COMPLIANCE MONITORING REPORT

Fall 2012

Pine Street Canal Superfund Site
Burlington, Vermont

Prepared for

Performing Defendants

Submitted to

U.S. Environmental Protection Agency
Region I
The State of Vermont

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Disclaimer

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1.0 INTRODUCTION

This document is the Compliance Monitoring Report (CMR) for monitoring activities performed during summer and fall 2012 at the Pine Street Canal Superfund Site (the Site) in Burlington, Vermont. This report was prepared by The Johnson Company on behalf of the Performing Defendants, pursuant to the Consent Decree, Section VI (Performance of the Work and the Projects by Performing Defendants), paragraph 13 (Compliance Monitoring) and the Statement of Work, Section VI.B.3 (Appendix C to the U.S. Environmental Protection Agency (EPA) Record of Decision).

On April 10, 2002, EPA granted approval of the April 3, 2002 Compliance Monitoring Workplan (CMWP), Revision 3. Subsequent to that approval, the need for additional remedial action and monitoring was identified as a result of nonaqueous phase liquid (NAPL) seeps observed in the west bank of the historic barge canal at the Site (Canal) approximately between transects T9+50 and T14+10. The West Bank Cap was installed in 2004 to address those seeps, and NAPL was removed from the Canal cap surface. Additional monitoring in the vicinity of the West Bank Cap was added to Revision 4 of the CMWP, which was submitted electronically to EPA and Vermont Department of Environmental Conservation (VT DEC) on August 3, 2004. Additional construction activity conducted in 2010 included the installation of several NAPL monitoring and recovery wells, dredging portions of the previously installed cap, and installation of a new Amended Cap in the vicinity of T9 to T12+50. The monitoring summarized in this report was performed consistent with the procedures presented in The Compliance Monitoring Work Plan (CMWP), final revision 5, dated December 27, 2006 (JCO, 2006), and subsequent revisions specific to stormwater in-flow monitoring (sediment traps) as well as the Operation, Maintenance and Monitoring Plan (OMMP) for the Amended Cap which was conditionally approved on October 28, 2011.

This report discusses the methods, laboratory analyses, quality assurance, and quality control (QA/QC) measures, and monitoring results for post-construction and long-term

monitoring performed from April through November 2012. The monitoring performed during this period includes the following:

- Fall 2012 groundwater monitoring
- Non-aqueous phase liquid (NAPL) monitoring and removal
- Surface water quality monitoring
- Cap coring and analysis
- Bathymetric and settlement plate surveys of the Amended Cap
- Biological monitoring
- Weir inspection
- Sediment transport monitoring
- Bi-weekly NAPL monitoring and removal
- Visual Canal surface sheen inspections performed in the vicinity of the Amended Cap

This report includes the following Appendices:

- Appendix 1 – Field Notes and Forms
- Appendix 2 – Summary of Potentiometric Data
- Appendix 3 – Chains of Custody
- Appendix 4 – Lake and Climate Data
- Appendix 5 – Summary of all Analytical Data and Groundwater Field Data
- Appendix 6 – Data Validation Reports and Related QA/QC Correspondence and Documentation
- Appendix 7 – Laboratory Data Packages
- Appendix 8 – Amended Cap Bathymetric Survey Data

2.0 FIELD SAMPLING/MONITORING ACTIVITIES

The compliance monitoring activities that are the subject of this report include:

- Groundwater Monitoring
  - Water level and field parameter monitoring in groundwater monitoring wells
  - Sampling and laboratory analysis of groundwater in unconsolidated deposits
  - Sampling and laboratory analysis of groundwater in bedrock monitoring wells

- NAPL Monitoring and Recovery
  - Bi-weekly NAPL monitoring and removal in selected recovery wells
  - Monitoring for presence of NAPL in groundwater monitoring wells, and removal of NAPL as feasible

- Surface Water Monitoring
  - Water quality monitoring
  - Visual observations of Canal conditions

- Cap Monitoring
  - Cap coring and analysis
  - Bathymetric survey of the Amended Cap
  - Settlement plate survey of the Amended Cap
  - Visual sheen inspections
  - Cap termination inspections

- Biological Monitoring
  - Benthic macroinvertebrate sampling
  - Aquatic vegetation observations

- Inspection of the outlet weir

- Sediment transport monitoring (automated storm water sampling)

The dates of each field activity are summarized in Table 2-1. Detailed descriptions of the various field activities performed are provided in Sections 2.1 – 2.7.

TABLE 2-1
COMPLIANCE MONITORING ACTIVITIES – SUMMER AND FALL 2012

Location	Description	NAPL Measurement Performed	Sampled for Laboratory Analysis	Water Level Measurements Completed	Visual Field Evaluations
Groundwater Monitoring					
MW-20A	Shallow well	NM	11/13/12	11/12/12, 11/13/12	N/A
MW-20B	Shallow well	NM	11/12/12	11/12/12	N/A
MW-21A	Shallow well	11/20/12	11/15/12	11/12/12, 11/15/12, 11/20/12	N/A
MW-21B	Shallow well	11/20/12	11/15/12	11/12/12, 11/15/12, 11/20/12	N/A
MW-22A	Shallow well	NM	11/13/12	11/12/12, 11/13/12	N/A
MW-22B	Shallow well	NM	11/14/12	11/12/12, 11/14/12	N/A
MW-23A	Shallow well	11/16/12	NS	11/12/12, 11/16/12	N/A
MW-23B	Shallow well	11/16/12	11/15/12	11/12/12, 11/15/12, 11/16/12	N/A
MW-24A	Shallow well	11/20/12	11/14/12	11/12/12, 11/14/12, 11/20/12	N/A
MW-24B	Shallow well	11/20/12	11/14/12	11/12/12, 11/14/12, 11/20/12	N/A
MW-9A	Shallow well	NM	11/13/12	11/12/12, 11/13/12	N/A
MW-9B	Shallow well	NM	11/13/12	11/12/12, 11/13/12	N/A
MW-1B	Deep well	11/16/12	NS	11/16/12	N/A
MW-3C	Deep well	11/16/12	NS	11/16/12	N/A
MW-4B	Deep well	11/16/12	NS	11/16/12	N/A
MW-8A	Deep well	11/16/12	NS	11/16/12	N/A
MW-11D	Deep well	NM	11/13/12	11/12/12, 11/13/12	N/A
MW-12	Deep well	11/16/12	NS	11/16/12	N/A
MW-13	Deep well	NM	11/15/12	11/12/12, 11/15/12	N/A
MW-17	Shallow well	11/16/12	NS	11/16/12	N/A
MW-18	Deep well	NM	11/14/12	11/12/12, 11/14/12	N/A
MW-19	Deep well	11/20/12	NS	11/20/12	N/A

TABLE 2-1
COMPLIANCE MONITORING ACTIVITIES – SUMMER AND FALL 2012

Location	Description	NAPL Measurement Performed	Sampled for Laboratory Analysis	Water Level Measurements Completed	Visual Field Evaluations
P-106	Deep well	11/16/12	NS	11/16/12	N/A
WE 89-5S	Gilbane shallow well	NM	NS	11/12/12	N/A
WE 89-6S	Gilbane shallow well	NM	NS	11/12/12	N/A
WE 89-7S	Gilbane shallow well	NM	NS	11/12/12	N/A
FLA-1	Gilbane shallow well	NM	NS	11/12/12	N/A
FLA-4	Gilbane shallow well	NM	NS	11/12/12	N/A
NAPL Monitoring and Recovery					
RW-101	NAPL Recovery Well	Bi-weekly from 04/12/12 through 11/19/12	NS	Bi-weekly from 04/12/12 through 11/19/12	N/A
RW-102	NAPL Recovery Well	Bi-weekly from 04/12/12 through 11/19/12	NS	Bi-weekly from 04/12/12 through 11/19/12	N/A
RW-103	NAPL Recovery Well	Bi-weekly from 04/12/12 through 11/19/12	NS	Bi-weekly from 04/12/12 through 11/19/12	N/A
RW-104	NAPL Recovery Well	Bi-weekly from 04/12/12 through 11/19/12	NS	Bi-weekly from 04/12/12 through 11/19/12	N/A
RW-105	NAPL Recovery Well	Bi-weekly from 04/12/12 through 11/19/12	NS	Bi-weekly from 04/12/12 through 11/19/12	N/A
RW-106	NAPL Recovery Well	Bi-weekly from 04/12/12 through 11/19/12	NS	Bi-weekly from 04/12/12 through 11/19/12	N/A
RW-107	NAPL Recovery Well	Bi-weekly from 04/12/12 through 11/19/12	NS	Bi-weekly from 04/12/12 through 11/19/12	N/A
RW-108	NAPL Recovery Well	Bi-weekly from 04/12/12 through 11/19/12	NS	Bi-weekly from 04/12/12 through 11/19/12	N/A
RW-109	NAPL Recovery Well	Bi-weekly from 04/12/12 through 11/19/12	NS	Bi-weekly from 04/12/12 through 11/19/12	N/A

TABLE 2-1
COMPLIANCE MONITORING ACTIVITIES – SUMMER AND FALL 2012

Location	Description	NAPL Measurement Performed	Sampled for Laboratory Analysis	Water Level Measurements Completed	Visual Field Evaluations
RW-110	NAPL Recovery Well	Bi-weekly from 04/12/12 through 11/19/12	NS	Bi-weekly from 04/12/12 through 11/19/12	N/A
RW-T9+80	NAPL Recovery Well	Bi-weekly from 04/12/12 through 11/19/12	NS	Bi-weekly from 04/12/12 through 11/19/12	N/A
RW-T10+25	NAPL Recovery Well	Bi-weekly from 04/12/12 through 11/19/12	NS	Bi-weekly from 04/12/12 through 11/19/12	N/A
RW-T11+00	NAPL Recovery Well	Bi-weekly from 04/12/12 through 11/19/12	NS	Bi-weekly from 04/12/12 through 11/19/12	N/A
RW-T14+00	NAPL Recovery Well	Bi-weekly from 04/12/12 through 11/19/12	NS	Bi-weekly from 04/12/12 through 11/19/12	N/A
Surface Water Monitoring					
Outlet to Lake T1+50W80	Surface Water	N/A	08/20/12	N/A	N/A
Cap Monitoring					
Area 1: T4+00E60	Cap coring location	N/A	8/21/12	N/A	8/21/12
Area 1: T6+00E20	Cap coring location	N/A	8/22/12	N/A	8/22/12
Area 1: T6+00E40	Cap coring location	N/A	8/22/12	N/A	8/22/12
Area 3: T15+50E150	Cap coring location	N/A	8/20/12	N/A	8/20/12
Area 3: T17+50E100	Cap coring location	N/A	8/20/12	N/A	8/20/12
Area 4/5: T22+00E50	Cap coring location	N/A	8/20/12	N/A	8/20/12
Area 4/5: T18+00E425	Cap coring location	N/A	8/20/12	N/A	8/20/12
Area 4/5: T19+00E15	Cap coring location	N/A	8/22/12	N/A	8/22/12
Area 8: T1+00E300	Cap coring location	N/A	8/22/12	N/A	8/22/12

TABLE 2-1
COMPLIANCE MONITORING ACTIVITIES – SUMMER AND FALL 2012

Location	Description	NAPL Measurement Performed	Sampled for Laboratory Analysis	Water Level Measurements Completed	Visual Field Evaluations
Area 8: T2+00E100	Cap coring location	N/A	8/22/12	N/A	8/22/12
Area 8: T3+00E50	Cap coring location	N/A	8/21/12	N/A	8/21/12
Area 8: T3+00E150	Cap coring location	N/A	8/21/12	N/A	8/21/12
T8 to T13	Visual Sheen Monitoring	N/A	N/A	N/A	Bi-weekly from 04/12/12 through 11/19/12
Amended Cap (T9 – T12+50)	Cap termination inspections	N/A	N/A	N/A	Monthly – concurrent with sheen inspections
Amended Cap (T9 – T12+50)	Settlement Plate Survey	N/A	N/A	N/A	Survey of 9 settlement plates on Amended Cap surface August 30, 2012
Amended Cap (T9 – T12+50)	Bathymetric Survey	N/A	N/A	N/A	Bathymetric survey of Amended Cap surface August 30, 2012
Biological Monitoring					
Area 8: T3+00E50	Benthic macroinvertebrate, TOC, AVS/SEM, and grain size sampling	N/A	8/21/12	N/A	8/21/12
Area 1: T4+00E60	Benthic macroinvertebrate, TOC, AVS/SEM, and grain size sampling	N/A	8/21/12	N/A	8/21/12
Area 4/5: T19+00E15	Benthic macroinvertebrate, TOC, AVS/SEM, and grain size sampling	N/A	8/22/12	N/A	8/22/12

TABLE 2-1
COMPLIANCE MONITORING ACTIVITIES – SUMMER AND FALL 2012

Location	Description	NAPL Measurement Performed	Sampled for Laboratory Analysis	Water Level Measurements Completed	Visual Field Evaluations
Outlet Weir					
Outlet to Lake Champlain	Visual inspection for integrity and elevation survey	N/A	N/A	N/A	Inspection performed 11/01/12
Sediment Transport Monitoring					
Outlet to Lake	Automated stage recording and stormwater sampling	N/A	Composite samples collected during 9/5/12 and 10/19—20/12 storms	April to November 2012	N/A
NS = Not sampled, NM = Not measured, N/A = Not applicable					

2.1 GROUNDWATER

2.1.1 Groundwater Level Measurements

Groundwater level measurements were performed according to *Site Specific Method #9 - Water Level Measurements*, and recorded in field log books (Appendix 1). Groundwater level measurements in shallow wells for potentiometric map generation were performed on November 12, 2012, and the data are summarized in Appendix 2, along with historical data from the ARI, Pre-Construction Phase, and Construction/Post Construction phase groundwater monitoring events. Canal stage measurements were made at the outlet weir during the Fall 2012 groundwater, cap, and biological monitoring events; those data are also included in Appendix 2. Groundwater level measurements performed at the time of groundwater sampling are included in the data printout titled Summary of all Analytical Data and Groundwater Field Data in Appendix 5.

Lake Champlain ("Lake") stage data for the period of groundwater level measurements were downloaded from the USGS web page for Station 04294500 at ECHO at the Leahy Center for Lake Champlain in Burlington, Vermont; the data are included in Appendix 4. The Lake stage data obtained from USGS are provided in reference to the 1929 National Geodetic Vertical Datum (NGVD29) and were adjusted to conform to the datum used at the Site (including the benchmark used to determine the Canal stage) which is the 1988 North American Vertical Datum (NAVD88). According to the Vermont Department of Transportation (VT DOT, 2001), the adjustment factor between the 1929 and 1988 datum is 0.48 feet (the 1988 datum is lower). Climate data from Burlington Airport were also obtained for the period of groundwater sampling and monitoring as required by the CMWP and are included in Appendix 4.

An evaluation of these data, including potentiometric maps, is included in Section 4.1.1.

2.1.2 Groundwater Sampling

Groundwater samples were collected November 12 – 15, 2012 from 14 wells: MW-9A, MW-9B, MW-20A, MW-20B, MW-21A, MW-21B, MW-22A, MW-22B, MW-23B, MW-24A,

MW-24B, MW-11D, MW-13, and MW-18. The locations of the sampled wells are shown on Figure 2-1.

All samples were collected according to *Site Specific Method #8 - Groundwater Sampling of Monitoring Wells: Water Quality* using dedicated bladder pumps (with the exception of well MW-23B, which was sampled with a peristaltic pump as specified in the CMWP). Installation depths of the pumps are listed on the field sampling forms which are included in Appendix 1 and also in the well purging summary in Appendix 5. Field parameter measurements made during sampling were recorded on field forms, which are also included in Appendix 1. A summary of the results of the field parameter measurements is provided in Appendix 5. All non-dedicated sampling equipment was decontaminated between wells according to *Site Specific Method #27 – Decontamination of Field Equipment*.

Sampling dates are listed in Table 2-1 and in the summary tables in Appendix 5. No field parameters were measured during sampling of well MW-23B due to the historical presence of NAPL in that well. In accordance with the QAPP, the appropriate QA/QC samples were delivered with the samples under chain-of-custody (COC) protocol to Lancaster Laboratories, Inc. of Lancaster, Pennsylvania. Copies of the COC forms are included in Appendix 3, and full analytical reports are included in Appendix 7. A discussion of the groundwater analytical results is presented in Section 4.1.2.

2.1.3 NAPL Monitoring – Groundwater Monitoring Wells

The NAPL monitoring portion of the groundwater monitoring program was performed on November 16 and 20, 2012, in accordance with Section 4.1.4 of the CMWP Field Sampling Plan, in wells MW-1B, MW-3C, MW-4B, MW-8A, MW-12, MW-17, MW-19, P_106, MW-23A, and MW-23B. In response to increased benzene concentrations in monitoring well clusters MW-21A/B and MW-24A/B, these wells were also monitored for NAPL following groundwater sampling collection. If NAPL thicknesses greater than 0.1 feet were observed in any of the wells, the NAPL was removed using a bailer or peristaltic pump until less than 0.1 foot of NAPL

remained. All recovered NAPL and associated PPE and disposable sampling equipment were stored on-Site in drums and plastic totes for eventual transport off-Site to an approved disposal facility. The NAPL monitoring results from these events are presented in Section 4.1.3 and Appendix 5, along with all available historical results. The locations of, and monitoring results for, the wells monitored for the presence of NAPL in 2012, are shown on Figure 2-2.

2.1.4 NAPL Monitoring/Removal – NAPL Recovery Wells

Bi-weekly NAPL monitoring and removal was performed from April through November 2012 in the following wells: RW-101, RW-102, RW-103, RW-104, RW-105, RW-106, RW-107, RW-108, RW-109, RW-110, RW-T9+80, RW-T10+25, RW-T11+00, and RW-T14+00. During each event, NAPL thickness and water depth were measured in each of the wells using a steel measuring tape. If DNAPL thickness was observed greater than 0.1 foot on the first day of each bi-weekly event, it was removed using a suction pump until approximately less than 10% of the fluid extracted contained NAPL based on visual observation. However, for the large diameter (16-inch) shallow galvanized steel wells RW-T10+25 and RW-T14+00, initial pumping of NAPL thicknesses of 0.3-0.4 feet resulted in the removal of large quantities of water and no substantial decrease in NAPL thickness. Based upon these results, it was determined that NAPL removal in large diameter wells with <0.3 ft. of NAPL is not practical, and was not attempted after the first event. If the initial DNAPL thickness measured on the first day of each bi-weekly event was greater than 2.5 feet, the DNAPL thickness was measured again the next day. If the DNAPL thickness recovered to greater than 2.5 feet on the second day, the DNAPL removal process was repeated. This cycle was repeated on the third day if necessary.

Results of the bi-weekly NAPL monitoring and removal activities are summarized in Section 4.1.4. The locations of the recovery wells and other monitoring locations are shown on Figure 2-3.

2.2 SURFACE WATER

Chemical monitoring of surface water quality at the Site was conducted at the outlet of the Turning Basin to Lake Champlain to monitor for the potential transport of contaminants to Lake Champlain during a non-precipitation period. Surface water samples for chemical analyses were collected from the Turning Basin outlet up-stream from the railroad bridge on August 20, 2012 (see Figure 2-4). The FSP anticipated that samples would be collected immediately preceding the cap coring event and after five consecutive days of no measured precipitation greater than two-tenths of an inch (0.2 in.) registered at Burlington Airport. This criterion was met for the 2012 sampling event. Approximately 0.06 inches of rain was registered at Burlington Airport on August 20, 2012.

The surface water samples were collected as discrete grab samples in accordance with *Site Specific Method #35 For Surface Water Sampling of Non-volatile Constituents.* In accordance with the Field Sampling Plan, the samples were not filtered. All samples were stored in an iced cooler until their delivery to the laboratory under chain-of-custody. The samples were analyzed by Lancaster Laboratories, Inc. for semivolatile organic compounds (SVOCs), specifically 17 polycyclic aromatic hydrocarbons (PAHs) by EPA 8270. The surface water monitoring results are summarized in Appendix 5 and discussed in Section 4.2.

2.3 CAP MONITORING

2.3.1 Cap Chemistry

Coring of the constructed caps in Areas 1, 3, 8, and in the non-capped Area 4/5 was conducted between August 20 and 22, 2012. The data were collected to evaluate the effectiveness of the caps in protecting benthic fauna from direct contact with contaminated sediments at unacceptable levels, and to verify that contaminant migration within the cap does not cause exceedances of benchmark concentrations over time. The scope of this cap monitoring did not include cap coring in Area 2 (consistent with the OMMP and recent previous monitoring events) because a large portion of Area 2 contains the Amended Cap.

A grid system based on the transects used in the Additional Remedial Investigation (ARI) (JCO, 1997) was developed for random selection of sediment monitoring locations within Areas 1, 3, 4/5, and 8. This grid system was based on east-west Transects through the Turning Basin and Canal at 100 foot intervals and in wetland areas in Areas 3 and 4/5 at approximately 50-foot intervals in the north-south direction. The Turning Basin and Area 3 grids include points spaced 50 feet apart along transects in the east-west direction. The Area 4/5 grid has points spaced 20 feet apart in the east-west direction. Three locations on each transect at 20, 40, and 60 feet offsets from the West Bank of the Canal were included in the sample location selection grid. The purpose of the grid system is to define the array of possible sampling locations from which a subset of specific sampling locations for a given sampling event could be selected on a pre-event basis using a statistically valid stratified random sampling process.

Site Specific Method No. 77 for Stratified Random Selection of Sample Location was used to determine the coring locations. The number of randomly chosen specific sampling locations was as follows: four locations in Area 8, three locations in Area 1, two locations in Area 3, and three locations in Area 4/5. Core locations for sampling and chemical analysis were selected at the following locations (as shown on Figures 4-14 and 4-15):

<u>Area 8 (Turning Basin)</u>
J_T1+00 E300
J_T2+00 E100
J_T3+00 E50
J_T3+00 E150

<u>Area 1 (northern Canal)</u>
J_T4+00 E60
J_T6+00 E20
J_T6+00 E40

<u>Area 3 (wetlands cap)</u>
J_T15+50 E150
J_T17+50 E100

<u>Area 4/5 (non-capped wetlands & tributary area)</u>
J_T18+00 E425

J_T19+00 E15
J_T22+00 E50

The depth intervals from which samples were collected for chemical analysis varied between study areas as specified in the CMWP. The intervals in Areas 1, 3, and 8 for the randomly selected locations included surface (0 - 10 cm) 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. Sample intervals in the non-capped Areas 4/5 were surface only (0 - 10 cm). Cap and sediment samples were collected from the 12 locations described above and submitted for laboratory analyses between August 20 and 22, 2012.

A minimum of two replicate samples were collected from each random coring location. Samples were composited on-site in accordance with *Site Specific Method No. 26 for Preparation of Soil/Sediment Composite Sample for Non-Volatile Constituents*, and the composited samples were placed in the laboratory-supplied sample containers. Samples for analysis were shipped in chilled coolers under Chain-of-Custody in accordance with *Site Specific Method No.* 7 *For Chain-of-custody Records* to Lancaster Laboratories, Inc. where they were analyzed for: SVOCs (17 PAHs) by EPA 8270C; metals (RCRA 8 plus Cu and Zn) by EPA 6010b; Total Organic Carbon (TOC) by Lloyd Kahn Method; and percent solids. Results of the chemical analyses are summarized in Appendix 5 and discussed in Section 4.3.1.

In the Canal and Turning Basin (Areas 1, 2, and 8), subaqueous cap core samples were collected from a barge in butyrate core liners using a two-inch diameter, 3-foot long Wildco™ corer equipped with a positive closure ball valve device at the top of the core liner. No baskets or other retaining devices were used below the liner. The Wildco™ corer was advanced by hammering it into the cap with a sledge hammer. The barge was held in position by ropes attached to anchors or trees on-shore, and the position was verified with a Trimble sub-meter global positioning system (GPS). Submersible anchors or spud poles were not used during cap coring.

The cap thickness was determined at each subaqueous sampling location prior to the collection of the cores by pushing or hammering a fiberglass rod into the cap to refusal (the geotextile layer). The Wildco™ corer was then advanced to either the bottom of the cap(represented by the location of the geotextile), or the full length of the core barrel (36 inches), whichever was shorter. For the purpose of collection of sub-samples for analysis, it was assumed that no sample compression occurred in the core. Each core was advanced through the entire cap thickness or to the maximum 36-inch core barrel length, and a minimum of two replicate cores were collected from each location. Recovery was sufficient (minimum of 23%, and generally greater than 50%, of the core penetration) to provide sufficient volume of sample from the middle third of the cap as required for laboratory analysis.

The samples from Area 3 were collected using a decontaminated Dutch soil auger which was advanced to refusal on the geotextile beneath the cap. Samples from Areas 4/5 were collected with the auger or a steel spade. All sampling equipment was decontaminated between locations in accordance with *Site Specific Method No. 27 for Decontamination of Field Equipment*.

2.4 AMENDED CAP MONITORING

2.4.1 Amended Cap Bathymetric Survey

In accordance with the OMMP, a bathymetric survey was conducted in the vicinity of the Amended Cap on August 30, 2012 by Little River Survey (LRS) of Stowe, Vermont. The survey accuracy was +/-0.1 foot both horizontally and vertically and the data presented relative to the historical PSCS NAD83 and NAVD88 datum. The surveyed area extended approximately 20 feet beyond each side of the Canal and 400 feet along the Canal from approximately T8+75 to T12+75. Nominal 10 foot grid spacing was used with additional survey points added to pick up breaks in slope. A figure showing the bathymetric contours of the surveyed area is provided as Figure 4-16 and a copy of the survey data is included in Appendix 8.

2.4.2 Amended Cap Settlement Plate Survey

On August 30, 2012 a survey of the nine settlement plates installed on the Amended Cap by ARCADIS in 2010 was completed by LRS. The work was completed in general accordance with the September 16, 2011 OMMP which was conditionally approved by EPA on October 28, 2011. The settlement plates were initially surveyed following their installation on December 10, 2010 by Little River Survey (LRS) of Stowe, Vermont.

Survey measurements of the settlement plate elevations were made using a total station and reported to +/- 0.1 foot vertical accuracy using the NAVD88 datum. Previously surveyed top-of-casing elevations of wells RW-106 and RW-107 were used for vertical control. Location measurements were performed using a total station. Existing LRS temporary benchmarks were used as positional control for the location survey. The location survey was performed with +/- 0.1 foot horizontal accuracy and referenced to the Vermont State Plane, NAD83 datum. Results of the survey are presented in Section 4.4.2.

2.4.3 Visual Sheen Monitoring

Visual Sheen inspections were conducted bi-weekly from April 2012 through November 2012. Inspections were conducted at 43 different locations in the vicinity of the Amended Cap between T8 and T13 (11 locations along each of the east and west banks spaced 50 feet apart and 21 locations along the middle of the Canal spaced 25 feet apart). At each location, the surface of the water was observed for five minutes in each direction (northeast and southeast along the west bank, northwest and southwest along the east bank, and north, south, east, and west from positions in the middle of the Canal). The purpose of these inspections was to note the presence of gas bubbles (and any associated sheens or NAPL) rising to the surface of the Canal near the Amended Cap. Results of the sheen observations conducted between April and November 2012 are summarized in Section 4.4.3.

2.4.4 Cap Termination Inspections

Visual inspections of the edges of the Amended Cap were conducted on a monthly basis beginning in April 2012 through November 2012 to note any deficiencies in the cap integrity. Results of these inspections are provided in Section 4.4.4.

2.5 BIOLOGICAL MONITORING

2.5.1 Benthic Survey

Benthic macroinvertebrate and sediment sampling was performed on August 21 and 22, 2012. Samples were collected in Areas 8, 1, and 4/5 using an Ekman grab sampler, as described in *Site Specific Method #28 For Sediment Sampling Using Ekman Grab*. Three replicate benthic macroinvertebrate samples and a composite physical/chemical parameter sample were collected at each sampling location. The CMWP calls for only one sample in Areas 1 and 2 combined. Sample locations were selected in Area 8, Area 1/2, and Area 4/5 using the Stratified Random Sampling Method described in *Site Specific Method #77 For Stratified Random Selection of Sample Location* of the CMWP. The portion of Area 2 that has been covered by the Amended Cap was not included in the sediment or macroinvertebrate sampling program. The sample locations are shown on Figure 2-5, and are as follows:

- Turning Basin, Area 8: J_T3+00E50
- Canal, Areas 1 and 2: J_T4+00E60
- Area 4/5: J_T19+00E15

Each benthic macroinvertebrate sample was passed through a #30 sieve bucket in the field to collect the macroinvertebrates. The macroinvertebrate samples were preserved in the field with denatured ethanol, and delivered within 24-hours to Aquatec Biological Services, Williston, Vermont, for enumeration and taxonomic identification. The enumeration and identification were performed following the protocols presented in Appendix F of the Vermont Indirect Discharge Permit rules consistent with the CMWP. Composite sediment samples collected concurrently with the macroinvertebrate samples were also prepared for Acid Volatile Sulfide/Simultaneously Extracted Metals (AVS/SEM), Total Organic Carbon (TOC), and grain size analysis following CMWP *Site Specific Method #80 For Preparation of Soil/Sediment*

Sample for AVS/SEM Analysis and *Site Specific Method #26 For Preparation of Soil/Sediment Composite Sample for Non-Volatile Constituents*, respectively. The sediment samples were sent to Lancaster Laboratories, Inc. for AVS/SEM Analysis, TOC (Lloyd Kahn Method), and grain size (ASTM-D422) analyses. Benthic survey monitoring data are summarized in Appendix 5 and discussed in Section 4.5.1.

2.5.2 Aquatic Vegetation

Observations of aquatic vegetation over the subaqueous caps on the Site were made on August 21 and 22, 2012, during the benthic macroinvertebrate sampling. The results of the qualitative vegetation monitoring are presented in Section 4.5.2.

2.6 WEIR INSPECTION

The outlet weir was inspected for settlement, erosion, and integrity on November 1, 2012. The inspection included a visual assessment of those portions of the weir that could be seen. Results are presented in Section 4.6.

2.7 SEDIMENT TRANSPORT MONITORING

2.7.1 Trigger Stage Modeling

For the 2012 sediment transport monitoring season (July 1 - November 8, 2012) a trigger stage elevation of 97.45 feet was utilized. The CMWP specifies that the trigger elevation only increases if a sampled storm causes a stage elevation that exceeds the previous highest stage storm in any prior year that did not yield detectable concentrations exceeding the laboratory reporting limits in the outlet water quality samples. The 97.45 feet elevation trigger limit was defined during a stormwater event sampled in August 2011 (Tropical Storm Irene), where the highest Canal stage elevation sampled was 97.45 feet and the stormwater sample laboratory analysis did not report detectable contaminant concentrations.

2.7.2 Stormwater System Setup and Monitoring

The stormwater sampling system was installed on April 6, 2012. This was the first available date after the Lake water elevation dropped below the weir elevation (a required condition to ensure that collected stormwater samples represent water that is flowing from the Canal to the Lake).

The stormwater sampling system is comprised of an ISCO Model 3700 automated sampler connected to a Campbell Scientific Model CR-10X data logger which is programmed to monitor surface water stage level fluctuations in the Canal and in Lake Champlain on hourly intervals. An electronic tipping bucket rain gage was installed to track hourly rainfall. All components were calibrated to ensure accurate measurements, and the data logger was programmed. If the Lake stage is below the top of the weir, and the Canal trigger elevation is exceeded, the program initiates sampling by making an alarm call to a pager three times and then pulsing the ISCO sampler. Subsequent samples are then automatically collected hourly for 12 hours. One 10-psi Keller pressure transducer was used to initially monitor stage fluctuations in the Canal, approximately 80 feet east of the weir.

Successful function of the stormwater system was tested April 6th by simulating a stormwater event (inserting an alarm value less than the ambient reading on the Canal transducer) and noting that the correct number of calls was received by the dedicated pager, and that the control interface between the data logger and ISCO sampler was intact. The data logger successfully sent a ‘sample’ command to the ISCO and the ISCO successfully collected a sample after the call-out routine was done, with subsequent samples collected on one-hour intervals.

Although the Lake elevation was below the outlet weir on April 6th, the beaver dam located beneath the vehicle access bridge on Vermont Railway property was observed to be keeping the Canal stage level elevated artificially high with respect to the Lake, approximately 0.8 feet over the weir spillway elevation and within 0.2 feet of the trigger elevation. An 8-inch diameter by-pass pipe beneath the beaver dam had been installed in 2010 to help alleviate the

artificial gradient between the Lake and the Canal created by the beaver dam, however, an inspection on April 6th revealed that the Canal outlet between the bypass pipe discharge and the weir had been filled with sand over the winter, thus allowing the artificially elevated Canal stage to be maintained. Because the artificially high elevation of the Canal was only slightly below the storm trigger elevation, lesser intensity storm events would have falsely triggered the system and the system was placed in sample by-pass mode. The sand was excavated on April 12th, and flow through the pipe commenced which allowed the Canal level to recede. However, rain storms in early May raise the Lake level above the weir spillway elevation, where it remained until early June. During the month of June, the Canal water level slowly dropped to the weir spillway elevation. By July 1, 2012 the Canal level was at the same approximate elevation as the outlet weir, and the system was placed in operational sampling mode. On November 1st, a second 8-inch by-pass pipe was installed beneath the beaver dam to allow quicker draining of the Canal following future precipitation events.

Although it calibrated successfully during system installation, the Canal transducer began to display transient (spike) readings indicating a possible malfunctioning gauge. As such, it was replaced on June 27, 2012 with a 10-psi Campbell Scientific transducer. A transducer was not placed in the Lake during the 2012 season, as described in the CMWP, because of periodic damage to the transducer cable by Site beavers in previous years. Instead, the Lake stage elevation was monitored on an on-going basis during the monitoring period via the United States Geological Survey's (USGS) website by downloading continuous stage elevation data from USGS Gaging Station #4294500 (Lake Champlain at Burlington VT) to determine if the Lake level was below the elevation of the outlet weir during the sampling season.

The ISCO sampler was connected via Teflon-lined tubing to a stainless steel intake tube set in the western-most deep portion of the Turning Basin, approximately 80 feet east of the weir, at approximately 0.6 feet above the bottom. A wireless modem connected to the data logger enabled routine calls to the system to monitor real-time stage levels, and collect the readings stored on an hourly basis. Additionally, the wireless modem allowed the data logger to make an

alarm call to JCO personnel announcing if sampling had been initiated in the event of a Canal stage trigger elevation exceedance. The location of the stormwater sampling intake and pressure transducer is shown in Figure 2-6. All above-water system components were located inside a locked enclosure throughout the monitoring season.

Two stormwater sampling events that exceeded the Canal trigger elevation were recorded on September 5, and October 19-20, 2012. The system was deactivated for the year on November 8, 2012 following three successive days of below freezing temperatures. A graph of the 2012 stormwater monitoring data is presented on Figure 4-19 and graphs of the September 5th and October 19-20th sample events on Figures 4-20 and 4-21, respectively. The stormwater monitoring data are presented and discussed in Section 4.7.

3.0 LABORATORY RESULTS AND QA/QC

3.1 LABORATORY RESULTS AND VALIDATION

Chemical analyses for surface water, groundwater, and cap chemistry samples (surface and mid-cap cores) collected during the summer and fall 2012 compliance monitoring were performed by Lancaster Laboratories, Inc, (Lancaster). Summary tables of all analytical results and groundwater field parameters are presented in Appendix 5. Enumeration and taxonomic identification of macroinvertebrate samples was performed by Aquatec Biological Services, Williston, Vermont. Composite sediment samples collected concurrently with the macroinvertebrate samples were analyzed for acid volatile sulfide/simultaneously extracted metals (AVS/SEM), total organic carbon (TOC), and grain size by Lancaster.

Summaries of the reported results for equipment blanks and other quality control samples which were not independently validated and Quality Assurance (QA) associated with field procedures is presented in Section 3.2.

The August 2012 cap core sample group was validated by the Independent Data Validator (IDV), Phoenix Chemistry Services, Inc., per the schedule outlined in the CMWP. In accordance with Table 4-1 of the QAPP, 10 percent of the water samples are subject to the IDV.

The data validation for 2012 water samples was performed on the spring 2012 groundwater sample group, thereby fulfilling this requirement.

Since all cap core data requires validation, the laboratory reports for the cap core samples were delivered to the IDV for validation. The IDV report on the validated sample delivery group for the cap core samples collected August 20-22, 2012 (Lancaster SDG Nos. JCP03, JCP04 and JCP06) was received at The Johnson Company on November 9, 2012. Discussions of the independently validated quality control sample results for the cap core samples are presented in Section 3.4.2.

3.2 LABORATORY QUALITY ASSURANCE ON NON-VALIDATED DATA

Surface Water – August 2012

The August 2012 surface water sample was collected August 20, 2012 and shipped via overnight courier the same day along with a duplicate, a field blank, and matrix spike/matrix spike duplicate to Lancaster under chain-of-custody protocol. The laboratory report, received on September 24, 2012, reported very low estimated concentrations (J) of fluoranthene (0.1 J micrograms per liter; µg/L) in the surface water sample (J_SW-T1+50W80) and pyrene (0.1 J µg/L) in the Field Duplicate (J_SW-DP). No detectable concentrations of SVOC 8270C parameters were reported in the field blank (J_SW-FB).

The laboratory narrative (included in the laboratory report in Appendix 7) indicates that the analyses of the field samples and associated method blank, blank spike, matrix spike (MS), and matrix spike duplicate (MSD), were all run within the method-prescribed quality control (QC) criteria.

Sediment Grab Samples Associated with Biological Monitoring – August 2012

Sediment grab samples collected August 21 and August 22, 2012 with the benthic macroinvertebrate samples were analyzed for percent solids, TOC, and AVS/SEM. The sample group for macroinvertebrate inventory was delivered to Aquatec Biological Sciences the same

day of sample collection. The samples specified for AVS/SEM, TOC, grain size, and percent solids were shipped via overnight courier within 24 hours to Lancaster. The samples were received chilled to 1.9 º centigrade. The narrative in the lab report for benthic samples (SDG JCP05) reported no difficulties in analyses of the AVS, SEM, grain size, and TOC except as discussed herein.

Due to the nature of the AVS-SEM procedure, insoluble mercury compounds can be formed causing the Laboratory Control Standard and Matrix Spikes to exhibit poor recoveries. The lab reported low matrix spike recovery for mercury during SEM analysis of all samples. No problems were reported regarding the AVS analyses.

The metals copper, lead, and zinc were reported present in the sediment parent and field duplicate samples, J_T4+00E60 (SIN 0412-10) and J_T4+00E60DUP (SIN 0412-10DUP), respectively. Good reproducibility was observed in the analytes detected in the sample and it's duplicate. All RPDs were within the 50% acceptable limit for solid samples indicating good reproducibility and usability. The RPDs between the two samples were 0% for AVS by wet chemistry, 16.3% for TOC, 12.3% for copper, 5.9% for lead, and 9% for zinc. No adverse impacts with respect to data usability were reported by the lab despite the minor QA issues described above.

Groundwater Samples - November 2012

The fall 2012 groundwater sampling was conducted November 12 – 15, 2012. With the exception of the Field Blank (J_0073-27FB) the laboratory data reported by Lancaster indicated no compounds or analytes present in any of the QA/QC blanks submitted with the groundwater sample group. An estimated (J) very low concentration of barium (1.3 µg/L) was reported in the Field Blank.

With respect to the field duplicate sample pair, detectable concentrations in the parent (J_MW-24A) and field duplicate sample (J_0085-27DP) were reported as follows: benzene (2/2

µg/L), total xylenes (2/2 µg/L), naphthalene (2/2 µg/L), barium (94.4/96.3 µg/L), arsenic (0. 69J/0. 72J µg/L), chromium (0. 56J/0. 56J µg/L), and lead (0. 70J/0. 63J µg/L).

Relative percent difference (RPD) calculated for the results of the field duplicate pairs were 10.5% or less, which is well within the acceptance limit of 30% for field duplicate reproducibility.

A review of the lab duplicates, RPDs, matrix spike, and lab control sample recovery indicated they were all within acceptable limits.

Splits of the groundwater sample collected at J_MW-21B (SIN 0082-27) were used as the Replicate (RP) for the sample group metals analyses, and as the MS and MSD for the VOC and PAH analyses. Percent recoveries for all metals tested were within the acceptable range (80-100%). Percent recoveries and RPD for the MS and MSD VOC and PAH compounds were also all reported to be within their acceptable ranges except for 11% and 202% reported benzene recovery in the MS/MSD respectively, where the un-spiked concentration (estimated 630 µg/L) was more than four times the concentration of the spike added. Additionally, toluene in the MS sample was reported at 78% recovery, slightly below the lower acceptable limit of 80%. The acceptable recoveries for the other analytes, and the presence of large concentrations of benzene relative to the spiked concentrations, indicates that the reported unacceptable recoveries for benzene were not due to laboratory error, and the data are suitable for use in the compliance monitoring program.

2012 Stormwater Samples

Stormwater sample events occurred September 5th and October 19-20, 2012. Due to the unique sampling setup whereby samples were collected automatically into an ISCO Model 3700 stormwater sampler, a separate duplicate sample for each event was not collected, nor were MS/MSD samples collected and submitted with each sample group. A total of six sample bottles associated with the six highest stage elevations collected during each stormwater event were sent

to Lancaster where they were composited into one composite sample per event and analyzed. Lancaster created the MS/MSD from a split of the composite sample for QA purposes. The Lancaster laboratory reports for the storm sample analyses are included in Appendix 7.

The laboratory report narrative for the September 5, 2012 storm sample indicates that the samples were received on September 7, 2012 in good condition, within temperature requirements, with all holding times met, and analyses of the composite samples and associated matrix spikes (MS) and matrix spike duplicates (MSD) run within the method - prescribed quality control criteria.

The laboratory report narrative for the October 19-20, 2012 storm sample indicates that the samples were received on October 23, 2012 in good condition, within temperature requirements, with all holding times met, and analyses of the composite samples and associated matrix spikes (MS) and matrix spike duplicates (MSD) run within the method - prescribed quality control criteria. The narrative did point out that acenaphthalene recovery of 129% in the Laboratory Control Spike (LCS) sample was above the QC acceptance limits of 122%; however, the data are considered usable for compliance monitoring purposes since the recovery was high and the analyte was not detected in the sample.

3.3 FIELD PROCEDURES QA

Field sampling procedures, except where documented (see Procedure Deviations below), were performed during the reporting period in conformance with the site specific methods and procedures listed in the QAPP and FSP. Quality assurance/quality control (QA/QC) batch samples (i.e., field duplicates, equipment blanks, matrix spike, matrix spike duplicates, and trip blanks) were collected and submitted with each respective sample group to the laboratory for analysis per the QAPP.

Field Calibration

All field and monitoring instruments were calibrated in accordance with applicable Site Specific Methods and manufacturer's instructions. The calibration log sheets are included with the field forms in Appendix 1.

Procedure Deviations

Procedure Deviation Alerts (PDAs) have been prepared for any apparent discrepancies with Site Specific Methods that were brought to the attention of the Quality Assurance/Quality Control (QA/QC) Officer by the Field Manager or technicians, or that were discovered by the QA/QC Officer during subsequent review of project documentation during audits.

Copies of all PDAs for the monitoring activities described in this report are included in Appendix 6. No adverse impacts to the quality of the data set have occurred due to the minor deviations from the Site Specific Methods which occurred during the monitoring period.

Project Database

Laboratory analytical data, once received from the laboratory (and/or the Independent Data Validator if applicable), were logged in and entered into The Johnson Company databases for each applicable sample media. Electronic entries were back-checked against the lab sheets by a second Johnson Company scientist following their addition to the databases.

3.4 INDEPENDENT DATA VALIDATION

3.4.1 Overview

The IDV for the project is Deborah Gaynor, Ph.D., Phoenix Chemistry Services of North Ferrisburg, Vermont. In accordance with Table 4-1 of the QAPP, an annual minimum of 10 percent of the water samples (e.g., groundwater, surface water, and stormwater) and 10% of the cap core samples are subject to independent data validation. Data validation was performed on the spring 2012 groundwater sample delivery group (SDG) and presented in the spring 2012 Compliance Monitoring Report. The spring 2012 data validation satisfied the annual minimum

requirement for water samples. Therefore, no independent data validation was performed on the fall 2012 groundwater and surface water analytical results.

The August 2012 cap coring event consisted of Lancaster Sample Delivery Group Nos. JCP03, JCP04, and JCP06, which were received at the laboratory in three batches: samples collected August 20, 2012, samples collected August 21, and samples collected August 22. Since the August 2012 cap coring is the only such event for the year, all of the cap core data were validated by the IDV.

A summary of the IDV's findings for the cap core analyses is presented in Section 3.4.2 below. The IDV's complete data validation reports are included in Appendix 6.

3.4.2 Cap Core IDV Summary

3.4.2.1 PAHs

Laboratory results for PAH compounds in the August 2012 cap core samples (Lancaster SDG Nos. JCP03, JCP04 and JCP06) were determined to be valid by the IDV with the following qualifiers:

- On the basis of professional judgment and the poor precision exhibited for all detected analytes, results for all analytes in the shallow core sample at J_T2+00E100 (SIN 0406-10) and its field duplicate J_0164-10DP were qualified as estimated (J, UJ).

- The laboratory appropriately applied "J" qualifiers to the sample Form I's when the concentration of an analyte was less than the sample-specific PQL.

The IDV reported Lancaster documentation presentation was acceptable with the following exceptions:

> Practical quantitation limits (PQLs) were reported on the Form I summaries on an "as received" basis; the PQLs and MDLs (also reported on the Form I summaries) were adjusted for the sample weight or volume extracted, but sample-specific results, PQLs, and MDLs were not adjusted for percent moisture content in sediment samples.

3.4.2.2 Inorganics

Laboratory results for the inorganic analytes in the August 2012 cap core samples (Lancaster SDG Nos. JCP03, JCP04 and JCP06) were determined to be valid by the IDV with the following qualifiers:

- Based on field blank contamination, the results that were less than the action limit for cadmium and barium in sediment samples were qualified as less than the reporting limit (U). Note that the action limit as used for inorganic data validation is defined as 5 times the reporting limit (RL)

- The laboratory reported all results to the reporting limit (RL) in the analysis results section of the data package; however, target compounds detected in the associated samples below the RL but greater than the Method Detection Limit (MDL; as reported on the Form 10) were reported on the Form I's with a "J" (estimated) qualifier. The "J" qualifiers were not removed by the validator, unless previously qualified, based on laboratory or field blank contamination (discussed above). Analysis Form I's included in the metals section of the data packages used "B" qualifiers for values less than the reporting limits. These Form I's were disregarded in the validation effort since the laboratory also reported results with a non-detect to the concentration of the MDL.

The IDV reported Lancaster documentation presentation was acceptable with the following exceptions:

Practical Quantitation Limits (PQLs) were reported on the Form I summaries on an "as-received" basis. PQLs and MDLs were not adjusted for percent moisture content in sediment samples.

3.4.2.3 Total Organic Carbon

Based on the IDV's findings, results for the analyte total organic carbon (TOC) in all samples were determined to be valid as reported.

The IDV reported Lancaster documentation presentation was acceptable with the following observations:

As noted as a method deviation in the SOP, the laboratory does not perform the quadruplicate sample analysis required by the Lloyd Kahn method.

3.5 DATA USABILITY

Based on the IDV reports (Appendix 6), the overall data quality objectives outlined in Section 1.5 of the QAPP, and Section 4.3 of the QAPP (Reconciliation with Data Quality Objectives), all of the laboratory data provided by Lancaster are considered useable for the purposes of Compliance Monitoring.

4.0 DATA SUMMARIES AND EVALUATIONS

4.1 GROUNDWATER

4.1.1 Hydrology

4.1.1.1 General Dynamics (G.P. Burlington North, LLC, or Gilbane)

The CMWP requires a potentiometric analysis of shallow groundwater at the Gilbane property based on data collected from monitoring wells WE-89-5S, WE-89-6S, WE-89-7S, J_FLA-1 and J_FLA-4. It is assumed that these wells, which are screened in the surficial fill unit, are hydraulically connected to the Canal; therefore, the Canal stage was incorporated into the potentiometric evaluation.

The resultant potentiometric maps for the fall 2012 and the previous two monitoring events on the Gilbane property are shown on Figures 4-1 through 4-3, respectively. The data from fall 2012 indicate flow from the Gilbane property primarily to the north and east towards Area 3, which is generally consistent with the prior monitoring events. The gradient between wells WE89-5S and FLA-1 indicates some flow to the west on the western portion of the Gilbane property.

4.1.1.2 Wells West of Canal

As discussed in the Fall 2000 Pre-Construction Compliance Monitoring Report, the three-zone cross section delineation proposed on Figure 4-1 of the CMWP Field Sampling Plan has been reduced to the two-zone delineation (Zone A and Zone B) that is shown for north-trending cross section P-P' on Figure 4-4 of this report (the P-P' cross section location in plan view is shown on Figures 2-1 and 4-8). Because only two wells are present in the upper sand layer

shown on Figure 4-4, a plan view potentiometric map for this stratigraphic unit could not be constructed. Therefore, as with previous reports, only wells screened in the Zone B sandy unit were used to create plan view potentiometric maps for the water level data.

The Zone B potentiometric map for the fall 2012 monitoring event is shown on Figure 4-5. Potentiometric maps for the prior two groundwater monitoring events (May 2012 and October 2011) are shown on Figures 4-6 and 4-7, respectively. The data indicate mounding in the vicinity of MW-20B with flow away from that well in all directions. The fall 2012 groundwater flow is similar to that observed during the previous monitoring events in May 2012 and October 2011, portraying groundwater gradients from the Canal west towards the Lake in the vicinity of Monitoring wells MW-23 A/B and MW-21A.

4.1.2 Chemistry

Portions of the Site were designated as "Class IV" groundwater in 1993, indicating that the groundwater is not suitable as a source of potable water. This designation acts as one of the institutional controls for the Site, and prohibits licensed well drillers from installing drinking water supply wells in the Class IV area. On January 23, 2006, the configuration of the Class IV area was changed by the Vermont Agency of Natural Resources following discussions with the Performing Defendants and the EPA, notice to the affected landowners, parties, and public notice, and a public comment period. The newly delineated Class IV area is larger than the 1993 area, and has boundaries that generally follow property lines rather than an amorphous shape, which was difficult to identify in the field. The new 2006 boundary is included in this report on applicable figures, including Figures 2-1, 4-8, and 4-12. The western edge of the 2006 boundary is defined as the approximate centerline of the railroad tracks (30 feet due west of the eastern edge of the Vermont Railway/State of Vermont Parcel #053-1-009-000).

A summary of analytical results for all groundwater samples, including cross-references between SINs and SLIDs, is provided in Appendix 5. The results for the targeted volatile organic, semivolatile organic, and inorganic compounds are discussed in the following subsections.

4.1.2.1 Volatile Organic Compounds – BTEX

Figure 4-8 presents a plan view of the Site showing reported concentrations of benzene, toluene, ethylbenzene, and total xylenes (BTEX) for all wells sampled in November, 2012 as part of the routine long term compliance monitoring program for the Site. Reported BTEX concentrations in wells along Cross Section P – P' (from north to south: MW-9, MW-20, MW-23, and MW-22) are shown on Figure 4-9.

Five of the sampled wells (MW-21A, MW-21B, MW-22A, MW-23B, and MW-24A) contained detectable BTEX compounds above the practical quantitation limit (PQL) of the analytical method (1.0 *µg/L*) during the November 2012 sampling event. Three of these wells are outside of the Class IV groundwater boundary (MW-21A, MW-21B, and MW-24A); MW-22A and MW-23B are located within the Class IV groundwater boundary. MW-21A, MW-21B, MW-22A, and MW-23B contained benzene at or above the Vermont Groundwater Enforcement Standard (VGES) and EPA maximum contaminant level (MCL) of 5 *µg*/L (730 *µg/L*, 580 *µg/L*, 29 *µg/L, and* 370 *µg/L, respectively).* None of the other detected BTEX compounds were reported in excess of their respective MCLs or VGES.

Figures 4-10 and 4-11 show historical benzene concentrations since 2000 in MW-21A, MW-21B, MW-24A, and MW-23B (the wells with a history of benzene detections). Along with the historical benzene concentrations, Figure 4-10 also shows the hydraulic gradient between the Canal and the Lake and Figure 4-10 shows DNAPL thickness in MW-23B. Between 2000 and around 2008, most of the groundwater samples from MW-21A/B and MW-24A had non-detect or occasional trace detections of benzene. Beginning around 2008, benzene concentrations increased in these wells until around 2011 when they began to stabilize. The November 2012

benzene results were slightly lower than the May 2012 results in MW-21A and MW-24A. Concentrations have been continually decreasing in MW-24A since the historical high reported in April 2011. MW-21B reported a low concentration of benzene during the May 2012 event (5 *µg/L*) relative to the previous two sampling events (480 *µg/L* in October 2011 and 640 *µg/L* in April 2011) but rebounded to 580 *µg/L* in the November 2012 sample. The benzene concentrations in MW-23B have been generally increasing since 2003, though the fall 2012 concentration of 370 *µg/L* was slightly lower than the spring 2012 concentration of 410 *µg/L*. Aside from three previous estimated concentrations below the laboratory reporting limit, the first unqualified detection of benzene in MW-22A was reported in spring 2012 (2 *µg/L*). The fall 2012 event reported an increase in benzene concentration to 29 *µg/L* (Figure 4-8).

After years of non-detected or trace detections of benzene in MW-21A, MW-21B, and MW-24A, benzene concentrations began to rise beginning in the fall of 2007 (about three months after initial construction of a beaver dam beneath the railroad trestle – see Figure 4-10). All three of these wells are outside the Class IV groundwater area. As can be seen in Figure 4-10, benzene in MW-24A has persisted since 2008 at concentrations between 2 – 12 *µg/L* but as evidenced by the three most recent reported concentrations of benzene (4.7 *µg/L* fall 2011, 4.0 *µg/L* spring 2012, and 2.0 *µg/L* fall 2012 the benzene concentrations in MW-24A are trending downward.

A beaver dam kept the Canal water elevation at approximately 97 ft. NAVD or higher throughout most of the summer and fall of 2007, 2008, 2009, and 2010. This prolonged elevated Canal water level increased the hydraulic gradient towards Lake Champlain. This increased gradient may have contributed to the historical benzene increases in wells MW-21A, MW-21B, and MW-24A, and the historical increased DNAPL thicknesses observed in MW-23B and MW-17 (discussed in Section 4.1.3). A wire cage and bypass pipe was installed in the fall of 2010 which has maintained the Canal elevation closer to its design stage of 96 feet. In winter 2011-2012, several severe storms caused a substantial quantity of sand to be deposited from the Lake into the Canal outlet, which reduced flow through the by-pass pipe. This accumulated storm

sediment was excavated in April 2012, but the Canal stage remained elevated until the end of June. In November 2012, a second by-pass pipe was installed beneath the beaver dam, which substantially expedited the outflow following precipitation events.

4.1.2.2 Semivolatile Organic Compounds – PAHs

Figure 4-12 provides a plan view of the Site showing reported concentrations of 17 targeted PAH compounds for all wells sampled in November 2012. Reported PAH concentrations in wells along Cross Section P – P' (from north to south: MW9, MW20, MW23, and MW22) are shown on Figure 4-13.

Of the wells outside the Class IV groundwater boundary only MW-21A and MW-24A reported detections of one target PAH; naphthalene (VGES of 20 *µg/L*) was reported at 250 *µg/L* and 2 *µg/L* in MW-21A and MW-24A, respectively (Figure 4-12). Prior to 2012 no PAHs had been detected in MW-21A. Naphthalene was detected in MW-21A in both sampling events conducted in 2012 with an increase in naphthalene concentration from values reported in the spring (6 *µg/L*) to the fall (250 *µg/L*, which exceeds the VGES and MCL of 20 *µg/L*). An estimated concentration of acenaphthene was also detected in MW-21A in the fall event (0.2 J *µg/L*). PAHs were not historically detected in MW-24A until April 2010 when naphthalene was reported at an estimated 4.6 *µg/L*, increasing to 16 *µg/L* in spring 2011, but decreasing to 4.1 J *µg/L* (fall 2011), 4.0 *µg/L* (spring 2012), and 2.0 *µg/L* (fall 2012).

Of the wells within the Class IV boundary, MW-23B contained elevated concentrations of all 17 targeted PAHs ranging from dibenzo(a,h)anthracene at 220 *µg/L* to naphthalene at 35,000 *µg/L*. Only five of the 17 targeted PAHs have established VGES including anthracene (2,100 *µg/L*), benzo(a)pyrene (0.2 *µg/L*), fluoranthene (280 *µg/L*), fluorene (*µg/L*), and naphthalene (20 *µg/L*). All of these VGES were exceeded in MW-23B. The reported PAH concentrations in MW-23B were significantly higher than those reported for previous sampling events except that they were lower than those reported in spring 2012. Historically, this well has contained NAPL, which is measured prior to sampling, and the groundwater sample intake point

has been adjusted so that it is collected approximately one foot above the NAPL/water interface. This process was repeated during the fall 2012 sampling event, and as has been the case in the past, sheens and small ganglia of NAPL were reported present in the purge water evacuated from the well prior to sampling. PAHs were detected in the fall 2012 samples in MW-9B, MW-20A and MW-22A, but all less than 1.0 *µg/L*. No PAHs were reported in samples from MW-9A, MW-20B, or MW-22B.

The position of the wells within the Class IV boundary with respect to the stratigraphic cross section P-P' is shown on Figure 4-12.

4.1.2.3 Inorganic Compounds – Metals

No exceedances of MCLs and/or VGES for any of the metals analyzed were reported for any of the wells during the November 2012 monitoring event with the exception of arsenic at 47 *µg/L* in MW-21B (VGES of 10 *µg/L*) and lead at 16.1 *µg/L* in MW-20B (VGES of 15 *µg/L*). Only MW-21B is located outside the Class IV groundwater boundary. The arsenic reported in MW-21B is consistent with the previous monitoring event in May 2012 and generally similar to prior events dating back to 2000. Lead concentrations in MW-20B have historically ranged from non-detect to 33.3 *µg/L* since 2000, with the November 2012 result being only the third to exceed the 15 *µg/L* VGES. As has been the case in the past, and despite utilizing low flow sampling techniques in accordance with the Sampling and Analysis Plan, MW-20B exhibited elevated turbidity readings just prior to sampling (30 NTUs).

4.1.2.4 Temporal Changes in Concentrations at Individual Wells

One of the few wells monitored in November 2012 that has historically contained BTEX is MW-23B. Well MW-23B, which is located within the Class IV groundwater boundary, had reported concentrations of benzene between 130 and 150 *µg*/L over the first four monitoring events (fall 2000 through spring 2002). From fall 2002 through spring 2007 the reported benzene concentrations ranged from 5.1 to 83 *µg*/L. As shown on Figures 4-10 and 4-11 a slight

upward trend in benzene concentrations in MW-23B is apparent between 2007 and 2010, and relatively stable concentrations since 2010.

Increasing benzene concentrations have also been reported in MW-21A (ranging from 7.4 *µg*/L to 1,100 *µg*/L) since 2008, though the November 2012 and previous two sample events have shown slightly lower benzene concentrations ranging from 730 to 970 *µg/L*. Benzene concentrations in MW-21B have ranged from 11 *µg/L* in 2009 to 640 *µg/L* in 2011. The May 2012 sample showed a sharp decline to 5 *µg/L*, but the November 2012 concentration reported a concentration similar to those reported in the two 2011 sampling events. Benzene concentrations in MW-24A also exhibited a spike in April 2008 when it jumped from less than 1 *µg/L* to 11 *µg/L* and has since ranged from 2.0 to 12 *µg/L* between spring 2008 and fall 2012. As depicted on Figures 4-10 and 4-11, concentrations of benzene in MW-24A currently are trending downward. Other than three previous estimated concentrations, benzene was detected in MW-22A for the first time in spring 2012 (2 *µg/L*). Benzene was detected again in MW-22A during the fall 2012 sampling event at 29 *µg/L*.

As stated above, the increased benzene concentrations observed in these monitoring wells may be related to the intermittent presence of a beaver dam beneath the railroad trestle (Figure 4-10) which causes an increase in the Canal level and subsequently an increase in the hydraulic gradient from the Canal towards the Lake (and the monitoring wells along the railroad tracks). A wire cage and bypass pipe were installed in the fall of 2010 which has maintained the Canal elevation nearer to its design elevation of 96 feet, except immediately after precipitation events, and in the winter/spring of 2012, when storm sediment blocked the pipe discharge as described above. A second pipe was added to the beaver dam by-pass in November 2012 to increase the rate of discharge from the Canal following precipitation events.

Since installation of the bypass pipe, benzene concentrations in most wells appear to be declining or stable, although recent 2011 and 2012 data suggest that the benzene plume in groundwater is expanding towards the south (MW-22A). More data are necessary to determine

if there is a relationship between the decreased hydraulic gradients and the stabilization/reduction of benzene concentrations. However, because of the persistent elevated benzene concentrations in the wells west of the Canal, the Performing Defendants are currently working to design and implement a vertical barrier between MW-23B and MW-21A/B to reduce the groundwater flux and possible NAPL migration from the Canal towards the Lake.

Toluene and xylene concentrations steadily increased in MW-23B from spring 2010 through spring 2012, but decreased in the fall 2012 event. MW-24A reported decreases in concentrations of xylene in groundwater from the spring to the fall 2012 events. MW-21A reported increases in ethylbenzene, toluene, and xylene in fall 2012 compared with previous events, but none of the concentrations exceeded the VGES.

MW-23B is the only well that has historically contained reported concentrations of PAH compounds greater than 10 *µg/L*. Reported PAH concentrations in MW-23B in May 2012 were significantly higher than those observed during previous monitoring events, probably due to the inclusion of DNAPL in the analysis aliquot (as described in the spring 2012 Compliance Monitoring report). Concentrations in November 2012 remained high relative to sampling events previous to 2012 (likely due to DNAPL being included in the analysis aliquot), but were significantly lower relative to the May 2012 event. MW-21A reported a concentration of naphthalene of 250 *µg/L* which represents a significant increase from the first detection of naphthalene at that location reported in the May 2012 event (6 *µg/L* in May 2012) and exceeds the VGES of 20 *µg/L*. Two previous samples from MW-21A reported estimated naphthalene concentrations of 1.7 J *µg/L* and 1.4 J *µg/L* in 2001 and 2010, respectively.

Reported concentrations of metals in the monitoring wells have been relatively constant (within an order of magnitude) over the monitoring period since 2001. Concentrations of metals measured during November 2012 were generally similar to those reported during previous monitoring events. As with the other inorganics, the concentration of arsenic in groundwater samples has remained relatively constant since 2001.

4.1.3 NAPL Monitoring – Groundwater Monitoring Wells

Wells MW-1B, MW-3C, MW-4B, MW-8A, MW-12, MW-17, MW-19, MW-21A, MW-21B, MW-23A, MW-23B, MW-24A, MW-24B, and P-106 were monitored for NAPL on November 16 and 20, 2012. A summary of the groundwater monitoring well DNAPL monitoring/removal events for 2012 is shown on Figure 2-2. The NAPL Summary Table in Appendix 5 details the results of DNAPL monitoring in groundwater monitoring wells at the Site since 2000.

No evidence of NAPL was noted in any of the monitored wells with the exception of MW-12, MW-17, MW-23A and MW-23B. The NAPL thickness measured in MW-4B (<0.05') was similar to measurements from previous fall NAPL monitoring events. NAPL droplets on the probe and smearing on the sorbent pad was noted in MW-12, and the thickness of NAPL in the well was estimated to be 0.01 feet, similar to previous events.

Approximately 1.0 feet of DNAPL thickness was measured in MW-17 on November 16, 2012. This thickness is slightly higher than the 0.8 feet measured in May 2012, and lower than the 1.3 feet reported in October 2011. DNAPL removal (required when DNAPL thickness exceeds 0.1 feet) was completed on November 16th. Approximately 0.6 liter of DNAPL along with 5 liters of a NAPL/water mixture was removed.

Approximately 0.5 feet of DNAPL was measured in MW-23A on November 16, 2012. Although DNAPL was observed during the installation of MW-23A, this was the first observation of DNAPL in the well since monitoring began in 2000. Approximately 1.1 liters of DNAPL and 0.78 liters of a NAPL/water mixture were removed.

Approximately 4.8 feet of DNAPL was measured in MW-23B on November 16. Previous DNAPL monitoring events reported DNAPL thicknesses of 3.3 feet in May 2012, 6.0 feet in October 2011, 4.6 feet in April 2011, and 4.2 feet in October 2010 (see Figure 4-11). On November 16, 2012 approximately 2.8 liters of DNAPL and 2.8 liters of a NAPL/water mixture

were removed. Less than 0.1 feet of DNAPL was measured in the well after the DNAPL removal.

All NAPL removed from the monitoring wells was placed in a 275-gallon plastic tote for eventual removal and disposal by a licensed waste hauler.

4.1.4 NAPL Monitoring/Removal – NAPL Recovery Wells

Bi-weekly NAPL monitoring and removal from NAPL recovery wells was conducted in general accordance with the OMMP from April through November 2012. Recovery wells monitored during the bi-weekly events included RW-101, RW-102, RW-103, RW-104, RW-105, RW-106, RW-107, RW-108, RW-109, RW-110, RW- T9+80, RW-T10+25, RW-T11+00 and RW-T14+00.

A total of seventeen bi-weekly events were conducted in 2012. No measureable LNAPL (>0.01 feet thick) was observed in any well during the monitoring period. Of the 14 recovery wells, 10 contained greater than 0.1 feet of DNAPL on at least one monitoring event triggering the DNAPL removal process. NAPL monitoring and removal for these 10 wells are summarized in Table 4-1. No measureable NAPL was detected in wells RW-106, RW-107, RW9+80, and RW-11.

During 2012 a total of approximately 2,300 gallons of NAPL and mixed NAPL/water was removed from the 10 passive recovery wells described above. Thirteen hundred (1,300) gallons were removed from recovery wells in 2011. Of these recovery wells, RW-109 consistently contained the largest quantity of NAPL. Prior to each of the bi-weekly removal events, 22.5 to 23.2 feet of DNAPL was measured in RW-109. Approximately 36 gallons of NAPL was pumped from RW-109 during each removal event to lower the DNAPL thickness to less than one foot, and follow-up pumping the 2nd and 3rd day was required during all monitoring events (due to 22-23 feet of DNAPL recharge in less than 24 hours).

Table 4-1 Bi-Weekly NAPL Monitoring and Removal Summary							
Well ID	**Date**	**DNAPL Thickness (feet)**	**DNAPL Removed (gallons)**	**DNAPL Thickness ~24 Hours After Pumping (feet)**	**DNAPL Removed 2nd Day (gallons)**	**DNAPL Thickness ~24 Hours After 2nd Day Pumping**	**DNAPL Removed 3rd Day (gallons)**
RW-101	4/12/2012	5.5	10[1]	0.17 (3 hours later)	[4]	-	-
	4/24/2012	<0.1	None	-	-	-	-
	5/7/2012	0.3	1[1]	<0.1	-	-	-
	5/21/2012	<0.1	None	-	-	-	-
	6/4/2012	<0.1	None	-	-	-	-
	6/18/2012	1.5	2	0.4	-	-	-
	7/2/2012	0.9	1	0.3	-	-	-
	7/16/2012	0.7	0.5	0.0	-	-	-
	7/30/2012	0.8	1.5	0.0	-	-	-
	8/14/2012	0.8	1	-	-	-	-
	8/27/2012	0.7	8[1]	-	-	-	-
	9/11/2012	0.8	5[1]	-	-	-	-
	9/25/2012	0.8	7[1]	-	-	-	-
	10/8/2012	0.8	2	-	-	-	-
	10/23/2012	0.9	1.5	-	-	-	-
	11/5/2012	0.9	1	-	-	-	-
	11/19/2012	0.9	1	-	-	-	-
RW-102	4/9/2012	18.1	24	4.9	[4]	-	-
	4/24/2012	6.2	8	0.9	-	-	-
	5/7/2012	3.3	5	3.7	5	2.7	3
	5/21/2012	3.6	5	1.6	-	-	-
	6/4/2012	4.3	18[1]	1.9	-	-	-
	6/18/2012	4.5	5	1.3	-	-	-
	7/2/2012	4.2	5	1.1	-	-	-
	7/16/2012	4.1	5	1.4	-	-	-
	7/30/2012	4.4	5	1.3	-	-	-
	8/14/2012	4.7	5	1.6	-	-	-
	8/27/2012	3.9	4	1.3	-	-	-
	9/11/2012	4.3	5	1.2	-	-	-
	9/25/2012	3.9	6	1.3	-	-	-

Table 4-1 Bi-Weekly NAPL Monitoring and Removal Summary

Well ID	Date	DNAPL Thickness (feet)	DNAPL Removed (gallons)	DNAPL Thickness ~24 Hours After Pumping (feet)	DNAPL Removed 2nd Day (gallons)	DNAPL Thickness ~24 Hours After 2nd Day Pumping	DNAPL Removed 3rd Day (gallons)
	10/8/2012	4.3	6	1.3	-	-	-
	10/23/2012	4.5	4.5	0.8	-	-	-
	11/5/2012	4.0	4	1.4	-	-	-
	11/19/2012	4.4	4.5	1.9	-	-	-
RW-103	4/12/2012	16	28	3.6 (2.2 hours later)	[4]	-	-
	4/24/2012	6.4	7	2.1	-	-	-
	5/7/2012	4.1	6	1.9	-	-	-
	5/21/2012	4.6	4[2]	3.5	22[1, 2]	3.7	7
	6/4/2012	2.9	4	2	-	-	-
	6/18/2012	4.5	5	2.3	-	-	-
	7/2/2012	4.3	5	1.7	-	-	-
	7/16/2012	4.3	5	1.9	-	-	-
	7/30/2012	4.6	4.5	1.9	-	-	-
	8/14/2012	4.5	4	1.9	-	-	-
	8/27/2012	4.3	4	1.7	-	-	-
	9/11/2012	4.3	4	1.4	-	-	-
	9/25/2012	4.5	5	1.8	-	-	-
	10/8/2012	4.7	5	1.6	-	-	-
	10/23/2012	4.4	5	1.8	-	-	-
	11/5/2012	5.0	5	2.2	-	-	-
	11/19/2012	5.0	5.5	2.0	-	-	-
RW-104	4/10/2012	13.3	18	0.5 (2 hours later)	[4]	-	-
	4/24/2012	1.8	2	0.6	-	-	-
	5/7/2012	2.3	2	0.5	-	-	-
	5/21/2012	1.4	1	N/A	-	-	-
	6/4/2012	4	9[1]	1.3	-	-	-
	6/18/2012	3.6	5	1.1	-	-	-
	7/2/2012	3.1	4	0.8	-	-	-
	7/16/2012	2.8	4	0.8	-	-	-
	7/30/2012	2.9	3	0.8	-	-	-
	8/14/2012	3.0	3	0.6	-	-	-

Table 4-1 Bi-Weekly NAPL Monitoring and Removal Summary

Well ID	Date	DNAPL Thickness (feet)	DNAPL Removed (gallons)	DNAPL Thickness ~24 Hours After Pumping (feet)	DNAPL Removed 2nd Day (gallons)	DNAPL Thickness ~24 Hours After 2nd Day Pumping	DNAPL Removed 3rd Day (gallons)
	8/27/2012	2.7	4	1.1	-	-	-
	9/11/2012	2.6	3.5	0.5	-	-	-
	9/25/2012	2.8	4	0.7	-	-	-
	10/8/2012	2.7	4.5	0.5	-	-	-
	10/23/2012	2.9	4	0.2	-	-	-
	11/5/2012	2.5	2.5	0.7	-	-	-
	11/19/2012	3.6	2.5	0.5	-	-	-
RW-105	4/10/2012	1.3	9[1]	0.8 (40 hours later)	[4]	-	-
	4/24/2012	0.6	1	0.3	-	-	-
	5/7/2012	0.1	-	-	-	-	-
	5/21/2012	<0.1	-	-	-	-	-
	6/4/2012	0.7	10[1]	0.4	-	-	-
	6/18/2012	0.3	4[1]	0.4	-	-	-
	7/2/2012	0.3	2[1]	0.4	-	-	-
	7/16/2012	0.5	15[1]	0.3	-	-	-
	7/30/2012	0.5	0.5	0.0	-	-	-
	8/14/2012	0.3	7[1]	-	-	-	-
	8/27/2012	0.3	5[1]	-	-	-	-
	9/11/2012	0.5	4[1]	-	-	-	-
	9/25/2012	0.4	1	-	-	-	-
	10/8/2012	0.4	1	-	-	-	-
	10/23/2012	0.5	1	-	-	-	-
	11/5/2012	0.4	0.5	-	-	-	-
	11/19/2012	0.5	1	-	-	-	-
RW-108	4/10/2012	16.7	27	2.7 (45 hours later)	[4]	-	-
	4/24/2012	4.4	5	0.4	-	-	-
	5/7/2012	2.5	5	2.5	5	2.3	-
	5/21/2012	4.3	25[1]	0.4	-	-	-
	6/4/2012	3	10[1]	0.7	-	-	-
	6/18/2012	3.1	6	0.8	-	-	-
	7/2/2012	2.9	5	0.7	-	-	-

Table 4-1 Bi-Weekly NAPL Monitoring and Removal Summary

Well ID	Date	DNAPL Thickness (feet)	DNAPL Removed (gallons)	DNAPL Thickness ~24 Hours After Pumping (feet)	DNAPL Removed 2nd Day (gallons)	DNAPL Thickness ~24 Hours After 2nd Day Pumping	DNAPL Removed 3rd Day (gallons)
	7/16/2012	3.0	5.3	0.6	-	-	-
	7/30/2012	3.0	5	0.6	-	-	-
	8/14/2012	3.2	4	0.6	-	-	-
	8/27/2012	3.2	4	0.6	-	-	-
	9/11/2012	3.1	4	0.5	-	-	-
	9/25/2012	3.2	3	0.7	-	-	-
	10/8/2012	3.2	3	0.8	-	-	-
	10/23/2012	3.4	3.5	0.8	-	-	-
	11/5/2012	3.5	3.5	0.8	-	-	-
	11/19/2012	3.3	3.5	1.1	-	-	-
RW-109	4/10/2012	22.9	42.5	18 (6 hours later)	[4]	-	-
	4/24/2012	22.7	39	22.7	39	22.7	12[2]
	5/7/2012	22.8	40	22.7	40	22.6	40
	5/21/2012	22.9	35	22.8	40	22.8	40
	6/4/2012	22.9	35	22.8	33	22.3	32
	6/18/2012	22.8	33	22.8	34	22.8	33
	7/2/2012	23.1	35	22.9	34	22.9	35
	7/16/2012	23.2	35	27.3	33	27.2	36
	7/30/2012	23.0	35	22.7	36	22.6	35
	8/14/2012	22.7	35	22.8	36	22.8	36
	8/27/2012	22.7	36	22.7	35[2]	22.7	0[2]
	9/11/2012	22.7	36	22.6	36	22.6	36
	9/25/2012	22.7	36	22.6	36	22.6	36
	10/8/2012	22.6	36	22.6	36	22.6	36
	10/23/2012	22.6	36	22.5	36	22.5	36
	11/5/2012	22.6	37	22.5	37	22.5	36
	11/19/2012	22.5	36	22.5	36	22.5	36
RW-110	4/10/2012	0.7	11[1]	0.0	[4]	-	-
	4/24/2012	<0.1	-	-	-	-	-
	5/7/2012	0.0	-	-	-	-	-
	5/21/2012	0.0	-	-	-	-	-
	6/4/2012	0.1	-	-	-	-	-

Table 4-1 Bi-Weekly NAPL Monitoring and Removal Summary

Well ID	Date	DNAPL Thickness (feet)	DNAPL Removed (gallons)	DNAPL Thickness ~24 Hours After Pumping (feet)	DNAPL Removed 2nd Day (gallons)	DNAPL Thickness ~24 Hours After 2nd Day Pumping	DNAPL Removed 3rd Day (gallons)
	6/18/2012	0.0	-	-	-	-	-
	7/2/2012	0.1	-	-	-	-	-
	7/16/2012	0.1	0.5	0.0	-	-	-
	7/30/2012	0.0	-	-	-	-	-
	8/14/2012	0.0	-	-	-	-	-
	8/27/2012	<0.1	-	-	-	-	-
	9/11/2012	0.0	-	-	-	-	-
	9/25/2012	<0.1	-	-	-	-	-
	10/8/2012	<0.1	-	-	-	-	-
	10/23/2012	0.5	3.5[1]	-	-	-	-
	11/5/2012	0.0	-	-	-	-	-
	11/19/2012	0.0	-	-	-	-	-
RW 10+25	4/12/2012	0.3	10[1]	0.3 (2 hours later)	[4]	-	-
	4/24/2012	0.2	None[3]	-	-	-	-
	5/7/2012	0.1	None[3]	-	-	-	-
	5/21/2012	<0.1	-	-	-	-	-
	6/4/2012	0.2	None[3]	-	-	-	-
	6/18/2012	0.0	-	-	-	-	-
	7/2/2012	0.2	None[3]	-	-	-	-
	7/16/2012	0.3	None[3]	-	-	-	-
	7/30/2012	0.1	None[3]	-	-	-	-
	8/14/2012	0.3	None[3]	-	-	-	-
	8/27/2012	0.3	None[3]	-	-	-	-
	9/11/2012	0.3	None[3]	-	-	-	-
	9/25/2012	0.1	None[3]	-	-	-	-
	10/8/2012	0.1	None[3]	-	-	-	-
	10/23/2012	0.1	None[3]	-	-	-	-
	11/5/2012	0.1	None[3]	-	-	-	-
	11/19/2012	0.1	None[3]	-	-	-	-
RW 14	4/12/2012	0.4	20[1]	0.2 (2 hours later)	[4]	-	-
	4/24/2012	0.1	None[3]	-	-	-	-

Table 4-1 Bi-Weekly NAPL Monitoring and Removal Summary

Well ID	Date	DNAPL Thickness (feet)	DNAPL Removed (gallons)	DNAPL Thickness ~24 Hours After Pumping (feet)	DNAPL Removed 2nd Day (gallons)	DNAPL Thickness ~24 Hours After 2nd Day Pumping	DNAPL Removed 3rd Day (gallons)
	5/7/2012	0.1	None[3]	-	-	-	-
	5/21/2012	<0.1	-	-	-	-	-
	6/4/2012	0.1	None[3]	-	-	-	-
	6/18/2012	0.1	None[3]	-	-	-	-
	7/2/2012	<0.1	-	-	-	-	-
	7/16/2012	0.0	-	-	-	-	-
	7/30/2012	0.1	None[3]	-	-	-	-
	8/14/2012	0.1	None[3]	-	-	-	-
	8/27/2012	0.1	None[3]	-	-	-	-
	9/11/2012	0.2	None[3]	-	-	-	-
	9/25/2012	0.1	None[3]	-	-	-	-
	10/8/2012	0.2	None[3]	-	-	-	-
	10/23/2012	0.0	-	-	-	-	-
	11/5/2012	0.0	-	-	-	-	-
	11/19/2012	0.1	None[3]	-	-	-	-

Notes:

[1] Liquid removed from well was mixture of NAPL and water.

[2] Problems with NAPL removal pump prevented complete NAPL removal.

[3] NAPL removal in large diameter, shallow wells with <0.3 feet NAPL not practical. Past attempts ineffective with large amounts of water pumped and very little NAPL removed.

[4] 1st removal event during week of 4/10/12 did not include collection of NAPL recharge data or removal beyond initial NAPL standing well volume.

4.2 SURFACE WATER

One unfiltered surface water sample (J_SWT1+50W80) was collected from the Canal outlet on August 20, 2012 and analyzed for 17 PAHs. The sample location is shown on Figure 2-4 (primary long-term location). No PAHs were reported detected by the laboratory. The reporting limit for each individual PAH was 0.5 μg/L. These data indicate that water quality in

Lake Champlain, downstream of the Canal outlet, was not adversely affected by Canal surface water at the time of sample collection.

Sections 6.2.1.6 and 6.2.1.7 of the FSP require that data evaluation include comparison of the analytical results to the current version of the Ambient Water Quality Criteria (AWQC). Additionally, for years following Year 2 after construction completion (2005), a graph for each analytical parameter that illustrates changes in data with time is required. These graphs are to include the AWQC limits for each compound. No PAHs have been detected in the available long-term surface water quality monitoring data, so the graphs were not prepared and comparison with AWQC was not performed. A summary table of all surface water analytical results (and the relevant AWQC), and a complete surface water sample results database printout, are presented in Appendix 5.

4.3 WETLANDS CAP AND SUBAQUEOUS CAP MONITORING

4.3.1 Cap Chemistry

Chemical analyses were conducted on samples from cores of the wetland and subaqueous caps. The objective of the chemical analyses is 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. Similar to the previous three years, cap coring in Area 2 was not conducted during this monitoring event due to the presence of the Amended Cap in a large portion of this area. A summary of the laboratory analytical data and IDV reports are presented in Appendix 5 and Appendix 6, respectively. The cap core sampling locations are shown on Figures 4-14 and 4-15. Field notes and sample forms are included in Appendix 1. Summaries of the analytical results are provided in Table 4-2.

Table 4-2

Summary of 2012 Long Term Cap Coring Analytical Results

		Mid-Cap							Top-Cap				
Area	**Sample Location**	**Sum of PAHs[1] (mg/kg)**	**Exceeds 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)**
8	T1+00 E300	U 0.221	No	9.11	U 0.1	2.24	21.8	No	J 0.459	11.1	U 0.099	6.31	38.7
	T2+00 E100	U 0.221	No	7.15	U 0.095	1.78	18.1	No	J 1.642	12	U 0.099	6.71	47.5
	T3+00 E50	J 0.207	No	8.11	U 0.099	1.87	20.7	No	J 0.355	9.6	U 0.097	3.73	33.4
	T3+00 E150	U 0.221	No	7.29	U 0.097	2.32	19.7	No	J 0.206	8.19	U 0.097	3	25
Area 8 Average		**0.218**	**No**	**7.92**	**J 0.098**	**2.05**	**20.08**	**No**	**0.666**	**10.45**	**J 0.098**	**4.94**	**36.15**
1	T4+00 E60	U 0.221	No	6.49	U 0.099	1.6	17.9	No	J 0.288	8.91	U 0.097	3.52	29.5
	T6+00 E20	U 0.221	No	8.55	U 0.095	2.02	19.8	No	J 0.634	10.7	U 0.095	3.86	36.6
	T6+00 E40	J 0.197	No	8.57	U 0.094	2.12	19	No	J 0.725	11.5	U 0.095	3.64	35.6
Area 1 Average		**J 0.213**	**No**	**7.87**	**J 0.096**	**1.91**	**18.9**	**No**	**J 0.549**	**10.37**	**J 0.096**	**3.67**	**33.9**
2	No Coring Performed in Area 2[4]												
3	T15+50E150	U 0.221	No	9.15	U 0.096	3.07	20.3	No	J 0.875	7.3	J 0.012	5.73	26.5
	T17+50E100	J 0.208	No	8.57	U 0.098	2.83	18.2	No	J 0.276	5.54	J 0.019	6.16	24.5
Area 3 Average		**J 0.215**	**No**	**8.86**	**J 0.097**	**2.95**	**19.25**	**No**	**J 0.576**	**6.42**	**J 0.016**	**5.95**	**25.5**
4/5	T18+00E425	No mid-cap samples in Area 4/5							J 22.04	38.6	J 0.071	112	190
	T19+00E15								J 18.08	138	0.37	99.8	274
	T22+00E50								J 28.22	42.6	0.88	48.7	137
Area 4/5 Average									**J 22.78**	**73.07**	**0.44**	**86.83**	**200.3**

Notes:
[1] Most PAHs were not detected in most samples. The reporting limit was used for non-detect analytes in calculating the sum of PAHs. As with previous reports, if the reporting limits were above 330 ug/kg, ½ the reporting limit was used in the summation (only occurred in T22+00E50 in 2012).
[2] Benchmark value for Mid-Cap PAHs is sum of ERMs for 13 PAHs: 21 ppm, no benchmark for Top-Cap samples
[3] Benchmark values for Mid-Cap metals are ERMs: copper – 270 ppm; lead – 218 ppm; mercury – 0.71 ppm; zinc – 410 ppm, no benchmark for Top-Cap.
[4] No Coring was performed in Area 2 during the fall 2012 monitoring period due to the presence of the Amended Cap U – indicates that analyte was not detected, with the associated value being the detection limit.
J – indicates an estimated concentration

4.3.1.1 Long-term Monitoring Mid-cap Results and Comparison to Benchmark Values

A summary of the results and a comparison to benchmark values for the mid-cap samples is presented in Table 4-2. The CMWP, Field Sampling Plan, Section 5.3.2.4: *Data Evaluation*; and associated Figure FSP 6-8: *Long Term Cap Monitoring Data Analysis*, presents the data evaluation procedures for the chemical monitoring of the caps at the Site. The primary basis for data evaluation is a comparison of the mid-cap sample laboratory results to the following benchmark values: the sum of the effects range median (ER-Ms) for 13 PAHs (21 mg/kg; the "PAH benchmark value"), and individual ER-M values for copper, lead, mercury, and zinc (270 mg/kg, 218 mg/kg, 0.71 mg/kg, and 410 mg/kg, respectively).

If the reported concentration for an individual mid-cap sample exceeds a benchmark value but the average concentration of all mid-cap samples within the study area (e.g., Area 8) do *not* exceed the benchmark value, then the location with the exceedance is to be re-sampled as soon as practical. If the re-sampled value also exceeds the benchmark, a data evaluation and best professional judgment assessment is required. If the re-sampled value does *not* exceed the benchmark value then no additional action is required. If the mean concentration from all mid-cap samples within the study area exceeds a benchmark value, then a full weight-of-evidence analysis (including toxicity testing) is required.

No reported metals or PAHs from any of the capped areas exceeded the benchmark values. Note that neither the Statement of Work (SOW) nor the CMWP relate the mid-cap benchmarks to the results from top of cap samples (0-10 cm) or the uncapped Area 4/5.

4.3.1.2 Long-term Top-of-Cap Monitoring Results

Overall, each of the nine selected top-of-cap samples (0–10 cm) collected at random sample locations from Areas 1, 3, and 8, had detected PAHs, though nearly all of the detections were reported as estimated concentrations (J) below the PQL. The sum of PAHs number shown in Table 4-2 was calculated using ½ of the PQL (when it exceeded 330 μg/kg) in accordance

with the CMWP. Three of the nine associated mid-cap samples contained detectable PAHs, although detections were reported as estimated concentrations. The sum-of-PAH values for all samples from mid-cap were less than the 21 mg/kg benchmark value associated with mid-cap samples.

The sums of PAHs from the three shallow samples collected from the uncapped Areas 4/5 were elevated relative to the cap samples in other areas. However, TOC in these samples ranged from 1.47% to 4.04%, making the PAHs largely unavailable to the biota, again consistent with prior findings. Copper, lead, mercury, and zinc were also elevated in the Area 4/5 samples relative to those collected from the capped areas, although are consistent with prior results. The AVS/SEM results from the grab sample locations collected as part of the biological monitoring program showed that metals were not bioavailable at T19+00E15, and suggest that they were not bioavailable at the other two sample locations (see Section 4.5.1).

4.4 AMENDED CAP MONITORING

4.4.1 Amended Cap Bathymetric Survey

In accordance with the OMMP, a bathymetric survey was conducted by Little River Survey of Stowe, Vermont (LRS) in the vicinity of the Amended Cap on August 30, 2012 as described in Section 2.4.1. LRS used steel posts, placed by them in 2010, to tie the survey to the elevation and location datum. The top-of-steel-casing elevations of two wells were surveyed in August 2012 to confirm the accuracy of the survey. The August 2012 top-of-casing reported elevations were 103.10 for RW-106 and 102.85 for RW-107 (all elevations provided in feet NAVD88). The ARCADIS Record Drawing #4, dated 1/7/2010, provided top-of-casing elevations of 102.95 for RW-106 and 102.72 for RW-107. These differences in reported elevations for the two wells between 2010 and 2012 are close to the level of accuracy of the field survey instrumentation, and likely do not represent actual increases in elevations.

A figure showing the bathymetric contours of the surveyed area is provided as Figure 4-16 and a copy of the survey data is included in Appendix 8. Three areas were identified as showing an approximate 1 foot decrease in elevation from 2011 to 2012. These areas, delineated in blue on Figure 4-16, include the edge of the Amended Cap near RW-104, the edge of the cap near RW-102, and the northern end of the Amended Cap from approximately 10 to 50 east of the west bank of the Canal.

4.4.2 Amended Cap Settlement Plate Survey

An elevation and location survey of the nine settlement plates (SP-A through SP-I) placed on the Amended Cap following its construction was completed on August 30, 2012 by LRS. Locations and elevations of two recovery wells were also surveyed to ensure accuracy as noted in section 4.4.1 above.

As was the case with previous similar surveys, attempts to insert the survey rod into the cone and pipe located in the middle of the plates were generally not successful. The elevation and horizontal location was therefore collected from the top of the plate near the approximate center, which provides for a potential horizontal error of +/- two feet due to the two-foot by two-foot size of the plates.

In August 2012 several flat, hard surfaces (presumed to be concrete blocks due to their approximately 8 x 16-inch size) were found on the Amended Cap surface while probing with the survey rod for the settlement plates. The discovery of these blocks suggests that some of the previously reported locations for settlement plates may actually have been concrete block locations. Most of the presumed concrete blocks were located near the western base-of-slope in the Canal. They were also found near the former South Slip and near the north end of the Amended Cap. Previously reported November 2011 and May 2012 surveyed locations of plates may have actually been locations of concrete blocks rather than settlement plates.

The reported plate locations from the four surveys are shown on Figure 4-17. The recent August 2012 data suggest that plates SP-B, SP-C, SP-G, and SP-I have not moved laterally since 2010. The vertical survey data indicate a 0.16 ft. and 0.28 ft. decrease in elevation since 2010 at SP-B and SP-C, a 0.17 ft. elevation increase at SP-G, and no significant elevation change at SP-I. The data for the remaining plates indicate substantial changes in their locations suggesting either the plates moved or concrete blocks were inadvertently surveyed as plates during one or more prior occasions. In either case, comparison of the elevation changes for those data would not reflect actual elevation changes in the Amended Cap.

4.4.3 Visual Sheen Monitoring

Visual sheen monitoring was conducted bi-weekly from April through November 2012 in the vicinity of the Amended Cap between T8 and T13.

Multiple areas of gas bubble emanation were observed during each sheen inspection event; with the number and frequency of the bubbling appearing generally to increase as the surface water temperature increased with the onset of summer temperatures and decreasing with the onset of winter. Gas bubbles have been observed within the footprint of the Amended Cap, as well as to the north and south of the Amended Cap area. To date, no sheens and/or NAPL associated with gas bubbles have been observed emanating from within the Amended Cap foot print.

Of the seventeen sheen monitoring events conducted in 2012 only thirteen events reported gas bubbling with associated sheens and/or NAPL droplets. Three distinct areas of sheen/NAPL bubbling were observed in 2012 (Figure 4-18) and are located as follows: Area 1 - Transect T7+80 to T8+50 (50 to 120 feet north of the Amended Cap); Area 2 - T12+50 to T12+75 (along the southern edge of the Amended Cap); and Area 3 - approximately T14+25. Field notes for the monitoring events are provided in Appendix 1.

Gas bubbles with an associated sheen and/or NAPL droplet were observed in Area 1 during nine of the seventeen monitoring events conducted in 2012. In this area NAPL transport to the surface of the Canal was generally observed as small sheens which dispersed quickly. The rate of NAPL seep emanation was approximately one droplet/sheen during the five minute observation period.

Gas bubbles with an associated sheen and/or NAPL droplet were observed in Area 2 during nine of the seventeen monitoring events in 2012. These locations were all approximately at the southern edge of the Amended Cap. Characteristics of observed NAPL transport to the surface of the Canal in Area 2 varied significantly from event to event. The rate of NAPL seeps observed ranged from 1 to 150 droplets/sheens during the five minute observation period. Diameters of the observed sheens ranged from 1-2 inches to 1-2 feet. Rate of dispersal was dependent upon the size of the sheen, whether a droplet or ganglia was present, and the presence, direction, and speed of wind.

One additional NAPL observation event was reported in Area 2 that was not associated with observed gas bubbles, yet the observed NAPL is believed to have sourced from Area 2. During the August 28, 2012 event the areas within the Canal south of the Amended Cap were clogged completely with dense growth of aquatic vegetation (predominantly Eurasian Milfoil). Along transect T12+50 (at the edge of the Amended Cap) 2-5 foot diameter areas of NAPL intermixed with milfoil were observed at approximately 40, 45, 50, and 60 feet east of the west bank of the Canal. Both NAPL ganglia and dissolved sheens were noted. An additional area with NAPL bound within milfoil was also observed at Transect T12+75 approximately 5 feet from the east bank of the Canal (T12+75E75).

Gas bubbles with an associated sheen were periodically observed at a rate of 1 to 2 bubbles per second at Area 3. Upon reaching the surface, the bubbles released bluish-gray and “rainbow” type sheens in May. This same area produced droplets and light brown ganglia of

NAPL during the June observation events. A sorbent boom was placed to surround the area and contain any sheens and/or NAPL. NAPL seeps continued to occur at Area 3 but were effectively contained with the boom through the end of the 2012 monitoring period.

In accordance with the OMMP FSP, since none of these release areas were observed emanating through the Amended Cap, no sheen/NAPL sampling was conducted.

4.4.4 Cap Termination Inspections

Visual examinations of the edges of the Amended Cap were conducted on a monthly basis from April to November, 2012. No extensive areas of damage were noted during any of the inspections. One small area of surficial damage to the turf reinforcing mat (TRM) was noted above the water's surface along the west bank at approximately transect T11+50. This damage was isolated to an area approximately 0.5 by 1.5 feet. This same area was noted during each of the monthly inspections with no changes. A second small (2 by 12 inches) area of damaged TRM was also noted at approximately Transect T12+20 on the west bank of the Canal, which did not worsen during 2012. Some minor curling of the TRM was observed on the east bank of the Canal in the vicinity of T11+70 to T11+80. These observations are considered relatively insignificant and are not impairing the effectiveness of the Amended Cap.

4.5 BIOLOGICAL MONITORING

4.5.1 Benthic Macroinvertebrate Monitoring

Benthic macroinvertebrate sampling was conducted on August 21 and 22, including one sample randomly selected in the combined Areas 1 and 2; one in Area 8 (the capped section of the Canal); and one in the uncapped Area 4/5. The Amended Cap portion of Area 2 was not included in the sampling. The data tables are presented in Appendix 5 and the laboratory reports are in Appendix 7. Summary results from macroinvertebrate sampling in the individual study areas are presented in Tables 4-3 through 4-5. Comparisons of relative abundance and number of dominant species from the Pre-construction sampling in 2001, and post-construction sampling

in 2003 through 2012 are presented in Table 4-6. Table 4-7 presents sediment physical data and Tables 4-8 and 4-9 present AVS/SEM data. Locations of benthic samples are shown on Figure 2-5. The benthic macroinvertebrate relative abundance data show the spatial heterogeneity that has been noted in previous years. These results do not appear to be the result of site contamination. The highest abundance was in Area 4/5 where the sediment contaminant concentrations were also the highest. The TOC content at this sample location was 2.07 percent and the AVS/SEM ratio was less than one indicating that the PAH and metals contaminants are not bioavailable. The data show the spatial heterogeneity that is common for benthic macroinvertebrate communities.

4.5.1.1 Benthic Macroinvertebrate Sampling

The benthic macroinvertebrate community in the Canal and Turning Basin sediments is dominated by tubificid worms. This is not surprising because the benthic macroinvertebrate community in adjacent Burlington Harbor is also dominated by this group of organisms. The sample from the Turning Basin, Area 8, showed lower abundance than in the last three years and was the lowest since 2006. However, the low abundance did not seem to be related to contamination since the PAH and metal concentrations were low. The relative abundance in Area 1 was similar to results for the last four years.

The uncapped Area 4/5 had the greatest diversity of organisms and the abundance was essentially the same as Area 1. It was the only area where species other than oligochaete worms were collected. While the numbers of individuals that were not oligochaete worms did not exceed 4 % in any sample, snails, pond scuds, chironomid midges, and a dragonfly nymph were collected.

Table 4-3 Summary of Benthic Macroinvertebrate Data Area 8 August 2012 (Major Component Species >4%)		
Sample Location: Area 8, J_3+00E50 **Date Sample Collected: 8/21/12** **Water Depth on Sample Collection Date: 8.2 ft.**		
Family	**Species**	**% of Total**
Replicate No. 1 – Total Abundance = 7		
Tubificidae	Spp.	100
Replicate No. 2 – Total Abundance = 5		
Tubificidae	*Spp.*	80
Tubificidae	*Limnodrilus hoffmeisteri*	20
Replicate No. 3 – Total Abundance = 57		
Tubificidae	*Spp.*	100
AREA 8 – RELATIVE ABUNDANCE = 23		
Note: Specimens are identified to the lowest practical taxon		

Table 4-4 Summary of Benthic Macroinvertebrate Data Area 1 August 2012 (Major Component Species >4%)		
Sample Location: Area 1, J_T4+00E60 **Date Sample Collected: 8/21/12** **Water Depth on Sample Collection Date: 7.1 ft.**		
Family	**Species**	**% of Total**
Replicate No. 1 – Total Abundance = 97		
Tubificidae	*Spp.*	100
Replicate No. 2 – Total Abundance = 171		
Tubificidae	*Spp.*	100
Replicate No. 3 – Total Abundance = 50		
Tubificidae	*Spp.*	100
AREA 1 - RELATIVE ABUNDANCE = 106		
Note: Specimens are identified to the lowest practical taxon		

Table 4-5
Summary of Benthic Macroinvertebrate Data Area 4/5
August 2012
(Major Component Species >4%)

Sample Location: Area 4/5, J_T19+00E15
Date Sample Collected: 8/22/12
Water Depth on Sample Collection Date: 0.0 ft. water at surface

Family	**Species**	**% of Total**
Replicate No. 1 – Total Abundance = 396		
Tubificidae	*Spp.*	72
Tubificidae	*Limnodrilus hoffmeisteri*	6
Naididae	*Dero sp.*	19
Replicate No. 2 – Total Abundance = 384		
Tubificidae	*Spp.*	59
Tubificidae	*Limnodrilus hoffmeisteri*	21
Naididae	*Dero sp.*	8
Replicate No. 3 – Total Abundance = 172		
Tubificidae	*Spp.*	28
Tubificidae	*Limnodrilus hoffmeisteri*	42
Tubificidae	*Ilyodrilus templetoni*	21
AREA 4/5 - RELATIVE ABUNDANCE = 317		
Note: Specimens are identified to the lowest practical taxon		

Table 4-6
Comparison of Relative Abundance and Diversity
Benthic Macroinvertebrates

Year	Area 8		Area 1		Area 2		Area 4/5	
	Relative Abun-dance	# Major Species (>4%)	Relative Abun-dance	# Major Species (>4%)	Relative Abun-dance	# Major Species (>4%)	Relative Abun-dance	# Major Species (>4%)
2001	NOT SAMPLED						260	4
2003	16	3	12	5	75	5	1898	6
2004	13	11	49	7	144	5	323	5
2005	2941	4	103	10	23	3	121	4
2006	7	6	8	13*	NS	NS	340	4
2007	64	6	349	7	NS	NS	70	5
2008	101	3	159	2	NS	NS	379	7
2009	120	3	385	3	NS	NS	2071	2
2010	491	4	390	2	NS	NS	95	9
2011	76	2	227	2	NS	NS	244	6
2012	23	2	106	1	NS	NS	317	4

* Replicate 1 accounted for 11 species, Relative Abundance was less than number of species in this replicate
NS = Not sampled, long-term monitoring calls for one random sample from Areas 1 and 2.

4.5.1.2 Sediment Physical/Chemical Characteristics

The grain size analyses performed on samples collected from the capped areas in conjunction with biological sampling indicated that the sediments at T3 in Area 8 (Turning Basin) were loamy sand and at T4 in the Canal were loamy sand (see Table 4-7). Total organic carbon (TOC) was lower in the capped areas than the uncapped Area 4/5 (see Table 4-7). TOC reduces the bioavailability of metal and organic contaminants. The simultaneously extracted metals (SEM) concentrations in the samples from capped Areas 8 and 1 were significantly lower than the values reported in Area 4/5 samples (see Table 4-8). The ratios of SEM/AVS were less than one for all three areas. An SEM/AVS ratio of less than one indicates that metals are not readily bioavailable.

In the Area 4/5 sample, the TOC reported was 2.07 % and the SEM/AVS ratio was less than one, indicating that PAHs and metals at that location are not readily bioavailable. Based on these data, it appears that the native surficial sediments in this area continue to function as a "natural cap" for contaminants present in the sediments.

Table 4-7
Total Organic Carbon & Sediment Data - Benthic Macroinvertebrate Sampling 2012

Location	Sample Point	Date	Water Depth (ft.)	Percent Solids	Total Organic Carbon (mg/kg)	Sediment Type (USDA)
Area 8	J_T3+00E50	8/21/12	8.2	66.8	11,500 (1.15%)	Loamy sand
Area 1	J_T4+00E60	8/21/12	7.1	45.3	6,620 (0.66%)	Loamy sand
Area 4/5	J_T19+00E15	8/22/12	0.0	83.1	20,700 (2.07%)	Organic

Table 4-8
Metals and AVS/SEM Sediment Data 2012

Area	Sample Point	Water Depth (ft.)	Acid Volatile Sulfide (µmole/g)	Area Mean[1] from 0-10 cm Core Samples and Simultaneously Extracted Metals						SEM/AVS Molar Ratio
				Cd	Cu	Pb	Hg	Ni	Zn	
				SEM (µmole/g)	SEM (µmole/g)	SEM (µmole/g)	SEM (µmole/g)	SEM (µmole/g)	SEM (µmole/g)	
Area 8	J_T3+00E50	8.2	6.4	NA	0.144	0.0403	U	NA	0.800	0.153
Area 1	J_T4+00E60[1]	7.1	3.3	NA	0.146	0.037	U	NA	0.621	0.244
Area 4/5	J_T19+00E15	0.0	10.4	NA	0.530	0.0622	U	NA	2.28	0.276

U – Sample was analyzed for the constituent, but it was not detected in any sample

[1] Values presented are the mean of the two duplicate samples.

Table 4-9
Area 4/5 "Natural Cap" Comparison of 2001 and 2003-2012 Sediment Data

Date	Sample Point	Water Depth (ft.)	Total Organic Carbon (mg/kg)	Acid Volatile Sulfide (mg/kg)	Simultaneously Extracted Metals (mg/kg)						SEM/AVS Molar Ratio
					Cd	Cu	Pb	Hg	Ni	Zn	
8/28/01	J_T24+30[1]	3.3	83,800	691	3.2	123	98.8	0.01	13.6	374	0.89
8/28/01	J_T24+30(Dup)[1]	3.3	96,500	663	3.0	122	91.7	0.01	13.3	367	0.90
8/13/03	J_T18+00E250	2.0	69,500	17.0	1.7	52.2	53.9	0.055	14.4	301	0.35
8/17/04	J_T20+00E75	1.5	103,000	367	1.2	26.2	56.8	U	7.4	164	0.29
8/19/05	J_T19+00E65	At surface	164,000	U	3.6	148	134	U	17.5	675	NA[2]
8/10/06	J_T21+00E25	2.75	82,600	1060	3.4	144	140	U	19.8	650	0.40
8/08/07	J_T19+00E45	3.5	244,000	1550	1.7	65.2	93.5	U	19.4	489	0.19
8/13/08	J_T18+00E425	3.5	77,500	2360	1.2	10.6	118	U	11.5	557	0.13
8/5/09	J_T18+00E400	1.5	88,000	694	1.1	53.5	61.6	U	6.6	368	0.32
6/30/10	J_T21+00E50	3.0	113,000	1800	4.7	1.3	136	U	12.7	559	0.17
8/24/11	J_T22+00E25	2.0	161,000	2270	NA	108	94.9	NA	NA	994	0.25
8/22/12	J_T19+00E15	At surface	20,700	335	NA	33.7	12.9	U	NA	149	0.28

[1] Using current Sample Point designation convention, this location would be J_T23+70E10

[2] Not available due to non-detect result for AVS

4.5.1.3 Compliance with Performance Standards

The Performance Standard for benthic macroinvertebrates is: "Presence of a macrobenthic invertebrate community consistent with sediment type, grain size, water depth, and total organic carbon content of sediments after three years." (Ref. SOW VII. H. 1.) The 2005, Year 3, sampling in Areas 1, 4/5, and 8 showed the presence of a benthic macroinvertebrate community consistent with the sediment type. Monitoring continues to show development of the benthic macroinvertebrate community. Thus the Performance Standard for these Areas continues to be met.

Looking at the comparisons of relative abundance and diversity over the 11 years of sampling data (see Table 4-6), spatial heterogeneity, or patchiness, continues to be evident. For example, in the uncapped Area 4/5 relative abundance data have varied from 70 to 2,071. The relative abundance data in Area 8 went from 13 to 2,941 from 2004 to 2005, down to 7 in 2006, up to 491 in 2010, and down to 23 in 2012. In Area 1, relative abundance since 2007 (the first year the Performance Standard took effect) has ranged from 390 in 2010 to 106 in 2012. While 106 in Area 1 is the lowest relative abundance since 2005 and 23 in Area 8 is the lowest since 2006, the values are more likely the result of patchiness than sediment contaminant concentrations. The PAH concentrations are low, and the AVS/SEM ratios are less than 1, indicating that metals are not bioavailable. Patchiness is a common occurrence in benthic macroinvertebrate distribution which makes determining trends with small numbers of samples difficult (Elliott, 1983). The worms, molluscs, and crustaceans that dominate the fauna at Pine Street are not extremely mobile, so the populations tend to expand spatially around the early colonizers creating a "patch". Random sampling may hit a patch or miss one. As the populations expand, the distance between "patches" would decrease, so in ideal conditions over the long term the populations would become uniformly distributed across an area. However, population expansion may be limited by predation, availability of food resources, or other natural or man-made stressors. Also, in newly colonized environments, such as the capped area of the Canal, the spatial heterogeneity may result because not enough time has elapsed for the benthic

macroinvertebrates to fully utilize the available habitat. However, there appears to be a general trend to greater abundance in the Canal and Turning Basin. The insect larvae like the chironomid midges would be expected to become widely distributed more rapidly, given suitable substrate conditions, because the next generation is produced from eggs laid by the flying adult. The species diversity is low due to the overwhelming dominance of the fauna by the tubificid worms.

The 0-10 cm PAH concentrations reported from the cap coring in 2012 showed that the summed PAH concentrations in the surface sediments were less than 1 mg/kg, well below the 21 mg/kg benchmark value (although that concentration is only a benchmark value for the mid-cap samples according to the CMWP) in Areas 8 and 1. The average summed PAH surface concentrations were above that mid-cap benchmark value in Area 4/5, as has been the case in all previous sampling (see Table 4-2). As discussed above, the high organic carbon of the sediments in Area 4/5 limits the bioavailability of PAHs. The SEM/AVS ratio was less than one in Area 4/5 which indicates that the metals would not be bioavailable. Therefore, the sediment chemical analyses do not indicate that chemical contamination is limiting the relative abundance of the benthic macroinvertebrate community.

4.5.2 Aquatic Vegetation Monitoring

4.5.2.1 Qualitative Vegetation Monitoring

Monitoring of Canal submergent vegetation was done during the macroinvertebrate sampling on August 21 and 22, 2012. On these days, the Lake level was lower than the weir.

Areas 8 and 1 – Turning Basin and Northern Portion of the Canal

These areas are the deeper areas of the Canal and Turning Basin. Water depth at the macroinvertebrate sampling station in the Turning Basin, Area 8, was 8.2 feet. Broadleaved cattail (*Typha latifolia*), burreed (*Sparganium eurycarpum*), and flowering rush (*Butomus umbellatus*) were observed on the shore. Common reed (*Phragmites australis*) was also present

on the shore. White water lily beds (*Nymphaea odorata*) were the dominant floating leaved plant. Eurasian milfoil (*Myriophyllum spicatum*) formed the dominant submergent vegetation in the Turning Basin. Waterweed (*Elodea canadensis*) was also present. In Area 1, the rooted aquatic vegetation noted were Eurasian milfoil, waterweed, and white water lily. Burreed was also present on the shore. In both areas, the water was turbid and suspended green algae appeared to be a significant component of the turbidity. Filamentous blue and green algae were also present in the canal.

Area 2 Southern Canal

The Amended Cap has been placed in this area. The Amended Cap consists of a sand layer covered by a reactive core mat, and a turf reinforcement mat (TRM) as the final surface. This mat consists of a plastic enmeshed in a wire mesh. Eventually silt will impregnate the TRM so that rooted vegetation may colonize the Canal bottom.

The TRM extends into the riparian area above the mean water level for the Canal. On the east side of the Canal, the TRM extends above the mean water level and an access road to the NAPL recovery wells will be retained. An area of soil from 8 to 12 feet wide exists between the termination of the TRM and the access road. The TRM and the area between the TRM and the access road will be maintained to prevent the growth of woody vegetation.

The TRM at the edges of the Canal on both east and west sides has been colonized by native plants and *Phragmites*. Eurasian milfoil has colonized the Amended Cap.

Area 2 Waterway

The bottom of the waterway in the southern half of Area 2 is stabilized with rock gabions and the waterway channel formed using coir logs. The waterway also supports a thick growth of waterweed and Eurasian milfoil that fills the channel. Floating algal clumps, both green algae and bluegreen algae, were observed in the Canal.

Area 3

Phragmites has become dominant in all but the wettest portion of Area 3. Broadleaved cattail dominates the wetter areas. Wetland vegetation monitoring has been completed for this area.

Area 7

Cattail and *Phragmites* are the dominant emergent wetland plants in Area 7. The black locust trees that have colonized the Site have become quite large. The alders at the south west side of the area that were planted continue to thrive. Wetland vegetation monitoring has been completed for this area.

100 ft. X 100 ft. Area

Phragmites was the dominant plant in this area.

West Bank Cap

Much of the West Bank Cap area was cleared for the construction of the Amended Cap. The TRM has been anchored in a trench there. The northernmost section of the TRM has been anchored by concrete poured into the trench. The remainder of the trench is earth filled. On August 21st and 22nd 2012, the West Bank Cap, including the area impacted by the Amended Cap construction, was well covered with vegetation. The area impacted by the Amended Cap construction was covered with the grasses and forbs that were present in the undisturbed area such as bur-reed, willow herb, wild lettuce, grasses, and swamp milkweed. An area of *Phragmites* was present just south of the concrete filled anchor trench. This small stand of *Phragmites* is isolated from the *Phragmites* stand at the south end of the West Bank Cap that was noted in 2009 and 2010.

4.5.2.2 Compliance with Performance Standards

Wetland restoration in the West Bank Cap area has met the Performance Standards for vegetation specified in the SOW for the fifth growing season post-construction:

- Plant community >50% of dominant wetland plants are wetland indicators (Ref. SOW VII H.2 and H.3)

The Performance Standard for Palustrine Open Water vegetation has been met:

- Presence of submergent vegetation (Ref. SOW VII. H.1.)

4.6 OUTLET WEIR INSPECTION

The outlet weir was inspected on November 12, 2012. No visual evidence of settlement of either the weir or the railroad bridge was observed. The concrete of the weir and its stop logs were in good condition, with no spalling, cracks, exposed rebar, scaling, or other deficiencies noted. The alignment of the weir remains unchanged.

4.7 SEDIMENT TRANSPORT MONITORING

The stormwater sampling system used for the 2012 sediment transport monitoring was activated on July 1, 2012. Two storms were sampled during the 2012 stormwater monitoring season. Storm #1 was on September 5, 2012 and Storm #2 started late night on October 19, 2012 and extended into October 20 (Figure 4-19).

4.7.1 Storm #1-September 5, 2012

The storm trigger Canal stage level of 97.45 feet was exceeded at 2:26 AM (97.57 feet) and the stormwater sampler was activated. The sampler successfully collected 12 samples during the event. The six highest Canal stage levels were recorded from 4:26 – 9:26 AM on September 5th, with the maximum stage elevation of 98.05 feet recorded for three successive hours from 6:26 - 8:26 AM (apparently caused by the stage level reaching the crest of the beaver dam). Figure 4-20 shows the measured Canal water level during the September 5, 2012 stormwater sampling event.

After the sampling event was terminated, the six sample bottles (#s 3-8) collected during the six highest Canal stage levels were shipped under chain of custody to Lancaster Laboratories, Inc,. Lancaster was instructed to composite the six samples for a single analysis of total suspended solids and the 17 PAHs. Lancaster performed the composite preparation and analysis of the unfiltered sample for PAHs using EPA Method 8270 and total suspended solids (TSS) by EPA Method 160.2.

TSS was reported at 31 mg/L, and very low (all 0.2 µg/L) estimated (J) concentrations of the following PAHs were reported: benzo(b)flouranthene, benzo(g,h,i)perylene, chrysene, fluoranthene, naphthalene, and pyrene.

4.7.2 Storm #2- October 19-20, 2012

The storm trigger Canal stage level of 97.45 feet was again exceeded at 9:48 PM on October 19 (97.46 feet) and the stormwater sampler was activated. The sampler successfully collected 12 samples during the event and the six highest Canal stage levels were recorded from 12:48 – 5:48 AM on October 20th, with the maximum stage elevation of 97.55 feet recorded for two consecutive samples from 3:48 - 4:48 AM. Figure 4-21 shows the measured Canal water level during the October 19-20, 2012 stormwater sampling event. The samples were not collected from the ISCO sample tray until the following Monday, October 22nd due to a low battery in the pager used for sampling notification. Due to the late fall ambient temperature, and the type of analyses specified (PAH and TSS only), the decision was made to analyze these samples despite the delay in getting them on ice and the samples were delivered to the laboratory.

After the sampling event was terminated, the six sample bottles (#s 4-9) collected during the six highest Canal stage levels were shipped under chain of custody to Lancaster Laboratories, Inc. Lancaster was instructed to composite the six samples for a single analysis of total suspended solids and the 17 PAHs. Lancaster performed the composite preparation and analysis

of the unfiltered sample for PAHs using EPA Method 8270 and total suspended solids (TSS) by EPA Method 160.2.

TSS was reported at an estimated (J) concentration of 3.2 mg/L. No detectable PAHs were reported present above the laboratory detection limit of 0.7 µg/L.

Because this event marks the highest Canal stage sampled with no detectable concentrations reported by analyses, the storm trigger elevation will be raised to 97.55 feet, the highest Canal stage measured during the sampling event, for subsequent sampling seasons in accord with the Compliance Monitoring Work Plan.

5.0 REFERENCES

Elliott, J.M., 1983. *Some Methods for the Statistical Analysis of Samples of Benthic Invertebrates.* Freshwater Biological Association, Scientific Publication No. 25.

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

JCO, 1997. Additional Remedial Investigation Pine Street Canal Superfund Site, Draft Final Revision No. 3, The Johnson Company, Inc. July 3.

VT DOT, 2001. Vermont Department of Transportation, personal communication.

FIGURES

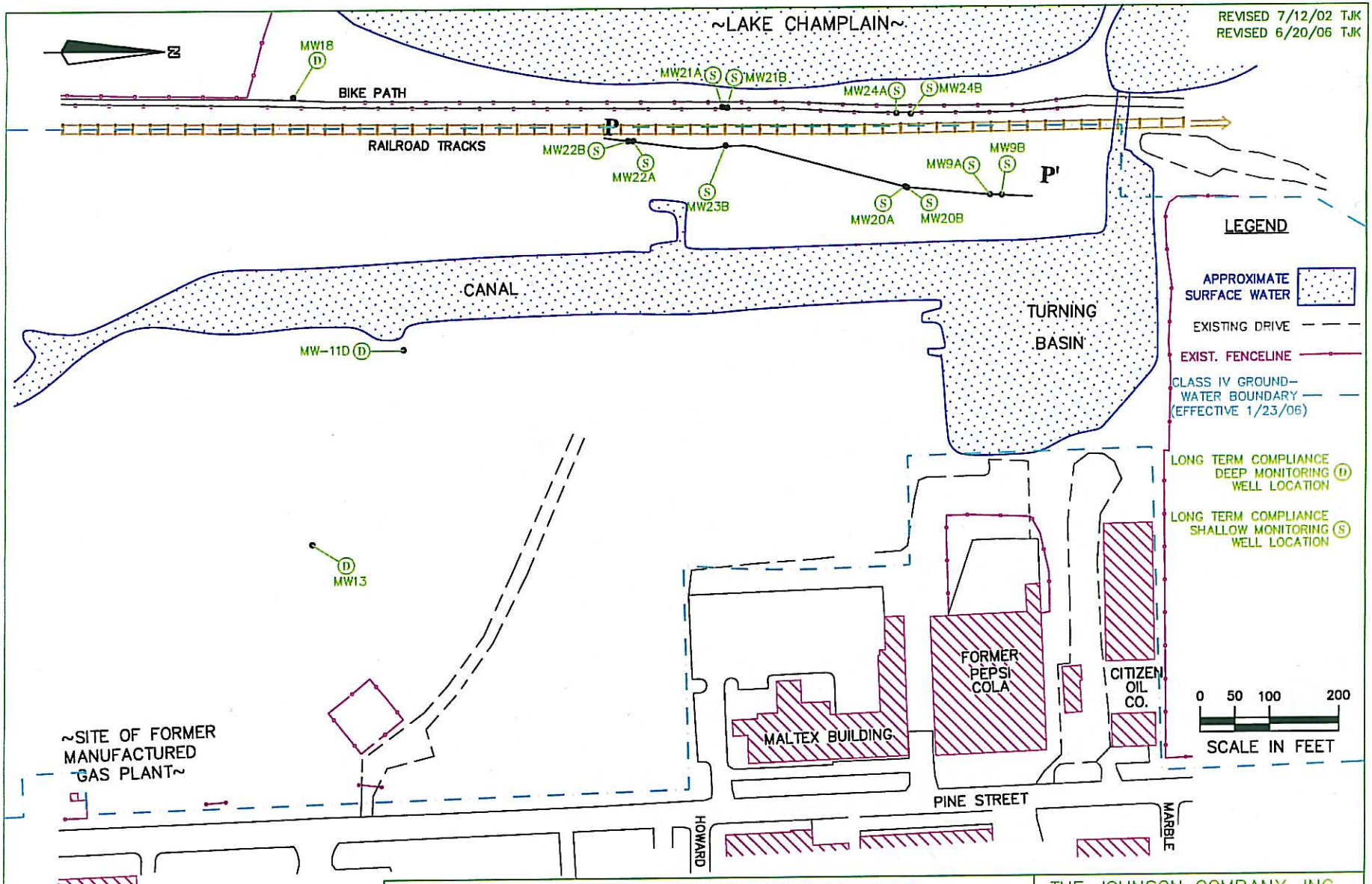


FIGURE 2-1: LOCATIONS OF WELLS USED FOR COMPLIANCE MONITORING PINE STREET CANAL SITE, BURLINGTON, VT

THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

DATE: 7/16/01 PROJECT: 1-0870-2
DRAWN BY: TJK SCALE: 1"=200'

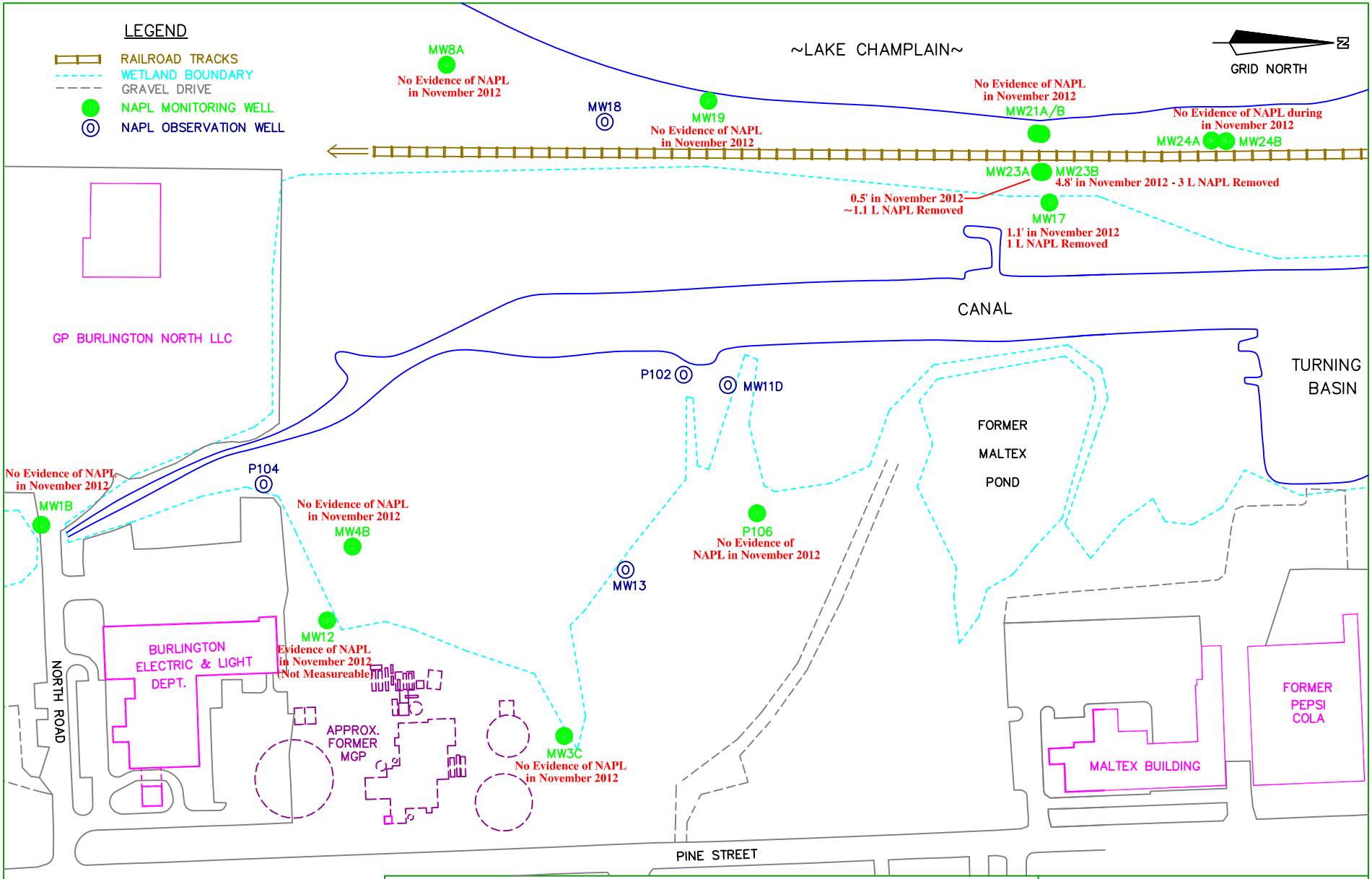


FIGURE 2-2: GROUNDWATER MONITORING WELLS
2012 NAPL MONITORING RESULTS
PINE STREET CANAL SITE, BURLINGTON, VERMONT

THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

DATE: 01/18/13 (rev.) PROJECT: 1-0870-2
DRAWN BY: TJK SCALE: 1"=200'

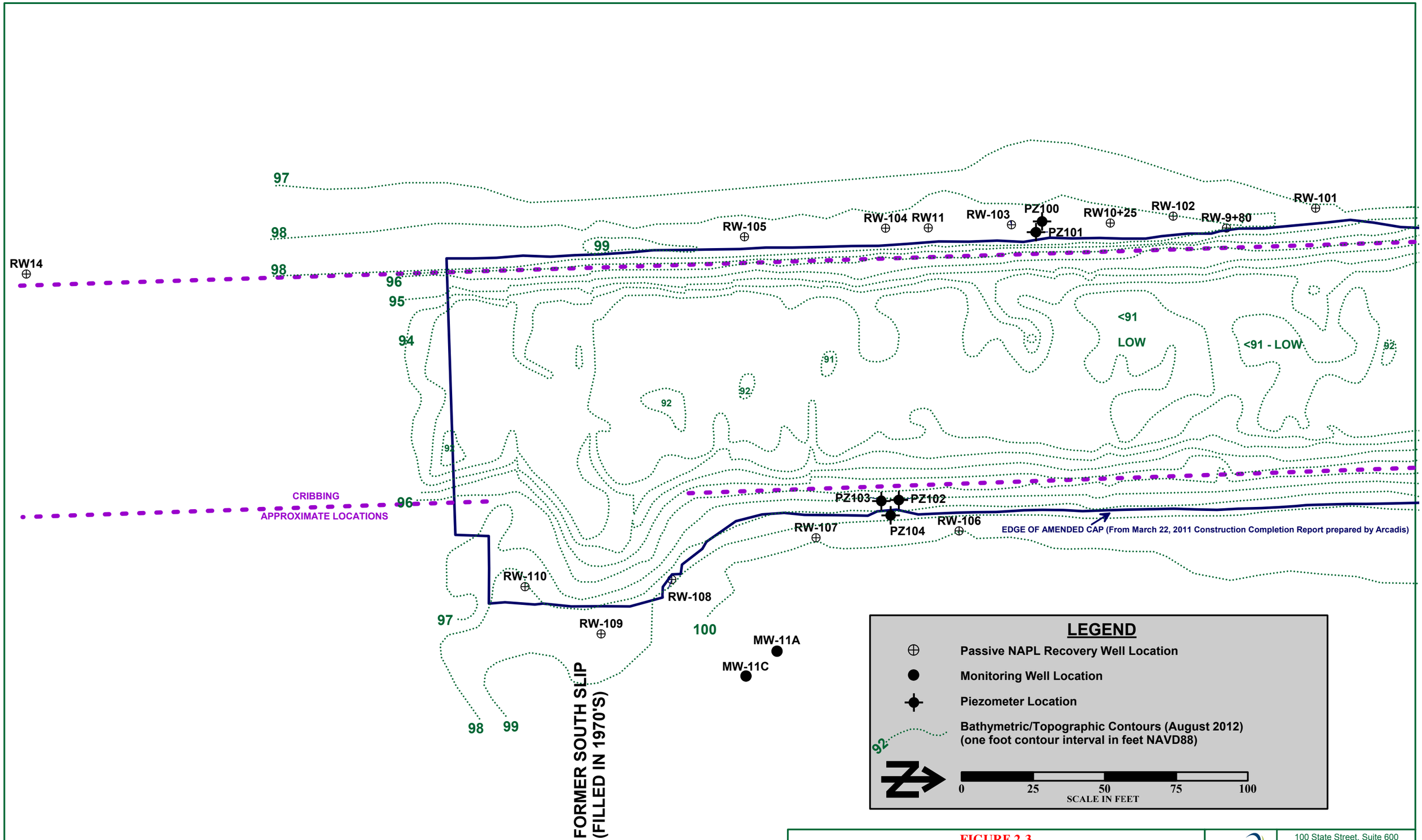


FIGURE 2-3
NAPL RECOVERY WELL LOCATION MAP
PINE STREET CANAL SUPERFUND SITE
453 PINE ST., BURLINGTON, VERMONT

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

Drawn by: DMM Date: 9/17/2012
Chk'd by:CMC Date: 01/04/13
Scale: As shown Project: 1-0870-2 (256)

1-0870-2_2012 RW well NAPl and sheen inspections_011813 RW well location map for fall 2012 CMR.srf

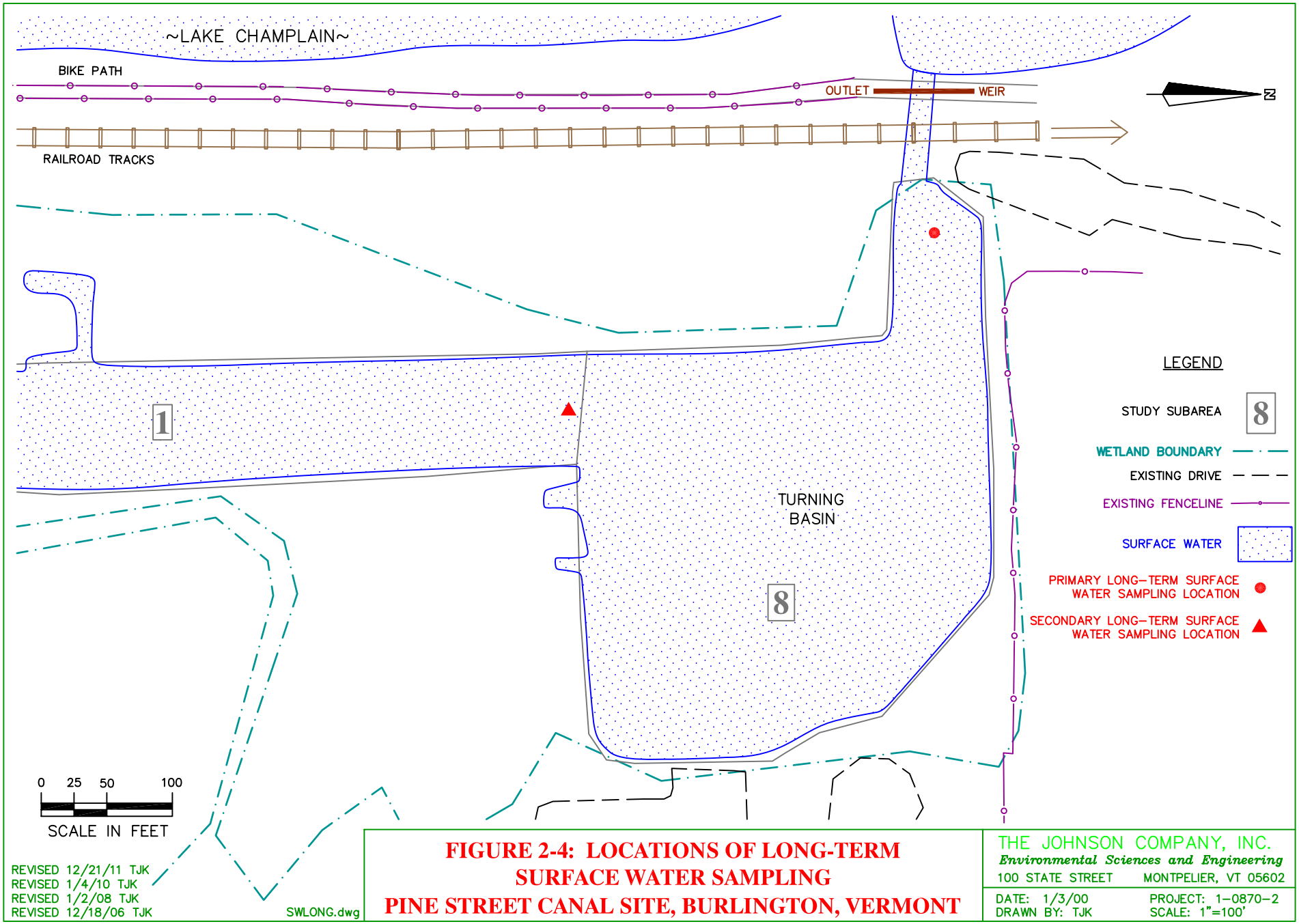


FIGURE 2-4: LOCATIONS OF LONG-TERM SURFACE WATER SAMPLING
PINE STREET CANAL SITE, BURLINGTON, VERMONT

THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

DATE: 1/3/00 PROJECT: 1-0870-2
DRAWN BY: TJK SCALE: 1"=100'

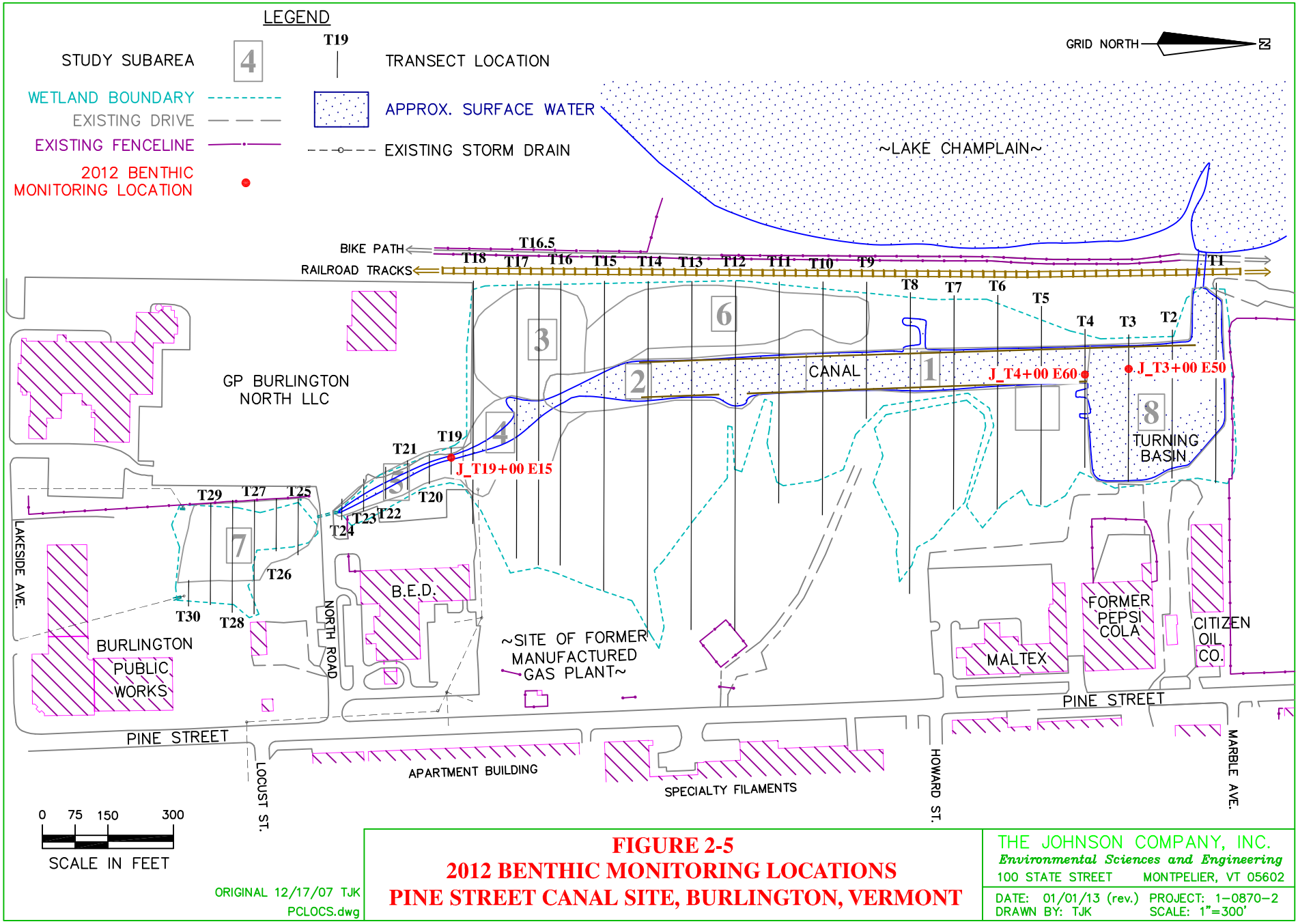


FIGURE 2-5
2012 BENTHIC MONITORING LOCATIONS
PINE STREET CANAL SITE, BURLINGTON, VERMONT

THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

DATE: 01/01/13 (rev.) PROJECT: 1-0870-2
DRAWN BY: TJK SCALE: 1"=300'

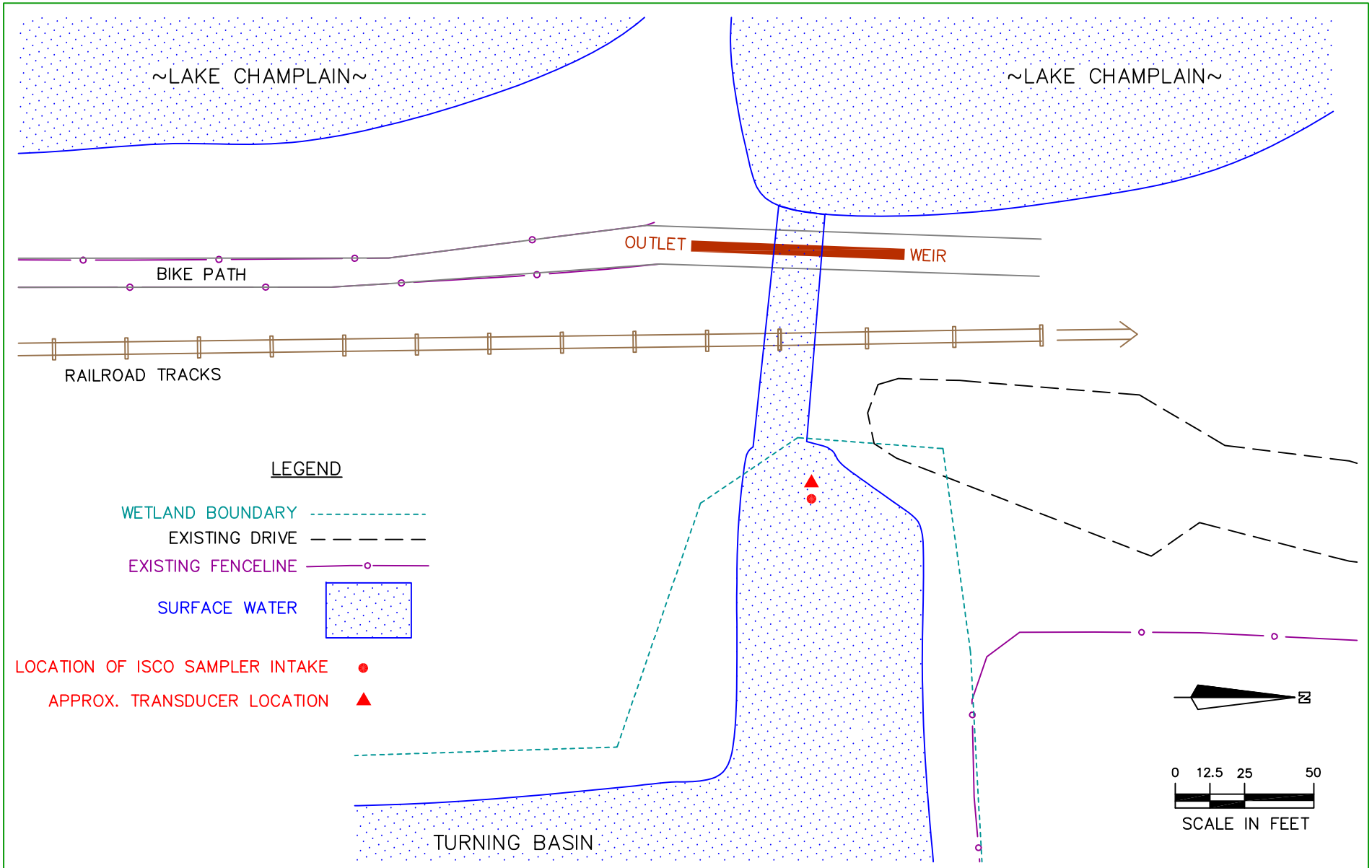


FIGURE 2-6: STORMWATER SAMPLING LOCATIONS
PINE STREET CANAL SITE
BURLINGTON, VERMONT

ORIGINAL 01/04/00 TJK
SWGRAB.dwg

THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

DATE: 01/02/13 (rev.) PROJECT: 1-0870-2
DRAWN BY: TJK SCALE: 1"=50'

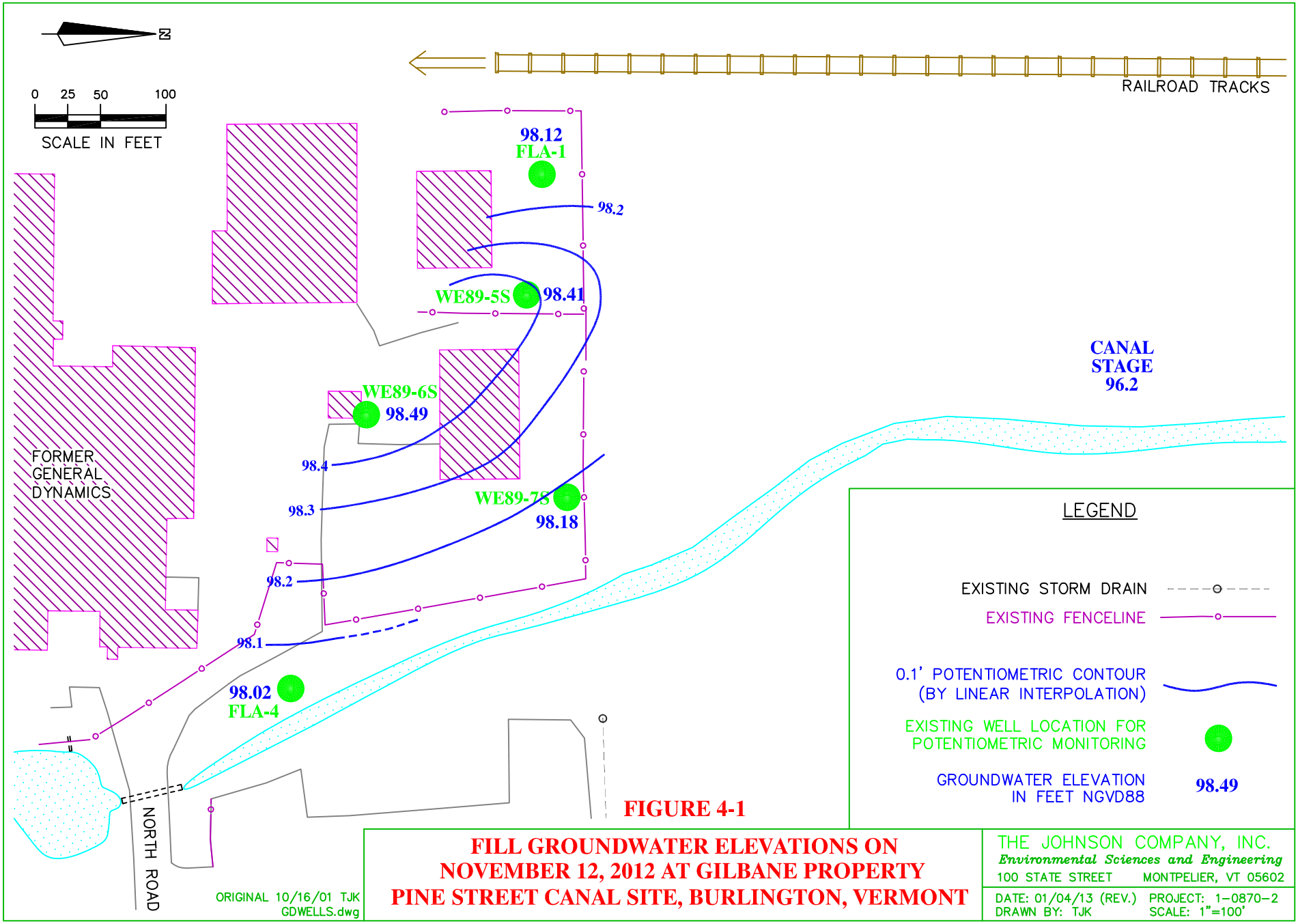


FIGURE 4-1

FILL GROUNDWATER ELEVATIONS ON NOVEMBER 12, 2012 AT GILBANE PROPERTY PINE STREET CANAL SITE, BURLINGTON, VERMONT

THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

DATE: 01/04/13 (REV.) PROJECT: 1-0870-2
DRAWN BY: TJK SCALE: 1"=100'

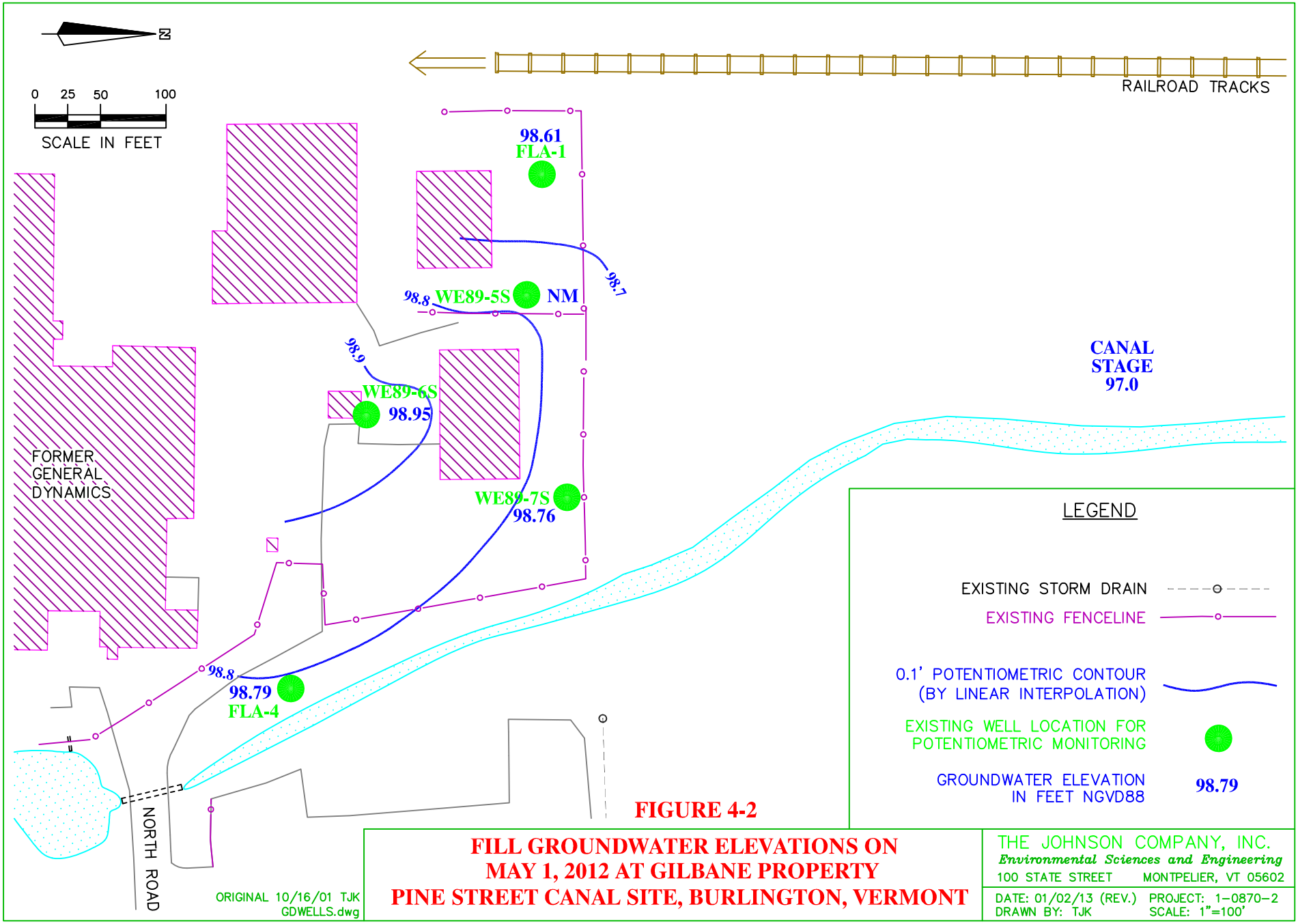


FIGURE 4-2

FILL GROUNDWATER ELEVATIONS ON
MAY 1, 2012 AT GILBANE PROPERTY
PINE STREET CANAL SITE, BURLINGTON, VERMONT

THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

DATE: 01/02/13 (REV.) PROJECT: 1-0870-2
DRAWN BY: TJK SCALE: 1"=100'

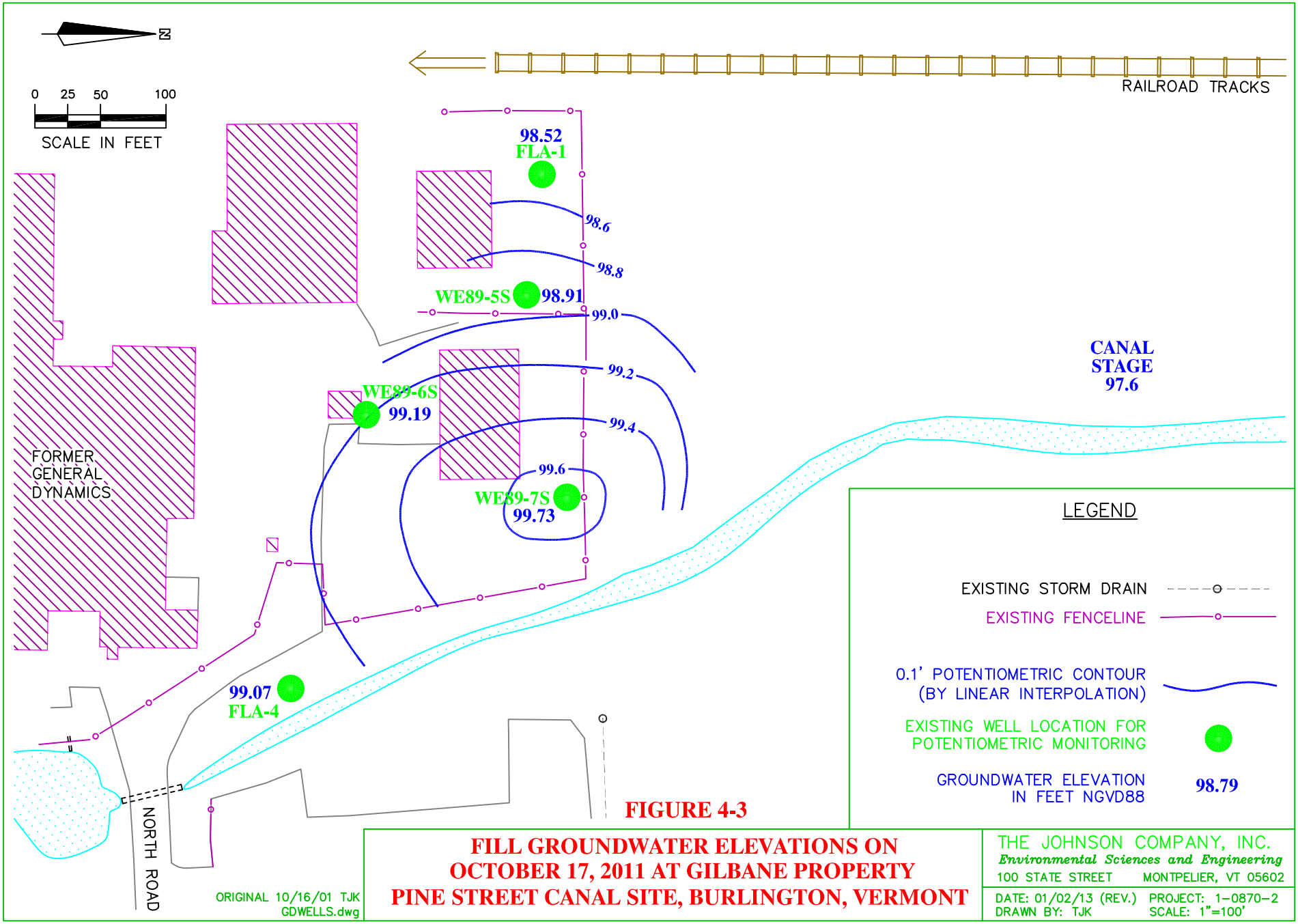
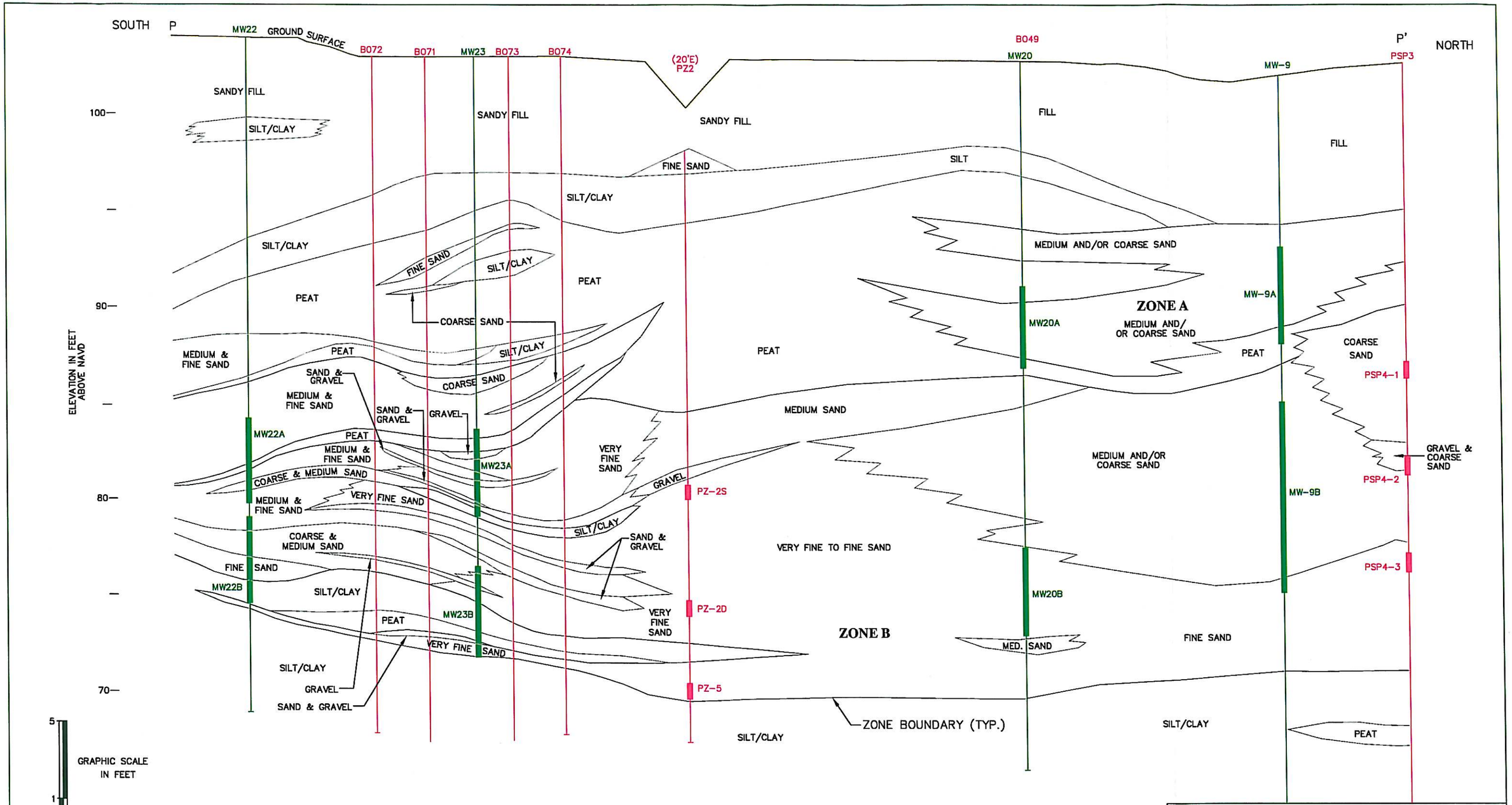


FIGURE 4-3

FILL GROUNDWATER ELEVATIONS ON OCTOBER 17, 2011 AT GILBANE PROPERTY PINE STREET CANAL SITE, BURLINGTON, VERMONT

THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

DATE: 01/02/13 (REV.) PROJECT: 1-0870-2
DRAWN BY: TJK SCALE: 1"=100'



CROSS SECTION P-P' WEST OF CANAL

SCALE: 1"=50' HOR.; 1"=5' VER.; V.E. = 10:1

1
1

FIGURE 4-4: INTERPRETIVE GEOLOGIC CROSS SECTION P - P' BASED ON BORINGS SHOWN PINE STREET CANAL SITE, BURLINGTON, VT

THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

DATE: 01/03/11 DRAWN BY: TJK PROJECT: 1-0870-2 SCALE: SHOWN

ORIGINAL 6/23/04 TJK

GEOP2007.dwg

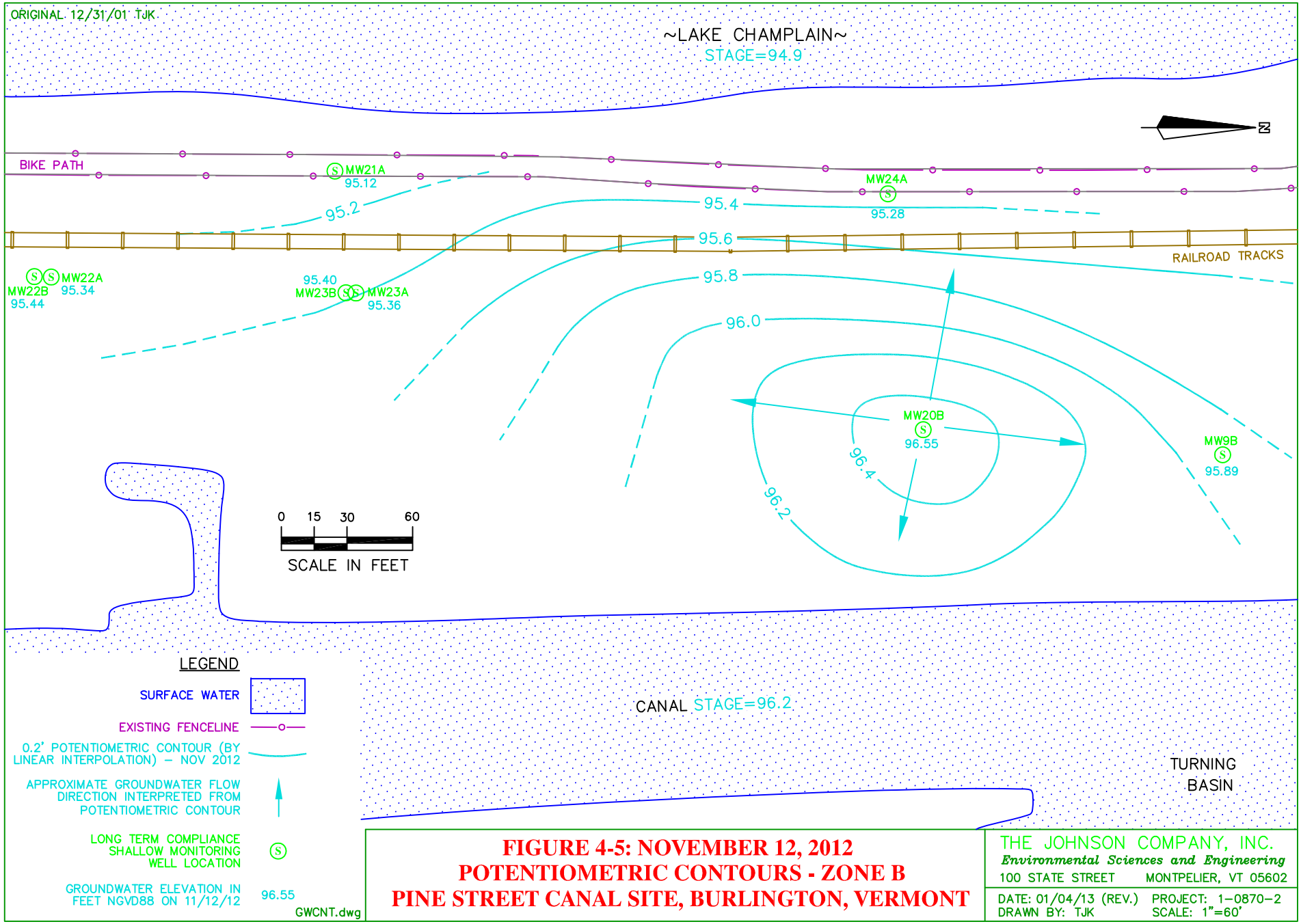


FIGURE 4-5: NOVEMBER 12, 2012
POTENTIOMETRIC CONTOURS - ZONE B
PINE STREET CANAL SITE, BURLINGTON, VERMONT

THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

DATE: 01/04/13 (REV.) PROJECT: 1–0870–2
DRAWN BY: TJK SCALE: 1"=60'

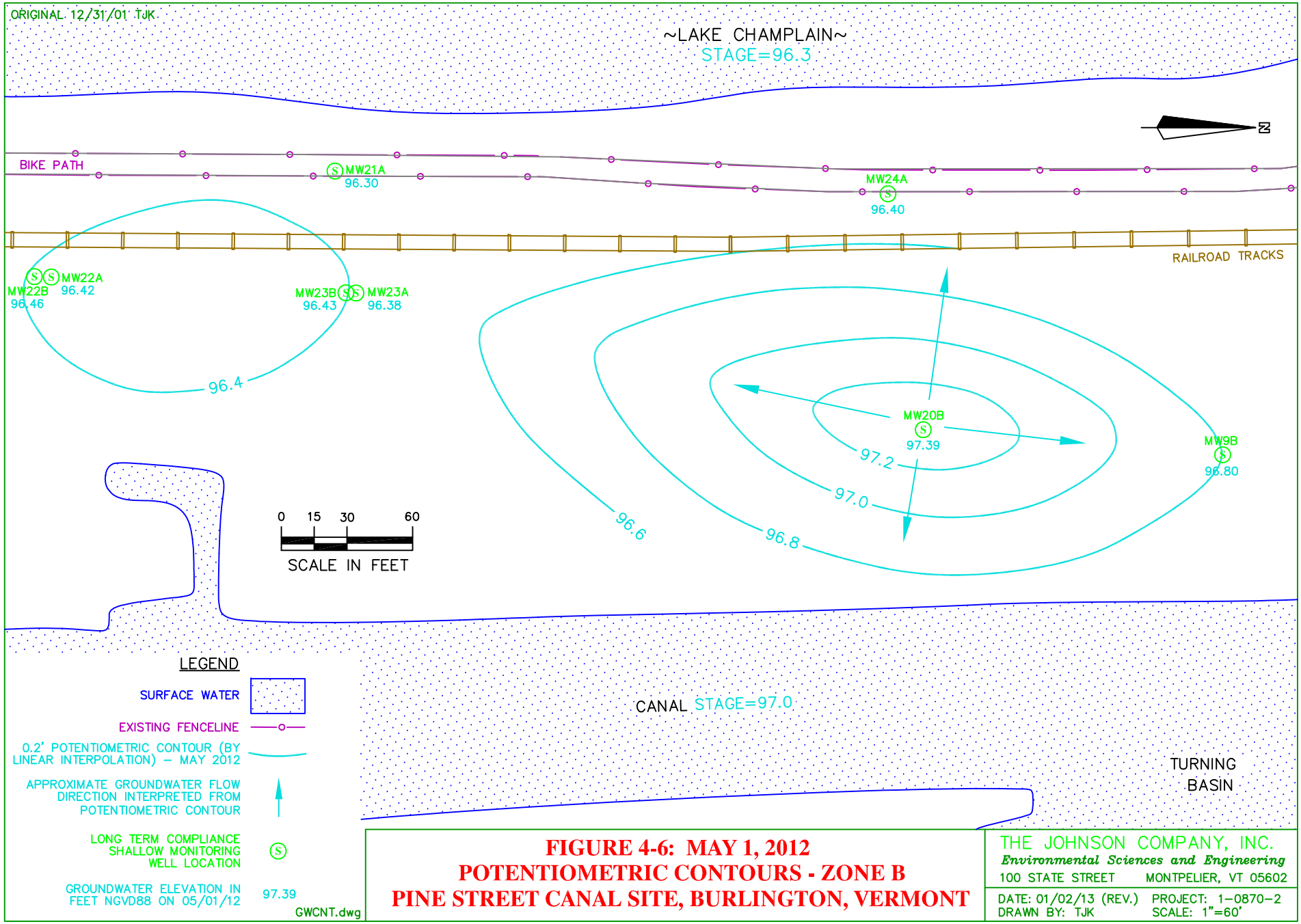


FIGURE 4-6: MAY 1, 2012
POTENTIOMETRIC CONTOURS - ZONE B
PINE STREET CANAL SITE, BURLINGTON, VERMONT

THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

DATE: 01/02/13 (REV.) PROJECT: 1–0870–2
DRAWN BY: TJK SCALE: 1"=60'

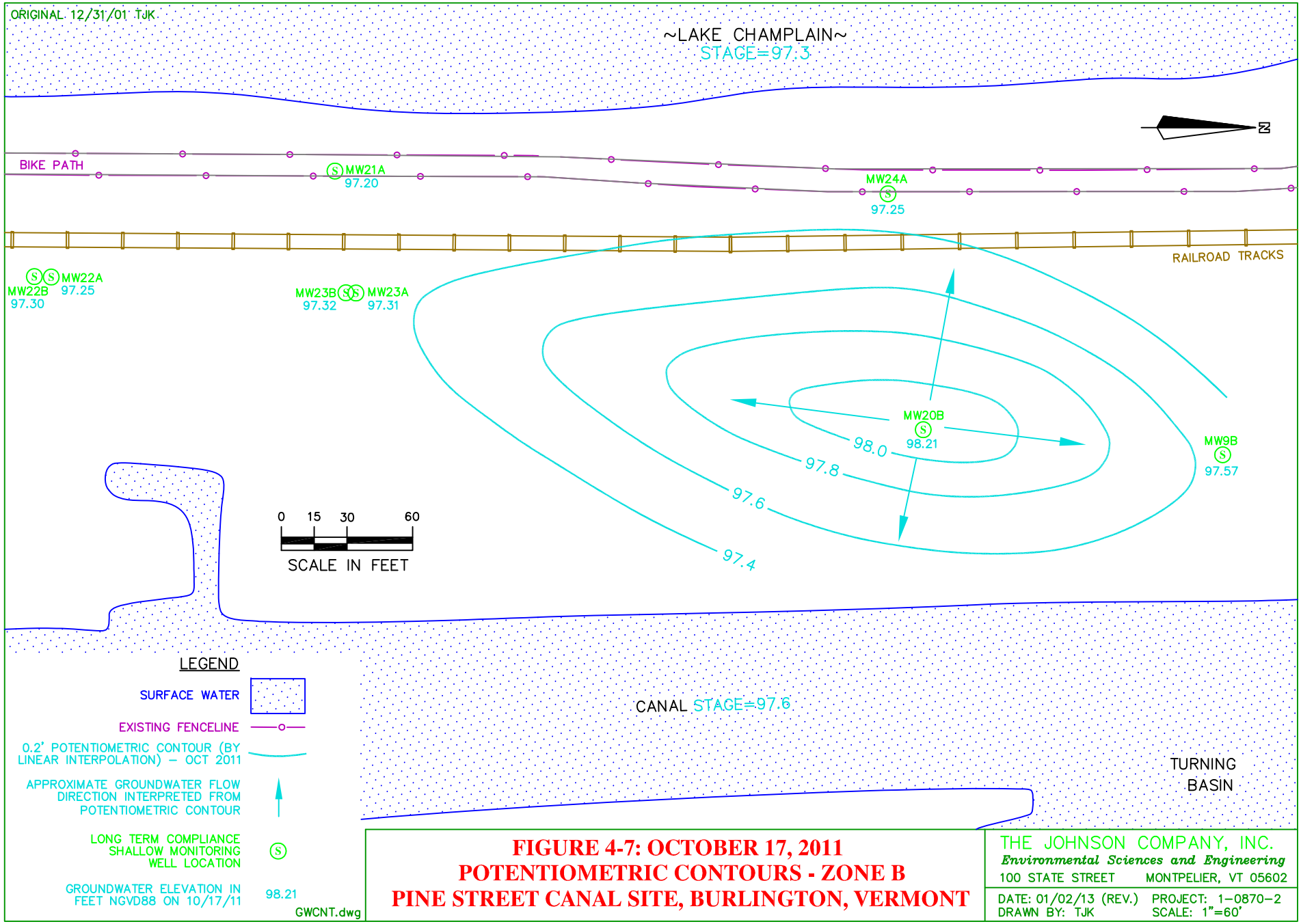


FIGURE 4-7: OCTOBER 17, 2011
POTENTIOMETRIC CONTOURS - ZONE B
PINE STREET CANAL SITE, BURLINGTON, VERMONT

THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

DATE: 01/02/13 (REV.) PROJECT: 1–0870–2
DRAWN BY: TJK SCALE: 1"=60'

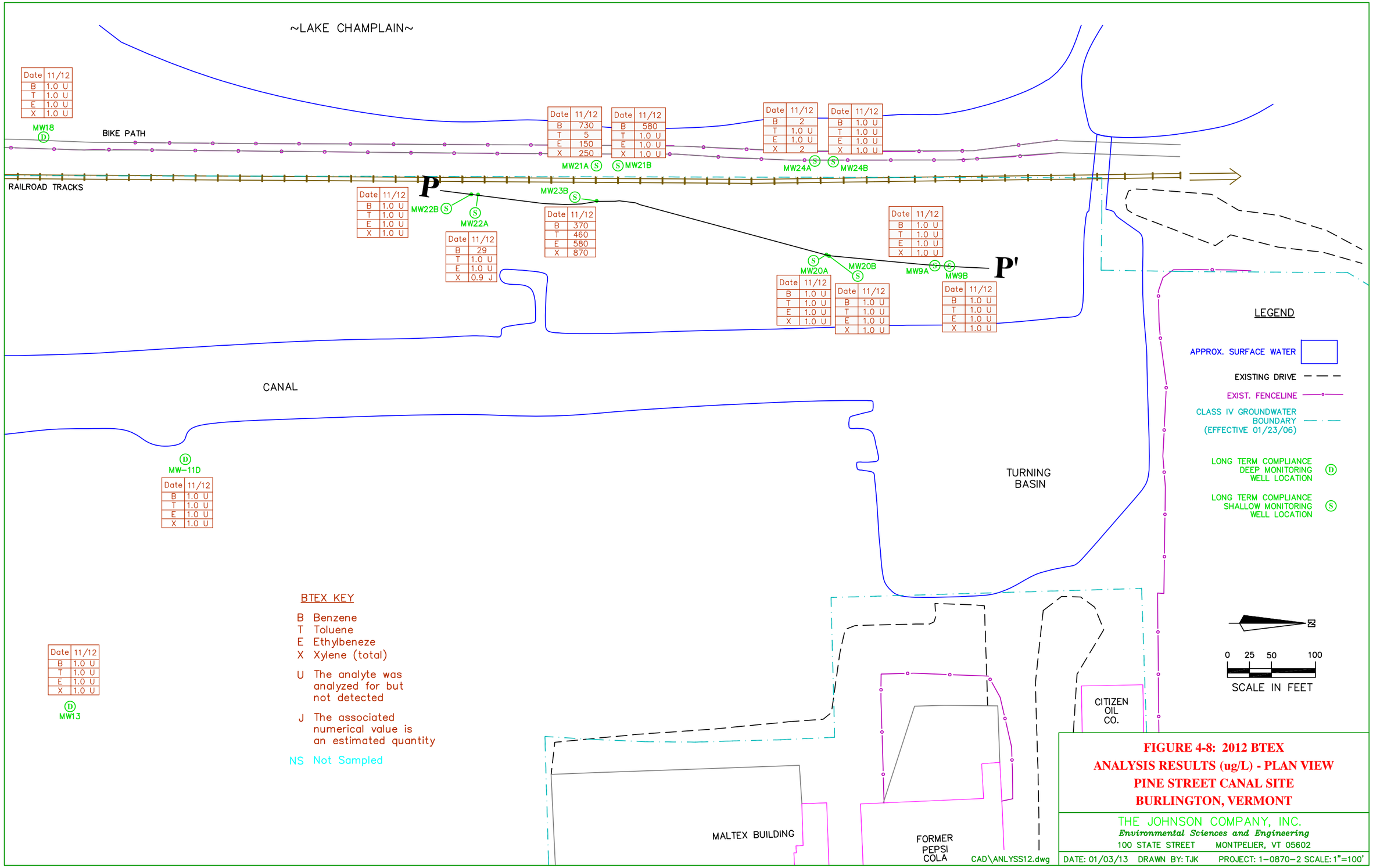
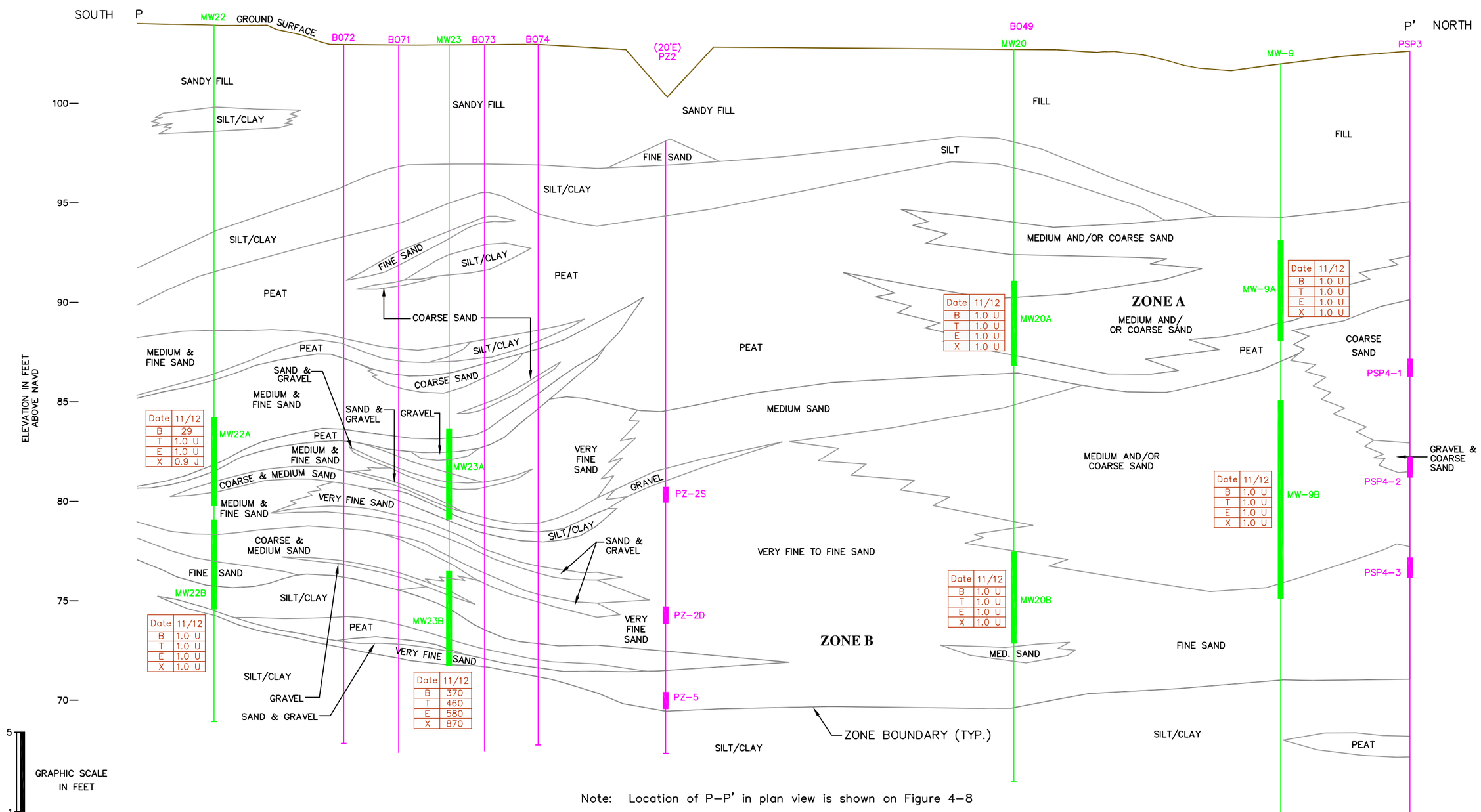


FIGURE 4-8: 2012 BTEX ANALYSIS RESULTS (ug/L) - PLAN VIEW
PINE STREET CANAL SITE
BURLINGTON, VERMONT

THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

DATE: 01/03/13 DRAWN BY: TJK PROJECT: 1-0870-2 SCALE: 1"=100'



Note: Location of P–P' in plan view is shown on Figure 4–8

BTEX KEY

B Benzene
T Toluene
E Ethylbeneze
X Xylene (total)
U The analyte was analyzed for but not detected
J The associated munerical value is an estimated quantity

CROSS SECTION P-P' WEST OF CANAL

SCALE: 1"=50' HOR.; 1"=5' VER.; V.E. = 10:1

1
1

FIGURE 4-9
2012 BTEX ANALYSIS RESULTS (ug/L)
CROSS SECTION P - P'
PINE STREET CANAL SITE, BURLINGTON, VT

THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

GEOP2012.dwg

DATE: 01/18/13 DRAWN BY: TJK PROJECT: 1–0870–2 SCALE: SHOWN

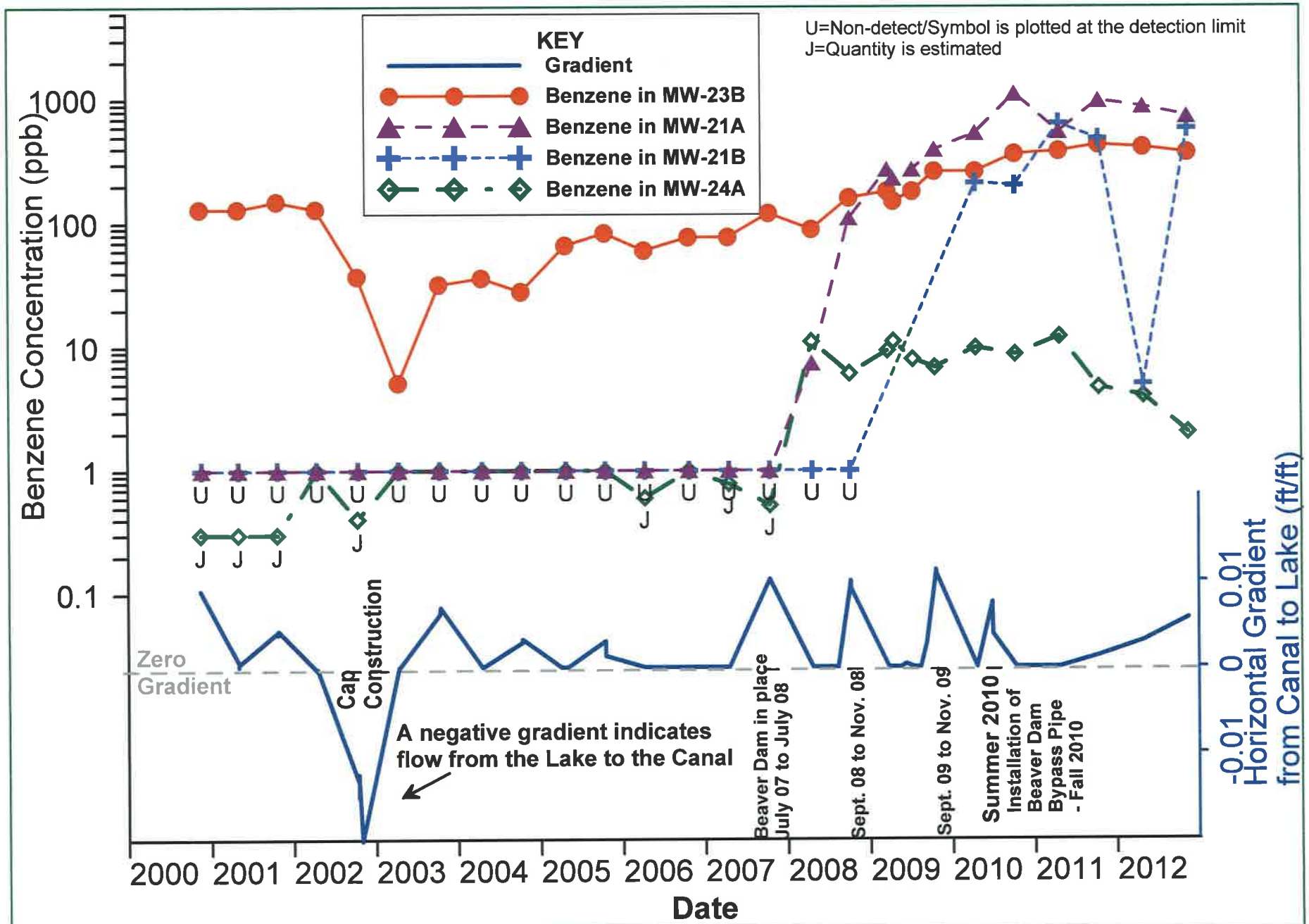
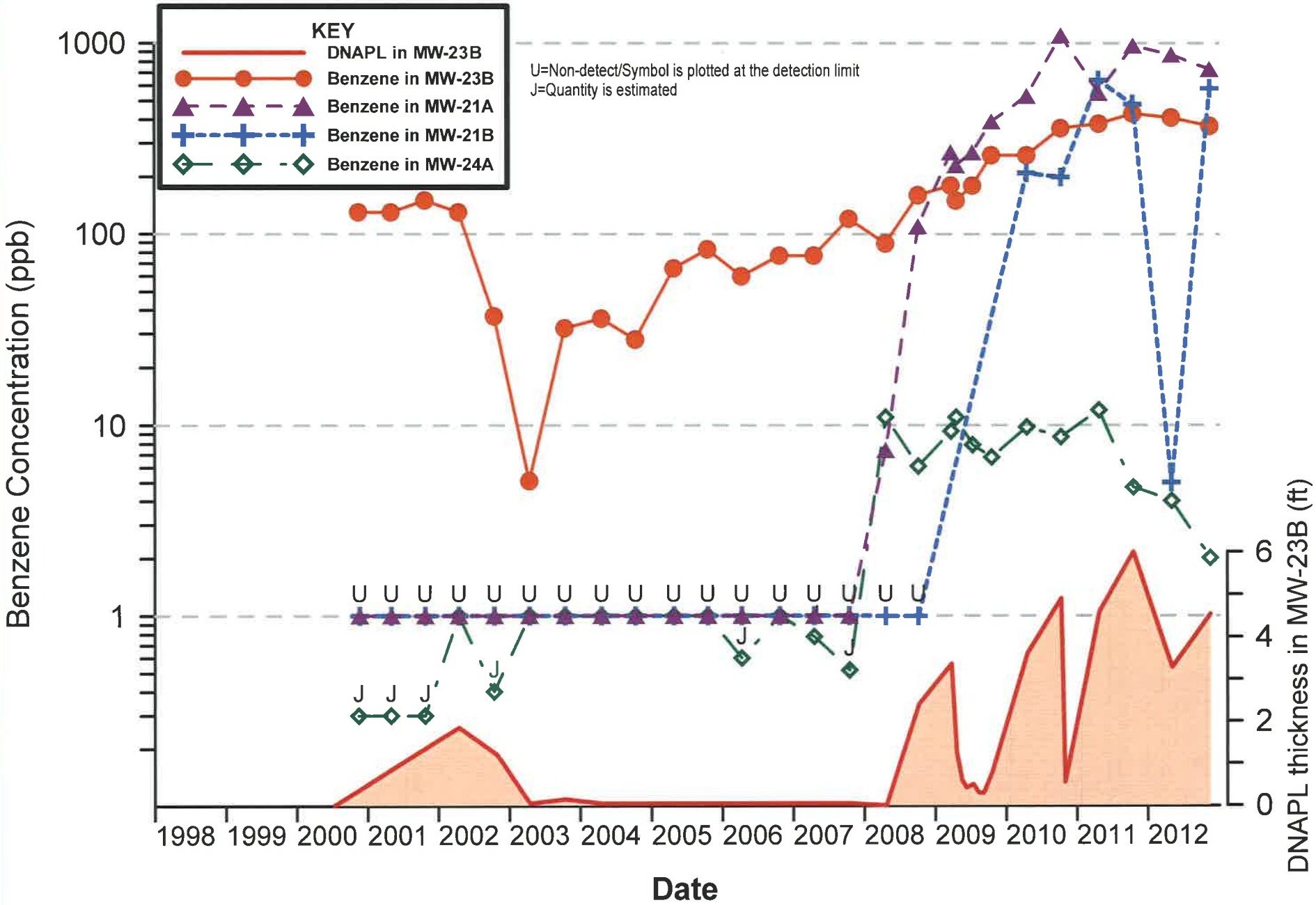


FIGURE 4-10: HISTORICAL BENZENE CONCENTRATIONS AND GRADIENT FROM CANAL TO LAKE PINE STREET CANAL SITE, BURLINGTON, VERMONT

The Johnson Company
100 State Street, Suite 600
Montpelier, VT 05602

Drawn by: CFF Date: 1/04/13
Reviewed by: CMC Date: 1/08/13
Scale: As Shown Project: 1-0870-2

1-0870-2_PostConstruction Compliance_Fall 2012 CMR__
MW-21AB 23B 24A benzene and VG 010413.GRF
WQ-WE-NAPL FOR GRAPHS 010413.xls



1-0870-2_PostConstruction Compliance_Fall 2012 CMR__
MW-21AB 23B 24A benzene-NAPL 010413.GRF
WQ-WE-NAPL FOR GRAPHS 010413.xls

FIGURE 4-11: HISTORICAL BENZENE CONCENTRATIONS AND DNAPL THICKNESS
PINE STREET CANAL SITE, BURLINGTON, VERMONT

The Johnson Company

100 State Street, Suite 600
Montpelier, VT 05602

Drawn by: CFF Date: 1/04/13
Reviewed by: CMC Date: 1/08/13

Scale: As Shown Project: 1-0870-2

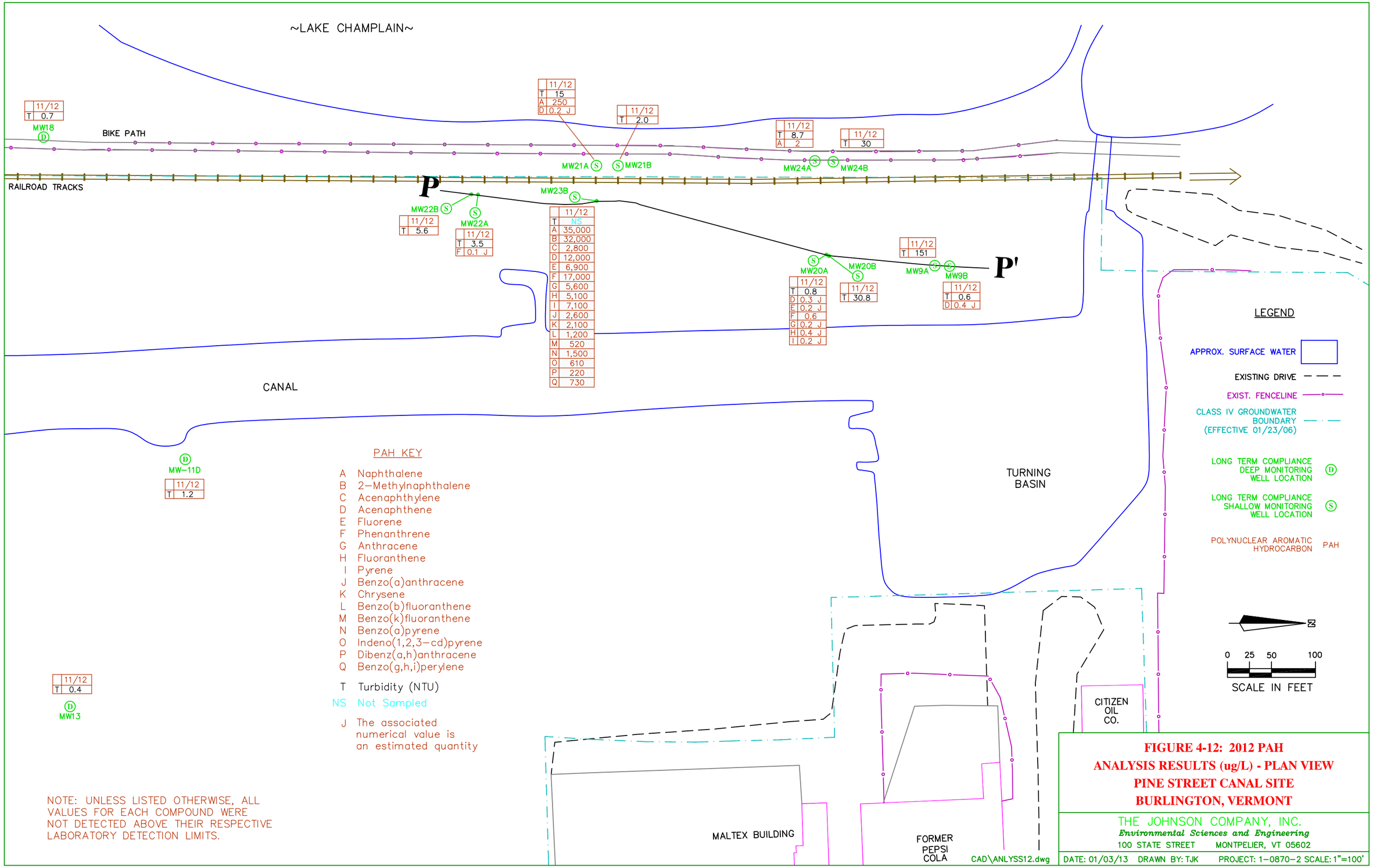
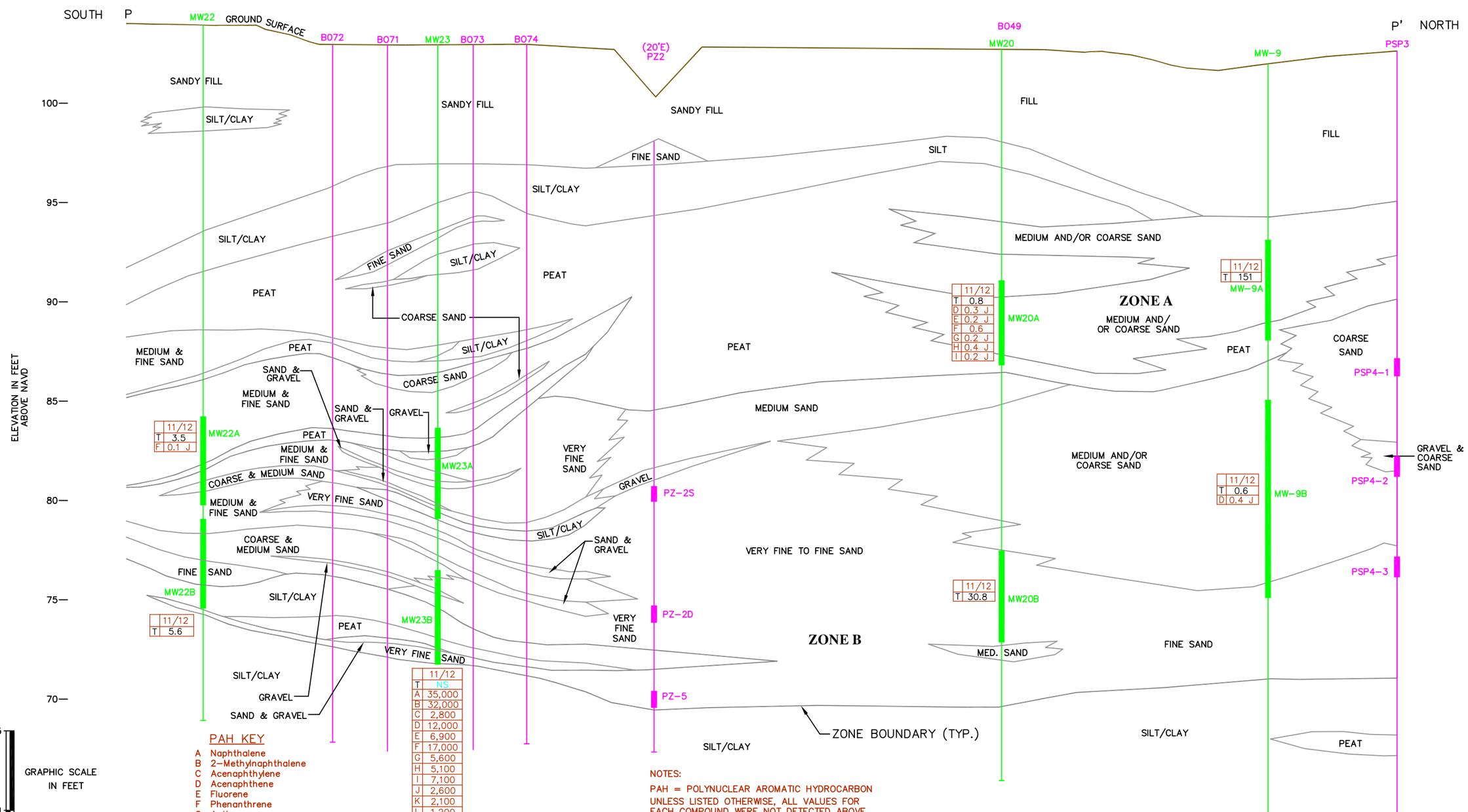


FIGURE 4-12: 2012 PAH ANALYSIS RESULTS (ug/L) - PLAN VIEW
PINE STREET CANAL SITE
BURLINGTON, VERMONT

THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

DATE: 01/03/13 DRAWN BY: TJK PROJECT: 1-0870-2 SCALE: 1"=100'



PAH KEY

A	Naphthalene
B	2-Methylnaphthalene
C	Acenaphthylene
D	Acenaphthene
E	Fluorene
F	Phenanthrene
G	Anthracene
H	Fluoranthene
I	Pyrene
J	Benzo(a)anthracene
K	Chrysene
L	Benzo(b)fluoranthene
M	Benzo(k)fluoranthene
N	Benzo(a)pyrene
O	Indeno(1,2,3-cd)pyrene
P	Dibenz(a,h)anthracene
Q	Benzo(g,h,i)perylene
T	Turbidity (NTU)
NS	Not Sampled
J	The associated munerical value is an estimated quantity

NOTES:

PAH = POLYNUCLEAR AROMATIC HYDROCARBON

UNLESS LISTED OTHERWISE, ALL VALUES FOR EACH COMPOUND WERE NOT DETECTED ABOVE THEIR RESPECTIVE DETECTION LIMITS.

Note: Location of P-P' in plan view is shown on Figure 4-12

CROSS SECTION P-P' WEST OF CANAL

SCALE: 1"=50' HOR.; 1"=5' VER.; V.E. = 10:1

1
1

FIGURE 4-13
2012 PAH ANALYSIS RESULTS (ug/L)
CROSS SECTION P - P'
PINE STREET CANAL SITE, BURLINGTON, VT

THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

GEOP2012.dwg

DATE: 01/03/13 DRAWN BY: TJK PROJECT: 1-0870-2 SCALE: SHOWN

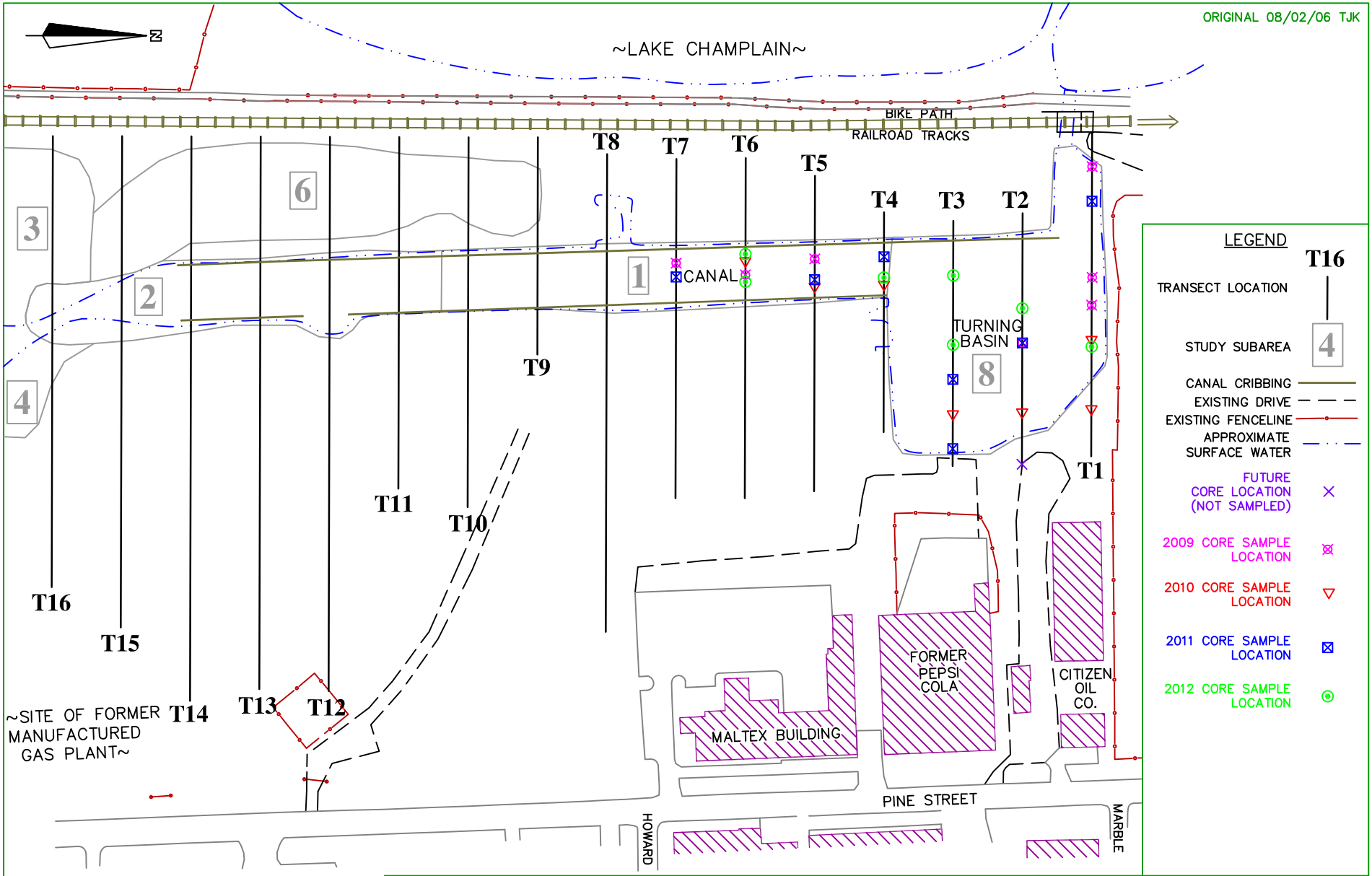
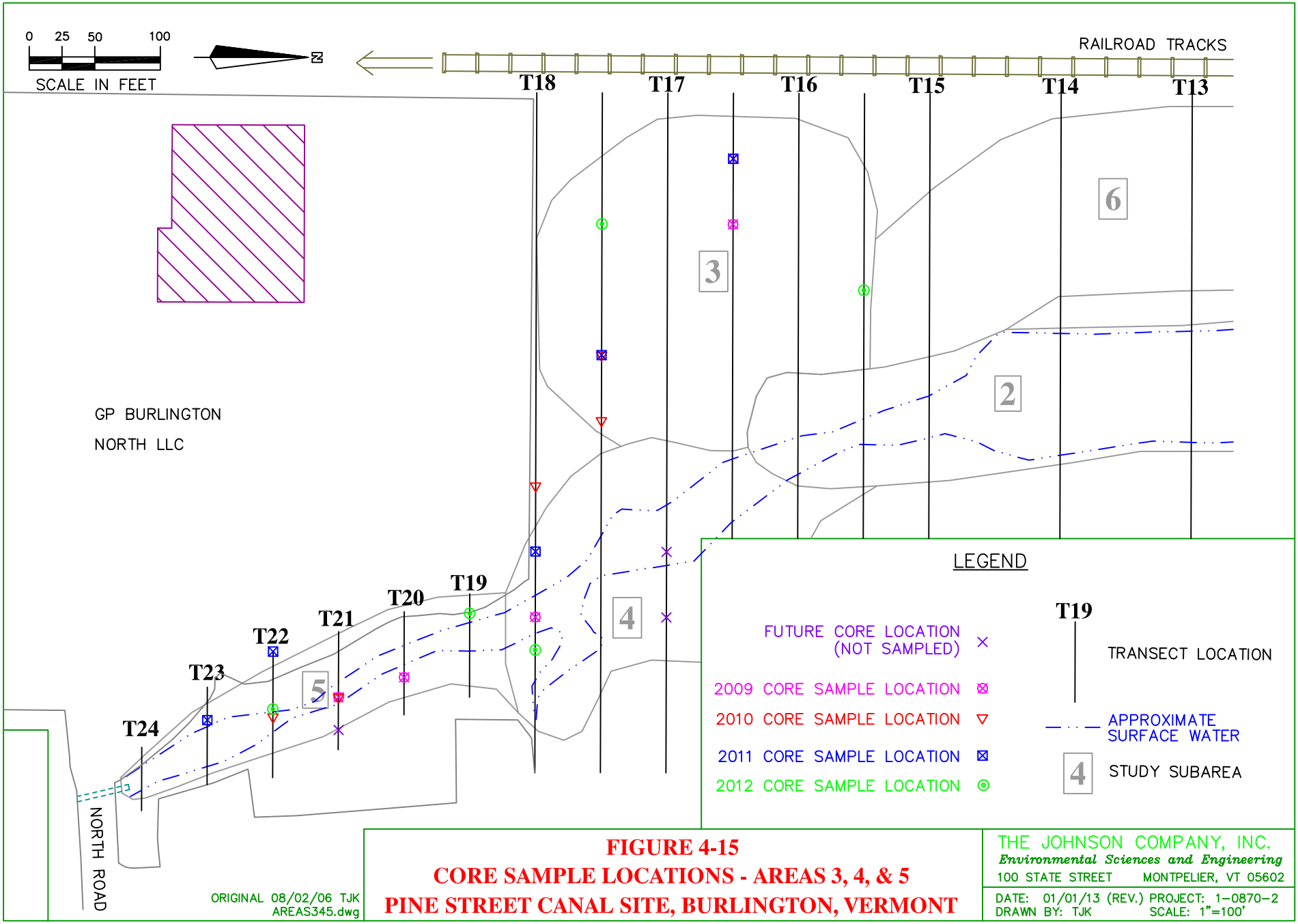


FIGURE 4-14
CORE SAMPLING LOCATIONS - AREAS 1, 2, & 8
PINE STREET CANAL SITE, BURLINGTON, VERMONT

THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

DATE: 01/01/13 (REV.) PROJECT: 1-0870-2
DRAWN BY: TJK SCALE: 1"=200'



ORIGINAL 08/02/06 TJK
AREAS345.dwg

FIGURE 4-15
CORE SAMPLE LOCATIONS - AREAS 3, 4, & 5
PINE STREET CANAL SITE, BURLINGTON, VERMONT

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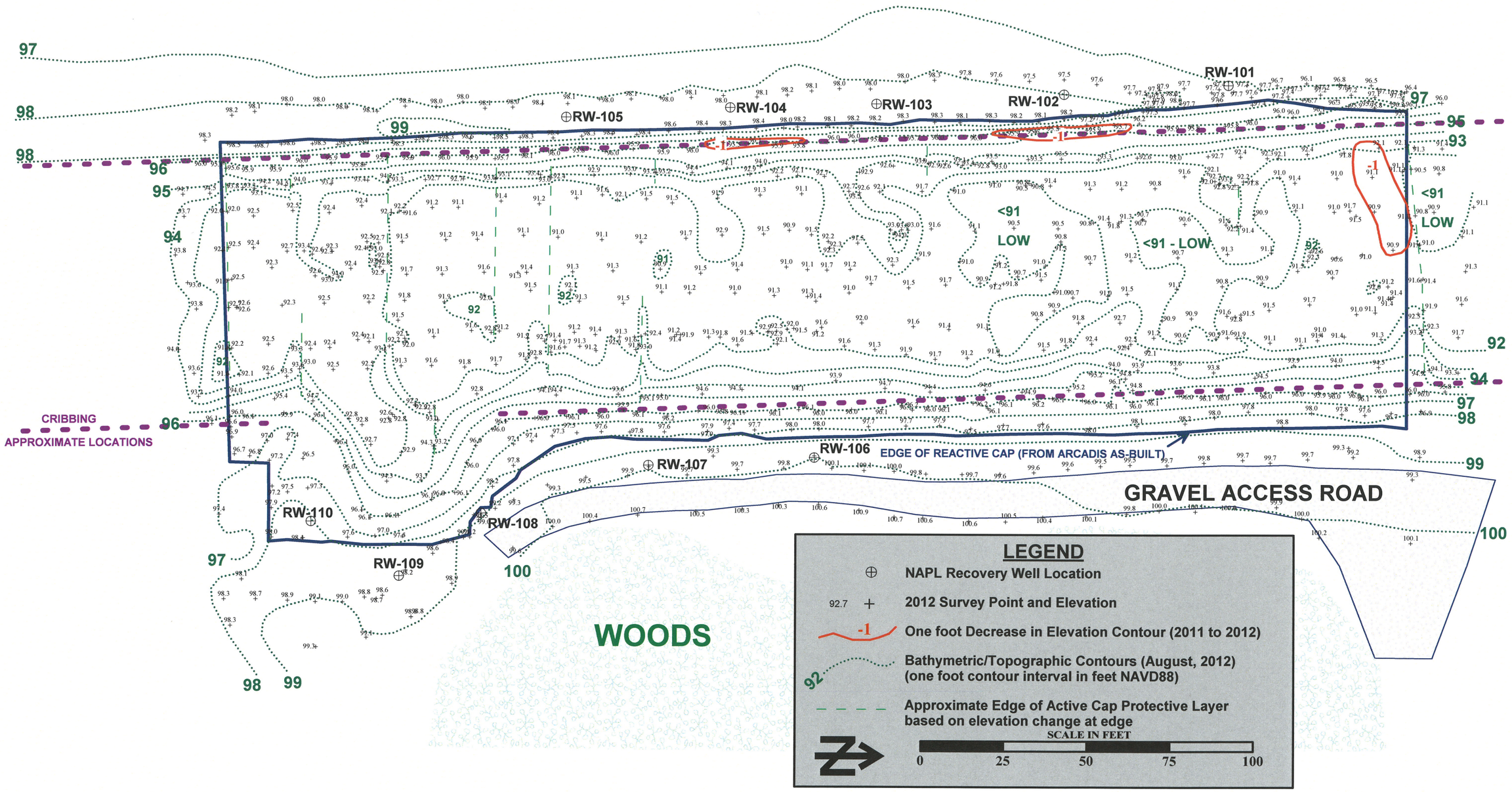
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

DATE: 01/01/13 (REV.) PROJECT: 1-0870-2
DRAWN BY: TJK SCALE: 1"=100'



Elevation Data provided by Little River Survey in feet NAVD88
1-0870-2_bathymetry_2012_011813 FINAL 2012 PSCS Bathymetry.srf LRS Bathymetry data 090412.xls

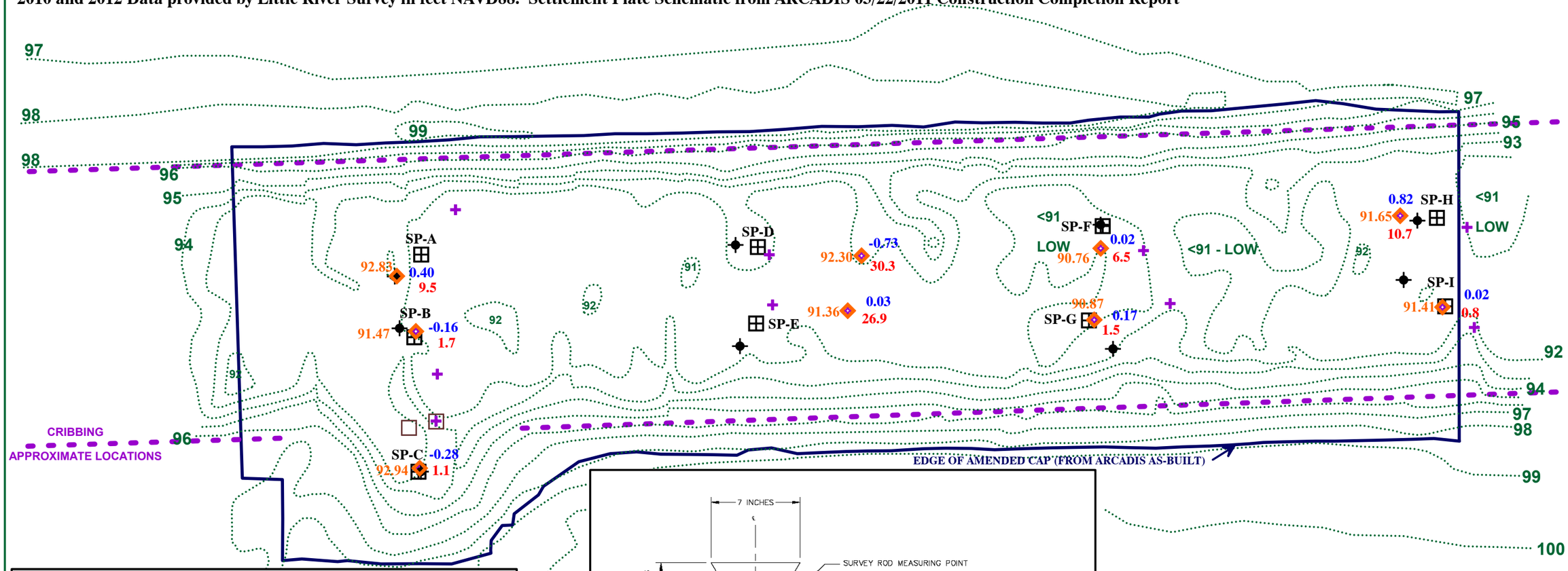
FIGURE 4-16: AUGUST 2012
AMENDED CAP BATHYMETRY
PINE STREET CANAL SUPERFUND SITE
453 PINE ST., BURLINGTON, VERMONT

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

Drawn by: DMM Date: 09/04/2012
Chk'd by: CFF Date: 01/04/2013
Scale: AS SHOWN Project: 1-0870-2 (256)

NOTES:

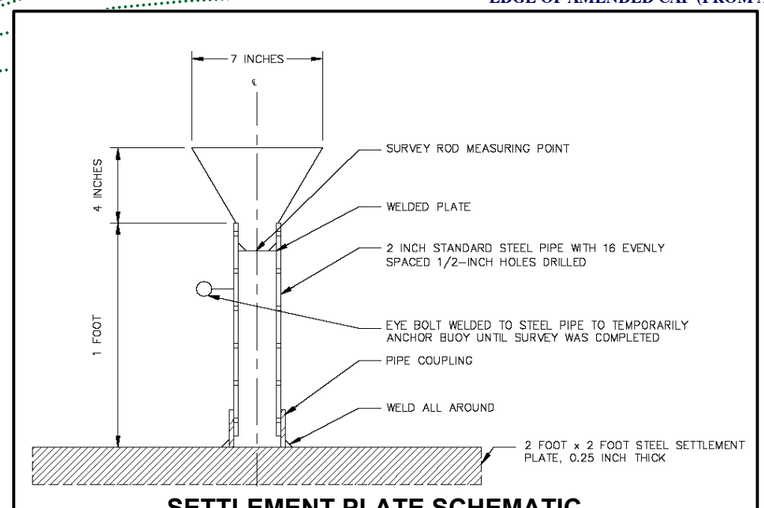
Multiple concrete blocks were found on the cap (based upon feeling them with the survey rod) during the August 2012 survey.
Most of the concrete blocks were located near the western base-of-slope in the Canal. They were also found near the former South Slip and near the north end of the amended cap.
It is likely that some previously reported 2011 and May 2012 surveyed locations of Plates were actually locations of concrete blocks.
The settlement plates are 2-foot square aluminum plates that include an inverted cone on top of a 1-foot long pipe to assist surveying. The difference in elevation between the cone/pipe and the plate itself is 1.1 feet.
The 2011 and 2012 surveys were completed by surveying the plate itself. Although considerable effort was made to place the survey rod in the center of the plates, the precise location of the survey rod on the plate is uncertain.
Therefore, a potential horizontal error of +/- two feet exists for each plate in each survey.
2010 and 2012 Data provided by Little River Survey in feet NAVD88. Settlement Plate Schematic from ARCADIS 03/22/2011 Construction Completion Report



LEGEND

- December 2010 Plate Location
- Reported November 2011 Plate Location
- Reported May 2012 Plate Location
- 92.70 / -0.35 / 10.2 — Reported August 2012 Plate Location and Elevation; Elevation Change December 2010 to August 2012; Lateral Distance Moved December 2010 to August 2012
- Inferred Concrete Block Location (based upon feel of survey rod)
- 92 — Bathymetric/Topographic Contours (August 2012) (one foot contour interval in feet NAVD88)

SCALE IN FEET: 0 25 50 75 100



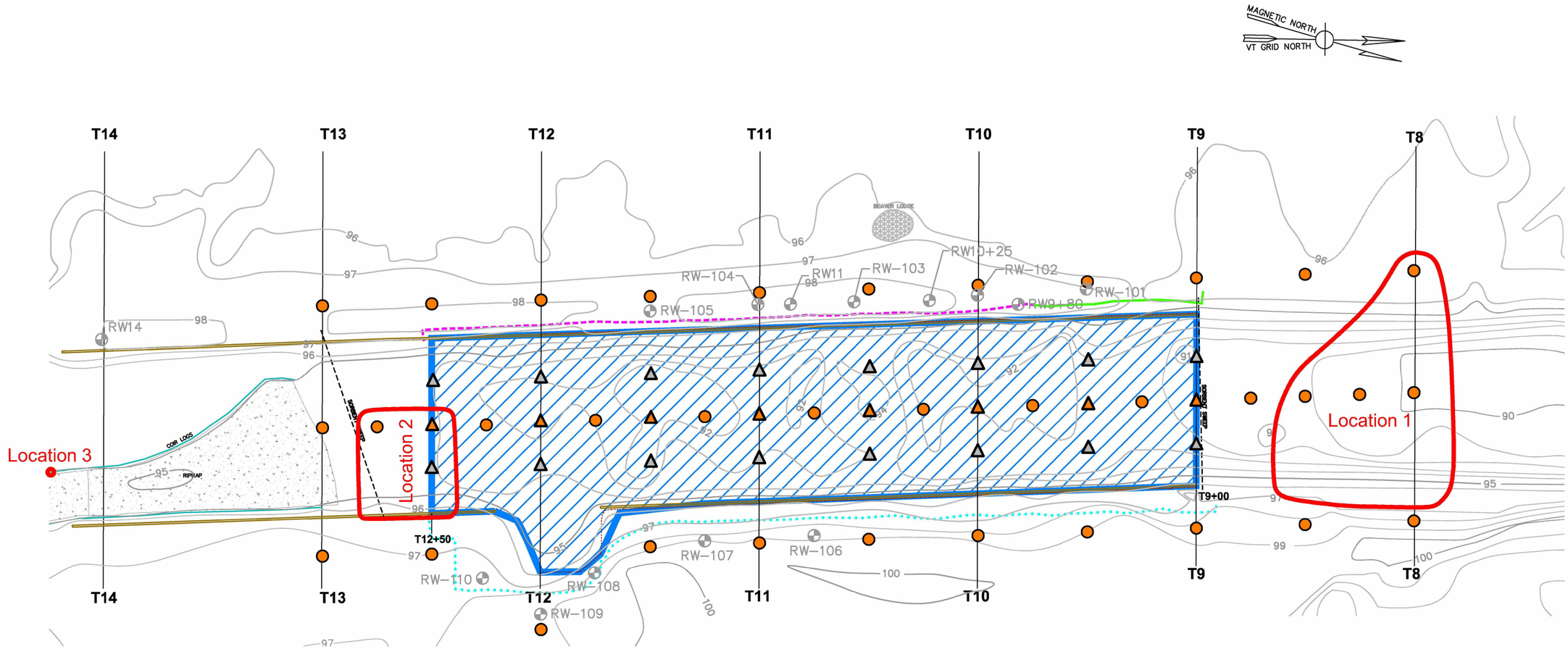
SETTLEMENT PLATE SCHEMATIC

1-0870-2_2011-12 settlement plates_
083012 PSCS SETTLEMENT PLATE SURVEY 011813.srf
Settlement Plate Locs 2010-2011-5+8-2012 091712.xlsx

FIGURE 4-17
AUGUST 2012 SETTLEMENT PLATE SURVEY
PINE STREET CANAL SUPERFUND SITE
453 PINE ST., BURLINGTON, VERMONT

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

Drawn by: DMM Date: 09/17/12
Chk'd by: CFF Date: 01/04/13
Scale: AS SHOWN Project: 1-0870-2 (256)



LEGEND:

- EXTENT OF AMENDED CAP
- VISUAL SHEEN MONITORING LOCATION
- RW-109 NAPL RECOVERY WELLS
- CAP NAPL PROBING LOCATION *
- VISUAL SHEEN MONITORING AND CAP NAPL PROBING LOCATION
- APPROXIMATE WEST BANK AMENDED CAP TERMINATION
- APPROXIMATE WEST BANK SUBMERGED AMENDED CAP TERMINATION
- APPROXIMATE EAST BANK AMENDED CAP TERMINATION
- NAPL SEEPAGE LOCATION OBSERVED IN 2012

* NOTE: CAP NAPL PROBING WAS NOT PERFORMED DURING THIS MONITORING EVENT.

GRAPHIC SCALE

25 0 25 50 100

(IN FEET)

BASE MAP BY:

ARCADIS

NOTES:

1. BATHYMETRIC SURVEY DATA BY THE JOHNSON COMPANY, INC. – 2005.
2. VISUAL SHEEN MONITORING INCLUDES MONITORING FOR NAPL SEEPS, SHEEN, DROPLETS AND GANGLIA.
3. VISUAL CAP INSPECTION WILL BE CONDUCTED ON EACH BANK OF THE CANAL FROM TRANSECT T9+00 TO T12+50.
4. THE EXTENT OF AMENDED CAP IS SHOWN FOR THE AREA IN THE CANAL. THE GEOCOMPOSITE, RCMS, AND TRM EXTEND BEYOND THE CRIBBING AND TERMINATE ON THE BANKS.
5. LOCATION OF AMENDED CAP TERMINATION ON WEST BANK REPRESENTS THE EAST SIDE OF THE ANCHOR TRENCH (i.e. extent of exposed amended cap layers).
6. LOCATION OF AMENDED CAP TERMINATION ON EAST BANK REPRESENTS THE EXTENT OF THE TRM (TOP LAYER OF AMENDED CAP). THE TRM EXTENDS A MINIMUM OF 1 FOOT BEYOND THE EXTENT OF THE RCM LAYER. THE RCM LAYER EXTENDED BEYOND THE CRIBBING BASED ON FIELD VERIFICATION.

DRAFT

K:\1-0870-3\CAD\NAPL Inspection.dwg

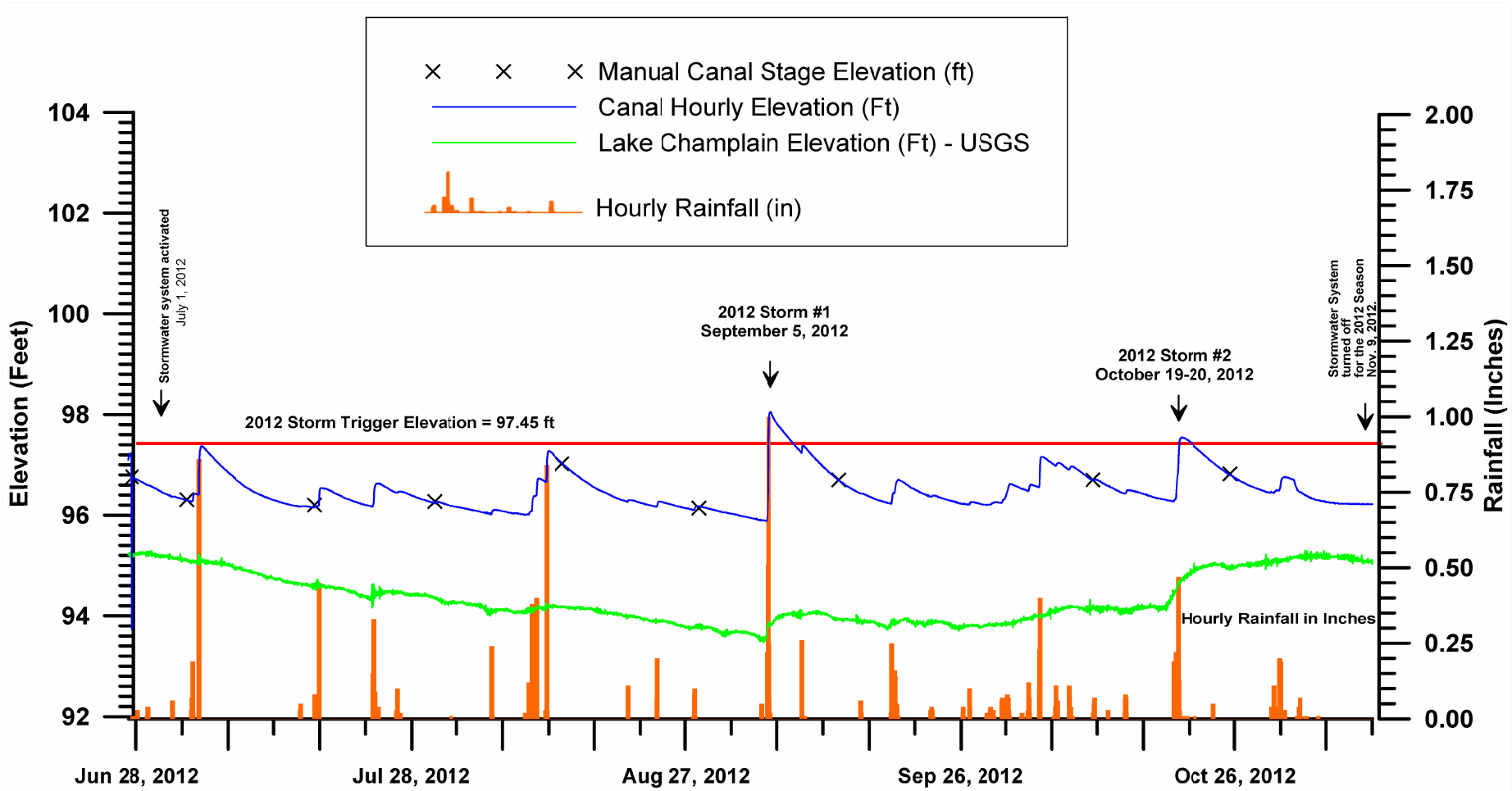
The Johnson Company

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

Drawn by: TJK Date: 01/09/13
Chk'd by: CFF Date: 01/09/13
Scale: As Shown Project: 1-0870-3

FIGURE 4-18

NAPL SEEPAGE MONITORING LOCATIONS
APRIL - NOVEMBER 2012
PINE STREET CANAL SITE
BURLINGTON, VERMONT



[1] Lake Champlain stage data retrieved from USGS Gaging Stn #4294500 (Burlington) and adjusted to 1988 NGVD

FIGURE 4-19: 2012 STORMWATER MONITORING DATA
PINE STREET CANAL SITE
BURLINGTON, VERMONT

STORMH2O.dwg

THE JOHNSON COMPANY, INC.
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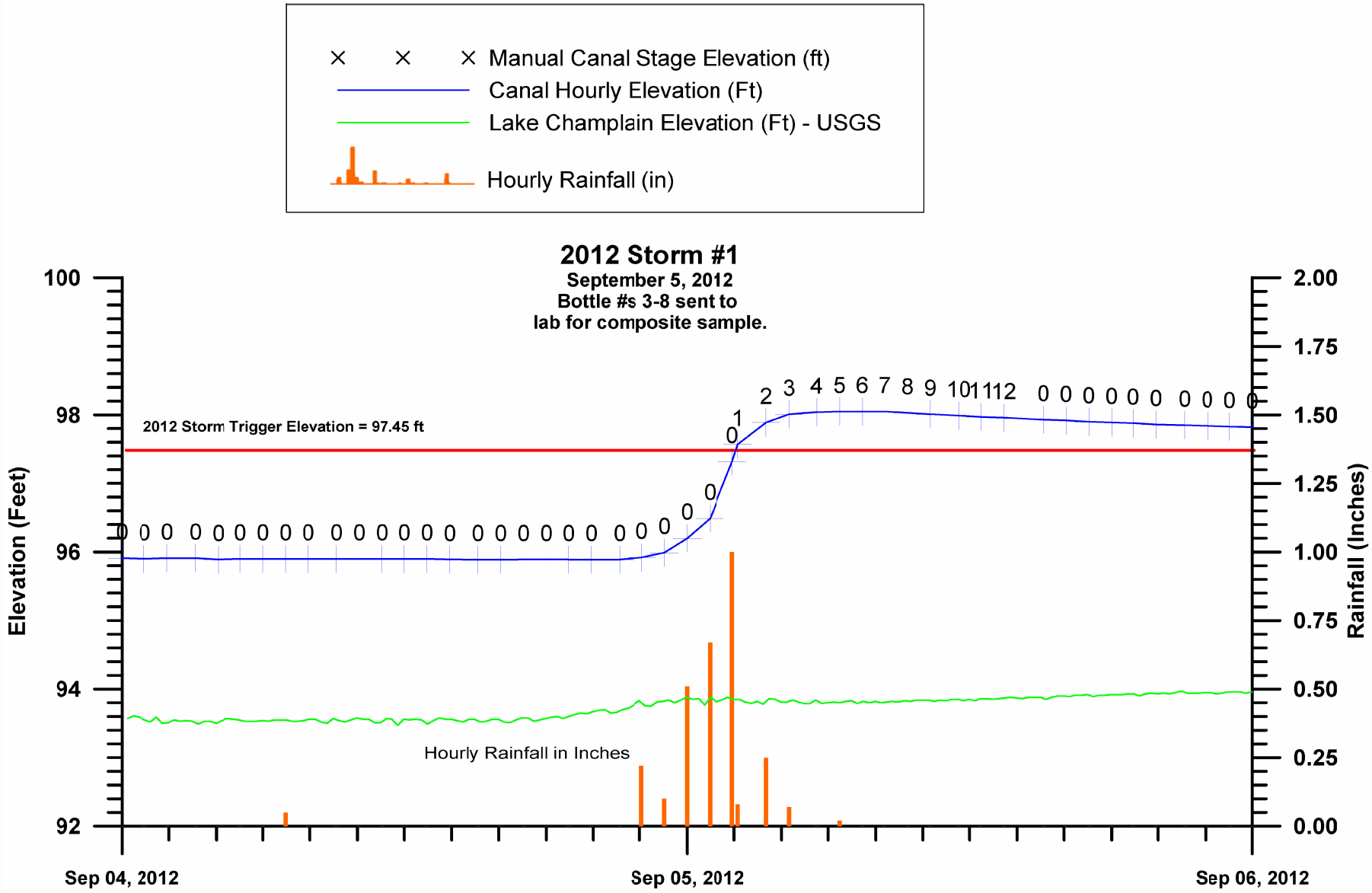
100 STATE STREET MONTPELIER, VT 05602

DATE: 01/09/13 PROJECT: 1-0870-2
DRAWN BY: TJK SCALE: AS SHOWN



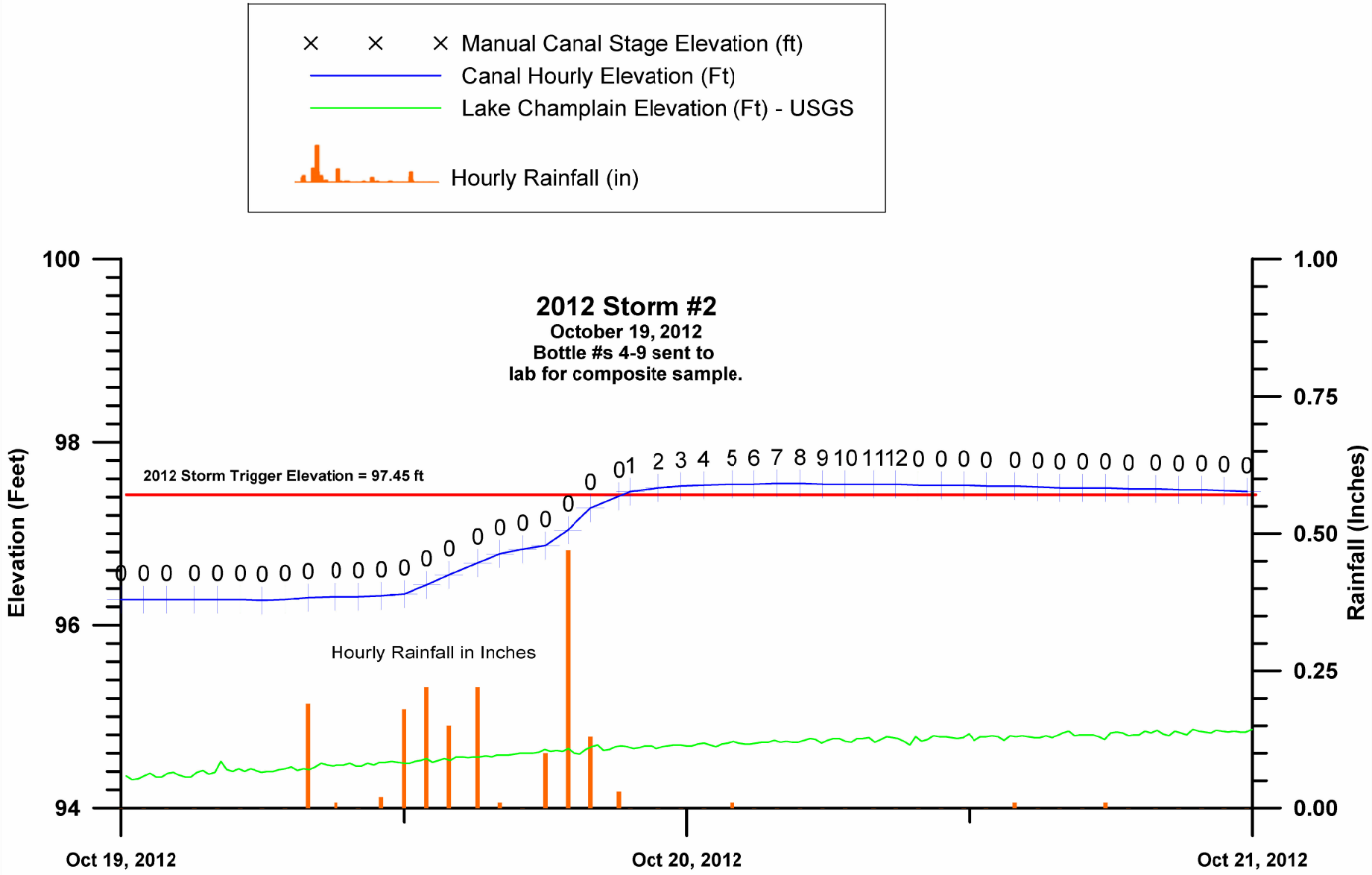
[1] Lake Champlain stage data retrieved from USGS Gaging Stn #4294500 (Burlington) and adjusted to 1988 NGVD

STORMH2O.dwg

FIGURE 4-20: 2012 STORMWATER SAMPLE EVENT #1
PINE STREET CANAL SITE
BURLINGTON, VERMONT

THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

DATE: 01/09/13 PROJECT: 1-0870-2
DRAWN BY: TJK SCALE: AS SHOWN



[1] Lake Champlain stage data retrieved from USGS Gaging Stn #4294500 (Burlington) and adjusted to 1988 NGVD

STORMH2O.dwg

FIGURE 4-21: 2012 STORMWATER SAMPLE EVENT #2
PINE STREET CANAL SITE
BURLINGTON, VERMONT

THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

DATE: 01/09/13 PROJECT: 1-0870-2
DRAWN BY: TJK SCALE: AS SHOWN