

11 September 2001
Reference: 143.57

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup
Northeast Regional Office
205 A Lowell Street
Wilmington, MA 01887

Re: Release Abatement Measure Plan - Groundwater Pilot Studies
Former Raytheon Facility
430 Boston Post Road
Wayland, Massachusetts
Permit No. 133939/RTN 3-13574

Dear Sir or Madam:

On behalf of Raytheon Company (Raytheon), Environmental Resources Management (ERM) is submitting this Release Abatement Measure (RAM) Plan for the above-referenced Site in Wayland, Massachusetts. The proposed RAM includes pilot studies for treatment of chlorinated hydrocarbons in groundwater using in-situ chemical oxidation. This RAM Plan was prepared in accordance with the requirements of 310 CMR 40.0444 of the Massachusetts Contingency Plan (MCP). The original RAM Transmittal Form BWSC-106 is included as Appendix A.

Since the Site is classified as a Tier 1B site, Department approval of this RAM Plan is not required pursuant to 310 CMR 40.0443(3).

BACKGROUND

The Site is an approximately 83-acre facility located at 430 Boston Post Road in Wayland, Massachusetts (Figure 1). Raytheon operated the facility from 1955 to 1995. Operations included electronic testing and research to support Raytheon's in-house prototype manufacturing. Raytheon operations have been terminated, and the facility decommissioned. The facility has since been sold and is currently utilized as commercial office space.

ERM submitted a Phase I-Initial Site Investigation (Phase I) report for the Site to the Massachusetts Department of Environmental Protection (MA

DEP) in July 1996 and a Tier Classification filing in January 1997. The Department issued Raytheon a Tier IB Permit, effective 21 May 1997. A Phase II-Comprehensive Site Assessment (Phase II) of the Site is currently in progress. Results of the ongoing Phase II assessment identified a potential imminent hazard condition in Site wetlands. Based on this condition, a reclassification permit application was submitted to the MA DEP. A new Tier IB Permit was issued by MA DEP, effective 15 December 2000.

ERM has completed Site investigation activities necessary to define the source, nature and extent of oil and/or hazardous materials (OHM) impact in affected media as part of Phase II. The Phase II report will be submitted to the Department in the near future, following completion of the Public Involvement Plan (PIP) process. Impacts to groundwater consist primarily of trichloroethene (TCE), with limited tetrachloroethene (PCE) and TCE degradation by-products. The source of release is suspect to have been a former manhole connected to the former printed circuit board shop (Figure 2). The extent of impact is consistent with the migration of dissolved phase chlorinated hydrocarbons via advective groundwater flow down-gradient from the former suspect source area (Figure 3).

Since the Site is located within the Zone II for the Baldwin Pond Well Field, impacts to groundwater at levels in excess of Massachusetts Maximum Contaminant Levels (MMCLs) pose a condition of "Significant Risk" to potential future receptors, requiring abatement. Groundwater within the defined and projected extent of impact is not utilized as a current source of drinking water and does not pose a "Significant Risk" under current conditions.

ERM completed a review of remedial alternatives as part of Phase III - Identification, Evaluation and Selection of Comprehensive Response Action Alternatives, and determined that in situ chemical oxidation is the preferred remedial alternative to abate chlorinated ethenes in groundwater at the Site. The Phase III report will be submitted to the Department in the near future, following completion of the PIP process. Therefore, ERM proposes performance of in situ chemical oxidation pilot studies as a RAM to evaluate the suitability and effectiveness of this technology.

PURPOSE & SCOPE

The purpose of the proposed RAM is to conduct pilot studies to evaluate the ability to reduce the concentration of chlorinated hydrocarbons in groundwater to levels that will enable achievement of a Permanent Solution, if feasible. This RAM Plan outlines responsibilities and procedures for conducting the pilot studies using in-situ chemical oxidation. The remainder of this RAM Plan is formatted consistent with the requirements of 310 CMR 40.0444 (1).

a) Name, address, telephone number and relationship of the person assuming responsibility for the RAM;

Mr. Ronald C. Slager
Manager, Environmental Restoration Program
Raytheon Systems Company
1001 Boston Post Road, MS-1-2-1567
Marlborough, MA 01752-3789
TEL: (508) 490-1707

Additional information is contained in Appendix A, Form BWSC-106, RAM Transmittal Form.

b) Description of the historical release, Site conditions and surrounding receptors;

Historical Release Description

A former manhole, W-4, located in the courtyard between Buildings 3 and 4, was inspected by Raytheon in July 1996 and found to contain a heavy oily sediment and hard silt material. Raytheon retained Clean Harbors, Inc. (CHI) on 24 July 1996 to sample the material, which was found to contain elevated levels of chlorinated hydrocarbons including TCE at 598,000 micrograms per liter ($\mu\text{g}/\text{L}$), associated degradation products and semi-volatile organic compounds (SVOCs).

On 1 August 1996, CHI removed three drums of solid waste and found the bottom of the manhole to have a solid concrete bottom. The manhole was cleaned and 15 drums of fluids were containerized and disposed off-Site. Inspection of the interior of Building 4 revealed a drain labeled "sanitary" that was found to

be connected to the manhole. A wipe sample collected from the drain indicated the presence of 613 μg of TCE per 100 square centimeters (cm^2) within the discharge pipe. As indicated in the Phase I Report, this portion of Building 4 had been formerly utilized as a Printed Circuit Board Shop from the 1960s until 1991.

Following cleaning of the drain line and manhole, two holes approximately four inches in diameter were observed in the bottom of the manhole. Water was also observed slowly seeping into the manhole. The water was sampled and found to contain 120,000 $\mu\text{g}/\text{L}$ of TCE, 1,100 $\mu\text{g}/\text{L}$ of cis-1,2-dichloroethene (cis-1,2-DCE) and 8.2 $\mu\text{g}/\text{L}$ of butyl cellusolve. The bottom of the manhole was subsequently sealed by Raytheon as part of facility decommissioning.

To evaluate the potential for impacts to soil and groundwater from manhole W-4, a soil boring was advanced immediately adjacent to the manhole and soil samples were collected for visual inspection, field screening and laboratory analysis. Field screening indicated no elevated VOCs in soil. Laboratory analysis of soil collected from six to eight feet in depth (targeting the bottom of the manhole) for VOCs and PCBs also indicated no impact to soil. The boring (MW-31) was advanced to a depth of 21 feet and a monitoring well was installed with a ten-foot long screen straddling the water table. Analysis of groundwater samples from this monitoring well (MW-31) indicated TCE at 190 $\mu\text{g}/\text{L}$.

Site Conditions

Figure 4 presents a generalized geologic cross-section showing overburden stratigraphy at the Site. The following overburden units, listed from top to bottom (i.e., youngest to oldest), have been observed at the Site:

- Brown, fine- to coarse-grained, bedded, sand, which likely represent deltaic or proximal glaciolacustrine deposits. This layer ranges from 30 to 50 feet thick.
- Gray silt, which likely represent distal glaciolacustrine deposits. This layer ranges from five to 20 feet thick.

- Gray-brown, fine- to medium-grained sand, which likely represent proximal glaciolacustrine deposits. This layer ranges from five to 10 feet thick.
- Brown, fine- to coarse-grained sand and gravel, which likely represents a stream channel deposit. This unit is discontinuous and appears to trend generally east-west beneath the central portion of the Site.
- Glacial till, consisting of poorly sorted, highly compact sediments with a fine-grained matrix. The till layer is generally less than five feet thick.
- Bedrock, consisting of crystalline metamorphic rock, primarily gneiss. Depths to bedrock vary from approximately of 60 feet to 80 feet below ground surface (bgs).

Groundwater was encountered beneath the Site at depths ranging from 2 to 19 feet bgs. A groundwater elevation contour map was developed based on the April 2000 gauging event (Figure 5). The primary direction of groundwater flow beneath the Site is southwesterly. A local groundwater divide appears to be located beneath the eastern portion of the main building complex trending northeast-southwest. Groundwater flow to the west of the divide is generally southwest. Groundwater flow to the east of the divide is generally south/southeast.

Up-gradient, and in the vicinity of, the suspect source area, precipitation results in groundwater recharge and downward vertical flow gradients. However, the presence of a silt layer beneath the potential source area appears to act as an aquitard, resulting in limited downward groundwater migration in this portion of the Site. This silt layer coarsens to the west. Downward vertical migration appears to occur in the central portion of the Site, west of the potential source area. Upward vertical hydraulic gradients have been measured near the southwestern property boundary.

Migration of dissolved-phase impacted groundwater is primarily controlled by groundwater flow. The predominant flow direction is from northeast to southwest beneath the Site (Figure 5). Dissolved phase TCE appears to be limited to wells in the vicinity of the potential source area (i.e., MW-43S) and down-gradient

wells (MW-33S, MW-47M, MW-45S/M/D, MW-46M and MW-37). This is supported by the relatively low levels of VOCs detected up-gradient of, and cross-gradient to, the suspect source area.

Surrounding Receptors

The Site is located in a portion of Wayland that is zoned for Limited Commercial/Residential use. Currently, the Site is being used for commercial office space.

Surrounding land use and zoning is residential and roadside commercial. Properties adjacent to the Site include:

- North – forest and upland wetlands designated as Protected Open Space and owned by the Town of Wayland.
- East – wooded area and residential properties.
- West – wetlands and the Sudbury River.
- South – Route 20 (Boston Post Road), commercial and residential properties.

As shown in Figure 1, the Sudbury River abuts the Site to the west. An unnamed brook abuts the Site to the east-southeast, and flows into the Sudbury River approximately ¼ mile south of the Site. Extensive wetlands are located along the banks of the Sudbury River.

The MA DEP Geographical Information System (GIS) Site Scoring Map (Figure 6), indicates that the Site is located within the MA DEP-approved Zone II Wellhead Protection Area for the Baldwin Pond Well Field, located approximately 0.5-mile to the north of the Site. Although the Site is located within the Zone II, the groundwater contour map on which the Zone II delineation is based shows that, even after 180 days of pumping at 1,510,000 gallons per day, the majority of groundwater that passes beneath the Site discharges to the Sudbury River (Anderson-Nichols, March 1994). In addition, an apparent southwest-northeast trending groundwater divide was inferred to exist along the northern boundary of the Site. Therefore, even when the Baldwin

Pond wells are being pumped at their hypothetical maximum allowable rate, the Zone II model shows that groundwater flow beneath the Site remains south-southwest toward the Sudbury River. The results of the Zone II study are documented in a report entitled, *Report on Conceptual Zone II Study of the Baldwin Pond Wellfield*, dated 31 March 1994.

c) ***Objectives, specific plans, and proposed implementation schedule for the RAM***

Objectives

The objective of the RAM is to evaluate the ability to reduce the concentration of chlorinated ethenes in groundwater to levels that enable achievement of a Permanent Solution, if feasible. If successful, data obtained as part of the RAM will be used to evaluate if the technology would be viable as a permanent solution for the site.

Specific Plans

In situ chemical oxidation is a remedial technology that, through a series of chemical reactions, transforms contaminant mass into neutral by-products. A variety of chemical oxidants exist, including hydrogen peroxide, permanganate, persulfate and ozone. All of these oxidants have been proven effective at destroying TCE. ERM is evaluating the use of permanganate or persulfate for the Site. The final oxidant selection will be based on data obtained from the proposed bench-scale soil oxidant demand test.

Based on our experience at similar sites, a full-scale in situ chemical oxidation system will involve injection of oxidant at several discrete locations throughout the remediation area using direct push technology. Successful implementation of in situ chemical oxidation is dependent on the effectiveness of delivering oxidants to the impacted groundwater. Transport of the oxidants within the aquifer may be conducted under either natural or forced hydraulic gradients. Based on the nature and extent of groundwater impacts and hydrogeologic characteristics of the Site, we anticipate that the majority of the Site may be treated by direct injection using the passive, natural groundwater flow

gradient to complete the distribution of the oxidant. Two pilot studies are proposed to obtain the following information necessary to support a remedy design:

- Dispersion rates, used to design optimal spacing between injection points;
- Total oxidant demand (natural, soil oxidant demand plus the stoichiometric contaminant demand) to design the optimal oxidant concentrations for the injection(s);
- Oxidant travel time and reaction rates to design the expected time required for remediation;
- The number of injections necessary and the time interval between successive injections to address the potential for rebound, if necessary; and
- The effectiveness of natural hydraulic gradients at transporting chemical oxidants to areas of impact, particularly where access restrictions may limit implementation of an optimal injection array.

To address these issues, ERM plans to inject the oxidants using the following two methods:

- Direct Push Injection: a detailed study down-gradient of the potential source area using a form of direct push injection technology to gather data necessary to potentially design a full-scale application of this technology; and,
- Single Well Injection: injection into a single source area well to evaluate the efficacy of natural hydraulic gradients to distribute oxidants beneath the existing building.

The Direct Push Injection will be conducted in the vicinity of the MW-33 well cluster (Figure 2), because:

- TCE concentrations here are similar to those in the potential source area (~350 µg/L).
- TCE is present only at shallow depth and within a discrete zone (limited to an aquifer thickness of 5-15 feet), due to the presence of a semi-confining silt layer at 30 to 35 feet depth.
- Results will allow for evaluation of TCE flux from beneath the building.

- This location will minimize interference with ongoing Site use.

The Direct Push Injection will include two or three direct push injection points located up-gradient of the MW-33 well cluster and a series of direct-push nested monitoring wells located up-gradient, cross-gradient and down-gradient of the injection wells (Figure 7). The oxidant will be injected under pressure (i.e., either low or high pressure, depending on hydrogeologic conditions) and allowed to migrate via natural advective and diffusive flow between injection points and throughout the study area. Groundwater samples will be collected to evaluate the flow rate of oxidants through the aquifer, the dispersivity rate within the aquifer and the rate of mass reduction achieved using this technology.

The Single Well Injection will be conducted utilizing existing monitoring well MW-43S. This pilot study will be conducted as a single-well injection-drift test. The oxidant will be passively injected (i.e., gravity feed) and allowed to migrate via natural advective and diffusive flow beneath the building. Six direct-push monitoring wells will be installed around and down-gradient of the injection well (Figure 8) to evaluate the radius of influence of the injection and the efficacy of the oxidants in reducing TCE concentrations down-gradient of the potential source area.

The in-situ chemical oxidation pilot studies will consist of the following tasks:

1. *Install Monitoring Wells*

ERM will conduct detailed hydrogeologic characterization within the upper sand unit within the Direct Push Injection area using a cone penetrometer (CPT). The CPT gathers real time stratigraphic (i.e., grain size) and permeability data to determine hydrogeologic conditions. These data will be used to evaluate heterogeneity by identifying layers of coarser-grained sediment that may act as preferred migration pathways or finer-grained sediment that may contain more sorbed VOCs. This is critical to selecting the appropriate delivery method (i.e., high or low pressure injection) to optimize delivery of oxidants within the subsurface.

A total of five nested monitoring points will be installed in the Direct Push Injection area in the CPT boreholes. The existing MW-33 well cluster will be used as the downgradient monitoring point. The locations of these wells are shown in Figures 7 and 9.

A total of six single screen monitoring wells will be installed in and down-gradient of the potential source area for the Single Well Injection. The existing well MW-43S will be used as the injection point. The locations of these wells are shown in Figure 8.

The newly-installed monitoring wells will be constructed of one-inch inside diameter (ID), Schedule 40, polyvinyl chloride (PVC) riser pipe and well screen.

2. Conduct Bench-Scale Oxidant Demand Tests

Potassium permanganate, sodium permanganate and sodium persulfate, the candidate oxidants for the in situ pilot study, are strong and somewhat non-selective oxidants. This means that, in addition to chlorinated ethenes, they can oxidize other reduced soil and groundwater constituents. These other constituents potentially include natural organic carbons, such as humic and fulvic acids, and reduced minerals.

ERM will determine the natural soil oxidant demand using bench-scale laboratory tests. Using the observed TCE concentrations in groundwater, the natural oxidant demand, and the injection radius, ERM will calculate the required concentration of permanganate and/or persulfate to be injected in each study area.

3. Establish Baseline Hydrogeochemistry

The purpose of this task is to establish baseline groundwater flow and groundwater quality within the test areas prior to beginning the oxidant injection. Newly installed wells will be surveyed relative to the existing well network to allow for determination of groundwater elevations within the treatment areas.

To ensure ambient groundwater conditions, ERM will perform well development at all new wells prior to oxidant injection. The purging will act to restore the natural hydraulic conductivity after the new wells are installed. One round of groundwater

monitoring will be conducted to establish baseline aquifer geochemistry. The baseline monitoring program will consist of the following field measurements and laboratory analyses:

Analysis	Method of Analysis	Rationale
pH	Field Flow-Through Cell	Evaluate aquifer conditions
Temperature	Field Flow-Through Cell	Evaluate aquifer conditions
Electrical Conductivity	Field Flow-Through Cell	Indicator of tracer and oxidant
Color	Field Visual Assessment	Indicator of MnO ₄ or S ₂ O ₈ *
Eh	Field Flow-Through Cell	Indicator of oxidant
Sodium, Potassium, or Fluoride	Field Ion Selective Electrode	Conservative tracer
Dissolved Oxygen	Field Flow-Through Cell	Evaluate aquifer conditions
VOCs	Lab - EPA Method 8021B	Contaminant concentrations
Manganese**	Lab - EPA Method 200.7	Degradation product of MnO ₄
Chromium	Lab - EPA Method 200.7	Oxidation can convert Cr ³ to Cr ⁶

Notes:

* If persulfate is used, color monitoring can be done by adding a starch-iodide indicator solution.

** Manganese will be included only if permanganate is used as the oxidant.

ERM will conduct surveying, gauging and groundwater sampling activities in accordance with accepted practices outlined in the DEP's Standard References for Monitoring Wells, WSC-310-91, dated April 1991 and updated July 1994. Groundwater samples will be preserved on ice and will be documented consistent with chain-of-custody protocols. For Quality Assurance/Quality Control (QA/QC) purposes, ERM will collect one duplicate sample and one trip blank during each monitoring round.

4. Apply Reagent

Once baseline conditions have been established, a solution of potassium permanganate, sodium permanganate or sodium persulfate and a conservative tracer (fluoride) will be prepared. The oxidant solution will be prepared by mixing concentrated oxidant with either potable water or purged groundwater to the appropriate concentration.

For the Direct Push Injection, oxidant will be injected using either low pressure direct push injection or pneumatic fracturing and liquid atomized injection (PFLAI), depending on the degree of heterogeneity of overburden deposits within the pilot study area. If the CPT data indicate that the overburden hydrogeology is relatively homogenous within the study area, then low pressure direct push injection will be implemented using three injection points (IP-1, IP-2 and IP-3 on Figure 7).

PFLAI will be used if the degree of heterogeneity is high. This approach is estimated to increase the radius of influence for each injection point from 10 to 20 feet up to 30 to 40 feet relative to direct push injection. In addition, PFLAI can homogenize the overburden, lessening the degree of channelization that can occur during injection. If PFLAI is implemented, oxidant will be injected at two locations (IP-4 and IP-5 on Figure 7).

The same procedure will be used at each injection point. A two-foot long injection tip will be advanced using a direct-push rig to the top of the underlying silt layer. A calculated volume of oxidant will be injected under low or high pressure using the direct push or PFLAI methods, respectively. The injection tip will then be withdrawn approximately two feet to the next interval and oxidant will be injected into this interval. This sequential injection will be repeated until the injection tip is four feet above the seasonal water table at each location. It is estimated that up to 10 vertical injection intervals will be needed at each location.

During the injection process, ERM will monitor for changes in groundwater elevation and baseline field parameters in the monitoring wells. The presence of oxidant in down-gradient wells will be determined based on:

- Increases in electrical conductivity, which indicates the presence of potassium/sodium and/or unreacted oxidant;
- Eh value greater than 600 millivolts (mV), which indicates the presence of oxidant; and,
- Visual indication of permanganate, which is visibly pink at a concentration of approximately 0.5 parts per million (ppm).
- Visual indication of persulfate using a starch-iodide indicator (blue color for positive)

5. Post-Injection Groundwater Monitoring

Groundwater samples will be collected from the monitoring points for field parameters, fluoride, and laboratory analysis of VOCs by EPA Method 8021B one day after oxidant injection is complete to evaluate potential dilution effects. Field parameter and fluoride monitoring will be conducted weekly following completion of oxidant injection to evaluate tracer and oxidant breakthrough. Groundwater samples will be collected from each monitoring point for laboratory analysis of VOCs once oxidant breakthrough has been detected at that point. Groundwater samples will be collected from all monitoring points one and two months following the detection of oxidant at the first monitoring point.

The final monitoring round (i.e., the two-month round) will be conducted as part of a semi-annual comprehensive monitoring event for the Site. The final monitoring round will also include analysis of manganese and chromium by EPA Method 200.7 to evaluate for any residual impacts to groundwater quality as a result of oxidant injection.

These data will allow for evaluation of oxidant diffusion, dispersion and degradation rates, and VOC destruction rates, and will be used to optimize well spacing and frequency of injections for a potential full-scale system.

Schedule

The proposed schedule includes application of oxidants during Fall 2001 or Winter 2001-2002, with monitoring for three to four months after injection.

d) *Management of Remediation Waste*

Remedial Waste and Remedial Wastewater will not be generated.

Remedial Additives will be discharged at the Site as discussed previously.

e) Proposed monitoring during and after the RAM

Monitoring will be performed in accordance with 310 CMR 40.0046(4) and as discussed above.

If the concentrations of Remedial Additives applied are above the applicable standards set forth in 310 CMR 40.0046(1)(b), ERM will monitor these wells for such additives for a reasonable period of time after the final application of the additives to demonstrate compliance.

f) Listing of all federal, state and local permits likely to be needed for the RAM;

In accordance with 310 CMR 40.0041(17), a permit pursuant to 314 CMR 5.00, the Massachusetts Ground Water Discharge Permit Program, is not needed, since Remedial Additives shall be applied in accordance with the requirements of 310 CMR 40.0000.

Pursuant to 310 CMR 40.0046(3), remedial additives are not being applied within 100 feet of any private water supply well, within 800 feet of any public water supply well or within 50 feet of any other surface water body, or any tributary. Therefore, Department approval is not required prior to conducting the RAM.

Pursuant to 310 CMR 40.0443(3), Department approval is not required prior to conducting the RAM because the Site has been Tier Classified and is not a Tier IA site. Therefore, Department approval is not required prior to conducting the RAM.

Public involvement will be performed in accordance with 310 CMR 40.1400 (Appendix C).

g) Seal and signature of the LSP who prepared the RAM Plan;

Refer to BWSC Form 106; Section J (Appendix A).

h) Certification for Remediation Waste in excess of 1,500 cubic yards;

Not Applicable.

i) *Department required information.*

To be submitted at the Department's request.

(2) *RAM Fees*

Since the Site has been Tier Classified as a Tier IB Site conducting response actions in compliance with the provisions of 310 CMR 40.0640, no RAM fee is required for this RAM pursuant to 310 CMR 40.0444(2).

(3) *RAM Transmittal Form BWSC-106*

Original RAM Transmittal Form BWSC-106 is attached (Appendix A).

If the Department requires additional information or clarification, please contact either of the undersigned at (617) 267-8377.

Sincerely,



John C. Drobinski, P.G., LSP
Principal-in-Charge



John W. McTigue, P.G., LSP
Project Manager



R. Joseph Fiacco, Jr., P.G.
Task Manager

Enclosures:

Figures: Figure 1 Site Locus Map
Figure 2 Site Plan
Figure 3 Approximate Horizontal Extent of TCE in
Groundwater - April 2000
Figure 4 Generalized Geologic Cross Section Map
Figure 5 Groundwater Elevation Contour Map - April 2000
Figure 6 Resource Area Map
Figure 7 Direct Push Pilot Study Plan
Figure 8 Single Well Injection Pilot Study Plan
Figure 9 Schematic Cross Section of Direct Push Pilot Study
Area

Appendices: Appendix A: RAM Transmittal Form BWSC-106
Appendix B: Copy of Notice to Public Officials

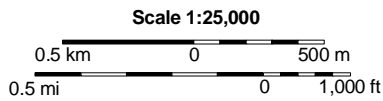
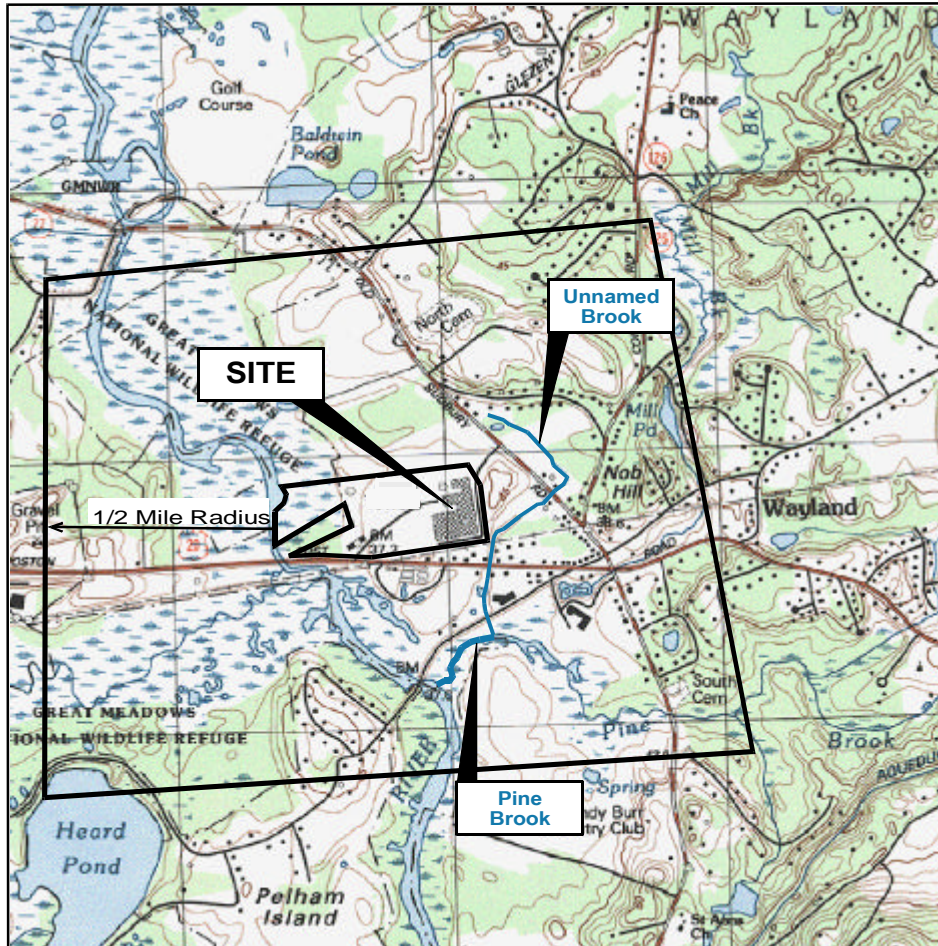
cc: Mr. Ron Slager, Manager, Environmental Restoration Program,
Raytheon Systems Company, 1001 Boston Post Rd., MS-1-2-1567,
Marlborough, MA 01752-3789


Public Repository (Primary Location), Former Raytheon Facility,
Wayland Public Library, Louise Brown, 5 Concord Road,
Wayland, MA 01778

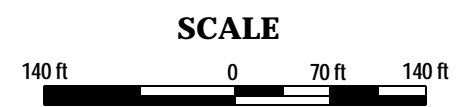
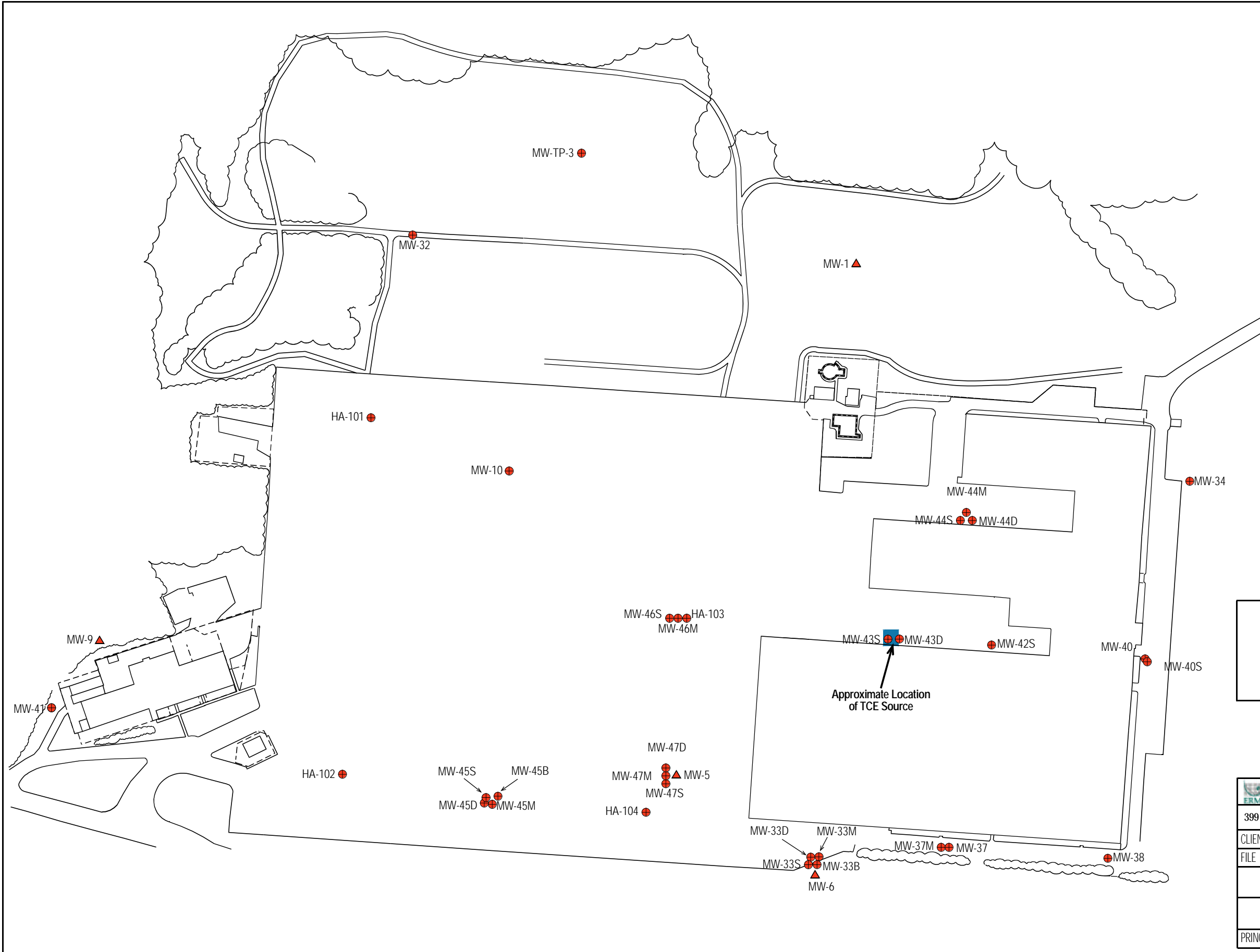
Public Repository (Secondary Location), Former Raytheon
Facility, Wayland Town Hall, 41 Cochituate Road, Wayland, MA
01778

Karen Stromberg, PIP Coordinator, MA Department of
Environmental Protection, Northeast Regional Office, 205A
Lowell Street, Wilmington, MA 01887

Figures




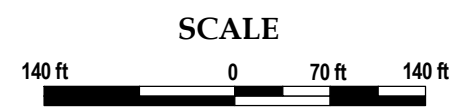
 ENVIRONMENTAL RESOURCES MANAGEMENT			
399 Boylston Street, Boston, Massachusetts 02116 (617) 267-8377			
CLIENT NAME:	Raytheon	DRAWN BY: RBL	DATE: 7/5/01
FILE NAME:	Locus Map	SCALE: 1:25,000	PROJ: 143.57
Raytheon Company 430 Boston Post Road Wayland, Massachusetts			
SITE LOCUS MAP			FIGURE NO.: 1
PRINCIPAL-IN-CHARGE:	JD	PROJECT MANAGER:	JMcT



LEGEND

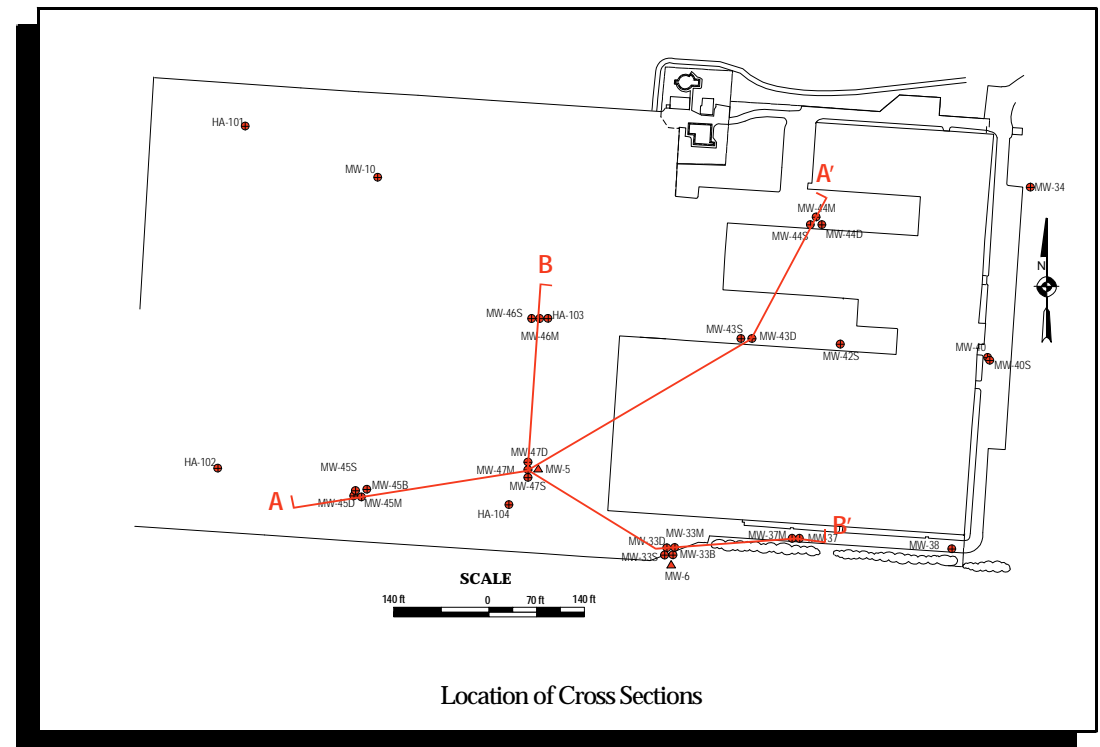
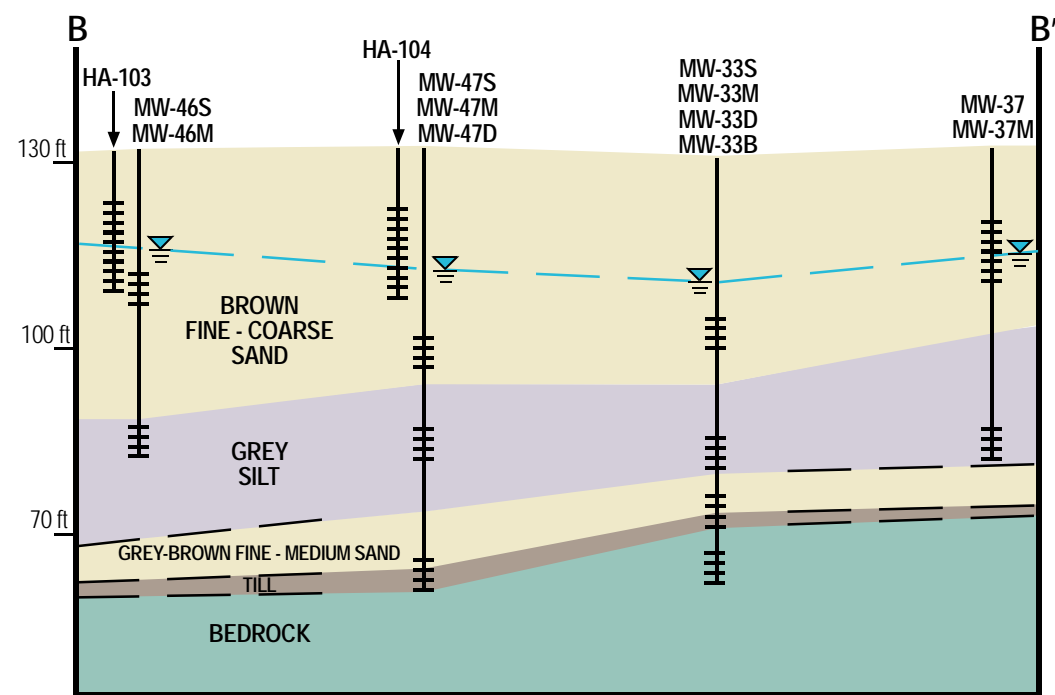
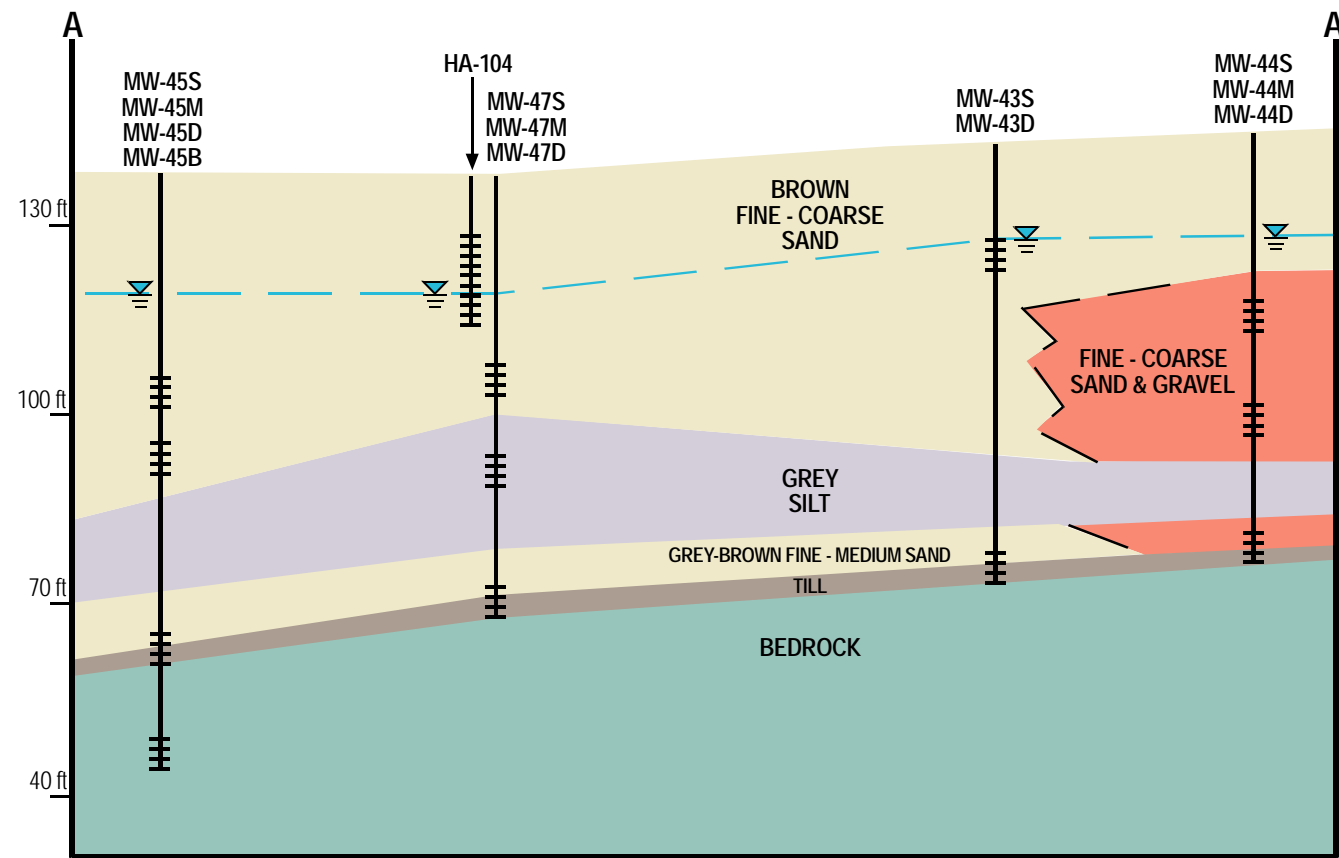
- MW-34 ● Monitoring Well
- MW-1 ▲ Microwell

 ENVIRONMENTAL RESOURCES MANAGEMENT			
399 Boylston Street, Boston, Massachusetts 02116 (617) 267-8377			
CLIENT NAME: Raytheon	DRAWN BY: RJF	DATE: 7/5/01	
FILE NAME: TCE Conc Apr 00	SCALE: 1" = 140'	PROJ: 143.57	
Raytheon Company 430 Boston Post Road Wayland, Massachusetts			
Site Plan			FIGURE NO.: 2
PRINCIPAL-IN-CHARGE: JD		PROJECT MANAGER: JMcT	



LEGEND	
MW-34 ●	Monitoring Well
MW-1 ▲	Microwell
16	TCE Concentration (µg/l)

ENVIRONMENTAL RESOURCES MANAGEMENT			
399 Boylston Street, Boston, Massachusetts 02116 (617) 267-8377			
CLIENT NAME:	Raytheon	DRAWN BY:	RJF
FILE NAME:	TCE Conc Apr 00	DATE:	7/5/01
		SCALE:	1"=140'
		PROJ:	143.57
Raytheon Company 430 Boston Post Road Wayland, Massachusetts			
Approximate Horizontal Extent of TCE in Groundwater-April 2000			FIGURE NO.: 3
PRINCIPAL-IN-CHARGE:	JD	PROJECT MANAGER:	JMcT

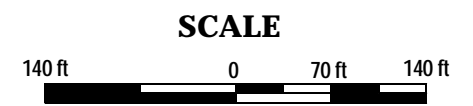
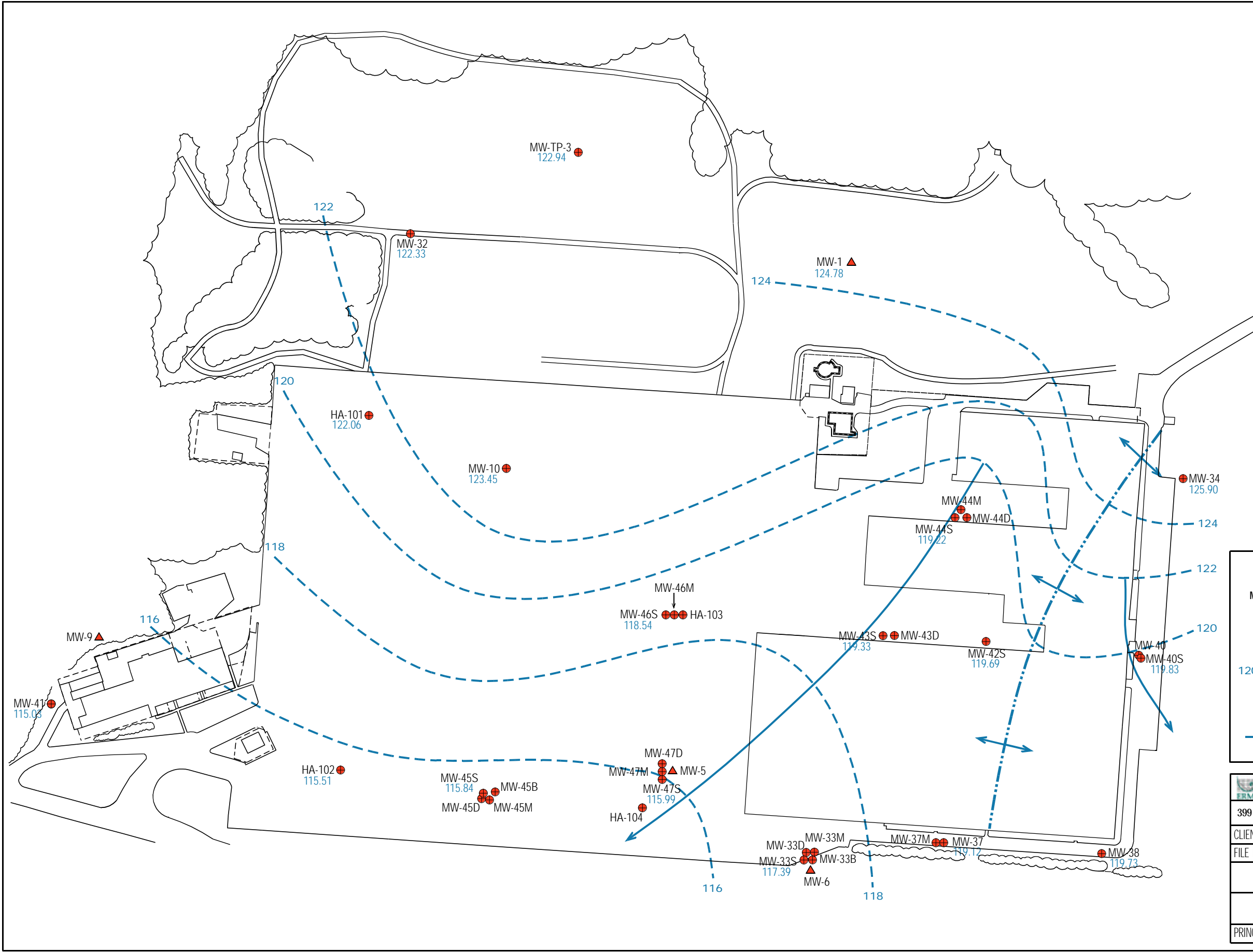


APPROXIMATE SCALE
 Horizontal: 1" = 140'
 Vertical: 1" = 30'

NOTE:
 All elevations are approximate and are relative to mean sea level.

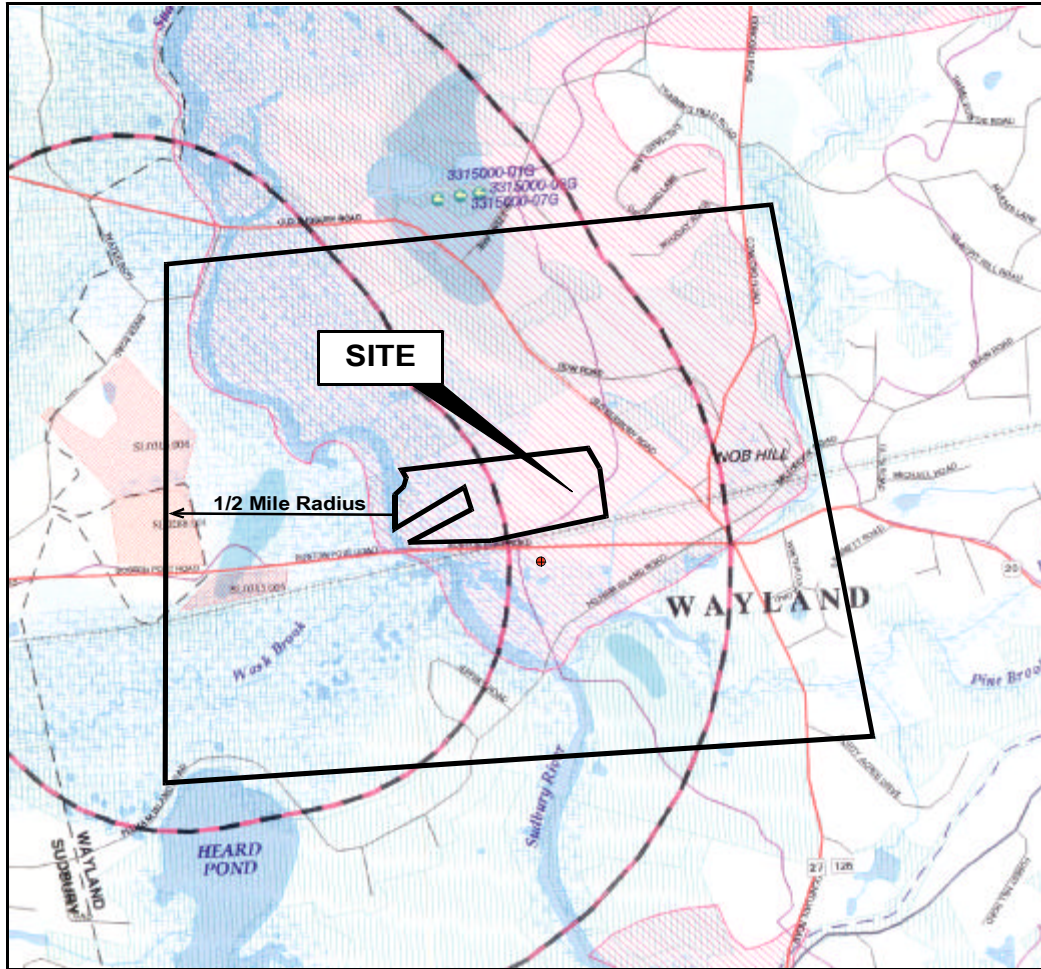
LEGEND			
MW-9D	Existing Monitoring Well		
---	Shallow Overburden Groundwater Table		

ENVIRONMENTAL RESOURCES MANAGEMENT			
399 Boylston Street, Boston, Massachusetts 02116 (617) 267-8377			
CLIENT NAME:	Raytheon	DRAWN BY:	RJF
FILE NAME:	Cross Section	SCALE:	1" = 140'
		DATE:	7/5/01
		PROJ:	143.57
Raytheon Systems Company 430 Boston Post Road Wayland, Massachusetts			
Generalized Geologic Cross-Section Map			FIGURE NO.: 4
PRINCIPAL-IN-CHARGE:	JD	PROJECT MANAGER:	JMcT



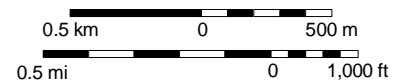
LEGEND	
MW-34 ●	Monitoring Well
MW-1 ▲	Microwell
125.35	Shallow Overburden Groundwater Elevation (feet ASL)
120 - - -	Shallow Overburden Groundwater Contour (dashed where inferred)
←	Inferred Groundwater Flow Direction
↕	Inferred Location of Groundwater Flow Divide

ENVIRONMENTAL RESOURCES MANAGEMENT			
399 Boylston Street, Boston, Massachusetts 02116 (617) 267-8377			
CLIENT NAME:	Raytheon	DRAWN BY: RJP	DATE: 7/5/01
FILE NAME: GW Contour Apr 00	SCALE: 1" = 140'	PROJ: 143.57	
Raytheon Company 430 Boston Post Road Wayland, Massachusetts			FIGURE NO.: 5
Groundwater Elevation Contour Map April 2000			
PRINCIPAL-IN-CHARGE: JD	PROJECT MANAGER: JMCT		

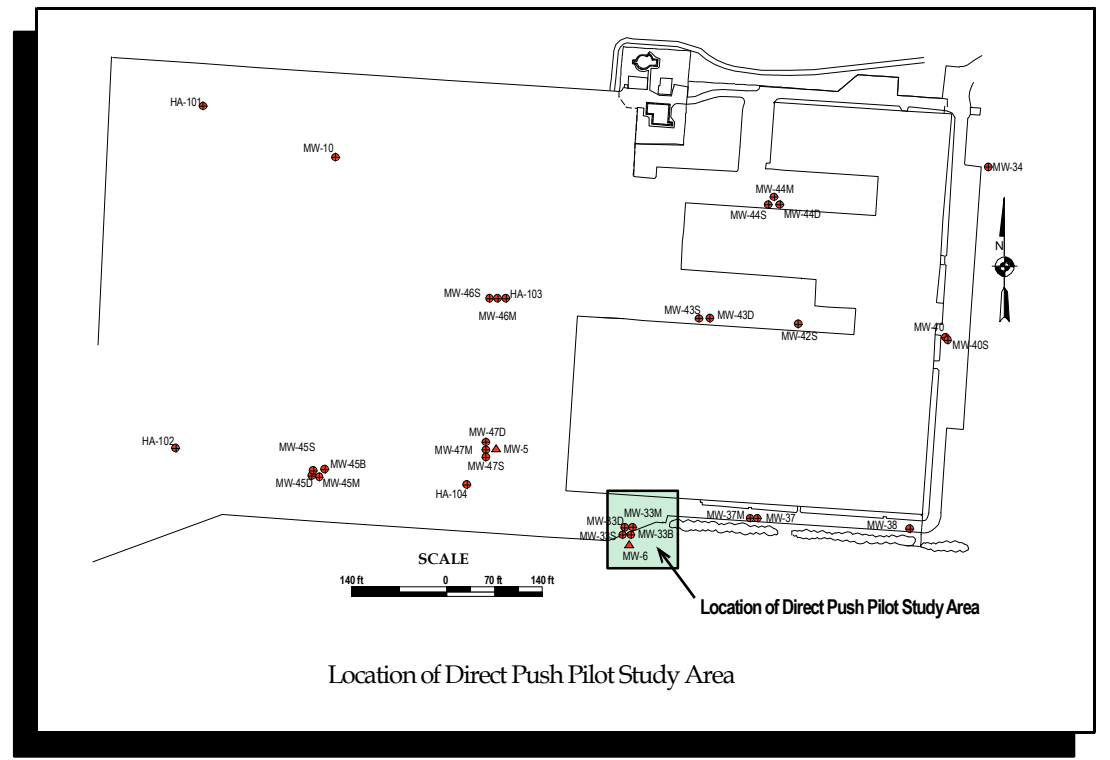
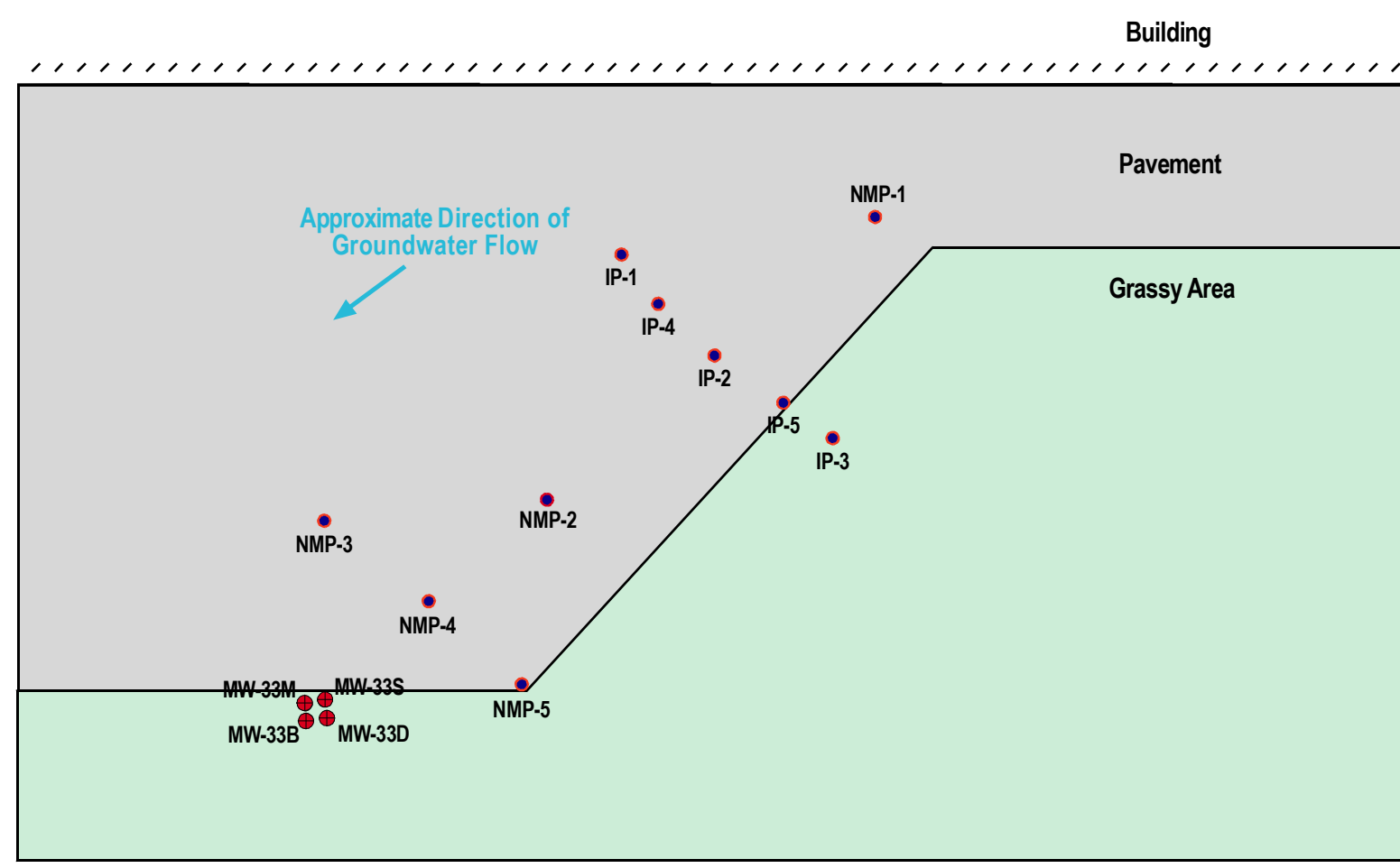


LEGEND	
■ Non Potential Drinking Water Source Area: Medium Yield	● Community Public Water Supply - Groundwater
■ Non Potential Drinking Water Source Area: High Yield	● Non Community Public Water Supply
■ Potentially Productive Medium Yield Aquifer	● NHESP 1999-2001 MA Certified Vernal Pool
■ Potentially Productive High Yield Aquifer	— 1/2 and 1 Mile Landfill Buffer
■ EPA Designated Sole Source Aquifer	— Limited Access Highway
■ DEP Approved Wellhead Protection Area (Zone I)	— Multi-Lane Highway; NOT Limited Access
■ DEP Interim Wellhead Protection Area (IWPA)	— Other Numbered Highway
■ Public Surface Water Supply Protection Area (Zone A)	— Major Road - Connector
■ Lake Pond Stream or other Fresh Water Feature	— Minor Street or Road
■ Bay Estuary or other Salt Water Feature	— Track or Trail
■ Fresh Water Non-Forested Wetland	— Municipal Boundary
■ Salt Water Wetland	— County Boundary
■ NHESP 1999-2001: Estimated habitats of Rare Wildlife: for Use with the MA Wetlands Protection Act, regulations (310 CMR10)	— Train
■ Protected and Recreational Open Space	— Powerline
■ Areas of Critical Environmental Concern	— Pipeline
■ Solid Waste Landfill	— Aqueduct
■ Public Surface Water Supply	— Major Drainage Basin
● Community Public Water Supply - Surface Water	— Salt Drainage Basin
	— USGS Quadrangle Boundary
	● Private Irrigation Well

Scale 1:25,000



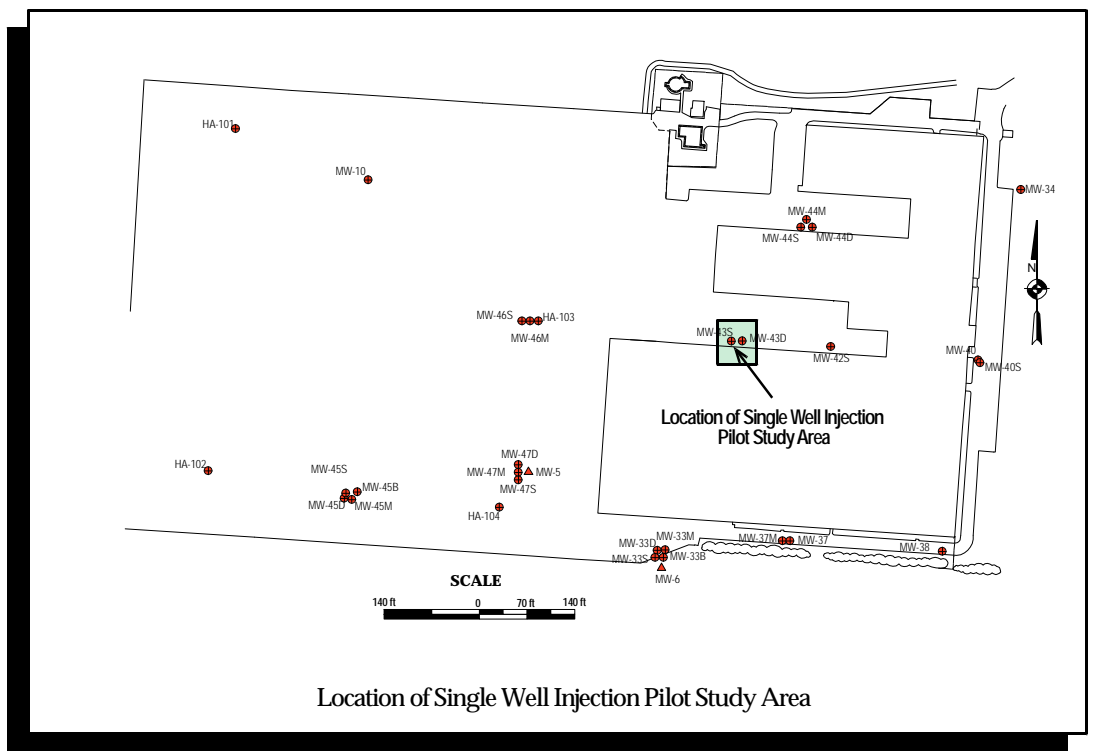
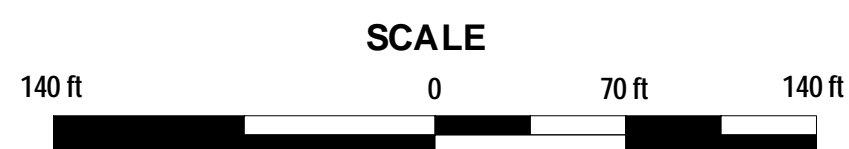
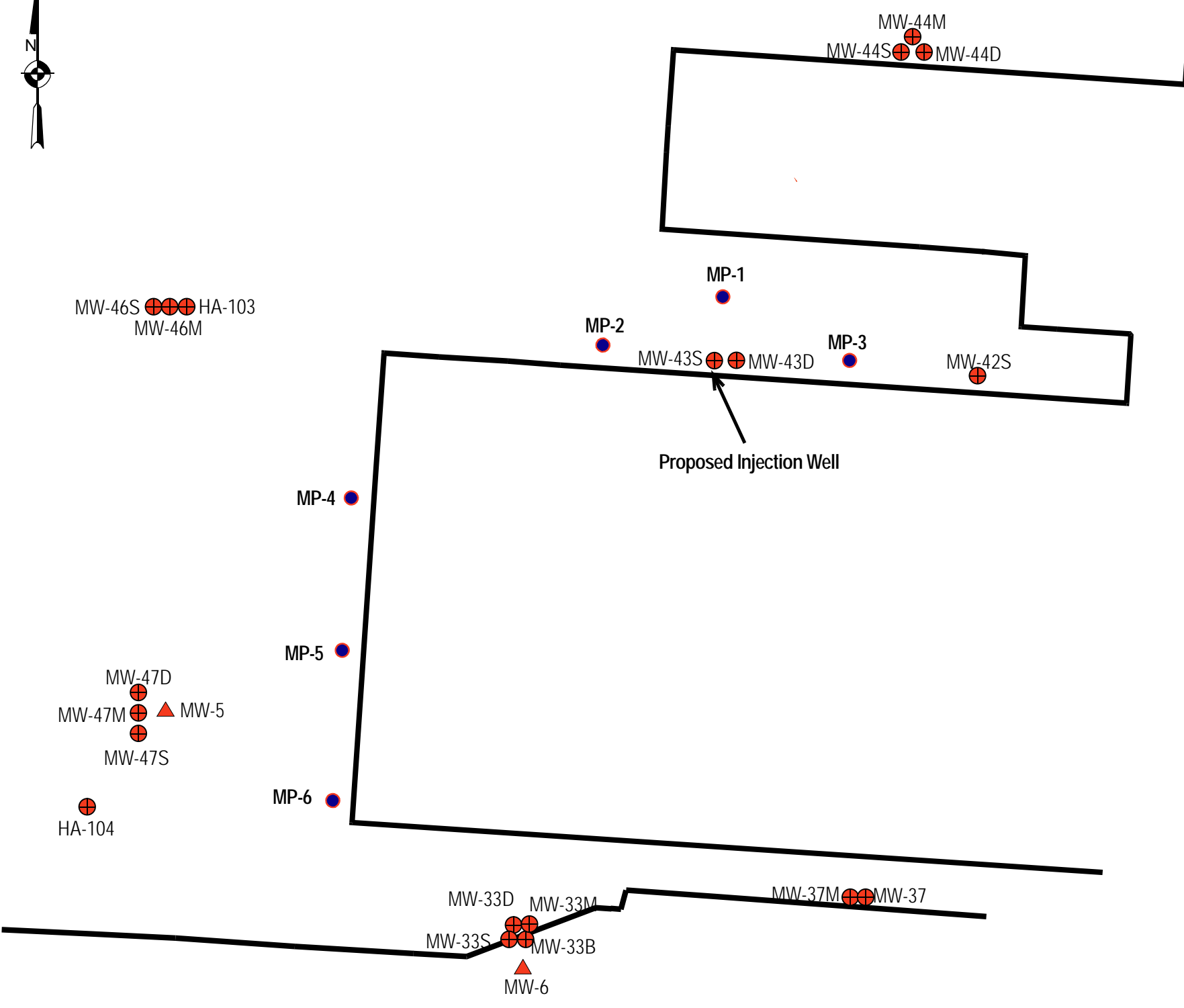
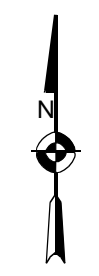
ENVIRONMENTAL RESOURCES MANAGEMENT			
399 Boylston Street, Boston, Massachusetts 02116 (617) 267-8377			
CLIENT NAME:	Raytheon	DRAWN BY: LA	DATE: 7/5/01
FILE NAME:	GIS Map 1.01	SCALE: 1:25,000	PROJ: 143.57
Raytheon Company 430 Boston Post Road Wayland, Massachusetts			FIGURE NO. 6
PRINCIPAL-IN-CHARGE: JD		PROJECT MANAGER: JMcT	



Legend	
●	NMP-3 Proposed Nested Monitoring Point
●	IP-1 Proposed Injection Point
●	MW-33S Monitoring Well

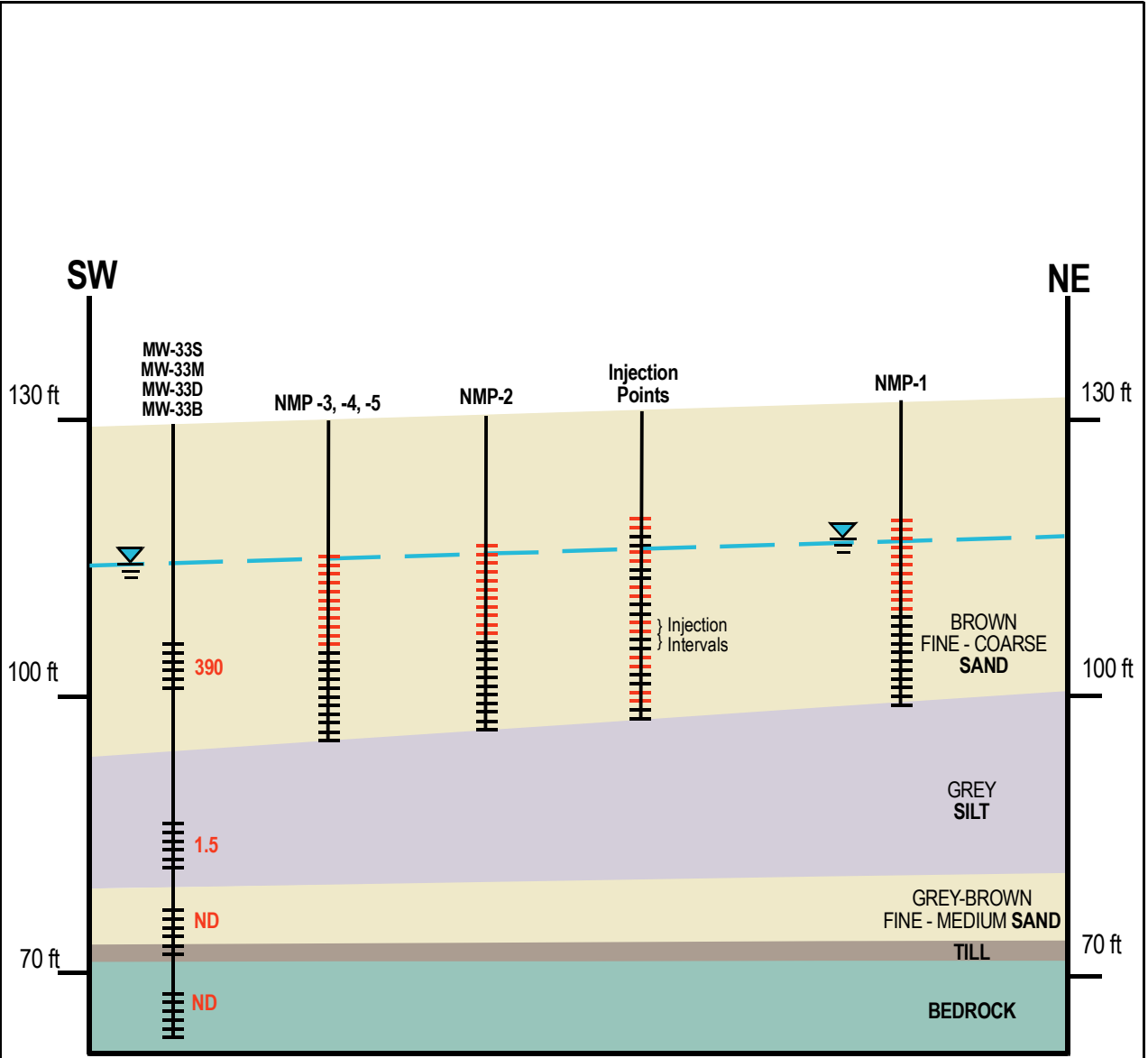
Note: Injection Points IP-1, IP-2 and IP-3 will be used if low pressure, direct push injection is implemented. Injection Points IP-4 and IP-5 will be used if high pressure PFLAI, direct push injection is implemented.

ENVIRONMENTAL RESOURCES MANAGEMENT 399 Boylston Street, Boston, Massachusetts 02116 (617) 267-8377			
CLIENT NAME:	Raytheon	DRAWN BY:	JC
		DATE:	7/5/01
FILE NAME:	Figure 7 Direct Push	SCALE:	Not to Scale
		PROJ:	143.57
Raytheon Company 430 Boston Post Road Wayland, Massachusetts			
Direct Push Pilot Study Plan			FIGURE NO.: 7
PRINCIPAL-IN-CHARGE:	JD	PROJECT MANAGER:	JMcT



Legend	
	MP-1 Monitoring Point
	MW-435 Monitoring Well

ENVIRONMENTAL RESOURCES MANAGEMENT			
399 Boylston Street, Boston, Massachusetts 02116 (617) 267-8377			
CLIENT NAME	Raytheon	DRAWN BY:	JC
		DATE	7/5/01
FILENAME	Figure 8 Single Well Inj	SCALE:	Not to Scale
		PROJ	143.57
Raytheon Company 430 Boston Post Road Wayland, Massachusetts			
Single Well Injection Pilot Study Plan			FIGURE NO.: 8
PRINCIPAL-IN-CHARGE:	JD	PROJECT MANAGER:	JMcT



LEGEND	
240	TCE Concentration April 2000 (ug/l)
—	Shallow Overburden Groundwater Table

ENVIRONMENTAL RESOURCES MANAGEMENT		
399 Boylston Street, Boston, Massachusetts 02116 (617) 267-8377		
CLIENT NAME:	Raytheon	DRAWN BY: MD
		DATE: 7/5/01
FILE NAME:	Pilot Study SOW Fig. 2	SCALE: Not to Scale
		PROJ: 143.57
Raytheon Company 430 Boston Post Road Wayland, Massachusetts		FIGURE NO.: 9
Schematic Cross Section Of Direct Push Pilot Study Area		
PRINCIPAL-IN-CHARGE:	JD	PROJECT MANAGER: JMCT

Appendix A
RAM Transmittal Form BWSC-106



**RELEASE & UTILITY-RELATED ABATEMENT
MEASURE (RAM & URAM) TRANSMITTAL FORM**

Release Tracking Number

Pursuant to 310 CMR 40.0444 - 0446 and 310 CMR 40.0462 - 0465 (Subpart D)

3 - 13574

A. SITE LOCATION:

Site Name: Former Raytheon Facility

Street: 430 Boston Post Road

Location Aid: Route 20

City/Town: Wayland

ZIP Code: 01778-0000

Check here if a Tier Classification Submittal has been provided to DEP for this Release Tracking Number.

Related Release Tracking Numbers That This RAM or URAM Addresses: _____

B. THIS FORM IS BEING USED TO: (check all that apply)

Submit a **RAM Plan** (complete Sections A, B, C, D, E, F, J, K, L and M).

Check here if this RAM Plan is an update or modification of a previously approved written RAM Plan. Date Submitted: _____

Submit a **RAM Status Report** (complete Sections A, B, C, E, J, K, L and M).

Submit a **RAM Completion Statement** (complete Sections A, B, C, D, E, G, J, K, L and M).

Confirm or Provide **URAM Notification** (complete Sections A, B, H, K, L and M).

Submit a **URAM Status Report** (complete Sections A, B, C, E, J, K, L and M).

Submit a **URAM Completion Statement** (complete Sections A, B, C, D, E, I, J, K, L and M).

You must attach all supporting documentation required for each use of form indicated, including copies of any Legal Notices and Notices to Public Officials required by 310 CMR 40.1400.

C. SITE CONDITIONS:

Check here if the source of the Release or Threat of Release is known.

If yes, check all sources that apply: UST Pipe/Hose/Line AST Drums Transformer Boat

Tanker Truck Vehicle Other Specify: Former manhole

Identify Media and Receptors Affected: (check all that apply) Air Groundwater Surface Water Sediments Soil

Wetlands Storm Drain Paved Surface Private Well Public Water Supply Zone 2 Residence

School Unknown Other Specify: _____

Identify Release and/or Threat of Release Conditions at Site: (check all that apply)

2 and 72 Hour Reporting Condition(s) 120 Day Reporting Condition(s) Other Condition(s)

Describe: Groundwater concentrations above applicable reportable concentrations

**RAMs may be conducted concurrently with an IRA only with written DEP approval
URAMs may not be conducted if any 2 or 72 Hour conditions exist at the site.**

Identify Oils and Hazardous Materials Released: (check all that apply)

Oils

Chlorinated Solvents

Heavy Metals

Others Specify: _____

D. DESCRIPTION OF RESPONSE ACTIONS: (check all that apply)

Assessment and/or Monitoring Only

Deployment of Absorbant or Containment Materials

Excavation of Contaminated Soils

Temporary Covers or Caps

Re-use, Recycling or Treatment

Bioremediation

On Site Off Site Est. Vol.: _____ cubic yards

Soil Vapor Extraction

Describe: _____

Structure Venting System

Store On Site Off Site Est. Vol.: _____ cubic yards

Product or NAPL Recovery

SECTION D IS CONTINUED ON THE NEXT PAGE.



**RELEASE & UTILITY-RELATED ABATEMENT
MEASURE (RAM & URAM) TRANSMITTAL FORM**

Release Tracking Number

Pursuant to 310 CMR 40.0444 - 0446 and 310 CMR 40.0462 - 0465 (Subpart D)

3 - 13574

D. DESCRIPTION OF RESPONSE ACTIONS (continued):

- Landfill Cover Disposal Est. Vol.: _____ cubic yards
- Removal of Drums, Tanks or Containers
- Removal of Other Contaminated Media
- Other Response Actions
- Groundwater Treatment Systems
- Air Sparging
- Temporary Water Supplies
- Temporary Evacuation or Relocation of Residents
- Fencing and Sign Posting

**See 310 CMR 40.0442 for limitations on the scope and type of RAMs.
See 310 CMR 40.0464 for performance standards for URAMs.**

- Check here if this RAM or URAM involves the use of Innovative Technologies. DEP is interested in using this information to aid in creating an Innovative Technologies Clearinghouse.

E. TRANSPORT OF REMEDIATION WASTE: (if Remediation Waste has been sent to an off-site facility, answer the following questions)

Name of Facility: N/A

Town and State: N/A

Quantity of Remediation Waste Transported to Date: N/A

F. RAM PLAN:

- Check here if this RAM Plan received previous oral approval from DEP as a continuation of a Limited Removal Action (LRA).
Date of Oral Approval: _____
- If a RAM Compliance Fee is required, check here to certify that the fee has been submitted. You **MUST** attach a photocopy of the payment. See 310 CMR 40.0444(2) to learn when a fee is not required.
- Check here if the RAM Plan is proposed for a Transition Site. If this is the case, you may need to attach an LSP Evaluation Opinion prior to undertaking the RAM, if not previously provided. See 310 CMR 40.0600 for further information about Transition Sites.

G. RAM COMPLETION STATEMENT:

- If a RAM Compliance Fee is required in connection with submission of the RAM Completion Statement, check here to certify that the fee has been submitted. You **MUST** attach a photocopy of the payment. You owe this fee when submitting a RAM Completion Statement if you received oral approval of a RAM that continued an LRA, and have NOT previously submitted a RAM Plan and accompanying fee.
- If any Remediation Waste will be stored, treated, managed, recycled or reused at the site following submission of the RAM Completion Statement, you must submit a Phase IV Remedy Implementation Plan, along with the appropriate transmittal form, as an attachment to the RAM Completion Statement.**

H. URAM NOTIFICATION:

- Identify Location Type: (check all that apply) Public Right of Way Utility Easement Private Property
- Identify Utility Type: (check all that apply) Sanitary/Combined Sewerage Water Drainage Natural Gas
- Telephone Steam Lines Telecommunications Electric Other Specify: _____
- Check here if you provided DEP with previous oral notification of this URAM. Date of Oral Notice: _____
 - Check here if the property owner was NOT contacted prior to initiation of the URAM. If this is the case, you must attach an explanation of why the owner was not contacted, including the date and time when contact ultimately occurred.
 - Check here if this URAM will occur in connection with the construction of new public utilities. If this is the case, document the nature and extent of encountered contamination, the scope and expense of necessary mitigation and the benefits and limitations of project alternatives.
- With the exception stated below, the person undertaking the URAM must provide the name and license number of an LSP engaged or employed in connection with the URAM:
- LSP Name: _____ LSP License Number: _____

LSP information is not required if the URAM is limited to the excavation and/or handling of not more than 100 cubic yards of soil contaminated by Oil, or not more than 20 cubic yards of soil contaminated either by a Hazardous Material or a mixture of a Hazardous Material and Oil.



RELEASE & UTILITY-RELATED ABATEMENT MEASURE (RAM & URAM) TRANSMITTAL FORM

Release Tracking Number

3 - 13574

Pursuant to 310 CMR 40.0444 - 0446 and 310 CMR 40.0462 - 0465 (Subpart D)

I. URAM COMPLETION STATEMENT:

Check here if this URAM was limited to the excavation and/or handling of not more than 100 cubic yards of soil contaminated by Oil, or not more than 20 cubic yards of soil contaminated by either a Hazardous Material or a mixture of a Hazardous Material and Oil.

If any Remediation Waste will be stored, treated, managed, recycled or reused at the site following submission of the URAM Completion Statement, you must submit either a Release Abatement Measure (RAM) Plan or a Phase IV Remedy Implementation Plan, along with the appropriate transmittal form, as an attachment to the URAM Completion Statement.

J. LSP OPINION:

I attest under the pains and penalties of perjury that I have personally examined and am familiar with this transmittal form, including any and all documents accompanying this submittal. In my professional opinion and judgment based upon application of (i) the standard of care in 309 CMR 4.02(1), (ii) the applicable provisions of 309 CMR 4.02(2) and (3), and (iii) the provisions of 309 CMR 4.03(5), to the best of my knowledge, information and belief,

> if Section B of this form indicates that a Release Abatement Measure Plan is being submitted, the response action(s) that is (are) the subject of this submittal (i) has (have) been developed in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, (ii) is (are) appropriate and reasonable to accomplish the purposes of such response action(s) as set forth in the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000 and (iii) complies(y) with the identified provisions of all orders, permits, and approvals identified in this submittal;

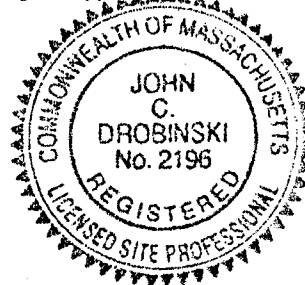
> if Section B of this form indicates that a Release Abatement Measure Status Report or a Utility-Related Abatement Measure Status Report is being submitted, the response action(s) that is (are) the subject of this submittal (i) is (are) being implemented in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, (ii) is (are) appropriate and reasonable to accomplish the purposes of such response action(s) as set forth in the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000 and (iii) complies(y) with the identified provisions of all orders, permits, and approvals identified in this submittal;

> if Section B of this form indicates that a Release Abatement Measure Completion Statement or a Utility-Related Abatement Measure Completion Statement is being submitted, the response action(s) that is (are) the subject of this submittal (i) has (have) been developed and implemented in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, (ii) is (are) appropriate and reasonable to accomplish the purposes of such response action(s) as set forth in the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000 and (iii) complies(y) with the identified provisions of all orders, permits, and approvals identified in this submittal;

I am aware that significant penalties may result, including, but not limited to, possible fines and imprisonment, if I submit information which I know to be false, inaccurate or materially incomplete.

Check here if the Response Action(s) on which this opinion is based, if any, are (were) subject to any order(s), permit(s) and/or approval(s) issued by DEP or EPA. If the box is checked, you MUST attach a statement identifying the applicable provisions thereof.

LSP Name: John C. Drobinski LSP #: 2198 Stamp: Telephone: 617-646-7850 Ext.: FAX: Signature: Date: 2/24/01



An LSP Opinion is not required for a Utility-Related Abatement Measure Notification.

An LSP Opinion is not required for a URAM Completion Statement if the URAM is limited to the excavation and/or handling of not more than 100 cubic yards of soil contaminated by Oil, or not more than 20 cubic yards of soil contaminated either by Hazardous Material or a mixture of Hazardous Material and Oil.

K. PERSON UNDERTAKING RAM OR URAM:

Name of Organization: Raytheon Systems Company Name of Contact: Ronald C. Slager Title: Manager, Env. Rest. Program Street: 1001 Boston Post Road, MS-1-2-1567 City/Town: Marlborough State: MA ZIP Code: 01752-3789 Telephone: 508-490-1707 Ext.: FAX: (optional)

Check here if there has been a change in person undertaking the RAM or URAM.



RELEASE & UTILITY-RELATED ABATEMENT MEASURE (RAM & URAM) TRANSMITTAL FORM

Release Tracking Number

3 - 13574

Pursuant to 310 CMR 40.0444 - 0446 and 310 CMR 40.0462 - 0465 (Subpart D)

L. RELATIONSHIP TO SITE OF PERSON UNDERTAKING RAM or URAM: (check one)

- RP or PRP Specify (checked) Owner Operator Generator Transporter Other RP or PRP Former Operator
Fiduciary, Secured Lender or Municipality with Exempt Status
Agency or Public Utility on a Right of Way
Any Other Person Undertaking RAM or URAM Specify Relationship:

M. CERTIFICATION OF PERSON UNDERTAKING RAM OR URAM:

I, Ronald C. Slager, attest under the pains and penalties of perjury (i) that I have personally examined and am familiar with the information contained in this submittal, including any and all documents accompanying this transmittal form, (ii) that, based on my inquiry of those individuals immediately responsible for obtaining the information, the material information contained in this submittal is, to the best of my knowledge and belief, true, accurate and complete, and (iii) that I am fully authorized to make this attestation on behalf of the entity legally responsible for this submittal. I/the person or entity on whose behalf this submittal is made am/is aware that there are significant penalties, including, but not limited to, possible fines and imprisonment, for willfully submitting false, inaccurate, or incomplete information.

By: [Signature] Title: Manager, Env. Rest. Program
For Ronald C. Slager Date: 9/11/01
(print name of person or entity recorded in Section K)

Enter address of person providing certification, if different from address recorded in Section K:
Street:
City/Town: State ZIP Code:
Telephone: Ext. FAX: (optional)

YOU MUST COMPLETE ALL RELEVANT SECTIONS OF THIS FORM OR DEP MAY RETURN THE DOCUMENT AS INCOMPLETE. IF YOU SUBMIT AN INCOMPLETE FORM, YOU MAY BE PENALIZED FOR MISSING A REQUIRED DEADLINE.

Appendix B
Copy of Notice to Public Officials

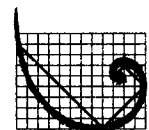
**Environmental
Resources
Management**

399 Boylston Street, 6th Floor
Boston, MA 02116
(617) 267-8377
(617) 267-6447 (fax)

<http://www.erm.com>

11 September 2001
Reference: 143.57

Steven Calichman
Director of Public Health
Town of Wayland
14 Cochituate Road
Wayland, MA 01778



ERM[®]

RE: Notification of Implementation of Release Abatement Measure
Former Raytheon Electronic Systems Facility
430 Boston Post Road
Wayland, Massachusetts

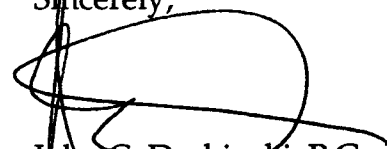
Dear Mr. Calichman:

On behalf of Raytheon Company, Environmental Resources Management (ERM), is submitting this letter to inform you that we will be implementing a Release Abatement Measure (RAM) at the above-referenced site in accordance with 310 CMR 40.0444 of the Massachusetts Contingency Plan (MCP).

The purpose of the RAM is to evaluate the efficacy of reducing the concentration of chlorinated hydrocarbons in groundwater at the site by conducting an in situ chemical oxidation pilot study. The duration of the pilot study is expected to be approximately three to four months.

Please direct any questions or correspondence to Ronald Slager, Jr., Raytheon Company at (508) 490-1707 or the undersigned at (617) 267-8377.

Sincerely,


John C. Drobinski, P.G., LSP
Principal-in-Charge


John W. McTigue, P.G., LSP
Project Manager

cc: Ronald Slager, Raytheon Company

**Environmental
Resources
Management**

399 Boylston Street, 6th Floor
Boston, MA 02116
(617) 267-8377
(617) 267-6447 (fax)

<http://www.erm.com>

11 September 2001
Reference: 143.57

Jeff Ritter
Executive Secretary
Town of Wayland
14 Cochituate Road
Wayland, MA 01778



**RE: Notification of Implementation of Release Abatement Measure
Former Raytheon Electronic Systems Facility
430 Boston Post Road
Wayland, Massachusetts**


Dear Mr. Ritter:

On behalf of Raytheon Company, Environmental Resources Management (ERM), is submitting this letter to inform you that we will be implementing a Release Abatement Measure (RAM) at the above-referenced site in accordance with 310 CMR 40.0444 of the Massachusetts Contingency Plan (MCP).

The purpose of the RAM is to evaluate the efficacy of reducing the concentration of chlorinated hydrocarbons in groundwater at the site by conducting an in situ chemical oxidation pilot study. The duration of the pilot study is expected to be approximately three to four months.

Please direct any questions or correspondence to Ronald Slager, Jr., Raytheon Company at (508) 490-1707 or the undersigned at (617) 267-8377.

Sincerely,


John C. Drobinski, P.G., LSP
Principal-in-Charge


John W. McTigue, P.G., LSP
Project Manager

cc: Ronald Slager, Raytheon Company