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ALTERNATIVES ANALYSIS REPORT FOR OPERABLE UNIT 4

ExxonMobil Former Buffalo Terminal
Buffalo, New York

Volume I of II

Prepared for:

EXXON MOBIL OIL CORPORATION
1001 Wampanoag Trail
Riverside, Rhode Island 02915

Remedial Engineering, P.C.

Environmental Engineers

and ROUX ASSOCIATES, INC.

209 Shafter Street, Islandia, New York 11749 ◆ 631-232-2600

TABLE OF CONTENTS

VOLUME I OF II

TABLE OF CONTENTS

(Continued)

TABLE OF CONTENTS

(Continued)

TABLE OF CONTENTS

(Continued)

TABLES

TABLE OF CONTENTS

(Continued)

TABLES (Continued)

FIGURES

APPENDICES

TABLE OF CONTENTS

(Continued)

VOLUME II OF II

PLATES

CERTIFICATION

I, Noelle M. Clarke, 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).

072491	8/5/10	[signature]
NYS Professional Engineer #	Date	Signature

1.0 INTRODUCTION

On behalf of ExxonMobil Oil Corporation (ExxonMobil), Roux Associates, Inc. (Roux Associates) and Remedial Engineering, P.C (Remedial Engineering) have prepared this Final Alternatives Analysis Report (AAR) for the portion of the ExxonMobil former Buffalo Terminal (Site) designated as Operable Unit 4 (OU-4), located east of the former Erie-Lackawanna Railroad Company rail tracks (former Erie-Lackawanna Railroad) and north/northwest of the Buffalo River. This Final AAR evaluates remedial alternatives to address soil, groundwater, and separate-phase product impacts due to former waste disposal and bulk petroleum storage operations on portions of OU-4. This Final AAR incorporates the following responses to comments provided by the New York State Department of Environmental Conservation (NYSDEC) on the initial AAR dated June 25, 2009, and the results of field work completed in May 26 and 27, 2010:

- NYSDEC comments dated November 13, 2009;
- Roux Associates letter response to NYSDEC November 13, 2009 comments regarding the AAR for OU-4 dated January 21, 2010;
- NYSDEC comments on the Roux Associates January 21, 2010 letter response dated February 24, 2010;
- Roux Associates letter response dated April 2, 2010 to additional follow-up NYSDEC comments on the Roux Associates letter dated January 21, 2010; and
- "Work Plan for Investigation of the Former Erie-Lackawanna Railroad in OU-4" dated April 28, 2010.

The alternatives evaluated and remedial action selected took into consideration:

- The current zoning of OU-4 as M2, general 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-4, as CM-Central 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 continued industrial use and surrounding restricted access green space within OU-4 and light industrial, back office, commercial, restricted and public access green space, and very limited retail use on the remainder of the Site and in the immediate vicinity of the Site.

- The historic use of OU-4 as a municipal waste landfill, petroleum waste diposal area, and bulk petroleum storage area.
- The current and reasonably anticipated future use of the property as a bulk petroleum storage area owned and operated by Buckeye Terminals LLC (Buckeye).
- Consistency and integration with anticipated remedial actions in other Site areas.

The former ExxonMobil 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-4 encompasses all of the former geographic area designated as the Eastern Tank Yard Area (ETYA), the access road between the ETYA and the Southern Tank Yard Area (STYA), and the portion of the former Erie-Lackawanna Railroad right-of-way that lies south of the access road. These properties are all owned and operated by Buckeye. As a note, the former Erie-Lackawanna Railroad right-of-way was never part of any ExxonMobil operations.

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 (the Babcock Street Properties Area [BSPA]) owned and operated by One Babcock Street, LLC (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 3, 2010. It is ExxonMobil's intention to conduct the remediation of OU-4 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 4.4[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-4, including ownership, current zoning, current and future land use, past and present operations (i.e., landfill, 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-4, and a summary of the pre-design geotechnical investigation and soil investigation of the former Erie-Lackawanna Railroad right-of-way conducted as part of this Final AAR;
- 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 selected remedy;
- Section 8.0 describes the remedial design;
- Section 9.0 describes the Final Construction Certification Report;
- 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 documents entitled "History of Operations at Buffalo Terminal" dated April 26, 2000, and "Site Investigation Completion Report" dated March 12, 2002.

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-4

The geographic area associated with OU-4 is the ETYA. OU-4, which is approximately 16.6 acres, is separated from the main part of the Site by the former Erie-Lackawanna Railroad Company railroad tracks. The following is a description of the ETYA, including former and current structures, waste handling areas, and spills/releases records.

2.1.1 Eastern Tank Yard Area

The ETYA is located between the eastern side of the former Erie-Lackawanna Railroad Company (formerly D.L.&W.R.R.) rail tracks and the bank of the Buffalo River. Prior to the straightening of the Buffalo River between 1914 and 1917, the river's course ran in a generally north to south direction through the ETYA, parallel to the D.L.&W.R.R. tracks. The river was filled in, relocated to the east, and rerouted to continue in a west-southwesterly direction. A small parcel of land that existed prior to the rerouting between the D.L.&W.R.R. tracks and the original river was owned by SOCONY. This parcel of land was relinquished by SOCONY to the City of Buffalo on July 8, 1915.

In 1951, the ETYA was purchased from the City of Buffalo who had utilized the property from 1921 through 1951 for the disposal of municipal waste. In 1953, the ETYA was developed with two 70,000-barrel storage tanks, four propane tanks, and a propane loading rack. The ETYA encompasses approximately 15.3 acres.

2.1.1.1 Former and Current Structures

In 1953, two aboveground storage tanks (Tanks 175 and 176), each with 70,000-barrel capacities, were constructed in the ETYA. The details concerning these storage tanks are provided in Table 1. To the southwest of the storage tanks, four propane tanks and a propane loading rack were constructed between 1958 and 1966. According to discussions with former and/or current ExxonMobil employees, the propane loading rack was never utilized. The propane tanks and loading rack were removed in 1988.

Three product pipelines are present within the ETYA (Plate 1). Two of the pipelines are owned by Buckeye, one is abandoned in place with flowable fill, and the other is currently active. Buckeye’s pipeline enters the ETYA at the northeast boundary. The abandoned portion crosses through the length of the ETYA in a south/southwesterly direction and continues into the STYA along the bulkhead immediately adjacent to the Buffalo River. According to a drawing of the pipeline, the depth of burial within the ETYA is approximately four feet. According to this drawing, the pipeline was purged of product and abandoned in place.

The active portion of the Buckeye pipeline follows the fence line in a northerly direction. The pipeline remains buried until it comes above grade along the northern border of the ETYA. The aboveground portion of the pipeline continues to follow the fence line until it crosses underneath the former Erie-Lackawanna Railroad and into the STYA at the location of the access road between the ETYA and the STYA.

Enbridge Pipelines Inc. (Enbridge) owns the third product pipeline. The approximate location of this pipeline is shown on Plate 1. This pipeline enters the ETYA at a location near the Buckeye pipeline, then it generally runs in a west/southwesterly direction south of the containment berm for Tanks 175 and 176 to a point approximately 200 feet beyond the tanks where it turns northwest and enters the STYA. Information provided to ExxonMobil by Enbridge indicates that the line was removed from active service in 1982 when the product was purged and the line was filled with nitrogen. A letter from Enbridge regarding the pipeline is included as Appendix A.

2.1.1.2 Waste Handling Areas

ExxonMobil also used the ETYA for disposal purposes. According to company records, the waste disposed in the ETYA included storage tank bottom material, spent cracking and reforming catalysts, oil/water separator material, slop oil solids, demolition debris, and asphalt-containing soil. ExxonMobil reportedly used this area for disposal between the years 1952 and 1974. Plate 1 shows disposal locations of wastes disposed in the ETYA as reported in the company records. In addition, a review of available aerial photographs indicates that the area southwest of the tanks was a possible disposal location.

2.1.1.3 Spills/Releases

Two spills were documented to have occurred in this area (Table 2). The following releases have supporting documentation in the form of ExxonMobil records and NYSDEC Spill Report Forms.

- On August 28, 1989, approximately 6,500 gallons of unleaded gasoline were released. This incident was reported to NYSDEC and assigned Spill No. 8905279. It was also reported to the City of Buffalo Fire Department. The incident occurred when Tank 176 was overfilled due to incorrect safe fill and high alarm settings being used. The area was barricaded and approximately 2,800 gallons of product were removed with a vacuum truck. In addition, the safe fill and high level alarm settings were corrected. Subsequently, monitoring wells were installed and monitored for the presence of product. The containment berm for this tank and Tank 175 were lined during the storage tank realignment project completed in 1991.

- On October 4, 2000, a sheen and seepage area was identified along the Buffalo River bank adjacent to the ETYA during the installation of MW-28. The NYSDEC was notified on that date and assigned Spill No. 0075417. In response, ExxonMobil installed a sorbent boom around two areas where impacts were observed (total length of approximately 300 feet). The booms were inspected and maintained daily until December 18, 2000 to prevent any adverse impacts to the Buffalo River from this area. The booms were destroyed on December 18, 2000 due to significant ice accumulation and movement in the river. Through March 2001, it was not possible to install permanent booms due to ice conditions in the river. Sorbent booms were installed along the riverbank around the seepage areas on March 16, 2001 and have been maintained since. Permanent slick-bar booms were installed around the areas of seepage in May 2001 (see Plate 1 for locations). Sorbent blankets were installed over the visible stain on the river embankment within the boomed area at the upstream seepage area in April 2009. The seepage areas have been inspected regularly since October 2000 from land or from a boat. These inspections include a description of the area of seepage noting any differences in the appearance of the area (i.e., presence or absence of sheen and its location if present). The inspections also note the position of the boom and blanket and any adjustments required. The inspection results are presented in the site monitoring reports issued to the NYSDEC on a quarterly basis.

2.2 Zoning and Land Use of OU-4

The zoning of OU-4 is M2 (general industrial district). A figure obtained from the City of Buffalo website showing the zoning for OU-4 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-4, is CM-Central Commercial District (Figure 5) with a proposed land use of mixed use commercial/light industrial (Figure 6).

The Site is located in an area of Buffalo that has numerous parcels of available vacant land. The immediate area surrounding OU-4 is comprised of a junk yard to the north, vacant land to the northeast, the Buffalo River to the south/southeast, and the former Erie-Lackawanna Railroad and OU-3 to the west.

Until recently, there was no comprehensive development plan in place for this portion of Buffalo. However, ExxonMobil and other stakeholders in the area have undertaken an evaluation of the best future use of the property and surrounding areas of this portion of Buffalo known as the "Elk Street Corridor." In October 2008, 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 incorporates 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-4, the current and reasonably anticipated future land use will remain as a storage area for petroleum products owned and operated by Buckeye, surrounded by restricted access green space.

3.0 SUMMARY OF ENVIRONMENTAL CONDITIONS

Data regarding environmental conditions on OU-4 were obtained from a review of the results of previous investigations. 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-4, except where separation is not practical. Sample locations and locations of monitoring and recovery wells from all previous investigations are presented on Plate 1.

3.1 Environmental Investigations

The following reports summarize all investigation data collected within OU-4:

- "Separate-Phase Product Investigation Report for the Eastern Tank Yard Area" dated June 28, 2001.
- "Site Investigation Completion Report" dated March 12, 2002, which provides a detailed presentation of investigation data for the OU-4 area.
- "Additional Sediment Sampling of the Buffalo River Shoreline Completion Letter Report" dated October 8, 2003.
- "Evaluation of Aquifer Characteristics" dated March 11, 2004, which provides a summary of well installation, aquifer testing, and groundwater and separate-phase product modeling in OU-4.
- "Remedial Action Selection Report for the Product Recovery Interim Remedial Measure in the Eastern Tank Yard Area" dated January 5, 2005, which provides a summary of field tests of remedial technologies and selection of an interim remedial measure.

In addition, a pre-design geotechnical investigation consisting of six land and four river borings was conducted in April and May 2009.

In response to the NYSDEC's November 13, 2009 comments on the initial AAR, a soil investigation was conducted in May 26 and 27, 2010 on the portion of the former Erie-Lackawanna Railroad right-of-way that is part of OU-4 and is currently owned by Buckeye.

<u>Separate-Phase Product Investigation Report for the Eastern Tank Yard Area</u>

The scope of work included the installation of MW-28 in the ETYA on October 4, 2000 and installation of soil borings, collection of soil samples, installation of monitoring wells, and collection of sediment samples conducted by Groundwater & Environmental Services, Inc.

(GES) and Roux Associates between December 2000 and April 2001. The findings are also summarized in the Site Investigation Completion Report.

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, Northern Tank Yard Area (NTYA), Former Refinery Area (FRA), Central Rail and Process Area (CRPA), STYA, ETYA, and Administrative Offices and Operations Area (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-5MWRR in the CRPA by Empire Soils Investigations, Inc. in July 1990;
- 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.

Additional Sediment Sampling of the Buffalo River Shoreline Completion Letter Report

Sediment samples along the Buffalo River shoreline of the ETYA were collected, visually inspected for evidence of separate-phase product, and screened for organic vapors with a photoionization detector (PID). All samples were analyzed for the following parameters:

- NYSDEC Spill Technology and Remediation Series (STARS) volatile organic compounds (VOCs);
- NYSDEC STARS semivolatile organic compounds (SVOCs);
- diesel range organics (DRO);
- gasoline range organics (GRO);
- total lead;

- toxicity characteristics leaching procedure (TCLP) lead; and
- tetraethyl lead.

Evaluation of Aquifer Characteristics

The Evaluation of Aquifer Characteristics included:

- recovery and monitoring well installation, performing and analyzing four step tests and performing and analyzing four constant-rate pumping tests;
- groundwater modeling; and
- multi-phase modeling.

The multi-phase model was used to estimate the separate-phase product volume present within OU-4.

Remedial Action Selection Report for the Product Recovery
Interim Remedial Measure in the Eastern Tank Yard Area

Field tests of four technologies were performed to evaluate their effectiveness as a remedial alternative for remediation of separate-phase product in the ETYA. The four technologies tested were:

- long term, separate-phase, product-only recovery;
- groundwater and separate-phase product containment and recovery;
- vacuum enhanced recovery; and
- chemical oxidation.

Chemical oxidation was the selected technology and was implemented as an interim remedial measure (IRM) in the ETYA from June 7, 2007 through March 27, 2009. Further details regarding this IRM are provided in Section 4.

The scopes of work for each of these investigations will not be reiterated in this Final AAR as they are described in detail in the original reports referenced above.

Pre-Design Geotechnical Investigation

In April and May 2009, six land borings and four river borings were advanced in OU-4 using mud rotary drilling techniques. The objective was to obtain geotechnical data (e.g., water content, Atterberg limits, strength, and compressibility) for use in the design of an engineered approach to minimize erosion and stabilize the steeply sloped embankment adjacent to the Buffalo River. The land borings were drilled to depths ranging from 61 to 82 feet below land surface (ft bls), and the river borings were drilled to depths ranging from 39 to 47 feet below the river bottom. Performance of the river borings was authorized under the Department of Army Nationwide Permit Number 6 (Survey Activities). The United States Coast Guard was notified prior to the initiation of the river borings. The data collected from this investigation generally corroborates the geologic descriptions from previous investigations. However, the borings were completed to deeper depths than any previous borings and therefore documented the thickness of the clay layer, identified an additional unconsolidated deposit of silty sands and clayey sands beneath the clay layer, and documented the depth to bedrock in OU-4. The findings are described further below.

Former Erie-Lackawanna Railroad Right-of-Way Soil Investigation

On May 26 and 27, 2010, three borings were advanced in the portion of the former Erie-Lackawanna Railroad right-of-way that is part of OU-4 and is currently owned by Buckeye. The objective was to characterize subsurface soils in this area to determine the type and extent of soil impacts, if any. Using a Geoprobe®, boring SB-201 was advanced to a depth of 47.5 ft bls, while borings SB-202 and SB-203 were both advanced to a depth of 40 ft bls. Soil samples were collected continuously from land surface to the bottom of the boring. The soil boring logs are included as Appendix B. Groundwater was encountered at approximately 35 ft bls at SB-201, at approximately 30 ft bls at SB-202, and at approximately 20 ft bls at SB-203. Shallow interval soil samples were collected from 0 to 2 ft bls at each boring, whereas deeper interval soil samples were collected from 33 to 35 ft bls at borings SB-201 and SB-203, and from 32 to 34 ft bls at boring SB-202. The soil samples were analyzed for the full list of parameters on Table 6.8 of Part 375. The findings of this investigation are provided in Section 3.2.7.

3.2 Environmental Conditions within OU-4

A summary of the results of all investigations completed in OU-4 is provided below.

3.2.1 Geology

The following is a general description of the geology of the entire site with specific references to OU-4, as appropriate. One hydrogeologic cross section running parallel to the Buffalo River bank (E-E') through OU-4, and two hydrogeologic cross sections running perpendicular to Section E-E' (F-F' and G-G') through OU-4, are presented as Figure 8 . One hydrogeologic cross section running east to west through a portion of OU-4 (B-B') is presented as Figure 9.

<u>General Description of Site Geology</u>

The 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 0.50 degrees to the south.

Three unconsolidated deposits exist at the Site. The first is a fill layer that consists of black cinders, silt, gravel, sand, slag, and trace 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, and sands and gravel. Underlying the alluvial layer is a gray to brown glaciolacustrine clay. Bedrock was not encountered in any of the wells installed to date.

The following generalization regarding the site geology can be made from available information.

- Fill thickness is generally greatest in the southern portion of the Site.
- The thickness of the alluvial deposits is greatest in the southern portion of the Site, in proximity to the Buffalo River. This layer pinches out at the central portion of the Site and the depth to the top of the clay layer decreases northward.

<u>Description of Geology in OU-4</u>

In general, the geology of the entire ETYA is influenced by the former disposal activities that were conducted in this area and re-routing of the Buffalo River. The description of the geology of OU-4 that follows has been updated based upon the results of the pre-design geotechnical evaluation. Four unconsolidated deposits (formerly described as three deposits) exist in the area under consideration (two are subsets of the alluvial deposits described above). The first is a fill layer that consists of black cinders, concrete, brick, glass, wood, silt, gravel, sand, and slag that is consistent with the historical disposal activities. This layer varies in thickness from 7 to 23 feet.

The second unit consists of sands; silt (sandy silt to clayey silts); and silts and clays. The thickness of this layer is between 0 and 20 feet throughout the area of interest (a subset of the alluvial deposits described above). The third layer is predominantly comprised of sand and gravel and ranges in thickness from 4 to 11 feet (a subset of the alluvial deposits described above). Underlying the sand and gravel layer is a clay layer. Lithological data collected during the pre-design geotechnical investigation indicate the thickness of the clay layer is between 16 to 29 feet. Underlying the clay layer is a stratum consisting mostly of silty sands and clayey sands, ranging in thickness from 2 to 20 feet. Bedrock was encountered at depths ranging from 65 to 77 ft bls.

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-southeast across OU-4 towards the Buffalo River. The most recent groundwater flow map is provided in Plate 2.

Monitoring wells in the southern portion of OU-3 (STYA) and the southwestern portion of OU-4 (ETYA) show influence of the eastern leg of the Well Point System (WPS). Results of previous investigations and the quarterly groundwater monitoring indicate that pumping of the WPS depresses the water table sufficiently to induce recharge from the Buffalo River into the aquifer in the area between the WPS and the Buffalo River. Plate 2 presents water level and separate-phase product thickness data for the Site from the quarterly gauging round.

3.2.3 Separate-Phase Product

The historical and current extent of separate-phase product within monitoring wells is limited to the area south of Tank 176 shown on Plate 2. In addition to existing wells that currently have measurable separate-phase product present, separate-phase product was noted at or near the water table interface during the completion of borings/wells SB-82 and SB-84 during December 2000. However, none of the wells installed in December 2000 have indicated the presence of measurable separate-phase product during ongoing water/product level gauging and/or groundwater sampling. Sheen was present at SB-80 during only one gauging round in January 2004. Above the water table, heavier black product was observed at SB-82 (7 to 9 ft bls) and

SB-84 (5 to 9 feet bls). Finally, thick black tar-like material, which was relatively solid, was observed above the water table at SB-79 (5 to 7 feet bls), SB-80 (7 to 9 feet bls), SB-81 (15-17 feet bls), SB-82 (11 to 11.5, 15 to 17, and 18.5 to 19 feet bls), and SB-85 (5 to 7 feet bls).

Separate-Phase Product Composition

Samples of separate-phase product were collected and analyzed from four wells in the ETYA (P-15, MW-3URS, LF-1S, and MW-28). The results from MW-28 and LF-1S indicate that the separate-phase product at these locations is comprised entirely of severely biodegraded diesel fuels. The results from P-15 indicate that the product is comprised of 80 percent diesel range hydrocarbons and 20 percent gasoline range hydrocarbons. Finally, the results from MW-3URS, in which separate-phase product has not been observed since 1998, indicate that the product was comprised of 85 percent diesel range organics and 15 percent gasoline range organics.

Separate-Phase Product Volume Estimate

The multi-phase model described in the Evaluation of Aquifer Characteristics report was used to estimate the volume of the separate-phase product plume within OU-4. The total volume of product within the main plume was estimated to be approximately 1,900 gallons. This volume is the sum of the potentially recoverable separate-phase product (i.e., the maximum amount of separate-phase that can theoretically be recovered by manipulating the hydraulic gradient) and the residual (trapped) separate-phase product in the subsurface. This volume is based upon average fluid properties from the samples collected from various locations within the plume. The variation in these fluid properties across the Site is indicative of historical site operations that resulted in numerous releases of a variety of different product types throughout the history of the Site.

3.2.4 Soil Quality

The evaluation of soil quality within OU-4 was performed considering 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.

Using the qualitative information, an attempt was made to evaluate field observations against the NYSDEC definition of grossly contaminated media in Part 375 for OU-4. The results indicate that petroleum impacted soil is present in portions of OU-4, based upon the following observations:

- sheen and separate-phase product were observed in multiple soil borings located in the eastern/southern portion of OU-4 during previous investigations;
- separate-phase product has been observed in 15 monitoring wells (LF-1S, LF-3, LF-4, LF-6, LF-7, P-15, MW-28, MW-39, MW-3URS, MW-CO-2, MW-CO-5, VERMW-1, VERMW-2, VERMW-3, and VERMW-4) within the limits of the historical product plume;
- the sheen and seepage area along the Buffalo River bank adjacent to OU-4;
- black staining, petroleum odor, and elevated PID readings were observed in multiple soil borings in the eastern/southern portion OU-4 during previous investigations; and
- black asphalt like material was observed at the surface and at depth in soil borings in the eastern/southern portion of OU-4;

Tables 4 through 7 summarize analytical results for VOCs, SVOCs, metals, and total petroleum hydrocarbons (TPH), respectively, for the soil samples collected during all investigations on OU-4 (except the investigation in the former Erie-Lackawanna Railroad right-of-way, which are summarized separately in Tables 14 through 18). Soil quality data from all investigations has been compared to the unrestricted use and industrial soil quality criteria presented in Table 8. The industrial soil criteria presented in Table 8 are the restricted industrial criteria for protection of human health presented in Part 375, as described in greater detail in Section 5. These comparisons enable 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-4 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-4; or
- an industrial land use scenario, which is consistent with the current zoning, current land use, and reasonably anticipated future use of OU-4 and the Elk Street Corridor Redevelopment Plan (which allows for industrial uses and restricted access green space), and is generally consistent with the proposed land use for the area presented in the City of Buffalo LWRP (which allows for commercial and light industrial uses).

Four summary maps (Plates 3 through 6) were prepared using the analytical database and Environmental Systems Research Institute, Inc (ESRI) Arc Geographic Information System (ArcGIS) Software. These maps compare soil concentration data for VOCs, SVOCs, metals, and TPH, respectively, from previous investigations and the May 2010 investigation (note, TPH was not analyzed in the May 2010 investigation) relative to the unrestricted use and industrial cleanup criteria, except for TPH which does not have a cleanup criteria and is presented as concentration ranges. On Plates 3, 4, and 5, only the highest exceedance of a particular criterion is shown at each sample location at different depth intervals, even though more than one constituent may have exceeded the criteria. Plates 3 through 6 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-4:

- zero to two feet below land surface;
- two to 31 (or 35) feet bls (further broken down to smaller intervals as defined below);
- two to 11 feet bls;
- 11 to 17 feet bls;
- 17 to 21 feet bls;
- 21 to 25 feet bls; and
- 25 to 31 feet bls outside the former Erie-Lackawanna Railroad right-of-way, and 32 to 35 feet bls inside the former Erie-Lackawanna Railroad right-of-way.

The rationale for selecting soil sample locations during previous investigations and the May 2010 investigation 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.

Please note, the remainder of this section discusses soil quality data pertinent to the portion of OU-4 outside the former Erie-Lackawanna Railroad right-of-way. Soil quality data within the former Erie-Lackawanna Railroad right-of-way are discussed in Section 3.2.7.

In general, the soil quality in OU-4 has been impacted by historical disposal practices and historical and current petroleum storage activities. 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-4. TPH is also present throughout OU-4 at varying concentrations.

In general, in OU-4, the highest petroleum related impacts were observed in samples collected in the vicinity of the bulk storage tanks, former WHAs, and the seepage areas along the Buffalo River (discussed in sediment quality section). During the SFI Completion, soil samples were collected continuously from five feet below ground surface to five feet below the water table. 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 in OU-4 was 31 feet bls at eight locations.

VOCs – Shallow Interval

As shown on Plate 3, the only sample that indicated VOC exceedances above the unrestricted use criteria was LF-1S, which is located outside the containment berm for Tanks 175 and 176. Xylenes were the only VOC that exceeded the unrestricted use criteria at less than two times the criteria.

Also shown on Plate 3, there were no exceedances of VOCs relative to the industrial criteria. Most of the detected VOCs were in the vicinity of the bulk storage tanks.

VOCs – Deep Interval

As shown on Plate 3, exceedances of the unrestricted use criteria were observed:

- in the two to 11 feet depth interval;
- in the 11 to 17 feet depth interval;
- in the 21 to 25 feet depth interval; and
- in the 25 to 31 feet depth interval.

Although there were VOC exceedances at four different depth intervals, most of the exceedances were detected in the two to 11 feet and the 25 to 31 feet depth intervals. Benzene and xylenes were the only VOCs with concentrations that exceeded the unrestricted use criteria in all depth intervals. These two compounds also represented the highest exceedance at each location in all intervals except at the 21 to 25 feet depth interval, where 1,2,4-trimethylbenzene was detected at 20 times the criteria.

There were no VOCs detected above the industrial criteria.

SVOCs – Shallow Interval

As shown on Plate 4, SVOC exceedances of the unrestricted use and the industrial criteria were detected in the vicinity of the bulk storage tanks. Seven SVOCs were detected above the unrestricted use criteria: benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, dibenzo[a,h]anthracene, and indeno[1,2,3-cd]pyrene, each at less than seven times the criteria. Only benzo[a]pyrene exceeded the industrial criteria at less than five times the criteria.

SVOCs – Deep Interval

As shown on Plate 4, exceedances of the unrestricted use criteria were present at all deep intervals but the concentrations and the number of exceedances decreased with depth. The SVOCs detected above the unrestricted use criteria were the same seven SVOCs detected above the unrestricted use criteria in the shallow interval.

As shown on Plate 4, exceedances of the industrial criteria were observed:

- in the two to 11 feet depth interval;
- in the 11 to 17 feet depth interval;
- in the 17 to 21 feet depth interval; and
- in the 25 to 31 feet depth interval.

Furthermore, the SVOC concentrations and number of exceedances decreased with depth, from four locations in the two to 11 feet depth interval to one in each of the lower intervals. Benzo[a]pyrene was the only SVOC in exceedance of the industrial criteria in all of the above intervals, at less than six times the criteria. In addition to benzo[a]pyrene, dibenzo[a,h]anthracene was in exceedance of the industrial criteria in the 11 to 17 feet depth interval at less than two times the criteria.

Metals – Shallow Interval

As shown on Plate 5, elevated metal concentrations in the shallow interval were detected across all of OU-4. The highest exceedances, however, were detected in the vicinity of the bulk storage tanks. Six metals were detected above the unrestricted use criteria: cadmium, chromium, lead, mercury, nickel, and selenium. Please note, the total chromium data was compared to the Part 375 trivalent chromium unrestricted use criteria and industrial use criteria because Part 375 does not have soil cleanup objectives for total chromium, and based upon soil data at the Site, hexavalent chromium is not present. Although exceedances of the unrestricted use criteria for cadmium, chromium, lead, mercury, and nickel were widespread across all areas of OU-4 in the shallow interval, only lead and mercury was detected at greater than ten times the criteria. The exceedance for selenium was at less than two times the criteria at SB-97, which is in one of the WHAs within the ETYA.

Mercury was the only metal that exceeded the industrial criteria. The exceedances for mercury were less than two times the criteria and were at LF-1S and SB-193, which are located outside the containment berm for Tanks 175 and 176.

Metals – Deep Interval

As shown on Plate 5, exceedances of the unrestricted use criteria were observed:

- in the two to 11 feet depth interval;
- in the 11 to 17 feet depth interval;
- in the 17 to 21 feet depth interval; and
- in the 21 to 25 feet depth interval.

The metals detected above the unrestricted use criteria were the same six metals detected above the unrestricted use criteria in the shallow interval. However, only lead was detected at greater than ten times the criteria and exceedances of this magnitude were limited to the two to 11 feet depth interval. There was also one exceedance for selenium at less than five times the criteria at SB-92 in the two to 11 feet depth interval, which is in one of the WHAs within the ETYA.

As shown on Plate 5, there were no metals detected above the industrial criteria in any depth greater than two feet below land surface.

Tetraethyl Lead and Hexavalent Chromium

Tetraethyl lead was analyzed and not detected in the one location (LF-1S) sampled in the ETYA during the SFI. Total lead in the sample was 1,030 mg/kg. Hexavalent chromium was analyzed and not detected in the two locations (LF-1S and LF-2S) sampled in the ETYA during the SFI. Total chromium in these samples ranged from seven mg/kg to 117 mg/kg.

Total Petroleum Hydrocarbons (TPH) – Shallow Interval

As presented on Plate 6, TPH-GRO and TPH-DRO were sampled in numerous locations across OU-4 during the Site Investigation Completion. Plate 6 presents TPH data relative to concentration ranges since there are no criteria for TPH in Part 375.

TPH-GRO was detected at fewer locations and at lower concentrations than TPH-DRO across OU-4 in the shallow interval. TPH-GRO was detected in 11 of the 13 samples, ranging in concentration from less than one to 15 milligrams per kilogram (mg/kg). TPH-DRO was detected in all 13 samples, ranging in concentration from 8.7 mg/kg to 5,600 mg/kg. Note, samples with the prefix “SS-” were sediment samples and are discussed in Section 3.2.6.

Total Petroleum Hydrocarbons (TPH) – Deep Interval

Similar to the shallow interval, concentrations of TPH-GRO were generally lower than concentrations of TPH-DRO in all depth intervals. However, TPH-GRO was detected in most of the locations sampled in the deep interval, while TPH-DRO was detected in all of the locations sampled in the deep interval. Concentrations of both TPH-GRO and TPH-DRO generally decreased with depth, as summarized below:

- In the 2 to 11 feet depth interval: TPH-GRO was detected at concentrations ranging from 19 mg/kg to 3,700 mg/kg, and TPH-DRO was detected at concentrations ranging from 3,260 mg/kg to 35,000 mg/kg;
- In the 11 to 17 feet depth interval: TPH-GRO was detected at concentrations ranging from 1.4 mg/kg to 4,300 mg/kg, and TPH-DRO was detected at concentrations ranging from 132 mg/kg to 6,800 mg/kg;
- In the 17 to 21 feet depth interval: TPH-GRO was detected at concentrations ranging from less than one mg/kg to 7.1 mg/kg, and TPH-DRO was detected at concentrations ranging from 11 mg/kg to 279 mg/kg;
- In the 21 to 25 feet depth interval: TPH-GRO was detected at concentrations ranging from less than one mg/kg to 14 mg/kg, and TPH-DRO was detected at concentrations ranging from 7.5 mg/kg to 380 mg/kg; and
- In the 25 to 31 feet depth interval: TPH-GRO was detected at concentrations ranging from 4.3 mg/kg to 130 mg/kg, and TPH-DRO was detected at concentrations ranging from 45 mg/kg to 560 mg/kg.

3.2.5 Groundwater Quality

Tables 9 through 11 summarize analytical results for VOCs, SVOCs, and metals, respectively, for the groundwater samples collected during all investigations in OU-4. In the tables, where applicable, the groundwater data is compared to NYSDEC Ambient Water Quality Standards and Guidance Values (AWQSGV) for Class GA groundwater presented in the Division of Water Technical and Operational Guidance Series (1.1.1) "Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations" (1998) as amended in April 2000. It should be noted that, although the groundwater beneath OU-4 is classified as Class GA, the groundwater is not a current or proposed source of drinking water and will not be used as such under any reasonably foreseen development scenario. Plate 7 presents a summary of ongoing quarterly site-wide sampling results between April 2009 and April 2010.

The groundwater sampling results from the SFI indicate the concentrations of VOCs and SVOCs in groundwater are generally low in the ETYA and that NYSDEC AWQSGVs are exceeded only in localized areas (in the southwest portion of the ETYA and in the vicinity of the separate-phase product plume). Metals concentrations exceeding AWQSGVs were distributed throughout the area.

Since May 2007, groundwater sampling results from outside the separate-phase product indicate VOC and SVOC concentrations within OU-4, with the exception of benzene, MTBE, and dissolved lead concentrations, have not exceeded the AWQSGVs. Therefore, there are few impacts to groundwater in OU-4 outside the extent of the separate-phase product.

<u>VOCs</u>

Historic groundwater sampling results from the SFI indicate at least one VOC was detected at nine of the 12 locations sampled (B-6MW, LF-2S, MW-1URS, MW-4URS, SB-75, SB-90, SB-91, SB-96 and SB-97). AWQSGVs were only exceeded at LF-2S in the southwest corner of the area and SB-75 located adjacent to the Buffalo River to the southwest of the product plume. The AWQSGV for benzene was exceeded at both locations and the AWQSGV for MTBE was exceeded at SB-75. Total VOC concentrations ranged from 0.3 micrograms per liter (µg/L) at MW-4URS, located furthest to the east adjacent to the Buffalo River, to 97.1 µg/L at SB-75.

As shown on Plate 7, excluding the wells inside the separate-phase product plume, MTBE at three locations (MW-1URS, SB-75, and SB-78) and benzene at LF-2S were the only VOCs detected within OU-4 during the five quarterly sampling events. MTBE exceeded the AWQSGV at MW-1URS at concentrations ranging from 32.3 to 49.8 µg/L, while benzene exceeded the AWQSGV at concentrations ranging from 1.5 to 3.8 µg/L.

<u>SVOCs</u>

Historic groundwater sampling results from the SFI indicate SVOCs were only detected at MW-1URS located in the far northeast corner of the ETYA. There were no exceedances of any AWQSGVs at this location. Total SVOC concentration at this location was 14 µg/L.

As shown on Plate 7, excluding the wells inside the separate-phase product plume, SVOCs have not been detected within OU-4 since October 2007.

Metals

Historic groundwater sampling results from the SFI indicate at least one metal was detected at all four Geoprobe® locations sampled (SB-90, SB-91, SB-96, and SB-97). The AWQSGV for at least one metal was exceeded at each of these four locations. However, in comparison to concentrations observed in other areas of the Site, the concentrations were relatively low, except for the lead concentration at SB-90 located within a former WHA west of Tank 176. Concentrations of metals exceeding the AWQSGVs were distributed throughout the area.

Metals are not sampled from the OU-4 monitoring wells regularly. The most recent metals analysis of groundwater in OU-4 was for dissolved and total lead from wells B-6MW, LF-2S, MW-1URS, and SB-75 in January 2010. The dissolved lead concentrations were all below the AWQSGVs. Total lead concentrations were consistently greater than the dissolved lead concentrations, indicative of lead being associated with suspended particulate matter.

3.2.6 Sediment Quality

Buffalo River sediment quality and remedial alternatives for sediment will be evaluated more fully in the AAR for OU-5. However, sediment quality is discussed in this section since the stabilization of the Buffalo River bank (a common element to any remedial alternative) in OU-4 will entail some handling of river sediments. Table 12 summarizes analytical results for VOCs, SVOCs, metals, and TPH for the sediment samples collected during all investigations on OU-4. Two summary maps (Plates 6 and 8) were prepared using the analytical database and ESRI ArcGIS Software to show sediment concentration data for VOCs, SVOCs, TPH, and metals from previous investigations. VOC and SVOC quality data from all investigations have been compared to the NYSDEC fresh water protection of benthic aquatic life acute toxicity criteria and the NYSDEC fresh water protection of benthic aquatic life chronic toxicity criteria. Sediment metals quality data from all investigations have been compared to the NYSDEC Lowest Effect Level and Severe Effect Level. The values for these criteria are presented in Table 13. Selection of these criteria is discussed in Section 5.2. Since there are no sediment criteria for TPH, the data on Plate 6 is presented as concentration ranges. On Plate 8, 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 6 and 8 present the available data in the following depth intervals in order to provide an indication of the depth at which impacts were observed along the shoreline of OU-4:

- for VOCs, SVOCs, and metals:
  - one foot below land surface; and
  - greater than one foot below land surface.
- for TPH:
  - zero to two feet below land surface; and
  - two to 11 feet below land surface.

The rationale for selecting sediment sample locations during previous investigations was to evaluate potential impacts from previous and/or current Site operations, and from the sheen and seepage area.

Please note, the sediment criteria for fresh water benthic aquatic life chronic toxicity and acute toxicity provided in the NYSDEC "Technical Guidance for Screening Contaminated Sediments" dated January 25, 1999 are per gram of organic carbon in the sediment. The organic carbon content of the OU-4 sediment was estimated using data from the following three sediment studies of the Buffalo River:

- "Assessment of Sediment in the Buffalo River Area of Concern" dated July 1996 by the United States Environmental Protection Agency (USEPA);
- "Buffalo River Sediment Study" dated March 2006 by the NYSDEC; and
- "Lower Buffalo River, City Ship Canal and Confluence Area (Buffalo River and Cazenovia Creek), Field Sampling Report, Volume 1" dated February 2008 by the NYSDEC.

The data from the above studies indicate the total organic carbon (TOC) content in the sediments were similar for all time periods. TOC for the river bank proximate to OU-4 ranged from 0.172 percent to 2.67 percent, with an average value of 1.83 percent. For the purposes of calculating the site-specific sediment criteria, the TOC content of the OU-4 sediment was assumed to be 2 percent.

Although VOCs, SVOCs, and metals are present in the sediment at shallow and deep intervals, some exceeding one or more of the criteria to varying degrees, their concentrations are similar to those reported by the NYSDEC for this portion of the Buffalo River in the March 2006 “Buffalo River Sediment Study”. TPH is also present throughout the sediment at varying concentrations.

<u>VOCs – Shallow Interval</u>

As shown on Plate 8, exceedances of VOCs relative to the benthic aquatic life chronic toxicity fresh water criteria in the shallow interval were detected at SS-8, SS-10, and SS-17. Four VOCs were detected above the benthic aquatic life chronic toxicity fresh water criteria (1,2,4-trimethylbenzene, isopropylbenzene, naphthalene, and xylenes).

Also shown on Plate 8, there were no exceedances of VOCs relative to the benthic aquatic life acute toxicity fresh water criteria in the shallow interval.

<u>VOCs – Deep Interval</u>

As shown on Plate 8, exceedances of VOCs relative to the benthic aquatic life chronic toxicity fresh water criteria in the deep interval were present at SS-4 and SS-16. Five of the six VOCs were detected above the benthic aquatic life chronic toxicity fresh water criteria (1,2,4-trimethylbenzene, benzene, ethylbenzene, naphthalene, and xylenes).

Also shown on Plate 8, exceedances of VOCs relative to the benthic aquatic life acute toxicity fresh water criteria in the deep interval were detected at SS-4 and SS-16. Three VOCs were detected above the benthic aquatic life acute toxicity fresh water criteria (benzene, isopropylbenzene, and naphthalene).

<u>SVOCs – Shallow Interval</u>

As shown on Plate 8, exceedances of SVOCs relative to the benthic aquatic life chronic toxicity fresh water criteria in the shallow interval were detected at 11 of the 16 locations sampled. Six SVOCs were detected above the benthic aquatic life chronic toxicity fresh water criteria (acenaphthene, anthracene, benzo[a]anthracene, fluorene, naphthalene, and phenanthrene). The higher concentrations were generally observed within the seepage areas of OU-4.

Also shown on Plate 8, exceedances of SVOCs relative to the benthic aquatic life acute toxicity fresh water criteria in the shallow interval were detected at SS-4, SS-5, SS-7, and SS-8. Only benzo[a]anthracene and fluorene were detected above the benthic aquatic life acute toxicity fresh water criteria.

SVOCs – Deep Interval

As shown on Plate 8, exceedances of SVOCs relative to the benthic aquatic life chronic toxicity fresh water criteria in the deep interval were detected at SS-3, SS-4, SS-12, and SS-16. The compounds exceeding the criteria were benzo[a]anthracene, fluorene, and phenanthrene. The higher concentrations were within one of the seepage areas of OU-4.

Also shown on Plate 8, exceedances of SVOCs relative to the benthic aquatic life acute toxicity fresh water criteria in the deep interval were detected at SS-3 only.

Metals – Shallow Interval

Lead was the only metal analyzed in sediment. As shown on Plate 8, three of the four samples collected in the shallow interval exceeded the Lowest Effect Level at less than five times the level. One of the four samples exceeded the Severe Effect Level.

Metals – Deep Interval

Lead was the only metal analyzed in sediment. As shown on Plate 8, both samples collected in the deep interval exceeded the Lowest Effect Level at less than three times the level. The concentrations were below the Severe Effect Level in both samples.

Tetraethyl Lead

Tetraethyl lead was analyzed in the deep interval at SS-15 and SS-16 and was not detected.

Total Petroleum Hydrocarbons (TPH) – Shallow Interval

As presented on Plate 6, TPH-GRO and TPH-DRO were sampled in numerous locations along the shoreline of OU-4 during the Site Investigation Completion and the Additional Sediment Sampling. Plate 6 presents TPH data relative to concentration ranges, since there is no sediment screening criteria for TPH.

In general, TPH-GRO was detected at fewer locations and at lower concentrations than TPH-DRO along the shoreline of OU-4 in the shallow interval. TPH-GRO was detected in 13 of the 16 samples, ranging in concentration from less than one mg/kg to 1,200 mg/kg. SS-8, the location where TPH-GRO was at 1,200 mg/kg, is within one of the seepage areas of OU-4. TPH-DRO was detected in all 16 samples, ranging in concentration from 16.9 mg/kg to 15,500 mg/kg. SS-4 and SS-5, which are two of the three locations where TPH-DRO was at greater than 10,000 mg/kg, are within one of the seepage areas of OU-4.

Total Petroleum Hydrocarbons (TPH) – Deep Interval

Similar to the shallow interval, concentrations of TPH-GRO were lower than concentrations of TPH-DRO. TPH-GRO was detected in all four samples, ranging in concentration from 4.7 mg/kg to 790 mg/kg. SS-4, the location where TPH-GRO was at 790 mg/kg, is within one of the seepage areas of OU-4. TPH-DRO was detected in all four samples, ranging in concentration from 1,000 mg/kg to 10,000 mg/kg.

3.2.7 Former Erie-Lackawanna Railroad Right-of-Way Soil Quality

Since the former Erie-Lackawanna Railroad right-of-way was never part of any ExxonMobil operations, its environmental conditions are discussed in this section, separate from the rest of OU-4. Tables 14 through 18 summarize analytical results for VOCs, SVOCs, metals, polychlorinated biphenyls (PCBs), and pesticides/herbicides, respectively, for the soil samples collected during the May 2010 investigation.

In general, the soil quality in the former Erie-Lackawanna Railroad right-of-way indicates VOCs, SVOCs, metals, and pesticides are present at shallow and deep intervals, while PCBs are present at the shallow interval. However, only some VOCs, metals, PCBs, and pesticides exceed one or more of the criteria to varying degrees. Moreover, petroleum odors were encountered from 30 to 35 ft bls at SB-201, and from 25 to 35 ft bls at both SB-202 and SB-203. Separate-phase product was encountered immediately above the water table at SB-202.

Plates 3 through 5 were prepared to compare soil concentration data for VOCs, SVOCs, and metals, relative to the unrestricted use and industrial cleanup criteria. On Plates 3 through 5, 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 3 through 5 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 the former Erie-Lackawanna Railroad right-of-way:

- zero to two feet bls; and
- 32 to 35 feet bls.

Note, TPH is not a parameter in Table 6.8 of Part 375 and thus was not analyzed.

<u>VOCs – Shallow Interval</u>

As summarized in Table 14 and shown on Plate 3, the only sample that indicated VOC exceedances above the unrestricted use criteria was SB-201. Acetone was the only VOC that exceeded the unrestricted use criteria at less than two times the criteria.

There were no exceedances of VOCs relative to the industrial criteria.

<u>VOCs – Deep Interval</u>

As summarized in Table 14 and shown on Plate 3, VOC exceedances of the unrestricted use criteria were detected at SB-201 and SB-202. Benzene was the only VOC detected above the unrestricted use criteria at SB-201, at less than two times the criteria. Six VOCs were detected above the unrestricted use criteria at SB-202: benzene, ethylbenzene, n-propylbenzene, xylenes, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene. Benzene was detected above the unrestricted use criteria at less than 12 times the criteria at SB-202. The remainder of the VOCs, except for xylenes, exceeded the unrestricted use criteria at less than four times the criteria at SB-202. Xylenes exceeded the unrestricted use criteria at 27 times the criteria at SB-202.

There were no VOCs detected above the industrial criteria.

<u>SVOCs – Shallow Interval</u>

As summarized in Table 15 and shown on Plate 4, there were no SVOC exceedances of the unrestricted use or the industrial criteria.

SVOCs – Deep Interval

As summarized in Table 15 and shown on Plate 4, there were no SVOC exceedances of the unrestricted use or the industrial criteria.

Metals – Shallow Interval

As summarized in Table 16 and shown on Plate 5, metal exceedances of the unrestricted use criteria were detected at all three sample locations. Seven metals were detected above the unrestricted use criteria: arsenic, cadmium, chromium, copper, lead, manganese, and zinc. Lead exceeded the unrestricted use criteria at less than four times the criteria at SB-201 and SB-202, and at less than three times the criteria at SB-203. The other six metals exceeded their respective unrestricted use criteria at less than three times the criteria.

Arsenic was the only metal that exceeded the industrial criteria at less than two times the criteria at SB-201.

Metals – Deep Interval

As summarized in Table 16 and shown on Plate 5, there were no metal exceedances of the unrestricted use or the industrial criteria.

PCBs – Shallow Interval

As summarized in Table 17, PCB exceedances of the unrestricted use criteria were detected at SB-201 and SB-202. Aroclor-1248 exceeded the unrestricted use criteria at less than 13 times the criteria at SB-201. Aroclor-1242 exceeded the unrestricted use criteria at less than three times the criteria at SB-202.

There were no PCBs detected above the industrial criteria.

PCBs – Deep Interval

As summarized in Table 17, there were no PCB exceedances of the unrestricted use or the industrial criteria.

Pesticides and Herbicides – Shallow Interval

As summarized in Table 18, pesticide/herbicide exceedances of the unrestricted use criteria were detected at SB-201 and SB-202. Three pesticides were detected above the unrestricted use criteria: 4,4'-DDE, 4,4'-DDT, and aldrin. All three pesticides exceeded the unrestricted use criteria at SB-201, at less than five times the criteria. 4,4'-DDT was the only pesticide that exceeded the unrestricted use criteria at SB-202, at less than two times the criteria.

There were no exceedances of pesticides/herbicides relative to the industrial criteria.

Pesticides and Herbicides – Deep Interval

As summarized in Table 18, the only sample that indicated pesticide/herbicide exceedances above the unrestricted use criteria was SB-202. Endrin was the only pesticide that exceeded the unrestricted use criteria at less than two times the criteria.

There were no exceedances of pesticides/herbicides relative to the industrial criteria.

3.3 Evaluation of Potential Offsite Migration to the North and East of OU-4

During the site investigations, the potential for offsite migration to the north and east of OU-4 was evaluated based upon historical property use, geologic logs, soil quality data, and groundwater monitoring data.

The ongoing groundwater monitoring data demonstrates that groundwater flow is southward to the Buffalo River (Plate 2). This would limit any potential for offsite migration to the north or east. In addition, the long term groundwater quality data from the northernmost (upgradient) well (MW-1URS) and easternmost (cross gradient) well (MW-4URS) indicate non-detect to low (below NYSDEC criteria) concentrations of VOCs and SVOCs. Based upon the groundwater flow and quality data described above, there has been no offsite migration to the north or east of OU-4.

Historical records indicate the property north of OU-4 was part of the landfill operated by the City of Buffalo, and that property east of OU-4 was either part of the landfill or was filled as part of the realignment of the Buffalo River. These properties to the north and east have been impacted by the historical land filling operations conducted by the City of Buffalo, as well as more recent operations of the current owners.

3.4 Qualitative Exposure Assessment

New York State 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 many portions of OU-4. In the past, benzene, MTBE, and metals have been detected in groundwater outside the historical/current separate-phase product area at concentrations exceeding their respective NYSDEC AWQSGVs for Class GA groundwater while in the vicinity of the separate-phase product plume concentrations of VOCs, SVOCs, and metals have exceeded their respective AWQSGVs. More recent data from January 2009 indicate dissolved lead concentrations are below its NYSDEC AWQSGV. At portions of the toe of the embankment, concentrations of lead and petroleum-related VOCs and PAHs in sediments exceed their respective NYSDEC sediment screening criteria. The NYSDEC Part 375 industrial criteria for soil were developed to be protective of public health based upon 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). The NYSDEC sediment screening criteria were developed to identify areas of sediment contamination and to quantify the potential level of risk that the contaminated sediment may pose to human health or the environment. 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-4.

Contaminant Sources

The primary sources of contamination in OU-4 are due to historical use of the ETYA as a disposal area from 1921 to 1974, and historical and current petroleum storage activities that have taken place since 1953. Given the intensive and prolonged use of OU-4 for these operations, the widespread occurrence of petroleum-related COCs and metals across OU-4, as documented in the site investigations, is not unexpected. In addition, the Site, including OU-4, is located in an area with an extensive industrial history of metal production, chemical manufacturing, and waste disposal. These background influences also have likely contributed to the concentrations of metals and PAHs across OU-4, in the surrounding areas, and in the Buffalo River.

Contaminant Release and Transport Mechanisms

The 1989 release of gasoline from Tank 176 and historical disposal practices of refinery and municipal wastes have resulted in impacts to soil, groundwater, and stormwater in OU-4.

The petroleum products released in OU-4 exist in the form of separate-phase product (both mobile and residual), hydrocarbon compounds adsorbed to soil particles in the unsaturated and saturated zones, and hydrocarbon compounds dissolved in groundwater. The separate-phase product serves as an ongoing source of contamination to groundwater beneath portions of OU-4.

Due to natural hydraulic gradients, mobile separate-phase product and dissolved hydrocarbons in groundwater beneath OU-4 migrate towards and discharge to the Buffalo River, as evidenced by the two seepage areas along the embankment. The discharge in both areas is contained by sorbent booms maintained by ExxonMobil.

Stormwater that comes in contact with impacted surface soil may also become contaminated. Stormwater runoff across OU-4, excluding the lined active tank farm area, currently infiltrates through OU-4 soils or runs off to the Buffalo River. Following remediation of OU-4, stormwater from remediated areas will likely be discharged to the Buffalo River under a 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-4. Impacted soil vapor may be transported beneath OU-4 and other areas of the Site through subsurface conduits, including sewers, other utility trenches, and product pipelines. Despite the presence of subsurface conduits in OU-4, impacted soil vapor is not likely to be transported offsite since contaminant source areas do not extend to offsite areas, the separate-phase product is present at deeper depths than other areas of the Site (up to 30 feet below grade), the volume of separate-phase product has decreased due to the implementation of two IRMs (see Section 4.0), and the levels of VOCs in the groundwater outside the separate-phase product are very low.

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, sediments, and surface water during general site maintenance activities. Such contact with contaminated media 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 contaminated media is limited by the fact that almost half of OU-4 is covered with asphalt or liner material and there is limited access to the riverbank. The potential for trespassing is also limited because the Site (including the majority of OU-4, but excluding the Buffalo River embankment) is completely fenced and under 24-hour surveillance.

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-4, 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. Except for the southwest portion of OU-4, the depth to groundwater is greater than 20 feet, and thus persons conducting excavation activities are unlikely to encounter groundwater and separate-phase product.

Though construction of buildings in OU-4 is not currently planned in areas of OU-4 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 buildings are constructed in the future. The potential for soil vapor intrusion would be limited based upon the depth to separate-phase product and the low concentrations of VOCs typically observed in OU-4. However, if such circumstances occur, building occupants could be exposed to contaminants via the indoor air inhalation route of exposure.

<u>Offsite Receptor Population and Potential Routes of Exposure</u>

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.

There are no offsite buildings in the immediate vicinity of contaminated soil or separate-phase product in OU-4 that could be impacted by migration of soil vapor.

The containment booms installed around the two seepage areas since the early 2000s prevent separate-phase product from adversely impacting the Buffalo River. The seepage areas and the booms are maintained and inspected regularly by ExxonMobil. The inspection results are presented in the site monitoring reports issued to the NYSDEC on a quarterly basis.

Surface water and sediments in the vicinity of the two seepage areas are impacted by petroleum sheen and petroleum hydrocarbon compounds, while sediments at the southwestern portion of OU-4 are impacted by lead (to be addressed in the AAR for OU-5). There is limited access to the impacted areas by land due to restricted access to the terminal and the perimeter fence surrounding OU-4 (with the exception of the narrow and steeply sloped embankment of the Buffalo River). Recreational users of the Buffalo River could access the impacted areas at the toe of the embankment by water and could contact contamination and be exposed via dermal adsorption or incidental ingestion. However, the access potential is limited due to the steep slope of the embankment down to the water line, as well as the densely vegetated nature of the embankment.

4.0 INTERIM REMEDIAL MEASURES WITHIN OU-4

There are three major IRMs that have been completed or are ongoing in OU-4:

- product recovery (ongoing);
- containment of seepage areas (ongoing); and
- chemical oxidation system (completed).

A brief description of each of the IRMs is provided below.

4.1 Product-Only Pumping Systems and Manual Bailing of Product

Several product-only pumping systems are operating at the Site. There are three mobile solar powered product-only pumping systems that can be moved from well to well to address product across the Site. Two are currently deployed in OU-4 in VERMW-4 and MW-28. Approximately 291 gallons of product have been recovered from systems installed in wells in OU-4 since the first quarter of 2000. Frequent gauging and manual bailing of product is also ongoing across the Site. Approximately 102 gallons of product have been recovered from manual/passive bailing of wells in OU-4 since the first quarter of 2000.

4.2 Containment of Seepage Areas

There are two sheen and seepage areas along the Buffalo River bank adjacent to the ETYA. To minimize impact to the Buffalo River, ExxonMobil has installed and maintains permanent slick-bar booms around these two areas. In addition, sorbent booms are also installed and maintained within the slick-bar booms. Finally, sorbent blankets were installed over the visible stain on the river embankment within the boomed area at the upstream seepage area in April 2009.

The seepage areas have been inspected regularly since October 2000 from land or from a boat. These inspections include a description of the area of seepage noting any differences in the appearance of the area (i.e., presence or absence of sheen and its location if present). The inspections also note the position of the boom and blanket and any adjustments required. The inspection results are presented in the site monitoring reports issued to the NYSDEC on a quarterly basis.

4.3 Chemical Oxidation System

An IRM Work Plan for Chemical Oxidation (ChemOx) was submitted on August 23, 2006. The layout of the ChemOx system is shown in Figure 10. The IRM was installed and operated in five ChemOx cells and within the bermed area of Tank 176, as shown on Figure 10. The ChemOx well installation for the first two cells was completed in the fourth quarter of 2006 and final equipment and piping acquisition and installation was finalized by May 2007. Baseline groundwater sampling was performed on May 9, 2007. Startup and testing of the system was scheduled for May 23, 2007. However, mechanical problems with the air compressor and subsequent repairs delayed full scale startup until June 7, 2007. The system had operated continuously until shutdown on March 27, 2009. From September 12 through 27, 2007, 11 ChemOx injection wells and two additional monitoring wells were installed in Cells 3, 4, and 5. From June 4 through 19, 2008, an additional nine ChemOx injection wells and two monitoring wells were installed inside of the Tank 176 bermed area.

A total of 378 gallons of product was recovered in OU-4 wells through manual bailing and automated product recovery between the start of the ChemOx operations and the system shut down on March 27, 2009. Temperatures within the injection wells within all cells generally ranged from 70 to 210 degrees when the system was in operation. Efforts to optimize the ozone/peroxide injections rates in order to maintain elevated temperatures and product removal rates continued throughout the system operation.

In order to provide a qualitative assessment of total VOCs in the subsurface prior to, during, and after long term operation of the ChemOx system, membrane interface probe (MIP) borings were completed within the ChemOx treatment area (Figure 10). The MIP borings were advanced to the approximate depth of the clay layer that forms the base of the aquifer in the target area (approximately 35-40 feet below grade, which varied slightly throughout the area). Several MIP events were conducted throughout the course of the IRM.

The MIP is a percussion-tolerant VOC sensor that can continuously log volatile organics that diffuse through a semi-permeable membrane. Using a carrier gas, the VOCs are brought to the surface through tubing, which is connected to a laboratory grade PID, Flame Ionization Detector

(FID), and Electron Capture Detector (ECD) for immediate screening. All three of these detectors are mounted in a Hewlett Packard 5890 Series II Gas Chromatograph cabinet.

As the operator advances the MIP sensor into the subsurface, a log is displayed onscreen by the field computer. This log provides information about VOCs in the subsurface using either the PID or FID or any combination of detectors. The real time log also provides a depth/speed graph, electrical log of the formation, and temperature log of the heated sensor onscreen.

The data provided is a scan of the subsurface, measured in micro-volts. The higher micro-volts equate to higher VOC concentrations. Generally, the micro-volts translate into a qualitative measurement of the VOCs present in the soil. Since there is no direct correlation between analytical data (measured in parts per million [ppm]) and the micro-voltage measurements at the boring locations, VOC distribution will be solely based on micro-voltage measurements before and after the completion of the ChemOx. The MIP data is shown in Appendix C. It was apparent from the MIP PID logs that total VOCs in the target area significantly decreased. The FID was found to be an unreliable indicator of subsurface conditions. Based upon PID readings from the MIP borings compared to pre-startup conditions and the decrease in product recovery during operation, despite high subsurface temperatures, it was determined that the ChemOx system had reached its limit of effectiveness and was shut down on March 27, 2009. The ChemOx system and associated aboveground piping were completely decommissioned by May 1, 2009.

5.0 REMEDIAL GOALS, SCGS AND REMEDIAL ACTION OBJECTIVES

Remedial goals and remedial action objectives (RAOs) have been developed for OU-4 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 Draft BCP Guide and Part 375.

The remedial goals for OU-4 have been developed considering:

- that two bulk storage tanks are located in OU-4;
- 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-4;
- additional available land surrounding the Site; and
- the reasonably anticipated continued use of OU-4 for petroleum bulk storage as part of Buckeye's ongoing operation.

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, the Part 375 and 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 restricted-residential, 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 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. Except in the case of an industrial use remedy, the backfill must meet the commercial criteria for protection of human health or 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-4 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” (ARARs) and the “to be considered” (TBCs) category of non-enforceable criteria or guidance, consistent with United States Environmental Protection Agency (USEPA) remediation programs. The following table provides a list of SCGs potentially applicable to the remediation of OU-4. 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
Not Applicable	City of Buffalo Local Waterfront Revitalization Program	City of Buffalo
6 NYCRR Part 608	Use and Protection of Waters	NYSDEC
6 NYCRR Part 621	Uniform Procedures Regulations	NYSDEC
6 NYCRR Parts 750-757	State Pollutant Discharge Elimination System	NYSDEC
Not Applicable	New York State Stormwater Management Design Manual	NYSDEC
Section 404	Clean Water Act	USACE
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 Values	NYSDEC
TOGS 2.1.3	Primary and Principal Aquifer	NYSDEC

Citation	Title	Regulatory Agency
Sediment		
Not Applicable	Technical Guidance for Screening Contaminated Sediments	NYSDEC
Air		
Air Guide No. 1	Guidelines for the Control of Toxic Ambient Air Contaminants	NYSDEC
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
USEPA: United States Environmental Protection Agency
USACE: United States Army Corps of Engineers
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 reasonable anticipated future use of OU-4. The industrial use criteria would be appropriate for

OU-4 based upon current land use and zoning, particularly considering that OU-4 is entirely owned by Buckeye and is separated from the remainder of the Site by the former Erie-Lackawanna Railroad bed. Industrial use criteria are also consistent with the proposed zoning and the Elk Street Corridor Redevelopment Plan that allows for continued industrial uses and restricted access green space, and is generally consistent with the proposed zoning and land use in the LWRP (which proposes commercial/light industrial uses). The Elk Street Corridor Redevelopment Plan preferred redevelopment scenario specifies OU-4 as a bulk storage area owned and operated by Buckeye that will remain as an "anchor property" surrounded by restricted access green space entirely owned by Buckeye. For the purposes of this Final AAR, the preferred redevelopment scenario will be assumed as the reasonable anticipated future use of OU-4. Therefore, for other than the Track 1 remedial alternative, the applicable soil cleanup objectives for OU-4 will be industrial use (for the Buckeye terminal and restricted access green space). 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-4 and the reasonably anticipated use of OU-4.

SCGs for soil for the protection of groundwater were considered. However, they were determined not to be applicable to OU-4 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-4 area is comprised of active and vacant industrial areas with no current ecological habitat of significance for evaluation. The vacant industrial land area is comprised primarily of fill and landfill waste from former municipal landfill operations and historic terminal operations. The vegetated embankment along the Buffalo River is narrow and eroding away rapidly due to its steepness and lack of protection from river erosion at the toe of the slope. Therefore, long term stabilization of the embankment, included as part of each remedial alternative, will require removal of the vegetation and substantial earthwork (i.e., excavation, backfill, and regrading). The ecological criteria will be applied to the backfill for the embankment to facilitate the re-creation and improvement of the embankment habitats.

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

<u>SCGs for Sediments</u>

Buffalo River sediment quality and remedial alternatives for sediment will be evaluated more fully in the AAR for OU-5. However, sediment quality is discussed in this section since the stabilization of the Buffalo River bank (a common element to any remedial alternative) in OU-4 will entail some handling of river sediments. The SCGs for sediments were developed to protect humans and the environment from the risk posed by contact with contaminated sediment. The NYSDEC has established four levels of sediment screening criteria for VOCs and SVOCs, and two levels of protection for metals. The VOC and SVOC sediment screening criteria are:

- protection of human health from toxic effects of bioaccumulation;
- protection of benthic aquatic life from acute toxicity;
- protection of benthic aquatic life from chronic toxicity; and
- protection of wildlife from toxic effects of bioaccumulation.

The metals sediment screening criteria are:

- lowest Effect Level, which indicates the concentration that the majority of the benthic community can tolerate; and
- severe Effect Level, which indicates the concentration that would strongly impact benthic organisms.

Consistent with the NYSDEC classification of the Buffalo River as a Class C waterway, which indicates the water is suitable for supporting fisheries and non-contact activities, the following sediment screening criteria are applicable for OU-4:

- protection of benthic aquatic life from acute toxicity;
- protection of benthic aquatic life from chronic toxicity;
- Lowest Effect Level; and
- Severe Effect Level.

The guidance strategy in the NYSDEC's "Technical Guidance for Screening Contaminated Sediments" for sediments exceeding criteria based on aquatic life toxicity, including metal's Lowest Effect Level, is to assess the degree of impairment to the benthic community. Although exceedances of the selected SCGs indicate potential impact to benthic organisms, toxicity tests performed by the NYSDEC and reported in the March 2006 "Buffalo River Sediment Study" indicate the sediments proximate to OU-4 did not impair the test benthic organisms. The concentrations of analytes in the sediments proximate to OU-4 reported by the NYSDEC are similar to the concentrations presented in this Final AAR, indicating that remediation may not be necessary. Sediments that may be disturbed as part of the remediation of OU-4 will be handled in a similar manner to soil depending upon the remediation track selected. Further evaluations of sediment will be deferred to the AAR for OU-5.

<u>SCG for Soil Vapor</u>

Evaluation of soil vapor intrusion is not applicable because there are no permanent buildings within OU-4. However, if a future redevelopment scenario for OU-4 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 Objective

The RAOs for OU-4 are established for the protection of public health and the environment and are 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 (including grossly contaminated soil similar to that identified by the NYSDEC in OU-2), 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-4:

- remediation of surface soils that pose a direct contact hazard;
- remediation of subsurface soils that are potentially a continuing source of groundwater impacts;
- free product recovery to the extent practical;
- preventing migration of free product to the Buffalo River;
- stormwater drainage and management controls across OU-4;
- stabilization of the river embankment that was formed by the historical waste disposal activities; and
- groundwater management controls to prevent exposure.

The following RAO was added based upon NYSDEC comments dated November 13, 2009:

- Replace and improve habitat appropriate for the location and current use.

6.0 REMEDY SELECTION PROCESS

The following is a detailed description of the alternatives analysis and remedy selection process for OU-4.

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 in Table 19.

As shown in Table 19, the remedial technologies for soil, groundwater, and separate-phase product 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;
- Stabilization/Solidification;
- Chemical Oxidation via Regenesis RegenOx™;
- Slurry Wall and Jet Grouting;
- Sheet Pile Wall and Jet Grouting;
- Phytoremediation;
- Groundwater Extraction and Treatment;
- Permeable Reactive Barrier (PRB);
- Separate-Phase Product-Only Recovery; and
- Dual Phase Groundwater and Separate Phase Product Recovery.

As shown in Table 19, only excavation/offsite disposal and capping were retained for further evaluation for soil remediation. For groundwater containment and treatment, PRB, slurry wall/jet grouting, and sheet pile wall/jet grouting were retained for further evaluation. The key technologies to be incorporated into the remedial alternatives evaluation for OU-4 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-4 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.

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 any depth above bedrock (estimated to be up to 31 feet bls in the majority of OU-4, and up to 35 feet bls in the former Erie-Lackawanna Railroad right-of-way). The excavated area will be backfilled with common fill followed by or six (6) inches of topsoil that both meet the unrestricted use or commercial use criteria, depending on the cleanup track to be achieved. Backfilled areas will be graded and seeded for drainage and erosion control.

6.1.2 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 low permeability cap scenarios to cover the landfill in OU-4, alone or in combination, may be installed. The caps will each 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 use criteria for protection of human health or the criteria for protection of groundwater.

The following are the two low permeability cap scenarios that may be considered for OU-4 alone or in combination:

- 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) or geosynthetic clay liner (GCL), six inches of offsite common fill, and six inches of topsoil meeting the lower of the commercial use criteria 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 lined gravel/stone cap constructed similarly to the lined soil cap, as described above, but with one foot of clean offsite stone above the liner. As a note, the existing active tank farm area is currently capped with a GCL and clean stone and, therefore, is already adequately capped under this proposed capping scenario.

The existing perimeter road (asphalt cap) around the tank berm will be considered an adequate cap and will be maintained (repaired as necessary) unless regrading is necessary.

Any stormwater management facilities constructed as part of the remedy would be of similar design to the caps described above.

6.1.3 Slurry Wall and Jet Grouting Containment

Slurry walls are non-structural barriers constructed underground to impede the flow of groundwater. They are frequently used to contain contaminated groundwater at remediation sites. Slurry walls have been used for decades to provide cost-effective, long term solutions for many groundwater control and groundwater remediation problems.

Within OU-4, the slurry wall would most likely be constructed using the slurry trench method, which involves excavating a narrow trench that is kept full of an engineered fluid or “slurry.” The slurry exerts hydraulic pressure against the trench walls and acts as shoring to prevent collapse. Slurry wall excavations can be performed in all types of soils, even below the groundwater table.

The slurry wall excavation would be performed with a hydraulic excavator (with specialized attachments to reach to 40 feet or more below grade). The width of a typical wall can vary from 1.5 to 5.0 feet and is anticipated to be approximately 2.5 feet for this Site. The excavation will “key” approximately three feet into the low permeability clay that underlies the Site. After an excavation segment is completed, the excavator would back up and begin a new overlapping segment to create a continuous trench. Once sufficient excavation is complete, trench backfilling would begin.

Bentonite slurry is the most common excavation fluid used in a slurry trench. Bentonite clay and water would be combined in a colloidal mixer and the resulting slurry would be pumped, as required, through a pipe to the excavation site. In addition to stabilizing the excavation, bentonite slurry would form a “filter cake” on the slurry trench walls that would reduce the slurry wall’s final soil permeability.

The slurry wall construction includes backfilling the trench; typically with a mixture of excavated soil, dry bentonite, and bentonite slurry. The wall constructed with this type of backfill would be referred to as a soil-bentonite (SB) slurry wall. Walls of this composition provide a low cost barrier with low soil permeability, on the order of 1×10^{-7} centimeters per second (cm/sec), and good chemical resistance to site-specific contaminants. Excavated soil that is determined to be suitable for use as backfill would be placed on the work platform adjacent to the trench or relocated to a remote mixing area when sufficient space is not available adjacent to the trench. A bulldozer would track and blade the material to produce soil-bentonite backfill, which has a consistency of wet concrete. Excavated soil that is not considered suitable for use as backfill would include construction debris, stones larger than three inches, and, potentially, soils with insufficient fines content or saturated with separate-phase product. Excavated soil that is determined to be unsuitable for use as backfill would be stockpiled separately within OU-4 for consolidation beneath an onsite cap or disposed offsite. The soil-bentonite backfill would be placed into the end of the slurry trench, in a manner that would displace the slurry forward toward the ongoing excavation. The excavation/backfill routine would continue until the slurry wall is complete.

A cement-bentonite (CB) slurry wall is another type of wall that would be more suitable for trenching through areas with difficult access. With this technique, trenching takes place under a slurry composed of cement and bentonite, and the slurry in the trench sets up and forms the permanent backfill. The cost of this type of wall is higher and the permeability is generally higher than the SB slurry wall but can be improved by using specialized cement blends. All soil removed during excavation for this type of wall would be stockpiled for consolidation beneath an onsite cap or disposed offsite.

At areas where it would be impractical to excavate with a backhoe (e.g., crossing under pipe rack or where buried pipelines are located), jet grouting (also known as jet mixing) can be used instead. Jet grouting consists of advancing a drill rod to the projected depth of the slurry wall. The drill rod is then slowly retracted in a rotating motion while grout is directed out horizontally at high pressures, resulting in a two to six feet diameter column of soil and grout. By overlapping the soil and grout columns, a water-tight barrier is created. Jet grouting is a well known, standard technical approach for creating an impermeable barrier. The effectiveness of jet grouting is assessed through measurement of quality control parameters during and post production, which will be defined during the design phase.

6.1.4 Sheet Pile Wall and Jet Grouting Containment

Sheet pile walls, similar to slurry walls, are barriers constructed underground to impede the flow of groundwater. Sheet pile walls consist of driving prefabricated interlocking sheeting into the ground using standard installation techniques and equipment (i.e., hammer or vibratory equipment). The seams are sealed using available equipment to create a water-tight barrier.

The following are three types of sheet pile walls that may be considered for OU-4:

- Steel sheeting with sealant – Standard steel sheeting is interlocked and sealed by epoxy, chemical grout, or urethane resin. The sealant is applied after the sheeting has been installed and the joints have been cleaned.

- Waterloo Barrier® – The Waterloo Barrier® is a proprietary steel sheet piling system that incorporates a sealable cavity at each interlocking joint. The steel sheets are installed using the same equipment and techniques as conventional sheeting. The cavities are flushed clean and then sealed with a clay-based, cementitious, or polymer sealant. The completed Waterloo Barrier has a hydraulic conductivity on the order of 1×10^{-8} to 1×10^{-10} cm/sec.

- GSE Vertical Barrier System – The GSE Vertical Barrier System consists of HDPE geomembrane panels that are installed using conventional equipment. The panels interlock using multiple sealant chambers (CurtainWall) or male and female profiles (GundWall). Additional sealing is provided by installing HyperTite™ hydrophilic rubber gaskets, which swell and fill the cavity after absorbing water.

At areas where it would be impractical to install sheeting (e.g., crossing under pipe rack or where buried pipelines are located), jet grouting (also known as jet mixing) can be used instead. Jet grouting consists of advancing a drill rod to the projected depth of the sheet pile wall. The drill rod is then slowly retracted in a rotating motion while grout is directed out horizontally at high pressures, resulting in a two to six feet diameter column of soil and grout. By overlapping the soil and grout columns, a water-tight barrier is created. Jet grouting is a well known, standard technical approach for creating an impermeable barrier. The effectiveness of jet grouting is assessed through measurement of quality control parameters during and post production, which will be defined during the design phase.

6.1.5 Permeable Reactive Barrier

PRB is an *in situ* remediation technology in which treatment media within the barrier degrades or retains contaminants in the groundwater flowing through the PRB. The type of treatment media that is utilized (e.g., organoclay, zero-valent iron, activated carbon, or limestone) depends on the contaminants of concern and groundwater conditions. A PRB requires no energy, is virtually maintenance free, and remains effective until the treatment media is exhausted.

The physical characteristics of the landfill and associated riverbank within OU-4, as well as safe construction requirements, dictate that any slurry wall or sheet pile wall be installed from the top of the embankment and set-back a certain distance from the Buffalo River. The removal and consolidation of petroleum impacted fill, soil and/or sediment (collectively referred to as material) to the satisfaction of the NYSDEC outside the slurry wall will eliminate, to the extent practical, ongoing impact to groundwater. Though not necessary due to the planned removal of petroleum impacts outside the slurry wall, a PRB would be installed between the slurry wall (or the sheet pile wall) and the Buffalo River as an additional protective measure. The treatment medium being considered is CETCO's Organoclay Reactive Core Mat® (RCM), which has been used to control embankment seepage and remediate groundwater. Organoclay is a proprietary product consisting of a non-swelling, permeable, granular clay compound. The RCM is constructed by encapsulating the organoclay in a nonwoven fabric core matrix bound between two layers of geotextile. This facilitates the installation of the RCM within trenches or underneath a layer of fill material (i.e., stone or sand).

6.2 Remedial Alternative Evaluation Criteria

The identification, description, and evaluation of remedial alternatives for OU-4 is provided in Sections 6.4 through 6.8. 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 4.2 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 participiation plan identified for a remdial 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-4. The scope of work and purpose of these activities will be similar for any remedial alternative.

- Mobilization and Site Preparation;
- Stormwater Management and Erosion Control during Construction;
- Dust Control;
- Temporary Staging and Stockpiling;
- Traffic Control;
- Offsite Disposal and Equipment Decontamination;
- Stabilization of the Buffalo River Bank*;
- Stormwater Management System Modifications (Remedial Alternatives 3 and 4 only)*;
- 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 the next section. The other elements will be described in detail for the selected alternative in the remedial design to be prepared following the approval of this Final AAR.

6.3.1 Embankment Stabilization

The OU-4 embankment is approximately 1,700 linear feet and was formed by historical waste disposal activities. The ground surface, except at the southwest corner, generally drops by approximately 22 to 25 feet to the river level in a horizontal span of approximately 25 to 30 feet (i.e., 1 horizontal to 1 vertical), but some portions of the existing slope drop 20 feet in a horizontal span of only approximately 12 feet (i.e., nearly 0.5 horizontal to 1 vertical). Erosion at the toe of the slope due to seasonal river flow, ice floes, and river debris is also evident. Existing trees and vegetation on the riverbank are currently the only forms of erosion control.

Two grading options for long term riverbank stabilization that would be implemented for the OU-4 embankment were identified and preliminarily evaluated and are described below:

- A two tier grading scenario; and
- A one tier grading scenario.

6.3.1.1 Two Tier Grading Scenario

A combination of two tier grading, rip rap, and reinforced bioengineering would be utilized to realize long term embankment stabilization (Figure 11). The slopes of this grading scenario were selected to achieve a factor of safety (FS) for short term stability, long term stability, and seismic stability equal to or greater than their respective criterion in the USACE Engineering Manual EM 1110-2-1902 *Slope Stability*. Global slope stability analyses conducted on four sections across the embankment indicate the described grading scenario would achieve satisfactory FS for all three conditions. Details of each stabilization component are provided below:

- Two tier grading – The existing embankment would be graded on a 3 horizontal to 1 vertical slope from 562 feet above mean sea level (ft amsl) to 583 ft amsl, which is the 100-year flood elevation per the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map for the City of Buffalo. The bottom elevation is below the typical mean water elevation of 571 ft amsl to accommodate five feet of rip rap at the toe of the slope. From 583 to 594 ft amsl (approximately top of the embankment), grading would be on a 4 horizontal to 1 vertical slope.

- Rip rap – Erosion protection from 562 to 583 ft amsl would be provided by a 30-inch layer of 15-inch mean diameter, 300 pound nominal weight armor stone. This type of rip rap was chosen based on the FEMA mean river velocity of 5.9 feet per second (ft/s) for the 100-year flood and high resistance to scouring by ice floes and river debris. Rip rap at the toe would extend eight feet into the embankment and four feet deep to reduce the likelihood of slope failure caused by undermining. A 12-inch layer of 1-inch stone, underlain by a non-woven geotextile, would be laid beneath the rip rap for support.

- Reinforced bioengineering – Erosion protection from 583 to 594 ft amsl would be provided by a combination of cellular confinement system (CCS) and bioengineered structure (e.g., brush mattress) installed at the surface of the slope. A CCS consists of lightweight, HDPE, honeycomb-like panels that confine soils or stones within the cells to protect the material from wind and water erosion. A brush mattress is a layer of interlaced live branch cuttings from willows and dogwoods placed on a bank face. The brush mattress is held together with wire or twine and staked in place with live stakes and/or dead stout stakes. Live fascines are frequently used as anchor at the toe. Once the live branches and fascines become well established, the vegetative cover provides erosion protection and serves as habitat for birds, small fur-bearing animals, and insects. Additional information regarding brush mattress is provided in Appendix D.

This grading scheme does not extend as far into OU-4 as the one tier grading plan (described in the next section). As a result, there would be minimal interference with a small portion of the Enbridge pipeline between the bulk storage tanks and the embankment, requiring only minor adjustments to the grading scheme at the top of the slope to avoid this structure or removal and replacement of portions of this structure. In addition it does not require removal of the asphalt road surrounding the tank farm. Excavated material from the embankment (including sediment at the toe and petroleum impacted soil) would be consolidated beneath the proposed low permeability cap or disposed offsite in accordance with applicable regulations, depending on the remedial alternative under evaluation. Backfill meeting the Part 375 ecological criteria (Table 20) would be used for re-creation of the embankment to enhance habitat creation.

Incorporating vegetation alone to stabilize the lower portion of the river embankment was determined to be inappropriate due to the potential for scouring by ice floes and river debris. Additionally, in accordance with the USACE "Engineering and Design – Handbook for the Preparation of Storm Water Pollution Prevention Plans for Construction Activities," hard structural erosion protection measures (i.e., rip rap) are recommended at river velocities greater than 5 ft/s. Native plant species suitable for the various elevation zones of the riverbank (i.e., emergent wetland species such as sedges, grasses, and rushes will be planted between the normal high-water elevation and the normal low-water elevation, while woody riparian species such as black willows will be planted above the normal high-water elevation) will be installed within the rip rap shore protection to create a natural appearance and improve the riparian habitat. The emergent species will provide an additional measure of groundwater management.

6.3.1.2 One Tier Grading Scenario

A combination of one tier grading, rip rap, and reinforced bioengineering would be utilized to realize long term embankment stabilization (Figure 11). Details of the grading component are provided below (all other components are the same as described in Section 6.3.1.1):

- One tier grading – The existing embankment would be graded on a 4 horizontal to 1 vertical slope from 562 ft amsl to 594 ft amsl (approximately top of the embankment).

This grading scheme extends further into OU-4 than the two tier grading plan. As a result, it may interfere with the product pipeline between the bulk storage tanks and the embankment, and will require adjustment to the grading to avoid this structure or removal and replacement of sections of the pipeline. Additionally, this grading scheme requires the removal/relocation of the asphalt road surrounding the tank farm.

Excavated material from the embankment (including sediment at the toe and petroleum impacted soil) would be consolidated beneath the proposed low permeability cap or disposed offsite in accordance with applicable regulations, depending on the remedial alternative under evaluation. Backfill meeting the Part 375 ecological criteria (Table 20) would be used for re-creation of the embankment to enhance habitat creation.

Based upon the distance the one tier grading scenario extends into the site, and the potential for impacting the existing pipeline between the tanks and the embankment and the asphalt road, the one tier grading scenario will not be evaluated further in this document.

6.3.2 Stormwater Management System Modifications

The stormwater management system modifications described in this section would only be constructed as part of Remedial Alternatives 3 and 4. For Remedial Alternatives 1 and 2, stormwater outside the tank farm will be allowed to infiltrate and naturally runoff to the Buffalo River, which is the current stormwater management approach for OU-4.

A stormwater wetland (NYSDEC stormwater management practice W-3) was selected to manage and treat the runoff from the 5-year, 24-hour storm event from OU-4 (approximately 200,000 gallons). The proposed location of the stormwater wetland is shown in Figure 12. Runoff from each rain event will be detained and treated within the stormwater wetland until it is displaced by runoff from the next storm. The stormwater wetland will be designed with freeboard capacity to reduce peak discharges of infrequent, large storm events.

Stormwater wetlands are one of the more reliable management practices used by various states to effectively remove and retain stormwater contaminants. In fact, the NYSDEC has specifically developed stormwater wetland design guidelines for stormwater treatment in the 2003 "New York State Stormwater Management Design Manual." Stormwater wetlands are highly engineered treatment systems designed to temporarily store runoff in shallow ponds and maximize the removal of contaminants from stormwater runoff via several synergistic mechanisms, including sedimentation, filtration, sorption, plant uptake, and microbial breakdown. Stormwater wetlands are designed to reduce peak discharges of infrequent large storm events to reduce the occurrence of downstream flooding.

Runoff from OU-4 will be conveyed via vegetated swales into a forebay to reduce velocities and provide quiescent conditions that enhance the removal of suspended solids. The forebay will be similar in appearance to open water marshes. Heavier sediments will drop out as runoff passes through the forebay, while lighter sediments will settle out as the runoff is retained in the permanent pool. Initial sedimentation in the forebay will enhance treatment performance, reduce maintenance, and increase the longevity of the stormwater wetland.

Water from the forebay will then overflow into a shallow emergent marsh. The shallow marsh is an area of plants such as rushes, reeds, and sedges designed to improve water quality through the trapping and filtering of fine particles and soluble pollutants (i.e., metals, organics, and nutrients). The wetland plants will also stabilize the sediments, thus preventing scouring and re-suspension during high flows.

Effluent from the shallow marsh will then overflow into a single micropool located at the outlet of the shallow marsh prior to discharge to the Buffalo River. The micropool will collect all the water in the system at one common point and will provide additional polishing prior to discharge. The micropool will be a small pond designed with sufficient depth (anticipated to be 4 feet) to increase the dissolved oxygen content and to retain sediments prior to discharge.

6.4 Identification of Remedial Alternatives

The following four remedial alternatives (one being an unrestricted use scenario) have been identified for OU-4:

- Remedial Alternative 1: Track 1 Scenario to Unrestricted Use Criteria via Excavation and Offsite Disposal and Embankment Stabilization;
- Remedial Alternative 2: Track 2 Scenario to Industrial Use Criteria via Excavation and Offsite Disposal and Embankment Stabilization;
- Remedial Alternative 3: Track 4 Scenario to Industrial Use Criteria via Low Permeability Cap and Slurry Wall/Jet Grouting Groundwater Containment and Embankment Stabilization; and
- Remedial Alternative 4: Track 4 Scenario to Industrial Use Criteria via Low Permeability Cap and Sheet Pile Wall Groundwater Containment and Embankment Stabilization.

The following sections provide a description and detailed evaluation of these four remedial alternatives in accordance with Section 4.8 of the Draft BCP Guide and Section 4.4[c] of DER-10.

The following sections provide a brief description of Remedial Alternatives 1 through 4, 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.

As a note, based on the results of the investigation completed in 2010, the portion of the former Erie-Lackawanna Railroad right-of-way owned by Buckeye will be included in the BCP Site remediation, as described under each alternative below.

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

The following sections provide an evaluation of Remedial Alternative 1, which would achieve a Track 1 cleanup of OU-4, as described in Section 5.1.

6.5.1 Description of Remedial Alternative 1

<u>Soil Remediation</u>

As discussed previously, the soil quality in many areas within OU-4 has been impacted by historical use and former refinery/terminal activities. Impacted soil exceeding the unrestricted use criteria has been found throughout OU-4 at depths ranging from zero to 31 feet below grade in the majority of OU-4, and from zero to 35 feet below grade in the former Erie-Lackawanna Railroad right-of-way. Landfill waste has been found at depths up to 20 feet below grade throughout OU-4. Historically, separate-phase product has been observed in wells downgradient of the active tanks. More recently, following completion of the ChemOx IRM, trace amounts of separate-phase product was observed in ten monitoring wells (LF-3, LF-6, P-15, MW-28, MW-CO-2, MW-3URS, VERMW-1, VERMW-2, VERMW-3, and VERMW-4). Therefore, excavation of impacted material exceeding unrestricted use criteria, landfill waste, and petroleum impacted soil would be performed to any depth above bedrock (estimated to be up to 31 feet below grade) in the majority of OU-4 and to any depth above the confining clay layer (estimated to be up to 35 feet below grade) in the former Erie-Lackawanna Railroad right-of-way. It is estimated that approximately 770,200 cubic yards of soil would require excavation in order to achieve these goals throughout OU-4. It should be noted that removal and replacement of the two active bulk storage tanks and product pipelines within OU-4 would be required to excavate beneath these facilities to achieve the Track 1 remedy. 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.

Excavated material and recovered separate-phase product would be disposed offsite in accordance with applicable regulations. Soil would be disposed of in a secured landfill and recovered product (if any) would 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 (6) inches of topsoil that both meet the unrestricted use criteria presented on Table 20. Sampling of the backfill material would be conducted to confirm that it meets the unrestricted use criteria. OU-4 would then be graded and seeded with turf grasses (or other appropriate vegetation).

Regarding groundwater remediation, existing data demonstrates that the groundwater beneath OU-4 is not significantly impacted. The removal of all impacted soil from OU-4 would result in further improvement of groundwater quality over time.

Embankment Stabilization

Embankment stabilization for Remedial Alternative 1 would entail a combination of two tier grading, rip rap, and reinforced bioengineering, as described in Section 6.3.1.1 and shown on Figure 11 and Plate 9. Excavated material from the embankment (including petroleum impacted soil and separate-phase product, if any) would be disposed offsite in accordance with applicable regulations. Backfill meeting the Part 375 ecological criteria (Table 20) would be used for re-creation of the embankment to enhance habitat creation.

Implementation of Remedial Alternative 1 would be completed within six years, (not including removal and replacement of the two active bulk storage tanks and product pipelines, which would significantly increase the implementation timeframe).

Plate 9 shows the areas to be addressed under Remedial Alternative 1. Estimated costs (not including the considerable costs associated with the removal and replacement of the two active bulk storage tanks and product pipelines) for Remedial Alternative 1 are presented in Appendix E.

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-4;
- removes all petroleum contaminated soil identified based on field observations and ongoing separate-phase product gauging to the extent practicable;
- recovers separate-phase product to the extent practicable during excavation activities; and
- allows for the site to be used for any purpose.

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

- requires a significant volume of material within an existing landfill to be excavated, transported, and placed in limited secure landfill space at another location without treatment and, therefore, constitutes an offsite containment remedy, which is the least favorable among the hierarchy provided in Part 375;
- results in the most significant short term impacts due to the long implementation duration of six years (not including removal and replacement of the two active bulk storage tanks and product pipelines, which would significantly increase the implementation timeframe), and the amount of heavy equipment operation required;
- would be a major disruption to regional petroleum deliveries and to Buckeye's business to remove and replace the two active bulk storage tanks and product pipelines in order to excavate beneath them to achieve the Track 1 remedy;
- is impractical and not compatible with current and reasonably anticipated future use of the property; and
- is the most difficult to implement due to significant excavation shoring and dewatering required.

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 21. Remedial Alternative 1 ranks third overall out of the four potential alternatives.

Embankment stabilization and the associated creation of green space and natural habitats were not considered in the detailed evaluation because they are structural rather than remedial elements of the remedy, and are common to all remedial 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-4 by eliminating the concentrations in soil of petroleum-related and non-petroleum-related constituents as a result of the historic site use and former refinery/terminal activities and background influences through source removal to estimated depths up to 31 feet below grade in the majority of OU-4, and up to 35 feet below grade in the former Erie-Lackawanna Railroad right-of-way. 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-4 would be eliminated by excavation of the impacted materials up to 31 feet (or deeper based on post-excavation sampling) in the majority of OU-4, and up to 35 feet or deeper in the former Erie-Lackawanna Railroad right-of-way, then 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-4 would be placed in a secured landfill without treatment; therefore, no net destruction of contaminants is achieved. In addition, the magnitude and duration of the excavation, transport, and disposal of 770,200 cubic yards of waste material 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 6.9.

In addition, the already minimal groundwater impacts would be remediated by the elimination of all impacted soil.

6.5.3.2 Standards, Criteria and Guidance

SCGs for the proposed remedy are presented in Section 5.0. Remedial Alternative 1 would achieve compliance with the unrestricted use criteria for soil throughout OU-4, 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. The groundwater remediation resulting from excavation and backfill of OU-4 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 at any depth (estimated to be up to 31 feet below grade in the majority of OU-4 and up to 35 feet below grade in the former Erie-Lackawanna Railroad right-of-way) that was impacted as a result of the historic site use and former refinery/terminal activities or that was impacted by background influences. Remedial Alternative 1 returns OU-4 to conditions that are less contaminated than area background (based upon data available from New York State Department of Health for the Seneca Babcock Street area). Therefore, with regard to the condition OU-4 would be left in following remediation (i.e., all impacted material above the criteria removed from the OU-4), 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-4 would be placed in a regulated facility without treatment; therefore, it is ultimately an offsite containment remedy which 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-4 by removing soil that exceeded the unrestricted use criteria or that was impacted by separate-phase product within OU-4 at any depth (estimated to be up to 31 feet below grade in the majority of OU-4 and up to 35 feet below grade in the former Erie-Lackawanna Railroad right-of-way). However, the soil removed from OU-4 would be placed in a secured 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. Remedial Alternative 1 also permanently eliminates the separate-phase product from OU-4 during excavation, to the extent practicable.

6.5.3.5 Short Term Impacts and Effectiveness

The health and environmental risks associated with implementation of Remedial Alternative 1 are significant. The remedy implementation time (six years) is long (not including the significant time required to remove and replace the two active bulk storage tanks and product pipelines). 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 and 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 6.9.

As previously noted, Remedial Alternative 1 would require removal and replacement of the two active bulk storage tanks and product pipelines. This would have a significantly adverse impact on Buckeye's operations. Moreover, the temporary closure of these facilities would impact numerous other parties by disrupting a major fuel supply line to the region.

Short term impacts to the Buffalo River due to excavation, dewatering, and sediment removal along the riverbank will require the installation of silt curtains, temporary coffer dams, or other similar mitigation measures. Details for these elements will be developed as part of the remedial design to be prepared following submission and NYSDEC approval of this Final AAR.

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-4 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 long implementation duration of approximately six construction seasons (not including the significant time required to remove and replace the two active bulk storage tanks and product pipelines).

Implementation would require the approval of Buckeye. As noted above, the level of excavation activity would render the facilities on OU-4 unusable to Buckeye for significant time periods during the performance of the work. As such, approval would, at best, be difficult to obtain and adversely impact implementability.

6.5.3.7 Cost

The construction and equipment costs associated with implementation of the remedial components of Remedial Alternative 1 are estimated at approximately $153,505,000, the highest of the alternatives under consideration. It should be noted that this cost does not include the significant costs associated with the removal and replacement of the two active bulk storage tanks and product pipelines.

Long term operation and maintenance (O&M) activities associated with Remedial Alternative 1 include inspecting and maintaining the stabilized embankment for 30 years and groundwater sampling for two years. Annual operation and maintenance costs are estimated to be $20,000 per year for the first two years and $10,000 for the remaining years. The present value of O&M for this alternative is estimated at $142,000. Therefore, the total present worth cost of this alternative is $153,647,000.

6.5.3.8 Compatibility with Land Use

Remedial Alternative 1 would allow for unrestricted use of OU-4 (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-4. Remedial Alternative 1 is not compatible with the current use and reasonably anticipated future use of the property by Buckeye because their existing facilities would need to be removed and replaced to implement the remedy, which would significantly adversely impact their business. A provision of restricted access green space in OU-4, which is an important component of the Elk Street Corridor Redevelopment Plan, would be easily incorporated into the remedial design for Remedial Alternative 1.

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

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

6.6.1 Description of Remedial Alternative 2

<u>Soil Remediation</u>

Remedial Alternative 2 is similar to Remedial Alternative 1 except that impacted soil would be excavated as follows:

- to depths up to 15 feet below grade throughout OU-4 to meet the industrial use criteria rather than the unrestricted use criteria;
- to any depth above bedrock (estimated to be up to 20 feet below grade) in certain areas of OU-4 to remove landfill waste; and
- to any depth above bedrock (estimated to be up to 31 feet below grade) in certain areas of OU-4 (not including the former Erie-Lackawanna Railroad right-of-way), and in the area encompassing SB-202 in the former Erie-Lackawanna Railroad right-of-way (estimated to be up to an estimated 35 feet below grade), to remove petroleum impacted soil (including soil similar to that identified by NYSDEC as grossly contaminated in OU-2) and separate-phase product, to the extent practicable.

An environmental easement would be implemented to restrict land use and the use of groundwater and to manage contaminated soils remaining at depth pursuant to a site management plan. Soil exceeding the industrial criteria at depths greater than 15 feet would be left in place since soil below that level meets the criteria presented in Section 5.1 to remain in place. An estimated 509,200 cubic yards of soil would require excavation in order to achieve industrial use criteria to 15 feet below grade, remove all landfill waste, and remove petroleum impacted soil throughout OU-4. It should be noted that removal and replacement of the bulk storage tanks and the product pipelines within OU-4 would be required to excavate beneath these facilities to achieve the Track 2 remedy.

After the completion of Remedial Alternative 2, the migration of separate-phase product from OU-4 to the Buffalo River would cease as a result of the removal of petroleum impacted soil and separate-phase product, to the extent practicable.

Embankment Stabilization

Embankment stabilization for Remedial Alternative 2 would entail a combination of two tier grading, rip rap, and reinforced bioengineering, as described in Section 6.3.1.1 and shown on Figure 11 and Plate 10. Excavated material from the embankment (including petroleum impacted soil and separate-phase product, if any) would be disposed offsite in accordance with applicable regulations. Backfill meeting the Part 375 ecological criteria (Table 20) would be used for re-creation of the embankment to enhance habitat creation.

Implementation of Remedial Alternative 2 would be completed within four construction seasons (not including removal and replacement of the bulk storage tanks and the product pipelines, which would significantly increase the implementation timeframe).

Plate 10 shows the areas to be addressed under Remedial Alternative 2. Estimated costs (not including the considerable costs associated with the removal and replacement of the bulk storage tanks and the product pipelines) for Remedial Alternative 2 are presented in Appendix E.

6.6.2 Preliminary Screening of Remedial Alternative 2

The major benefits of Remedial Alternative 2 are that it:

- removes contamination exceeding the industrial use criteria from OU-4 to 15 feet below grade;
- removes all landfill waste;
- removes petroleum contaminated soil identified based on field observations and ongoing gauging to the extent practicable;
- recovers separate-phase product during excavation activities to the extent practicable; and
- is compatible with reasonably anticipated future land use.

However, the main drawbacks of Remedial Alternative 2 are similar to Remedial Alternative 1 in that it:

- requires a significant volume of material within an existing landfill to be excavated, transported, and placed in limited secure landfill space at another location without treatment and, therefore, constitute 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 of four years (not including removal and replacement of the bulk storage tanks and the product pipelines, which would significantly increase the implementation timeframe), and the amount of heavy equipment operation required;
- would be a major disruption to regional petroleum deliveries and to Buckeye's business to remove and replace the two active bulk storage tanks and product pipelines in order to excavate beneath them to achieve the Track 2 remedy;
- is impractical and not compatible with current and reasonably anticipated future use of the property; and
- is the more difficult to implement than several other alternatives due to significant excavation shoring and dewatering required.

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 21. Remedial Alternative 2 ranks fourth overall out of the four potential alternatives.

Embankment stabilization and the associated creation of green space and natural habitats were not considered in the detailed evaluation because they are structural rather than remedial elements of the remedy, and are common to all remedial 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 similar to Remedial Alternative 1, except that soil exceeding the industrial criteria remains in place below 15 feet resulting in less soil being removed from OU-4 and contained in an offsite landfill.

6.6.3.2 Standards, Criteria and Guidance

The performance of Remedial Alternative 2 is similar to Remedial Alternative 1 relative to this criterion, except that soil exceeding the industrial criteria below 15 feet will remain in place. As required by Part 375, the criteria for backfill are the lower of the commercial criteria for protection of human health or the criteria for protection of groundwater.

6.6.3.3 Long Term Effectiveness and Permanence

The performance of Remedial Alternative 2 is similar to Remedial Alternative 1 relative to this criterion, except soil exceeding the industrial criteria remains in place below 15 feet and results in a lower volume of soil to be removed from OU-4 for placement in a secure landfill without treatment.

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

The performance of Remedial Alternative 2 is similar to Remedial Alternative 1 relative to this criterion, except that soil exceeding the industrial criteria remains in place and results in a lower volume of soil to be removed from OU-4 for placement in a secure landfill without treatment.

6.6.3.5 Short Term Impacts and Effectiveness

The performance of Remedial Alternative 2 is similar to Remedial Alternative 1 relative to this criterion, except that the duration of implementation is shorter due to the lower volume of material to be removed from OU-4 (not including the significant time required to remove and replace and the bulk storage tanks and the product pipelines). Therefore, the potential adverse impacts to the community and workers, though mitigated to the extent practical with engineering controls, would be less than what is anticipated for Remedial Alternative 1 but still significant.

6.6.3.6 Implementability

The performance of Remedial Alternative 2 is similar to Remedial Alternative 1 relative to this criterion. However, the implementation time is shorter due to the lower volume of material to be removed from OU-4 (not including the significant time required to remove and replace the bulk storage tanks and the product pipelines).

6.6.3.7 Cost

The construction and equipment costs associated with implementation of the remedial components of Remedial Alternative 2 are estimated at approximately $111,725,000, the second highest of the alternatives under consideration. It should be noted that this cost does not include the significant costs associated with the removal and replacement of the bulk storage tanks and the product pipelines.

Long term O&M activities associated with Remedial Alternative 2 include inspecting and maintaining the stabilized embankment for 30 years and groundwater sampling for five years. In addition, a certification of the institutional controls is required. Annual operation and maintenance costs are estimated to be $20,000 per year for the first five years and $10,000 for the remaining years. The present value of O&M for this alternative is estimated at $165,000. Therefore, the total present worth cost of this alternative is $111,890,000.

6.6.3.8 Compatibility with Land Use

Remedial Alternative 2 would allow for continued industrial use of OU-4 without the implementation of long term engineering and institutional controls (except for a restriction on the use of groundwater and site use). Remedial Alternative 2 is compatible with the current general industrial zoning and surrounding land use. However, Remedial Alternative 2 is not compatible with the current use of the property by Buckeye because their existing facilities would need to be removed and replaced to implement the remedy, which would significantly adversely impact their business. Remedial Alternative 2 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 specifies OU-4 as a bulk storage area owned and operated by Buckeye that will remain as an "anchor property" surrounded by restricted access green space).

6.7 Evaluation of Remedial Alternative 3: Track 4 Scenario to Industrial Use Criteria via Low Permeability Cap, Slurry Wall/Jet Grouting Groundwater Containment and Embankment Stabilization

The following sections provide a detailed evaluation of Remedial Alternative 3, which would achieve a Track 4 cleanup of OU-4, as described in Section 5.1.

6.7.1 Description of Remedial Alternative 3

This alternative includes implementation of various technologies for remediation of impacted soil, groundwater, and separate-phase product.

Soil Remediation

The proposed soil remediation is to construct the low permeability cap described in Section 6.1.2 and shown on Plate 11.

In addition, as indicated by NYSDEC in their November 13, 2009 and February 24, 2010 comment letters and as acknowledged by Roux Associates, Remedial Engineering, and ExxonMobil in their April 2, 2010 letter, petroleum impacted material outside the slurry wall in OU-4 will be removed or mitigated to the satisfaction of the NYSDEC and consolidated beneath the cap or disposed offsite during construction.

Groundwater Containment

Groundwater containment would be achieved by constructing a slurry wall with some limited jet grouting, as described in Section 6.1.3, around the entire OU-4 except for the part of the former Erie-Lackawanna Railroad south of the access road. Due to constructability issues, that area will be enclosed by the proposed jet grouting/slurry wall for OU-3. A small section of the proposed OU-3 jet grouting or slurry wall (method to be determined during the design), located at the southwestern end of the former Erie-Lackawanna Railroad right-of-way, would be constructed during the implementation of the OU-4 remedy in order to avoid re-disturbing the completed remedy, including the proposed stormwater treatment wetland in the southwestern portion of OU-4 during construction.

The approximate location of the OU-4 slurry wall is shown on Plate 11. Nearly all of the slurry wall would be constructed as a soil-bentonite (SB) wall. However, at locations where the slurry wall cannot be constructed due to crossings under pipe racks and buried pipelines, as indicated on Plate 11, jet grouting would be utilized to construct a water-tight barrier. The slurry wall excavation would be performed using a hydraulic excavator with specialized attachments to reach the desired depths. The width of the slurry wall would be approximately 2.5 feet. The excavation would “key” approximately three feet into the low permeability clay that underlies the Site. The depth of the slurry wall would range between 35 and 40 feet around the majority of OU-4. The depth of the slurry wall/jet grouting in the former Erie-Lackawanna Railroad right-of-way would be approximately 49 feet below grade.

Excavated soil that is determined to be suitable for use as backfill would be placed on the work platform adjacent to the trench or relocated to a remote mixing area when sufficient space is not available adjacent to the trench. A bulldozer would track and blade the material to produce soil-bentonite backfill, which has a consistency of wet concrete. Excavated soil that is not considered suitable for use as backfill, including construction debris, stones larger than three inches and, potentially, soils with insufficient fines content or saturated with separate-phase product, would be stockpiled separately within OU-4 for consolidation beneath the low permeability cap.

Embankment Stabilization

Embankment stabilization for Remedial Alternative 3 would entail a combination of two tier grading, rip rap, and reinforced bioengineering, as described in Section 6.3.1.1 and shown on Figure 11 and Plate 11. Excavated material removed from the embankment would be stockpiled separately within OU-4 for consolidation beneath the low permeability cap. Backfill meeting the Part 375 ecological criteria (Table 20) would be used for re-creation of the embankment to enhance habitat creation.

Permeable Reactive Barrier

The slurry wall implementation will provide containment of residual product, if any, within OU-4. Additionally, as indicated by NYSDEC in their November 13, 2009 and February 24, 2010 comment letters and as acknowledged by Roux Associates, Remedial Engineering, and ExxonMobil in their April 2, 2010 letter, petroleum impacted material outside the slurry wall will be removed or mitigated to the satisfaction of the NYSDEC and consolidated beneath the cap or disposed offsite during construction. The PRB described in Section 6.1.5 and shown on Plate 11 will provide additional treatment of residual petroleum impacts, if any, remaining outside the slurry wall from impacting the Buffalo River. The PRB would be located underneath the rip rap across the entire OU-4 embankment. The RCM would be laid from 565 to 576 ft amsl to maintain protection from typical low-water to high-water elevations. An 8-inch layer of sand would be placed between the RCM and the non-woven geotextile located beneath the rip rap to protect the RCM from angular protrusions.

Implementation of the bulk of the work for Remedial Alternative 3 would be completed within two construction seasons. However, some tasks may potentially extend into a third construction season, if necessary.

Plate 11 shows the areas to be addressed under Remedial Alternative 3. Estimated costs for Remedial Alternative 3 are presented in Appendix E.

6.7.2 Preliminary Screening of Remedial Alternative 3

The major benefits of Remedial Alternative 3 are that it:

- provides for protection of the public health and the environment based upon the current and reasonably foreseeable future Site use;
- removes or mitigates petroleum impacted material outside the slurry wall;
- results in minimal short term impacts that can be addressed through engineering controls;
- reduces/eliminates infiltration of stormwater through impacted material that has the potential to cause leaching of contaminants into the groundwater;
- does not require disruption to regional petroleum deliveries due to the removal and replacement of the active bulk storage tanks and/or product pipelines;
- provides a passive means of groundwater containment (slurry wall) that does not require the use of mechanical energy for operation (thus providing a more sustainable option for groundwater containment); and
- is compatible with reasonably anticipated future land use.

However, the main drawbacks of Remedial Alternative 3 are that it:

- is complex to implement due to the slurry wall;

- may impact Buckeye's operations during construction of the slurry wall; and
- is an onsite containment remedy, which allows impacted material to remain in place inside the slurry wall without treatment.

6.7.3 Detailed Evaluation of Remedial Alternative 3

The following sections provide a detailed evaluation of Remedial Alternative 3 based on eight of the nine specific evaluation criteria from Part 375 described in Section 6.2. The ninth criterion, community acceptance, cannot be fully evaluated until the public comment period is completed. The ranking of Remedial Alternative 3 relative to the evaluation criteria presented in Section 6.2 is shown on Table 21. Remedial Alternative 3 ranks first overall out of the four potential alternatives.

Embankment stabilization and the associated creation of green space and natural habitats were not considered in the detailed evaluation because they are structural, rather than remedial elements of the remedy, and are common to all remedial alternatives.

6.7.3.1 Overall Protection of Human Health and the Environment

Remedial Alternative 3 would provide protection of human health and the environment by isolating impacted material below a low permeability cap, thus preventing direct contact and minimizing/eliminating the potential for stormwater to infiltrate through impacted soil and further degrade groundwater quality. It also addresses groundwater impacts and potential discharge of impacted groundwater and/or separate-phase product to the Buffalo River through containment via the proposed slurry wall and removal or mitigation of petroleum impacted material outside the slurry wall.

6.7.3.2 Standards, Criteria and Guidance

Remedial Alternative 3 would achieve compliance with the industrial use criteria in the top one foot of soil throughout OU-4 by capping with clean material. However, impacted material would be left in place below the cap. Potential discharge of impacted groundwater to the Buffalo River would be addressed through containment by the proposed slurry wall and removal or mitigation of petroleum impacted material outside the slurry wall.

6.7.3.3 Long Term Effectiveness and Permanence

Remedial Alternative 3 provides permanent public health and environmental protection by eliminating potential for contact with impacted environmental media. Annual O&M would be implemented to ensure that engineering controls (cap, slurry wall, PRB, and Site perimeter fence) are properly maintained and institutional controls will ensure that land use remains compatible with the remedy. In the event of long term changes in land use, any breach of the cap or new construction would require evaluation and potential implementation of additional remedial measures (i.e., cap reconstruction, disposal of contaminated soil for building construction, soil vapor intrusion mitigation, etc.) in accordance with a SMP.

Remedial Alternative 3 will permanently alter the groundwater flow regime in the immediate vicinity of OU-4. Groundwater currently flows southeast across OU-4 toward the Buffalo River. Construction of the slurry wall would alter this natural flow pattern and cause groundwater flow to divert around OU-4 prior to discharge to the Buffalo River. Depending upon sequencing of the remedial actions in other operable units, groundwater may be diverted from OU-3 (prior to construction of the proposed slurry wall around OU-3) towards the south to be captured by the WPS and from OU-2 (prior to construction of the proposed phytotechnology plantings) to go around either the south side of OU-4 (from the southeastern portion of OU-3) to be captured by the WPS, or around the north side of the OU-4 (from the northeastern portion of OU-3). This new groundwater flow pattern is not a concern since groundwater in the eastern portion of OU-2 has been demonstrated to have none to very minimal impacts, and since groundwater from OU-3 (prior to slurry wall containment) would be captured by the WPS. Following remediation in OU-2, groundwater will be contained by the proposed phytotechnology plantings and groundwater from OU-3 will be contained by the proposed slurry wall.

Once the low permeability cap and slurry wall have been constructed and petroleum impacted material outside the slurry wall has been removed or mitigated to the satisfaction of the NYSDEC, the separate-phase product remaining within OU-4 will be permanently contained, thus eliminating, to the extent practical, ongoing impact to groundwater. Based on these reasons, the PRB is not required, but will be provided as an additional protective measure.

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

Remedial Alternative 3 reduces the mobility of contamination by capping to reduce the potential for infiltration of stormwater through impacted material that could further degrade groundwater quality. Remedial Alternative 3 further reduces the mobility of groundwater and separate-phase product through implementation of the slurry wall, and removal or mitigation of petroleum impacted material outside the slurry wall, which will be consolidated beneath the cap or disposed offsite. Based on this remedial strategy, the PRB is not necessary, however, it will be provided as an additional protective measure.

6.7.3.5 Short Term Impacts and Effectiveness

The health and environmental risks associated with implementation of Remedial Alternative 3 are minimal. The remedy implementation time is relatively short (two construction seasons for the bulk of the work with some tasks potentially extending into a third construction season, if necessary) 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 and stone transportation 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 capping and embankment stabilization phases. The potential impacts with respect to greenhouse gas emissions are discussed in Section 6.9.

Short term impacts to the Buffalo River due to excavation and sediment removal along the riverbank will require the installation of silt curtains, temporary coffer dams, or other similar mitigation measures. Details for these elements will be developed as part of the remedial design to be prepared following submission and NYSDEC approval of this Final AAR.

6.7.3.6 Implementability

The materials, equipment, and personnel associated with the implementation of Remedial Alternative 3 are commercially available and have been proven effective and reliable for remediation of the media of concern at OU-4 under similar circumstances. This alternative also has a relatively short construction implementation timeframe of two construction seasons for the bulk of the work, with some tasks potentially extending into a third construction season, if necessary.

6.7.3.7 Cost

The construction and equipment costs associated with implementation of the remedial components of Remedial Alternative 3 are estimated at approximately $8,702,000, which is the lowest cost of all other alternatives under consideration. Long term O&M activities associated with Remedial Alternative 3 include inspecting and maintaining the engineering controls (low permeability cap, stabilized embankment, slurry wall, PRB, and Site perimeter fence) for 30 years and groundwater sampling for ten years. In addition, a certification of the institutional and engineering controls is required. Annual operation and maintenance costs are estimated to be $50,000 per year for the first ten years and $35,000 for the remaining years. The present value of O&M for this alternative is estimated at $540,000. Therefore, the total present worth cost of this alternative is $9,242,000.

6.7.3.8 Compatibility with Land Use

Remedial Alternative 3 would allow for industrial use of OU-4 with the implementation of long term engineering and institutional controls. Remedial Alternative 3 is compatible with the current general industrial zoning and surrounding land use and with the results of the Elk Street Corridor Redevelopment Plan (which specifies OU-4 as a bulk storage area owned and operated by Buckeye that will remain as an “anchor property” surrounded by restricted access green space). Remedial Alternative 3 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). Remedial Alternative 3 is less disruptive to the active operations of Buckeye than Remedial Alternatives 1 and 2.

6.8 Evaluation of Remedial Alternative 4: Track 4 Scenario to Industrial Use Criteria via Low Permeability Cap, Sheet Pile Wall/Jet Grouting Groundwater Containment and Embankment Stabilization

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

6.8.1 Description of Remedial Alternative 4

This alternative includes implementation of various technologies for remediation of impacted soil, groundwater, and separate-phase product.

Soil Remediation

The proposed soil remediation is to construct the low permeability cap described in Section 6.1.2 and shown on Plate 12.

In addition, as indicated by NYSDEC in their November 13, 2009 and February 24, 2010 comment letters and as acknowledged by Roux Associates, Remedial Engineering, and ExxonMobil in their April 2, 2010 letter, petroleum impacted fill, soil and/or sediment outside the sheet pile wall/jet grouting in OU-4 will be removed or mitigated to the satisfaction of the NYSDEC and consolidated beneath the cap or disposed offsite during construction.

Groundwater Containment

Groundwater containment would be achieved by constructing a sheet pile wall and limited jet grouting, as described in Section 6.1.4, around the entire OU-4 except for the part of the former Erie-Lackawanna Railroad south of the access road. Due to constructability issues, that area will be enclosed by the proposed jet grouting/slurry wall for OU-3. A small section of the proposed OU-3 jet grouting or slurry wall (method to be determined during the design), located at the southwestern end of the former Erie-Lackawanna Railroad right-of-way, would be constructed during the implementation of the OU-4 remedy in order to avoid re-disturbing the completed remedy, including the proposed stormwater treatment wetland in the southwestern portion of OU-4 during construction.

The approximate location of the sheet pile wall is shown on Plate 12. The sheet pile wall would be constructed by using standard installation techniques and equipment to drive steel sheeting into the subsurface, then sealing the joints to make the sheet pile wall watertight. At locations where the sheet pile wall cannot be constructed due to crossings under pipe racks and buried pipelines, as indicated on Plate 12, jet grouting would be utilized to construct a water-tight barrier. The steel sheeting would "key" approximately three to five feet into the low permeability clay that underlies the Site. The depth of the sheet pile wall would range between

35 and 40 feet around the majority of OU-4. The depth of the jet grouting/slurry wall in the former Erie-Lackawanna Railroad right-of-way would be approximately 49 feet below grade.

Installation of a sheet pile wall would minimize the volume of soil that would need to be excavated. Only materials that obstruct the steel sheeting from being driven into the subsurface (e.g., boulders) would be removed and consolidated under the cap.

Embankment Stabilization

Embankment stabilization for Remedial Alternative 4 would entail a combination of two tier grading, rip rap, and reinforced bioengineering, as described in Section 6.3.1.1 and shown on Figure 11 and Plate 12. Excavated material removed from the embankment would be stockpiled separately within OU-4 for consolidation beneath the low permeability cap. Backfill meeting the Part 375 ecological criteria (Table 20) would be used for re-creation of the embankment to enhance habitat creation.

Permeable Reactive Barrier

The proposed PRB is described in Section 6.7.1 and shown on Plate 12.

Implementation of the bulk of the work for Remedial Alternative 4 would be completed within two construction seasons. However, some tasks may potentially extend into a third construction season, if necessary.

Plate 12 shows the areas to be addressed under Remedial Alternative 4. Estimated costs for Remedial Alternative 4 are presented in Appendix E.

6.8.2 Preliminary Screening of Remedial Alternative 4

The major benefits of Remedial Alternative 4 are that it:

- provides for protection of the public health and the environment based upon the current and reasonably foreseeable future Site use;
- removes or mitigates petroleum impacted material outside the sheet pile wall;
- results in minimal short term impacts that can be addressed through engineering controls;

- reduces/eliminates infiltration of stormwater through impacted material that has the potential to cause leaching of contaminants into the groundwater;
- does not require disruption to regional petroleum deliveries due to the removal and replacement of the active bulk storage tanks and/or product pipelines;
- provides a passive means of groundwater containment (sheet pile wall) that does not require the use of mechanical energy for operation (thus providing a more sustainable option for groundwater containment); and
- is compatible with reasonably anticipated future land use.

However, the main drawbacks of Remedial Alternative 4 are that it:

- is complex to implement due to the sheet pile wall;
- is more costly to install the sheet pile wall than the slurry wall;
- may impact Buckeye's operations during construction of the sheet pile wall;
- is an onsite containment remedy, which allows impacted material to remain in place inside the sheet pile wall without treatment.

6.8.3 Detailed Evaluation of Remedial Alternative 4

The following sections provide a detailed evaluation of Remedial Alternative 4 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 4 relative to the evaluation criteria presented in Section 6.2 is shown on Table 21. Remedial Alternative 4 ranks second overall out of the four potential alternatives.

Embankment stabilization and the associated creation of green space and natural habitats were not considered in the detailed evaluation because they are structural rather than remedial elements of the remedy and are common to all remedial alternatives.

6.8.3.1 Overall Protection of Human Health and the Environment

The level of protection of human health and the environment for Remedial Alternative 4 is similar to Remedial Alternative 3 since the two alternatives differ only in the use of a sheet pile wall versus a slurry wall, both of which are similarly effective at groundwater containment.

6.8.3.2 Standards, Criteria and Guidance

The performance of Remedial Alternative 4 is similar to Remedial Alternative 3 relative to this criterion since the two alternatives differ only in the use of a sheet pile wall versus a slurry wall, both of which are similarly effective at groundwater containment.

6.8.3.3 Long Term Effectiveness and Permanence

The performance of Remedial Alternative 4 is similar to Remedial Alternative 3 relative to this criterion since the two alternatives differ only in the use of a sheet pile wall versus a slurry wall, both of which have similar levels of long term effectiveness and permanence. The impact on the groundwater flow regime is also similar to Remedial Alternative 3.

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

The performance of Remedial Alternative 4 is similar to Remedial Alternative 3 relative to this criterion since the two alternatives differ only in the use of a sheet pile wall versus a slurry wall, both of which are similarly effective at groundwater containment.

6.8.3.5 Short Term Impacts and Effectiveness

The performance of Remedial Alternative 4 is similar to Remedial Alternative 3 relative to this criterion since the remedy implementation time is relatively short (two construction seasons for the bulk of the work with some tasks potentially extending into a third season), and the potential adverse impacts to the community and workers can be mitigated with engineering controls. The potential impacts with respect to greenhouse gas emissions are discussed in Section 6.9.

6.8.3.6 Implementability

The performance of Remedial Alternative 4 is similar to Remedial Alternative 3 relative to this criterion. This alternative also has a relatively short construction implementation timeframe of two construction seasons for the bulk of the work with some tasks potentially extending into a third season.

6.8.3.7 Cost

The construction and equipment costs associated with implementation of the remedial components of Remedial Alternative 4 are estimated at approximately $11,325,000, which is the second lowest cost of all other alternatives under consideration. Long term O&M activities associated with Remedial Alternative 4 include inspecting and maintaining the engineering controls (low permeability cap, stabilized embankment, sheet pile wall, PRB, and Site perimeter fence) for 30 years and groundwater sampling for ten years. In addition, a certification of the institutional and engineering controls is required. Annual operation and maintenance costs are estimated to be $50,000 per year for the first ten years and $35,000 for the remaining years. The present value of O&M for this alternative is estimated at $540,000. Therefore, the total present worth cost of this alternative is $11,865,000.

6.8.3.8 Compatibility with Land Use

Remedial Alternative 4 would allow for industrial use of OU-4 with the implementation of long term engineering and institutional controls. Remedial Alternative 4 is compatible with the current general industrial zoning and surrounding land use and with the results of the Elk Street Corridor Redevelopment Plan (which specifies OU-4 as a bulk storage area owned and operated by Buckeye that will remain as an “anchor property” surrounded by restricted access green space). Remedial Alternative 4 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). Remedial Alternative 4 is less disruptive to the active operations of Buckeye than Remedial Alternatives 1 and 2, and similarly disruptive as Remedial Alternative 3.

6.9 Summary of Alternatives Evaluation

Table 21 summarizes the ranking of each alternative relative to the eight of the nine evaluation criteria (with the exception of community acceptance). 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 21.

<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. Remedial Alternatives 3 and 4 were ranked equally and slightly better than Remedial Alternatives 1 and 2. While Remedial Alternative 1 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 3 and 4 provide a remediation approach that is fully protective based upon the anticipated future uses of OU-4. 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 3 and 4. 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.

Standards, Criteria and Guidance: 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 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-4 generally complies with AWQSGVs and exceedances are detected only in localized areas. Remedial Alternative 2 removes less soil than Remedial Alternative 1 and thus was ranked lower. Remedial Alternatives 3 and 4 were ranked slightly lower than Remedial Alternative 2 because they achieve compliance with numerical soil standards within the top one foot of soil and rely upon capping and institutional controls. In addition, SCGs for groundwater may not be met inside the slurry wall (or sheet pile wall) in the vicinity of the historic separate-phase product plume since continuing sources of groundwater impact will be left in place following remediation (separate-phase product and impacted soil). Removal and consolidation of petroleum impacted material outside the slurry wall (or sheet pile wall) beneath the cap or disposed offsite will eliminate, to the extent practical, ongoing impact to groundwater. Though not necessary due to the planned removal of petroleum impacts outside the slurry wall, the PRB will be provided as an additional protective measure.

Long term Effectiveness and Permanence: Remedial Alternative 1 was ranked the highest based upon its complete removal of contaminants down to a depth of 31 feet in the majority of OU-4 (and up to 35 feet below grade in the former Erie-Lackawanna Railroad right-of-way). Remedial Alternatives 3 and 4 can serve as effective, permanent remedies; however, they are ranked lower than Remedial Alternatives 1 and 2 because they will require the greatest long term commitment with respect to management of residual onsite contamination.

Reduction of Toxicity, Mobility, or Volume Through Treatment: 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 Alternatives 3 and 4 use varying engineering controls to reduce mobility and eliminate exposure pathways and, thus, were ranked slightly higher. Though not required, due to the removal of petroleum impacted material outside the slurry wall/sheet pile wall, the PRB was included in Remedial Alternatives 3 and 4 as an additional protective measure.

Short Term Impacts and Effectiveness: Remedial Alternatives 1 and 2 would have the greatest short term impacts and take the longest amount of time to implement. 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, and global greenhouse gas.

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, pile driving, slurry wall installation (Remedial Alternative 3 only) and fill onsite, and electricity to run pumps for dewatering (Remedial Alternatives 1 and 2 only) to complete the remediation project. The analysis specifically focused on the emissions associated with:

- excavators;
- loaders;
- pile drivers (i.e., crane);

- 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.
- Cranes were assumed to be similar to the Link-Belt H5/HSL series with similar fuel efficiency.
- Eighteen 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.
- Thirty yard dump trucks were assumed to drive 60 miles roundtrip for each disposal trip (Remedial Alternatives 1 and 2), or 0.3 miles roundtrip to transport material for consolidation underneath the low permeability cap (Remedial Alternatives 3 and 4), 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 (mpg).
- 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.

As summarized below, the climate impact analysis indicates Remedial Alternative 3 to have the lowest GHG emissions followed by Remedial Alternatives 4 and 2. Remedial Alternative 1 was

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

calculated to have the largest GHG emissions footprint. The climate impact model developed to calculate the GHG emissions of each remedial alternative is provided as Appendix F.

Remedial Alternative	**Greenhouse Gas Emissions** (metric tons of CO_2)
Alternative 1	14,674
Alternative 2	9,942
Alternative 3	1,988
Alternative 4	2,082

The differences in GHG emissions are primarily due to variances in the amount of excavation, backfill, and the quantity of steel sheeting for excavation shoring required to implement the alternative. In Remedial Alternative 1, approximately 770,200 cubic yards of soil would require excavation, which is significantly greater than the estimated 509,200 cubic yards of soil that would require excavation in Remedial Alternative 2. Both of these volumes are significantly greater than the estimated 28,610 cubic yards of sediment and soil that would be removed in order to stabilize the embankment in Remedial Alternatives 3 and 4. Similarly, the amount of backfill in Remedial Alternative 1 (approximately 744,800 cubic yards) is significantly greater than the amount of backfill in Remedial Alternative 2 (approximately 502,200 cubic yards), both of which are significantly greater than the amount of backfill in Remedial Alternatives 3 and 4 (approximately 30,110 cubic yards). The difference in GHG emissions between Remedial Alternatives 3 and 4 is due to the pile driving equipment required to install the steel sheeting for the perimeter sheet pile wall in Remedial Alternative 4.

Moreover, Remedial Alternatives 1 and 2 could not be implemented without causing the shutdown and reconstruction of the tank farm and buried pipelines, which would be a major impact to Buckeye's business and to a significant local fuel supply to the region. These impacts would continue through six construction seasons (Remedial Alternative 1) or four construction seasons (Remedial Alternative 2) and are much greater than those associated with Remedial Alternatives 3 and 4.

<u>Implementabilty</u>: 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-4 under similar circumstances at other sites. However, Remedial Alternative 1 and Remedial Alternative 2 are the most difficult to implement due to significant excavation, shoring, dewatering, and product recovery required. In addition, while implementation of all alternatives would require the approval of Buckeye, Remedial Alternatives 1 and 2 would render OU-4 unusable to Buckeye for significant time periods during the performance of the work. As such, approval by Buckeye would be difficult to obtain and adversely impact implementability.

In all of the alternatives, implementation of embankment stabilization measures would require review by the USACE.

Cost: Remedial Alternatives 1 and 2 are the most expensive alternatives at $153,647,000 and $111,890,000, respectively, due to the large volume of soil requiring excavation and disposal. Remedial Alternatives 3 and 4 are significantly less expensive at $9,242,000 and $11,865,000, respectively.

Land Use: Remedial Alternative 1 would allow for unrestricted use of OU-4 (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-4. For industrial use, engineering controls would need to be implemented for Remedial Alternatives 3 and 4, while institutional controls would need to be implemented for Remedial Alternatives 2 through 4. Remedial Alternatives 2 through 4 are compatible with the current general industrial zoning and surrounding land use and the results of the Elk Street Corridor Redevelopment Plan (which specifies OU-4 as a bulk storage area owned and operated by Buckeye that will remain as an "anchor property" surrounded by restricted access green space), and 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). However, Remedial Alternatives 1 and 2 are not compatible with the current use of the property by Buckeye because their existing facilities would need to be removed and replaced to implement the remedy, which would significantly disrupt their business.

6.10 Identification of Selected Remedy for OU-4

Remedial Alternative 3, a low permeability cap (lined soil or lined gravel), slurry wall, removal of petroleum impacted material from outside the slurry wall to the satisfaction of the NYSDEC and consolidation under the proposed cap or offsite disposal, PRB (as an additional protective measure, though not required), and two tier embankment stabilization with emergent vegetation at the toe of the embankment is the selected remedy for OU-4.

Remedial Alternative 3 was selected for implementation in OU-4 since it adequately meets each of the evaluation criteria but costs significantly less than excavation and offsite disposal remedies (Remedial Alternatives 1 and 2). In addition, it is the lowest cost of all other alternatives under consideration and has the benefit of providing a sustainable solution for long term groundwater containment via a passive groundwater containment (slurry wall), which does not require mechanical energy for operation.

In summary, the selected alternative:

- is protective of public health and the environment through low permeability capping, groundwater containment via the slurry wall, removal of petroleum impacted material from outside the slurry wall and consolidation under the proposed cap or offsite disposal, and maintenance of engineering and institutional controls;
- complies with the industrial use criteria for soil and the SCGs for groundwater outside the slurry wall
- provides long term effectiveness and permanence through capping, groundwater containment via the slurry wall, removal of petroleum impacted material from outside the slurry wall and consolidation under the proposed cap or offsite disposal, and the implementation and maintenance of engineering and institutional controls;
- reduces the toxicity, mobility, or volume of impacted material by capping to reduce the potential for infiltration of storm water through impacted material that could further degrade groundwater quality, by removal of petroleum impacted material from outside the slurry wall and consolidation under the proposed cap or offsite disposal, and by groundwater containment to reduce the mobility of contaminants in groundwater;
- provides short term effectiveness, including minimal impacts to workers or the surrounding neighborhood through the implementation of engineering controls during construction;
- is readily implemented;
- is the least costly of the remedial alternatives; and
- is compatible with current and reasonably anticipated land use.

The selected remedy is consistent with the approach for a Track 4 cleanup to industrial use criteria described in the Draft BCP Guide and Part 375.

7.0 DETAILED DESCRIPTION OF THE SELECTED REMEDY

Remedial Alternative 3 will provide a comprehensive and final remedy for OU-4. Implementation of the selected remedy will include the following elements:

- mobilization and site preparation;
- implementation of Site Control Measures During Construction;
- removal of petroleum impacted material outside of the slurry wall to the satisfaction of the NYSDEC and consolidation beneath the cap or offsite disposal;
- installation of a PRB as an additional protective measure;
- stabilization of Buffalo River embankment;
- construction of a low permeability cap;
- construction of a slurry wall;
- offsite disposal and equipment decontamination;
- modifications of stormwater management system;
- 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 Mobilization and Site Preparation

Mobilization will occur following 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-4 remediation area. A pre-construction survey will also be prepared by a land surveyor licensed by the State of New York.

7.2 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.

7.2.1 Stormwater Management and Erosion Controls

All necessary measures to temporarily control erosion will be employed. Since OU-4 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 to define appropriate 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. 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., silt fences, etc.) will be used to protect active stormwater drain (if any) 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.

Specific details will be developed to satisfy USACE requirements for stormwater and erosion controls associated with the embankment stabilization work in the Buffalo River.

7.2.2 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.

7.2.3 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 measures, as directed or as otherwise necessary, to minimize the levels of particulates at the limits of the work.

7.2.4 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 13.

7.3 Removal of Petroleum Impacted Material Outside the Slurry Wall

As described in Section 6.7.1, petroleum impacted material outside the slurry wall in OU-4 will be removed or mitigated to the satisfaction of the NYSDEC and consolidated beneath the cap or disposed offsite during construction. The quantity of material is currently unknown and will be determined during implementation. Grading plans to be developed during the design phase will account for some material consolidation beneath the cap, and excess material will be disposed offsite.

7.4 Permeable Reactive Barrier Installation

The proposed PRB is described in Sections 6.1.5 and 6.7.1 and shown on Plate 11.

7.5 Buffalo River Embankment Stabilization

The proposed embankment stabilization is described in Section 6.3.1.1 and shown on Plate 11.

7.6 Low Permeability Cap Construction

The two low permeability cap scenarios that may be constructed are described in Sections 6.1.2 and 6.7.1 and shown on Plate 11.

7.7 Slurry Wall Construction

The proposed slurry wall is described in Sections 6.1.3 and 6.7.1 and shown on Plate 11.

7.8 Offsite Disposal and Equipment Decontamination

Any 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:

- personal protective equipment (PPE); and
- decontamination water, if any is generated.

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. Offsite disposal of soil is not anticipated during the implementation of the remedy. However, if it becomes necessary, the soil 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.

7.9 Stormwater Management System Modifications

The proposed stormwater management system modifications are described in Section 6.3.2.

7.10 Installation of New Monitoring Wells

ExxonMobil will attempt to protect and maintain selected existing monitoring wells in OU-4 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.

7.11 Operation and Maintenance and Performance Monitoring

The Operation, Maintenance and Monitoring (OM&M) Plan for OU-4 will be incorporated into the SMP for the Site. The OM&M Plan will describe the OM&M activities to be performed to document the attainment of remedial objectives for OU-4.

7.11.1 Operation and Maintenance of the Low Permeability Cap

Inspections of the low permeability cap and the stabilized embankment will be completed to verify cover integrity and stability. Any recommendations resulting from the inspections, such as need for repair will be promptly implemented.

Details of how the field inspections will be conducted and documented will be provided in the SMP.

7.11.2 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 groundwater and stormwater is described below. A formal sampling plan for these components will be submitted with the SMP.

7.11.2.1 Performance Monitoring for Groundwater

As part of the selected Track 4 remedy, restrictions will be placed on groundwater use across OU-4. However, the slurry wall will control groundwater migration and, in conjunction with the additional protection provided by the PRB (though not necessary due to the removal of petroleum impacted material outside the slurry wall), mitigate discharge to the Buffalo River.

The effect of the slurry wall on groundwater flow, and the slurry wall and PRB on groundwater quality, will be documented through monitoring of water levels and groundwater quality between the slurry wall and the Buffalo River and the visual monitoring of water quality conditions along the shoreline of OU-4. A sampling and analysis plan to document the performance of the remedy will be submitted as part of the SMP. All necessary measures to maintain containment and prevent migration of contaminants out of the slurry wall will be implemented.

7.11.2.2 Performance Monitoring for Stormwater

Performance monitoring for the stormwater management system for OU-4 will include sampling and analysis of discharged water in accordance with the SPDES permit.

7.12 Site Management Plan

Following the remedy completion, constituents at depths greater than one foot below land surface would remain onsite at concentrations in excess of the industrial use criteria and/or petroleum impacted soil. 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.

<u>Soil Management Plan</u>

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-4 soils exceeding the industrial use criteria at depths greater than one foot 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
- a description of the proper procedures for repairing the cap.

The SoMP will provide requirements for the analytical testing of soil in remediated areas (i.e., areas beneath the cap) 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 residual contamination will remain within OU-4 beneath the low permeability cap, 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-4 would be restricted to industrial and restricted access green space uses) and the use of groundwater;
- a description of the engineering controls, including the low permeability cap, the slurry wall, the PRB, and the Site perimeter fence; 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-4 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-4 to industrial and restricted access green space uses;
- identify areas of residual contamination remaining onsite that would be managed in place (e.g., potential soil with concentrations in excess of industrial use criteria at depths greater than one foot below grade or petroleum impacted soil);
- identify areas where the low permeability cap is to be maintained or restored in the event of intrusive work;
- restrict the use of groundwater as a source of potable water; and

- require an annual certification (by a 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-4 would need to be performed in accordance with NYSDEC regulations. Any future modifications to OU-4 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 (i.e., low permeability cap, slurry wall, PRB, and Site perimeter fence). This would include any inspection and maintenance of the low permeability cap, groundwater monitoring to verify performance of the slurry wall and the PRB, and inspection of the perimeter fence around OU-4. Groundwater monitoring will continue in OU-4. As discussed above, ExxonMobil will attempt to protect and retain selected existing wells in OU-4 after construction and/or install new wells to be used for long term monitoring.

8.0 DESIGN DOCUMENTS

Following approval of the Final AAR, a detailed remedial design will be prepared and submitted to the NYSDEC. The NYSDEC stated in their November 13, 2009 comments letter that a Remedial Action Work Plan is not required.

9.0 FINAL CONSTRUCTION CERTIFICATION REPORT AND SITE MANAGEMENT PLAN

A Final Construction Certification Report (FCCR) for OU-4 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 and will include:

- a description of activities completed pursuant to the approved remedial work plan or remedial design;
- site boundaries;
- a description of any institutional controls that will be used, including mechanisms to implement, maintain, monitor, and enforce such controls;
- any changes or modifications to the work, as well as any problems encountered during construction and their resolution, will be documented;
- a list of all remediation standards applied; and
- a description of engineering and institutional controls.

The SMP, as described in Section 7.11, will be submitted concurrently with the FCCR.

The FCCR will also include a certification by a New York State Professional Engineer that:

- such party is, and at all pertinent times hereinafter mentioned was, a currently registered Professional Engineer in the State of New York;
- such party is the individual who had primary direct responsibility for the implementation of the subject remedial program;
- all requirements of the remedial program have been complied with;
- the data demonstrates that remediation requirements have been or will be achieved in accordance with timeframes contained in the approved remedial program;

- all activities described in the FCCR have been performed in accordance with the remedial program and any subsequent changes as agreed to and approved by the NYSDEC; and
- once the remediation of all Operable Units is completed, any use restrictions, institutional and/or engineering controls, and/or any SMP requirements will be contained in a duly recorded environmental easement and that every municipality in which the Site is located has been notified of the environmental easement.

10.0 OPERATION, MAINTENANCE AND MONITORING

The RAOs for OU-4 will be met upon completion of the proposed remedy. However, since the selected remedy relies on institutional controls (environmental easement) and engineering controls (low permeability cap, slurry wall for groundwater containment), 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-4. 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 that will be maintained. Engineering controls that will be implemented as part of the remedy include the use of a low permeability cap to prevent direct contact with impacted soil and to reduce infiltration through impacted soil, and a slurry wall to contain groundwater. 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 Citizen Participation Plan (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;
- forty-five day comment period on the Final AAR;
- 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." However, in their letter dated February 24, 2010, the NYSDEC indicated that they anticipate holding a public meeting during the comment period on the Final AAR.

13.0 SCHEDULE

Construction in OU-4 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 Final AAR and the remedy selected herein, a schedule for design and implementation is provided as Figure 14. After the submission of the Final AAR, the remedial design documents would be provided to the NYSDEC in accordance with the schedule in Figure 14.

A 45 day NYSDEC review period was assumed for the Final AAR and remedial design documents. Completion of the construction phase is estimated to take two construction seasons, with some tasks potentially extending into a third season. The FCCR will be submitted within 120 days after the construction is complete.

Respectfully submitted,

ROUX ASSOCIATES, INC.

Wai Kwan, Ph.D.
Senior Engineer

Andrew Baris
Vice President/
Principal Hydrogeologist

REMEDIAL ENGINEERING, P.C.

Noelle M. Clarke, P.E.
Principal Engineer