ALTERNATIVES ANALYSIS REPORT
OPERABLE UNIT 2

Prepared for:

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LIST OF ACRONYMS AND ABBREVIATIONS

AAR	Alternatives Analysis Report
Amec Foster Wheeler	Amec Foster Wheeler Environment & Infrastructure, Inc.
AOOA	Administrative Offices & Operations Area
ASTM	American Society for Testing and Materials
AWQSGV	Ambient Water Quality Standards and Guidance Values
BCP	Brownfield Cleanup Program
bls	below land surface
BSA	Buffalo Sewer Authority
BSPA	Babcock Street Properties Area
BTEX	benzene, toluene, ethylbenzene, xylenes
Buckeye	Buckeye Terminals, LLC
CAMP	Community Air Monitoring Plan
CETCO	CETCO Remediation Technologies
CKD	Cement Kiln Dust
CO_2	carbon dioxide
COC	contaminant of concern
CPP	Citizen Participation Plan
CRPA	Central Rail and Process Area
DER	Division of Environmental Remediation
DRO	diesel range organics
EAS	Environmental Analytical Service, Inc.
ECL	Environmental Conservation Law
EDX	energy dispersive x-ray spectroscopy
ERH	Electrical Resistance Heating
ESPA	Elk Street Properties Area
ETYA	Eastern Tank Yard Area
ExxonMobile	ExxonMobil Oil Corporation
FCCR	Final Construction Certification Report
FER	Final Engineering Report
ft	foot/feet
FRA	Former Refinery Area
GCM	grossly contaminated material
GES	Groundwater & Environmental Services, Inc.
GHG	global greenhouse gas
GRO	gasoline range organics
HASP	Health & Safety Plan
HCLKD	high calcium lime kiln dust
HDPE	high density polyethylene
HTTD	high temperature thermal desorption

IRM	Interim Remedial Measure
LEL	lower explosive limit
LKD	lime kiln dust
LPC	lime Portland cement
LWRP	Local Waterfront Revitalization Program
mg/kg	milligrams per kilogram
NAPL	non-aqueous phase liquid
NPSA	Northeast Process and Storage Area
NTYA	North Tank Yard Area
NYCRR	New York Code of Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSDOS	New York State Department of State
O&M	operation and maintenance
O M & M	Operation, Maintenance and Monitoring
One Babcock	One Babcock Street, LLC
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PC-GGBFS	Portland cement – ground granular blast furnace slag
PCB	polychlorinated biphenyl
PC	Portland cement
PCE	tetrachloroethene
P.D. Unit	Pressed Distillate Unit
PEL	permissible exposure limit
PID	photoionization detector
ppe	Personal Protective Equipment
ppm_v	parts per million by volume
psi	per square inch
PVC	Polyvinyl Chloride
RAO	remedial action objective
Remedial Engineering	Remedial Engineering, P.C.
Roux Associates	Roux Associates, Inc.
SB	Soil Boring
SCG	Standards, Criteria and Guidance
SEM	scanning electron microscopy
SFI	Site Facility Investigation
Site	ExxonMobil former Buffalo Terminal
SMP	Site Management Plan
SOCONY	Standard Oil Company of New York
SoMP	Soil Management Plan
SPDES	State Pollution Discharge Elimination System

SPLP	Synthethic Precipitation Leaching Procedure
STYA	Southern Tank Yard Area
SWPPP	Stormwater Pollution Prevention Plan
TAGM HWR	Technical and Administrative Guidance Memorandum - Hazardous Waste Remediation
TCC	Thermofor Catalytic Cracking
TCLP	Toxicity Characteristics Leaching Procedure
TestAmerica	TestAmerica Laboratories
TOGS	Technical Operational Guidance Series
TPH	petroleum hydrocarbons
TSP	Triple Super Phosphate
UCS	Unconfined Compressive Strength
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
WHA	Waste Handling Areas
WPS	Well Point System

CERTIFICATION

I, DANIEL FORLASTRO, certify that I am currently a NYS registered professional engineer and that this Alternatives Analysis Report was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10).

091171	11/11/16	
NYS Professional Engineer #	Date	Signature

1.0 INTRODUCTION

On behalf of ExxonMobil Oil Corporation (ExxonMobil), Amec E&E PC has prepared this Final Alternatives Analysis Report (AAR) for the portion of the ExxonMobil former Buffalo Terminal (Site) designated as Operable Unit 2 (OU-2), located south of Elk Street and north of Prenatt Street. This Final AAR incorporates responses to draft comments provided by the New York State Department of Environmental Conservation (NYSDEC) on the initial AAR dated April 13, 2007 and the Revised AAR dated October 5, 2007, and the results of new field work completed in 2008, 2009, and 2015 as follows:

- Draft NYSDEC comments from a meeting with ExxonMobil and Groundwater & Environmental Services, Inc. (GES) on May 24, 2007 that was held to discuss issues related to the AAR for OU-2 dated April 13, 2007;
- Draft NYSDEC comments on the Revised AAR for OU-2 dated October 5, 2007 emailed to ExxonMobil on December 5, 2007;
- Roux Associates Inc. (Roux Associates) letter response to NYSDEC December 5, 2007 comments regarding the Revised AAR for OU-2 dated February 7, 2008, which included a “Plan for Additional Soil Sampling and Test Pitting for Evaluation of Petroleum Impacted Soil”;
- NYSDEC comments (emailed on April 9, 2008) on the Roux Associates February 7, 2008 letter response;
- “Soil Vapor Sampling Plan” dated April 21, 2008;
- “Plan for Follow-Up Sampling in OU-2 Work Plan” dated May 20, 2008, which includes follow up soil sampling at and around four locations (Soil Boring [SB]-124, SB-107, SB-110 and BSPA 1-2-3/0);
- Roux Associates letter response dated June 16, 2008 to NYSDEC May 28, 2008 draft comments regarding the “Soil Vapor Sampling Plan”;
- Roux Associates letter response dated August 11, 2008 to the NYSDEC/New York State Department of Health (NYSDOH) emailed comments dated July 22, 2008 regarding the “Soil Vapor Sampling Plan” dated April 21, 2008 and associated responses to comments dated June 16, 2008;
- Roux Associates letter entitled “Requested Modification to State Pollution Discharge Elimination System (SPDES) Permit No. NY0204480” dated August 18, 2008;
- “Work Plan for Additional Test Trenches in OU-2 for Identification of Petroleum Impacted Soil” dated September 10, 2008;
- “Soil Vapor Sampling Report” dated January 30, 2009;
- “Work Plan for Additional Investigation for Lead in OU-2” dated March 23, 2009;
- “Work Plan for Bench Scale and Field Pilot Testing in Operable Unit 2” dated March 23, 2009;

- “Lime Kiln Dust Field Pilot Testing Work Plan for OU-2” dated October 7, 2009;
- NYSDEC comments on the Lime Kiln Dust Field Pilot Testing Work Plan for OU-2 dated October 14, 2009 emailed to ExxonMobil on October 16, 2009, with follow-up comments emailed to Roux Associates on October 23, 2009;
- Roux Associates October 16, 2009 and October 23, 2009 email responses to the NYSDEC comments on the Lime Kiln Dust Field Pilot Testing Work Plan for OU-2;
- “Second Round Soil Vapor Sampling Report and Scope of Work for Additional Sampling” dated November 6, 2009;
- NYSDEC comments dated November 19, 2009 on the request for modification of SPDES permit No. NY0204480 dated August 18, 2008;
- Roux Associates response dated January 18, 2010 to NYSDEC letter entitled “Buffalo Terminal SPDES Modification Request” dated November 19, 2009;
- NYSDEC comments dated January 19, 2010 on Roux Associates “Second Round Soil Vapor Sampling Report and Scope of Work for Additional Sampling” dated November 6, 2009;
- NYSDEC comments dated March 9, 2010 on the Roux Associates response to comments dated January 18, 2010 regarding “Buffalo Terminal SPDES Modification Request”;
- Roux Associates response dated April 2, 2010 to NYSDEC letter entitled “Buffalo Terminal SPDES Modification Request” dated November March 9, 2010;
- Roux Associates response dated April 14, 2010 to NYSDEC letter entitled “Soil Vapor Sampling Report” dated January 19, 2010, regarding the “Second Round Soil Vapor Sampling Report and Scope of Work for Additional Sampling” dated November 6, 2009;
- NYSDEC comments dated June 16, 2010 entitled “Soil Vapor Sampling Report” regarding Roux Associates April 14, 2010 response to comments;
- Remedial Engineering/Roux Associates “Design Documents for Stormwater Collection System Project on Buckeye Terminals LLC Property” dated September 24, 2010;
- NYSDEC comment letter entitled “Storm Water Collection System Design” dated January 16, 2011 regarding the “Design Documents for Stormwater Collection System Project on Buckeye Terminals LLC Property” dated September 24, 2010;
- Roux Associates response dated March 11, 2011 to the NYSDEC letter entitled “Storm Water Collection System Design” dated January 16, 2011;
- NYSDEC second comment letter entitled “Storm Water Collection System Design” dated April 5, 2011;
- Roux Associates letter dated April 12, 2011 entitled “Response to Second NYSDEC Comment Letter Dated April 5, 2011” regarding Stormwater Collection System Design;
- NYSDEC third letter entitled “Storm Water Collection System Design” dated April 18, 2011 approving the “Design Documents for Stormwater Collection System Project on

Buckeye Terminals LLC Property" dated September 24, 2010;

- NYSDEC letter entitled "Soil Vapor Sampling" dated June 25, 2012; and
- Roux Associates letter dated July 18, 2012 entitled "Response to NYSDEC Letters Entitled: "Soil Vapor Sampling Report" dated January 19, 2010 "Soil Vapor Sampling Report" dated June 16, 2010 and "Soil Vapor Sampling" dated June 25, 2012".

This Final AAR evaluates remedial alternatives to address soil and groundwater impacts due to former refinery and terminal operations on portions of OU-2. The alternatives evaluated and remedial action selected took into consideration:

- The current zoning of OU-2 as M3, heavy industrial.
- The proposed zoning based on the City of Buffalo's Local Waterfront Revitalization Program (LWRP), of the portion of the Site south of Elk Street, including OU-2, as CM-General Commercial District with a proposed land use of mixed use commercial/light industrial.
- The preferred redevelopment scenario from the Elk Street Corridor Redevelopment Plan, which includes light industrial, back office, commercial, green space and very limited retail use in the vicinity of the Site, and for OU-2 specifically, commercial uses west of the petroleum products storage and distribution terminal (except for limited retail space at the corners of Elk Street and Babcock Street), and light industrial uses on and to the east of the Buckeye terminal.
- The historic use of OU-2 as a petroleum refinery and petroleum distribution terminal.
- The current and reasonably anticipated future use of the property as vacant land with a portion operating as a petroleum products storage and distribution terminal owned and operated by Buckeye Terminals, LLC (Buckeye) and a portion (on the Babcock Street Properties Area [BSPA]) owned and operated by One Babcock Street, LLC (One Babcock) for various industrial purposes.
- Consistency and integration with the anticipated remedial action for OU-3.

The ExxonMobil former Buffalo Terminal and offsite areas currently and formerly owned by ExxonMobil located at 625 Elk Street, Buffalo, New York are shown on **Figure 1**.

In order to address the environmental conditions, ExxonMobil entered into a Brownfield Site Cleanup Agreement with the NYSDEC on April 3, 2006. Under this agreement, the Site entered into New York State's Brownfield Cleanup Program (BCP). The "Site" (BCP Site No. C915201) is defined, for the purposes of the BCP, as the area within the limits of the five Operable Units (OUs) as shown in **Figure 2**. In addition, the Site was divided into nine geographic areas for the purpose of assessing environmental conditions and reporting the results of area-specific activities (**Figure 3**). These geographic areas were designated according to the historical primary operations that occurred in each portion of the Site. As described by the metes and bounds in the Brownfield Site Cleanup Agreement, OU-2 encompasses portions of the former geographic areas designated as the northern portion of the BSPA, the northern portion of the Former Refinery Area (FRA), Northern Tank Yard Area (NTYA), Administrative Offices and Operations Area

(AOOA), Northeast Process and Storage Area (NPSA), and a small northern portion of the Central Rail and Process Area (CRPA).

The portion of the Site south of Elk Street is currently comprised of three operating areas:

1. A petroleum products storage and distribution facility owned and operated by Buckeye;

2. A surrounding non-operating area (formerly part of historic operations) owned by ExxonMobil; and 3) a parcel (BSPA) owned and operated by One Babcock that is used for various industrial purposes. The requirements and recommendations of the NYSDEC guidance document, Draft Brownfield Cleanup Program Guide (May 2004), were incorporated into this Final AAR in addition to the requirements and recommendations of the NYSDEC "DER-10 Technical Guidance for Site Investigation and Remediation (DER-10)", dated May 2010. It is ExxonMobil's intention to conduct the remediation of OU-2 in accordance with the Draft BCP Guide, DER-10, and Title 6 of the New York Code of Rule and Regulations (6 NYCRR) Part 375 (Part 375) dated December 14, 2006.

The Final AAR has been prepared in accordance with Section 4.8 of the Draft BCP Guide and Section 4.3[c] of DER-10.

The remainder of this Final AAR is organized as follows:

- Section 2.0 provides a summary of the history of OU-2, including ownership, current zoning, current and future land use, past and present operations (i.e., buildings, tanks, etc.), and spills or releases;
- Section 3.0 provides a summary of environmental conditions based upon the results of all investigations completed in OU-2;
- Section 4.0 describes interim remedial measures;
- Section 5.0 identifies remedial goals and remedial action objectives;
- Section 6.0 describes the alternative analysis and remedy selection process;
- Section 7.0 describes the recommended remedy;
- Section 8.0 describes the remedial action work plan and design documents;
- Section 9.0 describes the Final Construction Certification Report and Site Management Plan;
- Section 10.0 describes operation, maintenance and monitoring;
- Section 11.0 describes institutional and engineering controls;
- Section 12.0 describes the citizen participation plan (CPP); and
- Section 13.0 describes the project schedule.

2.0 SITE SETTING AND HISTORY

The historical information presented in this section was obtained from the document entitled "History of Operations at Buffalo Terminal" dated April 26, 2000.

The Site refinery and terminal operations occurred south of Elk Street in an area of approximately 89 acres. The petroleum refining operations at the Site began in 1880. The majority of the Site was purchased by Standard Oil Company of New York (SOCONY), ExxonMobil's predecessor, in 1892. Throughout the Site's history, the areal extent of property owned by ExxonMobil changed as portions of the property were acquired or sold for various reasons. In May 1981, the Site terminated all refinery operations. The Site continued as an ExxonMobil distribution terminal, receiving product via a pipeline and barge until May 2005. In 1995, the BSPA was sold to One Babcock. The active petroleum products storage and distribution terminal portion of the Site was sold on May 4, 2005 and is now owned and operated by Buckeye. The area of Buckeye's active terminal is approximately 35.8 acres. The area within the current ExxonMobil property boundary is approximately 43.6 acres.

2.1 General History of the OU-2

The portions of six geographic areas associated with OU-2 (BSPA, FRA, NTYA, AOOA, NPSA, and CRPA) are located south of Elk Street and north of Prenatt Street and encompass approximately 39.1 acres. The following is a description of these areas, including former and current structures, waste handling areas (if applicable), and spills/releases records (if applicable).

2.1.1 BSPA within OU-2

In total, the BSPA encompasses approximately 11.1 acres. The BSPA area within OU-2 encompasses approximately 4.3 acres. The northern portion of the BSPA is bounded by Elk Street to the north, Babcock Street to the east, Prenatt Street to the south, and Orlando Street to the west. The entire BSPA and associated structures were sold to One Babcock in 1994.

2.1.1.1 Former and Current Structures in the BSPA within OU-2

Following the purchase of various sections of the BSPA by SOCONY, the northern portion remained primarily vacant. The residential structures were removed. **Table 1** provides information regarding storage tanks that were previously located in this area. Two storage tanks, Tank Nos. 83 and 84, and two pipe tunnels to the FRA were constructed between 1939 and 1951.

Lakes Division Garage. The Lakes Division Garage was constructed on the northwest corner of Prenatt Street and Babcock Street between 1939 and 1951. The structure measures approximately 245 feet by 100 feet. The structure currently exists and is owned and occupied by One Babcock and their tenants.

2.1.1.2 Waste Handling Areas in the BSPA within OU-2

No Waste Handling Areas (WHAs) were identified in the BSPA.

2.1.1.3 Spills/Releases in the BSPA within OU-2

One release was documented in the northern portion of the BSPA within OU-2. Historical evidence supporting the occurrence of the following release in this area is based on the knowledge of current and/or former ExxonMobil employees (**Table 2**).

- The seals on the pumps located south of Tank 82 (in the FRA immediately adjacent to the BSPA) would reportedly leak due to handling the heavy, heated petroleum products. When the seals would leak, the heavy product would drain to the ground surface. The quantities of product released and the timeframe during which these incidents occurred are not known.

2.1.2 FRA within OU-2

The FRA was owned by various entities in the late 1800s. The northern portion of the FRA was sold to Atlas Refining Company in 1888 by Buffalo Lubricating Oil Company, Ltd. The parcel of land to the east was sold to Atlas Refinery Company from Solar Oil Company in 1885. These parcels were purchased on June 16, 1892 by SOCONY from the Atlas Refining Company. The entire FRA currently encompasses 15.3 acres. The FRA area within OU-2 encompasses approximately 10.3 acres.

2.1.2.1 Former and Current Structures in the FRA within OU-2

Within the FRA was a brick roadway that ran in a north to south direction and bridged Elk Street and Prenatt Street. Additionally, three major railroad tracks originating from Prenatt Street branched towards the north. These tracks were utilized to deliver supplies to the structures within the FRA for refinery operations. Based on the available information, prior to 1917 and through 1981, the FRA had been the primary location for the petroleum refining processes at the Site. Between 1917 and 1924, many of the refinery-associated structures on the east side of the brick roadway were removed and replaced with an electrical substation and storage tanks. The operations at the remaining portions of the FRA generally remained the same with some additions and modifications as refinery processes changed and evolved through the years. The refinery structures north of Prenatt Street were demolished between 1988 and 1991. **Table 1** provides information regarding storage tanks that were previously located in this area. The following former structures within OU-2 are summarized in chronological order according to their construction date in the FRA.

- **The Star Oil Barns and Office.** The Star Oil structure was constructed prior to 1917 on the corner of Elk Street and Babcock Street. This structure measured approximately 110 feet by 60 feet and was used as a barn for the horse drawn bulk oil delivery wagons and an office for administrative purposes. The Star Oil structure was removed between the years 1924 and 1939.

- **Warehouses No. 1-3.** According to a 1917 map, three warehouses existed south of the Star Oil Barns and Office. Warehouse No. 1 was a four-story structure and approximately 205 feet by 60 feet in size. A rail platform approximately 215 feet by 10 feet ran along the eastern wall of Warehouse No. 1. Rail tracks ran in a north to south direction adjacent to Warehouse No. 1 and terminated at the northeast corner of the warehouse. According to the 1939 map, Warehouse No. 1 was occupied by Star Oil Company, and according to the 1955 map, the Lakes Division occupied Warehouse No. 1. Warehouse No. 1 was demolished in 1989. Warehouse No. 2 was adjoined to the south wall of Warehouse No. 1. This warehouse was approximately 102 feet by 42 feet in size. Warehouse No. 3, adjoined to the south wall of Warehouse No. 2, was approximately 95 feet by 42 feet. Associated with Warehouse No. 3 was a 70-foot by 8-foot rail platform, which was removed between 1917 and 1924. Within the warehouses, asphalt was packaged into two-pound containers. Warehouse Nos. 2 and 3 were removed between the years 1924 and 1939 and replaced with Tanks 81 and 82.
- **Watchman's House.** This structure was constructed prior to 1917 and was used as a security watchman's station. The Watchman's House was approximately 10 feet by 5 feet in size and located along the northern border of the Site on Elk Street between the Star Oil Barns and Office and the Main Office of the Atlas Works. The structure was removed between the years 1917 and 1924.
- **Main Office of Atlas Works.** The Main Office of Atlas Works was constructed prior to 1917 and was approximately 78 feet by 45 feet in size. The structure was located on Elk Street, along the northern border of the Site, and was used for administrative operations for the Atlas Works Refinery. The Main Office was removed between the years 1958 and 1966.
- **Garages.** According to a 1917 map, adjacent to the east side of the Main Office of Atlas Works, was a structure consisting of two garages. The garages each measured approximately 19 feet by 17 feet in size and were removed between the years 1958 and 1966.
- **Barns.** The barns were constructed prior to 1917 and were located south of the garages in the northern portion of the FRA. The barns were used to house the horse drawn bulk oil delivery wagons. The structure was approximately 42 feet by 42 feet and was removed between the years 1917 and 1924.
- **Fan Houses.** Three fan houses were located adjacent to the Tower Stills and Coal Sheds. The Fan House located in the northeast corner of the FRA was constructed prior to 1917 and measured approximately 20 feet by 20 feet. According to the 1939 map, the structure was used as a fire truck garage/hose house. The 1951 map indicates that the structure was used as a medical department. The fan house was demolished in between 1955 and 1966. Two additional fan houses, each measuring 25 feet by 20 feet, were located adjacent to the west of the Tower Stills and Coal Sheds. These fan houses were built prior to 1917 and demolished between 1924 and 1939.
- **Watchman's House at Gate No. 5.** A watchman's house was constructed prior to 1917

on the northeast corner of the FRA at Gate No. 5. The structure measured approximately 10 feet by 5 feet and was used as a security station for the brick roadway that connected Elk Street to Prenatt Street. The Watchman's House was demolished between 1917 and 1924.

- **Sheds.** According to a 1917 map, three sheds existed in the FRA. Shed No. 1 was located in the central portion of the FRA, adjacent to Tank No. 29. This shed measured approximately 50 feet by 20 feet in size. Shed No. 1 was removed between 1917 and 1924. Shed No. 2 was located between the Star Oil Barns and Office structure and the Main Office of the Atlas Works Refinery Company and measured approximately 63 feet by 22 feet. Shed No. 2 was demolished between 1924 and 1939 and replaced by loading racks. Shed No. 3, located approximately 50 feet south of Shed No. 2, measured approximately 57 feet by 48 feet, and was removed between the years 1917 and 1924.
- **Pressure Stills/Coal Shed.** Adjacent on the west side of the brick roadway within the FRA were 15 pressure stills. The pressure stills were constructed prior to 1917 on brick structures. They were aligned directly adjacent to each other and in total measured approximately 185 feet by 42 feet. Adjoined to the east side of the pressure stills was a 185 feet by 12 feet coal shed used to supply coal to the pressure stills. By 1924, nine of the fifteen pressure stills were removed. The six remaining pressure stills were removed between 1924 and 1939.
- **Condensers.** A 1917 map indicates that approximately 15 condensers were located adjacent to the west of the Pressure Stills and Coal Shed. The condensers were utilized for the refining operations in the FRA as heat transfer units to condense vapor by removing heat from hot liquid product by utilizing a cooler medium. Two of these condensers were removed between 1917 and 1924. The remaining 13 condensers were removed between 1924 and 1939.
- **Tower Stills and Coal Sheds.** South of the Pressure Stills and Coal Shed, a structure consisting of seven coal sheds and twelve tower stills was constructed prior to 1917. This structure measured approximately 380 feet by 50 feet. Each coal shed had a rail spur connecting it to the rail track that ran in a north to south direction adjacent to the brick roadway. The coal sheds stored coal to support the tower stills operations. Ten tower stills and all seven coal sheds were removed between the years 1924 and 1939 and were replaced by the Houdry Unit. The two remaining tower stills were removed between 1939 and 1951.
- **Receiving Houses.** Based on the 1917 map, two receiving houses were located in the northern portion of the FRA, between the condensers and storage tanks. One of the receiving houses was located adjacent to the Star Oil Company filling tanks and measured approximately 80 feet by 12 feet. The second receiving house was located adjacent to the east of the Storage Tanks 173 and 175 and measured 63 feet by 20 feet. Both receiving houses were removed between 1924 and 1939.
- **Tar Cooler.** The tar cooler was constructed prior to 1917 and was located between the storage tanks and receiving house in the northern portion of the FRA. The cooler measured 27 feet by 22 feet and was used as a heat exchanger through which

hot liquid product was passed to lower its temperature. Between 1924 and 1939, the tar cooler was removed.

- **Watchman's House at Gate No. 7.** Gate No. 7 was on Babcock Street, south of the former location of Warehouse No. 3. The Watchman's House, constructed prior to 1917, was approximately 14 feet by 12 feet in size and served as the security watchman's station. The Watchman's House was removed between 1917 and 1924.
- **Hose House.** The Hose House was constructed prior to 1917 and was located approximately 110 feet north of Prenatt Street and adjacent to Tank No. 79. The Hose House was 22 feet by 8 feet in size and demolished between 1924 and 1939.
- **WC Structure.** This structure, constructed prior to 1917, was located adjacent to the east of the Hose House. The WC Building was approximately 25 feet by 10 feet. The specific use of this building could not be determined from the available information. The WC Structure was removed between 1917 and 1924.
- **Pipe Shop/Experimental Stills.** The Pipe Shop was located on the north side of Prenatt Street. The Pipe Shop was approximately 75 feet by 30 feet. Attached to the Pipe Shop were experimental stills, which were approximately 20 feet by 30 feet in size. According to the 1939 map, this structure was used as a wash room. The 1951 map indicates that the structure was used as a laboratory. The structure was later removed between 1958 and 1966. Adjacent to the east of the structure was Transformer No. 99. Located to the south of the Pipe Shop was a truck scale. The truck scale was constructed between 1939 and 1951 and was removed between 1977 and 1987.
- **Laboratory.** Constructed prior to 1917, the laboratory was situated on the northwest corner of the brick roadway and Prenatt Street. The structure measured 40 feet by 32 feet. The laboratory was demolished between the years 1958 and 1966.
- **Watchman/Clock House.** This 18-foot by 12-foot structure was constructed prior to 1917 and was located on the northeast corner of the FRA along Elk Street and a brick roadway connecting Elk Street to Prenatt Street. According to the 1924, 1939, and 1951 maps, this structure was used as a watchman or clock house. However, according to the 1940 Sanborn™ map, this structure was used as a hose house. The structure was replaced between 1940 and 1955 by Sub-Station "C." A 335-foot by 75-foot parking lot was constructed adjacent to the structure between 1924 and 1939.
- **Coal Shed and Reducing Stills.** The Coal Shed was constructed prior to 1917 and was approximately 45 feet by 15 feet in size. The Coal Shed stored coal used to power the refining processes occurring in the FRA. Affixed to the Coal Shed were two Reducing Stills, each measuring 34 feet by 18 feet. The Coal Shed and Reducing Stills structures were removed between the years 1917 and 1924.
- **Coal Sheds and Tar Stills.** A structure consisting of six tar stills and four coal sheds was located on the eastern side of the brick roadway. The structure was constructed prior to 1917. The structure was comprised of three sets of coal sheds adjoined by two tar stills. Each of the tar stills measured approximately 22 feet by 17 feet. The coal sheds varied in size and were used to store coal utilized to power the tar stills and

other refinery operations. The coal sheds and tar stills were removed between 1917 and 1924.

- **Condensers/Receiving House.** The Condensers/Receiving House structure was constructed prior to 1917 on the eastern side of the brick roadway in the FRA. The Receiving House was situated between the two condensers. The total structure measured 70 feet by 20 feet in size. Between 1917 and 1924, the Condensers/Receiving House structure was removed. Approximately 30 feet south of this structure was an additional condenser. This condenser measured approximately 30 feet by 20 feet and was constructed prior to 1917. The condenser was removed between 1917 and 1924.
- **Cooler.** A cooler was formerly located adjacent to the east side of the Condensers/Receiving House. The cooler, approximately 22 feet by 8 feet, was situated at this location prior to 1917 and was later removed between the years 1917 and 1924.
- **Pump House.** The Pump House was constructed prior to 1917 and located adjacent to the Condensers/Receiving House and storage tanks. The Pump House was removed between 1917 and 1924.
- **Coal Shed/Crude Oil Sheds/Condenser Structure.** This structure, constructed prior to 1917, was comprised of multiple units including coal sheds, crude oil compartments, condensers, a fan house, W.C. house, coolers, receiving houses, an economizer, an engine house, and five stacks. The primary coal shed unit, measuring approximately 180 feet by 40 feet, was adjoined by nine crude oil compartments (each approximately 32 feet by 22 feet), a fan house (25 feet by 22 feet), a W.C. house (approximately 22 feet by 17 feet), a 600-foot stack, and a 60-foot stack. To the south was a 185-foot by 25-foot structure utilized for housing condensers. Adjoined to this condenser structure were two 40-foot stacks, an additional condenser (approximately 22 feet by 8 feet), and a structure (15 feet by 15 feet) whose use could not be determined from the available documentation. Adjacent to the east of the condenser unit was a cooler (25 feet by 10 feet) and a receiving house (approximately 46 feet by 22 feet). South of the condenser unit were four crude oil compartments (approximately 25 feet by 16 feet each) adjoined by a coal shed (64 feet by 26 feet). Adjacent to the east of this coal shed and crude oil compartments was an economizer (approximately 60 feet by 12 feet) and a water purifier (approximately 35 feet by 26 feet). South of the economizer was an engine house, measuring approximately 30 feet by 15 feet in size, and a 200-foot stack. The majority of these units were removed between 1917 and 1924. According to the 1924 map, the economizer, the 200-feet stack, and the 22-feet by 8-feet condenser were the only remaining units. These units were subsequently removed between 1924 and 1939.
- **Steam Still Condensers/Receiving House.** Constructed prior to 1917, this structure was located on the north side of Prenatt Street in the central portion of the FRA. The Steam Still Condensers/Receiving House structure measured 185 feet by 25 feet and consisted of a receiving house centered between two steam still condenser units. Adjacent to the west were five steam stills varying in size. One steam still condenser

and the Receiving House were removed between 1917 and 1924. The remaining steam still condenser and five adjacent steam stills were removed between 1924 and 1939.

- **Refinery Office.** The Refinery Office served as the main administrative office for the FRA. The office was located on the northeast corner of the brick roadway and Prenatt Street. The structure measured 34 feet by 30 feet and was adjoined by a 17-foot by 14-foot auxiliary structure. The office was constructed prior to 1917 and was demolished prior to 1924. The Refinery Office was replaced by Hose House No. 85.
- **Building No. 85.** This 18-feet by 10-feet brick structure was constructed between 1917 and 1924 and was located north of the Pipe Shop/Experimental Stills structure. The structure was demolished between 1924 and 1939. The use of this structure could not be determined from the available information.
- **Pipe Still/Condenser Unit.** The Pipe Still/Condenser Unit replaced the Pressure Stills and Coal Shed between the years 1924 and 1939. This unit consisted of two pipe still units, two condensers, and three stacks. Stack No. 5, a 150-foot stack, was constructed between 1917 and 1924. Between 1939 and 1951, a pump house was constructed adjacent to the Pipe Still/Condenser Unit. The pump house measured 23 feet by 23 feet and was demolished between 1951 and 1955. The Pipe Still/Condenser Unit was also demolished between 1951 and 1955.
- **Building No. 35.** This structure, approximately 150 feet by 18 feet, was constructed between 1924 and 1939. The structure was located in the eastern portion of the FRA and adjacent to the south of the Watchman/Clock House. The specific use of this structure could not be determined from the available information. Building No. 35 was removed between 1951 and 1955.
- **Houdry Unit.** The Houdry Unit was constructed in 1939 at the former location of the Tower Stills and the Coal Sheds. This unit consisted of two steel framed structures that housed suspended tanks, towers and exchangers, an evaporator heater, a tar cooler box, a pump house, a control house, a heater control house, and two furnaces. Catalytic cracking processes were performed in the Houdry Unit in which heavy hydrocarbon stock (crude oil) was converted into lighter products. This process not only increased the quantity of gasoline but also increased the quality and octane rating of the gasoline. By 1950, an additional furnace was installed and the tar cooler box was removed from the Houdry Unit. The remainder of the Houdry Unit was removed between 1990 and 1995.
- **Salt Heater/Electric Substation "B"/Vacuum Still.** These three units replaced the Coal Shed/Crude Oil Sheds/Condenser Structure and steam stills between 1924 and 1939. The salt heater (approximately 151 feet by 7 feet), the Electric Substation "B" (approximately 53 feet by 13 feet), and the vacuum still (approximately 34 feet by 19 feet) were each associated with the refining processes performed in this area. The salt heater was removed in 1951. Substation "B" and the vacuum still were removed between 1951 and 1955.
- **Hose House No. 85.** The Hose House was constructed between 1924 and 1939 at the former location of the Refinery Office. The Hose House measured approximately 19

feet by 15 feet in size and was removed in between 1951 and 1955.

- **Lab Sample Storage Structure.** This structure, approximately 15 feet by 11 feet, was located north of Hose House No. 85 and adjacent to the east of the Laboratory. The Lab Sample Storage Structure was constructed between 1924 and 1939 and removed between 1977 and 1986.
- **Thermofor Catalytic Cracking (TCC) Area.** The TCC Area was constructed between 1939 and 1951 in the former location of the Pressure Stills and Coal Shed, between the Pipe Still/Condenser Unit and the Houdry Unit. This area was used for conversion of heavier petroleum hydrocarbons into lighter products such as kerosene, gasoline, liquefied petroleum gasoline, and heating oil. Typical units that comprise a TCC Unit include a catalytic reactor bed, a fractionating tower, and a carbon-monoxide boiler. The TCC Area measured approximately 105 feet by 50 feet. According to a 1955 map, a TCC heater and a W.H. boiler had been installed to the north of the TCC Unit. The TCC Unit and associated structures were removed between 1989 and 1995.
- **Catalytic Polymerization Area.** The Catalytic Polymerization Area was added to the FRA between 1939 and 1951. This area was located to the west of the Houdry Unit and housed processes in which light olefin gases were converted into higher-octane products to be used for gasoline blending. Typical units that comprise the polymerization process are a polymerization reactor, a stabilizer/fractionator system, and feed drums. The Catalytic Polymerization Area was removed between 1990 and 1995.
- **Compressor House.** A compressor house was constructed adjacent to the west of the Houdry Unit and north of the Catalytic Polymerization Area between the years 1939 and 1951. This structure measured approximately 105 feet by 30 feet and was removed between 1990 and 1995.
- **Cooling Tower.** A cooling tower was added to the FRA at the former location of the Coal Shed/Crude Oil Sheds/Condenser Structure between 1939 and 1951. The cooling tower was removed between 1951 and 1955.

Rail Loading Racks. A rail loading rack was constructed between 1939 and 1951 on the eastern side of the brick roadway in the FRA. The loading rack was located along rail tracks that branched from Prenatt Street towards the north and parallel to the brick roadway. The loading rack measured approximately 12 feet by 8 feet and was removed between 1951 and 1977. Two additional rail loading racks were constructed between 1939 and 1951 adjacent to Building No. 35 (Item 76). Each loading rack measured approximately 12 feet by 8 feet and was removed between 1951 and 1977.

- **Control House.** A control house was constructed to the northwest of the TCC Unit. The structure, approximately 60 feet by 45 feet, was constructed between 1951 and 1955. The control house was demolished between 1990 and 1995.
- **Gas Compressor/Exchanger Structure.** This structure was located adjacent to the west side of the TCC unit. The structure measured approximately 70 feet by 45 feet and was constructed between the years 1951 and 1955. The exact use of the

compressors and exchangers stored in this structure could not be determined. The structure was removed between 1977 and 1986.

- **Electric Substation "E".** This electric substation replaced Electric Substation "B" when the Sovaformer Area was constructed in 1956. The substation measured approximately 84 feet by 24 feet and was used to supply the FRA and neighboring areas with electricity to support refinery operations. Electric Substation "E" was removed between 1977 and 1986.
- **Tar Box.** A tar box, constructed between 1951 and 1955, was located north of Substation "E" and measured approximately 24 feet by 24 feet. The tar box was utilized to cool the rundown from the crude unit prior to storage in Tank 60. The structure was removed between 1977 and 1986.
- **Sovaformer Area.** This area was located in the former location of the Steam Stills Condensers/Receiving House. The Sovaformer unit became operational in 1956 and consisted of a control building (45 feet by 30 feet), a heater building (58 feet by 55 feet), four towers (approximately 110 feet in height), and storage tanks. The Sovaformer unit utilized three reactors containing platinum catalysts to convert low-octane paraffin hydrocarbons into high-octane aromatic hydrocarbons. This process allowed for the production of 100-octane gasoline. The Sovaformer unit was removed between 1990 and 1995.

2.1.2.2 Waste Handling Areas in the FRA within OU-2

The two WHAs (Main In-Ground Oil/Water Separator and the Dissolved Air Flotation Unit) in the FRA are not located within OU-2; therefore they will not be discussed in this Final AAR.

2.1.2.3 Spills/Releases in the FRA within OU-2

A list of spills/releases that occurred in the FRA within OU-2 is presented in **Table 2**. One significant spill is described below. Historical evidence supporting the occurrence of the release in this area exists in the form of knowledge from current and/or former ExxonMobil employees.

The following spill description is based on knowledge of current and/or former ExxonMobil employees.

- The seals on the pumps located south of Tank 82 would reportedly leak due to handling the heavy heated products. When the seals would leak, the heavy product would drain to the ground surface. The quantities of product released and the timeframe during which these incidents occurred are not known.

2.1.3 NTYA within OU-2

The Atlas Refining Company had purchased the NTYA from Peter Schermerhorn on December 22, 1882. The NTYA was acquired by the SOCONY from the Atlas Refining Company on June 16, 1892. The entire NTYA is located within OU-2 and encompasses approximately 9.2 acres in the northern section of the Site. The following sections discuss the former and current structures, WHAs located in the NYTA, and spills or product releases that have occurred in this area.

2.1.3.1 Former and Current Structures in the NTYA within OU-2

According to a 1917 map, the structures within this area were either associated with the paraffin and wax refinery operations in the NPSA or with the refining processes in the FRA. From 1917 to 1995, this area was primarily maintained as a tank yard, consisting of various sizes of storage tanks. **Table 1** provides information regarding storage tanks that were previously located in this area. The following structures were located in the NTYA and are itemized in chronological order according to its construction date.

- **Hose House.** The Hose House first appears on a 1917 map and was located near the northern border of the Site, adjacent to Elk Street. The structure was approximately 18 feet by 10 feet in size and was removed between the years 1924 and 1939.
- **Condensers/Receiving House.** This 47-foot by 18-foot structure, constructed prior to 1917, consisted of condensers and a Receiving House. The condenser structure measured approximately 30 feet by 18 feet. The Receiving House measured approximately 17 feet by 18 feet. Both the condensers and Receiving House were associated with the refining processes performed in the NTYA and FRA. This structure was demolished between 1917 and 1924.
- **Cooler.** This cooler was constructed prior to 1917 and located south of the Condenser/Receiving House. The cooler measured approximately 21 feet by 10 feet in size and acted as a heat exchanger to lower the temperature of the hot petroleum product refined in this area and the FRA. The cooler was removed between the years 1917 and 1924.
- **Blanket Room/Pipe Shop/Electrical Shop.** This structure, constructed prior to 1917 in the central portion of the NTYA, consisted of five adjoining structures including the Blanket Room, the Pipe Shop, the Electrical Shop, the Laboratory, and a cooler. The Blanket Room was “L-shaped” with major dimensions of 50 feet by 30 feet. The Pipe Shop was located south of the Blanket Room and Electrical Shop and measured approximately 42 feet by 36 feet. The Electrical Shop, located west of the Blanket Room, was approximately 26 feet by 14 feet. The Laboratory, in the northwest corner of the structure, measured approximately 15 feet by 14 feet. The cooler measured 20 feet by 10 feet in size. The structure was removed between the years 1917 and 1924. Approximately 5 feet to the west was a 22-foot by 12-foot hose house. This hose house was also removed between 1917 and 1924.
- **Bleachers Structure.** The Bleachers structure, measuring approximately 63 feet by 45 feet, housed two bleaching tanks (Tanks 76 and 77). This structure first appears on a 1917 map. The structure and the tanks were removed between the years 1917 and 1924.
- **In-Ground Oil/Water Separator (Yard Trap).** This collection trap was located in the

eastern portion of the NTYA and measured approximately 40 feet by 22 feet. The trap was constructed prior to 1917 and was used for the separation of petroleum from aqueous waste streams and stormwater. Between 1924 and 1939, Tanks 21 and 22 were constructed on either side of the trap. According to a 1955 map, the pipelines leading to the collection trap are storm sewers indicating that the collection trap was used for the collection of stormwater from the neighboring tank yards. The trap does not appear on a 1990 map. During implementation of a Site-wide sewer investigation, the corners of the concrete walls of this structure were located. No further investigation of this structure was performed. This structure was removed during pipe removal activities.

- **Pulp Oil Building.** The Pulp Oil Building was constructed prior to 1917. This structure measured approximately 118 feet by 78 feet and was located in the eastern portion of the NTYA. The Pulp Oil Building had two platforms, one along the northern wall (130 feet by 12 feet) and one along the eastern wall of the building (90 feet by 12 feet). The specific use of the Pulp Oil Building could not be determined from the available information. The Pulp Oil Building was demolished between the years 1917 and 1924.
- **Cripple Shed.** The Cripple Shed was an ironclad structure measuring approximately 125 feet by 30 feet in size. The structure was constructed prior to 1917 and was located in the eastern portion of the NTYA, south of the Pulp Oil Building. Rail tracks, which ran generally from east to west along Prenatt Street, branched northeast into the NPSA and into the Cripple Shed. The Cripple Shed was removed between the years 1917 and 1924.
- **Union Tank Line Storehouse and Bull Room.** The Union Tank Line (U.T.L) Storehouse and Bull Room was constructed prior to 1917 and measured approximately 115 feet by 45 feet. The structure was located in the eastern portion of the NTYA and south of the Pulp Oil Building. This structure was associated with the railcar construction and repair operations. The structure was demolished between the years 1917 and 1924.
- **Pump House No. 47.** Pump House No. 47 was constructed between 1924 and 1939 and located adjacent to Tank 184 on the southern boundary of the NTYA. The structure measured 17 feet by 15 feet in size and was removed between 1951 and 1958.
- **Paint Shed.** The Paint Shed was located adjacent and to the east of Tank 19 in the NTYA. The Paint Shed measured 21 feet by 15 feet and was constructed between 1939 and 1951. The structure was utilized for storing paint and was associated with the Wheel Shop/Blacksmith Shop/Machine Shop. The Paint Shed was removed between 1951 and 1955.
- **Sub-Station “C”.** This structure was “T-shaped” with major dimensions of 45 feet by 25 feet. Sub-Station “C” replaced the Watchman House between the years 1951 and 1955. This structure was demolished in accordance with applicable regulations in 2007.

2.1.3.2 Waste Handling Areas in the NTYA within OU-2

According to company records, any tank that was used to store leaded gasoline was cleaned out by spreading the tank bottoms in the tank yard. Consequently, the tank yards surrounding Tanks 21 and 187 were classified as WHAs and have been designated as WHA-4. The tank yards were surrounded by dikes and drained to the Main In-Ground Oil/Water Separator. The storage of leaded gasoline at the Site occurred between 1952 and 1989.

2.1.3.3 Spills/Releases in the NTYA within OU-2

One significant spill was documented to have occurred in this area (**Table 2**). The documentation for this spill is in the form of information provided by current and/or former ExxonMobil employees, photographs taken at the time and a NYSDEC Spill Report Form for Spill No. 9314016 dated February 1, 1994.

- The NYSDEC Spill Report Form was filed after the incident occurred and refers to the incident as the "Old Spill at Elk Street." The product release occurred on March 12, 1976. The roof of Tank 60 ruptured when hot cracking stock for the TCC unit entered the tank from the crude unit. The hot product contacted ice in the bottom of the tank, causing it to expand, increase the pressure within the tank, and damage the roof. The cracking stock spilled onto Elk Street and Parcels No. 4 and No. 5 in OU-1 (Elk Street Properties Area [ESPA]). At that time, Parcels No. 4 and No. 5 were vacant or occupied by residential and/or light commercial structures. The structures present were affected by the release. ExxonMobil cleaned up the cracking stock by vacuuming off excess product and then mixing the remaining material with sand, excavating the material and disposing it offsite. Subsequently, ExxonMobil purchased Parcels No. 4 and No. 5 of the OU-1 (ESPA) and demolished the structures present. Property and structures located to the north of Parcel No. 5 were not believed to be impacted by the release and, therefore, were not purchased by ExxonMobil. Soil sampling was not conducted as part of the demolition effort.

2.1.4 AOOA within OU-2

The AOOA is centered between the NPSA, the NTYA, the CRPA, and the Southern Tank Yard Area (STYA). The entire AOOA is located within OU-2 and encompasses approximately 3.7 acres.

Similar to the NPSA, the western portion of the AOOA was purchased by Atlas Refining Company from Peter Schermerhorn on December 22, 1882. Atlas Refining Company purchased the eastern portion of the AOOA from the National Transit Company on July 31, 1890. Subsequently, SOCONY purchased these two parcels from Atlas Refining Company on June 16, 1892.

2.1.4.1 Former and Current Structures in the AOOA within OU-2

Historically, the AOOA has housed structures related to railcar construction and repair, mechanical shops, and a laboratory. Prior to 1917, the structures located in the AOOA consisted primarily of railcar construction and repair shops and storage houses. After 1951, these structures were converted for usage as mechanical shops, storage houses, and boiler rooms. These structures were replaced with a mechanical shop, a storage house, and a laboratory between 1951 and 1955. These structures currently exist at the Site. Additionally, roadways were paved through the area. **Table 1** provides information regarding storage tanks that were previously located in this area. The following list of structures describes in further detail the types of structures located within the AOOA. The structures are listed in chronological order according to its construction date.

- **Coal Shed.** The Coal Shed was located adjacent to the southwest of the Car Repair Shop. The 43-foot by 15-foot shed was constructed prior to 1917 and stored coal used to power various operations. The Coal Shed was demolished between 1917 and 1924.
- **Wheel Shop/Blacksmith Shop/Machine Shop.** This structure was constructed prior to 1917 in the northern portion of the AOOA. The Wheel Shop measured approximately 48 feet by 55 feet. The Blacksmith Shop, adjoined to the east wall of the Wheel Shop, measured approximately 95 feet by 55 feet. The Machine Shop was adjoined to the east wall of the Blacksmith Shop and measured approximately 80 feet by 55 feet. Each of these units was associated with the railcar construction and repair processes that were performed in this area and the NPSA. After railcar construction operations ceased at the Site between 1924 and 1939, the Wheel Shop became the Electrical Shop. This structure was removed between 1951 and 1955.
- **Iron Rack.** An iron rack was located north of the Wheel Shop/Blacksmith Shop/Machine Shop structure. The rack, constructed prior to 1917, measured approximately 25 feet by 18 feet and was associated with the car construction and repair operations. The iron rack was removed between 1917 and 1924.
- **Car Shop.** The Car Shop, constructed prior to 1917, was a brick 203 foot by 102 foot building located to the south of the Wheel Shop/Blacksmith Shop/Machine Shop structure. The Car Shop was the prime location of railcar construction operations. Following the termination of railcar construction at the Site, this structure became the Boiler/Mechanical Shop. This structure was removed between 1951 and 1955.
- **Furnace Room/Sub-Station A.** The Furnace Room, constructed prior to 1917, was located adjacent to the west side of the Car Shop. This structure was a brick structure and measured 32 feet by 24 feet. During the period of time that the AOOA housed railcar construction and repair structures, the Furnace Room was used in conjunction with these processes. The structure was later changed to Electrical Sub-Station A. This structure currently exists at the Site.
- **Car Repair Shop/Steel Shed.** The Car Repair Shop was constructed prior to 1917 and located in the southwest corner of the AOOA. A railroad track that ran along Prenatt Street terminated at the structure. Located on the northeast corner of the Car Repair Shed was the Steel Shed. This structure measured approximately 40 feet by 52 feet in size and was used for storage. These two structures were removed between 1917 and 1924.

- **Car Shop Storehouse and Offices.** This structure was comprised of the Car Shop Storehouse (105 feet by 42 feet), an Engine Room and Boiler House (64 feet by 55 feet), and offices (approximately 42 feet by 42 feet). The structure was constructed prior to 1917 and was located south of the Car Shop. Adjacent and to the east of the Engine Room and Boiler House were a water heater and a 50-foot stack. Between 1917 and 1924, the Engine and Boiler Room, water heater and stack were removed from the structure and the remainder of the structure was utilized as a storehouse. The Car Shop Storehouse was demolished between 1951 and 1955.
- **Boiler House/Fire Foam House.** The Boiler House/Fire Foam House structure was constructed between 1917 and 1924 at the former location of the Car Repair Shop/Steel Shed. The Boiler House was approximately 200 feet by 52 feet in size with an adjoining 20-foot by 26-foot brick structure on the western wall. The Fire Foam House was a 63-foot by 33-foot structure adjoined to the northern wall of the Boiler House. Adjacent to the north wall of the Boiler House were three storage tanks (Tanks 9, 352, and 353) and a 250-foot stack. The structure was demolished between 1951 and 1955.
- **Laboratory Building.** The Laboratory building was constructed between 1951 and 1955 in the northern portion of the AOOA. The structure measures approximately 50 feet by 60 feet. The Laboratory building currently exists at the Site, but is no longer in active use.
- **Boiler House.** This Boiler House was constructed between 1951 and 1955 at the former location of the Boiler House/Fire Foam House. The structure was approximately 120 feet by 60 feet in size and was demolished between 1986 and 1990.
- **Mechanical Shop.** This structure was constructed between 1951 and 1955 at the former location of the Car Shop and the Wheel Shop/Blacksmith Shop/Machine Shop. The Mechanical Shop measured approximately 180 feet by 100 feet and contained a garage for repairs and offices. The Mechanical Shop currently exists at the Site and is used as the Main Office.
- **Store House.** The Store House was constructed between 1951 and 1955 adjacent and to the east of the Mechanical Shop. The structure measures approximately 100 feet by 120 feet. The Store House currently exists at the Site and is used as office and warehouse storage space leased by ExxonMobil and as a warehouse for storing miscellaneous equipment (i.e., snow plows) and remediation equipment. Located to the north were two storage sheds, one measuring approximately 30 feet by 65 feet, the other measuring approximately 35 feet by 40 feet. These storage sheds were removed between 1977 and 1986.

2.1.4.2 Waste Handling Areas in the AOOA within OU-2

One storage tank was identified in the AOOA as a WHA from company records. The storage tank was designated as WHA-11 and is represented on Plate 1. This storage tank measured approximately 6 feet by 4 feet by 2 feet and was located adjacent to the Mechanical Shop. The tank was utilized to store waste oils and solvents generated from the maintenance and repair operations in the Mechanical Shop. A contractor was retained, as needed, for offsite reclamation of the waste. According to company records dated 1994, the tank was moved to a wash bay.

2.1.4.3 Spills/Releases in the AOOA within OU-2

No significant spills have been documented to occur in this area. One spill, of less than 5 gallons, is described in **Table 2**.

2.1.5 NPSA within OU-2

The entire NPSA is located within OU-2 in the northeast section of the Site and encompasses approximately 10.7 acres. The northwest portion of the NPSA, along the northern border of the Site, was purchased by Atlas Refining Company from Peter Schermerhorn on December 22, 1882. Atlas Refining Company purchased the central eastern portion of the NPSA from National Transit Company on July 31, 1890. Two years later on June 16, 1892, SOCONY purchased both of these parcels from the Atlas Refining Company. The northeast portion of the NPSA, also along the northern border of the Site, was purchased by SOCONY from Mr. Edward Tanner in 1910. While there are no existing records indicating when SOCONY purchased the remainder of the NPSA (composed of land south of the lot formerly owned by Mr. Edward Tanner and east of the parcels formerly owned by the Atlas Refining Company), the land acquisition can be inferred to have taken place sometime after 1958 based on the change in land usage shown on the 1950 and 1986 Sanborn™ maps, the aerial photographs taken in 1951, 1958 and 1966, the "Map of Atlas Works Properties" dated September 12, 1951, and the "Map Showing Property Owned by Mobil Oil Corp." revised October 11, 1977. Prior to 1958, land usage was as follows based on the available Sanborn™ maps:

- 1900: The portion of land that would eventually become part of the NPSA was unoccupied. Immediately east of the NPSA was a Corroding House, a building for storing pig lead and coke, a building for storing finished goods, and several linseed oil storage tanks with varying capacities. These structures were part of the paint-related industries that were within the area adjacent to the NPSA (i.e., Spencer Kellogg & Company Varnish Oils, Buffalo Oil Paint & Varnish Company, McDougall White Lead Company, and McDougall Varnish Company).
- 1917: The portion of land that would eventually become part of the NPSA was lightly occupied by a small building, linseed oil storage tanks with varying capacities, and two tanks of unidentified content. Paint-related industries (Spencer Kellogg & Sons, Inc. Linseed Oil Refining and Foundry Oil Manufacturing, McDougall Varnish Company, and McDougall Paint Company, Inc.) and several linseed oil storage tanks with varying capacities were within the area adjacent to the NPSA.
- 1940: The portion of land that would eventually become part of the NPSA was used by R. H. Thompson Paper Company. Offices, paper storage warehouses, and the Nukem Products Corporation, a chemical cement manufacturer, replaced the paint-related industries that were within the area adjacent to the NPSA.
- 1950: The portion of land that would eventually become part of the NPSA and the

area adjacent to the NPSA continued to have similar usages as in 1940, except the Nukem Products Corporation was no longer present.

Additional information on land usage, as discerned from the 1951, 1958, and 1966 aerial photographs, are described below:

- 1951: Numerous bulk storage tanks, including Tanks 313, 156, 73, 3, 30, 183, and 15, were present at the eastern boundary of the SOCONY property. A small building and a trapezoidal structure, which is identified in the 1940 Sanborn™ map as Furniture Storage, can be seen within the portion of the land that would eventually become part of the NPSA. Buildings similar in shape to those in the 1940 Sanborn™ map can be seen within the area adjacent to the NPSA.
- 1958: Similar features to those in the 1951 aerial photograph can be identified in the eastern portion of the SOCONY property and within the portion of the land that would eventually become part of the NPSA. Minor changes in the shape of the buildings within the area adjacent to the NPSA can be discerned.
- 1966: Most of the buildings and bulk storage tanks within the NPSA, except Tanks 32, 218, 251, and 252, have been demolished. The small building and trapezoidal structure that were in the 1951 and 1958 aerial photographs are not present as that parcel of land appears to have been incorporated into the NPSA. Minor changes in the shape of the buildings within the area adjacent to the NPSA can be discerned.

2.1.5.1 Former and Current Structures in the NPSA within OU-2

The NPSA originally consisted primarily of structures and storage tanks associated with paraffin and wax refining/treatment and railcar construction and repair shops. The construction and repair of railcars terminated between 1917 and 1924. Through 1939, additional paraffin and wax refining structures and tanks replaced the railcar construction and repair shops. By 1951, roads were developed in the NPSA to provide access to the various portions of the area. A macadam roadway was constructed parallel to Elk Street, along the southern boundary of the NPSA. This roadway enabled better access to the paraffin and wax refining buildings in the northwest portion of the NPSA. A concrete roadway was constructed between the Wax Refinery and the Iroquois Gas Company Buildings. This roadway ran in a north to south direction and intersected with the macadam roadway. In 1959, many of the paraffin and wax refining structures and tanks were removed and replaced with larger storage tanks and the former Main Office building, formerly leased to Police Community Services. From the 1960s through the 1980s, the northeast portion of the NPSA was used for the storage of debris. In 1989, this area was cleared of all debris piles and the Biotreatment Cell was constructed. In 1990, a gated entrance was installed on the above-mentioned concrete road, adjacent to the Main Office, providing additional security to the Site. Currently, only the gated entrance exists in the NPSA. The Biotreatment Cell was decommissioned in February and March 2001. All soil was removed from and disposed offsite.

Table 1 provides information regarding storage tanks that were previously located in this area.

The following structures were located in the NPSA and are summarized in chronological order according to construction date.

- **Paraffin Boiler House.** This structure, first appearing in 1917, was located along the northern border of the Site, adjacent to Elk Street. The Paraffin Boiler House was approximately 100 feet by 70 feet. Attached to the Paraffin Boiler House were a Fan House (approximately 35 feet by 40 feet) and a Wash Room (approximately 40 feet by 45 feet). The Fan House and Wash Room were demolished between 1917 and 1924. During the period of 1924 through 1939, the use of the Paraffin Boiler House was changed to serve as a garage, locker room, and lunchroom for personnel and was later demolished in 1989. Adjacent to the east of the Paraffin Boiler House was Transformer No. 98 in 1924. This transformer was removed between 1955 and 1977.
- **Paraffin Office.** Located adjacent to the east of the Paraffin Boiler House, the Paraffin Office was approximately 17 feet by 32 feet. This structure first appeared on a 1917 map and was used to house office support to the paraffin and wax refinery. The Paraffin Office was demolished between 1917 and 1924.
- **Engine House and Press Rooms.** The primary paraffin refining processes were conducted in the Engine House and Press Rooms structure. The structure was constructed prior to 1917 and was located adjacent to the east of the Paraffin Office. The Engine House measured approximately 80 feet by 65 feet. Attached to the Engine House were a Pump House (approximately 60 feet by 30 feet), a Chilling Room (approximately 22 feet by 36 feet), and five Press Rooms (each 62 feet by 15 feet) to support the paraffin refining processes. A Conveyor Room, approximately 78 feet by 15 feet in size, adjoined the Press Rooms on the eastern side of the building. The Engine House and Press Rooms structure was demolished between 1917 and 1924.
- **Sweater Structures.** The Sweater structures, constructed prior to 1917, consisted of four adjoining structures along the northern boundary of the Site (each approximately 20 feet by 60 feet) and one single Sweater structure adjacent to the south (approximately 22 feet by 59 feet). Within the four adjoining Sweater structures was a pump house measuring approximately 11 feet by 60 feet. The Sweater structures were used for steam heating the wax to extract the oil from the wax. The wax was then used for the manufacture of products including candles. Three of the four adjoining Sweater structures were demolished between 1917 and 1924. The remaining Sweater structure and the single Sweater to the south were demolished between 1939 and 1955. Adjacent to the east were ten wax storage tanks with varying capacities. These tanks were constructed prior to 1917 and were dismantled between 1939 and 1951.
- **Pan House.** The Pan House was used to house pans in which the wax for the paraffin and wax refining process was stored. The structure was constructed prior to 1917 and was approximately 42 feet by 32 feet. The Pan House was demolished sometime between the years 1951 and 1955. According to a 1939 map, attached to the Pan House was a Switch House. The Switch House measured approximately 8 feet by 15 feet.

- **Wax House.** The Wax House structure consisted of three adjoining structures, each 25 feet by 60 feet in size and was located adjacent to the east of the Pan House. The Wax House was an integral structure in the paraffin and wax refining processes. A 10-foot by 76-foot platform ran along the eastern side of the Wax House, used for loading and unloading of wax products from the adjacent railroad track. The Wax House was constructed prior to 1917 and demolished in between the years 1951 and 1955.
- **Iroquois Gas Company Buildings.** The Iroquois Gas Company maintained six buildings in the NPSA. These buildings were constructed prior to 1917 and the exact uses are unknown. Two of the six Iroquois Gas Company structures were demolished between 1917 and 1924. Sometime between 1917 and 1924, NY Transit began occupying one of the four remaining buildings. The three Iroquois Gas Company structures were demolished between 1924 and 1939. The NY Transit building was demolished between 1951 and 1955.
- **Hose House No. 87.** Hose House No. 87 was located adjacent to the south of the Iroquois Gas Company Buildings. The hose house was constructed prior to 1917. The structure was 18 feet by 10 feet in size and was demolished between 1951 and 1955.
- **Car Shop.** The Car Shop was used to construct and house railcars. The Car Shop was constructed prior to 1917 and was approximately 260 feet by 101 feet in size. Railroad tracks that ran in a general east to west direction along Prenatt Street branched to the northeast into the NPSA. The tracks branched again and one branch ran towards the wax and paraffin refining structures while the other ran towards the Car Shop and Car Repair Shop, where the tracks terminated. A 1939 map indicates that the Car Shop was modified into a wax and paraffin refining structure, including two rooms of presses. The size and construction of the structure remained the same. The wax and refining structure was later demolished between 1951 and 1955.
- **Car Repair Shop.** The Car Repair Shop was constructed prior to 1917 and was 30 feet by 260 feet in size. This structure served as a repair shop for the railcars used on the Site. The Car Repair Shop and the tracks leading to the shop were removed between 1917 and 1924 and replaced with additional paraffin refining and treatment structures and tanks.
- **Scrap Shed.** The Scrap Shed was constructed prior to 1917 and was located to the south of the Car Repair Shop. The shed was approximately 130 feet by 15 feet in size. The scrap stored in the Scrap Shed was associated with the surrounding railcar construction structures. The Scrap Shed was removed between 1917 and 1924.
- **Pump House and Sweater Structure.** According to a 1924 map, additional pump house and sweater structures were constructed between 1917 and 1924, located south of the Wax House. The Pump House was an 18 foot by 44 foot brick structure. The Sweater Structure was also constructed of brick and measured approximately 23 feet by 44 feet in size. These two structures were used in association with the wax refining processes. The Pump House and Sweater Structure were demolished between the years 1951 and 1955.

- **Pump House No. 26.** Pump House No. 26 was constructed between 1917 and 1924 in the former location of Car Repair Shop. The pump house was a brick structure and 70 feet by 30 feet in size. Pump House No. 26 was demolished between the years 1951 and 1955.
- **In-Ground Oil/Water Separator.** An in-ground oil/water separator, approximately 10 feet by 30 feet, was located adjacent to Pump House No. 26 and was constructed between 1917 and 1924 near the former location of the Car Repair Shop. The trap was used for separation of petroleum from aqueous waste streams and stormwater. The exact origin of the waste streams collected in the trap could not be determined from the available information. The trap does not appear on a 1955 map. This structure was removed in 2007 during pipe removal activities.
- **Engine House No. 40.** Engine House No. 40 was constructed between 1917 and 1924 and was located adjacent to the Machine Shop in the AOOA. The Engine House, 14 feet by 20 feet in size, was demolished between the years 1951 and 1955.
- **Pressed Distillate Unit**. Consisting of five structures, the Pressed Distillate Unit (P.D. Unit) first appears on a 1924 map. These structures were located along the eastern border of the Site. The P.D. Unit received the wax oil extracted from the Sweater units and distilled the oil, which was then sent to the lube plant. The P.D. Unit included a receiving house, condensers, and a cooler. Also associated with the P.D. Unit was Stack No. 8, a brick stack measuring 5 feet in diameter and 100 feet in height. The P.D. Unit structures were demolished between the years 1958 and 1966, during which time the wax refining operations were ceased.
- **Sweater Structure No. 7.** This Sweater structure was constructed between the years 1924 and 1939. This structure, approximately 30 feet by 45 feet in size, was constructed in the location of the former Iroquois Gas Company buildings and adjacent to the former Car Shop. Similar to the Sweater structures discussed above, this structure was associated with the paraffin and wax refining and treatment process to extract the oil from the wax product. The Sweater structure was demolished between the years 1951 and 1955.
- **Building No. 38.** This structure was constructed adjacent to Sweater Structure No. 7 between the years 1924 and 1939. The use of this structure could not be determined from the available information. This structure was removed between the years 1951 and 1955.
- **Locomotive House No. 19.** The Locomotive House, approximately 8 feet by 15 feet, was located at the end of the tracks that ran toward the former Car Shop and Car Repair Shop. The structure first appears on a 1939 map, indicating that it was constructed between the years 1924 and 1939. Before the construction of the Locomotive House, the rail tracks continued towards the east and beyond the Site boundary. Therefore, at the time of construction, the tracks were removed and terminated at the location of the Locomotive House. The exact usage of the Locomotive House could not be determined from the available information. The Locomotive House was demolished between the years 1958 and 1966.

- **Rail Loading Racks.** According to a 1939 map, a 93 foot by 5 foot loading rack was constructed near the former location of the Car Repair Shop, adjacent to the rail track that ran towards the northeast and terminated at the Locomotive House. Two additional loading racks were constructed south of the former Car Shop between 1939 and 1951. These two loading racks measured approximately 28 feet by 8 feet and 15 feet by 8 feet. The specific function of these loading racks could not be determined from the available information.
- **Main Office.** The Main Office was constructed between the years 1951 and 1955. This building served as the main office structure for administrative operations at the terminal. The Main Office is a one-story building encompassing approximately 9,000 square feet. This structure was leased to the City of Buffalo Police Community Services until 2006, and then was demolished in accordance with applicable regulations in 2007.
- **Biotreatment Cell.** The Biotreatment Cell was constructed in 1989, was trapezoidal in shape, and measured approximately 570 feet from north to south and from east to west measured between 140 and 390 feet. The treatment cell had been used to biologically treat impacted soil from the terminal and other offsite ExxonMobil facilities. The Biotreatment Cell was lined with an impermeable plastic liner, was surrounded by a berm, and was capable of treating 6,000 cubic yards of soil. The Biotreatment Cell was decommissioned in February and March 2001. Approximately 7,227 tons of soil were removed from the Biotreatment Cell and disposed offsite at that time.
- **Gated Entrance.** The gated entrance was constructed adjacent to the west of the Main Office, at the northern border of the Site. Associated with the construction of the new Truck Loading Rack in the CRPA in 1991, the gated entrance permitted entrance to authorized vehicles, thus adding additional security to the Site.

2.1.5.2 Waste Handling Areas in the NPSA within OU-2

Two WHAs were identified in the company records as being located in the NPSA. These two units include a steel storage tank used to store leaded tank bottom material and a debris disposal/storage area. Each of the units and their functions are described below.

Steel Storage Tank

The WHA was a 450-gallon steel storage tank located in the southern portion of the NPSA. The storage tank, designated WHA-1, was three feet in diameter and 8.5 feet in length. The tank was utilized from 1970 through 1981 for the storage of leaded tank bottoms, at an estimated rate of 10 pounds per year. The residence time of the waste was unknown.

Demolition Debris Storage Area

This demolition debris storage area was located in the northeast portion of the Site, in the location of the former Biotreatment Cell. This area, designated WHA-9, was used for the disposal of onsite construction and demolition debris including old pumps, wood, paper, scrap metal, insulation, and transformer carcasses that may have contained polychlorinated biphenyls (PCBs) during operation, and empty process tanks. A contractor retained by ExxonMobil periodically removed the debris. The area was cleared and contaminated soil was removed prior to the construction of the Biotreatment Cell in 1989.

2.1.5.3 Spills/Releases in the NPSA within OU-2

No spills or releases were documented in this area.

2.1.6 CRPA within OU-2

The CRPA is located in the central portion of the Site and the portion north of Prenatt Street, which is within OU-2, encompasses approximately 0.9 acres.

The western portion of the CRPA was purchased by the Atlas Refining Company from Peter Schermerhorn on December 22, 1882, and later by SOCONY on June 16, 1915 from Buffalo Hardwood Lumber Company, the City of Buffalo and other unnamed entities.

2.1.6.1 Former and Current Structures in the CRPA within OU-2

In 1917, the CRPA consisted primarily of railroad tracks on Prenatt Street and structures associated with the construction of barrels. Between 1924 and 1990, this area was generally used for housing refinery process related structures. **Table 1** provides information regarding storage tanks that were previously located in this area. The following structures were previously located in the portion of CRPA within OU-2 and are summarized in chronological order according to their construction date.

- **Hose House.** This hose house was constructed prior to 1917 on the north side of Prenatt Street. The structure measured approximately 18 feet by 11 feet and was removed between 1917 and 1924.
- **Coal Shed.** A coal shed was located adjacent to the Hose House on the north side of the railroad tracks that ran from east to west along Prenatt Street. The Coal Shed was constructed prior to 1917 and measured approximately 27 feet by 11 feet in size. The coal shed was demolished between 1917 and 1924.
- **Tar Loading Rack.** The tar loading rack was located on the north side of Prenatt Street. The loading rack was constructed between 1924 and 1939 and measured approximately 180 feet by 6 feet. The loading rack was removed between 1951 and 1955.

2.1.6.2 Waste Handling Areas in the CRPA within OU-2

The two WHAs (Buried Acid Sludge Trench and three Hazardous Waste Dumpsters) identified in the CRPA from company records are not located within OU-2; therefore, they will not be described in this Final AAR.

2.1.6.3 Spills/Releases in the CRPA within OU-2

The only spill documented in the CRPA is located outside the OU-2 area; therefore, it will not be described in this Final AAR.

2.2 Zoning and Land Use of OU-2

The zoning of OU-2 is M3 (heavy industrial district). A figure obtained from the City of Buffalo website showing the zoning for OU-2 is provided as **Figure 4**. Additional information regarding zoning and land use was provided by the City of Buffalo during the public comment period on ExxonMobil's BCP application. This information indicates that, per the City's LWRP, the proposed zoning of the portion of the Site south of Elk Street, including OU-2, is CM-General Commercial District (**Figure 5**) with a proposed land use of mixed use commercial/light industrial (**Figure 6**).

There are currently three distinct types of land use within OU-2. From east to west, there is vacant land owned by ExxonMobil (6.7 acres); 2) the Main Office and other support buildings for the petroleum products storage and distribution terminal owned and operated by Buckeye (5.4 acres); 3) vacant land owned by ExxonMobil (22 acres); and 4) the BSPA owned and operated by One Babcock for various industrial purposes (5 acres). A 2011 aerial photograph of the terminal (Plate 2) shows the approximate extent of impervious cover (i.e., concrete, asphalt, and buildings) across OU-2.

The Site is located in an area of Buffalo that has numerous parcels of available vacant land, including large portions of OU-2. The immediate area surrounding OU-2 is comprised of several active industrial uses south of Elk Street, including, the active petroleum distribution terminal; an auto parts recycler; a fertilizer packaging facility and other industrial enterprises to the east; and a sulfuric acid manufacturing plant to the west. North of Elk Street there is vacant land; an auto parts recycler; several industrial enterprises; a tavern; and limited residential housing.

Until recently, there was no comprehensive development plan in place for this portion of Buffalo. However, ExxonMobil and other stakeholders commissioned an evaluation of the best future use of the property and surrounding areas of this portion of Buffalo known as the "Elk Street Corridor". The results of the evaluation were documented in a final report entitled "Elk Street Corridor Redevelopment Plan" dated October 2008. The proposed land use for the Site based on the preferred redevelopment is shown on **Figure 7** and incorporated the following general goals for the corridor:

- Maintaining four anchor properties in the area, one of which is the Buckeye Terminal;
- Building the proposed "Southtowns Connector" to connect areas south of the Buffalo River to Interstate 190; and
- Providing a green space setback of 100 feet from the Buffalo River shoreline, as well as other green space areas.

In the vicinity of the Site, the preferred redevelopment plan includes a combination of light industrial, back office, commercial, restricted access and public access green space, and very limited retail use. For OU-2 specifically, the preferred redevelopment plan calls for commercial uses west of the Buckeye Terminal (except for limited retail space at the corners of Elk Street and Babcock Street), and light industrial uses on and to the east of the Buckeye Terminal.

The reasonably anticipated near term use of OU-2 will remain vacant land/light industrial following remediation, with the east/central portion of OU-2 operating as a petroleum products storage and distribution terminal owned and operated by Buckeye, and the western portion (on the BSPA) owned and operated by One Babcock or others for various industrial purposes. The long-term proposed future use of OU-2 includes back office and commercial on the western portion of OU-2, and light industrial uses on and to the east of the Buckeye Terminal.

3.0 SUMMARY OF ENVIRONMENTAL CONDITIONS

Data regarding environmental conditions on OU-2 were obtained from a review of the results of previous investigations, coupled with the results of investigations conducted in 2007, 2008, and 2009, and 2016. This section includes a summary of the major findings and conclusions of the investigations completed in this area. This final AAR will only describe portions of previous investigations that are pertinent to OU-2, except where separation is not practical. Sample locations with the exception of the 2016 investigation and locations of monitoring wells from all previous investigations are presented on Plate 1. Test pit locations from the 2016 investigation are presented on Plate 15.

3.1 Environmental Investigations

The following is a description of the scope of work for all investigations completed in OU-2.

3.1.1 Investigations Completed Prior to 2007

The following reports, which were submitted and accepted as part of the BCP application, summarize all investigation data collected within OU-2 prior to 2007:

- “BSPA Investigation Completion Report” dated June 5, 2001.
- “Site Investigation Completion Report” dated March 12, 2002, which provides a detailed presentation of investigation data for the OU-2 areas with the exception of BSPA.
- Interim Pipe Removal Reports No. 1, No. 2 and No. 3, submitted in February 2005, February 2006, and January 2007, respectively, and Pipe Removal Report No. 4 (Final) submitted in October 2007, which provides additional soil sampling results collected during pipe removal efforts.

<u>BSPA Investigation Completion Report</u>

The results of the field activities conducted between June 2000 and May 2001 for the completion of investigation activities on the BSPA supplement the results of previous investigations conducted in the BSPA and other areas of the Site, which are the following:

- Installation of five monitoring wells (B-1MW, B-2MW and B-4MW through B-6MW) in various areas of the Site (including the BSPA) and performance of water-level and product thickness measurements in these new wells, by Empire Soils Investigations, Inc. in July 1989;
- Installation of monitoring well B-3MW in the BSPA and performance of water-level and product thickness measurements in the new well by Empire Soils Investigations, Inc. in October 1989;
- Environmental site assessment for the Lakes Division garage in the BSPA conducted by Groundwater Technology, Inc. in April 1994;

- Site Facility Investigation (SFI) conducted by GES from June through August 1998; and
- SFI Completion conducted by GES and Roux Associates from July through October 1999.

Site Investigation Completion Report

The scope of work conducted during the Site Investigation Completion supplemented the results of previous investigations conducted in the entire NPSA, NTYA, FRA, CRPA, STYA, Eastern Tank Yard Area (ETYA), and AOOA. The previous investigations, which were summarized in the Site Investigation Completion Report, are the following:

- Installation of five monitoring wells (B-1MW, B-2MW and B-4MW through B-6MW) in various areas of the Site and performance of water-level and product thickness measurements in these new wells by Empire Soils Investigations, Inc. in July 1989;
- Abandonment and replacement of well B-5MW with B-5MWR in the CRPA by Empire Soils Investigations, Inc. in May 1990;
- Abandonment and replacement of well B-5MWR with B-5MW(RR) in the CRPA by Empire Soils Investigations, Inc. in July 1990;
- SFI conducted by GES from June through August 1998;
- SFI Completion conducted by GES and Roux Associates from July through October 1999;
- Soil sampling program conducted during the Site Investigation Completion between August 2001 and February 2002 in the ETYA, NPSA, NTYA, FRA, CRPA, STYA, and AOOA;
- Groundwater sampling program from 26 Geophone® boring locations throughout the ETYA, NPSA, NTYA, FRA, CRPA, STYA, and AOOA during the Site Investigation Completion between October 2001 and December 2002; and
- Delineation of separate-phase product across the Site during the Site Investigation Completion in November and December 2001.

Interim Pipe Removal Reports

In accordance with the work plan for pipe removal, soil samples were collected during pipe removal activities in areas where soil conditions were different than conditions identified during previous investigation and where samples had not been collected during previous investigations.

The scopes of work for each of these investigations were described in detail in the original reports referenced above.

3.1.2 Investigations Completed in 2007

In response to comments provided by the NYSDEC in a meeting with ExxonMobil and GES on

May 24, 2007, additional investigation activities were undertaken in OU-2. The meeting was held to discuss issues related to the "Alternatives Analysis Report for Operable Unit 2" dated April 13, 2007.

The scope of work and results of additional investigation activities in OU-2 conducted in 2007 are also described in this section and include:

- Soil sampling for arsenic in the zero to one foot below grade interval that was not analyzed during previous investigations;
- Soil sampling for lead and mercury, to further delineate exceedances of the industrial criteria in the zero to one foot interval;
- Soil sampling for PCBs around BTC-5 to further delineate exceedances of the commercial criteria in the zero to one foot interval. Due to a reporting error in the original and revised AAR, this sampling data was collected, but was unnecessary because there were no exceedances for PCBs in OU-2; and
- Installation and gauging of five new monitoring wells and sampling of all existing and new wells in OU-2.

3.1.2.1 Soil Sampling for Arsenic in the Shallow Interval

Soil sampling for arsenic was conducted in accordance with the letter "Work Plan for Additional Investigation for Arsenic in OU-2" dated July 5, 2007. The work plan was prepared considering that the reasonably anticipated future use of OU-2 will be commercial or industrial. This is based upon the current zoning of OU-2 as M3 (heavy industrial district) and the City of Buffalo's LWRP, which indicates that the proposed zoning of the portion of the Site south of Elk Street, including OU-2, is CM-General Commercial District with a proposed land use of mixed-use commercial/light industrial. Therefore, in accordance with Part 375, the soil sampling program was focused on the conditions in the top one foot of material present. The objective was to characterize concentrations of arsenic, which was not analyzed during previous investigations.

In order to accomplish this goal, initially, in July 2007, one soil sample (plus two duplicates) was collected from each of 27 boring locations (shown on Plate 1) from the zero to one foot below land surface interval. Each of the 29 samples was collected using a hand auger. Samples were labeled as "SB-OU2-1/0-1", "SB-OU2-2/0-1", etc.

The soil sample locations were selected to provide a minimum of one sample for every two acres of area per the language in Section 3.9(f) of DER-10. This section of DER-10 relates to sampling of non-process areas and was applied to the arsenic sampling since arsenic is not a process-related constituent of concern for the former petroleum refinery/distribution operations that were conducted within OU-2. The sampling locations were placed in former process, waste handling or tank areas of OU-2 and adjacent to borings conducted during previous investigations. Furthermore, sampling locations were biased toward areas where other metals were present at concentrations exceeding the Part 375 unrestricted and/or industrial/commercial criteria. Therefore, a total of 29 samples (including two duplicates) were collected from OU-2, whereas 20 samples would have been required to meet the one sample per two acre guideline.

Subsequently, in August 2007, additional delineation was performed around seven of the 27 borings that had concentrations of arsenic above the industrial criteria. Twenty-six additional arsenic samples (including one duplicate) were collected. Sample locations are shown on Plate 1.

The soil boring locations were pre-surveyed by a New York State licensed surveyor.

3.1.2.2 Additional Soil Sampling for Lead, Mercury and PCBs in the Shallow Interval

Additional samples were collected in order to further delineate exceedances of the industrial criteria for lead and/or mercury in the shallow interval in isolated areas of the Site. Two samples were collected in the vicinity of SB-140 in the southwest corner of the FRA and analyzed for mercury and lead. Three samples were collected from the zero to one foot below land surface (ft bls) interval in the vicinity of BTC-4 in the NPSA and analyzed for mercury. Additional samples were collected in order to further delineate PCBs around BTC-5, which had erroneously been identified as exceeding the industrial criteria for PCBs in the shallow interval in the original and revised versions of the AAR for OU-2. In fact, the PCB concentration at BTC-5 (1.45 milligrams per kilogram [mg/kg]) only slightly exceeded the commercial criteria (1 mg/kg) and was below the industrial criteria (25 mg/kg), which applies for this portion of the property. Three samples were collected from the zero to one ft bls interval in the vicinity of BTC-5 in the NPSA and analyzed for PCBs.

3.1.2.3 Well Installation, Gauging and Sampling

Well installation, gauging and sampling in OU-2 were conducted in September 2007 in accordance with the letter to the NYSDEC entitled “Proposed Monitoring Wells in OU-2” dated August 20, 2007. Five new monitoring wells (MW-47 through MW-51) were installed within OU-2 and are shown on Plate 1. The new groundwater monitoring wells were intended to accomplish one or more of the following goals:

- Provide additional groundwater monitoring locations in portions of the Site without current coverage, particularly in the area between and to the north of wells MW-31 and MW-17, and to the north of B-MW5(RR); and/or
- Confirm potential impacts to groundwater from contaminated soil within OU-2; and/or
- Provide a long-term monitoring well network that will be used to assess the effectiveness of the recommended remedy in controlling groundwater migration and remediating groundwater impacts, as necessary.

Well Construction Details

Well installation logs are provided in **Appendix A**. The pilot borehole for each well was drilled with a hollow-stem auger rig using 6.25-inch diameter augers after pre-clearance using hand tools to five ft bls. Boreholes were advanced to the depths outlined below. Soil samples were collected continuously from five ft bls to the bottom of the boring. The supervising technical staff inspected all soil samples and recorded all applicable lithologic characteristics. In addition, all soil samples were visually inspected for evidence of separate-phase product (i.e., separate-phase product sheen, odors, staining, etc.) and screened for organic vapors with a photo-ionization detector (PID). Soil samples were not sent for laboratory analysis during the well installation program.

The wells were installed to a total depth of approximately 12 ft bls. Each monitoring well was constructed of 2-inch diameter, schedule 40, flush-joint internally-threaded, polyvinyl chloride (PVC) casing and a 10-foot length of 20-slot PVC screen (installed from two to 12 ft bls). Glue was not used to join the casing and screen lengths. The screen annulus of each monitoring well was gravel packed to approximately 0.5 foot above the top of the screen using No. 1 Morie sand. The additional 0.5 foot of gravel pack was to account for settlement that may occur during well development. A 0.5 foot thick bentonite pellet seal was placed on top of the gravel pack.

The remainder of the annulus was grouted and finished with a concrete cap. The concrete cap was sloped to divert precipitation away from the well. Each monitoring well was finished approximately two feet above grade and fitted with a steel casing.

Following installation, each well was developed to ensure hydraulic connection with the surrounding aquifer. The wells were developed by pumping until each monitoring well produced sediment-clear water, to the extent possible, and a good hydraulic connection was established between the well screen and the aquifer. The water generated during well development was collected and transported to ExxonMobil's water treatment system, which is located in the main portion of the former terminal south of Elk Street. Soil cuttings were spread on the ground surface in the vicinity of the monitoring well.

After completion, the ground surface and top of casing (i.e., measuring point) elevations of each well location were surveyed relative to the New York State Plane Coordinate System by a surveyor licensed in the State of New York.

Water-Level and Separate-Phase Product Gauging and Groundwater Sampling

Once all proposed monitoring wells were installed and developed, each new and existing monitoring well in OU-2 was gauged for water level and presence of separate-phase product. An electronic product-water interface probe was used to measure the water level, detect separate- phase product, if present, and to determine its thickness. These water-level data have been used to construct groundwater flow maps for quarterly gauging events (Plate 3), and are part of the on-going quarterly monitoring well gauging program for the Site.

Groundwater samples were collected from all new and existing wells in OU-2 that did not contain free product. The samples were analyzed for volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) according to United States Environmental Protection Agency (USEPA) methods SW-846 8260 and 8270 for all compounds listed in **Table 6.2** of Part

375. New and existing wells in OU-2 were also sampled for target analyte list metals by method SW-846 6010 and method SW-846 7470/7471 for mercury. Samples from the two wells

proposed in the NPSA were analyzed for PCBs by USEPA method SW-846 8082. An additional sample from each well was filtered through a 0.45-micron pore size filter to remove suspended particulate matter and the analytes that may be associated with the solids. The filtered samples were analyzed for the same parameters as the unfiltered sample except for VOCs.

3.1.3 Investigations Completed in 2008

The scope of work of investigations completed in 2008 is described below.

3.1.3.1 Sampling in April 2008 for Arsenic, Lead, and Mercury

In response to draft comments on the October 5, 2007 Revised AAR provided by the NYSDEC via email to ExxonMobil on December 5, 2007 and based upon the results of the more recent subsurface investigations as they progressed, additional investigation activities were undertaken in OU-2 to further delineate arsenic, lead and mercury. The sample locations and data collected during these investigations are presented on Plate 4 for arsenic, Plate 5 for mercury, and Plate 6 for lead.

The scope of work of additional investigation activities in OU-2 for arsenic, lead and mercury in soil that were conducted in April 2008 included:

- Additional soil sampling (11 samples) in the zero to one foot depth interval to delineate arsenic exceedances of the Part 375 industrial criteria;
- Re-sampling at SB-107 from 5 to 7 ft bls, 7 to 9 ft bls, and 9 to 11 ft bls for total lead. The samples from 7 to 9 ft bls and 9 to 11 ft bls were also analyzed for Toxicity Characteristics Leaching Procedure (TCLP) lead based on the high total lead results;
- Re-sampling at SB-110 from 0 to 2 ft bls, 2 to 2.5 ft bls, and 2.5 to 4.5 ft bls for total lead and TCLP lead;
- Re-sampling at SB-124 from 9 to 11 ft bls, 11 to 13 ft bls, and 13 to 15 ft bls for total lead. The sample from 11 to 13 ft bls was also analyzed for TCLP lead based on the high total lead result; and
- Additional soil sampling at BSPA 1-2-3/0 in the zero to one foot depth interval to confirm the occurrence of mercury in the shallow zone.

3.1.3.2 Follow Up Sampling in May 2008 for Lead and Mercury

The scope of work of additional investigation activities in OU-2 for lead and mercury in soil that were conducted between May 20 and May 22, 2008 included:

- Follow-up sampling at SB-107 from 11 to 13 ft bls and 15 to 16 ft bls for total lead and TCLP lead. Four additional soil samples (SB-107N, SB-107S, SB-107E, and SB-107W) were collected from 11 to 13 ft bls at approximately 20 feet due north, south, east and west of the original SB-107 for total lead. Samples SB-107N, SB-107E, and SB-107W were also analyzed for TCLP lead based on the high total lead results.
- Follow-up sampling at SB-110 from 0 to 2 ft bls, 2 to 4 ft bls, 4 to 5 ft bls, 5 to 7 ft bls,

and 7 to 9 ft bls for total lead and TCLP lead. Four additional soil samples (SB-110N, SB-110SE, SB-110SSE, and SB-110W) were collected from 2 to 4 ft bls at approximately 26 feet southeast and south-southeast, and approximately 20 feet due north and west of the original SB-110 for total lead and TCLP lead.

- Follow-up sampling at SB-124 from 4 to 6 ft bls for total lead and TCLP lead.
- Soil sampling at and around BSPA 1-2-3/0: a sample was collected for total mercury at the original location at the original depth of 2 to 2.5 feet below grade (that was sampled during pipe removal activities) and at a depth of 4 to 4.5 feet below grade. In addition, three locations were sampled for total mercury around the original location (in line with the north and eastern walls of the building and approximately 20 feet to the slight northeast, slight southeast and slight northwest of the original location) from 2 to 2.5 feet below grade at each location.

The sample locations and data collected during these investigations are presented on Plate 4 for arsenic, Plate 5 for mercury, and Plate 6 for lead.

3.1.3.3 Test Pits in May 2008 for Evaluation of Petroleum Impacted Soil

As discussed with the NYSDEC on January 16, 2008 and as presented in the February 7, 2008 response to the NYSDEC comments on the Revised AAR for OU-2, test pits were performed in order to address the NYSDEC comments regarding separate-phase product and petroleum impacted soil identified in OU-2 during pipe removal activities. On May 20 and May 21, 2008, ExxonMobil mobilized an excavator to the Site and performed a total of 21 test pits (TP-1 through TP-19, TP-20A and TP-21A). The test pits were completed in the vicinity of MW-38 in the NPSA, along the eastern property boundary in the NPSA and in portions of the FRA and CRPA where petroleum impacted soil was identified during pipe removal activities. The test pits were approximately three to four feet wide, 30 feet long and extended vertically to the water table. Test pits were visually inspected by a representative of the NYSDEC and no soil samples were collected as part of this work. The test pit locations are shown on Plate 7. The test pit logs are provided in **Appendix B**.

3.1.3.4 Test Pits for Delineation of Lead Impacted Soil in the NPSA and NTYA

Based upon total and TCLP lead data from soil borings competed in April and May 2008, and visual observations during test pitting for petroleum impacted soil in May 2008, it appeared that the lead impacts were primarily associated with black-colored slag material that was observed in the northeastern portion of the NPSA (near MW-38, SB-107, SB-110) and in the NTYA in the vicinity of SB-124. Therefore, 31 test pits (TP-20 through TP-50) to the water table were excavated between June 23 through June 26, 2008 in an attempt to identify the limits of the slag and better define the lead impacted soil in these areas (Plate 7). Test pits extended out from the original areas of interest at increasing distances until it appeared that the slag material was no longer present. The test pit logs are provided in **Appendix B**.

Samples for laboratory analysis were not collected at every location. Samples for laboratory analysis were collected from the bottom and sidewall of ten test pits and analyzed for total lead

(TP-23, TP-27, TP-30, TP-33, TP-34, TP-35, TP-37, TP-39, TP-45, and TP-50). TCLP lead samples were collected from the bottom of two test pits (TP-27 and TP-33) and the sidewall of three test pits (TP-33, TP-37, and TP-39). These samples were generally at the outermost test pit locations where the slag was no longer observed. It should be noted that due to the presence of former tank concrete foundations in the northwestern portion of the NPSA, the western limit of the slag was not determined.

3.1.3.5 Installation of Monitoring Well MW-52

In September 2008, MW-52 was installed along the eastern property boundary in OU-2 just downgradient from SB-110. The construction was similar to the wells installed in 2007 (Section 3.1.2.3). The well installation log is provided in **Appendix A**. This well was installed downgradient of the highest lead concentrations in soil observed along the property boundary in order to confirm if dissolved lead was an issue in this area.

3.1.3.6 Test Trenches in October 2008 for Evaluation of Petroleum Impacted Soil

Approximately 17,343 feet of test trenches were completed across OU-2 in October 2008. Test trenches were completed in accordance with the “Work Plan for Additional Test Trenches in OU-2 for Identification of Petroleum Impacted Soil” dated September 10, 2008, except where noted.

The test trenches were originally proposed in the work plan in several areas of the Site where petroleum impacted soil was observed in the June 2008 test pits. Based upon the field observations, the NYSDEC requested one soil sample collected at test trench TT-51 from 2 to 2.5 ft bls, and required that additional test trenches be excavated throughout the majority of OU-2. Test trenching was not completed in areas where the concrete foundations of former tanks and other former concrete structures remain, or where ponded surface water made access impossible. The locations of the test trenches are shown on Plate 7.

The test trenches were approximately 3.5 to 4 feet wide and extended vertically to the water table. Identification of petroleum impacted soil was based on olfactory and visual observations by the NYSDEC. No PID screening or laboratory sampling of soil was completed for this work.

3.1.3.7 Soil Vapor Sampling

Soil vapor sampling at eight locations (SV-1 through SV-6, SV-8 and SV-9) in OU-2 was completed between October 6 and October 29, 2008. The sample locations are shown on **Figure 8**. The soil vapor sampling was completed in October 2008 in accordance with:

- The “Soil Vapor Sampling Plan” dated April 21, 2008;
- The letter dated June 16, 2008 entitled “Response to NYSDEC Draft Comments Dated May 28, 2008 Regarding Soil Vapor Sampling Plan dated April 21, 2008 (Site #C915201)”; and
- The letter dated August 11, 2008 entitled “Response to NYSDEC/NYSDOH Emailed Comments Dated July 22, 2008 Regarding Soil Vapor Sampling Plan dated April

21, 2008 (Site #C915201)".

In accordance with the April 21, 2008 sampling plan, all samples were analyzed for VOCs via USEPA Method TO-15 and methane by modified American Society for Testing and Materials (ASTM) 1946 (the modified method achieves a detection limit of 10 parts per million by volume [ppmv]). SV-1 and SV-9 were analyzed for elemental mercury. The results of samples collected within OU-2 are briefly discussed in Section 3.2.6. A more detailed description of the sampling completed, results and recommendations for additional sampling are presented in the document entitled "Soil Vapor Sampling Report" dated January 30, 2009.

3.1.4 Investigations Completed in 2009

The scope of work for various field investigations and pilot studies completed in 2009 are described below.

3.1.4.1 Additional Characterization and Delineation of Lead within OU-2

Additional investigation activities were undertaken to further understand the speciation, characterization, and distribution of lead across OU-2, with a particular focus on the NPSA where prior investigations had identified elevated concentrations of total lead and leachable lead (via the TCLP method) in soil. Knowledge of the different lead species across OU-2, as well as the prevailing condition of the subsurface environment, are key to explaining why significant concentrations of lead are not leaching to groundwater even though the soil exhibits high TCLP lead concentrations. This information can also be used to refine potential remedial approaches.

The scope of work was presented in the "Work Plan for Additional Investigation for Lead in OU-2" dated March 23, 2009, and modified in response to verbal comments provided by the NYSDEC. A brief description of the scope of work that was performed, the rationale for selection of samples that underwent additional analyses, and deviations from the work plan, are provided below.

The soil borings proposed in the work plan were advanced from April 13 to 22, 2009, with additional soil borings advanced on May 11, 2009 and June 16, 2009. The soil borings were advanced by Zebra Environmental under the oversight of GES. Except as otherwise noted below, all laboratory analyses were performed by TestAmerica Laboratories, Inc. (TestAmerica). The sample locations are presented on Plate 1.

The following scope of work was conducted in accordance with the March 23, 2009 work plan:

- Completion of soil borings and collection of soil samples from land surface to the top of the underlying clay layer at SB-114, SB-126, SB-131, SB-140, NTYA 570, NTY-T1, NTY-T22, SB-OU2-40 to SB-OU2-72 for analysis of total lead. Samples for laboratory analysis were collected at either two or three depth intervals at each boring location depending upon the depth to clay layer. Two additional borings, SB-OU2-71 and SB-OU2-72, were added to the original scope of work to delineate lead in the northwestern and northeastern corner of the NPSA, respectively, after reviewing the total lead results of the two areas. A soil sample was collected from 0 to 2 and 4 to 6 ft bls at SB-OU2-71 on May 11, 2009. A soil sample was collected from 0 to 2 ft bls at SB-OU2-72 on June 16, 2009.

- The following soil samples that exhibited greater than 100 parts per million (ppm) of total lead were analyzed for TCLP lead:
  - SB-126 from 0 to 2 ft bls;
  - SB-140 from 0 to 2 ft bls;
  - NTYA 570 from 5 to 7 ft bls;
  - NTY-T22 from 0 to 2 ft bls;
  - SB-107 from 11 to 13 ft bls;
  - SB-OU2-40 from 0 to 2 and 5 to 7 ft bls;
  - SB-OU2-41 from 0 to 2 ft bls;
  - SB-OU2-43 from 0 to 2 ft bls;
  - SB-OU2-44 from 0 to 2 and 5 to 7 ft bls;
  - SB-OU2-45 from 0 to 2, 5 to 7, and 9 to 11 ft bls;
  - SB-OU2-46 from 0 to 2 and 9 to 11 ft bls;
  - SB-OU2-47 from 0 to 2 ft bls;
  - SB-OU2-48 from 0 to 2 ft bls;
  - SB-OU2-50 from 0 to 2 and 5 to 7 ft bls;
  - SB-OU2-51 from 5 to 7 ft bls;
  - SB-OU2-59 from 0 to 2 ft bls;
  - SB-OU2-64 from 0 to 2 ft bls;
  - SB-OU2-65 from 0 to 2 ft bls;
  - SB-OU2-67 from 0 to 2 ft bls;
  - SB-OU2-69 from 0 to 2 ft bls;
  - SB-OU2-70 from 0 to 2 ft bls; and
  - SB-OU2-72 from 0 to 2 ft bls.
- The following soil samples that exhibited greater than five mg/L of TCLP lead were analyzed for Synthethic Precipitation Leaching Procedure (SPLP) lead:
  - SB-107 from 11 to 13 ft bls;
  - SB-OU2-41 from 0 to 2 ft bls;
  - SB-OU2-44 from 5 to 7 ft bls;
  - SB-OU2-46 from 9 to 11 ft bls; and

- SB-OU2-65 from 0 to 2 ft bls.

Exceptions to the March 23, 2009 work plan are described below:

- Boring designation “SB-OU2-39” in the work plan was renamed as “SB-OU2-40” because the designation “SB-OU2-39” had been assigned to a soil boring completed in a previous soil investigation.
- There was no soil sample collected from the location designated “SB-OU2-40” in the work plan because refusal was encountered at each of four attempts.
- The following soil borings were moved from their proposed locations due to refusal but remained within their respective 100 feet by 100 feet grid:
  - SB-OU2-41;
  - SB-OU2-44;
  - SB-OU2-45;
  - SB-OU2-46;
  - SB-OU2-47;
  - SB-OU2-50; and
  - SB-107.
- The following soil borings were moved from their proposed locations to avoid damaging an underground water line but remained within their respective 100 feet by 100 feet grid:
  - SB-OU2-42;
  - SB-OU2-43;
  - SB-OU2-59;
  - SB-OU2-60;
  - SB-OU2-63; and
  - SB-OU2-64.

3.1.4.2 Speciation of Lead

The following scope of work was conducted in accordance with the March 23, 2009 work plan:

- Collection of a soil sample from SB-OU2-43 from 0 to 2 ft bls, SB-OU2-57 from 0 to 2 ft bls, SB-OU2-57 from 5 to 7 ft bls, SB-110 from 0 to 2 ft bls, and SB-107 from 11 to 13 ft bls for analysis of the following:
  - Organic lead;
  - Phosphate (phosphorous and total phosphate);
  - Sulfide;

  - Sulfate;
  - Iron; and
  - Total organic carbon.
- Completion of a soil boring from land surface to the top of the underlying clay layer at SB-110 for analysis of total lead.
- Collection of a soil sample from SB-107 from 11 to 13 ft bls for analysis of total lead, TCLP lead, and SPLP lead.

In addition to the above, a soil sample was collected at SB-140 from 1.5 to 2 ft bls on September 17, 2009, and at SB-107 from 11 to 13 ft bls on September 23, 2009. These two locations and intervals exhibited the highest lead concentration in the FRA and NPSA, respectively. Also, the 11 to 13 ft bls horizon was selected at SB-107 to determine the lead species in the white, paint-like materials, which are not present at SB-140. The soil samples were submitted to MicroVision Labs, Inc. of Chelmsford, Massachusetts for laboratory analysis of lead species utilizing scanning electron microscopy (SEM) and energy dispersive x-ray spectroscopy (EDX).

3.1.4.3 Second Round of Soil Vapor Sampling

Based on the results of the first round of soil vapor sampling conducted in October/November 2008, additional soil vapor sampling was conducted in July 2009 in accordance with the scope of work presented in the January 30, 2009 “Soil Vapor Sampling Report”. The scope of work completed within OU-2 included:

- Re-sampling of subslab soil vapor from SV-1 in Building 140;
- Sampling of soil vapor from SV-16 within an unimproved area to the west of the BCP site boundary to the west of SV-2;
- Sampling of soil vapor from SV-15 within a grassed area to the west of Babcock Street to evaluate the potential for migration of impacted soil vapor along the 72-inch municipal sewer in Babcock Street;
- Sampling of subslab soil vapor in the vicinity of sewer lines at SV-17 within Building 152 and SV-18 within Building 153; and
- Sampling of soil vapor from SV-19 within an unimproved area to the east of the main entrance to evaluate the potential for migration of impacted soil vapor along the sewer line that extends from Building 152 and 153 to Elk Street.

In accordance with the January 30, 2009 “Soil Vapor Sampling Report”, all samples were analyzed for VOCs via USEPA Method TO-15 and methane by modified ASTM 1946 (the modified method achieves a detection limit of 10 ppm_V). In addition, a separate summa canister was collected from soil vapor sample SV-1 for analysis of forensic parameters, including carbon and hydrogen isotopes and fixed gasses for assessment of the methane source (i.e., thermogenic versus biogenic). The results of samples collected within OU-2 are briefly discussed in Section 3.2.6. A more detailed description of the sampling completed, results and recommendations for additional sampling are presented in the document entitled "Second Round Soil Vapor Sampling Report and Scope of Work for Additional Sampling" dated November 6, 2009.

3.1.5 Bench Scale and Field Pilot Testing Completed in 2009

To evaluate potential remedial options for lead impacted and petroleum impacted soil in OU-2, bench scale and field pilot testing were conducted in accordance with the scope of work presented in the "Work Plan for Bench Scale and Field Pilot Testing in Operable Unit 2" dated March 23, 2009, and the "Lime Kiln Dust Field Pilot Testing Work Plan" dated October 7, 2009. A brief description of the bench scale and field pilot testing procedures, and deviations from the work plans, are provided below.

3.1.5.1 Bench Scale Testing for *In Situ* Stabilization of Lead Impacted Soil

Entact Environmental Services (Entact) performed bench scale testing of *in situ* stabilization technology on lead impacted soil collected during the week of April 27, 2009. Each soil sample was homogenized prior to being mixed with either EnviroBlend (a buffered, phosphate reagent for metal stabilization) or Triple Super Phosphate (TSP) at addition rates ranging from one percent to five percent to soil by weight. pH, total lead, TCLP lead, and SPLP lead were analyzed prior to and after treatment.

3.1.5.2 Bench Scale Testing for *In Situ* Treatment of Petroleum Impacted Soil

Entact and CETCO Remediation Technologies (CETCO) performed bench scale testing of *in situ* treatment of petroleum impacted soil collected during the week of April 27, 2009. Entact tested Portland Cement-Ground Granular Blast Furnace Slag grout (PC-GGBFS) and lime kiln dust (LKD) at addition rates of 10 percent and 15 percent to soil by weight. Each soil sample was homogenized prior to being mixed with either PC-GGBFS or LKD. Each soil-reagent mixture was tested for visual and olfactory observations of impact due to petroleum hydrocarbons (i.e., presence of separate-phase product, sheen or petroleum odor) prior to and after treatment. Volumetric expansion and hydraulic conductivity was determined after treatment. Unconfined compressive strength (UCS) was measured after 3, 7, 14 and 28 days of curing. The sample collected from the vicinity of boring SB-107, which exhibits high levels of lead, was also analyzed for pH, total lead, TCLP lead and SPLP lead prior to and after treatment.

CETCO originally intended the treatment to utilize organoclay only. However, CETCO modified the admixture to include lime Portland cement (LPC) and water to enhance the stabilization processes. The reagent addition rates, by weight, were as follows:

- 15.6 percent to 31.2 percent organoclay and 20.8 percent to 31.2 percent SPLP to SB-107 soil;
- 3.5 percent to 14.2 percent organoclay and 2.5 percent to 38.1 percent LPC to SB-116 soil; and

- 1.5 percent to 5.6 percent organoclay and 2.5 percent to 40.2 percent LPC to SB-120 soil.

Each soil sample was homogenized prior to being mixed with organoclay, LPC, and water. Visual and olfactory observations of impact due to petroleum hydrocarbons were determined for each soil sample prior to and after treatment. pH and oil and grease were determined for the initial soil-reagent samples prior to and after treatment. Hydraulic conductivity was measured after treatment. The sample collected from the vicinity of boring SB-107, which exhibits high levels of lead, was also analyzed for total lead and SPLP lead for the initial soil-reagent sample prior to and after treatment, and TCLP lead for all post-treatment samples.

3.1.5.3 Field Pilot Testing for *In Situ* Treatment of Petroleum Impacted Soil

During the week of April 27, 2009, Entact conducted field pilot testing of nitrate and Regenesis' RegenOx™ in accordance with the March 23, 2009 work plan. Plate 1 shows the two nitrate test plots (NIT-NTYA-NORTH and NIT-NTYA-SOUTH) and four chemical oxidation test plots (ISCOH-FRA, ISCOH-NTYA, ISCOL-FRA, and ISCOL-NTYA) that were completed. The locations were chosen to evaluate the performance of the reagents under field conditions to remediate areas identified as exhibiting moderate and high petroleum impacts. Field pilot testing was not performed in the NPSA to focus the performance evaluation on petroleum impacted soils (i.e., relatively low lead) only. An excavator was used to thoroughly mix the following quantities of each reagent *in situ* from approximately one foot below grade to the top of the native clay material:

- 800 gallons of 5 percent nitrate solution in two 30 foot by 30 foot test plots;
- 150 gallons of a water/RegenOx™ solution including 150 pounds of RegenOx™ (equivalent to 7.5 pounds of RegenOx™ per cubic yard of soil) in two 10 foot by 10 foot test plots; and
- 150 gallons of a water/RegenOx™ solution including 300 pounds of RegenOx™ (equivalent to 15 pounds of RegenOx™ per cubic of soil) in two 10 foot by 10 foot test plots.

Prior to the *in situ* mixing, each reagent was thoroughly dissolved in water in a portable tank. The solution was then introduced into the test plot via gravity flow. After the *in situ* mixing was completed, each test plot was covered with materials excavated from the top foot of each test plot that had been staged separately. Performance monitoring was conducted in accordance with the March 23, 2009 work plan prior to and at 12 weeks after nitrate addition, and prior to and at one week, four weeks, and 12 weeks after RegenOx™ addition.

Based on the favorable results of the bench scale testing, during the week of October 26, 2009, Entact conducted field pilot testing of LKD at four test plots in accordance with the October 7, 2009 work plan. Plate 1 shows the test plot locations (HIGH-5A LKD, HIGH-10 LKD, MOD-5 LKD, and MOD-10 LKD). The locations were chosen to evaluate the performance of LKD under field conditions to remediate areas identified as exhibiting moderate and high petroleum impacts. An excavator was used to thoroughly mix either 5 percent or 10 percent LKD to soil by weight *in situ*. Due to high groundwater table (approximately one ft bls) and deep clay layer (approximately 12 ft bls), the proposed test plot location for mixing high petroleum impacted soil with 5 percent LKD was moved to previously excavated test trench TT-41. After the *in situ* mixing was completed, the test plots were covered with materials excavated from the top one-half to one foot of each test plot that had been staged separately. Performance monitoring was conducted in accordance with the October 7, 2009 work plan prior to and on November 30, 2009 (33 days) after LKD addition. Excavation of the test plots for visual and olfactory observation by four representatives of the NYSDEC after approximately seven months was completed on May 20, 2010.

3.1.6 Test Pits and Bench Scale Testing Completed in 2016

To build upon previous bench and pilot testing, a test pit operation was conducted in January of 2016. The intent of the operation was to visually identify petroleum impacted soils in widely spaced explorations and to collect soil samples for additional bench scale treatability testing.

3.1.6.1 Test Pit Exploration

Under Amec Foster Wheeler supervision, GES excavated eight test pits designated TP-001 through TP-008 during a one day operation. The location of the test pits are shown on **Figure 15**. The test pits were excavated until the groundwater table was encountered. Soil samples from the explorations were collected and retained for a bench scale treatability testing program. Test pit records are included in **Appendix B**.

3.1.6.2 Bench Scale Treatability Testing for Lead Impacted Soils

A bench scale treatability study was conducted by Kemron Environmental Services, Inc. in January of 2016. The intent of the bench scale testing was to refine previous treatability mixes such that remedial goals and redevelopment objectives would be met. The remedial objectives for the bench scale testing were to reduce the lead leachability to less than five mg/L. Each soil sample was homogenized prior to being mixed with Portland cement or Portland cement with either high calcium lime kiln dust (HCLKD), Cement Kiln Dust (CKD) or GGBFS. Water was added at a rate of 50 percent by weight of reagent. PID readings and TCLP testing were analyzed prior to and after treatment. The reagent addition rates, by weight, were as follows:

- 4 percent Portland cement to TP-1 soil;
- 3.5 percent Portland cement to 8.0 percent HCLKD to TP-01 soil; and
- 3.5 percent Portland cement to 8.0 percent CKD to TP-01 soil.

3.1.6.3 Bench Scale Treatability Testing for Petroleum Impacted Soils

A bench scale treatability study was conducted by Kemron Environmental Services, Inc. in

January of 2016. The intent of the bench scale testing was to refine previous treatability mixes such that remedial goals and redevelopment objectives would be met. The remedial objectives for the bench scale testing were to address the visual and olfactory observations of impact due to hydrocarbons in petroleum impacted soils. A minimum UCS of 40 per square inch (psi) at twenty eight days was set as a redevelopment objective. Each soil sample was homogenized prior to being mixed with Portland cement or with Portland cement and either high calcium lime kiln dust or cement kiln dust. Water was added at a rate of 50 percent by weight of reagent. PID readings and TCLP testing were analyzed prior to and after treatment. The reagent addition rates, by weight, were as follows:

- 4 percent Portland cement to TP-3 soil;
- 2.5 percent Portland cement to 6 percent HCLKD to TP-3 soil;
- 3.5 percent Portland cement to 8 percent HCLKD to TP-3 soil; and
- 3.5 percent Portland cement to 8 percent CKD to TP-3 soil.

3.2 Environmental Conditions Within OU-2

The environmental conditions within OU-2 are described below based upon the results of all prior investigations.

3.2.1 Geology

The following is a general description of the geology of the entire Site with specific references to OU-2, as appropriate. One hydrogeologic cross section running west to east (A-A') through OU-2 is presented as **Figure 9** and two hydrogeologic cross sections running north to south (C-C' and D-D') through OU-2 are presented as **Figures 10** and **11**, respectively.

The former Buffalo Terminal is located within the Erie-Ontario Lowland physiographic region of the Interior Plains Division. In general, the region is underlain by Silurian and Devonian age interbedded shales, siltstones, sandstones, limestones and dolomites, dipping approximately degrees to the south.

Three unconsolidated deposits exist in OU-2. The first is a fill layer that consists of black cinders, silt, gravel, sand, slag, and varying amounts of concrete, brick, glass, and wood. The second unit, colored gray to brown, consists of alluvial deposits of silt (sandy silts to clayey silts), silts and clays, sands, sand and silt, and sand and gravel. Underlying the alluvial layer is a gray to brown glaciolacustrine clay. It should be noted that the layer of alluvial deposits is only present in portions of OU-2. Fill directly overlies the clay in major portions of OU-2 as shown on the cross sections. Bedrock was not encountered in any of the wells installed to date. However, during a review of the Buffalo Sewer Authority's Babcock Street records, a 1917 Plan for the Babcock Street Sewer Extension shows test borings with a clay layer approximately 25 to 30 feet thick and extending approximately 40 to 50 ft deep to bedrock in the area adjacent to the west edge of the Site.

The following generalization regarding OU-2 geology can be made from available information.

- Fill generally ranges from three to six feet thick, but there are localized areas where deeper fill material is present up to 15 feet below grade (i.e., within the Former Buffalo River Channel).
- The thickness of the alluvial deposits ranges from zero to five feet and is generally greater in the southern portion of the OU-2. This layer pinches out at the central portion of the Site and the depth to the top of the clay layer decreases northward. Fill directly overlies the clay layer throughout much of OU-2.
- The clay layer underlying the alluvial deposits is continuous throughout OU-2 based upon borings completed in the area. The depth to clay is approximately three to 15 feet below land surface in OU-2, but there are localized areas where the clay is at depths up to 15 feet below grade (i.e., within the Former Buffalo River Channel).

3.2.2 Hydrogeology

Based upon the water level and separate-phase product thickness data collected during prior investigations and recent quarterly groundwater monitoring (**Table 3**), the groundwater flow direction is generally south across OU-2 towards the Buffalo River. The groundwater gradient within OU-2 is relatively flat compared to the southern portion of the Site (OU-3). A recent groundwater flow map, including water level and separate-phase product data, is provided in Plate 3.

3.2.3 Separate-Phase Product

The results of the water-level and separate-phase product gauging from wells installed in 2007 and 2008, coupled with the results of previous investigations and on-going gauging of new and existing wells, have completed the delineation of separate-phase product across the OU-2. The current and historical limits of separate-phase product in all areas of the Site are presented on Plate 3. As shown on Plate 3, only two wells in OU-2 have shown evidence of separate-phase product (MW-35 in the NTYA and MW-38 in the NPSA). At MW-38, separate-phase product has been detected relatively consistently since it was installed in 2001, however the thickness and number of detections have generally decreased over time. On October 19, 2011, November 8, 2011, and June 6, 2012, separate-phase product was detected at thicknesses ranging from 0.02 to 0.03 feet. At MW-35, based on gauging data from 2007 through 2012, separate- phase product was only detected once at a thickness of 0.01 feet. Measurable separate-phase product was observed once in BTC-4, between July 1998 when the well was installed and January 2002 when the well was destroyed, on July 24, 1998 at a thickness of 0.01 feet. Separate-phase product was not detected during any of the subsequent eight gauging rounds. A slight sheen was observed during the development of well MW-50. Measurable separate-phase product was not encountered during gauging, nor was the sheen confirmed based on analytical results. Therefore, the historical data supports that free product is not recurrent at this location.

Also identified as part of separate-phase product observations in OU-2, separate-phase product was observed in two manholes gauged in OU-2 (MH-39 in the NTYA and MH-47 in the CRPA). These manholes are/were part of the active drainage system for OU-2. MH-39 was removed as part of pipe removal activities in 2006. At MH-39, separate-phase product was observed during 62 of 63 gauging rounds from April 2002 through July 2006. Product was recorded at thicknesses ranging from 0.01 feet (during 14 gauging rounds) to 1.35 feet (on April 15, 2002). At MH-47, separate- phase product was observed during 14 of 95 gauging rounds from April 2002 through June 2012, at thicknesses ranging from 0.01 feet to 0.03 feet. The locations of these catch basins are shown on Plate 3.

Petroleum impacted soil is present in OU-2, as described further in Section 3.2.4. Although separate-phase product has not been observed extensively in wells, indicating that the product is not mobile under current conditions, once the soil matrix is disturbed (e.g., during test pitting), separate-phase product has been observed to accumulate in open excavations.

3.2.4 Soil Quality

The evaluation of soil quality within OU-2 was performed considering both qualitative information generated from field screening results on the soil borings logs, as well as quantitative laboratory data generated from the extensive soil sampling and analysis programs performed during prior investigations.

3.2.4.1 Qualitative Assessment of Petroleum Impacted Soil

Using the qualitative information, an attempt was made to evaluate field observations for contaminated media as defined in Part 375 for OU-2. The following observations regarding petroleum impacted soil have been made based on visual and olfactory observations and PID screening results from soil boring and pipe removal activities, observation of sheen or separate- phase product in new and existing monitoring wells and test pitting performed in May 2008, and extensive test trenching performed in October 2008:

- Separate-phase product was observed within some excavations, most frequently in the interval shallower than four feet, in the western third of the FRA during pipe removal. The product was removed as a product/water mixture, allowed to separate, and the product was transferred to the on-site 8,000 gallon aboveground storage tank for later offsite disposal.
- Evidence of separate-phase product was observed in the interval zero to four feet below grade in six soil borings. One in the central portion of the BSPA, three in the northern half of the FRA, and two soil borings in the northern half of the NTYA.
- Evidence of separate-phase product was observed at deeper than four feet below land surface in three soil borings in the western and eastern portions of the BSPA, nine soil borings distributed throughout the majority of the FRA, three soil borings in the western portion of the NTYA, one soil boring in the western portions of the CRPA and AOOA and five soil borings distributed throughout the NPSA.
- PID readings and petroleum odor (varying in intensity) were observed by field personnel throughout OU-2 during the pipe removal activities.

- PID readings and petroleum odor (varying in intensity) were observed by supervising technical staff throughout OU-2 during all subsurface investigation work.
- Measurable separate-phase product is only present in MW-38 in the NPSA. Measurable product was observed during one gauging round at BTC-4 in 1998. Measurable product was observed during one gauging round at MW-35 in 2009. Separate-phase product was not encountered in any of the new wells installed in 2007 or 2008. A slight sheen was observed during development of MW-50, however, measurable separate-phase product was not encountered during gauging and analytical results from this well do not indicate the presence of sheen. Well development notes from the Site Investigation Completion do not indicate that sheen was present in any of the OU-2 wells during development. Historical gauging records indicate that sheen was observed in the NPSA in B-2MW in 1999 and 2001 and in BTC-5 in 2001.
- As shown on Plate 7, 21 test pits were performed in May 2008. NYSDEC observed the test pits to determine areas where, in their opinion, conditions met the Part 375 definition of grossly contaminated media. NYSDEC identified petroleum impacted soil in 17 of the 21 test pits. Test pits TP-8, TP-12, TP-19, and TP-20 were not considered petroleum impacted.
- As shown on Plate 7, 46 test trenches (totaling approximately 17,343 feet) were excavated in October 2008. NYSDEC observed all test trenching activities to determine areas where, in their opinion, conditions met the Part 375 definition of grossly contaminated media. NYSDEC identified petroleum impacted soil in all but 2,417 feet of test trenches performed. There were, however, areas of OU-2 where test trenching was not feasible due to the presence of concrete former tank foundations and other former concrete structures.

Based upon these observations, petroleum impacted soil is widespread throughout OU-2 in the zero to four foot depth interval and the greater than four foot depth interval. However, it is important to note that based on long-term gauging data, the occurrence of separate-phase product in monitoring wells is limited to MW-38 in the NPSA and once in MW-35 in the NTYA, the occurrence of separate-phase product in manholes is limited to sporadic occurrences in MH-39 in the NTYA and MH-47 in the CRPA, and the occurrence of sheen in the groundwater was only noted infrequently in wells in the NPSA.

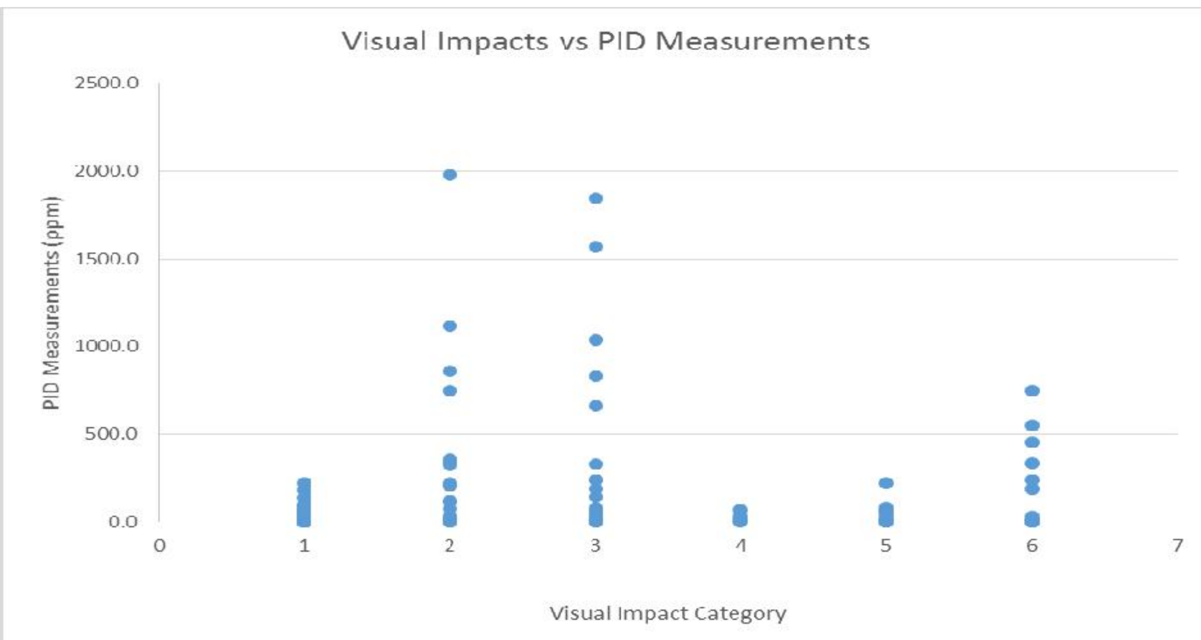
Soil remediation is largely driven by the need to address and remediate soil impacted by petroleum that meets the definition of grossly contaminated media (GCM). Title 6 NYCRR Part 375-1.2 (u) defines the term as follows:

> *"Grossly contaminated media" means soil, sediment, surface water or groundwater which contains sources or substantial quantities of mobile contamination in the form of* non-aqueous phase liquid *(NAPL), as defined in subdivision 375-1.2 (ac), that is identifiable either visually, through strong odor, by elevated contaminant vapor levels or is otherwise readily detectable without laboratory analysis.*

The significant determiner of GCM is that it is a media containing sources or substantial quantity of mobile contamination in the form of NAPL. Properties that will be significant will be those where NAPL can be detected in sufficient quantity and in an environment with potential for migration or mobility is evident. Detection of the GCM must be objective and reproducible and result in positive identification of free-phase liquid in soil or above groundwater. Furthermore, the measurement of unrelated facts leading to production of false positives must be avoided.

Although vapor levels may be monitored for health and safety purposes during those activities, evaluation of site data indicates photoionization detector (PID) data are not correlative to observed impacts indicative of GCM. The following graph is a summary of soil data that were generated during site assessment activities, where visual observations and PID measurements are provided for the same samples. In those observations, the following numeric code was equated to degree of soil impact, which enables plotting of those data:

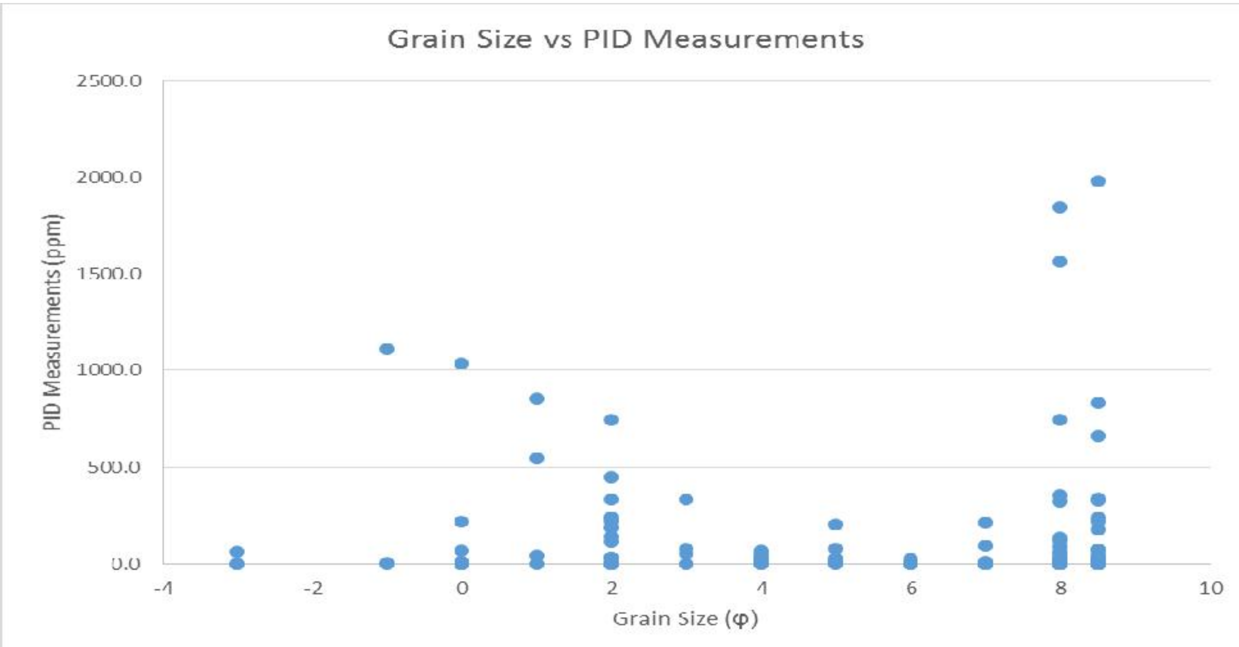
1. No Impacts
2. Odor
3. Staining
4. Sheen
5. Product Blebs, Globs, or Coatings
6. Product Present



PID measurements are indicative of odors. A trace quantity of petroleum may produce odor, but does not constitute “substantial quantities of mobile contamination if the form of NAPL”. In the above graph, the visually observed data are plotted directly against the PID measurements made on the same samples. The highest recorded PID measurements were recorded in the “Odor” (2) and “Staining” (3) categories. Neither of these categories meet the above definition of “*contains sources or substantial quantities of mobile contamination in the form of NAPL*”. While these PID data are effective at identification of low-molecular weight, volatile petroleum hydrocarbons, they are not necessarily suitable for the identification of liquid phase hydrocarbons, which may or may not contain significant concentrations of volatile organic compounds.

PID measurements were also plotted against soil grain size. The grain size of the formation that had been logged with the PID measurements were transformed to phi-size units to provide a logical numeric system to represent the grain size information on the graph. A phi-size of -3 to -1 represents gravel to sand and gravel, while 7 represents silty clay and 8.5 represents mottle clay.

Data indicate the PID measurements range from 0 to 1,100 ppm in coarse sand. The maximum PID concentrations decrease with increasing grain size from coarse sand to fine sand to silt. However the portions of soil with the finest grain size, silty clay and clay, included the PID concentrations with the greatest range. PID concentrations for the silty clay and clay ranged from 0 to 1,980 ppm.



Based on this evaluation, no correlation is found between grain size and PID measurements other than finer grain soil tends to contain more volatile organic compounds than the coarser soil. The active mechanism is likely the trapping of hydrocarbons and restricting the movement and ultimate degradation of the products. Similar to the previous comparison, this was not an indication of free phase liquid and/or mobile hydrocarbons.

3.2.4.2 Quantitative Assessment of Soil Quality

Tables 4 through **9** summarize analytical results for VOCs, SVOCs, metals, TCLP and SPLP lead, total petroleum hydrocarbons (TPH), and PCBs, respectively, for the soil samples collected during all investigations in OU-2. Soil quality data from all investigations has been compared to the unrestricted, commercial, and industrial soil quality criteria presented in **Table 10**. The commercial and industrial use soil criteria presented in **Table 10** are the respective restricted use criteria for protection of human health presented in Part 375, as described in greater detail in Section 5. This comparison enables identification of areas that may pose a potential risk under:

- An unrestricted land use scenario, which is not consistent with the reasonably anticipated future use of OU-2, given that use would require an upgrade to the current zoning and is not consistent with the preferred site plan developed by the Elk Street Corridor Redevelopment Plan regarding reasonably anticipated future use of OU-2;

- A commercial land use scenario, which is not consistent with the current zoning and land use or with the proposed future continued industrial land use for the Buckeye Terminal and land east of the terminal, but is consistent with the portions of the Elk Street Corridor Redevelopment Plan that allows for commercial uses west of the Buckeye Terminal regarding reasonably anticipated future use of OU-2; or
- An industrial land use scenario, which is consistent with the current zoning, current land use, and reasonably anticipated future use of OU-2, and is generally consistent with the proposed land use for the area presented in the City of Buffalo LWRP (which allows for commercial/light industrial use), and portions of the Elk Street Corridor Redevelopment Plan for the Buckeye Terminal and land east of the terminal (which allows for light industrial uses), but is not consistent with the portions of the Elk Street Corridor Redevelopment Plan that allows for commercial uses west of the Buckeye Terminal.

Four summary maps (Plates 8 through 11) were prepared using the analytical database and Environmental Systems Research Institute, Inc., and Arc Geographic Information System Software. These maps compare soil concentration data for VOCs, SVOCs, TPH and metals (except arsenic), respectively, from previous investigations relative to the unrestricted, commercial, and industrial cleanup criteria. The results for TPH, which does not have a cleanup criteria, are presented as concentration ranges. On Plates 8, 9, and 11, only the highest exceedance of a particular criteria is shown at each sample location at different depth intervals, even though more than one constituent may have exceeded the criteria. Plates 8 through 11 present the available data in the following depth intervals in order to provide an indication of the depth at which impacts were observed in various portions of OU-2:

- Zero to two ft bls;
- Two to 15 ft bls (further broken down to smaller intervals as defined below);
- Two to four ft bls;
- Four to six ft bls;
- Six to ten ft bls; and
- Ten to 15 ft bls.

Plates 4, 5, and 6 present a summary of arsenic, mercury, and lead data.

The rationale for selecting soil sample locations during previous investigations was to evaluate potential impacts from previous and/or current Site operations. In some cases, elevated concentrations of petroleum-related compounds were observed at the sample locations selected based on historical and current locations of structures, tanks, WHAs, and Site operations, indicating impacts from these operations.

In general, the soil quality in OU-2 has been impacted by former refinery and terminal activities, as well as historical non-petroleum uses and background influences. VOCs, SVOCs, and metals are present in the soil at shallow and deep intervals, some exceeding one or more of the criteria to varying degrees, across OU-2. In addition, lead exceeding the regulatory limit for hazardous waste is present in limited portions of the NTYA and NPSA. TPH is also present throughout OU-2 at varying concentrations.

The highest petroleum-related impacts were observed in samples collected during pipe removal activities, in the vicinity of former and/or current tanks, and some of the former WHAs. The highest metals concentrations are present in the eastern portion of the NPSA where previous land uses included white lead production and paint and varnish manufacturing, among others that likely resulted in lead impacts (as discussed further in Section 3.2.4.3). During the SFI Completion, soil samples were collected continuously from five feet below ground surface to five feet below the water table or to a minimum of seven feet below grade if the water table was encountered less than two feet below ground surface. If significant impacts were observed at the completion depth, the borings were continued with samples collected at two-foot intervals to define the vertical extent of impact. The maximum sample depth was 15 ft bls at four locations.

3.2.4.2.1 VOCs – Shallow Interval

As shown on Plate 8, exceedances of the unrestricted use criteria were observed:

- In the eastern portion of the BSPA (in the vicinity of former tanks);
- In the northwest and southwest portions of the FRA (in the vicinity of former loading racks and former tanks, respectively);
- Throughout the majority of the NTYA (in the vicinity of former tanks);
- In the northeast portion of the AOOA (between the warehouse and laboratory); and
- In the portion of the NPSA east of the main entrance road, to the west, southeast and south of the former Biotreatment Cell (in the vicinity of former tanks and within and to the east of a former WHA).

There were no exceedances of the unrestricted use criteria in the only boring collected on the portion of the CRPA that lies within OU-2.

Also shown on Plate 8, there were no exceedances of VOCs relative to the commercial or industrial criteria. The highest concentrations of individual VOCs were observed in the vicinity of former tanks in the BSPA, the western portion of the FRA, and the western portion of the NTYA, and in the vicinity of the former loading racks in the northwest corner of the FRA.

3.2.4.2.2 VOCs – Deep Interval

As shown on Plate 8, concentrations of VOCs generally decreased with depth. Exceedances of the unrestricted use criteria were observed:

- At up to ten ft bls in the BSPA, in the vicinity of the former pipe tunnel;

- At up to ten ft bls in various portions of the FRA;
- At up to ten ft bls in the western half of the NTYA;
- In the six to ten foot depth interval in the CRPA;
- In the four to six foot depth interval in the western portion of the AOOA; and
- Up to 15 ft bls in the NPSA, in the vicinity of the former Biotreatment Cell.

The highest concentrations of individual VOCs relative to the unrestricted use criteria were detected for benzene and total xylenes in the two to four ft bls interval in samples collected during pipe removal activities in the western portion of the FRA. The depth to which borings were completed to define the vertical limits of impact varied across OU-2, as reflected in Plates 8 through 11. The deepest sample interval shown on the plates is 10 to 15 ft bls, where only 11 samples were collected based on field screening of samples. This small amount of samples across the entire area of OU-2 indicates that impacts decreased with depth. Of these 11 samples, only one (SB-107) indicated volatile organic compound (VOC) impacts above the unrestricted use criteria at the deepest sample depth (13 to 15 ft bls for benzene). At the other location (SB-108), the concentration of total xylenes at 9 to 11 ft bls was equal to the unrestricted use criteria of 260 mg/kg.

There was only one exceedance of the commercial criteria in the vicinity of former tanks in the northwest portion of the FRA in the two to four foot depth interval. Similar to the shallow interval, no VOCs were detected above the industrial criteria in any depth interval greater than two ft bls.

3.2.4.2.3 SVOCs – Shallow Interval

As shown on Plate 9, exceedances for SVOCs of the three criteria were observed across the majority of OU-2. In the BSPA, exceedances of all three criteria were observed along the western border, whereas exceedances were more widespread across all other areas. The highest concentrations of individual SVOCs exceeding any criteria were observed in the vicinity of former tanks in the FRA and NTYA, and to the east of the former Biotreatment Cell. SVOCs with the highest concentrations exceeding any criteria in various portions of OU-2 were dibenzo[a,h]anthracene, benzo[b]fluoranthene, benzo[a]anthracene, chrysene, indeno [1,2,3cd] pyrene, benzo[a]pyrene, and benzo[k]fluoranthene.

3.2.4.2.4 SVOCs – Deep Interval

As shown on Plate 9, semi volatile organic compound concentrations decreased with depth. Exceedances of any of the three criteria were observed:

- At up to ten ft bls for all three criteria in the BSPA in the vicinity of the former pipe tunnel and in samples collected during pipe removal activities;
- At up to ten ft bls for all three criteria in various portions of the FRA;
- At up to six ft bls for all three criteria in various portions of the NTYA;
- At up to ten ft bls for the unrestricted use criteria at SB-114 and SB-119 in the NTYA, with no exceedances of the other two criteria;

- At up to ten ft bls for all three criteria at SB-122 and SB-133 in the NTYA;
- At up to 15 ft bls for all three criteria at SB-124 in the NTYA;
- In the six to ten foot depth interval in the CRPA for the unrestricted use criteria, with no exceedances of the other two criteria;
- In the four to six foot depth interval for all three criteria in the western portion of the AOOA; and
- At up to ten ft bls in the NPSA in the vicinity of former tanks to the east and west of the main entrance road and in the vicinity of the former Biotreatment Cell.

The highest concentrations of individual SVOCs exceeding any criteria were detected in the two to four foot depth interval in samples collected in the vicinity of former tanks and during pipe removal activities, and in the four to six foot depth interval in the vicinity of former tanks in the NTYA, NPSA, and AOOA. SVOCs with the highest concentrations exceeding any criteria in various portions of OU-2 were dibenzo[a,h]anthracene, benzo[b]fluoranthene, benzo[a]anthracene, chrysene, indeno[1,2,3-cd]pyrene, benzo[a]pyrene and benzo[k]fluoranthene. Concentrations of SVOCs were non-detect or below the three criteria in all samples collected between ten and 15 ft bls, except at SB-124 in the NTYA, which is in the vicinity of a former tank. Several SVOCs were detected at SB-124 in the 11 to 13 foot depth interval above the unrestricted use criteria, while only benzo[a]pyrene exceeded the commercial and industrial criteria.

3.2.4.2.5 Total Petroleum Hydrocarbons – Shallow Interval

As presented on Plate 10, total petroleum hydrocarbons-gasoline range organics (TPH-GRO) and total petroleum hydrocarbons-diesel range organics (TPH-DRO) were sampled in numerous locations across OU-2 during the Site Investigation Completion and during the pipe removal activities. Plate 10 presents TPH data relative to concentration ranges since there is no criteria for TPH in Part 375.

In general, TPH-GRO was detected at fewer locations and at lower concentrations than TPH-DRO across OU-2 in the shallow interval. TPH-GRO was detected in approximately 50 percent of the samples collected in the shallow interval ranging in concentration from less than one mg/kg to 7,000 mg/kg. TPH-DRO was detected in approximately 95 percent of the samples ranging in concentration from 65 mg/kg to 85,000 mg/kg.

3.2.4.2.6 Total Petroleum Hydrocarbons (TPH) – Deeper Interval

Similar to the shallow interval, concentrations of TPH-GRO were generally lower than concentrations of TPH-DRO in all depth intervals; however, both TPH-GRO and TPH-DRO were detected in the majority of the locations sampled in the deeper interval. Concentrations of both TPH-GRO and TPH-DRO decreased with depth, as summarized below:

- In the two to four feet depth interval: TPH-GRO was detected at concentrations ranging from less than one mg/kg to 7,270 mg/kg, and TPH-DRO was detected at concentrations ranging from 41.2 mg/kg to 81,000 mg/kg;

- In the four to six feet depth interval: TPH-GRO was detected at concentrations ranging from less than one mg/kg to 3,400 mg/kg, and TPH-DRO was detected at concentrations ranging from 5.2 mg/kg to 51,300 mg/kg;
- In the six to ten feet depth interval: TPH-GRO was detected at concentrations ranging from less than one mg/kg to 2,400 mg/kg, and TPH-DRO was detected at concentrations ranging from 41 mg/kg to 44,500 mg/kg; and
- In the ten to 15 feet depth interval: TPH-GRO was detected at concentrations ranging from less than one mg/kg to 410 mg/kg, and TPH-DRO was detected at concentrations ranging from 79 mg/kg to 3,700 mg/kg.

The highest concentrations of TPH were detected in deeper soils during pipe removal activities and in the vicinity of former tanks and former refinery process units.

3.2.4.2.7 Metals – Shallow Interval

As shown on Plate 11 (all metals except arsenic) and Plates 4 (arsenic), 5 (mercury) and 6 (lead), the distribution of elevated metals concentrations in the shallow interval is more widespread and more randomly distributed across the Site than the distribution of elevated VOCs and SVOCs. Exceedances of the unrestricted use criteria are widespread across all areas of OU-2 in the shallow interval. The only exceedances of the commercial use criteria are at two locations in the southwest corner of the FRA (one for mercury and one for lead and mercury), at one location in the western portion of the AOOA (for nickel), at one location in the central portion of the NTYA (for lead) and at ten locations on the north portions and eastern border of the NPSA (one for cadmium, lead, and mercury, and nine for lead). The TCLP regulatory threshold for hazardous waste (5 ppm) for lead was exceeded at several locations across OU-2, and is discussed in detail in Section 3.2.4.3. As a note, in the initial OU-2 AAR dated April 13, 2007, a metals exceedance was shown at boring location SB-51. However, based on further review of the data, there were no exceedances for metals at this location. Plate 11 has been modified accordingly.

The only metals with concentrations that exceeded the industrial criteria are lead, mercury and arsenic. The exceedances for lead and mercury are at two locations in the southwest corner of the FRA (one for lead and mercury and one for mercury only), and at five locations on the eastern border of the NPSA (one for mercury and five for lead). The additional delineation sampling conducted in 2007 confirmed that the exceedances for lead in the southwest corner of the FRA and mercury in the FRA and NPSA are very localized. The TCLP regulatory threshold for hazardous waste (5 ppm) for lead was exceeded at several locations across OU-2, and is discussed in detail in Section 3.2.4.3. As a note, in the initial OU-2 AAR dated April 13, 2007, a metals exceedance was shown at boring location SB-51. However, based on further review of the data, there were no exceedances for metals at this location. Plate 11 has been modified accordingly.

Arsenic was present in all samples collected in 2007 at relatively low levels. Concentrations ranged from 2.38 mg/kg to 42.8 mg/kg. The average arsenic concentration was 12.6 mg/kg. Only eight of the 55 samples collected exceeded the mean background concentration for the Seneca-Babcock neighborhood (19 mg/kg), presented in the NYSDOH report entitled "Seneca- Babcock Neighborhood Soil Sampling Program Results of December 1994 Sampling Final Technical Report" dated July 1998. The range of arsenic concentrations observed during the NYSDOH study was 6 mg/kg to 97 mg/kg. The distribution of arsenic is random across OU-2, does not appear to be related to former petroleum refinery, distribution or storage operations, and is likely due to urban fill present throughout OU-2, the Site in general and this area of Buffalo.

As shown on Plate 4, arsenic concentrations exceeded the unrestricted use criteria in 24 of the 65 samples collected. However, it is important to note that except for one sample location (SB-OU2-24N exhibits 42.8 mg/kg of arsenic, which is 3.29 times the unrestricted use criteria), concentrations of arsenic exceeded the criteria by two times or less. Exceedances of the unrestricted use criteria were observed in all geographic areas of OU-2 except the FRA, and do not appear to be related to former petroleum refinery, distribution or storage operations.

As shown on Plate 4, relative to the commercial and industrial use criteria (which are the same), arsenic concentrations exceeded both criteria in 14 of the 65 samples. Again, it is important to note that except for one sample location (SB-OU2-24N, at 2.68 times the commercial/industrial use criteria), concentrations of arsenic exceeded both criteria by less than two times. Exceedances of the commercial/industrial use criteria were observed in all geographic areas of OU-2 except the FRA, and do not appear to be related to former petroleum refinery, distribution or storage operations.

3.2.4.2.8 Metals – Deeper Interval

As shown on Plate 11, exceedances of the unrestricted use criteria were observed:

At up to 15 ft bls in the BSPA in the vicinity of the former tanks or from samples collected during pipe removal activities (the highest exceedance occurring in the two to four foot depth interval from a sample collected during pipe removal activities for mercury);

- At up to 15 ft bls in various portions of the FRA;
- At up to 15 ft bls in a sample in the northeast portion of the NTYA in the vicinity of former tanks;
- In the six to ten foot depth interval in the CRPA;
- In the two to four foot depth interval in one sample to the southwest of the warehouse building in the AOOA; and
- At up to 15 ft bls east of the former Biotreatment Cell in the NPSA.

Exceedances of the commercial criteria were observed:

- In the two to four foot depth interval in the BSPA in a sample collected during pipe removal activities for mercury;
- In the two to four foot depth interval in two samples in the FRA;

- In one sample in the four to six feet depth interval in the NTYA;
- In one sample in the ten to 15 feet depth interval in the NTYA; and
- At up to 15 ft bls to the east of the former Biotreatment Cell in the NPSA.

Exceedances of the industrial criteria were observed:

- In the two to four foot depth interval in the BSPA in a sample collected during pipe removal activities for mercury;
- In one sample in the ten to 15 feet depth interval in the NTYA; and
- At up to 15 ft bls to the east of the former Biotreatment Cell in the NPSA.

As a note, arsenic was not sampled in the deeper interval.

The highest concentrations (i.e., greater than 100 times criteria) of individual metals exceeding either the commercial or industrial criteria were observed:

- In the two to four foot depth interval in the BSPA in a sample collected during pipe removal activities for mercury; and
- In the ten to 15 foot depth interval east of the former Biotreatment Cell in the NPSA for lead.

3.2.4.2.8 Polychlorinated Biphenyls (PCBs)

Selected locations within OU-2 in the NPSA were analyzed for PCBs. PCBs were detected at five of 12 locations in the zero to two foot depth interval and at one of five locations deeper than two ft bls. Total PCBs in surface soil (0 to 0.5 feet below land surface) at location BTC-5 was the only detection to exceed both the unrestricted and commercial use criteria. Additional samples were collected from the zero to one foot bls interval in order to further delineate PCBs around BTC-5, which had erroneously been identified as an exceedance of the industrial criteria for PCBs in the shallow interval in the original and revised versions of the AAR for OU-2. In fact, the PCB concentration at BTC-5 only slightly exceeded the commercial criteria (1 mg/kg) and was well below the industrial criteria (25 mg/kg), which applies to this portion of OU-2. The additional PCB samples collected in three locations around BTC-5 indicated non-detect concentrations of PCBs and confirmed that the exceedance of the commercial criteria at BTC-5 was an isolated occurrence. The presence of PCBs in this area of the Site is potentially due to the staging of PCB-containing electrical equipment during demolition of the refinery. However, it should be noted, that results of the soil and groundwater samples collected in 2007 did not indicate the presence of PCBs. Furthermore, although a previously collected groundwater sample from SB-109 indicated the presence of PCBs, the groundwater sample was collected from a Geoprobe® boring and was not filtered. Therefore, the PCB detection could have been the result of sediments in the sample. Based upon this information, ExxonMobil contends that there is no PCB issue in this area.

3.2.4.2.10 Tetraethyl Lead and Hexavalent Chromium

Tetraethyl lead was analyzed in four locations within OU-2 during one or more of the investigations completed at the Site. Tetraethyl lead was not detected in any of these samples. Total lead in these samples ranged from 497 mg/kg to 2,660 mg/kg. Hexavalent chromium was analyzed in a total of 11 locations in the NPSA and NTYA during the SFI. Hexavalent chromium was not detected in any of these samples.

3.2.4.3 Characterization and Delineation of Lead Impacts within OU-2

Plate 6 summarizes the distribution of total lead and the TCLP and SPLP lead results across OU-2, based on previously and newly collected data. Plate 6 presents the available data in the following depth intervals in order to provide an indication of the depth at which lead impacts were observed in various portions of OU-2:

- Zero to five ft bls (shallow interval);
- Five to 10 ft bls (intermediate interval); and
- Greater than 10 ft bls (deep interval).

The distribution of total lead and TCLP lead in the portion of OU-2 located west of the Buckeye Terminal entrance road and administration offices (i.e., in the NTYA, FRA, BSPA, AOOA, and CRPA) is characterized as follows:

- Total lead concentrations were less than the commercial criteria (1,000 mg/kg) at all 34 locations and depth intervals sampled during the 2008 and 2009 investigations, with the exception of 2,720 mg/kg of lead detected at boring SB-OU2-70 from zero to two ft bls. In addition, the only four locations (NTY-T22, SB-124, SB-131, and SB-140) that exceeded the commercial criteria for lead during prior investigations did not exceed the criteria during re-sampling performed in 2008 and 2009.
- The sample at SB-124, from four to six ft bls, exhibited 16.8 mg/L of TCLP lead and was the only location to exceed the TCLP criteria of five mg/L. The total lead concentration in that sample was 629 mg/kg. The ring of sampling locations within the five to 10 feet depth interval that surrounded SB-124 all exhibited total lead that was less than 100 mg/kg. Therefore, the anomalous TCLP exceedance at SB-124 is localized and delineated.
- Total lead concentrations were less than the industrial criteria (3,900 mg/kg) at all 34 locations and depth intervals sampled during the 2008 and 2009 investigations. The re- sampled locations included SB-140 from zero to two ft bls and SB-124 from 11 to 13 ft bls, the two locations and depth intervals where total lead exceeded the industrial criteria during prior investigations. The previously detected lead concentrations were respectively 4,210 mg/kg and 9,380 mg/kg.

The distribution of total lead, TCLP and SPLP lead in the portion of OU-2 located east of the Buckeye Terminal entrance road and administrative offices (i.e., in the NPSA) is characterized as follows:

- Total lead concentration exceeded the commercial criteria (1,000 mg/kg) and industrial criteria (3,900 mg/kg) at several locations and at multiple depth intervals along and near the eastern boundary of OU-2. Thirteen samples also exceeded the TCLP criteria of five mg/L. These results show that the area of elevated lead concentrations in soil identified during prior investigations is delineated and limited to the far east central portion of OU- 2. Within the area of elevated lead concentrations, the areal distribution of criteria exceedances varies based upon depth interval as described below.
- Within the shallow interval (0-5 ft bls), the exceedances of the industrial criteria and the TCLP criteria are limited to an area approximately 200 feet long and less than 100 feet wide, extending southwesterly along the property line from points SB-OU2-57 to SB-OU2-65. Outside of this area, there were isolated exceedances of the commercial and TCLP criteria at SB-OU2-41 in the northeast corner of OU-2, and at locations SB-OU2-43 and SB-OU2-45 in the north central portion of OU-2.
- Within the intermediate interval (5-10 ft bls), the only exceedance of the industrial criteria was at SB-107 (in a sample from the 2001 investigation). Total lead exceeded the commercial criteria within the eastern portion of the NPSA at SB-OU2-51, SB-OU2-52, SB-107, and SB-110 from samples collected during the 2008 and 2009 investigations, and at SB-105 in a sample from the 2001 investigation. TCLP criteria exceedances were detected at SB-110 and TP-33. A TCLP criteria exceedance was also detected at SB-OU2-44, where the total lead did not exceed the commercial criteria.
- Samples from the deep interval (>10 ft bls) were collected at a limited number of locations due to the prevalence of clay at depths of less than 10 feet throughout the majority of OU-2. Exceedances of the industrial criteria and TCLP criteria are focused at SB-107, SB-107W and SB-107E. The TCLP criteria was also exceeded at nearby location SB-OU2-46.
- The highest concentrations of total lead (450,000 mg/kg) and TCLP lead (614 mg/L) within OU-2 were detected at SB-107 and SB-107E, respectively. It was observed that the samples at SB-107, as well as some of the other samples exhibiting elevated lead concentrations, contained white, paint-like material that was suspected as being related to the historical white lead manufacturing and lead paint operations of prior land owners within the NPSA. These historical paint-related industries and their significance on lead occurrence in the area are discussed further below in the lead speciation section.
- Five samples that exceeded the TCLP criteria of five mg/L were subsequently analyzed for SPLP lead. The SPLP lead concentrations ranged from less than 0.007 mg/L to a maximum of 0.151 mg/L, and were in all instances orders of magnitude less than the corresponding TCLP lead concentration. The significance of these results is further discussed below in the lead speciation section.

3.2.4.4 Lead Speciation within OU-2

Tables 11 and **12** present the laboratory results for organic lead, sulfate, phosphorous, sulfide, total phosphate, total organic carbon, and total iron from select soil samples within OU-2. These data, in conjunction with the groundwater field parameters and analytical results that were collected in January 2009 and presented in **Table 13**, were utilized to better understand the subsurface geochemical conditions and lead speciation within OU-2. In turn, this information was then used to further describe the historical operations that were the sources for the lead, as well as explain why significant concentrations of lead is not leaching to groundwater even though the soil exhibits high TCLP lead concentrations.

The field parameters, laboratory results, and the consistently low to non-detect levels of dissolved lead measured in groundwater samples collected from monitoring wells, indicate the subsurface environment within OU-2 is not conducive to lead dissolution and transport. First, lead is sparingly soluble at near neutral pH, and the groundwater pH ranged from 6.80 to 7.25. Second, the significant concentrations of ions that bind and precipitate dissolved lead (i.e., phosphate, sulfide, and iron) also decrease lead solubility. Third, the reducing groundwater and the iron, phosphate, and sulfate present in the soil maintain an environment rich in constituents that control lead mobility. Last, mobilization of dissolved lead is further reduced by adsorption onto iron oxides and clay in the soil.

The concentration of organic lead was less than 0.5 percent of the total lead detected in each of the five soil samples that were analyzed. Organic lead is therefore not a significant lead species within OU-2.

The results of the above investigations provide that nearly all of the lead within OU-2 is present as inorganic lead in soil. As shown on Plate 6 and discussed in Section 3.2.4.3, TCLP lead exceedances were detected only in the NPSA and at SB-124, which are areas that exhibited elevated levels of total lead. High concentrations of total lead, however, did not always correlate with TCLP lead exceedances. For example, at SB-OU2-45 in the zero to two feet depth interval, total lead was 3,510 ppm but TCLP lead was only 0.414 mg/L. In order to determine if the extent of TCLP lead exceedances could be attributed to the types of inorganic lead species within OU-2, soil samples from SB-107 and SB-140 were analyzed using SEM and EDX. The lead speciation results show that the SB-107 bulk soil contains lead oxide and lead carbonate in the form of elongated, needlelike crystals. Lead bearing particles were also detected in the SB-107 bulk soil, and were the only type of lead present in the SB-140 bulk soil. In striking contrast to the elongated, needlelike crystals of the lead oxide and lead carbonate, the lead bearing particles are small, round, and iron-rich. When the white, paint-like material in the SB-107 sample was segregated from the bulk soil and analyzed by SEM and EDX, organic binder and mineral filler common for paint, and a percentage of lead oxide and lead carbonate greater than the bulk soil, were identified. Although the type of lead in the lead bearing particles could not be identified, the SEM and EDX results clearly showed that lead oxide and lead carbonate are present at SB-107, particularly within the white, paint-like material.

These findings indicate that the TCLP lead exceedances in soil in the NPSA are due to the presence of significant quantities of lead oxide and lead carbonate, two lead species that are dissimilar in morphology and leachability from the lead bearing particles that appear throughout OU-2. The justifications for this conclusion are discussed below.

The most likely sources of lead oxide and lead carbonate are the waste materials disposed by the paint-related industries that were located within and adjacent to the NPSA (i.e., Kellogg Paint & Varnish, Buffalo Oil Paint & Varnish, McDougall White Lead Company, McDougall Paint Company, and McDougall Varnish Company, as shown on the 1900 and 1917 Sanborn™ maps and indicated on Plate 6). These waste materials, which were excavated from SB-107 during the collection of soil samples for the bench scale testing, include colored (mostly white), paint-like material, pieces of broken wooden casks, rubber plugs, and metal cans, and are consistent with waste materials potentially generated by the aforementioned paint-related industries. The McDougall White Lead Company, the McDougall Paint Company, and the McDougall Varnish Company had manufactured "white lead" (i.e., lead carbonate) that was used as a pigment in paint. As described in "The Lead and Zinc Pigments" by Clifford Dyer Holley (First Edition, 1909), the process of making white lead involved exposing metallic lead stored in a vessel (e.g., wooden cask) to weak acetic acid in a heated atmosphere enriched in carbon dioxide. The metallic lead slowly corrodes and is transformed into white lead. White lead dissolves in acid but does not react in air or water, so waste white lead in white paint or in soil would remain relatively unchanged and free in the subsurface (i.e., not bound tightly to the soil matrix), as indicated by the SEM and EDX results. On the other hand, the SEM and EDX results revealed the lead bearing particles are adsorbed to mineral particles or sequestered inside mineral aggregates. Thus, when the soil sample is subjected to TCLP analysis, the white lead (either in the soil or the organic binder) is readily extracted by the acidic solution and will be detected, whereas the lead in the lead bearing particles is unavailable for extraction and thus will not be detected.

There are two explanations for the much lower SPLP lead concentration observed in soil samples that exhibited high TCLP lead concentration. The first explanation is that the SPLP method simulates natural precipitation using sulfuric and nitric acid, both inorganic acids. In contrast, the TCLP method simulates leachates in a sanitary landfill using acetic acid, an organic acid. The organic binder within the paint-like material could be more susceptible to dissolution by the TCLP extraction fluid (like dissolves like), resulting in the extraction of a large quantity of lead oxide and lead carbonate that are then detected as TCLP lead. The second explanation is that the TCLP extraction fluid is buffered (i.e., the pH does not change greatly upon mixing with soil), while the SPLP extraction fluid, designed to simulate natural precipitation, is not a buffered solution. Therefore, the buffering capacity of the soil would change the pH of the TCLP extraction fluid slightly and not affect lead dissolution, but could raise the pH of the SPLP extraction fluid to near neutral and suppress lead dissolution. This phenomenon was demonstrated in a laboratory study for the USEPA, as noted in a Texas Natural Resource Conservation Commission interoffice memorandum on when to use TCLP or SPLP test to demonstrate the leaching potential of contaminants, dated October 28, 1998.

In summary, the leachable lead in the NPSA, as indicated by the TCLP lead exceedances, is the result of lead carbonate and lead oxide that are extractable and detectable under the chemical conditions that the TCLP method was designed to simulate (i.e., leachates in a sanitary landfill).

Lead across OU-2, however, is exposed to conditions that are much more similar to those simulated by the SPLP method (i.e., natural precipitation). The SPLP lead results indicate that the leachable lead species (i.e., lead carbonate and lead oxide) have a low potential for dissolution, in agreement with the consistently low dissolved lead concentrations measured in OU-2 groundwater.

3.2.5 Groundwater Quality

Tables 14 through **17** summarize analytical results for VOCs, SVOCs, metals and PCBs, respectively, for the groundwater samples collected during all investigations in OU-2. It should be noted that although the groundwater beneath the OU-2 is classified as Class GA, the groundwater is present as a thin layer perched above the silty clay, is not a current or proposed source of drinking water and will not be used as such under any reasonably foreseen development scenario. Plate 12 presents a summary of ongoing quarterly Site-wide sampling results between April 2011 and April 2012.

VOCs

Based on groundwater data collected during previous investigations and during the ongoing quarterly sampling program at the Site, the concentrations of VOCs and SVOCs are lower along the upgradient (or northern) portion of OU-2, and higher towards the southern border of OU-2 with OU-3. The highest VOC concentrations and the most exceedances of NYSDEC Ambient Water Quality Standards and Guidance Values (AWQSGV) for Class GA groundwater in OU-2 have historically been observed in B-5MW (RR) in the AOOA and have more recently been observed in MW-48 in the NTYA. Elevated VOC concentrations in this area are likely due to previous refinery and rail processing operations in the immediate vicinity of these wells. Based upon the ongoing quarterly sampling for NYSDEC Spills Technology and Remediation Series list compounds, relatively low-level exceedances of NYSDEC AWQSGV for Class GA groundwater were observed between April 2011 and April 2012 in MW-34 and MW-47 in the FRA, MW-48 in the NTYA, B-5MW (RR) in the AOOA, and MW-50 in the NPSA, again due to previous site operations in these areas.

As a note, in accordance with the work plan dated August 20, 2007, the new monitoring well MW-49 was installed in September 2007 in order to assess the groundwater conditions upgradient of B-5MW (RR), and to assess potential impacts due to petroleum impacted soils observed during pipe removal activities. The results from this well indicate no exceedances of AWQSGVs for VOCs or SVOCs.

Based upon this groundwater data, there are only limited VOC impacts to groundwater in OU-2.

SVOCs

SVOCs at concentrations exceeding AWQSGVs were detected in several monitoring wells and Geoprobe® borings located throughout OU-2 during previous investigations. As shown on Plate

12, the only detection of SVOCs between April 2011 and April 2012 was at MW-38. Chrysene was detected at 4.7 □g/L, which exceeds the AWQSGV value of 0.002 µg/L.

Based upon this groundwater data, SVOCs in groundwater are not a significant issue in OU-2.

Metals

Metals are not sampled from monitoring wells on a regular basis. The most recent samples were collected in September 2007 for all Part 375 parameters. Filtered and unfiltered lead are sampled quarterly in selected wells. Based on the 2007 results, the AWQSGV for eight metals (antimony, arsenic, cadmium, iron, lead, manganese, selenium, and sodium) was exceeded in at least one well in OU-2. The filtered samples did not show a consistent pattern of reduced concentrations. Metals results from previous investigations indicated a widespread distribution of metals exceeding AWQSGVs in monitoring wells and Geoprobe® boring locations. Nonetheless, the distribution of metals in groundwater is random across OU-2 and does not appear to be related to former petroleum refinery, distribution or storage operations

Plate 12 presents lead groundwater sampling data between April 2011 and April 2012. Total lead concentrations were consistently greater than dissolved lead concentrations. There was one exceedance of the dissolved lead NYSDEC AWQSGV of 25 micrograms per liter (µg/L) in MW-51, at 60.5 µg/L. Although the lead analyzed in some OU-2 soil samples in OU-2 (Section 3.2.4.3) is leachable under laboratory TCLP conditions, historical and current data show low concentrations of dissolved lead, indicating lead is associated with suspended particulate matter and has a low potential to impact the groundwater.

Based upon all the data collected, metals in groundwater are not a significant issue in OU-2.

PCBs, Hexavalent Chromium and Tetraethyl Lead

Within OU-2, these parameters were only sampled for in the NPSA due to the potential for PCB-containing electrical equipment stored in this area during the refinery demolition. Hexavalent chromium and tetraethyl lead were not detected in the NPSA. The only detection of any PCB above the AWQSGV was at SB-109 located within the former Biotreatment Cell and former WHA, and at BTC-4 and BTC-5. The groundwater sampling conducted in 2007, which did not show any detection of PCBs, indicated that the exceedance for PCBs was within the localized area around SB-109. The presence of PCBs in this area of the Site is potentially due to the staging of PCB-containing electrical equipment during demolition of the refinery. It should be noted that the groundwater sample from SB-109 collected previously was from an unfiltered Geoprobe® boring. Based upon this information, ExxonMobil contends that there is no PCB issue in this area.

3.2.6 Soil Vapor

A brief discussion of the soil vapor sampling results within OU-2 is provided below. The analytical results are provided in Tables 18 and 19. Additional details, including the results of sampling within OU-3, are contained in the January 30, 2009 "Soil Vapor Sampling Report" and the November 6, 2009 "Second Round Soil Vapor Sampling Report and Scope of Work For Additional Sampling". The following soil vapor comparison criteria were used to evaluate the soil vapor data:

- Background indoor air concentrations provided by the NYSDOH adjusted for comparison to soil vapor data (adjusted by attenuation factors of 20 and 150 as described in detail in the January 30, 2009 and November 6, 2009 reports). Because VOCs are present in indoor air regardless of the presence of a subsurface source, soil vapor data are compared to adjusted background indoor air concentrations to identify whether any indoor air impacts above background levels are potentially attributable to impacted soil vapor.
- Occupational Safety and Health Administration (OSHA) permissible exposure limits (PELs) adjusted for soil vapor comparison (adjusted by attenuation factors of 20 and 150 as described in detail in the January 30, 2009 and November 6, 2009 reports). Because onsite buildings are used for industrial/commercial purposes, OSHA PELs were identified as relevant worker-related comparison values.
- Twenty-five percent of the methane lower explosive limit (LEL), or 12,500 ppm_v. This was a conservative screening value selected to evaluate the methane concentrations detected.

The following is a summary of the results of the first round of sampling completed in October and November of 2008:

- Petroleum constituents do not appear to be present at elevated concentrations in the vicinity of Buildings 152 and 153. However, concentrations of carbon disulfide, trichloroethene, and select degradation compounds have been detected at SV-4 at concentrations exceeding comparison criteria. The presence of chlorinated compounds in this area may be due to historical vehicle maintenance activities that occurred within the building.
- Due to elevated detection limits, VOC concentrations at SV-1 and in the northern portion of Building 140 are unknown. Concentrations of VOCs detected in soil vapor under the southern portion of Building 140 (SV-2) are below levels of concern.
- No subsurface soil vapor VOC concentration exceeded its corresponding adjusted OSHA PEL. Therefore, no worker standards are expected to be exceeded in indoor air.
- No VOC exceeded any soil vapor or indoor air comparison criterion at boundary samples SV-8 (northern boundary), SV-9 (eastern boundary), and SV-2 (western boundary).
- Mercury was not detected in any samples.
- Soil vapor methane concentrations in OU-2 ranged from non-detect (less than 10

ppm$_V$) to 130,200 ppm$_V$ at SV-1, which is the only location in OU-2 that exceeded the methane comparison criterion of 12,500 ppm$_V$.

The following is a summary of the results of the second round of sampling in OU-2 completed in July 2009:

- No soil vapor or sub-slab vapor result exceeded any background comparison criteria. Therefore, no indoor air concentration above background is expected. All detection limits were below the adjusted background indoor air comparison criteria.
- No subsurface soil vapor or sub-slab vapor concentration exceeded its corresponding adjusted OSHA PEL. Therefore, no worker standards are expected to be exceeded in indoor air.
- Sub-slab vapor sampling results beneath Building 152 and Building 153 were all less than the adjusted indoor air comparison criteria. Therefore, no further assessment of VOCs or methane at these buildings is warranted.
- Soil vapor samples from the SV-1 sample point in Building 140 confirmed earlier results that no adjusted indoor air impacts above background are expected in the building. Thus, no further assessment of VOCs at Building 140 is warranted.
- No VOC or methane result exceeded any adjusted indoor air comparison criterion at soil vapor boundary sample SV-16 (western boundary) or samples completed along the northern property boundary to evaluate sewers (SV-15 and SV-19). Similarly, no VOC or methane exceeded comparison criteria in previously reported northern and eastern boundary soil vapor samples from 2008. Therefore, no further assessment of boundaries is required.
- Due to elevated concentrations of VOCs and/or methane in 2008 samples located near sewer lines, locations in the central portion of the Site and near Elk Street were assessed. Soil vapor sample SV-15 assessed soil vapor along sewer lines on Babcock Street in OU-2, and soil vapor samples SV-17, SV-18 and SV-19 assessed the potential for vapor migration between Buildings 152 and 153 and Elk Street. No VOC or methane sampling result exceeded any adjusted indoor air comparison value. Therefore, no additional assessment of soil vapor migration along sewer lines is required.
- Methane was detected beneath the northern portion of Building 140 at SV-1 at 1,644 ppm$_V$ (analyzed by Environmental Analytical Service, Inc. [EAS] as part of the forensic evaluation) and 7,007 ppm$_V$ (analyzed by TestAmerica). The methane concentrations in the sub-slab vapor sample SV-1 in Building 140 have decreased significantly between the 2008 and 2009 sampling rounds. Methane was screened in indoor air in the vicinity of SV-1 hourly during the 8-hour sampling period and all readings were 0.0% LEL.
- The methane detected in 2009 is consistent with thermogenic methane and therefore may not be associated with the biological breakdown of petroleum products in the subsurface, and could potentially be associated with a leaking natural gas pipeline.

Inquiries to National Fuel Gas, the natural gas supplier for the area, indicate that no leaks or repairs have been reported in the area. It is also possible that the elevated methane detected in soil gas in October 2008 was also thermogenic (and the July 2009 soil gas contains only a residue of this).

Based on the results of the 2008 and 2009 sampling and comments received from NYSDEC and NYSDOH, the following additional work is proposed in OU-2:

Building 153

A sub-slab soil vapor sample and a duplicate sub-slab sample were collected in July 2009 from SV-18, located beneath Building 153. Carbon tetrachloride was not detected in either sample, and concentrations of trichloroethene and 1,1,1-trichloroethane were less than the lowest NYSDOH sub-slab Matrix 1 & 2 values, respectively. However, tetrachloroethene (PCE) sampling results exceeded the lowest NYSDOH sub-slab Matrix 2 value of 100 micrograms per cubic meter (µg/m^3). PCE was detected in sample SV-18 at a concentration of 160 µg/m^3, and at SV-18 DUP at a concentration of 110 µg/m^3. Therefore, additional soil vapor sampling was conducted in 2013. The sampling was completed in accordance with the scope of work presented in the Response to NYSDEC Letters Entitled “Soil Vapor Sampling Report” dated January 19, 2010, “Soil Vapor Sampling Report” dated June 16, 2010 and “Soil Vapor Sampling” dated June 25, 2012 (Roux 2012a). The following activities are completed:

- An indoor air questionnaire and building inventory were be completed in Building 153, in accordance with **Appendix B** of the NYSDOH Soil Vapor Intrusion Guidance (NYSDOH, 2006). Since current activities of in the building were limited, the building inventory did not identify any current use of chlorinated volatile organic compounds. Historical product use is unknown at Building 153; therefore, it is possible that PCE was used within the building in the past.
- One indoor air sample and a duplicate (sample designations 153-Indoor Air and 153-Indoor Air (DUP), respectively) were collected from the office space of Building 153. The indoor air sample and duplicate were collected in a Summa canister over an 8-hour period using sampling methods in accordance with the NYSDOH Soil Vapor Intrusion Guidance (NYSDOH, 2006).
- An 8-hour sub-slab soil vapor sample was collected in a Summa canister from the permanent point located at SV-18. The sub-slab soil vapor sample was collected concurrently with the indoor air sample.

The field sampling team maintained a sample log sheet, summarizing the sample identification, date and time of sample collection, identity of samplers, sampling methods and devices utilized, vacuum of canisters before and after samples are collected, and sample analyses. The indoor air and sub-slab soil vapor samples were analyzed by EAS in San Luis Obispo, California for volatile organic compounds via USEPA Method TO-15.

The following is a summary of the results of the sampling completed in 2013:

- PCE in SV-18 was below the lowest NYSDOH sub-slab Matrix 2 value of 100 µg/m^3.
- TCE in SV-18 was below the lowest NYSDOH sub-slab Matrix 1 value of 5 µg/m^3.
- TCA in SV-18 was below the lowest NYSDOH sub-slab Matrix 2 value of 100 µg/m^3.
- Carbon tetrachloride in SV-18 was non-detectable.
- PCE in 153-Indoor Air and 153-Indoor Air (DUP) was non-detectable.
- TCE in 153-Indoor Air and 153-Indoor Air (DUP) was 33.47 and 7.42 µg/m^3 respectively. These concentrations are above the NYSDOH Air Guidance Value for indoor air of 5 µg/m^3.
- TCA in 153-Indoor Air and 153-Indoor Air (DUP) was non-detectable.
- Carbon tetrachloride 153-Indoor Air and 153-Indoor Air (DUP) was non-detectable.

Methane

Due to the variability in methane concentrations detected in 2008 and 2009, sub-slab soil vapor was resampled beneath Building 140 in 2013. One sample and one duplicate sample was taken at SV-2 (samples designations SV-1 and SV-1 (DUP), respectively). The samples were collected in a Summa canister over an 8-hour period. Indoor air in the vicinity of SV-1 was also screened with an LEL meter and a PID during the sampling. The soil vapor samples were analyzed by EAS in accordance with ASTM D1945. The testing results are as follows:

- Methane concentrations were 13.74 ppmv in SV-1 and 13.53 ppmv in SV-1 (DUP). Based upon the low concentrations, forensic analysis was not performed for these samples. In comparison, elevated concentrations of methane were observed in sub-slab soil vapor below Building No. 140 in SV-1 in 2008 (130,200 ppmv). Lower levels were observed at SV-1 in 2009 (1,664 ppmv and 7,007 ppmv in two samples). Forensic analysis of the 2009 results indicated that the methane at this location (though an estimated concentration) was typical of thermogenic methane and, thus, may have been related to a leak from nearby natural gas line(s). This, however, could not be confirmed with the gas company.
- LEL meter reading taken of indoor air in the vicinity of SV-1 in Building No. 140 ranged from non-detect to 0.1 percent LEL. PID readings ranged from 0.6 to 1.3 ppm.

3.3 Bench Scale and Field Pilot Testing Results

The results of the bench scale and field pilot testing are described below.

3.3.1 Bench Scale Testing Results for Lead Impacted Soil

Portland cement (PC), PC-HCLKD, PC-CKD, EnviroBlend and TSP all successfully reduced lead leachability to less than five mg/L of TCLP lead.

Portland cement

- TP-1 soil mixed with 4.0%: TCLP test result of mixture was 0.714 mg/L.

PC-HCLKD

- TP-1 soil mixed with 3.5% PC and 8.0% HCLKD: TCLP test result of mixture was 0.139. mg/L

PC-CKD

- TP-1 soil mixed with 3.5% PC and 8.0% CKD: TCLP test result of mixture was 0.231 mg/L.

EnviroBlend

As detailed below, all of the soil-reagent mixtures exhibited less than five mg/L of TCLP lead. Compared to TSP (results provided in next subsection), EnviroBlend was significantly more effective at reducing lead leachability as measured by TCLP lead and SPLP lead

- SB-107: TCLP lead ranged from 0.0107 mg/L to 0.0271 mg/L, compared to the pre- treatment value of 49.2 mg/L. SPLP lead ranged from 0.00373 mg/L to 0.00912 mg/L, compared to the pre-treatment value of 0.0926 mg/L. Total lead ranged from 51,000 mg/kg to 84,200 mg/kg, compared to the pre-treatment value of 36,500 mg/kg. The increase in total lead is likely the result of sample heterogeneity and an increase in pH, which ranged from 9.36 to 9.61, compared to the pre-treatment value of 7.34.
- SB-110: TCLP lead ranged from 0.0074 mg/L to 0.608 mg/L, compared to the pre-treatment value of 180 mg/L. SPLP lead ranged from 0.00516 mg/L to 0.0245 mg/L, compared to the pre-treatment value of 0.427 mg/L. Total lead ranged from 12,300 mg/kg to 23,700 mg/kg, compared to the pre-treatment value of 12,000 mg/kg. The increase in total lead is likely the result of sample heterogeneity and an increase in pH, which ranged from 9.50 to 9.63, compared to the pre-treatment value of 7.35.
- TP-37: TCLP lead ranged from 0.0143 mg/L to 0.606 mg/L, compared to the pre- treatment value of 75.7 mg/L. SPLP lead ranged from 0.00204 mg/L to 0.0352 mg/L, compared to the pre-treatment value of 0.629 mg/L. Total lead ranged from 2,610 mg/kg to 4,050 mg/kg, compared to the pre-treatment value of 3,100 mg/kg. The increase in total lead is likely the result of sample heterogeneity and an increase in pH, which ranged from 7.60 to 9.67, compared to the pre-treatment value of 7.38.
- SB-140E: TCLP lead ranged from 0.0285 mg/L to 0.290 mg/L, compared to the pre-treatment value of non-detect. SPLP lead ranged from 0.000484 mg/L to 0.00174 mg/L,

compared to the pre-treatment value of 1.45 mg/L. Total lead ranged from 2,530 mg/kg to 4,040 mg/kg, compared to the pre-treatment value of 3,010 mg/kg. The increase in total lead is likely the result of sample heterogeneity only since pH ranged from 7.45 to 7.85, compared to the pre-treatment value of 8.73.

Triple Super Phosphate

As detailed below, only certain soil-reagent mixtures exhibited less than five mg/L of TCLP lead. The soil-reagent mixtures that exhibited less than five mg/L of TCLP lead were: SB-107 soil mixed with five percent TSP, SB-110 soil mixed with four and five percent TSP, TP-37 soil mixed with two to five percent TSP, and SB-140E soil mixed with one to five percent TSP. TSP will not be pursued further as a stabilization reagent because the wide variations in percentages that resulted in less than five mg/L of TCLP lead would make field implementation difficult. In addition, in all cases, the addition of TSP caused an increase in the SPLP lead value, indicating that use of this reagent resulted in an increased mobilization of lead under the SPLP testing conditions. Lastly, EnviroBlend was significantly more effective at reducing lead leachability for all soil samples that were tested.

- SB-107: TCLP lead ranged from 2.27 mg/L to 341 mg/L, compared to the pre-treatment value of 49.2 mg/L. SPLP lead ranged from 25.0 mg/L to 59.3 mg/L, compared to the pre-treatment value of 0.0926 mg/L. Total lead ranged from 16,000 mg/kg to 59,600 mg/kg, compared to the pre-treatment value of 36,500 mg/kg. The increase in total lead is likely the result of sample heterogeneity and an increase in pH, which ranged from 9.03 to 10.6, compared to the pre-treatment value of 7.34.
- SB-110: TCLP lead ranged from 1.35 mg/L to 107 mg/L, compared to the pre-treatment value of 180 mg/L. SPLP lead ranged from 21.0 mg/L to 48.5 mg/L, compared to the pre-treatment value of 0.427 mg/L. Total lead ranged from 4,760 mg/kg to 24,600 mg/kg, compared to the pre-treatment value of 12,000 mg/kg. The increase in total lead is likely the result of sample heterogeneity and an increase in pH, which ranged from 8.88 to 11.2, compared to the pre-treatment value of 7.35.
- TP-37: TCLP lead ranged from 0.0234 mg/L to 7.02 mg/L, compared to the pre-treatment value of 75.7 mg/L. SPLP lead ranged from 6.58 mg/L to 11.6 mg/L, compared to the pre-treatment value of 0.629 mg/L. Total lead ranged from 2,030 mg/kg to 4,110 mg/kg, compared to the pre-treatment value of 3,100 mg/kg. The increase in total lead is likely the result of sample heterogeneity and an increase in pH, which ranged from 9.00 to 10.7, compared to the pre-treatment value of 7.38.
- SB-140E: TCLP lead ranged from 0.0159 mg/L to 1.52 mg/L, compared to the pre-treatment value of non-detect. SPLP lead ranged from 2.03 mg/L to 5.62 mg/L, compared to the pre-treatment value of 1.45 mg/L. Total lead ranged from 1,710 mg/kg to 5,680 mg/kg, compared to the pre-treatment value of 3,010 mg/kg. The increase in total lead is likely the result of sample heterogeneity and an increase in pH, which ranged from 9.93 to 11.1, compared to the pre-treatment value of 8.73.

3.3.2 Bench Scale Testing Results for Petroleum Impacted Soil

All reagents, PC, PC-HCLKD, PC-CKD, PC-GGBFS, LKD, and organoclay/LPC, successfully addressed visual and olfactory observations of impact due to petroleum hydrocarbons. Based on the results of the April 2009 bench scale tests, LKD was chosen for field pilot testing in October 2009 because of its efficacy and cost effectiveness in a preliminary evaluation as compared to PC-GGBFS and organoclay/LPC.

<u>Portland cement</u>

There were no discernable visual and olfactory observation of impact to petroleum hydrocarbons in the PC–soil reagent mixture after eight days of curing.

- TP-3 soil mixed with 4% PC had a PID reduction in peak VOC from 28 ppm to 7 ppm. The UCS at eight days was 23.9 psi.

<u>PC-HCLKD</u>

There were no discernable visual and olfactory observation of impact to petroleum hydrocarbons in the PC–HCLKD reagent mixture after eight days of curing.

- TP-3 soil mixed with 2.5% PC and 6% HCLKD had a PID reduction in peak VOC from 28 ppm to 8 ppm. The UCS at eight days was 44.3 psi.

- TP-3 soil mixed with 3.5% PC and 8% HCLKD had a PID reduction in peak VOC from 28 ppm to 5 ppm. The UCS at eight days was 69.1 psi.

<u>PC-GGBFS</u>

There were no discernible visual and olfactory observations of impact due to petroleum hydrocarbons in any of the soil-reagent mixtures after 28 days of curing. The results of the other parameters that were tested are provided below.

- SB-107 soil mixed with 10% PC-GGBFS: Volumetric expansion was 19 percent. Hydraulic conductivity was 4.6 x 10^{-7} centimeters per second (cm/sec), compared to the pre-treatment value of 5.8 x 10^{-5} cm/sec. UCS after 3, 7, 14 and 28 days of curing were 6, 14, 15, and 18 pounds per square inch (psi), respectively. TCLP lead was 474 mg/L, compared to the pre-treatment value of 49.2 mg/L. SPLP lead was 1.01 mg/L, compared to the pre-treatment value of 0.0926 mg/L. Total lead was 56,300 mg/kg, compared to the pre-treatment value of 36,500 mg/kg. The increase in total lead is likely the result of sample heterogeneity and an increase in pH, which was 10.0, compared to the pre- treatment value of 7.34.
- SB-107 soil mixed with 15% PC-GGBFS: Volumetric expansion was 18 percent.

Hydraulic conductivity was 4.8 x 10^{-7} cm/sec, compared to the pre-treatment value of 5.8 x 10^{-5} cm/sec. UCS after 3, 7, 14 and 28 days of curing were 11, 17, 20, and 25 psi, respectively. TCLP lead was 104 mg/L, compared to the pre-treatment value of 49.2 mg/L. SPLP lead was 1.18 mg/L, compared to the pre-treatment value of 0.0926 mg/L. Total lead was 40,100 mg/kg, compared to the pre-treatment value of 36,500 mg/kg. The increase in total lead is likely the result of sample heterogeneity and an increase in pH, which was 10.9, compared to the pre-treatment value of 7.34.

- SB-116 soil mixed with 10% PC-GGBFS: Volumetric expansion was 13 percent. Hydraulic conductivity was 4.2 x 10^{-8} cm/sec. UCS after 3, 7, 14 and 28 days of curing were 66, 129, 211, and 244 psi, respectively.
- SB-116 soil mixed with 15% PC-GGBFS: Volumetric expansion was 19 percent. Hydraulic conductivity was 5.1 x 10^{-8} cm/sec. UCS after 3, 7, 14 and 28 days of curing were 73, 214, 229, and 493 psi, respectively.
- SB-120 soil mixed with 10% PC-GGBFS: Volumetric expansion was 14 percent. Hydraulic conductivity was 1.0 x 10^{-7} cm/sec. UCS after 3, 7, 14 and 28 days of curing were 40, 59, 97, and 141 psi, respectively.
- SB-120 soil mixed with 15% PC-GGBFS: Volumetric expansion was 21 percent. Hydraulic conductivity was 5.2 x 10^{-8} cm/sec. UCS after 3, 7, 14 and 28 days of curing were 48, 161, 224, and 356 psi, respectively.

LKD

There were no discernible visual and olfactory observations of impact due to petroleum hydrocarbons in any of the soil-reagent mixtures after 28 days of curing. The results of the other parameters that were tested are provided below.

- SB-107 soil mixed with 10% LKD: Volumetric expansion was 13 percent. Hydraulic conductivity was 4.7 x 10^{-7} cm/sec, compared to the pre-treatment value of 5.8 x 10^{-5} cm/sec. UCS after 3, 7, 14 and 28 days of curing were 9, 10, 43, and 51 psi, respectively. TCLP lead was 121 mg/L, compared to the pre-treatment value of 49.2 mg/L. SPLP lead was 8.40 mg/L, compared to the pre-treatment value of 0.0926 mg/L. Total lead was 74,800 mg/kg, compared to the pre-treatment value of 36,500 mg/kg. The increase in total lead is likely the result of sample heterogeneity and an increase in pH, which was 10.8, compared to the pre-treatment value of 7.34.
- SB-107 soil mixed with 15% LKD: Volumetric expansion was 19 percent. Hydraulic conductivity was 9.7 x 10^{-7} cm/sec, compared to the pre-treatment value of 5.8 x 10^{-5} cm/sec. UCS after 3, 7, 14 and 28 days of curing were 12, 34, 43, and 78 psi, respectively. TCLP lead was 66.8 mg/L, compared to the pre-treatment value of 49.2 mg/L. SPLP lead was 335 mg/L, compared to the pre-treatment value of 0.0926 mg/L.

Total lead was 40,000 mg/kg, compared to the pre-treatment value of 36,500 mg/kg. The increase in total lead is likely the result of sample heterogeneity and an increase in pH, which was 12.3, compared to the pre-treatment value of 7.34.

- SB-116 soil mixed with 10% LKD: Volumetric expansion was 13 percent. Hydraulic conductivity was 3.5 x 10^{-6} cm/sec. UCS after 3, 7, 14 and 28 days of curing were 8, 11, 15, and 19 psi, respectively.
- SB-116 soil mixed with 15% LKD: Volumetric expansion was 20 percent. Hydraulic conductivity was 1.0 x 10^{-5} cm/sec. UCS after 3, 7, 14 and 28 days of curing were 8, 14, 16, and 16 psi, respectively.
- SB-120 soil mixed with 10% LKD: Volumetric expansion was 15 percent. Hydraulic conductivity was 5.4 x 10^{-4} cm/sec. UCS after 3, 7, 14 and 28 days of curing were 24, 36, 42, and 42 psi, respectively.
- SB-120 soil mixed with 15% LKD: Volumetric expansion was 16 percent. Hydraulic conductivity was 6.7 x 10^{-4} cm/sec. UCS after 3, 7, 14 and 28 days of curing were 16, 17, 21, and 34 psi, respectively.

Although LKD could be used to remediate petroleum impacted soil, the resulting increase in lead leachability indicates LKD may not be suitable in soils where lead stabilization is proposed.

Organoclay/LPC

In all soil-reagent mixtures except SB-116 soil mixed with 3.5 percent organoclay and 2.5 percent LPC, there were no discernible visual and olfactory observations of impact due to petroleum hydrocarbons after 48 hours of treatment. The results of the other parameters that were tested are provided below.

- SB-107 soil mixed with 31.2 percent organoclay and 31.2 percent LPC: Oil and grease was 17,025 mg/kg, compared to the pre-treatment value of 78,353 mg/kg. pH was 11.20, compared to the pre-treatment value of 6.72. The hydraulic conductivity was 6.10 x 10^{-6} cm/sec. TCLP lead ranged from non-detect to 0.359 mg/L (depending on the percentage of organoclay/LPC to soil), compared to the pre-treatment value of 361.7 mg/L. SPLP lead was 10 mg/L, compared to the pre-treatment value of 0.0926 mg/L. Total lead was 10,000 mg/kg, compared to the pre-treatment value of 47,000 mg/kg.
- SB-116 soil mixed with 14.2 percent organoclay and 38.1 percent LPC: Oil and grease was 19,231 mg/kg, compared to the pre-treatment value of 24,564 mg/kg. pH was 11.65, compared to the pre-treatment value of 7.28. The hydraulic conductivity was 2.47 x 10^{-5} cm/sec.
- SB-120 soil mixed with 5.6 percent organoclay and 40.2 percent LPC: Oil and grease was 2,391 mg/kg, compared to the pre-treatment value of 11,637 mg/kg. pH was 11.68, compared to the pre-treatment value of 7.24. The hydraulic conductivity was

7.20×10^{-5} cm/sec.

The TCLP lead result for the treated soil from SB-107 indicated that leachability was not increased under the TCLP test conditions. However, the increased SPLP lead result compared to the pre-treatment sample from this location indicated that use of this reagent resulted in an increased mobilization of lead under the SPLP testing conditions, and therefore may not be appropriate in high lead areas.

3.3.3 Field Pilot Testing Results for Petroleum Impacted Soil

Nitrate

Tables 20 through **23** present the laboratory results from the two test plots and nearby monitoring wells. Nitrate addition did not result in a clear pattern of decreasing concentrations of VOCs and SVOCs with time, and there was inconclusive evidence from the supporting indicators (i.e., ammonia, nitrate, petroleum degraders, pH, oxidation-reduction potential, and dissolved oxygen [DO]) that adding nitrate enhanced *in situ* bioremediation of petroleum hydrocarbons. Moreover, there was no noticeable difference in visual and olfactory observations of impact due to petroleum hydrocarbons between soil samples collected prior to and at 12 weeks after treatment. Therefore, nitrate addition was unsuccessful at remediating petroleum impacted soil and will not be pursued further.

RegenOx™

Tables 20 through **22** present the laboratory results from the four test plots. Although pH remained elevated up to 60 days after the RegenOx™ addition, which indicates the RegenOx™ is still active, chemical oxidation did not result in a clear pattern of decreasing concentrations of VOCs and SVOCs with time. Moreover, there was no noticeable difference in visual and olfactory observations of impact due to petroleum hydrocarbons between soil samples collected prior to and at 12 weeks after treatment. Therefore, chemical oxidation was unsuccessful at remediating petroleum impacted soil and will not be pursued further.

LKD

Tables 20 through **22** present the laboratory results from the four test plots. Visual and olfactory observations of impact due to petroleum hydrocarbons were mitigated immediately after the soils were mixed with LKD, and only mild petroleum odors could be discerned after 33 days. It is our understanding that seven months after treatment (May 2010), NYSDEC observers concurred that petroleum impacts within the test plots were successfully mitigated through the use of LKD. Therefore, LKD addition appeared successful at remediating petroleum impacted soil and therefore is considered a potentially viable technology.

3.4 Qualitative Exposure Assessment

New York State Environmental Conservation Law (ECL) Article 27-1415(2) requires that a qualitative exposure assessment be conducted for all sites in the BCP. The objective of the qualitative exposure assessment is to describe how onsite and offsite human receptors may be exposed to site contaminants based upon the site-specific conditions, and to assess whether there are any complete or potentially complete exposure pathways. As presented in Section 3.2, the contaminants of concern (COCs) at the Site include petroleum hydrocarbons, petroleum-related polycyclic aromatic hydrocarbons (PAHs) and VOCs, and metals that exceed NYSDEC Part 375 criteria across large portions of OU-2. Lead has been detected only in the eastern portion of the NPSA and at SB-124 at levels that exceed the USEPA threshold for hazardous waste (TCLP greater than five mg/L). In addition, several VOCs and PAHs, and various metals, have been detected in groundwater at concentrations exceeding their respective NYSDEC AWQSGVs for Class GA groundwater. The NYSDEC Part 375 commercial/industrial criteria were developed to be protective of public health based upon commercial or industrial land use exposure assumptions. The NYSDEC Class GA AWQSGVs were developed to be protective of public health based upon residential land use exposure assumptions and consideration of groundwater as a potential source of drinking water. While comparison to Class GA standards is required, it is noted that the exposure assumptions the Class GA standards were based upon are not applicable to the Site (i.e., no residential land use and no usage of groundwater at the Site or nearby areas as a source of drinking water). As specified in ECL Article 27-1415(2), the exposure assessment considers the current conditions, as well as the reasonably anticipated future land use of the Site and the affected offsite areas and the reasonably anticipated future groundwater use.

An exposure pathway describes the means by which an individual may be exposed to contaminants originating from a site. An exposure pathway has five elements: (1) a contaminant source; (2) contaminant release and transport mechanisms; (3) a receptor population; (4) a point of exposure, and (5) a route of exposure. The following paragraphs provide an overview discussion of contaminant sources, contaminant release and transport mechanisms, and onsite and offsite exposure pathways that may potentially exist for OU-2.

<u>Contaminant Sources</u>

The primary sources of contamination in OU-2 are the historical petroleum refining, storage and distribution operations that have taken place across the majority of the Site since the late 1800s. Given the intensive and prolonged use of OU-2 for these operations, the widespread occurrence of petroleum related COCs across OU-2, as documented in the Site investigations, is not unexpected. In addition, the Site, including OU-2, is located in an area with an industrial history of metal production, chemical manufacturing, paint and varnish manufacturing and waste disposal. These background influences also have likely contributed to the concentrations of metals and PAHs across OU-2, in the surrounding areas, and in the Buffalo River.

<u>Contaminant Release and Transport Mechanisms</u>

Releases of petroleum products from storage tanks, refinery process units and piping, which historically were present across the majority of OU-2, resulted in impacts to both soil and groundwater and stormwater. In addition, potential leaks from process equipment and/or former disposal practices of the previous paint and varnish manufacturing operations in portions of the NPSA resulted in impacts to soil and groundwater by metals, in particular lead.

The petroleum products released in OU-2 exist in the form of limited separate-phase product (both mobile and residual) in the NPSA, hydrocarbon compounds adsorbed to soil particles in the unsaturated and saturated zones, and hydrocarbons compounds dissolved in groundwater. The leaching of contaminants from soil serves as an ongoing source of contamination to groundwater and soil vapor beneath portions of OU-2. The limited separate-phase product present in the NPSA may also serve as a localized source of contamination to groundwater.

Under natural hydraulic gradients (i.e., non-pumping conditions), dissolved hydrocarbons in groundwater beneath OU-2 would migrate towards OU-3 and potentially discharge to the Buffalo River. However, the Well Point System (WPS) in OU-3 has been in operation since 1971 to prevent the discharge of petroleum hydrocarbons to the Buffalo River. This system recovers free product and intercepts groundwater migrating from beneath OU-2 to OU-3 prior to discharge to the Buffalo River, thus serving to mitigate the release of contaminants from OU-2 to the Buffalo River. Any remedial alternatives considered for OU-2 will include groundwater containment to prevent or reduce the discharge of contaminants to OU-3 and ultimately, the Buffalo River.

Stormwater that comes in contact with impacted surface soil may also become contaminated. Stormwater across OU-2, excluding the Buckeye property, currently infiltrates through OU-2 soils or is collected for treatment and discharged to the BSA. Following remediation of OU-2, stormwater from remediated areas will likely be discharged to the Buffalo River under an SPDES permit.

The separate-phase product and volatilization of contaminants from the soil and groundwater also serves as a potential ongoing source of contamination to soil vapor beneath OU-2. Impacted soil vapor may be transported beneath OU-2 and other areas of the Site through subsurface conduits, including sewer and other utility trenches. The results of the soil vapor sampling indicate that soil vapors are not migrating along sewers onsite.

Onsite Receptor Population and Potential Routes of Exposure

The potential onsite receptor populations include occupational workers, construction workers, visitors, and trespassers.

Onsite workers may come into contact with contaminants present in surface soil during general site maintenance activities. Such contact with contaminated soils can result in exposure via dermal adsorption or incidental ingestion. However, the potential for occupational workers on a daily basis, as well as visitors on an infrequent basis, to contact surface soils is limited by the fact that most of the activities occurring within the vacant, uncapped areas of OU-2 (i.e., those areas not owned by Buckeye or One Babcock) are short and infrequent in duration (e.g., quarterly groundwater monitoring). The potential for trespassing is also limited because the Site is completely fenced and under 24-hour surveillance. The ExxonMobil and Buckeye properties are fully fenced. The main entrance gate is locked at all times and can be opened by authorized personnel using a key card. Visitors must contact Buckeye's Terminal office to enter. All other access gates are locked when not in use. One Babcock's property is fenced with the main access gate located just north of building 140. Twelve security cameras exist on the property. The main gate on the One Babcock property is open from 6 AM till 6 PM. Building 140 on One Babcock's property has a security alarm system.

Construction and soil moving activities have the potential to generate fugitive dusts and also may allow volatilization of vapors from subsurface contaminated soil. Construction workers and other potential onsite receptors near or downwind from such activities may be exposed via the inhalation route of exposure.

The Site, including OU-2, and the surrounding properties are supplied with public drinking water. As a result, there is no potential for exposure to site contaminants via ingestion of groundwater as a source of drinking water. Persons conducting excavation activities in areas within OU-2, where the water table is high, may encounter groundwater and, potentially, separate-phase product. In such instances, there is potential for contact with COCs in groundwater and product, and for volatilization of COCs. Therefore, there is potential for exposure via the dermal adsorption and inhalation routes. It is assumed that adults performing such activities would not ingest groundwater or separate-phase product.

On OU-2, in areas where there are site buildings (or future site buildings) in the vicinity of separate-phase product, and areas of soil and groundwater contamination, there is potential for soil vapor intrusion into indoor air. If such circumstances occur, workers could be exposed to contaminants via the indoor air inhalation route of exposure. It should be noted that there have been no documented complaints of petroleum odors within any of the continuously occupied buildings on OU-2.

Offsite Receptor Population and Potential Routes of Exposure

The potential offsite receptors include offsite workers, offsite residents, and recreational users of the Buffalo River.

Construction and soil moving activities have the potential to generate fugitive dusts and also may allow volatilization of vapors from subsurface contaminated soil. Potential offsite receptors near or downwind from such activities may be exposed via the inhalation route of exposure.

The Site and the surrounding properties are supplied with public drinking water. As a result, there is no potential for exposure to site contaminants via ingestion of groundwater as a source of drinking water.

The results of the soil vapor sampling indicate that vapors are not migrating offsite in any direction from OU-2 or along sewers onsite.

The Buffalo River is not directly accessible from OU-2. Stormwater across OU-2, excluding the Buckeye property, currently infiltrates through OU-2 soils or is collected for treatment and discharged to the BSA. Groundwater migrating from OU-2 to OU-3 is intercepted by the WPS prior to discharge to the Buffalo River. Under current conditions, there is only minimal potential for recreational users of the Buffalo River to be exposed to contaminants originating from OU-2.

4.0 INTERIM REMEDIAL MEASURE WITHIN OU-2

The Interim Remedial Measure (IRM) has been completed within OU-2. A brief description is provided below.

4.1 Underground Pipe Removal

The objectives of the work were to identify and remove abandoned underground process piping related to former refinery operations at the Site in areas north of Prenatt Street and west of the Erie-Lackawanna Railroad (the areas include the NPSA, NTYA, portions of the BSPA, portions of the FRA, portions of the CRPA, and AOOA), as described in the March 4, 2004 work plan. Petroleum products remaining in the nonnative pipelines represent a potential source of impact to surrounding soil and groundwater. Removal of the lines and any product contained within them was part of the source removal activities at the Site. The work entailed:

- Identify and locate abandoned underground process piping using historical maps and aerial photographs, as well as a geophysical survey;
- Remove abandoned underground process piping; and
- Document all pipe removal activities.

The results of the electromagnetic survey, coupled with other available documentation (i.e., maps, aerial photographs, and visual observations) were used to identify and remove abandoned underground process piping related to former refinery operations in areas of OU-2.

The field work for pipe removal began during the week of June 7, 2004. An inspection log was used to record the location of the work, weather conditions, personnel present, equipment and material used, length, type and condition of pipe, soil conditions, PID readings, description of photographs taken, description of samples taken and sketches showing the location of the work, and the configuration of the pipe. Removal of underground piping (and tanks/structures if applicable) continued until November 2004 and was suspended due to winter weather conditions. Removal of underground piping (and tanks/structures if applicable) was restarted on June 6, 2005 and continued through November 2005, when work was suspended for the winter. Work was once again restarted in May 2006 and continued until November 2006. The last phase of work started in April 2007 and continued through June 2007. A total of three interim pipe removal reports (Nos. 1, 2 and 3) were submitted documenting the pipe removal activities performed in 2004, 2005 and 2006, respectively. A final pipe removal completion report documenting the work in 2007 and summarizing all pipe removal activities was submitted in October 2007. As a result of the IRM, approximately 117,642 linear feet of pipe were removed from OU-2.

5.0 REMEDIAL GOALS, SCGS AND REMEDIAL ACTION OBJECTIVES

Remedial goals and remedial action objectives (RAOs) have been developed for OU-2 based upon the results of the previous site investigations and the current and potential future use of the property. Also provided in this section is a description of Standards, Criteria and Guidance (SCGs) that are potentially applicable or relevant to the various remedial alternatives evaluated in the AAR, as well as the applicability of various cleanup "tracks" per the requirements of the Draft BCP Guide and Part 375.

The remedial goals for OU-2 have been developed considering:

- The current use of surrounding properties;
- The early phase and long-term nature of the regional redevelopment plan for the Elk Street Corridor, including OU-2;
- Additional available land surrounding the Site;
- The reasonably anticipated near-term and long-term use of OU-2; and
- The anticipated potential remedial options for OU-3.

5.1 Remedial Goals and Cleanup Tracks

As described in Section 4.1 of the Draft BCP Guide, "the goal of the remedy selection process in the BCP is to select a remedy for a site that is fully protective of public health and the environment, taking into account the current, intended, and reasonably anticipated future land use of the site." In order to achieve this goal, Part 375 and the Draft BCP Guide divides remedial actions into four Cleanup Tracks (Tracks 1 through 4). Each cleanup track can result in a remedy that is protective of public health and the environment, but the remedies for each track will differ in respect to extent of the cleanup, restrictions on future site use, the application of institutional controls/engineering controls, and the amount of site specific information required to support the remedy selection process.

<u>Track 1 Cleanup</u>

A Track 1 cleanup would achieve a cleanup level that will allow the site to be used for any purpose without any restrictions on the use of the site. It would also achieve a cleanup level that does not rely on the implementation of long-term institutional and engineering controls (except if a groundwater use restriction is placed upon the site if the necessary steps have been taken to reduce groundwater contamination to asymptotic levels and to a protective level). The soil cleanup must achieve the unrestricted use criteria at any depth above bedrock and the backfill used must meet the unrestricted use criteria. The BCP Guide and Part 375 require evaluation of Track 1 cleanup as part of the remedy selection process for all sites in the BCP.

Track 2 Cleanup

A Track 2 residential, restricted-residential, commercial, or industrial cleanup allows for the use of the generic soil criteria presented in Part 375. The remedy must address contaminants of concern in soils at any depth above bedrock to meet the appropriate restricted use criteria. The requirement to achieve the appropriate restricted use criteria for all soils above bedrock may not apply to soils at a depth greater than 15 feet below ground surface, provided that:

- The soils below 15 feet do not represent a source of contamination;
- The environmental easement for the site requires that any contaminated soils remaining at depth will be managed along with other site soils, pursuant to a site management plan;
- Offsite groundwater does not exceed standards; and
- Onsite groundwater use is restricted.

The soil portion of the remedy must meet the lowest of the relevant restricted use criteria for protection of human health or the criteria for protection of groundwater or the protection of ecological resources presented in Part 375 (unless the criteria for protection of groundwater and protection of ecological resources are determined not to apply). If offsite material is required to be imported for the remedy, it must meet the lower of the relevant restricted use criteria for protection of human health or for protection of groundwater presented in Part 375. In the case of an industrial use remedy, the backfill must meet the lower of the commercial criteria for protection of human health or the criteria for protection of groundwater. The remedy may not rely on the implementation of long-term institutional and engineering controls to address soil impacts. Long-term institutional or engineering controls can be implemented to address contamination related to other media including, but not limited to, groundwater and soil vapor.

Track 3 Cleanup

A Track 3 cleanup must satisfy the provisions for a Track 2 remedial program; however, the NYSDEC may approve the modification of one or more of the contaminant-specific soil cleanup objectives set forth in Table 375-6.8(b) based upon site-specific data. Any modification of criteria must be performed in accordance with section 375-6.9.

Track 4 Cleanup

A Track 4 cleanup utilizes site-specific information and guidance to identify soil cleanup objectives to achieve a restricted use remedy. Track 4 allows the use of the generic soil cleanup objectives table for the particular land use scenario, or allows for the development of site-specific criteria. To achieve Track 4 remedy, restrictions can be placed on the use of the property and upon groundwater use. Track 4 can utilize institutional/engineering controls to prevent exposure to soil contamination (capping and containment) and all other media. For a Track 4 remedy, surface soil must meet the requirements of the generic table or site-specific criteria for the intended use. For residential use, the top two feet, and for commercial or industrial use, the top one foot must meet the lowest of the respective restricted use criteria for protection of human health or the criteria for protection of groundwater or the protection of ecological resources presented in Part 375 (unless the criteria for protection of groundwater and protection of ecological resources are determined not to apply). If offsite material is required in the top one foot of soil, it shall meet the lower of the commercial criteria (for commercial and industrial uses) for protection of human health or for protection of groundwater presented in Part 375.

Consistent with the Draft BCP Guide, the proposed remedy for OU-2 will be fully protective of public health and the environment, taking into account the current, intended, and potential future land use. The alternatives that will be evaluated in Section 6 will meet a Track 1, Track 2, or Track 4 cleanup.

5.2 Standards, Criteria and Guidance

SCGs are promulgated requirements ("standards" and "criteria") and non-promulgated guidance ("guidance") that govern activities that may affect the environment and are used by the NYSDEC at various stages in the investigation and remediation of a site. SCGs incorporate both the concept of "applicable or relevant and appropriate requirements" and the "to be considered" (TBCs) category of non-enforceable criteria or guidance, consistent with USEPA remediation programs. The following table provides a list of SCGs potentially applicable to the remediation of OU-2. Key SCGs are discussed in greater detail below.

Citation	Title	Regulatory Agency
General		
6 NYCRR Part 375	Environmental Remediation Programs	NYSDEC
29 CFR 1910.120	Hazardous Waste Operations and Emergency Response	US Department of Labor, OSHA
29 CFR 1926	Safety and Health Regulations for Construction	US Department of Labor, OSHA
TAGM HWR-4031	Fugitive Dust Suppression and Particulate Monitoring Program at Inactive Hazardous Waste Sites	NYSDEC
Not Applicable	Analytical Services Protocol	NYSDEC
19 NYCRR Part 600	Waterfront Revitalization and Coastal Resources	NYSDOS

Citation	Title	Regulatory Agency
Not Applicable	City of Buffalo Local Waterfront Revitalization Program	City of Buffalo
6 NYCRR Parts 750-757	State Pollutant Discharge Elimination System	NYSDEC
Not Applicable	New York State Stormwater Management Design Manual	NYSDEC
Not Applicable	Better Site Design	NYSDEC
Soil		
6 NYCRR Part 375	Environmental Remediation Programs	NYSDEC
Ground Water		
6 NYCRR Part 700-705	Surface Water and Ground Water Classification Standards	NYSDEC
TOGS 1.1.1	Ambient Water Quality Standards and Guidance	NYSDEC
TOGS 2.1.3	Primary and Principal Aquifer	NYSDEC
Air		
Not Applicable	Final - Guidance for Evaluating Soil Vapor Intrusion in the State of New York	NYSDOH
Solid Waste		
6 NYCRR 360	Solid Waste Management Facilities	NYSDEC
6 NYCRR 364	Waste Transporters	NYSDEC

Legend:

SCG:	Standards, Criteria and Guidelines
NYCRR:	New York Code of Rules and Regulations
NYSDEC:	New York State Department of Environmental Conservation
NYSDOH:	New York State Department of Health
NYSDOS:	New York State Department of State
OSHA:	Occupational Safety and Health Administration
TOGS:	Technical Operational Guidance Series
TAGM HWR:	Technical and Administrative Guidance Memorandum - Hazardous Waste Remediation

SCGs for Soil

SCGs for soil at BCP sites are the numerical soil cleanup objectives presented in Part 375. The soil cleanup objectives are categorized into unrestricted use criteria and restricted use (restricted residential, residential, commercial, or industrial) criteria, as well as criteria for protection of groundwater and ecological resources (which can also be satisfied by application of the unrestricted use criteria). The applicability of each category of soil cleanup objectives is determined based upon the current and reasonable anticipated future use of the site, as well as cleanup tracks being evaluated.

The unrestricted criteria are applicable to the evaluation of a Track 1 cleanup per the requirements of the Draft BCP Guide. However, these criteria are not consistent with current or reasonably anticipated future use of OU-2. The industrial criteria would be appropriate for OU-2 based upon current land use and zoning. The commercial criteria would be consistent with the proposed zoning and land use specified in the LWRP (which proposes commercial/light industrial uses). The Elk Street Corridor Redevelopment Plan preferred redevelopment scenario specifies, for OU-2, commercial uses west of the Buckeye Terminal (except for limited retail space at the corners of Elk Street and Babcock Street), and light industrial uses on and to the east of the Buckeye Terminal. Based upon Part 375-1.8, commercial criteria would be the appropriate criteria for the portion of OU-2 west of the Buckeye Terminal, and industrial criteria would be the appropriate criteria for the Buckeye Terminal and the portion of OU-2 east of the Buckeye Terminal. For the purposes of this Final AAR, the preferred redevelopment scenario from the Elk Street Corridor Redevelopment Plan will be assumed as the reasonably anticipated future use of OU-2. Therefore, for other than the Track 1 remedial alternative, the applicable soil cleanup objectives for OU-2 will be a combination of industrial use (for the Buckeye Terminal and east of the Buckeye Terminal) and commercial use (west of the Buckeye Terminal). The selected SCGs take into account the current use of surrounding properties, the early phase and long term nature of the regional plan for the Elk Street Corridor including OU-2, additional available land surrounding the Site, the reasonably anticipated near-term use of OU-2, and the anticipated potential remedial options for OU-3.

SCGs for soil for the protection of groundwater and the protection of ecological resources were considered. However, they were determined not to be applicable to OU-2 based on site-specific conditions. In accordance with Part 375, the SCG for soil for protection of groundwater may not be applicable where:

- The groundwater standard exceedances are the result of an onsite source which is addressed by the remedial program;
- An environmental easement will be put in place which provides for a groundwater use restriction on the Site as set forth in paragraph 375-1.8(h)(2);
- The Department determines that contaminated groundwater at the site:
  - Is not migrating, or likely to migrate, offsite; or
  - Is migrating, or is likely to migrate, offsite; however, the remedy includes controls or treatment to address offsite migration; and

– The Department determines the groundwater quality will improve over time.

In this situation, all of these conditions will be met and, therefore, use of SCGs for soil for protection of groundwater is not applicable.

With respect to ecological resources, the OU-2 area is comprised of active and vacant industrial area with no current ecological habitat of significance for evaluation. The vacant industrial land area is comprised primarily of fill and demolition debris from former refinery/terminal structures. Based upon the above, the ecological criteria are not applicable.

The NYSDEC definition of grossly contaminated media provided in Part 375 will also be considered in evaluating the soil portion of the remedy.

SCG for Soil Vapor

The Final "Guidance for Evaluating Soil Vapor Intrusion in the State of New York", issued by the NYSDOH in October 2006, presents the guidelines that were used to evaluate potential soil vapor intrusion issues in existing buildings within OU-2. Evaluation of soil vapor intrusion is not required for areas of OU-2 that are proposed to remain vacant under the current land use scenario. However, if a future redevelopment scenario for OU-2 includes construction of buildings, vapor intrusion issues and potential mitigation measures will be evaluated in accordance with the most recent publication of the "Guidance for Evaluating Soil Vapor Intrusion in the State of New York" by the NYSDOH, and if necessary, addressed as part of the Site Management Plan (SMP) or redevelopment plan.

5.3 Remedial Action Objectives

The RAOs for OU-2 are established for the protection of public health and the environment and is developed based on the SCGs, described above.

As specified in DER-10, Section 4.1(c), RAOs are to be established by the following:

- Identifying contaminants exceeding applicable SCGs and the environmental media impacted by the contaminants;
- Identifying applicable SCGs, taking into consideration the current and, where applicable, future land use for the Site; and
- Identifying all actual or potential public health and/or environmental exposures resulting from contaminants in environmental media at, or impacted by, the Site.

The three factors listed above are addressed by the information presented in Section 3, as well as in Section 5.1 and 5.2. Based upon this information, the general RAOs for the proposed remedial action, as described in the Conceptual Site Plan dated April 13, 2006, are:

- Eliminate potential exposure pathways by preventing human contact, ingestion or inhalation of contaminated environmental media;

- Remove the source of groundwater contamination, including free product and petroleum impacted soil, to the extent technically and practicably feasible; and
- Eliminate, to the extent practicable, migration of groundwater not attaining groundwater standards.

In addition, as described in Section 6.3 of the Conceptual Site Plan, the following are Operable Unit specific RAOs for OU-2:

- Remove the direct contact hazard from impacted surface soil;
- Remove the potential of impact to groundwater from subsurface soil;
- Free product recovery to the extent practical;
- Stormwater drainage and management controls across the OU-2 area; and
- Groundwater management controls to prevent exposure.

6.0 REMEDY SELECTION PROCESS

The following is a detailed description of the alternatives analysis and remedy selection process for OU-2.

6.1 Identification of Remedial Technologies

Several remedial technologies were identified and reviewed for potential applicability at the Site. The advantages and disadvantages of the alternate remedial technologies listed below are presented on **Table 24**.

As shown on **Table 24**, the remedial technologies for soil and groundwater identified for initial screening included:

- Excavation and Offsite Disposal;
- Capping;
- High Temperature Thermal Desorption (*ex situ*);
- Bioventing (*in situ*);
- Landfarming/Biopiles (*ex situ*);
- Electrical Resistance Heating (ERH);
- Surfactant/ERH;
- Metals Stabilization (*in situ*);
- Treatment for Petroleum Impacted Soil (*in situ*);
- Enhanced Biodegradation Using Nitrate;
- Chemical Oxidation via Regenesis RegenOx™;
- Slurry Wall;
- Phytotechnologies; and
- Groundwater Extraction and Treatment.

As shown on **Table 24**, only excavation/offsite disposal, capping, onsite high temperature thermal desorption, stabilization of metals, *in situ* treatment of petroleum impacted soil and phytotechnologies were retained for further evaluation for soil. For groundwater containment and treatment, phytotechnologies were retained for further evaluation. The key technologies to be incorporated into the remedial alternatives evaluation for OU-2 are described in the following sections. Additional and ancillary details for each of the remedial technologies are presented in the descriptions of the remedial alternatives.

6.1.1 Excavation and Offsite Disposal

This technology would entail excavating impacted material from selected areas of OU-2 using mechanical equipment. The volume and depth of impacted material to be removed depends upon the soil criteria to be applied to achieve various land-use based goals as defined in Part 375, and the extent of petroleum impacted soil present. Excavated material would be disposed offsite at a secure landfill.

Post-excavation bottom and sidewall sampling and waste characterization sampling for material to be disposed will be conducted. Excavation shoring and dewatering would be required to excavate contaminated soil to depths of up to 15 ft bls. The excavated area would be backfilled with common fill followed by six (6) inches of topsoil that both meet the unrestricted use or appropriate criteria, depending on the cleanup track to be achieved. Backfilled areas would be graded and seeded for drainage and erosion control.

6.1.2 Excavation and Onsite Treatment

This technology would entail excavating impacted material from selected areas of OU-2 using mechanical equipment followed by treatment via high temperature thermal desorption (HTTD). *Ex situ* HTTD involves the application of heat to excavated wastes to volatilize organic contaminants and water. Typically, a carrier gas or vacuum system transports the volatilized water and organics to a treatment system, such as a thermal oxidation or recovery unit. During HTTD, excavated wastes are heated from 1,000 to 1,400 °F.

HTTD systems are effective for removal of petroleum-related contaminants including VOCs, SVOCs, and PAHs. Soils treated with HTTD have been demonstrated to lose many of their soil properties. As such, it is likely that treated soil would need to be amended if it were to be used as backfill in areas that may be redeveloped. Since HTTD does not treat metals, excavation and offsite disposal of soil (or capping of soil for Track 4 remedies) that exceeds a particular criteria for metals (except arsenic) would be required.

The volume and depth of impacted material to be removed depends upon the soil criteria to be applied to achieve various land-use based goals as defined in Part 375, and the extent of petroleum impacted soil present. Excavated material would be screened to create a more homogeneous mixture and treated onsite using HTTD. Post-excavation bottom and sidewall sampling and waste characterization sampling for material to be disposed will be conducted. Excavation shoring and dewatering would be required to excavate contaminated soil to depths of up to 15 ft bls. The excavated area would be backfilled with treated material amended, as necessary, with common fill followed by six (6) inches of topsoil that both meet the unrestricted use or appropriate criteria, depending on the cleanup track to be achieved. Backfilled areas would be graded and seeded for drainage and erosion control.

Onsite treatment is effective because it removes sources of contamination from OU-2 and permanently destroys contaminants. The effectiveness of this technology is balanced by relatively high costs, increased short-term risks compounded by long construction duration and the potential for air quality and noise impacts, difficult implementation due to the need to control the moisture content of the soil entering the treatment train, the likelihood for the treatment process to alter the physical properties of the soil making it unsuitable for backfill without amendments, the potential need to pre-screen the material prior to treatment, the potential for incomplete treatment if the soil characteristics are not homogeneous, and the inability to treat metals.

6.1.3 Capping

Capping technologies are widely used, proven, and commercially available technologies that provide a high level of protection. If properly maintained, they eliminate potential for direct contact with contaminants and minimize infiltration.

Two types of caps may be employed across various areas of OU-2, depending upon current and future use. Each type of cap could achieve the requirement for a Track 4 remedy that offsite fill used in the top one foot of material must meet the lower of the commercial criteria (for industrial and commercial use remedies) for protection of human health or the criteria for protection of groundwater.

The following are the two types of caps that may be considered for various portions of OU-2:

- A lined soil cap consisting of a non-woven geotextile fabric over the prepared subgrade of existing material, a 40-mil high density polyethylene (HDPE) liner or geosynthetic clay liner, six inches of offsite common fill, and six inches of topsoil meeting the lower of the commercial criteria (for commercial and industrial use) for protection of human health or the criteria for protection of groundwater, followed by seeding with turf grasses (or other appropriate vegetation) for dust and erosion control. A gas venting system will be installed beneath the proposed capped areas. Areas that do not exceed the respective use criteria for surface soil will be graded, as necessary, and seeded with turf grasses (or other appropriate vegetation).
- An unlined soil cap consisting of six inches of offsite common fill and six inches of topsoil meeting the lower of the commercial criteria (for commercial and industrial use) for protection of human health or the criteria for protection of groundwater, followed by seeding with selected phytotechnology grasses to provide treatment of VOCs, SVOCs, and PAHs to the respective use criteria to depths up to two feet below grade within a relatively short timeframe of five years (discussed in greater detail in Section 6.1.5). Areas that do not exceed the respective use criteria for surface soil will be graded, as necessary, and seeded with turf grasses (or other appropriate vegetation).

Existing buildings, structures or asphalt that will remain after remediation are also considered to provide an adequate near-term cap for all proposed capping scenarios (repaired as necessary). Portions of the BSPA, where buildings or asphalt may be removed in the future as part of the regional redevelopment plan, would be capped at that time, as described above or with an asphalt cap (stone base and asphalt pavement) that provide at least one foot of separation to impacted media.

6.1.4 Stabilization of Lead and *In Situ* Treatment of Petroleum Impacted Soil

Stabilization technology is the remediation process by which metals in soil or other media are rendered less mobile, less soluble, chemically inactive, and less toxic by the addition of properly selected and mixed additives and/or reagents. *In situ* treatment of petroleum impacted soil is the technology through which the visual and olfactory properties resulting from petroleum impacts are mitigated by the addition of properly selected and mixed additives and/or reagents. The selected reagents are mixed into the impacted soil using conventional excavation equipment or specialized augers, rakes or rotating mixing tools that inject the reagents while simultaneously mixing the soil. Metals stabilization is a proven technology that has been used to remediate many sites similar to OU-2. The applicability of *in situ* treatment of petroleum impacted soil was confirmed through site-specific bench and pilot testing, as described in Sections 3.3.2 and 3.3.3.

Based on the bench scale and field scale testing results presented in Section 3.3, the following two reagents may be considered for various portions of OU-2 depending on the type of impact (lead and petroleum impacted soil) and the concentration:

- EnviroBlend (or similar lead stabilization reagent); and
- LKD (for petroleum impacted soil).

The volume and depth of impacted material to be mixed depends upon the soil criteria to be applied to achieve various land use based goals as defined in Part 375, and the extent of petroleum impacted soil present. As the effectiveness of the above two reagents at treating other metals is unknown, soil that exceeds a particular criteria for metals (excluding arsenic) would be excavated and disposed offsite (or capped for Track 4 remedies).

6.1.5 Phytotechnologies

Phytotechnology is defined as the use of vegetation for *in situ* treatment/management of soils, sediments and water. It is applicable at sites containing organic, nutrient, or metal pollutants that can be accessed by the roots of plants and sequestered, degraded, immobilized, or metabolized in place. It is a rapidly emerging “green” technology that is presently applied at a variety of impacted sites. The following table introduces the various phytotechnology mechanisms.

Mechanism	Technology Description
Evapotranspiration	The use of plants to uptake large volumes of water to contain or control the migration of groundwater.
Phytostabilization	The immobilization of a contaminant through absorption and accumulation by roots, adsorption onto roots, or precipitation within the root zone of plants.
Rhizodegradation	The breakdown of a contaminant in soil through microbial activity that is enhanced by the presence of the root zone.
Phytoaccumulation	The uptake of a contaminant by plant roots and the translocation of that contaminant into the aboveground portion of the plants.
Phytodegradation	The breakdown of contaminants taken up by the plant through metabolic processes within the plant or through the effect of compounds (i.e., enzymes) produced by the plant.
Phytovolatilization	The uptake and transpiration of a contaminant by a plant, with release of the contaminant or a modified form of the contaminant to the atmosphere from the plant.

The most applicable phytotechnologies that will promote the degradation and stabilization of Site contaminants include evapotranspiration, phytostabilization and rhizodegradation. Reference documents regarding phytotechnologies, including several addressing implementation of the technology in cold climates and in combination with soil amendments, are included in **Appendix C**. The most applicable of these references to the Site conditions are the following five, which are included in their entirety in **Appendix C**:

- April, W. and R. C. Sims. 1990. Evaluation of the use of prairie grasses for stimulating polycyclic aromatic hydrocarbon treatment in soil. *Chemosphere* 20: 253-265.
- Banks, M.K., E. Lee, and A. P. Schwab. 1999. Evaluation of dissipation mechanisms for benzo(a)pyrene in the rhizosphere of tall fescue. *Journal of Environmental Quality* 28(1): 294-298.
- Olson, P.E., A. Castro, M. Joern, N.M. DuTeau, E. Pilon-Smits, and K.F. Reardon. 2008. Effects of Agronomic Practices on Phytoremediation of an Aged PAH-Contaminated Soil. *Journal of Environmental Quality* 37:1439-1446.
- Rentz J.A., P.J.J. Alvarez, and J. L. Schnoor. 2005. Benzo(a)pyrene co-metabolism in the presence of plant root extracts and exudates: Implications for phytoremediation. *Environmental Pollution* 136:477-484.

- Robinson, S.L., J.T. Novak, M.A. Widdowson, S.B. Croswell, and G.J. Fetteroll. 2003. Field and laboratory evaluation of the impact of tall fescue on polyaromatic hydrocarbon degradation in an aged creosote-contaminated surface soil. *Journal of Environmental Engineering* 129(3): 232-240.

Rhizodegradation will breakdown residual contaminants in the groundwater through enhanced microbial activity that occurs in the rhizosphere (i.e., root zone). Phytostabilization will sequester inorganics in the rhizosphere of selected plant species.

The typical range of effectiveness for phytotechnologies is contingent upon the rooting depth of each individual species. Phytoremediation utilizing groundcover plants (i.e., grasses and forbs) is typically restricted to between one and two ft bls. However, deep rooting trees such as hybrid poplars can achieve rooting depths and thus remediation benefits of up to 12 ft bls.

Since phytotechnologies do not provide removal, but rather stabilization, for the metals of concern within OU-2, excavation and offsite disposal of soil (or capping of soil for Track 4 remedies) that exceeds a particular commercial or industrial criteria for metals (excluding arsenic) would be required.

6.1.5.1 Evapotranspiration

Evapotranspiration is the ability of plants to intercept, take up and transpire large volumes of rainfall, groundwater and/or applied irrigation water. Enhanced evapotranspiration is the use of specialized vegetation (i.e., hybrid poplars) to increase the uptake of water in surface soils by plant roots. Hybrid poplar trees can transpire between 10 and 20 gallons per day per tree during the growing season. The use of plants to rapidly uptake large volumes of water to contain or control the migration of subsurface water is known as hydraulic control. Hydraulic control may be achieved by water consumption, using plants to increase the evaporation and transpiration rates. This hydraulic control can be used to prevent the horizontal migration or vertical leaching of contaminants. Plant roots can extend down toward the water table and establish a dense root mass that takes up large quantities of water, thus decreasing the potential for surface contaminants to migrate towards groundwater.

During the growing season, sap flow is needed to transport water and nutrients from the soil to the leaves. Trees predominately lose their water through leaf stomata. As trees senesce and leaves drop, the primary route for transpiration is lost, resulting in decreased sap flow to non- detectable levels. Thus it is likely that the hybrid poplar trees achieve minimal hydraulic control during the non-growing season. However, hybrid poplars will consume significant quantities of groundwater during the growing season, which dehydrates the soil and creates water storage capacity for the dormant winter months. During the winter months, moisture in the soil is often frozen, thus promoting surface runoff and not infiltration. Soil water does not fully recharge until the end of winter, thus the hybrid poplars will still provide some degree of hydraulic control even during dormancy. Then, just prior to senescence, hybrid poplar trees will store nutrients for future leaf out in the spring. In the spring, as nutrients accumulate in the sap, root pressure forces the sap to flow from the roots towards the leaves.

6.1.5.2 Phytostabilization

Phytostabilization is the immobilization of contaminants in the groundwater and soil through the adsorption onto plant roots, the precipitation or immobilization within the root zone, and the absorption and accumulation into the root tissue. The containment of contaminants within and surrounding the plant reduces the mobility, prevents migration, and ultimately reduces the bioavailability of the contaminants. Proteins and enzymes (i.e., sugars, amino acids, organic acids, fatty acids, sterols, growth factors, nucleotides, flavanones, enzymes, and other compounds) produced by plants are exuded into the rhizosphere through the plant root system. These plant products target contaminants in the surrounding soil, leading to the precipitation or immobilization of the contaminants in the root zone, thus reducing contaminant bioavailability. Proteins and enzymes directly associated with the root cell walls can bind and stabilize the contaminant on the exterior surfaces of the root membranes. This prevents the contaminant from entering into the plant itself. However, proteins and enzymes also are present on the root cell walls that can facilitate the transport of contaminants across the root membranes. Upon uptake, these contaminants are sequestered into the vacuole of the root cells, preventing further translocation to the aboveground plant shoots and leaves.

Plant root systems also stabilize soil, which prevent erosion and wind dispersal of soil contaminants. This technique can be used to stabilize contaminated sites by establishing a vegetative cover over areas where natural vegetation may be lacking due to high contaminant concentrations. Contaminant-tolerant species may be used to restore vegetation at the sites, thereby decreasing the potential migration of contamination through wind erosion, soil erosion, surface water runoff, and leaching of soil contamination to groundwater.

6.1.5.3 Rhizodegradation

Rhizodegradation is the breakdown of contaminants in the soil and groundwater through enhanced microbial activity that occurs in a plant's rhizosphere (i.e., root zone). The concentration of microorganisms in the rhizosphere can be up to 100 times greater than in the bulk soil. This increased microbial activity is derived from the proteins and enzymes that are produced and exuded by plants and organisms such as bacteria, yeast, and fungi. These natural substances contain organic carbon that provides food for the soil organisms, thereby stimulating biological activity in the rhizosphere and increasing contaminant biodegradation rates. Plant exudates also improve the microbial bioavailability of hydrophobic compounds (i.e., PAHs) and thus enhance the biodegradation in soil.

The dense nature of the plant rhizosphere increases the available surface area for microbial sorption, thus facilitating increased biodegradation rates. Plant roots also improve soil conditions through increased soil aeration and moderating soil moisture content, thereby creating conditions more favorable for biodegradation. Even when the plants turn dormant, the microbial activity within the root zone will continue to degrade and sequester COCs. Researchers have reported surges in PAH degradation rates of planted systems during the senescence period. Plant roots exude large amounts of phenolic compounds as they begin to senesce and enter winter dormancy. As noted above, these plant exudates provide a source of carbon and energy for microbes, thus resulting in enhanced biodegradation through the non-growing season. In summary, rhizodegradation is the result of a sustained symbiotic relationship where the plants provide nutrients necessary for the microbes to thrive, while the microbes provide a healthier soil environment where the plant roots can proliferate.

Rhizodegradation has proven effective in numerous pot studies, greenhouse trials, and full-scale demonstrations for the reduction of benzene, toluene, ethylbenzene, xylenes (collectively known as BTEX), TPH, both GRO and DRO, and PAHs. BTEX compounds are relatively easy to remediate by rhizodegradation because they are (i) rapidly degraded in the presence of oxygen, (ii) relatively soluble, thus making them bioavailable, and (iii) often used as the primary electron donor by many bacteria widely distributed in nature. Petroleum hydrocarbons are amenable to rhizosphere bioremediation using densely rooted grasses and legumes for shallow contamination, and deep-rooted trees for treatment of contamination in deeper soil profiles. It may require several growing seasons for performance goals to be met, but rhizodegradation is considered a proven technology for petrochemical remediation.

6.1.5.4 Phytotechnology Cap

Phytotechnologies incorporating hydraulic control are currently being implemented as alternatives to conventional low permeable clay or geomembrane caps. These alternative caps (i.e., phytotechnology caps) utilize various combinations of the above referenced phytotechnology mechanisms for contaminant remediation and control. Unlike conventional cover system designs that use low hydraulic permeability materials to minimize the downward migration of water from the cover to the waste, phytotechnology caps rely on the properties of soil to store water until it is either transpired through vegetation or evaporated from the soil surface. This conveys a predominant advantage to the phytotechnology cap since stormwater runoff to downgradient receptors (i.e., Buffalo River) is reduced.

A typical phytotechnology cap is comprised of the following elements:

- Amendments of existing soils to facilitate growth of vegetation;
- Installation of phytotechnology grasses and forbs to enhance and accelerate biodegradation, minimize stormwater runoff and minimize recharge to groundwater; and
- Installation of a stormwater management system (i.e., vegetated swales and/or catch basins and interconnected piping) to protect downgradient receptors.

Each of these elements is described below.

6.1.5.4.1 Soil Amendments

Nutrient and water availability is an important factor contributing to the success of phytoremediation. Phytoremediation strategies are often implemented in compacted nutrient-poor soils. Soil amendments, such as compost and fertilizer, can be tilled into the surficial soil to provide supplemental nutrients and improve soil moisture storage. Incorporating compost as an amendment can help break up compacted soils, lower the bulk density and improve soil moisture storage. This aids in plant establishment by facilitating oxygen diffusion into the soil, increasing root penetration, and improving soil permeability. Compost will also minimize potential contaminant migration through adsorption, and ultimately facilitate microbial degradation of organic COCs in the surface soil. In addition to stimulating plant growth, soil amendments support microbial growth which further enhances biodegradation of contaminants.

6.1.5.4.2 Grasses and Forbs

Fast growing and deep-rooted (i.e., greater than two ft bls) herbaceous species are planted in the phytotechnology cap to facilitate rhizodegradation and phytostabilization mechanisms, resulting in enhanced degradation of residual organic COCs throughout the top two feet of soil. Grasses are particularly effective in encouraging contaminant degradation due to their ability to favor root growth over shoot growth, thereby increasing potential microbial adsorption sites and populations. The phytotechnology species aid stormwater management through the temporary storage of rainwater within the surface soil, and subsequent uptake and transpiration of the soil moisture.

6.1.5.4.3 Stormwater Management System

Stormwater is typically managed via a network of vegetated swales and/or catch basins and interconnected piping. The captured stormwater will then be detained prior to final discharge, as discussed further in Section 6.3.3.

6.2 Remedial Alternative Evaluation Criteria

The identification, description, and evaluation of remedial alternatives for OU-2 is provided in Sections 6.4 through 6.10. The evaluation of alternatives is based on the following nine evaluation criteria presented in Part 375 Section 1.8(f):

- Overall protection of public health and the environment;
- Standards, criteria and guidance;
- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume of contamination through treatment;
- Short-term impacts and effectiveness;
- Implementability;
- Cost;
- Community acceptance; and
- Land use, provided the Department determines that there is reasonable certainty associated with such use.

Each of the criteria is described below based on definitions presented in Part 375 Section 1.8(f) or from Section 4.1 of the DER-10, where definitions are not provided in Part 375.

6.2.1 Overall Protection of Human Health and the Environment

From DER-10: "This criterion is an evaluation of the ability of each alternative or the remedy to protect public health and the environment.

1. How each alternative would eliminate, reduce, or control through removal, treatment, containment, engineering controls or institutional controls any existing or potential human exposures or environmental impacts identified by the remedial investigation.
2. The ability of each alternative to achieve each of the RAOs.
3. Overall protection of human health and the environment draws on the assessments of other evaluation criteria, especially long term effectiveness and permanence, short term effectiveness, and compliance with SCGs."

6.2.2 Standards, Criteria and Guidance

From Part 375: "The remedy will:

(i) conform to standards and criteria that are generally applicable, consistently applied, and officially promulgated, that are either directly applicable, or that are not directly applicable but are relevant and appropriate, unless good cause exists why conformity should be dispensed with. Good cause exists if any of the following is present:

  (a) the proposed action is only part of a complete program or project that will conform to such standard or criterion upon completion;

  (b) conformity to such standard or criterion will result in greater risk to the public health or to the environment than alternatives;

  (c) conformity to such standard or criterion is technically impracticable from an engineering perspective;

  (d) the program or project will attain a level of performance that is equivalent to that required by the standard or criterion through the use of another method or approach; and

(ii) consider applicable Department guidance."

6.2.3 Long-Term Effectiveness and Permanence

From Part 375: "A program or project that achieves a complete and permanent cleanup of the site is preferred over a program or project that does not do so."

6.2.4 Reduction in Toxicity, Mobility or Volume of Contamination Through Treatment

From Part 375: "Reduction in toxicity, mobility or volume of contamination through treatment: a program or project that permanently and significantly reduces the toxicity, mobility or volume of contamination is to be preferred over a program or project that does not do so. The following is the hierarchy of technologies ranked from the most preferable to the least preferable:

i. destruction, onsite or offsite;

ii. separation or treatment, onsite or offsite;

iii. solidification or chemical fixation, onsite or offsite; and

iv. control and isolation, onsite or offsite."

6.2.5 Short-Term Impacts and Effectiveness

From DER-10: "This criterion is an evaluation of the potential short term adverse environmental impacts and human exposures during the construction and/or implementation of an alternative or remedy.

1. Identify the potential human exposures, adverse environmental impacts, and nuisance conditions at the site resulting from the implementation of the remedy or alternative. Identify how they would be controlled and the effectiveness of the controls. The potential short term impacts to be evaluated include nuisance conditions or potential exposures resulting from increased traffic, including truck trips, detours or loss of the use of access to property, odors, vapors, dust, habitat disturbance, run off from the site, and noise.
2. A discussion of engineering controls that would be used to mitigate the short term impacts (i.e., dust control measures) should be included.
3. The length of time needed to implement the remedy or alternative including time to achieve the remedial objectives should be estimated.
4. While sustainability will be a consideration in remedy selection, as set forth in Section 1.14, it will not change any existing statute, regulation or guidance."

6.2.6 Implementability

From DER-10: "This criterion is an evaluation of the technical and administrative feasibility of implementing an alternative or remedy.

1. Technical feasibility includes the difficulties associated with construction and the ability to monitor the effectiveness of an alternative or remedy.
2. Administrative feasibility is evaluated, which includes:

   I. the availability of the necessary personnel and material; and

   II. potential difficulties in obtaining specific operating approvals, access for construction, etc.

3. The evaluation of the reliability and viability of implementation of the institutional or engineering controls necessary for a remedy, as detailed in subdivision 4.2(b)."

6.2.7 Cost

From DER-10: "This criterion is an evaluation of the overall cost effectiveness of an alternative or remedy.

1. A remedy is cost effective if its costs are proportional to its overall effectiveness. To evaluate cost effectiveness:
    i. the overall effectiveness of an alternative or remedy is determined by evaluating the criteria set forth in subdivisions (d), (e) and (f) above; and
    ii. a comparison of the overall effectiveness is then made to the cost of the alternative or remedy; and
    iii. an assessment is made as to whether the cost is proportional to the overall effectiveness, to determine whether it is cost effective.
2. Capital costs and costs associated with site management for each alternative are estimated in accordance with subparagraph 4.3(a)5.iii."

6.2.8 Community Acceptance

From DER-10: "This criterion is evaluated after the public review of the remedy selection process as part of the final DER selection/approval of a remedy for the site.

1. Any public comment relative to these criteria will be considered by DER after the close of the public comment period.
2. Documentation of the public comments received is to be consistent with the citizen participation plan identified for a remedial program in accordance with applicable DEC policy."

6.2.9 Land Use (Provided the Department Determines that There Is Reasonable Certainty Associated with Such Use)

From Part 375: "In assessing reasonable certainty, the Department shall consider:

(i) the current, intended, and reasonably anticipated future land uses of the site and its surroundings in the selection of the remedy for soil remediation under the brownfield cleanup and environmental restoration programs, and may consider land use in the State superfund program, where cleanup to pre-disposal conditions is determined not feasible;

(ii) the Department's determination on the use of the site will be in accordance with subdivision 375-1.8(g);

(iii) the reasonably anticipated future use of the site and its surroundings, which shall be documented in the analysis of alternatives, taking into consideration factors including, but not limited to, the following:

   (a) current use and historical and/or recent development patterns;

(b) applicable zoning laws and maps;

(c) brownfield opportunity areas as designated set forth in GML 970-r;

(d) applicable comprehensive community master plans, local waterfront revitalization plans as provided for in EL article 42, or any other applicable land use plan formally adopted by a municipality;

(e) proximity to real property currently used for residential use, and to urban, commercial, industrial, agricultural, and recreational areas;

(f) any written and oral comments submitted by members of the public on the proposed use as part of the activities performed pursuant to the citizen participation plan;

(g) environmental justice concerns, which for purposes of this subpart, include the extent to which the proposed use may reasonably be expected to cause or increase a disproportionate burden on the community in which the site is located, including low-income minority communities, or to result in a disproportionate concentration of commercial or industrial uses in what has historically been a mixed use or residential community;

(h) federal or State land use designations;

(i) population growth patterns and projections;

(j) accessibility to existing infrastructure;

(k) proximity of the site to important cultural resources, including federal or State historic or heritage sites or native American religious sites;

(l) natural resources, including proximity of the site to important federal, State or local natural resources, including waterways, wildlife refuges, wetlands, or critical habitats of endangered or threatened species;

(m) potential vulnerability of groundwater to contamination that might emanate from the site, including proximity to wellhead protection and groundwater recharge areas and other areas identified by the Department and the State's comprehensive groundwater remediation and protection program established in ECL article 15, title 31;

(n) proximity to flood plains;

(o) geography and geology; and

(p) current institutional controls applicable to the site."

6.3 Remedial Activities that Will Be Implemented for Any Remedial Alternative Selected

This section describes remedial activities that are common to each of the remedial alternatives described in Section 6.4. As such, these common activities will be completed for any remedial alternative that may be selected for OU-2. The scope of work and purpose of these activities will be similar for any remedial alternative.

- Demolition of Selected Existing Unoccupied Buildings*;
- Evaluation of Soil Vapor Intrusion and Mitigation*;
- Mobilization and Site Preparation;
- Stormwater Management and Erosion Control during Construction;
- Dust Control;
- Temporary Staging and Stockpiling;
- Traffic Control;
- Offsite Disposal and Equipment Decontamination;
- Stormwater Management System Modifications*;
- Phytotechnology Tree Plantings* (not included in Alternative 6);
- Removal and Disposal of Concrete*;
- Installation of New Monitoring Wells and Groundwater Monitoring; and
- Health and Safety and Community Air Monitoring.

* The more complex or critical of these elements are described in greater detail in this section. The other elements are described in detail in Section 7.0.

6.3.1 Demolition of Selected Existing Unoccupied Buildings

Demolition of the existing Sub-Station "C" and the former Scale House in the NTYA and the former Main Office Building (former Police Community Services Building) in the NPSA, was completed in accordance with applicable regulations during the second quarter of 2007 in preparation for remediation of OU-2.

6.3.2 Evaluation of Soil Vapor Intrusion

Soil vapor sampling and analytical results were discussed in Section 3.2.6. If a future redevelopment scenario for OU-2 includes construction of buildings, vapor intrusion issues and potential mitigation measures will be evaluated in accordance with the most recent publication of the "Guidance for Evaluation Soil Vapor Intrusion in the State of New York" by the NYSDOH, and if necessary, addressed as part of the SMP or redevelopment plan.

6.3.3 Stormwater Management System Modifications

As part of the remediation of OU-2 and OU-3, the storm water management systems for portions of Buckeye's active distribution operations (in OU-2 and OU-3) were separated from the drainage for properties owned by ExxonMobil. The new stormwater drainage system for the Buckeye property consists of catch basins and interconnected piping.

A request for modification of Buckeye's existing SPDES permit was submitted on August 18, 2008 to account for the additional water proposed to be discharged from Buckeye's property. The SPDES permit modification was issued on May 7, 2010. The "Design Documents for Stormwater Collection System Project on Buckeye Terminals LLC Property", dated September 24, 2010, was approved by NYSDEC on April 18, 2011 after several rounds of comments were addressed. Installation of the system began in the spring of 2011 and was substantially completed in July 2012, with the exception of one section of piping immediately north of existing Tanks 99, 38 and 97. The existing and proposed sewers in this area lie below several active pipelines and could not be accessed to install the proposed sewers. Options for addressing this area are currently being evaluated. The new drainage system discharges to a detention basin, which was completed in August 2011, sized to detain the 10-year, 24-hour storm. The basin is drained manually after inspection of the water within the basin confirms that neither a sheen nor separate-phase product is present. Since all components of the system are new and since they only drain non-impacted areas of OU-2 and OU-3, effluent from the detention basin connects to the existing pump station and piping that discharges to the Buffalo River after passing through an existing oil water separator.

Where new pipe and/or structures were installed in the same location as existing pipe/structures, the existing pipe and/or structures were removed, to the extent practical. Other existing piping and or structures that did not require removal due to new pipe or structure installation has been abandoned in-place using flowable fill.

Soil excavated during installation of new sewers in OU-2 and OU-3 in 2011 and 2012 was stabilized with LKD, temporarily stored in OU-3 and disposed offsite in August and September 2012.

The stormwater management system for the portion of OU-2 owned by ExxonMobil will consist of catch basins with interconnected piping and stormwater detention basins. The detention of stormwater would benefit the Buffalo River by removing solids prior to discharge and reducing the peak stormwater loading to the River. Since the proposed storm water management system will collect water only from remediated portions of OU-2 and since all components will be new, it is anticipated that ExxonMobil can discharge the water to the Buffalo River through a new SPDES permit. Details for drainage system improvements will be developed during the design phase of the project.

6.3.4 Phytotechnology Tree Plantings

Phytotechnology trees to control groundwater migration and to promote stabilization and degradation of contaminants in groundwater will be deep-rooted trees (called phreatophytes) that can reach and remove large amounts of water from the groundwater through transpiration. Phreatophytes tend to have large leaves that have more evaporative surface area than small leaves. The selected phreatophytes for OU-2 include trees of the *Populus* (Poplar) genera, specifically a mixture of two hybrid poplars (*Populus deltoides*) cultivars: DN-34 and OP-367. These poplar species do not produce seed or fruit.

Approximately 6,200 hybrid poplar trees will be planted along the southern border between

OU-2 and OU-3 (Plates 13 and 14). The planting density for the trees will be designed to balance the water needs of each plant with the hydraulic control requirements (approximately 870 trees per acre across 7 acres). In general, the depth to water is less than six ft bls throughout the majority of the OU-2 area. Shallow groundwater primarily flows south towards the Buffalo River through a two feet to eight feet thick layer of urban fill confined by an underlying clay zone. The hybrid poplar trees will be planted approximately four ft bls into the common fill layer to access this shallow groundwater.

An average of 60 percent of the annual precipitation falls during the growing season (April through October), leaving 40 percent to fall during the non-growing season when potential evapotranspiration is estimated to be zero. During winter months, moisture in the soil is frozen. As the soil thaws, spring precipitation recharges the soil moisture until field capacity is reached. As spring progresses, vegetation leafs out and begins to transpire soil water. As the growing season continues and temperatures increase, the hybrid poplars will transpire more water than is available through direct precipitation, resulting in a negative water balance and groundwater consumption.

In the fall, as the hybrid poplars begin to senesce, precipitation will exceed transpiration and begin to recharge the soil moisture. However, under the proposed design, the evapotranspiration potential of the hybrid poplar plot will consume groundwater and dewater the soil matrix in OU-2 over the course of the growing season. Since the soil matrix (up to six ft bls) has been dewatered, there is sufficient storage capacity for the dormant winter months and early spring precipitation. Thus, the phytotechnology tree plot will still provide hydraulic control even during dormancy periods with residual water stored in the cover soil material.

It is important to note that the planting recommendations incorporated above accommodate normal mean climatologic conditions. A stormwater management system, as described in Section 6.3.3, is required to manage extreme climatologic effects.

In addition to providing hydraulic control, the hybrid poplars will aid in the remediation of the residual groundwater COCs (i.e., BTEX) via rhizodegradation as described in Section 6.1.5.3.

6.3.5 Removal and Disposal of Concrete

As shown on Plate 2, concrete is present throughout OU-2. The concrete will therefore be removed and disposed of offsite, to the extent required, as part of the implementation of each remedy component.

6.4 Identification of Remedial Alternatives

The following six remedial alternatives (one being an unrestricted use scenario) have been identified for OU-2:

- Remedial Alternative 1: Track 1 Scenario to Unrestricted Use Criteria via Excavation and Offsite Disposal;
- Remedial Alternative 2: Track 2 Scenario to Commercial or Industrial Use Criteria via

Excavation and Offsite Disposal;

- Remedial Alternative 3: Track 2 Scenario to Commercial or Industrial Use Criteria via Onsite Treatment;
- Remedial Alternative 4: Track 4 Scenario to Commercial or Industrial Use Criteria via Lined Soil Cap, *In Situ* Stabilization of Leachable Lead, and Phased *In Situ* Treatment of Petroleum Impacted Soil;
- Remedial Alternative 5: Track 4 Scenario to Commercial or Industrial Use Criteria via Unlined Soil Cap, *In Situ* Stabilization of Leachable Lead, and Phased *In Situ* Treatment of Petroleum Impacted Soil; and
- Remedial Alternative 6: Track 4 Scenario to Commercial or Industrial Use Criteria via *In Situ* Stabilization of Leachable Lead *In Situ* Treatment of Petroleum Impacted Soil.

The following sections provide a description and detailed evaluation of these six remedial alternatives in accordance with Section 4.8 of the Draft BCP Guide and Section 4.3[c] of DER-10: a general description of the major positive and negative aspects of each alternative, a detailed evaluation of each alternative relative to eight of the nine specific evaluation criteria from Part 375 described in Section 6.2, and a numerical ranking of each alternative based on the evaluation criteria presented in Section 6.2. The ninth criteria, community acceptance, cannot be fully evaluated until the public comment period is completed.

6.5 Evaluation of Remedial Alternative 1: Track 1 Scenario to Unrestricted Use Criteria Via Excavation and Offsite Disposal

The following sections provide an evaluation of Remedial Alternative 1, which would achieve a Track 1 cleanup of OU-2, as described in Section 5.1.

6.5.1 Description of Remedial Alternative 1

As discussed previously, the soil quality in many areas within OU-2 has been impacted by former refinery and terminal activities. Impacted soil exceeding the unrestricted use criteria has been found at depths ranging from zero to 15 feet below grade. In addition, petroleum impacted soil has been found in the zero to four foot depth interval and the greater than four foot depth interval. Separate-phase product has been observed in monitoring well MW-38 in the northeast portion of OU-2, and in the past, once in destroyed monitoring well BTC-4 and once in monitoring well MW-35. Therefore, excavation of impacted material exceeding unrestricted use criteria would be performed to a depth of up to 15 feet below grade across OU-2, which would also remove the petroleum impacted soil. It is estimated that approximately 507,100 cubic yards of soil and 12,000 cubic yards of concrete would require excavation in order to achieve unrestricted use criteria throughout OU-2. Separate-phase product, if present, would be recovered from the excavations, to the extent practical, using pumps, vacuum trucks, or other appropriate means. However, it is anticipated that the majority of residual product present would be disposed of with the excavated soil.

The sporadic occurrences of arsenic above the unrestricted use criteria would be addressed under this alternative, as they are located in areas that require excavation based upon other constituents. However, it should be noted that it is ExxonMobil's contention that the widespread, low-level arsenic concentrations are well within background levels for an urban area such as this Site, are not related to former Site operations, and thus do not require remediation.

Excavated material and recovered separate-phase product would be disposed offsite in accordance with applicable regulations. Soil would be disposed of in a secure landfill and recovered product (if any) may be blended and recycled as fuel. Post-excavation bottom and sidewall sampling and waste characterization sampling for material to be disposed would be conducted. Excavation shoring and dewatering would be required. Treatment of the dewatering water would also be required. The excavated area would be backfilled with common fill followed by six inches of topsoil that both meet the unrestricted use criteria presented on **Table 25**. Sampling of the backfill material would be conducted to confirm that it meets the unrestricted use criteria. OU-2 would then be graded and seeded with turf grasses (or other appropriate vegetation).

Regarding groundwater remediation, existing data demonstrates that the groundwater beneath OU-2 is not significantly impacted. The highest concentrations of contaminants have historically been observed near the boundary between OU-2 and OU-3. The removal of all impacted soil from OU-2 would result in further improvement of groundwater quality over time. In addition, phytotechnology tree plantings (Section 6.3.4) installed along the south side of OU-2 (along Prenatt Street) would be designed to contain groundwater migration (as necessary for implementation of an OU-3 remedy) and remediate residual impacts, if any, remaining after the soil remedy is implemented. It is estimated that the phytotechnology tree plantings would limit groundwater migration within three years of planting. This timeframe coordinates well with continued operation of the WPS for groundwater control and treatment until the closure strategy for OU-3 is developed, approved and implemented. An environmental easement would be implemented to restrict use of groundwater.

Implementation of Remedial Alternative 1 would be completed within six construction seasons.

Plate 13 shows the areas to be addressed under Remedial Alternative 1. Estimated costs for Remedial Alternative 1 are presented in **Appendix D**.

6.5.2 Preliminary Screening of Remedial Alternative 1

The major benefits of Remedial Alternative 1 are that it:

- Removes all contamination exceeding the unrestricted use criteria from OU-2;
- Removes all petroleum impacted soil identified based on field observations and ongoing separate-phase product gauging to the extent practicable;
- Allows for the site to be used for any purpose; and
- Will not adversely impact the closure strategy for OU-3 to the south.

However, the main drawbacks of Remedial Alternative 1 are that it:

- Requires a significant volume of material to be placed in limited secure landfill space without treatment, and therefore constitutes an offsite containment remedy, which is the least favorable among the hierarchy provided in Part 375;
- Results in significant short-term impacts due to the long implementation duration (six construction seasons) and the amount of heavy equipment operation and offsite trucking required;
- Is the most difficult to implement due to significant excavation shoring and dewatering required; and
- Is significantly more costly than most of the other alternatives.

6.5.3 Detailed Evaluation of Remedial Alternative 1

The following sections provide a detailed evaluation of Remedial Alternative 1 based on eight of the nine specific evaluation criteria from Part 375 described in Section 6.2. The ninth criteria, community acceptance, cannot be fully evaluated until the public comment period is completed. The ranking of Remedial Alternative 1 relative to the evaluation criteria presented in Section 6.2 is shown on **Table 26**. Remedial Alternative 1 ranks fourth overall out of the six potential alternatives.

6.5.3.1 Overall Protection of Human Health and the Environment

Remedial Alternative 1 would be protective of human health and the environment within OU-2 by eliminating the concentrations in soil of petroleum-related and non-petroleum-related constituents as a result of the former refinery/terminal activities and background influences through source removal to estimated depths up to 15 feet below grade. Source areas including petroleum impacted soil and separate-phase product would also be removed to the extent practicable. The potential for human and environmental exposure to these constituents throughout OU-2 would be eliminated by excavation of the impacted materials up to 15 feet (or deeper based on post-excavation sampling) across most of OU-2, disposing of impacted material offsite and backfilling the area with material meeting the unrestricted use criteria. However, it should be noted that the soil removed from OU-2 would be placed in a secure landfill without treatment; therefore no net destruction of contaminants is achieved. In addition, groundwater migration to OU-3 would be contained and groundwater impacts, if any, would be remediated by the phytotechnology plantings. However, the magnitude and duration of the excavation, transport, and disposal of 507,100 cubic yards of impacted soil and 12,000 cubic yards of concrete over a six year period poses public health and environmental risks that detract from the overall protectiveness of this alternative. These factors are further discussed in subsequent sections. The environmental impact with respect to greenhouse gas emissions is discussed in Section 6.11.

6.5.3.2 Standards, Criteria and Guidance

SCGs for the proposed remedy are presented in Section 5.2. Remedial Alternative 1 would achieve compliance with the unrestricted use criteria for soil throughout OU-2, which is the most stringent of the soil criteria. The excavation would be backfilled with material meeting the unrestricted use criteria presented in Part 375, and a phytotechnology based hydraulic control system would be installed to control groundwater migration and treat remaining groundwater impacts, if any. The phytotechnology plantings, coupled with the groundwater remediation resulting from excavation and backfill of OU-2, would be expected to address groundwater to meet the SCGs.

6.5.3.3 Long-Term Effectiveness and Permanence

Remedial Alternative 1 removes the soil up to 15 feet in areas across the majority of OU-2 that was impacted as a result of the former refinery/terminal activities or that was impacted by background influences. Groundwater migration to OU-3 would be contained by the phytotechnology plantings, in addition to treating residual impacted groundwater, if any. Remedial Alternative 1 returns OU-2 to conditions that are less contaminated than area background (based upon data available from NYSDOH for the Seneca Babcock Street area). Therefore, with regard to the condition OU-2 would be left in following remediation (i.e., all impacted material above the criteria and all petroleum impacted soil removed from OU-2), Remedial Alternative 1 provides the most permanent remedial solution by removing impacted materials from the Site and, thereby, mitigating the potential for exposure to impacted soil and separate-phase product. However, the soil removed from OU-2 would be placed in a regulated facility without treatment, therefore it is ultimately an offsite containment remedy that does not result in a permanent reduction in contamination. In addition, the already minimal groundwater impacts would be remediated by the elimination of all impacted soil.

6.5.3.4 Reduction in Toxicity, Mobility or Volume of Contamination Through Treatment

Remedial Alternative 1 would permanently eliminate the toxicity, mobility, and volume of contaminants within OU-2 by removing soil that exceeded the unrestricted use criteria or that was impacted by separate-phase product across most of OU-2 up to 15 feet below grade. However, the soil removed from OU-2 would be placed in a secure landfill without treatment; therefore, it is ultimately an offsite containment remedy, which does not result in any net reduction in contamination and is the least favorable on the hierarchy provided in Part 375. Impacted groundwater would be treated via dewatering/water treatment during excavation and offsite disposal of impacted soil, mass elimination of potential continuing sources of groundwater impacts, and use of phytotechnology tree plantings. Remedial Alternative 1 also permanently eliminates the separate-phase product from OU-2 during excavation, to the extent practicable.

6.5.3.5 Short-Term Impacts and Effectiveness

The health and environmental risks associated with the implementation of Remedial Alternative 1 are significant. The remedy implementation time (six years) is long. Therefore, the potential adverse impacts to the community and workers, though mitigated to the extent practical with engineering controls, would be significant due to the long duration of the project and the amount of excavation, heavy construction, and transportation actions that would be needed to perform the remedy. These potential impacts (exposure to contaminants, exposure to equipment exhaust and property damage, and personal injury incidents during soil excavation and transportation) would be addressed in the site-specific Health & Safety Plan (HASP) and Community Air Monitoring Plan (CAMP), which also detail monitoring during the construction. These risks would be mitigated through the implementation of engineering controls as necessary (i.e., dust suppression and traffic control). The potential impacts of heavy construction equipment and transportation actions with respect to greenhouse gas emissions are discussed further in Section 6.11.

6.5.3.6 Implementability

The materials, equipment, and personnel associated with the implementation of Remedial Alternative 1 are commercially available and have been proven effective and reliable for remediation of the media of concern at OU-2 under similar circumstances at other sites. However, Remedial Alternative 1 is the most difficult to implement due to significant excavation, shoring, and dewatering required. In addition, Remedial Alternative 1 has a relatively long implementation duration of approximately six construction seasons.

6.5.3.7 Cost

The construction and equipment costs associated with the implementation of the remedial components of Remedial Alternative 1 are estimated at approximately $86,553,000, among the highest of the alternatives under consideration. Long-term operation and maintenance (O&M) activities associated with Remedial Alternative 1 are minimal and include inspection and maintenance of the phytotechnology plantings for 30 years and groundwater monitoring for four years. In addition, a certification of the institutional and engineering controls (phytotechnology tree plantings) is required. Annual operation and maintenance costs are estimated to be $32,500 per year for the first two years and $8,600 for the remaining years. The present value of O&M for this alternative is estimated at $150,700. Therefore, the total present worth cost of this alternative is $86,553,000. The cost of Remedial Alternative 1, which would allow for unrestricted use of OU-2, is not proportional to the overall effectiveness considering the current and reasonably anticipated land use and zoning of OU-2 (commercial/industrial). Remedial Alternative 1 is therefore not a cost effective approach for OU-2.

6.5.3.8 Compatibility with Land Use

Remedial Alternative 1 would allow for unrestricted use of OU-2 (with an institutional control to restrict the use of groundwater), which is an upgrade to the current and reasonably anticipated land use and zoning of OU-2. In addition, this alternative would not complicate the redevelopment of OU-2 or impact the closure strategy for OU-3. However, the significant cost of implementing Remedial Alternative 1 to bring OU-2 to a condition to allow unrestricted use is not warranted for the following reasons:

- The current zoning of OU-2 is M3 (heavy industrial district), and the proposed zoning of OU-2 under the City of Buffalo’s LWRP is CM-General Commercial District with a proposed land use of mixed use commercial/light industrial;

- The reasonably anticipated future use of OU-2 would remain vacant land with a portion operating as a petroleum products storage and distribution terminal owned and operated by Buckeye, and a portion (on the BSPA) owned and operated by One Babcock for various industrial purposes;
- OU-2 is surrounded by vacant land and primarily industrial uses, with limited commercial and residential uses; and
- The preferred redevelopment scenario from the Elk Street Corridor Redevelopment Plan, which includes light industrial, back office, commercial, green space and very limited retail use in the vicinity of the Site, and for OU-2 specifically, commercial uses west of the Buckeye Terminal (except for limited retail space at the corners of Elk Street and Babcock Street), and light industrial uses on and to the east of the Buckeye Terminal.

6.6 Evaluation of Remedial Alternative 2: Track 2 Scenario to Commercial or Industrial Use Criteria via Excavation and Offsite Disposal

The following sections provide a detailed evaluation of Remedial Alternative 2, which would achieve a Track 2 cleanup of OU-2, as described in Section 5.1.

6.6.1 Description of Remedial Alternative 2

Remedial Alternative 2 is similar to Remedial Alternative 1 with the exceptions being that impacted soil would be excavated to depths up to 15 feet below grade to meet the appropriate restricted use criteria (depending on area), rather than the unrestricted use criteria; and that an environmental easement will be implemented to restrict land use and the use of groundwater. The commercial criteria would apply to the portion of OU-2 west of the Buckeye Terminal. The industrial criteria would apply to the portion of OU-2 on and to the east of the Buckeye Terminal. An estimated 240,200 cubic yards of soil and 12,000 cubic yards of concrete would require excavation to meet the appropriate restricted use criteria. It should be noted that excavation of soil to meet the commercial or industrial criteria based on specific constituents would not address all areas identified as petroleum impacted based on field observations discussed in Section 3.2.4.1. An additional 106,900 cubic yards would be required to be excavated and treated to address petroleum impacted soil for a total of approximately 347,100 cubic yards for Alternative 2. The remainder of discussion regarding the Track 2 remedy is essentially identical to the Track 1 remedy and will not be repeated.

Regarding groundwater remediation, existing data demonstrates that the groundwater beneath OU-2 is not significantly impacted. The highest concentrations of contaminants have historically been observed near the boundary between OU-2 and OU-3. The removal of impacted soil from OU-2 would result in further improvement of groundwater quality over time. In addition, phytotechnology tree plantings (Section 6.3.4) installed along the south side of OU-2 (along Prenatt Street) would be designed to contain groundwater migration and remediate residual impacts remaining after the soil remedy is implemented. It is estimated that the phytotechnology tree plantings would limit groundwater migration within three years of planting. This timeframe coordinates well with continued operation of the WPS for groundwater control and treatment until the closure strategy for OU-3 is developed, approved and implemented. An environmental easement would be implemented to restrict land use and use of groundwater.

Implementation of Remedial Alternative 2 would be completed within four construction seasons.

Plate 13 shows the areas to be addressed under Remedial Alternative 2. Estimated costs for Remedial Alternative 2 are presented in **Appendix D**.

6.6.2 Preliminary Screening of Remedial Alternative 2

The major benefits of Remedial Alternative 2 are essentially the same as Alternative 1 and are described in Section 6.5.2.

6.6.3 Detailed Evaluation of Remedial Alternative 2

The following sections provide a detailed evaluation of Remedial Alternative 2 based on eight of the nine specific evaluation criteria from Part 375 described in Section 6.2. The ninth criteria, community acceptance, cannot be fully evaluated until the public comment period is completed. The ranking of Remedial Alternative 2 relative to the evaluation criteria presented in Section 6.2 is shown on **Table 26**. Remedial Alternative 2 ranks fifth overall out of the six potential alternatives.

6.6.3.1 Overall Protection of Human Health and the Environment

The level of protection of human health and the environment for Remedial Alternative 2 is essentially the same as Remedial Alternative 1, as described in Section 6.5.3.1.

6.6.3.2 Standards, Criteria and Guidance

The performance of Remedial Alternative 2 is essentially the same as Remedial Alternative 1 relative to this criterion, as described in Section 6.5.3.2.

6.6.3.3 Long-Term Effectiveness and Permanence

The performance of Remedial Alternative 2 is essentially the same as Remedial Alternative 1 relative to this criterion, as described in Section 6.5.3.3.

6.6.3.4 Reduction in Toxicity, Mobility or Volume of Contamination Through Treatment

The performance of Remedial Alternative 2 is essentially the same as Remedial Alternative 1 relative to this criterion, as described in Section 6.5.3.4.

6.6.3.5 Short-Term Impacts and Effectiveness

The performance of Remedial Alternative 2 is essentially the same as Remedial Alternative 1 relative to this criterion, as described in Section 6.5.3.5.

6.6.3.6 Implementability

The performance of Remedial Alternative 2 is essentially the same as Remedial Alternative 1 relative to this criterion, as described in Section 6.5.3.6.

6.6.3.7 Cost

The costs associated with Remedial Alternative 2 are estimated at approximately $61,455,000, among the highest of the alternatives under consideration. Long-term O&M activities associated with Remedial Alternative 2 are minimal and include inspection and maintenance of the phytotechnology plantings for 30 years and groundwater monitoring for four years. In addition, a certification of the institutional and engineering controls (phytotechnology tree plantings) is required. Annual operation and maintenance costs are estimated to be $32,500 per year for the first two years and $8,700 for the remaining years. The present value of O&M for this alternative is estimated at $150,700. Therefore, the total present worth cost of this alternative is $61,455,000. The cost of Remedial Alternative 2, which would allow for use of OU-2 for commercial/industrial purposes, is not proportional to the overall effectiveness considering that there are other potential remedial alternatives that would allow for the same land use, but at lower cost. Remedial Alternative 2 is therefore not a cost effective approach for OU-2.

6.6.3.8 Compatibility with Land Use

The performance of Remedial Alternative 2 is essentially the same as Remedial Alternative 1 relative to this criterion, as described in Section 6.5.3.8.

6.7 Evaluation of Remedial Alternative 3: Track 2 Scenario to Commercial or Industrial Use Criteria via Onsite Treatment

The following sections provide a detailed evaluation of Remedial Alternative 3, which would achieve a Track 2 cleanup of OU-2, as described in Section 5.1.

6.7.1 Description of Remedial Alternative 3

In Remedial Alternative 3, impacted soil would be excavated to depths up to 15 feet below grade to meet the appropriate restricted use criteria (depending on area), as well as to address petroleum impacted soil, and treated onsite using HTTD with offgas treatment. The commercial criteria would apply to the portion of OU-2 west of the Buckeye Terminal. The industrial criteria would apply to the portion of OU-2 on and to the east of the Buckeye Terminal. An estimated 240,200 cubic yards of soil would require to be excavated and treated, and 12,000 cubic yards of concrete would require to be excavated, in order to meet the appropriate restricted use criteria. It should be noted that excavation of soil to meet the commercial or industrial criteria would not address all areas identified as petroleum impacted based on field observations discussed in Section 3.2.4.1. An additional 106,900 cubic yards would be required to be excavated and treated to address petroleum impacted soil for a total of approximately 347,100 cubic yards for Alternative 3. In portions of OU-2 where metals exceed the respective use criteria, soil would be excavated and disposed offsite or capped with one foot of material since

HTTD would not address metals exceedances.

Post-excavation bottom and sidewall sampling would be conducted. Excavation shoring and dewatering would be required. The area will be backfilled with treated soil assuming that the physical properties of the treated soil would not be acceptable without amendments. The treated material would be amended with imported material meeting the lower of the commercial use criteria (for commercial or industrial use) for protection of human health or the criteria for protection of groundwater. Sampling of the offsite fill material would be conducted to confirm that it meets the quality criteria.

Regarding groundwater remediation, existing data demonstrates that the groundwater beneath OU-2 is not significantly impacted. The highest concentrations of contaminants have historically been observed near the boundary between OU-2 and OU-3. The removal of impacted soil from OU-2 would result in further improvement of groundwater quality over time. In addition, phytotechnology tree plantings (Section 6.3.4) installed along the south side of OU-2 (along Prenatt Street) would be designed to contain groundwater migration and remediate residual impacts remaining after the soil remedy is implemented. It is estimated that the phytotechnology tree plantings would limit groundwater migration within three years of planting. This timeframe coordinates well with continued operation of the WPS for groundwater control and treatment until the closure strategy for OU-3 is developed, approved and implemented. An environmental easement would be implemented to restrict land use and use of groundwater.

Implementation of Remedial Alternative 3 would be completed within 11 construction seasons.

Plate 13 shows the areas to be addressed under Remedial Alternative 3. Estimated costs for Remedial Alternative 3 are presented in **Appendix D**.

6.7.2 Preliminary Screening of Remedial Alternative 3

The ranking of Remedial Alternative 3 relative to the evaluation criteria presented in Section 6.2 is shown on **Table 26**. Remedial Alternative 3 ranks sixth overall out of the six potential alternatives.

The major benefits of Remedial Alternative 3 are that it:

- Treats all contamination (except metals) exceeding the relevant and appropriate restricted use criteria from OU-2, except where metals are present above the criteria;
- Removes and treats petroleum impacted soil identified based on field observations and ongoing separate-phase product gauging to the extent practicable;
- Utilizes the most preferable technology among the hierarchy of technologies provided in Part 375;
- Would not adversely impact the closure strategy for OU-3 to the south; and
- Is compatible with reasonably anticipated future land use. It should be noted that the commercial criteria is an upgrade to the current heavy industrial zoning for the portion of OU-2 west of the Buckeye Terminal, while the industrial criteria is compatible

with the current heavy industrial zoning for the portion of OU-2 including and east of the Buckeye Terminal, and both are consistent with the proposed land use for the area presented in the City of Buffalo's LWRP.

The main drawbacks of Remedial Alternative 3 are that it:

- Requires the offsite disposal (in a secure landfill space without treatment) of soil containing metals (though less than Remedial Alternatives 1 and 2) above the restricted use criteria since HTTD will not address these impacts, and therefore constitutes an offsite containment remedy, which is the least favorable among the hierarchy of technologies provided in Part 375;
- Results in significant short-term impacts due to the long implementation duration (11 construction seasons) and the potential for air quality and noise impacts and traffic related incidents;
- Is difficult to implement due to significant excavation shoring and dewatering required, the need to control the moisture content of the soil entering the treatment train, the likelihood for the treatment process to alter the physical properties of the soil making it unsuitable for backfill without amendments, the potential need to pre-screen the material prior to treatment, the potential for incomplete treatment if the soil characteristics are not homogeneous, and the difficulty associated with treating the SVOCs present; and
- Is the most costly of the alternatives.

Remedial Alternative 3 will not be retained for a more detailed evaluation.

6.8 Evaluation of Remedial Alternative 4: Track 4 Scenario to Commercial or Industrial Use Criteria via Lined Soil Cap, *In Situ* Stabilization of Leachable Lead, and Phased *In Situ* Treatment of Petroleum Impacted Soil

The following sections provide a detailed evaluation of Remedial Alternative 4, which would achieve a Track 4 cleanup of OU-2, as described in Section 5.1.

6.8.1 Description of Remedial Alternative 4

In Remedial Alternative 4, impacted surface soil exceeding the respective use criteria would be capped with a one-foot thick lined soil cap. The commercial criteria would apply to the portion of OU-2 west of the Buckeye Terminal. The industrial criteria would apply to the portion of OU-2 on and to the east of the Buckeye Terminal. An estimated 12,000 cubic yards of concrete would require excavation prior to cap installation. To facilitate cap construction and maintenance, the anticipated layout of the lined cap will extend in all directions to a sample location in compliance with the respective use criteria, or the property boundary/OU-2 boundary/currently paved surface. The lined soil cap would consist of a non-woven geotextile fabric over the prepared subgrade of existing material, a 40-mil HDPE liner or geosynthetic liner, six inches of common fill and six inches of topsoil meeting the lower of the commercial criteria (for commercial or industrial use) for protection of human health or the criteria for protection of groundwater, followed by seeding with turf grasses (or other appropriate vegetation). Sampling of the offsite fill material would be conducted to confirm that it meets the quality criteria. A gas venting system would be installed beneath the proposed capped areas. Areas that do not exceed the respective use criteria for surface soil would be graded, as necessary, and seeded with turf grasses (or other appropriate vegetation).

It should be noted that Remedial Alternative 4 would address direct contact with all areas identified as petroleum impacted based on field observations discussed in Section 3.2.4.1 through capping and containment, however, no source removal would be achieved. To prepare OU-2 for future redevelopment, ExxonMobil would address petroleum impacted soil identified through field observations by the application of LKD in a phased approach. As discussed in Section 3.3.3, LKD addition appeared successful at treating petroleum impacted soil. More information is needed, however, to evaluate the feasibility of full-scale LKD application. Therefore, LKD would be applied in a phased approach. The initial LKD application will be in the phytotechnology tree planting area shown on Plate 14 prior to grading and planting of trees in that area. During the first phase of application, field observations and sampling will be conducted to:

- confirm the applicability of the technology under large scale conditions within OU-2, including refining mixing ratios and methods;
- assess short term impacts and required engineering controls, particularly in the vicinity of the northern fenceline of OU-2, where a few local residents may be in closer proximity to the construction activities associated with the LKD mixing; and
- evaluate viability of vegetation grown within LKD treated soil.

Subsequent phases of LKD application across OU-2 would be completed in coordination with capping efforts at an estimated rate of three acres per year.

As discussed in Section 3.3.1, bench scale tests demonstrated that EnviroBlend can reduce lead leachability to less than five mg/L of TCLP lead. Therefore, EnviroBlend (or a similar reagent) would be used to address leachable lead present in the eastern portion of the NPSA, SB-124, and elsewhere within OU-2, if any. The *in situ* mixing will continue until TCLP lead results are less than five mg/L.

Regarding groundwater remediation, existing data demonstrates that the groundwater beneath OU-2 is not significantly impacted. The highest concentrations of contaminants have historically been observed near the boundary between OU-2 and OU-3. Phytotechnology tree plantings (Section 6.3.4) installed along the south side of OU-2 (along Prenatt Street) would be designed to contain groundwater migration and remediate residual impacts. It is estimated that the phytotechnology tree plantings would limit groundwater migration within three years of planting. This timeframe coordinates well with continued operation of the WPS for groundwater control and treatment until the closure strategy for OU-3 is developed, approved and implemented. An environmental easement would be implemented to restrict land use and use of groundwater.

Implementation of Remedial Alternative 4 would be completed within 10 construction seasons.

Plate 14 shows the areas to be addressed under Remedial Alternative 4. Estimated costs for Remedial Alternative 4 are presented in **Appendix D**.

6.8.2 Preliminary Screening of Remedial Alternative 4

The ranking of Remedial Alternative 4 relative to the evaluation criteria presented in Section 6.2 is shown on **Table 26**. Remedial Alternative 4 ranks third overall out of the six potential alternatives.

The major benefits of Remedial Alternative 4 are that it:

- Results in manageable short-term impacts that can be addressed through engineering controls;
- Treats leachable lead via *in situ* stabilization and treats petroleum impacted soil via *in situ* LKD mixing in a phased approach;
- Is less difficult to implement than the Track 2 remedies, but slightly more difficult to implement than the other Track 4 remedies due to the liner; and
- Is significantly less costly than the Track 2 remedies, but more costly than the other Track 4 remedies.

The main drawbacks of Remedial Alternative 4 are that it:

- Is not as compatible with the land use criteria as any of the other alternatives, as it may complicate the redevelopment of OU-2 due to the fact that the lined cap may need to be breached and/or redesigned in order to implement potential future redevelopment;
- Will impact the closure strategy for OU-3 as it will require collection of more stormwater runoff than any of the other alternatives, which must be handled by the stormwater management system and subsequently discharged;
- Is primarily an onsite containment remedy, which is the least favorable among the hierarchy of remedial options provided in Part 375; and
- Will inhibit the natural biodegradation of SVOCs and other petroleum impacts in soil by isolating the impacted material from the environment.

Since the groundwater data has shown that infiltration through impacted soil has not significantly impacted groundwater quality in OU-2, the liner included in this alternative is not necessary and only complicates the potential future redevelopment of OU-2 and impacts the closure strategy for OU-3.

Remedial Alternative 4 will not be retained for a more detailed evaluation.

6.9 Evaluation of Remedial Alternative 5: Track 4 Scenario to Commercial or Industrial Use Criteria via Unlined Soil Cap, *In Situ* Stabilization of Leachable Lead, and Phased *In Situ* Treatment of Petroleum Impacted Soil

The following sections provide a detailed evaluation of Remedial Alternative 5, which would achieve a Track 4 cleanup of OU-2, as described in Section 5.1.

6.9.1 Description of Remedial Alternative 5

In Remedial Alternative 5, impacted surface soil exceeding the respective use criteria would be capped with a one-foot thick unlined soil cap. The commercial criteria would apply to the portion of OU-2 west of the Buckeye Terminal. The industrial criteria would apply to the portion of OU-2 on and to the east of the Buckeye Terminal. An estimated 12,000 cubic yards of concrete would require excavation prior to cap installation. To facilitate cap construction and maintenance, the anticipated layout of the unlined cap will extend in all directions to a sample location in compliance with the respective use criteria, or the property boundary/OU-2 boundary/currently paved surface. The unlined soil cap would consist of six inches of common fill and six inches of topsoil meeting the lower of the commercial criteria (for commercial or industrial use) for protection of human health or the criteria for protection of groundwater, followed by vegetation with select phytotechnology grasses. Sampling of the offsite fill material would be conducted to confirm that it meets the quality criteria. Areas that do not exceed the respective use criteria for surface soil would be graded, as necessary, and seeded with phytotechnology grasses.

Petroleum impacted soil and leachable lead will be addressed in the same manner as described in Remedial Alternative 4.

The phytotechnology species would be fast growing and deep rooting (up to two feet), designed to enhance the biodegradation of PAHs within the OU-2 soil in the one to two foot depth interval and be compatible with LKD treated soil. Preliminary design estimates indicate that PAHs within this zone should achieve the respective use criteria within five years following planting. The phytotechnology species would also aid stormwater management through the temporary storage of rainwater within the surface soil, and the subsequent uptake of soil moisture by the select grasses and forbs. By the second year of planting, the grasses and forbs would be capable of balancing mean monthly direct precipitation, thus minimizing additional inputs to groundwater that would migrate toward OU-3.

Regarding groundwater remediation, existing data demonstrates that the groundwater beneath OU-2 is not significantly impacted. The highest concentrations of contaminants have historically been observed near the boundary between OU-2 and OU-3. Phytotechnology tree plantings (Section 6.3.4) installed along the south side of OU-2 (along Prenatt Street) would be designed to contain groundwater migration and remediate residual impacts. It is estimated that the phytotechnology tree plantings would limit groundwater migration within three years of planting. This timeframe coordinates well with continued operation of the WPS for groundwater control and treatment until the closure strategy for OU-3 is developed, approved and implemented. An environmental easement would be implemented to restrict land use and use of groundwater.

Construction of Remedial Alternative 5 would be completed within 15 years, which includes five years of phytoremediation treatment duration.

Plate 14 shows the areas to be addressed under Remedial Alternative 5. Estimated costs for Remedial Alternative 5 are presented in **Appendix D**.

6.9.2 Preliminary Screening of Remedial Alternative 5

The major benefits of Remedial Alternative 5 are that it:

- Provides for overall protection of human health and the environment by minimizing the potential for direct human contact with impacted material (including soil exceeding numeric criteria and soil identified as petroleum impacted based on field observations);
- Provides for the potential reduction in toxicity, mobility and volume of contamination and meets the SCGs for soil in the one foot of soil (one to two foot depth interval) beneath the proposed cap through treatment by phytotechnology grasses;
- Treats leachable lead via *in situ* stabilization and treats petroleum impacted soil via *in situ* LKD mixing in a phased approach;
- Results in manageable short-term impacts that can be addressed through engineering controls;
- Provides a relatively short-term (e.g., five years) solution for treatment of VOCs and SVOCs in soil to the industrial and/or commercial criteria in the one to two foot depth interval;
- Is easier to implement than the Track 1 remedy, all of the Track 2 remedies and the lined soil cap remedy;
- Is significantly less costly than the Track 1 remedy and all of the Track 2 remedies;
- Does not complicate the redevelopment of OU-2 or the closure strategy for OU-3; and
- Is compatible with reasonably anticipated future land use. It should be noted that the commercial criteria is an upgrade to the current heavy industrial zoning for the portion of OU-2 west of the Buckeye Terminal, while the industrial criteria is compatible with the current heavy industrial zoning for the portion of OU-2 on and to the east of the Buckeye Terminal, and both are consistent with the proposed land use for the area presented in the City of Buffalo's LWRP.

The main drawback of Remedial Alternative 5 is that it:

- Results in a portion of the impacted material remaining in place below the one to two foot zone of treated soil, which constitutes an onsite containment remedy and is the least favorable among the hierarchy of remedial options provided in Part 375.

6.9.3 Detailed Evaluation of Remedial Alternative 5

The following sections provide a detailed evaluation of Remedial Alternative 5 based on eight of the nine specific evaluation criteria from Part 375 described in Section 6.2. The ninth criteria, community acceptance, cannot be fully evaluated until the public comment period is completed. The ranking of Remedial Alternative 5 relative to the evaluation criteria presented in Section 6.2

is shown on **Table 26**. Remedial Alternative 5 ranks second overall out of the six potential alternatives.

6.9.3.1 Overall Protection of Human Health and the Environment

Remedial Alternative 5 would provide protection of human health and the environment by isolating impacted material below an unlined cap, thus preventing direct contact. It also addresses groundwater impacts through containment and mitigation via phytotechnology tree plantings along the border of OU-3. This alternative treats leachable lead via *in situ* stabilization and treats petroleum impacted soil via *in situ* LKD mixing in a phased approach, thus protecting human health and the environment. This alternative also potentially provides treatment of impacted soil within the one to two foot depth interval to SCGs, thus providing additional protection for human health and the environment.

6.9.3.2 Standards, Criteria and Guidance

Remedial Alternative 5 would achieve compliance with the respective use criteria in the top one foot of soil throughout OU-2, as required for a Track 4 remedy, immediately upon completion of the construction by capping with clean material. In addition, the respective use criteria would also be expected to be achieved within the one to two foot interval through treatment via the proposed phytotechnology grasses. However, impacted material would be left in place below two feet. Groundwater would be contained (i.e., hydraulic control) and remediated (i.e., rhizodegradation) through the incorporation of deep rooting phytotechnology trees along the border with OU-3. As discussed in Section 3.3.3, it is understood that the NYSDEC concurs that *in situ* treatment with LKD satisfactorily mitigates petroleum impacts in soil.

As required by Part 375, the criteria for backfill are the lower of the commercial criteria (for commercial or industrial use) for protection of human health or the criteria for protection of groundwater.

6.9.3.3 Long-Term Effectiveness and Permanence

Remedial Alternative 5 does not provide as “complete or permanent” remedy for OU-2 as the Track 1 alternative or any of the Track 2 alternatives under consideration since impacted material below one foot is left in place. It also provides less treatment than Remedial Alternative 6, which provides treatment of an additional one foot of soil.

Use of *in situ* treatment would permanently stabilize leachable lead and address petroleum impacted soils.

6.9.3.4 Reduction in Toxicity, Mobility or Volume of Contamination Through Treatment

Remedial Alternative 5 would achieve compliance with the respective use criteria in the top one foot of soil throughout OU-2 immediately upon completion of the construction by capping with clean material. In addition, the respective use criteria would also be expected to be achieved within the one to two foot interval through treatment via the proposed phytotechnology grasses. Remedial Alternative 5 employs a treatment method for VOCs and SVOCs in soil in the one to two foot depth interval that does not require the use of mechanical energy in the treatment process. In addition, Remedial Alternative 5 provides a relatively short-term solution for treatment of soil to the respective use criteria in the one to two foot depth interval.

6.9.3.5 Short-Term Impacts and Effectiveness

The health and environmental risks associated with the implementation of Remedial Alternative 5 are minimal. The remedy construction time is 15 years (which includes five years of phytoremediation treatment duration) and the potential adverse impacts to the community and workers can be mitigated with engineering controls. These potential impacts (exposure to traffic during imported soil transportation, construction activities associated with the LKD mixing, and dust during capping) would be addressed in the site-specific HASP and CAMP, which also detail monitoring during the construction. These risks would be mitigated through the implementation of engineering controls as necessary (i.e., dust suppression and traffic control) and would only be an issue during the *in situ* treatment and capping phase.

6.9.3.6 Implementability

The materials, equipment, and personnel associated with the implementation of Remedial Alternative 5 are commercially available and have been proven effective and reliable (large scale LKD efficacy to be confirmed via performance of the initial phase application) for remediation of the media of concern at OU-2 under similar circumstances at other sites. The estimated timeframe for the respective use criteria to be achieved for VOCs and SVOCs within the one to two foot interval through treatment via the proposed phytotechnology grasses is five years.

6.9.3.7 Cost

The construction and equipment costs associated with the implementation of the remedial components of Remedial Alternative 5 are estimated at approximately $26,006,700, which is the second lowest cost of all other alternatives under consideration. Long-term O&M activities associated with Remedial Alternative 5 are minimal and include inspection and maintenance of the one-foot soil cap and phytotechnology plantings for 30 years, and groundwater monitoring for four years. Additionally, monitoring of the *in situ* lead stabilization will be via TCLP testing following treatment and monitoring of the *in situ* treatment of petroleum impacted soil will be via visual and olfactory observations from the stabilized areas. In addition, a certification of the institutional and engineering controls (phytotechnology plantings) is required. Annual operation and maintenance costs are estimated to be $43,400 per year for the first two years and $65,000 for the remaining years. The present value of O&M for this alternative is estimated at $1,462,000. Therefore, the total present worth cost of this alternative is $26,006,700.

6.9.3.8 Compatibility with Land Use

Remedial Alternative 5 would allow for continued industrial use of Buckeye's property, and the appropriate restricted use for the remainder of OU-2 with the implementation of long-term engineering and institutional controls. Remedial Alternative 5 is compatible with the current general industrial zoning and surrounding land use, but is an upgrade to the portion west of the Buckeye Terminal. Remedial Alternative 5 is generally consistent with the proposed land use for the area presented in the City of Buffalo's LWRP (which allows commercial and light industrial uses) and is consistent with the results of the Elk Street Corridor Redevelopment Plan (which allows for commercial uses west of the Buckeye Terminal except for limited retail space at the corners of Elk Street and Babcock Street, and light industrial uses on and east of the Buckeye Terminal). In addition, this alternative would not complicate the redevelopment of OU-2 or impact the closure strategy for OU-3.

6.10 Evaluation of Remedial Alternative 6: Track 4 Scenario to Commercial or Industrial Use Criteria via *In Situ* Stabilization of Leachable Lead In Situ Treatment of Petroleum Impacted Soils

The following sections provide a detailed evaluation of Remedial Alternative 6, which would achieve a Track 4 cleanup of OU-2, as described in Section 5.1.

6.10.1 Description of Remedial Alternative 6

In Remedial Alternative 6, petroleum impacted soils within the upper four feet of the site will be stabilized in situ. A depth of four feet was selected as it adequately addresses GCM within OU2. Over approximately 40 percent of the site, lacustrine clay is encountered within the upper four feet of the soil column. In areas of the site where clay surface is at depths greater than four feet, the soils above the clay and below four feet do not contain GCM in substantial quantities. Any petroleum impacted soil that may remain below the depth of stabilization will be isolated, both physically and hydraulically, in localized depressions in the surface of the clay unit. The mobility criteria for GCM will not be met for this condition therefore the impacted soils cannot be considered GCM. Historic water level data indicates that soils below four feet are generally below the water table for all or most of any given year. Pilot scale tests utilizing LKD and other amendments including granulated blast furnace slag would be conducted prior to full scale implementation. As discussed in Section 3.3.3, previous test plots using LKD have been proven successful at the site for stabilizing petroleum impacted soils. Granulated blast furnace slag may be included in the pilot tests for the potential added strength it could provide to the stabilized mixture. Additional strength would benefit future redevelopment plans for the site. The area of stabilization is depicted in Plate 15. A one foot clean soil cover would be installed over the stabilized area.

Lead impacted soils would be stabilized in-situ in a similar manner to the petroleum impacted soils. Further evaluation, including pilot tests, will be required to determine what amendments would be required to meet TCLP and SPLP criteria. Unlike, the petroleum stabilization, all lead impacted soils will be stabilized to depth. Metals impacted soils, with the exception of soils only impacted by arsenic, will be excavated and disposed off-site.

Hydraulic control will be provided by extending the soil stabilization into the lacustrine clay along the upgradient areas of the site. At a few localized areas along Elk Street, along the eastern border of OU-2 (east of Buckeye Terminal) and adjacent to Babcock Street on the western portion of OU-2, the depth to clay is greater than four feet. In these areas, the depth of stabilization will be increased until the lacustrine clay is encountered. The minimum width of the deepened section will be approximately three feet wide, based on a hydraulic conductivity of $1x10^{-6}$cm/sec of the stabilized soils. Existing data demonstrates that the groundwater beneath OU-2 is not significantly impacted. The highest concentrations of contaminants have historically been observed near the boundary between OU-2 and OU-3. A discussion on contaminant fate and transport modelling is presented in Section 6.10.3.1.

Remedial construction of Remedial Alternative 6 could be completed in one construction season if multiple crews were used for demolishing concrete pads and implementing the in-situ stabilization. The areas to be addressed by Remedial Alternative 6 are shown on Plate 15. Estimated costs for Remedial Alternative 6 are presented in **Appendix D**.

6.10.2 Preliminary Screening of Remedial Alternative 6

The major benefits of Remedial Alternative 6 are that it:

- Provides for overall protection of human health and the environment in the short-term and long-term by minimizing the potential for direct human contact with impacted material (including soil exceeding numeric criteria and soil identified as petroleum impacted based on field observations) through the presence of a one foot cover soil overlying four feet of stabilized soil;
- Provides for the reduction in toxicity, mobility and volume of contamination;
- Treats leachable lead and petroleum impacted soils via in situ stabilization;
- Results in manageable short-term impacts that can be addressed through engineering controls;
- Is easier to implement than the Track 1 remedy, all of the Track 2 remedies and the lined soil cap Track 4 remedy;
- Is significantly less costly than the Track 1 and all of the Track 2 remedies;
- Allows for redevelopment of OU 2 by providing protection for on-site laborers and the resulting stabilized sol matrix will have a higher unconfined compressive strength than the current site soils which allows for more development variations; and
- Is compatible with reasonably anticipated future land use. It should be noted that the commercial criteria is an upgrade to the current heavy industrial zoning for the portion of OU-2 west of the Buckeye Terminal, while the industrial criteria is compatible with the current heavy industrial zoning for the portion of OU-2 on and to the east of the Buckeye Terminal, and both are consistent with the proposed land use for the area presented in the City of Buffalo's LWRP.
- The anticipated one construction season schedule is easily compatible with any future use alternatives that may be proposed during implementation.

The main drawback of Remedial Alternative 6 is that it:

- Results in a impacted material remaining in place below the four foot zone of treated soil, which is an onsite containment remedy and is the least favorable among the hierarchy of remedial options provided in Part 375, however impacted material left in place would largely be below the water table and not mobile; and

- Would require the offsite disposal (in a secure landfill without treatment) of soil containing metals above the respective use criteria.

6.10.3 Detailed Evaluation of Remedial Alternative 6

The following sections provide a detailed evaluation of Remedial Alternative 6 based on eight of the nine specific evaluation criteria from Part 375 described in Section 6.2. The ninth criteria, community acceptance, cannot be fully evaluated until the public comment period is completed. The ranking of Remedial Alternative 6 relative to the evaluation criteria presented in Section 6.2 is shown on **Table 26**. Remedial Alternative 6 ranks first overall out of the six potential alternatives.

6.10.3.1 Overall Protection of Human Health and the Environment

Remedial Alternative 6 would provide protection of human health and the environment through placing a one foot clean cap and stabilizing four feet of impacted soils. This will create a five foot barrier between potentially impacted soils and human contact. It is anticipated that if shallow spread footing or frost wall foundations are included in any redevelopment scenario, that the bottom of foundations would not be installed at depths greater than five feet. Therefore, the remedy would provide protection from laborers during redevelopment.

Based on the result of Domenico contaminant fate and transport modeling, groundwater migration from OU-2 would not produce surface water loading at the Buffalo River that would exceed any of the surface water criteria. In this analysis, the highest groundwater concentrations from water samples collected at wells in OU-2 were compared to the NYDEC Ambient Water Quality Standards published in **Table 1** of the Division of Water Technical and Operational Guidance Series. The most stringent standard for each compound was compared to the concentrations detected in groundwater. If the groundwater concentration was greater, the fate and transport modeling was conducted. In each case, the Domenico model predicts the concentrations of the individual compounds at the surface water interface will be below the modeled standard. Stabilized soils along the upgradient perimeter of the site would be keyed into the lacustrine clay layer creating a low permeability border around the site.

6.10.3.2 Standards, Criteria and Guidance

Remedial Alternative 6 would achieve compliance with the respective use criteria under the Track Four remedy. Impacted material above the respective use criteria would be left in place below the stabilized zone, which is acceptable under the Track 4 remedy. The isolated areas of OU-2 with metals exceedances (except for leachable lead) described in Section 3 would be remediated through direct excavation/disposal to achieve SCGs. However, it should be noted that the soil removed from areas OU-2 with metals (except arsenic) exceedances would be placed in a secure landfill without treatment; therefore no net destruction of contaminants is achieved. Leachable lead would be stabilized via soil amendments. As discussed in Section 3.3.3, it is understood that the NYSDEC concurs that treatment with LKD satisfactorily mitigates petroleum impacts in soil.

6.10.3.3 Long-Term Effectiveness and Permanence

Remedial Alternative 6 does not provide as "complete or permanent" remedy for OU-2 as the Track 1 alternative or any of the Track 2 alternatives under consideration since petroleum impacted material below four feet is left in place.

Use of in situ treatment would permanently stabilize leachable lead and address petroleum impacted soils.

Remedial Alternative 6 would also reduce long-term stormwater discharge to the Buffalo River. The cover would be designed to reduce stormwater runoff volumes and mitigate the erosive properties of significant storm events through site grading and stormwater control features and structures.

6.10.3.4 Reduction in Toxicity, Mobility or Volume of Contamination through Treatment

All impacted soils within the upper four feet of the site would be stabilized by in-situ mixing of LKD and other amendments based on results of pilot scale testing. Leachable lead at depths greater than four feet would also be stabilized by application of soil amendments. Groundwater elevations observed within the portion of the site identified for stabilization are generally within four feet of the ground surface. Petroleum impacted soils have been encountered at depths that are below four feet, however NAPL at these depths have restricted mobility. **Figure 14** is provided from the Interstate Technology and Regulatory Council training on the mobility of liquid hydrocarbons in the subsurface. The figure depicts graphically the permeability of a porous media when two immiscible fluids are present. When only groundwater is present, the soils would be wetted with only groundwater and the permeability of the soils for groundwater would be at it maximum. In other words, when only water is present in the porous media, the permeability of the media for water is at 100 percent. However, as a fluid that is immiscible with water, e.g., oil, is added to the soils, the permeability for groundwater begins to diminish. At this point, the volume of oil present is not sufficient to fill voids; therefore, the oil has no mobility and the formation has a relatively low permeability for the oil due to the presence of water. As the volume of oil increases, the volume of water must decrease to maintain 100 percent saturation of the media. As oil becomes the more dominant fluid in the pore spaces, the formation permeability for oil increases as the formation permeability for groundwater decreases. This relationship also holds as the depth increases toward groundwater. When LNAPL is situated on the saturated zone, approaching the saturated zone vertically is similar to the relationship depicted in **Figure 14**. As the phreatic surface is encountered, the level at which pore spaces are primarily filled by water limit the vertical mobility of LNAPL. Therefore, the depth to which petroleum impacted materials should be addressed is no greater than the annual low groundwater stand elevation. NAPL will remain immobile below this level due to the dual fluids permeability phenomenon described above and its physical isolation between the stabilized monolith and lacustrine clay unit.

Stabilizing to four feet would provide for a stabilized matrix of approximately 218,300 cubic yards of soil above the lacustrine clay. Extending the depth of stabilization to clay to stabilize all potential petroleum impacted soils would increase the amount of stabilized soils by 100,400 and would result in a cost increase of more than $2.5MM.

The isolated areas of OU-2 with metals exceedances (except for leachable lead) described in Section 3 would be remediated either through direct excavation/disposal or through stabilization. However, it should be noted that the soil removed from areas OU-2 with metals exceedances would be placed in a secure landfill without treatment; therefore no net destruction of contaminants is achieved.

6.10.3.5 Short-Term Impacts and Effectiveness

The health and environmental risks associated with the implementation of Remedial Alternative 6 are minimal in comparison to most other alternatives. The remedy implementation time one construction season. During construction activities, the potential adverse impacts to the community and workers can be mitigated with engineering controls. These potential impacts (exposure to traffic during imported soil amendments transportation, construction activities associated with the soil amendment mixing) would be addressed in the site- specific HASP and CAMP, which also detail monitoring during the construction. These risks would be mitigated through the implementation of engineering controls as necessary (i.e., dust suppression and traffic control) and would only be an issue during the *in situ* treatment/capping phase.

Remedial Alternative 6 includes constructing a one foot clean soil cover cap that would be vegetated o provide protection from wind and water erosion. Erosion control would be achieved within one growing season.

6.10.3.6 Implementability

The materials, equipment, and personnel associated with the implementation of Remedial Alternative 6 are commercially available and have been proven effective and reliable for remediation of the media of concern at OU-2 under similar circumstances at other sites. The estimated timeframe to achieve the respective use criteria is within one year.

6.10.3.7 Cost

The construction and equipment costs associated with the implementation of the remedial components of Remedial Alternative 6 are estimated at approximately $18,498,000, which is among the lowest cost of all other alternatives under consideration. Long-term O&M activities associated with Remedial Alternative 6 are minimal and include inspection and maintenance of the cap surface and groundwater monitoring for four years. Additionally, monitoring of the in situ lead stabilization will be via TCLP testing following treatment and monitoring of the in situ treatment of petroleum impacted soil will be via visual and olfactory observations from the stabilized areas. In addition, a certification of the institutional and engineering controls is required. Annual operation and maintenance costs are estimated to be $43,400 per year for the first two years and $65,000 for the remaining years. The present value of O&M for this alternative is estimated at $1,461,700. Therefore, the total present worth cost of this alternative is $18,498,000. Based upon the above evaluation criteria and the reasonably anticipated zoning and land use for OU-2, Remedial Alternative 6 is a cost effective approach.

6.10.3.8 Compatibility with Land Use

Remedial Alternative 6 would allow for continued industrial use of Buckeye's property, and the appropriate restricted use for the remainder of OU-2 with the implementation of long-term engineering and institutional controls. Remedial Alternative 6 is compatible with the current general industrial zoning and surrounding land use, but is an upgrade to the portion west of the Buckeye Terminal. Remedial Alternative 6 is generally consistent with the proposed land use for the area presented in the City of Buffalo's LWRP (which allows commercial and light industrial uses) and is consistent with the results of the Elk Street Corridor Redevelopment Plan (which allows for commercial uses west of the Buckeye Terminal except for limited retail space at the corners of Elk Street and Babcock Street, and light industrial uses on and to the east of the Buckeye Terminal). In addition, this alternative would facilitate the redevelopment of OU-2 and is easily adjusted based upon future use alternatives that may be proposed and supports the closure strategy for OU-3.

6.11 Summary of Alternatives Evaluation

Table 26 summarizes the ranking of each alternative relative to eight of the nine evaluation criteria (with the exception of community acceptance). For Remedial Alternatives 1, 2, 5, and 6, a detailed description of the evaluation of each alternative with respect to each criteria was provided in the prior sections. A comparative evaluation of the alternatives provides a further explanation of the ranking shown in **Table 26**.

<u>Overall Protection of Public Health and the Environment</u>: The alternatives were ranked similarly with respect to this evaluation factor and all provide adequate protection of public health and the environment. While Remedial Alternative 1 was ranked slightly better than the other alternatives because it will result in excavation of all impacted material down to unrestricted use criteria, this additional level of remediation does not result in any further protection of public health or the environment because the future use of the Site is not anticipated to be unrestricted. Remedial Alternatives 4, 5, and 6 provide a remediation approach that is fully protective based upon the anticipated future uses of OU-2. Moreover, the extensive excavation, transport, and disposal activities required by Remedial Alternatives 1 and 2 are orders of magnitude beyond those required for Remedial Alternatives 4, 5, and 6. These activities will result in potential risks to public health and significant environmental impact, as discussed below under short-term impacts and effectiveness. While most of these risks and impacts are short-term, as further evaluated below, their magnitude and duration warrant consideration when evaluating the overall protectiveness of Remedial Alternatives 1 and 2. The fewer transport and disposal activities associated with Remedial Alternative 3, compared to Remedial Alternatives 1 and 2, are more than offset by potential air quality and noise impacts occurring over an extended duration.

<u>Standards, Criteria and Guidance</u>: Remedial Alternative 1 was ranked the highest of the alternatives because all soil exceeding unrestricted use criteria would be removed to the extent possible. In conjunction with that effort, separate-phase product and petroleum impacted soil would also be removed. As a result of these actions, the groundwater quality conditions would likely improve the most towards compliance with ambient water quality standards. Please note, as previously discussed in Section 3.2.5, groundwater quality in OU-2 generally complies with

AWQSGVs and exceedances are detected only in localized areas. Remedial Alternatives 2 and 3 remove less soil than Remedial Alternative 1, and thus were ranked lower. Remedial Alternatives 4, 5, and 6 were ranked lower than Remedial Alternatives 2 and 3 because they achieve compliance with numerical soil standards within the top one to two feet (Alternatives 4 and 5) and within the top 4 feet (Alternative 6) of soil and rely upon capping and institutional controls. In addition, SCGs for groundwater may not be met since a percentage of the impacted material will remain in place below the one to two foot zone of treated soil and potentially continue to impact groundwater.

<u>Long-Term Effectiveness and Permanence</u>: Remedial Alternative 1, 2, and 3 were ranked the highest based upon their complete removal of contaminants down to a depth of 15 feet. Remedial Alternatives 4, 5, and 6 can serve as effective, permanent remedies; however, they are ranked lower than Remedial Alternatives 1, 2, and 3 because they will require the greatest long- term commitment with respect to management of the cap and residual onsite contamination.

<u>Reduction of Toxicity, Mobility or Volume through Treatment</u>: Remedial Alternatives 1 and 2 rely on removal actions to address the onsite soil and separate-phase product contamination; however, no treatment is provided. Remedial Alternative 3 uses treatment to destroy VOCs, but impacts due to metals and, to a lesser extent, SVOCs, are not addressed and thus, removal action is ultimately required. Remedial Alternatives 4, 5 and 6 use a combination of capping, phytotechnology and *in situ* stabilization of lead and *in situ* stabilization of petroleum impacted soil to reduce toxicity, mobility and eliminate exposure pathways, and thus were ranked slightly higher. Remedial Alternative 4 was ranked slightly lower because the liner inhibits natural biodegradation by plants and microbes. All the alternatives will entail groundwater treatment to varying degrees.

<u>Short-Term Impacts and Effectiveness</u>: Remedial Alternative 3 would have the greatest short-term impacts due to having the longest implementation time. The impacts include occupational risks to the onsite workers, offsite risks associated with large volumes of truck traffic and contamination transport, fuel consumption and air emissions contributing to local pollution, air impacts and noise generated by operation of the HTTD unit, and emission of global greenhouse gas. Remedial Alternatives 1 and 2 require significantly more offsite transportation due to the larger excavation and backfill volumes.

Reduction of global greenhouse gas (GHG) emissions is recognized as an important issue with respect to protection of the environment. Therefore, as part of the evaluation of each alternative with respect to protection of the environment, an analysis was performed to weigh the relative GHG emissions (in metric tons of carbon dioxide [CO_2]) associated with each remedial alternative. This analysis considered the key differentiators between each remedial alternative to quantify the relative potential impacts as opposed to being an in-depth analysis that exhaustively reviewed all potential GHG emissions (i.e., a life cycle impact assessment).

The analysis compared the emissions associated with heavy equipment required for excavation, waste removal, onsite soil treatment (Remedial Alternative 3 only) or for *in situ* treatment (Remedial Alternatives 4 through 6) and fill onsite, and electricity to run pumps for dewatering (Remedial Alternatives 1, 2, and 3 only) to complete the remediation project. The analysis specifically focused on the emissions associated with:

- Excavators;
- Loaders;
- Furnace boilers (HTTD only);
- Pickup trucks;
- Dump trucks; and
- Pumps.

In calculating the emissions associated with the onsite equipment, the following assumptions were made to predict fuel and electricity use:

- All heavy equipment was assumed to run in 28-week seasons with 5-day work weeks with the amount of heavy equipment and number of operating seasons being remedial alternative variables.
- Excavators were assumed to be similar to the Caterpillar 330 series with similar fuel efficiency.
- Loaders were assumed to be similar to the Komatsu 600 series with similar fuel efficiency.
- Boilers for HTTD plants were assumed to run nine hours each work day and consume 15 gallons of diesel fuel per hour per ton of soil treated.
- 18 yard dump trucks were assumed to drive 10 miles a day with the average fuel efficiency of a class 8 truck as measured by the United States Department of Energy.
- 30 yard dump trucks were assumed to drive 60 miles roundtrip for each disposal trip (Remedial Alternatives 1, 2, and 3), 0.3 miles roundtrip to transport material to the HTTD plants (Remedial Alternative 3), and 0.3 miles roundtrip to transport treated material for use as backfill (Remedial Alternative 3), with the average fuel efficiency of a class 8 truck as measured by the United States Department of Energy.
- Pickup trucks were assumed to drive 20 miles a day with a fuel efficiency of 15 miles per gallon.
- Pumps were assumed to require 230 watts of power.
- The diesel GHG emission factor was taken from the GHG Protocol[1].
- The electricity emission factor was taken from the USEPA's eGrid[2] database and assumed that the project is located in Buffalo, New York.

[1] *http://www.ghgprotocol.org*
[2] *http://cfpub.epa.gov/egridweb*

As summarized below, the climate impact analysis indicates Remedial Alternatives 1, 4, 5, and 6 are similar. Remedial Alternative 2 has the lowest GHG emissions footprint due to the shortest construction timeframe. The climate impact model developed to calculate the GHG emissions of each remedial alternative is provided as **Appendix E**.

Remedial Alternative	Greenhouse Gas Emissions (metric tons of CO_2)
Alternative 1	12,271
Alternative 2	8,264
Alternative 3	17,456
Alternative 4	13,076
Alternative 5	13,076
Alternative 6	1,867

Implementabilty: All of the alternatives utilize materials, equipment, and personnel that are commercially available and have been proven effective and reliable for remediation of the media of concern at OU-2 under similar circumstances at other sites. However, Remedial Alternative 1, 2, and 3 are the most difficult to implement due to significant excavation, shoring, and dewatering.

Cost: Remedial Alternatives 1 and 3 are the most expensive alternatives at $86,8552,500 and $122,310,300, respectively, due to the large volume of soil requiring excavation and disposal (Remedial Alternative 1) or onsite treatment (Remedial Alternative 3). Remedial Alternatives 5 and 6 are significantly less expensive at $26,006,700 and $18,498,000, respectively.

Land Use: Remedial Alternative 1 would allow for unrestricted use of OU-2 (with an institutional control to restrict the use of groundwater), which is an upgrade to the current and reasonably anticipated land use and zoning of OU-2.

Remedial Alternative 2 and 3 would allow for continued industrial use of Buckeye's property, and the appropriate restricted use for the remainder of OU-2 without the implementation of long-term engineering and institutional controls for the soil portion of the remedy.

Remedial Alternatives 4, 5, and 6 would allow for continued industrial use of Buckeye's property, and the appropriate restricted use for the remainder of OU-2 with the implementation of long-term engineering and institutional controls.

Remedial Alternatives 2 through 6 are compatible with the current general industrial zoning and surrounding land use, but is an upgrade to the portion west of the Buckeye Terminal. They are generally consistent with the proposed land use for the area presented in the City of Buffalo's LWRP (which allows commercial and light industrial uses) and is consistent with the results of the Elk Street Corridor Redevelopment Plan (which allows for commercial uses west of the Buckeye Terminal except for limited retail space at the corners of Elk Street and Babcock Street, and light industrial uses on and to the east of the Buckeye Terminal). In addition, Remedial Alternatives 2, 3, 5, and 6 would not complicate the redevelopment of OU-2 or impact the closure strategy for OU-3.

Remedial Alternative 4 is ranked the lowest since the lined cap may need to be breached and/or redesigned in order to implement potential future redevelopment.

6.12 Identification of Recommended Remedy for OU-2

Remedial Alternative 6, in situ stabilization of leachable lead and in situ treatment of petroleum impacted soils is the recommended remedy for OU-2.

In situ stabilization of leachable lead and in situ treatment petroleum impacted soil was selected for implementation in OU-2 since it adequately meets each of the evaluation criteria, but costs significantly less than excavation and offsite disposal remedies (Remedial Alternatives 1 and 2) or excavation and onsite treatment alternative (Remedial Alternative 3). In addition, it has the benefit of facilitating redevelopment of the site by providing greater load bearing soils above the soft lacustrine clay. Alternative 6 can also be completed within one construction season which is significantly faster than Remedial Alternatives 4 or 5.

In summary, the selected alternative:

- Is protective of public health and the environment immediately through the removal of metals, in situ stabilization of leachable lead, in situ treatment of petroleum impacted soils from zero to four feet below existing grade, maintenance of the perimeter fence, and the implementation and maintenance of engineering and institutional controls;
- Complies with the appropriate restricted use criteria for soil;
- Provides long-term effectiveness and permanence through in situ stabilization of leachable lead and in situ treatment of petroleum impacted soil, and the implementation and maintenance of engineering and institutional controls;
- Reduces the toxicity, mobility, or volume of impacted material through treatment of the top four feet of soil;
- Provides short-term effectiveness, including minimal impacts to workers or the surrounding neighborhood through the implementation of engineering controls during construction;
- Is compatible with land use;
- Is readily implemented and easily adjusted based upon future use alternatives that may be proposed; and
- Can be completed within one construction season.
- Can be implemented at a low cost compared to other alternatives.

The recommended remedy is consistent with the approach for a Track 4 cleanup to commercial or industrial criteria, depending on the area of OU-2, described in the Draft BCP Guide and Part 375.

7.0 DETAILED DESCRIPTION OF THE RECOMMENDED REMEDY

Remedial Alternative 6 will provide a comprehensive and final remedy for OU-2. Implementation of the recommended remedy will include the following elements:

- Demolition of selected existing unoccupied buildings in preparation for remedial construction (completed in 2007);
- Evaluation of soil vapor intrusion and mitigation;
- Mobilization and site preparation;
- Implementation of site control measures during construction;
- Concrete removal and disposal;
- In situ stabilization of leachable lead;
- In situ treatment of petroleum impacted soil from zero to four feet;
- Hydraulic control via upgradient low permeability zones;
- Installation of one foot soil cap over stabilized areas;
- Offsite disposal and equipment decontamination;
- Stormwater management system modifications;
- Installation of new monitoring wells;
- Operation and maintenance and performance monitoring;
- Preparation and implementation of a Site Management Plan; and
- An Environmental Easement as Institutional Control.

Each of these elements is discussed below. Additional details for each of these elements will be developed as part of the remedial design to be prepared following submission and NYSDEC approval of this Final AAR.

7.1 Demolition of Selected Existing Unoccupied Buildings

Demolition of selected existing unoccupied buildings was conducted as described in Section 6.3.1.

7.2 Evaluation of Soil Vapor Intrusion

The potential for soil vapor intrusion was evaluated per the NYSDOH Final "Guidance for Evaluating Soil Vapor Intrusion in the State of New York". The results to date were discussed in Section 3.2.6. Additional sampling will be conducted in the heating season of 2012, the results of which will be submitted under separate cover. Future evaluation of soil vapor intrusion, if necessary, will be performed as described in Section 6.3.2.

7.3 Mobilization and Site Preparation

Mobilization will occur following the NYSDEC approval of the remedial design documents and the completion of all community participation requirements. Upon mobilization to the Site, the Contractor will set up all temporary utilities and temporary facilities required. The Contractor will clear vegetation, as necessary, for access to the OU-2 remediation area. A pre-construction survey will also be prepared by a land surveyor licensed by the State of New York.

7.4 Implementation of Site Control Measures During Construction

The remedial design documents will include plans and specifications for establishing appropriate site controls to ensure the remedy will be implemented safely and in accordance with applicable regulations. Some of the control measures to be addressed include, but may not be limited to, the following:

- Stormwater Management and Erosion Controls;
- Dust and Materials Management Controls;
- Health and Safety and Community Air Monitoring; and
- Traffic Controls.

Each of these is described below.

7.4.1 Stormwater Management and Erosion Controls

All necessary measures to temporarily control erosion will be employed. Since OU-2 will be remediated under the BCP, coverage under the NYSDEC SPDES General Permit for Discharges from Construction Activities (GP-0-10-001) is not required. However, to meet the substantive requirements of the General Permit, a Stormwater Pollution Prevention Plan (SWPPP) will be prepared for the work. The SWPPP will define appropriate and maximize the potential benefits of pollution prevention and sediment and erosion control measures at the Site during construction activities. Soil erosion and sediment control measures will be installed prior to the implementation of the remediation and will be maintained throughout the duration of all remedial construction activities, as appropriate. Hay bales, silt fences, or other control measures will be placed by the Contractor to control sediment around the disturbed area/excavations or other work areas. Erosion and sediment control measures (i.e., hay bales, silt fences, etc.) will be used to protect active stormwater drain in proximity to the construction activities.

In addition, the entrance and adjacent street areas will be swept and/or cleaned, as necessary, throughout the work day and at the end of the work day to keep the streets free of soil or other debris generated from the work site during the duration of all excavation activities.

7.4.2 Dust and Materials Management Controls

Dust (particulate matter) will be controlled at the Site in accordance with the site-specific CAMP, the NYSDEC Technical and Administrative Guidance Memorandum #4031 – Fugitive

Dust Suppression and Particulate Monitoring Program at Inactive Hazardous Waste Sites (TAGM 4031), and all federal, state and local requirements. The Contractor will be required to maintain all excavations, material and waste stockpiles, and all other work areas to minimize dust that would cause a hazard or nuisance to others.

Dust will be monitored in accordance with the requirements of the Contractor's HASP, the CAMP, and the NYSDEC TAGM 4031. Based on the results of the monitoring, the Contractor will implement necessary measures to control dust to acceptable levels, including but not limited to, one or more of the following measures:

- Misting equipment and excavation fences;
- Spraying water (using atomizer) on buckets during excavation and dumping;
- Hauling materials in tarped or lined containers;
- Reducing speed of vehicles moving through the construction area;
- Covering excavated material stockpiles and/or portions of the stockpile, as necessary, throughout the day and after excavation activities cease each day; and
- Stopping work.

7.4.3 Health and Safety and Community Air Monitoring

All remedial construction activities will be performed in a manner consistent with 29 CFR Part 1910 and 1926. Each consultant and contractor onsite will operate under a site-specific HASP for the project. The HASP will be readily available during the work. During all phases of site work, the Contractor will monitor safety and health conditions and fully enforce the site-specific HASP. The Contractor will be responsible for monitoring general Site conditions and for safety hazards. Specifically, monitoring will be performed to verify that all requirements of the Occupational Safety and Health Administration, as outlined on 29 CFR Part 1910 and 1926, are adhered to. The HASP for the Site will be submitted to the NYSDEC under separate cover.

Ambient air will be monitored at the site perimeter throughout the course of the work for particulate matter in accordance with the CAMP, which will be submitted under separate cover. Monitoring for VOCs will be conducted as part of the CAMP using a PID. During the course of the work, the Contractor will take abatement, as directed or as otherwise necessary, to minimize the levels of particulates at the limits of the work. In addition the Contractor will communicate with Buckeye Terminal and Babcock Street property owners.

7.4.4 Traffic Control

Detailed traffic control procedures will be developed when preparing the Contractor's HASP. A truck route map showing primary and secondary routes from the project site to the New York State Thruway is provided as **Figure 12**.

7.5 Concrete Removal and Disposal

Concrete within the stabilized areas will be removed and disposed of offsite as part of the implementation of the recommended remedy. The approximate limits of concrete within the capped area are shown on Plate 2.

7.6 In Situ Stabilization of Leachable Lead

In situ stabilization of leachable lead will be as described in Section 6.10.1. The areas of treatment are shown on Plate 15.

7.7 In Situ Treatment of Petroleum Impacted Soil

In situ treatment of petroleum impacted soil will be as described in Section 6.10.1. The areas selected for the treatment is shown on Plate 15.

7.8 Limited Excavation and Backfill or Capping

Based on a comparison of the metals data to the commercial criteria west of the Buckeye Terminal and industrial criteria on and to the east of the Buckeye Terminal presented in Section 3.0, there are four isolated areas of metals impacted soil (excluding arsenic and leachable lead). These areas are shown (exaggerated for clarity) on Plate 14. The total area to be excavated around these four isolated areas is approximately 39,789 square feet and the volume would be approximately 1,473 cubic yards. In addition, soil excavation will extend in all directions to a passing metal sample location that verifies the concentration of the metal(s) of concern is below the applicable use criteria. Dewatering and shoring of excavations will not be required. The final approach for these areas will be determined during the remedial design phase.

Any metals impacted soil to be disposed offsite may be stockpiled temporarily. Stockpiles will be lined and covered with a single layer of minimum 6-mil plastic sheeting. Stockpiles will be routinely inspected and torn sheeting covers will be promptly replaced. Soil stockpiles will be continuously encircled with silt fence or hay bales.

Post excavation bottom and sidewall sampling and waste characterization sampling for material to be disposed will be conducted. The excavation or one foot soil cap areas would be backfilled with common fill followed by six inches of topsoil that meets the lower of the commercial criteria for human health or the criteria for protection of groundwater presented on **Table 25**. Sampling of the backfill material would be conducted to confirm that it meets the quality criteria.

The final horizontal and vertical limits of the one foot soil cap or excavation areas will be surveyed by a licensed New York State Land Surveyor.

7.9 Offsite Disposal and Equipment Decontamination

Any metals impacted soil excavated from the Site and other remediation-derived waste will be transported and disposed of in accordance with all applicable federal, state, and local regulations at a facility selected by ExxonMobil. The remediation-derived waste that will likely be generated for offsite disposal during the construction activities include:

- Metals impacted soil from OU-2 that may not be capped in-place;
- Personal Protective Equipment (PPE); and
- Decontamination water, if any is generated.

Haul vehicles for bulk soil will be secured with appropriate covers prior to exiting the construction area to prevent a release of waste. PPE generated during the implementation of the remedy will be consolidated and stored in appropriate bulk containers and temporarily staged at the Site waste storage area within the Site limits. Any full or partially filled containers will be appropriately labeled. ExxonMobil will coordinate waste characterization and disposal.

Any decontamination water that is generated will be collected and transported to ExxonMobil's water treatment system, which is located in the main portion of the former terminal south of Elk Street. The water (if any) will be treated through the onsite system or will be disposed of offsite at an ExxonMobil-approved disposal facility.

Soil that will be disposed offsite will be sampled for waste characterization in accordance with the permit requirements of the facility and disposed of in accordance with all applicable laws and regulations.

7.10 Stormwater Management System Modifications

Stormwater management system modifications will be as described in Section 6.3.3.

7.11 Installation of New Monitoring Wells

Six new monitoring wells have been installed in OU-2 since September 2007. ExxonMobil will attempt to protect and maintain these new wells, as well as selected existing wells in OU-2, to facilitate performance monitoring of the remedy. If additional wells are deemed necessary for long term monitoring, well locations and construction specifications will be provided with the remedial design.

7.12 Operations and Maintenance and Performance Monitoring

The Operation, Maintenance and Monitoring (OM&M) Plan for OU-2 will be incorporated into the SMP for the Site. The OM&M Plan will describe the OM&M activities to be performed to document that the remedy continues to achieve the remedial objectives for OU-2 and that engineering and institutional controls are in place and functional.

7.12.1 Performance Monitoring

Performance monitoring will be conducted to demonstrate the effectiveness of the remedy in achieving the remedial action objectives. The specific performance monitoring conducted with respect to soil, groundwater, and stormwater is described below. A formal sampling plan for these components will be submitted with the SMP.

7.12.2.1 Performance Monitoring for Soil Remediation

It is anticipated that during the first five years following remedy implementation, there will be a performance monitoring period to ensure compliance with the SCGs and the long-term viability of the remedy. The soil treatment goal of the remedy is to achieve the respective use criteria within the top zero to four feet of soil across OU-2. In order to document the effectiveness of the remedy, periodic soil sampling will commence three years following construction of the remedy. Monitoring of the in situ lead stabilization will be via TCLP testing following treatment. Monitoring of the in situ treatment of petroleum impacted soil will be via visual and olfactory observations from the treated areas. A sampling and analysis plan to document the performance of the remedy will be submitted with the SMP.

7.12.2.2 Performance Monitoring for Groundwater

The existing groundwater monitoring data demonstrates that the groundwater beneath OU-2 is not significantly impacted. The highest concentrations and most exceedances of groundwater criteria have historically been observed near the boundary between OU-2 and OU-3, and likely resulted from former refinery operations in the upgradient vicinity. As part of the selected Track 4 remedy, restrictions will be placed on groundwater use across OU-2.

The effect of the stabilizing soils and reducing the upgradient flow of groundwater onto OU-2 on groundwater flow and quality will be documented through monitoring of groundwater quality and water levels, and through estimates of evapotranspiration rates relative to groundwater flux beneath OU-2. A sampling and analysis plan to document the performance of the remedy will be submitted with the SMP.

7.12.2.3 Performance Monitoring for Stormwater

Performance monitoring for the stormwater management system for the portion of OU-2 owned by ExxonMobil will include sampling and analysis of discharged water in accordance with the SPDES permit.

7.13 Site Management Plan

Following the remedy completion, impacted materials and constituents at depths greater than four feet below land surface would remain onsite at concentrations in excess of the respective use criteria. In addition, onsite groundwater may continue to exceed groundwater criteria. For this reason, a SMP will be developed and implemented. Potential future site owners/operators will be required to retain a copy of the SMP for reference. The primary components of the SMP will include:

- A Soil Management Plan (SoMP);
- Institutional and Engineering Controls Plan; and

- An OM&M Plan.

The SMP will be referred to in the Environmental Easement.

Soil Management Plan

The SoMP would be prepared and implemented to minimize the potential exposure of workers and the community to constituents in soil after the remediation is completed. Further, the SoMP would establish applicable management practices for the future disturbance/reuse of OU-2 soils exceeding the respective use criteria and/or petroleum impacted soil at depths greater than four feet below grade.

Specifically, the SoMP will include:

- A description of the proper procedures for the management of excavated soil in a manner that would protect workers and the surrounding community from exposure (including health and safety procedures, dust control and CAMP); and

The SoMP will provide requirements for the analytical testing of soil below remediated areas (i.e., areas below four feet) requiring excavation work as part of future Site activities. In the event that analytical testing of the soil is not performed prior to intrusive Site disturbance activities, the soil will be stockpiled and sampled for analytical testing. Analytical results will be evaluated for the determination of soil reuse at the Site. The SoMP will also provide guidelines for workers in the event soil requires offsite disposal. Soil requiring offsite disposal will be sampled for waste characterization analyses as determined by the waste disposal facility.

Institutional and Engineering Controls Plan

Since impacted materials will remain within OU-2 beneath the stabilized areas, engineering controls and institutional controls will be implemented to protect public health and the environment in the future. The Institutional and Engineering Controls Plan will identify and describe the applicable engineering and institutional controls and the requirement for annual certifications of the controls. The plan will include:

- A description of the institutional controls including the Environmental Easement restricting the use of the Site (OU-2 would be restricted to industrial and commercial uses depending on area) and the use of groundwater; and
- A requirement that the property owner provide an Institutional Control/Engineering Control certification on an annual basis by a Professional Engineer licensed in New York State.

An Environmental Easement is an institutional control that subjects OU-2 to use restrictions or engineering controls that run with the land in perpetuity. An Environmental Easement is a form of institutional control that acts as an enforcement mechanism to ensure required institutional and engineering controls remain in place. The Environmental Easement will:

- Require compliance with the SMP;
- Restrict the use of OU-2 to industrial and commercial uses depending on area;
- Identify areas of impacted materials remaining onsite that would be managed in place;
- Restrict the use of groundwater as a source of potable water; and
- Require an annual certification (by a licensed New York State Professional Engineer) that the institutional and engineering controls remain in place and that they remain effective for the protection of human health and the environment.

The Environmental Easement will be incorporated in all agreements regarding rights to use the land such as leases and licenses.

Any future development in OU-2 would need to be performed in accordance with NYSDEC regulations. Any future modifications to OU-2 would require submittal of a work plan and approval by the NYSDEC.

<u>OM&M Plan</u>

The OM&M Plan would provide the detailed procedures necessary to maintain the engineering controls (e.g., site perimeter fence). This would include any inspection and maintenance of the perimeter fence around OU-2. Groundwater monitoring will continue in OU-2. As discussed above, ExxonMobil will attempt to protect and retain the six new and selected existing wells in OU-2 after construction and/or install new wells to be used for long-term monitoring.

8.0 REMEDIAL DESIGN DOCUMENTS

Following approval of the Final AAR, a Remedial Action Work Plan which will include a detailed remedial design will be prepared and submitted to the NYSDEC for review and approval.

9.0 FINAL CONSTRUCTION CERTIFICATION REPORT AND SITE MANAGEMENT PLAN

A Final Construction Certification Report (FCCR) for OU-2 will be prepared following completion of the remedial activities in accordance with Section 1.6 of Part 375 for Final Engineering Reports (FER). As a note, the NYSDEC has indicated that the report for completion of each operable unit of the Site should not be called a FER, but that the format and content should be similar to a FER. A FER is appropriate at the completion of the remedial actions for all operable units of the Site. The FCCR will describe the work performed as part of the remediation of OU-2 and will include:

- A description of activities completed pursuant to the approved remedial work plan or remedial design;
- Site boundaries;
- A description of any engineering or institutional controls that will be used, including mechanisms to implement, maintain, monitor, and enforce such controls;
- Disposal documentation for all material removed from the Site, including solid waste, and fluids (if any);
- Survey drawings and site maps;
- Any changes or modifications to the work, as well as any problems encountered during construction and their resolution, will be documented; and
- A list of all remediation standards applied.

The SMP, as described in Section 7.15, will be submitted concurrently with the FCCR.

In accordance with DER-10, the FCCR will include an appropriate certification by a New York State Professional Engineer.

10.0 OPERATION, MAINTENANCE AND MONITORING

The RAOs for OU-2 will be met upon completion of the proposed remedy. However, since the recommended remedy relies on institutional controls (environmental easement) and engineering controls perimeter fencing), there are OM&M activities required upon completion of the work as described in this Final AAR. A formal OM&M Plan will be submitted with the SMP to describe the OM&M activities required.

11.0 INSTITUTIONAL AND ENGINEERING CONTROLS

There are currently no institutional controls in place for OU-2. Institutional controls, in the form of the SMP and associated environmental easement as described in Section 7, are proposed as part of this Final AAR. Engineering controls currently in place include perimeter fencing and existing caps in the form of asphalt, concrete and buildings that will be maintained. Engineering controls that will be implemented as part of the remedy include a one-foot thick soil cap that will be constructed over stabilized soils. These engineering controls will be maintained. Annual certification of institutional and engineering controls will be provided by a licensed New York State Professional Engineer.

12.0 CITIZEN PARTICIPATION PLAN

A CPP for the Former Buffalo Terminal has been prepared in accordance with Section 2.10 and Section 8 of the Draft BCP Guide. The CPP was submitted under separate cover on April 13, 2006.

The citizen participation activities relevant to approval and implementation of this Final AAR, which are outlined in the CPP, include:

- Transmittal of a public notice and fact sheet regarding the NYSDEC approved Final AAR to the Brownfield Site Contact List presented in the CPP;
- Placement of the Final AAR in the Site's document repository;
- Comment period on the Final AAR;
- Public meeting, if requested during the public comment period, or otherwise requested by the NYSDEC;
- Placement of remedial design documents in the Site's document repository;
- Transmittal of a public notice and fact sheet announcing the proposed start of remedial construction to the Brownfield Site Contact List presented in the CPP at least 10 days prior to the start of construction;
- Transmittal of a public notice and fact sheet regarding the FCCR to the Brownfield Site Contact List presented in the CPP; and
- Placement of the FCCR in the Site's document repository.

Regarding public meetings, the Draft BCP Guide, Section 4.11 – Citizen's Participation for Remedy Selection, states "The Department is not required to hold a public meeting, unless one is requested, during the public comment period. If this occurs, the Department will work with the Applicant to arrange for and announce a public meeting."

13.0 SCHEDULE

Construction in OU-2 will commence following approval of all design related documents, including the appropriate public comment periods, public meetings (if required) and notifications, if required. Based on the assumptions presented in this AAR and the remedy recommended herein, a schedule for design submittal and implementation is provided as **Figure 13**. After the submission of the Final AAR, the remedial design documents would be provided to the NYSDEC. The Final AAR and the remedial design documents will be reviewed by the NYSDEC.

The recommended remedy is estimated to take eleven months to complete. The FCCR will be submitted within 120 days after completing the remedial actions.