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PHASE II COMPREHENSIVE SITE ASSESSMENT REPORT
284 Winter Street
Haverhill, Massachusetts
RTNs 3-32792 and 3-32875

April 2022
File No. 01.0172397.10

PREPARED FOR:
Boston Gas Company d/b/a National Grid
Waltham, Massachusetts

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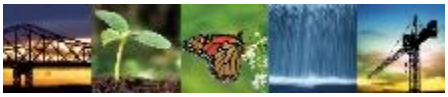

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April 5, 2022
File No. 01.0172397.10

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup
Northeast Regional Office
205B Lowell Street
Wilmington, Massachusetts 01887-2941

Re: Phase II Comprehensive Site Assessment Report
284 Winter Street
Haverhill, Massachusetts
Release Tracking Numbers (RTNs) 3-32792 and 3-32875

Ladies and Gentlemen:

GZA GeoEnvironmental, Inc. (GZA) is submitting the attached Phase II Comprehensive Site Assessment (CSA) Report on behalf of our client, Boston Gas Company d/b/a National Grid (National Grid). The report documents Phase II studies performed at the above-referenced Site in accordance with 310 CMR 40.0830 of the Massachusetts Contingency Plan. The Comprehensive Response Action Transmittal Form (BWSC108) was filed electronically with the Massachusetts Department of Environmental Protection and a copy of the form is included in Appendix B of this report.

Should you have any questions regarding this submittal, please contact the Mr. Lindberg at (781) 278-3830.

Very truly yours,

GZA GEOENVIRONMENTAL, INC.

Charles A. Lindberg, LSP
Senior Principal

Gregg McBride, LSP
Consultant/Reviewer

Attachment: Report

cc: Jesse Edmands, (National Grid)

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APPENDICES

1.0 INTRODUCTION

On behalf of Boston Gas Company d/b/a National Grid (National Grid), GZA GeoEnvironmental, Inc. (GZA) has prepared this Phase II Comprehensive Site Assessment (Phase II) report for the property at 284 Winter Street in Haverhill, Massachusetts (the "Site"). A Site Locus plan is provided as Figure 1 of this report, and an Exploration Location Plan is included as Figure 2.

The property is currently owned by Haffner Realty Trust (Haffner) and is occupied by a gasoline service station and car wash facility. In March 2015, Haffner filed a Release Notification Form (RNF) notifying the Massachusetts Department of Environmental Protection (MassDEP) that concentrations of certain Oil and/or Hazardous Materials (OHM) in soil samples exceeded the Reportable Concentrations (RCs) established by the Massachusetts Contingency Plan (MCP, 310 CMR 40.0000). MassDEP issued a Notice of Responsibility (NOR) to Haffner in April 2015 and assigned Release Tracking Number (RTN) 3-32792 to this 120-day reporting condition. Subsequently, in May 2015, MassDEP assigned RTN 3-32875 to a 2-hour reporting condition associated with a petroleum sheen on the surface water of the Little River adjacent to the property[1].

Between 2015 and 2019, response actions associated with both RTNs were conducted by Ramboll US Corporation, formerly known as Ramboll Environ, of Westford, Massachusetts (Ramboll) on behalf of Haffner. As required by the MCP, Ramboll submitted a Phase I Initial Site Investigation (ISI) and Tier Classification in April 2016, based on which the Site was classified as a Tier I Site. The Phase I ISI documented that the Site had been the location of a former Manufactured Gas Plant (MGP) operated by Haverhill Gas Works.

In November 2016, MassDEP issued an NOR to National Grid, a successor company to a former owner of the property, noting that the liability was joint and several between Haffner and National Grid. In November 2019, following Haffner's signing of a settlement agreement between the two potentially responsible parties (PRPs), National Grid assumed the role of Responsible Party for the two RTNs via a Tier Classification Transfer. Additional information about the Site's operational and regulatory history is provided in Section 2.0 of this report.

This report is subject to the Limitations included in Appendix A. A Comprehensive Response Action Transmittal Form (BWSC108) has been filed electronically with MassDEP; for convenience, a copy of this form is included in Appendix B.

1.1 SCOPE OF WORK

This report presents information collected by GZA on behalf of National Grid under two scopes of work, which were executed in 2016 and in 2020-2021. In 2016, GZA conducted a site investigation at the property to supplement the information collected by Ramboll. The scope of work for the 2016 investigation included a geophysical survey of the property; installation and sampling of eight temporary soil gas probes; collection of an ambient air sample; drilling of eight soil borings with soil sampling; installation, gauging and sampling of three groundwater monitoring wells; collection and analysis of non-aqueous phase liquid (NAPL) samples; and collection of sediment samples from storm water catch basins. Since National Grid's assumption of responsibility for MCP response actions at the Site in 2019, GZA has conducted additional response actions to delineate the nature and extent of the release, and to characterize the potential risks associated with the Site. These response actions were conducted in general accordance with a Phase II Scope of Work (SOW) included as part of Ramboll's 2016 Phase I ISI, and included the collection of three additional soil gas samples; the drilling of nine additional soil borings; the installation of three additional groundwater monitoring wells to delineate the

[1] A third RTN (3-34906) was assigned to the property in May 2018, when an elevated headspace reading was detected in a soil sample during the removal of an underground storage tank (UST). Additional information about this RTN, which was subsequently closed, is provided in Section 2.3.

extent of OHM in soil and groundwater at the Haffner property; and the collection and analysis of sediment and surface water samples to evaluate potential impacts to the Little River. Based on the findings of these investigations, the work scope was expanded to include the installation of four borings on properties west of the Little River, three of which were completed as monitoring wells. The data were compiled to support an assessment of the nature and extent of OHM and NAPL at the Site; an evaluation of the potential risks associated with vapor intrusion; and a Method 3 risk characterization to evaluate risks to human receptors.

The Ramboll Phase II SOW also proposed the completion of a Stage I Environmental Screening (ES). However, as described in Section 3.2.7 of this Phase II report, the sediment data collected by GZA in 2020 indicated that a portion of the Little River lies within the Site boundary, and that additional investigation was required to more fully characterize conditions in the river. National Grid contracted Anchor QEA LLC of Amesbury, Massachusetts (Anchor) to collect additional data in support of an ecological risk characterization, and to develop remedial alternatives for the portion of the river within the Site boundary. Anchor's findings are presented in a supplemental Phase II CSA report included as Appendix C of this report.

1.2 PHASE II CSA OBJECTIVES

As described in Section 310 CMR 40.0833 of the MCP, the objective of a Phase II CSA is to develop and evaluate sufficient information to support conclusions and opinions regarding the (i) source, nature, extent, and potential impacts of releases of OHM; (ii) risk of harm posed by the disposal site to health, safety, public welfare, and the environment; and (iii) need for remedial actions at the disposal site. Additionally, the MCP requires that the Phase II report document, evaluate, and discuss the findings and conclusions of the Phase II CSA, and where applicable, provide the basis for identifying and evaluating remedial action alternatives. This report describes the findings and conclusions of GZA's Phase II investigation in terms of the objectives established by the MCP. A Method 3 Risk Characterization (RC) addressing the objectives of item (ii) above is included as Appendix D of this submittal.

2.0 BACKGROUND

As required by the MCP, the following sections present a description of the Site and its ownership and regulatory history.

2.1 SITE DESCRIPTION

The Site comprises a 1.2-acre parcel located at 284 Winter Street in Haverhill, Massachusetts, at latitude 42.77723N, longitude 71.08760W (the Property), an adjacent parcel to the southeast, a portion of the Little River that abuts the Property to the west, and a narrow strip of land just west of the river. Figure 1 presents a Site Locus Map adapted from a United States Geological Survey (USGS) topographic quadrangle map. The Locus Map delineates the location of the Site with respect to surrounding features in Haverhill and depicts 500-foot and ½-mile radii around the Site. Figure 2 presents an Exploration Location Plan with key features of the Property and depicts the disposal site boundary based on the data collected during this Phase II CSA.

The Property comprises tax lot 2-1 on City of Haverhill Tax Assessors Map 307, and is zoned for general industrial (IG) uses. It is owned by the Haffner Realty Trust and has been occupied by a gas station and car wash facility since 1977. Information available on the MassDEP's underground storage tank (UST) facility database (accessed in July 2021) indicated there are five 20,000-gallon single-walled USTs located beneath a concrete pad in the northern part of the Property. These include two gasoline USTs, two fuel oil USTs, and a diesel fuel tank, all of which were installed in 1977. In addition, one 6,000-gallon, single-walled diesel UST was installed in 1983 and was removed in 2018 as discussed in Section 2.3.3.

The gasoline dispensing pumps and sales kiosk are located beneath a canopy in the north central portion of the Property, and the automated car wash building is located along the eastern Property boundary (Figure 2). Most of the rest of the Property is paved, with the exception of a row of trees along the eastern edge; in addition, there are small non-contiguous landscaped areas adjacent to the car wash building and along the northern and western Property boundaries. A 15- to 20-foot-high stone and masonry retaining wall along the western and southwestern edge separates the Property from the Little River.

The Property is bordered to the east by a Massachusetts Bay Transportation Authority (MBTA) railroad right-of-way, beyond which is a paved parking area and a residential apartment complex, and to the north by Winter Street. To the south and southwest of the Property lies the open channel of the Little River; past the Site, the river is culverted until its discharge into the Merrimack River approximately ¼ mile to the south. In the vicinity of the Site, the Little River demarcates a zoning change from IG to general commercial (CG); across the river to the west of the Property are several commercial properties with frontage on Winter Street, Lafayette Square and/or Essex Street. As shown on Figure 2, limited portions of the properties at 191, 221 and 235 Essex Street and 35 Lafayette Square (the portions within the Little River channel) lie within the disposal site boundary. The adjacent areas are comprised of a steep, heavily vegetated slope adjacent to the Little River, leading up to paved and unpaved lots used for commercial purposes. The property at 191 Essex Street is owned by the Alosky Realty Trust and identified as tax lot 296-18 on City of Haverhill Assessors Map 515; it consists of 0.92 acres of land with an 18,000 square foot (sf) building zoned for industrial uses and occupied by Merrimac Spool and Reel. The property at 221 Essex Street is owned by Mr. Stephen Leblanc and identified as tax lot 296-3 on Assessors Map 515; it comprises 0.64 acres of land with a 2,400 sf building occupied by Bradford Towing and Auto Repair. The lot at 235 Essex Street is comprised of several separate parcels totaling approximately 1.2 acres in size. The southern portion of the lot is occupied by an auto parts store; the rest of the property is vacant. The 35 Lafayette Square property is used for commercial purposes (including a restaurant and several retail shops) and comprises approximately 0.6 acres of land.

The primary Site occupants include the 3-5 employees who work at the gas station kiosk and car wash facility at 284 Winter Street. In addition, potential receptors in the western portion of the Site, which is separated from the Property by the river, include employees and customers of the commercial and industrial facilities on Essex Street. Based on GZA's observations, the portions of the Essex Street properties that lie within the Disposal Site are not accessed regularly by the property occupants. Land uses in the vicinity of the Site are a mix of commercial, light industrial, and residential uses; as documented in previous reports, the residential population located within a ½-mile radius of the Site is estimated to be between 500 and 1,000 people. No institutions (as defined by the MCP) or recreational areas were identified within 500 feet of the Disposal Site.

The Little River, which abuts to the Site to the south and west, is the only natural resource area present within 500 feet of the property. The River originates in New Hampshire to the north and flows south through Haverhill, discharging to the Merrimack River approximately one-half mile south of the Site. A stone masonry dam is located just upstream of Winter Street and the Site; the River enters a flood conduit that runs beneath downtown Haverhill (known as the Little River Conduit) just south of the Site. A more detailed description of the River and discussion of the resource area is provided with Anchor's report in Appendix C.

No wetlands, vernal pools, or other surface water bodies are present in the Site vicinity. Further, no Areas of Critical Environmental Concern (ACECs), including sole source aquifers, protected open space, fish habitat, threatened or endangered species habitat, or habitat of species of special concern, have been identified in the vicinity of the Site.

The Property is connected to the municipal water and sewer system. There are no known drinking water sources within 500 feet, including both public water supplies and private wells; however, there is one inactive and one active water well on the Property, installed to supply the car wash operations and which are not used for drinking water. Information provided in previous reports for the Property indicated that the wells were approximately 400 feet deep and finished in bedrock. There is a restroom within the car wash building for employee use which is serviced by municipal water and sewer, according to those previous reports.

2.2 SITE HISTORY

An extensive Site history was presented in Ramboll's 2016 Phase I ISI Report; the information from that report is briefly summarized below.

Between 1853 and 1970, the Site was occupied by an MGP facility operated by the Haverhill Gas Works, which originally manufactured coal gas. On-site infrastructure associated with the coal gas manufacturing process included two holders, retorts, condensers, and purifiers, as well as auxiliary sheds and other support structures. The manufactured gas was stored in holders on the Site until 1893, when storage was moved to holders located on Hilldale Avenue.

Sometime between 1910 and 1912, the MGP facility was converted to a carbureted gas manufacturing facility that used gas oil to manufacture gas. The process generated light oil and tar, and the facility distilled the tar to produce and sell light oils. By the 1950s, the facility was generating more than 600,000 gallons of tar per year. Subsequently, in 1951, the MGP began producing oil gas until production ended in 1960.

An undated historical Site plan included in Appendix E shows the various MGP structures present on the Site in the mid-20th century. Most of the aboveground MGP infrastructure was demolished in the 1970s, but remnants of brick walls associated with the facility are still present along the northwest boundary of the property along the Little River.

In November 1976, the Property was sold by the Haverhill Gas Company to Haffner, which began operating a gasoline service station and car wash on the premises following tank installation in 1977. Home delivery fuel oil trucks were also refilled at the Site from 1977 until 2015 via a loading rack located east of the car wash building. The two fuel oil USTs formerly associated with the loading rack were listed as "In Use" on the MassDEP UST Facility database with a third-party inspection date of February 15, 2021. However, dispensing operations for those USTs were not identified during GZA's Site visits. In spring 2015, HEG Inc. (HEG) assumed responsibility for the retail operations at the Property; however, Haffner retained ownership of the Property and USTs. MassDEP's UST facility database lists HEG, Inc. as the facility owner and Energy North, Inc. as the operator.

2.3 REGULATORY HISTORY

According to a February 1, 2017 internal memorandum prepared by MassDEP personnel ("Memo to The Files"), MassDEP was first notified of a release to the environment on April 19, 1988, when case number N88-552 was assigned to a release of tar material seeping into the Little River at 284 Winter Street. The memorandum indicates that no further information is available in MassDEP files regarding this notification. The incident was not identified as a Disposal Site or Location to Be Investigated on lists published by MassDEP prior to the promulgation of the 1993 MCP.

2.3.1 RTN 3-32792

In November 2014, Lessard Environmental, Inc. (Lessard) conducted an Environmental Site Assessment and Limited Site Investigation at the Property, during which they drilled and installed three groundwater monitoring wells to depths

between 15 and 22 feet below ground surface (bgs). According to Lessard, B-1/MW-1 was installed between two former gas holders, but this exploration was actually located within a relief holder according to historical plans (Figure 2). Lessard further indicated that B-2/MW-2 was installed within the footprint of the "water gas plant" and B-3/MW-3 was installed east of the former coal shed; these former features are shown on the plan in Appendix E. Two soil samples and three ground water samples were submitted for laboratory analysis; the results indicated that soil samples submitted from boring B-1 and ground water samples collected from MW-1 and MW-2 had volatile petroleum hydrocarbons (VPH) and polycyclic aromatic hydrocarbons (PAHs) at concentrations above RC-S1 and RC-GW2 reporting criteria. Based on these findings, Haffner submitted a Release Notification Form (RNF) to MassDEP on March 30, 2015, and RTN 3-32792 was assigned to the release.

In April 2015, Ramboll on behalf of Haffner contracted ground penetrating radar (GPR) and electromagnetic (EM) geophysical surveys to search for evidence/relics of former MGP structures at the Property. The surveys found small scale point and linear anomalies that were interpreted to represent remnants of former subsurface structures, foundations, debris, piping, etc., remaining after the demolition of the former MGP facility. In particular, a large ferrous metal anomaly was located in the approximate location of a former "8,500-gallon tar cooker" (along the western perimeter of the Site in the vicinity of ENV-3MW).

Following the survey, Ramboll supervised the drilling of 13 soil borings across the Site at the locations designated as ENV-1B through ENV-13B (Figure 2[2]). Soil samples were collected continuously from the ground surface to the bottom of each boring for field screening and logging. One soil sample from each boring was submitted for laboratory analysis of extractable petroleum hydrocarbons (EPH) and VPH by the MassDEP methods, and seven additional soil samples from the test borings were submitted for forensic analysis. Five of the 13 borings were completed as 1.5-inch-diameter PVC groundwater monitoring wells (ENV-1MW, ENV-3MW, ENV-5MW, ENV-8MW, and ENV-9MW) with a 10-foot-long screened interval at each location. Following development, the wells were gauged for NAPL, and groundwater samples from wells without NAPL were submitted for analysis of EPH and VPH by MassDEP Methods. The findings were presented to MassDEP in an April 2016 Phase I ISI and Tier Classification Report, based on which the Site was classified as Tier I. The soil and groundwater data collected by Ramboll are included in Tables 1 and 2, respectively, and have been incorporated into the data evaluation and risk characterization sections of this Phase II report.

2.3.2 RTN 3-32875

On May 12, 2015, while conducting response actions under RTN 3-32792, Ramboll observed a sheen in the Little River emanating from the base of the retaining wall along the western edge of the Property. Upon oral notification of this 2-hour reporting condition, MassDEP assigned RTN 3-32875 to the release[3] and approved an Immediate Response Action (IRA) that included sheen containment via sorbent booms; assessment of the USTs at the Site; assessment of subsurface contamination that could be contributing to the sheen; and assessment of Site conditions that could represent an Imminent Hazard (IH) or Substantial Release Migration (SRM) condition. The following sections describe the activities conducted under the IRA to address each of these criteria.

2.3.2.1 *Sheen Containment*

Under the IRA, Clean Harbors Environmental Services (CHES) installed and maintained temporary absorbent booms within the Little River until November 2016, when they were replaced by a semi-permanent containment boom system. The

[2] In cases where a monitoring well was installed in the boring, the location is designated as ENV-#MW on Figure 2. However, the soil data table (Table 1) and discussion in Section 6.2 retain the ENV-#B designation originally assigned to the location.
[3] In their April 2016 Phase I ISI and Tier Classification submittal, Ramboll linked RTN 3-32875 to the primary Site RTN 3-32792.

system consists of a curtain/flotation boom and sorbent "sausage" booms attached to support structures, which were described by Ramboll in their IRA status reports as follows:

> *The boom support structures consist of 14 horizontal aluminum supports installed at approximate 20-foot intervals along the retaining wall. The boom supports are constructed of square aluminum tubing attached to the concrete wall with stainless steel base plates and wedge anchors. The supports extend from approximately 8 to 19 feet from the retaining wall. Schedule 80 aluminum boom-support pipes extend vertically downward from the horizontal tubing and rest on square aluminum base plates resting on the riverbed. The boom supports are reinforced with gusset plates, additional aluminum piping, and stainless steel cables (2 per support) anchoring the vertical pipes to the retaining wall for additional stability.*
>
> *The curtain/flotation boom is attached to the boom support structures using metal rings, which allow for the boom to rise and fall on the supports with changing river levels, allowing the containment boom to remain on the water surface where it contains sheens emanating from the retaining wall. There are also ropes affixed to the curtain/flotation boom and boom supports that allow for the manual adjustment of the containment boom, if necessary. Finally, replaceable sorbent "sausage" booms are attached to the inside of the curtain/flotation boom which are replaced as necessary (as they become saturated with NAPL).*

Between May 2015 and October 2019, Ramboll and CHES monitored and maintained the booms at the Site and documented their findings in IRA status reports. In November 2019, IRA performance was transitioned to GZA on behalf of National Grid, whose activities are documented in Section 3.3.

2.3.2.2 *UST Assessment*

According to the 2017 MassDEP memo described above, UST systems at the Site passed tightness testing in January 2015 and May 2015, and a reconciliation of three months of tank monitoring records did not reveal discrepancies in quantities delivered and dispensed.

2.3.2.3 *Assessment of Subsurface Contamination Contributing to the Sheen*

As described earlier, Ramboll installed and sampled a number of soil borings and monitoring wells across the Site to assess subsurface conditions. The September 2015 IRA status report indicated that a sheen and/or measurable light non-aqueous phase liquid (LNAPL) was detected in wells ENV-3MW, ENV-5MW, ENV-8MW and ENV-9MW at thicknesses of up to 0.22 feet. Oil sorbent socks were installed in these wells and were monitored and replaced as necessary. In June 2016, the IRA Plan was modified to allow for LNAPL recovery using a peristaltic pump, and the use of sorbent socks was discontinued.

Following the installation of additional wells by GZA as discussed in Section 3.1.4, approximately 4 feet of LNAPL was measured in well NFSB-02(MW). When present, NAPL was recovered from this well, as well as ENV-3MW and ENV-9MW, using a peristaltic pump. Ramboll's NAPL recovery efforts under the IRA resulted in the removal of approximately 29 gallons of NAPL from the Site through September 2019, of which approximately 27 gallons were recovered from NFSB-02(MW). Subsequent IRA monitoring and NAPL recovery efforts by GZA are discussed in Section 3.3.2.

In addition to the subsurface assessment efforts described in Section 2.2, Ramboll also submitted samples of the following materials for forensic analysis in May 2018: (i) a tar-like substance emanating from an old discharge pipe exiting the retaining wall along riverbank; (ii) a tar fragment from 10 – 12.5 feet bgs at soil boring ENV-9B; and (iii) a sample of LNAPL

observed to be emanating from a space between several stones at the base of the retaining wall. Based on the laboratory reports, Ramboll concluded that historical MGP operations at the Property likely contributed to the release at the Site.

2.3.2.4 *IH/SRM Evaluation*

Based on an inspection of Site conditions, Ramboll concluded that no IH or SRM was identified associated with the existing subsurface stormwater conveyances (catch basins and piping) at the Site. However, it was determined that a condition of SRM did exist based on the observed tar-like substances apparently discharging to the Little River via a pipe protruding from the wall. Therefore, hydraulic cement was used to seal this pipe and terminate this migration pathway.

2.3.3 RTN 3-34906

In May 2018, the 6,000-gallon single-walled diesel UST was removed from the Property in the presence of representatives from Ramboll and GZA. It was noted that the spill bucket for the fill port on the eastern end of the UST was severely corroded, and localized NAPL was observed in the pea gravel below the bucket. Headspace readings of samples from this area exceeded the MassDEP 72-hour reporting threshold of 100 parts per million by volume (ppmV), resulting in a notification to MassDEP and the assignment of RTN 3-34906 to the release. The UST was removed, and the impacted pea gravel and sand fill material in the vicinity of the fill port (<3 cubic yards) were excavated and transported off-Site for disposal. Ramboll indicated that no staining, odors, or elevated headspace readings were observed in the fill material in direct contact with the UST in other areas, and a confirmatory soil sample from beneath the UST was found to have no VPH or EPH above laboratory reporting limits. Based on these findings, Ramboll submitted a Permanent Solution Statement (PSS) for RTN 3-34906 to MassDEP on July 2, 2018 on behalf of Haffner.

A brick foundation was observed along the southern sidewall of the UST excavation near the fill port which was attributed to a former MGP holder or ancillary structure. In addition, pieces of concrete debris also attributed to the former MGP infrastructure were encountered along the northern sidewall of the UST excavation near the fill port.

2.4 MASSDEP NOTICES AND FILING DEADLINES

MassDEP issued an NOR to Haffner under RTN 3-32792 on April 10, 2015, and subsequently issued an NOR to National Grid under RTN 3-32875 on November 29, 2016; the latter noted that a similar notice had been sent to Haffner, and that the liability was joint and several. On October 11, 2019, MassDEP issued a Notice of Noncompliance (NON) to Haffner for failure to submit a Phase II CSA within three years of the original RNF. The NON established a deadline of April 6, 2020 for submittal of a Phase II report and, if applicable a Phase III Remedial Action (RAP) and Phase IV Remedy Implementation Plan (RIP). The following month, on November 7, 2019, Haffner's LSP of Record submitted a Notification of Delay (NOD) accompanied by a letter of resignation in anticipation of the transfer of responsibility from Haffner to National Grid.

On November 26, 2019, GZA on behalf of National Grid submitted a Tier Classification transfer that took effect on December 26, 2019. In response, MassDEP issued an NOR to National Grid under RTN 3-32792, which was followed on March 13, 2020 by a notice re-establishing Response Action Deadlines for the Site. The re-established deadlines required submittal of a Phase II CSA, and if necessary, a Phase III RAP and a Phase IV RIP, by August 4, 2020, and a PSS by April 6, 2021. Based on initial data from this Phase II study, National Grid contacted MassDEP in June 2020 to discuss an additional extension to the response action deadlines for the Site. MassDEP and National Grid subsequently negotiated an Administrative Consent Order (ACO, Enforcement Document 00009941NT issued by MassDEP on October 2, 2020) extending the Phase II CSA deadline until April 6, 2022. In compliance with the terms of the ACO, National Grid filed a Tier Classification Extension on February 19, 2021 to allow the continuation of assessment and remedial response actions at the Site.

Following Ramboll's Phase I ISI, GZA on behalf of National Grid conducted supplemental site investigations in 2016 and 2020-2021 as described in the following sections.

3.0 GZA FIELD INVESTIGATION - 2016

In 2016, GZA conducted a field investigation at the Property in collaboration with NewFields Environmental Forensics Practice, LLC (NewFields) of Rockland, Massachusetts. The goal was to collect additional data from across the Property and the river to better understand potential sources for the LNAPL and tar detected by Ramboll during its Phase I ISI and IRA activities. The data obtained from the survey and sampling activities are described below and were used to develop the Conceptual Site Model (CSM) for this Site.

3.1 GEOPHYSICAL SURVEY

GZA subcontracted with Hager-Richter Geoscience Inc. (HRGS) of Salem, New Hampshire, to perform a geophysical survey of the Property prior to initiating subsurface explorations. The purpose of the survey was to identify subsurface obstructions such as buried piping, utilities, and/or concrete or metal infrastructure that could interfere with subsurface explorations. On September 15, 2016, GZA personnel observed HRGS conduct GPR, time domain electromagnetic induction metal detection (EM-61), and Precision Utility Locating (PUL) surveys. The survey excluded the car wash building and the southeastern wooded/brush area, where no subsurface investigations were proposed. The geophysical survey report identified subsurface utilities, two large, buried objects near the northwest corner of the car wash, a buried reinforced concrete structure along the western edge of the Property, and areas of buried metal, particularly in the northwest portion of the Property (Appendix F). The buried objects near the car wash were described as being approximately 3 feet by 10 feet, located approximately 2.5 to 3 feet bgs, of a size and shape somewhat consistent with small USTs. The objects could not be conclusively identified; HRGS speculated that they could be related to piping associated with a former water well located less than 10 feet away. It is also possible that these objects were recirculation tanks associated with car wash operations; Lessard had indicated that such tanks were present beneath the building footprint, but did not identify their exact location. The buried concrete structure along the western property edge was reported by HRGS to be approximately 10 feet by 35 feet in size, and located less than 1 foot bgs; it was attributed to unspecified infrastructure associated with former MGP operations at the Property.

Based on the HRGS findings, and with input from Ramboll on behalf of Haffner, the locations of several of the proposed subsurface explorations were adjusted.

3.2 SOIL GAS SAMPLING

On October 18, 2016, GZA personnel installed eight stainless steel soil gas probes (NFSV-01 through NFSV-08) within and/or proximate to the UST concrete pad and the gasoline dispensing island apron. The locations of the soil gas probes are shown on Figure 2. Soil screening with a photo-ionization detector (PID) for the presence of volatile organic compounds (VOCs) was conducted during probe installation and samples were collected in accordance with the procedures outlined in Appendix G. Additionally, an ambient air sample (NFAA-01) was collected upwind of the gasoline dispensing islands during the helium leak testing and collection of the soil gas samples (see Figure 2). The soil gas and ambient air samples were submitted under chain-of-custody by GZA/NewFields to Alpha Laboratories of Westborough, Massachusetts (Alpha) for PIANO (Paraffins, Isoparaffins, Aromatics, Naphthalenes, Olefins) analysis via United States Environmental Protection Agency (USEPA) Method TO-15. The laboratory analytical report is included in Appendix H and the results are summarized in Tables 3A and 3B.

3.3 CATCH BASIN SEDIMENT SAMPLING

On October 18 and 19, 2016 GZA personnel collected sediment samples (NFCB-01 and 02) from two storm water catch basins located on the Property and one sample (NFCB-03) from a catch basin located in the northwest corner of the gas station on City of Haverhill property; sample locations are shown on Figure 2. The sediment samples were collected using a stainless-steel hand auger, and were submitted by GZA/NewFields to Alpha for forensic analysis. The laboratory analytical report is included in Appendix I.

3.4 2016 SOIL BORING/MONITORING WELL INSTALLATION

Between October 20 and October 25, 2016, Technical Drilling Services Inc., (TDS), of Sterling, Massachusetts, under subcontract to GZA, advanced soil borings at nine locations (NFSB-01 through NFSB-09) on the Property via vacuum excavation and GeoProbe® techniques. Initially, each location was pre-cleared using vacuum excavation techniques to a depth of 5 to 8 feet bgs. Soil samples were collected at approximately 1-foot intervals via hand auger in advance of the vacuum excavator. Shallow refusals (<5 feet bgs) were encountered at locations NFSB-01A, NFSB-02A, NFSB-02B, NFSB-03A, NFSB-03B, NFSB-05A, NFSB-09A, NFSB-09B, and 09C on obstructions (e.g., foundations), debris (e.g., bricks), and/or large cobbles or boulders. Following pre-clearing, each boring location was backfilled with soil cuttings and temporarily patched with asphalt.

On October 24 and 25, 2016, GZA observed the advancement of eight soil borings (NFSB-01 through NFSB-08) by TDS within the previously vacuum excavated boreholes via GeoProbe® direct push drilling techniques. A GeoProbe® Dual Tube Sampler (model DT-22) was used to collect soil samples from the borings beyond the limits of the vacuum excavation depth, extending to depths ranging from 14.75 feet[4] to 25 feet bgs. Collection of deeper soil samples via GeoProbe® was not attempted at location NFSB-09, where shallow refusals were encountered on four attempts during vacuum excavation pre-clearing, due to the potential for encountering subsurface utility lines. Soil samples were obtained in 5-foot-long acetate sleeves from the GeoProbe® DT22 sampler. GZA personnel logged soil descriptions from each sample sleeve, collected samples for PID screening, and collected soil samples for laboratory analyses. Descriptions of the soil samples and field screening data are provided in the soil boring/well completion logs in Appendix J.

Three of the soil borings were completed as groundwater monitoring wells (NFSB-01(MW), 02(MW), and 08(MW)). The wells were constructed as 1.5-inch-diameter PVC wells with 10-foot-long sections of pre-packed screens; additional well construction details are shown on the logs (Appendix J). Following installation, the wells were developed and approximately three to five well volumes were purged from each location.

Select soil samples from the 2016 borings were submitted by GZA/NewFields to Alpha under chain-of-custody for analysis of High-Resolution Hydrocarbon Fingerprint (HRHF) by gas chromatograph-flame ionization detector (GC-FID). Certain soil samples were also analyzed for alkylated PAHs and geochemical biomarkers (BIO). Two field duplicate samples were collected for Quality Assurance/Quality Control (QA/QC) purposes from soil borings NFSB-02 (DUP-1-15-20') and NFSB-03 (DUP-2-15-17'). The laboratory analytical report is included in Appendix I and was used to support NewFields' conclusions as presented in Section 3.7.

3.5 GROUNDWATER SAMPLING

On November 1, 2016, GZA personnel gauged eleven wells - the three newly installed wells (NFSB-01(MW), NFSB-02(MW), and NFSB-08(MW)) and the eight wells previously installed by Lessard and Ramboll. An oil-water interface probe was used

[4] Soil boring NFSB-05 encountered refusal at 14.75 feet bgs on suspected cobbles or boulders.

to measure the depth to water and depth to NAPL, if present, in each well. The monitoring well gauging data are summarized in Table 4, which also includes results from IRA activities at the Site. As shown in Table 4, approximately 0.27 feet of LNAPL was measured in newly installed well NFSB-02, which was located immediately south of the known fuel dispenser area. This well was installed within the area of a former "Concrete Hot Water Well" associated with the former MGP, according to the undated historical plan in Appendix E. Consistent with Ramboll's findings, LNAPL was also detected in previously installed wells ENV-03MW (0.02 feet) and ENV-09MW (0.17 feet) during the November 1, 2016 gauging event; monitoring well ENV-05MW was noted to have a petroleum sheen.

Following gauging, GZA purged and collected groundwater samples from wells NFSB-01(MW) and NFSB-08(MW). A field duplicate (DUP-1) was collected from well NFSB-01(MW) for QA/QC purposes. The wells were purged using USEPA low-flow techniques using a peristaltic pump, dedicated tubing, and a flow through cell equipped with a multi-meter for monitoring groundwater parameters (temperature, pH, dissolved oxygen (DO), oxidation reduction potential (ORP) and specific conductance). Once the readings had stabilized, GZA collected groundwater samples from these two well locations. The groundwater samples were submitted by GZA/NewFields under chain-of-custody to Alpha for forensic analyses. The laboratory analytical report is included in Appendix K and was used to support Newfields' conclusions regarding the source of hydrocarbons at the Site as discussed in Section 3.7.

3.6 NAPL AND SHEEN SAMPLING

During the November 1, 2016 field event, GZA personnel also collected samples of LNAPL from wells NFSB-02(MW), ENV-03MW, and ENV-09MW using a peristaltic pump and dedicated tubing. Additionally, GZA collected a NAPL sample from a pipe located in the retaining wall that serves as the eastern bank of the Little River, which is located west of the Property. This pipe had been sealed by Ramboll under the IRA as described in Section 2.3.2.4; therefore, GZA personnel used a hammer drill and bit to drill three 3/8-inch-diameter holes in the concrete plug of the pipe. Several attempts were made to obtain samples of the NAPL inside the pipe with a 1/8-inch-diameter stainless steel rod, but the tar-like material appeared to have solidified and did not coat the rod as intended. The drill bit was used to penetrate the hardened tar, and NAPL was collected by wiping the bit with a sheet of polytetrafluoroethylene (PTFE) sampling fabric. Once the PTFE sampling fabric was sufficiently coated with tar-like material, it was placed in an 8-oz amber jar along with some oily water exhibiting a sheen that flowed out of the initial pilot hole. GZA plugged the three holes with hydraulic cement following sample collection. The approximate location of this sample (NFNP-01) is shown on Figure 2.

GZA also collected two sheen samples: one from groundwater with sheen that was seeping from the stones in the base of the retaining wall (NFNP-02) and one from the surface water sheens and sheen ebullitions within the Little River (NFNP-03). The sheen samples were collected on PTFE fabric and placed in separate 8-oz amber jars. The seeping groundwater with sheen was allowed to flow onto the PTFE fabric until petroleum staining was noted. The surface water sheen and sheen ebullitions were collected using a PTFE fabric net. GZA moved the PTFE sampling net through the sheens and ebullitions until a petroleum stain on the fabric was observed. These sample locations (NFNP-02 and 03) are shown on Figure 2.

The NAPL and sheen samples were submitted by GZA/NewFields to Alpha for forensic analyses. The laboratory analytical report is included in Appendix K.

3.7 NEWFIELDS FINDINGS

Based on the analytical data from various media sampled in 2016, NewFields concluded that conditions at the Site could not be attributed to a single source; rather, historical releases had resulted in the presence of both petroleum-related and MGP-related hydrocarbons at the Property, with impacts to portions of the Little River. These conclusions were used to

develop a preliminary CSM that was further informed via subsequent Phase II investigations, which are described in the following sections of this report.

4.0 2020-2021 FIELD INVESTIGATION - UPLAND AREAS

In 2020, GZA on behalf of National Grid initiated a subsurface sampling program at the Property in general accordance with Ramboll's 2016 Phase II Scope of Work to meet the objectives of a Phase II CSA. Subsequently, the upland work scope was expanded to investigate potential impacts from the former MGP on properties located across the Little River to the west. Concurrently, GZA also conducted LNAPL gauging and recovery activities in accordance with the IRA Plan for the Site. The field activities and their findings as they pertain to the nature and extent of contamination in the upland areas of the Site are discussed below.

A preliminary investigation into conditions in the Little River was conducted in June 2020 as summarized in Section 5.1; the nature and extent of contamination in the river was evaluated in more detail by Anchor as documented in Appendix C.

4.1 CONSERVATION COMMISSION PERMITTING

In April 2016, Ramboll submitted a Notice of Intent (NOI) under the Massachusetts Wetlands Protection Act (WPA) to the Haverhill Conservation Commission (HCC) to address the installation of the semi-permanent boom within the Little River. On June 15, 2016, the HCC issued an Order of Conditions (OOC) that included a number of conditions, including items related to the operation and maintenance of facilities at the property. Prior to initiating field activities, GZA submitted a courtesy notification to the HCC via email on December 6, 2019 regarding the planned sampling within and adjacent to the Little River. A supplemental notification was provided to HCC in September 2021 prior to the start of Anchor's field investigation of the river. No additional permitting obligations were imposed by the HCC for the Phase II fieldwork.

4.2 2020 SOIL GAS SAMPLING

On February 12, 2020, GZA personnel collected soil gas samples at locations SG-1 and SG-2 in the car wash building, and SG-3 beneath the canopy next to the gas station sales kiosk. The sample locations are shown on Figure 2. The soil gas probe installation and sample collection methods were similar to those implemented in 2016 and described in detail in Appendix G, except that helium leak testing was not employed. The samples were submitted to Alpha's Mansfield laboratory under chain-of-custody for analysis of air-phase petroleum hydrocarbons (APH) via the MassDEP method. The laboratory analytical report is included in Appendix H and the results are summarized in Table 3 and discussed in Section 7.4.

4.3 SOIL BORING/MONITORING WELL INSTALLATION

4.3.1 On-Property Wells

Between January 16 and 20, 2020, Geosearch, Inc. of Fitchburg, Massachusetts (Geosearch) used a vacuum excavator at proposed locations B101 through B110 (Figure 2) to clear utilities prior to drilling. Soil samples were collected using a hand auger in advance of vacuum excavation at each location. Proposed location B105 was not completed due to proximity to a utility line, and shallow refusal on a concrete slab was encountered at approximately 3 feet bgs at location B108. The remaining locations were cleared to depths of 5 to 8.5 feet bgs.

Subsequently, between January 21 and 23, 2020, Geosearch drilled borings B101 through B104, B106, B107, B109, and B110 using hollow-stem auger techniques. A GZA representative classified the soil samples collected at each location,

which were photo-documented, evaluated for evidence of potential MGP impacts, and field screened for VOCs using a PID following the MassDEP jar headspace analysis procedure. The PID screening data and soil classifications are presented on the soil boring/monitoring well logs included in Appendix J and were used to develop the cross-sections presented on Figures 3A and 3B. As shown in the boring logs, significant field evidence of impact (strong odors, coal tar saturated soil) was observed at boring B107, which was drilled within the former relief holder, from depths of approximately 5 to 15.5 feet bgs. Refusal, interpreted to be the bottom of the holder, was encountered at 15.5 feet bgs; therefore, the boring was terminated at this depth.

Soil samples were collected from select borings for submittal under chain-of-custody to ESS Laboratory (ESS) in Cranston, Rhode Island for analysis of VPH, EPH, and physiologically available cyanide (PAC) by MassDEP methodologies and arsenic, chromium, and lead by EPA Method 6010C. The primary objective of the laboratory analyses was to collect data to evaluate facility and utility worker exposures; a secondary objective was to assess soil samples that showed significant field evidence of impact for exceedances of the Upper Concentration Limits (UCLs) established by the MCP. The laboratory analytical reports are included in Appendix I and the data are summarized in Table 1 and discussed in Section 7.1

As shown on the boring logs, 2-inch-diameter groundwater monitoring wells were installed at boring locations B102, B106 and B107. The wells were constructed of PVC screen attached to solid PVC riser with appropriate sand filter packs and annular seals, and were completed with flush-mounted road boxes set in concrete pad. Monitoring wells B102 and B106 were screened from approximately 10 to 20 feet bgs; monitoring well B107, within the former holder, was screened from approximately 3 to 15.5 feet bgs. The remaining borings were completed by backfilling with a mixture of the drilling spoils and bentonite chips.

The newly installed monitoring wells B102, B106, and B107 were developed on February 5, 2020 by purging five to ten volumes of standing water from each location. Both previously installed and newly-installed wells were gauged on that date, and the data are summarized in Table 4. The depth to water during this gauging event ranged from 11.86 to 15 feet bgs in wells across the property, with the exception of wells MW-1 (3.18 feet bgs) and B107 (2.63 feet bgs). As shown on Figure 2, these wells are located within the former relief holder at the property, and the water level at these locations represents a perched water layer in the holder. Approximately 3.5 feet of dense non-aqueous phase liquid (DNAPL) was measured in well B107 during the February 2020 development event.

4.3.2 Off-Property Wells

Between August 31 and September 2, 2020, Geosearch drilled four borings (GZA-1, GZA-1A, GZA-2, and GZA-2A) and installed three monitoring wells on two properties on the west side of the Little River (191 and 221 Essex Street). The locations of these explorations are shown on Figure 2. The work was conducted under access agreements between National Grid and the property owners, and was directed at further delineating the western boundary of MGP impacts associated with the 284 Winter Street property and the adjacent portion of the Little River. Vacuum excavation and hollow stem auger techniques were used to advance the borings, with soil sampling protocols similar to those used during the January 2020 on-property drilling event described above.

Field screening data and soil classifications for the off-property borings are presented on the soil boring/monitoring well logs included in Appendix J. One soil sample collected from boring GZA-1 on the 191 Essex Street property was submitted to Alpha for Petroleum Hydrocarbon Identification in an attempt to characterize the source of elevated PID readings observed at a depth of approximately 15 feet bgs. The laboratory analytical report is included in Appendix I, and the data are summarized in Table 1. Alpha reported a Total Petroleum Hydrocarbon (TPH) concentration of 411 milligrams per kilogram (mg/kg – equivalent to parts per million or ppm), which is below the most stringent Reportable Concentration

(RC) for this constituent under the MCP. The laboratory report indicated that the sample contained material eluting in the low weight range of the chromatogram (C_8-C_{14}), and described the product as "similar to an Aviation Fuel" as opposed to an MGP-related release. GZA notes that aviation fuels are similar to kerosene, a more commonly used petroleum product.

Geosearch installed 2-inch diameter monitoring wells at locations GZA-1, GZA-1A, and GZA-2 in accordance with the protocols outlined above. Boring GZA-2A was not completed as a monitoring well based on the field observations from this exploration and nearby well GZ-2 which had not indicated obvious MGP or petroleum impacts. Wells GZA-1 and GZA-2 were screened from 15-25 feet bgs; GZA-1A was screened from 14-24 feet bgs. Additional well construction details are presented on the logs in Appendix J. Following installation, the wells were developed by pumping and surging and approximately three to five well volumes were purged from each location.

4.4 WELL GAUGING AND SAMPLING (PHASE II WORKSCOPE)

On February 12, 2020, GZA personnel gauged the newly installed groundwater monitoring wells for the presence of LNAPL concurrent with one of the IRA gauging rounds. Groundwater samples were then collected from new wells B102 and B106 and from existing wells MW-2, MW-3, ENV-1MW, and ENV-5MW using low-flow sampling procedures similar to those described for the 2016 sampling event. A second round of gauging and sampling was conducted on May 7, 2020, with samples collected from wells MW-2, ENV-3MW, ENV-5MW, NFSB-01(MW), NFSB-08(MW), B102 and B106. Groundwater samples were not collected from new well B107 due to the presence of DNAPL. The May 2020 data was used to develop an initial groundwater contour plan (Figure 4A). A supplemental sampling round which included wells ENV-1MW, ENV-3MW, ENV-5MW, ENV-8MW and B102 was completed on August 11, 2021. Groundwater analyses focused on the primary constituents of concern (COCs) for the Site that were identified during previous studies – EPH and VPH. The August 2021 sampling round also included analyses of selected other constituents that are typically associated with MGP sites (PAC and styrene).

Following the installation of the new wells on the 191 and 221 Essex Street properties, GZA conducted a Site-wide gauging event and collected groundwater samples from the new wells on September 15, 2020; an additional sample was collected from well MW-1 on the 284 Winter Street property during this event. The September 2020 gauging results are summarized in Table 4, and the data were used to prepare the contour map presented as Figure 4B. Subsequently, on December 2, 2020, GZA collected a second round of groundwater samples from the new wells at 191 and 221 Essex Street properties to evaluate potential trends in dissolved concentrations.

The groundwater samples collected during each sampling event were placed on ice and submitted under chain-of-custody to Alpha for analysis of EPH and VPH. The laboratory analytical reports are included in Appendix K; the results are summarized in Table 2 and are discussed in Section 7.2

4.5 WELL GAUGING AND NAPL RECOVERY (IRA WORKSCOPE)

Under the IRA, the wells at the Site were gauged on a monthly basis for the presence of NAPL, which was manually recovered when detected. This monthly gauging/NAPL recovery schedule was maintained through August 2020, at which time it was noted that five years of monitoring had indicated that significant thicknesses of NAPL are limited to a few monitoring locations at the site, with most wells consistently exhibiting non-detectable levels. Therefore, the September 2020 IRA Status Report indicated that subsequent IRA monitoring would focus on wells that had indicated significant

amounts of NAPL, namely NFSB-02, ENV-3MW, ENV-9MW[5] and B107, and that monthly monitoring of the other wells at the Site would be suspended. Monthly monitoring of well ENV-3MW was terminated in February 2022 after a year of non-detectable readings. Measurable thicknesses of LNAPL have been reported only at well NFSB-02(MW) during the time that GZA has conducted the monitoring (December 2019 to the present). The product thickness in this well ranged from 0.8 to 2.9 feet, and approximately 9 gallons of LNAPL were manually recovered from the well in this 30-month period. Plots of LNAPL thickness and recovery over time at NFSB-02(MW) are included in Appendix L. As these graphs indicate, the LNAPL thickness appears to be stable over time and product recovery rates are generally stable or declining.

During the IRA Site visits, GZA also confirmed the presence of DNAPL in well B107, located within the former relief holder at the Site. The DNAPL in this well is extremely viscous and initial attempts to penetrate it with the interface probe were generally unsuccessful. On October 21, 2020, GZA evacuated the DNAPL from well B107 using a bailer and absorbent pads, confirming the well bottom depth (15.2 feet from ground surface or 14.72 feet from the top of the well casing) and recovering approximately 0.5 gallons of product. DNAPL thickness measurements on the other dates in Table 4 are based on the measured depth to the top of the DNAPL and this bottom depth.

Additional information about the feasibility of NAPL recovery at the Site is presented in a subsequent section of this report.

4.6 NAPL RECOVERABILITY TESTING

GZA has completed an evaluation of the feasibility of continuing NAPL recovery at the Site in accordance with MassDEP guidance ("Light Nonaqueous Phase Liquids (LNAPL) and the MCP: Guidance for Site Assessment and Closure, Policy #WSC16-450" – NAPL Guidance). This evaluation included assessment of NAPL thicknesses and recovery rates over time, measurement of key NAPL properties and NAPL transmissivity (T_n) testing. An LNAPL bail down test was completed at well NFSB-02 in March 2020 in general accordance with ASTM International (ASTM) E2856-13: Standard Guide for Estimation of LNAPL Transmissivity. Analysis of the data was completed using the American Petroleum Institute's (API's) LNAPL transmissivity worksheet and is discussed in a subsequent report section. As part of this evaluation, GZA also collected NAPL samples from monitoring wells NFSB-02 and B-107 and submitted them to ESS for density and viscosity analyses. (ESS subcontracted this work to a specialty laboratory – Triton Analytics Corp of Houston Texas.) Results of the analyses are included in Appendix K and summarized below.

Well ID	Viscosity at 70°F (centipoise)	Density at 70°F (g/cm^3)
• NFSB-02	• 5.20	• 0.9141
• B107	• 4829.70	• 1.1525

GZA's evaluation of NAPL recovery feasibility and mobility at the Site is summarized in Section 8.34.

4.7 HYDRAULIC CONDUCTIVITY TESTING

On August 11, 2020 and August 11, 2021, falling-head hydraulic conductivity (K) tests were conducted at four of the existing wells to estimate the hydraulic properties of the subsurface materials. For each test, the steady state (static) water level was measured. Water levels (heads) in the wells were recorded with an Solinst 101 P7 Water Level Meter to record frequent water level measurements over a linear time scale. During the first part (falling-head) test, the water

[5] Well ENV-9MW, which was last gauged on March 11, 2020, has not been found since then, despite efforts to locate the well with a metal detector. Prior to that date, no measurable NAPL thickness had been detected in the well since November 2018 (Table 4).

column was raised to the top of the PVC monitoring well casing by adding potable water to the casing. The water within the well was allowed to recover to its initial static water level.

The data collected from the falling head tests were used to calculate hydraulic conductivity values for the wells using equations developed by the U.S. Army Corps of Engineers and referenced in the Technical Manual TM 5-818-5/AFM 88-5, Dewatering and Groundwater Control, developed by joint Departments of the Army, the Air Force, and the Navy. The results of the falling-head tests are summarized in Table 5 and are discussed in Section 6.2.2.

4.8 VACUUM EXCAVATION PROBES

In August 2021, GZA engaged Geosearch to conduct a series of shallow vacuum excavation probes in the central portion of the Site with the objective of assessing the condition of the wall of the former relief holder (Figure 2). The vacuum excavator and an air lance were used to advance several probe holes within the landscaped island that overlies the southern portion of the former relief holder footprint. GZA personnel observed and logged the probe holes (Appendix J). The probes in the vicinity of the southwestern edge of the historical relief holder footprint encountered brick and concrete debris beginning at depths of 2-3 feet bgs which appeared to be the remnants of a partially demolished wall (i.e., the holder wall). The probes to the north and east of the apparent wall remnants encountered groundwater at a depth of less than 4 feet, while the probes to the south and west did not encounter groundwater to a depth of up to 5 feet bgs. These observations suggest that the former holder wall remains intact at depths below 3 feet bgs and the structure is retaining water that infiltrates within the holder footprint, creating the apparent water table mound noted at B107 and MW-1.

5.0 RIVER INVESTIGATION PROGRAM – 2020-2021

GZA completed a focused evaluation of the portion of the Site within and adjacent to the Little River in 2020 and early 2021 during the initial stages of the Phase II work. Anchor subsequently conducted a comprehensive evaluation of the Little River portion of the Site in September 2021, as documented in Appendix C.

5.1 INITIAL SEDIMENT SAMPLING

Between June 8 and June 10, 2020, GZA personnel conducted a sediment sampling program along an approximately 420-foot stretch of the portion of Little River adjacent to the Property. As shown on Figure 2, the stretch of river was divided into five transects, spaced at approximately 75- to 100-foot intervals along the river. Three surface sediment samples were collected from depths of 0 to 6 inches below the surface at each transect location (except at transect 4, due to access constraints on the western portion of the Little River) using a hand auger. In addition, one deeper sediment core was collected at each transect; these samples, which were collected using a hand auger advanced through a section of three-inch PVC pipe, were designated as Samples 1A 1-5.5', 2A 1-4', 3B 2-2.5', 4A 1-2.5', and 5A 2-3'.

GZA personnel photographed each sample, prepared field logs of the sediment stratigraphy, and conducted field screening with a PID for the presence of VOCs. Sample descriptions and PID readings are summarized on Table 6. The samples were shipped to Alpha under chain-of-custody for laboratory analysis of EPH, VPH, PAC, alkylated PAHs, total organic carbon (TOC), black carbon, and/or total solids. In addition, on June 11, 2020, GZA collected surface water samples at the upstream and downstream edges of the Property, and submitted them to Alpha for laboratory analysis of EPH (carbon ranges only), VPH (carbon ranges only), and PAC. The laboratory reports are included in Appendix M; the data are presented in Tables 7A and 7B, and were used by GZA as described below, and by Anchor in their evaluation of conditions in the Little River (Appendix C).

GZA's observations during the sampling program (Table 6) indicated the presence of coal tar staining and saturation just below the surface of the Little River sediments throughout the area of investigation. In most areas, the coal tar-impacted sediments were encountered beneath a thin layer of surficial sediment that did not appear to be affected by MGP residuals. Visible oil and/or tar (VOT) was observed in the top 12 inches of the sediment surface at four of the five transects. Only one of the three samples from the upstream transect (eastern bank of the river) exhibited VOT, although the other samples exhibited faint coal tar odors. At the downstream transect, VOT was typically present slightly deeper than 12 inches below the sediment surface. Three samples collected along the western bank of the Little River (at the three downstream transects) indicated VOT within 12 inches of the sediment surface.

GZA's initial evaluation indicated that VOT is present within 12 inches of the sediment surface in an area of the Little River that exceeds 4,000 square feet, which is above the MCP criterion for "Readily Apparent Harm" to ecological receptors (VOT within 1,000 square feet). Upstream and downstream sediment transects indicated the presence of VOT, and the deepest sediment sample collected during the initial program (from a depth of 5.5 feet at the downstream transect) indicated the presence of MGP-related impacts. Based on these preliminary findings, it was concluded that additional vertical and horizontal delineation of conditions in the Little River was necessary to meet the Phase II requirements of the MCP; accordingly, a more extensive investigation was conducted by Anchor and is presented in Appendix C of this report.

5.2 PIPING INVENTORY

On June 11, 2020, GZA personnel inventoried and documented the piping penetrations in the retaining wall separating the upland portion of the Site from the Little River. The work included recording the pipe locations, diameters and materials of construction. Where direct access to piping was feasible, GZA attempted to determine open pipe distances from the face of the wall using a fish tape or snake. The objective of this task was to conduct a preliminary assessment of potential preferential pathways for the migration of NAPL or other Site COCs to the Little River. The preliminary findings are summarized in Table 8 and a photolog documenting GZA's observations is included in Appendix N. Further investigation of these penetrations will be conducted as necessary during the Phase III evaluation of remedial alternatives for the Site.

5.3 MONITORING OF SHEEN CONTAINMENT BOOM SYSTEM

Under the IRA, GZA personnel conducted monthly inspections to document the condition of semi-permanent and temporary containment booms within the Little River. Modifications and repairs to the boom(s), if needed, were conducted by CHES under direct contract to National Grid. The condition of the booms and any necessary adjustments have been documented in semi-annual IRA status reports submitted to MassDEP.

5.4 RIVER ELEVATION DATA

Concurrent with IRA efforts, GZA personnel measured the depth to the Little River water surface using an interface probe or water level meter from a fixed point on the bridge at Winter Street; beginning in 2021, a second reading was taken from a fixed downstream location along the edge of the property near boring B110. The river monitoring data are included in Table 4 and were used to evaluate river stage and support additional investigations. To further augment this dataset, GZA installed a survey rod in the Little River at the existing boom structure to act as a staff gauge and facilitate monitoring of river elevations over time; however, in January 2021 the base of the rod was observed to have broken off, rendering it nonfunctional. …….

6.0 SITE HYDROGEOLOGICAL CHARACTERISTICS

This section describes regional and Site hydrogeologic conditions that affect migration of COCs at the Site. Site and regional hydrogeology have been characterized using data from the subsurface explorations completed by GZA and previous consultants as well as published reference materials

6.1 SITE GEOLOGY

The local geology in the area of the Site consists of glacial stratified deposits, which are overlain by alluvium in the area of the Little River and Merrimack River. Historic fill consisting of reworked natural soils with varying amounts of anthropogenic material (wood, brick, concrete, asphalt, ash, etc.) overlies the alluvium throughout much of Haverhill.

The subsurface explorations installed by GZA and previous investigators typically extended to between 15 and 25 feet bgs, except at those locations where refusal was encountered at shallower depths as recorded on the boring logs. Drilling was extended beyond 25 feet bgs at four locations (B104, 34 feet bgs; B106, 38 feet bgs; B109, 52 feet bgs; and B110, 44 feet bgs) to collect information about lithologic and environmental conditions at depth. The lithology encountered at the Site is described on the boring logs in Appendix J and was used to develop cross-sections A-A' and B-B' (Figures 3A an3B).

Consistent with historical uses, fill with anthropogenic material was encountered in the borings across the upland portion of the Property. As anticipated, boring B107 within the former relief holder encountered only fill material to the bottom of the holder at 15.5 feet bgs; at other locations, the fill ranged in thickness from approximately 2 feet to 20 feet bgs. The fill was typically classified as granular (sand and gravel) mixed with miscellaneous materials such as brick, wood and concrete fragments. This material was highly variable in composition and density, which is typical of historic fill deposits, ranging in composition from a fine sand with less than 20% silt sizes to heterogeneous mixtures of silt, sand, gravel ad debris. In addition to brick, wood and concrete fragments that were commonly observed, the fill occasionally contained glass, asphalt and coal. A number of "refusals' encountered by the drilling equipment within 15 feet of ground surface likely indicate the remnants of historical structures.

As shown on the cross-sections, the fill was underlain by a fine-grained material that was variously described as either silt or silty sand. The silt/silty sand typically extended to the bottom of the borings, except at NFSB-08, where it was underlain by a clayey silt at 17.5 feet bgs; NFSB-01 and B106, where the material transitioned to a coarser sand at approximately 20 to 29 feet bgs (cross-section A-A'); and B108, where a coarse sand and gravel layer was encountered at 51 feet bgs. The silt/silty sand varied in composition from a fine or fine to medium sand with less than 20% silt sizes to a clayey silt with only small percentages of sand.

Based on data from nearby sites, the silt/silty sand and sand units observed at the 284 Winter Street property are likely underlain by glacial till deposits overlying bedrock. While bedrock was not encountered during Site investigations, regional mapping indicates that this area is underlain by metamorphic bedrock of the Berwick Formation (metasandstone or metasiltstone).

In the borings on the western properties, fill was observed to depths of 9 to 17 feet bgs and was underlain by fine sand, in turn underlain by poorly sorted deposits ranging in size from silty clay to gravel.

6.2 SITE HYDROGEOLOGY

Groundwater flow patterns and hydraulic properties are discussed in the following sections.

6.2.1 Groundwater Elevations and Flow Patterns

The depth to groundwater at the Site (Property and western properties) ranged between 11 and 16 feet bgs in monitoring wells other than B107 and MW-1, in which water was measured at much shallower depths of 2 to 4 feet bgs. As noted earlier, these wells were installed within the former relief holder, and the data from these locations represents a perched groundwater table within the holder. Based on the consistent measurements of groundwater depths within the footprint of the former holder that are 8 to 12 feet higher than surrounding wells, the base and wall of the structure appear to be intact and relatively watertight. The groundwater contour plans (Figure 4A and 4B) indicate that, as expected, groundwater at the 284 Winter Street property flows generally to the west/southwest toward the Little River. There is an apparent northwesterly component of flow in the northern portion of the Site; this may be related to preferential flow pathways associated with utilities or other structures below Winter Street. Based on the presence of the dam across the Little River just northwest of the Site and GZA's understanding of regional groundwater flow patterns, this northwesterly component is likely limited to the southern portion of Winter Street, with westerly flow predominant beyond that zone.

In the vicinity of 191 and 221 Essex Street on the western side of the Little River, the limited available groundwater elevation data indicate that groundwater flows to the northeast, toward the river. This pattern is consistent with regional hydrogeologic conditions, which would indicate that the Little River is the ultimate discharge point for groundwater in this area. The data suggest that the river represents an effective barrier for southeasterly flow from the Site.

6.2.2 Hydraulic Properties

The primary hydraulic properties relevant to groundwater flow include hydraulic gradient (i), hydraulic conductivity (K), and porosity. Hydraulic gradient, which is a measurement of the slope of the groundwater potentiometric surface (i.e., the change in groundwater elevation over distance), is generally expressed as feet per foot. Hydraulic conductivity, which measures the efficiency with which water moves through an aquifer material, is a function of the characteristics of both the fluid (water) and the soil matrix through which it flows and is measured in units of distance per unit time (e.g., feet per day). Porosity, which is a measure of the ratio between the void space volume and the total soil volume, is measured in percent.

Hydraulic gradient is calculated as the slope of the potentiometric surface of the groundwater as depicted by contours of water table elevation. Based on the groundwater data collected during the May and September 2020 gauging events (see Table 4 and Figures 4A and 4B), the hydraulic gradient across the Site typically ranges from approximately 0.01 ft/ft to 0.05 ft/ft, for an average of approximately 0.03 ft/ft.

Hydraulic conductivities were estimated based on data from falling head permeability testing conducted by GZA (Section 4.7) and review of data on similar soil types from published literature. Estimated K values for the silt/silty sand that is the primary water-bearing unit at the Site based on the field-testing data (Table 5) ranged between 0.02 and 0.6 feet per day (ft/d). The measured values are believed to be biased low based on GZA's evaluation of the data. For this Site, a K value of 1.0 ft/d was assumed. Deeper silt or clayey silt deposits observed at the Site would be expected to have lower K values and are not anticipated to play a significant role in groundwater transport.

Porosity, the measure of the relative volume of void space, is used in estimating groundwater flow velocities. Porosity has relatively minor variability compared to other hydraulic parameters, with soil porosities typically ranging between 25 and 55 percent (0.25 and 0.55). It should be noted that the porosity values may not reflect the actual pore space available for groundwater flow. Under field conditions, a percentage of the water in pore spaces is tightly bound to the surface of soil grains by surface tension, thus reducing the amount of porosity available for groundwater flow. Effective porosity is the ratio of interconnected void spaces through which groundwater flow can occur to the total volume of soil. Based on the

characteristics of soils from the Site, GZA estimates an effective porosity of approximately 0.3 for the purposes of calculating transport velocity.

6.2.3 Groundwater Flow Rates

The estimation of the quantity of groundwater flow through a matrix material is an important component of any hydrogeologic study and directly impacts the assessment of possible contaminant migration and the estimated impacts to downgradient receptors. For this study, the total groundwater flux through the shallow overburden soils at the Site was estimated using a form of Darcy's Law which is based on Site-specific hydraulic properties. Darcy's Equation for fluid flow through a porous medium is:

$$Q = KiA$$

where:

Q = flow rate (ft^3/day)

K = aquifer hydraulic conductivity (ft/day)

i = hydraulic gradient (ft/ft)

A = aquifer total cross-sectional area through which flow occurs (ft^2)

The hydraulic conductivity assumed for this analysis was 1 ft/day, and the average hydraulic gradient used was 0.03 ft/ft. To calculate the cross-sectional area through which shallow groundwater would flow, GZA assumed a saturated thickness of 20 feet for the sand deposit (based on groundwater gauging information and depth to silt/clay in the subsurface) and an estimated flow path width of 350 feet (based on the width of the Site perpendicular to the groundwater flow direction). These assumptions yield an estimated value of 210 ft^3/day, or approximately 1.1 gallons per minute (gpm) for shallow groundwater flow through the disposal site area. GZA developed an estimate of the groundwater transport or seepage velocity (v) at the Site, using another form of Darcy's Law (v-= Ki/n, where n is effective porosity and Ki and I as defined above). Based on an assumed effective porosity of 0.3 and the K and gradient values above, the estimated transport velocity is approximately 0.1 feet per day (37 feet per year).

6.2.4 Flood Potential

In accordance with 310 CMR 40. 0835(4)(d)(3)(d), GZA evaluated the potential for flooding at the Site by reviewing online flood maps made available by the Federal Emergency Management Agency (FEMA). Our review indicated that Little River in the vicinity of the Site is mapped by as a Regulatory Floodway, and that most of the upland portions of the Site are located in a shaded Zone X that indicates a moderate flood hazard (0.2 % annual chance of Flood Hazard, also known as the 500-year Special Flood Hazard Area).

7.0 ANALYTICAL RESULTS

Results of the analyses of environmental samples collected from the Site are outlined in the following paragraphs.

7.1 SOIL DATA

As an initial evaluation of the nature and extent of COCs in the upland portion of the Site, the soil analytical data were compared to MCP Method 1 S-3/GW-2 and/or S-3/GW-3 standards based on the location and depth of each sample with respect to the car wash facility or on-Site kiosk (Table 1). Samples from 0-15 feet bgs at locations B-1/MW-1, NFSB-07, NFSB-08, B103, B106, B107 were compared to S-3/GW-2/GW-3 standards, and the rest of the soil samples from the Site were compared to S-3/GW-3 standards. These comparisons were used strictly as a preliminary screening tool to evaluate the relative significance of the data; they are not intended to provide an assessment of risk, and therefore did not further characterize the soil as S-1/S-2/S-3 based on accessibility and frequency/intensity of use. Instead, the Site-specific exposures and potential risks were evaluated by a Method 3 Risk Characterization, which is included in Appendix D of this report.

As shown in Table 1, the primary COCs detected in soil samples from the Site included TPH, selected EPH and VPH fractions (mainly C_{11}-C_{22} aromatics and C_9-C_{10} aromatics) and PAHs, with naphthalene as the PAH compound found most frequently and at the highest concentrations. The other EPH and VPH fractions and volatile aromatic compounds - benzene, toluene, ethylbenzene and xylenes (BTEX) – were also reported in a number of soil samples. Reported concentrations of arsenic, chromium and lead in soils from the Site were within background ranges for historical fill materials. PAC was detected in the soil samples analyzed from the Site, but at concentrations well below the relevant MCP Method 1 standards.

Concentrations of the key COCs exceeding the Method 1 standards were reported in soil samples throughout the western, central and southern portion of the property. The highest concentrations were found in the 5 to 20 feet bgs depth interval. With a few exceptions (naphthalene at B106 and other PAHs at several other locations), concentrations within the upper 5 feet of soil were below the S-3 soil standards. Exceedances of the S-3 standards for PAHs in shallow soils at NFSB-01, 02 and 09 do not appear to correlate with observations of MGP or petroleum impacts; rather these appear to be associated with historic fill components. Soil samples at depths below 5 feet bgs from multiple locations west and south of the former relief gas holder in the center of the Site exceeded the S-3/GW-3 standards for COCs such as C_9-C_{10} aromatic hydrocarbons, C_9-C_{12} aliphatic hydrocarbons, C_9-C_{18} aliphatic hydrocarbons, C_{11}-C_{22} aromatic hydrocarbons, 2-methylnaphthalene (2-MN), acenaphthylene, and/or benzo(a)pyrene. In addition, the MCP Method 1 S-3/GW-2 standard for naphthalene was exceeded in samples from locations B-1, B106, and B107, which were collected within or near the former holder. The vertical extent of impact was evaluated based on samples collected at depth from B104 (32-34 feet bgs) and B109 (50-52 feet bgs), among other locations, which had VPH/EPH concentrations near or below reported detection limits. These data, coupled with the field observations and PID readings from multiple borings depicted on the cross-sections, indicate that MGP-related impacts in soil at the Property are highest near the water table toward the top of the silty sand zone, and decrease with depth.

TPH concentrations in soil exceeding the upper concentration limit (UCL) of 10,000 mg/kg were reported at NFSB-02 and at several other locations at depths below the water table. GZA notes that the TPH data were generated from forensic analyses completed by Alpha and are not considered appropriate for use in a risk characterization context. The reported concentrations at NFSB-01 correlate with the presence of petroleum LNAPL in this area. Only one soil sample collected for conventional characterization purposes indicated a concentration above the UCL value – the sample from the 17.5-20 feet bgs at ENV-13B. The C_{11}-C_{22} aromatic hydrocarbon fraction was reported at a concentration above the UCL value (15,600 mg/kg vs. 10,000 mg/kg) at this location.

The lateral extent of the MGP-related impacts extends west to the Little River (See Figure 5), as represented by EPH and VPH data collected below 10 feet bgs from ENV-3B, ENV-5B, and ENV-7B, but does not appear to extend to the northwest corner of the Property based on data from ENV-1B and ENV-2B. As shown on the boring logs in Appendix J, field

observations from borings GZA-1, GZA-1A, and GZA-2 on the west side of the Little River did not indicate evidence of MGP impact; this finding was confirmed by groundwater data from these wells as discussed in the following section.

7.2 GROUNDWATER DATA

Similar to the soil data, the groundwater data were compared to MCP Method 1 GW-2 standards (for wells located within 30 feet of a structure and screened above 15 feet bgs) and GW-3 standards (all wells). As shown in Table 2, the primary COCs detected in groundwater samples at levels above the Method 1 standards included naphthalene, C_9-C_{10} aromatics and benzene. Xylenes were also reported sporadically in groundwater at levels above the GW-2 and GW-3 standards. Several other COCs, including C_{11}-C_{22} aromatics, 2-MN, C_5-C_8 aliphatics, toluene and ethylbenzene were commonly detected in groundwater samples, but at levels below the Method 1 standards. PAC was consistently detected in downgradient wells sampled in August 2021 at concentrations above the GW-3 standards.

Consistent with the soil data, the highest concentrations of COCs were reported in groundwater from the central, western and southern portions of the 284 Winter Street property. (See Figure 6.) Substantially lower levels were observed in the two wells adjacent to the western border of the Site (NFSB-08 and MW-3), although both locations indicated detectable concentrations of EPH and VPH fractions, with other COCs (PAHs, BTEX) reported at MW-3. In contrast to the soil results, wells along the northern border of the Site (B102, ENV-1MW) exhibited elevated levels of certain COCs, including naphthalene and C_9-C_{10} aromatics. Significant impacts to groundwater extend to the Little River; however, wells installed on the western side of the river to the southwest of the 284 Winter Street property did not indicate detectable levels of the primary Site COCs.

7.3 NAPL

NAPL has been observed at several locations across the western, central and southern portions of the Site, but significant accumulations of separate-phase materials have only been observed at two locations – NFSB-02 and B107. At NFSB-02, an LNAPL resembling a weathered petroleum product has been observed at thicknesses ranging from 0.2 to 4.2 feet between 2017 and the present. Approximately 35 gallons of NAPL have been recovered from this well over that time period. NAPL recovery is further discussed in Section 8.3.4. Well B107 has consistently indicated the presence of a viscous DNAPL resembling coal tar at thicknesses between 2.2 and 3.9 feet since its installation in February 2020. Only a small quantity of product has been recovered from this location. Monitoring wells ENV-3MW and ENV9-MW had sporadically indicated the presence of an LNAPL between 2016 and 2018 at thicknesses up to 0.6 feet. Significant quantities of LNAPL were not recovered from these wells and neither has exhibited measurable LNAPL since October 2018. Separate-phase product has also been observed seeping from the retaining wall at several locations on the western edge of the 284 Winter Street property (as noted above and addressed by the IRA work) and sheen “blossoms” have been noted within the Little River adjacent to the Site.

7.4 SOIL GAS DATA

The soil gas data summarized on Table 3 include results from a broad-spectrum survey completed in 2016 for forensic purposes and some focused soil gas sampling by GZA in 2020. The 2016 sampling indicated the presence of a variety of VOCs in soil gas across the Site, most of which appear to be associated with the active fueling operations at the property or attributable to the ubiquitous presence of certain constituents in developed areas (ketones, chloroform, BTEX, etc.). The constituents found most frequently and at the highest concentrations in the forensic survey included 2-butanone, 2-MN, naphthalene, BTEX and methyl tert butyl ether (MTBE); the presence of these compounds appears to be directly related to incidental emissions and spills associated with the active gasoline and diesel storage and dispensing operations. With one exception, reported concentrations in soil gas were below the commercial/Industrial soil gas screening values

(SGSVs) from the MassDEP's Vapor Intrusion Guidance: Site Assessment, Migration and Closure Policy #WSC-16-435 dated October 2016 (VI Guidance). The soil gas sample from NFSV-01 (located adjacent to the northeast corner of the concrete slab covering the gasoline USTs) exceeded the screening value for naphthalene. Reported concentrations from the samples collected by GZA in 2020 and analyzed for APH were all well below the SGSVs.

8.0 NATURE AND EXTENT OF CONSTITUENTS OF CONCERN

This section summarizes the nature and extent of constituents detected at the disposal site. OHM distribution is influenced by factors such as the physical and chemical properties of the constituents, the nature and location of sources, and Site characteristics such as geology, hydrology, and topography. The types and properties of chemicals detected at the disposal site are discussed below, followed by a summary of their distribution within environmental media, and an assessment of potential migration.

The detected concentrations of COCs in soil, groundwater, soil gas and sediment are summarized in Tables 1, 2, 3, and 7A; the associated laboratory analytical reports are included in Appendices H, I, K, and L. Soil and groundwater data for key COCs are depicted on Figures 5 and 6. Brief summaries of the distribution of the key COCs in the environmental media of concern were provided in Section 7.0.

8.1 CONSTITUENT TYPES AND PROPERTIES

General definitions of relevant physical properties are discussed below, followed by a description of the characteristics of certain constituent classes.

8.1.1 Physical Properties

Physical properties of chemical compounds are important factors in evaluating their environmental distribution and movement. The properties (as defined below) of a given chemical represent behavior of a pure compound under laboratory conditions. These data are used in conjunction with information on environmental conditions to evaluate the fate of environmental contaminants. Selected physical properties are defined below.

- Specific Gravity: The specific gravity of a chemical is the ratio of the mass of a given volume of the chemical to an equal volume of water at a specified temperature, usually 4 or 20 degrees Centigrade. As such, specific gravity is a relative measure of density. Compounds with specific gravities greater than 1.0, if they are relatively immiscible with water, will separate as a sinking phase. Immiscible compounds with specific gravities less than 1.0 will tend to float on water.

- Water Solubility: The solubility of a chemical in water is the maximum amount of a pure chemical that will dissolve in pure water at a specified temperature and pressure. Water solubility is a general predictor of a chemical's potential mobility and distribution in the environment. Chemicals with moderate to high solubilities (greater than 100 mg/l) can leach rapidly from soils into groundwater, and once there, are generally mobile.

- Vapor Pressure: The vapor pressure of a liquid or solid is a relative measure of its volatility in its pure state. This value expresses the pressure of the gas phase of the compound in equilibrium with the liquid or solid phase of a compound at a given temperature. This pressure is directly proportional to the compound concentration in air. Vapor pressure is important in evaluating the migration of chemicals to air from other environmental media, but factors such as temperature, wind speed, water solubility, and degree of adsorption also play key roles. Chemicals with vapor pressures greater than 10 mm mercury are considered to be highly volatile.

- Henry's Law Constant: Henry's Law Constant (HLC) is another measure of chemical volatility. It is expressed as the ratio of the concentration (partial pressure) of a chemical in air to the chemical's concentration in solution, taking into account not only vapor pressure, but also solubility and molecular weight. The higher the HLC value, the greater the rate of volatilization. Chemicals with low HLCs are more likely to remain in soils and be subject to other transport processes. In general, compounds with values below 10-5 atm-m^3/mol would not be highly volatile and would have a greater potential for movement into groundwater.

- Organic Carbon Partition Coefficient (KOC): This value is a measure of the relative sorption potential for organic compounds. The KOC indicates the tendency of an organic chemical to be adsorbed onto soils and sediments. This value is expressed as the ratio of the amount of chemical adsorbed per unit weight of organic carbon to the chemical's concentration in solution at equilibrium. A chemical with a high KOC (greater than 1,000 ml/g) may exhibit a high sorption potential in soils and is less likely to leach into groundwater and thus will tend to migrate slowly. KOC values of less than 100 ml/g indicate that the chemical may have a higher potential to leach into groundwater and migrate with groundwater flow.

The key physical properties for Site COCs are summarized on Table 9 and discussed below.

8.1.2 Constituent Types

This section summarizes the types and characteristics of the constituents detected in samples of Site soil, groundwater, and sediment. Since constituents that are physically and chemically similar tend to exhibit similar behavior in the environment, the following discussions of contaminants are grouped into the following classes: petroleum hydrocarbons, VOCs, and PAHs. A separate discussion of NAPL is also included.

8.1.2.1 *Petroleum Hydrocarbons (PHCs)*

PHCs are a large complex family of compounds with widely varying chemical properties. In terms of fate and transport, lighter hydrocarbons are generally relatively mobile in groundwater but are subject to attenuation by biodegradation and volatilization. Heavier hydrocarbons display low solubilities and high KOC values, indicating limited potential for migration. At this Site, both light and heavier hydrocarbons were detected in the soil and groundwater. The three VPH fractions were commonly detected in soil with the C_9-C_{10} aromatics and the C_9-C_{12} aliphatics as the predominant constituents in terms of frequency of occurrence and relative concentrations. The C_9-C_{10} aromatic fraction was the primary VPH constituent found in groundwater samples. EPH constituents detected in soil include aliphatic hydrocarbons, which are collectively quantified within two carbon ranges (C_9-C_{18} and C_{19}-C_{36}), and aromatic hydrocarbons, which are collectively quantified within the C_{11}-C_{22} carbon range. The C_{11}-C_{22} aromatic fraction was the only EPH constituent reported commonly in groundwater samples from the Site. The PHCs reported in soil and groundwater samples from the Site appear to be attributable to residuals associated with historical MGP activities along with incidental releases from petroleum product storage and dispensing activities over the last 40 years.

8.1.2.2 *Aromatic VOCs*

VOCs are termed "volatile" due to their tendency to vaporize at environmental temperatures and pressures. The VOCs observed in samples collected from the Site include those in the subclass of aromatic VOCs. Aromatic hydrocarbons detected in soil and groundwater samples from the Site included benzene, toluene, ethylbenzene and xylenes. These compounds are components of light and medium weight oils and gasoline which have been stored and used at the Site and are common constituents of MGP residuals such as drip oils or coal tars. These constituents are less dense than water and have moderate solubility values, ranging from 152 mg/l for ethyl benzene to about 1,800 mg/l for benzene. They

display a moderate degree of adsorption to organic matter and relatively high vapor pressures. Accordingly, adsorption and volatilization are significant attenuation mechanisms for these constituents in the environment.

8.1.2.3 *PAHs*

PAHs are chemical constituents of asphalt, coal and oil tars and numerous other petroleum products and are byproducts of internal combustion engines and coal/wood burning. As a result, they are ubiquitous in urban environments. Several PAH compounds were detected in soil and sediment samples from the Site. The behavior of PAHs is variable and is dependent on the number of rings in the molecular structure. Due to the low solubilities and high KOC values of the higher molecular weight PAHs, they display only limited mobility in groundwater.

8.1.2.4 *Cyanide*

Cyanide is ubiquitous in the environment due to both natural (presence in plants, animals and microbes) and anthropogenic (cyanide compounds are common anti-caking agents in road salt) sources. This constituent can exist in a variety of different chemical forms, ranging from free cyanide (HCN or CN-) to various metal-cyanide complexes. At MGP sites, iron-cyanide complexes (strong-acid dissociable complexes) dominate the dissolved phase, because the primary source of dissolved phase constituents is the iron-cyanide complex Prussian Blue. Only 10% or less of the dissolved cyanide at such sites exists as weak metal-cyanide complexes, of which free cyanide constitutes only a few percent. Both free cyanide and dissolved metal-cyanide complexes can adsorb onto various natural soil adsorbents, with natural organic matter acting as an important adsorbent. In general, the highest retardation of dissolved cyanide in groundwater would be expected in acidic aquifer systems with high clay, iron and aluminum oxide content and high soil organic matter. None of the soluble metal-cyanide complexes that are the primary constituents in dissolved groundwater at MGP sites have significant vapor pressures at typical environmental conditions (note: HCN, which forms a small percentage of PAC, is volatile). Metal cyanide complexes are generally resistant to microbial degradation.

8.1.2.5 *NAPL*

The term NAPL refers to a free phase non-aqueous liquid that can be mobile in the environment; this term includes coal tar under certain circumstances. Coal tar typically exists as a black amorphous solid, a pliable material (generally at temperatures of between 50 and 70 degrees F) or a fluid, with a naphthalene-like odor. In the pliable or solid state, coal tar is not mobile in soil or groundwater, but in its fluid state, it can be mobile and thus is considered a NAPL. More specifically, since it has a specific gravity greater than water and will sink through a water column, coal tar generally is encountered in the subsurface environment as a DNAPL. Coal tars consist primarily of high molecular weight hydrocarbons (PAHs) of low solubility, and more soluble lighter-weight VOC fractions. If in contact with water, the soluble constituents of coal tar can be liberated and mobilized to dissolve into and flow with groundwater. At the Site, DNAPL was encountered within the former relief gas holder in the form of a viscous coal tar product. LNAPL resembling a weathered fuel-oil-like petroleum product with a relatively low viscosity was consistently observed at monitoring well NFSB-02. The NAPL observed sporadically at other locations within the Site appeared to be somewhere in between these two products – lighter than water but slightly viscous.

8.2 SOURCE AND DISTRIBUTION OF COCS

Available data on Site operations and information regarding the distribution of COCs in soil and groundwater in the central portion of the Site indicate that reported contaminants likely originated primarily from historical spillage/leakage of petroleum products and MGP residuals. Impacts from petroleum products and MGP residuals are apparent at depths below 5 feet bgs across the central and southern portion of the Site, with sporadic observations of impacts at shallower

depths. As indicated on Figure 5, elevated levels of EPH/VPH constituents and PAHs (with naphthalene as the dominant constituent) were consistently reported in soils to the south of the current dispenser island and UST pad, with lower levels to the north. The distribution of the individual COCs and the relative concentrations vary substantially across the Site, suggesting that there were multiple point sources and release mechanisms involved. Typically, field screening and observations indicated that significant soil impacts were initially encountered at approximately 5 feet bgs and extended to 20 feet bgs. In several locations, overt impacts (coal tar odors and staining) were noted deeper into the silty sand/silt deposit that underlies the fill at the Site. Laboratory analyses of soil samples supported the field observations indicating that COC concentrations were highest in the 5 to 20-foot depth range.

In some respects, the distribution of COCs in groundwater is similar to the soil data, with the highest concentrations of most constituents observed in the central and southwestern portions of the property. Concentrations of most of the Site COCs are consistently elevated in the groundwater within this portion of the Site. The "perched" or trapped groundwater within the historical relief holder has exhibited the highest levels of benzene observed at the site (up to 19,500 micrograms per liter - µg/l, equivalent to parts per billion or ppb). Elevated levels of other aromatic hydrocarbons were also reported in the samples from MW-1, within the holder. The groundwater data also indicate a separate northerly plume with a different mix of COCs. Wells B102, ENV-1MW and, to a lesser extent, MW-2, exhibited relatively higher concentrations of C_9-C_{10} aromatics, naphthalene and xylenes. These appear to be associated with a separate source area from the main body of groundwater impacts in the central and southern portion of the Site.

The distribution of COCs in the sediments of the Little River along the western border of the Site is discussed in Anchor's report within Appendix C. As noted previously and described further in Appendix C, NAPL/VOT in the form of apparent coal tar residuals was widespread within the Little River sediments adjacent to the Site. Elevated concentrations of certain Site COCs were also reported in sediment samples beginning just south of the Winter Street bridge and extending to the Little River Conduit to the south of the 284 Winter Street property.

8.3 MIGRATION PATHWAYS AND FATE OF CONTAMINANTS

Constituents released to the environment may migrate via a variety of transport mechanisms through various media (air, soil, groundwater, and surface water) potentially affecting environmental or human receptors. Thus, the evaluation of the migration potential and fate of chemicals represents a key element of the Phase II investigation. At the 284 Winter Street Site, migration through groundwater to the Little River with the potential for downstream transport have been identified as the principal pathways for Site COCs. The following sections discuss migration pathways, and general and chemical specific transport and attenuation mechanisms for constituents detected during the investigation, focusing primarily on groundwater-related factors.

8.3.1 Migration Pathways

Potential migration pathways at the Site include migration through soil, soil vapor, groundwater, surface water and sediments. Additionally, certain Site COCs may be taken up by microorganisms, fish, or other biota within the Little River. Given Site conditions (virtually all of the 284 Winter Street property is covered by pavement, concrete or structures), direct migration through soil via mechanisms like erosion or runoff is not a significant pathway at the Site. While soil vapor intrusion into the two occupied structures at the Site (the car wash building and the fueling station kiosk) is possible, data collected by GZA have indicated that this pathway is not significant. The primary mechanism for COC transport at the Site is groundwater flow and then potential migration via surface water and sediment transport in the Little River. Groundwater flow is toward and ultimately into the Little River at the Site, although the limited flow volumes through the Site would be subject to substantial dilution within the river. Limited testing of the Little River to date has not indicated

measurable concentrations of Site COCs in surface water. However, sediments within the Little River adjacent to the Site have been impacted by Site COCs, including NAPL, and there is potential for downstream transport of these materials toward the Merrimack River.

Note that direct migration of DNAPL under the force of gravity and LNAPL along the water table represents an additional potential migration pathway at the Site. Measurable quantities of DNAPL have been observed only at well B107, located within the remnants of the former relief holder at the Site. Migration of DNAPL in this area is restricted by the holder base and walls. Migration of LNAPL observed at well NFSB-02 and sporadically at other locations is a complex process governed by the configuration of the water table and soil/NAPL properties. Site observations indicate that NAPL mobility is currently limited. However, observations of NAPL/VOT within the Little River sediments and in seepage points along the retaining wall at the western edge of the Property indicate that NAPL has historically migrated from the likely release areas toward the river. NAPL mobility and recovery feasibility issues are further discussed below.

8.3.2 Transport Mechanisms

Chemical constituents can enter the groundwater flow regime via percolation of liquids discharged at ground surface or through subsurface structures, or by leaching of precipitation through surface wastes. Once chemicals enter the groundwater, they can be transported by two mechanisms: advection and dispersion. Advection involves the transport of dissolved constituents by the bulk motion of groundwater flow. Absent attenuation mechanisms (discussed below), dissolved constituents can be assumed to flow in the direction of groundwater flow at an average rate equal to the groundwater pore (transport) velocity. Two types of dispersion, chemical and mechanical, act to spread chemicals in groundwater. Transport via chemical diffusion is an extremely slow process driven by concentration gradients. Mechanical dispersion is governed by soil characteristics described by dispersion coefficients. Generally, chemical migration via dispersion can be considered limited in comparison to advective transport. Therefore, for the purpose of evaluating contaminant transport at the Site, dispersion was negligible and only advection was considered as the governing transport mechanism.

8.3.3 Attenuation Mechanisms

There are a number of processes which operate to reduce chemical concentrations in the groundwater as it migrates through the subsurface. These include dispersion, which acts as a dilution process to reduce chemical levels (and which has been considered negligible as described above), as well as adsorption, biodegradation, and volatilization.

Adsorption is the temporary or permanent immobilization of constituents by attachment to solid substrates. Adsorption is generally the most significant attenuation mechanism for metals and high molecular weight organic compounds migrating through soils. Primary adsorption sites include organic matter, which is present at variable levels within essentially all soils, and colloidal particles. The magnitude and rate of adsorption is a function of the chemical nature of the constituents, the nature and availability of the solid substrate, and the concentration of the constituent.

Biodegradation of aromatic VOCs and certain other PHCs is a significant attenuation mechanism which can substantially reduce contaminant levels in the environment. Biodegradation occurs via the transformation of organic compounds by naturally occurring microorganisms present within the soil mass. This is generally an aerobic process for aromatic hydrocarbons. Recent studies (Hadley and Armstrong, 1991) indicate that biodegradation of aromatic compounds like benzene can reduce concentrations of these constituents to below detection limits before substantial migration occurs.

Volatilization is the transformation of a chemical from the solid or liquid phase to the gaseous state, thus reducing chemical concentrations in the source material. Volatilization is an important attenuation mechanism for chemicals with high vapor pressure and HLC values.

8.3.4 NAPL Mobility and Recovery Feasibility

GZA evaluated NAPL mobility and recovery feasibility in accordance with MassDEP's February 2016 Guidance. Under the guidance, "LNAPL with Micro-scale Mobility" (basically, LNAPL that is visibly present in subsurface media) is present at various locations within the Site, so the mobility/feasibility evaluation focuses on "stability" and recoverability. The simplified approach under the guidance establishes "Stability Action Levels" (SALs) representing LNAPL thickness limits for various soil types which may be indicative of "Non-Stable LNAPL". Under the simplified approach, an LNAPL thickness exceeding 12 inches for any soil type measured "at any time" during the course of an LNAPL site investigation represents a potential Non-stable LNAPL condition. The simplified approach of the LNAPL guidance mandates one year of monthly monitoring to rebut the presumed "Non-Stable LNAPL" condition. As indicated on Table 4, there are several years of monthly NAPL thickness measurements for the two monitoring wells that have consistently shown significant accumulations (NFSB-02 and B107). These data show that NAPL thicknesses have not significantly increased over time, indicating that NAPL at these locations would be considered "stable" under the guidance. Note that NAPL adjacent to the retaining wall on the western border of the Property and within the sediments of the Little River in some areas would be deemed categorically "Non-stable" under the guidance because it is periodically discharging to the River.

Under the assumption that LNAPL stability was established for the upland portion of the Site, recoverability would remain as the key issue under the guidance. For the NAPL thickness values observed at the Site, the evaluation of whether continued recovery is feasible focuses on T_n and recovery volumes over time. As noted in Section 4.6, GZA completed an LNAPL bail down test at well NFSB-02 in March 2020 in general accordance with ASTM Guidance and analyzed the data using the relevant API worksheet (Appendix L)[6]. The T_n values calculated for NFSB-02 ranged from approximately 0.17 to 0.41 feet squared per day (ft^2/day), averaging 0.34 ft^2/day. MassDEP's NAPL Guidance indicates that T_n values less than 0.8 ft^2/day indicate that appreciable quantities of LNAPL cannot be recovered, and continued removal actions may be considered infeasible. Note that LNAPL recovery volumes at well NFSB-02 also support an infeasibility conclusion. The MassDEP Guidance indicates that total LNAPL recovery volumes of less than 1 gallon over any three-month period would indicate that it is no longer feasible to recover. Recovery rates at NFSB-02 have been below this value for several years with an average rate of about 0.8 gallons per three-month period for 2020 and 2021.

Conditions at B107 were not suitable for NAPL bail down testing; accordingly, GZA calculated T_n based on the NAPL saturated hydraulic conductivity[7] and the thickness of the NAPL zone. As noted in Section 4.7, we completed water hydraulic conductivity testing at well MW-1, which is adjacent to B107 and also installed within the former relief holder. GZA used the measured estimate of the water hydraulic conductivity, available subsurface data (regarding the thickness of the LNAPL-impacted zone), and the measured fluid properties of the LNAPL from B107 to calculate T_n. The estimated value was 0.0012 ft^2/day, which is well below the value provided in the LNAPL guidance (0.8 ft^2/day) for "Conditionally Infeasible" recovery. Recovery rates at well B107 are also well below the MassDEP Guidance criteria of 1 gallon over any three-month period for an infeasibility demonstration. The T_n calculation is documented in Appendix L. We conducted a

[6] The API worksheet analysis used methods developed by Bouwer and Rice (1976), Cooper and Jacob (1946), and Cooper, Bredehoeft, Papadopulos (1967); analytical results among the methods showed reasonable correlation.

[7] Note as indicated in the LNAPL guidance as well as elsewhere (e.g., American Petroleum Institute Publication 4760 dated January 2007), the NAPL zone is not fully saturated by NAPL (i.e., due to air-filled and water-filled pore space). As such the NAPL saturated conductivity will overstate the actual NAPL conductivity and thus the Tn calculated in this manner will overstate the actual Tn. Accordingly, this calculated Tn should be considered a conservative (i.e., upper bound) estimate of the actual Tn at the Site

similar evaluation for well NFSB-02 as a check on the bail down testing results and the estimated T_n (0.42 ft^2/day) was consistent with the value from the bail down testing. These results indicate that the NAPL in wells NFSB-02 and B107 is no longer feasible to recover under the MassDEP guidance.

8.3.5 Site-Specific Migration Issues

COCs present in soil at the Site would be expected to exhibit only limited mobility given the nature of the primary constituents (limited solubility and a propensity for adsorption to organic matter and solids) and Site conditions (an almost entirely paved or building-covered Site with low-permeability soils beneath the fill). Direct migration via runoff and the generation of fugitive dust would not be significant migration pathways under current conditions due to the primarily subsurface nature of Site COCs and the presence of pavement and structures. An evaluation of soil gas conditions has concluded that vapor intrusion into occupied structures is not a significant pathway at the Site. Site COCs present in groundwater will continue to migrate with groundwater flow toward the Little River. The rate of contaminant migration will be controlled by groundwater transport velocities (see Section 6.2.3) and attenuation effects. For the Site COCs, adsorption will reduce the transport velocity of the contaminants relative to groundwater pore velocities. This reduction, often termed a retardation factor, is a function of soil organic carbon content, COC properties, and physical characteristics of the soil mass. For the types of COCs found at the Site and observed soil conditions, retardation factors can exceed 10 (i.e., the constituents migrate at rates less than 10 percent of the groundwater transport velocity).

Site COCs will be subject to various attenuation mechanisms as they migrate with groundwater flow, including biodegradation and volatilization. For the most mobile of the Site COCs (BTEX and the VPH fractions), biodegradation by naturally occurring microbes has been demonstrated to significantly attenuate concentrations with distance from a source. Volatilization is also a significant attenuation mechanism for this same group of compounds. The residual COCs in groundwater would then be subject to substantial dilution as the limited flow from the Site discharges into the Little River. As part of this evaluation, GZA completed a quantitative assessment of the discharge to the River. Using the groundwater flow calculations outlined in Section 6.2.3 and estimates of stream flows developed from data included in a recent study of the dam just upstream of the Site, GZA developed site-specific dilution factors for discharge of groundwater to the Little River. Estimated stream flow for a "low flow" condition[8] in the Little River was 4.9 cubic feet per second (cfs), which is equivalent to approximately 2,200 gpm. The dilution factor for groundwater discharge from the Site to the River developed using these values and the previous estimates was approximately 2,000. With the combined impact of dilution and other attenuation mechanisms, it is unlikely that detectable levels of Site COCs would be found in Little River surface water.

Since 2019, measurable accumulations of NAPL have been observed within only two wells at the Site, and evaluations completed in accordance with MassDEP's NAPL Guidance have concluded that this material is stable and no longer feasible to recover. However, NAPL has migrated from the Site into the sediments of the Little River and observations indicate that such migration is still occurring under certain conditions. This condition will be a focus of future remedial evaluations.

8.4 DISPOSAL SITE BOUNDARY DELINEATION

Soil, groundwater, and sediment data collected during the Phase II study and prior investigations, coupled with information on groundwater/surface water flow patterns and Site history, were used to delineate the Disposal Site Boundary. To the north, Winter Street was designated as the Site Boundary based on historical information indicating

[8] In the report titled "Little River Dam Removal Feasibility Study dated June 2021 and prepared by Fuss & O'Neill, base flow in the Little River was estimated to be 9.8 cubic feet per second (cfs). GZA used one half of this value (4.9 cfs) as a conservative estimate of typical low flow in the River at the Site.

that Site operations did not extend beyond the current right-of-way and the anticipated southerly to southwesterly groundwater flow direction north of the Property, which would limit migration of COCs beyond the southern edge of the street. The easterly border of the Site was established based on historical information on the extent of Site activities, the presence of the elevated railroad embankment and the documented westerly to southwesterly flow direction for both groundwater and ground surface water runoff, which would preclude migration to the east of the property boundary. The Little River represents a groundwater flow boundary to the south and west and delineates the Disposal Site Boundary in those directions. While sediments within the river have been impacted by OHM from the Site, explorations to the west/southwest of the water body did not indicate evidence of MGP residuals and an apparent easterly groundwater flow direction was observed. To the southwest, we have conservatively assumed that sediments extending to the mouth of the Little River Conduit have been impacted by OHM from the Site. Based on the construction details and history of the Conduit, measurable impacts from the Site downstream of the northern edge of the structure would not be anticipated.

9.0 CONCEPTUAL SITE MODEL SUMMARY

This section provides a succinct description of the CSM that guided our evaluation of the Site. This description of the CSM, which was developed in accordance with the guidance developed by the MassDEP in conjunction with the LSP Association[9], outlines the Site's environmental setting, the nature and types of contaminants released at the Site, the nature of contaminant pathways, and the location of human and environmental receptors. Per MassDEP guidance, the CSM, which evolved as the work was completed, was used in the selection of the number, type and location of tests; and to establish a framework for evaluating the adequacy of the testing program.

9.1 ENVIRONMENTAL SETTING

The 284 Winter Street Site is located on the south side of Winter Street, adjacent to the Little River in the central portion of Haverhill, Massachusetts. Ground surface in the upland portion of the Site is relatively flat at approximately elevation 25 feet (North American Vertical Datum of 1988 – NAVD 88) with a sheer drop from a retaining wall along the western edge of the 284 Winter Street Property to the Little River, with a typical water level at elevation 6-9 feet NAVD 88. Regional groundwater flow is to the west/southwest toward the Little River with surface runoff also to the river. The river enters a concrete flood conduit that runs beneath downtown Haverhill at the southern edge of the Site. The Disposal Site consists of approximately 1.6 acres of land encompassing the former MGP facility and current gasoline service station at 284 Winter Street, the southern portion of the Winter Street right-of-way adjacent to the Property, a thin strip of vacant land owned by the MBTA between the Property and the railroad embankment to the east and a stretch of the Little River. The 284 Winter Street Property is the only portion of the Disposal Site that is occupied and in active use (as a gasoline service station and car wash).

9.2 NATURE AND SOURCES OF CONTAMINATION

The Property was formerly used as an MGP between approximately 1853 and 1970, with various gas production processes utilized over this period. Raw materials, manufactured gas and associated byproducts and wastes were stored within the property using various tanks, holders and other structures. While specific spill or disposal incidents were not documented during the MGP's operation, raw materials and byproducts were released to the environment within the plant footprint, as is common with these types of facilities in this time frame. The actual release mechanisms and specific types and volumes of materials released are unknown, but it is apparent that coal tar was released historically at several locations. It is also likely that other petroleum products (including fuel oils) were released to the soil and groundwater during the operation of the gasoline service station between 1977 and the present. These releases have resulted in the presence of

[9] LSP Association Seminar presented jointly with the MassDEP, MCP Representativeness Evaluations & Data Usability Assessments February 2008.

both light and dense NAPL and COCs such as PHCs (including C_9-C_{10} aromatics, C_9-C_{12} aliphatics and C_{11}-C_{22} aromatics), PAHs, and aromatic VOCs in the subsurface at the Site and in sediments of the Little River.

9.3 CONTAMINANT MIGRATION PATHWAYS

Potential contaminant migration pathways at the Site under current conditions include transport of dissolved constituents (naphthalene, aromatic VOCs, EPH and VPH fractions) via groundwater flow and migration of vapors from volatile constituents. The Little River is the discharge points for Site groundwater. Based on the observed levels of dissolved COCs in groundwater at the Site and the dilution/attenuation mechanisms that impact those constituents, measurable impacts on the Little River would not be anticipated. Two occupied structures, the gasoline station kiosk and the car wash building, are located within the groundwater plume; a vapor intrusion evaluation concluded that significant impacts to the indoor air at these structures would not be anticipated. Significant levels of Site COCs are generally not present in surface soils and most of the Site is covered with pavement, concrete slabs or buildings, so there is limited potential for transport via soil erosion/runoff or fugitive dust.

Measurable accumulations of NAPL are present in isolated spots within the upland portion of the Site, including coal tar DNAPL and a petroleum-based LNAPL. Evaluations completed under MassDEP's NAPL guidance concluded that the mobility of these materials is presently limited and continued recovery of the upland NAPL is considered infeasible. NAPL has historically migrated to the Little River and VOT is widespread in sediments below the Little River adjacent to the 284 Winter Street Property. Observations during the Phase II field program suggest that continued seepage of NAPL is occurring through the retaining wall at the Site under certain seasonal low water level conditions.

9.4 POTENTIAL RECEPTORS

Current potential receptors for COCs remaining in Site soil, groundwater and sediments include customers and workers at the 284 Winter Street Property, utility workers, and local residents who may contact surface water and sediments in the Little River. Note that the river is not easily accessible in the vicinity of the Site due to the presence of the retaining wall and steep banks on the western side of the river. However, what appeared to be homeless individuals have been infrequently observed in small huts or encampments adjacent to the river. There are also ecological receptors within the Little River which could be impacted by residuals from the Site that have been observed in sediments. Groundwater is not used for drinking water supply purposes downgradient of the Site, so that is not a possible exposure point for this Site. Potential future receptors would include future facility, construction and utility workers within the Site; possible future residential, school and recreational use of the 284 Winter Street property will be restricted by an Activity and Use Limitation (AUL) to be filed as part of the MCP closure activities. The relevant current and future receptors were evaluated in the context of the Method 3 risk characterization for the Site, which is outlined below.

10.0 SUMMARY OF RISK CHARACTERIZATION RESULTS

GZA completed a Method 3 Risk Characterization in accordance with the requirements of the MCP (including the 2014 amendments) and MassDEP Guidance for Disposal Site Risk Characterization (MassDEP, 1995, 1996, 2002a-c, and 2008) to evaluate Site-specific risks to human health, safety, public welfare, and the environment. This risk characterization was conducted to establish whether a condition of No Significant Risk, as defined by the MCP, exists at the disposal Site for identified human and terrestrial environmental receptors at the Site under current and foreseeable future land uses and activities. A Method 3 risk characterization incorporates comprehensive site information into the characterization of risk and is appropriate when the release of OHM is not limited to soil and groundwater. The full human health risk characterization report is presented in Appendix D; a summary of the risk characterization results is provided below. An

ecological risk characterization that evaluates the risks associated with impacts to the river is included in Anchor's report in Appendix C.

10.1 RISKS TO HUMAN HEALTH

The MCP indicates that a condition of No Significant Risk of harm to human health exists or has been achieved if:

- No Cumulative Receptor Non-Cancer Risk is greater than the Cumulative Receptor Non-Cancer Risk Limit of 1;
- No Cumulative Receptor Cancer Risk calculated is greater than the Cumulative Cancer Risk Limit of 1×10^{-5}; and
- No Exposure Point Concentration of OHM is greater than an applicable or suitably analogous public health standard.

The Method 3 Risk Characterization evaluated risks associated with the Site based on an evaluation of receptors, activities and use, exposure pathways and calculated exposure point concentrations (EPCs). Receptors included current and future employees, construction workers excavating into the subsurface, emergency repair/utility workers who perform emergency utility repair work, and service station customers. The risk characterization then calculated the cumulative risks via exposure to the Site and compared the risk estimates to the MCP non-cancer risk limit of a hazard index (HI) of one and the MCP cancer risk limit of an excess lifetime cancer risk (ELCR) of one in one hundred thousand (1×10^{-5}). With the exception of one receptor group/exposure scenario (construction/utility worker receptor group excavating below the water table within the former holder area), risk estimates were below the MCP criteria. The risk estimate for the one scenario which exceeded the limits were driven by benzene and naphthalene concentrations in the perched groundwater within the historical holder, where an active electrical line is apparently present.

10.2 RISKS TO SAFETY

The purpose of evaluating the risk of harm to safety is to identify release-related conditions within the Site area that could pose a threat of physical harm or bodily injury to people. Examples of conditions that constitute a risk of harm to safety are: the presence of rusted or corroded drums or containers; weakened berms; unsecured pits, ponds, lagoons, or other dangerous structures; any threat of fire or explosion, including the presence of explosive vapors resulting from a release of OHM; reactive chemicals stored or disposed of in a way that does not reasonably preclude uncontrolled reactions; any uncontained materials which exhibit the characteristics of corrosivity, reactivity, or flammability described in 310 CMR 40.0347; or the presence of ionizing or non-ionizing radiation.

No such release-related safety hazards were identified within the Site, nor are they anticipated to occur in the future. Therefore, a condition of No Significant Risk of harm to safety exists at the Site under the current and foreseeable future uses.

10.3 RISKS TO PUBLIC WELFARE

The risk of harm to public welfare considers the existence of nuisance conditions, loss of another person's active or passive property use, and any non-pecuniary costs that may accrue due to the degradation of public or private resources directly attributable to the release of OHM. The risk of harm to public welfare (and the environment) is also characterized by comparing arithmetic mean concentrations of COCs in soil and groundwater to the UCLs listed in 310 CMR 40. 0996(7) or identified pursuant to 310 CMR 40. 0996(8).

The arithmetic mean concentrations of soil and groundwater COCs at the Site do not exceed the corresponding UCLs. The portion of the Little River within the Site where sheens have been observed will be addressed for public welfare impacts as part of ongoing assessment activities.

10.4 RISKS TO THE ENVIRONMENT

The Site is less than two acres, and there is no contaminant transport from surficial soil to an ACEC. Therefore, the potential for significant risk to terrestrial receptors can be screened out in accordance with the MassDEP (1996) guidance. VOT is present within 12 inches of the sediment surface in an area of the Little River that exceeds 4,000 square feet, which represents a condition of "Readily Apparent Harm" to ecological receptors. Further discussion of environmental risks is provided in Appendix C. Additional work to evaluate and mitigate conditions in the Little River is required and will be documented in a Phase III RAP.

11.0 CONCLUSIONS

GZA GeoEnvironmental, Inc. and Anchor QEA LLC have completed a Phase II Comprehensive Site Assessment of the 284 Winter Street Site, in Haverhill, Massachusetts in accordance with the relevant requirements of the MCP (310 CMR 40.0830 et seq.). Based on this assessment, we developed the following conclusions:

1. The Site consists of the property located at 284 Main Street in Haverhill, Massachusetts and is currently occupied by a gasoline service station and car wash. An adjacent, vacant property to the southeast of the 284 Winter Street parcel also lies within the Disposal Site, along with a portion of the Little River which flows along the Property's western boundary. The Site occupies approximately 1.6 acres of land with a relatively level upland area separated from the Little River (at an elevation approximately 15 feet below that of the upland area) by a masonry retaining wall.

2. The Site lies within a commercial/industrial area in the downtown portion of Haverhill. No water supplies are located in the vicinity of the Site and environmentally sensitive areas other than the Little River have not been identified in the Site area. The Little River has been channelized in the Site area and it enters a concrete flood conduit at the downstream edge of the Disposal Site; this conduit flows beneath downtown Haverhill and discharges to the Merrimack River.

3. An MGP operated at the 284 Winter Street property between approximately 1853 and 1970, with various gas production processes utilized over this period. The Property has been used as a gasoline service station, fuel oil distribution facility and a car wash since 1977.

4. During a site assessment for a planned real estate transaction in November 2014, certain constituents were reported in soil and groundwater samples at concentrations exceeding the MCP RCs. The owner of the property (HRT) notified the MassDEP regarding this finding in March 2015 and RTN 3-32792 was assigned. During assessment of this RTN in May 2015, HRT's consultant (Ramboll) noted a sheen on the Little River that appeared to be emanating from the Property. An additional notification to MassDEP was made and an additional RTN (3-32875) was assigned. IRA activities were initiated in May 2015 in response to this finding and included gauging and recovery of NAPL in Site monitoring wells and installation of absorbent booms in the Little River. A semi-permanent boom system was installed within the River in November 2016 and has been maintained through the present under the IRA.

5. Ramboll completed a Phase I ISI on behalf of HRT in April 2016 for RTNs 3-32792 and 3-32875 and continued IRA activities through October 2019. The Phase II work required under the MCP was not completed by the specified deadline and MassDEP issued an NON. National Grid assumed responsibility for the MCP response actions for the two

RTNs in November 2019 with the filing of a Tier Classification transfer. National Grid and MassDEP signed an ACO in October 2020 which established a deadline of April 6, 2022 for submittal of the Phase II report.

6. The Site is underlain by an historic fill layer of varying thickness and composition which overlies a fine-grained deposit consisting of silt or silty sand. The fill underlying the 284 Winter Street property is typical of an historic urban fill, composed of reworked natural soils with significant quantities of debris, including concrete, asphalt, brick, wood, coal and glass. Remnants of former structures were encountered at number of locations during subsurface explorations at the Site.

7. Groundwater flow at the Site is generally toward the west/southwest, with the Little River as the main discharge point. A "perched" groundwater condition exists within the footprint of the historical relief holder in the central portion of the Site, with groundwater elevations typically 7-8 feet higher than elsewhere within the property and within 4 feet of ground surface. Total groundwater flow through the Site is estimated to be approximately 1 gpm, with flow rates restricted by the relatively low permeability of Site soils. The estimated transport velocity for groundwater at the Site is approximately 0.1 ft/day (37 ft/yr).

8. Petroleum and MGP-related constituents including naphthalene, other PAHs, EPH and VPH fractions and aromatic VOCs are present in soils throughout the 284 Winter Street Property, with the most significant impacts found at the 5 to 20 foot depth range. While COC concentrations in soil exceeded the MCP Method 1 cleanup standards at a number of locations, they were generally below the UCLs.

9. The primary COCs detected in groundwater samples at levels above the Method 1 standards included naphthalene, C_9-C_{10} aromatics and benzene, with the highest concentrations reported in the central, western and southern portions of the 284 Winter Street property. Significant impacts to groundwater extend from the eastern portion of the property to the Little River; wells installed on the western side of the river to the southwest of the 284 Winter Street property did not indicate detectable levels of the primary Site COCs.

10. Concentrations of constituents detected in soil gas at the Site appear to be primarily related to incidental emissions and spills associated with the active gasoline and diesel storage and dispensing operations. GZA's evaluation concluded that the reported concentrations do not indicate significant potential for vapor intrusion into occupied structures at the Site.

11. Significant impacts were observed to the sediments beneath the Little River adjacent to the Site, including elevated concentrations of Site COCs and the presence of VOT over a substantial area.

12. NAPL has been observed at several locations across the western, central and southern portions of the Site, but significant accumulations of separate-phase materials have only been observed at two locations in the upland area, one of which is within the historical relief gas holder. Evaluations of NAPL mobility and recoverability completed under MassDEP guidance concluded that these materials are not feasible to recover. NAPL has historically migrated to the Little River and has been observed seeping from the retaining wall at the edge of the Site under certain conditions.

13. A Method 3 Risk Characterization has indicated that quantitative human health risk estimates were below the relevant MCP criteria with the exception of one receptor group/exposure scenario (construction/utility workers excavating below the water table within the former holder area). The risk estimate for the one scenario which exceeded the limits were driven by benzene and naphthalene concentrations in the perched groundwater within the historical holder, where an active electrical line is apparently present.

14. Sediment conditions within the Little River adjacent to the Site represent a condition of Readily Apparent Harm (RAH) to environmental receptors due to the widespread VOT.

15. Achievement of a Permanent Solution cannot be demonstrated at this time for the 284 Winter Street Site, due to the exceedance of the human health risk criteria for that one exposure scenario and the RAH condition. A Phase III Remedial Action Plan will be submitted to MassDEP to evaluate the feasibility of performing remedial actions to address the identified risks and achieve a Temporary or Permanent Solution for the Site.

12.0 PUBLIC INVOLVEMENT

In accordance with Section 310 CMR 40.1403(3)(e) of the MCP, GZA has notified the Haverhill Mayor and Board of Health of the availability of this Phase II Comprehensive Response Action Report, and has provided them with a copy of the findings and conclusions. Copies of these public involvement notices are included in Appendix O. In addition, in accordance with Section 310 CMR 40.1406, the owners of the properties within the Site boundaries have been provided with a copy of the disposal site boundary map and conclusions of this Phase II CSA report. Copies of these notices to the property owners, as well as copies of the data transmittal forms for environmental samples submitted in accordance with Section 310 CMR 40.1403(10)(c), are also included in Appendix O of this Phase II CSA submittal.

13.0 REFERENCES

GZA GeoEnvironmental Inc., Tier I Classification Transfer, Haffner Realty Trust MCP Disposal Site, 284 Winter Street, Haverhill, Massachusetts, Release Tracking Numbers (RTNs) 3-32792 and 3-32875. November 2019.

GZA GeoEnvironmental Inc., Immediate Response Action Status Report No. 10, 284 Winter Street, Haverhill, Massachusetts, Release Tracking Numbers (RTNs) 3-32792 and 3-32875. March 2020.

Massachusetts Department of Environmental Protection, Memorandum to the File, From Timothy Boyle through Kyle MacAfee, 284 Winter Street, Haverhill, Release Tracking Numbers 3-0032792 and 3-0032875. February 2017.

Ramboll Environ, Immediate Response Action Plan, Haffner Realty Trust, 284 Winter Street, Haverhill, MA, RTN 3-32875. July 2015.

Ramboll Environ, Phase I Initial Site Investigation, Haffner Realty Trust, 284 Winter Street, Haverhill, MA. April 2016.

Ramboll Environ, Immediate Response Action Status Reports 1 through 9, Haffner Realty Trust, 284 Winter Street, Haverhill, MA, RTN 3-32875. September 2015 through September 2019.

Tables

TABLE 1
SOIL ANALYTICAL DATA
284 Winter Street
Haverhill, Massachussetts

Location				B-1	B-3	ENV-1B	ENV-2B	ENV-3B	ENV-5B	ENV-6B	ENV-7B		ENV-8B	ENV-9B	ENV-10B	ENV-11B	ENV-12B	ENV-13B	NFSB-01				
Sample ID				B-1 10-12'	B-3 15-17'	ENV-1B-15.0'-17.5'	ENV-2B-5.0'-6-5'	ENV-3B-12.5'-15.0'	ENV-5B-12.5'-15.0'	ENV-6B-6.0'-7.0'	ENV-7B-10.0'-11.0'	ENV-7B-10.0'-10-11	ENV-8B-12.5'-15.0'	ENV-9B-12.5'-15.0'	ENV-10B-0.0'-2.5'	ENV-11B-15.0'-15-17.5	ENV-12B-15.0'-15-17.5	ENV-13B-17.5'-17.5-20	NFSB-01 2-3'	NFSB-01 7-8'	NFSB-01 10-15'	NFSB-01 15-16'	NFSB-01 16-20'
Sample Depth (ft bgs)				10-12	15-17	15-17.5	5-6.5	12.5-15	12.5-15	6-7	10-11	10-11	12.5-15	12.5-15	0-2.5	15-17.5	15-17.5	N	2-3	7-8	10-15	15-16	16-20
Duplicate Sample				N	N	N	N	N	N	N	Y	Y	N	N	N	N	N	17.5-20	N	N	N	N	N
Sampling Date				11/24/2014	11/24/2014	4/28/2015	4/28/2015	4/28/2015	4/27/2015	4/27/2015	4/27/2015	4/27/2015	4/27/2015	4/27/2015	4/28/2015	4/27/2015	4/28/2015	4/28/2015	10/20/2016	10/20/2016	10/25/2016	10/25/2016	10/25/2016
MCP Standard	UCL	S-3/GW-2	S-3/GW-3	S-3/GW-2	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3
Total Petroleum Hydrocarbons (mg/kg)																							
Total Petroleum Hydrocarbons (TPH)	10,000	5,000	5,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.92	24	1,580	462	***24,200***
Extractable Petroleum Hydrocarbons (mg/kg)																							
C_9-C_{18} Aliphatics	20,000	5,000	5,000	<20	--	68.7	275	**12,600**	4,800	3,090	1,390	1,240	**6,750**	**8,040**	<6.66	**6,240**	**13,300**	904	--	--	--	--	--
C_{19}-C_{36} Aliphatics	20,000	5,000	5,000	250	--	51	113	1,990	860	1,440	757	721	861	830	<6.66	877	2,020	701	--	--	--	--	--
C_{11}-C_{22} Aromatics, Adjusted	10,000	5,000	5,000	4,000	--	106	462	**9,150**	3,910	2,290	3,100	3,020	**5,200**	**5,140**	<6.66	3,320	**5,270**	**15,600**	--	--	--	--	--
Naphthalene	10,000	20	3,000	*1,200*	--	--	<0.802	--	--	<1.51	109	112	--	362	<0.333	--	--	783	24.4	312	3.42	--	1,760
2-Methylnaphthalene	5,000	80	500	***570***	--	--	<0.802	--	--	7.49	87	86	--	234	<0.333	--	--	**714**	12.3	19.4	3.59	--	90.5
Acenaphthylene	10,000	600	10	**310**	--	--	2.2	--	--	<1.51	**25**	**21**	--	**10**	<0.333	--	--	**43.2**	**19.9**	**22.8**	1.56	--	**45.4**
Acenaphthene	10,000	5,000	5,000	34	--	--	1.86	--	--	2.77	11.2	10.7	--	32.6	<0.333	--	--	93.8	6.63	11.4	4.85	--	128
Fluorene	10,000	5,000	5,000	180	--	--	1.25	--	--	2.26	21.1	20.2	--	37.7	<0.333	--	--	116	20	30.6	4.18	--	143
Phenanthrene	10,000	3,000	3,000	550	--	--	7.22	--	--	27.3	91.1	92.3	--	96.9	<0.333	--	--	373	98	80.8	12.2	--	417
Anthracene	10,000	5,000	5,000	150	--	--	2.46	--	--	6.38	22.0	22.5	--	33.7	<0.333	--	--	57.8	28.1	16.5	2.93	--	67.9
Fluoranthene	10,000	5,000	5,000	180	--	--	2.8	--	--	12.9	38.8	38.0	--	26.8	<0.333	--	--	93.5	34.7	18.6	2.58	--	88.9
Pyrene	10,000	5,000	5,000	320	--	--	6.32	--	--	19.2	68.2	66.6	--	46.0	<0.333	--	--	133	63	29.5	4.76	--	142
Benzo(a)anthracene	3,000	300	300	87	--	--	2.16	--	--	8.07	21.7	20.6	--	13.9	<0.333	--	--	43.3	21.9	12.6	1.89	--	47.2
Chrysene	10,000	3,000	3,000	73	--	--	2.42	--	--	7.72	27.0	26.0	--	15.6	<0.333	--	--	55.1	21.2	14.2	2.12	--	51.7
Benzo(b)fluoranthene	3,000	300	300	80	--	--	1.24	--	--	4.19	14.2	13.2	--	<9.57	<0.333	--	--	<31.9	11.7	4.67	0.632	--	16.3
Benzo(k)fluoranthene	10,000	3,000	3,000	26	--	--	1.22	--	--	5.15	17.3	16.5	--	<9.57	<0.333	--	--	<31.9	15.1	6.76	0.927	--	22.9
Benzo(a)pyrene	300	30	30	***110***	--	--	2.62	--	--	7.27	24.5	24.5	--	11.9	<0.333	--	--	**39.2**	26.8	12.1	1.66	--	**38.9**
Indeno(1,2,3-cd)Pyrene	3,000	300	300	38	--	--	1.15	--	--	3.48	11.0	10.9	--	<9.57	<0.333	--	--	<31.9	9.89	3.45	0.432	--	10.2
Dibenzo(a,h)anthracene	300	30	30	11	--	--	<0.802	--	--	<1.51	<3.63	<2.94	--	<9.57	<0.333	--	--	<31.9	2.87	1.3	0.172	--	4.52
Benzo(ghi)perylene	10,000	5,000	5,000	50	--	--	1.27	--	--	3	12.2	12.1	--	<9.57	<0.333	--	--	<31.9	12.3	3.91	0.511	--	11.3
Volatile Petroleum Hydrocarbons (mg/kg)																							
C_5-C_8 Aliphatics, Adjusted	5,000	500	500	<1000	<20	<81.9	<4.89	<942	351	59	<109	<89.6	265	<345	3.63	466	384	<506	--	--	--	--	--
C_9-C_{12} Aliphatics, Adjusted	20,000	5,000	5,000	2000	150	<81.9	8.77	1,470	1,660	105	<109	<89.6	1,400	2,730	<2.32	1,220	1,230	2,280	--	--	--	--	--
C_9-C_{10} Aromatics	5,000	500	500	***<1000***	150	341	113	**3,530**	**2,220**	248	**522**	245	**2,360**	**648**	<2.32	**2,840**	**2,090**	**1,450**	--	--	--	--	--
Benzene	10,000	400	1,000	190	<0.2	--	0.28	<37.7	--	1.04	<4.37	<3.58	--	--	<0.093	--	--	<20.3	--	--	--	--	--
Toluene	10,000	2,000	3,000	230	<0.2	--	<0.196	<37.7	--	<0.406	<4.37	<3.58	--	--	<0.093	--	--	<20.3	--	--	--	--	--
Ethylbenzene	10,000	1,000	3,000	23	<0.2	--	4.22	268	--	6.26	7.16	5.40	--	--	<0.093	--	--	160	--	--	--	--	--
p/m-Xylene	10,000	100	3,000	100	<0.2	--	0.526	94	--	0.88	<4.37	<3.58	--	--	<0.093	--	--	227	--	--	--	--	--
o-Xylene	10,000	100	3,000	220	<0.2	--	0.591	134	--	1.31	<4.37	<3.58	--	--	<0.093	--	--	105	--	--	--	--	--
Total Xylene (calculated)	10,000	100	3,000	320	<0.2	--	1.12	228.30	--	2.19	<8.74	<7.16	--	--	<0.186	--	--	332	--	--	--	--	--
Methyl tert butyl ether	5,000	100	500	<20	<0.5	--	<0.098	<18.8	--	<0.203	<2.18	<1.79	--	--	<0.046	--	--	<10.1	--	--	--	--	--
Naphthalene	10,000	20	3,000	*2,900*	2.80	--	3.20	2,910	--	10.70	244	175	--	--	<0.185	--	--	1,940	--	--	--	--	--
Metals																							
Arsenic	500	50	50	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	2,000	200	200	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	6,000	600	600	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyanide (PAC)																							
Cyanide (PAC)	5,000	500	500	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Solids, Total (%)	NA	NA	NA	--	0	86.4	81.7	83	84	84	86	86	--	85	--	82	**89**	83					

Notes:
1. Only detected analytes are presented in this table.
2. For analytes below reported detection limits, 1/2 the detection limit value was compared to the standard.
3. "-" indicates not analyzed; NA indicates not applicable.
4. Massachusetts Contingency Plan (MCP) Method 1 standards and Upper Concentration Limits (UCLs) are from the tables in the 2014 MCP. Exceedances of applicable standards are highlighted as described below.

Italics, pale shading	concentration exceeds Method 1 S-3/GW-2 soil standard (samples collected from 0-15' bgs within 30 feet of an occupied building)
Bold, pale shading	concentration exceeds Method 1 S-3/GW-3 soil standard (samples collected below 15 feet bgs or greater than 30 feet from building)
Bold italics, pale shading	concentration exceeds both Method 1 S-3/GW-2 and S-3/GW-3 soil standards (samples collected from 0-15' bgs and within 30 feet of an occupied building)
Bold italics, dark shading	concentration exceeds UCL, applicable to all samples

5. Samples B-1 and B-3 collected by Lessard Environmental, Inc. and analyzed by Eastern Analytical Inc.
6. ENV-# series samples collected by Ramboll Environ Inc. of Westford, MA.
7. NFSB-# and B-100 series samples collected by GZA GeoEnvironmental, Inc. of Norwood, MA.
8. * The laboratory noted that for sample ENV-10B-0.0'-2.5' the non-hydrocarbon VPH compounds may have been included in the summation of the C5-C8 Aliphatics range; therefore, this result is considered biased high and the noted result is considered an estimated value.
9. Total Xylenes was calculated as the sum of the detected results for o-Xylene and p/m-Xylene. If both o-Xylene and p/m-Xylene were non-detect, Total Xylenes was reported as twice the lowest reporting limit between o-Xylene and p/m-Xylene.

TABLE 1
SOIL ANALYTICAL DATA
284 Winter Street
Haverhill, Massachussetts

Location				NFSB-02				NFSB-03					NFSB-04		NFSB-05			NFSB-06		NFSB-07		
Sample ID	UCL	S-3/GW-2	S-3/GW-3	NFSB-02 2-3'	NFSB-02 12-15'	NFSB-02 15-20'	NFSB-02 15-20' FD (DUP-1)	NFSB-03 1-2'	NFSB-03 10-15'	NFSB-03 15-17'	NFSB-03 15-17' LD	NFSB-03 15-17' FD (DUP-2)	NFSB-04 0-1'	NFSB-04 12.5-15'	NFSB-05 1-2'	NFSB-05 5-6'	NFSB-05 5-6'	NFSB-06 1-2'	NFSB-06 12.5-15'	NFSB-07 1-2'	NFSB-07 6-7'	NFSB-07 13-15'
Sample Depth (ft bgs)				2-3	12-15	15-20	15-20	1-2	10-15	15-17	15-17	15-17	0-1	12.5-15	1-2	5-6	5-6	1-2	12.5-15	1-2	6-7	13-15
Duplicate Sample				N	N	Y	Y	N	N	Y	Y	Y	N	N	N	Y	Y	N	N	N	N	N
Sampling Date				10/21/2016	10/24/2016	10/24/2016	10/24/2016	10/21/2016	10/25/2016	10/25/2016	10/25/2016	10/25/2016	10/20/2016	10/24/2016	10/20/2016	10/20/2016	10/20/2016	10/20/2016	10/25/2016	10/20/2016	10/20/2016	10/24/2016
MCP Standard				S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-2	S-3/GW-2	S-3/GW-2
Total Petroleum Hydrocarbons (mg/kg)																						
Total Petroleum Hydrocarbons (TPH)	10,000	5,000	5,000	**5,800**	***52,500***	***21,500***	***35,000***	1,000	**8,600**	3,860	3,900	**6,160**	3.74	**8,600**	1,980	**8,420**	**8,180**	1,260	***24,100***	549	***28,200***	***9,140***
Extractable Petroleum Hydrocarbons (mg/kg)																						
C_9-C_{18} Aliphatics	20,000	5,000	5,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C_{19}-C_{36} Aliphatics	20,000	5,000	5,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C_{11}-C_{22} Aromatics, Adjusted	10,000	5,000	5,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	10,000	20	3,000	9.86	1,490	702	1,120	1.25	--	371	381	348	0.00418	--	--	18.2	18.5	2.13	--	--	--	67.4
2-Methylnaphthalene	5,000	80	500	8.24	105	55.9	77.5	1.43	--	9.52	9.63	9.91	0.00338	--	--	1.95	2.06	1.54	--	--	--	17.8
Acenaphthylene	10,000	600	10	**39.6**	**63**	**29.5**	**40.5**	2.68	--	5.29	5.12	7.7	0.0137	--	--	**11.3**	**11.8**	3.71	--	--	--	5.09
Acenaphthene	10,000	5,000	5,000	2.07	148	119	140	0.56	--	34.2	34.2	38.1	0.00154	--	--	1.95	1.87	0.319	--	--	--	24
Fluorene	10,000	5,000	5,000	3.15	166	96.9	129	1.46	--	16	15.8	17.3	0.00221	--	--	3.04	2.71	0.876	--	--	--	14.7
Phenanthrene	10,000	3,000	3,000	25.6	494	288	388	7.51	--	46.2	46.4	53.4	0.0295	--	--	13.4	11.4	6.42	--	--	--	50.7
Anthracene	10,000	5,000	5,000	21.3	98.2	62.4	79.9	2.48	--	12	11.8	13.8	0.00973	--	--	6.51	7.14	2.69	--	--	--	17.4
Fluoranthene	10,000	5,000	5,000	19.1	115	72.4	100	4.05	--	14.3	14.4	17.8	0.0341	--	--	11.6	12.4	8.22	--	--	--	13.7
Pyrene	10,000	5,000	5,000	43.3	163	95.9	137	5.74	--	19.5	19.6	22.6	0.0525	--	--	19.8	20.9	9.64	--	--	--	24.6
Benzo(a)anthracene	3,000	300	300	18.2	57.2	35.3	41.8	2.98	--	8.08	8.2	10.4	0.0213	--	--	6.66	8.96	6.79	--	--	--	8.37
Chrysene	10,000	3,000	3,000	24	63.9	37.7	41.6	3.44	--	8.79	8.99	11.7	0.0222	--	--	8.1	10.8	6.82	--	--	--	8.82
Benzo(b)fluoranthene	3,000	300	300	23.5	20.5	14.1	17.2	2.41	--	3.62	3.74	5.37	0.0204	--	--	11.6	15.2	6.84	--	--	--	2.71
Benzo(k)fluoranthene	10,000	3,000	3,000	19.8	33.5	21.6	22	2.84	--	5.2	5.23	7.33	0.024	--	--	10.4	11.5	5.93	--	--	--	3.84
Benzo(a)pyrene	300	30	30	29.4	**48.5**	**30.3**	**34.9**	3.56	--	7.08	7.18	9.78	0.0275	--	--	16	18.3	7.98	--	--	--	7.35
Indeno(1,2,3-cd)Pyrene	3,000	300	300	18.1	14.2	9.92	11.6	2.12	--	2.81	3	4.18	0.0181	--	--	11.2	12.7	5.26	--	--	--	2.21
Dibenzo(a,h)anthracene	300	30	30	8.03	5.54	3.7	4.74	0.717	--	1.06	1.16	1.54	0.00583	--	--	4.29	4.83	1.73	--	--	--	1.05
Benzo(ghi)perylene	10,000	5,000	5,000	19.3	15.3	10.4	11.9	2.58	--	3.06	3.12	4.44	0.0207	--	--	13.3	14.8	5.52	--	--	--	2.88
Volatile Petroleum Hydrocarbons (mg/kg)																						
C_5-C_8 Aliphatics, Adjusted	5,000	500	500	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C_9-C_{12} Aliphatics, Adjusted	20,000	5,000	5,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C_9-C_{10} Aromatics	5,000	500	500	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzene	10,000	400	1,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	10,000	2,000	3,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	10,000	1,000	3,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
p/m-Xylene	10,000	100	3,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
o-Xylene	10,000	100	3,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Xylene (calculated)	10,000	100	3,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Methyl tert butyl ether	5,000	100	500	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	10,000	20	3,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Metals																						
Arsenic	500	50	50	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	2,000	200	200	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	6,000	600	600	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyanide (PAC)																						
Cyanide (PAC)	5,000	500	500	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Solids, Total (%)	NA	NA	NA																			

Notes:
1. Only detected analytes are presented in this table.
2. For analytes below reported detection limits, 1/2 the detection limit value was compared to the standard.
3. "-" indicates not analyzed; NA indicates not applicable.
4. Massachusetts Contingency Plan (MCP) Method 1 standards and Upper Concentration Limits (UCLs) are from the tables in the 2014 MCP. Exceedances of applicable standards are highlighted as described below.

Italics, pale shading	concentration exceeds Method 1 S-3/GW-2 soil standard (samples collected from 0-15' bgs within 30 feet of an occupied building)
Bold, pale shading	concentration exceeds Method 1 S-3/GW-3 soil standard (samples collected below 15 feet bgs or greater than 30 feet from building)
Bold italics, pale shading	concentration exceeds both Method 1 S-3/GW-2 and S-3/GW-3 soil standards (samples collected from 0-15' bgs and within 30 feet of an occupied building)
Bold italics, dark shading	concentration exceeds UCL, applicable to all samples

5. Samples B-1 and B-3 collected by Lessard Environmental, Inc. and analyzed by Eastern Analytical Inc.
6. ENV-# series samples collected by Ramboll Environ Inc. of Westford, MA.
7. NFSB-# and B-100 series samples collected by GZA GeoEnvironmental, Inc. of Norwood, MA.
8. * The laboratory noted that for sample ENV-10B-0.0'-2.5' the non-hydrocarbon VPH compounds may have been included in the summation of the C5-C8 Aliphatics range; therefore, this result is considered biased high and the noted result is considered an estimated value.
9. Total Xylenes was calculated as the sum of the detected results for o-Xylene and p/m-Xylene. If both o-Xylene and p/m-Xylene were non-detect, Total Xylenes was reported as twice the lowest reporting limit between o-Xylene and p/m-Xylene.

TABLE 1
SOIL ANALYTICAL DATA
284 Winter Street
Haverhill, Massachussetts

Location				NFSB-08			NFSB-09		B102		B103	B104		B106	B107			B108	B109		B110	GZA-1
Sample ID				NFSB-08 1-2'	NFSB-08 7-8'	NFSB-08 11-15'	NFSB-09 1-2'	NFSB-09 3-4'	B-102 S-1	B-102 S-6	B-103 S-1	B-104 S-1	B-104 S-12	B-106 S-1	B-107 S-2	B-107 S-4	B-107 S-4 and S-5	B-108 S-2	B-109 S-1	B-109 S-12	B-110 S-2	GZA-1 Fingerprint
Sample Depth (ft bgs)				1-2	7-8	11-15	1-2	3-4	0-3	12-14	0-3	0-3	32	0-2	0.5-3	5-7	5-9	1-3	0-3	50-52	1-2	15.5
Duplicate Sample				N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Sampling Date				10/20/2016	10/20/2016	10/24/2016	10/21/2016	10/21/2016	1/16/2020	1/22/2020	1/16/2020	1/16/2020	1/23/2020	1/17/2020	1/17/2020	1/21/2020	20/21/2020	1/23/2020	1/17/2020	1/21/2020	1/20/2020	9/1/2020
MCP Standard				S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-2	S-3/GW-3	S-3/GW-3	S-3/GW-2	S-3/GW-2	S-3/GW-2	S-3/GW-2	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3	S-3/GW-3
Total Petroleum Hydrocarbons (mg/kg)																						
Total Petroleum Hydrocarbons (TPH)	10,000	5,000	5,000	1,210	467	37.2	1,840	**9,300**	--	--	--	--	--	--	--	--	--	--	--	--	--	444
Extractable Petroleum Hydrocarbons (mg/kg)																						
C_9-C_{18} Aliphatics	20,000	5,000	5,000	--	--	--	--	--	<16.4	102	<18.2	<32.8	<83.3	168	102	--	<286	360	170	<71.5	52.2	--
C_{19}-C_{36} Aliphatics	20,000	5,000	5,000	--	--	--	--	--	<16.4	<80.6	<18.2	<32.8	<83.3	73.2	217	--	<286	<250	109	<71.5	53	--
C_{11}-C_{22} Aromatics, Adjusted	10,000	5,000	5,000	--	--	--	--	--	44	88.5	45.2	93.5	<83.3	803	689	--	813	1,140	314	76.8	224	--
Naphthalene	10,000	20	3,000	8.39	0.098	0.002	--	24	0.68	73.8	<0.48	<0.87	<2.22	*55.1*	13.6	--	*289*	45	8.11	<1.91	1.45	--
2-Methylnaphthalene	5,000	80	500	1.47	0.178	0.001	--	29.5	7.76	24.7	<0.24	<0.44	<1.11	40.6	3.21	--	*108*	45.2	5.53	<0.95	1.82	--
Acenaphthylene	10,000	600	10	1.6	0.037	0.008	--	**40**	0.3	2.86	<0.24	0.55	<1.11	2.59	5.89	--	**70.3**	6.41	2.81	1.5	1.21	--
Acenaphthene	10,000	5,000	5,000	1.47	0.067	0.004	--	16.6	<0.44	<2.15	<0.48	<0.87	<2.22	13.3	<2.23	--	10.1	7.22	1.36	<1.91	<0.96	--
Fluorene	10,000	5,000	5,000	2.1	0.100	0.006	--	82.2	<0.44	<2.15	<0.48	<0.87	<2.22	28.7	3.61	--	42.5	17.1	5.5	<1.91	0.97	--
Phenanthrene	10,000	3,000	3,000	11.4	0.345	0.018	--	404	0.91	<2.15	1.3	<0.87	<2.22	69	13.7	--	203	56.2	22.1	6.24	4.91	--
Anthracene	10,000	5,000	5,000	7.9	0.034	0.006	--	76.8	<0.44	<2.15	<0.48	<0.87	<2.22	4.62	3.74	--	50.5	7.9	4.62	<1.91	1.47	--
Fluoranthene	10,000	5,000	5,000	16.4	0.046	0.007	--	212	2.72	<2.15	2.55	0.89	<2.22	18.9	7.74	--	59.5	18.9	12.3	<1.91	4	--
Pyrene	10,000	5,000	5,000	14.6	0.052	0.007	--	169	2.86	<2.15	2	1.49	<2.22	31.2	12	--	116	30.7	18.5	2.59	7.09	--
Benzo(a)anthracene	3,000	300	300	11.2	0.024	0.004	--	112	1.48	<2.15	1.5	<0.87	<2.22	6.93	3.54	--	25.8	8.5	5.59	<1.91	2.39	--
Chrysene	10,000	3,000	3,000	10.3	0.027	0.004	--	99.9	1.45	<2.15	1.42	0.9	<2.22	8.33	4.29	--	28.4	9.68	5.79	<1.91	2.48	--
Benzo(b)fluoranthene	3,000	300	300	9.37	0.028	0.003	--	87.1	1.88	<2.15	1.61	1.15	<2.22	2.33	<2.23	--	11.8	<6.67	3.9	<1.91	2.12	--
Benzo(k)fluoranthene	10,000	3,000	3,000	11.3	0.044	0.004	--	87.8	1.1	<2.15	1.2	<0.87	<2.22	1.84	2.75	--	11.1	<6.67	2.57	<1.91	1.71	--
Benzo(a)pyrene	300	30	30	11.9	0.042	0.005	--	**105**	2.01	<2.15	1.8	1.18	<2.22	4.39	3.65	--	22.4	7.67	5.03	<1.91	3.05	--
Indeno(1,2,3-cd)Pyrene	3,000	300	300	7.26	0.030	0.003	--	58.2	1.25	<2.15	0.91	1.02	<2.22	1.47	2.4	--	10.2	<6.67	1.58	<1.91	1.27	--
Dibenzo(a,h)anthracene	300	30	30	2.77	0.011	0.001	--	18.8	0.33	<1.07	0.34	<0.44	<1.11	<0.46	<1.12	--	<3.82	<3.34	0.61	<0.95	0.5	--
Benzo(ghi)perylene	10,000	5,000	5,000	6.35	0.031	0.003	--	56.7	1.07	<2.15	0.83	1.01	<2.22	1.52	2.78	--	11	<6.67	1.56	<1.91	1.36	
Volatile Petroleum Hydrocarbons (mg/kg)																						
C_5-C_8 Aliphatics, Adjusted	5,000	500	500	--	--	--	--	--	<8.52	315	<11.5	<7.75	<13.5	20.7	<11.3	***609***	--	17.7	<9.86	<11.2	<10.4	--
C_9-C_{12} Aliphatics, Adjusted	20,000	5,000	5,000	--	--	--	--	--	<17.0	339	<22.9	<15.4	<26.9	120	<22.5	261	--	134	33.4	<22.2	<20.8	--
C_9-C_{10} Aromatics	5,000	500	500	--	--	--	--	--	<8.15	**748**	<11.0	<7.42	<12.9	286	17.9	***687***	--	165	53.2	<10.7	<9.98	--
Benzene	10,000	400	1,000	--	--	--	--	--	<0.16	<0.20	<0.22	0.71	<0.26	5.51	<0.22	155	--	0.87	0.61	<0.21	<0.20	--
Toluene	10,000	2,000	3,000	--	--	--	--	--	<0.16	1.32	<0.22	0.83	<0.26	0.52	<0.22	63.4	--	<0.28	0.36	<0.21	<0.20	--
Ethylbenzene	10,000	1,000	3,000	--	--	--	--	--	<0.16	27	<0.22	0.23	<0.26	6.58	1.71	33.7	--	3.68	0.7	<0.21	<0.20	--
p/m-Xylene	10,000	100	3,000	--	--	--	--	--	<0.33	59.1	<0.44	0.44	<0.52	6.4	<0.43	48.3	--	2.57	0.6	<0.43	<0.40	--
o-Xylene	10,000	100	3,000	--	--	--	--	--	<0.16	29.4	<0.22	0.31	<0.26	6.36	<0.22	36.7	--	2.58	1.05	<0.21	<0.20	--
Total Xylene (calculated)	10,000	100	3,000	--	--	--	--	--	<0.32	88.5	<0.44	0.75	<0.52	12.8	<0.44	85.0	--	5.15	1.65	<0.42	<0.4	--
Methyl tert butyl ether	5,000	100	500	--	--	--	--	--	<0.04	<0.05	<0.06	<0.04	<0.06	<0.05	<0.05	<0.09	--	<0.07	<0.05	<0.05	<0.05	--
Naphthalene	10,000	20	3,000	--	--	--	--	--	<0.16	119	<0.22	<0.15	0.54	*281*	15.6	*1,070*	--	158	23.1	<0.21	0.97	--
Metals																						
Arsenic	500	50	50	--	--	--	--	--	--	--	--	--	--	4.47	9.55	--	--	6.38	7.17	--	7.4	--
Chromium	2,000	200	200	--	--	--	--	--	--	--	--	--	--	14.9	16.8	--	--	12.1	15.4	--	13.9	--
Lead	6,000	600	600	--	--	--	--	--	--	--	--	--	--	10.3	96.4	--	--	24.7	74.1	--	55.8	--
Cyanide (PAC)																						
Cyanide (PAC)	5,000	500	500	--	--	--	--	--	1.58	--	1.25	1.37	--	9.46	2.55	--	--	21.2	11.3	--	9.74	--
Solids, Total (%)	NA	NA	NA																			

Notes:
1. Only detected analytes are presented in this table.
2. For analytes below reported detection limits, 1/2 the detection limit value was compared to the standard.
3. "-" indicates not analyzed; NA indicates not applicable.
4. Massachusetts Contingency Plan (MCP) Method 1 standards and Upper Concentration Limits (UCLs) are from the tables in the 2014 MCP. Exceedances of applicable standards are highlighted as described below.

Italics, pale shading	concentration exceeds Method 1 S-3/GW-2 soil standard (samples collected from 0-15' bgs within 30 feet of an occupied building)
Bold, pale shading	concentration exceeds Method 1 S-3/GW-3 soil standard (samples collected below 15 feet bgs or greater than 30 feet from building)
Bold italics, pale shading	concentration exceeds both Method 1 S-3/GW-2 and S-3/GW-3 soil standards (samples collected from 0-15' bgs and within 30 feet of an occupied building)
Bold italics, dark shading	concentration exceeds UCL, applicable to all samples

5. Samples B-1 and B-3 collected by Lessard Environmental, Inc. and analyzed by Eastern Analytical Inc.
6. ENV-# series samples collected by Ramboll Environ Inc. of Westford, MA.
7. NFSB-# and B-100 series samples collected by GZA GeoEnvironmental, Inc. of Norwood, MA.
8. * The laboratory noted that for sample ENV-10B-0.0'-2.5' the non-hydrocarbon VPH compounds may have been included in the summation of the C5-C8 Aliphatics range; therefore, this result is considered biased high and the noted result is considered an estimated value.
9. Total Xylenes was calculated as the sum of the detected results for o-Xylene and p/m-Xylene. If both o-Xylene and p/m-Xylene were non-detect, Total Xylenes was reported as twice the lowest reporting limit between o-Xylene and p/m-Xylene.

TABLE 2
GROUNDWATER ANALYTICAL TABLE
284 Winter Street
Haverhill, Massachusetts

Location					MW-1			MW-2				MW-3			ENV-1MW			ENV-3MW		ENV-5MW						ENV-8MW		B-102			B-106		NFSB-01 (MW)	NFSB-08(MW)	GZA-1		GZA-1A		GZA-2	
Screened Interval (ft bgs)					5-15			13.20				8-18			11-21			10-20		12-22						10-20		10-20			12-90		12-22	12-22						
Groundwater Depth[2] (ft bgs)					3.24							12.16			13.36			13.48		14.44						14.82		11.95					13.21	15.17						
Sample ID	GW-2	GW-3	UCL	Units	MW-1	MW-1-20150512	MW-1	MW-2	MW-2-20150512	MW-2	MW-2	MW-3	MW-3-20150512	MW-3	ENV-1MW-20150512	ENV-1MW	ENV-1MW	ENV-3MW	ENV-3MW	ENV-5MW-20150512	ENV-5MW-20150512	DUP-20150512	ENV-5MW	ENV-5MW	ENV-5MW	ENV-8MW-20150512	ENV-8MW	B102	B102	B102	B106	B106	NFSB-01 (MW)	NFSB-08(MW)	GZA-1	GZA-1	GZA-1A	GZA-1A	GZA-2	GZA-2
Sampling Date					12/1/2014	5/12/2015	9/15/2020	12/1/2014	5/12/2015	2/12/2020	5/7/2020	12/1/2014	5/12/2015	2/12/2020	5/12/2015	2/12/2020	8/11/2021	5/7/2020	8/11/2021	5/12/2015	5/12/2015	5/12/2015	2/12/2020	5/7/2020	8/11/2021	5/12/2015	8/11/2021	2/12/2020	5/7/2020	8/11/2021	2/12/2020	5/7/2020	5/7/2020	5/7/2020	9/15/2020	11/20/2020	9/15/2020	11/20/2020	9/15/2020	11/20/2020
Lab Sample ID					L1510372-07	L1510372-07	L2038556-04	L1510372-06	L1510372-06	L2006490-04	L2019097-04	L1510372-05	L1510372-05	L2006490-06	L1510372-04	L2006490-02	L214432-01	L2019097-01	L2143342-02	L1510372-02	L1510372-02	L1510372-03	L2006490-05	L2019097-02	L2143342-03	L1510372-01	L2143342-04	L2006490-01	L2019097-06	L2143342-05	L2006490-03	L2019097-05	L2019097-05	L2019097-07	L2038556-01	L2052184-01	L2038556-02	L2052184-02	L2038556-03	L2052184-03
Extractable Petroleum Hydrocarbons (µg/L)																																						
C_9-C_{18} Aliphatics	5,000	50,000	100,000	µg/l	610	<4,000	<5,000	-	<1,000	<100	<500	-	<100	<100	<1,000	172	--	<2000	<5000	<1,000	-	<1,000	<1000	<1000	<1000	<1,000		<2,000	<2,000		616	<4,000	<500	<100	<100	<100	<100	<100	<100
C_{19}-C_{36} Aliphatics	~	50,000	100,000	µg/l	1,500	<4,000	<5,000	-	<1,000	<100	<500	-	<100	<100	<1,000	<100	--	<2000	<5000	<1,000	-	<1,000	<1000	<1000	<1000	<1,000		<2,000	<2,000		<100	<4,000	<500	<100	<100	<100	<100	<100	<100
C_{11}-C_{22} Aromatics	~	~	~	µg/l	2,900	5,690	7,560	-	2,520	449	667	-	702	435	<1,000	<100	--	5,820	9,980	1,770	-	1,970	3,660	2,790	4,360	2,740		<2,000	<2,000		660	8200	1030	109	<100	<100	<100	<100	<100	<100
C_{11}-C_{22} Aromatics, Adjusted	50,000	5,000	100,000	µg/l	2,900	<4,000	<5,000	-	<1,000	250	<500	-	560	235	<1,000	<100	--	<2000	<5000	<1,000	-	<1,000	1,750	1,300	2,410	1,250		<2,000	<2,000		547	<4,000	828	109	<100	<100	<100	<100	<100	<100
Naphthalene	700	20,000	100,000	µg/l	*3,100*	*3,560*	*6,630*	-	1,520	165	220	-	37.3	166	1,080	<10	--	3,630	5,290	854	-	905	1,580	12,800	1,610	1,290		*2,000*	*1,660*		49	*4,230*	200	<10	0.886	<100	1.22	<100	<100	<100
2-Methylnaphthalene	2,000	20,000	100,000	µg/l	590	<400	549	-	279	34	<50	-	30.4	33.9	219	<10	--	378	<500	146	-	154	322	215	332	204		220	<200		<10	479	<50	<10	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Acenaphthylene	10,000	40	100,000	µg/l	**130**	<400	140	-	<100	<10	<50	-	28.4	<10	<100	<10	--	<200	<500	<100	-	<100	<100	<100	<100	<100		<200	<200		20	<400	<50	<10	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Acenaphthene	~	10,000	100,000	µg/l	35	<400	<100	-	<100	<10	<50	-	14.9	<10	<100	<10	--	<200	<500	<100	-	<100	<100	<100	<100	<100		<200	<200		15.8	<400	<50	<10	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Fluorene	~	40	400	µg/l	**91**	<400	<100	-	<100	<10	<50	-	13.9	<10	<100	<10	--	<200	<500	<100	-	<100	<100	<100	<100	<100		<200	<200		10.3	<400	<50	<10	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Phenanthrene	~	10,000	100,000	µg/l	230	<400	<100	-	<100	<10	<50	-	16.2	<10	<100	<10	--	<200	<500	<100	-	<100	<100	<100	<100	<100		<200	<200		18.2	<400	<50	<10	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Anthracene	~	30	600	µg/l	**59**	<400	<100	-	<100	<10	<50	-	<10	<10	<100	<10	--	<200	<500	<100	-	<100	<100	<100	<100	<100		<200	<200		<10	<400	<50	<10	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Fluoranthene	~	200	2,000	µg/l	79	<400	<100	-	<100	<10	<50	-	<10	<10	<100	<10	--	<200	<500	<100	-	<100	<100	<100	<100	<100		<200	<200		<10	<400	<50	<10	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Pyrene	~	20	600	µg/l	**110**	<400	<100	-	<100	<10	<50	-	<10	<10	<100	<10	--	<200	<500	<100	-	<100	<100	<100	<100	<100		<200	<200		<10	<400	<50	<10	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Benzo(a)anthracene	~	1,000	10,000	µg/l	35	<400	<100	-	<100	<10	<50	-	<10	<10	<100	<10	--	<200	<500	<100	-	<100	<100	<100	<100	<100		<200	<200		<10	<400	<50	<10	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Chrysene	~	70	700	µg/l	38	<400	<100	-	<100	<10	<50	-	<10	<10	<100	<10	--	<200	<500	<100	-	<100	<100	<100	<100	<100		<200	<200		<10	<400	<50	<10	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Benzo(b)fluoranthene	~	400	4,000	µg/l	24	<400	<100	-	<100	<10	<50	-	<10	<10	<100	<10	--	<200	<500	<100	-	<100	<100	<100	<100	<100		<200	<200		<10	<400	<50	<10	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Benzo(k)fluoranthene	~	100	1,000	µg/l	<10	<400	<100	-	<100	<10	<50	-	<10	<10	<100	<10	--	<200	<500	<100	-	<100	<100	<100	<100	<100		<200	<200		<10	<400	<50	<10	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Benzo(a)pyrene	~	500	5,000	µg/l	27	<400	<50	-	<100	<10	<50	-	<10	<10	<100	<10	--	<200	<500	<100	-	<100	<100	<100	<100	<100		<200	<200		<10	<400	<50	<10	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Indeno(1,2,3-cd)Pyrene	~	100	1,000	µg/l	13	<400	<100	-	<100	<10	<50	-	<10	<10	<100	<10	--	<200	<500	<100	-	<100	<100	<100	<100	<100		<200	<200		<10	<400	<50	<10	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Dibenzo(a,h)anthracene	~	40	400	µg/l	<10	<400	<100	-	<100	<10	<50	-	<10	<10	<100	<10	--	<200	<500	<100	-	<100	<100	<100	<100	<100		<200	<200		<10	<400	<50	<10	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Benzo(g,h,i)perylene	~	20	500	µg/l	17	<400	<100	-	<100	<10	<50	-	<10	<10	<100	<10	--	<200	<500	<100	-	<100	<100	<100	<100	<100		<200	<200		<10	<400	<50	<10	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Volatile Petroleum Hydrocarbons (µg/L)																																						
C_5-C_8 Aliphatics	~	50000	~	µg/l		15,700	29,000	<10,000	<2,5000	<400	434	910	170	134	<2500	<2000	<500	11,800	12,500	19,800*	12,200	14,200	13500	11300	12200	6,600	2,960	<5000	<2500		6910	<5000	1740	183	<100	<100	114	<100	<100	<100
C_9-C_{12} Aliphatics	~	~	~	µg/l		6,790	<10,000	20,000	11,500	867	1,140	710	592	493	20,900	12000	5240	14,300	14,000	1,900*	7,300	7,710	7190	6030	5670	25,200	4,800	29600	21600		17000	9600	3940	199	106	<100	104	<100	<100	<100
C_9-C_{10} Aromatics	4,000	50,000	100,000	µg/l	<10,000	<2,500	<10,000	11,000	2,680	554	697	1,000	270	478	5,720	6,150	2,800	7,930	7,080	<1,250*	<5,000	<2,500	<5000	5120	<5000	2,900	1,190	*19,900*	*15,200*		*10,200*	*6,840*	2,730	170	<100	<100	100	<100	<100	<100
C_5-C_8 Aliphatics, Adjusted	3,000	50,000	100,000	µg/l	<10,000	5,410	<10,000	<10,000	<2,500	<400	<400	910	165	132	<2500	<2000	<500	<5000	<5000	6,550*	<5,000	5,060	<5000	<5000	<5000	2,530	<1000	<5,000	<2,500		<5,000	<5,000	<1,000	183	<100	<100	114	<100	<100	<100
C_5-C_{12} Aliphatics, Adjusted	5,000	50,000	100,000	µg/l	<10,000	5,450	<10,000	20,000	6,430	<400	<400	710	311	<100	11,500	<2000	<500	<5000	<5000	<1,250*	5,810	5,940	<5000	<5000	<5000	14,700	<1000	<5,000	<2,500		<5,000	<5,000	<1,000	<100	103	<100	<100	<100	<100	<100
Benzene	1,000	10,000	100,000	µg/l	***16,000***	*9,150*	***19,500***	400	<100	66	96	15	5	3	<100	<40	14	8,820	8,390	12,000*	6,710	8,260	9730	8340	8020	4,010	1,990	<100	<50		*3,680*	*1,720*	1,020	<2	<2	<2	<2	<2	<2	<2
Toluene	50,000	40,000	100,000	µg/l	2,500	1,150	4,060	430	<100	13	19	2.1	<5	<2	<100	308	178	<100	<100	1,230*	664	834	382	374	253	51	<20.0	<100	<50		688	<100	3,704	<2	<2	<2	<2	<2	<2	<2
Ethylbenzene	20,000	5,000	100,000	µg/l	510	620	697	**7,000**	1,220	146	214	2.8	<5	<2	1,630	2,280	764	2,900	2,740	1,230*	661	812	1210	988	844	3,530	1,450	2,180	1,500		2,570	1,210	620	<2	<2	<2	<2	<2	<2	<2
p/m-Xylene	3,000	5,000	100,000	µg/l	770	335	718	3,600	551	38	49	8.4	5	3	1,230	1,410	593	1,190	1,070	855*	492	572	771	640	578	2,700	958	***5,150***	3,460		2,180	579	183	<2	2.32	<2	6.16	<2	<2	<2
o-Xylene	3,000	5,000	100,000	µg/l	380	390	1,450	2,700	656	64	133	6.7	6	4	797	1,300	786	1,590	1,520	562*	332	386	754	626	550	1,380	619	2,720	1,950		1,580	803	207	<2	<2	<2	<2	<2	<2	<2
Total Xylene	3,000	5,000	100,000	µg/l	1,150	725	2,168	**6,300**	1,207	102	182	15.1	11	8	2,027	2,710	1,379	2,780	2,590	1,417	824	958	1525	1266	1128	4,080	1,577	***7,870***	***5,410***		*3,760*	1,382	390	<2	2.32	<2	6.16	<2	<2	<2
Methyl tert butyl ether	50,000	50,000	100,000	µg/l	<500	<150	<300	<500	<150	35	42	<5	<7.5	<3	<150	<60	<15.0	<150	164	<75*	<300	<150	<150	<150	<150	<60	<30.0	<150	<150		<150	<150	<30	<3	<3	<3	<3	<3	<3	<3
Naphthalene	700	20,000	100,000	µg/l	*8,200*	*5,610*	*9,600*	11,000	3,510	402	558	350	64	195	2,490	2,220	906	8,770	7,690	2,210*	1,580	1,740	3700	3200	3020	3,180	1,210	*4,910*	*4,280*		*9,950*	*9,640*	477	<4	<4	<4	<4	<4	<4	<4
Volatile Organic Compounds (uz/L)																																						
Styrene	100	6,000	60,000	µg/l	--	--	--	--	--	--	--	--	--	--	--	--	100	--	<25	--	--	--	--	--	<25	--	<25	--	--	440	--	--	--	--	--	--	--	--	--
Inorganics and Miscellaneous																																						
Cyanide, Physiologically Available (PAC)	NS	30	2,000	mg/L	--	--	--	--	--	--	--	--	--	--	--	--	0.059	--	0.367	--	--	--	--	--	0.518	--	0.185	--	--	0.005	--	--	--	--	--	--	--	--	--

Notes

1. <X indicates analyte not detected above laboratory reporting limit; "~" indicates no MCP Method 1 standard; "--" indicates sample was not analyzed for this analyte.
2. Groundwater depth measurements in units of feet below ground surface (ft bgs) were taken on March 11, 2020.
3. "Total Xylenes" was calculated as the sum of m/p-xylene and o-xylene. When neither was detected, the maximum detection limit was used.
4. * According to the analytical data table provided by Ramboll Environ, "The laboratory noted high relative percent differences between the original and the re-analysis due to dilution for VPH sample ENV-5MW-20150512. The laboratory attributed the difference to varying analyte concentrations between the sample vials. The field duplicate pair to sample ENV-5MW-20150512 (DUP-20150512) was analyzed and confirmed the sample re-analysis result; as such, precision criterion between the sample and duplicate were met. Therefore, the original reported results are considered estimated values due to poor precision." As such, the original reported results were not compared to standards.
5. Massachusetts Contingency Plan (MCP) Method 1 standards and Upper Concentration Limits (UCLs) are from the tables in the 2014 MCP. Exceedances of applicable standards are highlighted as described below.

Italics, pale shading	concentration exceeds Method 1 GW-2 standard (sample collected from 0-15' bgs within 30 feet of an occupied building)
Bold, pale shading	concentration exceeds Method 1 GW-3 standard (sample collected deeper than 15' bgs or greater than 30 feet away from an occupied building)
Bold italics, pale shading	concentration exceeds both Method 1 GW-2 and GW-3 standards (sample collected from 0-15' bgs and within 30 feet of an occupied building)
Bold italics, dark shading	concentration exceeds UCL, applicable to all samples

6. Non-detect samples with high reported detection limits were not compared to MCP standards; instead, data collected at a late date with lower detection results were used to evaluate conditions at the well.

TABLE 3A
SOIL GAS ANALYTICAL DATA
284 Winter Street
Haverhill, Massachusetts

Method /Analyte	MA-CISSGV[1]	Sample ID Sampling Date Lab Sample ID	NFSV-01 10/19/2016 L1634001-09D	DUP101916 10/19/2016 L1634001-10D	NFSV-02 10/19/2016 L1634001-08	NFSV-03 10/19/2016 L1634001-07	NFSV-04 10/19/2016 L1634001-02	NFSV-05 10/19/2016 L1634001-04D	NFSV-05-DUP 10/19/2016 WG947959-6D	NFSV-06 10/19/2016 L1634001-05	NFSV-07 10/19/2016 L1634001-03	NFSV-08 10/19/2016 L1634001-06	SG-1 2/12/2020 L2006496-01	SG-2 2/12/2020 L2006496-02	SG-3 2/12/2020 L2006496-03
Volatile Organic Compounds															
1,1,1-Trichloroethane	310,000	µg/m3	<5.46	<5.46	<1.09	<1.09	<1.09	<3.64	<3.64	<1.09	<1.09	<1.09	--	--	--
1,1,2,2-Tetrachloroethane	14	µg/m3	<6.87	<6.87	<1.37	<1.37	<1.37	<4.58	<4.58	<1.37	<1.37	<1.37	--	--	--
1,1,2-Trichloroethane	50	µg/m3	<5.46	<5.46	<1.09	<1.09	<1.09	<3.64	<3.64	<1.09	<1.09	<1.09	--	--	--
1,1-Dichloroethane	50,000	µg/m3	<4.05	<4.05	<0.809	<0.809	<0.809	<2.7	<2.7	<0.809	<0.809	<0.809	--	--	--
1,1-Dichloroethene	12,000	µg/m3	<3.96	<3.96	<0.793	<0.793	<0.793	<2.64	<2.64	<0.793	<0.793	<0.793	--	--	--
1,2,4-Trichlorobenzene	240	µg/m3	**11.4**	<7.42	<1.48	**1.46**	<1.48	<4.95	<4.95	**3.99**	**0.564**	**0.661**	--	--	--
1,2-Dibromoethane	3	µg/m3	<7.69	<7.69	<1.54	<1.54	<1.54	<5.13	<5.13	<1.54	<1.54	<1.54	--	--	--
1,2-Dichlorobenzene	50,000	µg/m3	<6.01	<6.01	<1.2	<1.2	<1.2	<4.01	<4.01	<1.2	<1.2	<1.2	--	--	--
1,2-Dichloroethane	31	µg/m3	<4.05	<4.05	<0.809	<0.809	<0.809	**3.55**	**3.70**	<0.809	<0.809	<0.809	--	--	--
1,2-Dichloropropane	42	µg/m3	<4.62	<4.62	<0.924	<0.924	<0.924	<3.08	<3.08	<0.924	<0.924	<0.924	--	--	--
1,3-Dichlorobenzene	50,000	µg/m3	<6.01	<6.01	<1.2	<1.2	<1.2	<4.01	<4.01	<1.2	<1.2	<1.2	--	--	--
1,4-Dichlorobenzene	120	µg/m3	<6.01	<6.01	<1.2	<1.2	<1.2	<4.01	<4.01	<1.2	<1.2	<1.2	--	--	--
1,4-Dioxane	160	µg/m3	<3.6	<3.6	<0.721	<0.721	<0.721	<2.4	<2.4	<0.721	<0.721	<0.721	--	--	--
2-Butanone	310,000	µg/m3	**26.3**	**27.1**	**1.43**	**4.66**	**8.05**	**8.41**	**8.38**	**3.95**	**23.4**	**14.8**	--	--	--
2-Methylnaphthalene	2,400	µg/m3	**354**	**549**	<5.82	<5.82	<5.82	<19.4	<19.4	<5.82	<5.82	<5.82	--	--	--
4-Methyl-2-pentanone	190,000	µg/m3	<10.2	<10.2	<2.05	**0.496**	**10.1**	<6.84	<6.84	**2.55**	**24.1**	**10.2**	--	--	--
Acetone	50,000	µg/m3	**53.7**	**48.9**	**5.91**	**11.2**	**43.2**	<7.91	<7.91	**18.9**	**87.9**	**59.4**	--	--	--
Benzene	800	µg/m3	**473**	**460**	**0.447**	<0.639	**0.821**	**543**	**546**	**0.575**	**6.1**	**1.72**	<0.6	<0.6	<0.6
Bromodichloromethane	45	µg/m3	<6.7	<6.7	<1.34	<1.34	<1.34	<4.47	<4.47	<1.34	<1.34	<1.34	--	--	--
Bromoform	730	µg/m3	<10.3	<10.3	<2.07	<2.07	<2.07	<6.9	<6.9	<2.07	<2.07	<2.07	--	--	--
Bromomethane	310	µg/m3	<3.88	<3.88	<0.777	<0.777	<0.777	<2.59	<2.59	<0.777	<0.777	<0.777	--	--	--
Carbon tetrachloride	130	µg/m3	<6.29	<6.29	<1.26	<1.26	<1.26	<4.2	<4.2	<1.26	<1.26	<1.26	--	--	--
Chlorobenzene	3,100	µg/m3	<4.61	<4.61	<0.921	<0.921	<0.921	<3.07	<3.07	<0.921	<0.921	<0.921	--	--	--
Chloroform	210	µg/m3	<4.88	<4.88	<0.977	<0.977	<0.977	<3.26	<3.26	**1.14**	**1.59**	**0.327**	--	--	--
cis-1,2-Dichloroethene	370	µg/m3	**10.1**	**9.12**	<0.793	<0.793	<0.793	<2.64	<2.64	<0.793	<0.793	<0.793	--	--	--
Dibromochloromethane	33	µg/m3	<8.52	<8.52	<1.7	<1.7	<1.7	<5.68	<5.68	<1.7	<1.7	<1.7	--	--	--
Ethylbenzene	62,000	µg/m3	**242**	**246**	<0.869	<0.869	**0.83**	**79.5**	**79.5**	**0.361**	**1.75**	**0.356**	<0.9	<0.9	<0.9
Hexachlorobutadiene	320	µg/m3	<10.7	<10.7	<2.13	<2.13	<2.13	<7.11	<7.11	<2.13	<2.13	<2.13	--	--	--
Methyl tert butyl ether	190,000	µg/m3	**1030**	**1010**	**0.234**	<0.721	**1.06**	**164**	**166**	**2.40**	**0.299**	**0.735**	<0.7	<0.7	<0.7
Methylene chloride	37,000	µg/m3	<8.69	<8.69	<1.74	<1.74	<1.74	<5.8	<5.8	**1.06**	<1.74	**1.32**	--	--	--
Naphthalene	190	µg/m3	**603**	**703**	<1.05	**0.246**	**0.661**	**8.91**	**11.5**	**0.472**	**1.82**	**0.970**	<1.1	<1.1	<1.1
Styrene	1,400	µg/m3	**28.6**	**29.7**	<0.852	<0.852	<0.852	<2.84	<2.84	<0.852	**0.353**	<0.852	--	--	--
Tetrachloroethene	290	µg/m3	**11.1**	**11.8**	**122**	**94.3**	**1.68**	<4.52	<4.52	**2.07**	<1.36	**0.793**	--	--	--
Toluene	310,000	µg/m3	**315**	**321**	**1.53**	**0.818**	**6.14**	**852**	**863**	**1.34**	**5.09**	**1.49**	**1.2**	**1.5**	**1.5**
trans-1,2-Dichloroethene	3,700	µg/m3	<3.96	<3.96	<0.793	<0.793	<0.793	<2.64	<2.64	<0.793	<0.793	<0.793	--	--	--
Trichloroethene	120	µg/m3	<5.37	<5.37	<1.07	<1.07	<1.07	<3.58	<3.58	<1.07	<1.07	<1.07	--	--	--
Vinyl chloride	91	µg/m3	<2.56	<2.56	<0.511	<0.511	<0.511	<1.71	<1.71	<0.511	<0.511	<0.511	--	--	--
Xylene, o-		µg/m3	**184**	**188**	<1.51	<0.869	**1.63**	**123**	**126**	**0.947**	**1.09**	**0.330**	<0.9	<0.9	<0.9
Xylene, p/m-		µg/m3	**327**	**334**	<1.74	<1.74	**3.36**	**431**	**434**	**1.70**	**2.55**	**0.717**	**1.3**	**1.3**	**0.97**
Xylenes (total, calculated)	6,200	µg/m3	**511**	**522**	<0.869	<0.869	**4.99**	**554**	**560**	**2.647**	**3.64**	**1.047**	1.3	1.3	0.97
MassDEP APH															
C_5-C_8 Aliphatics, Adjusted	23,000		--	--	--	--	--	--	--	--	--	--	**100**	**190**	**38**
C_9-C_{10} Aromatics Total	3,100		--	--	--	--	--	--	--	--	--	--	<10	<10	<10
C_9-C_{12} Aliphatics, Adjusted	16,000		--	--	--	--	--	--	--	--	--	--	**3500**	**3400**	**160**

Notes:
1. MA-CISSGV - Massachusetts Soil Gas Screening Values (SGSV) for the evaluation of a vapor intrusion pathway for a commercial/industrial exposure per MassDEP Policy #WSC-16-435 Vapor Intrusion Guidance (October 2016).
2. Only compounds with CISSGVs are presented in this table.
3. < X = compound not detected above the laboratory reporting limits; -- = sample not analyzed for that parameter.
4. **bold** = indicates compound detected; **bold highlighted** = indicates compound detected above CISSGV.
5. Total Xylenes were calculated from o-Xylene and p/m-Xylene results. If both results were non-detect, the minimum detection limit is reported for Total Xylenes. If one result was non-detect, the sum of half of the non-detect detection limit and the detected result was reported as Total Xylenes.

TABLE 3B
INDOOR AIR ANALYTICAL DATA
284 Winter Street
Haverhill, Massachusetts

Method /Analyte	TVc/i	Sample ID Sampling Date Lab Sample ID	NFAA-01 10/19/2016 L1634001-01D
1,1,1-Trichloroethane	3	µg/m3	<1.89
1,1,2,2-Tetrachloroethane	0.04	µg/m3	<2.38
1,1,2-Trichloroethane	0.15	µg/m3	<1.89
1,1-Dichloroethane	0.8	µg/m3	<1.4
1,1-Dichloroethene	0.8	µg/m3	<1.38
1,2,4-Trichlorobenzene	0.4	µg/m3	<2.58
1,2-Dibromoethane	NA	µg/m3	<2.67
1,2-Dichlorobenzene	0.72	µg/m3	<2.09
1,2-Dichloroethane	0.09	µg/m3	<1.4
1,2-Dichloropropane	0.12	µg/m3	<1.6
1,3-Dichlorobenzene	0.6	µg/m3	<2.09
1,4-Dichlorobenzene	0.5	µg/m3	<2.09
1,4-Dioxane	0.47	µg/m3	<1.25
2-Butanone	NA	µg/m3	**0.779**
2-Methylnaphthalene	8	µg/m3	<10.1
4-Methyl-2-pentanone	NA	µg/m3	<3.56
Acetone	91	µg/m3	**9.45**
Benzene	11	µg/m3	**0.617**
Bromodichloromethane	0.13	µg/m3	<2.32
Bromoform	2.1	µg/m3	<3.59
Bromomethane	0.6	µg/m3	<1.35
Carbon tetrachloride	0.54	µg/m3	<2.18
Chlorobenzene	2.3	µg/m3	<1.6
Chloroform	1.9	µg/m3	<1.69
cis-1,2-Dichloroethene	0.8	µg/m3	**0.42**
Dibromochloromethane	0.097	µg/m3	<2.96
Ethylbenzene	7.4	µg/m3	<1.51
Hexachlorobutadiene	0.11	µg/m3	<3.70
Methyl tert butyl ether	2700	µg/m3	<1.25
Methylene chloride	NA	µg/m3	**1.98**
Naphthalene	2.7	µg/m3	<1.82
Styrene	20	µg/m3	<1.48
Tetrachloroethene	1.4	µg/m3	<2.35
Toluene	4400	µg/m3	**1.81**
trans-1,2-Dichloroethene	0.8	µg/m3	<1.38
Trichloroethene	0.4	µg/m3	<1.86
Vinyl chloride	0.27	µg/m3	<0.887
Xylene, o-		µg/m3	<1.51
Xylene, p/m-		µg/m3	<3.02
Xylenes (total, calculated)	88	µg/m3	<1.51

Notes:
1. TV c/i: Indoor air threshold values for the evaluation of a vapor intrusion pathway for a commercial/industrial exposure per MassDEP Policy #WSC-16-435 Vapor Intrusion Guidance (October 2016).
2. Sample(s) analyzed by EPA TO-15
3. < X = compound not detected above the laboratory reporting limits;
bold = indicates compound detected; highlighted bold = indicates sample exceeds TVc/i
4. Total Xylenes were calculated from o-Xylene and p/m-Xylene results. If both results were non-detect, the minimum detection limit is reported for Total Xylenes. If one result was non-detect, the sum of half of the non-detect detection limit and the detected result was reported as Total Xylenes.

TABLE 4
GROUNDWATER/NAPL GAUGING AND RECOVERY DATA
284 Winter Street
Haverhill, Massachusetts

Well ID	Well screen interval (feet)	Reference Elevation (feet MSL)	Date	Depth to Water (feet)	Water Elevation (feet MSL)	Depth to LNAPL (feet)	Depth to DNAPL (feet)	Depth to Bottom (feet)	LNAPL Thickness (feet)	DNAPL Thickness (feet)	Est. Vol. of NAPL Recovered (gallons)	Cumulative NAPL Removed (gallons)
MW-1	5-15	25.89	5/12/2015	3.31	22.58	ND	ND	--	ND	ND	0.00	0.00
			8/6/2015	3.56	22.33	ND	ND	--	ND	ND	0.00	0.00
			9/4/2015	3.88	22.01	ND	ND	--	ND	ND	0.00	0.00
			10/2/2015	4.00	21.89	ND	ND	--	ND	ND	0.00	0.00
			10/30/2015	4.14	21.75	ND	ND	--	ND	ND	0.00	0.00
			12/2/2015	4.23	21.66	ND	ND	--	ND	ND	0.00	0.00
			12/31/2015	3.82	22.07	ND	ND	--	ND	ND	0.00	0.00
			1/25/2016	3.78	22.11	ND	ND	--	ND	ND	0.00	0.00
			2/26/2016	2.86	23.03	ND	ND	--	ND	ND	0.00	0.00
			3/29/2016	3.08	22.81	ND	ND	--	ND	ND	0.00	0.00
			4/26/2016	3.30	22.59	ND	ND	--	ND	ND	0.00	0.00
			5/18/2016	3.50	22.39	ND	ND	--	ND	ND	0.00	0.00
			6/24/2016	3.74	22.15	ND	ND	--	ND	ND	0.00	0.00
			7/26/2016	4.04	21.85	ND	ND	--	ND	ND	0.00	0.00
			8/30/2016	4.30	21.59	ND	ND	--	ND	ND	0.00	0.00
			9/27/2016	4.48	21.41	ND	ND	--	ND	ND	0.00	0.00
			10/25/2016	3.73	22.16	ND	ND	--	ND	ND	0.00	0.00
			11/1/2016	3.40	22.49	ND	ND	--	ND	ND	0.00	0.00
			11/22/2016	3.48	22.41	ND	ND	--	ND	ND	0.00	0.00
			12/21/2016	3.48	22.41	ND	ND	--	ND	ND	0.00	0.00
			1/26/2017	2.62	23.27	ND	ND	--	ND	ND	0.00	0.00
			2/24/2017	--	--	ND	ND	--	ND	ND	0.00	0.00
			3/23/2017	3.04	22.85	ND	ND	--	ND	ND	0.00	0.00
			4/27/2017	3.02	22.87	ND	ND	--	ND	ND	0.00	0.00
			5/25/2017	3.18	22.71	ND	ND	--	ND	ND	0.00	0.00
			6/29/2017	3.15	22.74	ND	ND	--	ND	ND	0.00	0.00
			7/27/2017	3.40	22.49	ND	ND	--	ND	ND	0.00	0.00
			8/29/2017	3.70	22.19	ND	ND	--	ND	ND	0.00	0.00
			9/28/2017	3.30	22.59	ND	ND	--	ND	ND	0.00	0.00
			11/1/2017	3.45	22.44	ND	ND	--	ND	ND	0.00	0.00
			11/21/2017	3.31	22.58	ND	ND	--	ND	ND	0.00	0.00
			12/29/2017	3.81	22.08	ND	ND	--	ND	ND	0.00	0.00
			1/26/2018	Inaccessible (snow)							0.00	0.00
			2/27/2018	2.83	23.06	ND	ND	--	ND	ND	0.00	0.00
			3/23/2018	2.88	23.01	ND	ND	--	ND	ND	0.00	0.00
			4/26/2018	2.51	23.38	ND	ND	--	ND	ND	0.00	0.00
			6/4/2018	2.62	23.27	ND	ND	--	ND	ND	0.00	0.00
			6/26/2018	3.55	22.34	ND	ND	--	ND	ND	0.00	0.00
			7/31/2018	3.76	22.13	ND	ND	--	ND	ND	0.00	0.00
			8/27/2018	2.81	23.08	ND	ND	--	ND	ND	0.00	0.00
			10/3/2018	3.04	22.85	ND	ND	--	ND	ND	0.00	0.00
			10/30/2018	2.99	22.90	ND	ND	--	ND	ND	0.00	0.00
			11/29/2018	2.73	23.16	ND	ND	--	ND	ND	0.00	0.00
			1/3/2019	2.97	22.92	ND	ND	--	ND	ND	0.00	0.00
			1/31/2019	Inaccessible (snow)							0.00	0.00
			2/19/2019	Inaccessible (snow)							0.00	0.00
			3/28/2019	2.64	23.25	ND	ND	--	ND	ND	0.00	0.00
			4/30/2019	2.65	23.24	ND	ND	--	ND	ND	0.00	0.00
			6/5/2019	3.11	22.78	ND	ND	--	ND	ND	0.00	0.00
			7/3/2019	3.19	22.70	ND	ND	--	ND	ND	0.00	0.00
			8/1/2019	3.14	22.75	ND	ND	--	ND	ND	0.00	0.00
			9/3/2019	3.14	22.75	ND	ND	--	ND	ND	0.00	0.00
			10/1/2019	3.58	22.31	ND	ND	--	ND	ND	0.00	0.00
			11/5/2019	3.33	22.56	ND	ND	--	ND	ND	0.00	0.00
			12/18/2019	inaccessible (ice)							0.00	0.00
			1/8/2020	inaccessible (ice)							0.00	0.00
			2/5/2020	3.18	22.71	ND	ND	11.85	ND	ND	0.00	0.00
			3/11/2020	3.24	22.65	ND	ND	11.81	ND	ND	0.00	0.00
			5/7/2020	3.06	22.83	ND	ND	11.82	ND	ND	0.00	0.00
			6/17/2020	--	--	--	--	--	--	--	0.00	0.00
			7/14/2020	3.74	22.15	ND	ND	11.80	ND	ND	0.00	0.00
			8/11/2020	3.91	21.98	ND	ND	--	ND	ND	0.00	0.00
			8/31/2020	4.10	21.79	ND	ND	11.76	ND	ND	0.00	0.00
			9/15/2020	4.03	21.86	--	--	11.78	--	--	0.00	0.00
			10/21/2020	3.98	21.91	ND	ND	11.45	ND	ND	0.00	0.00

TABLE 4
GROUNDWATER/NAPL GAUGING AND RECOVERY DATA
284 Winter Street
Haverhill, Massachusetts

Well ID	Well screen interval (feet)	Reference Elevation (feet MSL)	Date	Depth to Water (feet)	Water Elevation (feet MSL)	Depth to LNAPL (feet)	Depth to DNAPL (feet)	Depth to Bottom (feet)	LNAPL Thickness (feet)	DNAPL Thickness (feet)	Est. Vol. of NAPL Recovered (gallons)	Cumulative NAPL Removed (gallons)
MW-2	5-15	24.22	5/12/2015	12.34	11.88	ND	ND	--	ND	ND	0.00	0.00
			8/6/2015	12.93	11.29	ND	ND	--	ND	ND	0.00	0.00
			9/4/2015	13.14	11.08	ND	ND	--	ND	ND	0.00	0.00
			10/2/2015	12.62	11.60	ND	ND	--	ND	ND	0.00	0.00
			10/30/2015	13.00	11.22	ND	ND	--	ND	ND	0.00	0.00
			12/2/2015	13.10	11.12	ND	ND	--	ND	ND	0.00	0.00
			12/31/2015	12.70	11.52	ND	ND	--	ND	ND	0.00	0.00
			1/25/2016	12.71	11.51	ND	ND	--	ND	ND	0.00	0.00
			2/26/2016	12.31	11.91	ND	ND	--	ND	ND	0.00	0.00
			3/29/2016	12.21	12.01	ND	ND	--	ND	ND	0.00	0.00
			4/26/2016	12.56	11.66	ND	ND	--	ND	ND	0.00	0.00
			5/18/2016	12.74	11.48	ND	ND	--	ND	ND	0.00	0.00
			6/24/2016	13.18	11.04	ND	ND	--	ND	ND	0.00	0.00
			7/26/2016	13.60	10.62	ND	ND	--	ND	ND	0.00	0.00
			8/30/2016	13.57	10.65	ND	ND	--	ND	ND	0.00	0.00
			9/27/2016	13.58	10.64	ND	ND	--	ND	ND	0.00	0.00
			10/25/2016	12.85	11.37	ND	ND	--	ND	ND	0.00	0.00
			11/1/2016	12.87	11.35	ND	ND	--	ND	ND	0.00	0.00
			11/22/2016	13.03	11.19	ND	ND	--	ND	ND	0.00	0.00
			12/21/2016	12.84	11.38	ND	ND	--	ND	ND	0.00	0.00
			1/26/2017	12.30	11.92	ND	ND	--	ND	ND	0.00	0.00
			2/24/2017	12.22	12.00	ND	ND	--	ND	ND	0.00	0.00
			3/23/2017	12.18	12.04	ND	ND	--	ND	ND	0.00	0.00
			4/27/2017	11.38	12.84	ND	ND	--	ND	ND	0.00	0.00
			5/25/2017	12.04	12.18	ND	ND	--	ND	ND	0.00	0.00
			6/29/2017	13.60	10.62	ND	ND	--	ND	ND	0.00	0.00
			7/27/2017	12.72	11.50	ND	ND	--	ND	ND	0.00	0.00
			8/29/2017	13.06	11.16	ND	ND	--	ND	ND	0.00	0.00
			9/28/2017	12.98	11.24	ND	ND	--	ND	ND	0.00	0.00
			11/1/2017	12.40	11.82	ND	ND	--	ND	ND	0.00	0.00
			11/21/2017	13.00	11.22	ND	ND	--	ND	ND	0.00	0.00
			12/29/2017	3.05	21.17	ND	ND	--	ND	ND	0.00	0.00
			1/26/2018	12.42	11.80	ND	ND	--	ND	ND	0.00	0.00
			2/27/2018	11.93	12.29	ND	ND	--	ND	ND	0.00	0.00
			3/23/2018	11.75	12.47	ND	ND	--	ND	ND	0.00	0.00
			4/26/2018	11.46	12.76	ND	ND	--	ND	ND	0.00	0.00
			6/4/2018	11.63	12.59	ND	ND	--	ND	ND	0.00	0.00
			6/26/2018	12.64	11.58	ND	ND	--	ND	ND	0.00	0.00
			7/31/2018	12.72	11.50	ND	ND	--	ND	ND	0.00	0.00
			8/27/2018	11.89	12.33	ND	ND	--	ND	ND	0.00	0.00
			10/3/2018	12.24	11.98	ND	ND	--	ND	ND	0.00	0.00
			10/30/2018	12.14	12.08	ND	ND	--	ND	ND	0.00	0.00
			11/29/2018	10.96	13.26	ND	ND	--	ND	ND	0.00	0.00
			1/3/2019	11.69	12.53	ND	ND	--	ND	ND	0.00	0.00
			1/31/2019	12.01	12.21	ND	ND	--	ND	ND	0.00	0.00
			2/19/2019	12.18	12.04	ND	ND	--	ND	ND	0.00	0.00
			3/28/2019	11.81	12.41	ND	ND	--	ND	ND	0.00	0.00
			4/30/2019	11.48	12.74	ND	ND	--	ND	ND	0.00	0.00
			6/5/2019	12.18	12.04	ND	ND	--	ND	ND	0.00	0.00
			7/3/2019	12.43	11.79	ND	ND	--	ND	ND	0.00	0.00
			8/1/2019	12.48	11.74	ND	ND	--	ND	ND	0.00	0.00
			9/3/2019	12.69	11.53	ND	ND	--	ND	ND	0.00	0.00
			10/1/2019	13.07	11.15	ND	ND	--	ND	ND	0.00	0.00
			11/5/2019	12.74	11.48	ND	ND	--	ND	ND	0.00	0.00
			12/18/2019	11.54	12.68	ND	ND	--	ND	ND	0.00	0.00
			1/8/2020	11.81	12.41	ND	ND	13.78	ND	ND	0.00	0.00
			2/5/2020	12.22	12.00	ND	ND	13.84	ND	ND	0.00	0.00
			3/11/2020	13.20	11.02	ND	ND	13.87	ND	ND	0.00	0.00
			5/7/2020	12.16	12.06	ND	ND	--	ND	ND	0.00	0.00
			6/17/2020	12.79	11.43	ND	ND	13.82	ND	ND	0.00	0.00
			7/14/2020	13.04	11.18	ND	ND	13.82	ND	ND	0.00	0.00
			8/11/2020	13.29	10.93	ND	ND	--	ND	ND	0.00	0.00
			8/31/2020	13.42	10.80	ND	ND	13.83	ND	ND	0.00	0.00
			9/15/2020	13.31	10.91	--	--	13.80	--	--	0.00	0.00
			10/21/2020	13.34	10.88	ND	ND	13.85	ND	ND	0.00	0.00

TABLE 4
GROUNDWATER/NAPL GAUGING AND RECOVERY DATA
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Well ID	Well screen interval (feet)	Reference Elevation (feet MSL)	Date	Depth to Water (feet)	Water Elevation (feet MSL)	Depth to LNAPL (feet)	Depth to DNAPL (feet)	Depth to Bottom (feet)	LNAPL Thickness (feet)	DNAPL Thickness (feet)	Est. Vol. of NAPL Recovered (gallons)	Cumulative NAPL Removed (gallons)
MW-3	8-18	25.18	5/12/2015	12.14	13.04	ND	ND	--	ND	ND	0.00	0.00
			8/6/2015	12.89	12.29	ND	ND	--	ND	ND	0.00	0.00
			9/4/2015	13.22	11.96	ND	ND	--	ND	ND	0.00	0.00
			10/2/2015	12.92	12.26	ND	ND	--	ND	ND	0.00	0.00
			10/30/2015	13.18	12.00	ND	ND	--	ND	ND	0.00	0.00
			12/2/2015	13.27	11.91	ND	ND	--	ND	ND	0.00	0.00
			12/31/2015	12.94	12.24	ND	ND	--	ND	ND	0.00	0.00
			1/25/2016	12.85	12.33	ND	ND	--	ND	ND	0.00	0.00
			2/26/2016	12.50	12.68	ND	ND	--	ND	ND	0.00	0.00
			3/29/2016	12.27	12.91	ND	ND	--	ND	ND	0.00	0.00
			4/26/2016	12.45	12.73	ND	ND	--	ND	ND	0.00	0.00
			5/18/2016	12.68	12.50	ND	ND	--	ND	ND	0.00	0.00
			6/24/2016	13.17	12.01	ND	ND	--	ND	ND	0.00	0.00
			7/26/2016	13.51	11.67	ND	ND	--	ND	ND	0.00	0.00
			8/30/2016	13.45	11.73	ND	ND	--	ND	ND	0.00	0.00
			9/27/2016	13.75	11.43	ND	ND	--	ND	ND	0.00	0.00
			10/25/2016	13.38	11.80	ND	ND	--	ND	ND	0.00	0.00
			11/1/2016	13.05	12.13	ND	ND	--	ND	ND	0.00	0.00
			11/22/2016	13.20	11.98	ND	ND	--	ND	ND	0.00	0.00
			12/21/2016	14.44	10.74	ND	ND	--	ND	ND	0.00	0.00
			1/26/2017	11.40	13.78	ND	ND	--	ND	ND	0.00	0.00
			2/24/2017	--	--	ND	ND	--	ND	ND	0.00	0.00
			3/23/2017	--	--	ND	ND	--	ND	ND	0.00	0.00
			4/27/2017	12.90	12.28	ND	ND	--	ND	ND	0.00	0.00
			5/25/2017	13.71	11.47	ND	ND	--	ND	ND	0.00	0.00
			6/29/2017	14.22	10.96	ND	ND	--	ND	ND	0.00	0.00
			7/27/2017	14.45	10.73	ND	ND	--	ND	ND	0.00	0.00
			8/29/2017	13.39	11.79	ND	ND	--	ND	ND	0.00	0.00
			9/28/2017	12.88	12.30	ND	ND	--	ND	ND	0.00	0.00
			11/1/2017	13.20	11.98	ND	ND	--	ND	ND	0.00	0.00
			11/21/2017	12.51	12.67	ND	ND	--	ND	ND	0.00	0.00
			12/29/2017	12.21	12.97	ND	ND	--	ND	ND	0.00	0.00
			1/26/2018	11.81	13.37	ND	ND	--	ND	ND	0.00	0.00
			2/27/2018	11.70	13.48	ND	ND	--	ND	ND	0.00	0.00
			3/23/2018	11.71	13.47	ND	ND	--	ND	ND	0.00	0.00
			4/26/2018	12.31	12.87	ND	ND	--	ND	ND	0.00	0.00
			6/4/2018	12.42	12.76	ND	ND	--	ND	ND	0.00	0.00
			6/26/2018	13.85	11.33	ND	ND	--	ND	ND	0.00	0.00
			7/31/2018	14.01	11.17	ND	ND	--	ND	ND	0.00	0.00
			8/27/2018	12.81	12.37	ND	ND	--	ND	ND	0.00	0.00
			10/3/2018	13.50	11.68	ND	ND	--	ND	ND	0.00	0.00
			10/30/2018	13.33	11.85	ND	ND	--	ND	ND	0.00	0.00
			11/29/2018	12.11		ND	ND	--	ND	ND	0.00	0.00
			1/3/2019	-		-	-	--	-	-	0.00	0.00
			1/31/2019	Inaccessible (snow)							0.00	0.00
			2/19/2019	13.18	12.00	ND	ND	--	-	ND	0.00	0.00
			3/28/2019	11.62	13.56	ND	ND	--	ND	ND	0.00	0.00
			4/30/2019	11.43	13.75	ND	ND	--	ND	ND	0.00	0.00
			6/5/2019	12.12	13.06	ND	ND	--	ND	ND	0.00	0.00
			7/3/2019	13.21	11.97	ND	ND	--	ND	ND	0.00	0.00
			8/1/2019	-		ND	ND	--	ND	ND	0.00	0.00
			9/3/2019	12.88	12.30	ND	ND	--	ND	ND	0.00	0.00
			10/1/2019	13.17	12.01	ND	ND	--	ND	ND	0.00	0.00
			11/5/2019	-		ND	ND	--	ND	ND	0.00	0.00
			12/18/2019	11.37	13.81	ND	ND	--	ND	ND	0.00	0.00
			1/8/2020	11.60	13.58	ND	ND	18.07	ND	ND	0.00	0.00
			2/5/2020	12.04	13.14	ND	ND	18.16	ND	ND	0.00	0.00
			3/11/2020	12.16	13.02	ND	ND	18.18	ND	ND	0.00	0.00
			5/7/2020	11.53	13.65	ND	ND	18.51	ND	ND	0.00	0.00
			6/17/2020	12.59	12.59	ND	ND	18.03	ND	ND	0.00	0.00
			7/14/2020	12.97	12.21	ND	ND	18.08	ND	ND	0.00	0.00
			8/11/2020	13.31	11.87	ND	ND	--	ND	ND	0.00	0.00
			8/31/2020	13.48	11.70	ND	ND	18.07	ND	ND	0.00	0.00
			9/15/2020	13.44	11.74	--	--	18.02	--	--	0.00	0.00
			10/21/2020	13.52	11.66	ND	ND	18.14	ND	ND	0.00	0.00

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ENV-1MW	11-21	23.40	5/12/2015	13.45	9.95	ND	ND	--	ND	ND	0.00	0.00
			8/6/2015	13.62	9.78	ND	ND	--	ND	ND	0.00	0.00
			9/4/2015	13.70	9.70	ND	ND	--	ND	ND	0.00	0.00
			10/2/2015	13.35	10.05	ND	ND	--	ND	ND	0.00	0.00
			10/30/2015	13.45	9.95	13.45	ND	--	Sheen	ND	0.00	0.00
			12/2/2015	13.59	9.81	ND	ND	--	ND	ND	0.00	0.00
			12/31/2015	13.30	10.10	ND	ND	--	ND	ND	0.00	0.00
			1/25/2016	13.51	9.89	ND	ND	--	ND	ND	0.00	0.00
			2/26/2016	12.44	10.96	ND	ND	--	ND	ND	0.00	0.00
			3/29/2016	12.76	10.64	ND	ND	--	ND	ND	0.00	0.00
			4/26/2016	13.51	9.89	ND	ND	--	ND	ND	0.00	0.00
			5/18/2016	13.58	9.82	ND	ND	--	ND	ND	0.00	0.00
			6/24/2016*	13.75	9.65	ND	ND	--	ND	ND	0.00	0.00
			7/26/2016	13.85	9.55	ND	ND	--	ND	ND	0.00	0.00
			8/30/2016	13.89	9.51	ND	ND	--	ND	ND	0.00	0.00
			9/27/2016	13.60	9.80	ND	ND	--	ND	ND	0.00	0.00
			10/25/2016	13.46	9.94	ND	ND	--	ND	ND	0.00	0.00
			11/1/2016	13.52	9.88	ND	ND	--	ND	ND	0.00	0.00
			11/22/2016	13.61	9.79	ND	ND	--	ND	ND	0.00	0.00
			12/21/2016	13.20	10.20	ND	ND	--	ND	ND	0.00	0.00
			1/26/2017	12.82	10.58	ND	ND	--	ND	ND	0.00	0.00
			2/24/2017	--		ND	ND	--	ND	ND	0.00	0.00
			3/23/2017	--		ND	ND	--	ND	ND	0.00	0.00
			4/27/2017	12.40	11.00	ND	ND	--	ND	ND	0.00	0.00
			5/25/2017	13.37	10.03	ND	ND	--	ND	ND	0.00	0.00
			6/29/2017	13.40	10.00	ND	ND	--	ND	ND	0.00	0.00
			7/27/2017	13.64	9.76	ND	ND	--	ND	ND	0.00	0.00
			8/29/2017	14.68	8.72	ND	ND	--	ND	ND	0.00	0.00
			9/28/2017	13.63	9.77	ND	ND	--	ND	ND	0.00	0.00
			11/1/2017	13.02	10.38	ND	ND	--	ND	ND	0.00	0.00
			11/21/2017	12.80	10.60	ND	ND	--	ND	ND	0.00	0.00
			12/29/2017	12.75	10.65	ND	ND	--	ND	ND	0.00	0.00
			1/26/2018	Inaccessible (snow)							0.00	0.00
			2/27/2018	12.67	10.73	ND	ND	--	ND	ND	0.00	0.00
			3/23/2018	12.23	11.17	ND	ND	--	ND	ND	0.00	0.00
			4/26/2018	12.36	11.04	ND	ND	--	ND	ND	0.00	0.00
			6/4/2018	12.36	11.04	ND	ND	--	ND	ND	0.00	0.00
			6/26/2018	13.72	9.68	ND	ND	--	ND	ND	0.00	0.00
			7/31/2018	14.11	9.29	ND	ND	--	ND	ND	0.00	0.00
			8/27/2018	12.81	10.59	ND	ND	--	ND	ND	0.00	0.00
			10/3/2018	--		--	--	--	--	--	0.00	0.00
			10/30/2018	12.63	10.77	ND	ND	--	ND	ND	0.00	0.00
			11/29/2018	11.88	11.52	ND	ND	--	ND	ND	0.00	0.00
			1/3/2019	12.73	10.67	ND	ND	--	ND	ND	0.00	0.00
			1/31/2019	13.31	10.09	ND	ND	--	ND	ND	0.00	0.00
			2/19/2019	12.85	10.55	ND	ND	--	ND	ND	0.00	0.00
			3/28/2019	12.92	10.48	ND	ND	--	ND	ND	0.00	0.00
			4/30/2019	12.52	10.88	ND	ND	--	ND	ND	0.00	0.00
			6/5/2019	13.18	10.22	ND	ND	--	ND	ND	0.00	0.00
			7/3/2019	13.49	9.91	ND	ND	--	ND	ND	0.00	0.00
			8/1/2019	13.50	9.90	ND	ND	--	ND	ND	0.00	0.00
			9/3/2019	13.57	9.83	ND	ND	--	ND	ND	0.00	0.00
			10/1/2019	13.64	9.76	ND	ND	--	ND	ND	0.00	0.00
			11/5/2019	13.48	9.92	ND	ND	--	ND	ND	0.00	0.00
			12/18/2019	Inaccessible (ice)							0.00	0.00
			1/8/2020	12.88	10.52	ND	ND	19.98	ND	ND	0.00	0.00
			2/5/2020	13.26	10.14	ND	ND	20.07	ND	ND	0.00	0.00
			3/11/2020	13.36	10.04	ND	ND	20.10	ND	ND	0.00	0.00
			5/7/2020	13.02	10.38	ND	ND	19.98	ND	ND	0.00	0.00
			6/17/2020	13.61	9.79	ND	ND	20.02	ND	ND	0.00	0.00
			7/14/2020	13.67	9.73	ND	ND	20.01	ND	ND	0.00	0.00
			8/11/2020	13.81	9.59	ND	ND	--	ND	ND	0.00	0.00
			8/31/2020	13.81	9.59	ND	ND	19.95	ND	ND	0.00	0.00
			9/15/2020	13.74	9.66	--	--	19.98	--	--	0.00	0.00
			10/21/2020	13.67	9.73	ND	ND	20.04	ND	ND	0.00	0.00

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ENV-3MW	10-20	24.12	5/12/2015	13.54	10.58	13.52	ND	--	0.02	ND	0.00	0.00
			8/6/2015	14.36	9.76	14.14	ND	--	0.22	ND	0.00	0.00
			9/4/2015	14.31	9.81	ND	ND	--	ND	ND	0.00	0.00
			10/2/2015	13.89	10.23	ND	ND	--	ND	ND	0.00	0.00
			10/30/2015	13.96	10.16	ND	ND	--	ND	ND	0.00	0.00
			12/2/2015	14.04	10.08	ND	ND	--	ND	ND	0.00	0.00
			12/31/2015	13.60	10.52	ND	ND	--	ND	ND	0.00	0.00
			1/25/2016	13.78	10.34	ND	ND	--	ND	ND	0.00	0.00
			2/26/2016	13.10	11.02	ND	ND	--	ND	ND	0.00	0.00
			3/29/2016	13.10	11.02	ND	ND	--	ND	ND	0.00	0.00
			4/26/2016	13.71	10.41	ND	ND	--	ND	ND	0.00	0.00
			5/18/2016	13.88	10.24	ND	ND	--	ND	ND	0.00	0.00
			6/24/2016*	14.32	9.80	ND	ND	--	ND	ND	0.00	0.00
			7/26/2016	14.49	9.63	ND	ND	--	ND	ND	0.00	0.00
			8/30/2016	14.59	9.53	ND	ND	--	Sheen	ND	0.00	0.00
			9/27/2016	14.51	9.61	ND	ND	--	Sheen	ND	0.00	0.00
			10/25/2016	14.04	10.08	ND	ND	--	Sheen	ND	0.00	0.00
			11/1/2016	13.99	10.13	13.97	ND	--	0.02	ND	0.00	0.00
			11/22/2016	14.08	10.04	ND	ND	--	Sheen	ND	0.00	0.00
			12/21/2016	13.91	10.21	ND	ND	--	Sheen	ND	0.00	0.00
			1/26/2017	13.22	10.90	ND	ND	--	Sheen	ND	0.00	0.00
			2/24/2017	--		ND	ND	--	Sheen	ND	0.00	0.00
			3/23/2017	13.32	10.80	ND	ND	--	Sheen	ND	0.00	0.00
			4/27/2017	12.55	11.57	ND	ND	--	Sheen	ND	0.00	0.00
			5/25/2017	13.33	10.79	ND	ND	--	ND	ND	0.00	0.00
			6/29/2017	13.73	10.39	ND	ND	--	Sheen	ND	0.00	0.00
			7/27/2017	13.99	10.13	13.99	ND	--	Sheen	ND	0.00	0.00
			8/29/2017	14.21	9.91	14.21	ND	--	Sheen	ND	0.00	0.00
			9/28/2017	14.13	9.99	14.13	ND	--	Sheen	ND	0.00	0.00
			11/1/2017	14.10	10.02	13.90	ND	--	0.20	ND	0.00	0.00
			11/21/2017	14.00	10.12	13.95	ND	--	Sheen	ND	0.00	0.00
			12/29/2017	14.10	10.02	14.05	ND	--	Sheen	ND	0.00	0.00
			1/26/2018	14.40	9.72	14.35	ND	--	Sheen	ND	0.00	0.00
			2/27/2018	12.94	11.18	ND	ND	--	ND	ND	0.00	0.00
			3/23/2018	13.01	11.11	12.98	ND	--	0.03	ND	0.00	0.00
			4/26/2018	12.69	11.43	12.65	ND	--	0.04	ND	0.00	0.00
			6/4/2018	12.78	11.34	12.72	ND	--	0.06	ND	0.00	0.00
			6/26/2018	13.66	10.46	13.61	ND	--	0.05	ND	0.00	0.00
			7/31/2018	13.63	10.49	13.59	ND	--	0.04	ND	0.00	0.00
			8/27/2018	13.66	10.46	13.58	ND	--	0.08	ND	0.00	0.00
			10/3/2018	13.30	10.82	ND	ND	--	ND	ND	0.00	0.00
			10/30/2018	13.20	10.92	ND	ND	--	ND	ND	0.00	0.00
			11/29/2018	12.08	12.04	ND	ND	--	ND	ND	0.00	0.00
			1/3/2019	12.70	11.42	ND	ND	--	ND	ND	0.00	0.00
			1/31/2019	13.23	10.89	ND	ND	--	ND	ND	0.00	0.00
			2/19/2019	13.41	10.71	ND	ND	--	ND	ND	0.00	0.00
			3/28/2019	12.93	11.19	ND	ND	--	ND	ND	0.00	0.00
			4/30/2019	12.72	11.40	ND	ND	--	ND	ND	0.00	0.00
			6/5/2019	13.44	10.68	ND	ND	--	ND	ND	0.00	0.00
			7/3/2019	13.74	10.38	ND	ND	--	ND	ND	0.00	0.00
			8/1/2019	13.88	10.24	ND	ND	--	ND	ND	0.00	0.00
			9/3/2019	13.98	10.14	13.98	ND	--	Sheen	ND	0.00	0.00
			10/1/2019	14.22	9.90	14.22	ND	--	Sheen	ND	0.00	0.00
			11/5/2019	13.66	10.46	ND	ND	--	ND	ND	0.00	0.00
			12/18/2019	12.62	11.50	ND	ND	--	Tip of probe	ND	0.00	0.00
			1/8/2020	12.97	11.15	ND	ND	--	Tip of probe	ND	0.00	0.00
			2/5/2020	14.41	9.71	ND	ND	19.59	ND	ND	0.00	0.00
			3/11/2020	13.48	10.64	ND	ND	19.59	ND	ND	0.00	0.00
			5/7/2020	14.14	9.98	--	ND	--	--	ND	0.00	0.00
			6/17/2020**	13.99	10.13	15.50*	ND	19.51	*No NAPL visible on probe		0.00	0.00
			7/14/2020	14.24	9.88	ND	ND	19.54	ND	ND	0.00	0.00
			8/11/2020	14.37	9.75	ND	ND	--	ND	ND	0.00	0.00
			8/31/2020	15.51	8.61	ND	ND	19.52	ND	ND	0.00	0.00
			9/15/2020	14.37	9.75	--	--	19.55	--	--	0.00	0.00
			10/21/2020	14.27	9.85	ND	ND	19.71	Tip of probe	ND	0.00	0.00
			11/20/2020	14.23	9.89	ND	ND	19.60	Tip of probe	ND	0.00	0.00
			12/30/2020	13.30	10.82	ND	ND	19.69	ND	ND	0.00	0.00
			1/15/2021	13.62	10.50	ND	ND	19.55	ND	ND	0.00	0.00
			2/9/2021	13.82	10.30	ND	ND	19.56	ND	ND	0.00	0.00
			3/12/2021	13.28	10.84	ND	ND	19.57	ND	ND	0.00	0.00
			4/8/2021	13.49	10.63	ND	ND	19.55	ND	ND	0.00	0.00
			5/11/2021	13.24	10.88	ND	ND	19.54	ND	ND	0.00	0.00
			6/8/2021	13.73	10.39	ND	ND	19.50	ND	ND	0.00	0.00
			7/14/2021	12.51	11.61	ND	ND	19.48	ND	ND	0.00	0.00
			8/11/2021	13.31	10.81	ND	ND	19.29	ND	ND	0.00	0.00
			9/24/2021	13.52	10.60	ND	ND	19.43	ND	ND	0.00	0.00
			10/28/2021	13.10	11.02	ND	ND	18.21	ND	ND	0.00	0.00
			11/23/2021	13.05	11.07	ND	ND	19.14	ND	ND	0.00	0.00
			12/13/2021	13.22	10.90	ND	ND	19.27	ND	ND	0.00	0.00
			1/5/2022	13.66	10.46	ND	ND	19.14	ND	ND	0.00	0.00
			2/8/2022	13.02	11.10	ND	ND	19.14	ND	ND	0.00	0.00

TABLE 4
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Well ID	Well screen interval (feet)	Reference Elevation (feet MSL)	Date	Depth to Water (feet)	Water Elevation (feet MSL)	Depth to LNAPL (feet)	Depth to DNAPL (feet)	Depth to Bottom (feet)	LNAPL Thickness (feet)	DNAPL Thickness (feet)	Est. Vol. of NAPL Recovered (gallons)	Cumulative NAPL Removed (gallons)
			5/12/2015	14.28	11.18	ND	ND	--	ND	ND	0.00	0.00
			8/6/2015	15.05	10.41	15.05	ND	--	Sheen	ND	0.00	0.00
			9/4/2015	15.34	10.12	ND	ND	--	ND	ND	0.00	0.00
			10/2/2015	15.01	10.45	ND	ND	--	ND	ND	0.00	0.00
			10/30/2015	15.05	10.41	ND	ND	--	ND	ND	0.00	0.00
			12/2/2015	15.07	10.39	ND	ND	--	ND	ND	0.00	0.00
			12/31/2015	14.64	10.82	ND	ND	--	ND	ND	0.00	0.00
			1/25/2016	15.39	10.07	ND	ND	--	ND	ND	0.00	0.00
			2/26/2016	14.25	11.21	ND	ND	--	ND	ND	0.00	0.00
			3/29/2016	14.11	11.35	ND	ND	--	ND	ND	0.00	0.00
			4/26/2016	14.46	11.00	ND	ND	--	ND	ND	0.00	0.00
			5/18/2016	14.74	10.72	ND	ND	--	ND	ND	0.00	0.00
			6/24/2016*	15.30	10.16	ND	ND	--	ND	ND	0.00	0.00
			7/26/2016	15.56	9.90	ND	ND	--	ND	ND	0.00	0.00
			8/30/2016	15.64	9.82	ND	ND	--	ND	ND	0.00	0.00
			9/27/2016	15.60	9.86	ND	ND	--	ND	ND	0.00	0.00
			10/25/2016	15.37	10.09	ND	ND	--	ND	ND	0.00	0.00
			11/1/2016	15.05	10.41	ND	ND	--	Sheen	ND	0.00	0.00
			11/22/2016	15.12	10.34	ND	ND	--	Sheen	ND	0.00	0.00
			12/21/2016	14.92	10.54	ND	ND	--	ND	ND	0.00	0.00
			1/26/2017	14.23	11.23	ND	ND	--	ND	ND	0.00	0.00
			2/24/2017	14.04	11.42	ND	ND	--	ND	ND	0.00	0.00
			3/23/2017	14.30	11.16	ND	ND	--	ND	ND	0.00	0.00
			4/27/2017	13.37	12.09	ND	ND	--	ND	ND	0.00	0.00
			5/25/2017	14.07	11.39	ND	ND	--	ND	ND	0.00	0.00
			6/29/2017	14.38	11.08	ND	ND	--	ND	ND	0.00	0.00
			7/27/2017	14.75	10.71	ND	ND	--	ND	ND	0.00	0.00
			8/29/2017	15.15	10.31	ND	ND	--	ND	ND	0.00	0.00
			9/28/2017	15.11	10.35	ND	ND	--	ND	ND	0.00	0.00
			11/1/2017	15.90	9.56	ND	ND	--	ND	ND	0.00	0.00
			11/21/2017	15.80	9.66	ND	ND	--	ND	ND	0.00	0.00
			12/29/2017	15.43	10.03	ND	ND	--	ND	ND	0.00	0.00
ENV-5MW	12-22	25.46	1/26/2018	14.59	10.87	14.59	ND	--	Sheen	ND	0.00	0.00
			2/27/2018	13.95	11.51	ND	ND	--	Sheen	ND	0.00	0.00
			3/23/2018	13.80	11.66	ND	ND	--	ND	ND	0.00	0.00
			4/26/2018	13.52	11.94	ND	ND	--	ND	ND	0.00	0.00
			6/4/2018	13.81	11.65	ND	ND	--	ND	ND	0.00	0.00
			6/26/2018	14.01	11.45	ND	ND	--	ND	ND	0.00	0.00
			7/31/2018	14.21	11.25	ND	ND	--	ND	ND	0.00	0.00
			8/27/2018	13.80	11.66	ND	ND	--	ND	ND	0.00	0.00
			10/3/2018	14.32	11.14	ND	ND	--	ND	ND	0.00	0.00
			10/30/2018	14.22	11.24	ND	ND	--	ND	ND	0.00	0.00
			11/29/2018	13.19	12.27	ND	ND	--	ND	ND	0.00	0.00
			1/3/2019	13.76	11.70	ND	ND	--	ND	ND	0.00	0.00
			1/31/2019	14.25	11.21	ND	ND	--	ND	ND	0.00	0.00
			2/19/2019	14.22	11.24	ND	ND	--	ND	ND	0.00	0.00
			3/28/2019	14.85	10.61	ND	ND	--	ND	ND	0.00	0.00
			4/30/2019	13.66	11.80	ND	ND	--	ND	ND	0.00	0.00
			6/5/2019	14.25	11.21	ND	ND	--	ND	ND	0.00	0.00
			7/3/2019	14.57	10.89	ND	ND	--	ND	ND	0.00	0.00
			8/1/2019	14.71	10.75	ND	ND	--	ND	ND	0.00	0.00
			9/3/2019	14.88	10.58	ND	ND	--	ND	ND	0.00	0.00
			10/1/2019	15.17	10.29	ND	ND	--	ND	ND	0.00	0.00
			11/5/2019	14.65	10.81	ND	ND	--	ND	ND	0.00	0.00
			12/18/2019	13.78	11.68	ND	ND	--	Tip of probe	ND	0.00	0.00
			1/8/2020	13.89	11.57	ND	ND	21.57	ND	ND	0.00	0.00
			2/5/2020	14.34	11.12	ND	ND	21.59	ND	ND	0.00	0.00
			3/11/2020	14.44	11.02	ND	ND	21.60	ND	ND	0.00	0.00
			5/7/2020	16.32	9.14	--	ND	--	--	ND	0.00	0.00
			6/17/2020	14.86	10.60	ND	ND	21.52	ND	ND	0.00	0.00
			7/14/2020	15.20	10.26	ND	ND	21.53	ND	ND	0.00	0.00
			8/11/2020	15.41	10.05	ND	ND	--	ND	ND	0.00	0.00
			8/31/2020	15.58	9.88	ND	ND	21.53	ND	ND	0.00	0.00
			9/15/2020	15.45	10.01	--	--	21.53	--	--	0.00	0.00
			10/21/2020	15.41	10.05	ND	ND	21.58	ND	ND	0.00	0.00

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Well ID	Well screen interval (feet)	Reference Elevation (feet MSL)	Date	Depth to Water (feet)	Water Elevation (feet MSL)	Depth to LNAPL (feet)	Depth to DNAPL (feet)	Depth to Bottom (feet)	LNAPL Thickness (feet)	DNAPL Thickness (feet)	Est. Vol. of NAPL Recovered (gallons)	Cumulative NAPL Removed (gallons)
ENV-8MW	10-20	26.44	5/12/2015	14.61	11.83	ND	ND	--	ND	ND	0.00	0.00
			8/6/2015	15.52	10.92	15.48	ND	--	0.04	ND	0.00	0.00
			9/4/2015	15.81	10.63	ND	ND	--	ND	ND	0.00	0.00
			10/2/2015	15.63	10.81	ND	ND	--	ND	ND	0.00	0.00
			10/30/2015	15.69	10.75	ND	ND	--	ND	ND	0.00	0.00
			12/2/2015	15.66	10.78	ND	ND	--	ND	ND	0.00	0.00
			12/31/2015	15.29	11.15	ND	ND	--	ND	ND	0.00	0.00
			1/25/2016	15.85	10.59	ND	ND	--	ND	ND	0.00	0.00
			2/26/2016	15.00	11.44	ND	ND	--	ND	ND	0.00	0.00
			3/29/2016	14.76	11.68	ND	ND	--	ND	ND	0.00	0.00
			4/26/2016	14.90	11.54	ND	ND	--	ND	ND	0.00	0.00
			5/18/2016	15.13	11.31	ND	ND	--	ND	ND	0.00	0.00
			6/24/2016*	15.74	10.70	ND	ND	--	ND	ND	0.00	0.00
			7/26/2016	16.11	10.33	ND	ND	--	ND	ND	0.00	0.00
			8/30/2016	16.24	10.20	ND	ND	--	ND	ND	0.00	0.00
			9/27/2016	16.22	10.22	ND	ND	--	ND	ND	0.00	0.00
			10/25/2016	15.70	10.74	ND	ND	--	ND	ND	0.00	0.00
			11/1/2016	15.53	10.91	ND	ND	--	ND	ND	0.00	0.00
			11/22/2016	16.64	9.80	ND	ND	--	ND	ND	0.00	0.00
			12/21/2016	15.52	10.92	ND	ND	--	ND	ND	0.00	0.00
			1/26/2017	14.90	11.54	ND	ND	--	ND	ND	0.00	0.00
			2/24/2017	14.75	11.69	ND	ND	--	ND	ND	0.00	0.00
			3/23/2017	14.73	11.71	ND	ND	--	ND	ND	0.00	0.00
			4/27/2017	13.72	12.72	ND	ND	--	ND	ND	0.00	0.00
			5/25/2017	14.36	12.08	ND	ND	--	ND	ND	0.00	0.00
			6/29/2017	14.70	11.74	ND	ND	--	ND	ND	0.00	0.00
			7/27/2017	15.15	11.29	ND	ND	--	ND	ND	0.00	0.00
			8/29/2017	15.60	10.84	ND	ND	--	ND	ND	0.00	0.00
			9/28/2017	15.59	10.85	ND	ND	--	ND	ND	0.00	0.00
			11/1/2017	12.10	14.34	ND	ND	--	ND	ND	0.00	0.00
			11/21/2017	14.28	12.16	ND	ND	--	ND	ND	0.00	0.00
			12/29/2017	14.28	12.16	ND	ND	--	ND	ND	0.00	0.00
			1/26/2018	15.59	10.85	ND	ND	--	ND	ND	0.00	0.00
			2/27/2018	15.51	10.93	ND	ND	--	ND	ND	0.00	0.00
			3/23/2018	14.15	12.29	ND	ND	--	ND	ND	0.00	0.00
			4/26/2018	11.62	14.82	ND	ND	--	ND	ND	0.00	0.00
			6/4/2018	14.36	12.08	ND	ND	--	ND	ND	0.00	0.00
			6/26/2018	15.21	11.23	ND	ND	--	ND	ND	0.00	0.00
			7/31/2018	15.32	11.12	ND	ND	--	ND	ND	0.00	0.00
			8/27/2018	14.21	12.23	ND	ND	--	ND	ND	0.00	0.00
			10/3/2018	14.35	12.09	ND	ND	--	ND	ND	0.00	0.00
			10/30/2018	14.82	11.62	ND	ND	--	ND	ND	0.00	0.00
			11/29/2018	13.70	12.74	ND	ND	--	ND	ND	0.00	0.00
			1/3/2019	14.20	12.24	ND	ND	--	ND	ND	0.00	0.00
			1/31/2019	14.61	11.83	ND	ND	--	ND	ND	0.00	0.00
			2/19/2019	14.77	11.67	ND	ND	--	ND	ND	0.00	0.00
			3/28/2019	14.34	12.10	ND	ND	--	ND	ND	0.00	0.00
			4/30/2019	14.10	12.34	ND	ND	--	ND	ND	0.00	0.00
			6/5/2019	14.64	11.80	ND	ND	--	ND	ND	0.00	0.00
			7/3/2019	14.98	11.46	ND	ND	--	ND	ND	0.00	0.00
			8/1/2019	15.03	11.41	ND	ND	--	ND	ND	0.00	0.00
			9/3/2019	15.21	11.23	ND	ND	--	ND	ND	0.00	0.00
			10/1/2019	15.61	10.83	ND	ND	--	ND	ND	0.00	0.00
			11/5/2019	15.09	11.35	ND	ND	--	ND	ND	0.00	0.00
			12/18/2019	14.28	12.16	ND	ND	19.52	ND	ND	0.00	0.00
			1/8/2020	14.21	12.23	ND	ND	19.48	ND	ND	0.00	0.00
			2/5/2020	14.74	11.70	ND	ND	19.44	ND	ND	0.00	0.00
			3/11/2020	14.82	11.62	ND	ND	19.46	ND	ND	0.00	0.00
			5/7/2020	14.18	12.26	ND	ND	19.34	ND	ND	0.00	0.00
			6/17/2020	15.22	11.22	ND	ND	19.27	ND	ND	0.00	0.00
			7/14/2020	14.62	11.82	ND	ND	19.04	ND	ND	0.00	0.00
			8/11/2020	15.85	10.59	ND	ND	--	ND	ND	0.00	0.00
			8/31/2020	16.04	10.40	ND	ND	18.96	ND	ND	0.00	0.00
			9/15/2020	16.00	10.44	--	--	19.00	--	--	0.00	0.00
			10/21/2020	15.98	10.46	ND	ND	19.06	ND	ND	0.00	0.00

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ENV-9MW	12-22	26.72	5/12/2015	15.12	11.60	15.09	ND	--	0.03	ND	0.00	0.00
			8/6/2015	16.09	10.63	15.90	ND	--	0.19	ND	0.00	0.00
			9/4/2015	16.20	10.52	ND	ND	--	ND	ND	0.00	0.00
			10/2/2015	16.03	10.69	ND	ND	--	ND	ND	0.00	0.00
			10/30/2015	16.04	10.68	ND	ND	--	ND	ND	0.00	0.00
			12/2/2015	16.07	10.65	ND	ND	--	ND	ND	0.00	0.00
			12/31/2015	15.72	11.00	ND	ND	--	ND	ND	0.00	0.00
			1/25/2016	14.87	11.85	ND	ND	--	ND	ND	0.00	0.00
			2/26/2016	15.40	11.32	ND	ND	--	ND	ND	0.00	0.00
			3/29/2016	15.15	11.57	ND	ND	--	ND	ND	0.00	0.00
			4/26/2016	15.34	11.38	ND	ND	--	ND	ND	0.00	0.00
			5/18/2016	15.52	11.20	ND	ND	--	ND	ND	0.00	0.00
			6/24/2016*	16.13	10.59	ND	ND	--	ND	ND	0.00	0.00
			7/26/2016	16.51	10.21	ND	ND	--	ND	ND	0.00	0.00
			8/30/2016	16.60	10.12	ND	ND	--	ND	ND	0.00	0.00
			9/27/2016	16.53	10.19	ND	ND	--	ND	ND	0.00	0.00
			10/25/2016	16.01	10.71	15.96	ND	--	0.05	ND	0.00	0.00
			11/1/2016	15.96	10.76	15.79	ND	--	0.17	ND	0.00	0.00
			11/22/2016	16.02	10.70	15.98	ND	--	0.04	ND	0.00	0.00
			12/21/2016	16.03	10.69	16.01	ND	--	0.02	ND	0.00	0.00
			1/26/2017	15.39	11.33	15.38	ND	--	0.01	ND	0.00	0.00
			2/24/2017	15.31	11.41	15.23	ND	--	0.08	ND	0.00	0.00
			3/23/2017	15.28	11.44	15.19	ND	--	0.09	ND	0.00	0.00
			4/27/2017	14.24	12.48	14.24	ND	--	Sheen	ND	0.00	0.00
			5/25/2017	15.02	11.70	15.01	ND	--	0.01	ND	0.00	0.00
			6/29/2017	15.15	11.57	ND	ND	--	Sheen	ND	0.00	0.00
			7/27/2017	15.89	10.83	15.89	ND	--	Sheen	ND	0.00	0.00
			8/29/2017	16.33	10.39	16.90	ND	--	0.57	ND	0.00	0.00
			9/28/2017	12.31	14.41	ND	ND	--	Sheen	ND	0.00	0.00
			11/1/2017	15.85	10.87	15.71	ND	--	0.14	ND	0.00	0.00
			11/21/2017	14.91	11.81	14.32	ND	--	0.59	ND	0.00	0.00
			12/29/2017	14.03	12.69	14.01	ND	--	Sheen	ND	0.00	0.00
			1/26/2018	15.56	11.16	15.57	ND	--	Sheen	ND	0.00	0.00
			2/27/2018	19.95	6.77	ND	ND	--	ND	ND	0.00	0.00
			3/23/2018	14.65	12.07	ND	ND	--	ND	ND	0.00	0.00
			4/26/2018	14.32	12.40	ND	ND	--	ND	ND	0.00	0.00
			6/4/2018	14.52	12.20	ND	ND	--	ND	ND	0.00	0.00
			6/26/2018	13.68	13.04	ND	ND	--	ND	ND	0.00	0.00
			7/31/2018	14.01	12.71	ND	ND	--	ND	ND	0.00	0.00
			8/27/2018	14.30	12.42	ND	ND	--	ND	ND	0.00	0.00
			10/3/2018	15.62	11.10	15.55	ND	--	0.07	ND	0.00	0.00
			10/30/2018	15.13	11.59	15.10	ND	--	0.03	ND	0.00	0.00
			11/29/2018	14.03	12.69	ND	ND	--	ND	ND	0.00	0.00
			1/3/2019	14.68	12.04	14.68	ND	--	0.00	ND	0.00	0.00
			1/31/2019	Inaccessible (snow)							0.00	0.00
			2/19/2019	Inaccessible (snow)							0.00	0.00
			3/28/2019	14.69	12.03	ND	ND	--	ND	ND	0.00	0.00
			4/30/2019	14.38	12.34	ND	ND	--	ND	ND	0.00	0.00
			6/5/2019	14.91	11.81	14.91	ND	--	0.00	ND	0.00	0.00
			7/3/2019	15.23	11.49	ND	ND	--	ND	ND	0.00	0.00
			8/1/2019	15.31	11.41	ND	ND	--	ND	ND	0.00	0.00
			9/3/2019	11.01	15.71	ND	ND	--	ND	ND	0.00	0.00
			10/1/2019	15.93	10.79	15.93	ND	--	0.00	ND	0.00	0.00
			11/5/2019	15.38	11.34	ND	ND	--	ND	ND	0.00	0.00
			12/18/2019	Inaccessible (ice)							0.00	0.00
			1/8/2020	Inaccessible (snow)							0.00	0.00
			2/5/2020	15.00	11.72	ND	ND	--	ND	ND	0.00	0.00
			3/11/2020	15.11	11.61	ND	ND	21.55	ND	ND	0.00	0.00
			5/7/2020	Well not found							0.00	0.00
			6/17/2020	Well not found							0.00	0.00
			7/14/2020	Well not found							0.00	0.00
			8/11/2020	Well not found							0.00	0.00
			8/31/2020	Attempted to locate well with metal detector; well not found							0.00	0.00
			9/15/2020	Well not found							0.00	0.00
			10/21/2020	Well not found							0.00	0.00

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Well ID	Well screen interval (feet)	Reference Elevation (feet MSL)	Date	Depth to Water (feet)	Water Elevation (feet MSL)	Depth to LNAPL (feet)	Depth to DNAPL (feet)	Depth to Bottom (feet)	LNAPL Thickness (feet)	DNAPL Thickness (feet)	Est. Vol. of NAPL Recovered (gallons)	Cumulative NAPL Removed (gallons)
NFSB-01(MW)	12-22	24.53	1/26/2017	13.17	11.36	ND	ND	--	ND	ND	0.00	0.00
			2/24/2017	13.03	11.50	ND	ND	--	ND	ND	0.00	0.00
			3/23/2017	13.08	11.45	ND	ND	--	ND	ND	0.00	0.00
			4/27/2017	12.21	12.32	ND	ND	--	ND	ND	0.00	0.00
			5/25/2017	12.91	11.62	ND	ND	--	ND	ND	0.00	0.00
			6/29/2017	13.28	11.25	ND	ND	--	ND	ND	0.00	0.00
			7/27/2017	13.70	10.83	ND	ND	--	ND	ND	0.00	0.00
			8/29/2017	14.07	10.46	ND	ND	--	ND	ND	0.00	0.00
			9/28/2017	13.98	10.55	ND	ND	--	ND	ND	0.00	0.00
			11/1/2017	13.65	10.88	ND	ND	--	ND	ND	0.00	0.00
			11/21/2017	13.38	11.15	ND	ND	--	ND	ND	0.00	0.00
			12/29/2017	13.38	11.15	ND	ND	--	ND	ND	0.00	0.00
			1/26/2018	14.21	10.32	ND	ND	--	ND	ND	0.00	0.00
			2/27/2018	11.82	12.71	ND	ND	--	ND	ND	0.00	0.00
			3/23/2018	12.21	12.32	ND	ND	--	ND	ND	0.00	0.00
			4/26/2018	12.13	12.40	ND	ND	--	ND	ND	0.00	0.00
			6/4/2018	12.31	12.22	ND	ND	--	ND	ND	0.00	0.00
			6/26/2018	13.01	11.52	ND	ND	--	ND	ND	0.00	0.00
			7/31/2018	13.56	10.97	ND	ND	--	ND	ND	0.00	0.00
			8/27/2018	12.51	12.02	ND	ND	--	ND	ND	0.00	0.00
			10/3/2018	13.30	11.23	ND	ND	--	ND	ND	0.00	0.00
			10/30/2018	13.08	11.45	ND	ND	--	ND	ND	0.00	0.00
			11/29/2018	11.75	12.78	ND	ND	--	ND	ND	0.00	0.00
			1/3/2019	12.73	11.80	ND	ND	--	ND	ND	0.00	0.00
			1/31/2019	12.94	11.59	ND	ND	--	ND	ND	0.00	0.00
			2/19/2019	13.08	11.45	ND	ND	--	ND	ND	0.00	0.00
			3/28/2019	12.66	11.87	ND	ND	--	ND	ND	0.00	0.00
			4/30/2019	12.38	12.15	ND	ND	--	ND	ND	0.00	0.00
			6/5/2019	13.13	11.40	ND	ND	--	ND	ND	0.00	0.00
			7/3/2019	13.37	11.16	ND	ND	--	ND	ND	0.00	0.00
			8/1/2019	13.49	11.04	ND	ND	--	ND	ND	0.00	0.00
			9/3/2019	13.68	10.85	ND	ND	--	ND	ND	0.00	0.00
			10/1/2019	14.06	10.47	ND	ND	--	ND	ND	0.00	0.00
			11/5/2019	11.63	12.90	ND	ND	--	ND	ND	0.00	0.00
			12/18/2019	12.38	12.15	ND	ND	--	ND	ND	0.00	0.00
			1/8/2020	12.62	11.91	ND	ND	22.09	ND	ND	0.00	0.00
			2/5/2020	13.11	11.42	ND	ND	21.86	ND	ND	0.00	0.00
			3/11/2020	13.21	11.32	ND	ND	22.20	ND	ND	0.00	0.00
			5/7/2020	13.23	11.30	ND	ND	--	ND	ND	0.00	0.00
			6/17/2020	--	--	--	--	--	--	--	0.00	0.00
			7/14/2020	14.02	10.51	ND	ND	21.84	ND	ND	0.00	0.00
			8/11/2020	14.32	10.21	ND	ND	--	ND	ND	0.00	0.00
			8/31/2020	14.47	10.06	ND	ND	21.61	ND	ND	0.00	0.00
			9/15/2020	13.39	11.14	--	--	21.82	--	--	0.00	0.00
			10/21/2020	14.32	10.21	ND	ND	20.85	ND	ND	0.00	0.00

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Well ID	Well screen interval (feet)	Reference Elevation (feet MSL)	Date	Depth to Water (feet)	Water Elevation (feet MSL)	Depth to LNAPL (feet)	Depth to DNAPL (feet)	Depth to Bottom (feet)	LNAPL Thickness (feet)	DNAPL Thickness (feet)	Est. Vol. of NAPL Recovered (gallons)	Cumulative NAPL Removed (gallons)
NFSB-02(MW)	12-22	24.53	11/1/2016	14.20	10.33	13.93	ND	--	0.27	ND	0.00	0.00
			1/26/2017	12.92	11.61	12.92	ND	--	Sheen	ND	0.00	0.00
			2/24/2017	13.40	11.13	13.37	ND	--	0.03	ND	0.00	0.00
			3/23/2017	15.28	9.25	13.03	ND	--	2.25	ND	0.75	0.75
			4/27/2017	15.02	9.51	12.07	ND	--	2.95	ND	1.00	1.75
			5/25/2017	15.96	8.57	13.04	ND	--	2.92	ND	1.00	2.75
			6/29/2017	17.82	6.71	13.87	ND	--	3.95	ND	1.50	4.25
			7/27/2017	15.63	8.90	13.77	ND	--	1.86	ND	0.50	4.75
			8/29/2017	16.10	8.43	14.10	ND	--	2.00	ND	0.25	5.00
			9/28/2017	15.94	8.59	14.02	ND	--	1.92	ND	1.50	6.50
			11/1/2017	15.92	8.61	14.36	ND	--	1.56	ND	0.75	7.25
			11/21/2017	15.21	9.32	15.01	ND	--	0.20	ND	0.15	7.40
			12/29/2017	15.21	9.32	15.01	ND	--	0.20	ND	0.20	7.60
			1/26/2018	14.95	9.58	14.19	ND	--	0.76	ND	0.10	7.70
			2/27/2018	14.23	10.30	12.71	ND	--	1.52	ND	0.15	7.85
			3/23/2018	16.85	7.68	12.95	ND	--	3.90	ND	1.50	9.35
			4/26/2018	16.15	8.38	12.42	ND	--	3.73	ND	1.00	10.35
			6/4/2018	16.81	7.72	12.62	ND	--	4.19	ND	2.00	12.35
			6/26/2018	14.21	10.32	13.10	ND	--	1.11	ND	0.25	12.60
			7/31/2018	14.56	9.97	14.01	ND	--	0.55	ND	0.15	12.75
			8/27/2018	13.01	11.52	12.78	ND	--	0.23	ND	0.20	12.95
			10/3/2018	12.82	11.71	12.18	ND	--	0.64	ND	0.75	13.70
			10/30/2018	14.10	10.43	12.84	ND	--	1.26	ND	1.50	15.20
			11/29/2018	11.03	13.50	8.55	ND	--	2.48	ND	1.00	16.20
			1/3/2019	14.61	9.92	12.31	ND	--	2.30	ND	1.50	17.70
			1/31/2019	15.12	9.41	12.96	ND	--	2.16	ND	1.00	18.70
			2/19/2019	15.14	9.39	13.21	ND	--	1.93	ND	1.00	19.70
			3/28/2019	15.01	9.52	12.85	ND	--	2.16	ND	1.50	21.20
			4/30/2019	14.46	10.07	12.49	ND	--	1.97	ND	1.00	22.20
			6/5/2019	14.54	9.99	13.13	ND	--	1.41	ND	1.00	23.20
			7/3/2019	15.46	9.07	13.52	ND	--	1.94	ND	1.50	24.70
			8/1/2019	15.29	9.24	13.68	ND	--	1.61	ND	1.00	25.70
			9/3/2019	15.41	9.12	13.80	ND	--	1.61	ND	1.50	27.20
			10/1/2019	15.58	8.95	14.06	ND	--	1.52	ND	1.00	28.20
			11/5/2019	16.00	8.53	13.50	ND	--	2.50	ND	0.75	28.95
			12/18/2019	14.35	10.18	12.44	ND	--	1.91	ND	0.30	29.25
			1/8/2020	14.57	9.96	12.80	ND	--	1.77	ND	0.30	29.55
			2/5/2020	14.63	9.90	13.20	ND	21.55	1.43	ND	0.50	30.05
			3/11/2020	15.17	9.36	13.33	ND	21.70	1.84	ND	0.50	30.55
			5/7/2020	12.81	11.72	NAPL visible on probe; probe not reading accurately				ND	0.25	30.80
			6/17/2020	15.28	9.25	13.77	ND	22.12	1.51	ND	0.25	31.05
			7/14/2020	--	--	14.01	ND	--	On probe	ND	0.25	31.30
			8/11/2020	15.87	8.66	14.35	ND	21.66	1.52	ND	0.25	31.55
			8/31/2020	14.45	10.08	NAPL visible on probe; could not be accurately gauged				ND	0.25	31.80
			9/15/2020	14.45	10.08	NAPL visible on probe; could not be accurately gauged				ND	0.25	31.80
			10/21/2020	15.38	9.15	14.48	ND	--	0.90	ND	0.25	32.05
			11/20/2020	15.32	9.21	14.31	ND	21.72	1.01	ND	0.30	32.35
			12/30/2020	14.40	10.13	13.35	ND	--	1.05	ND	0.30	32.65
			1/15/2021	15.08	9.45	13.60	ND	21.62	1.48	ND	0.25	32.90
			2/9/2021	14.73	9.80	13.71	ND	20.21	1.02	ND	0.50	33.40
			3/12/2021	13.90	10.63	13.10	ND	--	0.80	ND	0.25	33.65
			4/8/2021	14.80	9.73	13.57	ND	21.70	1.23	ND	0.25	33.90
			5/11/2021	14.48	10.05	13.14	ND	17.30	1.34	ND	0.20	34.10
			6/8/2021	NM	NM	NM	--	--	--	NM	0.00	34.10
			7/14/2021	13.25	11.28	--	ND	--	--	ND	0.40	34.50
			8/11/2021	15.16	9.37	13.07	ND	--	2.09	ND	0.30	34.80
			9/24/2021	14.22	10.31	13.29	ND	--	0.93	ND	0.15	34.95
			10/28/2021	13.74	10.79	12.76	ND	14.48	0.98	ND	0.16	35.11
			11/23/2021	14.25	10.28	12.92	ND	--	1.33	ND	0.22	35.33
			12/13/2021	14.44	10.09	13.02	ND	17.73	1.42	ND	0.23	35.56
			1/5/2022	14.01	10.52	13.08	ND	--	0.93	ND	0.15	35.71
			2/8/2022	13.78	10.75	12.82	ND	17.68	0.96	ND	0.16	35.87

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NFSB-08(MW)	12-22	24.41	1/26/2017	11.44	12.97	ND	ND	--	ND	ND	0.00	0.00
			2/24/2017	11.14	13.27	ND	ND	--	ND	ND	0.00	0.00
			3/23/2017	10.94	13.47	ND	ND	--	ND	ND	0.00	0.00
			4/27/2017	10.13	14.28	ND	ND	--	ND	ND	0.00	0.00
			5/25/2017	10.72	13.69	ND	ND	--	ND	ND	0.00	0.00
			6/29/2017	11.13	13.28	ND	ND	--	ND	ND	0.00	0.00
			7/27/2017	11.54	12.87	ND	ND	--	ND	ND	0.00	0.00
			8/29/2017	15.60	8.81	ND	ND	--	ND	ND	0.00	0.00
			9/28/2017	11.90	12.51	ND	ND	--	ND	ND	0.00	0.00
			11/1/2017	15.46	8.95	ND	ND	--	ND	ND	0.00	0.00
			11/21/2017	12.05	12.36	ND	ND	--	ND	ND	0.00	0.00
			12/29/2017	14.28	10.13	ND	ND	--	ND	ND	0.00	0.00
			1/26/2018	14.36	10.05	ND	ND	--	ND	ND	0.00	0.00
			2/27/2018	12.21	12.20	ND	ND	--	ND	ND	0.00	0.00
			3/23/2018	15.13	9.28	ND	ND	--	ND	ND	0.00	0.00
			4/26/2018	11.62	12.79	ND	ND	--	ND	ND	0.00	0.00
			6/4/2018	12.11	12.30	ND	ND	--	ND	ND	0.00	0.00
			6/26/2018	12.52	11.89	ND	ND	--	ND	ND	0.00	0.00
			7/31/2018	12.77	11.64	ND	ND	--	ND	ND	0.00	0.00
			8/27/2018	12.64	11.77	ND	ND	--	ND	ND	0.00	0.00
			10/3/2018	12.36	12.05	ND	ND	--	ND	ND	0.00	0.00
			10/30/2018	11.30	13.11	ND	ND	--	ND	ND	0.00	0.00
			11/29/2018	10.17	14.24	ND	ND	--	ND	ND	0.00	0.00
			1/3/2019	10.72	13.69	ND	ND	--	ND	ND	0.00	0.00
			1/31/2019	10.97	13.44	ND	ND	--	ND	ND	0.00	0.00
			2/19/2019	11.05	13.36	ND	ND	--	ND	ND	0.00	0.00
			3/28/2019	10.71	13.70	ND	ND	--	ND	ND	0.00	0.00
			4/30/2019	10.58	13.83	ND	ND	--	ND	ND	0.00	0.00
			6/5/2019	11.05	13.36	ND	ND	--	ND	ND	0.00	0.00
			7/3/2019	11.22	13.19	ND	ND	--	ND	ND	0.00	0.00
			8/1/2019	11.40	13.01	ND	ND	--	ND	ND	0.00	0.00
			9/3/2019	11.54	12.87	ND	ND	--	ND	ND	0.00	0.00
			10/1/2019	11.95	12.46	ND	ND	--	ND	ND	0.00	0.00
			11/5/2019	11.63	12.78	ND	ND	--	ND	ND	0.00	0.00
			12/18/2019	10.87	13.54	ND	ND	--	ND	ND	0.00	0.00
			1/8/2020	10.71	13.70	ND	ND	19.86	ND	ND	0.00	0.00
			2/5/2020	NR	NR	ND	ND	--	ND	ND	0.00	0.00
			3/11/2020	NR	NR	ND	ND	--	ND	ND	0.00	0.00
			5/7/2020	11.11	13.30	ND	ND	--	ND	ND	0.00	0.00
			6/17/2020	11.58	12.83	ND	ND	--	ND	ND	0.00	0.00
			7/14/2020	11.98	12.43	ND	ND	19.72	ND	ND	0.00	0.00
			8/11/2020	12.21	12.20	ND	ND	--	ND	ND	0.00	0.00
			8/31/2020	12.43	11.98	ND	ND	19.85	ND	ND	0.00	0.00
			9/15/2020	12.41	12.00	ND	ND	19.75	ND	ND	0.00	0.00
			10/21/2020	12.50	11.91	ND	ND	19.06	ND	ND	0.00	0.00

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284 Winter Street
Haverhill, Massachusetts

Well ID	Well screen interval (feet)	Reference Elevation (feet MSL)	Date	Depth to Water (feet)	Water Elevation (feet MSL)	Depth to LNAPL (feet)	Depth to DNAPL (feet)	Depth to Bottom (feet)	LNAPL Thickness (feet)	DNAPL Thickness (feet)	Est. Vol. of NAPL Recovered (gallons)	Cumulative NAPL Removed (gallons)
B102	10-20	24.54	2/5/2020	11.86	12.68	ND	ND	--	ND	ND	0.00	0.00
			3/11/2020	11.95	12.59	ND	ND	--	ND	ND	0.00	0.00
			5/7/2020	11.47	13.07	ND	ND	--	ND	ND	0.00	0.00
			6/17/2020	12.31	12.23	ND	ND	--	ND	ND	0.00	0.00
			7/14/2020	12.61	11.93	ND	ND	18.14	ND	ND	0.00	0.00
			8/11/2020	12.87	11.67	ND	ND	--	ND	ND	0.00	0.00
			8/31/2020	13.02	11.52	ND	ND	18.12	ND	ND	0.00	0.00
			9/15/2020	12.99	11.55	--	--	18.14	--	--	0.00	0.00
			10/21/2020	13.05	11.49	ND	ND	18.20	ND	ND	0.00	0.00
B106	10-20	25.23	2/5/2020	12.81	12.42	ND	ND	--	ND	ND	0.00	0.00
			3/11/2020	12.90	12.33	ND	ND	--	ND	ND	0.00	0.00
			5/7/2020	12.58	12.65	ND	ND	--	ND	ND	0.00	0.00
			6/17/2020	--	--	ND	ND	19.19	ND	ND	0.00	0.00
			7/14/2020	13.76	11.47	ND	ND	19.22	ND	ND	0.00	0.00
			8/11/2020	14.03	11.20	ND	ND	--	ND	ND	0.00	0.00
			8/31/2020	14.17	11.06	ND	ND	19.24	ND	ND	0.00	0.00
			9/15/2020	14.11	11.12	--	--	19.30	--	--	0.00	0.00
			10/21/2020	14.10	11.13	ND	ND	20.30	ND	ND	0.00	0.00
B107	3.0-15.0	25.32	2/5/2020	2.63	22.69	ND	12.50	--	ND	2.22	0.00	0.00
			3/11/2020	2.66	22.66	ND	11.56	14.40	ND	3.16	0.00	0.00
			5/7/2020	--	--	--	--	--	--	--	0.00	0.00
			6/17/2020	--	--	--	--	--	--	--	0.00	0.00
			7/14/2020	--	--	--	--	--	--	--	0.00	0.00
			8/11/2020	3.30	22.02	--	10.81	11.81	--	3.91	0.00	0.00
			8/31/2020	3.44	21.88	ND	11.55	--	ND	3.17	0.00	0.00
			9/15/2020	3.40	21.92	ND	11.85	--	ND	2.87	0.00	0.00
			10/21/2020	3.43	21.89	ND	11.52	14.72	ND	3.20	0.50	0.50
			11/20/2020	--	--	--	--	--	--	--	0.00	0.00
			12/30/2020	2.34	22.98	--	11.67	--	--	3.05	0.00	0.00
			1/15/2021	2.65	22.67	--	11.48	--	--	3.24	0.00	0.00
			2/9/2021	2.82	22.50	--	11.25	--		3.47	0.00	0.00
			3/12/2021	2.06	23.26	ND	11.35	--	ND	3.37	0.00	0.00
			4/8/2021	2.53	22.79	ND	11.33	--	ND	3.39	0.00	0.00
			5/11/2021	2.46	22.86	ND	11.48	--	ND	3.24	0.00	0.00
			6/8/2021	2.62	22.70	ND	11.27	--	ND	3.45	0.00	0.00
			7/14/2021	1.84	23.48	--	--	--	--	--	0.00	0.00
			8/11/2021	2.52	22.80	ND	11.40	14.44	ND	3.32	0.30	0.80
			9/24/2021	2.70	22.62		12.89			1.83		
			10/28/2021	2.37	22.95		12.97			1.75		
			11/23/2021	2.53	22.79		12.28			2.44		
			12/13/2021	3.78	21.54		12.70			2.02		
			1/5/2022	2.44	22.88		*			NM		
			2/8/2022	2.42	22.90		*			NM		
GZA-1	15-25	26.41	9/15/2020	15.27	11.14	ND	ND	24.86	ND	ND	0.00	0.00
			10/21/2020	14.79	11.62	ND	ND	24.85	ND	ND	0.00	0.00
			11/20/2020	15.12	11.29	ND	ND	24.86	ND	ND	0.00	0.00
GZA-1A	12-24	26.61	9/15/2020	11.53	15.08	ND	ND	23.25	ND	ND	0.00	0.00
			10/21/2020	11.45	15.16	ND	ND	23.25	ND	ND	0.00	0.00
			11/20/2020	11.61	15.00	ND	ND	23.35	ND	ND	0.00	0.00
GZA-2	13-25	27.30	9/15/2020	17.63	9.67	ND	ND	24.75	ND	ND	0.00	0.00
			10/21/2020	16.91	10.39	ND	ND	24.80	ND	ND	0.00	0.00
			11/20/2020	17.13	10.17	ND	ND	24.78	ND	ND	0.00	0.00
Upstream Surface Water	NA	26.87	5/7/2020	18.03	8.84	NA	NA	NA	NA	NA	NA	NA
			7/14/2020	18.56	8.31	NA	NA	NA	NA	NA	NA	NA
			8/11/2020	19.11	7.76	NA	NA	NA	NA	NA	NA	NA
			8/31/2020	19.11	7.76	NA	NA	NA	NA	NA	NA	NA
			9/15/2020	19.18	7.69	NA	NA	NA	NA	NA	NA	NA
			10/21/2020	18.89	7.98	NA	NA	NA	NA	NA	NA	NA
			11/20/2020	19.08	7.79	NA	NA	NA	NA	NA	NA	NA
			12/30/2020	18.29	8.58	NA	NA	NA	NA	NA	NA	NA
			1/15/2021	18.55	8.32	NA	NA	NA	NA	NA	NA	NA
			2/9/2021	18.65	8.22	NA	NA	NA	NA	NA	NA	NA
			3/12/2021	17.88	8.99	NA	NA	NA	NA	NA	NA	NA
			4/8/2021	18.78	8.09							
			5/11/2021	18.18	8.69							
			6/8/2021	18.62	8.25							
			7/14/2021	16.61	10.26							
			8/11/2021	18.39	8.48							
			9/24/2021	18.67	8.20							
			10/28/2021	17.42	9.45							
			11/23/2021	17.95	8.92							
			12/13/2021	17.98	8.89							
			1/5/2022	18.18	8.69							
			2/8/2022	18.50	8.37							
Staff Gauge	NA	See Note	8/31/2020	0.44	--	NA	NA	NA	NA	NA	NA	NA
			9/15/2020	0.40	--	NA	NA	NA	NA	NA	NA	NA

TABLE 4
GROUNDWATER/NAPL GAUGING AND RECOVERY DATA
284 Winter Street
Haverhill, Massachusetts

Well ID	Well screen interval (feet)	Reference Elevation (feet MSL)	Date	Depth to Water (feet)	Water Elevation (feet MSL)	Depth to LNAPL (feet)	Depth to DNAPL (feet)	Depth to Bottom (feet)	LNAPL Thickness (feet)	DNAPL Thickness (feet)	Est. Vol. of NAPL Recovered (gallons)	Cumulative NAPL Removed (gallons)
Downstream Surface Water	NA	25.92	7/14/2020	19.50	See Note	NA	NA	NA	NA	NA	NA	NA
			8/11/2020	19.50	See Note	NA	NA	NA	NA	NA	NA	NA
			8/31/2020	19.50	See Note	NA	NA	NA	NA	NA	NA	NA
			9/15/2020	19.50	See Note	NA	NA	NA	NA	NA	NA	NA
			12/30/2020	14.29	11.63	NA	NA	NA	NA	NA	NA	NA
			1/15/2021	18.37	7.55	NA	NA	NA	NA	NA	NA	NA
			2/9/2021	20.00	5.92	NA	NA	NA	NA	NA	NA	NA
			3/12/2021	17.6	8.32	NA	NA	NA	NA	NA	NA	NA
			4/8/2021	18.31	7.61	NA	NA	NA	NA	NA	NA	NA
			5/11/2021	17.7	8.22	NA	NA	NA	NA	NA	NA	NA
			6/8/2021	18.2	7.72	NA	NA	NA	NA	NA	NA	NA
			7/14/2021	16.72	9.20	NA	NA	NA	NA	NA	NA	NA
			8/11/2021	18.41	7.51	NA	NA	NA	NA	NA	NA	NA
			9/24/2021	19.48	6.44	NA	NA	NA	NA	NA	NA	NA
			10/28/2021	18.1	7.82	NA	NA	NA	NA	NA	NA	NA
			11/23/2021	18.1	7.82	NA	NA	NA	NA	NA	NA	NA
			12/13/2021	20.75	5.17	NA	NA	NA	NA	NA	NA	NA
			1/5/2022	20.95	4.97	NA	NA	NA	NA	NA	NA	NA
			2/8/2022	20.4	5.52	NA	NA	NA	NA	NA	NA	NA

Notes:
NAPL = Non-Aqueous Phase Liquid; ND = Not Detected; -- = Data not available; NM = Not Measured; NA = Not Applicable.
All depths expressed in feet below the top of the PVC well casing.
Data from May 2015 through November 5, 2019 collected by Ramboll Environ; subsequent data collected by GZA.
6/24/2016* = sorbent socks were removed from wells ENV-1MW, ENV-3MW, ENV-5MW, ENV-8MW, and ENV-9MW on June 24, 2016 and were not replaced.
An estimated 0.6 gallons of NAPL were recovered using the sorbent socks (Ramboll, IRA Status Report #3).
6/17/2020** The interface probe (IP) registered a solid tone at 15.50 feet bgs in well ENV-3MW, but no NAPL was visible on the probe.
The probe does not reliably penetrate through the coal tar in B107 to reach the bottom of the holder. The well was evacuated on October 21, 2020 and the depth to bottom was confirmed to be 14.72 feet from top of well casing (15.2 feet from ground). DNAPL thickness measurements on the other dates in the table are based on the measured depth to the top of the DNAPL and this bottom depth. * indicates apparent interface probe malfunction on 1/5 and 2/8/22 (readings in 4 foot range).
Reference elevations surveyed by GZA on May 7, 2020, except MW series.
GZA-1, GZA-1A, and GZA-2 reference elevations established by The Morin-Cameron Group, Inc survey on September 9, 2020.
A blockage in the well casing was noted in June 2021 at NFSB-02. This was addressed in July 2021 but the IP did not register the NAPL surface.
Upstream River elevation measured from plaque on Winter Street Bridge (Elevation 26.87).
Staff Gauge installed on August 31, 2020 . Elevation of 0.0 on staff gauge was placed on river bottom. River bottom at this location has not been surveyed to date.
Downstream Surface Water Elevation estimated from top of curb near southern portion of Site. Reference Point elevation estimated from surface elevation measured at B110.
Downstream Surface Water Elevation Measurement of ≥19.50 feet indicate depth to existing river bed (no surface water at this location).

TABLE 5
HYDRAULIC CONDUCTIVITY TESTING RESULTS
284 Winter Street
Haverhill, Massachusetts

Well ID	Type of Test	Stratum	Hydraulic Conductivity (cm/sec)	Hydraulic Conductivity (ft/day)
ENV-5MW	Falling Head	Fill/Silty Sand	2.7 E-05 -5.4 E-05	0.08 - 0.15
ENV-8MW	Falling Head	Fill/Silty Sand	6.0 E-06 -8.3 E-05	0.02 - 0.23
NFSB-01	Falling Head	Sand and Silt	2.00E-04	0.57
MW-1	Falling Head	Granular Fill	3.0E-04 - 3.9E-04	8.7-11

Notes:

1. Falling head test data evaluated using equations developed by the U.S. Army Corps of Engineers and referenced in the Technical Manual TM 5-818-5/AFM 88-5
2. Tests performed on August 11, 2020 and August 11, 2021.

TABLE 6
SEDIMENT SAMPLING SUMMARY
284 Winter Street
Haverhill, Massachusetts

Sample ID	Property Location	Sample Date	Sample Time	Sample Description	PID (ppm)	Notes	Sample sent to lab?	Analysis*
1C 0-6"	191 Essex Street	6/8/2020	945	Brown, f-c SAND, some Gravel, trace Silt, trace Debris, slight decaying organics odor	0.7	coal-tar impacted material begins deeper than 20"	Y	1
1B 0-6"	284 Winter Street	6/8/2020	1015	Brown, f-c SAND and GRAVEL, trace Silt, trace Debris, slight petroleum-like odor, sheen on water	18	coal-tar impacted material begins at 12"	Y	1
1A 0-6"	284 Winter Street	6/8/2020	1130	Brown, f-c SAND and GRAVEL, trace Silt, trace Debris, slight decaying organics odor	0.2		Y	1
1A 1-5.5'	284 Winter Street	6/8/2020	1430	Black-brown, f-c SAND, little Gravel, trace Silt, trace Debris, strong petroleum-like odor, coated in coal-tar	274.7	material looked saturated while augering 12-16" - coal-tar impacted material first observed (stained) 4' - heavily saturated, physically sticky product	Y	2
2C 0-6"	221 Essex Street	6/9/2020	830	Black-brown, f-c SAND, little Gravel, little Organics, little Silt, slight decaying organics odor, slight sheen	4.4		Y	1
2B 0-6"	284 Winter Street	6/9/2020	905	Black, fine SILTY SAND, some Organics, little Gravel, strong petroleum-like odor, coated/saturated in coal-tar	105.3	saturated/coated material encountered @ ~2" below surface	N	
2A 0-6"	284 Winter Street	6/9/2020	935	0-4" - Black, f-c SAND, little Organics, little Gravel, trace Silt, strong petroleum-like odor, coated in coal-tar 4-6" - Black, SILTY SAND, some Organics, trace gracel, strong petroleum-like odor, saturated/coated in coal-tar	93.5	impacted material encountered immediately at surface	Y	2
2A 1-4'	284 Winter Street	6/9/2020	1015	Black, f-c SAND and SILT, little Organics, trace Gravel, petroleum-like odor, coated in coal-tar	27.3		Y	2
3C 0-6"	221 Essex Street	6/9/2020	1025	Brown, m-c SAND, trace Gravel, trace Organics, trace Debris, trace Silt, petroleum-like odor, sheen	382	sheen on surface of water	Y	1
3B 0-6"	284 Winter Street	6/9/2020	1055	Black, f-c SAND and SILT, little Gravel, trace Organics, trace Debris, strong petroleum-like odor, saturated in coal-tar	682.3		Y	2
3A 0-6"	284 Winter Street	6/9/2020	1215	Black-brown, f-c SAND, some Gravel, little Silt, little Organics, trace Debris, strong petroleum-like odor, stained/coated in coal-tar	487.5		N	
4B 0-6"	284 Winter Street	6/9/2020	1245	Brown, m-c SAND, some Gravel, trace Organics, trace Debris, trace Silt, petroleum-like odor, sheen	169.9		Y	1
4A 1-2.5'	284 Winter Street	6/9/2020	1310	Black, f-c SAND, some Silt, some Gravel, trace Organics, trace Debris, strong petroleum-like odor, saturated in coal-tar	526.6	very soft, auger advanced under its own weight	Y	2
4A 0-6"	284 Winter Street	6/9/2020	1330	Black-brown, f-c SAND, some Gravel, little Silt, trace Debris, strong petroleum-like odor, coated in coal-tar	603.1		N	
5A 0-6"	284 Winter Street	6/9/2020	1405	Black-brown, SILTY SAND, little Gravel, little Organics, trace Debris, strong petroleum-like odor, coated in coal-tar	1027	Composite sample collected from location 3' from wall (sheen at surface) and location 12' from wall (sheen at 2-4" down)	Y	2
5C 0-6"	35 Lafayette Sq.	6/9/2020	1435	Brown, f-c SAND, some Gravel, some Organics, trace Silt, trace Debris, slight decaying organics odor	1.4		Y	1
5B 0-6"	35 Lafayette Sq.	6/9/2020	1455	Brown, f-c SAND, some Gravel, little Organics, little Sitl (w/ depth), slight decaying organics odor, slight petroleum-like odor	0.6		Y	1
5A 2-3'	284 Winter Street	6/10/2020	910	Black, f-c SAND, some Silt, some Gravel, little Organics, trace Debris, strong petroleum-like odor, coated/saturated in coal-tar	492	Significant sheen produced on water surface - boom and sorbent pads utilized	N	
3B 2-2.5'	284 Winter Street	6/10/2020	1005	Black, SILTY SAND, little Gravel, trace Organics, trace Debris, strong petroleum-like odor, saturated in coal-tar	714.4	Significant sheen produced on water surface - boom and sorbent pads utilized	N	

Notes
1. Alkylated PAHs - 8270 SIM, Total organic Carbon, Black Carbon, EPH - Carbon ranges only, VPH w/ target VOCs, Physiologically Available Cyanide, Total Solids
2. Total Organic Carbon, VPH w/ target VOCs, Total Solids, EPH w/ target PAHs
3. f = fine, m= medium, c= coarse.
4. PID (photoionization detector) readings represent total organic vapor levels referenced to a benzene standard measutred in the headspace of sealed sample jars using an Ion Science Tiger organic vapor meter with a 10.6 eV lamp. Results in parts per million by volume.

TABLE 7A
SEDIMENT SAMPLING ANALYTICAL RESULTS
284 Winter Street
Haverhill, Massachusetts

Sample ID		1A 0-6	1A 1-5.5	1B 0-6	1C 0-6	2A 0-6	2A 1-4	2C 0-6	3B 0-6	3C 0-6	4A 1-2.5	4B 0-6	5A 0-6	5A 2-3	5B 0-6	5C 0-6
Sample Depth (feet below sediment surface)		**0 - 0.5**	**1 - 5.5**	**0 - 0.5**	**0 - 0.5**	**0 - 0.5**	**1 - 4**	**0 - 0.5**	**0 - 0.5**	**0 - 0.5**	**1 - 2.5**	**0 - 0.5**	**0 - 0.5**	**2 - 3**	**0 - 0.5**	**0 - 0.5**
Laboratory Sample ID		**L2024182-03**	**L2024182-04**	**L2024182-02**	**L2024182-01**	**L2024182-06**	**L2024182-07**	**L2024182-05**	**L2024182-09**	**L2024182-08**	**L2024182-11**	**L2024182-10**	**L2024182-12**	**L2024416-03**	**L2024182-14**	**L2024182-13**
Sample Date		**08 Jun 2020**	**08 Jun 2020**	**08 Jun 2020**	**08 Jun 2020**	**09 Jun 2020**	**09 Jun 2020**	**09 Jun 2020**	**09 Jun 2020**	**09 Jun 2020**	**09 Jun 2020**	**09 Jun 2020**	**09 Jun 2020**	**11 Jun 2020**	**09 Jun 2020**	**09 Jun 2020**
Alkylated PAHs by 8270D-SIM(M)																
Anthracene	mg/kg	0.810	-	6.92	1.11	-	-	25.7	-	3.20	-	2.71	-	-	2.45	0.803
Pyrene	mg/kg	3.11	-	16.5	2.50	-	-	46.5	-	4.82	-	5.92	-	-	4.22	4.90
Benzo(ghi)perylene	mg/kg	0.906	-	3.33	0.561	-	-	8.62	-	0.583	-	1.32	-	-	0.882	0.892
Benzo(e)pyrene	mg/kg	0.854	-	3.50	0.578	-	-	9.70	-	0.705	-	1.21	-	-	0.894	0.810
Indeno(1,2,3-cd)pyrene	mg/kg	0.880	-	3.34	0.592	-	-	9.95	-	0.652	-	1.57	-	-	0.971	0.919
Perylene	mg/kg	0.288	-	1.09	0.215	-	-	3.93	-	0.268	-	0.612	-	-	0.372	0.336
Benzo(b)fluoranthene	mg/kg	0.869	-	3.44	0.634	-	-	12.2	-	0.793	-	1.82	-	-	1.18	1.03
Fluoranthene	mg/kg	2.03	-	10.3	2.16	-	-	41.2	-	3.90	-	5.82	-	-	4.88	4.57
Acenaphthylene	mg/kg	1.01	-	4.22	0.762	-	-	18.6	-	1.98	-	0.308	-	-	0.634	0.612
Chrysene	mg/kg	1.57	-	6.02	1.12	-	-	22.2	-	1.78	-	2.02	-	-	1.50	1.59
C1-Chrysenes	mg/kg	1.80	-	4.71	0.955	-	-	19.0	-	1.65	-	0.720	-	-	0.694	1.02
C2-Chrysenes	mg/kg	1.08	-	2.26	0.508	-	-	9.11	-	0.794	-	0.311	-	-	0.357	0.661
C3-Chrysenes	mg/kg	0.508	-	1.17	0.289	-	-	4.67	-	0.452	-	0.287	-	-	0.400	0.500
C4-Chrysenes	mg/kg	0.226	-	0.454	0.124	-	-	1.40	-	0.218	-	0.145	-	-	0.280	0.249
Benzo(a)pyrene	mg/kg	1.29	-	7.01	1.01	-	-	20.6	-	1.44	-	2.16	-	-	1.42	1.29
Benzo(a)anthracene	mg/kg	1.54	-	7.19	1.19	-	-	22.6	-	2.04	-	2.47	-	-	1.61	1.48
Acenaphthene	mg/kg	0.232	-	3.70	0.975	-	-	21.0	-	11.8	-	6.19	-	-	6.52	0.562
Phenanthrene	mg/kg	1.78	-	16.5	3.18	-	-	77.1	-	10.2	-	9.36	-	-	14.1	2.80
Fluorene	mg/kg	0.296	-	3.34	0.717	-	-	22.5	-	6.73	-	3.24	-	-	3.94	0.436
C1-Fluorenes	mg/kg	0.474	-	3.03	0.630	-	-	18.1	-	2.18	-	1.35	-	-	2.27	0.644
C2-Fluorenes	mg/kg	0.489	-	2.10	0.418	-	-	10.4	-	1.06	-	0.360	-	-	0.438	0.723
C3-Fluorenes	mg/kg	0.375	-	0.965	0.187	-	-	3.55	-	0.361	-	0.125	-	-	0.196	0.385
Naphthalene	mg/kg	0.154	-	2.92	0.926	-	-	8.60	-	76.4	-	37.0	-	-	0.342	0.175
C1-Naphthalenes	mg/kg	0.256	-	2.34	0.806	-	-	21.8	-	49.9	-	17.3	-	-	1.68	0.180
C2-Naphthalenes	mg/kg	0.578	-	5.04	1.15	-	-	35.7	-	14.2	-	7.17	-	-	4.81	0.458
C3-Naphthalenes	mg/kg	0.469	-	3.23	0.579	-	-	17.4	-	2.31	-	1.71	-	-	2.84	0.567
C4-Naphthalenes	mg/kg	0.202	-	1.12	0.169	-	-	4.34	-	0.478	-	0.259	-	-	0.330	0.283
Benzo(j+k)fluoranthene	mg/kg	0.886	-	3.66	0.694	-	-	11.5	-	0.850	-	1.67	-	-	1.09	0.964
C1-Phenanthrenes/Anthracenes	mg/kg	2.54	-	13.6	2.43	-	-	66.0	-	7.15	-	2.88	-	-	2.57	3.02
C2-Phenanthrenes/Anthracenes	mg/kg	1.69	-	5.82	1.16	-	-	27.5	-	2.72	-	0.632	-	-	0.709	1.71
C3-Phenanthrenes/Anthracenes	mg/kg	0.624	-	1.71	0.363	-	-	7.49	-	0.690	-	0.169	-	-	0.216	0.557
C4-Phenanthrenes/Anthracenes	mg/kg	0.166	-	0.409	0.086	-	-	1.60	-	0.153	-	0.061	-	-	0.088	0.152
Dibenz[ah]+[ac]anthracene	mg/kg	0.258	-	0.918	0.158	-	-	3.03	-	0.213	-	0.376	-	-	0.245	0.227
C1-Fluoranthenes/Pyrenes	mg/kg	2.82	-	12.5	2.03	-	-	49.0	-	4.63	-	2.04	-	-	1.46	2.47
Total PAHs	mg/kg	33.1	-	164	31.0	-	-	683	-	217	-	121	-	-	66.6	38.0
Extractable Petroleum Hydrocarbons (EPH)																
C9-C18 Aliphatic hydrocarbons	mg/kg	15.2	< 678	46.7	7.74	1,670	663	93.7	< 953	< 69.2	1,560	< 37.1	463	< 834	< 8.23	33.6
C19-C36 Aliphatic Fraction	mg/kg	34.9	< 678	55.4	22.5	1,250	< 660	130	< 953	87.8	851	< 37.1	284	907	57.9	86.9
C11-C22 Aromatic hydrocarbons, Adjusted	mg/kg	280	5,840	308	72.4	16,300	6,010	773	3,860	217	3,320	71.2	1,400	4,240	98.1	114
C11-C22 Aromatic hydrocarbons, Unadjusted	mg/kg	331	7,790	394	90.9	20,000	8,500	978	5,710	373	5,060	111	1,990	7,760	140	131
Anthracene	mg/kg	-	74.7	-	-	266	176	-	53.7	-	45.8	-	< 14	112	-	-
Pyrene	mg/kg	-	163	-	-	475	350	-	105	-	81.9	-	30.8	215	-	-
Benzo(ghi)perylene	mg/kg	-	< 33.9	-	-	< 50.7	39.2	-	< 47.6	-	< 23.2	-	< 14	< 41.7	-	-
Indeno(1,2,3-cd)pyrene	mg/kg	-	< 33.9	-	-	< 50.7	44.3	-	< 47.6	-	< 23.2	-	< 14	< 41.7	-	-
Benzo(b)fluoranthene	mg/kg	-	38.3	-	-	96.7	99.4	-	< 47.6	-	< 23.2	-	< 14	62.9	-	-
Fluoranthene	mg/kg	-	121	-	-	320	327	-	74.2	-	61.4	-	24.1	218	-	-
Benzo(k)fluoranthene	mg/kg	-	< 33.9	-	-	< 50.7	37.3	-	< 47.6	-	< 23.2	-	< 14	< 41.7	-	-
Acenaphthylene	mg/kg	-	< 33.9	-	-	< 50.7	88.8	-	< 47.6	-	< 23.2	-	< 14	42.6	-	-
Chrysene	mg/kg	-	72.6	-	-	192	117	-	< 47.6	-	28.2	-	14.7	78.5	-	-
Benzo(a)pyrene	mg/kg	-	41.6	-	-	109	98.0	-	< 47.6	-	< 23.2	-	< 14	56.2	-	-
Dibenzo(a,h)anthracene	mg/kg	-	< 33.9	-	-	< 50.7	< 33	-	< 47.6	-	< 23.2	-	< 14	< 41.7	-	-
Benzo(a)anthracene	mg/kg	-	65.0	-	-	201	146	-	< 47.6	-	30.4	-	14.5	88.5	-	-
Acenaphthene	mg/kg	-	170	-	-	454	126	-	115	-	93.8	-	27.3	215	-	-
Phenanthrene	mg/kg	-	295	-	-	1,020	610	-	248	-	184	-	39.0	412	-	-
Fluorene	mg/kg	-	103	-	-	434	187	-	102	-	74.7	-	15.6	150	-	-
Naphthalene	mg/kg	-	464	-	-	122	46.7	-	739	-	765	-	297	1,320	-	-
2-Methylnaphthalene	mg/kg	-	341	-	-	< 50.7	< 33	-	414	-	373	-	132	548	-	-
Total EPH PAHs	mg/kg	-	1,949	-	-	3,690	2,493	-	1,851	-	1,738	-	595	3,519	-	-

TABLE 7A
SEDIMENT SAMPLING ANALYTICAL RESULTS
284 Winter Street
Haverhill, Massachusetts

Sample ID		1A 0-6	1A 1-5.5	1B 0-6	1C 0-6	2A 0-6	2A 1-4	2C 0-6	3B 0-6	3C 0-6	4A 1-2.5	4B 0-6	5A 0-6	5A 2-3	5B 0-6	5C 0-6
Sample Depth (feet below sediment surface)		**0 - 0.5**	**1 - 5.5**	**0 - 0.5**	**0 - 0.5**	**0 - 0.5**	**1 - 4**	**0 - 0.5**	**0 - 0.5**	**0 - 0.5**	**1 - 2.5**	**0 - 0.5**	**0 - 0.5**	**2 - 3**	**0 - 0.5**	**0 - 0.5**
Laboratory Sample ID		**L2024182-03**	**L2024182-04**	**L2024182-02**	**L2024182-01**	**L2024182-06**	**L2024182-07**	**L2024182-05**	**L2024182-09**	**L2024182-08**	**L2024182-11**	**L2024182-10**	**L2024182-12**	**L2024416-03**	**L2024182-14**	**L2024182-13**
Sample Date		**08 Jun 2020**	**08 Jun 2020**	**08 Jun 2020**	**08 Jun 2020**	**09 Jun 2020**	**09 Jun 2020**	**09 Jun 2020**	**09 Jun 2020**	**09 Jun 2020**	**09 Jun 2020**	**09 Jun 2020**	**09 Jun 2020**	**11 Jun 2020**	**09 Jun 2020**	**09 Jun 2020**
Volatile Petroleum Hydrocarbons (VPH)																
C5-C8 Aliphatics, Adjusted	mg/kg	< 5.22	< 351	< 5.38	< 5.33	< 27.3	< 27.2	< 7.77	< 762	< 102	< 939	< 108	< 322	< 1340	< 6.05	< 12.7
C5-C8 Aliphatic hydrocarbons, Unadjusted	mg/kg	< 5.22	< 351	< 5.38	< 5.33	< 27.3	< 27.2	< 7.77	< 762	< 102	< 939	< 108	< 322	< 1340	< 6.05	< 12.7
C9-C12 Aliphatics, adjusted	mg/kg	< 5.22	< 351	< 5.38	< 5.33	67.8	60.4	< 7.77	950	< 102	< 939	110	326	1,380	7.49	24.5
C9-C12 Aliphatic hydrocarbons, Unadjusted	mg/kg	< 5.22	786	7.86	< 5.33	307	268	24.5	1,200	267	1,600	137	1,520	1,620	7.49	49.3
C9-C10 Aromatic hydrocarbons	mg/kg	< 5.22	571	5.87	< 5.33	225	200	16.9	< 762	158	971	< 108	740	< 1340	< 6.05	24.8
Ethylbenzene	mg/kg	< 0.104	33.8	< 0.108	< 0.106	10.3	5.59	< 0.155	106	23.4	128	12.9	203	130	< 0.121	< 0.254
Toluene	mg/kg	< 0.104	< 7.01	< 0.108	< 0.106	< 0.547	< 0.543	< 0.155	< 15.2	< 2.05	< 18.8	< 2.15	< 6.44	< 26.8	< 0.121	< 0.254
Methyl tert-butyl ether	mg/kg	< 0.052	< 3.51	< 0.054	< 0.053	< 0.273	< 0.272	< 0.078	< 7.62	< 1.02	< 9.39	< 1.08	< 3.22	< 13.4	< 0.061	< 0.127
Xylene P,M	mg/kg	< 0.104	16.6	< 0.108	< 0.106	0.887	< 0.543	< 0.155	92.8	16.6	118	8.60	173	63.8	< 0.121	< 0.254
Benzene	mg/kg	< 0.104	< 7.01	< 0.108	< 0.106	0.562	< 0.543	< 0.155	37.1	2.72	< 18.8	< 2.15	< 6.44	< 26.8	< 0.121	< 0.254
Naphthalene	mg/kg	< 0.209	672	3.71	1.53	37.5	32.5	7.54	746	181	945	88.6	372	1,300	0.288	0.706
Xylene O	mg/kg	< 0.104	12.9	< 0.108	< 0.106	2.73	1.76	< 0.155	47.4	7.68	62.4	5.47	83.6	40.5	< 0.121	< 0.254
Total VPH	mg/kg	ND	1,306	9.58	1.53	345	300	24.4	1,979	389	2,224	226	1,898	2,914	7.78	50.0
Inorganics																
Cyanide	mg/kg	< 1.1	-	< 1	< 1.1	-	-	< 1.2	-	< 1	-	< 1.2	-	-	< 1.2	< 1.2
SOLIDS, PERCENT	%	87.2	84.2	87.9	85.1	76.2	77.6	73.5	82.3	92.8	84.2	85.3	69.7	76.6	78.4	77.5
Total Organic Carbon and Soot																
% Soot (Average)	%	0.187	-	0.030	0.021	-	-	0.104	-	0.017	-	0.011	-	-	0.143	0.342
% Soot (Rep 1)	%	0.207	-	0.032	0.013	-	-	0.123	-	0.025	-	0.018	-	-	0.106	0.027
% Soot (Rep 2)	%	0.167	-	0.027	0.029	-	-	0.085	-	< 0.01	-	< 0.01	-	-	0.180	0.658
Graphite, Synthetic	%	-	-	-	-	-	-	-	-	-	-	-	-	6.21	-	-
Total Organic Carbon	%	0.993	5.77	0.798	0.462	15.8	4.00	1.86	3.21	0.621	1.62	0.220	5.14	5.95	0.451	1.06
Total Organic Carbon (Rep1)	%	1.13	5.28	0.741	0.505	15.9	3.48	1.86	3.06	0.382	1.70	0.208	5.08	-	0.489	0.911
Total organic carbon (2)	%	0.852	6.26	0.854	0.420	15.8	4.52	1.87	3.36	0.860	1.54	0.233	5.19	6.48	0.413	1.22

Notes:
1. "<" indicates analyte not detected above laboratory reporting limit.
2. "-" indicates the sample was not analyzed for the given analyte.
3. "ND" indicates all individual analytes included in the calculated sum were not detected above the respective laboratory reporting limits.

TABLE 7B
SURFACE WATER ANALYTICAL RESULTS
284 Winter Street
Haverhill, Massachusetts

Sample ID Laboratory Sample ID Sample Date	Units	DOWNSTREAM L2024416-01 11 Jun 2020	UPSTREAM L2024416-02 11 Jun 2020
Extractable Petroleum Hydrocarbons (EPH)			
C9-C18 Aliphatic hydrocarbons	ug/L	< 100	< 100
C19-C36 Aliphatic Fraction	ug/L	< 100	< 100
C11-C22 Aromatic hydrocarbons, Adjusted	ug/L	< 100	< 100
C11-C22 Aromatic hydrocarbons, Unadjusted	ug/L	< 100	< 100
Anthracene	ug/L	< 10.0	< 10.0
Pyrene	ug/L	< 10.0	< 10.0
Benzo(ghi)perylene	ug/L	< 10.0	< 10.0
Indeno(1,2,3-cd)pyrene	ug/L	< 10.0	< 10.0
Benzo(b)fluoranthene	ug/L	< 10.0	< 10.0
Fluoranthene	ug/L	< 10.0	< 10.0
Benzo(k)fluoranthene	ug/L	< 10.0	< 10.0
Acenaphthylene	ug/L	< 10.0	< 10.0
Chrysene	ug/L	< 10.0	< 10.0
Benzo(a)pyrene	ug/L	< 10.0	< 10.0
Dibenzo(a,h)anthracene	ug/L	< 10.0	< 10.0
Benzo(a)anthracene	ug/L	< 10.0	< 10.0
Acenaphthene	ug/L	< 10.0	< 10.0
Phenanthrene	ug/L	< 10.0	< 10.0
Fluorene	ug/L	< 10.0	< 10.0
Naphthalene	ug/L	< 10.0	< 10.0
2-Methylnaphthalene	ug/L	< 10.0	< 10.0
Volatile Petroleum Hydrocarbons (VPH)			
C9-C12 Aliphatics, adjusted	ug/L	< 100	< 100
C5-C8 Aliphatic hydrocarbons, Unadjusted	ug/L	< 100	< 100
C9-C10 Aromatic hydrocarbons	ug/L	< 100	< 100
C9-C12 Aliphatic hydrocarbons, Unadjusted	ug/L	< 100	< 100
Ethylbenzene	ug/L	< 2.00	< 2.00
Toluene	ug/L	< 2.00	< 2.00
Methyl tert-butyl ether	ug/L	< 3.00	< 3.00
Xylene P,M	ug/L	< 2.00	< 2.00
C5-C8 Aliphatics, Adjusted	ug/L	< 100	< 100
Benzene	ug/L	< 2.00	< 2.00
Naphthalene	ug/L	< 4.00	< 4.00
Xylene O	ug/L	< 2.00	< 2.00
Inorganics			
Cyanide	mg/l	< 0.005	< 0.005

Notes:
1. Samples collected by GZA and analyzed by Alpha Analytical of Westborough MA.
2. Cyanide = Physiologically available cyanide.

TABLE 8

PIPING PENETRATIONS IN RETAINING WALL

284 Winter Street

Haverhill, Massachusetts

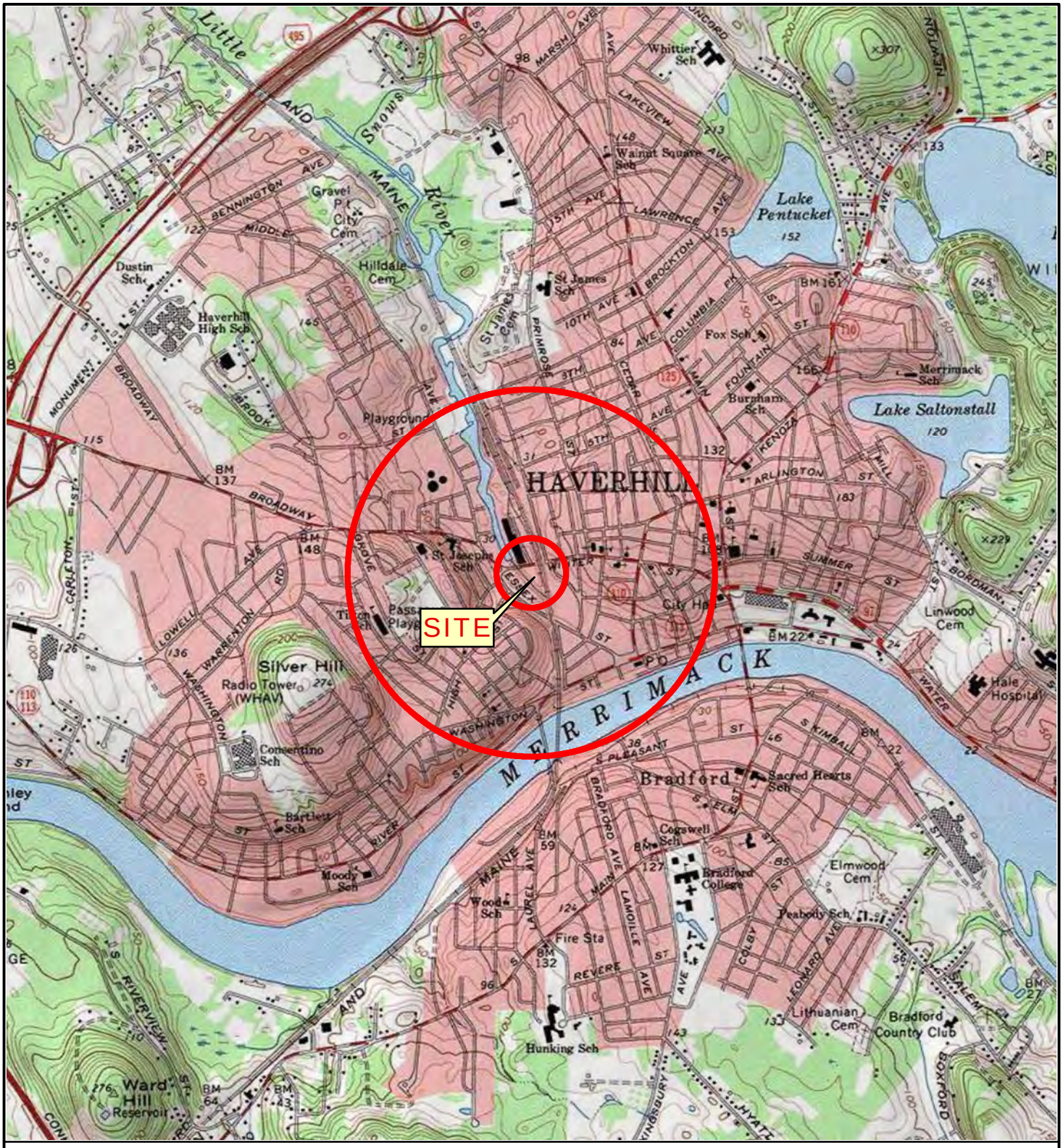
Designation	Number of pipes	Size (inches)	Material	Obstruction @ (feet)	Notes
P1	1	6	Steel	NM	Within small tunnel, adjacent to bridge
P2	1	8	PVC (green)	NM	
P3	1	13	clay	>15	
P4	1	10	cast iron	NM	
P5	1	6	cast iron	NM	Comes out of wall and into ground
Penetration 6	1 (hole in wall)	~1	hole in wall	NM	Visible seeping product, strong odor (no pipe present); between P5 and P6/7
P6 & P7	1	4	cast iron	NM	Initially logged as two pipes; single pipe in two sections
P8	1	4	cast iron	10	sand and leaves inside
P9	1	2	cast iron	NM	
P10	5	1	metal	NM	Five pipes protruding from wall at same location
		1	metal	NM	
		2	metal	NM	
		2	metal	NM	
		4	metal	NM	
P11, P12 & P13	3	4	cast iron	NM	hardened tar all along rock face
		6	clay	3	hardened tar coming out of pipe, and all along rock face
		6	cast iron	16	hardened tar all along rock face
P14	1	4	cast iron	NM	
P15	1	6	cast iron	7	
P16	1	4	cast iron	17	hardened tar all along rock wall both above and below pipe
P17	1	8	clay	3	hardened tar all along rock wall both above and below pipe
P18	1	6	metal	5	
P19	1	16	concerete	NM	
P20	1	4	cast iron	2	bottom pipe
P21	1	4	cast iron	3	top pipe
P22	1	12	clay	14.5	
P23	0	NA	NA		somewhat fresh product seeping from wall (no pipe present)
P24	1	8	metal	8	two locations below pipe where product appears to be seaping from wall
P25	1	8	metal	Sealed	sealed with concrete but mound of hardened tar below
P26	1	8	metal	8	contains muck

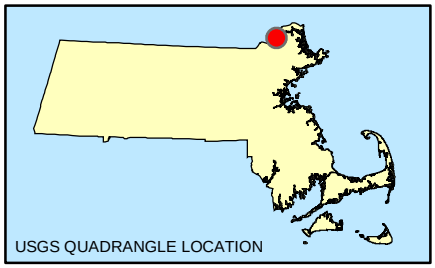
TABLE 9
SUMMARY OF CHEMICAL PROPERTIES FOR CONSTITUENTS DETECTED
284 Winter Street
Haverhill, Massachusetts

Compound	Properties				
	Specific Gravity	Solubility (mg/l)	Vapor Pressure (mm Hg)	Henry's Law Constant atm-m/mol	KOC (ml/g)
Volatile Organic Compounds					
Benzene	0.879	1,780	95	5.50E-03	59
Toluene	0.866	526	28	6.64E-03	182
Ethylbenzene	0.87	161	10	7.88E-03	363
Xylenes	0.88	178	6	5.19E-03	363
Semi-Volatile Organic Compounds - PAHs					
2-Methylnaphthalene	1.03	26	NDF	2.90E-04	720
Anthracene	1.25	1.29	1.70E-05	8.60E-05	1.40E+04
Acenaphthylene	0.9	16.1	0.029	1.13E-04	2.77E+03
Acenaphthene	1	4.2	NDF	1.55E-04	7.08E+03
Benzo(a) anthracene	1.27	0.010	5.0E-09	1.0E-06	2.00E+05
Benzo(a)pyrene	1.35	0.0038	5E-09	4.90E-07	5.50E+06
Benzo(b)fluoranthene	NDF	0.014	5.0E-07	1.22E-05	5.50E+05
Dibenzo(a,h)anthracene	1.28	0.0005	1E-10	7.30E-08	3.30E+06
Benzo(g,h,i)perylene	1.3	0.00026	1E-10	1.44E-07	1.60E+06
Chrysene	1.27	0.006	6.3E-09	1.05E-06	2.00E+05
Flourene	1.2	1.9	NDF	1.17E-04	7.30E+03
Fluoranthene	1.25	0.265	5.0E-06	6.5E-06	3.80E+04
Indeno(1,2,3-cd)pyrene	NDF	53	NDF	6.95E-08	1.60E+06
Naphthalene	1.15	31	0.082	4.83E-04	2.00E+03
Phenanthrene	1.18	1.15	9.6E-04	2.33E-05	8.14E+03
Pyrene	1.27	0.16	2.5E-06	5.1E-06	3.80E+04
Petroleum Fractions					
C9-C10 Aromatics	0.89	51	NDF	7.95E-03	1.78E+03
C11-C12 Aromatics	1	5.8	NDF	7.22E-04	5.01E+03

Notes:
1. Sources of chemical/physical properties, in order of hierarchy are:
   - MCP Numerical Standrads Development Spreadsheets (Accessed online, MassDEP web page, 8/2-2021)
   - "Background Documentation for the Development of the MCP Numerical Standards," (DEP, April 1994)
   - 310 CMR 40.0000 Massachusetts Contingency Plan January 13, 1995, Sub Part 0 (Numerical Ranking System)
   - "Groundwater Chemicals Desk Reference" (Montgomery & Welkom, 1990).
   - "Basics of Pump and Treat Groundwater Remediation Technology," (U.S. EPA, March 1990)
   - "Superfund Public Health Evaluation Manual," (U.S. EPA, October 1986).
   - Handbook of Environmental Data on Organic Chemicals, Verschueren (1983).
2. NDF indicates no data found.

Figures





SOURCE : THIS MAP CONTAINS THE ESRI ARCGIS ONLINE USA TOPOGRAPHIC MAP SERVICE, PUBLISHED JUNE 19, 2019 BY ESRI ARCIMS SERVICES AND UPDATED AS NEEDED. THIS SERVICE USES UNIFORM NATIONALLY RECOGNIZED DATUM AND CARTOGRAPHY STANDARDS AND A VARIETY OF AVAILABLE SOURCES FROM SEVERAL DATA PROVIDERS.

Data Supplied by : esri

0 1,000 2,000 4,000 6,000

SCALE IN FEET

N W E S

PROJ. MGR.: KFM
DESIGNED BY: KFM
REVIEWED BY: CAL
OPERATOR: SMW/EMD

DATE: 04-01-2022

LOCUS PLAN
SHOWING 500 FOOT & 1/2 MILE RADII

JOB NO. 01.0172397.10

PHASE II COMPREHENSIVE SITE ASSESSMENT
284 WINTER STREET
HAVERHILL, MASSACHUSETTS

FIGURE NO. 1

LEGEND

- AQSS-04 — APPROXIMATE SEDIMENT CORE LOCATION (ANCHOR QEA -
- VE-1 — VACUUM EXCAVATION PROBE PERFORMED BY GEOSEARCH AUGUST 11, 2021
- GZ-1 — MONITORING WELL INSTALLED BY GEOSEARCH AUGUST 31 - SEPTEMBER 1, 2020
- 1A — SEDIMENT SAMPLE COLLECTED BY GZA ON JUNE 8-10,
- P1 — PIPE OR SEEP LOCATION
- SG-1 — SOIL GAS POINT PERFORMED BY GZA ON FEBRUARY 5,
- B102 — MONITORING WELL INSTALLED BY GEOSEARCH JANUARY 21-23, 2020 AND OBSERVED BY GZA
- B101 — SOIL BORING PERFORMED BY GEOSEARCH (2020) AND OBSERVED BY
- NFNP-01 — NAPL SAMPLE COLLECTED BY GZA PERSONNEL NOVEMBER 1,
- NFSB-01 (MW) — MONITORING WELL INSTALLED BY TECHNICAL DRILLING SERVICES OCTOBER 20-25, 2016 AND OBSERVED BY GZA
- NFSB-05 — SOIL BORING PERFORMED BY TECHNICAL DRILLING SERVICES OCTOBER 20-25, 2016 AND OBSERVED BY GZA
- NFAA-01 — AMBIENT AIR SAMPLE COLLECTED BY GZA PERSONNEL OCTOBER 19,
- NFSV-01 — SOIL VAPOR SAMPLE COLLECTED BY GZA PERSONNEL OCTOBER 18-19,
- NFCB-01 — CATCH BASIN SEDIMENT SAMPLE COLLECTED BY GZA PERSONNEL OCTOBER 18-19, 2016
- ENV-1MW — MONITORING WELL INSTALLED BY RAMBOLL ENVIRON APRIL 27-28,
- ENV-2B(A) — SOIL BORING COMPLETED BY RAMBOLL ENVIRON APRIL 27-28,
- MW-1 — MONITORING WELL INSTALLED BY LESSARD
- DISPOSAL SITE BOUNDARY
- 284 WINTER STREET PROPERTY BOUNDARY AS RECORDED ON ALTA/ACSM LAND TITLE SURVEY PLAN PERFORMED BY MHF DESIGN CONSULTANTS (STAMPED FEBRUARY 12, 2015) NOTE: THIS BOUNDARY DIFFERS FROM THE MASSGIS ASSESSORS PARCEL DATA.
- ASSESSORS PARCEL DATA PROVIDED BY MASSGIS ON SEPTEMBER 1, 2020

SOURCE

1) THIS MAP CONTAINS THE ESRI ArcGIS ONLINE BING MAPS AERIAL LAYER PACKAGE, PUBLISHED APRIL 13, 2020 BY ESRI ARCIMS SERVICES AND UPDATED MONTHLY. THIS SERVICE USES UNIFORM NATIONALLY RECOGNIZED DATUM AND CARTOGRAPHY STANDARDS AND A VARIETY OF AVAILABLE SOURCES FROM SEVERAL DATA PROVIDERS.
2) THE LOCATIONS OF THE MONITORING WELLS INSTALLED BY GEOSEARCH AUGUST 31 - SEPTEMBER 1, 2020 WERE LOCATED FROM A SURVEY PERFORMED BY THE MORIN-CAMERON GROUP, INC. ON SEPTEMBER 29, 2020. THE LOCATIONS OF THE SEDIMENT SAMPLES COLLECTED BY GZA IN JUNE 2020 AND THE PIPE LOCATIONS WERE APPROXIMATELY DETERMINED USING A TRIMBLE GEO-7X HAND-HELD GPS ON 06-10-2020. THE LOCATIONS OF THE MONITORING WELLS AND SOIL BORINGS PERFORMED BY GEOSEARCH IN JANUARY 2020 WERE APPROXIMATELY DETERMINED USING A TRIMBLE GEO-7X HAND-HELD GPS ON 05-07-2020. THE LOCATIONS OF THE NF SERIES OF EXPLORATIONS AND SAMPLING LOCATIONS WERE APPROXIMATELY DETERMINED USING A TRIMBLE GEO-XH HAND-HELD GPS ON 10-18-2016. THE LOCATIONS OF THE SOIL GAS POINTS INSTALLED BY GZA IN FEBRUARY 2020, SOIL BORING INSTALLED BY GEOSEARCH AUGUST 31, 2021 (GZA-2A), AND THE VACUUM EXCAVATION PROBES PERFORMED BY GEOSEARCH AUGUST 11, 2021 WERE APPROXIMATELY DETERMINED BY LINE OF SIGHT FROM EXISTING TOPOGRAPHIC AND MAN-MADE FEATURES. THESE DATA SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.
3) THE LOCATIONS OF THE SOIL BORINGS AND MONITORING WELLS PERFORMED BY RAMBOLL AND THE MONITORING WELLS PERFORMED BY LESSARD WERE APPROXIMATELY DETERMINED FROM A PLAN PREPARED BY RAMBOLL ENTITLED: "SITE LAYOUT", FIGURE 2, DATED: 02-10-2017, PROJECT.: 1690005598.
4) THE LOCATIONS OF THE APPROXIMATE SEDIMENT CORE LOCATIONS PERFORMED BY ANCHOR QEA IN 2021 WERE DETERMINED FROM A GEODATABASE FILE PROVIDED BY ANCHOR QEA ON MARCH 29, 2022, FILE: AQ SAMPLE LOCATIONS 20220329.GDB.
5) THE HISTORIC RELIEF GAS HOLDER WAS APPROXIMATELY LOCATED FROM AN "UNDATED HISTORICAL PLAN" IN THE RAMBOLL ENVIRON PHASE I INITIAL SITE INVESTIGATION REPORT, DATED APRIL 2016.

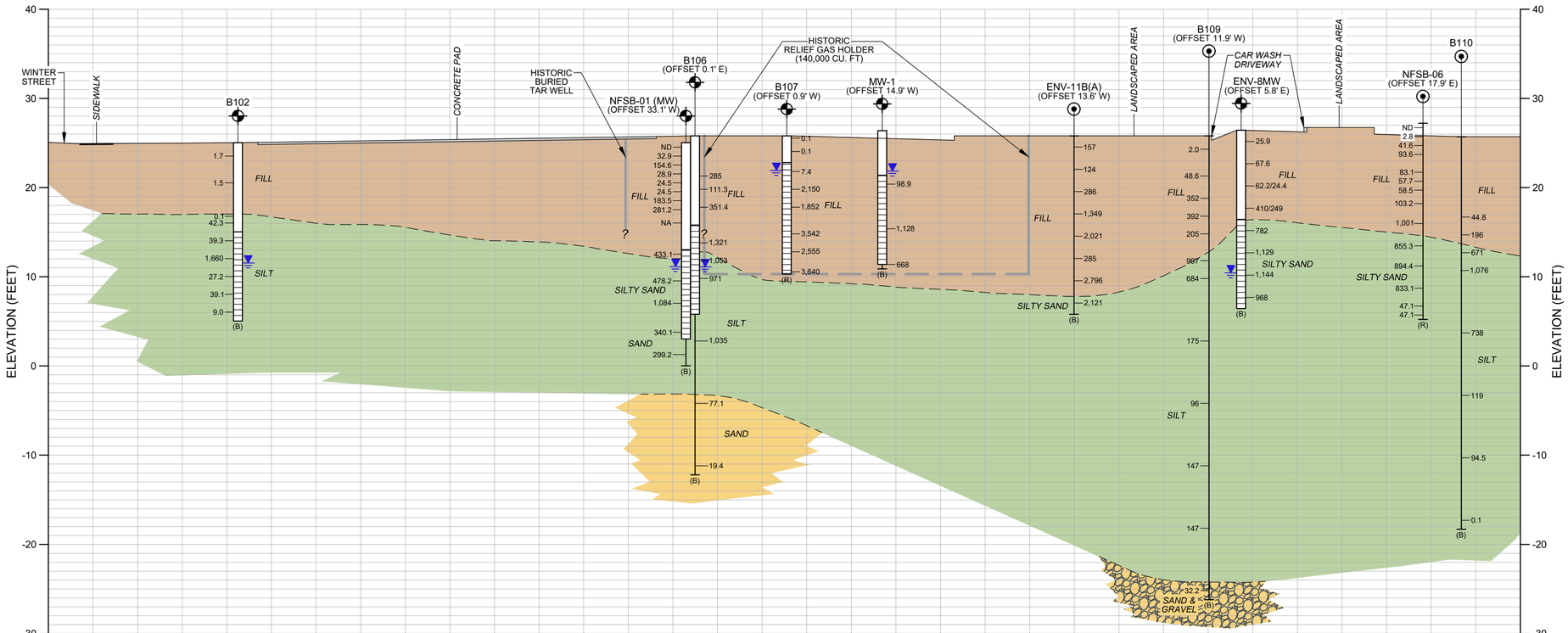
0 25 50 100
SCALE IN FEET

N

PHASE II COMPREHENSIVE SITE ASSESSMENT
284 WINTER STREET
HAVERHILL, MASSACHUSETTS

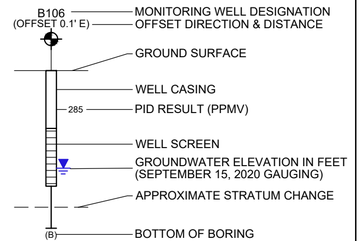
EXPLORATION LOCATION PLAN

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: nationalgrid	
PROJ MGR: KFM	REVIEWED BY: CAL	CHECKED BY: KFM	FIGURE 2
DESIGNED BY: KFM	DRAWN BY: SMW/EMD	SCALE: 1 " = 50 FEET	
DATE: 04/01/2022	PROJECT NO. 01.0172397.10	REVISION NO.	



GEOLOGIC CROSS-SECTION A-A'

LEGEND



(R) - REFUSAL OF BORING
PID - PHOTOIONIZATION DETECTOR
PPMV - PARTS PER MILLION BY VOLUME
ND - INDICATES NOT DETECTED ABOVE INSTRUMENT DETECTION LIMIT (<0.1 PPMV)
NA - INDICATES NOT ANALYZED

STRATUM KEY

- FILL
- SILTY SAND / SILT
- SAND
- SAND & GRAVEL

NOTES:

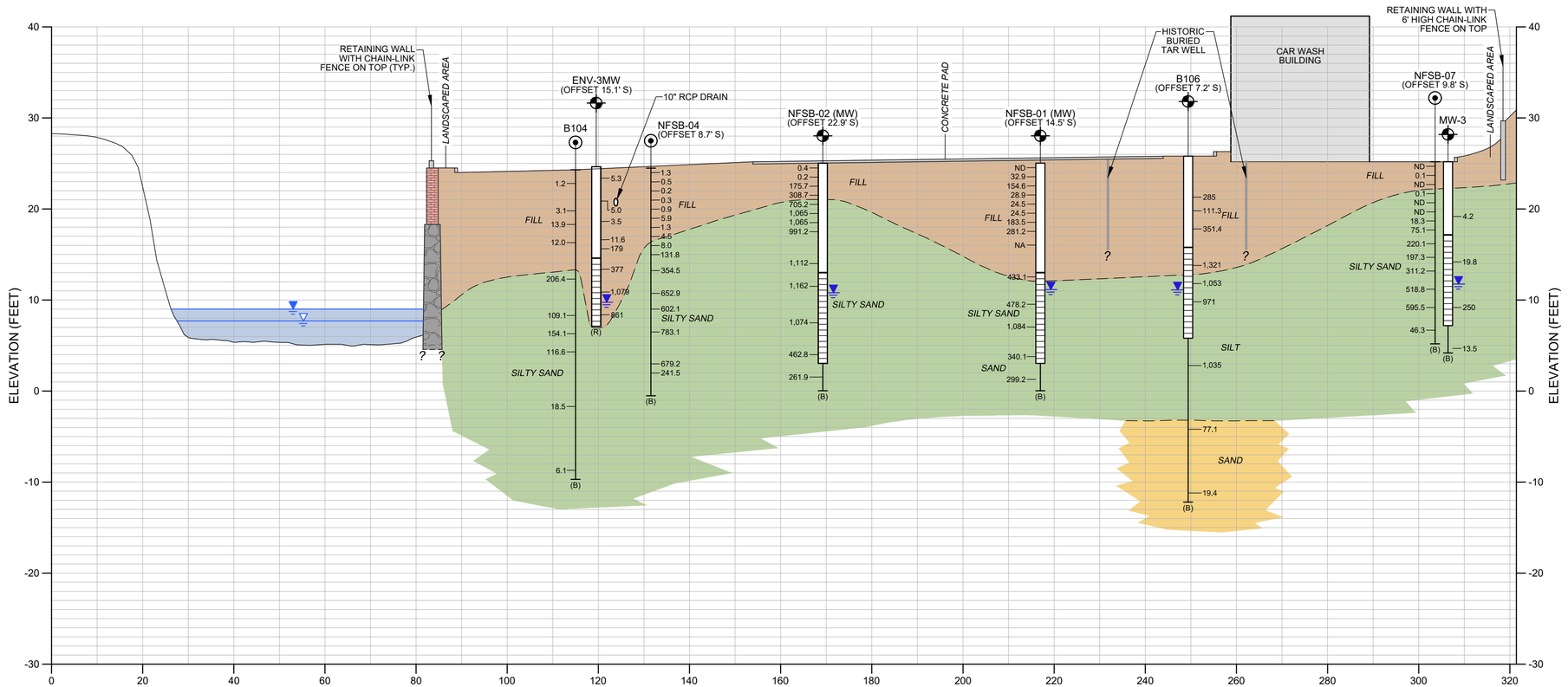
1. THE STRATIFICATION LINES ARE APPROXIMATE, BASED UPON DATA FROM A LIMITED NUMBER OF WIDELY SPACED EXPLORATIONS AND THUS REPRESENT APPROXIMATE BOUNDARIES BETWEEN STRATUM TYPES. THE ACTUAL TRANSITIONS ARE EXPECTED TO BE MORE GRADUAL AND VARY FROM THOSE SHOWN.

VERTICAL SCALE IN FEET
0 5' 10' 20'
0 10' 20' 40'
HORIZONTAL SCALE IN FEET

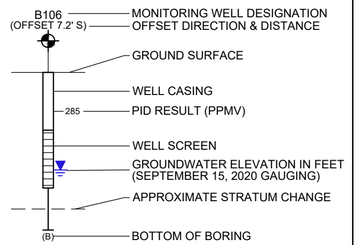
PHASE II COMPREHENSIVE SITE ASSESSMENT
284 WINTER STREET
HAVERHILL, MASSACHUSETTS

GEOLOGIC CROSS-SECTION A-A'

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: nationalgrid	
PROJ MGR: KFM	REVIEWED BY: CAL	CHECKED BY: KFM	FIGURE 3A
DESIGNED BY: KFM	DRAWN BY: EMD	SCALE: AS NOTED	
DATE: 04-01-2022	PROJECT NO. 01.0172397.10	REVISION NO.	



LEGEND



(R) - REFUSAL OF BORING
PID - PHOTOIONIZATION DETECTOR
PPMV - PARTS PER MILLION BY VOLUME
ND - INDICATES NOT DETECTED ABOVE INSTRUMENT DETECTION LIMIT (<0.1 PPMV)
NA - INDICATES NOT ANALYZED

STRATUM KEY

- FILL
- SILTY SAND / SILT
- SAND

NOTES:

1. THE STRATIFICATION LINES ARE APPROXIMATE, BASED UPON DATA FROM A LIMITED NUMBER OF WIDELY SPACED EXPLORATIONS AND THUS REPRESENT APPROXIMATE BOUNDARIES BETWEEN STRATUM TYPES. THE ACTUAL TRANSITIONS ARE EXPECTED TO BE MORE GRADUAL AND VARY FROM THOSE SHOWN.

VERTICAL SCALE IN FEET
0 5' 10' 20'
0 10' 20' 40'
HORIZONTAL SCALE IN FEET

PHASE II COMPREHENSIVE SITE ASSESSMENT
284 WINTER STREET
HAVERHILL, MASSACHUSETTS

GEOLOGIC CROSS-SECTION B-B'

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: nationalgrid	
PROJ MGR: KFM	REVIEWED BY: CAL	CHECKED BY: KFM	FIGURE 3B
DESIGNED BY: KFM	DRAWN BY: EMD	SCALE: AS NOTED	
DATE: 04-01-2022	PROJECT NO. 01.0172397.10	REVISION NO.	

LEGEND

- MW-1 — MONITORING WELL INSTALLED BY LESSARD ENVIRONMENTAL, INC.
- ENV-1MW — MONITORING WELL INSTALLED BY RAMBOLL ENVIRON APRIL 27-28, 2015
- NFSB-01(MW) 11.30 — MONITORING WELL INSTALLED BY TECHNICAL DRILLING SERVICES OCTOBER 20-25, 2016 AND OBSERVED BY GZA
  - GROUNDWATER ELEVATION IN FEET (MAY 7, 2020 GAUGING)
  - NM - GROUNDWATER ELEVATION NOT MEASURED
  - ( ) - GROUNDWATER ELEVATION NOT USED FOR CONTOURING PURPOSES
- 11 — GROUNDWATER CONTOUR IN FEET (MAY 7, 2020 GAUGING) DASHED WHERE INFERRED
- 284 WINTER STREET PROPERTY BOUNDARY AS RECORDED ON ALTA/ACSM LAND TITLE SURVEY PLAN PERFORMED BY MHF DESIGN CONSULTANTS (STAMPED FEBRUARY 12, 2015) NOTE: THIS BOUNDARY DIFFERS FROM THE MASSGIS ASSESSORS PARCEL DATA.
- ASSESSORS PARCEL DATA PROVIDED BY MASSGIS ON SEPTEMBER 1, 2020

SOURCE

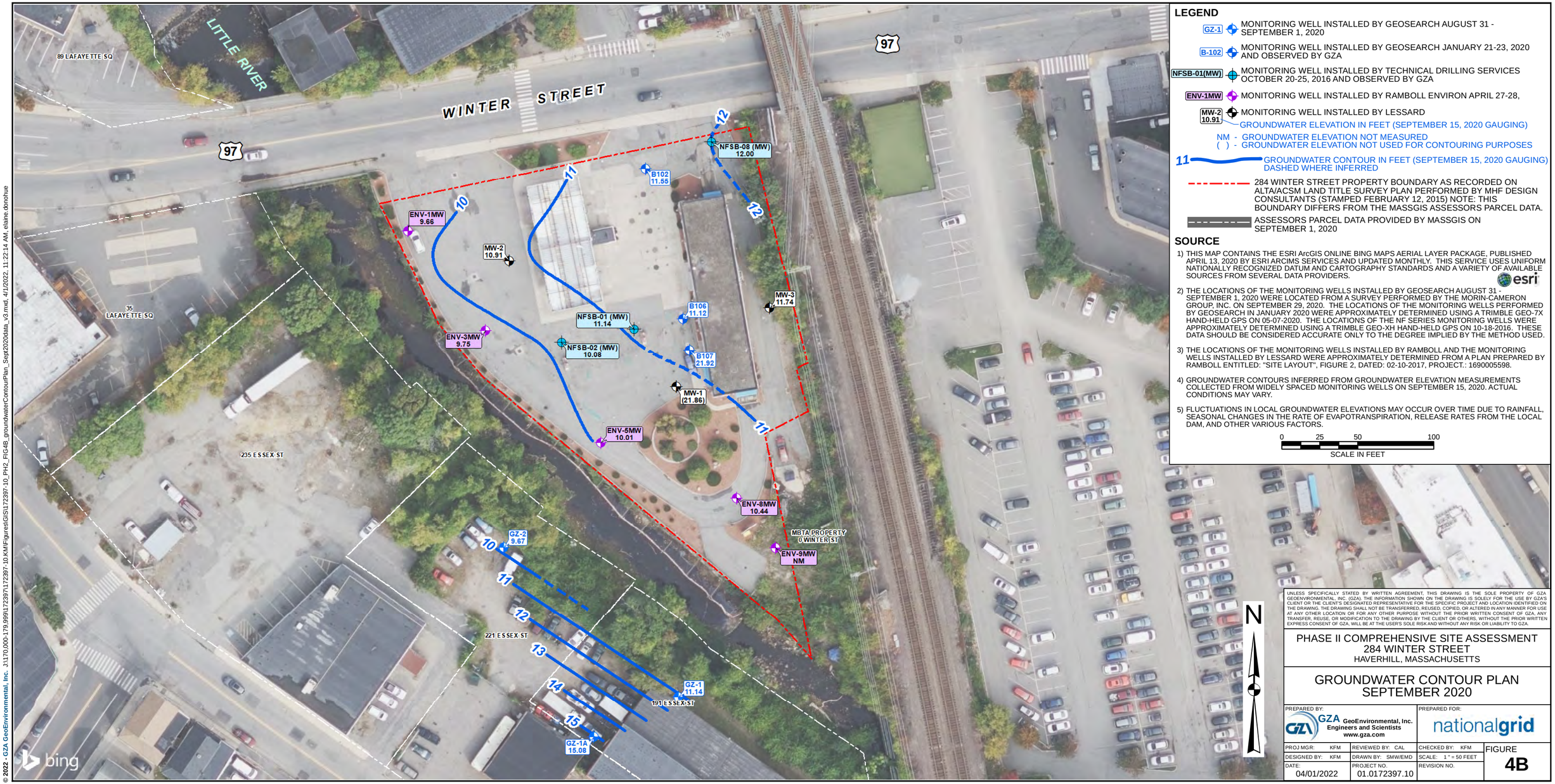
1) THIS MAP CONTAINS THE ESRI ArcGIS ONLINE BING MAPS AERIAL LAYER PACKAGE, PUBLISHED APRIL 13, 2020 BY ESRI ARCIMS SERVICES AND UPDATED MONTHLY. THIS SERVICE USES UNIFORM NATIONALLY RECOGNIZED DATUM AND CARTOGRAPHY STANDARDS AND A VARIETY OF AVAILABLE SOURCES FROM SEVERAL DATA PROVIDERS.
2) THE LOCATIONS OF THE NF SERIES MONITORING WELLS WERE APPROXIMATELY DETERMINED USING A TRIMBLE GEO-XH HAND-HELD GPS ON 10-18-2016. THESE DATA SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.
3) THE LOCATIONS OF THE MONITORING WELLS INSTALLED BY RAMBOLL AND THE MONITORING WELLS INSTALLED BY LESSARD WERE APPROXIMATELY DETERMINED FROM A PLAN PREPARED BY RAMBOLL ENTITLED: "SITE LAYOUT", FIGURE 2, DATED: 02-10-2017, PROJECT.: 1690005598.
4) GROUNDWATER CONTOURS INFERRED FROM GROUNDWATER ELEVATION MEASUREMENTS COLLECTED FROM WIDELY SPACED MONITORING WELLS ON 5-07-2020. ACTUAL CONDITIONS MAY VARY.
5) FLUCTUATIONS IN LOCAL GROUNDWATER ELEVATIONS MAY OCCUR OVER TIME DUE TO RAINFALL, SEASONAL CHANGES IN THE RATE OF EVAPOTRANSPIRATION, RELEASE RATES FROM THE LOCAL DAM, AND OTHER VARIOUS FACTORS.

0 25 50 100
SCALE IN FEET

PHASE II COMPREHENSIVE SITE ASSESSMENT
284 WINTER STREET
HAVERHILL, MASSACHUSETTS

GROUNDWATER CONTOUR PLAN
MAY 2020

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: nationalgrid	
PROJ MGR: KFM	REVIEWED BY: CAL	CHECKED BY: KFM	FIGURE 4A
DESIGNED BY: KFM	DRAWN BY: SMW/EMD	SCALE: 1 " = 50 FEET	
DATE: 04/01/2022	PROJECT NO. 01.0172397.10	REVISION NO.	



LEGEND

- GZ-1 — MONITORING WELL INSTALLED BY GEOSEARCH AUGUST 31 - SEPTEMBER 1, 2020
- B-102 — MONITORING WELL INSTALLED BY GEOSEARCH JANUARY 21-23, 2020 AND OBSERVED BY GZA
- NFSB-01(MW) — MONITORING WELL INSTALLED BY TECHNICAL DRILLING SERVICES OCTOBER 20-25, 2016 AND OBSERVED BY GZA
- ENV-1MW — MONITORING WELL INSTALLED BY RAMBOLL ENVIRON APRIL 27-28,
- MW-2 10.91 — MONITORING WELL INSTALLED BY LESSARD
  - GROUNDWATER ELEVATION IN FEET (SEPTEMBER 15, 2020 GAUGING)
  - NM - GROUNDWATER ELEVATION NOT MEASURED
  - ( ) - GROUNDWATER ELEVATION NOT USED FOR CONTOURING PURPOSES
- 11 — GROUNDWATER CONTOUR IN FEET (SEPTEMBER 15, 2020 GAUGING) DASHED WHERE INFERRED
- 284 WINTER STREET PROPERTY BOUNDARY AS RECORDED ON ALTA/ACSM LAND TITLE SURVEY PLAN PERFORMED BY MHF DESIGN CONSULTANTS (STAMPED FEBRUARY 12, 2015) NOTE: THIS BOUNDARY DIFFERS FROM THE MASSGIS ASSESSORS PARCEL DATA.
- ASSESSORS PARCEL DATA PROVIDED BY MASSGIS ON SEPTEMBER 1, 2020

SOURCE

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4) GROUNDWATER CONTOURS INFERRED FROM GROUNDWATER ELEVATION MEASUREMENTS COLLECTED FROM WIDELY SPACED MONITORING WELLS ON SEPTEMBER 15, 2020. ACTUAL CONDITIONS MAY VARY.
5) FLUCTUATIONS IN LOCAL GROUNDWATER ELEVATIONS MAY OCCUR OVER TIME DUE TO RAINFALL, SEASONAL CHANGES IN THE RATE OF EVAPOTRANSPIRATION, RELEASE RATES FROM THE LOCAL DAM, AND OTHER VARIOUS FACTORS.

0 25 50 100
SCALE IN FEET

N

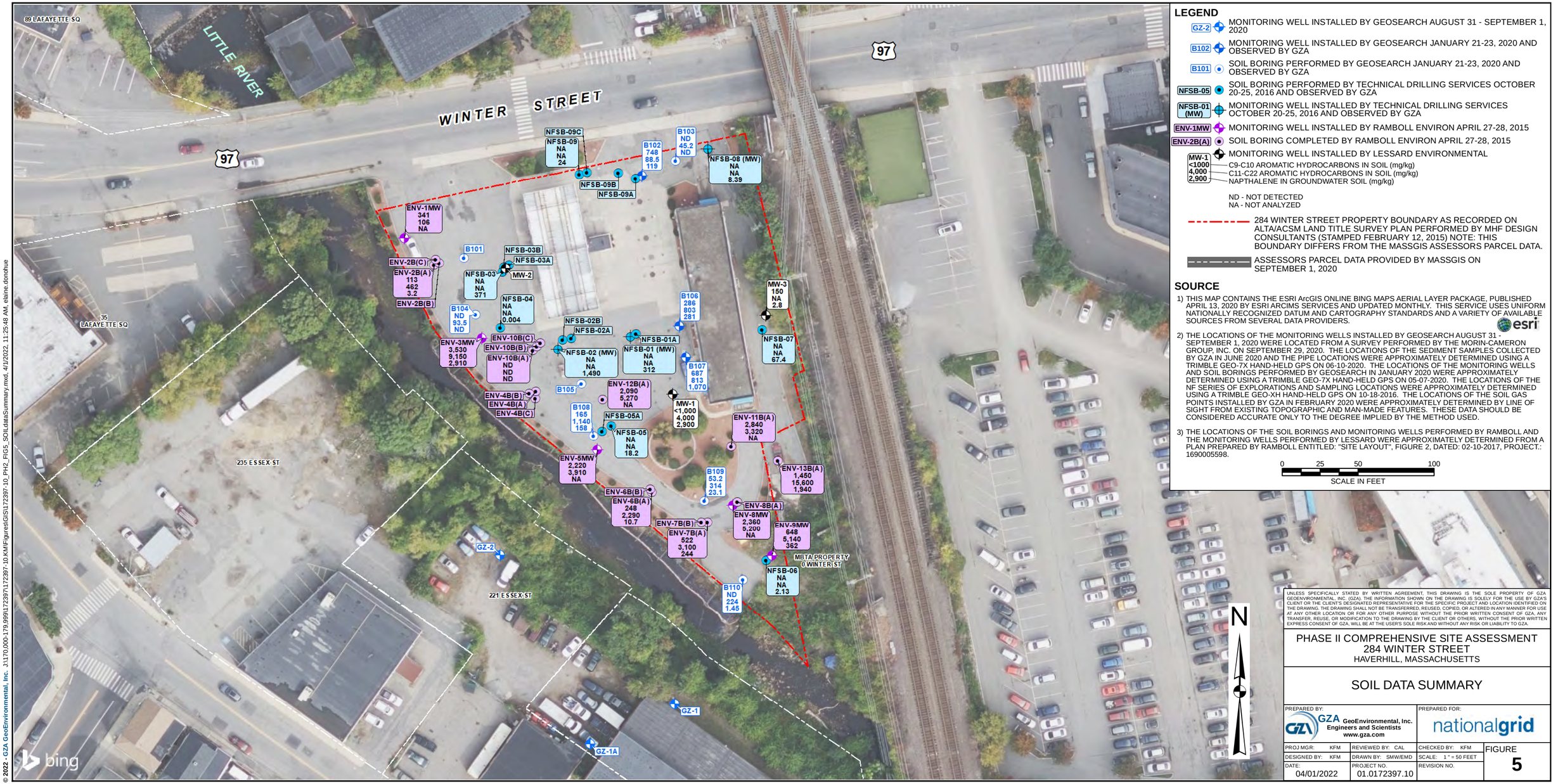
PHASE II COMPREHENSIVE SITE ASSESSMENT
284 WINTER STREET
HAVERHILL, MASSACHUSETTS

GROUNDWATER CONTOUR PLAN
SEPTEMBER 2020

PREPARED BY:
GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR:
nationalgrid

PROJ MGR: KFM	REVIEWED BY: CAL	CHECKED BY: KFM	FIGURE
DESIGNED BY: KFM	DRAWN BY: SMW/EMD	SCALE: 1 " = 50 FEET	4B
DATE: 04/01/2022	PROJECT NO. 01.0172397.10	REVISION NO.	



LEGEND

- GZ-2 — MONITORING WELL INSTALLED BY GEOSEARCH AUGUST 31 - SEPTEMBER 1, 2020
- B102 — MONITORING WELL INSTALLED BY GEOSEARCH JANUARY 21-23, 2020 AND OBSERVED BY GZA
- B101 — SOIL BORING PERFORMED BY GEOSEARCH JANUARY 21-23, 2020 AND OBSERVED BY GZA
- NFSB-05 — SOIL BORING PERFORMED BY TECHNICAL DRILLING SERVICES OCTOBER 20-25, 2016 AND OBSERVED BY GZA
- NFSB-01 (MW) — MONITORING WELL INSTALLED BY TECHNICAL DRILLING SERVICES OCTOBER 20-25, 2016 AND OBSERVED BY GZA
- ENV-1MW — MONITORING WELL INSTALLED BY RAMBOLL ENVIRON APRIL 27-28, 2015
- ENV-2B(A) — SOIL BORING COMPLETED BY RAMBOLL ENVIRON APRIL 27-28, 2015
- MONITORING WELL INSTALLED BY LESSARD ENVIRONMENTAL
  - MW-1
  - <1000 — C9-C10 AROMATIC HYDROCARBONS IN SOIL (mg/kg)
  - 4,000 — C11-C22 AROMATIC HYDROCARBONS IN SOIL (mg/kg)
  - 2,900 — NAPTHALENE IN GROUNDWATER SOIL (mg/kg)

ND - NOT DETECTED
NA - NOT ANALYZED

284 WINTER STREET PROPERTY BOUNDARY AS RECORDED ON ALTA/ACSM LAND TITLE SURVEY PLAN PERFORMED BY MHF DESIGN CONSULTANTS (STAMPED FEBRUARY 12, 2015) NOTE: THIS BOUNDARY DIFFERS FROM THE MASSGIS ASSESSORS PARCEL DATA.

ASSESSORS PARCEL DATA PROVIDED BY MASSGIS ON SEPTEMBER 1, 2020

SOURCE

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0 25 50 100
SCALE IN FEET

N

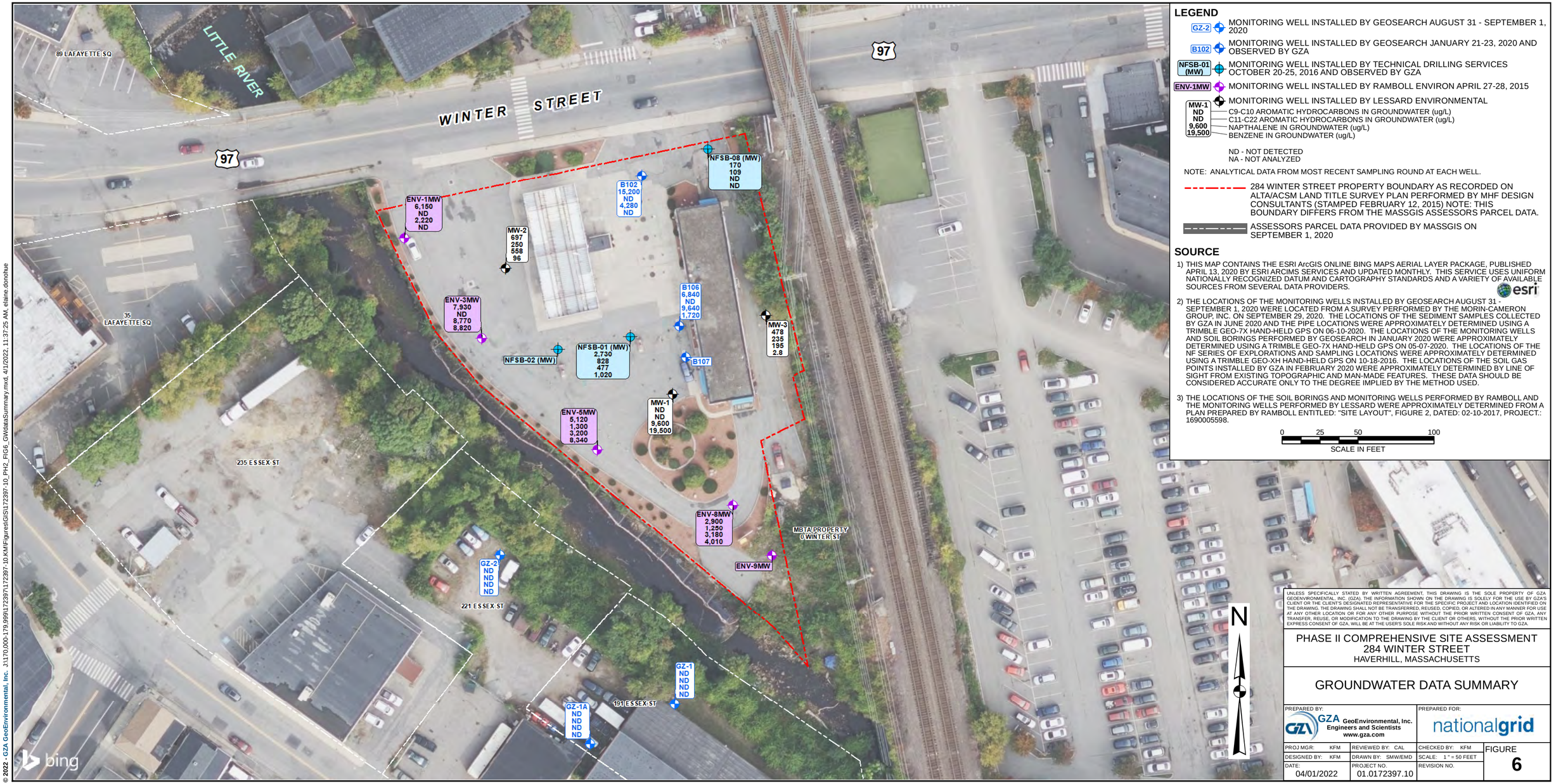
PHASE II COMPREHENSIVE SITE ASSESSMENT
284 WINTER STREET
HAVERHILL, MASSACHUSETTS

SOIL DATA SUMMARY

PREPARED BY:
GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR:
nationalgrid

PROJ MGR: KFM	REVIEWED BY: CAL	CHECKED BY: KFM	FIGURE 5
DESIGNED BY: KFM	DRAWN BY: SMW/EMD	SCALE: 1 " = 50 FEET	
DATE: 04/01/2022	PROJECT NO. 01.0172397.10	REVISION NO.	



LEGEND

- GZ-2 — MONITORING WELL INSTALLED BY GEOSEARCH AUGUST 31 - SEPTEMBER 1, 2020
- B102 — MONITORING WELL INSTALLED BY GEOSEARCH JANUARY 21-23, 2020 AND OBSERVED BY GZA
- NFSB-01 (MW) — MONITORING WELL INSTALLED BY TECHNICAL DRILLING SERVICES OCTOBER 20-25, 2016 AND OBSERVED BY GZA
- ENV-1MW — MONITORING WELL INSTALLED BY RAMBOLL ENVIRON APRIL 27-28, 2015
- MONITORING WELL INSTALLED BY LESSARD ENVIRONMENTAL

MW-1
ND
ND
9,600
19,500

- C9-C10 AROMATIC HYDROCARBONS IN GROUNDWATER (ug/L)
- C11-C22 AROMATIC HYDROCARBONS IN GROUNDWATER (ug/L)
- NAPTHALENE IN GROUNDWATER (ug/L)
- BENZENE IN GROUNDWATER (ug/L)

ND - NOT DETECTED
NA - NOT ANALYZED

NOTE: ANALYTICAL DATA FROM MOST RECENT SAMPLING ROUND AT EACH WELL.

284 WINTER STREET PROPERTY BOUNDARY AS RECORDED ON ALTA/ACSM LAND TITLE SURVEY PLAN PERFORMED BY MHF DESIGN CONSULTANTS (STAMPED FEBRUARY 12, 2015) NOTE: THIS BOUNDARY DIFFERS FROM THE MASSGIS ASSESSORS PARCEL DATA.

ASSESSORS PARCEL DATA PROVIDED BY MASSGIS ON SEPTEMBER 1, 2020

SOURCE

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0 25 50 100
SCALE IN FEET

N

PHASE II COMPREHENSIVE SITE ASSESSMENT
284 WINTER STREET
HAVERHILL, MASSACHUSETTS

GROUNDWATER DATA SUMMARY

PREPARED BY:
GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR:
nationalgrid

PROJ MGR: KFM	REVIEWED BY: CAL	CHECKED BY: KFM	FIGURE 6
DESIGNED BY: KFM	DRAWN BY: SMW/EMD	SCALE: 1 " = 50 FEET	
DATE: 04/01/2022	PROJECT NO. 01.0172397.10	REVISION NO.	

Appendix A – Limitations

LIMITATIONS

1. This Phase II Comprehensive Site Assessment report has been prepared on behalf of and for the exclusive use of Boston Gas Company d/b/a National Grid, solely for use in summarizing Phase II studies under Release Tracking Numbers (RTNs) 3-32792 and 3-32875 completed within the disposal site located at 284 Winter Street in Haverhill, Massachusetts ("Site") under the Massachusetts Contingency Plan (MCP - 310 CMR 40.0000). This report and the findings contained herein shall not, in whole or in part, be disseminated or conveyed to any other party, nor used by any other party in whole or in part, without the prior written consent of GZA or National Grid. However, GZA acknowledges and agrees that the report may be conveyed to the Massachusetts Department of Environmental Protection (MassDEP) to address MCP requirements.

2. GZA's work was performed in accordance with generally accepted practices of other consultants undertaking similar studies at the same time and in the same geographical area, and GZA observed that degree of care and skill generally exercised by other consultants under similar circumstances and conditions. GZA's findings and conclusions must be considered not as scientific certainties, but rather as our professional opinion concerning the significance of the limited data gathered during the course of the study. No other warranty, express or implied is made. Specifically, GZA does not and cannot represent that the Site contains no hazardous material, oil, or other latent condition beyond that observed by GZA during the Phase II studies.

3. The observations described in this report were made under the conditions stated therein. The conclusions presented in the report were based upon services performed and observations made by GZA.

4. In the event that National Grid or others authorized to use this report obtain information on environmental or hazardous waste issues at the Site not contained in this report, such information shall be brought to GZA's attention forthwith. GZA will evaluate such information and, on the basis of this evaluation, may modify the conclusions stated in this report.

5. The conclusions and recommendations contained in this report are based in part upon the data obtained from environmental samples obtained from relatively widely spread subsurface explorations. The nature and extent of variations between these explorations may not become evident until further exploration. If variations or other latent conditions then appear evident, it will be necessary to reevaluate the conclusions and recommendations of this report.

6. The generalized soil profile described in the text and depicted on figures is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretations of widely spaced explorations and samples; actual soil transitions are probably more gradual. For specific information, refer to the boring logs.

7. In the event this work included the collection of water level data, these readings have been made in the test pits, borings and/or observation wells at times and under conditions stated on the exploration logs. These data have been reviewed and interpretations have been made in the text of this report. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall and other factors different from those prevailing at the time measurements were made.

8. The conclusions contained in this report are based in part upon various types of chemical data and are contingent upon their validity. These data have been reviewed and interpretations made in the report. Moreover, it should be noted that variations in the types and concentrations of contaminants and variations in their flow paths may occur due to seasonal water table fluctuations, past disposal practices, the passage of time, and other factors. Should additional chemical data become available in the future, these data should be reviewed by GZA and the conclusions and recommendations presented herein modified accordingly.

9. In the event this work included the performance of a risk evaluation, GZA's risk evaluation was performed in accordance with generally accepted practices of the Massachusetts Contingency Plan and other consultants undertaking similar studies. The findings of the risk evaluation are dependent on numerous assumptions and uncertainties inherent in the risk assessment process. Sources of uncertainty may include the description of Site conditions and the nature and extent of chemical distribution and the use of toxicity information. Consequently, the findings of the risk assessment are not an absolute characterization of actual risks, but rather serve to highlight potential sources of risk at the Site. Although the range of uncertainties has not been quantified, the use of conservative assumptions and parameters throughout the assessment would be expected to err on the side of protection of human health and the environment.

Appendix B – BWSC108 Transmittal Form

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC 108

Release Tracking Number
3 - 32792

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: HAFFNER'S

2. Street Address: 284 WINTER STREET

3. City/Town: HAVERHILL 4. ZIP Code: 018300000

☑ 5. Check here if the disposal site that is the source of the release is Tier Classified. Check the current Tier Classification Category:

☑ a. Tier I ☐ b. Tier ID ☐ c. Tier II

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.

☐ 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 Permanent or Temporary Solution.

☐ b. The requirements of a Permanent Solution have been met. A completed Permanent Solution Statement and Report (BWSC104) will be submitted to DEP.

☐ c. The requirements of a Temporary Solution have been met. A completed Temporary Solution Statement and Report (BWSC104) will be submitted to DEP.

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 every six months, concurrent with a Status Report.

☐ iv. A Remedial Monitoring Report(s) submitted annually, concurrent with a Status Report.

c. Status of Site: (check one) ☐ i. Phase IV ☐ ii. Phase V ☐ iii. Remedy Operation Status ☐ iv. Temporary Solution

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 **Transfer and/or a Modification of Persons Maintaining a Remedy Operation Status (ROS),** pursuant to 310 CMR 40.0893(5) (check one, or both, if applicable).

☐ a. Submit a Transfer of Persons Maintaining an ROS (the transferee should be the person listed in Section D, "Person Undertaking Response Actions").

☐ b. Submit a Modification of Persons Maintaining an ROS (the primary representative should be the person listed in Section D, "Person Undertaking Response Actions").

c. Number of Persons Maintaining an ROS not including the primary representative: _____

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

☐ a. Submit a notice indicating ROS performance standards have not been met. A plan and timetable pursuant to 310 CMR 40.0893(6)(b) for resuming the ROS are attached.

☐ b. Submit a notice of Termination of ROS.

☐ 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 Permanent Solution have been met. A completed Permanent Solution Statement and Report (BWSC104) will be submitted to DEP.

☐ b. The requirements for a Temporary Solution have been met. A completed Temporary Solution 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 **Temporary Solution Status Report,** pursuant to 310 CMR 40.0898.

☐ 24. Submit a **Plan for the Application of Remedial Additives** near a sensitive receptor, pursuant to 310 CMR 40.0046(3).

a. Status of Site: (check one)

☐ i. Phase IV ☐ ii. Phase V ☐ iii. Remedy Operation Status ☐ iv. Temporary Solution

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*** *and/or a* ***Termination of a Remedy Operation Status*** *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 Temporary Solution Status Report,*** *a* ***Status Report to Maintain a Remedy Operation Status,*** *a* ***Transfer or Modification of Persons Maintaining 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#: 6891

2. First Name: CHARLES A 3. Last Name: LINDBERG

4. Telephone: 7812783830 5. Ext.: 6. Email: charles.lindberg@gza.com

7. Signature:

8. Date: (mm/dd/yyyy) 9. LSP Stamp:

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: BOSTON GAS CO D/B/A NATIONAL GRID

3. Contact First Name: JESSE 4. Last Name: EDMANDS

5. Street: 40 SYLVAN ROAD 6. Title: PROGRAM MANAGER

7. City/Town: WALTHAM 8. State: MA 9. ZIP Code: 024511120

10. Telephone: 7819073682 11. Ext: 12. Email: jesse.edmands@nationalgrid.com

E. RELATIONSHIP TO SITE OF PERSON UNDERTAKING RESPONSE ACTIONS: ☐ Check here to change relationship

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

☑ e. Other RP or PRP Specify: OTHER PRPS

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

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

☐ 8. Check here if any non-updatable information provided on this form is incorrect, e.g. Release Address/Location Aid. Send corrections to: BWSC.eDEP@state.ma.us.

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

G. CERTIFICATION OF PERSON UNDERTAKING RESPONSE ACTIONS:

1. I, _____, 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.

>*if Section B indicates that this is a* **Modification of a Remedy Operation Status (ROS),** I attest under the pains and penalties of perjury that I am fully authorized to act on behalf of all persons performing response actions under the ROS as stated in 310 CMR 40.0893(5)(d) to receive oral and written correspondence from MassDEP with respect to performance of response actions under the ROS, and to receive a statement of fee amount as per 4.03(3).

I understand that any material received by the Primary Representative from MassDEP shall be deemed received by all the persons performing response actions under the ROS, and I am 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: PROGRAM MANAGER

4. For: BOSTON GAS CO D/B/A NATIONAL GRID (Name of person or entity recorded in Section D) 5. Date: _____ (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. Email: _____

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:)

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

Miscellaneous Document Transmittal Form

BWSC 126

Release Tracking Number
3 - 32792

A. DISPOSAL SITE LOCATION:

1. Disposal Site Name: HAFFNER'S
2. Street Address: 284 WINTER STREET
3. City/Town: HAVERHILL 4. Zip Code: 018300000

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

☐ 1. Correct typographical errors and/or make corrections that do not materially affect the nature or complexity of the response actions. If changes are materially significant, then a revised or modified submittal must be made to the Department. List the report/form that is being corrected that is associated with the above Release Tracking Number (RTN). Attach an errata sheet containing a description of the errors and/or corrections.

Form/Report	Submittal Date(mm/dd/yyyy)	Transaction ID

☑ 2. Submit other documents associated with this RTN that cannot be submitted to the Department using any other BWSC transmittal form. Do not submit documents that are of a time-critical nature and/or that require a direct response from the Department and/or that require an LSP Opinion pursuant to 310 CMR 40.0015. (Section C is not required).

Description of Submittal SUPPORTING DOCUMENTATION FOR TRANSACTION #1358949

☐ 3. Resign as LSP-of-Record for the above Release Tracking Number (RTN). Attach a copy of the LSP resignation letter. (Section D, E, and F are not required).

☐ 4. Submit copies of Public Notices required pursuant to 310 CMR 40.1400: (check all that apply)
(Section C is not required)

- ☐ a. Tier I Classification — ☐ Check here if submitting a copy of a legal notice
- ☐ b. Tier II Classification — ☐ Check here if submitting a copy of a legal notice
- ☐ c. Immediate Response Action (IRA)
- ☐ d. Release Abatement Measure (RAM)
- ☐ e. Downgradient Property Status (DPS)
- ☐ f. Utility-related Abatement Measure (URAM)
- ☐ g. Comprehensive Response Actions
- ☐ h. Activities related to recording/registering an Activity and Use Limitation (AUL) — ☐ Check here if submitting a copy of a legal notice
- ☐ i. Permanent or Temporary Solution

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

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

☐ 5. Submit Public Involvement Petition documents. (check all that apply). (Section C is not required).

- ☐ a. Submit a Public Involvement Petition
- ☐ b. Submit a Public Involvement Petition Retraction
- ☐ c. Submit a Positive Public Involvement Petition Designation Letter
- ☐ d. Submit a Negative Public Involvement Designation Letter
- ☐ e. Submit a Draft Public Involvement Petition Plan
- ☐ f. Submit a Revised Public Involvement Petition Plan
- ☐ g. Submit a Final Public Involvement Petition Plan
- ☐ h. Submit a Notice of Public Comment Period

  Date of Close of Comment Period : _____ (mm/dd/yyyy)
- ☐ i. Submit a copy of a Public Involvement Petition legal notice
- ☐ j. Submit a Notice of Public Meeting

  Meeting Date: _____ (mm/dd/yyyy)
- ☐ k. Submit other Public Involvement Petition related documents not specified above:

  Describe: _____

☐ 6. Submit a RCRA Contained-In-Determination to document that soil and/or groundwater is no longer considered a hazardous waste pursuant to state (310 CMR 30.00) and federal (Title 40, Chapter I, Part 261 of the Code of Federal Regulations) hazardous waste regulations.

☐ 7. Submit notification and documentation of Reclamation Soil Reuse pursuant to 310 CMR 40.0031(2).

C. LSP SIGNATURE:

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. 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 #: _____
2. First Name: _____ 3. Last Name: _____
4. Telephone: _____ 5. Ext.: _____ 6. Email: _____
7. Signature: _____
8. Date: _____ (mm/dd/yyyy)

D. PERSON MAKING A SUBMITTAL:

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

2. Name of Organization: BOSTON GAS CO D/B/A NATIONAL GRID

3. Contact First Name: JESSE 4. Last Name: EDMANDS

5. Street: 40 SYLVAN ROAD 6. Title: PROGRAM MANAGER

7. City/Town: WALTHAM 8. State: MA 9. ZIP Code: 024511120

10. Telephone: 7819073682 11. Ext.: 12. Email: jesse.edmands@nationalgrid.com

☐ 13. Check here if the person is a Public Involvement Petitioner

E. RELATIONSHIP TO SITE OF PERSON MAKING SUBMITTAL:

☐ Check here to change relationship

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

☑ e. Other RP or PRP Specify: OTHER PRPS

☐ 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. CERTIFICATION OF PERSON MAKING SUBMITTAL:

1. I, _____, attest under the pains and penalties or 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: PROGRAM MANAGER
Signature

4. For: BOSTON GAS CO D/B/A NATIONAL GRID 5. Date: _____
(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. Email:

☐ Check here if any non-updatable information provided on this form is incorrect, e. g. property address. Send corrections to BWSC.eDEP@state.ma.us

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):

Appendix C – Phase II CSA Report for the Little River (Prepared by Anchor QEA, LLC)

April 2022
Former Haverhill MGP Site

ANCHOR QEA

Phase II Comprehensive Site Assessment – Little River

Boston Gas Company d/b/a National Grid

April 2022
Former Haverhill MGP Site

Phase II Comprehensive Site Assessment – Little River

Prepared for
National Grid
40 Sylvan Road
Waltham, Massachusetts 02451

Prepared by
Anchor QEA, LLC
9 Water Street, First Floor
Amesbury, Massachusetts 01913

Project Number: 180327-08.01
https://anchorqea-my.sharepoint.com/personal/bgauley_anchorqea_com/Documents/Haverhill/Draft_PhaseII_CSA/HAV_Client_Review/HAV_Phase-II_CSA_Report_2022-04-01.docx

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ABBREVIATIONS

µg/kg	micrograms per kilogram
AUL	activity and use limitation
bml	below mudline
BTEX	benzene, toluene, ethylbenzene, and xylenes
COPEC	contaminant of potential ecological concern
CSA	comprehensive site assessment
CSM	conceptual site model
CSO	combined sewer outfall
EDR	Environmental Data Resources, Inc.
EPH	extractable petroleum hydrocarbons
ERC	environmental risk characterization
GZA	GZA GeoEnvironmental, Inc.
Haffner	Haffner Realty Trust
IDW	investigation-derived waste
IGL	Integrated Geosciences Laboratories, LLC
ISI	initial site investigation
LSP	Licensed Site Professional
MassDEP	Massachusetts Department of Environmental Protection
MassGIS	Massachusetts Office of Geographic Information
MCP	Massachusetts Contingency Plan
mg/kg	milligrams per kilogram
MGP	manufactured gas plant
NAPL	nonaqueous phase liquid
NRC	National Response Center
NYSDEC	New York State Department of Environmental Conservation
OHM	oil or hazardous materials
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEC	probable effects concentration
RAH	readily apparent harm
RCRA	Resource Conservation and Recovery Act
RTN	release tracking number
SCO	sediment cleanup objective
Site	284 Winter Street, Haverhill, Massachusetts
SL	screening level
SOC	soot organic carbon

SVOC	semivolatile organic compound
TEC	threshold effects concentration
TOC	total organic carbon
TPAH	total polycyclic aromatic hydrocarbons
TPCBA	total PCB Aroclor
TPH	total petroleum hydrocarbons
USEPA	U.S. Environmental Protection Agency
UV	ultraviolet
VOC	volatile organic compound
VOT	visible oil and/or tar
VPH	volatile petroleum hydrocarbons
WA SMS	Washington Sediment Management Standards

1 Introduction

This Phase II Comprehensive Site Assessment (CSA) for the Little River portion of the former Haverhill manufactured gas plant (MGP) site was prepared by Anchor QEA, LLC, on behalf of Boston Gas Company, doing business as National Grid. The former MGP was located at 284 Winter Street in Haverhill, Massachusetts (the Site; Figure 1) on property that abuts the Little River to the east and is currently owned by Haffner Realty Trust (Haffner). The Site comprises an upland component and an in-river component and has been assigned Release Tracking Number (RTN) 3-32792 by the Massachusetts Department of Environmental Protection (MassDEP). GZA GeoEnvironmental, Inc. (GZA) of Norwood, Massachusetts, is conducting the upland investigation.

This report is intended to be an appendix to the Phase II CSA submittal being prepared by GZA (GZA 2022) on behalf of National Grid. The information in this report applies primarily to the Little River portion of the Site. Phase II information about the upland Site will be provided in GZA's Phase II CSA report unless otherwise noted.

1.1 Purpose

The Phase II CSA investigation was conducted to do the following:

- Identify the sources, nature, and extent of contamination at the Site
- Assess the risks to human health, safety, public welfare, and the environment posed by the Site
- Identify potential immediate response actions, release abatement measures, utility related abatement measures, or other remedial response actions that may be warranted at the Site
- Determine whether a Temporary or Permanent Solution can be achieved for the Site at the completion of the Phase I Investigation or additional comprehensive response actions are necessary at the Site before closure can be achieved

In-river field investigation activities were undertaken in June 2020 and September 2021.

The evaluation of sediment and surface water included collecting samples for laboratory analysis of their chemical and physical properties. The data have been used to evaluate the nature and extent of oil or hazardous materials (OHM) and to characterize potential risk to human health and the environment, in accordance with the Massachusetts Contingency Plan (MCP) requirements for a Phase II CSA and Method 3 Risk Characterization. Per the MCP, a Method 3 Risk Characterization is required for sites where contamination is being evaluated in aquatic habitats, as there are no promulgated Method 1 standards for the associated media.

1.2 Licensed Site Professional and Person Undertaking Response Action

National Grid is undertaking, and intends to continue to undertake, the actions required by MassDEP under Massachusetts General Law Chapter 21E and the MCP with respect to MGP waste at the Site. The contact information for National Grid will be provided in the MassDEP Phase II Comprehensive Response Action Transmittal Form (BWSC-108) that will accompany GZA's Phase II CSA report.

Charles Lindberg of GZA is the Licensed Site Professional (LSP) of Record for the Site (License Number 6891). His contact information, which is also provided in BWSC-108, is as follows:

Charles Lindberg, LSP
GZA GeoEnvironmental, Inc.
249 Vanderbilt Avenue
Norwood, Massachusetts 02062

1.3 Site Location and Description

The approximately 1.2-acre property at 284 Winter Street in downtown Haverhill is currently occupied by a Haffner's gasoline service station and car wash. The property is almost entirely covered by pavement or structures, and commercial and industrial properties surround the property.

The Site is abutted to the north by Winter Street, across which is a vacant industrial mill complex. The Site is abutted to the south and west by the Little River; a masonry retaining wall separates the Site from the river to the west. Beyond the river are commercial and residential buildings. The Site is abutted to the east by an active Massachusetts Bay Transportation Authority railroad right-of-way, beyond which is a residential apartment complex.

The Site was the location of an MGP facility operated by the Haverhill Gas Works, which manufactured coal gas from approximately 1853 to 1970. On-site infrastructure associated with the coal gas manufacturing process included two holders, retorts, condensers, and purifiers, as well as auxiliary sheds and other support structures. The manufactured gas was stored in holders on the Site until 1893, when storage was moved to holders on Hilldale Avenue. Historical research documented in an earlier report determined the MGP facility was converted to carbureted gas manufacturing sometime between 1910 and 1912. The MGP next produced oil gas, from 1951 until 1960.

Sometime between 1970 and 1976, most of the aboveground portions of the former MGP structures were removed or demolished. An aerial photograph from 1971 shows all that remained aboveground were the former coal bins adjacent to the railroad along the eastern side of the Site, an office and stock room on the northwestern portion of the Site, and one aboveground oil tank. Haffner Realty Trust has been continuously operating a retail gasoline station, car wash, and fuel oil distribution facility at the Site since approximately 1976 or 1977, when the Haffner facility was constructed (Ramboll 2016; GZA 2021).

1.3.1 In-River Component of the Site

The in-river component of the Site includes the portion of the Little River adjacent to the upland property where the former MGP stood (Figure 1). There, the river ranges from approximately 20 to 50 feet wide. During periods of low water, portions of the riverbed are exposed, but water several feet deep remains in a meandering channel. The sediment surface is a combination of sand, gravel, and cobbles; vegetation (e.g., grass, weeds) is present in the channel at several locations.

The Little River is approximately 12.9 miles long and rises in Kingston, New Hampshire. After flowing through a conduit beneath various properties in Haverhill, the Little River discharges into the Merrimack River approximately one-quarter mile south of the Site.

The Merrimack River is tidally influenced for 22 miles from the ocean to Haverhill. The Little River may be tidally influenced up to the Little River dam, which is just upstream of the Site. After evaluating the impact of tidal conditions in the Little River for the Little River dam feasibility study, Fuss & O'Neill concluded most of the Little River within the conduit just downstream of the Site experienced daily impacts from tides (Fuss & O'Neill 2021). However, only extreme high tides or coastal storm surges appear to have an impact on the Little River upstream of the conduit due to the channel bottom elevations (including the reach adjacent to the Site).

The in-river portion of the Site is constrained by several structures. Approximately 70 feet upstream of the Site is the Little River dam, a stone masonry structure built in the 1800s. The dam and the adjacent mill building likely predate the former MGP. Immediately downstream of the dam is the Winter Street bridge. Approximately 500 feet south of the Winter Street bridge is the headwall for the Little River Conduit, which was constructed from 1937 to 1938 as part of the U.S. Army Corps of Engineers' Haverhill Local Protection Project. The conduit is operated and maintained by the City of Haverhill. A vertical retaining wall 15 to 20 feet tall runs along most of the eastern side of the Little River. The river's western bank and the southern portion of the eastern bank are heavily overgrown, steep, and may include remnants of former structures such as retaining walls. Photographs of the Winter Street bridge, the Little River dam, and the river's eastern and western banks are included in Appendix A.

1.4 Scope of Work

Field investigations were conducted in 2016, 2020, and 2021 in addition to site research to meet the MCP requirements for CSA reports (310 CMR 40.0835). In 2016, GZA collected nonaqueous phase liquid (NAPL) and sheen samples for forensic evaluation. In 2020, GZA collected by hand auger sediment samples from 14 locations for visual observation and sampling: 11 parent samples came

from 0.0 to 0.5 foot below mudline (bml), and 4 parent samples came from more than 0.5 foot bml. In addition, GZA collected the following:

- Two surface water samples (one upstream and one downstream)
- A visual pipe inventory of retaining wall
- River elevation data

In 2021, Anchor QEA collected the following:

- Sediment cores from 14 locations (multiple cores were collected at select locations)
- Thirty sediment samples for chemical analysis
  - Fifteen samples (13 parent samples and 2 duplicates) from 0.0 to 0.5 foot bml
  - Fifteen parent samples from more than 0.5 foot bml
- Two cores for ultraviolet (UV) light photography
- Ten samples for NAPL mobility testing

From these investigations, the following combined samples were collected for laboratory analyses and physical property testing:

- Twenty-six sediment samples from 0.0 to 0.5 feet bml (24 parent samples and 2 duplicates)
- Nineteen parent sediment samples from greater than 0.5 feet bml
- Ten sediment samples for NAPL mobility testing
- Two surface water samples

The 2016 and 2020 field events and the data they collected are summarized in GZA's Phase II CSA. The results of the 2016 and 2020 field events will be used along with the results from the Anchor QEA 2021 field investigation to support the in-river Phase II CSA report.

The data collected during the review of historical information and the field and laboratory investigations were evaluated for quality assurance consistent with MassDEP Data Usability Assessment requirements, analyzed, and interpreted (Appendix B). The data were also used to evaluate the nature and extent of OHM, to characterize potential risks associated with OHM, and to prepare an MCP Stage II environmental risk characterization (ERC).

The information obtained during implementation of the field investigations is presented below in a format consistent with the MCP requirements for a Phase II CSA report (310 CMR 40.0835).

2 Site and Regulatory History

A detailed description of the general Site and the regulatory history associated with the Site will be presented in GZA's Phase II CSA report.

3 Phase II Field Investigations

3.1 In-River Investigations

Phase II CSA field investigations in the Little River were conducted in 2016, 2020, and 2021 and included NAPL and sheen sampling, sediment coring, and surface water sampling. Some sediment cores were collected for visual characterization only. Other sediment cores were collected for laboratory analysis of their chemical or physical properties or for NAPL mobility testing.

GZA collected sediment samples in 2020 along five transects from three hand auger locations per transect (except for transect 4). Sediment cores were collected in 2021 from upstream and downstream of the 2020 sample locations and from locations between the 2020 transects to provide additional sampling and visual characterization coverage (Figure 2).

Surface water samples were collected upstream and downstream of the Site for laboratory chemical analysis in 2020.

Details of the 2021 field investigation are presented in the following sections; details of the 2016 and 2020 field investigations are summarized in GZA's Phase II CSA report.

3.1.1 Field Classification of Visible Oil and/or Tar in Sediment Samples

One of the objectives of Phase II activities was to investigate the presence, if any, of readily apparent harm (RAH) as defined in Section 40.0995 (3)(b)1(c) of the MCP and as follows:

> Visible presence of oil, tar, or other nonaqueous phase hazardous material in soil within three feet of the ground surface over an area equal to or greater than two acres, or over an area equal to or greater than 1,000 square feet in sediment within one foot of the sediment surface.

Defined as the presence of NAPL within the sediment cores, visible oil and/or tar (VOT) was observed in 9 of 36 cores and hand auger samples collected from the Little River in the vicinity of the Site. The degree of NAPL ranged from discrete droplets to sediment saturated with NAPL; tar-like material was observed more frequently than less-viscous NAPL. Saturated sediment is defined as sediment pore space mostly occupied by NAPL. The NAPL appeared similar in color and consistency to typical source oil and tars observed at MGP sites.

To ensure residual MGP contamination not in the form of NAPL in the sediment (and therefore not considered VOT) was described consistently in the field, terms were developed to distinguish sediment that met the MCP definition of RAH from sediment that did not. These terms are consistent

with terms used at other National Grid sites and include "sheen" and "staining," which are defined as follows:

- "Sheen" indicates an oil and/or tar residue present as a very thin film in sediment or on water. Because sheen is present only as a very thin film, sheens do not have the same color or consistency as typical source oil and/or tar and so are considered a residue of source oil and/or tar. Consequently, Anchor QEA does not consider sheens in general to be consistent with the visible presence of oil and/or tar (i.e., sheens observed on sediment with no visual observation of oil and/or tar). Sheens appear in a range from trace and discontinuous to heavy and continuous. Although sheens are not defined as VOT, to be conservative sediment cores containing "heavy sheens" within the upper 1 foot of sediment were classified as including VOT and were therefore included in the RAH area.
- "Stained" indicates sediment particles had been in contact with oil and/or tar which left residual material that discolored the sediment, but the oil and/or tar was not present as a visible, separate phase material. Equipment used in the processing of sediment cores was observed as well as the core liner. Sediment was smeared on gloves, and the gloves were lightly rinsed with water. If no NAPL droplets were observed on the equipment, liner, or gloves, the sediment was considered stained. Stained sediment was considered not to represent VOT.

In summary, VOT was defined as the presence of NAPL within sediment cores. Degrees of contamination not considered VOT (i.e., sheens and staining) were defined to aid in consistent field descriptions. Various combinations of sheen, staining, and NAPL were observed in sediment cores.

3.1.2 2021 Investigation

Representatives from Anchor QEA were on site from September 28 to 30, 2021 to collect and process sediment cores (Figure 2).

Twenty-two vibracores were collected by TG&B Marine Services of Falmouth, Massachusetts, with assistance from Nappy Crane Services of Everett, Massachusetts. The original scope of work included sediment core collection by physically accessing the river on foot during a period of low water and collecting the cores using portable vibratory equipment. Due to the higher than anticipated water, accessing the river by foot was not feasible and the presence of vegetation, rocks, and remnant structures prohibited the use of a boat. The lack of access to the river by foot and the presence of the obstructions also prohibited the collection of bathymetric or topographic data. Due to the river conditions, a crane was used to lower the vibratory coring equipment into the river without field personnel entering the river. Using the crane enabled the field crew to use a heavier vibratory head that improved core penetration. The cores were collected from locations that were selected to assess

the nature and extent of VOT in the sediment. Anchor QEA field technicians processed the cores on the upland area of the Site.

Sediment core information was recorded by field personnel for the vibracores, including estimated field sample locations based on references to site features, time of collection, core recovery, and penetration and is presented in Table 1. The core locations are shown in Figure 2.

To collect the cores, a core catcher was inserted into the bottom of a clear acetate liner, and the liner was inserted into an aluminum core barrel onto which a core cutter was attached. The vibratory head and core barrel were attached by a cable to the crane, which raised the equipment vertically and placed it in the river at the approximate core location based on site features. When the end of the core was at the sediment surface, the crane let a little slack into the wire and the head vibrated the tube at approximately 7,200 vibrations per minute. When the tube met refusal, the vibrating head was turned off and the core was removed from the sediment. Upon reaching the upland, the core barrel was laid down, the catcher was removed from the core barrel, and the end of the liner was capped and taped. The liner was pulled out of the core barrel, standing water was drained from the top of the core, extra liner protruding above the top of the core was cut off, and the top was capped. Penetration, recovery, time, and VOT or sheens were recorded in a field notebook.

The vibracores were stored upright prior to processing. To process the core, the core was placed in a rack, and the liner was cut lengthwise on both sides. The core was then split open and photographed with a label and tape measure included in the field for identification and scale. Field personnel visually classified and recorded a description for each core. Samples were collected for laboratory analysis and physical property testing.

Two additional cores were collected from the visually most impacted locations (AQSS-12 and AQSS-13) for UV photography and NAPL mobility testing. The cores were kept intact and cut into segments of approximately 1.4 feet to fit into hard insulated coolers, so the core segments could be shipped to the laboratory in an upright position. The core segments were clearly labeled with the core ID, date, depth interval, and top and bottom of each segment.

Samples were submitted to Alpha Analytical Laboratory of Westborough, Massachusetts, for chemical analysis (Table 2). Samples were submitted for physical property to GeoTesting Express of Boxborough, Massachusetts (Table 2). Two intact cores were shipped to Integrated Geosciences Laboratories, LLC (IGL) of Houston, Texas, for NAPL mobility testing.

In addition, composite samples from select cores were submitted for waste characterization analysis (semivolatile organic compounds [SVOCs; USEPA Method 8270], volatile organic compounds [VOCs; USEPA Method 5035], polychlorinated biphenyls [PCBs; USEPA Method 8082], total petroleum hydrocarbons [TPH], Resource Conservation and Recovery Act [RCRA] 8 Metals, ignitability

[USEPA Method 1010], reactivity [USEPA Method SW-846], toxicity, corrosivity [USEPA Method 9045C], and paint filter test [USEPA Method 9095A]). Sediment was collected from visually impacted intervals. Sediment core logs are presented in Appendix C. Photographs of example sediment cores are included in Appendix A.

3.2 Investigation-Derived Waste Management

During sediment coring activities, spill controls were available in the upland. The spill controls included absorbent materials for managing sheens and sediment from core collection and processing activities.

Sediment cores were opened, photographed, and sampled on the upland portion of the Site near the top of the retaining wall. The table used for sediment core processing was lined with plastic to catch spills and drips from the sediment cores. The plastic was thrown away at the end of each day, and new plastic attached to the table each morning.

Waste was separated into ordinary rubbish and investigation-derived waste (IDW) in the sediment processing area. Ordinary rubbish included cleaned core barrel refuse, paper, plastic, and other nonhazardous waste. Ordinary rubbish was contained in plastic bags or barrels and removed from the Site for disposal as nonhazardous solid waste. IDW included sediment removed from the core barrels and other oily materials (e.g., soiled gloves and core liners). All sediment and liners impacted by VOT were stored in 5-gallon buckets and transferred to drums at the end of the day. IDW was containerized, stored in a drum containment box, and transported by a licensed waste hauler to a disposal facility.

4 Phase II Results

This section presents the results of the chemical and physical analyses of environmental samples collected from the in-water portion of the Site during the Phase II Investigation. Information pertaining to sampling methodology and laboratory analysis was presented in Section 3. Laboratory data sheets are provided in Appendix D.

4.1 In-Water Samples

Environmental samples were collected from the Little River between 2020 and 2021. Sediment and surface water were collected downstream of the Winter Street bridge and upstream of the Little River Conduit headwall (Figure 2). An attempt was made to collect sediment samples upstream of the Winter Street bridge to characterize local conditions, but no sediment was encountered upstream between the Winter Street bridge and the Little River dam. Therefore, sediment samples collected in 2020 and 2021 by Fuss & O'Neill on behalf of the City of Haverhill to support the Little River dam removal feasibility study were used to characterize local conditions. Defining and verifying local conditions samples is discussed in Section 5.2.

Statistics regarding the minimum, maximum, and average values and the number of samples are provided in Table 3. The samples were evaluated as two groups: Site Vicinity samples and Local Conditions samples. Site Vicinity and Local Conditions samples were designated based on the analysis summarized in Section 5.2.

4.1.1 Total and Alkylated Polycyclic Aromatic Hydrocarbons

Environmental samples were collected and analyzed for the U.S. Environmental Protection Agency (USEPA) 16 priority pollutant polycyclic aromatic hydrocarbons (PAHs; PAH16). Selected sediment samples were analyzed for an expanded list that included alkylated PAHs (PAH34). Total PAH (TPAH) concentrations were calculated from the results of these analyses (TPAH16 and TPAH34). A TPAH16 concentration was also calculated for samples that were analyzed for PAH34 (PAH16 being a subset of PAH34). Minimum, maximum, and average values were calculated for each environmental matrix on a site-wide basis at particular depth intervals to identify possible trends in the dataset. The minimum, maximum, and average concentrations of PAH16 and PAH34 are summarized in Table 3.

4.1.1.1 Total PAH16

Twenty-two sediment samples were collected from 0.0 to 0.5 foot bml, and 15 sediment samples were collected at varied vertical intervals between 1.0 and 5.5 feet bml. The samples were collected at various depths and locations to evaluate the vertical and lateral extent of OHM at the Site. The PAH16 results from sediment samples are summarized in Table 4. Figure 3 shows shallow sediment PAH16 concentrations across the sampled area, and Figure 4 shows PAH16 results in subsurface sediment.

TPAH16 concentrations in 22 samples collected from the top 6 inches of sediment ranged from 17.6 to 2,240 milligrams per kilogram (mg/kg), with an average TPAH16 concentration of 318.6 mg/kg. The maximum concentration of 2,240 mg/kg was detected in a sample collected from location AQSS-13B-0.0-0.5, near the head of the Little River Conduit.

Samples were collected from 15 select locations at depths greater than 1 foot. TPAH16 concentrations ranged from 0.6 to 14,900 mg/kg, with an average of 2,608.2 mg/kg. The samples with the highest detected TPAH16 concentration were from intervals with VOT.

4.1.1.2 Alkylated Polycyclic Aromatic Hydrocarbons

Sixteen sediment samples collected from 0.0 to 0.5 foot bml, and five sediment samples were collected at varied vertical intervals between 1.0 and 5.5 feet. The samples were collected at various depths and locations to evaluate the vertical and lateral extent of OHM in the Little River portion of the Site. Table 4 summarizes the alkylated PAH results in the samples.

TPAH34 concentrations in the 16 samples ranged from 40 to 6,072 mg/kg and averaged 676.2 mg/kg. The maximum concentration of 6,072 mg/kg was detected in a sample from location AQSS-13B-0.0-0.5, near the head of the Little River Conduit.

Samples were collected at depths greater than 0.5 foot at five select locations. TPAH34 concentrations ranged from 2.8 to 29,892 mg/kg, with an average of 13,731.6 mg/kg. The samples with the highest detected TPAH16 concentration were from intervals with VOT.

4.1.2 Extractable Petroleum Hydrocarbons and Volatile Petroleum Hydrocarbons

4.1.2.1 Sediment Samples

Sixteen sediment samples were analyzed for extractable petroleum hydrocarbons (EPH) and volatile petroleum hydrocarbons (VPH) during the 2020 sampling event, and one was analyzed for EPH and VPH during the 2021 sampling. Eleven of the 2020 samples were collected from 0.0 to 0.5 foot bml; four samples were collected from intervals deeper than 0.5 foot. The sample from 2021 was collected from 0.0 to 0.5 foot bml. The minimum, maximum, and average concentrations of EPH and VPH are summarized in Table 3.

Seven samples collected in 2020 were analyzed for EPH and PAHs, from which a TPAH16 concentration was calculated. Because EPH requires a different extraction and analysis method, it is reported separately from the samples analyzed for PAHs by USEPA Method 8270 (Section 4.1.1.1). TPAH16 EPH concentrations from 0.0 to 0.5 foot bml ranged from 463.0 to 3,689.70 mg/kg, with an average of 1,863.2 mg/kg. Concentrations in samples collected deeper than 0.5 foot bml ranged from 1,365.2 to 2,970.7 mg/kg and averaged 2,109.2 mg/kg. The highest concentration was detected

at location 2A at a depth of 0.0 to 0.5 foot bml. The higher TPAH16 EPH concentrations correlated to intervals with VOT.

4.1.2.2 Surface Water Samples

The upstream and downstream surface water samples collected in 2020 were analyzed for EPH and VPH. Concentrations were below detection limits.

4.1.3 Metals

Fourteen sediment samples collected from 0.0 to 0.5 feet in 2021 were analyzed for RCRA 8 metals. One sample, taken from more than 0.5 foot bml, was analyzed for copper. Metals were detected at the following concentrations:

- Arsenic – 6.2 to 74.6 mg/kg
- Barium – 11.6 to 41.5 mg/kg
- Cadmium – 0.21 to 1.28 mg/kg
- Chromium – 14.4 to 414 mg/kg
- Copper – 138 mg/kg
- Lead – 37 to 397 mg/kg
- Mercury – Nondetect to 0.15 mg/kg
- Selenium – Nondetect to 4.5 mg/kg
- Silver – Nondetect to 0.67 mg/kg

Table 3 summarizes the minimum, maximum, and average concentrations of individual metals. Table 4 summarizes the results for the RCRA 8 metals detected in sediment samples.

4.1.4 Polychlorinated Biphenyls

Fourteen sediment samples were collected from 0.0 to 0.5 feet bml during the 2021 field event. At least one Aroclor was detected in all 13 samples. Aroclors 1242, 1254, and 1260 were detected in 13 samples. Only Aroclors 1254 and 1260 were detected at location AQSS-20. Table 4 summarizes the total PCB Aroclor results in sediment samples.

Total PCB Aroclor (TPCBA) concentrations in the 13 samples ranged from 77.0 to 1,400.0 micrograms per kilogram (µg/kg), with an average concentration of 495.2 µg/kg. The maximum concentration of 1,400.0 µg/kg was detected in a sample from location AQSS-05-0.0-0.5B, adjacent to the Winter Street bridge.

The minimum, maximum, and average concentrations of PCBs are summarized in Table 3.

4.1.5 Cyanide

4.1.5.1 Sediment Samples

Eight sediment samples collected from 0.0 to 0.5 foot bml during the 2020 field event were analyzed for cyanide. Cyanide concentrations are below detection limits in all eight samples, ranging from 1.0 to 1.2 µg/kg and averaging 0.56 µg/kg. The results are summarized in GZA's Phase II CSA report (Table 7A). Table 3 summarizes the minimum, maximum, and average concentrations of cyanide.

4.1.5.2 Surface Water Samples

The upstream and downstream surface water samples collected in 2020 were analyzed for cyanide. Concentrations in both samples were below detection limits.

4.1.6 Waste Characterization Analyses

One composite sediment sample underwent a suite of waste characterization analyses, and the results were consistent with those of the discrete samples previously discussed (Table 5). Among the results of composite sediment sample analysis were the following:

- The TPAH16 concentration of 4,224.3 mg/kg was within the range of concentrations detected in samples collected from the sediment interval deeper than 1.0 foot bml (Section 4.1.1.1).
- The concentrations of ethylbenzene and xylenes were within the range of concentrations detected in samples collected from the sediment interval deeper than 1.0 foot bml (Section 4.1.2). Benzene and toluene were detected in the composite sample at concentrations of 1.8 and 2.0 mg/kg, respectively, but the benzene and toluene results from the discrete samples collected from sediment deeper than 1.0 foot bml were nondetect.
- Although discrete samples for RCRA 8 metals analysis were not collected from the sediment interval deeper than 1.0 foot bml (Section 4.1.3), the concentrations of RCRA 8 metals detected in the composite sample were consistent with those of the discrete samples collected from 0.0 to 0.5 foot bml with two exceptions: concentrations of lead and mercury (9,430 and 0.175 mg/kg, respectively) were higher than the maximum concentrations detected in the discrete sediment samples.
  - The detected lead concentration may represent an anomaly because it was significantly higher than those detected in the discrete samples (Section 4.1.3) or upstream samples (Section 5.2.3).
- The concentration of PCBs in the composite sample was nondetect.
- The concentration of cyanide in the composite sample was nondetect.
- The concentrations of pesticides and herbicides in the composite sample were nondetect.
- The composite sample was identified as not ignitable, nonreactive (i.e., concentrations of reactive cyanide and sulfide were nondetect), and noncorrosive (pH of 6.6), and they passed the paint filter test (i.e., no free liquid).

4.1.7 Total Organic Carbon

Total organic carbon (TOC) in 24 sediment samples collected from the 0.0 to 0.5-foot depth interval ranged from 0.19% to 15.80% and averaged 2.44%. The average TOC reported for 18 detect and 1 nondetect samples collected from more than 1.0 foot bml was 4.74%; concentrations ranged between 0.01% and 15.6%. Although the minimum and maximum concentrations were similar, the average TOC concentration in samples collected deeper than 1.0 foot bml was slightly higher.

Organic carbon was also analyzed as soot organic carbon (SOC) in 21 samples from the top 0.5 foot of sediment. The minimum concentration was 0.01%, and the maximum was 1.08%. The average concentration was 0.19%.

The minimum, maximum, and average percentages of TOC and SOC are summarized in Table 3. The TOC and SOC results in sediment samples are summarized in Table 4.

4.1.8 Grain Size and Stratigraphy

4.1.8.1 Grain Size

Grain size was analyzed for three sediment samples taken from a depth interval of 0.0 to 0.5 foot during the 2021 field event. The sediment samples were from 57.4% to 89.9% sand. The sample with the lowest percentage of sand had the highest percentage of gravel, 38.6%.

One sediment sample was collected from 0.5 to 1.0 foot bml. This sample was more similar in composition to the samples taken from 0.0 to 0.5 foot bml than to the samples collected from 2.6 to 4.0 feet bml. The two samples taken from more than 2.5 foot bml had a higher silt/clay component, an average of 31.3%, compared to the 6.3% in shallower samples.

The results of the grain size analysis are presented in Table 6.

4.1.8.2 Stratigraphy

Based on visual characterization and grain size analysis of the cores, the surficial sediment in the vicinity of the Site is brown to black sand to gravelly sand with little silt/clay and trace organics and anthropogenic debris. Anthropogenic debris includes glass, plastic, brick, slag, clinkers, and fibrous layers. A sharp contact was observed between the surficial sediment and a deeper gray, brown, black tight fine sand unit at sediment core locations AQSS-07D, AQSS-11D, AQSS-18, AQSS-19, and AQSS-20. This contact was seen between 2.7 and 4.9 feet bml. Sheen and NAPL were not observed in the lower unit.

4.1.9 Nonaqueous Phase Liquid Mobility Testing

During the 2021 field investigation, two additional, intact cores were collected from visually heavily impacted locations, AQSS-12 and AQSS-13, to evaluate whether NAPL observed in cores may be

mobile by advection. The intact cores were submitted to IGL. While the cores were being processed for shipment to the laboratory, it was observed that the bottom of AQSS-13 (4.3 feet) appeared visually unimpacted and the bottom of core AQSS-12 (4.6 feet) appeared visually impacted. Based on the white light photographs from IGL, a stratigraphic change from black sediment to gray sediment appeared to occur in core AQSS-13 between 3.5 and 3.6 feet bml. It is assumed that the gray sediment was the tight fine sand material observed in the field; unlike the cores processed in the field, NAPL appeared to be present in the lower stratigraphic interval of the additional core collected at location AQSS-13. A stratigraphic change was not apparent in the additional core collected at location AQSS-12 based on the white light photographs.

The sediment cores were photographed by IGL under white and UV light to identify intervals with potential NAPL impacts (Appendix E). The UV light causes the NAPL, if present, to fluoresce, and it appears as yellow, orange, and red in the photographs. The photographs provide an indication of the presence or absence of NAPL and may provide information regarding the relative amount of NAPL, but samples must be analyzed for percent NAPL saturation to provide a quantitative value.

Five samples were collected from each core for percent NAPL saturation and NAPL mobility testing. The results of that testing are provided in Appendix E. The initial percent NAPL saturation ranged from 2.9% to 18.0% in core AQSS-12 and from 6.9% to 28.3% in core AQSS-13. The percent NAPL saturation was measured in each sample after it was centrifuged for 10 hours at 25 times the force of gravity. The percent NAPL saturation after centrifuging was consistent with the initial percent NAPL saturation values, and no NAPL was produced from the samples during centrifuging. The lack of change in percent NAPL saturation and the lack of NAPL produced by centrifuging the samples indicates the NAPL in the samples was not mobile. This is consistent with the visual field observations of the NAPL having a tar-like consistency as opposed to a more liquid consistency.

5 Nature and Extent

This section of the Phase II CSA provides the information required in Section 40.0835(4)(f) of the MCP, including characterization of source(s), nature, and vertical and horizontal extent of OHM at the disposal Site, presence and distribution of any NAPL, tabulation of analytical testing results, and characterization of local conditions for OHM material in the Site vicinity.

OHM that originated at the former MGP Site may have been discharged directly into the Little River when the MGP was in operation or may have been released to upland soil and groundwater and subsequently migrated through the subsurface into the river. During investigations conducted through 2021, samples of soil, sediment, groundwater, and surface water were collected from the upland and in-river portions of the Site to assess the potential for OHM from the former MGP to have migrated, or to migrate in the future, to other areas of the Little River. Local conditions were also evaluated to assess other potential OHM sources.

The potential for OHM to migrate from the MGP to the Little River was assessed by comparing visual observations of impacted sediment and the results of laboratory analyses of sediment and surface water from the in-water portion of the Site to visual observations from borings and the results of laboratory analyses of soil and groundwater samples from the Site's upland portion. Additional factors related to OHM migration, including general groundwater and surface water hydraulics, sediment transport, and local conditions, were considered in this assessment.

The OHM releases considered in this CSA report include visible NAPL, OHM dissolved in groundwater, and OHM associated with shallow sediment and surface water. Site investigations discussed previously collected samples of sediment, soil, groundwater, and surface water. The analysis of the nature and extent of OHM considered OHM sources, migration pathways, field observations, and laboratory chemical analyses of OHM in samples of environmental media.

5.1 Other Potential Oil or Hazardous Materials Sources

5.1.1.1 Historical Spills

Sites with MassDEP Tier classifications and sites designated with activity and use limitation (AUL) within 1-mile of the Site were reviewed. The sites are summarized in Table 7, and their locations are shown in Figure 5. The closest upstream site (RTN 3-0018974) is a former gas station at 93 Lafayette Square currently used for commercial purposes. Based on a review of the available site documents, that site likely has not affected the MGP Site due to impacts apparently being limited to within the property boundary. During the Phase I environmental assessment of that site, elevated concentrations of VPH were identified in soil and groundwater. Following the completion of a Method 3 Risk Assessment, an AUL was placed on the property to eliminate potential exposure and restrict the site to commercial and industrial uses.

A search of the National Response Center (NRC) database was also conducted. The NRC receives reports of oil, chemical, radiological, and biological discharges to the environment and their etiology. From 1991 through February 2022, approximately seven discharges in the vicinity of the Little River were reported (Table 8). Two sheen observations on the Little River (#874126 in 2008 and #950294 in 2010) were upstream of the Little River dam and thus not related to the former MGP Site, but they did have the potential to affect surface water or sediment near the Site. Two sheen observations (#439735 in 1998 and #571940 in 2001) and one gas leak (#239135 in 1994) appeared to have been near the Site. The two remaining reported releases likely did not have the potential to affect surface water or sediment in the vicinity of the Site due to the description of the incidents and distance from the Site (#75829 – burying construction garbage; #1324491 – heating oil spill and fire).

The Environmental Data Resources, Inc. (EDR) report from the Phase I Initial Site Investigation (ISI) identified properties or facilities located in the vicinity of the property with reported environmental actions or operations that have potential to affect environmental conditions at the property (Ramboll 2016). Identified upstream properties in the vicinity of the Little River include 93 Lafayette Square and the Dyetex facility at Stevens Mill (14 Steven Street). A #6 fuel oil release caused by a damaged pipe occurred at the Dyetex facility in July 2001, generating a sheen on the Little River and the Merrimack River. It was estimated that approximately 1,000 gallons was involved in the release, with the majority contained in a trench system and pump pit. The sheen in the Little River and Merrimack River was addressed with absorbent booms. The damaged pipe was replaced and the trench system, pump pit and three sewer manholes were cleaned of oil and oil residue. This release had the potential to impact the sediment in the Little River adjacent to the former MGP.

In addition, the Phase I ISI report by Ramboll US Corporation (formerly Ramboll Environ) included a copy of a letter dated April 20, 1988, from the Deputy Fire Chief regarding a "spill" that had been reported by the U.S. Army Corps of Engineers on April 19, 1988. The Deputy Fire Chief surmised the "stain" could have been caused by "coal oil or tar from the old Gas Company operations when they manufactured gas." An RTN was not opened for the site at the time, and no additional information is available.

5.1.1.2 Combined Sewer Outfalls

The portion of the Little River adjacent to the former MGP is in an urban area with various potential OHM sources. According to the City of Haverhill, two sets of regulators share an outfall upstream of the Site (CDM Smith 2017). They are Winter Street (#021G)/Winter & Hale (#021H) and Broadway (#037)/High Street (#038). The combined sewer outfalls (CSOs) are managed under National Pollutant Discharge Elimination System permit MA0101621, and discharge is authorized under wet weather conditions. In 2020, the Winter Street regulator activated seven times and discharged 65,905 gallons; the Winter & Hale regulator activated 15 times and discharged 1,261,453 gallons

(City of Haverhill 2021). The High Street regulator activated once in 2020, discharging 4,101 gallons; the Broadway regulator did not activate in 2020.

Information developed during extensive research on stormwater chemistry and reported in scientific and engineering literature indicates PAHs and cyanide compounds are typically measured in stormwater runoff, particularly in urban areas like that surrounding the Little River. Researchers believe that PAHs enter stormwater in primarily two ways: via vehicle emissions that accumulate on roadways and via releases of petroleum to roadways (Menzie Cura 1995; Galvin and Moore 1982; Van Metre et al. 2000; Pitt and Barran 1989; Stenstrom et al. 1998; USEPA 1983; Masterson and Bannerman 1994; Burton and Pitt 2001). Cyanide enters stormwater because it is typically used as a de-caking agent in road salt (Paschka et al. 1999). As ice and snow on the road melts, the dissolved and particulate-sorbed cyanide compounds are carried to storm drains in runoff.

Storm drains discharge to the Little River, and some fraction of the dissolved and particulate-sorbed OHM in the stormwater may be deposited in the sediment. In addition, the Winter Street bridge immediately upstream of the Site is a potential source of OHM that may be generated by vehicular traffic and washed into the river during rain events. Based on this information, storm drain discharges and rainfall coming off the Winter Street bridge are likely OHM sources for the in-river portion of the Site.

5.2 Local Conditions

The MCP requires differentiation between OHM that originated at the disposal Site and OHM that originated from other locations. OHM that originates at other locations may be attributed to one of two categories, according to the MCP: 1) Local Conditions; and 2) Background OHM concentrations. In Anchor QEA's experience, attributing OHM to specific sources often is not practical, particularly in waterways with an industrial or urban history and numerous OHM sources.

Local Conditions, as defined by MassDEP's Guidance for Disposal Site Risk Characterization Section 9.4, "are concentrations of OHM that are higher than background levels, but nevertheless ubiquitous throughout the vicinity of the Site and are attributable to sources other than the site in question." Local Conditions around the former Haverhill MGP Site are associated with levels of OHM present in Little River sediment and surface waters that are attributable to other industrial sources, permitted discharges, and nonpoint sources. Evaluating Local Conditions sediment OHM concentrations requires detailed knowledge of the OHM source locations, the variability in OHM releases over time, and the migration and deposition of the OHM released from those sources based on hydraulic flows and sedimentation rates.

Background is defined in Section 310 CMR 40.0006 of the MCP as those levels of OHM that would exist in the absence of the disposal Site of concern and that are:

- Ubiquitous and consistently present in the environment at and in the vicinity of the disposal site of concern; and attributable to the geologic or ecological conditions, or atmospheric deposition of industrial process or engine emissions
- Attributable to coal ash or wood ash associated with fill material
- Releases to groundwater from a public water supply system
- Petroleum residues that are incidental to the normal operation of motor vehicles

Due to a combination of factors that includes structural constraints on the portion of the Little River adjacent to the former MGP, the presence of RAH in a significant portion of the Little River, and the limited distance between the northern extent of the Site and the Little River dam, Local Conditions do not significantly influence Site delineation.

As discussed in Section 4.1, attempts were not successful at collecting sediment between the Winter Street bridge and the Little River dam to potentially represent Local Conditions. This location was originally selected to represent an upstream location that appeared to have similar environmental conditions compared to the Site environmental conditions. Therefore, it is not possible to characterize OHM and Local Conditions in the area upstream of the Site and downstream of the dam. Local Conditions cannot be used to delineate potential impacts associated with the Site between the MGP and the dam.

Samples collected by Fuss & O'Neill in 2020 and 2021 upstream of the Little River dam are being used to represent Local Conditions (Fuss & O'Neill 2021a; Table 9 and Fuss & O'Neill 2021b; Table 4). Because these samples were collected from a depositional area upstream of the dam, they are assumed to have not been affected by the former MGP Site. These samples included a composite sediment sample that was created by compositing material from three cores taken on a transect parallel to the dam (Transect #1) and 10 discrete sediment samples (SED-1 to SED-10). The samples ranged in depth from 0.9 to 2.0 feet; therefore, concentrations may be biased low if cleaner material is present at depth. There were no visual impacts observed in the cores. Although additional sediment samples were collected farther upstream, the samples collected closest to the dam were selected to represent Local Conditions. In this screening, Local Conditions are represented by the arithmetic mean of the results from the 10 discrete and 1 composite sediment sample collected upstream of the Site in 2020 and 2021 by Fuss & O'Neill (Table 3).

5.2.1 Polycyclic Aromatic Hydrocarbons

As discussed in Section 4.2.1, the average concentration of TPAH16 within the upper 6 inches of sediment in the Little River portion of the Site is 306 mg/kg, and the concentrations ranged from 17.6 to 2,240 mg/kg. The average concentration for Local Conditions samples is 29.9 mg/kg, and the

concentrations ranged from 12.4 to 99.0 mg/kg. Therefore, the TPAH16 concentrations from 0.0 to 0.5 feet bml at locations AQSS-03, AQSS-04, and AQSS-05 (the closest samples from downstream of the Little River dam) are greater than the average Local Conditions concentration (125, 149, and 31.9 mg/kg, respectively). This could be due to the influence of the former MGP or to the proximity of the Winter Street bridge and potential contributions from vehicular traffic.

5.2.2 Extractable Petroleum Hydrocarbons and Volatile Petroleum Hydrocarbons

Only the composite sample representative of Local Conditions was analyzed for EPH. The concentration of TPAH16 calculated from the EPH results of Local Conditions sample was less than the average concentration detected in sediment samples adjacent to the former MGP. Sediment in the presumed Local Conditions samples was not analyzed for VPH.

5.2.3 Metals

As indicated previously, the sediment metal concentration data were analyzed to evaluate regional sediment OHM concentrations. In general, the metal concentrations in the surface sediments within the Site boundary are comparable to the metal concentrations in the sediment in the presumed Local Conditions samples (Table 3). The similarity between the metal concentrations indicates that the Site is not a significant source of metals to the area sediments, though there is some uncertainty given that the Local Conditions data represent deeper sediment than data collected for the Site.

5.2.4 Polychlorinated Biphenyls

Only two PCB Aroclors (Aroclor 1254 and 1260) were detected in the samples representing Local Conditions collected upstream of the dam. Therefore, a different source contributed to the PCBs detected in the vicinity of the Site because additional Aroclors were detected (specifically Aroclor 1242).

5.2.5 Local Conditions Summary

Based on the Local Conditions evaluation, concentrations of all constituents evaluated were conservatively carried forward through the Stage I ERC (Section 7).

5.3 Site Boundary

The Site boundary is defined by site features, visual observations, and site conditions (see Figure 2 in GZA's Phase II CSA report). The former MGP was limited to the footprint of 284 Winter Street; therefore, it is likely that Site impacts are limited to the adjacent area and possibly to downstream areas because the Little River experiences limited tidal impacts upstream of the conduit. This is supported by the lack of visually impacted sediment in the upstream cores (AQSS-03, AQSS-04, and

AQSS-05) and the lower TPAH16 concentrations in surface and subsurface sediment. The western bank of the Little River is assumed to be the western limit of the Site boundary. This is supported by the lack of visually impacted soil in the borings advanced by GZA on the properties to the west of the Little River and the potential method of NAPL release into the river (spills or direct discharges). The downstream Site boundary is conservatively assumed to extend to the headwall of the conduit. Due to site conditions, sediment cores could not be advanced between AQSS-20 and the headwall (approximately 50 feet). This boundary encompasses all samples affected by VOT.

5.4 Site Conditions

OHM sources for the in-river portion of the Site include releases from the upland portion of the Site. In general, upland OHM sources include subsurface NAPL and OHM and possible historical aboveground releases. In addition to NAPL and OHM, some fraction of the OHM in the upland subsurface dissolves in groundwater and may migrate into the surface water in the Little River.

During investigations conducted through 2021, samples of sediment and surface water were collected from the Little River to assess the potential for OHM from the former MGP Site to have migrated, or to migrate in the future, to other areas of the Little River.

5.4.1 Visible Oil and/or Tar in Sediment

VOT was observed in 25 of the 36 vibracore and hand auger samples collected from the in-river portion of the Site. Depth to, and descriptions of, sheens, staining, and VOT observed in each core are provided in Table 10, and the lateral and vertical extent of VOT is shown in Figure 6. The VOT observed in sediment ranged from trace droplets to saturated sediment. Sediment saturated with VOT was present in most cores as a very dark brown to black tar-like material with no apparent free flowing NAPL based on field observations. A strong coal-tar-like odor was generally associated with intervals containing VOT. Sheens and stained sediment were also observed in sediment.

Sheens were present as silver-blue to multicolored iridescent coatings on sediment solids, porewater, and standing water in core barrels shortly after core collection. Stained sediment appeared as discolored black sediment with no apparent immiscible liquid or NAPL.

VOT was observed in sediment from AQSS-06 and downstream to AQSS-20. No VOT was observed at the farthest upstream sediment core locations: AQSS-03, AQSS-03B, AQSS-04, and AQSS-05 (Figure 8). VOT was also not observed at hand auger locations 2C, 3C, 4B, 5B, and 5C. It is assumed, based on comparisons to adjacent sediment cores, VOT would have been observed at deeper depths at locations 2C, 3C, and 4B but the hand auger hole was too shallow. It is unknown whether VOT is present at locations 5B and 5C. Figures 8 and 9 respectively show VOT along cross sections parallel and perpendicular to the Little River.

VOT was observed from the sediment water interface (2A, 3A, 3B, 4A, 5A, AQSS-10, and AQSS-19) to a maximum observed depth of 5.5 feet at location 1A (depth to visually unimpacted material at location 1A not identified). Most of the VOT was observed in the upper black and brown sand to gravelly sand sediment. VOT was observed in deeper fine sand material only at location AQSS-12B and in white light and UV photographs of the additional core collected at location AQSS-13. There does not appear to be a strong relationship between depth of VOT and location upstream or downstream. There also does not appear to be a significant difference in the depth of VOT on the eastern or western portion of the river.

The depth to the base of the VOT-impacted interval was not determined in several cores because "clean" sediment was not observed at the cores' bottom. The bottom of the interval affected by VOT was not identified in 21 of the 36 cores. Four of the 21 were 0.5-foot hand auger cores.

Because the VOT was observed at various depths in the sediment cores and observations were not limited to a specific stratigraphic unit or along a stratigraphic interface, the VOT does not appear to have migrated at depth along pathways from the upland portion of the Site into Little River sediment. No cores appeared to contain evidence of upward migration of VOT. The variable deposition of VOT in the sediment, the lack of an apparent migration pathway, the presence of NAPL in pipes in the retaining wall, and the observations of hardened tar on the retaining wall blocks indicate that the deposition of VOT may have been caused by one or more releases into the Little River from the former MGP.

5.4.2 Site Observation of Sheen on Surface Water

As summarized in GZA's Phase II CSA report (GZA 2022), a sheen was observed by Ramboll emanating from the base of the retaining wall in the Little River on May 12, 2015. An Immediate Response Action was approved by MassDEP that included sheen containment via absorbent boom. In November 2016 the temporary absorbent booms were replaced with a semipermanent containment boom system composed of a curtain/flotation boom and absorbent booms attached to a support structure. Sheens continue to be observed on surface water. Absorbent booms are replaced as needed.

The presence of sheen on surface water in the Little River may be due to ebullition-facilitated transport of NAPL in sediment, discharge of NAPL through the blocks in the retaining wall, or a combination of both processes. Gas ebullition is defined as the release of gas bubbles from sediments into the overlying water column. Biogenic gases such as methane and carbon dioxide are generated in organic-rich sediments from the microbial breakdown of sedimentary organic matter. When the gas bubbles contact NAPL in the sediment, the NAPL may be transported with the gas to the water column and the water surface, producing a sheen.

5.4.3 Analytical Results

Laboratory chemical analysis results for samples of sediment and surface water are used in combination with field investigation observations to assess the nature and extent of OHM. Samples used in the nature and extent assessment include samples collected from 2020 and 2021.

5.4.3.1 Polycyclic Aromatic Hydrocarbons

As discussed in Section 4.1.1, TPAH16 was identified in sediment near the Site in concentrations ranging from 17.6 to 2,240 mg/kg (average of 318.6 mg/kg) at 0.0 to 0.5 foot bml and from 0.6 to 14,900 mg/kg (average of 2,608 mg/kg) deeper than 0.5 foot bml. The greatest concentrations of TPAH16 were generally in samples collected deeper than 0.5 foot bml and from intervals that contained VOT. Samples taken from four sediment core locations below visually impacted sediment (AQSS-07D, AQSS-18, AQSS-19, and AQSS-20) had TPAH16 concentrations ranging from 0.58 to 1.49 mg/kg.

In general, TPAH16 concentrations increase with depth, with maximum concentrations identified in intervals containing VOT. Below visually impacted sediment, TPAH16 concentrations appear to significantly decrease.

Three areas were identified in the vicinity of the Site based on VOT and TPAH16 distribution:

- The area containing VOT within the upper 12 inches of sediment, which represents RAH as defined by Section 40.0995 (3)(b)1(c) of the MCP (see Section 4.2)
- The area bounded by the in-river Site boundary but not within the RAH area
- The area outside the in-river Site boundary, which represents Local Conditions.

5.4.3.2 Metals

There does not appear to be a clear pattern to the concentration of metals in the Little River, which is not uncommon for an urban waterway.

5.4.3.3 Polychlorinated Biphenyls

As discussed in Section 4.1.4, total PCBs in concentrations ranging from 77 to 1,400 µg/kg (average of 495.2 µg/kg) were identified in the first 6 inches of sediment in the vicinity of the Site. Concentrations above 1,000 µg/kg (i.e., 1.0 mg/kg) were identified in only 2 of 14 sample locations, AQSS-5 and AQSS-11B. As with metals, there does not appear to be a clear pattern to the concentration of PCBs in the Little River.

6 Environmental Fate and Transport of Oil or Hazardous Materials

6.1 In-River Environmental Fate and Transport of Oil or Hazardous Materials

Environmental fate and transport characteristics were assessed for Site-related OHM. The existing and potential OHM migration pathways that were identified and characterized are air, sediment, groundwater, soil, surface water, the food web, subsurface utilities (including storm drains), and surface water runoff from rain and melting snow.

6.1.1 Identification of Site-Related Oil or Hazardous Materials in the In-River Environment

To characterize the former MGP's potential impacts on the water and sediment of the Little River, contaminants of potential ecological concern (COPECs) were identified by comparing detected concentrations against published screening values (Section 7). PAHs, select metals, VOCs, and petroleum hydrocarbon fractions quantified in the EPH/VPH analysis were designated COPECs.

6.1.2 Characteristics of Marine Site Contaminants of Potential Ecological Concern

The characteristics of the Site-related OHM discussed in this section of the report include type of compound, chemical composition, physical and chemical properties, toxicological characteristics, and environmental fate and transport characteristics. Environmental fate and transport characteristics include mobility, stability, volatility, and bioaccumulation potential.

The primary chemical and physical properties that affect the contaminants' fate and transport in Site media are molecular weight, vapor pressure, water solubility, Henry's Law constant, specific gravity, water-carbon partition coefficient, and octanol-water partition coefficient. Sources of chemical, physical, and fate and transport characteristics were obtained from the literature, including the Agency for Toxic Substances and Disease Registry website (www.atsdr.org). Table 11 summarizes the chemical and physical properties of the COPECs discussed in the following sections.

COPECs are typically found in environmental media in groups (e.g., PAHs, EPH, and VPH compounds) based on common sources and environmental fate and transport characteristics. Accordingly, the OHM are grouped together for the discussion of environmental fate and transport characteristics that follows.

6.1.2.1 Semivolatile Organic Compounds (Including Polycyclic Aromatic Hydrocarbons)

In general, SVOCs have high molecular weights, low water solubilities, low vapor pressures, low Henry's Law constants, high carbon-water partition coefficients, and moderate to high octanol-water partition coefficients. These chemicals tend to sorb to soil or sediment rather than dissolve into groundwater, porewater, or surface water, and they tend not to volatilize into soil gas or the atmosphere. The tendency to sorb to sediment increases with the number of aromatic rings in the compound. This tendency is evident at the Site where SVOCs detected in porewater are typically the lower molecular weight compounds such as naphthalene, and the higher molecular weight compounds such as pyrene are dominant in weathered soil and sediment.

PAHs are a subgroup of SVOCs that are of concern at the Site because they can make up to 80% of coal tar, the most voluminous byproduct of MGP processes. PAHs are compounds with two or more fused benzene rings. Some PAHs can be carcinogenic as well as toxic. PAH sources can be generalized as either petrogenic or pyrogenic. Petrogenic sources include petroleum product manufacturing, storage, and use. Among the pyrogenic sources are combustion byproducts, including those from MGP operations.

Coal tar is composed primarily of PAHs, with lesser amounts of other organic compounds and metals. Coal tar has a wide range of physical properties, although it has generally high viscosity and interfacial tension. Coal tar is relatively insoluble in water, is not very volatile, tends to sorb to organic carbon and solids, and does not biodegrade rapidly. These properties indicate coal tar is not very mobile in the environment and tends generally to resist degradation mechanisms.

Although PAHs are discussed as a group and their concentrations are often expressed as TPAHs (defined in this report as the sum of TPAH16 and TPAH34), individual PAH compounds exhibit a wide range of physical and chemical properties that influence their distribution, mobility, and availability in environmental media. Lower molecular weight PAHs (i.e., the 2- to 4-carbon ring PAHs) tend to degrade biologically (in most media) or photochemically (in surface water) and are more available to partition to porewater. These properties generally decrease with increasing molecular weight.

Sediment characteristics also influence the distribution of PAHs, which preferentially sorb to the low-density fraction and partition to the more recently deposited detrital material in sediment. Sediment characteristics and PAH properties can predict the ability of PAHs to desorb from sediment and the potential availability of PAHs to benthic organisms.

6.1.2.2 Extractable Petroleum Hydrocarbons and Volatile Petroleum Hydrocarbons

EPH and VPH fractions include groups of petroleum hydrocarbons, classified by MassDEP to include compounds with 5 to 36 carbon atoms. EPH compounds generally have heavier petroleum hydrocarbons (9 to 36 carbon atoms). In general, EPH compounds have a low solubility in water and

a lower specific gravity than water. TPAH16 and 2-methylnaphthalene are EPH compounds. Petroleum products characterized by EPH include No. 6 fuel oil (similar to "Bunker C" oil), coal tar (a byproduct of MGP operations), and gasoline and motor oil discharges (potentially associated with storm drain outfalls that discharge to the Little River).

EPH compounds are divided into two aliphatic fractions, C9-C18 and C19-C36, and one aromatic fraction, C11-C22. The C9-C18 EPH aliphatic fraction, which tends to occur in diesel fuel, has low to moderate viscosity and moderate interfacial tension, is relatively insoluble in water, is slightly volatile, will sorb to sediment organic carbon and solids, and is moderately to highly biodegradable. In contrast, the C19-C36 aliphatic fraction, and the C11-C22 aromatic fraction has greater viscosity and is insoluble and less biodegradable.

VPH compounds consist of lighter molecular weight petroleum hydrocarbons often associated with gasoline, but there are other sources of VPH, including petroleum product manufacturing, storage, and use. Many aromatic VPH compounds are used as solvents. Coal tar also contains aromatic VPH compounds.

VPH compounds are divided into an aliphatic fraction (C5-C8) and an aromatic fraction (C9-C10). The VPH target analytes are the BTEX compounds benzene, toluene, ethylbenzene, and xylenes and naphthalene, which was discussed in the section on PAHs.

When VPH is analyzed without EPH, a third VPH fraction (C9-C12 aliphatics) is included in the analysis. However, the C9-C12 aliphatics VPH fraction is a portion of the C9-C18 aliphatics EPH fraction, and when both EPH and VPH analyses are performed only the C9-C18 aliphatics fraction in EPH should be considered.

VPH compounds have low to moderate molecular weights, high water solubilities, high vapor pressures, moderate to high Henry's Law constants, low water-carbon partition coefficients, and low to moderate octanol-water partition coefficients. These attributes indicate VPH compounds are mobile in the environment; they will dissolve in water and tend to migrate from water to air via vaporization. VPH compounds typically are not present in shallow sediment or surface soil, and most VPH compounds do not build up to high levels in plants or animals.

BTEX compounds are less dense than water and have low to moderate solubility in water. They tend to volatilize readily into the atmosphere. The BTEX compounds are aromatic VOCs and tend to adsorb to organic soil, which slows the rate at which they migrate in sediment and porewater.

6.1.2.3 Metals

Metals are naturally occurring elements. Sources of metals in the environment include the erosion of geologic materials and the use and storage of refined metals for paints, poisons, gasoline

manufacturing and use, and other manufacturing processes. Because metals are conservative elements, they are also combustion byproducts.

Metals tend to be immobile in the environment because they have low solubilities and low soil/water partition coefficients, indicating that they prefer to stay in solid forms or sorbed to sediment. Metals are not degradable in the environment, although they may undergo changes in valence that can change their mobility and bioavailability. The physical and chemical conditions at the Site influence how metals will migrate in the environment. The behavior of metals is influenced by environmental factors such as pH, Eh, temperature, hydrostatic pressure, salinity, and the presence of complexing agents. For example, the presence of sediment organic matter, as measured by TOC, represents a physical condition that may sorb heavy metals and prevent them from migrating. Metals with a greater affinity to bind with organic carbon or acid volatile sulfide in sediment tend to exhibit the least toxicity to benthic organisms. Metals that tend to partition to porewater exhibit a greater potential for sediment toxicity.

6.2 Existing and Potential Oil or Hazardous Materials Migration Pathways

6.2.1 In-Water Potential Oil or Hazardous Materials Migration Pathways

The existing or potential migration pathways for OHM detected in the media at the Site include sediment, porewater, and surface water. Based on the results of the NAPL mobility testing, the samples selected for analysis contained NAPL that was likely immobile.

Sediment porewater is considered a potential OHM migration pathway because sediment porewater, including OHM dissolved in the porewater, generally migrates via advection to overlying surface water. The rate at which porewater advects to surface water is dependent on groundwater/surface water interaction and the permeability of the sediment to porewater flow. OHM dissolved in sediment porewater will typically dilute significantly upon entry into surface water.

OHM including TPAH16 and TPAH34 were detected and VOT was observed in sediment samples collected adjacent to the former MGP. Therefore, it is likely dissolved phase PAHs are present in porewater. If sediment porewater were a significant migration pathway, these compounds would be expected to migrate to and be detected in overlying surface water. However, concentration of EPH were nondetect in the surface water samples collected in 2020. In addition, other OHM including metals are generally of low solubility and are not expected to dissolve and partition from the sediment solid phase to the porewater phase. Therefore, sediment was not considered to be a significant potential porewater migration pathway.

Potential surface water migration pathways include three potential modes of OHM migration: 1) migration of OHM dissolved in surface water; 2) transport of OHM sorbed to sediment solids via

erosion, suspension, transport, and redeposition of sediment solids; and 3) transport of OHM via ebullition-facilitated transport.

Evaluating the dissolved OHM potential migration pathway included reviewing the results of laboratory chemical analyses of surface water. As discussed previously, concentrations of EPH, VPH, and cyanide were nondetect in the upstream and downstream surface water samples. Therefore, in surface water is not considered a significant potential migration pathway for dissolved OHM.

Evaluating sediment transport as a potential OHM migration pathway included evaluating the potential for sediment transport in the Little River, which is dependent on sediment stability. Sediment stability is a function of grain size and the hydrodynamic environment. In general, for sediment transport to occur via erosion/resuspension/transport, hydrodynamic flows need to be of sufficient magnitude to erode sediment from the bed, maintain the sediment particles in suspension, and transport the sediment to a redeposition location. Hydrodynamic flows of this magnitude are typically associated with higher velocity waterways. In these waterways, sediments are typically coarse grained (e.g., coarse sand, gravel, or cobbles). The sediment surface in the Little River is sand and gravelly sand with cobbles and boulders, which are indicative of an erosional environment. Therefore, sediment transport of particle-sorbed OHM is considered a potential migration pathway.

As discussed in Section 5.4.2, the observation of occasional sheen on the surface of the Little River indicated NAPL may be migrating through the retaining wall, via ebullition-facilitated transport up through sediment, or by a combination of the two and generating sheens on the water's surface. Therefore, ebullition-facilitated transport of OHM is considered to be a potential migration pathway.

7 Exposure Assessment and Risk Characterization

This section presents the results of the Method 3 ERC of the Little River sediments and surface water that will support the completion of the Phase II CSA report.

As required by 310 CMR 40.0942 of the MCP, a Method 3 ERC was completed to address potential exposures to release-related contaminants in sediments and surface water. Method 3 ERCs have two stages: Stage I and Stage II. The objective of Stage I is to determine whether a Stage II ERC is needed to further evaluate, on a quantitative basis, potential exposure pathways to determine if a condition of significant risk is present.

Results of a Stage I ERC can determine whether an exposure pathway can be eliminated from the Stage II assessment provided any of the following conditions are met:

- The harm is "readily apparent," because if harm is readily apparent, additional assessment would be redundant.
- An exposure pathway is incomplete.
- An exposure pathway is complete, but exposure is minimal and clearly supports a condition of "no significant risk of harm" for a site.

For this project, the Stage I ERC is adequate to characterize potential ecological risk due to an identified condition of RAH and therefore, supports the Phase II CSA.

Stage I screenings can be qualitative, through identification of complete exposure pathways, or quantitative, by involving an effects-based screening of complete exposure pathways. A Stage II ERC is a more refined characterization of risk, but it can also include an effects-based screening and is conducted only when none of the above conditions are met.

A Stage I ERC for the in-water portion of the Site was conducted in accordance with 310 CMR 40.0995 of the MCP and Section 9 of the Guidance for Disposal Site Risk Characterization – In Support of the MCP (MassDEP 1995). Under the MCP, a Stage I ERC comprises two steps: 1) exposure pathway identification; and 2) effects-based screening. In addition, as part of, or prior to, a Stage I ERC, data from a site can be compared to background and Local Conditions to determine the need for effects-based screening.

An ecological screening was conducted using 2020 and 2021 surface sediment and surface water analytical data and field reconnaissance information about potentially complete exposure pathways. Surface sediment data with start depths at the sediment–surface water interface were included. A condition of RAH was identified based on visual observations made during field investigations.

7.1 Problem Formulation

Exposure to Site sediment and surface water is considered complete for aquatic life based on field reconnaissance work performed by Anchor QEA in September 2021 and on information obtained from the Massachusetts Office of Geographic Information (MassGIS).

Direct access to Site sediments and surface water for upland receptors is limited. The Little River dam limits access immediately upstream of the Site, and the Little River Conduit limits access immediately downstream of the Site. Although the removal of the Little River dam could increase access to the in-river portion of the Site, the City of Haverhill indicated during a public meeting in 2021 that recreational use of the river would be focused upstream of the current dam location due to the proximity of the conduit downstream of the dam. A vertical retaining wall 15 to 20 feet tall is along most of the Little River's eastern side, and the western bank and southern portion of the eastern bank are heavily overgrown and steep, with some potential remnants of former structures such as retaining walls. An apparently limited vagrant population may access the river as evidenced by a former temporary shelter on the western side near the CSO outfall.

Based on a review of MassGIS information, there are no areas of critical environmental concern, no areas of Priority Habitat, and no areas of estimated rare habitat at or within a quarter mile of the in-water portion of the Site. However, the Merrimack River upstream and downstream of the Little River Conduit outfall is identified as both Priority Habitat and estimated habitat for rare wildlife according to MassGIS online maps.

In this screening, data are described in two groups: Local Conditions and Site. The Local Conditions dataset includes the 10 discrete and 1 composite sediment sample identified as upstream in Table 9 and 1 surface water sample identified as upstream (GZA 2022; Table 7B). An evaluation of Local Conditions is presented in Section 5.2. The Site data are for sediments collected adjacent to 284 Winter Street. No samples representative of downstream conditions were collected due to the proximity of the Little River Conduit.

7.2 Readily Apparent Harm

As discussed in Section 5.4.1, an area of RAH was identified adjacent to the former MGP. The area was conservatively defined by identifying locations where VOT was observed within the upper 1.0 foot of sediment and extending the area out to the next closest visually unimpacted core. The RAH area generally extends upstream from AQSS-05, and downstream it extends to between AQSS-20 and the headwall of the Little River Conduit (Figure 9). It is assumed that it extends to the edge of the Little River on the east and west sides.

7.3 Effects-Based Screening

Following the Local Conditions evaluation summarized previously, an effects-based screening was conducted as part of the Stage I ERC to address aquatic receptors' potentially complete exposures to Site-related constituents in the Little River to determine whether a condition of "no significant risk of harm" exists.

7.3.1 Sediment

Only three sediment core locations from which samples were submitted for chemical analysis (AQSS-03, AQSS-04, and AQSS-18) and one hand auger location (5C) are outside the RAH boundary; the boundary was conservatively defined by extending the area out to the next closest core where VOT was not observed in the upper 1 foot of sediment (Figure 9). Sediment data from the Site outside the RAH footprint were compared to available freshwater benthic invertebrate screening levels (SLs).

Available sediment data were compared to MassDEP freshwater effects-based screening levels as available for constituents. The 2006 Interim Technical Update by MassDEP (2006) revised the previously recommended freshwater sediment screening level from the threshold effects concentration (TEC) of MacDonald et al. (2000) to the probable effects concentration (PEC) for select OHM. As summarized by MassDEP (2006), the revision was made to streamline the risk assessment process and because risk assessments generally find a condition of "no significant risk of harm" when site concentrations of metals are below the PEC.

The primary source of sediment quality SLs used in this benthic evaluation are consensus-based PEC values from MacDonald et al. (2000). TEC values from MacDonald et al. (2000) are also provided for reference. The use of consensus-based values in this ERC provides a strong weight of evidence by incorporating the results from several different methods and datasets. The TEC represents a concentration below which adverse effects to the benthic community from exposure to OHM are unlikely. The PEC represents a concentration above which effects are likely. Concentrations below the TEC (and, therefore, below the PEC) generally represent a condition of no risk to benthic invertebrates; therefore, no further evaluation is required. Concentrations greater than the PEC (and, therefore, greater than the TEC) may indicate some potential for risk of harm. Concentrations between the TEC and the PEC indicate some probability that adverse effects will occur, but the effects may not be significant.

Although interim technical update (MassDEP 2006) recommends TECs for screening mercury and PCBs, PEC values were given preference over TEC values for all constituents of concern for screening for the following reasons:

- TEC values have unacceptably high false-positive error rates, so benthic effects are erroneously predicted 75% to 85% of the time (i.e., four of five predictions of adverse effects are erroneous; Avocet 2011).
- PEC values are much more reliable than TEC values (Avocet 2011).
- Additionally, the New York State Department of Environmental Conservation (NYSDEC) Class A Freshwater Sediment Guidance Value of 1 µg/kg provides a benchmark for the protection of both aquatic life and animals higher up the food chain that may bioaccumulate PCBs from food sources (NYSDEC 2014). According to NYSDEC, if the concentration of a contaminant in sediment is above the sediment guidance value that defines Class C, the contaminant can be considered to likely present risk to aquatic life.

MassDEP SLs are available for metals, individual PAHs, total PAHs, and total PCBs. For OHM without PECs, other common sources were used for SLs protective of benthic invertebrates, as cited in the tables.

USEPA's freshwater sediment screening values (USEPA 2018) were used as the SL for VOCs.

The results for selenium and silver were screened against the Washington Sediment Management Standards (WA SMS; Washington Administrative Code 173-204-563) sediment cleanup objective (SCO). The SCO is the level considered to be biologically meaningful for population-level effects. The advantage of the SCOs used in this screening is that they were derived (by Avocent 2011) using collocated chemistry and bioassay data. Concentrations at or below the SCOs correspond to sediment quality that results in no adverse effects to the benthic community (applied conservatively as a TEC in this ERC). The WA SMS SCO for selenium was adopted as a threshold effect screening level under the Sediment Evaluation Framework for the Pacific Northwest (RSET 2018).

No screening values were available from these sources for certain VOCs, and several individual PAHs. PAHs are evaluated via total PAHs in this screening. OHM for which there are screening values are assumed to address potential exposures to sediment that contains metals and VOCs for which there are no screening values.

Sediment data are summarized in Table 4. As indicated in Table 4, concentrations of TPAH16, chromium, lead, and EPH fractions from individual sample locations exceed SLs at sample locations outside the RAH boundary (Figure 9). The results by OHM group are as follows:

- Total PAH concentrations are greater than the SL value in surface sediment data from locations AQSS-03, AQSS-04, AQSS-18, and 5C.

- Concentrations of chromium at location AQSS-04 and concentrations of lead at AQSS-03 and AQSS-04 are greater than SL values in surface sediment data. Concentrations of arsenic, cadmium, mercury, and selenium are below SL values in surface sediment. Silver was not detected in any surface sediment sample.
- Total PCB concentrations are less than the SL value in surface sediment at locations AQSS-03, AQSS-04, and AQSS-18. PCBs were not analyzed at location 5C.
- EPH fractions are greater than SL values in surface sediment at location 5C. Samples were not submitted for EPH analysis from locations AQSS-03 or AQSS-04.

7.3.2 Surface Water

Concentrations of EPH, VPH, and cyanide were nondetect in upstream and downstream surface water samples. Therefore, dissolved concentrations of EPH, VPH, and cyanide do not pose risks to aquatic receptors.

7.4 Environmental Risk Characterization Summary

The MCP states that conditions of a site should be evaluated to determine whether significant environmental harm is "readily apparent." A condition of RAH, as defined in 310 CMR 40.0995(3)(b), currently exists for the Site based on the presence of VOT in the upper 1-foot of sediment over an area greater than 1,000 square feet.

To characterize potential risks to the aquatic community from direct exposure to in-river Site media, Site sediment from outside the RAH area and surface water data collected in 2020 and 2021 were compared to Local Conditions and to effects-based criteria. Based on the results of this Stage I ERC, concentrations of Site constituents in surface water do not pose a risk to aquatic receptors. Concentrations of PAHs, select metals, PCBs, and EPH fractions in surface sediment exceed SLs and, therefore, have the potential to pose a risk to aquatic receptors.

Based on the information reviewed in this ERC, a condition of "no significant risk of harm" does not exist for the Study Area due to a condition of RAH and concentrations of PAHs present in sediment at concentrations greater than SLs.

8 Conceptual Site Model – Little River Sediment

A conceptual site model (CSM) was developed based on the findings of the Phase II field investigations. This section presents the CSM applicable only to the Little River sediment adjacent to the former MGP. Potential OHM sources, migration pathways, and receptors for shallow sediment are assessed. A comprehensive CSM is presented in GZA's Phase II CSA report, which includes both the upland and in-river portions of the Site.

The significance of potential OHM migration pathways was assessed based on the combined Site environmental conditions, OHM transport and fate characteristics, and OHM nature and extent in sediment. This analysis was also used to further evaluate the possible location and relative OHM contribution from potential OHM sources.

Little River sediment generally includes an uppermost layer of brown to black sand to gravelly sand with little silt/clay and trace organics and anthropogenic debris. Anthropogenic debris includes glass, plastic, brick, slag, clinkers, and fibrous layers. At AQSS-07D, AQSS-11D, AQSS-18, AQSS-19, and AQSS-20, a sharp contact between the surficial sediment and a deeper gray, brown, black tight fine sand unit was observed at 2.7 to 4.9 feet bml.

Potential sources of NAPL, PAHs, EPH, and VPH include the former MGP and the use of the upland portion of the Site as a gasoline and fuel oil distribution facility since 1977. These OHM have been detected in upland soil and groundwater samples. Potential sources of PCBs and metals include general historical industrial and commercial uses of the Little River, storm drains, nearby roadways, and discharges from CSOs. During the site history research performed for this report, no information was found that indicated PCBs or metals were used or stored at the former MGP Site. In addition, based on our experience working on former MGP sites, PCBs and metals are generally not associated with former MGP operations.

VOT was observed in Little River sediment at numerous sediment core and hand auger locations. Observations of VOT ranged from droplets to intervals apparently saturated with VOT. In general, VOT observations appeared more like tar than high-viscosity fluid. Sheen and NAPL were observed in the uppermost black sand to gravelly sand stratigraphic unit but were not observed in the lower gray fine sand unit except in AQSS-12b and the UV and white light photographs of the additional core collected at location AQSS-13.

During the site history research performed for this report, no information was found that clearly indicated the presence of primary OHM migration pathways between potential OHM sources and sediment OHM. Based on observations of hardened tar-like material on the face of the retaining wall and the presence of NAPL-like material in at least one pipe exiting through the retaining wall, the

primary OHM sources for sediment are likely historical discharges from the former MGP to surface water and deposition in sediment.

Potential OHM migration pathways also include OHM movement through the upland subsurface, either in dissolved form in groundwater transitioning to sediment porewater or as NAPL present in sufficient volume to migrate through soil pore spaces to sediment pore spaces. This is supported by visual observations of stained and coated soil at depth in soil borings advanced near the retaining wall (GZA's Phase II CSA report—B104, B106, and B110). OHM dissolved in groundwater, and NAPL may potentially migrate through shallow upland subsurface soil to voids in the retaining wall to surface water. Sheens were observed originating from either the sediment or through the retaining wall during several visits to the Site.

The primary migration pathway connecting the sediment to the OHM source in the upland is surface water with potential additional pathways including soil and groundwater. In general, the concentrations of OHM in surficial sediment (i.e., 0.0 to 0.5 foot bml) were lower than concentrations detected in the subsurface, indicating that deposition of cleaner material has occurred since the closure of the former MGP. The lowest concentrations of OHM were detected in sediment cores collected below visually impacted sediment between depths of 3.0 to 4.9 feet bml (AQSS-07D, AQSS-18, AQSS-19, and AQSS-20). This distribution is consistent with an OHM discharge to surface water and deposition of OHM in the shallow sediment. The OHM in shallow sediment could migrate down through the shallow sediment to the underlying sediment over time (MGP NAPLs are usually denser than water). In addition or alternatively, sediment deposited on top of OHM deposits could have mixed with and covered the OHM over time. This is supported by the anthropogenic debris observed in the subsurface. Surficial sediment concentrations would decrease over time as sediment representative of Local Conditions are deposited.

Dissolved phase OHM and NAPL that migrate through sediment may migrate directly to surface water. Surface water is also a potential migration pathway for sediment solids and associated OHM sorbed to the sediment solids and for ebullition-facilitated transport of VOT. Sediment solids and sorbed OHM may be resuspended in surface water through natural erosive flows. After OHM has been incorporated in surface water flows through these mechanisms, the OHM would be expected to migrate downstream.

The lateral extent of impacted shallow sediment in the in-river portion of the Site has been defined based on the nature and extent of OHM in the Little River and the Local Conditions analysis presented in Section 5.2. The Site boundary is delineated in GZA's Phase II CSA report Figure 2.

9 Conclusions

This Phase II CSA meets the standards in the MCP for a Phase II Report (310 CMR 40.0830) and a Risk Characterization (310 CMR 40.0900). The Site consists of an upland portion where the former MGP was located and an in-river portion. Anchor QEA's conclusions based on the results of the Phase II CSA and Method 3 Risk Characterization are as follows:

- The lateral extent of VOT in the in-river portion of the Site generally extends from sediment core location AQSS-5 to south of location AQSS-20. VOT is assumed to be present in the river from the river's western edge to its eastern edge. The probable OHM sources include direct discharges or spills from the former MGP.
- VOT appears primarily to be located within the upper black and brown sand to gravelly sand stratigraphic unit. VOT was not seen in the lower fine sand unit except in two cores (AQSS-12b and the additional core collected at location AQSS-13).
- Additional sources (i.e., storm drains, CSOs, gas station operations, and runoff from roadways) likely contribute OHM to the Little River. Assessing the impact of these OHM discharges to the Site is not possible with the information available.
- Based on visual observations of sediment cores and PAH concentrations measured in sediment samples collected from the sediment cores, the primary OHM source and migration pathway in sediment are historical discharges of OHM from the vicinity of the former MGP to surface water, and subsequent deposition of OHM in shallow sediment.
- The Method 3 Risk Characterization concluded there is a risk of environmental harm in sediments due to detected concentrations of OHM that exceed screening criteria. Where VOT was observed in the upper 12 inches of sediment, a condition of RAH exists because VOT is present over an area greater than 1,000 square feet.
- The site boundary in the river has been identified to the west as the western edge of the river, to the south as the headwall of the Little River Conduit, and to the north as the area between the northernmost sediment cores (AQSS-03, AQSS-04, and AQSS-05) and the Little River dam. The RAH area is a subset of this area.
- Because a condition of RAH was identified, a Permanent Solution for the Site cannot be achieved at this time and additional comprehensive response actions are needed. Therefore, a Phase III – Identification, Evaluation, and Selection of Comprehensive Remedial Action Alternatives report will be prepared to select the appropriate remedial measures for the Site.
- The objectives of the Phase II CSA have been met because the source, nature, extent, and potential impacts of the releases at the Site have been identified; the risk of harm posed by the Site to human health, safety, public welfare, and the environment have been evaluated; and the need to conduct remedial actions at the Site have been identified.

10 Limitations

This Phase II CSA report was prepared exclusively for National Grid by Anchor QEA in accordance with generally accepted geohydrological practices. No warranty, expressed or implied, is made.

The conclusions presented in this report are based solely on the information provided in the document. Additional quantitative information regarding the Site, which was not available to Anchor QEA, may result in a modification of the conclusions presented in Section 9.

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Tables

Table 1
Summary of Sediment Cores Collected During 2021 Field Investigation

Core ID	Collection Date	Coordinates		Penetration (feet)	Recovery (feet)
		Latitude	Longitude		
AQSS-03	9/30/2021	42.777325	-71.088417	N/A	3.5
AQSS-03B	9/30/2021	Note 1		N/A	2.7
AQSS-04	9/30/2021	42.777330	-71.088352	N/A	2.2
AQSS-05	9/29/2021	42.777326	-71.088268	N/A	2.6
AQSS-06	9/29/2021	42.777208	-71.088229	N/A	2.0
AQSS-07	9/29/2021	42.777111	-71.088103	N/A	2.4
AQSS-07D	9/30/2021	42.777167	-71.08816	10	5.4
AQSS-08	9/29/2021	42.777001	-71.087998	N/A	1.7
AQSS-08B	9/29/2021	Note 1		N/A	2.9
AQSS-09	9/29/2021	42.776917	-71.087893	N/A	2.2
AQSS-10	9/29/2021	42.776824	-71.087725	N/A	0.6
AQSS-11	9/28/2021	Note 1		7.5	3.2
AQSS-11B	9/28/2021	42.776687	-71.087599	N/A	3.5
AQSS-11D	9/30/2021	42.776733	-71.087604	10	5.2
AQSS-12	9/28/2021	42.776632	-71.087427	4	2.4
AQSS-12B	9/28/2021	42.776632	-71.087427	N/A	3.8
AQSS-13	9/28/2021	42.776538	-71.087357	N/A	2.1
AQSS-13B	9/28/2021	42.776538	-71.087357	N/A	2.6
AQSS-18	9/30/2021	42.777128	-71.088226	N/A	4.8
AQSS-19	9/30/2021	42.776750	-71.087629	10	5.9
AQSS-19D	9/28/2021	42.776767	-71.087657	N/A	2.5
AQSS-20	9/30/2021	42.776509	-71.087260	10	4.6

Notes:
1. Multiple coring attempts were conducted at AQSS-03, AQSS-08, and AQSS-11. Locations AQSS-03B, AQSS-08B, and AQSS-11 were collected within approximately 10 feet of locations AQSS-03, AQSS-08, and AQSS-11B/11D, respectively.
N/A: not applicable

Table 2
Summary of Sediment Analyses from 2021 Field Investigation

Location ID	Sample ID	Depth Interval (feet)	Soot Carbon	TOC	PCB Aroclors	Metals (8 RCRA)	PAH (16)	PAH (34) (Alkylated)	VPH	EPH	SVOCs
AQSS-03	AQSS-03-0.0-0.5	0.0–0.5	X	X	X	X	X	—	—	—	Note 2
	AQSS-03-2.0-2.5	2.0–2.5	—	X	—	—	X	—	—	—	Note 2
AQSS-04	AQSS-04-0.0-0.5	0.0–0.5	X	X	X	X	X	X	—	—	X
	AQSS-04-1.0-1.5	1.0–1.5	—	X	—	—	X	X	—	—	X
	DUP2-20210930	0.0–0.5	—	X	—	—	X	X	—	—	X
AQSS-05	AQSS-05-0.0-0.5	0.0–0.5	X	X	X	X	X	—	X	X	Note 2
	AQSS-05-1.0-1.5	1.0–1.5	—	X	—	—	X	—	—	—	Note 2
AQSS-06	AQSS-06-0.0-0.5	0.0–0.5	X	X	X	X	X	X	—	—	X
	AQSS-06-1.5-2.0	1.5–2.0	—	X	—	—	X	—	—	—	Note 2
AQSS-07	AQSS-07-0.0-0.5	0.0–0.5	X	X	X	X	X	X	—	—	X
	AQSS-07-1.5-2.0	1.5–2.0	—	X	—	Note 1	X	X	—	—	X
	AQSS-07D-4.9-5.4	4.9–5.4	—	X	—	—	X	X	—	—	X
AQSS-08	AQSS-08-0.0-0.5	0.0–0.5	X	X	X	X	X	—	—	—	Note 2
	AQSS-08-1.0-1.5	1.0–1.5	—	X	—	—	X	—	—	—	Note 2
AQSS-09	AQSS-09-0.0-0.5	0.0–0.5	X	X	X	X	X	X	—	—	X
AQSS-10	AQSS-10-0.0-0.5	0.0–0.5	X	X	X	X	X	X	—	—	X
	DUP1-20210929	0.0–0.5	X	X	X	X	—	—	—	—	—
AQSS-11B	AQSS-11B-0.0-0.5	0.0–0.5	X	X	X	X	X	X	—	—	X
	AQSS-11B-1.5-1.9	1.5–1.9	—	X	—	—	X	X	—	—	X
	AQSS-11B-2.5-3.0	2.5–3.0	—	X	—	—	X	—	—	—	Note 2
AQSS-12B	AQSS-12B-0.0-0.5	0.0–0.5	X	X	X	X	X	—	—	—	Note 2
AQSS-13B	AQSS-13B-0.0-0.5	0.0–0.5	X	X	X	X	X	X	—	—	X
	AQSS-13B-1.5-2.0	1.5–2.0	—	X	—	—	X	X	—	—	X

Table 2
Summary of Sediment Analyses from 2021 Field Investigation

Location ID	Sample ID	Depth Interval (feet)	Soot Carbon	TOC	PCB Aroclors	Metals (8 RCRA)	PAH (16)	PAH (34) (Alkylated)	VPH	EPH	SVOCs
AQSS-18	AQSS-18-0.0-0.5	0.0–0.5	X	X	X	X	X	—	—	—	Note 2
	AQSS-18-3.0-3.5	3.0–3.5	—	X	—	—	X	—	—	—	Note 2
	AQSS-18-4.6-4.8	4.6–4.8	—	X	—	—	X	—	—	—	Note 2
AQSS-19	AQSS-19-3.0-3.5	3.0–3.5	—	X	—	—	X	—	—	—	Note 2
	AQSS-19-4.5-5.0	4.5–5.0	—	X	—	—	X	—	—	—	Note 2
AQSS-20	AQSS-20-0.0-0.5	0.0–0.5	X	X	X	X	X	—	—	—	Note 2
	AQSS-20-4.2-4.5	4.2–4.5	—	X	—	—	X	—	—	—	Note 2

Notes:

1. Only copper was analyzed.

2. Only 2 -Chloronaphthalene was analyzed.

—: data not collected

EPH: extractable petroleum hydrocarbons

PAH: polycyclic aromatic hydrocarbon

PCB: polychlorinated biphenyl

RCRA: Resource Conservation and Recovery Act

SVOC: semivolatile organic compound

TOC: total organic carbon

VPH: volatile petroleum hydrocarbons

Table 3
Analysis of OHM Concentrations in Reference Samples Compared to Samples in Site Vicinity

Constituent	Sample Interval (feet below sediment surface)	Sediment Samples in Site Vicinity						Sediment Samples Representative of Local Conditions						
		Minimum	Maximum	Average	Number of Detected Samples	Number of Nondetect Samples[1]	Total Number of Samples	Sediment Interval (feet below sediment surface)	Minimum	Maximum	Average	Number of Detected Samples	Number of Nondetect Samples[1]	Total Number of Samples
Inorganics (mg/kg)														
Cyanide	0–0.5	1.00	1.20	0.56	0	8	8	—	—	—	—	—	—	—
	>1	—	—	—	0	0	0							
Conventional Parameters (%)														
Soot Carbon	0–0.5	0.01	1.08	0.19	21	0	21	—	—	—	—	—	—	—
	>1	—	—	—	0	0	0							
Total Organic Carbon	0–0.5	0.19	15.80	2.44	24	0	24	0–1.0	6.00	6.00	6.00	1	0	1
	>1	ND	15.60	4.74	18	1	19							
PCB Aroclors (µg/kg)														
Total PCB Aroclors (U = 1/2 detected Aroclors)	0–0.5	77.00	1,400.00	495.22	13	0	13	0–2.0	ND	0.23	0.10	3	8	11
	>1	—	—	—	0	0	0							
Metals (mg/kg)														
Arsenic	0–0.5	6.17	74.60	20.93	13	0	13	0–2.0	ND	41.00	15.00	10	1	11
	>1	—	—	—	0	0	0							
Barium	0–0.5	11.60	41.50	26.02	13	0	13	0–1.0	99.00	99.00	99.00	1	1	1
	>1	—	—	—	0	0	0							
Cadmium	0–0.5	0.21	1.28	0.42	13	0	13	0–1.0	1.00	1.00	1.00	1	1	1
	>1	—	—	—	0	0	0							
Chromium	0–0.5	14.40	414.00	60.14	13	0	13	0–1.0	34.00	34.00	34.00	1	1	1
	>1	—	—	—	0	0	0							
Copper	0–0.5	—	—	—	0	0	0	0–1.0	40.00	40.00	40.00	1	1	1
	>1	138.00	138.00	138.00	1	0	1							
Lead	0–0.5	37.00	397.00	141.57	13	0	13	0–2.0	3.00	600.00	208.00	10	1	11
	>1	—	—	—	0	0	0							
Mercury	0–0.5	ND	0.15	0.05	2	13	14	0–1.0	0.29	0.29	0.29	1	1	1
	>1	—	—	—	0	0	0							
Selenium	0–0.5	ND	4.46	1.30	1	12	13	0–1.0	ND	ND	ND	1	1	1
	>1	—	—	—	0	0	0							
Silver	0–0.5	ND	ND	ND	0	13	13	0–1.0	ND	ND	ND	1	1	1
	>1	—	—	—	0	0	0							

Table 3
Analysis of OHM Concentrations in Reference Samples Compared to Samples in Site Vicinity

Constituent	Sample Interval (feet below sediment surface)	Sediment Samples in Site Vicinity						Sediment Samples Representative of Local Conditions						
		Minimum	Maximum	Average	Number of Detected Samples	Number of Nondetect Samples[1]	Total Number of Samples	Sediment Interval (feet below sediment surface)	Minimum	Maximum	Average	Number of Detected Samples	Number of Nondetect Samples[1]	Total Number of Samples
PAHs (mg/kg)														
Total PAHs (16) (U = 1/2)	0–0.5	17.62	2,240.00	318.59	21	0	21	0–2.0	ND	99.03	29.88	7	1	8
	>1	0.58	14,900.00	2,608.22	15	0	15							
Total Alkylated PAHs (34)	0–0.5	30.97	6,072.31	676.22	16	0	16	—	—	—	—	—	—	—
	>1	2.79	29,892.45	13,731.61	5	0	5							
EPH (mg/kg)														
Total PAH (16)	0–0.5	463.00	3,689.70	1863.20	3	0	3	0–1.0	861.00	861.00	861.00	1	0	1
	>1	1365.20	2,970.70	2,109.20	3	0	3							
VPH (mg/kg)														
Benzene	0–0.5	ND	37.10	3.77	3	9	12	—	—	—	—	—	—	—
	>1	ND	26.80	6.64	0	4	4							
Ethylbenzene	0–0.5	ND	203.00	29.68	5	7	12	—	—	—	—	—	—	—
	>1	5.59	130.00	74.35	4	0	4							
o–Xylene	0–0.5	ND	83.60	12.29	5	7	12	—	—	—	—	—	—	—
	>1	1.76	62.40	29.39	4	0	4							
p/m–Xylene	0–0.5	ND	173.00	24.37	5	7	12	—	—	—	—	—	—	—
	>1	ND	118.00	49.67	3	1	4							
Toluene	0–0.5	ND	ND	ND	0	12	12	—	—	—	—	—	—	—
	>1	ND	ND	ND	0	4	4							
Naphthalene	0–0.5	ND	746.00	130.83	10	1	11	—	—	—	—	—	—	—
	>1	32.50	1,300.00	737.38	4	0	4							

Notes:

1. Nondetect values were divided by two for the average calculation.

Samples included in the calculation of statistics in Site vicinity were collected during the GZA (2020) and AQ (2021) field investigations.

Samples included in the calculation of statistics for Local Conditions from Fuss & O'Neill, 2021b. FY22 MVP Action Grant Sediment Management Report, City of Haverhill, Haverhill, Massachusetts. Prepared for the City of Haverhill. November 19, 2021.

%: percent

—: sample not submitted for analysis

µg/kg: micrograms per kilogram

EPH: extractable petroleum hydrocarbons

mg/kg: milligrams per kilogram

ND: nondetect

PAH: polycyclic aromatic hydrocarbon

PCB: polychlorinated biphenyl

VPH: volatile petroleum hydrocarbons

Table 4
Summary of Laboratory Chemical Analyses Results in Sediment Samples – 2021

Chemical	TEC	PEC	Screening Level	Location ID	AQSS-03	AQSS-03	AQSS-04	AQSS-04	AQSS-04	AQSS-05	AQSS-05	AQSS-06
				Sample ID	AQSS-03-0.0-0.5	AQSS-03-2.0-2.5	AQSS-04-0.0-0.5	AQSS-04-1.0-1.5	DUP2-20210930	AQSS-05-0.0-0.5	AQSS-05-1.0-1.5	AQSS-06-0.0-0.5
				Sample Date	9/30/2021	9/30/2021	9/30/2021	9/30/2021	9/30/2021	9/29/2021	9/29/2021	9/29/2021
				Depth	0–0.5 ft	2–2.5 ft	0–0.5 ft	1–1.5 ft	0–0.5 ft	0–0.5 ft	1–1.5 ft	0–0.5 ft
Conventional Parameters (%)												
Soot carbon	—	—	—		**0.47 J**	—	**0.23 J**	—	—	**0.03 J**	—	**0.297**
Total organic carbon	—	—	—		**2.83 J**	**1.73 J**	**2.96 J**	**5.75 J**	**1.26 J**	**0.75 J**	**15.6 J**	**1.2**
Total Solids	—	—	—		**81.3**	**81.6**	**85.4**	**79.2**	**84.5**	**84.7**	**70.6**	**72.7**
Metals (mg/kg)												
Arsenic	9.79	33	33		**7.40 J**	—	**7.94 J**	—	—	**7.89 J**	—	**41.4**
Barium	—	—	—		**37.2**	—	**28.6**	—	—	**29.7**	—	**33.7**
Cadmium	0.99	4.98	4.98		**0.2943**	—	**0.6211**	—	—	0.23 U	—	**0.4515**
Chromium	43.4	111	111		**34.90 J**	—	**414.00 J**	—	—	**40.90 J**	—	**56.4**
Copper	—	149	149		—	—	—	—	—	—	—	—
Lead	35.8	128	128		**153.00 J**	—	**167.00 J**	—	—	**98.00 J**	—	**346**
Mercury	0.18	1.06	1.06		0.08 U	—	**0.13 J**	—	—	0.08 U	—	**0.15 J**
Selenium	—	—	11		2.42 U	—	2.27 U	—	—	2.31 U	—	2.67 U
Silver	—	—	0.57		0.60 U	—	0.57 U	—	—	0.58 U	—	0.67 U
SVOCs (mg/kg)												
1-Methylpyrene	—	—	—		—	—	**0.60 J**	**1.24**	**0.20 J**	—	—	**2.61**
2-Chloronaphthalene	—	—	—		0.49 U	0.09 U	—	—	—	0.456 U	0.214 U	—
2-Methylpyrene	—	—	—		—	—	**0.97 J**	**1.84**	**0.30 J**	—	—	**2.66**
3-Methylphenanthrene	—	—	—		—	—	**1.66 J**	**3.22**	**0.56 J**	—	—	**7.37**
4-Methylpyrene	—	—	—		—	—	**0.69 J**	**1.37**	**0.22 J**	—	—	**2.23**
Benzo(b)fluorene	—	—	—		—	—	**1.61 J**	**2.47**	**0.38 J**	—	—	**5.66**
Biphenyl (1,1'-Biphenyl)	—	—	—		—	—	**0.24 J**	**0.391**	**0.07 J**	—	—	**2.98**
PAH (mg/kg)												
1-Methyldibenzothiophene	—	—	—		—	—	**0.11 J**	**0.242**	**0.04 J**	—	—	**0.437**
1-Methylnaphthalene	—	—	—		—	—	**0.62 J**	**1.44**	**0.19 J**	—	—	**9.85**
1-Methylphenanthrene	—	—	—		—	—	**1.40 J**	**3.02**	**0.51 J**	—	—	**6.45**
2,3,5-Trimethylnaphthalene (1,6,7-Trimethylnaphthalene)	—	—	—		—	—	**0.12 J**	**0.29**	**0.05 J**	—	—	**1.24**
2,6-Dimethylnaphthalene	—	—	—		—	—	**0.40 J**	**0.722**	**0.13 J**	—	—	**5.29**
2-Methylanthracene	—	—	—		—	—	**0.94 J**	**1.84**	**0.28 J**	—	—	**4.64**
2-Methyldibenzothiophene & 3-Methyldibenzothiophene	—	—	—		—	—	**0.43 J**	**0.908**	**0.14 J**	—	—	**1.48**
2-Methylnaphthalene	—	—	—		**1.09 J**	**1.77 J**	**0.798**	**1.75 J**	**0.641**	**0.17 J**	**4.49**	**6.19**
2-Methylphenanthrene	—	—	—		—	—	**1.98 J**	**3.87**	**0.66 J**	—	—	**6.88**
4-Methyldibenzothiophene	—	—	—		—	—	**0.30 J**	**0.678**	**0.11 J**	—	—	**1.29**

Table 4
Summary of Laboratory Chemical Analyses Results in Sediment Samples – 2021

Chemical	TEC	PEC	Screening Level	Location ID	AQSS-03	AQSS-03	AQSS-04	AQSS-04	AQSS-04	AQSS-05	AQSS-05	AQSS-06
				Sample ID	AQSS-03-0.0-0.5	AQSS-03-2.0-2.5	AQSS-04-0.0-0.5	AQSS-04-1.0-1.5	DUP2-20210930	AQSS-05-0.0-0.5	AQSS-05-1.0-1.5	AQSS-06-0.0-0.5
				Sample Date	9/30/2021	9/30/2021	9/30/2021	9/30/2021	9/30/2021	9/29/2021	9/29/2021	9/29/2021
				Depth	0–0.5 ft	2–2.5 ft	0–0.5 ft	1–1.5 ft	0–0.5 ft	0–0.5 ft	1–1.5 ft	0–0.5 ft
4-Methylphenanthrene & 9-Methylphenanthrene	—	—	—		—	—	1.54 J	3.06	0.48 J	—	—	7.8
Acenaphthene	—	—	—		2.06	2.87	2.54 J	2.78 J	0.90 J	0.23 J	6.73	12
Acenaphthylene	—	—	—		2.76	4.39	1.1	2.88 J	0.83	0.574	7.19	5.7
Anthracene	0.057	0.845	0.845		7.64	12	5.84 J	9.18 J	1.92 J	0.848	27.7	16.4
Benzo(a)anthracene	0.11	1.05	1.05		8.81	13.8	9.92 J	16.20 J	3.31 J	2.38	34.3	14.6
Benzo(a)fluoranthene	—	—	—		—	—	1.72 J	2.61	0.43 J	—	—	2.81
Benzo(a)pyrene	0.15	1.45	1.45		8.14	12	9.13 J	15.10 J	3.00 J	2.44	30.5	12.4
Benzo(b)fluoranthene	—	—	—		7.06	9.31	7.82 J	12.20 J	2.64 J	2.38	21.7	9.19
Benzo(c)fluorene	—	—	—		—	—	0.66 J	1.25	0.15 J	—	—	1.62
Benzo(e)pyrene	—	—	—		—	—	5.80 J	8.59	1.50 J	—	—	7.07
Benzo(g,h,i)perylene	—	—	—		4.27	6.51	6.15 J	9.45 J	2.08 J	1.48	15.4	6.85
Benzo(j,k)fluoranthene	—	—	—		—	—	7.25 J	11 J	2.26 J	—	—	9.27
Benzo(k)fluoranthene	—	—	—		5.32	8.64	—	—	—	1.9	24.2	—
Benzonaphthothiophene	—	—	—		—	—	1.74 J	2.68	0.46 J	—	—	2.46
Benzothiophene	—	—	—		—	—	0.07 J	0.105	0.02 J	—	—	0.351
Carbazole	—	—	—		—	—	2.60 J	3.52	0.64 J	—	—	0.577
Chrysene	0.17	1.29	1.29		7.63	11.3	9.75 J	16.80 J	3.49 J	2.76	32.1	14.5
Decalin, cis- & trans-	—	—	—		—	—	0.00334	0.01 J	0.00 J	—	—	0.195
Dibenzo(a,h)anthracene	—	—	—		1.04	1.98	—	—	—	0.35 J	4.44	—
Dibenzo(a,h)anthracene and Dibenzo(a,c)anthracene	0.033	—	0.033		—	—	2.06 J	2.80 J	0.91 J	—	—	2.11
Dibenzofuran	—	—	—		—	—	1.76 J	2.47	0.51 J	—	—	6.15
Dibenzothiophene	—	—	—		—	—	1.55 J	2.67	0.46 J	—	—	4.15
Fluoranthene	0.42	2.23	2.23		20.3	32.9	27.70 J	35.50 J	6.73 J	5.53	71.7	42.7
Fluorene	0.077	0.536	0.536		5.05	8.2	2.75 J	4.19 J	1.11 J	0.535	20	12.1
Indeno(1,2,3-c,d)pyrene	—	—	—		4.42	7.08	6.37 J	9.40 J	2.11 J	1.41	15.4	6.91
Naphthalene	0.18	0.561	0.561		3.59 J	5.99 J	1.85 J	3.22 J	0.86 J	0.29 J	9.27	10.7
Perylene	—	—	—		—	—	2.30 J	3.4	0.59 J	—	—	2.98
Phenanthrene	0.2	1.17	1.17		19.4	31.8	25.60 J	36.10 J	7.12 J	3.89	75.6	47.5
Pyrene	0.2	1.52	1.52		17.6	26.9	22.70 J	31.30 J	5.76 J	4.94	65.7	40.2
Retene	—	—	—		—	—	0.01 U	0.03 U	0.01 U	—	—	0.01 U
Total PAH (16) (U = 1/2)	1.61	22.8	22.8		125.00 J	196.00 J	149.00 J	218.00 J	45.00 J	31.90 J	462	263
C1-Benzo(b)thiophene	—	—	—		—	—	0.05 J	0.104	0.02 J	—	—	0.701
C1-Chrysenes	—	—	—		—	—	4.24 J	7.68	1.31 J	—	—	8.77

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Chemical	TEC	PEC	Screening Level	Location ID	AQSS-03	AQSS-03	AQSS-04	AQSS-04	AQSS-04	AQSS-05	AQSS-05	AQSS-06
				Sample ID	AQSS-03-0.0-0.5	AQSS-03-2.0-2.5	AQSS-04-0.0-0.5	AQSS-04-1.0-1.5	DUP2-20210930	AQSS-05-0.0-0.5	AQSS-05-1.0-1.5	AQSS-06-0.0-0.5
				Sample Date	9/30/2021	9/30/2021	9/30/2021	9/30/2021	9/30/2021	9/29/2021	9/29/2021	9/29/2021
				Depth	0–0.5 ft	2–2.5 ft	0–0.5 ft	1–1.5 ft	0–0.5 ft	0–0.5 ft	1–1.5 ft	0–0.5 ft
C1-Decalins	—	—	—		—	—	**0.0104**	**0.0333**	**0.00631**	—	—	**0.502**
C1-Dibenzothiophenes	—	—	—		—	—	**0.99 J**	**2.2**	**0.36 J**	—	—	**3.81**
C1-Fluoranthenes/Pyrenes	—	—	—		—	—	**7.59 J**	**13.7**	**2.18 J**	—	—	**23.6**
C1-Fluorenes	—	—	—		—	—	**0.93 J**	**1.9**	**0.30 J**	—	—	**7.91**
C1-Naphthalenes	—	—	—		—	—	**0.93 J**	**2.08**	**0.54 J**	—	—	**10.4**
C1-Naphthobenzothiophenes	—	—	—		—	—	**0.79 J**	**1.49**	**0.25 J**	—	—	**1.58**
C1-Phenanthrenes/Anthracenes	—	—	—		—	—	**7.17 J**	**14.3**	**2.34 J**	—	—	**31.8**
C2-Benzo(b)thiophene	—	—	—		—	—	**0.08 J**	**0.174**	**0.03 J**	—	—	**1.41**
C2-Chrysenes	—	—	—		—	—	**1.88 J**	**3.57**	**0.60 J**	—	—	**4.19**
C2-Decalins	—	—	—		—	—	**0.04 J**	**0.0743**	**0.02 J**	—	—	**0.7**
C2-Dibenzothiophenes	—	—	—		—	—	**0.70 J**	**1.71**	**0.27 J**	—	—	**2.74**
C2-Fluoranthenes/Pyrenes	—	—	—		—	—	**3.84 J**	**7.06**	**1.27 J**	—	—	**7.31**
C2-Fluorenes	—	—	—		—	—	**0.86 J**	**1.85**	**0.32 J**	—	—	**5.94**
C2-Naphthalenes	—	—	—		—	—	**1.16 J**	**2.22**	**0.37 J**	—	—	**16.1**
C2-Naphthobenzothiophenes	—	—	—		—	—	**0.40 J**	**0.812**	**0.13 J**	—	—	**0.874**
C2-Phenanthrenes/Anthracenes	—	—	—		—	—	**3.42 J**	**7.42**	**1.18 J**	—	—	**14.7**
C3-Benzo(b)thiophene	—	—	—		—	—	**0.09 J**	**0.221**	**0.03 J**	—	—	**1.02**
C3-Chrysenes	—	—	—		—	—	**1.22 J**	**2.22**	**0.38 J**	—	—	**2.51**
C3-Decalins	—	—	—		—	—	**0.05 J**	0.02 U	0.00 UJ	—	—	**0.475**
C3-Dibenzothiophenes	—	—	—		—	—	**0.41 J**	**1.04**	**0.17 J**	—	—	**1.4**
C3-Fluoranthenes/Pyrenes	—	—	—		—	—	**1.52 J**	**2.76**	**0.50 J**	—	—	**2.95**
C3-Fluorenes	—	—	—		—	—	**1.34 J**	**2.64 J**	**0.51 J**	—	—	**2.2**
C3-Naphthalenes	—	—	—		—	—	**1.00 J**	**2.09**	**0.36 J**	—	—	**11.8**
C3-Naphthobenzothiophenes	—	—	—		—	—	**0.24 J**	**0.424**	**0.08 J**	—	—	**0.458**
C3-Phenanthrenes/Anthracenes	—	—	—		—	—	**1.31 J**	**2.92**	**0.45 J**	—	—	**4.74**
C4-Benzo(b)thiophene	—	—	—		—	—	**0.05 J**	**0.137**	**0.02 J**	—	—	**0.377**
C4-Chrysenes	—	—	—		—	—	**0.53 J**	**1.02**	**0.16 J**	—	—	**0.78**
C4-Decalins	—	—	—		—	—	**0.08 J**	**0.19**	**0.05 J**	—	—	**0.675**
C4-Dibenzothiophenes	—	—	—		—	—	**0.14 J**	**0.377**	**0.06 J**	—	—	**0.397**
C4-Fluoranthenes/Pyrenes	—	—	—		—	—	**0.80 J**	**1.51**	**0.27 J**	—	—	**1.27**
C4-Naphthalenes	—	—	—		—	—	**0.53 J**	**1.22**	**0.20 J**	—	—	**4.5**
C4-Naphthobenzothiophenes	—	—	—		—	—	**0.11 J**	**0.21**	**0.04 J**	—	—	**0.215**
C4-Phenanthrenes/Anthracenes	—	—	—		—	—	**0.42 J**	**0.971**	**0.15 J**	—	—	**1.18**

Table 4
Summary of Laboratory Chemical Analyses Results in Sediment Samples – 2021

Chemical	TEC	PEC	Screening Level	Location ID	AQSS-03	AQSS-03	AQSS-04	AQSS-04	AQSS-04	AQSS-05	AQSS-05	AQSS-06
				Sample ID	AQSS-03-0.0-0.5	AQSS-03-2.0-2.5	AQSS-04-0.0-0.5	AQSS-04-1.0-1.5	DUP2-20210930	AQSS-05-0.0-0.5	AQSS-05-1.0-1.5	AQSS-06-0.0-0.5
				Sample Date	9/30/2021	9/30/2021	9/30/2021	9/30/2021	9/30/2021	9/29/2021	9/29/2021	9/29/2021
				Depth	0–0.5 ft	2–2.5 ft	0–0.5 ft	1–1.5 ft	0–0.5 ft	0–0.5 ft	1–1.5 ft	0–0.5 ft
Total Alkylated PAHs	—	—	—		—	—	**220.30 J**	**340.60 J**	**67.93 J**	—	—	**523.03 J**
PCB Aroclors (µg/kg)												
Aroclor 1016	—	—	—		9.08 U	—	8.25 U	—	—	16.80 U	—	9.60 U
Aroclor 1221	—	—	—		9.08 U	—	8.25 U	—	—	16.80 U	—	9.60 U
Aroclor 1232	—	—	—		9.08 U	—	8.25 U	—	—	16.80 U	—	9.60 U
Aroclor 1242	—	—	—		**216**	—	**149**	—	—	**769.00 J**	—	**58.9**
Aroclor 1248	—	—	—		9.08 U	—	8.25 U	—	—	16.80 U	—	9.60 U
Aroclor 1254	—	—	—		**223**	—	**264**	—	—	**380.00 J**	—	**60.00 J**
Aroclor 1260	—	—	—		**105**	—	**108**	—	—	**181.00 J**	—	**45**
Aroclor 1262	—	—	—		9.08 U	—	8.25 U	—	—	16.80 U	—	9.60 U
Aroclor 1268	—	—	—		9.08 U	—	8.25 U	—	—	16.80 U	—	9.60 U
Total PCB Aroclors (U = 1/2)	59.8	676	676		**571**	—	**546**	—	—	**1380.00 J**	—	**193.00 J**
EPH (mg/kg)												
C9-C18 Aliphatics unadjusted	—	—	3.17		—	—	—	—	—	115.00 U	—	—
C19-C36 Aliphatics unadjusted	—	—	9.88		—	—	—	—	—	**414**	—	—
C11-C22 Aromatics adjusted	—	—	0.09		—	—	—	—	—	**1410**	—	—
C11-C22 Aromatics unadjusted	—	—	—		—	—	—	—	—	**2310**	—	—
VPH (mg/kg)												
Benzene	—	—	—		—	—	—	—	—	0.25 UJ	—	—
Ethylbenzene	—	—	—		—	—	—	—	—	0.25 UJ	—	—
m,p-Xylene	—	—	—		—	—	—	—	—	0.25 UJ	—	—
Methyl tert-butyl ether (MTBE)	—	—	—		—	—	—	—	—	0.13 UJ	—	—
o-Xylene	—	—	—		—	—	—	—	—	0.25 UJ	—	—
Toluene	—	—	—		—	—	—	—	—	0.25 UJ	—	—
C5-C8 Aliphatics adjusted	—	—	—		—	—	—	—	—	12.70 UJ	—	—
C5-C8 Aliphatics unadjusted	—	—	—		—	—	—	—	—	12.70 UJ	—	—
C9-C12 Aliphatics adjusted	—	—	2.72		—	—	—	—	—	12.70 UJ	—	—
C9-C12 Aliphatics unadjusted	—	—	—		—	—	—	—	—	12.70 UJ	—	—
C9-C10 Aromatics unadjusted	—	—	—		—	—	—	—	—	12.70 UJ	—	—

Table 4
Summary of Laboratory Chemical Analyses Results in Sediment Samples – 2021

Chemical	TEC	PEC	Screening Level	Location ID	AQSS-06	AQSS-07	AQSS-07	AQSS-07D	AQSS-08	AQSS-08	AQSS-09	AQSS-10
				Sample ID	AQSS-06-1.5-2.0	AQSS-07-0.0-0.5	AQSS-07-1.5-2.0	AQSS-07D-4.9-5.4	AQSS-08-0.0-0.5	AQSS-08-1.0-1.5	AQSS-09-0.0-0.5	AQSS-10-0.0-0.5
				Sample Date	9/29/2021	9/29/2021	9/29/2021	9/30/2021	9/29/2021	9/29/2021	9/29/2021	9/29/2021
				Depth	1.5–2 ft	0–0.5 ft	1.5–2 ft	4.9–5.4 ft	0–0.5 ft	1–1.5 ft	0–0.5 ft	0–0.5 ft
Conventional Parameters (%)												
Soot carbon	—	—	—	—	**0.2**	—	—	**0.062**	—	**0.03**	**0.115**	
Total organic carbon	—	—	—	**2.72**	**1.95**	**11**	**0.02 J**	**2.06**	**9.54**	**0.188**	**2.74**	
Total Solids	—	—	—	**87**	**85.9**	**58.2**	**83.6**	**91.1**	**75.6**	**91.7**	**76.2**	
Metals (mg/kg)												
Arsenic	9.79	33	33	—	**16.7**	—	—	**33.5**	—	**8.14**	**72**	
Barium	—	—	—	—	**11.6**	—	—	**23**	—	**18.7**	**36.7**	
Cadmium	0.99	4.98	4.98	—	0.22 U	—	—	**0.8718**	—	0.21 U	**1.249**	
Chromium	43.4	111	111	—	**18**	—	—	**27.4**	—	**32.3**	**61.9**	
Copper	—	149	149	—	—	**138**	—	—	—	—	—	
Lead	35.8	128	128	—	**107**	—	—	**128**	—	**58.1**	**102**	
Mercury	0.18	1.06	1.06	—	0.08 U	—	—	0.08 U	—	0.08 U	0.09 U	
Selenium	—	—	11	—	2.23 U	—	—	2.11 U	—	2.13 U	**4.46**	
Silver	—	—	0.57	—	0.56 U	—	—	0.53 U	—	0.53 U	0.64 U	
SVOCs (mg/kg)												
1-Methylpyrene	—	—	—	—	**0.235**	**66**	**0.0178**	—	—	**0.631**	**1.23**	
2-Chloronaphthalene	—	—	—	**0.03 J**	—	—	—	**0.09 J**	**0.626**	—	—	
2-Methylpyrene	—	—	—	—	**0.286**	**47.8**	**0.0185**	—	—	**0.68**	**1.2**	
3-Methylphenanthrene	—	—	—	—	**1.93**	**151**	**0.0347**	—	—	**2.86**	**4.82**	
4-Methylpyrene	—	—	—	—	**0.253**	**52.1**	**0.0163**	—	—	**0.568**	**1.09**	
Benzo(b)fluorene	—	—	—	—	**0.414**	**72.3**	**0.0391**	—	—	**1.23**	**1.73**	
Biphenyl (1,1'-Biphenyl)	—	—	—	—	**2.34**	**92.4**	**0.00439**	—	—	**4.86**	**18.6**	
PAH (mg/kg)												
1-Methyldibenzothiophene	—	—	—	—	**0.177**	**12.2**	**0.00265**	—	—	**0.232**	**0.382**	
1-Methylnaphthalene	—	—	—	—	**3.03**	**518**	**0.0103**	—	—	**44.7**	**86.5**	
1-Methylphenanthrene	—	—	—	—	**1.74**	**150**	**0.0345**	—	—	**2.62**	**3.65**	
2,3,5-Trimethylnaphthalene (1,6,7-Trimethylnaphthalene)	—	—	—	—	**0.949**	**35.5**	**0.00449**	—	—	**1.19**	**2.29**	
2,6-Dimethylnaphthalene	—	—	—	—	**0.31**	**195**	**0.00505**	—	—	**13.2**	**38.7**	
2-Methylanthracene	—	—	—	—	**0.532**	**73.6**	**0.0274**	—	—	**1.04**	**1.39**	
2-Methyldibenzothiophene & 3-Methyldibenzothiophene	—	—	—	—	**0.462**	**33.3**	**0.00852**	—	—	**0.724**	**1.28**	
2-Methylnaphthalene	—	—	—	**2.37**	**0.257**	**15.5**	**0.00513**	**89.30 J**	**1020.00 J**	**53.9**	**124**	
2-Methylphenanthrene	—	—	—	—	**1.71**	**162**	**0.0334**	—	—	**2.87**	**4.68**	
4-Methyldibenzothiophene	—	—	—	—	**0.426**	**35.4**	**0.0073**	—	—	**0.661**	**1.16**	

Table 4
Summary of Laboratory Chemical Analyses Results in Sediment Samples – 2021

Chemical	TEC	PEC	Screening Level	Location ID	AQSS-06	AQSS-07	AQSS-07	AQSS-07D	AQSS-08	AQSS-08	AQSS-09	AQSS-10
				Sample ID	AQSS-06-1.5-2.0	AQSS-07-0.0-0.5	AQSS-07-1.5-2.0	AQSS-07D-4.9-5.4	AQSS-08-0.0-0.5	AQSS-08-1.0-1.5	AQSS-09-0.0-0.5	AQSS-10-0.0-0.5
				Sample Date	9/29/2021	9/29/2021	9/29/2021	9/30/2021	9/29/2021	9/29/2021	9/29/2021	9/29/2021
				Depth	1.5–2 ft	0–0.5 ft	1.5–2 ft	4.9–5.4 ft	0–0.5 ft	1–1.5 ft	0–0.5 ft	0–0.5 ft
4-Methylphenanthrene & 9-Methylphenanthrene	—	—	—		—	**1.68**	**163**	**0.0333**	—	—	**2.52**	**4.12**
Acenaphthene	—	—	—		**18.1**	**22.9**	**529**	**0.0198**	**41.9**	**443**	**18.5**	**41.8**
Acenaphthylene	—	—	—		**8.68**	**0.934**	**51.5**	**0.0291**	**14**	**48**	**1.17**	**4.37**
Anthracene	0.057	0.845	0.845		**26.5**	**2.51**	**245**	**0.107**	**33.6**	**143**	**6.4**	**7.51**
Benzo(a)anthracene	0.11	1.05	1.05		**29.8**	**2.13**	**146**	**0.116**	**24.2**	**86.7**	**3.03**	**4.16**
Benzo(a)fluoranthene	—	—	—		—	**0.369**	**31.5**	**0.0233**	—	—	**0.497**	**0.819**
Benzo(a)pyrene	0.15	1.45	1.45		**24.1**	**1.92**	**126**	**0.101**	**23.3**	**70.3**	**2.55**	**3.95**
Benzo(b)fluoranthene	—	—	—		**15.8**	**1.66**	**71.3**	**0.0585**	**11.5**	**39.7**	**1.96**	**2.25**
Benzo(c)fluorene	—	—	—		—	**0.2**	**28.2**	**0.0131**	—	—	**0.43**	**0.753**
Benzo(e)pyrene	—	—	—		—	**1.23**	**63.7**	**0.0533**	—	—	**1.48**	**2.07**
Benzo(g,h,i)perylene	—	—	—		**10.2**	**1.39**	**78.8**	**0.0556**	**10.9**	**38.5**	**1.5**	**2.31**
Benzo(j,k)fluoranthene	—	—	—		—	**1.55**	**73.1**	**0.0788**	—	—	**1.93**	**2.52**
Benzo(k)fluoranthene	—	—	—		**14.8**	—	—	—	**12.4**	**38.8**	—	—
Benzonaphthothiophene	—	—	—		—	**0.406**	**46.2**	**0.0194**	—	—	**0.70 J**	**1.23**
Benzothiophene	—	—	—		—	**0.0457**	**1.78**	**0.00 J**	—	—	**2.65**	**8.46**
Carbazole	—	—	—		—	**0.387**	**22**	**0.004**	—	—	**1.36**	**10.5**
Chrysene	0.17	1.29	1.29		**25.2**	**2.42**	**174**	**0.13**	**20.7**	**87.2**	**3.08**	**4.37**
Decalin, cis- & trans-	—	—	—		—	**0.115**	**2.04**	**0.000676**	—	—	**0.05 J**	**0.332**
Dibenzo(a,h)anthracene	—	—	—		**3.3**	—	—	—	**2.8**	**10.8**	—	—
Dibenzo(a,h)anthracene and Dibenzo(a,c)anthracene	0.033	—	0.033		—	**0.372**	**18.2**	**0.0153**	—	—	**0.38**	**0.629**
Dibenzofuran	—	—	—		—	**1.62**	**49.1**	**0.0155**	—	—	**2.79**	**5**
Dibenzothiophene	—	—	—		—	**2.25**	**83.1**	**0.0187**	—	—	**3.47**	**6.93**
Fluoranthene	0.42	2.23	2.23		**66.6**	**6.76**	**396**	**0.226**	**45.7**	**222**	**11**	**12**
Fluorene	0.077	0.536	0.536		**24.9**	**9.85**	**232**	**0.0355**	**34.3**	**249**	**12.7**	**33**
Indeno(1,2,3-c,d)pyrene	—	—	—		**10.6**	**1.3**	**66.6**	**0.0538**	**9.7**	**33.3**	**1.51**	**2.1**
Naphthalene	0.18	0.561	0.561		**4.44**	**0.71**	**50.8**	**0.0121**	**158.00 J**	**2260.00 J**	**88.2**	**252**
Perylene	—	—	—		—	**0.487**	**25.4**	**0.0261**	—	—	**0.592**	**0.695**
Phenanthrene	0.2	1.17	1.17		**82**	**22.8**	**999**	**0.24**	**120**	**595**	**34.8**	**56.3**
Pyrene	0.2	1.52	1.52		**57**	**5.83**	**470**	**0.213**	**75.6**	**288**	**10.6**	**13.4**
Retene	—	—	—		—	**0.07**	1.49 U	0.00 U	—	—	0.14 U	0.03 U
Total PAH (16) (U = 1/2)	1.61	22.8	22.8		**422**	**85**	**3730**	**1.49**	**639.00 J**	**4650.00 J**	**199**	**443**
C1-Benzo(b)thiophene	—	—	—		—	**0.344**	**14.5**	**0.00 J**	—	—	**3.8**	**9.56**
C1-Chrysenes	—	—	—		—	**1.17**	**167**	**0.066**	—	—	**1.58**	**3.32**

Table 4
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Chemical	TEC	PEC	Screening Level	Location ID	AQSS-06	AQSS-07	AQSS-07	AQSS-07D	AQSS-08	AQSS-08	AQSS-09	AQSS-10
				Sample ID	AQSS-06-1.5-2.0	AQSS-07-0.0-0.5	AQSS-07-1.5-2.0	AQSS-07D-4.9-5.4	AQSS-08-0.0-0.5	AQSS-08-1.0-1.5	AQSS-09-0.0-0.5	AQSS-10-0.0-0.5
				Sample Date	9/29/2021	9/29/2021	9/29/2021	9/30/2021	9/29/2021	9/29/2021	9/29/2021	9/29/2021
				Depth	1.5–2 ft	0–0.5 ft	1.5–2 ft	4.9–5.4 ft	0–0.5 ft	1–1.5 ft	0–0.5 ft	0–0.5 ft
C1-Decalins	—	—	—	—	**0.0859**	**4.01**	**0.00239**	—	—	**0.166**	**0.153**
C1-Dibenzothiophenes	—	—	—	—	**1.22**	**94.5**	**0.0208**	—	—	**1.88**	**3.31**
C1-Fluoranthenes/Pyrenes	—	—	—	—	**2.27**	**432**	**0.165**	—	—	**5.79**	**9.5**
C1-Fluorenes	—	—	—	—	**4.39**	**189**	**0.0296**	—	—	**5.43**	**10.6**
C1-Naphthalenes	—	—	—	—	**2.1**	**340**	**0.00979**	—	—	**64.1**	**137**
C1-Naphthobenzothiophenes	—	—	—	—	**0.269**	**49.5**	**0.0131**	—	—	**0.459**	**1.08**
C1-Phenanthrenes/Anthracenes	—	—	—	—	**7.12**	**664**	**0.16**	—	—	**11.5**	**17.7**
C2-Benzo(b)thiophene	—	—	—	—	**1.5**	**35.1**	**0.0019**	—	—	**2.97**	**7.87**
C2-Chrysenes	—	—	—	—	**0.701**	**105**	**0.0299**	—	—	**0.764**	**1.77**
C2-Decalins	—	—	—	—	**0.0618**	**4.67**	**0.0047**	—	—	0.07 U	**0.289**
C2-Dibenzothiophenes	—	—	—	—	**0.427**	**90.7**	**0.0199**	—	—	**1.05**	**1.84**
C2-Fluoranthenes/Pyrenes	—	—	—	—	**1.22**	**192**	**0.0571**	—	—	**1.69**	**3.55**
C2-Fluorenes	—	—	—	—	**1.47**	**148**	**0.0294**	—	—	**1.98**	**2.87**
C2-Naphthalenes	—	—	—	—	**14.8**	**485**	**0.0253**	—	—	**36.8**	**97.8**
C2-Naphthobenzothiophenes	—	—	—	—	**0.286**	**34.1**	**0.00717**	—	—	**0.368**	**0.713**
C2-Phenanthrenes/Anthracenes	—	—	—	—	**1.75**	**379**	**0.0917**	—	—	**4**	**6.22**
C3-Benzo(b)thiophene	—	—	—	—	**1**	**25.7**	**0.00428**	—	—	**1**	**2.53**
C3-Chrysenes	—	—	—	—	**0.56**	**56.7**	**0.0156**	—	—	**0.624**	**0.862**
C3-Decalins	—	—	—	—	**0.0519**	**3.32**	**0.00508**	—	—	0.07 U	**0.301**
C3-Dibenzothiophenes	—	—	—	—	**0.24**	**51.2**	**0.012**	—	—	**0.459**	**1.03**
C3-Fluoranthenes/Pyrenes	—	—	—	—	**0.552**	**84**	**0.0214**	—	—	**0.852**	**1.57**
C3-Fluorenes	—	—	—	—	**0.53 J**	**72.6**	**0.017**	—	—	**1.01 J**	**1.26 J**
C3-Naphthalenes	—	—	—	—	**8.12**	**283**	**0.0412**	—	—	**9.34**	**19.5**
C3-Naphthobenzothiophenes	—	—	—	—	**0.297**	**16.7**	**0.00415**	—	—	**0.386**	**0.407**
C3-Phenanthrenes/Anthracenes	—	—	—	—	**0.582**	**146**	**0.0348**	—	—	**1.1**	**2.2**
C4-Benzo(b)thiophene	—	—	—	—	**0.2**	**10.9**	**0.00267**	—	—	**0.223**	**0.375**
C4-Chrysenes	—	—	—	—	**0.35**	**19.4**	**0.00809**	—	—	0.14 U	**0.488**
C4-Decalins	—	—	—	—	**0.0902**	0.75 U	**0.00787**	—	—	0.07 U	**0.573**
C4-Dibenzothiophenes	—	—	—	—	**0.124**	**17.1**	**0.00463**	—	—	**0.221**	**0.378**
C4-Fluoranthenes/Pyrenes	—	—	—	—	**0.355**	**35.9**	**0.00991**	—	—	**0.528**	**0.731**
C4-Naphthalenes	—	—	—	—	**1.45**	**97.1**	**0.0219**	—	—	**1.78**	**2.74**
C4-Naphthobenzothiophenes	—	—	—	—	**0.237**	**7.67**	0.00 U	—	—	**0.37**	**0.239**
C4-Phenanthrenes/Anthracenes	—	—	—	—	**0.21**	**34.7**	**0.00867**	—	—	**0.268**	**0.614**

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Chemical	TEC	PEC	Screening Level	Location ID	AQSS-06	AQSS-07	AQSS-07	AQSS-07D	AQSS-08	AQSS-08	AQSS-09	AQSS-10
				Sample ID	AQSS-06-1.5-2.0	AQSS-07-0.0-0.5	AQSS-07-1.5-2.0	AQSS-07D-4.9-5.4	AQSS-08-0.0-0.5	AQSS-08-1.0-1.5	AQSS-09-0.0-0.5	AQSS-10-0.0-0.5
				Sample Date	9/29/2021	9/29/2021	9/29/2021	9/30/2021	9/29/2021	9/29/2021	9/29/2021	9/29/2021
				Depth	1.5–2 ft	0–0.5 ft	1.5–2 ft	4.9–5.4 ft	0–0.5 ft	1–1.5 ft	0–0.5 ft	0–0.5 ft
Total Alkylated PAHs	—	—	—			**159.62 J**	**9866.13 J**	**2.79 J**	—	—	**498.95 J**	**1097.33 J**
PCB Aroclors (µg/kg)												
Aroclor 1016	—	—	—	—	8.73 U	—	—	7.63 U	—	7.79 U	9.21 U	
Aroclor 1221	—	—	—	—	8.73 U	—	—	7.63 U	—	7.79 U	9.21 U	
Aroclor 1232	—	—	—	—	8.73 U	—	—	7.63 U	—	7.79 U	9.21 U	
Aroclor 1242	—	—	—	—	**127.00 J**	—	—	**94.7**	—	**94.5**	**108 J**	
Aroclor 1248	—	—	—	—	8.73 U	—	—	7.63 U	—	7.79 U	9.21 U	
Aroclor 1254	—	—	—	—	**299**	—	—	**65.60 J**	—	**122**	**293**	
Aroclor 1260	—	—	—	—	**44.9**	—	—	**16.9**	—	**14.1 J**	**54.6**	
Aroclor 1262	—	—	—	—	8.73 U	—	—	7.63 U	—	7.79 U	9.21 U	
Aroclor 1268	—	—	—	—	8.73 U	—	—	7.63 U	—	7.79 U	9.21 U	
Total PCB Aroclors (U = 1/2)	59.8	676	676	—	**497.00 J**	—	—	**200.00 J**	—	**254 J**	**483 J**	
EPH (mg/kg)												
C9-C18 Aliphatics unadjusted	—	—	3.17	—	—	—	—	—	—	—	—	
C19-C36 Aliphatics unadjusted	—	—	9.88	—	—	—	—	—	—	—	—	
C11-C22 Aromatics adjusted	—	—	0.09	—	—	—	—	—	—	—	—	
C11-C22 Aromatics unadjusted	—	—	—	—	—	—	—	—	—	—	—	
VPH (mg/kg)												
Benzene	—	—	—	—	—	—	—	—	—	—	—	
Ethylbenzene	—	—	—	—	—	—	—	—	—	—	—	
m,p-Xylene	—	—	—	—	—	—	—	—	—	—	—	
Methyl tert-butyl ether (MTBE)	—	—	—	—	—	—	—	—	—	—	—	
o-Xylene	—	—	—	—	—	—	—	—	—	—	—	
Toluene	—	—	—	—	—	—	—	—	—	—	—	
C5-C8 Aliphatics adjusted	—	—	—	—	—	—	—	—	—	—	—	
C5-C8 Aliphatics unadjusted	—	—	—	—	—	—	—	—	—	—	—	
C9-C12 Aliphatics adjusted	—	—	2.72	—	—	—	—	—	—	—	—	
C9-C12 Aliphatics unadjusted	—	—	—	—	—	—	—	—	—	—	—	
C9-C10 Aromatics unadjusted	—	—	—	—	—	—	—	—	—	—	—	

Table 4
Summary of Laboratory Chemical Analyses Results in Sediment Samples – 2021

Chemical	TEC	PEC	Screening Level	Location ID	AQSS-10	AQSS-11B	AQSS-11B	AQSS-11B	AQSS-12B	AQSS-13B	AQSS-13B	AQSS-18
				Sample ID	DUP1-20210929	AQSS-11B-0.0-0.5	AQSS-11B-1.5-1.9	AQSS-11B-2.5-3.0	AQSS-12B-0.0-0.5	AQSS-13B-0.0-0.5	AQSS-13B-1.5-2.0	AQSS-18-0.0-0.5
				Sample Date	9/29/2021	9/28/2021	9/28/2021	9/28/2021	9/28/2021	9/28/2021	9/28/2021	9/30/2021
				Depth	0–0.5 ft	0–0.5 ft	1.5–1.9 ft	2.5–3 ft	0–0.5 ft	0–0.5 ft	1.5–2 ft	0–0.5 ft
Conventional Parameters (%)												
Soot carbon	—	—	—		**0.138**	**0.378**	—	—	**1.08**	**0.1**	—	**0.03 J**
Total organic carbon	—	—	—		**2.66**	**2.39**	**9.44**	**0.89**	**4.19**	**3.24**	**10.2**	**1.15 J**
Total Solids	—	—	—		**81.1**	**87.6**	**84**	**84**	**82.6**	**84.5**	**70.4**	**90.8**
Metals (mg/kg)												
Arsenic	9.79	33	33		**74.6**	**6.39**	—	—	**24.8**	**6.17**	—	**22.60 J**
Barium	—	—	—		**27.4**	**16.8**	—	—	**20.6**	**41.5**	—	**13.8**
Cadmium	0.99	4.98	4.98		**1.283**	**0.3826**	—	—	**0.6318**	**0.2457**	—	**0.6468**
Chromium	43.4	111	111		**48.4**	**17**	—	—	**25.8**	**16.8**	—	**14.40 J**
Copper	—	149	149		—	—	—	—	—	—	—	—
Lead	35.8	128	128		**103**	**54.9**	—	—	**67.4**	**397**	—	**37.00 J**
Mercury	0.18	1.06	1.06		0.10 U	0.07 U	—	—	0.08 U	0.09 U	—	0.08 U
Selenium	—	—	11		**3.14**	2.27 U	—	—	2.38 U	2.35 U	—	2.09 U
Silver	—	—	0.57		0.61 U	0.57 U	—	—	0.60 U	0.59 U	—	0.52 U
SVOCs (mg/kg)												
1-Methylpyrene	—	—	—		—	**4.78**	**128**	—	—	**36.9**	**131**	—
2-Chloronaphthalene	—	—	—		—	—	—	**0.00 J**	**0.03 J**	—	—	**0.01 J**
2-Methylpyrene	—	—	—		—	**4.1**	**123**	—	—	**25.1**	**111**	—
3-Methylphenanthrene	—	—	—		—	**12**	**360**	—	—	**80.9**	**347**	—
4-Methylpyrene	—	—	—		—	**3.84**	**102**	—	—	**27**	**99**	—
Benzo(b)fluorene	—	—	—		—	**5.76**	**257**	—	—	**33.9**	**144**	—
Biphenyl (1,1'-Biphenyl)	—	—	—		—	**5.94**	**222**	—	—	**40.1**	**221**	—
PAH (mg/kg)												
1-Methyldibenzothiophene	—	—	—		—	**0.886**	**21.8**	—	—	**6.44**	**25**	—
1-Methylnaphthalene	—	—	—		—	**37.6**	**1080**	—	—	**278**	**1630**	—
1-Methylphenanthrene	—	—	—		—	**11.2**	**314**	—	—	**81.9**	**333**	—
2,3,5-Trimethylnaphthalene (1,6,7-Trimethylnaphthalene)	—	—	—		—	**2.37**	**72.1**	—	—	**15.9**	**59.8**	—
2,6-Dimethylnaphthalene	—	—	—		—	**17.4**	**506**	—	—	**103**	**592**	—
2-Methylanthracene	—	—	—		—	**5.48**	**200**	—	—	**37.7**	**178**	—
2-Methyldibenzothiophene & 3-Methyldibenzothiophene	—	—	—		—	**3.14**	**68.7**	—	—	**18.6**	**82.3**	—
2-Methylnaphthalene	—	—	—		—	**44.8**	**962**	**3.92 J**	**2.19 J**	**400**	**2320**	**1.57 J**
2-Methylphenanthrene	—	—	—		—	**13.2**	**404**	—	—	**85.7**	**361**	—
4-Methyldibenzothiophene	—	—	—		—	**3.24**	**69.3**	—	—	**20.2**	**93**	—

Table 4
Summary of Laboratory Chemical Analyses Results in Sediment Samples – 2021

Chemical	TEC	PEC	Screening Level	Location ID	AQSS-10	AQSS-11B	AQSS-11B	AQSS-11B	AQSS-12B	AQSS-13B	AQSS-13B	AQSS-18
				Sample ID	DUP1-20210929	AQSS-11B-0.0-0.5	AQSS-11B-1.5-1.9	AQSS-11B-2.5-3.0	AQSS-12B-0.0-0.5	AQSS-13B-0.0-0.5	AQSS-13B-1.5-2.0	AQSS-18-0.0-0.5
				Sample Date	9/29/2021	9/28/2021	9/28/2021	9/28/2021	9/28/2021	9/28/2021	9/28/2021	9/30/2021
				Depth	0–0.5 ft	0–0.5 ft	1.5–1.9 ft	2.5–3 ft	0–0.5 ft	0–0.5 ft	1.5–2 ft	0–0.5 ft
4-Methylphenanthrene & 9-Methylphenanthrene	—	—	—		—	**11.6**	**328**	—	—	**86.4**	**336**	—
Acenaphthene	—	—	—		—	**26**	**805**	**2.34**	**13**	**223**	**1100**	**5.29**
Acenaphthylene	—	—	—		—	**7.35**	**198**	**0.204**	**9.59**	**35.1**	**168**	**0.39**
Anthracene	0.057	0.845	0.845		—	**16.6**	**989**	**1.52**	**12.4**	**109**	**599**	**1.32**
Benzo(a)anthracene	0.11	1.05	1.05		—	**13.7**	**592**	**2.6**	**9.1**	**62.6**	**274**	**1.24**
Benzo(a)fluoranthene	—	—	—		—	**2.91**	**121**	—	—	**15.6**	**55.3**	—
Benzo(a)pyrene	0.15	1.45	1.45		—	**11.5**	**546**	**2.29**	**6.63**	**56.5**	**204**	**1.14**
Benzo(b)fluoranthene	—	—	—		—	**6.56**	**353**	**1.92**	**3.5**	**28.7**	**102**	**1.1**
Benzo(c)fluorene	—	—	—		—	**2.68**	**89.5**	—	—	**14.4**	**73.6**	—
Benzo(e)pyrene	—	—	—		—	**5.67**	**272**	—	—	**27.9**	**97.6**	—
Benzo(g,h,i)perylene	—	—	—		—	**5.55**	**296**	**1.12**	**3.22**	**33.6**	**87.8**	**0.693**
Benzo(j,k)fluoranthene	—	—	—		—	**7.22**	**363**	—	—	**31.7**	**130**	—
Benzo(k)fluoranthene	—	—	—		—	—	—	**1.75**	**4.41**	—	—	**0.839**
Benzonaphthothiophene	—	—	—		—	**3.56**	**125**	—	—	**24.1**	**85.4**	—
Benzothiophene	—	—	—		—	**0.734**	**46.3**	—	—	**13.9**	**61.2**	—
Carbazole	—	—	—		—	**1.37**	**52.7**	—	—	**7.3**	**66**	—
Chrysene	0.17	1.29	1.29		—	**13.8**	**552**	**2.05**	**9**	**75.2**	**296**	**1.09**
Decalin, cis- & trans-	—	—	—		—	**0.08 J**	**1.09 J**	—	—	**0.37 J**	**2.13 J**	—
Dibenzo(a,h)anthracene	—	—	—		—	—	—	**0.328**	**1.01**	—	—	**0.186**
Dibenzo(a,h)anthracene and Dibenzo(a,c)anthracene	0.033	—	0.033		—	**1.72**	**82.8**	—	—	**8.32**	**24.2**	—
Dibenzofuran	—	—	—		—	**4.34**	**421**	—	—	**10.5**	**165**	—
Dibenzothiophene	—	—	—		—	**5.96**	**246**	—	—	**36.4**	**179**	—
Fluoranthene	0.42	2.23	2.23		—	**29.6**	**1770**	**4.53**	**15.2**	**154**	**641**	**3.16**
Fluorene	0.077	0.536	0.536		—	**16.3**	**780**	**1.59**	**11**	**98.1**	**520**	**1.9**
Indeno(1,2,3-c,d)pyrene	—	—	—		—	**5.45**	**296**	**1.15**	**2.97**	**27.9**	**83.8**	**0.742**
Naphthalene	0.18	0.561	0.561		—	**40.5**	**2320**	**8.43 J**	**3.14 J**	**672**	**3690**	**8.22 J**
Perylene	—	—	—		—	**2.21**	**128**	—	—	**10.3**	**39.3**	—
Phenanthrene	0.2	1.17	1.17		—	**66.4**	**3410**	**4.25**	**43.4**	**422**	**1930**	**5.84**
Pyrene	0.2	1.52	1.52		—	**34.9**	**1590**	**3.5**	**21.4**	**204**	**801**	**2.77**
Retene	—	—	—		—	0.12 U	6.52 U	—	—	1.22 U	10.50 U	—
Total PAH (16) (U = 1/2)	1.61	22.8	22.8		—	**303**	**14900**	**39.60 J**	**169.00 J**	**2240**	**10700**	**35.90 J**
C1-Benzo(b)thiophene	—	—	—		—	**2.16**	**59.3**	—	—	**17.2**	**119**	—
C1-Chrysenes	—	—	—		—	**11.3**	**314**	—	—	**82.6**	**264**	—

Table 4
Summary of Laboratory Chemical Analyses Results in Sediment Samples – 2021

Chemical	TEC	PEC	Screening Level	Location ID	AQSS-10	AQSS-11B	AQSS-11B	AQSS-11B	AQSS-12B	AQSS-13B	AQSS-13B	AQSS-18
				Sample ID	DUP1-20210929	AQSS-11B-0.0-0.5	AQSS-11B-1.5-1.9	AQSS-11B-2.5-3.0	AQSS-12B-0.0-0.5	AQSS-13B-0.0-0.5	AQSS-13B-1.5-2.0	AQSS-18-0.0-0.5
				Sample Date	9/29/2021	9/28/2021	9/28/2021	9/28/2021	9/28/2021	9/28/2021	9/28/2021	9/30/2021
				Depth	0–0.5 ft	0–0.5 ft	1.5–1.9 ft	2.5–3 ft	0–0.5 ft	0–0.5 ft	1.5–2 ft	0–0.5 ft
C1-Decalins	—	—	—	—	—	**0.273**	**7.67**	—	—	**1.18**	**12.4**	—
C1-Dibenzothiophenes	—	—	—	—	—	**8.34**	**191**	—	—	**52.1**	**230**	—
C1-Fluoranthenes/Pyrenes	—	—	—	—	—	**34.3**	**1110**	—	—	**225**	**920**	—
C1-Fluorenes	—	—	—	—	—	**12.9**	**375**	—	—	**93.2**	**401**	—
C1-Naphthalenes	—	—	—	—	—	**53.6**	**1320**	—	—	**442**	**2570**	—
C1-Naphthobenzothiophenes	—	—	—	—	—	**3.27**	**77.4**	—	—	**26.8**	**80.2**	—
C1-Phenanthrenes/Anthracenes	—	—	—	—	—	**50.9**	**1540**	—	—	**355**	**1500**	—
C2-Benzo(b)thiophene	—	—	—	—	—	**3.24**	**75.7**	—	—	**18.6**	**111**	—
C2-Chrysenes	—	—	—	—	—	**5.5**	**139**	—	—	**50.2**	**125**	—
C2-Decalins	—	—	—	—	—	**0.59**	**16.2**	—	—	**3.17**	**26.2**	—
C2-Dibenzothiophenes	—	—	—	—	—	**7**	**141**	—	—	**48.4**	**192**	—
C2-Fluoranthenes/Pyrenes	—	—	—	—	—	**12.6**	**332**	—	—	**99.2**	**324**	—
C2-Fluorenes	—	—	—	—	—	**8.35**	**216**	—	—	**70.2**	**257**	—
C2-Naphthalenes	—	—	—	—	—	**45.8**	**1290**	—	—	**296**	**1590**	—
C2-Naphthobenzothiophenes	—	—	—	—	—	**1.75**	**36.5**	—	—	**17.1**	**42.9**	—
C2-Phenanthrenes/Anthracenes	—	—	—	—	—	**25**	**674**	—	—	**190**	**729**	—
C3-Benzo(b)thiophene	—	—	—	—	—	**1.84**	**42.6**	—	—	**11.7**	**54.9**	—
C3-Chrysenes	—	—	—	—	—	**2.4**	**76.3**	—	—	**24.2**	**56.2**	—
C3-Decalins	—	—	—	—	—	**0.427**	3.26 U	—	—	0.61 U	5.27 U	—
C3-Dibenzothiophenes	—	—	—	—	—	**3.04**	**61.7**	—	—	**25**	**84.9**	—
C3-Fluoranthenes/Pyrenes	—	—	—	—	—	**4.18**	**117**	—	—	**41.9**	**116**	—
C3-Fluorenes	—	—	—	—	—	**3.93**	**94.40 J**	—	—	**34.3**	**123**	—
C3-Naphthalenes	—	—	—	—	—	**18.4**	**536**	—	—	**125**	**560**	—
C3-Naphthobenzothiophenes	—	—	—	—	—	**0.832**	**20.3**	—	—	**8.78**	**21.2**	—
C3-Phenanthrenes/Anthracenes	—	—	—	—	—	**7.89**	**207**	—	—	**68.9**	**220**	—
C4-Benzo(b)thiophene	—	—	—	—	—	**0.654**	**15**	—	—	**4.99**	**20.5**	—
C4-Chrysenes	—	—	—	—	—	**0.901**	**37.8**	—	—	**9.2**	10.50 U	—
C4-Decalins	—	—	—	—	—	**0.795**	3.26 U	—	—	**4.7**	5.27 U	—
C4-Dibenzothiophenes	—	—	—	—	—	**0.848**	**18.7**	—	—	**8.07**	**25.8**	—
C4-Fluoranthenes/Pyrenes	—	—	—	—	—	**1.7**	**54.1**	—	—	**16.1**	**39.4**	—
C4-Naphthalenes	—	—	—	—	—	**5.46**	**160**	—	—	**42.6**	**166**	—
C4-Naphthobenzothiophenes	—	—	—	—	—	**0.436**	**8.65**	—	—	**4.26**	10.50 U	—
C4-Phenanthrenes/Anthracenes	—	—	—	—	—	**1.63**	**43.8**	—	—	**16.5**	**47**	—

Table 4
Summary of Laboratory Chemical Analyses Results in Sediment Samples – 2021

Chemical	TEC	PEC	Screening Level	Location ID	AQSS-10	AQSS-11B	AQSS-11B	AQSS-11B	AQSS-12B	AQSS-13B	AQSS-13B	AQSS-18
				Sample ID	DUP1-20210929	AQSS-11B-0.0-0.5	AQSS-11B-1.5-1.9	AQSS-11B-2.5-3.0	AQSS-12B-0.0-0.5	AQSS-13B-0.0-0.5	AQSS-13B-1.5-2.0	AQSS-18-0.0-0.5
				Sample Date	9/29/2021	9/28/2021	9/28/2021	9/28/2021	9/28/2021	9/28/2021	9/28/2021	9/30/2021
				Depth	0–0.5 ft	0–0.5 ft	1.5–1.9 ft	2.5–3 ft	0–0.5 ft	0–0.5 ft	1.5–2 ft	0–0.5 ft
Total Alkylated PAHs	—	—	—		—	—	**29892.45 J**	—	—	**6072.31 J**	**28556.07 J**	—
PCB Aroclors (µg/kg)												
Aroclor 1016	—	—	—		9.23 U	16.90 U	—	—	17.50 U	8.51 U	—	7.81 U
Aroclor 1221	—	—	—		9.23 U	16.90 U	—	—	17.50 U	8.51 U	—	7.81 U
Aroclor 1232	—	—	—		9.23 U	16.90 U	—	—	17.50 U	8.51 U	—	7.81 U
Aroclor 1242	—	—	—		**122**	**597**	—	—	**225**	**48.90 J**	—	**65.7**
Aroclor 1248	—	—	—		9.23 U	16.90 U	—	—	17.50 U	8.51 U	—	7.81 U
Aroclor 1254	—	—	—		**280**	**411**	—	—	**541**	**118**	—	**33.80 J**
Aroclor 1260	—	—	—		**47.5**	**93.8**	—	—	**135**	**191**	—	**7.48 J**
Aroclor 1262	—	—	—		9.23 U	16.90 U	—	—	17.50 U	8.51 U	—	7.81 U
Aroclor 1268	—	—	—		9.23 U	16.90 U	—	—	17.50 U	8.51 U	—	7.81 U
Total PCB Aroclors (U = 1/2)	59.8	676	676		**477**	**1150**	—	—	**954**	**383.00 J**	—	**130.00 J**
EPH (mg/kg)												
C9-C18 Aliphatics unadjusted	—	—	3.17		—	—	—	—	—	—	—	—
C19-C36 Aliphatics unadjusted	—	—	9.88		—	—	—	—	—	—	—	—
C11-C22 Aromatics adjusted	—	—	0.09		—	—	—	—	—	—	—	—
C11-C22 Aromatics unadjusted	—	—	—		—	—	—	—	—	—	—	—
VPH (mg/kg)												
Benzene	—	—	—		—	—	—	—	—	—	—	—
Ethylbenzene	—	—	—		—	—	—	—	—	—	—	—
m,p-Xylene	—	—	—		—	—	—	—	—	—	—	—
Methyl tert-butyl ether (MTBE)	—	—	—		—	—	—	—	—	—	—	—
o-Xylene	—	—	—		—	—	—	—	—	—	—	—
Toluene	—	—	—		—	—	—	—	—	—	—	—
C5-C8 Aliphatics adjusted	—	—	—		—	—	—	—	—	—	—	—
C5-C8 Aliphatics unadjusted	—	—	—		—	—	—	—	—	—	—	—
C9-C12 Aliphatics adjusted	—	—	2.72		—	—	—	—	—	—	—	—
C9-C12 Aliphatics unadjusted	—	—	—		—	—	—	—	—	—	—	—
C9-C10 Aromatics unadjusted	—	—	—		—	—	—	—	—	—	—	—

Table 4
Summary of Laboratory Chemical Analyses Results in Sediment Samples – 2021

Chemical	TEC	PEC	Screening Level	Location ID	AQSS-18	AQSS-18	AQSS-19	AQSS-19	AQSS-20	AQSS-20
				Sample ID	AQSS-18-3.0-3.5	AQSS-18-4.6-4.8	AQSS-19-3.0-3.5	AQSS-19-4.5-5.0	AQSS-20-0.0-0.5	AQSS-20-4.2-4.5
				Sample Date	9/30/2021	9/30/2021	9/30/2021	9/30/2021	9/30/2021	9/30/2021
				Depth	3–3.5 ft	4.6–4.8 ft	3–3.5 ft	4.5–5 ft	0–0.5 ft	4.2–4.5 ft
Conventional Parameters (%)										
Soot carbon	—	—	—		—	—	—	—	**0.17 J**	—
Total organic carbon	—	—	—		**5.74 J**	0.01 U	**0.08 J**	**0.07 J**	**2.32 J**	**0.02 J**
Total Solids	—	—	—		**84.3**	**84**	**89.3**	**87.9**	**87.3**	**83.3**
Metals (mg/kg)										
Arsenic	9.79	33	33		—	—	—	—	**14.50 J**	—
Barium	—	—	—		—	—	—	—	**26.4**	—
Cadmium	0.99	4.98	4.98		—	—	—	—	0.22 U	—
Chromium	43.4	111	111		—	—	—	—	**22.00 J**	—
Copper	—	149	149		—	—	—	—	—	—
Lead	35.8	128	128		—	—	—	—	**124 J**	—
Mercury	0.18	1.06	1.06		—	—	—	—	0.08 U	—
Selenium	—	—	11		—	—	—	—	2.23 U	—
Silver	—	—	0.57		—	—	—	—	0.56 U	—
SVOCs (mg/kg)										
1-Methylpyrene	—	—	—		—	—	—	—	—	—
2-Chloronaphthalene	—	—	—		**0.14 J**	0.00 U	**0.00 J**	0.00 U	**0.25 J**	0.00 U
2-Methylpyrene	—	—	—		—	—	—	—	—	—
3-Methylphenanthrene	—	—	—		—	—	—	—	—	—
4-Methylpyrene	—	—	—		—	—	—	—	—	—
Benzo(b)fluorene	—	—	—		—	—	—	—	—	—
Biphenyl (1,1'-Biphenyl)	—	—	—		—	—	—	—	—	—
PAH (mg/kg)										
1-Methyldibenzothiophene	—	—	—		—	—	—	—	—	—
1-Methylnaphthalene	—	—	—		—	—	—	—	—	—
1-Methylphenanthrene	—	—	—		—	—	—	—	—	—
2,3,5-Trimethylnaphthalene (1,6,7-Trimethylnaphthalene)	—	—	—		—	—	—	—	—	—
2,6-Dimethylnaphthalene	—	—	—		—	—	—	—	—	—
2-Methylanthracene	—	—	—		—	—	—	—	—	—
2-Methyldibenzothiophene & 3-Methyldibenzothiophene	—	—	—		—	—	—	—	—	—
2-Methylnaphthalene	—	—	—		**34.10 J**	0.00 UJ	**0.30 J**	**0.15 J**	**243.00 J**	**0.08 J**
2-Methylphenanthrene	—	—	—		—	—	—	—	—	—
4-Methyldibenzothiophene	—	—	—		—	—	—	—	—	—

Table 4
Summary of Laboratory Chemical Analyses Results in Sediment Samples – 2021

Chemical	TEC	PEC	Screening Level	Location ID	AQSS-18	AQSS-18	AQSS-19	AQSS-19	AQSS-20	AQSS-20
				Sample ID	AQSS-18-3.0-3.5	AQSS-18-4.6-4.8	AQSS-19-3.0-3.5	AQSS-19-4.5-5.0	AQSS-20-0.0-0.5	AQSS-20-4.2-4.5
				Sample Date	9/30/2021	9/30/2021	9/30/2021	9/30/2021	9/30/2021	9/30/2021
				Depth	3–3.5 ft	4.6–4.8 ft	3–3.5 ft	4.5–5 ft	0–0.5 ft	4.2–4.5 ft
4-Methylphenanthrene & 9-Methylphenanthrene	—	—	—		—	—	—	—	—	—
Acenaphthene	—	—	—		**155**	**0.00 J**	**0.17 J**	**0.0932**	**118**	**0.0484**
Acenaphthylene	—	—	—		**50.1**	**0.00443**	**0.0193**	**0.00732**	**29.7**	**0.0148**
Anthracene	0.057	0.845	0.845		**189**	**0.039**	**0.09 J**	**0.0435**	**56.7**	**0.056**
Benzo(a)anthracene	0.11	1.05	1.05		**236**	**0.0484**	**0.0769**	**0.0257**	**54.9**	**0.0442**
Benzo(a)fluoranthene	—	—	—		—	—	—	—	—	—
Benzo(a)pyrene	0.15	1.45	1.45		**197**	**0.0401**	**0.0586**	**0.0206**	**43.6**	**0.0354**
Benzo(b)fluoranthene	—	—	—		**144**	**0.0329**	**0.0478**	**0.0174**	**27.7**	**0.027**
Benzo(c)fluorene	—	—	—		—	—	—	—	—	—
Benzo(e)pyrene	—	—	—		—	—	—	—	—	—
Benzo(g,h,i)perylene	—	—	—		**113**	**0.0202**	**0.0304**	**0.0109**	**23.6**	**0.0176**
Benzo(j,k)fluoranthene	—	—	—		—	—	—	—	—	—
Benzo(k)fluoranthene	—	—	—		**147**	**0.0284**	**0.04 J**	**0.0147**	**20**	**0.0223**
Benzonaphthothiophene	—	—	—		—	—	—	—	—	—
Benzothiophene	—	—	—		—	—	—	—	—	—
Carbazole	—	—	—		—	—	—	—	—	—
Chrysene	0.17	1.29	1.29		**217**	**0.0449**	**0.06 J**	**0.021**	**60.3**	**0.0375**
Decalin, cis- & trans-	—	—	—		—	—	—	—	—	—
Dibenzo(a,h)anthracene	—	—	—		**25.9**	**0.00663**	**0.00794**	**0.00 J**	**7.35**	**0.00 J**
Dibenzo(a,h)anthracene and Dibenzo(a,c)anthracene	0.033	—	0.033		—	—	—	—	—	—
Dibenzofuran	—	—	—		—	—	—	—	—	—
Dibenzothiophene	—	—	—		—	—	—	—	—	—
Fluoranthene	0.42	2.23	2.23		**614**	**0.103**	**0.14 J**	**0.0516**	**85.3**	**0.0969**
Fluorene	0.077	0.536	0.536		**213**	**0.00929**	**0.13 J**	**0.0718**	**48.4**	**0.0596**
Indeno(1,2,3-c,d)pyrene	—	—	—		**100**	**0.0234**	**0.0349**	**0.0114**	**19.7**	**0.0198**
Naphthalene	0.18	0.561	0.561		**67.60 J**	0.00 UJ	**0.33 J**	**0.215 J**	**227.00 J**	**0.17 J**
Perylene	—	—	—		—	—	—	—	—	—
Phenanthrene	0.2	1.17	1.17		**797**	**0.0887**	**0.38 J**	**0.214**	**246**	**0.191**
Pyrene	0.2	1.52	1.52		**534**	**0.0884**	**0.15 J**	**0.0508**	**150**	**0.096**
Retene	—	—	—		—	—	—	—	—	—
Total PAH (16) (U = 1/2)	1.61	22.8	22.8		**3800.00 J**	**0.58 J**	**1.76 J**	**0.87 J**	**1220.00 J**	**0.94 J**
C1-Benzo(b)thiophene	—	—	—		—	—	—	—	—	—
C1-Chrysenes	—	—	—		—	—	—	—	—	—

Table 4
Summary of Laboratory Chemical Analyses Results in Sediment Samples – 2021

Chemical	TEC	PEC	Screening Level	Location ID	AQSS-18	AQSS-18	AQSS-19	AQSS-19	AQSS-20	AQSS-20
				Sample ID	AQSS-18-3.0-3.5	AQSS-18-4.6-4.8	AQSS-19-3.0-3.5	AQSS-19-4.5-5.0	AQSS-20-0.0-0.5	AQSS-20-4.2-4.5
				Sample Date	9/30/2021	9/30/2021	9/30/2021	9/30/2021	9/30/2021	9/30/2021
				Depth	3–3.5 ft	4.6–4.8 ft	3–3.5 ft	4.5–5 ft	0–0.5 ft	4.2–4.5 ft
C1-Decalins	—	—	—		—	—	—	—	—	—
C1-Dibenzothiophenes	—	—	—		—	—	—	—	—	—
C1-Fluoranthenes/Pyrenes	—	—	—		—	—	—	—	—	—
C1-Fluorenes	—	—	—		—	—	—	—	—	—
C1-Naphthalenes	—	—	—		—	—	—	—	—	—
C1-Naphthobenzothiophenes	—	—	—		—	—	—	—	—	—
C1-Phenanthrenes/Anthracenes	—	—	—		—	—	—	—	—	—
C2-Benzo(b)thiophene	—	—	—		—	—	—	—	—	—
C2-Chrysenes	—	—	—		—	—	—	—	—	—
C2-Decalins	—	—	—		—	—	—	—	—	—
C2-Dibenzothiophenes	—	—	—		—	—	—	—	—	—
C2-Fluoranthenes/Pyrenes	—	—	—		—	—	—	—	—	—
C2-Fluorenes	—	—	—		—	—	—	—	—	—
C2-Naphthalenes	—	—	—		—	—	—	—	—	—
C2-Naphthobenzothiophenes	—	—	—		—	—	—	—	—	—
C2-Phenanthrenes/Anthracenes	—	—	—		—	—	—	—	—	—
C3-Benzo(b)thiophene	—	—	—		—	—	—	—	—	—
C3-Chrysenes	—	—	—		—	—	—	—	—	—
C3-Decalins	—	—	—		—	—	—	—	—	—
C3-Dibenzothiophenes	—	—	—		—	—	—	—	—	—
C3-Fluoranthenes/Pyrenes	—	—	—		—	—	—	—	—	—
C3-Fluorenes	—	—	—		—	—	—	—	—	—
C3-Naphthalenes	—	—	—		—	—	—	—	—	—
C3-Naphthobenzothiophenes	—	—	—		—	—	—	—	—	—
C3-Phenanthrenes/Anthracenes	—	—	—		—	—	—	—	—	—
C4-Benzo(b)thiophene	—	—	—		—	—	—	—	—	—
C4-Chrysenes	—	—	—		—	—	—	—	—	—
C4-Decalins	—	—	—		—	—	—	—	—	—
C4-Dibenzothiophenes	—	—	—		—	—	—	—	—	—
C4-Fluoranthenes/Pyrenes	—	—	—		—	—	—	—	—	—
C4-Naphthalenes	—	—	—		—	—	—	—	—	—
C4-Naphthobenzothiophenes	—	—	—		—	—	—	—	—	—
C4-Phenanthrenes/Anthracenes	—	—	—		—	—	—	—	—	—

Table 4
Summary of Laboratory Chemical Analyses Results in Sediment Samples – 2021

Chemical	TEC	PEC	Screening Level	Location ID	AQSS-18	AQSS-18	AQSS-19	AQSS-19	AQSS-20	AQSS-20
				Sample ID	AQSS-18-3.0-3.5	AQSS-18-4.6-4.8	AQSS-19-3.0-3.5	AQSS-19-4.5-5.0	AQSS-20-0.0-0.5	AQSS-20-4.2-4.5
				Sample Date	9/30/2021	9/30/2021	9/30/2021	9/30/2021	9/30/2021	9/30/2021
				Depth	3–3.5 ft	4.6–4.8 ft	3–3.5 ft	4.5–5 ft	0–0.5 ft	4.2–4.5 ft
Total Alkylated PAHs	—	—	—	—	—					
PCB Aroclors (µg/kg)										
Aroclor 1016	—	—	—	—	—	—	—	8.14 U	—	
Aroclor 1221	—	—	—	—	—	—	—	8.14 U	—	
Aroclor 1232	—	—	—	—	—	—	—	8.14 U	—	
Aroclor 1242	—	—	—	—	—	—	—	8.14 U	—	
Aroclor 1248	—	—	—	—	—	—	—	8.14 U	—	
Aroclor 1254	—	—	—	—	—	—	—	**53.40 J**	—	
Aroclor 1260	—	—	—	—	—	—	—	**19.50 J**	—	
Aroclor 1262	—	—	—	—	—	—	—	8.14 U	—	
Aroclor 1268	—	—	—	—	—	—	—	8.14 U	—	
Total PCB Aroclors (U = 1/2)	59.8	676	676	—	—	—	—	**101.00 J**	—	
EPH (mg/kg)										
C9-C18 Aliphatics unadjusted	—	—	3.17	—	—	—	—	—	—	
C19-C36 Aliphatics unadjusted	—	—	9.88	—	—	—	—	—	—	
C11-C22 Aromatics adjusted	—	—	0.09	—	—	—	—	—	—	
C11-C22 Aromatics unadjusted	—	—	—	—	—	—	—	—	—	
VPH (mg/kg)										
Benzene	—	—	—	—	—	—	—	—	—	
Ethylbenzene	—	—	—	—	—	—	—	—	—	
m,p-Xylene	—	—	—	—	—	—	—	—	—	
Methyl tert-butyl ether (MTBE)	—	—	—	—	—	—	—	—	—	
o-Xylene	—	—	—	—	—	—	—	—	—	
Toluene	—	—	—	—	—	—	—	—	—	
C5-C8 Aliphatics adjusted	—	—	—	—	—	—	—	—	—	
C5-C8 Aliphatics unadjusted	—	—	—	—	—	—	—	—	—	
C9-C12 Aliphatics adjusted	—	—	2.72	—	—	—	—	—	—	
C9-C12 Aliphatics unadjusted	—	—	—	—	—	—	—	—	—	
C9-C10 Aromatics unadjusted	—	—	—	—	—	—	—	—	—	

Table 4
Summary of Laboratory Chemical Analyses Results in Sediment Samples – 2021

Notes:
Bold: Detected result
Concentration exceeds screening value. Only samples outside the area of Readily Apparent Harm were screened.
—: sample not submitted for analysis
µg/kg: micrograms per kilogram
EPH: extractable petroleum hydrocarbons
J: Estimated value
mg/kg: milligrams per kilogram
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
RCRA: Resource Conservation and Recovery Act
SVOC: semivolatile organic compound
TOC: total organic carbon
U: Compound analyzed for, but not detected above detection limit
UJ: Compound analyzed for, but not detected above estimated detection limit
VPH: volatile petroleum hydrocarbons

Table 5
Summary of Waste Characterization Laboratory Chemical Analyses in Sediment

Sample ID	WC1-093021
Sample Date	9/30/2021
Chemical	
Conventional Parameters (unitless)	
Ignitability	1.0 U
Conventional Parameters (mg/kg)	
Total Cyanide	0.98 J
Cyanide, reactive	10 U
Sulfide, reactive	10 U
Conventional Parameters (%)	
Total Solids	**84.8**
Conventional Parameters (unitless)	
Free liquid	Negative
pH	**6.6**
Metals (mg/kg)	
Arsenic	**58.4**
Barium	**22.2**
Cadmium	0.2312 U
Chromium	**36.8**
Lead	**9430**
Mercury	**0.175**
Selenium	2.31 U
Silver	0.578 U
VOCs (µg/kg)	
1,1,1,2-Tetrachloroethane	100 U
1,1,1-Trichloroethane	100 U
1,1,2,2-Tetrachloroethane	100 U
1,1,2-Trichloroethane	200 U
1,1-Dichloroethane	200 U
1,1-Dichloroethene	200 U
1,1-Dichloropropene	100 U
1,2,3-Trichlorobenzene	400 U
1,2,3-Trichloropropane	400 U
1,2,4-Trichlorobenzene	400 U
1,2,4-Trimethylbenzene	**68000**
1,2-Dibromo-3-chloropropane	600 U
1,2-Dichlorobenzene	400 U
1,2-Dichloroethane	200 U
1,2-Dichloroethene	200 U

Table 5
Summary of Waste Characterization Laboratory Chemical Analyses in Sediment

Sample ID	WC1-093021
Sample Date	9/30/2021
Chemical	
1,2-Dichloroethene, cis-	200 U
1,2-Dichloroethene, trans-	300 U
1,2-Dichloropropane	200 U
1,3,5-Trimethylbenzene (Mesitylene)	**25000**
1,3-Dichlorobenzene	400 U
1,3-Dichloropropane	400 U
1,3-Dichloropropene	100 U
1,3-Dichloropropene, cis-	100 U
1,3-Dichloropropene, trans-	200 U
1,4-Dichlorobenzene	400 U
1,4-Dioxane	16000 U
2,2-Dichloropropane	400 U
2-Chlorotoluene	400 U
2-Hexanone (Methyl butyl ketone)	2000 U
4-Chlorotoluene	400 U
4-Methyl-2-pentanone (Methyl isobutyl ketone)	2000 U
Acetone	2000 U
Benzene	**1800**
Bromobenzene	400 U
Bromochloromethane	400 U
Bromodichloromethane	100 U
Bromoform (Tribromomethane)	810 U
Bromomethane (Methyl bromide)	400 U
Carbon disulfide	2000 U
Carbon tetrachloride (Tetrachloromethane)	200 U
Chlorobenzene	100 U
Chloroethane	400 U
Chloroform	300 U
Chloromethane	810 U
Cymene, p- (4-Isopropyltoluene)	**6000**
Dibromochloromethane	200 U
Dibromomethane	400 U
Dichlorodifluoromethane	2000 U
Dichloromethane (Methylene chloride)	1000 U
Diethyl ether	400 U
Diisopropylether (Isopropyl Ether)	400 U

Table 5
Summary of Waste Characterization Laboratory Chemical Analyses in Sediment

Sample ID	WC1-093021
Sample Date	9/30/2021
Chemical	
Ethyl tert-butyl ether (ETBE)	400 U
Ethylbenzene	**99000**
Ethylene dibromide (1,2-Dibromoethane)	200 U
Hexachlorobutadiene (Hexachloro-1,3-butadiene)	810 U
Isopropylbenzene (Cumene)	**16000**
m,p-Xylene	**89000**
Methyl ethyl ketone (2-Butanone)	2000 U
Methyl tert-butyl ether (MTBE)	400 U
Naphthalene	**1100000**
n-Butylbenzene	**1000**
n-Propylbenzene	**6100**
o-Xylene	**46000**
sec-Butylbenzene	**490**
Styrene	**56 J**
tert-Butylbenzene	400 U
Tetrachloroethene (PCE)	100 U
Tetrahydrofuran	810 U
Toluene	**2000**
Trichloroethene (TCE)	100 U
Trichlorofluoromethane (Fluorotrichloromethane)	810 U
Vinyl chloride	200 U
SVOCs (µg/kg)	
2-Chloronaphthalene	**341 J**
tert-Amyl methyl ether (TAME)	400 U
Pesticides (µg/kg)	
Hexachlorobenzene	18.8 U
PAHs (µg/kg)	
2-Methylnaphthalene	**581000**
Acenaphthene	**247000**
Acenaphthylene	**55000**
Anthracene	**209000**
Benzo(a)anthracene	**179000**
Benzo(a)pyrene	**146000**
Benzo(b)fluoranthene	**102000**
Benzo(g,h,i)perylene	**64600**
Benzo(k)fluoranthene	**69100**

Table 5
Summary of Waste Characterization Laboratory Chemical Analyses in Sediment

Sample ID	WC1-093021
Sample Date	9/30/2021
Chemical	
Chrysene	**160000**
Dibenzo(a,h)anthracene	**20600**
Fluoranthene	**443000**
Fluorene	**247000**
Indeno(1,2,3-c,d)pyrene	**74000**
Naphthalene	**1040000**
Phenanthrene	**779000**
Pyrene	**389000**
Pesticides (µg/kg)	
4,4'-DDD (p,p'-DDD)	18.8 U
4,4'-DDE (p,p'-DDE)	18.8 U
4,4'-DDT (p,p'-DDT)	35.2 U
Aldrin	18.8 U
Chlordane	156 U
Dieldrin	11.7 U
Endosulfan sulfate	7.82 U
Endosulfan, alpha- (I)	18.8 U
Endosulfan, beta (II)	18.8 U
Endrin	7.82 U
Endrin ketone	18.8 U
Heptachlor	9.39 U
Heptachlor epoxide	35.2 U
Hexachlorocyclohexane (BHC), alpha-	7.82 U
Hexachlorocyclohexane (BHC), beta-	18.8 U
Hexachlorocyclohexane (BHC), delta-	18.8 U
Hexachlorocyclohexane (BHC), gamma- (Lindane)	6.26 U
Methoxychlor	35.2 U

Table 5
Summary of Waste Characterization Laboratory Chemical Analyses in Sediment

Sample ID	WC1-093021
Sample Date	9/30/2021
Chemical	
Herbicides (µg/kg)	
2,4,5-T (2,4,5-Trichlorophenoxyacetic acid)	194 U
2,4,5-TP (Silvex)	194 U
2,4-D (2,4-Dichlorophenoxyacetic acid)	194 U
PCB Aroclors (µg/kg)	
Aroclor 1016	8.17 U
Aroclor 1221	8.17 U
Aroclor 1232	8.17 U
Aroclor 1242	8.17 U
Aroclor 1248	8.17 U
Aroclor 1254	8.17 U
Aroclor 1260	8.17 U
Aroclor 1262	8.17 U
Aroclor 1268	8.17 U
TPH (mg/kg)	
Diesel range organics (C10 - C36)	**28000**

Notes:
Bold: Detected result
%: percent
µg/kg: micrograms per kilogram
J: estimated value
mg/kg: milligrams per kilogram
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
SVOC: semivolatile organic compound
TPH: total petroleum hydrocarbons
U: Compound analyzed for, but not detected above detection limit
VOC: volatile organic compound

Table 6
Physical Property Testing of Sediment

Chemical	Location ID	AQSS-11D	AQSS-10	AQSS-19	AQSS-04	AQSS-7D	AQSS-11b
	Sample ID	AQSS-11D-0.0-0.5	AQSS-10-0.0-0.4	AQSS-19-3.5-4.0	AQSS-04-0.5-1.0	AQSS-7D-0.0-0.5	AQSS-11b-2.6-3.1
	Sample Date	10/14-15/2021	10/14/2021	10/14/2021	10/14/2021	10/14/2021	10/14/2021
	Depth	0.0-0.5 ft	0.0-0.4 ft	3.5-4.0 ft	0.5-1.0 ft	0.0-0.5 ft	2.6-3.1 ft
	Method						
Conventional Parameters							
Moisture (water) content (%)	D2216	19.1	21.9	10.5	15.8	12.2	10.9
Bulk density (pcf)[1]	D7263	90.41	114.7	122.8	104.4	105.1	131.1
Dry density (pcf)[1]	D7263	75.91	94.07	111.1	90.17	93.59	118.2
Specific gravity	D854	2.56	2.77	2.72	2.65	2.71	2.71
Grain Size (%)							
Cobble	D6913/D7928	—	—	—	—	—	—
Gravel	D6913/D7928	2.6	6	15.1	25	38.6	18.2
Sand	D6913/D7928	89.9	86.1	48	69.2	57.4	56.2
Silt and Clay size	D6913/D7928	7.5	7.9	36.9	5.8	4	25.6
Total fines (Reported, not calculated)	D6913/D7928	—	—	—	—	—	—
Percent passing 37500 micron sieve (1 1/2 inch)	D6913/D7928	—	—	100	—	—	—
Percent passing 25000 micron sieve (1 inch)	D6913/D7928	—	—	100	100	100	100
Percent passing 19000 micron sieve (3/4 inch)	D6913/D7928	—	—	86	100	71	100
Percent passing 12500 micron sieve (1/2 inch)	D6913/D7928	—	100	86	95	69	94
Percent passing 9500 micron sieve (3/8 inch)	D6913/D7928	100	100	86	85	65	90
Percent passing 4750 micron sieve (#4)	D6913/D7928	97	94	85	75	61	82
Percent passing 2000 micron sieve (#10)	D6913/D7928	88	77	81	61	59	75
Percent passing 850 micron sieve (#20)	D6913/D7928	64	47	75	38	40	67
Percent passing 420 micron sieve (#40)	D6913/D7928	40	24	67	22	23	60
Percent passing 250 micron sieve (#60)	D6913/D7928	23	16	60	15	13	54
Percent passing 150 micron sieve (#100)	D6913/D7928	13	12	50	10	7	43
Percent passing 110 micron sieve (#140)	D6913/D7928	10	9	44	7	5	34
Percent passing 75 micron sieve (#200)	D6913/D7928	7.5	7.9	37	5.8	4	26

Table 6
Physical Property Testing of Sediment

Notes:
1. Sample comments from GeoTesting Express: Method B-Volumetric, Reconstituted (compacted) Horizontal Datum
—: sample not submitted for analysis
%: percent
ft: foot
MA: Massachusetts
MGP: manufactured gas plant
pcf: pound per cubic foot

Table 7
Summary of Disposal Sites Reported in MassDEP Database within 1 Mile of 284 Winter Street, Haverhill, Massachusetts

RTN	City/Town	Release Address	Site Name/Location Aid	Reporting Category	Notification Date	Compliance Status	Phase	RAO Class	Chemical Type
3-0017252	Haverhill	60–62 Locke Street	No Location Aid	2 HR	2/7/2003	RAO	Phase III	A3	Fuel Oil #6
3-0014848	Haverhill	414 River Street	No Location Aid	72 HR	10/19/1998	RAO	Phase III	A3	Stoddard Solvent
3-0015115	Haverhill	Bailey Boulevard	Gar Park	120 DY	5/14/1999	RAO	Phase II	B2	Naphthalene, TPH, Vinyl Chloride
3-0003263	Haverhill	7–11 Kenoza Avenue	Hess Station 21506 Fmr Merit Oil	None	12/2/2013	RAO	Phase V	A3	Petroleum
3-0000323	Haverhill	98 Hilldale Avenue	Haverhill Gas Co	None	5/19/2017	PSC		PA	Unknown
3-0000325	Haverhill	81 Hale Street	Haverhill Salvage	None	5/14/2004	RAO	Phase IV	PA	PCBs
3-0002512	Haverhill	2 Hilldale Avenue	Lafayette Square Gulf Station	None	10/21/2013	RAO	Phase IV	A3	Unknown
3-0002940	Haverhill	262 River Street	Pope Machine Facility	None	9/6/1996	RAO	Phase III	B2	Petroleum
3-0019580	Haverhill	15 South Main Street	No Location Aid	120 DY	8/4/2000	RAO		B2	C9–C10 Aromatic Hydrocarbons C9–C18 Aliphatic Hydrocarbons
3-0021955	Haverhill	200 Merrimack Street	Franklin Block Condo	72 HR	5/20/2004	RAO	Phase II	B2	Fuel Oil #2, Fuel Oil
3-0028623	Haverhill	236 South Elm Street	Former Gasoline Station	72 HR	11/1/2018	PSC	Phase IV	PA	Gasoline
3-0017885	Haverhill	414 River Street	No Location Aid	72 HR	5/26/1999	RAO		A3	Mineral Spirits
3-0018852	Haverhill	312 River Street	No Location Aid	72 HR	10/20/2000	RAO		B2	Gasoline
3-0021140	Haverhill	72–76 South Main Street	Central Square	120 DY	9/20/2013	RAO	Phase V	A3	C9–C10 Aromatic Hydrocarbons C9–C18 Aliphatic Hydrocarbons
3-0027348	Haverhill	117 Essex Street	Beneath Building 1 TRC-7 Area	120 DY	12/23/2009	RAO	Phase II	A3	Cadmium, Acenapthene, Benzo[a]anthracene, Benzo[a]pyrene, Benzo[b]fluoranthene, Chrysene, Dibenzofuran, Dibenz[a,h]anthracene, Indeno(1,2,3-cd)pyrene, Naphthalene 1, Phenanthrene
3-0024258	Haverhill	16–38 Walnut Street	No Location Aid	120 DY	9/28/2005	RAO		A3	C9–C18 Aliphatic Hydrocarbons C11–C22 Aromatic Hydrocarbons
3-0018974	Haverhill	93 Lafayette Square	No Location Aid	120 DY	11/23/1999	RAO	Phase II	B2	C5–C8 Aliphatic Hydrocarbons
3-0022813	Haverhill	79 Sixth Avenue	Motorvation	72 HR	2/22/2005	RAO	Phase II	A3	Lead, PCBs, Waste Oil
3-0024941	Haverhill	50–54 Locust Street and 56–62 Rear	No Location Aid	120 DY	1/31/2006	RAO		B2	C9–C18 Aliphatic Hydrocarbons C11–C22 Aromatic Hydrocarbons C9–C10 Aromatic Hydrocarbons
3-0019242	Haverhill	15 South Main Street	No Location Aid	72 HR	8/4/2000	RAO		B2	Gasoline

Notes:
https://www.mass.gov/info-details/massgis-data-massdep-tier-classified-oil-andor-hazardous-material-sites-mgl-c-21e
https://www.mass.gov/info-details/massgis-data-massdep-oil-andor-hazardous-material-sites-with-activity-and-use-limitations-aul
DY: day
Fmr: former
HR: hour
MassDEP: Massachusetts Department of Environmental Protection
PCB: polychlorinated biphenyl
PSC: professional services contract
RAO: response action outcome
TPH: total petroleum hydrocarbons

Table 8
Summary of Report Releases from National Response Center

NRC Report #	Type of Call	Date/Time Received	Description of Incident	Type of Incident	Incident Cause	Incident Date/Time	Location	State	Nearest City	County	Suspected Responsible Company	Medium Affected	Material Name
75829	INC	6/17/1991 10:11	Dumping tires, shingles, construction garbage, burying on property	Unknown Sheen	Dumping	6/12/1991 15:00	116 Hill Dale Avenue	MA	Haverhill	Essex	Auto Unlimited	Land	Miscellaneous dumping
239135	INC	5/12/1994 10:33	Caller states that RPS tanks are leaking Gas	Fixed	Equipment Failure	5/5/1994 12:00	Winter and Lafayette	MA	Haverhill	Essex	Haffners Gas Station	Land	Gasoline: Automotive (Unleaded)
439735	INC	6/2/1998 16:01	Caller states: There is a sheen on Little River below the falls that is believed to be coming from a tank in the gas station	Fixed	Unknown	5/30/1998 10:00	Winter and Lafayette	MA	Haverhill	Essex	Haffners Gas Station	Water	Gasoline: Automotive (Unleaded)
571940	INC	7/5/2001 19:27	The caller is reporting a sheen of unknown origin	Unknown Sheen	Unknown	7/5/2001 18:45	284 Winter Street	MA	Haverhill	Essex	N/A	Water	Waste oil
874126	INC	6/14/2008 11:52	Caller is reporting an unknown rainbow sheen in the Little River. The sheen is 30 feet wide and an unknown length	Unknown Sheen	Unknown	6/14/2008 10:00	Little River off of 8th Avenue	MA	Haverhill	Essex	N/A	Water	Unknown oil
950294	INC	8/8/2010 13:56	Caller reported an unknown sheen coming from an unknown source	Unknown Sheen	Unknown	8/8/2010 13:30	1 Granville Court, Little River	MA	Haverhill	Essex	N/A	Water	Unknown oil
1324491	INC	12/14/21 12:01	Caller stated that a truck caught fire in the loading rack, causing an unknown amount of its heating oil to spill to the ground and catch fire as well. The cause of the fire is unknown and will be investigated. Local fire department on scene	Mobile	Unknown	12/14/2021 11:45	Oil Facility Loading Area, 168 Hale Street	MA	Haverhill	Essex	Broco Energy	Land	Oil, Fuel: No. 2 (Heating Oil)

Notes:
https://nrc.uscg.mil/
INC: incident
MA: Massachusetts
MISC: miscellaneous
N/A: information not reported

Table 9
Analytical Summary of Upstream Sediment Data

Chemical	Sample Type	Composite Sample	Discrete Samples									
	Sample Location	Transect #1	SED-1	SED-2	SED-3	SED-4	SED-5	SED-6	SED-7	SED-8	SED-9	SED-10
	Sample Number	1117-02	0917-01	0917-03	0917-02	0917-05	0917-06	0917-07	0917-04	0917-10	0917-09	0917-08
	Sample Depth (ft)[1]	9–10	0–2	0–2	0–2.5	0–2	0–2	0–2	0–2	0–1.6	0–1.0	0–0.9
	Headspace (ppmv)	0.0	1.5	0.6	2.5	0.0	0.1	0.2	0.0	0.1	1.0	0.0
	Sample Date	11/17/2020	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021
Chemical	**Method**											
Total Metals (mg/kg)												
Arsenic	USEPA 6010/7471	15	12	13	41	16	ND<4.3	13	14	14	11	12
Barium	USEPA 6010/7471	99	—	—	—	—	—	—	—	—	—	—
Cadmium	USEPA 6010/7471	1.1	—	—	—	—	—	—	—	—	—	—
Chromium	USEPA 6010/7471	34	—	—	—	—	—	—	—	—	—	—
Copper	USEPA 6010/7471	40	—	—	—	—	—	—	—	—	—	—
Lead	USEPA 6010/7471	220	150	600	240	320	3.0	200	79	160	160	160
Mercury	USEPA 6010/7471	0.29	—	—	—	—	—	—	—	—	—	—
Nickel	USEPA 6010/7471	21	—	—	—	—	—	—	—	—	—	—
Selenium	USEPA 6010/7471	ND<7.7	—	—	—	—	—	—	—	—	—	—
Silver	USEPA 6010/7471	ND<0.77	—	—	—	—	—	—	—	—	—	—
Zinc	USEPA 6010/7471	230	—	—	—	—	—	—	—	—	—	—
Leachable Lead (mg/L)	USEPA 1311/6010	0.154	—	—	—	—	—	—	—	—	—	—
PCBs (mg/kg)												
Aroclor-1254	USEPA 8082A	—	0.2	0.23	ND<0.19	0.20	ND<0.11	ND<0.14	ND<0.15	ND<0.16	ND<0.14	ND<0.19
Aroclor-1260[2C]	USEPA 8082A	ND<0.18	—	—	—	—	—	—	—	—	—	—
Total PCBs	USEPA 8082A	ND<0.18	0.2	0.23	ND<0.19	0.20	ND<0.11	ND<0.14	ND<0.15	ND<0.16	ND<0.14	ND<0.19
VOCs (mg/kg)												
Ethylbenzene	USEPA 8260C	ND<0.16	—	—	—	—	—	—	—	—	—	—
n-Butylbenzene	USEPA 8260C	—	—	—	—	—	—	—	—	—	—	—
sec-Butylbenzene	USEPA 8260C	—	—	—	—	—	—	—	—	—	—	—
Isopropylbenzene (Cumene)	USEPA 8260C	ND<0.16	—	—	—	—	—	—	—	—	—	—
p-Isopropyltoluene (p-Cymene)	USEPA 8260C	ND<0.16	—	—	—	—	—	—	—	—	—	—
Naphthalene	USEPA 8260C	ND<0.33	—	—	—	—	—	—	—	—	—	—

Table 9
Analytical Summary of Upstream Sediment Data

	Sample Type	Composite Sample	Discrete Samples									
	Sample Location	Transect #1	SED-1	SED-2	SED-3	SED-4	SED-5	SED-6	SED-7	SED-8	SED-9	SED-10
	Sample Number	1117-02	0917-01	0917-03	0917-02	0917-05	0917-06	0917-07	0917-04	0917-10	0917-09	0917-08
	Sample Depth (ft)[1]	9–10	0–2	0–2	0–2.5	0–2	0–2	0–2	0–2	0–1.6	0–1.0	0–0.9
	Headspace (ppmv)	0.0	1.5	0.6	2.5	0.0	0.1	0.2	0.0	0.1	1.0	0.0
	Sample Date	11/17/2020	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021
Chemical	Method											
n-Propylbenzene	USEPA 8260C	ND<0.16	—	—	—	—	—	—	—	—	—	—
1,2,4 - Trimethylbenzene	USEPA 8260C	ND<0.16	—	—	—	—	—	—	—	—	—	—
1,3,5 - Trimethylbenzene	USEPA 8260C	—	—	—	—	—	—	—	—	—	—	—
m+p Xylene	USEPA 8260C	—	—	—	—	—	—	—	—	—	—	—
Total VOCs	USEPA 8260C	ND<Various	—	—	—	—	—	—	—	—	—	—
PAHs (mg/kg)												
Acenaphthene	USEPA 8270D-E	ND<0.39	—	—	—	ND<0.41	ND<0.23	ND<0.30	ND<0.32	ND<0.34	0.37	3.2
Acenaphthylene	USEPA 8270D-E	ND<0.39	—	—	—	ND<0.41	ND<0.23	ND<0.30	ND<0.32	ND<0.34	ND<0.29	ND<0.40
Anthracene	USEPA 8270D-E	0.49	—	—	—	ND<0.41	ND<0.23	ND<0.30	ND<0.32	ND<0.34	1.5	3.8
Benzo(a)anthracene	USEPA 8270D-E	1.4	—	—	—	1.2	ND<0.23	1.0	1.0	1.2	2.9	6.5
Benzo(a)pyrene	USEPA 8270D-E	1.6	—	—	—	1.4	ND<0.23	1.2	1.2	1.2	2.8	5.3
Benzo(b)fluoranthene	USEPA 8270D-E	2.1	—	—	—	2.0	ND<0.23	1.6	1.5	1.6	3.3	5.8
Benzo(g,h,i)perylene	USEPA 8270D-E	0.96	—	—	—	0.84	ND<0.23	0.89	0.65	0.57	1.8	3.3
Benzo(k)fluoranthene	USEPA 8270D-E	0.79	—	—	—	0.77	ND<0.23	0.66	0.58	0.52	1.2	2.2
Chrysene	USEPA 8270D-E	1.7	—	—	—	1.5	ND<0.23	1.3	1.1	1.3	2.9	7.2
Dibenz(a,h)anthracene	USEPA 8270D-E	ND<0.39	—	—	—	ND<0.41	ND<0.23	ND<0.30	ND<0.32	ND<0.34	0.43	0.73
Fluoranthene	USEPA 8270D-E	3.8	—	—	—	2.6	ND<0.23	2.2	2.3	2.4	5.9	12
Fluorene	USEPA 8270D-E	ND<0.39	—	—	—	ND<0.41	ND<0.23	ND<0.30	ND<0.32	ND<0.34	0.59	2.7
Indeno(1,2,3-cd)pyrene	USEPA 8270D-E	1.1	—	—	—	0.87	ND<0.23	0.91	0.82	0.71	1.9	3.3
2-Methylnaphthalene	USEPA 8270D-E	—	—	—	—	ND<0.41	ND<0.23	ND<0.30	ND<0.32	ND<0.34	ND<0.29	1.3
Naphthalene	USEPA 8270D-E	0.39	—	—	—	ND<0.41	ND<0.23	ND<0.30	ND<0.32	0.89	ND<0.29	1.7
Phenanthrene	USEPA 8270D-E	2.0	—	—	—	1.4	ND<0.23	1.6	1.2	0.95	5.2	21
Pyrene	USEPA 8270D-E	2.8	—	—	—	2.4	ND<0.23	2.1	2.0	2.3	5.8	19
Total PAHs		19.13	—	—	—	14.98	ND<0.23	13.46	12.35	13.64	36.59	99.03

Table 9
Analytical Summary of Upstream Sediment Data

Chemical	Sample Type	Composite Sample	Discrete Samples									
	Sample Location	Transect #1	SED-1	SED-2	SED-3	SED-4	SED-5	SED-6	SED-7	SED-8	SED-9	SED-10
	Sample Number	1117-02	0917-01	0917-03	0917-02	0917-05	0917-06	0917-07	0917-04	0917-10	0917-09	0917-08
	Sample Depth (ft)[1]	9–10	0–2	0–2	0–2.5	0–2	0–2	0–2	0–2	0–1.6	0–1.0	0–0.9
	Headspace (ppmv)	0.0	1.5	0.6	2.5	0.0	0.1	0.2	0.0	0.1	1.0	0.0
	Sample Date	11/17/2020	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021
	Method											
EPH (mg/kg)												
C9-C18 Aliphatics	Mass DEP EPH rev 2.1	86	—	—	—	99	ND<14	49	24	29	51	34
C19-C36 Aliphatics	Mass DEP EPH rev 2.1	46	—	—	—	640	ND<14	190	150	280	190	400
C11-C12 Aromatics	Mass DEP EPH rev 2.1	1,600	—	—	—	320	ND<14	150	98	200	100	260
Acenaphthene	Mass DEP EPH rev 2.1	80	—	—	—	—	—	—	—	—	—	—
Acenaphthylene	Mass DEP EPH rev 2.1	28	—	—	—	—	—	—	—	—	—	—
Anthracene	Mass DEP EPH rev 2.1	16	—	—	—	—	—	—	—	—	—	—
Benzo(a)anthracene	Mass DEP EPH rev 2.1	12	—	—	—	—	—	—	—	—	—	—
Benzo(a)pyrene	Mass DEP EPH rev 2.1	7.0	—	—	—	—	—	—	—	—	—	—
Benzo(b)fluoranthene	Mass DEP EPH rev 2.1	8.2	—	—	—	—	—	—	—	—	—	—
Benzo(g,h,i)perylene	Mass DEP EPH rev 2.1	2.7	—	—	—	—	—	—	—	—	—	—
Benzo(k)fluoranthene	Mass DEP EPH rev 2.1	2.7	—	—	—	—	—	—	—	—	—	—
Chrysene	Mass DEP EPH rev 2.1	11	—	—	—	—	—	—	—	—	—	—
Dibenz(a,h)anthracene	Mass DEP EPH rev 2.1	0.98	—	—	—	—	—	—	—	—	—	—
Fluoranthene	Mass DEP EPH rev 2.1	43	—	—	—	—	—	—	—	—	—	—
Fluorene	Mass DEP EPH rev 2.1	68	—	—	—	—	—	—	—	—	—	—
Indeno(1,2,3-cd)pyrene	Mass DEP EPH rev 2.1	3.0	—	—	—	—	—	—	—	—	—	—
2-Methylnaphthalene	Mass DEP EPH rev 2.1	270	—	—	—	—	—	—	—	—	—	—
Naphthalene	Mass DEP EPH rev 2.1	380	—	—	—	—	—	—	—	—	—	—
Phenathrene	Mass DEP EPH rev 2.1	150	—	—	—	—	—	—	—	—	—	—
Pyrene	Mass DEP EPH rev 2.1	48	—	—	—	—	—	—	—	—	—	—
Herbicides (mg/kg)												
MCPA [1]	USEPA 8151A	ND<29	—	—	—	—	—	—	—	—	—	—
MCPP [1]	USEPA 8151A	ND<29	—	—	—	—	—	—	—	—	—	—
Various	USEPA 8151A	—	—	—	—	—	—	—	—	—	—	—

Table 9
Analytical Summary of Upstream Sediment Data

	Sample Type	Composite Sample	Discrete Samples									
	Sample Location	Transect #1	SED-1	SED-2	SED-3	SED-4	SED-5	SED-6	SED-7	SED-8	SED-9	SED-10
	Sample Number	1117-02	0917-01	0917-03	0917-02	0917-05	0917-06	0917-07	0917-04	0917-10	0917-09	0917-08
	Sample Depth (ft)[1]	9–10	0–2	0–2	0–2.5	0–2	0–2	0–2	0–2	0–1.6	0–1.0	0–0.9
	Headspace (ppmv)	0.0	1.5	0.6	2.5	0.0	0.1	0.2	0.0	0.1	1.0	0.0
	Sample Date	11/17/2020	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021
Chemical	**Method**											
Pesticides (mg/kg)												
Various	USEPA 8081B	ND<Various	—	—	—	—	—	—	—	—	—	—
TOC (mg/kg)	USEPA 9060A	6.0	—	—	—	—	—	—	—	—	—	—

Notes:

1 - Composite Sample "Sample Depth" represents depth below water surface; 0.0 - 1.0 ft bml. Discrete Sample "Sample Depth" represents depth below mudline.

Data Source: Fuss & O'Neill, 2021. FY22 MVP Action Grant Sediment Management Report, City of Haverhill, Haverhill, Massachusetts. Prepared for the City of Haverhill. November 19, 2021.

—: not analyzed

EPH: extractable petroleum hydrocarbons

ft bml: feet below mudline

MassDEP: Massachusetts Department of Environmental Protection

mg/kg: milligrams per kilogram

mg/L: milligrams per liter

NA: criteria not defined in applicable regulations

ND<X: not detected above the lab reporting limits shown.

PAH: polycyclic aromatic hydrocarbon

PCB: polychlorinated biphenyl

ppmv: parts per million by volume

TOC: total organic carbon

USEPA: United States Environmental Protection Agency

VOC: volatile organic compound

Table 10
Summary of Field Observations of Sheen, Staining, and VOT in Sediment Cores

Core ID	Date Collected	Penetration (ft)	Measured Recovery (ft)	Recovery	Measured Depth to Observation		Thickness (ft)	Description
					Upper (ft)	Lower (ft)		
AQSS-03	9/30/2021	N/A	3.5	N/A	0	3.5	3.5	No apparent odor; no apparent sheen
AQSS-3B	9/30/2021	N/A	2.7	N/A	0	2.7	2.7	No apparent odor; no apparent sheen
AQSS-04	9/30/2021	N/A	2.2	N/A	0	2.2	2.2	1.0–1.5 feet: trace spots of sheen
AQSS-05	9/29/2021	N/A	2.6	N/A	0	2.6	2.6	No apparent sheen; no apparent odor
AQSS-06	9/29/2021	N/A	2	N/A	0	1.5	1.5	Trace rainbow sheens
					1.5	2	0.5	Trace pinhead droplets of NAPL, no apparent odor
AQSS-07D	9/30/2021	10	5.4	54.0%	0	3.1	3.1	No apparent visual impacts; little sheen from 2.4–3.1 feet
					3.1	4.9	1.8	Tar; 3.1–3.9 feet: saturated; heavy sheen in saturated interval; 3.9–4.9 feet: heavy rainbow sheen
					4.9	5.4	0.5	No apparent odor; no apparent NAPL
AQSS-07	9/29/2021	N/A	2.4	N/A	0	1.3	1.3	No apparent NAPL
					1.3	2.4	1.1	Tar saturated
AQSS-08	9/29/2021	N/A	1.7	N/A	0	0.6	0.6	Rainbow sheen
					0.6	1.7	1.1	Tar saturated; strong odor
AQSS-08B	9/29/2021	N/A	2.9	N/A	0	0.5	0.5	No apparent NAPL
					0.5	2.9	2.4	Sand black; tan grease-like layer above and below reddish-brown layer at 1.6–1.7 feet; small tar inclusions throughout, does not appear saturated
AQSS-09	9/29/2021	N/A	2.2	N/A	0	0.8	0.8	Faint odor
					0.8	2.2	1.4	Silver sheen; strong odor; moderate black droplets increasing with depth; material in fingers coated with NAPL
AQSS-10	9/29/2021	N/A	0.6	N/A	0	0.4	0.4	Strong odor; heavy rainbow sheen; no apparent NAPL
					0.4	0.6	0.2	Strong odor; moderate rainbow sheen; no apparent NAPL
AQSS-11	9/28/2021	7.5	3.2	42.7%	0.0	2.0	2	No apparent NAPL; faint odor
					2.0	3.2	1.2	Sand, tar saturated; silver sheen; moderate odor; not stiff and/or sticky
AQSS-11b	9/28/2021	N/A	3.5	N/A	0	0.8	0.8	Very strong odor
					0.8	1.9	1.1	Sand saturated with tar; stiff, sticky; very strong odor; silver sheen
					1.9	3.5	1.6	Droplets of NAPL and rainbow sheen; moderate odor
AQSS-11D	9/30/2021	10	5.2	52.0%	0	0.3	0.3	No apparent NAPL or sheen
					0.3	0.6	0.3	Droplets of black NAPL, moderate silver sheen
					0.6	1.1	0.5	Moderate silver sheen
					1.1	5.2	4.1	No apparent odor, NAPL, or sheen
AQSS-12	9/28/2021	4	2.4	60.0%	0	0.8	0.8	No apparent NAPL
					0.8	2.4	1.6	Sand black saturated with tar; sticky, stiff, strong odor; 1.5–1.6 feet: visible product; 2.1–2.4 feet: silt saturated with tar
AQSS-12B	9/28/2021	N/A	3.8	N/A	0	0.9	0.9	Little rainbow sheen on water; no apparent NAPL
					0.9	2.9	2	Black stiff sticky sand and tar; heavy sheen; strong odor
					2.9	3.8	0.9	Droplets of NAPL and silver sheen; some material does not appear visually impacted
AQSS-13	9/28/2021	N/A	2.1	N/A	0	0.2	0.2	Silver sheen
					0.2	2.1	1.9	Stiff and sticky tar saturated throughout interval; strong odor
AQSS-13B	9/28/2021	N/A	2.6	N/A	0	0.4	0.4	Strong odor
					0.4	2.6	2.2	Saturated with tar; 1.1–1.5 feet: saturated, stiff, and sticky; strong coal tar-like odor

Table 10
Summary of Field Observations of Sheen, Staining, and VOT in Sediment Cores

Core ID	Date Collected	Penetration (ft)	Measured Recovery (ft)	Recovery	Measured Depth to Observation		Thickness (ft)	Description
					Upper (ft)	Lower (ft)		
AQSS-18	9/30/2021	N/A	4.8	N/A	0	2.8	2.8	No apparent sheen or NAPL
					2.8	2.9	0.1	Spots of sheen rainbow
					2.9	3.1	0.2	Spots of sheen rainbow; tar-coated/saturated material
					3.1	3.4	0.3	Spots of sheen rainbow
					3.4	4.8	1.4	No apparent NAPL; no apparent odor
AQSS-19D	9/28/2021	N/A	3.2	N/A	0	0.4	0.4	No apparent NAPL
					0.4	3.2	2.8	0.4–0.8 foot: NAPL coating; 1.7–2.5 feet: tar; very strong odor; tar-saturated organics at 2.2 feet
AQSS-19	9/30/2021	10	5.9	59.0%	0	2.7	2.7	Heavy silver sheen; droplets of NAPL on surface water; 0.6–0.7 foot: droplets of NAPL; 0.7–1.7 feet: NAPL saturated, strong odor; 1.7–2.7 feet: droplets of sticky black NAPL
					2.7	5.9	3.2	No apparent NAPL or sheen; no apparent odor
AQSS-20	9/30/2021	10	4.6	46.0%	0	0.4	0.4	No apparent sheen; no apparent odor
					0.4	3.1	2.7	Heavy silver sheen throughout; 0.6–3.1 feet: tar coated/saturated, visible product, sticky, stiff
					3.1	3.2	0.1	No apparent sheen or NAPL
					3.2	4	0.8	3.5–4.0 feet: silver sheen increases with depth; trace droplets of NAPL
					4	4.6	0.6	No apparent sheen or NAPL
1A	6/8/2020	N/A	N/A	N/A	0	1	1	No apparent NAPL or sheen
					1	5.5	4.5	Strong petroleum-like odor; coated in coal tar; 1.0–1.3 feet: stained; 4.0 feet heavily saturated, physically sticky product
1B	6/8/2020	N/A	N/A	N/A	0	0.5	0.5	Slight petroleum-like odor; sheen on water; NAPL at 1.0 foot
1C	6/8/2020	N/A	N/A	N/A	0	0.5	0.5	Coal-tar impacted material begins at >1.7 feet
2A	6/9/2020	N/A	N/A	N/A	0	0.5	0.5	Impacted material encountered immediately at surface; 0.0–0.3 foot strong petroleum-like odor, coated in coal tar; 0.3–0.5 foot strong petroleum-like odor, saturated/coated in coal tar
					1	4	3	Petroleum-like odor; coated in coal tar
2B	6/9/2020	N/A	N/A	N/A	0	0.17	0.17	No apparent NAPL
					0.17	0.5	0.33	Saturated/coated in coal tar at approximately 0.2 foot; below black, strong petroleum-like odor, and coated/saturated in coal tar
2C	6/9/2020	N/A	N/A	N/A	0	0.5	0.5	Slight sheen; sheen on water when surface augering
3A	6/9/2020	N/A	N/A	N/A	0	0.5	0.5	Strong petroleum-like odor, stained/coated
3B	6/9/2020	N/A	N/A	N/A	0	0.5	0.5	Strong petroleum-like odor; saturated in coal tar
	6/10/2020				2	2.5	0.5	Strong petroleum-like odor; saturated in coal tar; significant sheen produced on water surface
3C	6/9/2020	N/A	N/A	N/A	0	0.5	0.5	Petroleum-like odor, sheen
4A	6/9/2020	N/A	N/A	N/A	0	0.5	0.5	Strong petroleum-like odor; coated in coal tar
					1	2.5	1.5	Strong petroleum-like odor; saturated in coal tar
4B	6/9/2020	N/A	N/A	N/A	0	0.5	0.5	Petroleum-like odor, sheen
5A	6/9/2020	N/A	N/A	N/A	0	0.5	0.5	Strong petroleum-like odor; coated in coal tar
	6/10/2020				2	3	1	Strong petroleum-like odor; coated/saturated in coal tar; significant sheen produced on water surface
5B	6/9/2020	N/A	N/A	N/A	0	0.5	0.5	Slight petroleum-like odor, no apparent NAPL or sheen
5C	6/9/2020	N/A	N/A	N/A	0	0.5	0.5	No apparent NAPL or sheen

Notes:
ft: feet
N/A: not available at this time
NAPL: nonaqueous phase liquid

Table 11
Chemical and Physical Properties of OHM

Chemical	Molecular Weight (g/mol)	Water Solubility (µg/L @25°C)	Vapor Pressure (mmHg @25°C)	Henry's Law Constant (atm-m^3/mol @ 25°C)	K_{oc}	Log K_{ow}
Total Metals						
Arsenic	75	Insoluble	N/A	N/A	N/A	N/A
Antimony	122	Insoluble	N/A	N/A	N/A	N/A
Beryllium	9	Insoluble	N/A	N/A	N/A	N/A
Cadmium	112	Insoluble	N/A	N/A	N/A	N/A
Chromium	52	Insoluble	N/A	N/A	N/A	N/A
Copper	64	Insoluble	N/A	N/A	N/A	N/A
Lead	207	Insoluble	N/A	N/A	N/A	N/A
Mercury	201	3.10E-02	2.00E-03	4.67E-01	5.20E+01	N/A
Nickel	59	Insoluble	N/A	N/A	N/A	N/A
Selenium	79	Insoluble	N/A	N/A	N/A	N/A
Silver	107	Insoluble	N/A	N/A	N/A	N/A
Thallium	204	Insoluble	N/A	N/A	N/A	N/A
Zinc	65	Insoluble	N/A	N/A	N/A	N/A
Cyanide	26	1.00E+09	N/A	1.90E+03	8.9	1.1
EPH						
C5–C8 Aliphatics	93	1.10E+04	0.10	54	2.30E+03	<3
C9–C10 Aromatics	120	5.10E+04	2.90E-03	0.33	1.80E+03	<3
C9–C18 Aliphatics	170	10	1.40E-04	69	6.80E+05	>3
C9–C36 Aliphatics		Immobile				
C11–C22 Aromatics	150	5.80E+03	3.20E-03	0.03	5.00E+03	
VOCs						
Acetone	58	1.00E+06	270	2.06E-05	2	-0.24
Benzene	78	1.78E+06	95	5.50E-03	83	2.13
Toluene	92	5.35E+05	28	6.68E-03	270	2.79
Ethylbenzene	106	1.61E+05	10	3.43E-03	580	3.13
Chlorobenzene	113	4.88E+05	11.8	3.93E-03	330	2.84
Styrene	104	3.20E+02	N/A	N/A	N/A	N/A
Xylenes (total)	106	1.71E+05	6	5.27E-03	300	3.33
PAHs						
Acenapthene	154	3.42E+03	2.30E-03	2.41E-04	4.60E+03	3.98
Acenapthylene	154	3.93E+03	2.90E-02	1.54E-03	2.50E+03	4.07
Anthracene	178	1.29E+03	1.70E-05	8.60E-05	1.40E+04	4.45
Benzo(a)anthracene	228	10	5.00E-09	1.00E-06	2.00E-05	5.61
Benzo(a)pyrene	252	3.80E+00	5.00E-09	4.90E-07	5.50E+06	6.06
Benzo(b)fluoranthene	252	14	5.00E-07	1.22E-05	5.50E+05	6.06
Benzo(k)fluoranthene	252	0.8	9.59E-11	3.87E-05	5.50E+05	6.06
Benzo(g,h,I)perylene	276	0.26	1.00E-10	1.44E-07	1.60E+06	6.51
bis(2-Ethylhexyl)pthalate	391	1.30E+03	7.23E-08	3.00E-07	1.00E+05	5.11
Dibenzo(a,h)anthracene	278	0.5	1.00E-10	7.30E-08	3.30E06	6.84
Dibenzofuran	168	N/A	N/A	N/A	N/A	N/A
Chrysene	228	6	6.30E-09	1.05E-06	2.00E-05	5.61
Fluoranthene	202	2.65E+02	5.00E-06	6.50E-06	3.80E+04	4.9
Fluorene	166	1.90E+03	6.30E-05	1.17E-04	7.30E+03	4.18
Indeno(1,2,3-cd)pyrene	276	0.53	1.00E-09	6.95E-08	1.60E+06	6.58
Napthalene	128	3.10E+04	8.20E-02	1.18E-03	1.30E+03	3.29
Phenanthrene	178	8.16E+02	9.60E-04	3.93E-05	1.40E+04	4.45
Phenol	94	9.30E+07	3.41E-01	1.30E-06	9.10E-01	1.46
Pyrene	202	1.60E+02	2.50E-06	5.10E-06	3.80E+04	4.88
2-Methylnapthalene	142	2.60E+04	3.18E-04	2.90E-04	7.20E+02	3.86

Notes:
µg/L: micrograms per liter
atm-m^3/mol: atmospheres for air to moles per cubic meter for water
EPH: extractable petroleum hydrocarbons
g/mol: gram per mol
K_{oc}: organic carbon partition coefficient
K_{ow}: octanol-water partition coefficient
mg/kg: milligrams per kilogram
mmHg: millimeters of mercury
N/A: not analyzed
PAH: polycyclic aromatic hydrocarbon
VOC: volatile organic compound

Figures

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ANCHOR QEA

Figure 1
Site Location Map
Phase II Comprehensive Site Assessment – Little River
Former Haverhill MGP Site

LEGEND:

- Tax Parcel
- Property Boundary
- Approximate Sediment Core Location (Anchor QEA, 2021)
- Sediment Sample Location (GZA, 2020)
- Cross Section Location (See Figures 7-8)

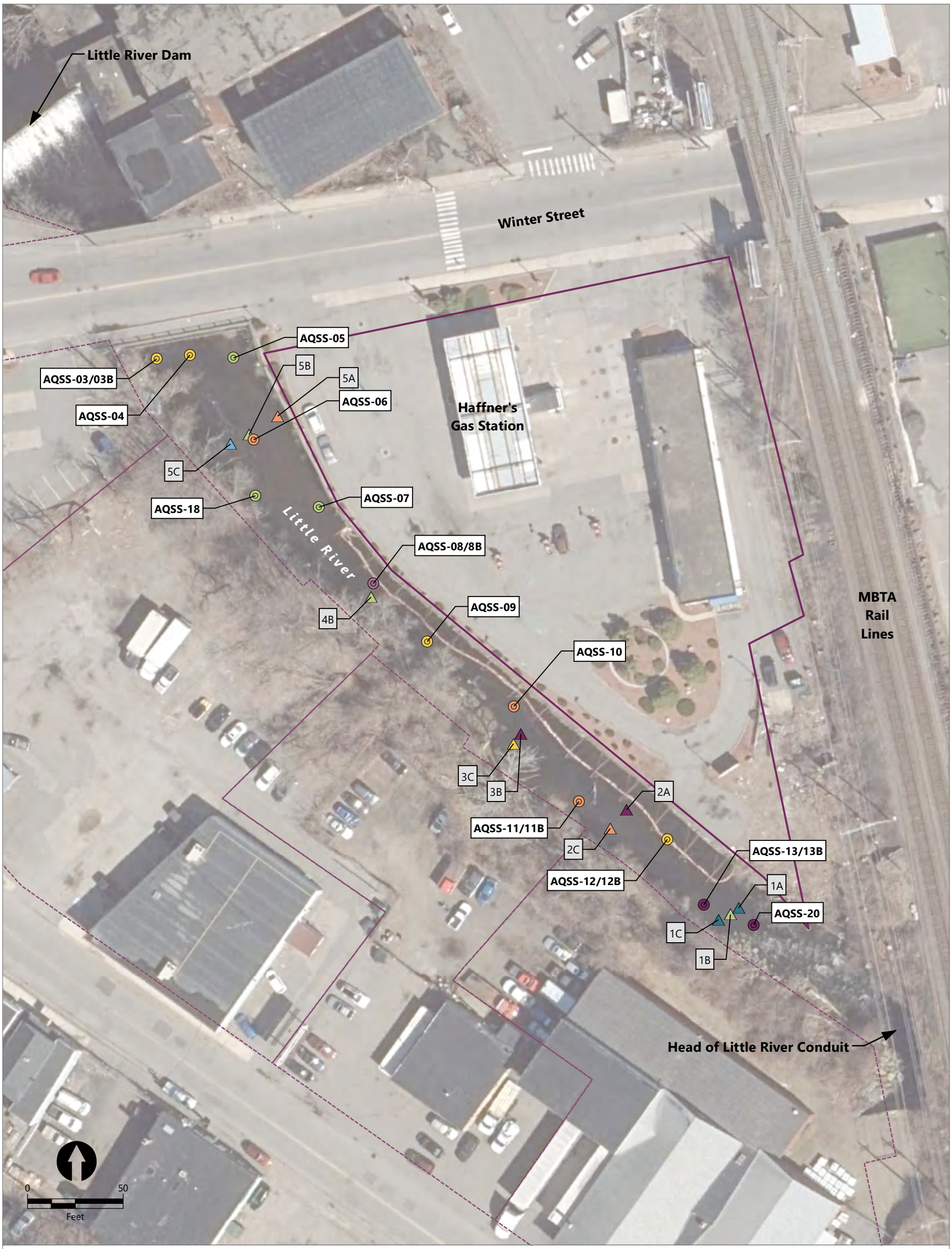
NOTES:

1. Horizontal datum is Massachusetts State Plane, North American Datum of 1983, U.S. Feet.
2. Aerial image is acquired from MassGIS at https://www.mass.gov/info-details/massgis-data-layers. Image date is 2019.
3. Tax parcels acquired from MassGIS at https://massgis.maps.arcgis.com on August 27, 2019.
4. Property boundary as recorded on ALTA/ACSM Land Title Survey plan performed by MHF Design Consultants (stamped February 12, 2015)

Publish Date: 2022/04/01, 12:38 PM | User: tweldy
Filepath: \\orcas\GIS\Jobs\National_Grid_0327\284_Winter_Street\Maps\Phase_2_Report\AQ_F2_Sample_Locations.mxd

ANCHOR QEA

Figure 2
Sample Location Map
Phase II Comprehensive Site Assessment – Little River
Former Haverhill MGP Site



LEGEND:

- Tax Parcel
- Property Boundary

Sediment Sampling Locations

- Approximate Sediment Core Location (Anchor QEA, 2021)
- Sediment Sample Location (GZA, 2020)[4]

tPAH16 Concentrations (mg/kg)

- ≤22.8
- >22.8 - 30
- >30 - 100
- >100 - 200
- >200 - 500
- >500 - 1000
- >1000

NOTES:

1. Horizontal datum is Massachusetts State Plane, North American Datum of 1983, U.S. Feet.
2. Aerial image is acquired from MassGIS at https://www.mass.gov/info-details/massgis-data-layers. Image date is 2019.
3. Tax parcels acquired from MassGIS at https://massgis.maps.arcgis.com on August 27, 2019.
4. Total PAH16 concentrations were calculated for the June 2020 sample locations 2A, 3B, and 5A from Extractable Petroleum Hydrocarbon (EPH) results.
5. Total PAH16 calculated from EPA Method 8270D-SIM results for 2021 samples and 2020 samples not referenced in Note 4.
6. Property boundary as recorded on ALTA/ACSM Land Title Survey plan performed by MHF Design Consultants (stamped February 12, 2015)

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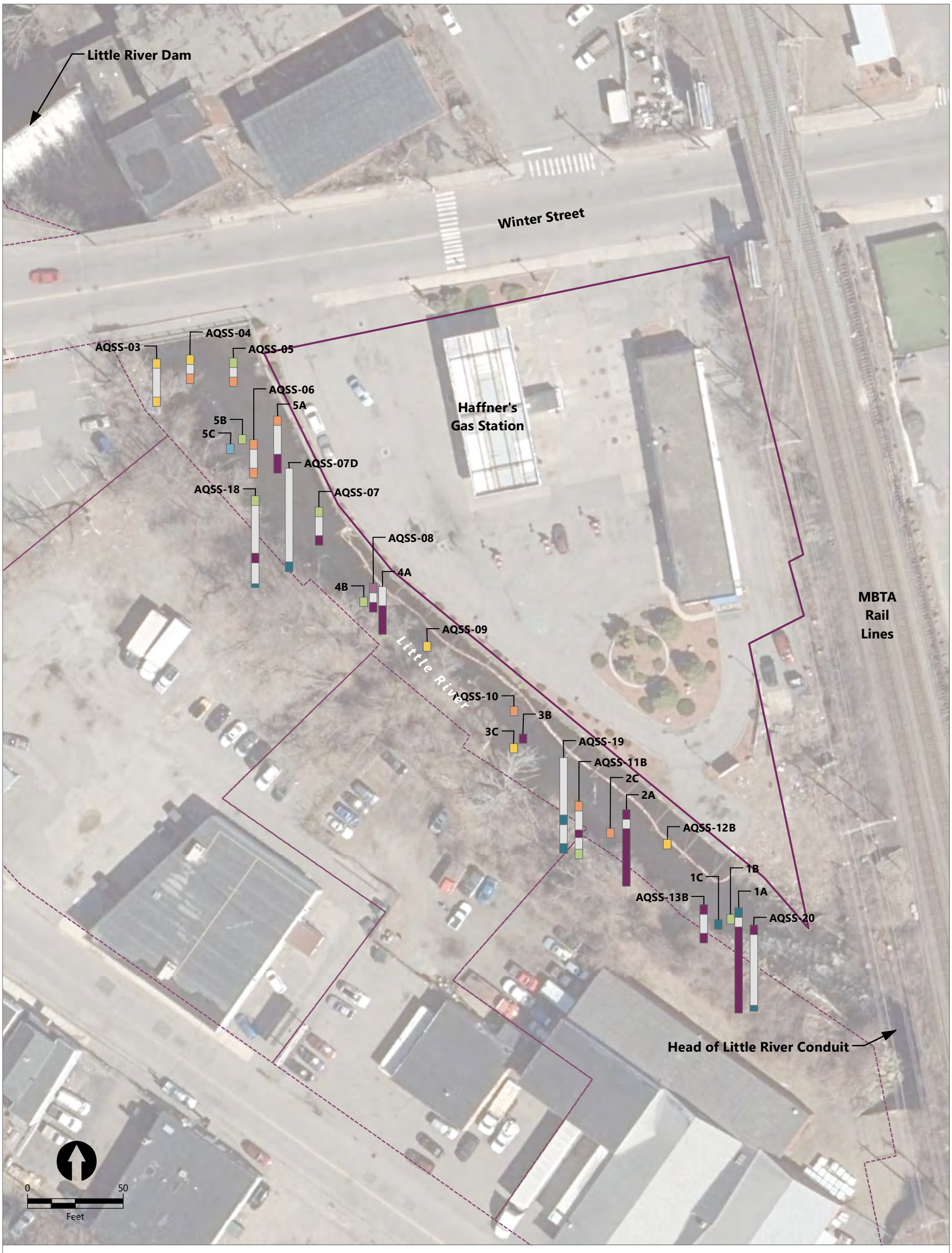
ANCHOR QEA

Figure 3
Total PAH16 Concentrations in Sediment Samples (0 - 0.5')
Phase II Comprehensive Site Assessment – Little River
Former Haverhill MGP Site



LEGEND:

- Tax Parcel
- Property Boundary
- Core Sample (0.5, 1.0, 2.0, 3.0, 4.0, 5.0)
- Depth below Mudline

tPAH16 Concentrations[4] (mg/kg)

- ≤22.8
- >22.8 - 30
- >30 - 100
- >100 - 200
- >200 - 500
- >500 - 1000
- >1000
- No Data

NOTES:

1. Horizontal datum is Massachusetts State Plane, North American Datum of 1983, U.S. Feet.
2. Aerial image is acquired from MassGIS at https://www.mass.gov/info-details/massgis-data-layers. Image date is 2019.
3. Tax parcels acquired from MassGIS at https://massgis.maps.arcgis.com on August 27, 2019.
4. Total PAH16 concentrations were calculated for the June 2020 sample locations 1A (1'-5.5'), 2A, 3B, 4A, and 5A from Extractable Petroleum Hydrocarbon (EPH) results
5. Total PAH16 calculated from EPA Method 8270D-SIM results for 2021 samples and 2020 samples not referenced in Note 4.
6. Property boundary as recorded on ALTA/ACSM Land Title Survey plan performed by MHF Design Consultants (stamped February 12, 2015)

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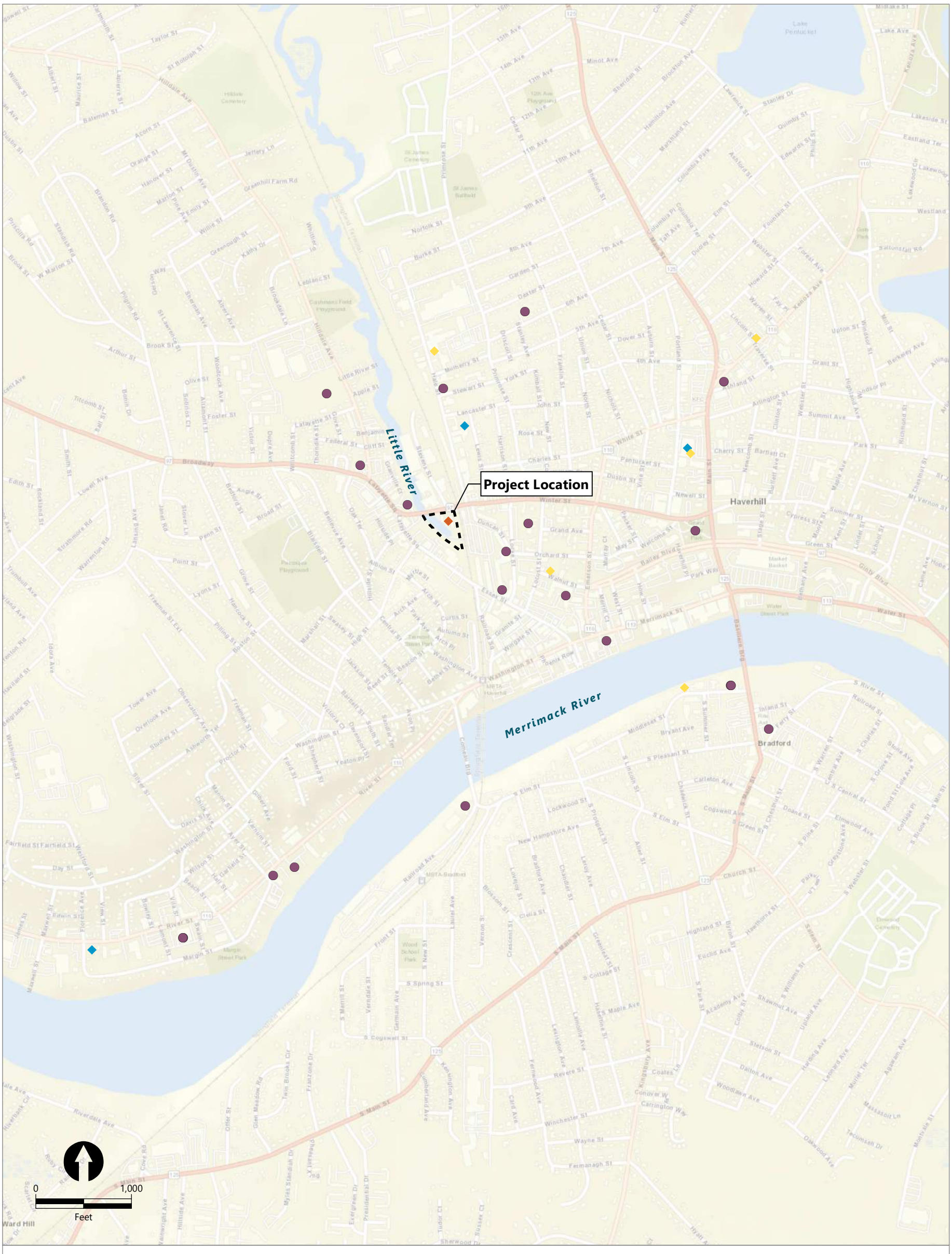
ANCHOR QEA

Figure 4
Total PAH16 Concentrations in Sediment Samples
Phase II Comprehensive Site Assessment – Little River
Former Haverhill MGP Site



LEGEND:

- Project Location
- Activity and Use Limitation Site

Chapter 21E Tier Classified Sites - Currently Active

Regulated Status

- TIER I
- TIER II
- TIER1D

NOTES:

1. Horizontal datum is Massachusetts State Plane, North American Datum of 1983, U.S. Feet.
2. Aerial image is acquired from MassGIS at https://www.mass.gov/info-details/massgis-data-layers. Image date is 2019.
3. Activity and use limitation sites acquired from https://www.mass.gov/info-details/massgis-data-massdep-oil-andor-hazardous-material-sites-with-activity-and-use-limitations-aul#downloads-
4. Chapter 21E Tier Classified Sites acquired from https://www.mass.gov/info-details/massgis-data-massdep-tier-classified-oil-andor-hazardous-material-sites-mgl-c-21e#downloads-

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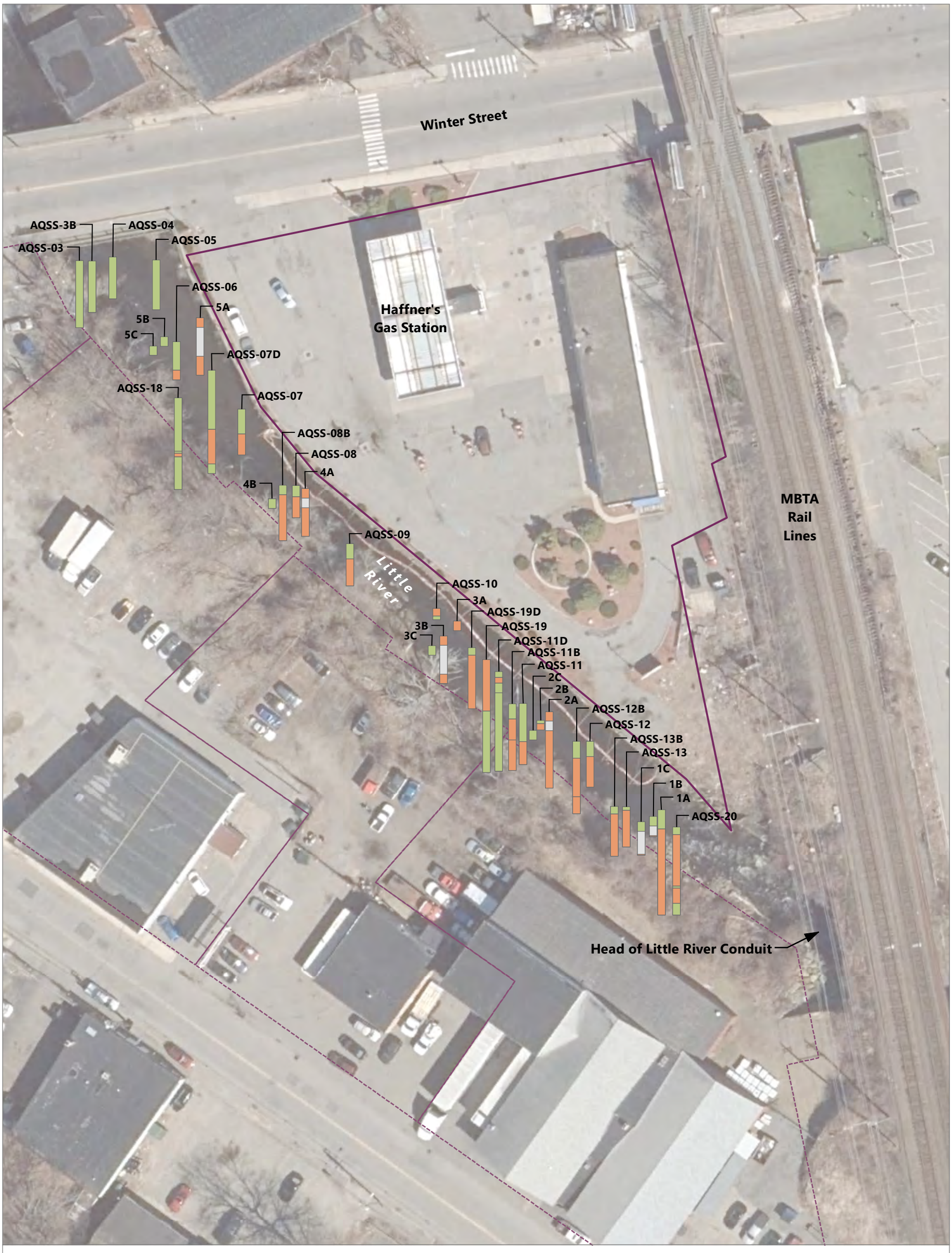
Figure 5

Activity and Use Limitation and Chapter 21E Tier Classified Sites within 1 Mile of Project Location

Phase II Comprehensive Site Assessment – Little River
Former Haverhill MGP Site



LEGEND:

- Tax Parcel
- Property Boundary

0.5
1.0
2.0
3.0
4.0
5.0
Core Sample

Depth below Mudline

NAPL Observations

- No Visible Oil and Tar Observed
- Visible Oil and Tar Observed
- No Data

NOTES:

1. Horizontal datum is Massachusetts State Plane, North American Datum of 1983, U.S. Feet.
2. Aerial image is acquired from MassGIS at https://www.mass.gov/info-details/massgis-data-layers. Image date is 2019.
3. Tax parcels acquired from MassGIS at https://massgis.maps.arcgis.com on August 27, 2019.
4. Property boundary as recorded on ALTA/ACSM Land Title Survey plan performed by MHF Design Consultants (stamped February 12, 2015)

0 50
Feet

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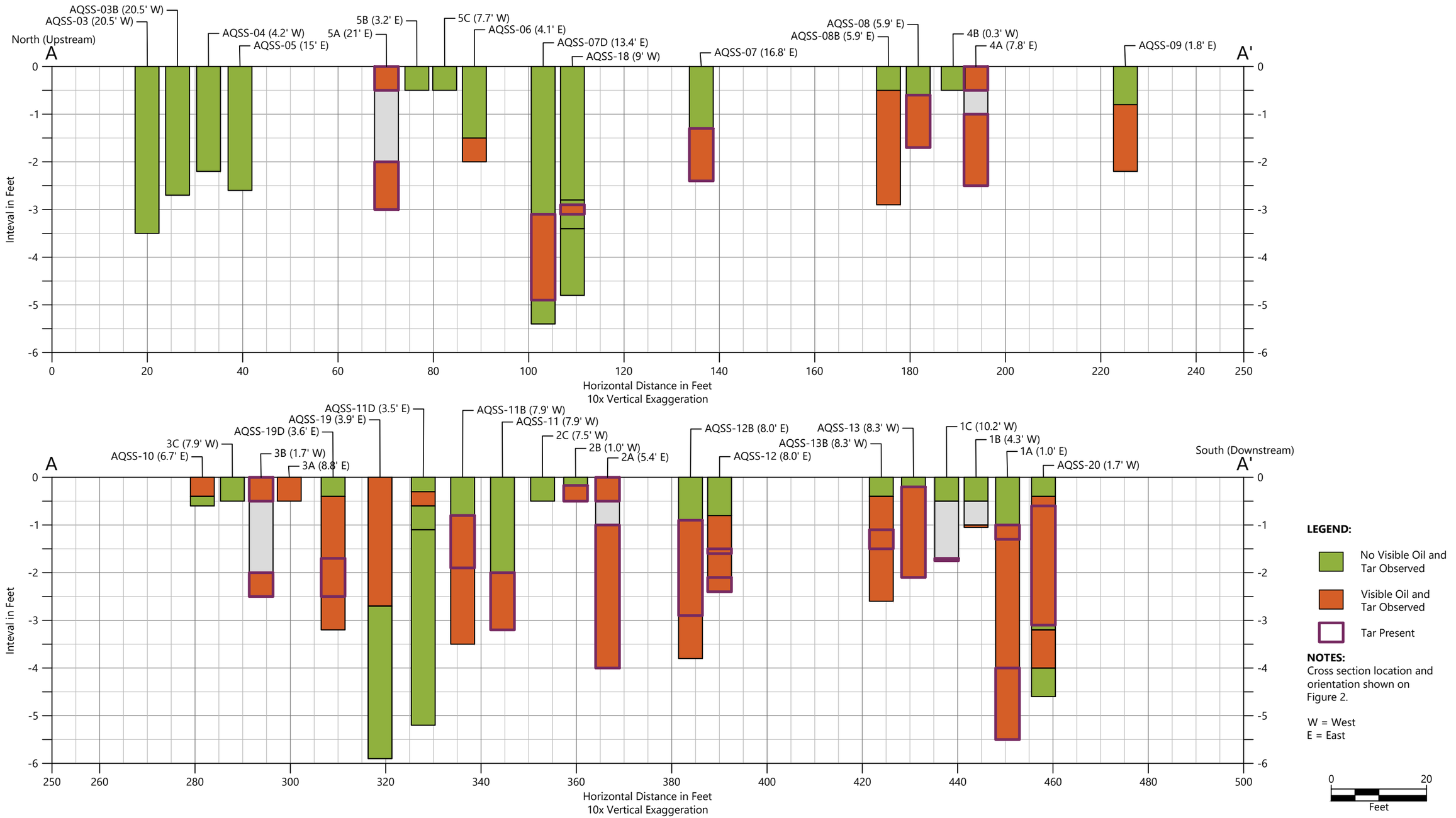
ANCHOR QEA

Figure 6
Field Observations of Visible Oil/Tar in Sediment Samples
Phase II Comprehensive Site Assessment – Little River
Former Haverhill MGP Site



Publish Date: 2022/03/31 1:14 PM | User: epipkin
Filepath: K:\Projects\0327-National Grid\Haverhill\Construction Plans\Phase2_Report\0327-Haverhill Ph2-Core Cross Sections.dwg NAPL AA'

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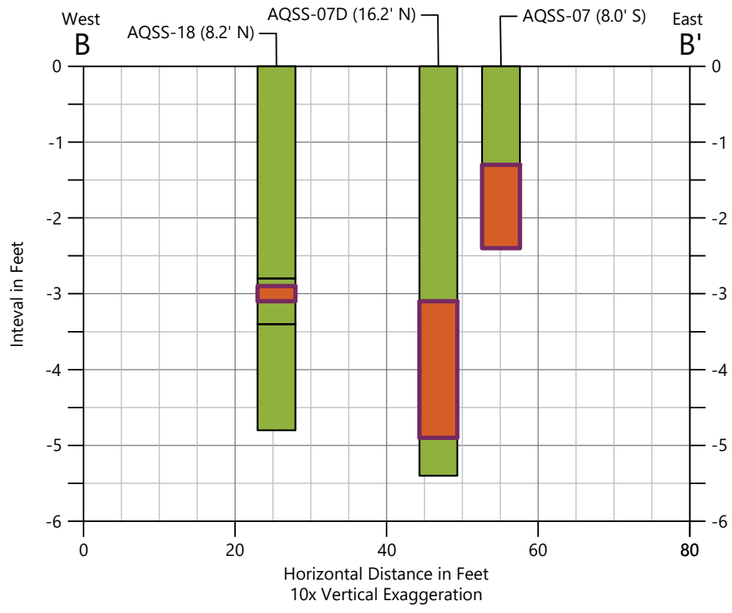
Figure 7
NAPL Cross Section A-A'

Phase II Comprehensive Site Assessment – Little River
Former Haverhill MGP Site



LEGEND:

- No Visible Oil and Tar Observed
- Visible Oil and Tar Observed
- Tar Present

NOTES:

Cross section location and orientation shown on Figure 2.

N = North
S = South

0 20
Feet

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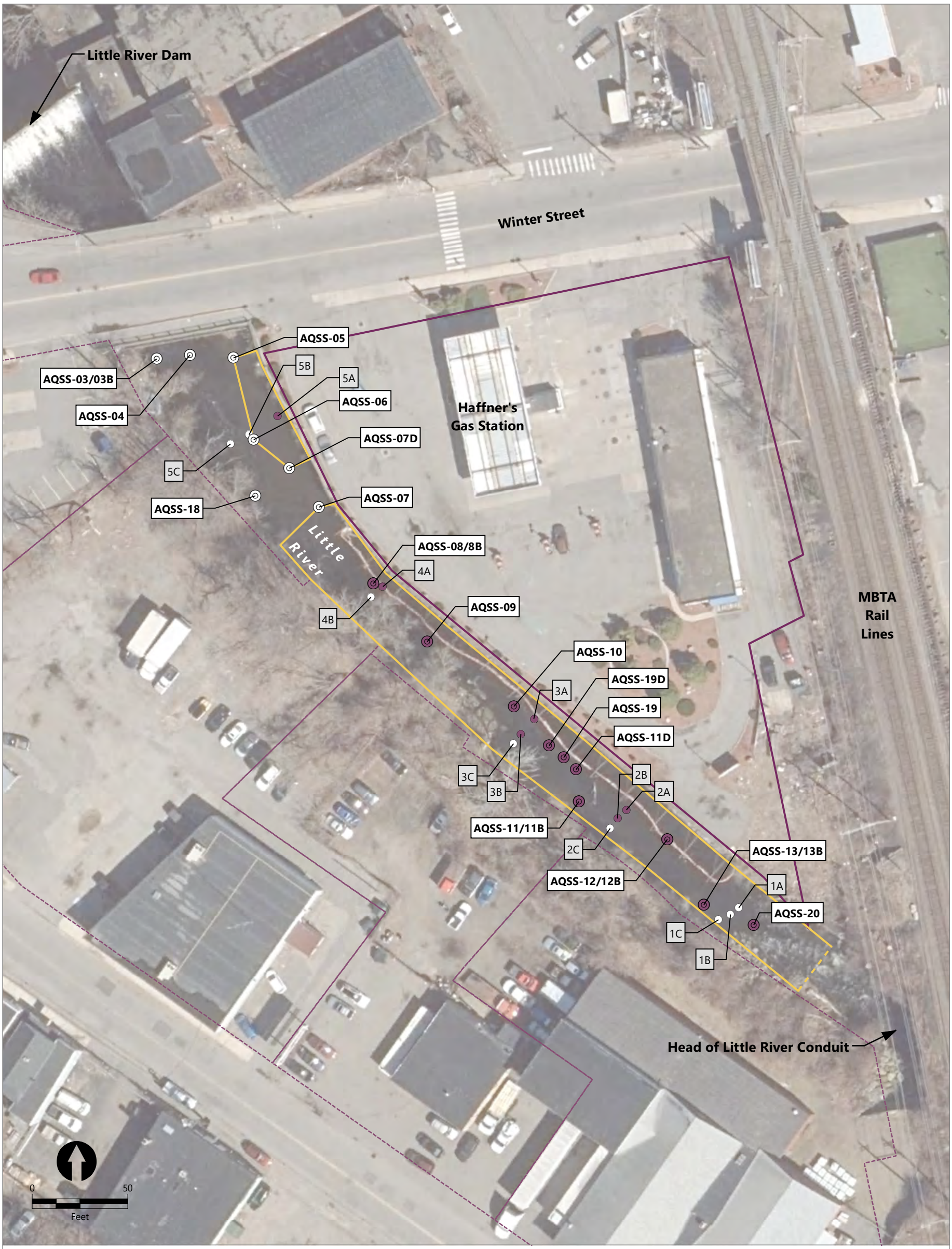
Figure 8
NAPL Cross Section B-B'

Phase II Comprehensive Site Assessment – Little River
Former Haverhill MGP Site



LEGEND:

- Tax Parcel
- Property Boundary
- Approximate Sediment Core Location (Anchor QEA, 2021)
- Sediment Sample Location (GZA, 2020)
- Visible Oil and/or Tar Present 0.0' - 1.0' below Mudline
- Approximate Area of Readily Apparent Harm

NOTES:

1. Horizontal datum is Massachusetts State Plane, North American Datum of 1983, U.S. Feet.
2. Aerial image is acquired from MassGIS at https://www.mass.gov/info-details/massgis-data-layers. Image date is 2019.
3. Tax parcels acquired from MassGIS at https://massgis.maps.arcgis.com on August 27, 2019.
4. Property boundary as recorded on ALTA/ACSM Land Title Survey plan performed by MHF Design Consultants (stamped February 12, 2015)

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ANCHOR QEA

Figure 9
Approximate Area of Readily Apparent Harm
Phase II Comprehensive Site Assessment – Little River
Former Haverhill MGP Site

Appendix A
Project Photographic Log

Photograph 1
Little River Dam during Low-Flow Conditions (7/27/2020)

Photograph 2
Little River Dam during High-Flow Conditions (9/17/2021)

Photograph 3
Little River during Low-Flow Conditions (7/27/2020)

Photograph 4
Little River during High-Flow Conditions (9/29/2021)

Photograph 5
Little River during Low-Flow Conditions (7/27/2020)

Photograph 6
Little River during High-Flow Conditions (9/17/2021)

Photograph 7
Western Bank of River

Photograph 8
Western Bank of River

Photograph 9
Western Bank of River

Photograph 10
Eastern Bank of River

Photograph 11
Winter Street Bridge

Photograph 12
Western Bank of River; Combined Sewer Outfall

Photograph 13
Outfall of the Little River Conduit into the Merrimack River

Photograph 14
Outfall of the Little River Conduit into the Merrimack River

Photograph 15
Sheen Visible in Little River Adjacent to 284 Winter St.

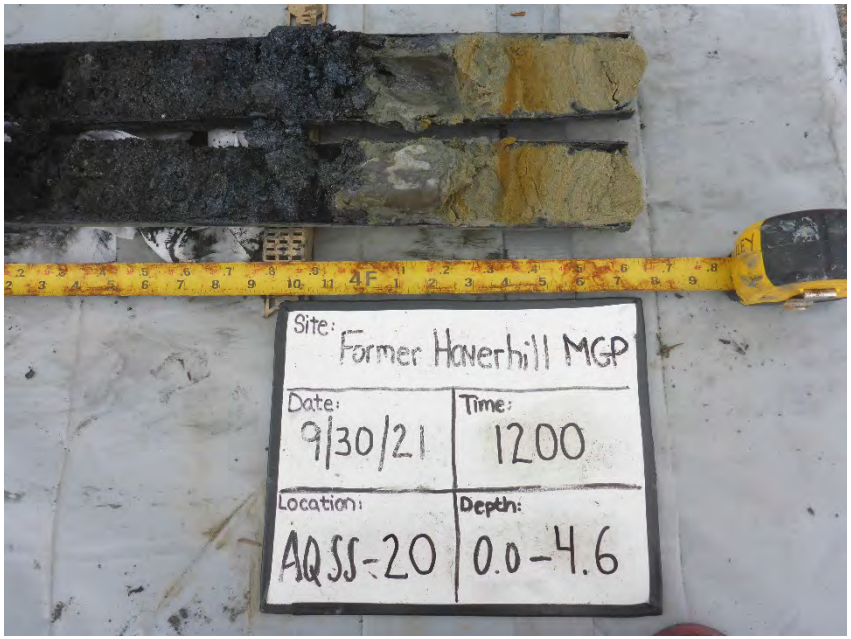
Photograph 16
Sheen inside Boom in Little River Adjacent to 284 Winter St.

Photograph 17
AQSS-20 from 0.0 to 1.3 Feet below Sediment Surface

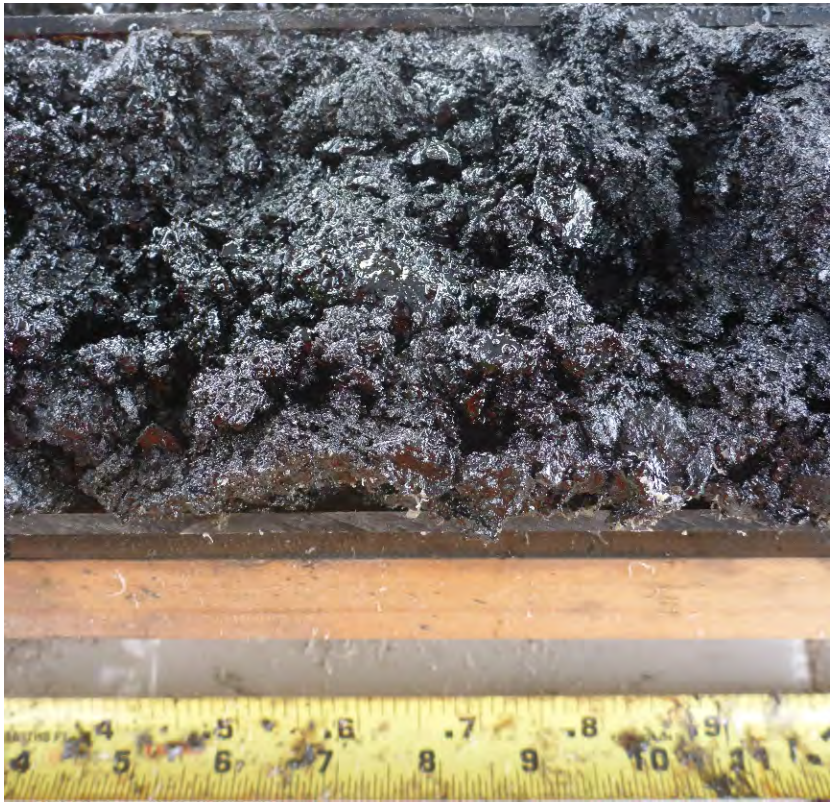
Photograph 18
AQSS-20 from 1.5 to 3.4 Feet below Sediment Surface

Photograph 19
AQSS-20 from 2.5 to 4.4 Feet below Sediment Surface

Photograph 20
AQSS-20 from 3.2 to 4.6 Feet below Sediment Surface



Photograph 21
Visible Oil and/or Tar Shown at AQSS-19D from 0.4 to 0.8 foot



Photograph 22
NAPL on the outside of the Core Barrel

Photograph 23
Core Collection Using a Crane and Vibracore

Photograph 24
Crane Setup

Appendix B
Data Usability Assessment

1201 3rd Ave Suite 2600
Seattle, Washington 98101
206.287.9130

Data Usability Assessment

December 9, 2021

Project: Haverhill Former Manufactured Gas Plant Site

Project Number: 180327-08.01

Introduction

This Data Usability Assessment (DUA) summarizes the results of the data validation of laboratory data for samples collected in September 2021. The validation was done on behalf of National Grid by Anchor QEA, LLC (AQ) as part of the Little River portion of the Haverhill Former Manufactured Gas Plan Site in Haverhill, Massachusetts. The objectives of the supplemental field investigation include collecting information to support the Phase II Comprehensive Site Assessment (CSA) and Phase III Comprehensive Response Action. This DUA has an analytical and a field component. The analytical component is used to evaluate whether the analytical data are valid and defensible and of a sufficient level of precision, accuracy, and sensitivity to support the CSA. The field component is used to evaluate the sampling procedures and ensure the samples are representative of actual site conditions. The field and laboratory IDs of the samples collected and analyzed for this sampling event are summarized in Table 1.

Table 1
Sample IDs and Matrices

Sample ID	Lab Sample ID	Matrix
AQSS-11B-0.0-0.5	L2152896-01	Sediment
AQSS-11B-1.5-1.9	L2152896-02	Sediment
AQSS-11B-2.5-3.0	L2152896-03	Sediment
AQSS-12B-0.0-0.5	L2152896-04	Sediment
AQSS-13B-0.0-0.5	L2152896-05	Sediment
AQSS-13B-1.5-2.0	L2152896-06	Sediment
AQSS-10-0.0-0.5	L2152896-07	Sediment
AQSS-09-0.0-0.5	L2152896-08	Sediment
DUP1-20210929	L2152896-09	Sediment
AQSS-08-0.0-0.5	L2152896-10	Sediment
AQSS-08-1.0-1.5	L2152896-11	Sediment
AQSS-07-0.0-0.5	L2152896-12	Sediment
AQSS-07-1.5-2.0	L2152896-13	Sediment
AQSS-06-0.0-0.5	L2152896-14	Sediment
AQSS-06-1.5-2.0	L2152896-15	Sediment
AQSS-05-0.0-0.5	L2153328-01	Sediment
AQSS-05-1.0-1.5	L2153328-02	Sediment
AQSS-04-0.0-0.5	L2153328-03	Sediment
AQSS-04-1.0-1.5	L2153328-04	Sediment
DUP2-20210930	L2153328-05	Sediment
AQSS-03-0.0-0.5	L2153328-06	Sediment

Sample ID	Lab Sample ID	Matrix
AQSS-03-2.0-2.5	L2153328-07	Sediment
AQSS-07D-4.9-5.4	L2153328-08	Sediment
AQSS-19-3.0-3.5	L2153328-09	Sediment
AQSS-19-4.5-5.0	L2153328-10	Sediment
AQSS-18-4.6-4.8	L2153328-11	Sediment
AQSS-18-3.0-3.5	L2153328-12	Sediment
AQSS-18-0.0-0.5	L2153328-13	Sediment
AQSS-20-0.0-0.5	L2153328-14	Sediment
AQSS-20-4.2-4.5	L2153328-15	Sediment
RB1-092921	L2153328-16	Water

Laboratory results were reviewed using the following guidelines:

- Quality Assurance Project Plan (QAPP), Haverhill Former Manufactured Gas Plant (Anchor QEA, 2021)
- USEPA 1986 (SW-846, Third Edition), Test Methods for Evaluating Solid Waste: Physical/Chemical Methods.
- USEPA National Functional Guidelines for Organic Superfund Methods Data Review (USEPA 2020a)
- USEPA National Functional Guidelines for Inorganic Superfund Methods Data Review (USEPA 2020b)

Analytical Data Usability Assessment

Analytical data that are compliant with the Massachusetts Department of Environmental Protection (MassDEP) Compendium of Analytical Methods (CAM) are assumed to have "Presumptive Certainty" and are considered data of known accuracy, precision, and sensitivity. Data reported under the methods compliant with Massachusetts Compendium for Analytical Methods (CAM) were validated at a Stage 2A level (PAHs, PCBs, EPH, VPH, metals) and non-CAM compliant methods (TOC and soot carbon) were validated at a Stage 2B level. Unless noted in this report, laboratory results for the samples listed above were within QC criteria.

Samples were analyzed by Alpha Analytical of Mansfield, Massachusetts for the following parameters:

- Polycyclic aromatic hydrocarbons (PAHs) and alkylated PAHs by U.S. Environmental Protection Agency (USEPA) method 8270D – select ion monitoring
- Polychlorinated biphenyls (PCBs) by USEPA method 8082A
- Metals by USEPA methods 6020B, 7470A, and 7471B
- Total organic carbon (TOC) and soot carbon by USEPA method 9060A
- Total solids (TS) by Standard Method 2540G

Laboratory instrument accuracy was evaluated by the calibration (when reviewed), laboratory control sample/ laboratory control sample duplicate (LCS/LCSD) percent recoveries. Precision was evaluated by the laboratory duplicate and LCS/LCSD relative percent difference (RPD) or difference values. Sensitivity was evaluated based on detection limits and reporting limits and laboratory method blank contamination. Any quality control deficiencies in the analytical data are described in the following sections and qualifiers applied to the data as a result of validation are summarized in Table 3.

Initial Calibrations and Calibration Verifications

Initial calibrations for TOC and soot carbon analyses met method requirements. Calibration verifications associated with TOC and soot carbon analyses were within laboratory standard operating procedure criteria.

Laboratory Control and Laboratory Control Sample Duplicates

Laboratory control samples (LCS) and laboratory control sample duplicates (LCSD) were analyzed at the required frequency and resulted in recoveries and/or RPD values were within project-required control limits except for naphthalene and 2-methylnaphthalene in the LCSD reported in batch WG1563704, which recovered below the control limit. Aroclor 1016 recovered below the control limit in the LCS and LCSD reported in association with the rinse blank. Associated sample results were qualified “J” or “UJ” to indicate a potentially low bias.

Laboratory Duplicates

Laboratory duplicates were analyzed at the required frequency. Sample or duplicate results that were less than five times the reporting limit were evaluated by the difference between them, using the control limit of plus or minus twice the MRL. Duplicate difference or RPD values were within project-required control limits except for the TOC duplicate analyzed on sample DUP2-20210930. Associated batch sample results have been qualified “J” to indicate they are estimated.

Laboratory Method Blanks

Laboratory method blanks were analyzed at the required frequencies. Method blanks were free of target analytes except for some low-level detections of PAHs in two method blanks. Most associated sample results were significantly greater than (greater than five times) the levels detected in the blanks and three results in two samples were qualified as non-detects.

Method Reporting Limits

Reporting limits were acceptable as reported. All values were reported using the laboratory reporting limits. Values were reported as undiluted or when diluted, the reporting limits reflect the dilution factor.

Field Data Usability Assessment

Field data usability was evaluated by reviewing sampling procedures, sample receipt, sample containers and preservation, holding times, equipment rinsate blanks, field duplicates, surrogate spikes, matrix spike/matrix spike duplicates, and column confirmation results.

Sample Collection Procedures

Sampling procedures were appropriate for the analyses requested. Field documentation was checked for completeness and accuracy.

Sample Receipt

Errors were initially discovered in one of the chain-of-custody (COC) forms and a revision was sent to the laboratory prior to sample analyses were initiated. COC forms were signed by the laboratory at the time of sample receipt. Samples were received at the laboratory in good condition.

Sample Containers and Sample Preservation

Sample containers were provided by the laboratory and were appropriate for the analyses requested. Samples were correctly preserved by storing them on ice and were received at the laboratory within the recommended temperature range.

Holding Times

All sample preparations and analyses were conducted within recommended holding times except for the VPH analysis of sample AQSS-05-0.0-0.5. The sample was analyzed 10 days past the 14-day hold time and results were qualified “UJ” to indicate a potentially low bias.

Equipment Rinse Blank

One rinse blank was collected in association with this sample set and analyzed for PAHs, PCBs, EPH, VPH, metals, TOC, and DOC. Results were below detection except for the low-level detections of barium, nine PAHs, TOC, and DOC. Associated sample results significantly greater than (greater than five times) the levels detected in the blank, so no data were qualified.

Field Duplicates

Two field duplicates were collected in association with these sample sets. Field duplicates were collected at the required frequency for all analyses except for the PAH analyses. One duplicate was analyzed for PAHs in association with 28 samples and the project requirement is one per 20 samples. Detected results are summarized in the data validation report. Results that were less than five times the method reporting limit (MRL) were assessed by the difference between them instead of the relative percent difference (RPD) value. Field duplicate RPD values were assessed by a 50% RPD value. Field duplicate difference values were assessed using ± 2 x MRL. Field duplicate RPD or

difference values were within control limits with the exceptions of all but four PAH RPD or difference values in the parent sample and duplicate pair AQSS-04-0.0-0.5 and DUP2-20210930 were above the control limit. The TOC RPD value was also above the control limit in this pair. Associated parent and duplicate results have been qualified "J" to indicate they are estimated.

Surrogate Spike Recoveries

Surrogates recovered within laboratory control limits with some exceptions for the PAH analyses. Surrogate recoveries that were outside of control limits were due to the inability to accurately quantify them because the samples were analyzed at dilutions, so no data were qualified.

Matrix Spike and Matrix Spike Duplicate Samples

Matrix spike (MS) and matrix spike duplicate (MSD) samples were analyzed at the required frequency. No data were qualified for sample concentrations that were greater than four times the spike concentration. Recoveries and/or RPD values were within laboratory control limits with some exceptions in the PAH, PCB, metals, and conventionals analyses. Results associated with MS/MSD outliers were qualified "J" or "UJ" to indicate they are biased or estimated, as required.

Column Confirmation Results

Detected Aroclor results were confirmed by second-column confirmation analyses and results were within method-required control limits with the exceptions of nine results in eight samples, which were qualified "J" to indicate they are estimated.

Overall Assessment

As was determined by this evaluation, the laboratory followed the specified analytical methods and all requested sample analyses were completed. Accuracy was acceptable as demonstrated by the calibration, surrogate, LCS/LCSD, and MS/MSD recovery values, with the exceptions noted above. Precision was acceptable as demonstrated by the LCS/LCSD, MS/MSD, laboratory and field duplicate RPD or difference values with the exceptions noted above. All data are acceptable as reported or as qualified.

Data Qualifier Definition

U Indicates the compound or analyte was analyzed for but not detected at or above the specified limit.

J Indicates an estimated value.

UJ Indicates the compound or analyte was analyzed for but not detected and the specified limit reported is estimated

Data Qualification Reason Codes

Code	Reason
1	Holding times
2	Sample preservation/cooler temperature
3	Sample custody
4	Missing deliverables
5	Calibration
6	Field blank contamination
7	Laboratory blank contamination
8	MS recoveries
9	Duplicate (laboratory duplicate, MS/MSD, or LCS/LCSD) RPD or difference values
10	LCS
11	Interference check sample
12	Column confirmation RPD
13	Surrogate recoveries
14	Field duplicate RPD or difference values
15	Peak resolution
16	Serial dilution percent difference values
17	Chemical recoveries
18	Trip blanks
19	Internal standard area counts
20	Linear range exceeded
21	Potential false positive
22	Do not report, other reported result more technically acceptable
23	Estimated maximum possible concentration
24	Other

Table 2
Data Qualification Summary

Sample ID	Parameter	Analyte	Validation Qualifier	Reason Code
AQSS-03-0.0-0.5	Conventionals	Soot carbon	J	8,9
		Total organic carbon	J	9
	Metals	Arsenic	J	8
		Chromium	J	8

Sample ID	Parameter	Analyte	Validation Qualifier	Reason Code
		Lead	J	8,9
	PAHs	2-Methylnaphthalene	J	10
		Naphthalene	J	10
AQSS-03-2.0-2.5	Conventionals	Total organic carbon	J	9
	PAHs	2-Methylnaphthalene	J	10
		Naphthalene	J	10
AQSS-04-0.0-0.5	Conventionals	Soot carbon	J	8,9
		Total organic carbon	J	9,14
	Metals	Arsenic	J	8
		Chromium	J	8
		Lead	J	8,9
		Mercury	J	8,9
	PAHs	1-Methyldibenzothiophene	J	14
		1-Methylnaphthalene	J	14
		1-Methylphenanthrene	J	14
		1-Methylpyrene	J	14
		2,3,5-Trimethylnaphthalene (1,6,7-Trimethylnaphthalene)	J	14
		2,6-Dimethylnaphthalene	J	14
		2-Methylanthracene	J	14
		2-Methyldibenzothiophene & 3-Methyldibenzothiophene	J	14
		2-Methylphenanthrene	J	14
		2-Methylpyrene	J	14
		3-Methylphenanthrene	J	14
		4-Methyldibenzothiophene	J	14
		4-Methylphenanthrene & 9-Methylphenanthrene	J	14
		4-Methylpyrene	J	14
		Acenaphthene	J	14
		Anthracene	J	14
		Benzo(a)anthracene	J	14
		Benzo(a)fluoranthene	J	14
		Benzo(a)pyrene	J	14
		Benzo(b)fluoranthene	J	14
		Benzo(b)fluorene	J	14
		Benzo(c)fluorene	J	14
		Benzo(e)pyrene	J	14
		Benzo(g,h,i)perylene	J	14
		Benzo(j,k)fluoranthene	J	14
		Benzonaphthothiophene	J	14
		Benzothiophene	J	14
		Biphenyl (1,1'-Biphenyl)	J	14
		C1-Benzo(b)thiophene	J	14
		C1-Chrysenes	J	14
		C1-Dibenzothiophenes	J	14
		C1-Fluoranthenes/Pyrenes	J	14
		C1-Fluorenes	J	14
		C1-Naphthalenes	J	14

Sample ID	Parameter	Analyte	Validation Qualifier	Reason Code
		C1-Naphthobenzothiophenes	J	14
		C1-Phenanthrenes/Anthracenes	J	14
		C2-Benzo(b)thiophene	J	14
		C2-Chrysenes	J	14
		C2-Decalins	J	14
		C2-Dibenzothiophenes	J	14
		C2-Fluoranthenes/Pyrenes	J	14
		C2-Fluorenes	J	14
		C2-Naphthalenes	J	14
		C2-Naphthobenzothiophenes	J	14
		C2-Phenanthrenes/Anthracenes	J	14
		C3-Benzo(b)thiophene	J	14
		C3-Chrysenes	J	14
		C3-Decalins	J	14
		C3-Dibenzothiophenes	J	14
		C3-Fluoranthenes/Pyrenes	J	14
		C3-Fluorenes	J	14,24
		C3-Naphthalenes	J	14
		C3-Naphthobenzothiophenes	J	14
		C3-Phenanthrenes/Anthracenes	J	14
		C4-Benzo(b)thiophene	J	14
		C4-Chrysenes	J	14
		C4-Decalins	J	14
		C4-Dibenzothiophenes	J	14
		C4-Fluoranthenes/Pyrenes	J	14
		C4-Naphthalenes	J	14
		C4-Naphthobenzothiophenes	J	14
		C4-Phenanthrenes/Anthracenes	J	14
		Carbazole	J	14
		Chrysene	J	14
		Dibenzo(a,h)anthracene and Dibenzo(a,c)anthracene	J	14
		Dibenzofuran	J	14
		Dibenzothiophene	J	14
		Fluoranthene	J	14
		Fluorene	J	14
		Indeno(1,2,3-c,d)pyrene	J	14
		Naphthalene	J	14
		Perylene	J	14
		Phenanthrene	J	14
		Pyrene	J	14
AQSS-04-1.0-1.5	Conventionals	Total organic carbon	J	9
	PAHs	2-Methylnaphthalene	J	8,9
		Acenaphthene	J	8,9
		Acenaphthylene	J	8,9
		Anthracene	J	8,9
		Benzo(a)anthracene	J	9
		Benzo(a)pyrene	J	9
		Benzo(b)fluoranthene	J	9

Sample ID	Parameter	Analyte	Validation Qualifier	Reason Code
		Benzo(g,h,i)perylene	J	8,9
		Benzo(j,k)fluoranthene	J	9
		C3-Fluorenes	J	24
		Chrysene	J	9
		Dibenzo(a,h)anthracene and Dibenzo(a,c)anthracene	J	8,9
		Fluoranthene	J	9
		Fluorene	J	8,9
		Indeno(1,2,3-c,d)pyrene	J	8,9
		Naphthalene	J	8,9
		Phenanthrene	J	9
		Pyrene	J	9
AQSS-05-0.0-0.5	Conventionals	Soot carbon	J	8,9
		Total organic carbon	J	9
	Metals	Arsenic	J	8
		Chromium	J	8
		Lead	J	8,9
	PCBs	Aroclor 1242	J	8
		Aroclor 1254	J	8
		Aroclor 1260	J	8
	VPH	Benzene	UJ	1
		C5-C8 Aliphatics adjusted	UJ	1
		C5-C8 Aliphatics unadjusted	UJ	1
		C9-C10 Aromatics unadjusted	UJ	1
		C9-C12 Aliphatics adjusted	UJ	1
		C9-C12 Aliphatics unadjusted	UJ	1
		Ethylbenzene	UJ	1
		m,p-Xylene	UJ	1
		Methyl tert-butyl ether (MTBE)	UJ	1
		Naphthalene	UJ	1
		o-Xylene	UJ	1
		Toluene	UJ	1
AQSS-05-1.0-1.5	Conventionals	Total organic carbon	J	9
AQSS-06-0.0-0.5	Metals	Mercury	J	8,9
	PCBs	Aroclor 1254	J	12
AQSS-07-0.0-0.5	PAHs	C3-Fluorenes	J	24
	PCBs	Aroclor 1242	J	12
AQSS-07D-4.9-5.4	Conventionals	Total organic carbon	J	9
AQSS-08-0.0-0.5	PAHs	2-Methylnaphthalene	J	10
		Naphthalene	J	10
	PCBs	Aroclor 1254	J	12
AQSS-08-1.0-1.5	PAHs	2-Methylnaphthalene	J	10
		Naphthalene	J	10
AQSS-09-0.0-0.5	PAHs	C3-Fluorenes	J	24
	PCBs	Aroclor 1260	J	12
AQSS-10-0.0-0.5	PAHs	C3-Fluorenes	J	24
	PCBs	Aroclor 1242	J	12

Sample ID	Parameter	Analyte	Validation Qualifier	Reason Code
AQSS-11B-1.5-1.9	PAHs	C3-Fluorenes	J	24
		2-Methylnaphthalene	J	10
		Naphthalene	J	10
AQSS-12B-0.0-0.5	PAHs	2-Methylnaphthalene	J	10
		Naphthalene	J	10
AQSS-13B-0.0-0.5	PCBs	Aroclor 1242	J	12
AQSS-18-0.0-0.5	Conventionals	Soot carbon	J	8,9
		Total organic carbon	J	9
	Metals	Arsenic	J	8
		Chromium	J	8
		Lead	J	8,9
	PAHs	2-Methylnaphthalene	J	10
		Naphthalene	J	10
	PCBs	Aroclor 1254	J	12
AQSS-18-3.0-3.5	Conventionals	Total organic carbon	J	9
	PAHs	2-Methylnaphthalene	J	10
		Naphthalene	J	10
AQSS-18-4.6-4.8	PAHs	2-Methylnaphthalene	UJ	7,10
		Naphthalene	UJ	7,10
AQSS-19-3.0-3.5	Conventionals	Total organic carbon	J	9
	PAHs	2-Chloronaphthalene	J	8
		2-Methylnaphthalene	J	8,10
		Acenaphthene	J	8
		Anthracene	J	8
		Benzo(k)fluoranthene	J	8
		Chrysene	J	8
		Fluoranthene	J	8
		Fluorene	J	8
		Naphthalene	J	8,10
		Phenanthrene	J	8
		Pyrene	J	8
AQSS-19-4.5-5.0	Conventionals	Total organic carbon	J	9
	PAHs	2-Methylnaphthalene	J	10
		Naphthalene	J	10
AQSS-20-0.0-0.5	Conventionals	Soot carbon	J	8,9
		Total organic carbon	J	9
	Metals	Arsenic	J	8
		Chromium	J	8
		Lead	J	8,9
	PAHs	2-Methylnaphthalene	J	10
		Naphthalene	J	10
	PCBs	Aroclor 1254	J	12
		Aroclor 1260	J	12
AQSS-20-4.2-4.5	Conventionals	Total organic carbon	J	9
	PAHs	2-Methylnaphthalene	J	10
		Naphthalene	J	10
DUP2-20210930	Conventionals	Total organic carbon	J	9,14
	PAHs	1-Methyldibenzothiophene	J	14

Sample ID	Parameter	Analyte	Validation Qualifier	Reason Code
		1-Methylnaphthalene	J	14
		1-Methylphenanthrene	J	14
		1-Methylpyrene	J	14
		2,3,5-Trimethylnaphthalene (1,6,7-Trimethylnaphthalene)	J	14
		2,6-Dimethylnaphthalene	J	14
		2-Methylanthracene	J	14
		2-Methyldibenzothiophene & 3-Methyldibenzothiophene	J	14
		2-Methylphenanthrene	J	14
		2-Methylpyrene	J	14
		3-Methylphenanthrene	J	14
		4-Methyldibenzothiophene	J	14
		4-Methylphenanthrene & 9-Methylphenanthrene	J	14
		4-Methylpyrene	J	14
		Acenaphthene	J	14
		Anthracene	J	14
		Benzo(a)anthracene	J	14
		Benzo(a)fluoranthene	J	14
		Benzo(a)pyrene	J	14
		Benzo(b)fluoranthene	J	14
		Benzo(b)fluorene	J	14
		Benzo(c)fluorene	J	14
		Benzo(e)pyrene	J	14
		Benzo(g,h,i)perylene	J	14
		Benzo(j,k)fluoranthene	J	14
		Benzonaphthothiophene	J	14
		Benzothiophene	J	14
		Biphenyl (1,1'-Biphenyl)	J	14
		C1-Benzo(b)thiophene	J	14
		C1-Chrysenes	J	14
		C1-Dibenzothiophenes	J	14
		C1-Fluoranthenes/Pyrenes	J	14
		C1-Fluorenes	J	14
		C1-Naphthalenes	J	14
		C1-Naphthobenzothiophenes	J	14
		C1-Phenanthrenes/Anthracenes	J	14
		C2-Benzo(b)thiophene	J	14
		C2-Chrysenes	J	14
		C2-Decalins	J	14
		C2-Dibenzothiophenes	J	14
		C2-Fluoranthenes/Pyrenes	J	14
		C2-Fluorenes	J	14
		C2-Naphthalenes	J	14
		C2-Naphthobenzothiophenes	J	14
		C2-Phenanthrenes/Anthracenes	J	14
		C3-Benzo(b)thiophene	J	14
		C3-Chrysenes	J	14

Sample ID	Parameter	Analyte	Validation Qualifier	Reason Code
		C3-Decalins	UJ	14
		C3-Dibenzothiophenes	J	14
		C3-Fluoranthenes/Pyrenes	J	14
		C3-Fluorenes	J	14,24
		C3-Naphthalenes	J	14
		C3-Naphthobenzothiophenes	J	14
		C3-Phenanthrenes/Anthracenes	J	14
		C4-Benzo(b)thiophene	J	14
		C4-Chrysenes	J	14
		C4-Decalins	J	14
		C4-Dibenzothiophenes	J	14
		C4-Fluoranthenes/Pyrenes	J	14
		C4-Naphthalenes	J	14
		C4-Naphthobenzothiophenes	J	14
		C4-Phenanthrenes/Anthracenes	J	14
		Carbazole	J	14
		Chrysene	J	14
		Dibenzo(a,h)anthracene and Dibenzo(a,c)anthracene	J	14
		Dibenzofuran	J	14
		Dibenzothiophene	J	14
		Fluoranthene	J	14
		Fluorene	J	14
		Indeno(1,2,3-c,d)pyrene	J	14
		Naphthalene	J	14
		Perylene	J	14
		Phenanthrene	J	14
		Pyrene	J	14
RB1-092921	PAHs	Phenanthrene	U	7
	PCBs	Aroclor 1016	UJ	10
		Aroclor 1221	UJ	10
		Aroclor 1232	UJ	10
		Aroclor 1242	UJ	10
		Aroclor 1248	UJ	10

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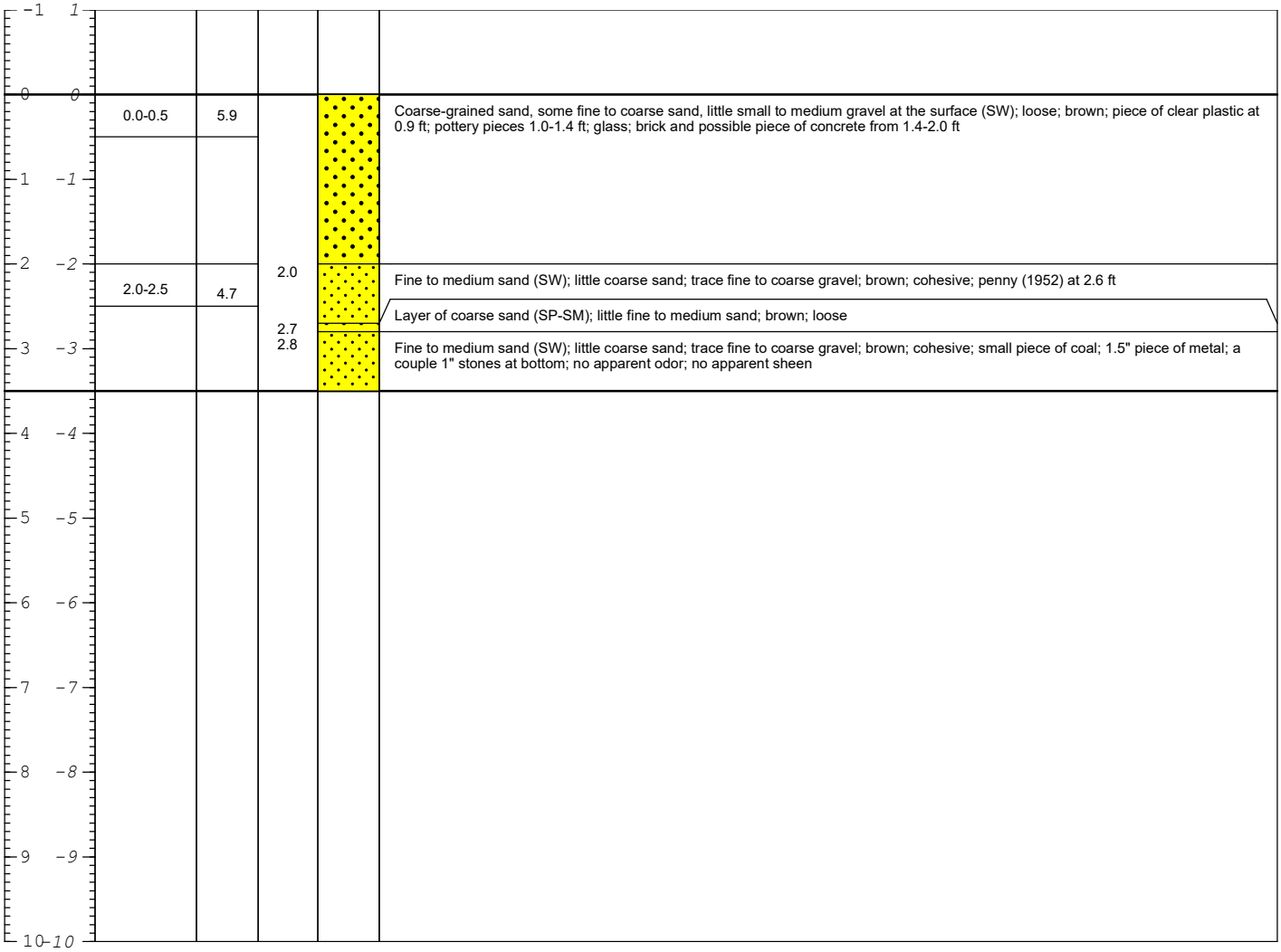
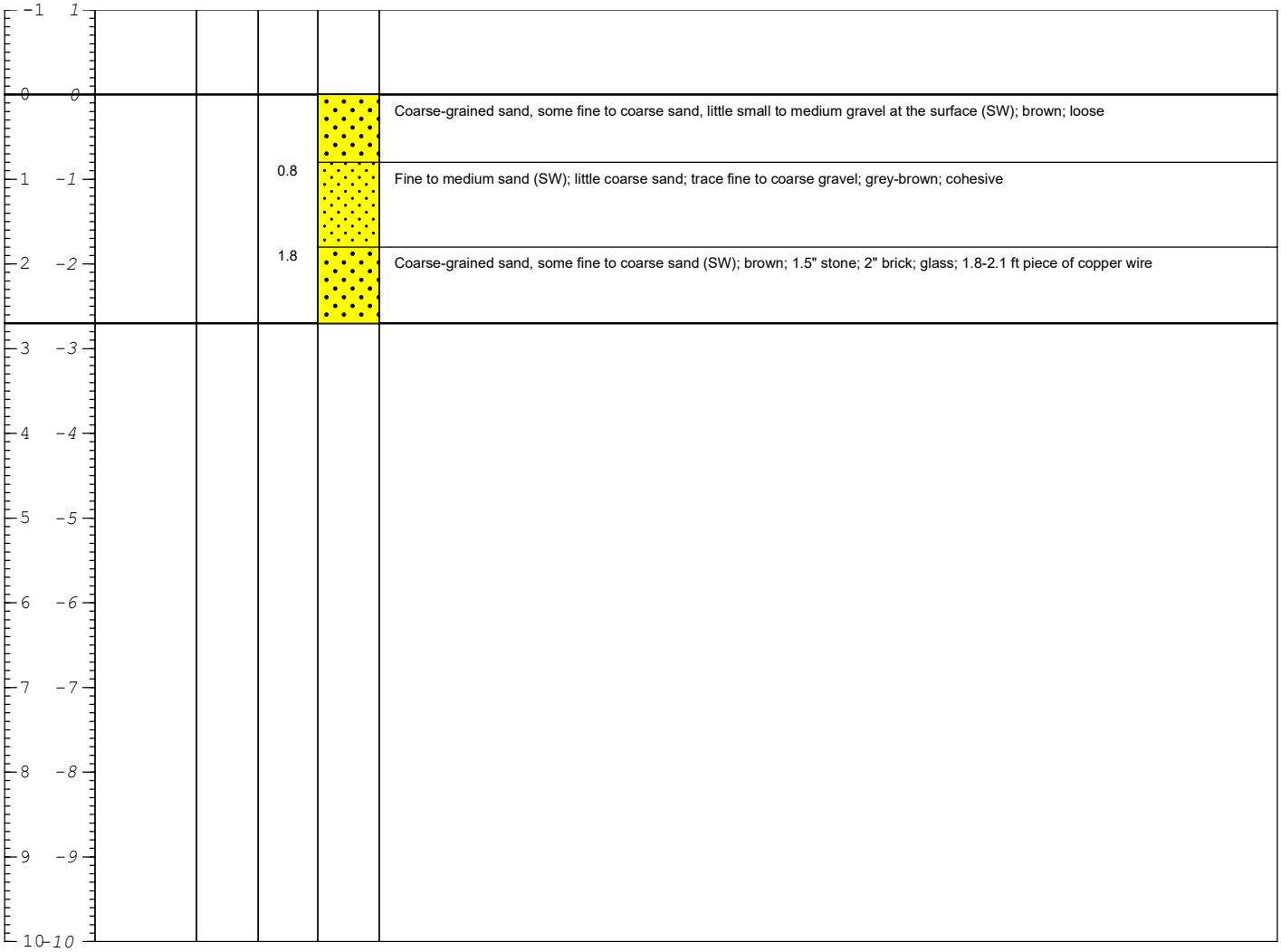
Appendix C
Sediment Core Logs

Date Start/Finish:	September 30, 2021	**Latitude:**	42.777325	**Core ID:**	AQSS-03
Drilling Company:	TG&B Marine Services, Inc. Nappy Crane Service, Inc.	**Longitude:**	-71.088417	**Client:**	National Grid
		Water Depth:	N/A	**Location:**	Former Haverhill MGP Site 284 Winter Street Haverhill, MA
Driller's Name:	Various	**Mudline Elevation:**	N/A		
Drilling Method:	Vibracore	**Recovery:**	3.5 ft		
Penetration:	N/A	**Scientist:**	B. Gauley		



Remarks: ppm: parts per million
NAPL: non-aqueous phase liquid
NA: Information not available
Depth of core termination NA
AQSS-03-0.0-0.5 PAH16, TOC, Soot, PCB, RCRA8 Metals
AQSS-03-2.0-2.5 PAH16, TOC

Date Start/Finish:	September 30, 2021	**Latitude:**	42.777325	**Core ID:**	AQSS-03B
Drilling Company:	TG&B Marine Services, Inc. Nappy Crane Service, Inc.	**Longitude:**	-71.088417	**Client:**	National Grid
		Water Depth:	N/A	**Location:**	Former Haverhill MGP Site 284 Winter Street Haverhill, MA
Driller's Name:	Various	**Mudline Elevation:**	N/A		
Drilling Method:	Vibracore	**Recovery:**	2.7 ft		
Penetration:	N/A	**Scientist:**	B. Gauley		

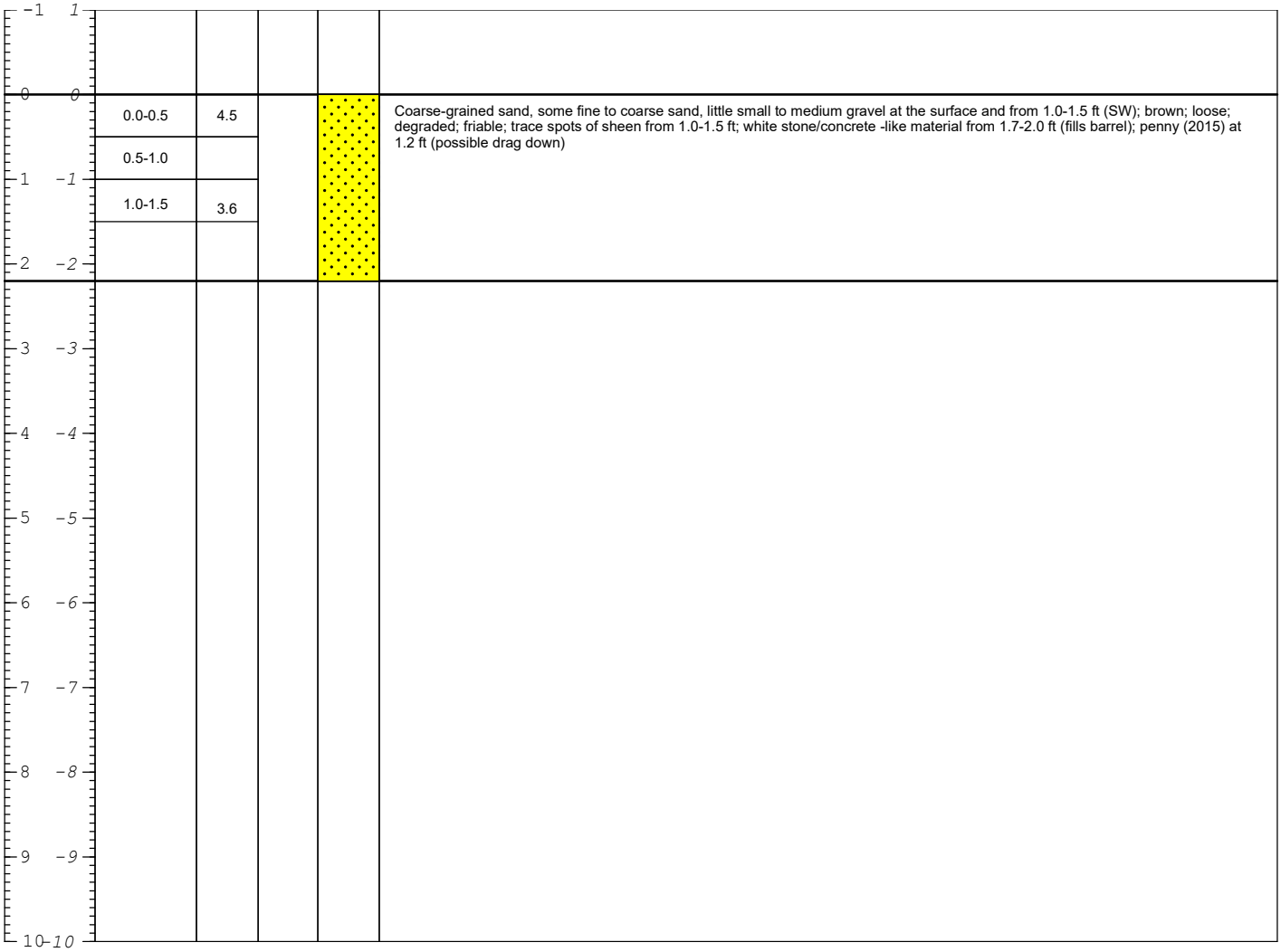


Remarks: ppm: parts per million
NAPL: non-aqueous phase liquid
NA: Information not available
Depth of core termination NA

Project: Former Haverhill MGP
Date: April 2022

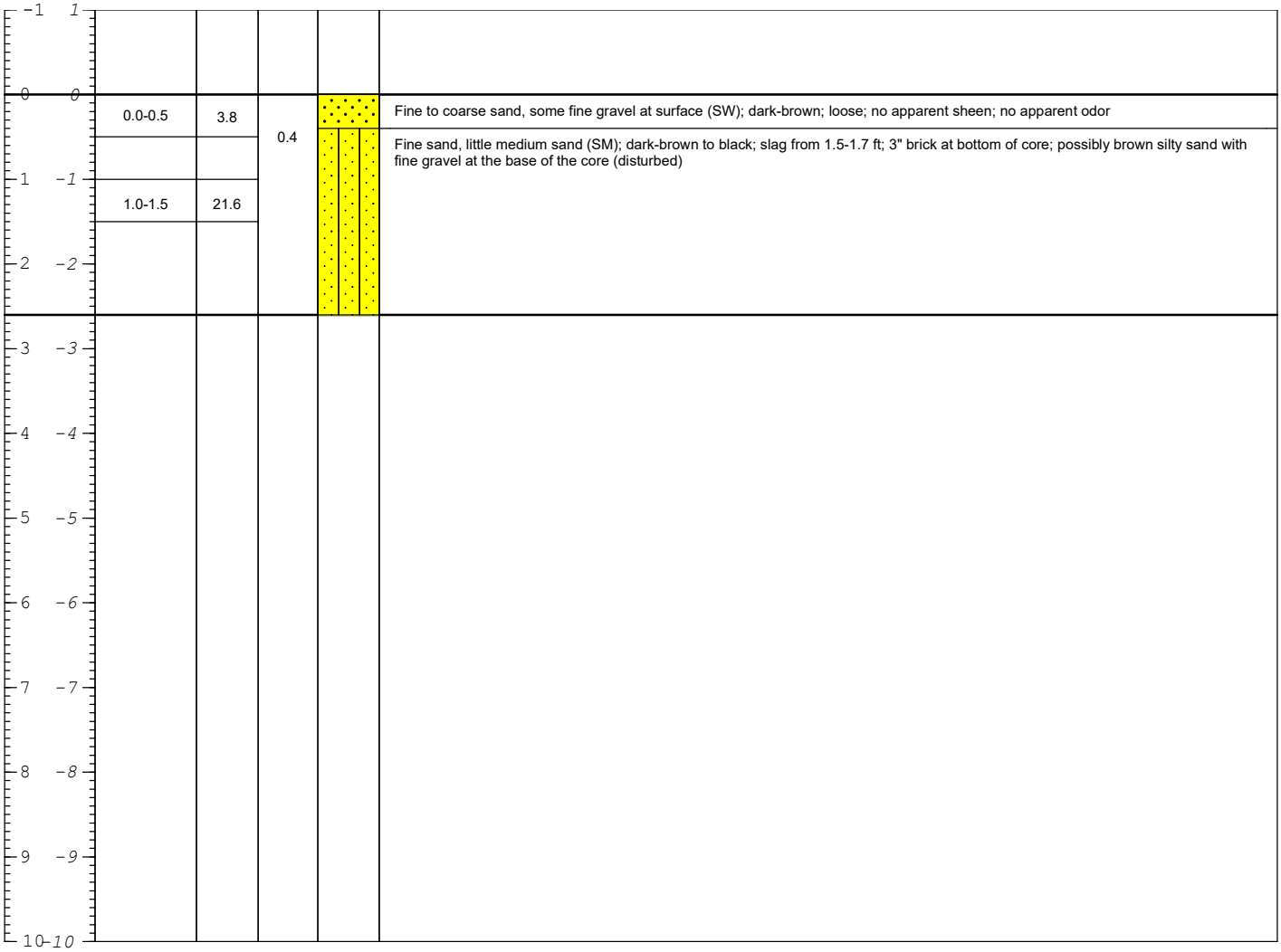
Template: Haverhill2022.ldfx

Date Start/Finish:	September 30, 2021	**Latitude:**	42.77733	**Core ID:**	AQSS-04
Drilling Company:	TG&B Marine Services, Inc. Nappy Crane Service, Inc.	**Longitude:**	-71.088352	**Client:**	National Grid
		Water Depth:	N/A	**Location:**	Former Haverhill MGP Site 284 Winter Street Haverhill, MA
Driller's Name:	Various	**Mudline Elevation:**	N/A		
Drilling Method:	Vibracore	**Recovery:**	2.2 ft		
Penetration:	N/A	**Scientist:**	B. Gauley		



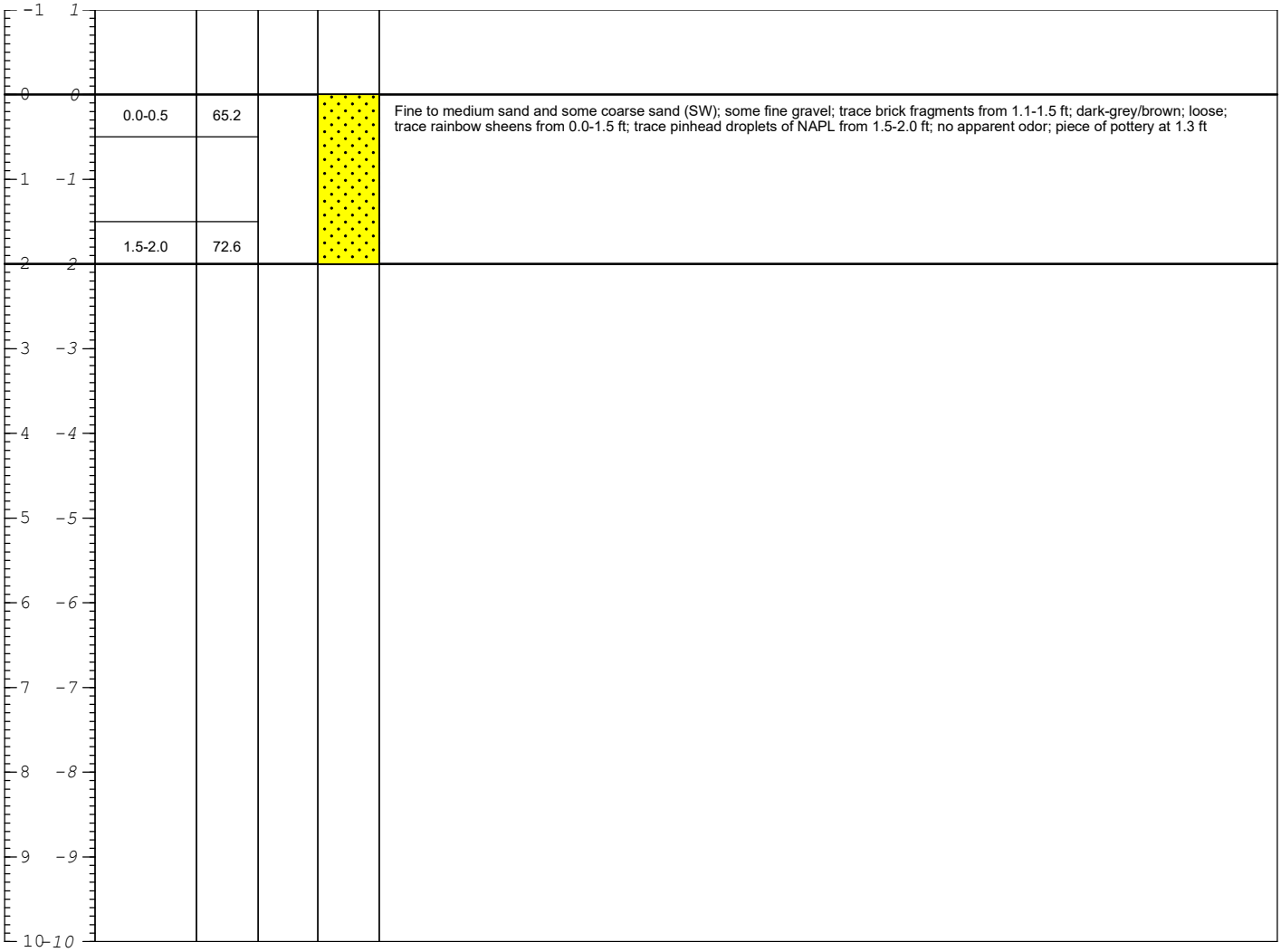
Remarks: ppm: parts per million
NAPL: non-aqueous phase liquid
NA: Information not available
Depth of core termination NA
AQSS-04-0.0-0.5 TOC, RCRA8 Metals, PCB, Soot, Alkylated PAH
AQSS-04-0.5-1.0 GS
AQSS-04-1.0-1.5 TOC, Alkylated PAH
AQSS-04(DUP) TOC, Alkylated PAH

Date Start/Finish:	September 29, 2021	**Latitude:**	42.777326	**Core ID:**	AQSS-05
Drilling Company:	TG&B Marine Services, Inc. Nappy Crane Service, Inc.	**Longitude:**	-71.088268	**Client:**	National Grid
		Water Depth:	N/A	**Location:**	Former Haverhill MGP Site 284 Winter Street Haverhill, MA
Driller's Name:	Various	**Mudline Elevation:**	N/A		
Drilling Method:	Vibracore	**Recovery:**	2.6 ft		
Penetration:	N/A	**Scientist:**	B. Gauley		



Remarks: ppm: parts per million
NAPL: non-aqueous phase liquid
NA: Information not available
Depth of core termination NA
AQSS-05-0.0-0.5 PAH16, EPH, VPH, TOC, Soot, PCB, RCRA8 Metals
AQSS05-1.0-1.5 PAH16, TOC

Date Start/Finish:	September 29, 2021	**Latitude:**	42.777208	**Core ID:**	AQSS-06
Drilling Company:	TG&B Marine Services, Inc. Nappy Crane Service, Inc.	**Longitude:**	-71.088229	**Client:**	National Grid
		Water Depth:	N/A	**Location:**	Former Haverhill MGP Site 284 Winter Street Haverhill, MA
Driller's Name:	Various	**Mudline Elevation:**	N/A		
Drilling Method:	Vibracore	**Recovery:**	2.0 ft		
Penetration:	N/A	**Scientist:**	B. Gauley		

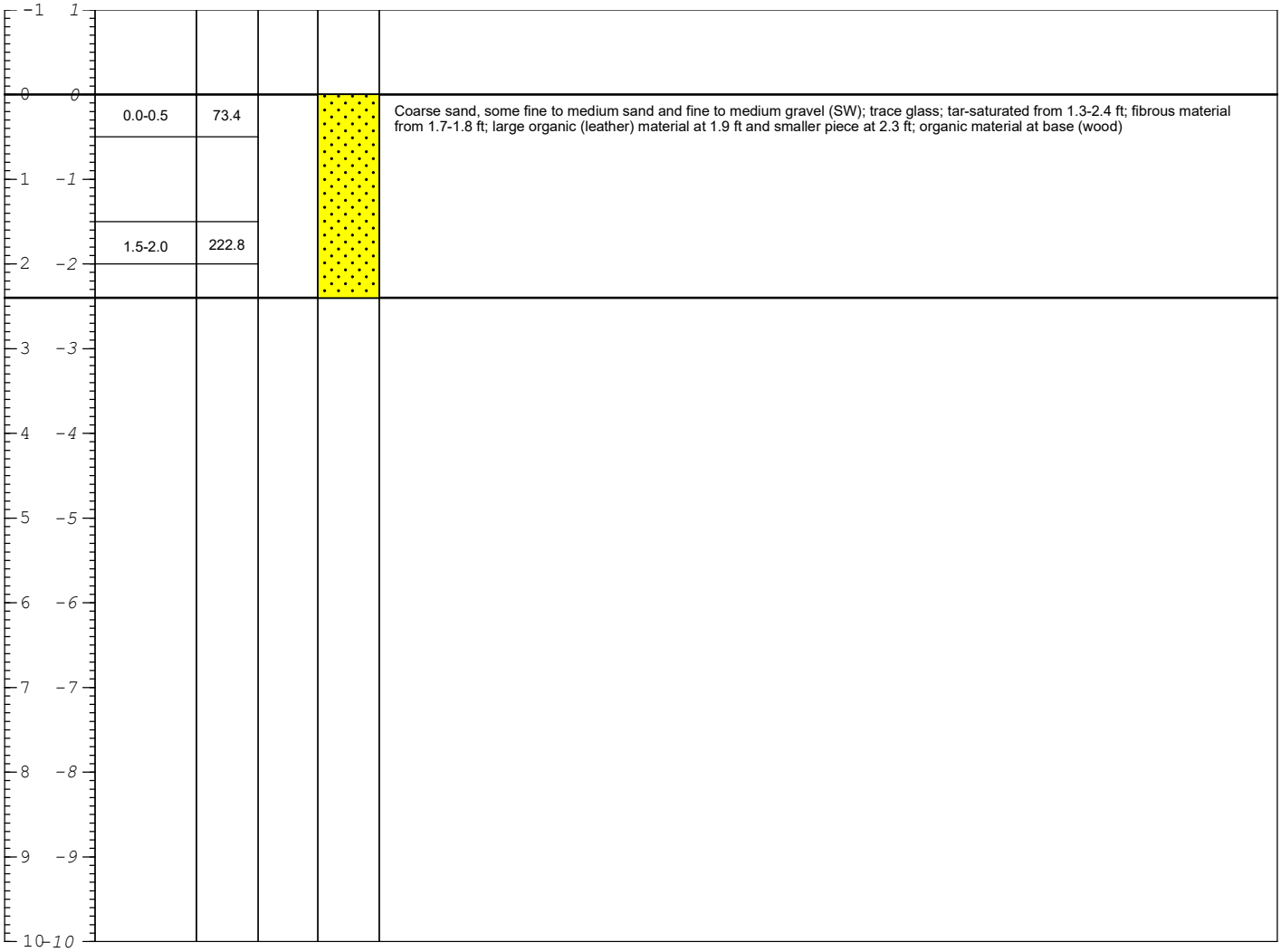


Remarks: ppm: parts per million
NAPL: non-aqueous phase liquid
NA: Information not available
Depth of core termination NA
AQSS-06-0.0-0.5 TOC, Soot, PCB, RCRA8 Metals, Alkylated PAH
AQSS-06 PAH16, TOC

Project: Former Haverhill MGP
Date: April 2022

Template: Haverhill2022.ldfx

Date Start/Finish:	September 29, 2021	**Latitude:**	42.777111	**Core ID:**	AQSS-07
Drilling Company:	TG&B Marine Services, Inc. Nappy Crane Service, Inc.	**Longitude:**	-71.088103	**Client:**	National Grid
		Water Depth:	N/A	**Location:**	Former Haverhill MGP Site 284 Winter Street Haverhill, MA
Driller's Name:	Various	**Mudline Elevation:**	N/A		
Drilling Method:	Vibracore	**Recovery:**	2.4 ft		
Penetration:	N/A	**Scientist:**	B. Gauley		



Remarks: ppm: parts per million
NAPL: non-aqueous phase liquid
NA: Information not available
Depth of core termination NA
AQSS-07-0.0-0.5 TOC, Soot, PCB, RCRA8 Metals, Alkylated PAH
AQSS07-1.5-2.0 TOC, Alkylated PAH, Copper

Project: Former Haverhill MGP
Date: April 2022

Template: Haverhill2022.ldfx

Date Start/Finish:	September 30, 2021	**Latitude:**	42.777167	**Core ID:**	AQSS-07D
Drilling Company:	TG&B Marine Services, Inc. Nappy Crane Service, Inc.	**Longitude:**	-71.08816	**Client:**	National Grid
		Water Depth:	N/A	**Location:**	Former Haverhill MGP Site 284 Winter Street Haverhill, MA
Driller's Name:	Various	**Mudline Elevation:**	N/A		
Drilling Method:	Vibracore	**Recovery:**	5.4 ft		
Penetration:	10.0 ft	**Scientist:**	B. Gauley		

Depth (ft) / Elevation (ft)	Sample Depth (see Remarks)	Headspace (ppm)	Depth to Interface (ft)	Geologic Column	Stratigraphic Description
0 / 0	0.0-0.5		1.2		Coarse sand, some fine to medium gravel (SP); little fine to medium sand; brown; loose; glass; no apparent visual impacts
1 / -1			2.4		Fine to coarse sand, some fine to medium gravel (SW); more compact; faint odor; black; no apparent visual impacts
2 / -2					Fine to coarse sand, some fine to medium gravel (SW); black; little sheen from 2.4-3.1 ft; hair-like material at 2.7 ft and 3.8 ft; tar, strong odor, heavily saturated from 3.1-3.9 ft with heavy sheen; heavy rainbow sheen 3.9-4.9 ft
3 / -3					
4 / -4					
5 / -5	4.9-5.4	9.9	4.9		Fine sand (SP); brown and black; tight piece of gravel at 5.1-5.2 ft; no apparent odor; no apparent NAPL
6 / -6					Core terminated at 10.0 ft
7 / -7					
8 / -8					
9 / -9					
10 / -10					

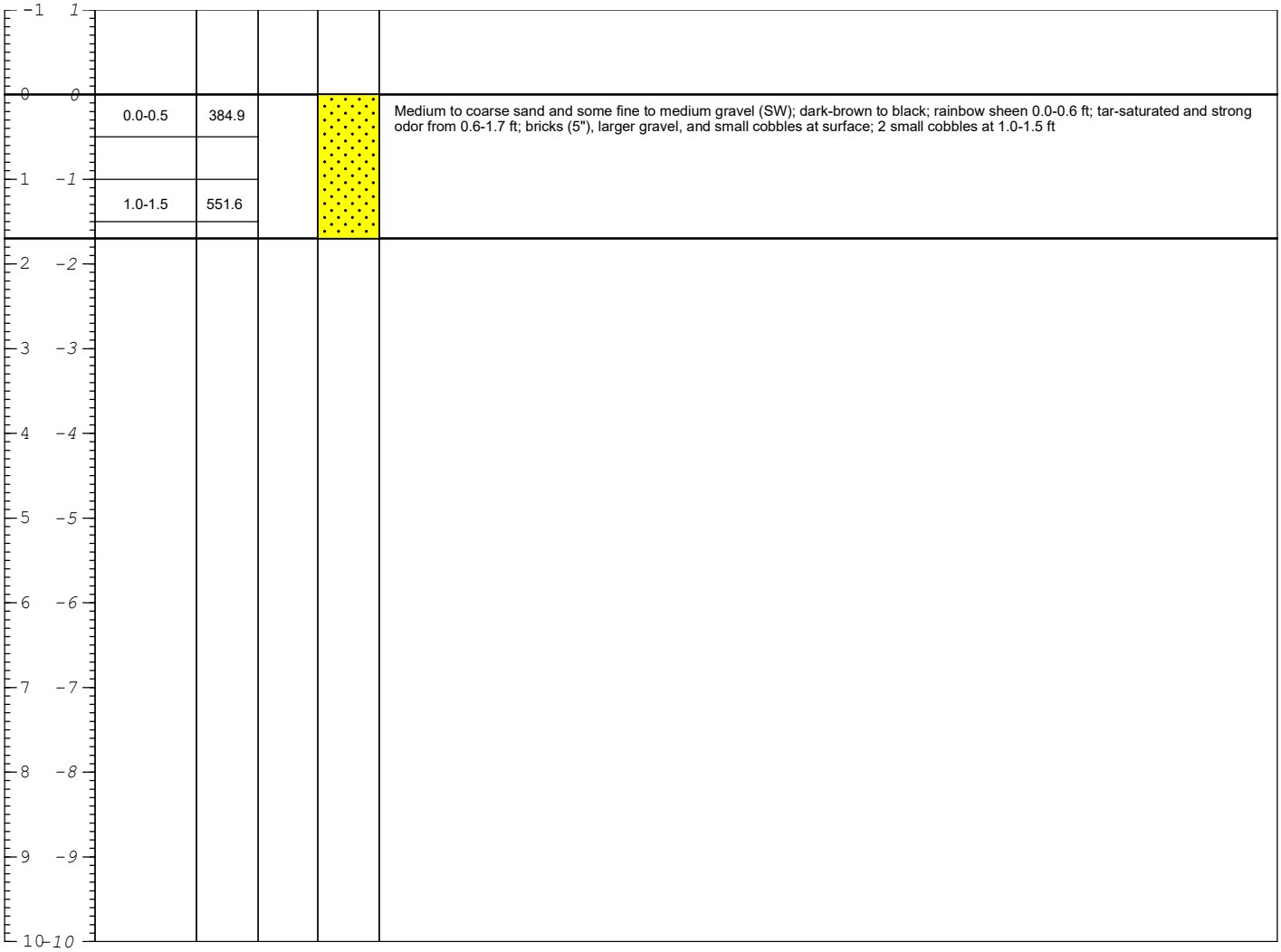
ANCHOR QEA

Remarks: ppm: parts per million
NAPL: non-aqueous phase liquid
NA: Information not available
AQSS-07D-0.0-0.5 GS
AQSS-07D-4.9-5.4 TOC, Alkylated PAH

Project: Former Haverhill MGP
Date: April 2022

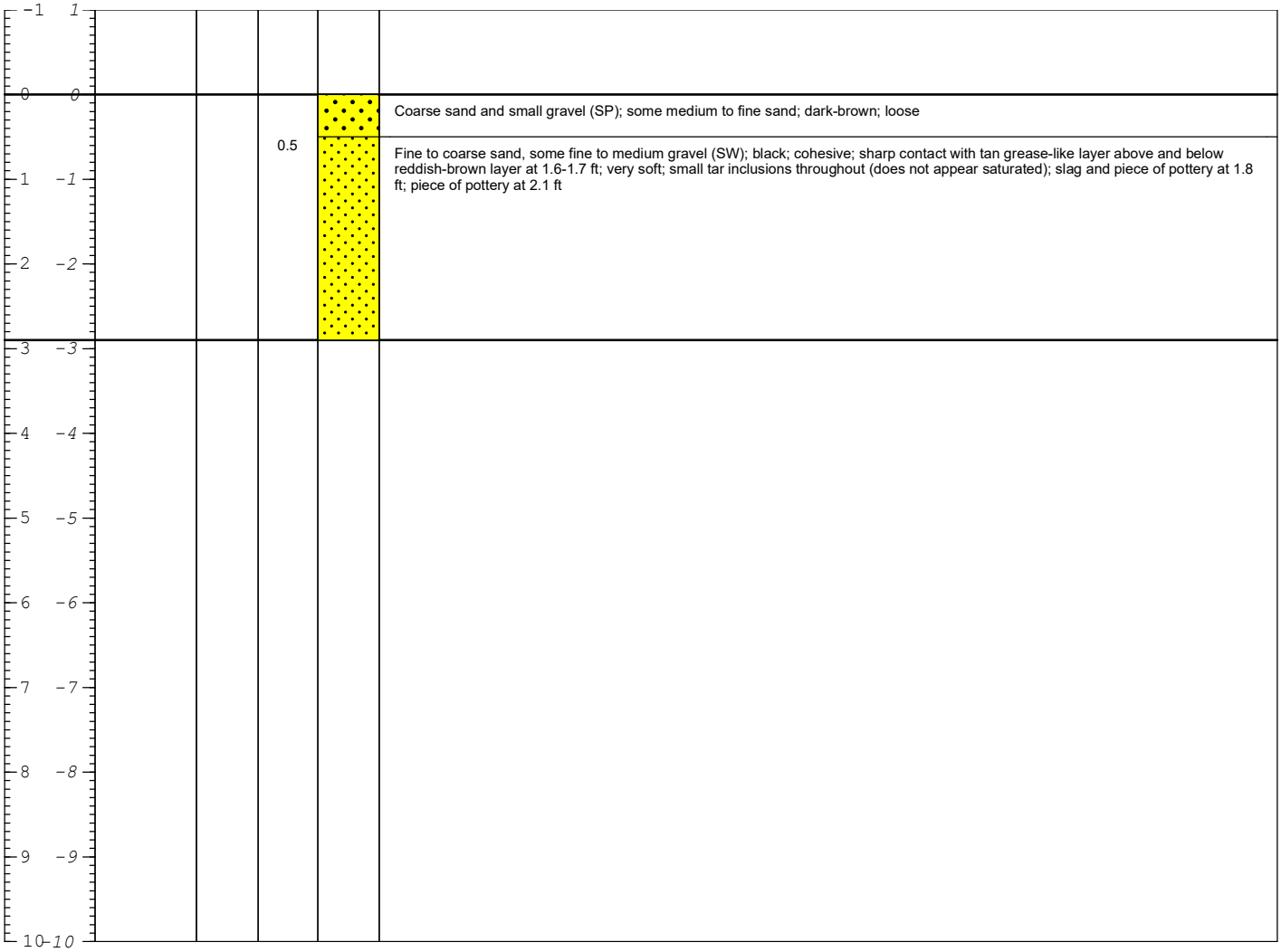
Template: Haverhill2022.ldfx

Date Start/Finish:	September 29, 2021	**Latitude:**	42.777001	**Core ID:**	AQSS-08
Drilling Company:	TG&B Marine Services, Inc. Nappy Crane Service, Inc.	**Longitude:**	-71.087998	**Client:**	National Grid
		Water Depth:	N/A	**Location:**	Former Haverhill MGP Site 284 Winter Street Haverhill, MA
Driller's Name:	Various	**Mudline Elevation:**	N/A		
Drilling Method:	Vibracore	**Recovery:**	1.7 ft		
Penetration:	N/A	**Scientist:**	B. Gauley		



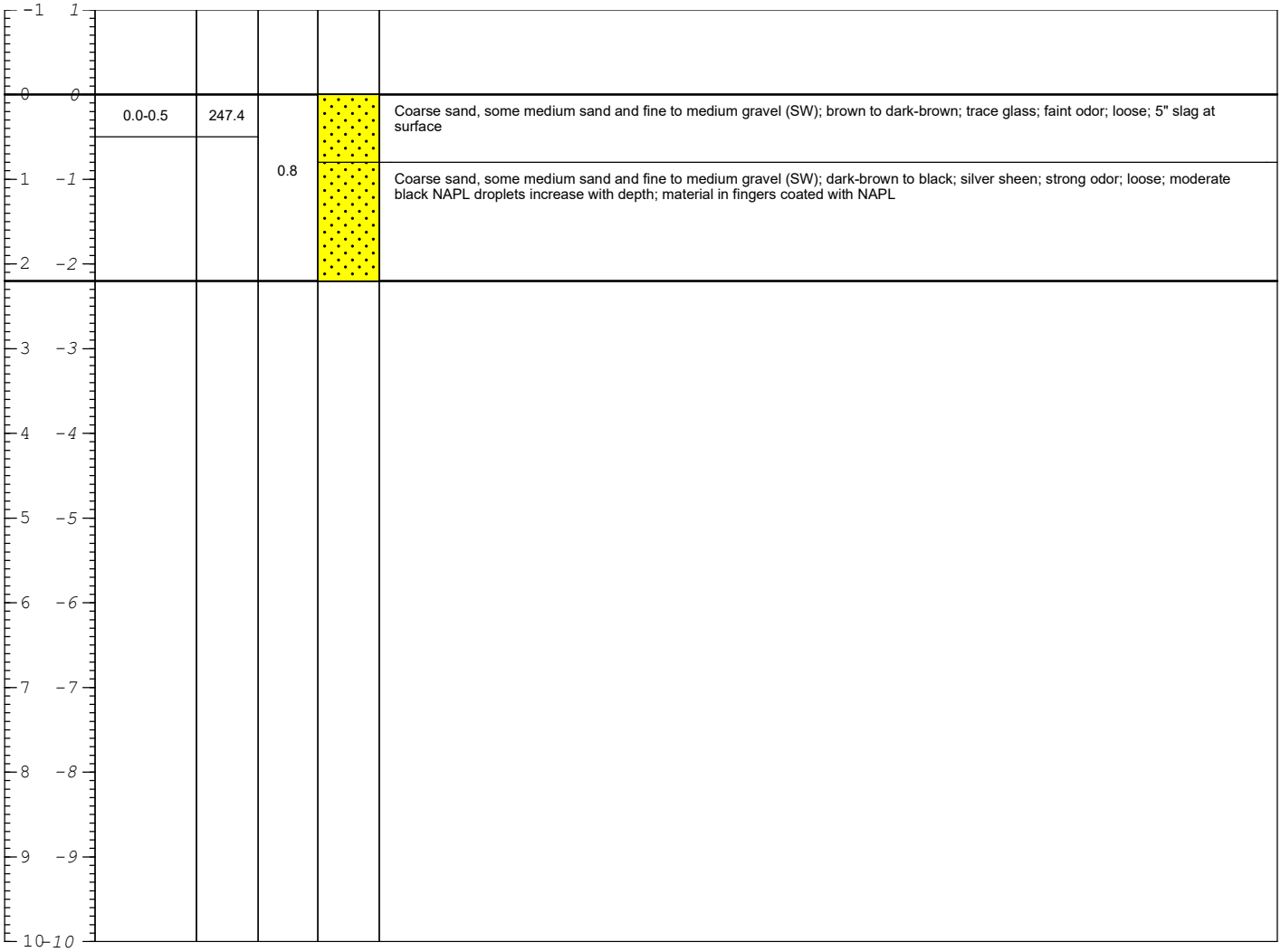
Remarks: ppm: parts per million
NAPL: non-aqueous phase liquid
NA: Information not available
Depth of core termination NA
AQSS-08-0.0-0.5 PAH16, TOC, Soot, PCB, RCRA8 Metals, Alkylated PAH
AQSS-08-1.0-1.5 PAH16, TOC
No apparent recovery on second attempt at AQSS-08; first attempt recovered ~1.0 ft; sticky black/brown tar on outside of barrel

Date Start/Finish:	September 29, 2021	**Latitude:**	42.777001	**Core ID:**	AQSS-08B
Drilling Company:	TG&B Marine Services, Inc. Nappy Crane Service, Inc.	**Longitude:**	-71.087998	**Client:**	National Grid
		Water Depth:	N/A	**Location:**	Former Haverhill MGP Site 284 Winter Street Haverhill, MA
Driller's Name:	Various	**Mudline Elevation:**	N/A		
Drilling Method:	Vibracore	**Recovery:**	2.9 ft		
Penetration:	N/A	**Scientist:**	B. Gauley		



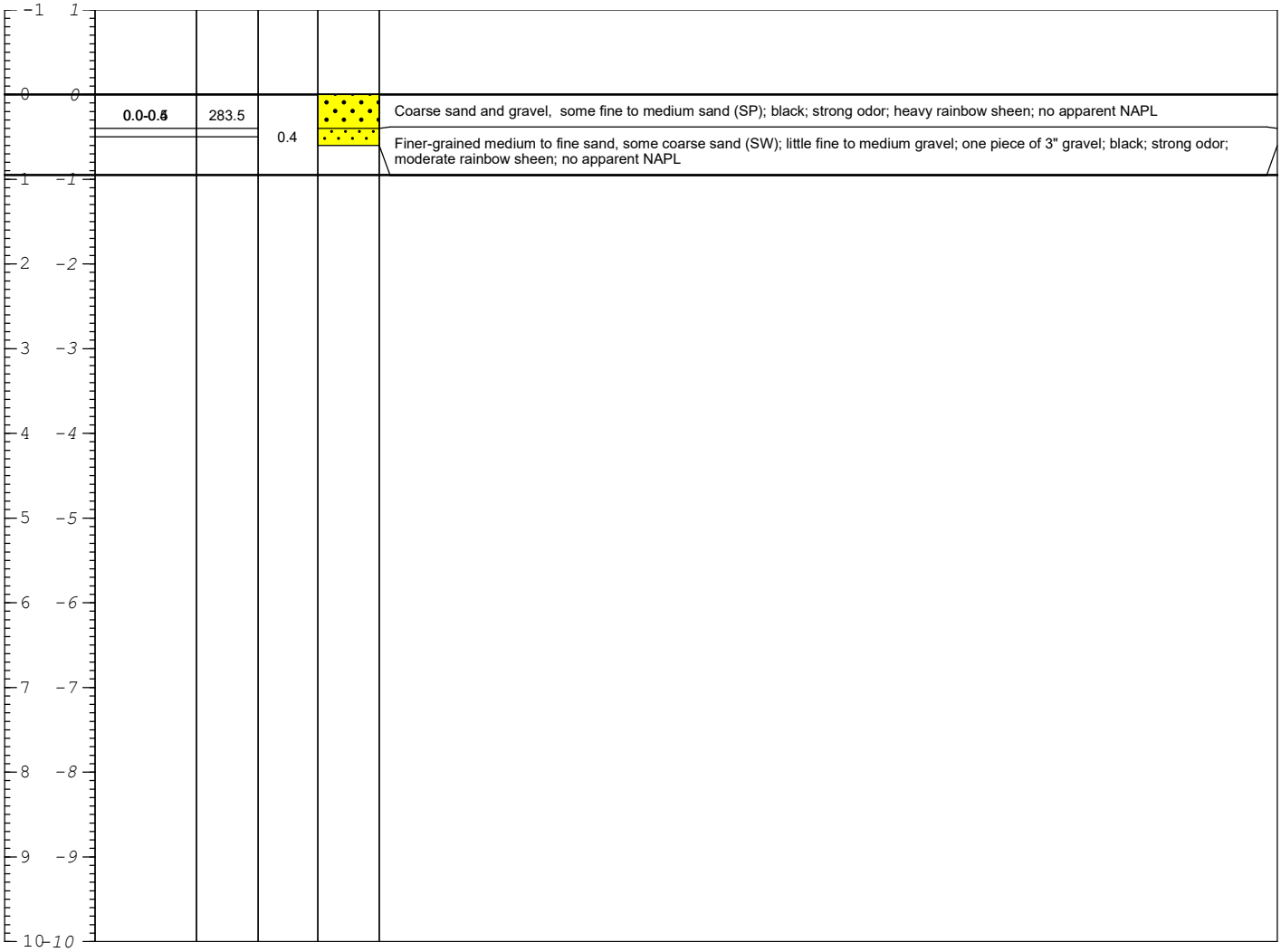
Remarks: ppm: parts per million
NAPL: non-aqueous phase liquid
NA: Information not available
Depth of core termination NA

Date Start/Finish:	September 29, 2021	**Latitude:**	42.776917	**Core ID:**	AQSS-09
Drilling Company:	TG&B Marine Services, Inc. Nappy Crane Service, Inc.	**Longitude:**	-71.087893	**Client:**	National Grid
		Water Depth:	N/A	**Location:**	Former Haverhill MGP Site 284 Winter Street Haverhill, MA
Driller's Name:	Various	**Mudline Elevation:**	N/A		
Drilling Method:	Vibracore	**Recovery:**	2.2 ft		
Penetration:	N/A	**Scientist:**	B. Gauley		



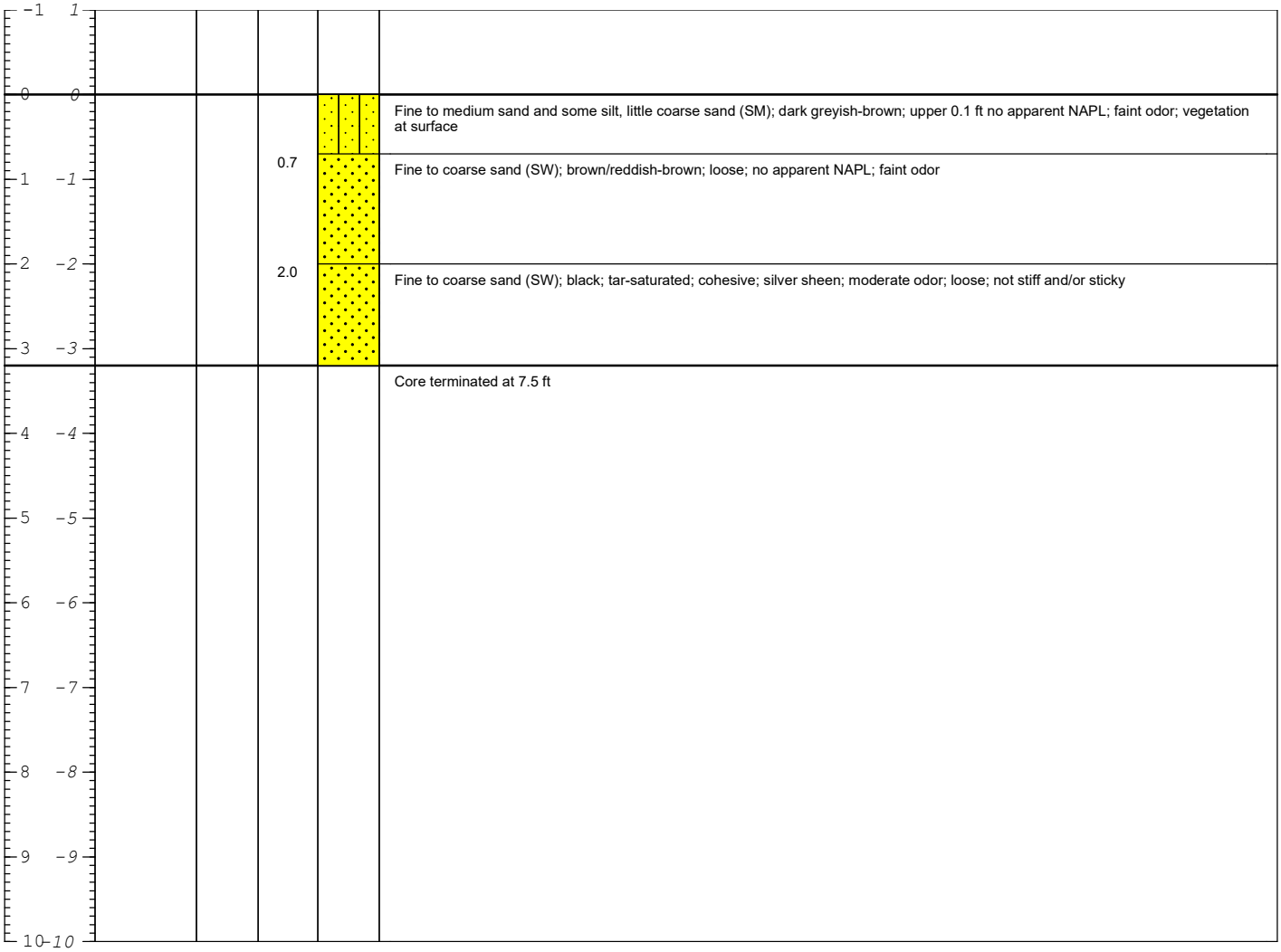
Remarks: ppm: parts per million
NAPL: non-aqueous phase liquid
NA: Information not available
Depth of core termination NA
AQSS-09-0.0-0.5 TOC, Soot, PCB, RCRA8 Metals, Alkylated PAH
AQSS-09(DUP) TOC, Soot, PCB, RCRA8 Metals
Poor penetration; hard refusal on initial attempt

Date Start/Finish:	September 29, 2021	**Latitude:**	42.776824	**Core ID:**	AQSS-10
Drilling Company:	TG&B Marine Services, Inc. Nappy Crane Service, Inc.	**Longitude:**	-71.087725	**Client:**	National Grid
		Water Depth:	N/A	**Location:**	Former Haverhill MGP Site 284 Winter Street Haverhill, MA
Driller's Name:	Various	**Mudline Elevation:**	N/A		
Drilling Method:	Vibracore	**Recovery:**	0.6 ft		
Penetration:	N/A	**Scientist:**	B. Gauley		



Remarks: ppm: parts per million
NAPL: non-aqueous phase liquid
NA: Information not available
Depth of core termination NA
Minimal penetration; three attempts with hard refusal; blown air hose
AQSS-10-0.0-0.4 GS
AQSS-10-0.0-0.5 TOC, Soot, PCB, RCRA8 Metals, Alkylated PAH

Date Start/Finish:	September 28, 2021	**Latitude:**	42.776687	**Core ID:**	AQSS-11
Drilling Company:	TG&B Marine Services, Inc. Nappy Crane Service, Inc.	**Longitude:**	-71.087599	**Client:**	National Grid
		Water Depth:	N/A	**Location:**	Former Haverhill MGP Site 284 Winter Street Haverhill, MA
Driller's Name:	Various	**Mudline Elevation:**	N/A		
Drilling Method:	Vibracore	**Recovery:**	3.2 ft		
Penetration:	7.5	**Scientist:**	B. Gauley		

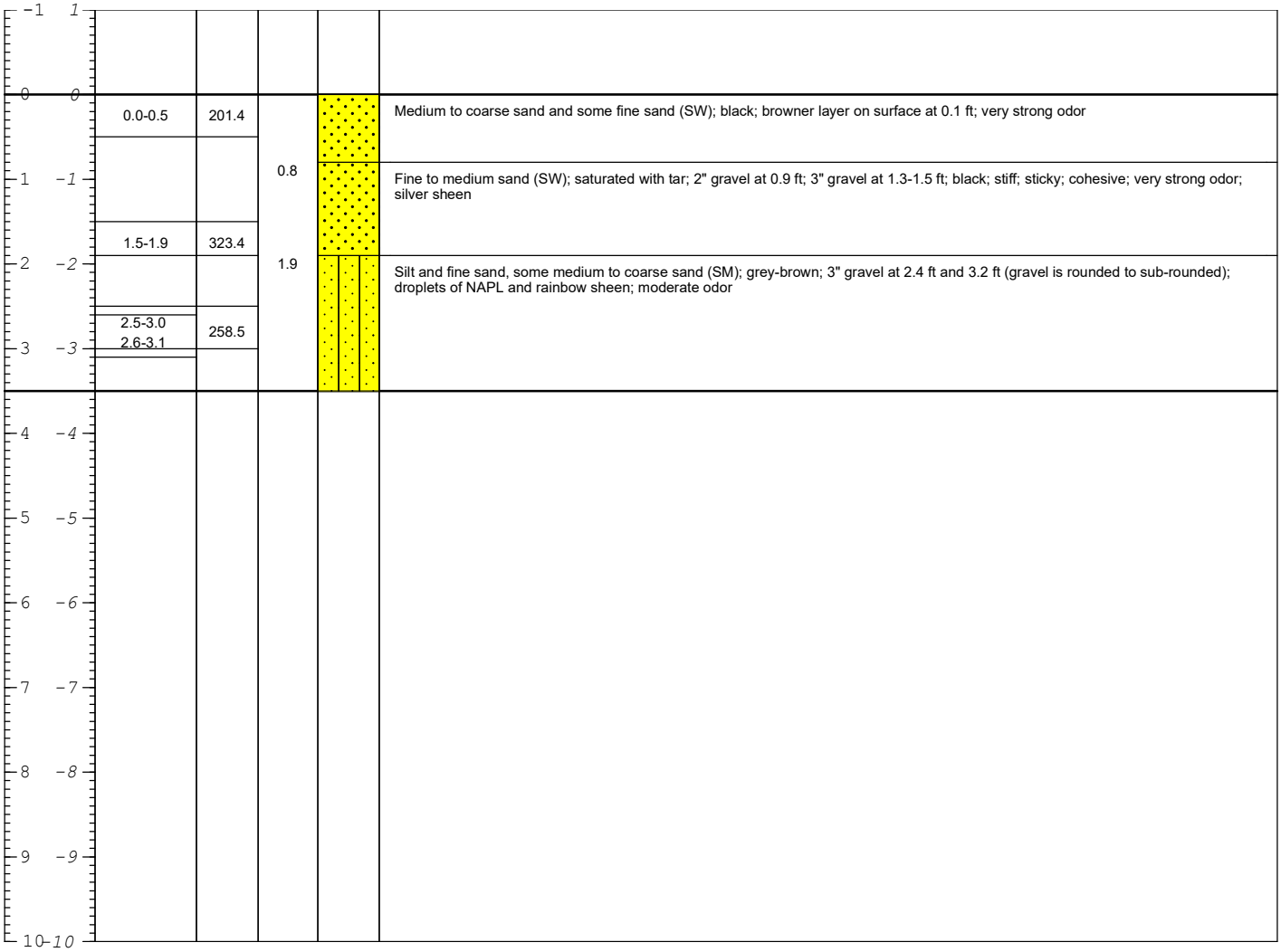


Remarks: ppm: parts per million
NAPL: non-aqueous phase liquid
NA: Information not available

Project: Former Haverhill MGP
Date: April 2022

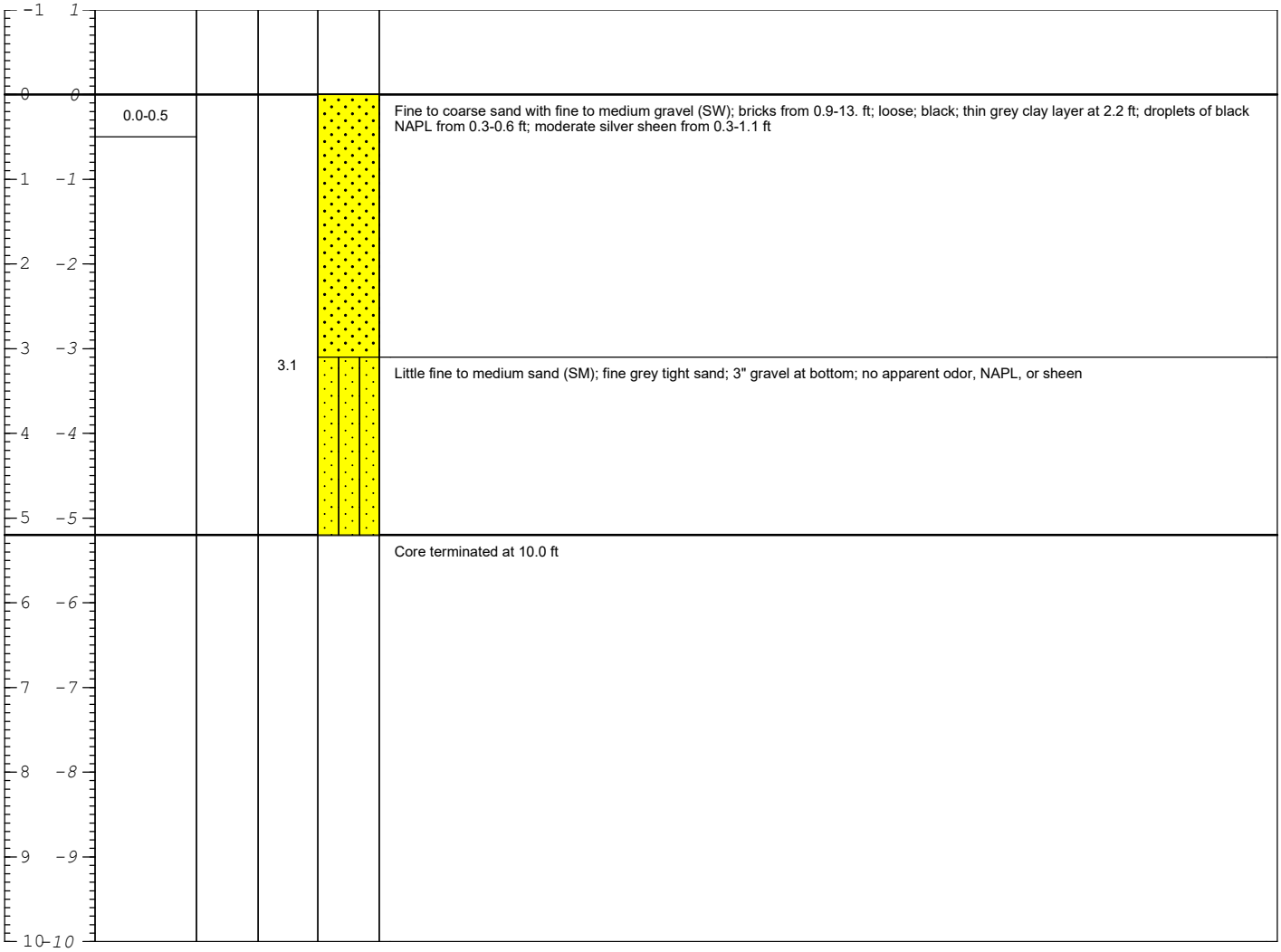
Template: Haverhill2022.ldfx

Date Start/Finish:	September 28, 2021	**Latitude:**	42.776687	**Core ID:**	AQSS-11B
Drilling Company:	TG&B Marine Services, Inc. Nappy Crane Service, Inc.	**Longitude:**	-71.087599	**Client:**	National Grid
		Water Depth:	N/A	**Location:**	Former Haverhill MGP Site 284 Winter Street Haverhill, MA
Driller's Name:	Various	**Mudline Elevation:**	N/A		
Drilling Method:	Vibracore	**Recovery:**	3.5 ft		
Penetration:	N/A	**Scientist:**	B. Gauley		



Remarks: ppm: parts per million
NAPL: non-aqueous phase liquid
NA: Information not available
Depth of core termination NA
AQSS-11B-0.0-0.5 TOC, Soot, PCB, RCRA8 Metals, Alkylated PAH
AQSS-11B-1.5-1.9 TOC; Alkylated PAH
AQSS-11B-2.5-3.0 PAH16, TOC
AQSS-11B-2.6-3.1 GS

Date Start/Finish:	September 30, 2021	**Latitude:**	42.776733	**Core ID:**	AQSS-11D
Drilling Company:	TG&B Marine Services, Inc. Nappy Crane Service, Inc.	**Longitude:**	-71.087604	**Client:**	National Grid
		Water Depth:	N/A	**Location:**	Former Haverhill MGP Site 284 Winter Street Haverhill, MA
Driller's Name:	Various	**Mudline Elevation:**	N/A		
Drilling Method:	Vibracore	**Recovery:**	5.2 ft		
Penetration:	10.0 ft	**Scientist:**	B. Gauley		

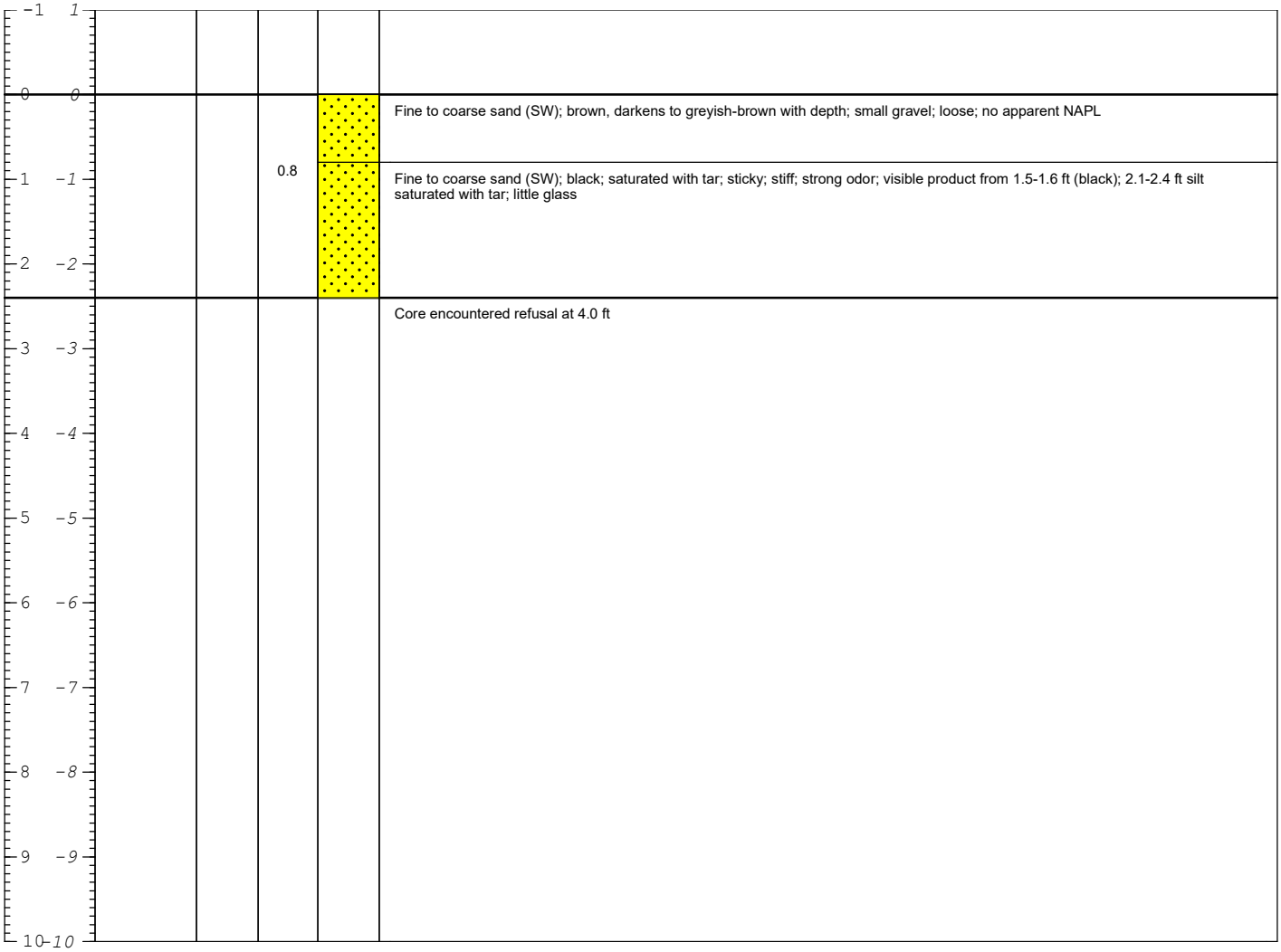


Remarks: ppm: parts per million
NAPL: non-aqueous phase liquid
NA: Information not available
AQSS-11D-0.0-0.5 GS

Project: Former Haverhill MGP
Date: April 2022

Template: Haverhill2022.ldfx

Date Start/Finish:	September 28, 2021	**Latitude:**	42.776632	**Core ID:**	AQSS-12
Drilling Company:	TG&B Marine Services, Inc. Nappy Crane Service, Inc.	**Longitude:**	-71.087427	**Client:**	National Grid
		Water Depth:	N/A	**Location:**	Former Haverhill MGP Site 284 Winter Street Haverhill, MA
Driller's Name:	Various	**Mudline Elevation:**	N/A		
Drilling Method:	Vibracore	**Recovery:**	2.4 ft		
Penetration:	4.0 ft	**Scientist:**	B. Gauley		

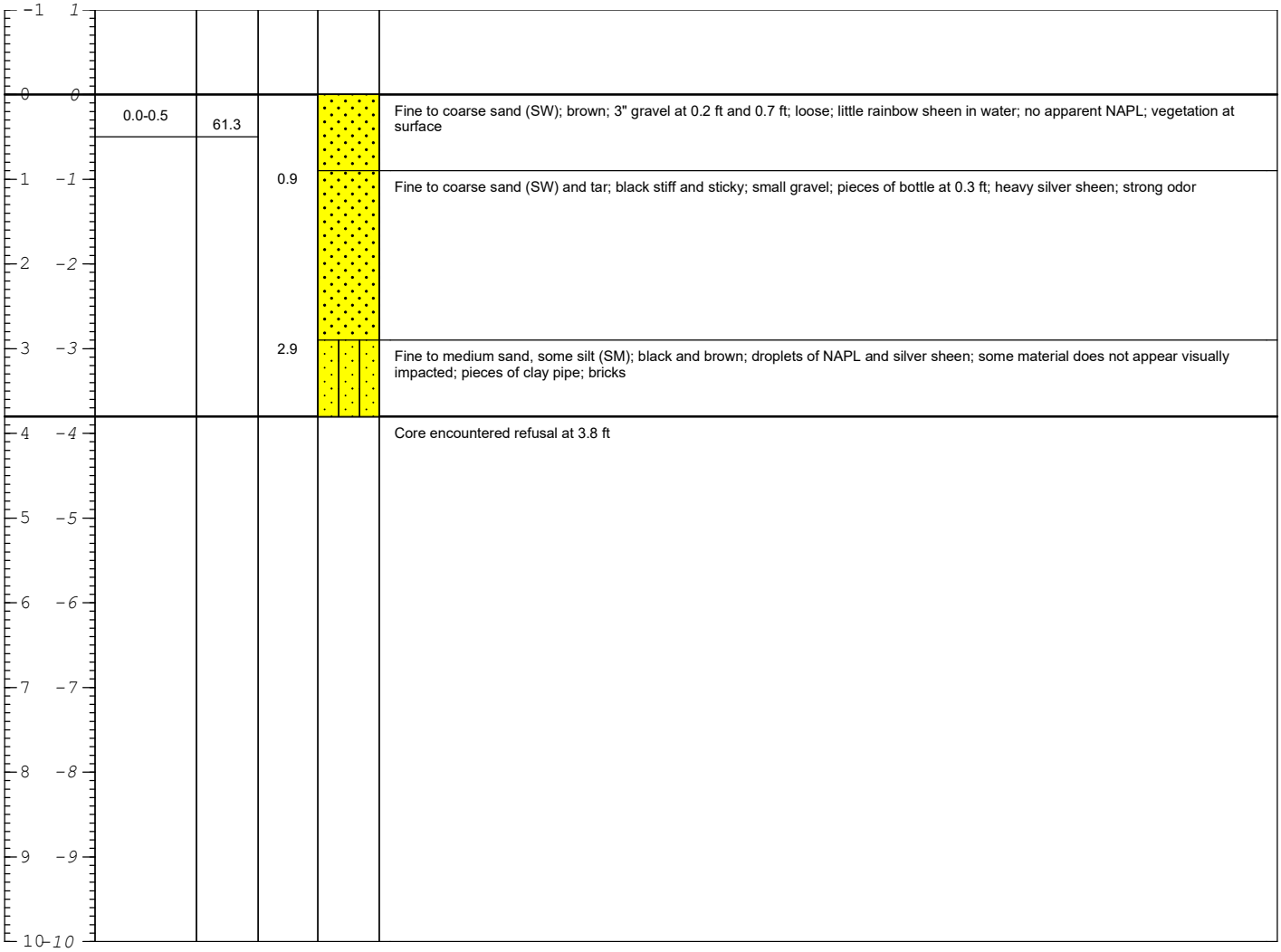


Remarks: ppm: parts per million
NAPL: non-aqueous phase liquid
NA: Information not available

Project: Former Haverhill MGP
Date: April 2022

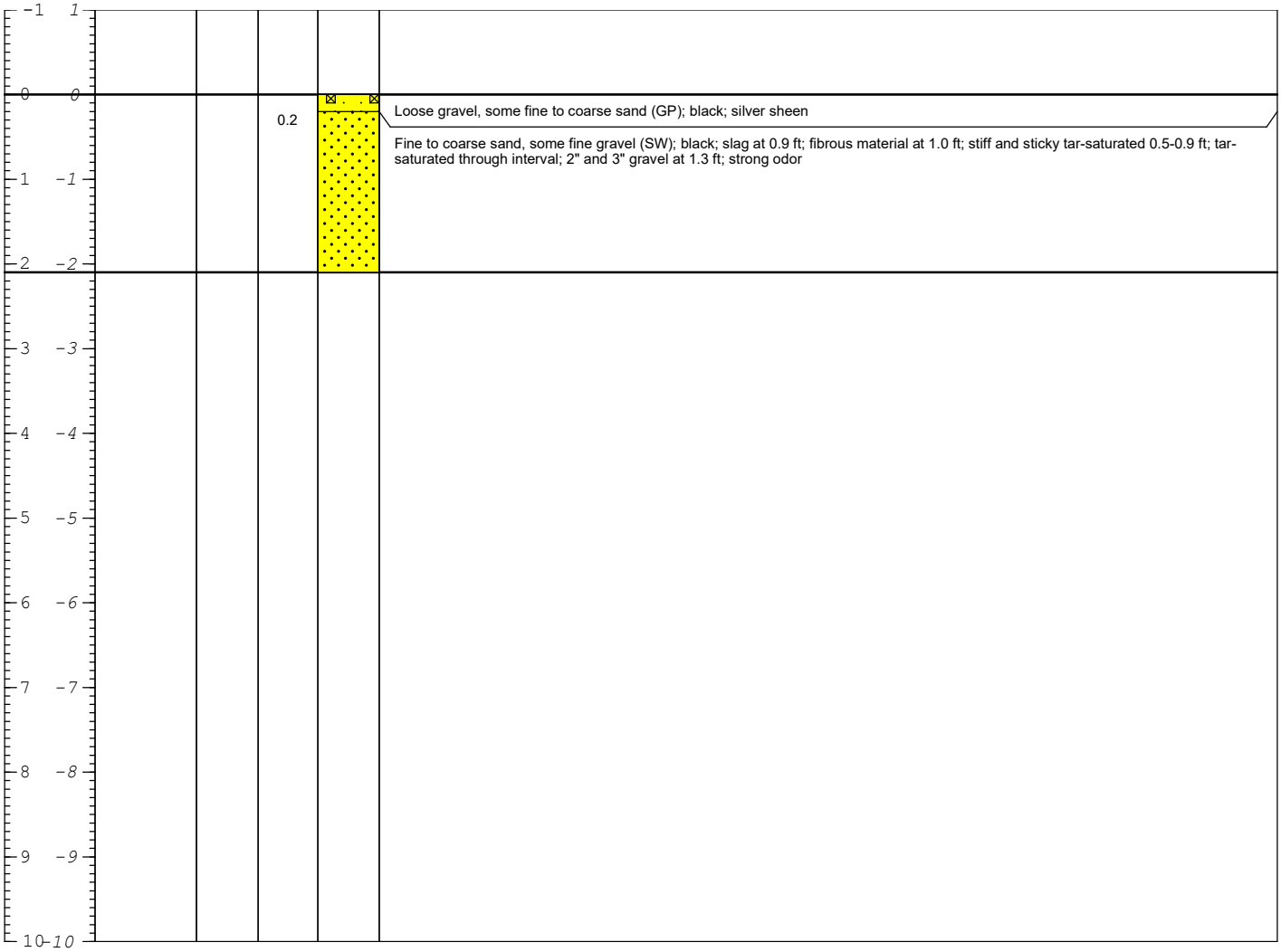
Template: Haverhill2022.ldfx

Date Start/Finish:	September 28, 2021	**Latitude:**	42.776632	**Core ID:**	AQSS-12B
Drilling Company:	TG&B Marine Services, Inc. Nappy Crane Service, Inc.	**Longitude:**	-71.087427	**Client:**	National Grid
		Water Depth:	N/A	**Location:**	Former Haverhill MGP Site 284 Winter Street Haverhill, MA
Driller's Name:	Various	**Mudline Elevation:**	N/A		
Drilling Method:	Vibracore	**Recovery:**	3.8 ft		
Penetration:	N/A	**Scientist:**	B. Gauley		



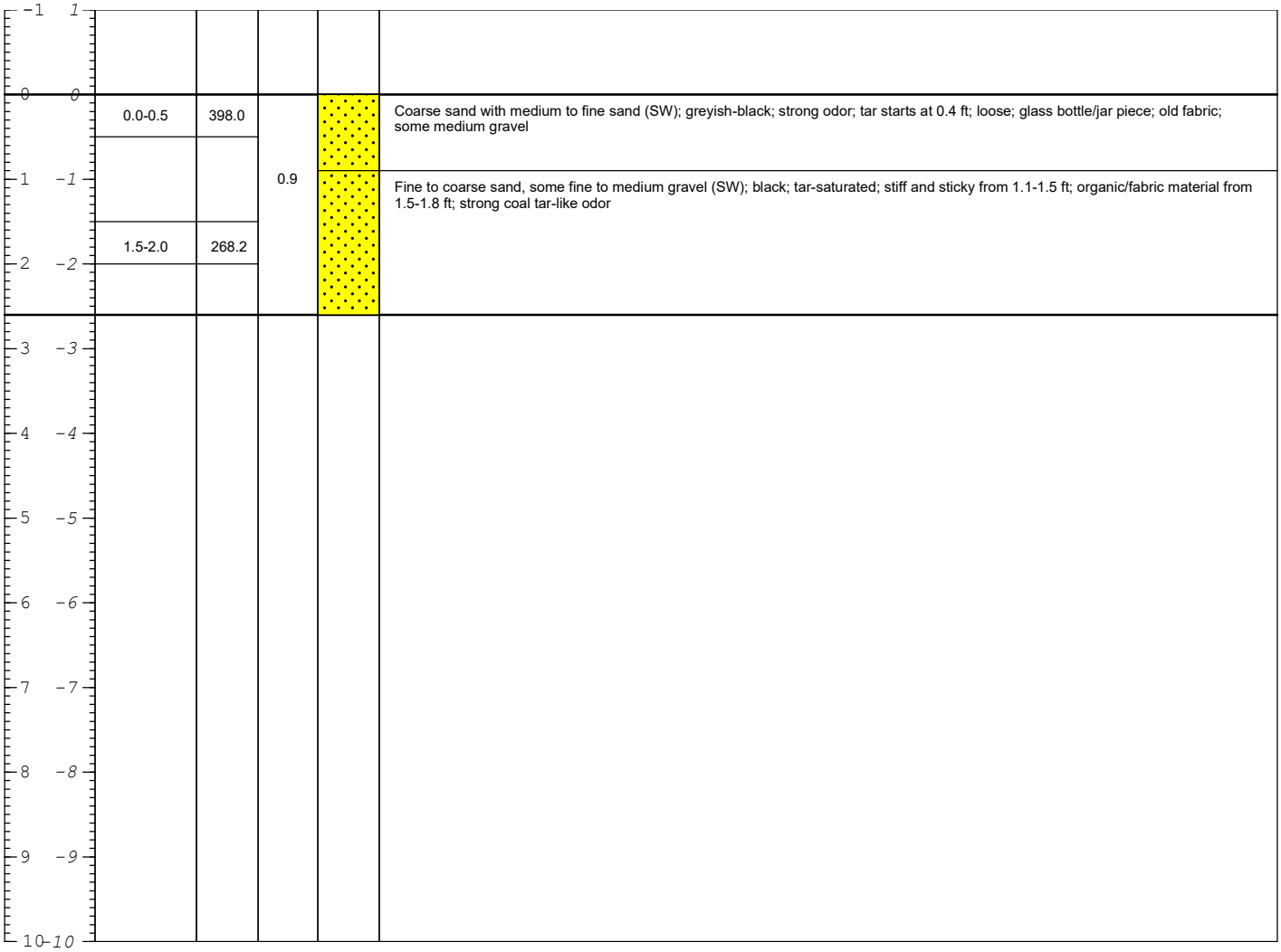
Remarks: ppm: parts per million
NAPL: non-aqueous phase liquid
NA: Information not available
AQSS-12B-0.0-0.5 PAH16, TOC, Soot, PCB, RCRA8 Metals

Date Start/Finish:	September 28, 2021	**Latitude:**	42.776538	**Core ID:**	AQSS-13
Drilling Company:	TG&B Marine Services, Inc. Nappy Crane Service, Inc.	**Longitude:**	-71.087357	**Client:**	National Grid
		Water Depth:	N/A	**Location:**	Former Haverhill MGP Site 284 Winter Street Haverhill, MA
Driller's Name:	Various	**Mudline Elevation:**	N/A		
Drilling Method:	Vibracore	**Recovery:**	2.1 ft		
Penetration:	N/A	**Scientist:**	B. Gauley		



Remarks: ppm: parts per million
NAPL: non-aqueous phase liquid
NA: Information not available
Depth of core termination NA

Date Start/Finish:	September 28, 2021	**Latitude:**	42.776538	**Core ID:**	AQSS-13B
Drilling Company:	TG&B Marine Services, Inc. Nappy Crane Service, Inc.	**Longitude:**	-71.087357	**Client:**	National Grid
		Water Depth:	N/A	**Location:**	Former Haverhill MGP Site 284 Winter Street Haverhill, MA
Driller's Name:	Various	**Mudline Elevation:**	N/A		
Drilling Method:	Vibracore	**Recovery:**	2.6 ft		
Penetration:	N/A	**Scientist:**	B. Gauley		

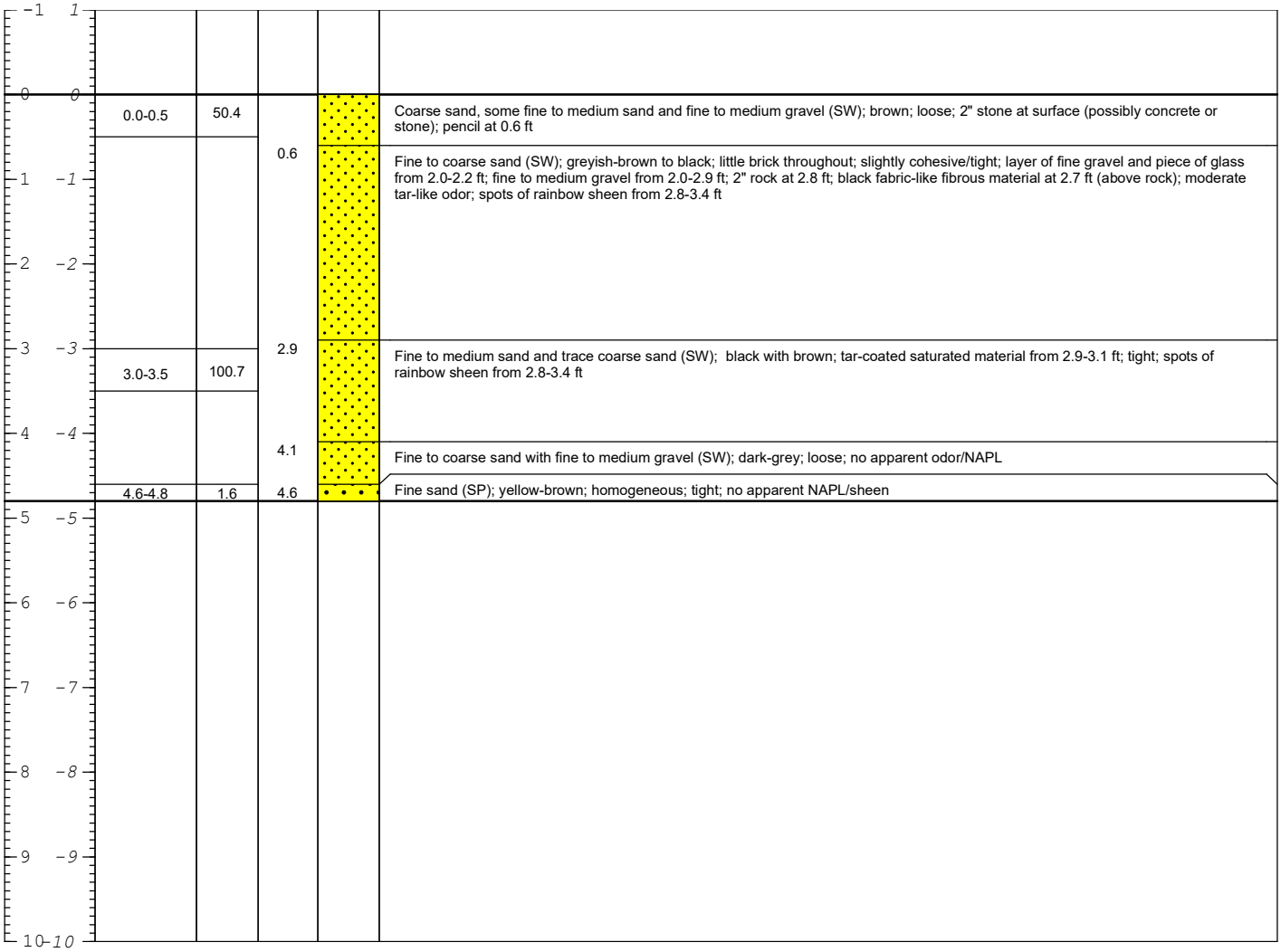


Remarks: ppm: parts per million
NAPL: non-aqueous phase liquid
NA: Information not available
Depth of core termination NA
AQSS-13B-0.0-0.5 TOC, Soot, PCB, RCRA8 Metals, Alkylated PAH
AQSS-13B-1.5-2.0 TOC, Alkylated PAH

Project: Former Haverhill MGP
Date: April 2022

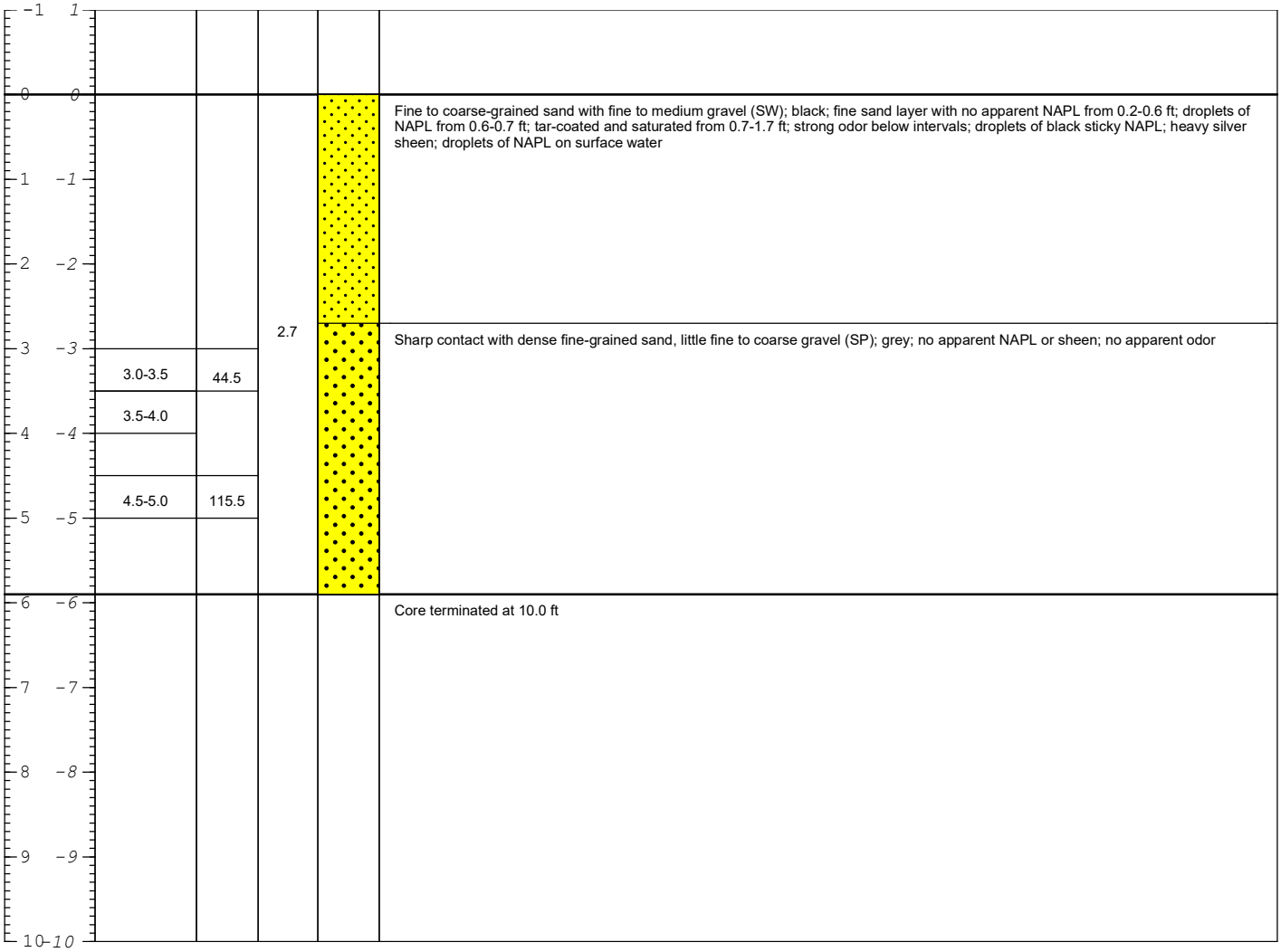
Template: Haverhill2022.ldfx

Date Start/Finish:	September 30, 2021	**Latitude:**	42.777128	**Core ID:**	AQSS-18
Drilling Company:	TG&B Marine Services, Inc. Nappy Crane Service, Inc.	**Longitude:**	-71.088226	**Client:**	National Grid
		Water Depth:	N/A	**Location:**	Former Haverhill MGP Site 284 Winter Street Haverhill, MA
Driller's Name:	Various	**Mudline Elevation:**	N/A		
Drilling Method:	Vibracore	**Recovery:**	4.8 ft		
Penetration:	N/A	**Scientist:**	B. Gauley		



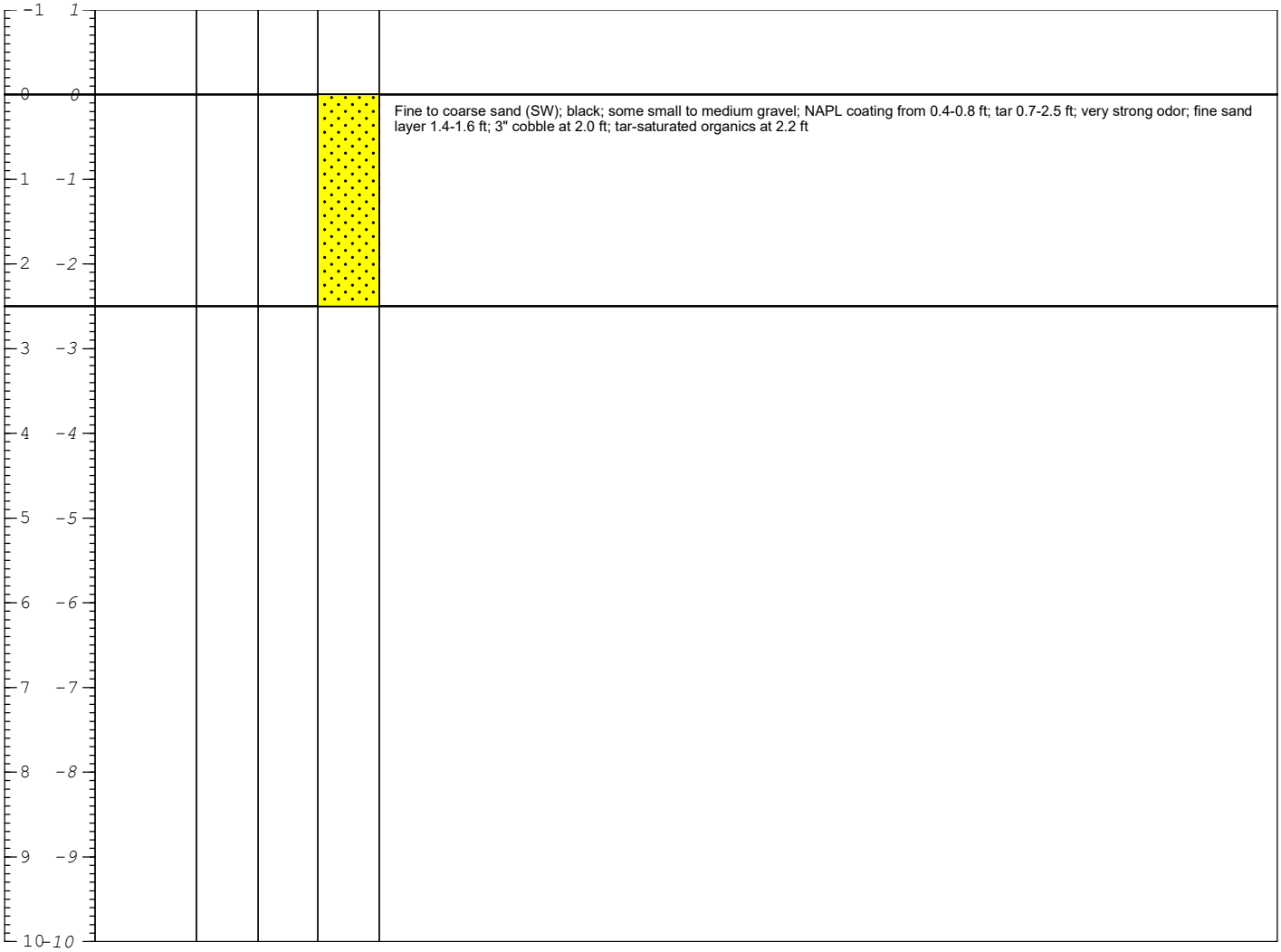
Remarks: ppm: parts per million
NAPL: non-aqueous phase liquid
NA: Information not available
Depth of core termination NA
AQSS-18-0.0-0.5 PAH16, TOC, Soot, PCB, RCRA8 Metals
AQSS-18-3.0-3.5 PAH16, TOC
AQSS-18-4.6-4.8 PAH16, TOC

Date Start/Finish:	September 30, 2021	**Latitude:**	42.77675	**Core ID:**	AQSS-19
Drilling Company:	TG&B Marine Services, Inc. Nappy Crane Service, Inc.	**Longitude:**	-71.087629	**Client:**	National Grid
		Water Depth:	N/A	**Location:**	Former Haverhill MGP Site 284 Winter Street Haverhill, MA
Driller's Name:	Various	**Mudline Elevation:**	N/A		
Drilling Method:	Vibracore	**Recovery:**	5.9 ft		
Penetration:	10.0 ft	**Scientist:**	B. Gauley		



Remarks: ppm: parts per million
NAPL: non-aqueous phase liquid
NA: Information not available
AQSS-19-3.0-3.5 PAH16, TOC
AQSS-19-3.5-4.0 GS
AQSS-19-4.5-5.0 PAH16, TOC

Date Start/Finish:	September 28, 2021	**Latitude:**	42.776767	**Core ID:**	AQSS-19D
Drilling Company:	TG&B Marine Services, Inc. Nappy Crane Service, Inc.	**Longitude:**	-71.087657	**Client:**	National Grid
		Water Depth:	N/A	**Location:**	Former Haverhill MGP Site 284 Winter Street Haverhill, MA
Driller's Name:	Various	**Mudline Elevation:**	N/A		
Drilling Method:	Vibracore	**Recovery:**	2.5 ft		
Penetration:	N/A	**Scientist:**	B. Gauley		

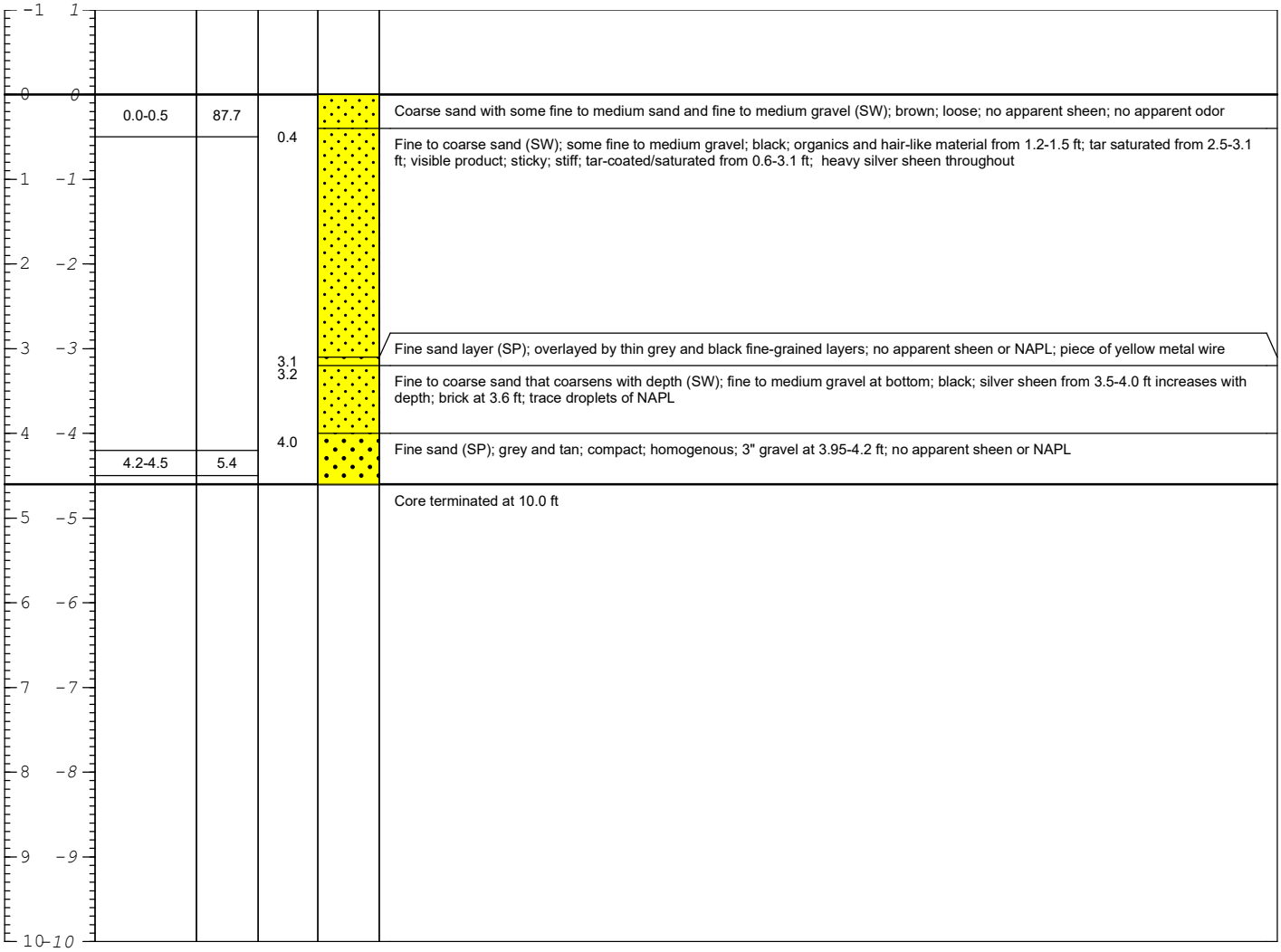


Remarks: ppm: parts per million
NAPL: non-aqueous phase liquid
NA: Information not available
Depth of core termination NA

Project: Former Haverhill MGP
Date: April 2022

Template: Haverhill2022.ldfx

Date Start/Finish:	September 30, 2021	**Latitude:**	42.776509	**Core ID:**	AQSS-20
Drilling Company:	TG&B Marine Services, Inc. Nappy Crane Service, Inc.	**Longitude:**	-71.08726	**Client:**	National Grid
		Water Depth:	N/A	**Location:**	Former Haverhill MGP Site 284 Winter Street Haverhill, MA
Driller's Name:	Various	**Mudline Elevation:**	N/A		
Drilling Method:	Vibracore	**Recovery:**	4.6 ft		
Penetration:	10.0 ft	**Scientist:**	B. Gauley		



Remarks: ppm: parts per million
NAPL: non-aqueous phase liquid
NA: Information not available
AQSS-20-0.0-0.5 PAH16, TOC, Soot, RCRA8 Metals, PCB
AQSS-20-4.2-4.5 PAH16, TOC

Project: Former Haverhill MGP
Date: April 2022

Template: Haverhill2022.ldfx

Appendix D
Analytical and Physical Property Reports

Client:	Anchor QEA, LLC				
Project:	Haverhill MGP				
Location:	Haverhill, MA			Project No:	GTX-314378
Boring ID:	---	Sample Type:	---	Tested By:	ckg
Sample ID:	---	Test Date:	10/14/21	Checked By:	bfs
Depth :	---	Test Id:	632873		

Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content, %
---	AQSS- 11D -0.0-0.5	---	Moist,very dark brown sand with silt	19.1
---	AQSS- 10 -0.0-0.4	---	Moist, black sand with silt	21.9
---	AQSS- 19 -3.5-4.0	---	Moist, gray silty sand with gravel	10.5
---	AQSS- 04 -0.5-1.0	---	Moist, dark brown sand with silt and gravel	15.8
---	AQSS- 7D -0.0-0.5	---	Moist, dark brown sand with gravel	12.2
---	AQSS- 11b -2.6-3.1	---	Moist, gray silty sand with gravel	10.9

Notes: Temperature of Drying : 110° Celsius

GeoTesting EXPRESS

Client:	Anchor QEA, LLC				
Project:	Haverhill MGP				
Location:	Haverhill, MA			Project No:	GTX-314378
Boring ID:	---	Sample Type:	---	Tested By:	ckg
Sample ID:	---	Test Date:	10/14/21	Checked By:	bfs
Depth :	---	Test Id:	632879		

Laboratory Determination of Density (Unit Weight) of Soil Specimens by ASTM D7263

Boring ID	Sample ID	Depth	Visual Description	Bulk Density pcf	Moisture Content %	Dry Density pcf	*
---	AQSS- 11D -0.0-0.5	---	Moist,very dark brown sand with silt	90.41	19.10	75.91	(1)
---	AQSS- 10 -0.0-0.4	---	Moist, black sand with silt	114.7	21.94	94.07	(2)
---	AQSS- 19 -3.5-4.0	---	Moist, gray silty sand with gravel	122.8	10.48	111.1	(3)
---	AQSS- 04 -0.5-1.0	---	Moist, dark brown sand with silt and gravel	104.4	15.79	90.17	(4)
---	AQSS- 7D -0.0-0.5	---	Moist, dark brown sand with gravel	105.1	12.25	93.59	(5)
---	AQSS- 11b -2.6-3.1	---	Moist, gray silty sand with gravel	131.1	10.90	118.2	(6)

* Sample Comments

(1): Method B-Volumetric, Reconstituted (compacted)

(2): Method B-Volumetric, Reconstituted (compacted)

(3): Method B-Volumetric, Reconstituted (compacted)

(4): Method B-Volumetric, Reconstituted (compacted)

(5): Method B-Volumetric, Reconstituted (compacted)

(6): Method B-Volumetric, Reconstituted (compacted)

Notes: Moisture Content determined by ASTM D2216.

Client:	Anchor QEA, LLC				
Project:	Haverhill MGP				
Location:	Haverhill, MA			Project No:	GTX-314378
Boring ID:	---	Sample Type:	---	Tested By:	htk
Sample ID:	---	Test Date:	10/14/21	Checked By:	bfs
Depth :	---	Test Id:	632885		

Specific Gravity of Soils by ASTM D854

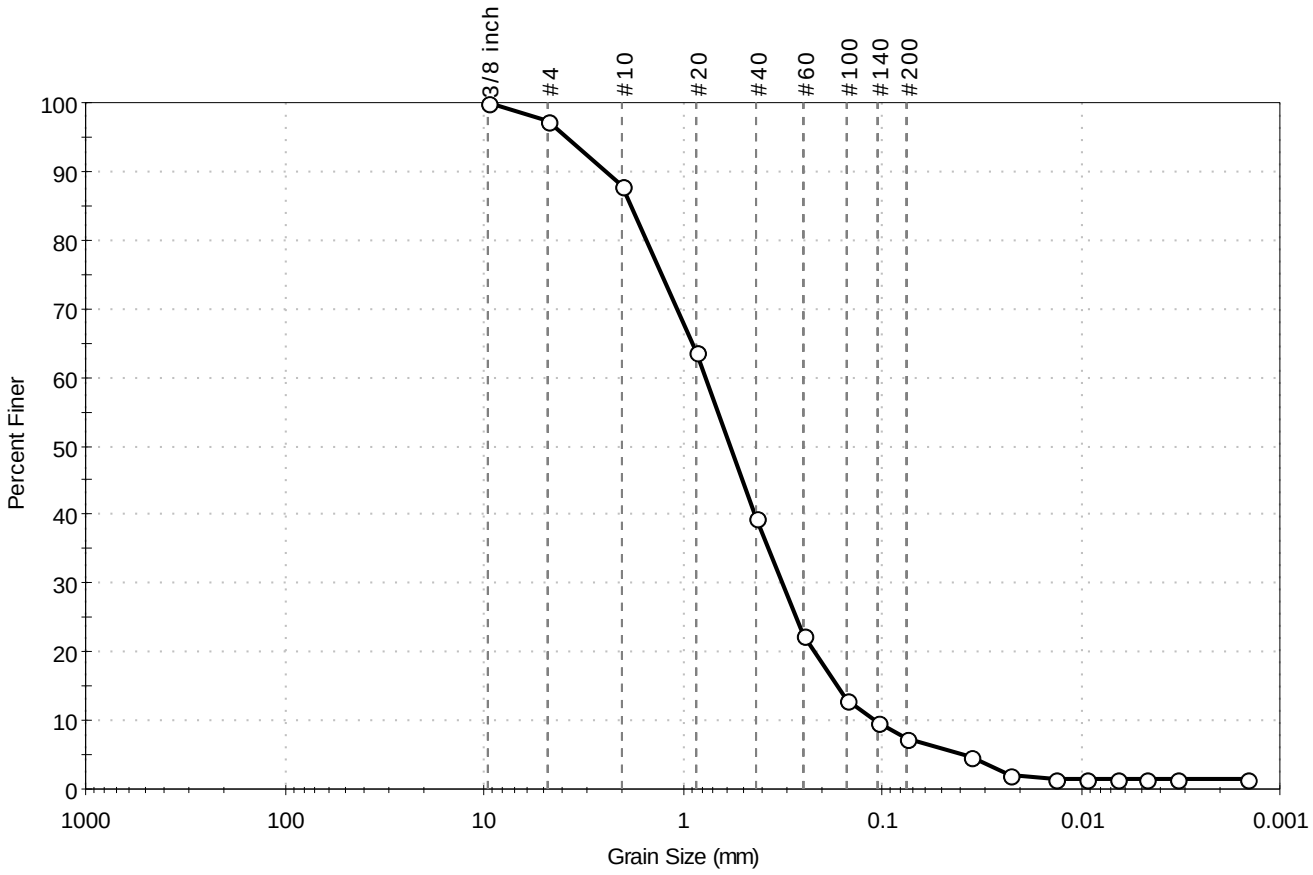
Boring ID	Sample ID	Depth	Visual Description	Specific Gravity	Comment
---	AQSS- 11D -0.0-0.5	---	Moist, very dark brown sand with silt	2.56	
---	AQSS- 10 -0.0-0.4	---	Moist, black sand with silt	2.77	
---	AQSS- 19 -3.5-4.0	---	Moist, gray silty sand with gravel	2.72	
---	AQSS- 04 -0.5-1.0	---	Moist, dark brown sand with silt and gravel	2.65	
---	AQSS- 7D -0.0-0.5	---	Moist, dark brown sand with gravel	2.71	
---	AQSS- 11b -2.6-3.1	---	Moist, gray silty sand with gravel	2.71	

Notes: Specific Gravity performed by using method B (oven dried specimens) of ASTM D854
Moisture Content determined by ASTM D2216.

GeoTesting EXPRESS

Client:	Anchor QEA, LLC				
Project:	Haverhill MGP				
Location:	Haverhill, MA			Project No:	GTX-314378
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	AQSS-11D -0.0-0.5	Test Date:	10/15/21	Checked By:	bfs
Depth :	---	Test Id:	632862		
Test Comment:	---				
Visual Description:	Moist,very dark brown sand with silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913/D7928



%Cobble	%Gravel	%Sand	%Silt & Clay Size
---	2.6	89.9	7.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/8 inch	9.50	100		
#4	4.75	97		
#10	2.00	88		
#20	0.85	64		
#40	0.42	40		
#60	0.25	23		
#100	0.15	13		
#140	0.11	10		
#200	0.075	7.5		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0361	5		
---	0.0226	2		
---	0.0134	1		
---	0.0095	1		
---	0.0066	1		
---	0.0047	1		
---	0.0033	1		
---	0.0014	1		

Coefficients

D_{85} = 1.8097 mm	D_{30} = 0.3156 mm
D_{60} = 0.7649 mm	D_{15} = 0.1675 mm
D_{50} = 0.5740 mm	D_{10} = 0.1106 mm
C_u = 6.916	C_c = 1.177

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (1))

Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

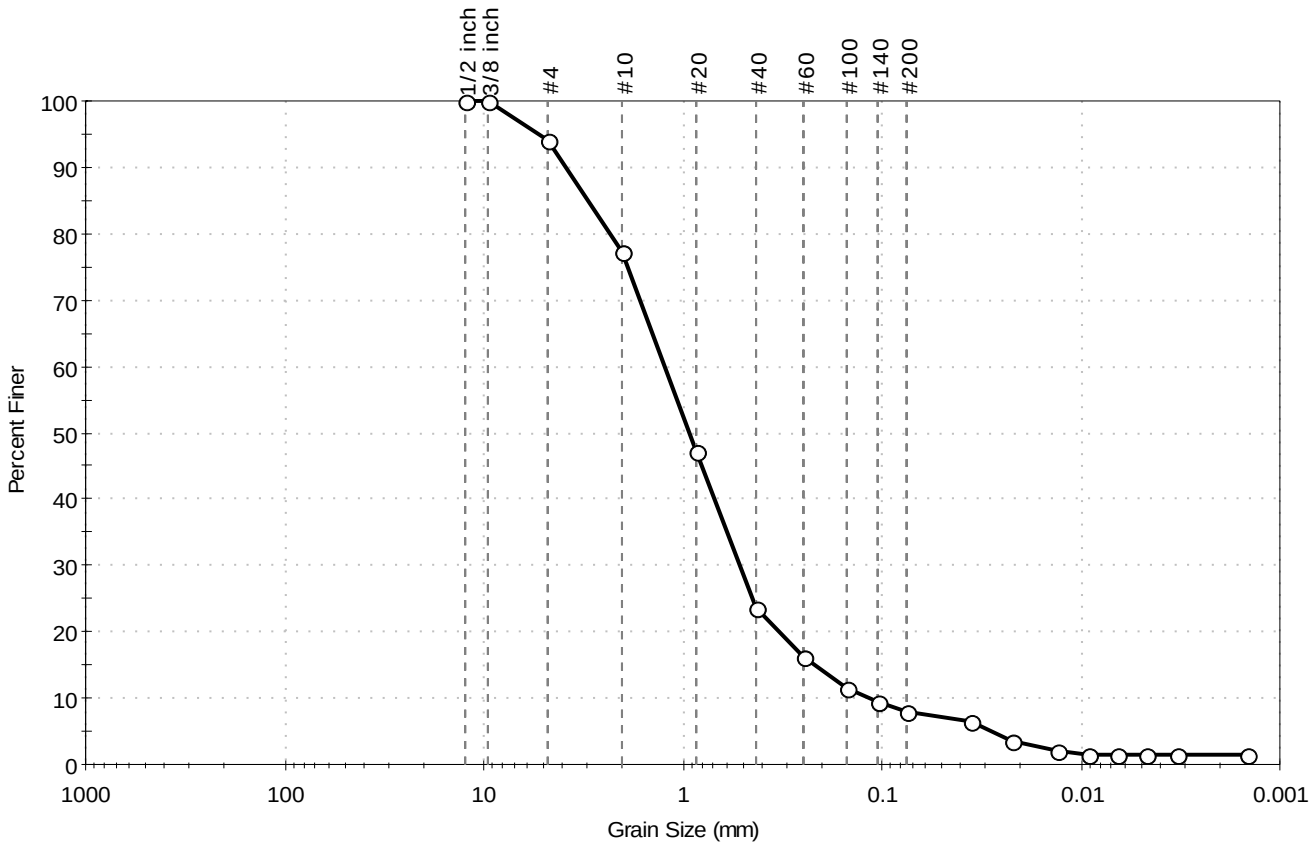
Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

GeoTesting EXPRESS

Client:	Anchor QEA, LLC				
Project:	Haverhill MGP				
Location:	Haverhill, MA			Project No:	GTX-314378
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	AQSS-10 -0.0-0.4	Test Date:	10/14/21	Checked By:	bfs
Depth :	---	Test Id:	632863		
Test Comment:	---				
Visual Description:	Moist, black sand with silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	6.0	86.1	7.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1/2 inch	12.50	100		
3/8 inch	9.50	100		
#4	4.75	94		
#10	2.00	77		
#20	0.85	47		
#40	0.42	24		
#60	0.25	16		
#100	0.15	12		
#140	0.11	9		
#200	0.075	7.9		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0357	7		
---	0.0224	4		
---	0.0131	2		
---	0.0093	1		
---	0.0067	1		
---	0.0047	1		
---	0.0033	1		
---	0.0015	1		

Coefficients

D_{85} = 2.9856 mm	D_{30} = 0.5113 mm
D_{60} = 1.2220 mm	D_{15} = 0.2207 mm
D_{50} = 0.9178 mm	D_{10} = 0.1157 mm
C_u = 10.562	C_c = 1.849

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (1))

Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Dispersion Device : Apparatus A - Mech Mixer

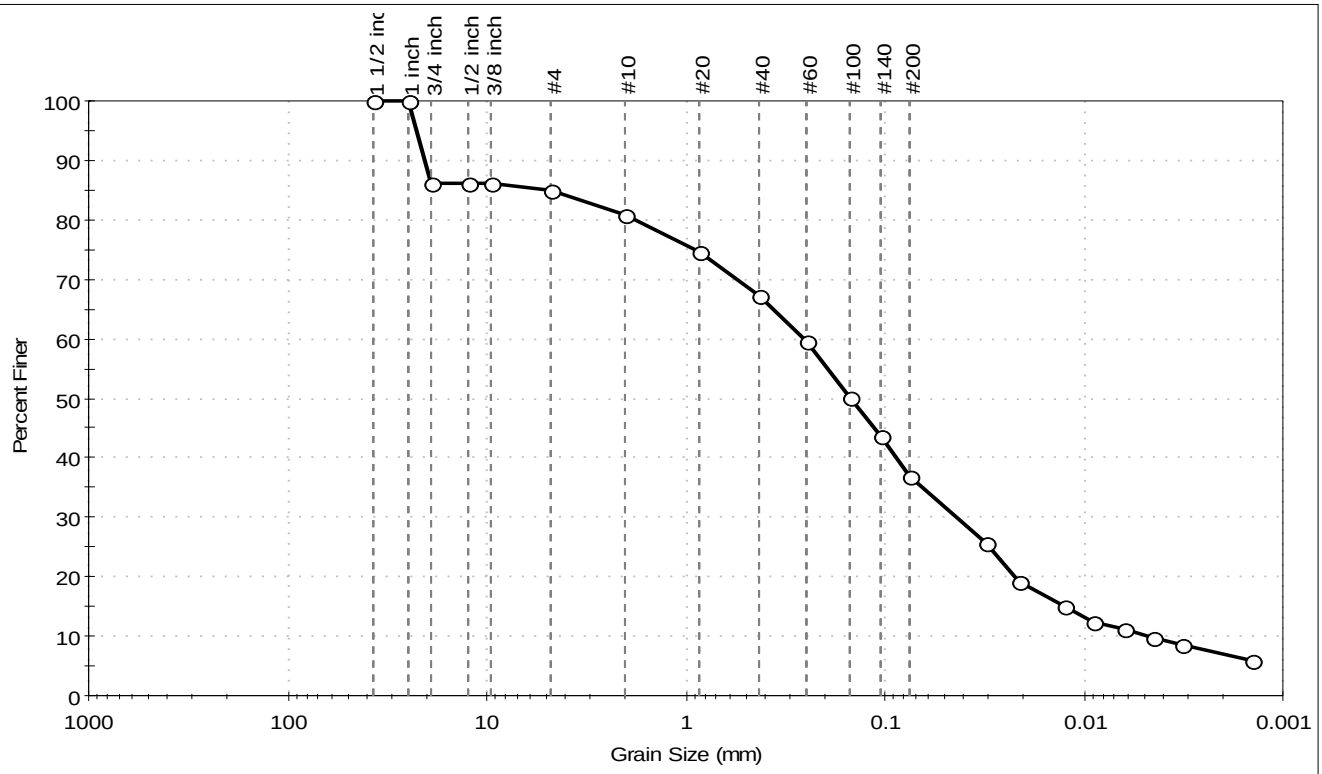
Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	Anchor QEA, LLC				
Project:	Haverhill MGP				
Location:	Haverhill, MA			Project No:	GTX-314378
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	AQSS-19 -3.5-4.0	Test Date:	10/14/21	Checked By:	bfs
Depth :	---	Test Id:	632864		
Test Comment:	---				
Visual Description:	Moist, gray silty sand with gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913/D7928



%Cobble	%Gravel	%Sand	%Silt & Clay Size
---	15.1	48.0	36.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 1/2 inch	37.50	100		
1 inch	25.00	100		
3/4 inch	19.00	86		
1/2 inch	12.50	86		
3/8 inch	9.50	86		
#4	4.75	85		
#10	2.00	81		
#20	0.85	75		
#40	0.42	67		
#60	0.25	60		
#100	0.15	50		
#140	0.11	44		
#200	0.075	37		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0311	26		
---	0.0210	19		
---	0.0126	15		
---	0.0089	12		
---	0.0063	11		
---	0.0045	10		
---	0.0032	9		
---	0.0014	6		

Coefficients

D_{85} = 5.0504 mm
D_{30} = 0.0438 mm
D_{60} = 0.2558 mm
D_{15} = 0.0124 mm
D_{50} = 0.1496 mm
D_{10} = 0.0047 mm
C_u = 54.426
C_c = 1.596

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

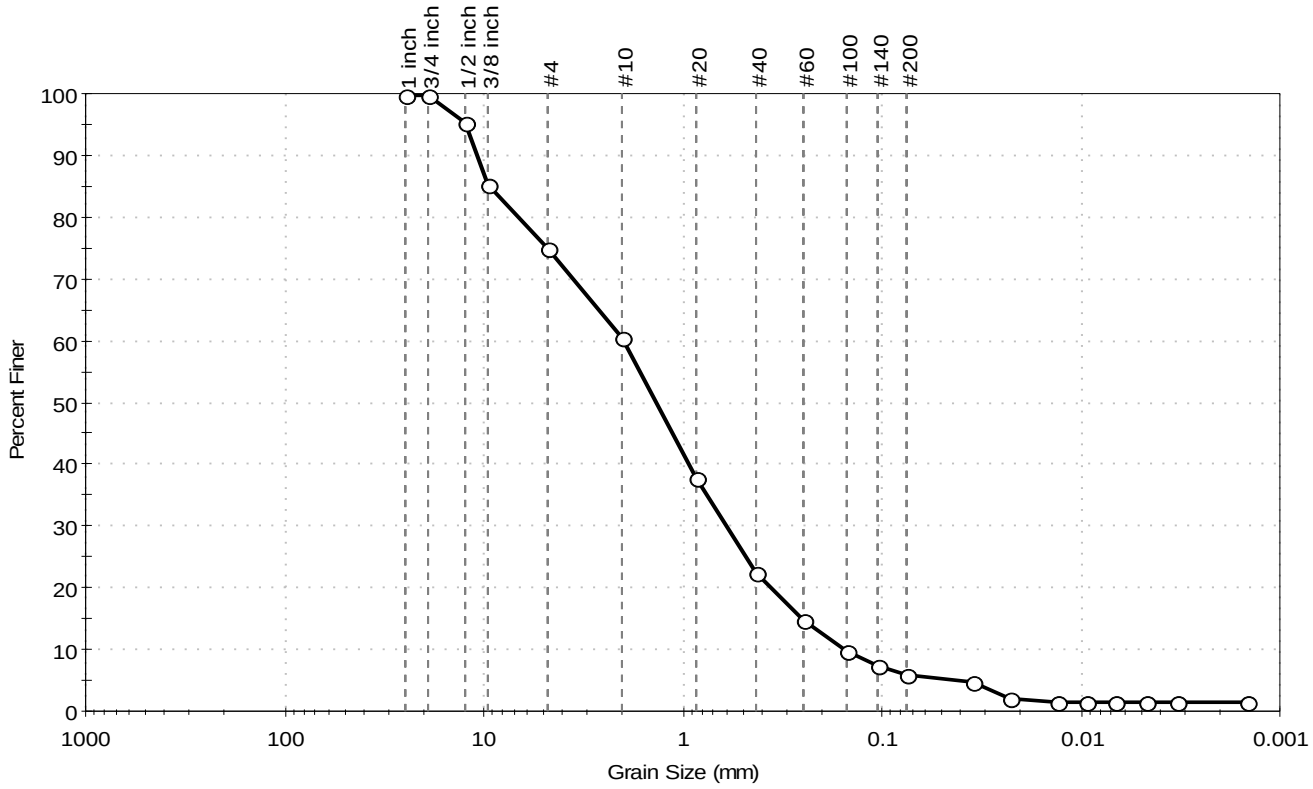
Separation of Sample: #200 Sieve

GeoTesting EXPRESS

Client:	Anchor QEA, LLC				
Project:	Haverhill MGP				
Location:	Haverhill, MA			Project No:	GTX-314378
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	AQSS-04 -0.5-1.0	Test Date:	10/14/21	Checked By:	bfs
Depth :	---	Test Id:	632865		

Test Comment: ---
Visual Description: Moist, dark brown sand with silt and gravel
Sample Comment: ---

Particle Size Analysis - ASTM D6913/D7928



%Cobble	%Gravel	%Sand	%Silt & Clay Size
---	25.0	69.2	5.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 inch	25.00	100		
3/4 inch	19.00	100		
1/2 inch	12.50	95		
3/8 inch	9.50	85		
#4	4.75	75		
#10	2.00	61		
#20	0.85	38		
#40	0.42	22		
#60	0.25	15		
#100	0.15	10		
#140	0.11	7		
#200	0.075	5.8		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0348	5		
---	0.0229	2		
---	0.0132	1		
---	0.0095	1		
---	0.0067	1		
---	0.0047	1		
---	0.0033	1		
---	0.0015	1		

Coefficients

D_{85} = 9.4004 mm
D_{30} = 0.5987 mm
D_{60} = 1.9594 mm
D_{15} = 0.2555 mm
D_{50} = 1.3429 mm
D_{10} = 0.1545 mm
C_u = 12.682
C_c = 1.184

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (1))

Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR
Sand/Gravel Hardness : HARD
Dispersion Device : Apparatus A - Mech Mixer
Dispersion Period : 1 minute
Est. Specific Gravity : 2.65
Separation of Sample: #200 Sieve

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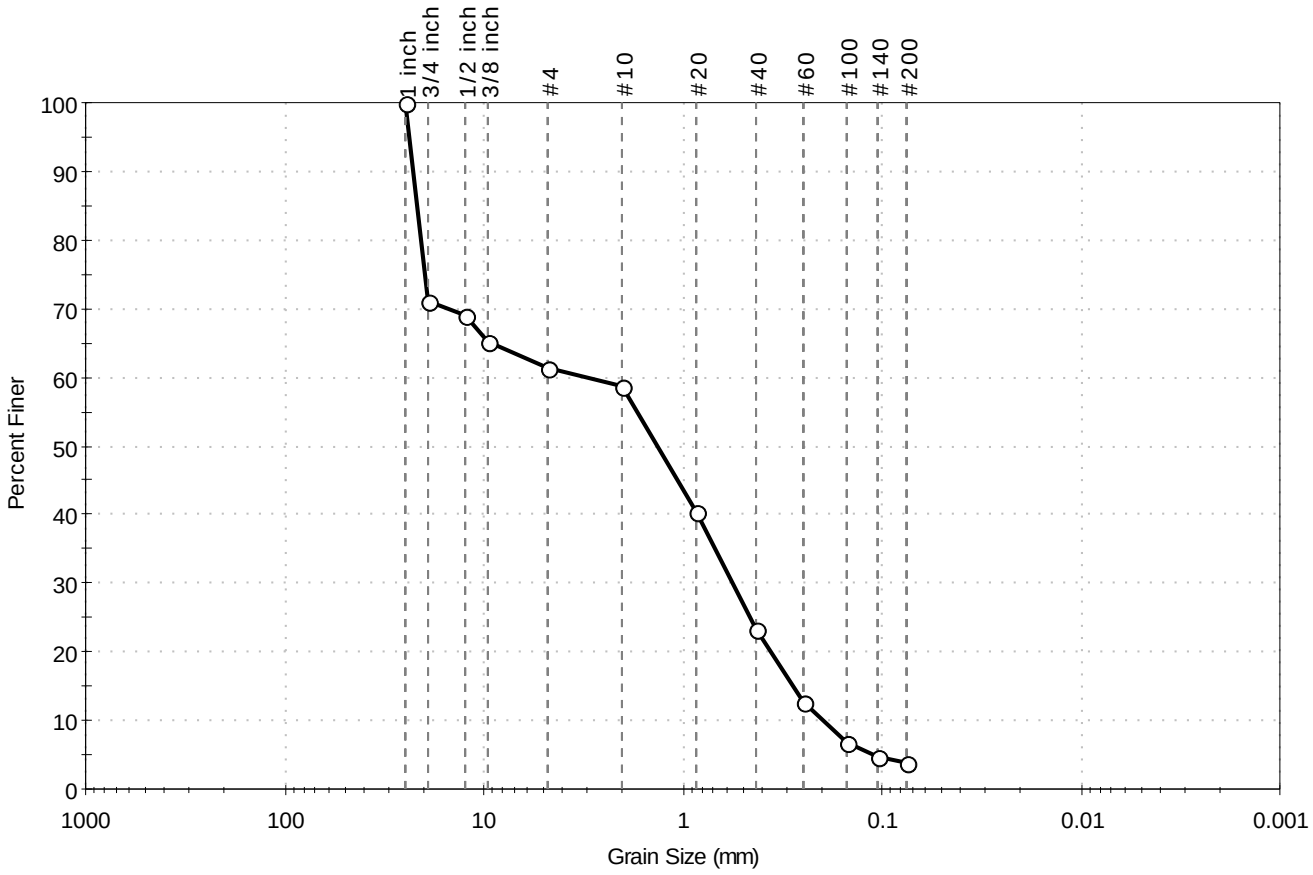
GeoTesting EXPRESS

Client:	Anchor QEA, LLC				
Project:	Haverhill MGP				
Location:	Haverhill, MA			Project No:	GTX-314378
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	AQSS-7D -0.0-0.5	Test Date:	10/14/21	Checked By:	bfs
Depth :	---	Test Id:	632866		
Test Comment:	---				
Visual Description:	Moist, dark brown sand with gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913/D7928



%Cobble	%Gravel	%Sand	%Silt & Clay Size
---	38.6	57.4	4.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 inch	25.00	100		
3/4 inch	19.00	71		
1/2 inch	12.50	69		
3/8 inch	9.50	65		
#4	4.75	61		
#10	2.00	59		
#20	0.85	40		
#40	0.42	23		
#60	0.25	13		
#100	0.15	7		
#140	0.11	5		
#200	0.075	4.0		

Coefficients

D_{85} = 21.6785 mm
D_{30} = 0.5549 mm
D_{60} = 3.0238 mm
D_{15} = 0.2802 mm
D_{50} = 1.3280 mm
D_{10} = 0.1990 mm
C_u = 15.195
C_c = 0.512

Classification

ASTM: Poorly graded SAND with Gravel (SP)

AASHTO: Stone Fragments, Gravel and Sand (A-1-b (1))

Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR

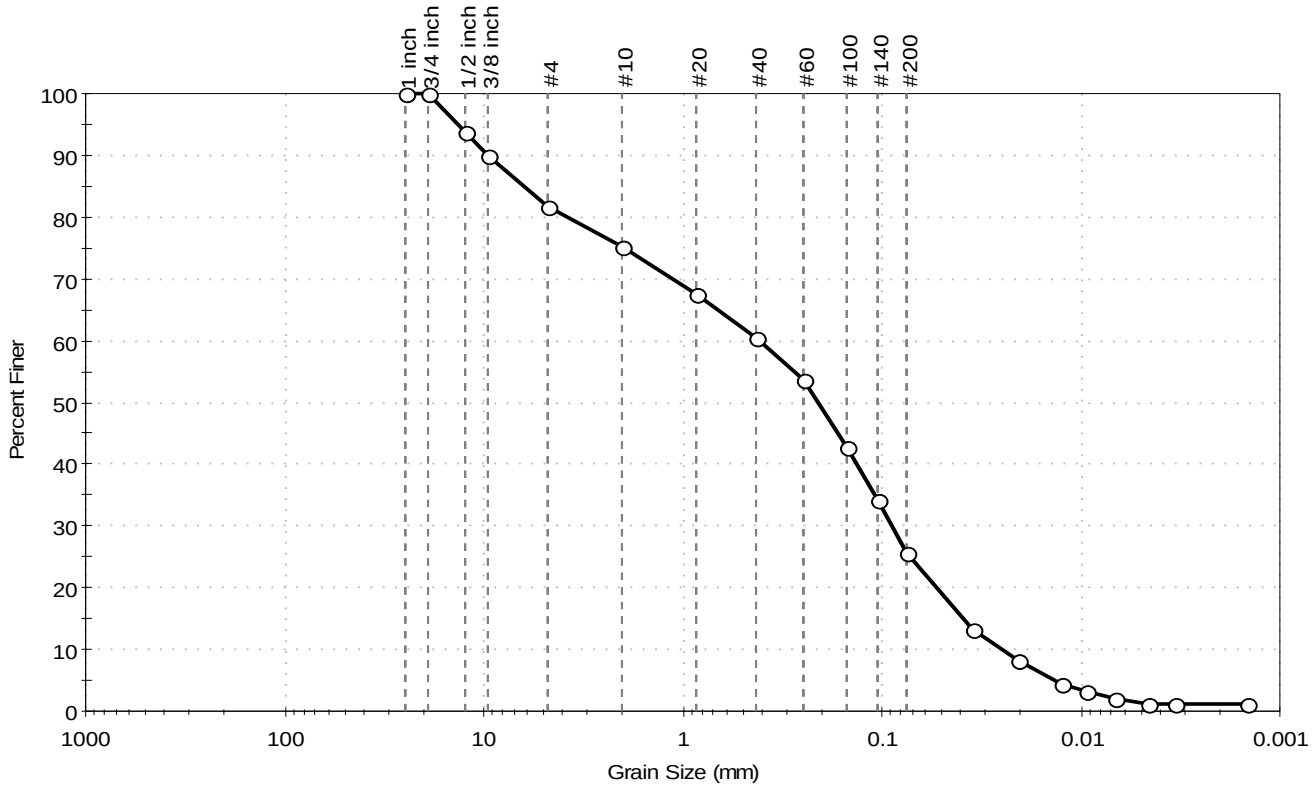
Sand/Gravel Hardness : HARD

GeoTesting EXPRESS

Client:	Anchor QEA, LLC				
Project:	Haverhill MGP				
Location:	Haverhill, MA			Project No:	GTX-314378
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	AQSS-11b -2.6-3.1	Test Date:	10/14/21	Checked By:	bfs
Depth :	---	Test Id:	632867		

Test Comment: ---
Visual Description: Moist, gray silty sand with gravel
Sample Comment: ---

Particle Size Analysis - ASTM D6913/D7928



%Cobble	%Gravel	%Sand	%Silt & Clay Size
---	18.2	56.2	25.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 inch	25.00	100		
3/4 inch	19.00	100		
1/2 inch	12.50	94		
3/8 inch	9.50	90		
#4	4.75	82		
#10	2.00	75		
#20	0.85	67		
#40	0.42	60		
#60	0.25	54		
#100	0.15	43		
#140	0.11	34		
#200	0.075	26		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0346	13		
---	0.0206	8		
---	0.0125	4		
---	0.0094	3		
---	0.0067	2		
---	0.0047	1		
---	0.0033	1		
---	0.0015	1		

Coefficients

D_{85} = 6.2512 mm
D_{30} = 0.0894 mm
D_{60} = 0.4118 mm
D_{15} = 0.0388 mm
D_{50} = 0.2109 mm
D_{10} = 0.0246 mm
C_u = 16.740
C_c = 0.789

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR
Sand/Gravel Hardness : HARD
Dispersion Device : Apparatus A - Mech Mixer
Dispersion Period : 1 minute
Est. Specific Gravity : 2.65
Separation of Sample: #200 Sieve

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ANALYTICAL REPORT

Lab Number:	L2152896
Client:	Anchor QEA, LLC 9 Water Street, 1st Floor Amesbury, MA 01913
ATTN:	Billie-Jo Gauley
Phone:	(978) 712-4475
Project Name:	FORMER HAVERHILL MGP
Project Number:	180327-08.01
Report Date:	11/19/21

Certifications & Approvals: MA (M-MA086), NH NELAP (2064), CT (PH-0574), IL (200077), ME (MA00086), MD (348), NJ (MA935), NY (11148), NC (25700/666), PA (68-03671), RI (LAO00065), TX (T104704476), VT (VT-0935), VA (460195), USDA (Permit #P330-17-00196).

Eight Walkup Drive, Westborough, MA 01581-1019
508-898-9220 (Fax) 508-898-9193 800-624-9220 - www.alphalab.com

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01

Lab Number: L2152896
Report Date: 11/19/21

Alpha Sample ID	Client ID	Matrix	Sample Location	Collection Date/Time	Receive Date
L2152896-01	AQSS-11B-0.0-0.5	SEDIMENT	HAVERHILL, MA	09/28/21 12:58	09/29/21
L2152896-02	AQSS-11B-1.5-1.9	SEDIMENT	HAVERHILL, MA	09/28/21 13:01	09/29/21
L2152896-03	AQSS-11B-2.5-3.0	SEDIMENT	HAVERHILL, MA	09/28/21 13:03	09/29/21
L2152896-04	AQSS-12B-0.0-0.5	SEDIMENT	HAVERHILL, MA	09/28/21 11:20	09/29/21
L2152896-05	AQSS-13B-0.0-0.5	SEDIMENT	HAVERHILL, MA	09/28/21 15:12	09/29/21
L2152896-06	AQSS-13B-1.5-2.0	SEDIMENT	HAVERHILL, MA	09/28/21 15:15	09/29/21
L2152896-07	AQSS-10-0.0-0.5	SEDIMENT	HAVERHILL, MA	09/29/21 09:15	09/29/21
L2152896-08	AQSS-09-0.0-0.5	SEDIMENT	HAVERHILL, MA	09/29/21 10:45	09/29/21
L2152896-09	DUP1-20210929	SEDIMENT	HAVERHILL, MA	09/29/21 00:00	09/29/21
L2152896-10	AQSS-08-0.0-0.5	SEDIMENT	HAVERHILL, MA	09/29/21 11:58	09/29/21
L2152896-11	AQSS-08-1.0-1.5	SEDIMENT	HAVERHILL, MA	09/29/21 12:00	09/29/21
L2152896-12	AQSS-07-0.0-0.5	SEDIMENT	HAVERHILL, MA	09/29/21 12:35	09/29/21
L2152896-13	AQSS-07-1.5-2.0	SEDIMENT	HAVERHILL, MA	09/29/21 12:50	09/29/21
L2152896-14	AQSS-06-0.0-0.5	SEDIMENT	HAVERHILL, MA	09/29/21 13:58	09/29/21
L2152896-15	AQSS-06-1.5-2.0	SEDIMENT	HAVERHILL, MA	09/29/21 14:00	09/29/21

Project Name:	FORMER HAVERHILL MGP	**Lab Number:**	L2152896
Project Number:	180327-08.01	**Report Date:**	11/19/21

MADEP MCP Response Action Analytical Report Certification

This form provides certifications for all samples performed by MCP methods. Please refer to the Sample Results and Container Information sections of this report for specification of MCP methods used for each analysis. The following questions pertain only to MCP Analytical Methods.

An affirmative response to questions A through F is required for "Presumptive Certainty" status		
A	Were all samples received in a condition consistent with those described on the Chain-of-Custody, properly preserved (including temperature) in the field or laboratory, and prepared/analyzed within method holding times?	YES
B	Were the analytical method(s) and all associated QC requirements specified in the selected CAM protocol(s) followed?	YES
C	Were all required corrective actions and analytical response actions specified in the selected CAM protocol(s) implemented for all identified performance standard non-conformances?	YES
D	Does the laboratory report comply with all the reporting requirements specified in CAM VII A, "Quality Assurance and Quality Control Guidelines for the Acquisition and Reporting of Analytical Data?"	YES
E a.	VPH, EPH, and APH Methods only: Was each method conducted without significant modification(s)? (Refer to the individual method(s) for a list of significant modifications).	N/A
E b.	APH and TO-15 Methods only: Was the complete analyte list reported for each method?	N/A
F	Were all applicable CAM protocol QC and performance standard non-conformances identified and evaluated in a laboratory narrative (including all "No" responses to Questions A through E)?	YES

A response to questions G, H and I is required for "Presumptive Certainty" status		
G	Were the reporting limits at or below all CAM reporting limits specified in the selected CAM protocol(s)?	NO
H	Were all QC performance standards specified in the CAM protocol(s) achieved?	YES
I	Were results reported for the complete analyte list specified in the selected CAM protocol(s)?	YES

For any questions answered "No", please refer to the case narrative section on the following page(s).

Please note that sample matrix information is located in the Sample Results section of this report.

Project Name:	FORMER HAVERHILL MGP	**Lab Number:**	L2152896
Project Number:	180327-08.01	**Report Date:**	11/19/21

Case Narrative

The samples were received in accordance with the Chain of Custody and no significant deviations were encountered during the preparation or analysis unless otherwise noted. Sample Receipt, Container Information, and the Chain of Custody are located at the back of the report.

Results contained within this report relate only to the samples submitted under this Alpha Lab Number and meet NELAP requirements for all NELAP accredited parameters unless otherwise noted in the following narrative. The data presented in this report is organized by parameter (i.e. VOC, SVOC, etc.). Sample specific Quality Control data (i.e. Surrogate Spike Recovery) is reported at the end of the target analyte list for each individual sample, followed by the Laboratory Batch Quality Control at the end of each parameter. Tentatively Identified Compounds (TICs), if requested, are reported for compounds identified to be present and are not part of the method/program Target Compound List, even if only a subset of the TCL are being reported. If a sample was re-analyzed or re-extracted due to a required quality control corrective action and if both sets of data are reported, the Laboratory ID of the re-analysis or re-extraction is designated with an "R" or "RE", respectively.

When multiple Batch Quality Control elements are reported (e.g. more than one LCS), the associated samples for each element are noted in the grey shaded header line of each data table. Any Laboratory Batch, Sample Specific % recovery or RPD value that is outside the listed Acceptance Criteria is bolded in the report. In reference to questions H (CAM) or 4 (RCP) when "NO" is checked, the performance criteria for CAM and RCP methods allow for some quality control failures to occur and still be within method compliance. In these instances, the specific failure is not narrated but noted in the associated QC Outlier Summary Report, located directly after the Case Narrative. QC information is also incorporated in the Data Usability Assessment table (Format 11) of our Data Merger tool, where it can be reviewed in conjunction with the sample result, associated regulatory criteria and any associated data usability implications.

Soil/sediments, solids and tissues are reported on a dry weight basis unless otherwise noted. Definitions of all data qualifiers and acronyms used in this report are provided in the Glossary located at the back of the report.

HOLD POLICY - For samples submitted on hold, Alpha's policy is to hold samples (with the exception of Air canisters) free of charge for 21 calendar days from the date the project is completed. After 21 calendar days, we will dispose of all samples submitted including those put on hold unless you have contacted your Alpha Project Manager and made arrangements for Alpha to continue to hold the samples. Air canisters will be disposed after 3 business days from the date the project is completed.

Please contact Project Management at 800-624-9220 with any questions.

Project Name:	FORMER HAVERHILL MGP	**Lab Number:**	L2152896
Project Number:	180327-08.01	**Report Date:**	11/19/21

Case Narrative (continued)

Report Revision

November 19, 2021: The sample ID for L2152896-13 has been revised.

Report Submission

All non-detect (ND) or estimated concentrations (J-qualified) have been quantitated to the limit noted in the MDL column.

Sample Receipt

L2152896: The samples were frozen upon receipt in order to arrest the holding time.

MCP Related Narratives

PAHs by SIM

In reference to question G:

One or more of the target analytes did not achieve the requested CAM reporting limits.

L2152896-03D, -04D, -10D, -11D, and -15D: The sample was re-analyzed on dilution in order to quantitate the results within the calibration range. The result(s) should be considered estimated, and are qualified with an E flag, for any compound(s) that exceeded the calibration range in the initial analysis. The re-analysis was performed only for the compound(s) that exceeded the calibration range.

The WG1569716-2/-3 LCS/LCSD RPD(s), associated with L2152896-15D and -15D2, are above the acceptance criteria for naphthalene (31%), 2-chloronaphthalene (34%), fluorene (31%), phenanthrene (31%), benzo(k)fluoranthene (31%), indeno(1,2,3-cd)pyrene (31%), dibenz(a,h)anthracene (32%) and benzo(ghi)perylene (32%).

PCBs

L2152896-05, -07, -08, -10, -12, and -14: One or more dual column RPDs are above the acceptance criteria; however, obvious column interferences are present. The result is qualified with a "P" if the higher of the two results is reported. The result is qualified with an "IP" if the lower of the two results is reported.

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2152896
Project Number: 180327-08.01 **Report Date:** 11/19/21

Case Narrative (continued)

In reference to question G:

One or more of the target analytes did not achieve the requested CAM reporting limits.

L2152896-01D and -04D: The sample has elevated detection limits due to the dilution required by the elevated concentrations of target compounds in the sample.

Non-MCP Related Narratives

Alkylated PAHs

L2152896-01D, -02D, -05D, -06D, -08D, and -13D: The sample has elevated detection limits due to the dilution required by the sample matrix.

L2152896-07, -12, and -14: The sample was re-analyzed on dilution in order to quantitate the results within the calibration range. The result(s) should be considered estimated, and are qualified with an E flag, for any compound(s) that exceeded the calibration range in the initial analysis. The re-analysis was performed only for the compound(s) that exceeded the calibration range.

Soot

L2152896-01 and -04: The Sample Replicate RPD is outside the acceptance criteria of 30%. A double-burn re-analysis was performed with a confirming result. The results of the original analysis are reported. The elevated RPD has been attributed to the non-homogeneous nature of the sample.

Total Organic Carbon

L2152896-01, -03, -04, -07, and -12: The Sample Replicate RPD for is outside the acceptance criteria of 30%. A double-burn re-analysis was performed with a confirming result. The results of the original analysis are reported. The elevated RPD has been attributed to the non-homogeneous nature of the sample.

I, the undersigned, attest under the pains and penalties of perjury that, to the best of my knowledge and belief and based upon my personal inquiry of those responsible for providing the information contained in this analytical report, such information is accurate and complete. This certificate of analysis is not complete unless this page accompanies any and all pages of this report.

Authorized Signature: Elizabeth Porta

Title: Technical Director/Representative Date: 11/19/21

QC OUTLIER SUMMARY REPORT

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01

Lab Number: L2152896
Report Date: 11/19/21

Method	Client ID (Native ID)	Lab ID	Parameter	QC Type	Recovery/RPD (%)	QC Limits (%)	Associated Samples	Data Quality Assessment
MCP PAHs by GC/MS-SIM - Mansfield Lab								
8270D-SIM	Batch QC	WG1569716-3	Naphthalene	LCSD	31	30	15	non-directional bias
8270D-SIM	Batch QC	WG1569716-3	2-Chloronaphthalene	LCSD	34	30	15	non-directional bias
8270D-SIM	Batch QC	WG1569716-3	Fluorene	LCSD	31	30	15	non-directional bias
8270D-SIM	Batch QC	WG1569716-3	Phenanthrene	LCSD	31	30	15	non-directional bias
8270D-SIM	Batch QC	WG1569716-3	Benzo(k)fluoranthene	LCSD	31	30	15	non-directional bias
8270D-SIM	Batch QC	WG1569716-3	Indeno(1,2,3-cd)Pyrene	LCSD	31	30	15	non-directional bias
8270D-SIM	Batch QC	WG1569716-3	Dibenz(a,h)anthracene	LCSD	32	30	15	non-directional bias
8270D-SIM	Batch QC	WG1569716-3	Benzo(ghi)perylene	LCSD	32	30	15	non-directional bias

ORGANICS

SEMIVOLATILES

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-01 D
Client ID: AQSS-11B-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/28/21 12:58
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 1,8270D-SIM(M)
Analytical Date: 11/09/21 17:31
Analyst: CC
Percent Solids: 88%

Extraction Method: ALPHA OP-013
Extraction Date: 10/27/21 20:16
Cleanup Method: EPA 3611B
Cleanup Date: 11/02/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
cis/trans-Decalin	84.1	J	ug/kg	58.2	11.6	10
C1-Decalins	273.		ug/kg	58.2	11.6	10
C2-Decalins	590.		ug/kg	58.2	11.6	10
C3-Decalins	427.		ug/kg	58.2	11.6	10
C4-Decalins	795.		ug/kg	58.2	11.6	10
Naphthalene	40500		ug/kg	116	33.5	10
C1-Naphthalenes	53600		ug/kg	116	33.5	10
C2-Naphthalenes	45800		ug/kg	116	33.5	10
C3-Naphthalenes	18400		ug/kg	116	33.5	10
C4-Naphthalenes	5460		ug/kg	116	33.5	10
2-Methylnaphthalene	44800		ug/kg	116	30.0	10
1-Methylnaphthalene	37600		ug/kg	116	36.7	10
Benzothiophene	734.		ug/kg	116	36.5	10
C1-Benzo(b)thiophenes	2160		ug/kg	116	36.5	10
C2-Benzo(b)thiophenes	3240		ug/kg	116	36.5	10
C3-Benzo(b)thiophenes	1840		ug/kg	116	36.5	10
C4-Benzo(b)thiophenes	654.		ug/kg	116	36.5	10
Biphenyl	5940		ug/kg	116	36.0	10
2,6-Dimethylnaphthalene	17400		ug/kg	116	27.7	10
Dibenzofuran	4340		ug/kg	116	36.7	10
Acenaphthylene	7350		ug/kg	116	22.2	10
Acenaphthene	26000		ug/kg	116	20.5	10
2,3,5-Trimethylnaphthalene	2370		ug/kg	116	19.0	10
Fluorene	16300		ug/kg	116	31.1	10
C1-Fluorenes	12900		ug/kg	116	31.1	10
C2-Fluorenes	8350		ug/kg	116	31.1	10
C3-Fluorenes	3930		ug/kg	116	31.1	10
Dibenzothiophene	5960		ug/kg	116	32.1	10

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2152896

Project Number: 180327-08.01 **Report Date:** 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-01 D
Client ID: AQSS-11B-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/28/21 12:58
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
4-Methyldibenzothiophene(4MDT)	3240		ug/kg	116	32.1	10
2/3-Methyldibenzothiophene(2MDT)	3140		ug/kg	116	32.1	10
1-Methyldibenzothiophene(1MDT)	886.		ug/kg	116	32.1	10
C1-Dibenzothiophenes BS	8340		ug/kg	116	32.1	10
C2-Dibenzothiophenes	7000		ug/kg	116	32.1	10
C3-Dibenzothiophenes	3040		ug/kg	116	32.1	10
C4-Dibenzothiophenes	848.		ug/kg	116	32.1	10
Phenanthrene	66400		ug/kg	116	38.6	10
3-Methylphenanthrene (3MP)	12000		ug/kg	116	38.6	10
2-Methylphenanthrene (2MP)	13200		ug/kg	116	38.6	10
2-Methylanthracene (2MA)	5480		ug/kg	116	38.6	10
9/4-Methylphenanthrene (9MP)	11600		ug/kg	116	38.6	10
C1-Phenanthrenes/Anthracenes	50900		ug/kg	116	38.6	10
C2-Phenanthrenes/Anthr BS	25000		ug/kg	116	38.6	10
C3-Phenanthrenes/Anthracenes	7890		ug/kg	116	38.6	10
C4-Phenanthrenes/Anthracenes	1630		ug/kg	116	38.6	10
Retene	ND		ug/kg	116	28.6	10
Anthracene	16600		ug/kg	116	24.0	10
Carbazole	1370		ug/kg	116	38.1	10
1-Methylphenanthrene	11200		ug/kg	116	30.8	10
Fluoranthene	29600		ug/kg	116	37.0	10
Benzo(b)fluorene	5760		ug/kg	116	33.7	10
7H-Benzo(c)fluorene	2680		ug/kg	116	33.7	10
2-Methylpyrene[1]	4100		ug/kg	116	30.6	10
4-Methylpyrene[1]	3840		ug/kg	116	30.6	10
1-Methylpyrene[1]	4780		ug/kg	116	30.6	10
Pyrene	34900		ug/kg	116	30.6	10
C1-Fluoranthenes/Pyrenes	34300		ug/kg	116	30.6	10
C2-Fluoranthenes/Pyrenes	12600		ug/kg	116	30.6	10
C3-Fluoranthenes/Pyrenes	4180		ug/kg	116	30.6	10
C4-Fluoranthenes/Pyrenes	1700		ug/kg	116	30.6	10
Naphthobenzothiophenes	3560		ug/kg	116	32.6	10
C1-Naphthobenzothiophenes	3270		ug/kg	116	32.6	10
C2-Naphthobenzothiophenes	1750		ug/kg	116	32.6	10
C3-Naphthobenzothiophenes	832.		ug/kg	116	32.6	10
C4-Naphthobenzothiophenes	436.		ug/kg	116	32.6	10
Benz(a)anthracene	13700		ug/kg	116	23.7	10

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2152896

Project Number: 180327-08.01 **Report Date:** 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-01 D Date Collected: 09/28/21 12:58
Client ID: AQSS-11B-0.0-0.5 Date Received: 09/29/21
Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
Chrysene	13800		ug/kg	116	23.5	10
C1-Chrysenes	11300		ug/kg	116	23.5	10
C2-Chrysenes BS	5500		ug/kg	116	23.5	10
C3-Chrysenes	2400		ug/kg	116	23.5	10
C4-Chrysenes	901.		ug/kg	116	23.5	10
Benzo(b)fluoranthene	6560		ug/kg	116	30.3	10
Benzo(j)+(k)fluoranthene	7220		ug/kg	116	23.1	10
Benzo(a)fluoranthene	2910		ug/kg	116	23.1	10
Benzo(e)pyrene	5670		ug/kg	116	24.0	10
Benzo(a)pyrene	11500		ug/kg	116	33.2	10
Perylene	2210		ug/kg	116	22.5	10
Indeno(1,2,3-cd)pyrene	5450		ug/kg	116	31.6	10
Dibenz(a,h)+(a,c)anthracene	1720		ug/kg	116	31.5	10
Benzo(g,h,i)perylene	5550		ug/kg	116	30.9	10

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Naphthalene-d8	63		50-130
Phenanthrene-d10	80		50-130
Benzo(a)pyrene-d12	73		50-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-02 D
Client ID: AQSS-11B-1.5-1.9
Sample Location: HAVERHILL, MA

Date Collected: 09/28/21 13:01
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 1,8270D-SIM(M)
Analytical Date: 11/09/21 21:52
Analyst: CC
Percent Solids: 84%

Extraction Method: ALPHA OP-013
Extraction Date: 10/27/21 20:16
Cleanup Method: EPA 3611B
Cleanup Date: 11/02/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
cis/trans-Decalin	1090	J	ug/kg	3260	648.	20
C1-Decalins	7670		ug/kg	3260	648.	20
C2-Decalins	16200		ug/kg	3260	648.	20
C3-Decalins	ND		ug/kg	3260	648.	20
C4-Decalins	ND		ug/kg	3260	648.	20
Naphthalene	2320000		ug/kg	6520	1870	20
C1-Naphthalenes	1320000		ug/kg	6520	1870	20
C2-Naphthalenes	1290000		ug/kg	6520	1870	20
C3-Naphthalenes	536000		ug/kg	6520	1870	20
C4-Naphthalenes	160000		ug/kg	6520	1870	20
2-Methylnaphthalene	962000		ug/kg	6520	1680	20
1-Methylnaphthalene	1080000		ug/kg	6520	2060	20
Benzothiophene	46300		ug/kg	6520	2040	20
C1-Benzo(b)thiophenes	59300		ug/kg	6520	2040	20
C2-Benzo(b)thiophenes	75700		ug/kg	6520	2040	20
C3-Benzo(b)thiophenes	42600		ug/kg	6520	2040	20
C4-Benzo(b)thiophenes	15000		ug/kg	6520	2040	20
Biphenyl	222000		ug/kg	6520	2020	20
2,6-Dimethylnaphthalene	506000		ug/kg	6520	1550	20
Dibenzofuran	421000		ug/kg	6520	2050	20
Acenaphthylene	198000		ug/kg	6520	1240	20
Acenaphthene	805000		ug/kg	6520	1150	20
2,3,5-Trimethylnaphthalene	72100		ug/kg	6520	1070	20
Fluorene	780000		ug/kg	6520	1740	20
C1-Fluorenes	375000		ug/kg	6520	1740	20
C2-Fluorenes	216000		ug/kg	6520	1740	20
C3-Fluorenes	94400	G	ug/kg	6520	1740	20
Dibenzothiophene	246000		ug/kg	6520	1800	20

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2152896

Project Number: 180327-08.01 **Report Date:** 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-02 D
Client ID: AQSS-11B-1.5-1.9
Sample Location: HAVERHILL, MA

Date Collected: 09/28/21 13:01
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
4-Methyldibenzothiophene(4MDT)	69300		ug/kg	6520	1800	20
2/3-Methyldibenzothiophene(2MDT)	68700		ug/kg	6520	1800	20
1-Methyldibenzothiophene(1MDT)	21800		ug/kg	6520	1800	20
C1-Dibenzothiophenes BS	191000		ug/kg	6520	1800	20
C2-Dibenzothiophenes	141000		ug/kg	6520	1800	20
C3-Dibenzothiophenes	61700		ug/kg	6520	1800	20
C4-Dibenzothiophenes	18700		ug/kg	6520	1800	20
Phenanthrene	3410000		ug/kg	6520	2160	20
3-Methylphenanthrene (3MP)	360000		ug/kg	6520	2160	20
2-Methylphenanthrene (2MP)	404000		ug/kg	6520	2160	20
2-Methylanthracene (2MA)	200000		ug/kg	6520	2160	20
9/4-Methylphenanthrene (9MP)	328000		ug/kg	6520	2160	20
C1-Phenanthrenes/Anthracenes	1540000		ug/kg	6520	2160	20
C2-Phenanthrenes/Anthr BS	674000		ug/kg	6520	2160	20
C3-Phenanthrenes/Anthracenes	207000		ug/kg	6520	2160	20
C4-Phenanthrenes/Anthracenes	43800		ug/kg	6520	2160	20
Retene	ND		ug/kg	6520	1600	20
Anthracene	989000		ug/kg	6520	1340	20
Carbazole	52700		ug/kg	6520	2130	20
1-Methylphenanthrene	314000		ug/kg	6520	1720	20
Fluoranthene	1770000		ug/kg	6520	2070	20
Benzo(b)fluorene	257000		ug/kg	6520	1890	20
7H-Benzo(c)fluorene	89500		ug/kg	6520	1890	20
2-Methylpyrene[1]	123000		ug/kg	6520	1720	20
4-Methylpyrene[1]	102000		ug/kg	6520	1720	20
1-Methylpyrene[1]	128000		ug/kg	6520	1720	20
Pyrene	1590000		ug/kg	6520	1720	20
C1-Fluoranthenes/Pyrenes	1110000		ug/kg	6520	1720	20
C2-Fluoranthenes/Pyrenes	332000		ug/kg	6520	1720	20
C3-Fluoranthenes/Pyrenes	117000		ug/kg	6520	1720	20
C4-Fluoranthenes/Pyrenes	54100		ug/kg	6520	1720	20
Naphthobenzothiophenes	125000		ug/kg	6520	1820	20
C1-Naphthobenzothiophenes	77400		ug/kg	6520	1820	20
C2-Naphthobenzothiophenes	36500		ug/kg	6520	1820	20
C3-Naphthobenzothiophenes	20300		ug/kg	6520	1820	20
C4-Naphthobenzothiophenes	8650		ug/kg	6520	1820	20
Benz(a)anthracene	592000		ug/kg	6520	1330	20

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2152896

Project Number: 180327-08.01 **Report Date:** 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-02 D
Client ID: AQSS-11B-1.5-1.9
Sample Location: HAVERHILL, MA

Date Collected: 09/28/21 13:01
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
Chrysene	552000		ug/kg	6520	1320	20
C1-Chrysenes	314000		ug/kg	6520	1320	20
C2-Chrysenes BS	139000		ug/kg	6520	1320	20
C3-Chrysenes	76300		ug/kg	6520	1320	20
C4-Chrysenes	37800		ug/kg	6520	1320	20
Benzo(b)fluoranthene	353000		ug/kg	6520	1700	20
Benzo(j)+(k)fluoranthene	363000		ug/kg	6520	1290	20
Benzo(a)fluoranthene	121000		ug/kg	6520	1290	20
Benzo(e)pyrene	272000		ug/kg	6520	1340	20
Benzo(a)pyrene	546000		ug/kg	6520	1860	20
Perylene	128000		ug/kg	6520	1260	20
Indeno(1,2,3-cd)pyrene	296000		ug/kg	6520	1770	20
Dibenz(a,h)+(a,c)anthracene	82800		ug/kg	6520	1760	20
Benzo(g,h,i)perylene	296000		ug/kg	6520	1730	20

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Naphthalene-d8	72		50-130
Phenanthrene-d10	101		50-130
Benzo(a)pyrene-d12	106		50-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-03
Client ID: AQSS-11B-2.5-3.0
Sample Location: HAVERHILL, MA

Date Collected: 09/28/21 13:03
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/05/21 18:55
Analyst: GP
Percent Solids: 84%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 09:09
Cleanup Method: EPA 3630
Cleanup Date: 11/01/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Naphthalene	5340	E	ug/kg	4.52	0.404	1
2-Methylnaphthalene	2750	E	ug/kg	4.52	0.560	1
2-Chloronaphthalene	2.76	J	ug/kg	4.52	0.354	1
Acenaphthylene	204		ug/kg	4.52	0.303	1
Acenaphthene	1700	E	ug/kg	4.52	0.506	1
Fluorene	1180	E	ug/kg	4.52	0.302	1
Phenanthrene	3110	E	ug/kg	4.52	0.533	1
Anthracene	1220	E	ug/kg	4.52	0.560	1
Fluoranthene	3260	E	ug/kg	4.52	0.827	1
Pyrene	2780	E	ug/kg	4.52	0.461	1
Benz(a)anthracene	2120	E	ug/kg	4.52	1.21	1
Chrysene	1660	E	ug/kg	4.52	0.397	1
Benzo(b)fluoranthene	1550	E	ug/kg	4.52	0.470	1
Benzo(k)fluoranthene	1230	E	ug/kg	4.52	0.465	1
Benzo(a)pyrene	1850	E	ug/kg	4.52	0.528	1
Indeno(1,2,3-cd)Pyrene	1190	E	ug/kg	4.52	1.29	1
Dibenz(a,h)anthracene	328		ug/kg	4.52	0.465	1
Benzo(ghi)perylene	934	E	ug/kg	4.52	0.372	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	51		30-130
Pyrene-d10	70		30-130
Benzo(b)fluoranthene-d12	60		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-03 D
Client ID: AQSS-11B-2.5-3.0
Sample Location: HAVERHILL, MA

Date Collected: 09/28/21 13:03
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/12/21 11:43
Analyst: GP
Percent Solids: 84%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 09:09
Cleanup Method: EPA 3630
Cleanup Date: 11/01/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Naphthalene	8430		ug/kg	45.2	4.04	10
2-Methylnaphthalene	3920		ug/kg	45.2	5.60	10
Acenaphthene	2340		ug/kg	45.2	5.06	10
Fluorene	1590		ug/kg	45.2	3.02	10
Phenanthrene	4250		ug/kg	45.2	5.33	10
Anthracene	1520		ug/kg	45.2	5.60	10
Fluoranthene	4530		ug/kg	45.2	8.27	10
Pyrene	3500		ug/kg	45.2	4.61	10
Benz(a)anthracene	2600		ug/kg	45.2	12.1	10
Chrysene	2050		ug/kg	45.2	3.97	10
Benzo(b)fluoranthene	1920		ug/kg	45.2	4.70	10
Benzo(k)fluoranthene	1750		ug/kg	45.2	4.65	10
Benzo(a)pyrene	2290		ug/kg	45.2	5.28	10
Indeno(1,2,3-cd)Pyrene	1150		ug/kg	45.2	12.9	10
Benzo(ghi)perylene	1120		ug/kg	45.2	3.72	10

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	72		30-130
Pyrene-d10	85		30-130
Benzo(b)fluoranthene-d12	84		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-04 D3
Client ID: AQSS-12B-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/28/21 11:20
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/15/21 10:19
Analyst: GP
Percent Solids: 83%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 09:09
Cleanup Method: EPA 3630
Cleanup Date: 11/01/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Phenanthrene	43400		ug/kg	382	45.0	80

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	71		30-130
Pyrene-d10	74		30-130
Benzo(b)fluoranthene-d12	73		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-04 D2
Client ID: AQSS-12B-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/28/21 11:20
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/12/21 13:45
Analyst: GP
Percent Solids: 83%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 09:09
Cleanup Method: EPA 3630
Cleanup Date: 11/01/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Pyrene	21400		ug/kg	191	19.5	40

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	65		30-130
Pyrene-d10	72		30-130
Benzo(b)fluoranthene-d12	65		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-04 D
Client ID: AQSS-12B-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/28/21 11:20
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/05/21 20:25
Analyst: GP
Percent Solids: 83%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 09:09
Cleanup Method: EPA 3630
Cleanup Date: 11/01/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Naphthalene	3140		ug/kg	95.4	8.54	20
2-Methylnaphthalene	2190		ug/kg	95.4	11.8	20
2-Chloronaphthalene	30.5	J	ug/kg	95.4	7.47	20
Acenaphthylene	9590		ug/kg	95.4	6.39	20
Acenaphthene	13000		ug/kg	95.4	10.7	20
Fluorene	11000		ug/kg	95.4	6.37	20
Phenanthrene	37500	E	ug/kg	95.4	11.2	20
Anthracene	12400		ug/kg	95.4	11.8	20
Fluoranthene	15200		ug/kg	95.4	17.5	20
Pyrene	22000	E	ug/kg	95.4	9.73	20
Benz(a)anthracene	9100		ug/kg	95.4	25.5	20
Chrysene	9000		ug/kg	95.4	8.39	20
Benzo(b)fluoranthene	3500		ug/kg	95.4	9.92	20
Benzo(k)fluoranthene	4410		ug/kg	95.4	9.83	20
Benzo(a)pyrene	6630		ug/kg	95.4	11.2	20
Indeno(1,2,3-cd)Pyrene	2970		ug/kg	95.4	27.2	20
Dibenz(a,h)anthracene	1010		ug/kg	95.4	9.83	20
Benzo(ghi)perylene	3220		ug/kg	95.4	7.86	20

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	58		30-130
Pyrene-d10	72		30-130
Benzo(b)fluoranthene-d12	60		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-05 D
Client ID: AQSS-13B-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/28/21 15:12
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 1,8270D-SIM(M)
Analytical Date: 11/09/21 23:18
Analyst: CC
Percent Solids: 85%

Extraction Method: ALPHA OP-013
Extraction Date: 10/27/21 20:16
Cleanup Method: EPA 3611B
Cleanup Date: 11/02/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
cis/trans-Decalin	367.	J	ug/kg	612	122.	20
C1-Decalins	1180		ug/kg	612	122.	20
C2-Decalins	3170		ug/kg	612	122.	20
C3-Decalins	ND		ug/kg	612	122.	20
C4-Decalins	4700		ug/kg	612	122.	20
Naphthalene	672000		ug/kg	1220	352.	20
C1-Naphthalenes	442000		ug/kg	1220	352.	20
C2-Naphthalenes	296000		ug/kg	1220	352.	20
C3-Naphthalenes	125000		ug/kg	1220	352.	20
C4-Naphthalenes	42600		ug/kg	1220	352.	20
2-Methylnaphthalene	400000		ug/kg	1220	316.	20
1-Methylnaphthalene	278000		ug/kg	1220	386.	20
Benzothiophene	13900		ug/kg	1220	383.	20
C1-Benzo(b)thiophenes	17200		ug/kg	1220	383.	20
C2-Benzo(b)thiophenes	18600		ug/kg	1220	383.	20
C3-Benzo(b)thiophenes	11700		ug/kg	1220	383.	20
C4-Benzo(b)thiophenes	4990		ug/kg	1220	383.	20
Biphenyl	40100		ug/kg	1220	378.	20
2,6-Dimethylnaphthalene	103000		ug/kg	1220	291.	20
Dibenzofuran	10500		ug/kg	1220	386.	20
Acenaphthylene	35100		ug/kg	1220	234.	20
Acenaphthene	223000		ug/kg	1220	216.	20
2,3,5-Trimethylnaphthalene	15900		ug/kg	1220	200.	20
Fluorene	98100		ug/kg	1220	326.	20
C1-Fluorenes	93200		ug/kg	1220	326.	20
C2-Fluorenes	70200		ug/kg	1220	326.	20
C3-Fluorenes	34300		ug/kg	1220	326.	20
Dibenzothiophene	36400		ug/kg	1220	338.	20

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2152896

Project Number: 180327-08.01 **Report Date:** 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-05 D
Client ID: AQSS-13B-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/28/21 15:12
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
4-Methyldibenzothiophene(4MDT)	20200		ug/kg	1220	338.	20
2/3-Methyldibenzothiophene(2MDT)	18600		ug/kg	1220	338.	20
1-Methyldibenzothiophene(1MDT)	6440		ug/kg	1220	338.	20
C1-Dibenzothiophenes BS	52100		ug/kg	1220	338.	20
C2-Dibenzothiophenes	48400		ug/kg	1220	338.	20
C3-Dibenzothiophenes	25000		ug/kg	1220	338.	20
C4-Dibenzothiophenes	8070		ug/kg	1220	338.	20
Phenanthrene	422000		ug/kg	1220	406.	20
3-Methylphenanthrene (3MP)	80900		ug/kg	1220	406.	20
2-Methylphenanthrene (2MP)	85700		ug/kg	1220	406.	20
2-Methylanthracene (2MA)	37700		ug/kg	1220	406.	20
9/4-Methylphenanthrene (9MP)	86400		ug/kg	1220	406.	20
C1-Phenanthrenes/Anthracenes	355000		ug/kg	1220	406.	20
C2-Phenanthrenes/Anthr BS	190000		ug/kg	1220	406.	20
C3-Phenanthrenes/Anthracenes	68900		ug/kg	1220	406.	20
C4-Phenanthrenes/Anthracenes	16500		ug/kg	1220	406.	20
Retene	ND		ug/kg	1220	300.	20
Anthracene	109000		ug/kg	1220	252.	20
Carbazole	7300		ug/kg	1220	400.	20
1-Methylphenanthrene	81900		ug/kg	1220	323.	20
Fluoranthene	154000		ug/kg	1220	389.	20
Benzo(b)fluorene	33900		ug/kg	1220	355.	20
7H-Benzo(c)fluorene	14400		ug/kg	1220	355.	20
2-Methylpyrene[1]	25100		ug/kg	1220	322.	20
4-Methylpyrene[1]	27000		ug/kg	1220	322.	20
1-Methylpyrene[1]	36900		ug/kg	1220	322.	20
Pyrene	204000		ug/kg	1220	322.	20
C1-Fluoranthenes/Pyrenes	225000		ug/kg	1220	322.	20
C2-Fluoranthenes/Pyrenes	99200		ug/kg	1220	322.	20
C3-Fluoranthenes/Pyrenes	41900		ug/kg	1220	322.	20
C4-Fluoranthenes/Pyrenes	16100		ug/kg	1220	322.	20
Naphthobenzothiophenes	24100		ug/kg	1220	342.	20
C1-Naphthobenzothiophenes	26800		ug/kg	1220	342.	20
C2-Naphthobenzothiophenes	17100		ug/kg	1220	342.	20
C3-Naphthobenzothiophenes	8780		ug/kg	1220	342.	20
C4-Naphthobenzothiophenes	4260		ug/kg	1220	342.	20
Benz(a)anthracene	62600		ug/kg	1220	250.	20

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2152896

Project Number: 180327-08.01 **Report Date:** 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-05 D Date Collected: 09/28/21 15:12
Client ID: AQSS-13B-0.0-0.5 Date Received: 09/29/21
Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
Chrysene	75200		ug/kg	1220	247.	20
C1-Chrysenes	82600		ug/kg	1220	247.	20
C2-Chrysenes BS	50200		ug/kg	1220	247.	20
C3-Chrysenes	24200		ug/kg	1220	247.	20
C4-Chrysenes	9200		ug/kg	1220	247.	20
Benzo(b)fluoranthene	28700		ug/kg	1220	318.	20
Benzo(j)+(k)fluoranthene	31700		ug/kg	1220	243.	20
Benzo(a)fluoranthene	15600		ug/kg	1220	243.	20
Benzo(e)pyrene	27900		ug/kg	1220	253.	20
Benzo(a)pyrene	56500		ug/kg	1220	349.	20
Perylene	10300		ug/kg	1220	236.	20
Indeno(1,2,3-cd)pyrene	27900		ug/kg	1220	332.	20
Dibenz(a,h)+(a,c)anthracene	8320		ug/kg	1220	331.	20
Benzo(g,h,i)perylene	33600		ug/kg	1220	325.	20

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Naphthalene-d8	63		50-130
Phenanthrene-d10	85		50-130
Benzo(a)pyrene-d12	76		50-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-06 D
Client ID: AQSS-13B-1.5-2.0
Sample Location: HAVERHILL, MA

Date Collected: 09/28/21 15:15
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 1,8270D-SIM(M)
Analytical Date: 11/10/21 00:45
Analyst: CC
Percent Solids: 70%

Extraction Method: ALPHA OP-013
Extraction Date: 10/27/21 20:16
Cleanup Method: EPA 3611B
Cleanup Date: 11/02/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
cis/trans-Decalin	2130	J	ug/kg	5270	1050	50
C1-Decalins	12400		ug/kg	5270	1050	50
C2-Decalins	26200		ug/kg	5270	1050	50
C3-Decalins	ND		ug/kg	5270	1050	50
C4-Decalins	ND		ug/kg	5270	1050	50
Naphthalene	3690000		ug/kg	10500	3030	50
C1-Naphthalenes	2570000		ug/kg	10500	3030	50
C2-Naphthalenes	1590000		ug/kg	10500	3030	50
C3-Naphthalenes	560000		ug/kg	10500	3030	50
C4-Naphthalenes	166000		ug/kg	10500	3030	50
2-Methylnaphthalene	2320000		ug/kg	10500	2720	50
1-Methylnaphthalene	1630000		ug/kg	10500	3320	50
Benzothiophene	61200		ug/kg	10500	3300	50
C1-Benzo(b)thiophenes	119000		ug/kg	10500	3300	50
C2-Benzo(b)thiophenes	111000		ug/kg	10500	3300	50
C3-Benzo(b)thiophenes	54900		ug/kg	10500	3300	50
C4-Benzo(b)thiophenes	20500		ug/kg	10500	3300	50
Biphenyl	221000		ug/kg	10500	3260	50
2,6-Dimethylnaphthalene	592000		ug/kg	10500	2510	50
Dibenzofuran	165000		ug/kg	10500	3320	50
Acenaphthylene	168000		ug/kg	10500	2010	50
Acenaphthene	1100000		ug/kg	10500	1860	50
2,3,5-Trimethylnaphthalene	59800		ug/kg	10500	1720	50
Fluorene	520000		ug/kg	10500	2810	50
C1-Fluorenes	401000		ug/kg	10500	2810	50
C2-Fluorenes	257000		ug/kg	10500	2810	50
C3-Fluorenes	123000		ug/kg	10500	2810	50
Dibenzothiophene	179000		ug/kg	10500	2910	50

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2152896

Project Number: 180327-08.01 **Report Date:** 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-06 D
Client ID: AQSS-13B-1.5-2.0
Sample Location: HAVERHILL, MA

Date Collected: 09/28/21 15:15
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
4-Methyldibenzothiophene(4MDT)	93000		ug/kg	10500	2910	50
2/3-Methyldibenzothiophene(2MDT)	82300		ug/kg	10500	2910	50
1-Methyldibenzothiophene(1MDT)	25000		ug/kg	10500	2910	50
C1-Dibenzothiophenes BS	230000		ug/kg	10500	2910	50
C2-Dibenzothiophenes	192000		ug/kg	10500	2910	50
C3-Dibenzothiophenes	84900		ug/kg	10500	2910	50
C4-Dibenzothiophenes	25800		ug/kg	10500	2910	50
Phenanthrene	1930000		ug/kg	10500	3490	50
3-Methylphenanthrene (3MP)	347000		ug/kg	10500	3490	50
2-Methylphenanthrene (2MP)	361000		ug/kg	10500	3490	50
2-Methylanthracene (2MA)	178000		ug/kg	10500	3490	50
9/4-Methylphenanthrene (9MP)	336000		ug/kg	10500	3490	50
C1-Phenanthrenes/Anthracenes	1500000		ug/kg	10500	3490	50
C2-Phenanthrenes/Anthr BS	729000		ug/kg	10500	3490	50
C3-Phenanthrenes/Anthracenes	220000		ug/kg	10500	3490	50
C4-Phenanthrenes/Anthracenes	47000		ug/kg	10500	3490	50
Retene	ND		ug/kg	10500	2590	50
Anthracene	599000		ug/kg	10500	2170	50
Carbazole	66000		ug/kg	10500	3450	50
1-Methylphenanthrene	333000		ug/kg	10500	2780	50
Fluoranthene	641000		ug/kg	10500	3350	50
Benzo(b)fluorene	144000		ug/kg	10500	3060	50
7H-Benzo(c)fluorene	73600		ug/kg	10500	3060	50
2-Methylpyrene[1]	111000		ug/kg	10500	2770	50
4-Methylpyrene[1]	99000		ug/kg	10500	2770	50
1-Methylpyrene[1]	131000		ug/kg	10500	2770	50
Pyrene	801000		ug/kg	10500	2770	50
C1-Fluoranthenes/Pyrenes	920000		ug/kg	10500	2770	50
C2-Fluoranthenes/Pyrenes	324000		ug/kg	10500	2770	50
C3-Fluoranthenes/Pyrenes	116000		ug/kg	10500	2770	50
C4-Fluoranthenes/Pyrenes	39400		ug/kg	10500	2770	50
Naphthobenzothiophenes	85400		ug/kg	10500	2950	50
C1-Naphthobenzothiophenes	80200		ug/kg	10500	2950	50
C2-Naphthobenzothiophenes	42900		ug/kg	10500	2950	50
C3-Naphthobenzothiophenes	21200		ug/kg	10500	2950	50
C4-Naphthobenzothiophenes	ND		ug/kg	10500	2950	50
Benz(a)anthracene	274000		ug/kg	10500	2150	50

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2152896

Project Number: 180327-08.01 **Report Date:** 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-06 D
Client ID: AQSS-13B-1.5-2.0
Sample Location: HAVERHILL, MA

Date Collected: 09/28/21 15:15
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
Chrysene	296000		ug/kg	10500	2130	50
C1-Chrysenes	264000		ug/kg	10500	2130	50
C2-Chrysenes BS	125000		ug/kg	10500	2130	50
C3-Chrysenes	56200		ug/kg	10500	2130	50
C4-Chrysenes	ND		ug/kg	10500	2130	50
Benzo(b)fluoranthene	102000		ug/kg	10500	2740	50
Benzo(j)+(k)fluoranthene	130000		ug/kg	10500	2090	50
Benzo(a)fluoranthene	55300		ug/kg	10500	2090	50
Benzo(e)pyrene	97600		ug/kg	10500	2180	50
Benzo(a)pyrene	204000		ug/kg	10500	3010	50
Perylene	39300		ug/kg	10500	2040	50
Indeno(1,2,3-cd)pyrene	83800		ug/kg	10500	2860	50
Dibenz(a,h)+(a,c)anthracene	24200		ug/kg	10500	2850	50
Benzo(g,h,i)perylene	87800		ug/kg	10500	2800	50

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Naphthalene-d8	85		50-130
Phenanthrene-d10	118		50-130
Benzo(a)pyrene-d12	99		50-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-07
Client ID: AQSS-10-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 09:15
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 1,8270D-SIM(M)
Analytical Date: 11/11/21 10:25
Analyst: CC
Percent Solids: 76%

Extraction Method: ALPHA OP-013
Extraction Date: 10/27/21 20:16
Cleanup Method: EPA 3611B
Cleanup Date: 11/02/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
cis/trans-Decalin	332.		ug/kg	16.1	3.21	1
C1-Decalins	153.		ug/kg	16.1	3.21	1
C2-Decalins	289.		ug/kg	16.1	3.21	1
C3-Decalins	301.		ug/kg	16.1	3.21	1
C4-Decalins	573.		ug/kg	16.1	3.21	1
Naphthalene	450000	E	ug/kg	32.3	9.28	1
C1-Naphthalenes	212000	E	ug/kg	32.3	9.28	1
C2-Naphthalenes	97800		ug/kg	32.3	9.28	1
C3-Naphthalenes	19500		ug/kg	32.3	9.28	1
C4-Naphthalenes	2740		ug/kg	32.3	9.28	1
2-Methylnaphthalene	199000	E	ug/kg	32.3	8.32	1
1-Methylnaphthalene	125000	E	ug/kg	32.3	10.2	1
Benzothiophene	8460		ug/kg	32.3	10.1	1
C1-Benzo(b)thiophenes	9560		ug/kg	32.3	10.1	1
C2-Benzo(b)thiophenes	7870		ug/kg	32.3	10.1	1
C3-Benzo(b)thiophenes	2530		ug/kg	32.3	10.1	1
C4-Benzo(b)thiophenes	375.		ug/kg	32.3	10.1	1
Biphenyl	18600		ug/kg	32.3	9.98	1
2,6-Dimethylnaphthalene	38700		ug/kg	32.3	7.67	1
Dibenzofuran	5000		ug/kg	32.3	10.2	1
Acenaphthylene	4370		ug/kg	32.3	6.16	1
Acenaphthene	54900	E	ug/kg	32.3	5.69	1
2,3,5-Trimethylnaphthalene	2290		ug/kg	32.3	5.28	1
Fluorene	44100	E	ug/kg	32.3	8.61	1
C1-Fluorenes	10600		ug/kg	32.3	8.61	1
C2-Fluorenes	2870		ug/kg	32.3	8.61	1
C3-Fluorenes	1260	G	ug/kg	32.3	8.61	1
Dibenzothiophene	6930		ug/kg	32.3	8.90	1

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2152896

Project Number: 180327-08.01 **Report Date:** 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-07 Date Collected: 09/29/21 09:15

Client ID: AQSS-10-0.0-0.5 Date Received: 09/29/21

Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
4-Methyldibenzothiophene(4MDT)	1160		ug/kg	32.3	8.90	1
2/3-Methyldibenzothiophene(2MDT)	1280		ug/kg	32.3	8.90	1
1-Methyldibenzothiophene(1MDT)	382.		ug/kg	32.3	8.90	1
C1-Dibenzothiophenes BS	3310		ug/kg	32.3	8.90	1
C2-Dibenzothiophenes	1840		ug/kg	32.3	8.90	1
C3-Dibenzothiophenes	1030		ug/kg	32.3	8.90	1
C4-Dibenzothiophenes	378.		ug/kg	32.3	8.90	1
Phenanthrene	76900	E	ug/kg	32.3	10.7	1
3-Methylphenanthrene (3MP)	4820		ug/kg	32.3	10.7	1
2-Methylphenanthrene (2MP)	4680		ug/kg	32.3	10.7	1
2-Methylanthracene (2MA)	1390		ug/kg	32.3	10.7	1
9/4-Methylphenanthrene (9MP)	4120		ug/kg	32.3	10.7	1
C1-Phenanthrenes/Anthracenes	17700		ug/kg	32.3	10.7	1
C2-Phenanthrenes/Anthr BS	6220		ug/kg	32.3	10.7	1
C3-Phenanthrenes/Anthracenes	2200		ug/kg	32.3	10.7	1
C4-Phenanthrenes/Anthracenes	614.		ug/kg	32.3	10.7	1
Retene	ND		ug/kg	32.3	7.92	1
Anthracene	7510		ug/kg	32.3	6.65	1
Carbazole	10500		ug/kg	32.3	10.6	1
1-Methylphenanthrene	3650		ug/kg	32.3	8.52	1
Fluoranthene	12000		ug/kg	32.3	10.2	1
Benzo(b)fluorene	1730		ug/kg	32.3	9.35	1
7H-Benzo(c)fluorene	753.		ug/kg	32.3	9.35	1
2-Methylpyrene[1]	1200		ug/kg	32.3	8.49	1
4-Methylpyrene[1]	1090		ug/kg	32.3	8.49	1
1-Methylpyrene[1]	1230		ug/kg	32.3	8.49	1
Pyrene	13400		ug/kg	32.3	8.49	1
C1-Fluoranthenes/Pyrenes	9500		ug/kg	32.3	8.49	1
C2-Fluoranthenes/Pyrenes	3550		ug/kg	32.3	8.49	1
C3-Fluoranthenes/Pyrenes	1570		ug/kg	32.3	8.49	1
C4-Fluoranthenes/Pyrenes	731.		ug/kg	32.3	8.49	1
Naphthobenzothiophenes	1230		ug/kg	32.3	9.03	1
C1-Naphthobenzothiophenes	1080		ug/kg	32.3	9.03	1
C2-Naphthobenzothiophenes	713.		ug/kg	32.3	9.03	1
C3-Naphthobenzothiophenes	407.		ug/kg	32.3	9.03	1
C4-Naphthobenzothiophenes	239.		ug/kg	32.3	9.03	1
Benz(a)anthracene	4160		ug/kg	32.3	6.58	1

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2152896

Project Number: 180327-08.01 **Report Date:** 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-07 Date Collected: 09/29/21 09:15

Client ID: AQSS-10-0.0-0.5 Date Received: 09/29/21

Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
Chrysene	4370		ug/kg	32.3	6.52	1
C1-Chrysenes	3320		ug/kg	32.3	6.52	1
C2-Chrysenes BS	1770		ug/kg	32.3	6.52	1
C3-Chrysenes	862.		ug/kg	32.3	6.52	1
C4-Chrysenes	488.		ug/kg	32.3	6.52	1
Benzo(b)fluoranthene	2250		ug/kg	32.3	8.40	1
Benzo(j)+(k)fluoranthene	2520		ug/kg	32.3	6.41	1
Benzo(a)fluoranthene	819.		ug/kg	32.3	6.41	1
Benzo(e)pyrene	2070		ug/kg	32.3	6.66	1
Benzo(a)pyrene	3950		ug/kg	32.3	9.22	1
Perylene	695.		ug/kg	32.3	6.23	1
Indeno(1,2,3-cd)pyrene	2100		ug/kg	32.3	8.76	1
Dibenz(a,h)+(a,c)anthracene	629.		ug/kg	32.3	8.72	1
Benzo(g,h,i)perylene	2310		ug/kg	32.3	8.58	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Naphthalene-d8	81		50-130
Phenanthrene-d10	98		50-130
Benzo(a)pyrene-d12	80		50-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-07 D
Client ID: AQSS-10-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 09:15
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 1,8270D-SIM(M)
Analytical Date: 11/10/21 07:58
Analyst: CC
Percent Solids: 76%

Extraction Method: ALPHA OP-013
Extraction Date: 10/27/21 20:16
Cleanup Method: EPA 3611B
Cleanup Date: 11/02/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
Naphthalene	252000		ug/kg	323	92.8	10
C1-Naphthalenes	137000		ug/kg	323	92.8	10
2-Methylnaphthalene	124000		ug/kg	323	83.2	10
1-Methylnaphthalene	86500		ug/kg	323	102.	10
Acenaphthene	41800		ug/kg	323	56.9	10
Fluorene	33000		ug/kg	323	86.1	10
Phenanthrene	56300		ug/kg	323	107.	10

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Naphthalene-d8	59		50-130
Phenanthrene-d10	80		50-130
Benzo(a)pyrene-d12	70		50-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-08 D
Client ID: AQSS-09-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 10:45
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 1,8270D-SIM(M)
Analytical Date: 11/09/21 18:58
Analyst: CC
Percent Solids: 92%

Extraction Method: ALPHA OP-013
Extraction Date: 10/27/21 20:16
Cleanup Method: EPA 3611B
Cleanup Date: 11/02/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
cis/trans-Decalin	53.8	J	ug/kg	68.1	13.5	10
C1-Decalins	166.		ug/kg	68.1	13.5	10
C2-Decalins	ND		ug/kg	68.1	13.5	10
C3-Decalins	ND		ug/kg	68.1	13.5	10
C4-Decalins	ND		ug/kg	68.1	13.5	10
Naphthalene	88200		ug/kg	136	39.1	10
C1-Naphthalenes	64100		ug/kg	136	39.1	10
C2-Naphthalenes	36800		ug/kg	136	39.1	10
C3-Naphthalenes	9340		ug/kg	136	39.1	10
C4-Naphthalenes	1780		ug/kg	136	39.1	10
2-Methylnaphthalene	53900		ug/kg	136	35.1	10
1-Methylnaphthalene	44700		ug/kg	136	42.9	10
Benzothiophene	2650		ug/kg	136	42.6	10
C1-Benzo(b)thiophenes	3800		ug/kg	136	42.6	10
C2-Benzo(b)thiophenes	2970		ug/kg	136	42.6	10
C3-Benzo(b)thiophenes	1000		ug/kg	136	42.6	10
C4-Benzo(b)thiophenes	223.		ug/kg	136	42.6	10
Biphenyl	4860		ug/kg	136	42.1	10
2,6-Dimethylnaphthalene	13200		ug/kg	136	32.4	10
Dibenzofuran	2790		ug/kg	136	42.9	10
Acenaphthylene	1170		ug/kg	136	26.0	10
Acenaphthene	18500		ug/kg	136	24.0	10
2,3,5-Trimethylnaphthalene	1190		ug/kg	136	22.3	10
Fluorene	12700		ug/kg	136	36.3	10
C1-Fluorenes	5430		ug/kg	136	36.3	10
C2-Fluorenes	1980		ug/kg	136	36.3	10
C3-Fluorenes	1010	G	ug/kg	136	36.3	10
Dibenzothiophene	3470		ug/kg	136	37.5	10

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2152896

Project Number: 180327-08.01 **Report Date:** 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-08 D
Client ID: AQSS-09-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 10:45
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
4-Methyldibenzothiophene(4MDT)	661.		ug/kg	136	37.5	10
2/3-Methyldibenzothiophene(2MDT)	724.		ug/kg	136	37.5	10
1-Methyldibenzothiophene(1MDT)	232.		ug/kg	136	37.5	10
C1-Dibenzothiophenes BS	1880		ug/kg	136	37.5	10
C2-Dibenzothiophenes	1050		ug/kg	136	37.5	10
C3-Dibenzothiophenes	459.		ug/kg	136	37.5	10
C4-Dibenzothiophenes	221.		ug/kg	136	37.5	10
Phenanthrene	34800		ug/kg	136	45.1	10
3-Methylphenanthrene (3MP)	2860		ug/kg	136	45.1	10
2-Methylphenanthrene (2MP)	2870		ug/kg	136	45.1	10
2-Methylanthracene (2MA)	1040		ug/kg	136	45.1	10
9/4-Methylphenanthrene (9MP)	2520		ug/kg	136	45.1	10
C1-Phenanthrenes/Anthracenes	11500		ug/kg	136	45.1	10
C2-Phenanthrenes/Anthr BS	4000		ug/kg	136	45.1	10
C3-Phenanthrenes/Anthracenes	1100		ug/kg	136	45.1	10
C4-Phenanthrenes/Anthracenes	268.		ug/kg	136	45.1	10
Retene	ND		ug/kg	136	33.4	10
Anthracene	6400		ug/kg	136	28.1	10
Carbazole	1360		ug/kg	136	44.5	10
1-Methylphenanthrene	2620		ug/kg	136	36.0	10
Fluoranthene	11000		ug/kg	136	43.2	10
Benzo(b)fluorene	1230		ug/kg	136	39.4	10
7H-Benzo(c)fluorene	430.		ug/kg	136	39.4	10
2-Methylpyrene[1]	680.		ug/kg	136	35.8	10
4-Methylpyrene[1]	568.		ug/kg	136	35.8	10
1-Methylpyrene[1]	631.		ug/kg	136	35.8	10
Pyrene	10600		ug/kg	136	35.8	10
C1-Fluoranthenes/Pyrenes	5790		ug/kg	136	35.8	10
C2-Fluoranthenes/Pyrenes	1690		ug/kg	136	35.8	10
C3-Fluoranthenes/Pyrenes	852.		ug/kg	136	35.8	10
C4-Fluoranthenes/Pyrenes	528.		ug/kg	136	35.8	10
Naphthobenzothiophenes	702.	J	ug/kg	136	38.1	10
C1-Naphthobenzothiophenes	459.		ug/kg	136	38.1	10
C2-Naphthobenzothiophenes	368.		ug/kg	136	38.1	10
C3-Naphthobenzothiophenes	386.		ug/kg	136	38.1	10
C4-Naphthobenzothiophenes	370.		ug/kg	136	38.1	10
Benz(a)anthracene	3030		ug/kg	136	27.8	10

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2152896

Project Number: 180327-08.01 **Report Date:** 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-08 D
Client ID: AQSS-09-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 10:45
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
Chrysene	3080		ug/kg	136	27.5	10
C1-Chrysenes	1580		ug/kg	136	27.5	10
C2-Chrysenes BS	764.		ug/kg	136	27.5	10
C3-Chrysenes	624.		ug/kg	136	27.5	10
C4-Chrysenes	ND		ug/kg	136	27.5	10
Benzo(b)fluoranthene	1960		ug/kg	136	35.4	10
Benzo(j)+(k)fluoranthene	1930		ug/kg	136	27.0	10
Benzo(a)fluoranthene	497.		ug/kg	136	27.0	10
Benzo(e)pyrene	1480		ug/kg	136	28.1	10
Benzo(a)pyrene	2550		ug/kg	136	38.9	10
Perylene	592.		ug/kg	136	26.3	10
Indeno(1,2,3-cd)pyrene	1510		ug/kg	136	36.9	10
Dibenz(a,h)+(a,c)anthracene	380.		ug/kg	136	36.8	10
Benzo(g,h,i)perylene	1500		ug/kg	136	36.2	10

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Naphthalene-d8	62		50-130
Phenanthrene-d10	84		50-130
Benzo(a)pyrene-d12	72		50-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-10 D2
Client ID: AQSS-08-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 11:58
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/12/21 12:14
Analyst: GP
Percent Solids: 91%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 09:09
Cleanup Method: EPA 3630
Cleanup Date: 11/01/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Phenanthrene	120000		ug/kg	873	103.	200

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	73		30-130
Pyrene-d10	77		30-130
Benzo(b)fluoranthene-d12	70		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-10 D
Client ID: AQSS-08-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 11:58
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/05/21 19:25
Analyst: GP
Percent Solids: 91%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 09:09
Cleanup Method: EPA 3630
Cleanup Date: 11/01/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Naphthalene	158000		ug/kg	436	39.1	100
2-Methylnaphthalene	89300		ug/kg	436	54.1	100
2-Chloronaphthalene	92.4	J	ug/kg	436	34.2	100
Acenaphthylene	14000		ug/kg	436	29.2	100
Acenaphthene	41900		ug/kg	436	48.9	100
Fluorene	34300		ug/kg	436	29.2	100
Phenanthrene	111000	E	ug/kg	436	51.5	100
Anthracene	33600		ug/kg	436	54.1	100
Fluoranthene	45700		ug/kg	436	79.9	100
Pyrene	75600		ug/kg	436	44.5	100
Benz(a)anthracene	24200		ug/kg	436	116.	100
Chrysene	20700		ug/kg	436	38.4	100
Benzo(b)fluoranthene	11500		ug/kg	436	45.4	100
Benzo(k)fluoranthene	12400		ug/kg	436	45.0	100
Benzo(a)pyrene	23300		ug/kg	436	51.1	100
Indeno(1,2,3-cd)Pyrene	9700		ug/kg	436	124.	100
Dibenz(a,h)anthracene	2800		ug/kg	436	45.0	100
Benzo(ghi)perylene	10900		ug/kg	436	36.0	100

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	66		30-130
Pyrene-d10	78		30-130
Benzo(b)fluoranthene-d12	68		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-11 D2
Client ID: AQSS-08-1.0-1.5
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 12:00
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/12/21 13:15
Analyst: GP
Percent Solids: 76%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 09:09
Cleanup Method: EPA 3630
Cleanup Date: 11/01/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Naphthalene	2260000		ug/kg	5050	452.	1000
2-Methylnaphthalene	1020000		ug/kg	5050	626.	1000
Acenaphthene	443000		ug/kg	5050	565.	1000
Fluorene	249000		ug/kg	5050	337.	1000
Phenanthrene	595000		ug/kg	5050	596.	1000
Anthracene	143000		ug/kg	5050	626.	1000
Fluoranthene	222000		ug/kg	5050	924.	1000
Pyrene	288000		ug/kg	5050	515.	1000

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	98		30-130
Pyrene-d10	84		30-130
Benzo(b)fluoranthene-d12	104		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-11 D
Client ID: AQSS-08-1.0-1.5
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 12:00
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/05/21 19:55
Analyst: GP
Percent Solids: 76%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 09:09
Cleanup Method: EPA 3630
Cleanup Date: 11/01/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Naphthalene	985000	E	ug/kg	505	45.2	100
2-Methylnaphthalene	715000	E	ug/kg	505	62.6	100
2-Chloronaphthalene	626		ug/kg	505	39.5	100
Acenaphthylene	48000		ug/kg	505	33.8	100
Acenaphthene	322000	E	ug/kg	505	56.5	100
Fluorene	126000	E	ug/kg	505	33.7	100
Phenanthrene	430000	E	ug/kg	505	59.6	100
Anthracene	127000	E	ug/kg	505	62.6	100
Fluoranthene	165000	E	ug/kg	505	92.4	100
Pyrene	228000	E	ug/kg	505	51.5	100
Benz(a)anthracene	86700		ug/kg	505	135.	100
Chrysene	87200		ug/kg	505	44.4	100
Benzo(b)fluoranthene	39700		ug/kg	505	52.5	100
Benzo(k)fluoranthene	38800		ug/kg	505	52.0	100
Benzo(a)pyrene	70300		ug/kg	505	59.1	100
Indeno(1,2,3-cd)Pyrene	33300		ug/kg	505	144.	100
Dibenz(a,h)anthracene	10800		ug/kg	505	52.0	100
Benzo(ghi)perylene	38500		ug/kg	505	41.6	100

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	85		30-130
Pyrene-d10	78		30-130
Benzo(b)fluoranthene-d12	69		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-12
Client ID: AQSS-07-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 12:35
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 1,8270D-SIM(M)
Analytical Date: 11/07/21 15:43
Analyst: CC
Percent Solids: 86%

Extraction Method: ALPHA OP-013
Extraction Date: 10/27/21 20:16
Cleanup Method: EPA 3611B
Cleanup Date: 11/02/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
cis/trans-Decalin	115.		ug/kg	5.56	1.10	1
C1-Decalins	85.9		ug/kg	5.56	1.10	1
C2-Decalins	61.8		ug/kg	5.56	1.10	1
C3-Decalins	51.9		ug/kg	5.56	1.10	1
C4-Decalins	90.2		ug/kg	5.56	1.10	1
Naphthalene	710.		ug/kg	11.1	3.20	1
C1-Naphthalenes	2100		ug/kg	11.1	3.20	1
C2-Naphthalenes	14800		ug/kg	11.1	3.20	1
C3-Naphthalenes	8120		ug/kg	11.1	3.20	1
C4-Naphthalenes	1450		ug/kg	11.1	3.20	1
2-Methylnaphthalene	257.		ug/kg	11.1	2.87	1
1-Methylnaphthalene	3030		ug/kg	11.1	3.50	1
Benzothiophene	45.7		ug/kg	11.1	3.48	1
C1-Benzo(b)thiophenes	344.		ug/kg	11.1	3.48	1
C2-Benzo(b)thiophenes	1500		ug/kg	11.1	3.48	1
C3-Benzo(b)thiophenes	1000		ug/kg	11.1	3.48	1
C4-Benzo(b)thiophenes	200.		ug/kg	11.1	3.48	1
Biphenyl	2340		ug/kg	11.1	3.44	1
2,6-Dimethylnaphthalene	310.		ug/kg	11.1	2.64	1
Dibenzofuran	1620		ug/kg	11.1	3.50	1
Acenaphthylene	934.		ug/kg	11.1	2.12	1
Acenaphthene	21400	E	ug/kg	11.1	1.96	1
2,3,5-Trimethylnaphthalene	949.		ug/kg	11.1	1.82	1
Fluorene	9850		ug/kg	11.1	2.96	1
C1-Fluorenes	4390		ug/kg	11.1	2.96	1
C2-Fluorenes	1470		ug/kg	11.1	2.96	1
C3-Fluorenes	530.	G	ug/kg	11.1	2.96	1
Dibenzothiophene	2250		ug/kg	11.1	3.06	1

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2152896

Project Number: 180327-08.01 **Report Date:** 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-12 Date Collected: 09/29/21 12:35

Client ID: AQSS-07-0.0-0.5 Date Received: 09/29/21

Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
4-Methyldibenzothiophene(4MDT)	426.		ug/kg	11.1	3.06	1
2/3-Methyldibenzothiophene(2MDT)	462.		ug/kg	11.1	3.06	1
1-Methyldibenzothiophene(1MDT)	177.		ug/kg	11.1	3.06	1
C1-Dibenzothiophenes BS	1220		ug/kg	11.1	3.06	1
C2-Dibenzothiophenes	427.		ug/kg	11.1	3.06	1
C3-Dibenzothiophenes	240.		ug/kg	11.1	3.06	1
C4-Dibenzothiophenes	124.		ug/kg	11.1	3.06	1
Phenanthrene	19800	E	ug/kg	11.1	3.68	1
3-Methylphenanthrene (3MP)	1930		ug/kg	11.1	3.68	1
2-Methylphenanthrene (2MP)	1710		ug/kg	11.1	3.68	1
2-Methylanthracene (2MA)	532.		ug/kg	11.1	3.68	1
9/4-Methylphenanthrene (9MP)	1680		ug/kg	11.1	3.68	1
C1-Phenanthrenes/Anthracenes	7120		ug/kg	11.1	3.68	1
C2-Phenanthrenes/Anthr BS	1750		ug/kg	11.1	3.68	1
C3-Phenanthrenes/Anthracenes	582.		ug/kg	11.1	3.68	1
C4-Phenanthrenes/Anthracenes	210.		ug/kg	11.1	3.68	1
Retene	70.0		ug/kg	11.1	2.73	1
Anthracene	2510		ug/kg	11.1	2.29	1
Carbazole	387.		ug/kg	11.1	3.64	1
1-Methylphenanthrene	1740		ug/kg	11.1	2.94	1
Fluoranthene	6760		ug/kg	11.1	3.53	1
Benzo(b)fluorene	414.		ug/kg	11.1	3.22	1
7H-Benzo(c)fluorene	200.		ug/kg	11.1	3.22	1
2-Methylpyrene[1]	286.		ug/kg	11.1	2.92	1
4-Methylpyrene[1]	253.		ug/kg	11.1	2.92	1
1-Methylpyrene[1]	235.		ug/kg	11.1	2.92	1
Pyrene	5830		ug/kg	11.1	2.92	1
C1-Fluoranthenes/Pyrenes	2270		ug/kg	11.1	2.92	1
C2-Fluoranthenes/Pyrenes	1220		ug/kg	11.1	2.92	1
C3-Fluoranthenes/Pyrenes	552.		ug/kg	11.1	2.92	1
C4-Fluoranthenes/Pyrenes	355.		ug/kg	11.1	2.92	1
Naphthobenzothiophenes	406.		ug/kg	11.1	3.11	1
C1-Naphthobenzothiophenes	269.		ug/kg	11.1	3.11	1
C2-Naphthobenzothiophenes	286.		ug/kg	11.1	3.11	1
C3-Naphthobenzothiophenes	297.		ug/kg	11.1	3.11	1
C4-Naphthobenzothiophenes	237.		ug/kg	11.1	3.11	1
Benz(a)anthracene	2130		ug/kg	11.1	2.27	1

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2152896

Project Number: 180327-08.01 **Report Date:** 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-12 Date Collected: 09/29/21 12:35

Client ID: AQSS-07-0.0-0.5 Date Received: 09/29/21

Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
Chrysene	2420		ug/kg	11.1	2.25	1
C1-Chrysenes	1170		ug/kg	11.1	2.25	1
C2-Chrysenes BS	701.		ug/kg	11.1	2.25	1
C3-Chrysenes	560.		ug/kg	11.1	2.25	1
C4-Chrysenes	350.		ug/kg	11.1	2.25	1
Benzo(b)fluoranthene	1660		ug/kg	11.1	2.89	1
Benzo(j)+(k)fluoranthene	1550		ug/kg	11.1	2.21	1
Benzo(a)fluoranthene	369.		ug/kg	11.1	2.21	1
Benzo(e)pyrene	1230		ug/kg	11.1	2.29	1
Benzo(a)pyrene	1920		ug/kg	11.1	3.17	1
Perylene	487.		ug/kg	11.1	2.14	1
Indeno(1,2,3-cd)pyrene	1300		ug/kg	11.1	3.02	1
Dibenz(a,h)+(a,c)anthracene	372.		ug/kg	11.1	3.00	1
Benzo(g,h,i)perylene	1390		ug/kg	11.1	2.95	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Naphthalene-d8	68		50-130
Phenanthrene-d10	76		50-130
Benzo(a)pyrene-d12	75		50-130

Project Name: FORMER HAVERHILL MGP
Lab Number: L2152896
Project Number: 180327-08.01
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-12 D
Client ID: AQSS-07-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 12:35
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 1,8270D-SIM(M)
Analytical Date: 11/10/21 03:37
Analyst: CC
Percent Solids: 86%

Extraction Method: ALPHA OP-013
Extraction Date: 10/27/21 20:16
Cleanup Method: EPA 3611B
Cleanup Date: 11/02/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
Acenaphthene	22900		ug/kg	22.2	3.92	2
Phenanthrene	22800		ug/kg	22.2	7.37	2

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Naphthalene-d8	58		50-130
Phenanthrene-d10	87		50-130
Benzo(a)pyrene-d12	80		50-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-13 D
Client ID: AQSS-07-1.5-2.0
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 12:50
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 1,8270D-SIM(M)
Analytical Date: 11/09/21 20:25
Analyst: CC
Percent Solids: 58%

Extraction Method: ALPHA OP-013
Extraction Date: 10/27/21 20:16
Cleanup Method: EPA 3611B
Cleanup Date: 11/02/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
cis/trans-Decalin	2040		ug/kg	747	148.	10
C1-Decalins	4010		ug/kg	747	148.	10
C2-Decalins	4670		ug/kg	747	148.	10
C3-Decalins	3320		ug/kg	747	148.	10
C4-Decalins	ND		ug/kg	747	148.	10
Naphthalene	50800		ug/kg	1490	429.	10
C1-Naphthalenes	340000		ug/kg	1490	429.	10
C2-Naphthalenes	485000		ug/kg	1490	429.	10
C3-Naphthalenes	283000		ug/kg	1490	429.	10
C4-Naphthalenes	97100		ug/kg	1490	429.	10
2-Methylnaphthalene	15500		ug/kg	1490	385.	10
1-Methylnaphthalene	518000		ug/kg	1490	471.	10
Benzothiophene	1780		ug/kg	1490	468.	10
C1-Benzo(b)thiophenes	14500		ug/kg	1490	468.	10
C2-Benzo(b)thiophenes	35100		ug/kg	1490	468.	10
C3-Benzo(b)thiophenes	25700		ug/kg	1490	468.	10
C4-Benzo(b)thiophenes	10900		ug/kg	1490	468.	10
Biphenyl	92400		ug/kg	1490	462.	10
2,6-Dimethylnaphthalene	195000		ug/kg	1490	355.	10
Dibenzofuran	49100		ug/kg	1490	470.	10
Acenaphthylene	51500		ug/kg	1490	285.	10
Acenaphthene	529000		ug/kg	1490	263.	10
2,3,5-Trimethylnaphthalene	35500		ug/kg	1490	244.	10
Fluorene	232000		ug/kg	1490	398.	10
C1-Fluorenes	189000		ug/kg	1490	398.	10
C2-Fluorenes	148000		ug/kg	1490	398.	10
C3-Fluorenes	72600		ug/kg	1490	398.	10
Dibenzothiophene	83100		ug/kg	1490	412.	10

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2152896

Project Number: 180327-08.01 **Report Date:** 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-13 D
Client ID: AQSS-07-1.5-2.0
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 12:50
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
4-Methyldibenzothiophene(4MDT)	35400		ug/kg	1490	412.	10
2/3-Methyldibenzothiophene(2MDT)	33300		ug/kg	1490	412.	10
1-Methyldibenzothiophene(1MDT)	12200		ug/kg	1490	412.	10
C1-Dibenzothiophenes BS	94500		ug/kg	1490	412.	10
C2-Dibenzothiophenes	90700		ug/kg	1490	412.	10
C3-Dibenzothiophenes	51200		ug/kg	1490	412.	10
C4-Dibenzothiophenes	17100		ug/kg	1490	412.	10
Phenanthrene	999000		ug/kg	1490	495.	10
3-Methylphenanthrene (3MP)	151000		ug/kg	1490	495.	10
2-Methylphenanthrene (2MP)	162000		ug/kg	1490	495.	10
2-Methylanthracene (2MA)	73600		ug/kg	1490	495.	10
9/4-Methylphenanthrene (9MP)	163000		ug/kg	1490	495.	10
C1-Phenanthrenes/Anthracenes	664000		ug/kg	1490	495.	10
C2-Phenanthrenes/Anthr BS	379000		ug/kg	1490	495.	10
C3-Phenanthrenes/Anthracenes	146000		ug/kg	1490	495.	10
C4-Phenanthrenes/Anthracenes	34700		ug/kg	1490	495.	10
Retene	ND		ug/kg	1490	366.	10
Anthracene	245000		ug/kg	1490	308.	10
Carbazole	22000		ug/kg	1490	489.	10
1-Methylphenanthrene	150000		ug/kg	1490	394.	10
Fluoranthene	396000		ug/kg	1490	475.	10
Benzo(b)fluorene	72300		ug/kg	1490	433.	10
7H-Benzo(c)fluorene	28200		ug/kg	1490	433.	10
2-Methylpyrene[1]	47800		ug/kg	1490	393.	10
4-Methylpyrene[1]	52100		ug/kg	1490	393.	10
1-Methylpyrene[1]	66000		ug/kg	1490	393.	10
Pyrene	470000		ug/kg	1490	393.	10
C1-Fluoranthenes/Pyrenes	432000		ug/kg	1490	393.	10
C2-Fluoranthenes/Pyrenes	192000		ug/kg	1490	393.	10
C3-Fluoranthenes/Pyrenes	84000		ug/kg	1490	393.	10
C4-Fluoranthenes/Pyrenes	35900		ug/kg	1490	393.	10
Naphthobenzothiophenes	46200		ug/kg	1490	418.	10
C1-Naphthobenzothiophenes	49500		ug/kg	1490	418.	10
C2-Naphthobenzothiophenes	34100		ug/kg	1490	418.	10
C3-Naphthobenzothiophenes	16700		ug/kg	1490	418.	10
C4-Naphthobenzothiophenes	7670		ug/kg	1490	418.	10
Benz(a)anthracene	146000		ug/kg	1490	304.	10

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2152896

Project Number: 180327-08.01 **Report Date:** 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-13 D Date Collected: 09/29/21 12:50
Client ID: AQSS-07-1.5-2.0 Date Received: 09/29/21
Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
Chrysene	174000		ug/kg	1490	302.	10
C1-Chrysenes	167000		ug/kg	1490	302.	10
C2-Chrysenes BS	105000		ug/kg	1490	302.	10
C3-Chrysenes	56700		ug/kg	1490	302.	10
C4-Chrysenes	19400		ug/kg	1490	302.	10
Benzo(b)fluoranthene	71300		ug/kg	1490	388.	10
Benzo(j)+(k)fluoranthene	73100		ug/kg	1490	296.	10
Benzo(a)fluoranthene	31500		ug/kg	1490	296.	10
Benzo(e)pyrene	63700		ug/kg	1490	308.	10
Benzo(a)pyrene	126000		ug/kg	1490	426.	10
Perylene	25400		ug/kg	1490	288.	10
Indeno(1,2,3-cd)pyrene	66600		ug/kg	1490	405.	10
Dibenz(a,h)+(a,c)anthracene	18200		ug/kg	1490	404.	10
Benzo(g,h,i)perylene	78800		ug/kg	1490	397.	10

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Naphthalene-d8	60		50-130
Phenanthrene-d10	83		50-130
Benzo(a)pyrene-d12	76		50-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-14
Client ID: AQSS-06-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 13:58
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 1,8270D-SIM(M)
Analytical Date: 11/07/21 20:00
Analyst: CC
Percent Solids: 73%

Extraction Method: ALPHA OP-013
Extraction Date: 10/27/21 20:16
Cleanup Method: EPA 3611B
Cleanup Date: 11/02/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
cis/trans-Decalin	195.		ug/kg	4.60	0.914	1
C1-Decalins	502.		ug/kg	4.60	0.914	1
C2-Decalins	700.		ug/kg	4.60	0.914	1
C3-Decalins	475.		ug/kg	4.60	0.914	1
C4-Decalins	675.		ug/kg	4.60	0.914	1
Naphthalene	10700		ug/kg	9.19	2.64	1
C1-Naphthalenes	10400		ug/kg	9.19	2.64	1
C2-Naphthalenes	16100		ug/kg	9.19	2.64	1
C3-Naphthalenes	11800		ug/kg	9.19	2.64	1
C4-Naphthalenes	4500		ug/kg	9.19	2.64	1
2-Methylnaphthalene	6190		ug/kg	9.19	2.37	1
1-Methylnaphthalene	9850		ug/kg	9.19	2.90	1
Benzothiophene	351.		ug/kg	9.19	2.88	1
C1-Benzo(b)thiophenes	701.		ug/kg	9.19	2.88	1
C2-Benzo(b)thiophenes	1410		ug/kg	9.19	2.88	1
C3-Benzo(b)thiophenes	1020		ug/kg	9.19	2.88	1
C4-Benzo(b)thiophenes	377.		ug/kg	9.19	2.88	1
Biphenyl	2980		ug/kg	9.19	2.84	1
2,6-Dimethylnaphthalene	5290		ug/kg	9.19	2.18	1
Dibenzofuran	6150		ug/kg	9.19	2.90	1
Acenaphthylene	5700		ug/kg	9.19	1.75	1
Acenaphthene	12000		ug/kg	9.19	1.62	1
2,3,5-Trimethylnaphthalene	1240		ug/kg	9.19	1.50	1
Fluorene	12400	E	ug/kg	9.19	2.45	1
C1-Fluorenes	7910		ug/kg	9.19	2.45	1
C2-Fluorenes	5940		ug/kg	9.19	2.45	1
C3-Fluorenes	2200		ug/kg	9.19	2.45	1
Dibenzothiophene	4150		ug/kg	9.19	2.54	1

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2152896

Project Number: 180327-08.01 **Report Date:** 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-14 Date Collected: 09/29/21 13:58

Client ID: AQSS-06-0.0-0.5 Date Received: 09/29/21

Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
4-Methyldibenzothiophene(4MDT)	1290		ug/kg	9.19	2.54	1
2/3-Methyldibenzothiophene(2MDT)	1480		ug/kg	9.19	2.54	1
1-Methyldibenzothiophene(1MDT)	437.		ug/kg	9.19	2.54	1
C1-Dibenzothiophenes BS	3810		ug/kg	9.19	2.54	1
C2-Dibenzothiophenes	2740		ug/kg	9.19	2.54	1
C3-Dibenzothiophenes	1400		ug/kg	9.19	2.54	1
C4-Dibenzothiophenes	397.		ug/kg	9.19	2.54	1
Phenanthrene	49600	E	ug/kg	9.19	3.05	1
3-Methylphenanthrene (3MP)	7370		ug/kg	9.19	3.05	1
2-Methylphenanthrene (2MP)	6880		ug/kg	9.19	3.05	1
2-Methylanthracene (2MA)	4640		ug/kg	9.19	3.05	1
9/4-Methylphenanthrene (9MP)	7800		ug/kg	9.19	3.05	1
C1-Phenanthrenes/Anthracenes	31800		ug/kg	9.19	3.05	1
C2-Phenanthrenes/Anthr BS	14700		ug/kg	9.19	3.05	1
C3-Phenanthrenes/Anthracenes	4740		ug/kg	9.19	3.05	1
C4-Phenanthrenes/Anthracenes	1180		ug/kg	9.19	3.05	1
Retene	ND		ug/kg	9.19	2.26	1
Anthracene	16700	E	ug/kg	9.19	1.90	1
Carbazole	577.		ug/kg	9.19	3.01	1
1-Methylphenanthrene	6450		ug/kg	9.19	2.43	1
Fluoranthene	44500	E	ug/kg	9.19	2.92	1
Benzo(b)fluorene	5660		ug/kg	9.19	2.66	1
7H-Benzo(c)fluorene	1620		ug/kg	9.19	2.66	1
2-Methylpyrene[1]	2660		ug/kg	9.19	2.42	1
4-Methylpyrene[1]	2230		ug/kg	9.19	2.42	1
1-Methylpyrene[1]	2610		ug/kg	9.19	2.42	1
Pyrene	43000	E	ug/kg	9.19	2.42	1
C1-Fluoranthenes/Pyrenes	23600		ug/kg	9.19	2.42	1
C2-Fluoranthenes/Pyrenes	7310		ug/kg	9.19	2.42	1
C3-Fluoranthenes/Pyrenes	2950		ug/kg	9.19	2.42	1
C4-Fluoranthenes/Pyrenes	1270		ug/kg	9.19	2.42	1
Naphthobenzothiophenes	2460		ug/kg	9.19	2.57	1
C1-Naphthobenzothiophenes	1580		ug/kg	9.19	2.57	1
C2-Naphthobenzothiophenes	874.		ug/kg	9.19	2.57	1
C3-Naphthobenzothiophenes	458.		ug/kg	9.19	2.57	1
C4-Naphthobenzothiophenes	215.		ug/kg	9.19	2.57	1
Benz(a)anthracene	17600	E	ug/kg	9.19	1.87	1

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2152896

Project Number: 180327-08.01 **Report Date:** 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-14 Date Collected: 09/29/21 13:58

Client ID: AQSS-06-0.0-0.5 Date Received: 09/29/21

Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
Chrysene	16700	E	ug/kg	9.19	1.86	1
C1-Chrysenes	8770		ug/kg	9.19	1.86	1
C2-Chrysenes BS	4190		ug/kg	9.19	1.86	1
C3-Chrysenes	2510		ug/kg	9.19	1.86	1
C4-Chrysenes	780.		ug/kg	9.19	1.86	1
Benzo(b)fluoranthene	9190		ug/kg	9.19	2.39	1
Benzo(j)+(k)fluoranthene	9270		ug/kg	9.19	1.82	1
Benzo(a)fluoranthene	2810		ug/kg	9.19	1.82	1
Benzo(e)pyrene	7070		ug/kg	9.19	1.90	1
Benzo(a)pyrene	14100	E	ug/kg	9.19	2.62	1
Perylene	2980		ug/kg	9.19	1.77	1
Indeno(1,2,3-cd)pyrene	6910		ug/kg	9.19	2.50	1
Dibenz(a,h)+(a,c)anthracene	2110		ug/kg	9.19	2.48	1
Benzo(g,h,i)perylene	6850		ug/kg	9.19	2.44	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Naphthalene-d8	86		50-130
Phenanthrene-d10	77		50-130
Benzo(a)pyrene-d12	78		50-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-14 D
Client ID: AQSS-06-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 13:58
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 1,8270D-SIM(M)
Analytical Date: 11/10/21 05:03
Analyst: CC
Percent Solids: 73%

Extraction Method: ALPHA OP-013
Extraction Date: 10/27/21 20:16
Cleanup Method: EPA 3611B
Cleanup Date: 11/02/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
Fluorene	12100		ug/kg	46.0	12.3	5
Phenanthrene	47500		ug/kg	46.0	15.2	5
Anthracene	16400		ug/kg	46.0	9.48	5
Fluoranthene	42700		ug/kg	46.0	14.6	5
Pyrene	40200		ug/kg	46.0	12.1	5
Benz(a)anthracene	14600		ug/kg	46.0	9.37	5
Chrysene	14500		ug/kg	46.0	9.29	5
Benzo(a)pyrene	12400		ug/kg	46.0	13.1	5

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Naphthalene-d8	70		50-130
Phenanthrene-d10	85		50-130
Benzo(a)pyrene-d12	81		50-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-15 D2
Client ID: AQSS-06-1.5-2.0
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 14:00
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/17/21 12:45
Analyst: GP
Percent Solids: 87%

Extraction Method: EPA 3570
Extraction Date: 11/10/21 17:07
Cleanup Method: EPA 3630
Cleanup Date: 11/16/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Phenanthrene	82000		ug/kg	905	107.	200
Fluoranthene	66600		ug/kg	905	166.	200
Pyrene	57000		ug/kg	905	92.3	200

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	77		30-130
Pyrene-d10	78		30-130
Benzo(b)fluoranthene-d12	73		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-15 D
Client ID: AQSS-06-1.5-2.0
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 14:00
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/16/21 18:42
Analyst: GP
Percent Solids: 87%

Extraction Method: EPA 3570
Extraction Date: 11/10/21 17:07
Cleanup Method: EPA 3630
Cleanup Date: 11/16/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Naphthalene	4440		ug/kg	181	16.2	40
2-Methylnaphthalene	2370		ug/kg	181	22.4	40
2-Chloronaphthalene	31.6	J	ug/kg	181	14.2	40
Acenaphthylene	8680		ug/kg	181	12.1	40
Acenaphthene	18100		ug/kg	181	20.3	40
Fluorene	24900		ug/kg	181	12.1	40
Phenanthrene	89600	E	ug/kg	181	21.4	40
Anthracene	26500		ug/kg	181	22.4	40
Fluoranthene	72100	E	ug/kg	181	33.1	40
Pyrene	68000	E	ug/kg	181	18.5	40
Benz(a)anthracene	29800		ug/kg	181	48.3	40
Chrysene	25200		ug/kg	181	15.9	40
Benzo(b)fluoranthene	15800		ug/kg	181	18.8	40
Benzo(k)fluoranthene	14800		ug/kg	181	18.6	40
Benzo(a)pyrene	24100		ug/kg	181	21.2	40
Indeno(1,2,3-cd)Pyrene	10600		ug/kg	181	51.6	40
Dibenz(a,h)anthracene	3300		ug/kg	181	18.6	40
Benzo(ghi)perylene	10200		ug/kg	181	14.9	40

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	81		30-130
Pyrene-d10	87		30-130
Benzo(b)fluoranthene-d12	74		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 97,8270D-SIM
Analytical Date: 11/05/21 11:45
Analyst: PS

Extraction Method: EPA 3570
Extraction Date: 10/27/21 09:09
Cleanup Method: EPA 3630
Cleanup Date: 11/01/21

Parameter	Result	Qualifier	Units	RL	MDL
MCP PAHs by GC/MS-SIM - Mansfield Lab for sample(s): 03-04,10-11 Batch: WG1563704-1					
Naphthalene	2.12	J	ug/kg	4.00	0.358
2-Methylnaphthalene	0.648	J	ug/kg	4.00	0.496
Acenaphthylene	ND		ug/kg	4.00	0.268
Acenaphthene	ND		ug/kg	4.00	0.448
Fluorene	ND		ug/kg	4.00	0.267
Phenanthrene	0.772	J	ug/kg	4.00	0.472
Anthracene	ND		ug/kg	4.00	0.496
Fluoranthene	ND		ug/kg	4.00	0.732
Pyrene	ND		ug/kg	4.00	0.408
Benz(a)anthracene	ND		ug/kg	4.00	1.07
Chrysene	ND		ug/kg	4.00	0.352
Benzo(b)fluoranthene	ND		ug/kg	4.00	0.416
Benzo(k)fluoranthene	ND		ug/kg	4.00	0.412
Benzo(a)pyrene	ND		ug/kg	4.00	0.468
Indeno(1,2,3-cd)Pyrene	ND		ug/kg	4.00	1.14
Dibenz(a,h)anthracene	ND		ug/kg	4.00	0.412
Benzo(ghi)perylene	ND		ug/kg	4.00	0.330

Surrogate	%Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	63		30-130
Pyrene-d10	78		30-130
Benzo(b)fluoranthene-d12	73		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 1,8270D-SIM(M)
Analytical Date: 11/07/21 02:58
Analyst: CC

Extraction Method: ALPHA OP-013
Extraction Date: 10/27/21 20:16
Cleanup Method: EPA 3611B
Cleanup Date: 11/02/21

Parameter	Result	Qualifier	Units	RL	MDL
PAHs - Mansfield Lab for sample(s): 01-02,05-08,12-14 Batch: WG1563968-1					
cis/trans-Decalin	ND		ug/kg	0.500	0.0994
C1-Decalins	ND		ug/kg	0.500	0.0994
C2-Decalins	ND		ug/kg	0.500	0.0994
C3-Decalins	ND		ug/kg	0.500	0.0994
C4-Decalins	ND		ug/kg	0.500	0.0994
Naphthalene	ND		ug/kg	1.00	0.287
C1-Naphthalenes	ND		ug/kg	1.00	0.287
C2-Naphthalenes	ND		ug/kg	1.00	0.287
C3-Naphthalenes	ND		ug/kg	1.00	0.287
C4-Naphthalenes	ND		ug/kg	1.00	0.287
2-Methylnaphthalene	ND		ug/kg	1.00	0.258
1-Methylnaphthalene	ND		ug/kg	1.00	0.315
Benzothiophene	ND		ug/kg	1.00	0.313
C1-Benzo(b)thiophenes	ND		ug/kg	1.00	0.313
C2-Benzo(b)thiophenes	ND		ug/kg	1.00	0.313
C3-Benzo(b)thiophenes	ND		ug/kg	1.00	0.313
C4-Benzo(b)thiophenes	ND		ug/kg	1.00	0.313
Biphenyl	ND		ug/kg	1.00	0.309
2,6-Dimethylnaphthalene	ND		ug/kg	1.00	0.238
Dibenzofuran	ND		ug/kg	1.00	0.315
Acenaphthylene	ND		ug/kg	1.00	0.191
Acenaphthene	ND		ug/kg	1.00	0.176
2,3,5-Trimethylnaphthalene	ND		ug/kg	1.00	0.164
Fluorene	ND		ug/kg	1.00	0.267
C1-Fluorenes	ND		ug/kg	1.00	0.267
C2-Fluorenes	ND		ug/kg	1.00	0.267
C3-Fluorenes	ND		ug/kg	1.00	0.267
Dibenzothiophene	ND		ug/kg	1.00	0.276
4-Methyldibenzothiophene(4MDT)	ND		ug/kg	1.00	0.276

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 1,8270D-SIM(M)
Analytical Date: 11/07/21 02:58
Analyst: CC

Extraction Method: ALPHA OP-013
Extraction Date: 10/27/21 20:16
Cleanup Method: EPA 3611B
Cleanup Date: 11/02/21

Parameter	Result	Qualifier	Units	RL	MDL
PAHs - Mansfield Lab for sample(s): 01-02,05-08,12-14 Batch: WG1563968-1					
2/3-Methyldibenzothiophene(2MDT)	ND		ug/kg	1.00	0.276
1-Methyldibenzothiophene(1MDT)	ND		ug/kg	1.00	0.276
C1-Dibenzothiophenes BS	ND		ug/kg	1.00	0.276
C2-Dibenzothiophenes	ND		ug/kg	1.00	0.276
C3-Dibenzothiophenes	ND		ug/kg	1.00	0.276
C4-Dibenzothiophenes	ND		ug/kg	1.00	0.276
Phenanthrene	ND		ug/kg	1.00	0.331
3-Methylphenanthrene (3MP)	ND		ug/kg	1.00	0.331
2-Methylphenanthrene (2MP)	ND		ug/kg	1.00	0.331
2-Methylanthracene (2MA)	ND		ug/kg	1.00	0.331
9/4-Methylphenanthrene (9MP)	ND		ug/kg	1.00	0.331
C1-Phenanthrenes/Anthracenes	ND		ug/kg	1.00	0.331
C2-Phenanthrenes/Anthr BS	ND		ug/kg	1.00	0.331
C3-Phenanthrenes/Anthracenes	ND		ug/kg	1.00	0.331
C4-Phenanthrenes/Anthracenes	ND		ug/kg	1.00	0.331
Retene	ND		ug/kg	1.00	0.245
Anthracene	ND		ug/kg	1.00	0.206
Carbazole	ND		ug/kg	1.00	0.327
1-Methylphenanthrene	ND		ug/kg	1.00	0.264
Fluoranthene	ND		ug/kg	1.00	0.318
Benzo(b)fluorene	ND		ug/kg	1.00	0.290
7H-Benzo(c)fluorene	ND		ug/kg	1.00	0.290
2-Methylpyrene[1]	ND		ug/kg	1.00	0.263
4-Methylpyrene[1]	ND		ug/kg	1.00	0.263
1-Methylpyrene[1]	ND		ug/kg	1.00	0.263
Pyrene	ND		ug/kg	1.00	0.263
C1-Fluoranthenes/Pyrenes	ND		ug/kg	1.00	0.263
C2-Fluoranthenes/Pyrenes	ND		ug/kg	1.00	0.263
C3-Fluoranthenes/Pyrenes	ND		ug/kg	1.00	0.263

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 1,8270D-SIM(M)
Analytical Date: 11/07/21 02:58
Analyst: CC

Extraction Method: ALPHA OP-013
Extraction Date: 10/27/21 20:16
Cleanup Method: EPA 3611B
Cleanup Date: 11/02/21

Parameter	Result	Qualifier	Units	RL	MDL
PAHs - Mansfield Lab for sample(s): 01-02,05-08,12-14 Batch: WG1563968-1					
C4-Fluoranthenes/Pyrenes	ND		ug/kg	1.00	0.263
Naphthobenzothiophenes	ND		ug/kg	1.00	0.280
C1-Naphthobenzothiophenes	ND		ug/kg	1.00	0.280
C2-Naphthobenzothiophenes	ND		ug/kg	1.00	0.280
C3-Naphthobenzothiophenes	ND		ug/kg	1.00	0.280
C4-Naphthobenzothiophenes	ND		ug/kg	1.00	0.280
Benz(a)anthracene	ND		ug/kg	1.00	0.204
Chrysene	ND		ug/kg	1.00	0.202
C1-Chrysenes	ND		ug/kg	1.00	0.202
C2-Chrysenes BS	ND		ug/kg	1.00	0.202
C3-Chrysenes	ND		ug/kg	1.00	0.202
C4-Chrysenes	ND		ug/kg	1.00	0.202
Benzo(b)fluoranthene	ND		ug/kg	1.00	0.260
Benzo(j)+(k)fluoranthene	ND		ug/kg	1.00	0.198
Benzo(a)fluoranthene	ND		ug/kg	1.00	0.198
Benzo(e)pyrene	ND		ug/kg	1.00	0.206
Benzo(a)pyrene	ND		ug/kg	1.00	0.285
Perylene	ND		ug/kg	1.00	0.193
Indeno(1,2,3-cd)pyrene	ND		ug/kg	1.00	0.271
Dibenz(a,h)+(a,c)anthracene	ND		ug/kg	1.00	0.270
Benzo(g,h,i)perylene	ND		ug/kg	1.00	0.266

Surrogate	%Recovery	Qualifier	Acceptance Criteria
Naphthalene-d8	77		50-130
Phenanthrene-d10	92		50-130
Benzo(a)pyrene-d12	76		50-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 97,8270D-SIM
Analytical Date: 11/16/21 12:32
Analyst: GP

Extraction Method: EPA 3570
Extraction Date: 11/10/21 17:07
Cleanup Method: EPA 3630
Cleanup Date: 11/16/21

Parameter	Result	Qualifier	Units	RL	MDL
MCP PAHs by GC/MS-SIM - Mansfield Lab for sample(s): 15 Batch: WG1569716-1					
Naphthalene	ND		ug/kg	4.00	0.358
2-Methylnaphthalene	ND		ug/kg	4.00	0.496
2-Chloronaphthalene	ND		ug/kg	4.00	0.313
Acenaphthylene	ND		ug/kg	4.00	0.268
Acenaphthene	ND		ug/kg	4.00	0.448
Fluorene	ND		ug/kg	4.00	0.267
Phenanthrene	ND		ug/kg	4.00	0.472
Anthracene	ND		ug/kg	4.00	0.496
Fluoranthene	ND		ug/kg	4.00	0.732
Pyrene	ND		ug/kg	4.00	0.408
Benz(a)anthracene	ND		ug/kg	4.00	1.07
Chrysene	ND		ug/kg	4.00	0.352
Benzo(b)fluoranthene	ND		ug/kg	4.00	0.416
Benzo(k)fluoranthene	ND		ug/kg	4.00	0.412
Benzo(a)pyrene	ND		ug/kg	4.00	0.468
Indeno(1,2,3-cd)Pyrene	ND		ug/kg	4.00	1.14
Dibenz(a,h)anthracene	ND		ug/kg	4.00	0.412
Benzo(ghi)perylene	ND		ug/kg	4.00	0.330

Surrogate	%Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	67		30-130
Pyrene-d10	81		30-130
Benzo(b)fluoranthene-d12	79		30-130

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2152896

Report Date: 11/19/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP PAHs by GC/MS-SIM - Mansfield Lab Associated sample(s): 03-04,10-11 Batch: WG1563704-2 WG1563704-3								
Naphthalene	59		48		40-140	21		30
2-Methylnaphthalene	57		47		40-140	19		30
Acenaphthylene	67		55		40-140	20		30
Acenaphthene	64		53		40-140	19		30
Fluorene	65		55		40-140	17		30
Phenanthrene	62		54		40-140	14		30
Anthracene	68		59		40-140	14		30
Fluoranthene	68		58		40-140	16		30
Pyrene	69		60		40-140	14		30
Benz(a)anthracene	73		61		40-140	18		30
Chrysene	67		58		40-140	14		30
Benzo(b)fluoranthene	80		69		40-140	15		30
Benzo(k)fluoranthene	68		57		40-140	18		30
Benzo(a)pyrene	76		65		40-140	16		30
Indeno(1,2,3-cd)Pyrene	78		68		40-140	14		30
Dibenz(a,h)anthracene	70		60		40-140	15		30
Benzo(ghi)perylene	76		65		40-140	16		30

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2152896

Report Date: 11/19/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP PAHs by GC/MS-SIM - Mansfield Lab Associated sample(s): 03-04,10-11 Batch: WG1563704-2 WG1563704-3								

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria
2-Methylnaphthalene-d10	60		49		30-130
Pyrene-d10	71		60		30-130
Benzo(b)fluoranthene-d12	69		57		30-130

Lab Control Sample Analysis
Batch Quality Control

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
PAHs - Mansfield Lab Associated sample(s): 01-02,05-08,12-14 Batch: WG1563968-2 WG1563968-3								
Naphthalene	84		82		50-130	2		30
2-Methylnaphthalene	86		85		50-130	1		30
Acenaphthylene	85		86		50-130	1		30
Acenaphthene	87		88		50-130	1		30
Fluorene	89		88		50-130	1		30
Phenanthrene	92		94		50-130	2		30
Anthracene	93		93		50-130	0		30
Fluoranthene	88		92		50-130	4		30
Pyrene	88		92		50-130	4		30
Benz(a)anthracene	80		80		50-130	0		30
Chrysene	85		83		50-130	2		30
Benzo(b)fluoranthene	81		83		50-130	2		30
Benzo(j)+(k)fluoranthene	80		81		50-130	1		30
Benzo(a)pyrene	87		89		50-130	2		30
Indeno(1,2,3-cd)pyrene	86		86		50-130	0		30
Dibenz(a,h)+(a,c)anthracene	86		87		50-130	1		30
Benzo(g,h,i)perylene	90		91		50-130	1		30

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2152896

Report Date: 11/19/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
PAHs - Mansfield Lab Associated sample(s): 01-02,05-08,12-14 Batch: WG1563968-2 WG1563968-3								

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria
Naphthalene-d8	81		82		50-130
Phenanthrene-d10	90		92		50-130
Benzo(a)pyrene-d12	79		82		50-130

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2152896

Report Date: 11/19/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP PAHs by GC/MS-SIM - Mansfield Lab Associated sample(s): 15 Batch: WG1569716-2 WG1569716-3								
Naphthalene	62		85		40-140	**31**	Q	30
2-Methylnaphthalene	64		86		40-140	29		30
2-Chloronaphthalene	64		90		40-140	**34**	Q	30
Acenaphthylene	68		92		40-140	30		30
Acenaphthene	66		89		40-140	30		30
Fluorene	69		94		40-140	**31**	Q	30
Phenanthrene	69		94		40-140	**31**	Q	30
Anthracene	74		100		40-140	30		30
Fluoranthene	73		98		40-140	29		30
Pyrene	71		95		40-140	29		30
Benz(a)anthracene	72		97		40-140	30		30
Chrysene	71		95		40-140	29		30
Benzo(b)fluoranthene	81		107		40-140	28		30
Benzo(k)fluoranthene	72		98		40-140	**31**	Q	30
Benzo(a)pyrene	80		107		40-140	29		30
Indeno(1,2,3-cd)Pyrene	70		96		40-140	**31**	Q	30
Dibenz(a,h)anthracene	71		98		40-140	**32**	Q	30
Benzo(ghi)perylene	74		102		40-140	**32**	Q	30

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2152896

Report Date: 11/19/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP PAHs by GC/MS-SIM - Mansfield Lab Associated sample(s): 15 Batch: WG1569716-2 WG1569716-3								

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria
2-Methylnaphthalene-d10	67		88		30-130
Pyrene-d10	72		95		30-130
Benzo(b)fluoranthene-d12	75		97		30-130

PCBS

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-01 D
Client ID: AQSS-11B-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/28/21 12:58
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8082A
Analytical Date: 11/09/21 14:19
Analyst: DP
Percent Solids: 88%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 10:47

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Column
MCP Polychlorinated Biphenyls by GC - Mansfield Lab							
Aroclor 1016	ND		ug/kg	16.9	6.21	2	A
Aroclor 1221	ND		ug/kg	16.9	8.33	2	A
Aroclor 1232	ND		ug/kg	16.9	7.97	2	A
Aroclor 1242	597		ug/kg	16.9	5.72	2	B
Aroclor 1248	ND		ug/kg	16.9	7.16	2	A
Aroclor 1254	411		ug/kg	16.9	7.12	2	B
Aroclor 1260	93.8		ug/kg	16.9	7.16	2	B
Aroclor 1262	ND		ug/kg	16.9	6.53	2	A
Aroclor 1268	ND		ug/kg	16.9	5.63	2	A
PCBs, Total	1100		ug/kg	16.9	5.63	2	B

Surrogate	% Recovery	Qualifier	Acceptance Criteria	Column
Tetrachloro-meta-Xylene	76		30-150	A
Decachlorobiphenyl	69		30-150	A
Tetrachloro-meta-Xylene	79		30-150	B
Decachlorobiphenyl	84		30-150	B

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-04 D
Client ID: AQSS-12B-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/28/21 11:20
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8082A
Analytical Date: 11/09/21 14:31
Analyst: DP
Percent Solids: 83%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 10:47

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Column
MCP Polychlorinated Biphenyls by GC - Mansfield Lab							
Aroclor 1016	ND		ug/kg	17.5	6.46	2	A
Aroclor 1221	ND		ug/kg	17.5	8.66	2	A
Aroclor 1232	ND		ug/kg	17.5	8.28	2	A
Aroclor 1242	225		ug/kg	17.5	5.94	2	B
Aroclor 1248	ND		ug/kg	17.5	7.44	2	A
Aroclor 1254	541		ug/kg	17.5	7.39	2	B
Aroclor 1260	135		ug/kg	17.5	7.44	2	B
Aroclor 1262	ND		ug/kg	17.5	6.78	2	A
Aroclor 1268	ND		ug/kg	17.5	5.85	2	A
PCBs, Total	901		ug/kg	17.5	5.85	2	B

Surrogate	% Recovery	Qualifier	Acceptance Criteria	Column
Tetrachloro-meta-Xylene	70		30-150	A
Decachlorobiphenyl	97		30-150	A
Tetrachloro-meta-Xylene	72		30-150	B
Decachlorobiphenyl	113		30-150	B

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-05
Client ID: AQSS-13B-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/28/21 15:12
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8082A
Analytical Date: 11/08/21 15:12
Analyst: DP
Percent Solids: 85%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 10:47

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Column
MCP Polychlorinated Biphenyls by GC - Mansfield Lab							
Aroclor 1016	ND		ug/kg	8.51	3.13	1	A
Aroclor 1221	ND		ug/kg	8.51	4.20	1	A
Aroclor 1232	ND		ug/kg	8.51	4.02	1	A
Aroclor 1242	48.9	P	ug/kg	8.51	2.88	1	B
Aroclor 1248	ND		ug/kg	8.51	3.61	1	A
Aroclor 1254	118		ug/kg	8.51	3.58	1	B
Aroclor 1260	191		ug/kg	8.51	3.61	1	B
Aroclor 1262	ND		ug/kg	8.51	3.29	1	A
Aroclor 1268	ND		ug/kg	8.51	2.84	1	A
PCBs, Total	358		ug/kg	8.51	2.84	1	B

Surrogate	% Recovery	Qualifier	Acceptance Criteria	Column
Tetrachloro-meta-Xylene	47		30-150	A
Decachlorobiphenyl	52		30-150	A
Tetrachloro-meta-Xylene	48		30-150	B
Decachlorobiphenyl	57		30-150	B

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-07
Client ID: AQSS-10-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 09:15
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8082A
Analytical Date: 11/08/21 15:25
Analyst: DP
Percent Solids: 76%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 10:47

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Column
MCP Polychlorinated Biphenyls by GC - Mansfield Lab							
Aroclor 1016	ND		ug/kg	9.21	3.39	1	A
Aroclor 1221	ND		ug/kg	9.21	4.54	1	A
Aroclor 1232	ND		ug/kg	9.21	4.34	1	A
Aroclor 1242	108	P	ug/kg	9.21	3.12	1	B
Aroclor 1248	ND		ug/kg	9.21	3.90	1	A
Aroclor 1254	293		ug/kg	9.21	3.88	1	B
Aroclor 1260	54.6		ug/kg	9.21	3.90	1	B
Aroclor 1262	ND		ug/kg	9.21	3.56	1	A
Aroclor 1268	ND		ug/kg	9.21	3.07	1	A
PCBs, Total	456		ug/kg	9.21	3.07	1	B

Surrogate	% Recovery	Qualifier	Acceptance Criteria	Column
Tetrachloro-meta-Xylene	54		30-150	A
Decachlorobiphenyl	42		30-150	A
Tetrachloro-meta-Xylene	53		30-150	B
Decachlorobiphenyl	49		30-150	B

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-08
Client ID: AQSS-09-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 10:45
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8082A
Analytical Date: 11/08/21 15:37
Analyst: DP
Percent Solids: 92%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 10:47

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Column
MCP Polychlorinated Biphenyls by GC - Mansfield Lab							
Aroclor 1016	ND		ug/kg	7.79	2.87	1	A
Aroclor 1221	ND		ug/kg	7.79	3.84	1	A
Aroclor 1232	ND		ug/kg	7.79	3.68	1	A
Aroclor 1242	94.5		ug/kg	7.79	2.64	1	B
Aroclor 1248	ND		ug/kg	7.79	3.30	1	A
Aroclor 1254	122		ug/kg	7.79	3.28	1	B
Aroclor 1260	14.1	P	ug/kg	7.79	3.30	1	B
Aroclor 1262	ND		ug/kg	7.79	3.01	1	A
Aroclor 1268	ND		ug/kg	7.79	2.60	1	A
PCBs, Total	231		ug/kg	7.79	2.60	1	B

Surrogate	% Recovery	Qualifier	Acceptance Criteria	Column
Tetrachloro-meta-Xylene	67		30-150	A
Decachlorobiphenyl	48		30-150	A
Tetrachloro-meta-Xylene	70		30-150	B
Decachlorobiphenyl	60		30-150	B

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-09
Client ID: DUP1-20210929
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 00:00
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8082A
Analytical Date: 11/08/21 15:49
Analyst: DP
Percent Solids: 81%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 10:47

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Column
MCP Polychlorinated Biphenyls by GC - Mansfield Lab							
Aroclor 1016	ND		ug/kg	9.23	3.40	1	A
Aroclor 1221	ND		ug/kg	9.23	4.55	1	A
Aroclor 1232	ND		ug/kg	9.23	4.36	1	A
Aroclor 1242	122		ug/kg	9.23	3.12	1	B
Aroclor 1248	ND		ug/kg	9.23	3.91	1	A
Aroclor 1254	280		ug/kg	9.23	3.89	1	B
Aroclor 1260	47.5		ug/kg	9.23	3.91	1	B
Aroclor 1262	ND		ug/kg	9.23	3.57	1	A
Aroclor 1268	ND		ug/kg	9.23	3.08	1	A
PCBs, Total	450		ug/kg	9.23	3.08	1	B

Surrogate	% Recovery	Qualifier	Acceptance Criteria	Column
Tetrachloro-meta-Xylene	57		30-150	A
Decachlorobiphenyl	44		30-150	A
Tetrachloro-meta-Xylene	58		30-150	B
Decachlorobiphenyl	53		30-150	B

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-10
Client ID: AQSS-08-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 11:58
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8082A
Analytical Date: 11/08/21 16:01
Analyst: DP
Percent Solids: 91%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 10:47

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Column
MCP Polychlorinated Biphenyls by GC - Mansfield Lab							
Aroclor 1016	ND		ug/kg	7.63	2.81	1	A
Aroclor 1221	ND		ug/kg	7.63	3.76	1	A
Aroclor 1232	ND		ug/kg	7.63	3.60	1	A
Aroclor 1242	94.7		ug/kg	7.63	2.58	1	B
Aroclor 1248	ND		ug/kg	7.63	3.24	1	A
Aroclor 1254	65.6	P	ug/kg	7.63	3.21	1	B
Aroclor 1260	16.9		ug/kg	7.63	3.24	1	B
Aroclor 1262	ND		ug/kg	7.63	2.95	1	A
Aroclor 1268	ND		ug/kg	7.63	2.54	1	A
PCBs, Total	177		ug/kg	7.63	2.54	1	B

Surrogate	% Recovery	Qualifier	Acceptance Criteria	Column
Tetrachloro-meta-Xylene	101		30-150	A
Decachlorobiphenyl	74		30-150	A
Tetrachloro-meta-Xylene	85		30-150	B
Decachlorobiphenyl	77		30-150	B

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-12
Client ID: AQSS-07-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 12:35
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8082A
Analytical Date: 11/08/21 16:14
Analyst: DP
Percent Solids: 86%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 10:47

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Column
MCP Polychlorinated Biphenyls by GC - Mansfield Lab							
Aroclor 1016	ND		ug/kg	8.73	3.21	1	A
Aroclor 1221	ND		ug/kg	8.73	4.31	1	A
Aroclor 1232	ND		ug/kg	8.73	4.12	1	A
Aroclor 1242	127	P	ug/kg	8.73	2.96	1	B
Aroclor 1248	ND		ug/kg	8.73	3.70	1	A
Aroclor 1254	299		ug/kg	8.73	3.68	1	B
Aroclor 1260	44.9		ug/kg	8.73	3.70	1	B
Aroclor 1262	ND		ug/kg	8.73	3.38	1	A
Aroclor 1268	ND		ug/kg	8.73	2.91	1	A
PCBs, Total	471		ug/kg	8.73	2.91	1	B

Surrogate	% Recovery	Qualifier	Acceptance Criteria	Column
Tetrachloro-meta-Xylene	66		30-150	A
Decachlorobiphenyl	46		30-150	A
Tetrachloro-meta-Xylene	65		30-150	B
Decachlorobiphenyl	59		30-150	B

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-14
Client ID: AQSS-06-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 13:58
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8082A
Analytical Date: 11/08/21 16:26
Analyst: DP
Percent Solids: 73%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 10:47

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Column
MCP Polychlorinated Biphenyls by GC - Mansfield Lab							
Aroclor 1016	ND		ug/kg	9.60	3.53	1	A
Aroclor 1221	ND		ug/kg	9.60	4.73	1	A
Aroclor 1232	ND		ug/kg	9.60	4.53	1	A
Aroclor 1242	58.9		ug/kg	9.60	3.25	1	B
Aroclor 1248	ND		ug/kg	9.60	4.07	1	A
Aroclor 1254	60.0	P	ug/kg	9.60	4.04	1	B
Aroclor 1260	45.0		ug/kg	9.60	4.07	1	B
Aroclor 1262	ND		ug/kg	9.60	3.71	1	A
Aroclor 1268	ND		ug/kg	9.60	3.20	1	A
PCBs, Total	164		ug/kg	9.60	3.20	1	B

Surrogate	% Recovery	Qualifier	Acceptance Criteria	Column
Tetrachloro-meta-Xylene	70		30-150	A
Decachlorobiphenyl	58		30-150	A
Tetrachloro-meta-Xylene	72		30-150	B
Decachlorobiphenyl	69		30-150	B

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 97,8082A
Analytical Date: 11/08/21 14:11
Analyst: DP

Extraction Method: EPA 3570
Extraction Date: 10/27/21 10:47

Parameter	Result	Qualifier	Units	RL	MDL	Column
MCP Polychlorinated Biphenyls by GC - Mansfield Lab for sample(s): 01,04-05,07-10,12,14 Batch: WG1563709-1						
Aroclor 1016	ND		ug/kg	7.50	2.76	A
Aroclor 1221	ND		ug/kg	7.50	3.70	A
Aroclor 1232	ND		ug/kg	7.50	3.54	A
Aroclor 1242	ND		ug/kg	7.50	2.54	A
Aroclor 1248	ND		ug/kg	7.50	3.18	A
Aroclor 1254	ND		ug/kg	7.50	3.16	A
Aroclor 1260	ND		ug/kg	7.50	3.18	A
Aroclor 1262	ND		ug/kg	7.50	2.90	A
Aroclor 1268	ND		ug/kg	7.50	2.50	A
PCBs, Total	ND		ug/kg	7.50	2.50	A

Surrogate	%Recovery	Qualifier	Acceptance Criteria	Column
Tetrachloro-meta-Xylene	111		30-150	A
Decachlorobiphenyl	103		30-150	A
Tetrachloro-meta-Xylene	105		30-150	B
Decachlorobiphenyl	104		30-150	B

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2152896

Report Date: 11/19/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits	Column
MCP Polychlorinated Biphenyls by GC - Mansfield Lab Associated sample(s): 01,04-05,07-10,12,14 Batch: WG1563709-2 WG1563709-3									
Aroclor 1016	100		100		40-140	0		30	A
Aroclor 1260	106		106		40-140	0		30	A

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria	Column
Tetrachloro-meta-Xylene	109		106		30-150	A
Decachlorobiphenyl	101		101		30-150	A
Tetrachloro-meta-Xylene	101		99		30-150	B
Decachlorobiphenyl	98		96		30-150	B

METALS

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2152896

Project Number: 180327-08.01 **Report Date:** 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-01 Date Collected: 09/28/21 12:58

Client ID: AQSS-11B-0.0-0.5 Date Received: 09/29/21

Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Matrix: Sediment

Percent Solids: 88%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Arsenic, Total	6.39		mg/kg	0.567	0.567	10	10/08/21 15:29	10/12/21 14:48	EPA 3050B	97,6020B	CD
Barium, Total	16.8		mg/kg	3.40	3.40	10	10/08/21 15:29	10/12/21 14:48	EPA 3050B	97,6020B	CD
Cadmium, Total	0.3826		mg/kg	0.2267	0.2267	10	10/08/21 15:29	10/12/21 14:48	EPA 3050B	97,6020B	CD
Chromium, Total	17.0		mg/kg	2.27	2.27	10	10/08/21 15:29	10/12/21 14:48	EPA 3050B	97,6020B	CD
Lead, Total	54.9		mg/kg	0.680	0.680	10	10/08/21 15:29	10/12/21 14:48	EPA 3050B	97,6020B	CD
Mercury, Total	ND		mg/kg	0.073	0.073	1	11/10/21 13:49	11/10/21 17:28	EPA 7471B	97,7471B	AC
Selenium, Total	ND		mg/kg	2.27	2.27	10	10/08/21 15:29	10/12/21 14:48	EPA 3050B	97,6020B	CD
Silver, Total	ND		mg/kg	0.567	0.567	10	10/08/21 15:29	10/12/21 14:48	EPA 3050B	97,6020B	CD

Project Name: FORMER HAVERHILL MGP
Lab Number: L2152896
Project Number: 180327-08.01
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-04
Client ID: AQSS-12B-0.0-0.5
Sample Location: HAVERHILL, MA
Date Collected: 09/28/21 11:20
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Percent Solids: 83%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Arsenic, Total	24.8		mg/kg	0.595	0.595	10	10/08/21 15:29	10/12/21 14:53	EPA 3050B	97,6020B	CD
Barium, Total	20.6		mg/kg	3.57	3.57	10	10/08/21 15:29	10/12/21 14:53	EPA 3050B	97,6020B	CD
Cadmium, Total	0.6318		mg/kg	0.2381	0.2381	10	10/08/21 15:29	10/12/21 14:53	EPA 3050B	97,6020B	CD
Chromium, Total	25.8		mg/kg	2.38	2.38	10	10/08/21 15:29	10/12/21 14:53	EPA 3050B	97,6020B	CD
Lead, Total	67.4		mg/kg	0.714	0.714	10	10/08/21 15:29	10/12/21 14:53	EPA 3050B	97,6020B	CD
Mercury, Total	ND		mg/kg	0.080	0.080	1	11/10/21 13:49	11/10/21 17:31	EPA 7471B	97,7471B	AC
Selenium, Total	ND		mg/kg	2.38	2.38	10	10/08/21 15:29	10/12/21 14:53	EPA 3050B	97,6020B	CD
Silver, Total	ND		mg/kg	0.595	0.595	10	10/08/21 15:29	10/12/21 14:53	EPA 3050B	97,6020B	CD

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2152896

Project Number: 180327-08.01 **Report Date:** 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-05 Date Collected: 09/28/21 15:12

Client ID: AQSS-13B-0.0-0.5 Date Received: 09/29/21

Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Matrix: Sediment

Percent Solids: 85%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Arsenic, Total	6.17		mg/kg	0.588	0.588	10	10/08/21 15:29	10/12/21 14:57	EPA 3050B	97,6020B	CD
Barium, Total	41.5		mg/kg	3.53	3.53	10	10/08/21 15:29	10/12/21 14:57	EPA 3050B	97,6020B	CD
Cadmium, Total	0.2457		mg/kg	0.2354	0.2354	10	10/08/21 15:29	10/12/21 14:57	EPA 3050B	97,6020B	CD
Chromium, Total	16.8		mg/kg	2.35	2.35	10	10/08/21 15:29	10/12/21 14:57	EPA 3050B	97,6020B	CD
Lead, Total	397		mg/kg	0.706	0.706	10	10/08/21 15:29	10/12/21 14:57	EPA 3050B	97,6020B	CD
Mercury, Total	ND		mg/kg	0.088	0.088	1	11/10/21 13:49	11/10/21 17:41	EPA 7471B	97,7471B	AC
Selenium, Total	ND		mg/kg	2.35	2.35	10	10/08/21 15:29	10/12/21 14:57	EPA 3050B	97,6020B	CD
Silver, Total	ND		mg/kg	0.588	0.588	10	10/08/21 15:29	10/12/21 14:57	EPA 3050B	97,6020B	CD

Project Name: FORMER HAVERHILL MGP
Lab Number: L2152896
Project Number: 180327-08.01
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-07
Client ID: AQSS-10-0.0-0.5
Sample Location: HAVERHILL, MA
Date Collected: 09/29/21 09:15
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Percent Solids: 76%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Arsenic, Total	72.0		mg/kg	0.641	0.641	10	10/08/21 15:29	10/12/21 15:02	EPA 3050B	97,6020B	CD
Barium, Total	36.7		mg/kg	3.84	3.84	10	10/08/21 15:29	10/12/21 15:02	EPA 3050B	97,6020B	CD
Cadmium, Total	1.249		mg/kg	0.2563	0.2563	10	10/08/21 15:29	10/12/21 15:02	EPA 3050B	97,6020B	CD
Chromium, Total	61.9		mg/kg	2.56	2.56	10	10/08/21 15:29	10/12/21 15:02	EPA 3050B	97,6020B	CD
Lead, Total	102		mg/kg	0.769	0.769	10	10/08/21 15:29	10/12/21 15:02	EPA 3050B	97,6020B	CD
Mercury, Total	ND		mg/kg	0.093	0.093	1	11/10/21 13:49	11/10/21 17:45	EPA 7471B	97,7471B	AC
Selenium, Total	4.46		mg/kg	2.56	2.56	10	10/08/21 15:29	10/12/21 15:02	EPA 3050B	97,6020B	CD
Silver, Total	ND		mg/kg	0.641	0.641	10	10/08/21 15:29	10/12/21 15:02	EPA 3050B	97,6020B	CD

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2152896

Project Number: 180327-08.01 **Report Date:** 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-08 Date Collected: 09/29/21 10:45

Client ID: AQSS-09-0.0-0.5 Date Received: 09/29/21

Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Matrix: Sediment

Percent Solids: 92%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Arsenic, Total	8.14		mg/kg	0.532	0.532	10	10/08/21 15:29	10/12/21 15:07	EPA 3050B	97,6020B	CD
Barium, Total	18.7		mg/kg	3.19	3.19	10	10/08/21 15:29	10/12/21 15:07	EPA 3050B	97,6020B	CD
Cadmium, Total	ND		mg/kg	0.2130	0.2130	10	10/08/21 15:29	10/12/21 15:07	EPA 3050B	97,6020B	CD
Chromium, Total	32.3		mg/kg	2.13	2.13	10	10/08/21 15:29	10/12/21 15:07	EPA 3050B	97,6020B	CD
Lead, Total	58.1		mg/kg	0.639	0.639	10	10/08/21 15:29	10/12/21 15:07	EPA 3050B	97,6020B	CD
Mercury, Total	ND		mg/kg	0.077	0.077	1	11/10/21 13:49	11/10/21 17:48	EPA 7471B	97,7471B	AC
Selenium, Total	ND		mg/kg	2.13	2.13	10	10/08/21 15:29	10/12/21 15:07	EPA 3050B	97,6020B	CD
Silver, Total	ND		mg/kg	0.532	0.532	10	10/08/21 15:29	10/12/21 15:07	EPA 3050B	97,6020B	CD

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-09
Client ID: DUP1-20210929
Sample Location: HAVERHILL, MA
Date Collected: 09/29/21 00:00
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Percent Solids: 81%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Arsenic, Total	74.6		mg/kg	0.612	0.612	10	10/08/21 15:29	10/12/21 15:12	EPA 3050B	97,6020B	CD
Barium, Total	27.4		mg/kg	3.67	3.67	10	10/08/21 15:29	10/12/21 15:12	EPA 3050B	97,6020B	CD
Cadmium, Total	1.283		mg/kg	0.2448	0.2448	10	10/08/21 15:29	10/12/21 15:12	EPA 3050B	97,6020B	CD
Chromium, Total	48.4		mg/kg	2.45	2.45	10	10/08/21 15:29	10/12/21 15:12	EPA 3050B	97,6020B	CD
Lead, Total	103		mg/kg	0.734	0.734	10	10/08/21 15:29	10/12/21 15:12	EPA 3050B	97,6020B	CD
Mercury, Total	ND		mg/kg	0.098	0.098	1	11/10/21 13:49	11/10/21 17:51	EPA 7471B	97,7471B	AC
Selenium, Total	3.14		mg/kg	2.45	2.45	10	10/08/21 15:29	10/12/21 15:12	EPA 3050B	97,6020B	CD
Silver, Total	ND		mg/kg	0.612	0.612	10	10/08/21 15:29	10/12/21 15:12	EPA 3050B	97,6020B	CD

Project Name: FORMER HAVERHILL MGP
Lab Number: L2152896
Project Number: 180327-08.01
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-10
Client ID: AQSS-08-0.0-0.5
Sample Location: HAVERHILL, MA
Date Collected: 09/29/21 11:58
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Percent Solids: 91%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Arsenic, Total	33.5		mg/kg	0.527	0.527	10	10/08/21 15:29	10/12/21 15:17	EPA 3050B	97,6020B	CD
Barium, Total	23.0		mg/kg	3.16	3.16	10	10/08/21 15:29	10/12/21 15:17	EPA 3050B	97,6020B	CD
Cadmium, Total	0.8718		mg/kg	0.2109	0.2109	10	10/08/21 15:29	10/12/21 15:17	EPA 3050B	97,6020B	CD
Chromium, Total	27.4		mg/kg	2.11	2.11	10	10/08/21 15:29	10/12/21 15:17	EPA 3050B	97,6020B	CD
Lead, Total	128		mg/kg	0.633	0.633	10	10/08/21 15:29	10/12/21 15:17	EPA 3050B	97,6020B	CD
Mercury, Total	ND		mg/kg	0.075	0.075	1	11/10/21 13:49	11/10/21 17:55	EPA 7471B	97,7471B	AC
Selenium, Total	ND		mg/kg	2.11	2.11	10	10/08/21 15:29	10/12/21 15:17	EPA 3050B	97,6020B	CD
Silver, Total	ND		mg/kg	0.527	0.527	10	10/08/21 15:29	10/12/21 15:17	EPA 3050B	97,6020B	CD

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2152896

Project Number: 180327-08.01 **Report Date:** 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-12 Date Collected: 09/29/21 12:35

Client ID: AQSS-07-0.0-0.5 Date Received: 09/29/21

Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Matrix: Sediment

Percent Solids: 86%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Arsenic, Total	16.7		mg/kg	0.558	0.558	10	10/08/21 15:29	10/12/21 15:42	EPA 3050B	97,6020B	CD
Barium, Total	11.6		mg/kg	3.34	3.34	10	10/08/21 15:29	10/12/21 15:42	EPA 3050B	97,6020B	CD
Cadmium, Total	ND		mg/kg	0.2230	0.2230	10	10/08/21 15:29	10/12/21 15:42	EPA 3050B	97,6020B	CD
Chromium, Total	18.0		mg/kg	2.23	2.23	10	10/08/21 15:29	10/12/21 15:42	EPA 3050B	97,6020B	CD
Lead, Total	107		mg/kg	0.669	0.669	10	10/08/21 15:29	10/12/21 15:42	EPA 3050B	97,6020B	CD
Mercury, Total	ND		mg/kg	0.083	0.083	1	11/10/21 13:49	11/10/21 17:58	EPA 7471B	97,7471B	AC
Selenium, Total	ND		mg/kg	2.23	2.23	10	10/08/21 15:29	10/12/21 15:42	EPA 3050B	97,6020B	CD
Silver, Total	ND		mg/kg	0.558	0.558	10	10/08/21 15:29	10/12/21 15:42	EPA 3050B	97,6020B	CD

Project Name: FORMER HAVERHILL MGP
Lab Number: L2152896
Project Number: 180327-08.01
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-13
Client ID: AQSS-07-1.5-2.0
Sample Location: HAVERHILL, MA
Date Collected: 09/29/21 12:50
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Percent Solids: 58%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Copper, Total	138		mg/kg	3.35	3.35	10	10/08/21 15:29	10/14/21 21:05	EPA 3050B	97,6020B	CD

Project Name: FORMER HAVERHILL MGP
Lab Number: L2152896
Project Number: 180327-08.01
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-14
Client ID: AQSS-06-0.0-0.5
Sample Location: HAVERHILL, MA
Date Collected: 09/29/21 13:58
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Percent Solids: 73%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Arsenic, Total	41.4		mg/kg	0.667	0.667	10	10/08/21 15:29	10/14/21 21:11	EPA 3050B	97,6020B	CD
Barium, Total	33.7		mg/kg	4.00	4.00	10	10/08/21 15:29	10/14/21 21:11	EPA 3050B	97,6020B	CD
Cadmium, Total	0.4515		mg/kg	0.2668	0.2668	10	10/08/21 15:29	10/14/21 21:11	EPA 3050B	97,6020B	CD
Chromium, Total	56.4		mg/kg	2.67	2.67	10	10/08/21 15:29	10/14/21 21:11	EPA 3050B	97,6020B	CD
Lead, Total	346		mg/kg	0.800	0.800	10	10/08/21 15:29	10/14/21 21:11	EPA 3050B	97,6020B	CD
Mercury, Total	0.149		mg/kg	0.110	0.110	1	11/10/21 13:49	11/10/21 18:01	EPA 7471B	97,7471B	AC
Selenium, Total	ND		mg/kg	2.67	2.67	10	10/08/21 15:29	10/14/21 21:11	EPA 3050B	97,6020B	CD
Silver, Total	ND		mg/kg	0.667	0.667	10	10/08/21 15:29	10/14/21 21:11	EPA 3050B	97,6020B	CD

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2152896

Project Number: 180327-08.01 **Report Date:** 11/19/21

Method Blank Analysis
Batch Quality Control

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab for sample(s): 01,04-05,07-10,12-14 Batch: WG1555699-1										
Arsenic, Total	ND		mg/kg	0.500	0.500	10	10/08/21 15:29	10/12/21 14:43	97,6020B	CD
Barium, Total	ND		mg/kg	3.00	3.00	10	10/08/21 15:29	10/12/21 14:43	97,6020B	CD
Cadmium, Total	ND		mg/kg	0.2000	0.2000	10	10/08/21 15:29	10/12/21 14:43	97,6020B	CD
Chromium, Total	ND		mg/kg	2.00	2.00	10	10/08/21 15:29	10/12/21 14:43	97,6020B	CD
Copper, Total	ND		mg/kg	2.00	2.00	10	10/08/21 15:29	10/12/21 14:43	97,6020B	CD
Lead, Total	ND		mg/kg	0.600	0.600	10	10/08/21 15:29	10/12/21 14:43	97,6020B	CD
Selenium, Total	ND		mg/kg	2.00	2.00	10	10/08/21 15:29	10/12/21 14:43	97,6020B	CD
Silver, Total	ND		mg/kg	0.500	0.500	10	10/08/21 15:29	10/12/21 14:43	97,6020B	CD

Prep Information

Digestion Method: EPA 3050B

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab for sample(s): 01,04-05,07-10,12,14 Batch: WG1569044-1										
Mercury, Total	ND		mg/kg	0.083	0.083	1	11/10/21 13:49	11/10/21 17:01	97,7471B	AC

Prep Information

Digestion Method: EPA 7471B

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2152896

Report Date: 11/19/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP Total Metals - Mansfield Lab Associated sample(s): 01,04-05,07-10,12-14 Batch: WG1555699-2 WG1555699-3 SRM Lot Number: D109-540								
Arsenic, Total	106		104		70-130	2		30
Barium, Total	107		104		75-125	3		30
Cadmium, Total	112		105		75-125	6		30
Chromium, Total	107		106		70-130	1		30
Copper, Total	105		101		75-125	4		30
Lead, Total	105		103		72-128	2		30
Selenium, Total	107		102		68-132	5		30
Silver, Total	102		103		68-131	1		30
MCP Total Metals - Mansfield Lab Associated sample(s): 01,04-05,07-10,12,14 Batch: WG1569044-2 WG1569044-3 SRM Lot Number: D109-540								
Mercury, Total	95		92		60-140	3		30

INORGANICS
&
MISCELLANEOUS

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-01
Client ID: AQSS-11B-0.0-0.5
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/28/21 12:58
Date Received: 09/29/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	1.75		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Rep2)	3.03		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Average)	2.39		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	87.6		%	0.100	0.100	1	-	10/18/21 12:18	121,2540G	BP
% Soot (Rep 1)	0.644		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP
% Soot (Rep 2)	0.112		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP
% Soot (Average)	0.378		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-02
Client ID: AQSS-11B-1.5-1.9
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/28/21 13:01
Date Received: 09/29/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	10.5		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Rep2)	8.40		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Average)	9.44		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	84.0		%	0.100	0.100	1	-	10/18/21 12:18	121,2540G	BP

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-03
Client ID: AQSS-11B-2.5-3.0
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/28/21 13:03
Date Received: 09/29/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	1.39		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Rep2)	0.387		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Average)	0.890		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	84.0		%	0.100	0.100	1	-	10/18/21 12:18	121,2540G	BP

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-04
Client ID: AQSS-12B-0.0-0.5
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/28/21 11:20
Date Received: 09/29/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	2.63		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Rep2)	5.75		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Average)	4.19		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	82.6		%	0.100	0.100	1	-	10/18/21 12:18	121,2540G	BP
% Soot (Rep 1)	1.77		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP
% Soot (Rep 2)	0.387		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP
% Soot (Average)	1.08		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-05
Client ID: AQSS-13B-0.0-0.5
Sample Location: HAVERHILL, MA
Date Collected: 09/28/21 15:12
Date Received: 09/29/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	3.28		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Rep2)	3.19		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Average)	3.24		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	84.5		%	0.100	0.100	1	-	10/18/21 12:18	121,2540G	BP
% Soot (Rep 1)	0.112		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP
% Soot (Rep 2)	0.088		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP
% Soot (Average)	0.100		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-06
Client ID: AQSS-13B-1.5-2.0
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/28/21 15:15
Date Received: 09/29/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	11.3		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Rep2)	9.17		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Average)	10.2		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	70.4		%	0.100	0.100	1	-	10/18/21 12:18	121,2540G	BP

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-07
Client ID: AQSS-10-0.0-0.5
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/29/21 09:15
Date Received: 09/29/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	1.80		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Rep2)	3.68		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Average)	2.74		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	76.2		%	0.100	0.100	1	-	10/18/21 12:18	121,2540G	BP
% Soot (Rep 1)	0.115		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP
% Soot (Rep 2)	0.115		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP
% Soot (Average)	0.115		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-08
Client ID: AQSS-09-0.0-0.5
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/29/21 10:45
Date Received: 09/29/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	0.206		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Rep2)	0.170		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Average)	0.188		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	91.7		%	0.100	0.100	1	-	10/18/21 12:18	121,2540G	BP
% Soot (Rep 1)	0.027		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP
% Soot (Rep 2)	0.032		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP
% Soot (Average)	0.030		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-09
Client ID: DUP1-20210929
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/29/21 00:00
Date Received: 09/29/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	2.88		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Rep2)	2.44		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Average)	2.66		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	81.1		%	0.100	0.100	1	-	10/18/21 12:18	121,2540G	BP
% Soot (Rep 1)	0.140		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP
% Soot (Rep 2)	0.136		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP
% Soot (Average)	0.138		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-10
Client ID: AQSS-08-0.0-0.5
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/29/21 11:58
Date Received: 09/29/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	2.05		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Rep2)	2.06		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Average)	2.06		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	91.1		%	0.100	0.100	1	-	10/18/21 12:18	121,2540G	BP
% Soot (Rep 1)	0.063		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP
% Soot (Rep 2)	0.061		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP
% Soot (Average)	0.062		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-11
Client ID: AQSS-08-1.0-1.5
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/29/21 12:00
Date Received: 09/29/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	10.3		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Rep2)	8.74		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Average)	9.54		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	75.6		%	0.100	0.100	1	-	10/18/21 12:18	121,2540G	BP

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-12
Client ID: AQSS-07-0.0-0.5
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/29/21 12:35
Date Received: 09/29/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	2.38		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Rep2)	1.52		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Average)	1.95		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	85.9		%	0.100	0.100	1	-	10/18/21 12:18	121,2540G	BP
% Soot (Rep 1)	0.182		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP
% Soot (Rep 2)	0.217		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP
% Soot (Average)	0.200		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-13
Client ID: AQSS-07-1.5-2.0
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/29/21 12:50
Date Received: 09/29/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	12.1		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Rep2)	9.98		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Average)	11.0		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	58.2		%	0.100	0.100	1	-	10/18/21 12:18	121,2540G	BP

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-14
Client ID: AQSS-06-0.0-0.5
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/29/21 13:58
Date Received: 09/29/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	1.18		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Rep2)	1.22		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Average)	1.20		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	72.7		%	0.100	0.100	1	-	10/18/21 12:18	121,2540G	BP
% Soot (Rep 1)	0.321		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP
% Soot (Rep 2)	0.273		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP
% Soot (Average)	0.297		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2152896
Report Date: 11/19/21

SAMPLE RESULTS

Lab ID: L2152896-15
Client ID: AQSS-06-1.5-2.0
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/29/21 14:00
Date Received: 09/29/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	2.71		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Rep2)	2.73		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Average)	2.72		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	87.0		%	0.100	0.100	1	-	10/18/21 12:18	121,2540G	BP

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2152896

Project Number: 180327-08.01 **Report Date:** 11/19/21

Method Blank Analysis
Batch Quality Control

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Mansfield Lab for sample(s): 01,04-05,07-10,12,14 Batch: WG1569608-1										
% Soot (Rep 1)	ND		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP
% Soot (Rep 2)	ND		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP
% Soot (Average)	ND		%	0.010	NA	1	-	11/09/21 12:50	91,-	SP
Total Organic Carbon - Mansfield Lab for sample(s): 01-15 Batch: WG1572641-1										
Total Organic Carbon (Rep1)	ND		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Rep2)	ND		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP
Total Organic Carbon (Average)	ND		%	0.010	0.010	1	-	11/16/21 11:37	1,9060A	SP

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2152896

Report Date: 11/19/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
General Chemistry - Mansfield Lab Associated sample(s): 01,04-05,07-10,12,14 Batch: WG1569608-2								
% Soot (Rep 1)	110		-		75-125	-		25
% Soot (Rep 2)	101		-		75-125	-		25
Total Organic Carbon - Mansfield Lab Associated sample(s): 01-15 Batch: WG1572641-2								
Total Organic Carbon (Rep1)	106		-		75-125	-		25
Total Organic Carbon (Rep2)	102		-		75-125	-		25
Total Organic Carbon (Average)	104		-		75-125	-		25

Matrix Spike Analysis
Batch Quality Control

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01

Lab Number: L2152896
Report Date: 11/19/21

Parameter	Native Sample	MS Added	MS Found	MS %Recovery	Qual	MSD Found	MSD %Recovery	Qual	Recovery Limits	RPD	Qual	RPD Limits
General Chemistry - Mansfield Lab Associated sample(s): 01,04-05,07-10,12,14 QC Batch ID: WG1569608-5 QC Sample: L2152896-14 Client ID: AQSS-06-0.0-0.5												
% Soot (Rep 1)	0.321	0.979	1.38	108		-	-		75-125	-		25
% Soot (Rep 2)	0.273	0.532	0.675	76		-	-		75-125	-		25

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01

Lab Number: L2152896
Report Date: 11/19/21

Sample Receipt and Container Information

Were project specific reporting limits specified? YES

Cooler Information

Cooler	Custody Seal
A	Absent

Container Information

Container ID	Container Type	Cooler	Initial pH	Final pH	Temp deg C	Pres	Seal	Frozen Date/Time	Analysis(*)
L2152896-01A	Glass 250ml/8oz unpreserved	A	NA		4.6	Y	Absent		A2-ALKPAH(14),A2-BA-MCP6020T-10(180),A2-CR-MCP6020T-10(180),A2-SOOT(28),A2-AS-MCP6020T-10(180),A2-MCP-8082-10(365),A2-CD-MCP6020T-10(180),A2-TS(7),A2-AG-MCP6020T-10(180),A2-HG-MCP7471T-10(28),A2-SE-MCP6020T-10(180),A2-PREP-3050:2T(180),A2-TOC-9060-2REPS(28),A2-PB-MCP6020T-10(180),A2-HGPREP-AA(28),A2-PREP-3050:1T(180)
L2152896-01B	Glass 250ml/8oz unpreserved	A	NA		4.6	Y	Absent		A2-ALKPAH(14),A2-BA-MCP6020T-10(180),A2-CR-MCP6020T-10(180),A2-SOOT(28),A2-AS-MCP6020T-10(180),A2-MCP-8082-10(365),A2-CD-MCP6020T-10(180),A2-TS(7),A2-AG-MCP6020T-10(180),A2-HG-MCP7471T-10(28),A2-SE-MCP6020T-10(180),A2-PREP-3050:2T(180),A2-TOC-9060-2REPS(28),A2-PB-MCP6020T-10(180),A2-HGPREP-AA(28),A2-PREP-3050:1T(180)
L2152896-02A	Glass 250ml/8oz unpreserved	A	NA		4.6	Y	Absent		A2-ALKPAH(14),A2-TS(7),A2-TOC-9060-2REPS(28)
L2152896-03A	Glass 250ml/8oz unpreserved	A	NA		4.6	Y	Absent		A2-TS(7),A2-MCPPAH-8270SIM-10(14),A2-TOC-9060-2REPS(28)
L2152896-04A	Glass 250ml/8oz unpreserved	A	NA		4.6	Y	Absent		A2-BA-MCP6020T-10(180),A2-CR-MCP6020T-10(180),A2-SOOT(28),A2-AG-MCP6020T-10(180),A2-MCPPAH-8270SIM-10(14),A2-MCP-8082-10(365),A2-TS(7),A2-CD-MCP6020T-10(180),A2-AS-MCP6020T-10(180),A2-SE-MCP6020T-10(180),A2-HG-MCP7471T-10(28),A2-PB-MCP6020T-10(180),A2-TOC-9060-2REPS(28),A2-PREP-3050:2T(180),A2-HGPREP-AA(28),A2-PREP-3050:1T(180)

*Values in parentheses indicate holding time in days

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01

Lab Number: L2152896
Report Date: 11/19/21

Container Information

Container ID	Container Type	Cooler	Initial pH	Final pH	Temp deg C	Pres	Seal	Frozen Date/Time	Analysis(*)
L2152896-04B	Glass 250ml/8oz unpreserved	A	NA		4.6	Y	Absent		A2-BA-MCP6020T-10(180),A2-CR-MCP6020T-10(180),A2-SOOT(28),A2-AG-MCP6020T-10(180),A2-MCPPAH-8270SIM-10(14),A2-MCP-8082-10(365),A2-TS(7),A2-CD-MCP6020T-10(180),A2-AS-MCP6020T-10(180),A2-SE-MCP6020T-10(180),A2-HG-MCP7471T-10(28),A2-PB-MCP6020T-10(180),A2-TOC-9060-2REPS(28),A2-PREP-3050:2T(180),A2-HGPREP-AA(28),A2-PREP-3050:1T(180)
L2152896-05A	Glass 250ml/8oz unpreserved	A	NA		4.6	Y	Absent		A2-BA-MCP6020T-10(180),A2-SOOT(28),A2-CR-MCP6020T-10(180),A2-ALKPAH(14),A2-MCP-8082-10(365),A2-AG-MCP6020T-10(180),A2-CD-MCP6020T-10(180),A2-TS(7),A2-AS-MCP6020T-10(180),A2-HG-MCP7471T-10(28),A2-SE-MCP6020T-10(180),A2-PB-MCP6020T-10(180),A2-TOC-9060-2REPS(28),A2-PREP-3050:2T(180),A2-HGPREP-AA(28),A2-PREP-3050:1T(180)
L2152896-05B	Glass 250ml/8oz unpreserved	A	NA		4.6	Y	Absent		A2-BA-MCP6020T-10(180),A2-SOOT(28),A2-CR-MCP6020T-10(180),A2-ALKPAH(14),A2-MCP-8082-10(365),A2-AG-MCP6020T-10(180),A2-CD-MCP6020T-10(180),A2-TS(7),A2-AS-MCP6020T-10(180),A2-HG-MCP7471T-10(28),A2-SE-MCP6020T-10(180),A2-PB-MCP6020T-10(180),A2-TOC-9060-2REPS(28),A2-PREP-3050:2T(180),A2-HGPREP-AA(28),A2-PREP-3050:1T(180)
L2152896-06A	Glass 250ml/8oz unpreserved	A	NA		4.6	Y	Absent		A2-ALKPAH(14),A2-TS(7),A2-TOC-9060-2REPS(28)
L2152896-07A	Glass 250ml/8oz unpreserved	A	NA		4.6	Y	Absent		A2-BA-MCP6020T-10(180),A2-ALKPAH(14),A2-SOOT(28),A2-CR-MCP6020T-10(180),A2-AG-MCP6020T-10(180),A2-TS(7),A2-CD-MCP6020T-10(180),A2-AS-MCP6020T-10(180),A2-MCP-8082-10(365),A2-HG-MCP7471T-10(28),A2-SE-MCP6020T-10(180),A2-HGPREP-AA(28),A2-PREP-3050:2T(180),A2-TOC-9060-2REPS(28),A2-PB-MCP6020T-10(180),A2-PREP-3050:1T(180)
L2152896-07B	Glass 250ml/8oz unpreserved	A	NA		4.6	Y	Absent		A2-BA-MCP6020T-10(180),A2-ALKPAH(14),A2-SOOT(28),A2-CR-MCP6020T-10(180),A2-AG-MCP6020T-10(180),A2-TS(7),A2-CD-MCP6020T-10(180),A2-AS-MCP6020T-10(180),A2-MCP-8082-10(365),A2-HG-MCP7471T-10(28),A2-SE-MCP6020T-10(180),A2-HGPREP-AA(28),A2-PREP-3050:2T(180),A2-TOC-9060-2REPS(28),A2-PB-MCP6020T-10(180),A2-PREP-3050:1T(180)

*Values in parentheses indicate holding time in days

Container Information

Container ID	Container Type	Cooler	Initial pH	Final pH	Temp deg C	Pres	Seal	Frozen Date/Time	Analysis(*)
L2152896-08A	Glass 250ml/8oz unpreserved	A	NA		4.6	Y	Absent		A2-ALKPAH(14),A2-CR-MCP6020T-10(180),A2-SOOT(28),A2-BA-MCP6020T-10(180),A2-AS-MCP6020T-10(180),A2-AG-MCP6020T-10(180),A2-CD-MCP6020T-10(180),A2-TS(7),A2-MCP-8082-10(365),A2-HG-MCP7471T-10(28),A2-SE-MCP6020T-10(180),A2-PREP-3050:2T(180),A2-TOC-9060-2REPS(28),A2-PB-MCP6020T-10(180),A2-HGPREP-AA(28),A2-PREP-3050:1T(180)
L2152896-08B	Glass 250ml/8oz unpreserved	A	NA		4.6	Y	Absent		A2-ALKPAH(14),A2-CR-MCP6020T-10(180),A2-SOOT(28),A2-BA-MCP6020T-10(180),A2-AS-MCP6020T-10(180),A2-AG-MCP6020T-10(180),A2-CD-MCP6020T-10(180),A2-TS(7),A2-MCP-8082-10(365),A2-HG-MCP7471T-10(28),A2-SE-MCP6020T-10(180),A2-PREP-3050:2T(180),A2-TOC-9060-2REPS(28),A2-PB-MCP6020T-10(180),A2-HGPREP-AA(28),A2-PREP-3050:1T(180)
L2152896-09A	Glass 250ml/8oz unpreserved	A	NA		4.6	Y	Absent		A2-CR-MCP6020T-10(180),A2-BA-MCP6020T-10(180),A2-SOOT(28),A2-TS(7),A2-AG-MCP6020T-10(180),A2-AS-MCP6020T-10(180),A2-CD-MCP6020T-10(180),A2-MCP-8082-10(365),A2-HG-MCP7471T-10(28),A2-SE-MCP6020T-10(180),A2-TOC-9060-2REPS(28),A2-PB-MCP6020T-10(180),A2-PREP-3050:2T(180),A2-HGPREP-AA(28),A2-PREP-3050:1T(180)
L2152896-10A	Glass 250ml/8oz unpreserved	A	NA		4.6	Y	Absent		A2-SOOT(28),A2-CR-MCP6020T-10(180),A2-BA-MCP6020T-10(180),A2-AG-MCP6020T-10(180),A2-TS(7),A2-CD-MCP6020T-10(180),A2-MCPPAH-8270SIM-10(14),A2-MCP-8082-10(365),A2-AS-MCP6020T-10(180),A2-SE-MCP6020T-10(180),A2-HG-MCP7471T-10(28),A2-PB-MCP6020T-10(180),A2-PREP-3050:2T(180),A2-HGPREP-AA(28),A2-TOC-9060-2REPS(28),A2-PREP-3050:1T(180)
L2152896-10B	Glass 250ml/8oz unpreserved	A	NA		4.6	Y	Absent		A2-SOOT(28),A2-CR-MCP6020T-10(180),A2-BA-MCP6020T-10(180),A2-AG-MCP6020T-10(180),A2-TS(7),A2-CD-MCP6020T-10(180),A2-MCPPAH-8270SIM-10(14),A2-MCP-8082-10(365),A2-AS-MCP6020T-10(180),A2-SE-MCP6020T-10(180),A2-HG-MCP7471T-10(28),A2-PB-MCP6020T-10(180),A2-PREP-3050:2T(180),A2-HGPREP-AA(28),A2-TOC-9060-2REPS(28),A2-PREP-3050:1T(180)

*Values in parentheses indicate holding time in days

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01

Lab Number: L2152896
Report Date: 11/19/21

Container Information

Container ID	Container Type	Cooler	Initial pH	Final pH	Temp deg C	Pres	Seal	Frozen Date/Time	Analysis(*)
L2152896-11A	Glass 250ml/8oz unpreserved	A	NA		4.6	Y	Absent		A2-MCPPAH-8270SIM-10(14),A2-TS(7),A2-TOC-9060-2REPS(28)
L2152896-12A	Glass 250ml/8oz unpreserved	A	NA		4.6	Y	Absent		A2-ALKPAH(14),A2-SOOT(28),A2-CR-MCP6020T-10(180),A2-BA-MCP6020T-10(180),A2-TS(7),A2-AS-MCP6020T-10(180),A2-MCP-8082-10(365),A2-AG-MCP6020T-10(180),A2-CD-MCP6020T-10(180),A2-HG-MCP7471T-10(28),A2-SE-MCP6020T-10(180),A2-PREP-3050:2T(180),A2-PB-MCP6020T-10(180),A2-HGPREP-AA(28),A2-TOC-9060-2REPS(28),A2-PREP-3050:1T(180)
L2152896-12B	Glass 250ml/8oz unpreserved	A	NA		4.6	Y	Absent		A2-ALKPAH(14),A2-SOOT(28),A2-CR-MCP6020T-10(180),A2-BA-MCP6020T-10(180),A2-TS(7),A2-AS-MCP6020T-10(180),A2-MCP-8082-10(365),A2-AG-MCP6020T-10(180),A2-CD-MCP6020T-10(180),A2-HG-MCP7471T-10(28),A2-SE-MCP6020T-10(180),A2-PREP-3050:2T(180),A2-PB-MCP6020T-10(180),A2-HGPREP-AA(28),A2-TOC-9060-2REPS(28),A2-PREP-3050:1T(180)
L2152896-13A	Glass 250ml/8oz unpreserved	A	NA		4.6	Y	Absent		A2-ALKPAH(14),A2-TS(7),A2-CU-MCP6020T-10(180),A2-PREP-3050(180),A2-TOC-9060-2REPS(28)
L2152896-14A	Glass 250ml/8oz unpreserved	A	NA		4.6	Y	Absent		A2-SOOT(28),A2-BA-MCP6020T-10(180),A2-CR-MCP6020T-10(180),A2-ALKPAH(14),A2-CD-MCP6020T-10(180),A2-AG-MCP6020T-10(180),A2-AS-MCP6020T-10(180),A2-MCP-8082-10(365),A2-TS(7),A2-SE-MCP6020T-10(180),A2-HG-MCP7471T-10(28),A2-PB-MCP6020T-10(180),A2-TOC-9060-2REPS(28),A2-HGPREP-AA(28),A2-PREP-3050:2T(180),A2-PREP-3050:1T(180)
L2152896-14B	Glass 250ml/8oz unpreserved	A	NA		4.6	Y	Absent		A2-SOOT(28),A2-BA-MCP6020T-10(180),A2-CR-MCP6020T-10(180),A2-ALKPAH(14),A2-CD-MCP6020T-10(180),A2-AG-MCP6020T-10(180),A2-AS-MCP6020T-10(180),A2-MCP-8082-10(365),A2-TS(7),A2-SE-MCP6020T-10(180),A2-HG-MCP7471T-10(28),A2-PB-MCP6020T-10(180),A2-TOC-9060-2REPS(28),A2-HGPREP-AA(28),A2-PREP-3050:2T(180),A2-PREP-3050:1T(180)
L2152896-15A	Glass 250ml/8oz unpreserved	A	NA		4.6	Y	Absent		A2-MCPPAH-8270SIM-10(14),A2-TS(7),A2-TOC-9060-2REPS(28)

*Values in parentheses indicate holding time in days

Project Name:	FORMER HAVERHILL MGP	**Lab Number:**	L2152896
Project Number:	180327-08.01	**Report Date:**	11/19/21

GLOSSARY

Acronyms

DL - Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the limit of quantitation (LOQ). The DL includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)

EDL - Estimated Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The EDL includes any adjustments from dilutions, concentrations or moisture content, where applicable. The use of EDLs is specific to the analysis of PAHs using Solid-Phase Microextraction (SPME).

EMPC - Estimated Maximum Possible Concentration: The concentration that results from the signal present at the retention time of an analyte when the ions meet all of the identification criteria except the ion abundance ratio criteria. An EMPC is a worst-case estimate of the concentration.

EPA - Environmental Protection Agency.

LCS - Laboratory Control Sample: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.

LCSD - Laboratory Control Sample Duplicate: Refer to LCS.

LFB - Laboratory Fortified Blank: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.

LOD - Limit of Detection: This value represents the level to which a target analyte can reliably be detected for a specific analyte in a specific matrix by a specific method. The LOD includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)

LOQ - Limit of Quantitation: The value at which an instrument can accurately measure an analyte at a specific concentration. The LOQ includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)

Limit of Quantitation: The value at which an instrument can accurately measure an analyte at a specific concentration. The LOQ includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)

MDL - Method Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The MDL includes any adjustments from dilutions, concentrations or moisture content, where applicable.

MS - Matrix Spike Sample: A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. For Method 332.0, the spike recovery is calculated using the native concentration, including estimated values.

MSD - Matrix Spike Sample Duplicate: Refer to MS.

NA - Not Applicable.

NC - Not Calculated: Term is utilized when one or more of the results utilized in the calculation are non-detect at the parameter's reporting unit.

NDPA/DPA - N-Nitrosodiphenylamine/Diphenylamine.

NI - Not Ignitable.

NP - Non-Plastic: Term is utilized for the analysis of Atterberg Limits in soil.

NR - No Results: Term is utilized when 'No Target Compounds Requested' is reported for the analysis of Volatile or Semivolatile Organic TIC only requests.

RL - Reporting Limit: The value at which an instrument can accurately measure an analyte at a specific concentration. The RL includes any adjustments from dilutions, concentrations or moisture content, where applicable.

RPD - Relative Percent Difference: The results from matrix and/or matrix spike duplicates are primarily designed to assess the precision of analytical results in a given matrix and are expressed as relative percent difference (RPD). Values which are less than five times the reporting limit for any individual parameter are evaluated by utilizing the absolute difference between the values; although the RPD value will be provided in the report.

SRM - Standard Reference Material: A reference sample of a known or certified value that is of the same or similar matrix as the associated field samples.

STLP - Semi-dynamic Tank Leaching Procedure per EPA Method 1315.

TEF - Toxic Equivalency Factors: The values assigned to each dioxin and furan to evaluate their toxicity relative to 2,3,7,8-TCDD.

TEQ - Toxic Equivalent: The measure of a sample's toxicity derived by multiplying each dioxin and furan by its corresponding TEF and then summing the resulting values.

TIC - Tentatively Identified Compound: A compound that has been identified to be present and is not part of the target compound list (TCL) for the method and/or program. All TICs are qualitatively identified and reported as estimated concentrations.

Report Format: DU Report with 'J' Qualifiers

Project Name:	FORMER HAVERHILL MGP	**Lab Number:**	L2152896
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Footnotes

1 - The reference for this analyte should be considered modified since this analyte is absent from the target analyte list of the original method.

Terms

Analytical Method: Both the document from which the method originates and the analytical reference method. (Example: EPA 8260B is shown as 1,8260B.) The codes for the reference method documents are provided in the References section of the Addendum.

Difference: With respect to Total Oxidizable Precursor (TOP) Assay analysis, the difference is defined as the Post-Treatment value minus the Pre-Treatment value.

Final pH: As it pertains to Sample Receipt & Container Information section of the report, Final pH reflects pH of container determined after adjustment at the laboratory, if applicable. If no adjustment required, value reflects Initial pH.

Frozen Date/Time: With respect to Volatile Organics in soil, Frozen Date/Time reflects the date/time at which associated Reagent Water-preserved vials were initially frozen. Note: If frozen date/time is beyond 48 hours from sample collection, value will be reflected in 'bold'.

Initial pH: As it pertains to Sample Receipt & Container Information section of the report, Initial pH reflects pH of container determined upon receipt, if applicable.

PAH Total: With respect to Alkylated PAH analyses, the 'PAHs, Total' result is defined as the summation of results for all or a subset of the following compounds: Naphthalene, C1-C4 Naphthalenes, 2-Methylnaphthalene, 1-Methylnaphthalene, Biphenyl, Acenaphthylene, Acenaphthene, Fluorene, C1-C3 Fluorenes, Phenanthrene, C1-C4 Phenanthrenes/Anthracenes, Anthracene, Fluoranthene, Pyrene, C1-C4 Fluoranthenes/Pyrenes, Benz(a)anthracene, Chrysene, C1-C4 Chrysenes, Benzo(b)fluoranthene, Benzo(j)+(k)fluoranthene, Benzo(e)pyrene, Benzo(a)pyrene, Perylene, Indeno(1,2,3-cd)pyrene, Dibenz(ah)+(ac)anthracene, Benzo(g,h,i)perylene. If a 'Total' result is requested, the results of its individual components will also be reported.

PFAS Total: With respect to PFAS analyses, the 'PFAS, Total (5)' result is defined as the summation of results for: PFHpA, PFHxS, PFOA, PFNA and PFOS. In addition, the 'PFAS, Total (6)' result is defined as the summation of results for: PFHpA, PFHxS, PFOA, PFNA, PFDA and PFOS. For MassDEP DW compliance analysis only, the 'PFAS, Total (6)' result is defined as the summation of results at or above the RL. Note: If a 'Total' result is requested, the results of its individual components will also be reported.

The target compound Chlordane (CAS No. 57-74-9) is reported for GC ECD analyses. Per EPA,this compound "refers to a mixture of chlordane isomers, other chlorinated hydrocarbons and numerous other components." (Reference: USEPA Toxicological Review of Chlordane, In Support of Summary Information on the Integrated Risk Information System (IRIS), December 1997.)

Total: With respect to Organic analyses, a 'Total' result is defined as the summation of results for individual isomers or Aroclors. If a 'Total' result is requested, the results of its individual components will also be reported. This is applicable to 'Total' results for methods 8260, 8081 and 8082.

Data Qualifiers

A - Spectra identified as "Aldol Condensates" are byproducts of the extraction/concentration procedures when acetone is introduced in the process.

B - The analyte was detected above the reporting limit in the associated method blank. Flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For MCP-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For DOD-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank AND the analyte was detected above one-half the reporting limit (or above the reporting limit for common lab contaminants) in the associated method blank. For NJ-Air-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte above the reporting limit. For NJ-related projects (excluding Air), flag only applies to associated field samples that have detectable concentrations of the analyte, which was detected above the reporting limit in the associated method blank or above five times the reporting limit for common lab contaminants (Phthalates, Acetone, Methylene Chloride, 2-Butanone).

C - Co-elution: The target analyte co-elutes with a known lab standard (i.e. surrogate, internal standards, etc.) for co-extracted analyses.

D - Concentration of analyte was quantified from diluted analysis. Flag only applies to field samples that have detectable concentrations of the analyte.

E - Concentration of analyte exceeds the range of the calibration curve and/or linear range of the instrument.

F - The ratio of quantifier ion response to qualifier ion response falls outside of the laboratory criteria. Results are considered to be an estimated maximum concentration.

G - The concentration may be biased high due to matrix interferences (i.e, co-elution) with non-target compound(s). The result should be considered estimated.

H - The analysis of pH was performed beyond the regulatory-required holding time of 15 minutes from the time of sample collection.

I - The lower value for the two columns has been reported due to obvious interference.

J - Estimated value. The Target analyte concentration is below the quantitation limit (RL), but above the Method Detection Limit (MDL) or Estimated Detection Limit (EDL) for SPME-related analyses. This represents an estimated concentration for Tentatively Identified Compounds (TICs).

M - Reporting Limit (RL) exceeds the MCP CAM Reporting Limit for this analyte.

ND - Not detected at the method detection limit (MDL) for the sample, or estimated detection limit (EDL) for SPME-related analyses.

Report Format: DU Report with 'J' Qualifiers

Project Name:	FORMER HAVERHILL MGP	**Lab Number:**	L2152896
Project Number:	180327-08.01	**Report Date:**	11/19/21

Data Qualifiers

NJ - Presumptive evidence of compound. This represents an estimated concentration for Tentatively Identified Compounds (TICs), where the identification is based on a mass spectral library search.

P - The RPD between the results for the two columns exceeds the method-specified criteria.

Q - The quality control sample exceeds the associated acceptance criteria. For DOD-related projects, LCS and/or Continuing Calibration Standard exceedences are also qualified on all associated sample results. Note: This flag is not applicable for matrix spike recoveries when the sample concentration is greater than 4x the spike added or for batch duplicate RPD when the sample concentrations are less than 5x the RL. (Metals only.)

R - Analytical results are from sample re-analysis.

RE - Analytical results are from sample re-extraction.

S - Analytical results are from modified screening analysis.

V - The surrogate associated with this target analyte has a recovery outside the QC acceptance limits. (Applicable to MassDEP DW Compliance samples only.)

Z - The batch matrix spike and/or duplicate associated with this target analyte has a recovery/RPD outside the QC acceptance limits. (Applicable to MassDEP DW Compliance samples only.)

Report Format: DU Report with 'J' Qualifiers

Project Name:	FORMER HAVERHILL MGP	**Lab Number:**	L2152896
Project Number:	180327-08.01	**Report Date:**	11/19/21

REFERENCES

1 Test Methods for Evaluating Solid Waste: Physical/Chemical Methods. EPA SW-846. Third Edition. Updates I - VI, 2018.

91 Analysis of Soot following ES&T publications by Accardi-Dey and Gschwend, 2003; and Gustafsson (et. al.), 1997.

97 EPA Test Methods (SW-846) with QC Requirements & Performance Standards for the Analysis of EPA SW-846 Methods under the Massachusetts Contingency Plan, WSC-CAM-IIA, IIB, IIIA, IIIB, IIIC, IIID, VA, VB, VC, VIA, VIB, VIIIA and VIIIB, July 2010.

121 Standard Methods for the Examination of Water and Wastewater. APHA-AWWA-WEF. Standard Methods Online.

LIMITATION OF LIABILITIES

Alpha Analytical performs services with reasonable care and diligence normal to the analytical testing laboratory industry. In the event of an error, the sole and exclusive responsibility of Alpha Analytical shall be to re-perform the work at it's own expense. In no event shall Alpha Analytical be held liable for any incidental, consequential or special damages, including but not limited to, damages in any way connected with the use of, interpretation of, information or analysis provided by Alpha Analytical.

We strongly urge our clients to comply with EPA protocol regarding sample volume, preservation, cooling, containers, sampling procedures, holding time and splitting of samples in the field.

Certification Information

The following analytes are not included in our Primary NELAP Scope of Accreditation:

Westborough Facility
EPA 624/624.1: m/p-xylene, o-xylene, Naphthalene
EPA 625/625.1: alpha-Terpineol
EPA 8260C/8260D: NPW: 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene, Azobenzene; SCM: Iodomethane (methyl iodide), 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene.
EPA 8270D/8270E: NPW: Dimethylnaphthalene,1,4-Diphenylhydrazine, alpha-Terpineol; SCM: Dimethylnaphthalene,1,4-Diphenylhydrazine.
SM4500: NPW: Amenable Cyanide; SCM: Total Phosphorus, TKN, NO2, NO3.

Mansfield Facility
SM 2540D: TSS
EPA 8082A: NPW: PCB: 1, 5, 31, 87,101, 110, 141, 151, 153, 180, 183, 187.
EPA TO-15: Halothane, 2,4,4-Trimethyl-2-pentene, 2,4,4-Trimethyl-1-pentene, Thiophene, 2-Methylthiophene, 3-Methylthiophene, 2-Ethylthiophene, 1,2,3-Trimethylbenzene, Indan, Indene, 1,2,4,5-Tetramethylbenzene, Benzothiophene, 1-Methylnaphthalene.
Biological Tissue Matrix: EPA 3050B

The following analytes are included in our Massachusetts DEP Scope of Accreditation

Westborough Facility:

Drinking Water
EPA 300.0: Chloride, Nitrate-N, Fluoride, Sulfate; **EPA 353.2**: Nitrate-N, Nitrite-N; **SM4500NO3-F**: Nitrate-N, Nitrite-N; **SM4500F-C, SM4500CN-CE, EPA 180.1, SM2130B, SM4500Cl-D, SM2320B, SM2540C, SM4500H-B, SM4500NO2-B**
EPA 332: Perchlorate; **EPA 524.2:** THMs and VOCs; **EPA 504.1:** EDB, DBCP.
Microbiology: **SM9215B; SM9223-P/A, SM9223B-Colilert-QT,SM9222D**.

Non-Potable Water
SM4500H,B, EPA 120.1, SM2510B, SM2540C, SM2320B, SM4500CL-E, SM4500F-BC, SM4500NH3-BH: Ammonia-N and Kjeldahl-N, **EPA 350.1**: Ammonia-N, **LACHAT 10-107-06-1-B**: Ammonia-N, **EPA 351.1, SM4500NO3-F, EPA 353.2**: Nitrate-N**, SM4500P-E, SM4500P-B, E, SM4500SO4-E, SM5220D, EPA 410.4, SM5210B, SM5310C, SM4500CL-D, EPA 1664, EPA 420.1, SM4500-CN-CE, SM2540D, EPA 300: Chloride, Sulfate, Nitrate.**
EPA 624.1: Volatile Halocarbons & Aromatics,
EPA 608.3: Chlordane, Toxaphene, Aldrin, alpha-BHC, beta-BHC, gamma-BHC, delta-BHC, Dieldrin, DDD, DDE, DDT, Endosulfan I, Endosulfan II, Endosulfan sulfate, Endrin, Endrin Aldehyde, Heptachlor, Heptachlor Epoxide, PCBs
EPA 625.1: SVOC (Acid/Base/Neutral Extractables), **EPA 600/4-81-045**: PCB-Oil.
Microbiology: **SM9223B-Colilert-QT; Enterolert-QT, SM9221E, EPA 1600, EPA 1603, SM9222D.**

Mansfield Facility:

Drinking Water
EPA 200.7: Al, Ba, Cd, Cr, Cu, Fe, Mn, Ni, Na, Ag, Ca, Zn. **EPA 200.8:** Al, Sb, As, Ba, Be, Cd, Cr, Cu, Pb, Mn, Ni, Se, Ag, TL, Zn. **EPA 245.1** Hg.
EPA 522, EPA 537.1.

Non-Potable Water
EPA 200.7: Al, Sb, As, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Ag, Na, Sr, TL, Ti, V, Zn.
EPA 200.8: Al, Sb**,** As, Be, Cd, Cr, Cu, Fe, Pb, Mn, Ni, K, Se, Ag, Na, TL, Zn.
EPA 245.1 Hg.
SM2340B

For a complete listing of analytes and methods, please contact your Alpha Project Manager.

CHAIN OF COUSTODY

PAGE 1 OF 2

ALPHA
8 Walkup Drive, Westboro, MA 01581, Tel: 508-898-9220
320 Forbes Blvd, Mansfield, MA 02048, Tel: 508-822-9300

Date Rec'd in Lab: 9/29/21

ALPHA Job #: L2152896

Client Information

Client: Anchor QEA
Address: 9 Water St
Amesbury, MA
Phone: 818 422 4820
Email: bgauley@anchorqea.com

Project Information

Project Name: Former Haverhill MGP
Project Location: Haverhill, MA
Project #: 180327-08.01
Project Manager: Billie-Jo Gauley
ALPHA Quote #:

Turn-Around Time

☒ Standard ☐ RUSH (only confirmed if pre-approved!)

Date Due:

Report Information - Data Deliverables

☒ ADEx ☐ EMAIL

Billing Information

☒ Same as Client info PO #:

Regulatory Requirements & Project Information Requirements

☒ Yes ☐ No MA MCP Analytical Methods ☐ Yes ☒ No CT RCP Analytical Methods
☒ Yes ☐ No Matrix Spike Required on this SDG? (Required for MCP Inorganics)
☐ Yes ☒ No GW1 Standards (Info Required for Metals & EPH with Targets)
☐ Yes ☒ No NPDES RGP
☐ Other State /Fed Program ______ Criteria ______

Additional Project Information:
Alkylated PAH analyses including fluoranthenes/pyrenes and naphthobenzothiophenes

ANALYSIS: VOC: ☐ 8260 ☐ 624 ☐ 524.2; SVOC: ☐ ABN ☒ PAH 16; METALS: ☐ MCP 13 ☐ MCP 14 ☐ RCP 15; METALS: ☐ RCRA5 ☒ RCRA8 ☐ PP13; EPH: ☐ Ranges & Targets ☐ Ranges Only; VPH: ☐ Ranges & Targets ☐ Ranges Only; ☒ PCB ☐ PEST; TPH: ☐ Quant Only ☐ Fingerprint; Alkylated PAH (see note); TOC; Soot; EPH; VPH

SAMPLE INFO — Filtration: ☐ Field ☐ Lab to do; Preservation: ☐ Lab to do

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection Date	Collection Time	Sample Matrix	Sampler Initials	VOC	SVOC	METALS (MCP)	METALS (RCRA)	EPH	VPH	PCB / PEST	TPH	Alkylated PAH	TOC	Soot	EPH	VPH	Sample Comments	TOTAL # BOTTLES
52896-01	AQSS-11b-0.0-0.5	9/28/21	1258	SE	BJEG				X			X		X	X	X				2
-02	AQSS-11b-1.5-1.9	↓	1301	↓	↓									X	X					1
-03	AQSS-11b-2.5-3.0	↓	1303	↓	↓		X								X					1
-04	AQSS-12b-0.0-0.5	↓	1120	↓	↓		X		X			X			X	X				1
-05	AQSS-13b-0.0-0.5	↓	1512	↓	↓				X			X		X	X	X				2
-06	AQSS-13b-1.5-2.0	↓	1515	↓	↓									X	X					1
-07	AQSS-10-0.0-0.5	9/29/21	0915	↓	↓				X			X		X	X	X				2
-08	AQSS-09-0.0-0.5	9/29/21	1045	↓	↓				X			X		X	X	X				2
-09	DUP1-20210929	9/29/21	—	↓	↓				X			X			X	X				1
-10	AQSS-08-0.0-0.5	9/29/21	1158	↓	↓		X		X			X			X	X				2
	Container Type						A		A			A		A	A	A				
	Preservative					A	A		A			A		A	A	A				

Container Type	Preservative
P= Plastic	A= None
A= Amber glass	B= HCl
V= Vial	C= HNO_3
G= Glass	D= H_2SO_4
B= Bacteria cup	E= NaOH
C= Cube	F= MeOH
O= Other	G= $NaHSO_4$
E= Encore	H = $Na_2S_2O_3$
D= BOD Bottle	I= Ascorbic Acid
	J = NH_4Cl
	K= Zn Acetate
	O= Other

Relinquished By:	Date/Time	Received By:	Date/Time
Billie-Jo L. Gauley	9/29/21 1421	J. David DAVIS AAL	9-29-21 14:21
David DAVIS AAL	9-29-21 1515	[illegible]	9/29 1515
[illegible]	9/29 2000	Joseph E. [illegible]	9/29/21 2000
Joseph E. [illegible]	9/29/21 2047	[illegible]	9/29/21 20:47

FORM NO: 01-01 (rev. 12-Mar-2012)

CHAIN OF CUSTODY

PAGE 2 OF 2

ALPHA
8 Walkup Drive, Westboro, MA 01581, Tel: 508-898-9220
320 Forbes Blvd, Mansfield, MA 02048, Tel: 508-822-9300

Date Rec'd in Lab: 9/29/21

ALPHA Job #: L2152896

Client Information

Client: Anchor QEA
Address: 9 Water St, Amesbury, MA
Phone: 818 422 4820
Email: bgauley@anchorqea.com

Project Information

Project Name: Former Haverhill MGP
Project Location: Haverhill, MA
Project #: 180327-08.01
Project Manager: Billie-Jo Gauley
ALPHA Quote #:

Turn-Around Time

☒ Standard ☐ RUSH (only confirmed if pre-approved!)

Date Due:

Report Information - Data Deliverables

☒ ADEx ☐ EMAIL

Billing Information

☒ Same as Client info PO #:

Regulatory Requirements & Project Information Requirements

☒ Yes ☐ No MA MCP Analytical Methods ☐ Yes ☒ No CT RCP Analytical Methods
☒ Yes ☐ No Matrix Spike Required on this SDG? (Required for MCP Inorganics)
☐ Yes ☒ No GW1 Standards (Info Required for Metals & EPH with Targets)
☐ Yes ☒ No NPDES RGP
☐ Other State /Fed Program ______ Criteria ______

Additional Project Information:

Alkylated PAH Analyses including Fluoranthenes/pyrenes and naphthobenzo-thiophenes

ANALYSIS

VOC: ☐ 8260 ☐ 624 ☐ 524.2; SVOC: ☐ ABN ☒ PAH 16; METALS: ☐ MCP 13 ☐ MCP 14 ☐ RCP 15; METALS: ☐ RCRA5 ☒ RCRA8 ☐ PP13; EPH: ☐ Ranges & Targets ☐ Ranges Only; VPH: ☐ Ranges & Targets ☐ Ranges Only; ☒ PCB ☐ PEST; TPH: ☐ Quant Only ☐ Fingerprint; Alkylated PAH; TOC; Soot; EPH; VPH; Copper

SAMPLE INFO: Filtration ☐ Field ☐ Lab to do; Preservation ☐ Lab to do

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection Date	Collection Time	Sample Matrix	Sampler Initials	VOC	SVOC	METALS	METALS	EPH	VPH	PCB	TPH	Alkylated PAH	TOC	Soot	EPH	VPH	Copper	Sample Comments	TOTAL # BOTTLES
52896-11	AQSS-08-1.0-1.5	9/24/21	1200	SE	BJLG		X								X						1
-12	AQSS-07-0.0-0.5	↓	1235	↓	↓				X			X		X	X	X					2
-13	AQSS-07-1.5-2.0	↓	1250	↓	↓									X	X				X		1
-14	AQSS-06-0.0-0.5	↓	1358	↓	↓				X			X		X	X	X					2
-15	AQSS-06-1.5-2.0	↓	1400	↓	↓		X								X						1
Container Type							A		A			A		A	A	A					
Preservative							A		A			A		A	A	A					

Container Type: P= Plastic, A= Amber glass, V= Vial, G= Glass, B= Bacteria cup, C= Cube, O= Other, E= Encore, D= BOD Bottle

Preservative: A= None, B= HCl, C= HNO_3, D= H_2SO_4, E= NaOH, F= MeOH, G= $NaHSO_4$, H = $Na_2S_2O_3$, I= Ascorbic Acid, J = NH_4Cl, K= Zn Acetate, O= Other

Relinquished By:	Date/Time	Received By:	Date/Time
Billie-Jo Gauley	9/24/21 1421	Paul DRUSAAL	9-29-21 1421
Paul DRUS AAL	9-29-21 1525	[illegible]	9/29 1525
[illegible]	9/29 2[illegible]	Joseph C. Bezio[illegible]	9/29/21 2000
Joseph C. Bezio[illegible]	9/29/21 2047	[illegible]	9/29/21 20:47

FORM NO: 01-01 (rev. 12-Mar-2012)

ANALYTICAL REPORT

Lab Number:	L2153328
Client:	Anchor QEA, LLC 9 Water Street, 1st Floor Amesbury, MA 01913
ATTN:	Billie-Jo Gauley
Phone:	(978) 712-4475
Project Name:	FORMER HAVERHILL MGP
Project Number:	180327-08.01
Report Date:	11/24/21

Certifications & Approvals: MA (M-MA086), NH NELAP (2064), CT (PH-0574), IL (200077), ME (MA00086), MD (348), NJ (MA935), NY (11148), NC (25700/666), PA (68-03671), RI (LAO00065), TX (T104704476), VT (VT-0935), VA (460195), USDA (Permit #P330-17-00196).

Eight Walkup Drive, Westborough, MA 01581-1019
508-898-9220 (Fax) 508-898-9193 800-624-9220 - www.alphalab.com

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01

Lab Number: L2153328
Report Date: 11/24/21

Alpha Sample ID	Client ID	Matrix	Sample Location	Collection Date/Time	Receive Date
L2153328-01	AQSS-05-0.0-0.5	SEDIMENT	HAVERHILL, MA	09/29/21 14:50	09/30/21
L2153328-02	AQSS-05-1.0-1.5	SEDIMENT	HAVERHILL, MA	09/29/21 14:45	09/30/21
L2153328-03	AQSS-04-0.0-0.5	SEDIMENT	HAVERHILL, MA	09/30/21 08:45	09/30/21
L2153328-04	AQSS-04-1.0-1.5	SEDIMENT	HAVERHILL, MA	09/30/21 08:48	09/30/21
L2153328-05	DUP2-20210930	SEDIMENT	HAVERHILL, MA	09/30/21 00:00	09/30/21
L2153328-06	AQSS-03-0.0-0.5	SEDIMENT	HAVERHILL, MA	09/30/21 09:25	09/30/21
L2153328-07	AQSS-03-2.0-2.5	SEDIMENT	HAVERHILL, MA	09/30/21 09:30	09/30/21
L2153328-08	AQSS-07D-4.9-5.4	SEDIMENT	HAVERHILL, MA	09/30/21 09:35	09/30/21
L2153328-09	AQSS-19-3.0-3.5	SEDIMENT	HAVERHILL, MA	09/30/21 10:33	09/30/21
L2153328-10	AQSS-19-4.5-5.0	SEDIMENT	HAVERHILL, MA	09/30/21 10:35	09/30/21
L2153328-11	AQSS-18-4.6-4.8	SEDIMENT	HAVERHILL, MA	09/30/21 13:52	09/30/21
L2153328-12	AQSS-18-3.0-3.5	SEDIMENT	HAVERHILL, MA	09/30/21 13:54	09/30/21
L2153328-13	AQSS-18-0.0-0.5	SEDIMENT	HAVERHILL, MA	09/30/21 13:55	09/30/21
L2153328-14	AQSS-20-0.0-0.5	SEDIMENT	HAVERHILL, MA	09/30/21 12:50	09/30/21
L2153328-15	AQSS-20-4.2-4.5	SEDIMENT	HAVERHILL, MA	09/30/21 12:45	09/30/21
L2153328-16	RB01-092921	WATER	HAVERHILL, MA	09/29/21 17:25	09/30/21
L2153328-17	WC1-093021	SEDIMENT	HAVERHILL, MA	09/30/21 14:20	09/30/21

Project Name:	FORMER HAVERHILL MGP	**Lab Number:**	L2153328
Project Number:	180327-08.01	**Report Date:**	11/24/21

MADEP MCP Response Action Analytical Report Certification

This form provides certifications for all samples performed by MCP methods. Please refer to the Sample Results and Container Information sections of this report for specification of MCP methods used for each analysis. The following questions pertain only to MCP Analytical Methods.

An affirmative response to questions A through F is required for "Presumptive Certainty" status		
A	Were all samples received in a condition consistent with those described on the Chain-of-Custody, properly preserved (including temperature) in the field or laboratory, and prepared/analyzed within method holding times?	YES
B	Were the analytical method(s) and all associated QC requirements specified in the selected CAM protocol(s) followed?	YES
C	Were all required corrective actions and analytical response actions specified in the selected CAM protocol(s) implemented for all identified performance standard non-conformances?	YES
D	Does the laboratory report comply with all the reporting requirements specified in CAM VII A, "Quality Assurance and Quality Control Guidelines for the Acquisition and Reporting of Analytical Data?"	YES
E a.	VPH, EPH, and APH Methods only: Was each method conducted without significant modification(s)? (Refer to the individual method(s) for a list of significant modifications).	YES
E b.	APH and TO-15 Methods only: Was the complete analyte list reported for each method?	N/A
F	Were all applicable CAM protocol QC and performance standard non-conformances identified and evaluated in a laboratory narrative (including all "No" responses to Questions A through E)?	YES

A response to questions G, H and I is required for "Presumptive Certainty" status		
G	Were the reporting limits at or below all CAM reporting limits specified in the selected CAM protocol(s)?	YES
H	Were all QC performance standards specified in the CAM protocol(s) achieved?	NO
I	Were results reported for the complete analyte list specified in the selected CAM protocol(s)?	YES

For any questions answered "No", please refer to the case narrative section on the following page(s).

Please note that sample matrix information is located in the Sample Results section of this report.

Project Name:	FORMER HAVERHILL MGP	**Lab Number:**	L2153328
Project Number:	180327-08.01	**Report Date:**	11/24/21

Case Narrative

The samples were received in accordance with the Chain of Custody and no significant deviations were encountered during the preparation or analysis unless otherwise noted. Sample Receipt, Container Information, and the Chain of Custody are located at the back of the report.

Results contained within this report relate only to the samples submitted under this Alpha Lab Number and meet NELAP requirements for all NELAP accredited parameters unless otherwise noted in the following narrative. The data presented in this report is organized by parameter (i.e. VOC, SVOC, etc.). Sample specific Quality Control data (i.e. Surrogate Spike Recovery) is reported at the end of the target analyte list for each individual sample, followed by the Laboratory Batch Quality Control at the end of each parameter. Tentatively Identified Compounds (TICs), if requested, are reported for compounds identified to be present and are not part of the method/program Target Compound List, even if only a subset of the TCL are being reported. If a sample was re-analyzed or re-extracted due to a required quality control corrective action and if both sets of data are reported, the Laboratory ID of the re-analysis or re-extraction is designated with an "R" or "RE", respectively.

When multiple Batch Quality Control elements are reported (e.g. more than one LCS), the associated samples for each element are noted in the grey shaded header line of each data table. Any Laboratory Batch, Sample Specific % recovery or RPD value that is outside the listed Acceptance Criteria is bolded in the report. In reference to questions H (CAM) or 4 (RCP) when "NO" is checked, the performance criteria for CAM and RCP methods allow for some quality control failures to occur and still be within method compliance. In these instances, the specific failure is not narrated but noted in the associated QC Outlier Summary Report, located directly after the Case Narrative. QC information is also incorporated in the Data Usability Assessment table (Format 11) of our Data Merger tool, where it can be reviewed in conjunction with the sample result, associated regulatory criteria and any associated data usability implications.

Soil/sediments, solids and tissues are reported on a dry weight basis unless otherwise noted. Definitions of all data qualifiers and acronyms used in this report are provided in the Glossary located at the back of the report.

HOLD POLICY - For samples submitted on hold, Alpha's policy is to hold samples (with the exception of Air canisters) free of charge for 21 calendar days from the date the project is completed. After 21 calendar days, we will dispose of all samples submitted including those put on hold unless you have contacted your Alpha Project Manager and made arrangements for Alpha to continue to hold the samples. Air canisters will be disposed after 3 business days from the date the project is completed.

Please contact Project Management at 800-624-9220 with any questions.

Project Name:	FORMER HAVERHILL MGP	**Lab Number:**	L2153328
Project Number:	180327-08.01	**Report Date:**	11/24/21

Case Narrative (continued)

Report Submission

All non-detect (ND) or estimated concentrations (J-qualified) have been quantitated to the limit noted in the MDL column.

Sample Receipt

L2153328: The samples were frozen upon receipt in order to arrest the holding time

MCP Related Narratives

Volatile Organics

L2153328-17D2: The sample was re-analyzed on dilution in order to quantitate the results within the calibration range. The result(s) should be considered estimated, and are qualified with an E flag, for any compound(s) that exceeded the calibration range in the initial analysis. The re-analysis was performed only for the compound(s) that exceeded the calibration range.

In reference to question H:

The WG1559101-3/-4 LCS/LCSD recoveries, associated with L2153328-17D2, are below the individual acceptance criteria for dichlorodifluoromethane (61%/56%), 2-butanone (61%/66%) and 2-hexanone (67%), but within the overall method allowances. The results of the associated samples are reported; however, all results for these compounds are considered to have a potentially low bias.

L2153328-17D2: Initial Calibration did not meet:

Lowest Calibration Standard Minimum Response Factor: 1,4-dioxane (0.0016), 4-methyl-2-pentanone (0.0805)

Average Response Factor: 1,4-dioxane, acrolein, tert-butyl alcohol

L2153328-17D2: The associated continuing calibration standard is outside the acceptance criteria for several compounds; however, it is within overall method allowances. A copy of the continuing calibration standard is included as an addendum to this report.

L2153328-17D: Initial Calibration did not meet:

Lowest Calibration Standard Minimum Response Factor: 1,4-dioxane (0.0016), 4-methyl-2-pentanone

Project Name:	FORMER HAVERHILL MGP	**Lab Number:**	L2153328
Project Number:	180327-08.01	**Report Date:**	11/24/21

Case Narrative (continued)

(0.0805)
Average Response Factor: 1,4-dioxane, acrolein, tert-butyl alcohol
L2153328-17D: The associated continuing calibration standard is outside the acceptance criteria for several compounds; however, it is within overall method allowances. A copy of the continuing calibration standard is included as an addendum to this report.

PAHs by SIM
L2153328-01D: The sample has elevated detection limits due to the dilution required by the sample matrix.
L2153328-02D, -07D, -14D, -12D and -17D: The sample was re-analyzed on dilution in order to quantitate the results within the calibration range. The result(s) should be considered estimated, and are qualified with an E flag, for any compound(s) that exceeded the calibration range in the initial analysis. The re-analysis was performed only for the compound(s) that exceeded the calibration range.
L2153328-06D and -13D: The sample has elevated detection limits due to the dilution required by the elevated concentrations of target compounds in the sample.
In reference to question H:
The WG1569716-2/-3 LCS/LCSD RPD(s), associated with L2153328-01D, -02D, and -02D2, are above the acceptance criteria for naphthalene (31%), 2-chloronaphthalene (34%), fluorene (31%), phenanthrene (31%), benzo(k)fluoranthene (31%), indeno(1,2,3-cd)pyrene (31%), dibenz(a,h)anthracene (32%) and benzo(ghi)perylene (32%).
The WG1563704-4/-5 MS/MSD recoveries, performed on L2153328-09, are outside the acceptance criteria for several compounds; however, the associated LCS/LCSD recoveries are within overall method allowances. The results of the native sample are considered to hav a potentially low bias for naphthalene (18%), 2-methylnaphthalene (35%/19%), acenaphthene (39%), phenanthrene (32%/18%) and fluoranthene (39%).

Petroleum Hydrocarbon Quantitation
In reference to question H:
L2153328-17D: The surrogate recoveries are below the acceptance criteria for o-terphenyl (0%) due to the

Project Name:	FORMER HAVERHILL MGP	**Lab Number:**	L2153328
Project Number:	180327-08.01	**Report Date:**	11/24/21

Case Narrative (continued)

dilution required to quantitate the sample. Re-extraction was not required; therefore, the results of the original analysis are reported.

VPH

L2153328-01: The sample was outside the recommended 1:1 methanol:soil ratio due to the amount of soil provided in the sample vial.

EPH

L2153328-01D: The sample has elevated detection limits due to the dilution required by matrix interferences encountered during the concentration of the sample.

PCBs

L2153328-01D: The sample has elevated detection limits due to the dilution required by the elevated concentrations of target compounds in the sample.

In reference to question H:

L2153328-13 and -14: One or more dual column RPDs are above the acceptance criteria; however, obvious column interferences are present. The result is qualified with a "P" if the higher of the two results is reported. The result is qualified with an "IP" if the lower of the two results is reported.

The WG1563709-4D/-5D MS/MSD recoveries, performed on L2153328-01, are outside the acceptance criteria for aroclor 1016 (331%/236%), and aroclor 1260 (147%). The unacceptable percent recoveries are above the method acceptance criteria due to interference with Aroclor 1242 present in the sample.

The WG1563709-4D/-5D MS/MSD RPDs, performed on L2153328-01, are outside the acceptance criteria for aroclor 1016 (35%) and aroclor 1260 (57%).

Pesticides

L2153328-17D: The sample has elevated detection limits due to the dilution required by the sample matrix.

In reference to question H:

Project Name:	FORMER HAVERHILL MGP	**Lab Number:**	L2153328
Project Number:	180327-08.01	**Report Date:**	11/24/21

Case Narrative (continued)

L2153328-17D: The internal standard (IS) response for 1-bromo-2-nitrobenzene (833%) was above the acceptance criteria on column A; however, the sample was not re-analyzed due to obvious interferences. Since the IS response was above method criteria, all associated compounds reported from this column are considered to have a potentially low bias. The surrogate recoveries are outside the method acceptance criteria for decachlorobiphenyl (19%) due to interference with the Internal Standard.

Herbicides

In reference to question H:

L2153328-17: The surrogate recovery is above the acceptance criteria for DCAA (1420%). Since the sample was non-detect for all target analytes, re-analysis was not required.

Total Metals

In reference to question H:

The WG1555837-4/-5 MS recoveries, performed on L2153328-01, are outside the acceptance criteria for arsenic (52%/56%) and chromium (60%) and lead (158%/34%). Re-analysis of the MS yielded unacceptable recoveries for arsenic, chromium, and lead in the range of 30-74% or >125%. The LCS recoveries are acceptable; therefore, no further action was taken.

The WG1555837-4/-5 MS/MSD RPD for lead (42%), performed on L2153328-01, is above the acceptance criteria.

Total Mercury

L2153328-16: The sample has an elevated detection limit for Hg due to the dilution required by the limited sample volume available for analysis.

L2153328-16: The sample was analyzed outsided the method required holding time, due to laboratory oversight.

In reference to question H:

The WG1569044-4/-5 MS/MSD recoveries, performed on L2153328-01, are outside the acceptance criteria

Case Narrative (continued)

for mercury (148%/612%). Re-analysis of the MS yielded unacceptable recoveries for mercury in the range of 30-74% or >125%. The LCS recoveries are acceptable; therefore, no further action was taken.
The WG1569044-4/-5 MS/MSD RPD for mercury (125%), performed on L2153328-01, is above the acceptance criteria.

Cyanide, Total
In reference to question H:
The WG1558514-2 LCS recovery for cyanide, total (59%), associated with L2153328-17, is outside our in-house acceptance criteria, but within the vendor-certified acceptance limits. The results of the original analyses are reported.
The LCS/LCSD RPD for cyanide, total (41%) is above the acceptance criteria.

Non-MCP Related Narratives
Alkylated PAHs
L2153328-03: The sample was re-analyzed on dilution in order to quantitate the results within the calibration range. The result(s) should be considered estimated, and are qualified with an E flag, for any compound(s) that exceeded the calibration range in the initial analysis. The re-analysis was performed only for the compound(s) that exceeded the calibration range.
The WG1563968-4/-5 MS/MSD recoveries and RPDs, performed on L2153328-04, are outside the acceptance criteria for several compounds. The unacceptable percent recoveries are attributed to the elevated concentrations of target compounds present in the native sample. See MS/MSD Summary for details.

Soot
L2153328-03: The Sample Replicate RPD is outside the acceptance criteria of 30%. A double-burn re-analysis was performed with a confirming result. The results of the original analysis are reported. The elevated RPD has been attributed to the non-homogeneous nature of the sample.
The WG1575312-6 MSD recoveries (Rep 2 - 182%) performed on L2153328-01, are outside the 75-125%

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328
Project Number: 180327-08.01 **Report Date:** 11/24/21

Case Narrative (continued)

acceptance criteria, possibly due to sample matrix. The associated SRM recoveries are within criteria, indicating the sample batch was in control, and all sample results were accepted.
The WG1575312-5/-6 Laboratory MS/MSD RPD (Rep 1 - 64%) / (Rep 2 - 61%), performed on L2153328-01, is outside the acceptance criteria of 25%. The elevated RPD has been attributed to the non-homogeneous nature of the native sample.

Total Organic Carbon
L2153328-04 and -05: The Sample Replicate RPD is outside the acceptance criteria of 30%. A double-burn re-analysis was performed with a confirming result. The results of the original analysis are reported. The elevated RPD has been attributed to the non-homogeneous nature of the sample.
The WG1573823-4/-5 MS/MSD recoveries (Rep1 - 254%/22%) / (Rep2 - 0%/0%) performed on L2153328-04, are outside the 75-125% acceptance criteria, possibly due to sample matrix. The associated SRM recoveries are within criteria, indicating the sample batch was in control, and all sample results were accepted.
The WG1573823-5 Laboratory MSD RPD (Rep1 - 31%), performed on L2153328-04, is outside the acceptance criteria of 25%. The elevated RPD has been attributed to the non-homogeneous nature of the native sample.
The WG1564782-3 Laboratory Duplicate RPD (22%), performed on L2153328-16, is above the acceptance criteria; however, the sample and duplicate results are less than five times the reporting limit. Therefore, the RPD is valid.
The WG1573823-3 Laboratory Duplicate RPD (Rep1 - 32%) and (Average - 27%), performed on L2153328-05, is outside the acceptance criteria of 25%. The elevated RPD has been attributed to the non-homogeneous nature of the native sample.

I, the undersigned, attest under the pains and penalties of perjury that, to the best of my knowledge and belief and based upon my personal inquiry of those responsible for providing the information contained in this analytical report, such information is accurate and complete. This certificate of analysis is not complete unless this page accompanies any and all pages of this report.

Authorized Signature: Elizabeth Porta

Title: Technical Director/Representative Date: 11/24/21

QC OUTLIER SUMMARY REPORT

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01

Lab Number: L2153328
Report Date: 11/24/21

Method	Client ID (Native ID)	Lab ID	Parameter	QC Type	Recovery/RPD (%)	QC Limits (%)	Associated Samples	Data Quality Assessment
MCP Volatile Organics by EPA 5035 High - Westborough Lab								
8260C	Batch QC	WG1559101-3	Dichlorodifluoromethane	LCS	61	70-130	17	potential low bias
8260C	Batch QC	WG1559101-3	Methyl ethyl ketone	LCS	61	70-130	17	potential low bias
8260C	Batch QC	WG1559101-3	2-Hexanone	LCS	67	70-130	17	potential low bias
8260C	Batch QC	WG1559101-4	Dichlorodifluoromethane	LCSD	56	70-130	17	potential low bias
8260C	Batch QC	WG1559101-4	Methyl ethyl ketone	LCSD	66	70-130	17	potential low bias
MCP PAHs by GC/MS-SIM - Mansfield Lab								
8270D-SIM	Batch QC (L2153328-09)	WG1563704-4	2-Methylnaphthalene	MS	35	40-140	06-07,09-15,17	potential low bias
8270D-SIM	Batch QC (L2153328-09)	WG1563704-4	Phenanthrene	MS	32	40-140	06-07,09-15,17	potential low bias
8270D-SIM	Batch QC (L2153328-09)	WG1563704-5	Naphthalene	MSD	18	40-140	06-07,09-15,17	potential low bias
8270D-SIM	Batch QC (L2153328-09)	WG1563704-5	2-Methylnaphthalene	MSD	19	40-140	06-07,09-15,17	potential low bias
8270D-SIM	Batch QC (L2153328-09)	WG1563704-5	Acenaphthene	MSD	39	40-140	06-07,09-15,17	potential low bias
8270D-SIM	Batch QC (L2153328-09)	WG1563704-5	Phenanthrene	MSD	18	40-140	06-07,09-15,17	potential low bias
8270D-SIM	Batch QC (L2153328-09)	WG1563704-5	Fluoranthene	MSD	39	40-140	06-07,09-15,17	potential low bias
8270D-SIM	Batch QC	WG1569716-3	Naphthalene	LCSD	31	30	01-02	non-directional bias
8270D-SIM	Batch QC	WG1569716-3	2-Chloronaphthalene	LCSD	34	30	01-02	non-directional bias
8270D-SIM	Batch QC	WG1569716-3	Fluorene	LCSD	31	30	01-02	non-directional bias
8270D-SIM	Batch QC	WG1569716-3	Phenanthrene	LCSD	31	30	01-02	non-directional bias
8270D-SIM	Batch QC	WG1569716-3	Benzo(k)fluoranthene	LCSD	31	30	01-02	non-directional bias
8270D-SIM	Batch QC	WG1569716-3	Indeno(1,2,3-cd)Pyrene	LCSD	31	30	01-02	non-directional bias
8270D-SIM	Batch QC	WG1569716-3	Dibenz(a,h)anthracene	LCSD	32	30	01-02	non-directional bias
8270D-SIM	Batch QC	WG1569716-3	Benzo(ghi)perylene	LCSD	32	30	01-02	non-directional bias
PAHs - Mansfield Lab								
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-4	Naphthalene	MS	2	50-150	03-05,08	potential low bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-4	2-Methylnaphthalene	MS	3	50-150	03-05,08	potential low bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-4	Acenaphthylene	MS	0	50-150	03-05,08	potential low bias

QC OUTLIER SUMMARY REPORT

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01

Lab Number: L2153328
Report Date: 11/24/21

Method	Client ID (Native ID)	Lab ID	Parameter	QC Type	Recovery/RPD (%)	QC Limits (%)	Associated Samples	Data Quality Assessment
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-4	Acenaphthene	MS	6	50-150	03-05,08	potential low bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-4	Fluorene	MS	0	50-150	03-05,08	potential low bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-4	Anthracene	MS	17	50-150	03-05,08	potential low bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-4	Benz(a)anthracene	MS	38	50-150	03-05,08	potential low bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-4	Chrysene	MS	38	50-150	03-05,08	potential low bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-4	Benzo(b)fluoranthene	MS	19	50-150	03-05,08	potential low bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-4	Benzo(j)+(k)fluoranthene	MS	26	50-150	03-05,08	potential low bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-4	Benzo(a)pyrene	MS	26	50-150	03-05,08	potential low bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-4	Indeno(1,2,3-cd)pyrene	MS	1	50-150	03-05,08	potential low bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-4	Dibenz(a,h)+(a,c)anthracene	MS	2	50-150	03-05,08	potential low bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-4	Benzo(g,h,i)perylene	MS	21	50-150	03-05,08	potential low bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Naphthalene	MSD	77	30	03-05,08	non-directional bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	2-Methylnaphthalene	MSD	72	30	03-05,08	non-directional bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Acenaphthylene	MSD	47	30	03-05,08	non-directional bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Acenaphthene	MSD	69	30	03-05,08	non-directional bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Fluorene	MSD	67	30	03-05,08	non-directional bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Phenanthrene	MSD	66	30	03-05,08	non-directional bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Phenanthrene	MSD	1470	50-150	03-05,08	potential high bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Anthracene	MSD	56	30	03-05,08	non-directional bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Anthracene	MSD	284	50-150	03-05,08	potential high bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Fluoranthene	MSD	73	30	03-05,08	non-directional bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Fluoranthene	MSD	1640	50-150	03-05,08	potential high bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Pyrene	MSD	70	30	03-05,08	non-directional bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Pyrene	MSD	1340	50-150	03-05,08	potential high bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Benz(a)anthracene	MSD	76	30	03-05,08	non-directional bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Benz(a)anthracene	MSD	788	50-150	03-05,08	potential high bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Chrysene	MSD	67	30	03-05,08	non-directional bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Chrysene	MSD	677	50-150	03-05,08	potential high bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Benzo(b)fluoranthene	MSD	82	30	03-05,08	non-directional bias

QC OUTLIER SUMMARY REPORT

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

Method	Client ID (Native ID)	Lab ID	Parameter	QC Type	Recovery/RPD (%)	QC Limits (%)	Associated Samples	Data Quality Assessment
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Benzo(b)fluoranthene	MSD	644	50-150	03-05,08	potential high bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Benzo(j)+(k)fluoranthene	MSD	65	30	03-05,08	non-directional bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Benzo(j)+(k)fluoranthene	MSD	426	50-150	03-05,08	potential high bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Benzo(a)pyrene	MSD	72	30	03-05,08	non-directional bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Benzo(a)pyrene	MSD	659	50-150	03-05,08	potential high bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Indeno(1,2,3-cd)pyrene	MSD	75	30	03-05,08	non-directional bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Indeno(1,2,3-cd)pyrene	MSD	408	50-150	03-05,08	potential high bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Dibenz(a,h)+(a,c)anthracene	MSD	81	30	03-05,08	non-directional bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Benzo(g,h,i)perylene	MSD	72	30	03-05,08	non-directional bias
8270D-SIM(M	Batch QC (L2153328-04)	WG1563968-5	Benzo(g,h,i)perylene	MSD	424	50-150	03-05,08	potential high bias
Petroleum Hydrocarbon Quantitation - Westborough Lab								
8015D(M)	WC1-093021	L2153328-17 D	o-Terphenyl	Surrogate	0	40-140	-	- - not applicable - -
MCP Polychlorinated Biphenyls by GC - Mansfield Lab								
8082A	Batch QC (L2153328-01)	WG1563709-4 D	Aroclor 1016 (A)	MS	331	40-140	01,03,06,13-14,17	potential high bias
8082A	Batch QC (L2153328-01)	WG1563709-4 D	Aroclor 1260 (B)	MS	147	40-140	01,03,06,13-14,17	potential high bias
8082A	Batch QC (L2153328-01)	WG1563709-5 D	Aroclor 1016 (A)	MSD	35	30	01,03,06,13-14,17	non-directional bias
8082A	Batch QC (L2153328-01)	WG1563709-5 D	Aroclor 1016 (A)	MSD	236	40-140	01,03,06,13-14,17	potential high bias
8082A	Batch QC (L2153328-01)	WG1563709-5 D	Aroclor 1260 (B)	MSD	57	30	01,03,06,13-14,17	non-directional bias
Chlorinated Herbicides by GC - Westborough Lab								
8151A	WC1-093021	L2153328-17	DCAA	Surrogate	1420	30-150	-	potential high bias
MCP Organochlorine Pesticides - Westborough Lab								
8081B	WC1-093021	L2153328-17 D	2,4,5,6-Tetrachloro-m-xylene (A)	Surrogate	2250	30-150	-	potential high bias
8081B	WC1-093021	L2153328-17 D	Decachlorobiphenyl (A)	Surrogate	19	30-150	-	potential low bias
8081B	WC1-093021	L2153328-17 D	Decachlorobiphenyl (B)	Surrogate	612	30-150	-	potential high bias

QC OUTLIER SUMMARY REPORT

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01

Lab Number: L2153328
Report Date: 11/24/21

Method	Client ID (Native ID)	Lab ID	Parameter	QC Type	Recovery/RPD (%)	QC Limits (%)	Associated Samples	Data Quality Assessment
MCP Total Metals - Mansfield Lab								
6020B	Batch QC (L2153328-01)	WG1555837-4	Arsenic, Total	MS	52	75-125	01,03,06,13-14,17	potential low bias
6020B	Batch QC (L2153328-01)	WG1555837-4	Chromium, Total	MS	60	75-125	01,03,06,13-14,17	potential low bias
6020B	Batch QC (L2153328-01)	WG1555837-4	Lead, Total	MS	158	75-125	01,03,06,13-14,17	potential high bias
6020B	Batch QC (L2153328-01)	WG1555837-5	Arsenic, Total	MSD	56	75-125	01,03,06,13-14,17	potential low bias
6020B	Batch QC (L2153328-01)	WG1555837-5	Lead, Total	MSD	34	75-125	01,03,06,13-14,17	potential low bias
6020B	Batch QC (L2153328-01)	WG1555837-5	Lead, Total	MSD	42	35	01,03,06,13-14,17	non-directional bias
7471B	Batch QC (L2153328-01)	WG1569044-4	Mercury, Total	MS	148	75-125	01,03,06,13-14,17	potential high bias
7471B	Batch QC (L2153328-01)	WG1569044-5	Mercury, Total	MSD	125	35	01,03,06,13-14,17	non-directional bias
7471B	Batch QC (L2153328-01)	WG1569044-5	Mercury, Total	MSD	612	75-125	01,03,06,13-14,17	potential high bias
General Chemistry - Mansfield Lab								
-	Batch QC (L2153328-01)	WG1575312-6	% Soot (Rep 1)	MSD	64	25	01,03,06,13-14	non-directional bias
-	Batch QC (L2153328-01)	WG1575312-6	% Soot (Rep 2)	MSD	61	25	01,03,06,13-14	non-directional bias
-	Batch QC (L2153328-01)	WG1575312-6	% Soot (Rep 2)	MSD	182	75-125	01,03,06,13-14	potential high bias
General Chemistry - Westborough Lab								
9010C/9012B	Batch QC	WG1558514-2	Cyanide, Total	LCS	59	80-120	17	potential low bias
9010C/9012B	Batch QC	WG1558514-3	Cyanide, Total	LCSD	41	35	17	non-directional bias
9060A	Batch QC (L2153328-16)	WG1564782-3	Total Organic Carbon	Duplicate	22	20	16	non-directional bias
Total Organic Carbon - Mansfield Lab								
9060A	Batch QC (L2153328-05)	WG1573823-3	Total Organic Carbon (Rep1)	Duplicate	32	25	01-15	non-directional bias
9060A	Batch QC (L2153328-05)	WG1573823-3	Total Organic Carbon (Average)	Duplicate	27	25	01-15	non-directional bias
9060A	Batch QC (L2153328-04)	WG1573823-4	Total Organic Carbon (Rep1)	MS	254	75-125	01-15	potential high bias
9060A	Batch QC (L2153328-04)	WG1573823-4	Total Organic Carbon (Rep2)	MS	0	75-125	01-15	potential low bias
9060A	Batch QC (L2153328-04)	WG1573823-5	Total Organic Carbon (Rep1)	MSD	22	75-125	01-15	potential low bias

QC OUTLIER SUMMARY REPORT

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01

Lab Number: L2153328
Report Date: 11/24/21

Method	Client ID (Native ID)	Lab ID	Parameter	QC Type	Recovery/RPD (%)	QC Limits (%)	Associated Samples	Data Quality Assessment
9060A	Batch QC (L2153328-04)	WG1573823-5	Total Organic Carbon (Rep1)	MSD	31	25	01-15	non-directional bias
9060A	Batch QC (L2153328-04)	WG1573823-5	Total Organic Carbon (Rep2)	MSD	0	75-125	01-15	potential low bias

ORGANICS

VOLATILES

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328

Project Number: 180327-08.01 **Report Date:** 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-17 D2 Date Collected: 09/30/21 14:20
Client ID: WC1-093021 Date Received: 09/30/21
Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8260C
Analytical Date: 10/14/21 17:27
Analyst: NLK
Percent Solids: 85%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP Volatile Organics by EPA 5035 High - Westborough Lab						
Methylene chloride	ND		ug/kg	1000	460	2.5
1,1-Dichloroethane	ND		ug/kg	200	29.	2.5
Chloroform	ND		ug/kg	300	28.	2.5
Carbon tetrachloride	ND		ug/kg	200	46.	2.5
1,2-Dichloropropane	ND		ug/kg	200	25.	2.5
Dibromochloromethane	ND		ug/kg	200	28.	2.5
1,1,2-Trichloroethane	ND		ug/kg	200	54.	2.5
Tetrachloroethene	ND		ug/kg	100	40.	2.5
Chlorobenzene	ND		ug/kg	100	26.	2.5
Trichlorofluoromethane	ND		ug/kg	810	140	2.5
1,2-Dichloroethane	ND		ug/kg	200	52.	2.5
1,1,1-Trichloroethane	ND		ug/kg	100	34.	2.5
Bromodichloromethane	ND		ug/kg	100	22.	2.5
trans-1,3-Dichloropropene	ND		ug/kg	200	55.	2.5
cis-1,3-Dichloropropene	ND		ug/kg	100	32.	2.5
1,3-Dichloropropene, Total	ND		ug/kg	100	32.	2.5
1,1-Dichloropropene	ND		ug/kg	100	32.	2.5
Bromoform	ND		ug/kg	810	50.	2.5
1,1,2,2-Tetrachloroethane	ND		ug/kg	100	34.	2.5
Benzene	1800		ug/kg	100	34.	2.5
Toluene	2000		ug/kg	200	110	2.5
Ethylbenzene	100000	E	ug/kg	200	28.	2.5
Chloromethane	ND		ug/kg	810	190	2.5
Bromomethane	ND		ug/kg	400	120	2.5
Vinyl chloride	ND		ug/kg	200	68.	2.5
Chloroethane	ND		ug/kg	400	91.	2.5
1,1-Dichloroethene	ND		ug/kg	200	48.	2.5
trans-1,2-Dichloroethene	ND		ug/kg	300	28.	2.5

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328

Project Number: 180327-08.01 **Report Date:** 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-17 D2 Date Collected: 09/30/21 14:20
Client ID: WC1-093021 Date Received: 09/30/21
Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP Volatile Organics by EPA 5035 High - Westborough Lab						
Trichloroethene	ND		ug/kg	100	28.	2.5
1,2-Dichlorobenzene	ND		ug/kg	400	29.	2.5
1,3-Dichlorobenzene	ND		ug/kg	400	30.	2.5
1,4-Dichlorobenzene	ND		ug/kg	400	34.	2.5
Methyl tert butyl ether	ND		ug/kg	400	40.	2.5
p/m-Xylene	89000		ug/kg	400	110	2.5
o-Xylene	46000		ug/kg	200	59.	2.5
Xylenes, Total	140000		ug/kg	200	59.	2.5
cis-1,2-Dichloroethene	ND		ug/kg	200	35.	2.5
1,2-Dichloroethene, Total	ND		ug/kg	200	28.	2.5
Dibromomethane	ND		ug/kg	400	48.	2.5
1,2,3-Trichloropropane	ND		ug/kg	400	26.	2.5
Styrene	56	J	ug/kg	200	40.	2.5
Dichlorodifluoromethane	ND		ug/kg	2000	180	2.5
Acetone	ND		ug/kg	2000	970	2.5
Carbon disulfide	ND		ug/kg	2000	220	2.5
Methyl ethyl ketone	ND		ug/kg	2000	450	2.5
Methyl isobutyl ketone	ND		ug/kg	2000	260	2.5
2-Hexanone	ND		ug/kg	2000	240	2.5
Bromochloromethane	ND		ug/kg	400	41.	2.5
Tetrahydrofuran	ND		ug/kg	810	320	2.5
2,2-Dichloropropane	ND		ug/kg	400	41.	2.5
1,2-Dibromoethane	ND		ug/kg	200	56.	2.5
1,3-Dichloropropane	ND		ug/kg	400	34.	2.5
1,1,1,2-Tetrachloroethane	ND		ug/kg	100	27.	2.5
Bromobenzene	ND		ug/kg	400	29.	2.5
n-Butylbenzene	1000		ug/kg	200	34.	2.5
sec-Butylbenzene	490		ug/kg	200	29.	2.5
tert-Butylbenzene	ND		ug/kg	400	24.	2.5
o-Chlorotoluene	ND		ug/kg	400	38.	2.5
p-Chlorotoluene	ND		ug/kg	400	22.	2.5
1,2-Dibromo-3-chloropropane	ND		ug/kg	600	200	2.5
Hexachlorobutadiene	ND		ug/kg	810	34.	2.5
Isopropylbenzene	16000		ug/kg	200	22.	2.5
p-Isopropyltoluene	6000		ug/kg	200	22.	2.5
Naphthalene	460000	E	ug/kg	810	130	2.5
n-Propylbenzene	6100		ug/kg	200	34.	2.5

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328

Project Number: 180327-08.01 **Report Date:** 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-17 D2 Date Collected: 09/30/21 14:20

Client ID: WC1-093021 Date Received: 09/30/21

Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP Volatile Organics by EPA 5035 High - Westborough Lab						
1,2,3-Trichlorobenzene	ND		ug/kg	400	65.	2.5
1,2,4-Trichlorobenzene	ND		ug/kg	400	55.	2.5
1,3,5-Trimethylbenzene	25000		ug/kg	400	39.	2.5
1,2,4-Trimethylbenzene	81000	E	ug/kg	400	67.	2.5
Diethyl ether	ND		ug/kg	400	69.	2.5
Diisopropyl Ether	ND		ug/kg	400	43.	2.5
Ethyl-Tert-Butyl-Ether	ND		ug/kg	400	26.	2.5
Tertiary-Amyl Methyl Ether	ND		ug/kg	400	36.	2.5
1,4-Dioxane	ND		ug/kg	16000	7100	2.5

Surrogate	% Recovery	Qualifier	Acceptance Criteria
1,2-Dichloroethane-d4	88		70-130
Toluene-d8	98		70-130
4-Bromofluorobenzene	98		70-130
Dibromofluoromethane	99		70-130

Project Name: FORMER HAVERHILL MGP
Lab Number: L2153328
Project Number: 180327-08.01
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-17 D
Client ID: WC1-093021
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 14:20
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8260C
Analytical Date: 10/14/21 02:22
Analyst: NLK
Percent Solids: 85%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP Volatile Organics by EPA 5035 High - Westborough Lab						
Ethylbenzene	99000		ug/kg	8100	1100	100
Naphthalene	1100000		ug/kg	32000	5200	100
1,2,4-Trimethylbenzene	68000		ug/kg	16000	2700	100

Surrogate	% Recovery	Qualifier	Acceptance Criteria
1,2-Dichloroethane-d4	107		70-130
Toluene-d8	92		70-130
4-Bromofluorobenzene	90		70-130
Dibromofluoromethane	122		70-130

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328

Project Number: 180327-08.01 **Report Date:** 11/24/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 97,8260C
Analytical Date: 10/14/21 13:38
Analyst: AJK

Parameter	Result	Qualifier	Units	RL	MDL
MCP Volatile Organics by EPA 5035 High - Westborough Lab for sample(s): 17 Batch: WG1559101-5					
Methylene chloride	ND		ug/kg	250	110
1,1-Dichloroethane	ND		ug/kg	50	7.2
Chloroform	ND		ug/kg	75	7.0
Carbon tetrachloride	ND		ug/kg	50	12.
1,2-Dichloropropane	ND		ug/kg	50	6.2
Dibromochloromethane	ND		ug/kg	50	7.0
1,1,2-Trichloroethane	ND		ug/kg	50	13.
Tetrachloroethene	ND		ug/kg	25	9.8
Chlorobenzene	ND		ug/kg	25	6.4
Trichlorofluoromethane	ND		ug/kg	200	35.
1,2-Dichloroethane	ND		ug/kg	50	13.
1,1,1-Trichloroethane	ND		ug/kg	25	8.4
Bromodichloromethane	ND		ug/kg	25	5.4
trans-1,3-Dichloropropene	ND		ug/kg	50	14.
cis-1,3-Dichloropropene	ND		ug/kg	25	7.9
1,3-Dichloropropene, Total	ND		ug/kg	25	7.9
1,1-Dichloropropene	ND		ug/kg	25	8.0
Bromoform	ND		ug/kg	200	12.
1,1,2,2-Tetrachloroethane	ND		ug/kg	25	8.3
Benzene	ND		ug/kg	25	8.3
Toluene	ND		ug/kg	50	27.
Ethylbenzene	ND		ug/kg	50	7.0
Chloromethane	ND		ug/kg	200	47.
Bromomethane	ND		ug/kg	100	29.
Vinyl chloride	ND		ug/kg	50	17.
Chloroethane	ND		ug/kg	100	23.
1,1-Dichloroethene	ND		ug/kg	50	12.
trans-1,2-Dichloroethene	ND		ug/kg	75	6.8
Trichloroethene	ND		ug/kg	25	6.8

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328

Project Number: 180327-08.01 **Report Date:** 11/24/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 97,8260C
Analytical Date: 10/14/21 13:38
Analyst: AJK

Parameter	Result	Qualifier	Units	RL	MDL
MCP Volatile Organics by EPA 5035 High - Westborough Lab for sample(s): 17 Batch: WG1559101-5					
1,2-Dichlorobenzene	ND		ug/kg	100	7.2
1,3-Dichlorobenzene	ND		ug/kg	100	7.4
1,4-Dichlorobenzene	ND		ug/kg	100	8.6
Methyl tert butyl ether	ND		ug/kg	100	10.
p/m-Xylene	ND		ug/kg	100	28.
o-Xylene	ND		ug/kg	50	14.
Xylenes, Total	ND		ug/kg	50	14.
cis-1,2-Dichloroethene	ND		ug/kg	50	8.8
1,2-Dichloroethene, Total	ND		ug/kg	50	6.8
Dibromomethane	ND		ug/kg	100	12.
1,2,3-Trichloropropane	ND		ug/kg	100	6.4
Styrene	ND		ug/kg	50	9.8
Dichlorodifluoromethane	ND		ug/kg	500	46.
Acetone	ND		ug/kg	500	240
Carbon disulfide	ND		ug/kg	500	55.
Methyl ethyl ketone	ND		ug/kg	500	110
Methyl isobutyl ketone	ND		ug/kg	500	64.
2-Hexanone	ND		ug/kg	500	59.
Bromochloromethane	ND		ug/kg	100	10.
Tetrahydrofuran	ND		ug/kg	200	80.
2,2-Dichloropropane	ND		ug/kg	100	10.
1,2-Dibromoethane	ND		ug/kg	50	14.
1,3-Dichloropropane	ND		ug/kg	100	8.4
1,1,1,2-Tetrachloroethane	ND		ug/kg	25	6.6
Bromobenzene	ND		ug/kg	100	7.2
n-Butylbenzene	ND		ug/kg	50	8.4
sec-Butylbenzene	ND		ug/kg	50	7.3
tert-Butylbenzene	ND		ug/kg	100	5.9
o-Chlorotoluene	ND		ug/kg	100	9.6

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328

Project Number: 180327-08.01 **Report Date:** 11/24/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 97,8260C
Analytical Date: 10/14/21 13:38
Analyst: AJK

Parameter	Result	Qualifier	Units	RL	MDL
MCP Volatile Organics by EPA 5035 High - Westborough Lab for sample(s): 17 Batch: WG1559101-5					
p-Chlorotoluene	ND		ug/kg	100	5.4
1,2-Dibromo-3-chloropropane	ND		ug/kg	150	50.
Hexachlorobutadiene	ND		ug/kg	200	8.4
Isopropylbenzene	ND		ug/kg	50	5.4
p-Isopropyltoluene	ND		ug/kg	50	5.4
Naphthalene	ND		ug/kg	200	32.
n-Propylbenzene	ND		ug/kg	50	8.6
1,2,3-Trichlorobenzene	18	J	ug/kg	100	16.
1,2,4-Trichlorobenzene	16	J	ug/kg	100	14.
1,3,5-Trimethylbenzene	ND		ug/kg	100	9.6
1,2,4-Trimethylbenzene	ND		ug/kg	100	17.
Diethyl ether	ND		ug/kg	100	17.
Diisopropyl Ether	ND		ug/kg	100	11.
Ethyl-Tert-Butyl-Ether	ND		ug/kg	100	6.4
Tertiary-Amyl Methyl Ether	ND		ug/kg	100	8.8
1,4-Dioxane	ND		ug/kg	4000	1800

Surrogate	%Recovery	Qualifier	Acceptance Criteria
1,2-Dichloroethane-d4	91		70-130
Toluene-d8	97		70-130
4-Bromofluorobenzene	92		70-130
Dibromofluoromethane	101		70-130

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328

Project Number: 180327-08.01 **Report Date:** 11/24/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 97,8260C
Analytical Date: 10/13/21 21:20
Analyst: AJK

Parameter	Result	Qualifier	Units	RL	MDL
MCP Volatile Organics by EPA 5035 High - Westborough Lab for sample(s): 17 Batch: WG1559114-5					
Methylene chloride	ND		ug/kg	250	110
1,1-Dichloroethane	ND		ug/kg	50	7.2
Chloroform	ND		ug/kg	75	7.0
Carbon tetrachloride	ND		ug/kg	50	12.
1,2-Dichloropropane	ND		ug/kg	50	6.2
Dibromochloromethane	ND		ug/kg	50	7.0
1,1,2-Trichloroethane	ND		ug/kg	50	13.
Tetrachloroethene	ND		ug/kg	25	9.8
Chlorobenzene	ND		ug/kg	25	6.4
Trichlorofluoromethane	ND		ug/kg	200	35.
1,2-Dichloroethane	ND		ug/kg	50	13.
1,1,1-Trichloroethane	ND		ug/kg	25	8.4
Bromodichloromethane	ND		ug/kg	25	5.4
trans-1,3-Dichloropropene	ND		ug/kg	50	14.
cis-1,3-Dichloropropene	ND		ug/kg	25	7.9
1,3-Dichloropropene, Total	ND		ug/kg	25	7.9
1,1-Dichloropropene	ND		ug/kg	25	8.0
Bromoform	ND		ug/kg	200	12.
1,1,2,2-Tetrachloroethane	ND		ug/kg	25	8.3
Benzene	ND		ug/kg	25	8.3
Toluene	ND		ug/kg	50	27.
Ethylbenzene	ND		ug/kg	50	7.0
Chloromethane	ND		ug/kg	200	47.
Bromomethane	ND		ug/kg	100	29.
Vinyl chloride	ND		ug/kg	50	17.
Chloroethane	ND		ug/kg	100	23.
1,1-Dichloroethene	ND		ug/kg	50	12.
trans-1,2-Dichloroethene	ND		ug/kg	75	6.8
Trichloroethene	ND		ug/kg	25	6.8

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328

Project Number: 180327-08.01 **Report Date:** 11/24/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 97,8260C
Analytical Date: 10/13/21 21:20
Analyst: AJK

Parameter	Result	Qualifier	Units	RL	MDL
MCP Volatile Organics by EPA 5035 High - Westborough Lab for sample(s): 17 Batch: WG1559114-5					
1,2-Dichlorobenzene	ND		ug/kg	100	7.2
1,3-Dichlorobenzene	ND		ug/kg	100	7.4
1,4-Dichlorobenzene	ND		ug/kg	100	8.6
Methyl tert butyl ether	ND		ug/kg	100	10.
p/m-Xylene	ND		ug/kg	100	28.
o-Xylene	ND		ug/kg	50	14.
Xylenes, Total	ND		ug/kg	50	14.
cis-1,2-Dichloroethene	ND		ug/kg	50	8.8
1,2-Dichloroethene, Total	ND		ug/kg	50	6.8
Dibromomethane	ND		ug/kg	100	12.
1,2,3-Trichloropropane	ND		ug/kg	100	6.4
Styrene	ND		ug/kg	50	9.8
Dichlorodifluoromethane	ND		ug/kg	500	46.
Acetone	ND		ug/kg	500	240
Carbon disulfide	ND		ug/kg	500	55.
Methyl ethyl ketone	ND		ug/kg	500	110
Methyl isobutyl ketone	ND		ug/kg	500	64.
2-Hexanone	ND		ug/kg	500	59.
Bromochloromethane	ND		ug/kg	100	10.
Tetrahydrofuran	ND		ug/kg	200	80.
2,2-Dichloropropane	ND		ug/kg	100	10.
1,2-Dibromoethane	ND		ug/kg	50	14.
1,3-Dichloropropane	ND		ug/kg	100	8.4
1,1,1,2-Tetrachloroethane	ND		ug/kg	25	6.6
Bromobenzene	ND		ug/kg	100	7.2
n-Butylbenzene	ND		ug/kg	50	8.4
sec-Butylbenzene	ND		ug/kg	50	7.3
tert-Butylbenzene	ND		ug/kg	100	5.9
o-Chlorotoluene	ND		ug/kg	100	9.6

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 97,8260C
Analytical Date: 10/13/21 21:20
Analyst: AJK

Parameter	Result	Qualifier	Units	RL	MDL
MCP Volatile Organics by EPA 5035 High - Westborough Lab for sample(s): 17 Batch: WG1559114-5					
p-Chlorotoluene	ND		ug/kg	100	5.4
1,2-Dibromo-3-chloropropane	ND		ug/kg	150	50.
Hexachlorobutadiene	ND		ug/kg	200	8.4
Isopropylbenzene	ND		ug/kg	50	5.4
p-Isopropyltoluene	ND		ug/kg	50	5.4
Naphthalene	ND		ug/kg	200	32.
n-Propylbenzene	ND		ug/kg	50	8.6
1,2,3-Trichlorobenzene	ND		ug/kg	100	16.
1,2,4-Trichlorobenzene	ND		ug/kg	100	14.
1,3,5-Trimethylbenzene	ND		ug/kg	100	9.6
1,2,4-Trimethylbenzene	ND		ug/kg	100	17.
Diethyl ether	ND		ug/kg	100	17.
Diisopropyl Ether	ND		ug/kg	100	11.
Ethyl-Tert-Butyl-Ether	ND		ug/kg	100	6.4
Tertiary-Amyl Methyl Ether	ND		ug/kg	100	8.8
1,4-Dioxane	ND		ug/kg	4000	1800

Surrogate	%Recovery	Qualifier	Acceptance Criteria
1,2-Dichloroethane-d4	104		70-130
Toluene-d8	95		70-130
4-Bromofluorobenzene	92		70-130
Dibromofluoromethane	114		70-130

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP Volatile Organics by EPA 5035 High - Westborough Lab Associated sample(s): 17 Batch: WG1559101-3 WG1559101-4								
Methylene chloride	102		97		70-130	5		20
1,1-Dichloroethane	101		96		70-130	5		20
Chloroform	94		90		70-130	4		20
Carbon tetrachloride	101		95		70-130	6		20
1,2-Dichloropropane	97		94		70-130	3		20
Dibromochloromethane	105		104		70-130	1		20
1,1,2-Trichloroethane	97		98		70-130	1		20
Tetrachloroethene	110		109		70-130	1		20
Chlorobenzene	107		104		70-130	3		20
Trichlorofluoromethane	101		94		70-130	7		20
1,2-Dichloroethane	85		85		70-130	0		20
1,1,1-Trichloroethane	103		98		70-130	5		20
Bromodichloromethane	95		93		70-130	2		20
trans-1,3-Dichloropropene	100		99		70-130	1		20
cis-1,3-Dichloropropene	102		100		70-130	2		20
1,1-Dichloropropene	109		103		70-130	6		20
Bromoform	84		87		70-130	4		20
1,1,2,2-Tetrachloroethane	84		87		70-130	4		20
Benzene	104		101		70-130	3		20
Toluene	103		100		70-130	3		20
Ethylbenzene	103		99		70-130	4		20
Chloromethane	94		87		70-130	8		20
Bromomethane	126		115		70-130	9		20

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP Volatile Organics by EPA 5035 High - Westborough Lab Associated sample(s): 17 Batch: WG1559101-3 WG1559101-4								
Vinyl chloride	101		93		70-130	8		20
Chloroethane	118		108		70-130	9		20
1,1-Dichloroethene	109		101		70-130	8		20
trans-1,2-Dichloroethene	109		102		70-130	7		20
Trichloroethene	106		102		70-130	4		20
1,2-Dichlorobenzene	103		100		70-130	3		20
1,3-Dichlorobenzene	106		102		70-130	4		20
1,4-Dichlorobenzene	103		100		70-130	3		20
Methyl tert butyl ether	82		83		70-130	1		20
p/m-Xylene	116		110		70-130	5		20
o-Xylene	103		98		70-130	5		20
cis-1,2-Dichloroethene	104		100		70-130	4		20
Dibromomethane	92		91		70-130	1		20
1,2,3-Trichloropropane	79		81		70-130	3		20
Styrene	107		102		70-130	5		20
Dichlorodifluoromethane	**61**	Q	**56**	Q	70-130	9		20
Acetone	83		87		70-130	5		20
Carbon disulfide	88		82		70-130	7		20
Methyl ethyl ketone	**61**	Q	**66**	Q	70-130	8		20
Methyl isobutyl ketone	77		83		70-130	8		20
2-Hexanone	**67**	Q	70		70-130	4		20
Bromochloromethane	104		103		70-130	1		20
Tetrahydrofuran	71		77		70-130	8		20

Lab Control Sample Analysis
Batch Quality Control

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01

Lab Number: L2153328
Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP Volatile Organics by EPA 5035 High - Westborough Lab Associated sample(s): 17 Batch: WG1559101-3 WG1559101-4								
2,2-Dichloropropane	100		94		70-130	6		20
1,2-Dibromoethane	91		91		70-130	0		20
1,3-Dichloropropane	97		98		70-130	1		20
1,1,1,2-Tetrachloroethane	106		105		70-130	1		20
Bromobenzene	108		105		70-130	3		20
n-Butylbenzene	102		98		70-130	4		20
sec-Butylbenzene	105		99		70-130	6		20
tert-Butylbenzene	107		101		70-130	6		20
o-Chlorotoluene	100		95		70-130	5		20
p-Chlorotoluene	99		94		70-130	5		20
1,2-Dibromo-3-chloropropane	92		96		70-130	4		20
Hexachlorobutadiene	98		94		70-130	4		20
Isopropylbenzene	103		96		70-130	7		20
p-Isopropyltoluene	108		102		70-130	6		20
Naphthalene	93		97		70-130	4		20
n-Propylbenzene	105		98		70-130	7		20
1,2,3-Trichlorobenzene	100		101		70-130	1		20
1,2,4-Trichlorobenzene	106		105		70-130	1		20
1,3,5-Trimethylbenzene	95		92		70-130	3		20
1,2,4-Trimethylbenzene	95		92		70-130	3		20
Diethyl ether	82		83		70-130	1		20
Diisopropyl Ether	92		91		70-130	1		20
Ethyl-Tert-Butyl-Ether	94		95		70-130	1		20

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP Volatile Organics by EPA 5035 High - Westborough Lab Associated sample(s): 17 Batch: WG1559101-3 WG1559101-4								
Tertiary-Amyl Methyl Ether	91		93		70-130	2		20
1,4-Dioxane	84		86		70-130	2		20

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria
1,2-Dichloroethane-d4	79		79		70-130
Toluene-d8	99		100		70-130
4-Bromofluorobenzene	91		90		70-130
Dibromofluoromethane	91		91		70-130

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP Volatile Organics by EPA 5035 High - Westborough Lab Associated sample(s): 17 Batch: WG1559114-3 WG1559114-4								
Methylene chloride	103		102		70-130	1		20
1,1-Dichloroethane	97		96		70-130	1		20
Chloroform	92		90		70-130	2		20
Carbon tetrachloride	101		100		70-130	1		20
1,2-Dichloropropane	96		96		70-130	0		20
Dibromochloromethane	108		105		70-130	3		20
1,1,2-Trichloroethane	100		97		70-130	3		20
Tetrachloroethene	110		110		70-130	0		20
Chlorobenzene	103		103		70-130	0		20
Trichlorofluoromethane	104		102		70-130	2		20
1,2-Dichloroethane	88		87		70-130	1		20
1,1,1-Trichloroethane	101		99		70-130	2		20
Bromodichloromethane	94		95		70-130	1		20
trans-1,3-Dichloropropene	101		97		70-130	4		20
cis-1,3-Dichloropropene	101		102		70-130	1		20
1,1-Dichloropropene	108		105		70-130	3		20
Bromoform	83		86		70-130	4		20
1,1,2,2-Tetrachloroethane	82		88		70-130	7		20
Benzene	102		101		70-130	1		20
Toluene	99		99		70-130	0		20
Ethylbenzene	99		96		70-130	3		20
Chloromethane	107		105		70-130	2		20
Bromomethane	120		118		70-130	2		20

Lab Control Sample Analysis
Batch Quality Control

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01

Lab Number: L2153328
Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP Volatile Organics by EPA 5035 High - Westborough Lab Associated sample(s): 17 Batch: WG1559114-3 WG1559114-4								
Vinyl chloride	112		109		70-130	3		20
Chloroethane	118		116		70-130	2		20
1,1-Dichloroethene	108		106		70-130	2		20
trans-1,2-Dichloroethene	105		104		70-130	1		20
Trichloroethene	104		102		70-130	2		20
1,2-Dichlorobenzene	100		101		70-130	1		20
1,3-Dichlorobenzene	101		101		70-130	0		20
1,4-Dichlorobenzene	98		99		70-130	1		20
Methyl tert butyl ether	88		87		70-130	1		20
p/m-Xylene	113		107		70-130	5		20
o-Xylene	102		97		70-130	5		20
cis-1,2-Dichloroethene	101		100		70-130	1		20
Dibromomethane	95		95		70-130	0		20
1,2,3-Trichloropropane	78		82		70-130	5		20
Styrene	106		101		70-130	5		20
Dichlorodifluoromethane	102		99		70-130	3		20
Acetone	122		121		70-130	1		20
Carbon disulfide	90		88		70-130	2		20
Methyl ethyl ketone	80		77		70-130	4		20
Methyl isobutyl ketone	83		84		70-130	1		20
2-Hexanone	72		74		70-130	3		20
Bromochloromethane	106		105		70-130	1		20
Tetrahydrofuran	82		80		70-130	2		20

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP Volatile Organics by EPA 5035 High - Westborough Lab Associated sample(s): 17 Batch: WG1559114-3 WG1559114-4								
2,2-Dichloropropane	98		95		70-130	3		20
1,2-Dibromoethane	95		92		70-130	3		20
1,3-Dichloropropane	100		98		70-130	2		20
1,1,1,2-Tetrachloroethane	104		103		70-130	1		20
Bromobenzene	100		104		70-130	4		20
n-Butylbenzene	94		95		70-130	1		20
sec-Butylbenzene	98		98		70-130	0		20
tert-Butylbenzene	102		100		70-130	2		20
o-Chlorotoluene	93		94		70-130	1		20
p-Chlorotoluene	93		94		70-130	1		20
1,2-Dibromo-3-chloropropane	96		94		70-130	2		20
Hexachlorobutadiene	91		91		70-130	0		20
Isopropylbenzene	95		95		70-130	0		20
p-Isopropyltoluene	100		100		70-130	0		20
Naphthalene	93		96		70-130	3		20
n-Propylbenzene	97		97		70-130	0		20
1,2,3-Trichlorobenzene	96		98		70-130	2		20
1,2,4-Trichlorobenzene	100		101		70-130	1		20
1,3,5-Trimethylbenzene	90		92		70-130	2		20
1,2,4-Trimethylbenzene	90		90		70-130	0		20
Diethyl ether	93		93		70-130	0		20
Diisopropyl Ether	87		89		70-130	2		20
Ethyl-Tert-Butyl-Ether	89		90		70-130	1		20

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP Volatile Organics by EPA 5035 High - Westborough Lab Associated sample(s): 17 Batch: WG1559114-3 WG1559114-4								
Tertiary-Amyl Methyl Ether	87		88		70-130	1		20
1,4-Dioxane	87		88		70-130	1		20

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria
1,2-Dichloroethane-d4	85		84		70-130
Toluene-d8	99		99		70-130
4-Bromofluorobenzene	89		91		70-130
Dibromofluoromethane	94		93		70-130

SEMIVOLATILES

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-01 D
Client ID: AQSS-05-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 14:50
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/16/21 17:35
Analyst: GP
Percent Solids: 85%

Extraction Method: EPA 3570
Extraction Date: 11/10/21 17:07
Cleanup Method: EPA 3630
Cleanup Date: 11/16/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Naphthalene	293	J	ug/kg	456	40.8	100
2-Methylnaphthalene	169	J	ug/kg	456	56.6	100
2-Chloronaphthalene	ND		ug/kg	456	35.7	100
Acenaphthylene	574		ug/kg	456	30.6	100
Acenaphthene	230	J	ug/kg	456	51.1	100
Fluorene	535		ug/kg	456	30.5	100
Phenanthrene	3890		ug/kg	456	53.8	100
Anthracene	848		ug/kg	456	56.6	100
Fluoranthene	5530		ug/kg	456	83.5	100
Pyrene	4940		ug/kg	456	46.5	100
Benz(a)anthracene	2380		ug/kg	456	122.	100
Chrysene	2760		ug/kg	456	40.1	100
Benzo(b)fluoranthene	2380		ug/kg	456	47.4	100
Benzo(k)fluoranthene	1900		ug/kg	456	47.0	100
Benzo(a)pyrene	2440		ug/kg	456	53.4	100
Indeno(1,2,3-cd)Pyrene	1410		ug/kg	456	130.	100
Dibenz(a,h)anthracene	345	J	ug/kg	456	47.0	100
Benzo(ghi)perylene	1480		ug/kg	456	37.6	100

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	82		30-130
Pyrene-d10	95		30-130
Benzo(b)fluoranthene-d12	79		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-02 D2
Client ID: AQSS-05-1.0-1.5
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 14:45
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/17/21 13:18
Analyst: GP
Percent Solids: 71%

Extraction Method: EPA 3570
Extraction Date: 11/10/21 17:07
Cleanup Method: EPA 3630
Cleanup Date: 11/16/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Phenanthrene	75600		ug/kg	428	50.5	80
Fluoranthene	71700		ug/kg	428	78.3	80
Pyrene	65700		ug/kg	428	43.6	80

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	77		30-130
Pyrene-d10	84		30-130
Benzo(b)fluoranthene-d12	68		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-02 D
Client ID: AQSS-05-1.0-1.5
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 14:45
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/16/21 19:16
Analyst: GP
Percent Solids: 71%

Extraction Method: EPA 3570
Extraction Date: 11/10/21 17:07
Cleanup Method: EPA 3630
Cleanup Date: 11/16/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Naphthalene	9270		ug/kg	214	19.2	40
2-Methylnaphthalene	4490		ug/kg	214	26.5	40
2-Chloronaphthalene	ND		ug/kg	214	16.8	40
Acenaphthylene	7190		ug/kg	214	14.3	40
Acenaphthene	6730		ug/kg	214	24.0	40
Fluorene	20000		ug/kg	214	14.3	40
Phenanthrene	82000	E	ug/kg	214	25.2	40
Anthracene	27700		ug/kg	214	26.5	40
Fluoranthene	79800	E	ug/kg	214	39.2	40
Pyrene	72200	E	ug/kg	214	21.8	40
Benz(a)anthracene	34300		ug/kg	214	57.1	40
Chrysene	32100		ug/kg	214	18.8	40
Benzo(b)fluoranthene	21700		ug/kg	214	22.2	40
Benzo(k)fluoranthene	24200		ug/kg	214	22.0	40
Benzo(a)pyrene	30500		ug/kg	214	25.0	40
Indeno(1,2,3-cd)Pyrene	15400		ug/kg	214	61.0	40
Dibenz(a,h)anthracene	4440		ug/kg	214	22.0	40
Benzo(ghi)perylene	15400		ug/kg	214	17.6	40

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	85		30-130
Pyrene-d10	86		30-130
Benzo(b)fluoranthene-d12	72		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-03
Client ID: AQSS-04-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 08:45
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 1,8270D-SIM(M)
Analytical Date: 11/07/21 21:26
Analyst: CC
Percent Solids: 85%

Extraction Method: ALPHA OP-013
Extraction Date: 10/27/21 20:16
Cleanup Method: EPA 3611B
Cleanup Date: 11/02/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
cis/trans-Decalin	3.34		ug/kg	3.28	0.653	1
C1-Decalins	10.4		ug/kg	3.28	0.653	1
C2-Decalins	36.1		ug/kg	3.28	0.653	1
C3-Decalins	53.6		ug/kg	3.28	0.653	1
C4-Decalins	84.4		ug/kg	3.28	0.653	1
Naphthalene	1850		ug/kg	6.57	1.89	1
C1-Naphthalenes	928.		ug/kg	6.57	1.89	1
C2-Naphthalenes	1160		ug/kg	6.57	1.89	1
C3-Naphthalenes	1000		ug/kg	6.57	1.89	1
C4-Naphthalenes	530.		ug/kg	6.57	1.89	1
2-Methylnaphthalene	798.		ug/kg	6.57	1.69	1
1-Methylnaphthalene	622.		ug/kg	6.57	2.07	1
Benzothiophene	67.4		ug/kg	6.57	2.06	1
C1-Benzo(b)thiophenes	50.1		ug/kg	6.57	2.06	1
C2-Benzo(b)thiophenes	76.6		ug/kg	6.57	2.06	1
C3-Benzo(b)thiophenes	90.2		ug/kg	6.57	2.06	1
C4-Benzo(b)thiophenes	51.4		ug/kg	6.57	2.06	1
Biphenyl	236.		ug/kg	6.57	2.03	1
2,6-Dimethylnaphthalene	403.		ug/kg	6.57	1.56	1
Dibenzofuran	1760		ug/kg	6.57	2.07	1
Acenaphthylene	1100		ug/kg	6.57	1.25	1
Acenaphthene	2540		ug/kg	6.57	1.16	1
2,3,5-Trimethylnaphthalene	121.		ug/kg	6.57	1.07	1
Fluorene	2750		ug/kg	6.57	1.75	1
C1-Fluorenes	932.		ug/kg	6.57	1.75	1
C2-Fluorenes	856.		ug/kg	6.57	1.75	1
C3-Fluorenes	1340	G	ug/kg	6.57	1.75	1
Dibenzothiophene	1550		ug/kg	6.57	1.81	1

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328

Project Number: 180327-08.01 **Report Date:** 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-03 Date Collected: 09/30/21 08:45

Client ID: AQSS-04-0.0-0.5 Date Received: 09/30/21

Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
4-Methyldibenzothiophene(4MDT)	295.		ug/kg	6.57	1.81	1
2/3-Methyldibenzothiophene(2MDT)	426.		ug/kg	6.57	1.81	1
1-Methyldibenzothiophene(1MDT)	106.		ug/kg	6.57	1.81	1
C1-Dibenzothiophenes BS	994.		ug/kg	6.57	1.81	1
C2-Dibenzothiophenes	699.		ug/kg	6.57	1.81	1
C3-Dibenzothiophenes	407.		ug/kg	6.57	1.81	1
C4-Dibenzothiophenes	136.		ug/kg	6.57	1.81	1
Phenanthrene	25400	E	ug/kg	6.57	2.18	1
3-Methylphenanthrene (3MP)	1660		ug/kg	6.57	2.18	1
2-Methylphenanthrene (2MP)	1980		ug/kg	6.57	2.18	1
2-Methylanthracene (2MA)	942.		ug/kg	6.57	2.18	1
9/4-Methylphenanthrene (9MP)	1540		ug/kg	6.57	2.18	1
C1-Phenanthrenes/Anthracenes	7170		ug/kg	6.57	2.18	1
C2-Phenanthrenes/Anthr BS	3420		ug/kg	6.57	2.18	1
C3-Phenanthrenes/Anthracenes	1310		ug/kg	6.57	2.18	1
C4-Phenanthrenes/Anthracenes	424.		ug/kg	6.57	2.18	1
Retene	ND		ug/kg	6.57	1.61	1
Anthracene	5840		ug/kg	6.57	1.35	1
Carbazole	2600		ug/kg	6.57	2.15	1
1-Methylphenanthrene	1400		ug/kg	6.57	1.73	1
Fluoranthene	26000	E	ug/kg	6.57	2.09	1
Benzo(b)fluorene	1610		ug/kg	6.57	1.90	1
7H-Benzo(c)fluorene	664.		ug/kg	6.57	1.90	1
2-Methylpyrene[1]	969.		ug/kg	6.57	1.73	1
4-Methylpyrene[1]	688.		ug/kg	6.57	1.73	1
1-Methylpyrene[1]	601.		ug/kg	6.57	1.73	1
Pyrene	21700	E	ug/kg	6.57	1.73	1
C1-Fluoranthenes/Pyrenes	7590		ug/kg	6.57	1.73	1
C2-Fluoranthenes/Pyrenes	3840		ug/kg	6.57	1.73	1
C3-Fluoranthenes/Pyrenes	1520		ug/kg	6.57	1.73	1
C4-Fluoranthenes/Pyrenes	799.		ug/kg	6.57	1.73	1
Naphthobenzothiophenes	1740		ug/kg	6.57	1.84	1
C1-Naphthobenzothiophenes	794.		ug/kg	6.57	1.84	1
C2-Naphthobenzothiophenes	404.		ug/kg	6.57	1.84	1
C3-Naphthobenzothiophenes	235.		ug/kg	6.57	1.84	1
C4-Naphthobenzothiophenes	114.		ug/kg	6.57	1.84	1
Benz(a)anthracene	11700	E	ug/kg	6.57	1.34	1

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328

Project Number: 180327-08.01 **Report Date:** 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-03 Date Collected: 09/30/21 08:45

Client ID: AQSS-04-0.0-0.5 Date Received: 09/30/21

Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
Chrysene	11400	E	ug/kg	6.57	1.33	1
C1-Chrysenes	4240		ug/kg	6.57	1.33	1
C2-Chrysenes BS	1880		ug/kg	6.57	1.33	1
C3-Chrysenes	1220		ug/kg	6.57	1.33	1
C4-Chrysenes	529.		ug/kg	6.57	1.33	1
Benzo(b)fluoranthene	9230	E	ug/kg	6.57	1.71	1
Benzo(j)+(k)fluoranthene	7250		ug/kg	6.57	1.30	1
Benzo(a)fluoranthene	1720		ug/kg	6.57	1.30	1
Benzo(e)pyrene	5800		ug/kg	6.57	1.35	1
Benzo(a)pyrene	10500	E	ug/kg	6.57	1.87	1
Perylene	2300		ug/kg	6.57	1.27	1
Indeno(1,2,3-cd)pyrene	6370		ug/kg	6.57	1.78	1
Dibenz(a,h)+(a,c)anthracene	2060		ug/kg	6.57	1.77	1
Benzo(g,h,i)perylene	6150		ug/kg	6.57	1.74	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Naphthalene-d8	79		50-130
Phenanthrene-d10	81		50-130
Benzo(a)pyrene-d12	77		50-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-03 D
Client ID: AQSS-04-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 08:45
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 1,8270D-SIM(M)
Analytical Date: 11/10/21 06:29
Analyst: CC
Percent Solids: 85%

Extraction Method: ALPHA OP-013
Extraction Date: 10/27/21 20:16
Cleanup Method: EPA 3611B
Cleanup Date: 11/02/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
Phenanthrene	25600		ug/kg	32.8	10.9	5
Fluoranthene	27700		ug/kg	32.8	10.4	5
Pyrene	22700		ug/kg	32.8	8.63	5
Benz(a)anthracene	9920		ug/kg	32.8	6.69	5
Chrysene	9750		ug/kg	32.8	6.64	5
Benzo(b)fluoranthene	7820		ug/kg	32.8	8.54	5
Benzo(a)pyrene	9130		ug/kg	32.8	9.37	5

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Naphthalene-d8	70		50-130
Phenanthrene-d10	92		50-130
Benzo(a)pyrene-d12	81		50-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-04
Client ID: AQSS-04-1.0-1.5
Sample Location: HAVERHILL, MA
Date Collected: 09/30/21 08:48
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 1,8270D-SIM(M)
Analytical Date: 11/07/21 22:51
Analyst: CC
Percent Solids: 79%

Extraction Method: ALPHA OP-013
Extraction Date: 10/27/21 20:16
Cleanup Method: EPA 3611B
Cleanup Date: 11/02/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
cis/trans-Decalin	8.07	J	ug/kg	15.1	3.00	1
C1-Decalins	33.3		ug/kg	15.1	3.00	1
C2-Decalins	74.3		ug/kg	15.1	3.00	1
C3-Decalins	ND		ug/kg	15.1	3.00	1
C4-Decalins	190.		ug/kg	15.1	3.00	1
Naphthalene	3220		ug/kg	30.2	8.67	1
C1-Naphthalenes	2080		ug/kg	30.2	8.67	1
C2-Naphthalenes	2220		ug/kg	30.2	8.67	1
C3-Naphthalenes	2090		ug/kg	30.2	8.67	1
C4-Naphthalenes	1220		ug/kg	30.2	8.67	1
2-Methylnaphthalene	1750		ug/kg	30.2	7.78	1
1-Methylnaphthalene	1440		ug/kg	30.2	9.51	1
Benzothiophene	105.		ug/kg	30.2	9.45	1
C1-Benzo(b)thiophenes	104.		ug/kg	30.2	9.45	1
C2-Benzo(b)thiophenes	174.		ug/kg	30.2	9.45	1
C3-Benzo(b)thiophenes	221.		ug/kg	30.2	9.45	1
C4-Benzo(b)thiophenes	137.		ug/kg	30.2	9.45	1
Biphenyl	391.		ug/kg	30.2	9.33	1
2,6-Dimethylnaphthalene	722.		ug/kg	30.2	7.17	1
Dibenzofuran	2470		ug/kg	30.2	9.50	1
Acenaphthylene	2880		ug/kg	30.2	5.76	1
Acenaphthene	2780		ug/kg	30.2	5.32	1
2,3,5-Trimethylnaphthalene	290.		ug/kg	30.2	4.94	1
Fluorene	4190		ug/kg	30.2	8.05	1
C1-Fluorenes	1900		ug/kg	30.2	8.05	1
C2-Fluorenes	1850		ug/kg	30.2	8.05	1
C3-Fluorenes	2640	G	ug/kg	30.2	8.05	1
Dibenzothiophene	2670		ug/kg	30.2	8.32	1

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328

Project Number: 180327-08.01 **Report Date:** 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-04 Date Collected: 09/30/21 08:48

Client ID: AQSS-04-1.0-1.5 Date Received: 09/30/21

Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
4-Methyldibenzothiophene(4MDT)	678.		ug/kg	30.2	8.32	1
2/3-Methyldibenzothiophene(2MDT)	908.		ug/kg	30.2	8.32	1
1-Methyldibenzothiophene(1MDT)	242.		ug/kg	30.2	8.32	1
C1-Dibenzothiophenes BS	2200		ug/kg	30.2	8.32	1
C2-Dibenzothiophenes	1710		ug/kg	30.2	8.32	1
C3-Dibenzothiophenes	1040		ug/kg	30.2	8.32	1
C4-Dibenzothiophenes	377.		ug/kg	30.2	8.32	1
Phenanthrene	36100		ug/kg	30.2	10.0	1
3-Methylphenanthrene (3MP)	3220		ug/kg	30.2	10.0	1
2-Methylphenanthrene (2MP)	3870		ug/kg	30.2	10.0	1
2-Methylanthracene (2MA)	1840		ug/kg	30.2	10.0	1
9/4-Methylphenanthrene (9MP)	3060		ug/kg	30.2	10.0	1
C1-Phenanthrenes/Anthracenes	14300		ug/kg	30.2	10.0	1
C2-Phenanthrenes/Anthr BS	7420		ug/kg	30.2	10.0	1
C3-Phenanthrenes/Anthracenes	2920		ug/kg	30.2	10.0	1
C4-Phenanthrenes/Anthracenes	971.		ug/kg	30.2	10.0	1
Retene	ND		ug/kg	30.2	7.40	1
Anthracene	9180		ug/kg	30.2	6.22	1
Carbazole	3520		ug/kg	30.2	9.87	1
1-Methylphenanthrene	3020		ug/kg	30.2	7.97	1
Fluoranthene	35500		ug/kg	30.2	9.59	1
Benzo(b)fluorene	2470		ug/kg	30.2	8.74	1
7H-Benzo(c)fluorene	1250		ug/kg	30.2	8.74	1
2-Methylpyrene[1]	1840		ug/kg	30.2	7.94	1
4-Methylpyrene[1]	1370		ug/kg	30.2	7.94	1
1-Methylpyrene[1]	1240		ug/kg	30.2	7.94	1
Pyrene	31300		ug/kg	30.2	7.94	1
C1-Fluoranthenes/Pyrenes	13700		ug/kg	30.2	7.94	1
C2-Fluoranthenes/Pyrenes	7060		ug/kg	30.2	7.94	1
C3-Fluoranthenes/Pyrenes	2760		ug/kg	30.2	7.94	1
C4-Fluoranthenes/Pyrenes	1510		ug/kg	30.2	7.94	1
Naphthobenzothiophenes	2680		ug/kg	30.2	8.44	1
C1-Naphthobenzothiophenes	1490		ug/kg	30.2	8.44	1
C2-Naphthobenzothiophenes	812.		ug/kg	30.2	8.44	1
C3-Naphthobenzothiophenes	424.		ug/kg	30.2	8.44	1
C4-Naphthobenzothiophenes	210.		ug/kg	30.2	8.44	1
Benz(a)anthracene	16200		ug/kg	30.2	6.15	1

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328

Project Number: 180327-08.01 **Report Date:** 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-04 Date Collected: 09/30/21 08:48

Client ID: AQSS-04-1.0-1.5 Date Received: 09/30/21

Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
Chrysene	16800		ug/kg	30.2	6.10	1
C1-Chrysenes	7680		ug/kg	30.2	6.10	1
C2-Chrysenes BS	3570		ug/kg	30.2	6.10	1
C3-Chrysenes	2220		ug/kg	30.2	6.10	1
C4-Chrysenes	1020		ug/kg	30.2	6.10	1
Benzo(b)fluoranthene	12200		ug/kg	30.2	7.85	1
Benzo(j)+(k)fluoranthene	11000		ug/kg	30.2	5.99	1
Benzo(a)fluoranthene	2610		ug/kg	30.2	5.99	1
Benzo(e)pyrene	8590		ug/kg	30.2	6.23	1
Benzo(a)pyrene	15100		ug/kg	30.2	8.62	1
Perylene	3400		ug/kg	30.2	5.82	1
Indeno(1,2,3-cd)pyrene	9400		ug/kg	30.2	8.19	1
Dibenz(a,h)+(a,c)anthracene	2800		ug/kg	30.2	8.15	1
Benzo(g,h,i)perylene	9450		ug/kg	30.2	8.02	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Naphthalene-d8	72		50-130
Phenanthrene-d10	82		50-130
Benzo(a)pyrene-d12	77		50-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-05
Client ID: DUP2-20210930
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 00:00
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 1,8270D-SIM(M)
Analytical Date: 11/08/21 03:07
Analyst: CC
Percent Solids: 85%

Extraction Method: ALPHA OP-013
Extraction Date: 10/27/21 20:16
Cleanup Method: EPA 3611B
Cleanup Date: 11/02/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
cis/trans-Decalin	2.30	J	ug/kg	2.80	0.557	1
C1-Decalins	6.31		ug/kg	2.80	0.557	1
C2-Decalins	19.4		ug/kg	2.80	0.557	1
C3-Decalins	ND		ug/kg	2.80	0.557	1
C4-Decalins	46.8		ug/kg	2.80	0.557	1
Naphthalene	860.		ug/kg	5.60	1.61	1
C1-Naphthalenes	544.		ug/kg	5.60	1.61	1
C2-Naphthalenes	374.		ug/kg	5.60	1.61	1
C3-Naphthalenes	356.		ug/kg	5.60	1.61	1
C4-Naphthalenes	196.		ug/kg	5.60	1.61	1
2-Methylnaphthalene	641.		ug/kg	5.60	1.44	1
1-Methylnaphthalene	188.		ug/kg	5.60	1.76	1
Benzothiophene	20.4		ug/kg	5.60	1.75	1
C1-Benzo(b)thiophenes	19.6		ug/kg	5.60	1.75	1
C2-Benzo(b)thiophenes	26.9		ug/kg	5.60	1.75	1
C3-Benzo(b)thiophenes	34.3		ug/kg	5.60	1.75	1
C4-Benzo(b)thiophenes	20.2		ug/kg	5.60	1.75	1
Biphenyl	73.7		ug/kg	5.60	1.73	1
2,6-Dimethylnaphthalene	127.		ug/kg	5.60	1.33	1
Dibenzofuran	508.		ug/kg	5.60	1.76	1
Acenaphthylene	830.		ug/kg	5.60	1.07	1
Acenaphthene	900.		ug/kg	5.60	0.987	1
2,3,5-Trimethylnaphthalene	49.4		ug/kg	5.60	0.916	1
Fluorene	1110		ug/kg	5.60	1.49	1
C1-Fluorenes	297.		ug/kg	5.60	1.49	1
C2-Fluorenes	319.		ug/kg	5.60	1.49	1
C3-Fluorenes	506.	G	ug/kg	5.60	1.49	1
Dibenzothiophene	464.		ug/kg	5.60	1.54	1

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328

Project Number: 180327-08.01 **Report Date:** 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-05 Date Collected: 09/30/21 00:00

Client ID: DUP2-20210930 Date Received: 09/30/21

Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
4-Methyldibenzothiophene(4MDT)	114.		ug/kg	5.60	1.54	1
2/3-Methyldibenzothiophene(2MDT)	138.		ug/kg	5.60	1.54	1
1-Methyldibenzothiophene(1MDT)	37.9		ug/kg	5.60	1.54	1
C1-Dibenzothiophenes BS	358.		ug/kg	5.60	1.54	1
C2-Dibenzothiophenes	272.		ug/kg	5.60	1.54	1
C3-Dibenzothiophenes	168.		ug/kg	5.60	1.54	1
C4-Dibenzothiophenes	63.3		ug/kg	5.60	1.54	1
Phenanthrene	7120		ug/kg	5.60	1.86	1
3-Methylphenanthrene (3MP)	557.		ug/kg	5.60	1.86	1
2-Methylphenanthrene (2MP)	656.		ug/kg	5.60	1.86	1
2-Methylanthracene (2MA)	282.		ug/kg	5.60	1.86	1
9/4-Methylphenanthrene (9MP)	481.		ug/kg	5.60	1.86	1
C1-Phenanthrenes/Anthracenes	2340		ug/kg	5.60	1.86	1
C2-Phenanthrenes/Anthr BS	1180		ug/kg	5.60	1.86	1
C3-Phenanthrenes/Anthracenes	446.		ug/kg	5.60	1.86	1
C4-Phenanthrenes/Anthracenes	153.		ug/kg	5.60	1.86	1
Retene	ND		ug/kg	5.60	1.37	1
Anthracene	1920		ug/kg	5.60	1.15	1
Carbazole	643.		ug/kg	5.60	1.83	1
1-Methylphenanthrene	508.		ug/kg	5.60	1.48	1
Fluoranthene	6730		ug/kg	5.60	1.78	1
Benzo(b)fluorene	378.		ug/kg	5.60	1.62	1
7H-Benzo(c)fluorene	154.		ug/kg	5.60	1.62	1
2-Methylpyrene[1]	300.		ug/kg	5.60	1.47	1
4-Methylpyrene[1]	224.		ug/kg	5.60	1.47	1
1-Methylpyrene[1]	199.		ug/kg	5.60	1.47	1
Pyrene	5760		ug/kg	5.60	1.47	1
C1-Fluoranthenes/Pyrenes	2180		ug/kg	5.60	1.47	1
C2-Fluoranthenes/Pyrenes	1270		ug/kg	5.60	1.47	1
C3-Fluoranthenes/Pyrenes	496.		ug/kg	5.60	1.47	1
C4-Fluoranthenes/Pyrenes	267.		ug/kg	5.60	1.47	1
Naphthobenzothiophenes	459.		ug/kg	5.60	1.57	1
C1-Naphthobenzothiophenes	251.		ug/kg	5.60	1.57	1
C2-Naphthobenzothiophenes	130.		ug/kg	5.60	1.57	1
C3-Naphthobenzothiophenes	75.7		ug/kg	5.60	1.57	1
C4-Naphthobenzothiophenes	37.1		ug/kg	5.60	1.57	1
Benz(a)anthracene	3310		ug/kg	5.60	1.14	1

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328

Project Number: 180327-08.01 **Report Date:** 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-05 Date Collected: 09/30/21 00:00

Client ID: DUP2-20210930 Date Received: 09/30/21

Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
Chrysene	3490		ug/kg	5.60	1.13	1
C1-Chrysenes	1310		ug/kg	5.60	1.13	1
C2-Chrysenes BS	598.		ug/kg	5.60	1.13	1
C3-Chrysenes	383.		ug/kg	5.60	1.13	1
C4-Chrysenes	159.		ug/kg	5.60	1.13	1
Benzo(b)fluoranthene	2640		ug/kg	5.60	1.46	1
Benzo(j)+(k)fluoranthene	2260		ug/kg	5.60	1.11	1
Benzo(a)fluoranthene	431.		ug/kg	5.60	1.11	1
Benzo(e)pyrene	1500		ug/kg	5.60	1.16	1
Benzo(a)pyrene	3000		ug/kg	5.60	1.60	1
Perylene	589.		ug/kg	5.60	1.08	1
Indeno(1,2,3-cd)pyrene	2110		ug/kg	5.60	1.52	1
Dibenz(a,h)+(a,c)anthracene	909.		ug/kg	5.60	1.51	1
Benzo(g,h,i)perylene	2080		ug/kg	5.60	1.49	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Naphthalene-d8	106		50-130
Phenanthrene-d10	108		50-130
Benzo(a)pyrene-d12	98		50-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-06 D
Client ID: AQSS-03-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 09:25
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/05/21 22:27
Analyst: GP
Percent Solids: 81%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 09:09
Cleanup Method: EPA 3630
Cleanup Date: 11/01/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Naphthalene	3590		ug/kg	492	44.0	100
2-Methylnaphthalene	1090		ug/kg	492	61.0	100
2-Chloronaphthalene	ND		ug/kg	492	38.5	100
Acenaphthylene	2760		ug/kg	492	33.0	100
Acenaphthene	2060		ug/kg	492	55.1	100
Fluorene	5050		ug/kg	492	32.9	100
Phenanthrene	19400		ug/kg	492	58.0	100
Anthracene	7640		ug/kg	492	61.0	100
Fluoranthene	20300		ug/kg	492	90.0	100
Pyrene	17600		ug/kg	492	50.2	100
Benz(a)anthracene	8810		ug/kg	492	131.	100
Chrysene	7630		ug/kg	492	43.2	100
Benzo(b)fluoranthene	7060		ug/kg	492	51.2	100
Benzo(k)fluoranthene	5320		ug/kg	492	50.7	100
Benzo(a)pyrene	8140		ug/kg	492	57.6	100
Indeno(1,2,3-cd)Pyrene	4420		ug/kg	492	140.	100
Dibenz(a,h)anthracene	1040		ug/kg	492	50.7	100
Benzo(ghi)perylene	4270		ug/kg	492	40.5	100

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	58		30-130
Pyrene-d10	70		30-130
Benzo(b)fluoranthene-d12	66		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-07 D2
Client ID: AQSS-03-2.0-2.5
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 09:30
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/12/21 14:16
Analyst: GP
Percent Solids: 82%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 09:09
Cleanup Method: EPA 3630
Cleanup Date: 11/01/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Phenanthrene	31800		ug/kg	190	22.4	40
Fluoranthene	32900		ug/kg	190	34.7	40
Pyrene	26900		ug/kg	190	19.4	40

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	55		30-130
Pyrene-d10	60		30-130
Benzo(b)fluoranthene-d12	58		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-07 D
Client ID: AQSS-03-2.0-2.5
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 09:30
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/05/21 22:57
Analyst: GP
Percent Solids: 82%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 09:09
Cleanup Method: EPA 3630
Cleanup Date: 11/01/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Naphthalene	5990		ug/kg	94.9	8.49	20
2-Methylnaphthalene	1770		ug/kg	94.9	11.8	20
2-Chloronaphthalene	ND		ug/kg	94.9	7.43	20
Acenaphthylene	4390		ug/kg	94.9	6.36	20
Acenaphthene	2870		ug/kg	94.9	10.6	20
Fluorene	8200		ug/kg	94.9	6.34	20
Phenanthrene	28600	E	ug/kg	94.9	11.2	20
Anthracene	12000		ug/kg	94.9	11.8	20
Fluoranthene	30500	E	ug/kg	94.9	17.4	20
Pyrene	26300	E	ug/kg	94.9	9.68	20
Benz(a)anthracene	13800		ug/kg	94.9	25.3	20
Chrysene	11300		ug/kg	94.9	8.34	20
Benzo(b)fluoranthene	9310		ug/kg	94.9	9.87	20
Benzo(k)fluoranthene	8640		ug/kg	94.9	9.78	20
Benzo(a)pyrene	12000		ug/kg	94.9	11.1	20
Indeno(1,2,3-cd)Pyrene	7080		ug/kg	94.9	27.0	20
Dibenz(a,h)anthracene	1980		ug/kg	94.9	9.78	20
Benzo(ghi)perylene	6510		ug/kg	94.9	7.82	20

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	49		30-130
Pyrene-d10	58		30-130
Benzo(b)fluoranthene-d12	53		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-08
Client ID: AQSS-07D-4.9-5.4
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 09:35
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 1,8270D-SIM(M)
Analytical Date: 11/08/21 05:58
Analyst: CC
Percent Solids: 84%

Extraction Method: ALPHA OP-013
Extraction Date: 10/27/21 20:16
Cleanup Method: EPA 3611B
Cleanup Date: 11/02/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
cis/trans-Decalin	0.676		ug/kg	0.593	0.118	1
C1-Decalins	2.39		ug/kg	0.593	0.118	1
C2-Decalins	4.70		ug/kg	0.593	0.118	1
C3-Decalins	5.08		ug/kg	0.593	0.118	1
C4-Decalins	7.87		ug/kg	0.593	0.118	1
Naphthalene	12.1		ug/kg	1.18	0.341	1
C1-Naphthalenes	9.79		ug/kg	1.18	0.341	1
C2-Naphthalenes	25.3		ug/kg	1.18	0.341	1
C3-Naphthalenes	41.2		ug/kg	1.18	0.341	1
C4-Naphthalenes	21.9		ug/kg	1.18	0.341	1
2-Methylnaphthalene	5.13		ug/kg	1.18	0.306	1
1-Methylnaphthalene	10.3		ug/kg	1.18	0.374	1
Benzothiophene	0.420	J	ug/kg	1.18	0.371	1
C1-Benzo(b)thiophenes	0.916	J	ug/kg	1.18	0.371	1
C2-Benzo(b)thiophenes	1.90		ug/kg	1.18	0.371	1
C3-Benzo(b)thiophenes	4.28		ug/kg	1.18	0.371	1
C4-Benzo(b)thiophenes	2.67		ug/kg	1.18	0.371	1
Biphenyl	4.39		ug/kg	1.18	0.366	1
2,6-Dimethylnaphthalene	5.05		ug/kg	1.18	0.282	1
Dibenzofuran	15.5		ug/kg	1.18	0.373	1
Acenaphthylene	29.1		ug/kg	1.18	0.226	1
Acenaphthene	19.8		ug/kg	1.18	0.209	1
2,3,5-Trimethylnaphthalene	4.49		ug/kg	1.18	0.194	1
Fluorene	35.5		ug/kg	1.18	0.316	1
C1-Fluorenes	29.6		ug/kg	1.18	0.316	1
C2-Fluorenes	29.4		ug/kg	1.18	0.316	1
C3-Fluorenes	17.0		ug/kg	1.18	0.316	1
Dibenzothiophene	18.7		ug/kg	1.18	0.327	1

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328

Project Number: 180327-08.01 **Report Date:** 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-08 Date Collected: 09/30/21 09:35

Client ID: AQSS-07D-4.9-5.4 Date Received: 09/30/21

Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
4-Methyldibenzothiophene(4MDT)	7.30		ug/kg	1.18	0.327	1
2/3-Methyldibenzothiophene(2MDT)	8.52		ug/kg	1.18	0.327	1
1-Methyldibenzothiophene(1MDT)	2.65		ug/kg	1.18	0.327	1
C1-Dibenzothiophenes BS	20.8		ug/kg	1.18	0.327	1
C2-Dibenzothiophenes	19.9		ug/kg	1.18	0.327	1
C3-Dibenzothiophenes	12.0		ug/kg	1.18	0.327	1
C4-Dibenzothiophenes	4.63		ug/kg	1.18	0.327	1
Phenanthrene	240.		ug/kg	1.18	0.393	1
3-Methylphenanthrene (3MP)	34.7		ug/kg	1.18	0.393	1
2-Methylphenanthrene (2MP)	33.4		ug/kg	1.18	0.393	1
2-Methylanthracene (2MA)	27.4		ug/kg	1.18	0.393	1
9/4-Methylphenanthrene (9MP)	33.3		ug/kg	1.18	0.393	1
C1-Phenanthrenes/Anthracenes	160.		ug/kg	1.18	0.393	1
C2-Phenanthrenes/Anthr BS	91.7		ug/kg	1.18	0.393	1
C3-Phenanthrenes/Anthracenes	34.8		ug/kg	1.18	0.393	1
C4-Phenanthrenes/Anthracenes	8.67		ug/kg	1.18	0.393	1
Retene	ND		ug/kg	1.18	0.291	1
Anthracene	107.		ug/kg	1.18	0.244	1
Carbazole	4.00		ug/kg	1.18	0.388	1
1-Methylphenanthrene	34.5		ug/kg	1.18	0.313	1
Fluoranthene	226.		ug/kg	1.18	0.377	1
Benzo(b)fluorene	39.1		ug/kg	1.18	0.344	1
7H-Benzo(c)fluorene	13.1		ug/kg	1.18	0.344	1
2-Methylpyrene[1]	18.5		ug/kg	1.18	0.312	1
4-Methylpyrene[1]	16.3		ug/kg	1.18	0.312	1
1-Methylpyrene[1]	17.8		ug/kg	1.18	0.312	1
Pyrene	213.		ug/kg	1.18	0.312	1
C1-Fluoranthenes/Pyrenes	165.		ug/kg	1.18	0.312	1
C2-Fluoranthenes/Pyrenes	57.1		ug/kg	1.18	0.312	1
C3-Fluoranthenes/Pyrenes	21.4		ug/kg	1.18	0.312	1
C4-Fluoranthenes/Pyrenes	9.91		ug/kg	1.18	0.312	1
Naphthobenzothiophenes	19.4		ug/kg	1.18	0.332	1
C1-Naphthobenzothiophenes	13.1		ug/kg	1.18	0.332	1
C2-Naphthobenzothiophenes	7.17		ug/kg	1.18	0.332	1
C3-Naphthobenzothiophenes	4.15		ug/kg	1.18	0.332	1
C4-Naphthobenzothiophenes	ND		ug/kg	1.18	0.332	1
Benz(a)anthracene	116.		ug/kg	1.18	0.242	1

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328

Project Number: 180327-08.01 **Report Date:** 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-08 Date Collected: 09/30/21 09:35

Client ID: AQSS-07D-4.9-5.4 Date Received: 09/30/21

Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
Chrysene	130.		ug/kg	1.18	0.240	1
C1-Chrysenes	66.0		ug/kg	1.18	0.240	1
C2-Chrysenes BS	29.9		ug/kg	1.18	0.240	1
C3-Chrysenes	15.6		ug/kg	1.18	0.240	1
C4-Chrysenes	8.09		ug/kg	1.18	0.240	1
Benzo(b)fluoranthene	58.5		ug/kg	1.18	0.308	1
Benzo(j)+(k)fluoranthene	78.8		ug/kg	1.18	0.235	1
Benzo(a)fluoranthene	23.3		ug/kg	1.18	0.235	1
Benzo(e)pyrene	53.3		ug/kg	1.18	0.245	1
Benzo(a)pyrene	101.		ug/kg	1.18	0.338	1
Perylene	26.1		ug/kg	1.18	0.229	1
Indeno(1,2,3-cd)pyrene	53.8		ug/kg	1.18	0.322	1
Dibenz(a,h)+(a,c)anthracene	15.3		ug/kg	1.18	0.320	1
Benzo(g,h,i)perylene	55.6		ug/kg	1.18	0.315	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Naphthalene-d8	69		50-130
Phenanthrene-d10	87		50-130
Benzo(a)pyrene-d12	77		50-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-09
Client ID: AQSS-19-3.0-3.5
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 10:33
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/05/21 14:18
Analyst: GP
Percent Solids: 89%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 09:09
Cleanup Method: EPA 3630
Cleanup Date: 11/01/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Naphthalene	329		ug/kg	4.24	0.379	1
2-Methylnaphthalene	301		ug/kg	4.24	0.525	1
2-Chloronaphthalene	0.378	J	ug/kg	4.24	0.332	1
Acenaphthylene	19.3		ug/kg	4.24	0.284	1
Acenaphthene	166		ug/kg	4.24	0.475	1
Fluorene	130		ug/kg	4.24	0.283	1
Phenanthrene	375		ug/kg	4.24	0.500	1
Anthracene	89.5		ug/kg	4.24	0.525	1
Fluoranthene	139		ug/kg	4.24	0.776	1
Pyrene	145		ug/kg	4.24	0.432	1
Benz(a)anthracene	76.9		ug/kg	4.24	1.13	1
Chrysene	64.9		ug/kg	4.24	0.372	1
Benzo(b)fluoranthene	47.8		ug/kg	4.24	0.441	1
Benzo(k)fluoranthene	41.6		ug/kg	4.24	0.436	1
Benzo(a)pyrene	58.6		ug/kg	4.24	0.496	1
Indeno(1,2,3-cd)Pyrene	34.9		ug/kg	4.24	1.21	1
Dibenz(a,h)anthracene	7.94		ug/kg	4.24	0.436	1
Benzo(ghi)perylene	30.4		ug/kg	4.24	0.349	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	63		30-130
Pyrene-d10	73		30-130
Benzo(b)fluoranthene-d12	70		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-10
Client ID: AQSS-19-4.5-5.0
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 10:35
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/05/21 15:50
Analyst: GP
Percent Solids: 88%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 11:50
Cleanup Method: EPA 3630
Cleanup Date: 11/01/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Naphthalene	215		ug/kg	4.44	0.398	1
2-Methylnaphthalene	152		ug/kg	4.44	0.551	1
2-Chloronaphthalene	ND		ug/kg	4.44	0.348	1
Acenaphthylene	7.32		ug/kg	4.44	0.298	1
Acenaphthene	93.2		ug/kg	4.44	0.498	1
Fluorene	71.8		ug/kg	4.44	0.297	1
Phenanthrene	214		ug/kg	4.44	0.524	1
Anthracene	43.5		ug/kg	4.44	0.551	1
Fluoranthene	51.6		ug/kg	4.44	0.813	1
Pyrene	50.8		ug/kg	4.44	0.453	1
Benz(a)anthracene	25.7		ug/kg	4.44	1.19	1
Chrysene	21.0		ug/kg	4.44	0.391	1
Benzo(b)fluoranthene	17.4		ug/kg	4.44	0.462	1
Benzo(k)fluoranthene	14.7		ug/kg	4.44	0.458	1
Benzo(a)pyrene	20.6		ug/kg	4.44	0.520	1
Indeno(1,2,3-cd)Pyrene	11.4		ug/kg	4.44	1.27	1
Dibenz(a,h)anthracene	2.74	J	ug/kg	4.44	0.458	1
Benzo(ghi)perylene	10.9		ug/kg	4.44	0.366	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	60		30-130
Pyrene-d10	75		30-130
Benzo(b)fluoranthene-d12	70		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-11
Client ID: AQSS-18-4.6-4.8
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 13:52
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/05/21 16:21
Analyst: GP
Percent Solids: 84%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 11:50
Cleanup Method: EPA 3630
Cleanup Date: 11/01/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Naphthalene	4.21	J	ug/kg	4.35	0.390	1
2-Methylnaphthalene	1.61	J	ug/kg	4.35	0.540	1
2-Chloronaphthalene	ND		ug/kg	4.35	0.341	1
Acenaphthylene	4.43		ug/kg	4.35	0.292	1
Acenaphthene	3.47	J	ug/kg	4.35	0.488	1
Fluorene	9.29		ug/kg	4.35	0.291	1
Phenanthrene	88.7		ug/kg	4.35	0.514	1
Anthracene	39.0		ug/kg	4.35	0.540	1
Fluoranthene	103		ug/kg	4.35	0.796	1
Pyrene	88.4		ug/kg	4.35	0.444	1
Benz(a)anthracene	48.4		ug/kg	4.35	1.16	1
Chrysene	44.9		ug/kg	4.35	0.383	1
Benzo(b)fluoranthene	32.9		ug/kg	4.35	0.453	1
Benzo(k)fluoranthene	28.4		ug/kg	4.35	0.448	1
Benzo(a)pyrene	40.1		ug/kg	4.35	0.509	1
Indeno(1,2,3-cd)Pyrene	23.4		ug/kg	4.35	1.24	1
Dibenz(a,h)anthracene	6.63		ug/kg	4.35	0.448	1
Benzo(ghi)perylene	20.2		ug/kg	4.35	0.359	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	54		30-130
Pyrene-d10	71		30-130
Benzo(b)fluoranthene-d12	68		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-12 D2
Client ID: AQSS-18-3.0-3.5
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 13:54
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/12/21 14:46
Analyst: GP
Percent Solids: 84%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 11:50
Cleanup Method: EPA 3630
Cleanup Date: 11/01/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Acenaphthene	155000		ug/kg	4590	514.	1000
Fluorene	213000		ug/kg	4590	307.	1000
Phenanthrene	797000		ug/kg	4590	542.	1000
Anthracene	189000		ug/kg	4590	570.	1000
Fluoranthene	614000		ug/kg	4590	840.	1000
Pyrene	534000		ug/kg	4590	468.	1000
Benz(a)anthracene	236000		ug/kg	4590	1230	1000
Chrysene	217000		ug/kg	4590	404.	1000
Benzo(b)fluoranthene	144000		ug/kg	4590	478.	1000
Benzo(k)fluoranthene	147000		ug/kg	4590	473.	1000
Benzo(a)pyrene	197000		ug/kg	4590	537.	1000
Indeno(1,2,3-cd)Pyrene	100000		ug/kg	4590	1310	1000
Benzo(ghi)perylene	113000		ug/kg	4590	378.	1000

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	100		30-130
Pyrene-d10	97		30-130
Benzo(b)fluoranthene-d12	110		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-12 D
Client ID: AQSS-18-3.0-3.5
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 13:54
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/05/21 23:27
Analyst: GP
Percent Solids: 84%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 11:50
Cleanup Method: EPA 3630
Cleanup Date: 11/01/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Naphthalene	67600		ug/kg	459	41.1	100
2-Methylnaphthalene	34100		ug/kg	459	57.0	100
2-Chloronaphthalene	144	J	ug/kg	459	36.0	100
Acenaphthylene	50100		ug/kg	459	30.8	100
Acenaphthene	117000	E	ug/kg	459	51.4	100
Fluorene	161000	E	ug/kg	459	30.7	100
Phenanthrene	556000	E	ug/kg	459	54.2	100
Anthracene	174000	E	ug/kg	459	57.0	100
Fluoranthene	451000	E	ug/kg	459	84.0	100
Pyrene	406000	E	ug/kg	459	46.8	100
Benz(a)anthracene	199000	E	ug/kg	459	123.	100
Chrysene	171000	E	ug/kg	459	40.4	100
Benzo(b)fluoranthene	123000	E	ug/kg	459	47.8	100
Benzo(k)fluoranthene	108000	E	ug/kg	459	47.3	100
Benzo(a)pyrene	168000	E	ug/kg	459	53.7	100
Indeno(1,2,3-cd)Pyrene	102000	E	ug/kg	459	131.	100
Dibenz(a,h)anthracene	25900		ug/kg	459	47.3	100
Benzo(ghi)perylene	92300	E	ug/kg	459	37.8	100

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	73		30-130
Pyrene-d10	106		30-130
Benzo(b)fluoranthene-d12	72		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-13 D
Client ID: AQSS-18-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 13:55
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/05/21 23:57
Analyst: GP
Percent Solids: 91%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 11:50
Cleanup Method: EPA 3630
Cleanup Date: 11/01/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Naphthalene	8220		ug/kg	82.3	7.36	20
2-Methylnaphthalene	1570		ug/kg	82.3	10.2	20
2-Chloronaphthalene	12.4	J	ug/kg	82.3	6.44	20
Acenaphthylene	390		ug/kg	82.3	5.51	20
Acenaphthene	5290		ug/kg	82.3	9.21	20
Fluorene	1900		ug/kg	82.3	5.50	20
Phenanthrene	5840		ug/kg	82.3	9.71	20
Anthracene	1320		ug/kg	82.3	10.2	20
Fluoranthene	3160		ug/kg	82.3	15.0	20
Pyrene	2770		ug/kg	82.3	8.39	20
Benz(a)anthracene	1240		ug/kg	82.3	22.0	20
Chrysene	1090		ug/kg	82.3	7.23	20
Benzo(b)fluoranthene	1100		ug/kg	82.3	8.56	20
Benzo(k)fluoranthene	839		ug/kg	82.3	8.47	20
Benzo(a)pyrene	1140		ug/kg	82.3	9.62	20
Indeno(1,2,3-cd)Pyrene	742		ug/kg	82.3	23.4	20
Dibenz(a,h)anthracene	186		ug/kg	82.3	8.47	20
Benzo(ghi)perylene	693		ug/kg	82.3	6.78	20

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	67		30-130
Pyrene-d10	78		30-130
Benzo(b)fluoranthene-d12	73		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-14 D2
Client ID: AQSS-20-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 12:50
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/12/21 15:17
Analyst: GP
Percent Solids: 87%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 11:50
Cleanup Method: EPA 3630
Cleanup Date: 11/01/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Naphthalene	227000		ug/kg	2280	204.	500
2-Methylnaphthalene	243000		ug/kg	2280	282.	500
Acenaphthene	118000		ug/kg	2280	255.	500
Phenanthrene	246000		ug/kg	2280	268.	500
Pyrene	150000		ug/kg	2280	232.	500

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	98		30-130
Pyrene-d10	94		30-130
Benzo(b)fluoranthene-d12	80		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-14 D
Client ID: AQSS-20-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 12:50
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/06/21 00:27
Analyst: GP
Percent Solids: 87%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 11:50
Cleanup Method: EPA 3630
Cleanup Date: 11/01/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Naphthalene	178000	E	ug/kg	455	40.7	100
2-Methylnaphthalene	195000	E	ug/kg	455	56.4	100
2-Chloronaphthalene	251	J	ug/kg	455	35.6	100
Acenaphthylene	29700		ug/kg	455	30.5	100
Acenaphthene	97000	E	ug/kg	455	51.0	100
Fluorene	48400		ug/kg	455	30.4	100
Phenanthrene	199000	E	ug/kg	455	53.7	100
Anthracene	56700		ug/kg	455	56.4	100
Fluoranthene	85300		ug/kg	455	83.3	100
Pyrene	132000	E	ug/kg	455	46.4	100
Benz(a)anthracene	54900		ug/kg	455	121.	100
Chrysene	60300		ug/kg	455	40.0	100
Benzo(b)fluoranthene	27700		ug/kg	455	47.3	100
Benzo(k)fluoranthene	20000		ug/kg	455	46.9	100
Benzo(a)pyrene	43600		ug/kg	455	53.2	100
Indeno(1,2,3-cd)Pyrene	19700		ug/kg	455	130.	100
Dibenz(a,h)anthracene	7350		ug/kg	455	46.9	100
Benzo(ghi)perylene	23600		ug/kg	455	37.5	100

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	72		30-130
Pyrene-d10	113		30-130
Benzo(b)fluoranthene-d12	70		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-15
Client ID: AQSS-20-4.2-4.5
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 12:45
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/05/21 16:52
Analyst: GP
Percent Solids: 83%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 11:50
Cleanup Method: EPA 3630
Cleanup Date: 11/01/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Naphthalene	168		ug/kg	4.72	0.422	1
2-Methylnaphthalene	78.2		ug/kg	4.72	0.585	1
2-Chloronaphthalene	ND		ug/kg	4.72	0.370	1
Acenaphthylene	14.8		ug/kg	4.72	0.316	1
Acenaphthene	48.4		ug/kg	4.72	0.529	1
Fluorene	59.6		ug/kg	4.72	0.315	1
Phenanthrene	191		ug/kg	4.72	0.557	1
Anthracene	56.0		ug/kg	4.72	0.585	1
Fluoranthene	96.9		ug/kg	4.72	0.864	1
Pyrene	96.0		ug/kg	4.72	0.482	1
Benz(a)anthracene	44.2		ug/kg	4.72	1.26	1
Chrysene	37.5		ug/kg	4.72	0.415	1
Benzo(b)fluoranthene	27.0		ug/kg	4.72	0.491	1
Benzo(k)fluoranthene	22.3		ug/kg	4.72	0.486	1
Benzo(a)pyrene	35.4		ug/kg	4.72	0.552	1
Indeno(1,2,3-cd)Pyrene	19.8		ug/kg	4.72	1.34	1
Dibenz(a,h)anthracene	4.62	J	ug/kg	4.72	0.486	1
Benzo(ghi)perylene	17.6		ug/kg	4.72	0.389	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	58		30-130
Pyrene-d10	77		30-130
Benzo(b)fluoranthene-d12	74		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-16
Client ID: RB01-092921
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 17:25
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Water
Analytical Method: 1,8270D-SIM(M)
Analytical Date: 10/11/21 00:11
Analyst: CC

Extraction Method: EPA 3510C
Extraction Date: 10/06/21 19:40

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
cis/trans-Decalin	ND		ng/l	4.95	1.10	1
C1-Decalins	ND		ng/l	4.95	1.10	1
C2-Decalins	ND		ng/l	4.95	1.10	1
C3-Decalins	ND		ng/l	4.95	1.10	1
C4-Decalins	ND		ng/l	4.95	1.10	1
Naphthalene	85.8		ng/l	9.90	1.95	1
C1-Naphthalenes	4.92	J	ng/l	9.90	1.95	1
C2-Naphthalenes	ND		ng/l	9.90	1.95	1
C3-Naphthalenes	ND		ng/l	9.90	1.95	1
C4-Naphthalenes	ND		ng/l	9.90	1.95	1
2-Methylnaphthalene	3.68	J	ng/l	9.90	2.28	1
1-Methylnaphthalene	2.20	J	ng/l	9.90	1.93	1
Benzothiophene	ND		ng/l	9.90	1.50	1
C1-Benzo(b)thiophenes	ND		ng/l	9.90	1.50	1
C2-Benzo(b)thiophenes	ND		ng/l	9.90	1.50	1
C3-Benzo(b)thiophenes	ND		ng/l	9.90	1.50	1
C4-Benzo(b)thiophenes	ND		ng/l	9.90	1.50	1
Biphenyl	ND		ng/l	9.90	2.31	1
2,6-Dimethylnaphthalene	ND		ng/l	9.90	2.31	1
Dibenzofuran	ND		ng/l	9.90	1.80	1
Acenaphthylene	ND		ng/l	9.90	1.98	1
Acenaphthene	ND		ng/l	9.90	1.27	1
2,3,5-Trimethylnaphthalene	ND		ng/l	9.90	1.50	1
Fluorene	ND		ng/l	9.90	1.75	1
C1-Fluorenes	ND		ng/l	9.90	1.75	1
C2-Fluorenes	ND		ng/l	9.90	1.75	1
C3-Fluorenes	ND		ng/l	9.90	1.75	1
Dibenzothiophene	ND		ng/l	9.90	1.44	1

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328

Project Number: 180327-08.01 **Report Date:** 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-16 Date Collected: 09/29/21 17:25

Client ID: RB01-092921 Date Received: 09/30/21

Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
4-Methyldibenzothiophene(4MDT)	ND		ng/l	9.90	1.44	1
2/3-Methyldibenzothiophene(2MDT)	ND		ng/l	9.90	1.44	1
1-Methyldibenzothiophene(1MDT)	ND		ng/l	9.90	1.44	1
C1-Dibenzothiophenes BS	ND		ng/l	9.90	1.44	1
C2-Dibenzothiophenes	ND		ng/l	9.90	1.44	1
C3-Dibenzothiophenes	ND		ng/l	9.90	1.44	1
C4-Dibenzothiophenes	ND		ng/l	9.90	1.44	1
Phenanthrene	5.62	J	ng/l	9.90	1.19	1
3-Methylphenanthrene (3MP)	ND		ng/l	9.90	1.19	1
2-Methylphenanthrene (2MP)	ND		ng/l	9.90	1.19	1
2-Methylanthracene (2MA)	ND		ng/l	9.90	1.19	1
9/4-Methylphenanthrene (9MP)	ND		ng/l	9.90	1.19	1
C1-Phenanthrenes/Anthracenes	ND		ng/l	9.90	1.19	1
C2-Phenanthrenes/Anthr BS	ND		ng/l	9.90	1.19	1
C3-Phenanthrenes/Anthracenes	ND		ng/l	9.90	1.19	1
C4-Phenanthrenes/Anthracenes	ND		ng/l	9.90	1.19	1
Retene	ND		ng/l	9.90	2.77	1
Anthracene	ND		ng/l	9.90	1.79	1
Carbazole	ND		ng/l	9.90	1.52	1
1-Methylphenanthrene	ND		ng/l	9.90	1.26	1
Fluoranthene	2.87	J	ng/l	9.90	1.76	1
Benzo(b)fluorene	ND		ng/l	9.90	2.62	1
7H-Benzo(c)fluorene	ND		ng/l	9.90	2.62	1
2-Methylpyrene[1]	ND		ng/l	9.90	1.80	1
4-Methylpyrene[1]	ND		ng/l	9.90	1.80	1
1-Methylpyrene[1]	ND		ng/l	9.90	1.80	1
Pyrene	3.24	J	ng/l	9.90	1.80	1
C1-Fluoranthenes/Pyrenes	3.99	J	ng/l	9.90	1.80	1
C2-Fluoranthenes/Pyrenes	ND		ng/l	9.90	1.80	1
C3-Fluoranthenes/Pyrenes	ND		ng/l	9.90	1.80	1
C4-Fluoranthenes/Pyrenes	ND		ng/l	9.90	1.80	1
Naphthobenzothiophenes	ND		ng/l	9.90	1.62	1
C1-Naphthobenzothiophenes	ND		ng/l	9.90	1.62	1
C2-Naphthobenzothiophenes	ND		ng/l	9.90	1.62	1
C3-Naphthobenzothiophenes	ND		ng/l	9.90	1.62	1
C4-Naphthobenzothiophenes	ND		ng/l	9.90	1.62	1
Benz(a)anthracene	ND		ng/l	9.90	1.15	1

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328

Project Number: 180327-08.01 **Report Date:** 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-16 Date Collected: 09/29/21 17:25

Client ID: RB01-092921 Date Received: 09/30/21

Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
PAHs - Mansfield Lab						
Chrysene	1.39	J	ng/l	9.90	1.25	1
C1-Chrysenes	ND		ng/l	9.90	1.25	1
C2-Chrysenes BS	ND		ng/l	9.90	1.25	1
C3-Chrysenes	ND		ng/l	9.90	1.25	1
C4-Chrysenes	ND		ng/l	9.90	1.25	1
Benzo(b)fluoranthene	ND		ng/l	9.90	1.46	1
Benzo(j)+(k)fluoranthene	ND		ng/l	9.90	1.48	1
Benzo(a)fluoranthene	ND		ng/l	9.90	1.48	1
Benzo(e)pyrene	ND		ng/l	9.90	1.30	1
Benzo(a)pyrene	ND		ng/l	9.90	2.13	1
Perylene	ND		ng/l	9.90	1.81	1
Indeno(1,2,3-cd)pyrene	ND		ng/l	9.90	2.44	1
Dibenz(a,h)+(a,c)anthracene	ND		ng/l	9.90	2.91	1
Benzo(g,h,i)perylene	ND		ng/l	9.90	2.62	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Naphthalene-d8	91		50-130
Phenanthrene-d10	102		50-130
Benzo(a)pyrene-d12	109		50-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-17 D2
Client ID: WC1-093021
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 14:20
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/12/21 15:47
Analyst: GP
Percent Solids: 85%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 11:50
Cleanup Method: EPA 3630
Cleanup Date: 11/01/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Naphthalene	1040000		ug/kg	4420	396.	1000
2-Methylnaphthalene	581000		ug/kg	4420	549.	1000
Acenaphthene	247000		ug/kg	4420	496.	1000
Fluorene	247000		ug/kg	4420	296.	1000
Phenanthrene	779000		ug/kg	4420	522.	1000
Anthracene	209000		ug/kg	4420	549.	1000
Fluoranthene	443000		ug/kg	4420	810.	1000
Pyrene	389000		ug/kg	4420	451.	1000
Benz(a)anthracene	179000		ug/kg	4420	1180	1000
Chrysene	160000		ug/kg	4420	389.	1000
Benzo(b)fluoranthene	102000		ug/kg	4420	460.	1000
Benzo(a)pyrene	146000		ug/kg	4420	518.	1000

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	122		30-130
Pyrene-d10	92		30-130
Benzo(b)fluoranthene-d12	85		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-17 D
Client ID: WC1-093021
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 14:20
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8270D-SIM
Analytical Date: 11/06/21 00:57
Analyst: GP
Percent Solids: 85%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 11:50
Cleanup Method: EPA 3630
Cleanup Date: 11/01/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by GC/MS-SIM - Mansfield Lab						
Naphthalene	681000	E	ug/kg	442	39.6	100
2-Methylnaphthalene	428000	E	ug/kg	442	54.9	100
2-Chloronaphthalene	341	J	ug/kg	442	34.6	100
Acenaphthylene	55000		ug/kg	442	29.6	100
Acenaphthene	185000	E	ug/kg	442	49.6	100
Fluorene	188000	E	ug/kg	442	29.6	100
Phenanthrene	553000	E	ug/kg	442	52.2	100
Anthracene	187000	E	ug/kg	442	54.9	100
Fluoranthene	316000	E	ug/kg	442	81.0	100
Pyrene	323000	E	ug/kg	442	45.1	100
Benz(a)anthracene	153000	E	ug/kg	442	118.	100
Chrysene	135000	E	ug/kg	442	38.9	100
Benzo(b)fluoranthene	101000	E	ug/kg	442	46.0	100
Benzo(k)fluoranthene	69100		ug/kg	442	45.6	100
Benzo(a)pyrene	126000	E	ug/kg	442	51.8	100
Indeno(1,2,3-cd)Pyrene	74000		ug/kg	442	126.	100
Dibenz(a,h)anthracene	20600		ug/kg	442	45.6	100
Benzo(ghi)perylene	64600		ug/kg	442	36.5	100

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	81		30-130
Pyrene-d10	112		30-130
Benzo(b)fluoranthene-d12	67		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 1,8270D-SIM(M)
Analytical Date: 10/10/21 20:00
Analyst: CC

Extraction Method: EPA 3510C
Extraction Date: 10/06/21 19:40

Parameter	Result	Qualifier	Units	RL	MDL
PAHs - Mansfield Lab for sample(s): 16 Batch: WG1555332-1					
cis/trans-Decalin	ND		ng/l	5.00	1.11
C1-Decalins	ND		ng/l	5.00	1.11
C2-Decalins	ND		ng/l	5.00	1.11
C3-Decalins	ND		ng/l	5.00	1.11
C4-Decalins	ND		ng/l	5.00	1.11
Naphthalene	ND		ng/l	10.0	1.97
C1-Naphthalenes	ND		ng/l	10.0	1.97
C2-Naphthalenes	ND		ng/l	10.0	1.97
C3-Naphthalenes	ND		ng/l	10.0	1.97
C4-Naphthalenes	ND		ng/l	10.0	1.97
2-Methylnaphthalene	ND		ng/l	10.0	2.30
1-Methylnaphthalene	ND		ng/l	10.0	1.95
Benzothiophene	ND		ng/l	10.0	1.52
C1-Benzo(b)thiophenes	ND		ng/l	10.0	1.52
C2-Benzo(b)thiophenes	ND		ng/l	10.0	1.52
C3-Benzo(b)thiophenes	ND		ng/l	10.0	1.52
C4-Benzo(b)thiophenes	ND		ng/l	10.0	1.52
Biphenyl	ND		ng/l	10.0	2.33
2,6-Dimethylnaphthalene	ND		ng/l	10.0	2.33
Dibenzofuran	ND		ng/l	10.0	1.82
Acenaphthylene	ND		ng/l	10.0	2.00
Acenaphthene	ND		ng/l	10.0	1.28
2,3,5-Trimethylnaphthalene	ND		ng/l	10.0	1.51
Fluorene	ND		ng/l	10.0	1.77
C1-Fluorenes	ND		ng/l	10.0	1.77
C2-Fluorenes	ND		ng/l	10.0	1.77
C3-Fluorenes	ND		ng/l	10.0	1.77
Dibenzothiophene	ND		ng/l	10.0	1.46
4-Methyldibenzothiophene(4MDT)	ND		ng/l	10.0	1.46

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 1,8270D-SIM(M)
Analytical Date: 10/10/21 20:00
Analyst: CC

Extraction Method: EPA 3510C
Extraction Date: 10/06/21 19:40

Parameter	Result	Qualifier	Units	RL	MDL
PAHs - Mansfield Lab for sample(s): 16 Batch: WG1555332-1					
2/3-Methyldibenzothiophene(2MDT)	ND		ng/l	10.0	1.46
1-Methyldibenzothiophene(1MDT)	ND		ng/l	10.0	1.46
C1-Dibenzothiophenes BS	ND		ng/l	10.0	1.46
C2-Dibenzothiophenes	ND		ng/l	10.0	1.46
C3-Dibenzothiophenes	ND		ng/l	10.0	1.46
C4-Dibenzothiophenes	ND		ng/l	10.0	1.46
Phenanthrene	1.35	J	ng/l	10.0	1.20
3-Methylphenanthrene (3MP)	ND		ng/l	10.0	1.20
2-Methylphenanthrene (2MP)	ND		ng/l	10.0	1.20
2-Methylanthracene (2MA)	ND		ng/l	10.0	1.20
9/4-Methylphenanthrene (9MP)	ND		ng/l	10.0	1.20
C1-Phenanthrenes/Anthracenes	ND		ng/l	10.0	1.20
C2-Phenanthrenes/Anthr BS	ND		ng/l	10.0	1.20
C3-Phenanthrenes/Anthracenes	ND		ng/l	10.0	1.20
C4-Phenanthrenes/Anthracenes	ND		ng/l	10.0	1.20
Retene	ND		ng/l	10.0	2.80
Anthracene	ND		ng/l	10.0	1.81
Carbazole	ND		ng/l	10.0	1.54
1-Methylphenanthrene	ND		ng/l	10.0	1.27
Fluoranthene	ND		ng/l	10.0	1.78
Benzo(b)fluorene	ND		ng/l	10.0	2.65
7H-Benzo(c)fluorene	ND		ng/l	10.0	2.65
2-Methylpyrene[1]	ND		ng/l	10.0	1.82
4-Methylpyrene[1]	ND		ng/l	10.0	1.82
1-Methylpyrene[1]	ND		ng/l	10.0	1.82
Pyrene	ND		ng/l	10.0	1.82
C1-Fluoranthenes/Pyrenes	ND		ng/l	10.0	1.82
C2-Fluoranthenes/Pyrenes	ND		ng/l	10.0	1.82
C3-Fluoranthenes/Pyrenes	ND		ng/l	10.0	1.82

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 1,8270D-SIM(M)
Analytical Date: 10/10/21 20:00
Analyst: CC

Extraction Method: EPA 3510C
Extraction Date: 10/06/21 19:40

Parameter	Result	Qualifier	Units	RL	MDL
PAHs - Mansfield Lab for sample(s): 16 Batch: WG1555332-1					
C4-Fluoranthenes/Pyrenes	ND		ng/l	10.0	1.82
Naphthobenzothiophenes	ND		ng/l	10.0	1.64
C1-Naphthobenzothiophenes	ND		ng/l	10.0	1.64
C2-Naphthobenzothiophenes	ND		ng/l	10.0	1.64
C3-Naphthobenzothiophenes	ND		ng/l	10.0	1.64
C4-Naphthobenzothiophenes	ND		ng/l	10.0	1.64
Benz(a)anthracene	ND		ng/l	10.0	1.16
Chrysene	ND		ng/l	10.0	1.26
C1-Chrysenes	ND		ng/l	10.0	1.26
C2-Chrysenes BS	ND		ng/l	10.0	1.26
C3-Chrysenes	ND		ng/l	10.0	1.26
C4-Chrysenes	ND		ng/l	10.0	1.26
Benzo(b)fluoranthene	ND		ng/l	10.0	1.47
Benzo(j)+(k)fluoranthene	ND		ng/l	10.0	1.49
Benzo(a)fluoranthene	ND		ng/l	10.0	1.49
Benzo(e)pyrene	ND		ng/l	10.0	1.31
Benzo(a)pyrene	ND		ng/l	10.0	2.15
Perylene	ND		ng/l	10.0	1.83
Indeno(1,2,3-cd)pyrene	ND		ng/l	10.0	2.46
Dibenz(a,h)+(a,c)anthracene	ND		ng/l	10.0	2.94
Benzo(g,h,i)perylene	ND		ng/l	10.0	2.65

Surrogate	%Recovery	Qualifier	Acceptance Criteria
Naphthalene-d8	77		50-130
Phenanthrene-d10	87		50-130
Benzo(a)pyrene-d12	91		50-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 97,8270D-SIM
Analytical Date: 11/05/21 11:45
Analyst: PS

Extraction Method: EPA 3570
Extraction Date: 10/27/21 09:09
Cleanup Method: EPA 3630
Cleanup Date: 11/01/21

Parameter	Result	Qualifier	Units	RL	MDL
MCP PAHs by GC/MS-SIM - Mansfield Lab for sample(s): 06-07,09-15,17 Batch: WG1563704-1					
Naphthalene	2.12	J	ug/kg	4.00	0.358
2-Methylnaphthalene	0.648	J	ug/kg	4.00	0.496
Acenaphthylene	ND		ug/kg	4.00	0.268
Acenaphthene	ND		ug/kg	4.00	0.448
Fluorene	ND		ug/kg	4.00	0.267
Phenanthrene	0.772	J	ug/kg	4.00	0.472
Anthracene	ND		ug/kg	4.00	0.496
Fluoranthene	ND		ug/kg	4.00	0.732
Pyrene	ND		ug/kg	4.00	0.408
Benz(a)anthracene	ND		ug/kg	4.00	1.07
Chrysene	ND		ug/kg	4.00	0.352
Benzo(b)fluoranthene	ND		ug/kg	4.00	0.416
Benzo(k)fluoranthene	ND		ug/kg	4.00	0.412
Benzo(a)pyrene	ND		ug/kg	4.00	0.468
Indeno(1,2,3-cd)Pyrene	ND		ug/kg	4.00	1.14
Dibenz(a,h)anthracene	ND		ug/kg	4.00	0.412
Benzo(ghi)perylene	ND		ug/kg	4.00	0.330

Surrogate	%Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	63		30-130
Pyrene-d10	78		30-130
Benzo(b)fluoranthene-d12	73		30-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 1,8270D-SIM(M)
Analytical Date: 11/07/21 02:58
Analyst: CC

Extraction Method: ALPHA OP-013
Extraction Date: 10/27/21 20:16
Cleanup Method: EPA 3611B
Cleanup Date: 11/02/21

Parameter	Result	Qualifier	Units	RL	MDL
PAHs - Mansfield Lab for sample(s): 03-05,08 Batch: WG1563968-1					
cis/trans-Decalin	ND		ug/kg	0.500	0.0994
C1-Decalins	ND		ug/kg	0.500	0.0994
C2-Decalins	ND		ug/kg	0.500	0.0994
C3-Decalins	ND		ug/kg	0.500	0.0994
C4-Decalins	ND		ug/kg	0.500	0.0994
Naphthalene	ND		ug/kg	1.00	0.287
C1-Naphthalenes	ND		ug/kg	1.00	0.287
C2-Naphthalenes	ND		ug/kg	1.00	0.287
C3-Naphthalenes	ND		ug/kg	1.00	0.287
C4-Naphthalenes	ND		ug/kg	1.00	0.287
2-Methylnaphthalene	ND		ug/kg	1.00	0.258
1-Methylnaphthalene	ND		ug/kg	1.00	0.315
Benzothiophene	ND		ug/kg	1.00	0.313
C1-Benzo(b)thiophenes	ND		ug/kg	1.00	0.313
C2-Benzo(b)thiophenes	ND		ug/kg	1.00	0.313
C3-Benzo(b)thiophenes	ND		ug/kg	1.00	0.313
C4-Benzo(b)thiophenes	ND		ug/kg	1.00	0.313
Biphenyl	ND		ug/kg	1.00	0.309
2,6-Dimethylnaphthalene	ND		ug/kg	1.00	0.238
Dibenzofuran	ND		ug/kg	1.00	0.315
Acenaphthylene	ND		ug/kg	1.00	0.191
Acenaphthene	ND		ug/kg	1.00	0.176
2,3,5-Trimethylnaphthalene	ND		ug/kg	1.00	0.164
Fluorene	ND		ug/kg	1.00	0.267
C1-Fluorenes	ND		ug/kg	1.00	0.267
C2-Fluorenes	ND		ug/kg	1.00	0.267
C3-Fluorenes	ND		ug/kg	1.00	0.267
Dibenzothiophene	ND		ug/kg	1.00	0.276
4-Methyldibenzothiophene(4MDT)	ND		ug/kg	1.00	0.276

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 1,8270D-SIM(M)
Analytical Date: 11/07/21 02:58
Analyst: CC

Extraction Method: ALPHA OP-013
Extraction Date: 10/27/21 20:16
Cleanup Method: EPA 3611B
Cleanup Date: 11/02/21

Parameter	Result	Qualifier	Units	RL	MDL
PAHs - Mansfield Lab for sample(s): 03-05,08 Batch: WG1563968-1					
2/3-Methyldibenzothiophene(2MDT)	ND		ug/kg	1.00	0.276
1-Methyldibenzothiophene(1MDT)	ND		ug/kg	1.00	0.276
C1-Dibenzothiophenes BS	ND		ug/kg	1.00	0.276
C2-Dibenzothiophenes	ND		ug/kg	1.00	0.276
C3-Dibenzothiophenes	ND		ug/kg	1.00	0.276
C4-Dibenzothiophenes	ND		ug/kg	1.00	0.276
Phenanthrene	ND		ug/kg	1.00	0.331
3-Methylphenanthrene (3MP)	ND		ug/kg	1.00	0.331
2-Methylphenanthrene (2MP)	ND		ug/kg	1.00	0.331
2-Methylanthracene (2MA)	ND		ug/kg	1.00	0.331
9/4-Methylphenanthrene (9MP)	ND		ug/kg	1.00	0.331
C1-Phenanthrenes/Anthracenes	ND		ug/kg	1.00	0.331
C2-Phenanthrenes/Anthr BS	ND		ug/kg	1.00	0.331
C3-Phenanthrenes/Anthracenes	ND		ug/kg	1.00	0.331
C4-Phenanthrenes/Anthracenes	ND		ug/kg	1.00	0.331
Retene	ND		ug/kg	1.00	0.245
Anthracene	ND		ug/kg	1.00	0.206
Carbazole	ND		ug/kg	1.00	0.327
1-Methylphenanthrene	ND		ug/kg	1.00	0.264
Fluoranthene	ND		ug/kg	1.00	0.318
Benzo(b)fluorene	ND		ug/kg	1.00	0.290
7H-Benzo(c)fluorene	ND		ug/kg	1.00	0.290
2-Methylpyrene[1]	ND		ug/kg	1.00	0.263
4-Methylpyrene[1]	ND		ug/kg	1.00	0.263
1-Methylpyrene[1]	ND		ug/kg	1.00	0.263
Pyrene	ND		ug/kg	1.00	0.263
C1-Fluoranthenes/Pyrenes	ND		ug/kg	1.00	0.263
C2-Fluoranthenes/Pyrenes	ND		ug/kg	1.00	0.263
C3-Fluoranthenes/Pyrenes	ND		ug/kg	1.00	0.263

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 1,8270D-SIM(M)
Analytical Date: 11/07/21 02:58
Analyst: CC

Extraction Method: ALPHA OP-013
Extraction Date: 10/27/21 20:16
Cleanup Method: EPA 3611B
Cleanup Date: 11/02/21

Parameter	Result	Qualifier	Units	RL	MDL
PAHs - Mansfield Lab for sample(s): 03-05,08 Batch: WG1563968-1					
C4-Fluoranthenes/Pyrenes	ND		ug/kg	1.00	0.263
Naphthobenzothiophenes	ND		ug/kg	1.00	0.280
C1-Naphthobenzothiophenes	ND		ug/kg	1.00	0.280
C2-Naphthobenzothiophenes	ND		ug/kg	1.00	0.280
C3-Naphthobenzothiophenes	ND		ug/kg	1.00	0.280
C4-Naphthobenzothiophenes	ND		ug/kg	1.00	0.280
Benz(a)anthracene	ND		ug/kg	1.00	0.204
Chrysene	ND		ug/kg	1.00	0.202
C1-Chrysenes	ND		ug/kg	1.00	0.202
C2-Chrysenes BS	ND		ug/kg	1.00	0.202
C3-Chrysenes	ND		ug/kg	1.00	0.202
C4-Chrysenes	ND		ug/kg	1.00	0.202
Benzo(b)fluoranthene	ND		ug/kg	1.00	0.260
Benzo(j)+(k)fluoranthene	ND		ug/kg	1.00	0.198
Benzo(a)fluoranthene	ND		ug/kg	1.00	0.198
Benzo(e)pyrene	ND		ug/kg	1.00	0.206
Benzo(a)pyrene	ND		ug/kg	1.00	0.285
Perylene	ND		ug/kg	1.00	0.193
Indeno(1,2,3-cd)pyrene	ND		ug/kg	1.00	0.271
Dibenz(a,h)+(a,c)anthracene	ND		ug/kg	1.00	0.270
Benzo(g,h,i)perylene	ND		ug/kg	1.00	0.266

Surrogate	%Recovery	Qualifier	Acceptance Criteria
Naphthalene-d8	77		50-130
Phenanthrene-d10	92		50-130
Benzo(a)pyrene-d12	76		50-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 97,8270D-SIM
Analytical Date: 11/16/21 12:32
Analyst: GP

Extraction Method: EPA 3570
Extraction Date: 11/10/21 17:07
Cleanup Method: EPA 3630
Cleanup Date: 11/16/21

Parameter	Result	Qualifier	Units	RL	MDL
MCP PAHs by GC/MS-SIM - Mansfield Lab for sample(s): 01-02 Batch: WG1569716-1					
Naphthalene	ND		ug/kg	4.00	0.358
2-Methylnaphthalene	ND		ug/kg	4.00	0.496
2-Chloronaphthalene	ND		ug/kg	4.00	0.313
Acenaphthylene	ND		ug/kg	4.00	0.268
Acenaphthene	ND		ug/kg	4.00	0.448
Fluorene	ND		ug/kg	4.00	0.267
Phenanthrene	ND		ug/kg	4.00	0.472
Anthracene	ND		ug/kg	4.00	0.496
Fluoranthene	ND		ug/kg	4.00	0.732
Pyrene	ND		ug/kg	4.00	0.408
Benz(a)anthracene	ND		ug/kg	4.00	1.07
Chrysene	ND		ug/kg	4.00	0.352
Benzo(b)fluoranthene	ND		ug/kg	4.00	0.416
Benzo(k)fluoranthene	ND		ug/kg	4.00	0.412
Benzo(a)pyrene	ND		ug/kg	4.00	0.468
Indeno(1,2,3-cd)Pyrene	ND		ug/kg	4.00	1.14
Dibenz(a,h)anthracene	ND		ug/kg	4.00	0.412
Benzo(ghi)perylene	ND		ug/kg	4.00	0.330

Surrogate	%Recovery	Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	67		30-130
Pyrene-d10	81		30-130
Benzo(b)fluoranthene-d12	79		30-130

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
PAHs - Mansfield Lab Associated sample(s): 16 Batch: WG1555332-2 WG1555332-3								
Naphthalene	67		72		50-130	7		30
2-Methylnaphthalene	66		74		50-130	11		30
Acenaphthylene	83		85		50-130	2		30
Acenaphthene	81		84		50-130	4		30
Fluorene	88		88		50-130	0		30
Phenanthrene	89		89		50-130	0		30
Anthracene	92		92		50-130	0		30
Fluoranthene	92		91		50-130	1		30
Pyrene	91		92		50-130	1		30
Benz(a)anthracene	90		89		50-130	1		30
Chrysene	87		87		50-130	0		30
Benzo(b)fluoranthene	96		95		50-130	1		30
Benzo(j)+(k)fluoranthene	98		99		50-130	1		30
Benzo(a)pyrene	108		107		50-130	1		30
Indeno(1,2,3-cd)pyrene	94		94		50-130	0		30
Dibenz(a,h)+(a,c)anthracene	103		103		50-130	0		30
Benzo(g,h,i)perylene	105		104		50-130	1		30

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
PAHs - Mansfield Lab Associated sample(s): 16 Batch: WG1555332-2 WG1555332-3								

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria
Naphthalene-d8	90		92		50-130
Phenanthrene-d10	89		94		50-130
Benzo(a)pyrene-d12	96		98		50-130

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP PAHs by GC/MS-SIM - Mansfield Lab Associated sample(s): 06-07,09-15,17 Batch: WG1563704-2 WG1563704-3								
Naphthalene	59		48		40-140	21		30
2-Methylnaphthalene	57		47		40-140	19		30
Acenaphthylene	67		55		40-140	20		30
Acenaphthene	64		53		40-140	19		30
Fluorene	65		55		40-140	17		30
Phenanthrene	62		54		40-140	14		30
Anthracene	68		59		40-140	14		30
Fluoranthene	68		58		40-140	16		30
Pyrene	69		60		40-140	14		30
Benz(a)anthracene	73		61		40-140	18		30
Chrysene	67		58		40-140	14		30
Benzo(b)fluoranthene	80		69		40-140	15		30
Benzo(k)fluoranthene	68		57		40-140	18		30
Benzo(a)pyrene	76		65		40-140	16		30
Indeno(1,2,3-cd)Pyrene	78		68		40-140	14		30
Dibenz(a,h)anthracene	70		60		40-140	15		30
Benzo(ghi)perylene	76		65		40-140	16		30

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP PAHs by GC/MS-SIM - Mansfield Lab Associated sample(s): 06-07,09-15,17 Batch: WG1563704-2 WG1563704-3								

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria
2-Methylnaphthalene-d10	60		49		30-130
Pyrene-d10	71		60		30-130
Benzo(b)fluoranthene-d12	69		57		30-130

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
PAHs - Mansfield Lab Associated sample(s): 03-05,08 Batch: WG1563968-2 WG1563968-3								
Naphthalene	84		82		50-130	2		30
2-Methylnaphthalene	86		85		50-130	1		30
Acenaphthylene	85		86		50-130	1		30
Acenaphthene	87		88		50-130	1		30
Fluorene	89		88		50-130	1		30
Phenanthrene	92		94		50-130	2		30
Anthracene	93		93		50-130	0		30
Fluoranthene	88		92		50-130	4		30
Pyrene	88		92		50-130	4		30
Benz(a)anthracene	80		80		50-130	0		30
Chrysene	85		83		50-130	2		30
Benzo(b)fluoranthene	81		83		50-130	2		30
Benzo(j)+(k)fluoranthene	80		81		50-130	1		30
Benzo(a)pyrene	87		89		50-130	2		30
Indeno(1,2,3-cd)pyrene	86		86		50-130	0		30
Dibenz(a,h)+(a,c)anthracene	86		87		50-130	1		30
Benzo(g,h,i)perylene	90		91		50-130	1		30

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
PAHs - Mansfield Lab Associated sample(s): 03-05,08 Batch: WG1563968-2 WG1563968-3								

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria
Naphthalene-d8	81		82		50-130
Phenanthrene-d10	90		92		50-130
Benzo(a)pyrene-d12	79		82		50-130

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP PAHs by GC/MS-SIM - Mansfield Lab Associated sample(s): 01-02 Batch: WG1569716-2 WG1569716-3								
Naphthalene	62		85		40-140	**31**	Q	30
2-Methylnaphthalene	64		86		40-140	29		30
2-Chloronaphthalene	64		90		40-140	**34**	Q	30
Acenaphthylene	68		92		40-140	30		30
Acenaphthene	66		89		40-140	30		30
Fluorene	69		94		40-140	**31**	Q	30
Phenanthrene	69		94		40-140	**31**	Q	30
Anthracene	74		100		40-140	30		30
Fluoranthene	73		98		40-140	29		30
Pyrene	71		95		40-140	29		30
Benz(a)anthracene	72		97		40-140	30		30
Chrysene	71		95		40-140	29		30
Benzo(b)fluoranthene	81		107		40-140	28		30
Benzo(k)fluoranthene	72		98		40-140	**31**	Q	30
Benzo(a)pyrene	80		107		40-140	29		30
Indeno(1,2,3-cd)Pyrene	70		96		40-140	**31**	Q	30
Dibenz(a,h)anthracene	71		98		40-140	**32**	Q	30
Benzo(ghi)perylene	74		102		40-140	**32**	Q	30

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP PAHs by GC/MS-SIM - Mansfield Lab	Associated sample(s): 01-02		Batch: WG1569716-2 WG1569716-3					

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria
2-Methylnaphthalene-d10	67		88		30-130
Pyrene-d10	72		95		30-130
Benzo(b)fluoranthene-d12	75		97		30-130

Matrix Spike Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	Native Sample	MS Added	MS Found	MS %Recovery	Qual	MSD Found	MSD %Recovery	Qual	Recovery Limits	RPD	Qual	RPD Limits
MCP PAHs by GC/MS-SIM - Mansfield Lab Associated sample(s): 06-07,09-15,17 QC Batch ID: WG1563704-4 WG1563704-5 QC Sample: L2153328-09 Client ID: AQSS-19-3.0-3.5												
Naphthalene	329	536	547	41		427	**18**	Q	40-140	25		30
2-Methylnaphthalene	301	536	490	**35**	Q	403	**19**	Q	40-140	19		30
2-Chloronaphthalene	0.378J	536	331	62		262	49		40-140	23		30
Acenaphthylene	19.3	536	372	66		305	54		40-140	20		30
Acenaphthene	166	536	448	53		372	**39**	Q	40-140	19		30
Fluorene	130	536	430	56		360	43		40-140	18		30
Phenanthrene	375	536	545	**32**	Q	470	**18**	Q	40-140	15		30
Anthracene	89.5	536	384	55		323	44		40-140	17		30
Fluoranthene	139	536	408	50		348	**39**	Q	40-140	16		30
Pyrene	145	536	422	52		358	40		40-140	16		30
Benz(a)anthracene	76.9	536	419	64		348	51		40-140	19		30
Chrysene	64.9	536	393	61		320	48		40-140	20		30
Benzo(b)fluoranthene	47.8	536	447	74		378	62		40-140	17		30
Benzo(k)fluoranthene	41.6	536	385	64		303	49		40-140	24		30
Benzo(a)pyrene	58.6	536	384	61		335	52		40-140	14		30
Indeno(1,2,3-cd)Pyrene	34.9	536	435	75		357	61		40-140	20		30
Dibenz(a,h)anthracene	7.94	536	392	72		314	58		40-140	22		30
Benzo(ghi)perylene	30.4	536	432	75		355	61		40-140	20		30

Surrogate	MS % Recovery	MS Qualifier	MSD % Recovery	MSD Qualifier	Acceptance Criteria
2-Methylnaphthalene-d10	62		49		30-130
Benzo(b)fluoranthene-d12	70		57		30-130

Matrix Spike Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	*Native Sample*	*MS Added*	*MS Found*	*MS %Recovery*	*Qual*	*MSD Found*	*MSD %Recovery*	*Qual*	*Recovery Limits*	*RPD*	*Qual*	*RPD Limits*
MCP PAHs by GC/MS-SIM - Mansfield Lab Associated sample(s): 06-07,09-15,17 QC Batch ID: WG1563704-4 WG1563704-5 QC Sample: L2153328-09 Client ID: AQSS-19-3.0-3.5												

Surrogate	*MS % Recovery*	*MS Qualifier*	*MSD % Recovery*	*MSD Qualifier*	*Acceptance Criteria*
Pyrene-d10	74		59		30-130

Matrix Spike Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	Native Sample	MS Added	MS Found	MS %Recovery	Qual	MSD Found	MSD %Recovery	Qual	Recovery Limits	RPD	Qual	RPD Limits
PAHs - Mansfield Lab Associated sample(s): 03-05,08 QC Batch ID: WG1563968-4 WG1563968-5 QC Sample: L2153328-04 Client ID: AQSS-04-1.0-1.5												
Naphthalene	3220	2660	3280	**2**	Q	7350	148		50-150	**77**	Q	30
2-Methylnaphthalene	1750	2660	1840	**3**	Q	3910	77		50-150	**72**	Q	30
Acenaphthylene	2880	2660	2690	**0**	Q	4340	52		50-150	**47**	Q	30
Acenaphthene	2780	2660	2930	**6**	Q	6000	115		50-150	**69**	Q	30
Fluorene	4190	2660	4120	**0**	Q	8300	147		50-150	**67**	Q	30
Phenanthrene	36100	2660	38800	101		77100E	**1470**	Q	50-150	**66**	Q	30
Anthracene	9180	2660	9630	**17**	Q	17100	**284**	Q	50-150	**56**	Q	30
Fluoranthene	35500	2660	37600	79		81200E	**1640**	Q	50-150	**73**	Q	30
Pyrene	31300	2660	33000	64		68600E	**1340**	Q	50-150	**70**	Q	30
Benz(a)anthracene	16200	2660	17200	**38**	Q	38200	**788**	Q	50-150	**76**	Q	30
Chrysene	16800	2660	17800	**38**	Q	35700	**677**	Q	50-150	**67**	Q	30
Benzo(b)fluoranthene	12200	2660	12700	**19**	Q	30200	**644**	Q	50-150	**82**	Q	30
Benzo(j)+(k)fluoranthene	11000	2660	11700	**26**	Q	22900	**426**	Q	50-150	**65**	Q	30
Benzo(a)pyrene	15100	2660	15800	**26**	Q	33500	**659**	Q	50-150	**72**	Q	30
Indeno(1,2,3-cd)pyrene	9400	2660	9420	**1**	Q	20800	**408**	Q	50-150	**75**	Q	30
Dibenz(a,h)+(a,c)anthracene	2800	2660	2850	**2**	Q	6730	141		50-150	**81**	Q	30
Benzo(g,h,i)perylene	9450	2660	10000	**21**	Q	21300	**424**	Q	50-150	**72**	Q	30

Surrogate	MS % Recovery	MS Qualifier	MSD % Recovery	MSD Qualifier	Acceptance Criteria
Benzo(a)pyrene-d12	76		64		50-130
Naphthalene-d8	70		63		50-130
Phenanthrene-d10	82		67		50-130

PETROLEUM HYDROCARBONS

Project Name: FORMER HAVERHILL MGP
Lab Number: L2153328
Project Number: 180327-08.01
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-17 D
Client ID: WC1-093021
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 14:20
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 1,8015D(M)
Analytical Date: 10/18/21 15:30
Analyst: SC
Percent Solids: 85%

Extraction Method: EPA 3546
Extraction Date: 10/11/21 09:49

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
Petroleum Hydrocarbon Quantitation - Westborough Lab						
TPH (C10-C36)	28000000		ug/kg	1850000	213000	50

Surrogate	% Recovery	Qualifier	Acceptance Criteria
o-Terphenyl	**0**	Q	40-140

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 1,8015D(M)
Analytical Date: 10/12/21 15:31
Analyst: JB

Extraction Method: EPA 3546
Extraction Date: 10/11/21 09:49

Parameter	Result	Qualifier	Units	RL	MDL
Petroleum Hydrocarbon Quantitation - Westborough Lab for sample(s): 17 Batch: WG1556977-1					
TPH (C10-C36)	6820	J	ug/kg	31600	3630

Surrogate	%Recovery	Qualifier	Acceptance Criteria
o-Terphenyl	101		40-140

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Petroleum Hydrocarbon Quantitation - Westborough Lab Associated sample(s): 17 Batch: WG1556977-2								
TPH (C10-C36)	134		-		40-140	-		40

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria
o-Terphenyl	103				40-140

Project Name: FORMER HAVERHILL MGP
Lab Number: L2153328
Project Number: 180327-08.01
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID:	L2153328-01	Date Collected:	09/29/21 14:50
Client ID:	AQSS-05-0.0-0.5	Date Received:	09/30/21
Sample Location:	HAVERHILL, MA	Field Prep:	Not Specified
Sample Depth:			
Matrix:	Sediment		
Analytical Method:	131,VPH-18-2.1		
Analytical Date:	10/24/21 01:09		
Analyst:	MKS		
Percent Solids:	85%		

Trap:	EST, Carbopack B/Carboxen 1000&1001	Analytical Column:	Restek, RTX-502.2, 105m, 0.53ID, 3um

Quality Control Information

Condition of sample received:	Satisfactory
Sample Temperature upon receipt:	Received on Ice
Were samples received in methanol?	Covering the Soil
Methanol ratio:	2.0:1

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
Volatile Petroleum Hydrocarbons - Westborough Lab						
C5-C8 Aliphatics	ND		mg/kg	12.7	12.7	1
C9-C12 Aliphatics	ND		mg/kg	12.7	12.7	1
C9-C10 Aromatics	ND		mg/kg	12.7	12.7	1
C5-C8 Aliphatics, Adjusted	ND		mg/kg	12.7	12.7	1
C9-C12 Aliphatics, Adjusted	ND		mg/kg	12.7	12.7	1
Benzene	ND		mg/kg	0.254	0.254	1
Toluene	ND		mg/kg	0.254	0.254	1
Ethylbenzene	ND		mg/kg	0.254	0.254	1
p/m-Xylene	ND		mg/kg	0.254	0.254	1
o-Xylene	ND		mg/kg	0.254	0.254	1
Methyl tert butyl ether	ND		mg/kg	0.127	0.127	1
Naphthalene	ND		mg/kg	0.507	0.507	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2,5-Dibromotoluene-PID	95		70-130
2,5-Dibromotoluene-FID	104		70-130

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328

Project Number: 180327-08.01 **Report Date:** 11/24/21

SAMPLE RESULTS

Lab ID:	L2153328-01 D	Date Collected:	09/29/21 14:50
Client ID:	AQSS-05-0.0-0.5	Date Received:	09/30/21
Sample Location:	HAVERHILL, MA	Field Prep:	Not Specified
Sample Depth:			
Matrix:	Sediment	Extraction Method:	EPA 3546
Analytical Method:	135,EPH-19-2.1	Extraction Date:	10/12/21 00:04
Analytical Date:	10/15/21 12:23	Cleanup Method1:	EPH-19-2.1
Analyst:	MEO	Cleanup Date1:	10/14/21
Percent Solids:	85%		

Quality Control Information

Condition of sample received:	Satisfactory
Sample Temperature upon receipt:	Received on Ice
Sample Extraction method:	Extracted Per the Method

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
Extractable Petroleum Hydrocarbons - Westborough Lab						
C9-C18 Aliphatics	ND		mg/kg	115	115.	15
C19-C36 Aliphatics	414		mg/kg	115	115.	15
C11-C22 Aromatics	2310		mg/kg	115	115.	15
C11-C22 Aromatics, Adjusted	1410		mg/kg	115	115.	15

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Chloro-Octadecane	41		40-140
o-Terphenyl	64		40-140
2-Fluorobiphenyl	71		40-140
2-Bromonaphthalene	69		40-140

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-16
Client ID: RB01-092921
Sample Location: HAVERHILL, MA
Date Collected: 09/29/21 17:25
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Water
Analytical Method: 131,VPH-18-2.1
Analytical Date: 10/09/21 23:31
Analyst: BAD

Trap: EST, Carbopack B/Carboxen 1000&1001
Analytical Column: Restek, RTX-502.2, 105m, 0.53ID, 3um

Quality Control Information

Condition of sample received: Satisfactory
Aqueous Preservative: Laboratory Provided Preserved Container
Sample Temperature upon receipt: Received on Ice

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
Volatile Petroleum Hydrocarbons - Westborough Lab						
C5-C8 Aliphatics	ND		ug/l	100	100.	1
C9-C12 Aliphatics	ND		ug/l	100	100.	1
C9-C10 Aromatics	ND		ug/l	100	100.	1
C5-C8 Aliphatics, Adjusted	ND		ug/l	100	100.	1
C9-C12 Aliphatics, Adjusted	ND		ug/l	100	100.	1
Benzene	ND		ug/l	2.00	2.00	1
Toluene	ND		ug/l	2.00	2.00	1
Ethylbenzene	ND		ug/l	2.00	2.00	1
p/m-Xylene	ND		ug/l	2.00	2.00	1
o-Xylene	ND		ug/l	2.00	2.00	1
Methyl tert butyl ether	ND		ug/l	3.00	3.00	1
Naphthalene	ND		ug/l	4.00	4.00	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2,5-Dibromotoluene-PID	85		70-130
2,5-Dibromotoluene-FID	83		70-130

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID:	L2153328-16	Date Collected:	09/29/21 17:25
Client ID:	RB01-092921	Date Received:	09/30/21
Sample Location:	HAVERHILL, MA	Field Prep:	Not Specified
Sample Depth:			
Matrix:	Water	Extraction Method:	EPA 3510C
Analytical Method:	135,EPH-19-2.1	Extraction Date:	10/11/21 17:17
Analytical Date:	10/12/21 08:47	Cleanup Method1:	EPH-19-2.1
Analyst:	SC	Cleanup Date1:	10/11/21

Quality Control Information

Condition of sample received:	Satisfactory
Aqueous Preservative:	Laboratory Provided Preserved Container
Sample Temperature upon receipt:	Received on Ice
Sample Extraction method:	Extracted Per the Method

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
Extractable Petroleum Hydrocarbons - Westborough Lab						
C9-C18 Aliphatics	ND		ug/l	100	100.	1
C19-C36 Aliphatics	ND		ug/l	100	100.	1
C11-C22 Aromatics	ND		ug/l	100	100.	1
C11-C22 Aromatics, Adjusted	ND		ug/l	100	100.	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Chloro-Octadecane	62		40-140
o-Terphenyl	87		40-140
2-Fluorobiphenyl	97		40-140
2-Bromonaphthalene	98		40-140

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 135,EPH-19-2.1
Analytical Date: 10/12/21 07:09
Analyst: SC

Extraction Method: EPA 3510C
Extraction Date: 10/11/21 17:17
Cleanup Method: EPH-19-2.1
Cleanup Date: 10/11/21

Parameter	Result	Qualifier	Units	RL	MDL
Extractable Petroleum Hydrocarbons - Westborough Lab for sample(s): 16 Batch: WG1557236-1					
C9-C18 Aliphatics	ND		ug/l	100	100.
C19-C36 Aliphatics	ND		ug/l	100	100.
C11-C22 Aromatics	ND		ug/l	100	100.
C11-C22 Aromatics, Adjusted	ND		ug/l	100	100.

Surrogate	%Recovery	Qualifier	Acceptance Criteria
Chloro-Octadecane	74		40-140
o-Terphenyl	77		40-140
2-Fluorobiphenyl	93		40-140
2-Bromonaphthalene	93		40-140

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 135,EPH-19-2.1
Analytical Date: 10/12/21 15:21
Analyst: SC

Extraction Method: EPA 3546
Extraction Date: 10/11/21 22:10
Cleanup Method: EPH-19-2.1
Cleanup Date: 10/12/21

Parameter	Result	Qualifier	Units	RL	MDL
Extractable Petroleum Hydrocarbons - Westborough Lab for sample(s): 01 Batch: WG1557278-1					
C9-C18 Aliphatics	ND		mg/kg	6.39	6.39
C19-C36 Aliphatics	ND		mg/kg	6.39	6.39
C11-C22 Aromatics	ND		mg/kg	6.39	6.39
C11-C22 Aromatics, Adjusted	ND		mg/kg	6.39	6.39

Surrogate	%Recovery	Qualifier	Acceptance Criteria
Chloro-Octadecane	73		40-140
o-Terphenyl	75		40-140
2-Fluorobiphenyl	78		40-140
2-Bromonaphthalene	79		40-140

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328

Project Number: 180327-08.01 **Report Date:** 11/24/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 131,VPH-18-2.1
Analytical Date: 10/09/21 13:18
Analyst: BAD

Parameter	Result	Qualifier	Units	RL	MDL
Volatile Petroleum Hydrocarbons - Westborough Lab for sample(s): 16 Batch: WG1557464-4					
C5-C8 Aliphatics	ND		ug/l	100	100.
C9-C12 Aliphatics	ND		ug/l	100	100.
C9-C10 Aromatics	ND		ug/l	100	100.
C5-C8 Aliphatics, Adjusted	ND		ug/l	100	100.
C9-C12 Aliphatics, Adjusted	ND		ug/l	100	100.
Benzene	ND		ug/l	2.00	2.00
Toluene	ND		ug/l	2.00	2.00
Ethylbenzene	ND		ug/l	2.00	2.00
p/m-Xylene	ND		ug/l	2.00	2.00
o-Xylene	ND		ug/l	2.00	2.00
Methyl tert butyl ether	ND		ug/l	3.00	3.00
Naphthalene	ND		ug/l	4.00	4.00

Surrogate	%Recovery	Qualifier	Acceptance Criteria
2,5-Dibromotoluene-PID	97		70-130
2,5-Dibromotoluene-FID	95		70-130

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328

Project Number: 180327-08.01 **Report Date:** 11/24/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 131,VPH-18-2.1
Analytical Date: 10/23/21 19:09
Analyst: MKS

Parameter	Result	Qualifier	Units	RL	MDL
Volatile Petroleum Hydrocarbons - Westborough Lab for sample(s): 01 Batch: WG1562763-4					
C5-C8 Aliphatics	ND		mg/kg	5.00	5.00
C9-C12 Aliphatics	ND		mg/kg	5.00	5.00
C9-C10 Aromatics	ND		mg/kg	5.00	5.00
C5-C8 Aliphatics, Adjusted	ND		mg/kg	5.00	5.00
C9-C12 Aliphatics, Adjusted	ND		mg/kg	5.00	5.00
Benzene	ND		mg/kg	0.100	0.100
Toluene	ND		mg/kg	0.100	0.100
Ethylbenzene	ND		mg/kg	0.100	0.100
p/m-Xylene	ND		mg/kg	0.100	0.100
o-Xylene	ND		mg/kg	0.100	0.100
Methyl tert butyl ether	ND		mg/kg	0.050	0.050
Naphthalene	ND		mg/kg	0.200	0.200

Surrogate	%Recovery	Qualifier	Acceptance Criteria
2,5-Dibromotoluene-PID	115		70-130
2,5-Dibromotoluene-FID	117		70-130

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Extractable Petroleum Hydrocarbons - Westborough Lab Associated sample(s): 16 Batch: WG1557236-2 WG1557236-3								
C9-C18 Aliphatics	58		60		40-140	3		25
C19-C36 Aliphatics	72		77		40-140	7		25
C11-C22 Aromatics	82		82		40-140	0		25
Naphthalene	79		78		40-140	1		25
2-Methylnaphthalene	79		79		40-140	0		25
Acenaphthylene	75		76		40-140	1		25
Acenaphthene	80		81		40-140	1		25
Fluorene	79		80		40-140	1		25
Phenanthrene	78		78		40-140	0		25
Anthracene	78		78		40-140	0		25
Fluoranthene	81		81		40-140	0		25
Pyrene	80		80		40-140	0		25
Benzo(a)anthracene	85		85		40-140	0		25
Chrysene	82		81		40-140	1		25
Benzo(b)fluoranthene	78		78		40-140	0		25
Benzo(k)fluoranthene	77		78		40-140	1		25
Benzo(a)pyrene	82		82		40-140	0		25
Indeno(1,2,3-cd)Pyrene	75		75		40-140	0		25
Dibenzo(a,h)anthracene	81		82		40-140	1		25
Benzo(ghi)perylene	77		78		40-140	1		25

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Extractable Petroleum Hydrocarbons - Westborough Lab Associated sample(s): 16 Batch: WG1557236-2 WG1557236-3								

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria
Chloro-Octadecane	65		68		40-140
o-Terphenyl	79		77		40-140
2-Fluorobiphenyl	97		86		40-140
2-Bromonaphthalene	95		84		40-140
% Naphthalene Breakthrough	0		0		
% 2-Methylnaphthalene Breakthrough	0		0		

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Extractable Petroleum Hydrocarbons - Westborough Lab Associated sample(s): 01 Batch: WG1557278-2 WG1557278-3								
C9-C18 Aliphatics	52		52		40-140	0		25
C19-C36 Aliphatics	85		84		40-140	1		25
C11-C22 Aromatics	82		86		40-140	5		25
Naphthalene	70		73		40-140	4		25
2-Methylnaphthalene	74		77		40-140	4		25
Acenaphthylene	74		76		40-140	3		25
Acenaphthene	80		83		40-140	4		25
Fluorene	78		81		40-140	4		25
Phenanthrene	78		82		40-140	5		25
Anthracene	80		84		40-140	5		25
Fluoranthene	78		82		40-140	5		25
Pyrene	80		84		40-140	5		25
Benzo(a)anthracene	81		85		40-140	5		25
Chrysene	79		83		40-140	5		25
Benzo(b)fluoranthene	76		80		40-140	5		25
Benzo(k)fluoranthene	73		77		40-140	5		25
Benzo(a)pyrene	78		82		40-140	5		25
Indeno(1,2,3-cd)Pyrene	71		75		40-140	5		25
Dibenzo(a,h)anthracene	78		82		40-140	5		25
Benzo(ghi)perylene	72		75		40-140	4		25

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Extractable Petroleum Hydrocarbons - Westborough Lab Associated sample(s): 01 Batch: WG1557278-2 WG1557278-3								

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria
Chloro-Octadecane	72		69		40-140
o-Terphenyl	75		76		40-140
2-Fluorobiphenyl	78		82		40-140
2-Bromonaphthalene	77		81		40-140
% Naphthalene Breakthrough	0		0		
% 2-Methylnaphthalene Breakthrough	0		0		

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Volatile Petroleum Hydrocarbons - Westborough Lab Associated sample(s): 16 Batch: WG1557464-2 WG1557464-3								
C5-C8 Aliphatics	115		111		70-130	4		25
C9-C12 Aliphatics	115		111		70-130	4		25
C9-C10 Aromatics	108		104		70-130	4		25
Benzene	111		107		70-130	4		25
Toluene	110		106		70-130	4		25
Ethylbenzene	112		108		70-130	4		25
p/m-Xylene	112		107		70-130	5		25
o-Xylene	112		107		70-130	5		25
Methyl tert butyl ether	112		112		70-130	0		25
Naphthalene	106		109		70-130	3		25
1,2,4-Trimethylbenzene	108		104		70-130	4		25
Pentane	116		111		70-130	4		25
2-Methylpentane	117		113		70-130	3		25
2,2,4-Trimethylpentane	114		110		70-130	4		25
n-Nonane	117		113		30-130	3		25
n-Decane	115		110		70-130	4		25
n-Butylcyclohexane	115		110		70-130	4		25

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria
2,5-Dibromotoluene-PID	109		107		70-130
2,5-Dibromotoluene-FID	107		104		70-130

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Volatile Petroleum Hydrocarbons - Westborough Lab Associated sample(s): 01 Batch: WG1562763-2 WG1562763-3								
C5-C8 Aliphatics	99		100		70-130	1		25
C9-C12 Aliphatics	101		102		70-130	1		25
C9-C10 Aromatics	91		93		70-130	2		25
Benzene	94		97		70-130	3		25
Toluene	93		96		70-130	3		25
Ethylbenzene	95		97		70-130	2		25
p/m-Xylene	95		97		70-130	2		25
o-Xylene	94		96		70-130	3		25
Methyl tert butyl ether	98		101		70-130	3		25
Naphthalene	106		111		70-130	5		25
1,2,4-Trimethylbenzene	91		93		70-130	2		25
Pentane	94		95		70-130	1		25
2-Methylpentane	102		103		70-130	1		25
2,2,4-Trimethylpentane	100		102		70-130	2		25
n-Nonane	101		102		30-130	1		25
n-Decane	102		103		70-130	1		25
n-Butylcyclohexane	100		102		70-130	2		25

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria
2,5-Dibromotoluene-PID	106		108		70-130
2,5-Dibromotoluene-FID	106		110		70-130

PCBS

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-01 D
Client ID: AQSS-05-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 14:50
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8082A
Analytical Date: 11/09/21 14:44
Analyst: DP
Percent Solids: 85%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 10:47

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Column
MCP Polychlorinated Biphenyls by GC - Mansfield Lab							
Aroclor 1016	ND		ug/kg	16.8	6.20	2	A
Aroclor 1221	ND		ug/kg	16.8	8.31	2	A
Aroclor 1232	ND		ug/kg	16.8	7.95	2	A
Aroclor 1242	769		ug/kg	16.8	5.71	2	B
Aroclor 1248	ND		ug/kg	16.8	7.14	2	A
Aroclor 1254	380		ug/kg	16.8	7.10	2	B
Aroclor 1260	181		ug/kg	16.8	7.14	2	B
Aroclor 1262	ND		ug/kg	16.8	6.52	2	A
Aroclor 1268	ND		ug/kg	16.8	5.62	2	A
PCBs, Total	1330		ug/kg	16.8	5.62	2	B

Surrogate	% Recovery	Qualifier	Acceptance Criteria	Column
Tetrachloro-meta-Xylene	88		30-150	A
Decachlorobiphenyl	65		30-150	A
Tetrachloro-meta-Xylene	83		30-150	B
Decachlorobiphenyl	79		30-150	B

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-03
Client ID: AQSS-04-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 08:45
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8082A
Analytical Date: 11/08/21 17:15
Analyst: DP
Percent Solids: 85%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 10:50

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Column
MCP Polychlorinated Biphenyls by GC - Mansfield Lab							
Aroclor 1016	ND		ug/kg	8.25	3.03	1	A
Aroclor 1221	ND		ug/kg	8.25	4.07	1	A
Aroclor 1232	ND		ug/kg	8.25	3.89	1	A
Aroclor 1242	149		ug/kg	8.25	2.79	1	B
Aroclor 1248	ND		ug/kg	8.25	3.50	1	A
Aroclor 1254	264		ug/kg	8.25	3.47	1	B
Aroclor 1260	108		ug/kg	8.25	3.50	1	B
Aroclor 1262	ND		ug/kg	8.25	3.19	1	A
Aroclor 1268	ND		ug/kg	8.25	2.75	1	A
PCBs, Total	521		ug/kg	8.25	2.75	1	B

Surrogate	% Recovery	Qualifier	Acceptance Criteria	Column
Tetrachloro-meta-Xylene	83		30-150	A
Decachlorobiphenyl	60		30-150	A
Tetrachloro-meta-Xylene	79		30-150	B
Decachlorobiphenyl	73		30-150	B

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-06
Client ID: AQSS-03-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 09:25
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8082A
Analytical Date: 11/08/21 17:27
Analyst: DP
Percent Solids: 81%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 10:50

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Column
MCP Polychlorinated Biphenyls by GC - Mansfield Lab							
Aroclor 1016	ND		ug/kg	9.08	3.34	1	A
Aroclor 1221	ND		ug/kg	9.08	4.48	1	A
Aroclor 1232	ND		ug/kg	9.08	4.28	1	A
Aroclor 1242	216		ug/kg	9.08	3.08	1	B
Aroclor 1248	ND		ug/kg	9.08	3.85	1	A
Aroclor 1254	223		ug/kg	9.08	3.82	1	B
Aroclor 1260	105		ug/kg	9.08	3.85	1	B
Aroclor 1262	ND		ug/kg	9.08	3.51	1	A
Aroclor 1268	ND		ug/kg	9.08	3.03	1	A
PCBs, Total	544		ug/kg	9.08	3.03	1	B

Surrogate	% Recovery	Qualifier	Acceptance Criteria	Column
Tetrachloro-meta-Xylene	100		30-150	A
Decachlorobiphenyl	66		30-150	A
Tetrachloro-meta-Xylene	79		30-150	B
Decachlorobiphenyl	68		30-150	B

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-13
Client ID: AQSS-18-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 13:55
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8082A
Analytical Date: 11/08/21 17:39
Analyst: DP
Percent Solids: 91%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 10:50

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Column
MCP Polychlorinated Biphenyls by GC - Mansfield Lab							
Aroclor 1016	ND		ug/kg	7.81	2.88	1	A
Aroclor 1221	ND		ug/kg	7.81	3.86	1	A
Aroclor 1232	ND		ug/kg	7.81	3.69	1	A
Aroclor 1242	65.7		ug/kg	7.81	2.65	1	B
Aroclor 1248	ND		ug/kg	7.81	3.31	1	A
Aroclor 1254	33.8	P	ug/kg	7.81	3.29	1	B
Aroclor 1260	7.48	J	ug/kg	7.81	3.31	1	B
Aroclor 1262	ND		ug/kg	7.81	3.02	1	A
Aroclor 1268	ND		ug/kg	7.81	2.60	1	A
PCBs, Total	107	J	ug/kg	7.81	2.60	1	B

Surrogate	% Recovery	Qualifier	Acceptance Criteria	Column
Tetrachloro-meta-Xylene	90		30-150	A
Decachlorobiphenyl	60		30-150	A
Tetrachloro-meta-Xylene	72		30-150	B
Decachlorobiphenyl	61		30-150	B

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-14
Client ID: AQSS-20-0.0-0.5
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 12:50
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8082A
Analytical Date: 11/08/21 17:51
Analyst: DP
Percent Solids: 87%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 10:50

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Column
MCP Polychlorinated Biphenyls by GC - Mansfield Lab							
Aroclor 1016	ND		ug/kg	8.14	2.99	1	A
Aroclor 1221	ND		ug/kg	8.14	4.01	1	A
Aroclor 1232	ND		ug/kg	8.14	3.84	1	A
Aroclor 1242	ND		ug/kg	8.14	2.76	1	A
Aroclor 1248	ND		ug/kg	8.14	3.45	1	A
Aroclor 1254	53.4	P	ug/kg	8.14	3.43	1	B
Aroclor 1260	19.5	P	ug/kg	8.14	3.45	1	B
Aroclor 1262	ND		ug/kg	8.14	3.14	1	A
Aroclor 1268	ND		ug/kg	8.14	2.71	1	A
PCBs, Total	72.9		ug/kg	8.14	2.71	1	B

Surrogate	% Recovery	Qualifier	Acceptance Criteria	Column
Tetrachloro-meta-Xylene	46		30-150	A
Decachlorobiphenyl	48		30-150	A
Tetrachloro-meta-Xylene	50		30-150	B
Decachlorobiphenyl	57		30-150	B

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-16
Client ID: RB01-092921
Sample Location: HAVERHILL, MA

Date Collected: 09/29/21 17:25
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Water
Analytical Method: 97,8082A
Analytical Date: 11/02/21 16:10
Analyst: DP

Extraction Method: EPA 3510C
Extraction Date: 11/01/21 17:26

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Column
MCP Polychlorinated Biphenyls by GC - Mansfield Lab							
Aroclor 1016	ND		ug/l	0.049	0.049	1	A
Aroclor 1221	ND		ug/l	0.049	0.049	1	A
Aroclor 1232	ND		ug/l	0.049	0.049	1	A
Aroclor 1242	ND		ug/l	0.049	0.049	1	A
Aroclor 1248	ND		ug/l	0.049	0.049	1	A
Aroclor 1254	ND		ug/l	0.049	0.049	1	A
Aroclor 1260	ND		ug/l	0.049	0.049	1	A
Aroclor 1262	ND		ug/l	0.049	0.049	1	A
Aroclor 1268	ND		ug/l	0.049	0.049	1	A
PCBs, Total	ND		ug/l	0.049	0.049	1	A

Surrogate	% Recovery	Qualifier	Acceptance Criteria	Column
Tetrachloro-meta-Xylene	50		30-150	A
Decachlorobiphenyl	70		30-150	A
Tetrachloro-meta-Xylene	50		30-150	B
Decachlorobiphenyl	72		30-150	B

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-17
Client ID: WC1-093021
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 14:20
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8082A
Analytical Date: 11/08/21 18:04
Analyst: DP
Percent Solids: 85%

Extraction Method: EPA 3570
Extraction Date: 10/27/21 10:50

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Column
MCP Polychlorinated Biphenyls by GC - Mansfield Lab							
Aroclor 1016	ND		ug/kg	8.17	3.01	1	A
Aroclor 1221	ND		ug/kg	8.17	4.03	1	A
Aroclor 1232	ND		ug/kg	8.17	3.86	1	A
Aroclor 1242	ND		ug/kg	8.17	2.77	1	A
Aroclor 1248	ND		ug/kg	8.17	3.46	1	A
Aroclor 1254	ND		ug/kg	8.17	3.44	1	A
Aroclor 1260	ND		ug/kg	8.17	3.46	1	A
Aroclor 1262	ND		ug/kg	8.17	3.16	1	A
Aroclor 1268	ND		ug/kg	8.17	2.72	1	A
PCBs, Total	ND		ug/kg	8.17	2.72	1	A

Surrogate	% Recovery	Qualifier	Acceptance Criteria	Column
Tetrachloro-meta-Xylene	33		30-150	A
Decachlorobiphenyl	50		30-150	A
Tetrachloro-meta-Xylene	37		30-150	B
Decachlorobiphenyl	55		30-150	B

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 97,8082A
Analytical Date: 11/08/21 14:11
Analyst: DP

Extraction Method: EPA 3570
Extraction Date: 10/27/21 10:47

Parameter	Result	Qualifier	Units	RL	MDL	Column
MCP Polychlorinated Biphenyls by GC - Mansfield Lab for sample(s): 01,03,06,13-14,17 Batch: WG1563709-1						
Aroclor 1016	ND		ug/kg	7.50	2.76	A
Aroclor 1221	ND		ug/kg	7.50	3.70	A
Aroclor 1232	ND		ug/kg	7.50	3.54	A
Aroclor 1242	ND		ug/kg	7.50	2.54	A
Aroclor 1248	ND		ug/kg	7.50	3.18	A
Aroclor 1254	ND		ug/kg	7.50	3.16	A
Aroclor 1260	ND		ug/kg	7.50	3.18	A
Aroclor 1262	ND		ug/kg	7.50	2.90	A
Aroclor 1268	ND		ug/kg	7.50	2.50	A
PCBs, Total	ND		ug/kg	7.50	2.50	A

Surrogate	%Recovery	Qualifier	Acceptance Criteria	Column
Tetrachloro-meta-Xylene	111		30-150	A
Decachlorobiphenyl	103		30-150	A
Tetrachloro-meta-Xylene	105		30-150	B
Decachlorobiphenyl	104		30-150	B

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 97,8082A
Analytical Date: 11/02/21 15:12
Analyst: DP

Extraction Method: EPA 3510C
Extraction Date: 11/01/21 17:26

Parameter	Result	Qualifier	Units	RL	MDL	Column
MCP Polychlorinated Biphenyls by GC - Mansfield Lab for sample(s): 16 Batch: WG1565654-1						
Aroclor 1016	ND		ug/l	0.050	0.050	A
Aroclor 1221	ND		ug/l	0.050	0.050	A
Aroclor 1232	ND		ug/l	0.050	0.050	A
Aroclor 1242	ND		ug/l	0.050	0.050	A
Aroclor 1248	ND		ug/l	0.050	0.050	A
Aroclor 1254	ND		ug/l	0.050	0.050	A
Aroclor 1260	ND		ug/l	0.050	0.050	A
Aroclor 1262	ND		ug/l	0.050	0.050	A
Aroclor 1268	ND		ug/l	0.050	0.050	A
PCBs, Total	ND		ug/l	0.050	0.050	A

Surrogate	%Recovery	Qualifier	Acceptance Criteria	Column
Tetrachloro-meta-Xylene	35		30-150	A
Decachlorobiphenyl	81		30-150	A
Tetrachloro-meta-Xylene	33		30-150	B
Decachlorobiphenyl	83		30-150	B

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits	Column
MCP Polychlorinated Biphenyls by GC - Mansfield Lab Associated sample(s): 01,03,06,13-14,17 Batch: WG1563709-2 WG1563709-3									
Aroclor 1016	100		100		40-140	0		30	A
Aroclor 1260	106		106		40-140	0		30	A

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria	Column
Tetrachloro-meta-Xylene	109		106		30-150	A
Decachlorobiphenyl	101		101		30-150	A
Tetrachloro-meta-Xylene	101		99		30-150	B
Decachlorobiphenyl	98		96		30-150	B

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits	Column
MCP Polychlorinated Biphenyls by GC - Mansfield Lab Associated sample(s): 16 Batch: WG1565654-2 WG1565654-3									
Aroclor 1016	46		42		40-140	9		20	A
Aroclor 1260	70		72		40-140	3		20	A

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria	Column
Tetrachloro-meta-Xylene	33		33		30-150	A
Decachlorobiphenyl	74		77		30-150	A
Tetrachloro-meta-Xylene	31		31		30-150	B
Decachlorobiphenyl	78		77		30-150	B

Matrix Spike Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	Native Sample	MS Added	MS Found	MS %Recovery	Qual	MSD Found	MSD %Recovery	Qual	Recovery Limits	RPD	Qual	RPD Limits	Column
MCP Polychlorinated Biphenyls by GC - Mansfield Lab Associated sample(s): 01,03,06,13-14,17 QC Batch ID: WG1563709-4 WG1563709-5 QC Sample: L2153328-01 Client ID: AQSS-05-0.0-0.5													
Aroclor 1016	ND	294	972	**331**	Q	684	**236**	Q	40-140	**35**	Q	30	A
Aroclor 1260	181	294	613	**147**	Q	341	55		40-140	**57**	Q	30	B

Surrogate	MS % Recovery	MS Qualifier	MSD % Recovery	MSD Qualifier	Acceptance Criteria	Column
Decachlorobiphenyl	68		55		30-150	A
Tetrachloro-meta-Xylene	93		76		30-150	A
Decachlorobiphenyl	80		65		30-150	B
Tetrachloro-meta-Xylene	85		72		30-150	B

PESTICIDES

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-17
Client ID: WC1-093021
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 14:20
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 1,8151A
Analytical Date: 10/13/21 19:43
Analyst: AR
Percent Solids: 85%
Methylation Date: 10/13/21 04:33

Extraction Method: EPA 8151A
Extraction Date: 10/12/21 07:25

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Column
Chlorinated Herbicides by GC - Westborough Lab							
2,4-D	ND		ug/kg	194	12.2	1	A
2,4,5-T	ND		ug/kg	194	6.01	1	A
2,4,5-TP (Silvex)	ND		ug/kg	194	5.16	1	A

Surrogate	% Recovery	Qualifier	Acceptance Criteria	Column
DCAA	**1420**	Q	30-150	A
DCAA	67		30-150	B

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-17 D
Client ID: WC1-093021
Sample Location: HAVERHILL, MA

Date Collected: 09/30/21 14:20
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Analytical Method: 97,8081B
Analytical Date: 10/13/21 16:58
Analyst: JAW
Percent Solids: 85%

Extraction Method: EPA 3546
Extraction Date: 10/11/21 11:10
Cleanup Method: EPA 3620B
Cleanup Date: 10/12/21

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Column
MCP Organochlorine Pesticides - Westborough Lab							
Delta-BHC	ND		ug/kg	18.8	18.8	10	B
Lindane	ND		ug/kg	6.26	6.26	10	B
Alpha-BHC	ND		ug/kg	7.82	7.82	10	B
Beta-BHC	ND		ug/kg	18.8	18.8	10	B
Heptachlor	ND		ug/kg	9.39	9.39	10	B
Aldrin	ND		ug/kg	18.8	18.8	10	B
Heptachlor epoxide	ND		ug/kg	35.2	35.2	10	B
Endrin	ND		ug/kg	7.82	7.82	10	B
Endrin ketone	ND		ug/kg	18.8	18.8	10	B
Dieldrin	ND		ug/kg	11.7	11.7	10	B
4,4'-DDE	ND		ug/kg	18.8	18.8	10	B
4,4'-DDD	ND		ug/kg	18.8	18.8	10	B
4,4'-DDT	ND		ug/kg	35.2	35.2	10	B
Endosulfan I	ND		ug/kg	18.8	18.8	10	B
Endosulfan II	ND		ug/kg	18.8	18.8	10	B
Endosulfan sulfate	ND		ug/kg	7.82	7.82	10	B
Methoxychlor	ND		ug/kg	35.2	35.2	10	B
Chlordane	ND		ug/kg	156	156.	10	B
Hexachlorobenzene	ND		ug/kg	18.8	18.8	10	B

Surrogate	% Recovery	Qualifier	Acceptance Criteria	Column
2,4,5,6-Tetrachloro-m-xylene	**2250**	Q	30-150	A
Decachlorobiphenyl	**19**	Q	30-150	A
2,4,5,6-Tetrachloro-m-xylene	73		30-150	B
Decachlorobiphenyl	**612**	Q	30-150	B

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 97,8081B
Analytical Date: 10/13/21 16:02
Analyst: JAW

Extraction Method: EPA 3546
Extraction Date: 10/10/21 13:56
Cleanup Method: EPA 3620B
Cleanup Date: 10/10/21

Parameter	Result	Qualifier	Units	RL	MDL	Column
MCP Organochlorine Pesticides - Westborough Lab for sample(s): 17 Batch: WG1556799-1						
Delta-BHC	ND		ug/kg	1.55	1.55	A
Lindane	ND		ug/kg	0.516	0.516	A
Alpha-BHC	ND		ug/kg	0.645	0.645	A
Beta-BHC	ND		ug/kg	1.55	1.55	A
Heptachlor	ND		ug/kg	0.774	0.774	A
Aldrin	ND		ug/kg	1.55	1.55	A
Heptachlor epoxide	ND		ug/kg	2.90	2.90	A
Endrin	ND		ug/kg	0.645	0.645	A
Endrin ketone	ND		ug/kg	1.55	1.55	A
Dieldrin	ND		ug/kg	0.968	0.968	A
4,4'-DDE	ND		ug/kg	1.55	1.55	A
4,4'-DDD	ND		ug/kg	1.55	1.55	A
4,4'-DDT	ND		ug/kg	2.90	2.90	A
Endosulfan I	ND		ug/kg	1.55	1.55	A
Endosulfan II	ND		ug/kg	1.55	1.55	A
Endosulfan sulfate	ND		ug/kg	0.645	0.645	A
Methoxychlor	ND		ug/kg	2.90	2.90	A
Chlordane	ND		ug/kg	12.9	12.9	A
Hexachlorobenzene	ND		ug/kg	1.55	1.55	A

Surrogate	%Recovery	Qualifier	Acceptance Criteria	Column
2,4,5,6-Tetrachloro-m-xylene	71		30-150	A
Decachlorobiphenyl	88		30-150	A
2,4,5,6-Tetrachloro-m-xylene	62		30-150	B
Decachlorobiphenyl	62		30-150	B

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 1,8151A
Analytical Date: 10/13/21 13:03
Analyst: AR

Extraction Method: EPA 8151A
Extraction Date: 10/12/21 07:25

Methylation Date: 10/13/21 04:33

Parameter	Result	Qualifier	Units	RL	MDL	Column
Chlorinated Herbicides by GC - Westborough Lab for sample(s): 17 Batch: WG1557389-1						
2,4-D	ND		ug/kg	164	10.3	A
2,4,5-T	ND		ug/kg	164	5.08	A
2,4,5-TP (Silvex)	ND		ug/kg	164	4.36	A

Surrogate	%Recovery	Qualifier	Acceptance Criteria	Column
DCAA	76		30-150	A
DCAA	61		30-150	B

Lab Control Sample Analysis
Batch Quality Control

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits	Column
MCP Organochlorine Pesticides - Westborough Lab Associated sample(s): 17 Batch: WG1556799-2 WG1556799-3									
Delta-BHC	61		68		40-140	11		30	A
Lindane	65		68		40-140	5		30	A
Alpha-BHC	64		63		40-140	2		30	A
Beta-BHC	65		65		40-140	0		30	A
Heptachlor	76		77		40-140	1		30	A
Aldrin	68		69		40-140	1		30	A
Heptachlor epoxide	62		64		40-140	3		30	A
Endrin	74		74		40-140	0		30	A
Endrin ketone	56		59		40-140	5		30	A
Dieldrin	76		76		40-140	0		30	A
4,4'-DDE	68		68		40-140	0		30	A
4,4'-DDD	78		78		40-140	0		30	A
4,4'-DDT	80		78		40-140	3		30	A
Endosulfan I	66		66		40-140	0		30	A
Endosulfan II	70		71		40-140	1		30	A
Endosulfan sulfate	56		60		40-140	7		30	A
Methoxychlor	66		70		40-140	6		30	A
Hexachlorobenzene	64		65		40-140	2		30	A

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP Organochlorine Pesticides - Westborough Lab Associated sample(s): 17 Batch: WG1556799-2 WG1556799-3								

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria	Column
2,4,5,6-Tetrachloro-m-xylene	68		67		30-150	A
Decachlorobiphenyl	94		94		30-150	A
2,4,5,6-Tetrachloro-m-xylene	59		61		30-150	B
Decachlorobiphenyl	64		66		30-150	B

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits	Column
Chlorinated Herbicides by GC - Westborough Lab Associated sample(s): 17 Batch: WG1557389-2 WG1557389-3									
2,4-D	72		76		30-150	5		30	A
2,4,5-T	73		74		30-150	1		30	A
2,4,5-TP (Silvex)	74		76		30-150	3		30	A

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria	Column
DCAA	79		75		30-150	A
DCAA	70		72		30-150	B

METALS

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328

Project Number: 180327-08.01 **Report Date:** 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-01 Date Collected: 09/29/21 14:50

Client ID: AQSS-05-0.0-0.5 Date Received: 09/30/21

Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Matrix: Sediment

Percent Solids: 85%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Arsenic, Total	7.89		mg/kg	0.579	0.579	10	10/11/21 22:44	10/13/21 16:45	EPA 3050B	97,6020B	CD
Barium, Total	29.7		mg/kg	3.47	3.47	10	10/11/21 22:44	10/13/21 16:45	EPA 3050B	97,6020B	CD
Cadmium, Total	ND		mg/kg	0.2315	0.2315	10	10/11/21 22:44	10/13/21 16:45	EPA 3050B	97,6020B	CD
Chromium, Total	40.9		mg/kg	2.31	2.31	10	10/11/21 22:44	10/13/21 16:45	EPA 3050B	97,6020B	CD
Lead, Total	98.0		mg/kg	0.694	0.694	10	10/11/21 22:44	10/13/21 16:45	EPA 3050B	97,6020B	CD
Mercury, Total	ND		mg/kg	0.081	0.081	1	11/10/21 13:49	11/10/21 17:11	EPA 7471B	97,7471B	AC
Selenium, Total	ND		mg/kg	2.31	2.31	10	10/11/21 22:44	10/13/21 16:45	EPA 3050B	97,6020B	CD
Silver, Total	ND		mg/kg	0.579	0.579	10	10/11/21 22:44	10/13/21 16:45	EPA 3050B	97,6020B	CD

Project Name: FORMER HAVERHILL MGP
Lab Number: L2153328
Project Number: 180327-08.01
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-03
Client ID: AQSS-04-0.0-0.5
Sample Location: HAVERHILL, MA
Date Collected: 09/30/21 08:45
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Percent Solids: 85%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Arsenic, Total	7.94		mg/kg	0.569	0.569	10	10/11/21 22:44	10/12/21 22:36	EPA 3050B	97,6020B	CD
Barium, Total	28.6		mg/kg	3.41	3.41	10	10/11/21 22:44	10/12/21 22:36	EPA 3050B	97,6020B	CD
Cadmium, Total	0.6211		mg/kg	0.2274	0.2274	10	10/11/21 22:44	10/12/21 22:36	EPA 3050B	97,6020B	CD
Chromium, Total	414		mg/kg	2.27	2.27	10	10/11/21 22:44	10/12/21 22:36	EPA 3050B	97,6020B	CD
Lead, Total	167		mg/kg	0.682	0.682	10	10/11/21 22:44	10/12/21 22:36	EPA 3050B	97,6020B	CD
Mercury, Total	0.127		mg/kg	0.090	0.090	1	11/10/21 13:49	11/10/21 18:04	EPA 7471B	97,7471B	AC
Selenium, Total	ND		mg/kg	2.27	2.27	10	10/11/21 22:44	10/12/21 22:36	EPA 3050B	97,6020B	CD
Silver, Total	ND		mg/kg	0.569	0.569	10	10/11/21 22:44	10/12/21 22:36	EPA 3050B	97,6020B	CD

Project Name: FORMER HAVERHILL MGP
Lab Number: L2153328
Project Number: 180327-08.01
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-06
Client ID: AQSS-03-0.0-0.5
Sample Location: HAVERHILL, MA
Date Collected: 09/30/21 09:25
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Percent Solids: 81%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Arsenic, Total	7.40		mg/kg	0.604	0.604	10	10/11/21 22:44	10/12/21 22:41	EPA 3050B	97,6020B	CD
Barium, Total	37.2		mg/kg	3.63	3.63	10	10/11/21 22:44	10/12/21 22:41	EPA 3050B	97,6020B	CD
Cadmium, Total	0.2943		mg/kg	0.2417	0.2417	10	10/11/21 22:44	10/12/21 22:41	EPA 3050B	97,6020B	CD
Chromium, Total	34.9		mg/kg	2.42	2.42	10	10/11/21 22:44	10/12/21 22:41	EPA 3050B	97,6020B	CD
Lead, Total	153		mg/kg	0.725	0.725	10	10/11/21 22:44	10/12/21 22:41	EPA 3050B	97,6020B	CD
Mercury, Total	ND		mg/kg	0.081	0.081	1	11/10/21 13:49	11/10/21 18:08	EPA 7471B	97,7471B	AC
Selenium, Total	ND		mg/kg	2.42	2.42	10	10/11/21 22:44	10/12/21 22:41	EPA 3050B	97,6020B	CD
Silver, Total	ND		mg/kg	0.604	0.604	10	10/11/21 22:44	10/12/21 22:41	EPA 3050B	97,6020B	CD

Project Name: FORMER HAVERHILL MGP
Lab Number: L2153328
Project Number: 180327-08.01
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-13
Client ID: AQSS-18-0.0-0.5
Sample Location: HAVERHILL, MA
Date Collected: 09/30/21 13:55
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Percent Solids: 91%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Arsenic, Total	22.6		mg/kg	0.523	0.523	10	10/11/21 22:44	10/12/21 22:46	EPA 3050B	97,6020B	CD
Barium, Total	13.8		mg/kg	3.14	3.14	10	10/11/21 22:44	10/12/21 22:46	EPA 3050B	97,6020B	CD
Cadmium, Total	0.6468		mg/kg	0.2094	0.2094	10	10/11/21 22:44	10/12/21 22:46	EPA 3050B	97,6020B	CD
Chromium, Total	14.4		mg/kg	2.09	2.09	10	10/11/21 22:44	10/12/21 22:46	EPA 3050B	97,6020B	CD
Lead, Total	37.0		mg/kg	0.628	0.628	10	10/11/21 22:44	10/12/21 22:46	EPA 3050B	97,6020B	CD
Mercury, Total	ND		mg/kg	0.079	0.079	1	11/10/21 13:49	11/10/21 18:11	EPA 7471B	97,7471B	AC
Selenium, Total	ND		mg/kg	2.09	2.09	10	10/11/21 22:44	10/12/21 22:46	EPA 3050B	97,6020B	CD
Silver, Total	ND		mg/kg	0.523	0.523	10	10/11/21 22:44	10/12/21 22:46	EPA 3050B	97,6020B	CD

Project Name: FORMER HAVERHILL MGP
Lab Number: L2153328
Project Number: 180327-08.01
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-14
Client ID: AQSS-20-0.0-0.5
Sample Location: HAVERHILL, MA
Date Collected: 09/30/21 12:50
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Percent Solids: 87%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Arsenic, Total	14.5		mg/kg	0.557	0.557	10	10/11/21 22:44	10/12/21 19:19	EPA 3050B	97,6020B	CD
Barium, Total	26.4		mg/kg	3.34	3.34	10	10/11/21 22:44	10/12/21 19:19	EPA 3050B	97,6020B	CD
Cadmium, Total	ND		mg/kg	0.2228	0.2228	10	10/11/21 22:44	10/12/21 19:19	EPA 3050B	97,6020B	CD
Chromium, Total	22.0		mg/kg	2.23	2.23	10	10/11/21 22:44	10/12/21 19:19	EPA 3050B	97,6020B	CD
Lead, Total	124		mg/kg	0.668	0.668	10	10/11/21 22:44	10/12/21 19:19	EPA 3050B	97,6020B	CD
Mercury, Total	ND		mg/kg	0.080	0.080	1	11/10/21 13:49	11/10/21 18:21	EPA 7471B	97,7471B	AC
Selenium, Total	ND		mg/kg	2.23	2.23	10	10/11/21 22:44	10/12/21 19:19	EPA 3050B	97,6020B	CD
Silver, Total	ND		mg/kg	0.557	0.557	10	10/11/21 22:44	10/12/21 19:19	EPA 3050B	97,6020B	CD

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328

Project Number: 180327-08.01 **Report Date:** 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-16 Date Collected: 09/29/21 17:25

Client ID: RB01-092921 Date Received: 09/30/21

Sample Location: HAVERHILL, MA Field Prep: Not Specified

Sample Depth:

Matrix: Water

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Arsenic, Total	ND		mg/l	0.0005	0.0005	1	11/10/21 17:02	11/11/21 18:17	EPA 3005A	97,6020B	CD
Barium, Total	0.0007		mg/l	0.0005	0.0005	1	11/10/21 17:02	11/11/21 18:17	EPA 3005A	97,6020B	CD
Cadmium, Total	ND		mg/l	0.0002	0.0002	1	11/10/21 17:02	11/11/21 18:17	EPA 3005A	97,6020B	CD
Chromium, Total	ND		mg/l	0.001	0.001	1	11/10/21 17:02	11/11/21 18:17	EPA 3005A	97,6020B	CD
Lead, Total	ND		mg/l	0.001	0.001	1	11/10/21 17:02	11/11/21 18:17	EPA 3005A	97,6020B	CD
Mercury, Total	ND		mg/l	0.0004	0.0004	1	11/10/21 16:53	11/11/21 09:10	EPA 7470A	97,7470A	AC
Selenium, Total	ND		mg/l	0.005	0.005	1	11/10/21 17:02	11/11/21 18:17	EPA 3005A	97,6020B	CD
Silver, Total	ND		mg/l	0.0005	0.0005	1	11/10/21 17:02	11/11/21 18:17	EPA 3005A	97,6020B	CD

Project Name: FORMER HAVERHILL MGP
Lab Number: L2153328
Project Number: 180327-08.01
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-17
Client ID: WC1-093021
Sample Location: HAVERHILL, MA
Date Collected: 09/30/21 14:20
Date Received: 09/30/21
Field Prep: Not Specified

Sample Depth:
Matrix: Sediment
Percent Solids: 85%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Arsenic, Total	58.4		mg/kg	0.578	0.578	10	10/11/21 22:44	10/12/21 19:24	EPA 3050B	97,6020B	CD
Barium, Total	22.2		mg/kg	3.47	3.47	10	10/11/21 22:44	10/12/21 19:24	EPA 3050B	97,6020B	CD
Cadmium, Total	ND		mg/kg	0.2312	0.2312	10	10/11/21 22:44	10/12/21 19:24	EPA 3050B	97,6020B	CD
Chromium, Total	36.8		mg/kg	2.31	2.31	10	10/11/21 22:44	10/12/21 19:24	EPA 3050B	97,6020B	CD
Lead, Total	9430		mg/kg	3.47	3.47	50	10/11/21 22:44	10/12/21 23:00	EPA 3050B	97,6020B	CD
Mercury, Total	0.175		mg/kg	0.086	0.086	1	11/10/21 13:49	11/10/21 18:24	EPA 7471B	97,7471B	AC
Selenium, Total	ND		mg/kg	2.31	2.31	10	10/11/21 22:44	10/12/21 19:24	EPA 3050B	97,6020B	CD
Silver, Total	ND		mg/kg	0.578	0.578	10	10/11/21 22:44	10/12/21 19:24	EPA 3050B	97,6020B	CD

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328

Project Number: 180327-08.01 **Report Date:** 11/24/21

Method Blank Analysis
Batch Quality Control

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab for sample(s): 01,03,06,13-14,17 Batch: WG1555837-1										
Arsenic, Total	ND		mg/kg	0.500	0.500	10	10/11/21 22:44	10/12/21 18:40	97,6020B	CD
Barium, Total	ND		mg/kg	3.00	3.00	10	10/11/21 22:44	10/12/21 18:40	97,6020B	CD
Cadmium, Total	ND		mg/kg	0.2000	0.2000	10	10/11/21 22:44	10/12/21 18:40	97,6020B	CD
Chromium, Total	ND		mg/kg	2.00	2.00	10	10/11/21 22:44	10/12/21 18:40	97,6020B	CD
Lead, Total	ND		mg/kg	0.600	0.600	10	10/11/21 22:44	10/12/21 18:40	97,6020B	CD
Selenium, Total	ND		mg/kg	2.00	2.00	10	10/11/21 22:44	10/12/21 18:40	97,6020B	CD
Silver, Total	ND		mg/kg	0.500	0.500	10	10/11/21 22:44	10/12/21 18:40	97,6020B	CD

Prep Information

Digestion Method: EPA 3050B

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab for sample(s): 01,03,06,13-14,17 Batch: WG1569044-1										
Mercury, Total	ND		mg/kg	0.083	0.083	1	11/10/21 13:49	11/10/21 17:01	97,7471B	AC

Prep Information

Digestion Method: EPA 7471B

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab for sample(s): 16 Batch: WG1569068-1										
Arsenic, Total	ND		mg/l	0.0005	0.0005	1	11/10/21 17:02	11/11/21 18:37	97,6020B	CD
Barium, Total	ND		mg/l	0.0005	0.0005	1	11/10/21 17:02	11/11/21 18:37	97,6020B	CD
Cadmium, Total	ND		mg/l	0.0002	0.0002	1	11/10/21 17:02	11/11/21 18:37	97,6020B	CD
Chromium, Total	ND		mg/l	0.001	0.001	1	11/10/21 17:02	11/11/21 18:37	97,6020B	CD
Lead, Total	ND		mg/l	0.001	0.001	1	11/10/21 17:02	11/11/21 18:37	97,6020B	CD
Selenium, Total	ND		mg/l	0.005	0.005	1	11/10/21 17:02	11/11/21 18:37	97,6020B	CD
Silver, Total	ND		mg/l	0.0005	0.0005	1	11/10/21 17:02	11/11/21 18:37	97,6020B	CD

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

Method Blank Analysis
Batch Quality Control

Prep Information

Digestion Method: EPA 3005A

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab for sample(s): 16 Batch: WG1569070-1										
Mercury, Total	ND		mg/l	0.0002	0.0002	1	11/10/21 16:53	11/11/21 09:01	97,7470A	AC

Prep Information

Digestion Method: EPA 7470A

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP Total Metals - Mansfield Lab Associated sample(s): 01,03,06,13-14,17 Batch: WG1555837-2 WG1555837-3 SRM Lot Number: D109-540								
Arsenic, Total	81		78		70-130	4		30
Barium, Total	78		78		75-125	0		30
Cadmium, Total	81		79		75-125	3		30
Chromium, Total	77		74		70-130	4		30
Lead, Total	79		76		72-128	4		30
Selenium, Total	81		78		68-132	4		30
Silver, Total	81		78		68-131	4		30
MCP Total Metals - Mansfield Lab Associated sample(s): 01,03,06,13-14,17 Batch: WG1569044-2 WG1569044-3 SRM Lot Number: D109-540								
Mercury, Total	95		92		60-140	3		30
MCP Total Metals - Mansfield Lab Associated sample(s): 16 Batch: WG1569068-2 WG1569068-3								
Arsenic, Total	106		105		80-120	1		20
Barium, Total	99		100		80-120	1		20
Cadmium, Total	102		102		80-120	0		20
Chromium, Total	96		98		80-120	2		20
Lead, Total	100		96		80-120	4		20
Selenium, Total	102		104		80-120	2		20
Silver, Total	103		104		80-120	1		20

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	LCSD %Recovery	%Recovery Limits	RPD	RPD Limits
MCP Total Metals - Mansfield Lab Associated sample(s): 16 Batch: WG1569070-2 WG1569070-3					
Mercury, Total	99	99	80-120	0	20

Matrix Spike Analysis
Batch Quality Control

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01

Lab Number: L2153328
Report Date: 11/24/21

Parameter	Native Sample	MS Added	MS Found	MS %Recovery	Qual	MSD Found	MSD %Recovery	Qual	Recovery Limits	RPD	Qual	RPD Limits
MCP Total Metals - Mansfield Lab Associated sample(s): 01,03,06,13-14,17 QC Batch ID: WG1555837-4 WG1555837-5 QC Sample: L2153328-01 Client ID: AQSS-05-0.0-0.5												
Arsenic, Total	7.89	10.9	13.6	**52**	Q	14.0	**56**	Q	75-125	3		35
Barium, Total	29.7	182	208	98		208	99		75-125	0		35
Cadmium, Total	ND	4.81	5.314	110		5.265	110		75-125	1		35
Chromium, Total	40.9	18.2	51.8	**60**	Q	57.7	93		75-125	11		35
Lead, Total	98.0	48.1	174	**158**	Q	114	**34**	Q	75-125	**42**	Q	35
Selenium, Total	ND	10.9	11.3	104		11.2	104		75-125	1		35
Silver, Total	ND	27.2	30.3	111		29.6	110		75-125	2		35
MCP Total Metals - Mansfield Lab Associated sample(s): 01,03,06,13-14,17 QC Batch ID: WG1569044-4 WG1569044-5 QC Sample: L2153328-01 Client ID: AQSS-05-0.0-0.5												
Mercury, Total	ND	0.158	0.234	**148**	Q	1.02	**612**	Q	75-125	**125**	Q	35

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01

Lab Serial Dilution Analysis
Batch Quality Control

Lab Number: L2153328
Report Date: 11/24/21

Parameter	Native Sample	Serial Dilution	Units	% D	Qual	RPD Limits
MCP Total Metals - Mansfield Lab Associated sample(s): 01,03,06,13-14,17 QC Batch ID: WG1555837-6 QC Sample: L2153328-01 Client ID: AQSS-05-0.0-0.5						
Lead, Total	98.0	98.1	mg/kg	0		20

INORGANICS
&
MISCELLANEOUS

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-17
Client ID: WC1-093021
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/30/21 14:20
Date Received: 09/30/21
Field Prep: Not Specified

Test Material Information

Source of Material: Unknown
Description of Material: Non-Metallic - Damp Soil
Particle Size: Medium
Preliminary Burning Time (sec): 120

Parameter	Result	Date Analyzed	Analytical Method	Analyst
Ignitability of Solids - Westborough Lab				
Ignitability	NI	10/14/21 14:45	1,1030	MD

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-01
Client ID: AQSS-05-0.0-0.5
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/29/21 14:50
Date Received: 09/30/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	0.806		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Rep2)	0.687		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Average)	0.746		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	84.7		%	0.100	0.100	1	-	10/28/21 10:25	121,2540G	AE
% Soot (Rep 1)	0.049		%	0.010	NA	1	-	11/23/21 10:25	91,-	SP
% Soot (Rep 2)	0.015		%	0.010	NA	1	-	11/23/21 10:25	91,-	SP
% Soot (Average)	0.032		%	0.010	NA	1	-	11/23/21 10:25	91,-	SP

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-02
Client ID: AQSS-05-1.0-1.5
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/29/21 14:45
Date Received: 09/30/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	16.7		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Rep2)	14.4		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Average)	15.6		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	70.6		%	0.100	0.100	1	-	10/28/21 10:25	121,2540G	AE

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-03
Client ID: AQSS-04-0.0-0.5
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/30/21 08:45
Date Received: 09/30/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	2.73		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Rep2)	3.20		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Average)	2.96		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	85.4		%	0.100	0.100	1	-	10/28/21 10:25	121,2540G	AE
% Soot (Rep 1)	0.263		%	0.010	NA	1	-	11/23/21 10:25	91,-	SP
% Soot (Rep 2)	0.192		%	0.010	NA	1	-	11/23/21 10:25	91,-	SP
% Soot (Average)	0.228		%	0.010	NA	1	-	11/23/21 10:25	91,-	SP

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-04
Client ID: AQSS-04-1.0-1.5
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/30/21 08:48
Date Received: 09/30/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	4.72		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Rep2)	6.78		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Average)	5.75		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	79.2		%	0.100	0.100	1	-	10/28/21 10:25	121,2540G	AE

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-05
Client ID: DUP2-20210930
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/30/21 00:00
Date Received: 09/30/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	1.53		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Rep2)	1.00		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Average)	1.26		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	84.5		%	0.100	0.100	1	-	10/28/21 10:25	121,2540G	AE

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-06
Client ID: AQSS-03-0.0-0.5
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/30/21 09:25
Date Received: 09/30/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	2.63		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Rep2)	3.04		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Average)	2.83		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	81.3		%	0.100	0.100	1	-	10/28/21 10:25	121,2540G	AE
% Soot (Rep 1)	0.504		%	0.010	NA	1	-	11/23/21 10:25	91,-	SP
% Soot (Rep 2)	0.437		%	0.010	NA	1	-	11/23/21 10:25	91,-	SP
% Soot (Average)	0.470		%	0.010	NA	1	-	11/23/21 10:25	91,-	SP

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-07
Client ID: AQSS-03-2.0-2.5
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/30/21 09:30
Date Received: 09/30/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	1.86		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Rep2)	1.60		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Average)	1.73		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	81.6		%	0.100	0.100	1	-	10/28/21 10:25	121,2540G	AE

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-08
Client ID: AQSS-07D-4.9-5.4
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/30/21 09:35
Date Received: 09/30/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	0.029		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Rep2)	0.018		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Average)	0.024		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	83.6		%	0.100	0.100	1	-	10/28/21 10:25	121,2540G	AE

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-09
Client ID: AQSS-19-3.0-3.5
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/30/21 10:33
Date Received: 09/30/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	0.074		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Rep2)	0.075		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Average)	0.075		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	89.3		%	0.100	0.100	1	-	10/28/21 10:25	121,2540G	AE

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-10
Client ID: AQSS-19-4.5-5.0
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/30/21 10:35
Date Received: 09/30/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	0.068		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Rep2)	0.070		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Average)	0.069		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	87.9		%	0.100	0.100	1	-	10/28/21 10:25	121,2540G	AE

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-11
Client ID: AQSS-18-4.6-4.8
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/30/21 13:52
Date Received: 09/30/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	ND		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Rep2)	0.010		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Average)	ND		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	84.0		%	0.100	0.100	1	-	10/28/21 10:25	121,2540G	AE

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-12
Client ID: AQSS-18-3.0-3.5
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/30/21 13:54
Date Received: 09/30/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	5.00		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Rep2)	6.48		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Average)	5.74		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	84.3		%	0.100	0.100	1	-	10/28/21 10:25	121,2540G	AE

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-13
Client ID: AQSS-18-0.0-0.5
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/30/21 13:55
Date Received: 09/30/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	1.07		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Rep2)	1.22		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Average)	1.15		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	90.8		%	0.100	0.100	1	-	10/28/21 10:25	121,2540G	AE
% Soot (Rep 1)	0.024		%	0.010	NA	1	-	11/23/21 10:25	91,-	SP
% Soot (Rep 2)	0.028		%	0.010	NA	1	-	11/23/21 10:25	91,-	SP
% Soot (Average)	0.026		%	0.010	NA	1	-	11/23/21 10:25	91,-	SP

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-14
Client ID: AQSS-20-0.0-0.5
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/30/21 12:50
Date Received: 09/30/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	2.06		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Rep2)	2.58		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Average)	2.32		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	87.3		%	0.100	0.100	1	-	10/28/21 10:25	121,2540G	AE
% Soot (Rep 1)	0.193		%	0.010	NA	1	-	11/23/21 10:25	91,-	SP
% Soot (Rep 2)	0.150		%	0.010	NA	1	-	11/23/21 10:25	91,-	SP
% Soot (Average)	0.172		%	0.010	NA	1	-	11/23/21 10:25	91,-	SP

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-15
Client ID: AQSS-20-4.2-4.5
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/30/21 12:45
Date Received: 09/30/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	0.021		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Rep2)	0.023		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Average)	0.022		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
General Chemistry - Mansfield Lab										
Solids, Total	83.3		%	0.100	0.100	1	-	10/28/21 10:25	121,2540G	AE

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-16
Client ID: RB01-092921
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Water

Date Collected: 09/29/21 17:25
Date Received: 09/30/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Total Organic Carbon	0.56		mg/l	0.50	0.11	1	-	10/27/21 05:19	1,9060A	DW
Dissolved Organic Carbon	0.54	J	mg/l	1.0	0.04	1	-	10/27/21 05:19	1,9060A	DW

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01
Lab Number: L2153328
Report Date: 11/24/21

SAMPLE RESULTS

Lab ID: L2153328-17
Client ID: WC1-093021
Sample Location: HAVERHILL, MA
Sample Depth:
Matrix: Sediment

Date Collected: 09/30/21 14:20
Date Received: 09/30/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	84.8		%	0.100	NA	1	-	10/02/21 11:14	121,2540G	RI
Cyanide, Total	0.98	J	mg/kg	1.1	0.24	1	10/14/21 13:00	10/14/21 17:20	1,9010C/9012B	JO
pH (H)	6.6		SU	-	NA	1	-	10/13/21 21:01	1,9045D	RM
Cyanide, Reactive	ND		mg/kg	10	10.	1	10/12/21 05:20	10/12/21 08:41	125,7.3	CS
Sulfide, Reactive	ND		mg/kg	10	10.	1	10/12/21 05:20	10/12/21 07:58	125,7.3	CS
Paint Filter Liquid	NEGATIVE		-	0	NA	1	-	10/05/21 20:50	1,9095B	AS

Project Name: FORMER HAVERHILL MGP **Lab Number:** L2153328

Project Number: 180327-08.01 **Report Date:** 11/24/21

Method Blank Analysis
Batch Quality Control

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab for sample(s): 17 Batch: WG1555532-1										
Sulfide, Reactive	ND		mg/kg	10	10.	1	10/12/21 05:20	10/12/21 07:56	125,7.3	CS
General Chemistry - Westborough Lab for sample(s): 17 Batch: WG1555534-1										
Cyanide, Reactive	ND		mg/kg	10	10.	1	10/12/21 05:20	10/12/21 08:39	125,7.3	CS
General Chemistry - Westborough Lab for sample(s): 17 Batch: WG1558514-1										
Cyanide, Total	ND		mg/kg	0.86	0.18	1	10/14/21 13:00	10/14/21 17:16	1,9010C/9012B	JO
General Chemistry - Westborough Lab for sample(s): 16 Batch: WG1563615-1										
Dissolved Organic Carbon	ND		mg/l	1.0	0.04	1	-	10/27/21 05:19	1,9060A	DW
General Chemistry - Westborough Lab for sample(s): 16 Batch: WG1564782-1										
Total Organic Carbon	ND		mg/l	0.50	0.11	1	-	10/27/21 05:19	1,9060A	DW
Total Organic Carbon - Mansfield Lab for sample(s): 01-15 Batch: WG1573823-1										
Total Organic Carbon (Rep1)	ND		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Rep2)	ND		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
Total Organic Carbon (Average)	ND		%	0.010	0.010	1	-	11/18/21 08:54	1,9060A	SP
General Chemistry - Mansfield Lab for sample(s): 01,03,06,13-14 Batch: WG1575312-1										
% Soot (Rep 1)	ND		%	0.010	NA	1	-	11/23/21 10:25	91,-	SP
% Soot (Rep 2)	ND		%	0.010	NA	1	-	11/23/21 10:25	91,-	SP
% Soot (Average)	ND		%	0.010	NA	1	-	11/23/21 10:25	91,-	SP

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
General Chemistry - Westborough Lab Associated sample(s): 17 Batch: WG1555532-2								
Sulfide, Reactive	120		-		60-125	-		40
General Chemistry - Westborough Lab Associated sample(s): 17 Batch: WG1555534-2								
Cyanide, Reactive	81		-		30-125	-		40
General Chemistry - Westborough Lab Associated sample(s): 17 Batch: WG1558189-1								
pH	100		-		99-101	-		
General Chemistry - Westborough Lab Associated sample(s): 17 Batch: WG1558514-2 WG1558514-3								
Cyanide, Total	**59**	Q	111		80-120	**41**	Q	35
General Chemistry - Westborough Lab Associated sample(s): 16 Batch: WG1563615-2								
Dissolved Organic Carbon	95		-		90-110	-		
General Chemistry - Westborough Lab Associated sample(s): 16 Batch: WG1564782-2								
Total Organic Carbon	95		-		90-110	-		

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	LCS %Recovery	LCSD %Recovery	%Recovery Limits	RPD	RPD Limits
Total Organic Carbon - Mansfield Lab Associated sample(s): 01-15 Batch: WG1573823-2					
Total Organic Carbon (Rep1)	110	-	75-125	-	25
Total Organic Carbon (Rep2)	102	-	75-125	-	25
Total Organic Carbon (Average)	106	-	75-125	-	25
General Chemistry - Mansfield Lab Associated sample(s): 01,03,06,13-14 Batch: WG1575312-2					
% Soot (Rep 1)	113	-	75-125	-	25
% Soot (Rep 2)	100	-	75-125	-	25

Matrix Spike Analysis
Batch Quality Control

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01

Lab Number: L2153328
Report Date: 11/24/21

Parameter	Native Sample	MS Added	MS Found	MS %Recovery	Qual	MSD Found	MSD %Recovery	Qual	Recovery Limits	RPD	Qual	RPD Limits
General Chemistry - Westborough Lab Associated sample(s): 16 QC Batch ID: WG1563615-4 QC Sample: L2153328-16 Client ID: RB01-092921												
Dissolved Organic Carbon	0.54J	40	39	97		-	-		80-120	-		20
General Chemistry - Westborough Lab Associated sample(s): 16 QC Batch ID: WG1564782-4 QC Sample: L2153328-16 Client ID: RB01-092921												
Total Organic Carbon	0.56	40	44	107		-	-		80-120	-		20
Total Organic Carbon - Mansfield Lab Associated sample(s): 01-15 QC Batch ID: WG1573823-4 WG1573823-5 QC Sample: L2153328-04 Client ID: AQSS-04-1.0-1.5												
Total Organic Carbon (Rep1)	4.72	0.758	6.65	**254**	Q	4.86	**22**	Q	75-125	**31**	Q	25
Total Organic Carbon (Rep2)	6.78	0.633	4.67	**0**	Q	4.25	**0**	Q	75-125	9		25
General Chemistry - Mansfield Lab Associated sample(s): 01,03,06,13-14 QC Batch ID: WG1575312-5 WG1575312-6 QC Sample: L2153328-01 Client ID: AQSS-05-0.0-0.5												
% Soot (Rep 1)	0.049	0.92	1.04	108		0.534	100		75-125	**64**	Q	25
% Soot (Rep 2)	0.015	0.556	0.602	106		1.13	**182**	Q	75-125	**61**	Q	25

Lab Duplicate Analysis

Batch Quality Control

Project Name: FORMER HAVERHILL MGP

Project Number: 180327-08.01

Lab Number: L2153328

Report Date: 11/24/21

Parameter	Native Sample	Duplicate Sample	Units	RPD	Qual	RPD Limits
General Chemistry - Westborough Lab Associated sample(s): 16 QC Batch ID: WG1563615-3 QC Sample: L2153328-16 Client ID: RB01-092921						
Dissolved Organic Carbon	0.54J	0.64J	mg/l	NC		20
General Chemistry - Mansfield Lab Associated sample(s): 01-15 QC Batch ID: WG1564210-1 QC Sample: L2153328-01 Client ID: AQSS-05-0.0-0.5						
Solids, Total	84.7	84.5	%	0		10
General Chemistry - Westborough Lab Associated sample(s): 16 QC Batch ID: WG1564782-3 QC Sample: L2153328-16 Client ID: RB01-092921						
Total Organic Carbon	0.56	0.70	mg/l	**22**	Q	20
Total Organic Carbon - Mansfield Lab Associated sample(s): 01-15 QC Batch ID: WG1573823-3 QC Sample: L2153328-05 Client ID: DUP2-20210930						
Total Organic Carbon (Rep1)	1.53	2.12	%	**32**	Q	25
Total Organic Carbon (Rep2)	1.00	1.18	%	17		25
Total Organic Carbon (Average)	1.26	1.65	%	**27**	Q	25

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01

Lab Number: L2153328
Report Date: 11/24/21

Sample Receipt and Container Information

Were project specific reporting limits specified? YES

Cooler Information

Cooler	Custody Seal
A	Absent
B	Absent

Container Information

Container ID	Container Type	Cooler	Initial pH	Final pH	Temp deg C	Pres	Seal	Frozen Date/Time	Analysis(*)
L2153328-01A	Vial MeOH preserved	A	NA		3.1	Y	Absent		VPH-DELUX-18(28)
L2153328-01B	Glass 60mL/2oz unpreserved	A	NA		3.1	Y	Absent		EPH-20(14)
L2153328-01C	Glass 250ml/8oz unpreserved	A	NA		3.1	Y	Absent		A2-BA-MCP6020T-10(180),A2-CR-MCP6020T-10(180),A2-SOOT(28),A2-MCP-8082-10(365),A2-TS(7),A2-AS-MCP6020T-10(180),A2-CD-MCP6020T-10(180),A2-AG-MCP6020T-10(180),A2-MCPPAH-8270SIM-10(14),A2-SE-MCP6020T-10(180),A2-HG-MCP7471T-10(28),A2-PREP-3050:2T(180),A2-TOC-9060-2REPS(28),A2-HGPREP-AA(28),A2-PB-MCP6020T-10(180),A2-PREP-3050:1T(180)
L2153328-01D	Glass 250ml/8oz unpreserved	A	NA		3.1	Y	Absent		A2-BA-MCP6020T-10(180),A2-CR-MCP6020T-10(180),A2-SOOT(28),A2-MCP-8082-10(365),A2-TS(7),A2-AS-MCP6020T-10(180),A2-CD-MCP6020T-10(180),A2-AG-MCP6020T-10(180),A2-MCPPAH-8270SIM-10(14),A2-SE-MCP6020T-10(180),A2-HG-MCP7471T-10(28),A2-PREP-3050:2T(180),A2-TOC-9060-2REPS(28),A2-HGPREP-AA(28),A2-PB-MCP6020T-10(180),A2-PREP-3050:1T(180)
L2153328-02A	Glass 250ml/8oz unpreserved	B	NA		4.3	Y	Absent		A2-TS(7),A2-MCPPAH-8270SIM-10(14),A2-TOC-9060-2REPS(28)
L2153328-03A	Glass 250ml/8oz unpreserved	B	NA		4.3	Y	Absent		A2-SOOT(28),A2-BA-MCP6020T-10(180),A2-ALKPAH(14),A2-CR-MCP6020T-10(180),A2-AG-MCP6020T-10(180),A2-MCP-8082-10(365),A2-CD-MCP6020T-10(180),A2-AS-MCP6020T-10(180),A2-TS(7),A2-HG-MCP7471T-10(28),A2-SE-MCP6020T-10(180),A2-PB-MCP6020T-10(180),A2-PREP-3050:2T(180),A2-TOC-9060-2REPS(28),A2-HGPREP-AA(28),A2-PREP-3050:1T(180)

*Values in parentheses indicate holding time in days

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01

Lab Number: L2153328
Report Date: 11/24/21

Container Information

Container ID	Container Type	Cooler	Initial pH	Final pH	Temp deg C	Pres	Seal	Frozen Date/Time	Analysis(*)
L2153328-03B	Glass 250ml/8oz unpreserved	B	NA		4.3	Y	Absent		A2-SOOT(28),A2-BA-MCP6020T-10(180),A2-ALKPAH(14),A2-CR-MCP6020T-10(180),A2-AG-MCP6020T-10(180),A2-MCP-8082-10(365),A2-CD-MCP6020T-10(180),A2-AS-MCP6020T-10(180),A2-TS(7),A2-HG-MCP7471T-10(28),A2-SE-MCP6020T-10(180),A2-PB-MCP6020T-10(180),A2-PREP-3050:2T(180),A2-TOC-9060-2REPS(28),A2-HGPREP-AA(28),A2-PREP-3050:1T(180)
L2153328-04A	Glass 250ml/8oz unpreserved	B	NA		4.3	Y	Absent		A2-ALKPAH(14),A2-TS(7),A2-TOC-9060-2REPS(28)
L2153328-05A	Glass 250ml/8oz unpreserved	B	NA		4.3	Y	Absent		A2-ALKPAH(14),A2-TS(7),A2-TOC-9060-2REPS(28)
L2153328-06A	Glass 250ml/8oz unpreserved	B	NA		4.3	Y	Absent		A2-SOOT(28),A2-CR-MCP6020T-10(180),A2-BA-MCP6020T-10(180),A2-TS(7),A2-AS-MCP6020T-10(180),A2-CD-MCP6020T-10(180),A2-MCP-8082-10(365),A2-MCPPAH-8270SIM-10(14),A2-AG-MCP6020T-10(180),A2-SE-MCP6020T-10(180),A2-HG-MCP7471T-10(28),A2-HGPREP-AA(28),A2-PREP-3050:2T(180),A2-PB-MCP6020T-10(180),A2-TOC-9060-2REPS(28),A2-PREP-3050:1T(180)
L2153328-06B	Glass 250ml/8oz unpreserved	B	NA		4.3	Y	Absent		A2-SOOT(28),A2-CR-MCP6020T-10(180),A2-BA-MCP6020T-10(180),A2-TS(7),A2-AS-MCP6020T-10(180),A2-CD-MCP6020T-10(180),A2-MCP-8082-10(365),A2-MCPPAH-8270SIM-10(14),A2-AG-MCP6020T-10(180),A2-SE-MCP6020T-10(180),A2-HG-MCP7471T-10(28),A2-HGPREP-AA(28),A2-PREP-3050:2T(180),A2-PB-MCP6020T-10(180),A2-TOC-9060-2REPS(28),A2-PREP-3050:1T(180)
L2153328-07A	Glass 250ml/8oz unpreserved	B	NA		4.3	Y	Absent		A2-MCPPAH-8270SIM-10(14),A2-TS(7),A2-TOC-9060-2REPS(28)
L2153328-08A	Glass 250ml/8oz unpreserved	B	NA		4.3	Y	Absent		A2-ALKPAH(14),A2-TS(7),A2-TOC-9060-2REPS(28)
L2153328-09A	Glass 250ml/8oz unpreserved	B	NA		4.3	Y	Absent		A2-MCPPAH-8270SIM-10(14),A2-TS(7),A2-TOC-9060-2REPS(28)
L2153328-10A	Glass 250ml/8oz unpreserved	B	NA		4.3	Y	Absent		A2-TS(7),A2-MCPPAH-8270SIM-10(14),A2-TOC-9060-2REPS(28)
L2153328-11A	Glass 250ml/8oz unpreserved	B	NA		4.3	Y	Absent		A2-MCPPAH-8270SIM-10(14),A2-TS(7),A2-TOC-9060-2REPS(28)
L2153328-12A	Glass 250ml/8oz unpreserved	B	NA		4.3	Y	Absent		A2-MCPPAH-8270SIM-10(14),A2-TS(7),A2-TOC-9060-2REPS(28)

*Values in parentheses indicate holding time in days

Project Name: FORMER HAVERHILL MGP
Project Number: 180327-08.01

Lab Number: L2153328
Report Date: 11/24/21

Container Information

Container ID	Container Type	Cooler	Initial pH	Final pH	Temp deg C	Pres	Seal	Frozen Date/Time	Analysis(*)
L2153328-13A	Glass 250ml/8oz unpreserved	B	NA		4.3	Y	Absent		A2-BA-MCP6020T-10(180),A2-CR-MCP6020T-10(180),A2-SOOT(28),A2-CD-MCP6020T-10(180),A2-MCP-8082-10(365),A2-AS-MCP6020T-10(180),A2-MCPPAH-8270SIM-10(14),A2-AG-MCP6020T-10(180),A2-TS(7),A2-HG-MCP7471T-10(28),A2-SE-MCP6020T-10(180),A2-TOC-9060-2REPS(28),A2-PB-MCP6020T-10(180),A2-HGPREP-AA(28),A2-PREP-3050:2T(180),A2-PREP-3050:1T(180)
L2153328-13B	Glass 250ml/8oz unpreserved	B	NA		4.3	Y	Absent		A2-BA-MCP6020T-10(180),A2-CR-MCP6020T-10(180),A2-SOOT(28),A2-CD-MCP6020T-10(180),A2-MCP-8082-10(365),A2-AS-MCP6020T-10(180),A2-MCPPAH-8270SIM-10(14),A2-AG-MCP6020T-10(180),A2-TS(7),A2-HG-MCP7471T-10(28),A2-SE-MCP6020T-10(180),A2-TOC-9060-2REPS(28),A2-PB-MCP6020T-10(180),A2-HGPREP-AA(28),A2-PREP-3050:2T(180),A2-PREP-3050:1T(180)
L2153328-14A	Glass 250ml/8oz unpreserved	B	NA		4.3	Y	Absent		A2-BA-MCP6020T-10(180),A2-CR-MCP6020T-10(180),A2-SOOT(28),A2-CD-MCP6020T-10(180),A2-TS(7),A2-AG-MCP6020T-10(180),A2-AS-MCP6020T-10(180),A2-MCPPAH-8270SIM-10(14),A2-MCP-8082-10(365),A2-HG-MCP7471T-10(28),A2-SE-MCP6020T-10(180),A2-HGPREP-AA(28),A2-PREP-3050:2T(180),A2-TOC-9060-2REPS(28),A2-PB-MCP6020T-10(180),A2-PREP-3050:1T(180)
L2153328-14B	Glass 250ml/8oz unpreserved	B	NA		4.3	Y	Absent		A2-BA-MCP6020T-10(180),A2-CR-MCP6020T-10(180),A2-SOOT(28),A2-CD-MCP6020T-10(180),A2-TS(7),A2-AG-MCP6020T-10(180),A2-AS-MCP6020T-10(180),A2-MCPPAH-8270SIM-10(14),A2-MCP-8082-10(365),A2-HG-MCP7471T-10(28),A2-SE-MCP6020T-10(180),A2-HGPREP-AA(28),A2-PREP-3050:2T(180),A2-TOC-9060-2REPS(28),A2-PB-MCP6020T-10(180),A2-PREP-3050:1T(180)
L2153328-15A	Glass 250ml/8oz unpreserved	B	NA		4.3	Y	Absent		A2-MCPPAH-8270SIM-10(14),A2-TS(7),A2-TOC-9060-2REPS(28)
L2153328-16A	Vial HCl preserved	A	NA		3.1	Y	Absent		VPH-DELUX-18(14)
L2153328-16B	Vial HCl preserved	A	NA		3.1	Y	Absent		VPH-DELUX-18(14)
L2153328-16C	Vial HCl preserved	A	NA		3.1	Y	Absent		VPH-DELUX-18(14)
L2153328-16D	Vial H2SO4 preserved	A	NA		3.1	Y	Absent		DOC-9060(28)
L2153328-16E	Vial H2SO4 preserved	A	NA		3.1	Y	Absent		DOC-9060(28)

*Values in parentheses indicate holding time in days

Container Information

Container ID	Container Type	Cooler	Initial pH	Final pH	Temp deg C	Pres	Seal	Frozen Date/Time	Analysis(*)
L2153328-16F	Vial H2SO4 preserved	A	NA		3.1	Y	Absent		DOC-9060(28)
L2153328-16G	Vial H2SO4 preserved	A	NA		3.1	Y	Absent		TOC-9060(28)
L2153328-16H	Vial H2SO4 preserved	A	NA		3.1	Y	Absent		TOC-9060(28)
L2153328-16I	Vial H2SO4 preserved	A	NA		3.1	Y	Absent		TOC-9060(28)
L2153328-16J	Plastic 250ml HNO3 preserved	A	<2	<2	3.1	Y	Absent		A2-PREP-7470A/245.1(28),A2-CR-MCP6020T-10(180),A2-BA-MCP6020T-10(180),A2-CD-MCP6020T-10(180),A2-AG-MCP6020T-10(180),A2-AS-MCP6020T-10(180),A2-HG-MCP7470T-10(28),A2-SE-MCP6020T-10(180),A2-PB-MCP6020T-10(180)
L2153328-16K	Amber 500ml unpreserved	A	7	7	3.1	Y	Absent		A2-MCP-8082-10(365)
L2153328-16L	Amber 500ml unpreserved	A	7	7	3.1	Y	Absent		A2-MCP-8082-10(365)
L2153328-16M	Amber 1000ml unpreserved	A	7	7	3.1	Y	Absent		A2-ALKPAH(7)
L2153328-16N	Amber 1000ml unpreserved	A	7	7	3.1	Y	Absent		A2-ALKPAH(7)
L2153328-16O	Amber 1000ml HCl preserved	A	<2	<2	3.1	Y	Absent		EPH-20(14)
L2153328-16P	Amber 1000ml HCl preserved	A	<2	<2	3.1	Y	Absent		EPH-20(14)
L2153328-17A	Vial MeOH preserved	B	NA		4.3	Y	Absent		MCP-8260HLW-10(14)
L2153328-17B	Vial water preserved	B	NA		4.3	Y	Absent	01-OCT-21 19:46	MCP-8260HLW-10(14)
L2153328-17C	Vial water preserved	B	NA		4.3	Y	Absent	01-OCT-21 19:46	MCP-8260HLW-10(14)
L2153328-17D	Plastic 2oz unpreserved for TS	B	NA		4.3	Y	Absent		TS(7)
L2153328-17E	Glass 250ml/8oz unpreserved	B	NA		4.3	Y	Absent		REACTS(14),TCN-9010(14),IGNIT-1030(14),MCP-8081-10(14),HERB-APA(14),PH-9045(1),PAINTF(),REACTCN(14),TPH-DRO-D(14)
L2153328-17F	Glass 500ml/16oz unpreserved	B	NA		4.3	Y	Absent		A2-BA-MCP6020T-10(180),A2-CR-MCP6020T-10(180),A2-MCP-8082-10(365),A2-AG-MCP6020T-10(180),A2-MCPPAH-8270SIM-10(14),A2-AS-MCP6020T-10(180),A2-CD-MCP6020T-10(180),A2-HG-MCP7471T-10(28),A2-SE-MCP6020T-10(180),A2-PREP-3050:2T(180),A2-PB-MCP6020T-10(180),A2-HGPREP-AA(28),A2-PREP-3050:1T(180)

*Values in parentheses indicate holding time in days

Project Name:	FORMER HAVERHILL MGP	**Lab Number:**	L2153328
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GLOSSARY

Acronyms

DL - Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the limit of quantitation (LOQ). The DL includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)

EDL - Estimated Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The EDL includes any adjustments from dilutions, concentrations or moisture content, where applicable. The use of EDLs is specific to the analysis of PAHs using Solid-Phase Microextraction (SPME).

EMPC - Estimated Maximum Possible Concentration: The concentration that results from the signal present at the retention time of an analyte when the ions meet all of the identification criteria except the ion abundance ratio criteria. An EMPC is a worst-case estimate of the concentration.

EPA - Environmental Protection Agency.

LCS - Laboratory Control Sample: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.

LCSD - Laboratory Control Sample Duplicate: Refer to LCS.

LFB - Laboratory Fortified Blank: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.

LOD - Limit of Detection: This value represents the level to which a target analyte can reliably be detected for a specific analyte in a specific matrix by a specific method. The LOD includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)

LOQ - Limit of Quantitation: The value at which an instrument can accurately measure an analyte at a specific concentration. The LOQ includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)

Limit of Quantitation: The value at which an instrument can accurately measure an analyte at a specific concentration. The LOQ includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)

MDL - Method Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The MDL includes any adjustments from dilutions, concentrations or moisture content, where applicable.

MS - Matrix Spike Sample: A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. For Method 332.0, the spike recovery is calculated using the native concentration, including estimated values.

MSD - Matrix Spike Sample Duplicate: Refer to MS.

NA - Not Applicable.

NC - Not Calculated: Term is utilized when one or more of the results utilized in the calculation are non-detect at the parameter's reporting unit.

NDPA/DPA - N-Nitrosodiphenylamine/Diphenylamine.

NI - Not Ignitable.

NP - Non-Plastic: Term is utilized for the analysis of Atterberg Limits in soil.

NR - No Results: Term is utilized when 'No Target Compounds Requested' is reported for the analysis of Volatile or Semivolatile Organic TIC only requests.

RL - Reporting Limit: The value at which an instrument can accurately measure an analyte at a specific concentration. The RL includes any adjustments from dilutions, concentrations or moisture content, where applicable.

RPD - Relative Percent Difference: The results from matrix and/or matrix spike duplicates are primarily designed to assess the precision of analytical results in a given matrix and are expressed as relative percent difference (RPD). Values which are less than five times the reporting limit for any individual parameter are evaluated by utilizing the absolute difference between the values; although the RPD value will be provided in the report.

SRM - Standard Reference Material: A reference sample of a known or certified value that is of the same or similar matrix as the associated field samples.

STLP - Semi-dynamic Tank Leaching Procedure per EPA Method 1315.

TEF - Toxic Equivalency Factors: The values assigned to each dioxin and furan to evaluate their toxicity relative to 2,3,7,8-TCDD.

TEQ - Toxic Equivalent: The measure of a sample's toxicity derived by multiplying each dioxin and furan by its corresponding TEF and then summing the resulting values.

TIC - Tentatively Identified Compound: A compound that has been identified to be present and is not part of the target compound list (TCL) for the method and/or program. All TICs are qualitatively identified and reported as estimated concentrations.

Report Format: DU Report with 'J' Qualifiers

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Footnotes

1 - The reference for this analyte should be considered modified since this analyte is absent from the target analyte list of the original method.

Terms

Analytical Method: Both the document from which the method originates and the analytical reference method. (Example: EPA 8260B is shown as 1,8260B.) The codes for the reference method documents are provided in the References section of the Addendum.

Difference: With respect to Total Oxidizable Precursor (TOP) Assay analysis, the difference is defined as the Post-Treatment value minus the Pre-Treatment value.

Final pH: As it pertains to Sample Receipt & Container Information section of the report, Final pH reflects pH of container determined after adjustment at the laboratory, if applicable. If no adjustment required, value reflects Initial pH.

Frozen Date/Time: With respect to Volatile Organics in soil, Frozen Date/Time reflects the date/time at which associated Reagent Water-preserved vials were initially frozen. Note: If frozen date/time is beyond 48 hours from sample collection, value will be reflected in 'bold'.

Initial pH: As it pertains to Sample Receipt & Container Information section of the report, Initial pH reflects pH of container determined upon receipt, if applicable.

PAH Total: With respect to Alkylated PAH analyses, the 'PAHs, Total' result is defined as the summation of results for all or a subset of the following compounds: Naphthalene, C1-C4 Naphthalenes, 2-Methylnaphthalene, 1-Methylnaphthalene, Biphenyl, Acenaphthylene, Acenaphthene, Fluorene, C1-C3 Fluorenes, Phenanthrene, C1-C4 Phenanthrenes/Anthracenes, Anthracene, Fluoranthene, Pyrene, C1-C4 Fluoranthenes/Pyrenes, Benz(a)anthracene, Chrysene, C1-C4 Chrysenes, Benzo(b)fluoranthene, Benzo(j)+(k)fluoranthene, Benzo(e)pyrene, Benzo(a)pyrene, Perylene, Indeno(1,2,3-cd)pyrene, Dibenz(ah)+(ac)anthracene, Benzo(g,h,i)perylene. If a 'Total' result is requested, the results of its individual components will also be reported.

PFAS Total: With respect to PFAS analyses, the 'PFAS, Total (5)' result is defined as the summation of results for: PFHpA, PFHxS, PFOA, PFNA and PFOS. In addition, the 'PFAS, Total (6)' result is defined as the summation of results for: PFHpA, PFHxS, PFOA, PFNA, PFDA and PFOS. For MassDEP DW compliance analysis only, the 'PFAS, Total (6)' result is defined as the summation of results at or above the RL. Note: If a 'Total' result is requested, the results of its individual components will also be reported.

The target compound Chlordane (CAS No. 57-74-9) is reported for GC ECD analyses. Per EPA,this compound "refers to a mixture of chlordane isomers, other chlorinated hydrocarbons and numerous other components." (Reference: USEPA Toxicological Review of Chlordane, In Support of Summary Information on the Integrated Risk Information System (IRIS), December 1997.)

Total: With respect to Organic analyses, a 'Total' result is defined as the summation of results for individual isomers or Aroclors. If a 'Total' result is requested, the results of its individual components will also be reported. This is applicable to 'Total' results for methods 8260, 8081 and 8082.

Data Qualifiers

A - Spectra identified as "Aldol Condensates" are byproducts of the extraction/concentration procedures when acetone is introduced in the process.

B - The analyte was detected above the reporting limit in the associated method blank. Flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For MCP-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For DOD-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank AND the analyte was detected above one-half the reporting limit (or above the reporting limit for common lab contaminants) in the associated method blank. For NJ-Air-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte above the reporting limit. For NJ-related projects (excluding Air), flag only applies to associated field samples that have detectable concentrations of the analyte, which was detected above the reporting limit in the associated method blank or above five times the reporting limit for common lab contaminants (Phthalates, Acetone, Methylene Chloride, 2-Butanone).

C - Co-elution: The target analyte co-elutes with a known lab standard (i.e. surrogate, internal standards, etc.) for co-extracted analyses.

D - Concentration of analyte was quantified from diluted analysis. Flag only applies to field samples that have detectable concentrations of the analyte.

E - Concentration of analyte exceeds the range of the calibration curve and/or linear range of the instrument.

F - The ratio of quantifier ion response to qualifier ion response falls outside of the laboratory criteria. Results are considered to be an estimated maximum concentration.

G - The concentration may be biased high due to matrix interferences (i.e, co-elution) with non-target compound(s). The result should be considered estimated.

H - The analysis of pH was performed beyond the regulatory-required holding time of 15 minutes from the time of sample collection.

I - The lower value for the two columns has been reported due to obvious interference.

J - Estimated value. The Target analyte concentration is below the quantitation limit (RL), but above the Method Detection Limit (MDL) or Estimated Detection Limit (EDL) for SPME-related analyses. This represents an estimated concentration for Tentatively Identified Compounds (TICs).

M - Reporting Limit (RL) exceeds the MCP CAM Reporting Limit for this analyte.

ND - Not detected at the method detection limit (MDL) for the sample, or estimated detection limit (EDL) for SPME-related analyses.

Report Format: DU Report with 'J' Qualifiers

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Data Qualifiers

NJ - Presumptive evidence of compound. This represents an estimated concentration for Tentatively Identified Compounds (TICs), where the identification is based on a mass spectral library search.

P - The RPD between the results for the two columns exceeds the method-specified criteria.

Q - The quality control sample exceeds the associated acceptance criteria. For DOD-related projects, LCS and/or Continuing Calibration Standard exceedences are also qualified on all associated sample results. Note: This flag is not applicable for matrix spike recoveries when the sample concentration is greater than 4x the spike added or for batch duplicate RPD when the sample concentrations are less than 5x the RL. (Metals only.)

R - Analytical results are from sample re-analysis.

RE - Analytical results are from sample re-extraction.

S - Analytical results are from modified screening analysis.

V - The surrogate associated with this target analyte has a recovery outside the QC acceptance limits. (Applicable to MassDEP DW Compliance samples only.)

Z - The batch matrix spike and/or duplicate associated with this target analyte has a recovery/RPD outside the QC acceptance limits. (Applicable to MassDEP DW Compliance samples only.)

Report Format: DU Report with 'J' Qualifiers

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Project Number:	180327-08.01	**Report Date:**	11/24/21

REFERENCES

1 Test Methods for Evaluating Solid Waste: Physical/Chemical Methods. EPA SW-846. Third Edition. Updates I - VI, 2018.

91 Analysis of Soot following ES&T publications by Accardi-Dey and Gschwend, 2003; and Gustafsson (et. al.), 1997.

97 EPA Test Methods (SW-846) with QC Requirements & Performance Standards for the Analysis of EPA SW-846 Methods under the Massachusetts Contingency Plan, WSC-CAM-IIA, IIB, IIIA, IIIB, IIIC, IIID, VA, VB, VC, VIA, VIB, VIIIA and VIIIB, July 2010.

121 Standard Methods for the Examination of Water and Wastewater. APHA-AWWA-WEF. Standard Methods Online.

125 Test Methods for Evaluating Solid Waste: Physical/Chemical Methods. EPA SW-846. Third Edition. Updates IIIA, April 1998.

131 Method for the Determination of Volatile Petroleum Hydrocarbons (VPH), MassDEP, February 2018, Revision 2.1 with QC Requirements & Performance Standards for the Analysis of VPH under the Massachusetts Contingency Plan, WSC-CAM-IVA, June 1, 2018.

135 Method for the Determination of Extractable Petroleum Hydrocarbons (EPH), MassDEP, December 2019, Revision 2.1 with QC Requirements & Performance Standards for the Analysis of EPH under the Massachusetts Contingency Plan, WSC-CAM-IVB, March 1, 2020.

LIMITATION OF LIABILITIES

Alpha Analytical performs services with reasonable care and diligence normal to the analytical testing laboratory industry. In the event of an error, the sole and exclusive responsibility of Alpha Analytical shall be to re-perform the work at it's own expense. In no event shall Alpha Analytical be held liable for any incidental, consequential or special damages, including but not limited to, damages in any way connected with the use of, interpretation of, information or analysis provided by Alpha Analytical.

We strongly urge our clients to comply with EPA protocol regarding sample volume, preservation, cooling, containers, sampling procedures, holding time and splitting of samples in the field.

Certification Information

The following analytes are not included in our Primary NELAP Scope of Accreditation:

Westborough Facility
EPA 624/624.1: m/p-xylene, o-xylene, Naphthalene
EPA 625/625.1: alpha-Terpineol
EPA 8260C/8260D: NPW: 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene, Azobenzene; SCM: Iodomethane (methyl iodide), 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene.
EPA 8270D/8270E: NPW: Dimethylnaphthalene,1,4-Diphenylhydrazine, alpha-Terpineol; SCM: Dimethylnaphthalene,1,4-Diphenylhydrazine.
SM4500: NPW: Amenable Cyanide; SCM: Total Phosphorus, TKN, NO2, NO3.

Mansfield Facility
SM 2540D: TSS
EPA 8082A: NPW: PCB: 1, 5, 31, 87,101, 110, 141, 151, 153, 180, 183, 187.
EPA TO-15: Halothane, 2,4,4-Trimethyl-2-pentene, 2,4,4-Trimethyl-1-pentene, Thiophene, 2-Methylthiophene, 3-Methylthiophene, 2-Ethylthiophene, 1,2,3-Trimethylbenzene, Indan, Indene, 1,2,4,5-Tetramethylbenzene, Benzothiophene, 1-Methylnaphthalene.
Biological Tissue Matrix: EPA 3050B

The following analytes are included in our Massachusetts DEP Scope of Accreditation

Westborough Facility:

Drinking Water
EPA 300.0: Chloride, Nitrate-N, Fluoride, Sulfate; **EPA 353.2**: Nitrate-N, Nitrite-N; **SM4500NO3-F**: Nitrate-N, Nitrite-N; **SM4500F-C, SM4500CN-CE, EPA 180.1, SM2130B, SM4500Cl-D, SM2320B, SM2540C, SM4500H-B, SM4500NO2-B**
EPA 332: Perchlorate; **EPA 524.2:** THMs and VOCs; **EPA 504.1:** EDB, DBCP.
Microbiology: **SM9215B; SM9223-P/A, SM9223B-Colilert-QT,SM9222D**.

Non-Potable Water
SM4500H,B, EPA 120.1, SM2510B, SM2540C, SM2320B, SM4500CL-E, SM4500F-BC, SM4500NH3-BH: Ammonia-N and Kjeldahl-N, **EPA 350.1**: Ammonia-N, **LACHAT 10-107-06-1-B**: Ammonia-N, **EPA 351.1, SM4500NO3-F, EPA 353.2**: Nitrate-N**, SM4500P-E, SM4500P-B, E, SM4500SO4-E, SM5220D, EPA 410.4, SM5210B, SM5310C, SM4500CL-D, EPA 1664, EPA 420.1, SM4500-CN-CE, SM2540D, EPA 300: Chloride, Sulfate, Nitrate.**
EPA 624.1: Volatile Halocarbons & Aromatics,
EPA 608.3: Chlordane, Toxaphene, Aldrin, alpha-BHC, beta-BHC, gamma-BHC, delta-BHC, Dieldrin, DDD, DDE, DDT, Endosulfan I, Endosulfan II, Endosulfan sulfate, Endrin, Endrin Aldehyde, Heptachlor, Heptachlor Epoxide, PCBs
EPA 625.1: SVOC (Acid/Base/Neutral Extractables), **EPA 600/4-81-045**: PCB-Oil.
Microbiology: **SM9223B-Colilert-QT; Enterolert-QT, SM9221E, EPA 1600, EPA 1603, SM9222D.**

Mansfield Facility:

Drinking Water
EPA 200.7: Al, Ba, Cd, Cr, Cu, Fe, Mn, Ni, Na, Ag, Ca, Zn. **EPA 200.8:** Al, Sb, As, Ba, Be, Cd, Cr, Cu, Pb, Mn, Ni, Se, Ag, TL, Zn. **EPA 245.1** Hg.
EPA 522, EPA 537.1.

Non-Potable Water
EPA 200.7: Al, Sb, As, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Ag, Na, Sr, TL, Ti, V, Zn.
EPA 200.8: Al, Sb**,** As, Be, Cd, Cr, Cu, Fe, Pb, Mn, Ni, K, Se, Ag, Na, TL, Zn.
EPA 245.1 Hg.
SM2340B

For a complete listing of analytes and methods, please contact your Alpha Project Manager.

Serial_No:11242117:57

CHAIN OF CUSTODY

PAGE 1 OF 4

ALPHA Analytical
8 Walkup Drive, Westboro, MA 01581, Tel: 508-898-9220
320 Forbes Blvd, Mansfield, MA 02048, Tel: 508-822-9300

Date Rec'd in Lab: 9/30/21

ALPHA Job #: L2153328

Client Information

Client: Anchor QEA
Address: 9 Water St
Amesbury, MA 01913
Phone: 818-422-4820
Email: bgauley@anchorqea.com

Additional Project Information:
Alkylated PAH analyses including Fluoranthenes/pyrenes and naphthobenzothisphenes

Project Information

Project Name: Former Haverhill MGP
Project Location: Haverhill, MA
Project #: 180327-08.01
Project Manager: B. Gauley
ALPHA Quote #:

Turn-Around Time

☒ Standard ☐ RUSH (only confirmed if pre-approved)

Date Due:

Report Information - Data Deliverables

☒ ADEx ☐ EMAIL

Billing Information

☒ Same as Client info PO #:

Regulatory Requirements & Project Information Requirements

☒ Yes ☐ No MA MCP Analytical Methods ☐ Yes ☒ No CT RCP Analytical Methods
☒ Yes ☐ No Matrix Spike Required on this SDG? (Required for MCP Inorganics)
☐ Yes ☒ No GW1 Standards (Info Required for Metals & EPH with Targets)
☐ Yes ☒ No NPDES RGP
☐ Other State /Fed Program ____ Criteria ____

ANALYSIS

VOC: ☐ 8260 ☐ 624 ☐ 524.2; SVOC: ☐ ABN ☒ PAH16; METALS: ☐ MCP 13 ☐ MCP 14 ☐ RCP 15; METALS: ☐ RCRA5 ☒ RCRA8 ☐ PP13; EPH: ☐ Ranges & Targets ☐ Ranges Only; VPH: ☐ Ranges & Targets ☐ Ranges Only; ☒ PCB ☐ PEST; TPH: ☐ Quant Only ☐ Fingerprint; Alkylated PAH; TOC; Soot

SAMPLE INFO
Filtration ☐ Field ☐ Lab to do
Preservation ☐ Lab to do

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection Date	Collection Time	Sample Matrix	Sampler Initials	VOC	SVOC	METALS (MCP)	METALS (RCRA)	EPH	VPH	PCB/PEST	TPH	Alkylated PAH	TOC	Soot	Sample Comments	Total # Bottles
53328-01	AQSS-05-0.0-0.5	9/24/21	1450	SE	BJLG		X		X	X	X	X			X	X	MS/MSD metals PCB Soil	2
-02	AQSS-05-1.0-1.5	9/24/21	1445	SE	BJLG		X								X			1
-03	AQSS-04-0.0-0.5	9/30/21	0845	↓	↓				X	~~X~~		X		X	X	X		2
-04	AQSS-04-1.0-1.5	↓	0848											X	X		MS/MSD PAH TOC	1
-05	Dup2-20210930								X			X				X		1
-06	AQSS-03-0.0-0.5		0925				X		X			X			X	X		2
-07	AQSS-03-2.0-2.5		0930				X								X			1
-08	AQSS-07D-4.9-5.4		0953											X	X			1
-09	AQSS-19-3.0-3.5		1033				X								X		MS/MSD PAH	1
-10	AQSS-19-4.5-5.0	↓	1035	↓	↓		X								X			1

Container Type
Preservative

Container Type
P= Plastic
A= Amber glass
V= Vial
G= Glass
B= Bacteria cup
C= Cube
O= Other
E= Encore
D= BOD Bottle

Preservative
A= None
B= HCl
C= HNO_3
D= H_2SO_4
E= NaOH
F= MeOH
G= $NaHSO_4$
H = $Na_2S_2O_3$
I= Ascorbic Acid
J = NH_4Cl
K= Zn Acetate
O= Other

Relinquished By:	Date/Time	Received By:	Date/Time
Billie J L Gauley	9/30/21 1612	[signature] DADS AAL	9-30-21 16:12
[signature]	9/30 [illegible]	[signature]	9-30 1722
Joseph C. [signature]	9/30/21 2122	Joseph C. [signature]	9/30/21 2000
		[signature] Bailey	9/30/21 21:22

FORM NO: 01-01 (rev. 12-Mar-2012)

Serial_No:11242117:57

CHAIN OF CUSTODY

PAGE 1 OF 4

ALPHA Analytical
8 Walkup Drive, Westboro, MA 01581, Tel: 508-898-9220
320 Forbes Blvd, Mansfield, MA 02048, Tel: 508-822-9300

Date Rec'd in Lab: 9/30/21

ALPHA Job #: L2153328

Client Information

Client: Anchor QEA
Address: 9 Water St
Amesbury, MA 01913
Phone: 818-422-4820
Email: bgauley@anchorqea.com

Project Information

Project Name: Former Haverhill MGP
Project Location: Haverhill, MA
Project #: 180327-08.01
Project Manager: B. Gauley
ALPHA Quote #:

Turn-Around Time

☒ Standard ☐ RUSH (only confirmed if pre-approved)

Date Due:

Report Information - Data Deliverables

☒ ADEx ☐ EMAIL

Billing Information

☒ Same as Client info PO #:

Regulatory Requirements & Project Information Requirements

☒ Yes ☐ No MA MCP Analytical Methods ☐ Yes ☒ No CT RCP Analytical Methods
☒ Yes ☐ No Matrix Spike Required on this SDG? (Required for MCP Inorganics)
☐ Yes ☒ No GW1 Standards (Info Required for Metals & EPH with Targets)
☐ Yes ☒ No NPDES RGP
☐ Other State /Fed Program ______ Criteria ______

Additional Project Information:
Alkylated PAH analyses including Fluoranthenes/pyrenes and naphthobenzothiophenes

ANALYSIS: VOC: ☐ 8260 ☐ 624 ☐ 524.2; SVOC: ☐ ABN ☒ PAH16; METALS: ☐ MCP 13 ☐ MCP 14 ☐ RCP 15; METALS: ☐ RCRA5 ☒ RCRA8 ☐ PP13; EPH: ☐ Ranges & Targets ☐ Ranges Only; VPH: ☐ Ranges & Targets ☐ Ranges Only; ☒ PCB ☐ PEST; TPH: ☐ Quant Only ☐ Fingerprint; Alkylated PAH; TOC; Soot

SAMPLE INFO: Filtration ☐ Field ☐ Lab to do; Preservation ☐ Lab to do

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection Date	Collection Time	Sample Matrix	Sampler Initials	VOC	SVOC	METALS (MCP)	METALS (RCRA)	EPH	VPH	PCB	TPH	Alkylated PAH	TOC	Soot	Sample Comments	Total # Bottles
53328-01	AQSS-05-0.0-0.5	9/24/21	1450	SE	BJLG		X		X	X	X	X			X	X	MS/MSD metals PCB Soot	2
-02	AQSS-05-1.0-1.5	9/24/21	1445	SE	BJLG		X								X			1
-03	AQSS-04-0.0-0.5	9/30/21	0845	↓	↓				X	~~X~~		X		X	X	X		2
-04	AQSS-04-1.0-1.5	↓	0848	↓	↓									X	X		MS/MSD PAH TOC	1
-05	Dup2-20210930	↓		↓	↓				~~X~~			~~X~~		X	X	~~X~~	BJLG 10/7/2021	1
-06	AQSS-03-0.0-0.5	↓	0925	↓	↓		X		X			X			X	X		2
-07	AQSS-03-2.0-2.5	↓	0930	↓	↓		X								X			1
-08	AQSS-07D-4.9-5.4	↓	0953	↓	↓									X	X			1
-09	AQSS-19-3.0-3.5	↓	1033	↓	↓		X								X		MS/MSD PAH	1
-10	AQSS-19-4.5-5.0	↓	1035	↓	↓		X								X			1

Container Type
Preservative

Container Type	Preservative
P= Plastic	A= None
A= Amber glass	B= HCl
V= Vial	C= HNO_3
G= Glass	D= H_2SO_4
B= Bacteria cup	E= NaOH
C= Cube	F= MeOH
O= Other	G= $NaHSO_4$
E= Encore	H = $Na_2S_2O_3$
D= BOD Bottle	I= Ascorbic Acid
	J = NH_4Cl
	K= Zn Acetate
	O= Other

Relinquished By:	Date/Time	Received By:	Date/Time
Billie J L Gauley	9/30/21 1612	J Davis AAL	9-30-21 16:12
[signature]	9/30 2200	Joseph C. [signature]	9-30 1722
Joseph C. [signature]	9/30/21 2122	[signature] Bailey	9/30/21 2200 / 9/30/21 21:22

CHAIN OF CUSTODY

PAGE 2 OF 4

Date Rec'd in Lab: 9/30/21

ALPHA Job #: L2153328

ALPHA ANALYTICAL
8 Walkup Drive, Westboro, MA 01581, Tel: 508-898-9220
320 Forbes Blvd, Mansfield, MA 02048, Tel: 508-822-9300

Project Information

Project Name: Former Haverhill MGP
Project Location: Haverhill, MA
Project #: 180327-08.01
Project Manager: B. Gauley
ALPHA Quote #:

Report Information - Data Deliverables

☒ ADEx ☐ EMAIL

Billing Information

☒ Same as Client info PO #:

Client Information

Client: Anchor QEA
Address: 9 Water St
Amesbury, MA 01913
Phone: 818-422-4820
Email: bgauley@anchorqea.com

Regulatory Requirements & Project Information Requirements

☒ Yes ☐ No MA MCP Analytical Methods ☐ Yes ☒ No CT RCP Analytical Methods
☒ Yes ☐ No Matrix Spike Required on this SDG? (Required for MCP Inorganics)
☐ Yes ☒ No GW1 Standards (Info Required for Metals & EPH with Targets)
☐ Yes ☒ No NPDES RGP
☐ Other State /Fed Program ______ Criteria ______

Turn-Around Time

☒ Standard ☐ RUSH (only confirmed if pre-approved!)

Date Due:

Additional Project Information:
Alkylated PAH analyses including Fluoranthenes/pyrenes and naphthobenzothisphenes

ANALYSIS: VOC: ☐ 8260 ☐ 624 ☐ 524.2; SVOC: ☐ ABN ☒ PAH 16; METALS: ☐ MCP 13 ☐ MCP 14 ☐ RCP 15; METALS: ☐ RCRA5 ☒ RCRA8 ☐ PP13; EPH: ☐ Ranges & Targets ☐ Ranges Only; VPH: ☐ Ranges & Targets ☐ Ranges Only; ☒ PCB ☐ PEST; TPH: ☐ Quant Only ☐ Fingerprint; Alkylated PAH; TOC; Soot

SAMPLE INFO — Filtration: ☐ Field ☐ Lab to do; Preservation: ☐ Lab to do

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection Date	Collection Time	Sample Matrix	Sampler Initials	PAH 16	RCRA8	PCB	Alkylated PAH	TOC	Soot	Sample Comments	Total # Bottles
53328-11	AQSS-18-4.6-4.8	9/30/21	13:52	SE	BSLG	X			X				1
-12	AQSS-18-3.0-3.5	↓	13:54	↓	↓	X			X				1
-13	AQSS-18-0.0-0.5	↓	13:55	↓	↓	X	X	X	X	X			2
-14	AQSS-20-0.0-0.5	↓	12:50	↓	↓	X	X	X	X	X			2
-15	AQSS-20-4.2-4.5	↓	12:45	↓	↓	X			X				1

	PAH 16	RCRA8	PCB	Alkylated PAH	TOC
Container Type	A	A	A	A	A
Preservative	A	A	A	A	A

Container Type: P= Plastic, A= Amber glass, V= Vial, G= Glass, B= Bacteria cup, C= Cube, O= Other, E= Encore, D= BOD Bottle

Preservative: A= None, B= HCl, C= HNO_3, D= H_2SO_4, E= NaOH, F= MeOH, G= $NaHSO_4$, H = $Na_2S_2O_3$, I= Ascorbic Acid, J = NH_4Cl, K= Zn Acetate, O= Other

Relinquished By:	Date/Time	Received By:	Date/Time
Billie J L Gauley	9/30/21 1613	Daniel DAVESAC	9-30-21 16:13
Daniel DAVESAC	9-30-21 17:40	[illegible]	9-30 17:[illegible]
[illegible]	9/30/21 [illegible]	Joseph C. Bezinsky	9/30/21 2000
Joseph C. Bezinsky	9/30/21 2122	Kim L. Bailey	9/30/21 21:22

ALPHA ANALYTICAL

8 Walkup Drive
Westboro, MA 01581
Tel: 508-898-9220

320 Forbes Blvd
Mansfield, MA 02048
Tel: 508-822-9300

CHAIN OF CUSTODY

PAGE 3 OF 4

Date Rec'd In Lab: 9/30/21

ALPHA Job #: L2153328

Client Information

Client: Anchor QEA
Address: 9 Water St
Amesbury MA
Phone: 818 422 4820
Email: bgauley@anchorqea.com

Project Information

Project Name: Former Haverhill MGP
Project Location: Haverhill, MA
Project #: 180327-08.01
Project Manager: Billie-Jo Gauley
ALPHA Quote #:

Turn-Around Time

☒ Standard ☐ RUSH (only confirmed if pre-approved)

Date Due:

Report Information - Data Deliverables

☒ ADEx ☐ EMAIL

Billing Information

☒ Same as Client info PO #:

Regulatory Requirements & Project Information Requirements

☒ Yes ☐ No MA MCP Analytical Methods
☐ Yes ☒ No CT RCP Analytical Methods
☒ Yes ☐ No Matrix Spike Required on this SDG? (Required for MCP Inorganics)
☐ Yes ☒ No GW1 Standards (Info Required for Metals & EPH with Targets)
☐ Yes ☒ No NPDES RGP
☐ Other State /Fed Program ______ Criteria ______

Additional Project Information:
Alkylated pah Analyses including fluoranthenes/pyrenes and naphthobenzo-thiophenes

ANALYSIS

Columns: VOC: ☐ 8260 ☐ 624 ☐ 524.2 | SVOC: ☐ ABN ☒ PAH16 | METALS: ☐ MCP 13 ☐ MCP 14 ☐ RCP 15 | METALS: ☐ RCRA5 ☒ RCRA8 ☐ PP13 | EPH: ☐ Ranges & Targets ☐ Ranges Only | VPH: ☐ Ranges & Targets ☐ Ranges Only | ☒ PCB ☐ PEST | TPH: ☐ Quant Only ☐ Fingerprint | Alkylated PAH | TOC | Soot | EPH | VPH | DOC

SAMPLE INFO
Filtration
☐ Field
☐ Lab to do
Preservation
☐ Lab to do

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection Date	Collection Time	Sample Matrix	Sampler Initials	VOC	SVOC	METALS (MCP)	METALS (RCRA)	EPH	VPH	PCB	TPH	Alkylated PAH	TOC	Soot	EPH	VPH	DOC	Sample Comments	TOTAL # BOTTLES
53328-16	RB1-092921	9/29/21	1725	X1	BJLG			X	X	X	X		X	X					X		16
Container Type								P	A	AV	A		A	V					V		
Preservative								C	B	B	A		A	D					A		

Container Type: P= Plastic, A= Amber glass, V= Vial, G= Glass, B= Bacteria cup, C= Cube, O= Other, E= Encore, D= BOD Bottle

Preservative: A= None, B= HCl, C= HNO_3, D= H_2SO_4, E= NaOH, F= MeOH, G= $NaHSO_4$, H = $Na_2S_2O_3$, I= Ascorbic Acid, J = NH_4Cl, K= Zn Acetate, O= Other

Relinquished By:	Date/Time	Received By:	Date/Time
Billie Jo L Gauley	9/30/21 1613	[signature] DAVIS AAL	9-30-21 1615
[signature]	9/30/21 1720	[signature]	9/30 1720
[signature]	9/30 2000	Joseph C. [signature]	9/30/21 2000
Joseph C. [signature]	9/30/21 2122	Kim L. Bailey	9/30/21 21:22

FORM NO: 01-01 (rev. 12-Mar-2012)

ALPHA

8 Walkup Drive
Westboro, MA 01581
Tel: 508-898-9220

320 Forbes Blvd
Mansfield, MA 02048
Tel: 508-822-9300

CHAIN OF CUSTODY

PAGE 4 OF 4

Date Rec'd in Lab: 9/30/21

ALPHA Job #: L2153328

Client Information

Client: Anchor QEA
Address: 9 Water St
Amesbury, MA 01913
Phone: 818-422-4820
Email: bgauley@anchorqea.com

Project Information

Project Name: Former Haverhill MGP
Project Location: Haverhill, MA
Project #: 180327-08.01
Project Manager: B. Gauley
ALPHA Quote #:

Turn-Around Time

☒ Standard ☐ RUSH (only confirmed if pre-approved!)

Date Due:

Report Information - Data Deliverables

☒ ADEx ☐ EMAIL

Billing Information

☒ Same as Client Info PO #:

Regulatory Requirements & Project Information Requirements

☒ Yes ☐ No MA MCP Analytical Methods
☐ Yes ☒ No CT RCP Analytical Methods
☒ Yes ☐ No Matrix Spike Required on this SDG? (Required for MCP Inorganics)
☐ Yes ☒ No GW1 Standards (Info Required for Metals & EPH with Targets)
☐ Yes ☒ No NPDES RGP
☐ Other State /Fed Program Criteria

Additional Project Information:

Will analyze for TCLP if there is a 20x exceedence

ANALYSIS

Columns: VOC: ☒ 8260 ☐ 624 ☐ 524.2 | SVOC: ☐ ABN ☒ PAH | METALS: ☐ MCP 13 ☐ MCP 14 ☐ RCP 15 | METALS: ☐ RCRA5 ☒ RCRA8 ☐ PP13 | EPH: ☐ Ranges & Targets ☐ Ranges Only | VPH: ☐ Ranges & Targets ☐ Ranges Only | ☒ PCB ☐ PEST | TPH: ☒ Quant Only ☐ Fingerprint | Herbicides/Pesticides | ignitability | Paint filter | pH | Total Cyanide | Reactivity (Cyanide/Sulfide)

SAMPLE INFO
Filtration
☐ Field
☐ Lab to do
Preservation
☐ Lab to do

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection Date	Collection Time	Sample Matrix	Sampler Initials	VOC	SVOC	METALS	METALS	EPH	VPH	PCB	TPH	Herbicides/Pesticides	ignitability	Paint filter	pH	Total Cyanide	Reactivity (Cyanide/Sulfide)	Sample Comments	TOTAL # BOTTLES
53328-17	WC1-093021	9/30/21	1420	SE	BJLG	X	X		X			X	X	X	X	X	X	X	X		6
	Container Type					AV	A		A			A	A	A	A	A	A	A	A		
	Preservative					F/A	A		A			A	A	A	A	A	A	A	A		

Container Type
P= Plastic
A= Amber glass
V= Vial
G= Glass
B= Bacteria cup
C= Cube
O= Other
E= Encore
D= BOD Bottle

Preservative
A= None
B= HCl
C= HNO_3
D= H_2SO_4
E= NaOH
F= MeOH
G= $NaHSO_4$
H = $Na_2S_2O_3$
I= Ascorbic Acid
J = NH_4Cl
K= Zn Acetate
O= Other

Relinquished By:	Date/Time	Received By:	Date/Time
Billie Jo L Gauley	9/30/21 1613	[signature] DAVIS AAL	9-30-21 1615
[signature] DAVIS AAL	9-30-21 1720	[signature]	9/30 1720
[signature]	9/30 [illegible]	Joseph C. [signature]	9/30/21 2000
Joseph C. [signature]	9/30/21 2122	Ken L. Bailey	9/30/21 2122

All samples submitted are subject to Alpha's Terms and Conditions. See reverse side.

FORM NO: 01-01 (rev. 12-Mar-2012)

Method Blank Summary
Form 4
Volatiles

Client	: Anchor QEA, LLC	**Lab Number**	: L2153328
Project Name	: FORMER HAVERHILL MGP	**Project Number**	: 180327-08.01
Lab Sample ID	: WG1559114-5	**Lab File ID**	: V04211013N04
Instrument ID	: VOA104		
Matrix	: SOIL	**Analysis Date**	: 10/13/21 21:20

Client Sample No.	Lab Sample ID	Analysis Date
WG1559114-3LCS	WG1559114-3	10/13/21 20:04
WG1559114-4LCSD	WG1559114-4	10/13/21 20:29
WC1-093021	L2153328-17D	10/14/21 02:22

Method Blank Summary
Form 4
Volatiles

Client	: Anchor QEA, LLC	**Lab Number**	: L2153328
Project Name	: FORMER HAVERHILL MGP	**Project Number**	: 180327-08.01
Lab Sample ID	: WG1559101-5	**Lab File ID**	: V04211014B06
Instrument ID	: VOA104		
Matrix	: SOIL	**Analysis Date**	: 10/14/21 13:38

Client Sample No.	Lab Sample ID	Analysis Date
WG1559101-3LCS	WG1559101-3	10/14/21 11:57
WG1559101-4LCSD	WG1559101-4	10/14/21 12:22
WC1-093021	L2153328-17D2	10/14/21 17:27

Calibration Verification Summary
Form 7
Volatiles

Client	: Anchor QEA, LLC	**Lab Number**	: L2153328
Project Name	: FORMER HAVERHILL MGP	**Project Number**	: 180327-08.01
Instrument ID	: VOA104	**Calibration Date**	: 10/13/21 20:04
Lab File ID	: V04211013N01	**Init. Calib. Date(s)**	: 07/07/21 07/08/21
Sample No	: WG1559114-2	**Init. Calib. Times**	: 20:54 00:16
Channel	:		

Compound	Ave. RRF	RRF	Min RRF	%D	Max %D	Area%	Dev(min)
Fluorobenzene	1	1	-	0	20	100	0
Dichlorodifluoromethane	0.29	0.297	-	-2.4	20	102	0
Chloromethane	0.386	0.414	-	-7.3	20	114	-.02
Vinyl chloride	0.321	0.361	-	-12.5	20	112	0
Bromomethane	40	48.222	-	-20.6*	20	112	0
Chloroethane	0.132	0.156	-	-18.2	20	131	0
Trichlorofluoromethane	0.418	0.436	-	-4.3	20	100	0
Ethyl ether	0.145	0.135	-	6.9	20	95	0
1,1-Dichloroethene	0.241	0.262	-	-8.7	20	106	0
Carbon disulfide	0.896	0.809	-	9.7	20	93	0
Freon-113	0.266	0.278	-	-4.5	20	101	0
Acrolein	0.0337	0.00413*	-	87.7*	20	12	0
Methylene chloride	40	41.131	-	-2.8	20	100	0
Acetone	40	48.933	-	-22.3*	20	128	0
trans-1,2-Dichloroethene	0.273	0.287	-	-5.1	20	103	0
Methyl acetate	0.154	0.128	-	16.9	20	81	0
Methyl tert-butyl ether	0.699	0.614	-	12.2	20	86	0
tert-Butyl alcohol	0.03	0.023*	-	23.3*	20	77	-.01
Diisopropyl ether	0.999	0.871	-	12.8	20	82	0
1,1-Dichloroethane	0.614	0.595	-	3.1	20	96	0
Halothane	0.221	0.233	-	-5.4	20	102	0
Acrylonitrile	0.092	0.066	-	28.3*	20	70	0
Ethyl tert-butyl ether	0.898	0.798	-	11.1	20	84	0
Vinyl acetate	0.61	0.494	-	19	20	78	0
cis-1,2-Dichloroethene	0.306	0.311	-	-1.6	20	101	0
2,2-Dichloropropane	0.433	0.422	-	2.5	20	97	0
Bromochloromethane	0.141	0.15	-	-6.4	20	106	0
Cyclohexane	0.574	0.559	-	2.6	20	96	0
Chloroform	0.536	0.493	-	8	20	97	0
Ethyl acetate	0.229	0.187	-	18.3	20	79	0
Carbon tetrachloride	0.4	0.406	-	-1.5	20	97	0
Tetrahydrofuran	0.089	0.073	-	18	20	82	0
Dibromofluoromethane	0.305	0.287	-	5.9	20	100	0
1,1,1-Trichloroethane	0.425	0.428	-	-0.7	20	99	0
2-Butanone	40	32.18	-	19.6	20	79	0
1,1-Dichloropropene	0.346	0.373	-	-7.8	20	100	0
Benzene	1.017	1.039	-	-2.2	20	98	0
tert-Amyl methyl ether	0.635	0.552	-	13.1	20	85	0
1,2-Dichloroethane-d4	0.289	0.245	-	15.2	20	91	0
1,2-Dichloroethane	0.399	0.353	-	11.5	20	89	0
Methyl cyclohexane	0.411	0.419	-	-1.9	20	96	0
Trichloroethene	0.28	0.29	-	-3.6	20	99	0
Dibromomethane	0.163	0.155	-	4.9	20	95	0

*** Value outside of QC limits.**

Calibration Verification Summary
Form 7
Volatiles

Client	: Anchor QEA, LLC	**Lab Number**	: L2153328
Project Name	: FORMER HAVERHILL MGP	**Project Number**	: 180327-08.01
Instrument ID	: VOA104	**Calibration Date**	: 10/13/21 20:04
Lab File ID	: V04211013N01	**Init. Calib. Date(s)**	: 07/07/21 07/08/21
Sample No	: WG1559114-2	**Init. Calib. Times**	: 20:54 00:16
Channel	:		

Compound	Ave. RRF	RRF	Min RRF	%D	Max %D	Area%	Dev(min)
1,2-Dichloropropane	0.338	0.323	-	4.4	20	93	0
2-Chloroethyl vinyl ether	0.17	0.038*	-	77.6*	20	21	0
Bromodichloromethane	0.385	0.362	-	6	20	93	0
1,4-Dioxane	0.00221	0.00193*	-	12.7	20	83	0
cis-1,3-Dichloropropene	0.415	0.42	-	-1.2	20	92	0
Chlorobenzene-d5	1	1	-	0	20	98	0
Toluene-d8	1.259	1.243	-	1.3	20	97	0
Toluene	0.836	0.83	-	0.7	20	95	0
4-Methyl-2-pentanone	0.123	0.102	-	17.1	20	75	0
Tetrachloroethene	0.392	0.431	-	-9.9	20	97	0
trans-1,3-Dichloropropene	0.471	0.474	-	-0.6	20	90	0
Ethyl methacrylate	0.387	0.32	-	17.3	20	77	0
1,1,2-Trichloroethane	0.234	0.234	-	0	20	92	0
Chlorodibromomethane	0.347	0.377	-	-8.6	20	95	0
1,3-Dichloropropane	0.459	0.458	-	0.2	20	91	0
1,2-Dibromoethane	40	37.861	-	5.3	20	91	0
2-Hexanone	0.235	0.17	-	27.7*	20	78	0
Chlorobenzene	0.964	0.991	-	-2.8	20	96	0
Ethylbenzene	1.631	1.608	-	1.4	20	95	0
1,1,1,2-Tetrachloroethane	0.351	0.364	-	-3.7	20	93	0
p/m Xylene	80	90.329	-	-12.9	20	100	0
o Xylene	0.641	0.653	-	-1.9	20	101	0
Styrene	1.017	1.075	-	-5.7	20	100	0
1,4-Dichlorobenzene-d4	1	1	-	0	20	112	0
Bromoform	0.444	0.369	-	16.9	20	88	0
Isopropylbenzene	3.164	2.999	-	5.2	20	100	0
4-Bromofluorobenzene	0.926	0.826	-	10.8	20	98	0
Bromobenzene	0.768	0.77	-	-0.3	20	106	0
n-Propylbenzene	3.548	3.448	-	2.8	20	102	0
1,4-Dichlorobutane	1.259	0.918	-	27.1*	20	80	0
1,1,2,2-Tetrachloroethane	0.659	0.542	-	17.8	20	89	0
4-Ethyltoluene	3.053	2.936	-	3.8	20	100	0
2-Chlorotoluene	2.126	1.982	-	6.8	20	99	0
1,3,5-Trimethylbenzene	2.596	2.336	-	10	20	95	0
1,2,3-Trichloropropane	0.51	0.4	-	21.6*	20	86	0
trans-1,4-Dichloro-2-buten	0.236	0.157	-	33.5*	20	70	0
4-Chlorotoluene	2.208	2.06	-	6.7	20	100	0
tert-Butylbenzene	2.194	2.238	-	-2	20	108	0
1,2,4-Trimethylbenzene	2.594	2.324	-	10.4	20	96	0
sec-Butylbenzene	3.441	3.386	-	1.6	20	103	0
p-Isopropyltoluene	2.789	2.8	-	-0.4	20	105	0
1,3-Dichlorobenzene	1.514	1.527	-	-0.9	20	107	0
1,4-Dichlorobenzene	1.547	1.52	-	1.7	20	106	0

*** Value outside of QC limits.**

Calibration Verification Summary
Form 7
Volatiles

Client	: Anchor QEA, LLC		**Lab Number**	: L2153328	
Project Name	: FORMER HAVERHILL MGP		**Project Number**	: 180327-08.01	
Instrument ID	: VOA104		**Calibration Date**	: 10/13/21 20:04	
Lab File ID	: V04211013N01		**Init. Calib. Date(s)**	: 07/07/21	07/08/21
Sample No	: WG1559114-2		**Init. Calib. Times**	: 20:54	00:16
Channel	:				

Compound	Ave. RRF	RRF	Min RRF	%D	Max %D	Area%	Dev(min)
p-Diethylbenzene	1.641	1.622	-	1.2	20	103	0
n-Butylbenzene	2.478	2.336	-	5.7	20	99	0
1,2-Dichlorobenzene	1.427	1.422	-	0.4	20	108	0
1,2,4,5-Tetramethylbenzene	2.664	2.622	-	1.6	20	105	0
1,2-Dibromo-3-chloropropan	0.11	0.105	-	4.5	20	103	0
1,3,5-Trichlorobenzene	1.078	1.091	-	-1.2	20	106	0
Hexachlorobutadiene	0.613	0.557	-	9.1	20	95	0
1,2,4-Trichlorobenzene	0.991	0.99	-	0.1	20	106	0
Naphthalene	2.108	1.959	-	7.1	20	101	0
1,2,3-Trichlorobenzene	0.902	0.867	-	3.9	20	104	0

*** Value outside of QC limits.**

Calibration Verification Summary
Form 7
Volatiles

Client	: Anchor QEA, LLC	**Lab Number**	: L2153328
Project Name	: FORMER HAVERHILL MGP	**Project Number**	: 180327-08.01
Instrument ID	: VOA104	**Calibration Date**	: 10/14/21 11:57
Lab File ID	: V04211014B02	**Init. Calib. Date(s)**	: 07/07/21 07/08/21
Sample No	: WG1559101-2	**Init. Calib. Times**	: 20:54 00:16
Channel	:		

Compound	Ave. RRF	RRF	Min RRF	%D	Max %D	Area%	Dev(min)
Fluorobenzene	1	1	-	0	20	99	0
Dichlorodifluoromethane	0.29	0.177	-	39*	20	60	0
Chloromethane	0.386	0.364	-	5.7	20	99	-.03
Vinyl chloride	0.321	0.325	-	-1.2	20	99	0
Bromomethane	40	50.212	-	-25.5*	20	115	0
Chloroethane	0.132	0.156	-	-18.2	20	130	0
Trichlorofluoromethane	0.418	0.421	-	-0.7	20	96	0
Ethyl ether	0.145	0.119	-	17.9	20	83	0
1,1-Dichloroethene	0.241	0.263	-	-9.1	20	104	0
Carbon disulfide	0.896	0.792	-	11.6	20	90	0
Freon-113	0.266	0.281	-	-5.6	20	100	0
Acrolein	0.034	0.031*	-	8.8	20	89	0
Methylene chloride	40	40.731	-	-1.8	20	98	0
Acetone	40	33.077	-	17.3	20	87	0
trans-1,2-Dichloroethene	0.273	0.298	-	-9.2	20	105	0
Methyl acetate	0.154	0.121	-	21.4*	20	75	0
Methyl tert-butyl ether	0.699	0.572	-	18.2	20	79	0
tert-Butyl alcohol	0.03	0.022*	-	26.7*	20	72	-.01
Diisopropyl ether	0.999	0.921	-	7.8	20	85	0
1,1-Dichloroethane	0.614	0.619	-	-0.8	20	99	0
Halothane	0.221	0.245	-	-10.9	20	106	0
Acrylonitrile	0.092	0.066	-	28.3*	20	70	0
Ethyl tert-butyl ether	0.898	0.846	-	5.8	20	88	0
Vinyl acetate	0.61	0.527	-	13.6	20	82	0
cis-1,2-Dichloroethene	0.306	0.317	-	-3.6	20	102	0
2,2-Dichloropropane	0.433	0.435	-	-0.5	20	99	0
Bromochloromethane	0.141	0.147	-	-4.3	20	102	0
Cyclohexane	0.574	0.551	-	4	20	93	0
Chloroform	0.536	0.505	-	5.8	20	98	0
Ethyl acetate	0.229	0.171	-	25.3*	20	71	0
Carbon tetrachloride	0.4	0.406	-	-1.5	20	96	0
Tetrahydrofuran	0.089	0.063	-	29.2*	20	70	0
Dibromofluoromethane	0.305	0.276	-	9.5	20	95	0
1,1,1-Trichloroethane	0.425	0.439	-	-3.3	20	100	0
2-Butanone	40	24.279	-	39.3*	20	60	0
1,1-Dichloropropene	0.346	0.377	-	-9	20	100	0
Benzene	1.017	1.06	-	-4.2	20	98	0
tert-Amyl methyl ether	0.635	0.578	-	9	20	87	0
1,2-Dichloroethane-d4	0.289	0.229	-	20.8*	20	83	0
1,2-Dichloroethane	0.399	0.34	-	14.8	20	85	0
Methyl cyclohexane	0.411	0.442	-	-7.5	20	100	0
Trichloroethene	0.28	0.296	-	-5.7	20	99	0
Dibromomethane	0.163	0.149	-	8.6	20	90	0

*** Value outside of QC limits.**

Calibration Verification Summary
Form 7
Volatiles

Client	: Anchor QEA, LLC		**Lab Number**	: L2153328	
Project Name	: FORMER HAVERHILL MGP		**Project Number**	: 180327-08.01	
Instrument ID	: VOA104		**Calibration Date**	: 10/14/21 11:57	
Lab File ID	: V04211014B02		**Init. Calib. Date(s)**	: 07/07/21	07/08/21
Sample No	: WG1559101-2		**Init. Calib. Times**	: 20:54	00:16
Channel	:				

Compound	Ave. RRF	RRF	Min RRF	%D	Max %D	Area%	Dev(min)
1,2-Dichloropropane	0.338	0.328	-	3	20	93	0
2-Chloroethyl vinyl ether	0.17	0.13	-	23.5*	20	70	0
Bromodichloromethane	0.385	0.367	-	4.7	20	92	0
1,4-Dioxane	0.00221	0.00185*	-	16.3	20	78	0
cis-1,3-Dichloropropene	0.415	0.425	-	-2.4	20	92	0
Chlorobenzene-d5	1	1	-	0	20	99	0
Toluene-d8	1.259	1.244	-	1.2	20	97	0
Toluene	0.836	0.86	-	-2.9	20	98	0
4-Methyl-2-pentanone	0.123	0.095*	-	22.8*	20	71	0
Tetrachloroethene	0.392	0.433	-	-10.5	20	98	0
trans-1,3-Dichloropropene	0.471	0.469	-	0.4	20	89	0
Ethyl methacrylate	0.387	0.307	-	20.7*	20	74	0
1,1,2-Trichloroethane	0.234	0.228	-	2.6	20	90	0
Chlorodibromomethane	0.347	0.365	-	-5.2	20	93	0
1,3-Dichloropropane	0.459	0.447	-	2.6	20	89	0
1,2-Dibromoethane	40	36.383	-	9	20	88	0
2-Hexanone	0.235	0.158	-	32.8*	20	73	0
Chlorobenzene	0.964	1.032	-	-7.1	20	100	0
Ethylbenzene	1.631	1.685	-	-3.3	20	100	0
1,1,1,2-Tetrachloroethane	0.351	0.372	-	-6	20	96	0
p/m Xylene	80	92.494	-	-15.6	20	103	0
o Xylene	0.641	0.661	-	-3.1	20	102	0
Styrene	1.017	1.085	-	-6.7	20	101	0
1,4-Dichlorobenzene-d4	1	1	-	0	20	107	0
Bromoform	0.444	0.372	-	16.2	20	85	0
Isopropylbenzene	3.164	3.247	-	-2.6	20	103	0
4-Bromofluorobenzene	0.926	0.841	-	9.2	20	96	0
Bromobenzene	0.768	0.832	-	-8.3	20	110	0
n-Propylbenzene	3.548	3.729	-	-5.1	20	105	0
1,4-Dichlorobutane	1.259	0.892	-	29.2*	20	74	0
1,1,2,2-Tetrachloroethane	0.659	0.554	-	15.9	20	87	0
4-Ethyltoluene	3.053	3.085	-	-1	20	101	0
2-Chlorotoluene	2.126	2.115	-	0.5	20	101	0
1,3,5-Trimethylbenzene	2.596	2.475	-	4.7	20	97	0
1,2,3-Trichloropropane	0.51	0.403	-	21*	20	83	0
trans-1,4-Dichloro-2-buten	0.236	0.171	-	27.5*	20	73	0
4-Chlorotoluene	2.208	2.182	-	1.2	20	101	0
tert-Butylbenzene	2.194	2.346	-	-6.9	20	109	0
1,2,4-Trimethylbenzene	2.594	2.459	-	5.2	20	97	0
sec-Butylbenzene	3.441	3.61	-	-4.9	20	105	0
p-Isopropyltoluene	2.789	3.005	-	-7.7	20	108	0
1,3-Dichlorobenzene	1.514	1.609	-	-6.3	20	108	0
1,4-Dichlorobenzene	1.547	1.596	-	-3.2	20	107	0

*** Value outside of QC limits.**

Calibration Verification Summary
Form 7
Volatiles

Client	: Anchor QEA, LLC		**Lab Number**	: L2153328	
Project Name	: FORMER HAVERHILL MGP		**Project Number**	: 180327-08.01	
Instrument ID	: VOA104		**Calibration Date**	: 10/14/21 11:57	
Lab File ID	: V04211014B02		**Init. Calib. Date(s)**	: 07/07/21	07/08/21
Sample No	: WG1559101-2		**Init. Calib. Times**	: 20:54	00:16
Channel	:				

Compound	Ave. RRF	RRF	Min RRF	%D	Max %D	Area%	Dev(min)
p-Diethylbenzene	1.641	1.747	-	-6.5	20	107	0
n-Butylbenzene	2.478	2.536	-	-2.3	20	103	0
1,2-Dichlorobenzene	1.427	1.475	-	-3.4	20	107	0
1,2,4,5-Tetramethylbenzene	2.664	2.823	-	-6	20	108	0
1,2-Dibromo-3-chloropropan	0.11	0.101	-	8.2	20	95	0
1,3,5-Trichlorobenzene	1.078	1.201	-	-11.4	20	112	0
Hexachlorobutadiene	0.613	0.597	-	2.6	20	98	0
1,2,4-Trichlorobenzene	0.991	1.054	-	-6.4	20	108	0
Naphthalene	2.108	1.951	-	7.4	20	96	0
1,2,3-Trichlorobenzene	0.902	0.902	-	0	20	104	0

*** Value outside of QC limits.**

Performance Evaluation Mixture Summary
Form 15
Pesticides

Client	: Anchor QEA, LLC	**Lab Number**	: L2153328
Project Name	: FORMER HAVERHILL MGP	**Project Number**	: 180327-08.01
Instrument ID	: PEST15	**Analysis Date**	: 10/13/21 07:39
PEM Standard	: R1489212-1		
Column 1	: RTX-5	**Column 2**	: RTX-CLPPesticides2

Parameter	Signal 1	Signal 2
4,4'-DDE	0	0
Endrin	929738772.5	755899327.1875
4,4'-DDD	1503194.87584	10749264.2902
4,4'-DDT	1713888242.8535	1277767108.5625
Endrin Aldehyde	0	0
Endrin Ketone	3740275.68024	2388854.91983

Parameter	%Breakdown 1	%Breakdown 2
Endrin	0.401	0.315
DDT	0.0876	0.834

Appendix E
NAPL Testing Reports

INTEGRATED GEOSCIENCES LABORATORIES, LLC
*Environmental * Geotechnical * Core Analysis*

6016 Centralcrest Street • Houston, Texas 77092
Telephone (713) 316-1800 • Fax (877) 255-9953

October 15, 2021

Billie-Jo Gauley,
Project Manager.
Anchor QEA.
9 Water St.
Amesbury, MA 01913.

Re: IGS Labs File No: **2110-140**
Project Name: **Haverhill MGP**
Project Number: **N/A**
Site Location: **Haverhill, MA**

Subject: Final Report: Free Product Mobility Package – mod. ASTM D425, API RP40, and Core Photography.

Dear Billie-Jo Gauley,

Please find enclosed report for Physical Properties Analysis conducted on soil samples received from your "**Haverhill MGP"** project. All analyses were performed by applicable ASTM, EPA, or API methodologies. The samples are currently in storage and will be retained for thirty days past the completion of testing at no charge. Please note that the samples will be disposed of at that time. You may contact me regarding storage, disposal, or return of the samples.

Integrated Geosciences Laboratories appreciate the opportunity to be of service. If you have any questions or require additional information, please contact me or Emeka Anazodo at (713) 316-1800.

Sincerely,
Integrated Geosciences Laboratories, LLC.

Wumi Andrew

Laboratory Technician.
Encl.

Integrated Geosciences Laboratories, LLC.

Project Name: Haverhill MGP
Project Number: N/A
Site Location: Haverhill MA

IGS Labs File No: 2110-140
Client: Anchor QEA
Date Received: 10/5/2021

TEST PROGRAM - 20211005

Serial Number	Sample ID	Date; Time Sampled	Depth (feet)	Matix Type	Free Product Mobility Package mod. ASTM D425, API RP40	Extended Time Free Product Mobility Package (10 hrs) mod. ASTM D425, API RP40	Photolog Core Photography ASTM D5079	Full-scale White Light & UV ASTM D5079	Core Slabbing ASTM D5079	Comments
Date Received: 20211005										
1	AQSS-13	9/30/21; 15:30	0-4.3	Soil	5X	5X	X	X	X	3- [2.75" X 14.5"] & 1-[2.75" X 12"]
2	AQSS-12	9/30/21; 15:31	0-4.6	Soil	5X	5X				3- [2.75" X 14.5"] & 1-[2.75" X 12"]
	TOTAL				**10**	**10**	**1**	**16ft**	**16ft**	**8**

Laboratory Test Program Notes

1. Standard TAT for basic analysis is 10-15 business days.
2. Free Product Mobility Package: Applied Centrifugal force demonstrates product mobility; includes residual saturation by Dean Stark, total porosity, grain and bulk density.
3. Full-scale white light & UV and core slabbing measured per foot (16').

Integrated Geosciences Laboratories, LLC.

FREE PRODUCT MOBILITY: INITIAL AND RESIDUAL SATURATIONS

(Centrifugal method: samples spun under air)

IGS Labs File No: 2110-140
Client: Anchor QEA
Report Date: 10/15/21

Project Name: Haverhill MGP
Project Number: N/A
Site Location: Haverhill MA

					METHODS:		**API RP 40**		**API RP 40**	**ASTM D425M, DEAN-STARK**			
										PORE FLUID SATURATIONS (3), % Pv			
	IGS Labs		**SAMPLE**		**TOTAL SAMPLE VOLUME**		**DENSITY**		**TOTAL**	**Initial Fluid Saturations**		**After Centrifuge at 25xG**	
SAMPLE ID.	**PLUG ID**	**DEPTH, ft.**	**ORIENTATION (1)**	**ANALYSIS DATE**	**INITIAL cc**	**FINAL cc**	**DRY BULK, g/cc**	**GRAIN, g/cc**	**POROSITY (2), %Vb**	**WATER (Swi) SATURATION**	**NAPL (Soi) SATURATION**	**WATER (Srw) SATURATION**	**NAPL (Sor) SATURATION**
AQSS-12-0.6-0.7	1	0.65	H	20211008	62.15	60.44	1.76	2.69	34.6	44.6	7.3	22.8	7.3
	NOTE: No visible NAPL produced. Produced water clear, with faint hydrocarbon / organic odor. Sample intact.												
AQSS-12-1.25-1.35	2	1.30	H	20211008	62.35	56.63	1.27	2.51	49.5	63.6	16.3	43.6	16.3
	NOTE: No visible NAPL produced. Produced water clear, with faint hydrocarbon / organic odor. Sample intact.												
AQSS-12-2.1-2.2	3	2.15	H	20211008	64.08	61.47	1.47	2.49	41.0	62.1	5.3	32.0	5.3
	NOTE: No visible NAPL produced. Produced water clear, with faint hydrocarbon / organic odor. Sample intact.												
AQSS-3.0-3.1	4	3.05	H	20211008	63.91	61.28	1.46	2.53	42.3	69.5	2.9	56.9	2.9
	NOTE: No visible NAPL produced. Produced water clear, with faint hydrocarbon / organic odor. Sample intact.												
AQSS-12-4.5-4.6	5	4.55	H	20211008	62.78	60.67	1.71	2.66	35.6	57.8	18.0	38.5	18.0
	NOTE: No visible NAPL produced. Produced water clear, with faint hydrocarbon / organic odor. Sample intact.												

(1) Sample Orientation: H = horizontal; V = vertical; R = remold
(2) Total Porosity = all interconnected pore channels.
(3) Fluid density used to calculate pore fluid saturations: Water = 0.9987 g/cc, DNAPL = 1.11040 g/cc.
Swi = Initial Water Saturation as received prior to centrifuging at 25xG, Soi = Initial NAPL Saturation as received prior to centrifuging at 25xG for 10 hours.
Srw = Residual Water Saturation after centrifuging at 25xG, Sor = Residual NAPL Saturation after centrifuging at 25xG for duration of 10 hours
Vb = Bulk Volume, cc; Pv = Pore Volume, cc; ND = Not Detected

Integrated Geosciences Laboratories, LLC.

FREE PRODUCT MOBILITY: INITIAL AND RESIDUAL SATURATIONS

(Centrifugal method: samples spun under air)

IGS Labs File No: 2110-140
Client: Anchor QEA
Report Date: 10/15/21

Project Name: Haverhill MGP
Project Number: N/A
Site Location: Haverhill MA

					METHODS:		**API RP 40**		**API RP 40**	**ASTM D425M, DEAN-STARK**			
										PORE FLUID SATURATIONS (3), % Pv			
	IGS Labs		**SAMPLE**		**TOTAL SAMPLE VOLUME**		**DENSITY**		**TOTAL**	**Initial Fluid Saturations**		**After Centrifuge at 25xG**	
SAMPLE ID.	**PLUG ID**	**DEPTH, ft.**	**ORIENTATION (1)**	**ANALYSIS DATE**	**INITIAL cc**	**FINAL cc**	**DRY BULK, g/cc**	**GRAIN, g/cc**	**POROSITY (2), %Vb**	**WATER (Swi) SATURATION**	**NAPL (Soi) SATURATION**	**WATER (Srw) SATURATION**	**NAPL (Sor) SATURATION**
AQSS-13-0.8-0.9	6	0.85	H	20211008	60.90	53.13	0.94	2.23	57.7	61.4	24.0	39.4	24.0
	NOTE: No visible NAPL produced. Produced water clear, light yellow with moderate hydrocarbon / organic odor. Sample intact.												
AQSS-13-1.25-1.35	7	1.30	H	20211008	63.38	57.98	1.35	2.46	45.0	72.6	8.2	45.0	8.2
	NOTE: No visible NAPL produced. Produced water clear, light yellow with moderate hydrocarbon / organic odor. Sample intact.												
AQSS-13-1.9-2.0	8	1.95	H	20211008	61.07	57.47	1.59	2.57	38.2	67.2	11.5	49.9	11.5
	NOTE: No visible NAPL produced. Produced water clear, with moderate hydrocarbon / organic odor. Sample intact.												
AQSS-13-2.5-2.6	9	2.55	H	20211008	61.63	61.35	1.63	2.54	35.6	51.0	28.3	31.0	28.3
	NOTE: No visible NAPL produced. Produced water clear, with moderate hydrocarbon / organic odor. Sample intact; visible NAPL on sample package and perm plate.												
AQSS-13-3.6-3.7	10	3.65	H	20211008	61.31	51.65	1.59	2.67	40.6	72.0	6.9	61.3	6.9
	NOTE: No visible NAPL produced. Produced water clear, with moderate hydrocarbon / organic odor. Sample intact with slight fine production; visible NAPL on sample package and perm plate.												

(1) Sample Orientation: H = horizontal; V = vertical; R = remold
(2) Total Porosity = all interconnected pore channels.
(3) Fluid density used to calculate pore fluid saturations: Water = 0.9987 g/cc, DNAPL = 1.11040 g/cc.
Swi = Initial Water Saturation as received prior to centrifuging at 25xG, Soi = Initial NAPL Saturation as received prior to centrifuging at 25xG for 10 hours.
Srw = Residual Water Saturation after centrifuging at 25xG, Sor = Residual NAPL Saturation after centrifuging at 25xG for duration of 10 hours
Vb = Bulk Volume, cc; Pv = Pore Volume, cc; ND = Not Detected

(samples shipped in two coolers)

INTEGRATED GEOSCIENCES LABORATORIES, LLC — CHAIN OF CUSTODY — PAGE 1 OF 1

(formerly PTS Laboratories, Inc.)

COMPANY: Anchor QEA

ADDRESS: 9 Water St. Amesbury MA 01913

PROJECT MANAGER NAME: Billie-Jo Gauley

EMAIL: bgauley@anchorqea.com

PHONE #: 818-422-4820

PROJECT NAME: Haverhill MGP

PROJECT NUMBER:

SITE LOCATION: Haverhill, MA

SAMPLER SIGNATURE: Billie-Jo L Gauley

ANALYSIS REQUEST

SAMPLE ID	DATE	TIME	DEPTH, FEET	NUMBER OF SAMPLES	SOIL PROPERTIES PACKAGE	HYDRAULIC CONDUCTIVITY/HYDRAULIC CONDUCTIVITY PACKAGE	PORE FLUID SATURATION PACKAGE	TCEQ/TNRCC PROPERTIES PACKAGE	CAPILLARITY PACKAGE	FLUID PROPERTIES PACKAGE	CORE PHOTOGRAPHY	VAPOR TRANSPORT PACKAGE	POROSITY: TOTAL, AIR-FILLED, WATER-FILLED	PROSITY: EFFECTIVE, ASTM D425M	SPECIFIC GRAVITY, ASTM D854	BULK DENSITY (DRY), API RP40 or ASTM D2937	AIR PERMEABILITY, API RP40	HYDRAULIC CONDUCTIVITY, EPA 9100/API RP40 OR ASTM D5084	GRAIN SIZE DISTRIBUTION, ASTM D422 or D6913 or D4464	TOC: WALKLEY-BLACK	ATTERBERG LIMITS, ASTM D4318	VAPOR INTRUSION PACKAGE	FREE PRODUCT MOBILITY PACKAGE	RESIDUAL SATURATION BY WATER DRIVE	
AQSS-13	9/30/21	1530	0-4.3ft								X															core in 4 sections
AQSS-12	9/30/21	1554	0-4.6ft								X															core in 4 sections

samples to be requested for free product mobility package analysis (at 25C for 10 hr) following review of core photos.

PO #:

BILLING ADDRESS: same as client

BILLING EMAIL:

BILLING CONTACT:

BILLING PHONE #:

TURNAROUND TIME

24 HOURS		5 DAYS	
72 HOURS		NORMAL	X
OTHERS:			

SAMPLE INTEGRITY (CHECK):

INTACT: TEMP (F)

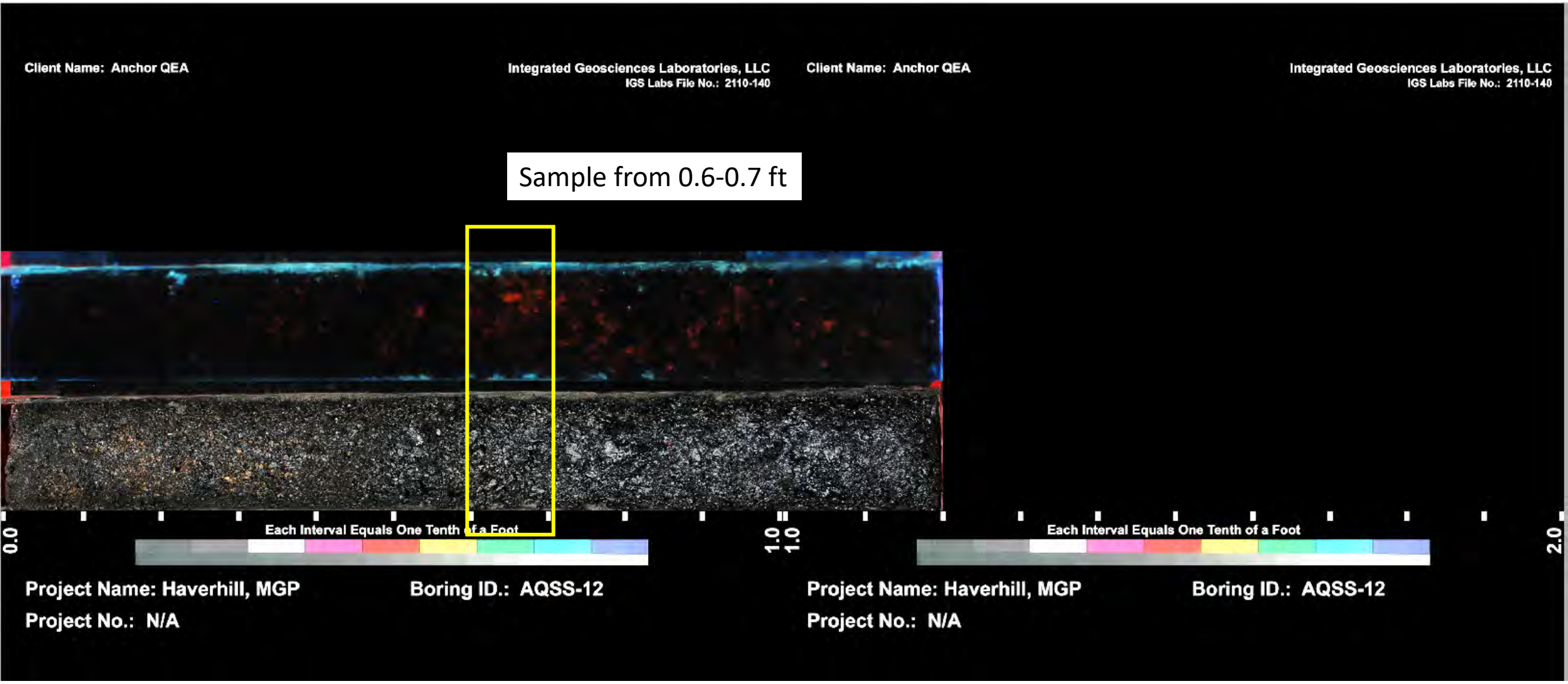
IGL QUOTE NO/DATE

IGL FILE NO: 2110-140

COMMENTS

1. RELINQUISHED BY	2: RECEIVED BY:	1. RELINQUISHED BY	2: RECEIVED BY:
Billie-Jo L Gauley	* FedEx *		
COMPANY: Anchor QEA	COMPANY	COMPANY	COMPANY: IGSL
DATE: 10/4/21 TIME: 1030	DATE TIME	DATE TIME	DATE: 10/5/21 TIME: 0800

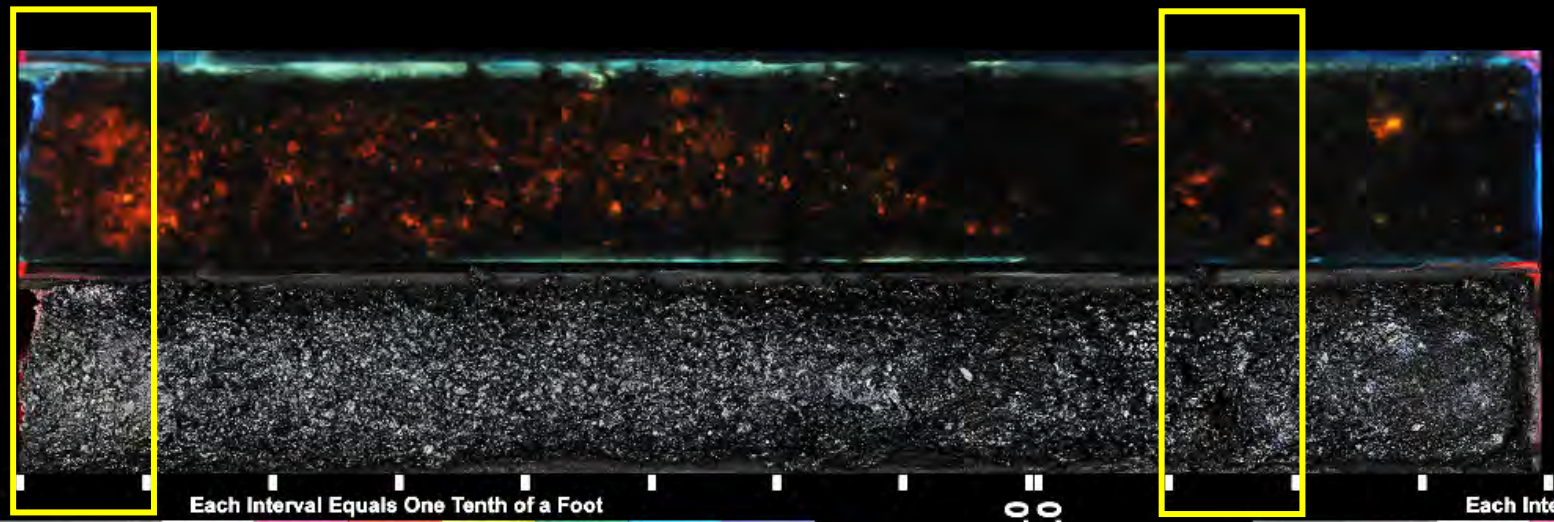
AQSS-12


Client Name: Anchor QEA
Integrated Geosciences Laboratories, LLC
IGS Labs File No.: 2110-140
Client Name: Anchor QEA
Integrated Geosciences Laboratories, LLC
IGS Labs File No.: 2110-140
Sample from 0.6-0.7 ft
Each Interval Equals One Tenth of a Foot
0.0
1.0
1.0
2.0
Each Interval Equals One Tenth of a Foot
Project Name: Haverhill, MGP
Boring ID.: AQSS-12
Project No.: N/A
Project Name: Haverhill, MGP
Boring ID.: AQSS-12
Project No.: N/A

Client Name: Anchor QEA

Integrated Geosciences Laboratories, LLC
IGS Labs File No.: 2110-140

Sample from 1.2-1.3 ft



1.0

Each Interval Equals One Tenth of a Foot

Project Name: Haverhill, MGP

Project No.: N/A

Boring ID.: AQSS-12

Client Name: Anchor QEA

Integrated Geosciences Laboratories, LLC
IGS Labs File No.: 2110-140

Sample from 2.1-2.2 ft

2.0

2.0

Each Interval Equals One Tenth of a Foot

3.0

Project Name: Haverhill, MGP

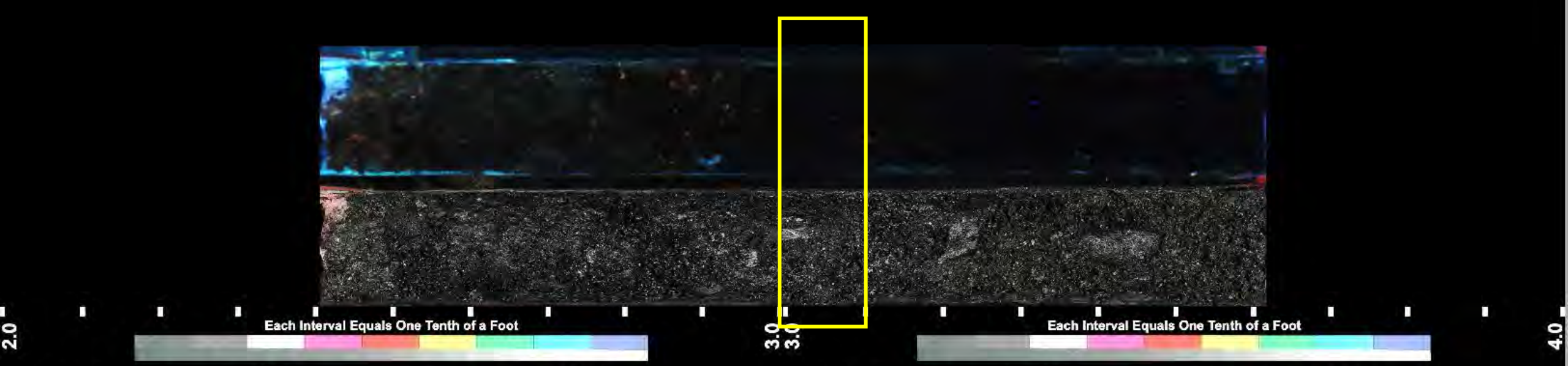
Project No.: N/A

Boring ID.: AQSS-12

Client Name: Anchor QEA

Integrated Geosciences Laboratories, LLC
IGS Labs File No.: 2110-140

Sample from 3.0-3.1 ft



Project Name: Haverhill, MGP

Boring ID.: AQSS-12

Project No.: N/A

Client Name: Anchor QEA

Integrated Geosciences Laboratories, LLC
IGS Labs File No.: 2110-140

Project Name: Haverhill, MGP

Boring ID.: AQSS-12

Project No.: N/A

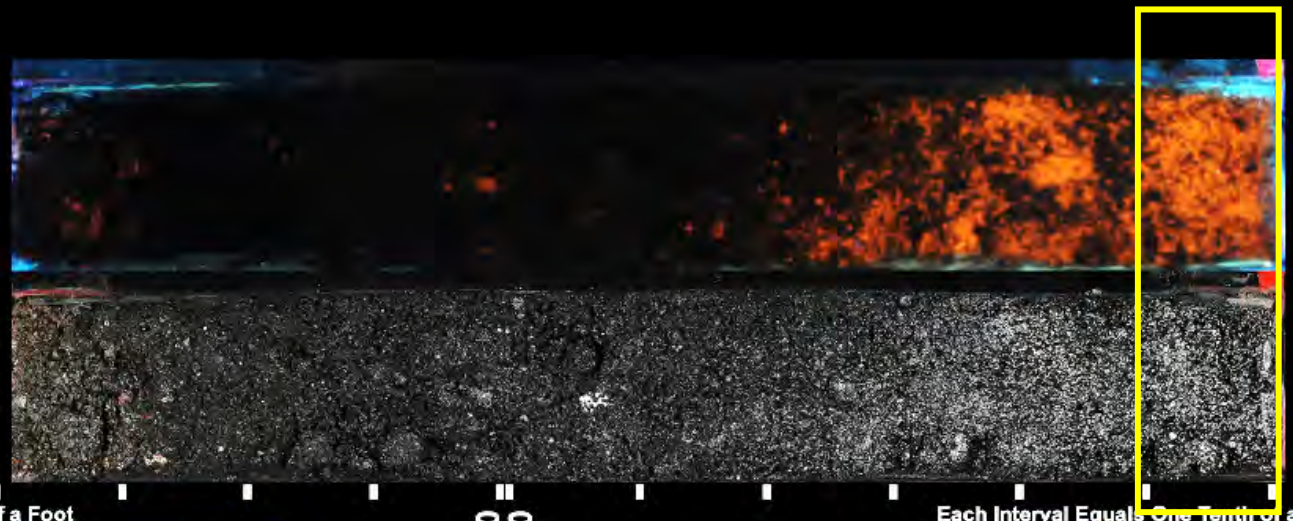
Client Name: Anchor QEA

Integrated Geosciences Laboratories, LLC
IGS Labs File No.: 2110-140

Client Name: Anchor QEA

Integrated Geosciences Laboratories, LLC
IGS Labs File No.: 2110-140

Sample from 4.5-4.6 ft



3.0

Each Interval Equals One Tenth of a Foot

4.0

4.0

Each Interval Equals One Tenth of a Foot

5.0

Project Name: Haverhill, MGP

Boring ID.: AQSS-12

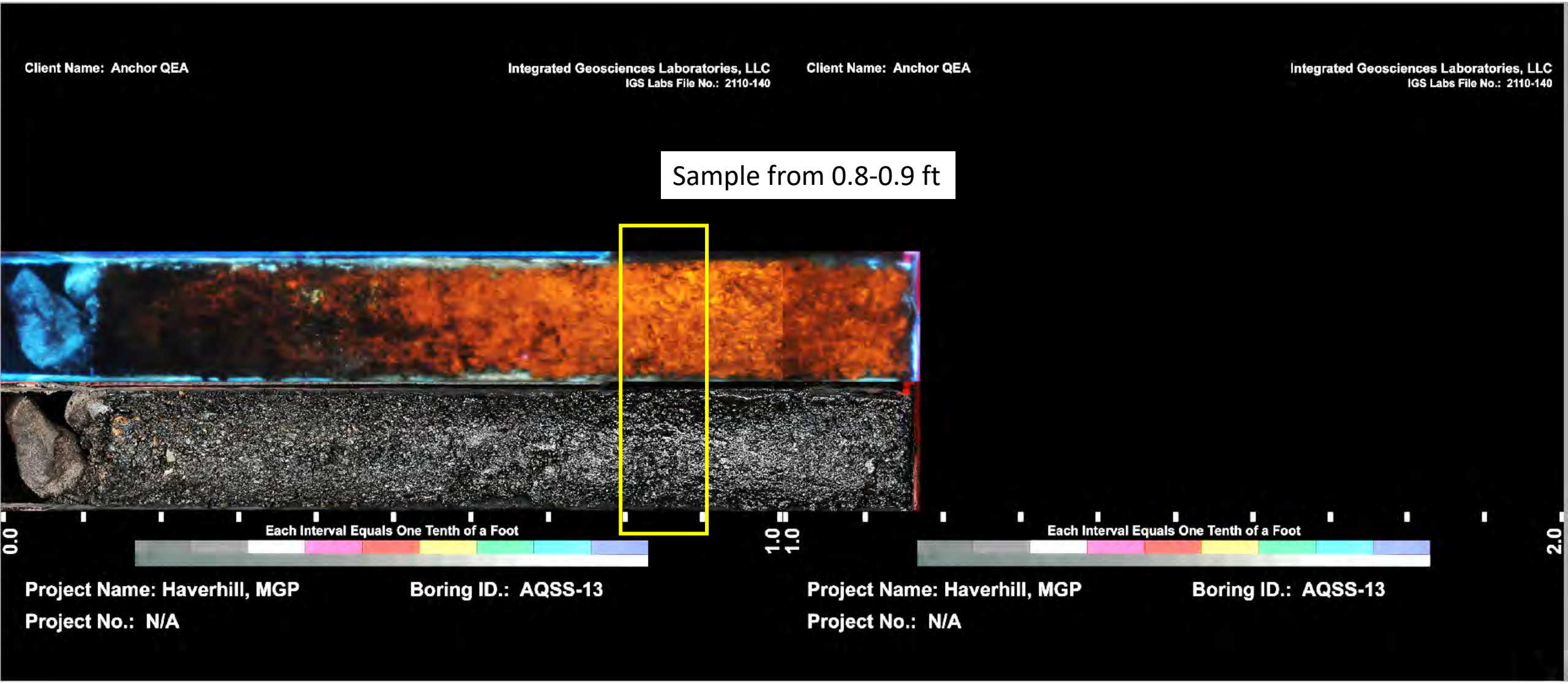
Project No.: N/A

Project Name: Haverhill, MGP

Boring ID.: AQSS-12

Project No.: N/A

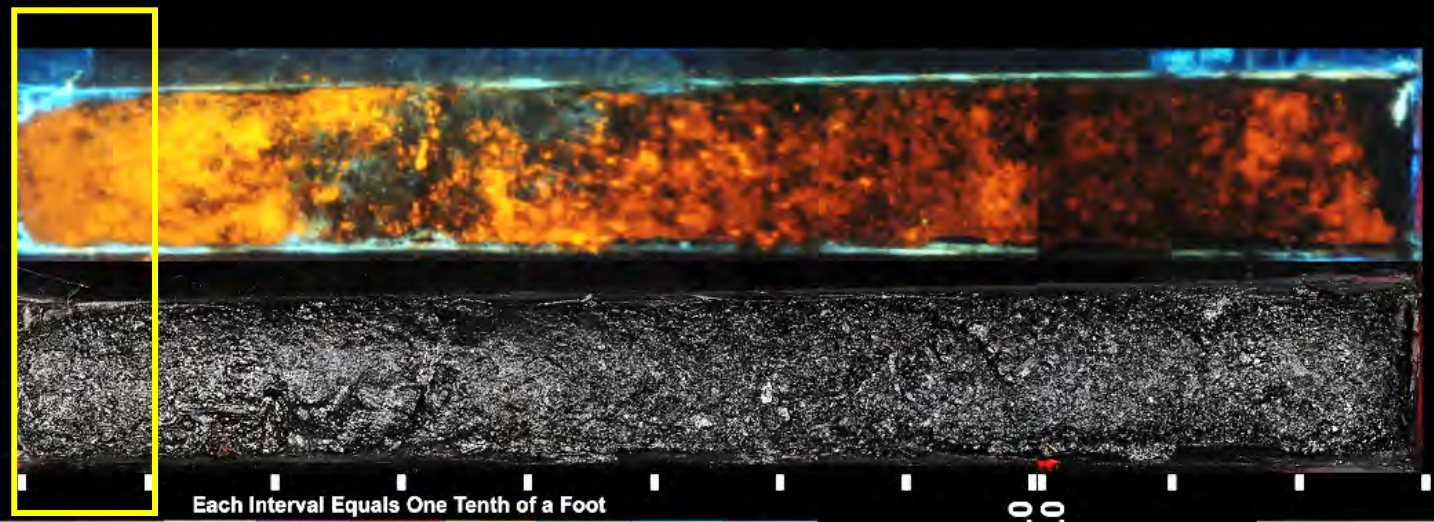
AQSS-13


Client Name: Anchor QEA
Integrated Geosciences Laboratories, LLC
IGS Labs File No.: 2110-140
Client Name: Anchor QEA
Integrated Geosciences Laboratories, LLC
IGS Labs File No.: 2110-140
Sample from 0.8-0.9 ft
0.0
Each Interval Equals One Tenth of a Foot
1.0
1.0
Each Interval Equals One Tenth of a Foot
2.0
Project Name: Haverhill, MGP
Boring ID.: AQSS-13
Project No.: N/A
Project Name: Haverhill, MGP
Boring ID.: AQSS-13
Project No.: N/A

Client Name: Anchor QEA

Integrated Geosciences Laboratories, LLC
IGS Labs File No.: 2110-140

Sample from 1.2-1.3 ft



1.0

Each Interval Equals One Tenth of a Foot

2.0

Project Name: Haverhill, MGP

Boring ID.: AQSS-13

Project No.: N/A

Client Name: Anchor QEA

Integrated Geosciences Laboratories, LLC
IGS Labs File No.: 2110-140

Each Interval Equals One Tenth of a Foot

2.0

3.0

Project Name: Haverhill, MGP

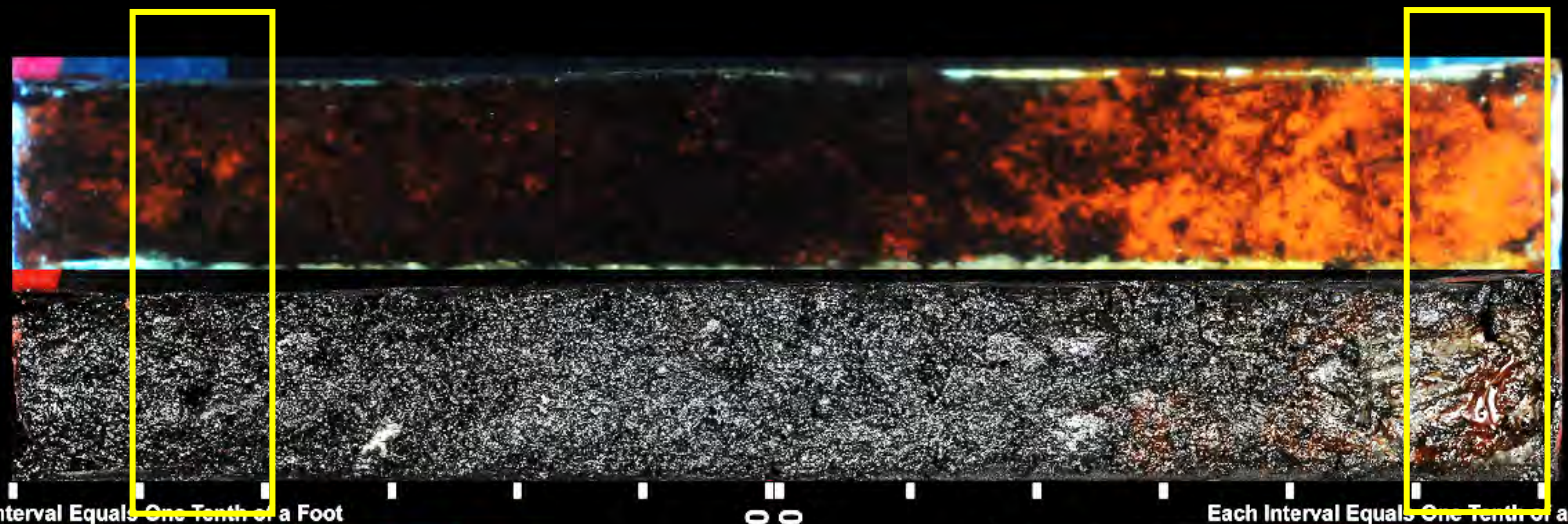
Boring ID.: AQSS-13

Project No.: N/A

Client Name: Anchor QEA

Integrated Geosciences Laboratories, LLC
IGS Labs File No.: 2110-140

Sample from 2.5-2.6 ft



2.0

Each Interval Equals One Tenth of a Foot

Project Name: Haverhill, MGP

Project No.: N/A

Boring ID.: AQSS-13

Client Name: Anchor QEA

Integrated Geosciences Laboratories, LLC
IGS Labs File No.: 2110-140

Sample from 3.5-3.6 ft

3.0

3.0

Each Interval Equals One Tenth of a Foot

4.0

Project Name: Haverhill, MGP

Project No.: N/A

Boring ID.: AQSS-13

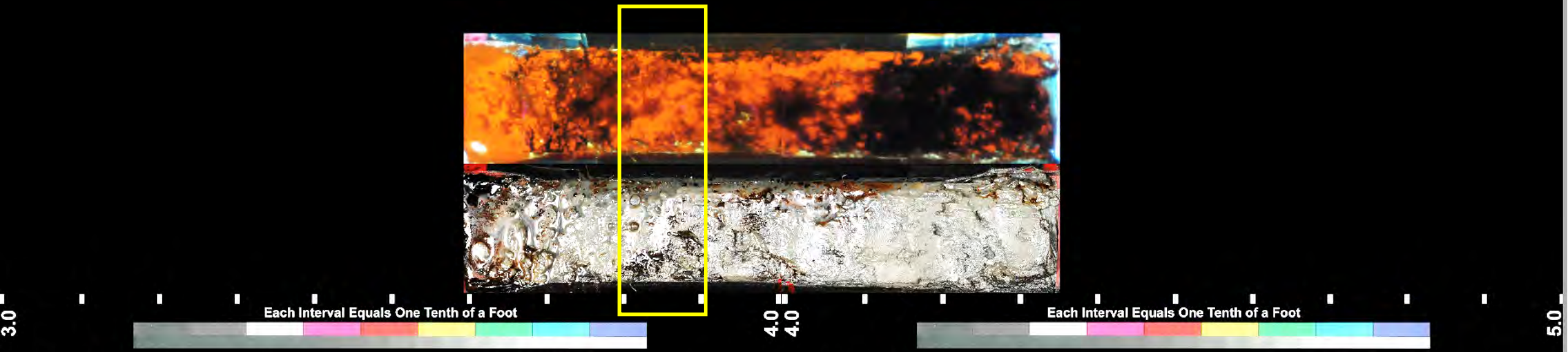
Client Name: Anchor QEA

Integrated Geosciences Laboratories, LLC
IGS Labs File No.: 2110-140

Client Name: Anchor QEA

Integrated Geosciences Laboratories, LLC
IGS Labs File No.: 2110-140

Sample from 3.8-3.9 ft



Project Name: Haverhill, MGP

Boring ID.: AQSS-13

Project No.: N/A

Project Name: Haverhill, MGP

Boring ID.: AQSS-13

Project No.: N/A

Appendix D – Method 3 Risk Characterization

1.0 INTRODUCTION AND SUMMARY OF RESULTS

GZA GeoEnvironmental, Inc. (GZA) performed a characterization of the risk of harm to health, safety, public welfare, and the environment associated with potential exposures to constituents detected in environmental media at the disposal site listed with the Massachusetts Department of Environmental Protection (MassDEP) under Release Tracking Numbers (RTNs) 3-32792 and 3-32875. The disposal site (Site) encompasses the property located at 284 Winter Street in Haverhill, Massachusetts, a portion of the Little River to the west of the property, and a narrow strip of land just west of the River on the 191 Essex Street property. This risk characterization was prepared to support the Phase II Comprehensive Site Assessment (CSA) being filed for the Site and is being submitted as an appendix to the Phase II CSA Report. The risk characterization was conducted to evaluate whether a condition of No Significant Risk, as defined by the MCP, exists at the Site for current and foreseeable future land uses and activities.

GZA conducted this Method 3 Risk Characterization in accordance with the requirements of the Massachusetts Contingency Plan (MCP) and the MassDEP (1995, 1996, 2002a-d, and 2008) Guidance for Disposal Site Risk Characterization and technical updates. The risk characterization presents the risks to human health, public welfare and safety associated with both the river and the upland areas of the Site, as well as the risks to the environment associated with the upland areas. The risks to the environment associated with the river have been characterized separately in an Ecological Risk Characterization (ERC) prepared by Anchor QEA, LLC (AQ) and included in Appendix C of the Phase II CSA.

This Method 3 Risk Characterization consists of several components, each of which is discussed in a subsequent section of this document: hazard identification (Section 2.0); exposure assessment (Section 3.0); dose-response assessment (Section 4.0); human health risk characterization (Section 5.0); uncertainty analysis (Section 6.0); safety and public welfare risk characterizations (Section 7.0); environmental risk characterization (Section 8.0); and risk characterization conclusions (Section 9.0). The references are listed in Section 10.0. This risk characterization was conducted subject to the limitations included in the main report.

1.1 CONCEPTUAL EXPOSURE MODEL

The conceptual exposure model provides a qualitative framework for presenting the assumptions, exposure pathways, receptors, and data that are used to characterize risks at a site. Characterizing risk is a multi-step process that results in an estimate of risk to people, plants, or animals ("the receptors") that may contact constituents at a site. The core of the risk characterization process is the exposure assessment. Risk assessors conduct an exposure assessment to identify the receptors and pathways that may result in contact with constituents at or near a site. Once the receptors have been identified, the risk characterization brings together analytical data and health effects data on the toxicity of the constituents of concern (COCs) to estimate exposure levels and risks for receptors at a site.

1.1.1 Site Description

This section provides a summary description of the Site, including current and former uses. The Phase II CSA provides details regarding the Site history, nature and extent of the release, and conceptual Site model.

In brief, the disposal site comprises a 1.2-acre parcel located at 284 Winter Street (the "Property") in Haverhill, Massachusetts, a portion of the Little River that abuts the Property to the west, and a narrow strip of land just west of the River on the 191 Essex Street property. The Property is zoned for general industrial uses. It is currently owned by Haffner Realty Trust (Haffner) and is occupied by a gasoline service station and car wash facility. There are currently five 20,000-gallon single-walled underground storage tanks (USTs) located beneath a concrete pad in the northern part of the Property. These include three gasoline USTs and two fuel oil USTs, all of which were installed in 1977. In addition, one 6,000-gallon single-walled diesel UST was installed in 1983 and was removed in 2018. The Property had been the location

of a former Manufactured Gas Plant (MGP) operated by Haverhill Gas Works between 1853 and 1970. Some of the former MGP infrastructure, including the remnants of a large relief holder, is still present in the subsurface at the Property.

Most of the Property is paved, with the exception of a row of trees along the eastern edge; in addition, there are small non-contiguous landscaped areas adjacent to the car wash building and along the northern and western Property boundaries. A 15- to 20-foot-high stone and masonry retaining wall along the western and southwestern edge separates the Property from the Little River. Approximately 15,000-square feet of the Little River lies within the disposal Site boundary.

The Little River flows in an open channel adjacent to the Property; just south of this area, the river is culverted until it discharges into the Merrimack River approximately ¼ mile to the south. This culverted stretch of the River is known as the Little River Conduit. According to 314 CMR 4.06, the entire length of the Little River is classified as a Class B surface water (warm water). Class B waters are designated as a habitat for fish, other aquatic life, and wildlife, and for primary and secondary contact recreation. The statute further states that Class B waters shall be suitable for irrigation and other agricultural uses, for compatible industrial cooling and process water uses, and shall have consistently good aesthetic value.

According to the on-line MassDEP Priority Resource (21E) Map, there are no wetlands or other surface water resource areas within 500 feet of the Site. No areas of critical environmental concern (ACEC), certified vernal pools, estimated Massachusetts Natural Heritage & Endangered Species Program (NHESP) habitat of rare wildlife in wetland areas, sole source aquifers, or protected open spaces have been identified within 500 feet of the Site.

The Property is connected to the municipal water and sewer system. There are no public water supply wells or interim wellhead protection areas within 500 feet of the Site; however, there is one inactive and one active water well on the Property, installed to supply the car wash operations.

1.2 RECEPTORS

The Site is zoned for general industrial uses; and is located in a commercial, light industrial, and residential area in Haverhill, Massachusetts. The residential population located within a ½-mile radius of the Site is estimated to be between 500 and 1,000 people. According to 310 CMR 40.0006, an "Institution" is defined as any publicly or privately-owned hospital, health care facility, orphanage, nursing home, educational facility, or correctional facility, where such a facility in whole or in part provides overnight housing. Based on a review of the area surrounding the Site, GZA did not identify any institution within 500 feet of the Site.

Potential receptors identified for the Site under the current use scenarios include landscapers, emergency/utility workers, facility workers, and customers and other Site visitors/trespassers (referred to as "trespassers"). Future use of the Site is expected to be similar to the current use, but may also include construction activities; therefore, construction workers were identified as potential receptors for the future use scenario. An Activity and Use Limitation (AUL) is being proposed for the Site that would prohibit residential use of the Site; therefore, residential receptors were not identified as potential receptors under either current or future scenarios.

GZA quantitatively evaluated the potential risks posed by conditions at the Site to three receptor groups – construction workers, facility workers, and trespassers. Emergency/utility workers and landscapers are not expected to have more exposure than construction workers and therefore the risks to emergency/utility workers or landscapers were not evaluated separately in this risk characterization. In other words, if a condition of no significant risk is demonstrated for construction workers, then a condition of no significant risk would exist for emergency/utility workers and landscapers. On the other hand, if a condition of no significant risk cannot be demonstrated for construction workers, either significant risk would be concluded for emergency/utility workers and landscapers or a refined evaluation would be performed for emergency/utility workers and landscapers. Similarly, the trespasser exposure scenario was used to evaluate potential risks to all incidental short-term receptors, including customers and Site visitors.

Exposure to surface water and sediment in the Little River by trespassers is possible but is limited to an occasional event. The River is not easily accessible from the surrounding areas due to steep banks and accessing the portion within the Site would pose significant physical risks to trespassers, which would likely outweigh marginal risks associated with potential exposure to Site COCs. In addition, exposure to surface water via dermal contact was not quantitatively evaluated in this risk characterization. A petroleum sheen was observed on the surface water of the Little River in May 2015, which resulted the assignment of RTN 3-32875 to the Site. However, no petroleum hydrocarbon constituents or cyanide was detected in the subsequent surface water samples collected from the river. Also, the primary area with sporadic sheens is demarcated by boom systems that serve as a visual marker to limit access. For these reasons, it is GZA's opinion that a quantitative evaluation of potential risks to human health associated with exposures to Little River water was not warranted. However, risks to occasional trespassers via exposure to impacted sediment in the river was conservatively evaluated in this risk characterization.

Groundwater is more than 10 feet below ground surface (bgs) at the Site, except within the former relief holder in the south-central portion of the Site (MW-1 and B107) where groundwater is perched at 3-5 feet below ground surface (bgs). Emergency/utility workers and construction workers could contact groundwater within the former relief holder area but would not be expected to encounter groundwater elsewhere at the Site. The AUL contemplated for the Property will require vapor monitoring and controls and health and safety protocols for construction work at the Site. As a result, exposure to groundwater via dermal contact is not expected to be a complete exposure pathway for area outside the former holder area and therefore was only quantitatively evaluated for the former relief holder area in this risk characterization. Similarly, emergency/utility workers and construction workers were assumed to be exposed to residual OHM via inhalation of air in a work area trench potentially impacted by groundwater within the former relief holder area.

In summary, the environmental media that receptors may contact include soil and soil-derived dust (all receptors), groundwater and air in a trench (construction workers working within the former relief holder area only), sediment in the Little River (trespassers only), and indoor air potentially impacted by volatile organic compounds (VOCs) detected in soil gas at the Site (facility workers only).

1.3 SUMMARY OF RISK RESULTS

This section summarizes the results for the human health, safety, public welfare, and environmental risk characterization.

1.3.1 Risks to Human Health

To assess whether a condition of No Significant Risk of harm to human health exists, the risk characterization focused on risks to human receptors under current and foreseeable future land uses. Activities and uses evaluated include emergency/utility work, construction work, and commercial use as well as trespassing. The risk estimates were compared to the MCP acceptable non-cancer risk limit of a hazard index (HI) of one (1), and the MCP acceptable cancer risk limit of an excess lifetime cancer risk (ELCR) of one in one hundred thousand (1×10^{-5}).

The risk estimates for the Site are summarized in Table D-1. The cumulative non-cancer and cancer risk estimates for the facility workers (HI = 0.44 and ELCR = 2.2×10^{-6}), the construction worker receptor group working in the area outside the former holder area (HI = 0.18 and ELCR = 9.4×10^{-8}), and the trespasser receptor group (HI = 0.71 and ELCR = 3.1×10^{-6}) do not exceed the MCP risk limits.

The cumulative non-cancer risk estimate for the construction worker receptor group working within the former holder area (HI = 7.7) exceeds the MCP non-cancer risk limit of 1; while the cancer risk estimate for the construction worker receptor group working within the former holder area (ELCR = 1.6×10^{-6}) does not exceed the MCP cancer risk limit of 1×10^{-5}. The elevated non-cancer risk estimate was driven by the inhalation of work area air potentially impacted by groundwater in a utility trench. The elevated non-cancer risk estimate was also assumed for emergency/utility workers working within the former holder area.

No exceedance of applicable public health standards has been identified. The applicable human health standards identified for the Site are the Ambient Water Quality Criteria (AWQC) protective of fish consumption presented in the U.S. Environmental Protection Agency (USEPA; 2020b) National Recommended Water Quality Criteria. These standards are applicable to surface water at or adjacent to the Site. No constituents were detected in either the upstream or downstream surface water sample.

1.3.2 Risks to Safety

The purpose of evaluating the risk of harm to safety is to identify release-related conditions at the Site that could pose a threat of physical harm or bodily injury to people. Examples of conditions that constitute a risk of harm to safety are: the presence of rusted or corroded drums or containers; weakened berms; unsecured pits, ponds, lagoons, or other dangerous structures; any threat of fire or explosion, including the presence of explosive vapors resulting from a release of oil or hazardous material (OHM); reactive chemicals stored or disposed of in a way that does not reasonably preclude uncontrolled reactions; any uncontained materials which exhibit the characteristics of corrosivity, reactivity, or flammability described in 310 CMR 40.0347; or the presence of ionizing or non-ionizing radiation.

No safety hazards described above were identified at the Site, nor are they anticipated to occur in the future in connection with conditions related to RTNs 3 32792 and 3-32875. Therefore, a condition of no significant risk of harm to safety exists at the Site under the current and foreseeable future uses.

1.3.3 Risks to Public Welfare

The risk of harm to public welfare considers the existence of nuisance conditions, loss of another person's active or passive property use, and any non-pecuniary costs that may accrue due to the degradation of public or private resources directly attributable to the release of OHM. The risk of harm to public welfare (and the environment) is also characterized by comparing soil and groundwater concentrations to the upper concentration limits (UCLs) listed in 310 CMR 40.0996(6) or identified pursuant to 310 CMR 40.0996(7).

The arithmetic mean concentrations of soil and groundwater COCs at the Site do not exceed the corresponding UCLs.

In summary, no UCL exceedances were noted at the Site. The portion of the Little River within the Site where sheens have been observed will be addressed for public welfare impacts as part of ongoing assessment activities.

1.3.4 Risks to the Environment

The Site is less than two acres, and there is no contaminant transport from surficial soil to an ACEC. Therefore, the potential for significant risk to terrestrial receptors can be screened out in accordance with the MassDEP (1996) guidance.

Other than sporadic sheen observed in certain area of the river, COCs from Site releases have not been detected in surface water in the Little River under the current conditions. For the future conditions, GZA compared surface water concentrations estimated from groundwater concentrations at the Site; and the estimated surface water concentrations do not exceed benchmark values with the exception of cyanide, benzene, and ethylbenzene. The estimated surface water concentrations for cyanide, benzene, and ethylbenzene (which were based on the conservative default attenuation factors) were above the conservative set of GZA identified water quality benchmark values (0.021 mg/L vs. 0.0052 mg/L for cyanide, 0.16 mg/L vs. 0.11 mg/L for benzene, and 0.047 mg/L vs. 0.014 mg/L for ethylbenzene, respectively)[1]. However, cyanide, benzene, and ethylbenzene were not detected in surface water at the Site. Further, the estimated surface water concentrations for benzene and ethylbenzene do not exceed the MassDEP (2019) established target surface

[1] The benchmark for cyanide is from USEPA (2022) National Recommended Water Quality Criteria. The benchmarks for benzene and ethylbenzene are from a compilation of ecological screening benchmarks from U.S. EPA Region 5, available at https://archive.epa.gov/region5/waste/cars/web/pdf/ecological-screening-levels-200308.pdf.

water concentrations (0.16 mg/L vs. 0.46 mg/L for benzene and 0.047 mg/L vs. 0.181 mg/L for ethylbenzene, respectively). A condition of no significant risk of harm to surface water by groundwater discharge exists at the Site under the current and future uses. River areas with sheens observed will be further evaluated for environmental risk.

Risks to the environment posed by sediment and surface water at the Site are included in Appendix C of the Phase II report.

2.0 HAZARD IDENTIFICATION

Identifying hazards involves summarizing the nature and extent of constituents at the Site and identifying COCs to be carried through the quantitative risk characterization. In addition, this Section summarizes the data used in the risk characterization, soil and groundwater classification, and sources of toxicity profiles for COCs.

2.1 DATA USED IN RISK CHARACTERIZATION

The soil analytical results used in this risk characterization are presented in Table D-2 and summarized in Table D-3. The groundwater analytical results used in this risk characterization are included in Table D-4 and summarized in Table D-5. The sediment analytical results used in this risk characterization are included in Table D-6; and the surface water analytical results are listed in Table D-7. The soil gas data are included in Table D-8.

In general, data were selected for inclusion in the risk characterization to provide a conservative estimate of potential risks to the receptors. Some Site-specific considerations are presented below:

- Multiple soil samples including B-3 15-17', EN, V-1B-15.0'-17.5', ENV-11B-15.0'-17.5', ENV-12B-15.0'-17.5', ENV-13B-17.5'-20.0', NFSB-01 15-16', NFSB-01 16-20', NFSB-02 15-20' and field duplicate NFSB-02 15-20' FD (DUP-1), and NFSB-03 15-17' and field duplicate NFSB-03 15-17' FD (DUP-2) were collected deeper than 15 feet bgs. The results of these above referenced samples (grey-highlighted in Table D-2) were not used to calculate soil exposure point concentrations (EPCs) for human health risk characterization as the associated soil was considered isolated per MCP (310 CMR 40.0933(4)(c)3). The results, however, were included for the arithmetic mean calculation for UCL comparison purposes.

- Multiple field duplicate pairs of soil samples were collected from the Site. The average concentrations of the duplicates were calculated to represent the results for each field duplicate pair; and the average concentrations were subsequently used to derive the soil EPCs. When an analyte was detected in at least one sample, half of the laboratory reporting limit (RL) was used for any non-detected result when calculating the average.

- Laboratory duplicate analysis was performed for NFSB-03 15-17'. The average concentrations of analytes in the sample and the laboratory duplicate were calculated and used to represent the results for NFSB-03 15-17'. The average results (of the sample and the laboratory duplicate) were then used to calculate the average of NFSB-03 15-17' and its field duplicate (i.e., NFSB-03 15-17' FD (DUP-2)), as described in the preceding bullet.

- For the soil samples collected in October 2016, the total petroleum hydrocarbon (TPH; C9-C44) results reported in the fingerprinting analysis were conservatively assumed to be C_{11}-C_{22} aromatics results. In addition, the benzo(j)fluoranthene/benzo(k)fluoranthene results were treated as the benzo(k)fluoranthene results; while the dibenzo(a,h)anthracene/dibenzo(a,c)anthracene results were treated as the dibenzo(a,h)anthracene results.

- As described earlier, direct contact exposure to groundwater was deemed a complete pathway only for the former holder area. The direct contact exposure to groundwater was not deemed a complete pathway outside of the former holder. As a result, groundwater EPCs for direct contact were derived only for the former holder area. Groundwater

data were identified to calculate the average concentrations among all the monitoring wells for UCL comparison purposes. For each monitoring well, data representative of the current conditions were identified. The 2014 or 2015 groundwater data were not considered representative of the current conditions unless there were no post-2015 data available for the monitoring wells. The gray-highlighted results in Table D-4 were deemed not representative of the current conditions and were consequently not included in the calculation of the groundwater EPCs or average concentrations for UCL comparison. The non-highlighted and green-highlighted results in Table D-4 were deemed representative of the current groundwater conditions.

- No target analyte was detected in the groundwater sample collected from GZA-2. Relatively minor levels of multiple target analytes were detected in the groundwater samples collected from GZA-1 and GZA-1A. GZA1, GZA-1A, and GZA-2 were either at or outside the disposal site boundary. The associated GZA-1, GZA-1A, and GZA-2 results (yellow-highlighted in Table D-4) were not included in the derivation of average groundwater concentrations for UCL comparison and for evaluation of potential impacts to downgradient surface water.

- For monitoring wells with multiple rounds of groundwater samples (i.e., green-highlighted in Table D-4), temporal averages were calculated and were used to represent analyte concentrations in the monitoring wells. If the analyte was not detected during any sampling round, the temporal average was presented as a non-detect and the lowest RL was used to represent the RL for the temporal average. When the analyte was detected in at least one round, half the RL was used for any non-detect for the temporal average calculation.

- All sediment and surface water data were evaluated in this risk characterization. Surface water was not identified as a significant medium of concern for human health risk characterization and therefore a quantitative risk evaluation was not performed based on surface water data. All sediment data were used to derive sediment EPCs for the human health risk characterization.

- Available soil gas data were included in this risk characterization to evaluate risks via the potential vapor intrusion pathway. Two field duplicate pairs of soil gas samples were collected from the Site. The average concentrations of the duplicates were calculated to represent the results for the field duplicate pair; and the average concentrations were subsequently used to derive the soil gas EPCs.

- Both the Extractable Petroleum Hydrocarbon (EPH) method and the Volatile Petroleum Hydrocarbon (VPH) method provide results for naphthalene. If naphthalene was reported by multiple analytical methods for the same sample, the maximum concentration detected among the multiple analytical methods was used to represent the naphthalene concentration for the sample. If naphthalene was not detected by either method, the minimum RL was used as the RL for the non-detected result.

- M&p-xylene and o-xylene were reported for soil, groundwater, sediment, surface water, and soil gas samples. Total xylene was included as a COC in the risk characterization[2]; and total xylene was calculated as the sum of the m/p-xylene and o-xylene results. If neither m&p-xylene nor o-xylene was detected, the lowest RL of m/p-xylene and o-xylene was used to represent the RL of total xylene. If either m&p-xylene or o-xylene was detected, the sum of the m/p-xylene and o-xylene results was used to represent the total xylene result and half RL for the non-detect (if any) was used for the summation.

- One-half of the RL was typically used for a non-detect result in calculating the average in the risk characterization for an analyte that was detected in at least one sample.

[2] M&p-xylene or o-xylene was not detected in the surface water samples; as a result, total xylene was not identified as a COC for surface water.

In summary, the soil data set used in this risk characterization includes 43[3] samples for the EPC derivation for human health risk characterization. In addition, 13[4] soil samples were included for the UCL comparison, along with the 43 samples used for soil EPC derivation. The soil analytical results are presented in Table D-2 and summarized in Table D-3.

The groundwater data set included in this risk characterization for the EPC derivation for human health risk characterization includes one representative sample collected from MW-1. The groundwater data set included in this risk characterization for the UCL comparison and environmental risk characterization includes 20 representative samples collected from 11 monitoring wells. The groundwater analytical results are presented in Table D-4 and summarized in Table D-5.

The sediment data set included in this risk characterization for the EPC derivation includes 15 samples collected from the Site in June 2020 (Table D-6A) and 30 samples collected from the Site in September 2021 (Table D-6B).

The surface water data set evaluated in this risk characterization includes two samples collected from the Little River in June 2020. The surface water analytical results are presented in Table D-7.

The soil gas data set included in this risk characterization for the EPC derivation includes 14[5] samples collected during two sampling events (October 2016 and February 2020). The soil gas analytical results are presented in Table D-8.

2.2 SOIL AND GROUNDWATER CLASSIFICATION

2.2.1 Soil Classification

As defined in the MCP (40.0933(4)(c)), soils located from 0 to 3 feet bgs in unpaved areas are considered accessible, soils located from 3 to 15 feet bgs in unpaved areas and from 0 to 15 feet bgs in paved areas are considered potentially accessible, and soils located greater than 15 feet bgs or beneath a building or permanent structure are considered isolated.

The MCP identifies three soil categories (S-1, S-2, and S-3) to describe the potential for contact with soil at a site. Category S-1 soils represent the highest potential for exposure (such as unrestricted residential exposure to soil), while category S-3 soils represent the lowest potential for exposure. The potential for exposure to constituents of concern in soil is determined through a qualitative analysis that considers both the accessibility of soil (i.e., accessible, potentially accessible, or isolated) and the frequency and intensity of potential exposure (low or high).

Under the current use scenario, children may be present at low frequency and low intensity; adults may be present at high frequency and low intensity (facility workers), low frequency and low intensity (customers, Site visitors, and trespassers), or low frequency and high intensity (emergency/utility workers, construction workers, and landscapers). Based on the soil category selection matrix contained in the MCP (310 CMR 40.0933(9)), accessible soil is classified as S-2 and potentially accessible soil and isolated soil are classified as S-3 under the current use scenario.

2.2.2 Groundwater Classification

Research completed by GZA indicates that groundwater at the Site is not located in a current or potential drinking water source area and does not meet the MCP criteria (310 CMR 40.0932(4)) for groundwater classification as category GW-1. It was confirmed that the site is:

[3] The field duplicated samples were counted as individual samples.
[4] The field duplicated samples were counted as individual samples while the laboratory duplicate was not counted as an additional sample.
[5] The field duplicated samples were counted as individual samples.

- Not within a Zone II[6] or interim wellhead protection area (IWPA);[7]
- Not within the Zone A[8] of a class a surface water body;
- Not above a medium-yield or high-yield potentially productive aquifer which may be used for potable water supply;
- Not within 500 feet of a private water supply well used for potable purposes; and
- Within 500 feet of a public water supply distribution pipeline.

There are no private drinking water wells within 500 feet of the Site, and the Site is not located within 400 feet of a Class A surface water body; therefore, contact with constituents in groundwater through drinking water supplies is not a potential exposure pathway at the Site.

Groundwater depth generally ranges between 12 and 15 feet bgs at the Site, with the exception of the former holder area in the south-central portion of the Site. The groundwater depth measured at MW-1 and B107 within the old holder area is approximately 3 feet bgs. Groundwater within 30 feet of the occupied buildings at the Site (the gasoline station kiosk and the car wash building) is classified as GW-2. The GW-2 classification indicates the potential for volatile constituents in groundwater to migrate into the indoor air of buildings but does not indicate that such migration has occurred.

According to the MCP (310 CMR 40.0932(2)), groundwater at all sites is considered to be a potential source of discharge to surface water and therefore is classified as GW-3.

2.3 SOIL ANALYTICAL RESULTS[9]

Soil samples collected from the Site were analyzed for VPH and target analytes, EPH and target analytes, Physiologically Available Cyanide (PAC), metals including arsenic, chromium, and lead, and alkylated polycyclic aromatic hydrocarbon (PAHs) and geochemical biomarkers. The soil analytical results are presented in Table D-2 and summarized in Table D-3.

All VPH target analytes but methyl tert butyl ether (MTBE) were detected in one or more soil samples collected from the Site. The maximum concentrations of benzene and toluene (190 mg/kg[10] and 230 mg/kg, respectively) were detected at B-1 (10-12' bgs). Ethylbenzene was most frequently detected; and was detected in 13 out of 20 samples. The maximum ethylbenzene concentration of 268 mg/kg was detected at ENV-3B (12.5'-15.0' bgs). The maximum total xylene concentration of 332 mg/kg was detected at ENV-13B (17.5'-20.0').

All three EPH fractions were detected in soil samples collected from the Site. The maximum concentrations of the C_9-C_{18} aliphatics and C_{19}-C_{36} aliphatics fractions (13,300 mg/kg and 2,020 mg/kg, respectively) were detected at ENV-12B (15.0'-

[6] Zone II means the area of an aquifer that contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated, as approved by MassDEP's Division of Water Supply, pursuant to 310 CMR 22.00.
[7] IWPA means: (1) with respect to public water supply wells and wellfields whose pumping rate is 100,000 gallons per day or greater and for which MassDEP has not approved a hydrologically delineated Zone II, the 1/2-mile radius surrounding such a well or wellfield; and (2) with respect to public water supply wells and wellfields whose pumping rate is less than 100,000 gallons per day and for which MassDEP has not approved a hydrologically delineated Zone II, the radius calculated by multiplying the maximum pumping rate in gallons per minute for such a well or wellfield by 32 and adding 400 feet thereto.
[8] Zone A means the area within 400 feet laterally from the bank of a Class A surface drinking water source (as identified in 314 CMR 4.00) or within 200 feet of its tributaries.
[9] Unless otherwise specified, the field duplicate pair of samples was counted as one sample. Further, laboratory duplicate results were not counted separately.
[10] Milligram per kilogram, or parts per million (ppm).

17.5'); while the maximum concentration of the C_{11}-C_{22} aromatic fraction (52,500 mg/kg)[11] was detected at NFSB-02 (12-15').

All three VPH fractions were detected in soil samples collected from the Site. The maximum concentrations of the C_9-C_{10} aromatics, C_5-C_8 aliphatics, and C_9-C_{12} aliphatics fractions (3,530 mg/kg, 609 mg/kg, and 2,730 mg/kg, respectively) were detected at ENV-3B (12.5'-15.0'), B-107 S-4 (5'-7'), and ENV-9B (12.5'-15.0'), respectively.

Seventeen PAHs were detected in soil samples at concentrations up to 2,910 mg/kg (naphthalene at ENV-3B (12.5'-15.0')). Benzo(a)pyrene, the predominant risk driver among the PAHs, was detected in 32 out of 36 soil samples; and the maximum concentration (110 mg/kg) was detected at B-1 (10-12').

Arsenic, chromium, and lead were detected in all eight soil samples submitted for analysis. The arsenic concentrations detected at the Site were below the MassDEP (2002c) proposed background level for natural soil (i.e., 20 mg/kg). The maximum chromium and lead concentrations (40 mg/kg and 205 mg/kg) were detected in sample B-103 S-1 (0'-3').

PAC was detected in all eight soil samples submitted for analysis. The maximum PAC concentration (2,910 mg/kg) was detected in sample B-108 S-2 (1'-3').

Multiple alkylated PAHs and geochemical biomarkers were detected in soil samples at concentrations up to 192 mg/kg (9/4-methylphenanthrene at NFSB-03 (15'-17')). The maximum concentrations of the alkylated PAHs and geochemical biomarkers were detected at NFSB-02 (12'-15'), NFSB-03 (15'-17'), or NFSB-09 (3'-4').

2.4 GROUNDWATER ANALYTICAL RESULTS[12]

Groundwater samples collected from the Site were analyzed for VPH and target analytes and EPH and target analytes. The groundwater data are presented in Table D-4 and summarized in Table D-5.

All VPH target analytes were detected in groundwater at the Site. Benzene was detected at 9 out of 11 monitoring wells and the maximum concentration (19,500 µg/L[13]) was detected in the sample collected from MW-1 in September 2020. The maximum concentration of toluene (4,060 µg/L) was detected in the sample collected from MW-1. The maximum concentrations of total xylenes, ethylbenzene, and MTBE (5,970 µg/L, 2,820 µg/L, and 120 µg/L) were the temporal average concentrations at B-102, ENV-3MW, and ENV-3MW, respectively.

Two EPH fractions (the C_9-C_{18} aliphatics and C_{11}-C_{22} aromatic fractions) were detected in groundwater at the Site. The maximum concentrations of the C_9-C_{18} aliphatics and C_{11}-C_{22} aromatic fractions (1,308 µg/L and 1,820 µg/L, respectively) were the temporal average concentrations for B-106 and ENV-5MW, respectively.

All three VPH fractions were detected in groundwater at the Site. The maximum concentrations of the C_9-C_{10} aromatics, C_5-C_8 aliphatics, and C_9-C_{12} aliphatics (16,067 µg/L, 1,515 µg/L and 7,600 µg/L) were the temporal average concentrations for B-102, ENV-8MW, and ENV-8MW, respectively..

Six EPH target analytes (2-methylnaphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and naphthalene) were detected in groundwater at the Site. Naphthalene and 2-methylnaphthalene were most frequently detected and were detected in 10 out 11 and 8 out of 11 monitoring wells, respectively. Acenaphthene, fluorene, and phenanthrene were only detected in one sample collected from B106 but were not detected in any of the other wells. Acenaphthylene was only detected in B106 and MW-1 but was not detected in any of the other wells.

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[11] The TPH result was conservatively assumed to be the C_{11}-C_{22} aromatic fraction result.

[12] Unless otherwise specified, the highlighted results in Table D-4 were not included in the discussion in this section. Note the green-highlighted results were included in the temporal average concentration calculations, which were included in the discussion in this section.

[13] Microgram per liter, or parts per billion (ppb).

2.5 SEDIMENT ANALYTICAL RESULTS

A total of 15 sediment samples were collected from the Little River in June 2020; and a total of 30[14] sediment samples were collected from the Little River in September 2021. Out of the 15 samples collected in June 2020, 11 samples were collected within top 6 inches of the sediment and the rest of the samples were collected at depths between 1 foot and 5.5 feet. Out of the 30 samples collected in September 2021, 15[15] samples were collected within top 6 inches of the sediment and the rest of the samples were collected at depths between 1 foot and 5.4 feet. The 2020 sediment samples were submitted for analyses of alkylated PAHs by 8270D-SIM[16], EPH and/or target analytes, VPH and/or target analytes, and cyanide[17]. The 2021 sediment samples were submitted for analyses of metals, alkylated PAHs by 8270D-SIM, EPH and/or target analytes, VPH and/or target analytes, and polychlorinated biphenyl (PCB) aroclors[18]. The sediment analytical results are presented in Table D-6A (2020 sample results) and Table D-6B (2021 sample results).

The C_5-C_8 aliphatics fraction was not detected in any sediment samples; while the other VPH fractions and all the EPH fractions were detected in one or more sediment samples collected from the Site. The maximum concentrations of the three EPH fractions (1,560 mg/kg, 851 mg/kg, and 3,320 mg/kg for the C_9-C_{18} aliphatics, C_{19}-C_{36} aliphatics, and C_{11}-C_{22} aromatic fractions, respectively) were detected at sediment location 2A (0-6). The maximum concentrations of the C_9-C_{12} aliphatics and C_9-C_{10} aromatics fractions (1,380 mg/kg and 971 mg/kg) were detected at locations 5A (2-3) and 4A (1-2.5), respectively.

Multiple PAHs (including alkylated PAHs) were detected in sediment at the Site at concentrations up to 1,320 mg/kg (naphthalene at 5A (2-3)). Multiple VOCs were detected in sediment at the Site at concentrations up to 257 mg/kg (total xylene at 5A (0-6)).

Three PCB aroclors (Aroclor 1242, Aroclor 1254, and Aroclor 1260) were detected in all the 2021 sediment samples submitted for PCB analysis. The maximum Aroclor 1242, Aroclor 1254, and Aroclor 1260 concentrations (0.769 mg/kg, 0.541 mg/kg, and 0.191 mg/kg, respectively) were detected in AQSS-05 (0-0.5 ft), AQSS-12B (0-0.5 ft), and AQSS-13B (0-0.5 ft), respectively. PCBs reported in river sediments do not appear to be related to releases associated with the 284 Winter Street Site.

Metals including arsenic, barium, cadmium, chromium, copper, lead, mercury, and selenium were detected in one or more sediment samples collected in 2021. The maximum arsenic concentrations were detected in the field duplicate pair collected from AQSS-10 (0-0.5 ft) at 72 mg/kg and 74.6 mg/kg. The maximum lead concentration (397 mg/kg) was detected in the sample collected from AQSS-13B (0-0.5 ft).

Cyanide was not detected in any sediment samples submitted for the analysis.

2.6 SURFACE WATER ANALYTICAL RESULTS

Two surface water samples were collected from the Little River in June 2020, one from upstream and the other downstream of the Site. The samples were analyzed for VPH and target analytes, EPH and target analytes, and cyanide. No analyte was detected in either sample. The surface water analytical results are included in Table D-7.

[14] Including two pairs of field duplicates.

[15] Including two pairs of field duplicates.

[16] Selected Ion Monitoring.

[17] The samples were submitted for one or more of the listed analyses.

[18] The samples were submitted for one or more of the listed analyses.

2.7 SOIL GAS ANALYTICAL RESULTS

A total of 14 soil gas samples were collected from the Site in 2016 and 2020 and submitted for VOC and/or Air-phase Petroleum Hydrocarbon (APH) analyses. The soil gas analytical results are presented in Table D-8.

Multiple VOCs were detected in the soil gas samples collected from the Site at concentrations up to 1,030 µg/m^3 (MTBE at NFSV-01). The maximum concentration of acrolein, the non-cancer risk driver for the indoor air pathway, 0.807 µg/m^3 was detected in the sample collected from NFSV-07 in October 2016. The maximum concentration of benzene, the cancer risk driver for the indoor air pathway, 545 µg/m^3 was the average concentration of the duplicate pair samples collected from location NFSV-05 in October 2016.

Two APH fractions, the C_5-C_8 aliphatics and C_9-C_{12} aliphatics fractions were detected in one or more soil gas samples collected from the Site. The maximum concentrations of the C_5-C_8 aliphatics and C_9-C_{12} aliphatics fractions (190 µg/m^3 and 3,400 µg/m^3) were detected at SG-2 in February 2020.

2.8 SELECTION OF CONSTITUENTS OF CONCERN

Constituents of concern are those constituents that are both identified at a disposal site and associated with a release of OHM. Unless specific justification can be provided for eliminating a constituent from the risk characterization, all constituents detected in soil and groundwater were included as COCs, and were carried through the risk characterization process. With the exception of the constituents discussed below, all constituents detected in impacted media were included as COCs and included in this risk characterization.

2.8.1 Background

Constituents may be eliminated from the list of COCs if they are present at levels that are consistent with "background" concentrations for the area and there is no evidence that these constituents are related to activities at the disposal site. The arsenic concentrations detected at the Site were consistent with the MassDEP (2002c) established background level; and there is no evidence that arsenic is related to any release or activities at the Site. As a result, arsenic was excluded as a soil COC based on background comparison.

No other constituents were excluded based on background comparison.

2.8.2 Xylenes

M&p-xylene and/or o-xylene was detected in soil, groundwater, sediment, and soil gas samples collected from the Site. Total xylenes, calculated as the sum of m&p-xylene and o-xylene, was identified as a COC for soil, groundwater, sediment, and soil gas.

2.8.3 Total Petroleum Hydrocarbon

The soil samples collected in October 2016 were submitted for fingerprinting analysis and TPH (C9-C44) was detected in the samples. TPH was not included as a soil COC in this risk characterization; and the TPH results were conservatively assumed to be C_{11}-C_{22} aromatics results.

2.8.4 C_9-C_{12} Aliphatics Hydrocarbon and C_9-C_{18} Aliphatics Hydrocarbon

Soil, groundwater, and sediment samples were analyzed via both the MassDEP EPH and VPH methods. The EPH method reports results for C_9-C_{18} aliphatic hydrocarbons and the VPH method reports results for C_9-C_{12} aliphatic hydrocarbons. Soil gas samples were analyzed via the APH method, which reports results for C_9-C_{12} aliphatic hydrocarbons. GZA has retained the C_9-C_{18} aliphatic hydrocarbon fraction as a COC to avoid redundancy and has adopted the higher of the concentrations reported for the two fractions as the EPCs for the COC.

2.8.5 Ancillary PAHs and VOCs

One objective of the laboratory analyses of the 2016 soil samples was to fingerprint potential sources for the OHM at the Site. In addition to the list of the compounds that are included in the MassDEP VPH/EPH methods that are typically used to characterize releases under the MCP, the fingerprinting analyses included several ancillary compounds. Specifically, alkylated PAHs and geochemical biomarkers including benzo(e)pyrene, perylene, cis/trans-decalin, benzothiophene, retene, dibenzothiophene, benzo(b)fluorene, benzo(a)fluoranthene, 4-methyldibenzothiophene, 2/3-methyldibenzothiophene, 1-methyldibenzothiophene, 3-methylphenanthrene, 2-methylanthracene, 9/4-methylphenanthrene, 1-methylphenanthrene, hopane, and moretane were reported in one or more soil samples collected from the Site. In addition, alkylated PAHs including benzo(e)pyrene, perylene, benzo(j+k)fluoranthene, dibenz(ah)+(ac)anthracene, c1-chrysenes, c2-chrysenes, c3-chrysenes, c4-chrysenes, c1-fluorenes, c2-fluorenes, c3-fluorenes, c1-naphthalenes, c2-naphthalenes, c3-naphthalenes, c4-naphthalenes, c1-phenanthrenes/anthracenes, c2-phenanthrenes/anthracenes, c3-phenanthrenes/anthracenes, c4-phenanthrenes/anthracenes, and c1-fluoranthenes/pyrenes were reported in one or more sediment samples collected from the Site. Some of the above referenced analytes (e.g., c1-chrysenes) represent groups of compounds. Further, certain ancillary VOCs (i.e., thiophene, 3-methylthiophene, octane, decane, indane, indene, undecane, 1,2,4,5-tetramethylbenzene, dodecane, and benzothiophene) were reported in soil gas data collected in 2016.

Toxicity values for these ancillary constituents are not available. However, the fingerprinting analysis concluded that the OHM present at the Site represented mixed sources associated with former MGP and current gas station operations (i.e. coal tar, gasoline, and diesel/#2 fuel oil). Such sources can be characterized by the compounds included in the EPH and VPH analyte lists without the ancillary compounds that were included for fingerprinting purposes, and the associated risks can be adequately addressed by evaluating risks via exposure to EPH, VPH, and their target analytes. Therefore, these ancillary constituents were not quantitatively evaluated in this risk characterization.

2.8.6 Sediment COCs

Multiple metals and PCB aroclors were detected in the sediment samples collected in 2021. Note that the primary metals associated with MGP residuals (arsenic, chromium and lead) were not found above typical urban background levels in soil samples from the Site. Accordingly, metals in sediments were not identified as COCs for the human health risk characterization. . There is no indication of PCB usage at the 284 Winter Street property based on historical records. Additionally, it is GZA's understanding that PCBs have been reported in sediments from locations in the Little River upstream of the 284 Winter Street Site and likely represent a regional condition. PCBs or metals detected in sediment were not included as sediment COCs in the human health risk characterization.

All other constituents detected in the representative soil, groundwater, soil gas, and sediment samples collected from the Site were included as COCs.

A list of the COCs identified for soil, groundwater, soil gas, and sediment at the Site is presented in Table D-9. The COCs identified for the Site include VOCs, semi-volatile organic compounds (SVOCs), cyanide, chromium, lead[19], and VPH/EPH fractions.

2.9 TOXICITY PROFILES

The COCs identified at the Site include VOCs, SVOCs, and VPH/EPH fractions. Toxicity profiles for these COCs, with the exception of petroleum hydrocarbon fractions (i.e., VPH and EPH fractions) which do not have specific USEPA toxicity profiles, are available on the following web site: http://rais.ornl.gov/tools/tox_profiles.html. Toxicity information for

[19] Chromium and lead were conservatively included as soil COCs because the maximum reported concentrations exceeded the natural soil background concentrations published by MassDEP (2002c). The maximum concentrations of chromium and lead in soil were equal to or less than the background values for fill containing coal ash or wood ash.

petroleum hydrocarbon fractions is available in the MassDEP (2002d) "Characterizing Risks Posed by Petroleum Contaminated Sites: Implementation of the MADEP VPH/EPH Approach". The profiles provide summaries of mechanisms of toxic action, acute and chronic non-cancer effects, and potential cancer effects from human and animal studies, as well as data on constituent and physical properties and transport and fate processes. These profiles provide general information and do not necessarily directly relate to potential effects associated with exposures to the constituents identified at the Site.

3.0 EXPOSURE ASSESSMENT

The purpose of the exposure assessment is to provide an estimate of the amount of COCs that a human receptor may contact at the Site over a period of time. The exposure assessment identifies potential human receptors and exposure pathways (Section 3.1); delineates potential exposure points and estimates exposure point concentrations (Section 3.2); and estimates potential doses of COCs to human receptors (Section 3.3).

3.1 POTENTIAL HUMAN RECEPTORS AND EXPOSURE PATHWAYS

For each identified receptor at each exposure point, complete or potentially complete exposure pathways[20] were identified based on activities and uses of the Site and the presence of COCs in environmental media. Exposure scenarios evaluated for the Site include:

- On-Site facility workers were assumed to contact soils via dermal contact, incidental ingestion, and inhalation of soil-derived fugitive dust. In addition, facility workers were assumed to inhale indoor air potentially impacted by soil gas via the vapor intrusion pathway.

- Two groups of construction workers were evaluated in this risk characterization – (1) construction workers working within the former folder area and (2) construction workers working outside the former folder area. Construction workers were assumed to encounter soil via dermal contact, incidental ingestion, and inhalation of soil-derived fugitive dust. Construction workers working within the former relief holder area were also assumed to contact groundwater and inhale VOCs in a utility trench[21].

- Trespassers were assumed to contact soils at the Site via dermal contact, incidental ingestion, and inhalation of soil-derived fugitive dust. In addition, trespassers were assumed to contact sediment at the Site via dermal contact and incidental ingestion.

The AUL for the Site will prohibit residential use at the Property and the off-Property portions of the Site are within the Little River or its adjacent bank and resource area. Therefore, residents were not identified as potential receptors at the Site. The AUL will also prohibit growing produce intended for human consumption in Property soil; therefore, the homegrown produce consumption exposure pathway was not considered a complete exposure pathway and was not included in this risk characterization.

Exposure to groundwater (either via dermal contact or via inhalation of ambient air in a utility trench) by construction workers was not deemed a complete exposure pathway beyond the limits of the former relief holder as groundwater depth is generally greater than 10 feet in this area. Risk to construction workers via dermal contact with groundwater beyond the limits of the former relief holder will be mitigated by the AUL, which will require a health and safety plan for construction work at the Site. Consequently risks via exposure to groundwater via dermal contact were only evaluated for construction workers working within the former holder area; while risks via exposure to groundwater were not

[20] A complete exposure pathway consists of the following elements: a source and mechanism of constituent release; a retention or transport medium; a point of potential human contact (exposure point); and an exposure route (e.g., dermal contact, ingestion, or inhalation).
[21] The groundwater data were conservatively used to represent trench air quality for this exposure scenario.

quantitatively evaluated for construction workers working outside the former relief holder area in this risk characterization.

Exposure to surface water at the Site by potential receptors such as trespassers via dermal contact was not quantitatively evaluated in this risk characterization. No petroleum hydrocarbon constituents or cyanide were detected in the surface water samples collected from the river. In addition, the primary area where sheens have been observed is demarcated by boom systems that serve as a visual marker to limit access. Additionally, the River is not easily accessible from the surrounding areas and accessing the portion within the Site would pose significant physical risks to trespassers, which would likely outweigh marginal risks associated with potential exposure to Site COCs in surface water.

Site visitors (trespassers) could potentially be exposed to indoor air impacted by the vapor intrusion pathway. Risks for these groups were not quantitatively evaluated in this risk characterization. The risk estimates for facility workers were used as upper risk limits for these groups.

Risk estimates were not calculated for other potential receptors that would be expected to have less exposure than the receptors evaluated. For example, emergency/utility workers were not evaluated since they are not expected to have more exposure than construction workers. If a condition of no significant risk is shown to exist for construction workers, a condition of no significant risk also exists for emergency/utility workers.

3.2 EXPOSURE POINT AND EXPOSURE POINT CONCENTRATION IDENTIFICATION

For receptors to be exposed to constituents at the Site, a realistic exposure pathway must be established leading from the source to the receptor. The point at which the contact occurs is referred to as the exposure point. The potential exposure points for the Site are described below and were identified based on the presence of COCs in environmental media according to the soil and groundwater categories presented in Sections 2.21 and 2.22.

EPCs provide an estimate of the COC concentrations that a receptor can potentially contact at an exposure point over the period of exposure. To evaluate potential future exposures, it was assumed that no further remedial actions would be taken and that levels of contamination currently existing at the Site would remain the same in the future. The EPCs for each exposure medium are summarized below and in Table D-10.

3.2.1 Soil Exposure Points and Exposure Point Concentrations

The MCP states that the following depths should be considered in identifying exposure points for the following types of activities (310 CMR 40.0924(2)(b)(4)):

- 0 to 3 feet: surficial activity
- 0 to 6 feet: utility installation and repair
- 0 to 15 feet: excavation and building construction

The Site is either occupied by the buildings or paved, with limited landscape area. Soil in the top 3 feet within unpaved area is accessible by receptors such as landscapers and trespassers. Emergency utility workers would be assumed to contact soil from 0 to 6 feet. Construction workers would be assumed to contact soil from 0 to 15 feet[22]. Future disturbances of soil could result in all of the top 15 feet of soil becoming accessible.

[22] It should be noted that the AUL proposed for the Site require a health and safety plan for construction work at the Site. Therefore, with the AUL in place, exposure to residual OHM in soil at the Site would be limited for construction workers. Nonetheless, as a conservative approach, exposure to soil by construction workers was deemed a complete exposure pathway in this risk characterization.

GZA constructed three sets of soil EPCs for this risk characterization:

1. the Sitewide soil EPCs for facility workers and trespassers;

2. the soil EPCs for area within the former relief holder area for construction workers; and

3. the soil EPCs for area outside the former relief holder area for construction workers.

The soil EPCs for area within the former relief holder area for construction workers were based on the arithmetic mean concentrations of the analytical results for soil samples B-1 10-12', B-107 S-4, B-107 S-4 and S-5, and B-107 S-2.

The Sitewide soil EPCs were based on all representative soil samples collected within top 15 feet of soil. GZA constructed one set of Sitewide soil EPCs for facility workers and trespassers. The Sitewide soil EPCs use the highest values that represent the conditions at the below three exposure points:

- Surface soil (0-3 ft). Arithmetic means of the soil samples collected within top 3 feet soil from the Site were used to represent the top 3 feet soil condition.

- Surface soil and subsurface soil (0-6 ft). Arithmetic means of the soil samples collected within top 6 feet soil from the Site were used to represent the top 6 feet soil condition.

- Surface and subsurface soil (0-15 ft). Arithmetic means of the soil samples collected within top 15 feet soil from the Site were used to represent the top 15 feet soil condition.

As the top 15 feet of soil is most impacted, the arithmetic means of the soil samples collected within top 15 feet soil from the Site were used as the Site-wide soil EPCs for all soil COCs but benzo(k)fluoranthene, carbazole, and dibenzofuran. For benzo(k)fluoranthene, carbazole, and dibenzofuran, the arithmetic mean concentrations of the soil samples collected within the top 6 feet of soil were the highest among the three exposure points (0-3 ft, 0-6 ft, and 0-15 ft) and were used as the Site-wide soil EPCs for these compounds as a conservative approach.

The soil EPCs outside the former relief holder area were constructed similarly as the Site-wide soil EPCs except that the soil samples B-1 10-12', B-107 S-4, B-107 S-4 and S-5, and B-107 S-2 were not included in the EPC derivation.

It should be noted that the constructed Site-wide soil EPCs for facility workers and trespassers and the soil EPCs outside the former relief holder area for construction workers represent a conservative approach to evaluate risks. The constructed EPCs do not represent actual EPCs for identified receptors, but rather represent the highest EPC for each constituent among the three potential exposure points (i.e., 0 to 3 feet, 0 to 6 feet, and 0 to 15 feet). Accordingly, the constructed EPCs were only used as a screening tool for the risk characterization. Since the constructed EPCs resulted in a conclusion of no significant risk, this conclusion was adopted without further analyses.

The soil data set for the Site was evaluated to assess whether "hot spots" of contamination, as defined in 310 CMR 40.0006, exist. The maximum concentration for each COC was compared to the average concentration for the same constituent with the maximum concentration excluded. The maximum concentrations of benzene and toluene (190 mg/kg and 230 mg/kg) were detected at B-1 (10-12' bgs). The maximum concentrations were below the applicable Method 1 Soil Standards (S3/GW-2 is 400 mg/kg and S3/GW-3 is 1,000 mg/kg for benzene; and S3/GW-2 is 2,000 mg/kg and S3/GW-3 is 3,000 mg/kg for toluene). In accordance with the MassDEP (1995) guidance[23], B-1 (10-12' bgs) was not identified as a hot spot due to the detection of benzene and toluene.

[23] As specified in the MassDEP (1995) guidance, "*In no case shall concentrations of oil or hazardous material equal to or less than an applicable Method 1 standard be considered indicative of a hot spot.*"

For the rest of the detected constituents, the maximum concentrations of a number of constituents were detected at more than 10 times, but not more than 100 times, the average concentrations. Furthermore, there is no evidence that the locations at which the maximum concentrations were detected would be associated with greater exposure under the current and foreseeable future land uses; therefore, GZA did not identify any hot spots at the Site.

3.2.2 Soil-Borne Fugitive Dust Exposure Points and Exposure Point Concentrations

Based on the accessibility of soils discussed in Section 3.21, the identified soil exposure point may also be the source of airborne fugitive dust.

Air-borne fugitive dust EPCs were calculated using the soil EPCs, according to the following equation:

$$EPC_{dust} = EPC_{soil} \times PM10 \times C1$$

Where:

EPC_{soil} = exposure point concentration in soil (mg/kg)

PM10 = concentration in air (mg/m^3) of particulate matter with an aerodynamic diameter of less than 10 micrometers, and

C1 = unit conversion factor (1×10^{-6} kg/mg).

For facility workers and trespassers, a PM10 for an open field scenario (0.032 mg/m^3) was used to calculate the fugitive dust concentration of each COC, and for construction workers, a PM10 for an excavation scenario (0.06 mg/m^3) was used. These PM10 values were obtained from the MassDEP (1995) guidance.

3.2.3 Groundwater Exposure Points and Exposure Point Concentrations

Groundwater is more than 10 feet bgs at the Site, except within the former relief holder where groundwater is perched at 3-5 feet bgs. Emergency/utility workers and construction workers could contact groundwater within the holder area but would not be expected to encounter groundwater elsewhere at the Site. The AUL contemplated for the Property will require vapor monitoring and controls and health and safety protocols for construction work at the Site. As a result, exposure to groundwater via dermal contact is expected to be a complete exposure pathway only for the former relief holder area.

The groundwater EPCs were based on the representative analytical results for MW-1 (i.e., the analytical results of the groundwater sample collected from MW-1 on September 15, 2020). Styrene and cyanide were detected in other wells at the Site but were not analyzed for the samples collected from MW-1. As a conservative approach, styrene and cyanide were included as groundwater COCs for the human health risk evaluation and the maximum detected styrene and cyanide concentrations among the wells at the Site were used as the groundwater EPCs.

3.2.4 Ambient Air Exposure Points and Exposure Point Concentrations

Constituents detected in groundwater within the former relief holder area may volatilize into the air within a utility trench, so the ambient air of a utility trench is considered a potential exposure point for construction workers.

A box model was used to estimate the potential concentrations in ambient air based on the groundwater concentrations detected within the former relief holder area. The ambient air model estimations are presented in Attachment I, Table I-1.

3.2.5 Indoor Air Exposure Points and Exposure Point Concentrations

Indoor air could be potentially impacted by VOCs in soil and groundwater at the Site, so indoor air was identified as a potential exposure point. Indoor air EPCs were estimated by multiplying a default attenuation factor of 0.014 (i.e., inverse of 70) by average soil gas concentrations for all COCs but acrolein and 1,1,2-trichloro-1,2,2-trifluoroethane. For acrolein and 1,1,2-trichloro-1,2,2-trifluoroethane, the maximum detected soil gas concentrations were used to calculate the indoor air EPCs. The default attenuation factor was proposed in the MassDEP (2016) Vapor Intrusion Guidance: Site Assessment, Mitigation and Closure.

3.2.6 Sediment Exposure Points and Exposure Point Concentrations

Although located in an industrial/commercial area of Haverhill and not generally used for recreational purposes, access to the Little River in the vicinity of the Property is possible. Sediment was identified as a potential exposure point to trespassers (i.e., occasional receptors); and the maximum detected concentrations among the sediment samples collected within the top 1 foot were used as sediment EPCs as a conservative measure.

3.3 CALCULATING EXPOSURE DOSE

The exposure dose represents the amount of a COC an individual receptor may contact and take up into its body, and is a function of receptor-specific exposure assumptions and constituent-specific exposure parameters. Exposure doses were calculated as the daily amount of constituent taken into the body per unit body weight per unit time (mg/kg-day). The exposure doses were based on conservative exposure assumptions and factors developed in accordance with MassDEP (1995, 2002a, 2002b, 2008, 2014, and 2015) and USEPA (2011a) guidelines.

The general equation used to estimate Average Daily Dose (ADD) and Lifetime Average Daily Dose (LADD) is:

$$ADDor\ LADD = \frac{TotalAmountofOHM \rightleftarrows Contacted/Ingested \times \text{Re}lativeAbsorptionFactor}{BodyWeight \times AveragingPeriod}$$

For inhalation exposures, Average Daily Exposures (ADEs) and Lifetime Average Daily Exposures (LADEs) were calculated, instead of ADDs and LADDs, by normalizing vapor and dust EPCs with averaging times.

$$ADE\ or\ LADE = \frac{Time - WeightedExposureConcentrationforAirborneConstituents}{AveragingPeriod}$$

The specific equations used to calculate the ADDs, ADEs, LADEs, and LADDs for each exposure pathway are presented in Tables D-11 through D-13. These equations incorporate receptor-specific exposure variables and pathway-specific contact rates, along with constituent-specific media exposure point concentrations and relative absorption factors (RAFs) to estimate the constituent-specific doses or exposures for each receptor and pathway. The skin permeability coefficient (Kp), which is a key parameter in estimating the dermal absorption of constituents in water, is presented in Table D-14.

Subchronic ADDs and ADEs were calculated for the evaluation of non-cancer effects associated with short-term exposures (i.e., less than 10 percent of a lifetime, or seven years). Chronic ADDs and ADEs were calculated for the evaluation of non-cancer effects that occur over a time period greater than seven years, and LADDs or LADEs were estimated for evaluation of cancer effects.

The following sections describe the receptor-specific exposure assumptions and constituent-specific exposure variables used to calculate doses and exposures for the exposure scenarios.

3.3.1 Receptor-Specific Exposure Assumptions

Receptor-specific exposure assumptions incorporated in the equations used to calculate ADDs, ADEs, LADDs or LADEs include parameters such as body weight, skin surface area, soil ingestion rate, frequency of exposure, duration of the exposure event, duration of the exposure period, and averaging period. These exposure assumptions were based on MassDEP and USEPA default or recommended values, as well as site-specific information. Key exposure assumptions are discussed below.

3.3.1.1 Facility workers

GZA assumed that facility workers who work at the Site could be exposed to constituents in soil via dermal contact, incidental ingestion, and inhalation of soil-derived fugitive dust. Refer to Table D-11 for details on receptor-specific exposure assumptions.

Facility workers were assumed to work at the Site for 27 years (MassDEP, 2019). Facility workers were assumed to contact soil via skin contact and incidental ingestion four days per week for 30 weeks per year (MassDEP, 2019). GZA assumed that facility workers would be exposed to the entire dose of soil via incidental ingestion and dermal contact during each exposure event (i.e., an event is equal to one day) regardless of the exposure duration.

The dose for dermal contact was based on a soil dermal contact rate (DCR_{soil} = 90 mg/day) that incorporates skin surface areas and area-specific adherence factors. The skin surface area for the facility workers was based on the average for hands (826 cm^2), face (352 cm^2), forearms (1,035 cm^2), and feet (1,136 cm^2) for females between ages 18 and 45. The adherence factors for hands (0.0697 mg/cm^2 [24]), face (0.0058 mg/cm^2), forearms (0.0133 mg/cm^2), and feet (0.0149 mg/cm^2) were used for the facility worker scenario. The skin surface areas and adherence factors were obtained from a MassDEP technical update (MassDEP, 2002b) and are consistent with the values presented in the MassDEP (2019) Development of MCP Risk-Based Levels for Soil and Groundwater.

For the incidental ingestion of soil pathway, the sum of the adult soil ingestion rate of 50 mg/day (MassDEP, 2002a) and the incremental ingestion rate to account for ingestion of inhaled dust, calculated to be 0.3 mg/day, was used. The calculation of the incremental soil ingestion rate is presented in Attachment II in more detail.

Facility workers were assumed to be exposed to fugitive dust for eight hours during the workday. Additional details of exposure assumptions regarding the inhalation of fugitive dust pathway are provided in Table D-11.

For the indoor air exposure pathway, facility workers were assumed to work indoor for eight hours each day, 250 days each year during the 27-year period.

To normalize the dose to the facility workers based on their body size, an age specific body weight (68 kg) was used as the average weight for female representatives of this age group (MassDEP, 2019).

3.3.1.2 Construction Workers

GZA assumed that construction workers working at the Site (including construction workers working within the former relief holder area and construction workers working outside the former holder area) would be exposed to constituents in soil via dermal contact, incidental ingestion, and inhalation of soil-derived fugitive dust. In addition, construction workers working within the former relief holder area were assumed to be exposed to contaminants in groundwater via dermal contact and inhalation of ambient air. Refer to Table D-12 for details about receptor-specific exposure assumptions.

[24] Milligrams per square centimeter.

GZA assumed that construction workers would contact soil five days per week for six months of a year, and that workers would be exposed to the entire dose of soil via incidental ingestion and dermal contact during each exposure event regardless of the exposure duration.

For dermal contact exposures to soil, adherence factors by body part were used to calculate a weighted soil dermal contact rate (1,050 mg/day) for construction workers (MassDEP, 2002b). The DCR_{soil} is equivalent to the skin surface area multiplied by the adherence factor. The body parts assumed to be exposed included forearms (SA = 1,035 cm^2 and AF = 0.3279 mg/cm^2), hands (SA = 826 cm^2 and AF = 0.3487 mg/cm^2), face (SA = 352 cm^2 and AF = 0.1102 mg/cm^2), lower legs (SA = 2,223 cm^2 and AF = 0.0419 mg/cm^2), and feet (SA = 1,136 cm^2 and AF = 0.2563 mg/cm^2). The calculated DCR_{soil} (1,050 mg/day) was used to evaluate construction workers' exposure to soil through dermal contact. The skin surface areas and adherence factors were obtained from the MassDEP Technical Update (MassDEP, 2002b), and the calculated DCR_{soil} is consistent with the MassDEP (2019) Development of MCP Risk-Based Levels for Soil and Groundwater.

For the incidental ingestion of soil pathway, MassDEP believes that "it is reasonable to assume that a construction/utility worker incidentally ingests approximately the amount ingested by a child" (MassDEP, 2002a). Therefore, the MassDEP-recommended enhanced incidental soil ingestion rate is 100 mg/day.

The ADD and ADE associated with inhalation of fugitive dust by a construction worker were calculated consistent with the methodology presented in the MassDEP (2008) technical update.

Construction workers were assumed to be exposed via inhalation to volatile constituents in ambient air of a trench impacted by groundwater within the former holder area at the Site. GZA assumed that this exposure would occur every workday (five days per week) for two hours during a six-month construction project (MassDEP, 1995).

To normalize the dose to these receptors based on their body size, an age specific body weight (65 kg) was used as the average weight for female adults representative of this age group (i.e., ages 18-25 years; MassDEP, 2019). Additional information on exposure assumptions is provided in Table D-12.

3.3.1.3 Trespassers

GZA assumed that trespassers would contact constituents in soil and sediment at the Site via dermal contact, incidental ingestion, and inhalation of soil-derived dust. Refer to Table D-13 for details about receptor-specific exposure assumptions for this receptor group.

Children, ages 7 to 15 years, were assumed to be the most likely group to trespass, so the exposure period for this scenario was assumed to be eight years. Trespassers were assumed to visit the Site 31 times per year (1 day per week during the non-winter months of April through October).

The dermal contact and incidental ingestion exposure routes were assumed to be independent of the time spent at the Site during a given exposure event (e.g., a trespasser is assumed to incidentally ingest 50 milligrams of soil each day it visits the Site regardless of the time spent at the Site on any given day). Therefore, GZA used an exposure duration of one day per event for these pathways. An incremental ingestion rate to account for ingestion of inhaled dust was calculated to be 0.09 mg/day. The calculation is presented in Attachment II in more detail.

To calculate a DCR_{soil} for trespassers, adherence factors and skin surface areas were obtained from MassDEP (2002b) Technical Update, "Weighted Skin-Soil Adherence Factors". Soil adherence varies by body part, based on body part shapes and movement patterns. In this 2002 document, MassDEP reviewed literature that considered a number of different types of population groups (such as farmers, groundskeepers, etc.) performing different tasks to evaluate soil adherence to different parts of the body. MassDEP recommends adherence factors and skin surface areas for "Trespassers." The SA and AF for each body part along with the DCR_{soil} are presented in Table D-13.

Trespassers were also assumed to incidentally ingest 50 milligrams of sediment each day. In addition, trespassers were assumed to contact sediment by hands, forearms, and feet. The sediment adherence factor was assumed to be 1 mg/cm^2. The SA and AF for each body part along with the $DCR_{sediment}$ are presented in Table D-13.

To normalize the dose to trespassers based on their body size, an age-specific body weight (38 kg) was used as the average weight for female representatives of this age group (MassDEP, 1995).

4.0 DOSE-RESPONSE ASSESSMENT

The dose-response assessment describes the observed effects in humans and/or laboratory animals associated with particular exposures (or doses) of COCs. Toxicity information is used to quantitatively characterize the relationship between the dose of a constituent and the incidence of adverse health effects in an exposed population. Toxicity information was gathered from published literature describing epidemiologic or toxicologic studies involving a particular constituent. Dose-response information may be divided into three major categories: (1) toxicity information associated with threshold (non-cancer) health effects; (2) toxicity information concerning carcinogenicity, either from human epidemiologic data or from laboratory studies; and (3) the relative absorption factors used to relate the toxicity information identified from the literature to the exposure pathways of concern identified in this evaluation.

USEPA and MassDEP have published constituent-specific Reference Doses (RfDs) and Reference Concentrations (RfCs) for threshold health effects, and Cancer Slope Factors (CSFs) and Unit Risks (URs) for carcinogenic effects. The values were developed to assess exposures through the oral and inhalation routes, respectively. No values have been established for dermal contact exposures; however, it is standard practice to use values derived for the oral route, with an applied dermal relative absorption factor, to evaluate dermal contact exposures.

Toxicity values for the evaluation of potential exposures via the identified exposure routes were obtained from: (1) MassDEP (2019) Development of MCP Risk-Based Levels for Soil and Groundwater; (2) USEPA (2022a), Integrated Risk Information System (IRIS; an on-line database); (3) USEPA (2011b), *Health Effects Assessment Summary Tables* (HEAST); or (4) USEPA (2022c) Provisional Peer Reviewed Toxicity Value (PPRTV). These values are presented in Tables D-15 through D-17. The relative absorption factor (RAF) values are listed in Table D-18. Refer to Attachment III for additional information on the sources and uses of agency-derived toxicity factors.

5.0 HUMAN HEALTH RISK CHARACTERIZATION

To characterize human health risk, toxicity and exposure assessments were summarized and integrated into quantitative expressions of risk. To characterize potential non-carcinogenic effects, comparisons were made between estimated intakes of substances and toxicity values. To characterize potential carcinogenic effects, probabilities that an individual will develop cancer over a lifetime of exposure were evaluated from estimated intakes and chemical-specific dose-response information.

The purpose of the risk characterization is to present the numerical estimates of risk for each receptor and compare those estimates to risk management criteria which include MCP risk limits and public health standards. Specifically, to assess the risk of harm to human health posed by the site, GZA compared receptor non-cancer and cancer risks to: (1) a non-cancer risk limit which is an HI equal to one; and (2) a cancer risk limit which is an ELCR of one-in-one hundred thousand (1×10^{-5}). Additionally, an evaluation of applicable or suitably analogous public health standards was conducted. A condition of no significant risk of harm to human health is achieved if all risk estimates are less than or equal to the MCP risk limits and EPCs are less than or equal to the applicable health standards. Refer to attachment IV for a discussion of the risk calculations performed for the Site to generate non-cancer and cancer risk estimates.

5.1 RISK ESTIMATES

The estimated risks for each receptor group are summarized in Table D-1 for exposure to residual OHM at the Site. Pathway-specific risk-estimates were combined to yield non-cancer and cancer risk estimates for each receptor group.

As shown in Table D-1, the cumulative non-cancer and cancer risk estimates for the facility worker receptor group (HI = 0.44 and ELCR = 2.2×10^{-6}), the construction worker receptor group working outside the former relief holder area (HI = 0.18 and ELCR = 9.4×10^{-8}) and the trespasser receptor group (HI = 0.76 and ELCR = 3.0×10^{-6}) exposed to residual OHMs at the Site do not exceed the MCP risk limits.

The cumulative non-cancer risk estimate for the construction worker receptor group working within the former relief holder area (HI = 7.7) exceeds the MCP non-cancer risk limit of 1; while the cumulative cancer risk estimate for the construction worker receptor group working within the former relief holder area (ELCR = 1.6×10^{-6}) does not exceed the MCP cancer risk limit of 1×10^{-5}. Inhalation of ambient air in a utility trench impacted by groundwater is the risk driving pathway for the non-cancer risk estimate and benzene and naphthalene in groundwater are the predominant risk drivers. The non-cancer risk estimate without the ambient air inhalation pathway would be at the MCP risk limit. In summary, the residual OHMs in impacted media within the former relief holder area would pose significant risk to construction workers. It was assumed that the residual OHMs in impacted media within the former relief holder area would also pose significant risks to emergency/utility workers[25]. Emergency/utility workers were identified as current receptors at the Site. The elevated risks for emergency/utility workers would be mitigated by relocation of utility lines that currently run through the former holder area. Exposure to future construction workers would be mitigated by the proposed AUL which would require appropriate health and safety protocols such as ventilation and monitoring

5.2 COMPARISON TO APPLICABLE OR SUITABLY ANALOGOUS STANDARDS

The MCP Method 1 Soil Standards are not applicable standards in a Method 3 risk characterization, and there are no other applicable promulgated soil standards for the Site. Therefore, no comparison of soil constituent concentrations to public health standards could be made.

The applicable human health standards identified for the Site are the Ambient Water Quality Criteria (AWQC) protective of fish consumption presented in the USEPA (2022b) National Recommended Water Quality Criteria. These standards are applicable to surface water at or adjacent to the Site. As shown in Table D-7, no constituents were detected in either the upstream or downstream surface water sample. As a result, there is no exceedance of applicable human health standards at the Site under the current use condition.

As a conservative approach, these AWQC were also compared with estimated surface water concentrations potentially impacted by Site groundwater COCs to evaluate potential future impact of groundwater to nearby surface water. To account for dilution during migration through the subsurface, a default dilution factor of 10[26] and an attenuation factor based on the chemical properties of each constituent were applied to the groundwater concentrations[27] to estimate

[25] For non-cancer risk, exposure frequency is the key parameter for exposure dose evaluation; and emergency/utility workers were assumed to have similar or even higher exposure frequency than construction workers. Exposure by emergency/utility workers however, would be considered acute exposure and therefore acute toxicity would be appropriate for the risk estimation. No acute toxicity values with consensus were readily available for the risk drivers such as naphthalene. As a result, a No Significant Risk condition could not be demonstrated for emergency/utility workers working in the former relief holder area.

[26] We used the default dilution factor of 10 from MassDEP's risk guidance for this evaluation as a conservative approach. As noted in the text of the main report (Section 8.3.5), the actual dilution factor for Site groundwater discharging to the Little River was estimated to be 2,000.

[27] For all groundwater COCs but cyanide and styrene, the average concentrations among the wells at the Site were used to represent groundwater conditions at the Site. For cyanide and styrene, the maximum detected concentrations were used to represent the groundwater concentrations as a conservative approach.

surface water concentrations. The comparison of the estimated surface water concentrations to applicable AWQC is presented in Table D-19.

The estimated benzene concentration in surface water is approximately three times of the AWQC protective of fish consumption. As indicated by the USEPA (2020b), *"This criterion is based on carcinogenicity of 10^{-6} risk. Alternate risk levels may be obtained by moving the decimal point (e.g., for a risk level of 10^{-5}, move the decimal point in the recommended criterion one place to the right)."* The estimated benzene concentration in surface water does not exceed the AWQC corresponding to a risk level of 10^{-5}.

6.0 UNCERTAINTY ANALYSIS

The findings of the human health risk characterization are dependent on a number of factors including, but not limited to, the representativeness and quality of the data collected to describe site conditions, the nature and extent of COCs in environmental media, and the assumptions made to evaluate risks for receptors potentially exposed to COCs in environmental media. Uncertainty may be introduced in each component of the risk characterization process. Although the magnitude of uncertainty has not been quantified for this Site, the primary sources of uncertainty in the hazard identification, exposure assessment, dose-response assessment, and risk characterization are qualitatively discussed below.

6.1 HAZARD IDENTIFICATION

The process of environmental sampling and analysis results in uncertainties from several sources, including errors inherent in sampling procedures or analytical methods. One area of uncertainty is sampling. Since it is not possible to sample the entire area of interest at a given site, several samples are taken from each medium, and the results are considered to be representative of the chemicals present throughout the area. This approach may overestimate or underestimate risk. The quantitative human health risk characterization for the Site was based on the results from more than 40 soil samples, 20 groundwater samples[28], 26 sediment samples collected from top 1 foot of sediment in the Little River, and 12 soil gas samples (plus 2 field duplicates). The data used to support the risk characterization were considered sufficient for the limited area of the Site.

Temporal variation information is available for multiple monitoring wells at the Site. Although only the most recent round of groundwater data were quantitatively used for the human health risk characterization (i.e., the September 2020 MW-1 data), the previous two rounds of data from MW-1 were generally consistent with the most recent round of data. Temporal variation information is limited for soil gas levels at the Site; therefore, there is uncertainty associated with the potential vapor intrusion pathway for facility workers. For the potential vapor intrusion pathway, the conservative attenuation factor was used to develop the potential indoor air EPCs. The conservative nature of the EPC derivation would result in potentially overstated risk estimates for the vapor intrusion pathway.

6.2 EXPOSURE ASSESSMENT

Estimating EPCs (including calculating representative concentrations and deriving EPCs based on exposure models), characterizing current and reasonably foreseeable land activities and uses, and calculating daily doses contribute most to the uncertainty in the exposure assessment component of the risk characterization. To counter this uncertainty, health-

[28] For all groundwater COCs but cyanide and styrene, the groundwater data set included in this risk characterization for the EPC derivation for human health risk characterization includes 1 representative sample collected from MW-1. For cyanide and styrene, the groundwater EPCs were based on 5 groundwater samples collected from 5 monitoring wells. The groundwater data set included in this risk characterization for the comparison to Applicable or Suitably Analogous Standards includes 20 representative samples collected from 11 monitoring wells.

protective exposure assumptions based on either Site-specific information or conservative default values provided in the MassDEP guidance were used to quantitatively evaluate potential risks.

Soil samples were collected from the Site at various depths. In general, as a conservative step, the larger value of the top 3-foot soil data set average, top 6-foot soil data set average, or 15-foot soil data set average was used as the soil EPC for each COC for all receptor groups[29]. This would result in overstated risk estimates and therefore the risk results should only be used for screening purposes. As such, if the constructed EPCs resulted in a conclusion of no significant risks, then this conclusion would be adopted without further analyses. However, if the screening analysis based on the constructed EPCs resulted in a conclusion that a significant risk could exist, further detailed analyses would have been conducted using more representative, exposure/receptor specific EPCs to confirm that the results of the risk characterization would not change. In this risk characterization, risks to all identified receptors but construction workers working within the former relief holder area were below the MCP risk limits; therefore no further evaluation was performed.

For all COCs in sediment, the maximum detected concentrations among various locations in top 1 foot of sediment were used as the sediment EPCs. This is a conservative approach and would be expected to result in overestimation of potential risks.

GZA used the USEPA (2007) recommended absorption factor of 0.3 for lead for the soil ingestion exposure pathway versus the MassDEP (2014 and2015) default RAF value of 0.5 for this Method 3 Risk Characterization. It is GZA's position that the MassDEP default RAF value of 0.5 is overstated and that the USEPA (2007) default absorption factor is a conservative assumption for the soil ingestion exposure. As indicated by the USEPA in its 1999 Short Sheet: IEUBK Model Bioavailability Variable, *"It is acknowledged that this value has significant variability and uncertainty, but it is the estimate under which the IEUBK model was validated with comprehensive blood lead study results."* A more detailed discussion is included in Attachment III.

With respect to determining exposure point concentrations for this evaluation, GZA assumed that the concentrations of chemicals in the medium evaluated would remain constant over time. This assumption may overestimate risks since some level of attenuation would be expected to occur over time for many of the contaminants.

In calculating receptor-specific doses for the quantitatively evaluated scenarios, the most health-protective of the default range of values available was used. Receptor-specific parameters, such as contact and ingestion rates, were obtained from the MassDEP guidance, which are intended to err on the side of protecting human health. When the default assumptions were inappropriate or not available, realistic but conservative assumptions were made based on Site-specific information.

6.3 DOSE-RESPONSE ASSESSMENT

The primary sources of uncertainty associated with the toxicity values used to quantify risks include: (1) extrapolation of dose-response information from effects observed at high doses to predict adverse effects at low levels anticipated for human exposure to environmental constituents, (2) the use of toxicity information compiled from short-term exposure studies to predict the effects associated with long-term exposures (and vice-versa), (3) the use of dose-response information from animal studies to predict likely effects in humans, and (4) the use of toxicity information based on homogeneous animal populations or healthy human populations to predict the effects that are likely to be observed in the general population (including sensitive subgroups).

The dose-response values used in the calculation of HIs and cancer risk estimates are conservative values. Since RfDs and RfCs are derived using a number of safety factors and are developed to protect sensitive populations, the actual dose or concentration associated with a health effect is likely to be higher than the dose or concentration established by USEPA

[29] For construction workers working within the former relief holder area, the average concentration among all four soil samples collected within the area was adopted as the EPC for each COC.

or MassDEP for most groups in the general population. In addition, the CSFs and unit risks are derived based on the upper 95 percent confidence limit and assume that no threshold level exists for exposure to carcinogens. To be conservative, when no subchronic dose-response value was available, the chronic value was used. Although no values have been established for dermal contact exposures, it is standard practice to use values derived from studies based on oral exposures to evaluate dermal contact exposures. This technique is health-protective since it has been demonstrated that the most significant exposures for most constituents occur via the oral and inhalation route.

Surrogate constituents were used to represent the aromatic and aliphatic petroleum fractions, although these surrogate constituents may not actually be present. Although this approach introduces uncertainty into the analysis, it overestimates potential risks since, per MassDEP (2002d) methodology, petroleum hydrocarbons were evaluated using surrogates associated with elevated toxicities.

Multiple constituents detected were not included in the risk characterization due to the lack of toxicity values. However, these constituents would generally be captured by EPH fractions and could have been included in the quantitative risk characterization. Omission of chemical-specific risk calculation is not expected to impact the overall risk characterization conclusions.

6.4 RISK CHARACTERIZATION

Important sources of uncertainty in the risk characterization include:

- the equal weight given to constituents whose RfDs have different confidence levels in estimating HIs; and
- the assumption of simple additivity of ELCRs and HIs across COCs.

As with the evaluation of EPCs, the use of conservative assumptions and parameters to develop risk estimates would be expected to err on the side of protecting human health. Thus, the calculated HIs and risk estimates are likely to result in upper bound estimates of the hazard resulting from exposure to COCs present at the Site. Consequently, the estimates should be used to highlight areas of potential concern and to assist in providing practical risk management information, rather than as absolute estimates of health risks.

7.0 SAFETY AND PUBLIC WELFARE RISK CHARACTERIZATIONS

7.1 RISK OF HARM TO SAFETY

The MCP lists the following as examples of potential safety hazards:

- The presence of rusted or corroded drums or containers, open pits, lagoons, or other dangerous structures;
- Any threat of fire or explosion, including the presence of explosive vapors resulting from a release of OHM; and
- Any uncontained materials that exhibit the characteristics of corrosivity, reactivity, or flammability as described in 310 CMR 40.0347.

No such release-related safety hazards were observed at the Site, nor are they anticipated to occur in the future; therefore, a condition of no significant risk of harm to safety exists at the Site.

7.2 RISK OF HARM TO PUBLIC WELFARE

The risk of harm to public welfare considers the existence of nuisance conditions, loss of another person's active or passive property use, and any nonpecuniary costs that may accrue due to the degradation of public or private resources directly attributable to the release of OHM. The risk of harm to public welfare (and the environment) is also characterized by comparing COC concentrations in soil and groundwater to the UCLs listed in 310 CMR 40.0996(6).

The soil and groundwater concentrations were compared to the respective UCLs (Table D-20). According to 310 CMR 40.0996(2), the comparison to UCLs should be based on the arithmetic mean of the samples. For soil, the average concentrations among the soil samples collected within the disposal site boundary (including those collected beyond 15 ft bgs) were adopted for the UCL comparison. For groundwater, the average concentrations among the monitoring wells located within the extent of contamination[30] were used for the UCL comparison[31].

Non Aqueous Phase Liquid (NAPL) has been observed at the Site; but NAPL in the upland portion of the Site is considered stable and does not pose adverse impacts to public welfare.

Sporadic sheening and NAPL seepage have been observed in surface water in the Little River. The river conditions are being addressed to further assess impacts on public welfare.

None of the comparisons for any COC at the Site were above the UCLs.

8.0 ENVIRONMENTAL RISK CHARACTERIZATION

GZA conducted a Stage I Environmental Screening for soil and groundwater at the Site in accordance with the MCP and associated guidance documents to assess potential impacts to biota and habitats related to potential exposures to residual OHMs at the Site. The objective of the characterization was to provide a screening-level assessment of potential risks to ecological receptors by identifying complete exposure pathways and evaluating whether these pathways represent "potentially significant" exposures. The environmental risk characterization for sediment and surface water at the Little River will be addressed separately.

Environmentally sensitive areas as defined by the MCP include wetlands, areas subject to 100-year frequency floods, and sensitive aquatic habitats. To characterize environmental resources associated with the Site and to assess whether distinctive environmental values may be present, such as habitats of rare or endangered wildlife, GZA consulted the MassDEP Priority Resource Map for the Site. According to the Priority Resource Map, no Protected Open Space, Estimated Habitats of Rare Wildlife or Certified Vernal Pools, reservoirs, lakes, streams, ponds, rivers, or wetlands are located on or within 500 feet of the Site with the exception of the Little River. No ACECs or Priority Habitats of Rare Species designated by the NHESP were identified within 500 feet of the Site. There are no institutions as defined by 310 CMR 40.0006 located within 500 feet of the Site.

MassDEP (1996) guidance for Stage I Environmental Screening allows for screening out terrestrial exposures based on habitat size and quality considerations. MassDEP guidance indicates that significant exposure to terrestrial receptors is unlikely if the size of the undeveloped land is less than two acres, there is no exposure to state-listed rare species, and

[30] As discussed in Section 2.1, GZA1, GZA-1A, and GZA-2 were either at or outside the disposal site boundary. The associated GZA-1, GZA-1A, and GZA-2 results (yellow-highlighted in Table D-4) were not included in the derivation of average groundwater concentrations for UCL comparison and for evaluation of potential impacts to downgradient surface water.

[31] For styrene and cyanide, the maximum detected concentrations were used for UCL comparison as a conservative approach.

there is no contaminant transport from surficial soil to an ACEC. GZA concludes that potentially significant exposures to terrestrial organisms are not present at the Site based on the rational summarized below:

- The Site is mainly occupied by the Site building with limited landscaped areas; these landscaped areas do not provide habitat for terrestrial receptors. The Disposal Site is less than two acres.
- there is no exposure to state-listed rare species, and
- there is no contaminant transport from surficial soil to an ACEC.

Groundwater discharging to surface water in the Little River has the potential to result in potentially significant exposures to aquatic organisms. To evaluate whether groundwater discharge presents a significant risk to aquatic receptors, GZA compared the estimated surface water concentrations developed from groundwater data as discussed in Section 5.2 to surface water quality benchmark concentrations intended to protect aquatic receptors. Those comparisons are presented in Table D-21. Except cyanide, benzene, and ethylbenzene, none of the estimated surface water concentrations exceed the surface water quality benchmark concentrations. The estimated surface water concentrations for cyanide, benzene and ethylbenzene based on the conservative default attenuation factors were 0.021 mg/L, 0.16 mg/L and 0.047 mg/L, respectively, above the GZA identified water quality benchmark values of 0.0052 mg/L, 0.11 mg/L, and 0.014 mg/L. Note that cyanide, benzene, and ethylbenzene were not detected in either the upstream or downstream surface water samples collected from the Site, indicating that there is no evidence that surface water has been impacted by groundwater discharge from the Site. Further, it should be noted that MassDEP (2019) has identified much higher target surface water concentrations for benzene and ethylbenzene for protection of surface water purposes (0.46 mg/L and 0.181 mg/L). The surface water concentrations estimated based on conservative assumptions for benzene and ethylbenzene do not exceed the MassDEP (2019) established target surface water concentrations. Discharge of groundwater to surface water in the Little River is not expected to present a significant risk of harm to aquatic organisms.

Risks to aquatic organisms by sediment were evaluated separately and included in Appendix C of the Phase II CSA.

9.0 RISK CHARACTERIZATION CONCLUSIONS

Results of the human health, safety, public welfare, and environmental risk characterizations are summarized below.

9.1 HUMAN HEALTH RISK CHARACTERIZATION

The MCP indicates that a condition of No Significant Risk of harm to human health exists or has been achieved if:

- no calculated Cumulative Receptor Non-cancer Risk estimate is greater than the Cumulative Receptor Non-cancer Risk Limit of 1;
- no calculated Cumulative Receptor Cancer Risk estimate is greater than the Cumulative Cancer Risk Limit of 1×10^{-5}; and
- no Exposure Point Concentration of OHM is greater than an applicable or suitably analogous public health standard.

GZA calculated non-cancer and cancer risks for facility workers, construction workers, and trespassers via exposure to residual OHMs in the impacted media at the Site. The calculated risks for facility workers, trespassers, and construction workers working outside the former relief holder area do not exceed the applicable MCP risk limits. The calculated non-cancer risk estimate for construction workers working within the former relief holder area exceeds the MCP non-cancer risk limit of 1; and inhalation of ambient air potentially impacted by groundwater is the risk-driving pathway. Residual OHM were also assumed to pose significant risks to emergency/utility workers working in the former relief holder area.

No exceedance of applicable public health standards was noted.

9.2 SAFETY RISK CHARACTERIZATION

Based on observations made and information collected during environmental investigations of the Site, conditions that are related to a release of OHM do not currently and will not in the foreseeable future pose a threat of physical harm or bodily injury to people. Therefore, a condition of No Significant Risk of harm to safety exists at the Site under the current and foreseeable future use conditions.

9.3 PUBLIC WELFARE RISK CHARACTERIZATION

Based on observations made and information collected during environmental investigations of the Site, no community in the vicinity of the Site experiences adverse impacts to public welfare under current or anticipated future conditions due to Site related conditions. In addition, the soil and groundwater concentrations do not exceed their applicable UCLs. Therefore, a condition of No Significant Risk to public welfare exists at the Site under the current and foreseeable future use conditions. Note that sediment conditions and sporadic sheening within the Little River are being evaluated separately.

9.4 ENVIRONMENTAL RISK CHARACTERIZATION

Vegetated habitat areas on the Site are less than two acres, therefore, the potential for significant risk to terrestrial receptors can be screened out in accordance with MassDEP guidance (MassDEP, 1996). A condition of No Significant Risk to the terrestrial environment exists at the Site under the current and foreseeable future use conditions.

Risks to aquatic environment are being evaluated separately.

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Tables

TABLE D-1
SUMMARY OF TOTAL HAZARD INDICES AND RISK ESTIMATES
284 Winter Street
Haverhill, Massachusetts

Receptor	Exposure Media/Route		Non-Cancer Hazard Index				Excess Lifetime Cancer Risk	
			Subchronic HI	Driver	Chronic HI	Driver	Estimate	Driver
RECEPTOR: Facility Workers	Dermal Contact with Soil	Subtotal:	NC	NA	0.015	C11-C22 Aromatic Fraction	8.4E-08	Benzo(a)Pyrene
	Incidental Ingestion of Soil	Subtotal:	NC	NA	0.045	C11-C22 Aromatic Fraction	7.5E-07	Benzo(a)Pyrene
	Inhalation of Soil-derived Fugitive Dust	Subtotal:	NC	NA	0.030	Benzo(a)Pyrene	3.0E-07	Chromium (total)
	Inhalation of Indoor Air	Subtotal:	NC	NA	0.35	Acrolein	1.0E-06	Benzene
	Total for RECEPTOR: Facility Workers:		**NC**		**0.44**		**2.2E-06**	
	MCP Risk Limits:		**1**		**1**		**1E-05**	
	Exceed MCP Risk Limits?		**NO**		**NO**		**NO**	
RECEPTOR: Construction/Utility Workers (Outside Holder Area)	Dermal Contact with Soil	Subtotal:	0.059	C11-C22 Aromatic Fraction	NC	NA	3.4E-08	Benzo(a)Pyrene
	Incidental Ingestion of Soil	Subtotal:	0.066	Lead	NC	NA	4.8E-08	Benzo(a)Pyrene
	Inhalation of Soil-derived Fugitive Dust	Subtotal:	0.051	Benzo(a)Pyrene	NC	NA	1.26E-08	Chromium (total)
	Absorption via Gastrointestinal Tract		0.0017	Lead			1.2E-09	Benzo(a)Pyrene
	Respiratory Absorption		0.050	Benzo(a)Pyrene			1.1E-08	Chromium (total)
	Total for RECEPTOR: Construction/Utility Workers (Outside Holder Area):		**0.18**		**NC**		**9.4E-08**	
	MCP Risk Limits:		**1**		**1**		**1E-05**	
	Exceed MCP Risk Limits?		**NO**		**NO**		**NO**	
RECEPTOR: Construction/Utility Workers (Holder Area)	Dermal Contact with Soil	Subtotal:	0.13	2-Methylnaphthalene	NC	NA	1.1E-07	Benzo(a)Pyrene
	Incidental Ingestion of Soil	Subtotal:	0.13	Benzo(a)Pyrene	NC	NA	1.9E-07	Benzo(a)Pyrene
	Inhalation of Soil-derived Fugitive Dust	Subtotal:	0.17	Benzo(a)Pyrene	NC	NA	1.7E-08	Chromium (total)
	Absorption via Gastrointestinal Tract		0.0035	Benzo(a)Pyrene			4.9E-09	Benzo(a)Pyrene
	Respiratory Absorption		0.16	Benzo(a)Pyrene			1.2E-08	Chromium (total)
	Dermal Contact with Groundwater	Subtotal:	0.15	Benzene	NC	NA	3.8E-07	Benzene
	Inhalation of Ambient Air	Subtotal:	7.2	Benzene	NC	NA	9.2E-07	Benzene
	Total for RECEPTOR: Construction/Utility Workers (Holder Area):		**7.7**		**NC**		**1.6E-06**	
	MCP Risk Limits:		**1**		**1**		**1E-05**	
	Exceed MCP Risk Limits?		**YES**		**NO**		**NO**	
RECEPTOR: Trespassers	Dermal Contact with Soil	Subtotal:	NC	NA	0.031	C11-C22 Aromatic Fraction	5.2E-08	Benzo(a)Pyrene
	Incidental Ingestion of Soil	Subtotal:	NC	NA	0.021	C11-C22 Aromatic Fraction	1.0E-07	Benzo(a)Pyrene
	Inhalation of Soil-derived Fugitive Dust	Subtotal:	NC	NA	0.0019	Benzo(a)Pyrene	5.8E-09	Chromium (total)
	Dermal Contact with Sediment	Subtotal:	NC	NA	0.61	C11-C22 Aromatic Fraction	2.3E-06	Benzo(a)Pyrene
	Incidental Ingestion of Sediment	Subtotal:	NC	NA	0.045	C11-C22 Aromatic	6.1E-07	Benzo(a)Pyrene
	Total for RECEPTOR: Trespassers:		**NC**		**0.71**		**3.1E-06**	
	MCP Risk Limits:		**1**		**1**		**1E-05**	
	Exceed MCP Risk Limits?		**NO**		**NO**		**NO**	

Abbreviations:
MCP = Massachusetts Contingency Plan; NA = Not applicable; NC = Not Calculated.

TABLE D-2
SOIL ANALYTICAL DATA
284 Winter Street
Haverhill, Massachusetts

Location Sampling Date Sample Depth (feet)	ENV-2B-5.0'-6-5'[9] 4/28/2015 5-6.5	ENV-6B-6.0'-7.0'[9] 4/27/2015 6-7	ENV-10B-0.0'-2.5'[9] 4/28/2015 0-2.5	NFSB-01 2-3' 10/20/2016 2-3	NFSB-02 2-3' 10/21/2016 2-3	NFSB-03 1-2' 10/21/2016 1-2	NFSB-04 0-1' 10/20/2016 0-1	NFSB-05 1-2' 10/20/2016 1-2	NFSB-05 5-6' 10/20/2016 5-6	NFSB-05 5-6' 10/20/2016 5-6	Average of NFSB-05 5-6' and laboratory duplicate 5-6	NFSB-06 1-2' 10/20/2016 1-2	NFSB-07 1-2' 10/20/2016 1-2	NFSB-07 6-7' 10/20/2016 6-7	NFSB-08 1-2' 10/20/2016 1-2	NFSB-09 1-2' 10/21/2016 1-2	NFSB-09 3-4' 10/21/2016 3-4	ENV-7B-10.0'-11.0'[9] 4/27/2015	ENV-7B-10.0'-11.0'DUP[9] 4/27/2015	Average of ENV-7B-10.0'-11.0' and duplicate	B-1 10-12'[10] 11/24/2014	ENV-8B-12.5'-15.0'[9] 4/27/2015	ENV-9B-12.5'-15.0'[9] 4/27/2015	ENV-3B-12.5'-15.0'[9] 4/28/2015	ENV-5B-12.5'-15.0' 4/27/2015	NFSB-02 12-15' 10/24/2016 12-15
Extractable Petroleum Hydrocarbons																										
C_9-C_{18} Aliphatics	275	3,090	<6.66	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,390	1,240	1315	<20	6,750	8,040	12,600	4,800	--
C_{19}-C_{36} Aliphatics	113	1,440	<6.66	--	--	--	--	--	--	--	--	--	--	--	--	--	--	757	721	739	250	861	830	1,990	860	--
C_{11}-C_{22} Aromatics	498	2,400	<6.66	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3,700	3,610	3655	4,000	5,610	6,060	12,500	4,420	--
C_{11}-C_{22} Aromatics, Adjusted	462	2,290	<6.66	2.92	5800	1000	3.74	1980	8420	8180	8300	1260	549	28200	1210	1840	9300	3,100	3,020	3060	4,000	5,200	5,140	9,150	3,910	52500
Naphthalene	<0.802	<1.51	<0.333	24.4	9.86	1.25	0.00418	--	18.2	18.5	18	2.13	--	--	8.39	--	24	109	112	111	1,200	--	362	--	--	1490
2-Methylnaphthalene	<0.802	7.49	<0.333	12.3	8.24	1.43	0.00338	--	1.95	2.06	2.0	1.54	--	--	1.47	--	29.5	87	86	86	570	--	234	--	--	105
Acenaphthylene	2.2	<1.51	<0.333	19.9	39.6	2.68	0.0137	--	11.3	11.8	12	3.71	--	--	1.6	--	40	25	21	23	310	--	10	--	--	63
Acenaphthene	1.86	2.77	<0.333	6.63	2.07	0.56	0.00154	--	1.95	1.87	1.9	0.319	--	--	1.47	--	16.6	11.2	10.7	11	34	--	32.6	--	--	148
Fluorene	1.25	2.26	<0.333	20	3.15	1.46	0.00221	--	3.04	2.71	2.9	0.876	--	--	2.1	--	82.2	21.1	20.2	21	180	--	37.7	--	--	166
Phenanthrene	7.22	27.3	<0.333	98	25.6	7.51	0.0295	--	13.4	11.4	12	6.42	--	--	11.4	--	404	91.1	92.3	92	550	--	96.9	--	--	494
Anthracene	2.46	6.38	<0.333	28.1	21.3	2.48	0.00973	--	6.51	7.14	6.8	2.69	--	--	7.9	--	76.8	22.0	22.5	22	150	--	33.7	--	--	98.2
Fluoranthene	2.8	12.9	<0.333	34.7	19.1	4.05	0.0341	--	11.6	12.4	12	8.22	--	--	16.4	--	212	38.8	38.0	38	180	--	26.8	--	--	115
Pyrene	6.32	19.2	<0.333	63	43.3	5.74	0.0525	--	19.8	20.9	20	9.64	--	--	14.6	--	169	68.2	66.6	67	320	--	46.0	--	--	163
Benzo(a)anthracene	2.16	8.07	<0.333	21.9	18.2	2.98	0.0213	--	6.66	8.96	7.8	6.79	--	--	11.2	--	112	21.7	20.6	21	87	--	13.9	--	--	57.2
Chrysene	2.42	7.72	<0.333	21.2	24	3.44	0.0222	--	8.1	10.8	9.5	6.82	--	--	10.3	--	99.9	27.0	26.0	27	73	--	15.6	--	--	63.9
Benzo(b)fluoranthene	1.24	4.19	<0.333	11.7	23.5	2.41	0.0204	--	11.6	15.2	13	6.84	--	--	9.37	--	87.1	14.2	13.2	14	80	--	<9.57	--	--	20.5
Benzo(k)fluoranthene	1.22	5.15	<0.333	15.1	19.8	2.84	0.024	--	10.4	11.5	11	5.93	--	--	11.3	--	87.8	17.3	16.5	17	26	--	<9.57	--	--	33.5
Benzo(a)pyrene	2.62	7.27	<0.333	26.8	29.4	3.56	0.0275	--	16	18.3	17	7.98	--	--	11.9	--	105	24.5	24.5	25	110	--	11.9	--	--	48.5
Indeno(1,2,3-cd)Pyrene	1.15	3.48	<0.333	9.89	18.1	2.12	0.0181	--	11.2	12.7	12	5.26	--	--	7.26	--	58.2	11.0	10.9	11	38	--	<9.57	--	--	14.2
Dibenzo(a,h)anthracene	<0.802	<1.51	<0.333	2.87	8.03	0.717	0.00583	--	4.29	4.83	4.6	1.73	--	--	2.77	--	18.8	<3.63	<2.94	<2.94	11	--	<9.57	--	--	5.54
Benzo(ghi)perylene	1.27	3	<0.333	12.3	19.3	2.58	0.0207	--	13.3	14.8	14	5.52	--	--	6.35	--	56.7	12.2	12.1	12	50	--	<9.57	--	--	15.3
Volatile Petroleum Hydrocarbons																										
C_5-C_{10} Aromatics	113	248	<2.32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	522	245	384	1,000	2,360	648	3,530	2,220	--
C_5-C_8 Aliphatics, Adjusted	<4.89	59	3.63	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<109	<89.6	<89.6	--	265	<345	<942	351	--
C_9-C_{12} Aliphatics, Adjusted	8.77	105	<2.32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<109	<89.6	<89.6	--	1,400	2,730	1,470	1,660	--
Benzene	0.28	1.04	<0.093	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<4.37	<3.58	<3.58	190	--	--	<37.7	--	--
Toluene	<0.196	<0.406	<0.093	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<4.37	<3.58	<3.58	230	--	--	<37.7	--	--
Ethylbenzene	4.22	6.26	<0.093	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.16	5.40	6.3	23	--	--	268	--	--
p/m-Xylene	0.526	0.88	<0.093	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<4.37	<3.58	<3.58	--	--	--	94	--	--
o-Xylene	0.591	1.31	<0.093	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<4.37	<3.58	<3.58	--	--	--	134	--	--
Total Xylene (calculated)	1.117	2.19	<0.093	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<4.37	<3.58	<3.58	--	--	--	228.3	--	--
Methyl tert butyl ether	<0.098	<0.203	<0.046	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<2.18	<1.79	<1.79	<20	--	--	<18.8	--	--
Naphthalene	3.2	10.7	<0.185	--	--	--	--	--	--	--	--	--	--	--	--	--	--	244	175	210	1900	--	--	2,910	--	--
Metals																										
Arsenic	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyanide (PAC)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene (Combined EPH and VPH Results)	3.2	10.7	<0.185	24.4	9.86	1.25	0.00418	--	18.2	18.5	18	2.13	--	--	8.39	--	24	244	175	210	1900	--	362	2910	--	1490
Alkylated Polycyclic Aromatic Hydrocarbon and Geochemical Biomarkers																										
cis/trans-Decalin	--	--	--	0.069	0.143	0.0768	0.000165	--	4.83	5.13	5.0	0.04	--	--	0.0496	--	0.0276	--	--	--	--	--	--	--	--	61.6
Benzothiophene	--	--	--	0.71	0.528	0.122	0.000255	--	0.566	0.563	0.56	0.116	--	--	0.421	--	2.37	--	--	--	--	--	--	--	--	53
Biphenyl	--	--	--	3.99	0.346	0.51	0.000651	--	0.842	0.84	0.84	0.258	--	--	0.791	--	10.8	--	--	--	--	--	--	--	--	83.8
Dibenzofuran	--	--	--	2.86	<0.0431	0.373	0.00106	--	0.733	0.655	0.69	0.4	--	--	2.66	--	67.2	--	--	--	--	--	--	--	--	34
Retene	--	--	--	<0.111	<0.0431	<0.0163	<0.000683	--	<0.0417	<0.0407	<0.0407	<0.0144	--	--	<0.0209	--	<0.145	--	--	--	--	--	--	--	--	<1.01
Dibenzothiophene	--	--	--	6.44	3.06	0.717	0.00136	--	1.21	1.22	1.2	0.462	--	--	0.857	--	19.4	--	--	--	--	--	--	--	--	80.5
Benzo(b)fluorene	--	--	--	5.69	3.56	0.914	0.00345	--	3.23	3.43	3.3	0.836	--	--	2.01	--	23.4	--	--	--	--	--	--	--	--	33.6
Benzo[a]fluoranthene	--	--	--	5.78	12.3	0.914	0.00748	--	5.77	6.24	6.0	2.2	--	--	3.21	--	24.4	--	--	--	--	--	--	--	--	12.3
Benzo[e]pyrene	--	--	--	13.5	23.7	2.44	0.022	--	13	15	14	5.5	--	--	7.64	--	65.2	--	--	--	--	--	--	--	--	22.8
Perylene	--	--	--	4.01	7.2	0.898	0.00616	--	3.84	4.39	4.1	2	--	--	3.02	--	26.9	--	--	--	--	--	--	--	--	8.52
Carbazole	--	--	--	0.243	0.256	0.117	0.00129	--	0.207	0.211	0.21	0.237	--	--	1.39	--	27.7	--	--	--	--	--	--	--	--	9.12
4-Methyldibenzothiophene	--	--	--	2.39	2.93	0.429	0.000574	--	0.508	0.556	0.53	0.318	--	--	0.188	--	2.06	--	--	--	--	--	--	--	--	38
2/3-Methyldibenzothiophene	--	--	--	2.34	2.71	0.419	<0.000683	--	0.688	0.728	0.71	0.313	--	--	0.314	--	3.04	--	--	--	--	--	--	--	--	35.8
1-Methyldibenzothiophene	--	--	--	0.567	0.849	0.108	0.000116	--	0.159	0.179	0.17	0.0988	--	--	0.0658	--	1.29	--	--	--	--	--	--	--	--	11.2
3-Methylphenanthrene	--	--	--	11.6	7.99	1.27	0.00303	--	1.66	1.74	1.7	1.35	--	--	1.2	--	24.2	--	--	--	--	--	--	--	--	94.9
2-Methylanthracene	--	--	--	5	5.39	0.737	0.00157	--	1.85	1.99	1.9	0.788	--	--	0.918	--	13	--	--	--	--	--	--	--	--	32
9/4-Methylphenanthrene	--	--	--	10.6	11.4	1.64	0.00336	--	3.12	3.52	3.3	1.62	--	--	1.03	--	19.1	--	--	--	--	--	--	--	--	86.7
1-Methylphenanthrene	--	--	--	6.75	5.3	1.02	0.00208	--	1.17	1.34	1.3	1.08	--	--	0.786	--	14.7	--	--	--	--	--	--	--	--	63.1
Hopane	--	--	--	0.0755	0.0523	0.12	0.00152	--	0.18	0.158	0.17	0.138	--	--	0.111	--	0.314	--	--	--	--	--	--	--	--	0.271
Moretane	--	--	--	0.0134	0.0143	0.0192	0.000244	--	0.032	0.0258	0.029	0.0247	--	--	0.0144	--	0.0931	--	--	--	--	--	--	--	--	0.0514

Notes:
1. Concentrations are presented in units of milligrams per kilogram (mg/kg) or parts per million (ppm) unless otherwise noted.
2. <= less than listed laboratory reporting limits (RLs).
3. Averages were calculated for field duplicate pair samples (yellow-highlighted). When the analyte was detected in at least one sample, the half reporting limit was used for the nondetect, if any, for the average calculation.
If the analyte was not detected in either sample, the average was presented as a nondetect and the lowest laboratory reporting limit was used to represent the reporting limit for the average result.
4. Averages were calculated for sample and laboratory duplicate sample (yellow-highlighted). When the analyte was detected in at least one sample, the half reporting limit was used for the nondetect, if any, for the average calculation.
If the analyte was not detected in either sample, the average was presented as a nondetect and the lowest laboratory reporting limit was used to represent the reporting limit for the average result.
5. Naphthalene was analyzed by both the VPH and EPH analytical methods. If naphthalene was detected via at least one method, the maximum detected concentration is listed to represent the sample result. If naphthalene was not detected via either method, the minimum RL is listed as the RL for the nondetected sample result.
6. The laboratory noted that for sample ENV-10B-0.0'-2.5' the non-hydrocarbon VPH compounds may have been included in the summation of the C5-C8 Aliphatics range; therefore, this result is considered biased high and the noted result is considered an estimated value.
7. Quality Assurance/Quality Control Samples include:
DUP = Field Duplicate
8. "--" indicates not analyzed.
9. Samples results were provided by Ramboll Environ Inc. of Westford, MA.
10. Samples results provided from the *Draft I/II Environmental Site Assessment. 284 Winter Street. Haverhill. MA* . preoared bv Lessard Environmental Inc.. December. 2014
For B-1 10-12', the unadjusted C11-C22 alimatics hydrocarbon result was conservatively used as the adjusted C11-C22 aromatics results.
11. Grey-highlighted results were for samples collected beyond 15 feet below ground surface. The results were not used to derive soil exposure point concentrations for human health risk characterization. The results however were included to calculate average for Upper Concentration Limit comparison.
12. TPH treated as C11-C22 aromatics. More specifically, the total petroleum hydrocarbons (C9-C44) results reported in the fingerprinting analysis were assumed to be C11-C22 aromatics results as a conservative approach.
Benzo[j]fluoranthene/Benzo[k]fluoranthene treated as benzo(k)fluoranthene.
Dibenz[ah]anthracene/Dibenz[ac]anthracene treated as dibenz(ah)anthracene

EPH = Extractable Petroleum Hydrocarbon; VPH = Volatile Petroleum Hydrocarbon; PAC = Physiologically Available Cyanide.

TABLE D-2
SOIL ANALYTICAL DATA
284 Winter Street
Haverhill, Massachusetts

Location	NFSB-01 7-8'	NFSB-01 10-15'	NFSB-03 10-15'	NFSB-04 12.5-15'	NFSB-06 12.5-15'	NFSB-07 13-15'	NFSB-08 7-8'	NFSB-08 11-15'	B-3 15-17'[10]	ENV-1B-15.0'-17.5'[9]	ENV-11B-15.0'-17.5'[9]	ENV-12B-15.0'-17.5'[9]	ENV-13B-17.5'-20.0'[9]	NFSB-01 15-16'	NFSB-01 16-20'	NFSB-02 15-20'	NFSB-02 15-20' FD (DUP-1)	Average of NFSB-02 15-20'	NFSB-03 15-17'	NFSB-03 15-17' LD	Average of NFSB-03 15-17'	NFSB-03 15-17' FD (DUP-2)
Sampling Date	10/20/2016	10/25/2016	10/25/2016	10/24/2016	10/25/2016	10/24/2016	10/20/2016	10/24/2016	11/24/2014	4/28/2015	4/27/2015	4/28/2015	4/28/2015	10/25/2016	10/25/2016	10/24/2016	10/24/2016	and duplicate	10/25/2016	10/25/2016	and lab duplicate	10/25/2016
Sample Depth (feet)	7-8	10-15	10-15	12.5-15	12.5-15	13-15	7-8	11-15						15-16	16-20	15-20	15-20		15-17	15-17		15-17
Extractable Petroleum Hydrocarbons																						
C_9-C_{18} Aliphatics	--	--	--	--	--	--	--	--	--	68.7	**6,240**	**13,300**	904	--	--	--	--	--	--	--	--	--
C_{19}-C_{36} Aliphatics	--	--	--	--	--	--	--	--	--	51	877	**2,020**	701	--	--	--	--	--	--	--	--	--
C_{11}-C_{22} Aromatics	--	--	--	--	--	--	--	--	--	161	3,820	**7,010**	18,200	--	--	--	--	--	--	--	--	--
C_{11}-C_{22} Aromatics, Adjusted	24	1580	8600	8600	24100	9140	467	37.2	--	106	**3,320**	**5,270**	**15,600**	462	24200	21500	35000	28250	3860	3900	3880	6160
Naphthalene	312	3.42	--	--	--	67.4	0.0984	0.00159	--	--	--	--	**783**	--	1760	702	1120	911	371	381	376	348
2-Methylnaphthalene	19.4	3.59	--	--	--	17.8	0.178	0.00107	--	--	--	--	**714**	--	90.5	55.9	77.5	67	9.52	9.63	9.575	9.91
Acenaphthylene	22.8	1.56	--	--	--	5.09	0.0373	0.00844	--	--	--	--	**43.2**	--	45.4	29.5	40.5	35	5.29	5.12	5.205	7.7
Acenaphthene	11.4	4.85	--	--	--	24	0.0666	0.00381	--	--	--	--	93.8	--	128	119	140	130	34.2	34.2	34.2	38.1
Fluorene	30.6	4.18	--	--	--	14.7	0.1	0.00642	--	--	--	--	116	--	143	96.9	129	113	16	15.8	15.9	17.3
Phenanthrene	80.8	12.2	--	--	--	50.7	0.345	0.0177	--	--	--	--	373	--	417	288	388	338	46.2	46.4	46.3	53.4
Anthracene	16.5	2.93	--	--	--	17.4	0.0338	0.00582	--	--	--	--	57.8	--	67.9	62.4	79.9	71	12	11.8	11.9	13.8
Fluoranthene	18.6	2.58	--	--	--	13.7	0.0462	0.00652	--	--	--	--	93.5	--	88.9	72.4	100	86	14.3	14.4	14.35	17.8
Pyrene	29.5	4.76	--	--	--	24.6	0.0516	0.00703	--	--	--	--	133	--	142	95.9	137	116	19.5	19.6	19.55	22.6
Benzo(a)anthracene	12.6	1.89	--	--	--	8.37	0.0235	0.00434	--	--	--	--	**43.3**	--	47.2	35.3	41.8	39	8.08	8.2	8.14	10.4
Chrysene	14.2	2.12	--	--	--	8.82	0.0265	0.00421	--	--	--	--	55.1	--	51.7	37.7	41.6	40	8.79	8.99	8.89	11.7
Benzo(b)fluoranthene	4.67	0.632	--	--	--	2.71	0.028	0.00286	--	--	--	--	<31.9	--	16.3	14.1	17.2	16	3.62	3.74	3.68	5.37
Benzo(k)fluoranthene	6.76	0.927	--	--	--	3.84	0.0438	0.00431	--	--	--	--	<31.9	--	22.9	21.6	22	22	5.2	5.23	5.215	7.33
Benzo(a)pyrene	12.1	1.66	--	--	--	7.35	0.0424	0.00538	--	--	--	--	**39.2**	--	38.9	30.3	34.9	33	7.08	7.18	7.13	9.78
Indeno(1,2,3-cd)Pyrene	3.45	0.432	--	--	--	2.21	0.0302	0.00318	--	--	--	--	<31.9	--	10.2	9.92	11.6	11	2.81	3	2.905	4.18
Dibenzo(a,h)anthracene	1.3	0.172	--	--	--	1.05	0.0106	0.00115	--	--	--	--	<31.9	--	4.52	3.7	4.74	4.2	1.06	1.16	1.11	1.54
Benzo(ghi)perylene	3.91	0.511	--	--	--	2.88	0.0306	0.0031	--	--	--	--	<31.9	--	11.3	10.4	11.9	11	3.06	3.12	3.09	4.44
Volatile Petroleum Hydrocarbons																						
C_9-C_{10} Aromatics	--	--	--	--	--	--	--	--	150	341	**2,840**	**2,090**	**1,450**	--	--	--	--	--	--	--	--	--
C_5-C_8 Aliphatics, Adjusted	--	--	--	--	--	--	--	--	--	<81.9	466	**384**	<506	--	--	--	--	--	--	--	--	--
C_9-C_{12} Aliphatics, Adjusted	--	--	--	--	--	--	--	--	--	<81.9	1,220	**1,230**	2,280	--	--	--	--	--	--	--	--	--
Benzene	--	--	--	--	--	--	--	--	<0.2	--	--	--	<20.3	--	--	--	--	--	--	--	--	--
Toluene	--	--	--	--	--	--	--	--	<0.2	--	--	--	<20.3	--	--	--	--	--	--	--	--	--
Ethylbenzene	--	--	--	--	--	--	--	--	<0.2	--	--	--	160	--	--	--	--	--	--	--	--	--
p/m-Xylene	--	--	--	--	--	--	--	--	--	--	--	--	**227**	--	--	--	--	--	--	--	--	--
o-Xylene	--	--	--	--	--	--	--	--	--	--	--	--	**105**	--	--	--	--	--	--	--	--	--
Total Xylene (calculated)	--	--	--	--	--	--	--	--	--	--	--	--	332	--	--	--	--	--	--	--	--	--
Methyl tert butyl ether	--	--	--	--	--	--	--	--	<0.5	--	--	--	<10.1	--	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	2.8	--	--	--	**1,940**	--	--	--	--	--	--	--	--	--
Metals																						
Arsenic	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyanide (PAC)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene (Combined EPH and VPH Results)	312	3.42	--	--	--	67.4	0.0984	0.00159	2.8	--	--	--	1940	--	1760	702	1120	911	371	381	376	348
Alkylated Polycyclic Aromatic Hydrocarbon and Geochemical Biomarkers																						
cis/trans-Decalin	2.17	0.725	--	--	--	9.56	0.432	0.00644	--	--	--	--	--	--	5.4	17.5	36.7	27	0.289	0.284	5.205	0.355
Benzothiophene	6.18	0.542	--	--	--	1.63	0.00394	<0.00166	--	--	--	--	--	--	37.6	25.4	43.8	35	8.18	8.1	34.2	8.61
Biphenyl	18.6	2.41	--	--	--	9.66	0.133	0.0167	--	--	--	--	--	--	73.3	48.7	66.2	57	11.8	11.7	15.9	14.2
Dibenzofuran	4.93	0.836	--	--	--	4.17	0.0782	0.00101	--	--	--	--	--	--	21	18.5	25.8	22	3	3.04	46.3	3.45
Retene	<0.409	<0.0281	--	--	--	<0.0212	<0.00288	<0.00166	--	--	--	--	--	--	<0.213	<0.393	<0.24	<0.24	<0.0446	<0.0463	376	<0.0876
Dibenzothiophene	9	1.25	--	--	--	6.38	0.0845	0.000741	--	--	--	--	--	--	42.6	38.2	58.6	48	4.07	4.08	14.35	4.72
Benzo(b)fluorene	5.92	0.78	--	--	--	4.76	0.00767	0.00144	--	--	--	--	--	--	32	20	27.4	24	4.25	4.27	19.55	4.23
Benzo[a]fluoranthene	2.55	0.393	--	--	--	2.47	0.00941	0.00197	--	--	--	--	--	--	10.1	7.88	9	8.4	1.9	1.9	34.2	2.4
Benzo[e]pyrene	5.77	0.809	--	--	--	4.02	0.0288	0.00296	--	--	--	--	--	--	17.9	14.8	16.9	16	3.86	3.87	15.9	5.48
Perylene	1.89	0.289	--	--	--	1.25	0.0116	0.00112	--	--	--	--	--	--	6.18	5.57	5.9	5.7	1.45	1.49	46.3	2.05
Carbazole	0.351	0.101	--	--	--	0.165	0.00406	0.0003	--	--	--	--	--	--	4.29	4.77	7.3	6.0	0.713	0.708	376	1
4-Methyldibenzothiophene	4.95	0.863	--	--	--	4.93	0.103	0.000515	--	--	--	--	--	--	22.4	17.2	27.5	22	2.26	2.27	14.35	2.36
2/3-Methyldibenzothiophene	4.34	0.773	--	--	--	4.57	0.128	<0.00166	--	--	--	--	--	--	19.6	15.6	25.2	20	2.1	2.11	19.55	2.15
1-Methyldibenzothiophene	1.3	0.211	--	--	--	0.995	0.00972	0.0000866	--	--	--	--	--	--	5.84	4.72	7.8	6.3	0.523	0.525	34.2	0.618
3-Methylphenanthrene	17.3	3.33	--	--	--	18	0.161	0.00101	--	--	--	--	--	--	91.5	52.9	75.4	64	8.75	8.84	15.9	9.89
2-Methylanthracene	6.77	1.4	--	--	--	8.38	0.0165	0.000565	--	--	--	--	--	--	29.9	20.5	26.5	24	3.9	3.94	46.3	3.77
9/4-Methylphenanthrene	17.4	3.55	--	--	--	20.6	0.116	0.00103	--	--	--	--	--	--	86.3	49.1	66.4	58	8.52	8.57	376	8.74
1-Methylphenanthrene	11.7	2.33	--	--	--	11.8	0.0739	0.000762	--	--	--	--	--	--	56.4	34.6	49.6	42	5.51	5.55	14.35	6.48
Hopane	0.604	0.0223	--	--	--	0.061	0.00131	<0.00166	--	--	--	--	--	--	0.0906	0.212	0.297	0.25	0.152	0.165	19.55	0.177
Moretane	0.113	0.00338	--	--	--	0.0109	<0.00144	<0.00166	--	--	--	--	--	--	0.0153	0.0352	0.0557	0.045	0.0244	0.0272	34.2	0.0288

Notes:
1. Concentrations are presented in units of milligrams per kilogram (mg/kg) or parts per million (ppm) unless otherwise noted.
2. <= less than listed laboratory reporting limits (RLs).
3. Averages were calculated for field duplicate pair samples (yellow-highlighted). When the analyte was detected in at least one sample, the half reporting limit was used for the nondetect, if any, for the average calculation.
If the analyte was not detected in either sample, the average was presented as a nondetect and the lowest laboratory reporting limit was used to represent the reporting limit for the average result.
4. Averages were calculated for sample and laboratory duplicate sample (yellow-highlighted). When the analyte was detected in at least one sample, the half reporting limit was used for the nondetect, if any, for the average calculation.
If the analyte was not detected in either sample, the average was presented as a nondetect and the lowest laboratory reporting limit was used to represent the reporting limit for the average result.
5. Naphthalene was analyzed by both the VPH and EPH analytical methods. If naphthalene was detected via at least one method, the maximum detected
concentration is listed to represent the sample result. If naphthalene was not detected via either method, the minimum RL is listed as the RL for the nondetected sample result.
6. The laboratory noted that for sample ENV-10B-0.0'-2.5' the non-hydrocarbon VPH compounds may have been included in the summatior
7. Quality Assurance/Quality Control Samples include:
DUP = Field Duplicate
8. "--" indicates not analyzed.
9. Samples results were provided by Ramboll Environ Inc. of Westford, MA.
10. Samples results provided from the *Draft I/II Environmental Site Assessment. 284 Winter Street. Haverhill. MA* . preparedbv Lessard Environmental Inc.. December. 2014
For B-1 10-12', the unadiusted C11-C22 alimatics hydrocarbon result was conservativelv used as the adjusted C11-C22 aromatics results.
11. Grey-highlighted results were for samples collected beyond 15 feet below ground surface. The results were not used to derive soil exposure point concentrations for human health risk characterization. The results however were included to calculate average for Upper Concentration Limit comparison.
12. TPH treated as C11-C22 aromatics. More specifically, the total petroleum hydrocarbons (C9-C44) results reported in the fingerprinting analysis were assumed to be C11-C22 aromatics results as a conservative approach.
Benzo[j]fluoranthene/Benzo[k]fluoranthene treated as benzo(k)fluoranthene.
Dibenz[ah]anthracene/Dibenz[ac]anthracene treated as dibenz(ah)anthracene

EPH = Extractable Petroleum Hydrocarbon; VPH = Volatile Petroleum Hydrocarbon; PAC = Physiologically Available Cyanide.

TABLE D-2
SOIL ANALYTICAL DATA
284 Winter Street
Haverhill, Massachusetts

Location Sampling Date Sample Depth (feet)	Average of NFSB-03 15-17' and field duplicate	B-107 S-4 1/21/2020 5-7	B-107 S-4 and S-5 20/21/2020 5-9	B-102 S-6 1/22/2020 12-14	B-108 S-2 1/23/2020 1-3	B-104 S-12 1/23/2020 32-34	B-109 S-12 1/21/2020 50-52	B-102 S-1 1/16/2020 0-3	B-103 S-1 1/16/2020 0-3	B-104 S-1 1/16/2020 0-3	B-106 S-1 1/17/2020 0-2	B-107 S-2 1/17/2020 0.5-3	B-109 S-1 1/17/2020 0-3	B-110 S-2 1/20/2020 1-2
Extractable Petroleum Hydrocarbons														
C_9-C_{18} Aliphatics	--	--	<286	102	360	<83.3	<71.5	<16.4	<18.2	<32.8	168	102	170	52.2
C_{19}-C_{36} Aliphatics	--	--	<286	<80.6	<250	<83.3	<71.5	<16.4	<18.2	<32.8	73.2	217	109	53
C_{11}-C_{22} Aromatics	--	--	1880	190	1400	<83.3	87.2	62.5	60.6	102	1090	772	422	261
C_{11}-C_{22} Aromatics, Adjusted	5020	--	813	88.5	1140	<83.3	76.8	44.1	45.2	93.5	803	689	314	224
Naphthalene	362	--	289	73.8	45	<2.22	<1.91	0.68	<0.48	<0.87	55.1	13.6	8.11	1.45
2-Methylnaphthalene	9.7	--	108	24.7	45.2	<1.11	<0.95	7.76	<0.24	<0.44	40.6	3.21	5.53	1.82
Acenaphthylene	6.5	--	70.3	2.86	6.41	<1.11	1.5	0.3	<0.24	0.55	2.59	5.89	2.81	1.21
Acenaphthene	36	--	10.1	<2.15	7.22	<2.22	<1.91	<0.44	<0.48	<0.87	13.3	<2.23	1.36	<0.96
Fluorene	17	--	42.5	<2.15	17.1	<2.22	<1.91	<0.44	<0.48	<0.87	28.7	3.61	5.5	0.97
Phenanthrene	50	--	203	<2.15	56.2	<2.22	6.24	0.91	1.3	<0.87	69	13.7	22.1	4.91
Anthracene	13	--	50.5	<2.15	7.9	<2.22	<1.91	<0.44	<0.48	<0.87	4.62	3.74	4.62	1.47
Fluoranthene	16	--	59.5	<2.15	18.9	<2.22	<1.91	2.72	2.55	0.89	18.9	7.74	12.3	4
Pyrene	21	--	116	<2.15	30.7	<2.22	2.59	2.86	2	1.49	31.2	12	18.5	7.09
Benzo(a)anthracene	9.3	--	25.8	<2.15	8.5	<2.22	<1.91	1.48	1.5	<0.87	6.93	3.54	5.59	2.39
Chrysene	10	--	28.4	<2.15	9.68	<2.22	<1.91	1.45	1.42	0.9	8.33	4.29	5.79	2.48
Benzo(b)fluoranthene	4.5	--	11.8	<2.15	<6.67	<2.22	<1.91	1.88	1.61	1.15	2.33	<2.23	3.9	2.12
Benzo(k)fluoranthene	6.3	--	11.1	<2.15	<6.67	<2.22	<1.91	1.1	1.2	<0.87	1.84	2.75	2.57	1.71
Benzo(a)pyrene	8.5	--	22.4	<2.15	7.67	<2.22	<1.91	2.01	1.8	1.18	4.39	3.65	5.03	3.05
Indeno(1,2,3-cd)Pyrene	3.5	--	10.2	<2.15	<6.67	<2.22	<1.91	1.25	0.91	1.02	1.47	2.4	1.58	1.27
Dibenzo(a,h)anthracene	1.3	--	<3.82	<1.07	<3.34	<1.11	<0.95	0.33	0.34	<0.44	<0.46	<1.12	0.61	0.5
Benzo(ghi)perylene	3.8	--	11	<2.15	<6.67	<2.22	<1.91	1.07	0.83	1.01	1.52	2.78	1.56	1.36
Volatile Petroleum Hydrocarbons														
C_9-C_{10} Aromatics	--	687	--	748	165	<12.9	<10.7	<8.15	<11.0	<7.42	286	17.9	53.2	<9.98
C_5-C_8 Aliphatics, Adjusted	--	609	--	315	17.7	<13.5	<11.2	<8.52	<11.5	<7.75	20.7	<11.3	<9.86	<10.4
C_9-C_{12} Aliphatics, Adjusted	--	261	--	339	134	<26.9	<22.2	<17.0	<22.9	<15.4	120	<22.5	33.4	<20.8
Benzene	--	155	--	<0.20	0.87	<0.26	<0.21	<0.16	<0.22	0.71	5.51	<0.22	0.61	<0.20
Toluene	--	63.4	--	1.32	<0.28	<0.26	<0.21	<0.16	<0.22	0.83	0.52	<0.22	0.36	<0.20
Ethylbenzene	--	33.7	--	27	3.68	<0.26	<0.21	<0.16	<0.22	0.23	6.58	1.71	0.7	<0.20
p/m-Xylene	--	48.3	--	59.1	2.57	<0.52	<0.43	<0.33	<0.44	0.44	6.4	<0.43	0.6	<0.40
o-Xylene	--	36.7	--	29.4	2.58	<0.26	<0.21	<0.16	<0.22	0.31	6.36	<0.22	1.05	<0.20
Total Xylene (calculated)	--	85	--	88.5	5.15	<0.26	<0.21	<0.16	<0.22	0.75	12.76	<0.22	1.65	<0.2
Methyl tert butyl ether	--	<0.09	--	<0.05	<0.07	<0.06	<0.05	<0.04	<0.06	<0.04	<0.05	<0.05	<0.05	<0.05
Naphthalene	--	1070	--	119	158	0.54	<0.21	<0.16	<0.22	<0.15	281	15.6	23.1	0.97
Metals														
Arsenic	--	--	--	--	6.38	--	--	4.72	10.6	8.37	4.47	9.55	7.17	7.4
Chromium	--	--	--	--	12.1	--	--	11.1	40.2	15.8	14.9	16.8	15.4	13.9
Lead	--	--	--	--	24.7	--	--	33.7	205	94.8	10.3	96.4	74.1	55.8
Cyanide (PAC)	--	--	--	--	21.2	--	--	1.58	1.25	1.37	9.46	2.55	11.3	9.74
Naphthalene (Combined EPH and VPH Results)	362	1070	289	119	158	0.54	<0.21	0.68	<0.22	<0.15	281	15.6	23.1	1.45
Alkylated Polycyclic Aromatic Hydrocarbon and Geochemical Biomarkers														
cis/trans-Decalin	2.8	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzothiophene	21	--	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl	15	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	25	--	--	--	--	--	--	--	--	--	--	--	--	--
Retene	188	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzothiophene	9.5	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(b)fluorene	12	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo[a]fluoranthene	18	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo[e]pyrene	11	--	--	--	--	--	--	--	--	--	--	--	--	--
Perylene	24	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbazole	189	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Methyldibenzothiophene	8.4	--	--	--	--	--	--	--	--	--	--	--	--	--
2/3-Methyldibenzothiophene	11	--	--	--	--	--	--	--	--	--	--	--	--	--
1-Methyldibenzothiophene	17	--	--	--	--	--	--	--	--	--	--	--	--	--
3-Methylphenanthrene	13	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Methylanthracene	25	--	--	--	--	--	--	--	--	--	--	--	--	--
9/4-Methylphenanthrene	192	--	--	--	--	--	--	--	--	--	--	--	--	--
1-Methylphenanthrene	10	--	--	--	--	--	--	--	--	--	--	--	--	--
Hopane	9.9	--	--	--	--	--	--	--	--	--	--	--	--	--
Moretane	17	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
1. Concentrations are presented in units of milligrams per kilogram (mg/kg) or parts per million (ppm) unless otherwise noted.
2. <= less than listed laboratory reporting limits (RLs).
3. Averages were calculated for field duplicate pair samples (yellow-highlighted). When the analyte was detected in at least one sample, the half reporting limit was used for the nondetect, if any, for the average calculation.
If the analyte was not detected in either sample, the average was presented as a nondetect and the lowest laboratory reporting limit was used to represent the reporting limit for the average result.
4. Averages were calculated for sample and laboratory duplicate sample (yellow-highlighted). When the analyte was detected in at least one sample, the half reporting limit was used for the nondetect, if any, for the average calculation.
If the analyte was not detected in either sample, the average was presented as a nondetect and the lowest laboratory reporting limit was used to represent the reporting limit for the average result.
5. Naphthalene was analyzed by both the VPH and EPH analytical methods. If naphthalene was detected via at least one method, the maximum detected concentration is listed to represent the sample result. If naphthalene was not detected via either method, the minimum RL is listed as the RL for the nondetected sample result.
6. The laboratory noted that for sample ENV-10B-0.0'-2.5' the non-hydrocarbon VPH compounds may have been included in the summation of the C5-C8 Aliphatics range; therefore, this result is considered biased high and the noted result is considered an estimated value.
7. Quality Assurance/Quality Control Samples include:
DUP = Field Duplicate
8. "--" indicates not analyzed.
9. Samples results were provided by Ramboll Environ Inc. of Westford, MA.
10. Samples results provided from the *Draft I/II Environmental Site Assessment. 284 Winter Street. Haverhill. MA* . prepared by Lessard Environmental Inc.. December. 2014
For B-1 10-12', the unadjusted C11-C22 alimatics hydrocarbon result was conservatively used as the adjusted C11-C22 aromatics results.
11. Grey-highlighted results were for samples collected beyond 15 feet below ground surface. The results were not used to derive soil exposure point concentrations for human health risk characterization. The results however were included to calculate average for Upper Concentration Limit comparison.
12. TPH treated as C11-C22 aromatics. More specifically, the total petroleum hydrocarbons (C9-C44) results reported in the fingerprinting analysis were assumed to be C11-C22 aromatics results as a conservative approach.
Benzo[j]fluoranthene/Benzo[k]fluoranthene treated as benzo(k)fluoranthene.
Dibenz[ah]anthracene/Dibenz[ac]anthracene treated as dibenz(ah)anthracene

EPH = Extractable Petroleum Hydrocarbon; VPH = Volatile Petroleum Hydrocarbon; PAC = Physiologically Available Cyanide.

TABLE D-3
SUMMARY OF SOIL ANALYTICAL RESULTS
284 Winter Street
Haverhill, Massachusetts

Constituent[1]	All Soil Data[2]					Soil (0-3 feet) Summary[2,5]			Soil (0-6 feet) Summary[2,6]			Soil (0-15 feet) Summary[2,7]			Soil (0-3 feet) Outside Holder Area Summary[2,5]			Soil (0-6 feet) Outside Holder Area Summary[2,6]			Soil (0-15 feet) Outside Holder Area Summary[2,7]			Background[8]	EPC for Human Health Risk Characterization Site-Wide[9]	EPC for Human Health Risk Characterization (Within Holder Area)9	EPC for Human Health Risk Characterization (Outside Holder Area)[9]	Concentrations for UCL Comparison[10]
	Frequency of Detection	Range Detected[3]	Maximum Detected Concentration ID	Arithmetic Mean Concentration[4]	Median Concentration[4]	Frequency of Detection	Maximum Detected Concentration	Arithmetic Mean Concentration[4]	Frequency of Detection	Maximum Detected Concentration	Arithmetic Mean Concentration[4]	Frequency of Detection	Maximum Detected Concentration	Arithmetic Mean Concentration[4]	Frequency of Detection	Maximum Detected Concentration	Arithmetic Mean Concentration[4]	Frequency of Detection	Maximum Detected Concentration	Arithmetic Mean Concentration[4]	Frequency of Detection	Maximum Detected Concentration	Arithmetic Mean Concentration[4]					
Extractable Petroleum Hydrocarbons																											
C9-C18 Aliphatics	17 / 25	52 - 13300	ENV-12B-15.0'-17.5'	2344	168	5 / 9	360	99	6 / 11	360	119	13 / 19	12600	2001	4 / 8	360	98	5 / 9	360	118	12 / 16	12600	2360	NA	2001	85	2360	2344
C19-C36 Aliphatics	16 / 25	51 - 2020	ENV-12B-15.0'-17.5'	464	125	4 / 9	217	68	5 / 11	217	79	12 / 19	1990	415	3 / 8	109	50	4 / 9	113	57	10 / 16	1990	454	NA	415	203	454	464
C11-C22 Aromatics, Adjusted	48 / 50	2.9 - 52500	NFSB-02 12-15'	5686	1420	17 / 18	5800	945	21 / 22	9300	1631	39 / 40	52500	5049	16 / 17	5800	960	19 / 20	9300	1719	36 / 37	52500	5310	NA	5049	1834	5310	5686
2-Methylnaphthalene	30 / 36	0.0011 - 714	ENV-13B-17.5'-20.0'	62	7.6	12 / 15	45	8.6	15 / 19	108	14	26 / 30	570	45	11 / 14	45	9.0	13 / 17	45	9.3	23 / 27	234	24	0.50	45	227	24	62
Acenaphthylene	32 / 36	0.0084 - 310	B-1 10-12'	22	3.3	13 / 15	40	5.8	17 / 19	70	11	27 / 30	310	22	12 / 14	40	5.8	15 / 17	40	8.0	24 / 27	63	9.8	0.50	22	129	9.8	22
Acenaphthene	27 / 36	0.0015 - 148	NFSB-02 12-15'	20	2.0	9 / 15	13	2.4	13 / 19	17	3.5	23 / 30	148	11	9 / 14	13	2.5	12 / 17	17	3.2	21 / 27	148	11	0.50	11	15	11	20
Fluorene	29 / 36	0.0022 - 180	B-1 10-12'	29	3.4	11 / 15	29	5.6	15 / 19	82	11	25 / 30	180	22	10 / 14	29	5.8	13 / 17	82	9.8	22 / 27	166	16	1	22	75	16	29
Phenanthrene	32 / 36	0.018 - 550	B-1 10-12'	98	18	13 / 15	98	21	17 / 19	404	50	27 / 30	550	78	12 / 14	98	22	15 / 17	404	43	24 / 27	494	59	3	78	256	59	98
Anthracene	29 / 36	0.0058 - 150	B-1 10-12'	22	5.5	11 / 15	28	5.7	15 / 19	77	12	25 / 30	150	19	10 / 14	28	5.9	13 / 17	77	9.9	22 / 27	98	14	1	19	68	14	22
Fluoranthene	32 / 36	0.0065 - 212	NFSB-09 3-4'	31	13	14 / 15	35	10	18 / 19	212	23	28 / 30	212	28	13 / 14	35	10	16 / 17	212	22	25 / 27	212	22	4	28	82	22	31
Pyrene	33 / 36	0.0070 - 320	B-1 10-12'	46	19	14 / 15	63	16	18 / 19	169	29	28 / 30	320	41	13 / 14	63	16	16 / 17	169	25	25 / 27	169	29	4	41	149	29	46
Benzo(a)anthracene	31 / 36	0.0043 - 112	NFSB-09 3-4'	16	7.4	13 / 15	22	6.1	17 / 19	112	13	27 / 30	112	15	12 / 14	22	6.3	15 / 17	112	12	24 / 27	112	12	2	15	39	12	16
Chrysene	32 / 36	0.0042 - 100	NFSB-09 3-4'	17	8.0	14 / 15	24	6.7	18 / 19	100	13	28 / 30	100	15	13 / 14	24	6.9	16 / 17	100	12	25 / 27	100	13	2	15	35	13	17
Benzo(b)fluoranthene	28 / 36	0.0029 - 87	NFSB-09 3-4'	10	3.6	12 / 15	24	4.8	16 / 19	87	9.7	25 / 30	87	11	12 / 14	24	5.0	15 / 17	87	10	23 / 27	87	8.3	2	11	31	10	10
Benzo(k)fluoranthene	28 / 36	0.0043 - 88	NFSB-09 3-4'	10	3.6	12 / 15	20	4.7	16 / 19	88	9.5	25 / 30	88	9.3	11 / 14	20	4.8	14 / 17	88	9.8	22 / 27	88	8.9	1	9.5	13	9.8	9.7
Benzo(a)pyrene	32 / 36	0.0054 - 110	B-1 10-12'	17	7.3	14 / 15	29	7.2	18 / 19	105	13	28 / 30	110	16	13 / 14	29	7.5	16 / 17	105	14	25 / 27	105	13	2	16	45	14	17
Indeno(1,2,3-cd)Pyrene	29 / 36	0.0032 - 58	NFSB-09 3-4'	7.2	2.9	13 / 15	18	3.7	17 / 19	58	7.2	26 / 30	58	7.2	12 / 14	18	3.8	15 / 17	58	7.3	23 / 27	58	6.1	1	7.2	17	7.3	7.2
Dibenzo(a,h)anthracene	22 / 36	0.0012 - 19	NFSB-09 3-4'	2.8	0.90	10 / 15	8.0	1.4	12 / 19	19	2.4	19 / 30	19	2.4	10 / 14	8.0	1.4	12 / 17	19	2.6	18 / 27	19	2.2	0.50	2.4	4.5	2.6	2.8
Benzo(ghi)perylene	29 / 36	0.0031 - 57	NFSB-09 3-4'	7.8	3.1	13 / 15	19	4.0	17 / 19	57	7.5	26 / 30	57	7.9	12 / 14	19	4.1	15 / 17	57	7.6	23 / 27	57	6.4	1	7.9	21	7.6	8
Volatile Petroleum Hydrocarbons																											
C9-C10 Aromatics	19 / 26	18 - 3530	ENV-3B-12.5'-15.0'	745	267	4 / 9	286	60	6 / 11	687	122	14 / 19	3530	657	3 / 8	286	65	4 / 9	286	71	11 / 16	3530	673	NA	657	568	673	745
C5-C8 Aliphatics, Adjusted	10 / 24	3.6 - 609	B-107 S-4	147	31	3 / 9	21	8.0	4 / 11	609	62	8 / 18	609	131	3 / 8	21	8.3	3 / 9	21	7.6	7 / 16	351	109	NA	131	307	109	147
C9-C12 Aliphatics, Adjusted	14 / 24	8.8 - 2730	ENV-9B-12.5'-15.0'	548	75	3 / 9	134	38	5 / 11	261	55	11 / 18	2730	464	3 / 8	134	41	4 / 9	134	37	10 / 16	2730	505	NA	NCC	NCC	NCC	NCC
Benzene	8 / 20	0.28 - 190	B-1 10-12'	19	0.45	4 / 9	5.5	0.91	6 / 11	155	15	8 / 16	190	23	4 / 8	5.5	1.0	5 / 9	5.5	0.92	6 / 13	5.5	2.3	NA	23	115	2.3	19
Toluene	6 / 20	0.36 - 230	B-1 10-12'	16	0.17	3 / 9	0.83	0.26	4 / 11	63	6.0	6 / 16	230	20	3 / 8	0.83	0.27	3 / 9	0.83	0.25	4 / 13	1.3	1.9	NA	20	98	1.3	16
Ethylbenzene	13 / 20	0.23 - 268	ENV-3B-12.5'-15.0'	27	2.7	5 / 9	6.6	1.5	7 / 11	34	4.7	12 / 16	268	24	4 / 8	6.6	1.4	5 / 9	6.6	1.7	9 / 13	268	25	NA	24	19	25	27
Total Xylene (calculated)	10 / 18	0.75 - 332	ENV-13B-17.5'-20.0'	42	1.4	4 / 9	13	2.3	6 / 11	85	9.7	9 / 15	228	29	4 / 8	13	2.6	5 / 9	13	2.4	8 / 13	228	26	NA	29	43	26	42
Metals																											
* **Arsenic**	8 / 8	4.5 - 11	B-103 S-1	7.3	7.3	8 / 8	11	7.3	8 / 8	11	7.3	8 / 8	11	7.3	7 / 7	11	7.0	7 / 7	11	7.0	7 / 7	11	7.0	20	NCC	NCC	NCC	NCC
Chromium	8 / 8	11 - 40	B-103 S-1	18	15	8 / 8	40	18	8 / 8	40	18	8 / 8	40	18	7 / 7	40	18	7 / 7	40	18	7 / 7	40	18	30	18	17	18	18
Lead	8 / 8	10 - 205	B-103 S-1	74	65	8 / 8	205	74	8 / 8	205	74	8 / 8	205	74	7 / 7	205	71	7 / 7	205	71	7 / 7	205	71	100	74	96	71	74
Cyanide (PAC)	8 / 8	1.3 - 21	B-108 S-2	7.3	6.0	8 / 8	21	7.3	8 / 8	21	7.3	8 / 8	21	7.3	7 / 7	21	8.0	7 / 7	21	8.0	7 / 7	21	8.0	NA	7.3	2.6	8.0	7.3
Naphthalene (Combined EPH and VPH Results)	35 / 39	0.0016 - 2910	ENV-3B-12.5'-15.0'	366	18	12 / 15	281	35	17 / 20	1070	97	29 / 32	2910	291	11 / 14	281	36	14 / 17	281	33	25 / 28	2910	216	0.5	291	819	216	366
Alkylated Polycyclic Aromatic Hydrocarbon and Geochemical Biomarkers																											
cis/trans-Decalin	17 / 17	0.00017 - 62	NFSB-02 12-15'	7	0.43	6 / 6	0.14	0.063	8 / 8	5.0	0.67	14 / 14	62	5.7	0 / 12	ND	ND	8 / 8	5.0	0.67	14 / 14	62	5.7	NA	NCC	NCC	NCC	NCC
Benzothiophene	16 / 17	0.00026 - 53	NFSB-02 12-15'	9	0.56	6 / 6	0.71	0.32	8 / 8	2.4	0.60	13 / 14	53	4.7	9 / 12	81	0.32	8 / 8	2.4	0.60	13 / 14	53	4.7	NA	NCC	NCC	NCC	NCC
Biphenyl	17 / 17	0.00065 - 84	NFSB-02 12-15'	16	2.4	6 / 6	4.0	0.98	8 / 8	11	2.2	14 / 14	84	9.4	9 / 12	34	1.0	8 / 8	11	2.2	14 / 14	84	9.4	NA	9.4	NCC	9.4	16
Dibenzofuran	16 / 17	0.0010 - 67	NFSB-09 3-4'	11	2.7	5 / 6	2.9	1.1	7 / 8	67	9.3	13 / 14	67	8.4	9 / 12	12	1.1	7 / 8	67	9.3	13 / 14	67	8.4	NA	9.3	NCC	9.3	11
Retene	1 / 17	188	Average of NFSB-03 15-17' and field duplicate	11	0.020	0 / 6	ND	ND	0 / 8	ND	ND	0 / 14	ND	ND	9 / 12	24	0.017	0 / 8	ND	ND	0 / 14	ND	ND	NA	NCC	NCC	NCC	NCC
Dibenzothiophene	17 / 17	0.00074 - 81	NFSB-02 12-15'	14	3.1	6 / 6	6.4	1.9	8 / 8	19	4.0	14 / 14	81	9.2	9 / 12	8.5	1.9	8 / 8	19	4.0	14 / 14	81	9.2	NA	NCC	NCC	NCC	NCC
Benzo(b)fluorene	17 / 17	0.0014 - 34	NFSB-02 12-15'	9.0	3.6	6 / 6	5.7	2.2	8 / 8	23	5.0	14 / 14	34	6.1	9 / 12	9.1	2.2	8 / 8	23	5.0	14 / 14	34	6.1	NA	NCC	NCC	NCC	NCC
Benzo[a]fluoranthene	17 / 17	0.0020 - 24	NFSB-09 3-4'	6.4	3.2	6 / 6	12	4.1	8 / 8	24	6.9	14 / 14	24	5.2	9 / 12	38	4.1	8 / 8	24	6.9	14 / 14	24	5.2	NA	NCC	NCC	NCC	NCC
Benzo[e]pyrene	17 / 17	0.0030 - 65	NFSB-09 3-4'	12	7.6	6 / 6	24	8.8	8 / 8	65	17	14 / 14	65	12	9 / 12	36	8.8	8 / 8	65	17	14 / 14	65	12	NA	NCC	NCC	NCC	NCC
Perylene	17 / 17	0.0011 - 27	NFSB-09 3-4'	5.7	3.0	6 / 6	7.2	2.9	8 / 8	27	6.0	14 / 14	27	4.3	9 / 12	11	2.9	8 / 8	27	6.0	14 / 14	27	4.3	NA	NCC	NCC	NCC	NCC
Carbazole	17 / 17	0.00030 - 189	Average of NFSB-03 15-17' and field duplicate	14	0.24	6 / 6	1.4	0.37	8 / 8	28	3.8	14 / 14	28	2.8	9 / 12	95	0.37	8 / 8	28	3.8	14 / 14	28	2.8	NA	3.8	NCC	3.8	14
4-Methyldibenzothiophene	17 / 17	0.00052 - 38	NFSB-02 12-15'	6.5	2.1	6 / 6	2.9	1.0	8 / 8	2.9	1.1	14 / 14	38	4.1	0 / 3	ND	ND	8 / 8	2.9	1.1	14 / 14	38	4.1	NA	NCC	NCC	NCC	NCC
2/3-Methyldibenzothiophene	15 / 17	0.13 - 36	NFSB-02 12-15'	6.3	2.3	5 / 6	2.7	1.0	7 / 8	3.0	1.2	12 / 14	36	4.0	9 / 12	32	1.0	7 / 8	3.0	1.2	12 / 14	36	4.0	NA	NCC	NCC	NCC	NCC
1-Methyldibenzothiophene	17 / 17	0.000087 - 17	Average of NFSB-03 15-17' and field duplicate	2.7	0.57	6 / 6	0.85	0.28	8 / 8	1.3	0.39	14 / 14	11	1.2	9 / 10	87	0.28	8 / 8	1.3	0.39	14 / 14	11	1.2	NA	NCC	NCC	NCC	NCC
3-Methylphenanthrene	17 / 17	0.0010 - 95	NFSB-02 12-15'	21	8.0	6 / 6	12	3.9	8 / 8	24	6.2	14 / 14	95	13	9 / 9	63	3.9	8 / 8	24	6.2	14 / 14	95	13	NA	NCC	NCC	NCC	NCC
2-Methylanthracene	17 / 17	0.00057 - 32	NFSB-02 12-15'	9.1	5.0	6 / 6	5.4	2.1	8 / 8	13	3.5	14 / 14	32	5.5	9 / 10	0.60	2.1	8 / 8	13	3.5	14 / 14	32	5.5	NA	NCC	NCC	NCC	NCC
9/4-Methylphenanthrene	17 / 17	0.0010 - 192	Average of NFSB-03 15-17' and field duplicate	30	11	6 / 6	11	4.4	8 / 8	19	6.1	14 / 14	87	13	9 / 10	0.11	4.4	8 / 8	19	6.1	14 / 14	87	13	NA	NCC	NCC	NCC	NCC
1-Methylphenanthrene	17 / 17	0.00076 - 63	NFSB-02 12-15'	13	5.3	6 / 6	6.8	2.5	8 / 8	15	3.9	14 / 14	63	8.6	0 / 1	ND	ND	8 / 8	15	3.9	14 / 14	63	8.6	NA	NCC	NCC	NCC	NCC
Hopane	16 / 17	0.0013 - 9.9	Average of NFSB-03 15-17' and field duplicate	0.71	0.11	6 / 6	0.14	0.083	8 / 8	0.31	0.12	13 / 14	0.60	0.14	0 / 1	ND	ND	8 / 8	0.31	0.12	13 / 14	0.60	0.14	NA	NCC	NCC	NCC	NCC
Moretane	15 / 17	0.00024 - 17	Average of NFSB-03 15-17' and field duplicate	1.0	0.015	6 / 6	0.025	0.014	8 / 8	0.093	0.026	12 / 14	0.11	0.028	0 / 0	NA	NA	8 / 8	0.093	0.026	12 / 14	0.11	0.028	NA	NCC	NCC	NCC	NCC

Notes:
1. Only detected analytes are listed. Laboratory reporting limits are shown in the Soil Analytical Results Table.
2. Samples included in these statistics are presented in the Soil Analytical Results Table.
   Field duplicate and laboratory duplicate results (yellow-highlighted in the Soil Analytical Results Table) were averaged and the average results are included in these statistics.
3. These statistics only include analytical results for samples in which a constituent was detected above the laboratory reporting limit (RL).
4. These statistics include all detected constituent concentrations and one-half the RL for samples in which a constituent was not detected above the RL.
5. Based on the statistics of samples with sampling depth include all or part of the 0 to 3 feet interval.
6. Based on the statistics of samples with sampling depth include all or part of the 0 to 6 feet interval.
7. Based on the statistics of samples with sampling depth include all or part of the 0 to 15 feet interval.
8. Background concentration from MassDEP, 2002. Technical Update: Background Levels of Polycyclic Aromatic Hydrocarbons and Metals in Soil. May.
   Values for natural soil were used.
9. EPCs for human health risk characterization were based on the arithmetic means of 0-15 feet soil samples, the arithmetic means of 0-6 feet soil samples, or the arithmetic means of 0-3 feet soil samples, whichever higher.
10. The soil concentrations for upper concentration limit (UCL) comparison purpose was based on the arithmetic mean of all soil samples included in the Soil Analytical Results table, including those collected beyond 15 feet below ground surface.
11. The arithmetic mean concentration of C9-C12 aliphatics was not higher than the arithmetic mean concentration of C9-C18 aliphatics. C9-C18 aliphatics was
    retained as a COC; and C9-C12 aliphatics was not included as a soil COC to avoid redundency.
12. Multiple alkylated polycyclic aromatic hydrocarbon and geochemical biomarkers were not included as COCs due to the lack of toxicity values.
13. Concentrations are presented in units of milligrams per kilogram (mg/kg) or parts per million (ppm).
14. Naphthalene was analyzed by multiple analytical methods. When multiple results are available for a sample, either the maximum detected concentration (detected via at least one method) or the minimum RL (if none detected) was used to represent the result.
15. Total Xylene is calculated by adding the m&p-xylene and o-xylene if they are both detected. If only one is detected, half the reporting limit of the other is used in the sum. If neither are detected the total is less than the minimum reporting limit.

Abbreviations:
EPC = exposure point concentration; NA = not available; ND = not detected; NCC = Not a constitute of concern; PAC = Physiologically Available Cyanide; COC = constituent of concern.

TABLE D-4
GROUNDWATER ANALYTICAL RESULTS
284 Winter Street
Haverhill, Massachusetts

Location	ENV-1MW				ENV-3MW			ENV-5MW								ENV-8MW			MW-1		
Screened Interval (ft bgs)	11-21				10-20			12-22								10-20			5-15		
Groundwater Depth[20] (ft bgs)	13.36				13.48			14.44								14.82			3.24		
Sample ID	ENV-1MW-20150512[10]	ENV-1MW	ENV-1MW	Temporal	ENV-3MW	ENV-3MW	Temporal	ENV-5MW-20150512[10,14,19]	ENV-5MW-20150512[10,14]	DUP-20150512[10,14]	ENV-5MW	ENV-5MW	ENV-5MW	Temporal	ENV-8MW-20150512[10]	ENV-8MW	Temporal	MW-1-20150512[10]	MW-1[11]	MW-1
Sampling Date	5/12/2015	2/12/2020	8/11/2021	Average	5/7/2020	8/11/2021	Average	5/12/2015	5/12/2015	5/12/2015	2/12/2020	5/7/2020	8/11/2021	Average	5/12/2015	8/11/2021	Average	5/12/2015	12/1/2014	9/15/2020
Lab Sample ID	L1510372-04	L2006490-02	L2143342-01		L2019097-01	L2143342-02		L1510372-02	L1510372-02	L1510372-03	L2006490-05	L2019097-02	L2143342-03		L1510372-01	L2143342-04		L1510372-07		
Extractable Petroleum Hydrocarbons (µg/L)																				
C_9-C_{18} Aliphatics	<1000	172	-	172	<2000	<5000	<2000	<1,000	-	<1,000	<1000	<1000	<1000	<1000	<1,000	<500	<500	<4,000	610	<5000
C_{19}-C_{36} Aliphatics	<1000	<100	-	<100	<2000	<5000	<2000	<1,000	-	<1,000	<1000	<1000	<1000	<1000	<1,000	<500	<500	<4,000	1,500	<5000
C_{11}-C22 Aromatics	1,960	<100	-	<100	5,820	9,980	7900	1,770	-	1,970	3660	2790	4360	3603	2,740	1,280	2010	5,690	2,900	7,560
C_{11}-C_{22} Aromatics, Adjusted	<1000	<100	-	<100	<2000	<5000	<2000	<1,000	-	<1,000	1750	1300	2410	1820	1,250	573	912	<4,000	-	<5000
Naphthalene	1,080	<10	-	<10	3,630	5,290	4460	854	-	905	1580	12800	1610	5330	1,290	704	997	3,560	3,100	6,630
2-Methylnaphthalene	219	<10	-	<10	378	<500	314	146	-	154	322	215	332	290	204	<50.0	115	<400	590	549
Acenaphthylene	<100	<10	-	<10	<200	<500	<200	<100	-	<100	<100	<100	<100	<100	<100	<50.0	<50	<400	130	140
Acenaphthene	<100	<10	-	<10	<200	<500	<200	<100	-	<100	<100	<100	<100	<100	<100	<50.0	<50	<400	35	<100
Fluorene	<100	<10	-	<10	<200	<500	<200	<100	-	<100	<100	<100	<100	<100	<100	<50.0	<50	<400	91	<100
Phenanthrene	<100	<10	-	<10	<200	<500	<200	<100	-	<100	<100	<100	<100	<100	<100	<50.0	<50	<400	230	<100
Anthracene	<100	<10	-	<10	<200	<500	<200	<100	-	<100	<100	<100	<100	<100	<100	<50.0	<50	<400	59	<100
Fluoranthene	<100	<10	-	<10	<200	<500	<200	<100	-	<100	<100	<100	<100	<100	<100	<50.0	<50	<400	79	<100
Pyrene	<100	<10	-	<10	<200	<500	<200	<100	-	<100	<100	<100	<100	<100	<100	<50.0	<50	<400	110	<100
Benzo(a)anthracene	<100	<10	-	<10	<200	<500	<200	<100	-	<100	<100	<100	<100	<100	<100	<50.0	<50	<400	35	<100
Chrysene	<100	<10	-	<10	<200	<500	<200	<100	-	<100	<100	<100	<100	<100	<100	<50.0	<50	<400	38	<100
Benzo(b)fluoranthene	<100	<10	-	<10	<200	<500	<200	<100	-	<100	<100	<100	<100	<100	<100	<50.0	<50	<400	24	<100
Benzo(k)fluoranthene	<100	<10	-	<10	<200	<500	<200	<100	-	<100	<100	<100	<100	<100	<100	<50.0	<50	<400	<10	<100
Benzo(a)pyrene	<100	<10	-	<10	<200	<500	<200	<100	-	<100	<100	<100	<100	<100	<100	<50.0	<50	<400	27	<50.0
Indeno(1,2,3-cd)Pyrene	<100	<10	-	<10	<200	<500	<200	<100	-	<100	<100	<100	<100	<100	<100	<50.0	<50	<400	13	<100
Dibenzo(a,h)anthracene	<100	<10	-	<10	<200	<500	<200	<100	-	<100	<100	<100	<100	<100	<100	<50.0	<50	<400	<10	<100
Benzo(g,h,i)perylene	<100	<10	-	<10	<200	<500	<200	<100	-	<100	<100	<100	<100	<100	<100	<50.0	<50	<400	17	<100
Volatile Petroleum Hydrocarbons (µg/L)																				
C_5-C_8 Aliphatics	<2500	<2000	<500	<500	11,800	12,500	12150	19,800*	12,200	14,200	13500	11300	12200	12333	6,600	2,960	4780	15,700	<10,000	29,000
C_9-C_{12} Aliphatics	20,900	12000	5240	8620	14,300	14,000	14150	1,900*	7,300	7,710	7190	6030	5670	6297	25,200	4,800	15000	6,790	<10,000	<10000
C_9-C_{10} Aromatics	5,720	6150	2800	4475	7,930	7,080	7505	<1,250*	<5,000	<2,500	<5000	5120	<5000	3373	2,900	1,190	2045	<2,500	<10,000	<10000
C_5-C_8 Aliphatics, Adjusted	<2500	<2000	<500	<500	<5000	<5000	<5000	6,550*	<5,000	5,060	<5000	<5000	<5000	<5000	2,530	<1000	1515	5,410	-	<10000
C_9-C_{12} Aliphatics, Adjusted	11,500	<2000	<500	<500	<5000	<5000	<5000	<1,250*	5,810	5,940	<5000	<5000	<5000	<5000	14,700	<1000	7600	5,450	-	<10000
Benzene	<100	<40	14.1	17	8,820	8,390	8605	12,000*	6,710	8,260	9730	8340	8020	8697	4,010	1,990	3000	9,150	16,000	19,500
Toluene	<100	308	178	243	<100	<100	<100	1,230*	664	834	382	374	253	336	51	<20	30	1,150	2,500	4,060
Ethylbenzene	1,630	2280	764	1522	2,900	2,740	2820	1,230*	661	812	1210	988	844	1014	3,530	1,450	2490	620	510	697
p/m-Xylene	1,230	1410	593	1002	1,190	1,070	1130	855*	492	572	771	640	578	663	2,700	958	1829	335	-	718
o-Xylene	797	1300	786	1043	1,590	1,520	1555	562*	332	386	754	626	550	643	1,380	619	1000	390	-	1450
Total Xylene	2,027	2710	1379	2045	2,780	2,590	2685	1,417	824	958	1525	1266	1128	1306	4,080	1,577	2829	725	1,150	2,168
Methyl tert butyl ether	<150	<60	<15.0	<15	<150	164	119.5	<75*	<300	<150	<150	<150	<150	<150	<60	<30.0	<30	<150	<500	<300
Naphthalene	2,490	2220	906	1563	8,770	7,690	8230	2,210*	1,580	1,740	3700	3200	3020	3307	3,180	1,210	2195	5,610	8,200	9,600
Naphthalene (via multiple analyses)	2,490	2,220	906	1563	8,770	7,690	8230	2,210	1,580	1,740	3,700	12,800	3,020	6507	3,180	1,210	2195	5,610	8,200	9,600
Volatile Organics (µg/L)																				
Styrene	-	-	100	100	-	<25	<25	-	-	-	-	-	<25	<25	-	<10	<10	-	-	-
Inorganics (µg/L)																				
Cyanide, Physiologically Available	-	-	59	59	-	367	367	-	-	-	-	-	518	518	-	185	185	-	-	-

Notes

1. <X indicates analyte not detected above laboratory reporting limit.
2. Grey-highlighted results were deemed no longer representative of the current conditions and therefore were not included in the risk characterization.
3. Green-highlighted results were used to calculate the temple averages for the monitoring wells.
4. Yellow-highlighted results were deemed at or outside the extent of the contamination and therefore not quantitatively included in this risk characterization.
5. Naphthalene was analyzed by both the VPH and EPH analytical methods. If naphthalene was detected via at least one method, the maximum detected concentration is listed to represent the sample result. If naphthalene was not detected via either method, the minimum RL is listed as the RL for the nondetected sample result.
6. Groundwater depth measurements in units of feet below ground surface (ft bgs) were taken on March 11, 2020.
7. For data qualified with an asterisk (*), according to the analytical data table provided by Ramboll Environ, "The laboratory noted high relative percent differences between the original and the re-analysis due to dilution for VPH sample ENV-5MW-20150512. The laboratory attributed the difference to varying analyte concentrations between the sample vials. The field duplicate pair to sample ENV-5MW-20150512 (DUP-20150512) was analyzed and confirmed the sample re-analysis result; as such, precision criterion between the sample and duplicate were met. Therefore, the original reported results are considered estimated values due to poor precision."
8. Quality Assurance/Quality Control Samples include:
   DUP = Field Duplicate
   EB = Equipment Blank
   TB = Trip Blank
9. "-" indicates not analyzed.
10. Samples results were provided by Ramboll Environ Inc. of Westford, MA.
11. Samples results provided from the *Draft I/II Environmental Site Assessment, 284 Winter Street, Haverhill, MA* , prepared by Lessard Environmental Inc., December, 2014
12. Total Xylenes was calculated from m/p-Sylene and o-Xylene. When neither was detected the maximum detection limit was used.
13. Based on the Site map provided by Ramboll Environ, it was assumed that samples MW-1-20150512 and MW-1; MW-1-20150512 and MW-2; and MW-3-20150515 and MW-3 were collected from the same monitoring wells.
14. It was assumed that DUP-201501512 is a field duplicate sample of ENV-5MW-20150512 (L1510372-02 and L1510372-02 R1). Laboratory reports from this sampling round will confirm this assumption.
15. A sample average was calculated for ENV-5MW-20150512 and DUP-20151512. For the EPH analytes, results for L1510372-02 were used in calculating the sample average, while the average for VOP analytes used results for L1510372-02 R1. For results below the detection limit, one half the detection limit was used to calculate the average.
16. When a sample duplicate was collected, the laboratory results for the sample and the sample duplicate were average. For results below the laboratory detection limit, one half the detection limit was used when calculating the average.
17. Temporal averages were calculated and used to represent the levels at each well when multiple rounds of results (gray highlighted) are available.
    When the analyte was deteced in at least one round, the half reporting limit was used for the nondetect, if any, for the average calculation.
    If the analyte was not detected during any sampling round, the temporal average was presented as a nondetect and the lowest laboratory reporting limit was used to represent the reporting limit for the temporal average result.

TABLE D-4
GROUNDWATER ANALYTICAL RESULTS
284 Winter Street
Haverhill, Massachusetts

Location	MW-2					MW-3			B-102				B-106			NFSB-01 (MW)	NFSB-08(MW)	GZA-1	GZA-1A	GZA-2
Screened Interval (ft bgs)	5-15					8-18			10-20				10-20			12-22	12-22			
Groundwater Depth[20] (ft bgs)	13.20					12.16			11.95				12.90			13.21	15.17			
Sample ID	MW-2-20150512[10]	MW-2[11]	MW-2	MW-2	Temporal Average	MW-3-20150512[10]	MW-3[11]	MW-3	B102	B102	B102	Temporal Average	B106	B106	Temporal Average	NFSB-01 (MW)	NFSB-08(MW)	GZA-1	GZA-1A	GZA-2
Sampling Date	5/12/2015	12/1/2014	2/12/2020	5/7/2020		5/12/2015	12/1/2014	2/12/2020	2/12/2020	5/7/2020	8/11/2021		2/12/2020	5/7/2020		5/7/2020	5/7/2020			
Lab Sample ID	L1510372-06		L2006490-04	L2019097-04		L1510372-05		L2006490-06	L2006490-01	L2019097-06	L2143342-05		L2006490-03	L2019097-05		L2019097-03	L2019097-07	L2038556-01	L2038556-02	L2038556-03
Extractable Petroleum Hydrocarbons (µg/L)																				
C_9-C_{18} Aliphatics	<1,000	-	<100	<500	<100	<100	-	<100	<2000	<2000	-	<2000	616	<4000	1308	<500	<100	<100	<100	<100
C_{19}-C_{36} Aliphatics	<1,000	-	<100	<500	<100	<100	-	<100	<2000	<2000	-	<2000	<100	<4000	<100	<500	<100	<100	<100	<100
C_{11}-C22 Aromatics	2,520	-	449	667	558	702	-	435	3510	3310	-	3410	660	8200	4430	1030	109	<100	<100	<100
C_{11}-C_{22} Aromatics, Adjusted	<1,000	-	250	<500	250	560	-	235	<2000	<2000	-	<2000	547	<4000	1274	828	109	<100	<100	<100
Naphthalene	1,520	-	165	220	193	37.3	-	166	2000	1660	-	1830	48.9	4230	2139	200	<10	0.886	1.22	<0.400
2-Methylnaphthalene	279	-	33.8	<50	29	30.4	-	33.9	220	<200	-	160	<10	479	242	<50	<10	<0.400	<0.400	<0.400
Acenaphthylene	<100	-	<10	<50	<10	28.4	-	<10	<200	<200	-	<200	20	<400	110	<50	<10	<0.400	<0.400	<0.400
Acenaphthene	<100	-	<10	<50	<10	14.9	-	<10	<200	<200	-	<200	15.8	<400	108	<50	<10	<0.400	<0.400	<0.400
Fluorene	<100	-	<10	<50	<10	13.9	-	<10	<200	<200	-	<200	10.3	<400	105	<50	<10	<0.400	<0.400	<0.400
Phenanthrene	<100	-	<10	<50	<10	16.2	-	<10	<200	<200	-	<200	18.2	<400	109	<50	<10	<0.400	<0.400	<0.400
Anthracene	<100	-	<10	<50	<10	<10	-	<10	<200	<200	-	<200	<10	<400	<10	<50	<10	<0.400	<0.400	<0.400
Fluoranthene	<100	-	<10	<50	<10	<10	-	<10	<200	<200	-	<200	<10	<400	<10	<50	<10	<0.400	<0.400	<0.400
Pyrene	<100	-	<10	<50	<10	<10	-	<10	<200	<200	-	<200	<10	<400	<10	<50	<10	<0.400	<0.400	<0.400
Benzo(a)anthracene	<100	-	<10	<50	<10	<10	-	<10	<200	<200	-	<200	<10	<400	<10	<50	<10	<0.400	<0.400	<0.400
Chrysene	<100	-	<10	<50	<10	<10	-	<10	<200	<200	-	<200	<10	<400	<10	<50	<10	<0.400	<0.400	<0.400
Benzo(b)fluoranthene	<100	-	<10	<50	<10	<10	-	<10	<200	<200	-	<200	<10	<400	<10	<50	<10	<0.400	<0.400	<0.400
Benzo(k)fluoranthene	<100	-	<10	<50	<10	<10	-	<10	<200	<200	-	<200	<10	<400	<10	<50	<10	<0.400	<0.400	<0.400
Benzo(a)pyrene	<100	-	<10	<50	<10	<10	-	<10	<200	<200	-	<200	<10	<400	<10	<50	<10	<0.200	<0.200	<0.200
Indeno(1,2,3-cd)Pyrene	<100	-	<10	<50	<10	<10	-	<10	<200	<200	-	<200	<10	<400	<10	<50	<10	<0.400	<0.400	<0.400
Dibenzo(a,h)anthracene	<100	-	<10	<50	<10	<10	-	<10	<200	<200	-	<200	<10	<400	<10	<50	<10	<0.400	<0.400	<0.400
Benzo(g,h,i)perylene	<100	-	<10	<50	<10	<10	-	<10	<200	<200	-	<200	<10	<400	<10	<50	<10	<0.400	<0.400	<0.400
Volatile Petroleum Hydrocarbons (µg/L)					-										-					
C_5-C_8 Aliphatics	<2,5000	<10,000	<400	434	317	170	910	134	<5000	<2500	<2500	<2500	6910	<5000	4705	1740	183	<100	114	<100
C_9-C_{12} Aliphatics	11,500	20,000	867	1140	1004	592	710	493	29600	21600	19800	23667	17000	9600	13300	3940	199	106	104	<100
C_9-C_{10} Aromatics	2,680	11,000	554	697	626	270	1,000	478	19900	15200	13100	16067	10200	6840	8520	2730	170	<100	100	<100
C_5-C_8 Aliphatics, Adjusted	<2,5000	-	<400	<400	<400	165	-	132	<5000	<2500	<2500	<2500	<5000	<5000	<5000	<1000	183	<100	114	<100
C_9-C_{12} Aliphatics, Adjusted	6,430	-	<400	<400	<400	311	-	<100	<5000	<2500	<2500	<2500	<5000	<5000	<5000	<1000	<100	103	<100	<100
Benzene	<100	400	66.1	96.2	81	5.18	15	2.8	<100	<50	<50	<50	3680	1720	2700	1020	<2	<2.00	<2.00	<2.00
Toluene	<100	430	12.7	18.6	16	<5	2.1	<2	<100	<50	<50	<50	688	<100	369	3704	<2	<2.00	<2.00	<2.00
Ethylbenzene	1,220	7,000	146	214	180	<5	2.8	<2	2180	1500	1210	1630	2570	1210	1890	620	<2	<2.00	<2.00	<2.00
p/m-Xylene	551	-	37.7	48.7	43	5.24	-	3.23	5150	3460	2900	3837	2180	579	1380	183	<2	2.32	6.16	<2.00
o-Xylene	656	-	64.4	133	99	5.62	-	4.48	2720	1950	1730	2133	1580	803	1192	207	<2	<2.00	<2.00	<2.00
Total Xylene	1,207	6,300	102.1	181.7	142	10.86	15	7.71	7870	5410	4630	5970	3760	1382	2571	390	<2	3.32	7.16	<2
Methyl tert butyl ether	<150	<500	34.5	41.6	38	<7.5	<5	<3	<150	<75	<75.0	<75	<150	<150	<150	<30	<3	<3.00	<3.00	<3.00
Naphthalene	3,510	11,000	402	558	480	64.1	350	195	4910	4280	3960	4383	9950	9640	9795	477	<4	<4.00	<4.00	<4.00
Naphthalene (via multiple analyses)	3,510	11,000	402	558	480	64	350	195	4,910	4,280	3,960	4383	9,950	9,640	9795	477	<4	0.89	1.2	<0.4
Volatile Organics (µg/L)																				
Styrene	-	-	-	-	-	-	-	-	-	-	440	440	-	-	-	-	-	-	-	-
Inorganics (µg/L)																				
Cyanide, Physiologically Available	-	-	-	-	-	-	-	-	-	-	12	12	-	-	-	-	-	-	-	-

Notes
1. <X indicates analyte not detected above laboratory reporting limit.
2. Grey-highlighted results were deemed no longer representative of the current conditions and therefore were not included in the risk characterization.
3. Green-highlighted results were used to calculate the temple averages for the monitoring wells.
4. Yellow-highlighted results were deemed at or outside the extent of the contamination and therefore not quantitatively included in this risk characterization.
5. Naphthalene was analyzed by both the VPH and EPH analytical methods. If naphthalene was detected via at least one method, the maximum detected concentration is listed to represent the sample result. If naphthalene was not detected via either method, the minimum RL is listed as the RL for the nondetected sample result.
6. Groundwater depth measurements in units of feet below ground surface (ft bgs) were taken on March 11, 2020.
7. For data qualified with an asterisk (*), according to the analytical data table provided by Ramboll Environ, "The laboratory noted high relative percent differences between the original and the re-analysis due to dilution for VPH sample ENV-5MW-20150512. The laboratory attributed the difference to varying analyte concentrations between the sample vials. The field duplicate pair to sample ENV-5MW-20150512 (DUP-20150512) was analyzed and confirmed the sample re-analysis result; as such, precision criterion between the sample and duplicate were met. Therefore, the original reported results are considered estimated values due to poor precision."
8. Quality Assurance/Quality Control Samples include:
   DUP = Field Duplicate
   EB = Equipment Blank
   TB = Trip Blank
9. "-" indicates not analyzed.
10. Samples results were provided by Ramboll Environ Inc. of Westford, MA.
11. Samples results provided from the *Draft I/II Environmental Site Assessment, 284 Winter Street, Haverhill, MA* , prepared by Lessard Environmental Inc., December, 2014
12. Total Xylenes was calculated from m/p-Sylene and o-Xylene. When neither was detected the maximum detection limit was used.
13. Based on the Site map provided by Ramboll Environ, it was assumed that samples MW-1-20150512 and MW-1; MW-1-20150512 and MW-2; and MW-3-20150515 and MW-3 were collected from the same monitoring wells.
14. It was assumed that DUP-201501512 is a field duplicate sample of ENV-5MW-20150512 (L1510372-02 and L1510372-02 R1). Laboratory reports from this sampling round will confirm this assumption.
15. A sample average was calculated for ENV-5MW-20150512 and DUP-20151512. For the EPH analytes, results for L1510372-02 were used in calculating the sample average, while the average for VOP analytes used results for L1510372-02 R1. For results below the detection limit, one half the detection limit was used to calculate the average.
16. When a sample duplicate was collected, the laboratory results for the sample and the sample duplicate were average. For results below the laboratory detection limit, one half the detection limit was used when calculating the average.
17. Temporal averages were calculated and used to represent the levels at each well when multiple rounds of results (gray highlighted) are available.
    When the analyte was deteced in at least one round, the half reporting limit was used for the nondetect, if any, for the average calculation.
    If the analyte was not detected during any sampling round, the temporal average was presented as a nondetect and the lowest laboratory reporting limit was used to represent the reporting limit for the temporal average result.

TABLE D-5
SUMMARY OF ANALYTICAL DATA FOR GROUNDWATER (µg/L)
284 Winter Street
Haverhill, Massachusetts

Analytical Parameter [1]	Frequency of Detection[2]	Range Detected[3]	Median Concentration[4]	Arithmetic Mean Concentration[4]	Maximum Detected Concentration	
					Location	Sampling Date
Extractable Petroleum Hydrocarbons (µg/L)						
C9-C18 Aliphatics	2 / 11	172 - 1308	250	648	B-106	Temporal Average
C11-C22 Aromatics, Adjusted	7 / 11	109 - 1820	912	907	ENV-5MW	Temporal Average
2-Methylnaphthalene	8 / 11	29 - 549	115	161	MW-1	15-Sep-20
Acenaphthylene	2 / 11	110 - 140	25	52	MW-1	15-Sep-20
Acenaphthene	1 / 11	108 - 108	25	43	B-106	Temporal Average
Fluorene	1 / 11	105 - 105	25	43	B-106	Temporal Average
Phenanthrene	1 / 11	109 - 109	25	44	B-106	Temporal Average
Volatile Petroleum Hydrocarbons (µg/L)						
C9-C10 Aromatics	10 / 11	170 - 16067	3373	4635	B-102	Temporal Average
C5-C8 Aliphatics, Adjusted	3 / 11	132 - 1515	1250	1503	ENV-8MW	Temporal Average
C9-C12 Aliphatics, Adjusted	1 / 11	7600 - 7600	1250	2036	ENV-8MW	Temporal Average
Benzene	9 / 11	2.8 - 19500	1020	3968	MW-1	15-Sep-20
Toluene	7 / 11	16 - 4060	50	803	MW-1	15-Sep-20
Ethylbenzene	9 / 11	180 - 2820	1014	1170	ENV-3MW	Temporal Average
p/m-Xylene	10 / 11	3.2 - 3837	718	981	B-102	Temporal Average
o-Xylene	10 / 11	4.5 - 2133	1000	848	B-102	Temporal Average
Total Xylene	10 / 11	7.7 - 5970	2045	1829	B-102	Temporal Average
Methyl tert butyl ether	2 / 11	38 - 120	38	49	ENV-3MW	Temporal Average
Naphthalene (via multiple analyses)	10 / 11	195 - 9795	2195	3948	B-106	Temporal Average
Volatile Organics (µg/L)						
Styrene	2 / 5	100 - 440	13	114	B-102	Temporal Average
Inorganics (µg/L)						
Cyanide, Physiologically Available	5 / 5	12 - 518	185	228	ENV-5MW	Temporal Average

Notes:

1. Only detected analytes are listed. Laboratory reporting limits (RLs)are shown in the Groundwater Analytical Results table.
2. These summary statistics include each groundwater monitoring wells as a discrete point. Temporal average was used to represent the result for each monitering well with multiple rounds of results. Yellow-highlighted results in the Groundwater Analytical Results table were not included in the summary statistics. Grey-highlighted results in the Groundwater Analytical Results table were not included in the calculation of temporal average.
3. These statistics only include analytical results for constituents detected above the RLs.
4. These statistics include all detected constituent concentrations and one-half the RLs for constituents not detected above the RLs.

TABLE D-6A
2020 SEDIMENT SAMPLING ANALYTICAL RESULTS
284 Winter Street
Haverhill, Massachusetts

Sample ID / Sample Date	1A 0-6 08 Jun 2020	1A 1-5.5 08 Jun 2020	1B 0-6 08 Jun 2020	1C 0-6 08 Jun 2020	2A 0-6 09 Jun 2020	2A 1-4 09 Jun 2020	2C 0-6 09 Jun 2020	3B 0-6 09 Jun 2020	3C 0-6 09 Jun 2020	4A 1-2.5 09 Jun 2020	4B 0-6 09 Jun 2020	5A 0-6 09 Jun 2020	5A 2-3 11 Jun 2020	5B 0-6 09 Jun 2020	5C 0-6 09 Jun 2020	Maximum Detected Concentration	Maximum Detected Concentration in Top 1 Foot
Alkylated PAHs by 8270D-SIM(M)																	
Anthracene	0.810	-	6.92	1.11	-	-	25.7	-	3.20	-	2.71	-	-	2.45	0.803	26	26
Pyrene	3.11	-	16.5	2.50	-	-	46.5	-	4.82	-	5.92	-	-	4.22	4.90	47	47
Benzo(ghi)perylene	0.906	-	3.33	0.561	-	-	8.62	-	0.583	-	1.32	-	-	0.882	0.892	8.6	8.6
Benzo(e)pyrene	0.854	-	3.50	0.578	-	-	9.70	-	0.705	-	1.21	-	-	0.894	0.810	9.7	9.7
Indeno(1,2,3-cd)pyrene	0.880	-	3.34	0.592	-	-	9.95	-	0.652	-	1.57	-	-	0.971	0.919	10.0	10.0
Perylene	0.288	-	1.09	0.215	-	-	3.93	-	0.268	-	0.612	-	-	0.372	0.336	3.9	3.9
Benzo(b)fluoranthene	0.869	-	3.44	0.634	-	-	12.2	-	0.793	-	1.82	-	-	1.18	1.03	12	12
Fluoranthene	2.03	-	10.3	2.16	-	-	41.2	-	3.90	-	5.82	-	-	4.88	4.57	41	41
Acenaphthylene	1.01	-	4.22	0.762	-	-	18.6	-	1.98	-	0.308	-	-	0.634	0.612	19	19
Chrysene	1.57	-	6.02	1.12	-	-	22.2	-	1.78	-	2.02	-	-	1.50	1.59	22	22
C1-Chrysenes	1.80	-	4.71	0.955	-	-	19.0	-	1.65	-	0.720	-	-	0.694	1.02	19	19
C2-Chrysenes	1.08	-	2.26	0.508	-	-	9.11	-	0.794	-	0.311	-	-	0.357	0.661	9.1	9.1
C3-Chrysenes	0.508	-	1.17	0.289	-	-	4.67	-	0.452	-	0.287	-	-	0.400	0.500	4.7	4.7
C4-Chrysenes	0.226	-	0.454	0.124	-	-	1.40	-	0.218	-	0.145	-	-	0.280	0.249	1.4	1.4
Benzo(a)pyrene	1.29	-	7.01	1.01	-	-	20.6	-	1.44	-	2.16	-	-	1.42	1.29	21	21
Benzo(a)anthracene	1.54	-	7.19	1.19	-	-	22.6	-	2.04	-	2.47	-	-	1.61	1.48	23	23
Acenaphthene	0.232	-	3.70	0.975	-	-	21.0	-	11.8	-	6.19	-	-	6.52	0.562	21	21
Phenanthrene	1.78	-	16.5	3.18	-	-	77.1	-	10.2	-	9.36	-	-	14.1	2.80	77	77
Fluorene	0.296	-	3.34	0.717	-	-	22.5	-	6.73	-	3.24	-	-	3.94	0.436	23	23
C1-Fluorenes	0.474	-	3.03	0.630	-	-	18.1	-	2.18	-	1.35	-	-	2.27	0.644	18	18
C2-Fluorenes	0.489	-	2.10	0.418	-	-	10.4	-	1.06	-	0.360	-	-	0.438	0.723	10	10
C3-Fluorenes	0.375	-	0.965	0.187	-	-	3.55	-	0.361	-	0.125	-	-	0.196	0.385	3.6	3.6
Naphthalene	0.154	-	2.92	0.926	-	-	8.60	-	76.4	-	37.0	-	-	0.342	0.175	76	76
C1-Naphthalenes	0.256	-	2.34	0.806	-	-	21.8	-	49.9	-	17.3	-	-	1.68	0.180	50	50
C2-Naphthalenes	0.578	-	5.04	1.15	-	-	35.7	-	14.2	-	7.17	-	-	4.81	0.458	36	36
C3-Naphthalenes	0.469	-	3.23	0.579	-	-	17.4	-	2.31	-	1.71	-	-	2.84	0.567	17	17
C4-Naphthalenes	0.202	-	1.12	0.169	-	-	4.34	-	0.478	-	0.259	-	-	0.330	0.283	4.3	4.3
Benzo(j+k)fluoranthene	0.886	-	3.66	0.694	-	-	11.5	-	0.850	-	1.67	-	-	1.09	0.964	12	12
C1-Phenanthrenes/Anthracenes	2.54	-	13.6	2.43	-	-	66.0	-	7.15	-	2.88	-	-	2.57	3.02	66	66
C2-Phenanthrenes/Anthracenes	1.69	-	5.82	1.16	-	-	27.5	-	2.72	-	0.632	-	-	0.709	1.71	28	28
C3-Phenanthrenes/Anthracenes	0.624	-	1.71	0.363	-	-	7.49	-	0.690	-	0.169	-	-	0.216	0.557	7.5	7.5
C4-Phenanthrenes/Anthracenes	0.166	-	0.409	0.086	-	-	1.60	-	0.153	-	0.061	-	-	0.088	0.152	1.6	1.6
Dibenz[ah]+[ac]anthracene	0.258	-	0.918	0.158	-	-	3.03	-	0.213	-	0.376	-	-	0.245	0.227	3.0	3.0
C1-Fluoranthenes/Pyrenes	2.82	-	12.5	2.03	-	-	49.0	-	4.63	-	2.04	-	-	1.46	2.47	49	49
Extractable Petroleum Hydrocarbons (EPH)																	
C9-C18 Aliphatic hydrocarbons	15.2	< 678	46.7	7.74	1,670	663	93.7	< 953	< 69.2	1,560	< 37.1	463	< 834	< 8.23	33.6	1670	1670
C19-C36 Aliphatic Fraction	34.9	< 678	55.4	22.5	1,250	< 660	130	< 953	87.8	851	< 37.1	284	907	57.9	86.9	1250	1250
C11-C22 Aromatic hydrocarbons, Adjusted	280	5,840	308	72.4	16,300	6,010	773	3,860	217	3,320	71.2	1,400	4,240	98.1	114	16300	16300
Anthracene	-	74.7	-	-	266	176	-	53.7	-	45.8	-	< 14	112	-	-	266	266
Pyrene	-	163	-	-	475	350	-	105	-	81.9	-	30.8	215	-	-	475	475
Benzo(ghi)perylene	-	< 33.9	-	-	< 50.7	39.2	-	< 47.6	-	< 23.2	-	< 14	< 41.7	-	-	39	ND
Indeno(1,2,3-cd)pyrene	-	< 33.9	-	-	< 50.7	44.3	-	< 47.6	-	< 23.2	-	< 14	< 41.7	-	-	44	ND
Benzo(b)fluoranthene	-	38.3	-	-	96.7	99.4	-	< 47.6	-	< 23.2	-	< 14	62.9	-	-	99	97
Fluoranthene	-	121	-	-	320	327	-	74.2	-	61.4	-	24.1	218	-	-	327	320
Benzo(k)fluoranthene	-	< 33.9	-	-	< 50.7	37.3	-	< 47.6	-	< 23.2	-	< 14	< 41.7	-	-	37	ND
Acenaphthylene	-	< 33.9	-	-	< 50.7	88.8	-	< 47.6	-	< 23.2	-	< 14	42.6	-	-	89	ND
Chrysene	-	72.6	-	-	192	117	-	< 47.6	-	28.2	-	14.7	78.5	-	-	192	192
Benzo(a)pyrene	-	41.6	-	-	109	98.0	-	< 47.6	-	< 23.2	-	< 14	56.2	-	-	109	109
Dibenzo(a,h)anthracene	-	< 33.9	-	-	< 50.7	< 33	-	< 47.6	-	< 23.2	-	< 14	< 41.7	-	-	ND	ND
Benzo(a)anthracene	-	65.0	-	-	201	146	-	< 47.6	-	30.4	-	14.5	88.5	-	-	201	201
Acenaphthene	-	170	-	-	454	126	-	115	-	93.8	-	27.3	215	-	-	454	454
Phenanthrene	-	295	-	-	1,020	610	-	248	-	184	-	39.0	412	-	-	1020	1020
Fluorene	-	103	-	-	434	187	-	102	-	74.7	-	15.6	150	-	-	434	434
Naphthalene	-	464	-	-	122	46.7	-	739	-	765	-	297	1,320	-	-	1320	739
2-Methylnaphthalene	-	341	-	-	< 50.7	< 33	-	414	-	373	-	132	548	-	-	548	414
Volatile Petroleum Hydrocarbons (VPH)																	
C5-C8 Aliphatics, Adjusted	< 5.22	< 351	< 5.38	< 5.33	< 27.3	< 27.2	< 7.77	< 762	< 102	< 939	< 108	< 322	< 1340	< 6.05	< 12.7	ND	ND
C9-C12 Aliphatics, adjusted	< 5.22	< 351	< 5.38	< 5.33	67.8	60.4	< 7.77	950	< 102	< 939	110	326	1,380	7.49	24.5	1380	950
C9-C10 Aromatic hydrocarbons	< 5.22	571	5.87	< 5.33	225	200	16.9	< 762	158	971	< 108	740	< 1340	< 6.05	24.8	971	740
Ethylbenzene	< 0.104	33.8	< 0.108	< 0.106	10.3	5.59	< 0.155	106	23.4	128	12.9	203	130	< 0.121	< 0.254	203	203
Toluene	< 0.104	< 7.01	< 0.108	< 0.106	< 0.547	< 0.543	< 0.155	< 15.2	< 2.05	< 18.8	< 2.15	< 6.44	< 26.8	< 0.121	< 0.254	ND	ND
Methyl tert-butyl ether	< 0.052	< 3.51	< 0.054	< 0.053	< 0.273	< 0.272	< 0.078	< 7.62	< 1.02	< 9.39	< 1.08	< 3.22	< 13.4	< 0.061	< 0.127	ND	ND
Xylene P,M	< 0.104	16.6	< 0.108	< 0.106	0.887	< 0.543	< 0.155	92.8	16.6	118	8.60	173	63.8	< 0.121	< 0.254	173	173
Benzene	< 0.104	< 7.01	< 0.108	< 0.106	0.562	< 0.543	< 0.155	37.1	2.72	< 18.8	< 2.15	< 6.44	< 26.8	< 0.121	< 0.254	37	37
Naphthalene	< 0.209	672	3.71	1.53	37.5	32.5	7.54	746	181	945	88.6	372	1,300	0.288	0.706	1300	746
Xylene O	< 0.104	12.9	< 0.108	< 0.106	2.73	1.76	< 0.155	47.4	7.68	62.4	5.47	83.6	40.5	< 0.121	< 0.254	84	84
Total Xylene (calculated)	< 0.104	29.5	< 0.108	< 0.106	3.62	2.03	< 0.155	140	24.3	180	14.1	257	104	< 0.121	< 0.254	257	257
Inorganics																	
Cyanide	< 1.1	-	< 1	< 1.1	-	-	< 1.2	-	< 1	-	< 1.2	-	-	< 1.2	< 1.2	ND	ND

Notes:
1. "<" indicates analyte not detected above laboratory reporting limit (RL).
2. "-" indicates the sample was not analyzed for the given analyte.
3. "ND" indicates all individual analytes included in the calculated sum were not detected above the respective laboratory reporting limits.
4. Concentrations are presented in units of milligrams per kilogram (mg/kg) or parts per million (ppm) unless otherwise noted.
5. The sum of the m/p-xylene and o-xylene results were used to represent the total xylene results. If neither was detected, the lowest RL of m/p-xylene and o-xylene was used to represent the RL of total xylene.
If either was detected, the sum of the m/p-xylene and o-xylene results was used to represent the total xylene result and half RL for the non-detect (if any) was used for the summation.
It should be noted that total xylene was reported for certain samples by the laboratory and the total xylene results derived using the above approach might be different from the results reported by the laboratory.
SIM = Selected Ion Monitoring; ND = Not Detected.

TABLE D-6B
2021 SEDIMENT ANALYTICAL RESULTS
284 Winter Street
Haverhill, Massachusetts

Location ID	AQSS-03	AQSS-03	AQSS-04	AQSS-04	AQSS-04	AQSS-05	AQSS-05	AQSS-06	AQSS-06
Sample ID	AQSS-03-0.0-0.5	AQSS-03-2.0-2.5	AQSS-04-0.0-0.5	AQSS-04-1.0-1.5	DUP2-20210930	AQSS-05-0.0-0.5	AQSS-05-1.0-1.5	AQSS-06-0.0-0.5	AQSS-06-1.5-2.0
Sample Date	09/30/21	09/30/21	09/30/21	09/30/21	09/30/21	09/29/21	09/29/21	09/29/21	09/29/21
Depth	0 - 0.5 ft	2 - 2.5 ft	0 - 0.5 ft	1 - 1.5 ft	0 - 0.5 ft	0 - 0.5 ft	1 - 1.5 ft	0 - 0.5 ft	1.5 - 2 ft
Sample Type	N	N	N	N	FD	N	N	N	N
Matrix	SE	SE	SE	SE	SE	SE	SE	SE	SE
Conventional Parameters (pct)									
Soot carbon	0.470 J	--	0.228 J	--	--	0.032 J	--	0.297	--
Total organic carbon	2.83 J	1.73 J	2.96 J	5.75 J	1.26 J	0.746 J	15.6 J	1.2	2.72
Total Solids	81.3	81.6	85.4	79.2	84.5	84.7	70.6	72.7	87
Metals (mg/kg)									
Arsenic	7.40 J	--	7.94 J	--	--	7.89 J	--	41.4	--
Barium	37.2	--	28.6	--	--	29.7	--	33.7	--
Cadmium	0.2943	--	0.6211	--	--	0.2315 U	--	0.4515	--
Chromium	34.9 J	--	414 J	--	--	40.9 J	--	56.4	--
Copper	--	--	--	--	--	--	--	--	--
Lead	153 J	--	167 J	--	--	98.0 J	--	346	--
Mercury	0.081 U	--	0.127 J	--	--	0.081 U	--	0.149 J	--
Selenium	2.42 U	--	2.27 U	--	--	2.31 U	--	2.67 U	--
Silver	0.604 U	--	0.569 U	--	--	0.579 U	--	0.667 U	--
Semivolatile Organics (µg/kg)									
1-Methylpyrene	--	--	601 J	1240	199 J	--	--	2610	--
2-Chloronaphthalene	492 U	94.9 U	--	--	--	456 U	214 U	--	31.6 J
2-Methylpyrene	--	--	969 J	1840	300 J	--	--	2660	--
3-Methylphenanthrene	--	--	1660 J	3220	557 J	--	--	7370	--
4-Methylpyrene	--	--	688 J	1370	224 J	--	--	2230	--
Benzo(b)fluorene	--	--	1610 J	2470	378 J	--	--	5660	--
Biphenyl (1,1'-Biphenyl)	--	--	236 J	391	73.7 J	--	--	2980	--
Polycyclic Aromatic Hydrocarbons (µg/kg)									
1-Methyldibenzothiophene	--	--	106 J	242	37.9 J	--	--	437	--
1-Methylnaphthalene	--	--	622 J	1440	188 J	--	--	9850	--
1-Methylphenanthrene	--	--	1400 J	3020	508 J	--	--	6450	--
2,3,5-Trimethylnaphthalene (1,6,7-Trimethylnaphthalene)	--	--	121 J	290	49.4 J	--	--	1240	--
2,6-Dimethylnaphthalene	--	--	403 J	722	127 J	--	--	5290	--
2-Methylanthracene	--	--	942 J	1840	282 J	--	--	4640	--
2-Methyldibenzothiophene & 3-Methyldibenzothiophene	--	--	426 J	908	138 J	--	--	1480	--
2-Methylnaphthalene	1090 J	1770 J	798	1750 J	641	169 J	4490	6190	2370
2-Methylphenanthrene	--	--	1980 J	3870	656 J	--	--	6880	--
4-Methyldibenzothiophene	--	--	295 J	678	114 J	--	--	1290	--
4-Methylphenanthrene & 9-Methylphenanthrene	--	--	1540 J	3060	481 J	--	--	7800	--
Acenaphthene	2060	2870	2540 J	2780 J	900 J	230 J	6730	12000	18100
Acenaphthylene	2760	4390	1100	2880 J	830	574	7190	5700	8680
Anthracene	7640	12000	5840 J	9180 J	1920 J	848	27700	16400	26500
Benzo(a)anthracene	8810	13800	9920 J	16200 J	3310 J	2380	34300	14600	29800
Benzo(a)fluoranthene	--	--	1720 J	2610	431 J	--	--	2810	--
Benzo(a)pyrene	8140	12000	9130 J	15100 J	3000 J	2440	30500	12400	24100
Benzo(b)fluoranthene	7060	9310	7820 J	12200 J	2640 J	2380	21700	9190	15800
Benzo(c)fluorene	--	--	664 J	1250	154 J	--	--	1620	--
Benzo(e)pyrene	--	--	5800 J	8590	1500 J	--	--	7070	--
Benzo(g,h,i)perylene	4270	6510	6150 J	9450 J	2080 J	1480	15400	6850	10200
Benzo(j,k)fluoranthene	--	--	7250 J	11000 J	2260 J	--	--	9270	--
Benzo(k)fluoranthene	5320	8640	--	--	--	1900	24200	--	14800
Benzonaphthothiophene	--	--	1740 J	2680	459 J	--	--	2460	--
Benzothiophene	--	--	67.4 J	105	20.4 J	--	--	351	--
Carbazole	--	--	2600 J	3520	643 J	--	--	577	--
Chrysene	7630	11300	9750 J	16800 J	3490 J	2760	32100	14500	25200
Decalin, cis- & trans-	--	--	3.34	8.07 J	2.30 J	--	--	195	--
Dibenzo(a,h)anthracene	1040	1980	--	--	--	345 J	4440	--	3300
Dibenzo(a,h)anthracene and Dibenzo(a,c)anthracene	--	--	2060 J	2800 J	909 J	--	--	2110	--
Dibenzofuran	--	--	1760 J	2470	508 J	--	--	6150	--
Dibenzothiophene	--	--	1550 J	2670	464 J	--	--	4150	--
Fluoranthene	20300	32900	27700 J	35500 J	6730 J	5530	71700	42700	66600
Fluorene	5050	8200	2750 J	4190 J	1110 J	535	20000	12100	24900
Indeno(1,2,3-c,d)pyrene	4420	7080	6370 J	9400 J	2110 J	1410	15400	6910	10600
Naphthalene	3590 J	5990 J	1850 J	3220 J	860 J	293 J	9270	10700	4440
Perylene	--	--	2300 J	3400	589 J	--	--	2980	--
Phenanthrene	19400	31800	25600 J	36100 J	7120 J	3890	75600	47500	82000
Pyrene	17600	26900	22700 J	31300 J	5760 J	4940	65700	40200	57000
Retene	--	--	6.57 U	30.2 U	5.60 U	--	--	9.19 U	--
Total PAH (16) (U = 1/2)	125000 J	200000 J	150000 J	220000 J	45000 J	32000 J	460000	260000	420000
C1-Benzo(b)thiophene	--	--	50.1 J	104	19.6 J	--	--	701	--
C1-Chrysenes	--	--	4240 J	7680	1310 J	--	--	8770	--
C1-Decalins	--	--	10.4	33.3	6.31	--	--	502	--
C1-Dibenzothiophenes	--	--	994 J	2200	358 J	--	--	3810	--
C1-Fluoranthenes/Pyrenes	--	--	7590 J	13700	2180 J	--	--	23600	--
C1-Fluorenes	--	--	932 J	1900	297 J	--	--	7910	--
C1-Naphthalenes	--	--	928 J	2080	544 J	--	--	10400	--
C1-Naphthobenzothiophenes	--	--	794 J	1490	251 J	--	--	1580	--
C1-Phenanthrenes/Anthracenes	--	--	7170 J	14300	2340 J	--	--	31800	--
C2-Benzo(b)thiophene	--	--	76.6 J	174	26.9 J	--	--	1410	--
C2-Chrysenes	--	--	1880 J	3570	598 J	--	--	4190	--
C2-Decalins	--	--	36.1 J	74.3	19.4 J	--	--	700	--
C2-Dibenzothiophenes	--	--	699 J	1710	272 J	--	--	2740	--
C2-Fluoranthenes/Pyrenes	--	--	3840 J	7060	1270 J	--	--	7310	--
C2-Fluorenes	--	--	856 J	1850	319 J	--	--	5940	--
C2-Naphthalenes	--	--	1160 J	2220	374 J	--	--	16100	--
C2-Naphthobenzothiophenes	--	--	404 J	812	130 J	--	--	874	--
C2-Phenanthrenes/Anthracenes	--	--	3420 J	7420	1180 J	--	--	14700	--
C3-Benzo(b)thiophene	--	--	90.2 J	221	34.3 J	--	--	1020	--
C3-Chrysenes	--	--	1220 J	2220	383 J	--	--	2510	--
C3-Decalins	--	--	53.6 J	15.1 U	2.80 UJ	--	--	475	--
C3-Dibenzothiophenes	--	--	407 J	1040	168 J	--	--	1400	--
C3-Fluoranthenes/Pyrenes	--	--	1520 J	2760	496 J	--	--	2950	--
C3-Fluorenes	--	--	1340 J	2640 J	506 J	--	--	2200	--
C3-Naphthalenes	--	--	1000 J	2090	356 J	--	--	11800	--
C3-Naphthobenzothiophenes	--	--	235 J	424	75.7 J	--	--	458	--
C3-Phenanthrenes/Anthracenes	--	--	1310 J	2920	446 J	--	--	4740	--
C4-Benzo(b)thiophene	--	--	51.4 J	137	20.2 J	--	--	377	--
C4-Chrysenes	--	--	529 J	1020	159 J	--	--	780	--
C4-Decalins	--	--	84.4 J	190	46.8 J	--	--	675	--
C4-Dibenzothiophenes	--	--	136 J	377	63.3 J	--	--	397	--
C4-Fluoranthenes/Pyrenes	--	--	799 J	1510	267 J	--	--	1270	--
C4-Naphthalenes	--	--	530 J	1220	196 J	--	--	4500	--
C4-Naphthobenzothiophenes	--	--	114 J	210	37.1 J	--	--	215	--
C4-Phenanthrenes/Anthracenes	--	--	424 J	971	153 J	--	--	1180	--
PCB Aroclors (µg/kg)									
Aroclor 1016	9.08 U	--	8.25 U	--	--	16.8 U	--	9.60 U	--
Aroclor 1221	9.08 U	--	8.25 U	--	--	16.8 U	--	9.60 U	--
Aroclor 1232	9.08 U	--	8.25 U	--	--	16.8 U	--	9.60 U	--
Aroclor 1242	216	--	149	--	--	769 J	--	58.9	--
Aroclor 1248	9.08 U	--	8.25 U	--	--	16.8 U	--	9.60 U	--
Aroclor 1254	223	--	264	--	--	380 J	--	60.0 J	--
Aroclor 1260	105	--	108	--	--	181 J	--	45	--
Aroclor 1262	9.08 U	--	8.25 U	--	--	16.8 U	--	9.60 U	--
Aroclor 1268	9.08 U	--	8.25 U	--	--	16.8 U	--	9.60 U	--
Total PCB Aroclors (U = 1/2)	571	--	546	--	--	1400 J	--	193 J	--
Extractable Petroleum Hydrocarbons (mg/kg)									
C9-C18 Aliphatics unadjusted	--	--	--	--	--	115 U	--	--	--
C19-C36 Aliphatics unadjusted	--	--	--	--	--	414	--	--	--
C11-C22 Aromatics adjusted	--	--	--	--	--	1410	--	--	--
C11-C22 Aromatics unadjusted	--	--	--	--	--	2310	--	--	--
Volatile Petroleum Hydrocarbons (mg/kg)									
Benzene	--	--	--	--	--	0.254 UJ	--	--	--
Ethylbenzene	--	--	--	--	--	0.254 UJ	--	--	--
m,p-Xylene	--	--	--	--	--	0.254 UJ	--	--	--
Methyl tert-butyl ether (MTBE)	--	--	--	--	--	0.127 UJ	--	--	--
o-Xylene	--	--	--	--	--	0.254 UJ	--	--	--
Toluene	--	--	--	--	--	0.254 UJ	--	--	--
C5-C8 Aliphatics adjusted	--	--	--	--	--	12.7 UJ	--	--	--
C5-C8 Aliphatics unadjusted	--	--	--	--	--	12.7 UJ	--	--	--
C9-C12 Aliphatics adjusted	--	--	--	--	--	12.7 UJ	--	--	--
C9-C12 Aliphatics unadjusted	--	--	--	--	--	12.7 UJ	--	--	--
C9-C10 Aromatics unadjusted	--	--	--	--	--	12.7 UJ	--	--	--

Location ID	AQSS-07	AQSS-07	AQSS-07D	AQSS-08	AQSS-08	AQSS-09	AQSS-10	AQSS-10	AQSS-11B	AQSS-11B	AQSS-11B
Sample ID	AQSS-07-0.0-0.5	AQSS-07-1.5-2.0	AQSS-07D-4.9-5.4	AQSS-08-0.0-0.5	AQSS-08-1.0-1.5	AQSS-09-0.0-0.5	AQSS-10-0.0-0.5	DUP1-20210929	AQSS-11B-0.0-0.5	AQSS-11B-1.5-1.9	AQSS-11B-2.5-3.0
Sample Date	09/29/21	09/29/21	09/30/21	09/29/21	09/29/21	09/29/21	09/29/21	09/29/21	09/28/21	09/28/21	09/28/21
Depth	0 - 0.5 ft	1.5 - 2 ft	4.9 - 5.4 ft	0 - 0.5 ft	1 - 1.5 ft	0 - 0.5 ft	0 - 0.5 ft	0 - 0.5 ft	0 - 0.5 ft	1.5 - 1.9 ft	2.5 - 3 ft
Sample Type	N	N	N	N	N	N	N	FD	N	N	N
Matrix	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE
Conventional Parameters (pct)											
Soot carbon	0.2	--	--	0.062	--	0.03	0.115	0.138	0.378	--	--
Total organic carbon	1.95	11	0.024 J	2.06	9.54	0.188	2.74	2.66	2.39	9.44	0.89
Total Solids	85.9	58.2	83.6	91.1	75.6	91.7	76.2	81.1	87.6	84	84
Metals (mg/kg)											
Arsenic	16.7	--	--	33.5	--	8.14	72	74.6	6.39	--	--
Barium	11.6	--	--	23	--	18.7	36.7	27.4	16.8	--	--
Cadmium	0.2230 U	--	--	0.8718	--	0.2130 U	1.249	1.283	0.3826	--	--
Chromium	18	--	--	27.4	--	32.3	61.9	48.4	17	--	--
Copper	--	138	--	--	--	--	--	--	--	--	--
Lead	107	--	--	128	--	58.1	102	103	54.9	--	--
Mercury	0.083 U	--	--	0.075 U	--	0.077 U	0.093 U	0.098 U	0.073 U	--	--
Selenium	2.23 U	--	--	2.11 U	--	2.13 U	4.46	3.14	2.27 U	--	--
Silver	0.558 U	--	--	0.527 U	--	0.532 U	0.641 U	0.612 U	0.567 U	--	--
Semivolatile Organics (µg/kg)											
1-Methylpyrene	235	66000	17.8	--	--	631	1230	--	4780	128000	--
2-Chloronaphthalene	--	--	--	92.4 J	626	--	--	--	--	--	2.76 J
2-Methylpyrene	286	47800	18.5	--	--	680	1200	--	4100	123000	--
3-Methylphenanthrene	1930	151000	34.7	--	--	2860	4820	--	12000	360000	--
4-Methylpyrene	253	52100	16.3	--	--	568	1090	--	3840	102000	--
Benzo(b)fluorene	414	72300	39.1	--	--	1230	1730	--	5760	257000	--
Biphenyl (1,1'-Biphenyl)	2340	92400	4.39	--	--	4860	18600	--	5940	222000	--
Polycyclic Aromatic Hydrocarbons (µg/kg)											
1-Methyldibenzothiophene	177	12200	2.65	--	--	232	382	--	886	21800	--
1-Methylnaphthalene	3030	518000	10.3	--	--	44700	86500	--	37600	1080000	--
1-Methylphenanthrene	1740	150000	34.5	--	--	2620	3650	--	11200	314000	--
2,3,5-Trimethylnaphthalene (1,6,7-Trimethylnaphthalene)	949	35500	4.49	--	--	1190	2290	--	2370	72100	--
2,6-Dimethylnaphthalene	310	195000	5.05	--	--	13200	38700	--	17400	506000	--
2-Methylanthracene	532	73600	27.4	--	--	1040	1390	--	5480	200000	--
2-Methyldibenzothiophene & 3-Methyldibenzothiophene	462	33300	8.52	--	--	724	1280	--	3140	68700	--
2-Methylnaphthalene	257	15500	5.13	89300 J	1020000 J	53900	124000	--	44800	962000	3920 J
2-Methylphenanthrene	1710	162000	33.4	--	--	2870	4680	--	13200	404000	--
4-Methyldibenzothiophene	426	35400	7.3	--	--	661	1160	--	3240	69300	--
4-Methylphenanthrene & 9-Methylphenanthrene	1680	163000	33.3	--	--	2520	4120	--	11600	328000	--
Acenaphthene	22900	529000	19.8	41900	443000	18500	41800	--	26000	805000	2340
Acenaphthylene	934	51500	29.1	14000	48000	1170	4370	--	7350	198000	204
Anthracene	2510	245000	107	33600	143000	6400	7510	--	16600	989000	1520
Benzo(a)anthracene	2130	146000	116	24200	86700	3030	4160	--	13700	592000	2600
Benzo(a)fluoranthene	369	31500	23.3	--	--	497	819	--	2910	121000	--
Benzo(a)pyrene	1920	126000	101	23300	70300	2550	3950	--	11500	546000	2290
Benzo(b)fluoranthene	1660	71300	58.5	11500	39700	1960	2250	--	6560	353000	1920
Benzo(c)fluorene	200	28200	13.1	--	--	430	753	--	2680	89500	--
Benzo(e)pyrene	1230	63700	53.3	--	--	1480	2070	--	5670	272000	--
Benzo(g,h,i)perylene	1390	78800	55.6	10900	38500	1500	2310	--	5550	296000	1120
Benzo(j,k)fluoranthene	1550	73100	78.8	--	--	1930	2520	--	7220	363000	--
Benzo(k)fluoranthene	--	--	--	12400	38800	--	--	--	--	--	1750
Benzonaphthothiophene	406	46200	19.4	--	--	702 J	1230	--	3560	125000	--
Benzothiophene	45.7	1780	0.420 J	--	--	2650	8460	--	734	46300	--
Carbazole	387	22000	4	--	--	1360	10500	--	1370	52700	--
Chrysene	2420	174000	130	20700	87200	3080	4370	--	13800	552000	2050
Decalin, cis- & trans-	115	2040	0.676	--	--	53.8 J	332	--	84.1 J	1090 J	--
Dibenzo(a,h)anthracene	--	--	--	2800	10800	--	--	--	--	--	328
Dibenzo(a,h)anthracene and Dibenzo(a,c)anthracene	372	18200	15.3	--	--	380	629	--	1720	82800	--
Dibenzofuran	1620	49100	15.5	--	--	2790	5000	--	4340	421000	--
Dibenzothiophene	2250	83100	18.7	--	--	3470	6930	--	5960	246000	--
Fluoranthene	6760	396000	226	45700	222000	11000	12000	--	29600	1770000	4530
Fluorene	9850	232000	35.5	34300	249000	12700	33000	--	16300	780000	1590
Indeno(1,2,3-c,d)pyrene	1300	66600	53.8	9700	33300	1510	2100	--	5450	296000	1150
Naphthalene	710	50800	12.1	158000 J	2260000 J	88200	252000	--	40500	2320000	8430 J
Perylene	487	25400	26.1	--	--	592	695	--	2210	128000	--
Phenanthrene	22800	999000	240	120000	595000	34800	56300	--	66400	3410000	4250
Pyrene	5830	470000	213	75600	288000	10600	13400	--	34900	1590000	3500
Retene	70	1490 U	1.18 U	--	--	136 U	32.3 U	--	116 U	6520 U	--
Total PAH (16) (U = 1/2)	85000	3700000	1500	640000 J	4700000 J	200000	440000	--	300000	15000000	40000 J
C1-Benzo(b)thiophene	344	14500	0.916 J	--	--	3800	9560	--	2160	59300	--
C1-Chrysenes	1170	167000	66	--	--	1580	3320	--	11300	314000	--
C1-Decalins	85.9	4010	2.39	--	--	166	153	--	273	7670	--
C1-Dibenzothiophenes	1220	94500	20.8	--	--	1880	3310	--	8340	191000	--
C1-Fluoranthenes/Pyrenes	2270	432000	165	--	--	5790	9500	--	34300	1110000	--
C1-Fluorenes	4390	189000	29.6	--	--	5430	10600	--	12900	375000	--
C1-Naphthalenes	2100	340000	9.79	--	--	64100	137000	--	53600	1320000	--
C1-Naphthobenzothiophenes	269	49500	13.1	--	--	459	1080	--	3270	77400	--
C1-Phenanthrenes/Anthracenes	7120	664000	160	--	--	11500	17700	--	50900	1540000	--
C2-Benzo(b)thiophene	1500	35100	1.9	--	--	2970	7870	--	3240	75700	--
C2-Chrysenes	701	105000	29.9	--	--	764	1770	--	5500	139000	--
C2-Decalins	61.8	4670	4.7	--	--	68.1 U	289	--	590	16200	--
C2-Dibenzothiophenes	427	90700	19.9	--	--	1050	1840	--	7000	141000	--
C2-Fluoranthenes/Pyrenes	1220	192000	57.1	--	--	1690	3550	--	12600	332000	--
C2-Fluorenes	1470	148000	29.4	--	--	1980	2870	--	8350	216000	--
C2-Naphthalenes	14800	485000	25.3	--	--	36800	97800	--	45800	1290000	--
C2-Naphthobenzothiophenes	286	34100	7.17	--	--	368	713	--	1750	36500	--
C2-Phenanthrenes/Anthracenes	1750	379000	91.7	--	--	4000	6220	--	25000	674000	--
C3-Benzo(b)thiophene	1000	25700	4.28	--	--	1000	2530	--	1840	42600	--
C3-Chrysenes	560	56700	15.6	--	--	624	862	--	2400	76300	--
C3-Decalins	51.9	3320	5.08	--	--	68.1 U	301	--	427	3260 U	--
C3-Dibenzothiophenes	240	51200	12	--	--	459	1030	--	3040	61700	--
C3-Fluoranthenes/Pyrenes	552	84000	21.4	--	--	852	1570	--	4180	117000	--
C3-Fluorenes	530 J	72600	17	--	--	1010 J	1260 J	--	3930	94400 J	--
C3-Naphthalenes	8120	283000	41.2	--	--	9340	19500	--	18400	536000	--
C3-Naphthobenzothiophenes	297	16700	4.15	--	--	386	407	--	832	20300	--
C3-Phenanthrenes/Anthracenes	582	146000	34.8	--	--	1100	2200	--	7890	207000	--
C4-Benzo(b)thiophene	200	10900	2.67	--	--	223	375	--	654	15000	--
C4-Chrysenes	350	19400	8.09	--	--	136 U	488	--	901	37800	--
C4-Decalins	90.2	747 U	7.87	--	--	68.1 U	573	--	795	3260 U	--
C4-Dibenzothiophenes	124	17100	4.63	--	--	221	378	--	848	18700	--
C4-Fluoranthenes/Pyrenes	355	35900	9.91	--	--	528	731	--	1700	54100	--
C4-Naphthalenes	1450	97100	21.9	--	--	1780	2740	--	5460	160000	--
C4-Naphthobenzothiophenes	237	7670	1.18 U	--	--	370	239	--	436	8650	--
C4-Phenanthrenes/Anthracenes	210	34700	8.67	--	--	268	614	--	1630	43800	--
PCB Aroclors (µg/kg)											
Aroclor 1016	8.73 U	--	--	7.63 U	--	7.79 U	9.21 U	9.23 U	16.9 U	--	--
Aroclor 1221	8.73 U	--	--	7.63 U	--	7.79 U	9.21 U	9.23 U	16.9 U	--	--
Aroclor 1232	8.73 U	--	--	7.63 U	--	7.79 U	9.21 U	9.23 U	16.9 U	--	--
Aroclor 1242	127 J	--	--	94.7	--	94.5	108 J	122	597	--	--
Aroclor 1248	8.73 U	--	--	7.63 U	--	7.79 U	9.21 U	9.23 U	16.9 U	--	--
Aroclor 1254	299	--	--	65.6 J	--	122	293	280	411	--	--
Aroclor 1260	44.9	--	--	16.9	--	14.1 J	54.6	47.5	93.8	--	--
Aroclor 1262	8.73 U	--	--	7.63 U	--	7.79 U	9.21 U	9.23 U	16.9 U	--	--
Aroclor 1268	8.73 U	--	--	7.63 U	--	7.79 U	9.21 U	9.23 U	16.9 U	--	--
Total PCB Aroclors (U = 1/2)	497 J	--	--	200 J	--	254 J	483 J	480	1150	--	--
Extractable Petroleum Hydrocarbons (mg/kg)											
C9-C18 Aliphatics unadjusted	--	--	--	--	--	--	--	--	--	--	--
C19-C36 Aliphatics unadjusted	--	--	--	--	--	--	--	--	--	--	--
C11-C22 Aromatics adjusted	--	--	--	--	--	--	--	--	--	--	--
C11-C22 Aromatics unadjusted	--	--	--	--	--	--	--	--	--	--	--
Volatile Petroleum Hydrocarbons (mg/kg)											
Benzene	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	--	--	--	--	--	--	--	--	--	--	--
m,p-Xylene	--	--	--	--	--	--	--	--	--	--	--
Methyl tert-butyl ether (MTBE)	--	--	--	--	--	--	--	--	--	--	--
o-Xylene	--	--	--	--	--	--	--	--	--	--	--
Toluene	--	--	--	--	--	--	--	--	--	--	--
C5-C8 Aliphatics adjusted	--	--	--	--	--	--	--	--	--	--	--
C5-C8 Aliphatics unadjusted	--	--	--	--	--	--	--	--	--	--	--
C9-C12 Aliphatics adjusted	--	--	--	--	--	--	--	--	--	--	--
C9-C12 Aliphatics unadjusted	--	--	--	--	--	--	--	--	--	--	--
C9-C10 Aromatics unadjusted	--	--	--	--	--	--	--	--	--	--	--

Location ID	AQSS-12B	AQSS-13B	AQSS-13B	AQSS-18	AQSS-18	AQSS-18	AQSS-19	AQSS-19	AQSS-20	AQSS-20	Maximum Detected Concentration	Maximum Detected Concentration in Top 1 Foot
Sample ID	AQSS-12B-0.0-0.5	AQSS-13B-0.0-0.5	AQSS-13B-1.5-2.0	AQSS-18-0.0-0.5	AQSS-18-3.0-3.5	AQSS-18-4.6-4.8	AQSS-19-3.0-3.5	AQSS-19-4.5-5.0	AQSS-20-0.0-0.5	AQSS-20-4.2-4.5		
Sample Date	09/28/21	09/28/21	09/28/21	09/30/21	09/30/21	09/30/21	09/30/21	09/30/21	09/30/21	09/30/21		
Depth	0 - 0.5 ft	0 - 0.5 ft	1.5 - 2 ft	0 - 0.5 ft	3 - 3.5 ft	4.6 - 4.8 ft	3 - 3.5 ft	4.5 - 5 ft	0 - 0.5 ft	4.2 - 4.5 ft		
Sample Type	N	N	N	N	N	N	N	N	N	N		
Matrix	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE		
Conventional Parameters (pct)												
Soot carbon	1.08	0.1	--	0.026 J	--	--	--	--	0.172 J	--	1.08	1.08
Total organic carbon	4.19	3.24	10.2	1.15 J	5.74 J	0.010 U	0.075 J	0.069 J	2.32 J	0.022 J	15.6	4.19
Total Solids	82.6	84.5	70.4	90.8	84.3	84	89.3	87.9	87.3	83.3	91.7	91.7
Metals (mg/kg)												
Arsenic	24.8	6.17	--	22.6 J	--	--	--	--	14.5 J	--	74.6	74.6
Barium	20.6	41.5	--	13.8	--	--	--	--	26.4	--	41.5	41.5
Cadmium	0.6318	0.2457	--	0.6468	--	--	--	--	0.2228 U	--	1.283	1.283
Chromium	25.8	16.8	--	14.4 J	--	--	--	--	22.0 J	--	414	414
Copper	--	--	--	--	--	--	--	--	--	--	138	ND
Lead	67.4	397	--	37.0 J	--	--	--	--	124 J	--	397	397
Mercury	0.080 U	0.088 U	--	0.079 U	--	--	--	--	0.080 U	--	0.149	0.149
Selenium	2.38 U	2.35 U	--	2.09 U	--	--	--	--	2.23 U	--	4.46	4.46
Silver	0.595 U	0.588 U	--	0.523 U	--	--	--	--	0.557 U	--	ND	ND
Semivolatile Organics (µg/kg)												
1-Methylpyrene	--	36900	131000	--	--	--	--	--	--	--	131000	36900
2-Chloronaphthalene	30.5 J	--	--	12.4 J	144 J	4.35 U	0.378 J	4.44 U	251 J	4.72 U	626	251
2-Methylpyrene	--	25100	111000	--	--	--	--	--	--	--	123000	25100
3-Methylphenanthrene	--	80900	347000	--	--	--	--	--	--	--	360000	80900
4-Methylpyrene	--	27000	99000	--	--	--	--	--	--	--	102000	27000
Benzo(b)fluorene	--	33900	144000	--	--	--	--	--	--	--	257000	33900
Biphenyl (1,1'-Biphenyl)	--	40100	221000	--	--	--	--	--	--	--	222000	40100
Polycyclic Aromatic Hydrocarbons (µg/kg)												
1-Methyldibenzothiophene	--	6440	25000	--	--	--	--	--	--	--	25000	6440
1-Methylnaphthalene	--	278000	1630000	--	--	--	--	--	--	--	1630000	278000
1-Methylphenanthrene	--	81900	333000	--	--	--	--	--	--	--	333000	81900
2,3,5-Trimethylnaphthalene (1,6,7-Trimethylnaphthalene)	--	15900	59800	--	--	--	--	--	--	--	72100	15900
2,6-Dimethylnaphthalene	--	103000	592000	--	--	--	--	--	--	--	592000	103000
2-Methylanthracene	--	37700	178000	--	--	--	--	--	--	--	200000	37700
2-Methyldibenzothiophene & 3-Methyldibenzothiophene	--	18600	82300	--	--	--	--	--	--	--	82300	18600
2-Methylnaphthalene	2190 J	400000	2320000	1570 J	34100 J	4.35 UJ	301 J	152 J	243000 J	78.2 J	2320000	400000
2-Methylphenanthrene	--	85700	361000	--	--	--	--	--	--	--	404000	85700
4-Methyldibenzothiophene	--	20200	93000	--	--	--	--	--	--	--	93000	20200
4-Methylphenanthrene & 9-Methylphenanthrene	--	86400	336000	--	--	--	--	--	--	--	336000	86400
Acenaphthene	13000	223000	1100000	5290	155000	3.47 J	166 J	93.2	118000	48.4	1100000	223000
Acenaphthylene	9590	35100	168000	390	50100	4.43	19.3	7.32	29700	14.8	198000	35100
Anthracene	12400	109000	599000	1320	189000	39	89.5 J	43.5	56700	56	989000	109000
Benzo(a)anthracene	9100	62600	274000	1240	236000	48.4	76.9	25.7	54900	44.2	592000	62600
Benzo(a)fluoranthene	--	15600	55300	--	--	--	--	--	--	--	121000	15600
Benzo(a)pyrene	6630	56500	204000	1140	197000	40.1	58.6	20.6	43600	35.4	546000	56500
Benzo(b)fluoranthene	3500	28700	102000	1100	144000	32.9	47.8	17.4	27700	27	353000	28700
Benzo(c)fluorene	--	14400	73600	--	--	--	--	--	--	--	89500	14400
Benzo(e)pyrene	--	27900	97600	--	--	--	--	--	--	--	272000	27900
Benzo(g,h,i)perylene	3220	33600	87800	693	113000	20.2	30.4	10.9	23600	17.6	296000	33600
Benzo(j,k)fluoranthene	--	31700	130000	--	--	--	--	--	--	--	363000	31700
Benzo(k)fluoranthene	4410	--	--	839	147000	28.4	41.6 J	14.7	20000	22.3	147000	20000
Benzonaphthothiophene	--	24100	85400	--	--	--	--	--	--	--	125000	24100
Benzothiophene	--	13900	61200	--	--	--	--	--	--	--	61200	13900
Carbazole	--	7300	66000	--	--	--	--	--	--	--	66000	10500
Chrysene	9000	75200	296000	1090	217000	44.9	64.9 J	21	60300	37.5	552000	75200
Decalin, cis- & trans-	--	367 J	2130 J	--	--	--	--	--	--	--	2130	367
Dibenzo(a,h)anthracene	1010	--	--	186	25900	6.63	7.94	2.74 J	7350	4.62 J	25900	7350
Dibenzo(a,h)anthracene and Dibenzo(a,c)anthracene	--	8320	24200	--	--	--	--	--	--	--	82800	8320
Dibenzofuran	--	10500	165000	--	--	--	--	--	--	--	421000	10500
Dibenzothiophene	--	36400	179000	--	--	--	--	--	--	--	246000	36400
Fluoranthene	15200	154000	641000	3160	614000	103	139 J	51.6	85300	96.9	1770000	154000
Fluorene	11000	98100	520000	1900	213000	9.29	130 J	71.8	48400	59.6	780000	98100
Indeno(1,2,3-c,d)pyrene	2970	27900	83800	742	100000	23.4	34.9	11.4	19700	19.8	296000	27900
Naphthalene	3140 J	672000	3690000	8220 J	67600 J	4.35 UJ	329 J	215 J	227000 J	168 J	3690000	672000
Perylene	--	10300	39300	--	--	--	--	--	--	--	128000	10300
Phenanthrene	43400	422000	1930000	5840	797000	88.7	375 J	214	246000	191	3410000	422000
Pyrene	21400	204000	801000	2770	534000	88.4	145 J	50.8	150000	96	1590000	204000
Retene	--	1220 U	10500 U	--	--	--	--	--	--	--	70	70
Total PAH (16) (U = 1/2)	170000 J	2240000	11000000	36000 J	3800000 J	583 J	1800 J	872 J	1200000 J	939 J	15000000	2240000
C1-Benzo(b)thiophene	--	17200	119000	--	--	--	--	--	--	--	119000	17200
C1-Chrysenes	--	82600	264000	--	--	--	--	--	--	--	314000	82600
C1-Decalins	--	1180	12400	--	--	--	--	--	--	--	12400	1180
C1-Dibenzothiophenes	--	52100	230000	--	--	--	--	--	--	--	230000	52100
C1-Fluoranthenes/Pyrenes	--	225000	920000	--	--	--	--	--	--	--	1110000	225000
C1-Fluorenes	--	93200	401000	--	--	--	--	--	--	--	401000	93200
C1-Naphthalenes	--	442000	2570000	--	--	--	--	--	--	--	2570000	442000
C1-Naphthobenzothiophenes	--	26800	80200	--	--	--	--	--	--	--	80200	26800
C1-Phenanthrenes/Anthracenes	--	355000	1500000	--	--	--	--	--	--	--	1540000	355000
C2-Benzo(b)thiophene	--	18600	111000	--	--	--	--	--	--	--	111000	18600
C2-Chrysenes	--	50200	125000	--	--	--	--	--	--	--	139000	50200
C2-Decalins	--	3170	26200	--	--	--	--	--	--	--	26200	3170
C2-Dibenzothiophenes	--	48400	192000	--	--	--	--	--	--	--	192000	48400
C2-Fluoranthenes/Pyrenes	--	99200	324000	--	--	--	--	--	--	--	332000	99200
C2-Fluorenes	--	70200	257000	--	--	--	--	--	--	--	257000	70200
C2-Naphthalenes	--	296000	1590000	--	--	--	--	--	--	--	1590000	296000
C2-Naphthobenzothiophenes	--	17100	42900	--	--	--	--	--	--	--	42900	17100
C2-Phenanthrenes/Anthracenes	--	190000	729000	--	--	--	--	--	--	--	729000	190000
C3-Benzo(b)thiophene	--	11700	54900	--	--	--	--	--	--	--	54900	11700
C3-Chrysenes	--	24200	56200	--	--	--	--	--	--	--	76300	24200
C3-Decalins	--	612 U	5270 U	--	--	--	--	--	--	--	3320	475
C3-Dibenzothiophenes	--	25000	84900	--	--	--	--	--	--	--	84900	25000
C3-Fluoranthenes/Pyrenes	--	41900	116000	--	--	--	--	--	--	--	117000	41900
C3-Fluorenes	--	34300	123000	--	--	--	--	--	--	--	123000	34300
C3-Naphthalenes	--	125000	560000	--	--	--	--	--	--	--	560000	125000
C3-Naphthobenzothiophenes	--	8780	21200	--	--	--	--	--	--	--	21200	8780
C3-Phenanthrenes/Anthracenes	--	68900	220000	--	--	--	--	--	--	--	220000	68900
C4-Benzo(b)thiophene	--	4990	20500	--	--	--	--	--	--	--	20500	4990
C4-Chrysenes	--	9200	10500 U	--	--	--	--	--	--	--	37800	9200
C4-Decalins	--	4700	5270 U	--	--	--	--	--	--	--	4700	4700
C4-Dibenzothiophenes	--	8070	25800	--	--	--	--	--	--	--	25800	8070
C4-Fluoranthenes/Pyrenes	--	16100	39400	--	--	--	--	--	--	--	54100	16100
C4-Naphthalenes	--	42600	166000	--	--	--	--	--	--	--	166000	42600
C4-Naphthobenzothiophenes	--	4260	10500 U	--	--	--	--	--	--	--	8650	4260
C4-Phenanthrenes/Anthracenes	--	16500	47000	--	--	--	--	--	--	--	47000	16500
PCB Aroclors (µg/kg)												
Aroclor 1016	17.5 U	8.51 U	--	7.81 U	--	--	--	--	8.14 U	--	ND	ND
Aroclor 1221	17.5 U	8.51 U	--	7.81 U	--	--	--	--	8.14 U	--	ND	ND
Aroclor 1232	17.5 U	8.51 U	--	7.81 U	--	--	--	--	8.14 U	--	ND	ND
Aroclor 1242	225	48.9 J	--	65.7	--	--	--	--	8.14 U	--	769	769
Aroclor 1248	17.5 U	8.51 U	--	7.81 U	--	--	--	--	8.14 U	--	ND	ND
Aroclor 1254	541	118	--	33.8 J	--	--	--	--	53.4 J	--	541	541
Aroclor 1260	135	191	--	7.48 J	--	--	--	--	19.5 J	--	191	191
Aroclor 1262	17.5 U	8.51 U	--	7.81 U	--	--	--	--	8.14 U	--	ND	ND
Aroclor 1268	17.5 U	8.51 U	--	7.81 U	--	--	--	--	8.14 U	--	ND	ND
Total PCB Aroclors (U = 1/2)	954	383 J	--	130 J	--	--	--	--	101 J	--	1400	1400
Extractable Petroleum Hydrocarbons (mg/kg)												
C9-C18 Aliphatics unadjusted	--	--	--	--	--	--	--	--	--	--	ND	ND
C19-C36 Aliphatics unadjusted	--	--	--	--	--	--	--	--	--	--	414	414
C11-C22 Aromatics adjusted	--	--	--	--	--	--	--	--	--	--	1410	1410
C11-C22 Aromatics unadjusted	--	--	--	--	--	--	--	--	--	--	2310	2310
Volatile Petroleum Hydrocarbons (mg/kg)												
Benzene	--	--	--	--	--	--	--	--	--	--	ND	ND
Ethylbenzene	--	--	--	--	--	--	--	--	--	--	ND	ND
m,p-Xylene	--	--	--	--	--	--	--	--	--	--	ND	ND
Methyl tert-butyl ether (MTBE)	--	--	--	--	--	--	--	--	--	--	ND	ND
o-Xylene	--	--	--	--	--	--	--	--	--	--	ND	ND
Toluene	--	--	--	--	--	--	--	--	--	--	ND	ND
C5-C8 Aliphatics adjusted	--	--	--	--	--	--	--	--	--	--	ND	ND
C5-C8 Aliphatics unadjusted	--	--	--	--	--	--	--	--	--	--	ND	ND
C9-C12 Aliphatics adjusted	--	--	--	--	--	--	--	--	--	--	ND	ND
C9-C12 Aliphatics unadjusted	--	--	--	--	--	--	--	--	--	--	ND	ND
C9-C10 Aromatics unadjusted	--	--	--	--	--	--	--	--	--	--	ND	ND

Notes:
1. "--" = Not analyzed for the compound/parameter.
J: Estimated value
U: Compound analyzed for, but not detected above detection limit
UJ: Compound analyzed for, but not detected above estimated detection limit
ND = Not Detected

TABLE D-7
SURFACE WATER ANALYTICAL RESULTS
284 Winter Street
Haverhill, Massachusetts

Sample ID Sample Date	DOWNSTREAM 11 Jun 2020	UPSTREAM 11 Jun 2020
Extractable Petroleum Hydrocarbons (EPH)		
C9-C18 Aliphatic hydrocarbons	< 100	< 100
C19-C36 Aliphatic Fraction	< 100	< 100
C11-C22 Aromatic hydrocarbons, Adjusted	< 100	< 100
Anthracene	< 10.0	< 10.0
Pyrene	< 10.0	< 10.0
Benzo(ghi)perylene	< 10.0	< 10.0
Indeno(1,2,3-cd)pyrene	< 10.0	< 10.0
Benzo(b)fluoranthene	< 10.0	< 10.0
Fluoranthene	< 10.0	< 10.0
Benzo(k)fluoranthene	< 10.0	< 10.0
Acenaphthylene	< 10.0	< 10.0
Chrysene	< 10.0	< 10.0
Benzo(a)pyrene	< 10.0	< 10.0
Dibenzo(a,h)anthracene	< 10.0	< 10.0
Benzo(a)anthracene	< 10.0	< 10.0
Acenaphthene	< 10.0	< 10.0
Phenanthrene	< 10.0	< 10.0
Fluorene	< 10.0	< 10.0
Naphthalene	< 10.0	< 10.0
2-Methylnaphthalene	< 10.0	< 10.0
Volatile Petroleum Hydrocarbons (VPH)		
C9-C12 Aliphatics, adjusted	< 100	< 100
C9-C10 Aromatic hydrocarbons	< 100	< 100
Ethylbenzene	< 2.00	< 2.00
Toluene	< 2.00	< 2.00
Methyl tert-butyl ether	< 3.00	< 3.00
Xylene P,M	< 2.00	< 2.00
C5-C8 Aliphatics, Adjusted	< 100	< 100
Benzene	< 2.00	< 2.00
Naphthalene	< 4.00	< 4.00
Xylene O	< 2.00	< 2.00
Inorganics		
Cyanide	< 5	< 5

Notes:
1. Concentrations are reported in micrograms per liter (µg/L; parts per billion).
2. Results indicated as "<" are below the laboratory reporting limit (RL) shown.

TABLE D-8
SOIL GAS ANALYTICAL RESULTS
284 Winter Street
Haverhill, Massachusetts

Method /Analyte	MA-CISSGV[1]	DUP101916	NFSV-01	Average of NFSV-01 and DUP101916	NFAA-01	NFSV-02	NFSV-03	NFSV-04	NFSV-05	NFSV-05-DUP	Average of NFSV-05 and NFSV-05-DUP	NFSV-06	NFSV-07	NFSV-08	SG-1	SG-2	SG-3	Maximum Detected Soil Gas Concentration	Average Soil Gas Concentration	Estimated Indoor Air Concentration
		10/19/2016	10/19/2016	10/19/2016	10/19/2016	10/19/2016	10/19/2016	10/19/2016	10/19/2016	10/19/2016	10/19/2016	10/19/2016	10/19/2016	10/19/2016	2/12/2020	2/12/2020	2/12/2020			
Dichlorodifluoromethane		2.42	2.47	2.4	1.79	1.83	1.73	1.47	3.71	4.12	3.9	2.86	1.33	0.925	--	--	--	3.9	2.0	0.029
Chloromethane		<2.07	<2.07	<2.07	1.05	0.271	<0.413	<0.413	<1.38	<1.38	<1.38	<0.413	0.318	<0.413	--	--	--	1.1	0.47	0.0067
Freon-114		<6.99	<6.99	<6.99	<2.43	<1.4	<1.4	<1.4	<4.66	<4.66	<4.66	<1.4	<1.4	<1.4	--	--	--	ND	ND	ND
Vinyl chloride	91	<2.56	<2.56	<2.56	<0.887	<0.511	<0.511	<0.511	<1.71	<1.71	<1.71	<0.511	<0.511	<0.511	--	--	--	ND	ND	ND
1,3-Butadiene		0.918	<2.21	1.0	<0.768	<0.442	<0.442	<0.442	<1.48	<1.48	<1.48	<0.442	0.708	0.763	<0.5	<0.5	<0.5	1.0	0.44	0.0062
Butane		280	280	280	7.13	6.44	0.849	3.19	333	342	338	17.3	75.1	12.8	--	--	--	338	82	1.2
Acetaldehyde		<22.5	<22.5	<22.5	<7.82	10.4	12.9	11.2	<15	<15	<15	<4.5	<4.5	<4.5	--	--	--	13	7.1	0.10
Bromomethane	310	<3.88	<3.88	<3.88	<1.35	<0.777	<0.777	<0.777	<2.59	<2.59	<2.59	<0.777	<0.777	<0.777	--	--	--	ND	ND	ND
Chloroethane		<2.64	<2.64	<2.64	<0.916	<0.528	<0.528	<0.528	<1.76	<1.76	<1.76	<0.528	2.62	<0.528	--	--	--	2.6	0.73	0.010
Ethanol		6.63	6.99	6.8	13.1	7.07	2.83	3.73	<15.7	<15.7	<15.7	2.39	5.43	5.41	--	--	--	13	6.1	0.087
Vinyl bromide		<4.37	<4.37	<4.37	<1.52	<0.874	<0.874	<0.874	<2.92	<2.92	<2.92	<0.874	<0.874	<0.874	--	--	--	ND	ND	ND
Acrolein		<5.73	<5.73	<5.73	<1.99	0.277	0.374	0.381	<3.83	<3.83	<3.83	0.305	0.807	0.713	--	--	--	0.81	0.96	0.012
Acetone	50,000	48.9	53.7	51	9.45	5.91	11.2	43.2	<7.91	<7.91	<7.91	18.9	87.9	59.4	--	--	--	88	32	0.46
Trichlorofluoromethane		1.32	1.26	1.3	1.18	2.41	2.57	1.28	3.28	3.44	3.4	4.02	0.983	0.618	--	--	--	4.0	2.0	0.028
Isopropanol		16.2	30.7	23	<2.13	11.7	22.1	8.5	21.3	21.2	21	10.1	17.5	18.9	--	--	--	23	15	0.21
Pentane		88.5	90.0	89	2.27	2.30	<0.59	1.01	144	147	146	6.34	9.41	4.22	--	--	--	146	29	0.41
1,1-Dichloroethene	12,000	<3.96	<3.96	<3.96	<1.38	<0.793	<0.793	<0.793	<2.64	<2.64	<2.64	<0.793	<0.793	<0.793	--	--	--	ND	ND	ND
tert-Butyl Alcohol		117	116	117	<2.63	6.73	1.90	5.37	6.67	6.7	6.7	5.61	7.15	7.55	--	--	--	117	18	0.25
Methylene chloride	37,000	<8.69	<8.69	<8.69	1.98	<1.74	<1.74	<1.74	<5.8	<5.8	<5.8	1.06	<1.74	1.32	--	--	--	2.0	1.7	0.024
3-Chloropropene		<3.13	<3.13	<3.13	<1.09	<0.626	<0.626	<0.626	<2.09	<2.09	<2.09	<0.626	<0.626	<0.626	--	--	--	ND	ND	ND
Carbon disulfide		15.0	15.5	15	<1.08	<0.623	0.246	1.07	0.57	0.551	0.56	0.517	6.6	1.96	--	--	--	15	3.0	0.043
Freon-113		<7.66	<7.66	<7.66	<2.66	0.468	0.406	0.406	<5.11	<5.11	<5.11	0.399	<1.53	<1.53	--	--	--	0.47	1.2	0.0067
trans-1,2-Dichloroethene	3,700	<3.96	<3.96	<3.96	<1.38	<0.793	<0.793	<0.793	<2.64	<2.64	<2.64	<0.793	<0.793	<0.793	--	--	--	ND	ND	ND
1,1-Dichloroethane	50,000	<4.05	<4.05	<4.05	<1.4	<0.809	<0.809	<0.809	<2.7	<2.7	<2.7	<0.809	<0.809	<0.809	--	--	--	ND	ND	ND
Methyl tert butyl ether	190,000	1010	1030	1020	<1.25	0.234	<0.721	1.06	164	166	165	2.40	0.299	0.735	<0.7	<0.7	<0.7	1020	99	1.4
2-Butanone	310,000	27.1	26.3	27	0.779	1.43	4.66	8.05	8.41	8.38	8.4	3.95	23.4	14.8	--	--	--	27	10	0.15
cis-1,2-Dichloroethene	370	9.12	10.1	9.6	0.42	<0.793	<0.793	<0.793	<2.64	<2.64	<2.64	<0.793	<0.793	<0.793	--	--	--	9.6	1.5	0.022
Chloroform	210	<4.88	<4.88	<4.88	<1.69	<0.977	<0.977	<0.977	<3.26	<3.26	<3.26	1.14	1.59	0.327	--	--	--	1.6	1.0	0.015
1,2-Dichloroethane	31	<4.05	<4.05	<4.05	<1.4	<0.809	<0.809	<0.809	3.55	3.70	3.6	<0.809	<0.809	<0.809	--	--	--	3.6	0.98	0.014
n-Hexane		25.8	25.3	26	0.638	1.05	<0.705	0.24	53.2	52.2	53	1.38	1.55	0.937	--	--	--	53	9.4	0.13
1,1,1-Trichloroethane	310,000	<5.46	<5.46	<5.46	<1.89	<1.09	<1.09	<1.09	<3.64	<3.64	<3.64	<1.09	<1.09	<1.09	--	--	--	ND	ND	ND
Benzene	800	460	473	467	0.617	0.447	<0.639	0.821	543	546	545	0.575	6.1	1.72	<0.6	<0.6	<0.6	545	85	1.2
Thiophene		3.99	3.99	4	<1.19	<0.688	<0.688	<0.688	1.04	1.16	1.1	<0.688	<0.688	<0.688	--	--	--	4.0	0.86	0.012
Carbon tetrachloride	130	<6.29	<6.29	<6.29	<2.18	<1.26	<1.26	<1.26	<4.2	<4.2	<4.2	<1.26	<1.26	<1.26	--	--	--	ND	ND	ND
Cyclohexane		38.6	39.3	39	<1.19	0.475	<0.688	<0.688	3.06	2.82	2.9	<0.688	0.768	0.509	--	--	--	39	5.0	0.072
1,2-Dichloropropane	42	<4.62	<4.62	<4.62	<1.6	<0.924	<0.924	<0.924	<3.08	<3.08	<3.08	<0.924	<0.924	<0.924	--	--	--	ND	ND	ND
Bromodichloromethane	45	<6.7	<6.7	<6.7	<2.32	<1.34	<1.34	<1.34	<4.47	<4.47	<4.47	<1.34	<1.34	<1.34	--	--	--	ND	ND	ND
1,4-Dioxane	160	<3.6	<3.6	<3.6	<1.25	<0.721	<0.721	<0.721	<2.4	<2.4	<2.4	<0.721	<0.721	<0.721	--	--	--	ND	ND	ND
Trichloroethene	120	<5.37	<5.37	<5.37	<1.86	<1.07	<1.07	<1.07	<3.58	<3.58	<3.58	<1.07	<1.07	<1.07	--	--	--	ND	ND	ND
2,2,4-Trimethylpentane		401	411	406	<1.62	0.598	<0.934	<0.934	9.48	9.43	9.5	<0.934	<0.934	2.70	--	--	--	406	47	0.67
Heptane		16.9	16.6	17	<1.42	0.520	<0.82	<0.82	16.1	16.6	16	0.422	0.779	0.471	--	--	--	17	4.1	0.058
cis-1,3-Dichloropropene		<4.54	<4.54	<4.54	<1.58	<0.908	<0.908	<0.908	<3.03	<3.03	<3.03	<0.908	<0.908	<0.908	--	--	--	ND	ND	ND
4-Methyl-2-pentanone	190,000	<10.2	<10.2	<10.2	<3.56	<2.05	0.496	10.1	<6.84	<6.84	<6.84	2.55	24.1	10.2	--	--	--	24	6.5	0.093
trans-1,3-Dichloropropene		<4.54	<4.54	<4.54	<1.58	<0.908	<0.908	<0.908	<3.03	<3.03	<3.03	<0.908	<0.908	<0.908	--	--	--	ND	ND	ND
1,1,2-Trichloroethane	50	<5.46	<5.46	<5.46	<1.89	<1.09	<1.09	<1.09	<3.64	<3.64	<3.64	<1.09	<1.09	<1.09	--	--	--	ND	ND	ND
Toluene	310,000	321	315	318	1.81	1.53	0.818	6.14	852	863	858	1.34	5.09	1.49	1.2	1.5	1.5	858	100	1.4
2-Methylthiophene		<4.02	<4.02	<4.02	<1.39	<0.803	<0.803	<0.803	<2.68	<2.68	<2.68	<0.803	<0.803	<0.803	--	--	--	ND	ND	ND
2-Hexanone		<4.1	9.79	5.9	<1.42	0.795	3.57	7.79	1.55	2.17	1.9	8.85	15.7	13.4	--	--	--	16	6.5	0.093
3-Methylthiophene		1.41	1.47	1.4	<1.39	<0.803	<0.803	<0.803	<2.68	<2.68	<2.68	<0.803	<0.803	<0.803	--	--	--	1.4	0.65	0.0093
Dibromochloromethane	33	<8.52	<8.52	<8.52	<2.96	<1.7	<1.7	<1.7	<5.68	<5.68	<5.68	<1.7	<1.7	<1.7	--	--	--	ND	ND	ND
1,2-Dibromoethane	3	<7.69	<7.69	<7.69	<2.67	<1.54	<1.54	<1.54	<5.13	<5.13	<5.13	<1.54	<1.54	<1.54	--	--	--	ND	ND	ND
Octane		25.3	23.4	24	<1.62	<0.934	0.383	<0.934	5.93	5.42	5.7	0.36	0.322	0.266	--	--	--	24	3.7	0.053
Tetrachloroethene	290	11.8	11.1	11	<2.35	122	94.3	1.68	<4.52	<4.52	<4.52	2.07	<1.36	0.793	--	--	--	122	26	0.38
Chlorobenzene	3,100	<4.61	<4.61	<4.61	<1.6	<0.921	<0.921	<0.921	<3.07	<3.07	<3.07	<0.921	<0.921	<0.921	--	--	--	ND	ND	ND
Ethylbenzene	62,000	246	242	244	<1.51	<0.869	<0.869	0.83	79.5	79.5	80	0.361	1.75	0.356	<0.9	<0.9	<0.9	244	27	0.39
2-Ethylthiophene		<4.59	<4.59	<4.59	<1.59	<0.918	<0.918	<0.918	<3.06	<3.06	<3.06	<0.918	<0.918	<0.918	--	--	--	ND	ND	ND
p/m-Xylene		334	327	331	<3.02	<1.74	<1.74	3.36	431	434	433	1.70	2.55	0.717	1.3	1.3	0.97	433	65	0.93
Bromoform	730	<10.3	<10.3	<10.3	<3.59	<2.07	<2.07	<2.07	<6.9	<6.9	<6.9	<2.07	<2.07	<2.07	--	--	--	ND	ND	ND
Styrene	1,400	29.7	28.6	29	<1.48	<0.852	<0.852	<0.852	<2.84	<2.84	<2.84	<0.852	0.353	<0.852	--	--	--	29	3.8	0.054
1,1,2,2-Tetrachloroethane	14	<6.87	<6.87	<6.87	<2.38	<1.37	<1.37	<1.37	<4.58	<4.58	<4.58	<1.37	<1.37	<1.37	--	--	--	ND	ND	ND
o-Xylene		188	184	186	<1.51	<0.869	<0.869	1.63	123	126	125	0.947	1.09	0.330	<0.9	<0.9	<0.9	186	26	0.38
Nonane		62.4	60.9	62	<1.82	<1.05	0.430	0.493	3.58	3.37	3.5	0.561	0.787	0.614	--	--	--	62	7.7	0.11
2-Chlorotoluene		<5.18	<5.18	<5.18	<1.80	<1.04	<1.04	<1.04	<3.45	<3.45	<3.45	<1.04	<1.04	<1.04	--	--	--	ND	ND	ND
4-Ethyltoluene		111	108	110	<1.71	<0.983	<0.983	0.541	18.0	18.2	18	0.413	0.747	<0.983	--	--	--	110	15	0.21
1,3,5-Trimethylbenzene		232	224	228	<1.71	<0.983	<0.983	0.541	34.2	35.9	35	0.565	0.447	<0.983	--	--	--	228	30	0.42
1,2,4-Trimethylbenzene		274	263	269	<1.71	<0.983	<0.983	1.63	83.6	87.0	85	1.44	1.33	0.364	--	--	--	269	40	0.57
Decane		79.2	74.5	77	<2.02	<1.16	3.39	2.99	7.80	8.15	8.0	1.93	9.37	2.98	--	--	--	77	12	0.17
1,3-Dichlorobenzene	50,000	<6.01	<6.01	<6.01	<2.09	<1.2	<1.2	<1.2	<4.01	<4.01	<4.01	<1.2	<1.2	<1.2	--	--	--	ND	ND	ND
1,4-Dichlorobenzene	120	<6.01	<6.01	<6.01	<2.09	<1.2	<1.2	<1.2	<4.01	<4.01	<4.01	<1.2	<1.2	<1.2	--	--	--	ND	ND	ND
1,2,3-Trimethylbenzene		146	140	143	<1.71	<0.983	<0.983	0.383	18.5	19.2	19	0.560	0.497	<0.983	--	--	--	143	18	0.26
1,2-Dichlorobenzene	50,000	<6.01	<6.01	<6.01	<2.09	<1.2	<1.2	<1.2	<4.01	<4.01	<4.01	<1.2	<1.2	<1.2	--	--	--	ND	ND	ND
Indane		84.1	80.7	82	<1.68	<0.967	<0.967	<0.967	4.66	4.88	4.8	<0.967	0.609	<0.967	--	--	--	82	10	0.14
Indene		79.4	76.0	78	<1.65	<0.951	<0.951	<0.951	<3.17	<3.17	<3.17	<0.951	<0.951	<0.951	--	--	--	78	9.2	0.13
Undecane		54.3	50.1	52	<2.22	<1.28	4.68	2.61	4.75	5.88	5.3	1.92	8.05	2.56	--	--	--	52	8.8	0.13
1,2,4,5-Tetramethylbenzene		29.0	25.7	27	<1.90	<1.1	<1.1	<1.1	2.47	2.87	2.7	<1.1	<1.1	<1.1	--	--	--	27	3.8	0.054
Dodecane		68.8	77.3	73	0.85	6.50	6.92	43.3	10.8	12.2	12	20.0	187	31.4	--	--	--	187	42	0.60
1,2,4-Trichlorobenzene	240	<7.42	11.4	7.6	<2.58	<1.48	1.46	<1.48	<4.95	<4.95	<4.95	3.99	0.564	0.661	--	--	--	7.6	2.2	0.031
Naphthalene	190	703	603	653	<1.82	<1.05	0.246	0.661	8.91	11.5	10	0.472	1.82	0.970	<1.1	<1.1	<1.1	653	56	0.80
Benzothiophene		9.93	8.34	9	<4.76	<2.74	<2.74	<2.74	<9.17	<9.17	<9.17	<2.74	<2.74	<2.74	--	--	--	9.1	2.7	0.039
Hexachlorobutadiene	320	<10.7	<10.7	<10.7	<3.70	<2.13	<2.13	<2.13	<7.11	<7.11	<7.11	<2.13	<2.13	<2.13	--	--	--	ND	ND	ND
2-Methylnaphthalene	2,400	549	354	452	<10.1	<5.82	<5.82	<5.82	<19.4	<19.4	<19.4	<5.82	<5.82	<5.82	--	--	--	452	54	0.77
1-Methylnaphthalene		558	389	474	<10.1	<5.82	<5.82	<5.82	<19.4	<19.4	<19.4	<5.82	<5.82	<5.82	--	--	--	474	56	0.80
Total Xylene (calculated)	6,200	522	511	517	<1.51	<0.869	<0.869	4.99	554	560	557	2.647	3.64	1.047	1.3	1.3	0.97	557	91	1.3
MassDEP APH																				
C_5-C_8 Aliphatics, Adjusted	23,000	--	--	--	--	--	--	--	--	--	--	--	--	--	100	190	38	190	109	1.6
C_9-C_{10} Aromatics Total	3,100	--	--	--	--	--	--	--	--	--	--	--	--	--	<10	<10	<10	ND	ND	ND
C_9-C_{12} Aliphatics, Adjusted	16,000	--	--	--	--	--	--	--	--	--	--	--	--	--	3500	3400	160	3500	2353	34

Notes:
1. MA-CISSGV - Massachusetts Soil Gas Screening Values (SGSV) for the evaluation of a vapor intrusion pathway for a commercial/industrial exposure per MassDEP Policy #WSC-16-435 Vapor Intrusion Guidance (October 2016).
Blank indicates that a standard is not available for the specified analyte.
2. <= less than listed laboratory reporting limits (RLs).
3. Averages were calculated for field duplicate pair samples (yellow-highlighted). When the analyte was detected in at least one sample, the half reporting limit was used for the nondetect, if any, for the average calculation.
If the analyte was not detected in either sample, the average was presented as a nondetect and the lowest laboratory reporting limit was used to represent the reporting limit for the average result.
4. Total Xylenes were calculated from o-Xylene and p/m-Xylene results. If both results were non-detect, the minimum detection limit is reported for Total Xylenes. If one result was non-detect, the sum of half of the non-detect detection limit and the detected result was reported as Total Xylenes.
5. Concentrations are reported in micrograms per cubic meter ($\mu g/m^3$).
6. Averages were calculated based on all soil gas data. The results for the field duplicate pair of samples (yellow-highlighted) were averaged and the average results were then used for the average soil gas concentration calculation.
When the analyte was detected in at least one sample, the half reporting limit was used for the nondetect, if any, for the average calculation.
If the analyte was not detected in either sample, the average was presented as "ND".
7. The estimated indoor air concentrations were calculated by multiplying the average soil gas concentrations by a default attenuation factor of 0.014.
ND = Not Detected.

TABLE D-9
SUMMARY OF CONSTITUENTS OF CONCERN
284 Winter Street
Haverhill, Massachusetts

CLASS	ANALYTE	SOIL	SOIL GAS/INDOOR AIR	GROUNDWATER	SEDIMENT
<<< VOC >>>	1,2,4-Trichlorobenzene	--	COC	--	--
	1,2,3-Trimethylbenzene	--	COC	--	--
	1,2,4-Trimethylbenzene	--	COC	--	--
	1,2-Dichloroethane	--	COC	--	--
	1,3,5-Trimethylbenzene	--	COC	--	--
	2-Butanone	--	COC	--	--
	2-Hexanone	--	COC	--	--
	4-Ethyltoluene	--	COC	--	--
	Acetaldehyde	--	COC	--	--
	Acetone	--	COC	--	--
	Acrolein	--	COC	--	--
	Benzene	COC	COC	COC	COC
	Carbon Disulfide	--	COC	--	--
	Chloroethane	--	COC	--	--
	Chloroform	--	COC	--	--
	Chloromethane	--	COC	--	--
	cis-1,2-Dichloroethene	--	COC	--	--
	Cyclohexane	--	COC	--	--
	Ethanol	--	COC	--	--
	Ethylbenzene	COC	COC	COC	COC
	Dichlorodifluoromethane	--	COC	--	--
	1,1,2-Trichloro-1,2,2-Trifluoroethane	--	COC	--	--
	Heptane	--	COC	--	--
	Hexane	--	COC	--	--
	Methylene Chloride	--	COC	--	--
	Methyl-Tert-Butyl-Ether	ND	COC	COC	ND
	Naphthalene	COC	COC	COC	COC
	n-Butane	--	COC	--	--
	n-Nonane	--	COC	--	--
	Pentane	--	COC	--	--
	tert-Butyl Alcohol	--	COC	--	--
	Tetrachloroethene	--	COC	--	--
	Toluene	COC	COC	COC	ND
	Trichlorofluoromethane	--	COC	--	--
	Xylene (Total)	COC	COC	COC	COC
	Styrene	--	COC	COC	--
	4-Methyl-2-Pentanone	--	COC	--	--
	Isopropyl Alcohol	--	COC	--	--
	1,3-Butadiene	--	COC	--	--
	2,2,4-Trimethylpentane	--	COC	--	--
<<< SVOC >>>	1-Methylnaphthalene	--	COC	--	--
	2-Methylnaphthalene	COC	COC	COC	COC
	Acenaphthene	COC	--	COC	COC
	Acenaphthylene	COC	--	COC	COC
	Anthracene	COC	--	ND	COC
	Benzo(a)Anthracene	COC	--	ND	COC
	Benzo(a)Pyrene	COC	--	ND	COC
	Benzo(b)Fluoranthene	COC	--	ND	COC
	Benzo(g,h,i)Perylene	COC	--	ND	COC
	Benzo(k)Fluoranthene	COC	--	ND	COC
	Biphenyl	COC	--	--	--
	Carbazole	COC	--	--	--
	Chrysene	COC	--	ND	COC
	Dibenzo(a,h)anthracene	COC	--	ND	COC
	Dibenzofuran	COC	--	--	--
	Fluoranthene	COC	--	COC	COC
	Fluorene	COC	--	COC	COC
	Indeno(1,2,3-cd)Pyrene	COC	--	ND	COC
	Phenanthrene	COC	--	COC	COC
	Pyrene	COC	--	COC	COC
<<< TPH >>>	C11-C22 Aromatic Fraction	COC	--	COC	COC
	C19-C36 Aliphatic Fraction	COC	--	ND	COC
	C5-C8 Aliphatic Fraction	COC	COC	COC	ND
	C9-C10 Aromatic Fraction	COC	ND	COC	COC
	C9-C18 Aliphatic Fraction	COC	COC	COC	COC
<<< Inorganics >>>	Chromium (total)	COC	--	--	--
	Cyanide	COC	--	COC	ND
	Lead	COC	--	--	--

Notes:
1. Only analytes detected in at least one soil, groundwater, sediment, or soil gas sample were evaluated as potential constituents of concern.
2. o-Xylenes and m&p-xylenes were evaluated as xylene (total).
3. All COCs detected in soil were evaluated as COCs in soil-borne fugitive dust, while all groundwater COCs considered "volatile" in accordance with the USEPA (2015) guidelines were evaluated as COCs in ambient air in a trench.
4. Reasons for exclusion as a COC:
   ND = Analyte not detected in this medium in samples being evaluated as part of this assessment
   -- = Analyte was not analyzed for this medium
5. The C9-C12 aliphatic hydrocarbon fraction was evaluated as part of the C9-C18 aliphatic fraction because concentrations of constituents in the C9-C12 aliphatic range are included in the C9-C18 aliphatic range.

Abbreviations:
COC = constituents of concern; VOC = volatile organic compound; SVOC = semi-volatile organic compound;
TPH = total petroleum hydrocarbon.

TABLE D-10
SUMMARY OF EXPOSURE POINT CONCENTRATIONS
284 Winter Street
Haverhill, Massachusetts

	EPC1	EPC3	EPC1A	EPC2A	EPC1B	EPC2B	EPC4B	EPC5	EPC6B	EPC7
COC	**Arithmetic Mean Concentration in Soil Site-Wide[a1] (mg/kg)**	**Estimated Concentration in Fugitive Dust Site-Wide[b2] (mg/m^3)**	**Arithmetic Mean Concentration in Soil Outside Holder Area[a2] (mg/kg)**	**Estimated Concentration in Fugitive Dust Outside Holder Area[b1] (mg/m^3)**	**Arithmetic Mean Concentration in Soil Within Holder Area[a3] (mg/kg)**	**Estimated Concentration in Fugitive Dust Within Holder Area[b1] (mg/m^3)**	**Groundwater Concentration Within Holder Area[c] (µg/L)**	**Estimated Concentration in Indoor Air[d] ($µg/m^3$)**	**Estimated Concentration in Ambient Air[e] (mg/m^3)**	**Maximum Detected Concentration in Top 1 Foot Sediment[f] (mg/kg)**
1,2,4-Trichlorobenzene	NCC	NC	NCC	NC	NCC	NC	NCC	3.1E-02	NCC	NCC
1,2,3-Trimethylbenzene	NCC	NC	NCC	NC	NCC	NC	NCC	2.6E-01	NCC	NCC
1,2,4-Trimethylbenzene	NCC	NC	NCC	NC	NCC	NC	NCC	5.7E-01	NCC	NCC
1,2-Dichloroethane	NCC	NC	NCC	NC	NCC	NC	NCC	1.4E-02	NCC	NCC
1,3,5-Trimethylbenzene	NCC	NC	NCC	NC	NCC	NC	NCC	4.2E-01	NCC	NCC
2-Butanone	NCC	NC	NCC	NC	NCC	NC	NCC	1.5E-01	NCC	NCC
2-Hexanone	NCC	NC	NCC	NC	NCC	NC	NCC	9.3E-02	NCC	NCC
4-Ethyltoluene	NCC	NC	NCC	NC	NCC	NC	NCC	2.1E-01	NCC	NCC
Acetaldehyde	NCC	NC	NCC	NC	NCC	NC	NCC	1.0E-01	NCC	NCC
Acetone	NCC	NC	NCC	NC	NCC	NC	NCC	4.6E-01	NCC	NCC
Acrolein	NCC	NC	NCC	NC	NCC	NC	NCC	1.2E-02	NCC	NCC
Benzene	23	7.5E-07	2.3	1.4E-07	115	6.9E-06	19500	1.2E+00	2.8E-01	3.7E+01
Carbon Disulfide	NCC	NC	NCC	NC	NCC	NC	NCC	4.3E-02	NCC	NCC
Chloroethane	NCC	NC	NCC	NC	NCC	NC	NCC	1.0E-02	NCC	NCC
Chloroform	NCC	NC	NCC	NC	NCC	NC	NCC	1.5E-02	NCC	NCC
Chloromethane	NCC	NC	NCC	NC	NCC	NC	NCC	6.7E-03	NCC	NCC
cis-1,2-Dichloroethene	NCC	NC	NCC	NC	NCC	NC	NCC	2.2E-02	NCC	NCC
Cyclohexane	NCC	NC	NCC	NC	NCC	NC	NCC	7.2E-02	NCC	NCC
Ethanol	NCC	NC	NCC	NC	NCC	NC	NCC	8.7E-02	NCC	NCC
Ethylbenzene	24	7.6E-07	25	1.5E-06	19	1.2E-06	697	3.9E-01	8.6E-03	2.0E+02
Dichlorodifluoromethane	NCC	NC	NCC	NC	NCC	NC	NCC	2.9E-02	NCC	NCC
1,1,2-Trichloro-1,2,2-Trifluoroethane	NCC	NC	NCC	NC	NCC	NC	NCC	6.7E-03	NCC	NCC
Heptane	NCC	NC	NCC	NC	NCC	NC	NCC	5.8E-02	NCC	NCC
Hexane	NCC	NC	NCC	NC	NCC	NC	NCC	1.3E-01	NCC	NCC
Methylene Chloride	NCC	NC	NCC	NC	NCC	NC	NCC	2.4E-02	NCC	NCC
Methyl-Tert-Butyl-Ether	NCC	NC	NCC	NC	NCC	NC	<300	1.4E+00	NCC	NCC
Naphthalene	291	9.3E-06	216	1.3E-05	819	4.9E-05	9600	8.0E-01	7.1E-02	7.4E+02
n-Butane	NCC	NC	NCC	NC	NCC	NC	NCC	1.2E+00	NCC	NCC
n-Nonane	NCC	NC	NCC	NC	NCC	NC	NCC	1.1E-01	NCC	NCC
Pentane	NCC	NC	NCC	NC	NCC	NC	NCC	4.1E-01	NCC	NCC
tert-Butyl Alcohol	NCC	NC	NCC	NC	NCC	NC	NCC	2.5E-01	NCC	NCC
Tetrachloroethene	NCC	NC	NCC	NC	NCC	NC	NCC	3.8E-01	NCC	NCC
Toluene	20	6.4E-07	1.3	7.9E-08	98	5.9E-06	4060	1.4E+00	5.4E-02	NCC
Trichlorofluoromethane	NCC	NC	NCC	NC	NCC	NC	NCC	2.8E-02	NCC	NCC
Xylene (Total)	29	9.1E-07	26	1.6E-06	43	2.6E-06	2168	1.3E+00	2.7E-02	2.6E+02
Styrene	NCC	NC	NCC	NC	NCC	NC	440	5.4E-02	5.2E-03	NCC
4-Methyl-2-Pentanone	NCC	NC	NCC	NC	NCC	NC	NCC	9.3E-02	NCC	NCC
Isopropyl Alcohol	NCC	NC	NCC	NC	NCC	NC	NCC	2.1E-01	NCC	NCC
1,3-Butadiene	NCC	NC	NCC	NC	NCC	NC	NCC	6.2E-03	NCC	NCC
2,2,4-Trimethylpentane	NCC	NC	NCC	NC	NCC	NC	NCC	6.7E-01	NCC	NCC
1-Methylnaphthalene	NCC	NC	NCC	NC	NCC	NC	NCC	8.0E-01	NCC	NCC
2-Methylnaphthalene	45	1.4E-06	24	1.5E-06	227	1.4E-05	549	7.7E-01	4.1E-03	4.1E+02
Acenaphthene	11	3.6E-07	11	6.5E-07	15	9.0E-07	<100	NCC	NCC	4.5E+02
Acenaphthylene	22	6.9E-07	9.8	5.9E-07	129	7.7E-06	140	NCC	4.6E-04	3.5E+01
Anthracene	19	6.1E-07	14	8.1E-07	68	4.1E-06	NCC	NCC	NCC	2.7E+02
Benzo(a)Anthracene	15	4.8E-07	12	7.4E-07	39	2.3E-06	NCC	NCC	NCC	2.0E+02
Benzo(a)Pyrene	16	5.1E-07	14	8.1E-07	45	2.7E-06	NCC	NCC	NCC	1.1E+02
Benzo(b)Fluoranthene	11	3.4E-07	10	6.1E-07	31	1.9E-06	NCC	NCC	NCC	9.7E+01
Benzo(g,h,i)Perylene	7.9	2.5E-07	7.6	4.6E-07	21	1.3E-06	NCC	NCC	NCC	3.4E+01
Benzo(k)Fluoranthene	9.5	3.1E-07	9.8	5.9E-07	13	8.0E-07	NCC	NCC	NCC	3.2E+01
Biphenyl	9.4	3.0E-07	9.4	5.7E-07	NCC	NC	NCC	NCC	NCC	NCC
Carbazole	3.8	1.2E-07	3.8	2.3E-07	NCC	NC	NCC	NCC	NCC	NCC
Chrysene	15	4.8E-07	13	7.7E-07	35	2.1E-06	NCC	NCC	NCC	1.9E+02
Dibenzo(a,h)anthracene	2.4	7.8E-08	2.6	1.6E-07	4.5	2.7E-07	NCC	NCC	NCC	8.3E+00
Dibenzofuran	9.3	3.0E-07	9.3	5.6E-07	NCC	NC	NCC	NCC	NCC	NCC
Fluoranthene	28	9.0E-07	22	1.3E-06	82	4.9E-06	<100	NCC	NCC	3.2E+02
Fluorene	22	7.2E-07	16	9.9E-07	75	4.5E-06	<100	NCC	NCC	4.3E+02
Indeno(1,2,3-cd)Pyrene	7.2	2.3E-07	7.3	4.4E-07	17	1.0E-06	NCC	NCC	NCC	2.8E+01
Phenanthrene	78	2.5E-06	59	3.5E-06	256	1.5E-05	<100	NCC	NCC	1.0E+03
Pyrene	41	1.3E-06	29	1.7E-06	149	9.0E-06	<100	NCC	NCC	4.8E+02
C11-C22 Aromatic Fraction	5049	1.6E-04	5310	3.2E-04	1834	1.1E-04	<5000	NCC	NCC	1.6E+04
C19-C36 Aliphatic Fraction	415	1.3E-05	454	2.7E-05	203	1.2E-05	NCC	NCC	NCC	1.3E+03
C5-C8 Aliphatic Fraction	131	4.2E-06	109	6.5E-06	307	1.8E-05	<10000	1.6E+00	NCC	NCC
C9-C10 Aromatic Fraction	657	2.1E-05	673	4.0E-05	568	3.4E-05	<10000	NCC	NCC	7.4E+02
C9-C18 Aliphatic Fraction	2001	6.4E-05	2360	1.4E-04	85	5.1E-06	<10000	3.4E+01	NCC	1.7E+03
Chromium (total)	18	5.6E-07	18	1.1E-06	17	1.0E-06	NCC	NCC	NCC	NCC
Cyanide	7.3	2.3E-07	8.0	4.8E-07	2.6	1.5E-07	518	NCC	1.3E-02	NCC
Lead	74	2.4E-06	71	4.3E-06	96	5.8E-06	NCC	NCC	NCC	NCC

Notes:

a. Three sets of soil EPCs were derived for this risk characterization.

1. For facility workers and trespassers, Site-wide soil EPCs were based on the arithmetic means of 0-15 feet soil samples, the arithmetic means of 0-6 feet soil samples, or the arithmetic means of 0-3 feet soil samples, whichever higher. All soil samples collected from the top 15 feet of soil were included in the EPC derivation.

2. For construction workers working outside the former relief holder area, soil EPCs were based on the arithmetic means of 0-15 feet soil samples, the arithmetic means of 0-6 feet soil samples, or the arithmetic means of 0-3 feet soil samples, whichever higher. All soil samples collected from top 15 feet of soil outside the former relief holder area were used for the EPC derivation.

3. For construction workers working within the former relief holder area, soil EPCs were based on the arithmetic means of the analytical results for soil samples B-1 10-12', B-107 S-4, B-107 S-4 and S-5, and B-107 S-2.

b. The soil-borne fugitive dust exposure point concentrations were estimated from the soil exposure point concentration according to the following equation:

$$EPC_{dust} = EPC_{soil} * PM_{10} * C1$$

EPC_{dust}	Exposure Point Concentration in Fugitive Dust	Calculated	mg/m^3	modeled from soil concentrations
EPC_{soil}	Exposure Point Concentration in Soil	Calculated	mg/kg	average concentrations used
1. PM_{10}	Respirable Particle Concentration - Construction/Utility Workers	0.06	mg/m^3	MADEP, 1995; heavy excavation scenario
2. PM_{10}	Respirable Particle Concentration - Facility Workers & Trespassers	0.032	mg/m^3	MADEP, 1995; open field scenario
C1	Unit Conversion Factor	1E-06	kg/mg	Constant

c. The groundwater EPCs were based on the representative analytical results for MW-1 (i.e., the analytical results of the groundwater sample collected from MW-1 on September 15, 2020). Styrene or cyanide was not analyzed for MW-1. The maximum concentrations among the wells at the Site were used as the EPCs as a conservative approach.

d. The indoor air exposure point concentrations were estimated by multipling the soil gas EPCs by a default attenuation factor of 0.014.

The soil gas EPCs were the average concentrations of the soil gas data (duplicates were averaged and then included in the soil gas average calculation) for all COCs but acrolein and 1,1,2-trichloro-1,2,2-trifluoroethane.

For acrolein and 1,1,2-trichloro-1,2,2-trifluoroethane the maximum detected concentrations were used as the soil gas EPCs.

e. The ambient air exposure point concentrations were modeled from groundwater data using a box model presented in TABLE I-1.

f. The sediment exposure point concentrations were based on the maximum concentrations detected among all the sediment samples collected from top 1 foot of sediment at the Site.

Abbreviations:

COC = constituent of concern; EPC = exposure point concentration.

TABLE D-11
FACILITY WORKER EXPOSURE PROFILE
284 Winter Street
Haverhill, Massachusetts

Equations Used to Calculate Average Daily Dose (ADD) and Lifetime Average Daily Dose (LADD)

EXPOSURE PATHWAY: Dermal Contact with Soil

$$ADD_{soil\text{-}dermal} = \frac{EPC_{soil} * DCR_{soil} * EF * ED * EP * RAF_{dermal\text{-}nc} * C1}{BW * AP_{nc}} \quad \text{Equation 1}$$

$$LADD_{soil\text{-}dermal} = \frac{EPC_{soil} * DCR_{soil} * EF * ED * EP * RAF_{dermal\text{-}c} * C1}{BW * AP_{c}} \quad \text{Equation 2}$$

Parameter	Definition	Units	Receptor-Specific Values (ages >18 years)	Rationale/Reference
$ADD_{soil\text{-}dermal}$	Average Daily Dose	mg/kg-day	Calculated	Equation 1
$LADD_{soil\text{-}dermal}$	Lifetime Average Daily Dose	mg/kg-day	Calculated	Equation 2
EPC_{soil}	Exposure Point Concentration in Soil	mg/kg	TABLE D-10	See Text
DCR_{soil}	Soil Dermal Contact Rate	mg/day	90	MassDEP 2019, Note A
EF	Exposure Frequency	events/year	120	MassDEP 2014 (Four days per week for 30 weeks)
ED	Exposure Duration	days/event	1	MassDEP, 1995
EP	Exposure Period	years	27	MassDEP, 2019
RAF_{dermal}	Relative Absorption Factor	unitless	Constituent-specific	TABLE D-18
C1	conversion factor for units	kg/mg	1E-06	Constant
BW	Body Weight of Receptor	kg	68	MassDEP, 2019
AP_{nc}	Averaging Period, non-cancer	days	9,855	equals EP * 365 days/year
AP_{c}	Averaging Period, cancer	days	25,550	equals average lifetime, 70 years * 365 days/year

Note:

A. The soil dermal contact rate (DCR_{soil}) was based on the median skin surface area for hands, face, forearms, and feet multiplied by the adherence factor specific to the body part. Skin surface areas and adherence factors for Landscapers/Groundskeepers were used based on MassDEP recommendations (MassDEP Technical Update,"Weighted Skin-Soil Adherence Factors", April 2002). The skin surface area and adherence factors for each body part are presented below for an adult. These values for an adult were used to calculate DCR_{soil} for this receptor group.

Adult Female (ages 18-45)

Body Part	SA (cm^2/day)	AF (mg/cm^2)	DCR_{soil} (mg/day)
Hands:	826	0.0697	58
Face:	352	0.0058	2
Forearms:	1,035	0.0133	14
Feet:	1,136	0.0149	17
		Total DCR_{soil}:	**90**

Abbreviations:

AF = Adherence Factor; MassDEP = Massachusetts Department of Environmental Protection; SA = Skin Surface Area.

TABLE D-11
FACILITY WORKER EXPOSURE PROFILE
284 Winter Street
Haverhill, Massachusetts

Equations Used to Calculate Average Daily Dose (ADD) and Lifetime Average Daily Dose (LADD)

EXPOSURE PATHWAY: Incidental Ingestion of Soil

$$ADD_{soil\text{-}oral} = \frac{EPC_{soil} * IR_{soil} * EF * ED * EP * RAF_{oral} * C1}{BW * AP_{nc}} \quad \text{Equation 3}$$

$$LADD_{soil\text{-}oral} = \frac{EPC_{soil} * IR_{soil} * EF * ED * EP * RAF_{oral} * C1}{BW * AP_{c}} \quad \text{Equation 4}$$

Parameter	Definition	Units	Receptor-Specific Values (ages >18 years)	Rationale/Reference
$ADD_{soil\text{-}oral}$	Average Daily Dose	mg/kg-day	Calculated	Equation 3
$LADD_{soil\text{-}oral}$	Lifetime Average Daily Dose	mg/kg-day	Calculated	Equation 4
EPC_{soil}	Exposure Point Concentration in Soil	mg/kg	TABLE D-10	See Text
IR_{soil}	Soil Ingestion Rate	mg/day	50.3	Adult soil ingestion rate (50 mg/day) plus calculated ingestion of inhaled dust (0.3 mg/day) (MassDEP 2002) Note A.
EF	Exposure Frequency	events/year	120	MassDEP 2014 (Four days per week for 30 weeks)
ED	Exposure Duration	days/event	1	MassDEP, 1995
EP	Exposure Period	years	27	MassDEP, 2019
RAF_{oral}	Relative Absorption Factor	unitless	Constituent-specific	TABLE D-18
C1	conversion factor for units	kg/mg	1E-06	Constant
BW	Body Weight of Receptor	kg	68	MassDEP, 2019
AP_{nc}	Averaging Period, non-cancer	days	9,855	equals EP * 365 days/year
AP_{c}	Averaging Period, cancer	days	25,550	equals average lifetime, 70 years * 365 days/year

Note:

A. The soil ingestion rate including the ingestion of particulates is described in Attachment II.

Abbreviation:

MassDEP = Massachusetts Department of Environmental Protection.

TABLE D-11
FACILITY WORKER EXPOSURE PROFILE
284 Winter Street
Haverhill, Massachusetts

Equations Used to Calculate Average Daily Exposure (ADE) and Lifetime Average Daily Exposure (LADE)

EXPOSURE PATHWAY: Inhalation of Soil-borne Fugitive Dust

$$ADE_{dust} = \frac{EPC_{dust} * EF * ED * EP * C2}{AP_{nc}} \quad \text{Equation 5}$$

$$LADE_{dust} = \frac{EPC_{dust} * EF * ED * EP * C2 * C3}{AP_{c}} \quad \text{Equation 6}$$

Parameter	Definition	Units	Receptor-Specific Values (ages >18 years)	Rationale/Reference
ADE_{dust}	Average Daily Exposure	mg/m^3	Calculated	Equation 5
$LADE_{dust}$	Lifetime Average Daily Exposure	$\mu g/m^3$	Calculated	Equation 6
EPC_{dust}	Exposure Point Concentration in Fugitive Dust	mg/m^3	TABLE D-10	modeled from soil concentrations using RP (Note A)
EF	Exposure Frequency	events/year	120	MassDEP 2014 (Four days per week for 30 weeks)
ED	Exposure Duration	hours/event	8	Typical workday
EP	Exposure Period	years	27	MassDEP, 2019
C2	conversion factor for units	days/hours	0.0417	Constant
C3	conversion factor for units	µg/mg	1,000	Constant
AP_{nc}	Averaging Period, non-cancer	days	9,855	equals EP * 365 days/year
AP_c	Averaging Period, cancer	days	25,550	equals average lifetime, 70 years * 365 days/year

Note:

A. A respirable particle concentration (RP) of 0.032 mg/m^3 (open field scenario PM_{10} from MassDEP, 1995) was applied to soil EPCs to calculate EPC_{dust}. See text for equation used to derive EPC_{dust}.

Abbreviation:

MassDEP = Massachusetts Department of Environmental Protection.

TABLE D-11
FACILITY WORKER EXPOSURE PROFILE
284 Winter Street
Haverhill, Massachusetts

Equations Used to Calculate Average Daily Exposure (ADE) and Lifetime Average Daily Exposure (LADE)

EXPOSURE PATHWAY: Inhalation of Vapors in Indoor Air

$$ADE_{ind\text{-}air} = \frac{EPC_{air} * EF * ED * EP * C2 * C5}{AP_{nc}} \quad \text{Equation 7}$$

$$LADE_{ind\text{-}air} = \frac{EPC_{air} * EF * ED * EP * C2}{AP_{c}} \quad \text{Equation 8}$$

Parameter	Definition	Units	Receptor-Specific Values (ages >18 years)	Rationale/Reference
$ADE_{ind\text{-}air}$	Average Daily Exposure	mg/m^3	Calculated	Equation 7
$LADE_{ind\text{-}air}$	Lifetime Average Daily Exposure	$\mu g/m^3$	Calculated	Equation 8
EPC_{air}	Exposure Point Concentration in Air	$\mu g/m^3$	TABLE D-10	modeled from groundwater concentrations
EF	Exposure Frequency	events/year	250	Five days per week for 50 weeks (assuming 2 weeks vacation)
ED	Exposure Duration	hours/event	8	MassDEP, 2011
EP	Exposure Period	years	27	MassDEP, 2019
C2	conversion factor for units	days/hr	0.0417	Constant
C5	conversion factor for units	mg/µg	0.001	Constant
AP_{nc}	Averaging Period, non-cancer	days	9,855	equals EP * 365 days/year
AP_c	Averaging Period, cancer	days	25,550	equals average lifetime, 70 years * 365 days/year

Abbreviation:
MADEP = Massachusetts Department of Environmental Protection.

TABLE D-12
CONSTRUCTION WORKER EXPOSURE PROFILE
284 Winter Street
Haverhill, Massachusetts

Equations Used to Calculate Average Daily Dose (ADD) and Lifetime Average Daily Dose (LADD)

EXPOSURE PATHWAY: Dermal Contact with Soil

$$ADD_{soil\text{-}dermal} = \frac{EPC_{soil} * DCR_{soil} * EF * ED * EP * RAF_{dermal\text{-}nc} * C1}{BW * AP_{nc}} \quad \text{Equation 1}$$

$$LADD_{soil\text{-}dermal} = \frac{EPC_{soil} * DCR_{soil} * EF * ED * EP * RAF_{dermal\text{-}c} * C1}{BW * AP_{c}} \quad \text{Equation 2}$$

Parameter	Definition	Units	Receptor-Specific Values (ages >18 years)	Rationale/Reference
$ADD_{soil\text{-}dermal}$	Average Daily Dose	mg/kg-day	Calculated	Equation 1
$LADD_{soil\text{-}dermal}$	Lifetime Average Daily Dose	mg/kg-day	Calculated	Equation 2
EPC_{soil}	Exposure Point Concentration in Soil	mg/kg	TABLE D-10	See Text
DCR_{soil}	Soil Dermal Contact Rate	mg/day	1050	MassDEP 2019, Note A
EF	Exposure Frequency	events/year	260	Five days per week for an entire year
ED	Exposure Duration	days/event	1	MassDEP, 1995
EP	Exposure Period	years	0.5	Assumes a six-month construction project; MassDEP, 1995
RAF_{dermal}	Relative Absorption Factor	unitless	Constituent-specific	TABLE D-18
C1	conversion factor for units	kg/mg	1E-06	Constant
BW	Body Weight of Receptor	kg	65	Average body weight for adult female (ages 18-25). MassDEP, 2019.
AP_{nc}	Averaging Period, non-cancer	days	183	equals EP * 365 days/year
AP_{c}	Averaging Period, cancer	days	25,550	equals average lifetime, 70 years * 365 days/year

Notes:

A. The soil dermal contact rate (DCR_{soil}) was based on the median skin surface area for hands, forearms, face, lower legs, and feet for adults multiplied by the adherence factor specific to the body part. Skin surface areas and adherence factor values are based on MassDEP (2019) recommendations for construction workers.

Adult Female (ages 18-25)

Body Part	SA (cm^2/day)	AF (mg/cm^2)	DCR_{soil} (mg/day)
Hands:	826	0.3487	288
Forearms:	1,035	0.3279	339
Face:	352	0.1102	39
Lower Legs	2,223	0.0419	93
Feet:	1,136	0.2563	291
		Total DCR_{soil}:	**1,050**

B. The exposure frequency is prorated to a six-month exposure period, or 130 events per 6 months. EP = 0.5 years (6 months)

Abbreviations:

AF = Adherence Factor; MassDEP = Massachusetts Department of Environmental Protection; SA = Skin Surface Area.

TABLE D-12
CONSTRUCTION WORKER EXPOSURE PROFILE
284 Winter Street
Haverhill, Massachusetts

Equations Used to Calculate Average Daily Dose (ADD) and Lifetime Average Daily Dose (LADD)

EXPOSURE PATHWAY: Incidental Ingestion of Soil

$$ADD_{soil\text{-}oral} = \frac{EPC_{soil} * IR_{soil} * EF * ED * EP * RAF_{oral} * C1}{BW * AP_{nc}} \quad \text{Equation 3}$$

$$LADD_{soil\text{-}oral} = \frac{EPC_{soil} * IR_{soil} * EF * ED * EP * RAF_{oral} * C1}{BW * AP_{c}} \quad \text{Equation 4}$$

Parameter	Definition	Units	Receptor-Specific Values (ages >18 years)	Rationale/Reference
$ADD_{soil\text{-}oral}$	Average Daily Dose	mg/kg-day	Calculated	Equation 3
$LADD_{soil\text{-}oral}$	Lifetime Average Daily Dose	mg/kg-day	Calculated	Equation 4
EPC_{soil}	Exposure Point Concentration in Soil	mg/kg	TABLE D-10	See Text
IR_{soil}	Soil Ingestion Rate	mg/day	100	Activity-weighted ingestion rate; MassDEP 2002 (Note A)
EF	Exposure Frequency	events/year	260	Five days per week for an entire year
ED	Exposure Duration	days/event	1	MassDEP, 1995
EP	Exposure Period	years	0.5	Assumes a six-month construction project; MassDEP, 1995
RAF_{oral}	Relative Absorption Factor	unitless	Constituent-specific	TABLE D-18
C1	conversion factor for units	kg/mg	1E-06	Constant
BW	Body Weight of Receptor	kg	65	Average body weight for adult female (ages 18-25). MassDEP, 2019.
AP_{nc}	Averaging Period, non-cancer	days	183	equals EP * 365 days/year
AP_{c}	Averaging Period, cancer	days	25,550	equals average lifetime, 70 years * 365 days/year

Notes:

A. The soil ingestion rate is based on MassDEP's recommended ingestion rate of 100 mg/day (Technical Update, April 2002) for receptors involved in heavy excavation.
B. The exposure frequency is prorated to a six month exposure period, or 130 events per 6 months. EP = 0.5 years (6 months)

Abbreviation:
MassDEP = Massachusetts Department of Environmental Protection

TABLE D-12
CONSTRUCTION WORKER EXPOSURE PROFILE
284 Winter Street
Haverhill, Massachusetts

Equations Used to Calculate Average Daily Exposure (ADE) and Lifetime Average Daily Exposure (LADE)

EXPOSURE PATHWAY: Inhalation of Soil-borne Fugitive Dust and Absorbtion via the Gastointestinal (GI) Tract

$$ADD_{dust\text{-}GI} = \frac{EPC_{dust} * 1.5 * INH * RAF_{oral} * EF * ED * EP * C2 * C3}{BW * AP_{nc}} \quad \text{Equation 5}$$

$$LADD_{dust\text{-}GI} = \frac{EPC_{dust} * 1.5 * INH * RAF_{oral} * EF * ED * EP * C2 * C3}{BW * AP_{c}} \quad \text{Equation 6}$$

Parameter	Definition	Units	Receptor-Specific Values (ages >18 years)	Rationale/Reference
$ADD_{dust\text{-}GI}$	Average Daily Exposure	mg/kg-day	Calculated	Equation 5
$LADD_{dust\text{-}GI}$	Lifetime Average Daily Exposure	mg/kg-day	Calculated	Equation 6
EPC_{dust}	Exposure Point Concentration in Fugitive Dust	mg/m^3	TABLE D-10	modeled from soil concentrations using PM_{10} (Note A)
INH	Inhalation Rate	l/min	60	MassDEP Technical Update, 2008
RAF_{oral}	Relative Absorption Factor	unitless	Constituent-specific	TABLE D-18
EF	Exposure Frequency	events/year	260	Five days per week for an entire year
ED	Exposure Duration	hours/event	8	Typical workday
EP	Exposure Period	years	0.5	Assumes a six-month construction project; MassDEP, 1995
C2	conversion factor for units	m^3/L	1E-03	Constant
C3	conversion factor for units	min/hr	60	Constant
BW	Body Weight of Receptor	kg	65	Average body weight for adult female (ages 18-25). MassDEP, 2019.
AP_{nc}	Averaging Period, non-cancer	days	183	equals EP * 365 days/year
AP_c	Averaging Period, cancer	days	25,550	equals average lifetime, 70 years * 365 days/year

Notes:

A. A PM_{10} concentration of 0.060 mg/m^3 (excavation scenario, MassDEP, 1995) was applied to soil EPCs to calculate EPC_{dust}. See text for equation used to derive EPC_{dust}.
B. Multiplier 1.5 is based on MassDEP's assumptions: (a) 100% of respirable particulate (RP) is PM_{30}; (b) 50% of RP is PM_{10}; and (c) 50% of PM_{10} and 100% of inhaled particulates other than PM_{10} are swallowed (MassDEP 2008).
C. Inhalation Rate, 60 l/min is ventilation rate for heavy exertion (Appendix B, MassDEP 1995).

Abbreviations:

PM_{10} (PM_{30}) = Particulates in air less than or equal to 10 (30) microns in diameter.
RP = Respirable Particle Concentration.
MassDEP = Massachusetts Department of Environmental Protection

TABLE D-12
CONSTRUCTION WORKER EXPOSURE PROFILE
284 Winter Street
Haverhill, Massachusetts

Equations Used to Calculate Average Daily Exposure (ADE) and Lifetime Average Daily Exposure (LADE)

EXPOSURE PATHWAY: Inhalation of Soil-borne Fugitive Dust and Respiratory Absorption

$$ADE_{dust\text{-}RA} = \frac{EPC_{dust} * 0.5 * EF * ED * EP * C4}{AP_{nc}} \quad \text{Equation 7}$$

$$LADE_{dust\text{-}RA} = \frac{EPC_{dust} * 0.5 * EF * ED * EP * C4 * C5}{AP_{c}} \quad \text{Equation 8}$$

Parameter	Definition	Units	Receptor-Specific Values (ages >18 years)	Rationale/Reference
$ADE_{dust\text{-}RA}$	Average Daily Exposure	mg/m^3	Calculated	Equation 7
$LADE_{dust\text{-}RA}$	Lifetime Average Daily Exposure	$\mu g/m^3$	Calculated	Equation 8
EPC_{dust}	Exposure Point Concentration in Fugitive Dust	mg/m^3	TABLE D-10	modeled from soil concentrations using PM_{10} (Note A)
EF	Exposure Frequency	events/year	260	MassDEP, 1995
ED	Exposure Duration	hours/event	8	Typical workday
EP	Exposure Period	years	0.5	Constant
C4	conversion factor for units	days/hr	0.0417	Constant
C5	conversion factor for units	µg/mg	1,000	Constant
AP_{nc}	Averaging Period, non-cancer	days	183	equals EP * 365 days/year
AP_c	Averaging Period, cancer	days	25,550	equals average lifetime, 70 years * 365 days/year

Notes:

A. A respirable particle concentration (RP) of 0.060 mg/m^3 (excavation scenario PM_{10} from MassDEP, 1995) was applied to soil EPCs to calculate EPC_{dust}. See text for equation used to derive EPC_{dust}.

B. Multiplier 0.5 is based on MassDEP's assumption that 50% of PM_{10} enters the lung (MassDEP 2008).

Abbreviation:
MassDEP = Massachusetts Department of Environmental Protection

TABLE D-12
CONSTRUCTION WORKER EXPOSURE PROFILE
284 Winter Street
Haverhill, Massachusetts

Equations Used to Calculate Average Daily Exposure (ADE) and Lifetime Average Daily Exposure (LADE)

EXPOSURE PATHWAY: Inhalation of Vapors in Ambient Air

$$ADE_{amb\text{-}air} = \frac{EPC_{air} * EF * ED * EP * C4}{AP_{nc}} \quad \text{Equation 11}$$

$$LADE_{amb\text{-}air} = \frac{EPC_{air} * EF * ED * EP * C4 * C5}{AP_{c}} \quad \text{Equation 12}$$

Parameter	Definition	Units	Receptor-Specific Values (ages >18 years)	Rationale/Reference
$ADE_{amb\text{-}air}$	Average Daily Exposure	mg/m^3	Calculated	Equation 11
$LADE_{amb\text{-}air}$	Lifetime Average Daily Exposure	$\mu g/m^3$	Calculated	Equation 12
EPC_{air}	Exposure Point Concentration in Air	mg/m^3	TABLE D-10	See Text
EF	Exposure Frequency	events/year	260	MassDEP, 1995
ED	Exposure Duration	hours/event	2	Assumption.
EP	Exposure Period	years	0.5	Assumes a six-month construction project; MassDEP, 1995
C4	conversion factor for units	days/hr	0.0417	Constant
C5	conversion factor for units	µg/mg	1,000	Constant
AP_{nc}	Averaging Period, non-cancer	days	183	equals EP * 365 days/year
AP_c	Averaging Period, cancer	days	25,550	equals average lifetime, 70 years * 365 days/year

Abbreviation:
MassDEP = Massachusetts Department of Environmental Protection.

TABLE D-12
CONSTRUCTION WORKER EXPOSURE PROFILE
284 Winter Street
Haverhill, Massachusetts

Equations Used to Calculate Average Daily Dose (ADD) and Lifetime Average Daily Dose (LADD)

EXPOSURE PATHWAY: Dermal Contact with Groundwater

$$ADD_{gw\text{-}dermal} = \frac{EPC_{gw} * SA * K_p * EF * ED * EP * RAF_{dermal} * C6 * C7}{BW * AP_{nc}} \quad \text{Equation 9}$$

$$LADD_{gw\text{-}dermal} = \frac{EPC_{gw} * SA * K_p * EF * ED * EP * RAF_{dermal} * C6 * C7}{BW * AP_{c}} \quad \text{Equation 10}$$

Parameter	Definition	Units	Receptor-Specific Values (ages >18 years)	Rationale/Reference
$ADD_{gw\text{-}dermal}$	Average Daily Dose	mg/kg-day	Calculated	Equation 9
$LADD_{gw\text{-}dermal}$	Lifetime Average Daily Dose	mg/kg-day	Calculated	Equation 10
EPC_{gw}	Exposure Point Concentration in Groundwater	µg/L	TABLE D-10	See Text
SA	Skin Surface Area	cm^2	2,997	Average for females within the age group including forearms, hands, and feet; MassDEP, 2019
K_p	Permeability Constant	cm/hr	Constituent-specific	TABLE D-14
EF	Exposure Frequency	events/year	104	Two days per week (Note A)
ED	Exposure Duration	hours/event	0.25	Assumed time for set-up and dismantling equipment
EP	Exposure Period	years	0.5	Assumes a six-month construction project; MassDEP, 1995
RAF_{dermal}	Relative Absorption Factor	unitless	Constituent-specific	TABLE D-18
C6	conversion factor for units	L/cm^3	0.001	Constant
C7	conversion factor for units	mg/µg	0.001	Constant
BW	Body Weight	kg	65	Average body weight for adult female (ages 18-25). MassDEP, 2019.
AP_{nc}	Averaging Period, non-cancer	days	183	equals EP * 365 days/year
AP_c	Averaging Period, cancer	days	25,550	equals average lifetime, 70 years * 365 days/year

Note:

A. The exposure frequency is prorated to a six-month exposure period, or 52 events per 6 months for setup and dismantling of dewatering equipment. EP = 0.5 years (6 months)

Abbreviation:
MassDEP = Massachusetts Department of Environmental Protection

TABLE D-13
TRESPASSER EXPOSURE PROFILE
284 Winter Street
Haverhill, Massachusetts

Equations Used to Calculate Average Daily Dose (ADD) and Lifetime Average Daily Dose (LADD)

EXPOSURE PATHWAY: Dermal Contact with Soil

$$ADD_{dermal} = \frac{EPC_{soil} * DCR * EF * ED * EP * RAF_{dermal\text{-}nc} * C1}{BW * AP_{nc}} \quad \text{Equation 1}$$

$$LADD_{dermal} = \frac{EPC_{soil} * DCR * EF * ED * EP * RAF_{dermal\text{-}c} * C1}{BW * AP_{c}} \quad \text{Equation 2}$$

Parameter	Definition	Units	Youth (ages 7-15)	Rationale/Reference
ADD_{dermal}	Average Daily Dose	mg/kg-day	calculated	Equation 1
$LADD_{dermal}$	Lifetime Average Daily Dose	mg/kg-day	calculated	Equation 2
EPC_{soil}	Exposure Point Concentration in Soil	mg/kg	TABLE D-10	See Text
DCR	Dermal Contact Rate	mg/day	404	DCR is the body part specific skin surface area (SA) multiplied by the adherence factor (AF). Body parts assumed to be exposed are hands (SA = 791 cm2; AF = 0.1259 mg/cm2), forearms (SA=1,002 cm2; AF = 0.0130 mg/cm2), and feet (SA=1,135 cm2; AF=0.2563). SA and AF values obtained from the Trespasser scenario presented in MassDEP, April 2002, Technical Update.
EF	Exposure Frequency	events/year	31	1 day per week during the non-winter months of April through October
ED	Exposure Duration	days/event	1	MassDEP, 1995
EP	Exposure Period	years	8	Interval for age group
RAF_{dermal}	Relative Absorption Factor	unitless	chemical-specific	TABLE D-18
C1	conversion factor for units	kg/mg	1E-06	Constant
BW	Body Weight of Receptor	kg	38	Mean body weight for females in the identified age group
AP_{nc}	Averaging Period, non-cancer	days	2,920	Equals EP * 365 days/year
AP_{c}	Averaging Period, cancer	days	25,550	Equals average lifetime, 70 years * 365 days/year

Abbreviation:
MassDEP = Massachusetts Department of Environmental Protection.

TABLE D-13
TRESPASSER EXPOSURE PROFILE
284 Winter Street
Haverhill, Massachusetts

Equations Used to Calculate Average Daily Dose (ADD) and Lifetime Average Daily Dose (LADD)

EXPOSURE PATHWAY: Ingestion of Soil

$$ADD_{oral} = \frac{EPC_{soil} * IR_{soil} * EF * ED * EP * RAF_{oral\text{-}nc} * C1}{BW * AP_{nc}} \quad \text{Equation 3}$$

$$LADD_{oral} = \frac{EPC_{soil} * IR_{soil} * EF * ED * EP * RAF_{oral\text{-}c} * C1}{BW * AP_{c}} \quad \text{Equation 4}$$

Parameter	Definition	Units	Youth (ages 7-15)	Rationale/Reference
ADD_{oral}	Average Daily Dose	mg/kg-day	calculated	Equation 3
$LADD_{oral}$	Lifetime Average Daily Dose	mg/kg-day	calculated	Equation 4
EPC_{soil}	Exposure Point Concentration in Soil	mg/kg	TABLE D-10	See Text
IR_{soil}	Soil Ingestion Rate	mg/day	50.09	Note A
EF	Exposure Frequency	events/year	31	1 day per week during the non-winter months of April through October
ED	Exposure Duration	days/event	1	MassDEP, 1995
EP	Exposure Period	years	8	Interval for age group
RAF_{oral}	Relative Absorption Factor	unitless	chemical-specific	TABLE D-18
C1	conversion factor for units	kg/mg	1E-06	Constant
BW	Body Weight of Receptor	kg	38	Mean body weight for females in the identified age group
AP_{nc}	Averaging Period, non-cancer	days	2,920	Equals EP * 365 days/year
AP_{c}	Averaging Period, cancer	days	25,550	Equals average lifetime, 70 years * 365 days/year

Note:

A. 50 mg/day in accordance with MassDEP, April 2002. "Calculation of an Enhanced Soil Ingestion Rate" plus calculated ingestion of inhaled dust 0.09mg/day (See Attachment II for details).

Abbreviation:
MassDEP = Massachusetts Department of Environmental Protection.

TABLE D-13
TRESPASSER EXPOSURE PROFILE
284 Winter Street
Haverhill, Massachusetts

Equations Used to Calculate Average Daily Dose (ADD) and Lifetime Average Daily Dose (LADD)

EXPOSURE PATHWAY: Dermal Contact with Sediment

$$ADD_{dermal} = \frac{EPC_{sediment} * DCR * EF * ED * EP * RAF_{dermal\text{-}nc} * C1}{BW * AP_{nc}} \quad \text{Equation 5}$$

$$LADD_{dermal} = \frac{EPC_{sediment} * DCR * EF * ED * EP * RAF_{dermal\text{-}c} * C1}{BW * AP_{c}} \quad \text{Equation 6}$$

Parameter	Definition	Units	Youth (ages 7-15)	Rationale/Reference
ADD_{dermal}	Average Daily Dose	mg/kg-day	calculated	Equation 5
$LADD_{dermal}$	Lifetime Average Daily Dose	mg/kg-day	calculated	Equation 6
$EPC_{sediment}$	Exposure Point Concentration in Sediment	mg/kg	TABLE D-10	See Text
DCR	Dermal Contact Rate	mg/day	2928	DCR is the body part specific skin surface area (SA) multiplied by the adherence factor (AF). Body parts assumed to be exposed are hands (SA = 791 cm2), forearms (1,002 cm2), and feet (SA = 1,135 cm2), obtained from the Trespasser scenario presented in MassDEP, April 2002, Technical Update. The AF for sediment was conservatively assumed to be 1mg/cm2.
EF	Exposure Frequency	events/year	31	1 day per week during the non-winter months of April through October
ED	Exposure Duration	days/event	1	MassDEP, 1995
EP	Exposure Period	years	8	interval for age group
RAF_{dermal}	Relative Absorption Factor	unitless	chemical-specific	TABLE D-18
C1	conversion factor for units	kg/mg	1E-06	Constant
BW	Body Weight of Receptor	kg	38	Mean body weight for females in the identified age group
AP_{nc}	Averaging Period, non-cancer	days	2,920	Equals EP * 365 days/year
AP_{c}	Averaging Period, cancer	days	25,550	Equals average lifetime, 70 years * 365 days/year

Abbreviation:
MassDEP = Massachusetts Department of Environmental Protection.

TABLE D-13
TRESPASSER EXPOSURE PROFILE
284 Winter Street
Haverhill, Massachusetts

Equations Used to Calculate Average Daily Dose (ADD) and Lifetime Average Daily Dose (LADD)

EXPOSURE PATHWAY: Ingestion of Sediment

$$ADD_{oral} = \frac{EPC_{sediment} * IR_{sediment} * EF * ED * EP * RAF_{oral\text{-}nc} * C1}{BW * AP_{nc}} \quad \text{Equation 7}$$

$$LADD_{oral} = \frac{EPC_{sediment} * IR_{sediment} * EF * ED * EP * RAF_{oral\text{-}c} * C1}{BW * AP_{c}} \quad \text{Equation 8}$$

Parameter	Definition	Units	Youth (ages 7-15)	Rationale/Reference
ADD_{oral}	Average Daily Dose	mg/kg-day	calculated	Equation 7
$LADD_{oral}$	Lifetime Average Daily Dose	mg/kg-day	calculated	Equation 8
$EPC_{sediment}$	Exposure Point Concentration in Sediment	mg/kg	TABLE D-10	See Text
$IR_{sediment}$	Sediment Ingestion Rate	mg/day	50	MassDEP, 1995
EF	Exposure Frequency	events/year	31	1 day per week during the non-winter months of April through October
ED	Exposure Duration	days/event	1	MassDEP, 1995
EP	Exposure Period	years	8	interval for age group
RAF_{oral}	Relative Absorption Factor	unitless	chemical-specific	TABLE D-18
C1	conversion factor for units	kg/mg	1E-06	Constant
BW	Body Weight of Receptor	kg	38	Mean body weight for females in the identified age group
AP_{nc}	Averaging Period, non-cancer	days	2,920	Equals EP * 365 days/year
AP_{c}	Averaging Period, cancer	days	25,550	Equals average lifetime, 70 years * 365 days/year

Abbreviation:
MassDEP = Massachusetts Department of Environmental Protection.

TABLE D-13
TRESPASSER EXPOSURE PROFILE
284 Winter Street
Haverhill, Massachusetts

Equations Used to Calculate Average Daily Exposure (ADE) and Lifetime Average Daily Exposure (LADE)

EXPOSURE PATHWAY: Inhalation of Fugitive Dust

$$ADE_{inh\ dust} = \frac{EPC_{dust} * EF * ED * EP * C2}{AP_{nc}} \quad \text{Equation 11}$$

$$LADE_{inh\ dust} = \frac{EPC_{dust} * EF * ED * EP * C2 * C4}{AP_{c}} \quad \text{Equation 12}$$

	Parameter Definition	Units	Youth (ages 7-15)	Rationale/Reference
ADE_{dust}	Average Daily Dose	mg/kg-day	calculated	Equation 11
$LADE_{dust}$	Lifetime Average Daily Dose	mg/kg-day	calculated	Equation 12
EPC_{dust}	Exposure Point Concentration in Fugitive Dust	mg/m^3	TABLE D-10	modeled from soil concentrations using RP (Note A)
EF	Exposure Frequency	events/year	31	1 day per week during the non-winter months of April through October
ED	Exposure Duration	hours/event	2	USEPA, 2011; Table 16-1; average outdoor time for the age group.
EP	Exposure Period	years	8	Interval for age group
C2	conversion factor for units	days/hours	0.0417	Constant
C4	conversion factor for units	µg/mg	1,000	Constant
AP_{nc}	Averaging Period, non-cancer	days	2,920	equals EP * 365 days/year
AP_{c}	Averaging Period, cancer	days	25,550	equals average lifetime, 70 years * 365 days/year

Notes:

A. A respirable particle concentration (RP) of 0.032 mg/m^3 (open field scenario PM_{10} from MassDEP, 1995) was applied to soil EPCs to calculate EPC_{dust}. See text for equation used to derive EPC_{dust}.

Abbreviation:
USEPA = United States Environmental Protection Agency.

TABLE D-14
CONSTITUENT-SPECIFIC PERMEABILITY COEFFICIENTS
284 Winter Street
Haverhill, Massachusetts

COC	Permeability Coefficient Kp (cm/hour)	Notes
Benzene	1.5E-02	t
Ethylbenzene	4.8E-02	t
Methyl-Tert-Butyl-Ether	2.1E-03	t
Naphthalene	4.6E-02	t
Toluene	3.1E-02	t
Xylene (Total)	4.9E-02	t
Styrene	3.7E-02	t
2-Methylnaphthalene	9.0E-02	t
Acenaphthene	8.4E-02	t
Acenaphthylene	8.7E-02	t
Dibenzofuran	9.5E-02	d
Fluoranthene	3.0E-01	t
Indeno(1,2,3-cd)Pyrene	1.2E+00	t
Phenanthrene	1.4E-01	t
Pyrene	1.9E-01	t
C19-C36 Aliphatic Fraction	2.0E+00	d,f
C5-C8 Aliphatic Fraction	1.7E-01	t
C9-C10 Aromatic Fraction	1.3E-01	t
Cyanide	1.0E-03	t

Notes:
d. Kp values were estimated by GZA using Equation 3.8 from US EPA, "Supplemental Guidance for Dermal Risk Assessment", OSWER No. 9285.7-02 EP, August, 2004. logKp=-2.80+0.66logKow-0.0056MW. Kow values from USEPA EPI Suite.
f. Cyclododecane was used as surrogate for this fraction.
t. MassDEP 2019 Development of MCP Risk-Based Levels for Soil and Groundwater.

TABLE D-15
SUMMARY OF DOSE-RESPONSE INFORMATION - NONCARCINOGENIC EFFECTS - ORAL
284 Winter Street
Haverhill, Massachusetts

COC	Oral Subchronic Reference Dose (mg/kg-day)		Oral Chronic Reference Dose (mg/kg-day)		Chronic Oral RfD UF X MF	Target Organ/System	Critical Effect	Study Animal	Study Method
1,2,4-Trichlorobenzene	0.09	g	0.01	a	1000 x 1	Reproductive	Increased adrenal weights; vacuolization of zona fasciculata in the cortex	rat	oral-drinking water
1,2,3-Trimethylbenzene	0.04	am	0.01	am	300	nervous	decreased pain sensitivity	rat	inhalation
1,2,4-Trimethylbenzene	0.04	a	0.01	a	300	nervous	decreased pain sensitivity	rat	inhalation
1,2-Dichloroethane	0.02	g	0.02	c	3,000	kidney	increased kidney weight	rat	oral-drinking water
1,3,5-Trimethylbenzene	0.04	am	0.01	am	300	nervous	decreased pain sensitivity	rat	inhalation
2-Butanone	0.6	d	0.6	a	1000 x 1	fetus	decreased fetal birth weight	rat	oral-drinking water
2-Hexanone	0.005	d	0.005	a	1000 x 1	nervous system	axonal swelling of the peripheral nerve	rat	oral-drinking water
4-Ethyltoluene									
Acetaldehyde									
Acetone	2.7	c	0.9	a	1000 x 1	liver, kidney	increased liver and kidney weights and nephrotoxicity	rat	oral-gavage
Acrolein	0.0005	d	0.0005	a	100 x 1	survival	decreased survival	rat	oral-gavage
Benzene	0.01	c	0.004	a	300 x 1	blood	decreased lymphocyte count	human	inhalation
Carbon Disulfide	0.1	b	0.1	a	100 x 1	fetus	fetal toxicity/malformations	rabbit	inhalation
Chloroethane	0.1	g							
Chloroform	0.01	b	0.01	a	1000 x 1	liver	fatty cyst formation, SGPT	dog	oral-capsule
Chloromethane									
cis-1,2-Dichloroethene	0.02	g	0.002	a	3000 x 1	kidney	increased relative kidney weight	rat	oral-gavage
Cyclohexane									
Ethanol									
Ethylbenzene	0.05	g	0.05	c,h	1,000	liver	centrilobular hepatocyte hypertrophy	rat	oral-gavage
Dichlorodifluoromethane	0.05	g	0.2	a	100X1	whole body	reduced body weight	rat	feeding study
1,1,2-Trichloro-1,2,2-Trifluoroethane	3	b	30	a	10 x 1	nervous system	Psychomotor impairment	human	inhalation
Heptane	0.3	g	0.3	h	10,000	stomach	forestomach lesions	mouse	gavage
Hexane	0.3	g	0.06	b	10,000	nervous system; testis	neurotoxicity; testis atrophy	rat	oral
Methylene Chloride	0.006	d	0.006	a	30 x 1	liver	hepatic effects (hepatic vacuolation, liver foci)	rat	drinking water
Methyl-Tert-Butyl-Ether	1	c	0.1	c	1,000	NA	no effects observed	sprague-Dawley rats	gavage
Naphthalene	0.2	c	0.02	a	3000 x 1	whole body	decreased body weight	rat	oral-gavage
n-Butane									
n-Nonane	0.003	g	0.0003	h	10,000	stomach	forestomach lesions	mice	oral
Pentane									
tert-Butyl Alcohol	1	ac	0.1	ac	1,000	nervous	hypoactivity and ataxia	rat	oral-gavage
Tetrachloroethene	0.006	d	0.006	a	1000 x 1	nervous system	neurotoxicity	human	inhalation
Toluene	0.8	g	0.08	a	3000 x 1	liver, kidney	organ weight changes	rat	oral-gavage
Trichlorofluoromethane	0.3	d	0.3	a	1000 x 1	Whole Body	Increased mortality	rat	oral
Xylene (Total)	0.4	g	0.2	a	1000 x 1	CNS, whole body	hyperactivity, decreased body weight, increased mortality	rat	oral-gavage
Styrene	2	c	0.2	a	1000 x 1	red blood cells, liver	Red blood cell and liver effects	dog	oral
4-Methyl-2-Pentanone	0.8	b	0.08	b	300: 3000	liver, whole body, kidney	increased organ weight	rat	oral - gavage
Isopropyl Alcohol	2	g	2	g	30 x 1	developmental	decreased fetal body weight	rabbit	oral - gavage
1,3-Butadiene									
2,2,4-Trimethylpentane									
1-Methylnaphthalene	0.007	d	0.007	ag	10,000	lung	pulmonary alveolar proteinosis	mouse	oral-diet
2-Methylnaphthalene	0.004	d,g	0.004	a	1000x1	lung	Pulmonary alveolar proteinosis	mouse	oral-diet
Acenaphthene	0.2	g	0.06	a	3000 x 1	liver	hepatoxicity	mouse	oral-gavage
Acenaphthylene	0.3	f	0.03	f					
Anthracene	1	g	0.3	a	3000 x 1	NA	no observed effects	mouse	oral-gavage
Benzo(a)Anthracene	0.3	f	0.03	f					
Benzo(a)Pyrene	0.0003	d	0.0003	a	300	neurobehavioral	neurobehavioral changes	rat	gavage
Benzo(b)Fluoranthene	0.3	f	0.03	f					
Benzo(g,h,i)Perylene	0.3	f	0.03	f					
Benzo(k)Fluoranthene	0.3	f	0.03	f					
Biphenyl	0.1	g	0.5	a		renal	renal papillary mineralization	rat	oral-diet
Carbazole									
Chrysene	0.3	f	0.03	f					
Dibenzo(a,h)anthracene	0.3	f	0.03	f					
Dibenzofuran	0.004	g	0.001	ag		whole body	aggregate critical effects of reduced length and organ weight and excess abdominal fat	rat	oral-diet
Fluoranthene	0.1	g	0.04	a	3000 x 1	kidney, liver	nephropathy, increased liver weights, hematological alterations	mouse	oral-gavage
Fluorene	0.4	b	0.04	a	3000 x 1	blood	decreased red blood cell and hemoglobin	mouse	oral-gavage
Indeno(1,2,3-cd)Pyrene	0.3	f	0.03	f					
Phenanthrene	0.3	f	0.03	f					
Pyrene	0.3	b,g	0.03	a	3000 x 1	kidney	tubular pathology, decreased organ weight	mouse	oral-gavage
C11-C22 Aromatic Fraction	0.3	f	0.03	f					
C19-C36 Aliphatic Fraction	6	f	2	f		liver	liver granuloma		
C5-C8 Aliphatic Fraction	0.4	f	0.04	f		whole body and nervous system	reduced body weight and neurotoxicity at higher doses	rat	
C9-C10 Aromatic Fraction	0.3	g	0.03	f					
C9-C18 Aliphatic Fraction	1	d	0.1	f		Hepatic and hematological			
Chromium (total)	0.02	c	0.003	a,ak	300 x 3	NA	no effects observed	rat	oral-diet
Cyanide	0.006		0.0006	a	3000 x 1	reproduction	Decreased cauda epididymis weight	male rats	oral-water
Lead	0.00075		0.00075	c,e		developmental, kidney, blood pressure	Delays in physical or mental development for infants and children, kidney problem and high blood pressure for adults		

Hierarchy of Sources:
a. US EPA Integrated Risk Information System (IRIS), http://www.epa.gov/IRIS, January, 2022.
b. US EPA, Health Effects Assessment Summary Tables (HEAST), Office of Solid Waste and Emergency Response/Office of Emergency and Remedial Response, current as of December 2011.
c. MassDEP 2019 Development of MCP Risk-Based Levels for Soil and Groundwater.
d. Chronic oral RfD has been used here as subchronic oral RfD equivalent.
e. Derived from the USEPA Action Level for lead for Treatment Technique (0.015 milligrams per liter, mg/L). The derivation is presented in the MassDEP (1992) Risk Assessment ShortForm - Residential Scenario.
f. MassDEP, Characterizing Risks Posed by Petroleum Contaminated Sites: Implementation of the MassDEP VPH/EPH Approach, Final Policy (#WSC-02-411). Table 4-13. December 2002.
g. US EPA Provisional Peer Reviewed Toxicity Values for Superfund (PPRTV); current as of January, 2022.
h. PPRTV subchronic value used as chronic RfD.
ac. Oral RfDs for n-butanol were used for tert-butyl alcohol.
ag. PPRTV screening value.
ak. Values for hexavalent chromium (CrVI).
am. Value for 1,2,4-trimethylbenzene was used for 1,2,3-trimethylbenzene and 1,3,5-trimethylbenzene.

Notes:
1. A blank space indicates no data found.

Abbreviations:

CNS=Central nervous system; SGPT=Serum glutamic pyruvic transaminase; COC = Constituent of Concern; MF= Modifying Factor; NA= Not Applicable; RfD = Reference Dose; UF= Uncertainty Factor.
EPH = Extractable Petroleum Hydrocarbon; VPH = Volatile Petroleum Hydrocarbon

TABLE D-16
SUMMARY OF DOSE-RESPONSE INFORMATION - NONCARCINOGENIC EFFECTS - INHALATION
284 Winter Street
Haverhill, Massachusetts

COC	Inhalation Subchronic Reference Concentration (mg/m^3)		Inhalation Chronic Reference Concentration (mg/m^3)		Chronic Inhalation RfC UF x MF	Target Organ/System	Critical Effect	Study Animal	Study Method
1,2,4-Trichlorobenzene	0.02	h	0.002	h	3,000	urinary	Significant changes in coproporphyrin and uroporphyrin excretion	rat	inhalation
1,2,3-Trimethylbenzene	0.2	w	0.06	w	300	neurological	decreased pain sensitivity	rats	inhalation
1,2,4-Trimethylbenzene	0.2	a	0.06	a	300	neurological	decreased pain sensitivity	rats	inhalation
1,2-Dichloroethane	0.07	h	0.007	h	3,000	Neurological	Neurobehavioral impairment	human	inhalation
1,3,5-Trimethylbenzene	0.2	w	0.06	w	300	neurological	decreased pain sensitivity	rats	inhalation
2-Butanone	5	d	5	a	300 x 1	fetus	developmental toxicity	mouse	inhalation
2-Hexanone	0.03	d	0.03	a	3000 x 1	nerve	Motor conduction velocity of the sciatic-tibial nerve	monkey	inhalation
4-Ethyltoluene									
Acetaldehyde	0.009	d	0.009	a	1,000	nervous system; respiratory	Degeneration of olfactory epithelium	rat	inhalation
Acetone	0.8	d	0.8	e					
Acrolein	0.00002	d	0.00002	a	1000 x 1	nasal cavity	Nasal lesions	rat	inhalation
Benzene	0.003	d	0.003	c,y	200	blood	decreased blood cell counts	human	inhalation
Carbon Disulfide	0.7	b	0.7	a	30 x 1	PNS	peripheral nervous system dysfunction	human	Inhalation-occupat.
Chloroethane	4	h	10	a	300 x 1	fetus	delayed fetal ossification	mouse	inhalation
Chloroform	0.66	d	0.66	e					
Chloromethane	0.09	d	0.09	a	1000 x 1	brain	cerebellar lesions	mouse	inhalation
cis-1,2-Dichloroethene	0.07	c,f	0.007	c,f		kidney			
Cyclohexane	6	d	6	a	300 x 1	reproductive/developmental	reduced pup weights	rat	inhalation
Ethanol									
Ethylbenzene	9	h	1	a	300 x 1	fetus	developmental toxicity	rat/rabbit Guinea pig,	inhalation
Dichlorodifluoromethane	1	h	0.1	ae	10,000	whole body	reduced body weight	rabbit, dog, and monkey	inhalation
1,1,2-Trichloro-1,2,2-Trifluoroethane	50	h	5	h	300	None	no effects	human	inhalation
Heptane	4	h	0.4	h	3,000	ears	loss of hearing sensitivity	rat	inhlaltion
Hexane	0.7	d	0.7	a	300 x 1	neurotoxicity	electrophysical alteration		
Methylene Chloride	0.6	d	0.6	a	100 x 1	liver	hepatic effects (hepatic vacuolation)	rat	inhalation
Methyl-Tert-Butyl-Ether	3	d	3	a	100 x 1	liver, kidney	renal lesions increased organ weight	rat	inhalation
Naphthalene	0.003	d	0.003	a	3000 x 1	respiratory system	hyperplasia and metaplasia in epithelium	mouse	inhalation
n-Butane									
n-Nonane	0.02	d	0.02	h	3,000	whole body	Salivation, lacrimation, and marginally depressed body weight	rat	inhalation
Pentane	1	d	1	h	3,000	whole body	no effects	rat	inhalation
tert-Butyl Alcohol									
Tetrachloroethene	0.04	d	0.04	a	1,000	nerve	neurotoxicity	humans	Inhalation-occupat.
Toluene	5	d	5	a	10	CNS	neurological effects	humans	Inhalation-occupat.
Trichlorofluoromethane	1	h	0.7	b	1000 x 1	kidney and lung	inflammation	dog	inhalation
Xylene (Total)	0.4	h	0.1	a	300 x 1	CNS	impaired motor coordination	rat	inhalation
Styrene	3	c	1	a	30 x 1	CNS	CNS effects	human	occupational, inhalation
4-Methyl-2-Pentanone	3	d	3	a	300 x 1	fetus	decreased weight	rat	developmental / inhalation
Isopropyl Alcohol	7	h	0.2	h	1000 x 1	testes	decreased absolute and relative testes weights	mouse	inhalation
1,3-Butadiene	0.002	d	0.002	a	1000 x 1	ovaries	Ovarian atrophy	mouse	inhalation
2,2,4-Trimethylpentane									
1-Methylnaphthalene	0.5	j	0.05	j					
2-Methylnaphthalene	0.5	t	0.05	t					
Acenaphthene	0.5	t	0.05	t					
Acenaphthylene	0.5	t	0.05	t					
Anthracene	0.5	t	0.05	t					
Benzo(a)Anthracene	0.5	t	0.05	t					
Benzo(a)Pyrene	0.000002	d	0.000002	a	3,000	developmental	decreased embryo/fetal survival	rat	inhalation
Benzo(b)Fluoranthene	0.5	t	0.05	t					
Benzo(g,h,i)Perylene	0.5	t	0.05	t					
Benzo(k)Fluoranthene	0.5	t	0.05	t					
Biphenyl	0.002	c	0.002	c					
Carbazole									
Chrysene	0.5	t	0.05	t					
Dibenzo(a,h)anthracene	0.5	t	0.05	t					
Dibenzofuran									
Fluoranthene	0.5	t	0.05	t					
Fluorene	0.5	t	0.05	t					
Indeno(1,2,3-cd)Pyrene	0.5	t	0.05	t					
Phenanthrene	0.5	t	0.05	t					
Pyrene	0.5	t	0.05	t					
C11-C22 Aromatic Fraction	0.5	g	0.05	g					
C19-C36 Aliphatic Fraction									
C5-C8 Aliphatic Fraction	0.2	g	0.2	g		neurological	neurotoxicity	epidemiology study	
C9-C10 Aromatic Fraction	0.5	g	0.05	g					
C9-C18 Aliphatic Fraction	0.6	g	0.2	g		nervous system	changes in blood chemistry, body and liver weight, neurotoxicity	rats	inhalation
Chromium (total)	0.0003	c,af	0.0001	a,af					
Cyanide	0.003	c	0.0008	a		thyroid	Thyroid enlargement and altered iodide uptake	Epidemiology study	inhalation
Lead	0.001	d	0.001	e					

Hierarchy of Sources:
a. US EPA Integrated Risk Information System (IRIS), http://www.epa.gov/IRIS, January, 2022.
b. US EPA, Health Effects Summary Tables (HEAST), Office of Solid Waste and Emergency Response/Office of Emergency and Remedial Response, current as of December 2011.
c. MassDEP 2019 Development of MCP Risk-Based Levels for Soil and Groundwater.
d. Chronic RfC has been used here as subchronic RfC as a conservative step.
e. MassDEP Methodology for Updating Air Guidelines: Allowable Ambient Limits (AALs) and Threshold Effects Exposure Limits (TELs) (MassDEP as of January 2020).
f. Oral chronic RfD was converted to chronic RfC.
g. MassDEP (2003), Final Updated Petroleum Hydrocarbon Fraction Toxicity Values for the VPH/EPH/APH Methodology. See: http://www.mass.gov/dep/cleanup/laws/tphtox03.doc
h. US EPA Provissional Peer Reviewed Toxicity Values for Superfund (PPRTV); current as of January, 2022.
j. Values for 2-methylnaphthalene were used for 1-methylnaphthalene.
t. Toxicity values for PAHs are consistent with the approach presented in "Updated Petroleum Hydrocarbon Fraction Toxicity Values for the VPH/EPH/APH Methodology" MassDEP 2003 and Characterizing Risks Posed by Petroleum Contaminated Sites MassDEP 2002.
w. Value for 1,2,4-trimethylbenzene was used for 1,2,3-trimethylbenzene and 1,3,5-trimethylbenzene.
y. CalEPA Chronic Reference Exposure Levels as on November 4, 2019. On-line resources available at http://www.oehha.ca.gov/air/allrels.html.
ae. PPRTV screening value.
af. Values for hexavalent chromium (CrVI).

Notes:
1. A blank space indicates no data found.

Abbreviations:
CNS = Central nervous system; PNS = Peripheral nervous system; COC = Constituent of Concern; MF = Modifying Factor; NA = Not Applicable/Not Available; RfC = Reference Concentration; UF = Uncertainty Factor.
EPH = Extractable Petroleum Hydrocarbon; VPH = Volatile Petroleum Hydrocarbon; APH = Air-Phase Petroleum Hydrocarbons; PAH = Polycyclic Aromatic Hydrocarbon.

TABLE D-17
SUMMARY OF DOSE-RESPONSE INFORMATION - CARCINOGENIC EFFECTS
284 Winter Street
Haverhill, Massachusetts

COC	Weight of Evidence Class		Oral Cancer Slope Factor $(mg/kg/day)^{-1}$		Target Organ/System (oral)	Study Animal	Study Method	Inhalation Unit Risk $(\mu g/m^3)^{-1}$		Target Organ/System (Inhalation)	Study Animal	Study Method
1,2,4-Trichlorobenzene	D	a										
1,2,3-Trimethylbenzene												
1,2,4-Trimethylbenzene	Inadequate information to assess carcinogenic potential	a										
1,2-Dichloroethane	B2	a	9.1E-02	a	blood	rat	gavage	2.6E-5	a	blood	rat	gavage
1,3,5-Trimethylbenzene	Inadequate information to assess carcinogenic potential	k										
2-Butanone	D	a										
2-Hexanone	inadequate to assess human carcinogenic potential	a										
4-Ethyltoluene												
Acetaldehyde	B2	a						2.2E-6	a	nasal	rat	inhalation
Acetone	D	a										
Acrolein	data are inadequate for an assessment of human carcinogenic potential for either the oral or inhalation route of exposure	a										
Benzene	A	a	5.5E-02	a	blood	human	inhalation	7.8E-6	c	blood	human	inhalation
Carbon Disulfide												
Chloroethane												
Chloroform	B2	a						2.3E-5	a	liver	mouse	oral-gavage
Chloromethane	D	a										
cis-1,2-Dichloroethene	D	a										
Cyclohexane	Data are inadequate for an assessment of human carcinogenic potential	a										
Ethanol												
Ethylbenzene	D	a										
Dichlorodifluoromethane	inadequate information to assess carcinogenic potential	k										
1,1,2-Trichloro-1,2,2-Trifluoroethane	inadequate information to assess carcinogenic potential	k										
Heptane	D	a										
Hexane	inadequate information to assess the carcinogenic potential	a										
Methylene Chloride	likely to be carcinogenic in humans	a	2.0E-03	a	liver	mouse	oral-drinking water	1.0E-8	a	liver, lung	mouse	inhalation
Methyl-Tert-Butyl-Ether	C	c										
Naphthalene	C	a										
n-Butane												
n-Nonane												
Pentane												
tert-Butyl Alcohol												
Tetrachloroethene	likely to be carcinogenic in humans by all routes of exposure	a	2.0E-02	c				3.0E-6	c			
Toluene	D	a										
Trichlorofluoromethane	inadequate information to assess carcinogenic potential	k										
Xylene (Total)	D	a										
Styrene	B2	c	3.0E-02	c				5.7E-7	c			
4-Methyl-2-Pentanone	data are inadequate for an assessment of human carcinogenic potential	a										
Isopropyl Alcohol	Inadequate information to assess carcinogenic potential (oral, inhalation is not likely to be carcinogenic)	k										
1,3-Butadiene	NA	a	3.4E+00	o				3.0E-5	a	blood	human	inhalation
2,2,4-Trimethylpentane												
1-Methylnaphthalene			2.9E-02	k	lung, adenoma, carcinoma	mouse	oral					
2-Methylnaphthalene	data are inadequate for an assessment of human carcinogenic potential	a										
Acenaphthene	inadequate information to assess carcinogenic potential	k										
Acenaphthylene	D	a										
Anthracene	D	a										
Benzo(a)Anthracene	B2	a	1.0E-01	g				6.0E-5	g			
Benzo(a)Pyrene	B2	a	1.0E+00	a	gastrointestinal	rat, mouse	oral-diet	6.0E-4	a			
Benzo(b)Fluoranthene	B2	a	1.0E-01	g				6.0E-5	g			
Benzo(g,h,i)Perylene	D	a										
Benzo(k)Fluoranthene	B2	a	1.0E-02	g				6.0E-6	g			
Biphenyl	Suggestive evidence of carcinogenic potential	a	8.0E-03	a	liver	mouse	oral-diet					
Carbazole	Inadequate information to assess carcinogenic potential.	k	2.0E-02	l	liver	mouse	oral-diet					
Chrysene	B2	a	1.0E-02	g				6.0E-6	g			
Dibenzo(a,h)anthracene	B2	a	1.0E+00	g				6.0E-4	g			
Dibenzofuran	D	a										
Fluoranthene	D	a										
Fluorene	D	a										
Indeno(1,2,3-cd)Pyrene	B2	a	1.0E-01	g				6.0E-5	g			
Phenanthrene	D	a										
Pyrene	D	a										
C11-C22 Aromatic Fraction												
C19-C36 Aliphatic Fraction												
C5-C8 Aliphatic Fraction												
C9-C10 Aromatic Fraction												
C9-C18 Aliphatic Fraction												
Chromium (total)	D	a						1.2E-2	a,t			
Cyanide	D	a										
Lead	B2	a										

Hierarchy of Sources:
a. US EPA Integrated Risk Information System (IRIS), http://www.epa.gov/IRIS, January, 2022.
c. MassDEP 2019 Development of MCP Risk-Based Levels for Soil and Groundwater.
g. MassDEP 2019 Development of MCP Risk-Based Levels for Soil and Groundwater. This Cancer Slope Factor or Unit Risk for benzo(a)pyrene (from IRIS) has been applied to the seven PAH compounds which are designated as category A, B1, B2 or C carcinogens based on the respective relative potency factor.
k. US EPA Provisional Peer Reviewed Toxicity Values for Superfund (PPRTV). Current as of January, 2022.
l. withdrawn from HEAST. Obtained from RAIS, current as of January, 2022.
o. CalEPA. Hot Spots Unit Risk and Cancer Potency Values published by the Office of Environmental Health Hazard Assessment (updated October 2020).
t. Value for hexavalent chromium (CrVI).

Notes:

1. Weight of evidence classification:
   A: Human carcinogen
   B: Probable human carcinogen
   B1: Limited evidence of carcinogenicity in humans from epidemiological studies
   B2: Sufficient evidence of carcinogenicity in animals, inadequate evidence in humans
   C: Possible human carcinogen
   D: Not classified
   E: No evidence of carcinogenicity
2. Inhalation unit risk is defined as the risk per concentration unit in air, e.g. risk per µg/m³.
3. Blank space indicates no data available.

Abbreviations:
COC = constituent of concern; CSF = cancer slope factor.

TABLE D-18
RELATIVE ABSORPTION FACTORS
284 Winter Street
Haverhill, Massachusetts

COC	Exposure Pathways					
	Oral Soil		Dermal Water		Dermal Soil	
	Carcinogen	Non-Carcinogen	Carcinogen	Non-Carcinogen	Carcinogen	Non-Carcinogen
1,2,4-Trichlorobenzene		1 a				0.03 a
1,2,3-Trimethylbenzene		1 b				0.12 b
1,2,4-Trimethylbenzene		1 b				0.12 b
1,2-Dichloroethane	1 a	1 a			0.03 a	0.03 a
1,3,5-Trimethylbenzene		1 b				0.12 b
2-Butanone		1 a		1 b		0.03 a
2-Hexanone						
4-Ethyltoluene						
Acetaldehyde						
Acetone		1 a		1 b		0.03 a
Acrolein						
Benzene	1 a	1 a			0.03 a	0.03 a
Carbon Disulfide		1 b		1 b		0.12 b
Chloroethane						
Chloroform		1 a				0.03 a
Chloromethane						
cis-1,2-Dichloroethene		1 a				0.03 a
Cyclohexane						
Ethanol						
Ethylbenzene		1 a		1 b		0.03 a
Dichlorodifluoromethane						
1,1,2-Trichloro-1,2,2-Trifluoroethane		1.1 b				0.12 b
Heptane		0.99 b				0.11 b
Hexane						
Methylene Chloride	1 a	1 a			0.03 a	0.03 a
Methyl-Tert-Butyl-Ether		1 a				0.03 a
Naphthalene		0.3 a		1 b		0.1 a
n-Butane						
n-Nonane						
Pentane						
tert-Butyl Alcohol		0.99 b				0.11 b
Tetrachloroethene	1 a	1 a			0.03 a	0.03 a
Toluene		1 a		1 b		0.03 a
Trichlorofluoromethane						
Xylene (Total)		1 a		1 b		0.03 a
Styrene	1 a	1 a			0.03 a	0.03 a
4-Methyl-2-Pentanone		1 a				0.03 a
Isopropyl Alcohol						
1,3-Butadiene						0.08 a
2,2,4-Trimethylpentane						
1-Methylnaphthalene		0.3 e		1 e		0.1 e
2-Methylnaphthalene		0.3 a				0.1 a
Acenaphthene		0.3 a		1.1 b		0.1 a
Acenaphthylene		0.3 a		1.1 b		0.1 a
Anthracene		0.3 a		1.1 b		0.1 a
Benzo(a)Anthracene	0.3 a	0.3 a	1.1 b	1.1 b	0.02 a	0.02 a
Benzo(a)Pyrene	0.3 a	0.3 a	1.1 b	1.1 b	0.02 a	0.02 a
Benzo(b)Fluoranthene	0.3 a	0.3 a	1.1 b	1.1 b	0.02 a	0.02 a
Benzo(g,h,i)Perylene		0.3 a		1.1 b		0.1 a
Benzo(k)Fluoranthene	0.3 a	0.3 a	1.1 b	1.1 b	0.02 a	0.02 a
Biphenyl	1 a	1 a			0.1 a	0.1 a
Carbazole	0.96 b				0.18 b	
Chrysene	0.3 a	0.3 a	1.1 b	1.1 b	0.02 a	0.02 a
Dibenzo(a,h)anthracene	0.3 a	0.3 a	1.1 b	1.1 b	0.02 a	0.02 a
Dibenzofuran						0.18 b
Fluoranthene		0.3 a		1.1 b		0.1 a
Fluorene		0.3 a		1.1 b		0.1 a
Indeno(1,2,3-cd)Pyrene	0.3 a	0.3 a	1.1 b	1.1 b	0.02 a	0.02 a
Phenanthrene		0.3 a		1.1 b		0.1 a
Pyrene		0.3 a		1.1 b		0.1 a
C11-C22 Aromatic Fraction		0.3 a				0.1 a
C19-C36 Aliphatic Fraction		1 a				0.2 a
C5-C8 Aliphatic Fraction		1 a				0.2 a
C9-C10 Aromatic Fraction		1 a				0.2 a
C9-C18 Aliphatic Fraction		1 a				0.2 a
Chromium (total)		1 a		9 b		0.1 a
Cyanide		1 a				0.1 a
Lead		0.3 c		1 b		0.006 a

Notes:
a. MassDEP 2019 Development of MCP Risk-Based Levels for Soil and Groundwater.
b. GZA-derived value based on the default absorption efficiencies listed in Table B-11 of the MassDEP (1995) guidance.
c. USEPA 2007. User's Guide for the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK) Windows.
e. Value for 2-methylnaphthalene used for 1-methylnaphthalene.

Notes:
1. A blank space indicates no data found.
2. Where data are lacking, a default value of 1 is used in subsequent risk calculations.

Abbreviations:
COC = Constituent of Concern; RAF = Relative Absorption Factors.

TABLE D-19
COMPARISON OF SURFACE WATER CONCENTRATIONS
TO AMBIENT WATER QUALITY CRITERIA FOR FISH CONSUMPTION
284 Winter Street
Haverhill, Massachusetts

Constituent	Mean Groundwater Concentration [1] (µg/L)	Dilution Factor	Attenuation Factor	Estimated Surface Water Concentration [2] (mg/L)	USEPA Ambient Water Quality Criteria Consumption of Organisms [3] (mg/L)
Benzene	3968	10	2.5	0.16	0.058
Ethylbenzene	1170	10	2.5	0.047	0.13
Methyl-Tert-Butyl-Ether	49	10	2.5	0.0019	NA
Naphthalene	3948	10	25	0.016	NA
Toluene	803	10	2.5	0.032	0.52
Xylene (Total)	1829	10	2.5	0.073	NA
Styrene	440	10	2.5	0.01760	NA
2-Methylnaphthalene	161	10	25	0.00064	NA
Acenaphthene	43	10	25	0.00017	NA
Acenaphthylene	52	10	25	0.00021	NA
Fluorene	43	10	25	0.00017	NA
Phenanthrene	44	10	25	0.00017	NA
C11-C22 Aromatic Fraction	907	10	25	0.0036	NA
C5-C8 Aliphatic Fraction	1503	10	25	0.0060	NA
C9-C10 Aromatic Fraction	4635	10	25	0.019	NA
C9-C18 Aliphatic Fraction	2036	10	100	0.0020	NA
Cyanide	518	10	2.5	0.0207	0.14

Notes:

1. For all groundwater COCs but styrene and cyanide, the average concentrations among the monitoring wells at the Site are listed and used for the comparison.
   For styrene and cyanide, the maximum concentrations among the monitoring wells at the Site are listed and used for the comparison.
   The temporal averages were used to represent the concentrations for wells with multiple rounds of representative data.
2. The surface water concentrations were estimated according to the following equation:
   $Csw = Cgw / (DF * AF * C)$
   where:
   Csw = estimated surface water concentration (mg/L)
   Cgw = average groundwater concentration (µg/L)
   DF = dilution factor; default value of 10 was used
   AF = attenuation factor; based on organic carbon partitioning coefficient (Koc) of constituent
   if Koc < 1,000, AF = 2.5
   if 1,000 < Koc < 100,000, AF = 25
   if Koc > 100,000, AF = 100
   C = units conversion factor, 1,000 mg/L
3. National Ambient Water Quality Criteria Standards taken from USEPA's Office of Water, National Recommended Water Quality Criteria. 2022.

Abbreviations:
NA = Not Available; COC = Constituent of Concern; USEPA = United States Environmental Protection Agency.

TABLE D-20
COMPARISON OF ARITHMETIC MEAN CONCENTRATIONS IN SOIL AND GROUNDWATER TO
UPPER CONCENTRATION LIMITS IN SOIL AND GROUNDWATER[1]
284 Winter Street
Haverhill, Massachusetts

COC	Arithmetic Mean Concentration in Groundwater (µg/L)	Upper Concentration Limit in Groundwater (µg/L)	Arithmetic Mean Concentration in Soil (mg/kg)	Upper Concentration Limit in Soil (mg/kg)
1,2,4-Trichlorobenzene	NCC	100,000	NCC	10,000
1,2,3-Trimethylbenzene	NCC	10,000*	NCC	1,000*
1,2,4-Trimethylbenzene	NCC	10,000*	NCC	1,000*
1,2-Dichloroethane	NCC	100,000	NCC	9,000
1,3,5-Trimethylbenzene	NCC	10,000*	NCC	1,000*
2-Butanone	NCC	100,000	NCC	10,000
2-Hexanone	NCC	10,000*	NCC	1,000*
4-Ethyltoluene	NCC	10,000*	NCC	1,000*
Acetaldehyde	NCC	10,000*	NCC	1,000*
Acetone	NCC	100,000	NCC	10,000
Acrolein	NCC	10,000*	NCC	1,000*
Benzene	3968	100,000	19	10,000
Carbon Disulfide	NCC	10,000*	NCC	1,000*
Chloroethane	NCC	10,000*	NCC	1,000*
Chloroform	NCC	100,000	NCC	10,000
Chloromethane	NCC	10,000*	NCC	1,000*
cis-1,2-Dichloroethene	NCC	100,000	NCC	5,000
Cyclohexane	NCC	10,000*	NCC	1,000*
Ethanol	NCC	10,000*	NCC	1,000*
Ethylbenzene	1170	100,000	27	10,000
Dichlorodifluoromethane	NCC	10,000*	NCC	1,000*
1,1,2-Trichloro-1,2,2-Trifluoroethane	NCC	10,000*	NCC	1,000*
Heptane	NCC	10,000*	NCC	1,000*
Hexane	NCC	10,000*	NCC	1,000*
Methylene Chloride	NCC	100,000	NCC	7,000
Methyl-Tert-Butyl-Ether	49	100,000	NCC	5,000
Naphthalene	3948	100,000	366	10,000
n-Butane	NCC	10,000*	NCC	1,000*
n-Nonane	NCC	10,000*	NCC	1,000*
Pentane	NCC	10,000*	NCC	1,000*
tert-Butyl Alcohol	NCC	10,000*	NCC	1,000*
Tetrachloroethene	NCC	100,000	NCC	10,000
Toluene	803	100,000	16	10,000
Trichlorofluoromethane	NCC	10,000*	NCC	1,000*
Xylene (Total)	1829	100,000	42	10,000
Styrene	440	60,000	NCC	10,000
4-Methyl-2-Pentanone	NCC	100,000	NCC	10,000
Isopropyl Alcohol	NCC	10,000*	NCC	1,000*
1,3-Butadiene	NCC	10,000*	NCC	1,000*
2,2,4-Trimethylpentane	NCC	10,000*	NCC	1,000*
1-Methylnaphthalene	NCC	10,000*	NCC	1,000*
2-Methylnaphthalene	161	100,000	62	5,000
Acenaphthene	43	100,000	20	10,000
Acenaphthylene	52	100,000	22	10,000
Anthracene	NCC	600	22	10,000
Benzo(a)Anthracene	NCC	10,000	16	3,000
Benzo(a)Pyrene	NCC	5,000	17	300
Benzo(b)Fluoranthene	NCC	4,000	10	3,000
Benzo(g,h,i)Perylene	NCC	500	7.8	10,000
Benzo(k)Fluoranthene	NCC	1,000	9.7	10,000
Biphenyl	NCC	100,000	16	10,000
Carbazole	NCC	10,000*	14	1,000*
Chrysene	NCC	700	17	10,000
Dibenzo(a,h)anthracene	NCC	400	2.8	300
Dibenzofuran	NCC	10,000*	11	1,000*
Fluoranthene	ND	2,000	31	10,000
Fluorene	43	400	29	10,000
Indeno(1,2,3-cd)Pyrene	NCC	1,000	7.2	3,000
Phenanthrene	44	100,000	98	10,000
Pyrene	ND	600	46	10,000
C11-C22 Aromatic Fraction	907	100,000	5686	10,000
C19-C36 Aliphatic Fraction	NCC	100,000	464	20,000
C5-C8 Aliphatic Fraction	1503	100,000	147	5,000
C9-C10 Aromatic Fraction	4635	100,000	745	5,000
C9-C18 Aliphatic Fraction	2036	100,000	2344	20,000
Chromium (total)	NCC	3,000	18	2,000
Cyanide	518	2,000	7.3	5,000
Lead	NCC	150	74	6,000

Notes:

1. Upper Concentration Limits (UCLs) are from Massachusetts Department of Environmental Protection, Bureau of Waste Site Cleanup, Massachusetts Contingency Plan, 310 CMR 40.0996(6).
2. For all groundwater COCs but styrene and cyanide, the average concentrations among the monitoring wells at the Site were used for the UCL comp
   For styrene and cyanide, the maximum concentrations among the monitoring wells at the Site are listed and used for the comparison.
   There is no evidence that GZA-1, GZA-1A, or GZA-2 has been impacted by Site release; as a conservative approach, the results from GZA-1, GZA-1A, and GZA-2 were not included in the average calculation.
   For wells with multiple rounds of representative data, the temporal average concentrations were used for the average calculation.
3. The average concentrations among all the soil samples collected from the Site (including those collected beyond 15 feet below ground surface) were used for the UCL comparison purposes.
   Field duplicates and laboratory duplicates were averaged to represent the conditions of the duplicate pair and included in the average calculation for UCL comparison.

* Default upper concentration limits for groundwater constituents is 10,000 µg/L and for soil constituents is 1,000 mg/kg [310 CMR 40.0996 (7)(a)].

Abbreviations:
COC = Constituent of Concern; NCC = Not Constituent of Concern.

TABLE D-21
COMPARISON OF ESTIMATED SURFACE WATER EXPOSURE POINT CONCENTRATIONS
TO WATER QUALITY BENCHMARKS
284 Winter Street
Haverhill, Massachusetts

COC	Arithmetic Mean Concentration in Groundwater[1] (µg/L)	Dilution Factor	Attenuation Factor	Estimated Surface Water Concentration[2] (mg/L)	Water Quality Benchmark (mg/L)
Benzene	3968	10	2.5	0.16	0.114 [c]
Ethylbenzene	1170	10	2.5	0.047	0.014 [c]
Methyl-Tert-Butyl-Ether	49	10	2.5	0.0019	NA
Naphthalene	3948	10	25.0	0.016	0.1935 [e]
Toluene	803	10	2.5	0.032	0.253 [c]
Xylene (Total)	1829	10	2.5	0.073	0.027 [c]
Styrene	440	10	2.5	0.01760	0.032 [c]
2-Methylnaphthalene	161	10	25	0.00064	0.07 [e]
Acenaphthene	43	10	25	0.00017	0.056 [e]
Acenaphthylene	52	10	25	0.00021	0.3069 [e]
Fluorene	43	10	25	0.00017	0.039 [e]
Phenanthrene	44	10	25	0.00017	0.01913 [e]
C11-C22 Aromatic Fraction	907	10	25	0.0036	0.00 [d]
C5-C8 Aliphatic Fraction	1503	10	25	0.0060	0.21800 [d]
C9-C10 Aromatic Fraction	4635	10	25	0.019	0.54 [d]
C9-C18 Aliphatic Fraction	2036	10	100	0.0020	1.8 [d]
Cyanide	518	10	2.5	0.021	0.0052 [b]

Notes:

1. For all groundwater constituents of concern but styrene and cyanide, the average concentrations among the monitoring wells at the Site are listed and used for the comparison. For styrene and cyanide, the maximum concentrations among the monitoring wells at the Site are listed and used for the comparison. The temporal averages were used to represent the concentrations for wells with multiple rounds of representative data.
2. The surface water concentrations were estimated according to the following equation:
   Csw = Cgw / (DF * AF * C)

   where:
   Csw = estimated surface water concentration (mg/L)
   Cgw = average groundwater concentration (µg/L)
   DF = dilution factor; default value of 10 was used
   AF = attenuation factor; based on organic carbon partitioning coefficient (Koc) of constituent
   if Koc < 1,000, AF = 2.5
   if 1,000 < Koc < 100,000, AF = 25
   if Koc > 100,000, AF = 100
   C = units conversion factor, 1,000 mg/L

Sources:

b US EPA National Recommended Water Quality Criteria; 2022. up-to-date values are available at: http://www.epa.gov/waterscience/criteria/

c These benchmarks are from a compilation of ecological screening benchmarks from U.S. EPA Region 5, available at https://archive.epa.gov/region5/waste/cars/web/pdf/ecological-screening-levels-200308.pdf.

d These are Final Chronic Values developed by Battelle of Duxbury, Massachusetts for the MassDEP. These benchmarks are presented in the September 2007 report titled "Sediment Toxicity of Petroleum Hydrocarbon Fractions" which is available at: http://www.mass.gov/eea/docs/dep/cleanup/laws/tphbat.pdf

e These are Final Chronic Values (FCVs) used to develop equilibrium partitioning benchmarks for PAHs in sediment. These FCVs were developed by the U.S. EPA, and are presented in "Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures", EPA-600-R-02-013. November, 2003.

Attachment I - Modeling Ambient Air Concentrations

1.0 INTRODUCTION

A combination of two exposure models was used to estimate exposure point concentrations of volatile constituents in groundwater which may accumulate and volatilize into a construction/utility trench. A conservative screening-level model (RTI Model; USEPA, 1990) describing simple mass transfer of volatile constituents from liquid surfaces to air was used in this analysis. The RTI model predicts mass emission rates (mass/time) based on an individual constituent's overall mass transfer coefficient, the area of the liquid surface, and the concentration of the constituent in the liquid phase. The overall mass transfer coefficient was based on an estimation technique presented in Lyman (1982).

The constituent-specific flux rate was then entered into a simple one-box mass balance model which integrates the effects of air movement through the trench. This model estimates the concentration of a constituent in air (mg of compound per m^3 of air) which was used as the exposure point concentration in ambient air of a trench for construction/utility workers who may perform excavation activities at the Site. Descriptions of both of these models and associated assumptions are provided below.

2.0 MODEL FOR VOLATILE CONSTITUENT MASS EMISSION RATE

The RTI model was developed for assessing volatile emissions from aerated and non-aerated lagoons. The model is also applicable to quiescent and turbulent conditions. The model was selected for this analysis due to the similarities between a quiescent lagoon and standing water in the bottom of a trench. This model, which predicts a mass emission rate, is based on the constituent concentration in the liquid phase (groundwater seeping into a trench), the area of the trench, and the overall mass transfer coefficient of each volatile constituent.

The RTI Model is summarized as follows:

$$E = K \times SA \times C$$

where,

E = Mass emission rate of constituent in air phase (g/sec)

K = Overall mass transfer coefficient (m/sec)

SA = Liquid surface area (m^2)

C = Concentration of constituent in liquid phase (g/m^3 or equivalently, mg/l)

The overall mass transfer coefficient, K (m/hr), is related to the liquid-phase exchange coefficient, K_L (m/hr), and the gas-phase exchange coefficient, K_g (m/hr), as follows:

$$\frac{1}{K} = \frac{1}{K_L} + \frac{R \times T}{H \times K_g}$$

where,

R = Universal gas constant, 8.206×10^{-5} (m^3-atm/mol-°K)

T = Temperature (298°K)

H = Henry's Law Constant (m^3-atm/mol)

For the calculation of E, K is converted from units of m/hr to m/sec with a conversion factor of 1 hour per 3,600 seconds.

The overall mass transfer coefficient can be determined from experiment or from knowledge of the liquid- and gas-phase exchange coefficients. Model calculations may also be performed relating these coefficients to physical properties such as the molecular weight and scaling based upon mass-transfer coefficients for other compounds. One set of such relationships, presented in Lyman (1981), is given by:

$K_L = 20 \times (44/M)^{½} \times CF$ (m/hr)

where,

K_L = Liquid-phase exchange coefficient (m/hr)

20 = Liquid-phase exchange coefficient of CO_2 (cm/hr)

44 = Molecular weight of CO_2 (g/mole)

M = Molecular weight of chemical of interest (g/mole)

CF = Units conversion factor (1 m per 100 cm)

and:

$K_g = 3{,}000 \times (18/M)^{½} \times CF$ (m/hr)

where,

K_g = Gas-phase exchange coefficient (m/hr)

3,000 = Gas-phase exchange coefficient for H_2O (cm/hr)

18 = Molecular weight of H_2O (g/mole)

M = Molecular weight of chemical of interest (g/mole)

CF = Units conversion factor (1 m per 100 cm)

The overall mass transfer coefficients and mass emission rates are presented in Table I-1.

3.0 MODEL FOR ESTIMATING AIR CONCENTRATIONS

To estimate the concentration of constituents in a utility trench, GZA used a simple one-box mass balance model. This model assumes that emissions from pooled groundwater in the trench are diluted into air passing through the excavation. The parameters used to calculate the volume of air flowing through the trench and thus the volume into which the emissions are diluted include: the windspeed, which was assumed to be 5.6 meters per second (mean wind speed for Boston, MA) (GRI, 1988) the width of the excavation, which was assumed to be 1 meter (or 3.3 feet), and the depth of the

excavation which was assumed to be 1.5 meters (or 5 feet). Concentrations of volatile organic compounds, the oil or hazardous material (OHM) of concern in air, were estimated as follows:

$$EPC_{air} = \frac{4.0\ E}{Q} \times \frac{1}{A} \times CF$$

Where,

EPC_{air} = Concentration of constituent in air (mg/m^3)

E = Mass emission rate of constituents (g/s) (as estimated in Section 2.00 of this Attachment)

Q = Windspeed of air moving through trench (m/s)

A = Cross-sectional area of trench (m^2)

CF = Units conversion factor (1000 mg per g)

The results of the mass emission rate modeling including derivation of mass transfer coefficients, chemical-specific volatilization rates, and estimated trench air concentrations are presented in Table I-1.

REFERENCES

Gas Research Institute (GRI), Management of Manufactured Gas Plant Sites, Volume III (Risk Assessment), Appendix B, May 1988.

Lyman, W.J., et.al, 1982, Handbook of Chemical Property Estimation Methods, American Chemical Society, Washington, D.C.

U.S. EPA, Office of Air Quality, "Estimation of Baseline Air Emissions at Superfund Sites," Report ASF-2a, August 1990.

TABLE I-1
ESTIMATION OF AMBIENT AIR CONCENTRATIONS - UTILITY TRENCH EXCAVATION
284 Winter Street
Haverhill, Massachusetts

Constituent [1]	C Groundwater Concentration [2] (mg/L)	SA [3] Liquid Surface Area (m^2)	Trench Dimensions [4] (L) Length (m)	(W) Width (m)	Receptor Height (D) (m)	H [5] Henry's Law Constant (m^3-atm/mol-K)	M [5] Molecular Weight (g/mole)	kg [6] Phase Exchange Coefficient - Gas (m/hr)	kl [7] Phase Exchange Coefficient - Liquid (m/hr)	K [8] Overall Mass Transfer Coefficient (m/sec)	E [9] Emission Rate (g/s)	Q [10] Wind Speed (m/s)	A [11] Cross-sectional Area of Air Flow (m^2)	Estimated [12] Ambient Air Conc. (mg/m^3)
Benzene	2.0E+01	3.0	12.2	1.0	1.5	5.6E-03	78	1.4E+01	1.5E-01	4.0E-05	2.4E-03	5.6	1.5	2.8E-01
Ethylbenzene	7.0E-01	3.0	12.2	1.0	1.5	7.9E-03	106	1.2E+01	1.3E-01	3.5E-05	7.4E-05	5.6	1.5	8.6E-03
Naphthalene	9.6E+00	3.0	12.2	1.0	1.5	4.4E-04	128	1.1E+01	1.2E-01	2.1E-05	6.0E-04	5.6	1.5	7.1E-02
Toluene	4.1E+00	3.0	12.2	1.0	1.5	6.6E-03	92	1.3E+01	1.4E-01	3.7E-05	4.6E-04	5.6	1.5	5.4E-02
Xylene (Total)	2.2E+00	3.0	12.2	1.0	1.5	6.6E-03	106	1.2E+01	1.3E-01	3.4E-05	2.3E-04	5.6	1.5	2.7E-02
Styrene	4.4E-01	3.0	12.2	1.0	1.5	2.8E-03	104	1.2E+01	1.3E-01	3.3E-05	4.4E-05	5.6	1.5	5.2E-03
2-Methylnaphthalene	5.5E-01	3.0	12.2	1.0	1.5	5.2E-04	142	1.1E+01	1.1E-01	2.1E-05	3.5E-05	5.6	1.5	4.1E-03
Acenaphthylene	1.4E-01	3.0	12.2	1.0	1.5	1.1E-04	154	1.0E+01	1.1E-01	9.2E-06	3.9E-06	5.6	1.5	4.6E-04
Cyanide	5.2E-01	3.0	12.2	1.0	1.5	2.4E-02	27	2.4E+01	2.6E-01	7.0E-05	1.1E-04	5.6	1.5	1.3E-02

Notes

1. All groundwater COCs considered "volatile" in accordance with the USEPA (2015) Office of Solid Waste and Emergency Response (OSWER) Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air were evaluated as COCs in ambient air in a trench.
   According to the USEPA (2015) guide, "a chemical generally is considered to be 'volatile' if 1) Vapor pressure is greater than 1 millimeter of mercury (mmHg), or 2) Henry's law constant (ratio of a chemical's vapor pressure in air to solubility in water) is greater than 10^{-5} atmosphere-meter cubed per mole (atm m^3 mol^{-1})"
2. Groundwater concentration is based on the arithmetic mean concentrations of VOCs detected in groundwater samples collected from the Site.
3. Liquid surface area was calculated as the length of the trench times the width of the trench. Although GZA assumed that no more than 10 percent of the trench will contain some standing water, GZA has assumed 25 percent to account for volatilization from two other transport mechanisms (i.e., from groundwater to soil gas to air and from soil to air). Therefore, a factor of 0.25 was applied to the liquid surface area. SA = (length * width) * 0.25
4. Repairs will be the predominant type of utility work at the Site. GZA assumed that 40 feet or 12.2 meters of an existing water, gas, or drain line may be accessed for repairs. To calculate the liquid surface area, the width of the trench was assumed to be 3 feet or 1 meter.
5. Constituent-specific values were obtained from MassDEP (2013) Shortforms for Human Health Risk Assessment under the MCP.
   For compounds not listed in the MassDEP documentations, values from USEPA's Johnson and Ettinger (1991) Model for Subsurface Vapor Intrusion into Buildings (GW-ADV-Feb04.xls), February, 2004 and other references were used.
6. Phase Exchange coefficient (gas) = [3000 * sqrt(18/mol wt)]/100
7. Phase Exchange coefficient (liquid) = [20 * sqrt (44/mol wt)] / 100
8. Mass Transfer coefficient = 1/kl + [(8.2E-5 * 298)/(H * kg)]
9. Emission Rate = C_{gw} * SA * K
10. Windspeed was based on Gas Research Institute (GRI) Management of Manufactured Gas Plant Sites, Volume III (Risk Assessment), Appendix B. The mean wind speed for Boston, Massachusetts of 5.6 m/s was used.
11. The cross-sectional area is based on the trench dimensions above and height of receptor. Therefore, the cross-sectional area was calculated as (W x D) or 1 meter x 1.5 meters = 1.5 square meters.
12. Estimated Ambient Air Concentration = [E/Q * 1/A] * 1000
13. US EPA Office of Water Quality Planning and Standards, Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF) Air Emissions Models, July 1990.

NA = Not Available; NC = Not Calculated; NVOC = Not a Volatile Organic Compound.

Attachment II - Calculating the Incremental Ingestion Rate of Particulates (IIRparticulate)

The Massachusetts Department of Environmental Protection (MassDEP) issued the Technical Update, "Characterization of Risks due to Inhalation of Particulates by Construction Workers" in April 2002 and revised it in July 2008. The Technical Update supersedes Section 7.2 and portions of Appendix B of the MassDEP "Guidance for Disposal Site Risk Characterization – In Support of the Massachusetts Contingency Plan", 1995 Guidance. The Technical Update requires quantification of two uptake pathways associated with the inhalation of airborne particulates: 1) the portion of dust which is trapped in the upper respiratory tract of an individual and is subsequently swallowed and absorbed via the gastrointestinal tract; and 2) the remaining portion of dust which enters the bloodstream via the alveoli of the lungs.

The following equation is used to quantify the amount of dust which enters the gastrointestinal tract (as opposed to the amount of dust entering the lung):

$IIR_{particulate} = 2 \times PM_{10} \times VR \times ED \times C1$

where:

$IIR_{particulate}$ = daily incremental ingestion rate to account for ingestion of inhaled particulates (mg/day)

2 = dimensionless factor; effective exposure concentration of respirable particulates for the GI system is 2 times the concentration of PM_{10} (MassDEP, 2008)

PM_{10} = airborne concentration of particulates less than or equal to 10 microns in diameter ($\mu g/m^3$).

ED = Exposure duration (hr/day), based on average time outdoors proposed in USEPA (2011) Exposure Factors Handbook.

VR = Ventilation rate = age-weighted and activity-weighted inhalation rate of receptor (L/min)

C1 = 0.00006, units conversion factors (mg/μg min/hr m^3/L)

Using age- and activity-weighted inhalation rates provided in Table B-4 of the MassDEP Guidance, the following $IIR_{particulate}$ are calculated for receptor groups:

	PM10 ($\mu g/m^3$)	VR (L/min)		ED (hr/day)	$IIR_{particulate}$ (mg/day)
Facility worker, adult	32	10	low activity	8	0.3
Trespasser age 7<15 years	32	11.2	light exertion	2	0.09

Attachment III - DosD-Response Assessment

1.0 NON-CANCER EFFECTS

For non-cancer health effects, regulatory guidance assumes that a threshold level exists at or below which no adverse health effects would be expected. This dose or threshold is called a No Observed Adverse Effect Level (NOAEL). The lowest dose at which an adverse effect occurs is identified as a Lowest Observed Adverse Effect Level (LOAEL). United States Environmental Protection Agency (USEPA) generates dose-response values for non-cancer effects, or reference dose (RfD) values, by applying uncertainty factors to a NOAEL or LOAEL obtained from studies of dose-response relationships. The purpose of these uncertainty factors is to establish exposure levels that are protective of human health, even for sensitive subpopulations. Uncertainty factors of 10 are used, as appropriate, to account for interspecies variability between humans and other mammals used in dose-response studies; use of a NOAEL derived from a subchronic rather than a chronic study; uncertainty when extrapolating from LOAELs to NOAELs; and variation in the general population with the intent to protect sensitive subpopulations (e.g. elderly, children). A modifying factor (MF) is an additional uncertainty factor that allows for "professional judgment," relative to confidence in the studies, in the estimation of allowable levels. The default MF is 1.

The chronic (oral) RfD and (inhalation) reference concentration (RfC), which may incorporate MFs and uncertainty factors, are conservative estimates of levels for humans, below which no adverse non-cancer health effects are expected to occur over long periods of exposure. The units of the RfD are mg/kg-day (mg constituent/kg body weight per day). The units of the RfC are mg/m^3 (mg constituent/m^3 volume of air). The subchronic RfD and RfC are calculated in a manner analogous to the chronic benchmarks; however, they are designed to be protective of shorter duration exposures (generally defined as representing exposures lasting from several days to less than seven years).

Non-cancer dose-response information for constituents of concern (COCs) is provided in Table D-15 and Table D-16 for the oral (also used for dermal) and inhalation exposure routes. These tables also provide information on the target organ/system that was affected in the toxicity study upon which the RfD or RfC is based.

1.1 DOSE-RESPONSE VALUES USED FOR VPH/EPH[1] FRACTIONS

To evaluate the potential risk of harm posed by petroleum hydrocarbons in soil, airborne fugitive dust, and indoor air at the Site, dose-response values were assigned to each selected range of hydrocarbon fractions detected via VPH/EPH analysis. MassDEP has published RfDs and RfCs for each aliphatic and aromatic hydrocarbon fraction (MassDEP, 2002 and 2003). These values are presented in Tables D-15 and D-16.

2.0 CANCER EFFECTS

For cancer effects, the dose-response curve indicates the relationship between the dose and the probability of developing cancer. In contrast to the dose-response assessment of non-cancer effects, carcinogens are assumed to act without a threshold. For carcinogenic substances, it is assumed that there is some level of cancer risk associated with every non-zero dose. The dose-response assessment for constituents suspected to be human carcinogens includes a weight-of-evidence classification and a cancer slope factor (CSF; oral) or unit risk (UR; inhalation). The weight-of-evidence classification indicates the likelihood that a constituent is a human carcinogen based on the quality of evidence from

[1] Volatile petroleum hydrocarbon/extractable petroleum hydrocarbon.

human and animal studies and other supportive information, such as mutagenic effects or structure-activity data. CSFs and unit risks are a measure of the cancer-causing potency of a substance in humans.

CSFs are typically derived by the USEPA's Carcinogen Assessment Group (CAG) using the linearized multistage model (for animal data) to extrapolate from high experimental doses to low environmental doses. The dose-response curve indicates the relationship between the dose of a particular constituent and the probability of obtaining cancer over a lifetime. USEPA utilizes the 95 percent upper confidence limit of the slope of the dose-response curve from the multistage model, expressed in $(mg/kg\text{-}day)^{-1}$. Use of a CSF assumes that the calculated dose received is expressed as a lifetime average.

The Unit Risk is the upper 95 percent Confidence Limit of the mean incremental lifetime cancer risk estimated to result from lifetime exposure to an agent if it is in the air at a concentration of 1 $\mu g/m^3$. These values are used in lieu of a CSF when an estimate of a lifetime average concentration of a constituent is available. Carcinogenic dose-response information for the COCs is provided in Table D-17.

3.0 RELATIVE ABSORPTION FACTORS

RAFs are necessary to account for differences in the absorption of a constituent in a given environmental medium relative to that in the dose-response study. Absorption differences can result from matrix attenuation effects as well as differences in the route of administration (e.g., oral versus dermal exposures). Additionally, RAFs are used to convert an exposure dose to an absorbed dose in cases where a dose-response value is based on an absorbed dose. Thus, the RAF is used to convert the dose-response value to an absorbed dose, if necessary.

GZA used RAFs derived by MassDEP (2014) when available with the exceptions discussed below. For chemicals without a MassDEP-derived RAF, applicable surrogate values were substituted, or RAFs were derived based on the default absorption efficiencies listed in Table B-11 of the MassDEP (1995) guidance. For chemicals that did not have adequate information to establish a RAF value, a default value of 1 was used. Refer to Table D-18 for a summary of COC- and medium-specific RAFs.

3.1 LEAD RAF FOR SOIL INGESTION

The default RAF for lead for the soil ingestion pathway is listed as 0.5 in the MassDEP (2019) Development of MCP[2] Risk-Based Levels for Soil and Groundwater. This value was first presented in the MassDEP (1992) User's Guide for Risk Assessment Shortform and was developed based on the highest value presented in the various literatures dated between 1971 and 1982. In this risk characterization, GZA adopted a RAF of 0.3 for lead for the soil ingestion pathway, consistent with the USEPA (2007) recommended default absorption factor[3] of 0.3 for lead in soil in the User's Guide for the Integrated Exposure Uptake Biokinetic Model for Lead in Children. As indicated in the MassDEP (1992) User's Guide for Risk Assessment Shortform, "*The oral and dermal chronic reference dose for lead is based on back-calculation from the drinking water action level. In this calculation, an absorbed dose was used. Therefore, the RAF is the absorption efficiency by the route in question.*" That is, the RAF for the soil ingestion pathway is the absorption efficiency by the soil ingestion pathway. Therefore, it is appropriate to use the USEPA default absorption factor for lead in soil as the RAF for the soil ingestion pathway.

It is GZA's position that the MassDEP default RAF value of 0.5 is outdated and overstated and the USEPA (2007) default absorption is a conservative assumption for the soil ingestion exposure. As indicated by USEPA in its 1999 Short Sheet:

[2] Massachusetts Contingency Plan.

[3] Termed as bioavailability, which was defined as absorption of intake from the gut or lung into the blood in the USEPA (2007) document.

IEUBK Model Bioavailability Variable, *"It is acknowledged that this value has significant variability and uncertainty, but it is the estimate under which the IEUBK model was validated with comprehensive blood lead study results."*

3.2 DERIVATION OF DERMAL-WATER RAFS

The methodology for estimating the risks posed by dermal exposure to chemicals of concern in water utilizes a chemical-specific permeability constant that estimates the rate at which the chemical passes into and through the skin from an aqueous solution. By definition, the dose estimated by this procedure is an absorbed dose. If the oral RfD and unit risk for a chemical are based on an administered (exposure) dose, an adjustment is necessary to convert the RfD and unit risk to be based on an absorbed dose. In order to use consistent dose-response criteria across all exposure pathways, the adjustment is made to the absorbed dermal dose in the exposure assessment, rather than to the dose-response criteria. This approach also enables all absorption adjustments (all pathways) to be performed in the exposure assessment section.

Volatile Organic Compounds (VOCs): The RAF for dermal-water equals 1/(absorption in the dose-response study), which is mathematically equivalent to adjusting the dose-response criteria (multiplying the RfD, or dividing the CSF, by the percent absorption). For VOCs, the RAF (dermal-water) is 1/(100%) = 1.

Polycyclic Aromatic Hydrocarbons (PAHs): The RAF (dermal-water) for use with the RfD for naphthalene and 2-methylnaphthalene is 1/100% = 1. For the other PAHs, the RAF (dermal-water) is 1/91% = 1.1 based on a default absorption factor of 91% for an oral gavage study.

4.0 SURROGATE DOSE-RESPONSE VALUES

Dose-response values (RfDs, RfCs, CSFs, URs) were not available for all of the COCs. Dose-response values were cross-assigned to structurally similar compounds, where appropriate. The corresponding RAF values were used for constituents to which surrogate toxicity values were applied.

- The subchronic and chronic oral RfDs for pyrene were used for PAHs for which a chronic RfD is not available (acenaphthylene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, indeno(123-cd)pyrene, and phenanthrene), C_9-C_{10} aromatics, and C_{11}-C_{22} aromatics.
- The RfC values for 1,2,4-trimethylbenzene were used for 1,3,5-trimethylbenzene and 1,2,3-trimethylbenzene.

5.0 REFERENCES

MassDEP, 1992. User's Guide for Risk Assessment Shortform, Residential Exposure Scenario, Version 1.6. October.

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MassDEP, 2002. Characterizing Risks Posed by Petroleum Contaminated Sites: Implementation of the MADEP VPH/EPH Approach. Final Policy. October.

MassDEP, 2003. Updated Petroleum Hydrocarbon Fraction Toxicity Values for the VPH/EPH/APH Methodology.

MassDEP, 2014. Shortforms for Human Health Risk Assessment under the MCP. Massachusetts Department of Environmental Protection, Office of Research and Standards and the Bureau of Waste Site Cleanup.

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United States Environmental Protection Agency (EPA), 2020a. Provisional Peer-Reviewed Toxicity Values for Thallium and Compounds. Superfund Health Risk Technical, National Center for Environmental Assessment, Office of Research and Development, Cincinnati, OH.

United States Environmental Protection Agency (EPA), 2020b. Integrated Risk Information System (IRIS). Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, Cincinnati, OH

Attachment IV – Risk Calculations

The methodology used to calculate hazard quotients (HQs) and Excess Lifetime Cancer Risks (ELCRs) is described below. Tables IV-1 through IV-19 present risks by exposure pathway for each receptor group evaluated.

To evaluate non-cancer risks, an HQ is calculated. The HQ, a ratio of the receptor's quantified exposure to the "acceptable" level of exposure, provides a general indication of whether exposures are likely to result in adverse health effects, but does not represent the severity of effects associated with an exposure. To evaluate the non-cancer effects for each COC, the estimated average daily dose (ADD) or average daily exposure (ADE) is divided by the appropriate reference dose (RfD) or reference concentration (RfC) to yield an HQ:

HQ_{oral} or HQ_{dermal} = ADD (mg/kg-day)/RfD (mg/kg-day)

$HQ_{inhalation}$ = ADE (mg/m^3)/RfC (mg/m^3)

For multiple constituent exposures, HQs are summed for all COCs to yield a Hazard Index (HI) for an individual exposure pathway. A cumulative HI is derived by summing the HIs for each exposure pathway for each receptor. A cumulative HI equal to or less than 1, the Cumulative Non-cancer Risk Limit, indicates that a receptor's exposure is equal to or less than the "acceptable" exposure level and it is considered unlikely that adverse health effects would occur. However, a cumulative HI greater than 1 does not imply that health impacts would necessarily be expected. The appropriateness of the exposure assumptions and the basis of the toxicity values used in calculation of the HI must also be considered. This approach assumes that toxic effects by different constituents are additive.

Cancer risks were evaluated as probabilities. The ELCR estimate is considered to be an upper bound probability of the likelihood of developing cancer over a lifetime as a result of exposure to individual constituents. To assess excess lifetime cancer risks, the lifetime average daily doses (LADDs) or lifetime average daily exposures (LADEs) are multiplied by their respective cancer slope factors (CSFs) or unit risks to yield a COC-specific lifetime cancer risk estimate:

$ELCR_{oral}$ or $ELCR_{dermal}$ = LADD (mg/kg-day) x CSF $(mg/kg\text{-}day)^{-1}$

$ELCR_{inhalation}$ = LADE ($\mu g/m^3$) x unit risk $(\mu g/m^3)^{-1}$

For multiple constituent exposures, COC-specific cancer risk estimates for specific exposure pathways are summed to yield a pathway-specific cancer risk estimate. A cumulative receptor cancer risk is calculated by summing pathway-specific ELCRs. The summation assumes that individual intakes are small. It also assumes independence of action by the constituents involved (i.e., there are no synergistic or antagonistic interactions, and all constituents have the same toxicological mechanism and endpoint).

The calculated cumulative receptor cancer risk estimates are compared to the Cumulative Cancer Risk Limit of 1×10^{-5} specified in the MCP. This level represents an incremental probability of one in 100,000 that an individual may develop cancer over his or her lifetime due to exposures to COCs at the Site.

TABLE IV-1
CALCULATION OF AVERAGE DAILY DOSES AND RISK ESTIMATES
FOR DERMAL CONTACT WITH SOIL
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Facility Workers
CHRONIC NON-CANCER EFFECTS

Dermal Contact with Soil

See TABLE D-11 for Exposure Variables and Rationale

$$ADD_{soil\text{-}dermal} = \frac{EPC_{soil} * DCR_{soil} * EF * ED * EP * RAF_{dermal\text{-}nc} * C1}{BW * AP_{nc}}$$

See TABLE D-10 for Exposure Point Concentration Derivation

$$HQ_{soil\text{-}dermal} = \frac{ADD_{soil\text{-}dermal}}{RfD}$$

$$HI_{soil\text{-}dermal} = \Sigma HQ_{soil\text{-}dermal}$$

COC	EPC_{soil} EPC1 (mg/kg)	$RAF_{dermal\text{-}nc}$ (unitless)	$ADD_{soil\text{-}dermal}$ (mg/kg-day)	RfD Chronic (mg/kg-day)	$HQ_{soil\text{-}dermal}$ (unitless)
Benzene	23	0.03	3.1E-07	4.0E-03	7.6E-05
Ethylbenzene	24	0.03	3.1E-07	5.0E-02	6.2E-06
Naphthalene	291	0.1	1.3E-05	2.0E-02	6.3E-04
Toluene	20	0.03	2.6E-07	8.0E-02	3.2E-06
Xylene (Total)	29	0.03	3.7E-07	2.0E-01	1.9E-06
2-Methylnaphthalene	45	0.1	1.9E-06	4.0E-03	4.8E-04
Acenaphthene	11	0.1	4.9E-07	6.0E-02	8.1E-06
Acenaphthylene	22	0.1	9.4E-07	3.0E-02	3.1E-05
Anthracene	19	0.1	8.3E-07	3.0E-01	2.8E-06
Benzo(a)Anthracene	15	0.02	1.3E-07	3.0E-02	4.3E-06
Benzo(a)Pyrene	16	0.02	1.4E-07	3.0E-04	4.6E-04
Benzo(b)Fluoranthene	11	0.02	9.2E-08	3.0E-02	3.1E-06
Benzo(g,h,i)Perylene	7.9	0.1	3.4E-07	3.0E-02	1.1E-05
Benzo(k)Fluoranthene	9.5	0.02	8.3E-08	3.0E-02	2.8E-06
Biphenyl	9.4	0.1	4.1E-07	5.0E-01	8.2E-07
Carbazole	3.8	1	1.6E-06	NA	NC
Chrysene	15	0.02	1.3E-07	3.0E-02	4.4E-06
Dibenzo(a,h)anthracene	2.4	0.02	2.1E-08	3.0E-02	7.1E-07
Dibenzofuran	9.3	0.18	7.2E-07	1.0E-03	7.2E-04
Fluoranthene	28	0.1	1.2E-06	4.0E-02	3.1E-05
Fluorene	22	0.1	9.7E-07	4.0E-02	2.4E-05
Indeno(1,2,3-cd)Pyrene	7.2	0.02	6.3E-08	3.0E-02	2.1E-06
Phenanthrene	78	0.1	3.4E-06	3.0E-02	1.1E-04
Pyrene	41	0.1	1.8E-06	3.0E-02	5.9E-05
C11-C22 Aromatic Fraction	5049	0.1	2.2E-04	3.0E-02	7.3E-03
C19-C36 Aliphatic Fraction	415	0.2	3.6E-05	2.0E+00	1.8E-05
C5-C8 Aliphatic Fraction	131	0.2	1.1E-05	4.0E-02	2.8E-04
C9-C10 Aromatic Fraction	657	0.2	5.7E-05	3.0E-02	1.9E-03
C9-C18 Aliphatic Fraction	2001	0.2	1.7E-04	1.0E-01	1.7E-03
Chromium (total)	18	0.1	7.6E-07	3.0E-03	2.5E-04
Cyanide	7.3	0.1	3.2E-07	6.0E-04	5.3E-04
				$HI_{soil\text{-}dermal}$ =	**1.5E-02**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.

TABLE IV-1 (Continued)
CALCULATION OF AVERAGE DAILY DOSES AND RISK ESTIMATES
FOR DERMAL CONTACT WITH SOIL
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Facility Workers
CANCER EFFECTS

Dermal Contact with Soil

See TABLE D-11 for Exposure Variables and Rationale

See TABLE D-10 for Exposure Point Concentration Derivation

$$LADD_{soil\text{-}dermal} = \frac{EPC_{soil} * DCR_{soil} * EF * ED * EP * RAF_{dermal\text{-}c} * C1}{BW * AP_c}$$

$$ELCR_{soil\text{-}dermal} = LADD_{soil\text{-}dermal} * CSF$$

Total $ELCR_{soil\text{-}dermal}$ = Σ $ELCR_{soil\text{-}dermal}$

COC	EPC_{soil} EPC1 (mg/kg)	$RAF_{dermal\text{-}c}$ (unitless)	$LADD_{soil\text{-}dermal}$ (mg/kg-day)	CSF $(mg/kg\text{-}day)^{-1}$	$ELCR_{soil\text{-}dermal}$ (unitless)
Benzene	23	0.03	1.18E-07	5.5E-02	6.5E-09
Ethylbenzene	24	1	3.99E-06	NA	NC
Naphthalene	291	1	4.87E-05	NA	NC
Toluene	20	1	3.33E-06	NA	NC
Xylene (Total)	29	1	4.77E-06	NA	NC
2-Methylnaphthalene	45	1	7.47E-06	NA	NC
Acenaphthene	11	1	1.87E-06	NA	NC
Acenaphthylene	22	1	3.63E-06	NA	NC
Anthracene	19	1	3.19E-06	NA	NC
Benzo(a)Anthracene	15	0.02	5.03E-08	1.0E-01	5.0E-09
Benzo(a)Pyrene	16	0.02	5.36E-08	1.0E+00	5.4E-08
Benzo(b)Fluoranthene	11	0.02	3.54E-08	1.0E-01	3.5E-09
Benzo(g,h,i)Perylene	7.9	1	1.32E-06	NA	NC
Benzo(k)Fluoranthene	9.5	0.02	3.19E-08	1.0E-02	3.2E-10
Biphenyl	9.4	0.1	1.58E-07	8.0E-03	1.3E-09
Carbazole	3.8	0.18	1.14E-07	2.0E-02	2.3E-09
Chrysene	15	0.02	5.06E-08	1.0E-02	5.1E-10
Dibenzo(a,h)anthracene	2.4	0.02	8.18E-09	1.0E+00	8.2E-09
Dibenzofuran	9.3	1	1.55E-06	NA	NC
Fluoranthene	28	1	4.72E-06	NA	NC
Fluorene	22	1	3.74E-06	NA	NC
Indeno(1,2,3-cd)Pyrene	7.2	0.02	2.42E-08	1.0E-01	2.4E-09
Phenanthrene	78	1	1.31E-05	NA	NC
Pyrene	41	1	6.86E-06	NA	NC
C11-C22 Aromatic Fraction	5049	1	8.45E-04	NA	NC
C19-C36 Aliphatic Fraction	415	1	6.94E-05	NA	NC
C5-C8 Aliphatic Fraction	131	1	2.20E-05	NA	NC
C9-C10 Aromatic Fraction	657	1	1.10E-04	NA	NC
C9-C18 Aliphatic Fraction	2001	1	3.35E-04	NA	NC
Chromium (total)	18	1	2.93E-06	NA	NC
Cyanide	7.3	1	1.22E-06	NA	NC
Lead	74	1	1.24E-05	NA	NC
				Total $ELCR_{soil\text{-}dermal}$:	**8.4E-08**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.
3. A default value of 1 is used when an RAF is otherwise unavailable.

TABLE IV-2
CALCULATION OF AVERAGE DAILY DOSES AND RISK ESTIMATES
FOR INCIDENTAL INGESTION OF SOIL
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Facility Workers
CHRONIC NON-CANCER EFFECTS

See TABLE D-11 for Exposure Variables and Rationale

See TABLE D-10 for Exposure Point Concentration Derivation

Incidental Ingestion of Soil

$$ADD_{soil\text{-}oral} = \frac{EPC_{soil} * IR_{soil} * EF * ED * EP * RAF_{oral\text{-}nc} * C1}{BW * AP_{nc}}$$

$$HQ_{soil\text{-}oral} = \frac{ADD_{soil\text{-}oral}}{RfD}$$

$$HI_{soil\text{-}oral} = \Sigma HQ_{soil\text{-}oral}$$

COC	EPC_{soil} EPC1 (mg/kg)	$RAF_{oral\text{-}nc}$ (unitless)	$ADD_{soil\text{-}oral}$ (mg/kg-day)	RfD Chronic (mg/kg-day)	$HQ_{soil\text{-}oral}$ (unitless)
Benzene	23	1	5.7E-06	4.0E-03	1.4E-03
Ethylbenzene	24	1	5.8E-06	5.0E-02	1.2E-04
Naphthalene	291	0.3	2.1E-05	2.0E-02	1.1E-03
Toluene	20	1	4.8E-06	8.0E-02	6.0E-05
Xylene (Total)	29	1	6.9E-06	2.0E-01	3.4E-05
2-Methylnaphthalene	45	0.3	3.2E-06	4.0E-03	8.1E-04
Acenaphthene	11	0.3	8.1E-07	6.0E-02	1.4E-05
Acenaphthylene	22	0.3	1.6E-06	3.0E-02	5.2E-05
Anthracene	19	0.3	1.4E-06	3.0E-01	4.6E-06
Benzo(a)Anthracene	15	0.3	1.1E-06	3.0E-02	3.6E-05
Benzo(a)Pyrene	16	0.3	1.2E-06	3.0E-04	3.9E-03
Benzo(b)Fluoranthene	11	0.3	7.7E-07	3.0E-02	2.6E-05
Benzo(g,h,i)Perylene	7.9	0.3	5.7E-07	3.0E-02	1.9E-05
Benzo(k)Fluoranthene	9.5	0.3	6.9E-07	3.0E-02	2.3E-05
Biphenyl	9.4	1	2.3E-06	5.0E-01	4.6E-06
Carbazole	3.8	1	9.1E-07	NA	NC
Chrysene	15	0.3	1.1E-06	3.0E-02	3.7E-05
Dibenzo(a,h)anthracene	2.4	0.3	1.8E-07	3.0E-02	5.9E-06
Dibenzofuran	9.3	1	2.2E-06	1.0E-03	2.2E-03
Fluoranthene	28	0.3	2.0E-06	4.0E-02	5.1E-05
Fluorene	22	0.3	1.6E-06	4.0E-02	4.1E-05
Indeno(1,2,3-cd)Pyrene	7.2	0.3	5.3E-07	3.0E-02	1.8E-05
Phenanthrene	78	0.3	5.7E-06	3.0E-02	1.9E-04
Pyrene	41	0.3	3.0E-06	3.0E-02	9.9E-05
C11-C22 Aromatic Fraction	5049	0.3	3.7E-04	3.0E-02	1.2E-02
C19-C36 Aliphatic Fraction	415	1	1.0E-04	2.0E+00	5.0E-05
C5-C8 Aliphatic Fraction	131	1	3.2E-05	4.0E-02	7.9E-04
C9-C10 Aromatic Fraction	657	1	1.6E-04	3.0E-02	5.3E-03
C9-C18 Aliphatic Fraction	2001	1	4.8E-04	1.0E-01	4.8E-03
Chromium (total)	18	1	4.2E-06	3.0E-03	1.4E-03
Cyanide	7.3	1	1.8E-06	6.0E-04	2.9E-03
Lead	74	0.3	5.4E-06	7.5E-04	7.2E-03
				$HI_{soil\text{-}oral}$ =	**4.5E-02**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.
3. A default value of 1 is used when an RAF is otherwise unavailable.

TABLE IV-2 (Continued)
CALCULATION OF AVERAGE DAILY DOSES AND RISK ESTIMATES
FOR INCIDENTAL INGESTION OF SOIL
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Facility Workers
CANCER EFFECTS

See TABLE D-11 for Exposure Variables and Rationale

See TABLE D-10 for Exposure Point Concentration Derivation

Incidental Ingestion of Soil

$$LADD_{soil\text{-}oral} = \frac{EPC_{soil} * IR_{soil} * EF * ED * EP * RAF_{oral\text{-}c} * C1}{BW * AP_c}$$

$ELCR_{soil\text{-}oral} = LADD_{soil\text{-}oral} * CSF$

Total $ELCR_{soil\text{-}oral} = \Sigma ELCR_{soil\text{-}oral}$

COC	EPC_{soil} EPC1 (mg/kg)	$RAF_{oral\text{-}c}$ (unitless)	$LADD_{soil\text{-}oral}$ (mg/kg-day)	CSF $(mg/kg\text{-}day)^{-1}$	$ELCR_{soil\text{-}oral}$ (unitless)
Benzene	23	1	2.19E-06	5.5E-02	1.2E-07
Ethylbenzene	24	1	2.22E-06	NA	NC
Naphthalene	291	1	2.71E-05	NA	NC
Toluene	20	1	1.85E-06	NA	NC
Xylene (Total)	29	1	2.66E-06	NA	NC
2-Methylnaphthalene	45	1	4.16E-06	NA	NC
Acenaphthene	11	1	1.04E-06	NA	NC
Acenaphthylene	22	1	2.02E-06	NA	NC
Anthracene	19	1	1.77E-06	NA	NC
Benzo(a)Anthracene	15	0.3	4.20E-07	1.0E-01	4.2E-08
Benzo(a)Pyrene	16	0.3	4.48E-07	1.0E+00	4.5E-07
Benzo(b)Fluoranthene	11	0.3	2.96E-07	1.0E-01	3.0E-08
Benzo(g,h,i)Perylene	7.9	1	7.36E-07	NA	NC
Benzo(k)Fluoranthene	9.5	0.3	2.67E-07	1.0E-02	2.7E-09
Biphenyl	9.4	1	8.80E-07	8.0E-03	7.0E-09
Carbazole	3.8	0.96	3.37E-07	2.0E-02	6.7E-09
Chrysene	15	0.3	4.23E-07	1.0E-02	4.2E-09
Dibenzo(a,h)anthracene	2.4	0.3	6.84E-08	1.0E+00	6.8E-08
Dibenzofuran	9.3	1	8.65E-07	NA	NC
Fluoranthene	28	1	2.63E-06	NA	NC
Fluorene	22	1	2.08E-06	NA	NC
Indeno(1,2,3-cd)Pyrene	7.2	0.3	2.03E-07	1.0E-01	2.0E-08
Phenanthrene	78	1	7.30E-06	NA	NC
Pyrene	41	1	3.82E-06	NA	NC
C11-C22 Aromatic Fraction	5049	1	4.71E-04	NA	NC
C19-C36 Aliphatic Fraction	415	1	3.87E-05	NA	NC
C5-C8 Aliphatic Fraction	131	1	1.22E-05	NA	NC
C9-C10 Aromatic Fraction	657	1	6.12E-05	NA	NC
C9-C18 Aliphatic Fraction	2001	1	1.87E-04	NA	NC
Chromium (total)	18	1	1.63E-06	NA	NC
Cyanide	7.3	1	6.81E-07	NA	NC
Lead	74	1	6.93E-06	NA	NC
				Total $ELCR_{soil\text{-}oral}$:	**7.5E-07**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.
3. A default value of 1 is used when an RAF is otherwise unavailable.

TABLE IV-3
CALCULATION OF AVERAGE DAILY EXPOSURES AND RISK ESTIMATES
FOR INHALATION OF FUGITIVE DUST
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Facility Workers
CHRONIC NON-CANCER EFFECTS

See TABLE D-11 for Exposure Variables and Rationale. See TABLE D-10 for Exposure Point Concentration Derivation	**Inhalation of Soil-derived Fugitive Dust** $ADE_{dust} = \frac{EPC_{dust} * EF * ED * EP * C2}{AP_{nc}}$ $HQ_{dust} = \frac{ADE_{dust}}{RfC}$		$HI_{dust} = \Sigma HQ_{dust}$	
COC	**EPC_{dust} EPC3 (mg/m^3)**	**ADE_{dust} (mg/m^3)**	**RfC Chronic (mg/m^3)**	**HQ_{dust} (unitless)**
Benzene	7.5E-07	8.2E-08	3.0E-03	2.7E-05
Ethylbenzene	7.6E-07	8.4E-08	1.0E+00	8.4E-08
Naphthalene	9.3E-06	1.0E-06	3.0E-03	3.4E-04
Toluene	6.4E-07	7.0E-08	5.0E+00	1.4E-08
Xylene (Total)	9.1E-07	1.0E-07	1.0E-01	1.0E-06
2-Methylnaphthalene	1.4E-06	1.6E-07	5.0E-02	3.1E-06
Acenaphthene	3.6E-07	3.9E-08	5.0E-02	7.9E-07
Acenaphthylene	6.9E-07	7.6E-08	5.0E-02	1.5E-06
Anthracene	6.1E-07	6.7E-08	5.0E-02	1.3E-06
Benzo(a)Anthracene	4.8E-07	5.3E-08	5.0E-02	1.1E-06
Benzo(a)Pyrene	5.1E-07	5.6E-08	2.0E-06	2.8E-02
Benzo(b)Fluoranthene	3.4E-07	3.7E-08	5.0E-02	7.4E-07
Benzo(g,h,i)Perylene	2.5E-07	2.8E-08	5.0E-02	5.5E-07
Benzo(k)Fluoranthene	3.1E-07	3.3E-08	5.0E-02	6.7E-07
Biphenyl	3.0E-07	3.3E-08	2.0E-03	1.7E-05
Carbazole	1.2E-07	1.3E-08	NA	NC
Chrysene	4.8E-07	5.3E-08	5.0E-02	1.1E-06
Dibenzo(a,h)anthracene	7.8E-08	8.6E-09	5.0E-02	1.7E-07
Dibenzofuran	3.0E-07	3.3E-08	NA	NC
Fluoranthene	9.0E-07	9.9E-08	5.0E-02	2.0E-06
Fluorene	7.2E-07	7.8E-08	5.0E-02	1.6E-06
Indeno(1,2,3-cd)Pyrene	2.3E-07	2.5E-08	5.0E-02	5.1E-07
Phenanthrene	2.5E-06	2.7E-07	5.0E-02	5.5E-06
Pyrene	1.3E-06	1.4E-07	5.0E-02	2.9E-06
C11-C22 Aromatic Fraction	1.6E-04	1.8E-05	5.0E-02	3.5E-04
C19-C36 Aliphatic Fraction	1.3E-05	1.5E-06	NA	NC
C5-C8 Aliphatic Fraction	4.2E-06	4.6E-07	2.0E-01	2.3E-06
C9-C10 Aromatic Fraction	2.1E-05	2.3E-06	5.0E-02	4.6E-05
C9-C18 Aliphatic Fraction	6.4E-05	7.0E-06	2.0E-01	3.5E-05
Chromium (total)	5.6E-07	6.1E-08	1.0E-04	6.1E-04
Cyanide	2.3E-07	2.6E-08	8.0E-04	3.2E-05
Lead	2.4E-06	2.6E-07	1.0E-03	2.6E-04
			HI_{dust}:	**3.0E-02**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.

TABLE IV-3 (Continued)
CALCULATION OF LIFETIME AVERAGE DAILY EXPOSURES AND RISK ESTIMATES
FOR INHALATION OF FUGITIVE DUST
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Facility Workers
CANCER EFFECTS

See TABLE D-11 for Exposure Variables and Rationale and TABLE D-10 for Exposure Point Concentration Derivation	**Inhalation of Soil-derived Fugitive Dust** $LADE_{dust} = \frac{EPC_{dust} * EF * ED * EP * C2 * C3}{AP_c}$			
	$ELCR_{dust}$ =	$LADE_{dust}$ * UR	Total $ELCR_{dust}$ =	Σ $ELCR_{dust}$
COC	**EPC_{dust} EPC3 (mg/m^3)**	**$LADE_{dust}$ ($\mu g/m^3$)**	**UR ($\mu g/m^3)^{-1}$**	**$ELCR_{dust}$ (unitless)**
Benzene	7.5E-07	3.2E-05	7.8E-06	2.5E-10
Ethylbenzene	7.6E-07	3.2E-05	NA	NC
Naphthalene	9.3E-06	3.9E-04	NA	NC
Toluene	6.4E-07	2.7E-05	NA	NC
Xylene (Total)	9.1E-07	3.9E-05	NA	NC
2-Methylnaphthalene	1.4E-06	6.0E-05	NA	NC
Acenaphthene	3.6E-07	1.5E-05	NA	NC
Acenaphthylene	6.9E-07	2.9E-05	NA	NC
Anthracene	6.1E-07	2.6E-05	NA	NC
Benzo(a)Anthracene	4.8E-07	2.0E-05	6.0E-05	1.2E-09
Benzo(a)Pyrene	5.1E-07	2.2E-05	6.0E-04	1.3E-08
Benzo(b)Fluoranthene	3.4E-07	1.4E-05	6.0E-05	8.6E-10
Benzo(g,h,i)Perylene	2.5E-07	1.1E-05	NA	NC
Benzo(k)Fluoranthene	3.1E-07	1.3E-05	6.0E-06	7.7E-11
Biphenyl	3.0E-07	1.3E-05	NA	NC
Carbazole	1.2E-07	5.1E-06	NA	NC
Chrysene	4.8E-07	2.0E-05	6.0E-06	1.2E-10
Dibenzo(a,h)anthracene	7.8E-08	3.3E-06	6.0E-04	2.0E-09
Dibenzofuran	3.0E-07	1.3E-05	NA	NC
Fluoranthene	9.0E-07	3.8E-05	NA	NC
Fluorene	7.2E-07	3.0E-05	NA	NC
Indeno(1,2,3-cd)Pyrene	2.3E-07	9.8E-06	6.0E-05	5.9E-10
Phenanthrene	2.5E-06	1.1E-04	NA	NC
Pyrene	1.3E-06	5.5E-05	NA	NC
C11-C22 Aromatic Fraction	1.6E-04	6.8E-03	NA	NC
C19-C36 Aliphatic Fraction	1.3E-05	5.6E-04	NA	NC
C5-C8 Aliphatic Fraction	4.2E-06	1.8E-04	NA	NC
C9-C10 Aromatic Fraction	2.1E-05	8.9E-04	NA	NC
C9-C18 Aliphatic Fraction	6.4E-05	2.7E-03	NA	NC
Chromium (total)	5.6E-07	2.4E-05	1.2E-02	2.8E-07
Cyanide	2.3E-07	9.9E-06	NA	NC
Lead	2.4E-06	1.0E-04	NA	NC
			Total $ELCR_{dust}$:	**3.0E-07**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.

TABLE IV-4
CALCULATION OF AVERAGE DAILY EXPOSURES AND RISK ESTIMATES
FOR INHALATION OF INDOOR AIR
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Facility Workers
CHRONIC NON-CANCER EFFECTS

See TABLE D-11 for Exposure Variables and Rationale and TABLE D-10 for EPC Descriptions

Inhalation of Indoor Air

$ADE_{ind\text{-}air} = \frac{EPC_{ind\text{-}air} * EF * ED * EP * C2 * C5}{AP_{nc}}$

$HQ_{ind\text{-}air} = \frac{ADE_{ind\text{-}air}}{RfC}$ $HI_{ind\text{-}air} = \Sigma HQ_{ind\text{-}air}$

COC	$EPC_{ind\text{-}air}$ EPC5 ($\mu g/m^3$)	$ADE_{ind\text{-}air}$ (mg/m^3)	RfC Chronic (mg/m^3)	$HQ_{ind\text{-}air}$ (unitless)
1,2,4-Trichlorobenzene	0.031	7.1E-06	2.0E-03	3.5E-03
1,2,3-Trimethylbenzene	0.26	6.0E-05	6.0E-02	1.0E-03
1,2,4-Trimethylbenzene	0.57	1.3E-04	6.0E-02	2.2E-03
1,2-Dichloroethane	0.014	3.2E-06	7.0E-03	4.5E-04
1,3,5-Trimethylbenzene	0.42	9.7E-05	6.0E-02	1.6E-03
2-Butanone	0.15	3.3E-05	5.0E+00	6.7E-06
2-Hexanone	0.093	2.1E-05	3.0E-02	7.1E-04
4-Ethyltoluene	0.21	4.8E-05	NA	NC
Acetaldehyde	0.10	2.3E-05	9.0E-03	2.6E-03
Acetone	0.46	1.1E-04	8.0E-01	1.3E-04
Acrolein	0.012	2.6E-06	2.0E-05	1.3E-01
Benzene	1.2	2.8E-04	3.0E-03	9.3E-02
Carbon Disulfide	0.043	9.8E-06	7.0E-01	1.4E-05
Chloroethane	0.010	2.4E-06	1.0E+01	2.4E-07
Chloroform	0.015	3.4E-06	6.6E-01	5.2E-06
Chloromethane	0.0067	1.5E-06	9.0E-02	1.7E-05
cis-1,2-Dichloroethene	0.022	5.0E-06	7.0E-03	7.1E-04
Cyclohexane	0.072	1.6E-05	6.0E+00	2.7E-06
Ethanol	0.087	2.0E-05	NA	NC
Ethylbenzene	0.39	9.0E-05	1.0E+00	9.0E-05
Dichlorodifluoromethane	0.029	6.6E-06	1.0E-01	6.6E-05
1,1,2-Trichloro-1,2,2-Trifluoroethane	0.0067	1.5E-06	5.0E+00	3.1E-07
Heptane	0.058	1.3E-05	4.0E-01	3.3E-05
Hexane	0.13	3.1E-05	7.0E-01	4.4E-05
Methylene Chloride	0.024	5.5E-06	6.0E-01	9.1E-06
Methyl-Tert-Butyl-Ether	1.4	3.2E-04	3.0E+00	1.1E-04
Naphthalene	0.80	1.8E-04	3.0E-03	6.1E-02
n-Butane	1.2	2.7E-04	NA	NC
n-Nonane	0.11	2.5E-05	2.0E-02	1.3E-03
Pentane	0.41	9.4E-05	1.0E+00	9.4E-05
tert-Butyl Alcohol	0.25	5.8E-05	NA	NC
Tetrachloroethene	0.38	8.6E-05	4.0E-02	2.1E-03
Toluene	1.4	3.3E-04	5.0E+00	6.5E-05
Trichlorofluoromethane	0.028	6.4E-06	7.0E-01	9.2E-06
Xylene (Total)	1.3	3.0E-04	1.0E-01	3.0E-03
Styrene	0.054	1.2E-05	1.0E+00	1.2E-05
4-Methyl-2-Pentanone	0.093	2.1E-05	3.0E+00	7.1E-06
Isopropyl Alcohol	0.21	4.9E-05	2.0E-01	2.4E-04
1,3-Butadiene	0.0062	1.4E-06	2.0E-03	7.1E-04
2,2,4-Trimethylpentane	0.67	1.5E-04	NA	NC
1-Methylnaphthalene	0.80	1.8E-04	5.0E-02	3.7E-03
2-Methylnaphthalene	0.77	1.8E-04	5.0E-02	3.5E-03
C5-C8 Aliphatic Fraction	1.6	3.6E-04	2.0E-01	1.8E-03
C9-C18 Aliphatic Fraction	34	7.7E-03	2.0E-01	3.8E-02
			$HI_{ind\text{-}air}$:	**3.5E-01**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.

TABLE IV-4 (Continued)
CALCULATION OF LIFETIME AVERAGE DAILY EXPOSURES AND RISK ESTIMATES
FOR INHALATION OF INDOOR AIR
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Facility Workers
CANCER EFFECTS

See TABLE D-11 for Exposure Variables and Rationale and TABLE D-10 for EPC Descriptions	**Inhalation of Indoor Air** $LADE_{ind\text{-}air} = \frac{EPC_{ind\text{-}air} * EF * ED * EP * C2}{AP_c}$			
	$ELCR_{ind\text{-}air} = LADE_{ind\text{-}air} * UR$		Total $ELCR_{ind\text{-}air} =$	$\Sigma ELCR_{ind\text{-}air}$
COC	**$EPC_{ind\text{-}air}$ EPC5 ($\mu g/m^3$)**	**$LADE_{ind\text{-}air}$ ($\mu g/m^3$)**	**UR ($\mu g/m^3)^{-1}$**	**$ELCR_{ind\text{-}air}$ (unitless)**
1,2,4-Trichlorobenzene	0.031	2.7E-03	NA	NC
1,2,3-Trimethylbenzene	0.26	2.3E-02	NA	NC
1,2,4-Trimethylbenzene	0.57	5.0E-02	NA	NC
1,2-Dichloroethane	0.014	1.2E-03	2.6E-05	3.2E-08
1,3,5-Trimethylbenzene	0.42	3.7E-02	NA	NC
2-Butanone	0.15	1.3E-02	NA	NC
2-Hexanone	0.093	8.2E-03	NA	NC
4-Ethyltoluene	0.21	1.8E-02	NA	NC
Acetaldehyde	0.10	8.9E-03	2.2E-06	2.0E-08
Acetone	0.46	4.1E-02	NA	NC
Acrolein	0.012	1.0E-03	NA	NC
Benzene	1.2	1.1E-01	7.8E-06	8.4E-07
Carbon Disulfide	0.043	3.8E-03	NA	NC
Chloroethane	0.010	9.2E-04	NA	NC
Chloroform	0.015	1.3E-03	2.3E-05	3.0E-08
Chloromethane	0.0067	5.9E-04	NA	NC
cis-1,2-Dichloroethene	0.022	1.9E-03	NA	NC
Cyclohexane	0.072	6.3E-03	NA	NC
Ethanol	0.087	7.6E-03	NA	NC
Ethylbenzene	0.39	3.5E-02	NA	NC
Dichlorodifluoromethane	0.029	2.6E-03	NA	NC
1,1,2-Trichloro-1,2,2-Trifluoroethane	0.0067	5.9E-04	NA	NC
Heptane	0.058	5.1E-03	NA	NC
Hexane	0.13	1.2E-02	NA	NC
Methylene Chloride	0.024	2.1E-03	1.0E-08	2.1E-11
Methyl-Tert-Butyl-Ether	1.4	1.2E-01	NA	NC
Naphthalene	0.80	7.0E-02	NA	NC
n-Butane	1.2	1.0E-01	NA	NC
n-Nonane	0.11	9.7E-03	NA	NC
Pentane	0.41	3.6E-02	NA	NC
tert-Butyl Alcohol	0.25	2.2E-02	NA	NC
Tetrachloroethene	0.38	3.3E-02	3.0E-06	9.9E-08
Toluene	1.4	1.3E-01	NA	NC
Trichlorofluoromethane	0.028	2.5E-03	NA	NC
Xylene (Total)	1.3	1.1E-01	NA	NC
Styrene	0.054	4.7E-03	5.7E-07	2.7E-09
4-Methyl-2-Pentanone	0.093	8.2E-03	NA	NC
Isopropyl Alcohol	0.21	1.9E-02	NA	NC
1,3-Butadiene	0.0062	5.5E-04	3.0E-05	1.6E-08
2,2,4-Trimethylpentane	0.67	5.9E-02	NA	NC
1-Methylnaphthalene	0.80	7.1E-02	NA	NC
2-Methylnaphthalene	0.77	6.8E-02	NA	NC
C5-C8 Aliphatic Fraction	1.6	1.4E-01	NA	NC
C9-C18 Aliphatic Fraction	34	3.0E+00	NA	NC
			Total $ELCR_{ind\text{-}air}$:	**1.0E-06**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.

TABLE IV-5
CALCULATION OF AVERAGE DAILY DOSES AND RISK ESTIMATES
FOR DERMAL CONTACT WITH SOIL
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Construction/Utility Workers (Outside Former Holder Area)
SUBCHRONIC NON-CANCER EFFECTS

Dermal Contact with Soil

See TABLE D-12 for Exposure Variables and Rationale

$$ADD_{soil\text{-}dermal} = \frac{EPC_{soil} * DCR_{soil} * EF * ED * EP * RAF_{dermal\text{-}nc} * C1}{BW * AP_{nc}}$$

See TABLE D-10 for Exposure Point Concentration Derivation

$$HQ_{soil\text{-}dermal} = \frac{ADD_{soil\text{-}dermal}}{RfD} \qquad HI_{soil\text{-}dermal} = \sum HQ_{soil\text{-}dermal}$$

COC	EPC_{soil} EPC1A (mg/kg)	$RAF_{dermal\text{-}nc}$ (unitless)	$ADD_{soil\text{-}dermal}$ (mg/kg-day)	RfD Subchronic (mg/kg-day)	$HQ_{soil\text{-}dermal}$ (unitless)
Benzene	2.3	0.03	8.0E-07	1.0E-02	8.0E-05
Ethylbenzene	25	0.03	8.6E-06	5.0E-02	1.7E-04
Naphthalene	216	0.1	2.5E-04	2.0E-01	1.2E-03
Toluene	1.3	0.03	4.6E-07	8.0E-01	5.7E-07
Xylene (Total)	26	0.03	9.1E-06	4.0E-01	2.3E-05
2-Methylnaphthalene	24	0.1	2.8E-05	4.0E-03	7.0E-03
Acenaphthene	11	0.1	1.2E-05	2.0E-01	6.2E-05
Acenaphthylene	9.8	0.1	1.1E-05	3.0E-01	3.8E-05
Anthracene	14	0.1	1.6E-05	1.0E+00	1.6E-05
Benzo(a)Anthracene	12	0.02	2.9E-06	3.0E-01	9.5E-06
Benzo(a)Pyrene	14	0.02	3.1E-06	3.0E-04	1.0E-02
Benzo(b)Fluoranthene	10	0.02	2.3E-06	3.0E-01	7.8E-06
Benzo(g,h,i)Perylene	7.6	0.1	8.8E-06	3.0E-01	2.9E-05
Benzo(k)Fluoranthene	9.8	0.02	2.3E-06	3.0E-01	7.6E-06
Biphenyl	9.4	0.1	1.1E-05	1.0E-01	1.1E-04
Carbazole	3.8	1	4.4E-05	NA	NC
Chrysene	13	0.02	3.0E-06	3.0E-01	9.9E-06
Dibenzo(a,h)anthracene	2.6	0.02	6.0E-07	3.0E-01	2.0E-06
Dibenzofuran	9.3	0.18	1.9E-05	4.0E-03	4.8E-03
Fluoranthene	22	0.10	2.6E-05	1.0E-01	2.6E-04
Fluorene	16	0.1	1.9E-05	4.0E-01	4.8E-05
Indeno(1,2,3-cd)Pyrene	7.3	0.02	1.7E-06	3.0E-01	5.7E-06
Phenanthrene	59	0.1	6.8E-05	3.0E-01	2.3E-04
Pyrene	29	0.1	3.3E-05	3.0E-01	1.1E-04
C11-C22 Aromatic Fraction	5310	0.1	6.1E-03	3.0E-01	2.0E-02
C19-C36 Aliphatic Fraction	454	0.2	1.0E-03	6.0E+00	1.7E-04
C5-C8 Aliphatic Fraction	109	0.2	2.5E-04	4.0E-01	6.3E-04
C9-C10 Aromatic Fraction	673	0.2	1.6E-03	3.0E-01	5.2E-03
C9-C18 Aliphatic Fraction	2360	0.2	5.5E-03	1.0E+00	5.5E-03
Chromium (total)	18	0.1	2.0E-05	2.0E-02	1.0E-03
Cyanide	8.0	0.1	9.2E-06	6.0E-03	1.5E-03
				$HI_{soil\text{-}dermal}$ =	**5.9E-02**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.

TABLE IV-5 (Continued)
CALCULATION OF AVERAGE DAILY DOSES AND RISK ESTIMATES
FOR DERMAL CONTACT WITH SOIL
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Construction/Utility Workers (Outside Former Holder Area)
CANCER EFFECTS

Dermal Contact with Soil

See TABLE D-12 for Exposure Variables and Rationale

$$LADD_{soil\text{-}dermal} = \frac{EPC_{soil} * DCR_{soil} * EF * ED * EP * RAF_{dermal\text{-}c} * C1}{BW * AP_c}$$

See TABLE D-10 for Exposure Point Concentration Derivation

$$ELCR_{soil\text{-}dermal} = LADD_{soil\text{-}dermal} * CSF$$

$$\text{Total } ELCR_{soil\text{-}dermal} = \sum ELCR_{soil\text{-}dermal}$$

COC	EPC_{soil} EPC1A (mg/kg)	$RAF_{dermal\text{-}c}$ (unitless)	$LADD_{soil\text{-}dermal}$ (mg/kg-day)	CSF $(mg/kg\text{-}day)^{-1}$	$ELCR_{soil\text{-}dermal}$ (unitless)
Benzene	2.3	0.03	5.73E-09	5.5E-02	3.2E-10
Ethylbenzene	25	1	2.05E-06	NA	NC
Naphthalene	216	1	1.78E-05	NA	NC
Toluene	1.3	1	1.09E-07	NA	NC
Xylene (Total)	26	1	2.17E-06	NA	NC
2-Methylnaphthalene	24	1	2.01E-06	NA	NC
Acenaphthene	11	1	8.88E-07	NA	NC
Acenaphthylene	9.8	1	8.10E-07	NA	NC
Anthracene	14	1	1.12E-06	NA	NC
Benzo(a)Anthracene	12	0.02	2.04E-08	1.0E-01	2.0E-09
Benzo(a)Pyrene	14	0.02	2.23E-08	1.0E+00	2.2E-08
Benzo(b)Fluoranthene	10	0.02	1.67E-08	1.0E-01	1.7E-09
Benzo(g,h,i)Perylene	7.6	1	6.26E-07	NA	NC
Benzo(k)Fluoranthene	9.8	0.02	1.62E-08	1.0E-02	1.6E-10
Biphenyl	9.4	0.1	7.79E-08	8.0E-03	6.2E-10
Carbazole	3.8	0.18	5.60E-08	2.0E-02	1.1E-09
Chrysene	13	0.02	2.12E-08	1.0E-02	2.1E-10
Dibenzo(a,h)anthracene	2.6	0.02	4.26E-09	1.0E+00	4.3E-09
Dibenzofuran	9.3	1	7.65E-07	NA	NC
Fluoranthene	22	1	1.83E-06	NA	NC
Fluorene	16	1	1.36E-06	NA	NC
Indeno(1,2,3-cd)Pyrene	7.3	0.02	1.21E-08	1.0E-01	1.2E-09
Phenanthrene	59	1	4.83E-06	NA	NC
Pyrene	29	1	2.39E-06	NA	NC
C11-C22 Aromatic Fraction	5310	1	4.38E-04	NA	NC
C19-C36 Aliphatic Fraction	454	1	3.75E-05	NA	NC
C5-C8 Aliphatic Fraction	109	1	9.00E-06	NA	NC
C9-C10 Aromatic Fraction	673	1	5.55E-05	NA	NC
C9-C18 Aliphatic Fraction	2360	1	1.95E-04	NA	NC
Chromium (total)	18	1	1.45E-06	NA	NC
Cyanide	8.0	1	6.59E-07	NA	NC
Lead	71	1	5.87E-06	NA	NC
				Total $ELCR_{soil\text{-}dermal}$:	**3.4E-08**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.
3. A default value of 1 is used when a RAF is otherwise unavailable.

TABLE IV-6
CALCULATION OF AVERAGE DAILY DOSES AND RISK ESTIMATES
FOR INCIDENTAL INGESTION OF SOIL
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Construction/Utility Workers (Outside Former Holder Area)
SUBCHRONIC NON-CANCER EFFECTS

Incidental Ingestion of Soil

See TABLE D-12 for Exposure Variables and Rationale

$$ADD_{soil\text{-}oral} = \frac{EPC_{soil} * IR_{soil} * EF * ED * EP * RAF_{oral\text{-}nc} * C1}{BW * AP_{nc}}$$

See TABLE D-10 for Exposure Point Concentration Derivation

$$HQ_{soil\text{-}oral} = \frac{ADD_{soil\text{-}oral}}{RfD} \qquad HI_{soil\text{-}oral} = \sum HQ_{soil\text{-}oral}$$

COC	EPC_{soil} EPC1A (mg/kg)	$RAF_{oral\text{-}nc}$ (unitless)	$ADD_{soil\text{-}oral}$ (mg/kg-day)	RfD Subchronic (mg/kg-day)	$HQ_{soil\text{-}oral}$ (unitless)
Benzene	2.3	1	2.5E-06	1.0E-02	2.5E-04
Ethylbenzene	25	1	2.7E-05	5.0E-02	5.5E-04
Naphthalene	216	0.3	7.1E-05	2.0E-01	3.6E-04
Toluene	1.3	1	1.5E-06	8.0E-01	1.8E-06
Xylene (Total)	26	1	2.9E-05	4.0E-01	7.2E-05
2-Methylnaphthalene	24	0.3	8.0E-06	4.0E-03	2.0E-03
Acenaphthene	11	0.3	3.5E-06	2.0E-01	1.8E-05
Acenaphthylene	9.8	0.3	3.2E-06	3.0E-01	1.1E-05
Anthracene	14	0.3	4.5E-06	1.0E+00	4.5E-06
Benzo(a)Anthracene	12	0.3	4.1E-06	3.0E-01	1.4E-05
Benzo(a)Pyrene	14	0.3	4.5E-06	3.0E-04	1.5E-02
Benzo(b)Fluoranthene	10	0.3	3.3E-06	3.0E-01	1.1E-05
Benzo(g,h,i)Perylene	7.6	0.3	2.5E-06	3.0E-01	8.3E-06
Benzo(k)Fluoranthene	9.8	0.3	3.2E-06	3.0E-01	1.1E-05
Biphenyl	9.4	1	1.0E-05	1.0E-01	1.0E-04
Carbazole	3.8	1	4.1E-06	NA	NC
Chrysene	13	0.3	4.2E-06	3.0E-01	1.4E-05
Dibenzo(a,h)anthracene	2.6	0.3	8.5E-07	3.0E-01	2.8E-06
Dibenzofuran	9.3	1	1.0E-05	4.0E-03	2.5E-03
Fluoranthene	22	0.3	7.3E-06	1.0E-01	7.3E-05
Fluorene	16	0.3	5.4E-06	4.0E-01	1.4E-05
Indeno(1,2,3-cd)Pyrene	7.3	0.3	2.4E-06	3.0E-01	8.1E-06
Phenanthrene	59	0.3	1.9E-05	3.0E-01	6.4E-05
Pyrene	29	0.3	9.5E-06	3.0E-01	3.2E-05
C11-C22 Aromatic Fraction	5310	0.3	1.8E-03	3.0E-01	5.8E-03
C19-C36 Aliphatic Fraction	454	1	5.0E-04	6.0E+00	8.3E-05
C5-C8 Aliphatic Fraction	109	1	1.2E-04	4.0E-01	3.0E-04
C9-C10 Aromatic Fraction	673	1	7.4E-04	3.0E-01	2.5E-03
C9-C18 Aliphatic Fraction	2360	1	2.6E-03	1.0E+00	2.6E-03
Chromium (total)	18	1	1.9E-05	2.0E-02	9.7E-04
Cyanide	8.0	1	8.8E-06	6.0E-03	1.5E-03
Lead	71	0.3	2.3E-05	7.5E-04	3.1E-02
				$HI_{soil\text{-}oral}$ =	**6.6E-02**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.

TABLE IV-6 (Continued)
CALCULATION OF AVERAGE DAILY DOSES AND RISK ESTIMATES
FOR INCIDENTAL INGESTION OF SOIL
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Construction/Utility Workers (Outside Former Holder Area)
CANCER EFFECTS

See TABLE D-12 for Exposure Variables and Rationale

See TABLE D-10 for Exposure Point Concentration Derivation

Incidental Ingestion of Soil

$$LADD_{soil\text{-}oral} = \frac{EPC_{soil} * IR_{soil} * EF * ED * EP * RAF_{oral\text{-}c} * C1}{BW * AP_c}$$

$ELCR_{soil\text{-}oral} = LADD_{soil\text{-}oral} * CSF$

Total $ELCR_{soil\text{-}oral} = \sum ELCR_{soil\text{-}oral}$

COC	EPC_{soil} EPC1A (mg/kg)	$RAF_{oral\text{-}c}$ (unitless)	$LADD_{soil\text{-}oral}$ (mg/kg-day)	CSF $(mg/kg\text{-}day)^{-1}$	$ELCR_{soil\text{-}oral}$ (unitless)
Benzene	2.3	1	1.82E-08	5.5E-02	1.0E-09
Ethylbenzene	25	1	1.95E-07	NA	NC
Naphthalene	216	1	1.69E-06	NA	NC
Toluene	1.3	1	1.04E-08	NA	NC
Xylene (Total)	26	1	2.07E-07	NA	NC
2-Methylnaphthalene	24	1	1.91E-07	NA	NC
Acenaphthene	11	1	8.45E-08	NA	NC
Acenaphthylene	9.8	1	7.71E-08	NA	NC
Anthracene	14	1	1.07E-07	NA	NC
Benzo(a)Anthracene	12	0.3	2.92E-08	1.0E-01	2.9E-09
Benzo(a)Pyrene	14	0.3	3.18E-08	1.0E+00	3.2E-08
Benzo(b)Fluoranthene	10	0.3	2.38E-08	1.0E-01	2.4E-09
Benzo(g,h,i)Perylene	7.6	1	5.96E-08	NA	NC
Benzo(k)Fluoranthene	9.8	0.3	2.32E-08	1.0E-02	2.3E-10
Biphenyl	9.4	1	7.41E-08	8.0E-03	5.9E-10
Carbazole	3.8	0.96	2.84E-08	2.0E-02	5.7E-10
Chrysene	13	0.3	3.03E-08	1.0E-02	3.0E-10
Dibenzo(a,h)anthracene	2.6	0.3	6.09E-09	1.0E+00	6.1E-09
Dibenzofuran	9.3	1	7.28E-08	NA	NC
Fluoranthene	22	1	1.74E-07	NA	NC
Fluorene	16	1	1.29E-07	NA	NC
Indeno(1,2,3-cd)Pyrene	7.3	0.3	1.73E-08	1.0E-01	1.7E-09
Phenanthrene	59	1	4.60E-07	NA	NC
Pyrene	29	1	2.27E-07	NA	NC
C11-C22 Aromatic Fraction	5310	1	4.17E-05	NA	NC
C19-C36 Aliphatic Fraction	454	1	3.57E-06	NA	NC
C5-C8 Aliphatic Fraction	109	1	8.57E-07	NA	NC
C9-C10 Aromatic Fraction	673	1	5.29E-06	NA	NC
C9-C18 Aliphatic Fraction	2360	1	1.85E-05	NA	NC
Chromium (total)	18	1	1.38E-07	NA	NC
Cyanide	8.0	1	6.27E-08	NA	NC
Lead	71	1	5.59E-07	NA	NC
				Total $ELCR_{soil\text{-}oral}$:	**4.8E-08**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.
3. A default value of 1 is used when a RAF is otherwise unavailable.

TABLE IV-7

CALCULATION OF AVERAGE DAILY EXPOSURES AND RISK ESTIMATES
FOR INHALATION OF FUGITIVE DUST VIA GASTROINTESTINAL (GI) TRACT
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Construction/Utility Workers (Outside Former Holder Area)
SUBCHRONIC NON-CANCER EFFECTS

See TABLE D-12 for Exposure Variables and Rationale. See TABLE D-10 for Exposure Point Concentration Derivation

Inhalation of Soil-derived Fugitive Dust via GI Tract

$$ADD_{dust\text{-}GI} = \frac{EPC_{dust} * 1.5 * INH * RAF_{oral} * EF * ED * EP * C2 * C3}{BW * APnc}$$

$$HQ_{dust\text{-}GI} = \frac{ADD_{dust\text{-}GI}}{RfD_{oral}}$$

$$HI_{dust\text{-}GI} = \sum HQ_{dust\text{-}GI}$$

COC	EPC_{dust} EPC2A (mg/m^3)	$RAF_{oral\text{-}nc}$ (unitless)	$ADD_{dust\text{-}GI}$ (mg/kg-day)	RfD_{oral} Subchronic (mg/kg-day)	$HQ_{dust\text{-}GI}$ (unitless)
Benzene	1.4E-07	1	6.6E-08	1.0E-02	6.6E-06
Ethylbenzene	1.5E-06	1	7.1E-07	5.0E-02	1.4E-05
Naphthalene	1.3E-05	0.3	1.8E-06	2.0E-01	9.2E-06
Toluene	7.9E-08	1	3.8E-08	8.0E-01	4.7E-08
Xylene (Total)	1.6E-06	1	7.5E-07	4.0E-01	1.9E-06
2-Methylnaphthalene	1.5E-06	0.3	2.1E-07	4.0E-03	5.2E-05
Acenaphthene	6.5E-07	0.3	9.2E-08	2.0E-01	4.6E-07
Acenaphthylene	5.9E-07	0.3	8.4E-08	3.0E-01	2.8E-07
Anthracene	8.1E-07	0.3	1.2E-07	1.0E+00	1.2E-07
Benzo(a)Anthracene	7.4E-07	0.3	1.1E-07	3.0E-01	3.5E-07
Benzo(a)Pyrene	8.1E-07	0.3	1.2E-07	3.0E-04	3.9E-04
Benzo(b)Fluoranthene	6.1E-07	0.3	8.7E-08	3.0E-01	2.9E-07
Benzo(g,h,i)Perylene	4.6E-07	0.3	6.5E-08	3.0E-01	2.2E-07
Benzo(k)Fluoranthene	5.9E-07	0.3	8.4E-08	3.0E-01	2.8E-07
Biphenyl	5.7E-07	1	2.7E-07	1.0E-01	2.7E-06
Carbazole	2.3E-07	1	1.1E-07	NA	NC
Chrysene	7.7E-07	0.3	1.1E-07	3.0E-01	3.7E-07
Dibenzo(a,h)anthracene	1.6E-07	0.3	2.2E-08	3.0E-01	7.4E-08
Dibenzofuran	5.6E-07	1	2.6E-07	4.0E-03	6.6E-05
Fluoranthene	1.3E-06	0.3	1.9E-07	1.0E-01	1.9E-06
Fluorene	9.9E-07	0.3	1.4E-07	4.0E-01	3.5E-07
Indeno(1,2,3-cd)Pyrene	4.4E-07	0.3	6.3E-08	3.0E-01	2.1E-07
Phenanthrene	3.5E-06	0.3	5.0E-07	3.0E-01	1.7E-06
Pyrene	1.7E-06	0.3	2.5E-07	3.0E-01	8.2E-07
C11-C22 Aromatic Fraction	3.2E-04	0.3	4.5E-05	3.0E-01	1.5E-04
C19-C36 Aliphatic Fraction	2.7E-05	1	1.3E-05	6.0E+00	2.2E-06
C5-C8 Aliphatic Fraction	6.5E-06	1	3.1E-06	4.0E-01	7.8E-06
C9-C10 Aromatic Fraction	4.0E-05	1	1.9E-05	3.0E-01	6.4E-05
C9-C18 Aliphatic Fraction	1.4E-04	1	6.7E-05	1.0E+00	6.7E-05
Chromium (total)	1.1E-06	1	5.0E-07	2.0E-02	2.5E-05
Cyanide	4.8E-07	1	2.3E-07	6.0E-03	3.8E-05
Lead	4.3E-06	0.3	6.1E-07	7.5E-04	8.1E-04
					1.7E-03

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.

TABLE IV-7 (Continued)
CALCULATION OF LIFETIME AVERAGE DAILY EXPOSURES AND RISK ESTIMATES
FOR INHALATION OF FUGITIVE DUST VIA GASTROINTESTINAL (GI) TRACT
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Construction/Utility Workers (Outside Former Holder Area)
CANCER EFFECTS

See TABLE D-12 for Exposure Variables and Rationale. See TABLE D-10 for Exposure Point Concentration Derivation

Inhalation of Soil-derived Fugitive Dust via GI Tract

$LADD_{dust\text{-}GI} = \frac{EPCdust * 1.5 * INH * RAF * EF * ED * EP * C2 * C3}{BW * APc}$

$ELCR_{dust\text{-}GI} = LADD_{dust\text{-}GI} * CSF_{oral}$

Total $ELCR_{dust\text{-}GI} = \sum ELCR_{dust\text{-}GI}$

COC	EPC_{dust} EPC2A (mg/m^3)	$RAF_{oral\text{-}c}$ (unitless)	$LADD_{dust\text{-}GI}$ ($\mu g/m^3$)	CSF_{oral} $(mg/kg\text{-}day)^{-1}$	$ELCR_{dust\text{-}GI}$ (unitless)
Benzene	1.4E-07	1	4.7E-10	5.5E-02	2.6E-11
Ethylbenzene	1.5E-06	1	5.1E-09	NA	NC
Naphthalene	1.3E-05	1	4.4E-08	NA	NC
Toluene	7.9E-08	1	2.7E-10	NA	NC
Xylene (Total)	1.6E-06	1	5.4E-09	NA	NC
2-Methylnaphthalene	1.5E-06	1	5.0E-09	NA	NC
Acenaphthene	6.5E-07	1	2.2E-09	NA	NC
Acenaphthylene	5.9E-07	1	2.0E-09	NA	NC
Anthracene	8.1E-07	1	2.8E-09	NA	NC
Benzo(a)Anthracene	7.4E-07	0.3	7.6E-10	1.0E-01	7.6E-11
Benzo(a)Pyrene	8.1E-07	0.3	8.3E-10	1.0E+00	8.3E-10
Benzo(b)Fluoranthene	6.1E-07	0.3	6.2E-10	1.0E-01	6.2E-11
Benzo(g,h,i)Perylene	4.6E-07	1	1.5E-09	NA	NC
Benzo(k)Fluoranthene	5.9E-07	0.3	6.0E-10	1.0E-02	6.0E-12
Biphenyl	5.7E-07	1	1.9E-09	8.0E-03	1.5E-11
Carbazole	2.3E-07	0.96	7.4E-10	2.0E-02	1.5E-11
Chrysene	7.7E-07	0.3	7.9E-10	1.0E-02	7.9E-12
Dibenzo(a,h)anthracene	1.6E-07	0.3	1.6E-10	1.0E+00	1.6E-10
Dibenzofuran	5.6E-07	1	1.9E-09	NA	NC
Fluoranthene	1.3E-06	1	4.5E-09	NA	NC
Fluorene	9.9E-07	1	3.4E-09	NA	NC
Indeno(1,2,3-cd)Pyrene	4.4E-07	0.3	4.5E-10	1.0E-01	4.5E-11
Phenanthrene	3.5E-06	1	1.2E-08	NA	NC
Pyrene	1.7E-06	1	5.9E-09	NA	NC
C11-C22 Aromatic Fraction	3.2E-04	1	1.1E-06	NA	NC
C19-C36 Aliphatic Fraction	2.7E-05	1	9.2E-08	NA	NC
C5-C8 Aliphatic Fraction	6.5E-06	1	2.2E-08	NA	NC
C9-C10 Aromatic Fraction	4.0E-05	1	1.4E-07	NA	NC
C9-C18 Aliphatic Fraction	1.4E-04	1	4.8E-07	NA	NC
Chromium (total)	1.1E-06	1	3.6E-09	NA	NC
Cyanide	4.8E-07	1	1.6E-09	NA	NC
Lead	4.3E-06	1	1.4E-08	NA	NC
					1.2E-09

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.

TABLE IV-8
CALCULATION OF AVERAGE DAILY EXPOSURES AND RISK ESTIMATES
FOR INHALATION OF FUGITIVE DUST VIA RESPIRATORY ABSORPTION
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Construction/Utility Workers (Outside Former Holder Area)
SUBCHRONIC NON-CANCER EFFECTS

See TABLE D-12 for Exposure Variables and Rationale and TABLE D-10 for EPC Descriptions	**Inhalation of Fugitive Dust via Respiratory Absorption** $ADE_{dust\text{-}RA} = \frac{EPC_{dust\text{-}RA} * 0.5 * EF * ED * EP * C4}{AP_{nc}}$ $HQ_{dust\text{-}RA} = \frac{ADE_{dust\text{-}RA}}{RfC}$		$HI_{dust\text{-}RA} = \sum HQ_{dust\text{-}RA}$
COC	**EPC_{dust} EPC2A (mg/m^3)**	**$ADE_{dust\text{-}RA}$ (mg/m^3)**	**RfC Subchronic (mg/m^3)**	**$HQ_{dust\text{-}RA}$ (unitless)**
Benzene	1.4E-07	1.6E-08	3.0E-03	5.5E-06
Ethylbenzene	1.5E-06	1.8E-07	9.0E+00	2.0E-08
Naphthalene	1.3E-05	1.5E-06	3.0E-03	5.1E-04
Toluene	7.9E-08	9.4E-09	5.0E+00	1.9E-09
Xylene (Total)	1.6E-06	1.9E-07	4.0E-01	4.7E-07
2-Methylnaphthalene	1.5E-06	1.7E-07	5.0E-01	3.5E-07
Acenaphthene	6.5E-07	7.7E-08	5.0E-01	1.5E-07
Acenaphthylene	5.9E-07	7.0E-08	5.0E-01	1.4E-07
Anthracene	8.1E-07	9.7E-08	5.0E-01	1.9E-07
Benzo(a)Anthracene	7.4E-07	8.8E-08	5.0E-01	1.8E-07
Benzo(a)Pyrene	8.1E-07	9.6E-08	2.0E-06	4.8E-02
Benzo(b)Fluoranthene	6.1E-07	7.2E-08	5.0E-01	1.4E-07
Benzo(g,h,i)Perylene	4.6E-07	5.4E-08	5.0E-01	1.1E-07
Benzo(k)Fluoranthene	5.9E-07	7.0E-08	5.0E-01	1.4E-07
Biphenyl	5.7E-07	6.7E-08	2.0E-03	3.4E-05
Carbazole	2.3E-07	2.7E-08	NA	NC
Chrysene	7.7E-07	9.2E-08	5.0E-01	1.8E-07
Dibenzo(a,h)anthracene	1.6E-07	1.8E-08	5.0E-01	3.7E-08
Dibenzofuran	5.6E-07	6.6E-08	NA	NC
Fluoranthene	1.3E-06	1.6E-07	5.0E-01	3.2E-07
Fluorene	9.9E-07	1.2E-07	5.0E-01	2.3E-07
Indeno(1,2,3-cd)Pyrene	4.4E-07	5.2E-08	5.0E-01	1.0E-07
Phenanthrene	3.5E-06	4.2E-07	5.0E-01	8.4E-07
Pyrene	1.7E-06	2.1E-07	5.0E-01	4.1E-07
C11-C22 Aromatic Fraction	3.2E-04	3.8E-05	5.0E-01	7.6E-05
C19-C36 Aliphatic Fraction	2.7E-05	3.2E-06	NA	NC
C5-C8 Aliphatic Fraction	6.5E-06	7.8E-07	2.0E-01	3.9E-06
C9-C10 Aromatic Fraction	4.0E-05	4.8E-06	5.0E-01	9.6E-06
C9-C18 Aliphatic Fraction	1.4E-04	1.7E-05	6.0E-01	2.8E-05
Chromium (total)	1.1E-06	1.3E-07	3.0E-04	4.2E-04
Cyanide	4.8E-07	5.7E-08	3.0E-03	1.9E-05
Lead	4.3E-06	5.1E-07	1.0E-03	5.1E-04
			$HI_{dust\text{-}RA}$:	**5.0E-02**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.

TABLE IV-8 (Continued)
CALCULATION OF LIFETIME AVERAGE DAILY EXPOSURES AND RISK ESTIMATES
FOR INHALATION OF FUGITIVE DUST VIA RESPIRATORY ABSORPTION
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Construction/Utility Workers (Outside Former Holder Area)
CANCER EFFECTS

See TABLE D-12 for Exposure Variables and Rationale and TABLE D-10 for EPC Descriptions	**Inhalation of Fugitive Dust via Respiratory Absorption** $LADE_{dust\text{-}RA} = \frac{EPC_{dust\text{-}RA} * 0.5 * EF * ED * EP * C4 * C5}{AP_c}$ $ELCR_{dust\text{-}RA} = LADE_{dust\text{-}RA} * UR$		Total $ELCR_{dust\text{-}RA} = \sum ELCR_{dust\text{-}RA}$
COC	**EPC_{dust} EPC2A (mg/m^3)**	**$LADE_{dust\text{-}RA}$ ($\mu g/m^3$)**	**UR $(\mu g/m^3)^{-1}$**	**$ELCR_{dust\text{-}RA}$ (unitless)**
Benzene	1.4E-07	1.2E-07	7.8E-06	9.2E-13
Ethylbenzene	1.5E-06	1.3E-06	NA	NC
Naphthalene	1.3E-05	1.1E-05	NA	NC
Toluene	7.9E-08	6.7E-08	NA	NC
Xylene (Total)	1.6E-06	1.3E-06	NA	NC
2-Methylnaphthalene	1.5E-06	1.2E-06	NA	NC
Acenaphthene	6.5E-07	5.5E-07	NA	NC
Acenaphthylene	5.9E-07	5.0E-07	NA	NC
Anthracene	8.1E-07	6.9E-07	NA	NC
Benzo(a)Anthracene	7.4E-07	6.3E-07	6.0E-05	3.8E-11
Benzo(a)Pyrene	8.1E-07	6.9E-07	6.0E-04	4.1E-10
Benzo(b)Fluoranthene	6.1E-07	5.2E-07	6.0E-05	3.1E-11
Benzo(g,h,i)Perylene	4.6E-07	3.9E-07	NA	NC
Benzo(k)Fluoranthene	5.9E-07	5.0E-07	6.0E-06	3.0E-12
Biphenyl	5.7E-07	4.8E-07	NA	NC
Carbazole	2.3E-07	1.9E-07	NA	NC
Chrysene	7.7E-07	6.6E-07	6.0E-06	3.9E-12
Dibenzo(a,h)anthracene	1.6E-07	1.3E-07	6.0E-04	7.9E-11
Dibenzofuran	5.6E-07	4.7E-07	NA	NC
Fluoranthene	1.3E-06	1.1E-06	NA	NC
Fluorene	9.9E-07	8.4E-07	NA	NC
Indeno(1,2,3-cd)Pyrene	4.4E-07	3.7E-07	6.0E-05	2.2E-11
Phenanthrene	3.5E-06	3.0E-06	NA	NC
Pyrene	1.7E-06	1.5E-06	NA	NC
C11-C22 Aromatic Fraction	3.2E-04	2.7E-04	NA	NC
C19-C36 Aliphatic Fraction	2.7E-05	2.3E-05	NA	NC
C5-C8 Aliphatic Fraction	6.5E-06	5.6E-06	NA	NC
C9-C10 Aromatic Fraction	4.0E-05	3.4E-05	NA	NC
C9-C18 Aliphatic Fraction	1.4E-04	1.2E-04	NA	NC
Chromium (total)	1.1E-06	9.0E-07	1.2E-02	1.1E-08
Cyanide	4.8E-07	4.1E-07	NA	NC
Lead	4.3E-06	3.6E-06	NA	NC
			Total $ELCR_{dust\text{-}RA}$:	**1.1E-08**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.

TABLE IV-9
CALCULATION OF AVERAGE DAILY DOSES AND RISK ESTIMATES
FOR DERMAL CONTACT WITH SOIL
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Construction/Utility Workers (Within Former Holder Area)
SUBCHRONIC NON-CANCER EFFECTS

Dermal Contact with Soil

See TABLE D-12 for Exposure Variables and Rationale

See TABLE D-10 for Exposure Point Concentration Derivation

$$ADD_{soil\text{-}dermal} = \frac{EPC_{soil} * DCR_{soil} * EF * ED * EP * RAF_{dermal\text{-}nc} * C1}{BW * AP_{nc}}$$

$$HQ_{soil\text{-}dermal} = \frac{ADD_{soil\text{-}dermal}}{RfD}$$

$$HI_{soil\text{-}dermal} = \sum HQ_{soil\text{-}dermal}$$

COC	EPC_{soil} EPC1B (mg/kg)	$RAF_{dermal\text{-}nc}$ (unitless)	$ADD_{soil\text{-}dermal}$ (mg/kg-day)	RfD Subchronic (mg/kg-day)	$HQ_{soil\text{-}dermal}$ (unitless)
Benzene	115	0.03	4.0E-05	1.0E-02	4.0E-03
Ethylbenzene	19	0.03	6.7E-06	5.0E-02	1.3E-04
Naphthalene	819	0.1	9.5E-04	2.0E-01	4.7E-03
Toluene	98	0.03	3.4E-05	8.0E-01	4.2E-05
Xylene (Total)	43	0.03	1.5E-05	4.0E-01	3.7E-05
2-Methylnaphthalene	227	0.1	2.6E-04	4.0E-03	6.6E-02
Acenaphthene	15	0.1	1.7E-05	2.0E-01	8.7E-05
Acenaphthylene	129	0.1	1.5E-04	3.0E-01	5.0E-04
Anthracene	68	0.1	7.9E-05	1.0E+00	7.9E-05
Benzo(a)Anthracene	39	0.02	9.0E-06	3.0E-01	3.0E-05
Benzo(a)Pyrene	45	0.02	1.0E-05	3.0E-04	3.5E-02
Benzo(b)Fluoranthene	31	0.02	7.2E-06	3.0E-01	2.4E-05
Benzo(g,h,i)Perylene	21	0.1	2.5E-05	3.0E-01	8.2E-05
Benzo(k)Fluoranthene	13	0.02	3.1E-06	3.0E-01	1.0E-05
Chrysene	35	0.02	8.1E-06	3.0E-01	2.7E-05
Dibenzo(a,h)anthracene	4.5	0.02	1.0E-06	3.0E-01	3.5E-06
Fluoranthene	82	0.10	9.5E-05	1.0E-01	9.5E-04
Fluorene	75	0.1	8.7E-05	4.0E-01	2.2E-04
Indeno(1,2,3-cd)Pyrene	17	0.02	3.9E-06	3.0E-01	1.3E-05
Phenanthrene	256	0.1	3.0E-04	3.0E-01	9.8E-04
Pyrene	149	0.1	1.7E-04	3.0E-01	5.7E-04
C11-C22 Aromatic Fraction	1834	0.1	2.1E-03	3.0E-01	7.1E-03
C19-C36 Aliphatic Fraction	203	0.2	4.7E-04	6.0E+00	7.8E-05
C5-C8 Aliphatic Fraction	307	0.2	7.1E-04	4.0E-01	1.8E-03
C9-C10 Aromatic Fraction	568	0.2	1.3E-03	3.0E-01	4.4E-03
C9-C18 Aliphatic Fraction	85	0.2	2.0E-04	1.0E+00	2.0E-04
Chromium (total)	17	0.1	1.9E-05	2.0E-02	9.7E-04
Cyanide	2.6	0.1	2.9E-06	6.0E-03	4.9E-04
				$HI_{soil\text{-}dermal}$ =	**1.3E-01**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern.

TABLE IV-9 (Continued)
CALCULATION OF AVERAGE DAILY DOSES AND RISK ESTIMATES
FOR DERMAL CONTACT WITH SOIL
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Construction/Utility Workers (Within Former Holder Area)
CANCER EFFECTS

Dermal Contact with Soil

See TABLE D-12 for Exposure Variables and Rationale

$$LADD_{soil\text{-}dermal} = \frac{EPC_{soil} * DCR_{soil} * EF * ED * EP * RAF_{dermal\text{-}c} * C1}{BW * AP_c}$$

See TABLE D-10 for Exposure Point Concentration Derivation

$$ELCR_{soil\text{-}dermal} = LADD_{soil\text{-}dermal} * CSF$$

Total $ELCR_{soil\text{-}dermal} = \sum ELCR_{soil\text{-}dermal}$

COC	EPC_{soil} EPC1B (mg/kg)	$RAF_{dermal\text{-}c}$ (unitless)	$LADD_{soil\text{-}dermal}$ (mg/kg-day)	CSF $(mg/kg\text{-}day)^{-1}$	$ELCR_{soil\text{-}dermal}$ (unitless)
Benzene	115	0.03	2.85E-07	5.5E-02	1.6E-08
Ethylbenzene	19	1	1.61E-06	NA	NC
Naphthalene	819	1	6.75E-05	NA	NC
Toluene	98	1	8.07E-06	NA	NC
Xylene (Total)	43	1	3.51E-06	NA	NC
2-Methylnaphthalene	227	1	1.87E-05	NA	NC
Acenaphthene	15	1	1.24E-06	NA	NC
Acenaphthylene	129	1	1.06E-05	NA	NC
Anthracene	68	1	5.62E-06	NA	NC
Benzo(a)Anthracene	39	0.02	6.40E-08	1.0E-01	6.4E-09
Benzo(a)Pyrene	45	0.02	7.48E-08	1.0E+00	7.5E-08
Benzo(b)Fluoranthene	31	0.02	5.11E-08	1.0E-01	5.1E-09
Benzo(g,h,i)Perylene	21	1	1.75E-06	NA	NC
Benzo(k)Fluoranthene	13	0.02	2.19E-08	1.0E-02	2.2E-10
Chrysene	35	0.02	5.81E-08	1.0E-02	5.8E-10
Dibenzo(a,h)anthracene	4.5	0.02	7.41E-09	1.0E+00	7.4E-09
Fluoranthene	82	1	6.80E-06	NA	NC
Fluorene	75	1	6.22E-06	NA	NC
Indeno(1,2,3-cd)Pyrene	17	0.02	2.78E-08	1.0E-01	2.8E-09
Phenanthrene	256	1	2.11E-05	NA	NC
Pyrene	149	1	1.23E-05	NA	NC
C11-C22 Aromatic Fraction	1834	1	1.51E-04	NA	NC
C19-C36 Aliphatic Fraction	203	1	1.68E-05	NA	NC
C5-C8 Aliphatic Fraction	307	1	2.53E-05	NA	NC
C9-C10 Aromatic Fraction	568	1	4.69E-05	NA	NC
C9-C18 Aliphatic Fraction	85	1	7.01E-06	NA	NC
Chromium (total)	17	1	1.39E-06	NA	NC
Cyanide	2.6	1	2.10E-07	NA	NC
Lead	96	1	7.95E-06	NA	NC
				Total $ELCR_{soil\text{-}dermal}$:	**1.1E-07**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.
3. A default value of 1 is used when a RAF is otherwise unavailable.

TABLE IV-10
CALCULATION OF AVERAGE DAILY DOSES AND RISK ESTIMATES
FOR INCIDENTAL INGESTION OF SOIL
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Construction/Utility Workers (Within Former Holder Area)
SUBCHRONIC NON-CANCER EFFECTS

See TABLE D-12 for Exposure Variables and Rationale

See TABLE D-10 for Exposure Point Concentration Derivation

Incidental Ingestion of Soil

$$ADD_{soil\text{-}oral} = \frac{EPC_{soil} * IR_{soil} * EF * ED * EP * RAF_{oral\text{-}nc} * C1}{BW * AP_{nc}}$$

$$HQ_{soil\text{-}oral} = \frac{ADD_{soil\text{-}oral}}{RfD}$$

$$HI_{soil\text{-}oral} = \sum HQ_{soil\text{-}oral}$$

COC	EPC_{soil} EPC1B (mg/kg)	$RAF_{oral\text{-}nc}$ (unitless)	$ADD_{soil\text{-}oral}$ (mg/kg-day)	RfD Subchronic (mg/kg-day)	$HQ_{soil\text{-}oral}$ (unitless)
Benzene	115	1	1.3E-04	1.0E-02	1.3E-02
Ethylbenzene	19	1	2.1E-05	5.0E-02	4.3E-04
Naphthalene	819	0.3	2.7E-04	2.0E-01	1.3E-03
Toluene	98	1	1.1E-04	8.0E-01	1.3E-04
Xylene (Total)	43	1	4.7E-05	4.0E-01	1.2E-04
2-Methylnaphthalene	227	0.3	7.5E-05	4.0E-03	1.9E-02
Acenaphthene	15	0.3	5.0E-06	2.0E-01	2.5E-05
Acenaphthylene	129	0.3	4.2E-05	3.0E-01	1.4E-04
Anthracene	68	0.3	2.2E-05	1.0E+00	2.2E-05
Benzo(a)Anthracene	39	0.3	1.3E-05	3.0E-01	4.3E-05
Benzo(a)Pyrene	45	0.3	1.5E-05	3.0E-04	5.0E-02
Benzo(b)Fluoranthene	31	0.3	1.0E-05	3.0E-01	3.4E-05
Benzo(g,h,i)Perylene	21	0.3	7.0E-06	3.0E-01	2.3E-05
Benzo(k)Fluoranthene	13	0.3	4.4E-06	3.0E-01	1.5E-05
Chrysene	35	0.3	1.2E-05	3.0E-01	3.9E-05
Dibenzo(a,h)anthracene	4.5	0.3	1.5E-06	3.0E-01	4.9E-06
Fluoranthene	82	0.3	2.7E-05	1.0E-01	2.7E-04
Fluorene	75	0.3	2.5E-05	4.0E-01	6.2E-05
Indeno(1,2,3-cd)Pyrene	17	0.3	5.6E-06	3.0E-01	1.9E-05
Phenanthrene	256	0.3	8.4E-05	3.0E-01	2.8E-04
Pyrene	149	0.3	4.9E-05	3.0E-01	1.6E-04
C11-C22 Aromatic Fraction	1834	0.3	6.0E-04	3.0E-01	2.0E-03
C19-C36 Aliphatic Fraction	203	1	2.2E-04	6.0E+00	3.7E-05
C5-C8 Aliphatic Fraction	307	1	3.4E-04	4.0E-01	8.4E-04
C9-C10 Aromatic Fraction	568	1	6.2E-04	3.0E-01	2.1E-03
C9-C18 Aliphatic Fraction	85	1	9.3E-05	1.0E+00	9.3E-05
Chromium (total)	17	1	1.8E-05	2.0E-02	9.2E-04
Cyanide	2.6	1	2.8E-06	6.0E-03	4.7E-04
Lead	96	0.3	3.2E-05	7.5E-04	4.2E-02
				$HI_{soil\text{-}oral}$ =	**1.3E-01**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern.

TABLE IV-10 (Continued)
CALCULATION OF AVERAGE DAILY DOSES AND RISK ESTIMATES
FOR INCIDENTAL INGESTION OF SOIL
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Construction/Utility Workers (Within Former Holder Area)
CANCER EFFECTS

See TABLE D-12 for Exposure Variables and Rationale

See TABLE D-10 for Exposure Point Concentration Derivation

Incidental Ingestion of Soil

$$LADD_{soil\text{-}oral} = \frac{EPC_{soil} * IR_{soil} * EF * ED * EP * RAF_{oral\text{-}c} * C1}{BW * AP_c}$$

$ELCR_{soil\text{-}oral} = LADD_{soil\text{-}oral} * CSF$

Total $ELCR_{soil\text{-}oral} = \sum ELCR_{soil\text{-}oral}$

COC	EPC_{soil} EPC1B (mg/kg)	$RAF_{oral\text{-}c}$ (unitless)	$LADD_{soil\text{-}oral}$ (mg/kg-day)	CSF $(mg/kg\text{-}day)^{-1}$	$ELCR_{soil\text{-}oral}$ (unitless)
Benzene	115	1	9.03E-07	5.5E-02	5.0E-08
Ethylbenzene	19	1	1.53E-07	NA	NC
Naphthalene	819	1	6.43E-06	NA	NC
Toluene	98	1	7.68E-07	NA	NC
Xylene (Total)	43	1	3.34E-07	NA	NC
2-Methylnaphthalene	227	1	1.78E-06	NA	NC
Acenaphthene	15	1	1.18E-07	NA	NC
Acenaphthylene	129	1	1.01E-06	NA	NC
Anthracene	68	1	5.35E-07	NA	NC
Benzo(a)Anthracene	39	0.3	9.13E-08	1.0E-01	9.1E-09
Benzo(a)Pyrene	45	0.3	1.07E-07	1.0E+00	1.1E-07
Benzo(b)Fluoranthene	31	0.3	7.30E-08	1.0E-01	7.3E-09
Benzo(g,h,i)Perylene	21	1	1.67E-07	NA	NC
Benzo(k)Fluoranthene	13	0.3	3.13E-08	1.0E-02	3.1E-10
Chrysene	35	0.3	8.30E-08	1.0E-02	8.3E-10
Dibenzo(a,h)anthracene	4.5	0.3	1.06E-08	1.0E+00	1.1E-08
Fluoranthene	82	1	6.47E-07	NA	NC
Fluorene	75	1	5.92E-07	NA	NC
Indeno(1,2,3-cd)Pyrene	17	0.3	3.97E-08	1.0E-01	4.0E-09
Phenanthrene	256	1	2.01E-06	NA	NC
Pyrene	149	1	1.17E-06	NA	NC
C11-C22 Aromatic Fraction	1834	1	1.44E-05	NA	NC
C19-C36 Aliphatic Fraction	203	1	1.60E-06	NA	NC
C5-C8 Aliphatic Fraction	307	1	2.41E-06	NA	NC
C9-C10 Aromatic Fraction	568	1	4.46E-06	NA	NC
C9-C18 Aliphatic Fraction	85	1	6.67E-07	NA	NC
Chromium (total)	17	1	1.32E-07	NA	NC
Cyanide	2.6	1	2.00E-08	NA	NC
Lead	96	1	7.57E-07	NA	NC
				Total $ELCR_{soil\text{-}oral}$:	**1.9E-07**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.
3. A default value of 1 is used when a RAF is otherwise unavailable.

TABLE IV-11

CALCULATION OF AVERAGE DAILY EXPOSURES AND RISK ESTIMATES
FOR INHALATION OF FUGITIVE DUST VIA GASTROINTESTINAL (GI) TRACT
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Construction/Utility Workers (Within Former Holder Area)
SUBCHRONIC NON-CANCER EFFECTS

See TABLE D-12 for Exposure Variables and Rationale. See TABLE D-10 for Exposure Point Concentration Derivation

Inhalation of Soil-derived Fugitive Dust via GI Tract

$$ADD_{dust\text{-}GI} = \frac{EPC_{dust} * 1.5 * INH * RAF_{oral} * EF * ED * EP * C2 * C3}{BW * APnc}$$

$$HQ_{dust\text{-}GI} = \frac{ADD_{dust\text{-}GI}}{RfD_{oral}}$$

$$HI_{dust\text{-}GI} = \sum HQ_{dust\text{-}GI}$$

COC	EPC_{dust} EPC2B (mg/m^3)	$RAF_{oral\text{-}nc}$ (unitless)	$ADD_{dust\text{-}GI}$ (mg/kg-day)	RfD_{oral} Subchronic (mg/kg-day)	$HQ_{dust\text{-}GI}$ (unitless)
Benzene	6.9E-06	1	3.3E-06	1.0E-02	3.3E-04
Ethylbenzene	1.2E-06	1	5.5E-07	5.0E-02	1.1E-05
Naphthalene	4.9E-05	0.3	7.0E-06	2.0E-01	3.5E-05
Toluene	5.9E-06	1	2.8E-06	8.0E-01	3.5E-06
Xylene (Total)	2.6E-06	1	1.2E-06	4.0E-01	3.0E-06
2-Methylnaphthalene	1.4E-05	0.3	1.9E-06	4.0E-03	4.9E-04
Acenaphthene	9.0E-07	0.3	1.3E-07	2.0E-01	6.4E-07
Acenaphthylene	7.7E-06	0.3	1.1E-06	3.0E-01	3.7E-06
Anthracene	4.1E-06	0.3	5.8E-07	1.0E+00	5.8E-07
Benzo(a)Anthracene	2.3E-06	0.3	3.3E-07	3.0E-01	1.1E-06
Benzo(a)Pyrene	2.7E-06	0.3	3.9E-07	3.0E-04	1.3E-03
Benzo(b)Fluoranthene	1.9E-06	0.3	2.6E-07	3.0E-01	8.8E-07
Benzo(g,h,i)Perylene	1.3E-06	0.3	1.8E-07	3.0E-01	6.1E-07
Benzo(k)Fluoranthene	8.0E-07	0.3	1.1E-07	3.0E-01	3.8E-07
Chrysene	2.1E-06	0.3	3.0E-07	3.0E-01	1.0E-06
Dibenzo(a,h)anthracene	2.7E-07	0.3	3.8E-08	3.0E-01	1.3E-07
Fluoranthene	4.9E-06	0.3	7.0E-07	1.0E-01	7.0E-06
Fluorene	4.5E-06	0.3	6.4E-07	4.0E-01	1.6E-06
Indeno(1,2,3-cd)Pyrene	1.0E-06	0.3	1.4E-07	3.0E-01	4.8E-07
Phenanthrene	1.5E-05	0.3	2.2E-06	3.0E-01	7.3E-06
Pyrene	9.0E-06	0.3	1.3E-06	3.0E-01	4.3E-06
C11-C22 Aromatic Fraction	1.1E-04	0.3	1.6E-05	3.0E-01	5.2E-05
C19-C36 Aliphatic Fraction	1.2E-05	1	5.8E-06	6.0E+00	9.7E-07
C5-C8 Aliphatic Fraction	1.8E-05	1	8.8E-06	4.0E-01	2.2E-05
C9-C10 Aromatic Fraction	3.4E-05	1	1.6E-05	3.0E-01	5.4E-05
C9-C18 Aliphatic Fraction	5.1E-06	1	2.4E-06	1.0E+00	2.4E-06
Chromium (total)	1.0E-06	1	4.8E-07	2.0E-02	2.4E-05
Cyanide	1.5E-07	1	7.3E-08	6.0E-03	1.2E-05
Lead	5.8E-06	0.3	8.2E-07	7.5E-04	1.1E-03
					3.5E-03

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern.

TABLE IV-11 (Continued)
CALCULATION OF LIFETIME AVERAGE DAILY EXPOSURES AND RISK ESTIMATES
FOR INHALATION OF FUGITIVE DUST VIA GASTROINTESTINAL (GI) TRACT
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Construction/Utility Workers (Within Former Holder Area)
CANCER EFFECTS

See TABLE D-12 for Exposure Variables and Rationale. See TABLE D-10 for Exposure Point Concentration Derivation

Inhalation of Soil-derived Fugitive Dust via GI Tract

$LADD_{dust\text{-}GI} = \frac{EPCdust * 1.5 * INH * RAF * EF * ED * EP * C2 * C3}{BW * APc}$

$ELCR_{dust\text{-}GI} = LADD_{dust\text{-}GI} * CSF_{oral}$

Total $ELCR_{dust\text{-}GI} = \sum ELCR_{dust\text{-}GI}$

COC	EPC_{dust} EPC2B (mg/m^3)	$RAF_{oral\text{-}c}$ (unitless)	$LADD_{dust\text{-}GI}$ ($\mu g/m^3$)	CSF_{oral} $(mg/kg\text{-}day)^{-1}$	$ELCR_{dust\text{-}GI}$ (unitless)
Benzene	6.9E-06	1	2.3E-08	5.5E-02	1.3E-09
Ethylbenzene	1.2E-06	1	4.0E-09	NA	NC
Naphthalene	4.9E-05	1	1.7E-07	NA	NC
Toluene	5.9E-06	1	2.0E-08	NA	NC
Xylene (Total)	2.6E-06	1	8.7E-09	NA	NC
2-Methylnaphthalene	1.4E-05	1	4.6E-08	NA	NC
Acenaphthene	9.0E-07	1	3.1E-09	NA	NC
Acenaphthylene	7.7E-06	1	2.6E-08	NA	NC
Anthracene	4.1E-06	1	1.4E-08	NA	NC
Benzo(a)Anthracene	2.3E-06	0.3	2.4E-09	1.0E-01	2.4E-10
Benzo(a)Pyrene	2.7E-06	0.3	2.8E-09	1.0E+00	2.8E-09
Benzo(b)Fluoranthene	1.9E-06	0.3	1.9E-09	1.0E-01	1.9E-10
Benzo(g,h,i)Perylene	1.3E-06	1	4.3E-09	NA	NC
Benzo(k)Fluoranthene	8.0E-07	0.3	8.1E-10	1.0E-02	8.1E-12
Chrysene	2.1E-06	0.3	2.2E-09	1.0E-02	2.2E-11
Dibenzo(a,h)anthracene	2.7E-07	0.3	2.7E-10	1.0E+00	2.7E-10
Fluoranthene	4.9E-06	1	1.7E-08	NA	NC
Fluorene	4.5E-06	1	1.5E-08	NA	NC
Indeno(1,2,3-cd)Pyrene	1.0E-06	0.3	1.0E-09	1.0E-01	1.0E-10
Phenanthrene	1.5E-05	1	5.2E-08	NA	NC
Pyrene	9.0E-06	1	3.0E-08	NA	NC
C11-C22 Aromatic Fraction	1.1E-04	1	3.7E-07	NA	NC
C19-C36 Aliphatic Fraction	1.2E-05	1	4.1E-08	NA	NC
C5-C8 Aliphatic Fraction	1.8E-05	1	6.3E-08	NA	NC
C9-C10 Aromatic Fraction	3.4E-05	1	1.2E-07	NA	NC
C9-C18 Aliphatic Fraction	5.1E-06	1	1.7E-08	NA	NC
Chromium (total)	1.0E-06	1	3.4E-09	NA	NC
Cyanide	1.5E-07	1	5.2E-10	NA	NC
Lead	5.8E-06	1	2.0E-08	NA	NC
					4.9E-09

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.

TABLE IV-12
CALCULATION OF AVERAGE DAILY EXPOSURES AND RISK ESTIMATES
FOR INHALATION OF FUGITIVE DUST VIA RESPIRATORY ABSORPTION
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Construction/Utility Workers (Within Former Holder Area)
SUBCHRONIC NON-CANCER EFFECTS

See TABLE D-12 for Exposure Variables and Rationale and TABLE D-10 for EPC Descriptions

Inhalation of Fugitive Dust via Respiratory Absorption

$$ADE_{dust\text{-}RA} = \frac{EPC_{dust\text{-}RA} * 0.5 * EF * ED * EP * C4}{AP_{nc}}$$

$$HQ_{dust\text{-}RA} = \frac{ADE_{dust\text{-}RA}}{RfC} \qquad HI_{dust\text{-}RA} = \sum HQ_{dust\text{-}RA}$$

COC	EPC_{dust} EPC2B (mg/m^3)	$ADE_{dust\text{-}RA}$ (mg/m^3)	RfC Subchronic (mg/m^3)	$HQ_{dust\text{-}RA}$ (unitless)
Benzene	6.9E-06	8.2E-07	3.0E-03	2.7E-04
Ethylbenzene	1.2E-06	1.4E-07	9.0E+00	1.5E-08
Naphthalene	4.9E-05	5.8E-06	3.0E-03	1.9E-03
Toluene	5.9E-06	7.0E-07	5.0E+00	1.4E-07
Xylene (Total)	2.6E-06	3.0E-07	4.0E-01	7.6E-07
2-Methylnaphthalene	1.4E-05	1.6E-06	5.0E-01	3.2E-06
Acenaphthene	9.0E-07	1.1E-07	5.0E-01	2.1E-07
Acenaphthylene	7.7E-06	9.2E-07	5.0E-01	1.8E-06
Anthracene	4.1E-06	4.8E-07	5.0E-01	9.7E-07
Benzo(a)Anthracene	2.3E-06	2.8E-07	5.0E-01	5.5E-07
Benzo(a)Pyrene	2.7E-06	3.2E-07	2.0E-06	1.6E-01
Benzo(b)Fluoranthene	1.9E-06	2.2E-07	5.0E-01	4.4E-07
Benzo(g,h,i)Perylene	1.3E-06	1.5E-07	5.0E-01	3.0E-07
Benzo(k)Fluoranthene	8.0E-07	9.5E-08	5.0E-01	1.9E-07
Chrysene	2.1E-06	2.5E-07	5.0E-01	5.0E-07
Dibenzo(a,h)anthracene	2.7E-07	3.2E-08	5.0E-01	6.4E-08
Fluoranthene	4.9E-06	5.9E-07	5.0E-01	1.2E-06
Fluorene	4.5E-06	5.4E-07	5.0E-01	1.1E-06
Indeno(1,2,3-cd)Pyrene	1.0E-06	1.2E-07	5.0E-01	2.4E-07
Phenanthrene	1.5E-05	1.8E-06	5.0E-01	3.6E-06
Pyrene	9.0E-06	1.1E-06	5.0E-01	2.1E-06
C11-C22 Aromatic Fraction	1.1E-04	1.3E-05	5.0E-01	2.6E-05
C19-C36 Aliphatic Fraction	1.2E-05	1.4E-06	NA	NC
C5-C8 Aliphatic Fraction	1.8E-05	2.2E-06	2.0E-01	1.1E-05
C9-C10 Aromatic Fraction	3.4E-05	4.0E-06	5.0E-01	8.1E-06
C9-C18 Aliphatic Fraction	5.1E-06	6.1E-07	6.0E-01	1.0E-06
Chromium (total)	1.0E-06	1.2E-07	3.0E-04	4.0E-04
Cyanide	1.5E-07	1.8E-08	3.0E-03	6.1E-06
Lead	5.8E-06	6.9E-07	1.0E-03	6.9E-04
			$HI_{dust\text{-}RA}$:	**1.6E-01**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.

TABLE IV-12 (Continued)
CALCULATION OF LIFETIME AVERAGE DAILY EXPOSURES AND RISK ESTIMATES
FOR INHALATION OF FUGITIVE DUST VIA RESPIRATORY ABSORPTION
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Construction/Utility Workers (Within Former Holder Area)
CANCER EFFECTS

See TABLE D-12 for Exposure Variables and Rationale and TABLE D-10 for EPC Descriptions	**Inhalation of Fugitive Dust via Respiratory Absorption** $LADE_{dust\text{-}RA} = \frac{EPC_{dust\text{-}RA} * 0.5 * EF * ED * EP * C4 * C5}{AP_c}$ $ELCR_{dust\text{-}RA} = LADE_{dust\text{-}RA} * UR$		Total $ELCR_{dust\text{-}RA} = \sum ELCR_{dust\text{-}RA}$
COC	**EPC_{dust} EPC2B (mg/m^3)**	**$LADE_{dust\text{-}RA}$ ($\mu g/m^3$)**	**UR ($(\mu g/m^3)^{-1}$)**	**$ELCR_{dust\text{-}RA}$ (unitless)**
Benzene	6.9E-06	5.9E-06	7.8E-06	4.6E-11
Ethylbenzene	1.2E-06	9.9E-07	NA	NC
Naphthalene	4.9E-05	4.2E-05	NA	NC
Toluene	5.9E-06	5.0E-06	NA	NC
Xylene (Total)	2.6E-06	2.2E-06	NA	NC
2-Methylnaphthalene	1.4E-05	1.2E-05	NA	NC
Acenaphthene	9.0E-07	7.7E-07	NA	NC
Acenaphthylene	7.7E-06	6.5E-06	NA	NC
Anthracene	4.1E-06	3.5E-06	NA	NC
Benzo(a)Anthracene	2.3E-06	2.0E-06	6.0E-05	1.2E-10
Benzo(a)Pyrene	2.7E-06	2.3E-06	6.0E-04	1.4E-09
Benzo(b)Fluoranthene	1.9E-06	1.6E-06	6.0E-05	9.5E-11
Benzo(g,h,i)Perylene	1.3E-06	1.1E-06	NA	NC
Benzo(k)Fluoranthene	8.0E-07	6.8E-07	6.0E-06	4.1E-12
Chrysene	2.1E-06	1.8E-06	6.0E-06	1.1E-11
Dibenzo(a,h)anthracene	2.7E-07	2.3E-07	6.0E-04	1.4E-10
Fluoranthene	4.9E-06	4.2E-06	NA	NC
Fluorene	4.5E-06	3.8E-06	NA	NC
Indeno(1,2,3-cd)Pyrene	1.0E-06	8.6E-07	6.0E-05	5.1E-11
Phenanthrene	1.5E-05	1.3E-05	NA	NC
Pyrene	9.0E-06	7.6E-06	NA	NC
C11-C22 Aromatic Fraction	1.1E-04	9.3E-05	NA	NC
C19-C36 Aliphatic Fraction	1.2E-05	1.0E-05	NA	NC
C5-C8 Aliphatic Fraction	1.8E-05	1.6E-05	NA	NC
C9-C10 Aromatic Fraction	3.4E-05	2.9E-05	NA	NC
C9-C18 Aliphatic Fraction	5.1E-06	4.3E-06	NA	NC
Chromium (total)	1.0E-06	8.5E-07	1.2E-02	1.0E-08
Cyanide	1.5E-07	1.3E-07	NA	NC
Lead	5.8E-06	4.9E-06	NA	NC
			Total $ELCR_{dust\text{-}RA}$:	**1.2E-08**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.

TABLE IV-13
CALCULATION OF AVERAGE DAILY EXPOSURES AND RISK ESTIMATES
FOR DERMAL CONTACT WITH GROUNDWATER
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Construction/Utility Workers (Within Former Holder Area)
SUBCHRONIC NONCANCER EFFECTS

See TABLE D-12 for Exposure Variables and Rationale

See TABLE D-10 for Exposure Point Concentration Derivation

Dermal Contact with Groundwater

$$ADD_{gw\text{-}dermal} = \frac{EPC_{gw} * SA * K_p * EF * ED * EP * RAF * C6 * C7}{BW * AP_{nc}}$$

$$HQ_{gw\text{-}dermal} = \frac{ADD_{gw\text{-}dermal}}{RfD}$$

$$HI_{gw\text{-}dermal} = \sum HQ_{gw\text{-}dermal}$$

COC	EPC_{gw} EPC4B	K_p	RAF	$ADD_{gw\text{-}dermal}$	RfD Subchronic	$HQ_{gw\text{-}dermal}$
	(µg/L)	(cm/hr)	(unitless)	(mg/kg-day)	(mg/kg-day)	(unitless)
Benzene	2.0E+04	1.5E-02	1.0E+00	9.5E-04	1.0E-02	9.5E-02
Ethylbenzene	7.0E+02	4.8E-02	1.0E+00	1.1E-04	5.0E-02	2.2E-03
Naphthalene	9.6E+03	4.6E-02	1.0E+00	1.4E-03	2.0E-01	7.2E-03
Toluene	4.1E+03	3.1E-02	1.0E+00	4.1E-04	8.0E-01	5.1E-04
Xylene (Total)	2.2E+03	4.9E-02	1.0E+00	3.5E-04	4.0E-01	8.7E-04
Styrene	4.4E+02	3.7E-02	1.0E+00	5.3E-05	2.0E+00	2.7E-05
2-Methylnaphthalene	5.5E+02	9.0E-02	1.0E+00	1.6E-04	4.0E-03	4.1E-02
Acenaphthylene	1.4E+02	8.7E-02	1.1E+00	4.4E-05	3.0E-01	1.5E-04
Cyanide	5.2E+02	1.0E-03	1.0E+00	1.7E-06	6.0E-03	2.8E-04
					Total $HI_{gw\text{-}dermal}$:	**1.5E-01**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern.

TABLE IV-13 (Continued)
CALCULATION OF LIFETIME AVERAGE DAILY DOSE AND RISK ESTIMATES
FOR DERMAL CONTACT WITH GROUNDWATER
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Construction/Utility Workers (Within Former Holder Area)
CANCER EFFECTS

See TABLE D-12 for Exposure Variables and Rationale

See TABLE D-10 for Exposure Point Concentration Derivation

Dermal Contact with Groundwater

$$LADD_{gw\text{-}dermal} = \frac{EPC_{gw} * SA * K_p * EF * ED * EP * RAF * C6 * C7}{BW * AP_c}$$

$ELCR_{gw\text{-}dermal} = LADD_{gw\text{-}dermal} * CSF$

Total $ELCR_{gw\text{-}dermal} = \sum ELCR_{gw\text{-}dermal}$

COC	EPC_{gw} EPC4B	K_p	RAF	$LADD_{gw\text{-}dermal}$	CSF	$ELCR_{gw\text{-}dermal}$
	(µg/L)	(unitless)	(unitless)	(mg/kg-day)	$(mg/kg\text{-}day)^{-1}$	(unitless)
Benzene	2.0E+04	1.5E-02	1.0E+00	6.8E-06	5.5E-02	3.7E-07
Ethylbenzene	7.0E+02	4.8E-02	1.0E+00	7.9E-07	NA	NC
Naphthalene	9.6E+03	4.6E-02	1.0E+00	1.0E-05	NA	NC
Toluene	4.1E+03	3.1E-02	1.0E+00	2.9E-06	NA	NC
Xylene (Total)	2.2E+03	4.9E-02	1.0E+00	2.5E-06	NA	NC
Styrene	4.4E+02	3.7E-02	1.0E+00	3.8E-07	3.0E-02	1.1E-08
2-Methylnaphthalene	5.5E+02	9.0E-02	1.0E+00	1.2E-06	NA	NC
Acenaphthylene	1.4E+02	8.7E-02	1.0E+00	2.9E-07	NA	NC
Cyanide	5.2E+02	1.0E-03	1.0E+00	1.2E-08	NA	NC
					Total $ELCR_{gw\text{-}dermal}$:	**3.8E-07**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.

TABLE IV-14
CALCULATION OF AVERAGE DAILY EXPOSURES AND RISK ESTIMATES
FOR INHALATION OF AMBIENT AIR
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Construction/Utility Workers (Within Former Holder Area)
SUBCHRONIC NON-CANCER EFFECTS

See TABLE D-12 for Exposure Variables and Rationale and TABLE D-10 for EPC Descriptions	**Inhalation of Ambient Air** $ADE_{amb\text{-}air} = \frac{EPC_{amb\text{-}air} * EF * ED * EP * C2}{AP_{nc}}$ $HQ_{amb\text{-}air} = \frac{ADE_{amb\text{-}air}}{RfC}$		$HI_{amb\text{-}air} = \sum HQ_{amb\text{-}air}$
COC	**$EPC_{amb\text{-}air}$ EPC6B (mg/m^3)**	**$ADE_{amb\text{-}air}$ (mg/m^3)**	**RfC Subchronic (mg/m^3)**	**$HQ_{amb\text{-}air}$ (unitless)**
Benzene	2.8E-01	1.6E-02	3.0E-03	5.5E+00
Ethylbenzene	8.6E-03	5.1E-04	9.0E+00	5.7E-05
Naphthalene	7.1E-02	4.2E-03	3.0E-03	1.4E+00
Toluene	5.4E-02	3.2E-03	5.0E+00	6.4E-04
Xylene (Total)	2.7E-02	1.6E-03	4.0E-01	4.0E-03
Styrene	5.2E-03	3.1E-04	3.0E+00	1.0E-04
2-Methylnaphthalene	4.1E-03	2.4E-04	5.0E-01	4.8E-04
Acenaphthylene	4.6E-04	2.7E-05	5.0E-01	5.4E-05
Cyanide	1.3E-02	7.7E-04	3.0E-03	2.6E-01
			$HI_{amb\text{-}air}$:	**7.2E+00**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern.

TABLE IV-14 (Continued)
CALCULATION OF LIFETIME AVERAGE DAILY EXPOSURES AND RISK ESTIMATES
FOR INHALATION OF AMBIENT AIR
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Construction/Utility Workers (Within Former Holder Area)
CANCER EFFECTS

See TABLE D-12 for Exposure Variables and Rationale and TABLE D-10 for EPC Descriptions	**Inhalation of Ambient Air**			
	$LADE_{amb\text{-}air}$ =	$\frac{EPC_{amb\text{-}air} * EF * ED * EP * C2 * C5}{AP_c}$		
	$ELCR_{amb\text{-}air}$ =	$LADE_{amb\text{-}air} * UR$	Total $ELCR_{amb\text{-}air}$ =	$\sum ELCR_{amb\text{-}air}$

COC	**$EPC_{amb\text{-}air}$ EPC6B (mg/m^3)**	**$LADE_{amb\text{-}air}$ ($\mu g/m^3$)**	**UR ($\mu g/m^3)^{-1}$**	**$ELCR_{amb\text{-}air}$ (unitless)**
Benzene	2.8E-01	1.2E-01	7.8E-06	9.2E-07
Ethylbenzene	8.6E-03	3.7E-03	NA	NC
Naphthalene	7.1E-02	3.0E-02	NA	NC
Toluene	5.4E-02	2.3E-02	NA	NC
Xylene (Total)	2.7E-02	1.1E-02	NA	NC
Styrene	5.2E-03	2.2E-03	5.7E-07	1.3E-09
2-Methylnaphthalene	4.1E-03	1.7E-03	NA	NC
Acenaphthylene	4.6E-04	1.9E-04	NA	NC
Cyanide	1.3E-02	5.5E-03	NA	NC
			Total $ELCR_{amb\text{-}air}$:	**9.2E-07**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.

TABLE IV-15
CALCULATION OF AVERAGE DAILY DOSES AND RISK ESTIMATES
FOR DERMAL CONTACT WITH SOIL
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Trespasser (Child, age 7<15)
CHRONIC NON-CANCER EFFECTS

Dermal Contact with Soil

See TABLE D-13 for Exposure Variables and Rationale

$$ADD_{soil\text{-}dermal} = \frac{EPC_{soil} * DCR_{soil} * EF * ED * EP * RAF_{dermal\text{-}nc} * C1}{BW * AP_{nc}}$$

See TABLE D-10 for Exposure Point Concentration Derivation

$$HQ_{soil\text{-}dermal} = \frac{ADD_{soil\text{-}dermal}}{RfD}$$

$$HI_{soil\text{-}dermal} = \Sigma HQ_{soil\text{-}dermal}$$

COC	EPC_{soil} EPC1 (mg/kg)	$RAF_{dermal\text{-}nc}$ (unitless)	$ADD_{soil\text{-}dermal}$ (mg/kg-day)	RfD Chronic (mg/kg-day)	$HQ_{soil\text{-}dermal}$ (unitless)
Benzene	23	0.03	6.4E-07	4.0E-03	1.6E-04
Ethylbenzene	24	0.03	6.5E-07	5.0E-02	1.3E-05
Naphthalene	291	0.1	2.6E-05	2.0E-02	1.3E-03
Toluene	20	0.03	5.4E-07	8.0E-02	6.7E-06
Xylene (Total)	29	0.03	7.7E-07	2.0E-01	3.9E-06
2-Methylnaphthalene	45	0.1	4.0E-06	4.0E-03	1.0E-03
Acenaphthene	11	0.1	1.0E-06	6.0E-02	1.7E-05
Acenaphthylene	22	0.1	2.0E-06	3.0E-02	6.5E-05
Anthracene	19	0.1	1.7E-06	3.0E-01	5.7E-06
Benzo(a)Anthracene	15	0.02	2.7E-07	3.0E-02	9.1E-06
Benzo(a)Pyrene	16	0.02	2.9E-07	3.0E-04	9.6E-04
Benzo(b)Fluoranthene	11	0.02	1.9E-07	3.0E-02	6.4E-06
Benzo(g,h,i)Perylene	7.9	0.1	7.1E-07	3.0E-02	2.4E-05
Benzo(k)Fluoranthene	9.5	0.02	1.7E-07	3.0E-02	5.7E-06
Biphenyl	9.4	0.1	8.5E-07	5.0E-01	1.7E-06
Carbazole	3.8	1	3.4E-06	NA	NC
Chrysene	15	0.02	2.7E-07	3.0E-02	9.1E-06
Dibenzo(a,h)anthracene	2.4	0.02	4.4E-08	3.0E-02	1.5E-06
Dibenzofuran	9.3	0.18	1.5E-06	1.0E-03	1.5E-03
Fluoranthene	28	0.1	2.6E-06	4.0E-02	6.4E-05
Fluorene	22	0.1	2.0E-06	4.0E-02	5.1E-05
Indeno(1,2,3-cd)Pyrene	7.2	0.02	1.3E-07	3.0E-02	4.4E-06
Phenanthrene	78	0.1	7.1E-06	3.0E-02	2.4E-04
Pyrene	41	0.1	3.7E-06	3.0E-02	1.2E-04
C11-C22 Aromatic Fraction	5049	0.1	4.6E-04	3.0E-02	1.5E-02
C19-C36 Aliphatic Fraction	415	0.2	7.5E-05	2.0E+00	3.8E-05
C5-C8 Aliphatic Fraction	131	0.2	2.4E-05	4.0E-02	5.9E-04
C9-C10 Aromatic Fraction	657	0.2	1.2E-04	3.0E-02	4.0E-03
C9-C18 Aliphatic Fraction	2001	0.2	3.6E-04	1.0E-01	3.6E-03
Chromium (total)	18	0.1	1.6E-06	3.0E-03	5.3E-04
Cyanide	7.3	0.1	6.6E-07	6.0E-04	1.1E-03
Lead	74	0.006	4.0E-07	7.5E-04	5.4E-04
				HI_{dermal} =	**3.1E-02**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.

TABLE IV-15 (Continued)
CALCULATION OF LIFETIME AVERAGE DAILY DOSES AND RISK ESTIMATES
FOR DERMAL CONTACT WITH SOIL
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Trespasser (Child, age 7<15)
CANCER EFFECTS

Dermal Contact with Soil

See TABLE D-13 for Exposure Variables and Rationale

$$LADD_{soil\text{-}dermal} = \frac{EPC_{soil} * DCR_{soil} * EF * ED * EP * RAF_{dermal\text{-}c} * C1}{BW * AP_c}$$

See TABLE D-10 for Exposure Point Concentration Derivation

$$ELCR_{soil\text{-}dermal} = LADD_{soil\text{-}dermal} * CSF$$

Total $ELCR_{soil\text{-}dermal} = \Sigma ELCR_{soil\text{-}dermal}$

COC	EPC_{soil} EPC1 (mg/kg)	$RAF_{dermal\text{-}c}$ (unitless)	$LADD_{soil\text{-}dermal}$ (mg/kg-day)	CSF $(mg/kg\text{-}day)^{-1}$	$ELCR_{soil\text{-}dermal}$ (unitless)
Benzene	23	0.03	7.3E-08	5.5E-02	4.00E-09
Ethylbenzene	24	1	2.5E-06	NA	NC
Naphthalene	291	1	3.0E-05	NA	NC
Toluene	20	1	2.1E-06	NA	NC
Xylene (Total)	29	1	2.9E-06	NA	NC
2-Methylnaphthalene	45	1	4.6E-06	NA	NC
Acenaphthene	11	1	1.2E-06	NA	NC
Acenaphthylene	22	1	2.2E-06	NA	NC
Anthracene	19	1	2.0E-06	NA	NC
Benzo(a)Anthracene	15	0.02	3.1E-08	1.0E-01	3.10E-09
Benzo(a)Pyrene	16	0.02	3.3E-08	1.0E+00	3.31E-08
Benzo(b)Fluoranthene	11	0.02	2.2E-08	1.0E-01	2.19E-09
Benzo(g,h,i)Perylene	7.9	1	8.2E-07	NA	NC
Benzo(k)Fluoranthene	9.5	0.02	2.0E-08	1.0E-02	1.97E-10
Biphenyl	9.4	0.1	9.8E-08	8.0E-03	7.80E-10
Carbazole	3.8	0.18	7.0E-08	2.0E-02	1.40E-09
Chrysene	15	0.02	3.1E-08	1.0E-02	3.12E-10
Dibenzo(a,h)anthracene	2.4	0.02	5.0E-09	1.0E+00	5.05E-09
Dibenzofuran	9.3	1	9.6E-07	NA	NC
Fluoranthene	28	1	2.9E-06	NA	NC
Fluorene	22	1	2.3E-06	NA	NC
Indeno(1,2,3-cd)Pyrene	7.2	0.02	1.5E-08	1.0E-01	1.50E-09
Phenanthrene	78	1	8.1E-06	NA	NC
Pyrene	41	1	4.2E-06	NA	NC
C11-C22 Aromatic Fraction	5049	1	5.2E-04	NA	NC
C19-C36 Aliphatic Fraction	415	1	4.3E-05	NA	NC
C5-C8 Aliphatic Fraction	131	1	1.4E-05	NA	NC
C9-C10 Aromatic Fraction	657	1	6.8E-05	NA	NC
C9-C18 Aliphatic Fraction	2001	1	2.1E-04	NA	NC
Chromium (total)	18	1	1.8E-06	NA	NC
Cyanide	7.3	1	7.6E-07	NA	NC
Lead	74	1	7.7E-06	NA	NC
				Total $ELCR_{dermal}$:	**5.2E-08**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.
3. A default value of 1 is used when a RAF is otherwise unavailable.

TABLE IV-16
CALCULATION OF AVERAGE DAILY DOSES AND RISK ESTIMATES
FOR INCIDENTAL INGESTION OF SOIL
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Trespasser (Child, age 7<15)
CHRONIC NON-CANCER EFFECTS

Incidental Ingestion of Soil

See TABLE D-13 for Exposure Variables and Rationale

$$ADD_{soil\text{-}oral} = \frac{EPC_{soil} * IR_{soil} * EF * ED * EP * RAF_{oral\text{-}nc} * C1}{BW * AP_{nc}}$$

See TABLE D-10 for Exposure Point Concentration Derivation

$$HQ_{soil\text{-}oral} = \frac{ADD_{soil\text{-}oral}}{RfD}$$

$$HI_{soil\text{-}oral} = \Sigma HQ_{soil\text{-}oral}$$

COC	EPC_{soil} EPC1 (mg/kg)	$RAF_{oral\text{-}nc}$ (unitless)	$ADD_{soil\text{-}oral}$ (mg/kg-day)	RfD Chronic (mg/kg-day)	$HQ_{soil\text{-}oral}$ (unitless)
Benzene	23	1	2.6E-06	4.0E-03	6.6E-04
Ethylbenzene	24	1	2.7E-06	5.0E-02	5.4E-05
Naphthalene	291	0.3	9.8E-06	2.0E-02	4.9E-04
Toluene	20	1	2.2E-06	8.0E-02	2.8E-05
Xylene (Total)	29	1	3.2E-06	2.0E-01	1.6E-05
2-Methylnaphthalene	45	0.3	1.5E-06	4.0E-03	3.8E-04
Acenaphthene	11	0.3	3.8E-07	6.0E-02	6.3E-06
Acenaphthylene	22	0.3	7.3E-07	3.0E-02	2.4E-05
Anthracene	19	0.3	6.4E-07	3.0E-01	2.1E-06
Benzo(a)Anthracene	15	0.3	5.1E-07	3.0E-02	1.7E-05
Benzo(a)Pyrene	16	0.3	5.4E-07	3.0E-04	1.8E-03
Benzo(b)Fluoranthene	11	0.3	3.6E-07	3.0E-02	1.2E-05
Benzo(g,h,i)Perylene	7.9	0.3	2.7E-07	3.0E-02	8.9E-06
Benzo(k)Fluoranthene	9.5	0.3	3.2E-07	3.0E-02	1.1E-05
Biphenyl	9.4	1	1.1E-06	5.0E-01	2.1E-06
Carbazole	3.8	1	4.2E-07	NA	NC
Chrysene	15	0.3	5.1E-07	3.0E-02	1.7E-05
Dibenzo(a,h)anthracene	2.4	0.3	8.2E-08	3.0E-02	2.7E-06
Dibenzofuran	9.3	1	1.0E-06	1.0E-03	1.0E-03
Fluoranthene	28	0.3	9.5E-07	4.0E-02	2.4E-05
Fluorene	22	0.3	7.5E-07	4.0E-02	1.9E-05
Indeno(1,2,3-cd)Pyrene	7.2	0.3	2.4E-07	3.0E-02	8.1E-06
Phenanthrene	78	0.3	2.6E-06	3.0E-02	8.8E-05
Pyrene	41	0.3	1.4E-06	3.0E-02	4.6E-05
C11-C22 Aromatic Fraction	5049	0.3	1.7E-04	3.0E-02	5.7E-03
C19-C36 Aliphatic Fraction	415	1	4.7E-05	2.0E+00	2.3E-05
C5-C8 Aliphatic Fraction	131	1	1.5E-05	4.0E-02	3.7E-04
C9-C10 Aromatic Fraction	657	1	7.4E-05	3.0E-02	2.5E-03
C9-C18 Aliphatic Fraction	2001	1	2.2E-04	1.0E-01	2.2E-03
Chromium (total)	18	1	2.0E-06	3.0E-03	6.6E-04
Cyanide	7.3	1	8.2E-07	6.0E-04	1.4E-03
Lead	74	0.3	2.5E-06	7.5E-04	3.3E-03
				HI_{oral} =	**2.1E-02**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.
3. A default value of 1 is used when a RAF is otherwise unavailable.

TABLE IV-16 (Continued)
CALCULATION OF LIFETIME AVERAGE DAILY DOSES AND RISK ESTIMATES
FOR INCIDENTAL INGESTION OF SOIL
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Trespasser (Child, age 7<15)
CANCER EFFECTS

Incidental Ingestion of Soil

See TABLE D-13 for Exposure Variables and Rationale

$$LADD_{soil\text{-}oral} = \frac{EPC_{soil} * IR_{soil} * EF * ED * EP * RAF_{oral\text{-}c} * C1}{BW * AP_c}$$

See TABLE D-10 for Exposure Point Concentration Derivation

$$ELCR_{soil\text{-}oral} = LADD_{soil\text{-}oral} * CSF$$

Total $ELCR_{soil\text{-}oral}$ = Σ $ELCR_{soil\text{-}oral}$

COC	EPC_{soil} EPC1 (mg/kg)	$RAF_{oral\text{-}c}$ (unitless)	$LADD_{soil\text{-}oral}$ (mg/kg-day)	CSF $(mg/kg\text{-}day)^{-1}$	$ELCR_{soil\text{-}oral}$ (unitless)
Benzene	23	1	3.0E-07	5.5E-02	1.65E-08
Ethylbenzene	24	1	3.1E-07	NA	NC
Naphthalene	291	1	3.7E-06	NA	NC
Toluene	20	1	2.5E-07	NA	NC
Xylene (Total)	29	1	3.7E-07	NA	NC
2-Methylnaphthalene	45	1	5.7E-07	NA	NC
Acenaphthene	11	1	1.4E-07	NA	NC
Acenaphthylene	22	1	2.8E-07	NA	NC
Anthracene	19	1	2.4E-07	NA	NC
Benzo(a)Anthracene	15	0.3	5.8E-08	1.0E-01	5.78E-09
Benzo(a)Pyrene	16	0.3	6.2E-08	1.0E+00	6.16E-08
Benzo(b)Fluoranthene	11	0.3	4.1E-08	1.0E-01	4.07E-09
Benzo(g,h,i)Perylene	7.9	1	1.0E-07	NA	NC
Benzo(k)Fluoranthene	9.5	0.3	3.7E-08	1.0E-02	3.67E-10
Biphenyl	9.4	1	1.2E-07	8.0E-03	9.69E-10
Carbazole	3.8	0.96	4.6E-08	2.0E-02	9.28E-10
Chrysene	15	0.3	5.8E-08	1.0E-02	5.82E-10
Dibenzo(a,h)anthracene	2.4	0.3	9.4E-09	1.0E+00	9.40E-09
Dibenzofuran	9.3	1	1.2E-07	NA	NC
Fluoranthene	28	1	3.6E-07	NA	NC
Fluorene	22	1	2.9E-07	NA	NC
Indeno(1,2,3-cd)Pyrene	7.2	0.3	2.8E-08	1.0E-01	2.79E-09
Phenanthrene	78	1	1.0E-06	NA	NC
Pyrene	41	1	5.3E-07	NA	NC
C11-C22 Aromatic Fraction	5049	1	6.5E-05	NA	NC
C19-C36 Aliphatic Fraction	415	1	5.3E-06	NA	NC
C5-C8 Aliphatic Fraction	131	1	1.7E-06	NA	NC
C9-C10 Aromatic Fraction	657	1	8.4E-06	NA	NC
C9-C18 Aliphatic Fraction	2001	1	2.6E-05	NA	NC
Chromium (total)	18	1	2.2E-07	NA	NC
Cyanide	7.3	1	9.4E-08	NA	NC
Lead	74	1	9.5E-07	NA	NC
				Total $ELCR_{oral}$:	**1.0E-07**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.
3. A default value of 1 is used when a RAF is otherwise unavailable.

TABLE IV-17
CALCULATION OF AVERAGE DAILY EXPOSURES AND RISK ESTIMATES
FOR INHALATION OF FUGITIVE DUST
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Trespasser (Child, age 7<15)
CHRONIC NON-CANCER EFFECTS

See TABLE II-1 for Exposure Variables and Rationale See TABLE D-10 for Exposure Point Concentration Derivation	**Inhalation of Soil-derived Fugitive Dust** $ADE_{inh\text{-}dust} = \frac{EPC_{dust} * EF * ED * EP * C2}{AP_{nc}}$ $HQ_{inh\text{-}dust} = \frac{ADE_{inh\text{-}dust}}{RfC}$		$HI_{inh\text{-}dust} = \Sigma HQ_{inh\text{-}dust}$	
COC	**EPC_{dust}** **EPC3**	**$ADE_{inh\text{-}dust}$**	**RfC** **Chronic**	**$HQ_{inh\text{-}dust}$**
	(mg/m³)	**(mg/m³)**	**(mg/m³)**	**(unitless)**
Benzene	7.5E-07	5.3E-09	3.0E-03	1.8E-06
Ethylbenzene	7.6E-07	5.4E-09	1.0E+00	5.4E-09
Naphthalene	9.3E-06	6.6E-08	3.0E-03	2.2E-05
Toluene	6.4E-07	4.5E-09	5.0E+00	9.0E-10
Xylene (Total)	9.1E-07	6.5E-09	1.0E-01	6.5E-08
2-Methylnaphthalene	1.4E-06	1.0E-08	5.0E-02	2.0E-07
Acenaphthene	3.6E-07	2.5E-09	5.0E-02	5.1E-08
Acenaphthylene	6.9E-07	4.9E-09	5.0E-02	9.8E-08
Anthracene	6.1E-07	4.3E-09	5.0E-02	8.6E-08
Benzo(a)Anthracene	4.8E-07	3.4E-09	5.0E-02	6.8E-08
Benzo(a)Pyrene	5.1E-07	3.6E-09	2.0E-06	1.8E-03
Benzo(b)Fluoranthene	3.4E-07	2.4E-09	5.0E-02	4.8E-08
Benzo(g,h,i)Perylene	2.5E-07	1.8E-09	5.0E-02	3.6E-08
Benzo(k)Fluoranthene	3.1E-07	2.2E-09	5.0E-02	4.3E-08
Biphenyl	3.0E-07	2.1E-09	2.0E-03	1.1E-06
Carbazole	1.2E-07	8.5E-10	NA	NC
Chrysene	4.8E-07	3.4E-09	5.0E-02	6.9E-08
Dibenzo(a,h)anthracene	7.8E-08	5.5E-10	5.0E-02	1.1E-08
Dibenzofuran	3.0E-07	2.1E-09	NA	NC
Fluoranthene	9.0E-07	6.4E-09	5.0E-02	1.3E-07
Fluorene	7.2E-07	5.1E-09	5.0E-02	1.0E-07
Indeno(1,2,3-cd)Pyrene	2.3E-07	1.6E-09	5.0E-02	3.3E-08
Phenanthrene	2.5E-06	1.8E-08	5.0E-02	3.6E-07
Pyrene	1.3E-06	9.3E-09	5.0E-02	1.9E-07
C11-C22 Aromatic Fraction	1.6E-04	1.1E-06	5.0E-02	2.3E-05
C19-C36 Aliphatic Fraction	1.3E-05	9.4E-08	NA	NC
C5-C8 Aliphatic Fraction	4.2E-06	3.0E-08	2.0E-01	1.5E-07
C9-C10 Aromatic Fraction	2.1E-05	1.5E-07	5.0E-02	3.0E-06
C9-C18 Aliphatic Fraction	6.4E-05	4.5E-07	2.0E-01	2.3E-06
Chromium (total)	5.6E-07	4.0E-09	1.0E-04	4.0E-05
Cyanide	2.3E-07	1.7E-09	8.0E-04	2.1E-06
Lead	2.4E-06	1.7E-08	1.0E-03	1.7E-05
			$HI_{inh\text{-}dust}$:	**1.9E-03**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.

TABLE IV-17 (Continued)
CALCULATION OF LIFETIME AVERAGE DAILY EXPOSURES AND RISK ESTIMATES
FOR INHALATION OF FUGITIVE DUST
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Trespasser (Child, age 7<15)
CANCER EFFECTS

See TABLE II-1 for Exposure Variables and Rationale

See TABLE D-10 for Exposure Point Concentration Derivation

Inhalation of Soil-derived Fugitive Dust

$$LADE_{inh\text{-}dust} = \frac{EPC_{dust} * EF * ED * EP * C2 * C4}{AP_c}$$

$ELCR_{inh\text{-}dust} = LADE_{inh\text{-}dust} * UR$ Total $ELCR_{inh\text{-}dust} = \Sigma ELCR_{inh\text{-}dust}$

COC	EPC_{dust} EPC3 (mg/m³)	$LADE_{inh\text{-}dust}$ (µg/m³)	UR (µg/m³)$^{-1}$	$ELCR_{inh\text{-}dust}$ (unitless)
Benzene	7.5E-07	6.1E-07	7.8E-06	4.7E-12
Ethylbenzene	7.6E-07	6.2E-07	NA	NC
Naphthalene	9.3E-06	7.5E-06	NA	NC
Toluene	6.4E-07	5.1E-07	NA	NC
Xylene (Total)	9.1E-07	7.4E-07	NA	NC
2-Methylnaphthalene	1.4E-06	1.2E-06	NA	NC
Acenaphthene	3.6E-07	2.9E-07	NA	NC
Acenaphthylene	6.9E-07	5.6E-07	NA	NC
Anthracene	6.1E-07	4.9E-07	NA	NC
Benzo(a)Anthracene	4.8E-07	3.9E-07	6.0E-05	2.3E-11
Benzo(a)Pyrene	5.1E-07	4.1E-07	6.0E-04	2.5E-10
Benzo(b)Fluoranthene	3.4E-07	2.7E-07	6.0E-05	1.6E-11
Benzo(g,h,i)Perylene	2.5E-07	2.0E-07	NA	NC
Benzo(k)Fluoranthene	3.1E-07	2.5E-07	6.0E-06	1.5E-12
Biphenyl	3.0E-07	2.4E-07	NA	NC
Carbazole	1.2E-07	9.8E-08	NA	NC
Chrysene	4.8E-07	3.9E-07	6.0E-06	2.3E-12
Dibenzo(a,h)anthracene	7.8E-08	6.3E-08	6.0E-04	3.8E-11
Dibenzofuran	3.0E-07	2.4E-07	NA	NC
Fluoranthene	9.0E-07	7.3E-07	NA	NC
Fluorene	7.2E-07	5.8E-07	NA	NC
Indeno(1,2,3-cd)Pyrene	2.3E-07	1.9E-07	6.0E-05	1.1E-11
Phenanthrene	2.5E-06	2.0E-06	NA	NC
Pyrene	1.3E-06	1.1E-06	NA	NC
C11-C22 Aromatic Fraction	1.6E-04	1.3E-04	NA	NC
C19-C36 Aliphatic Fraction	1.3E-05	1.1E-05	NA	NC
C5-C8 Aliphatic Fraction	4.2E-06	3.4E-06	NA	NC
C9-C10 Aromatic Fraction	2.1E-05	1.7E-05	NA	NC
C9-C18 Aliphatic Fraction	6.4E-05	5.2E-05	NA	NC
Chromium (total)	5.6E-07	4.5E-07	1.2E-02	5.4E-09
Cyanide	2.3E-07	1.9E-07	NA	NC
Lead	2.4E-06	1.9E-06	NA	NC
			Total $ELCR_{inh\text{-}dust}$:	**5.8E-09**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.

TABLE IV-18
CALCULATION OF AVERAGE DAILY DOSES AND RISK ESTIMATES
FOR DERMAL CONTACT WITH SEDIMENT
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Trespasser (Child, age 7<15)
CHRONIC NON-CANCER EFFECTS

Dermal Contact with Sediment

$$ADD_{sed\text{-}dermal} = \frac{EPC_{sed} * DCR_{sed} * EF * ED * EP * RAF_{dermal\text{-}nc} * C1}{BW * AP_{nc}}$$

See TABLE D-10 for Exposure Point Concentration Derivation

$$HQ_{sed\text{-}dermal} = \frac{ADD_{sed\text{-}dermal}}{RfD}$$

$HI_{sed\text{-}dermal} = \Sigma HQ_{sed\text{-}dermal}$

COC	EPC_{sed} EPC7 (mg/kg)	$RAF_{dermal\text{-}nc}$ (unitless)	$ADD_{sed\text{-}dermal}$ (mg/kg-day)	RfD Chronic (mg/kg-day)	$HQ_{sed\text{-}dermal}$ (unitless)
Benzene	37	0.03	7.3E-06	4.0E-03	1.8E-03
Ethylbenzene	203	0.03	4.0E-05	5.0E-02	8.0E-04
Naphthalene	739	0.1	4.8E-04	2.0E-02	2.4E-02
Xylene (Total)	257	0.03	5.1E-05	2.0E-01	2.5E-04
2-Methylnaphthalene	414	0.1	2.7E-04	4.0E-03	6.8E-02
Acenaphthene	454	0.1	3.0E-04	6.0E-02	5.0E-03
Acenaphthylene	35	0.1	2.3E-05	3.0E-02	7.7E-04
Anthracene	266	0.1	1.7E-04	3.0E-01	5.8E-04
Benzo(a)Anthracene	201	0.02	2.6E-05	3.0E-02	8.8E-04
Benzo(a)Pyrene	109	0.02	1.4E-05	3.0E-04	4.8E-02
Benzo(b)Fluoranthene	97	0.02	1.3E-05	3.0E-02	4.2E-04
Benzo(g,h,i)Perylene	34	0.1	2.2E-05	3.0E-02	7.3E-04
Benzo(k)Fluoranthene	32	0.02	4.2E-06	3.0E-02	1.4E-04
Chrysene	192	0.02	2.5E-05	3.0E-02	8.4E-04
Dibenzo(a,h)anthracene	8.3	0.02	1.1E-06	3.0E-02	3.6E-05
Fluoranthene	320	0.1	2.1E-04	4.0E-02	5.2E-03
Fluorene	434	0.1	2.8E-04	4.0E-02	7.1E-03
Indeno(1,2,3-cd)Pyrene	28	0.02	3.7E-06	3.0E-02	1.2E-04
Phenanthrene	1020	0.1	6.7E-04	3.0E-02	2.2E-02
Pyrene	475	0.1	3.1E-04	3.0E-02	1.0E-02
C11-C22 Aromatic Fraction	16300	0.1	1.1E-02	3.0E-02	3.6E-01
C19-C36 Aliphatic Fraction	1250	0.2	1.6E-03	2.0E+00	8.2E-04
C9-C10 Aromatic Fraction	740	0.2	9.7E-04	3.0E-02	3.2E-02
C9-C18 Aliphatic Fraction	1670	0.2	2.2E-03	1.0E-01	2.2E-02
				$HI_{sed\text{-}dermal}$ =	**6.1E-01**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern.

TABLE IV-18 (Continued)
CALCULATION OF AVERAGE DAILY DOSES AND RISK ESTIMATES
FOR DERMAL CONTACT WITH SEDIMENT
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Trespasser (Child, age 7<15)
CANCER EFFECTS

Dermal Contact with Sediment

$$LADD_{sed\text{-}dermal} = \frac{EPC_{sed} * DCR_{sed} * EF * ED * EP * RAF_{dermal\text{-}c} * C1}{BW * AP_c}$$

See TABLE D-10 for Exposure Point Concentration Derivation

$ELCR_{sed\text{-}dermal} = LADD_{sed\text{-}dermal} * CSF$

Total $ELCR_{sed\text{-}dermal} = \Sigma ELCR_{sed\text{-}dermal}$

COC	EPC_{sed} EPC7 (mg/kg)	$RAF_{dermal\text{-}c}$ (unitless)	$LADD_{sed\text{-}dermal}$ (mg/kg-day)	CSF $(mg/kg\text{-}day)^{-1}$	$ELCR_{sed\text{-}dermal}$ (unitless)
Benzene	37	0.03	8.35E-07	5.5E-02	4.6E-08
Ethylbenzene	203	1	1.52E-04	NA	NC
Naphthalene	739	1	5.54E-04	NA	NC
Xylene (Total)	257	1	1.92E-04	NA	NC
2-Methylnaphthalene	414	1	3.10E-04	NA	NC
Acenaphthene	454	1	3.40E-04	NA	NC
Acenaphthylene	35	1	2.63E-05	NA	NC
Anthracene	266	1	1.99E-04	NA	NC
Benzo(a)Anthracene	201	0.02	3.01E-06	1.0E-01	3.0E-07
Benzo(a)Pyrene	109	0.02	1.63E-06	1.0E+00	1.6E-06
Benzo(b)Fluoranthene	97	0.02	1.45E-06	1.0E-01	1.5E-07
Benzo(g,h,i)Perylene	34	1	2.52E-05	NA	NC
Benzo(k)Fluoranthene	32	0.02	4.75E-07	1.0E-02	4.8E-09
Chrysene	192	0.02	2.88E-06	1.0E-02	2.9E-08
Dibenzo(a,h)anthracene	8.3	0.02	1.25E-07	1.0E+00	1.2E-07
Fluoranthene	320	1	2.40E-04	NA	NC
Fluorene	434	1	3.25E-04	NA	NC
Indeno(1,2,3-cd)Pyrene	28	0.02	4.18E-07	1.0E-01	4.2E-08
Phenanthrene	1020	1	7.65E-04	NA	NC
Pyrene	475	1	3.56E-04	NA	NC
C11-C22 Aromatic Fraction	16300	1	1.22E-02	NA	NC
C19-C36 Aliphatic Fraction	1250	1	9.37E-04	NA	NC
C9-C10 Aromatic Fraction	740	1	5.55E-04	NA	NC
C9-C18 Aliphatic Fraction	1670	1	1.25E-03	NA	NC
				Total $ELCR_{sed\text{-}dermal}$:	**2.3E-06**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.
3. A default value of 1 is used when a RAF is otherwise unavailable.

TABLE IV-19
CALCULATION OF AVERAGE DAILY DOSES AND RISK ESTIMATES
FOR INCIDENTAL INGESTION OF SEDIMENT
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Trespasser (Child, age 7<15)
CHRONIC NON-CANCER EFFECTS

Incidental Ingestion of Sediment

$$ADD_{sed\text{-}oral} = \frac{EPC_{sed} * IR_{sed} * EF * ED * EP * RAF_{oral\text{-}nc} * C1}{BW * AP_{nc}}$$

See TABLE D-10 for Exposure Point Concentration Derivation

$$HQ_{sed\text{-}oral} = \frac{ADD_{sed\text{-}oral}}{RfD}$$

$$HI_{sed\text{-}oral} = \Sigma HQ_{sed\text{-}oral}$$

COC	EPC_{sed} EPC7 (mg/kg)	$RAF_{oral\text{-}nc}$ (unitless)	$ADD_{sed\text{-}oral}$ (mg/kg-day)	RfD Chronic (mg/kg-day)	$HQ_{sed\text{-}oral}$ (unitless)
Benzene	37	1	4.2E-06	4.0E-03	1.0E-03
Ethylbenzene	203	1	2.3E-05	5.0E-02	4.5E-04
Naphthalene	739	0.3	2.5E-05	2.0E-02	1.2E-03
Xylene (Total)	257	1	2.9E-05	2.0E-01	1.4E-04
2-Methylnaphthalene	414	0.3	1.4E-05	4.0E-03	3.5E-03
Acenaphthene	454	0.3	1.5E-05	6.0E-02	2.5E-04
Acenaphthylene	35	0.3	1.2E-06	3.0E-02	3.9E-05
Anthracene	266	0.3	8.9E-06	3.0E-01	3.0E-05
Benzo(a)Anthracene	201	0.3	6.8E-06	3.0E-02	2.3E-04
Benzo(a)Pyrene	109	0.3	3.7E-06	3.0E-04	1.2E-02
Benzo(b)Fluoranthene	97	0.3	3.3E-06	3.0E-02	1.1E-04
Benzo(g,h,i)Perylene	34	0.3	1.1E-06	3.0E-02	3.8E-05
Benzo(k)Fluoranthene	32	0.3	1.1E-06	3.0E-02	3.6E-05
Chrysene	192	0.3	6.5E-06	3.0E-02	2.2E-04
Dibenzo(a,h)anthracene	8.3	0.3	2.8E-07	3.0E-02	9.3E-06
Fluoranthene	320	0.3	1.1E-05	4.0E-02	2.7E-04
Fluorene	434	0.3	1.5E-05	4.0E-02	3.6E-04
Indeno(1,2,3-cd)Pyrene	28	0.3	9.4E-07	3.0E-02	3.1E-05
Phenanthrene	1020	0.3	3.4E-05	3.0E-02	1.1E-03
Pyrene	475	0.3	1.6E-05	3.0E-02	5.3E-04
C11-C22 Aromatic Fraction	16300	0.3	5.5E-04	3.0E-02	1.8E-02
C19-C36 Aliphatic Fraction	1250	1	1.4E-04	2.0E+00	7.0E-05
C9-C10 Aromatic Fraction	740	1	8.3E-05	3.0E-02	2.8E-03
C9-C18 Aliphatic Fraction	1670	1	1.9E-04	1.0E-01	1.9E-03
				$HI_{sed\text{-}oral}$ =	**4.5E-02**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern.
3. A default value of 1 is used when a RAF is otherwise unavailable.

TABLE IV-19 (Continued)
CALCULATION OF AVERAGE DAILY DOSES AND RISK ESTIMATES
FOR INCIDENTAL INGESTION OF SEDIMENT
284 Winter Street
Haverhill, Massachusetts

RECEPTOR: Trespasser (Child, age 7<15)
CANCER EFFECTS

Incidental Ingestion of Sediment

$$LADD_{sed\text{-}oral} = \frac{EPC_{sed} * IR_{sed} * EF * ED * EP * RAF_{oral\text{-}c} * C1}{BW * AP_c}$$

See TABLE D-10 for Exposure Point Concentration Derivation

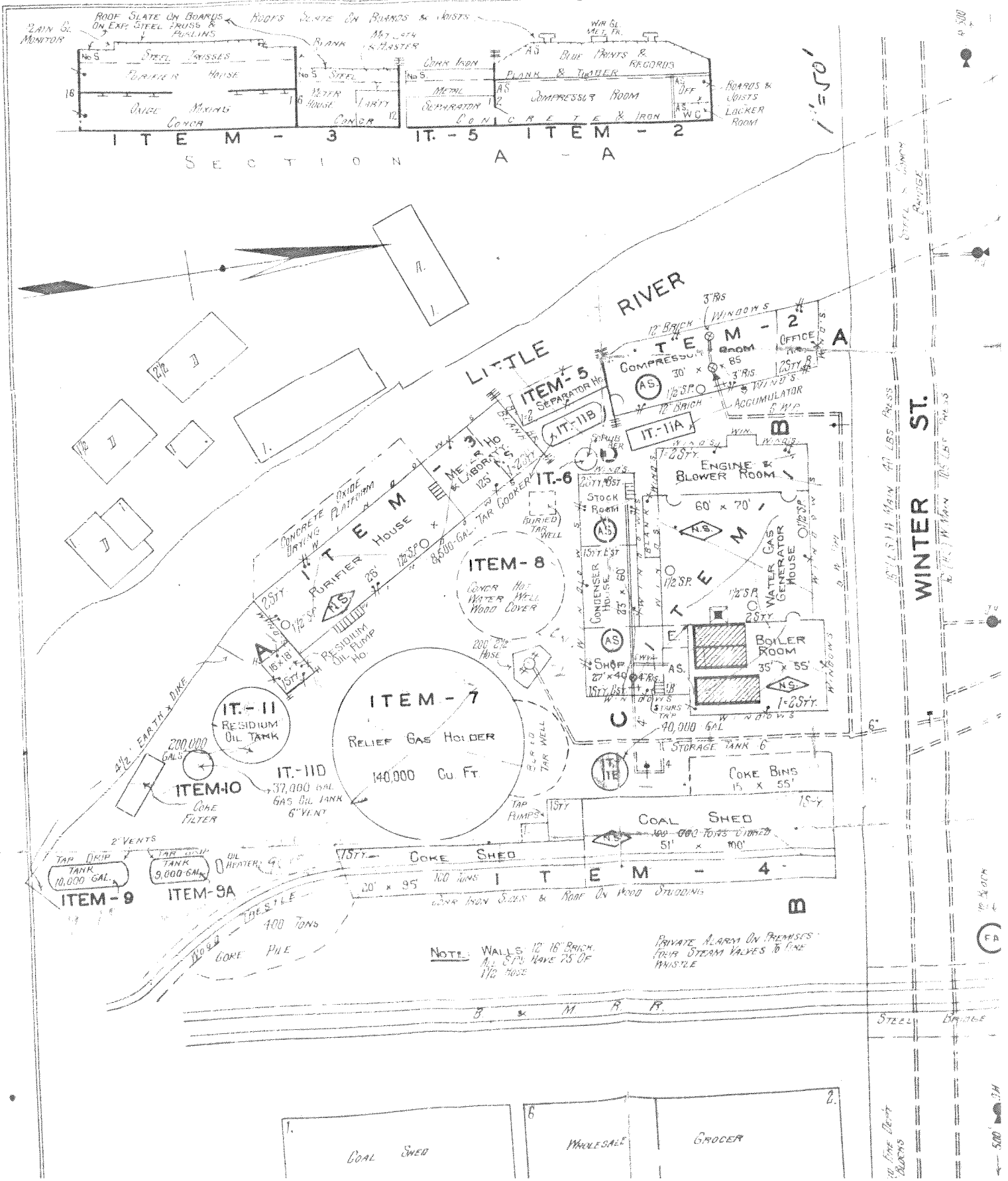
$ELCR_{sed\text{-}oral} = LADD_{sed\text{-}oral} * CSF$

Total $ELCR_{sed\text{-}oral} = \Sigma ELCR_{sed\text{-}oral}$

COC	EPC_{sed} EPC7 (mg/kg)	$RAF_{oral\text{-}c}$ (unitless)	$LADD_{sed\text{-}oral}$ (mg/kg-day)	CSF $(mg/kg\text{-}day)^{-1}$	$ELCR_{sed\text{-}oral}$ (unitless)
Benzene	37	1	4.75E-07	5.5E-02	2.6E-08
Ethylbenzene	203	1	2.60E-06	NA	NC
Naphthalene	739	1	9.46E-06	NA	NC
Xylene (Total)	257	1	3.29E-06	NA	NC
2-Methylnaphthalene	414	1	5.30E-06	NA	NC
Acenaphthene	454	1	5.81E-06	NA	NC
Acenaphthylene	35	1	4.49E-07	NA	NC
Anthracene	266	1	3.41E-06	NA	NC
Benzo(a)Anthracene	201	0.3	7.72E-07	1.0E-01	7.7E-08
Benzo(a)Pyrene	109	0.3	4.19E-07	1.0E+00	4.2E-07
Benzo(b)Fluoranthene	97	0.3	3.71E-07	1.0E-01	3.7E-08
Benzo(g,h,i)Perylene	34	1	4.30E-07	NA	NC
Benzo(k)Fluoranthene	32	0.3	1.22E-07	1.0E-02	1.2E-09
Chrysene	192	0.3	7.38E-07	1.0E-02	7.4E-09
Dibenzo(a,h)anthracene	8.3	0.3	3.20E-08	1.0E+00	3.2E-08
Fluoranthene	320	1	4.10E-06	NA	NC
Fluorene	434	1	5.56E-06	NA	NC
Indeno(1,2,3-cd)Pyrene	28	0.3	1.07E-07	1.0E-01	1.1E-08
Phenanthrene	1020	1	1.31E-05	NA	NC
Pyrene	475	1	6.08E-06	NA	NC
C11-C22 Aromatic Fraction	16300	1	2.09E-04	NA	NC
C19-C36 Aliphatic Fraction	1250	1	1.60E-05	NA	NC
C9-C10 Aromatic Fraction	740	1	9.48E-06	NA	NC
C9-C18 Aliphatic Fraction	1670	1	2.14E-05	NA	NC
				Total $ELCR_{sed\text{-}oral}$:	**6.1E-07**

Notes:
1. Only COCs that are detected at this exposure point are displayed.
2. COC = Constituent of Concern; NA = Not Applicable/Not Available; NC = Not Calculated.
3. A default value of 1 is used when a RAF is otherwise unavailable.

Appendix E – Historical Site Plan


SECTION A - A
ITEM - 3
IT. - 5
ITEM - 2
1" = 50'
RIVER
LITTLE
WINTER ST.
ITEM - 1
PURIFIER HOUSE
ITEM - 2
OFFICE
COMPRESSOR ROOM
ITEM - 3
ITEM - 4
COAL SHED
ITEM - 5
SEPARATOR
ITEM - 6
ENGINE & BLOWER ROOM
STOCK ROOM
ITEM - 7
RELIEF GAS HOLDER
140,000 Cu. FT
ITEM - 8
ITEM - 9
TAR DRIP TANK 10,000 GAL.
ITEM - 9A
TAR WELL TANK 9,000 GAL.
ITEM - 10
COKE FILTER
IT. - 11
RESIDUUM OIL TANK
200,000 GALS
IT. - 11A
IT. - 11B
IT. - 11D
37,000 GAL GAS OIL TANK
IT. - 11E
WATER GAS GENERATOR HOUSE
BOILER ROOM
SHOP
CONDENSER HOUSE
COKE BINS
40,000 GAL STORAGE TANK
COKE SHED
100 TONS
400 TONS COKE PILE
4½' EARTH DIKE
B & M R.R.
NOTE: WALLS 12" 16" BRICK. ALL STD. HAVE 75 OF 1½" HOSE
PRIVATE ALARM ON PREMISES FROM STEAM VALVES TO FIRE WHISTLE
WHOLESALE
GROCER
COAL SHED

Appendix F – Geophysical Survey

HAGER-RICHTER
GEOSCIENCE, INC.

GEOPHYSICAL SURVEY
284 WINTER STREET
HAVERHILL, MASSACHUSETTS

Prepared for:

GZA GeoEnvironmental, Inc.
249 Vanderbilt Avenue
Norwood, Massachusetts 02062

Prepared by:

Hager-Richter Geoscience, Inc.
8 Industrial Way - D10
Salem, New Hampshire 03079

File 16MH09
October, 2016

HAGER-RICHTER
GEOSCIENCE, INC.

CONSULTANTS IN GEOLOGY AND GEOPHYSICS
8 INDUSTRIAL WAY - D10
SALEM, NEW HAMPSHIRE 03079-5820
TELEPHONE (603) 893-9944
FAX (603) 893-8313

October 10, 2016
File 16MH09

Jason R. Chrzanowski
Project Manager
GZA GeoEnvironmental, Inc.
249 Vanderbilt Avenue
Norwood, Massachusetts 02062

Office: 781-278-5816
Direct: 781-223-0160
Email: jason.chrzanowski@gza.com

RE: Geophysical Survey
284 Winter Street
Haverhill, Massachusetts

Dear Mr. Chrzanowski:

In this report, we summarize the results of a geophysical survey conducted by Hager-Richter Geoscience, Inc. (H-R) at the above referenced site in Haverhill, Massachusetts for GZA GeoEnvironmental, Inc. (GZA) in September, 2016. The scope of the survey and the area of interest were specified by GZA.

INTRODUCTION

The site is an active Haffner's gasoline service station and car wash located at 284 Winter Street in Haverhill, Massachusetts. The general location of the site is shown on Figure 1. According to information provided by GZA, the property was formerly a MGP site from 1852 to 1975, and some of the related infrastructure could be present in the subsurface. GZA requested a geophysical survey to detect, and if detected, to locate subsurface utilities and former MGP related infrastructure in the accessible exterior portions of the site.

The area of interest (AOI) for the geophysical survey was specified by GZA to be the accessible exterior portions of the approximately 1.2 acre property. Six known underground storage tanks, pump islands, concrete pads, a fuel sales kiosk, and a car wash are currently present at the site. The ground surface was dominantly asphalt and concrete paved, with curbed landscape islands.

OBJECTIVES

The objectives of the geophysical survey were to detect, and if detected, to determine the location of: 1) possible subsurface utilities, and 2) former MGP related infrastructure that could be present in the accessible exterior portions of the Site.

THE SURVEY

Jeff Reid, P.G. and Steven Grant, P.G., of Hager-Richter conducted the geophysical survey on September 15, 2016. The project was coordinated with Mr. Jason R. Chrzanowski, of GZA. Mr. Andrew Sargent, also of GZA, was present for the field work and specified the area of interest. Photograph 1 shows representative field conditions.

Photograph 1. View to the southeast. Representative conditions at the site.

The geophysical survey was conducted using a combination of geophysical methods: time domain electromagnetic induction metal detection (EM61), ground penetrating radar (GPR), and precision utility location (PUL).

EM61 data were acquired at approximately 8-inch intervals along lines spaced 5 feet apart across the accessible portions of the AOI. The EM61 metal detection survey detects buried metal. However, the EM61 method cannot provide information on the type of objects causing an EM61 anomaly. The GPR survey was conducted along traverses oriented in two mutually perpendicular directions, with lines spaced no more than 5 feet apart across the accessible portions of the specified AOI. The GPR method is capable of detecting both metal and nonmetal objects. The PUL method was used to search for subsurface metallic utilities in the accessible portions of the specified AOI by searching for signals from active electric lines and by tracing signals induced by direct connections to accessible utility structures such as light poles and valves.

EQUIPMENT

EM61. The time domain electromagnetic induction survey was conducted using a Geonics EM61-MK2 time domain electromagnetic induction metal detector. The EM61-MK2

instrument was designed specifically for detecting buried metal objects such as USTs, drums, and utilities. An air-cored transmitter coil generates a pulsed primary magnetic field in the earth, thereby inducing eddy currents in nearby metal objects. The eddy current produces a secondary magnetic field that is sensed by two receiver coils, one coincident with the transmitter and one positioned 40 cm above the main coil. By measuring the secondary magnetic field after the current in the ground has dissipated but before the current in metal objects has dissipated, the instrument responds only to the secondary magnetic field produced by metal objects. Four channels of secondary response are measured in mV and are recorded on a digital data logger. The system is generally operated by pushing the coils configured as a wagon with an odometer mounted on the axle to trigger the data logger automatically at approximately 8-inch intervals.

GPR. The GPR survey was conducted using a Geophysical Survey Systems, Inc. UtilityScan DF digital dual-frequency system using both 300 MHz and 800 MHz antennas with 68 ns and 23 ns time windows, respectively. The UtilityScan DF system acquires data with the two antennas simultaneously, allowing for more rapid surveying without decreasing data density or quality.

GPR uses a high-frequency electromagnetic pulse (referred to herein as “radar signal”) transmitted from a radar antenna to probe the subsurface. The transmitted radar signals are reflected from subsurface interfaces of materials with contrasting electrical properties. Travel times of the radar signal can be converted to approximate depth below the surface by correlation with targets of known depths and by a curve matching routine. We monitor the acquisition of GPR data in the field and record the GPR data digitally for subsequent processing. Interpretation of the records is based on the nature and intensity of the reflected signals and on the resulting patterns.

Data from the GPR survey were processed using RADAN 7.4 GPR processing software from Geophysical Survey Systems, Inc. We reviewed profile images and created plan view time slice maps of the GPR data.

PUL. The PUL survey was conducted using a Radiodetection RD8000 series precision electromagnetic utility location instrument. The RD8000 series consists of a separate transmitter and receiver. The system can be used in "passive" and "active" modes to locate buried pipes by detecting radio frequency electromagnetic signals carried by the pipes. In the "passive" mode, only the receiver unit is used to detect signals carried by the pipe from nearby power lines, live signals transmitted along underground power cables, or very low frequency radio signals resulting from long wave radio transmissions that flow along buried conductors. In the "active" mode of operation, the transmitter is used to induce a signal on a target pipe, and the receiver is used to trace the signal along the length of the pipe. Our system uses a 10W transmitter.

LIMITATIONS OF THE METHODS

HAGER-RICHTER GEOSCIENCE, INC. MAKES NO GUARANTEE THAT ALL TARGETS OF INTEREST WERE DETECTED IN THIS SURVEY. HAGER-RICHTER GEOSCIENCE, INC. IS NOT RESPONSIBLE FOR DETECTING TARGETS THAT CANNOT BE DETECTED BY THE METHODS EMPLOYED OR BECAUSE OF SITE CONDITIONS. GPR SIGNAL PENETRATION MIGHT NOT BE SUFFICIENT TO DETECT ALL TARGETS OF INTEREST.

EM61. The EM61 cannot detect non-metallic objects. The data from an EM61 survey are adversely affected by surface metal. The EM61 has a depth sensitivity limited to about 12 feet. The instrument is relatively cumbersome, and works best where the transmit and receive coils can be hand pulled in a small trailer.

Detection and identification should be clearly differentiated. Detection is the recognition of the presence of a metal object, and the electromagnetic method is excellent for such purposes. Identification, on the other hand, is determination of the nature of the causative body (i.e., what is the body -- a cache of drums, UST, automobile, white goods, etc.?). Although the EM data cannot be used to *identify* all buried metal objects, they provide excellent guides to the identification of some objects. For example, buried metal utilities produce anomalies with lengths many times their widths.

GPR. There are limitations of the GPR technique as used to detect and/or locate targets such as those of the subject Site: (1) surface conditions, (2) electrical conductivity of the ground, (3) contrast of the electrical conductivities of the targets and the ground, and (4) spacing between lines. Of these limitations, only the fourth, line spacing, is controlled by the operator.

The condition of the ground surface can affect the quality of the GPR data and the depth of penetration of the GPR signal. Sites covered with high grass, bushes, landscape structures, debris, obstacles, soil mounds, etc. limit the survey access and the coupling of the GPR antenna with the ground. In many cases, the GPR signal will not penetrate below concrete pavement, especially inside of buildings, and a target may not be detectable.

The electrical conductivity of the ground determines the attenuation of the GPR signals, and thereby limits the maximum depth of exploration. The GPR signal does not penetrate clay-rich soils, and targets buried in clay can be missed.

A definite contrast in the electrical conductivities of the ground and the target is required to obtain a reflection of the GPR signal. If the contrast is too small, possibly due to construction

details or extremely corroded conditions of metal targets, then the reflection may be too weak to recognize, and the target can be missed.

The spacing between lines is under control of the GPR operator, and the design of the survey is based on the dimensions of the smallest feature of interest. Targets with dimensions smaller than the spacing between GPR survey lines can be missed.

RESULTS

The geophysical survey was conducted using time domain electromagnetic induction metal detection (EM), ground penetrating radar, and PUL methods across the accessible exterior portions of the site. Figure 2 is a color contour plot of the EM61 data, and Figure 3 shows the integrated interpretation of the geophysical data.

General. The EM61 data were acquired at approximately 8-inch intervals along survey lines spaced 5 feet apart across the accessible exterior portions of the area of interest. Interpretation of EM61 data is based on the *relative* response of the instrument in millivolts to local conditions. The instrument is not calibrated to provide an absolute measure of a particular property, such as the conductivity of the soil or the strength of the earth's magnetic field. Subsurface metal objects produce sharply defined positive anomalies when the EM61 is positioned directly over them. Acquiring data at short intervals along closely spaced lines, as was done at the subject site, provides high spatial resolution of the location and footprint of the targets. Thus, buried metal is recognized in contour plots of EM61 data by positive anomalies with spatial dimensions roughly corresponding to the dimensions of the buried metal.

Several moderate to high amplitude EM anomalies (green to red areas on Figure 2) are evident in the contour plot for the area of interest. Many of the high amplitude EM61 anomalies are attributed to metal in surface features such as buildings, pump and vacuum islands, catch basins, and reinforced concrete pads, and are shown as blue hatched areas in Figure 3. We note that the presence or absence of subsurface metal objects in such areas cannot be determined on the basis of the EM61 data alone because of the anomalies caused by the surface metal objects

Several moderate to high amplitude EM anomalies not attributable to surface metal objects are present and are attributed to buried metal. Linear EM anomalies are attributed to possible buried metallic utilities, and their locations are shown in Figure 3. Other EM anomalies not caused by surface metal are attributed to particular structures based on additional information or from other geophysical methods (e.g. EM anomaly south of pump islands related to a known UST, EM anomaly attributed to buried reinforced concrete) and are discussed below. The remainder of the moderate to high amplitude, EM anomalies not attributed to a particular feature are shown as areas of buried metal in Figure 3.

Apparent GPR signal penetration in the south portion and along the east and along the west sides of the site was generally fair to good with two-way traveltime reflections received from about 20 to 25 ns of the 70 ns time window. Based upon site-specific velocity matching calibrations made for the site, the GPR signal penetration is estimated to have been about 3 to 4 feet in such areas. GPR signal penetration was especially limited in much of the central portion of the site, with two-way traveltime reflections received from about 10 to 15 ns, or about 1 to 2 feet. The broad area of limited GPR signal penetration is shown on Figure 3.

Possible Subsurface Utilities and Known USTS. Gas, electric, water, and unidentified lines were detected at the time of the survey and their locations are shown in Figure 3. Note that water service to the site was marked by others in the sidewalk and landscaping on the north side of the site, but could not be detected by the present survey An unidentified utility that appears to continue from the south end of the water service marked by others is likely too shallow (<2 feet) to be a water line. The PUL instrument was used to locate many of the utilities by connecting the PUL transmitter to valves and conduits and the locations of some utilities were confirmed with GPR. Additional unidentified lines were detected after office review of the data and their locations are also shown in Figure 3 as black bold dashed lines because their locations were not marked in the field. *Whether additional utilities occur at a depth greater than the effective depth of penetration of the GPR signal or in areas inaccessible to the geophysical survey cannot be determined from the geophysical data.*

GPR reflections were received from portions of the six known USTs in use at the service station. GPR signal penetration in such areas was very limited, and the GPR reflections were received only for the very tops (about 2 ft depth) of the known USTs. With the exception of the southernmost known UST, it was not possible to determine the east and west ends of the known USTs. The locations of the known USTs are shown and black hatched areas in Figure 3.

Possible Former MGP Related Infrastructure. Attributing a detected feature to a former use, such as, in the present case, a MGP, is difficult unless the shape or location of such features is diagnostic. For instance, a large round area containing a high amplitude EM anomaly could be attributed to the buried foundations of a former gas holder, if such a feature is consistent with historic data. The following subsurface features detected by the geophysical survey are not identified in information provided by GZA as structures related to the current service station. It is possible that such features may be related to the former MGP.

GPR reflections consistent with two large buried objects are evident in the records for an area containing a moderate to high amplitude EM anomaly located at the northwest corner of the car wash. It is possible that such objects may be related to the former MGP, although an association with the car wash is suggested by their location. However, no structures related to

the existing service station are reported for this location. The objects are approximately 3 ft by 10 ft and size and are approximately 2.5 to 3 feet deep. The shape and size of the objects are somewhat consistent with small USTs, although it is possible that they are related to piping associated with the car wash (a former water well is located less than 10 feet from this location). The locations of the large buried objects are shown as crossed boxes in Figure 3. No other objects consistent USTs with: (1) electrical properties sufficiently contrasting with the surrounding soils to produce GPR reflections, or (2) a capacity of 500 gallons or more were detected within the effective depth of penetration of the GPR signal (see above) in the areas surveyed by GPR. *Whether a UST occurs at a depth greater than the effective depth of penetration of the GPR signal or in areas inaccessible to the geophysical survey cannot be determined from the geophysical data.*

A buried reinforced concrete structure was detected on the west edge of the site. The buried concrete structure is approximately 35 feet by 10 feet in size and the top of the structure is less than 1 foot deep. The identity of such a structure is unknown, although according to information provided by GZA, many of the structures related to the former MGP were located along the west side of the site. The location of the buried reinforced concrete structure is shown as areas stippled with black circles in Figure 3.

Large areas of buried metal are present at the site, and are especially common in the northwest portion of the site. GPR reflections from objects or structures were not received for such areas, although GPR signal penetration was limited to 1 to 2 feet for this area. Whether areas of buried metal are related to the former MGP cannot be determined on the basis of the geophysical data. Areas of buried metal are shown as red cross-hatched areas in Figure 3.

CONCLUSIONS

Based on the geophysical survey conducted by Hager-Richter Geoscience, Inc. at 284 Winter Street in Haverhill, Massachusetts for GZA in September, 2016, we conclude that:

- Utilities were detected at the site, and their locations are shown on Figure 3
- Two large buried objects are present near the northwest corner of the car wash.
- A buried reinforced concrete structure is located on the west edge of the site.
- Areas of buried metal are present and are especially common in northwest portion of the site

LIMITATIONS ON USE OF THIS REPORT

This letter report was prepared for the exclusive use of GZA (Client). No other party shall be entitled to rely on this Report or any information, documents, records, data, interpretations, advice or opinions given to Client by Hager-Richter Geoscience, Inc. (H-R) in the performance of its work. The Report relates solely to the specific project for which H-R has been retained and shall not be used or relied upon by Client or any third party for any variation or extension of this project, any other project or any other purpose without the express written permission of H-R. Any unpermitted use by Client or any third party shall be at Client's or such third party's own risk and without any liability to H-R.

H-R has used reasonable care, skill, competence and judgment in the performance of' its services for this project consistent with professional standards for those providing similar services at the same time, in the same locale, and under like circumstances. Unless otherwise stated, the work performed by H-R should be understood to be exploratory and interpretational in character and any results, findings or recommendations contained in this Report or resulting from the work proposed may include decisions which are judgmental in nature and not necessarily based solely on pure science or engineering. It should be noted that our conclusions might be modified if subsurface conditions were better delineated with additional subsurface exploration including, but not limited to, test pits, soil borings with collection of soil and water samples, and laboratory testing.

Except as expressly provided in this limitations section, H-R makes no other representation or warranty of any kind whatsoever, oral or written, expressed or implied; and all implied warranties of merchantability and fitness for a particular purpose, are hereby disclaimed.

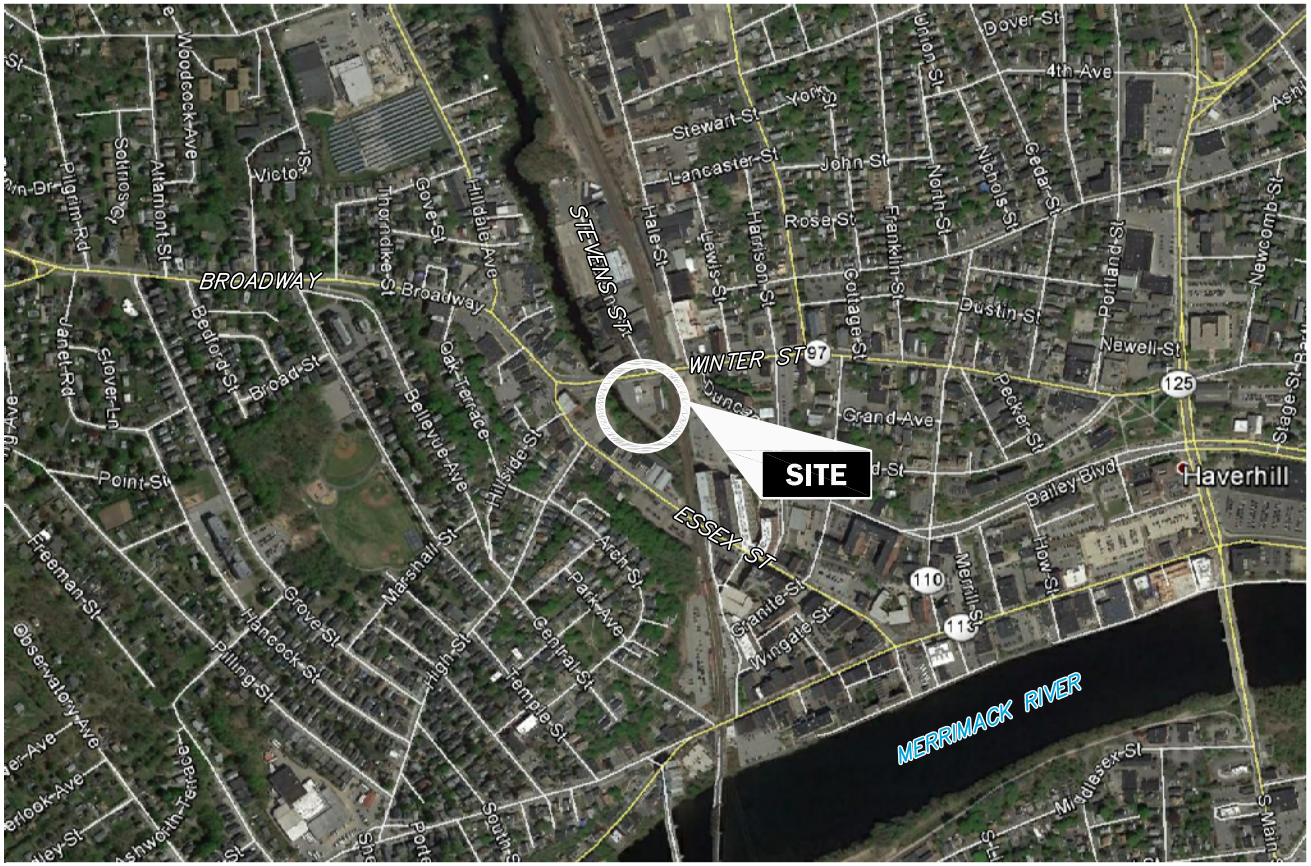
If you have any questions or comments on this letter report, please contact us at your convenience. It has been a pleasure to work with GZA on this project. We look forward to working with you again in the future.

Sincerely yours,
HAGER-RICHTER GEOSCIENCE, INC.

Steven Grant, P.G.
Senior Geophysicist

Dorothy Richter, P.G.
President

Attachments: Figures 1 - 3

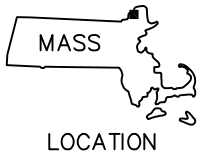


N

H-R

APPROXIMATE SCALE (feet)

0 1000 2000



LOCATION

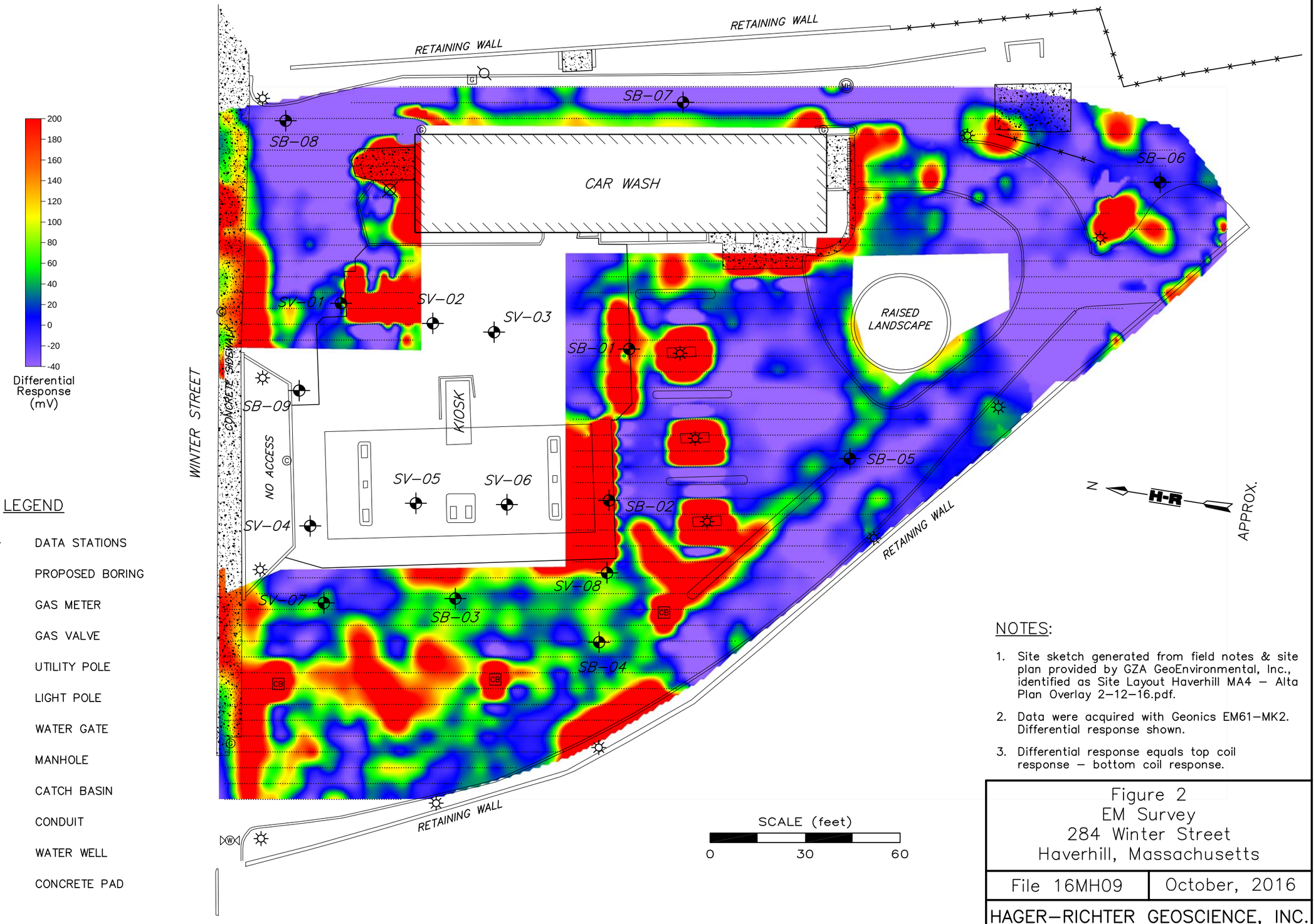
NOTE:

Modified from Google Earth Pro aerial photograph.

Figure 1
General Site Location
284 Winter Street
Haverhill, Massachusetts

File 16MH09 | October, 2016

HAGER–RICHTER GEOSCIENCE, INC.
Salem, New Hampshire



LEGEND

- DATA STATIONS
- PROPOSED BORING
- GAS METER
- GAS VALVE
- UTILITY POLE
- LIGHT POLE
- WATER GATE
- MANHOLE
- CATCH BASIN
- CONDUIT
- WATER WELL
- CONCRETE PAD

NOTES:

1. Site sketch generated from field notes & site plan provided by GZA GeoEnvironmental, Inc., identified as Site Layout Haverhill MA4 – Alta Plan Overlay 2–12–16.pdf.
2. Data were acquired with Geonics EM61–MK2. Differential response shown.
3. Differential response equals top coil response – bottom coil response.

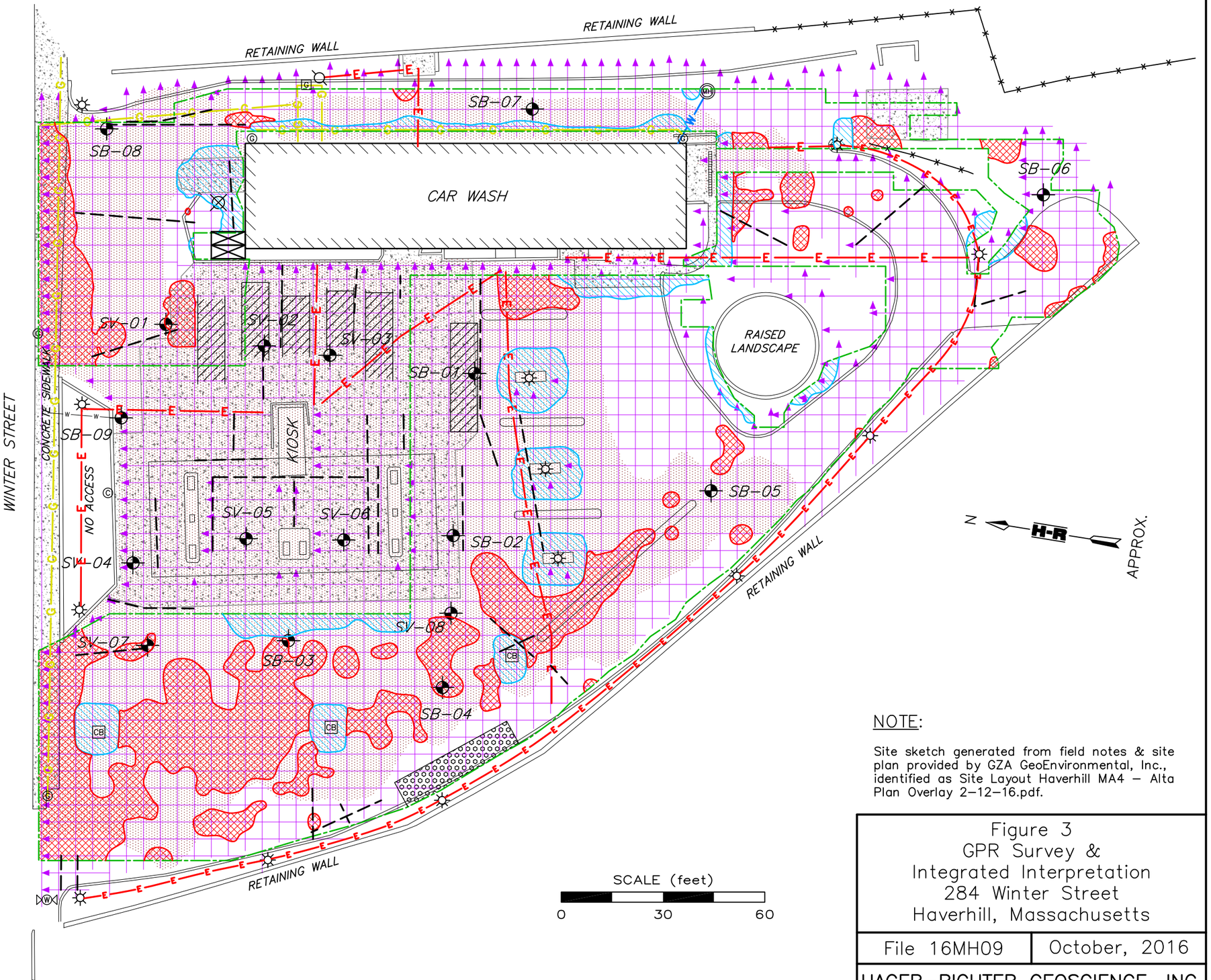
Figure 2
EM Survey
284 Winter Street
Haverhill, Massachusetts

File 16MH09 | October, 2016

HAGER–RICHTER GEOSCIENCE, INC.
Salem, New Hampshire

LEGEND

- APPROXIMATE LIMITS OF EM SURVEY AREA
- GPR TRAVERSE
- AREA OF POSSIBLE BURIED METAL
- GAS LINE
- ELECTRIC LINE
- WATER LINE – MARKED BY OTHERS
- POSSIBLE UTILITY
- UNIDENTIFIED BURIED OBJECT
- BURIED REINFORCED CONCRETE STRUCTURE
- AREA OF EXTREMELY LIMITED GPR SIGNAL PENETRATION
- EM ANOMALY ATTRIBUTED TO EFFECTS OF SURFACE OBJECTS. THE PRESENCE OR ABSENCE OF BURIED METAL WITHIN THIS AREA CANNOT BE DETERMINED ON THE BASIS OF THE EM61 DATA ALONE.
- KNOWN UST
- PROPOSED BORING
- GAS METER
- GAS VALVE
- UTILITY POLE
- LIGHT POLE
- WATER GATE
- MANHOLE
- CATCH BASIN
- CONDUIT
- WATER WELL
- CONCRETE PAD



NOTE:

Site sketch generated from field notes & site plan provided by GZA GeoEnvironmental, Inc., identified as Site Layout Haverhill MA4 – Alta Plan Overlay 2–12–16.pdf.

Figure 3
GPR Survey &
Integrated Interpretation
284 Winter Street
Haverhill, Massachusetts

File 16MH09	October, 2016

HAGER–RICHTER GEOSCIENCE, INC.
Salem, New Hampshire

Appendix G – Soil Gas Sampling Procedures

APPENDIX D
SOIL GAS SAMPLING PROCEDURES

Soil gas sampling was conducted at the Site on two occasions, in October 2016 and in February 2020. Similar procedures were employed during both sampling events, as described below.

On October 18, 2016, GZA personnel installed eight stainless steel soil gas probes (NFSV-01 through NFSV-08) within and/or proximate to the underground storage tank (UST) concrete pad and the gasoline dispensing island apron. The locations of the soil gas probes are shown on Figure 2. At each location, GZA personnel used an electric hammer drill and bit to drill a 1.5-inch-diameter hole through the concrete or asphalt surfaces. The soil below the concrete or asphalt was excavated using vacuum excavation techniques to depths ranging from 13.5 to 20-inches bgs within an approximately 1-inch diameter hole. As noted in Table G1, below, the concrete or asphalt thicknesses ranged from approximately 3.5 to 8.5 inches at the sample locations. Table G1 also summarizes soil gas probe installation depths and screen intervals. The soil gas probes were backfilled with sand and grouted in place with anchor cement, which was allowed to cure for approximately 24 hours prior to sample collection

The soil gas core holes were screened with a photo-ionization detector (PID) for the presence of volatile organic compounds (VOCs). PID screening was conducted at each core hole prior to removal of soil and probe installation, following soil excavation to depth and prior to probe installation, and during soil gas probe purging and prior to sample collection. The initial PID values at the eight locations ranged from <0.1 to 1.9 parts per million by volume (ppmv), the values in the open core holes following soil excavation ranged from <0.1 to 27.9 ppmv, and the values during soil gas purging ranged from 1.1 to 6.3 ppmv. These data are summarized on the attached Table G2.

On October 19, 2016, GZA personnel completed helium leak testing of each soil gas probe prior to collecting soil gas samples. A field duplicate sample (DUP101916) was collected for Quality Assurance/Quality Control (QA/QC) purposes from location NFSV-01; the duplicate was collected concurrently with the primary sample using a stainless-steel tee fitting. Additionally, an ambient air sample (NFAA-01) was collected upwind of the gasoline dispensing islands during the helium leak testing and collection of the soil gas samples (see Figure 2 of the main report).

Prior to sample collection, GZA installed a soil gas extractor fitting with polyfluorotetraethylene (PTFE) tubing to the top of each soil gas probe and then installed an 8-inch-diameter clear PVC shroud over the probe. To isolate the probe when installing the shroud over the sampling point, the tubing connected to the soil gas extractor fitting on top of the probe was passed through a Swagelok® fitting in the roof of the shroud to the exterior. The perimeter base of the shroud was sealed with a bead of hydrated bentonite clay. The exterior soil gas probe sample tubing was then connected to a 3-way valve, with one of the valve outlets connected with additional sections of tubing to a Gillian model air pump and the other connected to a laboratory-supplied Summa® canister. Laboratory grade helium (>99% purity) was then introduced via tubing and an inlet port in the shroud. Helium concentrations were measured inside the shroud via another port in the shroud using a Dielectric Model MGD2002 helium detector until the shroud had a helium-rich atmosphere of greater than 90% helium. Helium input into the shroud was maintained and intermittently monitored inside the shroud to check that a helium-rich atmosphere existed during probe purging.

Once a helium-rich atmosphere was confirmed to exist, the air pump was used to purge the soil gas probe for approximately 5 minutes at a rate of approximately 200 milliliters per minute (mls/min). The soil gas purged from each probe was collected into a Tedlar® bag. Each Tedlar® bag containing the purged soil

gas from the sample locations was screened for the presence of helium to evaluate potential ambient air leakage into the subsurface soil gas probe during purging, and for VOCs using a PID. Helium was not detected in soil gas probe sample locations NFSV-02 through NFSV-08 above the instrument detection limit (<25 parts per million). Helium was detected at a concentration of approximately 1.5% in the purge gas from NFSV-01; the asphalt at this location was approximately 3.5 inches thick and pavement cracks were noted around the sample location. Available guidance for helium leak testing for soil gas sampling indicates that helium concentrations less than 10% of the shroud concentration represent acceptable conditions for sample collection; the measured concentration at NFSV-01 was well below this target.

Following the completion of helium leak testing, GZA personnel collected soil gas samples on October 19, 2016 from each location into 2.7-liter laboratory certified clean Summa® canisters fitted with flow controllers to allow for sample collection at a rate of less than 200 mls/min. The helium shroud remained over the sampling point during sample collection.

On February 12, 2020, GZA personnel collected three additional soil gas samples at locations SG-1, SG-2 and SG-3. The sample locations are shown on Figure 2 of the main report. The soil gas probe installation and sample collection methods were similar to those implemented in 2016 and described above, except that helium leak testing was not employed. Details regarding the concrete thickness, probe screen interval and probe depths are summarized in Table G1 below.

TABLE G1
SUMMARY OF SOIL GAS SAMPLING LOCATIONS

Location ID	Concrete Pad or Asphalt Thickness (inches)	Probe Screen Interval (inches below ground surface)
October 2016		
NFSV-01	Asphalt - 3	14.4 to 17.4
NFSV-02	Concrete - 7.5	17-20
NFSV-03	Concrete - 8.5	17-20
NFSV-04	Concrete - 6.5	14.5-17.5
NFSV-05	Concrete - 5.5	14.5-17.5
NFSV-06	Concrete - 7.5	15.5-18.5
NFSV-07	Asphalt - 4	14.5-17.5
NFSV-08	Asphalt - 4	13.5-16.5
February 2020		
SG-1	Concrete - 5.5	6.5-9.75
SG-2	Concrete - 7.5	8.5-11.75
SG-3	Concrete - 6.25	7.25-10.5

Table G2
284 Winter Street Property, Haverhill MA
Soil Gas Samples NFSV-01 through NFSV-08
Project Name: Winter Street, Haverhill

Location ID	PID Screening (PPMV)[1] of open core hole prior to advancing to depth[2] (10/18/16)	PID Screening (PPMV) of open core hole to depth[3] (10/18/16)	PID Screening (PPMV) after purging probe (10/19/16)	Concrete Pad or Asphalt Thickness (inches)	Probe Screen Interval (inches below ground surface)	Helium Concentration in Purged Soil Gas[4]	Notes
NFSV-01	0.2	27.9	5.6	Asphalt - 3	14.4 to 17.4	1.50%	Pavement cracks observed near sample location
NFSV-02	0.1	ND	2.4	Concrete - 7.5	17-20	ND	
NFSV-03	1.1	1.1	6.3	Concrete - 8.5	17-20	ND	
NFSV-04	1.9	1.9	1.1	Concrete - 6.5	14.5-17.5	ND	
NFSV-05	0.5	3.7	1.8	Concrete - 5.5	14.5-17.5	ND	
NFSV-06	1.0	1.0	1.4	Concrete - 7.5	15.5-18.5	ND	
NFSV-07	ND	0.7	1.1	Asphalt - 4	14.5-17.5	ND	
NFSV-08	0.9	1.8	2.3	Asphalt - 4	13.5-16.5	ND	

Notes:

1. Soil samples were screened using an Ion Science Tiger Organic Vapor Meter (OVM) equipped with a 10.6 ev lamp for the presence of Voliatile Organics (VOCs). PPMV = Parts Per Million by Volume. ND = Not detected above the instrument detection limit (<0.1 ppmv)
2. PID screen reading was taken of the open asphalt or concrete core hole prior to soil removal for probe installation.
3. PID screen reading was recorded of highest noted value of the open probe hole prior to probe installation, backfill, and sealing with anchor cement.
4. Helium concentrations were measured using a Dielectric model DG2002 helium detector with a detection range of 25 ppm to 100% concentration; ND = not detected above the instrument detection limit (<25 ppm).

GZA GeoEnvironmental, Inc.