388 BRIDGE STREET

BROOKLYN, NEW YORK

Remedial Action Work Plan

NYSDEC BCP Number: C224134

Prepared For:
384 Bridge Street LLC
c/o Stahl Real Estate Company Inc.
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and
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Submitted to:
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Division of Environmental Remediation
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APRIL 2012

CERTIFICATIONS

I, Arnold F. Fleming, certify that I am currently a New York State registered professional engineer and that this Report, Remedial Action Work Plan, was prepared in accordance will all applicable statues and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10). I have primary direct responsibility for implementation of the remedial program for the 388 Bridge Street Site (NYSDEC BCA Index No. A2-0623-0709; Site No. C224134).

I certify that the Site description presented in this Remedial Action Work Plan (RAWP) is identical to the Site descriptions presented in the Brownfield Cleanup Agreement for 388 Bridge Street Site and related amendments.

I certify that this plan includes proposed use restrictions, Institutional Controls, Engineering Controls, and plans for all operation and maintenance requirements applicable to the Site and provision for development of an Environmental Easement to be created and recorded pursuant ECL 71-3605. This RAWP requires that all affected local governments, as defined in ECL 71-3603, will be notified that such Easement has been recorded. This RAWP requires that a Site Management Plan must be submitted by the Applicant for the continual and proper operation, maintenance, and monitoring of all Engineering Controls employed at the Site, including the proper maintenance of all remaining monitoring wells, for approval by the Department.

I certify that this RAWP has a plan for transport and disposal of all soil, fill, fluids and other material removed from the property under this Plan, and that all transport and disposal will be performed in accordance with all local, State and Federal laws and requirements. All exported material will be taken to facilities licensed to accept this material in full compliance with all Federal, State and local laws.

I certify that this RAWP has a plan for import of all soils and other material from off-Site and that all activities of this type will be in accordance with all local, State and Federal laws and requirements.

I certify that this RAWP has a plan for nuisance control during the remediation and all invasive development work, including a dust, odor and vapor suppression plan and that such plan is sufficient to control dust, odors and vectors and will prevent nuisances from occurring.

I certify that all information and statements in this certification are true. I understand that a false statement made herein is punishable as Class "A" misdemeanor, pursuant to Section 210.45 of the Penal Law.

050411	4/24/12	Arnold F. Fleming
NYS Professional Engineer #	Date	Arnold F. Fleming, P.E. Signature

It is a violation of Article 130 of New York State Education Law for any person to alter this document in any way without the express written verification of adoption by any New York State licensed engineer in accordance with Section 7209(2), Article 130, New York State Education Law.

REMEDIAL ACTION WORK PLAN

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AGV	NYSDOH Air Guidance Value
AOC	area of concern
AS	air sparging
BCA	Brownfield Cleanup Agreement
BCP	Brownfield Cleanup Program
ECL	Environmental Conservation Law
BTEX	benzene, toluene, ethylbenzene, and xylenes
CAMP	Community Air Monitoring Program
C&D	construction and demolition
CDS	construction dewatering system
Class GA Standards	NYSDEC TOGS 1.1.1 Class GA Ambient Water Quality Standards and Guidance Values
CEQR	City Environmental Quality Review
CFR	Code of Federal Regulations
CPP	Citizen Participation Plan
COC	Certificate of Completion
DCE	dichloroethylene
DER-10	NYSDEC Division of Environmental Remediation (DER), DER-10 / Technical Guidance for Site Investigation and Remediation
DRO	diesel range organics
DOC	dissolved organic carbon
DUSR	Data Usability Summary Report
EC	engineering control
ESA	Environmental Site Assessment
EZ	exclusion zone
FB	field blanks
FER	Final Engineering Report
ft-btoc	feet below top of well casing
ft-bsg	feet below sidewalk grade
FLS	Fleming-Lee Shue, Inc.
HASP	Health and Safety Plan

HSA	Hollow Stem Auger
HSO	Health and Safety Officer
IC	institutional control
ISCO	*in-situ* chemical oxidation
IRM	Interim Remedial Measure
MRCE	Meuser Rutledge Consulting Engineers
MTA	Metropolitan Transportation Authority
MW	Monitoring Well
NGVD	National Geodetic Vertical Datum
NIOSH	National Institute for Occupational Safety and Health
NJDEP	New Jersey Department of Environmental Protection
NYCDEP	New York City Department of Environmental Protection
NYCDOB	New York City Department of Buildings
NYCDOT	New York City Department of Transportation
NYCRR	New York Codes, Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSDOH-ELAP	New York State Department of Health Environmental Laboratory Approval Program
OSHA	Occupational Safety and Health Association
PCB	polychlorinated biphenyl
PCE	perchloroethylene, aka tetrachloroethylene
PID	photoionization detector
PP Metals	Priority Pollutant Metals
PPE	personal protective equipment
QA/QC	quality assurance / quality control
QAPP	Quality Assurance Project Plan
RAP	Remedial Action Plan
RMO	Remedial Measure Objective
RE	Remedial Engineer
RI	remedial investigation
RSCOs	Recommended Soil Cleanup Objectives

RUSCOs	6 NYCRR 375-6.8(b) Track 4 – Restricted-Residential Use Soil Cleanup Objectives
SB	soil boring
SG	soil gas
SJHS	Saint Joseph High School
SMP	Site Management Plan
SoMP	Soil/Material Management Plan
SSDS	sub-slab depressurization system
SVE	soil vapor extraction
SVOC	semi-volatile organic compound
TAL	Target Analyte List
TAGM 4046	NYSDEC Technical and Administrative Guidance Memorandum #4046
TB	trip blanks
TCE	trichloroethylene
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TCLP Limits	USEPA Maximum Concentrations of Contaminants for the Toxicity Characteristic
TOC	total organic carbon
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	underground storage tank
UUSCOs	6 NYCRR 375-6.8(a) Track 1 - Unrestricted Use Soil Cleanup Objectives
VOC	volatile organic compound
ZVI	zero valent iron

EXECUTIVE SUMMARY

SITE DESCRIPTION/PHYSICAL SETTING/SITE HISTORY

On August 13, 2009, 384 Bridge Street, LLC (the "Participant") entered into a Brownfield Cleanup Agreement (BCA) with the New York State Department of Environmental Conservation (NYSDEC), to investigate and remediate an approximately 0.46-acre lot located at 388 Bridge Street in Brooklyn, New York (hereafter referred to as the "Site"). The NYSDEC Brownfield Cleanup Agreement Index (BCA) Number is A2-0623-0709 and Site Number is C224134. On July 13, 2010, the BCA was amended to add R, K & G Associates, LLC, the owner of a portion (i.e., Lot 37) of the Site, as a party to the BCA.

A mixture of residential and commercial use is proposed for the property. When completed, the Site development will include a 53-story, mixed-use building with 234 rental units, 144 condominium units, retail spaces, a recreational facility, and a parking garage on the sub- cellar, cellar, and 2nd and 3rd floors.

The Site is located in downtown Brooklyn in the mid-block between Willoughby Street to the north and Fulton Street to the south. The legal description of the Site is Block 152, Lots 37 and 118. Figure 1 provides a Site Location Map and a Site Plan is provided as Figure 2. The Site is bordered to the east by Bridge Street and to the west by Lawrence Street. Lots 122 (Golden Crust Eatery) and Lot 18 (ASA Institute of Business) border Lot 118 (fronting Lawrence Street), to the north and south, respectively. Lot 37 (fronting Bridge Street) is bordered to the north by Saint Joseph High School (SJHS) and a portion of a 5-story commercial building (Lots 33 and 31, respectively), and to the south by a fabric discount store on the ground floor of a 5-story commercial building on Lot 6.

A review of historic documentation, including historic Sanborn Fire Insurance (Sanborn) Maps revealed that from 1887 to 1996, the Site was used for both residential and commercial purposes. The 1950 Sanborn map depicts the Site with multiple commercial businesses including a dry cleaning facility. Sanborn maps show that a dry cleaner operated on the Site until at least 1982. An interview with the former property lessee and images obtained from Google Maps indicate that a dry cleaning facility occupied the Site from 1986 through 2006, when the establishment moved across the street and south of the Site to 401 Bridge Street. In early 2008, the dry cleaning facility again relocated to 204 Livingston Street, approximately 800 feet south of the Site. Additionally, in 1997, a dry cleaning business started at 381 Bridge Street, across the street and northeast of the Site.

SUMMARY OF THE ON-SITE REMEDIAL INVESTIGATION

Subsurface investigations were performed on the Site in September, October, November and December 2008; September 2009; and March 2010. The subsurface investigations included the collection and analysis of groundwater, soil, and soil vapor samples.

Elevated levels of chlorinated VOCs were detected in groundwater samples collected at the Site during all subsurface investigations performed in 2008. These compounds were also detected, but at lower concentrations, in groundwater samples collected in September 2009. In March 2010, the concentrations of chlorinated VOCs detected in groundwater samples from the north and northeast portion of the Site continued the downward trend and were significantly lower than those detected in the 2008 and 2009 investigations. However, chlorinated VOC levels in groundwater at the south and southwest portions of the Site (upgradient) remained similar to levels observed in prior investigations.

Trace concentrations of chlorinated VOCs, at concentrations below the NYSDEC Part 375 Unrestricted Use Soil Cleanup Objectives (UUSCOs) listed in Table 375-6.8(a) of Part 375 of Title 6 of New York Codes, Rules and Regulations (NYCRR), were detected in the Site soils during all subsurface investigations.

Elevated concentrations of chlorinated VOCs in soil vapor were detected on Lot 37 and the eastern portion of Lot 118. The extent of the chlorinated VOC vapor contamination in the soils under the remaining portion of Lot 118 could not be determined due to the presence of a till layer and Site entrance ramp from Lawrence Street which impeded drilling in this area.

SUMMARY OF THE OFFSITE REMEDIAL INVESTIGATION

In January-May 2009, FLS performed off-site sub-slab soil vapor and indoor air sampling in the basement of SJHS, adjoining the site to the north, in order to evaluate the potential for soil vapor intrusion into the building. The results indicated that chlorinated VOCs were present in the soil vapor and the indoor air exceeding New York State Department of Health (NYSDOH) Air Guidance Values (AGVs).

In August 2010, FLS performed off-site soil vapor and/or indoor air sampling on several other properties surrounding the Site, at the request of NYSDEC, including 78 Willoughby Street, 139 Lawrence Street, and in front of 381 Bridge Street. The results indicated, through an analysis of the ratios of tetrachloroethene (PCE) to its breakdown products, that chlorinated VOCs on the other surrounding properties were likely related to a different off-site source, unrelated to the 388 Bridge Street site.

In July 2011, FLS sampled groundwater from existing on-Site and off-site monitoring wells. Overall, the analytical results from in the samples from most of the on-Site wells showed significant decreases in PCE concentrations since 2008, while the PCE concentration in the sample from the off-site well (MW-3) increased from the 2010 sampling. Further, the PCE concentration in MW-3 in July 2011 was significantly higher than the PCE concentrations in any of the on-Site wells. The higher PCE concentration and the increasing concentration trend in MW-3, which is located across Bridge Street from the site and directly in front of a former off-site dry cleaner, is strong evidence of an off-site source, unrelated to the Site.

QUALITATIVE HUMAN HEALTH EXPOSURE ASSESSMENT

The results of the remedial investigations provided sufficient data to complete a Qualitative Human Health Exposure Assessment, which identified several complete exposure pathways that include:

- Groundwater dermal contact by on-Site environmental and construction workers
- Inhalation of vapors and particulates by on-Site environmental and construction workers
- Inhalation of vapors and particulates by off-Site residents/building occupants

The potential exposure pathways associated with the remediation/construction phase of the redevelopment are temporary and of limited duration. Worker exposure to contaminated groundwater and airborne vapors and particulates will be addressed by adherence to health and safety protocols. Potential exposure of neighborhood residents and other off-site populations will be addressed through compliance with the Community Air Monitoring Plan (CAMP). A summary of the CAMP is included in Section 5.0 of the HASP and presented in Appendix A of this Remedial Action Work Plan (RAWP). Exposure of occupants at St. Joseph High School has been addressed by several mitigation measures that have been implemented at the school to date, which are further described in the following section.

SUMMARY OF THE REMEDIAL ACTIONS

The proposed remedial actions, intended to address all environmental issues associated with the Site, consist of the following;

1. Excavation of soil/fill for development purposes will be performed. The soil will be screened for indications of contamination (by visual means, odor, and monitoring with PID) of all excavated soil during any intrusive Site work. All soil must meet Track 4 Restricted-Residential Use SCOs (RRUSCOs), as listed in Table 1;
2. Off-Site disposal of all material removed from the Site in accordance with all Federal, State and local rules and regulations for handling, transport, and disposal;
3. Collection and analysis of end-point samples to evaluate attainment of Track 4 RRUSCOs included in Table 1;
4. If needed, import of materials to be used for backfill and cover in compliance with: (1) the UUSCO chemical limits included in Table 1, and (2) all Federal, State and local rules and regulations for handling and transport of material;
5. Removal of soil gas above New York State Department of Health (NYSDOH) Air Guidance Values (AGVs), as listed in the NYSDOH Final

Guidance for Evaluating Vapor Intrusion in the State of New York, October 2006, through a soil vapor extraction (SVE) system;

6. Installation of an active sub-slab depressurization system (SSDS) to address residual contamination at the Site;
7. Construction and maintenance of an engineered composite cover consisting of a vapor barrier and a concrete pressure slab to prevent human exposure to residual contaminated soil/fill remaining under the Site;
8. Monitored natural attenuation of groundwater;
9. Installation of an active SSDS and basement pressurization system, and sealing of the elevator pit at St. Joseph High School, which borders the Site to the north, to address off-site soil vapor contamination.
10. Development of a Site Management Plan for long term management of residual contamination as required by the Environmental Easement, including plans for: (1) Institutional and Engineering Controls, (2) monitoring, (3) operation and maintenance and (4) reporting;
11. All responsibilities associated with the Remedial Actions, including permitting requirements and pretreatment requirements, will be addressed in accordance with all applicable Federal, State and local rules and regulations.

Remedial activities will be performed at the Site in accordance with this NYSDEC-approved RAWP. Any deviations from the RAWP will be promptly reported to NYSDEC for approval and fully explained in the FER.

REMEDIAL ACTION WORK PLAN

1.0 INTRODUCTION

384 Bridge Street, LLC entered into a Brownfield Cleanup Agreement (BCA) with the New York State Department of Environmental Conservation (NYSDEC) in August 2009, to investigate and remediate an approximately 0.46-acre property located at 384-388 Bridge Street, Brooklyn, New York. 384 Bridge Street is a Participant in the Brownfield Cleanup Program. On July 13, 2010, the BCA was amended to add R, K & G Associates, LLC, the owner of a portion (i.e., Lot 37) of the Site, as a party to the BCA.

A mixture of residential and commercial use is proposed for the property. When completed, the Site will be developed into a 53-story mixed-use building that contains 378 residential units. A total of 234 residential units will be for rental and 144 units will be market-rate for-sale units. The building will also have retail spaces, a recreational facility, and a parking garage on the sub-cellar, cellar, second, and third floors.

This Remedial Action Work Plan (RAWP) replaces the Interim Remedial Measures Work Plan submitted in December 2010, and summarizes the nature and extent of contamination as determined from data gathered during the Remedial Investigation (RI), performed between September 2008 and August 2011 both on-Site and off-site. As Participants in the BCP, there is an obligation to characterize and remediate off-Site areas that were affected by the contamination from the Site, as well as the Site itself. This RAWP assesses the remediation for both the Site and the adjacent areas that have been demonstrated to have been affected by contamination emanating from the Site.

The RAWP provides an evaluation of a Track 4 cleanup and other applicable remedial measure alternatives, their associated costs, and the recommended and preferred remedy to address on-Site and off-Site contamination. The remedy described in this document is consistent with the procedures defined in DER-10 and complies with all applicable standards, criteria and guidance. The remedy described in this document also complies with all applicable Federal, State and local laws, regulations and requirements. The NYSDEC and New York State Department of Health (NYSDOH) have determined that this Site represents a significant threat to human health and the environment.

1.1 Site Location and Description

The Site is located in Kings County, New York and is identified as Block 152, Lots 37 and 118 on the New York City Tax Map. A United States Geological Survey (USGS) topographic map in Figure 1 shows the Site location. The Site is situated on an approximately 0.46-acre area bounded by Saint Joseph High School (SJHS) and a portion of a five-story commercial building (Lots 33 and 31, respectively) to the north, a fabric discount store (Lot 6) and ASA Institute of Business (Lot 18) to the south, Bridge Street to the east, and Lawrence Street to the west (see Figure 2). A boundary map is attached to the BCA as required by Environmental Conservation Law (ECL) Title 14 Section 27-1419. The 0.46-acre property is fully described in Appendix B – Metes and Bounds. A Latitude/Longitude for the starting point is included.

1.2 Contemplated Site Redevelopment Plan

The Remedial Actions being performed under the RAWP are intended to make the Site protective of human health and the environment consistent with the contemplated end use. The proposed development plan and end use is described here to provide the basis for this assessment.

The Site will be developed as a 53-story mixed use building containing approximately 234 rental and 144 condominium units. The foundation depths for the development area will extend to approximately 25 and 15 feet below grade on Lots 37 and 118, respectively. The structure will include a residential lobby to be located on the ground floor, a tenant storage area, retail/commercial space, a recreational facility, and a parking garage on the sub-cellar, cellar, 2nd, and 3rd floors. The development will be approximately 502,113 gross square feet (including 53,843 square feet of below-grade space) and 411,834 total net square feet, broken down as follows:

Intended Use	**Area (square feet)**
Residential rental	169,692
Residential condominiums	146,511
Parking	44,940
Tenant Storage	1,640
Retail commercial space	35,675
Recreational	13,376

The proposed Building Plans are included in Appendix C.

1.3 Description of Surrounding Property – Off-Site Area

The site is located in a mixed-use area and surrounded by residential, commercial, and manufacturing uses. Lot 33 contains a 10-story masonry building that is used as a high school. Lots 28, 29, and 31 contain 4- and 5-story commercial buildings. Lot 122 contains a 1-story commercial building that is used as a restaurant. Lot 18 is a 3-story commercial building occupied by the ASA Institute of Business. Lot 6 contains a 5-story masonry commercial building. The surrounding properties are depicted on Figure 2. The following table lists potential sensitive receptors nearest to the Site.

Sensitive Receptor	**Name**	**Address**	**Distance From Site (Miles)**
Rivers / Streams	East River		0.96
Day Care Facilities	Helen Keller Services For the Blind Children's Learning Center	57 Willoughby Street Brooklyn, NY 11201	0.16
Schools	Saint Joseph High School	80 Willoughby Street Brooklyn, NY 11201	0.00
Playgrounds	Columbus Park	Cadman Plaza West and Fulton Street	0.29

2.0 DESCRIPTION OF REMEDIAL INVESTIGATION FINDINGS

The Site was investigated in accordance with the scope of work presented in the NYSDEC-approved RI Work Plan submitted to NYSDEC on October 9, 2008, approved by NYSDEC on October 24, 2008 and supplemented in October and December 2008, September 2009, and March 2010. The off-Site areas adjacent to the Site were investigated in accordance with a work plan submitted to the NYSDEC in February 2010 approved February 18, 2010.

2.1 Site History

The Site is located in a mixed-use commercial area of the Borough of Brooklyn, New York. As indicated on the earliest available historic Sanborn fire insurance maps, from 1887 to 1915, the Site was occupied by residential dwellings and stores. In 1921, a large department store was developed south of and directly adjacent to the Site. In 1938, the Site is identified as a parking facility. Sometime between 1938 and 1950, the use of the Site for parking was discontinued. A review of the 1947 Certificate of Occupancy identified a residential structure at the Site with a one-car parking garage. The 1950 Sanborn map depicts the Site with multiple commercial businesses including a furniture store, miscellaneous stores and a dry cleaning facility. Sanborn maps show that the Site remained a dry cleaner until at least 1982. No Sanborn coverage was available between 1982 and 1986. However, an interview with the former property lessee and images obtained from Google Maps indicate that Bridge Cleaners occupied the Site from 1986 through 2006, when the establishment moved across the street and south of the Site at 401 Bridge Street. In early 2008, Bridge Cleaners again relocated to 204 Livingston Street, approximately 800 feet south of the Site. Additionally, in 1997, another dry cleaning operation was located at 381 Bridge Street across the street and northeast of the Site (Figure 2). DOB records indicate that, as of 2004, this dry cleaner no longer occupied the 381 Bridge Street address. Another source indicates that the dry cleaner vacated 381 Bridge Street sometime in 2006.

2.2 Geological Conditions

2.2.1 Geology

The Site is mapped on the *Brooklyn, NY-NY* Quadrant 7.5 Minute Topographic Map, published by the USGS. Review of the topographic map indicates that the Site is located approximately 45 feet above sea level (NGVD).

As indicated in the Meuser Rutledge Consulting Engineers (MRCE) subsurface geotechnical investigation report dated May 2007, there are two strata under the Site and surrounding area. The upper stratum is a miscellaneous fill with thicknesses ranging from 3 to 17 feet. The stratum below the fill layer is a natural glacial till deposit consisting of very compacted to compacted, brown to red-brown, fine to coarse sand and gravel with a trace of cobbles and boulders. The underlying till layer becomes less compacted and consists of coarse sand intermixed with some gravel at and below the water table. The glacial till stratum extends to 100 feet below sidewalk grade (ft-bsg) and is underlain by highly consolidated Gardiner's clay. Lot 37 was excavated to the depth of 25 ft-bsg to

accommodate sub-cellars for the proposed building. However, based on the delay in starting construction on the development site, the New York City Department of Buildings (NYCDOB) requested that, prior to foundation construction, this portion of the Site be temporarily filled to support the foundations of the buildings abutting the Site. Lot 37 was backfilled with 12 feet of mole rock (pulverized bedrock resulting from tunneling for subway construction) to raise the grade to 13 ft-bsg. Brown medium to coarse sand intermixed with some gravel was present in soil borings from just below the mole rock fill to 42 feet bsg.

A portion of Lot 118 was excavated to build the ramp that currently occupies that section of the Site. Additionally, during the 2008 FLS Lot 118 Remedial Investigation, the eastern portion of the ramp was further excavated to match the Lot 37 grade (25 ft-bsg) to facilitate groundwater and soil vapor sampling. All excavated soil was used to backfill and maintain the integrity of the ramp. The soil that remains on Lot 118 will be excavated to the depth of 15 feet below grade to accommodate a cellar.

2.2.2 Hydrogeology

Groundwater

The Site-specific hydrogeological information was obtained during the Additional Subsurface Investigation (ASI) (2008) and the Supplemental Remedial Investigation (SRI) conducted in October 2009. Subsequent groundwater sampling in 2011 confirmed the hydrogeological conditions at the Site.

Groundwater was encountered at depths ranging from approximately 43 to 44 ft-bsg. The local groundwater flow was initially assumed to be south/southwest toward the East River; however, based on site-specific data from five monitoring events conducted over 4 months in 2008, groundwater at the Site was determined to be flowing to the northeast. This localized groundwater flow direction may be influenced by the subway tunnels located north and southwest of the site and pumping operations at a Metropolitan Transit Authority (MTA) de-watering station located approximately 1.5 miles northeast of the Site. A groundwater contour map is provided as Figure 3.

Three additional shallow monitoring wells were installed in September 2009, subsequent to backfilling of the Site to 13 ft-bsg. Both existing and newly installed monitoring wells were surveyed and depth-to-groundwater measurements were collected from all wells over a 2-week period. A groundwater contour map was constructed and groundwater flow was determined to be to the northeast, thereby confirming the 2008 findings.

In July of 2011 groundwater was sampled from all available existing wells. The groundwater flow direction was confirmed to be to the southwest.

Groundwater in the New York City area is not used as a potable (drinking) water source. New York City residents receive their drinking water supply from surface reservoirs located in upstate New York.

Surface Water.
No surface water bodies exist on the Site. The closest surface water body is the East River, located approximately 0.96 mile west of the Site.

2.3 Summary Remedial Investigations Performed

This section provides an overview of the Remedial Investigations conducted on the Site.

2.3.1 Borings and Wells

From 2007 through 2010, nine remedial investigations have been conducted on the Site. In the course of this work, 107 borings have been installed, 11 of which have been converted into permanent monitoring wells. Information regarding soil borings is summarized in the following table; a comprehensive outline of all samples collected and analyzed to date is presented in Table 2.

Consultant	Date	Boring Type	Number	Installation Method
EMTEQUE	March 2007	Soil	14	Hand Auger
EMTEQUE	February 2008	Soil	12	Excavator
EMTEQUE	July 2008	Soil, End-point	33	Grab
EMTEQUE	September 2008	Groundwater / Soil Vapor	9 (W1, W2, W3)	not specified
MRCE	February 2007	Geotechnical	8	Mud Rotary – DK50 Electric Skid Rig
FLS	October/November 2008	Soil / Groundwater / Soil Vapor	16 (MW-1-MW-4)	Geoprobe / HSA DK50
FLS	December 2008	Groundwater / Soil Vapor	6	Geoprobe
FLS	September 2009	Soil / Groundwater / Soil Vapor	19 (MW-5 –MW-7)	Geoprobe / Sonic Rig
FLS	March 2010	Soil Vapor / Groundwater	17	Geoprobe

HSA – Hollow Stem Auger
MW – Monitoring Well
MRCE – Meuser Rutledge Consulting Engineers
FLS – Fleming Lee Shue, Inc.

2.4 Previous Investigations

This section presents the methodology and findings of previous investigations conducted on-Site and off-Site as well as the details of the findings of the following investigations performed by FLS:

- Additional Remedial Investigation (October 2008)
- Lot 118 Investigation (December 2008)
- Supplemental Remedial Investigation (September 2009)
- Pre-Design Remedial Investigation (2010)
- Investigation at St. Joseph High School

- Off-Site Soil Vapor/Indoor Air Sampling (August 2010)
- Supplemental Groundwater Sampling (August 2011)

This section also summarizes the results of several Site investigations conducted prior to 2008 by EMTEQUE and a geotechnical study performed by MRCE. These investigations have also been detailed in FLS' Remedial Investigation Report (RIR), which was submitted to the Department in January 2010 and approved on February 18, 2010.

Copies of the previous site investigation reports are provided in Appendix D.

2.4.1 EMTEQUE Phase I Environmental Site Assessments and Phase II Environmental Site Investigations

Phase I Environmental Site Assessment. A Phase I Environmental Site Assessment (ESA) was conducted by EMTEQUE Corporation in February 2007 and included a review of Sanborn maps from 1887 to 1993. The earliest map (1887) depicts the surrounding properties as having mixed residential and commercial uses; a dry cleaning facility existed on-Site as early as 1950 until at least 1982. Between 1982 and 1986 there is a gap in the records.

EMTEQUE subsequently assessed Site subsurface conditions during the following Phase II investigations/sampling programs.

Limited Phase II Subsurface Investigation. In March 2007, prior to demolition of the former building, EMTEQUE conducted soil sampling at 10 locations (Figure 4). A total of 14 soil samples were collected below the former basement floor from 2- and 10-foot intervals using a hand auger and analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and priority pollutant metals (PP metals). Petroleum-related VOCs, urban fill-related SVOCs and PP-Metals exceeded the NYSDEC Technical and Administrative Guidance Memorandum #4046 (TAGM 4046) Recommended Soil Cleanup Objectives (RSCOs).

Limited Subsurface Investigation. In February 2008, EMTEQUE performed a second soil investigation on Lot 37 to address the New York City Department of Environmental Protection (NYCDEP) "e" designation requirements and to characterize the soil for disposal purposes. Twelve soil borings were installed in a grid system, each grid square measured 35 feet by 35 feet (Figure 5). One composite soil sample, consisting of individual samples collected at 2, 7 and 10 feet below sidewalk grade, was collected from each of the 12 grids and analyzed for VOCs, SVOCs, PP Metals, toxicity characteristic leaching procedure (TCLP) metals, PCBs, reactive cyanide, reactive sulfide, ignitability, corrosivity, pH and diesel range organics (DRO). Analytical results indicated SVOCs and PP Metals at levels exceeding the NYSDEC TAGM 4046 RSCOs. EMTEQUE developed a Remedial Action Plan (RAP) to manage on-Site petroleum-contaminated soil and petroleum storage tank removal during Site development in accordance with applicable federal, state and local regulations. The RAP was approved by NYCDEP and a "Notice to Proceed" was issued on May 7, 2008.

Post-Excavation Soil Sampling and Soil Vapor Sampling. In May and June 2008, petroleum contamination was found during removal of on-Site fuel oil tanks and NYSDEC spill #0801499 was assigned. The Site was excavated to 25 ft-bsg and all visible petroleum contamination was removed. Following the soil excavation, EMTEQUE conducted endpoint sampling with samples collected at 20-foot intervals along the bottom and sidewalls of the excavation (Figure 6). Laboratory results were compared with regulatory guidance levels identified in the NYSDEC Spill Technology and Remediation Series (STARS) Memo # 1, TCLP Alternative Guidance Values, the TAGM 4046 RSCOs, the NYSDEC Subpart 375-6(a) UUSCOs, and the New Jersey

Department of Environmental Protection (NJDEP) Residential Clean-up Criteria. No soils containing contaminants above these State guidelines were found. The NYSDEC closed spill #0801499 on August 9, 2009.

In September 2008, EMTEQUE installed and sampled three monitoring wells (W1, W2, W3, [see Figure 7]) to determine if petroleum contamination had impacted groundwater under the Site. While no petroleum-related contamination was detected, chlorinated VOCs (specifically tetrachloroethene (PCE) and its degradation products, trichloroethylene (TCE) and cis-1, 2-dichloroethylene (DCE)) were detected above the NYSDEC Division of Water Technical and Operational Guidance Series (TOGS) 1.1.1 Class GA Groundwater Standards (Class GA Standards). Levels exceeding the Class GA standards were detected in the groundwater samples collected from the northeast quadrant of the site, in the vicinity of the former USTs and the historic on-Site dry cleaner. Subsequent soil vapor sampling performed by EMTEQUE in these areas indicated exceedances of the NYSDOH guidance for acetone, 2-butanone, cis-1, 2-DCE and PCE.

2.4.2 Meuser Rutledge 2007 Geotechnical Investigation

Meuser Rutledge (MRCE) performed a geotechnical investigation in May 2007 to characterize subsurface conditions prior to foundation design. A map depicting boring locations is included as Figure 8. The investigation results indicated the presence of between 3 and 17 feet of fill, underlain by a natural glacial till layer consisting of very compacted to compacted brown to red-brown fine to coarse sand and gravel with traces of cobbles and boulders. Groundwater was encountered at approximately 43 feet bgs in the monitoring wells.

2.4.3 FLS 2008 Additional Remedial Investigation

Based on the results of the previous Site investigations and subsequent discussions with NYSDEC, FLS recommended that additional subsurface investigations be conducted at the Site, including soil, soil vapor, and groundwater sampling. The objective of the investigation, which was performed in October and November 2008, was to evaluate whether the previously detected soil vapor, soil and groundwater contamination in the northeast quadrant of the Site had been caused by contamination from the historic on-site dry cleaning operations or was due to other sources, and to determine if contaminated soils were present and contributing to the observed groundwater contamination. An additional objective was to investigate whether soil vapor contamination had migrated to the high school located north of the Site.

The investigation consisted of the following:

- Installation of 10 soil borings on a 10 by 20-foot grid and collection of soil samples;
- Installation and sampling of four groundwater monitoring wells (two in the sidewalk in front of the Site on Bridge Street, one along the sidewalk in the

vicinity of the former off-site dry cleaner located at 381 Bridge Street across the street from the Site to the east, and one in the southwest portion of the Site); and
- Collection of soil vapor samples from two locations: the sidewalk area adjacent to the high school at the school basement depth (approximately 10 ft-bsg) and 3 feet above the soil/groundwater interface (40 ft-bsg) in the northeast section of the Site (under the sidewalk) in the vicinity of the former on-Site dry cleaner.

The sampling locations are shown on Figure 9.

The investigation findings are summarized below:

- VOCs were detected at concentrations below the NYSDEC TAGM 4046 RSCOs in all 10 soil samples. Low levels of chlorinated VOCs, including PCE, were detected in all samples.
- Chlorinated VOCs, most notably PCE, were detected in all four groundwater samples at concentrations ranging between 143 and 988 parts per billion (ppb), exceeding the Class GA Standard of 5 ppb. The investigation concluded that these elevated PCE levels were potentially associated with the former on-Site dry cleaning operations.
- Concentrations of PCE, and its degradation products, TCE, DCE and vinyl chloride, at levels above the NYSDOH AGVs were detected in both soil vapor samples, leading to the conclusion that elevated vapor concentrations were potentially associated with the former on-Site dry cleaning operations.

2.4.4 FLS December 2008 Lot 118 Investigation

On December 23, 2008, FLS performed a subsurface investigation on Lot 118 located at the southwestern portion of the Site. The investigation included collection of groundwater and soil vapor samples. The purpose of this investigation was to determine if the subsurface soils, groundwater, and soil vapor on Lot 118 had been impacted by the chlorinated VOCs detected on Lot 37 during the October-November 2008 investigation.

The investigation consisted of the following:

- Installation of three temporary groundwater wells: one well located approximately 15 feet from the Lot 37/Lot 118 boundary and approximately 5 feet from the south wall of Lot 118 (SS-1W); one well located approximately 15 feet from the Lot 37/Lot 118 boundary and approximately 5 feet from the north wall of Lot 118 (SS-2W); and one well located approximately 17 feet from the Lot 37/Lot 118 boundary and approximately 6-7 feet from the north wall of Lot 118 (SS-3W). One groundwater sample was collected from each temporary well.
- Installation of three soil vapor points and collection of one soil vapor sample from each point. Soil vapor points (SV-3, SV-4, and SV-5) were installed in the vicinity of the temporary well locations. Each soil vapor sample was collected at 2 feet above the soil/groundwater interface (approximately16 feet below Site grade 41 feet below sidewalk grade).

Temporary monitoring wells and soil vapor sampling locations are shown on Figure 10.

The investigation findings are summarized below:

- Groundwater analytical results were compared to the NYSDEC Class GA Standards. Laboratory analysis revealed that PCE was detected in all three samples at the following concentrations: SS-1W at 28.5 ppb, SS-2W at 98.1 ppb and SS-3W at 24.1 ppb. All PCE levels in the groundwater samples exceeded the Class GA Standard of 5 ppb. The investigation concluded that elevated PCE levels in the on-Site groundwater were potentially associated with the former on-Site dry cleaning operations.
- Concentrations of PCE, and its degradation products, TCE, and DCE were detected above the NYSDOH AGVs in soil vapor samples SV-3 and SV-5. Most notably, PCE was detected at concentrations ranging between 2,990 and 11,500 micrograms per cubic meter (ug/m^3), exceeding the NYSDOH AGV of 100 ug/m^3. The investigation concluded that the elevated vapor concentrations were potentially associated with the former on-Site dry cleaning operations.

2.4.5 FLS Interview with Previous Site Lessee, 2009

Previous investigations indicted that there was a data gap in Site usage between the years of 1982 and 1986. The gap in lessee information presented an inconsistency pertaining to the duration of a portion of Lot 37 maintenance of a dry cleaning operation. In 2009, FLS conducted interviews with the previous Site lessees. Lessee interviews, as well as Google Maps, indicate that the Site was occupied by Bridge Cleaners from 1986 through 2006, when the cleaners moved across the street and to the south of the Site. In early 2008, Bridge Cleaners again relocated to 204 Livingston Street, approximately 800 feet south of the Site. In 1997, another dry cleaning operation was located at 381 Bridge Street across the street and northeast of the Site. Records indicate that, as of 2004, the aforementioned dry cleaner no longer occupies the 381 Bridge Street address.

2.4.6 2009 Supplemental Remedial Investigation (SRI)

Based on the results of the previous Site investigations and subsequent discussions with NYSDEC, FLS recommended an additional subsurface investigation at the Site, including soil, soil vapor, and groundwater sampling, the installation of four additional groundwater monitoring wells, and the performance of slug tests. The purpose of the September 2009 SRI was to assess the potential presence of contaminated soil on the Site as a potential source of the observed PCE groundwater contamination, and to determine the nature and extent of contamination that may have originated at the Site and/or nearby off-site properties. An additional objective was to estimate the Site hydraulic conductivity in order to calculate more precise groundwater flow measurements.

The investigation consisted of the following:

- Installation and sampling of three on-Site soil borings and one soil boring along the sidewalk of Lawrence Street;
- Installation and sampling of one deep and three shallow monitoring wells (installed at the aforementioned soil boring locations and labeled MW-5, MW-6S, MW-6D, MW-7 [MW-7 is located off-Site on Lawrence Street]);
- Sampling of three existing on-Site (MW-1, MW-2, MW-4) and one off-site (MW-3) monitoring wells;
- Performance of slug tests in three of the newly-installed 4-inch wells (one deep and two shallow); and
- Collection of three soil vapor samples from two locations (totaling 6 samples) at depths of 20, 24, and 28 feet below existing Site grade (which is 13 feet below the grade of the properties surrounding the Site). Depths referenced in the sample names for this investigation are given in feet below existing Site grade.

Soil borings, monitoring wells, and soil vapor sampling locations are shown on Figure 11.

The investigation findings are summarized below:

- Low levels of chlorinated VOCs, including PCE, were detected in five of the six soil samples. However, all VOCs were detected in soils at concentrations below the Part 375 UUSCOs and shown on Table 1. Additionally, total organic carbon (TOC) was not detected in any of the soil samples.
- The four newly-installed and four existing monitoring wells were sampled and analyzed for Target Compound List (TCL) VOCs, nitrate, sulfate, and dissolved organic carbon (DOC). A total of eight samples were collected from one deep and seven shallow monitoring wells. No VOCs were detected at concentrations that exceeded the New York State Class GA groundwater standards and guidance values in the deep groundwater sample. Chlorinated VOCs were detected in six of the seven shallow groundwater samples, most notably PCE and its degradation products TCE and DCE. PCE concentrations ranged from 11.9 ppb in MW-5 to 220 ppb in MW-1, exceeding the Class GA Standard of 5 ppb. DCE was detected in groundwater samples MW-1 and MW-3 at concentrations of 8.1 and 10.6 ppb, respectively, above the Class GA Standard of 5 ppb. TCE was not detected above the Class GA Standard of 5 ppb in any of the seven shallow groundwater samples. Chloroform, a common laboratory contaminant, was detected in groundwater sample MW-7 at a concentration of 14.3 ppb, exceeding the Class GA Standard of 7.0 ppb. The concentrations of PCE exhibited a significant decreasing trend compared with prior groundwater results, with concentrations an average of 62 percent lower than the 2008 levels in the existing wells.
- The results of the slug test from the two shallow wells tested indicated that hydraulic conductivity values were 8.9×10^{-2} and 5.7×10^{-2} centimeters per second (cm/sec). The average hydraulic conductivity for the shallow aquifer was calculated to be 7.1×10^{-2} cm/sec (201 feet/day) which corresponds to literature values for a coarse sand aquifer material.

- The compounds PCE and/or TCE were detected at concentrations exceeding the NYSDOH AGVs in each of the soil vapor samples. DCE, another chlorinated VOC breakdown product, was also present at elevated levels. In addition to the aforementioned chlorinated VOCs, petroleum related compounds, benzene, toluene, ethylbenzene and xylenes (BTEX) were detected at levels exceeding background levels referenced by the NYSDOH in all three samples collected from one of the two soil vapor sampling locations, SV-4.

2.4.7 FLS 2010 Pre-Design Remedial Investigation (PRI)

In March and April 2010, FLS conducted an on-Site remedial investigation as detailed in the May 2010 PRI Report. These activities, as outlined in the sampling plan presented with the PRI Work Plan, and approved by NYSDEC, included the sampling of all shallow monitoring wells; the installation and sampling of 10 temporary soil vapor points; and the performance of a soil vapor extraction (SVE) pilot testing which included installation of one 4-inch SVE well and four 2-inch soil vapor monitoring points. These activities are described in the following sections. The PRI sample locations are shown on Figure 12. Pilot test SVE wells are shown on Figure 13.

The investigation consisted of the following:

- Collection of groundwater samples from 7 shallow on-Site wells installed by FLS in October 2008 and September 2009, including MW-1, MW-2, MW-3, MW-4, MW-5, MW-6S, and MW-7;
- Collection of 10 soil vapor samples from 10 locations; the samples were collected every 25 linear feet around the site perimeter at a depth of 24 feet below Site grade;
- One 4-inch SVE well was installed in the area of the highest previously measured PCE soil vapor concentrations and the highest historical on-Site groundwater concentrations (northeast corner of the Site). Four 2-inch temporary SVE monitoring points were installed at distances of 5 feet, 15 feet, 25 feet, and 50 feet from the extraction well to serve as observation points (PV-05, PV-15, PV-25. and PV-50). The well and monitoring points were installed to 26 feet below Site grade; and
- Performance of a SVE pilot test.

The investigation findings are summarized below:

- PCE was detected in six of the seven groundwater samples at concentrations ranging from 13.9 ppb in MW-6S to 93.7 ppb in MW-4, exceeding the Class GA standard of 5 ppb. DCE and TCE were not detected at concentrations exceeding their Class GA standard of 5 ppb in any of the seven groundwater samples. Overall, most of the VOC concentrations were lower than those measured in 2008 and 2009, continuing the downward trend previously observed.

- PCE and/or TCE were detected at concentrations exceeding the NYSDOH AGVs in each soil vapor sample collected. PCE was detected above the AGV of 100 ug/m^3 in all ten samples at concentrations ranging from 963 ug/m^3 in sample ASV-5 to 4,540 ug/m^3 in sample ASV-3. TCE, with an AGV of 5 ug/m^3, was detected in all ten samples with concentrations ranging from 76.3 ug/m^3 in sample ASV-2 to 229 ug/m^3 in sample ASV-9. AGVs have not been published for DCE or vinyl chloride (VC), the two remaining degradation products of PCE. DCE was detected in all ten samples at concentrations ranging from 133 ug/m^3 in sample ASV-10 to 404 ug/m^3 in sample ASV-8. VC was detected in one of the ten soil vapor samples; ASV-8 at 13 ug/m^3. In addition to the aforementioned chlorinated hydrocarbons, petroleum related compounds and BTEX were also detected at levels exceeding NYSDOH-referenced background levels in all samples.
- Vacuum influences were observed in P-05 through P-50 during all phases of the pilot test and generally decreased with distance at the same rate regardless of the applied vacuum. Vacuum influence of up to 0.7 inches of water, at both 60 and 70 inches-of-water of applied vacuum, was observed at the furthest pressure monitoring point P-50, located 49 feet away from SVE-1. The highest observed mass flow rate occurred during the 50 inches-of-water of applied vacuum portion of the test at a removal rate of approximately 6 grams per minute (g/min) or approximately 0.013 pound per minute (lb/min). This rate would be expected to decrease as the SVE system runtime progresses. A full-scale SVE system would be designed to treat a total of 1.4 pounds of VOC mass from on-Site. Although the radius of influence (ROI) was determined to be 50 feet, the assumed design ROI is conservatively estimated at 40 feet.

2.4.8 FLS 2008-2010 Investigation of Saint Joseph High School

In October 2008, FLS conducted sub-slab and indoor air sampling at SJHS, located on the northern adjacent Lot 33. The results indicated that chlorinated VOCs were present at elevated levels, including above the NYSDOH AGVs for PCE in some samples, in both the sub-slab soil gas and the indoor air.

Based on these results, in May/June 2009, visible cracks in the floor were sealed with polyurethane, several air changeouts were conducted in the basement using a 2000 CFM fan, an air scrubber was installed to capture VOCs in the indoor air and the kitchen ventilation system was refurbished to create positive pressure in the basement. Following these initial measures, a sub-slab depressurization system (SSDS) was installed to depressurize beneath the slab and made active in November 2009, the kitchen ventilation system was modified to allow for variable operation modes and the elevator pits were sealed with a vapor barrier. These actions are described in more detail in Section 5.1.3.

In September 2010, additional indoor air samples were collected to investigate the efficacy of the measures that were implemented. Eight indoor air samples were collected within the basement (five samples) and first floor (three samples) of the school building. One background air sample was also collected at the setback roof located at southwest

corner of the building. Samples were collected at the same locations as in the previous sampling event. The indoor air and background air results were compared to the NYSDOH indoor air guidance values. Concentrations of PCE and TCE were detected below NYSDOH AGVs in all samples collected in September 2010.

The engineering controls discussed above are further detailed in Section 9.2. SJHS Indoor Air Quality Reports and engineering control design specifications are provided in Appendix E. The SJHS sampling location plans with results are provided as Figures 14a and 14b.

2.4.9 Off-Site Soil Vapor/Indoor Air Quality

The potential for the Site to have impacted adjacent properties was assessed beyond the investigations at SJHS in 2010. A work plan to sample both indoor air and sub-slab soil vapors was submitted to the NYSDEC in February 2010 and approved on February 18, 2010. The properties investigated included 78 Willoughby Street (Block 152, Lot 31), 139 Lawrence Street (Block 152, Lot 122), and in front of 381 Bridge Street (Block 145, Lot 15).

The soil vapor, sub-slab vapor and indoor air/background analytical results were presented in the October 2010 Off-site Soil Vapor/Indoor air Sampling Report. The findings indicated that soil vapors exceeded the NYSDOH AGVs for TCE in samples from all lots, but not at all locations. The sub-slab samples had exceedances of the AGVs on Lot 31 for TCE only. Likewise, the indoor air samples exceeded the AGVs for TCE on Lot 31 only.

Analysis of the ratios of PCE, TCE and DCE indicate that Lot 31 was principally contaminated by TCE, but not PCE or DCE. This analysis, together with the fact that the highest levels of TCE were found on the portion of Lot 31 that is furthest from the Site, led to the conclusion that this lot is being impacted from a source other than the Site. Samples from the other lots did not exceed the sub-slab AGVs and therefore no further action is required. This investigation concluded that no other off-site remedial action was required other than at Saint Joseph High School.

2.4.10 Supplemental Groundwater Sampling 2011

All the available wells both on-Site and off-Site were sampled in July 2011 to present an updated assessment of groundwater conditions. This sampling event concluded that the groundwater flow direction was still to the northeast, and that the concentrations of the dissolved constituents of concern, chlorinated VOCs, had decreased in most wells, with the exception of the off-site well MW-3 in front of 381 Bridge Street and one of the monitoring wells at the upgradient end of the Site. The results from the wells in the sidewalk in front of the site, MW-1 and MW-2, showed decreasing concentrations. This is further evidence that the source of the increasing concentrations across the street at MW-3 is not related to the Site.

3.0 CONTAMINATION CONDITIONS

3.1 Conceptual Model of Site Contamination

Elevated levels of chlorinated VOCs were detected in groundwater and soil vapor samples collected at the Site during subsurface investigations performed by EMTEQUE in September 2008 and FLS in October 2008, September 2009 and March/April 2010. Trace levels of these compounds, at concentrations below the UUSCOs, were detected in the Site soils; however, as part of the Site redevelopment, soil on Lot 37 was excavated to a depth of 25 ft-bsg and disposed of off-Site, thereby reducing the potential for an existing on-Site source. Other potential sources are off-Site dry cleaners adjacent to and near the Site and/or other off-site commercial or industrial operations.

Chlorinated VOCs in soil gas were detected at elevated levels at locations across the Site, including Lot 37 and the eastern portion of Lot 118. The presence of these compounds may be attributed to historic dry cleaning operations and/or other commercial or industrial operations. The extent of the organic vapor contamination in the soils under the remaining portion of Lot 118 could not be determined due to the presence of the till layer and Site entrance ramp from Lawrence Street which impeded drilling in this area.

Although the results of the 2010 FLS PRI and the 2011 groundwater update showed the presence of chlorinated VOCs in groundwater samples collected at the north and northeast portion of the Site, the concentrations of these compounds were significantly lower than those detected in the 2009 SRI and earlier investigations, confirming the previously observed downward trend. However, chlorinated VOC concentrations in groundwater at the south and southwest portions of the Site (MW-4, MW-5, and off-Site MW-7) remained similar to previous levels. Given the northeast direction of groundwater flow, MW-4 and MW-5 are considered upgradient and MW-7 is off-Site and appears to be crossgradient. The detection of chlorinated VOCs contamination at higher concentrations in the upgradient portion of the Site suggests the potential presence of an off-Site contaminant source or a regional background contamination condition.

The NYSDEC defines natural attenuation as "Relying on natural (physical, chemical, or biological) processes to reduce mass, toxicity, mobility, volume or concentration of compounds in earth or groundwater."[1] The steady decrease in chlorinated VOCs (as well as the detection of the degradation products of PCE) observed over time indicates that natural attenuation is occurring on-Site, as a result of a combination of dispersion, dilution, sorption, and volatilization. These natural processes have been facilitated by three Site-specific factors:

1. Removal of Site Buildings and Excavation of Soil on Lot 37. The removal of the former Site buildings and excavation of soil on the majority of the Site to a depth of 25 ft-bsg had been performed by June 2008. These conditions resulted in removal of the highly consolidated till layer and percolation of significant precipitation through the sand layer into groundwater.

[1] http://www.dec.ny.gov/regulations/4632.html

2. Hydraulic Conductivity. Based on information obtained from the slug tests and published literature values, the hydraulic conductivity for the aquifer was estimated as 7.1×10^{-2} cm/sec (201 feet/day), corresponding to a coarse sand aquifer material.

3. Groundwater Velocity. The relatively high groundwater velocity at the Site, which has been estimated at 1.49 feet/day.

The presence of these conditions supports the effect of natural attenuation processes at the Site and the observed decrease in concentrations of chlorinated VOCs in Site groundwater. A graph depicting the decreasing trends in the concentrations of PCE in groundwater over time is provided as Figure 15.

3.2 Identification of Standards, Criteria and Guidance

The following standards, criteria, and guidance were used during the evaluation of site data for the purpose of remedy selection.

Soil

6 NYCRR Part 375-6(b) - Track 4 Restricted Residential SCOs. The Track 4 Restricted-Residential Use SCOs (RUSCOs) are presented in Table 1. Although the RUSCOs will be used for evaluation of residual soil on-Site, on-Site soil analytical results will also be compared to the 6 NYCRR Part 375-6(a) - Track 1 Unrestricted Use SCOs (UUSCOs).

Groundwater

Division of Water Technical and Operational Guidance Series (TOGS) 1.1.1 Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations – Class GA (Class GA Standards). The Class GA Standards are presented in Table 3.

Soil Vapor

NYSDOH AGVs for PCE, TCE and vinyl chloride are referenced in the NYSDOH Vapor Intrusion Guidance Document. (NYSDOH, 2006). The NYSDOH AGVs are presented in Table 4.

3.3 Soil/Fill Contamination

This section summarizes the soil analytical results for the Site.

3.3.1 Summary of Soil/Fill Data

Petroleum and chlorinated VOCs were detected in 43 out of 71 samples; out of the 43 samples with VOC detections, two samples were endpoint samples. All other samples

with VOC detections were from soils removed from the Site. The VOC analytical results are presented in Table 5.

SVOCs were detected in 22 out of 43 samples; out of the 22 samples with SVOC detections, two samples were endpoint samples. All other samples with SVOC detections were from soils removed from the Site. The SVOC analytical results are presented in Table 6.

Metals were detected in all 28 samples for which metals were analyzed. Metals analytical results are presented in Table 7.

3.3.2 Comparison of Soil/Fill with SCGs

Table 8 contains a summary of samples that exceeded the UUSCOs and/or RUSCOs for all soil/fill at the Site.

No VOCs were detected at concentrations exceeding the UUSCOs or RUSCOs.

Several SVOCs, typically found in historic urban fill were detected above UUSCOs and RUSCOs in one sample collected prior to excavation of the Site. The following SVOCs were detected at concentrations exceeding the UUSCOs in this sample: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene and indeno(1,2,3-cd)pyrene. Soils from this area were subsequently removed from the Site.

Metals related to historic urban fill were detected above UUSCOs in 25 samples prior to excavation of the Site; five samples had metals at concentrations exceeding the RUSCOs. The following metals were detected at concentrations exceeding the UUSCOs: nickel, lead, zinc, copper and mercury. Copper, lead and mercury were detected at concentrations exceeding the RUSCOs. All samples containing metals that exceeded either UUSCOs or RUSCOs were collected and analyzed in soils that were later excavated from of the Site.

No PCBs or pesticides were detected at concentrations exceeding the UUSCOs. The PCB and pesticide analytical results are presented in Table 9.

Fourteen soil samples were also analyzed for Toxicity Characteristic Leaching Procedure (TCLP) metals. The TCLP is an analytical method that simulates sanitary landfill contaminant leaching in waste samples. As contained in the Code of Federal Regulations (40 CFR 261.24), the Maximum Concentrations of Contaminants for the TCLP Limits are an appropriate comparison for determining if a material is a “toxicity characteristic” hazardous waste.

No compounds were detected at levels indicative of hazardous concentrations. The TCLP analytical results are presented in Table 10.

3.4 On-Site and Off-Site Groundwater Contamination

This section summarizes the groundwater sampling analytical results for the Site. A groundwater flow contour map is presented in Figure 3.

3.4.1 Summary of Groundwater Data

VOCs were detected in 31 out of the 32 samples collected from 2008 to 2011. VOC analytical results are presented in Table 11.

SVOC analysis was performed on three (3) out of the 25 samples collected. No SVOCs were detected in any of the samples. SVOC analytical results are presented in Table 12.

In order to assist in the selection of a remedy for the chlorinated VOC contaminated groundwater, fifteen (15) groundwater samples were collected in September 2009 and March 2010 analyzed for geochemical parameters by the laboratory for nitrate, nitrite, nitrate + nitrite, sulfate, and dissolved organic carbon (DOC). Lab analyzed groundwater geochemistry data is presented in Table 13.

3.4.2 Comparison of Groundwater with SCGs

Chlorinated VOCs were detected in the groundwater at concentrations exceeding the Class GA groundwater standards across the entire Site and in the off-Site wells. The following VOCs were detected at concentrations exceeding the Class GA standards: PCE, cis-1,2-DCE, and TCE.

A summary of the VOCs detected at concentrations exceeding the Class GA groundwater standards is provided in Table 14. Figure 16 presents a summary of the VOC concentrations detected at each sampling location as well as the sample results exceeding the GA groundwater standards. PCE concentration trends in groundwater are plotted on Figure 15.

3.5 On-Site and Off-Site Soil Vapor Contamination

Chlorinated VOCs were detected in 20 of 21 soil vapor samples collected on the site by FLS. VOCs were detected above AGVs or NYSDOH-referenced background levels in 20 of the 21 samples collected by FLS. The analytical results are presented in Table 15.

Table 16 summarizes the VOCs that were detected in soil vapor samples with concentrations exceeding the AGVs and/or NYSDOH-referenced background levels. Figure 17 presents the locations and concentrations of PCE, TCE and DCE in on-Site soil vapor samples.

Off-site sampling results collected at SJHS (Figures 14a and 14b) indicated that chlorinated VOCs were present at elevated levels, including above the NYSDOH AGVs for PCE for samples in both the sub-slab soil gas and the indoor air.

The off-Site soil vapor study on other properties adjacent to the Site that was performed in 2010 showed concentrations of soil gas exceeding the NYSDOH AGVs on all lots sampled. However, only one Lot (31) exceeded the AGVs in the sub-slab soil gas. Based on the assessment of the pattern of the VOCs and the lack of PCE breakdown products on this Lot, it was concluded that this lot is being impacted from an off-site source other than the Site.

4.0 ENVIRONMENTAL AND PUBLIC HEALTH ASSESSMENTS

4.1 Qualitative Human Health Exposure Assessment

A Qualitative Human Health Exposure Assessment evaluates the potential for populations to be exposed to Site contaminants. Five criteria must be met to create a pathway for potential exposure to contaminants. If any one or more of the criteria are not met, then the pathway is incomplete and exposure cannot occur. The five exposure pathway criteria are 1) contaminant source, 2) contaminant release and transport mechanism, 3) exposure point, 4) exposure route, and 5) receptor population. On-Site contaminated media include groundwater and soil vapor. Potential contaminant receptors include the following populations:

- On-Site environmental and construction workers
- Future residents
- Future Site maintenance workers
- Off-Site residents/ building occupants
- Off-Site maintenance workers

The following potential exposure routes are considered incomplete:

- **Groundwater Ingestion**

  This pathway is incomplete because New York City code prohibits the use of groundwater for potable purposes.

- **Inhalation of Vapors by Future Residents and Maintenance Workers**

  Remediation will include removal of contaminated soil vapor. The proposed residential building will include a waterproofing/vapor barrier system and a sub-slab depressurization system that would eliminate this pathway.

The following exposure pathways are considered potentially complete:

- **Inhalation of Vapors and Particulates by On-Site Environmental and Construction Workers**

  During excavation and soil handling, on-Site personnel and construction workers may be exposed to dust and vapors via inhalation.

- **Inhalation of Vapors and Particulates by Off-Site Residents/Building Occupants**

  Excavation and removal of soil from Lot 118 may generate dust and vapors that could be inhaled by off-Site residents/ building occupants and maintenance personnel.

  As summarized in Section 2.4.8.1, chlorinated VOCs in soil gas have impacted the soil gas and indoor air quality of the northern adjacent SJHS. Several engineering controls, including an SSDS, a modified ventilation system and sealing of floor cracks and the entire elevator pits, have been implemented in order to address this potentially complete pathway. The on-Site SVE system was also laid out to address a

potential source of these vapors. Locations and results of previous off-Site soil gas and indoor air sampling in SJHS are provided on Figures 14a and 14b.

Other potential complete pathways have been investigated for Block 152, Lots 31 and 122 and Block 145, Lot 15, as part of an off-Site soil vapor investigation. Elevated levels of chlorinated VOCs were not detected in sub-slab or indoor air samples collected on Lot 122. Elevated levels of PCE and TCE were detected in soil gas samples collected from the sidewalk in front of Lot 15. Elevated levels of TCE were detected in sub-slab and indoor air samples collected on Lot 31. A review of the results and historical property uses indicates that the contaminants detected may be related to multiple, off-Site sources.

With the exception of potential exposures through soil gas, the above potential exposures are associated with the remediation/construction phase of the development and are temporary and of limited duration. Worker exposure to contaminated soil vapors and groundwater will be addressed by adherence to health and safety protocols. Potential exposure of neighborhood residents and other offsite populations will be addressed through compliance with the Community Air Monitoring Plan (CAMP) described in Section 6.1.4 of this RAWP, summarized in Section 5.0 of the HASP and presented in Appendix A.

4.2 Remedial Action Objectives

The goals of remediation are to reduce the concentrations of contaminants in groundwater and soil vapor to levels acceptable to the NYSDEC and NYSDOH. Based on the results of the remedial investigations conducted at the Site, the following Remedial Action Objectives (RAOs) have been identified:

4.2.1 Soil

Soil on Lot 37 has been excavated to the depth of 25 feet below grade and no VOCs have been detected at concentrations exceeding regulatory guidance levels in the remaining soils. Soil on Lot 118 has only been partially removed, but will be excavated across the entire lot to a depth of 15 feet below grade to accommodate a cellar.

RAOs for Public Health Protection

- Prevent inhalation of or exposure to, contaminants volatilizing from soil.

4.2.2 Groundwater

RAOs for Public Health Protection

- Prevent ingestion of groundwater containing contaminant levels exceeding drinking water standards.
- Prevent contact with, or inhalation of, volatiles emanating from contaminated groundwater.

RAOs for Environmental Protection

- Restore groundwater aquifer, to the extent practicable, given potential off-Site sources and area background levels.

4.2.3 Soil Vapor

RAOs for Public Health Protection

- Prevent inhalation of, or exposure to, contaminated soil vapors.
- Prevent contaminated soil vapor from migrating into on-Site proposed buildings or to adjacent off-site buildings.

RAOs for Environmental Protection

- Remove/reduce soil vapor levels under the site and control its off-site migration to the extent practicable given potential off-Site sources and area background levels.

5.0 DESCRIPTION OF REMEDIAL ACTION PLAN

5.1 Evaluation of Remedial Measures

The remedial alternatives for soil, soil gas and groundwater are discussed in the following sections. Each alternative was evaluated based on the following remedy selection factors (as defined in DER-10, Section 4.2):

- Protection of human health and the environment
- Conformance with standards, criteria and guidelines
- Long-term effectiveness and performance
- Reduction in toxicity, mobility or volume
- Short-term effectiveness and performance
- Implementability
- Cost effectiveness
- Community Acceptance
- Land use

The results of the remedial alternatives analyses are summarized below. The alternatives considered to address potential contamination in soil and existing contamination in soil vapor and groundwater are discussed below:

5.1.1 Soil

Alternative 1 – Excavation and Off-Site Disposal. This is the sole alternative evaluated for Site soils since excavation has already been implemented on the majority of the Site and no VOCs were detected in any of the currently remaining soils exceeding the UUSCOs. Prior to excavation on Lot 37, some SVOCs and metals exceeded the unrestricted use SCOs; however, end-point samples documented that SVOCs were not present above the UUSCOs (analysis for metals was not conducted). End-point samples were also collected for analysis of VOCs, all of which were detected below the UUSCOs. Soil on Lot 118 will be excavated to approximately 15 ft-bsg in order to achieve development grade. Material has been imported to Lot 37 to meet NYCDOB requirements and analysis indicates that this material meets the UUSCOs; therefore, excavation of this imported material is not considered part of the remedy, but is being conducted for development purposes. Regardless, the CAMP (Appendix A) and Soil Management Plan (Appendix F) will be implemented during the excavation of both the imported fill on Lot 37 and the soil on Lot 118. End-point and sidewall samples will confirm the removal of soil to concentrations below RUSCOs.

5.1.2 Soil Gas (On-Site)

Two remedial alternatives were considered to address the persistent, elevated levels of chlorinated VOCs present in the soil gas at the Site.

Alternative 1 – Soil Vapor Extraction (SVE). SVE involves the removal and treatment of soil gas by the application of a vacuum to the vadose zone. Within the radius of influence (ROI), soil gas is captured and treated through activated carbon. On April 15, 2010, an SVE pilot study was performed at the Site, the results of which were included in the PRIR. Based upon information collected during prior investigations and the results of the pilot test, Site soil characteristics (e.g., permeability), the determined ROI, the ability to control the ROI and the demonstrated ability of SVE to capture the soil gas contaminants indicate that this is a feasible alternative. A design report prepared by Product Recovery Management of Durham, North Carolina is included as Appendix G.

Alternative 2 - Bioventing. Bioventing involves the addition of air (and by extension oxygen) into the subsurface to aid in the biological breakdown of the contaminants into less toxic degradation products. Based on the available information, a bioventing system could be designed and implemented at the Site. However, compared with SVE, the timeframe for remediation is likely to be significantly extended. In addition, since oxygen is the limiting factor in the effectiveness of the system, there is the potential for a leveling off of the treatment rate after the initial decrease after system start-up. While bioventing would address the soil gas contamination, the technique is primarily a soil treatment remedy.

5.1.3 Soil Gas (Off-Site)

Three remedial alternatives were considered to address the elevated levels of chlorinated VOCs present in the soil gas and indoor air at St. Joseph High School. The remedial systems installed in the School were begun as an emergency action prior to the Site entering the BCP. The alternatives considered below were the alternatives considered under the emergency action.

Alternative 1 – SVE System/Air Scrubber Installation/Basement Pressurization System/Sealing of Elevator Pit. Installing an SVE system as described herein beneath the SJHS building would be an effective way of mitigating contaminated soil vapor and would meet several of the other remedy selection criteria, while the other measures would serve to mitigate the indoor air. However, installing an SVE system underneath an existing building is technically infeasible and therefore not implementable.

Alternative 2 – Air Scrubber Installation/Basement Pressurization/Sealing of Elevator Pit. Installing air scrubber units within the building would serve to mitigate the indoor air in the short term. Creating a basement pressurization system would help to

create positive pressure in the basement, which would aid in preventing infiltration of soil vapor through the building slab, and sealing the elevator pit and all accessible cracks in the floor slab would also help serve the same purpose. However, this remedy was not preferred because it did not present a mechanism to prevent contaminated soil vapors from accumulating underneath the basement slab.

Alternative 3 – Sub-Slab Depressurization System (SSDS)/Air Scrubber Installation/Basement Pressurization System/Sealing of Elevator Pit. Installing a SSDS beneath the school involves cutting holes in the basement slab to install suction pits with slotted PVC pipe and gravel, and connecting these to a riser pipe that extends above the roof, where the vapors are drawn out by a fan. The use of activated charcoal scrubbers, pressurization of the basement through an existing HVAC system and sealing the potential entry points of sub-slab vapors were easily implementable and served to mitigate the indoor air in the short term. An SSDS is an effective long-term remedy that could be implemented relatively easily under the existing building. This remedy was chosen because it satisfies all of the remedy selection criteria. To date, each of these measures have been implemented at SJHS, and together they have been shown to be an effective remedy.

The measures that constitute Alternative 3 were implemented as follows: The alternatives of scrubbing the indoor air and sealing the basement slab cracks was the first emergency action implemented at the school while building plans were sought to determine if a sub-slab depressurization system could be retro-fitted to the building, and to assess the building HVAC systems to determine if a pressurized system for the basement could be installed. When it was determined that a SSDS could be retro-fitted, the system was designed and implemented. Likewise, when an unused HVAC system serving the basement was discovered, the fans were reversed to pressurize the basement. Finally, after indoor air sampling indicated that the elevator pits were a continuing source of soil vapor intrusion, a vapor barrier in the form of sprayed on Liquid Boot® was applied to the elevator pits. The combination of these actions eliminated the concentrations of VOCs exceeding the NYSDOH AGVs, as demonstrated by subsequent confirmatory air sampling.

5.1.4 Groundwater

Four remedial alternatives for groundwater have been considered and are described below.

Alternative 1 - Natural Attenuation. As previously discussed, elevated levels of chlorinated VOCs compounds were encountered in groundwater. Groundwater concentrations in most wells observed in September 2009 were significantly lower than those detected in September 2008. This decreasing trend was confirmed by the results of the March 2010 investigation, and again by the August 2011 results, which indicated that concentrations in samples collected at the north and northeast portion of the Site were significantly lower than those detected in September 2009. However, chlorinated VOC concentrations in groundwater at the south and southwest (upgradient and crossgradient)

portions of the Site remained similar to previous levels, suggesting the presence of a potential off-Site source or a regional background contamination condition.

NYSDEC defines natural attenuation as "Relying on natural (physical, chemical, or biological) processes to reduce mass, toxicity, mobility, volume or concentration of compounds in earth or groundwater." The processes potentially occurring on-Site include a combination of dispersion, dilution, sorption and volatilization.

The exponential decrease in chlorinated VOC concentrations in the north/northeast part of the Site indicates that natural attenuation of contaminants in groundwater is occurring, a conclusion that is consistent with the following on-Site conditions: removal of site buildings and excavation of soils on Lot 37, thereby removing the till layer and exposing the subsurface to an increased volume of rainwater; the hydraulic conductivity for the aquifer, which has been estimated at 7.1×10^{-2} cm/sec (201 feet/day), corresponding to a coarse sand aquifer material; and the groundwater velocity, which was estimated to be 1.49 feet/day. Furthermore, extensive soil sampling has indicated that no significant source of chlorinated VOCs remains in soils on the Site.

The significant decreasing concentration trend for chlorinated VOC contamination, coupled with the presence of factors that would enhance natural attenuation mechanisms, indicates that 1) natural attenuation of chlorinated VOCs in groundwater is likely already occurring, and 2) monitoring of natural attenuation on-Site and downgradient of the Site, is a feasible remedial alternative for groundwater at the Site.

Alternative 2 - Air Sparging/Soil Vapor Extraction (AS/SVE). Air sparging (AS), used in conjunction with SVE, involves the injection of air into the saturated zone to strip the contaminants from the dissolved phase and transfer them to the vapor phase. The vapor rises to the vadose zone and is captured and treated by the SVE system. AS/SVE is a feasible remedial alternative for groundwater contamination. However, the implementation of an AS remedy includes significant up-front capital and long-term operational costs. In addition, the injection of air in order to mobilize contaminants from the groundwater to the soil gas has the potential risk of impacting off-Site properties. Based on the cost-effectiveness as compared to natural attenuation, which is a viable remedy, and the potential risk of contaminant mobilization to off-Site sources, this remedy is not preferred.

Alternative 3 - *In-situ* Chemical Oxidation (ISCO). Implementation of ISCO involves introducing oxidants into the subsurface, usually via injection, to break down contaminants into less toxic degradation products. Typical oxidants are sodium and/or potassium permanganate. As with AS/SVE, ISCO is a viable alternative for groundwater remediation. However, as with AS/SVE, but to a greater degree, use of this alternative is precluded by the inability to safely inject a reactive material in an area characterized by a school, residences and, most notably, a subway tunnel, the bottom of which is located at the water table. Further, the timeframe for permitting an ISCO injection in the area of the subway tunnel is estimated to take many months, by which time the Site will be capped

with a building, limiting access to the subsurface. Based on safety consideration and the logistical difficulties, this alternative is considered infeasible.

Alternative 4 - Remediation by Chemical Reduction. Use of this alternative creates a highly reductive environment, which breaks down contaminants into less toxic compounds. For groundwater, this would typically be achieved using zero-valent iron (ZVI) in nanoscale or granular form, applying the ZVI as permeable reactive barriers. The barriers may consist of funnel-and-gate systems designed to direct groundwater through the treatment zone. The effective use of ZVI in permeable barriers can be hampered by the presence of oxic (or oxygenated) conditions. At the Site, it is anticipated that multiple injections of ZVI will be needed to create anoxic (or unoxygenated) groundwater conditions to increase the effectiveness of the ZVI. Due to accessibility concerns in the event that additional injections are required, which is likely due to the groundwater flow rates and chemistry at the Site, this alternative is considered infeasible.

5.2 Remedial Action Standards, Criteria and Guidance (SCGs)

The Remedial Action SCGs are listed below.

SCG	Scope / Application
6 NYCRR Part 375-6 Soil Cleanup Objectives	Soil: Excavation End-Point Sampling; determination of compliance with restricted residential RUSCOs
NYSDEC Ambient Water Quality Standards and Guidance Values – TOGS 1.1.1	Groundwater: Post-Remedial / Off-Site Groundwater Monitoring; determination of cleanup Track for groundwater
NYSDEC Draft DER-10 Technical Guidance for Site Investigation and Remediation - May 2010	Post-remedial soil sampling, UST removal (if encountered)
NYSDEC Draft Brownfield Cleanup Program Guide – May 2004	General Program Guidance
NYSDOH Generic Community Air Monitoring Plan	Guidance for monitoring odors, VOC vapors, and dust generated from excavation and removal activities.
NYSDOH Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York – October 2006	Soil gas will meet the AGVs
NYS Waste Transporter Permits – 6 NYCRR Part 364	Transportation of waste generated during remedial activities
NYS Solid Waste Management Requirements – 6 NYCRR Part 360 and Part 364	Off-Site solid waste disposal

5.3 Selection of the Preferred Remedial Actions

The preferred on-Site remedial actions for the Site include excavation of Site soils for development purposes, remediation of soil gas using an SVE system and monitored natural attenuation of groundwater. Implementation of these on-Site remedial actions will

result in a Track 4 remediation that, in conjunction with institutional and engineering controls, will be protective of human health and the environment. Site soils will meet the restricted-residential use SCOs, soil gas will meet the NYSDOH AGVs once the SVE system is operating and monitored natural attenuation will monitor and document the decreasing concentrations of chlorinated VOC contamination in Site groundwater.

The preferred off-site remedial actions for St. Joseph High School include installation of air scrubbers, an SSDS, a basement pressurization system, and sealing of the elevator pits. Implementation of these off-site remedial actions at SJHS has been shown to be protective of human health and the environment, as illustrated by confirmatory testing performed in September 2010.

The following land-use factors were considered in selecting these remedial measures.

Land Use Factor	Remedy Evaluation Result
Zoning	Remedy is Consistent
Applicable comprehensive community master plans or land use plans	Remedy is Consistent
Surrounding property uses	Remedy is Consistent
Citizen participation	Remedy is Consistent; CPP requirements implemented regardless of selected remedy
Environmental justice concerns	None
Land use designations	Remedy is Consistent
Population growth patterns	Remedy is Consistent
Accessibility to existing infrastructure	Remedy is Consistent
Proximity to cultural resources	None Identified
Proximity to natural resources	None Identified
Off-Site groundwater impacts	Remedy will consider potential off-Site groundwater impacts and potential recontamination of on-Site groundwater.
Proximity to floodplains	Site is not within the 500 year flood zone (Zone B)
Geography and geology of the Site	Remedy is consistent
Current Institutional Controls	None Present

6.0 REMEDIAL ACTION PROGRAM

6.1 Governing Documents

6.1.1 Site Specific Health and Safety Plan

A Site Specific HASP has been created for the site and is included in Appendix A. All remedial work performed under this plan will be in full compliance with governmental requirements, including Site and worker safety requirements mandated by Federal OSHA. An emergency contact sheet with names and phone numbers is included in Table 17 and defines the specific project contacts for use by NYSDEC and NYSDOH in the case of a day or night emergency. The HASP and requirements defined in this RAWP pertain to all remedial and invasive work performed at the Site until the issuance of a Certificate of Completion.

6.1.2 Quality Assurance Project Plan

A Quality Assurance Project Plan (QAPP) has been created for the site to address quality control and quality assurance procedures for all site sampling, including post excavation end-point sampling, and is included in Appendix H.

6.1.3 Soil/Materials Management Plan

The Soil/Materials Management Plan (SoMP) includes plans for managing all soils/materials that are disturbed at the Site. The SoMP, which describes procedures for excavation, handling, storage, transport and disposal, is included in Appendix F.

6.1.4 Community Air Monitoring Plan

The purpose of the CAMP is to protect downwind receptors (e.g., residences, businesses, schools, nearby workers, and the public) from potential airborne contaminants released as a direct result of the Remedial Action being performed at the Site. A summary of the CAMP plan is included in Section 5.0 of the HASP and presented in Appendix A.

6.2 General Remedial Construction Information

6.2.1 Project Organization

An organization chart is included in Figure 18. Resumes of key personnel involved in the Remedial Action are included in Appendix I.

6.2.2 Remedial Engineer

The Remedial Engineer (RE) for this project will be Arnold F. Fleming, P.E. The RE is a registered professional engineer (PE) licensed by the State of New York. The RE will have primary direct responsibility for implementation of the remedial program for the 388 Bridge Street Site (NYSDEC BCA Index No. A2-0623-0709; Site No. C224134384). The RE will certify in the Final Engineering Report (FER) that the remedial activities were observed by qualified environmental professionals under his supervision and that the remediation requirements set forth in the RAWP and any other relevant provisions of ECL 27-1419 have been achieved in full conformance with that Plan. Other RE certification requirements are listed later in this RAWP.

The RE will coordinate the work of other contractors and subcontractors involved in all aspects of remedial construction, including soil excavation, stockpiling, characterization, removal, air monitoring, emergency spill response, import of back fill material, and management of waste transport and disposal. The RE will be responsible for all appropriate communication with NYSDEC and NYSDOH.

The RE will review all pre-remedial plans submitted by contractors for compliance with this RAWP and will certify compliance in the FER.

6.2.3 Remedial Action Construction Schedule

A general Remedial Action construction schedule is included in Table 18.

6.3 Reporting

This section outlines the reporting requirements for the site. All daily and monthly reports will be included in the FER.

6.3.1 Weekly Reports

Weekly reports will be submitted to NYSDEC and NYSDOH Project Managers by the end of each week following the reporting period and will include:

- An update of progress made during the reporting week;
- Locations of work and quantities of material imported and exported from the Site;
- References to alpha-numeric map for Site activities;
- A summary of any and all complaints with relevant details (names, phone numbers);
- A summary of CAMP finding, including excursions;
- An explanation of notable Site conditions.

Weekly reporting will be conducted during active site remediation periods including soil excavation, air monitoring, soil segregation, trucking, end point sampling, vapor barrier installation, and pouring of the concrete foundation slab.

Weekly reports are not intended to be the mode of communication for notification to the NYSDEC of emergencies (accident, spill), requests for changes to the Remedial Action Work Plan or other sensitive or time critical information. However, such conditions must also be included in the weekly reports. Emergency conditions and changes to the Remedial Action Work Plan will be addressed directly to NYSDEC Project Manager via personal communication.

Weekly reports will include a description of weekly activities keyed to an alpha-numeric map for the Site that identifies work areas. These reports will include a summary of air sampling results, odor and dust problems and corrective actions, and any complaints received from the public.

A Site map that shows a predefined alpha-numeric grid for use in identifying locations described in reports submitted to NYSDEC is provided as Figure 2.

The NYSDEC assigned project number will appear on all reports.

6.3.2 Monthly Reports

Monthly reports will be submitted to NYSDEC and NYSDOH Project Managers by the 10th day of the following month and will include:

- Activities relative to the Site during the previous reporting period and those anticipated for the next reporting period, including a quantitative presentation of work performed (i.e., tons of material exported and imported, etc.);
- Description of approved activity modifications, including changes of work scope and/or schedule;
- Sampling results received following internal data review and validation, as applicable; and,
- An update of the remedial schedule including the percentage of project completion, unresolved delays encountered or anticipated that may affect the future schedule, and efforts made to mitigate such delays.

6.3.3 Other Reporting

Photographs will be taken of all remedial activities and submitted to NYSDEC in digital format after completion of active site remediation. Photos will illustrate all remedial program elements and will be of acceptable quality. Representative photos of the Site prior to any Remedial Actions will be provided. Representative photos will be provided of each contaminant source, source area and Site structures before, during and after remediation. Photos will be submitted to NYSDEC on CD or other acceptable electronic media and will be sent to NYSDEC's Project Manager (2 copies) and to NYSDOH's

Project Manager (1 copy). Each CD will have a label and a general file inventory structure that separates photos into directories and sub-directories according to logical Remedial Measure components. A photo log keyed to photo file ID numbers will be prepared to provide explanation for all representative photos. For larger and longer projects, photos should be submitted on a monthly basis or another agreed upon time interval.

Job-site record keeping for all remedial work will be appropriately documented. These records will be maintained on-Site at all times during the project and be available for inspection by NYSDEC and NYSDOH staff.

A complete list of all local, regional and national governmental permits, certificates or other approvals or authorizations required to perform the remedial and development work is attached in Table 20. This list includes a citation of the law, statute or code to be complied with, the originating agency, and a contact name and phone number in that agency. This list will be updated in the FER.

6.3.5 Deviations from the Remedial Action Work Plan

During the implementation of the RAWP, any deviation from the RAWP will be noted and immediately brought to the attention of the RE. The RE or his/her representative will contact the NYSDEC Project Manager and determine if the deviation necessitates a formal RAWP modification and NYSDEC approval. If no formal RAWP modification is required, the deviation will be noted in the Site reports and explained in the FER.

7.0 REMEDIAL ACTION: MATERIAL REMOVAL FROM SITE

As discussed in Section 5.3, the Site will be excavated to 15 ft-bsg on Lot 118 and 25 ft-bsg on Lot 37 for development purposes. The foundation of the proposed structure will rest on native soils. On Lot 118, end-point and sidewall samples will be collected every 900 square feet (SF), in accordance with DER-10, and analyzed for VOCs, SVOCs and metals. Sidewall samples will not be collected from areas where underpinning of adjacent buildings is present. On Lot 37, previous end-point sampling documented that VOCs, SVOCs, metals, PCBs and pesticides are not present above the UUSCOs; therefore, four confirmatory end-point samples will be collected (at a rate of one per approximately 3,400 SF) for analysis of VOCs, SVOCs and metals. Proposed end-point sample locations are shown on Figure 19. All end-point samples will be collected from native soil and not the fill material imported to Lot 37. Sidewall samples will not be collected from areas where underpinning of adjacent buildings is present or existing samples document the off-Site conditions.

Soil and materials management on-Site will be conducted in accordance with the SoMP as described below.

The goals of the SoMP are to handle all potentially contaminated soil and manage activities associated with soil in a manner that prevents contamination from reaching the community, workers, future occupants and workers, and the environment. Contaminated soil must be managed in a manner that ensures removal, transport, and disposal such that it fulfills applicable regulatory requirements. Another goal is to keep objectionable odors and/or particulate from reaching the surrounding community. At the conclusion of soil excavation, the Site will be secured and left in a condition ready for construction.

Any USTs, if found on-Site, will be closed in conformance to the criteria defined in DER-10.

All post-excavation sample results will be compared with Track 4 RRUSCOs. Any soils not meeting Track 4 RRUSCOs will be removed and the area backfilled with clean fill meeting the criteria outlined in this RAWP. Potential migration of off-Site contamination onto the Site will not affect the future use of the building due to the installation, operation and maintenance of engineering controls including an SSDS and composite cover system, as detailed in Sections 9.1.1.1 and 9.1.1.2.

The RRUSCOs for this Site are listed in Table 1.

7.1 Remedial Performance Evaluation (Post Excavation End-Point Sampling)

Soil on the Lot 37 portion of the Site was excavated to the depth of 25 ft-bsg for development purposes, prior to acceptance of the Site into the BCP. Although some soil was excavated from the Lot 118 portion of the Site for ramp construction, most of the soil on the Lot 118 remains and will be excavated to a depth of 15 ft-bsg to accommodate a cellar. Post excavation soil samples were collected from Lot 37 in July 2008, by

EMTEQUE. Post-excavation end-point sampling will be performed on both Lots, as detailed above, to ensure that all soils left on-Site will meet RRUSCOs. Samples will be taken from the off-Site excavation sidewalls if the foundations of the adjacent buildings to the north and south do not extend deeper than 15 ft-bsg (the total excavation depth on Lot 118). Figure 19 presents a generalized post excavation sampling location map.

End-point samples will be collected from native soil and not the fill material imported to Lot 37. This will be ensured by visual observation by a representative of the RE. The material to be sampled is a medium- to coarse-grain, brown to orange-brown sand. The fill material that was imported – and will not be sampled – is a fine- to medium- to coarse-grain, grey to black material with some gravel-sized pieces.

7.1.1 END-POINT SAMPLING FREQUENCY

Bottom end-point samples will be collected at a frequency of one sample per 900 SF on Lot 118 and at a frequency of one sample per approximately 3,400 SF on Lot 37. The reduced frequency of four total samples on Lot 37 is because end-point samples have been previously collected documenting that VOCs, SVOCs, metals, pesticides and PCBs meet UUSCOs. Sidewall samples will be collected at a frequency of one sidewall sample per 30 linear feet wherever sidewalls are present.

7.2 Estimated Material Removal Quantities

The estimated quantity of soil/fill to be removed from the Site for development purposes is approximately 6,100 cubic yards from Lot 37 (all of which is imported mole rock that meets the UUSCOs) and approximately 1,750 cubic yards from Lot 118.

7.2.1 MATERIALS TRANSPORT OFF-SITE

All transport of materials will be performed by licensed haulers in accordance with appropriate local, State, and Federal regulations, including 6 NYCRR Part 364. Haulers will be appropriately licensed and trucks properly placarded.

All trucks leaving the Site will proceed to route 278, a major highway that will direct them either west towards disposal facilities in New Jersey or Pennsylvania or east towards disposal facilities in Long Island.

Out-bound truck transport routes are as follows:

> To Route 278W: Trucks will depart from Lawrence Street; turn left on Willoughby Street; take Willoughby Street to Jay Street; turn left on Jay Street;

Jay Street becomes Smith Street. Take Smith Street to Atlantic Avenue; turn right on Atlantic Avenue and left onto route 278 West.

To Route 278E: Trucks will depart from Lawrence Street; turn left on Willoughby Street; take Willoughby Street to Jay Street; turn right on Jay Street; take Jay Street to Tillary Street; turn right on Tillary Street and merge onto route 278 East.

In-bound truck transport routes are as follows:

From Route 278E: Trucks will take 278 east to exit 29B Tillary Street; take Tillary Street to Jay Street; turn left on Jay Street; take Jay Street to Livingston Street; turn left on Livingston Street and left on Lawrence Street.

From Route 278W: Trucks will take 278 west to exit 27 Atlantic Avenue; take Atlantic Avenue to Smith Street, turn left on Smith Street; take Smith Street to Livingston Street; turn right on Livingston Street and left on Lawrence Street.

All trucks loaded with Site materials will exit the vicinity of the Site using only these New York City Department of Transportation (NYCDOT)-approved truck routes.

Proposed in-bound and out-bound truck routes to the Site are shown in Figure 20. This is the most appropriate route and takes into account: (a) limiting transport through residential areas and past sensitive sites; (b) use of city mapped truck routes; (c) limiting total distance to major highways; (d) promoting safety in access to highways; and (e) overall safety in transport; (f) community input.

Trucks will be prohibited from stopping and idling in the neighborhood outside the project Site.

Egress points for truck and equipment transport from the Site will be kept clean of dirt and other materials during Site remediation and development.

Material transported by trucks exiting the Site will be secured with covers. If loads contain wet material capable of producing free liquid, truck liners will be used.

All trucks will be washed prior to entering the City streets. Truck wash waters will be collected and disposed of off-Site in an appropriate manner.

8.0 REMEDIAL ACTION: OFF-SITE SOIL VAPOR MONITORING

Two soil vapor points located on the east side of Bridge Street opposite from the Site that were sampled in 2010 were found to have widely differing VOC concentrations. One monitoring point (sample location Off-SG-4) located in the sidewalk in front of 381 Bridge Street (the location of a former off-site dry cleaner) contained TCE at a concentration above the AGV and PCE at a concentration below the AGV. The ratio of PCE to TCE in soil vapor at sample location Off-SG-4 was 0.3, which was not consistent with the PCE:TCE ratios found in the soil vapor at several sampling locations on the eastern edge of the Site adjacent to Bridge Street, which ranged from 16.6 to 204.8. These data suggest that the VOCs detected in soil vapor at Off-SG-4 may be from a different source and not from the Site. The second soil vapor point located across Bridge Street from the Site (sample location Off-SG-5) had concentrations of both PCE and TCE above the AGV and had a PCE:TCE ratio of 15.8, which is slightly below the lower end of the range detected in on-Site soil vapor on the eastern portion of the Site adjacent to Bridge Street, as discussed above and similar to the ratios found on the southern side of the Site. Given the multiple solvent sources identified in the neighborhood, the similarity of the ratios of PCE to TCE in Off-SG-5 to the soil vapor on the portion of the Site furthest from the former On-Site dry cleaner, and the location of the Off-SG-5 closer to a known historic Off-Site dry cleaner than to the former On-Site dry cleaning operation, it is believed that the soil vapor detected at Off-SG-5 is likely from an Off-Site source.

NYSDOH has asked for further confirmation of this conclusion. Accordingly, limited additional off-site soil vapor monitoring will be conducted to further evaluate soil vapor adjacent to the Site in the area of Bridge Street during the implementation of the RAWP. This sampling will be performed using the two existing soil vapor probes on the east side of Bridge Street (Off-SG-4 and Off-SG-5), as well as an additional soil vapor probe that will be installed in the sidewalk on the west side of Bridge Street, adjacent to the Site. The three locations will be monitored simultaneously for comparison purposes. Monitoring will be performed via Summa canister sample collection and analysis by EPA TO-15. Following the implementation of the RAWP, the soil vapor data, including the off-site data described above, will be assessed to determine if additional monitoring or other actions may be warranted.

9.0 RESIDUAL CONTAMINATION TO REMAIN ON-SITE

The successful implementation of the Remedial Action Work Plan will result in the following:

- All residual soil left on-Site will meet RRUSCOs
- Groundwater may exceed the Class GA Standards
- Soil vapor will be at levels acceptable by the NYSDOH to the extent practicable, given potential off-Site sources.

Since residual contaminated groundwater and soil vapor will exist beneath the Site after the remedy is complete, Engineering and Institutional Controls (ECs and ICs) are required to protect human health and the environment. These ECs and ICs are described hereafter. Long-term management of EC/ICs and of residual contamination will be executed under a Site-specific Site Management Plan (SMP) that will be developed and included in the FER.

ECs will be implemented to protect public health and the environment by appropriately managing residual contamination. The Controlled Property (the Site) will have four primary EC systems. These are:

1. Composite Cover System;
2. Sub-Slab Depressurization System;
3. Soil Vapor Extraction System; and
4. Monitored Natural Attenuation.

The composite cover system and the SSDS are long-term ECs. The SVE system will not be a long-term EC, but rather part of the remedy that may be operated after the FER is submitted. In addition, while monitored natural attenuation is the selected remedy, it is presented as an EC because it will continue after the FER is submitted. The FER will report residual contamination on the Site in tabular and map form. This will include presentation of exceedances of both Track 1 and RRUSCOs.

10.0 ENGINEERING CONTROLS

10.1 Engineering Control Systems - On Site

As discussed above, four engineering controls (ECs) will be present at the Site: a composite cover system, a SSDS, a SVE system, and monitored natural attenuation. The conceptual remedial approach, general system design, system operation, maintenance and monitoring (OM&M) requirements and criteria for termination of each of these systems is described below.

10.1.1 Description of On Site Remedial Systems

10.1.1.1 Composite Cover System

Exposure to vapors associated with residual contaminated groundwater will be prevented by an engineered, composite cover system that will be built on the Site. This composite cover system will be comprised of a vapor barrier and concrete building slabs. The composite cover will range between 4 and 6 feet-thick on Lot 37 and will be 8 inches-thick on Lot 118. The vapor barrier will consist of a pre-applied waterproofing membrane that integrally bonds to poured concrete. Preprufe 300R membrane will be used under the foundation slab while Preprufe 160R will be applied to the below grade foundation walls. Vapor barrier specifications are provided in Appendix J.

The location of each remedial cover type used on the Site is shown on Figure 21. The SMP will outline the procedures required in the event the composite cover system and underlying residual contamination are disturbed as well as planned inspections of the composite cover system.

10.1.1.2 Sub-Slab Depressurization System (SSDS)

The vapor barrier will be used in conjunction with the SSDS to prevent soil vapor from entering the building through joints or cracks in the floor slab. The SSDS was designed to create a slight pressure differential, minimum 0.003 inches of water column (WC), between the interior and sub-slab environment of the building. Supporting documentation for the design and installation of the SSDS (including figures depicting the system layout) is provided in Appendix K.

The system design details are largely based on the NYSDOH *Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York* (2006), as well as documents referenced in the NYSDOH guidance, most notably, the United State Environmental Protection Agency (USEPA) *Radon Prevention in the Design and Construction of Schools and Other Large Buildings* (1994) and USEPA *Building Radon Out: A Step-by-Step Guide on How to Build Radon-Resistant Homes* (2001).

A minimum 8-inch layer of clean, 1.5-inch gravel will be placed below the composite cover system and between layers of geotextile fabric, which will prevent significant amounts of soil from entering the SSDS and protect the vapor barrier. Suction pits will be constructed with four 8 by 8 by 8-inch concrete blocks overlain by a 4 by 4-foot steel plate. A suction pipe will be inserted into the middle of each suction pit and run through the building to a regenerative blower.

The regenerative blower will be located outside the building on the roof of a mechanical room along Lawrence Street that is not accessible to the interior of the building. A flow meter with an alarm will be tied into the building management system.

The discharge location will be above the mechanical room and in conformance with NYSDOH and USEPA requirements. There are no operable windows within 10 feet of the exhaust location, per NYSDOH requirements. The nearest operable windows at the same or higher elevation will be the on-Site windows of the tower fronting Bridge Street, which will be over 100 feet away. The discharge point will be fitted with a rain cap.

The above-grade piping will be labeled to indicate that it is part of the SSDS system. Labels will be placed approximately every 10 feet stating:

CAUTION: DO NOT ALTER
SUBSURFACE VAPOR VENT PIPE

A label on the vent stack at the roof level will read:

Soil gas vent stack. DO NOT PLACE AIR INTAKE WITHIN 10 FEET.

As-built drawings will be included in the FER.

A start-up plan and procedures for operating and maintaining the SSDS, including annual inspections, will be included in the SMP. The SSDS will be started immediately upon completion of construction and will run concurrently with the SVE system. The SSDS exhaust will be sampled after system startup to determine if the treatment is required.

10.1.1.3 Soil Vapor Extraction System

The SVE system will be used to remove VOCs from the soil gas and, if present, soil by creating a vacuum from wells installed below the building slab. The system was designed based on the findings of FLS' SVE Pilot Test Report dated May 2010, included in Appendix L. The SVE system was designed to generate approximately 12.4 inches of water at six well points beneath the Site. The well points were screened from 29 to 39 ft-bsg and constructed as shown on Figure 2 of FLS' SVE Pilot Test Report (Appendix L).

The exhaust location is the same as the SSDS exhaust location. The nearest operable windows at the same or higher elevation will be the on-Site windows of the tower fronting Bridge Street, which will be over 100 feet away.

Based on pilot test data, two 5,000 pound (lb)-capacity, granular activated carbon (GAC) units will be plumbed in series to treat the extracted vapors. After system startup, effluent gas will be sampled after the primary unit (Canister #1) on a biweekly basis in order to monitor breakthrough. The sampling schedule will be modified based on the sample results. The secondary unit (Canister #2) will act as a backup and will be changed to the primary unit following breakthrough of the primary. After breakthrough, the GAC will be changed in Canister #1; spent GAC will be properly disposed off-Site in accordance with local, State, and Federal regulations.

A design report prepared by Product Recovery Management of Durham, North Carolina is also included in Appendix G. Supporting documentation by FLS for the design and installation of the SVE system is provided in Appendix G. A start-up plan and procedures for operating and maintaining the SVE, including inspections, will be included in an OM&M Plan to be provided under separate cover.

10.1.1.4 Monitored Natural Attenuation

Elevated levels of chlorinated VOCs were detected in groundwater samples collected at the Site during the subsurface investigations performed in September and October 2008. These compounds were also detected, but at lower concentrations, in groundwater samples collected in September 2009. In March 2010, the concentrations of chlorinated VOCs detected in groundwater samples from the north and northeast portion of the Site continued the downward trend and were significantly lower than those detected in the 2008 and 2009 investigations.

Chlorinated VOC levels in groundwater at the south and southwest portions of the Site (upgradient) remained similar to levels those previously observed. The detection of chlorinated VOC contamination at higher concentrations in the upgradient portion of the Site suggests the potential presence of an off-Site contaminant source or a regional background contamination condition.

Groundwater will be monitoring by sampling each of the monitoring wells on the Site in accordance with an SMP.

Long-term monitoring of the groundwater at the Site and off-Site will be conducted to determine if natural attenuation continues to occur. All monitoring wells will be sampled on a quarterly basis for VOCs and geochemical parameters. Monitoring well locations are shown on Figure 11.

10.1.2 Criteria for Termination of Remedial Systems

10.1.2.1 Composite Cover System

The composite cover system is a permanent control and the quality and integrity of this system will be inspected at defined, regular intervals in perpetuity.

10.1.2.2 Sub-Slab Depressurization System

A proposal to discontinue the active SSDS may be submitted by the property owner based on confirmatory data that justifies such request. The system will remain in place and operational until permission to discontinue use is granted in writing by NYSDEC and NYSDOH.

10.1.2.3 Soil Vapor Extraction System

A proposal to discontinue the system may be submitted by the property owner after VOC concentrations in soil gas reach the AGVs based on confirmatory data that justifies such request. The SVE system will remain in place and operational until permission to discontinue its use is granted in writing by NYSDEC and NYSDOH.

10.1.2.4 Monitored Natural Attenuation

Groundwater monitoring activities to assess natural attenuation will continue, as determined by NYSDOH and NYSDEC, until residual groundwater concentrations can be demonstrated to be protective of the human health and the environment, given the current and potential uses of the aquifer. This determination will be made based on the following:

1) a comparison of contaminant levels to the Class GA Standards.
2) a demonstration that contaminant levels across the Site and off-Site (downgradient) have reached asymptotic levels acceptable to NYSDEC (with respect to contamination that emanates from the Site and not from an off-site source).
3) a demonstration that contaminant levels at the downgradient boundary of the Site (north and northeast areas) have reached asymptotic levels acceptable to the NYSDEC and are at or below the contaminant levels detected in upgradient monitoring wells.

Monitoring will continue until permission to discontinue is granted in writing by NYSDEC and NYSDOH. Monitoring activities will be outlined in the SMP.

10.2 Engineering Control Systems – Off-Site

As outlined herein, four ECs have been implemented to date at St. Joseph High School, adjacent to the north of the Site: air scrubbers, an active SSDS, sealing of the elevator pits, and a basement pressurization system.

The four ECs were implemented as follows: The alternatives of scrubbing the indoor air and sealing the basement slab cracks was the first emergency action implemented at the school while building plans were sought to determine if a sub-slab depressurization system could be retro-fitted to the building, and to assess the building HVAC systems to determine if a pressurized system for the basement could be installed. When it was determined that a SSDS could be retro-fitted, the system was designed and implemented. Likewise, when an unused HVAC system serving the basement was discovered, the fans were reversed to pressurize the basement. Finally, after indoor air sampling indicated that the elevator pits were a continuing source of soil vapor intrusion, a vapor barrier in the form of sprayed on Liquid Boot® was applied to the elevator pits. The combination of these actions eliminated the concentrations of VOCs exceeding the NYSDOH AGVs, as demonstrated by subsequent confirmatory air sampling.

The conceptual remedial approach, general system design, system OM&M requirements and criteria for termination of each of these systems is described below.

10.2.1 Description of Off Site Remedial Actions

10.2.1.1 Air Scrubbers

After results of indoor air sampling at SJHS revealed concentrations of chlorinated VOCs exceeding NYSDOH AGVs, air scrubbers were installed as a temporary emergency measure to mitigate chlorinated VOC concentrations prior to installation of the SSDS. After installation and operation of the SSDS began, the use of air scrubbers was discontinued at the school.

10.2.1.2 Sub-Slab Depressurization System

The SSDS creates a negative pressure environment beneath the basement slab, relative to the pressure in the occupied building space, and vents the soil vapor to the ambient air. The goal of the SSDS is to provide a minimum pressure drop of 0.002 inches WC beneath the entire basement slab of SJHS.

The locations of the pits were determined based on the layout of the concrete footings which indicated that there are no barriers to sub-slab airflow within the majority of the building (from the southern wall at least to the north side of the cafeteria). The SJHS drawings provided were not clear on the northern side of the building and, therefore, additional pits were added in the northern area.

The pits were constructed by cutting a one-foot by one-foot hole in the floor at each location. Soil was removed to 18 inches below the slab with sloughing of the sidewall soils encouraged. A layer of geotextile fabric was placed at the bottom of the pit and covered with a one-inch layer of aggregate (clean, ¾ inch) to prevent silt from being pulled into the riser.

The piping from the pit was constructed of PVC plastic and sealed into the replaced slab with silicone sealant. In addition to the piping, a sub-slab pressure monitoring point was

installed into the area of the pit. At the top of each riser, a ball valve was installed to allow the flow to be regulated. While the piping is slanted towards the pits, the airflow across the ball valve in some cases does not allow the water to drain into the pit. Therefore, drains were placed immediately above the ball valve. A cut-through drawing of a typical pit is included as Figure 22. The area without barriers is approximately 4,400 ft^2 and six pipes were installed at a ratio of approximately one per 733 ft^2. Within the elevators and northern area, the distribution was greater per ft^2, ranging from one pit per 20 ft^2 in the elevator pits to 228 ft^2.

All horizontal pipe runs were slightly pitched back towards the suction pits so that any condensation does not accumulate, or have bulkhead fittings installed to serve as drainage points. Any horizontal pipe runs that do not have drainage points were pitched at the EPA-recommended $\frac{1}{8}$ inch per foot. Obvious depressions along the pipe runs were eliminated and a rain cap was placed over the exhaust location to prevent precipitation from entering the system.

A pipe header ties all of the risers from the pits into a header system that directs all soil vapors to a common 6-inch diameter main riser. The main riser runs out through the roof of the second-floor set back, is anchored to the side of the building and then over the parapet to the roof. The final discharge location was selected in accordance with the NYSDOH Soil Vapor Guidance. The discharge location also takes into account the future building being constructed at 384 Bridge Street. As the roof is used for maintenance of the heating-ventilation (H-V) system, the discharge location was installed 10 feet above this level. The final discharge location is on the roof along Bridge Street, approximately halfway between Willoughby Street and the Site. The fan is located in the southeast corner of the roof of SJHS. The fan is a Pacific Blower PB-802 regenerative blower.

OM&M requirements for the SSDS are described in the OM&M Plan submitted to NYSDEC in May 2011.

10.2.1.3 Sealing of Elevator Pits

A liquid-applied vapor barrier was installed on the floors and walls of both elevator pits. The surfaces were cleaned and inspected prior to application. A protective course, consisting of a plastic sheet with fabric covering, was placed over the vapor barrier. A non-flammable coating was added over the protective course to comply with New York City regulations. Liquid Boot® was used as the vapor barrier, with a protective course consisting of BaseFabric T-40 and UltraShield G-800. The non-flammable coating was Andek Firegard™ Fire Resistant Waterproof Coating.

10.2.1.4 Basement Pressurization System

Proper operation of the H-V system slightly pressurizes the building relative to the sub-slab environment and provides inflow of outside air. The increase in pressure is between 0.002 and 0.005 inches WC. The existing H-V system was refurbished, including the installation of a new fan belt, bearing lubrication and new air filters. Additionally, the existing H-V motor drive was updated to variable speed, and set for two levels of operation, one without kitchen hood exhaust operational, and the second with kitchen exhaust in operation. A new local start/stop control for the kitchen exhaust fan was

installed and the kitchen exhaust fan starter was connected with the H-V system for coordinated operation. New fan controls for the H-V system allowed it to be managed in conjunction with the kitchen exhaust fan.

The existing H-V ducting was used. The H-V motor drive was updated using a Marathon microMAX Inverter Duty variable speed motor. A local on/off switch was placed on the western wall to the right of the kitchen hood.

10.2.2 Criteria for Termination of Off-Site Remedial Systems

10.2.2.1 Sub-Slab Depressurization System

The active SSDS will not be converted to a passive system without written approval by NYSDEC and NYSDOH. A proposal to convert the active SSDS system may be submitted by the BCP Applicants based on confirmatory data that justifies such request. Confirmatory data will include, at a minimum, exhaust sampling and indoor air sampling when the system is operational for a baseline; indoor air sampling within 1 month of system shut off; and indoor air sampling 1 year after system shut off. All sampling will be conducted during heating season. All systems will remain in place and operational until permission to discontinue use is granted in writing by NYSDEC and NYSDOH.

10.2.2.2 Sealing of Elevator Pits

The vapor barrier applied to the elevator pits is a permanent control and the quality and integrity of this system will be inspected at defined, regular intervals in perpetuity.

10.2.2.3 Basement Pressurization System

The pressurizing of the basement will not be discontinued without written approval by NYSDEC and NYSDOH. A proposal to discontinue the system may be submitted by the BCP Applicants based on confirmatory data that justifies such request. Confirmatory data will include, at a minimum, indoor air sampling when the system is operational for a baseline; indoor air sampling within 1 month of system shut off; and indoor air sampling 1 year after system shut off. All sampling will be conducted during heating season. All systems will remain in place and operational until permission to discontinue use is granted in writing by NYSDEC and NYSDOH.

11.0 SCHEDULE

A Remedial Action schedule is included in Table 18. The schedule will be revised prior to the start of remediation and construction. Major deviations will be reported to the NYSDEC during the execution of the RAWP.