PHASE III
REMEDIAL ACTION PLAN

Former Malden MGP Site
(Malden River Portion)
Malden, Massachusetts
RTN 3-0362
June 2006

100 Commercial St. SL=U/A

BROWN AND CALDWELL

1 Corporate Drive
Andover, MA 01810

Tel: (978) 794-0336
Fax: (978) 794-0534

BROWN AND CALDWELL

June 30, 2006

Massachusetts Department of Environmental Protection
Northeast Regional Office
205B Lowell Street
Wilmington, MA 01887

Re: Submittal of Phase III Remedial Action Plan
Former Malden Manufactured Gas Plant Site – Malden River Portion
(RTN 3-0362)

Dear Sir or Madam:

Enclosed please find a copy of the Phase III Remedial Action Plan for the Malden River Portion of the Former Malden Manufactured Gas Plant (MGP) Site. Please contact me if you have any questions.

Sincerely,

BROWN AND CALDWELL

Donald W. Podsen

Donald W. Podsen
Licensed Site Professional

cc: Michele V. Leone – National Grid

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC108

COMPREHENSIVE RESPONSE ACTION TRANSMITTAL FORM & PHASE I COMPLETION STATEMENT

Pursuant to 310 CMR 40.0484 (Subpart D) and 40.0800 (Subpart H)

Release Tracking Number: 3 - 0362

RECEIVED
JUL 03 2006
DEP
NORTHEAST REGIONAL OFFICE

A. SITE LOCATION:

1. Site Name: Former Malden MGP Site (Malden River Portion)
2. Street Address: 100 Commercial Street
3. City/Town: Malden 4. ZIP Code: 02148-5510
5. UTM Coordinates: a. UTM N: 4698392 b. UTM E: 329376
6. [X] Check here if a Tier Classification Submittal has been provided to DEP for this disposal site.
   [ ] a. Tier IA [X] b. Tier IB [ ] c. Tier IC [ ] d. Tier II
7. If applicable, provide the Permit Number: 7378

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

- [ ] 1. Submit a **Phase I Completion Statement**, pursuant to 310 CMR 40.0484.
- [ ] 2. Submit a **Revised Phase I Completion Statement**, pursuant to 310 CMR 40.0484.
- [ ] 3. Submit a **Phase II Scope of Work**, pursuant to 310 CMR 40.0834.
- [ ] 4. Submit an **Interim Phase II Report**. This report does not satisfy the response action deadline requirements in 310 CMR 40.0500.
- [ ] 5. Submit a **final Phase II Report and Completion Statement**, pursuant to 310 CMR 40.0836.
- [ ] 6. Submit a **Revised Phase II Report and Completion Statement**, pursuant to 310 CMR 40.0836.
- [ ] 7. Submit a **Phase III Remedial Action Plan and Completion Statement**, pursuant to 310 CMR 40.0862.
- [X] 8. Submit a **Revised Phase III Remedial Action Plan and Completion Statement**, pursuant to 310 CMR 40.0862.
- [ ] 9. Submit a **Phase IV Remedy Implementation Plan**, pursuant to 310 CMR 40.0874.
- [ ] 10. Submit a **Modified Phase IV Remedy Implementation Plan**, pursuant to 310 CMR 40.0874.
- [ ] 11. Submit an **As-Built Construction Report**, pursuant to 310 CMR 40.0875.
- [ ] 12. Submit a **Phase IV Status Report**, pursuant to 310 CMR 40.0877.
- [ ] 13. Submit a **Phase IV Completion Statement**, pursuant to 310 CMR 40.0878 and 40.0879.

Specify the outcome of Phase IV activities: (check one)

- [ ] a. Phase V Operation, Maintenance or Monitoring of the Comprehensive Remedial Action is necessary to achieve a Response Action Outcome.
- [ ] b. The requirements of a Class A Response Action Outcome have been met. No additional Operation, Maintenance or Monitoring is necessary to ensure the integrity of the Response Action Outcome. A completed Response Action Outcome Statement and Report (BWSC104) will be submitted to DEP.
- [ ] c. The requirements of a Class C Response Action Outcome have been met. No additional Operation, Maintenance or Monitoring is necessary to ensure the integrity of the Response Action Outcome. A completed Response Action Outcome Statement and Report (BWSC104) will be submitted to DEP.
- [ ] d. The requirements of a Class C Response Action Outcome have been met. Further Operation, Maintenance or Monitoring of the remedial action is necessary to ensure that conditions are maintained and that further progress is made toward a Permanent Solution. A completed Response Action Outcome Statement and Report (BWSC104) will be submitted to DEP.

(All sections of this transmittal form must be filled out unless otherwise noted above)

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC108

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

☐ 14. Submit a **Revised Phase IV Completion Statement**, pursuant to 310 CMR 40.0878 and 40.0879.

☐ 15. Submit a **Phase V Status Report**, pursuant to 310 CMR 40.0892.

☐ 16. Submit a **Remedial Monitoring Report.** (This report can only be submitted through eDEP.)

a. Type of Report: (check one) ☐ i. Initial Report ☐ ii. Interim Report ☐ iii. Final Report

b. Frequency of Submittal: (check all that apply)

☐ i. A Remedial Monitoring Report(s) submitted monthly to address an Imminent Hazard.

☐ ii. A Remedial Monitoring Report(s) submitted monthly to address a Condition of Substantial Release Migration.

☐ iii. A Remedial Monitoring Report(s) submitted concurrent with a Status Report.

c. Status of Site: (check one) ☐ i. Phase V ☐ ii. Remedy Operation Status ☐ iii. Class C RAO

d. Number of Remedial Systems and/or Monitoring Programs: _____

A separate BWSC108A, CRA Remedial Monitoring Report, must be filled out for each Remedial System and/or Monitoring Program addressed by this transmittal form.

☐ 17. Submit a **Remedy Operation Status**, pursuant to 310 CMR 40.0893.

☐ 18. Submit a **Status Report to maintain a Remedy Operation Status**, pursuant to 310 CMR 40.0893(2).

☐ 19. Submit a **Modification of a Remedy Operation Status**, pursuant to 310 CMR 40.0893(5).

☐ 20. Submit a **Termination of a Remedy Operation Status**, pursuant to 310 CMR 40.0893(6).

☐ 21. Submit a **Phase V Completion Statement**, pursuant to 310 CMR 40.0894.

Specify the outcome of Phase V activities: (check one)

☐ a. The requirements of a Class A Response Action Outcome have been met. No additional Operation, Maintenance or Monitoring is necessary to ensure the integrity of the Response Action Outcome. A completed Response Action Outcome Statement (BWSC104) will be submitted to DEP.

☐ b. The requirements of a Class C Response Action Outcome have been met. No additional Operation, Maintenance or Monitoring is necessary to ensure the integrity of the Response Action Outcome. A completed Response Action Outcome Statement and Report (BWSC104) will be submitted to DEP.

☐ c. The requirements of a Class C Response Action Outcome have been met. Further Operation, Maintenance or Monitoring of the remedial action is necessary to ensure that conditions are maintained and/or that further progress is made toward a Permanent Solution. A completed Response Action Outcome Statement and Report (BWSC104) will be submitted to DEP.

☐ 22. Submit a **Revised Phase V Completion Statement**, pursuant to 310 CMR 40.0894.

☐ 23. Submit a **Post-Class C Response Action Outcome Status Report**, pursuant to 310 CMR 40.0898.

(All sections of this transmittal form must be filled out unless otherwise noted above)

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC108

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Release Tracking Number: 3 - 0362

Pursuant to 310 CMR 40.0484 (Subpart D) and 40.0800 (Subpart H)

C. LSP SIGNATURE AND STAMP:

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 309 CMR 4.03(2), and (iii) the provisions of 309 CMR 4.03(3), to the best of my knowledge, information and belief,

> *if Section B indicates that a* ***Phase I, Phase II, Phase III, Phase IV or Phase V 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) comply(ies) with the identified provisions of all orders, permits, and approvals identified in this submittal;

> *if Section B indicates that a* ***Phase II Scope of Work*** *or a* ***Phase IV Remedy Implementation 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) comply(ies) with the identified provisions of all orders, permits, and approvals identified in this submittal;

> *if Section B indicates that an* ***As-Built Construction Report, a Remedy Operation Status, a Phase IV, Phase V or Post-Class C RAO Status Report, a Status Report to Maintain a Remedy Operation Status*** *and/or a* ***Remedial Monitoring 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) comply(ies) 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.

1. LSP #: 4492

2. First Name: Donald 3. Last Name: Podsen

4. Telephone: 978-983-2041 5. Ext.: 6. FAX: 978-794-0534

7. Signature: Donald W. Podsen

8. Date: 6/23/06 (mm/dd/yyyy)

9. LSP Stamp:

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC108

Release Tracking Number
3 - 0362

COMPREHENSIVE RESPONSE ACTION TRANSMITTAL FORM & PHASE I COMPLETION STATEMENT

Pursuant to 310 CMR 40.0484 (Subpart D) and 40.0800 (Subpart H)

D. PERSON UNDERTAKING RESPONSE ACTIONS:

1. Check all that apply: ☐ a. change in contact name ☐ b. change of address ☐ c. change in the person undertaking response actions

2. Name of Organization: Massachusetts Electric Company dba National Grid

3. Contact First Name: Michele 4. Last Name: Leone

5. Street: 25 Research Drive 6. Title: Senior Environmental Engineer

7. City/Town: Westborough 8. State: MA 9. ZIP Code: 01582

10. Telephone: 508-389-4296 11. Ext.: 12. FAX: 508-389-4299

E. RELATIONSHIP TO SITE OF PERSON UNDERTAKING RESPONSE ACTIONS:

☒ 1. RP or PRP ☐ a. Owner ☐ b. Operator ☐ c. Generator ☐ d. Transporter

☐ e. Other RP or PRP Specify:

☐ 2. Fiduciary, Secured Lender or Municipality with Exempt Status (as defined by M.G.L. c. 21E, s. 2)

☐ 3. Agency or Public Utility on a Right of Way (as defined by M.G.L. c. 21E, s. 5(j))

☐ 4. Any Other Person Undertaking Response Actions Specify Relationship:

F. REQUIRED ATTACHMENT AND SUBMITTALS:

☒ 1. 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.

☒ 2. Check here to certify that the Chief Municipal Officer and the Local Board of Health have been notified of the submittal of any Phase Reports to DEP.

☒ 3. Check here to certify that the Chief Municipal Officer and the Local Board of Health have been notified of the availability of a Phase III Remedial Action Plan.

☐ 4. Check here to certify that the Chief Municipal Officer and the Local Board of Health have been notified of the availability of a Phase IV Remedy Implementation Plan.

☐ 5. Check here to certify that the Chief Municipal Officer and the Local Board of Health have been notified of any field work involving the implementation of a Phase IV Remedial Action.

☐ 6. If submitting a Modification of a Remedy Operation Status, check here to certify that a statement detailing the compliance history, as per 310 CMR 40.0893(5), for the person making this submittal is attached.

☐ 7. If submitting a Modification of a Remedy Operation Status, check here to certify that written consent of the person who submitted the Remedy Operation Status submittal, as per 310 CMR 40.0893(5), is attached.

☐ 8. Check here if any non-updatable information provided on this form is incorrect, e.g. Site Name. Send corrections to the DEP Regional Office.

☒ 9. Check here to certify that the LSP Opinion containing the material facts, data, and other information is attached.

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC108

Release Tracking Number
3 - 0362

COMPREHENSIVE RESPONSE ACTION TRANSMITTAL FORM & PHASE I COMPLETION STATEMENT

Pursuant to 310 CMR 40.0484 (Subpart D) and 40.0800 (Subpart H)

G. CERTIFICATION OF PERSON UNDERTAKING RESPONSE ACTIONS:

1. I, Michele V. Leone, 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.

2. By: _____ 3. Title: Sr. Environmental Engineer
Signature

4. For: Massachusetts Electric Co. dba National Grid 5. Date: 06/19/2006
(Name of person or entity recorded in Section D) (mm/dd/yyyy)

☐ 6. Check here if the address of the person providing certification is different from address recorded in Section D.

7. Street: _____

8. City/Town: _____ 9. State: _____ 10. ZIP Code: _____

11. Telephone: _____ 12. Ext.: _____ 13. FAX: _____

YOU ARE SUBJECT TO AN ANNUAL COMPLIANCE ASSURANCE FEE OF UP TO $10,000 PER BILLABLE YEAR FOR THIS DISPOSAL SITE. YOU MUST LEGIBLY 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.

Date Stamp (DEP USE ONLY)

RECEIVED
JUL 03 2006
DEP
NORTHEAST REGIONAL OFFICE

ATTACHMENT TO SECTION F
COMPREHENSIVE RESPONSE ACTION TRANSMITTAL FORM
RELEASE TRACKING NUMBER 3-0362

Item 1. The Phase III Remedial Action Plan for the Malden River Portion of the Former Malden Manufactured Gas Plant Site is being submitted in accordance with the timeframe identified in an Amended Notice of Noncompliance with the Massachusetts Contingency Plan (MCP). The Notice was issued by the Massachusetts Department of Environmental Protection (MADEP) on December 23, 2005. This Notice established a new compliance deadline for the submittal of an amended Phase III Remedial Action Plane to the MADEP by July 1, 2006.

PHASE III
REMEDIAL ACTION PLAN
(Malden River Portion)
Malden, Massachusetts
RTN 3-0362

June 2006

Prepared for:

National Grid
25 Research Drive
Westborough, MA 01582

BROWN AND CALDWELL

110 Commerce Drive
Allendale, NJ 07401

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BWSC108 Transmittal Form

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1 INTRODUCTION

1.1 Background

This Phase III Remedial Action Plan (RAP) was prepared by Brown and Caldwell on behalf of the Massachusetts Electric Company (MEC), doing business as National Grid. It presents an evaluation of potential remedial action alternatives for the Malden River portion of the former Malden Manufactured Gas Plant (MGP) Site (the Site) located in Malden, Massachusetts. The MGP operated at Commercial and Center Streets in Malden for approximately 120 years. The Malden River (Figure 1-1) was investigated as part of the Phase II Comprehensive Site Assessment (CSA) and a CSA Report (Haley and Aldrich, December 28, 2001) was completed for the Site, consistent with the Massachusetts Contingency Plan (MCP) – 310 CMR 40.0000. A Phase III RAP was subsequently prepared for the Site by Haley and Aldrich in July 2003. This RAP addressed the upland portion of the Site, but not the Malden River portion. In correspondence between MEC and the Department of Environmental Protection (MADEP) updated compliance deadlines were established for MEC to address the River portion of the Site. By letter dated December 23, 2005, MADEP established the following deadlines for the River portion of the Site:

1. An amended Phase III Remedial Action Plan and Completion Statement to be prepared in accordance with 310 CMR 40.0850, and submitted by July 1, 2006;

2. A Phase IV Remedy Implementation Plan to be prepared in accordance with 310 CMR 40.0874, and submitted by July 1, 2007; and

3. A Response Action Outcome (RAO) Statement or a Remedy Operation Status (ROS) Submittal to be prepared in accordance with 310 CMR 40.1000 and 310 CMR 40.0893, respectively, and submitted by December 28, 2009.

The next step in the MCP process, for the Malden River portion of the Site, is to prepare this Phase III RAP in accordance with 310 CMR 40.0850 of the MCP for submission by July 1, 2006.

The Malden River portion of the Site is the uppermost portion of the Malden River which is bounded, in general, by Charles Street to the north, Medford Street to the south, Canal Street to the east and Commercial Street to the west. Data assessment has indicated PAH impacts to sediments in the Malden River, related to the long industrial history of the area. The specific portion of the Malden River that is considered part of the Disposal Site starts from the discharge culvert at the upstream end, and extends 1,400 feet downstream. This downstream boundary was established in the Phase II CSA after a thorough evaluation of potential impacts from the former Malden MGP, distribution of polynuclear aromatic hydrocarbons (PAHs) in the River, other potential sources of PAHs (evaluated through fingerprinting analysis) and locations of other industries with ties to PAHs.

1.2 Report Organization

This Phase III RAP consists of the following sections:

- **Section 1:** Introduction – Provides Site description and background.

- **Section 2:** Development of Remedial Action Objectives - Presents the remedial action objectives for the Site and the basis for developing them. This section also presents a description of the areas, media, and constituents of concern at the Site for which remedial action alternatives will be evaluated.
- **Section 3:** Screening of Likely Remedial Action Alternatives – Identifies potential remedial technologies and presents the results of the initial screening process. Identifies and develops Likely Remedial Action Alternatives (RAAs) that will be evaluated in detail.
- **Section 4:** Detailed Evaluation – Presents the results from the detailed evaluation of potential remedial action alternatives.
- **Section 5:** Remedial Action Alternative Selection – Presents the recommended remedial action alternative based on the results of the detailed evaluation. Also presents the response action outcome (RAO) that the remedial action alternative is anticipated to achieve.
- **Section 6:** Feasibility Evaluations – Presents the results of the feasibility evaluations required by the MCP (310 CMR 40.0860).
- **Section 7:** Phase III Outcome and Projected Schedule for Implementation of Phase IV Activities – Summarizes the results of the Phase III evaluations and identifies anticipated future activities.

2 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES

Remedial action objectives were developed by reviewing the Method 3 Risk Characterization (RC) that was completed as part of the Phase II CSA. Sediment remediation goals for the Site were developed using the methodologies from the Method 3 RC. The development of sediment remediation goals is presented below.

2.1 Development of Sediment Remediation Goals

2.1.1 Approach

A Method 3 RC, completed as part of the Phase II CSA, concluded that a condition of No Significant Risk for human and ecological risk could not be demonstrated. In addition to human carcinogenic risk related to consumption of fish that has accumulated PAHs from sediment, two ecological risk Assessment Endpoints related to sediment were identified: direct effects on aquatic life due to contact with sediment, and impacts on fish-eating birds, also due to hypothetical accumulation of PAHs in fish. Details are provided in the table below.

The Assessment Endpoint of direct effects on aquatic life was based on the results of sediment toxicity studies that were completed to address direct toxicity to benthic life. However, these tests were inconclusive: of the four tests that were conducted (growth and survival in midges and amphipods, respectively), only one set of measurements showed results related to Site sediments (survival in the amphipods), and the effects were small and variable (in the duplicate sample pair, one sample had a statistically significant survival effect compared with controls, while the other did not). More important, there was no relationship whatsoever between PAH concentrations and decreased survival. Therefore, the slight impacts cannot be linked to PAHs in sediment, and could not serve as the basis for establishing cleanup goals.

Both the food chain model, which assesses risk to birds, and the human health risk characterization, indicated the potential for specific sediment contaminant-related impacts. These endpoints therefore serve as the basis for the sediment cleanup goal development. The risks that exceeded the MADEP benchmarks of 10^{-5} cancer risk or 1.0 hazard index (humans or wildlife) in the Method 3 RC from the Phase II CSA are summarized below.

Receptor	Pathway	Carcinogenic Risk or Hazard	Ratio of Risk/Hazard to Benchmark	Constituents with Individual Risks/Hazards Above Benchmarks
Recreational fisher (adult and child)	Fish ingestion	2E-03 (risk)	2,000	Benzo(a)anthracene (BaA); benzo(a)pyrene (BaP); Benzo(b)-fluoranthene (BbF); Dibenzo(a,h,)anthracene (DahA); Indeno(1,2,3-cd)pyrene (I123cdP)

Receptor	Pathway	Carcinogenic Risk or Hazard	Ratio of Risk/Hazard to Benchmark	Constituents with Individual Risks/Hazards Above Benchmarks
Great blue heron	Fish Ingestion	6E+02[1] (haz)	600	BaA; BaP; BbF; benzo(g,h,i)perylene (BghiP); DahA; Benzo(k)fluoranthene (BkF); Chrysene; I123cdP
Mallard duck	Diet/sediment ingestion	2E+00	2	BbF

The calculated Phase II CSA Method 3 RC risks over benchmarks to both humans and wildlife were driven by carcinogenic PAH compounds (cPAHs). The pathway which had the highest calculated risk in the Phase II evaluation relative to acceptable limits was fish ingestion in humans due to carcinogenic risk (2,000-fold over the acceptable MADEP limit of 10^{-5}, or one in one hundred thousand). The highest ecological risk, a hazard quotient of 600, was also due to fish ingestion. Therefore, a cleanup goal was developed by Brown and Caldwell (described in Sections 2.1.2 through 2.1.4) for cPAHs in sediments. Because the fish ingestion pathway in humans represented the highest risk, this pathway served as the basis for the cleanup goal calculation. However, since cPAHs represented all of the potential unacceptable risk associated with Malden River sediments, based on the results of the Method 3 RC, the sediment goal based on human fish ingestion will be protective of all human and ecological receptors exposed to media in the River. Since the Method 3 RC indicated that human health risks other than fish ingestion were negligible compared with the fish ingestion pathway, other pathways were not considered in the sediment cleanup goal development.

2.1.2 Calculations

The Phase II risk assessment used conservative default assumptions. The cleanup goal development presented here relies on the risk algorithms used in the original Phase II CSA Method 3 RC. However, additional research on two critical factors related to the risk drivers (PAHs) was performed by Brown and Caldwell. These factors and the changes to the risk characterization are discussed in Section 2.1.3.

The human health risk algorithms from the Method 3 were as follows:

$$ELCR = ADD \times CSF$$

[1] Based on the 0-6-inch sediment interval for consistency with the human health risk characterization.

$$C_F = \frac{C_S \times BSAF \times L_F}{fOC}$$

$$ADD = \frac{C_F \times IR \times FI \times EF \times ED \times C}{BW \times AP}$$

Where:

ELCR	=	Excess lifetime cancer risk (unitless)
ADD	=	Average daily dose in milligram per kilogram – day (mg/kg-day)
CSF	=	Carcinogenic slope factor $(mg/kg\text{-}day)^{-1}$
C_F	=	OHM concentration in fish (mg/kg; wet weight)
C_S	=	OHM concentration in sediment (mg/kg; dry weight)
BSAF	=	Biota Sediment Accumulation Factor (kgOC/kg lipid)
fOC	=	Fraction organic carbon (unitless)
L_F	=	Fish lipid concentration (kg lipid/kg fish)
IR	=	Ingestion rate of fish (g/day)
FI	=	Fraction of fish ingestion from Site (unitless)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AP	=	Averaging period (days)
C	=	Conversion factor (kg/g)

The cleanup goal was derived by combining and inverting these equations to solve for C_S. To use the algorithms to set one cleanup goal that considers the additive effects of children and adults, the adult and child body weights, and fish ingestion rates were combined per United States Environmental Protection Agency (USEPA) guidance to derive a lifetime age-adjusted fish ingestion rate:

$$IR_{adj} = \left(IR_C \times {ED_C}/{BW_C}\right) + \left(IR_A \times {ED_A}/{BW_A}\right)$$

Where:

IR_{adj}	=	Age-adjusted ingestion rate of fish (kg fish-year/kg body weight-day)
IR_C	=	Child ingestion rate of fish (kg fish/day)
IR_A	=	Adult ingestion rate of fish (kg fish/day)
ED_C	=	Child exposure duration (years)
ED_A	=	Adult exposure duration (years)

The final cleanup goal algorithm is:

$$C_S = {(AP \times fOC \times ELCR)}/{(BSAF \times L_F \times IR_{adj} \times FI \times EF \times CSF)}$$

Table 2-1 presents the values for each of the variables.

2.1.3 Risk Variables

2.1.3.1 Biota-Sediment Accumulation Factor (BSAF)

A critical assumption used in the risk evaluation to estimate fish tissue concentrations was the value for the Biota-Sediment Accumulation Factor (BSAF). The BSAF used in the Phase II RA was a lipid- and organic carbon-normalized value of 0.29 (USEPA, 1997). Exposures were calculated assuming 3% lipid in fish tissue and 2% organic carbon (OC) in sediment, which calculates to an actual dry weight-based fish-to-sediment ratio of 0.44. The BSAF of 0.29 is the 50th percentile statistic from a USEPA database, which, according to the USEPA 1997 document, were originally released in an internal 1995 USEPA memorandum. Although the actual BSAF values underlying the statistic are not available, USEPA states that the data were from benthic animals.

Studies have documented PAH accumulation in benthic animals (Hyotylainen *et* al., 2002; Millward *et* al., 2001; Brunson *et* al., 1998; Kukkonnen *et* al., 2004; Travey and Hansen, 1996). The United States Army Corps of Engineers (USACE) (2006) maintains a comprehensive BSAF database, with the studies cited by the database focusing almost exclusively on benthic invertebrates. The reported BSAF in the database for total PAHs in pooled organisms is 0.042 (dry weight based) with a pooled overall BSAF for BaP (the primary risk driver in the Malden River) of 0.03.

These values are approximately an order of magnitude below the BSAF of 0.29 used in the Phase II Risk Characterization. Furthermore, BSAFs to benthos over-predict uptake into fish. Benthos live in direct contact with sediment, and many species feed by ingesting sediment, retaining sediment in their guts and thereby increasing empirical BSAFs. More important, fish are widely known to metabolize PAHs, limiting accumulation (Eisler, 1987; McCarthy *et* al., 2003; ATSDR, 1999, 1995). Specifically, rapid PAH metabolism occurs in teleost fish (Kolok *et* al., 1996), which include virtually all food and game fish (Sportsmanschoice, 2006).

Since benthic-derived BSAFs cannot be used to reliably predict fish tissue concentrations, a literature search was performed to obtain representative BSAFs in fish. There is relatively little information in the literature on uptake of PAHs into fish, probably because fish uptake of PAHs is generally not of concern. A USEPA fish contaminant study of the Columbia River Basin (2002) detected little PAH presence in fish tissue. The cPAHs were only detected in the large-scale sucker (averaging 5 to 10 µg/kg [parts per billion or ppb] for each compound), with no detections in several other species analyzed. Sediment concentrations were not reported. A study of sediments and fish conducted by the Washington Department of Ecology (1999) did not even analyze for PAHs in fish, since the study was "limited to bioaccumulative chemicals." PAHs were measured in fish tissue from Chequamegon Bay by the Agency for Toxic Substances and Disease Registry (ATSDR) (1999). Despite presence adjacent to an MGP Site and sediments contaminated with "substantial free-product PAHs," (Great Lakes Mid-Atlantic Center for Hazardous Substance Research, 2006), fish tissue samples were 200 to 10,000 times below health screening levels. No cPAHs or high-molecular weight PAHs were detected (with reporting limits in the low ppb range). Adjacent to the Messer Street MGP Plant Site in Laconia, New Hampshire (New Hampshire Department of Health and Human Services, 2002), PAHs in fish tissue were reported to be hundreds of times below ATSDR Minimal Risk Levels (maximum of 2.5 ppb and 2.4 ppb for BaP and DahA, the only two cPAHs detected). Similarly, the New York State Department of Environmental Conservation (NYSDEC) (2000) reported that fish from Oneida Creek did not show elevated PAH presence compared with background, although sediments were highly contaminated with PAHs (which were found in all sediment samples, up to 47,000 parts per million or ppm). The

NYSDEC (2006) eliminated PAHs from the remedial action plan, and has concluded that "PAHs do not build up in edible tissues." The MADEP (1996) has stated that "because of their ability to metabolize and rapidly excrete PAHs, fish do not accumulate significant residues in muscle tissue."

The most relevant study identified in the literature for assessing fish BSAFs was completed by investigators from USEPA's Mid-Continent Ecology Division of the National Health and Environmental Effects Research laboratory (Burkhard and Lukasewycz, 2000), following an "extensive but unsuccessful literature search." The authors calculated BSAFs for several PAH compounds using field-measured sediment and lake trout tissue concentrations in the lake Superior ecosystem. The calculated BSAF for BaA is 0.0054 kg OC/kg lipid (for chrysene/triphenylene, the BSAF is 0.00033 kg OC/kg lipid).

A BSAF of 0.0054 kg OC/kg lipid is selected for the Malden River Site. BaA and chrysene (with triphenylene) were the two cPAHs evaluated by Burkhard and Lukasewycz. Of these, BaA is most appropriate to use because it is a more important risk driver than chrysene at this Site (chrysene did not have risks over MCP limits in the Phase II Risk Characterization), is generally more toxic (considered ten times more carcinogenic than chrysene), was measured as a single compound and not a mixture, and shows a higher (more conservative) BSAF from this study (thereby providing a protective bias).

Use of BaA as a proxy for predicting PAH accumulation in the Malden River fish is appropriate, since BaA is a high-molecular weight PAH (molecular weight = 228 g/mole). Higher-molecular weight PAHs drive risk since all the cPAHs are high molecular weight, and may show 10 to 100 times less bioconcentration than the lower-molecular weight, more soluble PAH species (Eisler, 1987). The uptake mechanism from sediment to biota reportedly occurs via partitioning from sediment to pore water (Eisler, 1987; Reible and Fleeger, 2004), with the kinetics of rapidly desorbed portion most predictive of bioavailability (Kukkonen *et* al., 2004). Uptake for higher-molecular weight, insoluble PAHs is therefore reduced by limited partitioning into the water column.

Overall, the scientific literature and various agency conclusions strongly support the position that cPAHs do not magnify and are rapidly metabolized by fish. The selected BSAF predicts a low level of tissue accumulation to allow the development of a quantitative cleanup goal from the fish ingestion pathway. It is unclear whether any PAH accumulation above background would be directly attributable to PAHs of MGP origin. Furthermore, BSAFs are also a function of sediment concentration, dropping as sediment PAH levels increase (Millward *et* al., 2001), so BSAFs in heavily contaminated areas would be expected to be far lower than those predicted in the Lake Superior system with sediment PAHs in the ppb range. Using the average BaP concentration in Malden River sediments of 9.14 ppm, the average detected OC concentration of 6.34%, and the MADEP fish lipid estimate of 3%, the predicted fish tissue concentration is 23 ppb. This predicted fish tissue concentration is well above the levels that have been reported for cPAHS in sediments adjacent to other MGP Sites and is therefore a conservative estimate for the Malden River. It is more than a hundred fold below the predicted BaP fish tissue concentration of 5.3 ppm used in the Phase II RC, a level that is not supported by any of the studies and reports reviewed.

The level of lipid in fish is an additional uncertainty with respect to the BSAF. Burkhard and Lukasewycz reported a fish lipid concentration of 20.5% (skinned and fat-trimmed fillets), which is several times above the MADEP value of 3% cited in the Phase II RC. Lower lipid values would be associated with lower empirical BSAFs. The actual lipid content in fish that could be caught in the Malden River is unknown. However, reported average edible fillet lipid levels in freshwater game

fish (USEPA, 2002) range from around 1% (walleye) to around 6% (white sturgeon), with estimates in between for whitefish, sucker, and trout. Therefore, the MADEP estimate of 3% seems reasonable.

2.1.3.2 Fish Ingestion Rates

Human fish consumption rates from fish caught off the Medford Street Bridge used in the Phase II risk assessment were 12 g/day for adults and 8 g/day for children (multiplied by a Fraction Intake, or FI, of 0.25 to account for other fishing locations). The USEPA has estimated lower average intakes for freshwater anglers (8 g/day). A New York State angler survey (USEPA, 2000) reported a 50th percentile ingestion rate of 4.0 g/day, and an upper-bound (90th percentile) rate of 32 g/day. Other surveys have also found that people release much of what they catch. An angler survey in Washington State (Washington Department Of Fish And Wildlife, 2004) reported that many recreational fishers throw back a substantial proportion of legal-sized fish that they catch (e.g., 42% for bass and 33% for carp). Overall, the statistics indicate that less than half of fish were retained. However, a large percentage of anglers did not release any legal fish of other species.

Overall, fish retention for consumption is variable and highly dependent on the species available and personal circumstances. "Subsistence" fishers typically addressed in risk scenarios might be expected to keep and eat most of what they catch. Since the published fish ingestion rates were reduced four-fold in the Phase II RC to account for fishing in other locations, no further adjustments to the fish ingestion rate were made as part of this cleanup goal development. **These Site-specific ingestion rates (3 g/day for adults and 2 g/day for children) seem reasonable and have been retained for this cleanup goal development.**

The quality of the habitat in this part of the river is relatively poor. Areas along the banks are lined with rip rap and steel sheeting. The water appeared to be stagnant during a Site visit in July 2005 and a docked boat suggests that there is propeller disturbance. The river appears to be limiting as a recreational resource due to poor access and no indication that game fish are present. The fish ingestion estimates from the Phase II RC can be considered upper-bound reasonable estimates of the fish ingestion that might actually occur.

2.1.3.3 Other Variables

All other variable values used in the cleanup goal development were MADEP or USEPA defaults.

2.1.4 Sediment Cleanup Goal

Applying the algorithms and variable values presented above, the derived sediment cleanup goal is 31 mg/kg total cPAHs. Table 2-1 presents the values used in the calculations.

2.2 Remedial Action Objective(s)

The remedial action objective is to address those portions of the Malden River sediment that will result in an overall average of 31 mg/kg cPAHs across the sediment surface. The PAHs that are considered carcinogenic by USEPA are BaA, BaP, BbF, BkF, chrysene, DahA and I123cdP. The toxicity of each of these compounds relative to BaP has been estimated by the USEPA and is reflected in a toxic equivalency factor or TEF. The TEFs for each of these compounds are 0.1, 1, 0.1, 0.01, 0.001, 1 and 0.1, respectively. The sum of the cPAHs in a given sample is determined by

multiplying the concentration of each of the carcinogenic PAHs by its respective TEF and then summing each result. This procedure was followed for all sediment samples taken within the Site, which included samples HASED-8 through HASED-21. One-half the detection limit was used for samples where the compound was not detected.

2.3 Areas Subject to Remediation

The sum of the cPAHs in the sediment samples within the upper foot (which contains the bioavailable zone) are presented below and depicted in Figure 2-1. These samples were taken from the 0 to 2 cm, 0- to 6-inch and 0- to 12-inch intervals. Samples were also collected and analyzed at an interval below the top foot, based on observations of the core. Results for these lower samples are also presented in Table 2-3 with the appropriate interval indicated in parentheses.

TABLE 2-3. Malden River Carcinogenic PAH Data

SAMPLE	Total PAH (mg/kg) 0-12"	Total cPAH Concentrations (mg/kg)			
		0-2 cm	0-6"	0-12"	Lower Segment (Interval in ft)
HASED-8	280	12	***33***	***39***	***60 (3-4.5)***
HASED-9	38	19	13	4	***55 (4-4.5)***
HASED-10	63	7	9	10	17 (2.5-4.5)
HASED-11	114	6	6	13	Not sampled
HASED-12	169	4	6	16	0.5 (2-3)
HASED-13	44	14	18	6	0.5 (2-3.5)
HASED-14	122	9	13	12	4.0 (2-2.5)
HASED-15	50	23	17	6	18 (1.5-3)
HASED-16	187	***33***	14	--	Not sampled
HASED-17	301	26	4	9	Not sampled
HASED-18	138	2	7	14	Not sampled
HASED-19	93	11	6	10	20 (1.5-2.5)
HASED-20	70	4	15	5	15 (1.5-2.5)
HASED-21	12	3	5	1	24 (1-1.5)
MEAN	**120**	**12**	**12**	**11**	**15**

Under the MCP, risks are based on average concentrations throughout each exposure point area. Since sediment risks at the Site are related to fish uptake, and fish are mobile, both the Phase II RC and the cleanup goal development presented in this RAP are based on consideration of the entire Disposal Site segment of river as one exposure point area. As seen in the table, the mean concentration of cPAHs in the upper foot of sediment is significantly lower than the 31 mg/kg target and is in fact barely one third that amount. Based on this finding, no remedial action is necessary at the Site. Since the current risks at the Site are acceptable, any remediation would only further reduce a risk level that is already acceptable per the MCP risk limits.

In order to complete the RAP, a range of potential remedial action alternatives has been identified, developed, and evaluated relative to the criteria in the MCP (presented in Sections 3, 4, and 5). It is assumed that if any of the remedial alternatives were implemented, it would target the two individual areas at the Site where the surficial sediment has cPAH concentrations in excess of the cleanup goal (highlighted in bold italics). As presented in Table 2-3 above, these locations are associated with samples HASED-8 and HASED-16. For this evaluation, the area around these sample locations that would be addressed has been determined through interpolation between samples.

Deeper samples at locations HASED-8 (3- to 4.5-foot interval) and HASED-9 (4- to 4.5-foot interval) also had concentrations of cPAHs above the cleanup goal. Because these intervals are more than 3 feet below the sediment surface, they are not expected to pose any significant threats at the Site. Only the upper 6-inch sediment interval is considered the bioavailable zone, although a foot may sometimes be selected to be conservative. Fish uptake, the basis of the unacceptable risk identified in the Method 3 RC, would only reflect the surficial, bioavailable layer. Other risks, such as sediment exposure by waders, were insignificant and were also calculated based on the top 6 inches of material. Significant sediment erosion in this portion of the Malden River is expected to be minimal and, if it were to occur, would be limited to the upper few inches. The surface layer of sediment in this portion of the River is comprised of sand-sized particles which would resuspend less readily than smaller clay-sized particles. Furthermore, flow into the Malden River is through a culvert with fixed dimensions. Therefore, there is an upper limit to the threshold flow that will erode sediment in the Malden River, even during extreme precipitation events.

Since cPAHs are the risk drivers at the Site, remediation for this group of constituents will address all of the unacceptable risks (if any) posed by the sediment. A cleanup goal was developed in Sections 2.1.2 through 2.1.4 for cPAHs in sediments, which, based on the results of the Method 3RC is protective of human and ecological receptors in the River. This goal of an average of 31 mg/kg cPAHs across the Site is already met Therefore, this RAP will target individual locations where cPAHs exceed 31 mg/kg for remedial consideration.

VN

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC108

Release Tracking Number
3 - 0362

COMPREHENSIVE RESPONSE ACTION TRANSMITTAL FORM & PHASE I COMPLETION STATEMENT

Pursuant to 310 CMR 40.0484 (Subpart D) and 40.0800 (Subpart H)

A. SITE LOCATION:

1. Site Name: Former Malden MGP Site (Malden River Portion)
2. Street Address: 100 Commercial Street
3. City/Town: Malden 4. ZIP Code: 02148-5510
5. UTM Coordinates: a. UTM N: 4698392 b. UTM E: 329376
6. [X] Check here if a Tier Classification Submittal has been provided to DEP for this disposal site.
   [ ] a. Tier IA [X] b. Tier IB [ ] c. Tier IC [ ] d. Tier II
7. If applicable, provide the Permit Number: 7378

RECEIVED JUL 03 2006 DEP NORTHEAST REGIONAL OFFICE

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

- [ ] 1. Submit a **Phase I Completion Statement**, pursuant to 310 CMR 40.0484.
- [ ] 2. Submit a **Revised Phase I Completion Statement**, pursuant to 310 CMR 40.0484.
- [ ] 3. Submit a **Phase II Scope of Work**, pursuant to 310 CMR 40.0834.
- [ ] 4. Submit an **interim Phase II Report**. This report does not satisfy the response action deadline requirements in 310 CMR 40.0500.
- [ ] 5. Submit a **final Phase II Report and Completion Statement**, pursuant to 310 CMR 40.0836.
- [ ] 6. Submit a **Revised Phase II Report and Completion Statement**, pursuant to 310 CMR 40.0836.
- [ ] 7. Submit a **Phase III Remedial Action Plan and Completion Statement**, pursuant to 310 CMR 40.0862.
- [X] 8. Submit a **Revised Phase III Remedial Action Plan and Completion Statement**, pursuant to 310 CMR 40.0862.
- [ ] 9. Submit a **Phase IV Remedy Implementation Plan**, pursuant to 310 CMR 40.0874.
- [ ] 10. Submit a **Modified Phase IV Remedy Implementation Plan**, pursuant to 310 CMR 40.0874.
- [ ] 11. Submit an **As-Built Construction Report**, pursuant to 310 CMR 40.0875.
- [ ] 12. Submit a **Phase IV Status Report**, pursuant to 310 CMR 40.0877.
- [ ] 13. Submit a **Phase IV Completion Statement**, pursuant to 310 CMR 40.0878 and 40.0879.

Specify the outcome of Phase IV activities: (check one)

- [ ] a. Phase V Operation, Maintenance or Monitoring of the Comprehensive Remedial Action is necessary to achieve a Response Action Outcome.
- [ ] b. The requirements of a Class A Response Action Outcome have been met. No additional Operation, Maintenance or Monitoring is necessary to ensure the integrity of the Response Action Outcome. A completed Response Action Outcome Statement and Report (BWSC104) will be submitted to DEP.
- [ ] c. The requirements of a Class C Response Action Outcome have been met. No additional Operation, Maintenance or Monitoring is necessary to ensure the integrity of the Response Action Outcome. A completed Response Action Outcome Statement and Report (BWSC104) will be submitted to DEP.
- [ ] d. The requirements of a Class C Response Action Outcome have been met. Further Operation, Maintenance or Monitoring of the remedial action is necessary to ensure that conditions are maintained and that further progress is made toward a Permanent Solution. A completed Response Action Outcome Statement and Report (BWSC104) will be submitted to DEP.

(All sections of this transmittal form must be filled out unless otherwise noted above)

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

☐ 14. Submit a **Revised Phase IV Completion Statement**, pursuant to 310 CMR 40.0878 and 40.0879.

☐ 15. Submit a **Phase V Status Report**, pursuant to 310 CMR 40.0892.

☐ 16. Submit a **Remedial Monitoring Report**. (This report can only be submitted through eDEP.)

a. Type of Report: (check one) ☐ i. Initial Report ☐ ii. Interim Report ☐ iii. Final Report

b. Frequency of Submittal: (check all that apply)

☐ i. A Remedial Monitoring Report(s) submitted monthly to address an Imminent Hazard.

☐ ii. A Remedial Monitoring Report(s) submitted monthly to address a Condition of Substantial Release Migration.

☐ iii. A Remedial Monitoring Report(s) submitted concurrent with a Status Report.

c. Status of Site: (check one) ☐ i. Phase V ☐ ii. Remedy Operation Status ☐ iii. Class C RAO

d. Number of Remedial Systems and/or Monitoring Programs: _____

A separate BWSC108A, CRA Remedial Monitoring Report, must be filled out for each Remedial System and/or Monitoring Program addressed by this transmittal form.

☐ 17. Submit a **Remedy Operation Status**, pursuant to 310 CMR 40.0893.

☐ 18. Submit a **Status Report to maintain a Remedy Operation Status**, pursuant to 310 CMR 40.0893(2).

☐ 19. Submit a **Modification of a Remedy Operation Status**, pursuant to 310 CMR 40.0893(5).

☐ 20. Submit a **Termination of a Remedy Operation Status**, pursuant to 310 CMR 40.0893(6).

☐ 21. Submit a **Phase V Completion Statement**, pursuant to 310 CMR 40.0894.

Specify the outcome of Phase V activities: (check one)

☐ a. The requirements of a Class A Response Action Outcome have been met. No additional Operation, Maintenance or Monitoring is necessary to ensure the integrity of the Response Action Outcome. A completed Response Action Outcome Statement (BWSC104) will be submitted to DEP.

☐ b. The requirements of a Class C Response Action Outcome have been met. No additional Operation, Maintenance or Monitoring is necessary to ensure the integrity of the Response Action Outcome. A completed Response Action Outcome Statement and Report (BWSC104) will be submitted to DEP.

☐ c. The requirements of a Class C Response Action Outcome have been met. Further Operation, Maintenance or Monitoring of the remedial action is necessary to ensure that conditions are maintained and/or that further progress is made toward a Permanent Solution. A completed Response Action Outcome Statement and Report (BWSC104) will be submitted to DEP.

☐ 22. Submit a **Revised Phase V Completion Statement**, pursuant to 310 CMR 40.0894.

☐ 23. Submit a **Post-Class C Response Action Outcome Status Report**, pursuant to 310 CMR 40.0898.

(All sections of this transmittal form must be filled out unless otherwise noted above)

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC108

COMPREHENSIVE RESPONSE ACTION TRANSMITTAL FORM & PHASE I COMPLETION STATEMENT

Release Tracking Number: 3 - 0362

Pursuant to 310 CMR 40.0484 (Subpart D) and 40.0800 (Subpart H)

C. LSP SIGNATURE AND STAMP:

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 309 CMR 4.03(2), and (iii) the provisions of 309 CMR 4.03(3), to the best of my knowledge, information and belief,

> *if Section B indicates that a **Phase I, Phase II, Phase III, Phase IV or Phase V 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) comply(ies) with the identified provisions of all orders, permits, and approvals identified in this submittal;

> *if Section B indicates that a **Phase II Scope of Work** or a **Phase IV Remedy Implementation 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) comply(ies) with the identified provisions of all orders, permits, and approvals identified in this submittal;

> *if Section B indicates that an **As-Built Construction Report, a Remedy Operation Status, a Phase IV, Phase V or Post-Class C RAO Status Report, a Status Report to Maintain a Remedy Operation Status** and/or a **Remedial Monitoring 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) comply(ies) 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.

1. LSP #: 4492

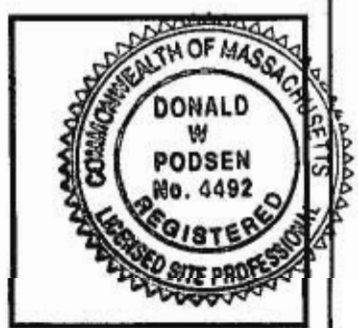
2. First Name: Donald 3. Last Name: Podsen

4. Telephone: 978-983-2041 5. Ext.: 6. FAX: 978-794-0534

7. Signature: Donald W. Podsen

8. Date: 6/23/06 (mm/dd/yyyy)

9. LSP Stamp:



Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC108

Release Tracking Number
3 - 0362

COMPREHENSIVE RESPONSE ACTION TRANSMITTAL FORM & PHASE I COMPLETION STATEMENT

Pursuant to 310 CMR 40.0484 (Subpart D) and 40.0800 (Subpart H)

D. PERSON UNDERTAKING RESPONSE ACTIONS:

1. Check all that apply: ☐ a. change in contact name ☐ b. change of address ☐ c. change in the person undertaking response actions

2. Name of Organization: Massachusetts Electric Company dba National Grid

3. Contact First Name: Michele 4. Last Name: Leone

5. Street: 25 Research Drive 6. Title: Senior Environmental Engineer

7. City/Town: Westborough 8. State: MA 9. ZIP Code: 01582

10. Telephone: 508-389-4295 11. Ext.: 12. FAX: 508-389-4299

E. RELATIONSHIP TO SITE OF PERSON UNDERTAKING RESPONSE ACTIONS:

☒ 1. RP or PRP ☐ a. Owner ☐ b. Operator ☐ c. Generator ☐ d. Transporter

☐ e. Other RP or PRP Specify:

☐ 2. Fiduciary, Secured Lender or Municipality with Exempt Status (as defined by M.G.L. c. 21E, s. 2)

☐ 3. Agency or Public Utility on a Right of Way (as defined by M.G.L. c. 21E, s. 5(j))

☐ 4. Any Other Person Undertaking Response Actions Specify Relationship:

F. REQUIRED ATTACHMENT AND SUBMITTALS:

☒ 1. 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.

☒ 2. Check here to certify that the Chief Municipal Officer and the Local Board of Health have been notified of the submittal of any Phase Reports to DEP.

☒ 3. Check here to certify that the Chief Municipal Officer and the Local Board of Health have been notified of the availability of a Phase III Remedial Action Plan.

☐ 4. Check here to certify that the Chief Municipal Officer and the Local Board of Health have been notified of the availability of a Phase IV Remedy Implementation Plan.

☐ 5. Check here to certify that the Chief Municipal Officer and the Local Board of Health have been notified of any field work involving the implementation of a Phase IV Remedial Action.

☐ 6. If submitting a Modification of a Remedy Operation Status, check here to certify that a statement detailing the compliance history, as per 310 CMR 40.0893(5), for the person making this submittal is attached.

☐ 7. If submitting a Modification of a Remedy Operation Status, check here to certify that written consent of the person who submitted the Remedy Operation Status submittal, as per 310 CMR 40.0893(5), is attached.

☐ 8. Check here if any non-updatable information provided on this form is incorrect, e.g. Site Name. Send corrections to the DEP Regional Office.

☒ 9. Check here to certify that the LSP Opinion containing the material facts, data, and other information is attached.

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC108

Release Tracking Number
3 - 0362

COMPREHENSIVE RESPONSE ACTION TRANSMITTAL FORM & PHASE I COMPLETION STATEMENT

Pursuant to 310 CMR 40.0484 (Subpart D) and 40.0800 (Subpart H)

G. CERTIFICATION OF PERSON UNDERTAKING RESPONSE ACTIONS:

1. I, Michele V. Leone, 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.

2. By: _____ (Signature) 3. Title: Sr. Environmental Engineer

4. For: Massachusetts Electric Co. dba National Grid (Name of person or entity recorded in Section D) 5. Date: 06/19/2006 (mm/dd/yyyy)

☐ 6. Check here if the address of the person providing certification is different from address recorded in Section D.

7. Street: _____

8. City/Town: _____ 9. State: _____ 10. ZIP Code: _____

11. Telephone: _____ 12. Ext.: _____ 13. FAX: _____

YOU ARE SUBJECT TO AN ANNUAL COMPLIANCE ASSURANCE FEE OF UP TO $10,000 PER BILLABLE YEAR FOR THIS DISPOSAL SITE. YOU MUST LEGIBLY 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.

Date Stamp (DEP USE ONLY:)

RECEIVED
JUL 03 2006
DEP
NORTHEAST REGIONAL OFFICE

ATTACHMENT TO SECTION F
COMPREHENSIVE RESPONSE ACTION TRANSMITTAL FORM
RELEASE TRACKING NUMBER 3-0362

Item 1. The Phase III Remedial Action Plan for the Malden River Portion of the Former Malden Manufactured Gas Plant Site is being submitted in accordance with the timeframe identified in an Amended Notice of Noncompliance with the Massachusetts Contingency Plan (MCP). The Notice was issued by the Massachusetts Department of Environmental Protection (MADEP) on December 23, 2005. This Notice established a new compliance deadline for the submittal of an amended Phase III Remedial Action Plane to the MADEP by July 1, 2006.

J. Fagan

1 Corporate Drive
Andover, MA 01810
Tel: (978) 794-0336
Fax: (978) 794-0534

BROWN AND CALDWELL

June 30, 2006

Massachusetts Department of Environmental Protection
Northeast Regional Office
205B Lowell Street
Wilmington, MA 01887

Re: Submittal of Phase III Remedial Action Plan
Former Malden Manufactured Gas Plant Site – Malden River Portion
(RTN 3-0362)

Dear Sir or Madam:

Enclosed please find a copy of the Phase III Remedial Action Plan for the Malden River Portion of the Former Malden Manufactured Gas Plant (MGP) Site. Please contact me if you have any questions.

Sincerely,

BROWN AND CALDWELL

Donald W. Podsen

Donald W. Podsen
Licensed Site Professional

cc: Michele V. Leone – National Grid

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DEP
NORTHEAST REGIONAL OFFICE

1 Corporate Drive
Andover, MA 01810

Tel: (978) 794-0336
Fax: (978) 794-0534

BROWN AND CALDWELL

June 30, 2006

Mr. Christopher J. Webb
City of Malden Board of Health
200 Pleasant Street
Malden, Massachusetts 02148

Re: Notice of Availability of Phase III Remedial Action Plan
Former Malden Manufactured Gas Plant Site – Malden River Portion
RTN 3-0362
Tier 1B Permit No. 7378

Dear Mr. Webb:

In accordance with the Massachusetts Contingency Plan (MCP) (310 CMR 40.0000), Brown and Caldwell has completed and filed with the Massachusetts Department of Environmental Protection a Phase III Remedial Action Plan for the above-referenced site on behalf of Massachusetts Electric Company (MEC) dba National Grid. Pursuant to Section 310 CMR 40.1403(3)(e) of the MCP, a copy of the findings and statement of conclusions of the Phase III report is attached. A copy of the Phase III Remedial Action Plan for the Malden River Portion of the Site is available for review at the Massachusetts Department of Environmental Protection's Northeast Regional Office in Wilmington, Massachusetts.

If you have any questions concerning this Notice of Availability, please contact Ms. Michele V. Leone of National Grid at 508-389-4296.

Sincerely,

Donald W. Podsen

Donald W. Podsen
Licensed Site Professional

cc: Michele V. Leone, National Grid

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Former Malden Manufactured Gas Plant Site
Malden River Portion – Malden, Massachusetts
Phase III Remedial Action Plan

FINDINGS AND CONCLUSIONS

SUMMARY AND FINDINGS

A Phase III Remedial Action Plan (RAP) was prepared, consistent with the Massachusetts Contingency Plan, for the Malden River portion of the Former Malden Manufactured Gas Plant (MGP) Site, located in Malden, Massachusetts. The purpose of the RAP is to document the evaluation of potential remedial action alternatives (RAAs) and selection of an appropriate RAA for the Malden River. Following review of existing site data contained in the Phase II Comprehensive Site Assessment Report and data from a 2006 Supplemental Investigation, the Method 3 risk calculations were updated. A number of potential RAAs were then identified and evaluated. This evaluation concluded that a Permanent Solution can be achieved through implementation of No Further Action in the River (the No-Action RAA), since a condition of No Significant Risk currently exists. Therefore, the No Action RAA is expected to achieve a Class A-2 Response Action Outcome (RAO).

Although the No Action RAA is expected to achieve a Class A-2 RAO, additional steps are proposed to confirm that this RAA would serve as a permanent remedy for the River. As a conservative measure prior to supporting a No Action RAA and a Class A-2 RAO, a Class C-2 RAO would be filed and additional investigation activities performed to confirm the current site understanding. Based on the conclusions of the Substantial Hazard Evaluation and the presence of control measures at the Former Malden MGP Site to mitigate potential contributions of polynuclear aromatic hydrocarbons (PAHs) to the Malden River, the Site meets the requirements for a Class C-2 RAO. The proposed investigation would be a very focused evaluation intended to reduce uncertainty so there is a high degree of confidence that the selected remedy is the most appropriate for the site." The investigation would include re-sampling locations where previous sampling indicated higher concentrations of PAHs than other locations, and collecting samples between existing sample locations and intervals.

STATEMENT OF CONCLUSIONS

Since a condition of No Significant Risk currently exists for the Site, the selected RAA is No Further Action. However, as a conservative approach, a Class C-2 RAO would be filed in the interim and an additional investigation performed to confirm this conclusion. Using the results of the additional investigation, the appropriateness of the selected remedial alternative would be re-evaluated. If the additional data supports the conclusion that a condition of No Significant Risk currently exists and would be maintained for the foreseeable future, then a Class A-2 RAO would be filed. Alternatively, if results of the additional investigation indicate that remedial actions are appropriate to facilitate a Permanent Solution, the RAAs in the RAP would be revisited and an active RAA would be selected. Consistent with the MCP, a Phase IV Remedy Implementation Plan (remedial design) would be prepared and implemented.

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Andover, MA 01810
Tel: (978) 794-0336
Fax: (978) 794-0534

BROWN AND CALDWELL

June 30, 2006

Mr. Richard C. Howard
City of Malden, Office of the Mayor
200 Pleasant Street
Malden, Massachusetts 02148

Re: Notice of Availability of Phase III Remedial Action Plan
Former Malden Manufactured Gas Plant Site – Malden River Portion
RTN 3-0362
Tier 1B Permit No. 7378

Dear Mr. Howard:

In accordance with the Massachusetts Contingency Plan (MCP) (310 CMR 40.0000), Brown and Caldwell has completed and filed with the Massachusetts Department of Environmental Protection a Phase III Remedial Action Plan for the above-referenced site on behalf of Massachusetts Electric Company (MEC) dba National Grid. Pursuant to Section 310 CMR 40.1403(3)(e) of the MCP, a copy of the findings and statement of conclusions of the Phase III report is attached. A copy of the Phase III Remedial Action Plan for the Malden River Portion of the Site is available for review at the Massachusetts Department of Environmental Protection's Northeast Regional Office in Wilmington, Massachusetts.

If you have any questions concerning this Notice of Availability, please contact Ms. Michele V. Leone of National Grid at 508-389-4296.

Sincerely,

Donald W. Podsen

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Licensed Site Professional

cc: Michele V. Leone, National Grid

Former Malden Manufactured Gas Plant Site
Malden River Portion – Malden, Massachusetts
Phase III Remedial Action Plan

FINDINGS AND CONCLUSIONS

SUMMARY AND FINDINGS

A Phase III Remedial Action Plan (RAP) was prepared, consistent with the Massachusetts Contingency Plan, for the Malden River portion of the Former Malden Manufactured Gas Plant (MGP) Site, located in Malden, Massachusetts. The purpose of the RAP is to document the evaluation of potential remedial action alternatives (RAAs) and selection of an appropriate RAA for the Malden River. Following review of existing site data contained in the Phase II Comprehensive Site Assessment Report and data from a 2006 Supplemental Investigation, the Method 3 risk calculations were updated. A number of potential RAAs were then identified and evaluated. This evaluation concluded that a Permanent Solution can be achieved through implementation of No Further Action in the River (the No-Action RAA), since a condition of No Significant Risk currently exists. Therefore, the No Action RAA is expected to achieve a Class A-2 Response Action Outcome (RAO).

Although the No Action RAA is expected to achieve a Class A-2 RAO, additional steps are proposed to confirm that this RAA would serve as a permanent remedy for the River. As a conservative measure prior to supporting a No Action RAA and a Class A-2 RAO, a Class C-2 RAO would be filed and additional investigation activities performed to confirm the current site understanding. Based on the conclusions of the Substantial Hazard Evaluation and the presence of control measures at the Former Malden MGP Site to mitigate potential contributions of polynuclear aromatic hydrocarbons (PAHs) to the Malden River, the Site meets the requirements for a Class C-2 RAO. The proposed investigation would be a very focused evaluation intended to reduce uncertainty so there is a high degree of confidence that the selected remedy is the most appropriate for the site." The investigation would include re-sampling locations where previous sampling indicated higher concentrations of PAHs than other locations, and collecting samples between existing sample locations and intervals.

STATEMENT OF CONCLUSIONS

Since a condition of No Significant Risk currently exists for the Site, the selected RAA is No Further Action. However, as a conservative approach, a Class C-2 RAO would be filed in the interim and an additional investigation performed to confirm this conclusion. Using the results of the additional investigation, the appropriateness of the selected remedial alternative would be re-evaluated. If the additional data supports the conclusion that a condition of No Significant Risk currently exists and would be maintained for the foreseeable future, then a Class A-2 RAO would be filed. Alternatively, if results of the additional investigation indicate that remedial actions are appropriate to facilitate a Permanent Solution, the RAAs in the RAP would be revisited and an active RAA would be selected. Consistent with the MCP, a Phase IV Remedy Implementation Plan (remedial design) would be prepared and implemented.

3 SCREENING OF LIKELY REMEDIAL ACTION ALTERNATIVES

This section screens sediment remedial technologies and remedial action alternatives that are potentially applicable to the Malden River portion of the Site. In addition to the data collected during the Phase II CSA activities, a supplemental field investigation was performed in January 2006. The purpose of this investigation was to collect geotechnical data for use in selecting and screening potential remedial action alternatives in the Phase III RAP. Details on the 2006 supplemental investigation are provided in Appendix A. The screening and identification of remedial action alternatives to be evaluated in this RAP are provided below.

3.1 Identification and Initial Screening of Remedial Technologies

Remedial technologies for sediment may be applied either in-situ, or ex-situ following removal. In-situ technologies include ongoing natural processes, institutional controls, containment and treatment. Ex-situ technologies are applied following removal and their use is dictated by the ultimate fate of the removed material. The removed sediment may be dewatered and reused, or disposed at an approved facility. Alternatively, sediment from some Sites may need to be treated prior to landfilling, or treated and reused. Some of these in-situ and ex-situ technologies may be employed alone or in combination to develop potential remedial action alternatives for sediment. An evaluation of these technologies as they potentially apply to the Malden River sediment is presented below and briefly summarized in Table 3-1.

No Action

This alternative does not include active remediation and is used as a baseline against which other remedial alternatives are compared. Under no action, Site conditions will change as a result of natural processes which commonly affect chemical residues in sediment. Sediment-surface water systems have considerable inherent capacity to recover from either natural or human disturbances. For PAH constituents, physical-chemical processes achieve reductions in contaminant mass, mobility and bioavailability through mechanisms such as burial, sorption, volatilization, dissolution, advection, and dispersion. Chemical transformation or biodegradation can also be important mechanisms for reducing the toxicity and mass of PAH when Site conditions are favorable (Pastorok *et* al., 2000; USEPA-OSWER, 1999). In most cases, there is evidence that PAHs degrade to compounds that are less toxic to environmental or human receptors (USEPA-ORD, 1999). No action will be retained as a remedial action alternative for further evaluation in this RAP.

Institutional Controls

Institutional controls are non-engineering measures intended to affect human activities in such a way as to minimize exposure to PAHs. Institutional controls may be used in conjunction with other remedial technologies and process options to achieve remedial targets. Institutional controls typically include, but are not limited to, access restriction, deed restrictions, and associated signage. Signs could be placed along the waterways to discourage direct contact with the sediment or consumption of fish, and intentional human disturbance of the PAH-containing sediments (e.g., anchor restrictions and limits on boat engine size). This is an easily implementable and low cost technology. Institutional controls will be retained for further evaluation in this RAP.

In-situ Containment

In-situ containment involves covering the targeted sediment with one or more layers of material. One form of capping is natural deposition of "clean" sediment over chemical-containing sediment, as discussed under no action. Another form of containment is engineered capping in which a single or multiple layers of select materials are placed over targeted sediment to achieve physical, chemical, and biological isolation and erosion control (if necessary). In a low energy system, a single isolation layer of soil may be sufficient to be an effective cap. In a high energy system, the cap may contain both an isolation layer and an erosion control layer. The isolation layer may be augmented with sorptive materials such as organic carbon to retard the migration of PAHs through the cap.

Capping has been employed at some Sites with PAH-containing sediments. It is a technology that has gained acceptance in the technical and regulatory communities. Increased attention to enhancing cap effectiveness has resulted in the development and testing of innovative products such as Aquablok ™ (a clay coated aggregate). Relatively recent tests have been performed in the Grasse River in New York and the Anacostia River in Washington, D.C. to test various capping and placement techniques.

Due to its effectiveness, ease of implementation, and relatively moderate costs, capping is being retained for further evaluation.

In-situ Treatment

In-situ treatment of sediment may be attempted through biological, chemical or physical means. Enhanced biodegradation relies on the addition of nutrients and/or microorganisms to the in-situ sediment to further facilitate or enhance microbial decomposition of PAHs in the sediment. Technologies for enhanced in-situ treatment of sediment are still in early stages of development, and few (if any) reliable methods are currently available commercially. Chemical in-situ treatment involves the introduction of surfactants, solvents or oxidants (e.g. hydrogen peroxide or potassium permanganate) to chemically destroy PAHs. For both biological and chemical treatment, the flowing river system serves to dilute additives introduced and thereby severely limit the effectiveness of treatment.

Physical treatment of sediment in-situ may involve the addition of a solidification/stabilization (S/S) agent to the sediment to immobilize the PAHs. A treatability study is typically performed to select the type and dosage of an effective S/S agent. However, due to the high organic content of the Malden River sediment it is unlikely that an effective S/S agent can be employed here. In addition, there are other more cost-effective remedial alternatives being considered.

Due to the inherent difficulties with introducing additives to the sediment in-situ, limited track record of successful applications, and availability of more cost effective remedial alternatives, in-situ treatment is not being retained for further evaluation.

Removal

Sediment may be removed from the river through a process called dredging. There are two basic types of dredge – hydraulic and mechanical. Hydraulic dredges use a pump to create a vacuum at the dredgehead to remove and transport sediment in a sediment/water slurry. The dredged material is usually pumped through a pipeline to a settling lagoon(s) or tank(s) on land. Environmental dredging using hydraulic dredges typically produce slurries in the range of 3 to 8% solids by weight.

There are various types of dredgehead configurations (USEPA-OSWER, 2005); the most common is a cutterhead. The cutterhead applies mechanical force to dislodge the sediments for subsequent removal by the dredge pump. Following removal, the sediment would need to be dewatered, and the resulting water would have to be treated to meet relevant criteria before being discharged back into the environment.

Mechanical dredges remove sediment by applying direct mechanical force to dislodge and contain the material. The dredged material is then lifted mechanically to the water surface, where it is placed onto a barge or land-based vehicles for transport to a dewatering facility. The most common mechanical dredge that is used for environmental applications is the clamshell. Although some water is entrained in the sediment during mechanical excavation, the water volume is considerably lower than that generated with hydraulic dredges. Dredging is a proven and relatively reliable technology. It has been used at a number of environmental Sites and labor and equipment are readily available. Therefore dredging is being retained for further evaluation.

Disposal

Disposition options (reuse or disposal) must be considered in conjunction with removal options. In some instances, dredged sediment needs to be treated prior to placement in a landfill. This results when chemicals in the sediment trigger land disposal restrictions. In other instances sediment may be treated to levels that allow the sediment to be reused as beach nourishment or as fill in low areas. For the Malden River sediment, current information indicates that for alternatives involving removal, the dredged sediment can be dewatered and disposed directly into a landfill licensed to accept the sediment.

3.2 Identification and Development of Remedial Action Alternatives

Based upon the screening of technologies discussed above, the following remedial action alternatives (RAA) are being retained for further evaluation in the RAP:

RAA-1 No Further Action

The "No Action" alternative (RAA-1) serves as a baseline against which the alternatives with active remedial components are compared. This alternative does not incorporate institutional controls or monitoring. The alternative considers the ongoing natural processes at the Site and source control actions taken in upland areas. There are no new or ongoing sources of PAHs to the Malden River since potential sources such as the Malden River Culvert and associated bedding material have been addressed and continue to be monitored under the Upland Class C RAO. Consequently, existing PAHs present in Malden River sediments will continue to undergo both natural degradation processes and containment by deposition of cleaner sediment from upstream sources.

RAA-2 Institutional Control

Alternative RAA-2 involves the use of institutional controls to limit both contact with, and ingestion of, River sediments and released PAH compounds. These institutional controls would include components such as advisories in the form of posted signs. The signs would be posted on both banks of the River, just upstream of the Medford Street Bridge and at the other public access locations along both banks. For purposes of this Report, it is assumed that a total of six signs would be placed. Additionally, natural restorative processes as discussed for Alternative 1 will also continue to proceed at the Site.

RAA-3 Cover

Alternative RAA-3 would involve the placement of a soil cover system over the two locations targeted for remedial considerations (Figure 4-1). As noted previously, these locations are identified by samples HASED-8 and HASED-16 with a total area of approximately 17,500 square feet. A one foot layer of soil mixed with a sorbent material such as anthracite would be placed over the sediment surface. This would be followed by placement of a 6-inch layer of larger granular material such as cobbles, as erosion protection. Natural processes would continue where clean sediment would deposit within the cobbles to further encapsulate the sediment. Natural degradation of PAH compounds would also continue to occur, and the PAHs would be less bioavailable.

RAA-4 Surficial Removal

Alternative RAA-4 would involve the removal of surficial sediment from the two locations targeted for remedial considerations (Figure 4-1). Sediment would be removed at the HASED-8 location to a depth of 1.5 feet and at the HASED-16 location to a depth of one-half foot. Note that concentrations only in the upper 2 cm of sediment at HASED-16 exceed the cleanup goal. The removal depths at both locations include a buffer thickness of up to one-half foot. It is estimated that a total of 900 cubic yards (cy) of sediment would be removed and disposed at an approved off-Site landfill. For purposes of this document, it is assumed that removal would be performed using a hydraulic dredge, followed by gravity dewatering and addition of a limited quantity of a stabilization agent, prior to transport for disposal. Landfilling is expected to be more cost-effective than treatment. This alternative does not require the backfilling of the dredged areas. Water removed from the sediment would be treated on-Site and discharged back into the Malden River.

RAA-5 Deep Removal

Alternative RAA-5 would include the removal of sediments from three locations to greater depths than in Alternative 4. These are locations where individual samples exceeded the cleanup goal at one or more intervals in the sediment core (Figure 4-2). At location HASED-16, sediment would be removed to a depth of one-half foot. At locations HASED-8 and HASED-9, sediment would be removed to a depth of 5 feet. These depths include a buffer of up to one-half foot and the excavated areas would not be backfilled following dredging. It is estimated that 5,500 cy of sediment would be removed, dewatered and disposed off-Site at an approved landfill. For purposes of this document, it is assumed that removal would be performed using mechanical equipment, dewatering would be by gravity and a quantity of stabilization agent would be mixed into the dewatered sediment prior to transport off-Site. Water removed from the sediment would be treated on-Site and discharged back into the Malden River.

4 DETAILED EVALUATION OF REMEDIAL ACTION ALTERNATIVES

The purpose of this section is to present the Detailed Evaluation of the RAAs against the criteria specified at 310 CMR 40.0858. The Detailed Evaluation provides the basis for selection of an RAA. The Detailed Evaluation criteria are as follows:

- **Effectiveness** - The effectiveness of the remedial action alternatives is evaluated in terms of:
  - achieving a Permanent or Temporary Solution;
  - reusing, recycling, destroying, detoxifying, or treating oil and hazardous material; and
  - achieving or approaching background concentrations.
- **Reliability** - The short-term and long-term reliability of the remedial action alternatives is evaluated in terms of:
  - degree of certainty that the alternative will be successful; and
  - effectiveness of measures required to manage residues or discharges to the environment.
- **Difficulty in Implementation** - The difficulty in implementation of the remedial action alternatives is evaluated in terms of:
  - technical complexity;
  - integration with existing Site operations and conditions;
  - monitoring, maintenance, operation, or Site access requirements;
  - availability of services, materials, equipment, or specialists;
  - availability of off-Site treatment, storage and disposal facilities; and
  - compliance with regulatory requirements, approvals, permits or licenses.
- **Cost** - The factors to be considered in the evaluation of this criterion include:
  - the capital and long-term operation and maintenance cost for each alternative; and
  - Cost of environmental restoration, potential damage to natural resources.
- **Risks** - The risks of the remedial action alternatives are evaluated in terms of:
  - long and short-term risks to health, safety, public welfare, and the environment associated with the implementation and operation of the alternative; and
  - potential risks to health, safety, public welfare, and the environment associated with the residual remaining on Site after the alternative is implemented.
- **Benefits** - The benefits of the remedial action alternatives are evaluated in terms of:
  - restoration of natural resources;
  - providing for the productive reuse of the Site;
  - avoided cost of relocating businesses, people, or providing alternative water supplies; and
  - avoided loss value of the Site.

- **Timeliness** - The timeliness of the remedial action alternatives is evaluated in terms of eliminating uncontrolled sources and achieving a level of No Significant Risk.

- **Non-Pecuniary Interests** - The remedial action alternatives are evaluated in terms of the relative effect of the non-pecuniary interests such as aesthetic values.

The following subsections present a discussion of the detailed evaluation of the RAAs with respect to each of the evaluation criteria outlined above. The detailed evaluation is summarized in Table 4-6.

4.1 Effectiveness

The No Action Alternative (RAA-1) currently achieves a level of No Significant Risk since there were no unacceptable risks noted for the Site. Ongoing natural processes of biodegradation and deposition of "clean" sediment on the current sediment surface will serve to further reduce the acceptable risks at the Site. These processes would serve to reduce the concentration of PAHs at the surface of the sediment. Implementation of the remaining alternatives, including Institutional Controls (RAA-2), Cover (RAA-3) Surficial Removal (RAA-4) or Deep Removal (RAA-5), would further reduce the already acceptable risk level at the Site to varying degrees. All alternatives would allow the current conditions of No Significant Risk to persist.

4.2 Reliability

Since a condition of No Significant Risk currently exists for the Site, all of the alternatives would be reliable in both the short- and long-term. Previous source control measures at the Upland Portion Of The Site (culvert and stone bed) have been implemented and continue to be monitored. The largest mass removal would result from the implementation of RAA-5 followed by RAA-4. No mass removal occurs with the implementation of RAA-1, -2 and -3, however RAA-3 would result in a relatively cleaner sediment surface in remediated areas.

4.3 Implementability

The No Action Alternative is the easiest to implement since it involves no active remedial measures. The Institutional Controls Alternative could also be readily implemented as it is limited to placement of signs along the River bank. The Cover Alternative (RAA-3) needs to be implemented carefully, to prevent failures such as mud waves that could arise from quick loading of softer underlying sediment. Furthermore, permitting would be more complex because placement of materials in the River would reduce its effective cross-section and likely water depth. Potential permits include USACE Section 404 and Section 401 Water Quality Certification. Required equipment and labor are readily available.

The two removal alternatives (RAA-4 and-5) are implementable with equipment and labor being readily available. Low water levels during remediation may limit the size of barges and hence equipment that can be utilized and the rate of sediment removal. Landfill capacity would need to be available for the removed material although this is not expected to be an issue due to the relatively small quantities. The deeper removal alternative would take longer and would require more landfill space than the surficial removal alternative. Controls would be needed to control downstream

migration of disturbed sediment. In addition, permitting for both removal alternatives would be more complex due to the significant disturbance of the area during implementation. . Potential permits include USACE Section 404, Section 401 Water Quality Certification and permit to discharge treated water into the River.

There are also limited access areas from which equipment can be deployed and where removed material can be processed. Agreements to access the River would be needed from adjacent land owners. National grid does not own any land directly adjacent to the River portion of the Site and ownership of the River bed is uncertain. There are no public boat ramps in this portion of the River and the Medford Street bridge restricts large equipment getting under it from downstream. Additionally, relatively low water depths in some locations limit the size and capacity of barges and dredges that can be used.

4.4 Cost

Estimated costs (rounded) for each of the remedial action alternatives are summarized below:

Number	Alternative	Estimated Implementation Cost
RAA -1	No Action	-0-
RAA -2	Institutional Controls	$20,000
RAA -3	Containment	$465,000
RAA -4	Surficial Removal	$690,000
RAA -5	Deep Removal	$1,900,000

These costs include material, labor, design, construction equipment, permits, disposal, oversight and reporting, as appropriate. The costs also include provisions for oil booms, silt curtains and water treatment during remediation, where applicable. The individual cost estimate developed for each RAA is presented in Tables 4-1 through 4-5. These costs are at a -30, +50 percent order of magnitude, consistent with feasibility level cost estimates. If active remediation such as removal is performed at the Site, there is the potential for disturbed sediment to migrate downstream if not properly controlled. Additional costs would potentially be incurred to address any damages arising from such an occurrence.

4.5 Risks

Since a condition of No Significant Risk currently exists for the Site under present conditions and for the foreseeable future, long-term risks are considered acceptable for each of the alternatives. The alternatives that include additional remedial measures (i.e., RAA-2, -3, -4, and -5) would further reduce the already acceptable risk level at the Site to varying degrees. Therefore, where the

alternatives vary from a risk standpoint is in the short-term risks posed by implementation of the RAAs.

The No Action and Institutional Control Alternatives pose no significant short-term risks. The Cover Alternative involves transporting material on-Site and construction over water. Therefore, in addition to typical construction hazards, this alternative would have potential short-term risks associated with disturbed sediments, and typical vehicular and water hazards.

The two removal alternatives would have similar hazards as the Cover Alternative, including typical construction hazards, direct contact risk, and vehicular and water hazards. In addition, the two removal alternatives would have short-term risks associated with transporting PAH-containing sediment on roadways to disposal locations. There is also the potential for disturbed sediments to be carried downstream if extreme weather events were to occur and contingency measures fail. These risks would be greater for the Deep Removal Alternative than for the Surficial Removal Alternative.

4.6 Benefits

Implementation of the No Action Alternative would provide no new benefit to the Site. The Institutional Controls Alternative could provide an incremental benefit in limiting human contact with River sediments by posting warning signs. However, it is not conclusively documented that there is regular human contact with River sediments. Implementation of the Containment Alternative would reduce the average surficial concentration of PAHs in the River sediment and would therefore further reduce the already acceptable risk level at the Site. The two Removal Alternatives would similarly result in reduced PAH concentrations and reduced risk. However, there is the potential for PAHs in buried sediment to be suspended in the water column and settle onto the dredged surface or in downstream areas. This could be minimized through the use of engineering controls, although such a redistribution of PAH compounds is very unlikely to result in a condition of Significant Risk at the Site.

4.7 Timeliness

Each of the alternatives would immediately result in a level of No Significant Risk since such a condition already exists at the Site. In the event that active remediation is selected, consideration would be given to implementing the remediation with other activities being proposed for the Malden River, such as an ecorestoration project proposed by the USACE. The estimated times to design, permit and implement RAA-1 and -2 are approximately 0 and 3 months, respectively. Implementation of Alternatives RAA-3 through -5 may be implemented within 12 to 15 months. The actual time of the work will be dictated by northeast weather conditions

4.8 Non-Pecuniary Interests

None of the Alternatives are expected to negatively impact Non-Pecuniary Interests except perhaps the Institutional Controls Alternative which involves placement of signs along the River. Although the Site is in an urban, industrial setting, placement of signs slightly decreases the aesthetics along the River.

5 REMEDIAL ACTION ALTERNATIVE SELECTION

5.1 Overview

All of the Alternatives would result in a condition of No Significant Risk at the Site. Implementation of any of these Alternatives other than No Action would provide additional protection beyond the existing acceptable risk conditions. However, as the complexity of the Alternatives increase, the cost and potential for negative impacts to the environment during implementation increases. Therefore, due to its similar level of effectiveness, reliability, benefits, and timeliness compared to other alternatives coupled with its lower short-term risks, lower costs, and ease of implementation, the No Action Alternative (RAA-1) has been selected as the remedial action for the Site.

Implementation of source control measures at the Former Malden MGP Site (especially the culvert and underlying crushed stone) has mitigated potential PAH contributions to the Malden River. As discussed in Section 2, since there is a condition of No Significant Risk for River sediments, no further action is necessary. The River can utilize its natural restorative capacity to further improve with time. Solids from upstream sources would both cover and mix with surficial sediment, thereby reducing the concentrations of PAHs that may be present. Furthermore, biodegradation of PAHs, which readily occurs in natural systems, would continue to mineralize the concentrations of PAHs to non-toxic derivatives. These natural processes are typically relied upon to address residuals at Sites that have undergone active remediation. This alternative is easily implementable at no cost. There are no concerns regarding timeliness of this alternative or risks from its implementation. As noted previously, the natural restorative processes will benefit the River sediment and will not compromise aesthetics in the area. The No Action Remedial Action Alternative would therefore be effective in further reducing the already acceptable risks at the Site.

5.2 Applicability of a Class A-2 RAO

According to the MCP (310 CMR 40.1036), a Class A-2 Response Action Outcome (RAO) applies to disposal Sites where:

- a Permanent Solution has been achieved;
- the level of oil and hazardous material in the environment has not been reduced to background; and
- one or more Activity and Use Limitations are not required to maintain a level of No Significant Risk.

Based on the Site characterization data and Method 3 RC presented in the Phase II CSA and taking into account the information and revised risk calculations presented in Section 2 of this RAP, the selected remedial action is anticipated to maintain the current level of No Significant Risk for the foreseeable future and is therefore considered a Permanent Solution. Under the selected remedial alternative, PAHs will remain in River sediment above "background" concentrations. Therefore, based on the MCP, the alternative is anticipated to achieve a Class A-2 RAO.

5.3 Applicability of a Class C RAO

According to the MCP (310 CMR 40.1050), a Class C RAO shall apply to disposal Sites where a Temporary Solution has been achieved. A Temporary Solution shall ensure:

> (a) the elimination of any Substantial Hazard at the disposal Site; and
>
> (b) the identification, characterization, and to the extent feasible, elimination, control or mitigation of any source of oil and/or hazardous material as that term is described in 310 CMR 40.1003(5).

The Substantial Hazard Evaluation, which was presented in the Phase II CSA, was updated using Site-specific data and more appropriate risk calculation variables (refer to Section 2). The Substantial Hazard Evaluation presented in Appendix B demonstrates that there is No Substantial Hazard to human or ecological receptors at the Site. Therefore, based on the conclusions of the Substantial Hazard Evaluation and the presence of control measures at the Former Malden MGP Site to mitigate potential PAH contributions to the Malden River, the Site is a candidate for a Class C RAO. Because it is considered feasible to achieve a Permanent Solution at the Site, a Class C-2 RAO is appropriate.

5.4 Supporting the Appropriate RAO

The Phase III evaluations and updated Method 3 RC concluded that a Permanent Solution can be achieved through implementation of the No Action Alternative. Based on the current Site data, the No Action Alternative is expected to achieve a Class A-2 RAO. Although the No Action RAA is expected to achieve a Class A-2 RAO, additional steps are proposed to confirm that this RAA would serve as a permanent remedy for the River. As a conservative measure prior to supporting a No-Action RAA and a Class A-2 RAO, a Class C-2 RAO would be filed and additional investigation activities performed to confirm the current Site understanding. According to the MCP, under a Class C RAO, definitive and enterprising steps are to be taken toward achieving a Permanent Solution. The following definitive and enterprising steps are proposed at the Site:

- Implementation of a supplemental effort to further investigate sediment (as discussed below) and reduce uncertainties.
- Revise the Substantial Hazard Evaluation and the Method 3 RC.
- Re-evaluation of the selected Remedial Alternative (i.e., No Action) based on the results of the supplemental efforts.

If results of the additional evaluation support the conclusion that a condition of No Significant Risk currently exists and will be maintained for the foreseeable future, then a Class A RAO will be filed. Alternatively, the results of the supplemental work may indicate that remedial actions are necessary, in which case additional evaluation of remedial alternatives would be performed.

The supplemental work effort is planned to include collection of additional sediment samples to confirm the current Site understanding. Anticipated components of the supplemental investigation include:

- Re-sampling locations where previous sampling indicated elevated concentrations (i.e., HASED-8, HASED-9, and HASED-16) to confirm the data;
- Increasing the overall sample density by collecting several samples between existing sample locations to reduce uncertainties; and
- Collecting samples from an intermediate sediment interval (e.g., 1- to 2-ft interval) to confirm the current Site understanding.

Following the evaluation of these data, a decision will be made as to whether a Permanent Solution can be supported and a Class A RAO filed.

6 FEASIBILITY EVALUATIONS

Pursuant to 310 CMR 40.0860, this section addresses the feasibility evaluations required by the MCP. The pertinent MCP feasibility evaluations that apply to this Site are the feasibility of:

- Implementing a Permanent Solution in cases where the selected RAA is a Temporary Solution;
- Eliminating, preventing or mitigating Critical Exposure Pathway(s); and
- Reducing Concentrations to Levels that Achieve or Approach Background.

In accordance with the MCP, the feasibility evaluations, presented below, primarily consider the technological feasibility (310 CMR 40.0860(6)) and benefit-cost analysis (310 CMR 40.0860(7)). In addition to the MCP, where applicable, the MADEP document entitled "Conducting Feasibility Evaluations Under the MCP" (WSC-04-160) served as useful reference when performing the feasibility evaluations.

6.1 Implementing a Permanent Solution

The MCP [310 CMR 40.0860(2)] requires a feasibility evaluation of implementing a Permanent Solution only in cases where the remedial action alternative is a Temporary Solution. As discussed in Section 5, a Permanent Solution is feasible for this Site. However, as a conservative measure, prior to supporting a No-Action RAA and a Class A-2 RAO, a Class C-2 RAO would be filed and additional investigation activities performed to confirm the current Site understanding.

6.2 Eliminating, Preventing or Mitigating Critical Exposure Pathway(s)

The MCP [310 CMR 40.0860(1)d] requires an evaluation of the feasibility of eliminating, preventing or mitigating Critical Exposure Pathway(s) (CEPs). No CEPs have been identified at this Site, therefore this feasibility evaluation need not be pursued further.

6.3 Reducing Concentrations to Levels that Achieve or Approach Background

The MCP [310 CMR 40.0860(3)] requires an evaluation of the feasibility of reducing the concentrations of OHM in the environment at the Site to levels that achieve or approach background when a remedial alternative is selected that constitutes a Class A-2, A-3 or A-4 RAO. Since the No Action Alternative is expected to achieve a Class A-2 RAO, an evaluation to assess the feasibility of reducing the concentrations of OHM in the environment to levels that achieve or approach background is required.

Since the Site is located at the headwaters of the Malden River, there is no appropriate background to reference, which complicates the ability to readily evaluate the feasibility of achieving background. However, Alternative 5 involves removal of sediment exhibiting the most elevated concentration of cPAHs at the Site and can therefore be considered the alternative that would best approach "background" concentrations, if implemented. Comparing the selected alternative (i.e., No Action Alternative), which has no implementation or O&M costs, to Alternative 5 (Deep Sediment Removal), which was estimated to cost $1.9 million, it is evident that the cost to approach background is significant. The MADEP guidance, "Conducting Feasibility Evaluation Under the

MCP" (WSC-04-160), states that it shall be considered feasible to conduct remedial actions to achieve or approach background conditions if the additional costs to remediate beyond a condition of No Significant Risk condition are equal to or less than 20% of the cost to remediate to No Significant Risk. Therefore, based on this interpretation of the MCP provide by the MADEP guidance, the substantial incremental costs to approach background are not justified.

7 PHASE III OUTCOME AND PROJECTED SCHEDULE FOR IMPLEMENTATION OF PHASE IV ACTIVITIES

The Phase III evaluations and updated Method 3 RC concluded that a Permanent Solution can be achieved through implementation of the No Action Alternative. Based on the current Site data, the No Action Alternative is expected to achieve a Class A-2 RAO. Although the No Action RAA is expected to achieve a Class A-2 RAO, additional steps are proposed to confirm that this RAA would serve as a permanent remedy for the River. As a conservative measure prior to supporting a No-Action RAA and a Class A-2 RAO, a Class C-2 RAO would be filed and additional investigation activities performed to confirm the current Site understanding. The conclusions of the Substantial Hazard Evaluation (Appendix B) and the presence of control measures at the Former Malden MGP Site to mitigate potential contributions of PAHs to the Malden River, indicate that the Site meets the requirements for a Class C-2 RAO. The proposed investigation would be a very focused evaluation intended to reduce uncertainty so there is a high degree of confidence that the selected remedy is the most appropriate for the Site. The investigation would include re-sampling locations where previous sampling indicated higher concentrations of PAHs than other locations, and collecting samples between existing sample locations and intervals. Using these data, both the Method 3 RC and the Substantial Hazard Evaluation would be revised, as appropriate.

Typically, the remedial action alternative selected during the Phase III evaluation is developed and implemented in accordance with the Phase IV requirements of the MCP (310 CMR 40.0870), which include preparation of a Remedy Implementation Plan (RIP). The RIP typically includes a list of relevant contacts, documentation of the engineering concepts and criteria used in the design and implementation of the remedy, construction plans and specifications, operation, maintenance, and monitoring plan, health and safety plan, and a list of any necessary federal, state, or local permits. A plan is also prepared for long-term monitoring and maintenance activities.

Since a condition of No Significant Risk currently exists for the Site, the selected remedy is No Action and Phase IV activities are deemed unnecessary. The supplemental investigation will be used to further evaluate this conclusion. If the supplemental investigation indicates that remedial actions are appropriate to facilitate a Permanent Solution, then Phase IV activities will be performed.

The schedule for performing the Definitive and Enterprising steps that are outlined in Section 5 is to initiate the additional sampling within six months of submitting this Report and then proceed to meet the applicable deadlines set forth by MADEP (see page 1-1).

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Table 2-1
Former Malden MGP Site (Malden River Portion) - Malden, Massachusetts
Phase III Remedial Action Plan
Summary of Risk Variables

Variable		Value	Source/Comment
Excess lifetime cancer risk (unitless)	ELCR	1.00E-05	MCP Requirement
Carcinogenic slope factor $(mg/kg\text{-}day)^{-1}$	CSF	7.3	Value is for BaP; other cPAHs have CSFs scaled to BaP (see text)
Biota Sediment Accumulation Factor (kg OC/kg lipid)	BSAF	0.0054	Taken from Burkhard and Lukasewycz, 2000, following a literature review; see text
Fraction organic carbon in sediment	fOC	0.0634	Average of measured values in site sediments
Fraction lipid in fish tissue	L_F	0.03	MADEP estimate; value used in Phase II risk characterization
Ingestion rate of fish (kg/day), child	IR_c	0.0081	Value used in Phase II risk characterization; taken from Ebert et al, 1993
Ingestion rate of fish (kg/day), adult	IR_a	0.012	Value used in Phase II risk characterization; taken from Rupp et al, 1980
Age-adjusted fish ingestion rate (kg fish−years/kg bw−day)	IR_{adj}	0.00514	Calculated from IR and BW; see text
Fraction of fish ingestion from site (unitless)	FI	0.25	Value used in Phase II risk characterization; based on professional judgment
Exposure frequency (days/year)	EF	365	Default assuming year-round fish ingestion
Exposure duration (years), child	ED_C	6	Ages 10-16
Exposure duration (years), adult	ED_A	24	Default residence time of 30 years minus child ED of 6 years
Body weight (kg), child	BW_c	47.2	MADEP value used in Phase II risk characterization for ages 10-16
Body weight (kg), adult	BW_a	70	USEPA default value used in Phase II risk characterization
Averaging period (days)	AP	27375	75-year lifetime

Table 2-2
Former Malden MGP Site (Malden River Portion) - Malden, Massachusetts
Phase III Remedial Action Plan
Sediment Cleanup Goal Calculation

IR_c kgfish/day	IR_a kgfish/day	ED_c yrs	ED_a yrs	BW_c	BW_a
0.0081	0.012	6	24	47.2	70
IRadj =	**0.00514**	**kgfish-yr/ kgBW-day**			

AP	fOC	ELCR unitless	BSAF	L_F	IR_{adj}	FI	EF	CSF
27375	0.0634	1.00E-05	0.0054	0.03	0.00514	0.25	365	7.3
Cs =	**3.13E+01**	**mg/kgsed**						

TABLE 3-1
Former Malden MGP Site (Malden River Portion) – Malden, Massachusetts
Phase III Remedial Action Plan
Screening Remedial Technologies for PAHs in Sediment

Remedial Technology	Process Option	Description	Screening Results
No Action	No Action	Includes ongoing natural attenuation of PAHs in sediment, but would not involve any remedial action, and as such serves as a baseline for comparison to other remedial technologies.	Retained as a baseline remedial action alternative against which other alternatives are evaluated.
Institutional Controls	Institutional Controls	Could include legal, administrative, and/or physical controls that reduce the potential for exposure to PAHs in sediments. Potential examples include actions taken to reduce the potential for activities that may disturb PAH-containing sediments or jeopardize the integrity of any remedy, and could include deed restrictions (e.g., land use restrictions), access restrictions (e.g., fencing), and/or posting of signs (restricting access and/or fishing).	Retained as potentially applicable to this site.
In-Situ Containment	Natural Deposition	Includes the process of covering PAH-containing sediment via the settling of clean particles, thereby minimizing exposure via natural deposition.	Retained as potentially applicable to this site.
	Capping (Engineered)	Involves covering PAH-containing sediment via construction of a cap designed to minimize exposure potential.	
In-Situ Treatment	Bioremediation	Expected to occur naturally due to pre-existing microorganisms and nutrients present in the sediment. It may also be enhanced with engineering controls designed to introduce additional amendments, such as microorganisms and/or nutrients into the treatment zone to increase ongoing biodegradation rates of PAHs in sediments.	Not being retained due to difficulty with delivering reagents in an aquatic system and limited documented success with full scale applications.
	Immobilization	Involves injecting and mixing an immobilization agent into the sediment, which binds chemical constituents within a solidified mass .	
	Chemical	Chemical surfactants/solvents or oxidants, such as hydrogen peroxide or permanganate, are injected into the treatment area to remove or destroy PAH constituents.	
Removal	Dredging	Involves physical removal of PAH-containing sediments. Typical dredging equipment would include hydraulic or mechanical dredges.	Retained as potentially applicable to this site.
Disposition	Treatment (Biological, Chemical, Physical)	Removed sediment could be landfarmed or amended to enhance the biodegradation of PAH compounds using microorganisms and nutrients in an aerobic or anaerobic environment Involves mixing an immobilization agent with the removed sediment to produce a stable, non-leacheable material, and typically results in an increased volume/mass of treated sediment Chemical surfactants are mixed with excavated PAH-containing sediments to remove PAHs. Removed PAHs would require treatment/disposal. Removed PAH-containing sediments are heated to remove and/or destroy PAHs. May involve heating to volatilize and/or destroy PAHs.	Landfilling is retained as the disposal option for removed sediment because treatment is deemed unnecessary for landfilling.
	Landfill	PAH-containing sediment would be consolidated on-site or transported to an off-site permitted landfill for disposal (following treatment if necessary).	

TABLE 4-1

Former Malden MGP Site (Malden River Portion) - Malden, Massachusetts

Phase III Remedial Action Plan

Remedial Action Alternative RAA-1 (No Action) Cost Estimate

No.	Remedial Component	Quantity	Unit	Unit Cost	Cost
1	None	0	N/A	$0	$0
TOTAL					**$0**

TABLE 4-2

Former Malden MGP Site (Malden River Portion) - Malden, Massachusetts

Phase III Remedial Action Plan

Remedial Action Alternative RAA-2 (Institutional Controls) Cost Estimate

No.	Remedial Component	Quantity	Unit	Unit Cost	Cost
1	Permits/Access	1	LS	$5,000	$5,000
2	Specifications	1	LS	$500	$500
3	Material (signs) and labor	6	Each	$400	$2,400
4	Surveying	1	LS	$5,000	$5,000
5	Restoration	1	LS	$2,500	$2,500
6	Construction Oversight/ Documentation	1	Week	$2,500	$2,500
7	Contingency	1	LS	$2,000	$2,000
	TOTAL				**$19,900**

Assumptions/Notes:

1. Assumes coordination with affected property owners along the River and the City of Malden.
2. Development of specifications consistent with applicable ordinances.
3. Purchase and installation of the signs by a contractor.
4. Surveying to document locations of signs for municipal records.
5. Removal of excess excavated soil and replacement of affected vegetation
6. Oversight by National Grid representative and preparation of Final Inspection Report.
7. Contingency to cover unforeseen costs (e.g. coring through rock if encountered).

TABLE 4-3

Former Malden MGP Site (Malden River Portion) - Malden, Massachusetts

Phase III Remedial Action Plan

Remedial Action Alternative RAA-3 (Cover) Cost Estimate

No.	Remedial Component	Quantity	Unit	Unit Cost	Cost
1	Design/Bid/Permits/Access	1	LS	$140,000	$140,000
2	Mobilization/Demobilization	1	LS	$70,000	$70,000
3	Silt Curtains/Monitoring	1	LS	$10,000	$10,000
4	Access/Staging Area Preparation	1	LS	$25,000	$25,000
5	Cap Material and Placement	650	YDS	$150	$97,500
6	Erosion Control - Material and Placement	325	YDS	$100	$32,500
7	Restoration	1	LS	$20,000	$20,000
8	Construction Oversight/Security/CQA	2	Week	$15,000	$30,000
9	Reporting/Documentation	1	LS	$10,000	$10,000
10	Contingency	1	LS	$30,000	$30,000
TOTAL					**$465,000**

Assumptions/Notes:

1. Assumes permits can be obtained to place materials in the River.
2. Equipment will be mobilized and demobilized at a location in the vicinity of the site.
3. Silt curtains to contain turbidity and areas outside monitored
4. An area to stage capping materials would be prepared adjacent to the River.
5. The cap will comprise one foot of soil augmented with an organic material such as anthracite.
6. A six-inch layer of granular (cobbles) material will be placed over the cap as an erosion protection layer.
7. The staging area would be restored following use.
8. Oversight and Construction Quality Assurance and site security during non-work hours.
9. Site activities will be documented in a Final Inspection Report.
10. A contingency based on approximately 20 percent of the material and placement cost is included

TABLE 4-4

Former Malden MGP Site (Malden River Portion) - Malden, Massachusetts

Phase III Remedial Action Plan

Remedial Action Alternative RAA-4 (Surficial Removal) Cost Estimate

No.	Remedial Component	Quantity	Unit	Unit Cost	Cost
1	Design/Bid/Permits/Access	1	LS	$160,000	$160,000
2	Mobilization/Demobilization	1	LS	$80,000	$80,000
3	Silt Curtains/Monitoring	1	LS	$20,000	$20,000
4	Access/Staging Area Preparation/restoration	1	LS	$50,000	$50,000
5	Dredging	900	CY	$40	$36,000
6	Dewatering/ Stabilization	900	CY	$20	$18,000
7	Water Treatment	1	LS	$110,000	$110,000
8	Transport and Disposal	1200	Tons	$80	$96,000
9	Construction Oversight/Security/CCA	2	Weeks	$15,000	$30,000
10	Reporting/Documentation	1	LS	$15,000	$15,000
11	Pre-design Investigation	1	LS	$25,000	$25,000
12	Contingency	1	LS	$50,000	$50,000
TOTAL					**$690,000**

Assumption/Notes:

1. Permits apply to modifying the riverbed and for treated discharge into the River.
2. Equipment will be mobilized and demobilized at a location near the site
3. Silt curtains will be used and monitored to contain turbidity
4. Dewatering and water treatment areas will need to be prepared and restored.
5. A hydraulic dredge will be employed to perform precision surficial dredging.
6. Dewatering will be by gravity followed by addition of a 5% (w/w) solidification agent.
7. 120-gpm packaged treatment system consisting of filtration and granular activated carbon treatment. Assumes operation of the system for approximately 2 weeks (normal working schedule) with discharge of effluent to the river under a NPDES permit. Assumed 5% solids content for removed sediment.
8. Stabilized sediment would be transported to an off-site landfill for disposal. Assumes 1 unstabilized CY = 1.2 tons.
9. Oversight and Construction Quality Assurance and site security during off hours
10. Site activities will be properly documented in a Final Inspection Report.
11. A pre-design investigation would be performed to refine removal limits.
12. A contingency based on approximately 20 percent of the removal and processing cost is included

TABLE 4-5

Former Malden MGP Site (Malden River Portion) - Malden, Massachusetts

Phase III Remedial Action Plan

Remedial Action Alternative RAA-5 (Deep Removal) Cost Estimate

No.	Remedial Component	Quantity	Unit	Unit Cost	Cost
1	Design/Bid/Permits/Access	1	LS	$250,000	$250,000
2	Mobilization/Demobilization	1	LS	$100,000	$100,000
3	Silt Curtains/Monitoring	1	LS	$30,000	$30,000
4	Access/Staging Area Preparation/Restoration	1	LS	$75,000	$75,000
5	Dredging	5500	CY	$50	$275,000
6	Dewatering /Stabilization	5500	CY	$25	$137,500
7	Water Treatment	1	LS	$120,000	$120,000
8	Transport and Disposal	7260	Tons	$80	$580,800
9	Construction Oversight/Security/CQA	5	Weeks	$15,000	$75,000
10	Reporting/Documentation	1	LS	$20,000	$20,000
11	Pre-design Investigation	1	LS	$40,000	$40,000
12	Contingency	1	LS	$200,000	$200,000
	TOTAL				**$1,903,300**

Assumption/Notes:

1. Permits apply to modifying the riverbed and for treated discharge into the River.
2. Equipment will be mobilized and demobilized at a location near the site
3. Silt curtains will be used and monitored to contain turbidity.
4. Dewatering and water treatment areas will need to be prepared and restored.
5. A mechanical dredge will be employed to make deeper cuts.
6. Dewatering will be by gravity followed by addition of a 10% (w/w) solidification agent.
7. 120-gpm packaged treatment system consisting of filtration and granular activated carbon treatment. Assumes operation of the system for approximately 5 weeks (normal working schedule) with discharge of effluent to the river under a NPDES permit. Assumed 20% solids content for removed sediment
8. Stabilized sediment would be transported to an off-site landfill for disposal. Assumes 1 unstabilized CY = 1.2 tons
9. Oversight and Construction Quality Assurance and site security during off hours
10. Site activities will be properly documented in a Final Inspection Report.
11. A pre-design investigation would be performed to refine removal limits.
12. A contingency based on approximately 20 percent of the removal and processing cost is included

TABLE 4-6
Former Malden MGP Site (Malden River Portion) - Malden, Massachusetts
Phase III Remedial Action Plan
Detailed Evaluation Summary

EVALUATION CRITERIA	RAA-1: No Action	RAA-2: Institutional Controls	RAA-3: Cover	RAA-4: Surficial Removal	RAA-5:Deep Removal
1) EFFECTIVENESS					
• Achieving a Permanent or Temporary Solution.	Likely achieves a permanent solution	Likely achieves a permanent solution	Likely achieves a permanent solution	Likely achieves a permanent solution	Likely achieves a permanent solution
• Reusing, recycling, destroying, detoxifying, or treating oil and hazardous material	Ongoing natural PAH attenuation	Ongoing natural PAH attenuation	Ongoing natural PAH attenuation	Removes some surficial PAHs	Removes some deeper PAHs
• Achieving or approaching background concentrations	Approaching through natural processes	Approaching through natural processes	Reduced average surface concentrations	Reduced average surface PAH concentrations expected	Reduced average PAH concentrations expected
2) RELIABILITY					
• Degree of certainty that the alternative will be successful	No significant risk already met	No significant risk already met	No significant risk already met	No significant risk already met	No significant risk already met
• Effectiveness of measures to manage residues or control discharge to the environment	PAH degradation effective but relatively slow	PAH degradation effective but relatively slow	Soil cover is effective	Silt curtains can control potential migration	Silt curtains can control potential migration
3) IMPLEMENTABILITY					
• Technical complexity	Not complex	Not complex	Placement under water	Removal under water	Removal under water
• Integration with existing site operations and conditions	Easily integrated	Can be integrated	Need minimum draft to float equipment	Need minimum draft to float equipment	Need minimum draft to float equipment
• Operation, maintenance, and monitoring (OMM) requirements	None required	None required	None required	None required	None required
• Availability of services, materials, equipment, or specialists	Not applicable	Available	Organic additive is a specialty item	Generally available	Generally available
• Availability of off-site treatment, storage and disposal facilities	Not applicable	Not applicable	Not applicable	Facilities typically available	Facilities typically available
• Compliance with regulatory requirements, approvals, permits or licenses	None required	Can comply	Challenging to permit reduction in cross-section	Potentially challenging to permit treated water discharge	Potentially challenging to permit treated water discharge
4) Cost	-$0-	$20,000	$465,000	$690,000	$1,900,000
5) RISKS					
• Long and short-term risks	None due to no active remediation	Minimal risk during sign placement	Limited risk of increased turbidity. Potential for construction-related accidents.	Increased risk of increased turbidity. Potential for construction-related accidents.	Highest risk of increased turbidity. Potential for construction-related accidents.
• Potential risks associated with the residuals remaining	None due to no significant risk	None due to no significant risk	Benthos will re-establish in time	Some suspended residuals may resettle. Benthos will re-establish in time	Some suspended residuals may resettle. Benthos will re-establish in time
6) BENEFITS					
• Restoration of natural resources	Resources undamaged	Resources undamaged	Benthos will re-establish in time	Benthos will re-establish in time	Benthos will re-establish in time
• Providing for the productive reuse of the site	Current use unchanged	Current use unchanged	Reduction in River cross-section and water depth	Current use unchanged	Current use unchanged
• Avoided cost of relocating businesses, people, or providing alternative water supplies	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
• Avoided loss value of the site	Current use unchanged	Current use unchanged	Current use relatively unchanged	Current use unchanged	Current use unchanged
7) TIMELINESS					
• Time to achieve a level of No Significant Risk	Currently achieves no significant risk	Currently achieves no significant risk	Continues to achieves no significant risk	Expected to continue achieving no significant risk	Expected to continue achieving no significant risk
8) NON-PECUNIARY INTERESTS					
• Aesthetics	None	Signs reduce aesthetics	None	None	None

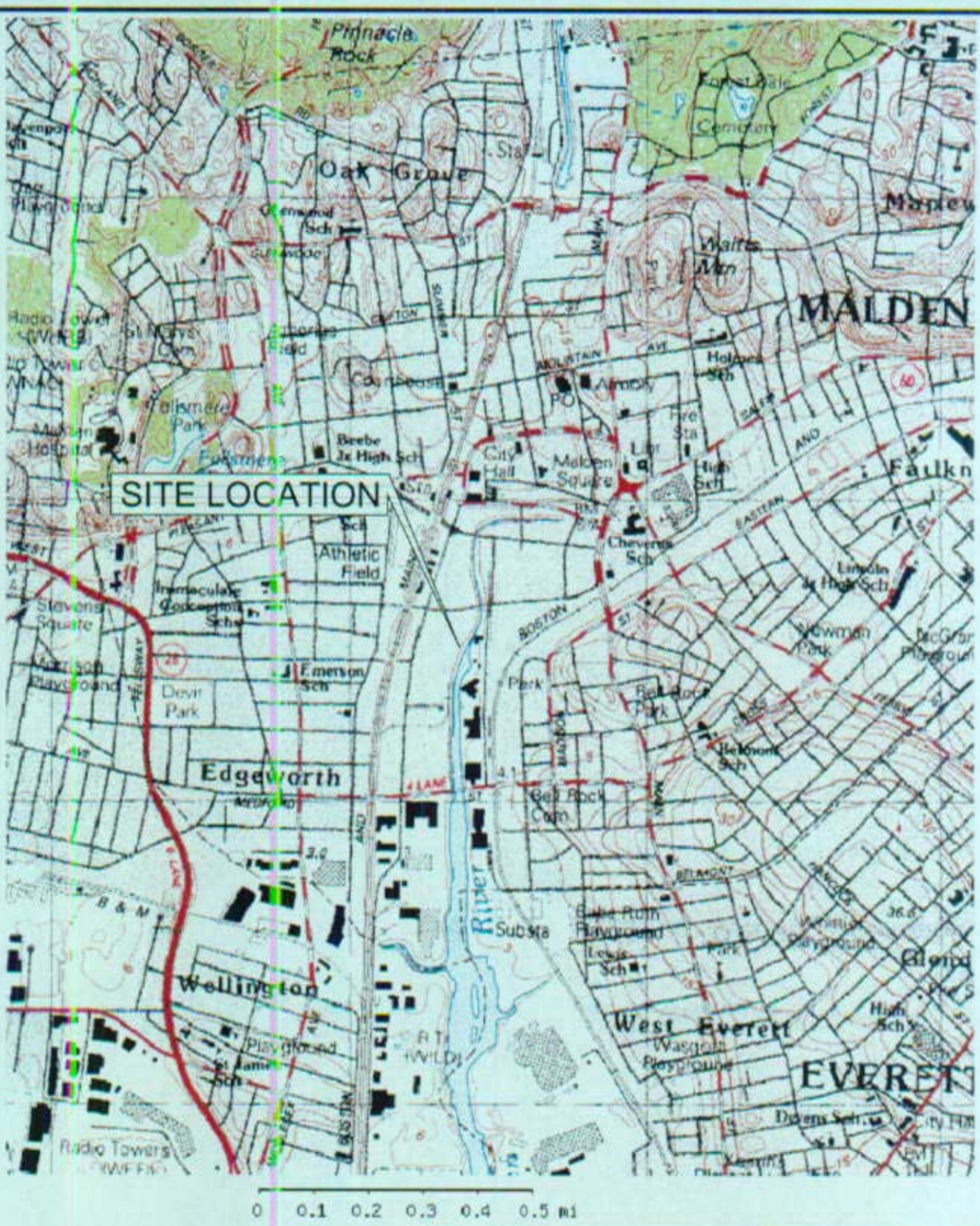

FIGURE 1-1

SITE LOCATION MAP
PHASE III REMEDIAL ACTION PLAN

SOURCE: www.Topozone.com
MAP CENTER IS UTM 19 329538E 4698893N
(WGS84/NAD83)
BOSTON NORTH QUADRANGLE

PROJECT LOCATION	DATE	PROJECT NUMBER
FORMER MALDEN MGP SITE (MALDEN RIVER PORTION) MALDEN, MASSACHUSETTS	JUNE, 2006	129490.050

BROWN AND CALDWELL
ALLENDALE, NEW JERSEY

P:\DRAFTING\NATIONAL_GRID\MALDEN\129490\FIGURE 1-1 LOCATION MAP.DWG 06/06/2006 06:49:05AM Byrnoleinyk XREFS: Layout: 8.5x11

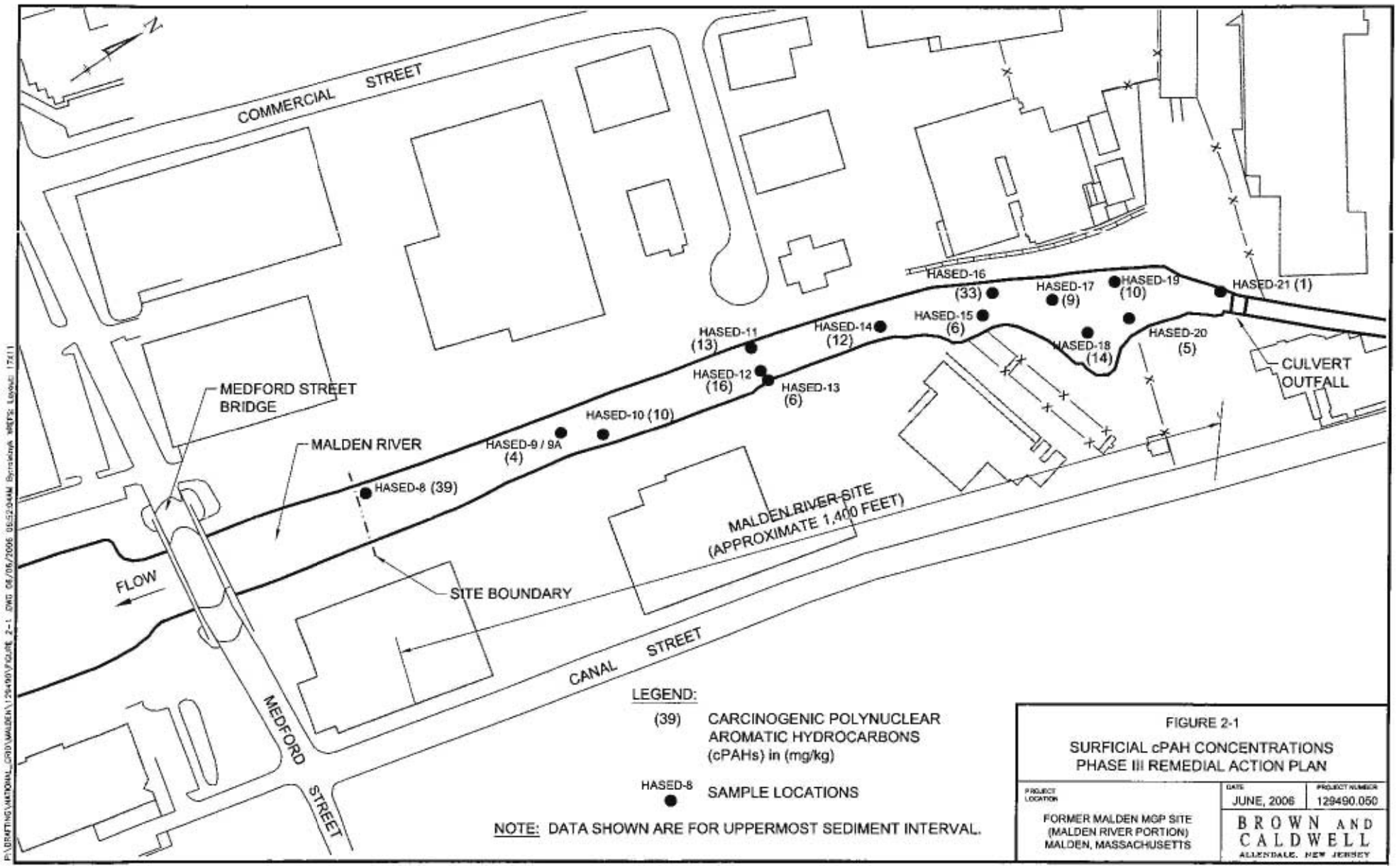

FIGURE 2-1

SURFICIAL cPAH CONCENTRATIONS
PHASE III REMEDIAL ACTION PLAN

PROJECT LOCATION	DATE	PROJECT NUMBER
FORMER MALDEN MGP SITE (MALDEN RIVER PORTION) MALDEN, MASSACHUSETTS	JUNE, 2006	129490.050

BROWN AND CALDWELL
ALLENDALE, NEW JERSEY

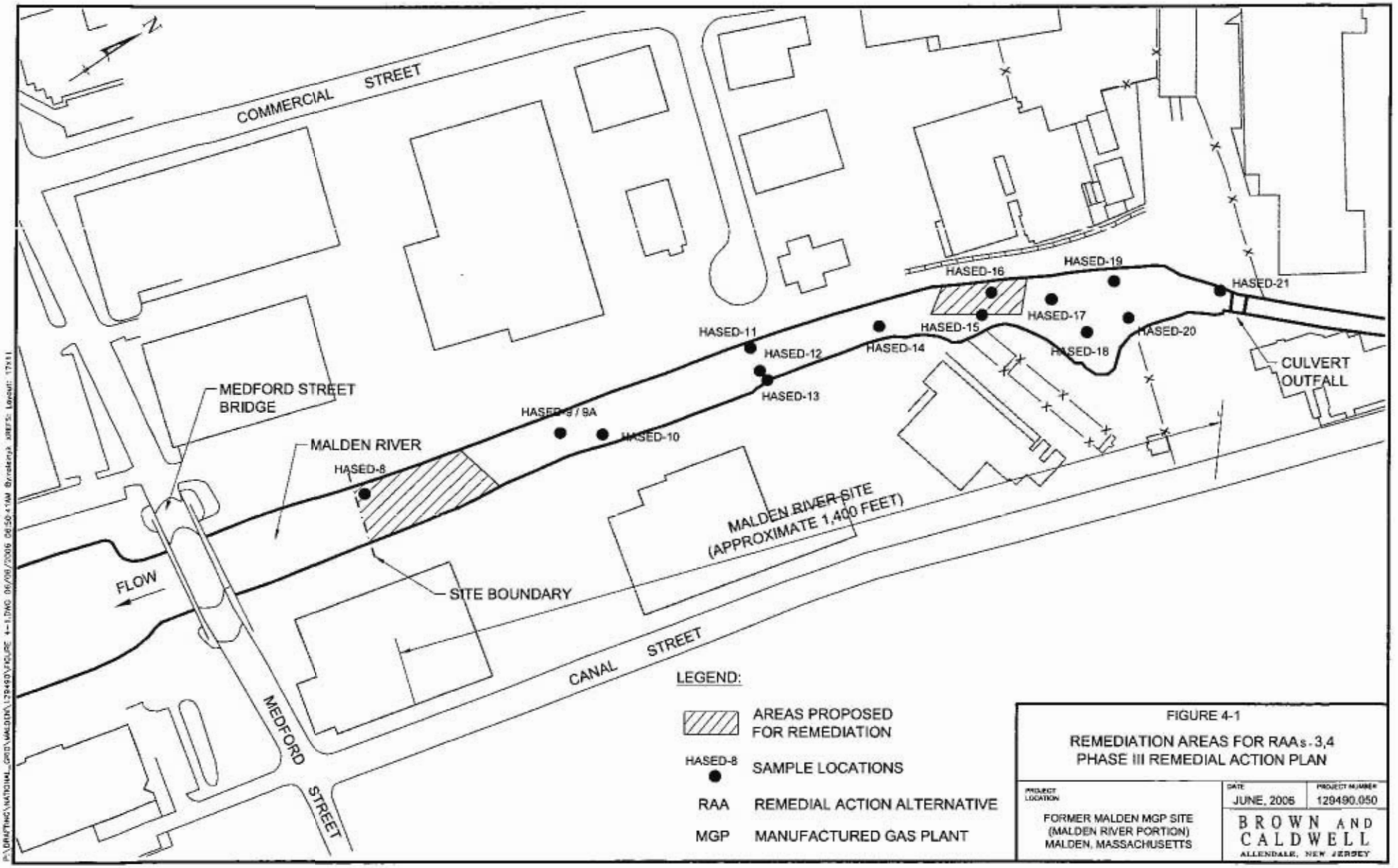

FIGURE 4-1

REMEDIATION AREAS FOR RAAs 3,4
PHASE III REMEDIAL ACTION PLAN

PROJECT LOCATION	DATE	PROJECT NUMBER
FORMER MALDEN MGP SITE (MALDEN RIVER PORTION) MALDEN, MASSACHUSETTS	JUNE, 2006	129490.050

BROWN AND CALDWELL
ALLENDALE, NEW JERSEY

P:\DRAFTING\NATIONAL_GRID\MALDEN\129490\FIGURE 4-1.DWG 06/09/2006 08:50:41 AM Byrakenyk XREFS: Layout: 17x11

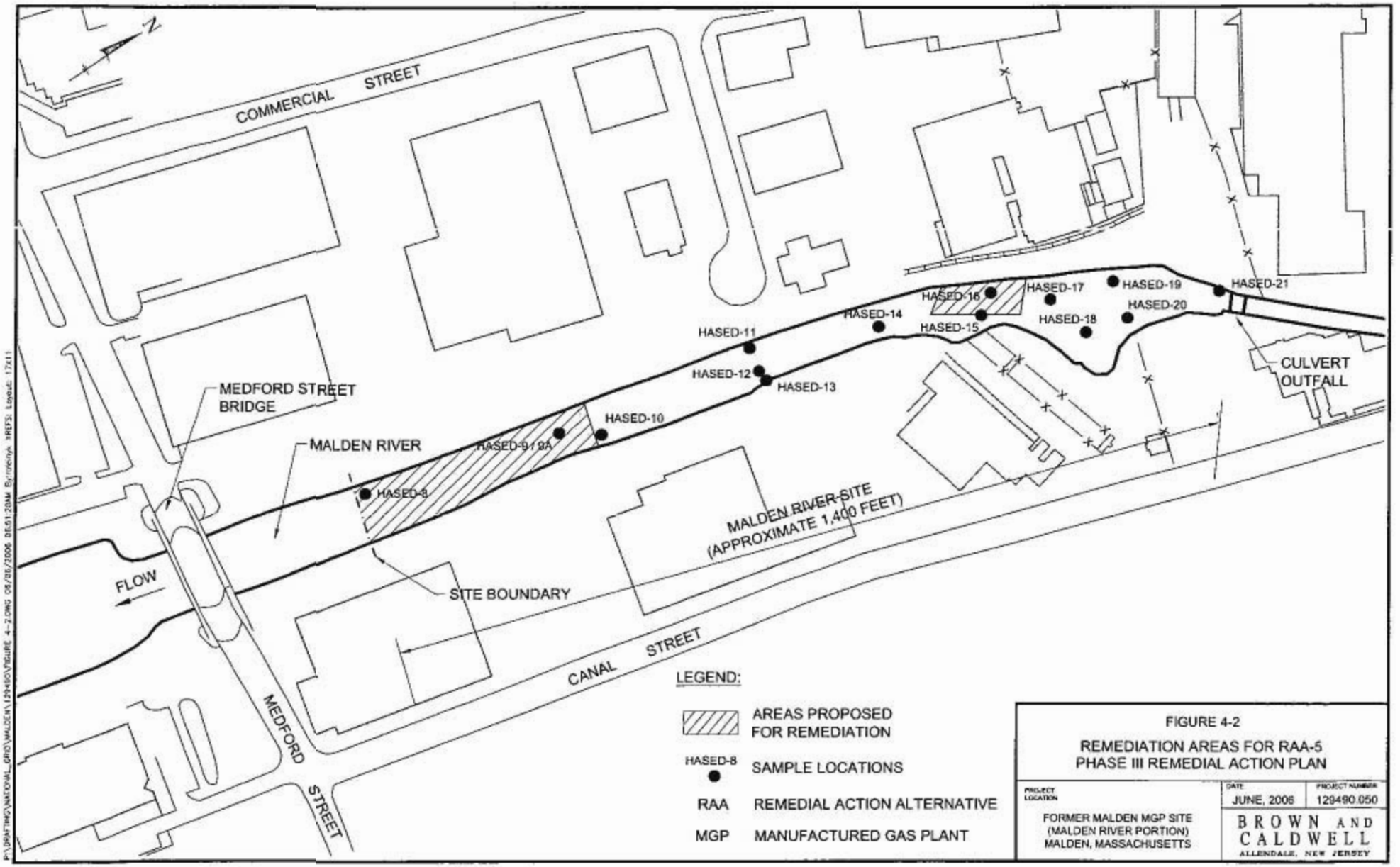

FIGURE 4-2

REMEDIATION AREAS FOR RAA-5
PHASE III REMEDIAL ACTION PLAN

PROJECT LOCATION: FORMER MALDEN MGP SITE (MALDEN RIVER PORTION) MALDEN, MASSACHUSETTS

DATE: JUNE, 2006

PROJECT NUMBER: 129490.050

BROWN AND CALDWELL
ALLENDALE, NEW JERSEY

APPENDIX A

2006 SUPPLEMENTAL DATA COLLECTION REPORT

APPENDIX A

Former Malden MGP Site
(Malden River Portion) - Malden, Massachusetts
Phase III Remedial Action Plan
2006 Supplemental Data Collection Report

Site Description. This report presents supplemental data for the Malden River portion of the former Malden Manufactured Gas Plant (MGP) Site (the Site) located in Malden, Massachusetts. The Malden River portion of the Site is the uppermost portion of the Malden River which is bounded, in general, by Charles Street to the north, Medford Street to the south, Canal Street to the east and Commercial Street to the west. The specific portion of the Malden River that is considered to be part of the Disposal Site starts from the discharge culvert at the upstream end and extends 1400 feet downstream (Figure A-1). This downstream boundary was established in the Phase II CSA after a thorough evaluation of potential impacts from the former Malden MGP, PAH distribution in the River, other potential sources of PAHs (evaluated through fingerprinting analysis) and locations of other industries with ties to PAHs.

Site History. The MGP operated at Commercial and Center Streets in Malden for approximately 120 years. The Malden River was investigated as part of the Phase II Comprehensive Site Assessment (CSA) and a CSA Report was prepared by Haley and Aldrich in December, 2001 for the Site, consistent with the Massachusetts Contingency Plan (MCP) – 310 CMR 40.0000. Data assessment has indicated PAH impacts to sediments in the Malden River, related to the long industrial history of the area. The next step in the MCP process, relating to the Malden River portion of the Site, is to prepare this Phase III RAP in accordance with 310 CMR 40.0850 of the MCP.

Project Objectives. The objective of the field sampling effort was to collect supplemental data for use in preparing the Phase III RAP for the river portion of the Site. Specifically, the collection efforts focused on geotechnical data for use in evaluating the feasibility of various remedial action alternatives.

Field Activities. The field work involved a one-day effort to collect sediment cores from a boat and take certain field measurements. Sample collection was performed by Aqua Survey Inc., acting as a subcontractor to Brown and Caldwell. Six sediment cores were collected to a depth of 10 feet or refusal, whichever was shallower, using an electric vibracorer with a 4-inch OD barrel. The cores were collected along the six transects shown on Figure A-1. Specifically, each core was collected from the approximate middle of the River at transects spaced 200, 400, 600, 800, 1,000 and 1,200 feet from the culvert outfall at the upstream end of the River. Samples collected at each of these transects were called SED-1, SED-2, SED-3, SED-4, SED-5 and SED-6, respectively. Water depths were noted at intervals across each of these transects as summarized below.

Transect	Distance from Outfall (feet)	Water Depths (feet)
1	200	3.2, 4.6, 6.7, 3.9
2	400	4.4, 3.7, 3.7, 4.7
3	600	5.5, 4.9, 4.5, 1.5
4	800	4.0, 4.3, 4.1, 3.5
5	1000	2.7, 4.0, 4.2, 3.2
6	1200	1.1, 5.1, 5.3, 3.6

Water depths across each transect are from left to right, looking upstream.

During the field activities it was noticed that the uppermost layer of sediment in five of the six cores was comprised of sand (see attached Core Logs). Below the sand layer was a layer of cohesive material that comprised of either clay or silt. The top of this cohesive layer was tested for strength in the field by using an S-170 Pocket Penetrometer to estimate unconfined compressive strength and a Torvane hand-held shear tester to estimate undrained shear strength of the sediment. For some of the longer cores (SED-1, SED-2 and SED-3) strength tests were performed at two intervals. The results are presented in Table A-1.

Sample Analysis. Three samples for four of the cores and two samples for the other two cores underwent geotechnical testing. The 16 samples were tested for moisture content (ASTM D2216), specific gravity (ASTM D854), particle size distribution (ASTM D422), organic content (ASTM D2974) and Atterberg Limits (ASTM D4318) for the cohesive samples. Results for this testing are provided in Table A-2 together with estimated bulk densities that were calculated using water contents and specific gravities. The upper three inches of each core was also analyzed for total organic carbon (TOC) using the Lloyd Kahn method (USEPA 1988). The TOC results for samples SED-1, SED-2, SED-3, SED-4, SED-5 and SED-6 were 3.1, 8.6, 3.2, 6.2, 11 and 6.4 percent, respectively.

TABLES

TABLE A-1
Former Malden MGP Site (Malden River Portion) - Malden, Massachusetts
Phase III Remedial Action Plan – Supplemental Data Collection Report (2006)
January 2006 Penetrometer and Vane Shear Test Results

Location	Sed-1		Sed-2		Sed-3		Sed-4	Sed-5	Sed-6
Total Core Recovery (ft)	10		9		5		2.5	3.5	4
Depth (ft)	4	7	4	7	4	5	2.5	3.5	
Material	clay	clay	silt	clay	clay	clay	clay	clay	all sand
Penetrometer - kg/cm^2 ($tons/ft^2$)	1.5	2	0.5	1	1.5	2.5 - 3.5	> 4.5	3.5 - 4	N/A
Penetrometer as undrained shear strength - kg/cm^2 ($tons/ft^2$)	0.75	1	0.25	0.5	0.75	1.25 - 1.75	> 2.25	1.75 - 2	N/A
Vane Shear - kg/cm^2 ($tons/ft^2$)	0.45	0.55	0.1	0.5	0.05	0.5 - 0.6	> 1.0	> 1.0	N/A

Notes:
Depths are below mudline where readings were taken
Penetrometer readings are unconfined compressive strength and were collected using a S-170 Pocket Penetrometer
Vane shear readings are undrained shear strength and were collected using a Torvane hand-held shear tester
N/A - not applicable, non-cohesive sample

TABLE A-2
Former Malden MGP Site (Malden River Portion) - Malden, Massachusetts
Phase III Remedial Action Plan – Supplemental Data Collection Report (2006)
January 2006 Geotechnical Data

Location-from outfall (ft)	Max. Water Depth (ft)	Core Length (ft)	Sample	Interval (ft)	Water Content (%)	Specific Gravity	Organic Content (%)	Sediment Type	Atterberg Limits			Estimated Density (lbs/ft^3)
									PL	LL	PI	
200	6.7	10	SED-1	Upper	24	2.7	3.1	Sand	nd	nd	nd	126
				Middle	35	2.8	1.5	Clay	23	43	20	119
				Lower	31	2.7	1.2	Clay	19	33	14	120
400	4.4	9	SED-2	Upper	30	2.7	2.6	Sand	nd	nd	nd	121
				Middle	69	2.3	5.3	Silt	42	89	47	94
				Lower	41	2.7	1.5	Clay	27	53	26	113
600	5.5	5	SED-3	Upper	26	2.7	1.0	Sand	nd	nd	nd	125
				Lower	35	2.8	1.7	Clay	23	43	20	118
800	4.3	2.5	SED-4	Upper	27	2.5	2.9	Sand	nd	nd	nd	119
				Lower	26	2.9	2.4	Clay	27	42	20	130
1000	4.2	3.5	SED-5	Upper	32	2.8	0.9	Sand	nd	nd	nd	120
				Middle	99	2.7	9.4	Silt	55	89	34	92
				Lower	22	2.8	1.0	Clay	25	45	20	131
1200	5.3	4	SED-6	Upper	33	2.8	0.4	Sand	nd	nd	nd	121
				Middle	30	2.5	7.1	Sand	nd	nd	nd	117
				Lower	9.0	2.6	3.7	Sand	nd	nd	nd	142

Notes:
Unconfined compressive strength collected using a S-170 Pocket Penetrometer
PL – Plastic Limit PI – Plasticity Index
LL – Liquid Limit nd – not determined

FIGURE

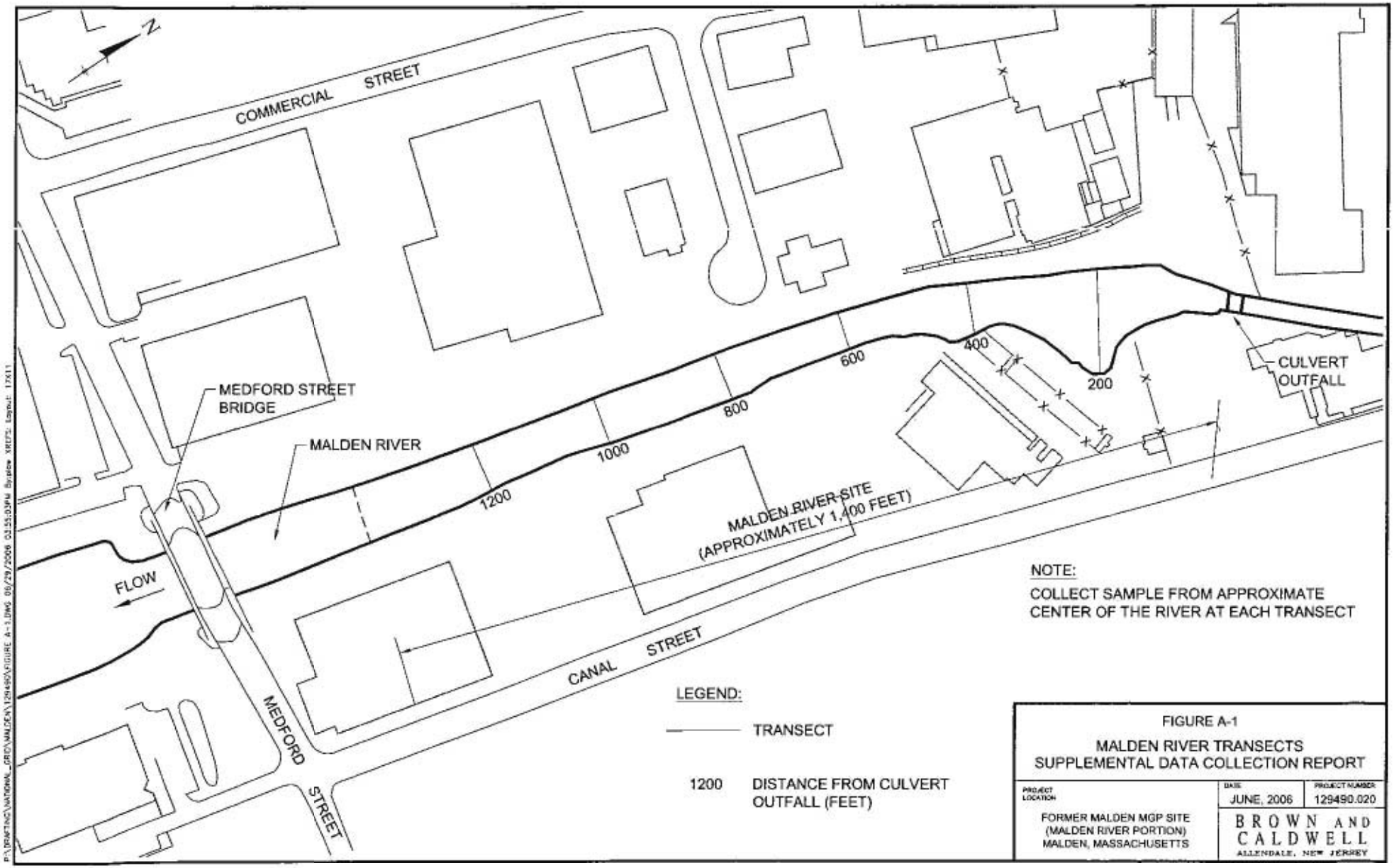

FIGURE A-1

MALDEN RIVER TRANSECTS
SUPPLEMENTAL DATA COLLECTION REPORT

PROJECT LOCATION	DATE	PROJECT NUMBER
FORMER MALDEN MGP SITE (MALDEN RIVER PORTION) MALDEN, MASSACHUSETTS	JUNE, 2006	129490.020

BROWN AND CALDWELL
ALLENDALE, NEW JERSEY

P:\DRAFTING\NATIONAL_GRID\MALDEN\129490\FIGURE A-1.DWG 06/29/2006 03:55:03PM Bygrave XREFS: Layout: 11x11

ATTACHMENTS

BROWN and CALDWELL

Subsurface Boring Log

Well Name / Location: **Sed-1 (200')**

Project:	Malden River	Project No:	129490
Client:	Rohm Tech	Start Date:	1/19/2006
		Finish Date:	1/19/2006

DRILLING DATA

Geologist:	Stephanie Root
Contractor:	Aqua Survey
Equipment:	25' aluminum pontoon boat
Method:	Vibra Core

SAMPLING METHODS

	Sampler	Tube	Core
Type:	Vibra Core	X	
Diameter:			
Other:			

WELL CONSTRUCTION

	Riser	Screen
Material:	NA	NA
Diameter (ID):	NA	NA
Coupling:	NA	NA

WELL DEVELOPMENT

Method:	NA
Duration:	NA
Gals. Purged:	NA
Slug Test:	NA
(cm / sec)	NA

SURVEY DATA

DATUM:

Grade:	NA
TWC:	NA
TPC:	NA
North:	NA
East:	NA

Geophysical Log: yes no X

Comments:

Depth (ft)	WELL CONSTRUCTION	soil / rock	Samp. No. / Run No.	Rec (ft) / Rec. (ft)	Penetrometer kg/cm²	Vane Shear kg/cm2	VISUAL CLASSIFICATION	REMARKS
0							Top 3" black, coarse sand with organics, 0-1' Black, very coarse to coarse sand with a strong odor	TOC sample collected @ 0940
5			1	10	1.5	0.45	1-10' - Remaining core a gray/green clay	
					2.0	0.55		
10								

End of Boring

5

BROWN and CALDWELL

Subsurface Boring Log

Well Name / Location: **Sed-2 (400')**

Project:	Malden River	Project No:	Start Date: 1/19/2006
Client:	Rohm Tech	129490	Finish Date: 1/19/2006

DRILLING DATA

Geologist:	Stephanie Root
Contractor:	Aqua Survey
Equipment:	25' aluminum pontoon boat
Method:	Vibra Core

SAMPLING METHODS

	Sampler	Tube	Core
Type:	Vibra Core	x	
Diameter:			
Other:			

WELL CONSTRUCTION

	Riser	Screen
Material:	NA	NA
Diameter (ID):	NA	NA
Coupling:	NA	NA

WELL DEVELOPMENT

Method:	NA
Duration:	NA
Gals. Purged:	NA
Slug Test:	NA
(cm / sec)	NA

SURVEY DATA

DATUM:

Grade:	NA
TWC:	NA
TPC:	NA
North:	NA
East:	NA

Geophysical Log: yes no X

Comments:

Depth (ft)	WELL CONSTRUCTION	soil / rock	Samp. No. / Run No.	Rec. (ft)	Penetrometer kg/cm²	Vane Shear kg/cm2	VISUAL CLASSIFICATION	REMARKS
0							0-2' - Black, very coarse to coarse sand with organics in top few inches and an odor	TOC sample collected @ 1055
5			1	9	0.5	0.1	2-9' - Remaining core a gray/green clay	
					1.0	0.5		
10								

End of Boring

15

BROWN and CALDWELL

Subsurface Boring Log

Well Name / Location: **Sed-3 (600')**

Project:	Malden River	Project No:	129490
Client:	Rohm Tech	Start Date:	1/19/2006
		Finish Date:	1/19/2006

DRILLING DATA

Geologist:	Stephanie Root
Contractor:	Aqua Survey
Equipment:	25' aluminum pontoon boat
Method:	Vibra Core

SAMPLING METHODS

	Sampler	Tube	Core
Type:	Vibra Core	X	
Diameter:			
Other:			

WELL CONSTRUCTION

	Riser	Screen
Material:	NA	NA
Diameter (ID):	NA	NA
Coupling:	NA	NA

WELL DEVELOPMENT

Method:	NA
Duration:	NA
Gals. Purged:	NA
Slug Test:	NA
(cm / sec)	NA

SURVEY DATA

DATUM:

Grade:	NA
TWC:	NA
TPC:	NA
North:	NA
East:	NA

Geophysical Log: yes no X

Comments:

depth (ft)	WELL CONSTRUCTION	soil / rock	Samp. No. / Run No.	Rec. (ft)	Penetrometer kg/cm²	Vane Shear kg/cm2	VISUAL CLASSIFICATION	REMARKS
0							0-2.5' - Black, medium to coarse sand, some gravel and some very coarse sand with organics in top few inches and an odor with no sheen	TOC sample collected @ 1145
			1	9				
					1.5	0.05	2.5-5' - Remaining core a gray/green clay	
5					2.5-3.5	0.5-0.6		
	Refusal at 5'							
10								

BROWN and CALDWELL

Subsurface Boring Log

Well Name / Location: **Sed-4 (800')**

Project:	Malden River	Project No:	129490
Client:	Rohm Tech	Start Date:	1/19/2006
		Finish Date:	1/19/2006

DRILLING DATA

Geologist:	Stephanie Root
Contractor:	Aqua Survey
Equipment:	25' aluminum pontoon boat
Method:	Vibra Core

SAMPLING METHODS

	Sampler	Tube	Core
Type:	Vibra Core	X	
Diameter:			
Other:			

WELL CONSTRUCTION

	Riser	Screen
Material:	NA	NA
Diameter (ID):	NA	NA
Coupling:	NA	NA

WELL DEVELOPMENT

Method:	NA
Duration:	NA
Gals. Purged:	NA
Slug Test: (cm / sec)	NA

SURVEY DATA

DATUM:

Grade:	NA
TWC:	NA
TPC:	NA
North:	NA
East:	NA

Geophysical Log: yes no X

Comments:

depth (ft)	WELL CONSTRUCTION	soil / rock	Samp. No. / Run No.	Rec. (ft) / Rec. (ft)	Penetrometer kg/cm²	Vane Shear kg/cm2	VISUAL CLASSIFICATION	REMARKS
0								
			1	2.5			0-2' - Black, medium to coarse sands with organic material at top 9 inches	TOC sample collected @ 1235
					> 4.5	> 1.0	2-2.5' - Remaining core a gray/green clay	
	Refusal at 2.5'							
5								
10								

BROWN and CALDWELL

Subsurface Boring Log

Well Name / Location: **Sed-5 (1000')**

Project:	Malden River	Project No:	Start Date: 1/19/2006
Client:	Rohm Tech	129490	Finish Date: 1/19/2006

DRILLING DATA

Geologist:	Stephanie Root
Contractor:	Aqua Survey
Equipment:	25' aluminum pontoon boat
Method:	Vibra Core

SAMPLING METHODS

	Sampler	Tube	Core
Type:	Vibra Core	X	
Diameter:			
Other:			

WELL CONSTRUCTION

	Riser	Screen
Material:	NA	NA
Diameter (ID):	NA	NA
Coupling:	NA	NA

WELL DEVELOPMENT

Method:	NA
Duration:	NA
Gals. Purged:	NA
Slug Test: (cm / sec)	NA

SURVEY DATA

DATUM:

Grade:	NA
TWC:	NA
TPC:	NA
North:	NA
East:	NA

Geophysical Log: yes no X

Comments:

depth (ft)	WELL CONSTRUCTION	soil / rock	Samp. No. / Run No.	Rec. (ft)	Penetrometer kg/cm²	Vane Shear kg/cm2	VISUAL CLASSIFICATION	REMARKS
0			1	3.5			0-1' - Organic material with some sand	TOC sample collected @ 1320
							1-1.5 - Black, medium to coarse sand with strong odor and sheen	
							1.5-2' - Tan, medium to coarse sand with no odor	As core pulled up, sheen rose to surface
					3.5-4	> 1.0	2-3' - Silt and fine sand with some organic material, strong odor and sheen	
5	Refusal at 3.5'						3-3.5' - Gray/green clay	
0								

BROWN and CALDWELL

Subsurface Boring Log

Well Name / Location: **Sed-6 (1200')**

Project:	Malden River	Project No:	Start Date: 1/19/2006
Client:	Rohm Tech	129490	Finish Date: 1/19/2006

DRILLING DATA

Geologist:	Stephanie Root
Contractor:	Aqua Survey
Equipment:	25' aluminum pontoon boat
Method:	Vibra Core

SAMPLING METHODS

	Sampler	Tube	Core
Type:	Vibra Core	X	
Diameter:			
Other:			

WELL CONSTRUCTION

	Riser	Screen
Material:	NA	NA
Diameter (ID):	NA	NA
Coupling:	NA	NA

WELL DEVELOPMENT

Method:	NA
Duration:	NA
Gals. Purged:	NA
Slug Test: (cm / sec)	NA

SURVEY DATA

DATUM:

Grade:	NA
TWC:	NA
TPC:	NA
North:	NA
East:	NA

Geophysical Log: yes no X

Comments:

depth (ft)	WELL CONSTRUCTION	soil / rock	Samp. No. / Run No.	Rec. (ft)	Penetrometer kg/cm²	Vane Shear kg/cm2	VISUAL CLASSIFICATION	REMARKS
0					N/A	N/A	0-1' - Leafy organics with some sediment	TOC sample collected @ 1420
					N/A	N/A	1-2.5' - Black, medium to coarse sand with an odor	
					N/A	N/A	2.5-3.5' - Tan, medium to coarse sand with no odor	As core pulled up, sheen rose to surface
			1	4	N/A	N/A	3.5-6' - Black, coarse sand with a strong odor and a sheen	
5					N/A	N/A		
					N/A	N/A		
					N/A	N/A	6-8' - Black, coarse sand with some gravel. Very coarse sand and gravel at 8 feet.	No clay encountered
					N/A	N/A		
	Refusal at 8'							
0								

APPENDIX B

UPDATED SUBSTANTIAL HAZARD EVALUATION

APPENDIX B

Former Malden MGP Site
(Malden River Portion) - Malden, Massachusetts
Phase III Remedial Action Plan

Updated Substantial Hazard Evaluation

A Substantial Hazard Evaluation (SHE) was completed for the site by AMEC Earth and Environmental (Boston, MA) in 2003 ("Amendment to Method 3 Risk Characterization [RC] and Substantial Hazard Evaluation") as part of the Phase III Remedial Action Plan for the "Upper Site" (non-river portions of the site). The Substantial Hazard Evaluation was completed to support a Class C Response Action Outcome (RAO) in accordance with 310 CMR 40.0956. The 2003 SHE did not include the river, which is the subject of the current Phase III RAP. Therefore, this SHE has been performed to confirm that no substantial hazard exists under current site use conditions for the river-related exposure pathways.

Human Health

Table B-1 presents the risk calculations for the SHE. The exposure duration, per 310 CMR 40.0956, is the "time from notification to the date that the Substantial Hazard evaluation is conducted, plus five years." The notification date for the site is January 15, 1989, so at the next anniversary it will be 18 years since notification. Therefore, the exposure duration for the SHE is 23 years.

In order to characterize all potential risks in the river, it was conservatively assumed that the recreator (child and adult fish eater) could be the same individual as the adolescent trespasser. Therefore, the following exposure pathways were assumed to be additive:

- Fish ingestion (child and adult receptors handled through the use of an age-adjusted fish ingestion rate, as described in Section 2 of this Phase III Remedial Action Plan or RAP);
- Incidental ingestion of surface water;
- Incidental ingestion of sediment;
- Dermal contact with surface water; and
- Dermal contact with sediment.

The fish ingestion risks for carcinogenic polynuclear aromatic hydrocarbons (cPAHs) were calculated based on the updated variables presented in Section 2 of this Phase III RAP. The site-specific organic carbon concentration of 6.34% was used, and the biota-sediment accumulation factor (BSAF) was adjusted to 0.0054 kilogram (kg) organic carbon/kg lipid.

The risks presented in the Method 3 RC for chemicals of concern (COCs) other than cPAHs were not reviewed in detail or recalculated. However, the following adjustments were made for consistency prior to summing the risks for non-cPAH COCs with those for cPAHs:

- Risks for organic COCs, which have organic carbon-based BSAFs, were scaled to adjust for the site specific value (the Phase II Method 3 RC used a value of 1.5%). The scaling factor is 0.015/0.0634.

- Risks for arsenic were adjusted to zero since the Phase II Method 3 report lists a BSAF of 0 for arsenic. Although arsenic can be taken up by fish, it tends to accumulate in an organic form, whereas risks and hazards are based on the inorganic form. Omitting arsenic therefore does not significantly affect the overall risk estimate.

The risks for surface water and sediment direct contact were taken directly from the Phase II Method 3 report.

The total lifetime carcinogenic risk with the limited adjustments described above is estimated at 2E-06. Since this risk is below the MCP risk limit of 1E-05, there is **No Substantial Hazard** based on human health risk.

Ecological Risk

An Ecological SHE focuses on mitigation of identified impacts on environmental resource areas. Per 310 CMR 40.0956(2), these conditions include a) evidence of stressed biota attributable to the release at the disposal site; (b) visible presence of oil, tar or other non-aqueous phase hazardous material within one foot of the sediment surface in an area of 1000 square feet or more; (c) continuing discharge of contaminated groundwater to surface water where Massachusetts Surface Water standards are already exceeded; (d) continuing discharge of contaminated groundwater to surface water where there is already a related significant risk; (e) potential future significant future risk resulting from continued migration of oil or hazardous material; or (f) ecological risk or harm that would be harder for the resource to recover from if remediation were delayed.

None of the above conditions exist at the site. There are no visible oil, tar or other non-aqueous phase hazardous material within one foot of the sediment surface in an area of 1000 square feet or more of the River. There are also no continuing discharges of groundwater to surface water that represent an ecological threat. Therefore, there is **No Substantial Hazard** based on ecological risk.

This SHE has determined that there are no substantial hazards associated with the Malden River portion of the site in its current condition. However, prior to making final risk management decisions about the site additional work is proposed in the PHASE III RAP. The proposed work would be a very focused evaluation intended to reduce uncertainty so there is a high degree of confidence that the selected remedy is the most appropriate for the Site. The investigation would include re-sampling locations where previous sampling indicated higher concentrations of PAHs than other locations, and collecting samples between existing sample locations and intervals. Using these data, both the Method 3 RC and the Substantial Hazard Evaluation would be revised, as appropriate.

TABLES

Table B-1
Former Malden MGP Site (Malden River Portion)
Malden, Massachusetts
Phase III Remedial Action Plan - Substantial Hazard Evaluation
Calculation of Human Health Carcinogenic Risk

IR_c kgfish/day	IR_a kgfish /day	ED_c yrs	ED_a yrs	BW_c	BW_a
0.0081	0.012	6	12	47.2	70
IRadj =	**0.00309**				

	Sed. Conc.[a]	BSAF	fOC	L_F	IRadj	FI	EF	AP	CSF[b]	Risk
	mg/kg sed	(kg OC/ kg lipid)	kg OC/ kg sed	kg lip/ kg fish	kgfish-yr/ kgBW-day		days/yr	days		
Fish Ingestion										
Benzo(a)anthracene	9.29	0.0054	0.0634	0.03	0.003087	0.25	365	27375	0.73	**2E-07**
Benzo(a)pyrene	9.74	0.0054	0.0634	0.03	0.003087	0.25	365	27375	7.3	**2E-06**
Benzo(b)fluoranthene	9.85	0.0054	0.0634	0.03	0.003087	0.25	365	27375	0.73	**2E-07**
Benzo(k)fluoranthene	3.51	0.0054	0.0634	0.03	0.003087	0.25	365	27375	0.07	**7E-09**
Chrysene	8.99	0.0054	0.0634	0.03	0.003087	0.25	365	27375	0.07	**2E-08**
Dibenz(a,h,)anthracene	1.33	0.0054	0.0634	0.03	0.003087	0.25	365	27375	7.3	**3E-07**
Indeno(1,2,3-cd)pyrene	3.27	0.0054	0.0634	0.03	0.003087	0.25	365	27375	0.73	**6E-08**
									Total	**2E-06**
Non-CPAH constituents						From Phase II Method 3; see table B-2				**4E-06**
River Direct Contact[c]										
Surface Water Ingestion										**1E-09**
Surface Water Dermal Contact										**2E-09**
Sediment Ingestion										**1E-07**
Sediment Dermal Contact										**9E-07**
RIVER TOTAL										**8E-06**

See Table 2-1 for risk variable values except as noted below.

(a) Sediment concentrations obtained from Phase II CSA.

(b) MADEP values. http://www.mass.gov/dep/toxics/pahs.htm.

(c) River direct contact risk values were taken directly from the Phase II Risk Characterization.

IR_a	=	Fish intake rate (adult)
IR_c	=	Fish intake rate (child)
IRadj	=	Age-adjusted fish intake rate
ED_a	=	Exposure duration (adult)
ED_c	=	Exposure duration (child)
BW_a	=	Body weight (adult)
BW_c	=	Body weight (child)
BSAF	=	Biota-sediment accumulation factor
fOC	=	Fraction organic carbon
L_F	=	Fraction lipid
FI	=	Fraction of fish ingested from site
EF	=	Exposure frequency
AP	=	Averaging period
CSF	=	Carcinogenic slope factor

Table B-2
Former Malden MGP Site (Malden River Portion)
Malden, Massachusetts
Phase III Remedial Action Plan - Substantial Hazard Evaluation
Human Health Carcinogenic Risks from Fish Ingestion for COCs Other than cPAHs

Non-cPAH Fish Carcinogenic Risks from Phase 2 Method 3 Risk Characterization

	Child	Adult	Total	Adjusted Tot.	
Arsenic	1.03E-07	5.10E-07	6.13E-07	0.00E+00	(b)
bi(2-Ethylhexyl)phthalate	1.68E-06	8.40E-06	1.01E-05	2.38E-06	(a)
Carbazole	2.36E-07	1.20E-06	1.44E-06	3.40E-07	(a)
Methylene chloride	2.37E-09	1.20E-08	1.44E-08	3.40E-09	(a)

(a) Risks scaled by 0.015/0.0634 based on site-specific organic carbon content of 6.34% vs. value of 1.5% used in Phase II

(b) Risk assumed to be 0 based on BSAF of 0 listed in Table 11 of Method 3 Environmental Risk Characterization from Phase II report