TETRA TECH

Remedial Investigation Report

Site 016
Jersey City, New Jersey

PPG Industries, Inc.
Pittsburgh, PA

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ACRONYMS

bgs	below ground surface
CCPW	Chromate chemical production waste
COPEC	Contaminants of Potential Environmental Concern
COPR	Chromite ore processing residue
CrSCC	NJDEP Chromium Soil Cleanup Criteria
EE	Ecological Evaluation
EPI	Environmental Probing, Inc.
ESNR	environmentally sensitive natural resources
GWQS	Ground Water Quality Standard
HSA	Hollow stem auger
IDW	Investigation derived waste
IGW SSL	Impact to Groundwater Soil Screening Level
mg/kg	milligram per kilogram
MS/MSD	Matrix spike and matrix-spike duplicate
NJDEP	New Jersey Department of Environmental Protection
NRDC SRS	Non Residential Direct Contact Soil Remediation Standard
PPG Industries, Inc.	PPG
RDC SRS	Residential Direct Contact Soil Remediation Standard
RI	Remedial Investigation
SPLP	Synthetic Precipitation Leaching Procedure
Tetra Tech	Tetra Tech, Inc.
ug/L	Microgram per Liter
USEPA	United States Environmental Protection Agency

EXECUTIVE SUMMARY

On behalf of PPG Industries, Inc. (PPG), Tetra Tech has prepared this Remedial Investigation (RI) Report summarizing field activities conducted at Site 016, in Hudson County, Jersey City, New Jersey. The RI was conducted to determine the nature and extent of the chromate chemical production waste (CCPW, aka COPR - chromite ore processing residue) contamination.

Investigations conducted at the Site are subject to the 1990 Administrative Consent Order between PPG and the New Jersey Department of Environmental Protection (NJDEP). In 2009, PPG, NJDEP and the City of Jersey City entered into a Judicial Consent Order with the purpose of remediating the sources and soil contamination at the impacted sites (AECOM, 2011).

Site 016 was investigated due to the presence of CCPW that contains chromium, hexavalent chromium, and other metals on the property. Interim remedial actions were conducted in 1992 to minimize the exposure to CCPW. The investigation conducted for this RI report consisted of sampling soil, groundwater, and concrete from the floor slab and foundation of the building.

Initial investigation field activities were conducted during August and September 2011 and January 2012. The soil and groundwater samples for the initial investigation were analyzed using United States Environmental Protection Agency (USEPA) Method SW-846 6010C (USEPA, 2007b), based on the Remedial Investigation Work Plan (RIWP) (AECOM, 2011). The results (both detections and non-detections) were compared to the New Jersey Department of Environmental Protection (NJDEP) Residential Direct Contact Soil Remediation Standard (RDC SRS), Non-Residential Direct Contact Soil Remediation Standard (NRDC SRS), and default and site-specific Impact to Groundwater Soil Screening Levels (IGW SSL) for the CCPW metals, each on a separate table and the exceedances of these soil remediation standards/screening levels are shown on separate figures.

During the initial investigation, 463 samples were collected, 69 samples were surface soil and 394 samples were subsurface soil. Chromium, nickel, vanadium, antimony, and hexavalent chromium were present in the samples obtained from Site 016. The samples obtained during the initial investigation that contained chromium did not exceed the NJDEP Chromium Soil Cleanup Criteria (CrSCC) for trivalent chromium (120,000 mg/kg). Hexavalent chromium was detected in 126 soil samples, where 15 samples had a concentration higher than the hexavalent chromium soil cleanup criteria (20 mg/kg). Most of the exceedances of hexavalent chromium in the soil samples were located in the central eastern side of the warehouse under the floor.

One sample containing nickel was higher than the RDC SRS and the site-specific IGW SSL (650 mg/kg); and 48 samples where vanadium was present were above the RDC SRS (78 mg/kg). Antimony was detected in 31 soil samples with two samples having detected concentrations greater than the IGW SSL. Thallium was not detected in the soil samples collected from Site 016.

Eight new groundwater monitoring wells were installed at the site and groundwater samples were collected from these wells and three existing monitoring wells were analyzed for the CCPW metals. The highest concentrations of chromium, nickel, vanadium, and hexavalent chromium were detected in 016_MW08, however only the chromium exceeded the Groundwater Quality Standard (GWQS). Antimony and thallium were not present in the groundwater samples obtained. Fifteen samples (14 samples and one duplicate) had non-detected concentrations of thallium that were above the GWQS of 2 ug/L when they were analyzed using USEPA Method SW-846 6010C (USEPA, 2007b).

Two concrete core samples from the warehouse floor and four concrete samples were obtained from the foundation near the loading dock. Hexavalent chromium was detected in one concrete floor core sample that exceeded the NJDEP CrSCC. Hexavalent chromium was not detected in the other concrete samples. Chromium was detected in these samples at concentrations below the CrSCC (120,000 mg/kg).

Further soil and groundwater delineation was conducted in December 2012 and January 2013 according to the Technical Memorandum sent to NJDEP on July 16, 2012 with minor revisions, conference calls and discussions with NJDEP. Six borings were drilled and three new groundwater wells were installed. Soil, groundwater, and Synthetic Precipitation Leaching Procedure (SPLP) samples were collected SPLP samples were collected from soil borings 016_K013, 016_K007, and 016_F005 (at 2 depths). The delineation investigation analyzed the soil and groundwater samples using USEPA Method SW-846 6020A (USEPA, 2007a), which has a lower quantitation level for the metals. The method detection limit for the metals was less than the minimum soil remediation standard/screening level of CCPW metals. This eliminated the reporting of non-detections that were greater than the minimum soil remediation standard/screening level of CCPW metals.

During the delineation investigation, 29 soil samples were collected, six samples were surface soil and 23 samples were subsurface soil. Chromium, nickel, vanadium, antimony, thallium and hexavalent chromium were present in the samples obtained. The samples collected during the delineation investigation that contained chromium did not exceed the CrSCC for trivalent chromium (120,000 mg/kg). Hexavalent chromium was detected in four soil samples, where the concentrations of hexavalent chromium were not greater than the CrSCC (20 mg/kg). Samples containing nickel were no higher than the RDC SRS (1600 mg/kg) or the site-specific IGW SSL (650 mg/kg). Two samples contained vanadium at concentrations above the RDC SRS (78 mg/kg). Antimony was detected in five soil samples and did not have concentrations greater than the IGW SSL.

Two new groundwater monitoring wells were installed at the site and groundwater samples were collected from these wells and existing monitoring wells. Samples were analyzed for the CCPW metals. Chromium concentrations detected in three monitoring wells were above the GWQS (70 ug/L). One sample contained vanadium that was above the GWQS (60 ug/L). Thallium was not present in the samples collected during the delineation investigation. Non-detected concentrations of thallium were less than the GWQS.

The ecological evaluation concluded that an ecological risk assessment does not need to be conducted. Even though several metals were identified as contaminants of potential environmental concern (COPECs) because they were detected at concentrations in surface soil that exceeded their respective NJDEP Ecological Screening Criteria, no environmentally sensitive natural resources (ESNRs) have been identified at or near the Site. Therefore, there is not a complete exposure pathway between the COPECs in surface soil and the ESNRs.

1.0 INTRODUCTION

1.1 Purpose of Report

On behalf of PPG Industries, Inc. (PPG), Tetra Tech has prepared this Remedial Investigation (RI) Report summarizing field activities conducted at Site 016, in Hudson County, Jersey City, New Jersey. Site 016 is located at 45 Linden Avenue East (Block 1507, Lot 4L), Jersey City, Hudson County, New Jersey (see Figure 1). The Site Remediation Program Identification Number for the Site is G000008791. The RI was conducted to determine the nature and extent of chromate chemical production waste (CCPW, aka COPR - chromite ore processing residue) contamination. Remedial Investigations were conducted in accordance with the scope of work outlined in AECOM's March 2011 Remedial Investigation Work Plan for Non-Residential Chromate Production Waste Sites – Site 016.

Investigations conducted at the Site are subject to the 1990 Administrative Consent Order between PPG and the New Jersey Department of Environmental Protection (NJDEP). In 2009, PPG, NJDEP and the City of Jersey City entered into a Judicial Consent Order with the purpose of remediating the sources and soil of contamination at the impacted sites (AECOM, 2011).

Site 016 was investigated due to the presence of CCPW that contains chromium, hexavalent chromium, and other metals on the property. Interim remedial actions were conducted in 1992 to minimize the exposure to CCPW. The investigation conducted for this RI report consisted of sampling soil (at different depths), groundwater, and concrete from the foundation near the loading docks.

The RI report provides the following:

☐ Characterization of potential CCPW-contaminated soil, groundwater, and concrete in the foundation at the Site;

☐ Horizontal and vertical extent of CCPW-contaminated media at the Site;

☐ Assessment of surface and subsurface site characteristics, including groundwater depth and flow direction;

☐ Presentation of data needed to develop a remedial action work plan to mitigate the effects of CCPW and CCPW-contamination on human health and the environment.

1.2 Historical Information

Site 016 was originally part of the Upper New York Area, which is a large area (more than 5 acres) containing historic fill for industrial development, according to the New Jersey Geological Survey Historic Fill of the Jersey City Quadrangle (2004). The fill most likely came from material dredged by Morris & Cummings Dredging Company. Previous buildings at Site 016 included a transformer house. The east side of Site 016 was occupied by Lehigh Valley Railroad (LVRR) Warehouse and the west side was occupied by a junk yard. The LVRR occupied the majority of the area in Site 016, as well as the area to the east of Site 016. Standard Oil occupied the area to the north of Site 016 (AECOM, 2011). The warehouse was constructed by Lawrence Construction and is currently used as a storage facility. It is unknown whether the warehouse was ever used to store or to generate hazardous waste or hazardous materials (AECOM, 2011).

Three previous investigations were conducted at Site 016. Appendix A contains maps and figures from the previous investigations. As part of the first investigation, soil sampling was conducted in 1987 to determine the extent of chromium impacted-soil within State Route 185 which is a “paper” roadway located along the eastern boundary of the Site. Surface water and sediment sampling was also conducted during the first investigation to determine whether the man-made drainage ditch along the northern boundary of the property was impacted by chromium. The drainage ditch is not a natural occurring stream; it is a drainage channel that was excavated and that material was used elsewhere. The primary source of water entering the ditch is storm water from surface drainage from Caven Point Road. As a result of the first investigation, the ditch was remediated and lined as part of a remedial action. In 1989, a second investigation was conducted at Site 016 with the purpose of identifying the extent of chromium present in soil and to determine the potential impacts on surface water and sediments. In 1992, a third investigation was conducted to verify the extent of chromium and hexavalent chromium contamination in sediment and soil. This investigation also characterized Site 16 hydrogeological properties and groundwater (AECOM, 2011).

In 1992, interim remedial measures were implemented at Site 016, including fencing and paving of the access road along the north side of Site 016 to reduce potential exposure to CCPW-impacted soil. Figures showing the 1992 interim remedial measures for Site 016 can be found in Appendix A-1 and the paving interim remedial measure is shown on the figures of this report. In 2008, additional interim remedial measures were implemented in the current loading dock area. Pre-excavation borings were advanced adjacent to the building and the results identified CCPW in the nine borings, ranging from 0.5 to 5 feet below ground surface (bgs), however CCPW was not continuous through the depth range. Soil was excavated from this area and disposed of offsite. The excavated areas were backfilled with certified clean aggregate and/or clean crushed stone. Post excavation soil sampling was conducted throughout the excavated area. One soil sample, PE11-001, had a hexavalent chromium concentration (22.5 mg/kg) above the soil cleanup criteria (20 mg/kg). Post-excavation concrete foundation sampling was conducted on the west end of the excavation area. Two concrete samples, sample 016-K01-001 and 016-K01-001 (0-1) had a hexavalent chromium concentration of 91.1 mg/kg and 101 mg/kg respectively. Due to the high concentrations of hexavalent chromium present in the concrete foundation, a liner was installed along the building foundation (AECOM, 2011). Figures showing the 2008 IRM can be found in Appendix A-2.

In 2002, the drainage ditch was remediated and lined as a result of Site 112A investigations (Appendix A-3 contains the drawing for this remedial action). Site 112A and the drainage ditch were both remediated prior to the construction of the Liberty National Golf Course and received No Further Action determinations from the New Jersey Department of Environmental Protection (NJDEP) on August 3, 2004. Copies of the No Further Action determinations are provided in Appendix A-4. Additional investigation was not proposed in these two areas (AECOM, 2011).

The site layout shown on Figure 2 also shows the areas of the IRMs.

1.3 Site Description

Site 016 is located at 45 Linden Avenue East (Block 1507, Lot 4L), Jersey City, Hudson County, New Jersey. The site has been identified by NJDEP to be a Non-Residential Hudson County Chromium Site. The present land use for the Site is industrial. The area around Site 016 is mainly industrial, commercial, and recreational (see Figures 1 and 2). Site 016 is approximately 12.9 acres; the warehouse covers approximately 7.5 acres, a paved area (asphalt parking lot) covers approximately 2.0 acres, and the remaining 3.4 acres is unpaved area (AECOM, 2011). Site 016 is bounded on the north by athletic fields and a drainage ditch; on the south by Linden Avenue; on the east by Site 112A and the Liberty National Golf Course; and on the west by the Caven Point Road and New Jersey Turnpike Extension (AECOM, 2011).

Areas surrounding Site 016 are part industrial according to the City of Jersey City; however, there are areas that are environmentally sensitive, such as the golf course and the athletics field. People working at the Site 016 warehouse, the surrounding businesses, and the athletic facilities are potential human receptors. These potential human receptors, along with construction workers conducting excavations at Site 016, may be exposed to dust impacted by hexavalent chromium (AECOM, 2011). The interim remedial measures were conducted in order to minimize the exposure to dust from Site 016.

1.4 Report Organization

This report is organized as follows:

- Section 1 provides a brief introduction and history of the site.
- Section 2 describes the field activities that were conducted.
- Section 3 describes the environmental settings of Site 016.
- Section 4 summarizes the results from the RI.
- Section 5 contains information regarding the receptor evaluation and the baseline ecological evaluation.
- Section 6 provides an overall summary and conclusions for the site.

2.0 INVESTIGATION SUMMARY

2.1 Modifications to the Work Plan

Several minor modifications were made during the initial and delineation field investigations at Site 016:

- Disposable, dedicated plastic trowels and paper bowls were used for soil sampling and homogenization. This eliminated the need to decontaminate stainless steel trowels and bowls, and eliminated the associated volume of decontamination water.
- Bentonite chips were used to fill the relatively small diameter Geoprobe holes instead of grout.
- Five-foot long Geoprobe cores and sleeves were used instead of 4-foot long cores and sleeves.
- Borings 016_H015 and 016_C019 were not accessible because of the storage of cocoa beans, and therefore, borings were not drilled at these locations. Monitoring well 016_MW01, which was originally located at 016_C019, was moved to location 016_E019.
- Many of the sampling locations were moved (less than 10 feet) relative to their original map locations due to the presence of underground utilities, surficial obstructions, and general accessibility.
- Some proposed soil sample intervals from borings 016_C009, 016_E011, 016_E013, 016_F012, 016_G005, 06_G011, 016G_012, 016_G014, 016_G016, 016_H005, 016_H009, 016_H011, 016_H013, 016_I006a, 016_I011, 016_I012, 015_I013, 016_I015 and 015_J014, 016_K013 were not collected due to “no recovery” at varying depths in each of those borings.
- As specified in the NJDEP approved work plan, foundation wall samples were to be collected from a depth of 5 feet below the loading dock. Given that the loading dock areas are continuously occupied by trucks and the newly installed concrete pad of the loading dock would need to be removed, foundation wall samples 016_I010FW, 016_I010aFW, 016_I011FW, 016_I012FW were moved to locations directly outside of the loading dock areas as indicated on Figure 2.
- The work plan indicated 5 existing monitoring wells were located at the site, however only three existing monitoring wells were found. Monitoring wells PPG4-MW13 and PPG4-MW14 were not observed or found using geophysical surveys while Tetra Tech was performing the utility clearance at the site. Monitoring well PPG4-MW16 was sampled during the initial investigation; however it was not sampled during the delineation investigation because it was destroyed during the construction of the Spectra pipeline along Caven Point Road.
- Monitoring well MW-09 was destroyed by truck traffic shortly after installation.
- For the initial investigation field work, samples were analyzed using United States Environmental Protection Agency (USEPA) Method SW-846 6010C, based on the Remedial Investigation Work Plan (RIWP) (AECOM, 2011). However, because USEPA Method SW-846 6010C (USEPA, 2007b) created several instances where the method detection limit was greater than the screening level, samples collected during the delineation investigation were analyzed using USEPA Method SW-846 6020A (USEPA, 2007a) which provides lower method detection limits.

2.2 Soil Investigation

2.2.1 Soil Boring Investigation

The objective of the soil sampling program was the horizontal and vertical delineation of CCPW and CCPW-impacted materials at the Site. A copy of the Health and Safety Plan for this investigation can be found in Appendix B. A 60-foot by 60-foot grid was applied to the Site map to facilitate the location of soil borings. A total of 69 soil borings were drilled between July 5, 2011 and September 2, 2011. Two of the original proposed borings, 016_H015 and 016_C019, were not accessible, and therefore, borings were not drilled at these locations. Table 1 summarizes pertinent characteristics of the soil borings, Figure 2 shows the soil borings and geological cross section locations, Figure 3 and 4 are the geological cross sections (including the presence of CCPW), and Appendix C-1 contains the soil boring logs. Sample nomenclature for the soil samples consists of the NJDEP site number (016) and the grid location (number/letter combination) from which the sample was collected as described in the Remedial Investigation Work Plan (AECOM, 2011).

Further soil delineation was conducted in December 2012 and January 2013 according to the Technical Memorandum sent to NJDEP on July 16, 2012 with minor revisions, conference calls and discussions with NJDEP. Six borings were drilled and four Synthetic Precipitation Leaching Procedure (SPLP) samples were collected. SPLP samples were collected from 016_K013, 016_K007, and 016_F005 (at 2 depths). Table 1 summarizes pertinent characteristics of the soil borings, Figure 2 shows the location of the soil borings, and Appendix C-2 contains the soil boring logs completed for the delineation investigation.

2.2.2 Soil Sampling

A concrete coring machine was first used to core through the floor slab at borings located within the building interior. The floor slab ranged in thickness between 0.4 feet to 1.3 feet, but was generally 0.5 feet (6 inches). Soil samples were collected using a track-mounted Geoprobe rig operated by New Jersey licensed drillers employed with Environmental Probing, Inc. of Cream Ridge, New Jersey except for samples 016_I006_0.6, 016_I006a_0.7, 016_H005_0.5, and 016_G005_0.5, which were collected using a decontaminated hand-auger. Additionally, boring 016_H005 was drilled using a Dingo direct push unit equipped with 4-foot long, 2-inch diameter sampling tubes. Geoprobe soil cores were collected by hydraulically advancing a 5-foot long, 2-inch diameter sampling tube with dedicated 1½-inch acetate liners to a designated depth in the subsurface. The majority of the soil borings were advanced to a depth of 25 feet to 30 feet to facilitate soil sample collection.

Each soil core collected in the acetate liner was opened and field screened with a Photoionization Detector (PID). The soil cores were logged according to the Burmeister Soil Classification System and Unified Soil Classification System, and soil color was classified using Munsell Color Charts to provide consistent descriptions. Additional observations (e.g.: staining, sheens, mottling, CCPW material) and recovery percentages were noted. Soil boring logs are included in Appendix C-1 and C-2.

In accordance with the approved Remedial Investigation Work Plan (AECOM, 2011), analytical samples were selected from each boring based upon the following sample rationale:

- Where applicable, one sample from the bottom 2 inches of the concrete core if CCPW material was noted in the soil directly below the concrete or if the concrete appeared to be impacted by chromium (i.e., yellow or green staining, etc.)
- One surficial soil sample from 0 to 0.5 feet bgs (or from the first 6-inch soil/fill interval beneath pavement and sub-base);
- One analytical sample within each 4-foot interval unless CCPW is visually identified.
- Where CCPW material is visually identified:
- One sample directly above visible CCPW material unless the surficial sample contains CCPW;
- One sample within the CCPW material
- One sample directly below the bottom of visible CCPW;
- One sample directly above the first native soil;
- One sample approximately 4 feet below the fill/native soil interface; and
- One sample approximately 8 feet below the fill/native soil interface
- One sample approximately 12 feet below the fill/native soil interface

Table 1 provides a sample summary including details regarding sample collection depths.

Soil samples were collected within 6-inch discrete intervals for laboratory analysis. Disposable, dedicated plastic trowels and paper bowls were used for soil sampling and homogenization. This eliminated the need to decontaminate stainless steel trowels and bowls, and eliminated the associated volume of decontamination water. Soil samples were placed in laboratory-provided glassware. Concrete samples were obtained from concrete cores at some of the soil boring locations using a decontaminated metal chisel and hammer to break off the bottom two inches of the core. The core sample was placed in a zip-lock bag. After the designation of a sample identification number, samples were sealed, labeled, packed on ice, documented following proper chain of custody procedures and delivered by courier to TestAmerica in Edison, New Jersey, a NJDEP-certified laboratory for analysis. Soil samples were analyzed for hexavalent chromium, total chromium, antimony, nickel, thallium, vanadium, ORP (Eh), and pH. Concrete core samples were milled by the laboratory and analyzed for hexavalent chromium, total chromium, ORP (Eh), and pH. See Table 2 for a list of the analytical methods used.

After the termination of each soil boring, the boreholes were back-filled with bentonite and the soil cuttings were disposed of in 55-Gallon drums for waste disposal. The building floor slab was patched with new concrete at the locations within the building interior that were cored.

2.2.3 Concrete Foundation Wall Sampling

Four concrete samples from the foundation wall were obtained during the field investigation that took place the first week of January 2012. A concrete coring machine was used to core into the foundation to obtain concrete cores at locations just outside of the loading dock area. The concrete core samples were collected approximately 4.5 to 5 feet below the ground surface, below the former ground surface corresponding to the CCPW identified during the interim remedial measures. After the samples were obtained, the area was backfilled and restored to its original condition. Figure 2 shows the alternate locations where the concrete foundation wall samples were obtained.

2.3 Groundwater Investigation

2.3.1 Monitoring Well Installation

Eight monitoring wells were installed into the surficial aquifer in August 2011, including wells 016_MW01, 016_MW02, 016_MW03, 016_MW04, 016_MW05, 016_MW06, 016_MW07, and 016_MW08. Groundwater field sheets, notes and NJDEP Monitoring Well Certification Forms Part A & B for the monitoring wells can be found in Appendix D-1. The monitoring wells coincided with soil boring locations where soil samples were also collected. The wells were installed using the hollow stem auger (HSA) method using a track-mounted Geoprobe rig operated by New Jersey licensed drillers employed with Environmental Probing, Inc. of Cream Ridge, NJ. The locations of the monitoring wells are shown on Figure 2, and pertinent well characteristics are included in Table 3. Well 016_MW01 was moved to location 016_E019 due to access issues at the original location 016_C019.

Three monitoring wells, 016_MW-9, 016_MW-10, and 016_MW-11, were installed in January 2013 during the delineation investigation. Monitoring wells 016_MW-9 and 016_MW-11 were installed to delineate the lateral extent of impacts, while monitoring well 016_MW-10 was installed for vertical delineation at the Site. Information regarding these monitoring wells can be found in Table 3 and the location of these monitoring wells is shown on Figure 2. Groundwater field sheets, notes and NJDEP Monitoring Well Certification Forms Part A & B for the monitoring wells can be found in Appendix D-2.

The wells (with the exception of 016_MW-10) were drilled to a depth ranging from 8.5 feet to 10 feet below grade with 5 feet of screen to facilitate the placement of the top of the well screen directly at the water table within the surficial aquifer, but above the underlying confining meadow mat layer based on the visual observations from the soil sampling in accordance with the Remedial Investigation Work Plan (AECOM, 2011). Monitoring well 016_MW-10 was completed at a depth of 34 feet bgs with a five foot screened interval. For wells located within the building interior, a 1- foot diameter concrete core machine was used to core through the building floor slab. The wells were constructed of 2-inch I.D., schedule 40, flush-threaded, NSF-approved PVC well screen and casing riser pipe. The screen slot size was 0.010 inches (10 slot), and the screen length was 5 feet. Monitoring well 016_MW-9 was destroyed subsequent to installation presumably due to truck traffic which uses the area as a “turn-around”.

A filter pack of clean silica sand was installed flush with the bottom of the well to at least one foot above the top of the well screen. A minimum 1-foot seal of bentonite was placed on top of the sand pack. The annular space above the bentonite was then backfilled with a cement/bentonite grout mixture from the top of the primary seal to within 1 to 2 feet of ground surface to allow for the placement of a flush-mount casing with flush-mount steel covers. A 2-foot by 2-foot wide by 6-inch thick concrete pad was placed flush with ground surface for wells located outside. Monitoring well construction details are summarized in Table 3.

2.3.2 Monitoring Well Development

Following installation, each monitoring well was developed to remove drill cuttings or formation fines from the well screen. The monitoring wells were developed by air lifting, then by surging and pumping if not fully developed after using air lifting. Measurements of pH, temperature, turbidity, and specific conductance were collected until these parameters stabilized or, at the discretion of the site geologist, the purged water was visibly clear of sediment. The water quality measurements and the volume of water removed from each well were recorded on the well development forms for both field investigations and are included in Appendix D-1 and D-2.

2.3.3 Water Level Measurements

Prior to groundwater sampling in September 2011, synoptic groundwater level measurements were collected from existing and new monitoring wells at Site 016 to provide data for calculating groundwater elevations. Only three out of the five existing monitoring wells were able to be located, which included wells PPG4-MW2, PPG4-MW15, and PPG4-MW16. Depth to groundwater in the wells was measured on September 15, 2011. Monitoring well construction details are summarized in Table 3. The measurements were obtained from the top of inner casing at the referenced measuring point. The water level measurements were noted with the time and recorded to the nearest 0.01 foot using an electronic water level meter. Depth to water measurements recorded on September 15, 2011 and the resulting groundwater elevations are summarized in Table 3. A groundwater elevation contour map is provided on Figure 5.

For the delineation investigation, groundwater level measurements were obtained January 30, 2013 for the existing and newly installed monitoring wells at the Site. Groundwater elevations are summarized in Table 3. Groundwater elevation measurements were obtained from the top of inner casing at the referenced measuring point. The water level measurements were noted with the time and recorded to the nearest 0.01 foot using an electronic water level meter. Depth to water measurements recorded on January 30, 2013 and the resulting groundwater elevations are summarized in Table 3. A groundwater elevation contour map is provided on Figure 5A.

2.3.4 Groundwater Sampling

Initial investigation monitoring wells were sampled on August 5, 2011 and on September 15 and 16, 2011. On August 5, 2011, the existing monitoring wells PPG4-MW2, PPG4-MW15, and PPG4-MW16 were sampled, given that the new wells had yet to be constructed or developed.

The remaining wells, existing and new (11 total), were sampled on September 15 and 16, 2011. Wells PPG4-MW13 and PPG4-MW14 were not sampled because they could not be located. Samples were analyzed for hexavalent chromium, total chromium, antimony, nickel, thallium, vanadium, ORP (Eh), and pH. Wells PPG4-MW2, PPG4-MW15, and PPG4-MW16 were sampled at a deeper interval since these monitoring wells had 10 foot screens, given that they were only sampled at one interval on August 5, 2011. The NJDEP Field Sampling Procedures Manual dated August 2005 requires multiple sample locations at 5-foot intervals for wells with a screen length/water column greater than five feet in length. Table 2 lists the analytical methods used. Monitoring well locations are shown on Figure 2. Groundwater sampling field record sheets are provided in Appendix D-1.

As part of the delineation investigation, the Site monitoring wells were sampled on January 30 through February 1, 2013. PPG4-MW16 was not sampled during this investigation because it was destroyed during the construction of the Spectra pipeline along Caven Point Road.

Groundwater sampling was conducted using low-flow purging and sampling procedures consistent with the NJDEP Field Sampling Procedures Manual dated August 2005. Groundwater sampling procedures for the above well are described below. The wells were sampled using two-inch diameter QED submersible bladder pumps. Polyethylene tubing and bladders was utilized given that Teflon tubing and bladders are only required for sampling volatile organic compounds, consistent with the NJDEP Field Sampling Procedures Manual dated August 2005. A new polyethylene bladder was dedicated to each well. A properly decontaminated pump was lowered to the middle of the well screen interval of each well. A new piece of disposable, 1/4-inch diameter, polyethylene tubing was used at each well. The pumping rate was measured with a graduated beaker and a stop-watch, and the flow rate was adjusted to remain between 100 and 500 milliliters per minute (mL/min). Purging continued until field parameters had stabilized, consistent with procedures outlined in the August 2005 NJDEP Field Sampling Procedures Manual. Copies of the complete field parameter records are provided in Appendix D-1 and D-2.

2.4 Surveying

The soil borings and monitoring wells were surveyed for horizontal and vertical control by DPK Consulting LLC of Middlesex, New Jersey. At each monitoring well location, the vertical elevation of the ground surface and the top of casing were surveyed. The vertical elevations are based upon the North American Vertical Datum 1988. The horizontal locations of each sample location are based upon the New Jersey State Plane Coordinate System (North American Datum 1983).

2.5 Investigation Derived Waste (IDW) Disposal

During the investigation, both solid and liquid IDW was generated, including soil cuttings, concrete cores, well development and purge water, decontamination water, disposable personal protective equipment (PPE), Geoprobe soil sample acetate liners, and disposable sampling utensils, tubing, and bladders. The solid and liquid IDW was placed in U.S. Department of Transportation (DOT) approved 55-gallon drums. Drums were left at a designated secure location on site until the contents could be disposed. The drums were sent to the proper disposal facilities offsite by a licensed contractor. The IDW manifest can be found in Appendix E. AECOM managed the waste disposal during the initial field investigation and WTS managed the waste disposal during the delineation RI for PPG.

2.6 Analytical Methods, QA/QC, Data Validation, and Sample Handling

2.6.1 Analytical Methods

Soil, groundwater, and concrete core samples were analyzed by TestAmerica Laboratories of Edison, NJ (NJDEP Certification # 12028). The analytical methods are summarized in Table 2.

2.6.2 Equipment Decontamination

To reduce the possibility of cross-contamination, equipment that may have come in contact with soil or groundwater was properly decontaminated utilizing the following procedure from the Field Sampling Plan/Quality Assurance Project Plan (AECOM 2010): 1) utensils and downhole equipment (e.g., Geoprobe sampling tubes, Geoprobe rods, sampling pumps,) were wiped clean and were scrubbed with Liquinox soap plus a tap water wash to remove visible contamination; 2) these items were next rinsed with tap water to remove any remaining debris; 3) the equipment was again rinsed with distilled and deionized water. Disposable items (e.g., acetate soil sample core liners) were utilized to reduce the potential spread of contamination on site.

2.6.3 Quality Assurance/Quality Control

Quality assurance and quality control (QA/QC) samples collected and submitted for laboratory analysis during this investigation include field blanks, field duplicates, and matrix spike/matrix spike duplicate (MS/MSD) samples.

Aqueous field blanks were created by passing analyte-free water through the sampling equipment (disposal soil sampling equipment or polyethylene bladder/tubing) and collecting it in laboratory-provided glassware. Analysis of the field blank for the compounds of concern was intended to demonstrate that no residual amounts of these compounds were introduced into the samples by the sampling equipment. One aqueous field blank was collected and analyzed for the parameters sampled for during the day.

Field duplicate samples were collected at a ratio of five per cent (i.e., one field duplicate per 20 samples matrix). Field duplicate soil samples were extracted from the location and soil type as the respective soil sample. Aqueous field duplicate samples were collected simultaneously with the sample that was duplicated.

Matrix spike and matrix-spike duplicate (MS/MSD) samples were collected at a ratio of five per cent (i.e., one field duplicate per 20 samples matrix). MS/MSD samples provide information about the effect of the sample matrix on the preparation and measurement methodology. MS/MSD samples were extracted from the location and soil type as the respective soil sample. Aqueous MS/MSD samples were collected simultaneously with the sample that was duplicated.

2.6.4 Data Validation

Validation is a comparison of data quality indicators (DQIs) against prescribed acceptance criteria to assess analytical method performance and whether analytical laboratory data were of an acceptable technical quality for use in decision making. The laboratory data was validated and the results can be found in Appendix F along with the Electronic Data Deliverables. The data were reviewed with reference to the NJDEP documents titled "Quality Assurance Data Validation of Analytical Deliverables for Inorganics (based on USEPA SW-846 methods SOP5.A.16)", Standard Operating Procedure for Analytical Data Validation of Hexavalent Chromium, SOP 5.A.16, Rev 3, September 2009, and "Field Sampling Plan/Quality Assurance Project Plan" prepared by AECOM and dated June 2010. The following minor non-compliances were noted during validation: laboratory blank contamination, MS/MSD recovery non-compliances, LCS/LCSD recovery non-compliances, lab duplicate imprecision, field duplicate impression, and uncertainty near the detection limit. Estimated qualifications applied during validation were minor and did not affect data quality or usability.

Non-detected results were reported to the method detection limit (MDL). Non-detected results for antimony and thallium exceeded minimum soil remediation standard/screening level for several samples from the initial investigation with the laboratory using USEPA Method SW-846 6010C (USEPA, 2007b). For the delineation investigation the laboratory used USEPA Method SW-846 6020A (USEPA, 2007a) which provides lower method detection limits and eliminated the reporting of non-detections that were greater than the minimum soil remediation standard/screening level of CCPW metals.

Over 250 soil samples were reanalyzed for hexavalent chromium because the analytical quality control criteria failed. Low percent recoveries in MS/MSDs resulted in samples being reanalyzed as per USEPA Method SW-846 7196 (USEPA, 1992) requirements.

2.6.5 Sample Handling

The samples were picked up from field personnel by a laboratory-employed courier for delivery to the laboratory within the prescribed holding time. Samples were packed in coolers with ice to prevent breakage and to keep them cool. A chain-of-custody form accompanied the samples from the time of collection until the laboratory received them, and was signed by parties relinquishing and receiving the samples. Copies of the chain-of-custody sheets are provided in Appendix F.

3.0 ENVIRONMENTAL SETTING

3.1 Climate

The climate and meteorology of the Jersey City Area have been summarized based on climatological data reported for the nearest National Oceanic and Atmospheric Administration office, located in Newark, New Jersey.

In general, New Jersey has a continental climate with prevailing northwest winds during the winter months and southwest winds during the summer months. Based on data from the Newark, New Jersey, Airport, temperature falls of 5 to 15 degrees, depending on the season, are not uncommon when the wind changes from southwesterly to southeasterly. Periods of very hot weather, lasting as long as a week, are associated with a west-southwest airflow which has a long trajectory over land. Extremes of cold are related to rapidly moving outbreaks of cold air traveling southeastward from the Hudson Bay region. Temperatures of zero or below occur in one winter out of four, but are much more common several miles to the west of the NOAA station (NOAA, 2011).

A considerable amount of precipitation is realized from the Northeasters of the Atlantic coast. These storms, more typical of the fall and winter, generally last for a period of two days and commonly produces between one and two inches of precipitation. Storms producing four inches or more of snow occur between two and five times each winter. Snowstorms producing eight inches or more have occurred in about one-half the winters.

Average daily temperatures at Jersey City range from 32.8°F in January to 75.8°F in July, with a minimum temperature of -12°F, and a maximum temperature of 106°F. The mean annual temperature is approximately 54°F.

Mean annual rainfall at Jersey City is 43.96 inches. The lowest average monthly rainfall (2.86 inches) occurs in November and the highest average monthly rainfall (4.15 inches) occurs in July. Approximately half of the annual precipitation falls during the warm season (April through September). Annual snowfall totals about 25 inches in central New Jersey and 34.1 inches in Newark. Prevailing wind direction and mean annual wind speed at the Newark NOAA station are southwest and 10.2 mph, respectively (NOAA, 2011).

3.2 Topography

The topography at Site 016 is relatively flat, gradually sloping towards the drainage ditch on the northern side of the Site (Figure 2). The warehouse is approximately 10 feet above mean sea level, and the lowest elevation encountered at the Site is 5 feet above mean sea level. Runoff from the Site flows towards the drainage ditch (AECOM, 2011).

3.3 Regional Geology

Site 016 lies within the glaciated section of the Piedmont Physiographic Province of the Appalachian Highlands, along the eastern edge of the Newark Basin; the area is underlain by formations of Recent and Pleistocene sediments. The Triassic age bedrock throughout the region is composed of non-marine sedimentary rocks, consisting mainly of sandstone, mudstone, and conglomerate. The Triassic Newark Supergroup consists of non-marine sedimentary rocks with diabase intrusives. It is common for the Triassic Newark Supergroup to exhibit a slight dip to the northwest with local warping and occasional faulting. The formations generally strike northeast to southwest and dip between 10 to 20 degrees northwest. The Newark Supergroup can be divided into three formations based on lithology: 1) the Stockton Formation, 2) the Lockatong Formation, and 3) the Passaic Formation (AECOM, 2011).

The Stockton Formation beneath Site 016 has a gray to reddish-brown sandstone, combined with conglomerate, siltstone, and shale. The siltstone may be gray, green, or purple and fossiliferrous. The Stockton Formation is about 850 feet thick beneath Site 016. The Lockatong Formation, located west of the Site, consists of fossil-rich thinly laminated to thickly bedded gray to black siltstone and shale. A diabase sill of Lower Jurassic Age intrudes the Lockatong Formation west of the Site within Jersey City. The Passaic Formation is located west of the Site, and it is the thickest formation (about 10,000 feet). The Passaic consists of reddish-brown mudstones, shale, siltstone, and sandstone with interbedded conglomeritic sandstones along the basin margins (AECOM, 2011).

3.4 Hydrology and Hydrogeology

Upper New York Bay is the body of water that is closest (approximately 700 feet away) to Site 016. In the immediate vicinity of Site 016 (within half-mile radius), a man-made drainage ditch is located at the edge of the site. This ditch was remediated and lined in 2002 as result of an interim remedial measure. Several landscape ponds and other drainage features have been constructed in the golf course property (AECOM, 2011).

3.4.1 Regional Hydrogeology

Groundwater in the region occurs in three overburden water-bearing zones and within bedrock fractures. The water-bearing zones include an unconfined water-bearing zone within the fill material, an unconfined to semi-confined zone within the alluvial sediments beneath the fill, and an unconfined to semi-confined zone within the glacial silt, sand and gravel overlaying the bedrock (AECOM, 2011).

The shallow water-bearing zone can range from moderate to high hydraulic conductivity, depending on the fill materials. Hydraulic conductivity within the Stockton Formation is non-existent. The water-bearing zones underneath the fill are characterized with low to moderate conductivity due to silt and clay content. Groundwater flow in this water-bearing zone is influenced by infiltration and the characteristics of the fill material. Groundwater in the fill material is typically within 5 to 10 feet bgs. Groundwater flow in the intermediate and deep water-bearing zones is expected to be towards Upper New York Bay. Groundwater beneath Site 016 is not considered to be potable; thus, public water supply is not drawn from this formation in the Jersey City area. No potable water supply is present near Site 016. A previous pre-1990 report indicated that one industrial groundwater well was located in the vicinity of the site. However, it has since been determined that one domestic water well (Well Permit Number 2600012777) was identified in the vicinity, but it has been abandoned. Updated well search materials are presented in Appendix G (AECOM, 2011).

3.4.2 Study Area Specific Hydrogeology

Monitoring wells were installed in the shallow groundwater table at the site and the hydrogeology on the site is expected to be similar to the regional hydrogeology. Monitoring wells have been placed to assess the CCPW impacts to the groundwater. Based on groundwater gauging data collected during the September 15, 2011 and the January 30, 2013 sampling event, site-specific water level measurements indicate groundwater flow is towards the north-northeast to the Upper New York Bay (see Figure 5 and 5A).

4.0 NATURE AND EXTENT OF CONTAMINATION

This section contains the nature and extent of contamination of metals in soil, groundwater, and concrete cores at Site 016. The following sections contain the discussion and results for the contamination in each of the media. Initial investigation results are presented in Sections 4.1 through 4.4. The delineation investigation results are presented in Sections 4.5 through 4.7.

This investigation was conducted in accordance with the NJDEP approved AECOM Remedial Investigation Work Plan (RIWP) (AECOM, 2011) using USEPA Method SW-846 6010C (USEPA, 2007b) for analysis of metals. Initially, the laboratory (Test America) reported the results to the Reporting Limit which led to a number of instances where the Reporting Limit was greater than the minimum soil remediation standard/screening level for CCPW metals. In July 2012, after discussions with Shaw, NJDEP, and the laboratory, it was determined that the results should be reported to the Method Detection Limit. This change eliminated the majority of non-detect concentrations which occurred above the minimum soil remediation standard/screening level for CCPW metals. The delineation sampling conducted in December 2012 and January 2013 utilized USEPA Method SW-846 6020A (USEPA, 2007a) that has a lower quantitation level for the metals discussed in the subsequent sections.

Metal concentrations in soil, groundwater, and concrete core samples were compared to soil remediation standards, soil screening levels and groundwater quality standards identified in the AECOM RIWP (2011). Table 4 shows the remediation standards and screening level for each of the metals evaluated in this report. The results obtained during the initial investigation were compared to the NJDEP Residential Direct Contact Soil Remediation Standard (RDC SRS), Non-Residential Direct Contact Soil Remediation Standard (NRDC SRS), and default and site-specific Impact to Groundwater Soil Screening Level (IGW SSL), each on a separate table and the exceedances of these standards/screening levels are shown on separate figures.

However, based on comments provided to PPG by NJDEP on June 4, 2012, a site-specific IGW SSL was calculated using the NJDEP approved SPLP method for nickel. Soil samples were collected for SPLP analysis of nickel ranging in concentration from 50 mg/kg to 651 mg/kg. Site-specific IGW SSL was calculated for nickel, with a site-specific value of 650 mg/kg. Appendix H has the calculation spreadsheets for the site-specific IGW SSL.

4.1 Soil Results Initial Investigation

A total of 463 soil samples were collected from Site 016 at different soil depths. From these samples, 69 were obtained as surface samples (first sample obtained from each boring from either 0 to 0.5 feet or from the first 6-inch soil/fill interval beneath concrete or pavement and sub-base) and 394 samples were obtained at several depths in the subsurface. Figure 2 shows the location where the soil borings were drilled to obtain these samples. Figure 6 displays the location of the soil borings and the analytical results from the samples. In Figure 6, the location of soil borings with an exceedance are identified with the color red and the locations with no exceedance are colored blue. Figure 6 also shows the soil borings where CCPW is present (green). If CCPW was not present in the soil boring the location is colored white.

Figures 7A and 7B have a summary of the sample locations and depths of where the CCPW metals exceeded the NJDEP RDC SRS, and default and default and site-specific IGW SSL, respectively.

Table 5 contains the positive detections from the soil analytical results for Site 016 (Appendix I contains the complete data set [detections and non-detections] resulting from soil analysis). Tables 5A, 5B, and 5C contain the soil analytical results with the comparison to the NJDEP RDC SRS, NRDC SRS, and default and site-specific IGW SSL, respectively. Information regarding frequency of detection, minimum and maximum detection, location of maximum, and statistics (average and standard deviation) can be found on Table 6 (surface and subsurface soil results), Table 7 (surface soil results) and Table 8 (subsurface soil results).

4.1.1 Chromium

Chromium was present in each of the surface soil samples collected. None of the surface soil samples had a concentration above the NJDEP Chromium Soil Cleanup Criteria (CrSCC) of 120,000 mg/kg. The subsurface soil samples also contained chromium at concentrations lower than the NJDEP CrSCC. The location of the sample with the highest concentration of chromium is 016_I013, at a depth of 3.1 feet bgs, with a concentration of 7,090 mg/kg.

4.1.2 Hexavalent Chromium

Twenty surface soil samples detected concentrations of hexavalent chromium, from which; two samples had a concentration higher than the NJDEP CrSCC (20 mg/kg). The location of the surface soil sample with the highest concentration of hexavalent chromium is 016_K013 at a depth of 1.2 feet bgs (first soil sample collected under the asphalt pavement) with an estimated concentration of 208 mg/kg. There were 106 subsurface soil samples that detected concentrations of hexavalent chromium; from these samples, 13 subsurface soil samples exhibited concentrations above the NJDEP CrSCC (20 mg/kg). The location of the subsurface soil sample with the highest concentration (estimated at 276 mg/kg) of hexavalent chromium is 016_I012 at a depth of 2.5 feet bgs.

The locations where hexavalent chromium exceeded the NJDEP CrSCC are primarily located within the center of the warehouse building beneath the concrete floor. The locations where the concentrations, ranging from 21.2 mg/kg to an estimated 276 mg/kg, were above the CrSCC (20 mg/kg) were found are in soil borings 016_F005, 016_F012, 016_G013, 016_G014, 016_H012, 016_H016, 016_I011, 016_I012, 016_I013, 016_K013 and 016_L010.

4.1.3 Antimony

Seven surface samples exhibited detectable concentrations of antimony. The location of the sample in the surface soil with the highest concentration (estimated at 9.6 mg/kg) is located at 016_K013 collected at a depth of 1.2 feet bgs (first soil sample collected under the asphalt pavement). There were 24 samples in the subsurface soil that had detectable concentrations of antimony. The location of the sample with the highest concentration of antimony (estimated at 10.4 mg/kg) is 016_L010 collected at a depth of 2.1 feet bgs. There were two occurrences of antimony greater than the applicable minimum remediation standard/screening level. There were no occurrences of the method detection limit being greater than the RDC SRS (31 mg/kg), NRDC SRS (450 mg/kg), or IGW SSL (6 mg/kg).

4.1.4 Nickel

Each of the surface soil samples obtained from Site 016 contained nickel. One surface soil sample exhibited a nickel concentration above the site-specific IGW SSL (650 mg/kg). The location of the surface soil sample with the highest concentration of nickel is 016_H009 at a depth of 0.4 feet bgs with a concentration of 3,220 mg/kg (first soil sample collected below the warehouse concrete floor). Each of the subsurface soil samples collected contained nickel that was below the site-specific IGW SSL (650 mg/kg). The location of the subsurface soil sample with the highest concentration (626 mg/kg) of nickel is 016_I013 occurring at a depth 3.1 feet bgs. There were no occurrences of the method detection limit being greater than the RDC SRS, NRDC SRS, or the site-specific IGW SSL.

4.1.5 Vanadium

Each of the surface soil samples collected contained vanadium. Five surface soil samples exhibited concentrations of vanadium that are above the RDC SRS of 78 mg/kg. The highest detectable concentration (589 mg/kg) of vanadium occurred in the surface soil sample collected from 016_K013 at a depth of 1.2 feet bgs (first soil sample collected under the asphalt pavement). Vanadium was detected in each of the subsurface soil samples. Forty-three of the subsurface samples were above the RDC SRS level (78 mg/kg). The location of the subsurface soil sample exhibiting the highest concentration (1,060 mg/kg) of vanadium is 016_H005 at a depth of 5.5 feet bgs.

The exceedances of vanadium are spread out through Site 016. There is no apparent clustering of exceedances for vanadium. There were no occurrences of the method detection limit being greater than the minimum soil remediation standard for vanadium.

4.1.6 Thallium

Thallium was not detected in the samples collected from the site. However, four subsurface soil samples had non-detect concentrations that were above the RDC SRS (5 mg/kg). The locations for those samples are 016_F014, 016_G014, 016_I012 and 016_I013. Additionally, five samples collected from subsurface soil had non-detect concentrations that were above the IGW SSL (3 mg/kg). The locations for those samples are 016_F014, 016_G014, 016_H005, 016_I012, 016_I013.

4.1.7 Comparison to the Residential Direct Contact Soil Remediation Standard

The comparison of the soil concentration to the RDC SRS can be found on Table 5A and Figure 7A. Antimony detected in surface and subsurface soil did not exceed the RDC SRS (31 mg/kg). Nickel was detected in 69 surface soil samples, and one of those was above the RDC SRS of 1,600 mg/kg. The location of the sample exceeding the RDC SRS is 016_H09 at a depth of 0.4 feet bgs with a concentration of 3,220 mg/kg (first soil sample collected below the warehouse concrete floor). Nickel did not exceed the RDC SRS in subsurface soil. Vanadium was detected in 69 samples, and five of those samples were above the RDC SRS. The surface soil sample with the highest concentration above the RDC SRS is 016_K013_1.2 (first soil sample collected under the asphalt pavement). Sixty-nine samples detected vanadium in subsurface soil, from which 43 samples contained vanadium above the RDC SRS. The subsurface soil sample with the highest concentration above the RDC SRS is 016_H005_5.5.

4.1.8 Comparison to the Non-Residential Direct Contact Soil Remediation Standard

Since this site has been identified as a Non-Residential CCPW Site, the comparison of the soil results to the NRDC SRS can be found in Tables 5B, 7, and 8. There were no exceedances of the NRDC SRS in surface or subsurface soil for antimony, nickel, vanadium and thallium.

4.1.9 Comparison to the Impact to Groundwater Soil Screening Levels

IGW SSLs that were used to compare the results from the field investigation can be found on Table 4. A site-specific IGW SSL for nickel was calculated through SPLP method described in the NJDEP Guidance for the Use of the Synthetic Precipitation Leaching Procedure to Develop Site-Specific Impact to Ground Water Remediation Standards (2008). Nickel was detected in surface soil in 69 samples, with one of those samples were above the site-specific IGW SSL. The location of the surface soil sample with the highest concentration of nickel is 016_H009 at a depth of 0.4 feet bgs with a concentration of 3,220 mg/kg (first soil sample collected below the warehouse concrete floor). For subsurface soil, nickel was detected in 394 samples, where the samples were below the IGW SSL. The location of the subsurface soil sample with the highest concentration (626 mg/kg) of nickel is 016_I013 occurring at a depth 3.1 feet bgs. Antimony had two surface soil exceedances to the default IGW SSL. The sample location with the estimated maximum concentration of 10.4 mg/kg is 015_L010 at a depth of 2.1 feet bgs. Thallium did not have detections above the default IGW SSL. Vanadium does not have an IGW SSL.

4.1.10 CCPW in Soil

CCPW was observed in several soil borings (see Appendix C). Figures 3 and 4 show the cross sections where CCPW was identified (in green) at the depth that was observed during the field investigation. Figures 6, 7A, and 7B show the presence of CCPW by the designation of the color green. The depth where CCPW was observed can be seen in the tag associated with each soil boring. Appendix C contains the soil borings and the depth where CCPW was observed. The CCPW was observed in the shallow soil usually less than 6 feet bgs outside the warehouse footprint.

4.2 Groundwater Results Initial Investigation

Fourteen groundwater samples were collected from monitoring wells 016_MW01 through 016_MW08, PPG_MW2, PPG_MW15, and PPG_MW16. As dictated by NJDEP guidelines, two samples were collected from 016_MW02, PPG4_MW15, and PPG4-MW16 due to their well screen depth of 10 feet. Locations of the groundwater monitoring wells are presented on Figure 2. Figure 8 has the groundwater results from these samples. Groundwater results were compared to Groundwater Quality Standard (GWQS) shown on Table 4. Figure 9 shows the location and results where the concentration of metals exceeded the GWQS. The groundwater results from the groundwater analysis can be found on Table 9, and the frequency of detection, minimum and maximum detection, location of maximum, and statistics (average and standard deviation) information can be found on Table 10. Appendix J contains the data obtained regarding the contaminant concentrations in groundwater.

According to the Jersey City Municipal Utilities Authority, a storm sewer line (36 inch RCP Class IV) along Caven Road and a sanitary sewer line (27 inch RCP Class IV) were identified along Linden Ave (Appendix K). These underground utilities could potentially act as preferential pathways for the movement of groundwater.

4.2.1 Chromium

Chromium was detected in 13 of 14 samples. One sample collected from 016_MW08 exhibited a detectable concentration of 397 ug/L which is higher than the GWQS of 70 ug/L for chromium. Figure 10 shows the isoconcentration map with the chromium results.

4.2.2 Hexavalent Chromium

Nine of the groundwater samples collected contained hexavalent chromium, with concentrations ranging from 1.5 ug/L to 182 ug/L. The sample with the highest concentration of hexavalent chromium was collected from 016_MW08 with a concentration was 182 ug/L. There is no

NJDEP GWQS for hexavalent chromium. Figure 11 shows the isoconcentration map with the hexavalent chromium results.

4.2.3 Antimony

Antimony was not detected in the 14 groundwater samples collected at Site 016. Non-detected concentrations of antimony were less than the GWQS of 6 ug/L.

4.2.4 Nickel

Two of the groundwater samples had detectable concentrations of nickel below the GWQS of 100 ug/L. The sample with the highest concentration (estimated) of nickel (7.3 ug/L) was collected from 016_MW08. None of the groundwater samples exceeded the GWQS. Figure 12 shows the isoconcentration map with the nickel results.

4.2.5 Vanadium

Twelve of the collected samples contained vanadium and the results were below the GWQS of 60 ug/L. The location of the sample with the highest concentration (estimated) of vanadium (18.2 ug/L) was collected from 016_MW08. None of the groundwater samples exceeded GWQS. Figure 13 shows the isoconcentration map with the vanadium results.

4.2.6 Thallium

Thallium was not detected in the 14 groundwater samples collected at Site 016. However, the non-detect concentrations were greater than the GWQS of 2 ug/L when analyzed using USEPA Method SW-846 6010C (USEPA, 2007b) in accordance with the RIWP (AECOM, 2011). Groundwater samples collected during the groundwater sampling event in January 2013 were analyzed by USEPA Method SW-846 6020A (USEPA, 2007a) which yielded method detection limits lower than the GWQS. Results of the January 2013 sampling event are discussed in Section 4.7.

4.3 Core Results

Two concrete core samples were analyzed from the initial field investigation. These two concrete core samples were collected because CCPW was visually identified below the warehouse floor within the first foot of soil below the concrete slab. CCPW was observed at 016_H016 at depths from 0.6 to 1.1 feet bgs and at 016_I015 at depths from 0.7 to 0.9 feet bgs. Hexavalent chromium found in the concrete core sample 016_H016 exceeded the NJDEP CrSCC (20 mg/kg) with an estimated concentration of 38.4 mg/kg. The concrete core results were compared to NJDEP CrSCC shown on Table 4. The results from the core analysis can be found on Table 11.

4.4 Foundation Results

Four concrete foundation samples were obtained from Site 016 (see Figure 2). There was no detection of hexavalent chromium in these samples from the foundation. The foundation samples contained chromium but none of them were above the NJDEP CrSCC of 20 mg/kg. The sample with the highest concentration of chromium was 016_I011_FW with a concentration of 13.1 mg/kg. The concrete foundation results were compared to NJDEP CrSCC shown on Table 4. The results from the foundation sampling can be found on Table 12.

4.5 Delineation Investigation Results

Soil and groundwater delineation was conducted in December 2012 and January 2013 according to the Technical Memorandum sent to NJDEP on July 16, 2012 with minor revisions, conference calls and discussions with NJDEP. Six borings were drilled and three additional groundwater monitoring wells were installed. Soil, groundwater, and four SPLP samples were collected. SPLP samples were collected from soil borings 016_K013, 016_K007, and 016_F005 (at 2 depths). Table 1 summarizes pertinent data for the soil borings, and their locations are shown on Figure 2. Boring logs completed for the delineation investigation are presented in Appendix C-2.

The delineation investigation utilized USEPA Method SW-846 6020A (USEPA, 2007a), which has a lower quantitation level for the metals analyzed. The method detection limit for the metals was less than the minimum soil remediation standard/screening level for CCPW metals. This eliminated the reporting of non-detections that were greater than the minimum soil remediation standard/screening level for CCPW metals.

Metal concentrations in soil and groundwater were compared to minimum standard/screening level identified in the AECOM work plan (2011). Table 4 shows the minimum soil remediation standard/screening level for each of the CCPW metals evaluated in this report. The results obtained during the delineation investigation were also compared to the NJDEP RDC SRS, NRDC SRS, and IGW SSL, each on a separate table and the exceedances of these standards/screening level are shown on separate figures.

Based on comments provided to PPG by NJDEP on June 4, 2012, an IGW site-specific level was calculated using the NJDEP guidance document (NJDEP, 2008). Soil samples were collected for SPLP analysis of nickel ranging in concentration from 50 mg/kg to 651 mg/kg. Site-specific IGW SSL was calculated for nickel, with a site-specific IGW SSL of 650 mg/kg. Appendix H has the calculation spreadsheets for the site-specific IGW SSL.

4.6 Soil Results

Twenty-nine soil samples were collected at different soil depths. From these samples, six were obtained as surface samples (0 to 0.5 feet) and 23 samples were obtained at several depths in the subsurface. Figure 2 shows the location where the soil borings were drilled to obtain these samples. Figure 14 displays the location of the soil borings and the analytical results from the samples. In Figure 14, the locations of soil borings with an exceedance are identified with the color red and the locations with no exceedance are colored blue. Figure 14 also shows the soil borings where CCPW is present (green). If CCPW was not present in the soil boring the location is colored white.

Figures 7A and 7B have a summary of the sample locations and depths of where the metals exceeded the NJDEP RDC SRS, and default and site-specific IGW SSL respectively.

Table 13 contains the positive detections from the soil analytical results from the delineation investigation (Appendix I contains the complete data [detections and non-detections] resulting from soil analysis). Tables 13A, 13B, and 13C contain the soil analytical results from the delineation investigation with the comparison to the NJDEP RDC SRS, NRDC SRS, and default and site-specific IGW SSL, respectively. Information regarding frequency of detection, minimum and maximum detection, location of maximum, and statistics (average and standard deviation) can be found on Table 14 (surface and subsurface soil results), Table 15 (surface soil results) and Table 16 (subsurface soil results).

4.6.1 Chromium

Chromium was detected in each of the surface samples collected. The surface soil samples did not have concentrations above the NJDEP CrSCC of 120,000 mg/kg. The subsurface soil samples also contained chromium concentrations lower than the NJDEP CrSCC. The location of the sample with the highest concentration of chromium is 016_K013, at a depth of 0.0 feet bgs, with a concentration of 3,240 mg/kg.

4.6.2 Hexavalent Chromium

Hexavalent chromium was not detected in the six surface soil samples. Four subsurface samples detected hexavalent chromium. The location of the subsurface soil sample with the highest concentration of hexavalent chromium is 016_J020 at a depth of 3.5 feet bgs with a concentration of 5.4 mg/kg. Detected concentrations of hexavalent chromium were below the NJDEP CrSCC (20 mg/kg).

4.6.3 Antimony

Five samples exhibited detectable concentrations of antimony. The location of the surface soil sample with the highest concentration (77 mg/kg) is located at 016_G020 at a depth of 0.0 feet bgs. The location of the subsurface soil sample with the highest concentration (2.1 mg/kg) is at 016_J020 at a depth of 3.5 feet bgs. There were no occurrences of antimony greater than the applicable minimum soil remediation standard/screening level.

4.6.4 Nickel

Each of the surface and subsurface soil samples from the delineation investigation contained nickel. The surface and subsurface soil samples did not exceed the minimum soil remediation standard/screening level. The sample location where the highest concentration of nickel was found was at 016_K013 at a depth of 0.0 feet bgs with an estimated concentration of 273 mg/kg.

4.6.5 Vanadium

Each of the surface soil samples collected contained vanadium. One surface soil sample exhibited concentration of vanadium that is greater than the RDC SRS of 78 mg/kg. The location where the highest concentration of vanadium was found in the surface soil was 016_K013 at a depth of 0.0 feet bgs with an estimated concentration of 391 mg/kg. Vanadium was detected in each of the subsurface soil samples. One subsurface sample was above the RDC SRS of 78 mg/kg. The location of subsurface soil sample exhibiting the highest concentration (97 mg/kg) of vanadium is 016_J020 at 3.5 feet bgs.

4.6.6 Thallium

Thallium was not detected in the surface soil samples collected but thallium was detected in one subsurface soil sample. The location in the subsurface soil with the highest concentration of thallium was 016_G020 at a depth of 5 feet bgs with a concentration of 0.48 mg/kg. The sample containing thallium was below the minimum soil remediation standard/screening level.

4.6.7 Comparison to the Residential Direct Contact Soil Remediation Standard

The comparison of the soil concentration to the RDC SRS can be found on Table 13A and Figure 7A. Antimony was detected in five samples, where concentrations were below the RDC SRS of 31 mg/kg. Chromium was detected in the samples collected at concentrations below

120,000 mg/kg. Nickel was detected in the samples collected at concentrations below 1,600 mg/kg. Thallium was detected in one subsurface sample with a concentration below the NRC SRS of 5 mg/kg. Hexavalent chromium was detected in ten samples (six surface samples and four subsurface samples) with concentrations below 20 mg/kg (CrSCC). Vanadium was detected in each surface and subsurface soil sample collected at Site 016. One surface soil, at location 016_K013 at a depth of 0.0 feet bgs with an estimated concentration of 391 mg/kg was above the RDC SRS of 78 mg/kg. One subsurface soil, at location 016_J020 at a depth of 3.5 feet bgs with a concentration of 97 mg/kg was above the RDC SRS of 78 mg/kg. Tables 15 and 16 present information about the frequency of detection and exceedances for the soil samples, surface and subsurface samples respectively.

4.6.8 Comparison to the Non-Residential Direct Contact Soil Remediation Standard

Since this site has been identified as a Non-Residential CCPW Site, the comparison of the soil results to the NRDC SRS can be found in Tables 13B, 15, and 16. There were no exceedances of the NRDC SRS in surface or subsurface soil for antimony, nickel, thallium, and vanadium.

4.6.9 Comparison to the Impact to Groundwater Soil Screening Levels

IGW SSLs that were used to compare the results from the field investigations can be found on Table 4. A site-specific IGW SSL for nickel was calculated through SPLP method described in the NJDEP Guidance for the Use of the Synthetic Precipitation Leaching Procedure to Develop Site-Specific Impact to Ground Water Remediation Standards (2008). Concentrations in the soil samples for antimony, nickel and thallium were below the IGW SSL. Table 13C presents the comparison of the concentrations to the IGW SSL. Tables 15 and 16 present frequency of detection for surface and subsurface soils respectively. Vanadium does not have an IGW SSL.

4.6.10 CCPW in Soil

CCPW was observed in one of the soil borings. CCPW was present at 016_L020 at a depth ranging from 0.0 to 1.0 feet bgs. Appendix C-2 contains the soil borings and the depth where CCPW was observed.

4.7 Groundwater Results

Groundwater samples were collected from the existing monitoring wells 016_MW01 through 016_MW08, PPG4_MW2 and PPG4_MW15. Two new monitoring wells were installed, 016_MW10 and 016_MW11, were also sampled. Monitoring well PPG4_MW16 was not sampled because it was destroyed during the construction of the Spectra pipeline along Caven Point Road and the new monitoring well 016_MW09 was destroyed between the time it was installed and the time it was to be sampled. As dictated by NJDEP guidelines, two samples were collected from PPG4_MW02 and PPG4_MW15 due to their well screen length of 10 feet. Locations of the groundwater monitoring wells are presented on Figure 2. Figure 8 shows the groundwater results from these samples. Groundwater results were compared to GWQS shown on Table 4. Figure 9 shows the location and results where the concentration of metals exceeded the GWQS. The results from the groundwater analysis can be found on Table 17, and the frequency of detection, minimum and maximum detection, location of maximum, and statistics (average and standard deviation) information can be found on Table 18. Appendix J-2 contains the data obtained regarding the contaminant concentrations in groundwater.

Groundwater samples obtained during the delineation investigation were analyzed using USEPA Method SW-846 6020A (USEPA, 2007a). Non-detected concentrations for the metal analyzed did not exceed the GWQS.

According to the Jersey City Municipal Utilities Authority, a storm sewer line (36 inch RCP Class IV) along Caven Road and a sanitary sewer line (27 inch RCP Class IV) were identified along Linden Ave (Appendix K). These underground utilities could potentially act as preferential pathways for the movement of groundwater.

4.7.1 Chromium

Chromium was detected in 13 of 14 samples. The sample with the highest concentration of chromium (742 ug/L) was found at 016_MW07. Three samples (016_MW02, 016_MW07 and 016_MW08) had concentrations that were above the GWQS (70 ug/L). Figure 16 shows the isoconcentration map with the chromium results.

4.7.2 Hexavalent Chromium

Two groundwater samples detected concentrations of hexavalent chromium. The sample with the highest concentration of hexavalent chromium was collected from 016_MW08 with a concentration of 27.9 ug/L. There is no NJDEP GWQS for hexavalent chromium. Figure 17 shows the isoconcentration map with the hexavalent chromium results.

4.7.3 Antimony

Antimony was detected in three groundwater samples. Monitoring well 016_MW07 detected antimony at a concentration of 4.9 ug/L (highest concentration of the detected samples). This groundwater sample did not exceed the GWQS for antimony of 6 ug/L. Figure 15 shows the isoconcentration map with antimony results.

4.7.4 Nickel

Six groundwater samples had detectable concentrations of nickel. The location where the highest concentration of nickel (78.7 ug/L) was found was at 016_MW07. Detected concentrations of nickel were below the GWQS (100 ug/L). Figure 18 shows the isoconcentration map with nickel results.

4.7.5 Vanadium

Vanadium was detected in 13 groundwater samples. The highest concentration of vanadium (84.1 ug/L) was found at 016_MW07. This one groundwater sample exceeded the GWQS (60 ug/L). Figure 19 shows the isoconcentration map with vanadium results.

4.7.6 Thallium

Groundwater samples did not have detectable concentrations of thallium. The non-detected concentrations of thallium were less than the GWQS of 2 ug/L.

4.8 Conclusions

4.8.1 Soil

The results obtained from the initial and delineation investigation were used to determine the extent of soil contamination (area and volume) at Site 016. The initial investigation results determined where the delineation investigation would be conducted. Together, the initial and delineation investigations defined the extent of horizontal and vertical contamination in the soil at the site. Additional field investigation is needed for further delineation in the southeastern corner of the site (at the east end of Linden Ave). Figure 20 presents a visual interpretation of where contamination is present at any given depth (color red) based on RDC SRS exceedances, and where CCPW was observed (color green), mainly in the first few feet bgs, during the field investigations. Figure 20 identifies the areas where remediation is needed within the site. The total amount of soil that would need to be excavated and disposed is approximately 39,000 cubic yards.

The contamination at the northern part of the site is bounded by the remediated drainage ditch. Contamination to the east of the site is confined to the remediation line for Site 112A. The southern portion of the site is bounded by Linden Ave east and the western side of the site is bounded by the historical samples along Caven Point Road.

4.8.2 Groundwater

Groundwater contamination has been vertically delineated with the installation of a deep well (016_MW10). High concentrations of chromium (ranging from 18 ug/L to 397 ug/L) were present in three monitoring wells during the initial investigation. During the delineation investigation, high concentration of chromium (ranging from 147 ug/L to 742 ug/L) was present on the same three wells as the initial investigation (016_MW02, 016_MW07 and 016_MW08).

There is a possibility that the results obtained from the delineation investigation may have been affected due to Super Storm Sandy, which occurred in October 2012.

5.0 RECEPTOR EVALUATION AND BASELINE ECOLOGICAL EVALUATION

This receptor evaluation and baseline ecological evaluation (EE) was performed in accordance with the requirements of New Jersey Administrative Code 7:26E in addition to the New Jersey Department of Environmental Protection (NJDEP) Ecological Evaluation Technical Guidance to assess actual or potential adverse ecological effects on wildlife and plants resulting from site-related contamination at Hudson County Chromium Site 016 (the Site) in Jersey City, Hudson County, New Jersey (Figure 1). The receptor evaluation for Site 16 is presented in Appendix G, and is discussed further in in Section 5.2.

In accordance with New Jersey Administrative Code 7:26E, the EE documents the following actions:

- Evaluates the data identified or collected in the site investigation to identify the site-specific contaminants that are of ecological concern.
- Identifies environmentally sensitive natural resources (ESNRs) within the site boundaries and on properties immediately adjacent to the Site.
- Identifies potential contaminant migration pathways to the ESNR identified or observations of potential impact to the identified ESNR that might be attributed to site contamination. Such observations shall include, but not be limited to: stressed or dead vegetation; discolored soil, sediment, or water; absence of biota in a specified area of the system as compared to other similar areas of the same system; or presence of a seep or discharge; and
- Draws conclusions regarding the need to conduct further investigations.

5.1 Site Background, Setting, and Facility History

A more detailed site background is presented in Section 1, therefore, only a brief discussion is presented here. The area immediately surrounding the Site is primarily commercial, recreational, and industrial. Site 016 is approximately 12.9 acres in size. A warehouse covers approximately 7.5 acres, an asphalt parking lot covers approximately 2.0 acres, and unpaved areas cover approximately 3.4 acres. Most of the unpaved area is covered with gravel. A description of the location of the site and its history is provided in Section 1. Current land use within 1,000-foot radius of Site 016 is shown on Figure 4 in Appendix G.

The topography at Site 016 is generally flat, gradually sloping towards the drainage ditch along the northern edge of the Site (Figure 2). The facility buildings are at an approximate elevation of 10 feet above mean sea level with the lowest elevations at the Site nearing 5 feet above mean sea level near the drainage ditch. Surface runoff on the Site and surrounding area flows across the Site toward the drainage ditch. Surface water near the loading docks and the building is channeled into a storm sewer system which discharges into the drainage ditch.

Activities that occurred at the Site are primarily related to warehouse activities.

5.2 Receptor Evaluation

A receptor evaluation was performed for Site 16. The report of this evaluation can be found in Appendix G. In summary, no ESNRs have been identified at or near the Site.

5.3 Environmentally Sensitive Natural Resources

ESNRs include, but may not be limited to, all areas defined within New Jersey Administrative Code 7:1E-1.8(a), ground water, and areas and/or resources that are protected or managed pursuant to the Pinelands Protection Act, New Jersey Statutes Annotated 13:18A-1 et seq. and the Pinelands Comprehensive Management Plan, New Jersey Administrative Code 7:50. Some of these areas include water bodies such as rivers, streams, creeks, ponds, lakes and reservoirs, wetlands and wetland transition areas, and habitat for Federal and State endangered or threatened plant and animal species.

The ecological habitat at the Site is very poor and the habitat immediately surrounding the Site is generally poor as well. Although there are some small vegetated areas along the perimeter, the majority of the Site is covered with the warehouse, paved parking lot, and gravel. The area surrounding the Site is a mixture of roads, industrial complexes, and landscaped lawns. Therefore, the area would provide very limited habitat for ecological receptors.

There is one natural surface water feature and several man-made surface water features within a half-mile radius of the Site (Figure 6 in Appendix G). The Upper New York Bay is located approximately 700 feet to the east of the Site. A man-made drainage ditch (Claremont Ditch) borders the northern Site boundary. The drainage ditch was remediated and lined during the remedial action work completed by Liberty National Development Company in 2002. Several landscaped ponds and drainage features were constructed on the Liberty National Golf Course for aesthetic purposes and run-off control.

About 75 percent of the Site is paved or covered by the existing warehouse. Surface runoff on the Site and surrounding areas on paved (impervious) surfaces is generally channeled into a storm sewer system which discharges into the drainage ditch along the northern Site border.

No wetlands were identified on the Site. Wetland maps from the New Jersey Geographic Information System show the closest wetlands were constructed as part of the Liberty National Golf Course and are located about 300 feet east of the Site (Figure 7 in Appendix G).

A formal search for rare, threatened, and endangered species was not conducted because given the industrial nature of the Site and surrounding area, and because of the site activities that have occurred to date, it is highly unlikely that protected species are present at the Site. Also, no sensitive areas were found at or adjacent to the Site on the NJDEP i-Map NJDEP web site (http://njgin.state.nj.us/dep/DEP_iMapNJDEP/viewer.htm) or the NJ GeoWeb (http://www.state.nj.us/dep/gis/geoweblaunch.htm), with the exception of the wetlands at the golf course.

5.4 Contaminants of Potential Ecological Concern

Pursuant to New Jersey Administrative Code 7:26E-3.11, the investigator must identify the presence of Contaminants of Potential Environmental Concern (COPECs). The only ESNRs have been identified at or near the Site at the offsite wetlands associated with the golf course.

Although the habitat at the site is very poor and not conducive for ecological receptors, COPECs at the Site (surface soil and groundwater) were identified for completeness of the document. The surface soil COPECs were identified by comparing the chemical concentrations in the surface soil samples to values in the most recent version of the NJDEP Ecological Screening level Table, available at http://www.nj.gov/dep/srp/guidance/ecoscreening/ (see Tables 19 and 20). Table 19 presents the data from the initial investigation, while Table 20 presents the data from the delineation investigation. Based on this comparison, antimony, chromium, hexavalent chromium, nickel, and vanadium were detected at concentrations that exceeded their respective screening level and are identified as COPECs. However, because the habitat at the site is very poor, it is not likely that significant populations of ecological receptors would be present.

The groundwater COPECs were identified by comparing the chemical concentrations in the groundwater samples to values in the most recent version of the NJDEP Ecological Screening Criteria Table (see Tables 21 and 22) (NJDEP 2011e). This comparison was only conducted separately for the initial investigation and the delineation investigation groundwater results. The average metal concentrations in the groundwater samples were compared to the surface water aquatic screening criteria because the groundwater would be discharging as an average concentration as it flows across the site. Freshwater screening criteria were used because the ditch is fresh, and a default water hardness of 100 mg/L was used to adjust the screening criteria based on hardness because water hardness data were not available. The criteria were not converted to dissolved values because the groundwater samples were not filtered.

Claremont Ditch is lined so it is unlikely that significant amounts of groundwater (if any) would directly discharge to the ditch. The primary source of water entering the ditch is storm water from surface drainage from Caven Point Road. If it would discharge to the ditch, however, the groundwater would be mixed with surface water immediately after discharging. Therefore, the average groundwater concentration in Tables 21 and 22 were first compared to directly the surface water criteria, and were then compared to the surface water criteria multiplied by a factor of 10 (for a 10x dilution factor). Based on the initial investigation data, the average hexavalent chromium concentration slightly exceeded the screening criteria without a dilution factor, but did not exceed the screening levels with a dilution factor of 10. Based on the delineation investigation data, the average chromium and vanadium concentrations slightly exceeded the screening criteria without a dilution factor, but do not exceed the screening levels with a dilution factor of 10. Therefore, it is not likely that aquatic organisms would be impacted by metals in groundwater if it discharges to surface water.

5.5 Conclusions

Several metals, including antimony, chromium, hexavalent chromium, nickel, and vanadium were identified as COPECs because they were detected at concentrations in surface soil that exceeded their respective NJDEP Ecological Screening Criteria. However, no ESNRs have been identified at the Site. Therefore, there is not a complete exposure pathway between the COPECs in surface soil and the ESNRs. For that reason, an ecological risk assessment in accordance with New Jersey Administrative Code 7:26E-4.7 does not need to be conducted for the soil at the site. It is recommended that three surface samples be collected along the northeastern border adjacent to the ditch. The data from these locations will be used to assess the potential pathway to the ditch during the soil remedy.

There is a possibility that groundwater might migrate from the site and discharge into the drainage ditch, which would then discharge into the wetland at the golf course. The primary source of water entering the ditch is storm water from surface drainage from Caven Point Road. After applying a dilution factor of 10, none of the average metal concentrations in the groundwater exceeded screening levels.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Site 016 is in a large area (more than 5 acres) of historic fill for industrial development based on the New Jersey Geological Survey Historic Fill of the Jersey City Quadrangle (2004). It was investigated due to contamination from CCPW. Several remedial actions were conducted since 1992 to minimize the exposure to CCPW through the site. This initial investigation consisted in sampling soil, groundwater, and concrete cores to determine the nature and extent of contamination. The initial field investigation occurred from July to September 2011 and during early January 2012 using the USEPA Method SW-846 6010C (USEPA, 2007b) for analysis of metals. The results of the initial investigation are summarized as follows:

Soil

- 463 soil samples were obtained; 69 were surface soil samples and 394 were subsurface soil samples.
- The presence of chromium in soil is extensive. The highest concentration of chromium found was 7,090 mg/kg at location 016_I013 at a depth of 3.1 feet bgs. The lowest concentration of chromium found was 0.33 mg/kg. Chromium concentrations in the soil samples did not exceed the NJDEP CrSCC of 120,000 mg/kg.
- Hexavalent chromium was detected in 126 soil samples. The samples with hexavalent chromium that exceeded the NJDEP CrSCC were localized (center of the warehouse and the north east edge of the site). The highest concentration of hexavalent chromium was found at an estimated concentration of 276 mg/kg in soil sample 016_I012 at a depth of 2.5 feet bgs.
- Nickel and vanadium were found in the soil samples throughout Site 016. The highest concentration of nickel was 3,220 mg/kg in sample 016_H009 (below the concrete floor) at a depth of 0.4 feet bgs. The highest concentration of vanadium was 1060 mg/kg in sample 016_H005 (below the concrete floor) at a depth of 5.5 feet bgs. Forty-eight samples contained vanadium concentrations greater than the RDC SRS of 78 mg/kg. One sample containing nickel was above the RDC SRS of 1,600 mg/kg and the site-specific IGW SSL of 650 mg/kg.
- Thallium was not detected in the samples collected.
- Antimony was detected in 31 soil samples and the highest estimated concentration (10.4 mg/kg) was detected in sample 016_L010 at a depth of 2.1 feet bgs. Two soil samples contained antimony above the default IGW SSL of 6 mg/kg.

Groundwater

- Fourteen groundwater samples were obtained, eight from monitoring wells that were installed for this initial investigation and six samples from three existing monitoring wells at two different depths.
- The groundwater sample where the highest concentration of chromium, nickel, vanadium, and hexavalent chromium was detected is 016_MW08.
- Antimony and thallium were not present in the groundwater samples.

- 13 groundwater samples detected chromium. One sample had a concentration that exceeded the GWQS. The highest concentration of chromium was 397 ug/L.
- Two groundwater samples detected nickel. The groundwater samples did not exceed the GWQS
- Twelve groundwater samples contained vanadium and those samples did not exceed the GWQS.
- Nine samples contained hexavalent chromium. The highest concentration found was 182 ug/L. .
- Vertical delineation of groundwater contamination needed to be addressed.

Core Samples

- Two core samples were obtained.
- Hexavalent chromium found in samples 016_H016 exceeded the NJDEP CrSCC with an estimated concentration of 38.4 mg/kg

Foundation Samples

- Four foundation samples were obtained near the loading docks.
- Chromium was detected in the samples, but detections did not exceed the NJDEP CrSCC for soil.
- Hexavalent chromium was not detected in the foundation samples.

Based on the results of the soil and groundwater initial investigation further delineation of the contamination was required. According to the Technical Memorandum sent to NJDEP on July 16, 2012 with minor revisions, conference calls and discussions with NJDEP, further soil delineation was conducted in December 2012 and January 2013. Six borings were drilled and three monitoring wells were installed. Soil, groundwater, and four SPLP samples were collected. Three new monitoring wells, including a deep groundwater well were installed to investigate the vertical delineation of the contamination. The delineation sampling utilized USEPA Method SW-846 6020A (USEPA, 2007a) that has a lower quantitation level for the metals discussed in the subsequent sections.

A summary of the results of the delineation investigation are as follow:

Soil

- 29 soil samples were obtained; 6 were surface soil samples and 23 were subsurface soil samples.
- Antimony was detected in five soil samples and the highest estimated concentration (77 mg/kg) was detected in sample 016_G020 at a depth of 0.0 feet bgs.
- The highest concentration of chromium found was 3,240 mg/kg at location 016_K013 at a depth of 0.0 feet bgs. The lowest estimated concentration of chromium found was 9.8

mg/kg. Chromium concentrations in the soil samples did not exceed the CrSCC of 120,000 mg/kg.

- Hexavalent chromium was detected in four soil samples. The highest concentration of hexavalent chromium was found at a concentration of 5.4 mg/kg in soil sample 016_J020 at a depth of 3.5 feet bgs. Samples containing hexavalent chromium did not exceed the CrSCC of 20 mg/kg.
- The highest concentration of nickel was 273 mg/kg in sample 016_K013 at a depth of 0.0 feet bgs. Detected concentrations of nickel did not exceed the minimum soil remediation standard/screening level.
- The highest estimated concentration of vanadium was 391 mg/kg in sample 016_K013 at a depth of 0.0 feet bgs. Two soil samples (one surface and one subsurface) were above the RDC SRS.
- Thallium was not detected in the surface soil samples collected. One subsurface soil sample detected thallium at a concentration of 0.48 mg/kg at 016_G020 at a depth of 5 feet bgs. The detected concentration of thallium did not exceed the minimum soil remediation standard/screening level.

Groundwater

- 14 groundwater samples were obtained, two from monitoring wells that were installed for the delineation investigation and 12 samples from existing monitoring wells.
- The groundwater sample where the highest concentration of chromium, nickel, and vanadium was detected is 016_MW07.
- The groundwater sample where the highest concentration of hexavalent chromium was detected at 016_MW08.
- Antimony and thallium were not present in the groundwater samples.
- Thirteen groundwater samples detected chromium. Three samples had a concentration that exceeded the GWQS. The highest concentration of chromium was 742 ug/L.
- Two samples contained hexavalent chromium. The highest concentration found was 27.9 ug/L.
- Six groundwater samples detected nickel. Groundwater samples did not exceed the GWQS.
- Thirteen groundwater samples contained vanadium. One of those samples did not exceed the GWQS.

The extent of soil contamination is shown on Figure 20. Contamination is clustered along the eastern edge of the warehouse and towards the center of the warehouse. The edge of the site that is contiguous to the drainage ditch also presents a line of contaminated borings. The southeast corner of the site (along Linden Ave) (near 016_L020) needs to be further evaluated in order to obtain a defined limit of contamination. Historical data shown on Figure 20 indicate that Caven Point Road is a boundary for the site. The main areas where historical data shows exceedances when compared to the soil remediation standard are in in the general area (along the drainage ditch and within the parking lot) where the results from both investigations (initial and delineation) exceed the soil remediation standard.

The initial investigation results show that in some cases, samples that contained non-detected concentrations of thallium were greater than the minimum soil remediation standard/screening level. During the delineation investigation using USEPA SW-846 Method 6020A (USEPA, 2007a), the non-detected concentrations for thallium were less than the minimum soil remediation standard/screening level.

High concentrations of chromium (for the initial and delineation investigation) can be localized to three monitoring wells (016_MW02, 016_MW07 and 016_MW08) (see Figure 9). With the installation of the deep monitoring well and the groundwater results from this well less than the GWQS, the vertical extent of the contamination was delineated.

The EE concluded that an ecological risk assessment does not need to be conducted. Even though several metals were identified as COPECs, because they were detected at concentrations in surface soil that exceeded their respective NJDEP Ecological Screening Criteria, no ESNRs have been identified at or near the Site. Therefore, there is no complete exposure pathway between the COPECs in surface soil and the ESNRs.

6.2 Recommendations

Figure 20 presents a visual interpretation of where contamination is present at any given depth (color red) based on RDC SRS exceedances, and where CCPW was observed (color green), mainly in the first few feet bgs, during the field investigations. Figure 20 identifies the areas where remediation is needed within the site. Pre-excavation or pre-design sampling of the remedial limits to the south of boring 016_H016, to the south/southeast of boring 016_J020, to the south, east and west of boring 016_L020 and possibly to the north and east of borings 016_K007 and 016_K009 will be conducted as part of the Remedial Action Work Plan. Soil samples with exceedances of the impact to groundwater standard for thallium and antimony are collocated with the residential direct contact exceedances and the Remedial Action Work Plan will incorporate these exceedances into the remedial design of the soil remedy. It is recommended the impacted soil be excavated and disposed of properly. The total amount of soil that would need to be excavated and disposed is approximately 39,000 cubic yards.

Based on the groundwater results, a Groundwater Classification Exception Area/Well Restriction Area (N.J.A.C. 7:26E-4.3(a)7 and N.J.A.C. 7:26E-4.9(a)7) for the shallow groundwater should be prepared following the requirements detailed in N.J.A.C 7:26C-73. An additional groundwater investigation will be completed following the implementation of the soil remedy. This groundwater investigation will include the determination of locations and invert depths of the utilities in the vicinity of the impacted groundwater in order to determine if there is the potential for contaminant migration along utility bedding and/or infiltration into utilities.

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