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Project No. 60493065.27
September 2020

Remedial Investigation Report/ Remedial Action Work Plan/ Remedial Action Report Building No. 2 – Boiler Room Subslab Soil and Interior Concrete Surfaces (AOC 3)

Final

Hudson County Chromate Site 156
Metropolis Towers

270-280 Luis Munoz Marin Boulevard
Jersey City, New Jersey
NJDEP Program Interest Number: G000008770
Case Tracking Number: 104063

Document No. 156-008

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List of Acronyms

ACO	Administrative Consent Order
amsl	above mean sea level
AOC	Area of Concern
ARS	Alternative Remediation Standard
bgs	below ground surface
CCPW	Chromate Chemical Production Waste
CEC	Civil & Environmental Consultants
CID	Case Inventory Document
COPR	Chromite Ore Processing Residue
Cr	total chromium
Cr^{+3}	trivalent chromium
Cr^{+6}	hexavalent chromium
CrSCC	Chromium Soil Cleanup Criteria
CSM	Conceptual Site Model
cy	cubic yards
DIGWSSL	Default Impact to Groundwater Soil Screening Level
Eh	redox potential
El.	elevation
FB	field blank
FSPM	NJDEP Field Sampling Procedures Manual
FSP-QAPP	Field Sampling Plan – Quality Assurance Project Plan
ft	Foot or feet
GGM	green-gray mud
GWQS	Groundwater Quality Standard
HASP	Health and Safety Plan
HCC	Hudson County Chromate
HEPA	high-efficiency particulate air
HUD	Housing and Urban Development Authority
IRM	Interim Remedial Measure
JCO	Judicial Consent Order
LSRP	Licensed Site Remediation Professional
MDL	method detection limit
MEP	mechanical, electrical, and plumbing
mg/kg	milligram(s) per kilogram
MRCE	Mueser Rutledge Consulting Engineers
NAVD 88	North American Vertical Datum of 1988

List of Acronyms (Continued)

Ni	nickel
N.J.A.C.	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection
NRDCSRS	Non-Residential Direct Contact Soil Remediation Standard
OM&M	Operation, Maintenance, and Monitoring
PATH	Port Authority Trans Hudson
PI	Program Interest
PVC	polyvinyl chloride
Q1	first quarter
Q2	second quarter
Q3	third quarter
Q4	fourth quarter
QA	quality assurance
QC	quality control
RA	Remedial Action
RAP	Remedial Action Permit
RAR	Remedial Action Report
RAWP	Remedial Action Work Plan
RDCSRS	Residential Direct Contact Soil Remediation Standard
rebar	reinforcing bar
RI	remedial investigation
RIR	Remedial Investigation Report
RL	reporting limit
SA	Site Administrator
SAP	Sampling and Analysis Plan
Sb	antimony
SOP	standard operating procedure
SRP	Site Remediation Program
SRRA	Site Remediation Reform Act
SRS	Soil Remediation Standard(s)
Tl	thallium
TOC	total organic carbon
TRSR	Technical Requirements for Site Remediation
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
V	vanadium
WGI	Warren George Inc.
µg/L	microgram(s) per liter

List of Definitions

The following definitions apply solely to this document.

CCPW	Chromate Chemical Production Waste, a by-product generated from the production of sodium bichromate, including Chromite Ore Processing Residue (COPR), Green-Gray Mud, and fill mixed with COPR or Green-Gray Mud.
Chromium	An element found in nature that is commonly used in manufacturing activities. Chromium may be present in soil or water as trivalent chromium and hexavalent chromium (Cr^{+6}). Trivalent chromium is an essential nutrient at trace concentrations. Cr^{+6} can be present in many forms, some of which are carcinogenic at high concentrations. Total chromium, as measured in soil or groundwater, is the sum of trivalent and Cr^{+6}.
Cr^{+6} Bloom	Appearance of light- to bright-yellow powdery crystals of a Cr^{+6} salt precipitate on porous surfaces (soil, concrete, etc.) resulting from the movement of Cr^{+6}-contaminated groundwater upward, by hydraulic pressure and/or capillary action, and subsequent evaporation of the contaminated groundwater on the surface.
COPR	Chromite Ore Processing Residue is a specific type of CCPW generally characterized as a reddish brown, coarse to fine gravel with varying amounts of sand and silt particles. The gravel portion of the matrix is typically defined as nodules from the chromium manufacturing process that range in size from 3/4- to 1/8-inch in diameter. However, nodules have been infrequently detected at diameters of over an inch. Different size nodules may be found cemented together to form larger clusters. The matrix of these clusters may consist of cement-like silt. These nodules can be disintegrated easily with a hammer. Occasionally when detected in the saturated zone, COPR nodules may appear as a fine grained material that has been weathered. The permeability of this material is variable. The inner matrix of COPR nodules typically contains higher concentrations of Cr^{+6} than the surface of the nodules but lower concentrations than Green-Gray Mud. The typical approximate range of Cr^{+6} concentrations in COPR is between 300 and 5,000 mg/kg.
GGM	Green-gray mud (GGM) is generally a lime green, dense silt with minor amounts of fine sand and clay. When found in the saturated zone, the grain size of this material may have been affected further due to weathering processes. This can give the material a wet, clayey silt or silty clay appearance with little or no physical or structural integrity. This material has a low permeability. The pH of this material is generally 11 to 12 units. The typical approximate range of Cr+6 in green-gray mud is greater than 5,000 mg/kg.
Groundwater	The supply of fresh water found beneath the surface of the Earth, which can be extracted by wells or through natural springs.

IRM	Interim Remedial Measure. Remedial action taken at a contaminated site to reduce the potential for human health or environmental exposure to contaminants at a site before a remedial investigation is complete.
Meadow Mat	A naturally occurring organic estuarine deposit located at approximately 13 to 20 feet below the ground surface, pre-excavation.
RAWP	Remedial Action Work Plan. A document describing how a responsible party intends to remediate a contaminated site.
Remediation	Actions to reduce, isolate, or remove contamination with the goal of protecting human health and the environment.
Site Administrator (SA)	Under terms of an agreement among PPG, the New Jersey Department of Environmental Protection, and the City of Jersey, this court-appointed individual is responsible for: • Developing a master schedule; • Resolving issues that might arise; • Obtaining technical expertise required for the review of PPG's submittals; and, • Maintaining regular communications with community representatives.
SRS	New Jersey Soil Remediation Standards (SRS), (New Jersey Administrative Code [N.J.A.C.] 7:26D et seq.).

Executive Summary

This Remedial Investigation Report (RIR)/Remedial Action Work Plan (RAWP)/Remedial Action Report (RAR) has been prepared by AECOM on behalf of PPG for Hudson County Chromate (HCC) Site 156, Metropolis Towers (the Site) Area of Concern (AOC) 3, the Building No. 2 Boiler Room Subslab Soil and Interior Concrete Surfaces. The New Jersey Department of Environmental Protection (NJDEP) Site Remediation Program (SRP), Program Interest (PI) Number for the Site is G000008770.

This RIR/RAWP/RAR provides the results of remedial investigation (RI) activities, evaluates remedial alternatives for the identified impacts, and presents and documents the selected Remedial Action (RA) for AOC 3. The objective of this RIR/RAWP/RAR is to obtain NJDEP concurrence that no further RA is necessary for AOC 3.

During a site inspection on November 5, 2012, subsequent to significant flooding caused by Hurricane Sandy (AECOM, 2012b), green/yellow staining was observed on the base of a concrete support column located in the Boiler Room of Building No. 2. Samples were collected for laboratory analysis, and were found to contain elevated levels of hexavalent chromium (Cr^{+6}), confirming the presence of a Cr^{+6} bloom. Therefore, an Interim Remedial Measure (IRM) consisting of polyethylene sheeting, plywood, and caulk seam sealant was installed on November 13, 2012 to reduce the potential for exposure and to prevent disturbance of the column by building maintenance personnel. Additional IRMs, consisting of epoxy floor coating, were later installed at four concrete chip sample locations during the 2015 Third Quarter and Fourth Quarter IRM inspections, in the vicinity of the boilers and impacted column at laboratory-confirmed Cr^{+6} blooms. Results of quarterly IRM inspections, which were initiated in November 2012, are documented by AECOM via Quarterly IRM Inspection Reports, which are distributed to the stakeholders.

Beginning with the initial concrete column sampling event on November 5, 2012, multiple sampling events were conducted through April 11, 2016. These activities included interior concrete sampling and contaminant delineation, sampling of the subsurface concrete column foundation (column footer), sampling and delineation of soils beneath the concrete floor slab, and the collection of water samples, including Boiler Room sumps, boiler system circulation water, and groundwater from a test pit excavation area inside the Boiler Room.

RI activities and results were proposed and documented on a preliminary basis in a series of Sampling and Analysis Plans (SAP) and/or Technical Memoranda, which were developed with, and reviewed by, NJDEP, and are referenced throughout this report.

During these RI activities, the concrete support column and portions of the floor surface beneath and around the boilers were found to be impacted with Cr^{+6} at concentrations greater than the Chromium Soil Cleanup Criteria (CrSCC) of 20 milligrams per kilogram (mg/kg). Additionally, a small area of Cr^{+6} impacted soils was identified, situated beneath the concrete floor in an area south of the boilers.

In response to the identified impacts, a Retro-Coat™ barrier was installed. This barrier consists of a durable, high-strength, chemical-resistant epoxy-like coating (20-30 mil thickness), which prevents direct contact with the impacted concrete. The Retro-Coat™ was originally identified as the selected remedial action in the *Remedial Investigation Report/Remedial Action Work Plan Building No. 2 – Boiler Room Subslab Soil and Interior Concrete Surfaces (AOC 3)* (RIR/RAWP) (AECOM, 2018a). Following installation of the Retro-Coat™, it was observed that construction and non-routine maintenance activities resulted in chipping and cracking of the coating, exposing the underlying concrete. Monthly inspections of the basement did not identify any potential Cr^{+6} blooms where the concrete was exposed.

The recommended and implemented final remedies presented in this RIR/RAWP/RAR for AOC 3 include:

- Concrete floor slab and column: Cr^{+6} remains in place at concentrations greater than the CrSCC and is addressed by engineering controls appropriate for the property's current use (signage prohibiting penetrating or damaging the concrete floor slab or column and conduct inspections for potential Cr^{+6} blooming; if potential Cr^{+6} blooms are observed, sample the location for Cr^{+6}; if the sample result for Cr^{+6} exceeds the CrSCC, remove the impacted concrete and install an epoxy coating over the affected area); and institutional control (deed notice).
- Soil: Cr^{+6} remains in place at concentrations greater than the CrSCC and antimony and nickel remain in place at concentrations greater than the Default Impact to Groundwater Soil Screening Levels (DIGWSSLs). These are addressed by engineering controls appropriate for the property's current use (existing concrete floor slab as a cap; signage prohibiting penetrating the concrete floor slab) and institutional control (deed notice).

The required NJDEP SRP/Site Remediation Reform Act (SRRA) forms are provided with this submission, including the Cover/Certification Form, Case Inventory Document (CID), and updated Receptor Evaluation Form.

A draft Deed Notice is included within this RIR/RAWP/RAR. The final Deed Notice will be filed with the appropriate government agencies upon agreement by the Property Owner. Once the Deed Notice is filed, the Remedial Action Permit (RAP) package for soil and concrete will be submitted to NJDEP with this RIR/RAWP/RAR included by reference.

1.0 Introduction

This Remedial Investigation Report (RIR)/Remedial Action Work Plan (RAWP)/Remedial Action Report (RAR) has been prepared by AECOM on behalf of PPG for Hudson County Chromate (HCC) Site 156, Metropolis Towers Area of Concern (AOC) 3.

The Site is located at 270-280 Luis Munoz Marin Boulevard, also known as 280 Gregory Park Plaza, in Jersey City, Hudson County, New Jersey (**Figure 1**). The Site is bounded to the north by Christopher Columbus Drive; to the south by Montgomery Street; to the east by Warren Street; and to the west by Luis Munoz Marin Boulevard. The Site occupies tax parcels Block 13101 Lots 1 and 2. AOC 3 is located inside Building No. 2, in the north east corner of the Boiler Room basement.

In 1990, PPG and the New Jersey Department of Environmental Protection (NJDEP) entered into an Administrative Consent Order (ACO) (NJDEP, 1990) to investigate and remediate locations where Chromate Chemical Production Waste (CCPW)[1] or CCPW-impacted materials related to former PPG operations may be present. On June 26, 2009, NJDEP, PPG, and the City of Jersey City entered into a *Partial Consent Judgment Concerning the PPG Sites*, also referred to as the Judicial Consent Order (JCO) (Superior Court of New Jersey Law Division – Hudson County, 2009), with the purpose of remediating the soils and sources of contamination at these HCC Sites as expeditiously as possible. The goal of the JCO is to complete the investigation and remediation of the PPG Sites in accordance with a judicially enforceable master schedule. Priority for the remedial activities was given to residential locations where CCPW and CCPW-related contamination is present. The provisions of the original ACO remain in effect with the JCO taking precedence where conflicts exist between the two documents.

This RIR/RAWP/RAR addresses the impacts at AOC 3 for which PPG is responsible under the ACO and JCO. These impacts include:

- Hexavalent chromium (Cr^{+6}) associated with CCPW in concrete structures and the underlying soil; and
- CCPW metals associated with CCPW (antimony [Sb], total chromium [Cr], nickel [Ni], thallium [Tl], and vanadium [V]) in the underlying soil.

The objectives of this RIR/RAWP/RAR are to:

- Document the remedial investigation (RI) activities conducted at AOC 3;
- Document the Interim Remedial Measures (IRMs) implemented at AOC 3;
- Evaluate remedial alternatives to address identified impacts;
- Present the selected Remedial Action (RA); and
- Document the protectiveness of the RA.

The required NJDEP Site Remediation Program (SRP)/Site Remediation Reform Act (SRRA) forms are provided with this submission, including the Cover/Certification Form, Case Inventory Document (CID), ,and updated Receptor Evaluation Form.

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[1] Chromate Chemical Production Waste, a by-product generated from the production of sodium bichromate, including Chromite Ore Processing Residue (COPR), green-gray mud, and fill mixed with COPR or Green-Gray Mud.

1.1 Remedial Investigation/ Remedial Action Technical Requirements

This RIR/RAWP/RAR was prepared in accordance with the following technical requirements and guidance:

- Technical Requirements for Site Remediation (TRSR), New Jersey Administrative Code (N.J.A.C.) 7:26E (NJDEP, 2012a);
- Remediation Standards, N.J.A.C. 7:26D (NJDEP, 2012b);
- Appendix F of the July 19, 1990 NJDEP ACO;
- June 26, 2009 Partial Consent Judgment or JCO; and
- NJDEP Field Sampling Procedures Manual (FSPM) (NJDEP, 2011).

1.2 Remedial Standards

Currently there are no soil remediation standards (SRS) for Cr or Cr^{+6}. Therefore, Cr and Cr^{+6} concentrations are compared to the NJDEP Chromium Soil Cleanup Criteria (CrSCC). The CrSCC of 20 milligrams per kilogram (mg/kg) for Cr^{+6} and 120,000 mg/kg for trivalent chromium (Cr^{+3}) will be utilized for remediation compliance. While there is no NJDEP criteria for Cr^{+6} in concrete, NJDEP considers concrete CCPW-impacted when the concentration of Cr^{+6} exceeds the NJDEP CrSCC.

The SRS for CCPW-related metals for the Site are based on current NJDEP Residential Direct Contact Soil Remediation Standards (RDCSRS), with the exception of vanadium, which has a NJDEP-approved Alternative Remedial Standard (ARS). In a December 16, 2011 letter, NJDEP accepted the use of a 370 mg/kg ARS for vanadium. The ARS for Vanadium was also indicated in the November 16, 2012 RAWP prepared by Civil & Environmental Consultants (CEC), which was approved by NJDEP on January 22, 2013. The December 16, 2011 and January 22, 2013 approval letters from NJDEP are included in **Appendix A**.

The concentrations of other metals found in association with CCPW are compared to the most stringent SRS, or site-specific value, as indicated in **Table 1** below:

Table 1 Soil Remediation Standards for CCPW Metals

Contaminant	RDCSRS (mg/kg)	NRDCSRS (mg/kg)	DIGWSSL (mg/kg)
Antimony (Sb)	31	450	6
Nickel (Ni)	1,600	23,000	48
Thallium (Tl)	NA	NA	3
Vanadium (V)	370*	1,100	NA

Notes:
RDCSRS – Residential Direct Contact Soil Remediation Standard
NRDCSRS – Non-Residential Direct Contact Soil Remediation Standard
DIGWSSL – Default Impact to Groundwater Soil Screening Level
NA – Standard Not Available
*Site-specific Alternative Remediation Standard (ARS)

Groundwater results for Cr^{+6} were compared to the NJDEP Ground Water Quality Standard (GWQS) for Cr of 70 micrograms per liter (µg/L). There is no specific GWQS for Cr^{+6}. The groundwater data for other metals (as applicable) were compared to their respective GWQS at N.J.A.C. 7:9C (NJDEP, 2010).

A site-specific Cr^{+6} criterion for the allergic contact dermatitis endpoint is not required for this RA in accordance with NJDEP's February 8, 2007 Chromium Cleanup Policy (NJDEP, 2007).

1.3 Project Team

The key project personnel, and their roles and responsibilities, are described in **Table 2**.

Table 2 Project Team

Project Team	Personnel	Address	Phone
PPG:			
PPG Project Manager	Jody Overmyer	440 College Park Drive Monroeville, PA USA 15146	(724) 325-5070
PPG Legal Contact	Dorothy Laguzza	K&L Gates LLP One Newark Center Newark, NJ 07102	(973) 848-4118
Facility Contacts:			
Property Owners Representative	Alki Antonopoulos	Metropolis Towers Apartments 280 Marin Blvd. Jersey City, N.J. 07302	(201) 435-6200
PPG Public Relations	Jeff Worden, APR	Worden Public Relations P.O. Box 10443 Pittsburgh, Pa. 15234	(412) 253-0816
AECOM:			
Project Manager	William Spronz	30 Knightsbridge Road Building 5, Suite 520 Piscataway, New Jersey 08854	O (732) 564-3917
Licensed Site Remediation Professional (LSRP)	To be determined for Remedial Action Permit (RAP)		
JCO Team:			
Site Administrator (SA)	Ronald Riccio	McElroy, Deutsch, Mulvaney & Carpenter, LLP One Hovchild Plaza 4000 Route 66 Tinton Falls, NJ 07753	O (201) 874-4581
SA Project Manager	James Ray	McElroy, Deutsch, Mulvaney & Carpenter, LLP One Hovchild Plaza 4000 Route 66 Tinton Falls, NJ 07753	O (973) 425-8707
SA Assistant	Nancy Colson	McElroy, Deutsch, Mulvaney & Carpenter, LLP One Hovchild Plaza 4000 Route 66 Tinton Falls, NJ 07753	O (732) 749-8449
NJDEP	Wayne Howitz	401 E. State Street Trenton, NJ 08625	O (609) 984-1351
NJDEP	David Doyle	401 E. State Street Trenton, NJ 08625	O (609) 292-2713
Technical Consultant	Prabal Amin	Weston Solutions, Inc. 205 Campus Drive	O (732) 417-5857

Project Team	Personnel	Address	Phone
		Edison, NJ 08837	

1.3.1 Site Administrator

The SA provides oversight of implementation of the JCO for the PPG HCC Sites. The SA team includes the SA, Ronald Riccio, the SA Project Manager, James Ray, and the SA Assistant, Nancy Colson.

Wayne Howitz of the NJDEP is responsible for providing regulatory review and approval of the RIR/RAWP/RAR. Weston Solutions (herein referred to as "Weston") will serve as the Independent Technical Consultant for review of the RA plans and procedures under the JCO.

1.3.2 Management

Jody Overmyer is the PPG Project Manager and is responsible for implementation of RI/RA activities at this Site.

AECOM is PPG's selected environmental consultant for this Site. William Spronz is the AECOM Project Manager for this Site. Mr. Spronz is responsible for design, scheduling, and implementation of the RA for AOC 3 at Site 156.

1.3.3 Licensed Site Remediation Professional

As detailed in the following sections, the selected RA for AOC 3 is a Restricted Use remedy. A Deed Notice will be filed for AOC 3 and, in accordance with NJDEP requirements, Deed Notice Biennial Certification forms will be submitted. Because these forms will continue to be submitted following NJDEP's issuance of a Consent Judgement letter, PPG will retain an LSRP to oversee the continuing implementation of the RA, required monitoring and reporting, and the submittal of the Deed Notice Biennial Certification form to the NJDEP, Division of Remediation Management and Response, Bureau of Operation, Maintenance, and Monitoring Deed Notice Inspection Program.

2.0 Background Information

This section provides a review of Site background information including physical setting, geology, hydrogeology, the receptor evaluation update, and AOC summary.

2.1 General Site History

Site 156 encompasses the Metropolis Towers property (also referred to as Gregory Park Apartments) which occupies approximately 8.6 acres (see **Figure 1**). The property consists of two 20-story multi-unit residential buildings (Buildings 1 and 2). Most of the area surrounding the buildings is paved and is used as parking for property residents. A small percentage of the property consists of green space. The buildings were constructed between 1961 and 1967 with aid from Federal grants issued by the Housing and Urban Development Authority (HUD). The buildings are constructed of reinforced concrete and are supported by driven piles.

Historically, a two-story building known as the Central Building was located between Buildings 1 and 2. An in-ground swimming pool was located on the second floor of the Central Building. The building was demolished in 2006, but pilings and grade beams from the building were still present at the Site prior to excavation.

A 1906 Sanborn map indicates that between the late 1800's and 1950, Site 156 was historically occupied by several industries including National Iron Works, a filling station, a painting contractor, a chemical warehouse, auto truck parking, a motor freight station, a machine shop, and a furniture manufacturer. Aerial photographs from 1951 depict various commercial, light industrial, and row-style housing buildings at Site 156.

In 1990, the NJDEP notified PPG that Mr. Claude Perretti issued a statement noting that approximately 9,000 cubic yards (cy) of CCPW was used as backfill at the Site in 1961. The exact location of where the material was placed was not known. Several soil removal activities have taken place at the Site since 1961. In 1976 or 1977, a total of 5,200 to 6,800 cy of soil was excavated from the north and south parking lots of Building 1. There is no indication that this excavation was conducted for remedial purposes. An unknown volume of soil was excavated from the northeast corner of Building 1 in response to a leak from an above ground heating oil tank in 1986-1987 and again in 1987 as part of the Port Authority Trans Hudson (PATH) ventilation duct remodeling (CEC, 2012).

2.2 Surrounding Land Use

The surrounding land use is a mix of residential and commercial properties. Located west of the apartment complex and across Luis Munoz Marin Boulevard is the City Hall of Jersey City. Nearby are several office towers, as well as several public schools and churches. The PATH Grove Street Station is located across Christopher Columbus Drive (formerly Railroad Avenue) and a PATH subway tunnel runs beneath Christopher Columbus Drive along the northern edge of the Site. A ventilator shaft for the PATH tunnel lies adjacent to the Site at the corner of Christopher Columbus Drive and Warren Street.

2.3 Local and Regional Geology

2.3.1 Topography

The project area has little topographic relief, with ground surface elevations generally ranging from approximately 4 to 8 feet (ft) above mean sea level (amsl) using the North American Vertical Datum of 1988 (NAVD 88). Storm water runoff is channeled into the municipal storm sewer system. **Figure 1** shows the regional topography near the Site on a United States Geological Survey (USGS) Topographic Map.

2.3.2 Regional Geology

The Site lies within physiographic province of the Piedmont Plain, which is characterized by low ridges trending in the northeasterly direction. The area is underlain by formations of Recent, Pleistocene, and Triassic ages. The bedrock at the Site belongs to the Newark Basin, which is the most northerly of the three basins known as the Newark Supergroup. The Newark Supergroup is comprised of rock from the Upper Triassic and Jurassic ages and lies along an arcuate belt stretching from southern New York to central Virginia.

The Newark Supergroup is divided into three formations on the basis of lithology: (1) the lower unit - the Stockton Formation, (2) the middle unit – the Lockatong Formation, and (3) the upper unit - the Passaic Formation. Site 156 is underlain primary by the Stockton Formation; however, a gradational contact and/or interfingering with the Lockatong Formation may exist at the Site. The Stockton Formation consists of gray to reddish brown sandstone, interbedded with conglomerate, siltstone, and shale. The siltstone may be gray, green, or purple and fossiliferrous. This formation may be found at depths greater than 40 ft and has a thickness of approximately 850 ft beneath the Site. The Stockton Formation dips gently to the west. The Lockatong Formation is a fossil-rich gray to black siltstone and shale, which is thinly laminated to thick bedded.

The sediments overlying the Newark Supergroup in this area are usually Pleistocene glacial drift deposits. The Pleistocene glacial drift deposits exist as stratified and unstratified sediments ranging from silty clay to sands and gravels. Preglacial Lakes Hackensack and Hudson, which existed to the north of the Site, may have contributed outwash deposits to this area as drainage of these lakes occurred. The terminal moraine stretches to south of Jersey City, across Perth Amboy, New Jersey; Staten Island, New York; and western Long Island.

Recent alluvial deposits consist of unconsolidated mud and silt, with peat and other organic material, and occasional sand and gravel lenses. Streams have deposited alluvial sediments either directly on the Stockton Formation or on top of the Pleistocene age glacial sediments. These deposits have resulted in the creation of the meadowlands tidal marshes (Special Report No. 10, 1951). A peat layer called meadow mat is frequently associated with the tidal marsh deposits of silty clay. These marsh areas have been dewatered and backfilled in many areas of Jersey City resulting in a surface layer of fill material overlying the meadow mat unit (first natural deposit).

2.3.3 Project Area Geology

The Project Area is located on fill material placed on top of the salt marsh and estuarine native soils for the expansion of Jersey City. A thick sequence of unconsolidated natural material underlies the fill. The major geologic units at the Site from top to bottom include:

- A non-native fill layer (the shallow zone);
- Native soils consisting of sand, silty sand, and clays generally separated from the fill by organic sediments or meadow mat (the intermediate zone);
- Till directly above the bedrock consist of glacial drift deposits that exist as stratified and unstratified sediments ranging from silty clay to sands and gravels; and

- Bedrock of the Stockton Formation and possibly Lockatong Formation (bedrock zone).

2.3.4 Project Area Overburden

Shallow soils (consisting of fill material) in the vicinity of the Project Area generally extend from the ground surface to between 11 and 18 ft below ground surface (bgs). At Site 156, the deepest soil borings, which were previously installed at the Site for investigation purposes unrelated to the Boiler Room, have extended to 80.3 ft bgs. Bedrock beneath the Site has been encountered between 47 and 55.5 ft bgs, with one notable exception where bedrock was encountered at 37.5 ft bgs in a historical boring, LB-23, located near the boundary of the property along Columbus Drive (Langan, 2004). The meadow mat was encountered during pre-design investigations between 11.8 and 15.3 ft bgs.

CCPW can consist of chromite ore processing residue (COPR), green-gray mud (GGM), or a mixture of these materials with fill. COPR is generally reddish-brown waste material generated during the ore processing that is found in nodules ranging from sand to gravel-size. These nodules are often found in clusters loosely cemented together with silt-sized material. The GGM is generally lime green dense silt, with minor amounts of fine sand and clay. When found in the saturated zone, the grain size of this material may have been affected further due to weathering processes. This can give the material a wet, clayey silt or silty clay appearance with little or no physical or structural integrity. This material has a low permeability. The pH of this material is generally 11 to 12 standard units. GGM is often associated with the highest concentrations of Cr^{+6}.

2.4 Local and Regional Hydrogeology

Regionally, groundwater occurs in four hydrostratigraphic zones:

1. The shallow fill zone (shallow water-bearing unit);
2. The intermediate sand and silty sand zone (intermediate water-bearing zone);
3. The deep sand, till, and gravel lenses (deep water bearing zone); and
4. Bedrock of the Stockton and Lockatong Formations (bedrock water-bearing zone).

2.4.1 Regional Groundwater in Fill Deposits

Groundwater is typically encountered within the fill at depths between 5 to 10 ft bgs. In general, shallow groundwater flow patterns represent a subdued version of land surface topography. Variations from this can be attributed to factors such as heterogeneities in the fill, subsurface structures, and spatially variable recharge due to the presence of impervious surfaces.

2.4.2 Regional Groundwater in Native Unconsolidated Deposits

While there are some more permeable zones of sand and gravel in the intermediate zone, the aquifer below the meadow mat can be characterized as low to moderately permeable because of the high silt content. Observations of clay also support a lower permeability below the meadow mat.

Groundwater flow in the deep zone glacial deposits and alluvium is controlled by primary permeability or flow through the interconnected pore spaces in the soil matrix. Groundwater moves most readily through the glacial deposits. Conceptually, in this stratum, groundwater flows horizontally but is influenced strongly by local recharge and discharge zones (i.e., drainage divides and surface water bodies, respectively).

2.4.3 Regional Groundwater in Stockton and Lockatong Formations (Bedrock)

Regionally, the unconsolidated native deposits and bedrock are considered part of an aquifer system serving most of the industrialized sections of northern New Jersey. Hydrogeologic properties of the Stockton and Lockatong Formations are not well-documented, but are expected to be similar to the Passaic Formation. Hydraulic conductivity within the rock matrix is virtually nonexistent. Hydraulic conductivity is due to secondary features such as fractures and joints. The thickness of water-bearing zones is limited to fractures or fracture sets ranging from a few inches up to several feet. Groundwater occurrence and flow is controlled by major bedding plane partings and/or intensely fractured seams (Michalski, 1990). Near-vertical fractures are also present but are considered minor flow paths. Groundwater flow within the bedrock is generally anisotropic, with preferential flow northeast or southwest along the strike of the beds. Well yields range from several gallons to several hundred gallons per minute, with yields generally decreasing with depth. Groundwater within the bedrock occurs under both unconfined and confined conditions.

2.4.4 Project Area Hydrogeology

The shallow water-bearing zone includes groundwater present in fill material, from the water table to the top of the meadow mat (typically between 11.8 and 19.5 ft bgs). Five groundwater monitoring wells were installed at the Site during the 1993 RI, completed by ICF Kaiser. Additional wells were installed during subsequent RIs, There are currently nine active monitoring wells located on the Site. Data from these wells indicate that the water table is between approximately 3.5 and 7 ft bgs across the Site. Groundwater flow at the Site has historically been observed to be towards the southwest. During the 2017 monitoring events, a groundwater elevation high was present in the center of the Site resulting in northwesterly and northeasterly groundwater flow components on the northwestern and northeastern portions of the Site.

2.5 Surface Water and Wetlands

2.5.1 Wetlands

There are no wetlands on or adjacent to Site 156.

2.5.2 Surface Water

There are no surface water bodies on or adjacent to Site 156. Major water bodies in the vicinity of the Site include the Hudson River, located approximately 2,000 ft to the east, and the Morris Canal Basin of the Upper New York Bay, located approximately 2,000 ft south. There are no open water bodies on Site. Most of Site 156 is improved with impervious pavement. Therefore, surface drainage at the Site is directed into the city’s combined sewer overflow system. During precipitation periods, some runoff water may seep into the ground via infiltration through the limited vegetated areas and through cracks in the pavement.

2.6 Receptor Evaluation Update

The purpose of a receptor evaluation is to document the existence of human or ecological receptors, and the actions taken to protect those receptors, at contaminated Sites. Pursuant to N.J.A.C. 7:25E-1.12, receptor evaluations must include general Site information, an evaluation of surrounding land use, a description of contamination, a discussion of groundwater use in the area, an evaluation of vapor intrusion potential, and an ecological evaluation.

As part of the receptor evaluation, an ecological receptor evaluation for Site 156 was conducted in accordance with the NJDEP requirements in N.J.A.C. 7:26E-1.16 for areas contaminated with, or by, CCPW. The evaluation was qualitative in nature and was used to determine whether further ecological investigation is required based on the co-occurrence of the following conditions:

- Contaminants of ecological concern exist on-Site;
- An environmentally sensitive area exists on or immediately adjacent to the Site; and
- Potential contaminant migration pathways to an environmentally-sensitive area exist, or an impact to an environmentally sensitive area is indicated based on visual observation.

The Site is residential and there are soil and concrete impacts in the Building No. 2 basement; the latter included potential Cr^{+6} blooms. However, soil impacts are located beneath the basement slab near the boilers, which are not currently accessible to direct contact, and concrete impacts are in a basement/maintenance area of the building where access is restricted to maintenance personnel. Potential human receptors for contamination in the Building No. 2 Boiler Room are limited to the building employees or contractors working in the vicinity of the boilers. To prevent disturbance of the area by building maintenance personnel, institutional and engineering controls are proposed as discussed in **Section 8.0**.

Prior to AOC 1 remediation, groundwater appeared to be impacted due to Cr and Cr^{+6} concentrations from AOC 1 and not those related to AOC 3 (refer to **Section 2.7**).

Contaminants of ecological concern associated with the chromate waste at Site 156 can include Cr^{+6}, other metals, and elevated pH. Environmentally sensitive areas do not exist on or immediately adjacent to this Site, except for groundwater. Contaminant migration pathways to an environmentally sensitive area do not exist based on visual observations of the Site, except for migration of CCPW contaminants to groundwater. Because all three conditions have not been met, no further ecological investigations are needed for Site 156. Further investigation of the groundwater beneath the Boiler Room was conducted concurrent with the Site-wide AOC 2 investigation activities.

PPG submitted an Initial Receptor Evaluation Form for Site 156 in August 2011. An updated Receptor Evaluation Form is included with this submittal.

2.7 Summary of Remedial Investigations

Historical investigations conducted at the Site identified two AOCs: AOC 1 for CCPW impacts to soils; and AOC 2 for CCPW impacts to groundwater. Soil AOC 1 consists of eight remedial areas: A, B, C North, C South, D, E, F, and F1, which were grouped into three Layout Areas for remediation.

This RIR/RAWP/RAR addresses AOC 3 for concrete and soil Cr^{+6} contamination identified within or beneath the footprint of the Building No. 2 Boiler Room. The attached CID provides a description of each AOC and summarizes the contaminants identified in each, as well as the current regulatory status. **Figure 2** provides the location of AOC 1, AOC 2, and AOC 3. Pertinent correspondence with NJDEP regarding AOC 3 is provided in **Appendix A**.

2.7.1 AOC 1 – CCPW Impacts to Soil (Beyond AOC 3 Footprint)

Based on the findings from previous RI activities, soil remedial areas within AOC 1 were identified to include the following:

- The Site-wide presence of historic fill material including brick, glass, concrete, wood, etc., at depths ranging from the ground surface to between 6.5 and 19 ft bgs;
- The presence of Cr^{+6} at concentrations greater than the CrSCC;
- The presence of visible CCPW;
- The presence of CCPW-related metals (Sb and V) at concentrations greater than NJDEP RDCSRS and ARS, respectively; and
- The presence of CCPW-related metals (Sb, Ni, and Tl) at concentrations greater than NJDEP DIGWSSLs.

Pursuant to the approved RAWP (CEC, 2012), the proposed overall approach to RA of AOC 1 at Site 156 was to excavate soils impacted with Cr^{+6} at concentrations greater than the CrSCC of 20 mg/kg and to excavate areas where visible CCPW was identified. Soils that may be impacted with other CCPW-related metals at concentrations greater than their respective RDCSRS and/or DIGWSSL would also be excavated, but only to the extent that they are co-located with visible CCPW or Cr^{+6} exceedances. Soil RA activities at AOC 1 were implemented beginning in March 2013 and continued through May 2014. Additional soil excavation was conducted from September 2017 through October 2017 to remediate residual soil contamination in the parking lot between Building Nos. 1 and 2. Results of the AOC 1 RA are documented in a separate RAR (AECOM, 2018b).

2.7.2 AOC 2 - CCPW Impacts to Groundwater (Site-wide)

The 1993 RIR (ICF Kaiser, 1993) documented CCPW impacts to groundwater from samples collected in January and July 1993 from five shallow zone monitoring wells screened above the meadow mat. At the main COPR source area where COPR deposits are thickest (MW-2), Cr and Cr^{+6} were detected in the unfiltered samples at concentrations of up to 1,630 µg/L and 476 µg/L, respectively. Well MW-2, which was removed as part of the 2013/2014 RA activities in AOC 1, was located in the center of the Site between Building Nos. 1 and 2 and was located approximately 200 ft southwest of the Building No. 2 Boiler Room. Downgradient of this source area to the south, at monitoring wells MW-3 and MW-4, Cr concentrations were less than 6 µg/L and Cr^{+6} was not detected at concentrations exceeding the detection limit of 25 µg/L in the samples. Downgradient of the main COPR area to the north, at MW-1, Cr concentrations ranged from 24.6 µg/L to 89.8 µg/L, and Cr^{+6} was not detected at concentrations exceeding the detection limit of 25 µg/L. Based on this data and the Site hydrogeology, the area where groundwater Cr^{+6} concentrations exceed 100 µg/L was limited to the central area of the Site.

The 2006 RAWP (CEC, 2006) was prepared by CEC on behalf of PPG to address remediation of COPR and Cr^{+6}-impacted soil at Site 156. Re-sampling of the five RI monitoring wells was conducted as part of this RAWP investigation. A single RI well (MW-2) was found to have Cr results that exceeded the GWQS of 70 µg/L.

A groundwater RI was conducted in 2016 following the AOC 1 remediation conducted in 2013 and 2014. One well (MW-10) was installed in the Boiler Room basement of Building No. 2. Two rounds of groundwater sampling were conducted at all wells between May 2016 and July 2016. No concentrations exceeded the applicable standards for CCPW metals, with the exception of the Cr results from monitoring well MW-8 (472 µg/L in May 2016 and 730 µg/L in June 2016), which exceeded the GWQS of 70 µg/L.

Soil removal was conducted in the vicinity of monitoring well MW-8 from September 2017 through October 2017. A shallow replacement well (156-MW8A) and an intermediate monitoring well (156-MW8B) screened below the meadow mat were installed in November 2017. Two rounds of groundwater sampling at wells 156-MW8A and 156-MW8B were conducted in November 2017 and December 2017. Cr was detected at concentrations ranging from 0.9 J µg/L to 4.5 J µg/L, which are less than the 70 µg/L GWQS. Cr^{+6} was not detected at concentrations greater than a detection limit of 8.1 µg/L in the samples collected from 156-MW8A and 156-MW8B. These results indicate that the CCPW-related contamination in groundwater was effectively remediated by the AOC 1 soil removal activities. No further investigation or action is warranted with respect to AOC 2. The 2016 and 2017 AOC 2 RI is presented in the document entitled, *Final Remedial Investigation Report Groundwater Area of Concern (AOC 2) Hudson County Chromium Site 156 Metropolis Towers,* dated June 2018 (AECOM, 2018c).

2.7.3 AOC 3 – CCPW Impacts to Building No. 2 Boiler Room Subslab Soils and Interior Concrete Surfaces

The investigation of AOC 3 was initiated when a potential Cr^{+6} bloom (indicated by the presence of green/yellow staining) was observed in concrete at the base of a building support column located in the Boiler Room of Building No. 2. The staining was observed on November 5, 2012, during an inspection subsequent to significant flooding caused by Hurricane Sandy (AECOM, 2012b). A sample of the stained concrete was collected, and results of laboratory analysis indicated a Cr^{+6} concentration of 939 mg/kg, which exceeds the NJDEP CrSCC of 20 mg/kg for Cr^{+6}.

On November 13, 2012, a confirmation concrete sample was collected from the area of the Cr^{+6} bloom on the affected column and analyzed for Cr^{+6}. Results of laboratory analysis indicated a Cr^{+6} concentration of 645 mg/kg, which exceeds the NJDEP CrSCC of 20 mg/kg for Cr^{+6}.

Based on the detection of elevated levels of Cr^{+6} at the base of the concrete column, an Interim Remedial Measure (IRM) was installed on the column on November 13, 2012, to prevent disturbance of the area by building maintenance personnel. The IRM is discussed in detail in **Section 4.0**.

Subsequent to installation of the IRM, additional investigative activities were initiated to determine the source of the observed Cr^{+6} bloom and delineate the extent of contamination in both concrete and underlying soil. These remedial investigation activities and the proposed RA for the Building No. 2 Boiler Room are the subject of this report, as presented in the following sections. Agency correspondence related to AOC 3 is provided in **Appendix A**. Previous reports documenting the history of the investigations are provided in **Appendix B**.

2.8 Interim Remedial Measures

Multiple IRMs have been installed to prevent contact with concrete impacted by Cr^{+6}. Concrete is considered impacted by Cr^{+6} when analytical results for a concrete sample indicate Cr^{+6} is present in concentrations exceeding the CrSCC. However, IRMs were installed where potential Cr^{+6} blooming was observed while sample analysis was in process.

Based on the detection of elevated levels of Cr^{+6} at the base of the concrete column, discussed in **Section 2.7.3**, an IRM consisting of polyethylene sheeting, plywood, and caulk seam sealant was installed at the base of the column (from ground level to a height of approximately 1.5 ft above the floor) on November 13, 2012. Quarterly inspections of this column by AECOM and NJDEP personnel were initiated at that time, and continued to be conducted during the RI phases.

Based on the findings and analytical results presented to NJDEP in a Technical Memorandum dated October 11, 2013 (AECOM, 2013a), PPG proposed that the cleaning and/or removal of Cr^{+6} impacts on the column was not feasible or safe, and proposed that the current IRM remain in place. Additional IRMs, consisting of epoxy floor coating, were installed at four concrete chip sample locations during the 2015 Third Quarter (Q3) and Fourth Quarter (Q4) IRM inspections, in the vicinity of the boiler and impacted column.

During the 2016 First Quarter (Q1) Site 156 IRM inspection conducted on March 30, 2016, yellow staining was observed. An area of yellow discoloration was observed roughly 17 feet to the east of Boiler #1, five feet west of the drain to the east, and three feet north of the electrical panel to the south (**Figure 11**). The impacted area was less than one inch in diameter; however, an epoxy coating was applied to a larger area measuring approximately three inches long by three inches wide. A concrete chip sample was collected from the stained area (156-Q1-2016-EF1). As a precaution, the area was covered with epoxy following the sampling.

Results of the laboratory analysis of the concrete chip sample (156-Q1-2016-EF1) indicated a Cr^{+6} concentration of 139 mg/kg, which exceeds the NJDEP CrSCC of 20 mg/kg for Cr^{+6} . As a result, six additional concrete samples were collected in April 2016 to horizontally delineate (four surface slab samples) and vertically delineate (two samples from the middle and bottom of the slab) the Cr^{+6} exceedance detected in the concrete chip sample. After collection of the six additional samples, a three-foot diameter area of epoxy was applied to cover the concrete core and chip sample locations. None of the additional samples had concentrations of Cr^{+6} that exceeded the CrSCC.

Quarterly inspections of these IRMs installed within AOC 3 were conducted by AECOM and NJDEP personnel until October 2017 when the Retro-Coat™ was installed. The results of these quarterly inspections are documented by AECOM via Quarterly IRM Inspection Reports, which are distributed to the stakeholders.

2.9 Retro-Coat™ Installation

To prevent contact with any additional Cr^{+6} impacts in concrete, a presumed remedy consisting of Retro-Coat™ and a protective wearing surface was installed. Retro-Coat™ is a durable, high-strength, chemical-resistant epoxy-like coating (20-30 mil thickness), which functions as a barrier system to prevent direct contact with the impacted concrete. Additionally, a protective wearing surface was installed consisting of

NoTrax rubber mat designed to absorb shock of movement of heavy equipment and provide traction for workers.

Installation of Retro-Coat™ coating over the floor slab and certain support columns was the selected remedial alternative presented in the *Remedial Investigation Report/Remedial Action Work Plan Building No. 2 – Boiler Room Subslab Soil and Interior Concrete Surfaces (AOC 3)* (RIR/RAWP) (AECOM, 2018a), based on the analyses presented in the March 27, 2017 memorandum from AECOM to stakeholders titled *PPG Site 156 (Metro Towers), Building 2 Boiler Room – Remedial Alternatives Evaluation* (AECOM, 2017).

Installation of the Retro-Coat™ was completed from October 2, 2017 through October 13, 2017 and the protective wearing surface was installed from June 18, 2018 to July 17, 2018. The extents of the Retro-Coat™, presented on **Figure 11**, encompass the area within which potential Cr^{+6} blooming was observed and concrete sampling results for Cr^{+6} exceeded the CrSCC.

Installation of the Retro-Coat™ coating included the following:

1. Reconfiguration of the mechanical, electrical, and plumbing equipment in the Boiler Room to provide adequate clearance for remediation work, including scarification of concrete surfaces and applying Retro-Coat™.

2. Coordination with the property owner and the boiler contractor for boiler switchover so that work could be conducted under and around the inactive boiler while the other boiler was operating.

3. Extension of the air in-take of the building on the north side of the Boiler Room. Extension of the air-intake served as a precautionary measure to reduce the potential for nuisance odors generated by the Retro-Coat™ to enter the ventilation system of the building.

4. Installation of plastic enclosures consisting of polyethylene sheeting extended 10 to 12 feet vertically within the work area to delineate the exclusion zone and control fugitive dust generated during the concrete scarification activities. High-efficiency particulate air (HEPA) filters were also installed in the plastic enclosures to create a negative-air environment and to filter the air inside the plastic enclosures.

5. Use of real-time air monitoring instruments to monitor fugitive dust in the breathing zone outside the plastic enclosures and at the two entrances to the Boiler Room.

6. Scarification of concrete surfaces prior to the application of Retro-Coat™ using electrical-powered hand tools under vacuum to collect concrete dust in 55-gallon drums. Scarification removed preexisting IRMs (e.g., epoxy coating applied to specific areas).

7. Application of Retro-Coat™ to the scarified concrete surfaces in three distinct layers and colors:

    a. Prime coat – red color

    b. Base coat (first top coat) – blue color

    c. Top coat (final top coat) – gray color

The different colored layers serve as a visual indicator if the top coat surface is breached or worn down to the Retro-Coat™ prime coat (red color).

Because the extent of the Retro-Coat™ encompassed the area that was either affected by potential Cr^{+6} blooms or where concrete sampling results for Cr^{+6} exceeded the CrSCC, Cr^{+6} on the surface of the concrete slab or the concrete pillar was removed by scarification. Following scarification, no potential Cr^{+6} blooming or discoloration that would indicate the presence of Cr^{+6} was observed. Drummed concrete dust generated by scarification was sampled for waste characterization and sent to an appropriate disposal facility. Bills of lading for this waste are included in **Appendix C**.

2.9.1 Ongoing Inspections

Quarterly IRM inspections were conducted prior to the installation of the Retro-Coat™. Following the installation of the Retro-Coat™, AECOM commenced monthly inspections in November 2017 to evaluate the performance of the anticipated remedy. The results of the inspections were submitted to the NJDEP biannually in Remedial Action Engineering Control Inspection Reports, which are included in **Appendix D**. Monthly inspections are currently ongoing.

Inspections have identified numerous chips and cracks in the Retro-Coat™ due to ongoing construction and non-routine maintenance activities. In some cases, the chips and cracks penetrated down through the prime coat to the underlying concrete. In general, the chips in the coating measured approximately ¼-inch to 1-inch in size. Chips were observed where the protective wearing surface (rubber mats) was not installed, as well as beneath the wearing surface. Peeling of the coating was observed in a couple of small areas near the boilers. Repairs to the coating were conducted in February 14, 2018. Further repairs have not been conducted due to ongoing access issues caused by construction and maintenance in the basement.

No potential Cr^{+6} blooming or discoloration that would indicate the presence of elevated levels of Cr^{+6} was observed during the monthly inspections of the Retro-Coat™, including areas where the coating had been chipped, cracked, or was observed to be peeling.

3.0 Technical Overview

This section provides a technical overview of the remedial investigation activities in AOC 3, and includes a description of the procedures and methods employed to characterize the Cr^{+6} contamination observed within this AOC.

3.1 Summary of Overall Nature of Contamination

Site contaminants identified in Site soils (AOC 1) and groundwater (AOC 2) prior to remediation included Cr^{+6} and CCPW-related metals at concentrations greater than the applicable remediation standards for soil and groundwater, as identified in **Section 1.2**.

Within AOC 3, Cr^{+6} was found in the surface (top 2 inches) of the concrete floor slab, and the bottom 18 inches of the building support column above the floor surface located between the heating system boilers, at concentrations greater than the NJDEP CrSCC of 20 mg/kg. No Cr^{+6} exceedances were observed on the underside of the floor slab or the concrete pile cap situated beneath the support column below the floor. The area of Cr^{+6} contamination in interior concrete surfaces was delineated and will be remediated pursuant to the RAWP presented in **Section 8.0**.

Soils below the Boiler Room floor adjacent to the column pile cap did not exhibit Cr^{+6} exceedances; however, Cr^{+6} at concentrations greater than 20 mg/kg was observed in soil samples collected below the slab within a small area located south of the boilers. In addition, Sb and Ni concentrations exceeded their respective DIGWSSLs in this small area. The area of Cr^{+6}, Sb, and Ni contamination in the soil below the concrete floor has been delineated, and will be remediated pursuant to the RAWP presented in **Section 8.0**.

3.2 Remedial Investigation Sampling Events

To date, the investigation of the Boiler Room has consisted of the following sampling events:

AOC 3 Initial Characterization:

- November 5, 2012 – One concrete sample from the impacted support column in Building 2, one groundwater sample from a sump in Building 1, and one groundwater sample from a sump in Building 2;
- November 13, 2012 – One concrete sample from the impacted support column in Building 2; and
- November 26, 2012 – One sample of water circulating in the boilers in Building 2.

Phase 1:

- January 7, 2013 – Three concrete floor slab samples and eight soil samples.

Phase 2:

- February 18, 2013 – Four concrete floor slab samples, one concrete sample from the impacted support column, four concrete samples from outer columns, and two soil samples; and
- June 25, 2013 – Twelve concrete core samples from the impacted support column.

Phase 3:

- August 15, 2013 – Seven concrete samples from the impacted support column and one concrete floor slab sample;
- August 28, 2013 – One concrete sample from the impacted support column and two concrete floor slab samples; and
- September 11, 2013 – Two concrete floor slab samples.

Phase 4:

- February 14, 2014 – Three concrete floor slab samples;
- February 25, 2014 – Three samples of water dripping from the boilers and one sample of water pooled on the floor;
- February 28, 2014 – One concrete floor slab sample; and
- March 4, 2014 – Two soil samples.

The results of Phases 1 through 4 are presented in a series of Technical Memoranda, which are included in **Appendix B**.

Phase 5:

- September 4, 2014 – Two concrete samples from the pile cap below the impacted support column;
- September 8, 2014 – One groundwater sample collected from a test pit near the impacted support column;
- September 9, 2014 – One concrete floor slab sample collected near the pile cap and three soil samples collected from a test pit in the vicinity of the impacted support column;
- October 24, 2014 – Eight concrete floor slab samples;
- October 30, 2014 – Four soil samples;
- November 7, 2014 – Five concrete floor slab samples;
- November 24, 2014 – Four concrete floor slab samples;
- December 8, 2014 – Seven soil samples; and
- December 19, 2014 – Nine soil samples.

Phase 6:

- March 31, 2015 – One concrete floor slab sample and one foam insulation sample;
- June 22, 2015 – One concrete precipitate sample;
- August 12, 2015 – One concrete slab sample and one concrete precipitate sample; and
- December 3, 2015 – Three concrete slab precipitate samples.

Phase 7

- April 11, 2016 – Six concrete floor samples.

Results of the various phases of sampling are presented in **Table 3**. Note that during all Phases, additional quality assurance/quality control (QA/QC) samples were collected, including blind sample duplicates and method spike/method duplicates, and analyzed as required.

3.3 Geophysical Survey

On December 12, 2012, TPI Environmental of New Hope, Pennsylvania conducted a geophysical survey of the Building No. 2 Boiler Room to locate subsurface utilities. Sections of private electric and floor drainage piping were detected using ground-penetrating radar and radio frequency line locating and marked with chalk. Due to extenuating on-Site conditions including physical obstructions and a thick steel reinforcing bar (rebar) reinforced concrete floor, TPI Environmental was unable to effectively locate all subslab utilities. AECOM prepared a base map for use in identifying the soil boring locations using the subsurface utility information from TPI Environmental and measurements of the size and location of structures within the Boiler Room. Additionally, Enviroprobe Services, Inc. of Moorestown, New Jersey was present at the start of the field efforts on January 17, 2013, February 18, 2013, and February 14, 2014 to locate proposed sample points away from underground utilities and rebar. Reports of the geophysical surveys are provided in **Appendix E**.

3.4 Sampling Methodology and Parameters

3.4.1 Sampling Methodology

3.4.1.1 Soil Borings & Grab Samples

In order to collect samples, a concrete coring drill or jackhammer was used to penetrate the floor slab. Soil borings were advanced manually using a hand auger or slide hammer, or mechanically using an electric hammer drill with a Macro-Core® or split-spoon sampler. Grab soil samples were collected using a hand trowel. Concrete floor thickness varied from 10.8 inches to 12 inches, and a variable void space of 0.5 to 1.1 ft between the underside of the slab and the surface of soil beneath it was observed. (Note: Depth measurements of soil samples are measured from the top of the floor slab.)

Soil type was identified using the Unified Soil Classification System. Boring logs are provided in **Appendix F**. No COPR or yellow or green coloration indicating the potential presence of Cr^{+6} was observed at the soil sampling locations. Each soil sample obtained was thoroughly mixed, collected in laboratory supplied bottles, and shipped under chain-of-custody to the laboratory for analysis.

3.4.1.2 Concrete Samples

Concrete samples were collected via multiple methods, including chipping/drilling selected intervals of concrete floor cores, chipping the floor surface or chipping/drilling the support columns using an electric rotary drill or hammer drill with a decontaminated drill bit or chisel attachment. Cuttings and/or concrete chips were then collected in laboratory sample jars for analysis.

3.4.2 Parameters

A summary of analytical parameters analyzed during each Phase of the work is provided below:

- During the initial investigation in November 2012, all samples were analyzed for Cr^{+6}.
- During Phase 1, the concrete slab and soil samples were analyzed for Cr^{+6} and CCPW metals (including Sb, Cr, Ni, Tl, and V).
- During Phase 2, the samples from the impacted support column were analyzed for Cr^{+6} only. The concrete samples from the outer columns, the concrete floor slab samples, and the soil samples were analyzed for Cr^{+6} and CCPW metals.
- During Phase 3, the concrete floor slab samples and the concrete samples from the impacted support column were analyzed for Cr^{+6} and CCPW metals.
- During Phase 4, the concrete floor slab samples, soil samples, and boiler water samples were analyzed for Cr^{+6} and CCPW metals.
- During Phase 5, the concrete floor slab samples collected near the pile cap and the concrete floor slab sample collected adjacent to the pile cap were analyzed for Cr^{+6} and CCPW metals. The remaining concrete floor slab samples were analyzed for Cr^{+6} only. The groundwater sample was analyzed for Cr^{+6} and CCPW metals. The soil samples were analyzed for analyzed for Cr^{+6} and CCPW metals, except for seven soil samples which were analyzed for Cr^{+6} only.
- During Phase 6, all samples were analyzed for $Cr^{+6.}$ Additionally, one concrete floor slab sample was analyzed for Cr.
- During Phase 7, all samples were analyzed only for Cr^{6}.

Note that one sample from the column was also analyzed for total zinc, total nitrate, inorganic phosphates, organic phosphates, and total copper. These specific results are not presented in **Table 3**, which only summarizes the Cr, Cr^{+6} and CCPW metals data.

Soil samples were analyzed by an NJDEP-certified laboratory (Accutest Laboratories, Dayton, New Jersey), which holds current approvals for Cr^{+6} SW-846 Methods 3060/7196A and 7199, with supplementary analysis of pH and redox potential (Eh) at the laboratory on each field sample prior to sample preparation.

3.5 Decontamination and Investigation Derived Waste

Sampling equipment was decontaminated as specified in the *Field Sampling Plan – Quality Assurance Project Plan (FSP-QAPP)* (AECOM, 2010):

Soil cuttings were either returned to the borehole where they were generated or drummed and disposed of off site. Groundwater removed during test pit activities was drummed and disposed of off site. Off-site disposal of investigation-derived waste was completed in accordance with applicable laws and regulations. Fully executed bills of lading are provided in **Appendix C**.

3.6 Sample Location Restoration

A void was encountered below the slab at each boring location in the Boiler Room. The borings were backfilled with bentonite, and the core holes in the concrete floor were restored with concrete. Holes drilled in the columns were patched using hydraulic cement. Following collection of chip samples, concrete surfaces were repaired using concrete.

3.7 Factors Influencing Data

No significant events, external factors, or seasonal variations are known to have impacted sampling procedures or the sampling results presented in this report.

3.8 Reliability of Laboratory Data

Laboratory data packages are provided in **Appendix G**. Data were generated and validated and data validation reports are provided in **Appendix H**. The sample data generated for this RI were validated by AECOM. The tabulated data used in this report include qualifiers applied during validation.

The data were reviewed in accordance with the FSP-QAPP and the following NJDEP validation Standard Operating Procedures (SOPs):

- NJDEP Office of Data Quality SOP 5.A.10, Rev 3 (September 2009), SOP for Analytical Data Validation of Hexavalent Chromium - for United States Environmental Protection Agency (USEPA) SW-846 Method 3060A, USEPA SW-846 Method 7196A and USEPA SW-846 Method 7199; and,
- NJDEP Office of Data Quality SOP 5.A.16, Rev 1 (May 2002), Quality Assurance Data Validation of Analytical Deliverables for Inorganics (based on USEPA SW-846 Methods).

In an email dated September 10, 2015 (**Appendix A**) regarding data validation procedures, NJDEP approved continuing the application of the NJDEP Office of Data Quality SOP 5.A.10, Rev 3 for Cr^{+6} and NJDEP Office of Data Quality SOP 5.A.16, Rev 1 (May 2002) for inorganics in lieu of the current NJDEP Data of Known Quality Protocol Guidance.

Samples were collected using the methods described in NJDEP's FSPM, last updated April 11, 2011. Aqueous and soil (solid) samples were placed in laboratory-supplied sample containers, labeled, and placed in an ice-filled cooler to reduce the sample temperature to approximately 4 degrees Celsius.

Samples were analyzed by Accutest Laboratories of Dayton, NJ (NJDEP Certification #12129). Samples were extracted and/or analyzed within the method recommended holding times. Based on a review of the laboratory non-conformance summaries and QA/QC data, no data quality issues were identified. All data was found to be reliable for decision-making purposes although the Cr^{+6} result of 78.5 mg/kg for sample 156-Q2-2015 collected in Phase 6 was qualified “RA,” which is defined as rejected, but is still considered usable.

The laboratory method detection limits (MDLs) were compared to the applicable standards. There were no exceedances of the applicable standards. Field duplicate samples were collected for soil and concrete samples and included in the data validation review.

4.0 Remedial Investigation (AOC 3)

In general, investigative activities were first proposed to Weston/NJDEP via Sampling and Analysis Plans (SAPs), Technical Memoranda, and/or verbally via telephone, and subsequently revised or approved by NJDEP either verbally, or in writing via email, comment letter, or approval letter.

Laboratory data packages and electronic data deliverables are provided in **Appendix G**. Data validation reports are provided in **Appendix H**. Sampling results are provided in **Table 3**. The sample locations and results are depicted on the following figures:

- Subslab Soil Sample Hexavalent Chromium Results (**Figure 3**);
- Boiler Circulation Water and Groundwater (Test Pit & Sump) Sample Hexavalent Chromium Results (**Figure 3A**);
- Below Surface (Bottom) Slab Concrete Sample Hexavalent Chromium Results (**Figure 4**);
- Surface Slab (Top) Concrete Sample Hexavalent Chromium Results (**Figure 5**);
- Other Column Concrete Sample Hexavalent Chromium Results (**Figure 6**);
- Hexavalent Chromium Results for Concrete Samples Obtained Within the Column IRM (**Figure 7**);
- Hexavalent Chromium Results for Concrete Samples Obtained Above the Column IRM (**Figure 8**); and
- Test Pit Sample Hexavalent Chromium Results (**Figure 9**).

The investigation of the Boiler Room was initiated on November 5, 2012, when green/yellow staining (indicating a potential Cr^{+6} bloom) was observed in the basement Boiler Room of Building No. 2, on the base of a concrete building support column located between the two boilers. On that date, a concrete chip sample (156-MT2CNCT-20121105) was collected from the stained area on the column and analyzed for Cr and Cr^{+6}. The column was subsequently wrapped and sealed with polyethylene sheeting to prevent potential exposure pending analytical results.

Analytical results indicate that Cr and Cr^{+6} were detected in the concrete sample at concentrations of 1,880 mg/kg and 939 mg/kg, respectively. The Cr^{+6} result exceeds the CrSCC of 20 mg/kg. The sampling results are provided in **Table 3**, and depicted on **Figure 7**.

Also on November 5, 2012, aqueous samples were collected from a nearby sump in the Boiler Room of Building No. 2 (156-MT2SUMP-20121105), and from a sump located in the Boiler Room of Building No. 1 (156-MT1SUMP-20121105). The samples were sent to the laboratory for Cr and Cr^{+6} analysis. Analytical results indicate that concentrations of Cr and Cr^{+6} in the aqueous samples from the sump were either not detected at concentrations greater than the sample-specific reporting limit (RL)/MDL or were less than the NJDEP GWQS of 70 µg/L. The sampling results are provided in **Table 3**, and the results for sample 156-MT2SUMP-20121105 are depicted on **Figure 3A**. Note that sample156-MT1SUMP-20121105 is not depicted on **Figure 3A** since it was collected within Building No.1, and is not an exceedance.

On November 13, 2012, a confirmatory concrete sample (156-MT2CNCT-20121113) was collected from the area on the base of the column where the Cr^{+6} blooming was observed and analyzed for Cr^{+6}. Laboratory analytical results indicated an estimated Cr^{+6} concentration of 645 J mg/kg, which exceeds the CrSCC of 20 mg/kg. The sampling result is provided in **Table 3** and depicted on **Figure 7**.

Based on the detection of elevated levels of Cr^{+6} at the base of the concrete column, an IRM consisting of polyethylene sheeting, plywood, and caulk seam sealant was installed on the base of the column to prevent exposure of building maintenance personnel to the area.

On November 26, 2012, a sample of the Building No. 2 boiler system circulation water (Boiler Circ Water) was collected and analyzed for Cr^{+6}. Results of the analysis indicated that Cr^{+6} was not detected at concentrations greater than the sample-specific RL/MDL; the results are provided in **Table 3**, and depicted on **Figure 3A.**

4.1 Phase 1

Subsequent to installation of the IRM, NJDEP requested that additional investigation be conducted in the Boiler Room to further characterize and delineate conditions. A *Sampling and Analysis Plan (December 2012)* (AECOM, 2012a) was subsequently prepared and implemented. Activities included additional concrete sampling inside the Boiler Room, and sampling of soil below the concrete floor slab. These activities were conducted in January 2013. Samples were collected from the bottom 2 inches of the floor slab and from soil borings at three locations: C1, C2, and C3.

In summary, the Phase 1 soil and concrete sampling resulted in one exceedance of the CrSCC for Cr^{+6} in one soil sample, 156-C2-C, which was collected from beneath the concrete floor slab and exhibited an estimated Cr^{+6} concentration of 42.7 J mg/kg. Additional details of activities conducted during this phase are included in related Technical Memoranda provided in **Appendix B**.

The sampling results for Phase 1 are provided in **Table 3**. Cr^{+6} soil sample results are presented on **Figure 3**. Cr^{+6} floor slab sample results for depths below the slab surface are presented in **Figure 4**.

4.2 Phase 2

Based on the Phase 1 results, and at NJDEP's request for additional sampling, a follow-up Phase 2 SAP was prepared in February 2013 (AECOM, 2013d) and additional soil and concrete sampling was conducted to delineate the subslab soil Cr^{+6} exceedance detected during Phase 1.

Samples were collected from one soil boring location, C4. The bottom 2 inches of the floor slab were also sampled at boring C4. Concrete slab surface samples were collected from between the boilers at G3, G4, and G5. Concrete samples were also collected from the surface of other columns in the Boiler Room at a height of approximately 5 ft above the floor. One sample was also collected from the IRM column at approximately 5 ft above floor surface along the eastern side of the column at G2.

The sampling was completed in February 2013. The sampling results for Phase 2 are provided in **Table 3**. Cr^{+6} soil sample results are presented in **Figure 3**. Cr^{+6} floor slab sample results for depths below the slab surface are presented in **Figure 4**. Cr^{+6} floor surface slab sample results are presented in **Figure 5**. Cr^{+6} concrete sample results from the surface of other columns are presented in **Figure 6**. The Cr^{+6} concrete sample result from the surface of column is presented in **Figure 8**.

The additional sampling results indicated there were no exceedances of the CrSCC in the additional soil boring, surface concrete slab, or concrete column samples collected during Phase 2.

Based on these findings, additional actions were proposed, including preparation of a subsequent sampling plan and implementation of additional sampling of the concrete column beneath the IRM to verify previously detected Cr^{+6} concentrations and assess the feasibility of cleaning or repairing (remediating) the column.

During a conference call on April 3, 2013, NJDEP requested that PPG/AECOM prepare a brief SAP Addendum (AECOM, 2013c), which consisted of the following additional sampling steps:

- Temporarily remove the current IRM to allow for sampling and re-install upon completion of sampling activities;
- Using a concrete core drill, collect two concrete core samples from each of the four sides of the concrete column, for a total of eight cores;
- Advance cores horizontally into the column at the bottom of the column (flush with floor level) and at a height of approximately one-foot above the floor;

- Cores were to be approximately 2 inches in diameter and advanced to a depth of approximately 4 inches;
- Collect two samples from each concrete core – one from the 0- to 1-inch depth interval (surface) and one from the 3- to 4-inch depth interval (total of 16 samples); and
- Analyze the samples for Cr^{+6}.

The concrete column sampling was implemented on June 25, 2013 as outlined above, with the exception that a hammer drill was used to collect the concrete samples, and the west side of the column could not be sampled due to its proximity to the adjacent boiler.

The hammer drill was used to generate samples on the east, south, and north faces of the column, both at floor level and approximately 1-foot above the floor, and concrete samples (cuttings) were collected from the surface to 1-inch, and 3 to 4-inch depth intervals at each location.

Each sample was identified with a unique Sample ID using the following nomenclature: *156-BLDG2-CONC-EB-1* indicating the sample is from Site 156 Building No. 2, is concrete media (CONC), the face of the column that was sampled (e.g., “E” for East, “N” for North, “S” for South), whether the sample was from the “Top” or “Bottom” of the column (e.g., “T” = Top, “B”=Bottom), and the depth designation of the sample (e.g., “1”=1-inch, “4”=4-inch). A field blank was also collected from the sampling equipment for quality control purposes. Field Blanks are designated (FB). Each sample was analyzed for Cr^{+6}, Eh, pH, and percent solids by Accutest Laboratories of Dayton, NJ. (Note that sample JB40573-5 was mislabeled in the field, and the sample ID (156-BLDG20-ONC-NB-4) is correct as written on the chain-of-custody.)

The sampling results are provided in **Table 3**. Cr^{+6} concrete sample results are presented in **Figure 7** for the IRM column. Additional details of activities conducted during this phase are included in related Technical Memoranda provided in **Appendix B**.

4.3 Phase 3

Subsequent to review of the Phase 2 results, which were presented to NJDEP in a July 26, 2013 Technical Memorandum (AECOM, 2013b), NJDEP requested additional sampling in the area of the column and IRM as follows:

> A) One (1) concrete chip sample collected from each side of the column, just above the currently installed IRM (approximately 3 ft above the floor), for a total of four (4) samples on the column at this height.
>
> B) One (1) concrete chip sample collected from the north, south, and west sides of the column (three samples total), at a height of approximately 5 ft above the floor.
>
> C) At least one surficial concrete chip sample collected from the Boiler Room floor on the north side of the column, as close to the column as possible.

This sampling was implemented on August 15, 2013. As with the previous events, each sample was identified with a unique Sample ID using the following nomenclature: *156-BLDG2-CONC-EB-1* indicating the sample is from Site 156 Building 2, is concrete media (CONC), the face of the column that was sampled (e.g., “E” for East, “N” for North, “S” for South), whether the sample was from the “Top” or “Bottom” of the column (e.g., “T” = Top, “B”=Bottom), and the depth designation of the sample (e.g., “1”=1-inch, “4”=4-inch). Floor samples are designated with a “G” for Ground. Field Blanks are designated (FB).

Each sample was analyzed for Cr^{+6}, Eh, pH, and percent solids by Accutest Laboratories of Dayton, NJ.

Note that the lower samples were collected at a lower elevation than the planned 3 ft (at 1.7 ft to 2.5 ft) due to obstructions on the column and the proximity to the boiler on the west side of the column. In addition, the upper sample from the south side of the column was collected at a lower elevation than the planned 5 ft (3.2 ft) due to obstructions on the column. The east side of the column had already been sampled at this height.

The sampling results are provided in **Table 3**. Cr^{+6} concrete sample results are presented in **Figure 8** for the column. The August 15, 2013 sampling analytical results were compared to the CrSCC of 20 mg/kg. No exceedances of the CrSCC were observed for samples collected above (higher in elevation than) the existing IRM on the column. The concrete floor sample (156-BLDG2-CONC-G11), which was collected approximately 0.7 ft north of the column, exceeded the CrSCC at an estimated Cr^{+6} concentration of 61.3 J mg/kg.

Based on subsequent data review and data validation reports, AECOM requested that the laboratory re-run samples 156-BLDG2-CONC-G11 and 156-BLDG2-CONC-W3ft-0.5; however, the laboratory indicated there was not enough of the original samples left to perform re-analysis, so plans were made to re-collect these samples.

On August 28, 2013, AECOM returned to the Boiler Room to re-collect 156-BLDG2-CONC-G11 and 156-BLDG2-CONC-W3ft-0.5. In addition, AECOM collected an additional “step-out” sample from the concrete floor (156-BLD2-CONC-G12), approximately 1-foot north of sample 156-BLDG2-CONC-G11.

Results from sample 156-BLDG2-CONC-W3ft-2-0.5, which was re-collected from the column above the IRM, did not exceed the CrSCC. Sample 156-BLDG2-CONC-G11-2, which was re-collected from the floor north of the column, confirmed the prior CrSCC exceedance and was estimated at a Cr^{+6} concentration of 1,040 J mg/kg (estimated at 371 J mg/kg in the field duplicate sample 156-BLDG2-CONC-G61-2). The “step-out” out sample, 156-BLDG2-CONC-G12, also exceeded the CrSCC and exhibited an estimated Cr^{+6} concentration of 294 J mg/kg.

Based on the findings, NJDEP requested additional “step-out” samples of the concrete floor for delineation purposes. A total of five additional samples were proposed, two samples to be analyzed immediately after collection, and three contingency samples placed on “hold” at the laboratory pending results of initial analysis.

Sample 156-BLDG2-CONC-G13 exceeded the CrSCC with an estimated concentration of 93.9 J mg/kg. The field duplicate sample, 156-BLDG2-CONC-G63, also exceeded the CrSCC with an estimated concentration of 188 J mg/kg, but results were significantly lower than the next closest sample to the column.

Sample 156-BLDG2-CONC-G14, which was the next farthest from the column to the north, did not exceed the CrSCC; therefore, the three contingency samples did not require analysis. The sampling results are provided in **Table 3**, and Cr^{+6} concrete sample results are presented on **Figure 5.** Additional details of activities conducted during this phase are included in related Technical Memoranda provided in **Appendix B**.

Based on the analytical results, a small area of concrete with Cr^{+6} concentrations greater than the CrSCC was identified on and near the concrete building support column situated between the two building boilers. The column itself is impacted on all sides, from ground level to a height of approximately 1.5 ft above the floor. This area of the column is currently covered by an IRM. In addition, the surface of the concrete floor is impacted on the north side of the column, between the boilers, to a distance on the floor of approximately 4 ft north of the column.

The findings and analytical results up to this point were presented to NJDEP in a Technical Memorandum dated October 11, 2013 (AECOM, 2013a). Based on the sampling results, PPG proposed that the cleaning and/or removal of Cr^{+6} impacts on the column was not feasible or safe, and proposed that the current IRM remain in place and an epoxy sealant be placed on the impacted areas of the concrete floor in the area of the boilers and column.

Weston and the NJDEP (Department) reviewed the October 11, 2013 Technical Memorandum, and provided the following comments via e-mail dated November 13, 2013 (**Appendix A**):

1. *The Department requests that PPG retain the services of a licensed professional structural engineer to evaluate and identify permanent options for remediating the impacted column, impacted floor adjacent to the column and contaminated soils beneath the concrete slab in the Boiler Room.*
2. *Please perform a feasibility analysis of the identified permanent remedial options, and present the results of this analysis and the proposed permanent remedy for all impacted media within a RIR/RAWP addendum. This RIR/RAWP Addendum will also include the findings from the structural assessment and consolidate all of the results from the various investigations performed to date in the Boiler Room. Note that the RIR/RAWP Addendum should be presenting the final remedial options rather than interim remedial measures (IRMs).*
3. *PPG must maintain the IRMs already in place (i.e., caution tape, plastic/plywood, and notifications), must inspect these IRMs on a regular basis, and must repair IRMs immediately as necessary.*
4. *The Department does not agree that the schedule for implementing additional remedial actions within the Boiler Room should be tied to the completion of the remedial excavations in Layout Areas 2/3. The RIR/RAWP Addendum must be presented to the Department within 45 days, and should include a proposed schedule for implementation*.

PPG subsequently retained the services of Mueser Rutledge Consulting Engineers (MRCE) to address structural issues related to the remediation of the impacted column, as discussed below in **Section 4.4** and **Section 4.5**.

4.4 Phase 4

To further examine the feasibility that potential alternate sources may be the cause of, or contributing to, the Cr^{+6} issue in the Boiler Room, PPG requested that AECOM proceed with additional testing and investigative activities prior to the finalization of a RIR/RAWP.

A conference call with NJDEP was conducted on February 27, 2014 to discuss the previously proposed additional investigative activities, and it was agreed that the next steps would be to conduct additional concrete floor coring and sampling, and also conduct subslab video inspection activities. In addition, NJDEP requested that additional soil samples be collected from below the floor using the concrete core locations for access. NJDEP agreed that the need for groundwater sampling and forensics activities would be deferred until additional soil and concrete sampling was conducted and the results received and discussed.

On February 14, 2014, an additional concrete core was advanced between the boilers, in the floor near the column. Concrete core G19 was advanced approximately 3 ft south of the column, as depicted in **Figure 5**. Samples were collected from three vertical intervals on the core: 0-2 inches (top), 2-4 inches (mid) and 8-12 inches (bottom). The samples were forwarded to Accutest Laboratories in Dayton, NJ for analysis. Sample 156-B2-CONC-G19-00-02IN had a CrSCC exceedance of Cr^{+6} estimated at 203 J mg/kg. The sampling results are provided in **Table 3**.

On February 28, 2014, a second concrete core (G20) was advanced approximately 4 ft north of the boiler area footprint and the bottom of the core (8-11 inches) was sampled. The sample G20(8.5-11) was forwarded to Accutest Laboratories in Dayton, NJ for Cr, Cr^{+6}, and CCPW-related metals analysis. The sampling results are provided in **Table 3**. Cr^{+6} results from the samples below the surface (bottom) slab concrete are presented in **Figure 4**. No exceedances were observed.

On March 4, 2014, soil samples were collected from beneath the concrete Boiler Room floor, at the G19 and G20 concrete core locations. The samples G19(17.5-23.5) and G20(22-28) were forwarded to Accutest Laboratories in Dayton, NJ for Cr, Cr^{+6}, and CCPW related metals analysis. Analytical results indicate no exceedances of either the CrSCC, RDCSRS, or the DIGWSSLs. The sampling results are provided in **Table 3**. Cr^{+6} soil sample results are presented in **Figure 3**. Cr^{+6} floor slab sample results for depths below the slab surface are presented in **Figure 4**. Cr^{+6} floor surface slab sample results are presented in

Figure 5. Additional details of activities conducted during this phase are included in related Technical Memoranda provided in **Appendix B**.

On February 14 and 28, 2014, using remote video technology, assessment of evidence of potential groundwater preferential pathways or conduits (electrical lines, sewer lines, drain lines) below the floor was performed at the G19 and G20 core locations. In summary, the following observations were noted:

- Given the limitations encountered in the field (low light below the floor slab, diameter of the boreholes, etc.) a limited radial area of approximately 5 ft in all directions was visible below the concrete floor slab at each borehole location;
- The continuity of the concrete column through the floor slab to the top of the pile cap was confirmed by AECOM and MRCE. Regarding the collection of samples from the column beneath the slab, AECOM considered this and discussed with MRCE the feasibility of sampling the column, and concluded this was impractical due to Site conditions and underlying technical factors;
- No evidence of staining, potential Cr^{+6} blooms, or visible CCPW was observed on either the concrete or soil during the video inspection;
- It was noted that the floor drain on the south side of the column (near borehole G19) was deteriorated and that fluids that discharge to the drain would fall directly on the soils beneath the floor. The drain line leads southwesterly, away from the column and boilers. Regarding the testing of the sediments and soils beneath the floor drain, samples were collected adjacent and beneath the floor drain from borehole G19 at sample location G19 (17.5-23.5). Cr was reported at 2,860 mg/kg and Cr^{+6} at 9.6 mg/kg; and
- A number of other potential conduits (drain lines, electrical lines) were observed in the void space between the underside of the concrete floor and the soils below the floor.

Since the installation of the column IRM, water had been observed on a regular basis pooled on the floor around the base of the column. AECOM traced the source of the water to a number of leaking valves on the boilers adjacent to the column. On February 25, 2014, both the source water at the three leaking valve locations and the water that were pooled on the floor were sampled. The samples were analyzed for Cr^{+6} and CCPW-related metals. Analytical results indicate that none of the sampled constituents within the source water were detected at concentrations greater than the sample-specific RL/MDL; however, analysis of the water pooled on the floor detected the following: Sb (24.5 µg/L); Cr (496 µg/L); Cr^{+6} (29 µg/L); Ni (222 µg/L); Tl (1.7 J µg/L); and V (28.4 J µg/L). Subsequent to the water samples being collected, AECOM installed a series of polyvinyl chloride (PVC) drain lines re-directing the leaking water to a nearby floor drain. Since that time no water has been observed pooled at the base of the column exhibiting Cr^{+6} impacts. Analytical results of this sampling are depicted on **Figure 3A**.

Based on the presence of potential preferential pathways and conduits for contaminated groundwater to migrate to this area of the property (as previously observed in deeper exterior excavation areas and also beneath the Boiler Room floor), and the confirmed continuity of the concrete column through the floor to the underlying pile cap, the vertical migration of contaminated groundwater up from the subsurface into the Boiler Room would be further investigated. AECOM proposed the installation of a groundwater monitoring well as close to the column as possible within the Boiler Room. A groundwater RI was conducted in 2016 and 2017, as summarized in **Section 2.7.2** of this RI/RAWP.

Based on the presence of elevated levels of Cr and Ni in the pooled water around the base of the column exhibiting Cr^{+6} impacts , AECOM recommended collecting samples of both the protective coating and corroded steel associated with the adjacent boiler (if feasible), in order to investigate if the boiler may be a contributing source of the contaminants detected in the pooled water.

At the request of NJDEP, these recommendations were not implemented. The NJDEP alternately requested that a soil sample be collected from below the pile cap that supports the affected column and analyzed for Cr^{+6}, as discussed in the **Section 4.5**.

4.5 Phase 5

4.5.1 Test Pit

Soil sampling beneath the pile cap, as well as the collection of additional concrete samples and a groundwater sample (Phase 5), was conducted in September 2014. The investigation procedures and analytical results are presented below.

As background, in May 2014, NJDEP requested that a soil sample be collected from below the concrete pile cap that supports the column exhibiting Cr^{+6} impacts. Since the pile cap is a support structure for the building, PPG retained MRCE to assist with establishing procedures and protocol to safely obtain soil samples from the area of the pile cap.

Based on a review of building construction drawings and other information regarding building structural characteristics near the column exhibiting Cr^{+6} impacts, MRCE presented two options to collect soil samples from beneath the pile cap via concrete coring and soil boring, and a third “test-pit” option, which could be implemented if the coring/boring options were unsuccessful. All three options were presented to NJDEP for review. NJDEP requested that the test pit option be implemented.

The test pit field work was initiated on September 3, 2014. Warren George, Inc. (WGI) was retained as the contractor to perform the work, and they began to cut and remove the concrete floor and reinforcing bar to allow access to the soils adjacent to the pile cap for sampling. A floor opening of sufficient size was established, and WGI personnel began to remove soil adjacent to the pile cap using hand tools. Excavated material was temporarily stockpiled on plastic in the Boiler Room and transferred to steel drums for subsequent off-site disposal.

Groundwater was encountered at a depth of approximately 2.6 ft bgs, (i.e., below the interior surface of the concrete floor) and excavation activities were temporarily postponed until dewatering measures could be implemented. At that time, NJDEP requested that, in addition to the planned soil samples from beneath the pile cap, concrete chip samples be collected from the exposed pile cap and the underside of the Boiler Room floor adjacent to the pile cap, and that a groundwater screening sample be collected from the excavated test pit.

Field activities resumed on September 4, 2014 when the proper equipment was mobilized to the Site. Two concrete chip samples were collected from the exposed side of the pile cap [BOILER ROOM PILE CAP (1.1) and BOILER ROOM PILE CAP (1.6)]. The samples were analyzed for Cr, Cr^{+6}, and CCPW-related metals. No exceedances were reported.

On September 8, 2014, one “grab” groundwater screening sample (BOILER ROOM TEST PIT WATER) was collected from the water that had accumulated within the test pit excavation and analyzed for Cr, Cr^{+6}, and CCPW-related metals. The total Cr concentration of 188 μg/L exceeded the GWQS for Cr of 70 μg/l. Note that the Cr^{+6} fraction of the sample was reported at 120 μg/L. There were no other exceedances reported. Analytical results are presented in **Table 3** and depicted on **Figure 3A** and **Figure 9**.

It is important to note that the water sample was collected as a “grab” sample from an excavation for screening purposes, and was not collected from a properly installed groundwater monitoring well. Therefore, these results should be utilized for screening purposes only and should not be considered representative of groundwater quality at this location of the Site.

On September 9, 2014 one “grab” soil sample was collected by hand trowel from the excavation sidewall [BOILER ROOM PILE CAP ADJ (2.6)], and three soil samples were collected using a split spoon sampler [BOILER ROOM PILE CAP ADJACENT (5.9-6.5), BOILER ROOM PILE CAP ADJACENT (6.5-7.2), and BOILER ROOM PILE CAP ADJACENT (9.0-9.5)]. Note that the 9.0-9.5-foot sample was placed on hold at the laboratory pending results of the 6.5-7.2-foot sample, and was ultimately not analyzed since the shallower sample results were less than the standards.

A concrete chip sample was also collected from the underside of the concrete floor directly adjacent to the top of the pile cap [BOILER ROOM PILE CAP (0.8)].

In summary, soil and concrete samples collected during Phase 5 did not exhibit concentrations of Cr, Cr^{+6}, or CCPW-related metals at concentrations greater than their respective NJDEP CrSCC or RDCSRS. The sampling results are provided in **Table 3**. Cr^{+6} test pit sample results are presented in **Figure 9**.

During excavation activities, the following vertical profile was observed in the test pit (in ft bgs):

- 0.0-0.9' Concrete Slab
- 0.9-1.6' Void Space
- 1.6-2.1' Brown to dark brown, coarse to fine SAND, < 5% subrounded gravel (2 centimeters), no odor, no evidence of CCPW, related impacts, or nodules, damp
- 2.1-4.0' "Historic Fill" (encountered elsewhere on Site) dark gray to black silty medium to fine SAND, ~35% bricks and brick pieces, lens and pockets of light gray ash, no odor, no evidence of CCPW, related impacts, or nodules.

During field and sampling activities, potential Cr^{+6} impacts (green/yellow staining) were visually observed within the top 0-1 inches of the concrete floor profile at a number of locations near the column along the floor cut for the test pit. However, no staining was observed on the underside surfaces of the concrete floor, nor on the surface of the pile cap itself. Additionally, no visual evidence of the presence of CCPW was observed in any of the soil samples collected. A Conceptual Site Model (CSM), which is presented as **Figure 10**, was prepared to visually depict the relationship of the analytical results from the column, floor, and underlying soils and groundwater.

4.5.2 Soil Sampling

Based on the results of a conference call with NJDEP on Tuesday, October 14, 2014, NJDEP agreed that there is a "data usability and quality issue" with regard to a previous single Cr^{+6} exceedance in a soil sample collected from beneath the Boiler Room floor (Boring C2, sample 156-C2-C estimated concentration of 42.7 J mg/kg Cr^{+6}). As a result, NJDEP allowed confirmation re-sampling of soil at that location. NJDEP also requested that that two additional adjacent confirmation soil samples be collected.

To meet this objective, additional soil samples were collected beneath the floor slab at the previous C2 boring location (now referred to as C2-1), as well as two additional core locations, C4-1W (located east of C2) and C5 (located west of C2), as depicted on **Figure 3**.

At location C2-1, confirmation soil sample 156-C2-1-0-6 was collected on October 30, 2014 at a depth of 1.5-2.0 ft and analyzed for Cr^{+6}. Analytical results indicate an estimated concentration of 55.2 J mg/kg Cr^{+6}, which confirms the previous Cr^{+6} concentration at boring C2 (which was estimated at 42.7 J mg/kg).

At location C4-1W, two soil samples (156-C4-0-6 and 156-C4-6-12) were collected on October 30, 2014 at depths of 1.5-2.0 ft and 2.0-2.5 ft, respectively, and analyzed for Cr^{+6}. Analytical results indicate estimated concentrations of 58.6 J mg/kg and 23.4 J mg/kg Cr^{+6}, respectively, which exceed the CrSCC.

At location C5, one soil sample (156-C5-1-0-6) was collected on October 30, 2014 at a depth of 1.5-2.0 ft and analyzed for Cr^{+6}. Analytical results indicate an estimated concentration of 17.8 J mg/kg Cr^{+6}.

Based on these results, as shown on **Table 3**, additional vertical delineation soil samples were collected at location C4-1W, and additional delineation boring locations C4-1E, C6, C7, C8, and C10 were installed in December 2014, as described below.

At location C4-1W, four additional soil samples (156-C4-1-2.5-3, 156-C4-1-3-3.5, 156-C4-1-3.5-4, and 156-C4-1-4-4.5) were collected on December 19, 2014 for vertical delineation purposes at this boring location and analyzed for Cr, Cr^{+6}, and CCPW-related metals. The analytical results for sample 156-C4-1-2.5-3 indicate an estimated Cr^{+6} concentration 47.5 J mg/kg, which exceeds the CrSCC. The next deepest sample,156-C4-1-3-3.5, was not analyzed for Cr^{+6}. Sample 156-C4-1-3.5-4 exhibited a Cr^{+6} concentration of 7.0 mg/kg. Sample 156-C4-1-4-4.5 exhibited a Cr^{+6} concentration of 9.5 mg/kg. There were no exceedances of the SRS for other analytical parameters.

At location C4-1E, two soil samples (156-C4-1-2.5-3 and 156-C4-1-3-3.5) were collected on December 8, 2014 and analyzed for Cr, Cr^{+6}, and CCPW-related metals. Analytical results, as shown on **Table 3**, indicate Cr^{+6} concentrations of 37.3 mg/kg (which exceeds the CrSCC) and 4.8 mg/kg, respectively. There were no exceedances of the SRS for other analytical parameters.

At location C6, two soil samples (156-C6-1.5-2 and 156-C6-2-2.5) were collected on December 8, 2014 and analyzed for Cr, Cr^{+6}, and CCPW-related metals. Analytical results, as shown on **Table 3**, indicate Cr^{+6} concentrations of 5.9 mg/kg and 14.6 mg/kg, respectively. There were no exceedances of the SRS for other analytical parameters.

At location C8, three soil samples (156-C8-1.5-2, 156-C8-2-2.5, and 156-C8-2.5-3) were collected on December 8, 2014 and analyzed for Cr, Cr^{+6}, and CCPW-related metals. Analytical results, as shown on **Table 3**, indicate estimated Cr^{+6} concentrations of 14.4 J mg/kg, 33.4 J mg/kg (which exceeds the CrSCC), and 12.6 J mg/kg, respectively. Sb was detected at an estimated concentration of 6.1 J mg/kg, which slightly exceeds the DIGWSSL of 6.0 mg/kg in sample 156-C8-1.5-2. There were no exceedances of the SRS for other analytical parameters.

At location C7, three soil samples (156-C7-1.5-2, 156-C7-2-2.5, and 156-C7-2.5-3) were collected on December 19, 2014 and analyzed for Cr, Cr^{+6}, and CCPW-related metals. Analytical results, as shown on **Table 3**, indicate estimated Cr^{+6} concentrations of 15.7 J mg/kg, 6.6 J mg/kg and 14.2 J mg/kg respectively. There were no exceedances of the SRS for other analytical parameters.

At location C10, two soil samples (156-C10-1.5-2 and 156-C10-2-2.5) were collected on December 19, 2014 and analyzed for Cr, Cr^{+6}, and CCPW-related metals, as shown on **Table 3**. Analytical results indicate Cr^{+6} concentrations of 21.6 mg/kg (which exceeds the CrSCC) and 0.30 mg/kg, respectively. There were no exceedances of the SRS for other analytical parameters.

Analytical results for these Cr^{+6} samples are depicted **Figure 3** and **Figure 12**. The sampling results are provided in **Table 3**.

Based on the analytical results of soil samples collected to date, soil impacts are vertically delineated, and limited to a relatively small area located south of the boilers beneath the concrete slab, as depicted on **Figure 12**.

4.5.3 Concrete Investigation

In furtherance of selecting a final remedy for Cr^{+6} exceedances in concrete inside the Boiler Room, additional surficial concrete chip samples were collected near the boilers to delineate the extent of impacts to the floor surrounding the impacted column. A total of 17 additional concrete chip samples were collected in October and November 2014. Floor surface chip samples were collected beneath each boiler on the "column-side" of the boilers within the overall boiler footprint, and based on analytical results additional contingency floor surface chip samples were collected from the outside perimeter of the boiler footprint. Samples were analyzed for Cr^{+6}, Eh, pH and percent solids by Accutest Laboratories of Dayton, NJ.

The sampling results are provided in **Table 3**. Cr^{+6} floor surface slab sample results are presented in **Figure 5**.

Based on the analytical results of all surface concrete samples collected to date, the area of Cr^{+6} impacts on the interior concrete floor is fully delineated to the north, south, east, and west of the column. **Figure 11** depicts the overall area of impact that will require remediation.

4.6 Phase 6

Sampling and analysis was performed during several of the quarterly IRM inspections at the Site, as follows.

During the 2015 First Quarter (Q1) Site 156 IRM inspection on March 31, 2015, a green/yellow staining (approximately 1 inch by 9 inches in size) was observed inside the Boiler Room, roughly 1 foot northwest of the northwest corner of Boiler #2. This stained area was observed in a broken section of flooring with precipitates around the northwest edge. Discoloration of precipitates varied from brown to white with some areas of light green and yellow staining. A sample of the concrete (156-IRM-2015Q1-CONC) was collected. On the same date, green foam insulation covering a pipe near the northeast corner of Boiler #1 was observed. A sample of the insulation (156-IRM-2015Q1-FOAM) was collected. As a precaution, the concrete floor in the area sampled was covered with epoxy after sampling. The Cr^{+6} results for both samples were less than the CrSCC of 20 mg/kg, as indicated in **Table 4** below.

Table 4 AOC 3 Phase 6 Concrete Sample Collection (March 2015)

Sample ID	Lab ID	Collection Date	Validated	Hexavalent Chromium (Cr^{+6}) (mg/kg)	
				R	Q
156-IRM-2015Q1-CONC	JB91264-1	3/31/2015	Y	0.83	--
156-IRM-2015Q1-FOAM	JB91264-2	3/31/2015	Y	0.41	--

mg/kg – milligrams per kilogram
R – Result
Q - Qualified value
Y – Yes
-- - Not qualified

The sampling results are presented in **Table 3** and also depicted on **Figure 5** and **Figure 11** (with the exception of the foam insulation sample). The data validation reports are included in **Appendix H**.

During the 2015 2nd Quarter (Q2) Site 156 IRM inspection, a potential Cr^{+6} bloom was observed in the Boiler Room under the northern side of Boiler #1, and consisted of white and yellow crystals/precipitates. The precipitate was scraped up and sampled (156-Q2-2015) on June 22, 2015 for Cr^{+6}. As a precaution, the concrete floor was covered with plastic and sealed with duct tape after sampling.

The concrete floor beneath the boiler in the area of the precipitate was later sampled (156-Q3-2015-CF) during the Q3 IRM inspection in August 2015. Analytical results indicate the Cr^{+6} result was greater than the CrSCC of 20 mg/kg, as presented in **Table 5** below. Note that the Cr^{+6} result (78.5 RA mg/kg) for sample 156-Q2-2015 collected on June 22, 2015 was qualified by the validators as “RA”.

An RA Qualifier is assigned to certain Cr^{+6} results that were rejected due to failure of the matrix spikes to meet the NJDEP-specified control limits of 50-150% to indicate the result may have value for information purposes. This qualifier is typically used for Cr^{+6} where the spiked sample matrix appears to be reducing and would not be expected to support the presence of Cr^{+6}. The presence of other indicators of a reducing environment such as total organic carbon (TOC), sulfide, or ferrous iron is a factor in the decision to utilize the RA qualifier.

Table 5 AOC 3 Phase 6 Concrete Sample Collection (June and August 2015)

Sample ID	Lab ID	Collection Date	Validated	Hexavalent Chromium (Cr^{+6}) (mg/kg)	
				R	Q
156-Q2-2015	JB97572-1	6/22/1015	Y-RA	**78.5**	RA 1,2,3
156-Q3-2015-CF	JC1473-2	8/12/2015	Y	**476**	J 1, 4, 5

mg/kg – milligrams per kilogram
R – Result
Q - Qualified value
1 – In the Duplicate Sample Analysis, Hexavalent Chromium fell outside the control limits of + 20 percent for sample results > 4xRL or + RL for sample results < 4xRL. Therefore, the result was qualified.
2 – The reported sample results were rejected because the redigestion spike recovery was greater than 150 percent.
3 - The reported result was rejected because the laboratory failed to perform the reanalysis due to insufficient sample volume.
4 - The reported value was qualified (J/UJ) because the sample moisture content exceeded 50 percent.
5 - The reported value was qualified as estimated (J/UJ) but the bias is uncertain due to both high and low MS recoveries.
6 – Exceedances of the CrSCC of 20 mg/kg are shown in **bold** font.
Y - Yes
J - Estimated
RA – Rejected, but still is considered usable.
RL – reporting limit

The sampling results are presented in **Table 3** and also depicted on **Figure 5** and **Figure 11**. The data validation reports are included in **Appendix H**.

During the 2015 Q4 Site 156 IRM inspection, four new areas of potential Cr^{+6} impacts were identified, as described below:

- 156-Q4-2015-PRECIP1 was an area of yellow and white precipitate beneath the northeast corner of Boiler #2. This area measured roughly 2 feet long by 1 foot wide;
- 156-Q4-2015-PRECIP2 was an area of yellow and white precipitate, located adjacent to and to the east of Boiler #1 under a pipe. This area measured roughly 4 feet long by 4 inches wide;
- 156-Q4-2015-PRECIP3 was an area of yellow and white precipitate, located along the western and northern edges of restored concrete associated with a test pit, adjacent to and south of the space between the two boilers. The western edge measured roughly 4 feet long by 4 inches wide. The northern edge measured roughly 2 feet long by 4 inched wide; and
- 156-Q4-2015-PRECIP4 was an area of yellow and white precipitate, centered underneath the southern half of Boiler #1. This area measured approximately 2 feet by 3 feet.

On December 3, 2015, concrete chip samples were taken from areas 156-Q4-2015-PRECIP1, 156-Q4 2015-PRECIP2, and 156-Q4-2015-PRECIP3. Then, as a precaution, each area sampled was covered with epoxy. Due to accessibility issues, area 156-Q4-2015-PRECIP4 was not sampled but was covered with plastic and sealed with duct tape. Analytical results indicate that Cr^{+6} was present at concentrations greater than the CrSCC of 20 mg/kg, as presented in **Table 6** below.

Table 6 AOC 3 Phase 6 Concrete Chip Sample Collection (December 2015)

Sample ID	Lab ID	Collection Date	Validated	Hexavalent Chromium (Cr^{+6}) (mg/kg)	
				R	Q
156-Q4-2015-PRECIP1	JC9766-1R	12/03/2015	Y	**63.9**	J 1, 2
156-Q4-2015-PRECIP2	JC9766-2R	12/03/2015	Y	**22.5**	J 1,2
156-Q4-2015-PRECIP3	JC9766-3	12/03/2015	Y	**102**	J 1

Notes:
mg/kg – milligrams per kilogram
R – Result
Q - Qualified value
J - Estimated
1. The reported value was qualified as estimated (J) but the bias is uncertain due to both high and low soluble MS recoveries.
2. In the Duplicate Sample Analysis, Hexavalent Chromium fell outside the control limits of < 20 percent for sample results > 4xRL or + RL for sample results < 4xRL. Therefore, the result was qualified.
3. Exceedances of the CrSCC of 20 mg/kg are shown in **bold** font.
Y - Yes

The sampling results are presented in **Table 3** and also depicted on **Figure 5** and **Figure 11**. The data validation reports are included in **Appendix H**.

4.7 Phase 7

During the 2016 First Quarter (Q1) Site 156 IRM inspection conducted on March 30, 2016, yellow staining was observed. An area of yellow discoloration was observed roughly 17 ft to the east of Boiler #1, five feet west of the drain to the east and three feet north of the electrical panel to the south. The impacted area was less than one inch in diameter. A concrete chip sample (156-Q1-2016-EF1) was collected from the area. As a precaution, the area was covered with epoxy following sampling. A Cr^{+6} concentration of 139 mg/kg was detected in sample 156-Q1-2016-EF1.

On April 11, 2016, a core of the slab and slab surface chip samples were collected from the Boiler Room floor slab at the area of sample156-Q1-2016-EF1 identified during the 2016 Q1 IRM inspection. Locations of the core samples and chip samples are depicted in **Figure 4** (156-C11-MID and 156-C11-BTM) and **Figure 5** (156-G42, 156-G43, 156-G44 and 156-G45). Note that the 139 mg/kg Cr^{+6} exceedance at sample location 156-Q1-2016-EF1 was remediated when the concrete core was removed from the floor.

The Cr^{+6} concentrations ranged from 0.86 mg/kg to 3.4 mg/kg. No Cr^{+6} concentrations exceeded the CrSCC. **Table 7** provides a summary of the April 2016 concrete sample results.

Table 7 AOC 3 Phase 7 Concrete Core and Chip Sample Collection (April 2016)

Sample ID	Lab ID	Collection Date	Validated	Cr^{+6} (mg/kg)	
				R	Q
156-C11-MID	JC18036-8	4/11/2016	Y	0.86	--
156-C11-BTM	JC18036-9	4/11/2016	Y	1.1	--
156-G42	JC18036-10	4/11/2016	Y	0.87	--
156-G43	JC18036-11	4/11/2016	Y	3.4	--
156-G44	JC18036-12	4/11/2016	Y	2.2	--
156-G45	JC18036-13	4/11/2016	Y	1.3	--

Notes:
mg/kg – milligrams per kilogram
R – Result
Q - Qualified value
Y - Yes
-- - Not qualified

The sampling results are also presented in **Table 3** and depicted on **Figure 4, Figure 5,** and **Figure 11**. The data validation reports are included in **Appendix H**.

5.0 Discussion of Remedial Investigation Findings

In summary, AOC 3 RI activities conducted through April 2016 indicate the following:

5.1 Phases 1, 2, and 3

- Cr^{+6} contamination is present at concentrations greater than the CrSCC of 20 mg/kg on the concrete building support column situated between the two large gas-fired boilers in the Boiler Room of Building No. 2. This is the same column where Cr^{+6} blooming was observed during a post-Hurricane Sandy visual inspection in November 2012 (AECOM, 2012b);
- The bottom 12-18 inches of the concrete on the column were found to be impacted with Cr^{+6} at concentrations ranging from 25.2 mg/kg (156-BLDG2-CONC-EB-1) to 761 mg/kg (156-BLDG2-CONC-NB-1), as shown on **Figure 7**. Impacts were confirmed on the column both at the exterior surface and within the column at depth. The impacted areas on the column surface are currently covered with an epoxy coating;
- The surface (top 2 inches) of the concrete floor near the column is impacted with Cr^{+6} at concentrations greater than 20 mg/kg. Concentrations range from 1.2 mg/kg to an estimated concentration of 1,040 J mg/kg, and Cr^{+6} concentrations generally decrease as you move away from the column, as shown on **Figures 5** and **11**;
- Sample results from all concrete floor cores collected outside the perimeter of the footprint of the boilers (approximately 10 ft east, south, west, and north of the column) indicate that the concrete floor is not impacted with Cr^{+6} at concentrations greater than 20 mg/kg , as shown on **Figures 4, 5** and **11**; and
- On March 25, 2014, PPG's excavation contractor (ENTACT) completed excavation within AOC 1 to cutline limits within 15 ft of the Boiler Room exterior. The excavation was inspected by AECOM and Weston and there was no evidence of visible CCPW at the excavation limits outside and nearest to the Boiler Room area of the building.

5.2 Phase 4

- No visible evidence of CCPW was observed during Phase 4 test pit excavation activities;
- No visible evidence of Cr^{+6} impact (staining, Cr^{+6} blooms) was observed on the pile cap;
- No visible evidence of Cr^{+6} impact (discoloration) was observed in the water sample;
- Chip samples from the concrete pile cap did not exhibit Cr^{+6} concentrations greater than the CrSCC, as shown on **Figure 9**;
- Concrete samples from the underside of the concrete floor near the impacted column (Cores G19 and G20) did not exhibit Cr^{+6} impacts, as shown on **Figure 4**;
- Soil samples G19 and G20 collected from below the Boiler Room floor near the column did not exhibit visible CCPW or concentrations of Cr^{+6} greater than 20 mg/kg. However, one previous surficial soil sample, located approximately 10 ft south of the column, exhibited an estimated Cr^{+6} concentration of 42.7 mg/kg, as shown on **Figure 3**;
- The groundwater sample from the test pit (**Figure 3A**) exceeds the NJDEP GWQS for Cr; however, this sample was not collected from a groundwater monitoring well and is not considered to be representative of groundwater quality at this location of the Site. These results are used for screening purposes only;

- As shown on **Table 3**, the analytical sample of pooled water on the concrete floor around the base of the impacted column exhibited elevated concentrations of Cr and Ni. The results of the analysis of the boiler circulation source water indicated that none of the parameters were detected at concentrations greater than the sample-specific RL/MDL;
- During field and sampling activities, potential Cr^{+6} impacts (green/yellow staining) were visually observed within the top 0-1 inches of the concrete floor profile at a number of locations near the impacted column along the floor cut for the test pit. However, no staining was observed on the underside surfaces of the concrete floor, nor on the surface of the pile cap itself. Additionally, no visual evidence of the presence of CCPW was observed in any of the soil samples collected;
- Based on the video inspection results, it was confirmed that underlying soils are not in contact with the bottom of the concrete floor and a variable void space of approximately 6 to 8 inches exists between the bottom of the concrete floor and the underlying soil material;
- The continuity of the concrete column through the floor slab to the top of the pile cap was also confirmed by AECOM and MRCE during the video inspection. This is consistent with what is expected based on a review of building drawings;
- No evidence of staining, potential Cr^{+6} blooms, or visible CCPW was observed on either the concrete or soil beneath the slab during the video inspection; and
- A number of potential conduits/pathways for groundwater (drain lines, electrical conduit) were observed in the void space between the underside of the concrete floor and the soil below the floor.

5.3 Phases 5, 6, and 7

- Based on the analytical results of soil samples collected through Phase 5, it appears that Cr^{+6} soil impacts that exceed the CrSCC are present beneath the Boiler Room floor slab, are vertically delineated, and are limited to a relatively small area south of the boilers inside the overall footprint of the Boiler Room. **Figure 12** depicts this area; and
- Based on the analytical results of all surface concrete samples collected through Phase 7, the area of Cr^{+6} impacts on the interior concrete floor is fully delineated to the north, south, east, and west of the column. **Figure 11** depicts the overall area of impact that will require remediation.

6.0 Remedial Investigation Conclusions and Recommendations

Conclusions and recommendations based upon the RI performed at Site 156 AOC 3 are provided below.

6.1 AOC 3 Impacted Concrete

Cr^{+6} was detected at concentrations greater than the CrSCC in samples of the concrete building support column situated between the two large gas-fired boilers in the Boiler Room of Building No. 2 and the floor surface slab near and around the boilers. An RA is necessary for impacted concrete in AOC 3. A remedial alternatives analysis for the impacted concrete in AOC 3 is presented in **Section 7.1**.

6.2 AOC 3 Soil

Cr^{+6} concentrations exceeded the CrSCC in soil in a small area beneath the concrete floor, located south of the boilers. Additionally, Sb was detected at estimated concentrations exceeding the DIGWSSL in two soil samples [156-C8-1.5-2 and G19(17.5-23.5)] and Ni was detected at an estimated concentration exceeding the DIGWSSL in one soil sample [G19(17.5-23.5)], also south of the boilers. No other concentrations of CCPW metals exceeded their applicable standards. An RA is necessary for impacted soil in AOC 3. A remedial alternatives analysis for the impacted soil in AOC 3 is presented in **Section 7.2**.

6.3 AOC 3 Boiler Water

There were no exceedances of applicable criteria for Cr^{+6} or Cr in water from the boilers in samples BOILER CIRC WATER, SOURCE1, SOURCE 2N, and SOURCE2S. The pooled water on the surface was removed, and no further water pooling has been observed in the vicinity of the boiler since the source area discharges have been redirected to a nearby drain. No further action is required for the boiler water.

6.4 AOC 3 Groundwater

A groundwater screening sample was collected from the test pit that was excavated beneath the concrete slab between the boilers. The Cr results from this screening sample exceeded the GWQS for Cr; no other concentrations of CCPW metals exceeded their applicable standards. Therefore, one monitoring well (MW-10) was installed in the basement and additional groundwater sampling was conducted during the AOC-2 groundwater investigation, as summarized in **Section 2.7.2**. Two rounds of low-flow groundwater sampling were conducted in May 2016 and July 2016. The groundwater sample results from MW-10 indicated that the concentrations did not exceed the applicable standards for the CCPW metals, including total Cr. No further investigation of groundwater is recommended.

7.0 Remedial Action Selection

Based on the findings of the RI, RA alternatives were developed and evaluated for the interior concrete surfaces of the Boiler Room and the soils underlying the concrete slab, as presented below.

Both Unrestricted and Restricted future use scenarios were evaluated, with the objective that the RA be protective of public health, safety, and the environment.

7.1 Concrete Surfaces

The evaluation of RA alternatives considered the following:

- Adherence to NJDEP regulations and guidance;
- Acceptability to the New Jersey Department of Labor and Workforce Development - Bureau of Boiler & Pressure Vessel Compliance;
- Compatibility with boiler manufacturer installation specifications and operating requirements;
- Effect on the concrete floor slab and surrounding structural elements;
- Effect of construction work on mechanical, electrical, and plumbing (MEP) equipment;
- The duration of construction;
- The inherent risks; and
- The relative cost.

7.1.1 Nature of Concrete Impacts

Cr^{+6} blooms are caused by two physical processes:

- Transport of Cr^{+6}-impacted groundwater through the concrete structure, driven by hydraulic pressure or capillary action; and subsequently
- Evaporation of Cr^{+6}-impacted groundwater on the interior facing surface of the concrete, leaving behind a Cr^{+6} salt precipitate (i.e., "Cr^{+6} blooms").

The first process requires the concrete structure to be in contact with either groundwater, saturated soil, or soil located in the capillary fringe. When the concrete is below the groundwater table, hydraulic pressure can cause Cr^{+6}-impacted groundwater to weep through the concrete pores. When the concrete is above the groundwater table, capillary action, driven by evaporation at the surface of the concrete, causes the groundwater to "wick" upwards through the pore structure of the concrete.

Once Cr^{+6}-impacted groundwater is transported to the surface of the concrete, the water evaporates, leaving behind a Cr^{+6} salt precipitate. Over time, this process concentrates Cr^{+6} on the surface of the concrete.

While concrete that has been exposed to Cr^{+6}-impacted groundwater may contain Cr^{+6} impacts within the concrete pore structure, the processes driving Cr^{+6} blooms cause the majority of Cr^{+6} impacts to be on the surface of the concrete.

Records of borings and test pits installed within the extent of AOC 3 indicate an approximately 6- to 12-inch thick void space is present between the concrete floor slab and underlying soils. This void space functions as a capillary break between the concrete floor slab and the underlying soils. However, concrete footers of the support columns are still in contact with the underlying soil. Exceedances of the CrSCC were detected on the concrete column up to a height of 1 foot above the floor surface. The impacts to these columns is discussed in detail in **Section 2.7.3**, and analytical results for the column samples are presented on **Table 3**.

Groundwater gauging conducted as part of the groundwater RI indicates a depth to water within the extent of this AOC ranging from elevation (El.) 0.44 to El. 2.78 (in ft NAVD88) (AECOM, 2018c), while the surface of the concrete floor is at El. 5.65. Given the thickness of the slab and the void space, the depth to water measured indicates that the void space was not saturated during the groundwater gauging events. Therefore, the concrete floor slab is not in contact with groundwater, saturated soil, or the soil located in the capillary fringe. However, the concrete footers of the support columns sit within the water table.

Given the presence of the void space underlying the concrete slab and the observed depth to water, the concrete floor slab most likely came into contact with Cr^{+6}-impacted groundwater during a major rain event, specifically Hurricane Sandy, that saturated the void space.

7.1.2 Remedial Alternatives Evaluation

Four concrete surface RA alternatives were evaluated. The evaluation was based on available structural drawings, analytical results from previous investigations, Site visits to the Boiler Room (to understand available space restrictions and to observe the MEP equipment), and limitations based on structural integrity as presented in the *Feasibility Study for Structural Remediation* prepared by MRCE dated December 2014 (MRCE, 2014) [as revised (Rev1) October 5, 2015], and the *Removal of Boiler Room Structural Slab Site 156 – Metropolis Towers Boiler Room* prepared by MRCE dated April 28, 2015 (MRCE, 2015) (**Appendix I**).

A summary of the remedial alternatives evaluated is presented in **Table 8**:

Table 8
Remedial Action Alternatives
AOC 3 – Boiler Room - Concrete

Alternative	Remedial Action	Cost	Short-Term Effectiveness	Practicability	Community Benefit
1	Seal contaminated column and floor surface in place with membrane and armor (Institutional and Engineering Controls - Restricted Use Alternative).	Low	High	Technically Impracticable[1]	High
2	Remove and replace exposed contaminated column and floor slab (Boilers left in place). (Unrestricted Use Alternative)	High	High	Technically Impracticable[2]	High
3	Maintain the Retro-Coat™. (Institutional and Engineering Controls – Restricted Use Alternative)	Medium	High	Low	High
4	Leave Retro-Coat™ in place and conduct periodic inspections. (Institutional and Engineering Controls – Restricted Use Alternative)	Low	High	High	High

[1] As concluded in the October 4, 2016 e-mail correspondence from Michael Amuzie, Assistant Chief, New Jersey Department of Labor and Workforce Development - Bureau of Boiler & Pressure Vessel Compliance (**Appendix A**).
[2] As concluded in the document entitled *Removal of Boiler Room Structural Slab Site 156 – Metropolis Towers Boiler Room* prepared by MRCE dated April 28, 2015 (MRCE, 2015) (**Appendix I**).

7.1.2.1 Alternative 1

Alternative 1 is a Restricted Use alternative, which addresses the mechanical hazard resulting from concrete spalling and other structural degradation by providing structural confinement to the concrete through the use of structural fiber wrap technology (membrane), a 3-inch thick fiber-reinforced floor topping (armor) placed over the floor with metal lath, and concrete mortar (trowel–on) placed around the column.

However, installation of this membrane and armor system would restrict the ability of the boiler stands to expand and contract, which is contrary to the boiler manufacturer's operating specifications and does not conform to applicable regulatory code requirements. Therefore, this alternative has been determined to be technically impracticable and will not be utilized.

Alternative 1 was evaluated and found to be impracticable based on existing conditions, as noted on **Table 8**.

7.1.2.2 Alternative 2

Alternative 2 is an Unrestricted Use alternative, which removes and replaces all concrete with concentrations of Cr^{+6} greater than 20 mg/kg. However, MRCE has determined that this alternative is technically impracticable based on building construction and load-bearing characteristics of the existing concrete floor slab (MRCE, 2015) (**Appendix I**).

Alternative 2 was evaluated and found to be impracticable based on existing conditions, as noted on **Table 8**.

7.1.2.3 Alternative 3

Alternative 3 is a Restricted Use alternative, which addresses concrete with concentrations of Cr^{+6} exceeding the CrSCC by maintaining the existing Retro-Coat™ coating. The coating is a barrier that prevents direct contact with the impacted concrete and prevents Cr^{+6} blooms.

Based on an evaluation of this alternative, as documented in a March 27, 2017 Technical Memorandum prepared by AECOM, and subsequent conditional approval of this approach by the boiler manufacturer, the New Jersey Department of Labor and Workforce Development - Bureau of Boiler & Pressure Vessel Compliance, Weston, and NJDEP, installation of the Retro-Coat™ coating was identified as a preferred remedial action for Cr^{+6}-impacted concrete.

This alternative consists of monitoring and maintaining the Retro-Coat™. The coating will continue to prevent direct contact with the Cr^{+6} present in the concrete. The coating also prevent the formation of Cr^{+6} blooms on the concrete surface by preventing evaporation of groundwater, which is transported upward through the concrete by capillary action. As discussed in **Section 2.9.1**, as of September 18, 2019, locations where repairs are needed have been documented. As part of this alternative, these locations will be repaired. Ongoing inspections will identify any locations that may require repairs in the future, and repairs will be scheduled as needed.

Repairs to the Retro-Coat™ coating were put on hold pending completion of maintenance of equipment in the Boiler Room. This maintenance, which involved the moving of heavy equipment across the floor where the coating is present, contributed to the chipping, cracking, and peeling of the coating. Any similar work in the future may cause additional damage to the coating. Repairing the existing damage, as well as any potential future damage, would be moderately disruptive to building operations.

As part of this alternative, signage (i.e., the engineering control) will be put in place informing Boiler Room workers that removing the Retro-Coat™ coating or penetrating or damaging the concrete is prohibited.

An institutional control (i.e,. deed notice) and corresponding RAP would be required for this Restricted Use remedy. Monitoring of the Retro-Coat™ would be conducted in accordance with an approved operation, maintenance, and monitoring plan. A draft Deed Notice, which includes remedial action extents and the deed notice area, was previously approved by the property owner via e-mail correspondence.

However, as described in **Section 7.1.3** below, the Retro-Coat™ has proven unnecessary over time; therefore, Alternative 4 is the selected remedy.

7.1.2.4 Alternative 4

Alternative 4 is a Restricted Use alternative, which addresses concrete with concentrations of Cr^{+6} exceeding the CrSCC through a combination of signage, inspections, and removal of any Cr^{+6}-impacted concrete observed in the future.

Signage will be put in place informing Boiler Room workers that penetrating (including drilling), or damaging the surface of the concrete is prohibited. This signage is the primary engineering control in Alternative 4 to prevent exposure of Boiler Room workers or others to any Cr^{+6} impacts that may be present within the concrete floor slab or concrete column.

Ongoing inspections will identify any potential Cr^{+6} blooming that may occur in the future. Inspections and follow-up actions will be conducted in accordance with the *Operation, Maintenance, and Monitoring (OM&M) Manual*, which is included as **Appendix J2**, and which will be consistent with the *IRM Inspections and Reporting Procedure* (AECOM, 2016). If potential Cr^{+6} blooming or discoloration is observed, the field team will collect a concrete chip sample to verify whether Cr^{+6} is present. If potential Cr^{+6} impacts are observed, a temporary cover or barrier (e.g., plastic sheeting, traffic cones, caution tape, etc.) will be installed to limit inadvertent contact and access to potentially impacted areas until samples can be collected (if unable to be collected during the inspection), and an epoxy coating will be applied. In certain travel areas, the installation of a temporary cover along with a barrier to demarcate the cover will be implemented. Sampling equipment and epoxy will be available during the inspections so that samples may be collected and epoxy may be applied immediately, if feasible.

A institutional control (i.e, deed notice) and corresponding RAP would be required for this Restricted Use remedy. Monitoring of the engineering control and the restricted area would be conducted in accordance with an approved operation, maintenance, and monitoring plan.

7.1.3 Evaluation and Conclusion

Alternative 1 and Alternative 2 are impracticable based on existing conditions, as noted on **Table 8**.

The exposure pathways for concrete with concentrations of Cr^{+6} exceeding the CrSCC are:

- Direct contact with concrete or inhalation of dust generated by disturbing the concrete; and
- Direct contact with or inhalation of the salts contributing to Cr^{+6} blooms.

Both Alternative 3 and Alternative 4 prevent direct contact with the concrete or inhalation of concrete dust by restricting access. Institutional (i.e., deed notice) and engineering (i.e., signage) controls are used to prevent any activity that penetrates/damages the concrete and generates concrete dust or debris. The risk of exposure to Cr^{+6} from direct contact with the concrete surface (when no Cr^{+6} blooms are present) is minimal. During installation of the Retro-Coat™ coating, the affected concrete was scarified, removing any Cr^{+6} that may have been present on the surface of the concrete. No visual indicators of Cr^{+6} (e.g., green/yellow staining) were observed since scarification.

Alternative 3 prevents direct contact with or inhalation of the salts contributing to Cr^{+6} blooms. The Retro-Coat™ coating provides a barrier that prevents the formation of Cr^{+6} blooms on the surface of the concrete. Alternative 4 does not provide a barrier to prevent the formation of Cr^{+6} blooms; however, multiple lines of evidence suggest that the risk of exposure to Cr^{+6} blooms has been reduced and a barrier is no longer necessary. These lines of evidence are:

- More than two years of monthly inspections of the Retro-Coat™ have been completed and continue to be performed. Potential Cr^{+6} blooms have not been observed in any locations where the surface of the concrete is exposed due to chips, gouges, or cracks. The lack of Cr^{+6} blooms in more than two years of monthly inspections suggests that the factors contributing to Cr^{+6} blooming have abated.

- Remediation of AOC 1, CCPW-impacted soils outside the extent of the Boiler Room, is complete. For AOC 1, the objective of the RA was excavation and off-site disposal of all soils with visible CCPW and Cr^{+6} exceeding the CrSCC. As discussed in **Section 6.0**, no visible CCPW was identified beneath the concrete floor slab of the Boiler Room. While the exact physical/chemical processes that cause Cr^{+6} blooming are not well understood, the presence of source material is correlated with Cr^{+6} blooming. The absence of source material suggests the potential for Cr^{+6} blooming in the future is reduced.
- Following the completion of the RA for AOC 1, residual Cr^{+6} groundwater contamination attenuated. The results of the groundwater RI indicate that the AOC 1 RA was successful in reducing CCPW-related contaminants in groundwater to concentrations less than the applicable GWQS. This includes the results of groundwater monitoring at MW-10, which was installed within the extent of the Boiler Room basement. While the minimum concentration of Cr^{+6} in groundwater capable of causing Cr^{+6} blooming is unknown, the concentration of Cr^{+6} in groundwater is correlated with the potential for Cr^{+6} blooming. The reduction of Cr^{+6} in groundwater to concentrations less than the GWQS suggests that the potential for Cr^{+6} blooming is reduced.
- As discussed in **Section 7.1.1**, under normal weather conditions a void space is present that serves as a capillary break between the concrete floor slab and the underlying soils. Under normal weather conditions, this capillary break prevents groundwater from coming into contact with the concrete floor slab. Without concrete in contact with either impacted groundwater, saturated soil, or soil located in the capillary fringe, groundwater cannot be transported through the concrete and evaporate on the surface of the concrete, which is necessary for Cr^{+6} blooming to occur.

Taken together, these lines of evidence indicate that Alternative 4 mitigates the risk of exposure to Cr^{+6} blooms by direct contact or inhalation.

Given the disruptions to building operations associated with Alternative 3, and that Alternative 4 is protective of human health and the environment under prevailing conditions, Alternative 4 is the selected RA for AOC 3 (concrete).

The area of Cr^{+6}-impacted concrete is depicted on **Figure 11** and the Concrete Restricted Area Limits are depicted on Deed Notice Exhibit B-1A-1 provided in **Appendix J1**. The Concrete Restricted Area – Engineering Control (Signage) is depicted in Deed Notice Exhibit B-1A-3 provided in **Appendix J1.**

7.2 Remedial Action Alternatives – Soils

Based on the concentrations of Cr^{+6} in impacted soils and the physical location and limited access to the soils beneath the Boiler Room floor, four RA alternatives were developed and evaluated for Site 156 AOC 3:

- Alternatives 1 & 2: Soil Excavation/Physical Removal (Unrestricted Use)
- Alternative 3: In-Situ Soil Remediation (Chemical) (Limited/Unrestricted Use)
- Alternative 4: Deed Notice with Engineering Control (Restricted Use)

Alternatives were evaluated with regard to structural feasibility, effect on surrounding structural elements, impact of the construction work on MEP equipment and overall Boiler Room operations, the duration of construction, the construction equipment required, the inherent risks, and the relative cost.

A summary of the remedial alternatives evaluated is presented in **Table 9**.

Table 9

Remedial Action Alternatives
AOC 3 – Boiler Room - Soils

Alternative	Remedial Action	Cost	Short-Term Effectiveness	Practicability	Community Benefit
1	Drill hole to gain access through floor and to vacuum remediate underlying impacted soils (Unrestricted Use Alternative)	Low	High	Technically Impracticable[1]	High
2	Saw cut and jack hammer opening in floor to access and physically remove underlying soils (Unrestricted Use Alternative)	High	High	Technically Impracticable[1]	High
3	In-situ chemical treatment of soils (Limited/Unrestricted Use)	High	High	High	High
4	Soils remain in place with Institutional and Engineering Controls (Restricted Use)	Low	High	High	High

[1] As concluded in the document entitled *Removal of Boiler Room Structural Slab Site 156 – Metropolis Towers Boiler Room* prepared by MRCE dated April 28, 2015 (MRCE, 2015).

In summary, MRCE evaluated remedial Alternatives 1 and 2 and determined they are technically impracticable based on building construction and load-bearing characteristics of the existing concrete floor slab. Documentation regarding impracticability of these options is provided in **Appendix I**.

PPG and NJDEP reviewed Alternative 3 (In-Situ Chemical Treatment) and, although technically feasible, NJDEP had concerns with regard to the ability to effectively implement and monitor this remedy given its location under the building.

Alternative 4 has been selected as the preferred remedial alternative for soil in AOC 3. Alternative 4 is a Restricted Use alternative, under which an institutional control (i.e., deed notice) is established and engineering controls are implemented for the soil impacted by Cr^{+6} (Soil Restricted Area) underlying the Boiler Room floor. The existing Boiler Room concrete floor and the placement of signage will serve as the primary engineering controls to restrict access to underlying soil impacted with Cr^{+6}. The Boiler Room area of Cr^{+6} impacted soil is depicted on **Figure 12** and the Soil Restricted Area – Engineering Control and Limits are depicted on Deed Notice Exhibit B-1B-1 provided in **Appendix J1**. A portion of the floor designated as the engineering control is also depicted on **Figure 11**. Soil Restricted Area – Engineering Control (Signage), to restrict disturbance of the concrete floor slab in the Boiler Room, is depicted on Deed Notice Exhibit B-1B-3 provided in **Appendix J1**.

7.3 Applicable Standards

The objective of this RA is to remediate visible CCPW and co-located CCPW-related impacts that exceed the NJDEP CrSCC and/or RDCSRS in soil and concrete present at Site 156 AOC 3. The contaminant of concern in the concrete is Cr^{+6}. The CrSCC of 20 mg/kg for Cr^{+6} was utilized to determine the extent of the remedy based on the RI sample results.

7.4 Satisfaction of N.J.A.C. 7:26E-5

This RAWP is in compliance with N.J.A.C. 7:26E-5 and satisfies the requirements therein. Specifically, this RAWP has determined the appropriate RA that will reduce or eliminate exposure to contaminants at concentrations greater than the applicable remediation criteria and standards that is based on protection of public health, safety, and the environment.

7.5 Protectiveness of Remedial Alternative

The RA for Site 156 AOC 3 will reduce the potential for direct contact, inhalation, or ingestion of contaminated concrete and soils, accomplishing the goal of isolating the health hazard of Cr^{+6} at concentrations greater than 20 mg/kg.

8.0 Remedial Action

As presented in Section 7, the selected RA for Cr^{+6} at concentrations greater than the CrSCC in concrete is Alternative 4, and the selected RA for Cr^{+6} greater than the CrSCC in soil is Alternative 4. The RA for the Boiler Room basement is summarized as follows:

- Concrete floor slab and column: Cr^{+6} remains in place at concentrations greater than the CrSCC and is addressed by engineering controls appropriate for the property's current use (signage prohibiting penetrating or damaging the concrete floor slab or column and conducting inspections for potential Cr^{+6} blooming; if potential Cr^{+6} blooms are observed, sample the location for Cr^{+6}; if the sample result for Cr^{+6} exceeds the CrSCC, remove the impacted concrete and install an epoxy coating over the affected area); and institutional control (deed notice).
- Soil: Cr^{+6} remains in place at concentrations greater than the CrSCC and Sb and Ni remain in place at concentrations greater than the Default Impact to Groundwater Soil Screening Levels (DIGWSSLs). These are addressed by engineering controls appropriate for the property's current use (existing concrete floor slab as a cap; signage prohibiting penetrating or damaging the concrete floor slab) and institutional control (deed notice).

The extents of the RA are shown on **Figures 11** and **12.**

8.1 Applicable Remedial Standards

The CrSCC of 20 mg/kg is the applicable remedial standard for Cr^{+6}. The CrSCC of 120,000 mg/kg is the applicable remedial standard for Cr^{+3}. For CCPW-related metals, the current NJDEP RDCSRS and NRDCSRS, with the exception of vanadium, are the applicable remedial standards. In a December 16, 2011 letter, NJDEP accepted the use of 370 mg/kg as the ARS for vanadium (**Appendix A**). The DIGWSSLs are the applicable remedial standard for potential soil impacts to groundwater.

8.2 Construction Activities

No construction activities are required to implement the selected RA. Likewise, no construction-related permits are required, and no subcontractors are needed for RA implementation.

As part of the engineering control, signage (in English and Spanish) will be posted, in places easily visible to building workers, prohibiting penetrating or damaging the concrete floor slab or column. If damage to or unauthorized removal of the signage is observed, the signage will be replaced in kind. Figures presenting the proposed signage are presented in the Deed Notice in **Appendix J1**.

8.3 Health and Safety Plan and Field Sampling Plan/Quality Assurance Project Plan

A program-wide Health and Safety Plan (HASP) and FSP-QAPP were prepared for work within the HCC Sites under PPG jurisdiction. These are available as **Appendices K and L**, respectively, of this RIR/RAWP/RAR. The HASP establishes general health and safety protocols to be followed by Site personnel during implementation of the RAWP. The HASP describes training, medical surveillance, personnel hygiene practices, hazard exposure monitoring, and monitoring equipment maintenance requirements. It is a dynamic document and will be updated as needed.

The FSP-QAPP establishes the overall QA objectives for the project and documents sampling and analytical procedures to be used for collecting and analyzing environmental samples. It describes procedures for equipment decontamination, sample handling, sample chain-of-custody protocols, and standard QA procedures for conducting sampling. The FSP-QAPP will be updated as conditions warrant. The FSP-QAPP was prepared to address the requirements presented in the ACO. No confirmation sampling was required for this RA; however, the FSP-QAPP will be followed when sampling potential Cr^{+6} impacts in concrete. The FSP-QAPP is provided in the event sampling is required.

8.4 Remedial Action Schedule

No construction is required to implement the selected RA. Signage will be posted by October 1, 2020, dependent on approval by the property owner. Following approval of the RIR/RAWP/RAR, the Deed Notice will be filed with the County Clerk. At the time of the submittal of this RIR/RAWP/RAR, the property owner has accepted the Deed Notice. Once the Deed Notice is filed, PPG will submit the RAP application for the remaining-in-place impacts, incorporating this RIR/RAWP/RAR by reference, for NJDEP approval.

8.5 Deed Notice

A draft Deed Notice is included in **Appendix J1**. The final Deed Notice will be filed after acceptance by the property owner is received. Once the Deed Notice is filed, the RAP for Soil can be submitted to NJDEP, with the RAR included by reference, for approval.

8.6 Monitoring Plan

Inspections to check for potential Cr^{+6} blooming and discoloration, as part of the engineering controls to address the concrete floor slab and column with Cr^{+6} remaining in place at concentrations greater than the CrSCC, will be conducted in accordance with the *OM&M Manual*, which is included as **Appendix J2**. Inspection and reporting procedures will be consistent with the *IRM Inspections and Reporting Procedure* (AECOM, 2016).

PPG will conduct performance inspections of the engineering control (i.e., concrete floor slab and signage) on a quarterly basis for the first four years after engineering control installation, and biennially thereafter provided that the quarterly inspections indicate, and NJDEP concurs, that the remedy is performing and functioning as designed.

In summary, monitoring will consist of:

- Notifying the property owner, mobilizing, and conducting a safety tailgate meeting;
- Conducting a full inspection of accessible areas to look for areas exhibiting potential Cr^{+6} impacts (e.g., green/yellow discoloration/staining);
- Confirming that signage remains in place, is legible, and easily noticeable by building workers;
- Recording field notes, observations, measurements, sketches, and photographs that fully document the status of the engineering controls in the Boiler Room basement, any potential Cr^{+6} impacts, and any inaccessible areas (if relevant); and
- If potential Cr^{+6} impacts are observed, installing a temporary cover or barrier (e.g., plastic sheeting, traffic cones, caution tape, etc.) to limit inadvertent contact and access to potentially-impacted areas until samples can be collected (if unable to be collected during inspections) and epoxy will be applied to the affected area. In travel areas, the installation of a temporary cover along with a barrier to demarcate the cover will be used. Sampling equipment and epoxy will be available during the inspections so that samples may be taken and epoxy may be applied immediately, if feasible.

8.6.1 Response to Potential Blooming and Discoloration

If potential Cr^{+6} blooming is observed during the inspections of the engineering control (i.e., concrete floor slab and signage), the field team will collect concrete chip samples to verify if Cr^{+6} is present. The field staff will be prepared to collect samples and cover the area with epoxy during inspections, where feasible. Inspections and follow up actions will be conducted in accordance with the *OM&M Manual*, which is included as **Appendix J2**, and which is consistent with the *IRM Inspections and Reporting Procedure* (AECOM, 2016). Waste concrete will be drummed for disposal in accordance with applicable regulations. The area will be cleaned and the location will be covered with epoxy, applied in accordance with manufacturer's specifications. Cones, caution tape, or other means will be used to prevent contact with the affected area until the epoxy is cured. The response will be documented and the formerly affected area will be inspected during future monitoring events.

8.7 Performance Evaluation

Routine sampling will not be required in order to demonstrate ongoing compliance with remediation standards. The results of ongoing monitoring of the engineering controls will be presented in monitoring reports, which will be submitted to the property owner and included as attachments to the Deed Notice Biennial Certification forms. Monitoring reports will include a summary of any potential Cr^{+6} blooms observed, as well as sampling results and the actions taken (removal and epoxying of the affected area). Monitoring reports will be prepared biannually while monitoring is conducted quarterly, and biennially when monitoring is conducted biennially.

9.0 Documentation of the Protectiveness of the Remedial Action

The results of the RI, the documentation of the installation of the Retro-Coat™, and the results of ongoing inspections following the installation of the Retro-Coat™ informed the selection of the RA and document the protectiveness of the selected RA. The Cr^{+6} and CCPW metals impacts remaining in place are mitigated by the selected RA. The Cr^{+6} and CCPW metals impacts remaining in place have been presented in **Tables 3** through **7** and **Figures 3** through **9**. Laboratory data deliverables are included in **Appendix G**. Data validation reports are included in **Appendix H**.

9.1 Documentation of Waste Generation and Disposal

No waste was generated as a result of implementation of the selected RA.

As a result of the installation of the Retro-Coat™ IRM, a total of three 55-gallon drums of concrete dust, spent HEPA filters, and wood removed from the column IRM were generated, and were transported for off-site disposed at Stablex Canada Inc., located in Blaineville, Quebec. Bills of lading and manifests/paperwork related to disposal are included in **Appendix C**.

9.2 Remedial Action Permit, Consent Judgement Compliance Letter, and the Site Remediation Program

After the final Deed Notice is filed, the RAP for Soil can be submitted to NJDEP, with the RAR included by reference, for approval. If the RAP is accepted by the NJDEP, the NJDEP will issue a Consent Judgment Compliance letter for AOC 3. Following issuance of the Consent Judgment Compliance Letter, PPG will retain an LSRP, who will review the results of ongoing monitoring and approve the Biennial Certification Monitoring Report, which, in accordance with NJDEP regulations, is submitted to the NJDEP, Division of Remediation Management and Response, Bureau of Operation, Maintenance, and Monitoring Deed Notice Inspection Program.

9.3 Remedial Action Cost

The estimated cost of the remedial action, including the Retro-Coat™previously installed, is estimated to be $132,000. The cost of monitoring and maintenance will be presented in the forthcoming RAP.

10.0 References

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