, including forensic evaluation of selected samples.

Forensic evaluation was conducted for several samples, including some samples collected for the Phase II investigation as well as some samples collected prior to the Phase II investigation to evaluate whether the PAH detected in the samples was derived from a pyrogenic or petrogenic source. If the PAH were derived from a petrogenic source, the evaluation considered whether that source was the B120 release. For this Phase II investigation, the forensic evaluation considered Phase II samples collected from Pope's Beach (W2A-03), Harbor View (W2A-02), and Round Hill Beach West (W3A-05), where analytical results indicated anomalously elevated PAH (particularly PAH that are typically characteristic of pyrogenic sources) detected in several samples. The forensic evaluation concluded that the PAH detected in these samples are primarily derived from non-B120 pyrogenic sources and can be considered to be a local condition. Additional information regarding the forensic evaluation is included in the forensic evaluation summary attached as Appendix G.

9.0 RISK CHARACTERIZATION SUMMARY

A Method 3 Risk Characterization was conducted to evaluate the risk of harm to health, safety, public welfare, and the environment associated with potential exposures to spill constituents detected in environmental media affected by the release of No. 6 fuel oil from Barge B120 that occurred on April 27, 2003. The characterization was conducted in accordance with the requirements of the MCP (Subpart I) and the MADEP *Guidance for Disposal Site Risk Characterization* (July 1995 and updates). A Method 3 Risk Characterization is a cumulative, Site-specific risk approach that addresses potential cumulative impacts to identified human and ecological receptors. It also characterizes the risk of harm to safety and public welfare. This method is used when environmental media other than (or in addition to) soil and ground water (e.g., air, sediment, surface water) have been affected by a release of oil and/or hazardous material (OHM). In this case, a Method 3 Risk Characterization was conducted because sediment, weathered oil, and shellfish tissue were initially identified as potential environmental media of concern. The purpose of the risk characterization is to determine whether a condition of No Significant Risk (NSR), as defined in the MCP (310 CMR 40.0006)[8], has been achieved at the Site under current and foreseeable future uses and activities. In this characterization, worst-case conditions were identified as discussed in Section 7.0 for the primary intertidal shoreline types and subtidal area.

9.1 HUMAN HEALTH RISK CHARACTERIZATION SUMMARY

The human health risk characterization used the following two methodologies to evaluate potential risks: 1) a traditional Method 3 Risk Characterization which assumes residential exposures to environmental media of concern using data collected from worst-case samples used in forward progressing risk calculations; and 2) development of screening benchmarks to residential exposure to environmental media of concern using conservative exposure scenarios.

9.1.1 Traditional Method 3 Risk Characterization

Traditional forward progressing risk calculations were used to support a Method 3 Human Health Risk Characterization (HHRC). The risk calculations were performed using maximum detected concentrations in each potential environmental media of concern and are included in Attachment IV to Appendix D. In a traditional Method 3 HHRC, a site- and receptor-specific Hazard Index (HI) for potential non-cancer risks and an Excess Lifetime Cancer Risk (ELCR) for potential carcinogenic risks are calculated from exposure point concentrations (EPC), exposure assumptions, and toxicological information. In this case it was assumed that residents were exposed to constituents of concern (COC) in sediment, shellfish, and weathered residual oil. The cumulative HIs representing risk estimates from COC in these three media were less than MCP risk limits (non-cancer risk limit HI = 1, carcinogenic risk limit ELCR = 1×10^{-5}).

[8] *"No Significant Risk means a level of control of each identified substance of concern at a site or in the surrounding environment such that no such substance of concern shall present a significant risk of harm to health, safety, public welfare or the environment during any foreseeable period of time." 310 CMR 40.0006*

The results of the forward-calculated risk characterization indicated that HI values were less than 1 and ELCR values were less than 1×10^{-5}, indicating that a condition of NSR exists for human health using this conservative exposure scenario (i.e., using maximum detected concentrations in each potential media of environmental concern).

9.1.2 Development of Risk-Based Threshold Concentrations

Site-specific risk-based threshold concentrations (RBTC) were developed to serve as benchmarks for the screening evaluation of COC in site media that might pose potential human health risks at some point in the future. RBTC for relevant environmental media (sediment and weathered residual oil) were developed relying on the basic structure outlined in the MCP for Method 3 Risk Assessments and recommended by the USEPA. Using conservative exposure assumptions, appropriate toxicity and carcinogenicity information, and target MCP cumulative risk limits for carcinogenic and non-carcinogenic effects, RBTC for environmental media were "back-calculated." These RBTC were used as screening benchmarks against which EPC for each environmental medium of concern were compared in order to determine the potential for human health risk. RBTC represent media-specific maximum acceptable concentration thresholds for constituents of concern (COC) below which a condition of NSR to human health exists. If the RBTC were exceeded, a more site-specific human health risk assessment would be conducted.

RBTC were developed for total PAH (including concentrations of detected EPH fractions) to assess non-cancer risks[9] , and RBTC were developed for benzo(a)pyrene equivalents (BaP)[10] to assess carcinogenic risks. No RBTC were derived for surface water because concentrations of COC were at or below detection limits in this medium within weeks of the spill and it is therefore not a medium of concern. Likewise, no RBTC were derived for COC in shellfish tissue as this was demonstrated to be an insignificant exposure pathway, and PAH concentrations in shellfish collected in affected shoreline segments were consistent with pre-release region-wide values.[11] Non-cancer and carcinogenic RBTC were developed for each of the following four residential exposure scenarios[12]:

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[9] *C_{11}-C_{22} aromatic fraction non-cancer toxicity value was used.*

[10] *The toxicity of known carcinogenic PAH are in terms relative to benzo(a)pyrene. Concentrations of detected carcinogenic PAH were converted to equivalent concentrations of BaP based upon the relative toxicity values.*

[11] *Note that ingestion of shellfish tissue was included in the forward-calculated risk characterization in order to demonstrate that this pathway does not contribute significantly to overall cumulative risk estimates..*

[12] *The exposure pathway "consumption of shellfish" was included in the forward calculations and the potential risk estimates were orders of magnitude less than risk estimates generated for sediment and weathered oil exposure pathways.*

1. Dermal contact with sediment;
2. Incidental ingestion of sediment;
3. Dermal contact with weathered, residual oil; and
4. Incidental ingestion of weathered, residual oil.

The minimum non-cancer and carcinogenic RBTC for each media were selected as the most conservative screening benchmark for the assessment of potential human health risks. Conservative yet representative exposure assumptions were used to develop these RBTC, as described in detail in Appendix D.

Sediment EPC for total PAH were compared to the minimum sediment non-cancer RBTC, and sediment EPC for BaP equivalents were compared to the minimum sediment cancer RBTC. Similarly, the minimum non-cancer and cancer RBTC calculated for weathered oil were compared to a weathered oil sample collected from Harbor View in Fairhaven (collected in June 2005). The weathered B120 oil sample from Harbor View is considered to be representative of the worst-case conditions of residual oil along the shoreline.

A condition of NSR to human health was concluded to exist for worst-case representative segments with EPC that are less than the conservative RBTCs, and the same was assumed true for all remaining segments of that shoreline type that were characterized as having less residual oil (i.e., not "worst-case"). If an EPC were to exceed one or more RBTC, indicating the presence of potential risks to human receptors for that shoreline segment type or subtidal area, a more refined segment-specific risk characterization would have been conducted to better define specific areas within individual segments that might need additional response actions.

Based upon the data and comparisons described in this assessment, none of the total PAH or BaP concentrations detected in sediment or weathered oil exceed the calculated RBTC, supporting the conclusion of NSR to human health at this Site. Because the RBTC represent concentrations at which cumulative non-cancer and cancer risks for current and future residential exposures do not exceed applicable MCP risk limits, a condition of NSR of harm to human health has been achieved at the Site.

9.2 SAFETY RISK CHARACTERIZATION SUMMARY

No safety hazards, such as corroded drums, lagoons, threat of fire or explosion, or uncontained materials with characteristics described in 310 CMR 40.0347 are associated with this release. The small amounts of residual oil on the shoreline (primarily small, isolated areas of weathered splatter) are hardened and do not present a slip and fall hazard. Therefore, a condition of NSR of harm to safety exists at the Site.

9.3 PUBLIC WELFARE RISK CHARACTERIZATION SUMMARY

The potential risk of harm to public welfare considers the existence of nuisance conditions, loss of another person's active or passive property use, and nonpecuniary

costs that may accrue due to the degradation of public or private resources directly attributable to the release of OHM. The risk of harm to public welfare was evaluated using two criteria: 1) comparing concentrations of detected constituents to appropriate Upper Concentration Limits (UCLs) defined in the MCP; and 2) evaluating the potential for the existence of a nuisance condition to the degree that would limit the use of the shoreline under current and reasonably foreseeable future uses that is directly attributable to the release of OHM.

Concentrations of EPH fractions and PAH in sediment samples were compared to the applicable UCLs in soil (although it is recognized that the soil UCLs are not directly applicable to sediment concentrations), and these concentrations were below soil UCLs for those analytes. Although small amounts of weathered residual oil splatter (i.e., dime or quarter size, occasionally an area of 4 by 4 inches) may be present in some shoreline areas, the splatter is discontinuous, less than ½ inch thick, and does not constitute a UCL exceedence for non-aqueous phase liquid (NAPL). The splatter is not readily visible or distinguishable from algae and other naturally occurring dark patches on rocks.

The potential risk of harm to public welfare was also evaluated for the potential for residual oil to create a nuisance condition (such as rubbing off on skin when touched) to the degree that could significantly limit public or community use (active or passive) of each intertidal shoreline segment. In a memorandum attached to the MADEP June 27, 2006 Phase II SOW Addendum approval letter, MADEP provided additional Site-specific guidance on evaluating potential risks to public welfare, which included the visual and/or olfactory evidence of oil residuals that may discourage use of otherwise publicly accessible shoreline due to the potential for contact and adherence to their skin, or if residual oil would adversely impact the economic interest of a region. It is important to note that while there may be a risk of contact to a small amount of oil, this does not necessarily constitute a significant risk. In accordance with the MADEP guidance, a condition of No Significant Risk to public welfare exists in the subtidal zone and at all but two localized areas within the intertidal segments. Although isolated splatter may be present in some intertidal locations, the splatter is weathered and hard to the touch, and contact with this splatter would not create a nuisance condition.

In summary, a condition of No Significant Risk to public welfare exists at 61 of the remaining 63 shoreline segments, as well as the subtidal zone. The localized areas where residual oiling has been characterized as presenting a potential nuisance condition (and therefore different from residual oil in other areas) are a portion of the Leisure Shores location of segment W1F-02 and the southern tip of Hoppy's Landing in segment W2A-10. Residual oil at portions of segments W1F-02 and W2A-10 could potentially create a nuisance condition if the residual oil was encountered by residents, therefore, a condition of No Significant Risk to public welfare has not been demonstrated at these two locations at this time.

9.4 ENVIRONMENTAL RISK CHARACTERIZATION SUMMARY

In accordance with MADEP (1996, 2006) and consistent with relevant USEPA guidance (including USEPA 1998), the Stage I Environmental Screening (ES) eliminates from further evaluation those situations in which either: (1) the exposures are clearly unlikely to result in environmental harm; or (2) those exposures where environmental harm is readily apparent. The objective of the ES was to provide a screening-level assessment of potential risks to ecological receptors at the Site associated with exposures to concentrations of PAH and petroleum fractions detected in sediment samples. This was accomplished by characterizing the constituents of potential ecological concern (COPEC) detected, identifying potential environmentally sensitive receptors (ESR), identifying constituent migration pathways connecting the COPEC with ESRs, and comparing constituent concentrations found in environmental media to protective "benchmark" concentrations.

Since this is a screening-level assessment, this assessment conservatively evaluated the most sensitive species of concern exposed to worst case conditions. The intertidal and shallow subtidal zone of the shoreline provides habitat for wildlife species such as shorebirds, fish, and marine invertebrates. Potential primary environmental media of interest include surface water, surficial sediments, and residual oil. Since constituents in surface water declined to detection limits within weeks of the release, this media does not currently pose a complete exposure pathway. The potentially complete exposure pathways were identified as follows:

- Benthic macroinvertebrates exposed to sheening due to residual oil and PAH in sediments via direct contact and through incidental ingestion; and,

- COPECs can be taken up by the root systems of marsh plants through direct contact with sediment.

In effects-based screening, EPC are compared to conservative benchmarks. Effects Range-Low (ER-L) values derived by Long and Morgan (1995) are accepted in the scientific community as conservative benchmarks used to screen constituent concentrations in marine sediment. These values represent the 10^{th} percentile of concentrations at which exposure resulted in some measurable or observable effect in benthic organisms. None of the spill-related exposure point concentrations exceeded applicable ER-Ls. No sediment phytotoxicity screening benchmarks for PAH compounds have been developed by NOAA or other regulatory agencies for coastal wetland salt grasses (i.e., Spartina alterniflora). Suitable phytotoxicity benchmarks for Spartina were derived based upon published scientific literature. The minimum applicable concentrations found in the literature (7,000 – 16,000 mg/kg total petroleum hydrocarbons [TPH] and 368 mg/kg total PAH), were used as benchmarks. At these concentrations, no inhibition of growth or survival of S. alterniflora was observed in these studies. Both the maximum total PAH concentrations in marsh sediment from the Site (less than 1 mg/kg) and the maximum detected petroleum hydrocarbon fractions (280 mg/kg; sum of the maximum detected concentrations of C11-C22 aromatics and C19-

C36 aliphatics in marsh sediments, see Table 4c in Appendix D), are below the literature-derived benchmarks. None of the individual PAH or total PAH concentrations exceeded applicable ER-Ls. In addition, no UCL are applicable to sediments, and there are no applicable or suitably analogous standards.

No visual evidence of chemical or physiological stress in salt marsh grass was observed, and none of the phytotoxicity benchmarks described above were exceeded. Viscous weathered oil has been observed sporadically in spaces underlying cobble in the intertidal zone of a portion of Hoppy's Landing, and sheen has been observed in tidal pools adjacent to the weathered oil. This poses a potential exposure to wildlife that will be addressed further.

On the basis of this evaluation, it is concluded that a condition of NSR to the environment has been achieved at the 62 of the 63 shoreline segments and the subtidal zone. Because viscous weathered oil and sheen have been encountered at the southern portion of Hoppy's Landing, it cannot be concluded at this time that a condition of NSR to the environment has been achieved at that portion of the W2A-10 shoreline segment.

10.0 PUBLIC NOTIFICATION

Notification of this Phase II CSA report was provided to owners of property within the boundaries of the shoreline segments that comprise the Site, as required by the MCP regulations. Please note that although properties in Massachusetts may extend to mean low water, not all properties necessarily extend to mean low water (e.g., the property lines at some properties may only extend to mean high water and the property does not include the intertidal zone). Evaluating whether a particular property extended to mean low water would require conducting an extensive review of the deed for each property within the segments included in this Phase II CSA. Deed research for each property was not conducted and notification was therefore provided to the owners of properties along the shoreline, recognizing that some of these properties may not actually extend to mean low water (and, therefore, may not actually be part of the Site).

Notification was also provided to the chief municipal officers and local boards of health in each town where shoreline segments included in this Phase II CSA were present, as required by the MCP regulations. Examples of the notification letters to property owners and municipal officials, as well as the list of notification recipients, are included in Appendix H.

11.0 CONCLUSIONS

As stated in the introduction, the primary objectives of the Report were to:

1. Characterize the magnitude and extent of residual oil using sufficient laboratory analytical data and qualitative surveys; and

2. Evaluate if a condition of No Significant Risk to human health, public welfare, safety, and the environment is present at each of the remaining 63 segments and the subtidal zone.

As discussed in detail in Section 7.0 - Phase II Assessment Activities, weathered residual oil is predominantly absent from the majority of the 63 intertidal shoreline segments and the subtidal zone. Where residual oiling has been observed in the most recent surveys, its presence is limited to either haphazard, discontinuous, hardened rock splatter, small sand-sized oil particles, or sand-encrusted tarballs, tarmats or pavement found in discrete and oftentimes sheltered locations. If encountered by a field team or reported by the public, this residual oil was typically either removed or remediated (e.g., rototilling). More than 160 sediment samples representing the current worst-case conditions were collected and analyzed for EPH fractions and PAH. EPH fractions were rarely detected in sediment (7 out of 161 samples or a frequency of less than 5 percent). PAH were detected in more than half the sediment samples, as would be expected because PAH are derived from both combustion ("pyrogenic") and petroleum ("petrogenic") sources. Forensic evaluation was conducted to evaluate the source of PAH for a few samples where elevated PAH (compared to other samples) were detected, and most were found to be unrelated to the B120 oil. Those samples that were determined to be related to the B120 oil, as well as those samples with detected PAH compounds that were not forensically evaluated, were assumed to be related to the release of B120 oil, and evaluated as such in the Method 3 Risk Characterization.

The Method 3 Risk Characterization (Appendix D) evaluated potential risks associated with identified constituents of concern to human health, safety, public welfare, and the environment in accordance with the MCP (310 CMR 40.0090), MADEP Technical Updates (2002 a-e; 2006) and MADEP Guidance (1995; 1996). This assessment concluded that a condition of No Significant Risk to human health and safety exists at the Site. A condition of No Significant Risk to public welfare exists at 61 of the remaining 63 segments, and a condition of No Significant Risk to the environment exists at 62 of the 63 remaining segments and in the subtidal zone. A condition of No Significant Risk to public welfare has not been demonstrated at this time for two localized areas where residual oiling has been characterized as a potential nuisance condition (and therefore different from residual oil in other areas) at a portion of the Leisure Shores area at segment W1F-02 and the southern tip of Hoppy's Landing in segment W2A-10. A condition of No Significant Risk to the environment was not concluded at this time for the southern tip of Hoppy's Landing due to the presence of pavement amongst the cobble and tarballs on marsh sediment.

Based on the conclusions above, additional assessment and/or cleanup activities will be conducted at a portion of the Leisure Shores location at segment W1F-02 and the southern portion of Hoppy's Landing at segment W2A-10. These additional assessment and/or cleanup activities will be described in a separate Phase III Remedial Action Plan. For the remaining 61 of 63 segments and the intertidal zone where a condition of No Significant Risk to human health, public welfare, safety, and the environment was demonstrated in the Method 3 Risk Characterization, response actions are complete and a Partial Class A-2 Response Action Outcome statement for these locations will be submitted under separate cover.