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January 11, 2011

VIA FEDEX

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RE: Fall 2010 Compliance Monitoring Report
Pine Street Canal Superfund Site, Burlington, Vermont

Dear Ms. Lumino and Mr. Smith:

On behalf of the Performing Defendants and pursuant to Section IV.B.3. of the Statement of Work, attached is the Fall 2010 Compliance Monitoring Report.

Please do not hesitate to call me at (781) 642-8775 should you have any questions.

Sincerely,
de maximis, inc.

Carol LaCom for:

Thor Helgason
Project Coordinator

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Kenneth Munney - U. S. Fish and Wildlife Service/DOI

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COMPLIANCE MONITORING REPORT

Fall 2010

Pine Street Canal Superfund Site
Burlington, Vermont

Prepared for

Performing Defendants

Submitted to

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

PREPARED BY:

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Revision 0
January 2011

Disclaimer

This document is a DRAFT document prepared by the Performing Defendants under a government Consent Decree. This document has not undergone formal review by the EPA and VT DEC. The opinions, findings, and conclusions, expressed are those of the author and not those of the U.S. Environmental Protection Agency and VT DEC.

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Appendix 2 Summary of Potentiometric Data
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Appendix 4 Lake and Climate Data
Appendix 5 Summary of all Analytical Data and Groundwater Field Data
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1.0 INTRODUCTION

This document is the Compliance Monitoring Report for monitoring activities performed during summer and fall 2010 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. 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). 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 2010. The monitoring performed during this period includes the fall 2010 groundwater monitoring; surface water quality monitoring; cap coring and analysis; biological monitoring; weir inspection; stormwater inflow monitoring; and sediment transport monitoring.

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); and laboratory-supplied data packages (Appendix 7).

2.0 FIELD SAMPLING/MONITORING ACTIVITIES

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

- Groundwater Monitoring
  - Water level and field parameter monitoring in groundwater monitoring wells
  - Sampling and laboratory analysis of groundwater in unconsolidated deposits
  - Sampling and laboratory analysis of groundwater in bedrock monitoring wells
  - Monitoring for presence of non-aqueous phase liquid (NAPL) in groundwater monitoring wells, and removal of NAPL as feasible

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

- Cap Monitoring
  - Cap coring and analysis
  - Non Aqueous Phase Liquid Probing

- Biological Monitoring
  - Benthic macroinvertebrate sampling
  - Aquatic vegetation observations

- Inspection of the outlet weir

- Stormwater in-flow monitoring (sediment traps)

- 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 2010

Location	Description	NAPL Measurement Performed	Sampled for Laboratory Analysis	Water Level Measurements Completed	Visual Field Evaluations
Groundwater Monitoring					
MW-20A	Shallow well	NM	10/11/10	10/11/10	N/A
MW-20B	Shallow well	NM	10/11/10	10/11/10	N/A
MW-21A	Shallow well	10/12/10	10/12/10	10/11/10, 10/12/10	N/A
MW-21B	Shallow well	10/12/10	10/12/10	10/11/10, 10/12/10	N/A
MW-22A	Shallow well	NM	10/12/10	10/11/10, 10/12/10	N/A
MW-22B	Shallow well	NM	10/12/10	10/11/10, 10/12/10	N/A
MW-23A	Shallow well	10/14/10	NS	10/11/10, 10/14/10	N/A
MW-23B	Shallow well	10/14/10, 11/1/10	10/12/10	10/11/10, 10/12/10, 10/14/10	N/A
MW-24A	Shallow well	10/12/10	10/12/10	10/11/10, 10/12/10	N/A
MW-24B	Shallow well	10/12/10	10/12/10	10/11/10, 10/12/10	N/A
MW-9A	Shallow well	NM	10/11/10	10/11/10	N/A
MW-9B	Shallow well	NM	10/11/10	10/11/10	N/A
MW-1B	Deep well	10/14/10	NS	10/14/10	N/A
MW-3C	Deep well	10/14/10	NS	10/14/10	N/A
MW-4B	Deep well	10/14/10	NS	10/14/10	N/A
MW-8A	Deep well	10/14/10	NS	10/14/10	N/A
MW-11D	Deep well	NM	10/13/10	10/11/10, 10/13/10	N/A
MW-12	Deep well	10/14/10	NS	10/14/10	N/A
MW-13	Deep well	NM	10/13/10	10/11/10, 10/13/10	N/A
MW-17	Shallow well	10/14/10, 11/1/10	NS	10/14/10	N/A
MW-18	Deep well	NM	10/13/10	10/11/10, 10/13/10	N/A
MW-19	Deep well	10/14/10	NS	10/14/10	N/A
P-106	Deep well	NM	NS	NM	N/A
WE 89-5S	Gilbane shallow well	NM	NS	10/11/10	N/A

TABLE 2-1
COMPLIANCE MONITORING ACTIVITIES – SUMMER AND FALL 2010

Location	Description	NAPL Measurement Performed	Sampled for Laboratory Analysis	Water Level Measurements Completed	Visual Field Evaluations
WE 89-6S	Gilbane shallow well	NM	NS	10/11/10	N/A
WE 89-7S	Gilbane shallow well	NM	NS	10/11/10	N/A
FLA-1	Gilbane shallow well	NM	NS	10/11/10	N/A
FLA-4	Gilbane shallow well	NM	NS	10/11/10	N/A
Surface Water Monitoring					
Outlet to Lake T1+50W80	Surface Water	N/A	6/28/10	N/A	N/A
Cap Monitoring					
Area 1: T4+00E60	Cap coring location	N/A	6/29/10	N/A	6/29/10
Area 1: T5+00E60	Cap coring location	N/A	6/30/10	N/A	6/30/10
Area 1: T6+00E20	Cap coring location	N/A	6/30/10	N/A	6/30/10
Area 3: T17+50E200	Cap coring location	N/A	6/28/10	N/A	6/28/10
Area 3: T17+50E250	Cap coring location	N/A	6/28/10	N/A	6/28/10
Area 4/5: T18+00E300	Cap coring location	N/A	6/28/10	N/A	6/28/10
Area 4/5: T21+00E50	Cap coring location	N/A	6/30/10	N/A	6/30/10
Area 4/5: T22+00E50	Cap coring location	N/A	6/30/10	N/A	6/30/10
Area 8: T1+00E250	Cap coring location	N/A	6/29/10	N/A	6/29/10
Area 8: T1+00E400	Cap coring location	N/A	6/29/10	N/A	6/29/10
Area 8: T2+00E250	Cap coring location	N/A	6/29/10	N/A	6/29/10

TABLE 2-1
COMPLIANCE MONITORING ACTIVITIES – SUMMER AND FALL 2010

Location	Description	NAPL Measurement Performed	Sampled for Laboratory Analysis	Water Level Measurements Completed	Visual Field Evaluations
Area 8: T3+00E250	Cap coring location	N/A	6/29/10	N/A	6/29/10
Between T9+30 and T14+20	Cap surface NAPL probing	7/1/10	N/A	N/A	7/1/10
Biological Monitoring					
Area 8: T1+00E250	Benthic macroinvertebrate, TOC, AVS/SEM, and grain size sampling	N/A	6/29/10	N/A	6/29/10
Area 1: T4+00E60	Benthic macroinvertebrate, TOC, AVS/SEM, and grain size sampling	N/A	6/29/10	N/A	6/29/10
Area 4/5: T21+00E50	Benthic macroinvertebrate, TOC, AVS/SEM, and grain size sampling	N/A	6/30/10	N/A	6/29/10
Outlet Weir					
Outlet to Lake Champlain	Visual inspection for integrity and elevation survey	N/A	N/A	N/A	9/7/10
Stormwater Inflow Monitoring					
SD1+28 W25 SD2+08 E50 SD2+33 E155 SD4+62 E47 SD7+25 E43 SD9+08 E45 SD11+70 E35 SD12+68 E55	Retrieve sediment from traps and re-install traps for subsequent year	N/A	6/24/10	N/A	N/A

TABLE 2-1
COMPLIANCE MONITORING ACTIVITIES – SUMMER AND FALL 2010

Location	Description	NAPL Measurement Performed	Sampled for Laboratory Analysis	Water Level Measurements Completed	Visual Field Evaluations
Sediment Transport Monitoring					
Outlet to Lake	Automated stage recording and stormwater sampling	N/A	NS	June to October 2010	N/A

NS = Not sampled
NM = Not measured
N/A = Not applicable

2.1 GROUNDWATER

2.1.1 Groundwater Level Measurements

Groundwater level measurements were performed according to *Site Specific Method #9 - Water Level Measurements*, and recorded in field log books (Appendix 1). Groundwater level measurements in shallow wells for potentiometric map generation were performed on October 11, 2010, 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 2010 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 11 – 13, 2010 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

NAPL monitoring was performed on October 14, 2010, 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, MW-23A, and MW-23B. One monitoring well normally included in the routine NAPL monitoring network (P_106) could not be accessed on October 14 due to construction activities related to the installation of the amended cap and was therefore not measured. 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 on October 12, 2010. 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 60 minutes following NAPL removal, and again approximately 24 hours 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 2010 are shown on Figure 2-2.

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 2.3). Water samples for chemical analyses were collected from the Turning Basin outlet up-stream from the railroad bridge on June 28, 2010. 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. However, it was not possible to meet the precipitation criteria and still meet the cap coring schedule. Approximately 1.0 inches of rain was registered at Burlington Airport on June 24, 2010 and 0.7 inches of rain was registered on June 28, 2010.

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 4.2.1.

2.2.1 Visual Inspections

Visual inspections of the Canal were performed as part of routine monitoring activities during the summer of 2010. The visual inspections of the surface water for sheens, bubbles and NAPL were generally performed from a canoe or boat. Gas bubbles, NAPL or sheens observed emanating to the water surface were recorded, and visual estimates of the locations were made. No sheens were observed after July 1, 2010 which was the last day of compliance monitoring activities in Area 2 prior to construction of the Amended Cap. Use of the canal by waterfowl in areas where sheens or NAPL have been observed between T7 and T12 was also noted. The observations are summarized in Section 4.2.2.

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 June 28 and June 30, 2010. 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 event was similar to the 2008 and 2009 monitoring events in that cap coring in Area 2 was not performed as portions of that area are subject to the Amended Cap installation.

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:

<u>Area 8 (Turning Basin)</u>
J_T1+00 E250
J_T1+00 E400
J_T2+00 E250
J_T3+00 E250

<u>Area 1 (northern Canal)</u>
J_T4+00 E60
J_T5+00 E60
J_T6+00 E20

<u>Area 3 (wetlands cap)</u>
J_T17+50 E200
J_T17+50 E250

<u>Area 4/5 (non-capped wetlands & tributary area)</u>
J_T18+00 E300

J_T21+00 E50
J_T22+00 E50

Cores were collected on June 28-30, 2010 at these locations except J_T1+00E400. The sample location at J_T1+00 E400 had to be adjusted in the field so that it fell within the capped surface of the canal. This sample point was part of the original sampling grid but was outside the as-built capped area. The actual sampling point was moved south and west to the closest point within the capped area. A deviation alert was prepared to document this field adjustment and is located within Appendix 6.

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 June 28 and 30, 2010.

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 Non-Aqueous Phase Liquid Probing

As part of the 2010 cap monitoring program, NAPL probing of the cap surface was completed on July 1, 2010 to identify any signs of non-aqueous phase liquids (NAPL) on the cap surface. In accordance with the Compliance Monitoring Work Plan, the probed locations were

located approximately 20 feet east of the canal west cribbing at intervals of approximately 25 feet in a north-south direction between Transects T9+30 and T14+20. Additional probing was conducted on five transects (T9+50, T10+00, T10+50, T11+00, and T11+50) at points 30, 40, 50, and 60 feet east of the west canal cribbing. The NAPL probing locations are shown on Figure 4-15.

The NAPL probing was conducted using strips of white, oil-only absorbent pads secured to the bottom of a thin fiberglass rod. At each location a new strip was briefly lowered to the cap surface then visually inspected for evidence of NAPL. In addition to the NAPL probing, each of the four NAPL recovery wells (RW14, RW11, RW10+25, and RW9+80) located along the west bank (see Figure 2-2) were inspected using a bailer for accumulation of NAPL. Results of the NAPL probing effort are presented in Section 4.3.2 below.

2.4 BIOLOGICAL MONITORING

2.4.1 Benthic Survey

The benthic macroinvertebrate and sediment sampling was performed on June 29 and 30, 2010. Samples were collected in Areas 8, 1, and 4/5 using an Ekman grab, 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, Area 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. Sample locations are shown on Figure 2-4, and are as follows:

- Turning Basin, Area 8: J_T1+00E250
- Canal, Areas 1 and 2: J_T4+00E60
- Area 4/5: J_T21+00E50

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 4.3.3.

2.4.2 Aquatic Vegetation

Observations of aquatic vegetation over the subaqueous caps on the Site were made on June 29 and 30, 2010, during the benthic macroinvertebrate sampling. The results of the qualitative vegetation monitoring are presented in Section 4.3.4.

2.5 WEIR INSPECTION

The outlet weir was inspected for settlement, erosion and integrity on September 7, 2010. 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 7, 2010 to determine the relative elevations of the weir abutments and the railroad bridge abutments. Results are presented in Section 4.4.

2.6 STORMWATER IN-FLOW`

Sediment traps were designed 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.

Sediment traps were originally installed on March 2, 2005, in subaqueous cap Areas 1, 2 and 8 (see Figure 2-5). Three sediment traps were installed in Area 1 (SD9+08E45, SD7+25E43, and SD4+62E47), two in Area 2 (SD11+70E35 and SD12+68E55), and three in Area 8 (SD1+28W25, SD2+08E50, and SD2+33E155). Sediment trap locations were selected taking into consideration as-built bathymetry to ensure that sufficient water depth is present at each location to allow the traps to extend above the cap surface and not be impacted by formation of ice on the water's surface. These locations have been monitored annually since the original installation date.

All sediment traps for this report were constructed and installed as presented in Section 6.3 of the FSP from the CMWP (JCO, 2006). All sediment traps were installed immediately following the 2009 sediment trap retrieval on November 17 and 18, 2009. A duplicate sediment trap was installed adjacent to location SD7+25E43 for data quality verification. At all locations buoys were attached to both the inner and outer sediment trap sleeves to designate the sediment trap locations for future sample collection and to provide a retrieval method for sample collection.

The sediment traps were collected on June 24, 2010. Sediment trap collection occurred in June 2010 rather than the normal fall collection time frame specified in the CMWP to avoid complications that might have resulted from the construction of the amended cap. The traps were retrieved by first locating the buoys in the Canal and/or Turning Basin, followed by locating the existing tie off ropes attached to the inner sleeve of the sediment traps. Once the inner sleeve ropes were located, the inner sleeve was retrieved by the attached retrieval lines.

Once the inner sleeves were retrieved, the contents of the inner sleeves were sampled as outlined below:

1. Each sediment trap sleeve was carefully decanted at each location so that no solids were lost, while retaining a sufficient amount of water in the sleeve to allow for transfer of the solids.

2. The contents of the sleeve were transferred into a 1-liter wide-mouth glass sample container by pouring the water/sediment mixture into the container. The contents in the sleeve were first agitated into a slurry-like composition, and then poured into the sample container, such that all the contents were transferred to the sample containers.

3. Water reserved from the sleeve decanting process was used to rinse out any remaining solids from the sleeve into the sample container with a triple rinse.

4. The volume of solids in each container was estimated based upon visual observations after the solids had settled.

5. The samples were packaged and shipped to the laboratory for analysis by the methods described in the FSP: polynuclear aromatic hydrocarbons (PAHs) by EPA Method 8270; selective ion monitoring (SIM); and metals by EPA Methods 6010B/7471A.

6. Upon receipt at the laboratory, the samples were logged in and placed in refrigeration pending processing. The samples were further decanted and centrifuged by the lab so that sufficient solids were present for the analysis to be performed.

2.7 SEDIMENT TRANSPORT MONITORING

2.7.1 Trigger Stage Modeling

For the 2010 sediment transport monitoring season (June through November 2010) a trigger stage elevation of 96.83 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 96.83 trigger limit of 2009 was retained for the 2010 stormwater monitoring season since no storm events triggering sampling occurred in 2009.

2.7.2 Sediment Transport Monitoring

The sediment transport monitoring apparatus was installed on June 22, 2010. 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 June 23, 2010. The system was fully operational on June 23, 2010.

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 96.83 ft. If the lake level is below the top of the weir and the canal trigger elevation is exceeded, the program initiates sampling by pulsing the ISCO sampler. Two 10-psi Keller pressure transducers were used to monitor stage fluctuations. One transducer was placed in the Canal approximately 30 feet east of the weir, and the other transducer in Lake Champlain, approximately 50 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.

No storm events large enough to trigger the automated sampling system occurred during the 2010 monitoring season. A failure of the data logger battery was discovered July 20, 2010 which resulted in a loss of stormwater monitoring data from July 13-20, 2010. The cause of the failed battery was related to a disconnected terminal from the solar panel that charges the battery, which appeared to be the result of a vandalism attempt to remove the solar panel. Later in the summer (sometime in late August) the solar panel used to charge the data logger battery was stolen from inside of the enclosure. No data were lost from the data logger as a result of this theft because it was discovered before all the power in the battery drained. A replacement solar panel was installed on September 1, 2010. The system remained on-line from September 1 to

October 8, 2010 when damage to both surface water transducers was discovered. The damage was likely related to the removal of the adjacent beaver dam located approximately 50 feet east of the transducer installations by Arcadis on October 8, 2010. The system was deactivated on October 8, 2010 due to the damaged transducers, and also due to heavy rains which had increased the Lake Champlain stage level to equal that of the canal. A graph of the 2010 stormwater monitoring data is presented as Figure 4-17.

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 2010 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) and sediment trap samples 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 (QA) associated with field procedures is presented in Section 3.2.

Ten percent of the cap chemistry data for the summer 2010 cap core sample group were validated by the Independent Data Validator (IDV), Phoenix Chemistry Services, Inc., per the schedule outlined in the CMWP. In accordance with Table 4-1 of the QAPP, 10 percent of the water samples are subject to the IDV. The data validation for 2010 water samples was performed on the spring 2010 groundwater sample group, thereby fulfilling this requirement.

Since all cap core and sediment trap data requires validation, the laboratory reports were delivered to the IDV for validation. The IDV report on the validated sample delivery group for the cap core samples collected June 28-30, 2010 (Katahdin SDG No. PSC-10) was received at The Johnson Company on November 15, 2010. The IDV report for the sediment trap data collected June 24, 2010 was received November 16, 2010. Discussions of the independently validated quality control sample results for the cap core samples are presented in Section 3.4.2, and for the sediment trap data in Section 3.4.3.

3.2 LABORATORY QUALITY ASSURANCE ON NON-VALIDATED DATA

Surface Water – June 2010

The June 2010 surface water sample was collected June 28, 2010 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 July 14, 2010, 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 samples and associated method blank, blank spike, matrix spike (MS), and matrix spike duplicate (MSD), were all run within the method-prescribed quality control (QC) criteria. The laboratory reported that the results for the initial calibration curve responses for some of the analytes were outside the QC limit. Specifically, indeno (1,2,3-cd) pyrene (reported at 26.9% relative standard deviation or RSD), dibenz (a,h) anthracene (25% RSD) and benzo (g,h,i) perylene (25.9% RSD) exceeded the QC limit of 15% RSD. None of these compounds were detected in any of the samples, however, and there are no adverse impacts to the usability of the data set.

Sediment Grab Samples Associated with Biological Monitoring – June 2010

Sediment grab samples collected June 29 and 30, 2010 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 chilled at 4.7 º centigrade the same day to TestAmerica in Burlington VT. The lab report was received July 13, 2010 at The Johnson Co. The lab reported that the matrix spike (MS) and replicate analysis performed on sample J_T4+00E60 (SIN 370-08) yielded recoveries and relative percent differences (RPD) of one or more analytes that were outside the established QC limits. According to the lab narrative, this was indicative of a problem due to the sample matrix itself. In addition, the analysis of the lab control sample (LCS) ID LCS070710A yielded recovery of mercury outside the QC limit.

The metals cadmium, copper, lead, nickel, and zinc were reported present in the sediment parent and field duplicate samples, J_T4+00E60 (SIN 0380-08) and J_0182-08DP (SIN 0182-08DP), 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 8% for AVS by wet chemistry, 51% for Total Organic Carbon (slightly above the QC limit of 50% and likely due to the sample matrix), 7% for cadmium, 26% for copper, 19% for lead, 8% for nickel, and 16% for zinc. With the exception of TOC, 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 2010

The fall 2010 groundwater sampling was conducted October 11 – 13, 2010. The groundwater sample analytical report for the fall 2010 compliance monitoring was received from TestAmerica on October 29, 2010. 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 the exception of one analyte: arsenic was reported at an estimated concentration of 4.2 micrograms per liter (µg/L) in the field blank sample J_0073-23FB. With respect to the field duplicate sample, the only detectable PAH compound in the parent sample (J_MW-24A) and its duplicate (J_0085-21DUP) was naphthalene. Naphthalene was reported at

estimated concentrations of 4.6 and 4.3 µg/L, respectively (RPD = 6.7%, which is well within the acceptance limit of 30% for field duplicate reproducibility).

With respect to VOC's, benzene was reported in both the parent and duplicate samples at 8.7 and 8.8 µg/L, respectively. Total xylenes were reported at 10.0 µg/L in both samples. RPDs of 1.1% and 0% were calculated for both analytes (well within the acceptance limits for field duplicate reproducibility).

Of the metals analyzed, the only detectable metal concentration in both the parent and duplicate samples was barium, reported at estimated (J) concentrations of 81.5 and 82.5 µg/L, respectively (RPD of 1.2%). 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 0082-23) 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.

3.3 FIELD PROCEDURES QA

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

Field Calibration

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

Procedure Deviations

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

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 (e.g., groundwater, surface water and stormwater) and 10% of the cap core samples are subject to independent data validation. Data validation was performed on the spring 2010 groundwater sample delivery group (SDG) and presented in the spring 2010 Compliance Monitoring Report. The spring 2010 data validation satisfied the annual minimum

requirement for water samples, therefore no independent data validation was performed on the fall 2010 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 June 2010 cap coring event consisted of sample delivery group PSC-10, which was received at the laboratory in two batches: the first batch of samples collected June 28-29, 2010 and the second batch collected June 30, 2010. Since the June 2010 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. Similarly, all sediment trap data were subject to data validation.

A summary of the IDV's findings for the cap core analyses is presented in Section 3.4.2 below. The sediment trap summary of IDV's findings is presented in Section 3.4.3. 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 June 2010 cap core samples (KAS SDG No. PSC-10) were determined to be valid by the IDV with the following qualifiers:

- On the basis of an unacceptably high percent difference (%D) value for 2-methylnaphthalene in the associated continuing calibration (CC) standard, the non-detect results for 2-methylnaphthalene in shallow (0-10 cm) cores at T1+00E250, T1+00E400, T18+00E300; mid-depth core samples collected at T14+00E60, T5+00E60, and T6+00E20; and, both the shallow and mid-depth samples collected at T16+50E100 were qualified as estimated (UJ).

- The three field blanks J_0160-08FB, J_0161-08FB, and J_0163-08FB were originally analyzed by the laboratory at higher detection limits using the full scan method. Since all field samples were not analyzed by the SIM method, The Johnson Company and the IDV requested that the laboratory re-extract the field blanks to demonstrate that no field contamination was detectable at the lower reporting limit. The laboratory complied, but the re-extractions were performed 2-4 days out of holding time for the field blanks collected June 28-June 30, 2010. On the basis of extraction out of holding time, all non-detect results from the re-extracted field blanks J_0160-08FBRE, J_0161-

08FBRE, and J_0163-08FBRE were qualified as estimated (UJ). Since the original scan results for the field blanks were not used further, those results were rejected (R).

- The result for pyrene in the mid-cap core sample collected at T5+00E60 was qualified as estimated (J) on the basis of unacceptably high recoveries in the associated matrix spike (MS) and matrix spike duplicate (MSD) analyses.

- Results for phenanthrene, fluoranthene, pyrene, benzo(a)antrhacene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, and benzo(g,h,i)perylene in the shallow core samples collected at T21+00E50 and T22+00E50; and for fluorene and anthracene in the shallow core sample at T21+00E50 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.

- Results for all other compounds except those noted above in the diluted analyses of the shallow core samples at T21+00E50 and T22+00E50 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.

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 seven analytes were qualified as less than the quantitation limit value (U) or reported value (U) in all soils samples, since the sample was less than the action limit derived to qualify the affected samples. The seven analytes are listed as follows:
    - Results for arsenic in all soil samples less than the action limit of 0.82 mg/kg.
    - Results for barium in all soil samples less than the action limit of 0.21 mg/kg.
    - Results for cadmium in all samples less than the action limit of 0.15 mg/kg.
    - Results for chromium in all samples less than the action limit of 0.23 mg/kg.
    - Results for copper in all samples less than the action limit of 0.28 mg/kg.
    - Results for silver in all samples less than the action limit of 0.29 mg/kg.

- Results for zinc in all samples less than the action limit of 0.53 mg/kg.

- Based on the poor reproducibility in the laboratory duplicate pair, results for barium in the soil samples were qualified as estimated (J). The laboratory appropriately flagged all barium data a "*" indicating the potential for matrix interference. The "*" qualifier was removed by the IDV and replaced with a "J" qualifier.

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

- The laboratory reported all results to the instrument detection limit (IDL); target compounds detected in the associated samples below the practical quantitation limit (PQL) but greater than the IDL (as reported on the Form 9) 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 sample at T1+00E250 and its field duplicate (J_0162-08DP) were qualified as estimated (J) on the basis of unacceptably high recovery in the matrix spike (MS) analysis, and on the basis of unacceptable precision.

3.4.3 *Sediment Trap IDV Summary*

The IDV report on the sediment trap sample results for the samples collected June 24, 2010 was received on November 16, 2010. Following is a summary of the IDV report on the sediment trap data. The complete IDV report is included in Appendix 6.

PAHs

Laboratory results for PAH compounds in the June 2010 sediment trap samples (Katahdin SDG No. SD3720) were validated by the IDV, and reported to The Johnson Company on November 16, 2010. Results for PAH compounds were determined to be valid as reported for all samples in SDG SD3720 with the following qualifiers:

- On the basis of unacceptable recoveries in the associated Independent Calibration Verifications (ICV), results for 2-methylnaphthalene in the samples at J_SD1+28W25 and J_SD2+33E155, and results for naphthalene, 2-methylnaphthalene, acenaphthene, fluorene and benzo(a)pyrene in the field duplicate sample J_0286-06DUP (collected at J_SD7+25E43), the sample collected at J_SD2+80E50, and the diluted sample collected J_SD11+70E35 were qualifed as estimated (J). Results for chrysene in the field duplicate and J_SD11+70E35 were also qualified as estimated (J).

- Results for 2-methylnaphthalene in the field duplicate (J_0286-06DUP), results for chrysene in the sample collected at SD2+08E50, and results for naphthalene, 2-methylnaphthalene, acenaphthene, fluorene, chrysene, and benzo(a)pyrene in the diluted Selective Ion Method (SIM) analysis of the sample collected at SD9+08E45 warranted qualification as estimated (J); however, since more accurate results were available in the undiluted analysis, these results were subsequently rejected (R) by the IDV and the R qualifier takes precedence.

- On the basis of unacceptably high percent difference (%D) in the SIM Continuing Calibration (CC) standard analyzed at 12:08 on July 12, 2010 results for 2-methylnaphthalene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene warrant an estimated qualification (J, UJ) for all sample results except the field blank; however, due to more accurate results available from the undiluted analysis, all SIM results were subsequently rejected (R) in sample SD9+08E45; similarly, results for 2-methylnaphthalene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene were subsequently rejected in the diluted samples SD1+28W25, SD2+33E155, SD7+25E43, SD12+68E55 and SD11+70E35; results for 2-methylnaphthalene and benzo(k)fluoranthene were subsequently rejected in diluted sample SD2+08E50; and the R qualifier takes precedence. Results for benzo(k)fluoranthene and indeno(1,2,3-cd)pyrene in sample SD2+08E50 and for 2-methylnaphthalene benzo(k)flouranthene and indeno(1,2,3-cd)pyrene in the diluted samples SD7+25E43, SD12+68E55 and sample SD4+62E47 were qualified as estimated (J, UJ) on the basis of unacceptably high %D.

- On the basis of the unacceptably high recovery of 2-methylnaphthalene in the associated MS and MSD analyses, the result for 2-methylnaphthalene in SD1+28W25 was qualified as estimated (J).

- On the basis of unacceptable precision (>50% RPD), results for phenanthrene in the diluted analyses of the field duplicate pair (SD7+25E43 and its duplicate SD0286-05DP) were qualified as estimated (J).

- On the basis of recoveries below Region I acceptance limits in the solid SIM and scan Laboratory Control Sample (LCS) and LCS Duplicate (LCSD) analyses, scan results for benzo(g,h,i)perylene and SIM results for 2-methylnapththalene and indeno(1,2,3-

cd)pyrene not previously qualified or subsequently rejected in all sediment samples were qualified as estimated (J, UJ).

- All results for analytes above the calibration range in the initial analyses of all samples except the field blank (SD0247-06FB) were rejected (R) due to detection of these compounds outside the linear range of the instrument in undiluted samples. Results for these compounds were replaced with the acceptable concentrations from the more diluted analysis of each of the samples.

- Results for all other compounds except those as noted above in the diluted analyses of all the sediment samples except the field blank (SD0247-05FB) were rejected because acceptable results for these compounds were taken from the undiluted analysis of each of these samples.

- "E" qualifiers (for results that exceed instrument calibration range) were appropriately applied by the laboratory to sample Form I results when concentrations of target analytes were greater than the instrument calibration range. "D" qualifiers were not applied by the laboratory to positive results from diluted sample analyses. The IDV removed all laboratory-applied "E" qualifiers and replaced the corresponding analytical results with the diluted sample results.

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

Inorganics

Laboratory results for the inorganic analytes in the sediment trap samples in Katahdin SDG SD3720 were determined by the IDV to be valid as reported by the laboratory with the following exceptions:

- Based on laboratory blank contamination, the following results were qualified as less than the reported Practical Quantitation Limit (PQL) value (U) or the reported value (U) in all soil samples since the concentration in the sample was less than the derived action limit used to qualify the samples (field blanks were not qualified based on laboratory blank contamination):
    - Results for cadmium in all samples less than the action limit of 0.20 mg/Kg.
    - Results for chromium in all samples less than the action limit of 0.24 mg/Kg.
    - Results for copper in all samples less than the action limit of 9.0 mg/Kg.

  - Results for silver in all samples less than the action limit of 0.24 mg/Kg.
  - Results for zinc in all samples less than the action limit of 4.1 mg/Kg.

- Based on the low recovery for zinc in the MS analysis, results for zinc in all sediments were qualified as estimated (J).

- Based on poor reproducibility in the field duplicate pair, results for chromium in all sediment samples were qualified as estimated (J).

- "N" qualifiers were appropriately applied by the laboratory to all sample Form I results when %R value was outside the acceptance limits in the MS/MSD pair. The validator removed all laboratory-applied "N" qualifiers and replaced them with a "J" qualifier.

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 2010 and the previous two monitoring events on the Gilbane property are shown on Figures 4-1 through 4-3, respectively. The data

from fall 2010 indicate flow from the Gilbane property towards Area 3 and the Canal tributary, which is 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 2010 monitoring event is shown on Figure 4-5. Potentiometric maps for the prior two groundwater monitoring events (April 2010 and October 2009) 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 2010 groundwater flow (Figure 4-6) is similar to that observed during the previous monitoring event in April 2010. Fall 2009 groundwater flow was from the Canal toward the Lake (Figure 4-7).

4.1.2 <u>Chemistry</u>

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 4-11. 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 BTEX for all wells sampled in 2010. 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 two other wells, MW-22A and MW-9B contained estimated concentrations below the PQL of benzene and/or xylenes. 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 1,100 *µg/L*, from MW-21B at 200 *µg/L* and from MW-24A at a concentration of 8.7 *µg/L* during the October 2010 monitoring event. 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 530 *µg/L* in April 2010, 390 *µg/L* in October 2009, and 230 *µg/L* in April 2009. Benzene was previously reported in samples collected from MW-21B at 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 depicts historical benzene concentrations and water levels since 2000 in MW-21A, MW-21B, MW-24A, and MW-23B.

The overall trend over the past 24 months shows relatively stable benzene concentrations in MW-24A ranging between 6.1 and 11.0 *µg/L* while benzene concentrations in MW-21A, MW-21B, and MW-23B appear to be trending upward (Figure 4-9). In response to these increased benzene concentrations additional investigation activities were conducted between MW-23B and MW-21A/B during the fall of 2010. These included advancement of several soil borings as well as a grout injection pilot test. Results from this investigation were reported in the Report of October 2010 Soil Data and Subsurface Investigation and Evaluation, Northwestern Well Area produced by The Johnson Company, Inc.

Similar to the previous three years, water levels during portions of 2010 were unusual in that beavers had dammed up the Canal beneath the railroad bridge from late June 2010 to October 8, 2010. The beaver dam was removed on October 8, 2010, restoring the canal to its design elevation of 96 feet. On November 3, 2010 a wire cage and bypass pipe were installed below the railroad bridge to discourage beaver activity and prevent impoundment of the canal above the 96 foot design elevation.

The beaver dam kept the Canal water elevation at approximately 97 ft NGVD or higher throughout most of the summer and fall of 2008, 2009, and 2010. This increased elevation of the Canal water level increases the hydraulic gradient towards Lake Champlain. This increased gradient may be the cause of the reported benzene increases in wells MW-21A, MW-21B, and

MW-24A, and the increased DNAPL thicknesses observed in MW-23B and MW-17 (discussed in Section 4.1.3). Based on the available data, it remains unclear whether the increased NAPL and benzene concentrations are directly related to the increased gradient caused by the beaver dam, though this is the only noticeable change in Site conditions since placement of the West Bank Cap in July 2004. Installation of the wire cage and bypass pipe should prevent further beaver activity and maintain the canal water level elevation at its design stage of 96 feet.

4.1.2.2 Semivolatile Organic Compounds – PAHs

Figure 4-11 provides a plan view of the Site showing reported concentrations of 17 targeted PAH compounds for all wells sampled in October 2010. None of the wells outside of the Class IV groundwater boundary contained any reported detected concentrations of target PAHs above their respective PQLs. Concentrations exceeding the PQL for some of these PAH compounds were only observed at well MW-23B, which is located within the Class IV groundwater boundary.

Concentrations exceeding the PQLs in MW-23B were reported for naphthalene and 2-methylnaphthalene, as well as acenaphthene which had an estimated concentration below its PQL. Reported PAH concentrations in MW-23B were similar to those detected in this well for previous monitoring events. No MCLs have been established for these compounds. As described previously (and summarized in Section 4.1.3), evidence of NAPL was detected in this well during this and previous monitoring events. The position of the well with respect to the stratigraphic cross section P-P' is indicated on Figure 4-12. Because MW-23B is the only well with concentrations exceeding the PQLs, it is not practical to define an area of the cross section that exceeds the PQLs.

Estimated concentrations less than the PQL for naphthalene were reported in MW-21A and MW-24A located outside the Class IV groundwater boundary. Low (i.e., less than the PQL of 10 $\mu g/L$) estimated concentration of naphthalene was reported in MW-24A during the April 2010 monitoring event. No other PAHs have been reported in these wells in the past, however

the current presence of naphthalene in these wells may be related to the recent increases in benzene.

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 2010 monitoring event with the exception of arsenic at 22.2 *µg/L* in MW-9A, 11.3 *µg*/L in MW-20B, and 61.8 *µg/L* in MW-21B. 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 297 NTUs in MW-9A, 55 NTUs in MW-20B, and 14 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

The only well monitored in 2010 that has historically contained benzene consistently above the MCL is MW-23B (although benzene has been reported above the MCL in MW-21A and MW-24A since 2008 and in MW-21B since 2009). 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), between 5.1 and 120 *µg/L* from fall 2002 through spring 2008, and between 150 and 360 *µg/L* since April 2008 (see Figure 4-9). Benzene concentrations in MW-21A and MW-21B are shown on Figure 4-9. Since 2008, concentrations in these wells have steadily increased. Possible explanations for this increase are discussed in Section 4.1.2.1 above. Benzene concentrations in MW-24A (Figure 4-9) appear to be relatively stable since spring 2008 when they increased from less than 1 *µg/L* to around 10 *µg/L*.

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 2010 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-20B, and MW-21B are likely attributable to elevated turbidity in the wells, which was measured at 297, 14, and 55 NTUs, respectively, prior to sampling. MW-9A has historically been reported with elevated turbidity ranging from 50 to 700 NTUs. MW-21B has been reported with sporadic elevated turbidity up to 30 NTUs since its installation in 2000.

As with the other inorganics, the concentration of arsenic in groundwater samples has remained relatively constant since 2001. The MCL for arsenic was lowered from 50 μg/L to 10 μg/L in 2002. Prior to this change, reported results for arsenic were all consistently below the MCL. After the change in 2003, the revised MCL was exceeded in well MW-21B during all monitoring events except April 2006, MW-9A during six events, and MW-20B during four events.

4.1.3 NAPL

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 on October 12 and 14, 2010. MW-23B and MW-17 were also monitored on November 1, 2010. 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 0.9 feet of DNAPL thickness was measured in MW-17 on October 14, 2010 and 0.2 feet measured on November 1, 2010 (following NAPL removal on October 14).

These levels were similar to the 1.0 feet measured in April 2010, slightly higher than the 0.3 feet measured in October 2009, less than the 0.1 feet measured in May and June, 2009, and less than the 1.1 feet measured in March 2009. DNAPL removal (required only when DNAPL thickness exceeds 0.1 feet) was attempted on October 14th. Approximately 0.5 liters of DNAPL along with 1 liter on NAPL/water mix was removed and placed in a drum for future disposal. The well was re-measured approximately 1 hour later and less than 1 inch of DNAPL was measured.

Approximately 4.15 feet of DNAPL was measured in MW-23B on October 14, followed by 0.55 feet on November 1, 2010 (following NAPL removal on October 14). Previous DNAPL monitoring events showed 3.5 feet of DNAPL in April 2010, 0.8 feet in October 2009, 1.3 feet in April 2009, and 3.4 feet of DNAPL in March. On October 14, 2010 approximately 2.5 liters of DNAPL and 3 liters of NAPL/water mix were removed and placed in a drum for future disposal. As with MW-17, less than 1 inch of DNAPL was measured in the well approximately 1 hour after the DNAPL removal event. A summary of the DNAPL monitoring/removal events for 2010 are shown on Figure 2-2. The NAPL Summary Table in Appendix 5 details the results of DNAPL monitoring at the Site since 2000. All NAPL removed from the monitoring wells was placed in a 55-gallon drum for future removal for disposal by a licensed hazardous waste hauler.

4.2 SURFACE WATER

4.2.1 Surface Water Sampling

One unfiltered surface water sample (J_SWT1+50W80) was collected from the Canal outlet on June 28, 2010 and analyzed for 17 PAHs. The sample location is shown on Figure 2-3. 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 and comparison with AWQC were 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.

4.2.2 Visual Inspections

Visual inspections of the Canal water surface were made periodically during other routine monitoring activities during the summer of 2010. As with previous years, booms were continually maintained at T7 and T12. The condition of these booms was noted during the inspections and they were replaced as necessary. Gas bubbles that release a small sheen and occasionally released small droplets of brown NAPL were observed in several areas between T10 and T12 at various times; the latest being July 1, 2010, prior to construction of the Amended Cap. In addition, numerous gas bubbles that did not release sheens and/or NAPL were frequently observed. Wildlife, including mallard ducks, green frogs, bull frogs, box turtles, beavers, black crowned night herons, great blue herons, and other waterfowl were noted throughout the Canal. All of the observed wildlife appeared healthy and no deceased or stressed animals were observed. Copies of the field notes related to these inspections are included in Appendix 1.

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 2008 and 2009, cap coring in Area 2 was not conducted during this monitoring event due to the Amended Cap investigation/construction activities in portions of this area. This modification was approved in a July 31, 2008 email correspondence from the EPA

and VT DEC. 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 4-13 and 4-14. Field notes and sample forms are included in Appendix 1. Summaries of the analytical results are provided in Table 4-1.

Table 4-1

Summary of 2010 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 E250	0.03	No	8.4	U 0.01	3.9	22.3	No	0.78	11.4	U 0.01	7.9	41.1
	T1+00 E400	0.01	No	11.6	U 0.01	16.7	36.4	No	1.32	13.5	0.01	10.5	46.3
	T2+00 E250	0.13	No	21.7	0.02	10.7	52.1	No	0.70	12.4	U 0.01	8.1	44.8
	T3+00 E250	U 0.22	No	9.1	U 0.01	3.6	23.1	No	0.47	8.5	U 0.01	5.7	26.7
Area 8 Average		**0.04**	**No**	**12.7**	**0.02**	**8.7**	**33.5**	**No**	**0.82**	**11.5**	**0.01**	**8.1**	**39.7**
1	T4+00 E60	0.01	No	6.7	U 0.01	2.9	19.0	No	0.19	9.0	U 0.01	4.0	26.6
	T5+00 E60	0.01	No	8.4	U 0.01	3.5	23.7	No	0.55	8.4	U 0.01	4.1	28.8
	T6+00 E20	0.01	No	12.4	U 0.01	4.9	36.2	No	0.56	8.9	U 0.01	3.9	32.0
Area 1 Average		**0.01**	**No**	**9.2**	**U 0.01**	**3.8**	**16.3**	**No**	**0.43**	**8.8**	**U 0.01**	**4.0**	**29.1**
2	No Coring Performed in Area 2[4]												
3	T17+50E200	0.03	No	11.9	U 0.01	4.1	23.9	No	0.46	16.0	J 0.05	18.4	58.5
	T17+50E250	U0.31	No	13.0	U 0.01	4.5	31.6	No	0.56	16.2	0.06	17.4	58.5
Area 3 Average		**0.03**	**No**	**12.5**	**U 0.01**	**4.3**	**27.8**	**No**	**0.51**	**16.1**	**0.06**	**17.9**	**58.5**
4/5	T18+00E300	--	--	--	--	--	--	--	0.33	12.0	0.05	12.1	54.0
	T21+00E50	--	--	--	--	--	--	--	48.02	241	0.80	177	651
	T22+00E50	--	--	--	--	--	--	--	33.28	100	0.19	47.9	580
Area 4/5 Average		**--**	**--**	**--**	**--**	**--**	**--**	**--**	**27.21**	**117.7**	**0.35**	**79.0**	**428.3**

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 2010 monitoring period due to ongoing amended cap activities in accordance with the July 31, 2008 email correspondence from EPA.
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 4-1. 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, all 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 4-1 was calculated using ½ of the PQL (when it exceeded 330 μg/kg) in accordance with the CMWP). Seven of the nine associated mid-cap samples also contained detectable PAHs (though as with the top-of-cap

samples most detections were reported as estimated concentrations below the PQL) though the sum-of-PAHs value for all samples from the installed caps was less than 21 ppm.

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 5.6% to 12%, making the PAHs largely unavailable to the biota, again consistent with prior findings. Copper, lead, mercury and zinc were also elevated in the Areas 4/5 samples relative to those collected from the capped areas. The AVS/SEM results from the grab sample locations collected as part of the biological monitoring program showed that metals were not bioavailable at T21+00E50, and suggest that they were not bioavailable at the other two sample locations (see Section 4.3.3.2).

4.3.2 Non-Aqueous Phase Liquid Probing and Recovery Well Monitoring

Probing of the cap surface for the presence of NAPL was conducted on July 1, 2010 using strips of white oil-only absorbent pads secured to a thin fiberglass rod. Results of the NAPL probing are presented in Table 4-2 below and shown on Figure 4-15.

Table 4-2
Summary of Cap Surface NAPL Probing – 2010

Location	Results
T9+30E20	No sheens or NAPL
T9+55E20	No sheens or NAPL
T9+80E20	One pinhead sized spec NAPL on pad, light sheen
T10+5E20	Few pinhead sized specs NAPL on pad
T10+30E20	No sheens or NAPL
T10+55E20	Few pinhead sized specs NAPL on pad
T10+80E20	No sheens or NAPL
T11+5E20	Few pinhead sized specs NAPL on pad
T11+30E20	Few pinhead sized specs NAPL on pad
T11+55E20	Several pinhead sized specs NAPL on pad
T11+80E20	Few pinhead sized specs NAPL on pad
T12+5E20	No sheens or NAPL
T12+30E20	One pinhead sized spec NAPL on pad, no sheen
T12+55E20	No sheens or NAPL
T12+80E20	No sheens or NAPL
T13+5E20	No sheens or NAPL
T13+30E20	No sheens or NAPL
T13+55E20	No sheens or NAPL
T13+80E20	No sheens or NAPL

Table 4-2
Summary of Cap Surface NAPL Probing – 2010

Location	Results
T14+5E20	No sheens or NAPL
T14+20E20	No sheens or NAPL
T11+50E30	Few pinhead sized specs NAPL on pad
T11+50E40	No sheens or NAPL
T11+50E50	Slight sheen, No NAPL
T11+50E60	Few 1/8" sized specs NAPL on pad
T11+00E30	Pad saturated with NAPL
T11+00E40	Pad ~70% saturated with NAPL
T11+00E50	Pad ~70% saturated with NAPL
T11+00E60	Few pinhead sized specs NAPL on pad
T10+50E30	Few 1/8" sized specs NAPL on pad
T10+50E40	Few 1/8" sized specs NAPL on pad
T10+50E50	Few 1/8" sized specs NAPL on pad
T10+50E60	One ½" glob NAPL on pad
T10+00E30	Pad saturated with NAPL
T10+00E40	Pad saturated with NAPL
T10+00E50	No sheens or NAPL
T10+00E60	No sheens or NAPL
T9+50E30	Few pinhead sized specs NAPL on pad
T9+50E40	Few pinhead sized specs NAPL on pad
T9+50E50	No sheens or NAPL
T9+50E60	No sheens or NAPL

With the exception of T11+00E30, T11+00E40, T11+00E50, T10+00E30 and, T10+00E40 none of the probed locations contained large quantities of NAPL on the surface of the cap. Several of the probed locations, mostly between T10 and T11+50, showed some evidence of NAPL in the form of tiny pinhead size specs on the bottom of the absorbent pad. It should be noted that a majority of the probed area was covered in rooted aquatic vegetation from the canal bottom to the water surface and some of the observed NAPL may have been transferred to the absorbent pads via the plant matter and not the cap surface.

Each of the four NAPL recovery wells located along the west bank (RW9+80, RW10+25, RW-11, and RW-14 – see Figure 2-2) was checked for the presence of NAPL on July 1, 2010. RW9+80 contained no LNAPL or DNAPL though approximately 0.3 feet of black algae/sediment was noted in the bottom of the bailer. RW10+25 had a film (<0.01 foot) of LNAPL on the water surface along with rainbow sheens, and approximately 0.4 feet of DNAPL was measured in the bottom of the well. Approximately 0.3 feet of black organic sediment was

measured at the bottom of RW-11, but no sheens or NAPL were noted. A film of LNAPL (<0.01 foot) along with rainbow sheens was observed on the water surface in RW-14 along with approximately 0.7 feet of DNAPL measured in the bottom of the well.

4.3.3 Benthic Macroinvertebrate Monitoring

Benthic macroinvertebrate sampling was conducted on June 29 and 30, 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 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, 2004, 2005, 2006, 2007, 2008, 2009, and 2010 are presented in Table 4-6. Table 4-7 presents sediment physical data and Tables 4-8 and 4-9 presents AVS/SEM data. Locations of benthic samples are shown on Figure 2-4. 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. Although the lowest abundance was in Area 4/5 where the sediment contaminant concentrations were highest, the TOC content at this sample location was 11 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.

4.3.3.1 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 higher abundance than in the last few years, and the sample from the Canal, Area 1, showed little change in abundance and species composition from previous samples.

The uncapped Area 4/5 had the greatest diversity of organisms, but the lowest abundance. The abundance is significantly lower than in recent sampling events, but not the lowest recorded for this area. The samples from this location were dominated by snails, and the species composition was significantly different from the 2009 sample results which were dominated by tubificid worms and fingernail clams. Tubificid worms were a minor component of the benthic community and no fingernail clams were reported. The sample location was in the cattails near the west edge of Area 4/5 so the conditions there may be different from the more central portion of Area 4/5 that would experience environmental conditions more similar to the Canal.

Table 4-3
Summary of Benthic Macroinvertebrate Data Area 8
June 2010
(Major Component Species >4%)

Sample Location: Area 8, J_1+00E250
Date Sample Collected: 6/29/10
Water Depth on Sample Collection Date: 5.8 ft

Family	Species	% of Total
Replicate No. 1 – Total Abundance = 437		
Tubificidae	Spp.	45
Tubificidae	*Limnodrilus hoffmeisteri*	26
Naididae	*Nais spp.*	10
Chironomidae	*Chironomus sp.*	17
Replicate No. 2 – Total Abundance = 520		
Tubificidae	*Spp.*	80
Chironomidae	*Chironomus sp.*	18
Replicate No. 3 – Total Abundance = 516		
Tubificidae	*Spp.*	74
Tubificidae	*Limnodrilus hoffmeisteri*	14
Chironomidae	*Chironomus sp.*	12
AREA 8 – RELATIVE ABUNDANCE = 491		
Note: Specimens are identified to the lowest practical taxon		

Table 4-4
Summary of Benthic Macroinvertebrate Data Area 1
June 2010
(Major Component Species >4%)

Sample Location: Area 1, J_T4+00E60
Date Sample Collected: 6/29/10
Water Depth on Sample Collection Date: 9.0 ft

Family	Species	% of Total
Replicate No. 1 – Total Abundance = 357		
Tubificidae	*Spp.*	92
Tubificidae	*Limnodrilus hoffmeisteri*	7
Replicate No. 2 – Total Abundance = 281		
Tubificidae	*Spp.*	80
Tubificidae	*Limnodrilus hoffmeisteri*	19
Replicate No. 3 – Total Abundance = 533		
Tubificidae	*Spp.*	83
Tubificidae	*Limnodrilus hoffmeisteri*	14
AREA 1 - RELATIVE ABUNDANCE = 390		
Note: Specimens are identified to the lowest practical taxon		

Table 4-5
Summary of Benthic Macroinvertebrate Data Area 4/5
June 2010
(Major Component Species >4%)

Sample Location: Area 4/5, J_T21+00E50
Date Sample Collected: 6/30/10
Water Depth on Sample Collection Date: 3.0 ft

Family	Species	% of Total
Replicate No. 1 – Total Abundance = 78		
Naididae	*Nais sp.*	8
Bithyniidae	*Bithynia tentaculata*	33
Valvatidae	*Valvata sp.*	36
Asellidae	*Caecidotea communis*	8
Chironomidae	*Chironomus sp.*	5

Table 4-5
Summary of Benthic Macroinvertebrate Data Area 4/5
June 2010
(Major Component Species >4%)

Sample Location: Area 4/5, J_T21+00E50
Date Sample Collected: 6/30/10
Water Depth on Sample Collection Date: 3.0 ft

Family	Species	% of Total
Replicate No. 2 – Total Abundance = 98		
Tubificidae	*Spp.*	6
Physidae	*Physella*	20
Bithyniidae	*Bithynia tentaculata*	33
Valvatidae	*Valvata sp.*	14
Asellidae	*Caecidotea communis*	10
Replicate No. 3 – Total Abundance = 110		
Naididae	*Nais sp.*	11
Physidae	*Physella sp.*	9
Planorbidae	*Gyraulus sp*	4
Bithyniidae	*Bithynia tentaculata*	29
Hydrobiidae	*Amnicola sp.*	4
Valvatidae	*Valvata sp.*	22
Asellidae	*Caecidotea communis*	15
Chironomidae	*Chironomus sp.*	4
AREA 4/5- RELATIVE ABUNDANCE = 95		
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

* 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.

4.3.3.2 *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 T1 in Area 8 (Turning Basin) were silt loam and at T4 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) except for copper, which was lower in the Area 4/5 sample. 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 11.3% 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 2010

Location	Sample Point	Date	Water Depth (ft)	Percent Solids	Total Organic Carbon (mg/kg)	Sediment Type (USDA)
Area 8	J_T1+00E250	6/29/10	5.8	34.0	35,900 (3.59%)	Silt Loam
Area 1	J_T4+00E60	6/29/10	9.0	59.4	10,435 (1.04%)	Loamy fine sand
Area 4/5	J_T21+00E50	6/30/10	3.0	24.4	113,000 (11.3%)	Organic

Table 4-8
Metals and AVS/SEM Sediment Data 2010

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_T1+00E250	5.8	7.4	0.18	0.0016	2.1	0.033	13.1	0.063	U	ND	1.5	0.026	55.5	0.85	0.13
Area 1	J_T4+00E60[1]	9.0	26.8	0.17	0.0020	4.6	0.059	15.7	0.061	U	ND	2.4	0.044	107	1.3	0.05
Area 4/5	J_T21+00E50	3.0	56.1	4.7	0.042	1.3	0.020	136	0.66	U	ND	12.7	0.22	559	8.5	0.17

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 2003-2010 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

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

4.3.3.3 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. Relative abundance data for 2010 showed greater abundance in the capped areas than in 2009. Thus the Performance Standard for these Areas continues to be met.

Looking at the comparisons of relative abundance and diversity over the nine 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 has varied from 70 to 2,071 and the relative abundance in Area 8 went from 13 to 2,941 from 2004 to 2005, down to 7 in 2006, and up to 491 in 2010. In Area 1, relative abundance went from 8 in 2006 to 349 in 2007, to 159 in 2008 and up to 390 in 2010. Patchiness is a common occurrence in benthic macroinvertebrate distribution which makes determining trends with small numbers of samples difficult (Elliott, 1983). The worms 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 2010 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 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 4-1). 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.

4.3.4 Aquatic Vegetation Monitoring

4.3.4.1 Qualitative Vegetation Monitoring

Monitoring of canal submergent vegetation was done during the macroinvertebrate sampling on June 29 and 30, 2010.

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

These areas are the deeper areas of the Canal and Turning Basin. Beaver dams upstream of the weir have elevated water levels in the Canal above the lake level in 2010, including at the time of biological and aquatic vegetation monitoring. Water depth at the macroinvertebrate sampling station in the Turning Basin, Area 8, was 5.8 feet. Arrowhead (*Sagittaria latifolia*), 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*), yellow water lilies (*Nuphar advena*), and water shield (*Brasenia schreberi*), another floating leaved aquatic plant, were noted. Eurasian milfoil (*Myriophyllum spicatum*) formed the dominant submergent

vegetation in the Turning Basin. Waterweed (*Elodea canadensis*) and curly pondweed (*Potamogeton crispus*) were also present. In Area 1, the rooted aquatic vegetation consisted of Eurasian milfoil, waterweed, water pennywort (*Hydrocotyle americana*), and water shield. Small patches of filamentous green algae and blue-green algae were present in Area 1.

Area 2 Southern Canal

Thick masses of the rooted aquatic plants consisting of Eurasian milfoil, waterweed, and curly pondweed were present from T10 south. Cattail (*Typha latifolia*) was the dominant emergent vegetation. Burreed (*Sparganium eurycarpum*) and algal mats were also present.

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

Area 3 is well vegetated with grasses, shrubs, and emergent plants. *Phragmites* and cattail and dominate the wetter areas. Wetland vegetation monitoring has been completed for this area.

Area 7

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

100 ft X 100 ft Area

Phragmites was the dominant plant in this area.

West Bank Cap

The West Bank cap is covered with a dense growth of grasses. Some buckthorn shrubs have become established along the edge of the canal. *Phragmites* is now present in the south end of the capped area but has not spread noticeably since 2009.

4.3.4.2 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 2010.

4.3.4.3 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.)

4.4 OUTLET WEIR INSPECTION

The outlet weir was inspected on September 7, 2010. 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 7, 2010 were nearly identical (to within 0.06 feet) to the initial elevations as determined on October 1, 2001. The elevation determined at the center of the weir crest (Benchmark “C”) in 2010 is within 0.06 feet of that determined immediately after construction in 2001. The elevation of the north abutment of the weir (Benchmark “B”) in 2010 was 0.06 feet below that determined immediately after

construction in 2001, and the south abutment (Benchmark "A") elevation was 0.04 feet below 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 is 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
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
North Abutment	97.98	97.97	97.97	97.96	97.95	98.00	97.95	97.96	97.96	97.95	97.92
South Abutment	97.97	97.97	97.99	97.97	97.96	98.00	97.97	97.97	97.97	97.96	97.93
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
Northwest	100.12	100.12	100.12	100.13	100.11	100.16	100.12	100.12	100.12	100.09	100.08
Southeast[2]	103.64	103.64	103.64	103.64	103.64	103.64	103.64	103.66	103.66	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

[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)

4.5 STORMWATER INFLOW MONITORING

The Johnson Company was on site June 24, 2010 to retrieve and collect sediment samples from nine sediment traps (eight locations plus one duplicate sediment trap) that had been re-installed in the subaqueous cap on November 18, 2009. During the collection and sampling of the sediment traps on June 24, 2010 the inner sleeves were retrieved from the bottom of the Canal and the contents of the inner sleeves were sampled as described in Section 2.2 (Stormwater In-flow). In addition, all of the outer sleeves were removed from the Canal at the time of inner sleeve collection in anticipation of planned construction of the amended cap.

The results of the analyses of the collected sediment are presented in Appendix 5 and summarized in Table 4-11 below. The analytical results are also shown on a plan view map of the Site on Figure 4-16. The overall contaminant mass captured by each trap during the sampling interval was calculated by multiplying the dry weight of the sample by the reported contaminant concentration. The overall mass was then divided by the cross-sectional area of each trap (0.05726 square feet) and the duration of time over which the sample was collected to yield a contaminant mass loading for each sediment trap (mg/(ft^2*day)). The contaminant mass loading rate for each area (in grams/day) was then determined by multiplying the arithmetic mean of the calculated contaminant mass loading rates for all traps within that area by the overall cap surface area. These calculated mass loading rates are presented in Table 4-11.

Table 4-11
Summary of 2010 Sediment Trap
Analytical Results – Concentrations and Mass Loading

Area	Sample Location	Sum of PAHs		Copper		Mercury		Lead		Zinc	
		mg/kg	mg/sf*day	mg/kg	mg/sf*day	mg/kg	mg/sf*day	mg/kg	mg/sf*day	mg/kg	mg/sf*day
8	SD1+28 W25	**44.0**	0.211	115	0.551	0.18	$8.62e^{-4}$	177	0.847	**553**	2.647
8	SD2+08 E50	**27.4**	0.035	94	0.119	0.12	$1.52e^{-4}$	86	0.109	**495**	0.627
8	SD2+33 E155	19.0	0.032	65	0.110	0.12	$2.02e^{-4}$	76	0.128	364	0.614
Area 8 Average:		**30.1**	0.092	91	0.260	0.14	$4.05e^{-4}$	113	0.361	**471**	1.296
Area 8 Mass Loading (100,000 sf):		9.2 g/day		26 g/day		0.041 g/day		36.1 g/day		129 g/day	
1	SD4+62 E47	19.9	0.024	74	0.091	0.13	$1.60e^{-4}$	54	0.066	374	0.460
1	SD7+25 E43	**160.4**	0.346	88	0.190	0.08	$1.73e^{-4}$	51	0.109	370	0.799
1	SD9+08 E45	**1,083.2**	4.107	114	0.432	0.10	$3.79e^{-4}$	65	0.248	**524**	1.987
Area 1 Average:		**421.2**	1.492	92	0.238	0.10	$2.37e^{-4}$	57	0.141	**422**	1.082
Area 1 Mass Loading (61,000 sf):		91.0 g/day		14.52 g/day		0.014 g/day		8.61 g/day		66.0 g/day	
2	SD11+70 E35	**1,157.7**	2.012	131	0.228	0.12	$2.09e^{-4}$	65	0.113	**640**	1.112
2	SD12+68 E55	**114.8**	0.532	127	0.589	0.10	$4.64e^{-4}$	50	0.232	**569**	2.639
Area 2 Average:		**636.3**	1.272	129	0.409	0.11	$3.37e^{-4}$	58	0.173	**606**	1.876
Area 2 Mass Loading (56,600 sf):		72.0 g/day		23.15 g/day		0.019 g/day		9.79 g/day		106.2 g/day	

Mid-Cap Benchmark value for PAHs is sum of ER-Ms for 13 PAHs: 21 mg/kg
Mid-Cap Benchmark values for metals are ER-Ms: copper - 270 mg/kg; lead - 218 mg/kg; mercury - 0.71 mg/kg; zinc - 410 mg/kg.
Bold signifies exceedance of cap benchmark.

The reported sum-of-13-PAH compounds exceeded the Mid-Cap Benchmark values of 21 mg/kg in all of the sediment traps with the exception of SD2+33 E155 in Area 8 and SD4+62 E47 in Area 1. Zinc concentrations in all of the Area 2 traps as well as the SD9+08 E45 trap in Area 1 and SD1+28 W25 and SD2+08 E50 traps in Area 8 exceeded the Mid-Cap Benchmark value of 410 mg/kg. The reported copper, lead and mercury concentrations in the sediment traps were all below their respective Mid-Cap Benchmark values of 270, 218, and 0.71 mg/kg, respectively. These results are consistent with the ranges of analytical results from previous sediment trap sampling events as summarized in Table 4-12 below

Table 4-12
Summary of Sediment Trap
Analytical Results 2005 – 2010

Area	Sample Location	Date	Sum of PAHs	Copper	Mercury	Lead	Zinc
			mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
8	SD1+28 W25	Nov. 16-17, 2005	**23**	54	0.16	59.3	**581**
		Nov. 14-15, 2006	**49.09**	70.1	0.15	75.0	**426**
		Nov. 27-29, 2007	**53.3**	92.4	0.15	103	**422**
		Nov. 17-18, 2008	**47.3**	132	<0.36	148	**598**
	SD1+28 W25	Nov. 18, 2009	**22.1**	75	0.09	92	349
		June 24, 2010	**44.0**	115	0.18	177	**553**
8	SD2+08 E50	Nov. 16-17, 2005	18	60.6	0.12	63.2	**953**
		Nov. 14-15, 2006	**22.82**	47.4	0.07	46.4	296
		Nov. 27-29, 2007	**48.2**	134	0.21	142	**693**
		Nov. 17-18, 2008	**27.8**	124	0.35	147	**2020**
		Nov. 18, 2009	19.5	85	0.1	90	398
		June 24, 2010	**27.4**	94	0.12	86	**495**
8	SD2+33 E155	Nov. 16-17, 2005	19	71.3	0.19	70.2	**1180**
		Nov. 14-15, 2006	**27.76**	81.4	0.12	92.3	**635**
		Nov. 27-29, 2007	16.3	54.4	0.13	66.3	344
		Nov. 17-18, 2008	**44.2**	132	<0.24	167	**756**
		Nov. 18, 2009	15.2	65	0.09	71	343
		June 24, 2010	19.0	91	0.14	113	**471**
1	SD4+62 E47	Nov. 16-17, 2005	**28**	63.0	0.15	50.3	**1100**
		Nov. 14-15, 2006	**33.09**	55.4	0.15	51.0	**418**
		Nov. 27-29, 2007	**49.0**	92.2	0.18	109	**625**
		Nov. 17-18, 2008	**66.0**	102	<0.29	93.9	**3460**
		Nov. 18, 2009	**25.8**	68	0.03	47	299
		June 24, 2010	19.9	74	0.13	54	374
1	SD7+25 E43	Nov. 16-17, 2005	**45**	58.2	0.13	44.6	**766**
		Nov. 14-15, 2006	**100.30**	65.1	0.09	49.0	372
		Nov. 27-29, 2007	**35.4**	58.4	0.09	50.4	388
		Nov. 17-18, 2008	**339.0**	145	<0.27	117	**875**
		Nov. 18, 2009	**288.9**	93	<0.09	56	383
		June 24, 2010	**160.4**	88	0.08	51	370
1	SD9+08 E45	Nov. 16-17, 2005	**209**	52.4	0.12	48.0	**650**
		Nov. 14-15, 2006	**711.96**	67.8	0.10	51.1	**510**
		Nov. 27-29, 2007	**1013.1**	104	0.15	81.4	**643**
		Nov. 17-18, 2008	**946.4**	125	<0.27	79.4	**599**
		Nov. 18, 2009	**1075.6**	144	0.09	82	**608**
		June 24, 2010	**1083.2**	114	0.10	65	**524**
2	SD11+70 E35	Nov. 16-17, 2005	**1136**	91.9	0.21	67.4	**1380**
		Nov. 14-15, 2006	**556.6**	88.2	0.16	71.8	**814**
		Nov. 27-29, 2007	**712.8**	112	0.16	85.1	**779**
		Nov. 17-18, 2008	**1676.6**	109	0.22	63.5	**5130**
		Nov. 18, 2009	**838.2**	115	0.10	55	**486**
		June 24, 2010	**1157.7**	131	0.12	65	**640**

Table 4-12
Summary of Sediment Trap
Analytical Results 2005 – 2010

Area	Sample Location	Date	Sum of PAHs	Copper	Mercury	Lead	Zinc
			mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
2	SD12+68 E55	Nov. 16-17, 2005	**38**	87.4	0.21	57.9	**1610**
		Nov. 14-15, 2006	**175.81**	72.2	0.06	64.1	**634**
		Nov. 27-29, 2007	**270.5**	101	0.15	79.4	**760**
		Nov. 17-18, 2008	**137.4**	125	0.25	76.0	**830**
		Nov. 18, 2009	**90.4**	165	0.20	83	**608**
		June 24, 2010	**114.8**	127	0.10	50	**569**

Mid-Cap Benchmark value for PAHs is sum of ER-Ms for 13 PAHs: 21 mg/kg
Mid-Cap Benchmark values for metals are ER-Ms: copper - 270 mg/kg; lead - 218 mg/kg; mercury - 0.71 mg/kg; zinc - 410 mg/kg. Bold signifies exceedance of cap benchmark.

The sum of PAHs in the sediment trap samples have exceeded the benchmark value of 21 ppm for every collected sample since 2005 with the exception of SD2+08 E50 in 2005 and 2009, SD2+33 E155 in 2005, 2007, 2009, and 2010, and SD4+62 E47 in 2010. Areas 1 and 2 have generally had higher PAH values than samples collected from Area 8. Copper, mercury, and lead concentrations have consistently been reported below their respective benchmark values, while zinc concentrations have exceeded its benchmark value in most samples collected.

The top-of-cap core samples collected each summer are a composite of the solids entering the Site via stormwater and settling onto the cap and the clean cap sand located just below the cap surface. These data suggest that PAH and metals concentrations in the top-of-cap samples could increase over time as the stormwater transported sediment continues to accumulate on the cap surface, and the proportion of stormwater-derived contamination in the 0-10 cm samples increases compared with the underlying cap sand portion of the sample. However, analysis of the average sum of PAH concentrations and metals in the top of cap samples in Areas 1 and 8 do not show a significant upward trend as discussed in Section 4.3.1.2 above.

4.6 SEDIMENT TRANSPORT MONITORING

The sediment transport monitoring apparatus was installed on June 22, 2010 and placed online from June 23 to July 13, 2010 when a power outage to the data logger occurred. The battery was replaced and the system restored on line from July 20 to October 8, 2010 when it was deactivated due to damaged transducers and also the high lake stage level from heavy rainfall. No storm events large enough to trigger the automated sampling system occurred during the 2010 monitoring season. The graph depicting the 2010 stormwater data recorded over the season is included as Figure 4-17.

5.0 REFERENCES

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

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

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

Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder, 1995. Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. Environmental Management 19(1): 81-97.

McIntosh, A., 1994. An Assessment of Sediment – Associated Contaminants in Lake Champlain – Phase I. Lake Champlain Sediment Toxics Assessment Program. Lake Champlain Management Conference, Technical Report No. 5. February 1994.

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

United States Environmental Protection Agency, September 29, 1998. Final Declaration for the Record of Decision (ROD); Appendix C, Revised Outline for the Remedial Design/Remedial Action Statement of Work. September.

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

FIGURES