FOURTH FIVE-YEAR REVIEW REPORT FOR
PINE STREET CANAL SUPERFUND SITE
BURLINGTON
CHITTENDEN COUNTY, VERMONT

Prepared by

U.S. Environmental Protection Agency
Region 1
Boston, MA

KAREN MCGUIRE Digitally signed by KAREN MCGUIRE
Date: 2021.12.14 15:17:28 -05'00'

Karen McGuire, Director
Enforcement and Compliance Assurance Division
On behalf of Bryan Olson, Director
Superfund and Emergency Management Division

Date

SEMS Doc ID 100019664

Table of Contents

List of Tables:

List of Figures:

List of Appendices

LIST OF ABBREVIATIONS & ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirement
AVS	acid volatile sulfide
BED	Burlington Electric Department
BRA	Baseline Risk Assessment
BTEX+N	benzene, toluene, ethylbenzene, xylene + naphthalene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CMR	Compliance Monitoring Report
CMWP	Compliance Monitoring Work Plan
COC	Contaminants of Concern
CSMP	Consolidated Site Monitoring Plan
DNAPL	dense nonaqueous phase liquids
ESD	Explanation of Significant Differences
FYR	Five-Year Review
ICs	Institutional Controls
LCMM	Lake Champlain Maritime Museum
MCL	Maximum Contaminant Level
MGP	manufactured gas plant
MOA	Memorandum of Agreement
NAPL	non-aqueous phase liquid
NAVD88	North American Vertical Datum
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAA	National Oceanic Atmospheric Administration
NPL	National Priorities List
O&M	operation and maintenance
OMMP	Operation Maintenance and Monitoring Plan
OU	Operable Unit
PAH	Polycyclic aromatic hydrocarbons
PRP	Potentially Responsible Party
PSBCCC	Pine Street Barge Canal Coordinating Council
QAPP	Quality Assurance Project Plan
RAO	Remedial Action Objectives
RCM	reactive core mat
RD/RA	Remedial Design/Remedial Action
ROD	Record of Decision
RPM	Remedial Project Manager
SBERA	Supplemental Baseline Ecological Risk Assessment
SEM	simultaneously extracted metals
SLERA	Screening Level Ecological Risk Assessment
SOW	Statement of Work
SVOC	semi-volatile organic compounds
TBC	To be considered
TOC	total organic carbon
USEPA	United States Environmental Protection Agency

UU/UE	unlimited use and unrestricted exposure
VGES	Vermont Groundwater Enforcement Standard
VISL	Vapor Intrusion Screening Level
VOC	volatile organic compounds
VTDEC	Vermont Department of Environmental Conservation

I. INTRODUCTION

The purpose of a Five-Year Review (FYR) is to evaluate the implementation and performance of a remedy in order to determine if the remedy is and will continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in five-year review reports such as this one. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The U.S. Environmental Protection Agency (EPA) is preparing this FYR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121, consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP)(40 CFR Section 300.430(f)(4)(ii)) and considering EPA policy.

This is the fourth FYR for the Pine Street Canal Superfund Site. The triggering action for this statutory review is the completion of the third FYR, dated December 19, 2016 (USEPA, 2016b). This FYR has been prepared because hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure (UU/UE). Appendix A lists the documents reviewed for, and referenced in, this FYR.

The Site consists of one Operable Unit (OU) that will be addressed in this FYR.

The Pine Street Canal Superfund Site Five-Year Review was led by Richard Hull, Remedial Project Manager for EPA Region 1. Participants included Paulina Do and Taya Gibeau (EPA Region 1 risk assessors), Eve Vaudo (EPA Region 1 attorney) and Charlotte Gray (EPA Region 1 community involvement coordinator). Graham Bradley, Project Manager with Vermont Agency of Natural Resources, Department of Environmental Conservation (VTDEC), also participated in this review. The relevant entities such as the Potentially Responsible Parties (PRPs) were notified of the initiation of the five-year review. The review began on 3/18/2021.

Site Background

The Pine Street Canal Superfund Site (the Site) is located on Pine Street in Burlington, Vermont, on the shores of Lake Champlain (the Lake; Figure 1). The Site consists of an abandoned barge canal and turning basin, surrounding wetlands, and upland areas (Figure 2). It is hydraulically connected to Lake Champlain and is subject to seasonal flooding from the Lake. The Site is a 38-acre area where contaminants associated with wastes from a manufactured gas plant (MGP) have been found. Currently most of the Site is vacant, and portions are zoned as Recreation/Open Space-Conservation. Wetlands on the Site support a diversity of mammals, birds, reptiles, amphibians, and fish. The canal and turning basin are connected to the Lake and support reptiles, amphibians, and fish.

Surrounding properties and portions of the Site are zoned as Enterprise-Light Manufacturing, and future development is expected in the vacant area east of the Site in conjunction with the ongoing redevelopment of the Pine Street corridor. The State of Vermont has reclassified the groundwater under the Site as Class IV: not suitable for potable use, but possibly suitable for agricultural or industrial use. Human consumption of groundwater from the Site is prohibited. Several industrial facilities near the Site have deep bedrock wells that supply process and non-contact cooling water. Institutional controls in the form of deed restrictions on parcels within and certain parcels outside the Site boundary (Figure 3) prohibit residential use and use for children's day care centers, as well as generally restricting use that may cause recontamination of the Site, impact the Lake or

interfere with ongoing remedial actions. A Site Chronology and more detail about Site characteristics and history are presented in Appendix B.

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: Pine Street Canal Superfund Site		
EPA ID: VTD980523062		
Region: 1	State: VT	**City/County:** Burlington, Chittenden
SITE STATUS		
NPL Status: Final		
Multiple OUs? No	Has the site achieved construction completion? Yes	
REVIEW STATUS		
Lead agency: EPA		
Author name: Richard Hull, Remedial Project Manager		
Author affiliation: USEPA Region 1		
Review period: 3/18/2021 - 12/19/2021		
Date of site inspection: 10/26/2021		
Type of review: Statutory		
Review number: 4		
Triggering action date: 12/19/2016		
Due date (five years after triggering action date): 12/19/2021		

II. RESPONSE ACTION SUMMARY

Basis for Taking Action

Both human-health risks and ecological risks were investigated at the Site. Table II-1 presents a list of the Human Health and Ecological Contaminants of Concern (COC) listed in the 1998 Record of Decision (ROD; USEPA, 1998).

Summary of Human-Health Risks

The 1992 Human-Health Risk Assessment (M&E, 1992) concluded that the most significant human-health risk at the Site was associated with potential residential ingestion of groundwater. The estimated carcinogenic risk for groundwater exceeded EPA's target risk range of 10^{-6} to 10^{-4}, and the estimated non-carcinogenic hazard for groundwater ingestion exceeded a hazard index of 1. Carcinogenic and non-carcinogenic risk estimates were below, within, or close to EPA's target risk range for individuals, including swimmers in Lake Champlain, outdoor workers exposed to soils less than a depth of 5 feet, and current and future visitors (adults and children) to an area that may be zoned for recreation, conservation, and open space.

COCs that were evaluated included polycyclic aromatic hydrocarbons (PAHs), cyanide, volatile organic compounds (VOCs), non-PAH semi-volatile organic compounds (SVOCs), pesticides, and metals. In 1992, the Pine Street Barge Canal Coordinating Council (PSBCCC) identified human-health exposure pathways requiring additional consideration beyond the 1992 Baseline Risk Assessment (BRA). Additional studies conducted during the 1994-1997 remedial investigation were used to evaluate these exposure pathways; these are documented in position papers included in the Additional Remedial Investigation Report (JCO, 1997). The following summarizes the additional evaluations and results for the additional exposure pathways.

- Additional shallow soil samples were collected and confirmed the previous findings regarding shallow soils.
- Additional air sampling confirmed that the Site does not impact local ambient air under undisturbed conditions.
- Use of Site groundwater for agricultural and commercial uses was evaluated, and it was concluded that there is no unacceptable risk.
- An evaluation of metals and fish consumption concluded that it is not likely that fish consumption would occur at a rate high enough to pose an unacceptable risk from metals, except for mercury, which is a wide-spread problem in fish due to non-point anthropogenic sources, and the reason for numerous fish consumption advisories throughout the region, including the Lake.
- An evaluation of PAHs and fish consumption concluded that there is not likely an unacceptable risk.
- Legal controls would be needed to limit potential future exposure to subsurface soils (deeper than 5 feet).
- Additional studies confirmed that there is no unacceptable Site-related human health-risk to swimmers in the Lake or to persons using it as a drinking water source.
- The 1992 human-health risk assessment was conservative enough to accommodate the possibility of some synergistic (i.e., greater than additive) effects between chemicals.

- Zoning ordinances at the time of the 1998 ROD did not restrict the placement of a day care center for children on the Site; however, it was concluded that there is a concern from potential exposures of children to lead and carcinogenic PAHs in Site soils.

Summary of Ecological Risks

COCs identified in the BRA (M&E, 1992) and Supplemental Baseline Ecological Risk Assessment (SBERA; Weston, 1997) included several PAHs and metals (including mercury). The BRA and SBERA concluded that there was an unacceptable risk to environmental receptors from Site-related contaminants. The following summarizes the conclusions of those two ecological risk assessments:

- PAHs and metals in sediments exceeded sediment guidelines published by the National Oceanic and Atmospheric Administration (NOAA) and the Ontario Ministry of Environment and Energy indicating possible impacts to sediment-dwelling organisms and benthic species.
- Data collected in the turning basin and the canal exceeded draft EPA sediment quality criteria for certain PAHs.
- Brown bullhead fish bile samples contained biochemical biomarker levels and PAH metabolite levels that were statistically significantly higher than corresponding levels for fish collected in the reference area.
- Frog embryos exposed to sediments from the southern section of the canal had 100% mortality, and embryo survival was significantly reduced when exposed to sediments from the wetland south of North Road.

The above conclusions regarding the Site contamination and risks to human health and the environment formed the basis of the remedy selected in the 1998 ROD.

Response Actions

Activities undertaken prior to and since the issuance of the ROD in September 1998 are summarized below.

- October 23, 1981 Proposed for National Priorities List (NPL)
- September 8, 1983 Site listed on NPL
- May 1990 Draft Remedial Investigation Report
- March 1992 Supplemental Remedial Investigation Final Report
- May 1992 Baseline Risk Assessment Final Report
- November 1992 Feasibility Study Report
- November 1992 EPA issued Proposed Plan
- March 1993 State of Vermont implements Class IV Groundwater designation
- Spring 1993 EPA withdrew Proposed Plan issued November 1992
- Fall 1993 Pine Street Barge Canal Coordinating Council (PSBCCC) formed
- July 1997 Supplemental Baseline Ecological Risk Assessment
- July 1997 Additional Remedial Investigation Report
- May 1998 Additional Feasibility Study Report

- May 1998 EPA issued second Proposed Plan
- September 1998 Record of Decision Signed by EPA
- February 2000 Consent Decree between EPA and Defendants for Implementation of the Remedy
- Oct 2001-Mar 2003 Remedy constructed
- Summer 2004 Cap extended over the West Bank
- December 2006 First FYR conducted
- April 2009 EPA issued first ESD
- September 2011 EPA issued second ESD
- December 2011 Second FYR conducted
- Nov 2013-Feb 2014 Vertical Barrier and NAPL recovery wells constructed
- December 2016 Third FYR conducted
- September 2017 Vertical Barrier – Southern Extent Focused Investigation conducted
- September 2019 Lake Sediment and Pore Water Investigation conducted

Remedial Action Objectives

The 1998 ROD includes the following remedial action objectives.

Ecological

(a) In areas where risks are unacceptable, including Subareas 1, 2, 3, 7, and 8, eliminate direct exposure of ecological receptors to contaminated soils and sediments, or reduce exposure to levels representing an acceptable risk.

(b) In areas as identified in item (a) above, where it is not feasible to eliminate direct exposure to contaminated soils and sediments or reduce exposure to levels presenting an acceptable risk, reduce direct exposures of ecological receptors to contaminants of concern to the extent feasible.

(c) Prevent or minimize the long-term adverse effects of remediation activities on the existing aquatic environment and/or wetland habitat.

(d) Restore wetlands affected by remediation.

Human Health

(a) Absent an appropriate risk assessment which has been approved by EPA, prevent unacceptable exposure (direct contact, ingestion, and inhalation) to contaminated soils located greater than five feet below grade.

(b) Prevent ingestion and exposures associated with residential use (direct contact, ingestion and inhalation) to contaminated groundwater where contaminated groundwater presents unacceptable risks, including Class IV areas.

(c) Prevent exposures associated with residential use (direct contact, ingestion and, inhalation) to contaminated soils, sediments, air and surface water at the Site.

Management of Migration

(a) Protect Lake Champlain from being impacted by contaminants left on site.

(i) Ensure Lake Champlain is not impacted by a significant increase in mass flux of contaminants through groundwater migration.
(ii) Ensure Lake Champlain is not impacted by a significant increase in mass flux of contaminants through contaminated sediment migration.
(iii) Prevent changes in hydrogeologic conditions that will likely cause migration of contaminated groundwater to Lake Champlain in concentrations that exceed a standard to be developed.

(b) Protect areas not targeted for remediation (both on- and off-site) by preventing significant migration of contamination from on-site sources.
(i) Ensure that contaminated groundwater with concentration levels above drinking water standards does not migrate beyond the Class IV boundary.
(ii) Ensure that contaminated on-site sediments are not significantly mobilized.
(iii) Ensure that non-aqueous phase liquid (NAPL) is not significantly mobilized.
(iv) Prevent degradation of surface water to levels above ambient water quality criteria.
(v) Prevent degradation of local (urban) background air quality.

(c) Protect remediated areas on the Site from becoming re-contaminated from on-site and off-site sources.
(i) Ensure that hazardous substances left in place do not mobilize or create unacceptable risk to ecological receptors and humans in remediated areas.
(ii) Monitor to provide necessary data to determine if non-CERCLA substances are mobilizing or creating unacceptable risks.
(iii) Monitor to provide the necessary data to determine whether storm water and non-contact cooling water may be creating an unacceptable risk to ecological receptors and humans in remediated areas.

Site Uses

(a) Ensure to the extent practical that the remedy itself does not reduce the suitability of the Site for current and future uses, including a highway.
(b) Retain or expand current Class IV groundwater classification and boundary.
(c) Maintain or replace beneficial functions and values of wetlands.

Remedy Components

The remedial action for the Site selected in the 1998 ROD included the following components:

- Capping contaminated sediments in all areas where an unacceptable ecological risk has been found in order to isolate the contamination below the biologically active zone. This includes a subaqueous sand/silt cap in the canal and turning basin, sand/topsoil cap in certain emergent wetlands, and a soil cover over an approximately 100x100-foot area of upland/wetlands south of the turning basin on the east bank of the canal.
- Long-term performance monitoring of groundwater, surface water, storm water, sediments, and cap.
- Establishing institutional controls to:

- Prevent the use of on-site groundwater for drinking water.
- Prevent land uses that could result in unacceptable risks to human health, such as residential use, use as a children's day care center, and most excavations below 5 feet.
- Prevent or limit the migration of existing contamination.

The selected remedy also included construction of a permanent weir at the mouth of the turning basin where it enters the Lake; aquatic and wetlands habitat restoration; the redirection of stormwater from municipal storm sewers at the Site; and five-year reviews of the remedy. Because the remedy selected is primarily a containment remedy with no active treatment or source control components, no cleanup levels were selected in the ROD. Performance standards for the constructed components of the remedy were established during remedial design.

Remedy Components Modified by Explanation of Significant Differences (ESD)

April 2009 ESD

Coal tar in the form of non-aqueous phase liquid (NAPL) was migrating through the sand cap in a 400-foot section at the southern end of the canal by methane formation in the sediments below the cap – a process called gas ebullition. Depending on the density, releases either floated on the surface of the water in the canal or accumulated in pools on the surface of the sand cap. The ESD called for a redesign and reconfiguration of the cap in this area. An Amended Cap was proposed to address this problem and consisted of a high-permeability layer to reduce the gas gradient, a reactive core mat (RCM) to facilitate passive capture of NAPL, and a final sand layer to provide habitat for benthic organisms. The Amended Cap was completed in February 2011.

September 2011 ESD

Groundwater monitoring showed an increase in dissolved benzene and the presence of NAPL in some monitoring wells near the edge of the Class IV groundwater boundary that lies between the canal and the Lake. The ESD called for the addition of a 200- to 300-foot-long vertical barrier wall below the ground surface and roughly parallel to the railroad track and bike path (the Vertical Barrier), and the installation of NAPL removal and groundwater monitoring wells. Construction of these features was completed in February 2014.

Status of Implementation

This section presents summaries of the remedial actions conducted at the Site in accordance with the 1998 ROD and the 2009 and 2011 ESDs. Ongoing operation and maintenance (O&M) activities and long-term performance monitoring are also described below. As a PRP-lead site, all remedial actions, O&M, and long-term monitoring are being implemented pursuant to a Consent Decree and Remedial Design/Remedial Action Statement of Work (RD/RA SOW) agreed to by EPA, the State of Vermont, and Performing Defendants that was entered by the United States District Court for the State of Vermont on February 11, 2000.

Construction of the remedy selected in the ROD was initially designed to be implemented in three phases: construction of the outlet weir (Phase 1A); cap construction in the emergent wetlands (Phase 1B); and construction of the subaqueous cap in the canal and turning basin (Phase 2). As a result of design changes, however, the cap in the canal and turning basin was constructed as an extension to Phase 1B while the canal was dewatered. This change was made because it was determined that placement of the geotextile and sand could be

better controlled in the "dry"; construction in the winter months could take advantage of increased sediment strength due to freezing; and the schedule could be accelerated. The outlet weir was constructed first to allow for better control of the canal water elevation during subsequent construction phases.

Phase 1A – Construction of the Weir

Phase 1A was completed in October 2001 (JCO, 2002a) and included the construction of a cast-in-place, broad-crested concrete weir at the canal outlet to Lake Champlain. The approximately 50-foot-long weir, located beneath the Burlington Bike Path bridge at the canal outlet, was designed to provide a normal canal stage elevation between 96.0 and 96.5 feet, using the North American Vertical Datum (NAVD88). Removable stop logs and a 6-foot-wide sluice were incorporated into the design to allow variation in the canal stage elevation after completion of construction, in order to improve wetlands hydrology and optimize wetlands functions at the Site and to improve access conditions for cap maintenance activities.

Phase 1B/2 – Cap Construction

Phase 1B, which consisted of capping emergent wetlands Areas 3 and 7 (Figure 4), construction of the Burlington Electric Department (BED) stormwater outfall and other stormwater management features and capping and construction of the Area 2 waterway in the southern end of the canal, was implemented in the summer and fall of 2002. Phase 2 construction on the remainder of Areas 2 and 1 (canal) and Area 8 (turning basin) was implemented over the winter of 2002-2003 as an extension to Phase 1B. The cap consists of a geotextile material covered by sand in the canal and turning basin, and sand and topsoil in the upland areas. In the wetland waterways, GeoWeb® or gabion baskets were placed on sand and filled with crushed stone to provide erosion protection. The 100x100-foot upland area was capped with sand and topsoil (JCO, 2004c). The canal and turning basin were reflooded in March 2003, in advance of spring flooding.

West Bank Cap

In the spring of 2003, following completion of the cap in Areas 1, 2, 3, 7, and 8 (Figure 4), pools of free-phase coal tar were observed outside the cap footprint on the west bank of the canal and on the surface of the subaqueous cap in the canal. Oily sheens and globules of NAPL were also observed on the surface of the water in the canal. During the fall of 2003, a response strategy was developed that recommended extending the sand cap over the affected portion of the west bank of the canal and removal of NAPL that had accumulated on the surface of the cap in the canal. The west bank cap construction and NAPL removal were implemented in the summer of 2004 (JCO, 2004c).

Wetland Restoration

Wetland restoration activities were performed in accordance with the Wetland Restoration Plan (JCO, 2002b), as modified to include restoration of the west bank. The initial seeding and planting within the restoration areas occurred during March and August 2003 and July 2004, and replacement planting was conducted in October 2004.

Subaqueous 'Amended' Cap in Areas 1 and 2

In 2006, it was discovered that significant seepage of coal tar into the canal had occurred due to gas ebullition through the subaqueous sand cap in the southern portion of the canal. The remedy was no longer protective of human health (i.e., contaminants could potentially migrate into Lake Champlain, a source of public drinking water) or the environment (i.e., the substrate was no longer suitable habitat for benthic organisms). In April 2009, following a 30-day comment period, EPA issued an ESD for the modification of the sand cap. Following discussions with EPA and the VTDEC, the Performing Defendants designed a modification, referred to as the Amended Cap (ARCADIS, 2010). The Amended Cap was constructed from August 2010 to February 2011.

Due to the absence of a surface sand layer in the Amended Cap, the cap mid-depth chemical sediment trap performance standard and habitat restoration performance standard established in the RD/RA SOW are no longer applicable in that area. The performance standard for the isolation of contaminants, which requires that contaminant migration through the cap be minimized, is still applicable to the Amended Cap; the long-term monitoring program has been revised to include monitoring for visual sheens, potential gas build-up, and the removal of NAPL from monitoring/recovery wells.

Vertical Barrier

Beginning in 2008, groundwater monitoring showed an increase in dissolved benzene and the presence of NAPL in some monitoring wells beyond the Class IV groundwater boundary in the area between the canal and the Lake (Figure 4). In September 2011, following a 30-day public comment period, EPA issued an ESD that called for the addition of a 200- to 300-foot-long vertical barrier below the ground surface and roughly parallel to the railroad tracks and bike path to contain NAPL, and prevent the migration of dissolved BTEX and naphthalene contamination in groundwater, under the railroad tracks to Lake Champlain. The ESD also specified the installation of NAPL removal wells and additional monitoring wells. The Vertical Barrier construction was completed in February 2014 (TRC, 2014).

EPA's statement of Other Findings in the third FYR in 2016 (USEPA, 2016b) included the following: *"If decreasing trends in dissolved contaminants outside of the vertical barrier are not observed over the next two compliance monitoring periods (Fall 2016 and Spring 2017), additional monitoring wells and a re-examination of groundwater flow conditions will be needed to determine the impact of contaminant migration across the Class IV boundary towards Lake Champlain".* As a result, the Performing Defendants conducted a focused field investigation to delineate the extent of Site-related dissolved-phase contaminants in groundwater at locations south of the Vertical Barrier and to identify the locations for additional long-term monitoring wells to be incorporated into the semi-annual groundwater monitoring program. The investigation included the advancement of five investigative boreholes south of the Vertical Barrier and the installation of three pairs of monitoring wells at the locations shown on Figure 5, and as reported in the November 15, 2017, Well Installation and Boring Report, Vertical Barrier – Southern Extent Focused Investigation Technical Memorandum (JCO, 2017c). The investigative soil borings and the semi-annual groundwater monitoring data collected at the six new wells indicate that the extent of Site-related constituents south of the Vertical Barrier have been delineated.

In 2019, in response to the same EPA statement of Other Findings, the Performing Defendants conducted the Lake Sediment and Pore Water Investigation (the Lake Study) to evaluate if Site contaminants were migrating to the Lake via groundwater, and if so, to determine the magnitude and extent of contamination in pore water, sediment, or surface water within the Lake west and southwest of the Vertical Barrier. Additionally, a Screening Level Ecological Risk Assessment (SLERA) was completed to evaluate the potential for adverse effects of Site

groundwater discharges to aquatic biota (fish and benthic invertebrates) in the near-shore area of the Lake. The Performing Defendants conducted this investigation and issued the June 2020, Lake Sediment and Pore Water Investigation Report, Revision 1.0 (JCO, 2020b). The investigation concluded that there is no significant risk to human health via direct contact and that, based on the absence of Site contaminants in surface water, there appears to be no measurable mass discharge to the Lake surface water. The SLERA concluded that because the maximum concentrations of all Site compounds were well below conservative screening values and water quality criteria, no potential for ecological risk in surface water, pore water, or sediment is expected to exist from the presence of Site contaminants in the near-shore areas of the Lake (JCO, 2020b).

Vapor Intrusion

The vapor intrusion pathway was not considered during remedial investigations for the 1998 ROD. In 2012, the Performing Defendants evaluated the potential for vapor intrusion using the November 2011 EPA Vapor Intrusion Screening Level (VISL) calculator with existing groundwater data. EPA determined that the potential for a complete pathway existed for one building on the Site, the BED building located at 585 Pine Street. The Performing Defendants installed four soil vapor and groundwater monitoring points in the immediate vicinity of the BED building at the locations shown on Figure 6. Evaluation of data collected from these locations in 2013, 2016, and again in 2021 were submitted to EPA. The 2021 data was evaluated using the 2021 updated VISL calculator and indicates, consistent with earlier evaluations, that there continues to be no unacceptable risk to human health due to vapor intrusion at the BED building (VHB, 2021d).

Historic Resources

It was determined that the capping remedy would adversely affect the canal and other features at the Site that are eligible for the National Register of Historic Places (JMA, 2001). The Performing Defendants entered into a Memorandum of Agreement (MOA) with EPA and the State of Vermont to mitigate those impacts (USEPA, 2002). Under the MOA, researchers from the Lake Champlain Maritime Museum (LCMM) studied a sunken barge of similar type to those in the canal and turning basin but located at the bottom of the Lake. Investigation of the barge—the Sloop Island Canal Boat—during the summers of 2002 and 2003 identified a large number of artifacts that were collected and subsequently housed at a museum in Vergennes, Vermont. In addition to a detailed technical report, LCMM created a report entitled *The Archaeology of a Champlain Canal Boat and the Pine Street Barge Canal* (https://semspub.epa.gov/src/document/01/454657) and developed signage for the Site chronicling its role in Burlington's booming lumber industry in the late 1800s to its cleanup under Superfund.

Institutional Controls (ICs)

ICs, in the form of deed restrictions that restrict certain activities, have been placed on parcels on and adjacent to the Site (Figure 3 and Table II-2). In the 2006 FYR, EPA concluded that the remedy would not be protective in the future without a mechanism in place to determine compliance with institutional controls that had been established to restrict land and groundwater use at the Site, and to protect the ongoing implementation of the remedy. In September 2007, EPA conditionally approved the Institutional Controls Plan (H&W, 2004), which contains a mechanism to monitor and maintain compliance with the institutional controls. Each landowner subject to institutional controls must submit an annual certification to EPA stating whether they have complied with the institutional controls required in the Consent Decree, and specifically with the deed restrictions placed on their property.

Modifications to O&M Plan since last FYR (2016)

A revised Consolidated Site Monitoring Plan (CSMP; VHB, 2021a) was submitted to EPA on June 17, 2021, and incorporated monitoring requirements at the Site from the following documents:

- Compliance Monitoring Work Plan (CMWP) revision 5, dated December 7, 2006
- Amended Cap Operation Maintenance and Monitoring Plan (OMMP), dated November 14, 2011
- Letters from EPA to the Performing Defendants' Project Coordinator dated August 27, 2012; August 9, 2013; March 31, 2016; and April 26, 2021
- Table 9 from the Draft Remedial Design Report rev. 1 dated October 1, 2012
- Restoration Plan for Mitigation of Habitat Loss Due to Installation of the Amended Cap, dated July 26, 2012
- Current (as of December 13, 2019) Standard Operating Procedures (SOPs) and Site-Specific Methods (SSMs) to the December 27, 2006 Quality Assurance Project Plan (QAPP)

As presented in the 2021 CSMP, several monitoring activities in the CMWP include provisions for their discontinuation ("sunset"). Where these provisions have been met, the monitoring activities have been omitted from the CSMP. Several other CMWP activities, discontinued for reasons described in past Compliance Monitoring Reports (CMRs), are listed below:

- Site-wide topography/bathymetry (sunset)
- Vegetation transect monitoring (sunset)
- Wetlands soil hydrology assessment (sunset)
- Wetlands groundwater elevation monitoring (sunset)
- Stormwater in-flow monitoring – sediment traps (sunset)
- Annual post-Amended Cap remediation wetlands restoration monitoring (sunset)
- Seepage meters (discontinued – see Section 2.5 of the Fall 2003 CMR dated January 14, 2004)
- Amended Cap Settlement Plate Survey (discontinued per EPA letter dated March 31, 2016)
- Annual post-Amended Cap remediation wetlands restoration monitoring (sunset)

In addition to the discontinued activities above, changes to several details in the CMWP have been made since 2006 due to technical or regulatory changes, minor modification to field methods, practical or logistical considerations, or in response to EPA correspondence of March 31, 2016 (USEPA, 2016a) and April 26, 2021 (USEPA, 2021). These changes include:

- Updates to SOPs and SSMs
- Grain size analysis of cap samples discontinued in 2012
- Cap chemistry and biological sampling discontinued in 2010 in the area of the Amended Cap
- Reduction in frequency and analytes for the sand cap coring
- Reduction in the frequency of benthic and submergent vegetation biological monitoring
- Reduction in the frequency of visual sheen monitoring
- Reduction in the frequency of metals analysis (except arsenic and lead) of groundwater samples
- Reduction in frequency of weir elevation survey
- Adjustments made to the sediment transport monitoring program

- NAPL pumping in large diameter shallow recovery wells (RW9+80, RW10+25, RW11, and RW14) discontinued in 2012 because previous attempts to remove NAPL from these wells yielded mostly water
- Reduction in the frequency of NAPL monitoring and removal in the area of the Amended Cap to one day every four weeks, with the exception of RW-109, which will be monitored and NAPL removed during three consecutive days every four weeks
- Reduction in the frequency of groundwater sampling of monitoring wells MW-9A, MW-9B, MW-24A, MW-24B, MW-30A, MW-30B, MW-31A, & MW-31B to annually, only in the fall, except for five-year review years, when they will be sampled semiannually
- Reduction in the frequency of analysis of samples for PAHs and metals for MW-21A, MW-21B, and MW-23B to annually, except for five-year review years, when samples will be analyzed for these contaminants semiannually

Ongoing Operation, Maintenance, and Monitoring Activities

Three monitoring phases were specified in the ROD: pre-construction, construction/post-construction, and long-term. Post-construction monitoring for each component of the remedy began once construction on that component was completed. Monitoring moved from post-construction to long-term, including operation and maintenance, with EPA approval from the Remedial Action Construction Completion Report (JCO, 2004c) in December 2004.

Long-term compliance monitoring is performed to determine achievement of the performance standards specified in the ROD and RD/RA SOW. Beginning with the spring 2021 sampling event, long-term compliance monitoring is performed according to the CSMP, Revision 5 (VHB, 2021c). Long-term monitoring activities from 2016 to 2021included:

Groundwater Monitoring

- Water level and field parameter monitoring in groundwater monitoring wells
- Sampling and laboratory analysis of groundwater in 25 wells screened in unconsolidated deposits
- Sampling and laboratory analysis of groundwater in three wells screened in deep unconsolidated deposits or bedrock monitoring wells

NAPL Monitoring and Recovery

- Monitoring wells: NAPL monitoring in 14 groundwater monitoring wells and removal of NAPL from these wells when present and as feasible
- Vertical Barrier Passive Recovery Wells: NAPL monitoring in the four recovery wells along the railroad tracks near the Vertical Barrier
- Amended Cap Passive Recovery Wells: NAPL monitoring and removal in the 14 recovery wells along both sides of the Amended Cap

Surface Water Monitoring

- Water quality monitoring
- Visual sheen and NAPL monitoring on the canal water surface near the Amended Cap

Cap Monitoring

- Cap coring and analysis

- Visual integrity inspections of the Amended Cap terminations

Biological Monitoring
- Benthic macroinvertebrate sampling
- Aquatic vegetation observations

Outlet Weir Inspection
- Visual inspection
- Elevation survey

Sediment Transport Monitoring
- Storm event water quality sampling

As requested by EPA in the 2016 FYR Other Findings, five wells near the Amended Cap were abandoned in August 2018: PZ-100, PZ-101, PZ-102, PZ-103, and PZ-104. The wells had been installed in 2007 to evaluate NAPL during the design of the Amended Cap and were not used for long-term monitoring.

Maintenance of the stormwater sediment accumulation Area 7 and the BED Outfall is conducted by the Burlington Department of Public Works (DPW). The DPW inspected and measured sediment accumulation in Area 7 and the BED Outfall in July 2016 and May 2021 and removed accumulated sediment in April of 2017. Sediment removal will be conducted again by the DPW in the spring of 2022.

III. PROGRESS SINCE THE LAST REVIEW

This section includes the protectiveness determinations and statements from the 2016 five-year review as well as the recommendations from that review and the status of those recommendations.

Protectiveness Determinations/Statements from the 2016 FYR

OU #	Protectiveness Determination	Protectiveness Statement
Sitewide	Protective	EPA has determined, as part of the third five-year review, that the remedy at the Pine Street Canal Superfund Site is protective of human health and the environment. All construction activities specified in the 1998 ROD, 2009 ESD and 2011 ESD are complete and operating as intended. Ecological, human health and management of migration RAOs are being met. The Performing Defendants continue to perform compliance monitoring and O&M and report the results to EPA and VTDEC twice a year.

There were no Issues & Recommendations identified in the 2016 FYR.

IV. FIVE-YEAR REVIEW PROCESS

Community Notification, Involvement & Site Interviews

A public notice of the performance of the FYR was made available by via a press release on October 27th. A copy of the press release is included in Appendix C.

The results of the review and the completed FYR report will be made available to the public online at EPA's Site Profile web page http://www.epa.gov/superfund/pinestreet.

During the FYR process, interviews were conducted to document any perceived problems or successes with the remedy that has been implemented to date. Summarized below are interviews that EPA conducted with members of the local community and the VTDEC.

Community Member Interview - Resident 1:
On November 12th, 2021, a community member who lives close to the Site was interviewed. Resident 1 has lived about a quarter of a mile from the Site for the past 16 years. Resident 1 first became aware of the Site and the contamination in early 2000's when she owned a business on Pine Street. In the early 2000's she felt that the community did not seem overly concerned by the Site and since then this concern has lessened. She feels that she hears less about the Site now then back in the early stages of the cleanup.

Resident 1's interaction with the Site has primarily been from walking and driving down Pine street. She has been curious about the Site as she feels it's a great green space in the area. She enjoys walking her dog around the Site area and enjoys seeing beavers and deer around the Site. Other ways Resident 1 has interacted with the Site is by spreading awareness about the Site. Resident 1 is an elementary school teacher in Burlington and taught a lesson to her students about the Site. Her lesson focused on the connection the Site has to the greater community and how the Site and Burlington have changed over time.

Generally speaking, Resident 1 feels that this Site is actually a net positive for the community living nearby. The positives come from having the green space that stretched along Pine street that is just wooded and provides a healthy ecosystem for local wildlife. Also, she feels that this site is a sound buffer for the lake and waterfront to the communities. The walking and bike paths are also heavily used. Resident 1 feels that the ecosystem benefits that the Site provides outweigh the contamination at the Site. While this Site is generally looked upon favorably the biggest concern for her and the community is the homeless camps that tend to pop up around the Site.

Resident 1 indicated that she does not feel well informed about the Site. She felt that she had to do a lot of digging to be able to find out information from the Site. Some of the sources where she gets her information from are local news sources or neighbors and she has not used the EPA Site Profile page extensively. She feels that EPA should be having more communication with the community about the Site and suggested that EPA conduct bi-annual updates for the Site. She suggested that this bi-annual update be presented at a Neighbored Planning Assembly meeting and that updates be posted in the Community Front Porch Forum.

Resident 1 has no real concerns about the Site and feel that the government is committed to cleaning up the Site. She indicated that the general opinion of local community members is that having the federal government involved at the Site is favorable, but that VTDEC and local officials are more trusted sources of information. Resident 1 has worked before with EPA, VTDEC and local officials regarding Site ownership and conducting a

class field trip. She felt like her emails were not taken seriously and that her questions/emails were forgotten or "pushed to the bottom of the email pile". She would like to see faster response from all parties involved in the Site when she reaches out.

Concerning redevelopment Resident 1 does not want the site to be overly redeveloped. She would like for it to stay as a green space that has walking trails and other natural resources that the community can access, stating "I would hate to see it redeveloped".

Community Member Interview - Resident 2:
On November 15th, a second community member was interviewed. Resident 2 is a property owner that owns property that abuts the Site. He has lived in Burlington since he was a child and has been aware of the Site since then and his family would discuss the Site and the cleanup. Resident 2's family viewed the cleanup at the Site as a positive thing for the community. Resident 2 even referred to the Site as a "Hidden gem in Burlington".

Overall, Resident 2 feels that the Site has had a positive effect on Burlington. The reason is that there is a cleanup implemented at the Site that will allow for redevelopment at and around the Site. Resident 2 is not aware of any concerns the community may have around the Site but did say that he has been discouraged by other community members from buying property near the Site because they believe the Site will never get cleaned up and that there are too many restrictions on the Site and neighboring properties. This has made Resident 2 nervous about buying but after discussions with EPA he felt he understood the restrictions better.

Resident 2 does not feel well informed about the Site. He stated that unless you reach out to EPA, a community member would likely not know what is going on at the Site. He would like to have quarterly updates from EPA and VTDEC about the progress of the Site and to know when anything major happens. He feels that sending an email or factsheet out quarterly would be a great way to keep the community informed. Resident 2 does not often check the website unless looking for something specific and feels that the community doesn't either. He suggested that information be shared with 7 Days and the VT Digger. Additionally, Resident 2 would like to hear more about Deed Restrictions and if EPA is working to change anything involving Deed Restriction. He also feels more information should be shared on how much longer cleanup of the Site will take.

Resident 2 has had a good relationship working with EPA and feels the Agency has been quick in responding to any questions he may have. Resident 2 has worked with both RPM (Richard Hull) and the CIC (Charlotte Gray) and felt that they were patient and easy to talk to about the project.

Concerning redevelopment, Resident 2 would like for the Site to stay as wild as possible. He did suggest having a walking path would be nice or an area for ice skating in the winter. Keeping it a green space would be ideal and he felt it would be a shame if it was to be redeveloped into something that took away the natural aspect of the Site and access to the lake.

VTDEC:
The US EPA interviewed Graham Bradley the VTDEC Project Manager for the Site. His overall impression of the Site is that "the remedy continues to meet remedial action objectives in relation to protection of ecological receptors, human health, and controlling unacceptable contaminant migration, while as far as possible not reducing the suitability for future land use." He does feel that the remedy is functioning as expected for the most part and that there are no strong concerns that is impacting the community negatively. Additionally, Graham feels that the institutional controls enacted using the Consent Decree and Grants of Environmental Restrictions are ensuring appropriate land use and development.

While there is no continuous on-site presence for monitoring, Graham reports that the Performing Defendants' consultant is on site regularly, to undertake the complex monitoring program. Monitoring has shown that the remedy is functioning as expected. There has been some change in the monitoring at the Site to reduce some of the groundwater monitoring and NAPL recovery requirements west of the canal. Following thorough review by both EPA and VTDEC, some of these modifications were agreed and were incorporated into the Consolidated Site Monitoring Plan. No changes affect the protectiveness or effectiveness of the remedy. There have been no unexpected difficulties or significant changes to the cost associated with long-term monitoring and O&M since the last review.

Concerning the EPA's management of the Site, Graham has had continual communication with Richard Hull the EPA RPM for the Site since taking over as VTDEC Project manager in 2020. Graham and VTDEC have not received any complaints or concern surrounding the Site. The only concern that Graham has is "the difficulty and slowness of encouraging reuse of the Site", including adjacent properties with land use restrictions. Recently there has been redevelopment and reuse in the Site neighborhood. Graham acknowledged that different land uses are likely appropriate for specific areas of the Site and adjacent properties, and the final land uses will depend upon both institutional controls, and the wishes of stakeholders, including landowners. There has been increased interest in the Site and adjacent properties from prospective developers interested in reuse and redevelopment.

Other entities including the City of Burlington and consultants for the Performing Defendants were approached by EPA for interviews but did not respond or declined to be interviewed.

Data Review

Performance standards for the remedy include the requirement that the subaqueous cap prevent contact between underlying contaminants and benthic organisms and fish in the biologically active part of the benthic habitat at ecologically harmful levels. They also include long-term monitoring of groundwater, surface water, sediment transport, and physical and chemical monitoring of the cap to demonstrate compliance with statutes and regulations identified in the ROD and requirements of the Consent Decree and RD/RA SOW. Performance standards also include monitoring associated with the aquatic and wetland habitat restoration areas. The performance standard for the institutional controls requires that land use restrictions be established, maintained, and where necessary, enforced.

Groundwater

Site groundwater is monitored to assess hydraulic conditions, to determine compliance conditions of the Class IV groundwater boundary, and to evaluate if there is any significant increase in mass flux for Site contaminants to the Lake. The Class IV boundary and groundwater monitoring well locations are shown on Figure 7. The sitewide groundwater monitoring scope, outlined in the 2021 CSMP, includes groundwater level measurements, results of sampling and analysis, and details of NAPL monitoring in these wells; the scope of monitoring for each well is summarized in Table 3-3 of the 2021 CSMP.

Potentiometric Data

Groundwater potentiometric analyses are performed during each spring and fall groundwater monitoring event for the area near the former General Dynamics building and near the Vertical Barrier. Table IV-1 summarizes the groundwater level data from the last five years.

Figure 8 shows the potentiometric contours as presented in the spring 2021 CMR, which are typical of the spring and fall measurements recorded during the last five years and indicate flow toward the north/northeast from the Gilbane property (former General Dynamics building) towards Area 3 and Areas 4/5.

Groundwater elevations near the Vertical Barrier are controlled by the surface water elevations in the canal and Lake. Typically, in the spring, the Lake and canal water elevations are approximately the same, which results in a flat hydraulic gradient and negligible groundwater flow and transport toward the Lake. Throughout the summer and into the fall, the Lake level tends to decrease while the canal level stays consistent, as the elevation is controlled by the outlet weir. This results in a greater hydraulic gradient from the canal to the Lake during the late summer and fall, the magnitude of which is dictated by the fluctuating Lake level. One deviation from this seasonal trend was observed during the spring 2021 monitoring event, in which the Lake level was observed to be lower than what is typically observed during spring monitoring events, thereby inducing a slight gradient between the canal and the Lake.

Typically, the greatest hydraulic gradients and groundwater flow rates are observed in August or early September when the Lake is at its lowest level. Figure 9 presents groundwater elevations near the Vertical Barrier on October 26, 2020, which is consistent with typical fall data as recorded during the last five years. Groundwater measurements recorded during the fall semi-annual monitoring events over the last five years indicate that the Vertical Barrier is halting groundwater flow to the east of it, which indicates that groundwater is being directed upward into the peat, as designed. Water levels in wells on the west (Lake) side of the Vertical Barrier are lower, near the center of the Vertical Barrier, similar to that of the Lake level. Water levels near the south edge of the Vertical Barrier (MW-22A & B), however, are slightly lower than the mounded groundwater behind (upgradient of) the Vertical Barrier and higher than the area on the west side of the Vertical Barrier. This suggests that a portion of the groundwater flows south and around the Vertical Barrier. The potentiometric depression on the downgradient (west) side of the Vertical Barrier apparently draws the groundwater that flows around the southern end of the Vertical Barrier and northwest toward location MW-28.

The potentiometric data observed during the last five years are consistent with data collected prior to 2016 and indicates that the direction of groundwater flow is from the south, southeast towards the Site and into the Class IV groundwater boundary. As discussed above, the exception is the vicinity of the Vertical Barrier, where seasonal variations in the Lake level result in groundwater flow from the canal toward the Lake.

Groundwater Sampling and Analysis Data

Groundwater sampling and analyses from select deep overburden and bedrock wells and in overburden wells near the Vertical Barrier are performed during each spring and fall groundwater monitoring event. Groundwater analyses vary for different monitoring wells as summarized in Table 3-3 of the CSMP, and consist of VOCs (BTEX+N), SVOCs (17 PAHs), and metals (arsenic and lead annually, other RCRA 8 metals every five years). The results are compared to the current Maximum Contaminant Levels (MCLs) and Vermont Groundwater Enforcement Standard (VGES) and presented in the semi-annual CMRs.

A summary of the last five years of BTEX+N groundwater analytical results along with applicable MCLs and VGES is provided in Table IV-2**.**

During the last five years, no monitoring wells outside the vicinity of the Vertical Barrier have had concentrations of Site contaminants above the MCL/VGES. The only compounds that were regularly detected in groundwater above their respective MCL/VEGS were near the Vertical Barrier and included benzene,

ethylbenzene, naphthalene, and arsenic. There have been some sporadic, slight exceedances of the MCL/VGES for lead in MW-20B (maximum of 22 µg/L, MCL/VGES is 15 µg/L) and benzo(a)pyrene, fluoranthene, and fluorene in MW-23B (MW-23B historically contained NAPL); both MW-20B and MW-23B are within the limits of the Class IV groundwater boundary.

During the last five years, there were exceedances of the benzene and/or naphthalene MCL/VGES in wells outside the Class IV groundwater boundary, including MW-21A, MW-21B, MW-24A, MW-27B, MW-28B, MW-29A, and MW-29B. As of spring 2021, however, concentrations of benzene and naphthalene have decreased below the MCL/VGES in all wells except MW-28B and MW-29B. Benzene and naphthalene concentrations in MW-28B and MW-29B have been consistent during the last five years. Arsenic has been consistently detected in MW-21B above the MCL/VGES, however the concentrations may be attributable to elevated turbidity in the samples, which are not filtered prior to analysis; arsenic is not known to be an MGP-related compound.

Within the Class IV groundwater boundary, arsenic is detected above the MCL/VGES only at MW-9A, and the concentration fluctuates slightly above and below the MCL/VGES, seasonally. Benzene in the MW-22 pair increased from 2011 to 2017 but remained generally stable for the rest of the five-year monitoring period. Naphthalene concentrations generally increased in MW-22A from when it was first detected in 2013 until spring 2017; it has been relatively stable since then. Naphthalene in MW-22B increased since its first detection in fall 2014 until fall 2017 and stabilized thereafter. Ethylbenzene was also detected more recently above the MCL/VGES in MW-22A & B.

The fluctuations in contaminant concentrations mentioned above were noted in the 2016 FYR Report: "*Overburden wells that had previously seen increases in concentrations of BTEX compounds between 2008 and 2011, have decreased and/or stabilized. However, at the southern end of the vertical barrier, concentrations of benzene and/or naphthalene appear to be increasing at some locations (e.g., MW-22 and MW-28) since installation of the vertical barrier."* EPA further commented that, "*If decreasing trends in dissolved contaminants outside of the vertical barrier are not observed over the next two compliance monitoring periods (Fall 2016 and Spring 2017), additional monitoring wells and a re-examination of groundwater flow conditions will be needed to determine the impact of contaminant migration across the Class IV boundary towards Lake Champlain."*

In response to this comment, two investigations were conducted to assess the groundwater conditions near the Vertical Barrier. The first was conducted in September 2017 and results were reported in the November 15, 2017, Well Installation and Boring Report, Vertical Barrier – Southern Extent Focused Investigation Technical Memorandum (JCO, 2017c). This focused field investigation included the advancement of five investigative boreholes south of the Vertical Barrier to delineate the southern extent of Site-related contamination and the installation of three pairs of monitoring wells (MW-29A&B, MW-30A&B, and MW-31A&B) for long-term monitoring of the southern extent of contamination (Figure 5). Of the newly installed wells, only MW-29B has had concentrations that exceed the MCL/VGES, and those were limited to benzene and naphthalene.

In 2019, to *"... determine the impact of contaminant migration across the Class IV boundary towards Lake Champlain,*" the Performing Defendants conducted the Lake Study. That study helped to determine if Site contaminants are migrating to the Lake via groundwater, and if so, to determine the magnitude and extent of contamination in pore water, sediment, and surface water within the Lake at locations west and southwest of the Vertical Barrier (the Lake Study Area). A SLERA was completed to evaluate the potential for adverse

effects of Site groundwater discharge on the aquatic biota (fish and benthic invertebrates) in the near-shore area of the Lake.

The Lake Study results, presented in the June 2020 Lake Sediment and Pore Water Investigation Report, Revision 1.0 (JCO, 2020b), concluded that benzene is the only compound that appears to be originating from the Site and migrating into the pore water of the Lake. Figure 10 presents the Lake Study benzene sampling results. At the four sample locations where benzene was detected in pore water, the concentrations decrease from the deep pore water to the shallow pore water, indicating that attenuation is occurring. Benzene was not detected above the laboratory limit of quantitation in any sediment or surface water samples, and thus Site groundwater is not a significant source of benzene to the sediment and surface water. The Lake Study also concluded that there is no significant risk to human health via direct contact and that, based on the absence of Site contaminants in surface water, there appears to be no actual mass discharge to the surface water of the Lake; the SLERA concluded that no potential for ecological risk is expected to exist from the presence of Site contaminants in the near-shore areas of the Lake (JCO, 2020b).

Based on the findings of the Lake Study and the observed long-term stable and decreasing groundwater concentration trends, it can be concluded that the Vertical Barrier is helping to manage the mass flux of Site constituents migrating off-site, as intended.

NAPL Monitoring Data

Ten groundwater monitoring wells and four Vertical Barrier recovery wells (RW-111 – RW-114) are monitored for evidence of NAPL in conjunction with the semi-annual monitoring event (Figure 11). Of those 14 wells, only three (MW-17, MW-23A, and MW-23B) have had more than 0.1 feet of dense nonaqueous phase liquid (DNAPL) present during the last five years; those three wells are east and upgradient of the Vertical Barrier and have had decreasing levels of DNAPL during the last five years as shown in Figure 12. Since spring 2020, less than 0.1 feet of DNAPL has been measured.

The Vertical Barrier was designed to prevent coal tar from migrating in sand and gravel layers towards the Lake, and to promote groundwater to upwell into a thick peat deposit to facilitate sorption and biodegradation of dissolved organic compounds associated with the coal tar. The reduction in NAPL levels in the Vertical Barrier monitoring wells and the absence of NAPL in the Vertical Barrier recovery wells indicate that the Vertical Barrier is functioning as designed. The absence of evidence of NAPL in the remaining, deeper monitoring wells indicates that NAPL is not migrating downwards into deeper strata.

Cap Monitoring Data

As discussed in the sections above, several components of the cap monitoring program have demonstrated remedy effectiveness and have therefore sunset or expired. Only the ongoing cap monitoring program elements that were conducted during the last five years are presented in the following section.

Amended Cap Operation, Maintenance, and Monitoring

Operation, maintenance, and monitoring consists of visual sheen monitoring, NAPL probing, Amended Cap integrity inspections, and Amended Cap recovery well NAPL pumping/removal. The areal extent of the Amended Cap is shown on Figure 13.

No sheens associated with bubbles were observed emanating through the Amended Cap during monthly visual sheen monitoring events conducted during the last five years. Occasional NAPL seeps, observed as

sheens associated with bubbles, were recorded on the canal surface, north of and near the southern edge of the Amended Cap. These sheens have been observed periodically during monitoring events conducted since the Amended Cap was installed in 2011. The sheens were observed to be temporary, dissipating within ten feet of where the NAPL seeps are observed, indicating a very low concentration and mass of contaminant.

Annual NAPL probing consists of probing the Amended Cap surface at 43 different locations with a sorbent pad attached to a fiberglass rod to identify if NAPL is present on the Amended Cap surface. No NAPL was observed on the surface of the Amended Cap during any of the annual NAPL probing events during the last five years.

Monthly Amended Cap integrity inspections conducted during the 2016-2021 monitoring period included visual inspection of the edges of the Amended Cap to note potential areas of concern; no areas of damage were observed.

NAPL pumping/removal from Amended Cap recovery wells occurs monthly at the 14 locations shown on Figure 13. During each event, NAPL thickness and water depth were measured in each of the wells. If a DNAPL thickness was greater than 0.1 foot (or greater than 0.3 feet in the large-diameter 18-inch wells: RW9+80, RW10+25, RW11, and RW14) on the first day of each event, the DNAPL was removed using a peristaltic pump until it was estimated that less than 10% of the fluid extracted contained NAPL, based on visual observation. The process was repeated for the two subsequent days. Data in recent years has shown that generally less than five of the recovery wells have more than 0.1 feet of DNAPL present on the second and third days of NAPL monitoring, and those wells typically contain one to two gallons of DNAPL or less, with the exception being recovery well RW-109, where approximately 90-120 gallons of DNAPL are recovered over three days. Accordingly, in April 2021, the monitoring requirement was reduced, and only RW-109 was measured and pumped on the two subsequent days (USEPA, 2021). During the last five years of NAPL pumping/removal, an average of approximately 1,000 gallons of DNAPL was removed annually. This is a reduction from the previous five-year period, in which approximately 1,600 gallons of DNAPL were removed each year. To date, approximately 13,000 gallons of DNAPL have been removed from the Amended Cap recovery wells.

The Amended Cap operation, maintenance, and monitoring activities conducted over the last five years indicate that the Amended Cap remains in place and is functioning as designed.

Sediment Cap Chemistry Data

Sediment cap samples were collected for PAH, total organic carbon (TOC), and moisture content analysis in 2017, 2019, and 2021. Because 2021 was a FYR year, samples were also collected for copper, mercury, lead, and zinc analyses, consistent with the 2021 CSMP (VHB, 2021c). The data are collected to evaluate the effectiveness of the cap in protecting benthic fauna from direct contact with contaminated sediments at unacceptable levels, to evaluate potential contaminant migration within the cap, and to compare the mid-cap sample data with benchmark values set forth in the ROD and SOW. Intervals in Areas 1, 3, and 8 for the randomly selected locations included surface at zero to ten centimeters, and mid-cap depths. The mid-cap intervals were determined to be the approximate middle third of the cap based upon field measurements at the time of sampling. Only surface samples were collected from the non-capped Area 4/5. Benchmark values, as defined in the SOW, are presented in Table IV-3, and the analytical results from the last five years are presented in Table IV-4.

The results from the last five years of monitoring are consistent with the previously collected data. The top-of-cap samples were compared to the mid-cap samples to determine if contamination was migrating through the cap and contaminating the 0-10 cm zone of benthic macroinvertebrate habitat. In Areas 1, 3, and 8 (Figure 4), the sum of PAHs in the top-of-cap samples were all greater than collocated mid-cap samples, which indicates that upward migration of contaminants through the cap is not occurring. The PAHs in the top-of-cap samples can largely be attributed to contribution from storm water.

Area 4/5 does not include a sediment cap because, as stated in the 1998 ROD, contaminants were not bioavailable due to high levels of TOC in the sediments during the design of the cap. Historically, the top-of-cap PAH results in Area 4/5 have been elevated relative to the top-of-cap samples collected in areas where the sediment cap was installed. In 2021, the data were consistent with prior events, with elevated PAH results as compared to Areas 1 and 8, however, the TOC results were high, indicating that the PAHs are not readily bioavailable.

During the last five years, the mid-cap sample results were all less than their associated benchmark effects range median (ER-M) values indicating that the sediment cap is meeting its performance objective and functioning as designed (Table IV-4).

Sediment Cap Biota Data

Once every five years, concurrent with the FYR report preparation, sediment cap samples from Areas 1, 4/5, and 8 are collected for benthic macroinvertebrate taxonomy and enumeration, acid volatile sulfide / simultaneously extracted metals (AVS/SEM), and TOC analysis. The analyses are to assess the benthic community and determine if metals present in the sediment cap are bioavailable. The AVS/SEM data are summarized in Table IV-5, and the benthic macroinvertebrate results are shown in Table IV-6 and Table IV-7. The data collected in June 2021 are consistent with those collected previously and indicate that the metals present are not bioavailable (as indicated by SEM/AVS ratio less than one) and that a low-diversity benthic community consistent with the sediment type is present. These data indicate that the performance standard for benthic macroinvertebrates continues to be met.

Sediment Cap Vegetation Assessment

A qualitative assessment of the submergent plant community in Areas 1, 2, and 8 (Figure 4) was performed in June 2021. The sediment cap is supporting aquatic vegetation; Area 2 of the Amended Cap supports rooted submerged aquatic vegetation; and the edges of the canal and turning basin support emergent vegetation. This assessment indicates that the performance standard for the development of submergent aquatic plant community continues to be met.

Surface Water

Following the post-construction period, surface water samples for PAH analysis have been collected annually near the canal outlet to the Lake. No PAHs have been detected above the reporting limit since surface water sampling began in 2005, which indicates that Site-related contaminants are not migrating from the canal to Lake Champlain via surface water.

Sediment Transport Monitoring

Sediment transport monitoring consists of sampling and analysis of canal surface water near the canal outlet for PAHs and total suspended solids when the canal stage reaches the trigger elevation following a rain event of greater than one inch in 24 hours as recorded at the Burlington Airport, modified from the previous automated sediment transport monitoring system (USEPA, 2016a). During the last five years, the sampling was triggered on one occasion – on August 4, 2020 – and no PAHs were detected above the reporting limits. The stormwater trigger elevation is defined as the highest recorded canal stage in which the PAH concentrations in surface water sample collected during the event were below the reporting limits. During the August 4, 2020 event, the maximum canal stage was measured to be 97.67 feet (NAVD88) and no PAHs were detected; therefore, the current stormwater trigger elevation is 97.67 feet (NAVD88). The data indicate that the remedy is functioning as designed and preventing contaminated sediment from being discharged from the canal to the Lake during rain events.

Wetland Habitat Restoration

As reported in the 2016 FYR Report, the Performance Standards for wetland restoration in the capped Areas 2, 7, and the West Bank Cap have been achieved (USEPA, 2016b). Construction of the Amended Cap included a Restoration Plan (JCO, 2012c) for restoring areas impacted by Amended Cap construction as well as off-site compensatory wetland. The off-site compensatory wetlands restoration at the Ethan Allen Homestead was monitored on June 7, 2017, and the inspection indicated that objectives have been achieved and that no further wetland habitat restoration action or monitoring is necessary (JCO, 2017b).

Soil Vapor Intrusion Evaluation

In July 2021, concurrent soil vapor and groundwater samples were collected near the BED building (Figure 6) to evaluate the potential for soil vapor intrusion. The results were consistent with the prior 2013 and 2016 soil vapor intrusion data evaluation and concluded, based on the 2021 updated VISL calculator, that there is no unacceptable risk to human health due to vapor intrusion at the BED building (VHB, 2021d). The CSMP (VHB, 2021c) has been modified to specify periodic soil vapor and groundwater sampling near the BED building, and an evaluation of potential for soil vapor intrusion, every five years.

Site Inspection

The inspection of the Site was conducted on 10/26/2021. In attendance were Richard Hull, EPA RPM; Graham Bradley, VTDEC Project Manager; Thor Helgason, de Maximis (consultant to the Performing Defendants); George Lester, P.E., VHB (consultant to the Performing Defendants); Brian Stearns, National Grid; Jay Mullowney, Vermont Gas Systems; John Tedesco, Green Mountain Power Corp.; and Chapin Spencer, Norm Baldwin, Jenna Olson and James Sherrard representing the City of Burlington DPW. The purpose of the inspection was to assess conditions at the Site relative to the protectiveness of the remedy. The temperature was in the 50s with a steady rain during the duration of the inspection. Appendix D includes the site inspection check list.

The locked gate to the access road at the Site, off Pine Street, was in good condition and secure, and no trespassing signs are posted. However, the perimeter of the Site is not fenced and is accessible to trespassers. Historically, trespassing and camping have been observed at the Site, and at the time of the inspection, an occupied tent was located at the Site. Property owners and the City of Burlington are aware of the trespassing issue at the Site.

The surface and banks of the canal and turning basin were inspected and no visible sheens, globules of coal tar and/or odor were observed. The edges of the chain link layer protecting the Amended Cap remain sufficiently anchored in place. Vegetation around the canal and in the wetland areas was observed to continue to be abundant and healthy and supporting of various wildlife as observed and noted during periodic monitoring events. The weir outlet from the canal to Lake Champlain was observed to be in good condition and functioning as designed. The ground surface above the vertical barrier was observed to be intact and groundwater monitoring wells in the vicinity of the vertical barrier and the railroad easement were observed to be in good condition. No evidence of impacts from the canal, including sheens or staining, were observed on the shore of Lake Champlain. NAPL recovery wells were all observed to be in good condition.

The constructed wetland and drainage areas at the Site that are inspected and maintained by the City of Burlington DPW (Area 7 and BED Outfall) were observed to be functioning as intended. Due to weather conditions (steady rain), both the Area 7 and BED Outfall were discharging stormwater at the time of the inspection. The City of Burlington DPW conducted sediment depth measurements in May 2021 and have scheduled sediment dredging in Area 7 and BED Outfall for 2022.

V. TECHNICAL ASSESSMENT

QUESTION A: Is the remedy functioning as intended by the decision documents?

Yes, the remedy is functioning as intended by the decision documents. The capping of contaminated sediments within the canal has eliminated direct exposure to ecological receptors. Long-term monitoring and NAPL recovery efforts remain effective at evaluating and reducing the extent of contamination within groundwater, surface water, and sediments, and for evaluating the overall remedy performance. Institutional controls remain in place to prevent exposure to contaminated groundwater and soils, and to prevent the migration of existing contamination. The addition of the barrier wall has helped limit the migration of contaminated groundwater to Lake Champlain.

Remedial Action Performance

Ecological
The ecological remedial action objectives are to eliminate or reduce direct exposure of ecological receptors to contaminated soils and sediments posing an acceptable risk, where feasible, prevent or minimize the long-term adverse effects of remediation activities on the existing aquatic environment and/or wetland habitat, and restore wetlands affected by remediation.

The capping of the canal and turning basin, Areas 1, 2, and 8, and the addition of the Amended Cap in Area 2 continue to eliminate exposure of ecological receptors to contaminated canal sediments that pose unacceptable risk. Capped wetland Areas 3 and 7 are fully vegetated, and the cap remains in place continuing to protect ecological receptors from contaminated soils. Monitoring shows that Area 4/5 remains protective due to the presence of high levels of TOC and SEM/AVS ratio of less than one.

Construction of the Amended Cap in 2011 resulted in a temporary impact to wetland habitat from construction activities and a long-term impact to the riparian area along the east side of the canal adjacent to the Amended Cap. EPA has determined that this area must be maintained free of woody vegetation that would impair visual

monitoring of canal conditions. Planting of the impacted areas has remedied the temporary construction impacts. The long-term loss of wooded riparian area has been mitigated by planting trees and shrubs in former construction lay-down areas and an off-site compensatory buffer enhancement project at the Ethan Allen Homestead in Burlington.

The Lake Study was conducted in 2019 to evaluate if Site-related contaminants were migrating to the Lake via groundwater. That study concluded that there appears to be no measurable mass discharge to the surface water of the Lake, and the SLERA concluded that no potential for ecological risk in surface water, pore water, or sediment is expected to exist from the presence of Site contaminants in the near-shore areas of the Lake.

The remedy is functioning as intended to protect ecological receptors.

Human Health
Remedial action objectives for human health are to prevent unacceptable exposure to contaminated soils located greater than five feet below grade, prevent ingestion and exposures to contaminated groundwater associated with residential use where contaminated groundwater presents unacceptable risks, and prevent exposures to contaminated soils, sediments, air and surface water associated with residential use at the Site.

Institutional controls in the form of deed restrictions limiting certain activities on parcels on and adjacent to the Site have been used as response actions to prevent unacceptable risk to human health. The State of Vermont has classified the affected groundwater as Class IV (not suitable for human consumption) and this classification remains in place. In addition, deed restrictions placed on properties, including the Site, parcels immediately adjacent to the Site, and areas of Class IV groundwater, prevent the use of groundwater, prohibit drinking water wells, limit land uses, and require additional investigation if activities would take place in soils greater than five feet below ground surface. Property owners must complete and submit a checklist to EPA each year certifying that they are complying with the institutional controls. On an annual basis, EPA sends out reminder letters to those property owners that have failed to submit the checklist on time, and follows up directly with any property owners who still have not responded. Based on the completed checklists, the property owners are in compliance with the deed restrictions.

The 2019 Lake Study evaluated if Site-related contaminants were migrating to the Lake via groundwater and concluded that there is no unacceptable risk to human health via direct contact based on the absence of Site-related contaminants in surface water.

The remedy is functioning as intended to protect human health.

Management of Migration
The remedial action objectives for the management of migration are to protect the Lake from being impacted by contaminants left on site, protect areas not targeted for remediation (both on- and off-site) by preventing significant migration of contamination from on-site sources, and protect remediated areas on the Site from becoming re-contaminated from on-site and off-site sources.

Remediation conducted to date, including the outlet weir that continues to provide a normal canal stage elevation (between 96.0 and 96.5 feet NAVD88), has successfully prevented contaminated sediment migration from the canal to the Lake. In addition, Site activities have prevented the recontamination of the canal from on-Site sources and known off-Site sources.

The Vertical Barrier has been successful at containing NAPL and reducing dissolved BTEX and naphthalene concentrations in groundwater immediately down-gradient of the Vertical Barrier. The 2017 investigative soil borings and the semi-annual groundwater monitoring data collected at the six wells installed in 2017 indicate that the nature and extent of Site-related constituents south of the Vertical Barrier has been delineated. The nature and extent of benzene above the MCLs/VGES is limited to sample locations downgradient of the southern wing wall of the Vertical Barrier; this location was a focus of the 2019 Lake Study, which concluded that, despite the migration of groundwater contaminated with levels above MCLs/VGES beyond the Class IV groundwater boundary, there appears to be no measurable mass discharge to the surface water of the Lake. Based on the Lake Study findings, groundwater monitoring results, and observed long-term groundwater concentration trends, the mass flux of Site constituents migrating off-site is either stable or decreasing. As directed by EPA, the Performing Defendants must continue to evaluate the mass flux of contaminants migrating off-site. EPA will review the data submitted with the bi-annual compliance monitoring reports and continue to evaluate the need to repeat the lake study and HHRS and SLERA.

The remedy is functioning as intended to manage migration of Site contaminants to prevent unacceptable risks.

Site Uses
The remedial action objectives for Site uses are to ensure to the extent practical that the remedy itself does not reduce the suitability of the Site for current and future uses, including a highway, retain or expand current Class IV groundwater classification and boundary, and maintain or replace beneficial functions and values of wetlands.

The Site and surrounding parcels include prime lakefront property ideal for developers. Implementation of the remedy, including institutional controls, anticipated future development on and around the Site. Deed restrictions are in place that prohibit properties from residential use and child day care centers, and limit excavation activities, but redevelopment and improvement of many of these properties continues.

The remedy is functioning as intended to protect site uses.

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

No. There have been changes in standards, toxicity values, and methods of evaluating risk since the 1998 ROD was issued as discussed below. The changes as described below are not expected to alter the protectiveness of the remedy because the remedy continues to limit the exposure of ecological and human receptors to site contaminants in groundwater, sediment and soil. All additional investigation and monitoring that has been conducted since the 1998 ROD has been compared to the current standards, toxicity values, and methods of evaluating risk.

Changes in Standards and TBCs

New standards should be considered during the five-year review process as part of the protectiveness determination. Under the NCP, if a new requirement is promulgated after the ROD is signed, and the requirement is determined to be an ARAR, the new requirement must be attained only if necessary to ensure that the remedy is protective of human health and the environment.

EPA guidance states:

> "Subsequent to the initiation of the remedial action new standards based on new scientific information or awareness may be developed and these standards may differ from the cleanup standards on which the remedy was based. These new … [standards] should be considered as part of the review conducted at least every five years under CERCLA §121(c) for sites where hazardous substances remain on-site. The review requires EPA to assure that human health and the environment are being protected by the remedial action. Therefore, the remedy should be examined in light of any new standards that would be applicable or relevant and appropriate to the circumstances at the site or pertinent new [standards], in order to ensure that the remedy is still protective. In certain situations, new standards or the information on which they are based may indicate that the site presents a significant threat to health or environment. If such information comes to light at times other than at the five-year reviews, the necessity of acting to modify the remedy should be considered at such times." (See CERCLA Compliance with Other Laws Manual: Interim Final (Part 1) EPA/540/G-89/006 August 1988, p. 1-56.)

The remedy at the Site was based on site-specific human health and ecological risk assessments and uses the most recent standards and risk assessment methods during compliance monitoring. Some changes to ARARs and TBCs have occurred since the selection of the remedy, including the July 6, 2019, adoption of a revised Vermont Groundwater Protection Rule and Strategy, which included a reduction of the VGES for naphthalene from 20 µg/L to 0.5 µg/L; these changes do not affect the remedies that have been selected from continuing to protect human health and the environment.

In May 2016, EPA issued final lifetime drinking water health advisories (HA) for PFOA and PFOS. The EPA HA for PFOA and PFOS is 70 ng/L (ppt) individually or combined. See also EPA's Interim Recommendations to Address Groundwater Contaminated with Perfluorooctanoic Acid and Pefluorooctanesulfonate [OSWER DIRECTIVE 9283.1-47, Dec. 19, 2019] which establishes a screening level of 40 ng/L(ppt) for PFOA and PFOS individually. Using the standard Superfund approach, an unacceptable non-cancer risk may be triggered by an exceedance of a Hazard Quotient (HQ) of 1. EPA's HA of 70 ng/L (ppt) equates to an HQ of less than 1 (approximately 0.1-0.2). Should data indicate PFAS levels have reached or exceeded 40 ng/L (ppt) for either PFOA or PFOS, EPA recommends that further evaluation be conducted.

On July 6, 2019, the Vermont Agency of Natural Resources (ANR) adopted an amended Groundwater Protection Rule and Strategy. The amendment, among other things, updated the list of groundwater enforcement standards. In particular, the amendment finalized a groundwater enforcement standard of 20 ng/L (ppt) for any combination of PFOA, PFOS, PFNA, PFHpA and PFHxS. (See Groundwater Protection Rule and Strategy, Appendix One.) Vermont also promulgated MCLs of 20 ng/L (ppt), individually or combined, for the same five PFAS compounds in drinking water through an amendment of its Water Supply Rules, adopted on March 17, 2020.

Based on the type of operations that generated waste (manufactured gas) at the Site, the timeframe of those operations, and the nature and extent of contaminants that are present at the Site, EPA and VTDEC have determined that it is not likely that PFAS compounds would be associated with, or present at the Site. To date, samples from the Site have not been analyzed for PFAS compounds.

Federal regulations at 40 CFR Part 6, Appendix A identified in the 1998 ROD were withdrawn. Furthermore, these regulations, and therefore the current CERCLA remedy, only addressed potential floodplain impacts up to

the 100-year flood elevation. Current federal floodplain regulations at 40 CFR Part 9 require a greater assessment of potential floodplain impacts, including preventing the release of contamination from waste management units and other remedial infrastructure up to the 500-year floodplain elevation. EPA has assessed potential floodplain impacts from a 500-year flood event on the sediment cap, vertical barrier wall and reconstructed wetlands. Because EPA has not identified any protectiveness issues at this time, we do not include a recommendation to add this requirement as an ARAR in a future determination.

Changes in Toxicity and Other Contaminant Characteristics

The only change to contaminant characteristics that has the potential to affect the selected remedy is the reduction of the VGES for naphthalene from 20 µg/L to 0.5 µg/L, as a result of a change to the toxicity and associated risk calculations. Groundwater concentrations are always compared to the most recent MCL/VGES, however, and as discussed herein, the conclusion remains that the remedy is protective. Soil and sediment contaminants that were present at concentrations that would result in unacceptable risk to ecological receptors have been isolated by capping. Human exposure to contaminants that would result in unacceptable risk has been eliminated by institutional controls.

- Lead in Soil Cleanups

EPA continues to examine the science around lead exposure. Updated scientific information indicates that adverse health effects are associated with blood lead levels (BLLs) at less than 10 µg/dL. Several studies have observed "clear evidence of cognitive function decrements in young children with mean or group BLLs between 2 and 8 µg/dL."

Based on this updated scientific information, EPA is including an evaluation of potential lead risks with a goal to limit exposure to residential and commercial soil lead levels such that a typical (or hypothetical) child or group of similarly exposed children would have an estimated risk of no more than 5% of the population exceeding a 5 µg/dL blood lead level (BLL). This is based on evidence indicating cognitive impacts at BLLs below 10 µg/dL. A target BLL of 5 µg/dL reflects current scientific literature on lead toxicology and epidemiology that provides evidence that the adverse health effects of lead exposure do not have a threshold.

EPA's 2017 OLEM memorandum "Transmittal of Update to the Adult Lead Methodology's Default Baseline Blood Lead Concentration and Geometric Standard Deviation Parameters" (OLEM Directive 9285.6-56) provides updates on the default baseline blood lead concentration and default geometric standard deviation input parameters for the Adult Lead Methodology. These updates are based on the analysis of the NHANES 2009-2014 data, with recommended updated values for baseline blood lead concentration being 0.6 µg/dL and geometric standard deviation being 1.8.

Using updated default IEUBK and ALM parameters at a target BLL of 5 µg/dL, site-specific lead soil screening levels (SLs) of 200 ppm and 1,000 ppm are developed for residential and commercial/industrial exposures, respectively.

Given the ongoing review of information, the above SLs are considered in this Five-Year Review for informational purposes. Sediment cap samples and Lake sediment samples are the only soils analyzed for lead. Seven cap sediment samples were analyzed for lead in 2021, with the average concentration approximately 40 ppm, which is below the SLs. In 2019, as part of the Lake Study, 22 Lake sediment samples were analyzed for

lead, the maximum concentration was 18.9 ppm. Therefore, no further remedial work is necessary, and no issue/recommendation or Other Finding for lead is needed.

- 2017 Polycyclic Aromatic Hydrocarbons (PAHs) cancer and non-cancer toxicity values

On January 19, 2017, EPA issued revised (less carcinogenic) cancer toxicity values and new non-cancer toxicity values for benzo(a)pyrene. Benzo(a)pyrene did not have non-cancer toxicity values prior to January 19, 2017. Benzo(a)pyrene is now considered to be carcinogenic by a mutagenic mode of action; therefore, cancer risks must be evaluated for different human developmental stages using age-dependent potency adjustment factors (ADAFs) for different age groups. The cancer potency of other carcinogenic PAHs is adjusted by the use of relative potency factors (RPFs), which are expressed relative to the potency of benzo(a)pyrene. The non-cancer effects of benzo(a)pyrene were not evaluated in the past due to the absence of non-cancer values.

As discussed herein, exposure to PAH impacts at the Site are limited to groundwater in select wells and in the sediment cap. In both cases, there is no human exposure risk, and thus the data are not compared to the human toxicity levels.

Changes in Risk Assessment Methods

The 2019 Lake Study included a SLERA, which was conducted using the most recent EPA ecological risk assessment methodology as presented in the following guidance documents:

- EPA, 1997. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments. Interim Final. EPA-540-R-97-006.
- EPA, 1998. Guidelines for Ecological Risk Assessment. EPA/630/R-95/002F
- EPA, 2001. ECO Update: The Role of Screening Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments. EPA 540/F-01/014.

The Lake Study concluded that there is no potential for ecological risk in the groundwater discharge area investigated.

Changes in Exposure Pathways

There have been no newly identified contaminants or contaminant sources, and no new routes of exposure or receptors have been identified. The institutional controls in place to protect human health anticipated future land use changes on or near the Site, and developers that propose redevelopment projects have been made aware of those controls and are complying with them.

- 2018 EPA VISL Calculator

In February 2018, EPA launched an online Vapor Intrusion Screening Level (VISL) calculator which can be used to obtain risk-based screening level concentrations for groundwater, sub-slab soil gas, and indoor air. The VISL calculator uses the same database as the Regional Screening Levels for toxicity values and physiochemical parameters and is automatically updated during the semi-annual RSL updates. Please see the User's Guide for further details on how to use the VISL calculator. https://www.epa.gov/vaporintrusion/vapor-intrusion-screening-level-calculator.

The Performing Defendants used the online VISL calculator to obtain risk-based screening level concentrations for the BED building. The most recent toxicity values, exposure parameters, and chemical-specific parameters from September 2021 were used to evaluate the vapor intrusion pathway for this FYR. The evaluation concluded that there is no unacceptable risk to human health due to vapor intrusion at the BED building. The BED building will be evaluated every five years concurrent with the Five-Year Review to assess for potential vapor intrusion.

Expected Progress Towards Meeting RAOs

Performance monitoring indicates that the selected remedy is functioning as intended and is currently meeting RAOs. The capping of contaminated sediments has reduced to acceptable levels the direct exposure of ecological receptors to contaminated soils and sediments that pose an unacceptable risk; institutional controls prevent unacceptable exposure to contaminated soils and groundwater and associated human health risks. The Lake Study concluded that there appears to be no measurable mass discharge to the surface water of the Lake. Based on those findings, the groundwater monitoring results, and the observed long-term groundwater concentration trends, the mass flux of Site constituents migrating off-site is determined to be either stable or decreasing.

QUESTION C: Has any other information come to light that could call into question the protectiveness of the remedy?

No other information has come to light that could call into question the protectiveness of the remedy in managing the migration of contaminants and reducing risk from exposure to contaminants. The 2019 Lake Study included an evaluation of the Lake Champlain water levels over the last 30 years. The number of days of hydraulic gradient, and thus groundwater flow (as discussed above), from the canal to the Lake has been fairly consistent over the last 30-year, 20-year, and five-year time periods, ranging from 268 to 277 days per year. Lake levels, however, have trended lower over this time and were relatively depressed over the last five years compared with the earlier two time periods. This results in higher gradients between the canal and the Lake and therefore greater potential for migration toward the Lake. The semi-annual CMRs include a statement of whether the data indicate an increase in the mass flux of Site contaminants migrating off-Site or not. The Performing Defendants must continue to evaluate the mass flux of contaminants migrating off-site based on the most recent monitoring data. If the results reveal an increasing trend, EPA will evaluate the need to repeat the lake study and HHRS and SLERA. The trend of decreasing Lake levels is not currently affecting the protectiveness of the remedy.

VI. ISSUES/RECOMMENDATIONS

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the Five-Year Review:
All

There were no issues or recommendations identified.

OTHER FINDINGS

The following are recommendations that were identified during the FYR and may improve performance of the remedy, and improve management of O&M, but do not affect current and/or future protectiveness:

- EPA and the Performing Defendants work with the City of Burlington and others in the community to ensure that any future recreational use of the Site is protective of human health and consistent with all components of the remedy.
- Burlington Department of Public Works maintain a more regular schedule for inspecting, maintaining and removing sediment, as necessary, from the sediment accumulation structures in Area 7 and at the outfall at the BED building.
- Continued coordination between EPA, VTDEC, City of Burlington and Performing Defendants is recommended for the future redevelopment of properties at and abutting the Site, in compliance with applicable institutional controls.

VII. PROTECTIVENESS STATEMENT

Sitewide Protectiveness Statement	
Protectiveness Determination: Protective	Planned Addendum Completion Date: N/A
Protectiveness Statement: EPA has determined, as part of the fourth five-year review, that the remedy at the Pine Street Canal Superfund Site is protective of human health and the environment. All construction activities specified in the 1998 ROD, 2009 ESD, and 2011 ESD are complete and operating as intended. Ecological, human health, and management of migration RAOs are being met. The Performing Defendants continue to perform compliance monitoring and O&M and report the results to EPA and VT DEC twice a year.	

VIII. NEXT REVIEW

The next five-year review report for the Pine Street Canal Superfund Site is required five years from the completion date of this review.

TABLES

Table II-1: Contaminants of Concern for the Pine Street Canal Site

Chemical Name	Groundwater	Soil	Sediment	Surface water
Vinyl Chloride	X			
Methylene Chloride	X			
Acetone	X		X	
Carbon Disulfide				X
1,2-dichloroethene				X
1,2-dichloroethane	X			
2-hexanone	X			
Chloroform				X
Trichloroethene	X			X
Benzene	X	X		X
Toluene	X	X		X
Ethylbenzene	X	X		X
Styrene	X			
Xylene				X
Naphthalene	X	X	X	X
2-methylnaphthalene	X	X	X	X
1-methylnaphthalene	X	X		
Acenaphthylene	X	X	X	X
Acenaphthene	X	X	X	
Flourene	X	X	X	
Phenanthrene	X	X	X	
Anthracene	X	X	X	
Flouranthene	X	X	X	
Pyrene	X	X	X	
Benzo(a)anthracene	X	X	X	
Chrysene	X	X	X	
Benzo(b)flouranthene	X	X	X	
Benzo(k)flouranthene	X	X	X	
Benzo(a)pyrene	X	X	X	
Indeno(1,2,3-c,d)pyrene	X	X	X	
Dibenz(a,h,)anthracene	X	X	X	
Benzo(g,h,i)perylene	X	X	X	
2-methylphenol				X
4-chloroaniline			X	
4-nitrophenol			X	
Dibenzofuran	X	X	X	
Bis(2-ethylhexyl)phthalate	X		X	X
Methoxychlor	X			
Endosulfan	X			
Dieldrin	X			
gamma-chlordane				X
Antimony	X		X	X

Table II-1: Contaminants of Concern for the Pine Street Canal Site

Chemical Name	Groundwater	Soil	Sediment	Surface water
Arsenic	X		X	X
Barium	X			X
Beryllium	X			
Cadmium	X		X	
Chromium VI	X	X	X	X
Cobalt	X	X	X	
Copper			X	
Lead	X	X	X	X
Manganese	X		X	X
Mercury	X		X	
Nickel			X	
Selenium			X	X
Silver			X	
Thallium			X	
Vanadium	X	X	X	X
Zinc			X	X
Cyanide	X	X	X	X

Notes:

Contaminants of Concern identified by the October 1998 Record of Decision

Bold text indicates Human Health and Ecological Contaminant Concern

Bold Italic text indicates Ecological Contaminant of Concern only

Table II-2 - Summary of Implemented Institutional Controls

Media, engineered controls, and areas that do not support UU/UE based on current conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or planned)
Groundwater	Yes	Yes	049-2-019-000 049-2-038-000 053-1-003-000 053-1-003-001 053-1-009-000 053-1-010-000 053-1-011-000 053-1-012-000 053-1-017-000 053-2-005-000 053-2-010-000 Class IV only: 049-2-039-000 053-1-007-000 Grants only: 053-1-002-000	Groundwater under properties shall not be used for potable water; no production well will be installed where free phase contamination has been shown to be present	Grants of Environmental Restriction and Rights of Access 2004. Class IV Groundwater Designation 1993, 2006
Land Use	Yes	Yes	049-2-019-000 049-2-038-000 053-1-002-000 053-1-003-000 053-1-003-001 053-1-009-000 053-1-010-000 053-1-011-000 053-1-012-000 053-1-017-000 053-2-005-000 053-2-010-000	Properties will not be used for residential use or children's daycare centers.	Grants of Environmental Restriction and Rights of Access 2004
Land Use	Yes	Yes	049-2-019-000 049-2-038-000 053-1-002-000 053-1-003-000 053-1-003-001 053-1-009-000 053-1-010-000 053-1-011-000 053-1-012-000 053-1-017-000 053-2-005-000 053-2-010-000	Properties will not be used so as to interfere with environmental investigations, cause recontamination of the Site or contamination of offsite properties	Grants of Environmental Restriction and Rights of Access 2004

Table II-2 - Summary of Implemented Institutional Controls

Media, engineered controls, and areas that do not support UU/UE based on current conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or planned)
Excavation	Yes	Yes	049-2-019-000 049-2-038-000 053-1-002-000 053-1-003-000 053-1-003-001 053-1-009-000 053-1-010-000 053-1-011-000 053-1-012-000 053-1-017-000 053-2-005-000 053-2-010-000	Excavations to depths greater than 5 ft prohibited. Exceptions: a) install, repair, maintain, service or remove underground utilities in place bellow 5 ft. at time of ROD; b) drilling, driving, or boring to install pilings; c) excavation is performed where contaminant concentrations below 5 ft are less than 140 mg/kg total PAH. For exceptions a and b, workers must use appropriate personal protective equipment unless a site-specific risk assessment, approved by EPA, shows such protection is not needed	Grants of Environmental Restriction and Rights of Access 2004
1. Note: City parcel numbering has been revised since Institutional Controls were implemented. Parcel numbers shown are the current parcel numbers based upon a September 2, 2021 review of : gis.burlingtonvt.gov; https://property.burlingtonvt.gov					

Table IV-1 - Summary of Water Level Monitoring
2016 -2021

Sampling Event	Lake Champlain	Canal	8_MW-9A	8_MW-9B	J_MW-20A	J_MW-20B	J_MW-21A	J_MW-21B	J_MW-22A	J_MW-22B	J_MW-23A	J_MW-23B
Spring 2016	96.77	96.70	97.63	96.92	97.55	97.66	96.74	96.69	96.77	96.79	96.82	96.79
Fall 2016	93.26	96.00	95.39	95.24	95.26	95.63	93.52	93.48	94.38	94.72	94.61	93.99
Spring 2017	99.26	99.15	99.28	99.36	99.19	100.04	99.39	99.13	99.11	99.11	99.09	99.08
Fall 2017	93.77	96.13	96.12	95.51	96.02	96.05	94.01	93.98	95.12	95.24	95.50	95.51
Spring 2018	97.69	97.62	98.19	97.75	98.06	98.53	97.68	97.56	97.78	97.66	97.62	97.53
Fall 2018	93.74	96.30	97.05	95.50	96.93	95.95	93.89	93.83	94.70	95.07	95.62	95.44
Spring 2019	100.32	100.32	100.35	100.51	100.39	101.21	100.39	100.29	100.32	100.28	100.22	100.21
Fall 2019	95.10	96.63	97.58	96.32	97.54	96.86	95.17	95.19	95.76	95.97	96.40	95.65
Spring 2020	97.55	97.55	97.69	97.67	97.89	98.46	97.52	97.49	97.51	97.71	97.47	97.44
Fall 2020	93.64	96.66	97.43	95.93	97.35	96.43	94.07	94.01	94.93	95.46	96.03	95.87
Spring 2021	96.21	96.50	97.43	96.67	97.42	97.32	96.16	96.13	96.34	96.37	96.49	96.18

Sampling Event	J_MW-24A	J_MW-24B	T_MW-25B	T_MW-26A	T_MW-26B	T_MW-27A	T_MW-27B	T_MW-28A	T_MW-28B	T_MW-29A	T_MW-29B	T_MW-30A
Spring 2016	96.84	96.57	96.73	96.92	96.70	96.69	96.68	96.68	96.68	--	--	--
Fall 2016	94.19	94.19	94.38	94.30	93.63	93.52	93.52	93.53	93.69	--	--	--
Spring 2017	99.17	98.72	99.14	98.99	99.11	99.07	99.11	99.09	99.10	--	--	--
Fall 2017	95.54	94.47	94.76	94.95	94.05	93.96	93.92	93.95	94.19	94.00	94.05	94.00
Spring 2018	97.64	97.75	97.59	97.62	97.52	97.57	97.55	97.54	97.52	97.57	97.53	97.55
Fall 2018	94.46	94.44	94.7	94.86	93.95	93.85	93.84	93.86	94.07	93.94	93.98	93.53
Spring 2019	100.43	100.41	100.28	100.09	100.34	100.35	100.33	100.35	100.34	100.33	100.3	100.31
Fall 2019	95.49	95.69	95.59	95.63	95.18	95.14	95.09	95.14	95.27	95.19	95.20	95.16
Spring 2020	97.58	97.56	97.51	97.59	97.45	97.41	97.45	97.46	97.46	97.43	97.41	97.43
Fall 2020	94.78	94.77	95.08	95.12	94.12	93.94	94.00	94.01	94.26	94.11	94.07	93.65
Spring 2021	96.41	96.29	96.35	96.34	96.15	96.14	96.09	96.12	96.18	96.18	96.18	95.95

Sampling Event	T_MW-30B	T_MW-31A	T_MW-31B	RW-111	RW-112	RW-113	RW-114	5_WE89-5S	5_WE89-6S	5_WE89-7S	J_FLA-1	J_FLA-4
Spring 2016	--	--	--	96.76	96.84	96.74	96.77	98.75	101.64	98.66	98.37	98.46
Fall 2016	--	--	--	95.13	95.18	94.66	95.12	98.09	98.52	99.26	97.74	98.22
Spring 2017	--	--	--	99.08	99.01	99.10	99.61	99.47	98.67	99.09	99.11	99.30
Fall 2017	94.21	96.17	95.66	95.47	95.49	94.99	95.35	98.43	98.45	98.35	98.00	98.24
Spring 2018	97.48	97.57	97.49	97.54	97.51	97.50	97.35	98.99	99.32	99.10	98.56	98.89
Fall 2018	94.07	96.37	95.73	95.49	95.57	95.04	95.40	98.60	97.73	98.54	98.21	98.44
Spring 2019	100.25	100.31	100.19	100.24	100.22	100.18	99.91	100.51	100.60	100.59	100.18	100.38
Fall 2019	95.31	96.83	96.41	96.19	96.17	95.79	95.94	99.10	NM	99.77	98.59	99.15
Spring 2020	97.44	97.44	97.46	97.46	97.43	97.37	97.45	98.89	98.92	99.27	98.58	99.10
Fall 2020	94.19	96.90	96.29	96.09	96.00	95.41	95.76	98.73	98.56	98.83	98.36	98.60
Spring 2021	96.13	96.66	96.50	96.44	96.41	96.28	96.30	98.84	99.11	98.81	98.46	98.66

Notes:

1. Water elevations are in feet above mean sea level, NAVD 1988.
2. Lake Champlain levels are taken from USGS station 04294500.
3. Canal levels are measured at the railroad abutment and equipment bridge.
4. "--" = monitoring well was not yet instaled.
5. NM = not measured, well inaccessible at time of measurement.
6. Deep wells are measured in fall only and are not included in this table.

Table IV-2 - Summary of Groundwater BTEX Concentrations 2016-2021

Sampling Location	Sampling Event	VOC Results 2016-2021 *MCL / VGES (µg/L)*				
		Benzene	**Toluene**	**Ethylbenzene**	**Xylenes**	**Naphthalene**
		5 / 5	*1000 / 1000*	*700 / 700*	*10,000 / 10,000*	*NS / 0.5*
Inside Class IV Groundwater Boundary						
MW-9B	Spring 2016	ND < 1	ND < 1	ND < 1	ND < 1	ND < 4
	Fall 2016	ND < 1	ND < 1	ND < 1	ND < 1	ND < 4
	Spring 2017	ND < 1	ND < 1	ND < 1	ND < 1	ND < 4
	Fall 2017	ND < 1	ND < 1	ND < 1	ND < 1	ND < 4
	Spring 2018	ND < 1	ND < 1	ND < 1	ND < 1	0.2 J'
	Fall 2018	ND < 1	ND < 1	ND < 1	ND < 5	ND < 0.5'
	Spring 2019	ND < 1 J	ND < 1 J	ND < 1 J	ND < 5 J	ND < 0.5 J'
	Fall 2019	ND < 0.5	ND < 0.5	ND < 0.5	0.2 J	ND < 0.5'
	Spring 2020	0.2 J	ND < 0.5	ND < 0.5	0.7 J	ND < 0.5'
	Fall 2020	ND < 1	ND < 1	ND < 1	ND < 6	ND < 0.5'
	Spring 2021	4.6	0.54 J	22	20	**63'**
MW-22A	Spring 2016	**1500**	9 J	570	670	**980**
	Fall 2016	**1400**	73	630	730	**1900**
	Spring 2017	**1800**	ND < 20	**740**	900	**1900**
	Fall 2017	**1800**	65	**770**	890	**2200 J**
	Spring 2018	**1700**	8 J	**710**	860	**2600**
	Fall 2018	**1800**	140	**760**	900	**2700**
	Spring 2019	**1700**	6	**730**	810	**2200**
	Fall 2019	**1900**	190	**870**	960	**3700**
	Spring 2020	**1900**	6.8 J	670	840	**2500**
	Fall 2020	**2100**	220	**970**	1100	**1200'**
	Spring 2021	**1500**	11	**710**	920	**2800'**
MW-22B	Spring 2016	**670**	6 J	420	550	**1100**
	Fall 2016	**810**	18	500	640	**1900**
	Spring 2017	**770**	ND < 20	420	500	**1600**
	Fall 2017	**890**	6 J	480	610	**1800**
	Spring 2018	**880**	10 J	520	640	**1900**
	Fall 2018	**1200**	33	610	780	**2500**
	Spring 2019	**770**	3 J	400	440	**1600**
	Fall 2019	**1100**	22	600	680	**2300**
	Spring 2020	**1100**	5.1 J	540	610	**2500**
	Fall 2020	**1200**	53	**740**	820	**1600'**
	Spring 2021	**1400**	5.3	**800**	740	**1700'**
MW-23B	Spring 2016	**390**	300	490	750	**3200**
	Fall 2016	**370**	280	590	810	**3900**
	Spring 2017	**480**	260	590	840	**3600**
	Fall 2017	**460**	270	660	910	**3300**
	Spring 2018	**440**	260	630	890	**4100**
	Fall 2018	**510**	300	**730**	980	**3900**
	Spring 2019	**490**	230	680	960	**3700**
	Fall 2019	**530**	260	**800**	990	**4500**
	Spring 2020	**460**	210	690	1000	**4700**
	Fall 2020	**470**	220	**760**	1200	**2400'**
	Spring 2021	**430**	200	670	960	**2800'**

Table IV-2 - Summary of Groundwater BTEX Concentrations 2016-2021

Sampling Location	Sampling Event	VOC Results 2016-2021 *MCL / VGES (µg/L)*				
		Benzene	**Toluene**	**Ethylbenzene**	**Xylenes**	**Naphthalene**
		5 / 5	*1000 / 1000*	*700 / 700*	*10,000 / 10,000*	*NS / 0.5*
Outside Class IV Groundwater Boundary						
MW-25B	Spring 2016	ND < 1	ND < 1	ND < 1	ND < 1	ND < 4
	Fall 2016	ND < 1	ND < 1	ND < 1	ND < 1	ND < 4
	Spring 2017	ND < 1	ND < 1	ND < 1	ND < 1	ND < 4
	Fall 2017	ND < 1	ND < 1	ND < 1	ND < 1	ND < 4
	Spring 2018	ND < 1	ND < 1	ND < 1	ND < 1	ND < 4
	Fall 2018	ND < 1	ND < 1	ND < 1	ND < 5	ND < 5
	Spring 2019	ND < 1 J	ND < 1 J	ND < 1 J	ND < 5 J	ND < 5 J
	Fall 2019	ND < 0.5	ND < 0.5	ND < 0.5	ND < 1	--
	Spring 2020	ND < 0.5	ND < 0.5	ND < 0.5	ND < 1	ND < 0.5
	Fall 2020	ND < 1	ND < 1	ND < 1	ND < 6	ND < 5
	Spring 2021	ND < 1	ND < 1	ND < 1	ND < 6	**7.2 J**
MW-21A	Spring 2016	**150**	ND < 5	ND < 5	8	**310**
	Fall 2016	**160**	ND < 5	ND < 5	21	**580**
	Spring 2017	**71**	ND < 1	ND < 1	14	**200**
	Fall 2017	**79**	ND < 1	0.6 J	17	**210 E**
	Spring 2018	**32**	ND < 1	ND < 1	14	**64**
	Fall 2018	**50**	ND < 1	ND < 1	15	**86**
	Spring 2019	**8**	ND < 1	ND < 1	5 J	4 J
	Fall 2019	**16**	0.08 J	0.1 J	6.7	0.3 J'
	Spring 2020	**1.8**	ND < 0.5	ND < 0.5	2.9	1
	Fall 2020	**11**	ND < 1	ND < 1	2.5 J	0.26 J'
	Spring 2021	2.8	ND < 1	ND < 1	1.6 J	0.34 J'
MW-21B	Spring 2016	ND < 1	ND < 1	ND < 1	ND < 1	ND < 4
	Fall 2016	**37**	ND < 1	ND < 1	ND < 1	ND < 4
	Spring 2017	**24**	ND < 1	ND < 1	ND < 1	ND < 4
	Fall 2017	**17**	ND < 1	ND < 1	ND < 1	ND < 4
	Spring 2018	**12**	ND < 1	ND < 1	ND < 1	ND < 4
	Fall 2018	ND < 1	ND < 1	ND < 1	ND < 5	ND < 0.5'
	Spring 2019	**19 J+**	ND < 1	ND < 1	2 J	ND < 5
	Fall 2019	ND < 0.5	ND < 0.5	ND < 0.5	ND < 1	0.3 J'
	Spring 2020	4.2	ND < 0.5	ND < 0.5	ND < 1	ND < 0.5
	Fall 2020	ND < 1	ND < 1	ND < 1	ND < 6	ND < 0.5'
	Spring 2021	ND < 1 J	ND < 1 J	ND < 1 J	ND < 6 J	0.21 J'
MW-27B	Spring 2016	**59**	ND < 1	10	8	**81**
	Fall 2016	**38**	ND < 1	3	7	**69**
	Spring 2017	**24**	ND < 1	ND < 1	8	**49**
	Fall 2017	**25**	ND < 1	ND < 1	10	**76**
	Spring 2018	**14**	ND < 1	ND < 1	8	**62**
	Fall 2018	**10**	ND < 1	ND < 1	7	**33**
	Spring 2019	4 J-	ND < 1 J	ND < 1 J	5 J-	12 J-
	Fall 2019	**10**	ND < 5	ND < 5	4.6 J	4.3 J
	Spring 2020	**8.8**	ND < 5	ND < 5	2.9 J	0.9 J
	Fall 2020	3 J	ND < 5	ND < 5	ND < 30	ND < 25
	Spring 2021	0.53 J	ND < 1	ND < 1	1.4 J	ND < 5

Table IV-2 - Summary of Groundwater BTEX Concentrations 2016-2021

Sampling Location	Sampling Event	VOC Results 2016-2021 *MCL / VGES (µg/L)*				
		Benzene	**Toluene**	**Ethylbenzene**	**Xylenes**	**Naphthalene**
		5 / 5	*1000 / 1000*	*700 / 700*	*10,000 / 10,000*	*NS / 0.5*
Outside Class IV Groundwater Boundary						
MW-28B	Spring 2016	**900**	ND < 1	ND < 1	ND < 1	ND < 4
	Fall 2016	**1500**	ND < 10	ND < 10	10 J	ND < 40
	Spring 2017	**1800**	ND < 10	ND < 10	50	15 J
	Fall 2017	**1800**	6 J	61	200	**53**
	Spring 2018	**1500**	6	220	320	ND < 20
	Fall 2018	**1600**	6 J	510	600	**110**
	Spring 2019	**1300**	3 J	360	330	**83**
	Fall 2019	**1400**	4.9 J	510	500	**330**
	Spring 2020	**1300**	2.2 J	250	240	**300**
	Fall 2020	**1200**	6.8	400	390	**970**
	Spring 2021	**1500**	9.4	340	340	**1500**
MW-29A	Fall 2017	**8**	11	ND < 1	ND < 1	3 J
	Spring 2018	ND < 1	ND < 1	ND < 1	ND < 1	ND < 4
	Fall 2018	0.6 J	ND < 1	ND < 1	ND < 5	ND < 5
	Spring 2019	ND < 1	ND < 1	ND < 1	ND < 5	ND < 5
	Fall 2019	0.8	ND < 0.5	ND < 0.5	ND < 1	ND < 0.5
	Spring 2020	1.5	ND < 0.5	ND < 0.5	ND < 1	ND < 0.5
	Fall 2020	2.6	ND < 1	ND < 1	ND < 6	ND < 5
	Spring 2021	3.6	ND < 1	ND < 1	ND < 6	ND < 5
MW-29B	Fall 2017	**610**	ND < 5	7	27	ND < 20
	Spring 2018	**660**	ND < 5	22	45	ND < 20
	Fall 2018	**850**	ND < 20	96	130	ND < 100
	Spring 2019	**730**	ND < 5	57	70	17 J
	Fall 2019	**810**	1 J	130	170	**80**
	Spring 2020	**480**	ND < 2.5	52	51	**50**
	Fall 2020	**720**	1.8 J	190	230	**200**
	Spring 2021	**850**	1.7	220	270	**300**
MW-30A	Fall 2017	ND < 1	ND < 1	ND < 1	ND < 1	ND < 4
	Spring 2018	ND < 1	ND < 1	ND < 1	ND < 1	ND < 4
	Fall 2018	ND < 1	ND < 1	ND < 1	ND < 5	ND < 5
	Spring 2019	ND < 1	ND < 1	ND < 1	ND < 5	ND < 5
	Fall 2019	ND < 0.5	ND < 0.5	ND < 0.5	ND < 1	ND < 0.5
	Spring 2020	ND < 0.5	ND < 0.5	ND < 0.5	ND < 1	ND < 0.5
	Fall 2020	ND < 1	ND < 1	ND < 1	ND < 6	ND < 5
	Spring 2021	ND < 1	ND < 1	ND < 1	ND < 6	**1.7 J**

Notes:
1. Only sampling results from wells with at least one BTEX exceedance of MCLs/VGES from 2016-2021 are shown.
2. J = concentration estimated by either the laboratory or data validator.
2. J- = concentration estimated by either the laboratory or data validator (low bias).
2. J+ = concentration estimated by either the laboratory or data validator (high bias).
3. ND = not detected above laboratory reporting limits.
4. Results in bold type exceed the MCL/VGES.
5. If sample was duplicated, the higher of the two results for each analyte is shown.
6. " ' " = Sample was analyzed via Method 8270D
7. "--" = Compound was not analyzed

Table IV-3 Cap Monitoring Benchmarks

Metals	**ER-M[1] ppm dry wt.**
Copper Benchmark	**270**
Lead Benchmark	**218**
Mercury Benchmark	**0.71**
Zinc Benchmark	**410**
PAHs	**ER-M[1] ppm dry wt.**
Acenaphthene	500
Acenaphthylene	640
Anthracene	1100
Fluorene	540
2-methyl naphthalene	670
Naphthalene	2100
Phenanthrene	1500
Benzo(a)anthracene	1600
Benzo(a)pyrene	1600
Chrysene	2800
Dibenzo(a,h)anthracene	260
Fluoranthene	5100
Pyrene	2600
Sum of PAHs Benchmark	**21 ppm dry wt.**

1. Long, et al., 1995.
2. "ER-M" = Effects Range Median
3. Cap Monitoring Benchmarks are identified in the December 1999 Statement of Work

Table IV-4 - Summary of Long Term Cap Coring Analytical Results 2016 - 2021

Area	Mid-Cap							Top-Cap					
	Sum of PAHs[1] (mg/kg)	Exceeds 21 ppm PAH Benchmark[2]	Copper (mg/kg)	Mercury (mg/kg)	Lead (mg/kg)	Zinc (mg/kg)	Exceeds Metals Benchmark[3]	Sum of PAHs (mg/kg)	Copper (mg/kg)	Mercury (mg/kg)	Lead (mg/kg)	Zinc (mg/kg)	Total Organic Carbon (mg/kg)
2017													
Area 8 Averages	0.029 J	No	No metals analysis performed[4]					1.155 J	No metals analysis performed[4]				6,010
Area 1 Averages	0.005 J	No						1.003 J					2,117
Area 3 Averages	0.091 J	No						0.552 J					48,660
Area 4/5 Averages	No mid-cap sampling, sediment cap not present[6]							26.882					61,200
2019													
Area 8 Averages	0	No	No metals analysis performed[4]					2.189 J	No metals analysis performed[4]				10,480
Area 1 Averages	0.008 J	No						1.420 J					11,130
Area 3 Averages	0	No						0.673 J					63,200
Area 4/5 Averages	No mid-cap sampling, sediment cap not present[6]							10.658 J					88,100
2021													
Area 8 Averages	0.487 J	No	9.6	ND	4.7	26.8 J	No	1.411 J	14.6	0.030 J	13.0	68.8	4,575
Area 1 Averages	0.031 J	No	9.1	ND	3.5	23.7 J	No	1.137 J	11.1	ND	5.5	37.3	2,233
Area 3 Averages	0.294 J	No	10.5	0.021 J	7.9	35.0	No	1.297 J	19.0	0.101 J	18.0	91.5	48,000
Area 4/5 Averages	No mid-cap sampling, sediment cap not present[6]							19.709 J	214.7	0.97 J	248.3	549.3	28,333

Notes:

1. Most PAHs were not detected in most mid-cap samples. Zero was used for non-detect analytes in calculating the sum of PAHs. When reporting limits exceeded 330 µg/kg, 1/2 the reporting limit was used in the summation.

2. Benchmark values for Mid-Cap PAHs is sum of ERMs for 13 PAHs: 21 mg/kg, No Benchmark for Top-Cap Samples.

3. Benchmark values for Mid-Cap metals are ERMs: copper - 270 mg/kg; lead - 218 mg/kg; mercury - 0.71 mg/kg; zinc - 410 mg/kg, no benchmark for Top-Cap.

4. Metals analysis is performed coincident Five Year Review years only.

5. "J" indicates concentration is estimated.

6. Per the 1998 ROD, Area 4/5 does not have a sediment cap because contaminants were not bioavailable.

Table IV-5 - 2021 AVS/SEM Sediment Data

Date	Sample Point	Sample Location Area	Water Depth (ft)	Total Organic Carbon (mg/kg)	Acid Volatile Sulfide (mg/kg)	Simultaneously Extracted Metals (mg/kg)				SEM/AVS Molar Ratio
						Cu	Pb	Hg	Zn	
8/5/2021	J_T2+00 E270	8	6.8	6,200	613.8	36.86	76.66	U	255.06	0.27
8/5/2021	J_T6+00 E20	1	6.8	2,500	1466.3	43.85	53.87	U	268.14	0.12
8/5/2021	J_T20+00 E25	4/5	3.0	18,000	1193.5	76.26	66.30	U	719.40	0.36

Notes:

1. U = Constituent was not detected in the sample

Table IV-6 - Total Organic Carbon Sediment Data - Benthic Macroinvertebrate Sampling 2021

Location	Sample Point	Date	Water Depth (ft.)	Percent Solids	Total Organic Carbon (mg/kg)	Sediment Type (USDA)
Area 8	J_T2+00-E270	6/22/2021	6.8	72.5	6,200	Organic
Area 1	J_T6+00-E20	6/22/2021	6.8	73.0	2,500	Organic
Area 4/5	J_T20+00-E25	6/23/2021	3	33.1	18,000	Organic

Table IV-7 - Comparison of Relative Abundance and Diversity - Benthic Macroinvertebrates

Summary of Benthic Macroinvertebrate Data - Area 1 June 2021 (Major Component Species ≥4%)		
Sample Location: Area 1, J_T6+00 E20 **Date Sample Collected: 6/22/21** **Water Depth on Sample Collection Date: 6.8 ft**		
Family	Genus and Species	% of Total
Replicate No. 1 - Total Abundance = 8		
Chironomidae	*Chironomus sp.*	25.0
Naididae-Tubificoid	*Limnodrilus sp.*	12.5
Naididae-Tubificoid	*Naididae naididae unid*	25.0
Chironomidae	*Procladius sp.*	12.5
Chironomidae	*Tanytarsus sp.*	12.5
Chironomidae	*Tanypus sp.*	12.5
Replicate No. 2 - Total Abundance = 20		
Chironomidae	*Chironomus sp.*	35.0
Chironomidae	*Tanypus sp.*	5.0
Chironomidae	*Cladopelma sp.*	15.0
Naididae-Tubificoid	*Naididae-Tubificoid w/o setae*	5.0
Chironomidae	*Parachironomus sp.*	5.0
Chironomidae	*Paratanytarsus sp.*	10.0
Bithyniidae	*Bithynia sp.*	5.0
Chironomidae	*Dicrotendipes sp.*	10.0
Chironomidae	*Endochironomus sp.*	5.0
Chironomidae	*Procladius sp.*	5.0
Replicate No. 3 - Total Abundance = 128		
Chironomidae	*Chironomus sp.*	31.3
Chironomidae	*Endochironomus sp.*	19.5
Chironomidae	*Paratanytarsus sp.*	31.3
Chironomidae	*Dicrotendipes sp.*	27.3
Chironomidae	*Parachironomus sp.*	5.5
Area 1 - Relative Abundance = 52		
Note: Specimens are identified to the lowest practical taxon		

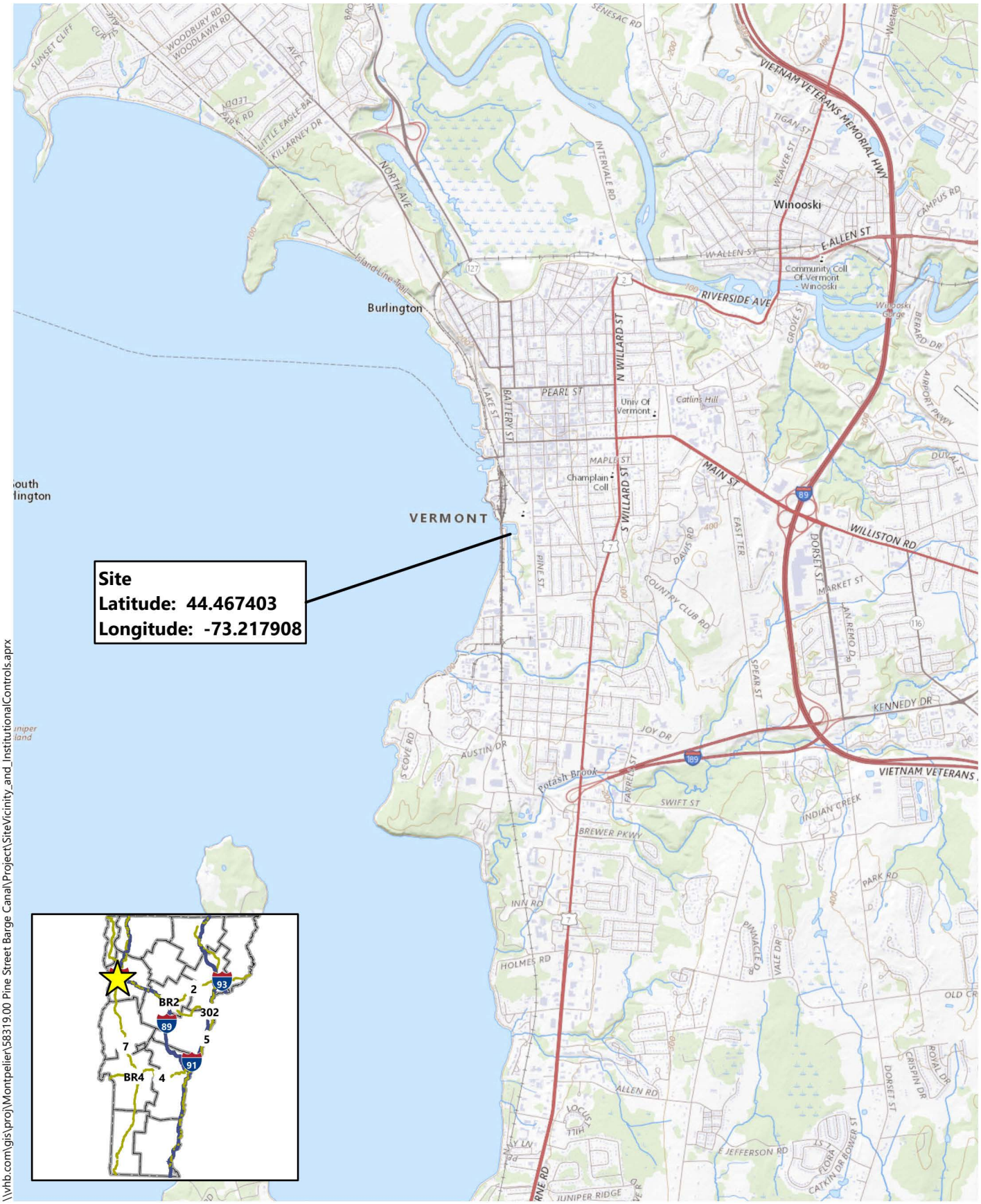
Table IV-7 - Comparison of Relative Abundance and Diversity - Benthic Macroinvertebrates

Summary of Benthic Macroinvertebrate Data - Area 8 June 2021 (Major Component Species ≥4%)		
Sample Location: Area 8, J_T2+00 E270 **Date Sample Collected: 6/22/21** **Water Depth on Sample Collection Date: 6.8 ft**		
Family	Genus and Species	% of Total
Replicate No. 1 - Total Abundance = 89		
Naididae-Tubificoid	*Aulodrilus sp.*	24.7
Chironomidae	*Dicrotendipes sp.*	10.1
Chironomidae	*Chironomus sp.*	49.4
Replicate No. 2 - Total Abundance = 604		
Chironomidae	*Endochironomus sp.*	38.4
Chironomidae	*Parachironomus sp.*	8.6
Chironomidae	*Dicrotendipes sp.*	32.5
Chironomidae	*Paratanytarsus sp.*	7.0
Replicate No. 3 - Total Abundance = 31		
Naididae-Tubificoid	*Limnodrilus sp.*	6.5
Naididae-Tubificoid	*Naididae-Tubificoid uid wsetae*	9.7
Naididae-Tubificoid	*Aulodrilus sp.*	32.3
Chironomidae	*Chironomus sp.*	41.9
Area 8 - Relative Abundance = 241		
Note: Specimens are identified to the lowest practical taxon		

Table IV-7 - Comparison of Relative Abundance and Diversity - Benthic Macroinvertebrates

Summary of Benthic Macroinvertebrate Data - Area 4/5 June 2021 (Major Component Species ≥4%)		
Sample Location: Area 4/5, J_T20+00 E25 **Date Sample Collected: 6/23/21** **Water Depth on Sample Collection Date: 3.0 ft**		
Family	Genus and Species	% of Total
Replicate No. 1 - Total Abundance = 254		
Chironomidae	*Chironomus sp.*	18.5
Chironomidae	*Paratanytarsus sp.*	40.6
Chironomidae	*Orthocladius sp. A*	8.3
Chironomidae	*Acricotopus sp.*	7.1
Ceratopogonidae	*Ceratopogonidae imm*	9.1
Replicate No. 2 - Total Abundance = 29		
Chironomidae	*Endochironomus sp.*	10.3
Naididae	*Nais sp.*	13.8
Chironomidae	*Paratanytarsus sp.*	34.5
Chironomidae	*Chironomus sp.*	13.8
Bithyniidae	*Bithynia sp.*	6.9
Chironomidae	*Orthocladius sp. A*	13.8
Replicate No. 3 - Total Abundance = 698		
Chironomidae	*Orthocladius sp. B*	8.9
Chironomidae	*Chironomus sp.*	49.6
Chironomidae	*Acricotopus sp.*	6.3
Chironomidae	*Paratanytarsus sp.*	31.2
Area 4/5 - Relative Abundance = 327		
Note: Specimens are identified to the lowest practical taxon		

FIGURES



\\vhb.com\gis\proj\Montpelier\58319.00 Pine Street Barge Canal\Project\SiteVicinity_and_InstitutionalControls.aprx

0 2000 4000 Feet

Pine Street Canal Superfund Site | Burlington, VT

Site Vicinity Map

Source Info:
- Basemap from ESRI/USGS Topo Map

AERIAL IMAGE FROM VCGI, APRIL 2018

LEGEND

— - — SITE BOUNDARY

N

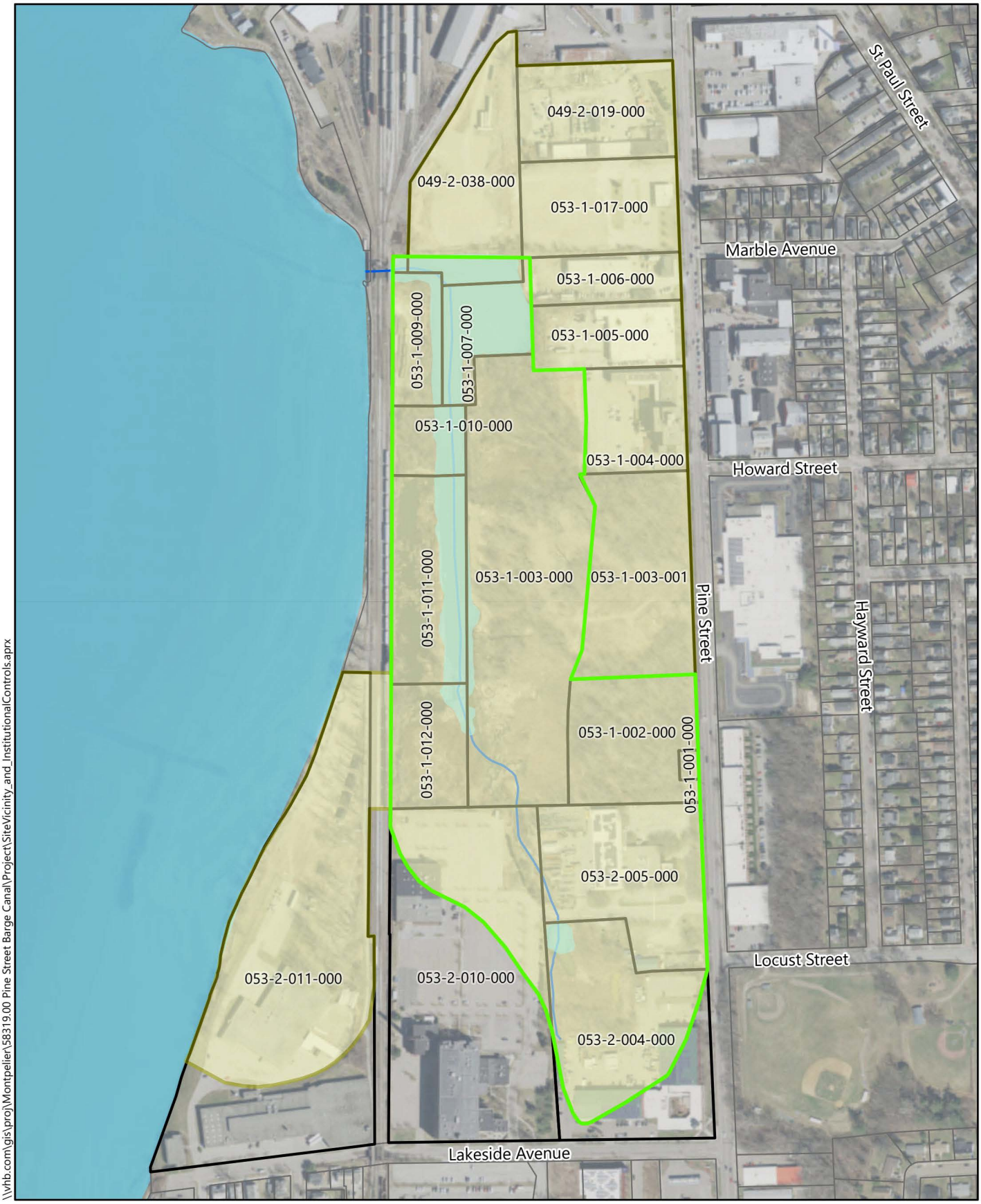
0 200' 400'

vhb
100 State Street, Suite 600
Montpelier, VT 05602
(802) 229-4600

Drawn by: QML Date: 8/11/21
Chk'd by: BDJ Date: 9/2/21
Scale: As Shown Project: 58319.00

FIGURE 2:
SITE BOUNDARY
PINE STREET CANAL SITE
BURLINGTON, VERMONT

\\vhb\gbl\proj\Montpelier\58319.00 Pine Street Barge Canal\4_Working\cad\Base\Planset\2021.08_FiveYearReview.dwg | Plotted by: Quinn Ledak 9/13/2021 8:18:17 AM



\\vhb.com\gis\proj\Montpelier\58319.00 Pine Street Barge Canal\Project\SiteVicinity_and_InstitutionalControls.aprx

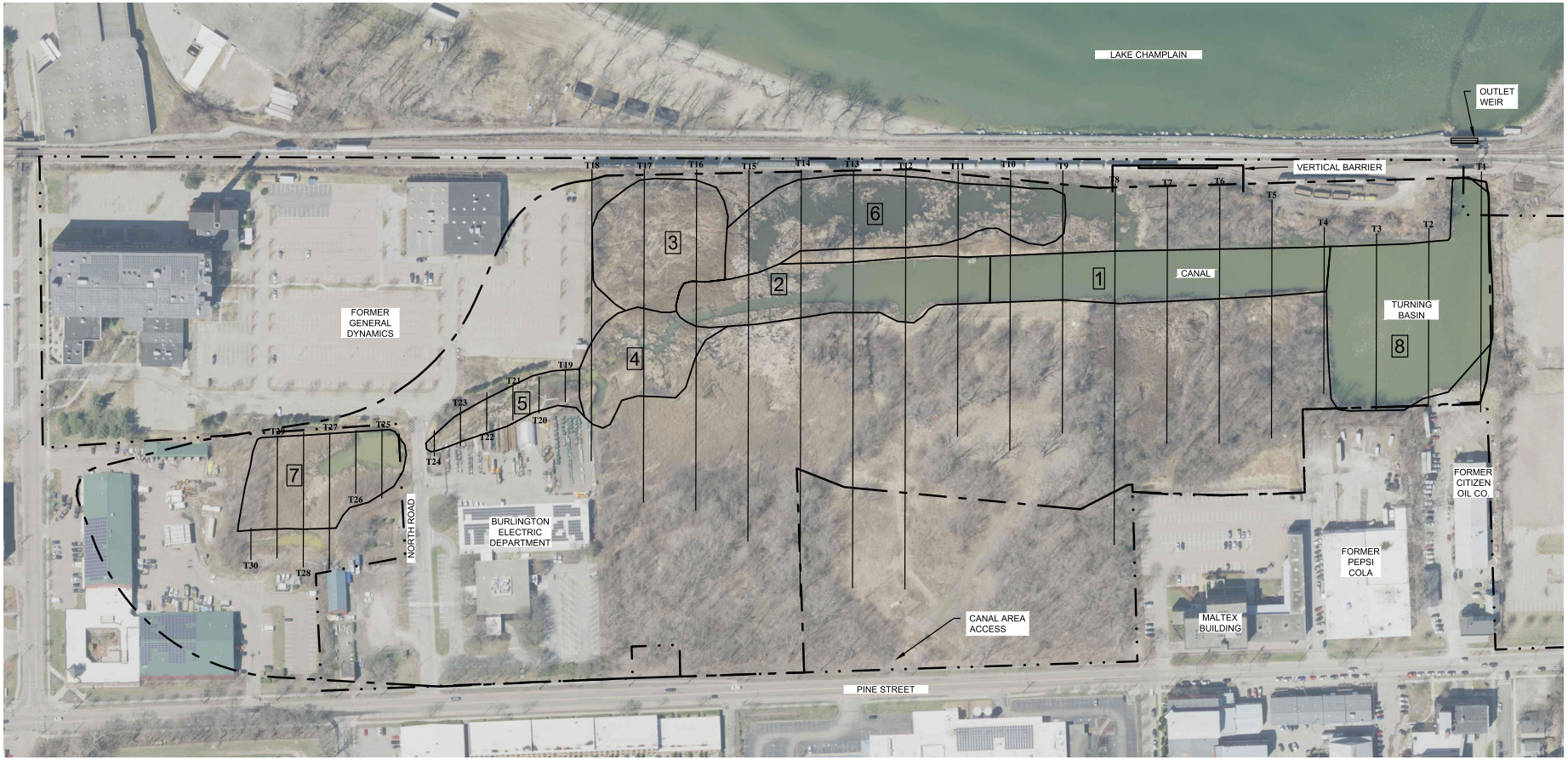
0 100 200 400 Feet

Institutional Controls Boundary
Institutional Control Property
Parcel Boundary
Water Body (VHD)
Stream (VHD) Superfund
Site Boundary

Pine Street Canal Superfund Site | Burlington, VT

Source Info:
- Basemap from ESRI/VCGI (2018).
- Parcel data from VCGI (2020).
- VHD = Vermont Hydrography Dataset.

Properties with Institutional Controls



AERIAL IMAGE FROM VCGI, APRIL 2018

LEGEND

- AREA BOUNDARY
- 4 AREA NUMBER
- CLASS IV GROUNDWATER BOUNDARY
- SITE TRANSECT
- SITE BOUNDARY

N

0 200' 400'

vhb
100 State Street, Suite 600
Montpelier, VT 05602
(802) 229-4600

Drawn by: QML Date: 8/12/21
Chk'd by: BDJ Date: 9/2/21
Scale: As Shown Project: 58319.00

FIGURE 4:
GENERAL SITE PLAN
PINE STREET CANAL SITE
BURLINGTON, VERMONT

\\vhb\gbl\proj\Montpelier\58319.00 Pine Street Barge Canal\4_Working\cad\Base\Planset\2021.08_FiveYearReview.dwg | Plotted by: Quinn Ledak 9/14/2021 9:19:32 AM

LEGEND

- (S) GROUNDWATER MONITORING WELL - SHALLOW OVERBURDEN
- (D) GROUNDWATER MONITORING WELL - DEEP OVERBURDEN
- (N) GROUNDWATER MONITORING WELL - NAPL MONITORING
- VERTICAL BARRIER WALL
- CLASS IV GROUNDWATER BOUNDARY
- INVESTIGATIVE SOIL BORING LOCATION - SEPTEMBER 2017
- MONITORING WELL LOCATION - INSTALLED SEPTEMBER 2017

AERIAL IMAGE FROM VCGI, APRIL 2018

N

0 50' 100'

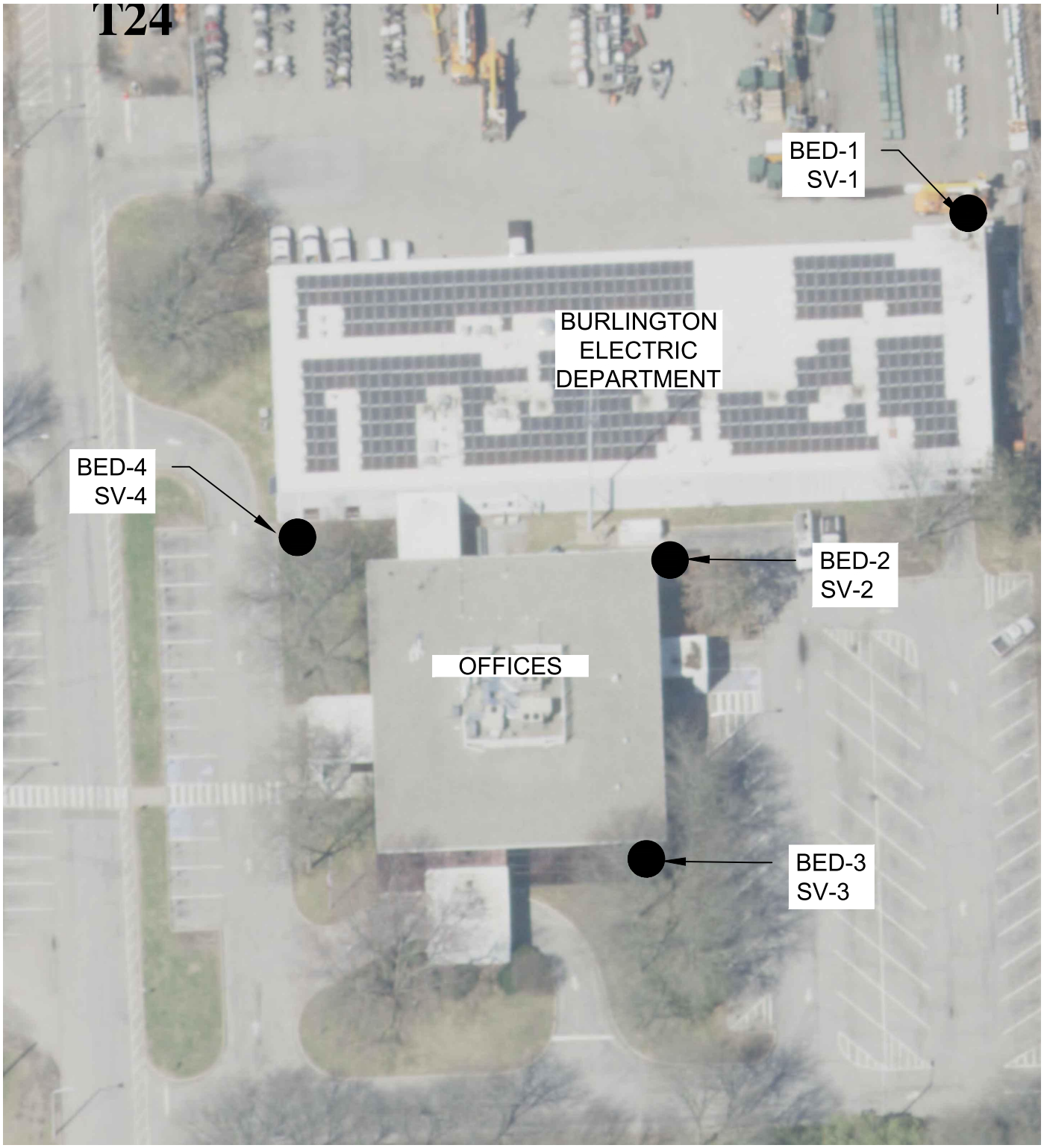
vhb
100 State Street, Suite 600
Montpelier, VT 05602
(802) 229-4600

Drawn by: QML Date: 9/1/21
Chk'd by: BDJ Date: 9/2/21
Scale: As Shown Project: 58319.00

FIGURE 5: SOUTHERN EXTENT
FOCUSED INVESTIGATION LOCATIONS
PINE STREET CANAL SITE
BURLINGTON, VERMONT

\\vhb\gbl\proj\Montpelier\58319.00 Pine Street Barge Canal\4_Working\cad\Base\Planset\2021.09_FYR_LakeStudyandSEFI.dwg | Plotted by: George Lester 9/16/2021 2:34:52 PM

T24



NOTES:

1. GROUNDWATER AND SOIL VAPOR SAMPLING POINTS ARE CO-LOCATED

AERIAL IMAGE FROM VCGI, APRIL 2018

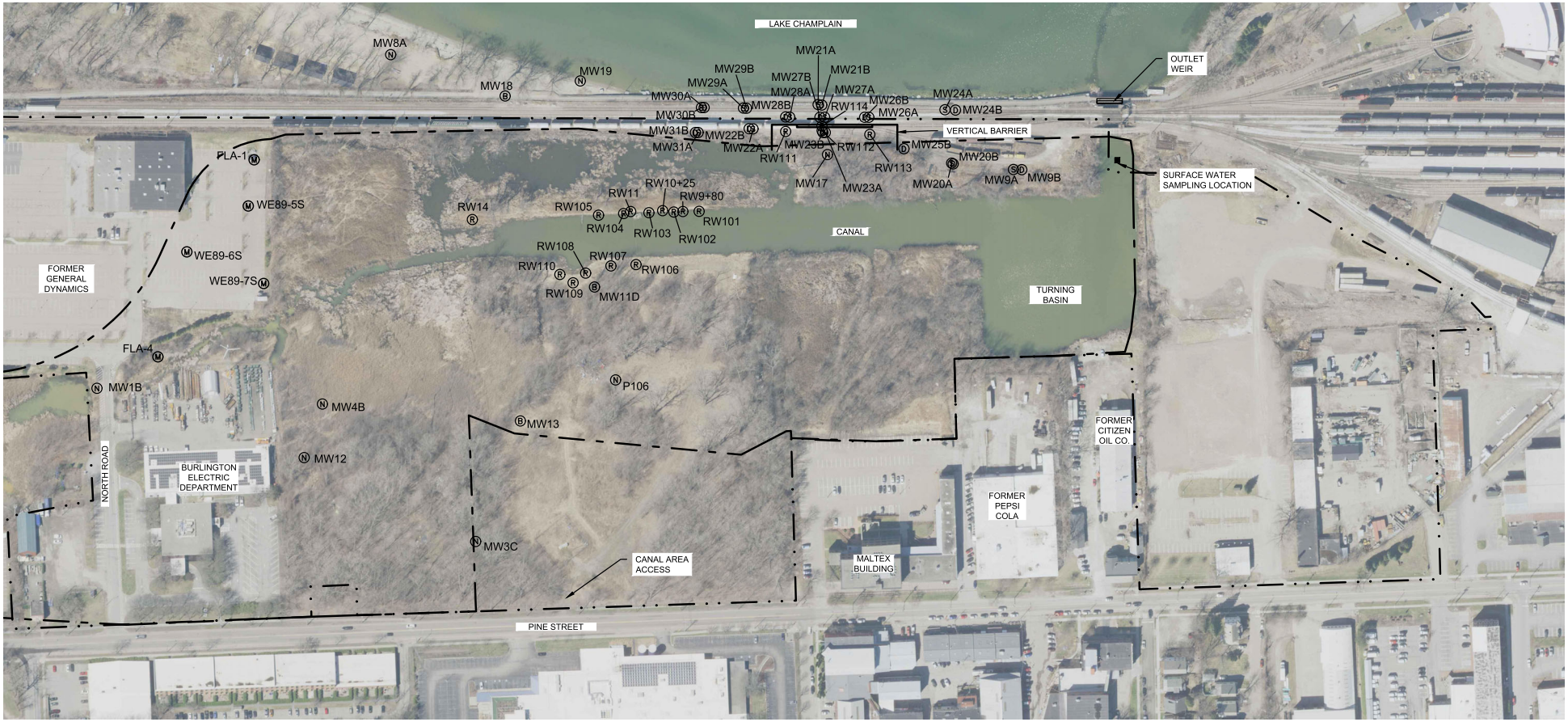
N

0 50' 100'

100 State Street, Suite 600
Montpelier, VT 05602
(802) 229-4600

Drawn by: GWL Created: 05/26/21
Chk'd by: GWL Revised: 05/26/21
Scale: As Shown Project: 58319.00

FIGURE 6:
BED SAMPLE LOCATIONS
PINE STREET CANAL SITE
BURLINGTON, VERMONT



AERIAL IMAGE FROM VCGI, APRIL 2018

LEGEND

- Ⓝ GROUNDWATER MONITORING WELL FOR NAPL MONITORING
- Ⓑ GROUNDWATER MONITORING WELL - BEDROCK
- Ⓜ GROUNDWATER WELL FOR POTENTIOMETRIC MONITORING
- Ⓡ PASSIVE NAPL RECOVERY WELL
- Ⓢ GROUNDWATER MONITORING WELL - SHALLOW OVERBURDEN
- Ⓓ GROUNDWATER MONITORING WELL - DEEP OVERBURDEN
- VERTICAL BARRIER
- CLASS IV GROUNDWATER BOUNDARY
- SITE BOUNDARY

N

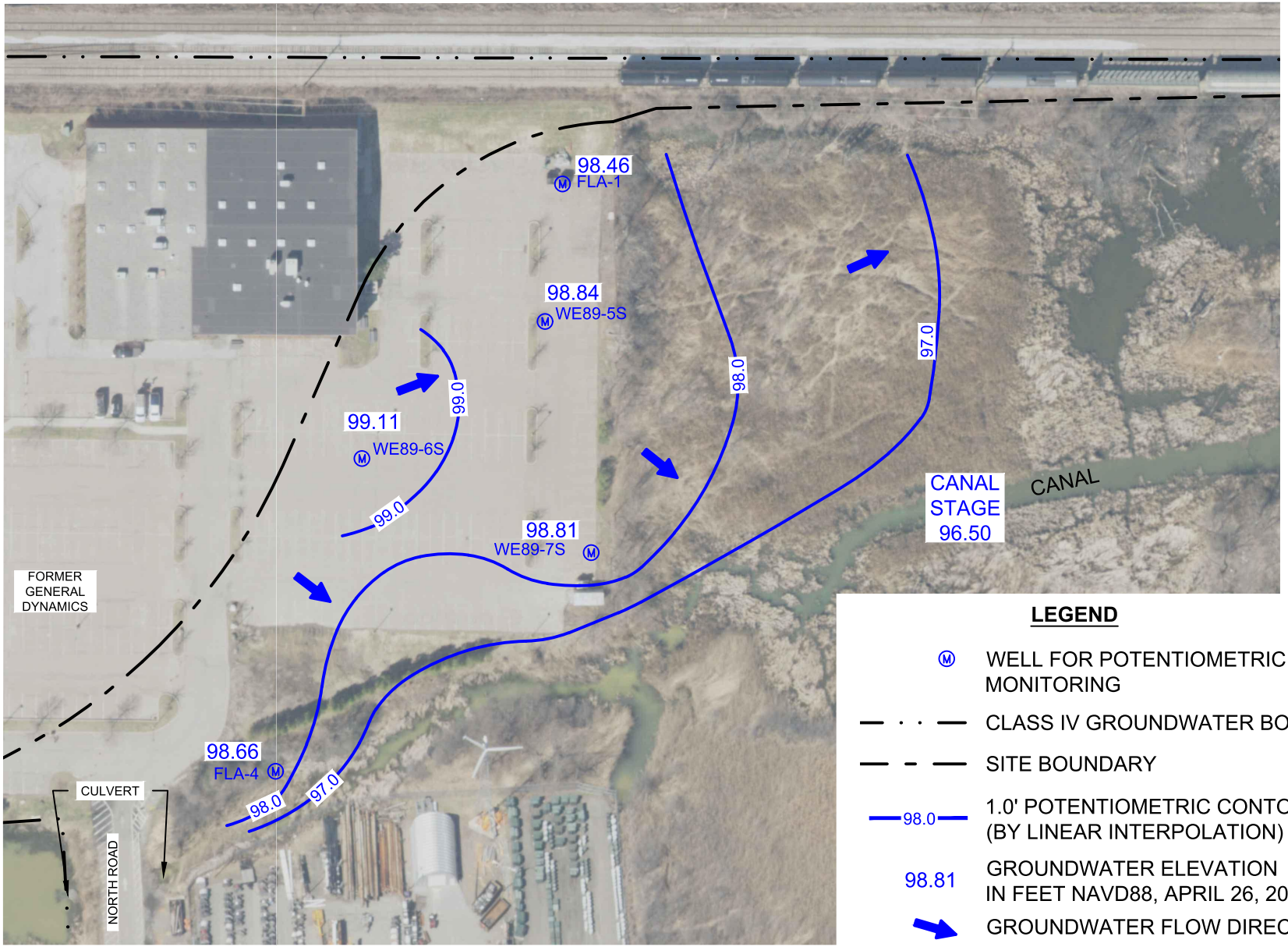
0 200' 400'

vhb
100 State Street, Suite 600
Montpelier, VT 05602
(802) 229-4600

Drawn by: GWL Date: 12/17/18
Chk'd by: GWV Date: 12/18/18
Scale: As Shown Project: 58319.00

FIGURE 7:
COMPLIANCE MONITORING LOCATIONS
PINE STREET CANAL SITE
BURLINGTON, VERMONT

\\vhb\gbl\proj\Montpelier\58319.00 Pine Street Barge Canal\4_Working\cad\Base\Planset\2021.08_FiveYearReview.dwg | Plotted by: George Lester 9/16/2021 2:11:08 PM



LEGEND

- Ⓜ WELL FOR POTENTIOMETRIC MONITORING
- CLASS IV GROUNDWATER BOUNDARY
- SITE BOUNDARY
- 98.0 — 1.0' POTENTIOMETRIC CONTOUR (BY LINEAR INTERPOLATION)
- 98.81 — GROUNDWATER ELEVATION IN FEET NAVD88, APRIL 26, 2021
- GROUNDWATER FLOW DIRECTION

N

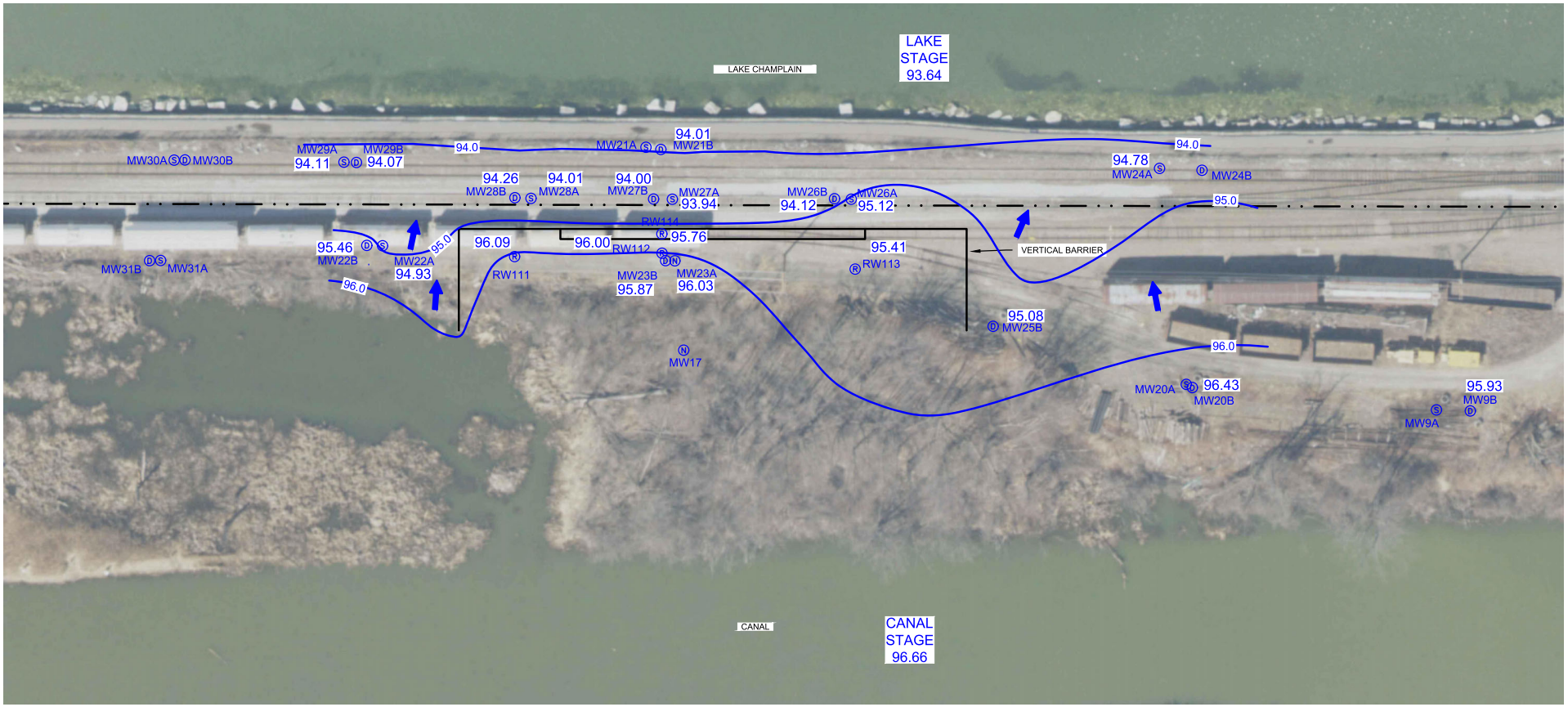
0 100' 200'

AERIAL IMAGE FROM VCGI, APRIL 2018

100 State Street, Suite 600
Montpelier, VT 05602
(802) 229-4600

Drawn by: QML Date: 6/7/21
Chk'd by: GWL Date: 7/12/21
Scale: As Shown Project: 58319.00

FIGURE 8: FILL GROUNDWATER ELEVATIONS FORMER GENERAL DYNAMICS PROPERTY - APRIL 26, 2021
PINE STREET CANAL SITE
BURLINGTON, VERMONT



AERIAL IMAGE FROM VCGI, APRIL 2018

LEGEND

- Ⓝ GROUNDWATER MONITORING WELL FOR NAPL MONITORING
- Ⓡ PASSIVE NAPL RECOVERY WELL
- Ⓢ GROUNDWATER MONITORING WELL - SHALLOW OVERBURDEN
- Ⓓ GROUNDWATER MONITORING WELL - DEEP OVERBURDEN
- CLASS IV GROUNDWATER BOUNDARY
- VERTICAL BARRIER
- 96.0 1.0' POTENTIOMETRIC CONTOUR FOR ZONE B (BY LINEAR INTERPOLATION)
- 95.93 GROUNDWATER ELEVATION IN FEET NAVD88, OCTOBER 26, 2020
- GROUNDWATER FLOW DIRECTION

N

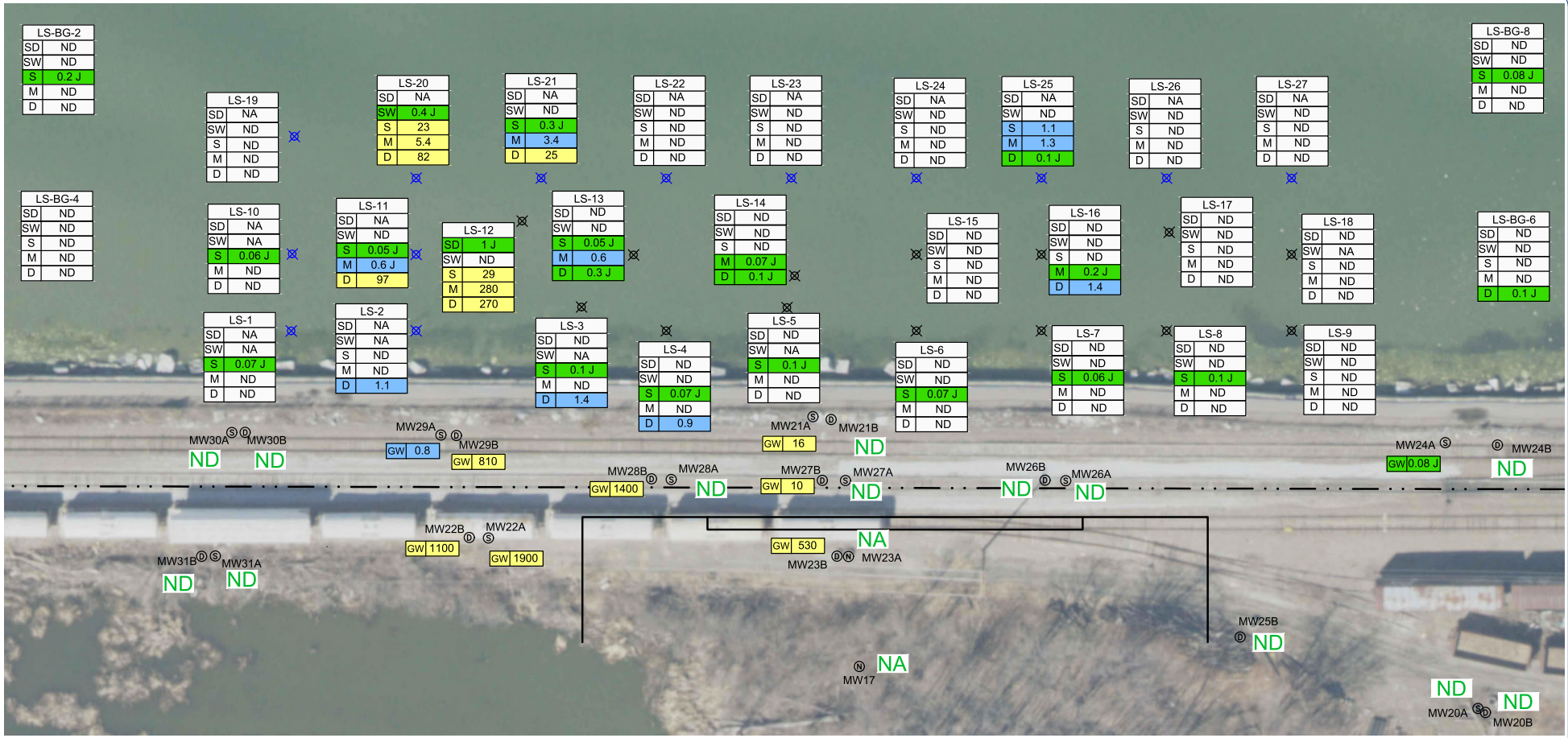
0 50' 100'

vhb
100 State Street, Suite 600
Montpelier, VT 05602
(802) 229-4600

Drawn by: QML Date: 12/14/20
Chk'd by: GWL Date: 1/5/21
Scale: As Shown Project: 58319.00

FIGURE 9: ZONE B GROUNDWATER ELEVATIONS
VERTICAL BARRIER AREA - OCTOBER 26, 2020
PINE STREET CANAL SITE
BURLINGTON, VERMONT

\\vhb\gbl\proj\Montpelier\58319.00 Pine Street Barge Canal\4_Working\cad\Base\Planset\2021.08_FiveYearReview.dwg | Plotted by: Quinn Ledak 9/14/2021 9:29:13 AM



LEGEND

- Ⓢ GROUNDWATER MONITORING WELL - SHALLOW OVERBURDEN
- Ⓓ GROUNDWATER MONITORING WELL - DEEP OVERBURDEN
- Ⓝ GROUNDWATER MONITORING WELL - NAPL MONITORING
- VERTICAL BARRIER WALL
- CLASS IV GROUNDWATER BOUNDARY
- LAKE SAMPLE LOCATION - SURFACE AND PORE WATER ONLY
- LAKE SAMPLE LOCATION - SURFACE WATER, PORE WATER, AND SEDIMENT
- INDICATES AREA WHERE NO SURFACE WATER WAS PRESENT

SAMPLE DEPTH KEY

GW GROUNDWATER SAMPLE (OCTOBER 2019)
SD SEDIMENT SAMPLE
SW SURFACE WATER SAMPLE
S SHALLOW PORE WATER SAMPLE (0.5')
M MIDDLE PORE WATER SAMPLE (3.0')
D DEEP PORE WATER SAMPLE (5.5')

- D | 1700 — INDICATES CONCENTRATION EXCEEDS MCL/VGES
- D | 4 — INDICATES CONCENTRATION GREATER THAN LOQ BUT LESS THAN MCL/VGES
- D | 0.1 J — INDICATES COMPOUND WAS DETECTED BUT LESS THAN THE LOQ
- D | ND — INDICATES COMPOUND WAS NOT DETECTED OR NOT ANALYZED

NOTES

1. WATER CONCENTRATIONS ARE IN ug/l
2. SEDIMENT CONCENTRATIONS ARE IN ug/kg
3. "ND" INDICATES COMPOUND WAS NOT DETECTED
4. "NA" INDICATES COMPOUND WAS NOT ANALYZED
5. NO SURFACE WATER WAS PRESENT AT LS-1, LS-2, LS-3, LS-5, LS-10, LS-18
6. SEDIMENT SAMPLES WERE COLLECTED AT LS-3 - LS-9 AND LS-12 - LS-18
7. BACKGROUND SAMPLE RESULTS ARE SHOWN FOR REFERENCE ONLY, NOT AT THE ACTUAL BACKGROUND SAMPLE LOCATION
8. WHERE A LOCATION WAS SAMPLED IN DUPLICATE, THE HIGHER VALUE IS SHOWN
9. BENCHMARK CONCENTRATIONS FOR SEDIMENT WILL BE DETERMINED BY THE SLERA

AERIAL IMAGE FROM VCGI, APRIL 2018

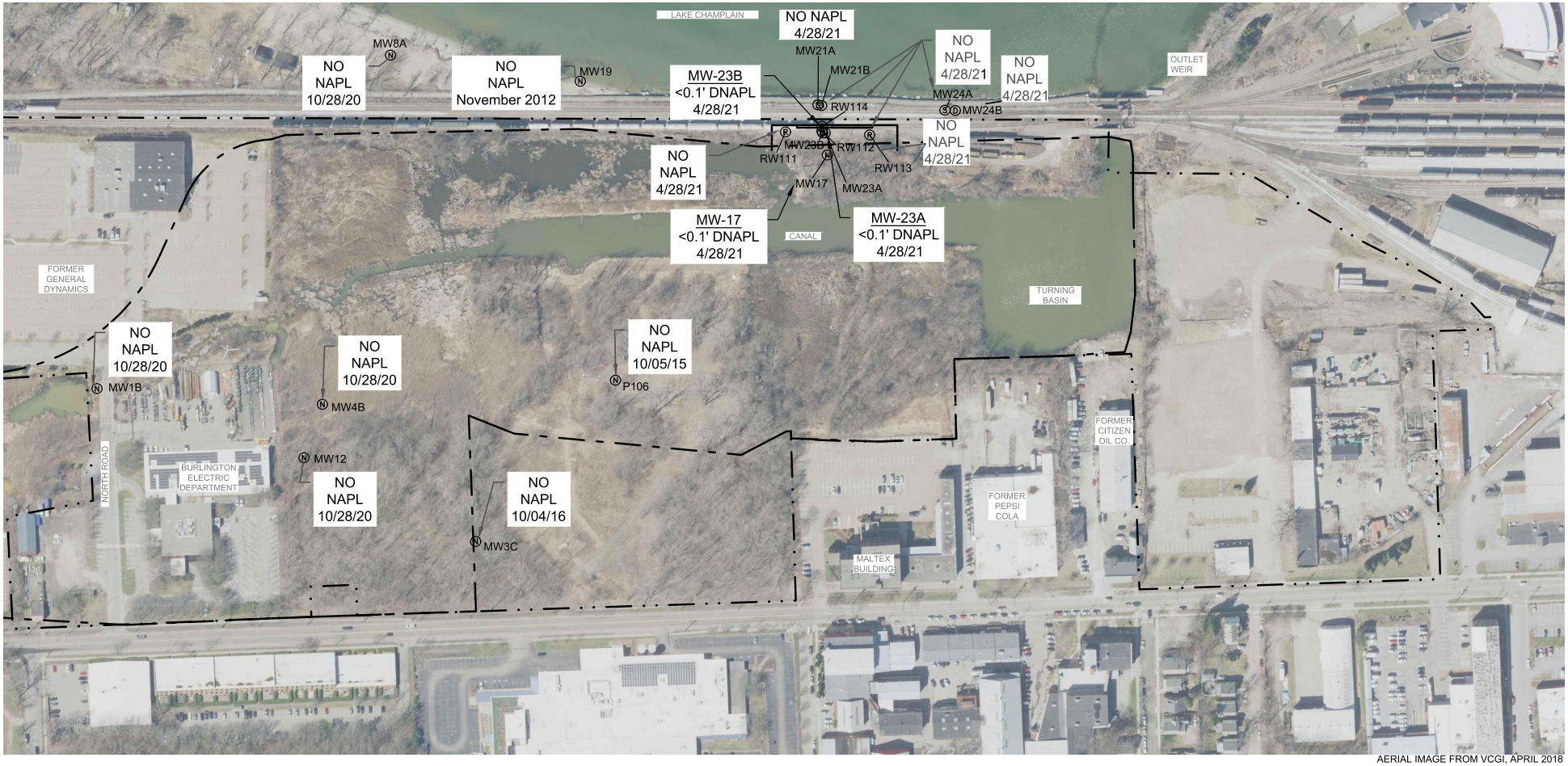
N

0 40' 80'

vhb
100 State Street, Suite 600
Montpelier, VT 05602
(802) 229-4600

Drawn by: GWL Date: 12/12/19
Chk'd by: GWV Date: 12/16/19
Scale: As Shown Project: 58319.00

FIGURE 10 - BENZENE CONCENTRATIONS IN LAKE SEDIMENT, POREWATER, AND SITE GROUNDWATER - SEPTEMBER 2019
PINE STREET CANAL SITE
BURLINGTON, VERMONT



AERIAL IMAGE FROM VCGI, APRIL 2018

LEGEND

- Ⓝ GROUNDWATER MONITORING WELL FOR NAPL MONITORING
- Ⓡ PASSIVE NAPL RECOVERY WELL
- Ⓢ GROUNDWATER MONITORING WELL - SHALLOW OVERBURDEN
- Ⓓ GROUNDWATER MONITORING WELL - DEEP OVERBURDEN
- VERTICAL BARRIER
- CLASS IV GROUNDWATER BOUNDARY
- SITE BOUNDARY

NOTES:
1. THE MOST RECENT NAPL MEASUREMENT FOR EACH WELL IS SHOWN

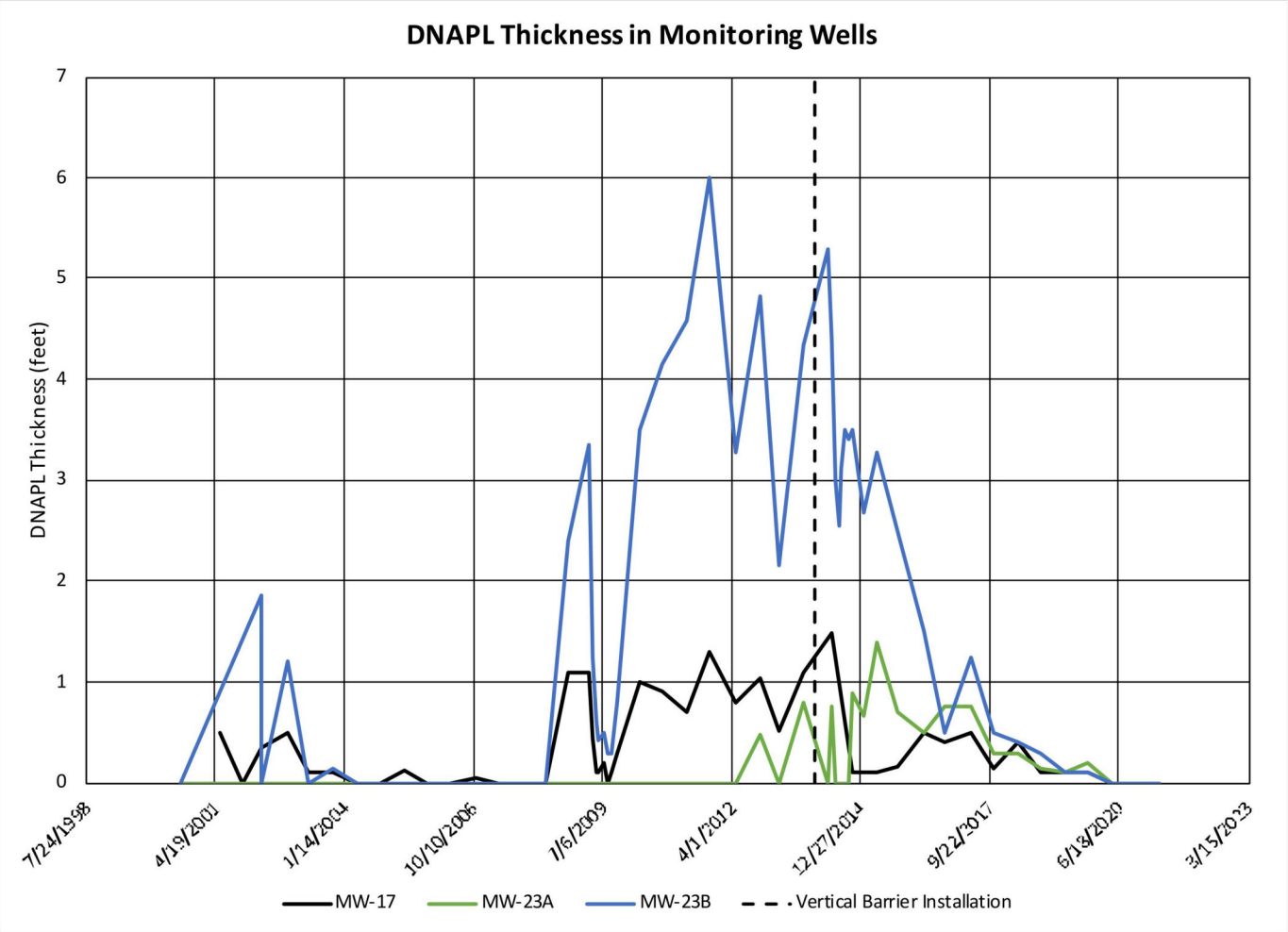
N

0 200' 400'

vhb
100 State Street, Suite 600
Montpelier, VT 05602
(802) 229-4600

Drawn by: QML Date: 8/12/21
Chk'd by: BDJ Date: 9/2/21
Scale: As Shown Project: 58319.00

FIGURE 11: GROUNDWATER MONITORING WELLS AND PASSIVE RECOVERY WELLS NAPL MONITORING RESULTS PINE STREET CANAL SITE BURLINGTON, VERMONT



100 State Street, Suite 600
Montpelier, VT 05602
(802) 229-4600

Drawn by: QML Date: 6/8/21
Chk'd by: GWL Date: 7/12/21
Scale: As Shown Project: 58319.00

FIGURE 12: MONITORING WELL DNAPL THICKNESS TRENDS - VERTICAL BARRIER AREA
PINE STREET CANAL SITE
BURLINGTON, VERMONT

AERIAL IMAGE FROM VCGI, APRIL 2018

LEGEND

® PASSIVE NAPL RECOVERY WELL

EXTENTS OF AMENDED CAP (SOURCE: ARCADIS CONSTRUCTION COMPLETION REPORT, 3/22/11)

T11 TRANSECT LINES

N

0 50' 100'

vhb
100 State Street, Suite 600
Montpelier, VT 05602
(802) 229-4600

Drawn by: QML Date: 8/12/21
Chk'd by: BDJ Date: 9/2/21
Scale: As Shown Project: 58319.00

FIGURE 13: AMENDED CAP PASSIVE RECOVERY WELL LOCATION MAP
PINE STREET CANAL SITE
BURLINGTON, VERMONT

\\vhb\gbl\proj\Montpelier\58319.00 Pine Street Barge Canal\4_Working\cad\Base\Planset\2021.08_FiveYearReview.dwg | Plotted by: George Lester 9/16/2021 2:17:32 PM

APPENDIX A
DOCUMENTS REVIEWED AND REFERENCES

ARCADIS, 2010. *Design Report Pine Street Canal Superfund Site*. Prepared for: Performing Defendants. August 6, 2010.

Brown, E., A. Duchovnay, A. Shambaugh, and A. Williams, 1992. *1991 Lake Champlain Biomonitoring Program*. Vermont Water Resources and Lake Studies Center. School of Natural Resources, University of Vermont.

H&W, 2004. *Institutional Controls Plan*. Hunton & Williams. Prepared for: Performing Defendants. Amended April 2, 2004.

JCO, 1997. *Additional Remedial Investigation Report - Pine Street Canal Superfund Site*. Volumes I and II. The Johnson Company, Inc. July 3.

JCO, 2002a. *Phase IA Remedial Action Construction Completion Report*. Prepared for: Performing Defendants. The Johnson Company, Inc. January 2002.

JCO, 2002b. *Wetland Restoration Plan Summary*. The Johnson Company, Inc. Prepared for: Performing Defendants and the Pine Street Barge Canal Coordinating Committee. April 2002.

JCO, 2004c. *Remedial Action Construction Completion Report*. The Johnson Company, Inc. December 2004.

JCO, 2006. *Compliance Monitoring Workplan Pine Street Canal Superfund Site, Revision 5*, The Johnson Company, Inc. December 27.

JCO, 2012c. *Pine Street Canal Superfund Site - Restoration Plan for Mitigation of Habitat Loss Due to Installation of the Amended Cap*. The Johnson Company, Inc. July 26.

JCO, 2017a. *Fall Compliance Monitoring Report, 2016*. The Johnson Company, Inc., January 2017

JCO, 2017b. *Spring Compliance Monitoring Report, 2017*. The Johnson Company, Inc., August, 2017.

JCO, 2017c. *Well Installation and Boring Report, Vertical Barrier – Southern Extent Focused Investigation Technical Memorandum.* The Johnson Company, Inc., November 15.

JCO, 2018a. *Fall Compliance Monitoring Report, 2017*. The Johnson Company, Inc., January 2018

JCO, 2018b. *Spring Compliance Monitoring Report, 2018*. The Johnson Company, Inc., July 2018

JCO, 2019a. *Fall Compliance Monitoring Report, 2018*. The Johnson Company, Inc., January 2019

JCO, 2019b. *Spring Compliance Monitoring Report, 2019*. The Johnson Company, Inc., July 2019

JCO, 2020a. *Fall Compliance Monitoring Report, 2019*. The Johnson Company, Inc., January 2020

JCO, 2020b. *Lake Sediment and Pore Water Investigation Report, Revision 1.0.* The Johnson Company, Inc, June 2020.

JMA, 2001. *Historic Resources Study, Pine Street Canal Superfund Site, Burlington, Chittenden County, Vermont.* Prepared for the Performing Defendants. Revised May 2001.

M&E, 1992. *Baseline Risk Assessment Final Report*. Pine Street Canal Superfund Site. Prepared for: U.S. Environmental Protection Agency, November 1992.

McIntosh, A., M. Watzin, and E. Brown, 1997. *An Assessment of Sediment – Associated Contaminants in Lake Champlain – Phase II. Lake Champlain Sediment Toxics Assessment Program. Lake Champlain Management Conference, Technical Report No. 23B.* October 1997.

TRC, 2014. *Completion of Work Report, Pine Street Canal Superfund Site*. TRC Environmental Corporation. July 2014.

USEPA, 1998. *Final Declaration for the Record of Decision Pine Street Canal Superfund Site, Burlington, Vermont*. United States Environmental Protection Agency. October 9.

USEPA, 2002. *Memorandum of Agreement for Mitigation of Adverse Effects*. United States Environmental Protection Agency. June 2002.

USEPA, 2009. *Explanation of Significant Differences*. Pine Street Canal Superfund Site, Burlington, Vermont. United States Environmental Protection Agency. April 7.

USEPA, 2011. *Explanation of Significant Differences*. Pine Street Canal Superfund Site, Burlington, Vermont. United States Environmental Protection Agency. September 1.

USEPA, 2013. *Letter to Performing Defendants Project Coordinator. Re: Operation, Maintenance and Monitoring Plan Modification, Pine Street Canal Superfund Site.* United States Environmental Protection Agency. August 19.

USEPA, 2016a. *Letter to Performing Defendants Project Coordinator. Re: Operation, Maintenance and Compliance Monitoring Plan, Pine Street Canal Superfund Site.* United States Environmental Protection Agency. March 31.

USEPA, 2016b. *Pine Street Canal Superfund Site Five Year Review*. United States Environmental Protection Agency. December 19.

USEPA, 2021. *Letter to Performing Defendants Project Coordinator. Re: Request for Modifications to the Ongoing Monitoring Program – Pine Street Canal Superfund Site.* United States Environmental Protection Agency. February 24.

VHB, 2020. *Spring Compliance Monitoring Report, 2020*. VHB, Inc., August 2020.

VHB, 2021a. *Fall Compliance Monitoring Report, 2020.* VHB, Inc., January 2021.

VHB, 2021b. *Spring Compliance Monitoring Report, 2021*. VHB, Inc., July 2021.

VHB, 2021c. *Consolidated Site Monitoring Plan, Pine Street Canal Superfund Site,* Rev. 5. VHB. June 17.

VHB, 2021d. *Pine Street Canal Superfund Site Technical Memorandum. Re: BED Vapor Intrusion Risk Evaluation Result.* VHB, Inc., September 9.

Weston, 1997. *Supplemental Baseline Ecological Risk Assessment*. Roy F. Weston, Inc. July 1997.

APPENDIX B
PINE STREET CANAL SITE CHRONOLOGY

DATE	EVENT
Around 1895	Burlington Gas Works moves to Pine Street and begins producing manufactured gas
1926	Light tar running into Lake Champlain noted in Burling Gas Works daily log book
1944	Large amount of potentially-contaminated clay is excavated from the floors of the former General Electric Facility (a.k.a. former General Dynamics and/or Gilbane properties) and replaced by concrete flooring
April 1967	City of Burlington issues permit to Vermont Gas Systems to dismantle buildings on manufactured gas plant site
July 14, 1967	Burlington Free Press article and picture of fire in the foundation of the gas holder
October 1967	20,000 yd^3 of dirt excavated for Burlington Electric Department (BED) building
1968	Drainage ditch that had funneled oil and coal tar from the former gasification plant to the canal is plugged
July 1968	State of Vermont investigates oil spills from the canal into Lake Champlain; holds landowner meetings to discuss installation of dike around the spills and booms across the canal to protect the lake
1977 – 1978	VTAOT performs exploratory boring; estimates that 150,000 – 200,000 yd^3 of contaminated material would need to be removed for the proposed Southern Connector highway
1979	Army Corps of Engineers requires GE to remediate potentially-hazardous waste they are believed to have disposed on site from 1948 to 1967
October 23, 1981	Site Proposed for the National Priorities List
September 8, 1983	Site Listed on the National Priorities List
October to December 1985	EPA undertakes emergency removal at Maltex Pond; 444 tons of contaminated soil disposed at GSX, Pinewood, SC
May 1990	*Draft Remedial Investigation Report* completed by PEER Consultants for EPA
March 1992	*Supplemental Remedial Investigation Final Report* completed by Metcalf & Eddy for EPA
May 1992	*Baseline Risk Assessment Final Report* completed by Metcalf & Eddy for EPA
November 1992	EPA issues proposed plan*; Feasibility Study Report* completed by Metcalf & Eddy for EPA
March 1993	State of Vermont designates groundwater at the Site non-potable (Class IV)
Spring 1993	EPA withdraws cleanup plan proposed in November 1992
Fall 1993	Pine Street Barge Canal Coordinating Council Forms

DATE	EVENT
July 1997	*Supplemental Baseline Ecological Risk* Assessment completed by Roy F. Weston for EPA
July 1997	Potentially-responsible parties (PRPs) submit *Additional Remedial Investigation Report*
May 1998	EPA issues second proposed plan; PRPs submit *Additional Feasibility Study Report*
September 29, 1998	EPA issues the *Record of Decision* which sets forth the remedy for the Site and will form the basis for all remedial design/ remedial action (RD/RA) activities
November 23, 1999	EPA/DOJ lodges RD/RA Consent Decree with the US District Court in Vermont
February 11, 2000	Consent Decree entered by US District Court
February 24, 2000	Performing Defendants submit *Remedial Design Workplan* (RDWP)
September 28, 2000	EPA conditionally approves RDWP
Fall 2000	Performing Defendants begin pre-design investigations and pilot tests
April 2001	Decision to break remedial action into phases due to seasonal constraints, Lake Champlain water level and construction sequence
October 2, 2001	EPA approves design of outlet weir (Phase 1A)
October 2001	Performing Defendants construct outlet weir (starting clock for five-year reviews)
November 1, 2001	EPA and VTDEC conduct final construction inspection of outlet weir
April 10, 2002	EPA gives final approval of RDWP and *Compliance Monitoring Workplan*
June 2002	*Memorandum of Agreement* for mitigation of adverse effects to historic resources at the Site is fully executed
July 8, 2002	EPA conditionally approves design for capping enhanced storm water management features (Area 7 and BED outfall), Area 3 and the Area 2 waterway (Phase 1B); Performing Defendants initiate construction
September 19, 2002	EPA approves conceptual design for subaqueous cap in canal (Areas 1 and 2) and turning basin (Area 8) (Phase 2)
December 3, 2002	EPA approves *Design Change #10* – dewatering the canal and capping sediments in the “dry”
January 24, 2003	EPA approves *Design Change #11* – capping sediments in the turning basin in the “dry” and capping a 100 x 100 foot upland area
March 2003	Performing Defendants complete construction on subaqueous cap; re-flood canal and turning basin
Spring 2003	Oily sheens and coal tar (a.k.a “NAPL”) is observed on the surface water in the canal and in pools in an uncapped area of the west bank
Fall 2003	Performing Defendants conduct first round of post-construction monitoring; results are presented in bi-annual *Compliance Monitoring Reports*
December 2003	Performing Defendants submit supplemental *West Bank Capping Remedial Action Workplan*
January 29, 2004	EPA approves *West Bank Capping Remedial Action Workplan*

DATE	EVENT
June to July 2004	Performing Defendants cap west bank and remove NAPL
July 2004	Restrictive easements recorded on parcels listed in Attachment 1 of the *Institutional Controls Plan*
August 6, 2004	EPA and VTDEC conduct final construction inspection for subaqueous cap and west bank cap
September 2004	Performing Defendants submit *Remedial Action Construction Completion Report*; Burlington DPW submits O&M plan for Area 7 and the BED outfall
Fall 2004	Continued observations of accumulations of coal tar on the cap surface in the canal
November 2005	Performing Defendants submit *Draft NAPL Action Plan*
January 2006	State of Vermont expands Class IV boundary; Performing Defendants submit *Draft NAPL Workplan*
April 2006	EPA approves *Final NAPL Action Plan* and *Workplan*
May 2006 to February 2007	Performing Defendants complete spring, summer and winter NAPL field investigations
October 2006	EPA completes first five-year review
September 2007	EPA conditionally approves the *Institutional Controls Plan*, which includes a mechanism to monitor and determine compliance with the institutional controls
February 2008	Performing Defendants submit *Final NAPL Investigation Report*
June 2008	Performing Defendants submit *Final NAPL Controls Report*
April 2009	EPA, following a 30-day public comment period, issues an *Explanation of Significant Differences* which outlines modifications to the 1998 remedy to address coal tar migration through the sand cap at the southern end of the Site
July 2010	Performing Defendants submit a memorandum regarding sharp increases in benzene concentrations in groundwater samples collected from monitoring wells outside the Class IV boundary in the northwestern corner of the Site
August 2010	Performing Defendants submit *Design Report* for the amended cap
August 2010 to February 2011	Performing Defendants install amended cap and NAPL monitoring/recovery wells
October 2010	Performing Defendants conduct field investigations to evaluate the feasibility of a vertical barrier to address the potential for off-site migration of the benzene plume
December 2010	Performing Defendants submit *Subsurface Investigation and Evaluation Report* with results of field investigation in the area of the northwestern wells
March 2011	Performing Defendants submit construction completion report for amended cap
August 3, 2011	EPA and VTDEC conduct final construction inspection of amended cap
September 19, 2011	EPA, following 30-day public comment period, issues a second *Explanation of Significant Differences* to the 1998 remedy that calls for additional containment in the northwestern corner of the Site to protect Lake Champlain from potentially

DATE	EVENT
	being impacted by the migration of contaminated groundwater and NAPL left on site
December 2011	EPA completes second Five Year Review
July 26, 2012	Performing Defendants submit *Restoration Plan for Mitigation of Habitat Loss Due to Installation of the Amended Cap*
October 1, 2012	Performing Defendants submit *Remedial Design Report, Pine Street Canal Vertical Barrier*
2013	Performing Defendants implement ecological wetlands restoration
August 9, 2013	EPA approves modifications to NAPL monitoring/collection frequency
February 2014	Performing Defendants complete construction of a Vertical Barrier to address potential for off-site migration of benzene plume
March 24, 2014	Performing Defendants submit results of March and October groundwater and soil vapor sampling around the 585 Pine Street Burlington Electric Department building, concluding that no unacceptable risk to human health due to vapor intrusion exists at the building and no further action is required
March 31, 2016	EPA approves additional modifications to the Compliance Monitoring requirements
May 20, 2016	Performing Defendants submit *Draft Consolidated Site Monitoring Plan* incorporating monitoring requirements from the December 7, 2005 *Compliance Monitoring Work Plan, Revision 5*; the November 14, 2011 *Amended Cap Operation Maintenance and Monitoring Plan*; August 27, 2012 and March 31, 2016 letters from EPA; the Vertical Barrier monitoring requirements in the October 1, 2012 *Draft Remedial Design Report, Revision 1*; and the July 26, 2012 *Restoration Plan for Mitigation of Habitat Loss Due to Installation of the Amended Cap*
May 2016	EPA requires additional vapor intrusion sampling around the Burlington Electric Department building in support of the 2016 Five Year Review
July 2016	EPA approves 2016 *Proposed Approach for Vapor Intrusion Risk Evaluation – Revision 2* and *Quality Assurance Project Plan for Soil Vapor Testing, Revision 2*. Groundwater and soil vapor testing conducted at Burlington Electric Department on July 16, 2016.
December 2016	EPA completes third Five Year Review
July 2017	Performing Defendants complete the Vertical Barrier Southern Extent Focused Investigation.
December 13, 2019	Performing Defendants submit *Consolidated Site Monitoring Plan – Revision 4* in response to EPA correspondence dated March 31, 2016
December 19, 2019	Performing Defendants submit results of the *Lake Sediment and Porewater Investigation Report.*
June 17, 2021	Performing Defendants submit *Consolidated Site Monitoring Plan – Revision 5* in response to EPA correspondence dated April 26, 2021.
December 2021	EPA completes fourth Five Year Review

APPENDIX C

PRESS RELEASE

News Releases from Region 01

CONTACT US <https://epa.gov/newsreleases/forms/contact-us>

EPA Begins Reviews of Burlington and Williston, Vermont Superfund Site Cleanups

October 27, 2021

Contact Information

Mikayla Rumph (rumph.mikayla@epa.gov)
(617) 918-1016

BOSTON (Oct. 27, 2021) – The U.S. Environmental Protection Agency (EPA) will conduct a comprehensive review of previously completed site cleanup work at both the Pine Street Canal Site in Burlington and Commerce Street Plume Site in Williston this year. The sites, listed as National Priorities List (NPL) Superfund sites, will undergo a legally required Five-Year Review to ensure that previous remediation efforts at the sites continue to be protective of human health and the environment.

"Ensuring previously completed Superfund site cleanup work remains protective of human health and the environment is a major priority for EPA," **said EPA New England Acting Regional Administrator Deborah Szaro.** "By completing reviews of the cleanups every five years, EPA fulfills its duty to remain vigilant of these sites so that these communities continue to be protected."

"Cleaning up Superfund sites like Pine Street Canal and Commerce Street Plume benefits Vermont's environment and protects people living in these communities," **said Vermont Department of Environmental Conservation Commissioner Peter Walke.** "The Five-Year Review process offers an opportunity to evaluate if the remedy was effective and determine whether any additional information has come to light that requires us to adjust our course to ensure we're protecting public health and the environment.

Background

The Superfund program, a federal program established by Congress in 1980, investigates and cleans up the most complex, uncontrolled or abandoned hazardous waste sites in the country and works to facilitate activities to return them to productive use. EPA is actively involved in Superfund studies and cleanups at 14 sites in Vermont. The Superfund cleanup process involves many phases, including consideration of the future use and redevelopment at the sites and post cleanup monitoring of sites. EPA must make sure remedies protect the public health and the environment and that any redevelopment will uphold that goal in the future.

More information:

Pine Street Canal, Burlington, Vermont
www.epa.gov/superfund/pinestreet <https://epa.gov/superfund/pinestreet>

Commerce Street Plume, Williston, Vermont
www.epa.gov/superfund/commercestreet <https://epa.gov/superfund/commercestreet>

Once the Five-Year Reviews are complete, the findings will be posted to the websites in final reports.

Superfund and other cleanup sites in New England
www.epa.gov/cleanups/cleaning-new-england <https://epa.gov/cleanups/cleaning-new-england>

Contact Us <https://epa.gov/newsreleases/forms/contact-us> to ask a question, provide feedback, or report a problem.

Discover.

Accessibility <https://epa.gov/accessibility>

Budget & Performance <https://epa.gov/planandbudget>

Contracting <https://epa.gov/contracts>

EPA www Web Snapshot <https://epa.gov/home/wwwepagov-snapshots>

Grants <https://epa.gov/grants>

No FEAR Act Data <https://epa.gov/ocr/whistleblower-protections-epa-and-how-they-relate-non-disclosure-agreements-signed-epa-employees>

Plain Writing <https://epa.gov/web-policies-and-procedures/plain-writing>

Privacy <https://epa.gov/privacy>

Privacy and Security Notice <https://epa.gov/privacy/privacy-and-security-notice>

Connect.

Data.gov <https://www.data.gov/>

Inspector General <https://epa.gov/office-inspector-general/about-epas-office-inspector-general>

Jobs <https://epa.gov/careers>

Newsroom <https://epa.gov/newsroom>

Open Government <https://epa.gov/data>

Regulations.gov <https://www.regulations.gov/>

Subscribe <https://epa.gov/newsroom/email-subscriptions-epa-news-releases>

USA.gov <https://www.usa.gov/>

White House <https://www.whitehouse.gov/>

Ask.

Contact EPA <https://epa.gov/home/forms/contact-epa>

EPA Disclaimers <https://epa.gov/web-policies-and-procedures/epa-disclaimers>

Hotlines <https://epa.gov/home/epa-hotlines>

FOIA Requests <https://epa.gov/foia>

Frequent Questions <https://epa.gov/home/frequent-questions-specific-epa-programstopics>

Follow.

LAST UPDATED ON OCTOBER 27, 2021

APPENDIX D

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: Pine Street Canal Superfund Site	**Date of inspection:** October 26, 2021
Location and Region: Burlington, VT, EPA Region 1	**EPA ID:** VTD980523062
Agency, office, or company leading the five-year review: USEPA, Region 1	**Weather/temperature:**

Remedy Includes: (Check all that apply)

☐ Landfill cover/containment
X Access controls
X Institutional controls
☐ Groundwater pump and treatment
☐ Surface water collection and treatment
☐ Monitored natural attenuation
X Groundwater containment
X Vertical barrier walls
X Other: sediment capping, NAPL recovery wells, constructed wetlands_____

Attachments: ☐ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** _____ _____ _____
   Name Title Date
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions; ☐ Report attached _____
   _____

2. **O&M staff** _____ _____ _____
   Name Title Date
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions; ☐ Report attached _____
   _____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached _____
_____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached _____
_____

4. **Other interviews** (optional) ☐ Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**

X O&M manual	**X** Readily available	☐ Up to date	☐ N/A
X As-built drawings	**X** Readily available	☐ Up to date	☐ N/A
X Maintenance logs	**X** Readily available	☐ Up to date	☐ N/A

Remarks_____
_____

2. **Site-Specific Health and Safety Plan** **X** Readily available ☐ Up to date ☐ N/A
☐ Contingency plan/emergency response plan ☐ Readily available ☐ Up to date ☐ N/A
Remarks_____
_____

3. **O&M and OSHA Training Records** ☐ Readily available ☐ Up to date **X** N/A
Remarks_____
_____

4. **Permits and Service Agreements**

☐ Air discharge permit	☐ Readily available	☐ Up to date	**X** N/A
☐ Effluent discharge	☐ Readily available	☐ Up to date	**X** N/A
☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	**X** N/A
☐ Other permits_____	☐ Readily available	☐ Up to date	**X** N/A

Remarks_____
_____

5. **Gas Generation Records** ☐ Readily available ☐ Up to date **X** N/A
Remarks_____
_____

6. **Settlement Monument Records** ☐ Readily available ☐ Up to date **X** N/A
Remarks_____

7. **Groundwater Monitoring Records** **X** Readily available **X** Up to date ☐ N/A
Remarks_____

8. **Leachate Extraction Records** ☐ Readily available ☐ Up to date **X** N/A
Remarks_____

9. **Discharge Compliance Records**
☐ Air ☐ Readily available ☐ Up to date **X** N/A
☐ Water (effluent) ☐ Readily available ☐ Up to date **X** N/A
Remarks_____

10. **Daily Access/Security Logs** ☐ Readily available ☐ Up to date **X** N/A
Remarks_____

IV. O&M COSTS

1. **O&M Organization**
☐ State in-house ☐ Contractor for State
☐ PRP in-house **X** Contractor for PRP
☐ Federal Facility in-house ☐ Contractor for Federal Facility
☐ Other_____

2. **O&M Cost Records**
☐ Readily available ☐ Up to date
☐ Funding mechanism/agreement in place
Original O&M cost estimate_____ ☐ Breakdown attached

Total annual cost by year for review period if available

From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost
From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost
From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost
From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost
From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**
Describe costs and reasons: _____

V. ACCESS AND INSTITUTIONAL CONTROLS **X** Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** **X** Location shown on site map **X** Gates secured ☐ N/A
Remarks: **Access road secured by locked gate. Areas of the site are not fenced and are accessible by trespassers.**

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A
Remarks: **Signs indicate access is restricted and that contamination is located at the Site.**

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented	☐ Yes	**X** No	☐ N/A
Site conditions imply ICs not being fully enforced	☐ Yes	**X** No	☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by): **Self Certification**
Frequency: **Annually**
Responsible party/agency: **USEPA/ VTDEC**
Contact: **Richard Hull** (Name) **Remedial Project Manager** (Title) **617-918-1882** (Phone no.)

Reporting is up-to-date	**X** Yes	☐ No	☐ N/A
Reports are verified by the lead agency	**X** Yes	☐ No	☐ N/A
Specific requirements in deed or decision documents have been met	**X** Yes	☐ No	☐ N/A
Violations have been reported	☐ Yes	☐ No	**X** N/A

Other problems or suggestions: ☐ Report attached
_____

2. **Adequacy** **X** ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks_____

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map **X** No vandalism evident
Remarks: **Past issue with trespassers accessing the site and camping. Evidence of trespassing witnessed during inspection. No signs of vandalism observed during inspection.**

2. **Land use changes on site X** N/A
Remarks_____
_____

3. **Land use changes off site** ☐ N/A
Remarks: **Recent sale and potential development of 501 Pine Street Gatehouse Lot. Phase I and II Environmental Site Assessments completed. Other abutting parcels are for sale.**

VI. GENERAL SITE CONDITIONS

A. Roads ☐ Applicable **X** N/A

1. **Roads damaged** ☐ Location shown on site map ☐ Roads adequate **X** N/A
Remarks_____
_____

B. Other Site Conditions

Remarks _____
_____
_____
_____
_____
_____

VII. LANDFILL COVERS ☐ Applicable **X** N/A

A. Landfill Surface

1. **Settlement** (Low spots) ☐ Location shown on site map ☐ Settlement not evident
Areal extent_____ Depth_____
Remarks_____
_____

2. **Cracks** ☐ Location shown on site map ☐ Cracking not evident
Lengths_____ Widths_____ Depths_____
Remarks_____
_____

3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident
Areal extent_____ Depth_____
Remarks_____
_____

4. **Holes** ☐ Location shown on site map ☐ Holes not evident
Areal extent_____ Depth_____
Remarks_____
_____

5. **Vegetative Cover** ☐ Grass ☐ Cover properly established ☐ No signs of stress
☐ Trees/Shrubs (indicate size and locations on a diagram)
Remarks_____
_____

6. **Alternative Cover (armored rock, concrete, etc.)** ☐ N/A
Remarks_____
_____

7. **Bulges** ☐ Location shown on site map ☐ Bulges not evident
Areal extent_____ Height_____
Remarks_____
_____

8. **Wet Areas/Water Damage** ☐ Wet areas/water damage not evident
☐ Wet areas ☐ Location shown on site map Areal extent_____
☐ Ponding ☐ Location shown on site map Areal extent_____
☐ Seeps ☐ Location shown on site map Areal extent_____
☐ Soft subgrade ☐ Location shown on site map Areal extent_____
Remarks_____
_____

9. **Slope Instability** ☐ Slides ☐ Location shown on site map ☐ No evidence of slope instability
Areal extent_____
Remarks_____
_____

B. Benches ☐ Applicable **X** N/A
(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** ☐ Location shown on site map ☐ N/A or okay
Remarks_____
_____

2. **Bench Breached** ☐ Location shown on site map ☐ N/A or okay
Remarks_____
_____

3. **Bench Overtopped** ☐ Location shown on site map ☐ N/A or okay
Remarks_____
_____

C. Letdown Channels ☐ Applicable **X** N/A
(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** ☐ Location shown on site map ☐ No evidence of settlement
Areal extent_____ Depth_____
Remarks_____
_____

2. **Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation
Material type_____ Areal extent_____
Remarks_____
_____

3. **Erosion** ☐ Location shown on site map ☐ No evidence of erosion
Areal extent_____ Depth_____
Remarks_____
_____

4. **Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting
Areal extent_____ Depth_____
Remarks_____
_____

5. **Obstructions** Type_____ ☐ No obstructions
☐ Location shown on site map Areal extent_____
Size_____
Remarks_____
_____

6. **Excessive Vegetative Growth** Type_____
☐ No evidence of excessive growth
☐ Vegetation in channels does not obstruct flow
☐ Location shown on site map Areal extent_____
Remarks_____
_____

D. Cover Penetrations ☐ Applicable **X** N/A

1. **Gas Vents** ☐ Active☐ Passive
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance
☐ N/A
Remarks_____
_____

2. **Gas Monitoring Probes**
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
Remarks_____
_____

3. **Monitoring Wells** (within surface area of landfill)
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
Remarks_____
_____

4. **Leachate Extraction Wells**
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
Remarks_____
_____

5. **Settlement Monuments** ☐ Located ☐ Routinely surveyed ☐ N/A
Remarks_____
_____

E. Gas Collection and Treatment ☐ Applicable **X**☐ N/A

1. **Gas Treatment Facilities**
   ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse
   ☐ Good condition☐ Needs Maintenance
   Remarks_____
   _____

2. **Gas Collection Wells, Manifolds and Piping**
   ☐ Good condition☐ Needs Maintenance
   Remarks_____
   _____

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)
   ☐ Good condition☐ Needs Maintenance ☐ N/A
   Remarks_____
   _____

F. Cover Drainage Layer ☐ Applicable **X** N/A

1. **Outlet Pipes Inspected** ☐ Functioning ☐ N/A
   Remarks_____
   _____

2. **Outlet Rock Inspected** ☐ Functioning ☐ N/A
   Remarks_____
   _____

G. Detention/Sedimentation Ponds ☐ Applicable **X** N/A

1. **Siltation** Areal extent_____ Depth_____ ☐ N/A
   ☐ Siltation not evident
   Remarks_____
   _____

2. **Erosion** Areal extent_____ Depth_____
   ☐ Erosion not evident
   Remarks_____
   _____

3. **Outlet Works** ☐ Functioning ☐ N/A
   Remarks_____
   _____

4. **Dam** ☐ Functioning ☐ N/A
   Remarks_____
   _____

H. Retaining Walls ☐ Applicable **X** N/A

1. **Deformations** ☐ Location shown on site map ☐ Deformation not evident
   Horizontal displacement_____ Vertical displacement_____
   Rotational displacement_____
   Remarks_____
   _____

2. **Degradation** ☐ Location shown on site map ☐ Degradation not evident
Remarks_____
_____

I. Perimeter Ditches/Off-Site Discharge ☐ Applicable **X** N/A

1. **Siltation** ☐ Location shown on site map ☐ Siltation not evident
Areal extent_____ Depth_____
Remarks_____
_____

2. **Vegetative Growth** ☐ Location shown on site map ☐ N/A
☐ Vegetation does not impede flow
Areal extent_____ Type_____
Remarks_____
_____

3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident
Areal extent_____ Depth_____
Remarks_____
_____

4. **Discharge Structure** ☐ Functioning ☐ N/A
Remarks_____
_____

VIII. VERTICAL BARRIER WALLS **X** Applicable ☐ N/A

1. **Settlement** ☐ Location shown on site map **X** Settlement not evident
Areal extent_____ Depth_____
Remarks_____
_____

2. **Performance Monitoring** Type of monitoring: **Groundwater levels and contaminant concentrations monitored to evaluate barrier wall performance.**
☐ Performance not monitored
Frequency_____ ☐ Evidence of breaching
Head differential_____
Remarks_____
_____

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable **X** N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable **X** N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
☐ Good condition☐ All required wells properly operating ☐ Needs Maintenance ☐ N/A
Remarks_____
_____
_____

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
☐ Good condition☐ Needs Maintenance
Remarks_____
_____

3. **Spare Parts and Equipment**
☐ Readily available ☐ Good condition☐ Requires upgrade ☐ Needs to be provided
Remarks_____
_____

B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable **X** N/A

1. **Collection Structures, Pumps, and Electrical**
☐ Good condition☐ Needs Maintenance
Remarks_____
_____

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
☐ Good condition☐ Needs Maintenance
Remarks_____
_____

3. **Spare Parts and Equipment**
☐ Readily available ☐ Good condition☐ Requires upgrade ☐ Needs to be provided
Remarks_____
_____

C. Treatment System ☐ Applicable **X** N/A

1. **Treatment Train** (Check components that apply)
☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
☐ Air stripping ☐ Carbon adsorbers
☐ Filters_____
☐ Additive (*e.g.*, chelation agent, flocculent)_____
☐ Others_____
☐ Good condition ☐ Needs Maintenance
☐ Sampling ports properly marked and functional
☐ Sampling/maintenance log displayed and up to date
☐ Equipment properly identified
☐ Quantity of groundwater treated annually_____
☐ Quantity of surface water treated annually_____
Remarks_____
_____

2. **Electrical Enclosures and Panels** (properly rated and functional)
☐ N/A ☐ Good condition☐ Needs Maintenance
Remarks_____
_____

3. **Tanks, Vaults, Storage Vessels**
☐ N/A ☐ Good condition☐ Proper secondary containment ☐ Needs Maintenance
Remarks_____
_____

4. **Discharge Structure and Appurtenances**
☐ N/A ☐ Good condition☐ Needs Maintenance
Remarks_____
_____

5. **Treatment Building(s)**
☐ N/A ☐ Good condition (esp. roof and doorways) ☐ Needs repair
☐ Chemicals and equipment properly stored
Remarks_____
_____

6. **Monitoring Wells** (pump and treatment remedy)
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks_____
_____

D. Monitoring Data

1. Monitoring Data
X Is routinely submitted on time **X** Is of acceptable quality

2. Monitoring data suggests:
X Groundwater plume is effectively contained ☐ Contaminant concentrations are declining

E. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
X Properly secured/locked **X** Functioning **X** Routinely sampled **X** Good condition
X All required wells located ☐ Needs Maintenance ☐ N/A
Remarks: **NAPL recovery wells also inspected and in good condition.**

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

Remedy includes management of migration of the contaminant plume to Lake Champlain via groundwater and releases to the barge canal. The contaminated groundwater and NAPL is contained with a vertical barrier and a cap system in the canal, which are functioning as intended.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

O&M of the vertical barrier, sediment cap system in the canal, groundwater monitoring network and NAPL recovery wells is being conducted as required by O&M and Consolidated Site Monitoring Plans.

_____

C. Early Indicators of Potential Remedy Problems

	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. **Surface water, sediment and pore water sampling event conducted in 2019 to evaluate extent of contaminated groundwater discharging to Lake Champlain and the effectiveness of the vertical barrier. The evaluation, which included a screening level ecological risk assessment (SLERA) determined that there was no unacceptable risk present.**
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. **None**