Phase II Comprehensive Site Assessment – Scope of Work

Former Raytheon Facility
430 Boston Post Road
Wayland, Massachusetts
RTN 3-22408
Tier IB Permit Number W045278

25 April 2005

Raytheon Company

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1.0 INTRODUCTION

1.1 BACKGROUND

On behalf of Raytheon Company (Raytheon), Environmental Resources Management (ERM) has prepared this Phase II - Comprehensive Site Assessment (CSA) Scope of Work (Phase II SOW), pursuant to 310 CMR 40.0834, for portions of an approximately 83-acre property located at 430 Boston Post Road in Wayland, Massachusetts (Figure 1).

On behalf of Raytheon, ERM submitted a Release Notification Form (RNF, BWSC-103) to the Department of Environmental Protection (Department) on 17 December 2002 (ERM, 2002a), pursuant to 310 CMR 40.0315(1), for three identified release conditions. The three release conditions were identified based on the detection of constituents in groundwater at concentrations in excess of applicable Reportable Concentrations (RCGW-1) and include the following:

- chlorinated volatile organic compounds (CVOCs); tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (cDCE), and vinyl chloride (VC) in the Northern Area (Figure 2);
- arsenic in the Western Area (Figure 2); and
- methyl tert butyl ether (MTBE) in the Southern Area (Figure 2).

These release conditions constitute three distinct and separate areas of concern (AOC), based on geographic location and nature of release, and are hereinafter referred to as the Northern Area, Western Area, and Southern Area (Figure 2). The Northern and Western Areas are located in undeveloped portions of the Former Raytheon Facility property and the Southern Area is located beneath a parking lot on the property. The composite of these three AOCs are hereinafter referred to in this document as the Site.

The Department issued a Notice of Responsibility and Release Tracking Number (RTN) 3-22408 on 16 January 2003 for the RNF (MA DEP, 2003). A Phase I Initial Site Investigation (Phase I) report was submitted to the Department on 17 December 2003 (ERM, 2003c). Findings and conclusions from the Phase I report included the following:

- Impacts to groundwater quality in the Northern Area resulted from an unknown historical release of TCE. PCE, TCE, cDCE and VC were detected at concentrations exceeding Reportable Concentrations (RCs) in groundwater in the Northern Area. An apparent historical release of primarily TCE occurred in the vicinity of MW-261S and B-241 (Figure 3). The source signature also includes significantly lower concentrations of PCE. Historically, the area has been filled and only transient equipment testing was known to have been conducted in the Northern Area of the Site. Therefore, the release mechanism was likely transient and no longer exists. Intrinsic biodegradation of TCE is occurring, resulting in production of cDCE and VC. CVOC impacts to groundwater are confined to a fine sand and silt unit in the Northern Area.

- A release of MTBE from an upgradient property has impacted groundwater quality in the Southern Area. MTBE was detected at concentrations exceeding RCs in groundwater in the Southern Area. The source of MTBE in the Southern Area was likely a gasoline release at an upgradient gasoline service station located at 365 Boston Post Road (RTN 3-17974). Pursuant to 310 CMR 40.0180, Raytheon may file a Downgradient Property Status Submittal for the Southern Area.

- Naturally occurring arsenic has impacted groundwater quality in the Western Area. Arsenic was detected at concentrations exceeding RCs in groundwater in the Western Area. Naturally occurring arsenic present in soil has been mobilized as a result of the natural reducing conditions in the wetlands bordering the Sudbury River. The presence of arsenic in groundwater in the Western Area likely represents a background condition.

- Impacts to groundwater at the Site maintain a low potential to impact Site occupants or nearby receptors given current or potential future use scenarios.

- The Site has been classified as Tier IB, Permit No. W045278.

Additional Site investigation and characterization activities were completed since the submittal of the Phase I report in December 2003. The completed activities were presented in the Final Scope of Work, dated 13 June 2003, submitted to the Department (ERM, 2003a). The Final Scope of Work was developed in an effort to keep the public and the Department informed regarding ongoing assessment activities at the Site. Completed activities include the advancement of 15 Waterloo Vertical Profiler borings along two transects located to the north of the Former Raytheon Facility on adjacent properties. The vertical profiling borings were advanced to evaluate the potential for migration of CVOCs from the Northern Area toward the Baldwin Pond Wellfield, a municipal drinking water supply well for the Town of Wayland, located approximately one-half mile to the north/northeast of the Former Raytheon Facility. Results of the vertical profiling boring investigation indicate a low probability that CVOCs from the Former Raytheon Facility are impacting or have the potential to impact these municipal wells.

1.2 PURPOSE AND SCOPE

The purpose of this document is to describe the scope of investigation and sampling programs that will be undertaken to satisfy performance standards for a Phase II – CSA. As specified in 310 CMR 40.0833, Phase II performance standards include the collection and evaluation of data necessary to support conclusions and render opinions regarding:

- the source, nature, extent, and potential impacts of releases of oil and/or hazardous materials (OHM);
- the potential risk of harm posed by the disposal Site to health, safety, public welfare, and the environment; and
- the need to conduct remedial actions at the disposal Site.

1.3 REPORT ORGANIZATION

This report is organized as follows:

Section 2.0 - Provides additional Site characterization information, as follows:

- a summary of previous investigation results;
- a Site conceptual model describing our current understanding of Site conditions, the nature and extent of Site impacts, and contaminant fate and transport; and
- ERM's recommended approach for the Phase II investigation.

Section 3.0 - Describes ERM's recommended Phase II SOW and details the following tasks designed to meet the Phase II performance standards:

- Conduct Additional Source Area Characterization;

- Conduct Additional Delineation of CVOC Impacts to Groundwater;
- Perform Aquifer Testing;
- Survey, Gauge, and Sample Monitoring Wells;
- Perform Risk Characterization; and
- Prepare the Phase II – CSA report.

Section 4.0 – Presents a proposed project schedule for the tasks presented in this report.

2.0 *SUMMARY OF PREVIOUS INVESTIGATION RESULTS AND CONCEPTUAL SITE MODEL*

An extensive investigation program has been conducted on the Former Raytheon Facility property since 1995. The majority of this work was conducted to characterize release conditions currently tracked under RTN 3-13302 and Tier IB Permit No. 133939. As noted in Section 1.0, three additional release conditions to groundwater were identified in 2002 and assigned RTN 3-22408, which are the subject of the proposed Phase II investigation:

- CVOCs (PCE, TCE, cDCE, and VC) in the Northern Area;
- arsenic in the Western Area; and
- MTBE in the Southern Area.

This overview of Site investigation activities, results, and conclusions is focused on presenting data related to these three release conditions. However, for the purposes of evaluating geology, hydrogeology, and extents of impact to groundwater, ERM has drawn from an extensive dataset for the entire Former Raytheon Facility property.

2.1 *SITE GEOLOGY*

Site geology was defined using the following techniques:

- review of regional geologic data;
- soil logging conducted during boring advancement;
- cone penetrometer (CPT) boring advancement;
- index of hydraulic conductivity (I_k) data collected using the Modified Waterloo Profiler; and
- a geophysical survey (i.e., seismic refraction).

Historical investigative borings and existing monitoring well locations are displayed in Figure 2. Five general geologic units have been identified across the Former Raytheon Facility property, from top to bottom (i.e., from shallowest to deepest):

- upper, interbedded, fine to coarse sand;
- silt with some clay and fine sand interbeds;

- lower, interbedded, fine to coarse sand;
- glacial till, consisting of poorly sorted, highly compacted sediments, with a fine-grained matrix (the till layer is generally less than five feet thick and appears to be discontinuous); and
- bedrock, which is mapped as gneiss of the Claypit Hill formation and undifferentiated gabbro and diabase (USGS, 1975).

The vertical sequence, depth, thickness, and exact composition of these generalized geologic units vary across the Former Raytheon Facility property.

Confirmed depths to bedrock vary from 60 feet (MW-33B) in the southern portion of the property to 130 feet (MW-268B) in the northwestern portion of the property. A seismic refraction survey was conducted to the north of the Former Raytheon Facility property, which indicated a maximum depth to bedrock of approximately 180 feet. Figure 3 shows the location of the seismic refraction survey.

The geologic sequence beneath the Former Raytheon Facility property is generally reflective of a glaciolacustrine environment. That is, a deep bedrock river valley was dammed by ice or sediment after the Late Wisconsinan ice sheet receded through the area, creating a glacial lake that eventually filled with fine-grained lake bottom sediments (USGS, 1974). Consistent with this type of environment, the overburden deposits are laterally and vertically heterogeneous. The overburden deposits vary from east to west, with generally coarser deposits to the east, suggesting proximity to the former shoreline, and finer deposits to the west. The overburden deposits generally dip and thicken to the west, as the depth to bedrock increases significantly.

2.2 *SITE HYDROGEOLOGY*

A series of comprehensive groundwater gauging rounds have been conducted to evaluate groundwater flow directions across the Former Raytheon Facility property. Groundwater elevation data collected during calendar year 2004 are presented in Table 1. Potentiometric surface elevations from each of these gauging rounds were collected on a single day under steady atmospheric conditions.

For the purpose of evaluating groundwater flow directions across the entire Former Raytheon Facility property, ERM routinely prepares two groundwater elevation contour maps for each gauging round representing:

- wells with screens set across the water table or with the top of the well screen located within five feet of the water table; and
- wells with screens set in the deep overburden (defined as the lower fine sand and silt unit in the Northern Area and the fine to medium sand unit in the Southern Area). It is important to note that well screens set within this unit vary significantly in depth. However, head data collected from these wells appear to represent a single hydrologic unit and therefore, represent a single piezometric surface. The lower fine sand and silt unit of the Northern Area is particularly significant because it appears to control CVOC migration in this portion of the Site.

Figures 4 and 5 display the upper and lower aquifer potentiometric surface maps for the December 2004 gauging event, respectively. The 2004 data sets indicate that groundwater across the entire Site generally flows to the west, potentially controlled by the presence of the Sudbury River.

In addition to evaluating horizontal groundwater flow, ERM routinely calculates vertical hydraulic gradients for well clusters (i.e., two or more wells installed in close proximity to one another) located on the Former Raytheon Facility property. The vertical gradients are calculated using groundwater elevation data from the shallowest overburden well and the deepest overburden well at each location. Vertical gradients were also calculated between deep overburden and bedrock wells, where present. Table 2 presents vertical hydraulic gradients calculated using calendar year 2004 potentiometric surface data. In general, downward vertical gradients were measured in the eastern portion of the Former Raytheon Facility property. This is generally consistent with the regional hydrogeologic setting, which consists of a local groundwater flow divide located coincident with a topographic high east of the Former Raytheon Facility property and a regional discharge boundary (i.e., the Sudbury River) located to the west. Vertical gradients are typically downward in the vicinity of a recharge boundary (e.g., area of high ground) indicating that groundwater is seeking to achieve a lower elevation, consistent with the regional water table. As groundwater flows away from the recharge boundary, vertical gradients typically become less downward and transition to upward gradients as groundwater approaches the regional discharge boundary. This transition from downward to upward vertical gradients has been observed in the central and western portions of the Former Raytheon Facility property.

Eleven overburden soil samples from the Northern Area of the Site have been submitted for grain size analyses and laboratory estimates of permeability. The overburden permeability range in this portion of the Site was between 10^{-4} and 10^{-6} centimeters per second (cm/s).

2.3 *SOURCES, NATURE, AND EXTENT OF CONTAMINATION*

Pursuant to 310 CMR 40.0300, the detection of CVOCs, arsenic, and MTBE in groundwater at concentrations exceeding applicable RCs (i.e., RCGW-1) constitutes a release to the environment. The current understanding of the sources, nature, and extent of impacts to soil and groundwater for the Northern, Southern, and Western Areas are presented below.

Soil

Northern Area

A series of 18 soil borings was advanced in the vicinity of B-241 to evaluate the potential for a residual source of CVOCs in this area (Figure 3). Continuous soil samples were collected in 17 of the borings from ground surface to approximately 15 feet below ground surface (bgs), and in B-260 from ground surface to 20 feet bgs. These samples were field screened using a Photo-ionization Detector (PID) and one sample from each location was submitted for laboratory analysis of volatile organic compounds (VOCs). The soil samples submitted to the laboratory were collected from both above and below the water table.

Overburden borings were advanced at nine locations across the Northern Area to facilitate monitoring well installation. During boring advancement, over 100 additional soil samples were collected from the ground surface to 130 feet bgs and field screened using a PID. Nine soil samples collected from depths of 2 to 9 feet bgs (i.e., above the groundwater table) were submitted for laboratory analysis of VOCs.

PID soil screening values ranged from less than 0.1 parts per million (ppm; i.e., the instrument detection limit) to 147 ppm. In general, the highest PID readings in soil were detected within a fine sand and silt unit and are attributed to the presence of CVOCs in groundwater within this unit. No VOCs were detected in 19 of the 27 soil samples collected from the unsaturated zone. No VOCs were detected in soil at concentrations above applicable RCs.

Western Area

To date, no soil samples have been collected from the Western Area specific to RTN 3-22408. An extensive soil and sediment sampling program has been conducted within the wetlands and along the adjacent bank and lowland area, within the Western Area, as part of RTN 3-13302 and Tier IB Permit No. 133939 (ERM, 2001, 2002b, 2003b, 2004a). Results from these sampling activities are presented in the Phase IV Completion Report for RTN 3-13302 and show arsenic detected in all collected soil samples, ranging in concentration from 1.1 to 65 mg/kg (ERM, 2004a). Additional historical Site soil samples collected during Site investigation activities and analyzed for arsenic have produced concentrations ranging from non-detect to 13 mg/kg. The presence of arsenic in soil samples, especially samples collected within or near the wetlands, is prevalent and naturally occurring.

Southern Area

Four soil samples were collected from depths of 8 to 18 feet bgs (i.e., above the groundwater table) for laboratory analysis of VOCs. No VOCs were detected in these samples at concentrations above laboratory method detection limits.

Groundwater

Site groundwater quality has been investigated through samples collected from Waterloo Profiler borings and monitoring wells. Investigation techniques and laboratory analytical results vary by Site area, as follows:

Northern Area

Chlorinated ethenes (i.e., PCE, TCE, cDCE, and VC) are detected above their applicable RCGW-1 in the Northern Area. Of the chlorinated ethenes detected, cDCE was detected at the highest concentration followed by TCE, VC, and PCE. Table 3 presents laboratory analytical data for CVOC concentrations in groundwater for samples collected in the calendar year 2004.

Waterloo Profiler field screening data and subsequent laboratory data for groundwater collected from monitoring wells indicate that chlorinated ethenes (i.e., PCE, TCE, cDCE, and VC) are the primary constituents of concern in the Northern Area.

Both PCE and TCE have been detected in groundwater in the Northern Area. Both compounds are used as chlorinated solvents and could represent the "source" signature. Analysis of chemical ratios indicates that TCE was likely the primary compound released along with significantly lesser concentrations of PCE. The TCE signature is most dominant in MW-261S and Waterloo Profiler B-241 (Figure 6). These locations also exhibited the highest TCE concentrations in the Northern Area. Therefore, the area around MW-261S and B-241 is interpreted to represent the likely area of historical release (i.e., source area).

Water quality data suggest that the TCE plume degrades as it migrates to the northwest and west. As the plume migrates downgradient from the source area, the TCE is biologically degraded to cDCE, VC, and ethene. The most downgradient well within the plume (MW-268M) exhibits a chemical signature containing TCE, cDCE, VC, and ethene. The TCE concentration at MW-268M is roughly one-half of that in the source area.

Consistent with the Waterloo Profiler field screening data, the monitoring well installation and sampling data indicate that CVOCs are generally confined to the lower fine sand and silt unit in the Northern Area. This unit is significantly deeper in the western portion of the Northern Area, reaching a maximum depth of approximately 90 feet below grade at MW-268M. To date, no CVOCs above RCGW-1 have been detected beneath this layer.

Western Area

Arsenic was detected above its RCGW-1 (0.05 milligrams per liter (mg/L)) in the Western Area. Detected arsenic concentrations range from 0.005 mg/L to 0.239 mg/L.

Arsenic is a naturally occurring element within the environment, and is ubiquitously detected in soil throughout the Western Area (ERM, 2004a). The availability of arsenic as a dissolved species in groundwater depends on the aqueous and physical geochemistry of an aquifer system. Arsenic concentrations in the groundwater of New England are relatively high and have been the subject of scientific studies. Ayotte et al. (2003) propose that arsenic within New England is "dominantly natural and originates from minerals in the rocks of the region including arsenic-bearing sulfide minerals or trace amounts of the element within rocks (Ayotte et al., 1999).

Studies show high concentrations of arsenic within many river deltas because of the high organic content and reducing geochemical conditions found there (Stronach, 2003). Dissolved-phase arsenic is also commonly found under basic pH conditions (i.e., pH greater than 7; Ayotte et al., 1999; Ayotte et al., 2003). These conditions are present in the Western Area, as described below.

The Western Area is located within and adjacent to wetlands of the Sudbury River. Wetlands, with their naturally high organic content and saturated soils, often display chemically-reduced conditions. Groundwater within the Western Area generally exhibited negative oxidation-reduction potential (ORP) measurements, indicative of chemically reduced conditions. Arsenic oxyanions are known to adsorb to iron hydroxides, present as coatings on sediment (Horesh, 2001). Under reduced conditions, the iron hydroxides become soluble and no longer act as sorption sites for the arsenic oxyanion (Horesh, 2001).

An ORP-pH diagram for all arsenic detections within groundwater samples collected within the Western Area was presented in the Phase I report (Figure 16; ERM, 2003c). Concentrations of arsenic above RCs were most frequently detected in groundwater samples having relatively low ORPs (i.e., less than 0.00 millivolts (mV)). A subset of these samples also exhibits basic pH values (i.e., greater than 7).

Based on a review of historical chemical usage at the Former Raytheon Facility (ERM, 1996) and current chemical usage at the Wayland Business Center, arsenic does not appear to have been used at the facility. Based on the absence of an apparent anthropogenic source, the abundance of naturally occurring arsenic in soil across the property and the geochemical environment of the Western Area, ERM believes that the detections of arsenic in groundwater in this portion of the Site represent a naturally occurring background condition.

Southern Area

MTBE was detected above its RCGW-1 (70 ug/L) in the Southern Area. Historical detections of MTBE concentrations range from 1.7 ug/L to 280 ug/L. The highest concentrations of MTBE are found within the middle well screens at three onsite well clusters: MW-202M (28 to 33 feet bgs), MW-204M (41 to 46 feet bgs), and MW-205M (42 to 47 feet bgs). MTBE was not detected in groundwater samples collected from the shallow wells at any of these well clusters, nor was it detected in soil samples collected from above the water table at these locations. MTBE was detected in only one of the deep wells at these well clusters (MW-202D at 51 to 56 feet bgs) at a concentration of 3.4 ug/L.

MTBE has been detected in groundwater at concentrations up to 6,100 ug/L at a gasoline service station located at 365 Boston Post Road (Strata, 2003). This property is currently in Phase IV of the MCP process and is tracked under RTN 3-17974. MTBE was initially detected at this property in August 2001 and concentrations have subsequently declined (Strata, 2003), suggesting that MTBE has migrated from the source area. Raytheon has collected groundwater samples from the Southern Area since 1999 for MTBE analyses. MTBE was first detected on the Former Raytheon Property in 2002. The highest MTBE concentration detected in groundwater on the gasoline service station property (i.e., 6,100 ug/L) is higher than that detected in groundwater in the Southern Area (i.e., 280 ug/L).

Based on groundwater elevation data, the service station at 365 Boston Post Road is located hydraulically upgradient of the Southern Area. Downward vertical hydraulic gradients exist in the eastern portion of the Former Raytheon Facility. Similar downward vertical gradients were measured on the 365 Boston Post Road site (Strata, 2003).

Collectively, these data suggest that the source of MTBE is likely located on the 365 Boston Post Road site (RTN 3-17974) and that advective groundwater transport has resulted in migration of MTBE into the Southern Area. Pursuant to 310 CMR 40.0180, Raytheon may file a Downgradient Property Status Submittal for MTBE.

2.4 *CONCEPTUAL SITE MODELS*

ERM has developed Conceptual Site Models (CSM) for impacts to groundwater in the Northern, Southern, and Western Areas.

Northern Area

Based on data collected to date, ERM has developed the following CSM for the Northern Area.

- An apparent historical release of primarily TCE occurred in the vicinity of MW-261S and B-241. The source signature also includes significantly lower levels of PCE. The area was believed to be have been filled between 1969 and 1988, however, there are no historical records indicating when filling occurred (ERM, 2003c). Only transient radar equipment testing was known to have been conducted in this portion of the Site. Therefore, the release mechanism was likely transient and no longer exists.

- A residual source of impact to groundwater appears to be present in the relatively low hydraulic conductivity, upper fine sand and silt unit in the vicinity of MW-261S and B-241. TCE appears to migrate via flushing by recharge events or diffusion out of the upper fine sand and silt unit into the underlying, higher hydraulic conductivity, medium to fine sand unit. When the TCE reaches the medium to fine sand unit, it migrates via advective groundwater flow initially to the northwest and ultimately to the west.

- The medium to fine sand unit fines and dips to the west becoming the lower fine sand and silt unit in the western portion of the Northern Area. The moderate hydraulic conductivity lower fine sand and silt unit is overlain by a low conductivity silt and clay unit. The relative difference in hydraulic conductivities between the two units, combined with downward vertical hydraulic gradients, have minimized or prevented CVOC impacts to the silt and clay unit along the axis of the plume. The moderate conductivity lower fine sand and silt unit is underlain by a higher hydraulic conductivity gravel unit. This relatively higher conductivity gravel unit does not appear to be the contaminant transport zone for this portion of the plume, as evidenced by significantly lower or non-detectable CVOC concentrations within and beneath this unit.

- As the TCE migrates away from the source area and vertically downward within the lower fine sand and silt unit, intrinsic biodegradation converts TCE to cDCE, VC, and ethene, resulting in enrichment of cDCE relative to TCE in the westernmost wells. Intrinsic biodegradation, along with a series of physical and chemical processes (e.g., advection, dispersion, diffusion, and dilution), are collectively referred to as natural attenuation. These processes act to limit the distance over which a CVOC plume can travel by naturally reducing concentrations in groundwater until a steady state condition is achieved. Given the historical nature of the TCE release, it is anticipated that the plume has reached a steady-state condition. However, at this time, the downgradient extent of the CVOC plume has not yet been defined.

- It is currently known that the CVOC plume trends westward and appears to be migrating beneath wetlands toward the Sudbury River. The Sudbury River is the regional hydraulic discharge boundary. In theory, the plume should migrate upward and discharge to the river and/or its associated wetlands. In order to do so, the plume must migrate at least 90 feet vertically upward through the low hydraulic conductivity silt and clay unit, which is not likely. Two potential scenarios are being considered with respect to the downgradient extent of the plume:

1. The silt and clay unit may coarsen to the west beneath the Sudbury River and/or associated wetlands allowing the plume to migrate upward and potentially discharge to the river and/or wetlands.

2. The silt and clay unit remains consistent to the west forcing the plume to remain in the lower fine sand and silt unit. Hydraulic gradients from the west side of the river prevent groundwater from flowing further westward. Because the plume is unable to discharge upward to the river and is unable to flow further to the west, it deviates to the north and follows the river valley in the downstream direction. The plume may continue to migrate within the river valley until the overlying silt and clay unit coarsens, allowing upward discharge to the river, or until natural attenuation processes decrease CVOC concentrations to non-detectable levels.

The Northern Area Phase II investigation will evaluate these two scenarios in an effort to define the extent of CVOC impacts to groundwater.

Western Area

Based on data collected to date, ERM has developed the following CSM for the Western Area.

- Arsenic appears to be a naturally occurring element within soil across the entire Site (ERM, 2001).
- A natural reducing environment exists beneath the wetlands in the Western Area, due to high organic content in wetland sediments.
- Arsenic is soluble under reduced conditions and is detected in groundwater in the Western Area.
- The extent of arsenic in groundwater is likely constrained to the area beneath the Sudbury River and associated wetlands. Once arsenic-bearing groundwater mixes with oxygenated groundwater present to the east and west of the wetlands, the arsenic will re-precipitate onto soil grains, significantly reducing arsenic concentrations in groundwater.

Southern Area

Based on data collected to date, ERM has developed the following CSM for the Southern Area.

- A spill of oxygenated gasoline (i.e., containing MTBE) was hypothesized to have occurred in the Summer of 2001 at the gasoline service station located at 365 Boston Post Road (Strata, 2003).
- Advective groundwater flow transported the highly soluble MTBE to the west-northwest and downward within the aquifer.
- Because MTBE is recalcitrant to both physical and chemical degradation processes, it migrated in groundwater onto the Former Raytheon Facility property.
- Assuming that the source of release on the 365 Boston Post Road property has been controlled and therefore, is not ongoing, a slug of MTBE should continue to migrate in groundwater across the Former Raytheon Facility property toward the Sudbury River. MTBE concentrations will decrease with distance due to dilution, dispersion, and diffusion.

3.0 SCOPE OF WORK

ERM proposes the following Phase II SOW to satisfy the remaining Phase II Performance Standards, pursuant to 310 CMR 40.0833.

3.1 CONDUCT ADDITIONAL SOURCE AREA CHARACTERIZATION

The purpose of this task is to further characterize the Northern Area source area. ERM proposes to conduct a dynamic source area investigation in the Northern Area. This assessment strategy has been shown to be more efficient than a traditional phased approach. Inherent in this approach is the difficulty in defining the exact activities that will be conducted throughout the investigation process. Some of the tasks presented below may be deemed unnecessary as the investigation progresses, while alternate tasks may be deemed appropriate. The end result is an assessment strategy that maximizes knowledge of subsurface conditions while minimizing the time necessary to obtain this knowledge.

Due to the dynamic nature of the investigation, some or all of the following investigation methods will be employed, as appropriate, to provide adequate information for the evaluation of remedial alternatives:

- Membrane Interface Probe (MIP) – The MIP is a direct-push characterization tool that provides a continuous record of total VOC response and electrical conductivity measurements of the subsurface, both within the saturated and unsaturated zones.
- Waterloo Profiler – The Waterloo Profiler is a direct-push characterization tool that provides a continuous record of relative hydraulic conductivity data in the saturated zone. It also allows for collection of groundwater elevation, aqueous geochemistry, and groundwater samples for laboratory analyses at selected depth intervals below the water table.
- Soil Sample Collection and Analysis – Soil borings may be advanced for the collection of soil samples for laboratory analysis of CVOC concentrations, permeability, grain size distribution, and/or sorption potential.
- Installation of Groundwater Monitoring Points – Additional groundwater monitoring points may be installed for the collection of groundwater samples for laboratory analysis of CVOC concentrations.

As shown in Figure 3, ERM proposes to conduct additional investigation activities both within and immediately downgradient of the source area. Assessment directly within the source area will be conducted first and will utilize the MIP tool to further characterize and define the distribution of source contamination. Use of the MIP is most beneficial within this zone because of its ability to log the relative total VOC response both within the saturated and unsaturated zones of the subsurface. The electrical conductivity log provided by the MIP provides an additional dataset to aid in the interpretation of contaminant hydrogeology. Up to 28 MIP boring locations to approximately 20 feet bgs are proposed for this source area characterization. The general area of investigation and the proposed boring locations are displayed in Figure 3. As noted above, the actual locations may change based on real-time interpretation of data collected during each boring advancement.

Following the source-area definition, additional investigation activities will be conducted approximately 20 feet downgradient of the source area, in an area generally perpendicular to groundwater flow. These data will be used to quantify near-source baseline CVOC concentrations. The baseline data will be used to evaluate the effects of potential future remedial actions on plume dynamics and to design a plume abatement system. ERM proposes to initiate this investigation with the advancement of the MIP, followed by the Waterloo Profiler. The subsequent need for advancement of soil borings, collection of soil samples, and installation of additional groundwater monitoring points will be evaluated based on the results of the initial phase of the investigation. The number of proposed borings and monitoring well installations in this area are listed as follows, with the proposed locations displayed on Figure 3:

- up to 13 MIP borings advanced at 5-foot intervals to approximate depths of 40 feet bgs;

- up to seven Waterloo Profiler borings advanced at locations identified by the interpretation of MIP data, to approximate depths of 40 feet bgs; and

- up to five multi-level monitoring wells having three one-foot screens of different vertical elevations, installed at appropriate locations for long-term monitoring based on the results of the MIP and Waterloo Profiler programs.

3.2 *CONDUCT ADDITIONAL DELINEATION OF CVOC IMPACTS TO GROUNDWATER*

The purpose of this task is to further delineate the horizontal and vertical extent of CVOC impacts in the western portion of the Northern Area. Installation of monitoring wells and advancement of Waterloo Profiler borings during Phase I activities has provided much data to support delineation of groundwater CVOC impacts within the Northern Area of the Site. Vertical and horizontal delineation of CVOCs above RCGW-1 standards has been achieved for the Northern Area with the exception of the downgradient extent of the plume, located to the west within wetlands along the Sudbury River margins. Table 3 presents laboratory analytical data for CVOC concentrations in groundwater for samples collected in 2004. Figure 6 displays a plan view map of groundwater CVOC concentrations for the Northern Area.

In order to assess the western extent of the plume, ERM proposes to advance three borings and install three monitoring well triplets within the wetlands adjacent to the Sudbury River along the apparent axis of the CVOC plume (Figure 3). These monitoring wells were proposed in the Final Scope of Work, dated 13 June 2003 (ERM, 2003a). However, these wells have not yet been installed due to elevated surface water elevations of the Sudbury River and access restrictions emplaced by the Massachusetts Division of Fisheries & Wildlife, Natural Heritage & Endangered Species Program (i.e., access is only allowed to the wetlands from September 1 thru March 31). ERM anticipates installing these monitoring wells in September and/or October 2005, depending on the elevation of the Sudbury River.

ERM submitted a Notice of Intent (NOI), dated 26 September 2003, with the Town of Wayland Conservation Commission (Commission) and the Department for activities to be conducted within the wetland areas or wetland buffer zones. The Department assigned Wetland Protection Act File No. 322-0564 for these activities. The Conservation Commission issued an Order of Conditions, dated 20 November 2003. ERM notified the Commission of intent to modify the Department File No. 322-0564 in a letter dated 21 July 2004. The Commission verbally approved the modification, without requiring submittal of a new NOI, during a Commission meeting on 25 August 2004. Raytheon has not received a Revised Order of Conditions for this modification to the NOI.

A temporary roadway will be constructed to each drilling location using a combination of support systems such as geotextiles and various wood and metal platform devices. This system will be designed to limit the potential damage to the wetlands. A drill rig will be used to advance each boring to the top of bedrock using sonic drilling techniques. Continuous soil samples will be collected and screened in the field for total VOCs using a PID and the jar headspace method. PID screening results were successfully used in the December 2002 Northern Area drilling program to locate the CVOC plume. Soil samples may be submitted for laboratory analyses of soil properties and/or CVOC concentrations.

ERM proposes to install three monitoring wells in each boring at the following depths:

- shallow well screen within the upper fine sand and silt unit or the silt and clay unit;
- intermediate well screen within the lower fine sand and silt unit at the depth of the highest PID readings; and
- deep well screen at the top of till or top of bedrock (i.e., deep overburden).

Monitoring wells will be constructed using two-inch ID, PVC, 0.010-inch machine-slotted well screen, PVC riser pipe, sand filter pack, bentonite seal, concrete surface seal, and locking steel protective standpipes. The deep and shallow well at each location will be installed using a five-foot long well screen. The middle well will be installed using either five-foot or ten-foot long well screens, depending on field screening results. Monitoring wells will be developed and sampled following installation.

If CVOCs are detected in samples collected from shallow monitoring well(s), ERM may also collect shallow groundwater samples from within the shallow riverbed and/or wetland sediments. These groundwater samples would be representative of groundwater baseflow into the river, and be used to evaluate the potential presence of CVOC mass flux into the river.

Depending on the actual timing of installation of these monitoring wells, data associated with these monitoring wells may be included in a subsequent regulatory submittal (i.e., Phase II Addendum or Phase IV – Remedy Implementation Plan Report).

3.3 SURVEY, GAUGE, AND SAMPLE MONITORING WELLS

The purpose of this task is to continue to evaluate groundwater elevations and groundwater quality at the Site. ERM proposes to conduct three groundwater elevation gauging rounds across the entire Site and a minimum of one groundwater monitoring round for selected monitoring wells at the Site during calendar year 2005.

3.3.1 *Groundwater Elevation Gauging*

To accurately determine groundwater elevations and flow directions across the Site, ERM proposes to conduct groundwater elevation gauging rounds during three seasons (i.e., all except winter). ERM will measure depths to groundwater in all accessible and functional existing Site wells on a single day using electronic water-level indicators. Newly installed monitoring wells will be surveyed relative to mean sea level and locations will be surveyed relative to the existing Site grid. Gauging will be conducted prior to sample collection.

3.3.2 *Groundwater Sampling*

To evaluate groundwater quality at the Site, ERM proposes to conduct a minimum of one groundwater monitoring event for existing wells in Spring 2005. Groundwater samples will be collected using low-flow or passive diffusion bag sampling techniques. For wells sampled using low-flow sampling techniques, physico-chemical parameters (pH, temperature, specific conductance, dissolved oxygen and ORP) will be monitored during purging until equilibration is achieved, at which time groundwater samples will be collected for laboratory analyses. Groundwater samples will be analyzed for one or more of the following parameters:

- VOCs by EPA Method 8260 (newly constructed wells only);
- CVOCs by EPA Method 8021B;
- MTBE and benzene by EPA Method 8021B; and/or
- arsenic by EPA Method 6010B.

Table 4 presents the detailed annual monitoring schedule for the Site. In general, Northern Area monitoring wells will be sampled for CVOCs, the Western Area monitoring wells will be sampled for CVOCs and arsenic, and the Southern Area wells will be sampled for MTBE and benzene.

3.4 *PERFORM AQUIFER TESTING*

The purpose of this task is to collect additional data to assist in the evaluation of groundwater and contaminant migration pathways and the estimation of the CVOC plume advective flow rate. ERM proposes to conduct one or more of the following tests in order to obtain Site-specific estimates of hydraulic conductivity (K):

- calculation of K from soil grain size distribution analyses;
- laboratory permeameter testing; and/or
- slug tests.

The average K value will be incorporated into a seepage velocity calculation for the generalized Northern Area plume flow pathway.

Slug testing will also be performed on wells located along the plume centerline and having screened portions within the impacted geologic units. Groundwater elevation measurements will be collected during the slug test using a down-hole pressure transducer and datalogger. Aqtesolv, or similar computer software program, will be employed for the analysis of aquifer response to the slug test. The most appropriate analytical method for slug test interpretation will be selected based upon aquifer and well characteristics.

3.5 TREATABILITY STUDY

The purpose of this task is to conduct a laboratory treatability study to determine if, and to what extent, the native microbial population can degrade the chlorinated solvents with the addition of various carbon substrates (i.e., electron donors) and nutrients to support metabolism (biostimulation). ERM proposes to evaluate lactate and acetate as potential substrates, though a number of additional substrates may be considered (e.g., hydrogen release compound (HRC®), emulsified soybean oil, methanol, ethanol, and molasses). The treatability study will not evaluate bioaugmentation using an exogenous dechlorinating enrichment culture.

The treatability study is conducted by preparing a series of microcosms using soil and groundwater samples collected from the Site. Soil and groundwater samples will be collected from borings advanced for the construction of multi-level monitoring wells downgradient of the source area (Figure 3). The samples will be collected under anaerobic conditions using specialized techniques to minimize changes to the redox geochemistry of the aquifer material and to minimize deleterious effects to the indigenous microbial population. Each microcosm will contain soil and groundwater from the site, and will be amended with various combinations of carbon substrate and nutrients. The microcosm studies are typically conducted for a period of up to six months. In some cases, it is appropriate to continue the microcosms for a longer duration.

3.6 *PERFORM RISK CHARACTERIZATION*

The purpose of this task is to perform a risk characterization to assess the risk of harm to human health, public welfare, safety, and the environment associated with the release. As required by 310 CMR 40.0900, the risk characterization will include:

- Selection of Study Chemicals;
- Identification of Site Activities and Uses;
- Identification of Potential Human Receptors;
- Identification of Potential Environmental Receptors;
- Identification of Potential Exposure Points;
- Identification of Potential Exposure Pathways;
- Identification of Exposure Point Concentrations;
- Identification of Applicable Soil and Groundwater Categories;
- Characterization of Risk of Harm to Human Health and Public Welfare and the Environment; and
- Characterization of Risk to Safety.

Based on soil and groundwater data collected to date, ERM anticipates performing a Method 1 risk characterization, which compares concentrations of OHM detected in soil and groundwater to applicable MCP Method 1 standards. However, a Method 2 or Method 3 risk characterization will be performed, if appropriate.

3.7 *PREPARE PHASE II/PHASE III REPORT*

The purpose of this task is to provide the documentation required for a Phase II – CSA report, Phase II Completion Statement, and Phase III – Identification, Evaluation and Selection of Comprehensive Remedial Action Alternatives report pursuant to 310 CMR 40.0835, 40.0836, and 40.0850, respectively.

3.8 *PUBLIC INVOLVEMENT PLAN ACTIVITIES*

Raytheon is committed to involving the public in the Phase II process through regular communication with the Town's technical representative(s) and public meetings. This investigation will be conducted in accordance with the current Public Involvement Plan (PIP) (ERM, 2004b) that has been established for the Site.

4.0 PROJECT SCHEDULE

A proposed Phase II project schedule is summarized below:

- Spring 2005 – Conduct Additional Source Area Characterization
- Spring 2005 – Perform Aquifer Testing
- Spring 2005 – Gauge and Sample Monitoring Wells
- Summer 2005 – Gauge Monitoring Wells
- Fall 2005 – Gauge Monitoring Wells
- Fall 2005 – Install, Gauge and Sample Wetland Monitoring Wells
- Fall 2005 – Submit Draft Phase II Report for Public Review and Comment
- Fall 2005 – Submit Draft Phase III Report for Public Review and Comment
- December 2005 – Submit Final Phase II Report to the Department
- December 2005 – Submit Final Phase III Report to the Department

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