REMEDIAL INVESTIGATION REPORT
CAROL CLEANERS/ROUSE STATEN ISLAND MALL
STATEN ISLAND, NEW YORK

NYSDEC IHWDS SITE #2-43-020

Prepared for:

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CERTIFICATION STATEMENT

"I, Frank Getchell, certify that I am currently a Qualified Environmental Professional and that this Remedial Investigation 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."

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3/30/2012

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Date

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1.0 INTRODUCTION

On behalf of General Growth Properties, Inc. (GGP; formerly The Rouse Company [Rouse]), the hydrogeological and environmental consulting firm of Leggette, Brashears and Graham, Inc. (LBG) has prepared this Remedial Investigation Report (RIR) as a summary of supplemental activities conducted 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 RIR activities were completed in accordance with the Remedial Investigation Workplan (RIW) Addendum dated April 7, 2010, and as approved by the New York State Department of Environmental Conservation (NYSDEC) on October 14, 2010. The RIW addendum work focused on developing a better understanding of the on-site subsurface mechanisms for chlorinated volatile organic compound (CVOCs) fate and transport [specifically, the dry-cleaning solvent tetrachloroethene (PCE) and its breakdown products]; further delineation of the extent of groundwater impacted by CVOCs; and preliminary identification of conceptual methods for preventing future CVOC vapor intrusion into the indoor air space of respective Site tenants. These activities were performed under an existing Order On Consent between the NYSDEC and GGP (formerly Rouse), effective October 14, 2002 and recently updated by the Order On Consent effective October 5, 2011.

1.1 Background

An IRM investigation was completed by LBG on behalf of GGP in 2002 (Appendix I). The IRM investigation focused on identifying and locating the general source area for PCE and related CVOCs detected in the subsurface environment at the Site. As part of the IRM-related activities, soil and groundwater samples were collected at locations proximal to the Carol Cleaners and the Damowa Laundry & Dry Cleaning (aka Tumble Dry Cleaners) facilities (see Figure 2). The work completed as part of the past IRM ("Task 1" through "Task 6") was conducted to address the following: 1) the vertical and horizontal extent of CVOCs in soil in the area of the Carol Cleaners and Tumble Dry Cleaners 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 route of 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 "soil cleanup objective" [1.40 parts per million (ppm) as defined by NYSDEC "Technical and Administrative Guidance Manual (TAGM) 4046", Volatile Organic Compounds (VOCs) Soil Cleanup Criteria Table 1/ Recommended Soil Cleanup Objectives (RSCO)]. The detected exceedance was minor (2.05 ppm versus the 1.40 ppm RSCO) and isolated, occurring in only one soil sample ("B-1-6") that was collected at a depth of about 6-feet below grade (ft bg), which was just above the encountered local groundwater surface. The boring (B-1) from which the sample was collected, was completed at a location 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 Monitor Well MW-3 (Appendix I - Figure 3)]. No remediation of the overburden material near Boring B-1 (the "source area") was considered warranted based on: the relatively low concentration of PCE detected in the overburden at depth (about 6 feet) in the source area; the comparatively lower concentrations of PCE (below the TAGM objective of 1.4 ppm) detected at the numerous 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 groundwater sampling conducted between 1995 and 2004, indicated the presence of one or more CVOCs at concentrations above NYSDEC groundwater standards, as defined by 6 NYCRR Part 703, were detected 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 of the detected

compounds at Monitor Wells MW-3, MW-4, MW-5, MW-7, MW-8 and MW-9 occurred proximal to the Carol Cleaners facility and was of a limited extent.

Based on in-situ 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 formation at the Site is low to moderate. As such, groundwater and CVOC movement through the overburden on-site 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 of the groundwater sampling conducted 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 detection of methane, ethane and/or ethene in groundwater at most of the monitor wells, specifically those which are located the closest with respect to groundwater flow direction to the source area (Carol Cleaners).

Following completion of the IRM investigation activities, a Remedial Investigation (RI) was performed between 2006 and 2008 (Appendix II). The work completed as part of the RI focused on establishing the current soil vapor/indoor air quality, and refining previous assessment findings regarding 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 Babies R Us, SI Shoe Repair, Carol Cleaners, Mon Amie Nails and Carvel spaces indicated that the appropriate action for the respective tenant spaces were to reduce exposure to PCE and TCE. 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. In addition to the soil borings, seven additional monitor wells were installed at the Site as part of the RI activities including one shallow bedrock monitor well (MW-3D). The results of the subsequent round of groundwater sampling 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 affected by local subsurface utilities.

Based on the RI findings, LBG recommended continued groundwater monitoring to confirm the rate of natural degradation and further investigation of the role that on-site and nearby subsurface utilities potentially play in connection with the migration of CVOCs in groundwater in the vicinity of the Site and Platinum Avenue. The following RI report summarizes recent field activities conducted in connection with the recommendations from the RI report submitted in 2008, and those to further investigate the CVOC-impacted groundwater along Platinum Avenue.

2.0 SCOPE OF SUPPLEMENTAL RI WORK

Based on the results of the previous IRM investigation, the subsequent RI activities conducted between 2006 and 2008, and related discussions with the NYSDEC, LBG on behalf of GGP presented a Remedial Investigation Workplan (RIW) that proposed supplemental RI activities intended to: assess the potential for impacts from subsurface utility routes in the migration and extent of the CVOC plume; to further delineate the extent of CVOC-impacted groundwater; and to undertake an evaluation of current indoor air and sub-slab vapor conditions in the tenant spaces proximal to the Carol Cleaner.

As part of the proposed RIW activities, soil borings were advanced in May and July 2011, at on-site and off-site locations. The on-site locations corresponded to the Site storm water system route, while the off-site locations corresponded to utility routes beneath Platinum Avenue. In addition to the respective soil borings, water samples were collected from the on-site storm drain catch basins for the same purpose.

Following completion of the soil and storm water sampling program, four additional monitor wells (MW-16, MW-17, MW-18 and MW-19) were installed in July 2011 at off-site locations to further address plume delineation requirements as per the RIW addendum. Following installation of the additional monitor wells, a round of groundwater sampling inclusive of both previously installed and newly installed monitor wells was performed in August 2011. A second, confirmatory round will be completed in 2011.

As per the RIW addendum, the conceptual design of a sub-slab depressurization (SSD) system for the Babies R Us and adjacent strip mall space (e.g., Carol Cleaners) was developed based on an indoor air diagnostic program completed in November 2010. This RIR presents the details of the diagnostic testing performed in order to design an appropriate SSD system and also presents a proposed SSD design.

2.1 Soil Boring Program

2.1.1 Soil Borings – May 2011

Six (6) soil borings (SB-1 through SB-6) were advanced in May 2011 by Summit Drilling Co. of Bridgewater, New Jersey using a Geoprobe® rig. The borings were advanced at locations intended to assess the potential for CVOC-impacts from on-site subsurface utility routes, specifically storm water lines and as such were advanced in the parking areas on the western and southern sides of the mall building proximal to storm drain catch basins (Figure 3). The locations of the respective soil borings were surveyed in September 2011 by Volosin Associates, LLC.

Due to equipment-related limitations, each of the borings could only be advanced to the respective completion depths ranging from approximately 6 to 9 feet below grade (ft bg). Soil samples were continuously collected from the respective boreholes using a macro-core device with dedicated, disposable, clear-acetate sleeves. All drilling and sample collection equipment was decontaminated before and between set-ups at each boring location. All of the resulting

boreholes were backfilled with bentonite, and cold patch /concrete was used to finish the respective grade surfaces.

The subsurface materials and conditions encountered at each boring location (e.g., depth to groundwater and bedrock) were characterized by the on-site LBG hydrogeologist. The grain-size makeup of the encountered overburden materials were described using the Unified Soil Classification System and the Modified Burmister Method. The respective soil boring logs are provided in Appendix III. The LBG hydrogeologist also recorded any evidence of odor, staining, and VOC presence (determined using a PID). Samples exhibiting elevated VOC concentrations (as per the PID) were screened for DNAPL using hydrophobic dye (i.e., Sudan IV). Cuttings generated during the completion of the respective borings were placed in 55-gallon sealable steel drums, labeled and staged in a previously determined location for appropriate disposal at a later time.

The overburden materials encountered at each of the boring locations were consistent with those encountered during previous on-site subsurface explorations elsewhere at the Site. The naturally-occurring materials generally consisted mainly of fine grain-size deposits of clay, silt, and fine sand with varying amounts of gravel. A total of nine (9) soil samples were collected for subsequent laboratory analyses at depths corresponding to immediately above the encountered groundwater surface (typically about 5 ft bg) and/or above refusal at each boring location. The respective soil samples along with QA/QC blanks (field and trip) were submitted for laboratory analyses in laboratory provided containers. No soil samples were collected from Boring SB-3 due to refusal of the Geoprobe at a shallow depth of 3 ft bg.

A written chain-of-custody record was maintained by the on-site LBG hydrogeologist to trace the collection, possession, and handling of each sample from the time of its collection to its final fate, including all transfers, storage, analysis, and ultimate disposition by the laboratory. The collected samples and QA/QC blanks were submitted to Accutest Laboratories (Accutest) of Dayton, New Jersey (an NYSDEC Certified Laboratory), and analyzed for VOCs using EPA Method 8260B, and for total organic carbon (TOC). The detection limits used by Accutest for

Method 8260B were lower than the respective regulatory action levels for the corresponding VOCs. The data were reviewed by Accutest to confirm compliance with NYSDEC "Guidance for the Development of Data Usability Summary Reports" (DUSR). The laboratory data package is provided in Appendix IV.

A summary of the analytical results is provided as Table 2. The analytical results for the respective soil samples did not indicate the occurrence of any of the CVOCs of interest at concentrations in exceedance of the respective NYSDEC Restricted Use Commercial Soil Cleanup Criteria (SCOs). No evidence of DNAPL was encountered at any of the boring locations.

2.1.2 Soil Borings – July 2011

Five (5) soil borings (SB-7 through SB-11) were advanced in July 2011 by Summit Drilling Co. of Bridgewater, New Jersey using a hollow-stem auger rig. The borings were advanced at locations intended to assess the potential for CVOC-impacts from off-site subsurface utility routes, specifically the sanitary sewer line running beneath Platinum Avenue. As such, one soil boring (SB-7) was advanced in the entry to the mall building from Platinum Avenue and the remaining four soil borings (SB-8 through SB-11) were advanced in a line along Platinum Avenue (Figure 3). The locations of the respective soil borings were surveyed in September 2011 by Volosin Associates, LLC.

Each soil boring was advanced from grade to refusal, which typically corresponded to the top of the local bedrock surface. Soil samples were continuously collected from the respective boreholes using a split-spoon device. All drilling and sample collection equipment was decontaminated before and between set-ups at each boring location. All of the resulting boreholes were backfilled with bentonite, and cold patch /concrete was used to finish the respective grade surfaces.

The subsurface materials and conditions encountered at each boring location (e.g., depth to groundwater and bedrock) were characterized by the on-site LBG hydrogeologist. The grain-

size makeup of the encountered overburden materials were described using the Unified Soil Classification System and the Modified Burmister Method. The respective soil boring logs are provided in Appendix III. The LBG hydrogeologist also recorded any evidence of odor, staining, and VOC presence (determined using a PID). Samples exhibiting elevated VOC concentrations (as per the PID) were screened for DNAPL using hydrophobic dye (i.e., Sudan IV). Cuttings generated during the completion of the respective borings were placed in 55-gallon sealable steel drums, labeled and staged in a previously determined location for appropriate disposal at a later time.

As with previous borings, the overburden materials encountered at each of the boring locations was consistent with those encountered during previous subsurface explorations at the Site. The naturally-occurring materials generally consisted mainly of fine grain-size deposits of clay, silt and fine sand with varying amounts of gravel. The encountered depth to groundwater and bedrock ranged from about 7 to 13 ft bg, and 15 to 18 ft bg, respectively. Soil samples were collected at the interval immediately above the encountered groundwater surface and the interval immediately above the bedrock surface at each boring location. The collected soil samples along with QA/QC blanks (field and trip) were submitted for laboratory analyses in laboratory provided containers.

A written chain-of-custody record was maintained by the on-site LBG hydrogeologist to trace the collection, possession, and handling of each sample from the time of its collection to its final fate, including all transfers, storage, analysis, and ultimate disposition by the laboratory. The collected samples and QA/QC blanks were submitted to Accutest and analyzed for VOCs using EPA Method 8260B, and for total organic carbon (TOC). The detection limits used by Accutest for Method 8260B were lower than the respective regulatory action levels for the corresponding VOCs. The data were reviewed by Accutest to confirm compliance with NYSDEC DUSR. The laboratory data package is provided in Appendix V.

A total of ten (10) soil samples were collected from the soil borings conducted in Platinum Avenue. A summary of the analytical results is provided as Table 2. The analytical

results for the respective soil samples did not indicate the occurrence of any of the CVOCs of interest at concentrations in exceedance of the respective NYSDEC Restricted Use Commercial Soil Cleanup Criteria (SCOs). No evidence of DNAPL was encountered at any of the boring locations.

2.2 Storm Drain Sampling Program

On May 13, 2011 six (6) storm drain catch basins were sampled in order to assess the potential for subsurface storm water piping routes to influence the migration and extent of the CVOC plume. The respective catch basins are identified as Storm Drain 1 through Storm Drain 4 (labeled as CB-1 through CB-4) and Storm Drains 6 and 7 (labeled as CB-6 and CB-7). Storm Drain 5 (labeled as CB-5) could not be sampled as there was no standing water present at the time of sampling. The locations of the storm drains are provided on Figure 3. The storm drain system flows from CB-4 to CB-8 towards the south, then towards the northwest. The bottom depths of the respective storm drain catch basins range between 3.0 ft bg at catch basin CB-3 to 6.28 ft bg at catch basin CB-7. The respective storm drain catch basin location and grade elevations were surveyed in September 2011 by Volosin Associates, LLC. Using the survey and depth information, the respective catch basin bottom elevations were established (Table 3). Based on the respective calculations, the corresponding storm drain piping and catch basin bottom elevations are higher than the proximal groundwater elevation as determined from the nearby monitor wells.

A total of six (6) water samples were collected from the on-site catch basins with dedicated Teflon bailers. The samples were transferred directly into laboratory supplied bottles and placed in a cooler with ice for later laboratory analysis. The collected samples were submitted along with the soil boring samples collected on May 12, 2011 to Accutest for VOC analysis via EPA Method 8260. Laboratory QA/QC blanks (field and trip) were submitted and analyzed using Method 8260 as part of the sampling program. The data were reviewed by Accutest to confirm compliance with NYSDEC DUSR. The laboratory data package is provided in Appendix IV.

The analytical results for the respective surface water samples indicated exceedances of the NYSDEC Surface Water/Groundwater Standards for PCE, TCE, cis-1,2-DCE, and toluene as shown in Table 4. The concentrations of PCE of 39.6 ug/L, 59.9 ug/L and 30.5 ug/L exceeded the standard of 5 ug/L or parts per billion (ppb) at catch basins CB-1, 2 and 6, respectively. The concentrations of TCE of 6.5 ug/L and 9 ug/L exceeded the standard of 5 ug/L at catch basins CB-1 and 2, respectively. The concentrations of cis-1,2-DCE of 17.8 ug/L, 23.1 ug/L, 10.7 ug/L, and 12.5 ug/L exceeded the standard of 5 ug/L at catch basins CB-1, 2, 3 and 6, respectively. The concentration of toluene of 7.6 ug/L exceeded the standard for toluene of 5 ug/L at catch basin CB-4.

The CVOC-impacted surface water detected in catch basins CB-1, 2, 3 and 6 occurs at locations corresponding to the eastern and southern portions of the Site. Though the soil samples collected from borings located adjacent to the respective storm drains did not exhibit CVOC concentrations above the respective SCOs, the comprising compounds of PCE, TCE, cis-1,2-DCE, and VC were still detected. Based on the fact that the surface water in the storm drains is higher in elevation than the surrounding groundwater it does appear that CVOCs in the storm water system have impacted the on-site overburden groundwater and that historical dumping of CVOCs into the storm drains took place at some point in time.

2.3 Supplemental Groundwater Sampling

2.3.1 Monitor-Well Installations

As part of the RIW addendum, four (4) monitor wells (MW-16, MW-17, MW-18 and MW-19) were installed off-site, under New York City Department of Transportation (NYCDOT) Street Opening Permit # S01-2011196-014, along Platinum Avenue at locations as close as possible to the southern Pergament property boundary (Figure 4). These monitor wells were installed in order to provide for a more comprehensive delineation of the off-site CVOC-impacted groundwater. All existing and newly installed on-site and off-site monitor wells were surveyed in September 2011 by Volosin Associates, LLC.

The monitor well boreholes were advanced to the respective bedrock surface by Summit Drilling Co. using hollow stem augers. As per the RIW addendum, the respective monitor wells were constructed with 2-inch diameter PVC riser and screen set. Each monitor well was constructed with five feet of screen with the bottom set immediately at the encountered bedrock surface, and surrounded by a gravel pack overlain by a bentonite seal. Soil samples retrieved during the drilling of the respective monitor-well boreholes were screened for VOCs using a PID. Samples exhibiting elevated VOC concentrations (as per the PID) were screened for DNAPL using hydrophobic dye (i.e., Sudan IV). No evidence of DNAPL was encountered during advancement of any of the monitor well boreholes. Each completed monitor well was developed, and the purge water contained on-site for future appropriate disposal. Activities associated with the installation of each of the monitor wells were implemented following applicable NYSDOH Community Air Monitoring Plan (CAMP) guidelines.

Monitor Wells MW-16, MW-17, MW-18 and MW-19 were completed at depths of 28 ft bg, 26 ft bg, 20.5 ft bg and 20.5 ft bg, respectively. The depths to water encountered at Monitor Wells MW-16, MW-17, MW-18 and MW-19 were approximately 9.5 ft bg, 8.4 ft bg, 9.5 ft bg, and 10.0 ft bg, respectively. The construction information for all of the on-site and off-site monitor wells completed to date is summarized in Table 5. Geologic logs for each of the newly installed monitor wells (MW-16, MW-17, MW-18 and MW-19) are provided in Appendix VI.

2.3.2 Groundwater Sampling

A comprehensive round of groundwater samples was collected between August 2 and 4, 2011 from the existing and newly installed monitor wells with the exception of Monitor Well MW-14 (Figure 4). The United States Environmental Protection Agency (USEPA) "low-flow" purging and sampling method, was employed using a peristaltic pump at each of the monitor wells.

Prior to purging, the depth to water was measured at each of the candidate monitor wells utilizing a combination electric water-level/DNAPL interface probe, accurate to the nearest 0.01-

feet. The collected groundwater levels were subsequently converted to groundwater elevations using survey information for the respective monitor wells (Table 5). The subsurface cover for Monitor Well MW-14 was damaged and could not be opened at the time of sampling. Therefore a water level measurement and groundwater sample could not be collected during the August 2011 sampling event. Based on the distribution of the respective groundwater elevations, the general direction of groundwater flow is toward the southwest (Figure 4). This direction is relatively consistent with the historic direction determined for the Site. The groundwater elevation data also indicate that the local vertical flow gradient is downward from the overburden into the bedrock (i.e., Monitor Wells MW-3 and MW-3D).

During purging, the temperature, pH, conductivity, turbidity, dissolved oxygen concentration, and redox potential of the discharged water were monitored using a Horiba U-22 flow-through cell water-quality meter. The respective readings were recorded on the low-flow groundwater sampling log sheets as provided in Appendix VII. The purge water was contained in drums on-site for future disposal.

Groundwater samples were collected from the peristaltic pump discharge downstream of the Horiba flow-through cell, and placed directly into laboratory supplied bottles. The collected samples were then submitted to Accutest for analysis of VOCs via EPA Method 8260. Samples were also analyzed for natural-degradation indicator parameters including: methane and ethane/ethene via EPA Method 8015; hardness; and chloride. Sulfate and carbon dioxide concentrations in the discharge water were determined in the field using the Horiba water-quality meter. Laboratory QA/QC blanks (field and trip) were submitted and analyzed using Method 8260 as part of the sampling program. The analytical data was reviewed by Accutest in accordance with NYSDEC DUSR. The laboratory data package is provided in Appendix VIII.

Based on the analytical results for the nineteen groundwater samples collected during the August 2011 sampling round, one or more CVOCs were detected at all the sampled monitor well locations with the exception of Monitor Wells MW-1, MW-6R and MW-15 (Table 6).

Exceedances of the respective NYSDEC Groundwater Standards were identified for one of more CVOCs at Monitor Wells MW-2, MW-3, MW-4, MW-5, MW-7, MW-8, MW-9, MW-11, MW-12, MW-13 and newly installed Monitor Wells MW-16, MW-17, MW-18 and MW-19. Concentrations of PCE ranged from not detected at Monitor Wells MW-1, MW-6R, MW-10 and MW-15 to 2,490 ug/L (ppb) at Monitor Well MW-4. The occurrence of the related "breakdown" CVOCs (TCE, cis-1,2-DCE, and VC) at concentrations above the respective groundwater standards was generally detected in those monitor wells located downgradient (southwest) of Carol Cleaners. There were no exceedances of CVOCs detected in the groundwater sample collected from bedrock Monitor Well MW-3D.

The distribution of PCE concentrations and its breakdown CVOCs in groundwater occurring during the August 2 – 4, 2011 sampling round are presented on Figure 5. Based on the historic (Table 1) and most recent analytical data, the CVOC distribution in groundwater and the encompassing PCE plume is generally following the local direction of groundwater flow towards Platinum Avenue. The related distribution of breakdown constituents including TCE, cis-1,2-DCE and VC along Platinum Avenue confirms this general migration direction. However, as presented in the RI, the plume migration route also appears to reflect a localized hydraulic influence corresponding to the route of Platinum Avenue.

The analytical results regarding the corresponding reductive-dechlorination indicator parameters are summarized in Table 7. The analytical results indicate that groundwater at the locations of most of the existing and newly installed monitor wells exhibit the occurrence of methane, ethane and/or ethene, which indicates that the corresponding PCE and related CVOCs are undergoing some degree of reductive dechlorination. Monitor Wells MW-5 and MW-7 were the exception where methane, ethane and ethene were not detected, however these wells are located on the edge of the CVOC plume and as such do not have much contributory source mass. As described previously Monitor Well MW-14 was not accessible during the August sampling round, however, PCE and related CVOCs historically have not been detected at this monitor well.

2.4 Hydrogeologic Characterization

In order to further characterize the on-site and off-site subsurface environment, and its related influence on groundwater flow and CVOC migration, in-situ hydraulic testing and mapping of local geologic formations were completed using the information gleaned from the recently completed borings and expanded monitor-well network. To this end, "slug tests" were performed on a select number of monitor wells located about the CVOC plume area. Additionally, a hydrogeologic cross-section was prepared utilizing several existing and newly installed monitor wells to illustrate the sub-surface conditions at the Site with respect to the CVOC plume. These tasks and the results are further described below.

2.4.1 Hydraulic Conductivity

Slug testing was previously conducted at the Site in November 2002. Based on the slug testing performed in 2002, it was determined that the hydraulic conductivity of the overburden materials underlying the Site generally ranged from 0.06 feet per day (ft/d) to 0.7 ft/d and are typical for fine sand and mixtures of fine sand and silt that primarily comprise the overburden.

Additional slug testing was performed in October 2011 utilizing on-site Monitor Wells MW-4, MW-5, MW-6R, MW-15, and off-site Monitor Wells MW-11 and MW-16. The tests were conducted by rapidly introducing a solid, 2½" diameter inert PVC "slug" beneath the standing groundwater within the respective monitor well. A complimentary test was subsequently completed as the slug was removed from the monitor well. The corresponding rise and fall of the standing column water level was monitored at rapid intervals using a pressure transducer and data logger. The collected data were analyzed using the Bouwer-Rice method. The respective slug-test data and analysis results are summarized in Appendix VIV.

The slug test analysis results indicate a range of on-site hydraulic conductivity values of about 0.4 ft/d at Monitor Well MW-6R to 1.8 ft/d at Monitor Well MW-15. The hydraulic conductivity values for off-site overburden materials underlying Platinum Avenue ranged from about 29.2 ft/d at Monitor Well MW-11 to 7.0 ft/d at Monitor Well MW-16. The contrast

between the ranges of on-site overburden and off-site hydraulic conductivity values appear to reflect an increase in the amount of coarse sand and gravel in the deeper portion of the overburden that occurs to the west-southwest of the Site. As such, groundwater movement through the on-site overburden is anticipated to occur at a slower rate than that occurring off-site along Platinum Avenue. However, the relative difference is not significant enough to cause the on-site overburden to be any more or less favorable than the off-site overburden to naturally occurring reductive dechlorination.

2.4.2 Bedrock Surface/Geologic Cross-Section

As part of the soil boring completion and monitor-well installation activities implemented since the 1990s, the respective encountered materials and depth to bedrock were characterized by an LBG hydrogeologist. As such the depth to bedrock encountered at the Site ranges from approximately 12 ft bg at Monitor Well MW-2 to 28 ft bg at Monitor Well MW-16. The encountered depths to bedrock were converted to approximate elevations and water used to map the surface elevation of the bedrock across the Site (Figure 6). Based on the respective map, the corresponding bedrock surface generally slopes downwards in elevation from the vicinity of Monitor Well MW-1 where the bedrock elevation is 31 feet above mean sea level (famsl) towards the southwest at Monitor Well MW-16 where the bedrock elevation is 2 famsl. In addition to the general slope in surface towards the southwest, 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 groundwater flow in the overburden.

Besides determining the local bedrock surface, the boring and monitor-well logs were used to prepare a hydrogeologic cross-section (A-A') that illustrates the vertical distribution of encountered surface conditions across the Site (Figure 7). The respective cross-section illustrates the general slope of the bedrock surface from northeast to southwest, and a similar slope in groundwater surface. The cross-section also illustrates the increase in thickness of the naturally occurring overburden materials (primarily fine sand and silt) from northeast to southwest.

2.5 CVOC Plume Delineation

As of the 2008 groundwater sampling event, it was concluded that the local on-site storm water system could be locally influencing CVOC migration at the Site. As described in Section 2.3, water samples collected from the storm drain system catch basins on the eastern and southern side of the mall building exhibited PCE concentrations ranging from "not detected" at CB-4 (upgradient of the CVOC-impacted groundwater plume) to 59.9 ug/L and 39.6 ug/L identified at CB-2 and CB-1, respectively. It should be noted that though the storm water sampled at CB-1 exhibited a PCE concentration of 39.6 ug/L, the adjacent monitor well (MW-6R) did not exhibit the presence of PCE or any of the related VOCs. Given that most of the soil samples collected above the groundwater surface and adjacent to the on-site storm water catch basins and sanitary sewer lines along Platinum Avenue exhibited slightly detectable CVOC concentrations (e.g., CB-4 and Boring SB-6), it appears that a link exists between the respective utility lines and the respective CVOC plume.

Based on the distribution of PCE and related CVOCs in groundwater, the corresponding plume is generally following the local direction of groundwater flow from the Site towards Platinum Avenue. The wide-spread occurrence of PCE breakdown constituents (TCE, cis-1,2-DCE and VC) occurring in groundwater along Platinum Avenue substantiates the plume migration route and persistence of reductive dechlorination along its extent. Based on historical and recent sampling results, it can be concluded that: the on-site CVOC-impacted groundwater has been delineated in the overburden; the shallow bedrock groundwater underlying the Site near the Carol Cleaners (MW-3D) exhibits minimal CVOC impact (all detections below the respective NYSDEC Groundwater Standards); and no evidence of DNAPL has been found on-site. The off-site portion of the plume exhibits elevated CVOC concentrations to the west of the intersection of Platinum Avenue and Staten Island Mall Drive, and includes a localized "hot spot" of PCE-impacted groundwater. The absence of DNAPL and occurrence of an off-site "hot spot" in the plume suggest an intermittent source of PCE.

The data collected to date, suggests that the initially identified PCE-impacted groundwater occurring at the rear of Carol Cleaners, in the vicinity of Monitor Well MW-3 has diminished in influence. However, the historic data also suggest that either the initially identified "source area" has shifted from the vicinity of Monitor Well MW-3 or has been replaced and/or supplemented by another source near Monitor Well MW-4 along Platinum Avenue. Furthermore, the apparent shift and/or addition of a "source area" appear to be influencing PCE concentrations near Monitor Well MW-13. Based on the recent storm water and soil boring sampling, in conjunction with the August 2011 monitor well sampling round, it appears that the shift in CVOC concentration discussed above may be due to contributions from other sources besides Carol Cleaners. Specifically, it appears that PCE discharges to one or more of the on-site storm water system catch basins, this along with the downward bedrock-surface slope and groundwater gradient allows for plume persistence and migration along Platinum Avenue. As such, the existing monitor-well network is adequate for long-term monitoring of CVOC migration and attenuation relative to the Site.

2.6 Sub-Slab Vapor Mitigation

The results of the April 2006 and February 2008 indoor air and sub-slab air sampling summarized in the RI report submitted in 2008, indicated that PCE and related CVOCs have impacted the indoor air in the Babies R Us space, and the adjacent strip mall spaces occupied by SI Shoe Repair, Carol Cleaners, Mon Amie Nails and Carvel (Appendix II). The locations and results of previously collected indoor air and sub-slab air samples are shown on Figure 8. The areas where indoor air impacts appear to be greatest are generally coincident with areas corresponding to the nearby groundwater plume. Based on the detected concentrations and respective NYSDOH guidelines, a sub-slab depressurization (SSD) system is proposed to mitigate these impacts.

As per the RIW addendum, sub-slab communication testing was performed in November 2010 at the respective spaces. The testing was completed by Obar Systems of Highland Lakes, New Jersey under the observation of LBG and focused on the preparation of an appropriate SSD

system design for the Babies R Us and the adjacent strip mall spaces. The following sections summarize the results of the diagnostic testing and describe the conceptual design aspects of the proposed SSD system for the Site.

2.6.1 General Building Information

The property was developed in the early 1970s in three separate phases as a retail shopping mall (the SI Mall). The portion of the building where Babies R Us, SI Shoe Repair, Carol Cleaners, Mon Amie Nails and Carvel spaces are situated was constructed during the initial phase in the early 1970s. The building is a slab-on-grade steel frame and masonry construction. There is no basement in this building.

In designing an SSD system for a large building such as the SI Mall, it is important to understand the nature and extent of the CVOC source beneath the building, and the range of pressure differentials between the sub-slab vapor and the indoor air space. Large commercial buildings with sub-slab vapor contaminant issues are often found to have source zones that underlie only a portion of the floor slab and that may be isolated due to footings and other subsurface construction components. Typical indoor air vapor source zones may include areas of contaminated soil above the groundwater surface or the presence of a plume of contaminated groundwater. In developing the system design for a large building it is important to focus the design on areas where depressurization is required in order to intercept contaminated soil vapor before it can enter the building. Soil gas beneath other portions of the building (not overlying or in proximity to the source zone) will eventually become depleted of CVOCs if an effective, source-focused SSD system is put into operation.

2.6.2 SSD System Design Focus Area

An SSD system installation focus area was developed for the portion of the SI Mall building that was based upon the locations of the more elevated PCE concentrations observed in the sub-slab and in an area coincident with the CVOC-impacted groundwater. The comprehensive area includes a portion of the Babies R Us, SI Shoe Repair, Carol Cleaners, Mon Amie Nails and Carvel spaces of the mall building (Figure 9). The affected portions of the

building can be best addressed by performing active mitigation efforts on the area where the highest concentrations were observed. Any residual vapors in the more distal portions of the sub-slab area can be depleted during the initial weeks of operation of the mitigation system. Thus, the objective of an appropriately designed SSD system for the space has been determined to be one that will effectively achieve a vacuum of at least 0.004 inches of water column (inches w.c.) beneath the slab floor within the focus area.

In a large commercial facility such as the SI Mall, the degree of pneumatic communication between the sub-slab vapor environment and the indoor air (and consequently VOC levels in indoor air) can be highly variable because of ventilation changes due to entry dynamics, weather and building operation. Despite these variations, it has been concluded that an SSD system can be implemented to maintain a negative pressure below the slab to mitigate the intrusion of VOCs from soil vapor.

2.6.3 Sub-Slab Communication Testing

In order to prepare a design for the SSD system, sub-slab pneumatic communication tests were performed throughout the SSD focus area. A total of 115 diagnostic measurements were collected at 28 locations in the Babies R Us space, while 23 diagnostic measurements were collected at 10 locations in the adjacent strip mall as shown on Figure 9.

The diagnostics testing consisted of first installing 2.5-inch diameter suction test holes (drilled through the slab). Two suction test holes designated as S1 and S2 were installed at the Babies R Us space and at the adjacent strip mall (S1) as shown on Figure 9. Numerous smaller, 5/16-inch diameter, vacuum observation holes were installed in the Babies R Us space (SSP1 through T26) and in the adjacent strip mall spaces (SSP1 through T10). A specialized Sub-Slab Diagnostic Vacuum (SSDV) capable of pulling a flow of 200 cubic feet per minute (cfm) and vacuum of 45 inches w.c. was used with a variable speed controller to withdraw air from the suction test holes while pressure differential measurements were obtained from the vacuum test holes. Suction tests were conducted at the suction test holes at different operating vacuum

levels. The resulting sub-slab vacuum fields were observed in the test holes and recorded for each test. Using these observations, presented in Tables 8 and 9, the relative pneumatic permeability of the underlying soil was evaluated based on the vacuum generated at the suction hole versus the resulting negative pressure observed in the nearest test hole. This information, when plotted relative to a number of commonly used commercial fan curves, was used to determine an appropriate fan and the corresponding system piping necessary to adequately depressurize the sub-slab soil.

2.6.4 Sub-Slab Communication Testing Results

The diagnostic testing in the Babies R Us space indicates that the perimeter of the store has a large volume of available sub-slab air with communication observed beyond 100 feet. The interior of the building has a denser sub-slab material and a lower volume of available sub-slab air with communication observed at 65 feet. The diagnostic testing in the adjacent strip mall spaces indicate a sub-slab communication of 45 feet in addition to a large volume of air available at the rear of the building which is caused by fill materials settling in the areas of the slab located above grade.

The data showing the results of the radius of influence of the applied vacuum field during pneumatic communication testing at the Babies R Us space and the adjacent strip mall spaces are graphically presented in Figures 10 and 11, respectively. Based on the vacuum extension data observed during the diagnostic testing, a total of six suction points will be required: three suction points at the Babies R Us space; and three suction points in the Carol Cleaners space. One of the suction points will be connected directly to a high volume blower fan to address the large volume of air available at the rear of this space. All together, the suction points will be capable of inducing a pressure change of 0.004 inches w.c. in the focus area.

2.6.5 Determination of the Fan Size

Plots showing the observed pneumatic resistance of the soil relative to the predicted performance of two pre-selected system fans when connected to single suction locations are provided in Figure 12. The fan performance curve is indicated in blue with the soil resistance

lines showing the extrapolations of the observed vacuums induced at the various suction points (in cfm) versus the corresponding pressure change observed at the nearest monitoring point (about one foot from the respective suction hole). The fans must be properly sized to produce the necessary negative pressure and flow rate at each of the suction ports. The fan performance plots indicate the required vacuum needed to produce a given airflow at each suction test location as a function of the observed pneumatic permeability of the sub-slab soil. The intersection of the fan curve and the observed soil resistance curve is used to predict the final airflow required to achieve the desired sub-slab pressure at the location tested.

Based on the diagnostic data, two different fan makes were selected due to the differing sub-slab soil characteristics across the focus area for the mitigation system design, and to minimize the number of roof penetrations. Two high output GBR 76 blowers will be utilized to tie in three suction points together at the Babies R Us space and two suction points in the Carol Cleaners space. In addition, a Fan Tech FR-225 will also be utilized at one suction point in the rear of the Carol Cleaners space to handle the higher volume of sub-slab air encountered during the diagnostic testing. The performance chart for the Fan Tech-225 is shown in Figure 13.

2.6.6 SSD Design Parameters and Layout

Based on the results of the diagnostic testing and the effective radius calculations, the property will require as stated previously, a total of six suction points: three suction points at the Babies R Us space; and three suction points in the Carol Cleaners space. One of the suction points will be connected directly to a high volume blower fan to address the large volume of air available at the rear of this space. All together, the suction points will be capable of inducing a pressure change of 0.004 inches w.c in the focus area.

The SSD system will consist of three suction points in the Babies R Us space connected to a GBR 76 blower fan capable of providing a vacuum of 15 inches w.c. with a flow of 90 cfm or a vacuum of 15 inches w.c. with a flow of 30 cfm at each suction point.

The SSD system in the Carol Cleaners space will consist of two suction points connected to a GBR 76 blower fan capable of providing a vacuum of 22 inches w.c. with a flow of 66 cfm or a vacuum of 22 inches w.c. with a flow of 33 cfm at each suction point. Additionally, a third suction point located on the exterior southern wall of the Carol Cleaners space will be connected to Fantech FR-225 fan operating at a vacuum of 1.5 inches w.c. with a flow of 300 cfm. This third suction point is designed to handle the large volume of sub-slab air encountered in this area during the diagnostic testing. The blower fans will be a mounted on the roof of the mall building. A design drawing showing the location of these features is provided as Figure 14. The installation specifications for the SSD system are provided in Appendix X.

3.0 SUMMARY

The results of the recent RI activities completed at the Carol Cleaners/Rouse Staten Island Mall indicate the following:

1) The subsurface conditions encountered as part of the soil boring program indicate the generally dominant occurrence of finer-grain overburden materials consistent with those previously encountered at the Site. The depth to bedrock encountered at the recently installed monitor wells slopes drastically downward to the southwest. The observed conditions did not indicate any evidence of DNAPL in the overburden or at the bedrock interface. The respective analytical results for the collected soil samples indicate that no CVOCs occurred in the unsaturated overburden at concentrations above the respective NYSDEC SCOs. Furthermore, most of the results indicate non-detect concentrations. This is generally consistent with previous soil sampling results from 2002, 2006 and 2008.

2) The groundwater conditions which were determined using the expanded monitor-well network indicate that the general groundwater flow direction in the overburden is towards the southwest, towards Platinum Avenue, and the vertical gradient is downward from overburden to the bedrock.

3) The analytical results for the recent groundwater sampling round indicate the presence of one or more CVOCs at concentrations above the respective NYSDEC Groundwater Standards at Monitor Wells MW-2, MW-3, MW-4, MW-5, MW-7, MW-8, MW-9, MW-11, MW-12, MW-13 and newly installed Monitor Wells MW-16, MW-17, MW-18 and MW-19. The detected elevated CVOCs consist of PCE and its breakdown products: TCE, cis-1,2-DCE, and VC. Based on the limited occurrence of CVOC-impacted soil, absence of DNAPL, the determined groundwater flow direction, and distribution of the respective CVOCs in groundwater at the Site, past activities at the Carol Cleaners space

and the on-site storm water system are the apparent source areas associated with the plume emanating from the Site.

4) The historical and recent analytical data indicate that the PCE occurring in the groundwater at the Site is clearly undergoing reductive dechlorination resulting as reflected in the observed formation of the related breakdown compounds (TCE, cis-1,2-DCE and VC). This point is further corroborated by the detection of methane, ethane, and/or ethene at mostly all of the monitor wells. As such, the naturally occurring subsurface conditions and slow groundwater transport at the Site are conducive to the continued natural degradation of the CVOCs in soil and groundwater associated with the on-site dry cleaner source areas. In addition, these areas do not exhibit evidence of residual source material (DNAPL). Enhancement of the naturally occurring degradation of PCE and related CVOCs is expected to be promoted by focused remediation of the plume area near Carol Cleaners, and possible remedial measures associated with the on-site storm drain system (e.g., catch basin cleaning and sealing).

4.0 RECOMMENDATIONS

Based on the investigation completed to date, the following recommendations are warranted:

1) The extent of the CVOC-impacted groundwater in the vicinity of recently installed monitor wells along Platinum Avenue is adequate for long-term monitoring of the continued migration and attenuation of CVOC-impacted groundwater emanating from the Site. However, additional evaluations regarding the role of the on-site storm water system need to be implemented.

2) A feasibility study (FS) focused on removal of residual PCE source(s) has been prepared in conjunction with this RIR and is presented under separate cover.

3) Though reductive dechlorination and low on-site groundwater velocity is continuing to mitigate the impact of PCE in groundwater at the Site, continued groundwater monitoring on an annual basis is recommended to confirm the rate of natural degradation.

4) The diagnostics testing results indicate that an SSD system located in the Babies R Us and Carol Cleaners spaces will be effective in mitigating the CVOC-impacted indoor air at these locations.

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