FEASIBILITY STUDY
CAROL CLEANERS/ROUSE STATEN ISLAND MALL
STATEN ISLAND, NEW YORK

NYSDEC IHWDS SITE #2-43-020

Prepared for:

GGP Staten Island Mall, LLC.
c/o General Growth Properties, Inc.
(Formerly The Rouse Company)
10440 Little Patuxent Parkway
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Attn: Kelly Webb

November 2011

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March 30, 2012

Mr. Frank Getchell
Leggette, Brashears & Graham, Inc.
600 East Crescent Avenue, Suite 200
Upper Saddle River, NJ 07458

RE: Feasibility Study
Carol Cleaners/Rouse Staten Island Mall
Staten Island, New York
NYSDEC IHWDS Site #2-43-020

Dear Mr. Getchell:

LBG Engineering Services, P.C. (LBGES) was retained by Leggette, Brashears & Graham, Inc. to review the above-referenced Feasibility Study for consistency with applicable regulatory requirements. The review has been completed and the following certification is provided:

"I, William Beckman, certify that I am currently a NYS registered professional engineer and that this Feasibility Study was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10) and all activities were performed in full accordance with the DER-approved work plan and any DER-approved modifications."

Very truly yours,

LBG ENGINEERING SERVICES, P.C.

William K. Beckman

William K. Beckman, P.E.
President

STATE OF NEW YORK
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1.0 INTRODUCTION

On behalf of General Growth Properties, Inc. (GGP; formerly The Rouse Company [Rouse]), the hydrogeological consulting and engineering firm of Leggette, Brashears and Graham, Inc. (LBG) has prepared this Feasibility Study (FS) which details the Remedial Action Objectives (RAOs), and development, screening, and selection of remedial action alternatives in connection with the Carol Cleaners/Rouse Staten Island Mall (the Site), located at 280 Marsh Avenue in Staten Island, New York (Figure 1). The FS was completed in accordance with the requirements of an existing Order On Consent between the New York State Department of Environmental Conservation (NYSDEC) and GGP (formerly Rouse), effective October 14, 2002, and recently updated by the Order On Consent effective October 5, 2011. The goals of this FS were discussed with the NYSDEC as part of an FS Scoping conference call on October 14, 2011.

2.0 SITE DESCRIPTION AND HISTORY

2.1 Background

As per the 2002 Order On Consent, an interim remedial measures (IRM) investigation was previously completed by LBG on behalf of GGP. The IRM investigation focused on identifying and locating the general source area for tetrachloroethylene (PCE) and related chlorinated volatile organic compounds (CVOCs) detected in the subsurface environment at the Site. The work completed as part of the IRM investigation activities ("Task 1" through "Task 6") addressed the following: 1) the vertical and horizontal extent of CVOCs in soil in the area of the Carol Cleaners and Tumble Dry Cleaners (aka Damowa Laundry & Dry Cleaning) facilities; 2) determination of the existence of CVOC-related dense non-aqueous phase liquid (DNAPL) at the potential release location, and, if detected, the potential for the local overburden materials (e.g., soil) and underlying bedrock surface to influence DNAPL migration; and 3) delineation of the current extent and migration mechanisms for CVOCs in groundwater at the Site.

The IRM investigation results indicated that PCE was the only CVOC detected in any of the collected soil samples that occurred at a concentration above its respective recommended soil cleanup objective (RSCO) as defined by the NYSDEC "Technical and Administrative Guidance Manual (TAGM) 4046". The detected exceedance was slightly above the respective RSCO [2.05 parts per million (ppm) versus the 1.40 ppm RSCO], and limited to only one soil sample ("B-1-6") that was collected at a depth of about 6 feet below grade (ft bg), just above the encountered local groundwater surface. The boring (B-1) from which the sample was collected, was located proximal to the identified suspected "source area", that consisted of an area of broken-up asphalt near the discharge point for a building rooftop storm-water leader at the rear of the Carol Cleaners [near existing Monitor Well MW-3 (Figures 2 and 3)]. No remediation of the overburden material near Boring B-1 (the "source area") was considered warranted based on: the slightly elevated concentration of PCE detected in the respective overburden at a singular location and only at depth in the source area; the comparatively lower concentrations of PCE (all below the TAGM objective of 1.4 ppm) detected at the surrounding boring locations; the composition of the overburden (primarily fine sand and silt); the absence of CVOC DNAPL; and the prevalence of primarily impervious surfaces at the Site.

Results of corresponding groundwater sampling conducted between 1995 and 2004, indicated the presence of one or more CVOCs at concentrations above respective NYSDEC groundwater/surface water standards, as defined by 6 NYCRR Part 703, at Monitor Wells MW-2, MW-3, MW-4, MW-5, MW-7, MW-8 and MW-9 (Table 1; Figure 2). The detected elevated CVOCs consisted of PCE, and its breakdown products: trichloroethylene (TCE); cis-1,2-dichloroethylene (cis-1,2-DCE); and vinyl chloride (VC). Based on the determined groundwater flow direction and distribution of the respective CVOCs in groundwater at the Site, the apparent source area occurred proximal to the Carol Cleaners facility, and the resulting plume was of a limited extent.

Based on in-situ hydraulic ("slug") testing conducted at several of the on-site monitor wells during the IRM investigation activities, it was determined that the hydraulic conductivity of the overburden at the Site is low to moderate. As such, groundwater and CVOC movement through the on-site overburden is expected to occur at a slow rate, which in turn should afford greater potential for natural degradation (e.g., reductive dechlorination) of the respective constituents to occur. The analytical results for the groundwater samples collected since 1995 indicate that PCE related to the on-site source area is clearly undergoing reductive dechlorination (i.e., breakdown to TCE, cis-1,2-DCE, and VC), which substantiates the occurrence of natural degradation at the Site. The occurrence of natural degradation of PCE is further corroborated by the general detection of methane, ethane, and/or ethene in groundwater samples collected from most of the monitor wells.

A Remedial Investigation (RI) was performed between 2006 and 2008 following completion of the IRM investigation activities. The work completed as part of this phase of the overall RI focused on: establishing the current soil vapor/indoor air quality conditions in tenant spaces proximal to Carol Cleaners, and refining previously determined soil and groundwater conditions in the vicinity of the Carol Cleaners portion of the mall building. The RI work also assessed the potential for use of monitored natural attenuation (MNA) as an appropriate remedial measure for the Site.

The analytical results for the indoor air and sub-slab air samples collected at the targeted tenant spaces (Babies R Us, SI Shoe Repair, Carol Cleaners, Mon Amie Nails and Carvel) indicated that appropriate action to reduce exposure to PCE and TCE was warranted. Supplemental soil samples collected as part of the RI work exhibited no evidence of DNAPL or CVOC concentrations above the respective NYSDEC RSCOs with most of the analytical results indicating non-detectable concentrations of the targeted compounds. In addition to advancement of the supplemental soil borings, seven new monitor wells were installed at the Site, including one completed in the shallow bedrock (Monitor Well MW-3D). The results of the subsequent round of groundwater sampling utilizing the expanded monitor-well network indicated that the CVOC plume originating near the Carol Cleaners facility was generally following the local

direction of groundwater flow towards Platinum Avenue, and may be influenced by local subsurface utilities.

Based on the RI findings, LBG recommended in 2008 the continued monitoring of groundwater to confirm the rate of natural CVOC degradation, and to further investigate the potential influence of on-site and nearby off-site subsurface utilities on plume migration in the vicinity of the Site and Platinum Avenue. Between 2010 and 2011 additional RI activities were performed including: installation of additional on-site and off-site soil borings; sampling of storm-water catch basins; installation of additional off-site monitor wells along Platinum Avenue; and diagnostic indoor vapor mitigation testing in the Babies R Us and adjacent tenant spaces.

Groundwater sampling conducted in August and October 2011 confirms that the CVOC plume continues to migrate toward and along Platinum Avenue, and that reductive dechlorination is persisting within the plume. In addition, surface-water samples and associated soil samples indicated that the local storm drain system was influencing the CVOC plume emanating from the Site. Based on the most recent findings, LBG recommended in the respective Remedial Investigation Report (RIR) that enhancement of the naturally occurring degradation of PCE and related CVOCs, and implementation of remedial measures associated with the on-site storm-water system (e.g. catch basin cleaning and sealing) be pursued.

3.0 RI SUMMARY AND EXPOSURE ASSESSMENT

3.1 Preliminary Investigations

In July 1995, groundwater samples were collected from five temporary points near the Carol Cleaners and Tumble Dry Cleaners. The analytical results of the groundwater samples collected from the temporary points indicated the presence of CVOCs primarily near the Carol Cleaners. An "Expanded Phase II Subsurface Investigation" included the installation of six monitor wells (MW-1 through MW-6) that same month. Groundwater samples were collected

from each monitor well in July 1995 and the results indicated that concentrations of PCE ranged from not detected at Monitor Wells MW-1 and MW-4 to 71 parts per billion (ppb) at Monitor Well MW-5. A second round of groundwater sampling performed in September 1995 indicated that concentrations of PCE ranged from not detected at Monitor Wells MW-1 and MW-6 to 660 ppb at Monitor Well MW-5. Based on the results of the site investigations a proposal for an IRM Work Plan was submitted to the NYSDEC. The approved IRM Work Plan included additional subsurface investigations, but did not provide for remediation other than the potential removal of impacted soils, if warranted.

3.2 Remedial Investigation Summary

An IRM investigation was completed by LBG on behalf of GGP in 2002. Twenty five soil borings (B-1 through B-25) were advanced proximal to Carol Cleaners in September 2002 (Figure 3). Soil samples were collected from depths of approximately 5 to 19 ft bg. Out of the fifty-four soil samples collected, one soil sample collected from Boring B-1 at a depth of 6 ft bg had a minor exceedance of the RSCO for PCE. As part of the IRM investigation, four monitor wells [(MW-6R (replacement for MW-6) through MW-9)] were installed in September and October 2002. Groundwater samples were collected from each monitor well in November 2002. The results indicated that CVOCs were detected above the respective NYSDEC Technical and Operational Guidance Series (TOGs) at all of the monitor wells with the exception of Monitor Wells MW-1 and MW-6R, both of which are located upgradient of the mall building.

Following completion of the IRM investigation activities, an RI was performed between 2006 and 2008. Eight soil borings (B-26 through B-33) were advanced in May 2006 (Figure 3). Soil samples were collected from depths of approximately 4.5 to 16 ft bg. Out of the sixteen soil samples collected, the results indicated no concentrations in exceedance of the RSCOs with most of the analytical results indicating non-detectable concentrations. Additionally, seven Monitor Wells (MW-3D and MW-10 through MW-15) were installed on and off-site between May 2006 and March 2008. Monitor Well MW-3D was a shallow bedrock monitor well installed to address the vertical extent of CVOC-impacts in groundwater on-site. Monitor Wells MW-10, MW-14 and MW-15 were installed in cross-gradient locations on-site. Monitor Wells MW-11,

MW-12 and MW-13 were installed off-site along Platinum Avenue. Groundwater samples were collected from each monitor well in April 2008. The results indicated that CVOCs were detected above the respective NYSDEC Ambient Water Quality Standard Guidance Values (AWQSGVs) at on-site Monitor Wells MW-2, MW-3, MW-4, MW-5, MW-7, MW-8, and MW-9 and at off-site Monitor Wells MW-11 and MW-12 along Platinum Avenue. Monitor Wells MW-1, MW-6R, MW-10, MW-14 and MW-15 did not indicate concentrations above the respective AWQSGVs and are located upgradient and crossgradient of the CVOC plume. The presence of PCE-breakdown products including TCE, cis-1,2-DCE and VC indicated natural degradation of the CVOC-impacts was occurring. This was further corroborated by the detection of methane, ethane, and/or ethene at or near the source area.

Indoor air and sub-slab air samples were collected in the tenant spaces proximal to the Carol Cleaners as part of the RI activities in 2006 and 2008. The analytical results from these sampling events indicated indoor air and sub-slab air impacts in these tenant spaces (Figure 4). The indoor air samples collected in February 2008 were compared to the New York State Department of Health (NYSDOH) "PCE/TCE Decision Matrices" to determine the appropriate action for the identified impacts. Based on the decision matrices, the appropriate action was to reduce exposure to PCE and TCE.

The most recent phase of the RI was performed between late 2010 and August 2011 and supplemented by groundwater sampling in October 2011. Eleven soil borings (SB-1 through SB-11) were advanced between May and July 2011 (Figure 3). Soil samples were collected from depths of approximately 1.5 to 18 ft bg. Out of the nineteen samples collected, the results indicated low-level CVOC-impacts in the soil samples collected adjacent to the sampled storm water catch basins. Additionally, four monitor wells (MW-16 through MW-19) were installed off-site, along Platinum Avenue, in July 2011 in order to further assess the role of subsurface utilities on CVOC plume migration.

Groundwater samples were collected from each monitor well in August and October 2011. The results indicated that CVOCs were detected above the respective NYSDEC groundwater/surface water standards at on-site and off-site monitor wells including the additional newly installed off-site monitor wells (MW-16, MW-17, MW-18 and MW-19). The presence of PCE-breakdown products indicated natural degradation was continuing to occur and confirmed migration of the plume along Platinum Avenue. The surface water samples collected from the storm drain catch basins indicated the presence of CVOCs in exceedance of the NYSDEC groundwater/surface water standards on the eastern and southern portions of the Site (Figure 3).

The historical results of the groundwater and soil sampling are summarized in Table 1 and Appendix I, respectively. Soil boring logs for all of the soil investigations are provided in Appendix II. Monitor well logs for all on-site and off-site monitor wells are provided in Appendix III.

3.3 Qualitative Human Health Exposure Assessment

A qualitative Human Health Exposure Assessment (HHEA) was performed to evaluate and document the potential exposure pathways related to the CVOC plume as they pertain to the current and anticipated future use of the Site. The NYSDOH defines an exposure pathway as consisting of: (1) a contaminant source; (2) release and transport mechanism; (3) a point of exposure; (4) a route of exposure; and (5) a receptor population. The Site's current primary use is commercial and the Site is occupied by one mall building (the SI Mall). The current receptor population includes mall occupants and shoppers.

3.3.1 Contaminant Source Description

Based on the results of on-site and off-site soil investigations, CVOC-impacted soil proximal to the Carol Cleaners source area is of minimal concentration exceedance and localized in extent. The resulting CVOC plume extends from this source area following the general direction of groundwater flow towards the southwest and Platinum Avenue (Figure 5).

A map of the distribution of PCE and related CVOCs in groundwater associated with the October 2011 sampling round is presented as Figure 6. The extent of the corresponding plume generally follows the local direction of groundwater flow from the Site towards Platinum Avenue. The wide-spread occurrence of PCE-breakdown CVOCs throughout the plume substantiates the ongoing occurrence of widespread reductive dechlorination. Plume migration is discussed further in Section 4.0.

3.3.2 Release and Transport Mechanisms

Impacts in the soil and groundwater proximal to the Carol Cleaners migrated into the soil vapor (the air spaces between soil particles) in the unsaturated (vadose) zone beneath the building slab. Through pressure differences between the indoor building space and the unsaturated zone created by cracks and holes in the foundation or other preferential pathways, these vapors were able to migrate into indoor air.

3.3.3 Exposure Points

Once in the indoor air the soil vapor impacts accumulated in indoor air in the breathing zone creating an exposure point to the currently exposed population.

3.3.4 Routes of Exposure

Groundwater at the Site is not used for drinking water or any recreational purpose therefore its ingestion is not a primary exposure route. Since respective concentration exceedances are minimal and localized; and the surface of the Site is paved and covered by the mall building, the potential for ingestion and dermal adsorption of CVOC-impacted soil is not a primary exposure route.

Exposure from inhalation is the primary route of exposure at the Site based on the identified CVOC-impacts to sub-slab and indoor air. As presented in the RIR submitted in October 2011, a sub-slab depressurization (SSD) system is proposed to address indoor air impacts at the Babies R Us and adjacent tenant spaces.

3.3.5 Receptor Population

As described previously, the Site's current primary use is commercial and the Site is occupied by the SI Mall. The current receptor population includes mall occupants and shoppers. The anticipated future use of the Site remains commercial; therefore the receptor population will remain the same.

Groundwater at the Site is not used for drinking water or any recreational purpose therefore ingestion of groundwater is not a primary exposure route for the current receptor population. Additionally, groundwater bearing formations underlying the Site area are not known to be favorable as water supply sources. The current receptor population is limited from exposure to soil due to the existence of paved and covered surfaces at the Site and adjoining areas. However, construction or utility workers doing subsurface work near the Carol Cleaners may be exposed to CVOC-impacted soil; resulting in the occurrence of a potential exposure pathway. The CVOC-impacts in soil were minimal and at 6 ft bg. The groundwater in the overburden ("water table") generally occurs at depths between approximately 6 and 11 feet below grade (ft bg). It is not anticipated that construction or redevelopment will include activities at this depth therefore this is not a complete exposure pathway.

Indoor air impacted by CVOCs has been identified at the Babies R Us and adjacent tenant spaces as described previously. This condition represents a complete exposure pathway. However, once the proposed SSD system is in place these impacts should be mitigated.

3.4 Fish and Wildlife Resources Impact Analysis

As per the NYSDEC requirements for an FS, a Fish and Wildlife Resources Impact Analysis (FWRIA) may be needed to identify actual or potential impacts to fish and wildlife resources from the CVOCs originating at the Site. According to DER-10, no FWRIA is needed if the following conditions exist at a site:

1. The remediation is directed toward a specific discharge or spill event that does not adversely impact fish and wildlife resources.

2. The areas of concern (AOCs) at the site consist solely of an underground storage tank(s) or an underground tank system, with no significant impact on surrounding groundwater or surface water.

3. The site is a point source of contamination to the groundwater (i.e. dry cleaner or gas station) which will be prevented from discharging to surface water, and there is no widespread soil contamination or habitat of an endangered, threatened or special concern species present.

4. There are no ecological resources present on or in the vicinity of the site.

Conditions 1 and 3 pertain to the Site. The relevance of Condition 4 was assessed using the NYSDEC's Environmental Resource Mapper to identify natural resources and environmental features that are state protected or of on-site conservation concern. According to the mapper output (provided in Appendix IV) the Site is designated as "Natural Communities Nearby" and the corresponding community is an "oak-tulip tree forest". However, since the Site has been used for commercial purposes since the 1970s this community is considered not to exist on-site. Furthermore, this community is not expected to occur on-site in the future, since the Site is expected to remain commercial.

Based on the above discussion, Conditions 1, 3, and 4 are assumed to pertain to the Site. Using the FWRIA "Decision Key" (Appendix 3 - DER-10), it can be concluded that the CVOC contamination at the Site does not have the potential to "migrate to, erode into or otherwise impact" the potential resources as provided in "Item 9" of the key. Therefore, no FWRIA is required as part of this FS.

4.0 REMEDIATION GOALS AND ACTION OBJECTIVES

4.1 Remedial Action Goals

The stated goal of a remedial program implemented under 6 NYCRR Part 375-2.8(a) is to restore the subject site to "pre-disposal" conditions, to the extent feasible. At a minimum, the remedy selected shall eliminate or mitigate all significant threats to the public health and to the environment presented by contaminants disposed at the site as set forth in the Comprehensive Environmental Resource Conservation and Liability Act (CERCLA) and amended by Superfund Amendments and Reauthorization Action (SARA).

4.2 Remedial Action Objectives

Remedial Action Objectives (RAOs) are defined in DER-10 as medium or operable unit-specific objectives for the protection of public health and the environment and are developed based on "Standards, Criteria and Guidance" (SCG) for the specific contaminant(s). These are the applicable SCGs for the Site:

Division of Environmental Remediation (DER) SCGs as follows:

- DER-10 – Technical Guidance for Site Investigation and Remediation
- DER-15 – Presumptive/Proven Remedial Technologies
- 6 NYCRR Part 375 – Environmental Remediation Programs
- 6 NYCRR Part 375-6 – Remedial Program Soil Cleanup Objectives

Division of Water SCGs as follows:

- 6 NYCRR Part 703 - Surface Water and Groundwater Quality Standards and Groundwater Effluent Standards

NYSDOH SCGs as follows:

- Guidance for Evaluating Soil Vapor Intrusion in New York
- NYSDOH Drinking Water Standards

As per the applicable SCGs, the generic, medium specific RAOs are as follows:

4.2.1 Protection of Public Health

Soil

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

Groundwater

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

Soil Vapor

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

4.2.2 Protection of the Environment

Soil

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

Groundwater

- Restore ground water aquifer to pre-disposal/pre-release conditions, to the extent practicable.
- Prevent the discharge of contaminants to surface water.
- Remove the source of ground or surface water contamination.

4.3 Nature and Extent of Contamination

4.3.1 Soil

Based on the analytical results for eighty-nine soil samples collected on and off-site during multiple remedial investigations completed between 2002 and 2011 near the expected source area, only one exceedance of the respective RSCOs was encountered. Therefore impacts to soil are minimal, localized, and do not appear to be acting as a continuing source for impact to groundwater. The soils are effectively capped, as the entire property is covered by asphalt, concrete and the footprint of the mall building.

The generic protection of health and the environment RAOs for soil would prevent ingestion/direct contact with contaminated soil and prevent inhalation of or exposure from contaminants volatilizing from soil. In addition, they would prevent migration of contaminants that would result in groundwater or surface water contamination and prevent impacts to biota

from ingestion/direct contact with soil causing toxicity or impacts from bioaccumulation through the terrestrial food chain. The soil impacts at the Site do not appear to be migrating into groundwater and there are no surface water bodies on-site, therefore the only RAOs for soil at the Site would be protection of public health RAOs.

4.3.2 Groundwater

The source of PCE contamination at the Site appears to be related to a historic point source discharge event associated with the Carol Cleaners. Based on the current distribution of PCE and related breakdown CVOCs in groundwater as detected during the October 2011 sampling event, the corresponding plume is generally following the local direction of groundwater flow from the Site towards Platinum Avenue. Additional discussion on groundwater migration is provided in Section 4.4.

The generic protection of health RAOs for groundwater would prevent ingestion of groundwater with contaminant levels exceeding drinking water standards, prevent contact/inhalation of volatiles from impacted groundwater, and restore the aquifer to pre-release conditions to the extent practicable. The groundwater at the Site is not used for on-site drinking water or any recreational purpose. Therefore there is no potential for ingestion of groundwater. However, the applicable RAOs for the Site require prevention of contact with/inhalation of CVOCs from impacted groundwater (see Soil Vapor section below) and the restoration of the groundwater bearing overburden to pre-release conditions to the extent practicable. In addition, the RAOs applicable to the generic protection of the environment require prevention of the discharge of CVOCs to surface-water, and removal the respective source. There are no on-site surface-water bodies; however, the water within the on-site storm-water catch basins appears to be CVOC-impacted. The source(s) of impacts to the on-site storm-water catch basins is currently under investigation.

4.3.3 Soil Vapor

The analytical results for the indoor air and sub-slab air samples collected at the Babies R Us, SI Shoe Repair, Carol Cleaners, Mon Amie Nails and Carvel spaces during the 2006 and 2008 investigations indicated that the appropriate action for the respective tenant spaces was to reduce exposure to PCE and TCE at the breathing level.

The generic RAOs for soil vapor are to mitigate impacts to public health resulting from existing, or the potential for soil vapor intrusion into buildings. As presented in the 2011 RIR, a sub-slab depressurization (SSD) system is proposed for the Site to mitigate the impacts identified at the respective tenant spaces.

4.4 Conceptual Hydrogeologic Model for the Site

The naturally occurring overburden underlying the Site and immediately surrounding area consists of units of fine sand, as well as units of fine sand and silt overlying a serpentinite metamorphic bedrock formation. The overburden off-site to the west-southwest becomes thicker as the bedrock surface elevation decreases. Based on soil boring data, the off-site overburden becomes increasingly coarser at depth, being dominated by sand and gravel overlying bedrock. As described previously, the water table generally occurs at depths between approximately 6 and 11 feet below grade (ft bg).

Based on "slug" testing performed during RI activities in 2011, the calculated hydraulic conductivity of the on-site overburden ranges from approximately 0.4 feet per day (ft/d) at Monitor Well MW-6R to 1.8 ft/d at Monitor Well MW-15. The calculated hydraulic conductivity for the off-site overburden ranges from about 7 ft/d at Monitor Well MW-11 to 29 ft/d at Monitor Well MW-16. The average hydraulic gradient calculated from groundwater elevation determined for the October 2011 groundwater sampling event is about 0.02 feet. Assuming an average "typical" porosity for the overburden (silt, sand, and gravel) of 0.3 the respective groundwater velocity ranges from 0.1 ft/d in the on-site overburden, to approximately 1 ft/d in the off-site overburden. As such, groundwater movement and corresponding CVOC

plume migration in the overburden is anticipated to occur at a faster rate off-site than that occurring on-site.

As discussed above, the bedrock surface generally slopes downwards from the vicinity of the upgradient-most on-site monitor well (Monitor Well MW-1) where the bedrock elevation is 31 feet above mean sea level (famsl) towards the southwest at off-site Monitor Well MW-16, where the bedrock elevation is 2 famsl (Figure 7). Based on the subsurface data for the Site, three localized "channels" occur in the bedrock surface in the vicinity of Platinum Avenue. These channels are anticipated to impart a localized influence on the basal component of groundwater flow in the overburden. Figure 8 illustrates the increase in thickness of the naturally occurring overburden materials from northeast to southwest, the general slope of the bedrock surface from northeast to southwest, and a similar slope of the groundwater surface. The vertical hydraulic gradient is downward into the bedrock from the overburden as determined by groundwater elevations at Monitor Wells MW-3 and MW-3D.

The data collected in connection with the most recent groundwater sampling event indicates that the CVOC plume continues to migrate to the west-southwest in the overburden (Tables 2 and 3). Based on the most recent data for bedrock Monitor Well MW-3D, the on-site bedrock groundwater bearing formation has not been impacted by CVOCs at concentrations above the respective NYSDEC groundwater/surface water standards.

5.0 GENERAL RESPONSE ACTIONS

As presented above, groundwater, soil, and soil vapor are the impacted media at the Site, and are the media for which general response actions (GRAs) have been developed. The GRAs were evaluated on a media basis for their potential to successfully achieve the RAOs for the Site.

5.1 Soil

5.1.1 No Action

A 'No Action' response for soil would not involve any remedial efforts. Though the current surface cover at the Site prevents ingestion/direct contact or inhalation of CVOCs in soil, 'no action' does not provide for maintenance of the existing surface cover and does not limit disturbance of soil during any future construction or Site redevelopment activities. Therefore, this GRA would not successfully achieve the RAOs for soil at the Site. As previously noted, the CVOC-impacts in soil were minimal and at 6 ft bg. The water table is situated at depths of 6 to 11 ft bg, therefore it is not anticipated that construction or redevelopment will include activities at this depth.

5.1.2 Institutional Controls

An institutional control for soil would not involve any remedial efforts, however implementation would provide for maintenance of the existing surface cover and limit disturbance of the area during any future construction or Site redevelopment activities. This GRA could potentially achieve the RAOs for soil at the Site as its successful implementation would prevent ingestion/direct contact with CVOC-impacted soil, and prevent inhalation of or exposure to CVOCs volatilizing from soil.

atoms to produce end-product molecules of ethene and ethane. Treatments would be performed under a NYSDEC discharge to groundwater (DGW) permit and the groundwater would be monitored. This GRA could potentially achieve the RAOs for groundwater at the Site.

5.2.4 Pump and Treat

Pump and treat is used for groundwater plume control and treatment and would involve pumping the CVOC-impacted groundwater out of the subsurface for treatment likely via carbon adsorption. This GRA could potentially achieve the RAOs for groundwater at the Site.

5.2.5 Air Sparge/Soil Vapor Extraction

Soil vapor extraction (SVE) involves the application of vacuum to the unsaturated soil matrix (vadose zone) in order to extract CVOC vapors for treatment. Air sparging (AS) of the saturated zone allows for phase transfer of the CVOCs from the dissolved (in groundwater) to the vapor state for venting within the vadose zone where it is captured by the SVE portion of the system. This GRA could potentially achieve the RAOs for groundwater at the Site.

5.3 Soil Vapor

5.3.1 No Action

A 'No Action' response for soil vapor would not involve any remedial efforts, therefore this GRA would not mitigate the impacts identified in indoor air at the respective tenant spaces. This GRA would not successfully achieve the RAOs for soil vapor intrusion at the Site.

5.3.2 Sub-Slab Depressurization (SSD) System

An SSD system uses an exhaust fan to draw vapors from the soil beneath the slab and discharges them to the atmosphere. The fan creates a vacuum beneath the slab which lowers the sub-slab air pressure relative to the indoor air pressure preventing the infiltration of sub-slab vapors into the building. Based on the diagnostic indoor vapor mitigation testing performed during the 2011 RI activities, an SSD system would successfully achieve the RAOs for soil vapor intrusion at the Site.

6.0 TECHNOLOGY IDENTIFICATION AND SCREENING

The following section presents the remedial technologies identified and screened for use at the Site. Each remedial technology was screened according to its effectiveness, implementability, and relative cost.

6.1 Soil

6.1.1 No Action

Although the 'No Action' GRA would not successfully achieve the RAOs for soil, it provides a baseline for other remedial technology alternatives therefore it is carried through the remedial technology screening. This GRA is only effective as long as the existing surface cover remains intact and in place. This alternative is easily implementable at no cost.

6.1.2 Institutional Controls

Institutional controls would provide for the continued maintenance of the existing surface cover and limit disturbance of the area in the event of construction or future redevelopment activities limiting exposure to impacted soil. Institutional controls would be effective and easily implementable at low cost.

6.1.3 Excavation

Excavation is moderately implementable; however the area is relatively small, present at the water table, and adjoins the mall building proximal to Carol Cleaners. Excavation at this depth would require dewatering and excavation near the building would require building structural support. Additionally, potential CVOC-impacted soil could extend beneath the building footprint which would disrupt tenant operations and again would require structural support. The excavated soils would require disposal and the excavation would need to be filled with 'clean fill'. Local permits including those for dewatering would likely be required. Excavation of the soil impacts would effectively achieve the RAOs for soil; however costs would

be high considering how impacts to soil are minimal and localized. Soil impacts also do not appear to be acting as a continuing source for impact to groundwater.

6.2 Groundwater

6.2.1 No Action

Although the 'No Action' GRA would not successfully achieve the RAOs for groundwater, it provides a baseline for other remedial technology alternatives therefore it is carried through the remedial technology screening. This alternative is easily implementable at no cost.

6.2.2 Monitored Natural Attenuation

As described in Section 5.0, MNA would not involve any remedial efforts and therefore the process would take a long time to achieve the RAOs for groundwater at the Site. Although MNA cannot be used alone to achieve the RAOs for groundwater, it can be used in conjunction with a form of active remediation to monitor changes in the CVOC plume, confirm the rate of degradation, and track the progress of the remediation. Monitored natural attenuation is easily implementable at low cost.

6.2.3 In-Situ Biological Treatment

In-situ biological treatment would treat the groundwater in place with only the installation of injection points. There is no infrastructure or Operations and Maintenance (O&M) only monitoring to determine effectiveness. A pilot test is proposed to determine if this alternative would effectively achieve the RAOs for groundwater at the Site.

Treatments would be performed under a NYSDEC discharge to groundwater (DGW) permit. In-situ biological treatments are easily implementable at moderate cost.

6.2.4 Pump and Treat

It is not known if pump and treat would control plume migration at the Site, based on the low to moderate hydraulic conductivity values (i.e., significant presence of silt in the overburden materials) and the current absence of information regarding the potential capture zone. Pilot testing would need to be performed to determine if this alternative would effectively achieve the RAOs for groundwater at the Site.

Pump and treat requires significant infrastructure and O&M. In addition, given the relatively low to moderate hydraulic conductivity values for the overburden, the timeframe to reduce concentrations to the SCGs could be long in duration. Operation of a pump and treat system will require a NYSDEC State Pollution Discharge Elimination System (SPDES) permit for discharge and an air permit for treatment. Groundwater remediation via pump and treat is moderately implementable and the capital costs are high.

6.2.5 Air Sparge/Soil Vapor Extraction

The soils at the Site may not be conducive to SVE as some areas consist of higher silt content which inhibits vacuum extraction. In addition, the effectiveness of AS to treat the groundwater is not known. Pilot testing would need to be performed to determine if this alternative would effectively achieve the RAOs for groundwater at the Site. It is likely that this remedial technology would have to be combined with groundwater control (dual phase extraction) to treat the CVOC-impacted groundwater.

Similar to pump and treat, AS/SVE requires significant infrastructure and O&M. Operation of an AS/SVE system will require an NYSDEC air permit for treatment. Removal via AS/SVE is moderately implementable and the capital costs are high.

6.3 Soil Vapor

6.3.1 No Action

Although the 'No Action' GRA would not successfully achieve the RAOs for soil vapor intrusion, it provides a baseline for other remedial technology alternatives therefore it is carried through the remedial technology screening. This alternative is easily implementable at no cost.

6.3.2 Sub-Slab Depressurization (SSD) System

A sub-slab depressurization (SSD) system has been proposed to mitigate the impacts identified in the respective tenant spaces. As per the NYSDOH Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York – October 2006, an active SSD is the preferred mitigation method for buildings with a slab-on-grade foundation such as the SI Mall. Based on the diagnostic indoor vapor mitigation testing performed during the 2011 RI activities, an SSD system would effectively achieve the RAOs for soil vapor intrusion. An SSD system is easily implementable at low cost.

7.0 ALTERNATIVE DEVELOPMENT AND ANALYSIS

According to DER-10 the remedial party should evaluate remedial technology alternatives using the threshold and primary balancing criteria as set forth in 6 NYCRR Part 375. Threshold criteria must be satisfied for a remedial technology to be considered for selection. Once a remedial technology satisfies the threshold criteria, the primary balancing criteria are used to compare the negative and positive aspects of the selected remedial technology. Tables 4 through 6 present a summary of the evaluated remedial alternatives.

7.1 Threshold Criteria

There are two threshold criteria: (1) the ability of the remedial technology to provide overall protectiveness of public health and the environment and (2) the conformance of the remedial technology with standards criteria and guidance (SCGs).

7.1.1 Overall Protectiveness of Public Health and the Environment

The overall protective of public health and the environment criteria was previously outlined by media in order to develop the GRAs as presented in Section 5.0. Those GRAs which remain after the remedial technology screening in Section 6.0 are presented as alternatives by media as follows:

Soil

- **Alternative 1 – No Action**

  The 'No Action' alternative would leave the soil in place with no remedial efforts. This alternative would not remain protective of public health and the environment and is carried forward for comparison purposes only.

- **Alternative 2 – Institutional Controls**

  This alternative would leave the soil in place with no remedial efforts, however this alternative would provide for the continued maintenance of the existing surface cover and limit disturbance of the area. This alternative would be protective of public health and the environment.

- **Alternative 3 – Excavation**

  This alternative is provided in the event that construction activities or future redevelopment would expose the impacted soils. Excavation would provide for the removal of the limited area of CVOC-impacted soil and would be protective of public health and the environment.

Groundwater

- **Alternative 1 – No Action**

  The 'No Action' alternative would provide no remedial efforts for CVOC-impacts in groundwater. The 'No Action' alternative would not treat the CVOC plume therefore this alternative would not remain protective of public health and the environment and is carried forward for comparison purposes only.

- **Alternative 2 – In-Situ Biological Treatment & Monitored Natural Attenuation (MNA)**

  Monitored natural attenuation and in-situ treatment are carried through jointly in order to monitor changes in the CVOC plume, the rate of degradation, and track the progress of the remediation. This alternative could be protective of public health and the environment if pilot testing indicated Site conditions were favorable.

- **Alternative 3 – Air Sparge/Soil Vapor Extraction (AS/SVE) & Pump and Treat**

  Groundwater pump and treat and AS/SVE are carried through jointly to address both residual soil impacts and groundwater plume control and treatment. This alternative could be protective of public health and the environment if pilot testing indicated Site conditions were favorable.

Soil Vapor

- **Alternative 1 – No Action**

  The 'No Action' alternative would not mitigate the indoor air impacts identified in the respective tenant spaces and therefore this alternative would not remain protective of public health and the environment and is carried forward for comparison purposes only.

- **Alternative 2 – Sub-Slab Depressurization System**

  An SSD system would mitigate the indoor air impacts identified in the respective tenant spaces and would be protective of public health and the environment.

7.1.2 Conformance with Standards, Criteria and Guidance (SCGs)

Soil

Only Alternative 3 (excavation) would conform to the SCGs. However, based on the current use of the Site and the minimal impacts in soil, Alternative 2 (institutional controls) would likely be a more practical alternative. Alternative 3 (excavation) is an option if necessary based on future construction or redevelopment activities at the Site, although subsurface activities to the water table are not likely.

Groundwater

Alternative 1 (no action) does not conform to the SCGs since there would be no remedial efforts and CVOC concentrations would remain in groundwater in exceedance of the SCGs. Alternative 2 (in-situ biological treatment & MNA) and Alternative 3 (AS/SVE & Pump and Treat) may conform to the SCGs as these are active remedial technologies which should reduce CVOC concentrations in groundwater. As described previously, pilot study testing of these alternatives would be required to determine their potential to conform to the SCGs.

Soil Vapor

Alternative 1 (no action) does not conform to the SCGs as outlined in the NYSDOH guidance. Alternative 2 (SSD system) does conform to the SCGs by mitigating the impacts in indoor air. Soil vapor mitigation systems are not designed to treat impacts.

7.2 Primary Balancing Criteria

There are six primary balancing criteria for the remedial technology: (1) long-term effectiveness and permanence, (2) reduction of toxicity, mobility or volume of contamination, (3) short-term impact and effectiveness, (4) implementability, (5) cost effectiveness, and (6) current and potential land use. Once the Proposed Remedial Action Plan (PRAP) is produced by the NYSDEC Division of Environmental Remediation (DER), and the public comment period has closed, the final criterion for evaluation is community acceptance which is evaluated by the DER prior to remedy selection.

7.2.1 Long-Term Effectiveness and Permanence

Soil

Both Alternative 2 (institutional controls) and Alternative 3 (excavation) would be considered effective in the long term. However, only Alternative 3 (excavation) would be considered a permanent remedial technology as it removes the impacted soils.

Groundwater

Both Alternative 2 (in-situ biological treatment & MNA) and Alternative 3 (AS/SVE & Pump and Treat) would be considered effective in the long term and permanent if pilot testing indicated that Site conditions were favorable. Reductive dechlorination is naturally occurring at the Site and therefore the effectiveness of Alternative 2 is already expected to be favorable.

Soil Vapor

Alterative 2 (SSD system) will effectively mitigate impacted soil vapor for as long as the SSD system is required.

7.2.2 Reduction of Toxicity, Mobility or Volume of Contamination

Soil

Only Alternative 3 (excavation) would reduce the toxicity, mobility or volume of the contamination in soil. However, this alternative would only be required in the event of future construction or redevelopment activities at the Site, although subsurface activities to the water table are not likely.

Groundwater

Both Alternative 2 (in-situ biological treatment & MNA) and Alternative 3 (AS/SVE & Pump and Treat) could reduce the toxicity, mobility or volume of the contamination in groundwater. The mobility of the contamination in groundwater would be reduced most by the pump and treat component of Alternative 3 (AS/SVE & Pump and Treat) if a capture zone could be determined for the Site. As described previously, pilot testing would need to be performed to determine if these alternatives would conform to the SCGs and effectively achieve the RAOs for groundwater at the Site.

Soil Vapor

Alternative 2 (SSD system) does not include any treatment only mitigation of indoor air impacts.

7.2.3 Short-Term Impact and Effectiveness

Soil

As described in Section 6.0, Alternative 2 (institutional controls) is effective and viable in the short-term as it limits the potential for ingestion and dermal adsorption from soil. Although Alternative 3 (excavation) would be effective, the Site is commercial and there is a lot of traffic of shoppers and mall occupants in and out of the area. The impacted area is near the water table, in close proximity to the building footprint and may extend beneath the footprint. Excavation

activities would be disruptive to operations, expose the population to dust, vapors and potentially impacted groundwater and the risks would not outweigh the benefits since the impacts are localized and are effectively capped.

Groundwater

Alternative 2 (in-situ biological treatment & MNA) is an effective short-term treatment technology followed by longer term monitoring. In-situ treatment only requires the installation of injection points therefore the short-term impact to the currently exposed population is minimal. Reductive dechlorination is naturally occurring at the Site and in-situ biological treatment would enhance this process.

Alternative 3 (AS/SVE & Pump and Treat) incorporates pump and treat to capture and treat the plume; however Alternative 3 has not been pilot-tested and is not considered a short-term treatment alternative, both technologies require significant infrastructure which will displace the currently exposed population and may require many years of operation.

Soil Vapor

As described in Section 6.0, Alternative 2 (SSD system) is effective and viable in the short-term as it immediately mitigates the potential for soil vapor intrusion into the respective tenant spaces. There is only minimal impact on the currently exposed population from the installation and operation of an SSD system.

7.2.4 Implementability

Soil

As described in Section 6.0, Alternative 2 (institutional controls) does not require any technical implementation with the exception of maintenance of the existing cover whereas Alternative 3 (excavation) requires significantly more technical and administrative

implementation associated with potential dewatering, construction in close proximity to and possibly beneath the building footprint.

Groundwater

Alternative 2 (in-situ biological treatment & MNA) is easily implementable as it only requires installation of injection points, and monitoring of the treatment and MNA can be performed through the existing monitor well network. Additionally, in-situ biological treatment would enhance the naturally occurring reductive dechlorination.

As described in Section 6.0, Alternative 3 (AS/SVE & Pump and Treat) would need to be pilot-tested, requires infrastructure and O&M and is technically and administratively more difficult to implement.

Soil Vapor

Alterative 2 (SSD system) is both technically and administratively easily implementable. The infrastructure required for an SSD system is minimal and once installed the system will run without the need for significant O&M.

7.2.5 Cost Effectiveness

Soil

As described in Section 6.0, the most effective cost option for the Site is Alternative 2 (institutional controls). For Alternative 3 (excavation) there would be no cost benefit considering how localized the impacts are, their depth and the proximity to the building footprint.

Groundwater

The most cost effective alternative for groundwater is Alternative 2 (in-situ biological treatment & MNA). In-situ treatment would treat the groundwater in place with only the

installation of injection points. Alternative 3 (AS/SVE & Pump and Treat) requires infrastructure and O&M, and operation of pump and treat is typically a longer term treatment technology extending the costs over many years.

Soil Vapor

The costs to install and operate Alternative 2 (SSD system) are low, therefore this is a cost effective alternative for soil vapor intrusion.

7.2.6 Land Use

As described previously, the Site's current primary use is commercial and the Site is occupied by the SI Mall. The current receptor population includes mall occupants and shoppers. The anticipated future use of the Site remains commercial therefore the receptor population will remain the same.

Soil

As there are no plans to change the commercial use of the Site in the near future, Alternative 2 (institutional controls) is the best alternative as it does not impact the currently exposed population as would Alternative 3 (excavation). Alternative 2 (institutional controls) also takes into account future exposure by limiting disturbance of the area. In the event that future construction or redevelopment activities are proposed, Alternative 3 (excavation) would be an option, although subsurface activities to the water table are not likely.

Groundwater

Similarly, for groundwater the best alternative for the currently exposed population is Alternative 2 (in-situ biological treatment & MNA) as it requires minimal impact to the currently exposed population as compared with the significant infrastructure required for Alternative 3 (AS/SVE & Pump and Treat).

Soil Vapor

Installation and operation of Alternative 2 (SSD system) requires minimal disruption to the currently exposed population and is adequate to mitigate impacts in the breathing zone.

As described above, the last criteria, community acceptance is evaluated following public comment on the PRAP prepared by the NYSDEC DER.

8.0 REMEDY SELECTION AND RECOMMENDATION

This section provides the selected remedial technology based on the alternatives analysis in Section 7.0. A figure representing the approximate extent of the selected remedial alternatives is provided as Figure 9. The total Present Worth of the selected remedial alternatives is approximately $204,000 which includes capital costs of approximately $120,000.

8.1 Soil

The remedial technology selected for soil is Alternative 2 (institutional controls). Institutional controls will limit the potential for ingestion and dermal adsorption from soil for the currently exposed population and limit disturbance of the area during any future construction or Site redevelopment activities. It is anticipated that institutional controls will need to be in place indefinitely as long as the exposed population remains the same and residual CVOCs exist above the SCOs. Institutional controls will include asphalt cover and maintenance for 10 years. The Present Worth cost of implementation of institutional controls is approximately $11,000, which includes capital costs of approximately $5,000 (Table 4).

In the event that future construction or redevelopment activities are proposed, Alternative 3 (excavation) would be an option, although subsurface activities to the water table are not likely.

8.2 Groundwater

The remedial technology selected for groundwater is Alternative 2 (in-situ biological treatment & MNA) using sodium lactate. The benefit to using sodium lactate is it is a food grade product which biodegrades in the subsurface. In-situ biological treatment does not require infrastructure or O&M, and as presented in Section 4.0, would promote the already naturally occurring degradation of PCE and related breakdown CVOCs.

Injection points would be installed on-site near the Carol Cleaners source area and along the SI Mall parking lot adjacent to Platinum Avenue. The on-site and off-site monitor wells would be used to monitor the progress of the in-situ biological treatment. Monitor Wells MW-16, MW-17, MW-18 and MW-19 on the far side of Platinum Avenue will be used to determine compliance with the drinking water standards.

A detailed design including the locations of the injection points and monitor wells to be used will be presented in the pilot study workplan anticipated for submittal to the NYSDEC in April 2012. A pilot study is proposed to evaluate the effectiveness of lactate injections to enhance reductive dechlorination and determine the necessary number of rounds. The Present Worth cost of implementation of one round of full-scale in-situ biological treatment followed by 10 years of groundwater monitoring is approximately $130,000, which includes capital costs of approximately $70,000 (Table 5).

8.3 Soil Vapor

As proposed in the 2011 RIR, the remedial technology selected for soil vapor mitigation is Alternative 2 (SSD system). In addition, the selected remedial technology for groundwater (in-situ biological treatment & MNA) will address groundwater impacts and residual impacts in soil proximal to the respective tenant spaces which are influencing soil vapor concentrations.

The design for the SSD system was presented in the 2011 Remedial Investigation Report (RIR) submitted to the NYSDEC in October 2011. The timeframe required for operation of the SSD system is not known, however it is anticipated that when the groundwater remedial technology is implemented the soil vapor concentrations will be reduced and once the indoor air concentrations are below the NYSDOH guidance values the SSD system can be turned off. The Present Worth cost to install and operate the SSD system for 10 years is approximately $63,000, which includes capital costs of approximately $45,000 (Table 6).

Very Truly Yours

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