COMPLIANCE MONITORING REPORT

Fall 2011

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 2011 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 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 as well as dredging portions of the previously installed cap and installation of a new amended cap in the vicinity of T9 to T14. 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) (see Section 2.6) as well as the Operation, Maintenance and Monitoring Plan (OMMP) for the amended cap which was conditionally approved on October 28, 2011. The CMWP includes the Field Sampling Plan (FSP), Quality Assurance Project Plan (QAPP), and all Site-specific methods referenced in this report.

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 June to November 2011. The monitoring performed during this period includes the fall 2011 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; and sediment transport monitoring. Stormwater inflow monitoring (Sediment Traps), which in the past has been included in the Fall CMR, is no longer required in the CMWP.

As required in the CMWP, all field notes and forms generated during sample collection and monitoring are included in this report (Appendix 1). Also included are: a summary of potentiometric data (Appendix 2); chains-of-custody (Appendix 3); lake and climate data (Appendix 4); a summary of all analytical and field data (Appendix 5); data validation reports prepared by an Independent Data Validator (IDV) and QA/QC correspondence and documentation (Appendix 6); laboratory-supplied data packages (Appendix 7); a report of the recovery well RW-109 pump test study and NAPL monitoring and removal (Appendix 8); and data and summaries of the amended cap bathymetric and settlement plates surveys (Appendices 9 and 10, respectively).

2.0 FIELD SAMPLING/MONITORING ACTIVITIES

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

- <u>Groundwater Monitoring</u>
  - 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

- <u>NAPL Monitoring and Recovery</u>
  - NAPL pumping and recovery testing in RW-109
  - 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

- <u>Surface Water Monitoring</u>
  - 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

- 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 2011

Location	Description	NAPL Measurement Performed	Sampled for Laboratory Analysis	Water Level Measurements Completed	Visual Field Evaluations
Groundwater Monitoring					
MW-20A	Shallow well	NM	10/17/11	10/17/11	N/A
MW-20B	Shallow well	NM	10/17/11	10/17/11	N/A
MW-21A	Shallow well	10/19/11	10/18/11	10/17/11, 10/18/11	N/A
MW-21B	Shallow well	10/19/11	10/18/11	10/17/11, 10/18/11	N/A
MW-22A	Shallow well	NM	10/18/11	10/17/11, 10/18/11	N/A
MW-22B	Shallow well	NM	10/18/11	10/17/11, 10/18/11	N/A
MW-23A	Shallow well	10/19/11	NS	10/17/11, 10/19/11	N/A
MW-23B	Shallow well	10/18-20/11	10/18/11	10/17-20/11	N/A
MW-24A	Shallow well	10/19/11	10/18/11	10/17-19/11	N/A
MW-24B	Shallow well	10/19/11	10/18/11	10/17-19/11	N/A
MW-9A	Shallow well	NM	10/17/11	10/17/11	N/A
MW-9B	Shallow well	NM	10/17/11	10/17/11	N/A
MW-1B	Deep well	10/20/11	NS	10/20/11	N/A

TABLE 2-1
COMPLIANCE MONITORING ACTIVITIES – SUMMER AND FALL 2011

Location	Description	NAPL Measurement Performed	Sampled for Laboratory Analysis	Water Level Measurements Completed	Visual Field Evaluations
MW-3C	Deep well	10/20/11	NS	10/20/11	N/A
MW-4B	Deep well	10/20/11	NS	10/20/11	N/A
MW-8A	Deep well	10/20/11	NS	10/20/11	N/A
MW-11D	Deep well	NM	10/19/11	10/17/11, 10/19/11	N/A
MW-12	Deep well	10/20/11	NS	10/20/11	N/A
MW-13	Deep well	NM	10/19/11	10/17/11, 10/19/11	N/A
MW-17	Shallow well	10/18/11	NS	10/18/11	N/A
MW-18	Deep well	NM	10/18/11	10/17-18/11	N/A
MW-19	Deep well	10/19/11	NS	10/19/11	N/A
P-106	Deep well	10/18/11	NS	10/18/11	N/A
WE 89-5S	Gilbane shallow well	NM	NS	10/17/11	N/A
WE 89-6S	Gilbane shallow well	NM	NS	10/17/11	N/A
WE 89-7S	Gilbane shallow well	NM	NS	10/17/11	N/A
FLA-1	Gilbane shallow well	NM	NS	10/17/11	N/A
FLA-4	Gilbane shallow well	NM	NS	10/17/11	N/A
NAPL Monitoring and Recovery					
RW-101	NAPL Recovery Well	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	NS	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	N/A
RW-102	NAPL Recovery Well	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	NS	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	N/A
RW-103	NAPL Recovery Well	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	NS	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	N/A

TABLE 2-1
COMPLIANCE MONITORING ACTIVITIES – SUMMER AND FALL 2011

Location	Description	NAPL Measurement Performed	Sampled for Laboratory Analysis	Water Level Measurements Completed	Visual Field Evaluations
RW-104	NAPL Recovery Well	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	NS	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	N/A
RW-105	NAPL Recovery Well	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	NS	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	N/A
RW-106	NAPL Recovery Well	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	NS	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	N/A
RW-107	NAPL Recovery Well	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	NS	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	N/A
RW-108	NAPL Recovery Well	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	NS	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	N/A
RW-109	NAPL Recovery Well	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	NS	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	N/A
RW-110	NAPL Recovery Well	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	NS	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	N/A
RW-T9+80	NAPL Recovery Well	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	NS	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	N/A
RW-T10+25	NAPL Recovery Well	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	NS	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	N/A
RW-T11+00	NAPL Recovery Well	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	NS	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	N/A
RW-T14+00	NAPL Recovery Well	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	NS	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	N/A

TABLE 2-1
COMPLIANCE MONITORING ACTIVITIES – SUMMER AND FALL 2011

Location	Description	NAPL Measurement Performed	Sampled for Laboratory Analysis	Water Level Measurements Completed	Visual Field Evaluations
MW-11C	Shallow Well	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	NS	8/30/11, 9/7-9/11, 9/21-23/11, 10/4-7/11, 10/20-21/11, 11/3-4/11, 11/17-18/11	N/A
Surface Water Monitoring					
Outlet to Lake T1+50W80	Surface Water	N/A	8/22/11	N/A	N/A
Cap Monitoring					
Area 1: T4+00E20	Cap coring location	N/A	8/23/11	N/A	8/23/11
Area 1: T5+00E60	Cap coring location	N/A	8/23/11	N/A	8/23/11
Area 1: T7+00E40	Cap coring location	N/A	8/24/11	N/A	8/24/11
Area 3: T16+50E50	Cap coring location	N/A	8/22/11	N/A	8/22/11
Area 3: T17+50E200	Cap coring location	N/A	8/22/11	N/A	8/22/11
Area 4/5: T18+00E350	Cap coring location	N/A	8/24/11	N/A	8/24/11
Area 4/5: T22+00E25	Cap coring location	N/A	8/24/11	N/A	8/24/11
Area 4/5: T23+00E50	Cap coring location	N/A	8/24/11	N/A	8/24/11
Area 8: T1+00E100	Cap coring location	N/A	8/23/11	N/A	8/23/11
Area 8: T2+00E150	Cap coring location	N/A	8/23/11	N/A	8/23/11
Area 8: T3+00E200	Cap coring location	N/A	8/24/11	N/A	8/24/11
Area 8: T3+00E250	Cap coring location	N/A	8/24/11	N/A	8/24/11

TABLE 2-1
COMPLIANCE MONITORING ACTIVITIES – SUMMER AND FALL 2011

Location	Description	NAPL Measurement Performed	Sampled for Laboratory Analysis	Water Level Measurements Completed	Visual Field Evaluations
Biological Monitoring					
Area 8: T2+00E150	Benthic macroinvertebrate, TOC, AVS/SEM, and grain size sampling	N/A	8/23/11	N/A	8/23/11
Area 1: T5+00E60	Benthic macroinvertebrate, TOC, AVS/SEM, and grain size sampling	N/A	8/23/11	N/A	8/23/11
Area 4/5: T22+00E25	Benthic macroinvertebrate, TOC, AVS/SEM, and grain size sampling	N/A	8/24/11	N/A	8/24/11
Outlet Weir					
Outlet to Lake Champlain	Visual inspection for integrity and elevation survey	N/A	N/A	N/A	9/22/11
Sediment Transport Monitoring					
Outlet to Lake	Automated stage recording and stormwater sampling	N/A	NS	July to October 2011	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 between October 17 - 20, 2011, 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 daily at the outlet weir during the Fall 2011 groundwater, cap, and biological monitoring events, and 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 Field Groundwater Data in Appendix 5.

Lake Champlain stage data for the period of groundwater level measurements were downloaded from the USGS web page for Station 09294500 at the King Street Ferry Dock in Burlington, Vermont, and the data are included in Appendix 4. The Lake stage data obtained from USGS are provided in reference to the 1929 North American Vertical Datum (NAVD) 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 National Geodetic Vertical Datum (NGVD88). According to the Vermont Department of Transportation (VTDOT, 2001), the adjustment factor between the 1929 and 1988 datums 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 October 17 – 19, 2011 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 TestAmerica, Inc., formerly Severn Trent Laboratories (STL), of South Burlington, Vermont. 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 October 19-20, 2011, 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 foot 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. NAPL recovery in wells where NAPL was removed was monitored using a rigid steel measuring tape approximately 60 minutes following NAPL removal. All recovered NAPL and associated PPE and disposable sampling equipment were stored onsite in drums for eventual transport offsite 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 2011 are shown on Figure 2-2.

2.1.4 NAPL Monitoring/Removal – NAPL Recovery Wells

Additional NAPL monitoring and removal activities were performed from October 4-7, 2011 (the RW-109 Pump Test Study and NAPL Monitoring/Removal) in accordance with the OMMP. For this study, on each of the four days the thickness of DNAPL and groundwater levels were measured in wells RW-108, RW-109, RW-110, and MW-11C. A gasoline powered suction pump was used to pump DNAPL from RW-109 until approximately less than 10% of the fluid extracted contained NAPL based on visual observation. Depth to water and DNAPL thickness measurements in the four wells were monitored during NAPL removal from MW-109 at a frequency of approximately once every five minutes. The water level and accumulation of NAPL in each well was also measured at approximately 15 minutes, 30 minutes, 1 hour, 2 hours, 4 hours, and 6 hours following NAPL removal from RW-109. This procedure was repeated each day from October 4 through 7, 2011.

Bi-weekly NAPL monitoring, removal and recovery was also performed from August 30 through November 18, 2011 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 an interface probe and decontaminated steel measuring tape. If DNAPL thickness was observed greater than 0.1 foot in any of the wells, it was removed using procedures similar to those described above for the RW-109 Pump Test Study, and NAPL recovery was measured once or twice later the same day. If the initial DNAPL thickness was greater than 2.5 feet, the DNAPL thickness was measured again the next day. If the DNAPL thickness was again greater than 2.5 feet on the second day, the DNAPL process was repeated. This cycle was repeated on the third day if necessary.

Results of the RW-109 Pump Test Study and bi-weekly NAPL monitoring, removal and recovery activities are summarized in Section 4.1.4, and a summary report presenting the results is included in Appendix 8. 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 (see Figure 2-4). Surface water samples for chemical analyses were collected from the Turning Basin outlet up-stream from the railroad bridge on August 22, 2011. 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 2011 sampling event. Approximately 0.16 inches of rain was registered at Burlington Airport on August 21, 2011.

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 TestAmerica (formerly Severn Trent Laboratory) of South Burlington, Vermont 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 and Grain Size

Coring of the constructed caps in Areas 1, 3, 8, and in the non-capped Area 4/5 was conducted between August 22 and 24, 2011. 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 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 E100
J_T2+00 E150
J_T3+00 E200
J_T3+00 E300

<u>Area 1 (northern Canal)</u>
J_T4+00 E20
J_T5+00 E60
J_T7+00 E40

<u>Area 3 (wetlands cap)</u>
J_T16+50 E50
J_T17+50 E200

<u>Area 4/5 (non-capped wetlands & tributary area)</u>
J_T18+00 E350

J_T22+00 E25
J_T23+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 22 and 24, 2011.

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 Katahdin Laboratories in Scarborough, Maine. The samples were analyzed by Katahdin for: SVOCs (16 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). 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. Core recovery was generally from 40-80% of the total penetration depth. Each core was advanced through the entire cap thickness, and a minimum of two replicate cores were collected from each location. Recovery was sufficient (minimum of 33%, and generally greater than 50% of the cap thickness) 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*.

2.3.2 Amended Cap Bathymetric Survey

In accordance with the OMMP, a bathymetric survey was conducted in the vicinity of the Amended Cap in September, 2011. The survey accuracy was +/-0.1 foot both horizontally and vertically and the data presented relative to the historic 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 9.

2.3.3 Amended Cap Settlement Plate Survey

On November 22, 2011 The Johnson Company performed a survey of the nine settlement plates installed on the amended cap by ARCADIS in 2010. 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 an autolevel with +/- 0.1 foot vertical accuracy using the NAVD88 datum. Previously surveyed top-of-casing elevations of wells RW-6 and RW-8 were used for vertical control. Location measurements were performed using a transit and level. 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 4.3.3.

2.4 BIOLOGICAL MONITORING

2.4.1 Benthic Survey

The benthic macroinvertebrate and sediment sampling was performed on August 23 and 24, 2011. 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.

The Sample locations are shown on Figure 2-5, and are as follows:

- Turning Basin, Area 8: J_T2+00E150
- Canal, Areas 1 and 2: J_T5+00E60
- Area 4/5: J_T22+00E25

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 were 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 TestAmerica Laboratories, Colchester, Vermont 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 4.4.1.

2.4.2 Aquatic Vegetation

Observations of aquatic vegetation over the subaqueous caps on the Site were made on August 23 and 24, 2011, during the benthic macroinvertebrate sampling. The results of the qualitative vegetation monitoring are presented in Section 4.4.2.

2.5 WEIR INSPECTION

The outlet weir was inspected for settlement, erosion and integrity on September 22, 2011. The inspection included a visual assessment of those portions of the weir that could be seen, including the integrity of the visible rip-rap. Autolevel survey measurements were also made on September 22, 2011 to determine the relative elevations of the weir abutments and the railroad bridge abutments. Results are presented in Section 4.5.

2.6 STORMWATER IN-FLOW

Sediment traps were originally designed and installed to monitor the potential effects of sediment inflow to the Site via urban stormwater to determine if contaminated sediment from off-site stormwater is jeopardizing the quality of the subaqueous cap. In accordance with the CMWP, sediment trap monitoring was conducted for 5 years following submission of the Construction Completion Report (2005 through 2010). Further sediment trap monitoring is no longer being conducted at the Site.

2.7 SEDIMENT TRANSPORT MONITORING

2.7.1 Trigger Stage Modeling

For the 2011 sediment transport monitoring season (July 28 through November 4, 2011) a trigger stage elevation of 96.96 feet was utilized. The CMWP specifies that the trigger elevation only increase if a sampled storm causes a stage elevation that exceeds the previous highest stage storm in any prior year that yielded below lab reporting limit concentrations in the outlet water quality samples. The 96.96 trigger limit was defined during a stormwater event sampled in 2007, where the highest canal stage elevation sampled was 96.96 feet and the stormwater sample analysis reported non-detects of all analyzed compounds.

2.7.2 Sediment Transport Monitoring

The sediment transport monitoring apparatus was installed on July 27, 2011. 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 system was tested, and adjustments were made on July 28, 2011 after which the system was fully operational.

The stormwater sampling system is comprised of an ISCO Model 3700 automated sampler connected to a Campbell Scientific Model CR-10 data logger which is programmed to monitor surface water stage level fluctuations in the Canal and 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 to compare stage levels in Lake Champlain and in the Canal to the top of weir elevation and to the established trigger stage elevation of 96.96 ft. If the lake level 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 and pulsing the ISCO sampler. One 10-psi Keller pressure transducer was used to monitor stage fluctuations in the Canal, approximately 80 feet east of the weir. One 10-psi Keller pressure transducer was installed in Lake Champlain, approximately 40 feet west of the weir. The ISCO sampler was connected via Teflon 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 sediments. 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 that sampling had been initiated. The location of the stormwater sampling system and associated sensors is shown in Figure 2-6. All above water system components were located inside a locked enclosure throughout the monitoring season.

Lake level monitoring during the 2011 monitoring period was accomplished by downloading Lake elevation data available from the USGS Gaging Station #4294500 (Lake Champlain at Burlington VT) located approximately 1,500 feet north of the Canal. A malfunctioning Lake transducer prevented collection of lake levels immediately adjacent to the weir. The downloaded USGS data were retrieved from the USGS web site in order to verify that the Lake level was below the elevation of the outlet weir during the sampling season.

One sampling event was initiated during the 2011 monitoring program due to a storm that caused an exceedance of the trigger stage elevation on August 28, 2011. The system was deactivated on November 4, 2011 in anticipation of ice formation on the Canal. The stormwater monitoring data are presented and discussed in Section 4-6.

3.0 LABORATORY RESULTS AND QA/QC

3.1 LABORATORY RESULTS AND VALIDATION

Chemical analyses for surface water and groundwater collected during the summer and fall 2011 compliance monitoring were performed by TestAmerica laboratory of South Burlington, Vermont. Summary tables of all analytical results and groundwater field parameters are presented in Appendix 5. The cap chemistry samples (i.e., surface and mid-cap cores) were analyzed by Katahdin Analytical Services, Inc. (KAS), of Scarborough, Maine. 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 TestAmerica.

Summaries of the reported results for equipment blanks and other quality control samples which were not independently validated, and quality assurance reviews associated with field procedures, are presented in Section 3.2.

The CMWP requires validation of a minimum of ten percent of all annual cap core data. Since the August 2011 cap core sampling was the only such event in 2011,, all the laboratory reports from the August 2011 cap core sample group (a single sample delivery group) were delivered to the Independent Data Validator (IDV), Phoenix Chemistry Services, Inc., for validation. The IDV report on the validated sample delivery group for the cap core samples collected August 22-24, 2011 (Katahdin SDG No. PSC-11) was received at The Johnson Company on October 27, 2011. Discussions of the independently validated quality control sample results for the cap core samples are presented in Section 3.4.2.

In accordance with Table 4-1 of the QAPP, a minimum of ten percent of all annual water samples are also subject to independent data validation. The data validation for 2011 water samples was performed on the spring 2011 groundwater sample group, thereby fulfilling this requirement.

3.2 LABORATORY QUALITY ASSURANCE ON NON-VALIDATED DATA

Surface Water – August 2011

The August 2011 surface water sample was collected August 22, 2011 and delivered the same day along with a duplicate, a field blank, and matrix spike/matrix spike duplicate to TestAmerica under chain-of-custody protocol. The laboratory report, received on September 8, 2011, reported no detectable concentrations of SVOC 8270C parameters in either the sample (J_SW-T1+50W80), its duplicate (J_SW-DP), or the field blank (J_SW-FB).

The laboratory narrative (included in the laboratory report in Appendix 7) indicates that the analyses of the field sample 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. The laboratory reported that the recovery results for the surrogate 2-Fluorobiphenyl was reported above the acceptable range for the field blank J_SW-FB and the lab control sample (LCS-200-24263/2-A); however, since no compounds were detected in any of the samples, this represents no adverse impacts to the usability of the data set.

Sediment Grab Samples Associated with Biological Monitoring – August 2011

Sediment grab samples collected August 23-24, 2011 with the benthic macroinvertebrate samples were analyzed for percent solids, total organic carbon (TOC), and acid volatile sulfides/simultaneously extracted metals (AVS/SEM). The sample group was delivered the same day to TestAmerica in Burlington VT. The samples were received chilled at 3.2 º centigrade. The lab report was received September 15, 2011 at The Johnson Co. The lab narrative reported no difficulties during the analyses for AVS, SEM, grain size and TOC except as follows.

The lab reported low MS recovery for the metals copper and zinc during SEM analysis of sample J_T5+00E60 (SIN 393-09), and low MS recovery of copper, lead and zinc in sample J_T22+00E25 (SIN 402-09). Analyses of the lab duplicate for sample J_T2+00E150 (SIN 385-09) indicated that lead exceeded the relative percent difference (RPD) acceptability limit; and lead and zinc exceeded the RPD limit in the lab duplicates for J_T5+00E60 and J_T22+00E25.

No problems were reported for the AVS analyses except the MS associated with the sample J_T5+00E60 which was slightly above the acceptance range of 75-125% (the spike was reported at 128%).

The metals copper, lead, and zinc were reported present in the sediment parent and field duplicate samples, J_T2+00E150 (SIN 0385-09) and J_0182-09DP (SIN 0182-09DP), respectively. In general, good reproducibility was observed in the analytes detected in the sample and it's duplicate. The RPDs between the two samples were 54.5% for AVS by wet chemistry (slightly above the QC limit of 50% and likely due to the sample matrix), 4.1% for total organic carbon, 48.6% for copper, 41% for lead, and 27% for zinc. With the exception of AVS, all RPDs were within the 50% acceptable limit for solid samples indicating good reproducibility and usability. No adverse impacts with respect to data usability were reported by the lab despite the minor QA issues described above.

Groundwater Samples - October 2011

The fall 2011 groundwater sampling was conducted October 17 – 20, 2011. The groundwater sample analytical report for the fall 2011 compliance monitoring was received from TestAmerica on December 1, 2011. The laboratory data reported by TestAmerica indicated no compounds or analytes present in any of the QA/QC blanks submitted with the groundwater sample group. With respect to the field duplicate sample, the only detectable PAH compound in the parent sample (J_MW-24A) and its duplicate (J_0085-25DUP) was naphthalene. Naphthalene was reported in the parent and duplicate samples at estimated concentrations of 4.1 and 4.3 µg/L, respectively (RPD = 4.8%, which is well within the acceptance limit of 30% for field duplicate reproducibility for aqueous samples).

With respect to VOC's, benzene was reported at a concentration of 4.7 µg/L in both the parent and duplicate samples, respectively. Total xylenes were reported at 4.4 and 4.5 µg/L in the parent and duplicate samples, respectively. RPDs were therefore 0% for benzene and 2.2% for xylene, both well within the acceptance limits for field duplicate reproducibility.

Of the metals analyzed, the only detectable metal concentrations present in both the parent and duplicate samples were barium and chromium. Barium was reported in the parent and duplicate samples at estimated (J) concentrations of 65.9 and 68.5 µg/L, respectively (RPD of 3.7%), and chromium was reported in both the parent and duplicate samples at an estimated concentration of 1.2 µg/L. The acceptable QA limit is 30% for metals in field duplicates of water samples. A review of the lab duplicates, RPDs, and lab control sample recovery indicated they were all within acceptable limits.

Splits of the groundwater sample collected at J_MW-21B (SIN 0082-25) 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.

Stormwater Samples - August 28, 2011

A stormwater sample event occurred August 28, 2011. Due to the unique sampling setup whereby samples were collected automatically into an ISCO Model 3700 stormwater sampler, a separate duplicate sample could not be collected, nor could MS/MSDs be collected and submitted with each sample group. In accordance with the CMWP, a total of six sample bottles collected during the stormwater event that were observed to be associated with the six highest stage elevations were sent to TestAmerica, where they were composited into one composite sample and analyzed. TestAmerica created a MS/MSD from the composite sample for QA purposes.

The August 28, 2011 stormwater sample laboratory narrative (included in the laboratory report in Appendix 7) indicates that the samples were received in good condition on August 30, 2011 and chilled at 3.7° C. Analyses of the composite samples and associated MS/MSD were all run within the method - prescribed quality control criteria.

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, MS, MSD, 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.

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. Copies of all PDAs for the monitoring activities described in this report are included in Appendix 6.

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 (i.e., groundwater, surface water and stormwater) and 10 percent of the cap core samples are subject to independent data validation. Data validation was performed on the spring 2011 groundwater sample delivery group (SDG) and presented in the spring 2011 Compliance Monitoring Report. The spring 2011 data validation satisfied the annual minimum requirement for water samples, therefore no independent data validation was performed on the fall 2011 groundwater and surface water analytical results.

For long term monitoring of soil media (e.g., cap sand, sediment), Table 4-1 of the QAPP specifies data validation on a minimum of 10% of these samples. The August 2011 cap coring event consisted of sample delivery group PSC-11, which was received at the laboratory in two batches: the first batch of samples collected August 22-23, 2011 and the second batch collected August 24, 2011. Since the August 2011 cap coring is the only such event for the year, and since there was only one sample delivery group, 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 2011 cap core samples (KAS SDG No. PSC-11) were determined to be valid by the IDV with the following qualifiers:

- All results from the original analysis of sample J_T16+50E50 (11-22") were rejected (R) due to all three surrogate standard recoveries being below the lower acceptance limits in the original extract. The sample was re-extracted and acceptable surrogate recoveries were obtained. Only the results from the re-extracted sample are used,

however due to the re-extraction taking place 8 days out of hold time, all positive results in J_T16_50E50 (11-22") have been qualified as estimated (J).

- Due to no surrogates being used in the SIM extracts, all results from the SIM analyses of samples J_T22+00E25 (0-10 cm) and J_T23+00E50 (0-10 cm) were qualified as estimated (J).

- Results for benzo (g,h,i) perylene in J_T2+00E150 (9-18") and J_T3+00E300 (10-20") and indeno (1,2,3-cd) pyrene in J_T3+00E300 (10-20") were qualified as estimated (UJ) on the basis of unacceptably low recoveries in the associated MS analysis.

- Results for phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, and benzo(g,h,i)perylene in the SIM analyses of shallow core samples collected at T22+00E25 and T23+00E50; and for fluoranthene, pyrene, chrysene, benzo(b)fluoranthene, benzo (a) pyrene and indeno(1,2,3-cd)pyrene in the initial scan analysis of the diluted sample T23+00E50DL were rejected (R) due to detection of these compounds outside the linear range of the instrument. Results for these compounds were replaced with acceptable concentrations from the more diluted analyses of each of these samples (T22+00E25 DL, T23+00E50DL and T23+00E50DL2).

- Results for all other compounds except those noted above in the diluted analyses of the shallow core samples at T22+00E50DL, T23+00E50DL and T23+00E50DL2 were rejected (R) because acceptable results for these compounds were taken from the original (less diluted) analyses of each of the samples.

- The laboratory appropriately applied "J" qualifiers listed on the sample Form I print outs when the concentration of an analyte was less than the sample-specific Quantitation Limit (QL). The IDV did not remove these qualifiers.

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

- The GPC log book pages for the clean-up of the method blank, lab control sample (LCS) and LCS duplicate samples, and the re-extracted deep core sample at location T16+50E50, were not included in the original data package. At the IDV's request, the laboratory submitted these additional documents on October 20, 2011. These pages should be considered part of the data package for all future distributions of the PAH analysis data.

- In the SIM analysis of the shallow core sample T23+00E50, the analyst performed a manual integration for the analyte indeno(1,2,3-cd)pyrene. However, the result was

reported as "0.0" with a "J" (estimated) qualifier. Results above the upper linear range of the instrument should be reported with an "E" qualifier, even in instances where the result is non-calculable, and any anomalous results should be described and explained in the Case Narrative. The laboratory was made aware of these documentation issues.

3.4.2.2 Inorganics

Based on the IDV's report, results for the inorganic analytes in all samples were determined to be valid with the following qualifiers:

- Based on the associated laboratory blank contamination, the results for eight analytes were qualified as less than the quantitation limit value (U) or reported value (U) in all soils samples, since the sample concentration was less than the action limit derived to qualify the affected samples. The analytes are listed as follows:
  - Results for arsenic in all soil samples less than the action limit of 1.3 mg/kg.
  - Results for barium in all soil samples less than the action limit of 0.37 mg/kg.
  - Results for cadmium in all samples less than the action limit of 0.11 mg/kg.
  - Results for chromium in all samples less than the action limit of 0.47 mg/kg.
  - Results for copper in all samples less than the action limit of 0.89 mg/kg.
  - Results for selenium in all samples less than the action limit of 1.95 mg/kg.
  - Results for silver in all samples less than the action limit of 0.14 mg/kg.
  - Results for zinc in all samples less than the action limit of 1.15 mg/kg.

- Based on the unacceptable percent difference (%D) in the serial dilution, results for arsenic in all soils were qualified as estimated (J). The laboratory appropriately applied an "E" qualification for results greater than 10 %D. Since all results were qualified as estimated, the "E" qualifier was removed by the IDV.

- The laboratory reported all results to the method detection limit (MDL); target compounds detected in the associated samples below the practical quantitation limit (PQL) but greater than the MDL (as reported on the Form 10) were reported on the Form I's with a "J" qualifier. The "J" qualifiers were not removed by the validator, unless previously qualified, based on laboratory or field blank contamination (discussed above).

3.4.2.3Total Organic Carbon (TOC)

Based on the IDV's findings, results for the analyte TOC in all samples were determined to be valid as reported, with the following exceptions:

- Results for TOC in the shallow core samples at T16+50E50 and T3+00E300 were qualified as estimated (J) on the basis of unacceptably high recovery in the MS analysis and unacceptable precision in the laboratory duplicate analysis.

- Results for TOC in the shallow sample at T3+00E300 and the field duplicate J_0164-09DP were qualified as estimated (J) on the basis of unacceptable precision in the field duplicate pair.

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 Katahdin and TestAmerica laboratories 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 2011 and the previous two monitoring events on the Gilbane property are shown on Figures 4-1 through 4-3, respectively. The data from fall 2011 indicate flow from the Gilbane property to the north and east towards Area 3, which is generally consistent with the prior monitoring events.

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 2011 monitoring event is shown on Figure 4-5. Potentiometric maps for the prior two groundwater monitoring events (April 2011 and October 2010) are shown on Figures 4-6 and 4-7, respectively. Average potentiometric head values of deep and shallow well pairs were used for the maps where applicable. The data indicate mounding in the vicinity of MW-20B with flow away from that well in all directions. The fall 2011 groundwater flow is similar to that observed during the previous monitoring events in April 2011 and October 2001.

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 xylenes (BTEX) for all wells sampled in October, 2011 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 4-11.

Four of the sampled wells (MW-23B, MW-21A, MW-21B, and MW-24A) contained detectable BTEX compounds above the practical quantitation limit (PQL) of the analytical method (1.0 *µg/L*) and one other well, MW-22A contained estimated concentrations below the PQL of benzene. Three of these wells are outside of the Class IV groundwater boundary (MW-21A, MW-21B, and MW-24A). BTEX detections above the PQLs have been reported since the spring 2008 monitoring event for MW-21A and MW-24A, but not before. The October 2009 monitoring event was the first time since monitoring began in 2000 that BTEX was reported in MW-21B above the PQL, though estimated concentrations below one *µg/L* were reported during the previous two sampling events in April and July 2009. MW-23B is located within the Class IV groundwater boundary, and has historically contained BTEX compounds above the PQL since its installation in 2000.

Benzene was reported in the sample from MW-21A at a concentration of 970 *µg/L*, from MW-21B at 480 *µg/L* and from MW-24A at a concentration of 4.7 *µg/L* during the October 2011 monitoring event. With the exception of MW-24A, these reported concentrations are above the Vermont Groundwater Enforcement Standard (VGES) and EPA maximum contaminant level (MCL) of 5 *µg*/L. None of the other detected BTEX compounds in these wells were reported in

excess of their respective MCLs or VGES. Benzene previously was reported in samples collected from MW-21A at 550 *µg/L* in April 2011, 1,100 *µg/L* in October 2010, 530 *µg/L* in April 2010, and 390 *µg/L* in October 2009. Benzene was previously reported in samples collected from MW-21B at 640 *µg/L* in April 2011, 200 *µg/L* in October 2010, 210 *µg/L* in April 2010 and 11 *µg/L* in October 2009. Benzene concentrations between 6 and 11 *µg/L* have been reported in MW-24A since spring 2008.

Figure 4-9 and 4-10 depict historical benzene concentrations since 2000 in MW-21A, MW-21B, MW-24A, and MW-23B. Between 2000 and 2008, most of the groundwater samples from MW-21A/B and MW-24A had non-detect or occasional trace detections of BTEX compounds. Since 2008 benzene concentrations have generally increased in these three wells, although the October 2011 results are lower than the previously reported historical high concentrations (October 2010 for MW-21A and April 2011 for MW-21B and MW-24A). MW-23B has consistently had detectable concentrations of benzene significantly above the MCL since monitoring began in 2000. MW-23A has not been sampled since 2001 due to the presence of NAPL in that well. The benzene concentrations in MW-23B have been generally increasing since 2003 to its highest reported concentration of 430 *µg/L* in October 2011 (see Figures 4-9 and 4-10).

As discussed in previous monitoring reports, the increasing benzene concentrations observed in these monitoring wells coincides with the presence of a beaver dam beneath the railroad trestle (Figure 4-10) which caused an increase in the Canal water level and subsequently an increase in the hydraulic gradient from the Canal towards the lake (and the monitoring wells along the railroad tracks). Benzene concentrations are plotted along with Canal to Lake gradients (and beaver dam presence) on Figure 4-10. A wire cage and bypass pipe was installed in the fall of 2010 to discourage further beaver activity and restore the canal elevation to its design stage of approximately 96 feet. The bypass pipe functioned as designed throughout 2011, maintaining a maximum Canal elevation of approximately 96 feet when the Lake elevation dropped below that height (except immediately following storm events when the incoming

stormwater flow rate exceeds the bypass pipe capacity resulting in temporary storage of stormwater behind the beaver dam until the retained water drains down). As discussed above, the benzene concentrations dropped in October 2011 from recent historical highs in MW-21A, MW-21B and MW-24A, although they continue to increase in MW-23B.

In response to the continuing elevated benzene concentrations in monitoring wells west of the Canal, additional investigation activities have been conducted between MW-23B and MW-21A/B during the past year. These included advancement of several soil borings as well as a grout injection pilot test. In September 2011, EPA issued an Explanation of Significant Differences (ESD) for the installation of a vertical barrier and NAPL recovery wells between MW-23B and MW-21A/B to reduce the groundwater flux from the Canal towards the Lake. The Performing Defendants are currently working to design and implement such a barrier.

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 October 2011. Reported 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 4-13.

Of the wells outside the Class IV groundwater boundary only MW-24A reported one detection of a targeted PAH (naphthalene at an estimated concentration of 4.1 *µg/L*, below the PQL of 9.4 *µg/L*). PAHs have not historically been detected in MW-24A until April 2010. Since then reported concentrations have remained relatively consistent between 3.6 *µg/L* and 16 *µg/L*, and have not exceeded the MCL of 20 *µg/L*. None of the other targeted PAHs have been reported above their respective PQLs in any of the wells outside the Class IV groundwater boundary since monitoring began in 2000.

Of the wells within the Class IV boundary, only MW-23B reported PAH concentrations that exceeded the PQLs: naphthalene and 2-methylnaphthalene (3,100 *µg/L and 220 µg/L*,

respectively). Acenaphthene was also reported in MW-23B at levels below the PQLs. Reported PAH concentrations in MW-23B were similar to those detected in this well for previous monitoring events. The position of this well with respect to the stratigraphic cross section P – P' is indicated on Figure 4-13.

Of the 16 PAHs analyzed at the Site, only 5 have established Vermont Groundwater Enforcement Standards (anthracene at 2,100 *µg/L*, benzo(a)pyrene at 0.2 *µg/L*, fluoranthene at 280 *µg/L*, fluorene at 280 *µg/L*, and naphthalene at 20 *µg/L*). Of these, only naphthalene and benzo(a)pyrene have been reported at concentrations in excess of their respective VGES and only in monitoring well MW-23B. Benzo(a)pyrene was not detected in MW-23B in the most recent October 2011 sample. All of the previously reported benzo(a)pyrene concentrations in MW-23B were estimated values below its PQL.

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 October 2011 monitoring event with the exception of arsenic at 16.6 *µg/L* in MW-9A, 10.1 *µg*/L in MW-22B, and 70.7 *µg/L* in MW-21B, and lead at 30.2 *µg/L* in MW-9A (MCL of 15 *µg/L*). These concentrations are generally similar to results from previous sampling events and, with the exception of MW-21B, lower than the 50 *µg*/L arsenic MCL in place in 2001 when the Record of Decision (ROD) was finalized (the current MCL for arsenic is 10 *µg*/L). The reported metals concentrations in these wells are possibly attributable to elevated turbidity which was measured prior to sampling at 331 NTUs in MW-9A, 19 NTUs in MW-20B, and 25 NTUs in MW-21B. MW-9A has consistently been reported with elevated turbidity during previous sampling events. The well has consistently exhibited very slow recharge during purging and consequently has been purged nearly dry (and allowed to slowly recharge) prior to sample collection during nearly every sample event since 2000.

4.1.2.4 Temporal Changes in Concentrations at Individual Wells

One of the few wells monitored in October 2011 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 dropped to between 5.1 and 83 *µg/L*. As shown on Figure 4-9 and 4-10, benzene concentrations in MW-23B continue to increase to their recent (October 2011) high of 430 *µg/L*.

Increasing benzene concentrations have also been reported in MW-21A (ranging from 7.4 *µg/L* to 1,100 *µg/L*) since 2008 and in MW-21B (ranging from 11 *µg/L* to 640 *µg/L*) since 2009, although in both wells benzene concentrations in the most recent samples (October 2011) have dropped below their previous highs. Benzene concentrations in MW-21A were consistently less than 1 *µg/L* in all samples prior to the spring 2008 sampling event at which time a detection was reported at 7.4 *µg/L* and the concentration continued to rise until fall 2010 when it peaked at 1,100 *µg/L* (it subsequently dropped to 550 *µg/L* in April 2011, then increased again to 970 *µg/L* in October 2011). Benzene in MW-21B was reported at less than 1 *µg/L* in all samples prior to the fall 2009 sampling event at which time a detection was reported at 11 *µg/L* and the concentration continued to rise until spring 2011 when it peaked at 640 *µg/L* (it subsequently dropped to 480 *µg/L* in October 2011). Benzene concentrations in MW-24A were similarly consistently less than 1 *µg/L* until spring 2008 when they jumped to 11 *µg/L* and have since been fairly consistent with no apparent increasing trend with concentrations ranging from 4.7 *µg/L* to 12 *µg/L* (the most recent October 2011 benzene concentration of 4.7 *µg/L* is the lowest reported concentration since fall 2007.

As stated above, the increasing benzene concentrations observed in these monitoring wells may be the result of the intermittent presence of a beaver dam beneath the railroad trestle (Figure 4-10) which caused 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). More data are necessary to determine if there is a relationship between the increased hydraulic gradients and the benzene concentrations. Never the less, because of the persistent elevated benzene concentrations in the wells west of the Canal, the Performing Defendants are currently working in conjunction with EPA to design and implement a barrier system between MW-23B and MW-21A/B to reduce the groundwater flux and possible NAPL migration from the Canal towards the Lake.

MW-23B is the only well that has historically contained concentrations of PAH compounds greater than 10 μg/L. Reported PAH concentrations in MW-23B in October 2011 were similar to those reported for previous monitoring events since October 2007.

Reported concentrations of metals in the monitoring wells have been relatively constant (within an order of magnitude) over the monitoring events conducted since 2001. As discussed above, the elevated metals concentrations in MW-9A, MW-22B, and MW-21B are likely attributable to elevated turbidity in the wells, which was measured at 331, 19, and 25 NTUs, respectively, prior to sampling. MW-9A has historically been reported with elevated turbidity ranging from 50 to 700 NTUs. MW-22B has been reported with sporadic elevated turbidity up to 91 NTUs since its installation in 2000.

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-17, MW-21A, MW-21B, MW-23A, MW-23B, MW-24A, MW-24B, MW-1B, MW-3C, MW-4B, MW-8A, MW-12, and MW-19 were monitored for NAPL between October 18 and 20, 2011. A summary of the groundwater monitoring well DNAPL monitoring/removal events for 2011 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-4B, MW-12, MW-23B and MW-17. NAPL levels measured in wells MW-4B and MW-12 (<0.05') were similar to measurements from previous fall NAPL monitoring events.

Approximately 1.3 feet of DNAPL thickness was measured in MW-17 on October 18, 2011. This thickness is slightly higher than the 0.7 feet measured in April 2011, and 0.9 feet in October 2010. DNAPL removal (required only when DNAPL thickness exceeds 0.1 feet) was completed on October 18th. Approximately 1 liter of DNAPL along with 6 liters of NAPL/water mix was removed and placed in a drum for future disposal. The well was re-measured approximately 24 hours later and approximately 0.2feet of DNAPL was measured.

Approximately 6.0 feet of DNAPL was measured in MW-23B on October 18. Previous DNAPL monitoring events reported DNAPL thicknesses of 4.6 feet in April 2011, 4.15 feet in October 2010, 3.5 feet in April 2010, and 0.8 feet in October 2009. On October 18, 2011 approximately 5 liters of DNAPL and 12 liters of NAPL/water mix were removed and placed in a drum for future disposal. Less than 1 inch of DNAPL was measured in the well approximately 1 hour after the DNAPL removal, with 2.75 feet measured on October 19, approximately 24 hours following the initial DNAPL removal. Approximately 3 additional liters of DNAPL was removed from the well the following day, October 20.

All NAPL removed from the monitoring wells was placed in a 55-gallon drum for future removal for disposal by a licensed waste hauler.

4.1.4 NAPL Monitoring/Removal – NAPL Recovery Wells

A RW-109 Pump Test and NAPL Monitoring/Removal event was performed from October 4-7, 2011 as described in Section 2.1.4 (in accordance with the OMMP). During and after NAPL removal from RW-109 (for four subsequent days) the thickness of DNAPL and groundwater levels were periodically measured in wells RW-108, RW-109, RW-110, and MW-11C.

At the start of each day approximately 22 to 23 feet of DNAPL was measured in RW-109 and between approximately 37 to 50 gallons of NAPL was then removed from the well at a rate of 1 to 3 gallons per minute. In total, just less than 200 gallons of DNAPL was removed from RW-109 over the course of the four days of testing. No changes in water level elevation or NAPL thickness was observed in the nearby wells RW-108, RW-110, or MW-11C during any of the removal events. A copy of the Report of RW-109 Pump Test Study and NAPL Monitoring/Removal report, including graphs and figures of the testing results is included in Appendix 8.

Bi-weekly NAPL and water level monitoring, removal and recovery was also performed from August 30 through November 18, 2011 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 as described in Section 2.1.4.

Table 4-1 summarizes the NAPL removal activities for the bi-weekly monitoring events. A complete description of the results can be found in the Summary of RW-109 Pump Test Study and NAPL Monitoring/Removal included in Appendix 8.

Table 4-1
Summary of Fall 2011 Bi-Weekly NAPL Monitoring and Removal Events

	NAPL Thickness (feet) and Gallons of NAPL Removed for Each Monitoring Event												
Well ID	August 30, 2011[2]	September 7-9, 2011		September 21-23, 2011		October 4-7, 2011		October 20-21, 2011		November 3-5, 2011		November 17-18, 2011	
RW-101	3.6 ft.	3.9 ft.	0.0[1] gal	4.1 ft.	8.9 gal	0.2 ft.	0.0[1] gal	1.0 ft.	5.3 gal	0.8 ft.	3.5 gal	0.7 ft.	3.0 gal
RW-102	16.05 ft.	16.6 ft.	37 gal	4.8 ft.	17 gal	3.2 ft.	10 gal	4.3 ft.	5 gal	4.5 ft.	5.0 gal	4.4 ft.	6.0 gal
RW-103	15.60 ft.	16.2 ft.	40 gal	4.9 ft.	14 gal	4.9 ft.	8.9 gal	4.7 ft.	7.1 gal	4.8 ft.	6.2 gal	5.1 ft.	5.7 gal
RW-104	11.60 ft.	13.1 ft.	34 gal	2.6 ft.	3.5 gal	3.3 ft.	8.9 gal	3.2 ft.	5.3 gal	3.0 ft.	3.5 gal	3.6 ft.	3.0 gal
RW-105	0.9 ft.	1.3 ft.	5.3 gal	0.9 ft.	1.8 gal	0.2 ft.	---	0.8 ft.	3.5 gal	0.1 ft.	---	0.1 ft.	---
RW-106	<0.1 ft.	0.0 ft.	---	0.0 ft.	---	0.0 ft.	---	0.0 ft.	---	0.0 ft.	---	0.0 ft.	---
RW-107	<0.1 ft.	0.0 ft.	---	0.0	---	0.0 ft.	---	0.0 ft.	---	0.0 ft.	---	0.0 ft.	---

Table 4-1
Summary of Fall 2011 Bi-Weekly NAPL Monitoring and Removal Events

	NAPL Thickness (feet) and Gallons of NAPL Removed for Each Monitoring Event												
Well ID	August 30, 2011[2]	September 7-9, 2011		September 21-23, 2011		October 4-7, 2011		October 20-21, 2011		November 3-5, 2011		November 17-18, 2011	
RW-108	12.21 ft.	15.4 ft.	21.2 gal	5.5 ft.	5.3 gal	5.0 ft.	5.3 gal	2.2 ft.	7.1 gal	3.5 ft.	5.3 gal	1.1 ft.	3.5 gal
RW-109	21.1 ft.	22.8 ft.	119 gal	22.9 ft.	118 gal	23.2 ft.	167 gal	22.8 ft.	43.5 gal	22.8 ft.	43.4 gal	22.9 ft.	34.7 gal
RW-110	0.0 ft.	0.0 ft.	---	0.0 ft.	---	0.0 ft.	---	0.0 ft.	---	0.0 ft.	---	0.7 ft.	0.9 gal
RW-T9+80	0.0 ft.	0.0 ft.	---	0.0	---	0.0 ft.	---	0.0 ft.	---	0.0 ft.	---	0.0 ft.	---
RW-T10+25	0.0 ft.	0.3 ft.	2.7 gal	0.1 ft.	---	0.0 ft.	---	0.0 ft.	---	0.0 ft.	---	0.0 ft.	---
RW-T11+00	0.0 ft.	0.0 ft.	---	0.0	---	0.0 ft.	---	0.0 ft.	---	0.0 ft.	---	0.0 ft.	---
RW-T14+00	0.8 ft.	0.6 ft.	8.9 gal	0.5 ft.	5.3 gal	0.1 ft.	---	0.1 ft.	---	0.1 ft.	---	0.1 ft.	---

[1] = No NAPL removal attempted due to high water level in Canal.
2 = No NAPL removal was performed on August 30, 2011.

4.2 SURFACE WATER

One unfiltered surface water sample (J_SWT1+50W80) was collected from the Canal outlet on August 22, 2011 and analyzed for 17 PAHs. The sample location is shown on Figure 2-4. No PAHs were reported detected by the laboratory. The reporting limit for each individual PAH was 9.5 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. This modification was approved in a July 31, 2008 email correspondence from the EPA and VT DEC and is consistent with the OMMP. 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 2011 Long Term Cap Coring Analytical Results[1]

		Mid-Cap							Top-Cap				
Area	**Sample Location**	**Sum of PAHs (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 E100	2.34	No	9.6	J 0.005	3.3	21.8	No	2.67	10.8	J 0.01	7.3	38.7
	T2+00 E150	2.47	No	10.9	U 0.005	3.4	23.6	No	2.63	8.4	J 0.01	5.2	32.3
	T3+00 E200	2.47	No	8.0	J 0.006	3.2	19.2	No	2.49	14.0	J 0.006	7.2	50.0
	T3+00 E300	2.54	No	10.0	J 0.005	3.6	25.5	No	2.25	11.4	J 0.01	8.2	44.6
Area 8 Average		**2.46**	**No**	**9.6**	**J 0.005**	**3.4**	**22.5**	**No**	**2.51**	**11.2**	**J 0.01**	**7.0**	**41.4**
1	T4+00 E20	2.47	No	8.6	J 0.007	3.2	20.5	No	2.28	9.3	U 0.005	3.9	29.0
	T5+00 E60	2.47	No	8.3	U 0.006	3.2	21.3	No	2.47	9.5	J 0.01	4.2	29.8
	T7+00 E40	2.54	No	10.7	J 0.01	3.4	24.2	No	2.80	13.1	J 0.01	5.6	48.1
Area 1 Average		**2.49**	**No**	**9.2**	**J 0.009**	**3.3**	**22.0**	**No**	**2.52**	**10.6**	**J 0.01**	**4.6**	**35.6**
2	No Coring Performed in Area 2[4]												
3	T16+50E50	0.73	No	6.1	0.10	31.5	46.4	No	0.65	13.0	0.18	23.2	66.8
	T17+50E200	2.73	No	10.7	U 0.006	3.8	24.1	No	0.13	11.5	J 0.02	8.1	35.1
Area 3 Average		**1.73**	**No**	**8.4**	**0.10**	**17.7**	**35.3**	**No**	**0.39**	**12.3**	**0.10**	**15.7**	**51.0**
4/5	T18+00E350	--	--	--	--	--	--	--	5.37	21.0	0.04	22.9	59.3
	T22+00E25	--	--	--	--	--	--	--	53.08	84.7	0.25	123	367
	T23+00E50	--	--	--	--	--	--	--	100.09	298	1.3	306	758
Area 4/5 Average		**--**	**--**	**--**	**--**	**--**	**--**	**--**	**52.85**	**134.6**	**0.53**	**150.6**	**394.8**

Notes: [1] Most PAHs were not detected in most samples. However, due to high moisture contents, reporting limits were above 330 ug/kg, so ½ the reporting limit was used for non-detect analytes in calculating the sum of PAHs provided in this table.
[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 2011 monitoring period due to the presence of the amended cap in accordance with the July 31, 2008 email correspondence from EPA and consistent with the OMMP.
U – indicates that analyte was not detected, with the associated value being the detection limit.

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 ppm; the "PAH benchmark value"), and individual ER-M values for copper, lead, mercury and zinc (270 ppm, 218 ppm, 0.71 ppm, and 410 ppm, 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, of the 9 selected top-of-cap samples (0–10 cm) collected at random sample locations, 7 had detected PAHs (though nearly all of the detections were reported as estimated concentrations below the PQL and 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). Only one of

the nine associated mid-cap samples contained detectable PAHs (again, most detections were reported as estimated concentrations below the PQL). The sum-of-PAH values for all samples from the installed caps (top-of-cap and mid-cap) were less than the 21 ppm benchmark value associated with mid-cap samples.

The sums of PAHs from two of 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 1.2% to 1.4%, 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 T22+00E25, and suggest that they were not bioavailable at the other two sample locations (see Section 4.4.1).

4.3.2 Amended Cap Bathymetric Survey

In accordance with the OMMP, a bathymetric survey was conducted in the vicinity of the Amended Cap in September, 2011 as described in Section 2.3.2. 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 9.

4.3.3 Amended Cap Settlement Plate Survey

A settlement plate survey was completed on November 22, 2011 as described in Section 2.3.3. The purpose of the survey was to document any settlement or evidence of gas accumulation since its installation. The elevation and locational results of the surveys are shown on Figure 4-17. The settlement plates were initially surveyed following their installation on December 10, 2010.

The positional survey data indicate that the settlement plates moved laterally up to 14 feet between December 2010 and November 2011. Only two of the plates, SP-C and SP-F, remained within a foot of their 2010 location. Because all of the other plates moved laterally, comparisons between their 2010 and 2011 elevations are not suitable for direct comparison. While it is not possible to conclusively establish the cause of the apparent movement of the plates, it should be noted that during much of 2011 the Canal experienced unprecedented flooding conditions. The plates will be re-surveyed laterally and vertically in the spring of 2012.

4.4 BIOLOGICAL MONITORING

4.4.1 Benthic Macroinvertebrate Monitoring

Benthic macroinvertebrate sampling was conducted on August 23 and 24, and as noted in Section 2.4, the post-construction monitoring protocols were followed which require one sample randomly selected in the combined Areas 1 and 2; one from Area 8, of the capped section of the Canal; and one from 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 2011 are presented in Table 4-6. Table 4-7 presents sediment physical data and Tables 4-8 and 4-9 present the 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 16.1 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.

4.4.1.1 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. The relative abundance in Area 1 was slightly lower than in 2010, but similar to results for the last four years.

The uncapped Area 4/5 had the greatest diversity of organisms and the highest abundance. The samples from this location were dominated by fingernail clams, *Pisidium sp.*, but the species composition was similar to the sample results from 2010. Fingernail clams were also a major component of the benthic macroinvertebrate samples in 2009.

Table 4-3
Summary of Benthic Macroinvertebrate Data - Area 8
August 2011
(Major Component Species >4%)

Sample Location: Area 8, J_2+00E150
Date Sample Collected: 8/23/11
Water Depth on Sample Collection Date: 5.8 ft.

Family	Species	% of Total
Replicate No. 1 – Total Abundance = 64		
Tubificidae	Spp.	100
Replicate No. 2 – Total Abundance = 81		
Tubificidae	*Spp.*	86
Tubificidae	*Limnodrilus hoffmeisteri*	14
Replicate No. 3 – Total Abundance = 82		
Tubificidae	*Spp.*	96
Tubificidae	*Limnodrilus hoffmeisteri*	4
AREA 8 – RELATIVE ABUNDANCE = 76		

Note: Specimens are identified to the lowest practical taxon

Table 4-4
Summary of Benthic Macroinvertebrate Data - Area 1
August 2011
(Major Component Species >4%)

Sample Location: Area 1, J_T5+00E60
Date Sample Collected: 8/23/11
Water Depth on Sample Collection Date: 7.1 ft.

Family	Species	% of Total
Replicate No. 1 – Total Abundance = 524		
Tubificidae	*Spp.*	95
Tubificidae	*Limnodrilus hoffmeisteri*	5
Replicate No. 2 – Total Abundance = 119		
Tubificidae	*Spp.*	100
Replicate No. 3 – Total Abundance = 38		
Tubificidae	*Spp.*	100
AREA 1 - RELATIVE ABUNDANCE = 227		

Note: Specimens are identified to the lowest practical taxon

Table 4-5
Summary of Benthic Macroinvertebrate Data - Area 4/5
August 2011
(Major Component Species >4%)

Sample Location: Area 4/5, J_T22+00E25
Date Sample Collected: 8/24/11
Water Depth on Sample Collection Date: 2.0 ft.

Family	Species	% of Total
Replicate No. 1 – Total Abundance = 176		
Tubificidae	*Spp.*	7
Valvatidae	*Valvata sp.*	9
Sphaeriidae	*Pisidium sp.*	75
Gammaridae	*Gammarus sp.*	5
Replicate No. 2 – Total Abundance = 328		
Tubificidae	*Spp.*	5
Planorbidae	*Gyraulus sp.*	13
Valvatidae	*Valvata sp.*	10
Sphaeriidae	*Pisidium sp.*	59

Table 4-5
Summary of Benthic Macroinvertebrate Data - Area 4/5
August 2011
(Major Component Species >4%)

Sample Location: Area 4/5, J_T22+00E25
Date Sample Collected: 8/24/11
Water Depth on Sample Collection Date: 2.0 ft.

Family	Species	% of Total
Asellidae	*Caecidotea communis*	9
Replicate No. 3 – Total Abundance = 228		
Planorbidae	*Gyraulus sp*	23
Sphaeriidae	*Pisidium sp.*	46
Gammaridae	*Gammarus sp.*	5
Asellidae	*Caecidotea communis*	18
AREA 4/5- RELATIVE ABUNDANCE = 244		

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

* 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.

4.4.1.2 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 T2 in Area 8 (Turning Basin) were fine sandy loam and at T5 in the Canal were loamy fine sand (see Table 4-7). Total organic carbon (TOC) was significantly 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 16.1% 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 2011

Location	Sample Point	Date	Water Depth (ft.)	Percent Solids	Total Organic Carbon (mg/kg)	Sediment Type (USDA)
Area 8	J_T2+00E150	8/23/11	5.8	63.5	12,050 (1.21%)	Fine sandy loam
Area 1	J_T5+00E60	8/23/11	7.1	55.8	14,500 (1.45%)	Loamy fine sand
Area 4/5	J_T22+00E25	8/24/11	2.0	13.1	161,000 (16.1%)	Organic

Table 4-8
Metals and AVS/SEM Sediment Data 2011

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 mg/kg	SEM µmole/g	SEM mg/kg	SEM µmole/g	SEM mg/kg	SEM µmole/g	SEM mg/kg	SEM µmole/g	SEM mg/kg	SEM µmole/g	SEM mg/kg	SEM µmole/g	
Area 8	J_T2+00E150[1]	5.8	6.45	NA	NA	7.45	0.115	15.85	0.077	NA	NA	NA	NA	67.3	1.045	0.19
Area 1	J_T5+00E60	7.1	14.5	NA	NA	10.5	0.17	16.5	0.080	NA	NA	NA	NA	101	1.5	0.12
Area 4/5	J_T22+00E25	2.0	70.7	NA	NA	108	1.7	94.9	0.46	NA	NA	NA	NA	994	15.2	0.25

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 2003-2011 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

1. Using current Sample Point designation convention, this location would be J_T23+70E10
2. Not available due to non-detect result for AVS

4.4.1.3 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 ten 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 76 in 2011. In Area 1, relative abundance since 2007 has ranged from 159 to 349, which shows that a relatively stable benthic invertebrate community has been established. 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 2011 showed that the summed PAH concentrations in the surface sediments were below the 21 ppm 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.

4.4.2 Aquatic Vegetation Monitoring

4.4.2.1 Qualitative Vegetation Monitoring

Monitoring of Canal submergent vegetation was done during the macroinvertebrate sampling on August 23 and 24, 2011. On these days, the lake level was lower than the weir. However, the lake level set a historical record of 103.2 feet in May and lake levels remained above the weir until the end of July. This extended period of high water may have affected the emergent vegetation typically observed along the Canal and Turning Basin.

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

These areas are the deeper areas of the Canal and Turning Basin. Record lake levels in the spring of 2011 caused the Canal and Turning Basin water levels to be higher than the weir from March through July. Water depth at the macroinvertebrate sampling station in the Turning Basin, Area 8, was 5.8 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. Rooted aquatic vegetation had not colonized the canal bottom at the time of sampling. 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 and 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. On August 24th, a few herbaceous plants were visible on the TRM and in the soil strip between the road and the TRM. This area had not been seeded due to high water levels in the spring, so the vegetation consisted of volunteers. Most of the area was not vegetated.

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.

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 this area 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 along this area. 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 24th, 2011, 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. A small 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.

4.4.2.2 Wetland Transect Monitoring

The last wetland transect monitoring for all capped wetland areas was completed in 2009. All areas have met the performance standard for wetland vegetation. No transect monitoring was required in 2011.

4.4.2.3 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.)

4.5 OUTLET WEIR INSPECTION

The outlet weir was inspected on September 22, 2011. An autolevel survey of the relative elevations of the weir abutments and the railroad bridge abutments indicates that no significant settlement has occurred within the accuracy of the instrument since construction of the weir (see Table 4-10). The railroad abutment elevations determined on September 22, 2011 were nearly identical (to within 0.03 feet) to the initial elevations as determined on October 1, 2001. The elevation determined at the center of the weir crest (Benchmark "C") in 2011 is within 0.02 feet of that determined immediately after construction in 2001. The elevation of the north abutment of the weir (Benchmark "B") in 2011 was 0.02 feet below that determined immediately after construction in 2001, and the south abutment (Benchmark "A") elevation was identical to the 2001 elevation. These differences are all within the accuracy of the measurement method. There is no visual evidence of settlement of either the weir or the railroad bridge. 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.

Table 4-10
Outlet Weir Elevation Survey Data (fNGVD 1986)

Survey Point	Initial Survey Elevation[1]	7/27/02 Elevation	10/30/02 Elevation	9/17/03 Elevation	10/15/04 Elevation	11/17/05 Elevation	11/13/06 Elevation	10/19/07 Elevation	9/10/08 Elevation	11/18/09 Elevation	9/7/10 Elevation	9/22/11 Elevation
WEIR												
Sluice Crest	96.48	96.48	96.48	96.47	96.46	NM[3]	96.46	96.47	96.47	96.46	96.42	96.46
North Abutment	97.98	97.97	97.97	97.96	97.95	98.00	97.95	97.96	97.96	97.95	97.92	97.96
South Abutment	97.97	97.97	97.99	97.97	97.96	98.00	97.97	97.97	97.97	97.96	97.93	97.97
RR BRIDGE ABUTMENT												
Northeast	100.12	100.13	100.12	100.12	100.12	100.15	100.12	100.12	100.12	100.09	100.10	100.15
Northwest	100.12	100.12	100.12	100.13	100.11	100.16	100.12	100.12	100.12	100.09	100.08	100.12
Southeast[2]	103.64	103.64	103.64	103.64	103.64	103.64	103.64	103.66	103.66	103.64	103.64	103.64
Southwest	100.18	100.18	100.18	100.18	100.17	100.21	100.18	100.17	100.17	100.15	100.14	100.17

[1]Initial Survey conducted October 1, 2001 concurrent with the as-built survey of the weir
[2]Bench Mark RV 124 - Rivet set in concrete abutment
[3]Not measured due to high water and waves; Lake stage was at 98.5 (fNVDG 1929)

4.6 SEDIMENT TRANSPORT MONITORING

The stormwater sampling system used for the 2011 sediment transport monitoring was installed on July 28, 2011. One storm (Tropical Storm Irene) was sampled during the 2011 stormwater monitoring season, starting mid-day on August 28, 2011. The storm trigger Canal stage of 96.96 feet was exceeded at 11:48 AM on August 28 and the stormwater sampler was activated. The sampler successfully collected 24 samples during the event and the six highest stage levels were recorded between 3:48 and 8:48 PM on August 28th, with the maximum stage elevation of 97.45 feet recorded at 5:48 PM. Based on the maximum water level observed, the stage trigger criteria will be adjusted to 97.45 for 2012. Figure 4-19 illustrates the water level fluctuations during the stormwater sampling event.

After the storm sampling was terminated, the six sample bottles (#5-10) collected during the six highest canal stage levels were delivered on August 30, 2011 under chain of custody protocol to TestAmerica in Burlington, Vermont. The samples were composited by the laboratory, which then analyzed the one composite sample for total suspended solids and PAHs. TestAmerica 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. Results were received from TestAmerica on September 12, 2011. The TSS result was reported at 12.2 mg/L, and no detectable PAHs were reported. In accordance with the CMWP, the TSS data were compared to the previously collected ARI TSS data. The 2011 TSS results (12.2 mg/L) were generally similar to the ARI results (11 mg/L, 8 mg/L, and <5 mg/L).

5.0 REFERENCES

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FIGURES

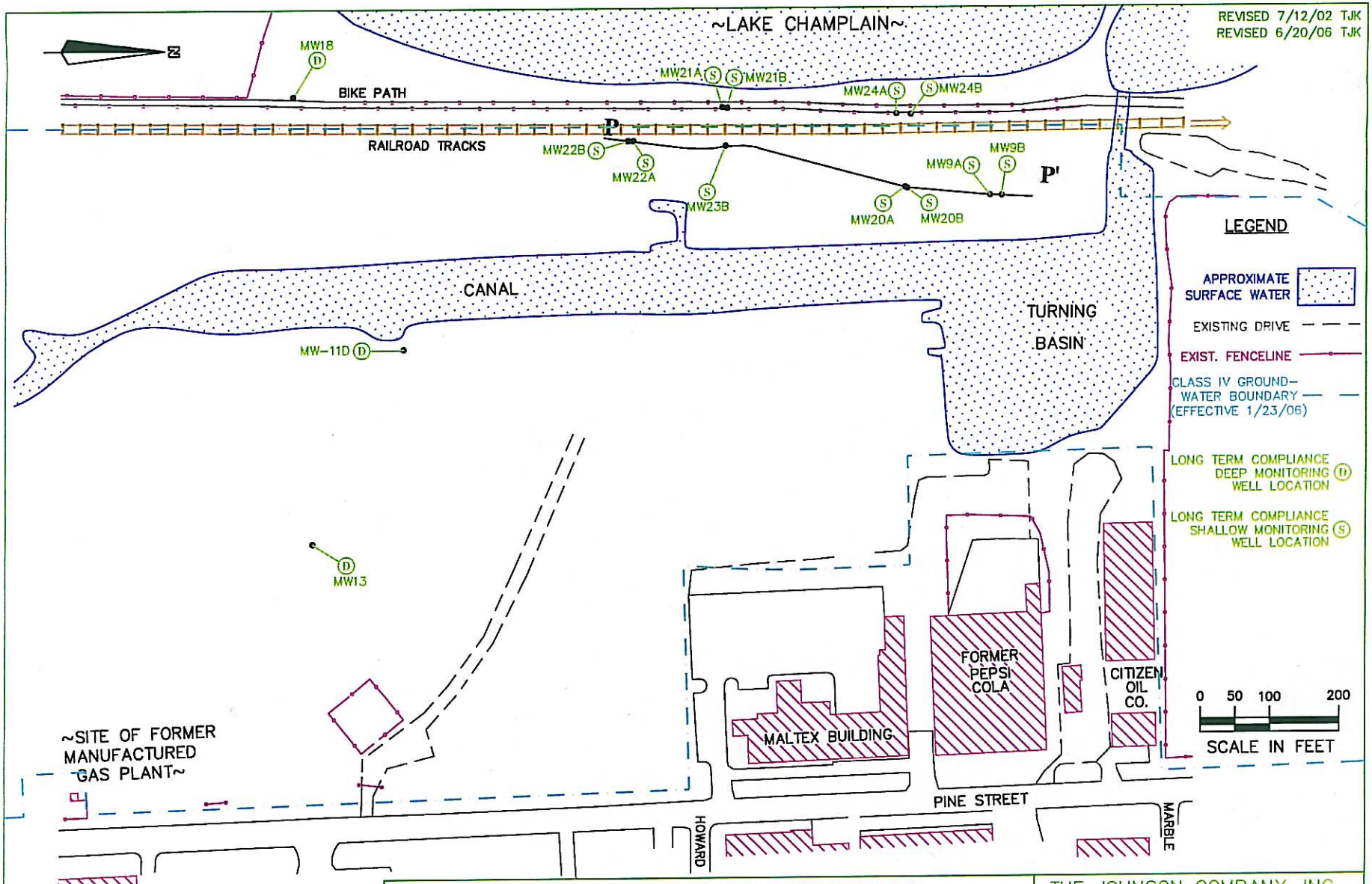


FIGURE 2-1: LOCATIONS OF WELLS USED FOR COMPLIANCE MONITORING PINE STREET CANAL SITE, BURLINGTON, VT

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'

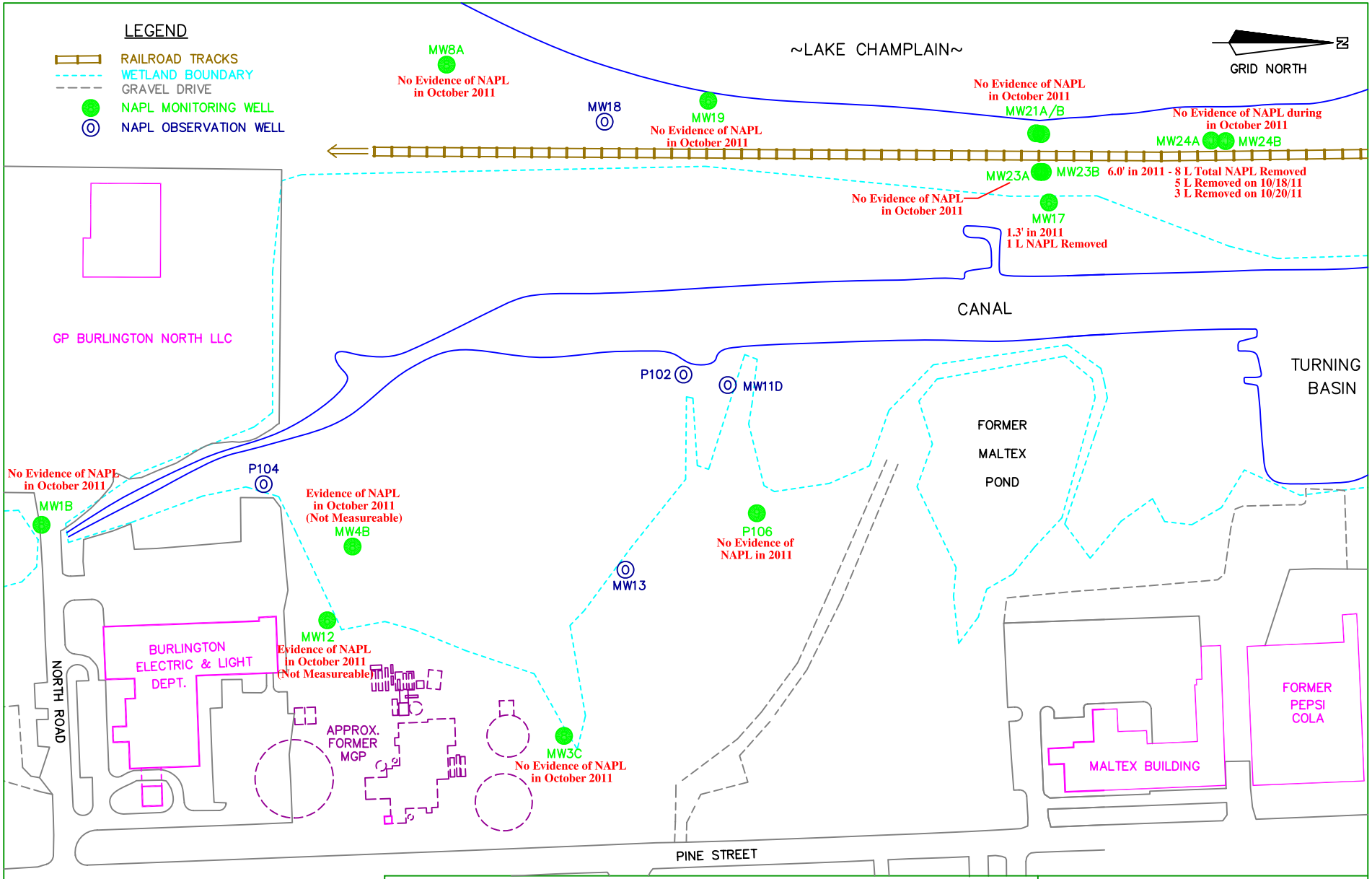
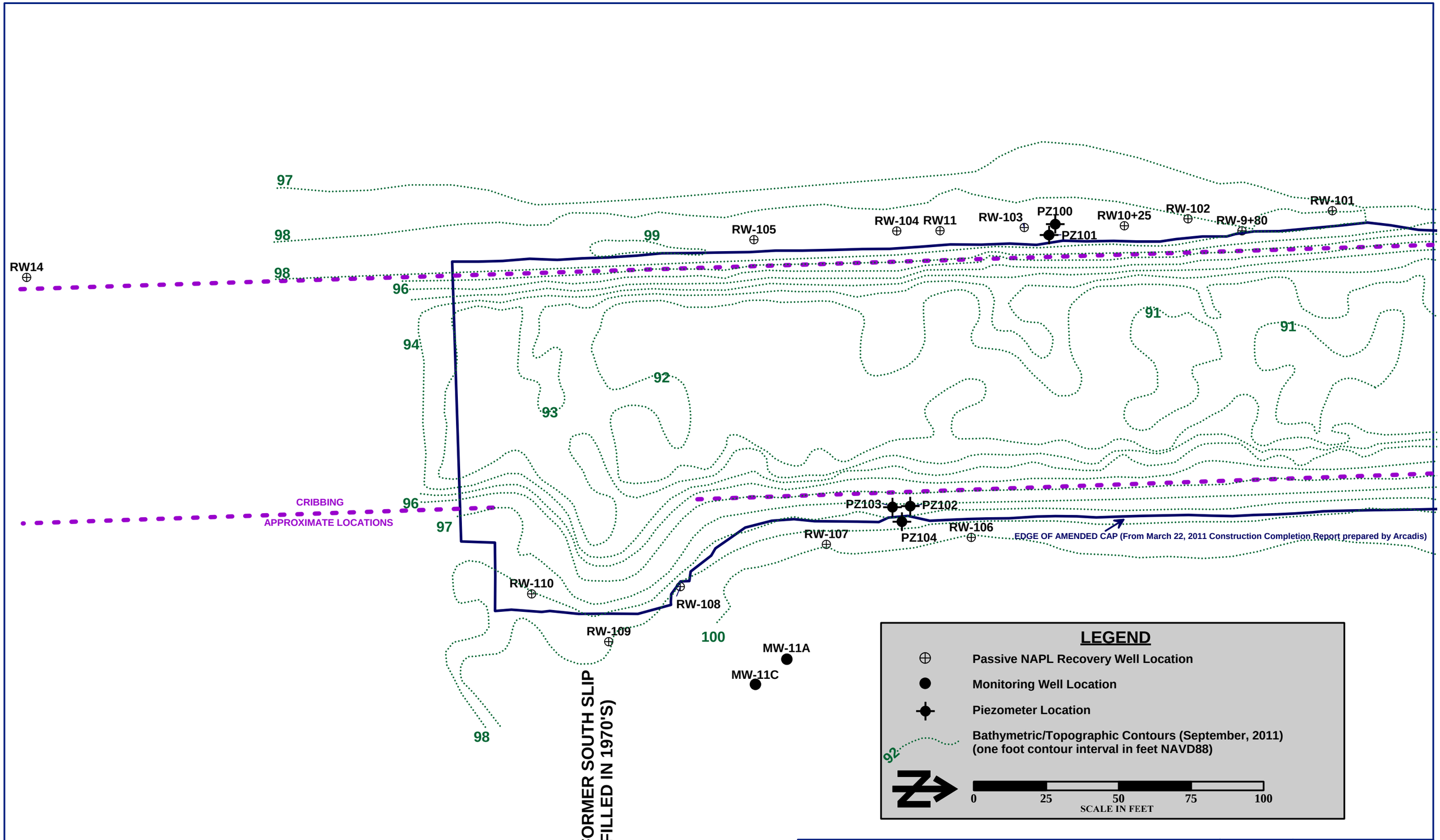


FIGURE 2-2: GROUNDWATER MONITORING WELLS
2011 NAPL MONITORING RESULTS
PINE STREET CANAL SITE, BURLINGTON, VERMONT

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

DATE: 01/05/12 (rev.) PROJECT: 1-0870-2
DRAWN BY: TJK SCALE: 1"=200'



1-0870-2_2011 NAPL Monitoring_010512 RW well location map for fall 2011 CMR.srf

FIGURE 2-3
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: 11/03/2011
Chk'd by: Date:
Scale: AS SHOWN Project: 1-0870-2 (256)

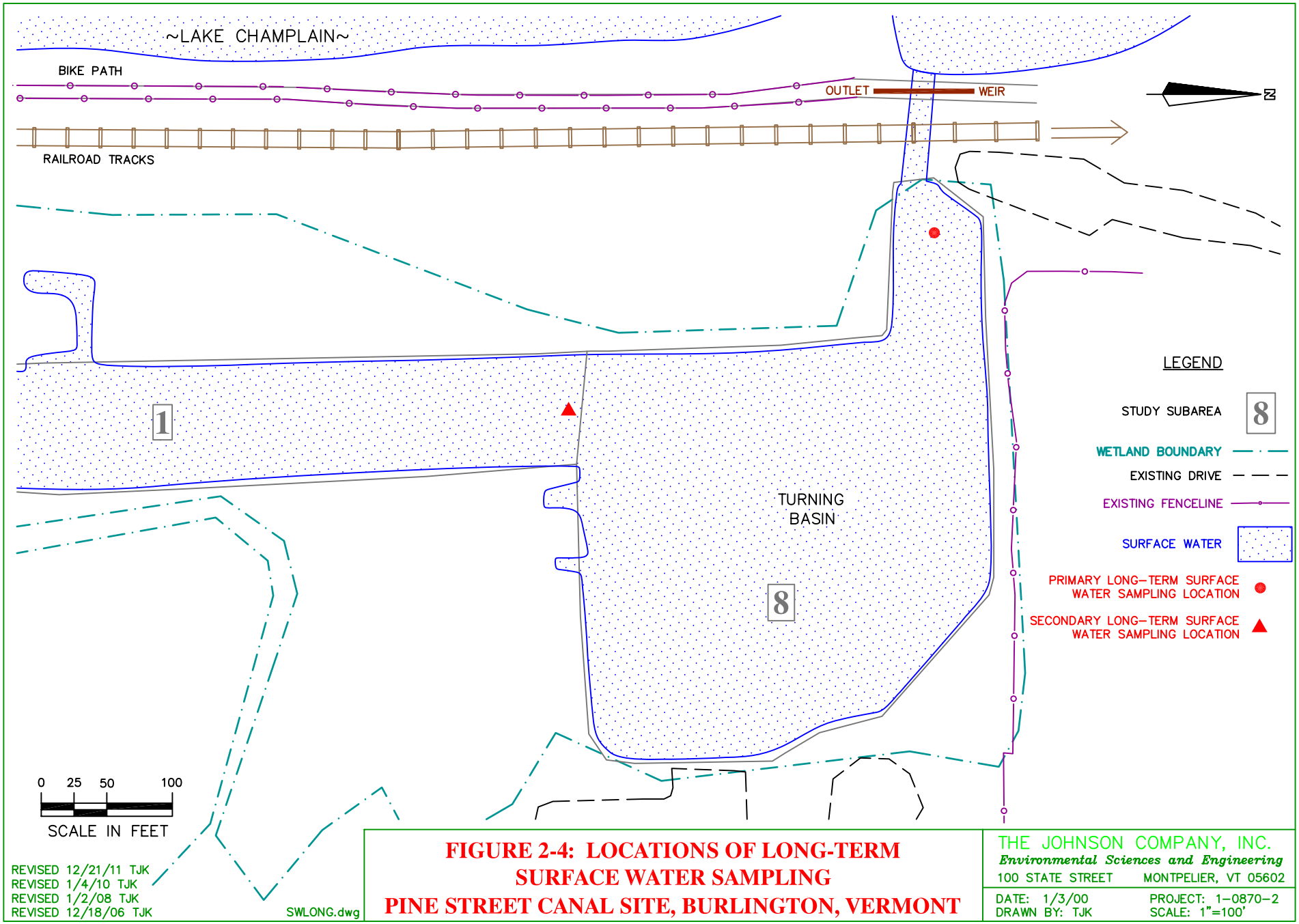
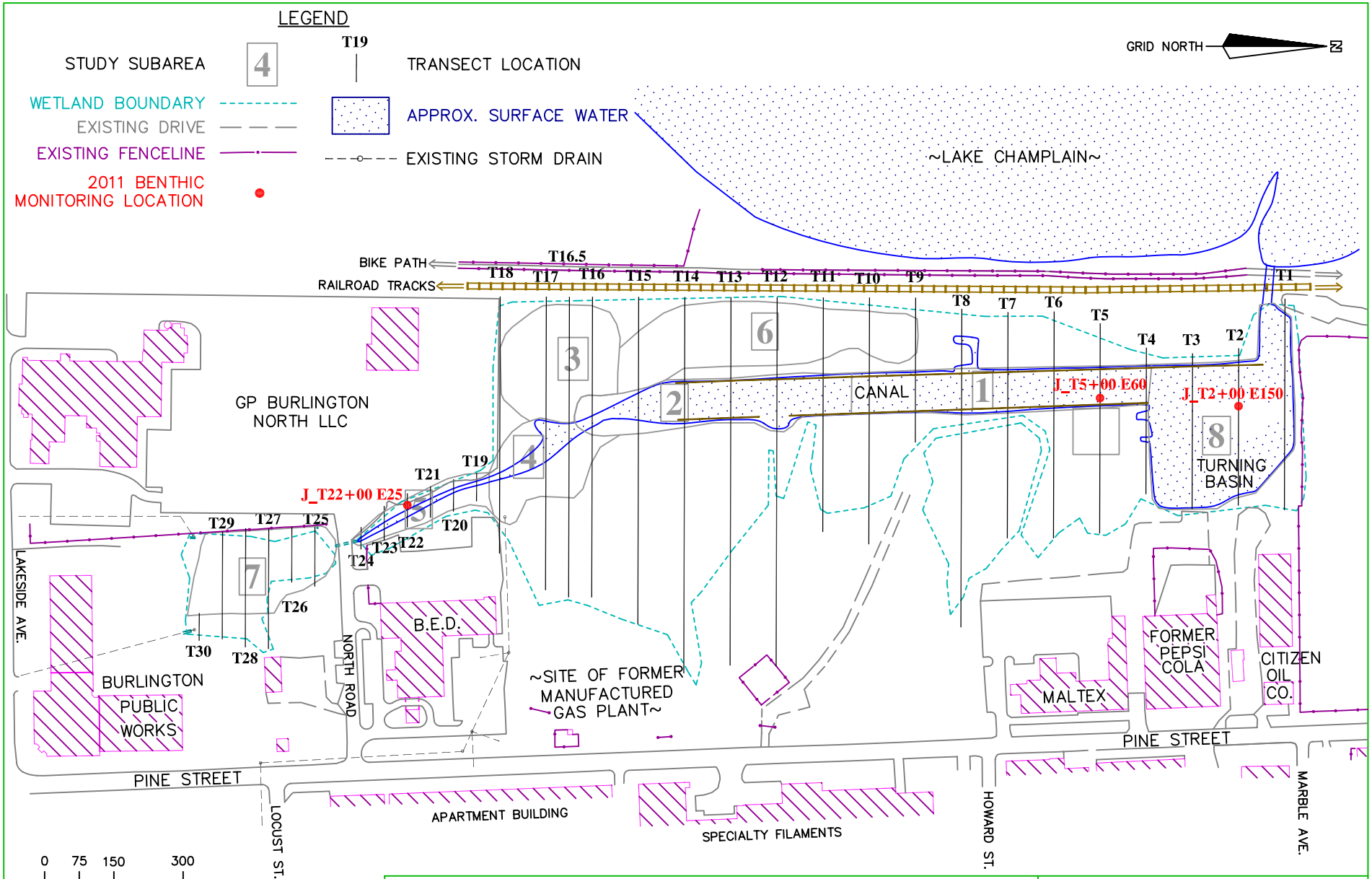


FIGURE 2-4: LOCATIONS OF LONG-TERM SURFACE WATER SAMPLING
PINE STREET CANAL SITE, BURLINGTON, VERMONT

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'



REVISED 01/05/12 TJK
REVISED 12/16/10 TJK
REVISED 12/11/09 TJK
REVISED 12/16/08 TJK
PCLOCS.dwg

FIGURE 2-5
2011 BENTHIC MONITORING LOCATIONS
PINE STREET CANAL SITE, BURLINGTON, VERMONT

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

DATE: 12/17/07 PROJECT: 1-0870-2
DRAWN BY: TJK SCALE: 1"=300'

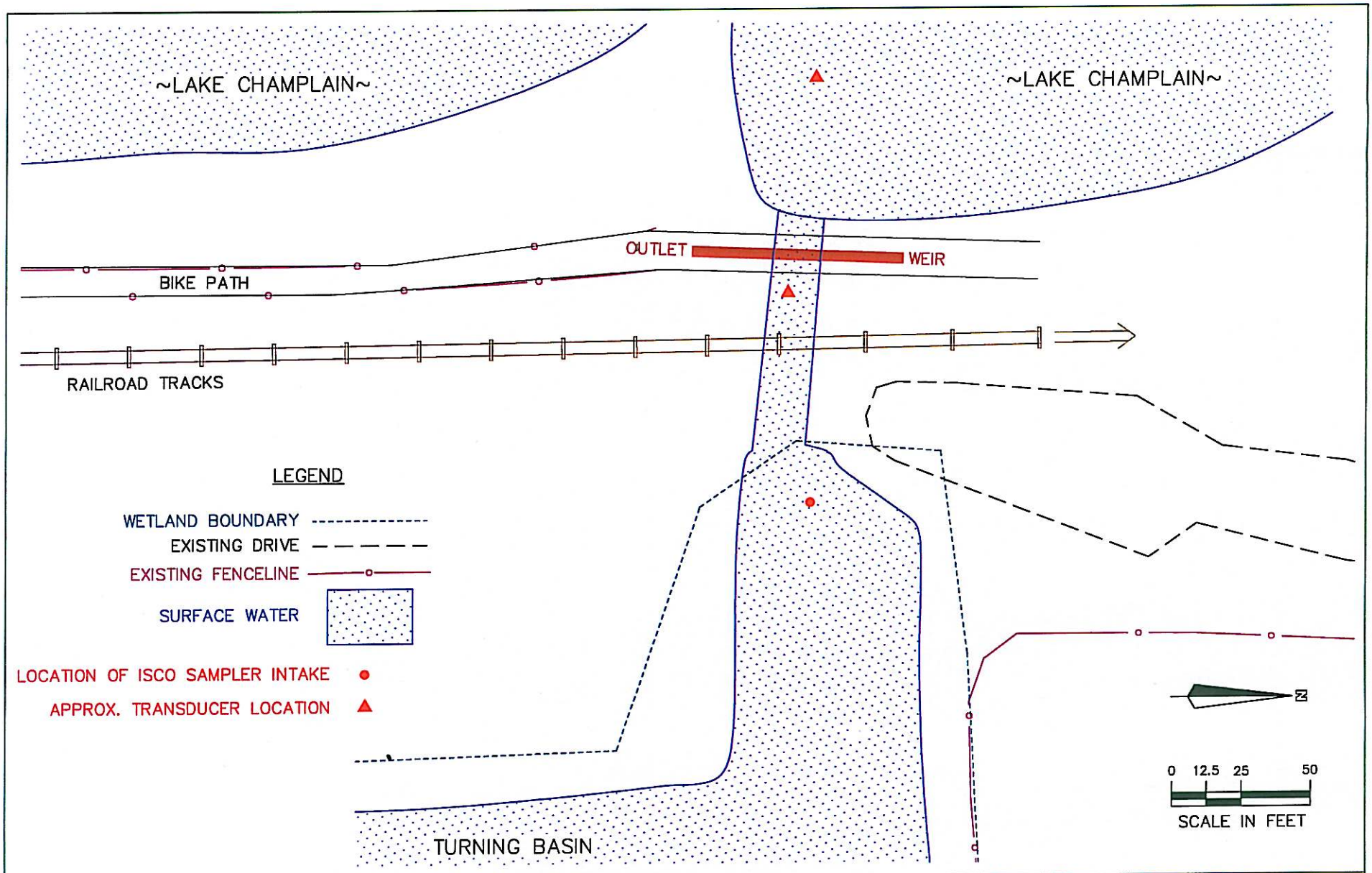


FIGURE 2-6: STORMWATER SAMPLING LOCATIONS
PINE STREET CANAL SITE
BURLINGTON, VERMONT

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

DATE: 12/16/10 (rev.) PROJECT: 1-0870-2
DRAWN BY: TJK SCALE: 1"=50'

ORIGINAL 01/04/00 TJK
SWGRAB.dwg

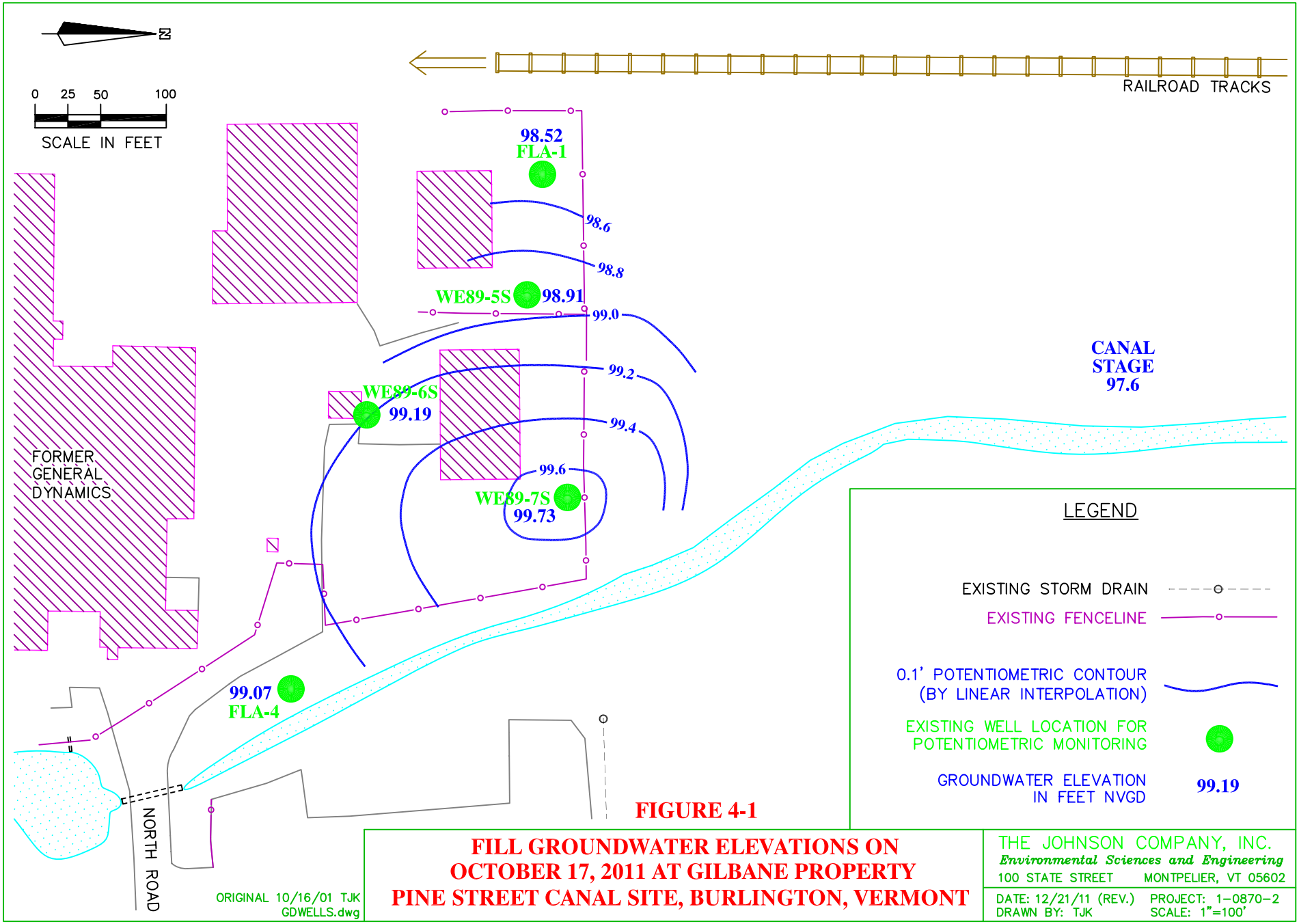


FIGURE 4-1

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: 12/21/11 (REV.) PROJECT: 1-0870-2
DRAWN BY: TJK SCALE: 1"=100'

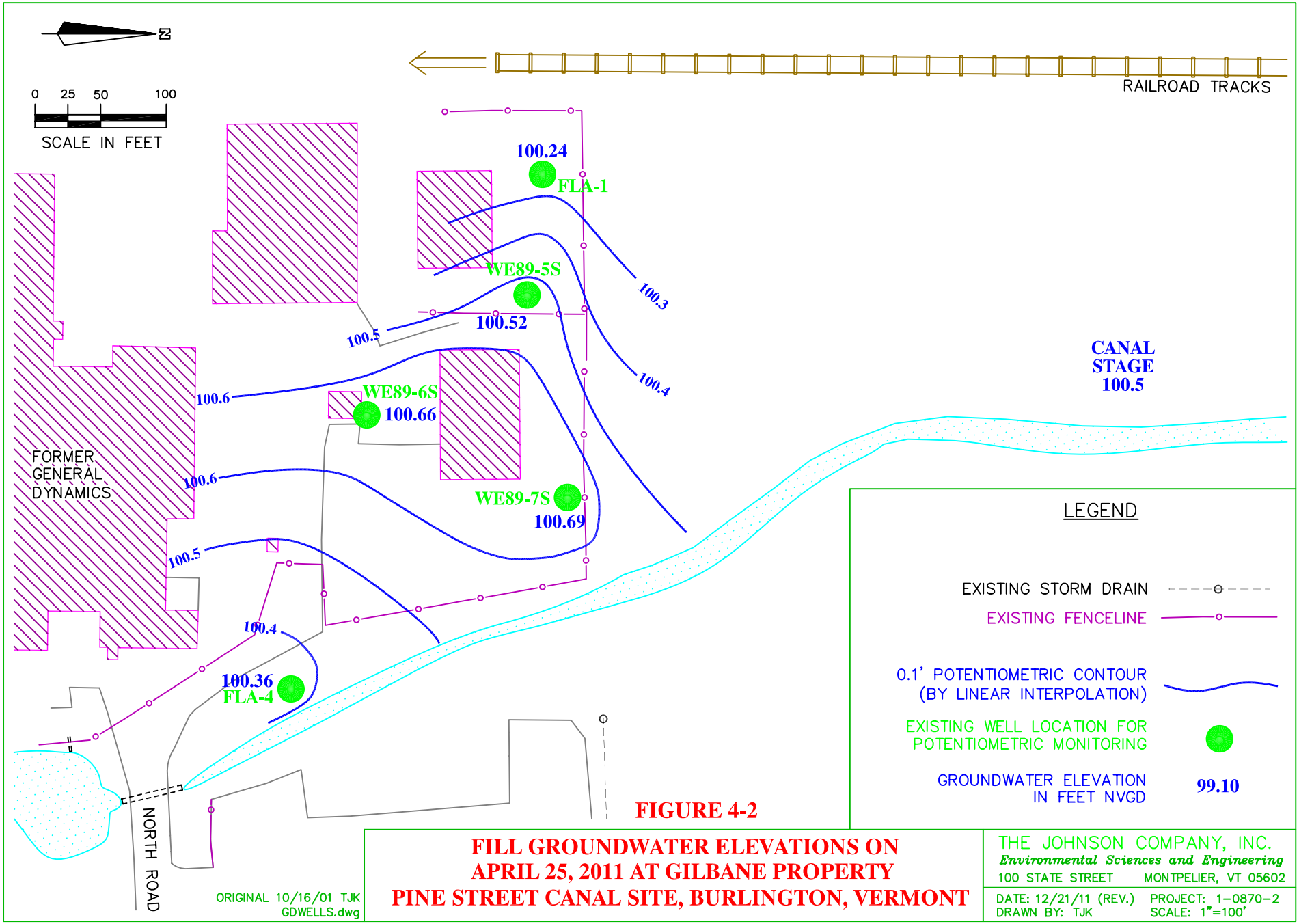


FIGURE 4-2

FILL GROUNDWATER ELEVATIONS ON APRIL 25, 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: 12/21/11 (REV.) PROJECT: 1-0870-2
DRAWN BY: TJK SCALE: 1"=100'

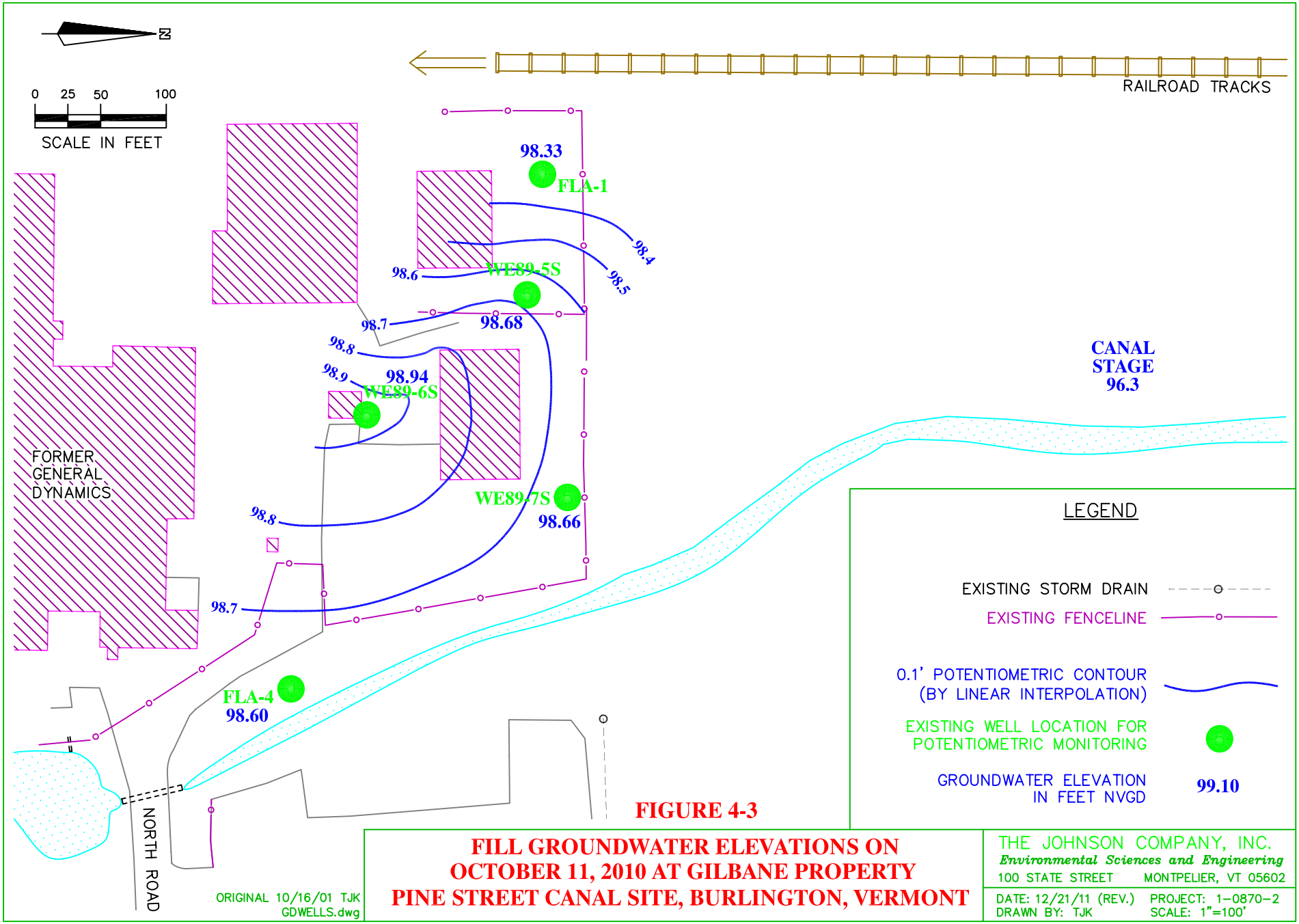


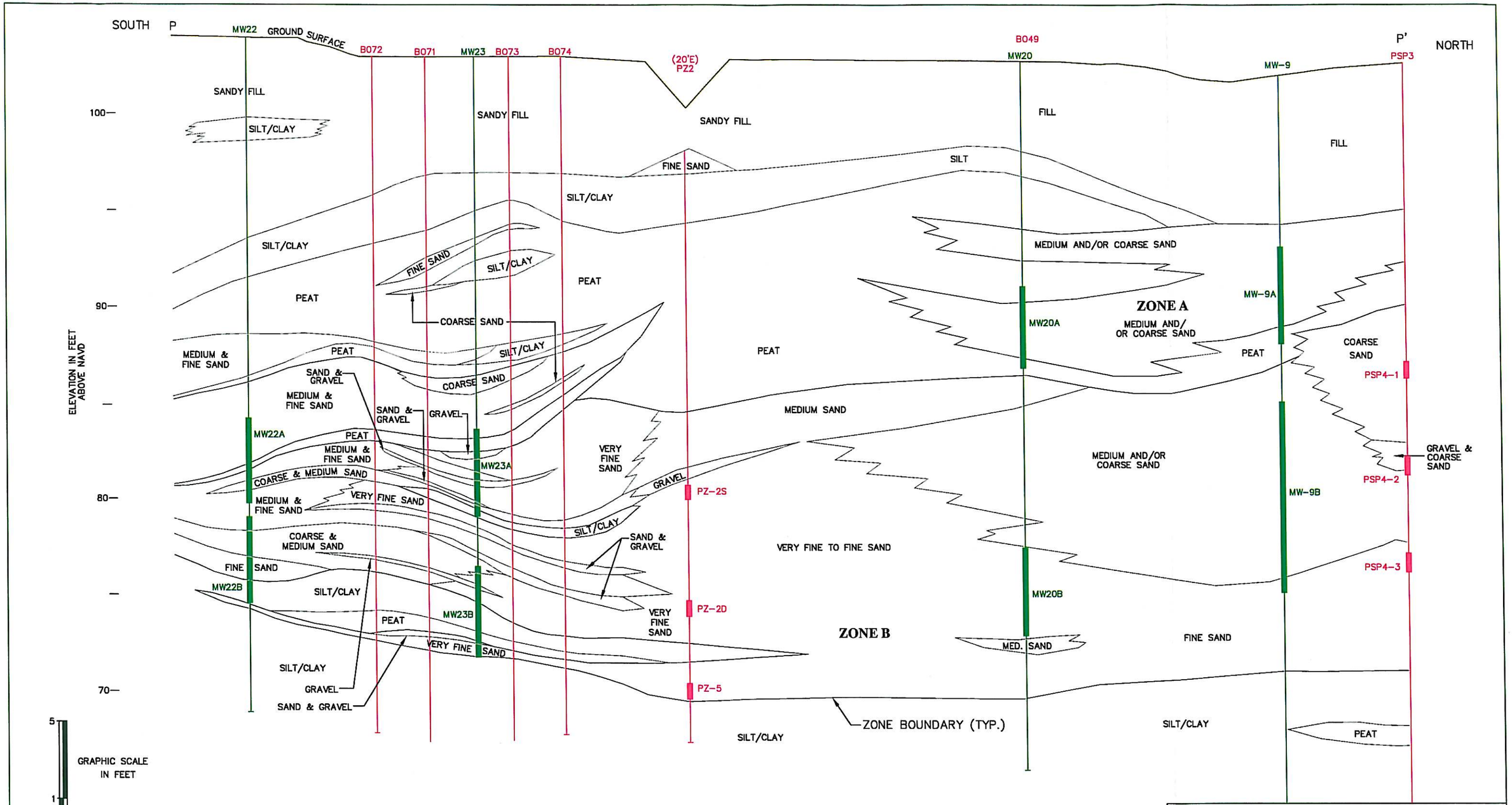
FIGURE 4-3

FILL GROUNDWATER ELEVATIONS ON OCTOBER 11, 2010 AT GILBANE PROPERTY PINE STREET CANAL SITE, BURLINGTON, VERMONT

ORIGINAL 10/16/01 TJK
GDWELLS.dwg

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

DATE: 12/21/11 (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

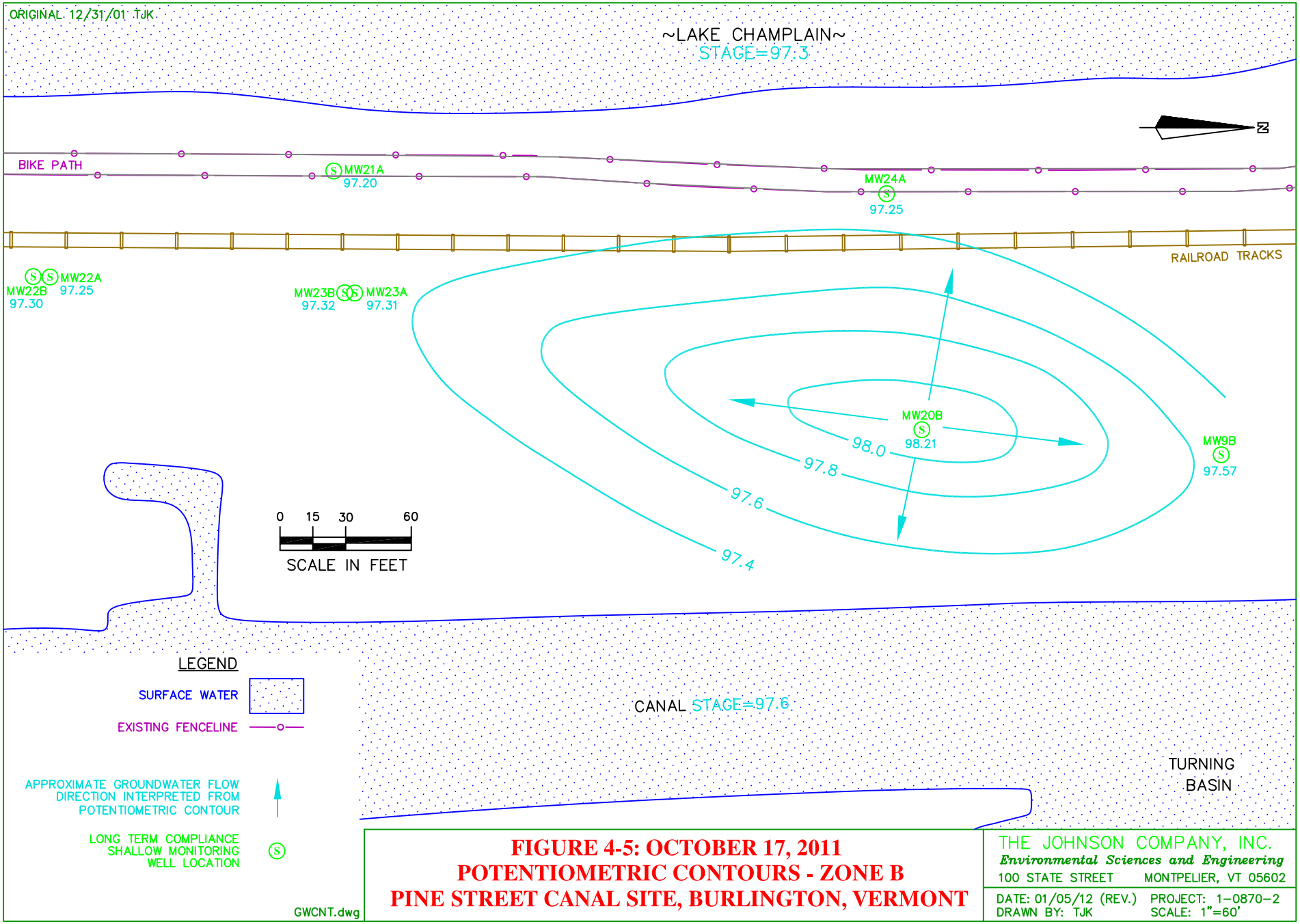


FIGURE 4-5: OCTOBER 17, 2011
POTENTIOMETRIC CONTOURS - ZONE B
PINE STREET CANAL SITE, BURLINGTON, VERMONT

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

DATE: 01/05/12 (REV.) PROJECT: 1-0870-2
DRAWN BY: TJK SCALE: 1"=60'

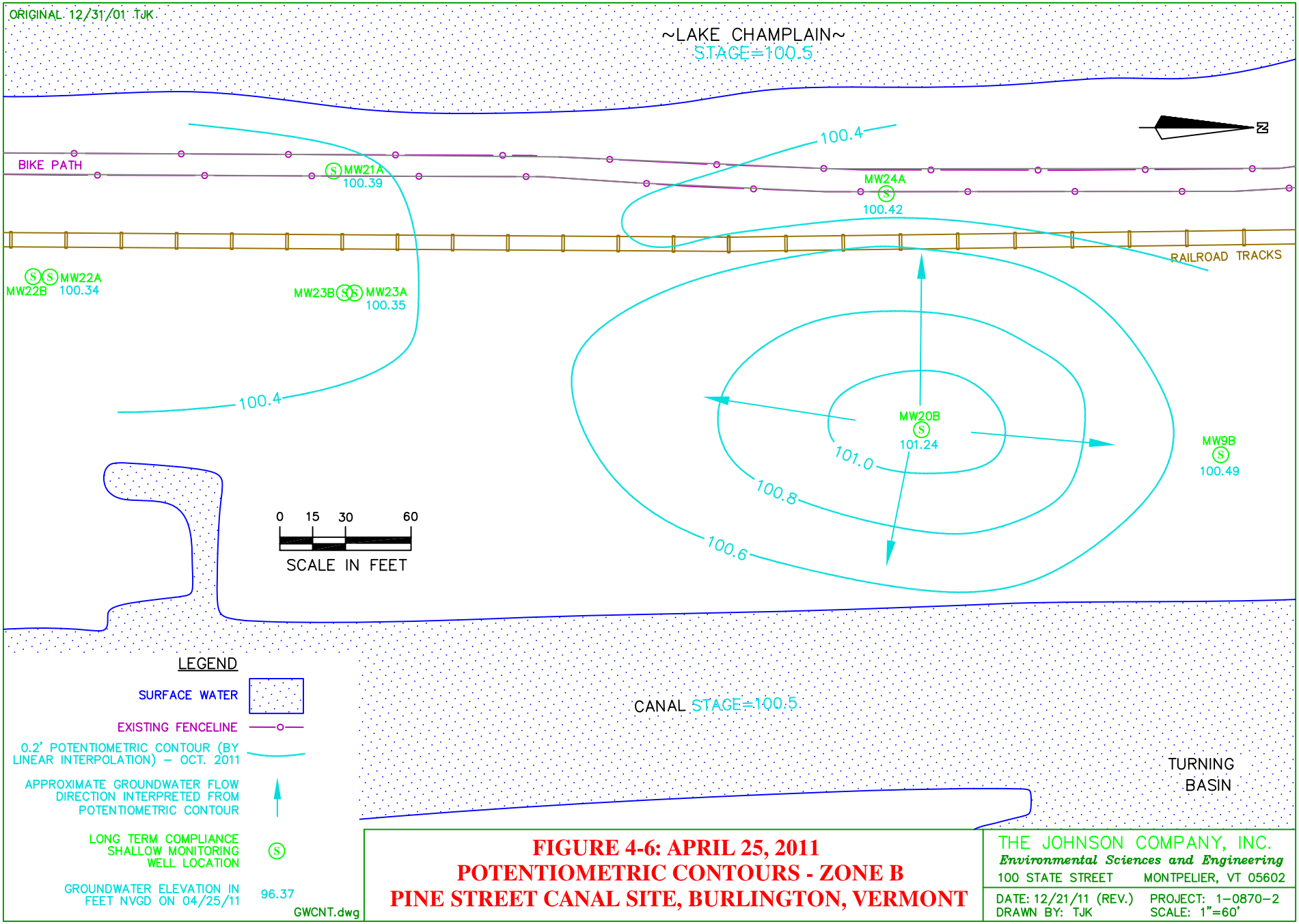


FIGURE 4-6: APRIL 25, 2011
POTENTIOMETRIC CONTOURS - ZONE B
PINE STREET CANAL SITE, BURLINGTON, VERMONT

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

DATE: 12/21/11 (REV.) PROJECT: 1–0870–2
DRAWN BY: TJK SCALE: 1"=60'

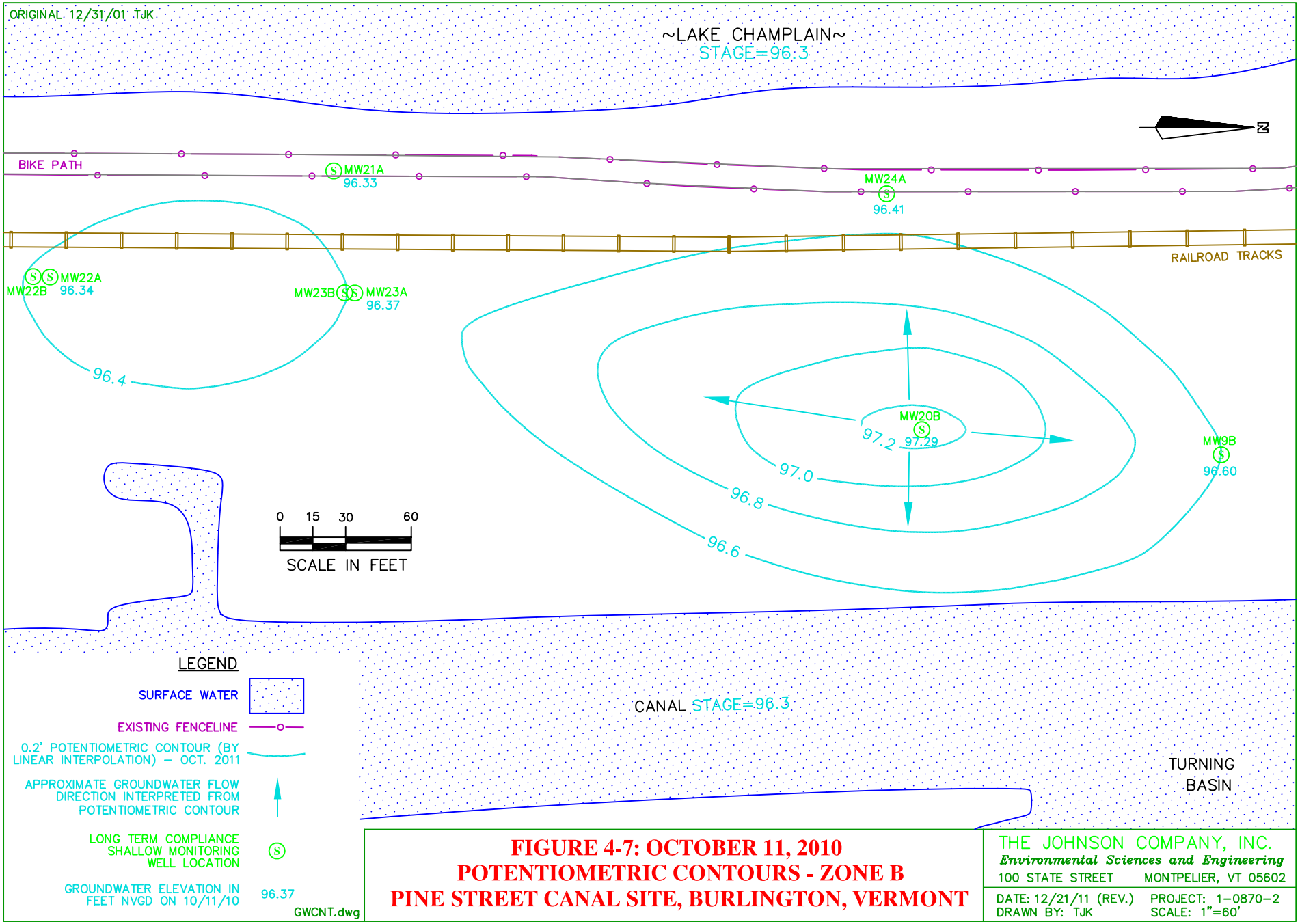
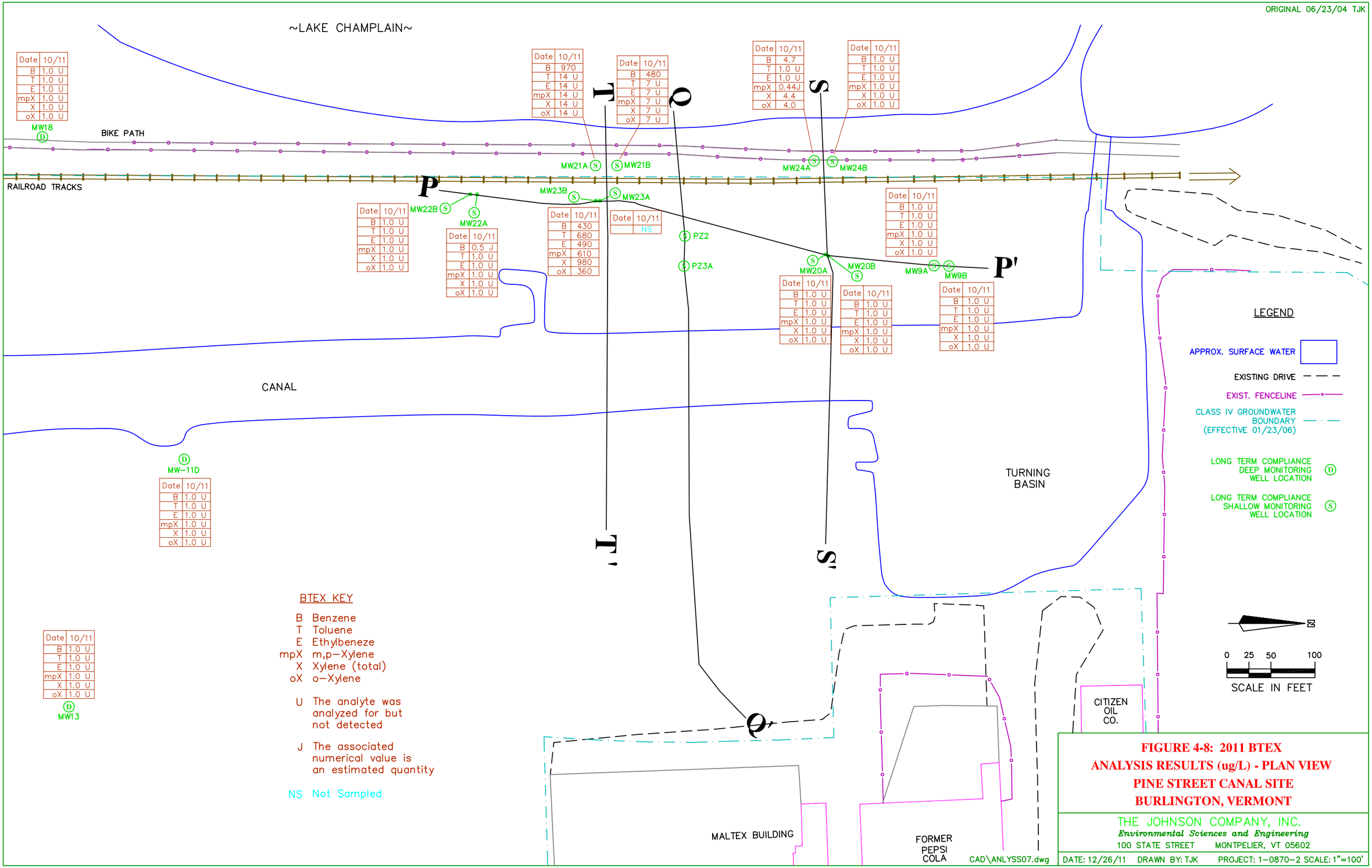


FIGURE 4-7: OCTOBER 11, 2010
POTENTIOMETRIC CONTOURS - ZONE B
PINE STREET CANAL SITE, BURLINGTON, VERMONT

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

DATE: 12/21/11 (REV.) PROJECT: 1–0870–2
DRAWN BY: TJK SCALE: 1"=60'

ORIGINAL 06/23/04 TJK



Date	10/11
B	1.0 U
T	1.0 U
E	1.0 U
mpX	1.0 U
X	1.0 U
oX	1.0 U

Date	10/11
B	970
T	14 U
E	14 U
mpX	14 U
X	14 U
oX	14 U

Date	10/11
B	480
T	7 U
E	7 U
mpX	7 U
X	7 U
oX	7 U

Date	10/11
B	4.7
T	1.0 U
E	1.0 U
mpX	0.44J
X	4.4
oX	4.0

Date	10/11
B	1.0 U
T	1.0 U
E	1.0 U
mpX	1.0 U
X	1.0 U
oX	1.0 U

Date	10/11
B	1.0 U
T	1.0 U
E	1.0 U
mpX	1.0 U
X	1.0 U
oX	1.0 U

Date	10/11
B	0.5 J
T	1.0 U
E	1.0 U
mpX	1.0 U
X	1.0 U
oX	1.0 U

Date	10/11
B	430
T	680
E	490
mpX	610
X	980
oX	360

Date	10/11
	NS

Date	10/11
B	1.0 U
T	1.0 U
E	1.0 U
mpX	1.0 U
X	1.0 U
oX	1.0 U

Date	10/11
B	1.0 U
T	1.0 U
E	1.0 U
mpX	1.0 U
X	1.0 U
oX	1.0 U

Date	10/11
B	1.0 U
T	1.0 U
E	1.0 U
mpX	1.0 U
X	1.0 U
oX	1.0 U

Date	10/11
B	1.0 U
T	1.0 U
E	1.0 U
mpX	1.0 U
X	1.0 U
oX	1.0 U

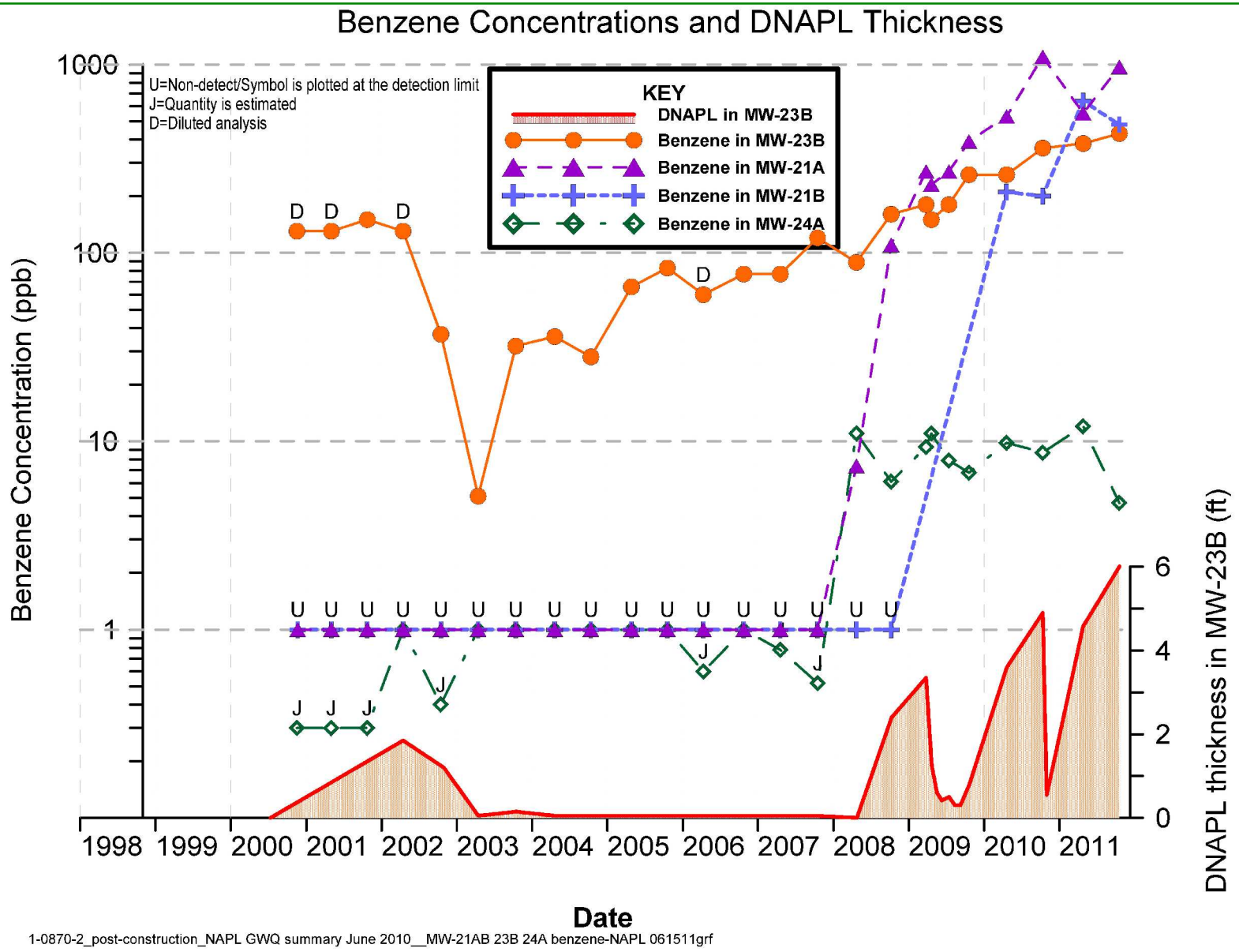
Date	10/11
B	1.0 U
T	1.0 U
E	1.0 U
mpX	1.0 U
X	1.0 U
oX	1.0 U

Date	10/11
B	1.0 U
T	1.0 U
E	1.0 U
mpX	1.0 U
X	1.0 U
oX	1.0 U

FIGURE 4-8: 2011 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: 12/26/11 DRAWN BY: TJK PROJECT: 1–0870–2 SCALE: 1"=100'



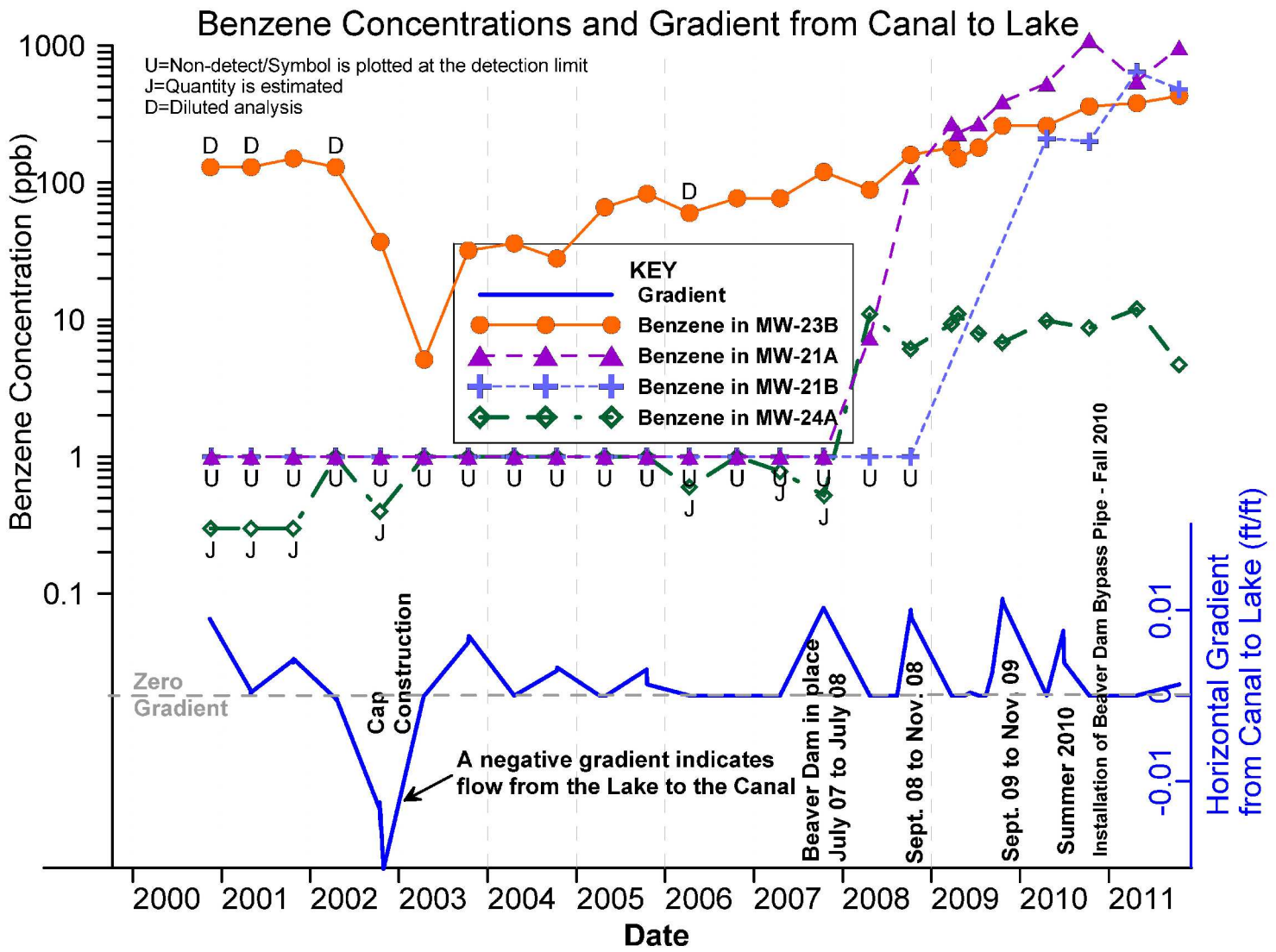
1-0870-2_post-construction_NAPL GWQ summary June 2010__MW-21AB 23B 24A benzene-NAPL 061511grf

FIGURE 4-9: BENZENE CONCENTRATIONS AND DNAPL THICKNESS
PINE STREET CANAL SITE, BURLINGTON, VERMONT

CAD\FALL 2011\Figure 4-9.pdf
CAD\FALL 2011\Benzene.apr

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

DATE: 01/05/12 PROJECT: 1-0870-2
DRAWN BY: TJK SCALE: AS SHOWN



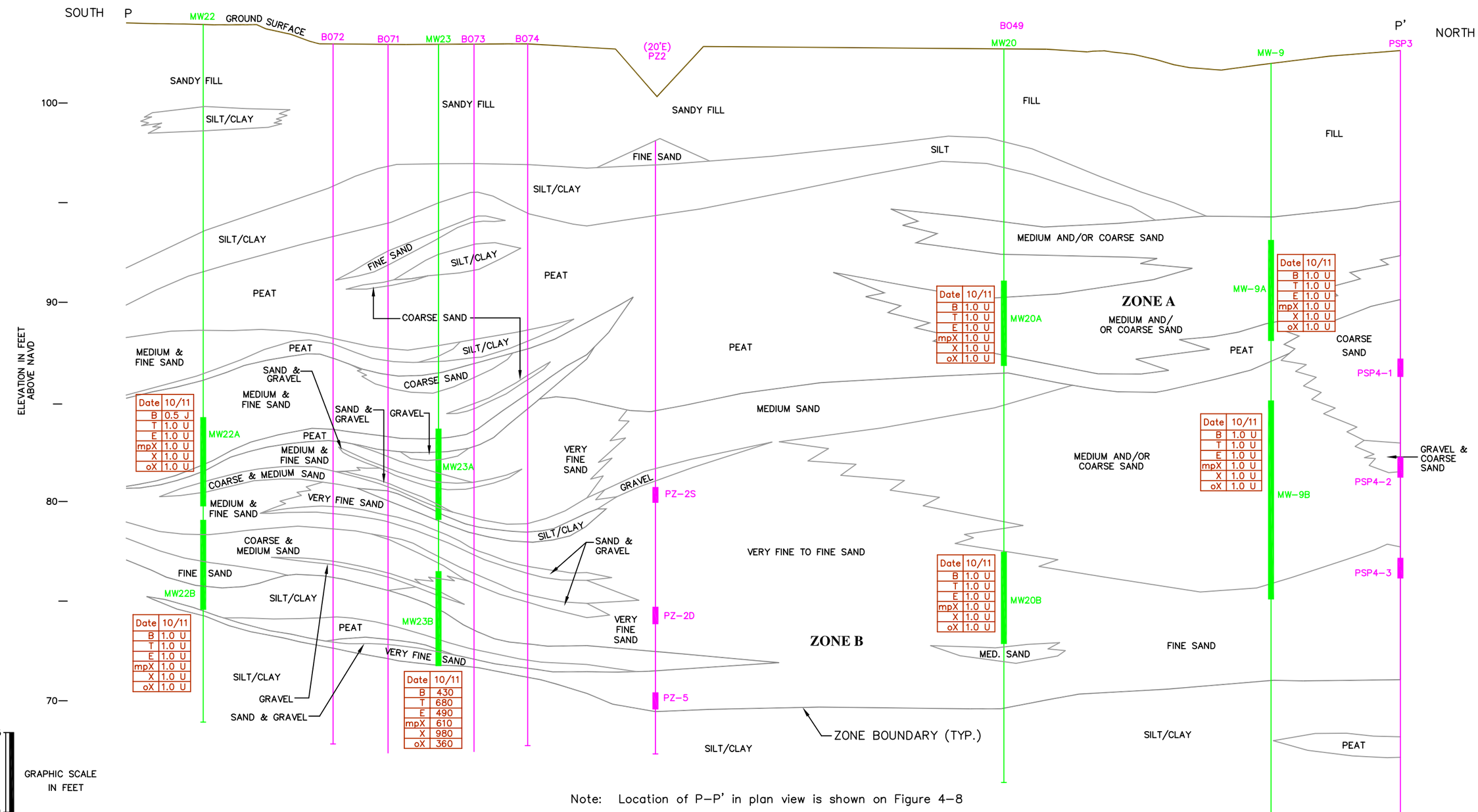
1-0870-2_post-construction_NAPL GWQ summary June 2010__MW-21AB 23B 24A benzene and VG 061511grf

FIGURE 4-10: BENZENE CONCENTRATIONS AND HYDRAULIC GRADIENTS PINE STREET CANAL SITE, BURLINGTON, VERMONT

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

DATE: 01/05/12 PROJECT: 1-0870-2
DRAWN BY: TJK SCALE: AS SHOWN

CAD\FALL 2011\Figure 4-10.pdf
CAD\FALL 2011\Benzene.apr



Date	10/11
B	0.5 J
T	1.0 U
E	1.0 U
mpX	1.0 U
X	1.0 U
oX	1.0 U

Date	10/11
B	1.0 U
T	1.0 U
E	1.0 U
mpX	1.0 U
X	1.0 U
oX	1.0 U

Date	10/11
B	1.0 U
T	1.0 U
E	1.0 U
mpX	1.0 U
X	1.0 U
oX	1.0 U

Date	10/11
B	1.0 U
T	1.0 U
E	1.0 U
mpX	1.0 U
X	1.0 U
oX	1.0 U

Date	10/11
B	1.0 U
T	1.0 U
E	1.0 U
mpX	1.0 U
X	1.0 U
oX	1.0 U

Date	10/11
B	1.0 U
T	1.0 U
E	1.0 U
mpX	1.0 U
X	1.0 U
oX	1.0 U

Date	10/11
B	430
T	680
E	490
mpX	610
X	980
oX	360

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

BTEX KEY

B Benzene
T Toluene
E Ethylbeneze
mpX m,p–Xylene
X Xylene (total)
oX o–Xylene
NS Not Sampled
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 4-11
2011 BTEX ANALYSIS RESULTS (ug/L)
CROSS SECTION P - P'
PINE STREET CANAL SITE, BURLINGTON, VT

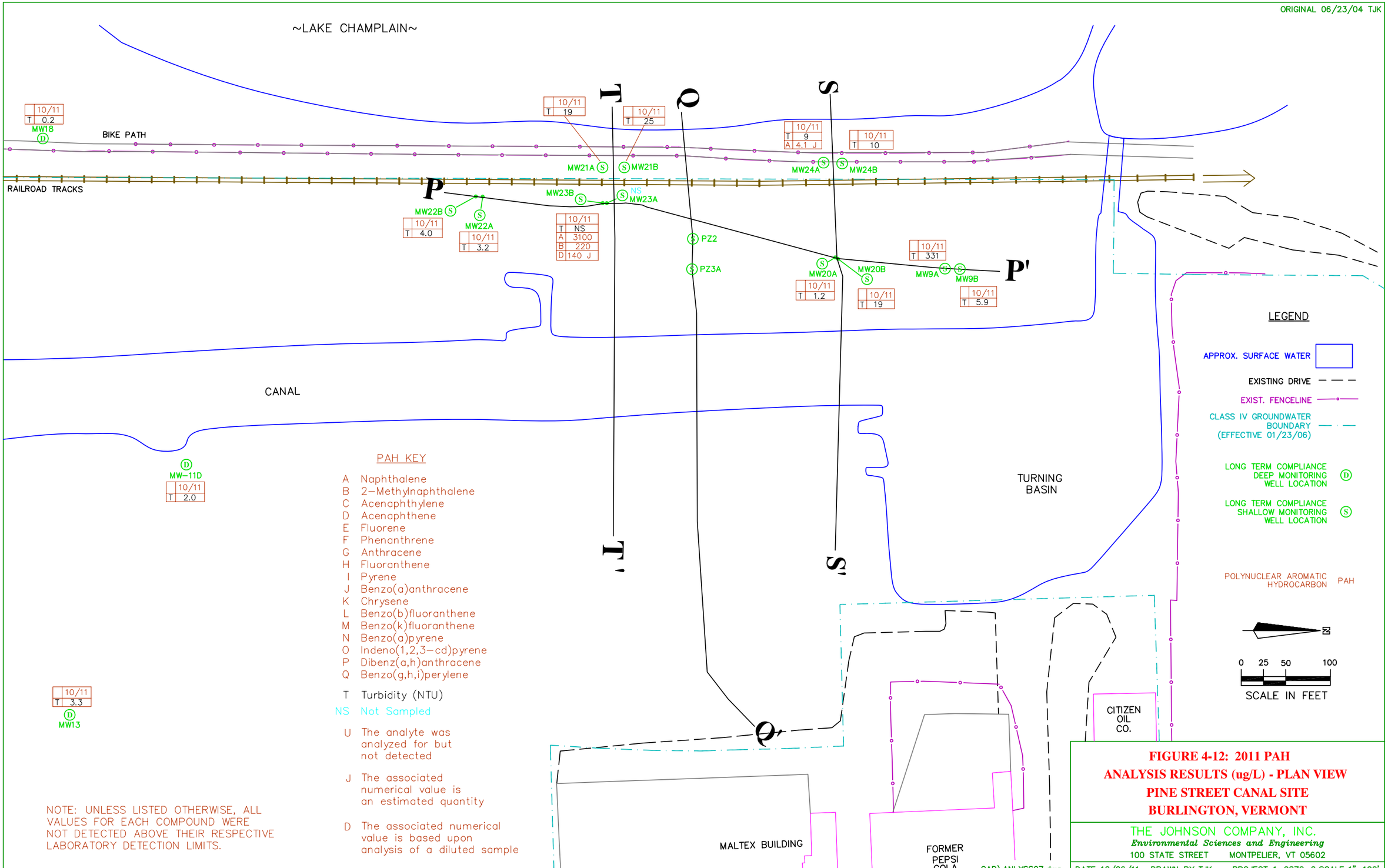
THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

DATE: 12/26/11 DRAWN BY: TJK PROJECT: 1–0870–2 SCALE: SHOWN

ORIGINAL 6/23/04 TJK

GEOP2007.dwg

ORIGINAL 06/23/04 TJK



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
- U The analyte was analyzed for but not detected
- J The associated numerical value is an estimated quantity
- D The associated numerical value is based upon analysis of a diluted sample

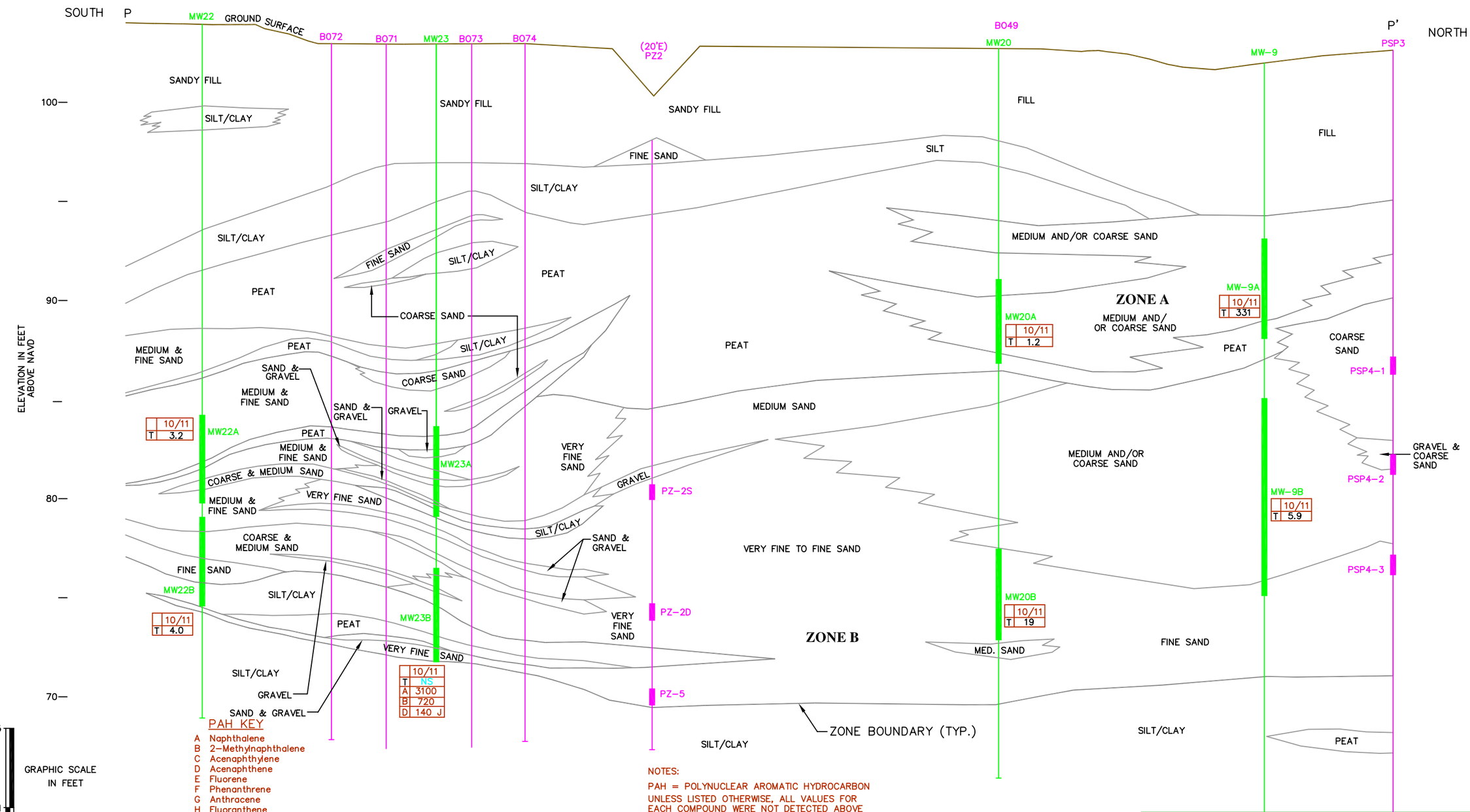
NOTE: UNLESS LISTED OTHERWISE, ALL VALUES FOR EACH COMPOUND WERE NOT DETECTED ABOVE THEIR RESPECTIVE LABORATORY DETECTION LIMITS.

FIGURE 4-12: 2011 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: 12/26/11 DRAWN BY: TJK PROJECT: 1-0870-2 SCALE: 1"=100'

CAD\ANLYSS07.dwg



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
- U The analyte was analyzed for but not detected
- J The associated munerical value is an estimated quantity
- D The associated numerical value is based upon analysis of a diluted sample

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

2011 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

DATE: 12/26/11 DRAWN BY: TJK PROJECT: 1-0870-2 SCALE: SHOWN

ORIGINAL 6/23/04 TJK

GEOP2007.dwg

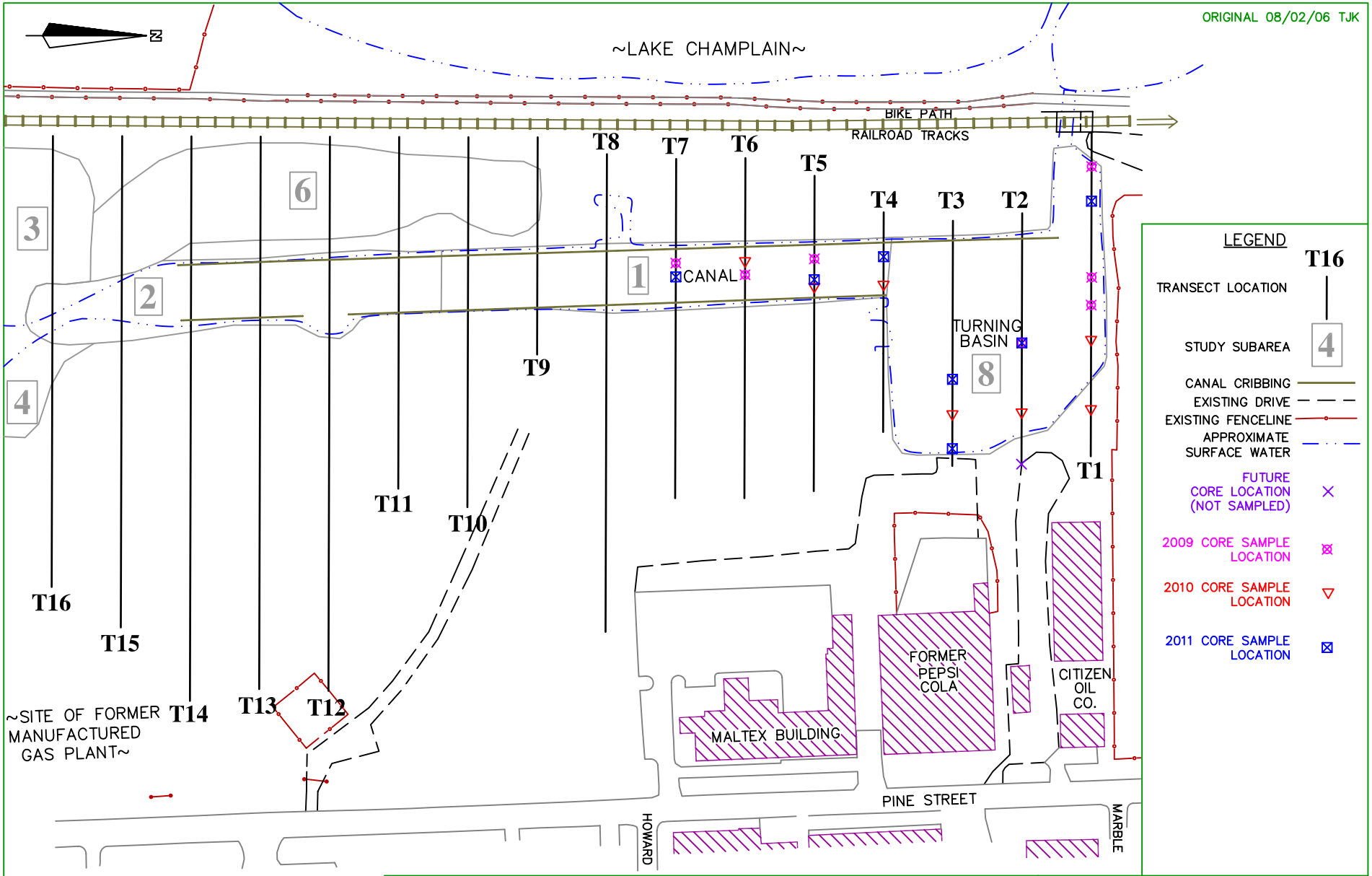


FIGURE 4-14
CORE SAMPLING LOCATIONS - AREAS 1, 2, & 8
PINE STREET CANAL SITE, BURLINGTON, VERMONT

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

DATE: 12/26/11 (REV.) PROJECT: 1-0870-2
DRAWN BY: TJK SCALE: 1"=200'

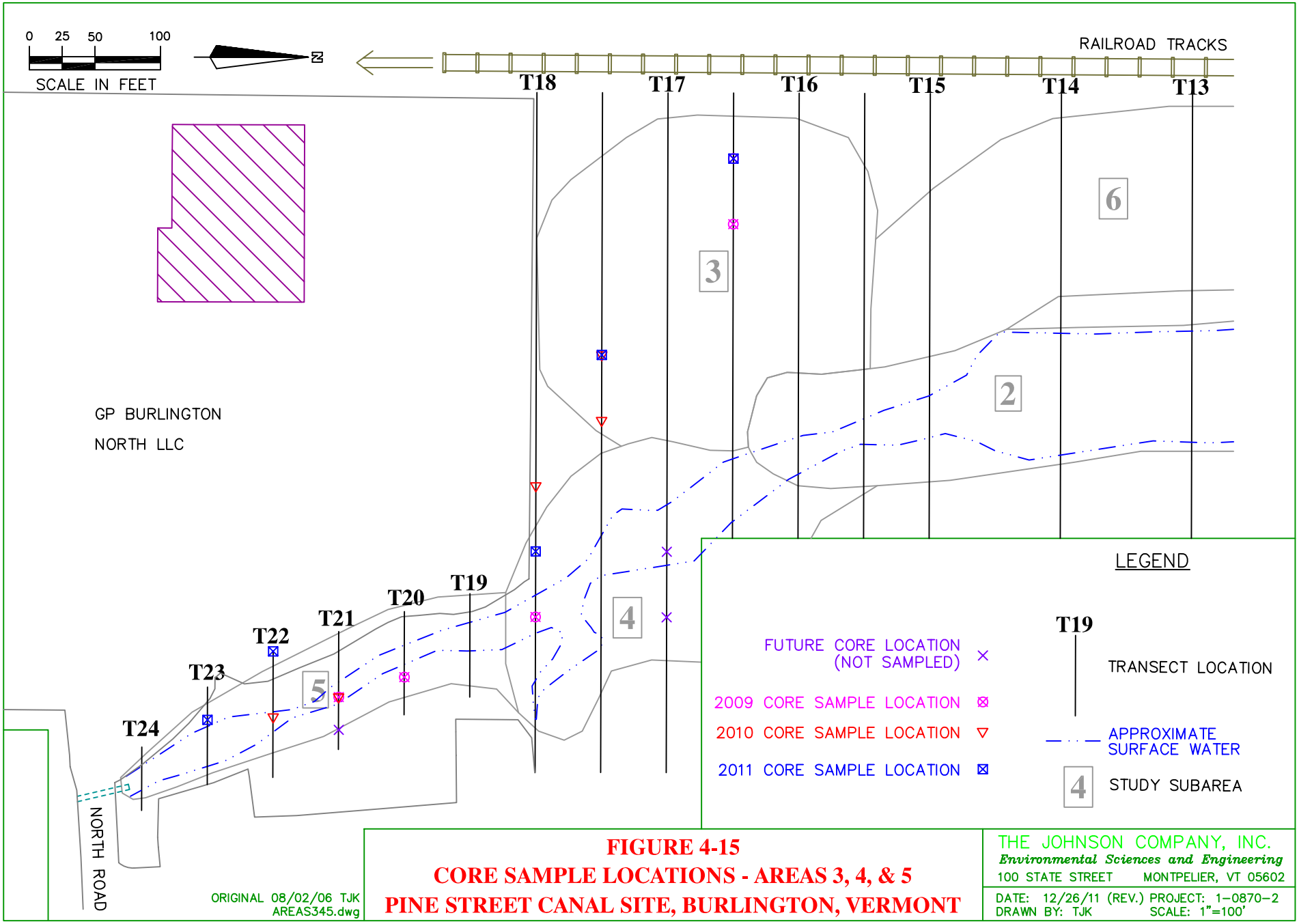
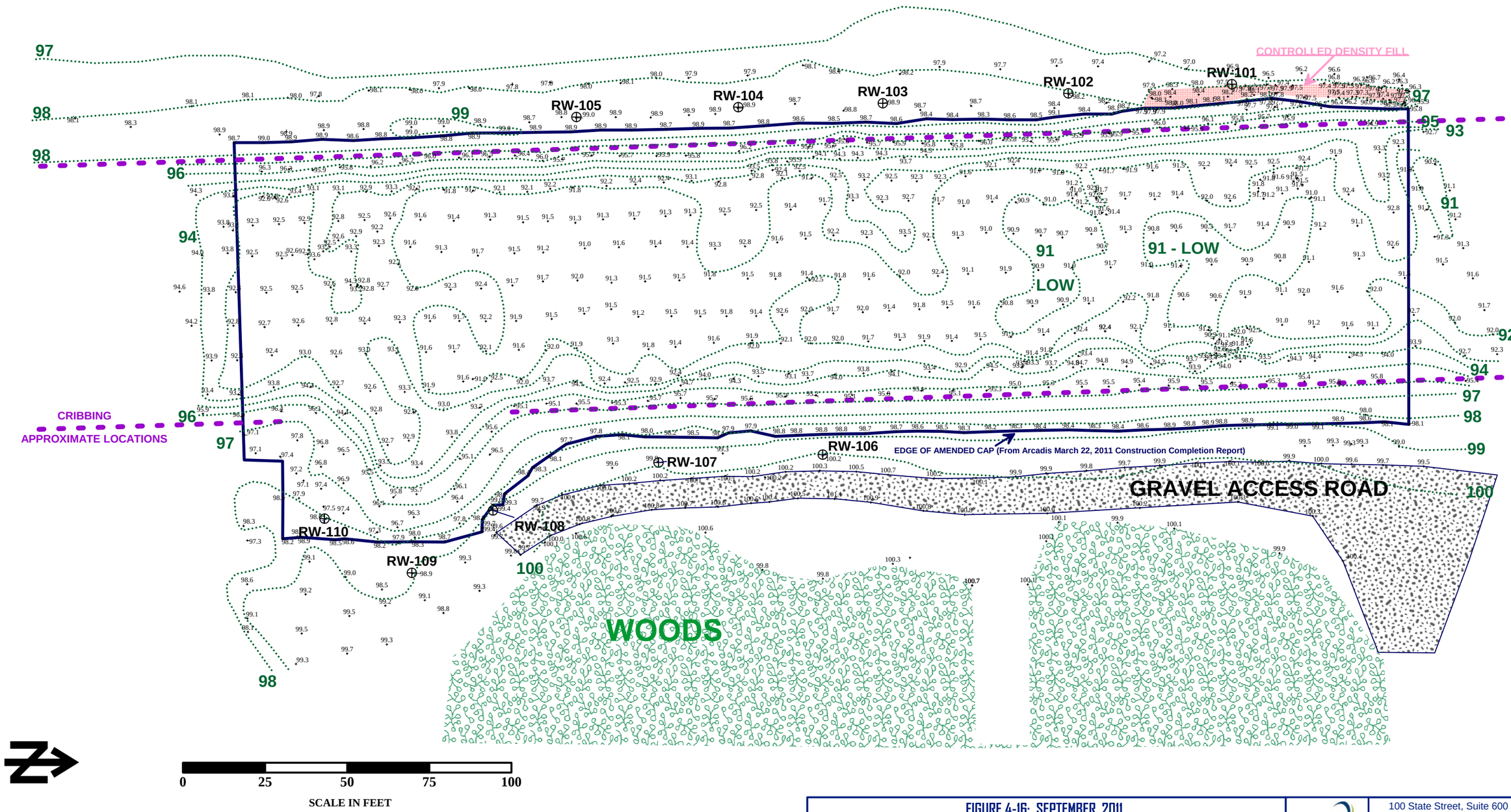


FIGURE 4-15
CORE SAMPLE LOCATIONS - AREAS 3, 4, & 5
PINE STREET CANAL SITE, BURLINGTON, VERMONT

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

DATE: 12/26/11 (REV.) PROJECT: 1-0870-2
DRAWN BY: TJK SCALE: 1"=100'



Elevation Data provided by Little River Survey in feet NAVD88
1-0870-2_Post Construction Compliance_Fall 2011 CMR_010512 Figure 4-16 2011 Bathymetry survey.srf

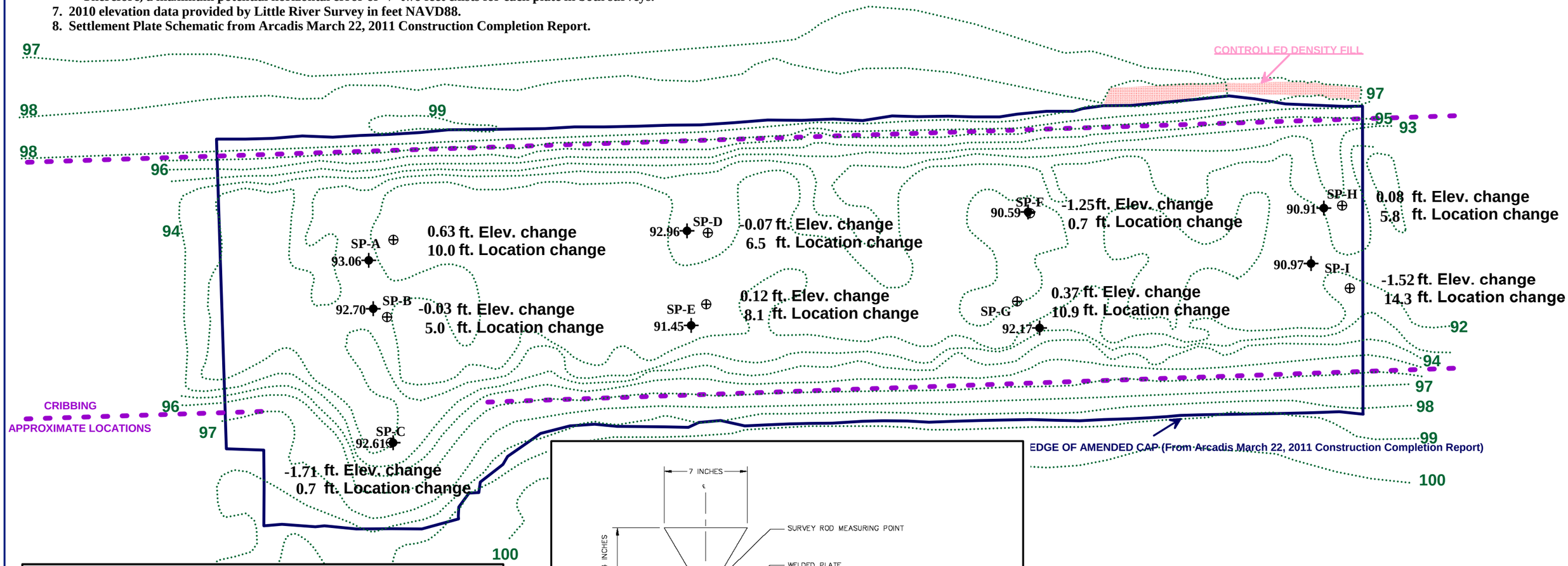
FIGURE 4-16: SEPTEMBER, 2011
AMENDED CAP BATHYMETRY
PINE STREET CANAL SUPERFUND SITE
453 PINE ST., BURLINGTON, VERMONT

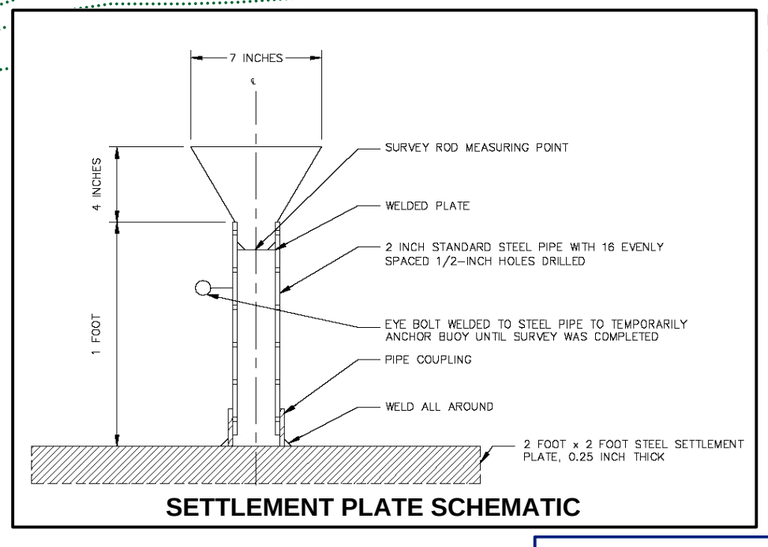
The Johnson Company
100 State Street, Suite 600
Montpelier, VT 05602
(802) 229-4600

Drawn by: DMM Date: 10/24/2011
Chk'd by: J-B Date: 10/25/2011
Scale: AS SHOWN Project: 1-0870-2 (256)

NOTES:

1. The settlement plates are approximately 2-foot by 2-foot metal plates that were fabricated to include an inverted cone on top of a 1-foot long pipe to assist surveying (see schematic below).
2. Discussions with Little River Survey indicate that attempts to insert the survey rod into the cone and pipe in 2010 may not have been successful in every case.
3. In 2011, The Johnson Company was only able to insert the rod into the cone and pipe at one location, SP-C. The SP-C plate elevation was also measured.
   The difference in elevation between the SP-C cone/pipe and the plate itself was 1.1 feet (greater than the schematic indicates potentially due to sediment buildup in the cone).
4. 2011 elevations shown on Figure are all top of plate elevations. Indicated elevation change calculated assuming 2010 measurements were all also top of plate elevations.
5. Approximately 1.1 feet of the observed elevation differences at Plates SP-C, SP-F and SP-I may be due to successful survey of the cone/pipe in 2010 (rather than the plate).
6. Although considerable effort was made to place the survey rod near the center of the plates, the precise horizontal location of the survey rod relative to the plate dimensions is uncertain.
   Therefore, a maximum potential horizontal error of +/- two feet exists for each plate in both surveys.
7. 2010 elevation data provided by Little River Survey in feet NAVD88.
8. Settlement Plate Schematic from Arcadis March 22, 2011 Construction Completion Report.





SETTLEMENT PLATE SCHEMATIC

LEGEND

⊕ December 2010 Plate Location (Surveyed by Little River Survey)

92.70 ✦ November 2011 Plate Location and Elevation (Surveyed by The Johnson Company)

92 Bathymetric/Topographic Contours (September, 2011) (one foot contour interval in feet NAVD88)

0 25 50 75 100
SCALE IN FEET

FIGURE 4-17
NOVEMBER, 2011 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: 12/02/2011
Chk'd by: J-B Date: 12/6/2011
Scale: AS SHOWN Project: 1-0870-2 (258)

1-0870-2_Post Construction Compliance_Fall 2011 Compliance Monitoring Report_010512 Figure 4-17 2011 Settlement Plate Survey.srf

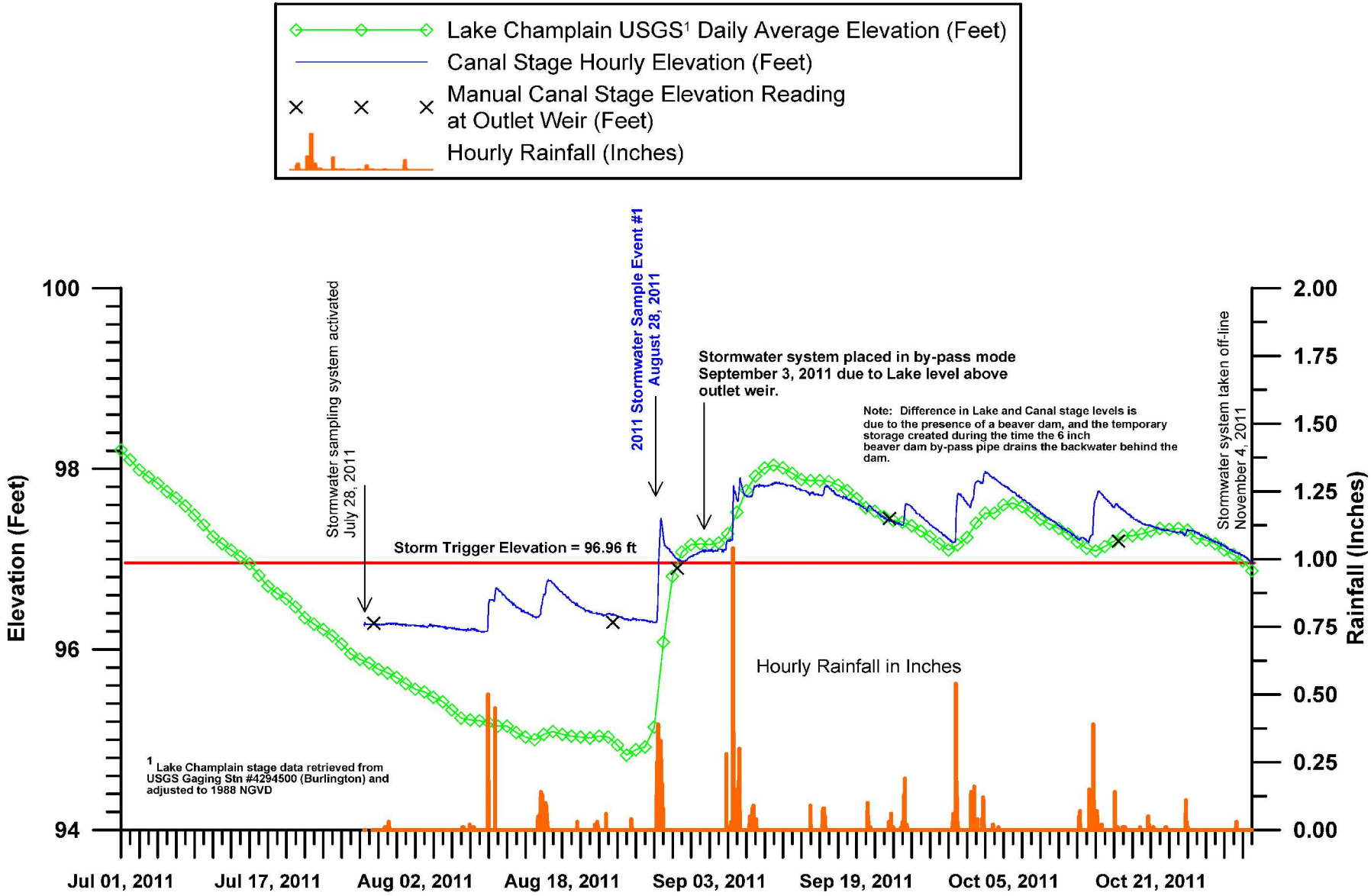


FIGURE 4-18
2011 STORMWATER MONITORING DATA
PINE STREET CANAL SITE, BURLINGTON, VERMONT

CAD\FALL 2011\Figure 4-18.pdf
CAD\FALL 2011\Stormwater.apr

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

DATE: 12/26/11 PROJECT: 1-0870-2
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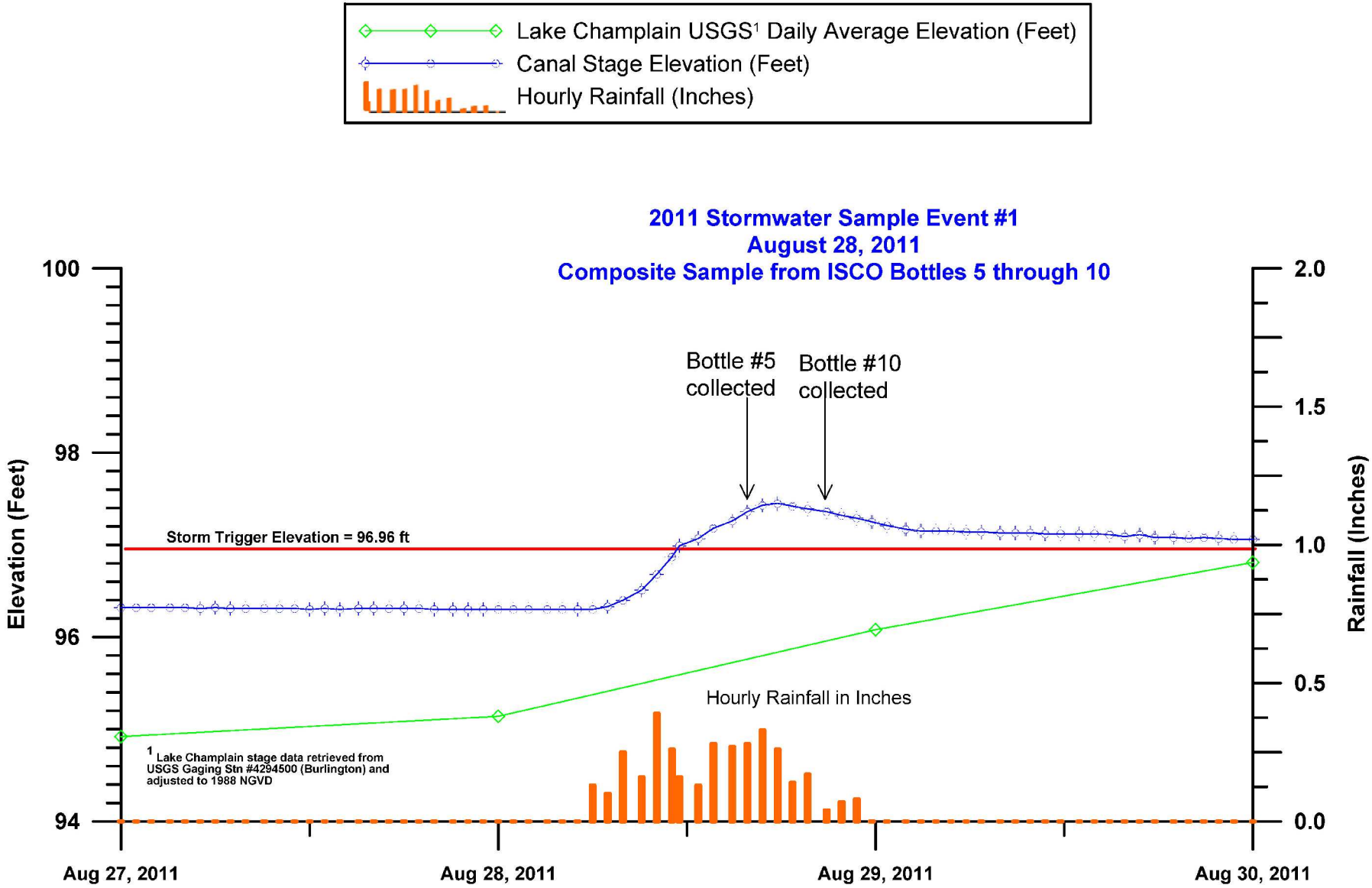

FIGURE 4-19
2011 STORMWATER SAMPLE EVENT #1
PINE STREET CANAL SITE, BURLINGTON, VERMONT

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