FEASIBILITY STUDY REPORT

WORK ASSIGNMENT D007622-34

FORMER KLINK COSMO CLEANERS SITE
GREENPOINT/EAST WILLIAMSBURG
INDUSTRIAL AREA

SITE NO. 224130
KINGS (C) NY

Prepared for:
NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
625 Broadway, Albany, New York

Basil Seggos, Commissioner

DIVISION OF ENVIRONMENTAL REMEDIATION
Remedial Bureau B

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Final
September 2018

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FOR THE

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SITE ID NO. 224130

BROOKLYN, KINGS COUNTY, NEW YORK

PREPARED FOR:

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

DIVISION OF ENVIRONMENTAL REMEDIATION

REMEDIAL BUREAU B

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PREPARED BY:

URS CORPORATION – NEW YORK

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BUFFALO, NEW YORK 14202

SEPTEMBER 2018

Engineering Certification

I, Mark E. Lang, certify that I am currently a New York State registered professional engineer as defined in 6NYCRR Part 375 and that this Feasibility Study Report for the Former Klink Cosmo Cleaners Site (Site #224130) was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the Division of Environmental Remediation (DER) Technical Guidance for Site Investigation and Remediation (DER-10) and that all activities were performed in full accordance with the DER-approved work plan and any DER-approved modifications.

Respectfully submitted,

URS Corporation – New York

STATE OF NEW YORK ★ MARK E. LANG ★ 074013 ★ LICENSED PROFESSIONAL ENGINEER

9/11/18

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LIST OF ACRONYMS AND ABBREVIATIONS

3rd Rock	3rd Rock LLC
AARCO	AARCO Environmental Services, Corporation
ACME	ACME Architectural Products, Inc.
ADT	Aquifer Drilling and Testing, Inc.
Aka	also known as
amsl	above mean sea level
AS	Air Sparge
ASP	Analytical Services Protocol
Associated	Associated Environmental Services, Ltd.
AST	above ground storage tank
ASTM	American Society for Testing and Materials
AWL	AWL Industries, Inc.
bgs	below ground surface
BP	British Petroleum
BQE	Brooklyn-Queens Expressway
B. Thayer	B. Thayer Associates
BTEX	benzene, toluene, ethylbenzene, xylenes
cis-1,2-DCE	cis-1,2-dichloroethene, aka cis-1,2-dichloroethylene
C&D	construction and demolition
CD	compact disc
cm/sec	centimeters per second
COC	chain-of-custody
Con Edison	Consolidated Edison Company of New York
CPCs	chemicals of potential concern
CRA	Conestoga-Rovers & Associates
Crown	Crown Enterprises, Inc.
CSIA	compound-specific stable isotope analysis
CVOC	chlorinated volatile organic compound
4,4-DDD	dichlorodiphenyldichloroethane
4,4-DDE	dichlorodiphenyldichloroethylene
4,4-DDT	dichlorodiphenyltrichloroethane
DCA	dichloroethane
DCE	dichloroethene, aka dichloroethylene
1,2-DCE	1,2-dichloroethene
DEP	Department of Environmental Protection
DER	Division of Environmental Remediation
DIs	drop inlets
DNAPL	dense non-aqueous phase liquid
DOB	Department of Buildings
DOT	Department of Transportation
DNSY	City of New York Department of Sanitation
DUSR	Data Usability Summary Report
EE	Environmental Easement
ELAP	Environmental Laboratory Approval Program
EM	electromagnetic
EPM	Environmental Planning and Management, Inc.

ERH	electrical resistivity heating
ESA	environmental site assessment
EOA	Expanded Outreach Area
ExxonMobil	ExxonMobil Brooklyn Terminal
FAP	Field Activities Plan
FS	Feasibility Study
ft./ft.	foot per foot
ft^3	cubic feet
FWRIA	Fish and Wildlife Resources Impact Analysis
Glacier	Glacier Drilling, LLC
gpm	gallons per minute
GPR	ground penetrating radar
HHEA	Human Health Exposure Assessment
HASP	Health and Safety Plan
HDPE	high-density polyethylene
HSA	hollow stem augers
ICs	Institutional Controls
ID	inside diameter
IDW	investigation derived wastes
Impact	Impact Environmental Consulting, Inc.
ISCO	in-situ chemical oxidation
ISCR	in-situ chemical reduction
K	hydraulic conductivity
k_i	intrinsic permeability
L	liter
L/min	liters per minute
LNAPL	light non-aqueous phase liquid
MEK	methyl ethyl ketone
META	META Environmental, Inc.
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mL	milliliter
MGP	Manufactured Gas Plant
MTBE	methyl tert-butyl ether
MW	monitoring well
NAD83	North American Datum of 1983
NAPL	non-aqueous phase liquid
NAVD	North American Vertical Datum
NOD	natural oxidant demand
NYC	New York City
NYCDEP	New York City Department of Environmental Protection
NYCDOT	New York City Department of Transportation
NYCRR	New York Code Rules and Regulations
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSDOT	New York State Department of Transportation
OD	outside diameter

Off-Site System	Off-Site Free Product Recovery System
OM&M	operation, maintenance and monitoring
ORP	Oxidation/Reduction Potential
Pace	Pace Analytical Service
PCBs	polychlorinated biphenyls
PCE	perchloroethene, aka tetrachloroethene or tetrachloroethylene or perchloroethylene
PID	photoionization detector
POET	Point of Entry Treatment
ppbv	parts per billion by volume
ppm	parts per million
PRB	permeable reactive barrier
PVC	polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
RAGS	Risk Assessment Guidance for Superfund
RAOs	remedial action objectives
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
Roux	Roux Associates, Inc.
RQD	rock quality designation
RSI	Radar Solutions International
SAP	Sampling and Analysis Plan
SC	Site Characterization
SCGs	Standards, Criteria, and Guidance
SCO	soil cleanup objectives
SPDES	Spill Discharge Elimination System
sf	square feet
Site	Former Klink Cosmo Cleaners Site
SMP	Site Management Plan
SSD	subslab depressurization
SVE	soil vapor extraction
SVOC	semi-volatile organic compound
TAGM	Technical and Administrative Guidance Memorandums
TAL	Target Analyte List
TCE	trichloroethene
TCL	Target Compound List
TMV	toxicity, mobility or volume
TOGS	Technical and Operational Guidance Series
trans-1,2-DCE	trans-1,2-dichloroethene, aka trans-1,2-dichloroethylene
µg/kg	micrograms per kilogram (parts per billion)
µg/L	micrograms per liter (parts per billion)
$\mu g/m^3$	microgram per cubic meter
UIC	Underground Injection Control
USCG	United States Coast Guard
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Services
USGS	United States Geological Survey

URS	URS Corporation – New York
UST	underground storage tank
VC	vinyl chloride
VOCs	volatile organic compounds
WA	Work Assignment
Zebra	Zebra Environmental Corporation
ZVI	zero valent iron

EXECUTIVE SUMMARY

On behalf of the New York State Department of Environmental Conservation (NYSDEC), this Feasibility Study (FS) report was prepared by URS Corporation – New York (URS) for the Former Klink Cosmo Cleaners Site (Site - NYSDEC ID # 224130), located in the Greenpoint/East Williamsburg Industrial Area section of Brooklyn, Kings County, New York. The Former Klink Cosmo Cleaners Site is shown on Sanborn Maps to be a clothing warehouse from the mid 1950’s until sometime after 1995. Klink Cosmo Cleaners is listed in the Environmental Data Resources (EDR) Report as a generator of F002 waste (spent halogenated solvents) for this facility and several manifests are listed in the EDR Report. The current property owner, AWL Industries, Inc., acquired the property in 1997.

Based on data gathered during investigations at the Meeker Avenue Plume Trackdown Site (NYSDEC ID # 224121) conducted between May 2007 and July 2009, and a groundwater sampling event conducted in November 2009, a source of groundwater contamination was identified originating near the buildings housing the Former Klink Cosmo Cleaners, which was located at 364-392 Richardson Street (Tax District of Brooklyn, Block 02860, Lot 0001). In January 2009, the above mentioned source of groundwater contamination was listed as a NYSDEC Class 2 Inactive Hazardous Waste Disposal Site (Site Number 224130). Results of the Remedial Investigation (RI) Phases prepared by URS (June 2015) and previous investigations indicated the presence of perchloroethene (PCE) and related degradation products in soil, soil vapor, and groundwater at the Site. The horizontal and vertical extent of PCE and other chlorinated volatile organic compounds (CVOCs) in soil, soil vapor, and groundwater has been delineated, although other sources of CVOC contamination north of the Former Klink Cosmo Cleaners Site are contributing to the overall horizontal and vertical extent of dissolved phase groundwater contamination in the site area. The other sources are being managed separately under various NYSDEC programs.

Based on investigations performed to date, PCE and its degradation products were detected in numerous groundwater monitoring wells in both the shallow and deep overburden groundwater as well as in downgradient top of clay monitoring wells. High concentrations of PCE were detected on-site, in soil, soil vapor, and groundwater samples collected directly beneath and within the contaminated soil source area located beneath the AWL Industries, Inc. building, and in groundwater samples collected from shallow and deep overburden groundwater monitoring wells located adjacent to and downgradient of the on-site soil source area. The horizontal extent of the dissolved phase PCE and TCE groundwater plume extends to the northeast into the ACME Steel Metal Works Site and ACME Steel Brass Foundry Site

Area (NYSDEC Site ID #s 224131 and 224132) which are situated near the intersection of Lombardy Street and Porter Avenue). Based upon the observed concentrations of CVOCs from groundwater sampling events, a dissolved phase chlorinated solvent plume originates at the Former Klink Cosmo Cleaners Site. The horizontal extent of dissolved phase CVOC contamination associated with the Klink Cosmo Site chlorinated solvents has been delineated, although other sources are contributing to the overall distribution of CVOCs. The chlorinated solvent plumes in the shallow and deep overburden have higher concentrations of PCE immediately north and east of the Former Klink Cosmo Cleaners Site. The extent of PCE has a larger footprint in the shallow groundwater compared to the deep groundwater and is migrating to the northeast and comingles with the dissolved chlorinated solvent plume originating from other sources and within the ACME Steel source area.

The vertical extent of PCE and TCE impacted groundwater was determined to extend down to the top of the Raritan Formation (i.e., approximately 110 feet below ground surface). The vertical extent of PCE and TCE impacted groundwater is not expected to migrate below the top of the Raritan Formation due to its vast areal extent and low permeability. Based upon the data collected to assess the potential for degradation of PCE in the groundwater system as presented above, there is evidence that little reductive dechlorination is occurring in the vicinity of the site. Rates of degradation are very difficult to determine due to the unknown quantity of source material present beneath the Former Klink Cosmo Cleaners Site. Based upon the geochemical conditions in the groundwater system, the aquifer is only slightly conducive for naturally occurring reductive dechlorination. VOC contamination has exceeded applicable standards, criteria, and guidance (SCGs) in soil, soil vapor, and groundwater.

The remedial action goal for the Former Klink Cosmo Cleaners Site is to eliminate or mitigate all significant threats to human health and/or the environment, to the extent practicable, caused by contaminants present due to the release of PCE from the former dry cleaners onsite. In order to meet this goal, remedial action objectives (RAOs) have been established to protect human health and the environment. These RAOs provide the basis for selecting appropriate technologies and developing remedial alternatives. RAOs were established on the basis of contaminated media, SCGs for the site (especially Part 375 soil cleanup objectives), the results of Klink Cosmo Cleaners Site Remedial Investigation Phases, and the qualitative human health exposure assessment. The RAOs for the Site are as follows:

Soil

Public Health Protection

- Prevent ingestion/direct contact with contaminated soil
- Prevent inhalation exposure to contaminants volatilizing from soil.

Environmental Protection

- Prevent migration of contaminants that would result in groundwater, surface water, or sediment contamination.
- Prevent impacts to biota from ingestion/direct contact with soil causing toxicity or impacts from bioaccumulation through the terrestrial food chain.

Groundwater

Public Health Protection

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

Environmental Protection

- Restore groundwater aquifer to pre-release conditions, to the extent practicable.
- Prevent the discharge of contaminants to surface water and sediments.
- Remove the source of groundwater contamination.

Soil Vapor

Public Health Protection

- Mitigate impacts to public health resulting from existing, or the potential for, soil vapor intrusion into buildings.

In order to meet the remedial goal and remedial action objectives for the Site, the following remedial alternatives were developed:

- **Alternative 1** – No Action, Institutional Controls with Site Management
- **Alternative 2** – IRM SVE/AS, Soil Cover, SSDS, Institutional Controls with Site Management

- **Alternative 3** – IRM SVE/AS, Permanganate Injection, Soil Cover, SSDS, Institutional Controls with Site Management
- **Alternative 4** – IRM SVE/AS, EHC Injection, Soil Cover, SSDS, Institutional Controls with Site Management
- **Alternative 5** – IRM SVE/AS, Permanganate Injection, Hydraulic Containment/Removal, Soil Cover, SSDS, Institutional Controls with Site Management

These alternatives were evaluated against the New York State Department of Environmental Conservation (NYSDEC) criteria: Overall Protection of Public Health and the Environment; Compliance with Standards; Criteria and Guidance; Long-term Effectiveness and Permanence; Reduction of Toxicity, Mobility and Volume with Treatment; Short-term Effectiveness (including green remediation and sustainability); Implementability; Land Use; and Cost. Alternative 3 is the recommended alternative for the Site because it is comparable to Alternatives 4 and 5 for most evaluation criteria and is superior to Alternative 5 in terms of implementability and cost and superior to Alternative 4 in terms of implementability.

Components of Remediation

A conceptual layout for Alternative 3 is shown on Figure 5-2. SVE/AS (Source Area Remediation): Five air sparge wells will be constructed. These wells along with three existing wells would be used to introduce compressed air into groundwater below the Former Klink Cosmo building to remove VOCs. Four soil vapor extraction wells will be constructed. These wells along with two existing wells would be used to capture VOCs volatilized by air sparging into the groundwater beneath the Former Klink Cosmo building. The existing concrete slab will be maintained as part of the Soil Cover element. A Sub-slab Depressurization System will mitigate impacts to indoor air.

In-Situ Groundwater Remediation: Approximately 30 injection wells will be installed to inject sodium permanganate into contaminated groundwater. Conceptually, 29,000 gallons of a 5% solution will be injected into the groundwater during 4 separate injection events. Injection well quantities and locations as well as the amount of sodium permanganate injected will be further evaluated and finalized during the remedial design phase of the project.

1 INTRODUCTION

1.1 Contract Authority

URS Corporation – New York (URS) prepared this Feasibility Study (FS) report for the Former Klink Cosmo Cleaners Site (ID # 224130) [Site] located in the Greenpoint/East Williamsburg Industrial Area section of Brooklyn, Kings County, New York. The report was prepared for the New York State Department of Environmental Conservation (NYSDEC) as Work Assignment D007622-34.

1.2 Scope of Feasibility Study

This FS report evaluates the remedial action for the contaminants found to be present at and in the vicinity of the Site. This FS was developed to meet the requirements set forth in the New York State Code Rules and Regulations (NYCRR) 6 NYCRR 375, and NYSDEC Department of Environmental Remediation (DER) DER-10 Technical Guidance for Site Investigation and Remediation. This FS specifies the remedial goal and remedial action objectives, identifies potential remedial technologies feasible for use at this site, and develops remedial alternatives that meet the remedial action objectives. Remedial alternatives are evaluated in sufficient detail such that the NYSDEC can prepare a Proposed Remedial Action Plan and issue a Record of Decision.

1.3 Report Organization

This document has been organized consistent with NYSDEC DER-10 and includes the following sections:

- Executive Summary
- Introduction
- Site Description and History
- Remedial Goal and Remedial Action Objectives
- Identification and Screening of Remedial Technologies
- Development and Description of Alternatives
- Detailed Analysis of Alternatives.

2 SITE DESCRIPTION AND HISTORY

This section presents a site description, summary of previous investigations, summary of contamination, and a summary of a human health exposure assessment.

2.1 Site Background and Description

The Site is located in the Greenpoint/East Williamsburg Industrial Area section of the Borough of Brooklyn, New York and is located within the Meeker Avenue Plume Trackdown Site (NYSDEC Site Number 224121) investigation area. A site location map is shown in Figure 2-1.

Based on the results of several investigations conducted in the greater Meeker Avenue Plume Trackdown area, chlorinated solvents including tetrachloroethene (PCE) and trichloroethene (TCE) were found in soil vapor, soil, and groundwater in areas outside the historic petroleum ExxonMobil spill. As these chemicals are not related to petroleum, the NYSDEC initiated the Meeker Avenue Plume Trackdown Site investigation in order to determine the source(s) of this contamination. Information was gathered relevant to the Former Klink Cosmo Cleaners Site and other nearby potential contamination sources as part of these previous investigations.

In September 1978, the United States Coast Guard (USCG) noted oil entering Newtown Creek from the northeastern end of Meeker Avenue. A subsequent investigation concluded that the area of the spill under the Greenpoint/East Williamsburg Industrial Area was in excess of 52 acres and the total spill volume, as estimated in 1979, was approximately 17 million gallons of petroleum products (Roux Associates, Inc. [Roux] October 14, 2005). The current BP property was determined to be the source of a petroleum free-product plume located generally north of the Brooklyn-Queens Expressway (BQE). Investigation activities were conducted by Roux, on behalf of ExxonMobil, from 1990 to the present to further define the extent of the plume. The "Off-Site Plume" area consists of the area underlain by the petroleum free-product plume that is not on the BP Terminal or the Peerless, Inc. properties. Currently, the extent of the Off-Site Plume area is less than what it was in 1990 due to the operation of the Off-Site Free-Product Recovery System (Off-Site System). The Off-Site System has recovered over 6.8 million gallons of free-product since it became operational in 1995 (Roux, May, 2016). Based upon water level information, some hydraulic influence associated with the operation of the product recovery system has been noted in the Former Klink Cosmo Cleaners Site area.

The Former Klink Cosmo Cleaners property is currently owned by AWL Industries, Inc., (AWL). AWL also owns adjacent parcels to the west to Morgan Avenue and they are currently being used for sheet metal fabrication. The entire site property and the majority of the nearby surrounding area are covered by one-story buildings and/or pavement/concrete. The contaminated and impacted area associated with the Former Klink Cosmo Cleaners Site consists of an On-Site source area (i.e., 364-392 Richardson Street [Tax District of Brooklyn, Block 02860, Lot 0001]), and the Off-Site impacted area which is bounded by Lombardy Street to the north, Porter Avenue to the east, Withers Street to the south, and Morgan Avenue to the west. Residential areas are found along Beadel Street between Morgan Avenue and Porter Avenue, interspersed along Morgan Avenue between Lombardy Street and Beadel Street, and along Vandervoort Avenue between Lombardy Street and Division Place. A public recreational area (baseball diamonds) is located across Vandervoort Avenue from the Site.

The topography of the site investigation area slopes gently downward to the south. The elevation near the Klink Cosmo area ranges from approximately at 39 feet (NAVD 88 – North America Vertical Datum of 1988) near the corner of Morgan Avenue and Richardson Street to 35 feet near the corner of Vandervoort Avenue and Richardson Street to 28 feet farther south at the corner of Frost Street and Vandervoort Avenue.

The area east of the Former Klink Cosmo Cleaners Site, across Vandervoort Avenue, includes two former manufactured gas plant (MGP) gas holders which were part of a Brooklyn Union Gas Company Former MGP site. The 400-foot tall gas holders were constructed in 1927 and 1948, and used until the 1990's by the Brooklyn Union Gas Company, a predecessor to KeySpan, currently National Grid. The gas holders, used to help maintain consistent gas pressure to customers, were removed via a controlled implosion in July 2001. The outlines of the Former gas holders are clearly visible east of the residences and baseball diamonds shown in Plate 1 and Figure 2-2.

Limited green space is present in the area and is generally situated in the vicinity of residential properties. Surface soil is present in landscape boxes adjacent to area sidewalks; however, given the nature of the urban environment the soil should not be construed as representative of clean surface soil. Recreation areas in the vicinity are baseball fields directly east of the Site, across Vandervoort Avenue, and Monsignor McGolrick Park which is a 9.13 acre park 2,000 feet northwest of the Site bounded by Monitor and Russell Streets and Nassau and Driggs Avenues.

2.1.1 Demography and Land Use

The population of Brooklyn (Kings County) is 2,504,700 according to the 2010 Census. The Former Klink Cosmo Cleaners Site is located south of a region of historic petroleum refining and storage operations that occupied a significant portion of the Greenpoint area. By 1870, over 50 refineries were located along the banks of Newtown Creek located north and east of the Meeker Plume Trackdown Site (NYSDEC Site ID # 224121). Currently, bulk oil storage terminals north of the Site include the British Petroleum (BP) Terminal and the ExxonMobil Brooklyn Terminal (ExxonMobil). The Former Paragon Oil facility was located along Newtown Creek, north of Bridgewater Street, between Meeker Avenue and Apollo Street.

The area in the vicinity of the Former Klink Cosmo Cleaners Site is a mixture of residences and manufacturing facilities, including both commercial and industrial facilities. A recreational area is situated directly east of the Site across Vandervoort Avenue.

Land use in New York City is regulated by the City's Zoning Resolution, which has two parts: zoning text and zoning maps. The text establishes zoning districts and sets forth regulations governing their land use and development. The maps show the locations and boundaries of the zoning districts. The City is divided into three basic zoning districts: residential (R), commercial (C), and manufacturing (M). The three basic districts are further divided into a range of lower-, medium-, and higher-density residential, commercial, and manufacturing districts. A copy of the most current land use map is included in Appendix A.

The project area falls within three zoning districts identified by the New York City Department of City Planning (http://www.nyc.gov/html/dcp/html/zone/zh_zmaptable.shtml). These zoning districts are: R6B, M1-1, and M3-1. The current (2011) zoning and land use of individual properties was determined through the NYCityMap (http://gis.nyc.gov/doitt/nycitymap).

R6 and R6B Residential Districts (medium density). Primary permitted uses in the R6 district include medium density residential. A mixture of building types are allowed and range from small apartment buildings set back on small lots to row houses to large-scale apartment towers. The "B" suffix indicates a contextual district, where supplemental regulations require a new development to maintain the scale and form of the existing neighborhood context. Residential buildings are zoned as R6B north of Division Place and south of Lombardy Street between Morgan and Porter Avenues.

M1-1 Manufacturing District (light industrial). Permitted uses in the M1 districts include typical light industrial, office and retail uses. M1 districts are often a buffer between M2 or M3 manufacturing districts and adjacent residential or commercial districts. Residences are generally not included within M1 districts unless as part of a Special Mixed Use District. The majority of properties south of Meeker Avenue east of Morgan Avenue and west of Porter Avenue are located in the M1-1 district.

M3-1 Manufacturing District (heavy industrial). Permitted uses in the M-3 industrial district include heavy industry that generate potential nuisance effects such as noise, traffic or pollutants and include power plants and fuel supply depots. The "1" suffix refers to supplemental parking requirements. Properties south of Meeker and east of Porter Avenue are zoned M3-1.

2.2 Site History

The Former Klink Cosmo Cleaners Site is shown on Sanborn Maps to be a clothing warehouse from the mid 1950's until sometime after 1995. Klink Cosmo Cleaners is listed in the Environmental Data Resources (EDR) Report as a generator of F002 waste (spent halogenated solvents) for this facility and several manifests are listed in the EDR report. The current property owner, AWL, acquired the property in 1997.

Based on data gathered during investigations at the Meeker Avenue Plume Trackdown Site conducted between May 2007 and July 2009, and a groundwater sampling event conducted in November 2009, a source of groundwater contamination was identified originating near the buildings housing the Former Klink Cosmo Cleaners, which was located at 364-392 Richardson Street (Tax District of Brooklyn, Block 02860, Lot 0001). Monitoring wells DEC-031 and DEC-031D are located on the southwest corner of Vandervoort Avenue and Richardson Street (northeast building corner). Groundwater samples from these wells indicated significant PCE and TCE contamination that decrease with depth. The PCE contamination is in the shallow groundwater zone, indicating the contamination is near its source. Although PCE, TCE and their associated degradation products have been found in groundwater samples from surrounding upgradient, downgradient and sidegradient wells, the concentrations are one to two orders of magnitude lower than in DEC-031/031D. Soil-gas samples also indicated the presence of elevated levels of PCE and TCE in the vicinity of this building. The highest concentration was at soil-gas point SG-049, located adjacent to monitoring wells DEC-031/031D on the corner of Richardson Street and Vandervoort Avenue. In January 2009, the above mentioned source of groundwater contamination was listed as a NYSDEC Class 2 Inactive Hazardous Waste Disposal Site (Site Number 224130).

2.3 Previous Investigations at Nearby Facilities

Several investigations were performed prior to the RI and are summarized below.

2.3.1 Investigations by Impact Environmental Consulting, Inc.

In March 1998, Impact Environmental Consulting, Inc. (Impact Environmental) conducted a Phase I Environmental Site Assessment (ESA) for a nearby facility located across Vandervoort Avenue at 46-60 Anthony Street/ 95 Lombardy Street for ACME Architectural Products Inc., of Brooklyn, New York (ACME) (Impact Environmental, March 30, 1998a). The property historically had been utilized for iron working, metal shearing and finishing operations. At the time of the ESA, operations at the property included office space and operational space. The operational space was utilized for the machining, finishing, and storage of materials and products used in the manufacture of doors and knock down frames. The ESA identified a number of potential contamination sources that existed on the property due to current and/or past site activities. Numerous floor drains were identified throughout the building and their outfall locations were unknown. It was suspected that some drains may have discharged directly to on-site soils. Several underground storage tanks (USTs) and above ground storage tanks (ASTs) were identified and had been used for fuel oil storage and storage of degreasing products, respectively. It was noted that at the time of the ESA the facility was using a phosphate wash and rinse as a degreaser. During a personal interview, it was revealed that any regulated waste (i.e., waste paint, waste oil, waste degreaser and waste water precipitate) generated at the property was stored in the yard at 72 Anthony Street prior to disposal.

In March 1998, Impact Environmental conducted a Phase I ESA at 72 Anthony Street for ACME (Impact Environmental, March 30, 1998b). The property historically had been utilized as a brass foundry and civilian observation patrol. Operations on the property at the time of the ESA included office space and operational space. The operational space was utilized for the grinding, sanding and finishing of steel doors. The investigation identified a number of potential contamination sources that existed on the property due to current and/or past site activities. Numerous floor drains were identified throughout the building and their outfall locations were unknown. It is suspected that some drains may have discharged directly to on-site soils. One UST and one AST dip tank existed and were used for fuel oil storage and storage of degreasing products, respectively. It was noted that at the time of the ESA, the facility was using a phosphate wash and rinse as a degreaser. It was also noted that the floor of the room containing the AST dip tank was impacted by the release of degreasers from the dip tank. In addition, significant storage of portable chemical containers was observed in the building. A paint room was identified in the center of the building, as was an associated paint storage room. The floor of the paint room was significantly stained by painting operations. Floor drains were observed in the paint storage room. A chemical storage area existed outside and to the east of the building and a bermed, concrete storage pad was also observed. Numerous chemical containers were noted outside the building and consisted of 55-gallon drums and smaller containers of primers, cutting oils, hydraulic oils, waste water, xylene, waste paints, adhesives, waste degreasers, steam cleaners and waste oil contaminated absorbents. However, most of the drums were located outside the bermed, concrete storage pad and were uncovered or missing screw caps. Two dry wells were identified along the south side of the building. In addition, during a personal interview it was revealed that the property previously maintained two dip tanks for degreasing. It was noted that a Phase I ESA was previously performed on the property in June 1995 by Conestoga-Rovers & Associates (CRA). The CRA Phase I revealed that 1,1,1-trichloroethane (1,1,1-TCA) was formerly utilized in the dip tanks and that a floor drain was observed under one of the dip tanks.

In June 1998, Impact Environmental conducted a Phase II ESA at 46-60 Anthony Street/ 95 Lombardy Street for ACME (Impact Environmental, June 1998). The scope of the Phase II ESA was based on the recommendations of the Phase I ESA and included a remote survey [i.e., ground penetrating radar (GPR)] of a floor drain located in the northeast portion of the building and the collection of a sample from 0-2 feet bgs below the floor drain. The remote survey conducted confirmed that the floor drain directly discharged to the subsurface soils. A soil sample collected from the 0-2 foot interval below the floor drain contained the volatile organic compounds (VOCs) PCE and TCE, at 1,190 and 99.2 micrograms per kilogram (µg/kg), respectively. In addition, the semi-volatile organic compounds (SVOCs) di-n-butylphthalate, pyrene and bis (2-ethylhexyl) phthalate were detected at 4,460, 539 and 1,690 µg/kg, respectively. Metals which included arsenic (4.93 milligrams per kilogram [mg/kg]), barium (114 mg/kg), cadmium (6.53 mg/kg), chromium (123 mg/kg), lead (906 mg/kg) and mercury (0.045 mg/kg) were also detected. Cadmium, chromium and lead exceeded their respective criteria found in the Technical and Administrative Guidance Memorandum (TAGM) #4046, Determination of Soil Cleanup Objectives and Cleanup Levels (NYSDEC, January 24, 1994). The Phase II ESA concluded that on-site operations had impacted the environmental quality beneath the property and recommended that corrective actions were required to mitigate the contaminated soil associated with the floor drain.

2.3.2 Investigations by Environmental Planning and Management, Inc.

In September 2005, Environmental Planning and Management, Inc. (EPM) completed an investigation for the New York State Department of Transportation (NYSDOT) in connection with the Kosciuszko Bridge Project (EPM, January 2006). The investigation included the collection and analysis of soil and groundwater samples. PCE was also detected at a concentration of 89.9 micrograms per liter (µg/L) in ExxonMobil monitoring well MW-018 (east side of Vandervoort Avenue between Anthony and Cherry Streets).

2.3.3 Investigations by Roux Associates

In September 2005, Roux Associates on behalf of ExxonMobil sampled soil vapor at 23 temporary locations in and around the perimeter of the Off-Site Plume area (Roux, October 14, 2005). The soil vapor samples collected in September 2005 indicated the presence of PCE at a concentration of 10,200 micrograms per cubic meter ($\mu g/m^3$) at a monitoring point located on the southwest corner of the Vandervoort Avenue and Anthony Street intersection. It was determined that the chlorinated solvents detected (i.e., PCE and TCE) were from a different source than the petroleum free-product plume.

2.3.4 Investigations by URS

To date, URS has completed nine phases of site investigation fieldwork and a tenth phase is in progress at the Meeker Avenue SC Plume Trackdown Site (NYSDEC Site Number 224121) within which the Former Klink Cosmo Cleaners Site is located. The SC Phase IV activities were focused in an area to the northeast of the Former Klink Cosmo Cleaners Site. The SC Phase V activities were focused in an area to the northwest of Klink Cosmo. SC Phases VIII through X activities were focused in the area to the west of Morgan Avenue, west of the Former Klink Cosmo Cleaners Site and north of the BQE in the Expanded Outreach Area (EOA). Only data gathered during the SC Phases I, II, III, V, VI, and VII field activities are relevant to the Former Klink Cosmo Cleaners Site. In addition, the September 2009 Groundwater Split Sampling event, and the November 2009 Groundwater Sampling Event field activities, Klink Cosmo Phases I and II RI field work, both on-site and off-site Phase III RI field work and reports, and the Soil Vapor Extraction (SVE)/Air Sparge (AS) Pilot Test and report have been performed. The various reports from which information is summarized in this FS Report are listed below.

DEC Site ID: 224130 – Former Klink Cosmo Cleaners Site

Remedial Investigation Phase I Investigation Report (URS, December 2011):

- Fieldwork: 5/2/2011 - 7/15/2011
- Installed/sampled 10 soil vapor points & 17 groundwater monitoring wells
- Advanced 17 soil borings

Remedial Investigation Phase II Investigation Report (URS, November 2012):

- Fieldwork: 2/27/2012 - 4/20/2012
- Installed/sampled 12 soil vapor points & 12 groundwater monitoring wells

- Advanced 12 soil borings

Off-Site Phase III Remedial Investigation Letter Report (URS, September 2014):

- Fieldwork: 12/9/2013 - 3/7/2014
- Installed/sampled 5 soil vapor points & 3 groundwater monitoring wells
- Advanced 3 soil borings

On-Site Phase III Remedial Investigation Report (URS, March 2016):

- Fieldwork: 4/13/2015 - 8/27/2015
- Installed 3 observation wells, 2 air sparge wells, 1 combined observation/air sparge well, & 2 soil vapor extraction wells
- Sampled 6 sub-slab soil vapor implants
- Installed/sampled 7 groundwater monitoring wells
- Advanced 7 soil borings

SVE/AS Pilot Study Report (URS, March 2016):

- Fieldwork: 11/16/2015 - 11/19/2015
- Conducted to determine the effectiveness of the air sparge wells and soil vapor extraction wells installed during the On-Site Phase III Remedial Investigation
- Determined radius of influence

DEC Site ID: 224121 - Meeker Avenue Plume Trackdown

Site Characterization Phase I Summary Report, September 2007 (URS, September 2007):

- Fieldwork: 5/7/2007 - 9/11/2007
- Installed/sampled 23 soil vapor points, 22 soil borings & 22 groundwater monitoring wells

Site Characterization Phase II Summary Report, April 2008 (URS, April 2008):

- Fieldwork: 11/5/2007 - 12/27/2007
- Installed/sampled 28 soil vapor points, 25 soil borings, 15 direct-push groundwater sampling locations, & 14 groundwater monitoring wells

Site Characterization Phase III Summary Report, October 2008 (URS, October 2008):

- Fieldwork: 5/5/2008 - 7/24/2008
- Installed/sampled 14 soil vapor points, 24 soil borings, 20 direct-push groundwater sampling locations, & 24 groundwater monitoring wells

Site Characterization Phase IV Summary Report, May 2009 (URS, May 2009):

- Fieldwork: 11/3/2008 - 12/8/2008
- Advanced 4 Membrane Interface Probe borings
- Installed/sampled 8 groundwater monitoring wells
- Advanced 8 soil borings

Site Characterization Phase V Summary Report, October 2009 (URS, October 2009):

- Fieldwork: 6/15/2009 - 7/13/2009
- Installed/sampled 10 groundwater monitoring wells
- Advanced 8 soil borings

Groundwater Split Sampling Event Letter Report, January 2010 (URS, January 2010):

- Fieldwork: 9/24/2009
- Sampled 8 groundwater monitoring wells for Compound Specific Isotope Analysis (CSIA)

Site Characterization Phase VI Summary Report, April 2012 (URS, April 2012):

- Fieldwork: 8/2/2011 - 1/13/2012
- Installed/sampled 10 soil vapor points & 35 groundwater monitoring wells
- Advanced 58 soil borings

Site Characterization Phase VII Summary Report, November 2013 (URS, November 2013):

- Fieldwork: 6/11/2012 - 3/27/2013
- Installed/sampled 10 soil vapor points & 24 groundwater monitoring wells
- Advanced 24 soil borings

Relevant information pertaining to the Site area from the above-referenced reports is summarized in the following Sections below.

2.4 Geology

2.4.1 Regional Geology

The Klink Cosmo Site is located within the Atlantic Coastal Plain physiographic province of New York State (Broughton, et al. 1966). The Atlantic Coastal Plain is characterized by low relief with elevations ranging from sea level to almost 400 feet (NAVD 88). The lithology of Brooklyn and Queens consists of Cretaceous and Pleistocene age unconsolidated deposits underlain by Precambrian crystalline bedrock. The unconsolidated deposits pinch out in northwestern Queens where bedrock outcrops, but reach a thickness of more than 1,000 feet in southeastern Queens. The unconsolidated deposits form six distinct hydrogeologic units consisting of four aquifers and two confining layers that generally dip to the south-southeast. The units in ascending order are the Lloyd aquifer (0-300 feet thick), the Raritan confining unit (0-200 feet thick), the Magothy aquifer (0-500 feet thick), the Jameco aquifer (0-200 feet thick), the Gardiners clay (0-150 feet thick), and the upper glacial aquifer (0-300 feet thick) (USGS, 1999a and b). The units pinch out to the north-northeast and may not all be found at any one location.

Based on deep borings performed near the site for unrelated work, the site is underlain from the surface down by upper glacial aquifer, the Raritan Formation, and crystalline bedrock. The upper glacial aquifer is of Wisconsin age and consists of a terminal moraine, a ground moraine, and glacial outwash deposits whose area is characterized as an unsorted and unstratified mixture of clay, sand, gravel and boulders. The Raritan Formation is recognized as a regional confining unit which has been described as light to dark gray, brown-red, pink, red and gray-white clay, silty clay and clayey to silty fine sand. Disseminated lignite and pyrite are common and calcareous concretions may be found. Prior to the SC Phase VI fieldwork, the Raritan Formation had previously been encountered in three borings performed near the site by the United States Geological Survey (USGS): one boring near Morgan Avenue and Meeker Avenue (-47 feet); one boring under the BQE near the west bank of Newtown Creek (-48 feet); and one boring near Meeker Avenue between Stewart Avenue and Gardner Avenue (-71 feet). The boring near Morgan Avenue and Meeker Avenue penetrated the Raritan Formation into the underlying crystalline bedrock at an elevation of -163 feet.

As of May 2017, the Raritan Formation was positively encountered in twelve top of clay monitoring well locations within the greater Meeker Avenue Plume Trackdown area at depths between approximately 108.5 and 138.0 feet bgs (elevations of approximately -57 to -121.2 feet) and was described as gray with white banding, brown, brownish gray, greenish gray, dark gray to greenish brown, fine sand and silt, clays with carbonized plant fragments, clays with varying amounts of sand to silts with varying amounts of sand and clay. In the vicinity of the Klink Cosmo Site, these locations include DEC-006TC, DEC-028TC, DEC-029TC, and DEC-031TC (Figure 2-2). The Raritan Formation is recognized as a laterally extensive and regional aquitard in the greater NYC metropolitan area.

2.4.2 Site Geology

Figure 2-2 presents the locations of the monitoring wells and cross sections developed as part of the RIs. Cross sections A-A', B-B', C-C', D-D' and E-E' are shown on Figures 2-3 through 2-7, respectively. The following textural units have been found in the upper glacial aquifer in most borings, from the surface downward: a fill unit; a sand unit or a discontinuous glacial till unit; a sand unit if the discontinuous glacial till unit was encountered at the surface; a discontinuous clayey silt unit within the sand unit; sand and gravel unit; and the Raritan Formation. Due to the heterogeneous nature of the geology, some, but not all, of the units may or may not be present at each boring. The thickness of the upper glacial aquifer adjacent to the Site is approximately 108.5 feet thick (DEC-031TC). An isopleth of the top of Raritan Formation is shown on Figure 2-8.

The fill unit, varying in thickness from approximately 0 to 11 feet, consists of a heterogeneous mixture of sand, silt, clay and varying amounts of construction and demolition debris (i.e., bricks, concrete, coal, slag, etc.). Potentially former MGP related fill material (i.e., cinder and/or trace slag) was found to be present across Vandervoort Avenue in the vicinity of a Former MGP facility in DEC-014D (5-7 feet below ground surface [bgs]), DEC-043 (1-11 feet bgs), SG-079 (1-2 feet bgs), and SG-086 (at 1 foot bgs) [Plate 2]. The fill layer was also identified between 2.5 and 7 feet bgs in borings AWL-1 through AWL-6 advanced inside the AWL Industries, Inc. building.

The glacial till unit was noted at the surface in some borings and consists of a heterogeneous mixture of sand, silt, and clay and varying amounts of gravel, cobbles and boulders. The sand unit is present at all the boring locations and is represented by stratified sands of varying textures containing some to no fines. The lacustrine clayey silt/silt unit has been observed as an inclusive unit within the sand unit. The thickness of the clayey silt/silt unit, where present, varies from 0.5 to over 10 feet thick.

The sand and gravel unit has been found to overlie the Raritan Formation at DEC-029TC and DEC-031TC. The Raritan Formation consisted of gray or dark gray, silt with some clay and fine sand stringers; clay with some sand; clay and silt; or fine sand and silt.

2.5 Geotechnical Test Results

Geotechnical samples were collected from the Klink Cosmo area during both phases of the RI field activities and from the SC Phase VI field activities. Soil samples from grab samples and Shelby tubes were analyzed by 3rd Rock for grain size distribution (ASTM D422), Atterberg Limits (ASTM D4318), and falling head permeability (ASTM D5084). Results are discussed below.

2.5.1 Geotechnical Samples from Upper Glacial Aquifer

Upper glacial aquifer samples were collected from DEC-011D, DEC-028D, DEC-029D, and DEC-044D with depths between 50 and 84.5 feet bgs. The soils were identified as poorly graded sand, well graded sand with silt and gravel, silt, clay, and clay with sand with USCS classifications of SP, SW-SM, ML, CL and CH. Soils were identified as either non-plastic or of low plasticity. Three samples were analyzed by ASTM D5084 Method C for permeability. The measured permeability values were 2.0×10^{-3} cm/sec for the silty sand.

2.5.2 Geotechnical Samples from Top of Raritan Formation

Samples were collected from the top of the Raritan Formation, and included samples from the silty sand material from above the clay, DEC-029TC (108-113 feet bgs) and DEC-031TC (105-106 feet bgs), and from the clay DEC-029TC (115-117 feet bgs) and DEC-031TC (115-116.5 feet bgs). USCS classifications in the Raritan Formation ranged from SM, ML, and CL. Soils were identified as either non-plastic or of low plasticity. The measured permeability values varied between 1.7×10^{-6} to 9.9×10^{-6} cm/sec for the clay.

2.6 Groundwater Levels and Hydrogeology

The primary hydrogeologic unit identified within the investigation area is the upper glacial aquifer. Groundwater in the area is generally present in unconfined conditions; however, localized semi-confined or confined conditions are possible due to the presence of interbeds of sand, clay, and silt. The water table surface may be found between approximately 25 and 50 feet bgs depending on the well location.

During RI Phase II field activities, an additional synoptic round of groundwater levels was obtained on March 28 and 29, 2012 from monitoring wells in the Klink Cosmo area. Potentiometric surface maps based on the water level measurements obtained on March 28 and 29, 2012 are provided in

Figure 2-9 for the shallow overburden wells (i.e., up to 60 feet bgs) and in Figure 2-10 for the deep overburden wells (i.e., between approximately 60 and 110 feet bgs). During the SC Phase VI field activities the flow direction of groundwater above the top of Raritan clay (i.e., approximately 110 feet bgs) was determined to be to the northeast/northwest. In the immediate vicinity of the Former Klink Cosmo Cleaners Site area, the shallow and deep groundwater flow is east/northeast. The horizontal hydraulic gradient of the shallow groundwater flow during the RI Phases was less than approximately 0.001 to 0.004 foot per foot (ft/ft). In the immediate vicinity of the Former Klink Cosmo Cleaners Site area, groundwater measurements in the top of Raritan Formation monitoring wells were similar (2 feet in DEC-031TC and 2.18 feet in DEC-029TC).

Vertical hydraulic gradients in well pairs DEC-043/043D, DEC-064/064D, DEC-065/065D, and DEC-066/066D are positive or downwards (0.004, 0.002, 0.012, 0.006 ft/ft, respectively). Vertical hydraulic gradients in the majority of well pairs downgradient of the site, DEC-014R/014D, DEC-015/015D, DEC-029/029D, DEC-031/031D, and DEC-045/045D, were slightly negative, or upwards (-0.002 to -0.007 ft/ft) based upon the water level information. Vertical hydraulic gradients in well pairs DEC-006D/006DD, DEC-007/007D, DEC-013/013D, DEC-030/030D, and DEC-044/044D were also upwards but were greater in magnitude (-0.012 to -0.017 ft/ft).

The vertical hydraulic gradients in top of Raritan Formation well triplets were similar in direction and magnitude during RI Phase II field activities. Vertical hydraulic gradients between the shallow and top of Raritan Formation wells at DEC-029/029TC and DEC-031/031TC were slightly negative or upwards (-0.002 to -0.006 ft/ft, respectively). Vertical hydraulic gradients between the deep and top of Raritan Formation wells at DEC-029D/029TC and DEC-031D/031TC were slightly positive or downwards (0.004 to 0.003 ft/ft, respectively).

2.6.1 Slug Test Results

Horizontal hydraulic conductivity values calculated based upon rising and falling head slug tests for the shallow overburden (i.e., upper Glacial Aquifer) ranged from 2.69×10^{-5} cm/sec to 4.77×10^{-3} cm/sec, and for the deep overburden ranged from 9.74×10^{-3} cm/sec to 2.48×10^{-2} cm/sec.

2.7 Surface Water and Hydrology

The site area slopes slightly to the east and south and is bounded by streets on the north, west and east. The surface of the site is mostly covered by buildings and/or pavement/sidewalks. There is a storm water drop inlet (DI) along Richardson Street near Vandervoort Avenue.

The nearest surface water body is Newtown Creek located approximately 2,500 feet northeast of the site. Newtown Creek is classified as a Class SD (marine waters) surface water body by the NYSDEC. The best usage of Class SD waters is fishing. These waters are suitable for fish, shellfish, and wildlife survival. The classification may be given to those waters that, because of natural or man-made conditions, cannot meet the requirements of primary and secondary contact recreation and fish propagation. While Newtown Creek may not be suitable for swimming and other recreational activities that involve human contact with surface water, individuals use Newtown Creek for fishing and boating. Water is not withdrawn from Newtown Creek for potable use. Numerous storm water drains from surrounding roadways and permitted Spill Discharge Elimination System (SPDES) outfalls discharge into Newtown Creek, including those discharging groundwater collected and treated on the nearby ExxonMobil remediation site.

Surface water levels within Newtown Creek vary depending on the tide. High tide in Newtown Creek is generally at an elevation of 4 to 5 feet above mean sea level (amsl); low tide is generally at an elevation of 0 to -1 feet amsl (www.saltwatertides.com).

2.8 Utilities

Utilities on and near the site include underground water, electric, natural gas, sanitary and storm sewer. There is a storm water drop inlet (DI) along Richardson Street near Vandervoort Avenue. Overhead electric and communication lines run north-south adjacent to the site within the eastern sidewalk along Morgan Avenue, north-south within the western sidewalk along Vandervoort Avenue, and east-west within the north sidewalk along Withers Street. Fire hydrants are located on Richardson Street, Morgan Avenue, Withers Street, and Vandervoort Avenue. A series of interconnected floor drains were identified inside the AWL Industries, Inc., building and these are depicted on Figure 2-11 (i.e., AWL-FD-1 through AWL-FD-4).

2.9 Nature and Extent of Contamination

The overall nature and extent of contamination associated with the Former Klink Cosmo Cleaners Site is based upon the information obtained as part of the investigation phases. The findings of the investigations were summarized in the various reports noted above and the key aspects of the nature and extent of contamination in affected media is presented in this section and provides the estimated areas, volumes, and quantities appropriate for remediation. Based upon the findings of the investigations conducted to date, this summary is divided into two separate areas that were affected by operations at the Former Klink Cosmo Cleaners Site: 1) On-Site Source Area; and 2) Off-Site Areas of affected media.

2.9.1 Standards, Criteria, and Guidance

For each medium, detected concentrations of individual contaminants were compared to applicable standards, criteria and guidance values (SCGs). The SCGs determined during the RI, SC, and Pilot Study phases for the individual media are identified below.

Three sources of soil SCGs are considered appropriate for this site: site-specific background soil results, NYSDEC Part 375, and NYSDEC CP-51. CP-51 supplements Part 375 by providing criteria for contaminants previously included under TAGM 4046 where values were not included in Part 375. Hereafter, mention of Part 375 includes incorporation of CP-51 criteria values. Part 375 Unrestricted Use Criteria are considered to assist in the development of a remedial alternative capable of achieving unrestricted future use as required by DER-10 Section 4.4 (b) 3 ii. In addition, Commercial use soil criteria and Protection of Groundwater criteria for the AWL Industries, Inc. property. The SCGs for groundwater are the Class GA standards and guidance values presented in TOGS 1.1.1. There are no criteria for soil vapor analytical data. There are no criteria for soil vapor analytical data beneath public sidewalks. However, NYSDOH promulgates sub-slab soil vapor/indoor air concentrations for TCE, cis-1,2-DCE, 1,1-DCE, carbon tetrachloride (Matrix A); PCE, 1,1,1-TCA, and methylene chloride (Matrix B); and vinyl chloride (Matrix C) at locations occupied by structures/residences, and these are considered applicable SCGs.

2.9.2 Soil

On August 3, 2011, eight soil samples were obtained from the 0 to 2-foot depth interval from eight locations in Monsignor McGolrick Park, located northwest of the site, as part of the SC Phase VI field activities. These samples were analyzed for target compound list/target analyte list (TCL/TAL) contaminants. Detected concentrations will be considered to be representative of site-specific background for the Klink Cosmo Site. These soil background concentrations will be included as soil SCGs on the soil analytical tables presented below. Since the detected concentrations of di-n-butylphthalate, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, dieldrin, arsenic, copper, iron, lead, mercury, and zinc exceeded Part 375 Unrestricted Use criteria in the background soil samples, these contaminants are considered to be present as background for the site.

As part of the field investigations, soil samples were obtained from soil borings on properties zoned residential and/or manufacturing by the NYC Department of City Planning. The zoning classification for the property of location of the soil boring is a consideration in the determination of the appropriate soil SCGs. The majority of properties within the investigation area are zoned manufacturing.

As discussed in Section 2.1.1, properties located in the manufacturing districts in NYC may be either industrial or commercial use. However, land uses allowed within manufacturing districts include residential use either within special mixed use districts or by special permit. Residences may be present on properties throughout the entire investigation area. The nearest residences are located along the west side of Vandervoort Avenue just north of Division Place. The AWL Industries, Inc. property is used for commercial purposes, therefore the commercial Part 375 commercial use soil cleanup criteria applies. Residential use soil cleanup objectives were also used for comparison purposes given the special mixed use zoning.

2.9.2.1 On-Site Source Area

A statistical summary of the detected analytical results in on-site soil samples as compared to Unrestricted Use, Protection of Groundwater, Commercial, and Site Background SCGs is presented in Table 2-1A through 2-1D for the locations within the AWL Industries, Inc. building. Thirty-seven soil samples were collected and analyzed for VOCs, and seven soil samples were collected for SVOCs, pesticides, PCBs, and metals as part of site investigations. Not all locations were sampled for all parameters during the sampling events.

Detected VOCs exceeding criteria included chlorinated VOCs (CVOCs) and acetone. SVOCs exceeding criteria included di-n-butylphthalate and PAHs [i.e., benzo(a)anthracene, benzo(a)pyrene, benzo(f)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene and indeno(1,2,3-cd)pyrene]. Pesticides and metals exceeding criteria included 4,4'-DDD and aldrin, arsenic, barium, cadmium, calcium, chromium, copper, iron, lead, mercury, nickel, and zinc (Figures 2-12 and 2-12A). However, detected compounds exceeding Commercial Use criteria included tetrachloroethene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, barium, copper, and lead. Detected concentrations of SVOCs, metals, and pesticides are typical for urban fill materials and shallow soil and are not considered to be associated with past operations at the AWL Industries, Inc. property. The primary contaminants originating from the Site are CVOCs, in particular, PCE and TCE. The other detected compounds and metals are not likely attributable to former dry cleaning operations at the Site. This following discussion focuses on the CVOCs.

Isoconcentration contours and/or detected maximum PCE and TCE concentrations in soil for each sampling location (i.e., on-site and off-site locations) are shown on Figures 2-13 and 2-14 (see inset for on-site locations), respectively. The highest concentration of PCE was found in samples collected from borings advanced inside the AWL Industries, Inc. building and, with the exception of AWL-06, all on-site soil results exceeded Unrestricted and Protection of Groundwater criteria. Concentrations of PCE exceeded the Commercial Use criterion at four samples and were detected at the highest concentration at AWL-02 (273 mg/kg). The highest concentration of TCE was also found in soil beneath the AWL Industries, Inc. building. Locations AWL-02 and AWL-03 had concentrations that exceeded only Unrestricted Use and Protection of Groundwater criteria. No other locations exceeded any criteria. Based upon the soil sample results, the source of PCE and TCE contamination is located beneath the concrete floor slab in the eastern portion of the AWL Industries, Inc. building at depths ranging from immediately below the concrete slab to 35 feet bgs, which is the depth to the water table surface.

2.9.2.2 Floor Drain Sediment Analytical Results

The floor drain sediment samples collected during the On-Site RI were compared to Part 375 criteria identified for the soil samples discussed in Section 2.9. Soil sample SCGs were used because these are samples from floor drains and not sediment samples from a water body.

A summary of the detected analytical results in floor drain sediment samples were compared to Unrestricted Use, Protection of Groundwater, Commercial, and Soil Background SCGs and are presented in Tables 2-2A through 2-2D.

Compounds exceeding Unrestricted Use criteria include: PCE; the SVOC di-n-butlyphthalate; the pesticides 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, dieldrin, endrin, and heptachlor epoxide; and the metals antimony, arsenic, cadmium, calcium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, vanadium and zinc. The highest concentration of PCE was at location AWL-FD-1 at 15 mg/kg followed by AWL-FD-3 with 1.7 mg/kg. The majority of non-VOC exceedances and highest concentrations were at location AWL-FD-1.

The following compounds exceeded Protection of Groundwater criteria in one or more locations: PCE, dieldrin, heptachlor epoxide, arsenic, cadmium, copper, lead, manganese, mercury, nickel and zinc. Almost all the Protection of Groundwater exceedances were at location AWL-FD-1. PCE, heptachlor epoxide, copper and nickel at location AWL-FD-3 were the only other exceedances.

The following compounds exceeded Commercial Use criteria in one or more locations: arsenic, cadmium, chromium, copper, lead, and nickel.

Compounds exceeding Site Background criteria in On-Site RI floor drain sediment samples include di-n-butlyphthalate, 4,4'-DDD, dieldrin, aluminum, arsenic, copper, iron, lead, mercury and zinc. The majority of exceedances were at location AWL-FD-1.

2.9.2.3 Off-Site Area

A statistical summary of the detected analytical results in off-site soil samples as compared to Unrestricted Use, Protection of Groundwater, Residential, and Site Background SCGs is presented in Tables 2-3A through 2-3D for the off-site locations. One hundred seventeen soil samples were collected and analyzed for VOCs, and eight soil samples were collected for SVOCs. Seven samples were collected for pesticides, PCBs, and metals. Not all locations were sampled for all parameters during the sampling events.

Detected VOCs exceeding criteria included PCE, acetone, xylenes, and methylene chloride. SVOCs exceeding criteria included di-n-butylphthalate and 2-methyl naphthalene. Metals exceeding criteria included aluminum, chromium, cobalt, iron, lead, mercury, nickel, and vanadium. The primary contaminant originating from the Site is PCE. The other detected compounds and metals are not likely attributable to former dry cleaning operations at the Site. This following discussion focuses on PCE.

In the adjacent off-site area, only Unrestricted Use, Residential Use, and Protection of Groundwater criteria were exceeded for PCE, at locations AS-01 and SVE-01, which were advanced in the sidewalk area adjacent to the AWL Industries, Inc. building. No other off-site locations had concentrations of PCE that exceeded criteria. TCE did not exceed any criteria in any off-site sample locations.

2.10 Groundwater

2.10.1 On-Site Area

Groundwater samples were collected from five temporary well locations within the building (AWL-01, AWL-02, AWL-03, AWL-04 and AWL-05). Figure 2-15 depicts groundwater results exceeding criteria for sampling locations in the on-site area and adjacent off-site area. Table 2-4 provides a statistical summary of the detected parameters for the On-Site groundwater samples (including quality assurance/quality control samples) as follows: the number of detections; the minimum, maximum and average values; and the location of the maximum value. Groundwater samples from these locations are representative of the shallow groundwater. PCE was detected above Class GA groundwater standards in four of five sample locations within the building footprint with concentrations ranging from a high of 2,800 µg/L (AWL-05) to a low of 870 µg/L (AWL-01). TCE was detected in four of five sample locations within the building footprint near the northeast corner, ranging from a high of 12 µg/L (AWL-03) to a low of 1.8 µg/L (AWL-01) with AWL-03, AWL-04 and AWL-05 exceeding groundwater criteria

(Figure 2-15). The presence of PCE and TCE degradation products have also been detected in the groundwater samples at concentrations exceeding groundwater criteria. Cis-1,2-DCE was detected above groundwater criteria in 3 of 5 groundwater sample locations from within the AWL building footprint. The range of cis-1,2-DCE varied from 11 µg/L to 1.8 µg/L, with the highest concentration detected at AWL-05. No other breakdown products were detected within the building footprint.

Benzene and toluene were detected above criteria only in samples AWL-03 (1.3 µg/L) and AWL-01 (7.8 µg/L), respectively.

Metals detected above criteria in the groundwater samples include arsenic, barium, beryllium, cadmium, chromium, copper, iron, lead, magnesium, manganese, nickel, sodium and thallium. The AWL exceedances, especially metals, may be high biased since they are from temporary monitoring wells. Because temporary monitoring wells are not constructed with sandpacks and are not developed or purged, they tend to have high turbidity levels. For example, iron concentrations in the AWL well samples ranged from 61,800 µg/L to 332,000 µg/L. In contrast iron concentrations in groundwater from the surrounding off-site monitoring well results ranged from 1,200 µg/L to 17,800 µg/L.

2.10.2 Off-Site Area Shallow Groundwater Zone

Three-hundred and three groundwater samples were collected and analyzed for VOCs, seven groundwater samples were collected for SVOCs and metals, and six groundwater samples were collected for pesticides and PCBs as part of site investigations. Total and dissolved iron were analyzed in 100 and 94 groundwater samples, respectively, and several groundwater samples were collected and analyzed for miscellaneous water quality parameters, natural attenuation parameters, and CSIA parameters. Not all locations were sampled for all parameters during the multiple sampling events. A summary of the detected TCL VOCs, SVOCs, total and dissolved metals, miscellaneous water quality and natural attenuation parameters from groundwater samples collected during investigations to date is presented in Table 2-5. This table also provides a statistical summary of the detected parameters for the groundwater samples. Results exceeding TOGS No. 1.1.1 Class GA groundwater criteria are indicated with a circle.

Detected VOCs exceeding Class GA groundwater criteria included CVOCs, BTEX compounds, chlorinated benzene isomers, chloroform, acetone, MTBE, and other aromatic hydrocarbons. Detected SVOCs included di-n-butylphthalate and phenol. Concentrations of dieldrin and gamma-BHC exceeded SCGs in one groundwater sample. Concentrations of total iron, manganese, and sodium exceeded SCGs in at least 1 location and as many as 77 locations in the case for iron. The primary contaminants originating from the Site are CVOCs, in particular, PCE, TCE, and to a lesser extent - cis- and trans-1,2-

DCE, and VC. Other notable CVOC detections but at generally low concentrations include 1,1,1-trichloroethane, 1,1-dichloroethane, and 1,2-dichloroethane. BTEX compounds, aromatic benzene compounds, acetone, chlorinated benzenes, and metals are not attributable to former dry cleaning operations at the Site, and are likely attributable to miscellaneous spills or other sources. This following discussion focuses on the CVOCs.

Isoconcentration contours and/or detected maximum PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, and VC concentrations recorded from all sampling events for each groundwater sampling location designated within the on-site and off-site areas in the shallow groundwater overburden zone are shown on Figures 2-16, 2-17, 2-18, 2-19 and 2-20, respectively.

PCE was detected in 260 of the 303 samples collected from monitoring well locations as part of investigations to date at concentrations ranging from 1.2 µg/L to 46,000 µg/L (Figure 2-16). Two hundred thirty six samples had concentrations exceeding the groundwater criterion. The highest concentration of PCE in the shallow groundwater was detected at DEC-014R (46,000 µg/L). The extent of the PCE contamination plume in the shallow zone is several blocks wide extending beyond Lombardy Street to the northeast. The direction of the plume flow is toward the north/northeast.

TCE (Figure 2-17) was generally detected at much lower concentrations compared to the PCE concentrations, suggesting that little reductive dechlorination of PCE and TCE is occurring. TCE was detected in 236 of the 303 samples collected from monitoring well locations as part of investigations to date at concentrations ranging from 0.52 µg/L to 2,100 µg/L. One hundred seventy one samples had concentrations exceeding the groundwater criterion. The highest concentrations of TCE in the shallow groundwater was detected at DEC-156 (2,100 µg/L) and DEC-071 (1,000 µg/L) which are located on Morgan Avenue a few blocks northwest of the Site. TCE contamination in this area appears to be attributable to another source(s). At and near the Klink Cosmo Site, the extent of the TCE contamination plume in the shallow zone is much less concentrated than the PCE contamination plume suggesting that little reductive dechlorination of PCE is occurring.

Cis-1,2-DCE and trans-1,2-DCE were generally detected at much lower concentrations and less frequently than PCE and TCE (Figures 2-18 and 2-19, respectively). Cis-1,2-DCE was detected in 174 of the 303 samples collected from monitoring well locations as part of investigations to date at concentrations ranging from 0.90 µg/L to 230 µg/L. Trans-1,2-DCE was detected in 26 of the 303 samples collected from monitoring well locations as part of investigations to date at concentrations ranging from 0.69 µg/L to 48 µg/L. VC was detected in 21 of the 303 samples collected from monitoring well locations as part of investigations to date at concentrations ranging from 1.0 µg/L to 48 µg/L (Figure 2-20). It appears that DCE and VC is attributable to the source(s) of TCE near DEC-156 and DEC-071).

2.10.3 Off-Site Deep Overburden Groundwater Zone

One-hundred and sixty seven groundwater samples were collected and analyzed for VOCs, three groundwater samples were collected for SVOCs and pesticides and PCBs, and two samples were collected for metals as part of site investigations. Total and dissolved iron were analyzed in 78 and 76 groundwater samples, respectively, and several groundwater samples were collected and analyzed for miscellaneous water quality parameters, natural attenuation parameters, and CSIA parameters. Not all locations were sampled for all parameters during the multiple sampling events. A summary of the detected TCL VOCs, SVOCs, total and dissolved metals, miscellaneous water quality and natural attenuation parameters from groundwater samples collected during investigations to date is presented in Table 2-6. This table also provides a statistical summary of the detected parameters for the groundwater samples. Results exceeding TOGS No. 1.1.1 Class GA groundwater criteria are indicated with a circle.

Detected VOCs exceeding Class GA groundwater criteria included CVOCs, and chloroform. There were no SVOCs exceeding SCGs. No pesticides or PCBs were detected. Concentrations of total iron, magnesium, manganese, and sodium exceeded SCGs in at least 1 location and as many as 44 locations in the case for iron. The primary contaminants originating from the Site are CVOCs, in particular, PCE, TCE, and to a lesser extent cis- and trans-1,2-DCE, and VC. Other notable CVOC detections but at generally low concentrations include 1,1,1-trichloroethane, 1,1-dichloroethane, and 1,2-dichloroethane. The following discussion focuses on PCE and TCE.

Isoconcentration contours and/or detected maximum PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, and VC concentrations recorded from all sampling events for each groundwater sampling location designated within the off-site area in the deep groundwater overburden zone are shown on Figures 2-21, 2-22, 2-23, 2-24 and 2-25, respectively.

PCE was detected in 130 of the 167 samples collected from monitoring well locations as part of investigations to date at concentrations ranging from 0.44 µg/L to 7,000 µg/L (Figure 2-21). One hundred five samples had concentrations exceeding the groundwater criterion. The highest concentration of PCE in the deep groundwater was detected at DEC-029D (7,000 µg/L). TCE (Figure 2-22) was generally detected at much lower concentrations compared to the PCE concentrations, suggesting that little reductive dechlorination of PCE and TCE is occurring. TCE was detected in 120 of the 167 samples collected from monitoring well locations as part of investigations to date at concentrations ranging from

0.46 µg/L to 1,300 µg/L. Seventy-nine samples had concentrations exceeding the groundwater criterion. The highest concentrations of TCE in the deep groundwater was detected at DEC-005D (70,000 µg/L) and DEC-039D (1,300 µg/L) which are located on Vandervoort Avenue and Lombardy Street a few blocks northwest of the Site adjacent to the ACME Steel/Metal Works Site (Site No. 224131). TCE contamination at these locations appears to be attributable to the ACME Steel Site. The extent of the TCE contamination plume in the shallow zone is much less concentrated than the PCE contamination plume suggesting that little reductive dechlorination of PCE is occurring at and near the Klink Cosmo Site.

Cis-1,2-DCE and trans-1,2-DCE were generally detected at much lower concentrations and less frequently than PCE and TCE (Figures 2-23 and 2-24, respectively). Cis-1,2-DCE was detected in 86 of the 167 samples collected from monitoring well locations as part of investigations to date at concentrations ranging from 0.61 µg/L to 290 µg/L. Trans-1,2-DCE was detected in 14 of the 167 samples collected from monitoring well locations as part of investigations to date at concentrations ranging from 1.1 µg/L to 67 µg/L. VC was detected in 7 of the 167 samples collected from monitoring well locations as part of investigations to date at concentrations ranging from 1.1 µg/L to 41 µg/L (Figure 2-25).

2.10.4 Summary of Groundwater Analytical Results in the Klink Cosmo Area

PCE and its degradation products were detected in numerous groundwater monitoring wells in both the shallow and deep overburden groundwater as well as in downgradient top of clay monitoring wells. High concentrations of PCE were detected at the site, in groundwater samples collected directly beneath and within the contaminated soil source area located beneath the AWL Industries, Inc. building, and in groundwater samples collected from shallow and deep overburden groundwater monitoring wells located adjacent to and downgradient of the onsite soil source area.

The horizontal extent of the dissolved phase PCE and TCE groundwater plume extends to the northeast into the ACME Steel Area (near the intersection of Lombardy Street and Porter Avenue). Based upon the observed concentrations of CVOCs from groundwater sampling events, a dissolved phase chlorinated solvent plume originates at the Former Klink Cosmo Cleaners Site. The horizontal extent of dissolved phase CVOC contamination associated with the Klink Cosmo Site chlorinated solvents has been delineated, although other sources are contributing to the overall distribution of CVOCs. The chlorinated solvent plumes in the shallow and deep overburden have higher concentrations of PCE immediately north and east of the Former Klink Cosmo Cleaners Site. The extent of PCE has a larger footprint in the shallow groundwater compared to the deep groundwater and is migrating to the northeast and comingles with the dissolved chlorinated solvent plume originating from other sources and within the ACME Steel source area.

The vertical extent of PCE and TCE impacted groundwater was determined to extend down to the top of the Raritan Formation. The vertical extent of PCE and TCE impacted groundwater is not expected to migrate below the top of the Raritan Formation due to its vast areal extent and low permeability.

Based upon the data collected to assess the potential for degradation of PCE in the groundwater system as presented above, there is evidence that some reductive dechlorination is occurring in the vicinity of the site. Rates of degradation are very difficult to determine due to the unknown quantity of source material present beneath the Former Klink Cosmo Cleaners Site. Based upon the geochemical conditions in the groundwater system, the aquifer is only slightly conducive for naturally occurring reductive dechlorination. It is possible that the geochemical conditions could be enhanced via in-situ bioremediation technologies to further promote higher rates of reductive dechlorination.

2.11 <u>Non-Aqueous Phase Liquids</u>

During the RI Phase I field activities, petroleum related light non-aqueous phase liquid (LNAPL) found in upgradient monitoring well DEC-048 was analyzed for VOCs, SVOCs, and fuel fingerprint (SW-846 Method 8015), and specific gravity. Fuel oil was detected at a concentration of 950,000 mg/kg (95%). NYSDEC Spill No. 1103190 was assigned on June 21, 2011 to the LNAPL found in this area. Organics detected, at concentrations ranging from 130 ppm to 3,500 ppm, include: 1,2,4-trimethylbenzene, 2-methylnaphthalene, acenaphthene, fluorene, naphthalene, phenanthrene, and pyrene. These detected compounds are consistent with fuel oil(s). Two additional compounds, 1,1-biphenyl and bis (2-ethylhexyl) phthalate were also detected within the same range of concentrations. The specific gravity of the sample at 60 degrees F was determined to be 0.8608, which is consistent with a No. 2 fuel. A comparison of the DEC-048 sample chromatogram to a general diesel/Fuel Oil No. 2 chromatogram indicates a similarity, although degradation of the product found in DEC-048 is evident. The spill is being managed under the NYSDEC Spills Program and will not be addressed as part of the FS.

2.12 <u>Soil Vapor Results</u>

Soil vapor in the Klink Cosmo area has been adversely impacted by the presence of PCE, TCE and their daughter products. The elevated soil vapor concentrations were generally present to the west, north and the eastern perimeter of the Former Klink Cosmo Cleaners building (Figure 2-26) and immediately down gradient (SG-060, SG-082, SG-083, SG-084, SG-086, SG-087, SG-116, SG-117, SG-118, and SG-119) [Figures 2-27 and 2-28]. A second area of elevated soil vapor concentration was found north/ northwest of the site (i.e., SG-048 and SG-056).

2.12.1 On-Site RI Soil Vapor Results

The six subslab sampling locations where VOCs were detected in soil vapor during the On-Site Phase III RI, including PCE and its breakdown products, are shown on Figure 2-26. A summary of detected VOCs in the soil vapor and ambient air samples collected during the On-Site Phase III RI is presented in Table 2-7. Table 2-7 provides a statistical summary of the detected parameters for the On-Site Phase III RI soil vapor samples as follows: the number of detections; the minimum, maximum and average values; and the location of the maximum value.

One outdoor air sample was collected during the On-Site Phase III RI sampling to represent background air conditions. VOCs detected in the outdoor air sample include 1,2,4-trimethylbenzene, acetone, benzene, chloromethane, dichlorofluoromethane, ethylbenzene, methyl ethyl ketone, methylene chloride, PCE, toluene, trichlorofluoromethane and xylene. Concentrations of VOCs in the outdoor air samples ranged from 0.056 to 16.3 µg/m^3. PCE was the highest concentration VOC detected in the outdoor air.

PCE was detected in all six subslab soil vapor sampling locations, at concentrations ranging from 27,300 µg/m^3 (AWL-SV-5) to 2,090,000 µg/m^3 at location AWL-SV-4. Reported PCE concentrations at all subslab locations were above the soil vapor intrusion SCG criterion of 1,000 µg/m^3, indicating mitigation is required. The average PCE concentration was 1,040,000 µg/m^3. All of these subslab soil vapor sampling locations are located within the footprint of the AWL Industries, Inc. building and soil vapor contamination correlates with the subsurface soil contamination.

Concentrations of TCE, detected in all sample locations, were significantly lower than PCE concentrations, ranging from 140 µg/m^3 (AWL-SV-5) to 7,380 µg/m^3 at AWL-SV-2. The average concentration was 4,193 µg/m^3. Reported TCE concentrations at all subslab locations were above the soil vapor intrusion SCG criterion of 60 µg/m^3, indicating mitigation is required. Cis-1,2-dichloroethene was the only other breakdown product, detected in five of seven locations (5.95 µg/m^3 to 3,570 µg/m^3 with an average of 1,093 µg/m^3). Detected concentrations of cis-1,2-dichloroethene exceeded the soil vapor intrusion criterion of 60 µg/m^3, indicating mitigation is required. It should be noted that because of the high PCE concentrations, the reporting limits for the non-detect compounds are elevated due to sample dilution. Therefore, additional daughter products may be present but were at concentrations below the reporting limits.

In addition to the VOCs listed above, detections in the sampled locations include: 1,1,1-trichloroethane, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, acetone, chloroform, ethylbenzene, methyl ethyl ketone, methylene chloride, toluene and xylene. 1,2,4-Trimethylbenzene, 1,3,5-trimethylbenzene, ethylbenzene, toluene and xylene contaminants suggest a possible petroleum source.

2.12.2 Off-Site Soil Vapor Results

Using the maximum detected results from the sampling events at each soil vapor location in the Klink Cosmo area, isoconcentration contours were developed for PCE and TCE and presented in Figures 2-27 and 2-28, respectively. A summary of detected VOCs in the soil vapor and ambient air samples collected during the Off-Site investigations is presented in Table 2-8. The highest soil vapor concentrations were beneath the AWL Industries, Inc. building and to the north, east and south of the building. A second area of elevated PCE soil vapor concentration was found north/northwest of the site (i.e., SG-112, SG-048 and SG-056). Other areas with high PCE concentration were further northwest (SG-0043 and SG-040) and west (SG-086). These high concentration pockets of PCE may be attributable to other sources in the area. VOCs (in addition to PCE and TCE) detected in approximately half (or more) of the sampled locations include: 1,1,1-trichloroethane, 1,2,4-trimethylbenzene, cis-1,2-dichloroethene, benzene, chloroform, ethanol, MEK, methylene chloride, hexane, toluene, and xylene. These contaminants suggest a possible petroleum or fuel source. The majority of soil vapor samples along Vandervoort Avenue and Division Place all had significant concentrations of petroleum related compounds. SG-113 (along Vandervoort Avenue) and SG-114 (along Division Place) had the highest total VOCs concentrations compared to other locations in the area. Fewer contaminants were present along Morgan Avenue and Richardson Street. The highest levels of TCE were found on the eastern side of the AWL Industries, Inc. building along Vandervoort Avenue (SG-049, SG-116).

2.13 Qualitative Human Health Exposure Assessment

Based upon the analytical data obtained and presented in this Section, the contaminants of potential concern (CPCs) were selected based on the frequency of detection, range of concentrations, and potential for migration, as well as whether the detected analytes exceeded applicable standards, criteria, or guidance values for the media. A “medium of potential concern” is identified as a physical medium (soil, groundwater, soil vapor) in which one or more contaminants were detected at concentrations exceeding their SCGs.

Soil analytical results were compared to soil background concentrations (surface soil samples from McGolrick Park), and Part 375 Unrestricted Use criteria as presented on Tables presented in Section 2. VOCS, SVOCs, pesticides, and metals exceeded background concentrations or Part 375 Unrestricted Use criteria and are considered CPCs for soil.

Several VOCs, SVOCs, pesticides, and metals were detected in groundwater. For groundwater, the SCGs are the NYSDEC Class GA (groundwater) standards and guidance values presented in TOGS 1.1.1, April 2000 (including subsequent revisions). All contaminants detected in groundwater that exceeded SCGs are considered CPCs. Table 2-9 presents a summary of CPCs for soil, groundwater, and soil vapor at on-site and off-site sampling locations.

Soil vapor was also sampled during the investigation and found to be contaminated with VOCs. There are no criteria for soil vapor analytical data; however, the NYSDOH Soil Vapor Guidance Decision Matrices A, B, and C (NYSDOH 2006, with updates) were utilized to evaluate the potential for soil vapor intrusion by reviewing sub-slab vapor concentrations for the VOCs relevant to the Decision Matrices: Matrix A - 60 $\mu g/m^3$ for TCE, carbon tetrachloride, cis-1,2-dichloroethene, and 1,1-dichloroethene; Matrix B - 1,000 $\mu g/m^3$ for PCE, 1,1,1-trichloroethane, and methylene chloride; and Matrix C - 60 $\mu g/m^3$ for VC. Detected analytical results were sufficiently high for either PCE and/or TCE and methylene chloride at many locations to indicate the highest level of action recommended: mitigate. These compounds are therefore considered CPCs for soil vapor as indicated on Table 2-9.

Tables 2-10 and 2-11 present a summary of the potential routes of exposure, the potential receptors, and the potential completed pathways. There are completed exposure pathways from soil under the current and future use conditions during construction activities. There are potential exposure pathways from soil vapor and outdoor air through the inhalation of VOCs to construction workers, On-Site employees, and the pubic under both the current and future use scenarios. Exposure pathways are not complete for any receptors for groundwater. Figure 2-29 depicts the Conceptual Site Model.

2.13.1 Fish and Wildlife Resources Impact Analysis

Results of the Fish and Wildlife Resources Impact Analysis indicate that the site is located in an old, highly developed, urbanized area. Plant communities in the off-site project area include mowed lawn and trees, mowed lawn, and vegetated areas on disturbed sites. These communities are associated with residential, recreational, commercial and industrial areas in the project area. No plant communities were identified in the on-site area. The results of the FWRIA Step I analysis indicate that there is limited potential for wildlife at the site. Because of its location in an urbanized area and the presence of the building and sidewalks which cover most of the surface of the site, the site provides very little if any suitable habitat for wildlife other than Norway rat, house mouse and perching birds. The site does not provide any current or potential value to humans as a nature recreation area.

2.14 Summary of Soil Vapor Extraction/Air Sparge Pilot Test

URS conducted a combination soil vapor extraction/air sparge (SVE/AS) pilot test at the Former Klink Cosmo Cleaners Site in mid-November 2015 to verify that SVE would be effective at this Site and to determine values for design of a full-scale remediation system. Based on the vacuum gauge pressure measurements during the SVE/AS Pilot Test with both SVE wells operating, the ROI developed was at least 40 feet. Average radius of influence (ROI) based upon data collected as part of the SVE/AS Pilot Study indicated the ROIs in SVE-1 and SVE-2 ranged from approximately 40 to 75 ft. The intrinsic permeability is the measurement for the ability of fluids (groundwater and air) to pass through soils, and is typically used as an indicator to determine the effectiveness of SVE. Intrinsic permeability is a function of soil properties only, whereas hydraulic conductivity is a function of both soil and fluid properties. Using the hydraulic conductivity values provided in the Remedial Investigation Phase II Report, the intrinsic permeability (k_i) was calculated to be 5.55 $x10^{-8}$ cm^2. This corresponds to the permeability expected for fill, sand, gravel, and a sandy silt layer observed in the formation above the water table and corresponds to an environment that would be conducive to SVE remediation. Based upon the results of the SVE/AS Pilot Test, the NYSDEC determined that this technology would be used to remediate the on-site source area as an Interim Remedial Measure (IRM). Because the on-site source area is not accessible due to the AWL Industries, Inc. operations, the NYSDEC determined that the IRM would need to be designed to operate from the adjacent perimeter sidewalk area as discussed below.

2.14.1 Conceptual Design Layout for Source Perimeter Treatment

Figure 2-30 provides a conceptual design layout of SVE and AS wells for treating the contaminant source along the perimeter of the warehouse building. The following paragraphs and details in the Pilot Test Report (URS, 2016) provide the basis, assumptions, calculations and references used to develop the conceptual design.

2.14.1.1 Recommended Locations and Depths of Soil Vapor Extraction Wells

Based on an ROI of 40 feet, four additional SVE wells will be installed on the sidewalk adjacent to the Former Klink Cosmo building to remediate the source area. One of the additional extraction wells will be installed near the intersection of Richardson Street and Vandervoort Avenue, two additional extraction wells will be installed south of the intersection approximately 40 feet away from each other, and the remaining additional extraction well will be installed on Richardson Street between SVE-1 and SVE-2, drilled on an approximately 15-degree angle to extend beneath the warehouse building (extending approximately 20 feet from the building perimeter). Figure 2-30 provides the locations of the existing and proposed extraction wells.

As summarized in the SVE/AS Pilot Test Report, the screened interval of the new extraction wells will be 15 feet.

2.14.1.2 Soil Vapor Extraction Well Flow Rates

The total treatment area encompassed by the six SVE wells will total approximately 19,175 ft^2. Groundwater exists approximately 32 feet below grade. As such the treatment volume is 613,600 cubic feet (ft^3). At a soil porosity of 0.24 and extracting at least two pore volumes per day the vacuum extraction rate is 213 ft^3/ minute.

Assuming that the subsurface conditions are relatively homogenous, each SVE well will be designed to have an extraction flow rate of approximately 35 scfm. At 35 scfm per well, the total extraction rate would be 210 scfm.

2.14.1.3 Determination of Soil Vapor Extraction Well Vacuum

The intrinsic permeability of 5.55×10^{-8} cm^2 was used to determine the vacuum pressure at the SVE wells. As summarized in the SVE/AS Pilot Test Report, the vacuum in the extraction wells should be approximately 50.2 inches H_2O to achieve the required radius of influence.

2.14.1.4 Air Sparge Flow Rate

As summarized in the SVE/AS Pilot Test Report, the AS system should consist of eight 2-inch diameter wells spaced between 15 to 20 feet. A 3 foot screen length should be used for design of the additional sparge wells since subsurface conditions are relatively uniform in the treatment zone.

Assuming a one pore exchange rate and an SVE extraction rate equal to two times the sparging injection rate, the air sparging flow rate is 100 ft^3/ minute.

Operation of the air sparge system can vary from having all eight wells online or pulsing the system with a few wells online at one time. With all eight wells online, the air sparging rate per well would be 12.5 ft^3/ minute

2.14.1.5Sparging Air Pressure

The majority of on-site contamination in the unsaturated zone extends up to approximately 35 feet bgs. On-site dissolved phase contamination in the saturated zone was detected from approximately 35 to 80 bgs. The shallow groundwater zone within the upper glacial aquifer is considered to be 35 to 60 feet bgs, and the deep groundwater zone within the upper glacial aquifer is considered to be 60 to 80 feet bgs. The air sparging pressure should be maintained between the minimum pressure necessary to induce flow and the pressure at which fracturing occurs. Because contaminants exist in both the shallow and deep groundwater zones beneath the site, air should be injected in two different zones.

As summarized in the SVE/AS Pilot Test Report, an acceptable pressure range for the shallow aquifer is 5.4 to 32.8 psig. Injection pressures in the deep aquifer range between 22.6 and 62.0 psig. This exceeds the acceptable pressure range provided in the reference documents.

If the well screen is placed at 75 feet bgs, at the midpoint of DEC-031D, minimum air pressure (P_{min}) would be 18.3 psig and $P_{fracture}$ would be 54.8 psig. The range of P_{min} for treating the shallow and deep aquifer is 5.4 to 18.3 psi (top of screen for deep aquifer set at 75 feet bgs). This is in the range of acceptable values for air sparge pressure. Actual operation of the air sparge system would warrant treatment of the shallow and deep aquifer to be conducted separately due to the fracture pressure when treating the shallow aquifer.

3 REMEDIAL GOAL AND REMEDIAL ACTION OBJECTIVES

3.1 Remedial Goal

In accordance with DER-10, the remedial goal for site remediation is as follows:

- The remedy will eliminate or mitigate all significant threats to human health and/or the environment, to the extent practicable, caused by contaminants present due to the release of PCE from the former dry cleaners onsite.

3.2 Remedial Action Objectives

In order to meet the remedial goal, remedial action objectives (RAOs) were developed to protect public health and the environment and provide the basis for selecting technologies and developing alternatives. The results of the RI have shown that soil is contaminated with contaminants of concern and that there is a significant risk to human health or the environment from soil. Consequently, RAOs were established for soil. RAOs were established for all contaminated media (soil, groundwater, and soil vapor) are presented below.

Soil

Public Health Protection

- Prevent ingestion/direct contact with contaminated soil
- Prevent inhalation exposure to contaminants volatilizing from soil.

Environmental Protection

- Prevent migration of contaminants that would result in groundwater, surface water, or sediment contamination.
- Prevent impacts to biota from ingestion/direct contact with soil causing toxicity or impacts from bioaccumulation through the terrestrial food chain.

Groundwater

Public Health Protection

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

Environmental Protection

- Restore groundwater aquifer to pre-release conditions, to the extent practicable.
- Prevent the discharge of contaminants to surface water and sediments.
- Remove the source of groundwater contamination.

Soil Vapor

Public Health Protection

- Mitigate impacts to public health resulting from existing, or the potential for, soil vapor intrusion into buildings.

3.3 Remediation Areas and Volumes

The extent of soil, groundwater, and soil vapor contamination is discussed below. Areas and volumes of contamination have been developed based on the characterization information provided in the RI reports and will serve as the basis for development and evaluation of alternatives in this FS.

3.3.1 Soil

Contaminants detected above the soil cleanup criteria in soil include CVOCs, SVOCs, and metals. However, the SVOCs and metals are typical for urban fill materials and will not be addressed by this FS. Active remediation will address only the CVOC contaminants. CVOC soil contamination is limited to the source area underneath the Klink Cosmo building at 368 Richardson Street. The estimated area of soil contamination is 6,000 square feet as shown on Figure 3-1. The estimated average depth of soil contamination is 34 feet which results in an estimated volume of 204,000 cubic feet (approximately 7,600 cubic yards).

3.3.2 Groundwater

The FS will address remediation of contaminated groundwater within the 1,000 ppb contours for dissolved phase PCE in the shallow groundwater zone (at a depth between approximately 35 feet and 60 feet bgs) as shown on Figures 3-2 and 3-3. The FS will also address remediation of contaminated groundwater within the 1,000 ppb contours for dissolved phase PCE in the deep groundwater zone (at a depth between approximately 60 feet and 110 feet bgs) as shown on Figures 3-4 and 3-5.

3.3.3 Soil Vapor

The horizontal extent of PCE contamination in soil vapor is shown on Figure 3-6 and the horizontal extent of TCE contamination in soil vapor is shown on Figure 3-7.

3.4 General Response Actions

General response actions are broad response categories capable of satisfying the remedial action objectives for the Site.

No Action: A no action response provides a baseline for comparison with other alternatives.

Institutional Controls: Institutional controls (ICs), such as Environmental Easements (EEs) and Site Management Plans (SMPs), are measures to provide protection to human health and the environment by identifying contamination and reducing exposure.

Exposure Point Mitigation: Remedial measures may be implemented at the point of exposure to mitigate exposure to contaminated material and provide adequate protection to human health and the environment.

Containment: Containment measures are those remedial actions whose purpose is to contain and/or isolate contaminants. These measures prevent migration from, or direct human exposure to, contaminated media without treating, disturbing or removing the contamination.

Removal: Removal measures remove contamination from the subsurface for subsequent treatment and/or disposal.

Treatment: Treatment and disposal measures include technologies whose purpose is to reduce the toxicity, mobility, or volume of contaminants by directly altering, isolating, or destroying those contaminants.

4 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

This section identifies specific remedial technologies for soil, groundwater and soil vapor and evaluates their effectiveness with respect to their technical feasibility in meeting the RAOs for this site. Appropriate technologies will be carried forward into the development of alternatives. Table 4-1 provides a summary of the remedial technologies and screening process for soil, groundwater, and soil vapor. General response actions that will be considered for the Former Klink Cosmo site include the following:

- Soil
  - Institutional Controls/Engineering Controls (ICs/ECs) with an SMP
  - Barriers/Soil Covers
  - Removal

- Groundwater
  - ICs/ECs with an SMP
  - Exposure Point Mitigation
  - Containment
  - Removal
  - In-Situ Treatment

- Soil Vapor
  - Exposure Point Mitigation
  - Removal

4.1 Identification of Technologies for Soil

This section identifies and provides a screening of remedial technologies for subsurface soil. There is no exposed surface soil at the site. All soil is covered by buildings or sidewalks.

4.1.1 Institutional Controls

Institutional controls would provide no action towards remediating soil contamination, but would include an environmental easement and a Site Management Plan (SMP) which may be used in conjunction with, or in the absence of, remedial measures. Institutional controls would:

- Require compliance with the approved SMP.

- Include requirements to complete and submit reports to the NYSDEC with certification of compliance with institutional controls/engineering controls. Specify procedures to manage potential exposure to residual contaminated soil, including procedures for soil characterization, soil excavation and handling, and the health and safety of workers and the community.

- Restrict the use of the property.
- Include requirements to sample, analyze and evaluate soil vapor in future on-site buildings or existing buildings that have been modified, and institute soil vapor intrusion mitigation, only if necessary, in accordance with NYSDOH guidance.
- Restrict groundwater use.

Effectiveness: Institutional controls such as an SMP and an environmental easement would not be effective by themselves in meeting the RAOs for protection of human health, nor for meeting the RAO for preventing migration of contaminants in soil into groundwater and other RAOs for the site. Institutional controls can be combined with other technologies in order to meet the RAOs.

Implementability: Institutional controls would not be difficult to implement.

Cost: The cost for institutional controls would be relatively low.

Conclusion: Institutional controls are retained for the development of alternatives for the Site.

4.1.2 Barriers

A low permeability cap and vertical subsurface barriers are potential technologies for the site.

4.1.2.1 Barriers/Soil Covers

A soil cover is a material cover such as a soil cover with demarcation layer or concrete slab that serves to provide a barrier against direct contact with contaminated soil. The existing concrete slab at the AWL Industries, Inc. property is a type of barrier.

Effectiveness: A soil cover would be effective in preventing direct contact with contaminated soil and would meet the RAOs for protection of human health. A soil cover would also reduce migration and provide some environmental protection.

Implementability: This technology is readily implementable.

Cost: The cost of soil covers is low since much of the existing site area structures are serving as a soil cover.

Conclusion: Soil cover is retained as a technology to prevent direct contact exposure.

4.1.3 Removal

4.1.3.1 Excavation and Disposal Off-Site

Soil would be removed from under the Former Klink Cosmo Cleaners building at 368 Richardson Street.

Effectiveness: Soil excavation is effective at removing contaminated source material.

Implementability: Soil excavation is not considered to be feasible at this site. It would require building demolition and extensive excavation protection measures to excavate to a depth of 34 feet in this urban area.

Cost: The costs of soil excavation and disposal would be high.

Conclusion: Soil excavation and disposal will not be retained for the development of alternatives for the Site.

4.1.3.2 Soil Vapor Extraction and Air Sparging

URS conducted a soil vapor extraction/ air sparge (SVE/AS) pilot test at the Klink Cosmo Cleaners site in November 2015. The results of the pilot test were published in the SVE/AS Pilot Study Report submitted by URS to the NYSDEC in March 2016. The results of the pilot study demonstrate that SVE is feasible and NYSDEC determined that it would be the best method for remediating contaminated soil and dissolved phase contaminated groundwater (AS) beneath the Former Klink Cosmo Cleaners building and will be completed as an IRM under a presumptive remedial approach. This technology is therefore retained and is included in all of the Alternatives evaluated in Section 5.0. The pilot study report provided design parameters for the SVE/AS system that are presented in Section 2.14.

Effectiveness: The effectiveness of this technology has been demonstrated in the pilot study. During the pilot test approximately 5 pounds of VOCs were removed in one day of system operation.

Implementability: The SVE/AS system is implementable at the under the Former Klink Cosmo building at 368 Richardson Street as demonstrated by the pilot test. A conceptual design, which includes well locations and construction details, has been provided in the pilot study report.

Cost: The cost for air sparging with soil vapor extraction would be moderate.

Conclusion: Treatment via SVE and air sparging will be retained for the development of alternatives for the Site. Because of the success of the pilot study at the Site, other treatment technologies (e.g. thermal treatment technologies such as electrical resistance heating [ERH]) will not be considered for the development of alternatives.

4.2 Identification of Technologies for Groundwater

This section identifies and provides a screening of remedial technologies for groundwater.

4.2.1 Institutional Controls

Institutional controls for groundwater would include the controls discussed in Section 4.1.1 and long-term monitoring. In the absence of active remedial measures, monitoring would be used to assess the degree to which natural processes were reducing contaminant concentrations in groundwater.

Natural processes which would be expected to occur include physical processes such as hydrodynamic dispersion and dilution by infiltration, and microbial degradation, which transforms the contaminants into typically less toxic daughter products and, ultimately, to carbon dioxide and water. Given sufficient time, a plume will stabilize after reaching a size where all of the mass delivered by the source is either diluted to a very low concentration or destroyed. Further, if the source is removed or isolated from the aquifer through remediation, natural processes will cause the remaining plume to collapse with time, as the contaminant mass residing within the plume is diluted and destroyed, assuming no new mass is introduced.

Groundwater on-site and in the vicinity of the site is not utilized for potable or other known purposes. ICs which maintain use restrictions regarding groundwater and a monitoring plan to assess future groundwater conditions would be in line with current practices and be protective of human health. Monitoring would consist of periodic sampling of select existing monitoring wells, and analysis for VOCs and natural attenuation indicator parameters (i.e., such as dissolved oxygen and oxidation reduction potential).

Effectiveness: Institutional controls such as an SMP and an environmental easement would be effective in meeting the RAOs to protect public health by preventing ingestion of groundwater with contaminant levels exceeding drinking water standards, and preventing contact with groundwater contaminated with VOCs during work-related activities for construction workers, employees, and residents, but would not be effective in meeting the RAOs to protect the environment by restoring the aquifer to pre-disposal/pre-release conditions or removing the source of groundwater contamination. Institutional controls alone would not prevent the migration of groundwater contamination.

Implementability: Institutional controls would not be difficult to implement considering that potable water is provided by the City of New York.

Cost: The cost for institutional controls would be relatively low.

Conclusion: Institutional Controls are retained for the development of alternatives for the Site.

4.2.2 Exposure Point Mitigation

Point of Entry Treatment (POET) systems are used in homes when residents use groundwater for their water supply. All residents in the remediation area are supplied with water from the municipality; therefore, these systems are unnecessary at the site. Exposure point mitigation is not retained for use in the development of alternatives for the Site.

4.2.3 Containment

4.2.3.1 Hydraulic Containment/Control

Groundwater containment technologies limit the migration of contaminated groundwater. Containment can be accomplished through physical isolation or hydraulic control. Primary physical containment technologies are the installation of sheet piling or slurry walls. These technologies are particularly effective on small source areas that have not migrated significantly. Hydraulic control utilizes pumping wells to reverse natural hydraulic gradients to prevent plume migration. Extracted groundwater would require treatment prior to discharge.

Effectiveness: Because the groundwater plume has migrated across several adjacent properties and because the plume is located in a highly populated urban area that would limit the locations and depths of barriers, physical containment would not be effective at this Site. Hydraulic control would be effective for preventing groundwater from migrating away from the source area.

Implementability: Physical containment of the groundwater plume would not be implementable at this Site because of the limitations imposed by structures and utilities in the area. Hydraulic control via groundwater extraction and subsequent treatment would be feasible to implement at this Site.

Cost: The cost of hydraulic control would be high because of the cost of long term pumping, maintenance, and monitoring required for the groundwater treatment system.

Conclusion: Hydraulic control via pumping wells is retained for the development of alternatives.

4.2.4 Removal

Groundwater contamination can removed by extracting groundwater or by volatilizing contamination in the groundwater and then capturing contaminated vapors. Some technologies may be suitable for treating groundwater near the source area but not the dissolve-phase plume as discussed below.

4.2.4.1 Groundwater Extraction

Extraction via pumping wells is the typical method for groundwater removal as a liquid. Collection trenches are also used for groundwater extraction, but are not feasible in this densely populated urban area. Collected groundwater would require treatment prior to discharge.

Effectiveness: Groundwater extraction would be effective at the Site because the soil is relatively permeable.

Implementability: Groundwater extraction through wells is technically implementable.

Cost: The cost of groundwater removal would be high because of the cost of long term pumping from multiple wells, maintenance, and monitoring required for the groundwater treatment system.

Conclusion: Groundwater extraction via pumping wells is retained for the development of alternatives.

4.2.4.2 Soil Vapor Extraction and Air Sparging

Soil vapor extraction and air sparging was discussed in Section 2.14. The pilot study conducted adjacent to the Former Klink Cosmo building demonstrated that it is a feasible and preferred method of remediating soil and groundwater under the building in the source area. However, soil vapor extraction and air sparging are not considered feasible for the off-site groundwater plume. This technology would not be practical in removing contamination in the dissolved phase plume due to the expanse of the plume and extreme difficulty in constructing and operating this technology in a densely populated urban area with numerous buildings and utilities. Therefore soil vapor extraction and air sparging is not retained for the development alternatives with respect to the groundwater plume.

4.2.4.3 Electrical Resistance Heating

ERH is a treatment method which uses the flow of electricity to heat soil and groundwater to vaporize contaminants. Electric current is passed through the soil between subsurface electrodes. The resistance to the electrical flow in the soil causes an increase in temperature until the boiling point of water is reached. The groundwater then forms steam, and the contaminants are volatilized. These volatilized contaminants are then captured and removed by a soil vapor extraction system.

Effectiveness: ERH would be effective in limited areas of source contamination, but not in the dissolved phase plume.

Implementability: ERH produces heat that could impact subsurface utilities or other infrastructure. It would be difficult to implement in a heavily populated urban area.

Cost: The cost of ERH is high.

Conclusion: ERH is not retained for the development of alternatives

4.2.5 Treatment

Treatment technologies destroy or alter contaminants, converting them to less toxic or non-toxic end products. Organic contaminants at the Site can be converted through oxidation or reduction processes.

4.2.5.1 Permanganate Injection

Permanganate is a reagent used for in-situ chemical oxidation (ISCO), which uses oxidants delivered into the saturated zone to oxidize the contaminants to non-toxic compounds such as water, carbon dioxide, and chloride ions. Permanganate is available in two forms, i.e. potassium permanganate or sodium permanganate.

Effectiveness: Permanganate injection is dependent upon aqueous phase contact between the delivered oxidant materials and the contaminant. Therefore, the ability to achieve adequate subsurface distribution closely determines the effectiveness of the approach.

Permanganate is preferred to the other ISCO reagents because it can be used over a wide range of pH values, does not require a catalyst, and is a long-lasting oxidant. It has the potential to remain active in the subsurface for months, allowing it to diffuse and otherwise travel into the lower permeability zones more effectively. It is especially applicable at inaccessible areas, such as for groundwater contamination present beneath buildings.

Permanganate effectiveness is greatly impacted by the presence of oxidizable materials present in the subsurface that are not contaminants. These materials exert what is termed a natural oxidant demand (NOD). The NOD reacts with and consumes permanganate that can slow the rate of remediation. The NOD has been measured in soil samples collected at the site, and the results show that the NOD is relatively low. This is a favorable condition for remediation using permanganate.

Implementability: The location of wells will be limited because the remediation area is located in an urban area. Potassium permanganate is delivered to the site as a solid and must be mixed at the site prior to injection. In addition, the quantity of potassium present on the site is limited by Homeland Security regulations making it more difficult to coordinate and implement potassium permanganate injections. Sodium permanganate is delivered in liquid form which can be directly injected into groundwater and is not restricted by Homeland Security regulations. The injection of sodium permanganate would be easier to implement than potassium permanganate.

Cost: The costs for permanganate injection are moderate to high depending on the number of injections required to achieve acceptable results.

Conclusion: Sodium permanganate injection is retained for the development of alternatives.

4.2.5.2 EHC Injection

EHC® is a reagent used for in-situ chemical reduction (ISCR). In-situ chemical reduction (ISCR) works by supplying an excess of hydrogen atoms to substitute for each chlorine atom on the contaminant molecules, thus sequentially dechlorinating the molecules. The chlorinated compounds are converted through a series of daughter products until they are finally converted to ethene and ethane.

EHC is composed of controlled release carbon and zero valent iron (ZVI). Consequently, EHC stimulates both biotic reductive dechlorination via the carbon source and abiotic reductive dechlorination via ZVI.

Effectiveness: Under reducing conditions, PCE breaks down into its daughter products, TCE, DCE and vinyl chloride. These daughter products have been detected infrequently in groundwater indicating that little reductive dechlorination is occurring at the site. EHC injection would promote reductive dechlorination and should be effective for groundwater remediation.

Implementability: The location of injection points will be limited because the remediation area is located in a densely populated urban area.

Cost: The costs of EHC injections are expected to be moderate to high depending on the number of injections required for remediation.

Conclusion: EHC injections are retained for the development of alternatives.

4.2.5.3 Ozone and Hydrogen Peroxide Injection

Hydrogen peroxide can be circulated through the contaminated groundwater zone to increase oxygen levels. Though hydrogen peroxide has the potential of providing some of the highest levels of available oxygen to contaminated groundwater, it is toxic to microbes at high concentrations. Hydrogen peroxide also decomposes quickly to oxygen, which limits the extent to which it can be distributed in the subsurface.

Ozone can be injected into the subsurface in a dissolved or gaseous phase. Ozone is a strong oxidant, with an oxidation potential greater than that of hydrogen peroxide. Because of its oxidizing potential, ozone can be toxic to microbes and can actually suppress subsurface biological activity. However, this is generally temporary, and a sufficient number of bacteria can survive and resume biodegradation after ozone has been applied.

Effectiveness: Hydrogen peroxide and ozone injections are dependent upon aqueous phase contact between the delivered oxidant materials and the contaminant. Therefore, the ability to achieve adequate subsurface distribution closely determines the effectiveness of the approach. Due to the quick decomposition of these reagents, and the relatively low permeability of the soil, hydrogen peroxide and ozone would not be expected to be effective at the Site.

Implementability: The location of injection points will be limited because the remediation area is located in an urban area. Hydrogen peroxide and ozone are very strong oxidants and would require heightened safety precautions during implementation.

Cost: The costs of hydrogen peroxide and ozone injections are expected to moderate to high depending on the number of injections required.

Conclusion: Treatment via ozone and hydrogen peroxide injection is not retained for the development of alternatives.

4.2.5.4 Permeable Reactive Barrier

Permeable reactive barriers (PRBs) are barriers constructed in the subsurface used to intercept and treat contaminated groundwater. The most common PRB construction used ZVI to promote reductive dechlorination of chlorinated contaminants.

Effectiveness: The PRB can effectively treat and destroy chlorinated contaminants in groundwater.

Implementability: The construction of a PRB in a densely populated urban area is not feasible.

Cost: The cost of a PRB would be high.

Conclusion: The PRB will not be retained for the development of alternatives.

4.3 Identification of Technologies for Soil Vapor

4.3.1 Institutional Controls

The institutional controls for soil vapor area would be as described in Section 4.1.1. The effectiveness, implementability and cost would be similar to that described in Section 4.2.1. The SMP would include measures to sample, analyze and evaluate soil vapor in future on-site buildings or existing buildings that have been modified, and institute soil vapor intrusion mitigation, only if necessary, in accordance with NYSDOH guidance. Institutional controls alone would not be protective of human health for soil vapor, but are retained for the development of alternatives for the Site.

4.3.2 Exposure Point Mitigation

4.3.2.1 SSD Systems

Sub-slab depressurization systems (SSD systems) consist of the installation of a fan and pipes to collect air from beneath a building floor. The fan creates a vacuum beneath the slab, which prevents volatilized contaminants in soil from penetrating up into the building itself. The air collected by the fan is vented outdoors.

Effectiveness: SSD systems are very effective at preventing soil vapor intrusion into buildings.

Implementability: Temporary access to buildings is required to install SSD systems. However, access would only be needed for a relatively short time (e.g., a matter of days). Therefore, there should be little interruption of business activities or inconvenience for residents and businesses.

Cost: The cost of SSD systems would be low to moderate.

Conclusion: SSD systems are retained for the development of alternatives for the Site.

4.3.3 Removal

4.3.3.1 SVE/AS

Soil vapor extraction and air sparging was discussed in Sections 4.1.2.2 and 4.2.4.2. The pilot study conducted at the Former Klink Cosmo building demonstrated that it is a feasible and preferred method of remediating soil and groundwater in the source area and would prevent soil vapors from entering the Former Klink Cosmo building. However, soil vapor extraction and air sparging are not considered feasible throughout the rest of the groundwater plume where contamination is at significantly lower levels. These systems would be extremely difficult to construct and operate in this densely populated urban area with numerous building and utilities. Therefore soil vapor extraction and air sparging is not retained for the development alternatives with respect to soil vapor.

4.4 Summary of Remedial Technologies

Remedial technologies retained for use in the development of alternatives include the following:

Soil (under Former Klink Cosmo building)

- Institutional Controls and Monitoring with an SMP

- Barrier/Soil Cover
- Soil Vapor Extraction and Air Sparging

Groundwater

- Institutional Controls and Monitoring with an SMP
- Hydraulic Containment
- Hydraulic Extraction
- Permanganate Injection
- EHC Injection

Soil Vapor

- Institutional Controls with SMP
- SSD Systems

5 DEVELOPMENT AND DESCRIPTION OF ALTERNATIVES

This section combines the remedial technologies considered feasible for each media into a list of remedial alternatives that best meet the remedial goal and RAOs for the site as a whole. The alternatives are described in this section with regards to: size and configuration, time for remediation, spatial requirements, options for disposal, permitting requirements, limitations, and ecological impacts in accordance with DER-10.

5.1 Development of Alternatives

Alternatives have been developed to address the general response actions identified for the site including: no action, institutional controls, exposure point mitigation, containment, removal and treatment. The No Action alternative serves as a baseline of comparison. Remedial alternatives other than No Action include combinations of remedial technologies for soil, groundwater and soil vapor.

An Environmental Easement (EE) with an SMP are basic requirements for all alternatives. A soil cover, installation of SSD systems as needed, and an SVE/AS system in the source area under the Former Klink Cosmo building are considered basic components of all alternatives except No Action.

There are four feasible technologies for remediation of groundwater, i.e. hydraulic containment, permanganate injection, hydraulic extraction, and EHC injection. Each of these technologies was used to develop an alternative for site remediation.

A summary of the remedial alternatives including their components is presented in Table 5-1.

Based on the technologies considered feasible for remediation listed in Section 4.4 and the discussion above, five alternatives have been developed for the Site as follows:

Alternative 1 – No Action, Institutional Controls with Site Management

Alternative 2 – IRM SVE/AS, Soil Cover, SSDS, Institutional Controls with Site Management

Alternative 3 – IRM SVE/AS, Permanganate Injection, Soil Cover, SSDS, Institutional Controls with Site Management

Alternative 4 – IRM SVE/AS, EHC Injection, Soil Cover, SSDS, Institutional Controls with Site Management

Alternative 5 – IRM SVE/AS, Permanganate Injection, Hydraulic Containment/Removal, Soil Cover, SSDS, Institutional Controls with Site Management

5.2 Description of Alternatives

Alternatives are described in accordance with DER-10, with regard to: size and configuration, time for remediation, spatial requirements, options for disposal, permitting requirements, limitations, and ecological impacts.

5.2.1 Alternative 1 – No Action, Institutional Controls with Site Management

Under this alternative, contaminants present in soil, groundwater and soil vapor would attenuate over time by natural processes; however, given the relatively high levels of PCE, TCE, and their degradation products, the RAOs for soil, groundwater and soil vapor would not be met for an extensive period of time.

Size and Configuration

- No active remedial construction would take place. ICs in the form of an EE and companion SMP would be components of the remedial alternative. An SMP would be developed to include institutional controls to manage residual contaminated media and potential worker or community exposures to contaminated media; evaluate potential vapor intrusion as required per NYSDOH guidance; and maintain use restrictions regarding site development and groundwater use.

Time for Remediation

- No active remedial measures are included.

Spatial Requirements

- There are no spatial requirements.

Options for Disposal

- There are no materials requiring disposal other than those associated with the SMP. Because an SMP is required in each alternative, the costs associated with the monitoring sampling, etc. will be the same and not have any effect on the cost comparative analysis.

Permit Requirements

- No permits would be required for this alternative.

Limitations

- This alternative does not meet SCGs for soil, groundwater or soil vapor or provide protection to potentially exposed receptors.

Ecological Impacts

- This alternative is not anticipated to have any negative impacts on fish and wildlife resources.

5.2.2 Alternative 2 - IRM SVE/AS, Soil Cover, SSDS, Institutional Controls with Site Management

Alternative 2 would include an SMP specifying required institutional controls for the Site, SSD systems installed at any locations determined not to be compliant with NYSDOH guidelines based on air sampling, and installation of an SVE/AS system to remediate the source area underneath the Former Klink Cosmo building, and maintain the existing concrete slab which serves as a soil cover. A conceptual layout of this alternative is presented on Figure 5-1.

Size and Configuration

- An SMP would be developed to include institutional and engineering controls to manage residual contaminated media and potential worker or community exposures to contaminated media; evaluate potential vapor intrusion as required per NYSDOH guidance; and maintain use restrictions regarding site development and groundwater use.
- SSD systems would be installed wherever sampling showed air quality was not in compliance with NYSDOH guidelines.
- Five additional air sparge wells would be constructed. These wells along with three existing wells would be used to introduce compressed air into groundwater below the Former Klink Cosmo building to remove VOCs.
- Four additional soil vapor extraction wells will be constructed. These wells along with two existing wells would be used to capture VOCs volatilized by air sparging into the groundwater beneath the Former Klink Cosmo building.
- The existing concrete slab will be maintained and serve as the soil cover to prevent direct contact with contaminated soil.

- Annual sampling and analysis for VOCs, as well as routine water quality indicator parameters, would be performed in approximately 40 selected existing groundwater monitoring wells.

- An annual report and Five-Year review would evaluate site conditions, OM&M activities and recommend any changes necessary to the OM&M program.

Time for Remediation

- For the purposes of this report, a 30-year period is assumed for monitoring and a 5-year period for source removal by the SVE/AS system.

- Construction would require less than one year.

Spatial Requirements

- Space is very limited in this densely populated urban area.
- Based on the conceptual design presented in the pilot study report there is adequate space to construct air sparge and SVE wells. It will be more difficult to find space for the air sparging and SVE equipment. The equipment will have to be located outside of the building.

Options for Disposal

- Well drill cuttings will have to be disposed of off-site.

Permit Requirements

- An air permit will not be required for the SVE/AS system. However, the system discharge to the atmosphere will be required to meet the substantive requirements of NYSDEC air emissions regulations, including air emissions control equipment, if necessary.

Limitations

- This alternative does not address immediately address the contamination in the off-site groundwater plume.

Ecological Impacts

- This alternative is not anticipated to have any negative impacts on fish and wildlife resources.

5.2.3 Alternative 3 – IRM SVE/AS, Permanganate Injection, Soil Cover, SSDS, Institutional Controls with Site Management

Alternative 3 would include an SMP specifying required institutional controls for the Site, SSD systems installed at any locations determined not to be compliant with NYSDOH guidelines based on air sampling, installation of an SVE/AS system to remediate the source area underneath the Former Klink Cosmo building and permanganate injection to address dissolved phase groundwater contamination, and maintain the existing concrete slab which serves as a soil cover. A conceptual layout of this alternative is presented on Figure 5-2.

Size and Configuration

- An SMP would be developed to include institutional and engineering controls to manage residual contaminated media and potential on-site worker or community exposures to contaminated media; evaluate potential vapor intrusion as required per NYSDOH guidance; and maintain use restrictions regarding site development and groundwater use.

- SSD systems would be installed wherever sampling showed air quality was not in compliance with NYSDOH guidelines.

- Five additional air sparge wells would be constructed. These wells along with three existing wells would be used to introduce compressed air into groundwater below the Former Klink Cosmo building to remove VOCs.

- Four additional soil vapor extraction wells will be constructed. These wells along with two existing wells would be used to capture VOCs volatilized by air sparging into the groundwater beneath the Former Klink Cosmo building.

- Conceptually, ten sodium permanganate injection well pairs (one shallow and one deep well at each location – five pairs in ‘source perimeter’ area), and 16 shallow sodium permanganate injection wells and four deep sodium permanganate injection wells would be installed as shown on Figure 5-2 (‘Division east’ area). These wells were established in two linear arrays including: 1) ‘source perimeter’ which are situated along the north side of Richardson Street and west side of Vandervoort Avenue opposite the Former Klink Cosmo Site building source area; 2) ‘Division east’ which are situated along the east side of Vandervoort Avenue south of Division Street and along the south side of Division Street east of Vandervoort Avenue. The injection well arrays are positioned to treat the dissolved phase contaminated zones downgradient of the former Klink Cosmo source area. The groundwater injection treatment areas are positioned upgradient of the nearest residential and commercial properties.

- An estimated 115,000 gallons of a 5% sodium permanganate solution would be injected into groundwater (Appendix B). It is assumed that the 115,000 gallons of sodium permanganate solution would be injected quarterly in four separate events of approximately 29,000 gallons per event.

- The existing concrete slab will be maintained and serve as the soil cover to prevent direct contact with contaminated soil.

- Quarterly sampling and analysis for VOCs for 2 years and annually thereafter as well as routine water quality indicator parameters, would be performed in approximately 40 selected existing groundwater monitoring wells.

- An annual report and Five-Year review would evaluate site conditions, OM&M activities and provide recommendations for any changes necessary to the OM&M program.

Time for Remediation

- For the purposes of this report, a 30-year period is assumed for monitoring and a 5-year period for source removal by the SVE/AS system.

- It is estimated that construction (including permanganate injections) would require a period of 1 to 2 years.

Spatial Requirements

- Space is very limited in this densely populated urban area.

- Based on the conceptual design presented in the pilot study report there is adequate space to construct air sparge and SVE wells. It will be more difficult to find space for the air sparging and SVE equipment. The equipment will have to be located outside of the building.

Options for Disposal

- Well drill cuttings will have to be disposed of off-site.

Permit Requirements

- An air permit will not be required for the SVE/AS system. However, the system discharge to the atmosphere will be required to meet the substantive requirements of NYSDEC air emissions regulations, including air emissions control equipment, if necessary.

- Injection may require submission of an Inventory of Injection Wells Form 7520-16 as part of the Underground Injection Control (UIC) program operated by the United States Environmental Protection Agency (USEPA). Injection wells incidental to aquifer remediation and experimental technologies are distinguished from hazardous waste injection wells and are designated as Class V under the Underground Injection Control (UIC) program. Class V wells covered by the Federal UIC program are authorized by rule and do not require a separate UIC permit.

Limitations

- Injection wells can only be placed in accessible areas such as sidewalks within the plume; thereby, potentially limiting the effectiveness of the injection wells.

Ecological Impacts

- This alternative is not anticipated to have any negative impacts on fish and wildlife resources.

5.2.4 Alternative 4 – IRM SVE/AS, EHC Injection, Soil Cover, SSDS, Institutional Controls with Site Management

Alternative 4 is similar to Alternative 3 except off-site groundwater would be treated with EHC. Alternative 4 would include an SMP specifying required institutional controls for the Site, SSD systems installed at any locations determined not to be compliant with NYSDOH guidelines based on air sampling, installation of an SVE/AS system to remediate the source area underneath the Former Klink Cosmo building, soil cover, and EHC injection to address dissolved phase groundwater contamination. A conceptual layout of this alternative is presented on Figure 5-3.

Size and Configuration

- An SMP would be developed to include institutional and engineering controls to manage residual contaminated media and potential on-site worker or community exposures to contaminated media; evaluate potential vapor intrusion as required per NYSDOH guidance; and maintain use restrictions regarding site development and groundwater use.

- SSD systems would be installed wherever sampling showed air quality was not in compliance with NYSDOH guidelines.

- Five additional air sparge wells would be constructed. These wells along with three existing wells would be used to introduce compressed air into groundwater below the Former Klink Cosmo building to remove VOCs.

- Four additional soil vapor extraction wells will be constructed. These wells along with two existing wells would be used to capture VOCs volatilized by air sparging into the groundwater beneath the Former Klink Cosmo building.

- Conceptually, ten injection well pairs (one shallow and one deep well at each location – five pairs each in ‘source perimeter’ area), and 16 shallow injection wells and four deep injection wells would be installed as shown on Figure 5-2 (‘Division east’ area). These wells were established in two linear arrays including: 1) ‘source perimeter’ which are situated along the north side of Richardson Street and west side of Vandervoort Avenue opposite the Former Klink Cosmo Site building source area; 2) ‘Division east’ which are situated along the east side of Vandervoort Avenue south of Division Street and along the south side of Division Street east of Vandervoort Avenue. The injection well arrays are positioned to treat the dissolved phase contaminated zones downgradient of the former Klink Cosmo source area. The groundwater injection treatment areas are positioned upgradient of the nearest residential and commercial properties.

- An estimated 150,000 gallons of 12.3% EHC solution would be injected into groundwater. It is assumed that the 150,000 gallons of EHC solution would be injected in four separate events of 37,500 gallons per event (Appendix C).

- The existing concrete slab will be maintained and serve as the soil cover to prevent direct contact with contaminated soil.

- Quarterly sampling and analysis for VOCs for 2 years and annually thereafter as well as routine water quality indicator parameters, would be performed in approximately 40 selected existing groundwater monitoring wells.

- An annual report and Five-Year review would evaluate site conditions, OM&M activities and provide recommendations for any changes necessary to the OM&M program.

Time for Remediation

- For the purposes of this report, a 30-year period is assumed for monitoring and a 5-year period for source removal by the SVE/AS system.

- It is estimated that construction (including EHC injections) would require a period of 1 to 2 years.

Spatial Requirements

- Space is very limited in this densely populated urban area.

- Based on the conceptual design presented in the pilot study report there is adequate space to construct air sparge and SVE wells. It will be more difficult to find space for the air sparging and SVE equipment. The equipment will have to be located outside of the building.

Permit Requirements

- An air permit will not be required for the SVE/AS system. However, the system discharge will be required to meet the substantive requirements of NYSDEC air emissions regulations, including air emissions control equipment, if necessary.

- Injection may require submission of an Inventory of Injection Wells Form 7520-16 as part of the Underground Injection Control (UIC) program operated by the United States Environmental Protection Agency (USEPA). Injection wells incidental to aquifer remediation and experimental technologies are distinguished from hazardous waste injection wells and are designated as Class V under the Underground Injection Control (UIC) program. Class V wells covered by the Federal UIC program are authorized by rule and do not require a separate UIC permit.

Limitations

- Injection wells can only be placed in accessible areas such as sidewalks within the plume; thereby, potentially limiting the effectiveness of the injection wells.

Ecological Impacts

- This alternative is not anticipated to have any negative impacts on fish and wildlife resources.

5.2.5 Alternative 5 – IRM SVE/AS, Permanganate Injection, Hydraulic Containment/Removal, Soil Cover, SSDS, Institutional Controls with Site Management

Alternative 5 would include an SMP specifying required institutional controls for the Site, SSD systems installed at any locations determined not to be compliant with NYSDOH guidelines based on air sampling, installation of an SVE/AS system to remediate the source area underneath the Former Klink Cosmo building, sodium permanganate injection to address off-site dissolved phase groundwater contamination, maintain the existing concrete slab which serves as a soil cover, and hydraulic containment to prevent further contaminant migration in groundwater. A conceptual layout of this alternative is presented on Figure 5-4.

Size and Configuration

- An SMP would be developed to include institutional and engineering controls to manage residual contaminated media and potential on-site worker or community exposures to contaminated media; evaluate potential vapor intrusion as required per NYSDOH guidance; and maintain use restrictions regarding site development and groundwater use.

- SSD systems would be installed wherever sampling showed air quality was not in compliance with NYSDOH guidelines.

- Five additional air sparge wells would be constructed. These wells along with three existing wells would be used to introduce compressed air into groundwater below the Former Klink Cosmo building to remove VOCs.

- Four additional soil vapor extraction wells will be constructed. These wells along with two existing wells would be used to capture VOCs volatilized by air sparging into the groundwater beneath the Former Klink Cosmo building.

- Conceptually, ten sodium permanganate injection well pairs (one shallow and one deep well at each location – five pairs in 'source perimeter' area), and 16 shallow sodium permanganate injection wells and four deep sodium permanganate injection wells would be installed as shown on Figure 5-2 ('Division east' area). These wells were established in two linear arrays including: 1) 'source perimeter' which are situated along the north side of Richardson Street and west side of Vandervoort Avenue opposite the Former Klink Cosmo Site building source area; 2) 'Division east' which are situated along the east side of Vandervoort Avenue south of Division Street and along the south side of Division Street east of Vandervoort Avenue. The injection well arrays are positioned to treat the dissolved phase contaminated zones downgradient of the former Klink Cosmo source area. The groundwater injection treatment areas are positioned upgradient of the nearest residential and commercial properties.

- An estimated 115,000 gallons of a 5% sodium permanganate solution would be injected into groundwater (Appendix B). It is assumed that the 115,000 gallons of sodium permanganate solution would be injected quarterly in four separate events of approximately 29,000 gallons per event.

- The existing concrete slab will be maintained and serve as the soil cover to prevent direct contact with contaminated soil.

- Conceptually, three extraction wells would be installed at the locations shown on Figure 5-4. Hydraulic extraction wells would be situated along the south side of Richardson Street and west side of Vandervoort Avenue near the northeast corner of the Former Klink Cosmo building, and along the north side of Richardson Street opposite from the northeast corner of the Former Klink Cosmo building. It is assumed that the property located in the southeast corner of Vandervoort Avenue and Richardson Street would be acquired by NYSDEC to allow for construction of a structure for the pump and treatment of groundwater.

- An approximately 30 gallon per minute treatment system would be installed to treat groundwater before discharging to the sanitary sewer.

- Quarterly sampling and analysis for VOCs for 2 years and annually thereafter as well as routine water quality indicator parameters, would be performed in approximately 40 selected existing groundwater monitoring wells.

- An annual report and Five-Year review would evaluate site conditions, OM&M activities and provide recommendations for any changes necessary to the OM&M program.

Time for Remediation

- For the purposes of this report, a 30-year period is assumed for groundwater extraction and treatment and monitoring and a 5-year period for source removal by the SVE/AS system.
- It is estimated that construction (including permanganate injections) would require a period of 1 to 2 years.

Spatial Requirements

- Space is very limited in this densely populated urban area.
- Based on the conceptual design presented in the pilot study report there is adequate space to construct air sparge and SVE wells adjacent to the building. It will be more difficult to find space for the air sparging and SVE equipment. The equipment will have to be located outside of the building.
- It will difficult to find space for groundwater treatment equipment in this area. It is assumed that the property located at the southwest corner of the intersection of Vandervoort Avenue and Richardson Street would be acquired to house the treatment building.

Options for Disposal

- Well drill cuttings will have to be disposed of off-site.
- Filter socks from the water treatment system will need to be disposed of off-site.
- Spent carbon from the water treatment system will have to be disposed of off-site.

Permit Requirements

- An air permit will not be required for the SVE/AS system. However, the system discharge to the atmosphere will be required to meet the substantive requirements of NYSDEC air emissions regulations, including air emissions control equipment, if necessary.
- Injection may require submission of an Inventory of Injection Wells Form 7520-16 as part of the Underground Injection Control (UIC) program operated by the United States Environmental Protection Agency (USEPA). Injection wells incidental to aquifer

remediation and experimental technologies are distinguished from hazardous waste injection wells and are designated as Class V under the Underground Injection Control (UIC) program. Class V wells covered by the Federal UIC program are authorized by rule and do not require a separate UIC permit.

- A permit will be required for the groundwater treatment system discharge to the sanitary sewer.

Limitations

- Injection wells can only be placed in accessible areas such as sidewalks within the plume; thereby, potentially limiting the effectiveness of the injection wells.
- Extraction wells can only be placed in accessible areas such as sidewalks within the plume; thereby, potentially limiting the effectiveness of the extraction wells.
- Groundwater extraction and treatment will be required for a long period of time which will require extensive maintenance and repair activities that will increase over time.

Ecological Impacts

- This alternative is not anticipated to have any negative impacts on fish and wildlife resources.

6 DETAILED ANALYSIS OF ALTERNATIVES AND RECOMMENDED REMEDY

6.1 Description of Evaluation Criteria

Each of the alternatives is subjected to a detailed evaluation with respect to the criteria outlined in 6 NYCRR Part 375. A description of each of the evaluation criteria is provided below. This evaluation aids in the selection process for remedial actions in New York State.

Overall Protection of Public Health and the Environment

This criterion is an assessment of whether the alternative meets requirements that are protective of human health and the environment. The overall assessment is based on a composite of factors assessed under other evaluation criteria, particularly long-term effectiveness and permanence, short-term effectiveness, and compliance with SCGs. This evaluation focuses on how a specific alternative achieves protection over time and how site risks are reduced. The analysis includes how the source of contamination is to be eliminated, reduced, or controlled.

Compliance with Standards, Criteria, and Guidance

This criterion determines whether or not each alternative and the proposed remedial technologies comply with applicable environmental laws and SCGs pertaining to the chemicals detected in contaminated media and the location of the Site.

Long-term Effectiveness and Permanence

This criterion addresses the performance of a remedial action in terms of its permanence and the quantity/nature of waste or residuals remaining at the Site after implementation. An evaluation is made on the extent and effectiveness of controls required to manage residuals remaining at the Site and the operation and maintenance systems necessary for the remedy to remain effective. The factors that are evaluated include permanence of the remedial alternative, magnitude of the remaining risk, adequacy and reliability of controls used to manage residual contamination.

Reduction of Toxicity, Mobility or Volume with Treatment

This criterion assesses the remedial alternative's use of technologies that permanently and significantly reduce toxicity, mobility, or volume (TMV) of the contamination as their principal element. Preference is given to remedies that permanently and significantly reduce the toxicity, mobility, or volume of the contaminants at the Site.

Short-term Effectiveness

This criterion assesses the effects of the alternative during the construction and implementation phase with respect to the effect on human health and the environment. The factors that are assessed include protection of the workers and the community during remedial activities, environmental impacts that result from remediation, and the time required until the remedial action objectives are achieved. In addition, sustainability and green remediation concepts and techniques per DER-31 Green Remediation (NYSDEC, January 2011) are discussed.

Implementability

This criterion addresses the technical and administrative feasibility of implementing the alternative and the availability of various services and materials required during implementation. The evaluation includes the feasibility of construction and operation, the reliability of the technology, the ease of undertaking additional remedial action, monitoring considerations, activities needed to coordinate with regulatory agencies, availability of adequate equipment, services and materials, offsite treatment, and storage and disposal services.

Land Use

This criterion addresses the current, intended, and reasonably anticipated future land use of the Site and surroundings. The current and continued use of the Site is as an active laundromat, with storage in the basement. The second floor is apartments. Commercial properties, many with residences on the upper floors, are located along Astoria Blvd. Residential properties are located on the side streets.

Cost

Capital costs and operation, maintenance, and monitoring costs (OM&M) are estimated for each alternative and presented as present worth using a 5% discount rate for duration of future activities.

Community and State Acceptance

Concerns of the State and the Community will be addressed separately in accordance with the public participation program developed for this site.

6.2 Alternative 1 – No Action, Institutional Controls with Site Management

Under this alternative, contaminated soil and groundwater would remain onsite above SCGs. Soil vapor and the presence of indoor air contaminants would continue. No construction would be required.

6.2.1 Overall Protection of Public Health and the Environment

While there is some protection through the EE and SMP, this alternative is not protective of public health and the environment and does not meet the RAOs.

6.2.2 Compliance with SCGs

This alternative does not meet the soil, groundwater, or soil vapor intrusion SCGs.

6.2.3 Long-Term Effectiveness and Permanence

This alternative is not effective in the long term.

6.2.4 Reduction of Toxicity, Mobility and Volume with Treatment

Natural processes, which are currently active in groundwater, would continue to reduce contaminant levels. However, the existing natural processes would not destroy the majority of the contamination within the foreseeable future.

6.2.5 Short-Term Effectiveness

As there is no construction associated with this alternative, there would be no short-term impacts to workers or the community.

6.2.6 Implementability

This alternative would be difficult to implement due to administrative issues, especially State and local approvals. The RAOs would not be met and soil and groundwater contamination would remain above SCGs.

6.2.7 Land Use

This alternative would not be protective for continued Site use.

6.2.8 Cost

Estimated capital and OM&M costs for Alternative 1 are presented on Table 6-1. The capital cost is $40,600, present worth of OM&M costs is $488,846, and the total capital with annual present worth cost of Alternative 1 is $557,000.

6.3 Alternative 2 - IRM SVE/AS, Soil Cover, SSDS, Institutional Controls with Site Management

6.3.1 Overall Protection of Public Health and the Environment

Active remedial measures and institutional controls included in this alternative would meet RAOs for soil and soil vapor, but not groundwater. SVE/AS will eliminate the source of contamination, but the groundwater plume would not be actively remediated and groundwater contamination would only be reduced slowly over time by natural attenuation. Potential human exposure or environmental impacts would be addressed by SSD systems and institutional controls.

6.3.2 Compliance with SCGs

SCGs for soil would be met for soil under the Former Klink Cosmo building. Groundwater quality would be greatly improved; however, groundwater SCGs would probably not be achieved in the dissolved phase groundwater plume for a number of years after remediation by natural attenuation. SCGs for soil vapor intrusion would be met through the operation of a SSDS to mitigate any potential soil vapor exposure.

6.3.3 Long-Term Effectiveness and Permanence

This alternative addresses the major source of contamination at the site, i.e. soil under the Former Klink Cosmo building, through SVE/AS. Institutional and engineering controls would adequately address the remaining residual contamination at the site. However, this alternative does not address RAOs with regard to environmental protection to restore the groundwater aquifer and prevent migration of contamination.

6.3.4 Reduction of Toxicity, Mobility and Volume with Treatment

SVE/AS would greatly reduce the volume of contamination at the site, mainly in the source area.

6.3.5 Short-Term Effectiveness

Short term risks to workers and the public are possible during well installation. These risks could be controlled by implementing proper health and safety measures, e.g. by performing air monitoring and using PPE as required. Construction would be completed in less than one year. This alternative complies with DER-31Green Remediation in that it aggressively remediates the source to reduce long term OM&M associated with groundwater remediation.

6.3.6 Implementability

The proposed remedial technologies are commonly used for remediation and are readily available from many vendors. The conceptual layout for the SVE/AS system shows that well installation is feasible in the area of the building. Location of equipment is somewhat more problematic and will require coordination with building owners and the City.

6.3.7 Land Use

The site is expected to remain zoned as M3-1, a multi-unit residential and commercial area for the foreseeable future. Alternative 2 will restrict land use to commercial through deed restrictions. In addition, land use in the area of the SVE/AS wells would be temporarily limited.

6.3.8 Cost

Estimated capital and OM&M costs for Alternative 2 are presented on Table 6-1. The capital cost is $682,236, present worth of OM&M costs is $614,593, and the total capital with annual present worth cost of Alternative 2 is $2,063,000.

6.4 Alternative 3 - IRM SVE/AS, Permanganate Injection, Soil Cover, SSDS, Institutional Controls with Site Management

6.4.1 Overall Protection of Public Health and the Environment

Active remedial measures and institutional controls included in this alternative would meet most RAOs for the Site. SVE/AS will eliminate the source of contamination. Potential human exposure or environmental impacts would be addressed by SSD systems, in-situ groundwater treatment and institutional controls.

6.4.2 Compliance with SCGs

SCGs for soil would be met at the source, i.e. at 368 Richardson Street. Groundwater quality would be greatly improved; however, groundwater SCGs would probably not be achieved for a number of years after the completion of injections. Contaminant concentrations would continue to decrease after the injections. SCGs for soil vapor intrusion would be met through the operation of a SSD system to mitigate any potential soil vapor exposure.

6.4.3 Long-Term Effectiveness and Permanence

This alternative addresses the major source of contamination at the site, i.e. the soil source area under the building at 368 Richardson Street. Permanganate injections would greatly reduce groundwater contamination. Deed restrictions and engineering controls would adequately address the remaining residual contamination at the site.

6.4.4 Reduction of Toxicity, Mobility and Volume with Treatment

Alternative 3 includes removal of soil and groundwater contamination under the building at 368 Richardson Street and in-situ treatment the dissolved phase plume. These remedial components combined would greatly reduce the volume of contamination at the Site.

6.4.5 Short-Term Effectiveness

Air emissions would be a concern during well installation for the SVE/AS system and for permanganate injection. Air monitoring would be required to protect workers and the public. It is estimated that construction (including permanganate injections) would require a period of 1 to 2 years.

6.4.6 Implementability

The technologies employed for remediation are conventional technologies for addressing the types of contamination at the site. Considerable coordination with the City for installation of injection points and with business owners and residents for installation of SVE/AS and SSD systems would be required.

6.4.7 Land Use

The site is expected to remain a multi-unit residential and commercial area for the foreseeable future. Alternative 3 will restrict land use to commercial through deed restrictions. In addition, land use in the area of the injection points would be temporarily limited.

6.4.8 Cost

Estimated capital and OM&M costs for Alternative 3 are presented on Table 6-1. The capital cost is $2,142,981, present worth of OM&M costs is $614,593, and the total capital with annual present worth cost of Alternative 3 is $4,512,000.

6.5 Alternative 4 - IRM SVE/AS, EHC Injection, Soil Cover, SSDS, Institutional Controls with Site Management

6.5.1 Overall Protection of Human Health and the Environment

Active remedial measures and institutional controls included in this alternative would meet most RAOs for the Site. SVE/AS will eliminate the source of contamination. Potential human exposure or environmental impacts would be addressed by SSD systems, in-situ groundwater treatment and institutional controls.

6.5.2 Compliance with SCGs

SCGs for soil would be met at the source, i.e. at 368 Richardson Street. Groundwater quality would be greatly improved; however, groundwater SCGs would probably not be achieved for a number of years after the completion of injections. Contaminant concentrations would continue to decrease after the injections. SCGs for soil vapor intrusion would be met through the operation of a SSD system to mitigate any potential soil vapor exposure.

6.5.3 Long-Term Effectiveness

This alternative addresses the major source of contamination at the site, i.e. the soil source area under the building at 368 Richardson Street. EHC injections would greatly reduce groundwater contamination in the dissolved phase plume. Deed restrictions and engineering controls would adequately address the remaining residual contamination at the site.

6.5.4 Reduction of Toxicity, Mobility and Volume with Treatment

Alternative 4 includes removal of soil and groundwater contamination under the building at 368 Richardson Street and in-situ treatment of the dissolved phase plume. These remedial components combined would greatly reduce the volume of contamination at the Site.

6.5.5 Short-Term Effectiveness

Air emissions would be a concern during well installation for the SVE/AS system and for EHC injection. Air monitoring would be required to protect workers and the public. It is estimated that construction (including EHC injections) would require a period of 1 to 2 years.

6.5.6 Implementability

The technologies employed for remediation are conventional technologies for addressing the types of contamination at the site. Considerable coordination with the City for installation of injection points and with business owners and residents for installation of SVE/AS and SSD systems would be required.

6.5.7 Land Use

The site is expected to remain zoned as M3-1, a multi-unit residential and commercial area for the foreseeable future. Alternative 4 will restrict land use to commercial through deed restrictions. In addition, land use in the area of the injection points would be temporarily limited.

6.5.8 Cost

Estimated capital and OM&M costs for Alternative 4 are presented on Table 6-1. The capital cost is $2,215,517, present worth of OM&M costs is $614,593, and the total capital with annual present worth cost of Alternative 4 is $4,634,000.

6.6 Alternative 5 - IRM SVE/AS, Permanganate Injection, Hydraulic Containment/Removal, Soil Cover, SSDS, Institutional Controls with Site Management

6.6.1 Overall Protection of Human Health and the Environment

Active remedial measures and institutional controls included in this alternative would meet RAOs for the Site. SVE/AS will eliminate the source of contamination. Potential human exposure or environmental impacts would be addressed by SSD systems, in-situ groundwater treatment and institutional controls. Groundwater would eventually be restored to pre-disposal conditions, however, this would take many years.

6.6.2 Compliance with SCGs

SCGs for soil would be met at the source, i.e. at 368 Richardson Street. Groundwater quality would be greatly improved; however, groundwater SCGs would probably not be achieved for a number of years after the completion of injections. Contaminant concentrations would continue to decrease after the injections and with continued groundwater extraction and treatment. SCGs for soil vapor intrusion would be met through the operation of a SSD system to mitigate any potential soil vapor exposure.

6.6.3 Long-Term Effectiveness

This alternative addresses the major source of contamination at the site, i.e. the soil source area under the building at 368 Richardson Street. Permanganate injections would greatly reduce groundwater contamination. Hydraulic containment would prevent migration of contamination while these measures were in place. Deed restrictions and engineering controls would adequately address the remaining residual contamination at the site.

6.6.4 Reduction of Toxicity, Mobility and Volume with Treatment

Alternative 5 includes removal of soil and groundwater contamination under the building at 368 Richardson Street and in-situ groundwater treatment that greatly reduces the volume of contamination at the Site. Hydraulic containment limits the mobility of groundwater contamination by preventing further migration of the contamination in groundwater.

6.6.5 Short-Term Effectiveness

Air emissions would be a concern during well installation for the SVE/AS system, operation of the pump and treat groundwater remediation system which would include an air stripper, and for permanganate injection. Air monitoring would be required to protect workers and the public. It is estimated that construction (including permanganate injections) would require a period of 1 to 2 years.

6.6.6 Implementability

The technologies employed for remediation are conventional technologies for addressing the types of contamination at the site. Considerable coordination with the City for installation of injection points and extraction wells and with business owners and residents for installation of SVE/AS, pump and treat and SSD systems would be required.

6.6.7 Land Use

The site is expected to remain zoned as M3-1, a multi-unit residential and commercial area for the foreseeable future. Alternative 5 will restrict land use to commercial through deed restrictions. In addition, land use in the area of the injection points and extraction wells would be temporarily limited.

6.6.8 Cost

Estimated capital and OM&M costs for Alternative 5 are presented on Table 6-1. The capital cost is $4,123,369, present worth of OM&M costs is $1,561,539, and the total capital with annual present worth cost of Alternative 5 is $8,781,000.

6.7 Comparative Analysis of Alternatives

The following section presents the comparative analysis of the five remedial alternatives for the Site based on the evaluation criteria used for remedial alternatives.

6.7.1 Overall Protection of Public Health and the Environment

Alternative 1 is not protective of public health and the environment. Alternative 2 is protective of human health, but does not meet the environmental RAO to restore the groundwater to pre-release conditions, to the extent practicable. All remaining alternatives would eventually meet the RAOs for the Site. All alternatives except No Action include removal of the source of contamination below the building at 368 Richardson Street. These four alternatives all also include SSD systems to mitigate potential soil vapor intrusion exposure, a soil cover to prevent direct contact with contaminated soil, institutional controls including deed restrictions limiting property use for commercial purposes, and (e.g. restrictions on groundwater use for drinking water. Alternatives 3, 4 and 5 are more protective of public health and the environment than alternative 2 because they will require less time to remediate groundwater. Alternative 5 is most protective but will take a long time.

6.7.2 Compliance with SCGs

Alternative 1 does not comply with soil, soil vapor, or groundwater SCGs. For all other alternatives, SCGs for soil would be met through SVE in the source area, pathway elimination via soil cover, and institutional controls. SCGs for soil vapor intrusion would be met through operation of a SSD system. Groundwater quality would be greatly improved; however, groundwater SCGs would not be achieved for a number of years following remediation. Alternatives 3, 4 and 5 that include in-situ treatment would be expected to achieve groundwater SCGs most quickly. Alternative 2, which includes source removal, but no in-situ treatment of the groundwater plume, would take longer to achieve groundwater SCGs than all other alternatives except No Action.

6.7.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence is directly related to the quantity of residuals remaining on the site. Alternative 1 does not address the source of contamination and is the least effective and permanent. All other alternatives include source removal that minimizes soil residual contamination. Alternatives 3, 4 and 5 include remediation of the groundwater plume, and are consequently more effective and permanent than alternative 2 which only addresses the source of contamination.

For all alternatives, monitoring and deed restrictions implemented through an SMP would be an effective means of managing residual contamination.

6.7.4 Reduction of Toxicity, Mobility and Volume with Treatment

The greatest reduction in TMV would be achieved by Alternative 5 since it includes reduction of contamination by SVE/AS and in-situ groundwater treatment, and reduction of contaminant mobility by hydraulic containment. Alternatives 3 and 4 would reduce TMV somewhat less than Alternative 5 because they do not reduce contaminant mobility. Alternative 2 reduces contamination less than Alternatives 3, 4 and 5 because there is no active groundwater remediation. Alternative 1 does not reduce TMV.

6.7.5 Short-Term Effectiveness

Alternative 1 does not include any active remediation, and therefore, poses no risk to human health or the environment during construction. However, this alternative would not achieve the remedial action objectives for public health or the environment. Alternative 2 poses the least risk to human health and the environment other than Alternative 1. It will take less than a year to construct and has significantly less drilling than Alternatives 3, 4 and 5. Alternatives 3 and 4 pose a greater risk than Alternative 2, but are comparable to each other with respect to short term effectiveness. Alternative 5 includes the most drilling and consequently poses the most short-term risks. Alternative 5 includes continued operation and maintenance of a groundwater treatment system that would continue to pose a risk to local residents.

6.7.6 Implementability

Since there is no construction, there is no implementation issue associated with Alternative 1 however, there would be administrative issues. Alternatives 2, 3, 4 and 5 all include drilling which would require coordination with the City. However, Alternatives 3, 4 and 5 would require much more extensive drilling in public areas. Alternatives 3, 4 and 5 include in-situ groundwater remediation; however, permanganate injection included in Alternatives 3 and 5 has been used at more sites than EHC injection included in Alternative 4 and is a more proven technology. Alternative 5 includes a groundwater treatment system that would be difficult to find space for and would be difficult to operate and maintain in this densely populated urban area.

6.7.7 Land Use

The site is expected to remain zoned as M3-1, a multi-unit residential and commercial area for the foreseeable future. Deed restrictions would be required under all alternatives in the areas impacted by contamination.

6.7.8 Cost

Capital costs and operation, maintenance, and monitoring costs (OM&M) are provided for each alternative and presented as present worth using a 5% discount rate. Cost estimates for each alternative are presented in Appendix D and are summarized on Table 6-1.

7 RECOMMENDED ALTERNATIVE

Alternatives were developed, screened and evaluated for the remediation of the Former Klink Cosmo Cleaners site. The evaluation of alternatives focused on remedial action objectives that were designed to provide source reduction, eliminate exposure pathways and attain SCGs to the extent practicable. Remediation areas and volumes were calculated for contaminated media identified for the site. Costs were developed for each alternative. The overall approach used to select the recommended alternative considered protection of human health and the environment during construction and after completion of remediation, the potential difficulties associated with implementing the alternative and the cost-effectiveness of the alternative. The recommendation is presented below.

7.1 Basis for Recommendations

Alternative 1 is not protective of human health and the environment and is rejected as a viable alternative for remediation. Alternative 2 includes measures to remove the source of contamination. However, Alternative 2 does not address the contamination in the groundwater plume, and is not as protective as alternatives other than No Action. Therefore, Alternative 2 is not considered further in this evaluation. The three most feasible remedial alternatives, Alternatives 3, 4 and 5 are discussed below.

- Overall Protection of Public Health and the Environment: Alternatives 3, 4 and 5 include measures to reduce the major source of contamination. These alternatives all also include SSD systems to address soil vapor contamination and institutional controls (e.g. restrictions on groundwater use for drinking water) to protect the public. All three alternatives meet the RAOs for the site.
- Compliance with Standards, Criteria and Guidance: All three alternatives would meet the SCGs for soil, soil vapor intrusion, and improve groundwater quality although all alternatives rely on long-term attenuation to ultimately achieve SCGs for groundwater.
- Long-Term Effectiveness and Permanence: Long-term effectiveness and permanence is directly related to the quantity of residual contamination remaining on the site after remediation. All alternatives are comparable in this respect.
- Reduction of Toxicity, Mobility with Treatment: All alternatives are comparable with respect to reducing the volume of contamination. However, alternative 5 also includes hydraulic containment that will limit the mobility of contamination.
- Short-Term Effectiveness: The three alternatives are comparable with respect to short-term effectiveness since they all would include drilling a part of the remediation and

because they would require comparable times to complete construction of the remediation.

- Implementability: Alternative 5 includes a groundwater treatment system that would be difficult to install and to operate in an urban area. Although all alternatives employ in-situ groundwater treatment, Alternatives 3 and 5 are superior to Alternative 4 because there is much greater experience using the technology included these alternatives for remediation.
- Cost: Alternative 5 is the most costly alternative and includes long-term O&M, but provides limited additional improvement in meeting RAOs. The estimated costs of Alternatives 3 and 2 are $4,512,000 and $2,063,000, respectively.
- Land Use: The site is expected to remain a multi-unit residential commercial area for the foreseeable future. Remediation will not significantly impact the use of the site although deed restrictions will impact activities on the site. Alternative 3 is the recommended alternative for the Site because it is comparable to Alternatives 4 and 5 for most evaluation criteria and is superior to Alternative 5 in terms of implementability and cost and superior to alternative 4 in terms of implementability.

7.2 Components of Remediation

A conceptual layout for Alternative 3 is shown on Figure 5-2. The major components of the alternative are SVE/AS for source remediation and in-situ groundwater remediation which are described below.

SVE/AS (Source Area Remediation): Five air sparge wells will be constructed. These wells along with three existing wells would be used to introduce compressed air into groundwater below the Former Klink Cosmo building to remove VOCs. Four soil vapor extraction wells will be constructed. These wells along with two existing wells would be used to capture VOCs volatilized by air sparging into the groundwater beneath the Former Klink Cosmo building.

In-Situ Groundwater Remediation: Approximately 30 injection wells will be installed to inject sodium permanganate into contaminated groundwater. Conceptually, approximately 29,000 gallons of a 5% solution will be injected into the groundwater during 4 separate injection events. Injection well quantities and locations as well as the amount of sodium permanganate injected will be further evaluated and finalized during the remedial design phase of the project.

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