US Army Corps
of Engineers ®
Pittsburgh District

DRAFT

Detailed Project Report and
Integrated Environmental Assessment

North Shore Riverfront Ecosystem Restoration Project
Pittsburgh, Pennsylvania

Conducted Pursuant to WRDA 1996, Section 206

May 2016

Executive Summary

A Detailed Project Report (DPR) and Integrated Environmental Assessment (EA) were developed for the North Shore Riverfront Ecosystem Restoration Project in Pittsburgh, Pennsylvania to describe the planning process undertaken to formulate and evaluate alternatives for aquatic and floodplain ecosystem restoration activities within the project area.

The project area is located along the North Shore of the Ohio River at its headwaters. This area is highly urbanized, has a history of industrial usage followed by commercial development, and is heavily utilized for recreation activities including biking, jogging, kayaking, recreational boating, fishing, and other related uses. Natural floodplain features, such as riparian forest, wetlands, side channels, backwaters and riparian shelf habitats, are highly limited and in some places almost completely absent in this location. The Ohio River has been altered to provide conditions suitable for navigation which has contributed to the loss of these floodplain features as well as degradation of aquatic habitat in the project area. Along with bank protection and stabilization, this has contributed to a lack of floodplain connectivity and natural floodplain functions.

Bird's Eye View of the Project Area (prior to Casino Development)

In addition to the No Action plan, three alternatives were analyzed to determine the cost, benefits, and potential environmental effects of ecosystem restoration within the project area. Habitat benefits were modeled and the cost effectiveness of each plan and management measure was assessed. The Recommended Plan (Alternative 4) would restore approximately 7.3 acres of aquatic and floodplain habitat by restoring a floodplain wetland, improving aquatic habitat through the placement of aquatic substrate and habitat features, removing invasive species, re-grading existing high riverbanks to more natural banks that will restore a portion of the riparian corridor, and construction of compatible recreation features including interpretive signs and soft trails. Based on October 2015 price levels, the estimated project first cost is $10,266,000 which includes monitoring and adaptive management costs of $376,000 (including cost contingencies). The Federal share of the project first cost is estimated to be $6,672,900 and the non-Federal share is estimated to be $3,593,100 which equates to 65% Federal and 35% non-Federal. The Fully Funded cost escalated to the midpoint of construction is estimated to be $10,798,000. The estimated total federal cost of the project (including feasibility costs) is $7,248,000). The annualized costs over the period of project performance (50 years) are estimated at $424,054. The AAHUs estimated for this project are 2.54 over this same period yielding a cost/AAHU of $166,950.

There are no Significant Impacts anticipated as a result of implementing the recommended plan. However, some contingency measures have been put in place to address the potential for inadvertent discoveries of cultural resources during construction and to determine the presence or absence of federally-listed mussel species and, if present, to avoid impacts to these species. Additional monitoring and potential adaptive management actions are described in the report that would measure the outcome of implementation and ensure that the projected environmental benefits are achieved. It is recommended in the DPR that the Recommended Plan / Preferred Alternative move forward to the Design and Implementation phase.

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1 INTRODUCTION

1.1 STUDY PURPOSE AND SCOPE

Section 206 of the Water Resources Development Act of 1996, Public Law 104-305, authorizes the Secretary of the Army to carry out a program of aquatic ecosystem restoration. The North Shore Riverfront Ecosystem Restoration project is a partnership between the US Army Corps of Engineers, Pittsburgh District (USACE) and the Pittsburgh-based non-profit Riverlife under the Section 206 authority. Under this authority, a detailed project report (DPR) is prepared in order to document the plan formulation process in accordance with guidance for feasibility studies that are specifically authorized by Congress (ER 1105-2-100). An environmental assessment and biological assessment was integrated into the DPR in order to ensure compliance with the National Environmental Policy Act and Endangered Species Act while reducing redundancy of background information, alternative descriptions, and analyses. The purpose of this DPR is to analyze alternatives for the restoration of floodplain and near-shore aquatic habitat in an urbanized area on the City of Pittsburgh's North Shore along the Ohio River. This project seeks to restore important fish and wildlife habitat that is limited within the immediate vicinity of the project area. The need for this project stems from the historic alteration of natural riverine habitats and development of the floodplain due to efforts to maintain a navigation channel, reduce flood risk, and develop commercial facilities in the project area. This feasibility report documents the environmental, planning, engineering, and construction details of the recommended plan, which will allow final design and construction to proceed following approval of this report.

This project is integral to Riverlife's mission of reclaiming, restoring, and promoting Pittsburgh's riverfronts as the environmental, recreational, cultural, and economic hub for the region. As an active member of the Urban Waters Federal Partnership, formed to reconnect urban communities with their waterways by improving coordination among Federal agencies, USACE is committed to collaborating with community-led revitalization efforts to improve our Nation's water systems and promote their economic, environmental, and social benefits.

1.2 LOCATION

1.2.1 Study Area

The study area is located on the south eastern edge of the Ohio River – Montour Run Watershed (HUC 12), in the North Shore and Chateau neighborhoods of the City of Pittsburgh just downstream of Point State Park. The area is characterized by heavy commercial and industrial development including surface lots, Heinz Field, the Rivers Casino, the Carnegie Science Center and warehouse and outdoor storage areas.

The area is also heavily used for recreation. The Three Rivers Heritage Trail runs the length of the North Shore from upstream of the Allegheny River down the Ohio, through the entire length of the project site. Much of the shore is popular recreation areas for paddle sports and motorized boats. The urban nature of the project study area leads to significant constraints on available land and improvements while minimizing impact to existing facilities.

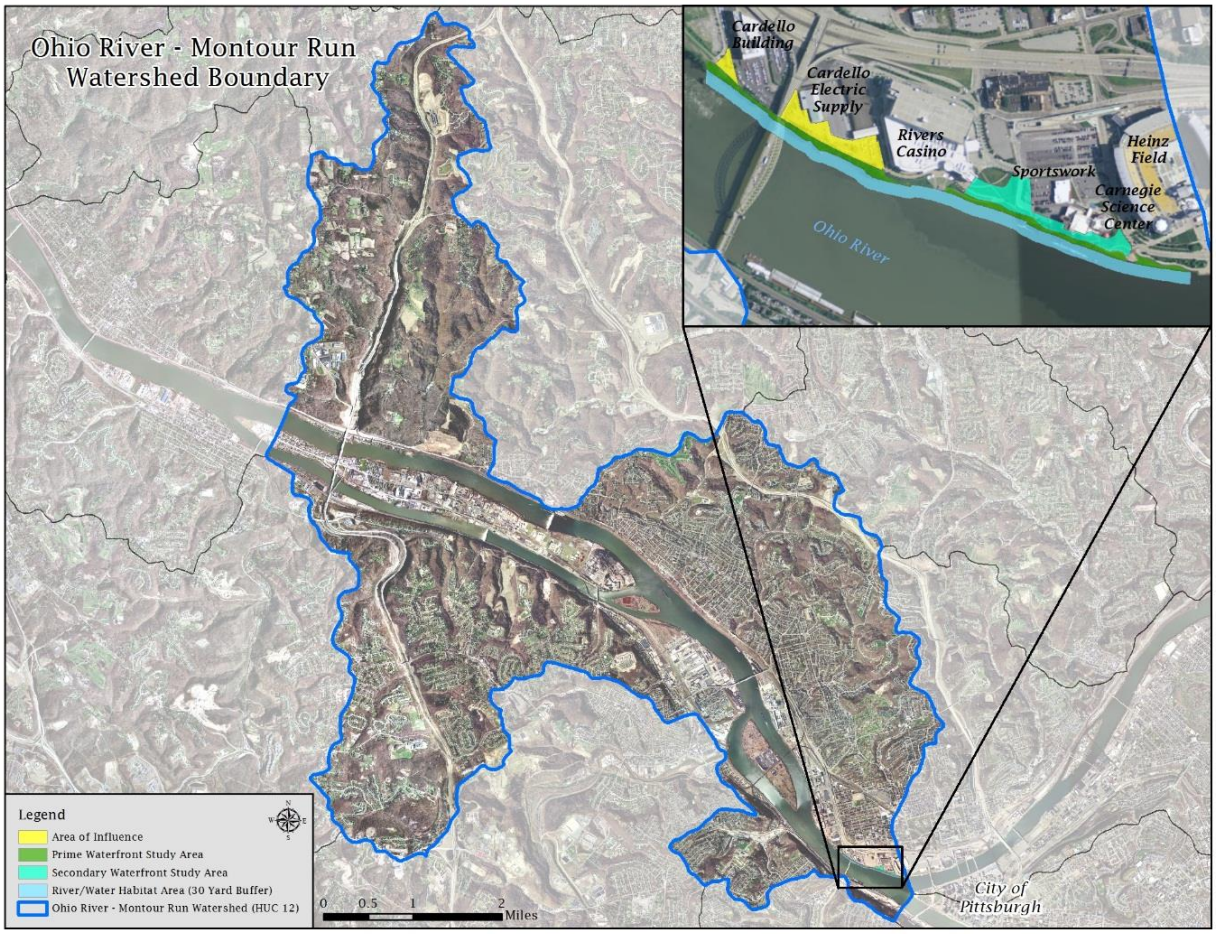


Figure 1: Map of the Ohio River – Montour Run Watershed Boundary

The area is a largely impervious, commercially developed strip bounded in the north by PA Route 65. The city's North Shore riverfront has historically been a region of heavy industrial development with non-commercial access to the river heavily restricted. Previous development within the proposed project footprint include coke and steel production as well as the National Casket Factory, railway terminals in support of production and barge mooring areas. While no longer industrial in nature, the study area includes parcels with a significant legacy of site contamination. The Upper Ohio Basin saw expansive urban and industrial infrastructure until the 1970s with the decline of the steel industry. It now suffers from its legacy of abandoned sites and brownfields, particularly along the waterfront, which contributes to degraded ecosystems and habitat.

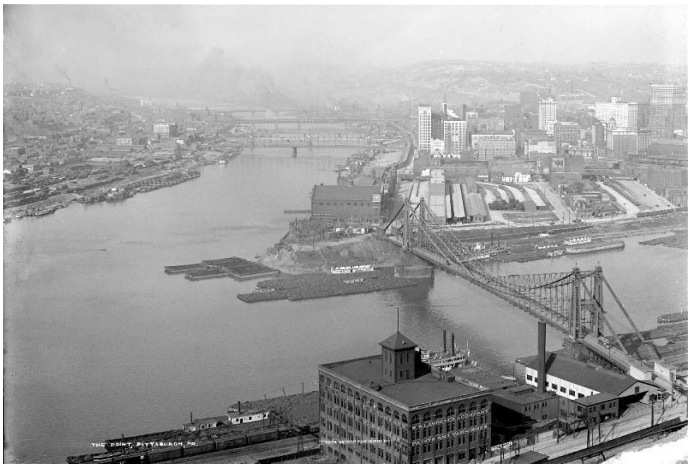


Figure 2: 1900, View of the City of Pittsburgh and North Shore (credit: Brooline Connection)

1.2.2 Project Area

The project area will include approximately 13 acres of heavily degraded aquatic and riparian shoreline habitat along 4,000 feet of the right-descending bank of the Ohio River, the North Shore, extending from downstream of the West End Bridge to upstream of the Carnegie Science Center, in the City of Pittsburgh.

The North Shore of the City of Pittsburgh is a mixed use commercial area consisting of professional sports stadiums, the Rivers Casino, commercial warehousing and professional services buildings. The area under consideration in this feasibility study covers part of eleven real estate parcels on both public and private land.

Figure 3: Proposed Project Area as seen from Downtown Pittsburgh

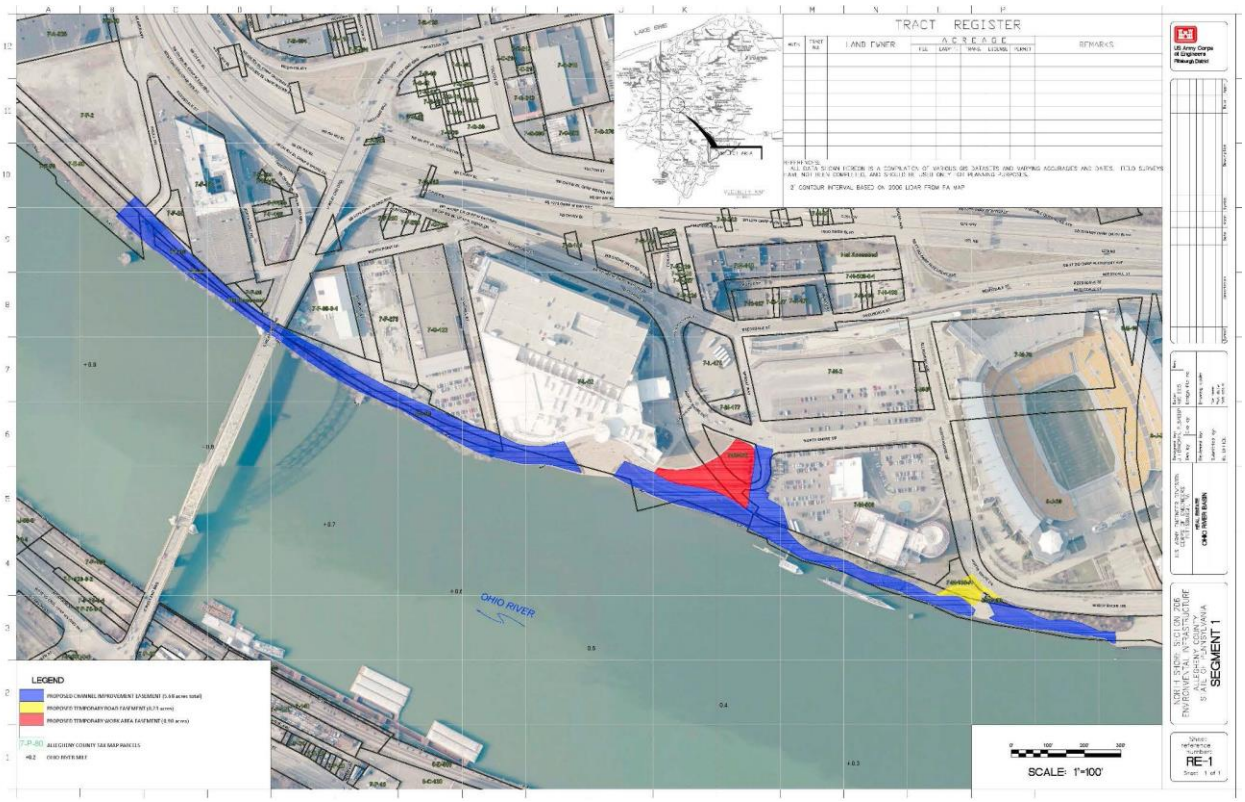


Figure 4: Project Area Real Estate Overlay

1.3 STUDY AUTHORITY

Section 206 of the Water Resources Development Act of 1996 (Public Law 104-303) authorizes the Secretary of the Army to carry out a program of aquatic ecosystem restoration with the objective of restoring degraded ecosystem structure, function, and dynamic processes to a less degraded, more natural condition considering the ecosystem's natural integrity, productivity, stability and biological diversity. This authority is primarily used for manipulation of the hydrology in and along bodies of water, including wetlands and riparian areas. This authority also allows for dam removal. It is a Continuing Authorities Program (CAP) which focuses on water resource related projects of relatively smaller scope, cost and complexity. Traditional USACE civil works projects are of wider scope and complexity and are specifically authorized by Congress. The Continuing Authorities Program is a delegated authority to plan, design, and construct certain types of water resource and environmental restoration projects without specific Congressional authorization.

1.4 RELEVANT PRIOR STUDIES AND REPORTS

Previous studies conducted within or adjacent to the project area that helped inform this planning effort are listed below.

- Ecosystem Flow Recommendations for the Upper Ohio River Basin in Western Pennsylvania, Report to the Pennsylvania Department of Environmental Protection, 2013.
- Riverlife Headwaters Lagoon Project - Various reports and analyses, 2011 - 2012.
- Three Rivers Management Plan, Pennsylvania Fish and Boat Commission, 2012.
- Three Rivers Park Landscape Management Guidelines, Prepared for Riverlife Task Force, 2006.

- Upper Ohio Navigation Study Final Feasibility Report and Integrated Environmental Impact Statement, US Army Corps of Engineers, 2014.
- Civil & Environmental Consultants, Inc. (2013). Geotechnical Report: Rivers Casino Hotel. Pittsburgh.
- A&A Consultants (2000). Geotechnical Engineering Report for the North Shore Riverfront Park. Pittsburgh.

2 AFFECTED ENVIRONMENT - EXISTING CONDITIONS

The following sections document the current existing conditions within the project area based on the best available data.

2.1 CLIMATE

The project area has a humid continental climate with four distinct seasons. The area receives approximately 38 inches of precipitation and 41 inches of snowfall on average each year. High temperatures in the summer months average in the high 70's and low 80's and average low temperatures in the winter months are in the mid to low 20's.

2.2 SOILS AND GEOLOGY

2.2.1 Geology and Physiography

The project area lies within the Pittsburgh Low Plateau physiographic province which is marked by a smooth, undulating surface with narrow and relatively shallow valleys. Bedrock underlying the study area is Pennsylvanian-aged and belongs to the Glenshaw Formation of the Conemaugh Group and is comprised mainly of claystone, sandstone, and shale. The site is within the alluvial flood plain of the Allegheny and Ohio Rivers. Location of Station references is in Section 4.0 of the Engineering Appendix (Appendix A).

Further information on bedrock characteristics are available from test boring information included in two previously completed reports: a Geotechnical Report for the Rivers Casino Hotel (Civil & Environmental Consultants, 2013b) and a Geotechnical Engineering Report for the North Shore River Front Park (A&A Consultants, 2000). These test borings were located between approximately Stations 5+00 and 25+00.

The Study Area has encountered heavily industrialized activity for over 100 years. This activity resulted in the deposition of slag and coal waste products ranging up to 30 feet in thickness at some locations along and adjacent to the North Shore. Based on the core boring information referenced above, black oil-stained sand and silt and coal tar was observed at depths ranging between 20 and 50 feet below the ground surface. Underlying the fill materials are alluvial sands and gravels extending to depths of about 60 feet. In borings performed for the Rivers Casino Hotel project, bedrock was encountered at depths of about 65 feet—an elevation of about 663 feet.

2.2.2 Soil Associations

The soil association in the project area is Urban Land-Philo-Rainsboro. These are deep, moderately to well-drained soils. In particular, the lands in the project area are classified as "Urban Lands". These soils are classified as soils having been altered by significant disturbance and development. The project area lies within the floodplain (FEMA, 2015) and was covered with a variety of fill materials to facilitate urban development. Unaltered soils in these locations typically have high seasonal water tables and a high risk of flooding.

2.2.3 Hydric Soils

As the soils in this location have largely been altered and amended, there are likely no hydric soils in the area due to urbanization. However, within the geological context, sediment within the Ohio River could be classified as hydric soil.

2.3 SURFACE WATER AND OTHER AQUATIC RESOURCES

2.3.1 Surface Water

The Study Area is located on the right bank of the Ohio River, just below the confluence of the Allegheny and Monongahela Rivers at Pittsburgh ("The Point"). It is located within the navigation pool created by Emsworth Lock and Dam, which is situated approximately 6.2 miles downstream of the Point. Emsworth Lock and Dam is operated to maintain a normal pool elevation of 710 feet NGVD29 near Pittsburgh. Water surface elevations near the study area are within ±1 foot of this elevation 90% of the year. Significant flood events can affect the study area as a result of elevated flows on the Allegheny River, Monongahela River, or a combination of the two. The trail known as the North Shore Riverwalk begins to flood when the river is near elevation 714 feet NGVD29 and businesses on the lower North Side are affected by flood waters near flood stage elevation 719 feet NGVD29.

Note: Ohio River pool elevations are referenced to a legacy vertical datum thought to be NGVD29. The geodetic conversion from NGVD29 to NAVD88 vertical datum is -0.52 feet (Vertcon, http://www.ngs.noaa.gov/TOOLS/Vertcon/vertcon.html, accessed 8 February 2016).

The Upper Ohio River is US Geological Survey (USGS) Hydrologic Unit Code 05030101 (HUC-8). The Study Area is within the HUC-12 of 050301010303 (Ohio River-Montour Run), which has an area of almost 33 square miles that is 50% forest, 35% developed, 7% open water and 6% agricultural.

The contributing area to the Ohio River near the Point is approximately 19,100 square miles. The Allegheny River watershed is approximately 11,720 square miles (61%) and the Monongahela River watershed is approximately 7,380 square miles (39%) of this total watershed area.

The Ohio River channel is 1,000-1,200 feet wide along the Study Area with a water depth at normal pool of up to 30 feet. Existing right bank side slopes range from 2:1 to 6:1 (horizontal: vertical).

Surface water quality in the project area has improved in recent years, although some water quality issues still exist. Adjacent to the site, dissolved oxygen levels are average approximately 10.6 mg/l which is well above the minimum level of 5.0 - 6.0mg/l required to support diverse populations of aquatic life. Adjacent to this area, pH levels averaged approximately 8.1, which is on the upper end of general pH requirements necessary to support diverse aquatic life (Alabaster and Lloyd, 1980). Concentrations of nitrite-nitrate nitrogen, ammonia nitrogen, and phosphorous concentrations in the project area remain well below standards set to protect human health. As of 2008, approximately 53% of water quality samples within the project area exceeded minimal standards for fecal coliform. Waters adjacent to the project area remain impaired for contact recreation and fish consumptions uses due to these high levels of fecal coliform.

2.3.2 Groundwater

Due to the proximity to the Ohio River, the water table within the project area is likely to be very high. Below the existing fill in the project area, soils are likely to be comprised of permeable sands and gravels approximately 50 feet deep that are well suited to holding groundwater. Below this layer is likely bedrock.

2.3.3 Flood Plains

Most of the project site is within the 100-year floodplain (FEMA, 2015). The floodplain within the study area is terraced with a lower floodplain along the right bank varying in width from 600-1200 feet at elevations ranging from 720-730 feet. The upper floodplain terrace along the right bank varies in width from 3000-4000 feet at elevations ranging from 740-800 feet. The right bank floodplain is highly developed with industrial, commercial, and recreational businesses occupying the lower terrace while the upper floodplain terrace is primarily residential.

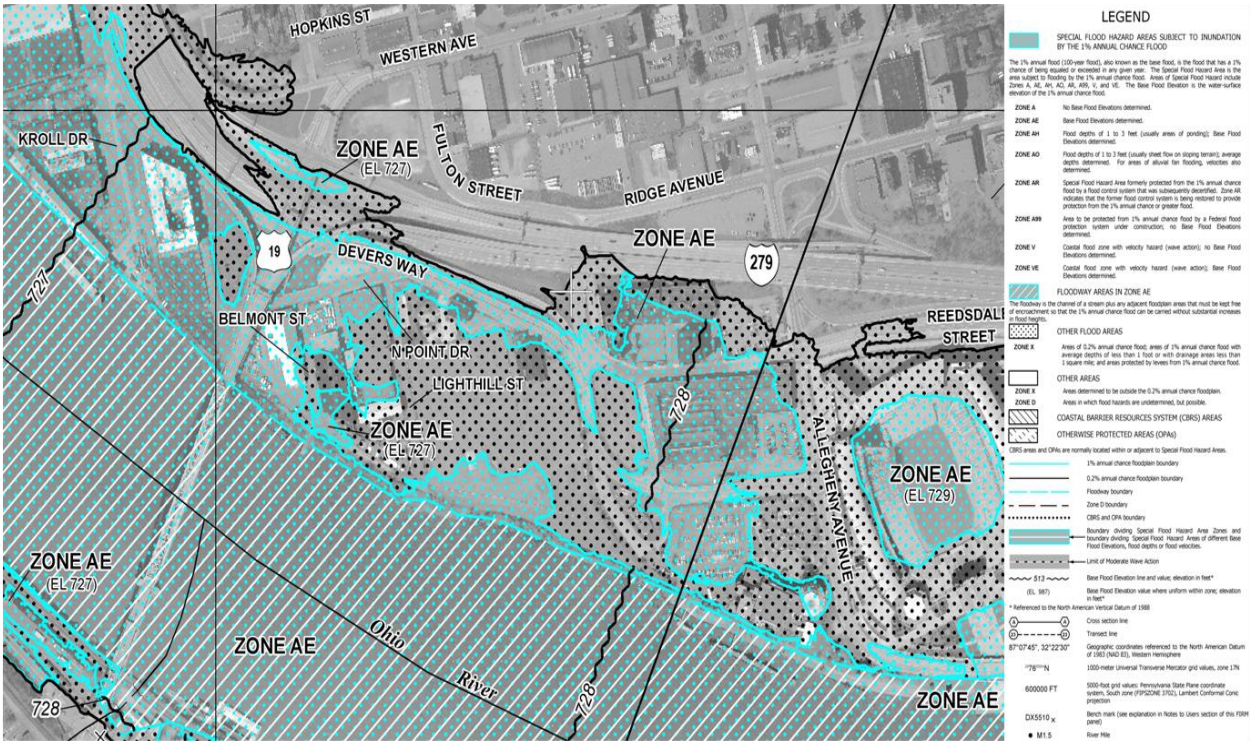


Figure 5: Flood Plain Map of Study Area (Source: FEMA)

2.3.4 Wetlands

According to the National Wetlands Inventory (NWI), there are no wetlands within the project area (USFWS, 2015b). Based on the project area location within the Ohio River floodplain, it is likely that there were historically wetlands at this location. However, a history of fill placement for industrial and urban development in the floodplain likely covered these wetlands. Neither the 1981 nor the current soil survey show any hydric soils within the project area (SCS, 1981 and NRCS, 2015).

2.4 FISH AND WILDLIFE HABITATS

2.4.1 Riparian and Aquatic Vegetation

Within the project area, existing vegetation is typical of the Upper Ohio and Lower Allegheny River and includes a variety of native tree species such as dogwoods, maples, willows, American sycamore, green ash, eastern cottonwood, slippery elm, yellow birch, red mulberry, Eastern redbud, and American basswood. It also includes a wide variety of native grasses, forbs, and shrubs. The existing community

also includes large stands of non-native species including Japanese knotweed, purple loosestrife, reed canary grass, and numerous thistles. For a full list of species observed within the project area, see Appendix A: Environmental. Aquatic plants are not likely to be common in the project area but could include water-willow, and several species of smartweed and rushes.

Invasive species that have been documented in the project area include purple loosestrife, common nettle, common ivy, bindweed, multiple thistle species, tree of heaven, empress tree, and Japanese knotweed. Of particular concern is Japanese knotweed which has four large established patches (totaling 1.9 acres) within the project area. Additional information on non-native species documented within the project area is located in Appendix B.

2.4.2 Fauna

Many of the species within the project area are common in the region. Common mammal species likely to occur within the project area include Virginia opossum, shrews, moles, bats, rabbits, beaver, mice, voles, squirrels, chipmunk, woodchuck, skunk, weasels, mink, and raccoons. Bird species likely to occur within the project area include cardinal, crow, robin, blue jay, sparrows, mourning dove, woodpeckers, wrens, starlings, black-capped chickadee, finches, gulls, red-winged blackbird, grackle, Canada goose, mallard, common merganser, wood duck, green-winged teal, great blue heron, wild turkey, turkey vulture, and red-tailed hawk.

A recent fisheries survey in the project area noted the occurrence of smallmouth bass, hybrid striped bass, sauger, freshwater drum, longnose gar, smallmouth buffalo, several sucker species, and a juvenile muskellunge (PFBC, 2015). Other fish likely to occur in the project are include carp, gizzard shad, walleye and mooneye. Mussel species within the project area are likely to include threehorn wartyback, pink heelsplitter, pink papershell, fawnsfoot, three-ridge, Wabash pigtoe, fatmucket, white heelsplitter, and giant floater. Zebra mussels are an invasive mussel species that is also present in the upper Ohio and lower Allegheny rivers.

2.4.3 Existing Riparian and Aquatic Habitats

The existing vegetation is within a narrow corridor (approximately 50 feet) which is further segmented by walking trails, an amphitheater, bridges and other recreational features. Outside of this strip there is a variety of development including buildings (warehouses, museums, stadiums, casinos), parking lots and landscaped areas. These areas are also largely disconnected from the adjacent Upper Ohio River due to a variety of bank stabilization features including corrugated steel walls, cement walls, rip rap, concrete piers, brick landings, and other similar features. The Ohio River in the project area is approximately 1,000 feet wide and is approximately 15 feet deep on average, with a maximum depth of approximately 30 feet. Within the project area, which includes the nearshore area of the Ohio River within 150 feet of the river bank, the average depth is approximately 10 feet. These aquatic habitats currently lack many of the historic features of the river such as backwaters, side channels, gravel and sand bars, floodplain connectivity, and adjacent wetland areas. Additionally the current river is deeper than it would have been historically due to the dams on the system and the maintained navigation channel. Seasonal fluctuations of water levels are also curtailed with regard to historic conditions.

2.5 ENDANGERED AND THREATENED SPECIES

2.5.1 Federal

There is the potential for five federally-listed mussel species to occur within the project area: northern riffleshell (endangered), clubshell (endangered), rayed bean (endangered), snuffbox (endangered), and rabbitsfoot (threatened). All five of these species ranges include the Ohio River. The specific habitat

requirements of the species are not fully known, but the rabbitsfoot typically occurs in shallow waters, near the bank in areas with reduced water velocity. They are generally found utilizing gravel and sand substrates. These conditions are likely to be optimal for most mussel species. Within the project area, water velocities are generally high (see engineering appendix) and substrates are likely to be comprised of finer sediments such as silts and sands. Therefore it is not highly likely that these species would occur within the project area, but they do have the potential to occur.

The Indiana Bat (*Myotis sodalis*) and the Northern Long-Eared Bat (*Myotis septentrionalis*) are federally-listed as "Endangered" within the Commonwealth of Pennsylvania. This small bat species hibernates during the winter in caves and abandoned mines. They require humid caves with stable temperatures between for hibernation. They utilize trees for roosting and foraging sites during the summer months. Females complete their reproductive cycle roosting under the peeling bark of dead or dying trees during the summer months in colonies of up to 100 or more bats. Based on coordination with the US Fish and Wildlife Service, impacts to Indiana Bats are not a concern for this project (USFWS, 2015a).

2.5.2 State

There are no State-listed species of concern within the project area.

2.5.3 Critical Habitat

There is no designated critical habitat within the project area.

2.6 RECREATIONAL, SCENIC, AND AESTHETIC RESOURCES

2.6.1 Local Resources

The Three Rivers Heritage Trail runs the length of the project site and is primarily used for cycling, running and walking. This trail system extends both upstream and downstream of the project area and connects to numerous other trail systems, including the Great Allegheny Passage. Adjacent to the project area are the Carnegie Science Center, Heinz Field, and Rivers Casino. Permanently docked in front of the Carnegie Science Center is a historic submarine, the USS Requin. The upstream area of the project site has been previously altered, during construction of Heinz Field and the Rivers Casino, to improve site aesthetics. This included planting of gardens and other landscaped areas, development of concrete ampitheaters, park like manicured lawns, sculptures and other similar features. The downstream portion of the project area is less aesthetically pleasing with remnant infrastructure (such as docks and moorings), abandoned buildings, industrial areas and a less well-maintained trail. River-based recreational activities in the project area include fishing, pleasure boating, and regattas.

2.6.2 Regional Resources

The Great Allegheny Passage trail system, which is connected to the Three Rivers Heritage Trail system at the project site, is a rail trail that connects to the C&O Canal Towpath in Cumberland Maryland to form a continuous trail system from Washington, D.C. to Pittsburgh, PA. The status of Pittsburgh's major rivers as a fishing destination was dramatically illustrated by the arrival of the Bassmaster Classic tournament in 2005. It was reaffirmed in August 2009 when the Forest L. Wood Cup Championship, a four-day bass fishing tournament that pays the winning angler $1 million and has a total purse of $2 million, was held around Pittsburgh. Also, the largest flathead catfish caught in Pennsylvania during 2008 (over 37 pounds) was caught in the Ohio River.

2.7 CULTURAL RESOURCES

2.7.1 Cultural History

Cultural resources within the general area represent human behaviors and occupations over many centuries, including both pre-contact and historic period uses. People are believed to have been present in and continually used the study area since at least 14,000 years ago. Previously identified cultural resources demonstrate the central role of the Ohio River as a transportation artery and resource extraction area during both the pre-contact and historic periods. Historic period cultural resources are represented both in the archaeological record as sites, as well as in the built environment as records and structural remains. The previously recorded historic period archaeological site types represent domestic, industrial, and military uses of the region. In addition to these, there are numerous historic markers in the study area that denote places of historical significance and interest despite the absence of physical remains. The historical markers present in the study area relate to many aspects of both Native American and Euro-American history and recollect locations of important industrial, military, religious, and sporting events, as well as Native American towns and burial mounds, and the homes of important artists, politicians, and military persons.

Cultural resources potentially present in the study area include both pre-contact and historic period archaeological sites and historic period structures. Based on the presence of previously identified pre-contact period archaeological sites, the presence of known Indian trails/paths, and 18th century Indian towns in the study area, additional as of yet unidentified pre-contact period archaeological sites may be present. Some pre-contact period archaeological remains may be submerged along the river banks due to the changes in river and pool water levels over time. As has been proven in the past for projects located in urban/industrialized areas (e.g., Pittsburgh Light Rail project located in downtown Pittsburgh, and the USACE construction of Braddock Dam at Leetsdale), pre-contact period archaeological remains may continue to be preserved beneath these historic and modern period uses. However, there are no known historic structures within the project area (PHMC, 2015a) itself and occurrence of cultural resources is less likely within the project area due to widespread previous disturbances and placement of fill of up to 30 feet in the project area.

2.7.2 Previous Investigations

There are no historic buildings, structures, districts, or objects within the project area. A cultural resources reconnaissance survey of the majority of the site area was conducted in 2007, prior to expanded development by Rivers Casino, and concluded with negative results. (PHMC, 2015b)

2.8 AIR QUALITY

Although it has improved greatly over the years, air quality within the study area is not currently attaining minimum national ambient air quality standards (EPA, 2015) for ozone (O_3)and particulate pollution ($PM_{2.5}$) in portions of Allegheny County. In addition, portions of Allegheny County are currently in “Maintenance” status for carbon monoxide (CO). Additional details are provided in the table below.

Table 1: Air Quality Non-Attainment Pollutants Summary (USACE, 2014)

State	Non-attainment Area Name	Counties
Designations for 2008 8-hour O_3 Standard		
Pennsylvania	Pittsburgh-Beaver Valley	Allegheny
Designations for 2006 $PM_{2.5}$ **(p = partial)**		
Pennsylvania	Pittsburgh-Beaver Valley	Allegheny (partial)
Designations for 1971 Carbon Monoxide **(p = partial)**		
Pennsylvania	portions of City of Pittsburgh	Allegheny (partial)

2.9 NOISE

Sources of noise pollution in the project area include traffic noise from the West End Bridge and nearby surface roads, shipping and receiving activities at warehouses located on the north shore, recreational boaters, concerts conducted at the outdoor amphitheater in front of the casino, sporting events, festivals conducted in the area (primarily in the summer months), and concerts and other activities conducted at and around Heinz Field. In addition, the area sees a great deal of recreational use which may contribute to noise pollution.

2.10 HAZARDOUS AND TOXIC SUBSTANCES

A Phase I Environmental Site Assessment (ESA) was performed to evaluate and identify whether or not hazardous substances or petroleum products may be present at the project site and to conclude whether or not recognized environmental conditions (RECs) exist. The term "recognized environmental condition" is defined as the presence or likely presence of hazardous substances or petroleum products which indicate an existing release, past release, or a material threat of a release of hazardous substances or petroleum products into structures on the properties or into the ground, groundwater or surface water of the project site. Phase I ESA analysis was performed in accordance with American Society for Testing and Materials (ASTM), International Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process E1527-13.

Results of the Phase I ESA indicate reason to believe that soil and groundwater at the project site and surrounding area are likely to be contaminated from historic industrial use. These results are based on a review of environmental records and historic information provided by Environmental Data Resources (EDR), interviews with current property managers and owners and site reconnaissance. Information obtained during the Phase I ESA that support these results include the following:

- Review of environmental records and historic information from the late 1880s to the 1970s indicate that the west end of the project site between Kroll Drive and Lighthill Street historically included steel production, lumber mills, cement manufacturing facilities, railroads, and a casket manufacturing factory with varnishing shops

- Review of environmental records and historic information from the late 1880s to the 1970s indicate that the east end of the project site from Lighthill Street to North Shore Drive historically included automobile gasoline service stations, dry cleaners, iron works/foundries and scrap iron yards, steel manufacturing, paint factories, tar chemical works/tar and roofing

companies, asphalt plants, galvanizing companies, railroads and rail yards, a manufactured gas plant, and a printing facility.

- The Rivers Casino property is currently subject to an agreement under the Pennsylvania Act 2 Land Recycling Program due to soil and groundwater contamination by volatile and semi-volatile organic compounds (VOCs/SVOCs), polycyclic aromatic hydrocarbons (PAHs) and various metals including arsenic, lead and mercury. Phase I ESAs conducted in 2005 and 2007 prior to construction of the existing Rivers Casino indicate that the general area surrounding the casino included historic industrial uses that have likely adversely affected soil and groundwater in the vicinity. Phase II ESAs conducted in 1993, 1994 and 1998 indicate soil in the vicinity of the casino was contaminated with several parameters including VOCs, SVOCs, heavy metals and petroleum products and the groundwater was contaminated with trichloroethane (TCE), xylenes, mercury, lead, cadmium, and cyanide. Results of a 2006 Phase II ESA indicated arsenic contamination in groundwater. Remediation of the site was not documented.

- Initial Site Assessment (ISA) and Phase I, II and III ESAs conducted in 1999 for properties owned by the Sports and Exhibition Authority indicate that the site historically included gasoline stations, foundries, lead works, linseed oil works, junk yards, railroad repair shops, and rail yards. Phase II/III ESA investigations indicated an area of contamination directly adjacent to the project site near the southeast corner of existing Heinz Field along North Shore Drive.

- Previous underground storage tanks (USTs) include a diesel tank removed 15 years ago on the Cardello property.

2.11 SOCIOECONOMIC AND ENVIRONMENTAL JUSTICE

2.11.1 EO 12898 Environmental Justice

Executive Order 12898 (Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations), mandates that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." The Executive Order (EO) makes clear that its provisions apply fully to programs involving Native Americans. Pursuant to this executive order, there are no minority or low-income populations within or directly adjacent to the project area or any communities that have the potential to be negatively affected by actions at this site. There is one small homeless camp east of the west end bridge that could be affected due to construction, however this is not covered under the jurisdiction of EO 12898.

2.11.2 EO 13045 Protection of Children

Executive Order 13045 concerns environmental health and safety risks that may disproportionately affect children. While the Carnegie Science Center is adjacent to the study area, which is an attraction primarily for children, there are no permanent residences within or adjacent to the project area and the project does not have the potential to negatively affect children.

3 PLAN FORMULATION

3.1 PROBLEMS AND OPPORTUNITIES

This section identifies the problems and opportunities based on the assessment of existing and expected future without project conditions in the study area. Problems and opportunities can be viewed as local and regional resource conditions that could be modified in response to expressed public concern.

3.1.1 Problems

Degraded Aquatic Habitat – Historical changes in the regulation of the adjacent river systems for flood risk management and navigation, as well as elevating floodplains to raise structures to reduce flood risk, the aquatic habitat within the river has been degraded. Effects include reduced abundance of pools and habitat structure, a reduction in the abundance of gravel and sandbars for fish spawning, a reduction in the abundance and quality of natural floodplain features such as backwaters and wetlands, and reduced floodplain connectivity.

Degraded Riparian Habitat – Due to the historical development within the study area, much of the historic riparian habitat has been removed and the remaining habitat exists in a narrow band along the river that is fragmented by various developments. In addition, invasive species now dominate numerous zones of the project area, likely due to previous disturbances.

Historical Site Pollution - Previous industrial development across the study area has led to contaminated soils both in the riverbed and the landside riparian zone. These contaminants are dispersed into the river during flooding, high flow, or storm water run-off events. Leftover toxic materials in soils and sediments could impact water quality and habitats through ongoing releases.

Invasive Species – As with many regions, the study area is experiencing significant problems with invasive, non-natives species to the detriment of native ecosystems and the benefits derived from them. The temporary disturbance present during restoration projects invites colonization by invasive species which, once established, can undermine restoration efforts and lead to further spread of these harmful species. Removal of non-native species is a primary consideration of this restoration project.

Floodplain Connectivity - Due to the altered floodplain, controlled flows and armored banks within the project area there is generally very little floodplain connectivity, which is important for primary productivity in river systems.

Water Velocities – Water velocities within the project area are generally consistent at approximately 4 - 7 cfs and the Ohio River in this location generally lacks slow-water and slack-water areas which are important refugia for native fish and mussel species. See the engineering appendix for more detail.

3.1.2 Opportunities

Restore Floodplain and Riparian Habitat - Previous industrial development has changed the characterization of the existing stream banks from naturally sloped to steep and hard-scaped banks anchored with sheet piling and retaining walls. Opportunities exist to re-establish more natural shorelines and enhance floodplain connectivity within the project area.

Improve Stormwater Flows – Current riverbank slopes do little to retain or slow storm water flows before entering the water. Increased development on the city's North Shore and an increase in impervious surface in the drainage areas has further reduced storm water runoff from taking its natural course back to surface waters through transpiration, infiltration, and gradual runoff.

Improve Shoreline Adjacent Fish and Mussel Habitat – Create diverse fish and mussel habitat along the banks of the Ohio River through varying depths, rock placement, sand beds, anchored debris, slack water areas, and contouring of the in water habitat. The study area includes potential habitat suited to threated and endangered species.

Control of Non-Native and Pest Species – Controlling invasive species and protecting native species through integrated pest control, plantings, monitoring and surveillance as well as adaptive management to ensure non-natives do not encroach on the improved project area.

Improve Water Quality through Wetland Capture and Reduction in Combined Sewer Overflows – Increases in wetland habitat within the study area would improve storm water management by redirecting existing storm water flows out of the combined sewer. Wetland enhancements would also serve as habitat for multiple species while naturally treating and retaining water that would normally enter the combined sewer, therefore acting to buffer potential contaminants from the river.

Enhance Site Aesthetics – Opportunities exist to enhance site aesthetics by clearing invasive and aggressive species, removing deteriorating infrastructure, and installing aesthetically pleasing planting areas.

Enhance Existing Recreation and Educational Opportunities – Recreational and educational opportunities could be enhanced in the project area by providing additional access points to the river, providing trails stemming from the main trail system, and through the use of interpretive signs and displays.

3.2 OBJECTIVES AND CONSTRAINTS

3.2.1 Planning Objectives

The following planning objectives summarize the future conditions the alternatives for this study are seeking to achieve based on the identified problems and opportunities.

a. Improve aquatic habitat form and function to include shallow water areas and enhanced substrate within the Ohio River near-shore portion of the project area through 2065.
b. Improve the abundance and quality of floodplain habitat to include expansion of riparian areas and improved quality of riparian habitat along the Ohio River portion of the project area through 2065.
c. Restore more natural floodplain features and functions that connect the riparian and aquatic habitat to include restoration of wetlands and floodplain shelf habitat along the Ohio River portion of the project area through 2065.
d. To the extent feasible, provide ancillary benefits for recreation, education and site aesthetics within the project area through 2065.

3.2.2 Constraints

The constraints below represent restrictions on the project scope that would affect the constructability of the project due to financial, ecological, environmental, or hydrological limitations. Each of these constraints represents a condition to be avoided or minimized to the extent possible when formulating management measures and alternatives.

a. **Exposing Hazardous, Toxic or Radioactive Wastes** - The environmental site assessment shows potential high levels of historical contaminants on sites within the study area. Alternatives

should avoid disturbing or exposing these materials to the extent possible. The site soil and vegetation could be protected from contamination by reducing or eliminating toxic and hazardous materials by further buffering exposed waterways with additional fill materials used to restore more natural slopes or terracing along the riverfront.

b. **Impacts to planned future development** - Existing plans for future development adjacent to the project area are described in the Future Without Project Condition. Alternatives should be formulated to not impinge upon these plans or in any way negatively affect them.
c. **Impacts to existing businesses and recreation facilities -** The entire length of the study area includes the Three Rivers Heritage Trail and permanent easements held by Friends of the Riverfront. Beyond the trail are private businesses that are excluded from improvements under the proposed project. Alternatives should seek to avoid or minimize impacts to the facilities during construction and should not impinge upon their existing purposes.
d. **Increasing flood risk -** Alternative plans should not increase flood risk within the project area.
e. **Impacts to the navigation channel -** Alternative plans should not affect the ability of commercial and recreational ships to effectively navigate the adjacent waterways.

3.3 MOST PROBABLE FUTURE WITHOUT PROJECT CONDITIONS

The future without project condition looks at what the mostly likely conditions within the project area would be over the period of analysis (50 years) under the "No Action" alternative.

3.3.1 Development

Adjacent to the project area there is likely to be increased development including expansion of the casino facilities, expansion of the science center facilities, development of new business offices and possibly apartment buildings. Some plans for this are already in place or in discussion and some are speculative based on increasing trends of development within the Pittsburgh area and particularly those areas near downtown and adjacent to the rivers.

3.3.2 Climate Change

Studies recently published by the Pennsylvania Department of Environmental Protection (e.g., Pennsylvania Climate Change Action Plan (2009), its 2013 Update, the Pennsylvania Climate Adaptation Planning Report: Risks and Practical Recommendations, and 2013 Pennsylvania Climate Impacts Assessment Report Update) indicate that over the next 20 years projected climate change for Pennsylvania is very likely to be warmer and wetter. Likely changes in precipitation will translate to impacts in snowpack, runoff, soil moisture/drought, evapotranspiration, groundwater, stream temperature, floods, and water quality. However, it should be noted that the system is managed to maintain fairly consistent pool levels within a designated band to support navigation within the project area so changes to water levels due to climate change should not be a concern within the project area.

A generally warmer regional climate anticipates greater extremes with intensity of precipitation and with longer dry periods. The most significant effects predicted for stream and wetland communities are increased water temperature and increased variability of the water environment. The latter may be reflected in changing seasonal patterns of water levels, reduced stream flows during dry periods, larger floods, and longer droughts.

3.3.3 Habitat Trends

Increased spread of invasive species is likely to occur under the No Action / Future Without Project Condition scenario. Continuing current trends, invasive species like Japanese knotweed are likely to take over greater areas within the project site and reduce the overall quality of floodplain habitat. Invasive aquatic species including zebra mussels will likely become more established within the project

area and it is likely that Asian Carp species will become established in the project area in the near future. Increased pressure on natives due to warmer climates and altered precipitation cycles could exacerbate this problem. Riparian corridors would remain segmented and may even be further segmented due to development without restoration and protection. Near-shore riverine habitats are likely to remain degraded at a level similar to their current state without any further action.

3.4 MANAGEMENT MEASURES TO ACHIEVE THE PLANNING OBJECTIVES

Management measures are potential actions that could be taken to achieve the planning objectives within the project area. These measures are the building blocks of alternative plans. They can be structural in nature, such as the construction of a backwater, or non-structural in nature, such as altering flow regimes to improve floodplain connectivity. The management measures that were formulated for this project are discussed in the following sections.

3.4.1 Preliminary Structural and Non-Structural Measures

3.4.1.1 Structural Measures

A number of structural measures were considered to improve the existing ecosystem within the project area. These measures generally fall into three categories: aquatic habitat restoration, wetland restoration, and floodplain habitat restoration.

3.4.1.1.1 Aquatic Habitat Restoration

3.4.1.1.1.1 Substrate Modifications

Figure 6: Walleye over a Submerged Gravel Bar

This measure would involve placement of larger diameter gravels to improve aquatic habitat for fish species. The existing substrates in the project area are largely comprised of silts, muds, and sands with some gravel bars and sand bars. These substrates are important spawning habitats for many fish species including paddlefish, walleye, sauger, river redhorse, and other native fish species of concern. These areas also provide habitat for macroinvertebrates which serve as prey for many smaller and juvenile fish species and are one of the prey bases of the overall fish community. This measure is primarily aimed at meeting planning objective 1. See Engineering Appendix (Appendix A), Miscellaneous Details, for an example of the Substrate Modification Measure.

3.4.1.1.1.2 Backwaters

This measure would involve re-shaping existing submerged aquatic habitat to provide slack-water areas adjacent to the shore that are protected from flow. Slack-water habitat is important for numerous aquatic species as it provides refugia from high flows, areas where organic material can settle and accumulate, areas of heightened macroinvertebrate production, rearing habitat for fry and juvenile fish species, and are important habitat niches for many mussel species. Backwaters are a similar to river side-channels except that they are closed on the upstream end and, as such, are do not have water flowing through them at normal river levels. Figure 7 shows a constructed backwater on the Missouri River. In addition, the substrate of these areas would be altered to a heterogeneous mix of sands and

gravels. This areas would also provide additional habitat niches for fish species; especially as juvenile-rearing habitat. Backwaters would likely need to be armored with rock, concrete, or another suitable material in order to ensure that they remain protected from main channel flows during normal operating flows. This measure is primarily aimed at meeting planning objective 1. See Engineering Appendix (Appendix A), Miscellaneous Details, for an example of a Backwater Measure.

Figure 7: Constructed Backwater

3.4.1.1.1.3 Parallel Dikes

This measure would involve construction of dikes parallel to the river bank for the purpose of creating slack-water areas shoreward of the dikes, similar to the habitat provided by backwaters. Slack-water habitat is important for numerous aquatic species as it provides refugia from high flows, areas where organic material can settle and accumulate, areas of heightened macroinvertebrate production, rearing habitat for fry and juvenile fish species, and are important habitat niches for many mussel species. These features could have the added benefit of providing bank protection for existing or restored shoreline habitat. The parallel dikes will likely re-direct flows toward the navigation channel, creating a low velocity zone near the shoreline that may induce sediment deposition and vegetation establishment. Figure 8 shows an example of a parallel dike that is exposed above the water line. For this project, dikes would remain just below the water surface during normal conditions and would be overtopped on an average of 1-2 times per year, allowing for flow to flush out settled substrates and cleaning the backwaters to preserve the desired gravel substrates. This cycling of material should serve to replicate a natural river habitat more closely than the current channel conditions. This measure is primarily aimed at meeting planning objective 1. See Engineering Appendix (Appendix A), for an example of the Parallel Dike Measure.

Figure 8: Exposed Parallel Dike

3.4.1.1.1.4 Perpendicular dikes

Figure 9: Perpendicular Dike Placement

Perpendicular dikes that would extend out from the shoreline approximately 50 feet and would be spaced 50 feet apart to form slack water refugia areas were also considered. These features have slightly higher benefits when compared to parallel dikes, but also higher costs making them less cost-effective than both backwaters and parallel dikes. Based on initial cost estimates and design considerations, this measure was considered but ultimately eliminated during iterative phases of the plan formulation process. Additional details about the cost and benefits of this measure can be found in Section 3.5.3 and Table 6.

3.4.1.1.1.5 Placement of Habitat Features

Figure 10: Large Woody Debris Placement under Rock Piles

Under this measure, habitat features such as large woody debris and boulders would be placed, and anchored if necessary, to provide additional habitat structures for fish species. Large woody debris would be gathered as part of any necessary clearing activities and placed in deeper holes, potentially within backwaters, to provide additional habitat structure. These areas provide additional habitat niches for fish species such as bass, walleye, and juvenile fish of multiple species. They also provide habitat for the development of macroinvertebrate communities important to many fish species and younger age classes. In addition, boulders may be brought in from off-site and placed as additional habitat features. These features help to disrupt flow patterns in the river and provide refugia for fish species downstream. This measure is primarily aimed at meeting planning objective 1.

3.4.1.1.2 Wetland Restoration

3.4.1.1.2.1 Floodplain Wetland

Figure 11: Small Wetland

This measure would involve construction of an approximately 0.36 acre wetland within the project area. This feature is only feasible on the open land and road right of way between the Carnegie Science Center and Rivers Casino, which is currently being used as a park area. This measure would utilize water from an existing stormwater outflow that would need to be daylighted, however an additional source of water (a planned rain garden being developed by Rivers Casino on adjacent property) as well will also be explored during the design and implementation phase. Native wetland plants would be planted within the restored wetland which would provide benefits for migratory bird species with ancillary water quality benefits. Examples of wetland species to be planted include arrowhead, pickerel weed, water smart weed, duck weed, river bulrush, smooth cord grass, water willow, black rush, wool grass and small cattail. A complete list of species to be planted is included in Appendix B. Wetland habitats are of national significance and within the immediate, urbanized area, this is a limited habitat type.

Riverlife and the City of Pittsburgh have been in discussions to vacate Sproat Way in order to maximize the area of this feature while accommodating potential future development at the Casino. This measure would involve the removal of the existing road, relocation of utilities, recontouring existing on-site materials in order to form a wetland area, and creation of an overflow to the river either by piping the excess water under the existing footpath to the river or by elevating the footpath and directing water underneath it to the river. The addition of an overflow to the proposed wetlands reduces flood risk in the project area. This measure is primarily aimed at meeting planning objective 3. See Engineering Appendix (Appendix A), for an example of a Constructed Wetland Measure.

Figure 12: Japanese Knotweed Infestation

3.4.1.1.3 Riparian Restoration

3.4.1.1.3.1 Removal of invasive plant species

Numerous aggressive invasive plant species, including Japanese knotweed and purple loosestrife, are established in the existing riparian plant community within the project area. This measure would involve the removal of these plants, treatment with herbicides as necessary to prevent re-growth, and finally planting of native species. Treatment will include an initial herbicide spraying, followed by physical removal of the plants, and in dense stands use of root-rakes or similar equipment to remove remaining debris and shallow roots / rhizomes. Erosion control measures will be put in place in disturbed areas to ensure that erosion is limited to tolerable levels at the site. Following removal of invasive species, native plants will be established at the site. Species were selected for planting based on the recommendations from the Three Rivers Park Landscape Management Guidelines (2006) which provides native species list for various riparian zones within the project area. Examples of native species to be planted include box elder, silver maple, gray dogwood, ninebark, eastern cottonwood, prairie willow, swamp white oak, American elm, wild columbine, joe pye weed, wild rye, and cinnamon fern. A full species list is provided in Appendix B. This will improve the existing plant community and reduce the potential for a future monoculture of invasives within the project area. This measure is primarily aimed at meeting planning objective 2.

3.4.1.1.3.2 Re-shape Existing Banks

Figure 13: Existing Banks in the Project Area

Many of the existing banks are extremely steep (i.e. steeper than a 1:1 slope) within the project area and provide virtually no floodplain connectivity. This includes areas where the bank line is a vertical wall made of corrugated steel and vertical concrete walls (as seen in Figure 13). In these areas, additional fill materials could be placed to re-establish a more natural bank line and re-establish some floodplain connectivity. Banks would be restored to an approximately 1.5:1 and would include a very gradually sloped shelf near the water interface of approximately 10 feet wide. The toe of these extended banks beneath the water would be comprised of angular rock boulders. This measure would also include planting of native species on newly created riparian banks and could be accomplished in conjunction with aquatic habitat restoration management measures. Species were selected for planting based on the recommendations from the Three Rivers Park Landscape Management Guidelines (2006) which provides native species list for various riparian zones within the project area. Examples of native species to be planted include box elder, silver maple, gray dogwood, ninebark, eastern cottonwood, prairie willow, swamp white oak, American elm, wild columbine, joe pye weed, wild rye, and cinnamon fern. A full species list is provided in Appendix B. A combination of

natural and engineered bank stabilization would likely need to be considered in order to ensure these areas remain stable in the future and do not experience excessive erosion. This measure is primarily aimed at meeting planning objectives 2 and 3.

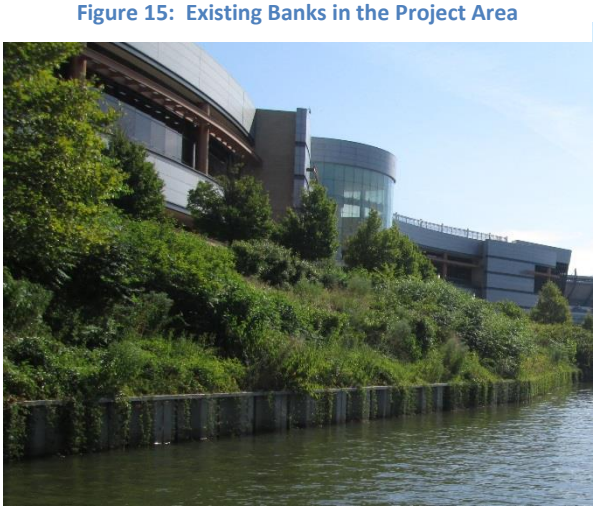
3.4.1.1.3.3 Greenwalls

Figure 14: Greenwall Pilot Project

In locations where vertical walls exist along the river bank and there is elevated risk of erosion threatening existing structures, such as in the downstream portion of the project area adjacent to the West End Bridge, vertical "greenwalls" may be installed in order to improve riparian habitat. These structures would either horizontal or vertically tiered planter beds installed into existing walls and planted with native riparian forbs and shrubs. A pilot project installation of low cost greenwalls on the Thames river is pictured in Figure 14. This measure would provide additional habitat for native birds, provide increased organic inputs to adjacent aquatic habitat and provide ancillary aesthetic benefits. This measure is primarily aimed at meeting planning objective 2. See Engineering Appendix (Appendix A), for an example of a Greenwall System Measure.

3.4.1.1.3.4 Floodplain Shelf

Figure 15: Existing Banks in the Project Area



In areas where the existing streambank is protected by a low wall or shallow-sloped rip rap (see Figure 15), a floodplain shelf could be installed. This would involve placement of fill material to create an approximately 25-foot low elevation riparian zone that is elevated above water by approximately one foot at normal pool levels. This area would be inundated during higher flows, increasing floodplain connectivity and providing organic inputs to the adjacent aquatic habitat zones. Additionally this would provide habitat for migratory bird species and other native wildlife and provide an overall increase in the abundance of riparian habitat. This measure is most applicable to the upstream portion of the project area. This measure is primarily aimed at meeting planning objectives 2 and 3. See Engineering Appendix (Appendix A), for an example of a Floodplain Shelf Measure.

3.4.1.1.4 Additional Recreation Measures and Opportunities for Ancillary Benefits

There are additional opportunities that could be conducted along with the primary measures in order to improve water quality, reduce runoff, enhance site aesthetics, and improve recreational opportunities within the project area. One such opportunity involves the daylighting of stormwater outflows. If construction activities occur in areas with stormwater outfalls and require the modification or relocation of these features, there is the potential to "daylight" them to provide areas where water is deposited onto riparian zones rather than directly into the water. This could help improve water quality and site aesthetics within the project area. Additionally, if any concrete is removed or damaged during construction activities and needs to be replaced, permeable materials could be used in order to improved groundwater infiltration and reduce runoff. There are also opportunities for trails and interpretive signs within the restoration areas to help educate visitors and provide enhanced access to the river. Abandoned docks and mooring areas could also be removed during construction activities to improve site aesthetics. Permissible recreation features (trails and signs) would be cost-shared at a 50-

50 ratio (as opposed to the 65-35 ratio for other project features). Other ancillary opportunities would only be implemented if they could be accomplished at no additional cost to the project or were the only method of accomplishing a selected measure targeted at ecosystem restoration. These measures are aimed at achieving objective 4.

3.4.2 Excluded Measures

Following is a list of measures that were originally considered but eliminated from alternative formulation.

3.4.2.1 Re-contouring

Originally, re-contouring of the aquatic habitat areas was considered in order to increase deep holes. This measure was eliminated due to concerns over feasibility and low potential benefits. It was also assumed that the existing topography was already conducive to habitat improvements proposed under other measures.

3.4.2.2 Non-structural Measures

Non-structural measures such as flow management, pool level changes, and land use changes were considered but they would either violate planning constraints or not meet the planning objectives for this project.

3.4.2.3 Ancillary Recreation Improvements

Originally, incorporation of a kayak launch was considered for inclusion in compatible alternatives. However, this measure was removed from further consideration as it is not included in the approved list of recreation measures in Planning Guidance Letter #59.

3.5 Formulation and Comparison of Alternative Solution Sets

3.5.1 Identifying Restoration Alternatives

Alternatives were formulated by combining the management measures using three general restoration "themes". This plan formulation strategy was used to develop distinguishable alternatives that meet the identified planning objectives. Due to the limited availability of land within this urban restoration project, alternatives were developed that sought to use the available land to maximize the potential benefits for aquatic habitat restoration, maximize the potential benefits for floodplain habitat, or maximize both aquatic habitat and floodplain habitats in balance with each other.

3.5.1.1 Combinability and Dependency of Management Measures

During the plan formulation process, the PDT looked at the combinability and dependency of various management measures in order to determine which measures could be combined into alternatives, which measures could not be combined, which could be combined but with caveats, and which measures were dependent upon each other for their implementation. The following table displays the combinability of management measures that were analyzed during plan formulation. All measures are combinable except where discussed below.

Aquatic Habitat Features – This measure is combinable with all measures but is dependent the "Remove Invasive Species" measure as it is re-using trees cleared during that process and also dependent upon one of the other aquatic habitat restoration measures (backwaters, perpendicular dikes, or parallel dikes) that would be used to anchor the large woody debris. Ultimately, this was not considered as an individual measure but as an add on for alternative 4

Backwaters – This measure is not be combinable with either parallel dikes or perpendicular dikes as these measures all occupy the same physical area within the river. Additionally, when combined with the "re-shape banks" measure, or the floodplain shelf measure, the overall project area available for this measure is reduced due to the 100 foot width limitations that were self-imposed to eliminate localized flooding concerns and due to depth considerations that exponentially increase costs associated with this measure. This measure cannot be combined with both the "re-shape banks" measure and the floodplain shelf measure as the latter two measures together would eliminate all available space in the 100 foot river width to implement this measure.

Parallel Dikes – Following the same logic as laid out in the backwaters description, this measure is not combinable with backwaters or perpendicular dikes, not combinable with both the "re-shape" banks and floodplain shelf measures, and combining with either of those two measures reduces potential restored acreage.

Perpendicular Dikes - Following the same logic as laid out in the backwaters description, this measure is not combinable with backwaters or parallel dikes, not combinable with both the "re-shape" banks and floodplain shelf measures, and combining with either of those two measures reduces potential restored acreage.

3.5.1.2 Alternatives Development, Cost Effectiveness and Incremental Cost Analysis

Management measures were combined into nineteen different alternatives according to the combinability and dependencies discussed in section 3.5.1.1. The list of alternatives represents combinations that had the potential to be cost effective based analysis of the individual measures and potential combinations but does not represent an exhaustive list of all possible combinations. These alternatives were analyzed for cost effectiveness using the estimated construction cost of the individual measures alone (not including contingencies, design costs, real estate, monitoring, interest rate, etc.). Alternatives that produced the same or more habitat units for less cost were considered "cost effective". All non-cost-effective measures were eliminated from further consideration (shown grayed out on the table below). Incremental cost analysis was conducted on the remaining ten cost effective measures and six were identified as "Best Buy" plans. These plans have the lowest incremental cost per habitat unit when compared to the next "Best Buy" plan, beginning with the No Action alternative. Of the ten cost-effective alternatives, the three that maximized habitat units under their respective theme (2 - aquatic habitat, 3 - floodplain habitat, and 4 - balanced aquatic and floodplain habitat) were selected and moved forward for more detailed alternative analysis.

The table below provides the cost effectiveness and incremental cost analysis for the alternatives considered. Both Annual Average Habitat Units (AAHUs) and Cumulative Habitat Units (CHUs) over the 50 year period of analysis are reported. See Table B-17 in Appendix B for additional details on the break-down of costs and benefits for each alternative. It should be noted that these cost estimates were generated earlier in the project and were not updated based on revised costs estimates generated during the agency technical review.

Table 2: Cost Effectiveness and Incremental Cost Analysis of Alternatives

Alternatives	Measures Included	AAHU	CHU	Construction Cost	Cost per CHU	Incremental Cost	Best Buy?
Alternative 1	No Action	0	0	0	NA	0	Y
Alternative 3a	Greenwalls	0.01	0.27	$ 98,750	$ 365,741		
Alternative 3b	Floodplain Wetland	0.24	12.00	$ 649,946	$ 54,162		
Alterantive 3c	Invasive Removal	0.25	12.35	$ 89,912	$ 7,280	$ 7,280	Y
Alternative 3d	Floodplain Shelf	1.23	61.60	$ 4,484,550	$ 72,801		
Alternative 3e	Reshape Banks	1.48	74.20	$ 2,328,000	$ 31,375		
Alterantive 2c	Substrate Alone	1.57	78.40	$ 1,055,700	$ 13,466	$ 14,622	Y
Alternative 4c	Wetland, Invasive Removal, Substrate	1.60	80.35	$ 1,364,158	$ 16,978	$ 158,184	
Alternative 3f	Reshape Banks, Invasive Removal	1.73	86.55	$ 2,417,912	$ 27,937		
Alternative 4d	Banks, Invasive Removal, Substrate	1.90	94.85	$ 2,222,501	$ 23,432	$ 70,930	
Alternative 2a	Backwater, Substrate	1.96	98.00	$ 3,383,700	$ 34,528		
Alternative 2	**Parallel Dikes, Substrate**	**1.96**	**98.00**	**$ 2,710,700**	**$ 27,660**	$ 84,439	
Alternative 2b	Perp. Dikes, Substrate	2.07	103.60	$ 5,144,400	$ 49,656		
Alternative 4a	Wetland, Banks, Invasive Removal, Substrate	2.14	106.85	$ 2,872,447	$ 26,883	$ 63,858	Y
Alternative 4b	Wetland, Banks, Invasive Removal, Backwater, Substrate	2.42	120.85	$ 5,200,447	$ 43,032		
Alternative 4	**Wetland, Banks, Invasive Removal, Par. Dikes, Substrate**	**2.54**	**126.85**	**$ 4,527,447**	**$ 35,691**	$ 82,750	Y
Alterantive 4e	Wetland, Banks, Invasive Removal, Perp. Dikes, Substrate	2.62	130.85	$ 6,961,147	$ 53,199		
Alternative 3g	Shelf, Banks, Invasive Removal	2.96	148.15	$ 6,902,462	$ 46,591	$ 111,503	
Alternative 3	**Wetland, Shelf, Banks, Invasive Removal**	**3.20**	**160.15**	**$ 7,552,408**	**$ 47,158**	$ 90,840	Y

3.5.2 Alternative Plan Descriptions

The following sections describe the alternative plans considered for this project. Plans were formulated based on the initial cost effectiveness and incremental cost analysis comparison, but were narrowed down to the no action alternative and those the maximized habitat units under their respective theme (2 - aquatic habitat focus, 3 - floodplain habitat focus, and 4 - balanced aquatic and floodplain habitat focus) were selected and moved forward for more detailed alternative analysis. This included development of additional cost details such as PED, real estate, cost contingencies and other related considerations. Although Alternative 4a was also identified as a "Best Buy" plan, Alternative 4 provided more outputs under this theme and was also identified as a "Best Buy" plan. Additionally, Alternative 4 increased the abundance of slackwater habitat / pools which was thought to be an important factor for both native fish and federally listed mussel species, the importance of which was not adequately highlighted by the aquatic model outputs.

3.5.2.1 Alternative 1: No Action

For all projects, the Corps is required to consider a "No Action" alternative. Under this alternative, the Corps would take no additional actions targeted at ecosystem restoration within the project area. However, other actions that can reasonably be expected to take place are considered within this alternative, such as private development within the project area. Existing trends in resource conditions will be used to estimate the changes in existing conditions from No Action over the planning horizon (50 years). This alternative will form the basis of comparison for the other alternative plans. See Section 3.3 for a description of the "Most Likely Future Without Project Condition" that would occur under this No Action alternative.

3.5.2.2 Alternative 2: Aquatic Habitat Focus

This alternative seeks to maximize the benefits associated with aquatic habitat within the near-shore (100 feet) aquatic zone of the project area. Although, alternative 2 was not considered a "Best Buy" plan, it was cost effective and provided the maximum amount of aquatic CHUs for any of the cost effective plans formulated under this alternative. Alternative 2b provided more CHUs but was not found

to be cost effective in comparison to other alternatives during plan formulation. This alternative would involve the restoration of 5.6 acres of aquatic habitat including 0.9 acres of acres of aquatic pools formed by 20 parallel dikes that are 50 feet long each, and 4.7 acres of improved substrate. Additional habitat features would be added including placement of boulders and large woody debris in existing deep holes to improve fisheries habitat. The cost for this alternative is estimated at $5,080,463.

3.5.2.3 Alternative 3: Floodplain Habitat Focus

This alternative would maximize floodplain habitat within the project area. It would include restoration of 7.3 acres of habitat, including a 0.4 acre wetland, 2.8 acres of re-shaped riparian banks, 2.2 acres of restored floodplain shelf habitat, 1.9 acres of invasive species removal and replanting with native species,. Compatible recreational features would be included with this alternative at a cost of $52,650 (less than 1% of project cost). These would include interpretative signs, soft trails, and replacing damaged concrete trails with permeable pavers. The total cost for this alternative is estimated at $13,808,110.

3.5.2.4 Alternative 4: Maximize Aquatic and Floodplain Benefits

This alternative would seek to maximize the potential benefits for both aquatic habitat and floodplain habitats within the project area while maximizing the cost effectiveness of potential management measures that share spatial footprints. This alternative would involve the restoration of 7.4 acres of habitat including 0.4 acres of floodplain wetlands, 1.0 acre of re-shaped riparian banks, 1.9 acres of invasive species removal and replanting with native species, 0.9 acres of aquatic pools formed by 20 parallel dikes that are 50 feet long each, and 3.1 acres of aquatic substrate modification. Inclusion of the "riparian shelf" measure within this alternative was originally considered but this was eliminated because it was not compatible with the parallel dikes measure. The inclusion of the "perpendicular dikes" measure in place of the parallel dikes was also considered during plan formulation. The benefits and costs of both the parallel and perpendicular dikes were evaluated and ultimately the parallel dikes provided a more cost effective means of creating slack water habitat. Additional details regarding these measures and comparison of cost effectiveness can be found in Section 3.5.3 and Table 6. Additional aquatic habitat features would be added including placement of large woody debris in deep holes to improve fisheries habitat. Compatible recreational features would be included with this alternative at a cost of $52,650 (less than 1% of project cost). These would include interpretative signs, soft trails, and replacing damaged concrete trails with permeable pavers. The cost for this alternative is estimated at $10,226,000.

3.5.3 Evaluation and Comparison of Alternative Plans

In order to assess the relative benefits of the alternative plans, two planning models were applied to the alternatives, which were then compared to the No Action Alternative in order to assess increase in the quantity and quality of habitat.

For riparian and floodplain habitats, the Floristic Quality Assessment (FQA) Model for the Mid-Atlantic Region (MAR) was utilized to assess the quality of restored habitats. This is a regional version of the FQA Coefficients of Conservatism for the Chicago Region which is approved for regional use by the Ecosystem Restoration Planning Center of Expertise (ECO PCX). The process for adapting the MAR FQA is discussed in "Developing coefficients of conservatism to advance floristic quality assessment in the Mid-Atlantic region." (Chamberlain and Ingram, 2012). The tool was accessed online at: http://apps.cei.psu.edu/fqacalc/

The MAR FQA was selected as it is applicable to the region in which the project occurs and provides a general index for riparian and wetland habitat quality. The model calculates both a mean "Coefficient of

Conservatism" (CoC) and a "Floristic Quality Index" (FQI) for a given species. These are methods of assessing the habitat nativity and resource condition of a plant community given a recorded or projected species list. Coefficients of Conservatism are assigned based on the degree of tolerance to which plants are adapted. Plants that score low (0-3) have high tolerance and are found in a variety of plant communities while plants that score (9-10) have a high degree of fidelity to a narrow range of habitats. Plants with higher scores tend to be more limited from an ecological perspective and are often important components of that natural community that are threatened by habitat pressures and are more desirable from a restoration perspective. The FQI score takes the mean CoC for a plant community and factors in the number of native plant species in the area to measure the "naturalness" of the site. For this project, we used the mean CoC as a metric of habitat quality. Since the mean CoC ranges from 0 to 10, dividing this number by 10 provides a habitat quality index that can be multiplied by a given acreage in order to obtain "habitat units" (HUs) that measure both the quantity and quality of habitat to be restored. The more acres restored and the higher the habitat quality of those acres (represented by the habitat quality index) will result in greater habitat units to be restored. Maximizing habitat units is desirable from an ecological perspective.

Similarly, the Smallmouth Bass Habitat Suitability Index (HSI) model was used to measure the benefits of aquatic habitat restoration measures (Edwards et. al., 1983). This model was selected because the life requisites of bass and habitat characteristics reflected in the model (such as pools, gravel substrates, and habitat structure) are important to a number of target species including walleye, paddlefish, and numerous mussel species. Additionally, the model was previously certified by the ECO PCX. Additional details on modeling efforts are contained in the Environmental Appendix.

Below are a series of tables summarizing the benefits and cost effectiveness analysis for the three action alternatives using the screening level cost estimates developed for the alternatives. "Shared costs" in these tables represent the cost for planning, engineering, and design; design during construction, construction management, and digital imagery collection. The No Action Alternative (Alternative 1) would have no costs and no benefits above and beyond the future without project condition. For the purposes of this evaluation and comparison, both aquatic and floodplain habitats were given equal weighting. Habitat units developed from both the quantity and quality of both habitat types and compared equally across all alternatives. The real estate costs for Alternatives 3 and 4 were estimated at the same cost because they both involved alteration of the same riparian area and similar portions of aquatic habitat. For Alternative 2, real estate costs were based on the need for a 3 year easement for a staging area and additional costs required to secure interests for in-water work. In tables 3, 4, and 5, average annual habitat units (AAHU), cumulative habitat units (CHU), and total estimated cost (Cost) are reported. Total cost is then compared to CHU as a measure of cost effectiveness. Costs were only annualized for the recommended plan (see section 3.6) because a project first cost was not developed for each of the alternatives. The total cost / CHU was assumed to be a representative comparison of annualized cost / AAHU for the purposes of cost effectiveness comparison amongst alternatives.

Table 3: Alternative 2 Cost Effectiveness Analysis

Measure	Acres	AAHU	CHU	Cost	Cost per CHU
Par. Dikes / Substrate	5.6	1.96	98.00	$3,213,640	$32,792
Real Estate				$158,000	
Shared Costs				$724,331	
Contingency				$984,493	
TOTAL	**5.6**	**1.96**	**98.0**	**$5,080,463**	**$51,841**

Table 4: Alternative 3 Cost Effectiveness Analysis

Measure	Acres	AAHU	CHU	Cost	Cost per HU
Floodplain Wetland	0.4	0.24	12.00	$ 709,682	$ 59,140
Floodplain Shelf	2.2	1.23	61.60	$ 4,674,450	$ 75,884
Reshape Banks	2.8	1.48	74.20	$ 2,794,000	$ 37,655
Invasive Removal	1.9	0.25	12.35	$ 207,770	$ 16,823
Recreational Features				$ 52,650	
Real Estate				$ 885,000	
Shared Costs				$ 1,899,936	
Contingency				$ 2,584,622	
TOTAL	**7.3**	**3.2**	**160.2**	**$ 13,808,110**	**$ 86,220**

Table 5: Alternative 4 Cost Effectiveness Analysis

Measure	Acres	AAHU	CHU	Cost	Cost per HU
Floodplain Wetlands	0.4	0.24	12.00	$ 709,682	$ 59,140
Reshape Banks	1.0	0.53	26.50	$ 1,873,129	$ 70,684
Invasive Removal	1.9	0.25	12.35	$ 207,770	$ 16,823
Par. Dikes / Substrate	4.0	1.52	76.00	$ 2,705,240	$ 35,595
Recreational Features				$ 52,650	
Real Estate				$ 885,000	
Shared Costs				$ 1,249,668	
Contingency				$ 1,699,535	
TOTAL	**7.3**	**2.54**	**126.9**	**$ 9,382,673**	**$ 73,967**

Plans were then compared based on the extent to which they addressed the planning objectives and did not violate the constraints. A relative comparison of High, Medium, Low, and None was made as to the extent to which each of the planning objectives was achieved by the alternatives and the extent to which each of the planning constraints was avoided by the alternatives. The No Action alternative did not meet any of the objectives. Alternative 2 was very effective at meeting Objective 1 (aquatic habitat) but less effective at meeting floodplain habitat and connectivity objectives, and less effective than other alternatives at providing ancillary benefits to recreation and aesthetics as the measures were not compatible with the development of additional soft trails or removal of dilapidated infrastructure. Alternative 3 was less effective at meeting Objective 1, but was highly effective at meeting all other planning objectives. Alternative 4 was highly effective at meeting all of the stated planning objectives.

The No Action alternative was successful at avoiding all of the planning constraints. Alternative 2 was highly effective at avoiding potential impacts to all of the constraints except for a temporary impact to recreational usage during construction (which was also the case for alternatives 3 and 4). Alternatives 3 and 4 also had a slight potential to impact Constraint A: Avoid Disturbance of HTRW sites. This is because these two alternatives involve disturbance of the river bank for construction purposes and construction of a wetland where a road currently exists. A summary table is provided below.

Table 6: Alternatives Comparison against Planning Objectives and Constraints

	Objectives				Constraints				
Alternatives	1: Aquatic Habitat	2: Floodplain Habitat	3: Functions & Connectivity	4: Ancillary Benefits	a: HTRW	b: Development	c: Businesses & Recreation	d: Flood Risk	e: Navigation
1: No Action	None	None	None	None	High	High	High	High	High
2: Aquatic Focus	High	None	Low	Med	High	High	Med	High	High
3: Floodplain Focus	Low	High	High	High	Med	High	Med	High	High
4: Floodplain and Aquatic Focus	High	High	High	High	Med	High	Med	High	High

Alternatives were also compared based on the extent to which they met the four criteria identified in the 1983 "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies." These criteria are described below along with the specific metrics used to assess the performance of each alternative against these criteria and the scores used to rank their performance.

Completeness: The extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects. For this study, completeness was determined based on the inherent risk involved in implementation. Alternatives 1 and 2 were considered to be the most complete as they had negligible risks associated with their implementation when compared to the other alternatives. These were both awarded a score of 10. Alternatives 3 and 4 both had elevated risk of implementation associated with the wetland measure and removal of the pier (see Section 3.5.5). This wetland measure involves some risk associated with the ability of the sponsor to acquire the necessary land from the city as well as some cost risk associated with utility re-locations. Based on these risks, these alternatives were awarded a score of 7.

Effectiveness: The extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities. The performance against the planning objectives was used to assess effectiveness of alternatives for this study. A score of 10 was awarded if it performed highly at meeting all four planning objectives down to a score of zero if it met no planning objectives. Scores in between were awarded based on the extent to which they met each of the objectives using the High, Med, and Low rankings from the table above to award fractional points when applicable.

Efficiency: The extent to which an alternative plan is the most cost effective means of alleviating the specified problems and opportunities. The results of the cost effectiveness and incremental cost analysis were used to assess efficiency for this study. A score of 10 was awarded for Best Buy plans (Alternative 1, 3, and 4) and a score of 5 was awarded for cost effective plans.

Acceptability: The workability and viability of the alternative plan with respect to acceptance by State and local entities and the public and compatibility with existing laws, regulations and public policies. The extent to which alternatives avoided potential constraints was used to assess acceptability for this study. A score of 10 was awarded if it performed highly at avoiding all five planning constraints down to a score of zero if it completely violated all constraints. Scores in between were awarded based on the extent to which they performed against the constraints using the High, Med, and Low rankings from the table above to award fractional points when applicable. The final adjusted cost of Alternative 3 made this alternative potentially unacceptable for implementation under the Section 206 authority as the federal investment would be greater than $10,000. The existing federal costs for this alternative are very close to the federal investment limit and it was assumed that a fully developed cost estimate with line item specific contingencies, adaptive management costs and O&M costs would have put it over that limit. While this alternative could still be implemented, the sponsor would either have to pay the difference or it would have or it would have to be pursued under a General Investigation authority,

requiring a specific authorization from Congress. Both of these scenarios make this Alternative much less likely to be implemented. Based on this, 5 points were deducted from the acceptability score.

The performance of the alternatives against these four criteria is illustrated in the table below. Of the action alternatives, Alternative 4 performed best, Alternative 2 was second, and Alternative 3 performed the worst.

Table 7: Performance of Alternatives against the Principles and Guidelines Criteria

	Completeness	Effectiveness	Efficiency	Acceptability	Total
1: No Action	10	0	10	10	30
2: Aquatic Focus	10	5	5	9.3	29.3
3: Floodplain Focus	7	8.3	10	3.6	28.9
4: Floodplain and Aquatic Focus	7	10	10	8.6	35.6

The significance of outputs was also assessed for the three action alternatives. Alternative 2 would provide improvements in substrate and aquatic habitat beneficial to native fish species and mussel species, including federally listed mussel species. Alternative 3 would provide wetland habitat that is nationally scarce and important for a regional flyway used by migratory birds. Alternative 4 would provide both of the significant habitat types of Alternative 2 and Alternative 3, making it the best performer with regard to habitat significance.

3.5.4 Risk and Uncertainty

This study was undertaken using Risk Informed Decision Making to ensure that study, implementation, and project outcome risks were taken into account when formulating plans, selecting a plan for implementation, and during feasibility- level design efforts. A discussion of risk and uncertainty allows the Project Design Team (PDT) and Project Sponsor (Sponsor) to assess risks likely to be encountered as well as the consequences that could result from actions taken (or not taken) and items considered (or not considered) during each stage of the Project. The risks and uncertainties for this project have been summarized in both a study and a cost engineering "Risk Register" which can be found in Appendices E and C, respectively. Each item listed in the risk registers was assigned a rating. This summarizes, in numeric form, the probability that a certain risk is "likely to occur, should be given additional weight during design efforts; etc. or otherwise defined as risky from the perspectives of Project formulation, design, implementation or monitoring."

Moderate risks for this project include concerns over potential impacts to ESA-listed species, the potential to encounter HTRW resources during construction, potential real estate access concerns, and concerns over the ability of the sponsor to conduct operations and maintenance activities.

While there is a low potential for ESA-listed mussel species to occur within the project area, there is a still a risk they may be encountered during construction. Overall the project should have a long-term benefit for these species, but if they are present in the project area, there could be a short-term negative impact. In order to address this risk, a pre-construction mussel survey would be conducted in order to identify the presence or absence of listed species, with the potential to relocate either temporarily or permanently any species discovered in the project area based on continued coordination with the US Fish and Wildlife Service.

It is fairly certain that HTRW resources are present within the project area. As such, one of the constraints formulated for this project was to avoid and/or minimize to the maximum extent

practicable, any potential disturbance of these resources. Project alternatives were formulated with this risk in mind, as remediation that may be necessary is the sole burden of the non-federal sponsor. While the recommended plan does involve some ground disturbing activities, the only materials proposed to be removed from the site are concrete and gravel fill materials from the existing road, any concrete from damaged trails, and portions of concrete and corrugated metal that would be removed from high banks. All other materials would remain undisturbed. Therefore, it was the decision of the PDT to accept this risk and proceed with the recommended plan. Additional risks exist that potential future HTRW remediation (or lack thereof) at or near the site may negatively affect project benefits achieved by the recommended plan. However, past development activities at or near this site have not required large-scale remediation efforts that would disturb restored areas at the project site and, if these actions did take place, it is assumed that any disturbed areas would need to be restored to the pre-action condition. If this is the case, project benefits would persist, although there may be a temporary disturbance.

There is also a risk that real estate interests for site access and construction may not be able to be obtained. While the non-federal sponsor has been in contact with landowners in the area and is fairly certain proper interests can be obtained, ability to construct the project is potentially affected by this risk. The non-federal sponsor has chosen to accept this risk and proceed with project with the knowledge that they will be responsible for obtaining these interests.

The Rivers Casino has indicated their intent to build a hotel in the study area within the next 5 years. The proposed project has not received city approval, but multiple alternatives have been developed. The PDT worked in coordination with the Casino to determine a 'worst case' scenario in terms of access and land use. The final recommendation for temporary easements and placement of the constructed wetland have incorporated these considerations in order to mitigate any potential impact to feature placement or function. A potential expansion of the Science Center would be outside of the project study area and would have minimal impact on the recommended alternative.

A risk associated with post-construction project success is the ability of the sponsor to conduct operations and maintenance of project features. In order to address this risk, the sponsor is seeking a partner as a signatory to the Project Partnership Agreement that will assist with implementation of the required O&M activities.

While stormwater and rainwater are often used for constructed wetlands for the purpose of improving water quality (EPA, 1993), there is uncertainty about the particular water quantity and quality at the location of the restored wetland analyzed for this study. During the design phase, additional investigation into the quality of water should be undertaken, as this could affect the ultimate selection of plants necessary to effectively treat potential pollutants. Additionally, the quantity of water anticipated should be further analyzed as to how much water may come from the stormwater outflow and from the adjacent planned rain garden. It is possible that only the rain garden may be necessary in order to maintain the water level necessary for the success of the wetland, in which case, the stormwater may not be re-routed into the wetland. Additionally, preliminary constructed wetland sizing and location have been chosen based on Pennsylvania Department of Environmental Protection (PADEP) best management practices guidance criteria for type, size, and application of such a wetland measure. There may be risks associated with meeting all of these criteria. Each of these criteria will be reviewed in detail and incorporated in the final design of the wetland measure.

3.5.5 Risk Associated with Cost and Engineering Considerations

Two notable risks were identified associated with the cost estimate as part of an abbreviated risk analysis that was conducted. One is related to unknown conditions of an existing pier structure that is to be removed as part of the project. The pier is in disrepair and is not believed to be structurally sound. However, the construction materials used for the core of the pier are unknown. As such, it was assumed that approximately 75% of the pier's core is filled with material (likely rubble or some similar material). The other risk is costs associated with utility relocations that would be required to implement the wetlands restoration portion of the recommended plan. Currently, there are sewer lines and stormwater lines that are assumed to be at this area, as well as some buried electrical wiring. However, it is unknown whether additional utilities such as gas lines and fiber optic cables exist within the footprint that would need to be relocated. Cost contingencies were adjusted for these items to address the associated risks. Refer to the risk register matrix in Appendix C for a comprehensive discussion of these risks. Refer to the Engineering Appendix (Appendix A) for associated Engineering Considerations.

3.6 RECOMMENDED PLAN

Alternative 4 was identified as the National Ecosystem Restoration plan, and the recommended plan. This alternative is highly effective at meeting all of the identified objectives, was the most effective at meeting the four Principles and Guidelines Criteria, provided for both types of significant habitat identified, and was identified as a "Best Buy" plan using cost effectiveness and incremental cost analysis (see section 3.5.3). It includes compatible recreation features that comprise less than 1% of the total project cost (within the allowable 10% threshold), and is within the overall federal cost investment limit of the 206 program of $10,000,000. A more detailed cost estimate was conducted on the recommended plan. Based on October 2015 price levels, the estimated project first cost is $10,266,000 which includes monitoring and adaptive management costs of $376,000 (including cost contingencies). The Federal share of the project first cost is estimated to be $6,672,900 and the non-Federal share is estimated to be $3,593,100 which equates to 65% Federal and 35% non-Federal. The Fully Funded cost escalated to the midpoint of construction is estimated to be $10,798,000. The estimated total federal cost of the project (including feasibility costs) is $7,248,000). The annualized costs over the period of project performance (50 years) are estimated at $424,054. The AAHUs estimated for this project are 2.54 over this same period yielding a cost/AAHU of $166,950.

Table 8: Annualization of Recommended Plan Costs

	Recommmended Plan
Investment	
First Cost	$10,266,000
Interest During Construction (9 Months @ 3-1/8%)	$119,377
Total Investment, Rounded	$10,385,377
Average Annual Cost	
Interest & Amortization	$413,265
Estimated Annual Operation & Maintenance	$10,789
Total, Average Annual Costs, Rounded	$424,054
*Based on an economic life of 50 years at 3 -1/8%	

3.6.1 Recommended Plan Description

Alternative 4 was identified as the NER plan and the recommended plan. Following is a description of the management measures associated with this alternative:

Substrate Placement: Placement of larger diameter gravels to improve aquatic habitat for fish species. The existing substrates in the project area are largely comprised of silts, muds, and sands. Gravel would be added to the riverbed providing important spawning habitats for many fish species including paddlefish, walleye, sauger, river redhorse and other native fish species of concern. This area is identified in Figure 6 in tan. Placement of substrate to improve aquatic habitat will not involve excavation or disturbance of existing soil that could be potentially contaminated.

Parallel Dikes: Construction of dikes parallel to the river bank for the purpose of creating slack water areas shoreward of the dikes. These features could have the added benefit of providing bank protection for existing or restored shoreline habitat. This area is identified in Figure 6 in brown. Construction dikes will not involve excavation or disturbance of existing soil that could be potentially contaminated.

The riparian features include four main components:

Re-shape Existing Banks: Placement of additional fill materials to re-establish a more natural bank line and re-establish some floodplain connectivity. This measure would also include planting of native species and removal of any invasive species in the affected area and could be accomplished in conjunction with aquatic habitat restoration management measures. A combination of natural and engineered bank stabilization would likely need to be considered in order to ensure these areas remain stable in the future and do not experience excessive erosion. This area is identified in Figure 6 in yellow. Re-shaping of existing banks by placement of additional fill materials in-water and along the banks of the river will require very minimal disturbance (depth of less than 1 ft) of existing surface soils. Therefore, disturbance of potentially contaminated surficial soil is expected to be minimal.

Invasive removal and native replanting: Removal and treatment of these plants, followed by planting of native species. This will improve the existing plant community and reduce the potential for a future monoculture of invasives within the project area. This area is identified in Figure 6 in green. Removal of invasive species and native replanting will involve minimal disturbance of potentially contaminated soil identified during the Phase I ESA. Depth of soil disturbance in this location is expected to be less than 4 feet.

Constructed wetland: Utilize water an existing stormwater outflow that would need to be daylighted to create a wetland. During design efforts, further coordination would occur on the potential to use water from a planned rain garden being developed by Rivers Casino on adjacent property. This water would likely contain less nutrient pollution and sediment than the stormwater runoff and would require less operations and maintenance. If feasible, this would be the more desirable source of water. Native wetland plants would be planted within the wetland which would provide benefits for migratory bird species as well as ancillary water quality benefits. A list of candidate wetland species is included in Appendix B, however, this list may be refined during design efforts to adapt to planned depths and anticipated water quality. Wetland habitats are of national significance and within the immediate, urbanized area, this is a limited habitat type. This area is identified in Figure 6 in blue. PADEP Best Management Practices related to constructed wetland application, type and sizing, will be applied to final design efforts. The currently proposed location of the constructed wetland allows for design criteria flexibility (such as limiting the area contributing to the wetland, varying permanent pool depth; etc.) so that the final product will meet the stated objectives of the recommended alternative.

When developing the feasibility-level design for the recommended plan, the PDT considered the sensitivity of the project features to climate change and potential ways to bolster resilience. If water temperatures during the growing season of fish species (May – October) increased by greater than 10 degrees Celsius, this would negatively impact forecasted habitat quality for the suite of alternatives considered in this study. However, it is highly unlikely this would occur under any climate change scenario. If water levels decrease during prolonged droughts, this could negatively affect habitat conditions in the area and decrease the overall availability of habitat during these times, however, this could also result in vegetation establishment that, once submerged during regular flows, provides additional habitat structure for fish species and increases in local primary productivity. However, it should be noted that the system is managed to maintain fairly consistent pool levels within a designated band to support navigation within the project area so changes to water levels due to climate change should not be a concern within the project area. The bigger risk from extended droughts is desiccation of wetland species. The design of the wetlands includes an impervious clay cap that will hold water until it overflows into the river which should make the wetland more resilient to these types of changes and allow it to better perform under shore term drought scenarios. Warmer climates may negatively impact native species plantings and could lead to increased spread of invasive species. However, the spread of invasives and replacement of native species lost over time should be addressed as part of operations and maintenance of the project. More tolerant species were selected for plantings to address this potential risk and enhance resiliency.

The recommended plans seeks a balanced floodplain and aquatic habitat plan to maximize the potential environmental benefits within project area. While space and development constraints limit the amount of property available for improvements therefore the proposed alternative seeks to maximize impact within the funding constraints of the 206 program.

Potential areas of contaminated soil and groundwater identified during the Phase I ESA are located within the wetland area. However, soil disturbance in this location is expected to be less than 7 feet and groundwater is not likely to be encountered during excavation.

Figure 16: Plan View of the Recommended Alternative

Figure 17: Conceptual Drawing of the Completed Project

3.6.2 Estimated Project Costs and Schedule

The full breakdown of cost of project features for each alternative is included in Appendix C. Table 8 shows the breakdown for costs between feasibility, design and construction phases and estimated expenditures per year with project initiation in FY 15 and closeout projected in FY 19.

Table 9 – Estimated Project Costs and Apportionment (Including Contingency)*

	FY2015	FY2016	FY2017	FY2018	Total
Feasibility Study Costs*					
FED share	$ 53,105	$ 175,895			$ **229,000**
non-FED cash					
non-FED WIK		$ 129,000			$ **129,000**
Total Feasibility Cost	$ 53,105	$ 304,895	$ -	$ -	$ **358,000**
Design & Implementation Costs					
Design Analyses, Plans & Specs			$ 1,174,000		$ 1,174,000
Construction				$ 7,201,000	$ 7,201,000
Construction Management				$ 564,000	$ 564,000
LERRDs				$ 885,000	$ 885,000
Recreation				$ 66,000	$ 66,000
Monitoring & Adaptive Management				$ 376,000	$ 376,000
Total Project Cost	$ -	$ -	$ **1,174,000**	$ **9,092,000**	$ **10,266,000**
FED share of Total Project Cost			$763,100	**$5,898,650**	$ 6,662,550
non-FED share of Total Project Cost			**$410,900**	$3,203,700	$ 3,603,450
non-FED cash			**$410,900**	$2,308,350	$ 2,718,450
non-FED WIK			$0	$0	
non-FED LERRDs				$885,000	$885,000

* Recreational features account for $69,000 of total project costs and have been adjusted to a 50/50 cost share. The remainder of the PED and construction costs are divided 65% Federal/35% Non-Federal

Table 10 - Implementation Schedule

Milestone	**Scheduled**	**Actual**
Initiate Feasibility Phase	6/3/2014	6/3/2014
Submit Federal Interest Determination Report	11/25/2014	11/25/2014
MSC Approved FID report	11/25/2014	11/25/2014
Execute Feasibility Cost Share Agreement	6/29/2015	6/29/2015
Submit MSC Decision Milestone Draft DPR	3/18/2016	4/26/2016
MSC Approved MDM Draft DPR	5/16/2016	
Submit draft Final DPR	7/10/2016	
MSC Approved Decision Document	8/10/2016	
Project Approval - Initiate D&I phase	9/10/2016	
Fully Executed PPA	9/30/2016	
RE Certification	1/15/2017	
ATR Certified Construction Plans and Specifications	6/16/2017	
Construction Contract Award	9/12/2017	
Construction Complete	7/23/2018	
Project Closeout	10/15/2018	

3.6.3 Non-Federal Sponsor Responsibilities

Riverlife is the non-Federal sponsor for this project, and is responsible for 35 percent of the project costs. Up to 50 percent of the non-Federal share of project implementation costs can be provided as in-

kind services, and operation and maintenance of those projects is a non-Federal responsibility. This section describes the primary non-Federal Sponsor responsibilities in conjunction with the Federal Government to implement the recommended plan.

The Feasibility Study and plans and specifications costs shall be included as part of the total project costs to be shared 65 percent Federal and 35 percent non-Federal. The non-Federal Sponsor shall:

• Provide all LERRDs.

• Provide, during construction, any additional costs as necessary to make the total non-Federal contributions equal to 35 percent of the total project costs. The sponsor will provide work in kind during final design and construction as well as providing the post-construction monitoring. The non-Federal share is estimated at $885,000. The value of the LERRDs needed for the project will be deducted from this amount.

• Operate, maintain, repair, replace, and rehabilitate the completed project or functional portion of the completed project at no cost to the Federal Government, in accordance with the applicable Federal and State laws and any specific directions prescribed by the Federal Government for so long as the project is authorized.

• Hold and save the Federal Government harmless from damages due to the construction and operation and maintenance of the project, except where such damages are due to the fault or negligence of the Federal Government or its contractors.

• Grant the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon land which the non-Federal Sponsor owns or controls for access to the project for the purpose of inspection, and, if necessary, for the purposes of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.

• Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs for a minimum of three years after completion of the project construction for which such books, records, documents, and other evidence are required.

• Perform, or cause to be performed, any investigations for hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way necessary for construction, operation, and maintenance of the project; except that the non-Federal Sponsor shall not perform such investigations on lands, easements, or rights-of-way that the Federal Government determines to be subject to the navigation servitude without prior specific written direction by the Federal Government.

• Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA-regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines are necessary for construction, operation, and maintenance of the project.

• Agree that, as between the Federal Government and the non-Federal Sponsor, the non-Federal Sponsor shall be the operator, and all categories of potentially responsible parties, of the project for the

purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA.

• Prevent obstructions of, or encroachments on, the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) that might reduce the aquatic ecosystem restoration, hinder its operation and maintenance, or interfere with the proper function such as any new development on project lands or the addition of facilities that would degrade the benefits of the project.

• Not use Federal funds to meet the non-Federal Sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized.

4 ENVIRONMENTAL EFFECTS OF ALTERNATIVE PLANS

The following section discusses the potential impacts of the four detailed alternatives with regard to the resources identified. These four alternatives adequately represent the range of potential effects that could occur under the broader suite of alternatives considered during the cost effectiveness and incremental cost analysis.

4.1 CLIMATE

The action alternatives (2,3 and 4) are not anticipated to affect the climate of the region. However, projections indicate that the climate will change within the project area over the next 50 years under the future without project condition as a result of the No Action alternative. Over this period, average air temperatures in the winter are projected to increase between 2.5 and 4 degrees Fahrenheit on average while summer temperatures are projected to increase between 1.5 and 3.5 degrees Fahrenheit, with more pronounced heat waves and temperature extremes (Frumhoff, et. al., 2007). Winter precipitation in the region is anticipated to increase by between 10 and 20 percent with more occurring as rain rather than snow. Summer precipitation is projected to remain fairly consistent overall but more extreme precipitation events are expected as well as increased frequency of short-term droughts. For stream flows, peak spring flows are expected to occur nine days earlier, with high flow events occurring more frequently. However, it should be noted that the system is managed to maintain fairly consistent pool levels within a designated band to support navigation within the project area so changes to water levels due to climate change should not be a concern within the project area. Summer is projected to begin six to eleven days earlier and last 10 to 16 days longer and the growing season may extend by two to four weeks. Water temperatures within the project area may increase slightly over the next 50 years due to Climate Change. Overall, no significant impact to climate is anticipated as a result of the recommended plan.

4.2 SOILS

4.2.1 Alternative 1: No Action

Under the No Action Alternative, additional forecasted development adjacent to the project area is likely to disturb soils. However, these areas have been highly disturbed in the past and are unlikely to be adversely impacted. No significant impact to soils are anticipated.

4.2.2 Alternative 2: Aquatic Focus

Under Alternative 2, no additional alterations to soils would occur within the project area. No significant impact to soils are anticipated.

4.2.3 Alternative 3: Floodplain Focus

Under Alternative 3, existing riverbanks would be altered by extending them into the near-shore area of the river. Additionally, soils within the footprint of the proposed wetland area would be amended to make them suitable for the restoration of wetlands. Since this area is currently a road, this is considered an overall improvement to soils in the project area. No significant impact to soils are anticipated.

4.2.4 Alternative 4: Preferred Alternative

Under the preferred alternative, existing riverbanks would be altered by extending them into the near-shore area of the river. Additionally, soils within the footprint of the proposed wetland area would be amended to make them suitable for the restoration of wetlands. Since this area is currently a road, this is considered an overall improvement to soils in the project area. No significant impact to soils are anticipated.

4.3 SURFACE WATERS AND OTHER AQUATIC RESOURCES

4.3.1 Surface Water

4.3.1.1 Alternative 1: No Action

Under the No Action alternative, no significant impact to surface waters is anticipated.

4.3.1.2 Alternative 2: Aquatic Focus

Under Alternative 2, the existing near-shore surface water area within the project site would be altered through the placement of more natural floodplain habitat features including backwaters, habitat structure, and gravel bars totaling approximately 5.6 acres of habitat. These flow obstructions are likely to cause a small loss in local conveyance within the Ohio River, but no significant change is anticipated. The hydraulic analysis conducted recommends that less than 100 feet of obstruction from the shoreline should have negligible impacts on the water surface elevation, velocity, and shear stress through the study area (see the Engineering Appendix). Under this alternative, a maximum of 50 feet from the shoreline would be obstructed by restoration features. Under this alternative, no significant impact to surface waters is anticipated.

4.3.1.3 Alternative 3: Floodplain Focus

Under Alternative 3, the overall area of surface water within the project area would be reduced by approximately 5 surface acres to facilitate the restoration of riparian floodplain habitats. This would infringe on up to 100 feet of the river. However, the river is between 1,000 and 1,200 feet wide in this location and the section of the river immediately adjacent to the project area constitutes approximately 106 surface acres. As a conservative estimate, less than 5% of the immediately adjacent river would be converted to floodplain habitat. The hydraulic analysis conducted recommends that less than 100 feet of obstruction from the shoreline should have negligible impacts on the water surface elevation, velocity, and shear stress through the study area (see the Engineering Appendix). Under this alternative, a maximum of 100 feet from the shoreline would be obstructed by restoration features.

Water quality may be negatively impacted temporarily during construction. As material is placed in the river to re-shape the banks and construct floodplain shelf habitats, it is likely that local turbidity would increase as some of this material is transported downstream by river currents. However, the Ohio River experiences periods of high turbidity at times (greater than 50 NTUs) so this temporary increase in turbidity is not out of the ordinary in this area and would not represent a significant negative impact. Under this alternative, no significant impact to surface waters is anticipated.

4.3.1.4 Alternative 4: Preferred Alternative

Under the Preferred Alternative, the overall area of surface water within the project area would be reduced by approximately 4 surface acres to facilitate the restoration of riparian floodplain and aquatic habitats. This would infringe on up to 50 feet of the river. However, the river is between 1,000 and 1,200 feet wide in this location and the section of the river immediately adjacent to the project area constitutes approximately 106 surface acres. As a conservative estimate, less than 5% of the immediately adjacent river would be converted to floodplain habitat. The hydraulic analysis conducted recommends that less than 100 feet of obstruction from the shoreline should have negligible impacts on the water surface elevation, velocity, and shear stress through the study area (see the Engineering Appendix). Under this alternative, a maximum of 50 feet from the shoreline would be obstructed by restoration features.

Water quality may be negatively impacted temporarily during construction. As material is placed in the river to re-shape the banks and construct floodplain shelf habitats, it is likely that local turbidity would increase as some of this material is transported downstream by river currents. However, the Ohio River experiences periods of high turbidity at times (greater than 50 NTUs) so this temporary increase in turbidity is not out of the ordinary in this area and would not represent a significant negative impact. Under this alternative, no significant impact to surface waters is anticipated.

4.3.2 Groundwater

4.3.2.1 Alternative 1: No Action

Under the No Action alternative, groundwater recharge via surface water infiltration will continue to be limited due to abundance of impervious surfaces within and adjacent to the project area. As little change from the existing condition is expected, no significant impact to groundwater is anticipated.

4.3.2.2 Alternative 2: Aquatic Focus

The proposed management measures under Alternative 2 are centered around aquatic restoration and should have no effect on groundwater. No significant impact to groundwater resources is anticipated.

4.3.2.3 Alternative 3: Floodplain Focus

Under Alternative 3, the area of natural, pervious surfaces would be increased through the restoration of riparian shelf and re-shaping of existing banks. These measures are expected to provide a small increase in groundwater recharge within the project area and are not expected to have any negative impacts on groundwater resources. No significant impact to groundwater resources is anticipated.

4.3.2.4 Alternative 4: Preferred Alternative

Under the Preferred Alternative, the area of natural, pervious surfaces would be increased through the re-shaping of existing banks. Additionally, 0.7 acres of existing impervious surface (road to wetlands, impervious path to pervious path) would be removed and replaced with pervious surfaces. This measure is expected to provide a small increase in groundwater recharge within the project area and is not expected to have any negative impacts on groundwater resources. No significant impact to groundwater resources is anticipated.

4.3.3 Flood Plains

4.3.3.1 Alternative 1: No Action

Under the No Action alternative, it is likely that some additional structures will be constructed within the 0.2% chance floodplain, however, these areas are already heavily urbanized and no significant impact to floodplains is anticipated.

4.3.3.2 Alternative 2: Aquatic Focus

The measures proposed under Alternative 2 do not involve any changes to the floodplain directly and have been formulated to ensure that no adverse effect to flooding will result, consistent with Constraint D. The hydraulic analysis conducted recommends that less than 100 feet of obstruction from the shoreline should have negligible impacts on the water surface elevation, velocity, and shear stress through the study area (see the Engineering Appendix). Under this alternative, a maximum of 50 feet from the shoreline would be obstructed by restoration features. As this is a riverfront ecosystem restoration project, there is no practicable alternative to siting this project in the floodplain. No significant adverse impact is anticipated.

4.3.3.3 Alternative 3: Floodplain Focus

Alternative 3 would involve the creation of approximately 5.0 additional acres of floodplain habitat. Similar to Alternative 2, this alternative was formulated to ensure that no adverse effect to flooding will result, consistent with Constraint D. The hydraulic analysis conducted recommends that less than 100 feet of obstruction from the shoreline should have negligible impacts on the water surface elevation, velocity, and shear stress through the study area (see the Engineering Appendix). Under this alternative, a maximum of 100 feet from the shoreline would be obstructed by restoration features. As this is a riverfront ecosystem restoration project, there is no practicable alternative to siting this project in the floodplain. No significant adverse impact is anticipated.

4.3.3.4 Alternative 4: Preferred Alternative

The Preferred Alternative would involve the creation of approximately 1.0 additional acres of floodplain habitat. Similar to Alternatives 2 and 3, this alternative was formulated to ensure that no adverse effect to flooding will result, consistent with Constraint D. The hydraulic analysis conducted recommends that less than 100 feet of obstruction from the shoreline should have negligible impacts on the water surface elevation, velocity, and shear stress through the study area (see the Engineering Appendix). Under this alternative, a maximum of 50 feet from the shoreline would be obstructed by restoration features. As this is a riverfront ecosystem restoration project, there is no practicable alternative to siting this project in the floodplain. No significant adverse impact is anticipated.

4.3.4 Wetlands

4.3.4.1 Alternative 1: No Action

The No Action alternative would not involve the alteration of any wetlands. No significant impact is anticipated.

4.3.4.2 Alternative 2: Aquatic Focus

Alternative 2 would not involve the alteration of any wetlands. No significant impact is anticipated.

4.3.4.3 Alternative 3: Floodplain Focus

Alternative 3 would involve the creation of approximately 0.4 acres of wetland within the project area. In addition, re-shaping existing banks and creating riparian shelf habitats would increase the acreage of wetlands at the river-land interface. An overall positive impact on wetlands is anticipated and no significant adverse impact on wetlands is anticipated as a result of this alternative.

4.3.4.4 Alternative 4: Preferred Alternative

The Preferred Alternative would involve the creation of approximately 0.4 acres of wetland within the project area. Restoring these wetlands within a highly urbanized area would provide a significant regional benefit. In addition, re-shaping existing banks would increase the acreage of wetlands at the

river-land interface. An overall positive impact on wetlands is anticipated and no significant adverse impact on wetlands is anticipated as a result of this alternative.

4.4 WILDLIFE HABITATS

4.4.1 Riparian and Aquatic Vegetation

4.4.1.1 Alternative 1: No Action

Under the No Action alternative it is anticipated that riparian vegetation would continue to degrade due to the continued expansion of invasive species within the project area. As many of these areas are already degraded due to the prevalence of invasive species, no significant impact is anticipated. Aquatic vegetation is likely to remain similar to its existing state, which is fairly limited in the project area.

4.4.1.2 Alternative 2: Aquatic Focus

Under Alternative 2, riparian vegetation would be unaffected. There may be some benefit to aquatic vegetation under this alternative as slack-water and lower velocity areas may provide more suitable conditions for the establishment of aquatic vegetation. No significant adverse effects are anticipated.

4.4.1.3 Alternative 3: Floodplain Focus

Under Alternative 3, existing invasive species would be removed from approximately 1.9 acres and an additional 5 acres of floodplain areas would be constructed. All 6.9 acres would be replanted with native species. An overall benefit to riparian vegetation is expected and no significant adverse effects are anticipated.

4.4.1.4 Alternative 4: Preferred Alternative

Under the Preferred Alternative, existing invasive species would be removed from approximately 1.9 acres and an additional 1.0 acres of floodplain areas would be constructed (reshaped river banks and floodplain wetlands). All areas would be replanted with native species. An overall benefit to riparian vegetation is expected and no significant adverse effects are anticipated. There may be some benefit to aquatic vegetation under this alternative as slack-water and lower velocity areas may provide more suitable conditions for the establishment of aquatic vegetation. No significant adverse effects are anticipated.

4.4.2 Fauna

4.4.2.1 Alternative 1: No Action

Under the No Action alternative, populations of aquatic and riparian fauna within the project area would likely continue at their current levels. Invasive zebra mussels would likely become more established within the project area and invasive Asian carp species are likely to become established within the project area. No significant impact is anticipated.

4.4.2.2 Alternative 2: Aquatic Focus

Under Alternative 2, aquatic species such as native mussels and fish species may be temporarily disturbed during construction activities, but would benefit long-term from the improved aquatic habitat in the project area. No significant impact is anticipated.

4.4.2.3 Alternative 3: Floodplain Focus

Under Alternative 3, aquatic and riparian species would likely be temporarily disturbed during construction. Riparian species such as birds, aquatic mammals, rodents and waterfowl would benefit

long-term from the increased abundance, quality, and connectivity of riparian habitat within the project area. Waterfowl and aquatic mammals are likely to benefit from the restoration of wetlands within the project area. During high water periods, heightened primary productivity of aquatic habitats is expected within the project area as riparian vegetation becomes submerged. No significant impact is anticipated.

4.4.2.4 Alternative 4: Preferred Alternative

Under the preferred alternative, aquatic species such as native mussels and fish species may be temporarily disturbed during construction activities, but would benefit long-term from the improved aquatic habitat in the project area. Riparian species such as birds, aquatic mammals, rodents and waterfowl would benefit long-term from the increased abundance, quality, and connectivity of riparian habitat within the project area. Construction activities will seek to avoid nesting periods of migratory birds and a survey for nesting activities will be conducted prior to clearing and grubbing to ensure compliance with the Migratory Bird Treaty Act. Waterfowl would benefit particularly from restoration of wetland habitats, which are extremely limited within the project area. No significant impact is anticipated.

4.4.3 Existing Riparian and Aquatic Habitats

4.4.3.1 Alternative 1: No Action

Under the No Action alternative, degraded riparian and aquatic habitats are likely to persist within the project area. Riparian habitats are likely to further degrade due to the increased spread of invasive species. Aquatic and riparian habitats would remain largely disconnected within the project area. However, no significant impact is anticipated.

4.4.3.2 Alternative 2: Aquatic Focus

Under Alternative 2, aquatic habitats would be improved by adding larger diameter gravel to the area, adding habitat structure including boulders and large woody debris, and by creating additional pools and slackwater areas through the restoration of backwaters. No impacts to riparian habitats is anticipated. No significant adverse impact is anticipated as a result of these improvements.

4.4.3.3 Alternative 3: Floodplain Focus

Under Alternative 3, both the quality and quantity of riparian habitats would be improved through re-establishing more natural river banks, restoring floodplain shelf habitat, removal of invasive species, and restoration of wetlands within the project area. No significant adverse impact is anticipated as a result of these improvements.

4.4.3.4 Alternative 4: Preferred Alternative

Under the Preferred Alternative, aquatic habitats would be improved by adding gravel substrate to the area, adding habitat structure including boulders and large woody debris, and by creating additional pools and slackwater areas through the placement of submerged dike fields. Both the quality and quantity of riparian habitats would be improved through re-establishing more natural river banks and wetland habitats. No significant adverse impact is anticipated as a result of these improvements.

4.5 ENDANGERED AND THREATENED SPECIES

4.5.1 Federal

4.5.1.1 Alternative 1: No Action

Under the No Action alternative, no in-water work would be undertaken with the potential to impact federally-listed mussel species. No significant adverse impacts are anticipated.

4.5.1.2 Alternative 2

Under Alternative 2, approximately 5.6 acres of existing near-shore river habitat would be modified to reduce water velocities, create pools and alter the substrate from silt and sand to sand and gravels. Placement of this habitat has the potential to impact any federally-listed mussel species currently in the area. While it is unlikely that federally-listed mussel species are present in the project area due to the existing habitat conditions, there remains a possibility that they are present. Long-term, these improvements to aquatic habitat would likely benefit these species. In order to address concerns related to temporary impacts during construction, a presence/absence survey for federally-listed mussel species would be conducted prior to any proposed construction. If detected, federally-listed mussels would be temporarily relocated to a similar habitat type until construction is complete. If this process is followed, no significant adverse impacts to federally-listed mussel species is anticipated.

4.5.1.3 Alternative 3: Floodplain Focus

Under Alternative 3, approximately 5 acres of existing near-shore river habitat would converted to floodplain. This would result in removal of some potential habitat for federally-listed mussel species, however this habitat type is extremely abundant within the Ohio River and the resulting habitat that is formed at the interface of the expanded floodplain and the water is likely to be of similar quality to the habitat lost. While it is unlikely that federally-listed mussel species are present in the project area due to the existing habitat conditions, there remains a possibility that they are present. In order to address this concern, a presence/absence survey for federally-listed mussel species would be conducted prior to any proposed construction. If detected, federally-listed mussels would be relocated to a similar habitat type. If this process is followed, no significant adverse impacts to federally-listed mussel species is anticipated.

4.5.1.4 Alternative 4: Preferred Alternative (BIOLOGICAL ASSESSMENT)

The Preferred Alternative involves the placement of gravel substrates and parallel dikes in approximately 4 acres of the existing nearshore area of the Ohio River as well as conversion of 1 acre from steep banks to a more natural, connected floodplain. While these actions are likely to have long-term positive benefits for the five federally-listed mussel species that exist within the project area, it is unclear whether or not they could have an impact during construction as their presence/absence within the project area is currently unknown. Due to the known and assumed preferred habitat types of these species, it is unlikely that they would exist within the project area, but their presence cannot be ruled out. If they are present, they could be buried during construction activities and there is the potential for a taking in this instance. In order to address this uncertainty and ensure that there is no adverse effect to federally-listed mussel species as a result of the preferred alternative, a mussel survey of the construction area would be conducted prior to construction activities commencing in order to detect presence / absence of these species. If any listed species are detected, the Corps would coordinate with the USFWS to determine an adequate temporary or permanent relocation area for these species. If a temporary relocation area is selected, then these species would later be relocated back to the project area following construction. If these steps are followed, it is anticipated that the preferred alternative "may affect but is not likely to adversely affect" the northern riffleshell (endangered), clubshell (endangered), rayed bean (endangered), snuffbox (endangered), and rabbitsfoot (threatened); and have "no effect" on any other federally-listed species.

4.5.2 Critical Habitat

There is no critical habitat within the project area and there and no significant impacts to critical habitat are anticipated under any of the project alternatives.

4.5.3 State

There are no state-listed species within the project area and there and no significant impacts are anticipated under any of the project alternatives.

4.6 RECREATIONAL, SCENIC, AND AESTHETIC RESOURCES

4.6.1 Alternative 1: No Action

Under the No Action alternative, the site would continue to be heavily used for recreation, however it is not anticipated that any improvements in recreation or aesthetics would occur given the reasonably foreseeable future actions that the Corps is currently aware of. Site aesthetics could be negatively impacted by the continued spread of invasive species, but no significant impact to recreation or aesthetics is anticipated.

4.6.2 Alternative 2: Aquatic Focus

Alternative 2 is not likely to have a large impact of recreation or aesthetics at the site. This alternative involves primarily changes to aquatic habitat that would not be visible during normal flows. The outer wall of the two constructed backwater sites would be visible during most flows and would be constructed in an aesthetically pleasing manner. However, these areas would remain largely disconnected from the recreation areas. No significant impact to these resources in anticipated.

4.6.3 Alternative 3: Floodplain Focus

Alternative 3 would result in benefits to recreation, scenic quality, and site aesthetics. By removing invasive species, removing dead trees, and replanting with native floodplain plants, the site should provide a more manicured and less overgrown aesthetic and visitors will have a better view of the river and opposite bank. Additionally, reestablishing more natural river banks and shelf habitats provides the opportunity for river access via soft trail systems that stem from the main trail. The restored backwater will also provide an aesthetically pleasing and diverse visitor experience and may provide educational benefits for visitors with the opportunity for interpretive signs and guided tours from the adjacent science center. Additionally, this alternative would involve the removal of a dilapidated concrete peer and removal and burying of several tall bank lines currently constructed of rusted corrugated metal which should improve site aesthetics from the river. Overall a net benefit to recreational, scenic and aesthetic resources is anticipated and no significant adverse impact is anticipated.

4.6.4 Alternative 4: Preferred Alternative

The Preferred Alternative would result in minor benefits to recreation, scenic quality, and site aesthetics. By removing invasive species, removing dead trees, and replanting with native floodplain plants, the site should provide a more manicured and less overgrown aesthetic and visitors will have a better view of the river and opposite bank. Additionally, reestablishing more natural river banks provides the opportunity for river access via soft trail systems that stem from the main trail. This alternative would involve burying of several tall bank lines currently constructed of rusted corrugated metal which should improve site aesthetics from the river. Overall a net benefit to recreational, scenic, and aesthetic resources is anticipated and no significant adverse impact is anticipated.

4.7 CULTURAL RESOURCES

4.7.1 Alternative 1: No Action

Under the No Action Alternative, any additional development may involve disturbance of ground activities within the project area. However, it is assumed that these activities would follow a process to ensure that there are no known cultural sites within the footprint of the development and take the proper steps to coordinate and properly handle and inadvertent discoveries during construction. As such, no significant impact is anticipated.

4.7.2 Alternative 2: Aquatic Focus

Alternative 2 does not involve any ground disturbing activities. Rather, it involves placement of additional materials in aquatic habitat which have the potential to provide additional protection for any undiscovered resources in these areas. No significant impact is anticipated.

4.7.3 Alternative 3: Floodplain Focus

Alternative 3 would involve some ground disturbing activities of approximately 0.4 acres to facilitate restoration of a wetland in an area that has already been highly disturbed (it is currently a road) and has historically been disturbed by the placement of up to 30 ft. of fill atop the existing floodplain. Areas along the water-shore interface would be minimally disturbed to smooth out transitions between the existing high-bank and low-bank areas. However, fill would only be added to these areas and no fill would be removed. It is possible that during this activity, an inadvertent discovery could occur. In order to address this uncertainty, the construction crew would receive training from a qualified archaeologist on how to identify potential cultural resources and a construction crew member would be responsible for monitoring during these ground disturbing activities. If a discovery is made, all construction would cease until a qualified archaeologist could report to the site to assess the discovery and ensure that the proper process is followed to address the discovery. If this process is followed, no significant impact is anticipated.

4.7.4 Alternative 4: Preferred Alternative

The Preferred Alternative would involve some ground disturbing activities of approximately 0.4 acres to facilitate construction of a wetland in an area that has already been highly disturbed (it is currently a road) and has historically been disturbed by the placement of up to 30 ft. of fill atop the existing floodplain. Additionally this alternative would involve minimal ground disturbing activities of areas along the water-shore interface which would be minimally disturbed to smooth out transitions between the existing high-bank bank areas. Fill would only be added to these areas and no fill would be removed. Additional disturbance would occur in the footprint of the wetland area which would involve removal of fill from an existing roadway. This area was already previously disturbed during road construction. It is possible that during these activities, an inadvertent discovery could occur. In order to address this uncertainty, the construction crew would receive training from a qualified archaeologist on how to identify potential cultural resources and a construction crew member would be responsible for monitoring during these ground disturbing activities. If a discovery is made, all construction would cease until a qualified archaeologist could report to the site to assess the discovery and ensure that the proper process is followed to address the discovery. If this process is followed, no significant impact is anticipated.

4.8 AIR QUALITY

Section 176(c) of the Clean Air Act (CAA) (40 C.F.R. Part 93) provides that “no department, agency, or instrumentality of the Federal Government shall engage in, support in any way or provide financial assistance for, license or permit, or approve, any activity which does not conform to an [approved State

Implementation Plan]." 40 C.F.R. §93.150(b) outlines the basic requirement: "A Federal agency must make a determination that a Federal action conforms to the applicable implementation plan in accordance with the requirements of this subpart before the action is taken." For projects other than transportation, the U.S. Environmental Protection Agency (EPA) has set *de minimis* levels beneath which the conformity requirements do not apply. For pollutants in non-attainment status within the project area, the *de minimis* levels are indicated in the table below.

Table 11: *De Minimis* Levels Applicable to the Project Area

Pollutant	Area Type	De Minimis Levels (Tons/Year)
Ozone	Marginal	100
NOx		100
VOC		50
PM2.5	Moderate	100
Carbon Monoxide	Not Classified	100

Air emissions calculations are performed utilizing emissions factors associated with an activity. Emissions factors are a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. The general equation for emissions estimation is:

E = A x EF x (1-ER/100)

where E = emissions; A = activity rate; EF = emission factor, and ER =overall emission reduction efficiency, %

The EPA manual Compilation of Air Pollutant Emission Factors (AP-42) was the main source consulted for specific equations and emission factors used in the calculations for this site. In order to calculate the expected emissions the following sources were used: cost engineering assumptions from the feasibility study; existing data from current District concrete batching operations; and established professional methods and references for air quality quantification. To further refine the calculations for particulate matter less than 2.5 micrometers (PM2.5) the South Coast Air Quality Management District's Final Methodology to Calculate Particulate Matter (PM) 2.5 and PM 2.5 Significance Thresholds (FMPM2.5) was consulted.

Particulate emissions from construction activities may substantially affect local air quality for a temporary period. Potential construction activities for this project include land clearing, drilling, ground excavation, and cut/fill operations (i.e., earth moving). The amount of particulate emissions is proportional to the area of land being worked on and the level of construction activity. Equipment traffic is a major contributor of emissions. The particulate emission factor for construction activity operations provided in AP-42, chapter 13.2.3 is:

EF = 1.2 tons/acre/months of activity

In order to use this emission factor the area of the construction site and the duration of construction activities must be known. Construction activities are anticipated to occur over a maximum area of 10 acres for approximately 9 months. This is considered a conservative estimate as it is highly unlikely that the entire project area would be under construction for the full construction period. Using the emission

factor and the assumptions above, total particulate (PMT) emission can be calculated by using the following equation:

PM-T= EF*Area*Duration

Particulate matter that is less than 2.5 microns in diameter (PM2.5) is a default factor utilized for fugitive dust derived from construction and demolition activities, and represents a fraction of total PM (PM-T). In order to obtain figures for PM2.5, the calculated PM-T value is multiplied by an estimated PM2.5 fraction (f) of 0.102. The table below provides calculations for the potential maximum PM2.5 emissions.

Table 12: Potential Maximum PM2.5 Emissions

EF (tons/acre/month)	Area (acres)	Duration (months)	PMT (tons)	f	PM2.5 (tons)
1.2	10	9	108	0.102	11.0

There are two methods for calculating annual emissions from internal combustion units. If the engine's brake horsepower (bhp) and annual hours of operation are available, the following equation can be used:

AE = EF x bhp x t

Where: AE = Annual emissions of chemical (lb/yr), EF = Chemical emission factor (lb/bhp-hr), t = Total annual number of hours of operation (hr/yr), bhp = Unit brake horse power (bhp)

Emission factors from AP-42 Section 3.4 for diesel-fired internal combustion engines were used and are shown in Table 13. As nearly all particulate matter from engine exhaust is less than 1 micrometer in diameter, all calculated values of particulate matter are grouped as PM2.5 although they may represent larger fractions as well. In addition, emission factors are given for "total organic compounds" (TOC). This term is used in AP-42 to indicate all VOCs and all exempted organic compounds including methane, ethane, chlorofluorocarbons, toxics and hazardous air pollutants, aldehydes, and semi-volatile compounds. As the project is located in a nonattainment for ozone, and VOCs and NOx are precursors to ozone, TOC (in lieu of VOCs) and NOx emissions were calculated for site activities. Please note that the estimates in the Table 14 reflect the worse-case scenario of possible emissions. Table 15 contains the total maximum potential estimate of emissions from the project related to applicable standards, all of which are below the *De Minimis* levels.

Table 13: Engine Exhaust Emission Factors

	Diesel Fuel EF
NOx	0.013
PM	0.0007
CO	0.00809
TOC	0.000705

Table 14: Engine Exhaust Emission Factors

Equipment	Net Power (bhp)	Fuel	Daily Operation (hr)	Number per day	Timeframe (months)	Total Operation (hr)	PM2.5 (tons/yr)	NOx (tons/yr)	TOC (tons/yr)	CO (tons/yr)
Excavator[1]	360	Diesel	6	2	2	480	0.06	1.12	0.06	0.70
Triaxle[2]	387	Diesel	6	2	9	2160	0.29	5.43	0.29	3.38
Bulldozer[3]	139.5	Diesel	6	2	6	1440	0.07	1.31	0.07	0.81
Grader[4]	185	Diesel	6	2	6	1440	0.09	1.73	0.09	1.08
Total							0.52	9.59	0.52	5.97

[1] Catepillar 245B Series II, [2] Kenworth T300/400/800, [3] Caterpillar D-6, [4] Caterpillar 140H

Table 15: Total Estimated Releases Compared to *De Minimis* Levels

Non-Attainment Area Emission Rates (tons/ year)		Total Maximum Estimated Releases (tons/year)
NOx	100	9.59
PM-2.5	100	11.52
VOC	50	0.52
CO	100	5.97

None of the alternatives are anticipated to significantly impact air quality in the project area. Under the action alternatives (2,3, and 4) there would be a temporary impact on air quality during construction due to exhaust outputs and dust from construction equipment. This could cause marginal increases in NOx PM-2.5, VOC, CO, and other pollutants within and adjacent to the project site for the period of construction. The analysis conducted indicates that the project emissions are below the *De Minimis* levels and a conformity analysis is not required. Construction activities would utilize best management practices, such as those outlined in the City of Pittsburgh's Clean Air Act of 2010 (City of Pittsburgh, 2015), to further reduce any potential impacts to air quality. Due to the temporary nature of this disturbance, no significant impact is anticipated.

4.9 NOISE

None of the alternatives are anticipated to significantly impact noise levels in the project area. Under the action alternatives (2,3, and 4) there would be a temporary noise disturbance during construction that would impact recreational users of the trail system. However, there are no residences that would be affected by noise during construction and there are no long term changes in noise levels anticipated as a result of any of the project alternatives. No significant impact is anticipated.

4.10 HAZARDOUS AND TOXIC SUBSTANCES

Potential impacts of the four study alternatives with regard to hazardous and toxic substances were identified and summarized below based on information obtained from the Phase I Environmental Site Assessment (ESA).

4.10.1 Alternative 1: No Action

Under the No Action Alternative, any additional forecasted development in the project area is likely to disturb land potentially contaminated with Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) regulated substances present as a result of historic industrial activities. However,

it is assumed that these development activities would follow approved EPA and state regulatory processes to ensure that contaminated soils and groundwater are properly handled during and after development. As a result, no significant impact is anticipated.

4.10.2 Alternative 2: Aquatic Focus

Alternative 2 does not involve ground disturbing activities that would involve disturbance or removal of potentially contaminated soil and groundwater. Rather, it involves placement of additional materials in aquatic habitat which have the potential to provide additional protection for any undiscovered aquatic resources in these areas. As a result, no significant impact is anticipated.

4.10.3 Alternative 3: Floodplain Focus

Alternative 3 would involve some ground disturbance of approximately 0.4 acres to facilitate restoration of a wetland area. In addition, locations along the water/land interface would be minimally disturbed to ease the transition between the existing high-bank and low-bank areas to reestablish a more natural bank line. No soil material would be removed from the site, but rather fill material would be placed.

Based on historic industrial activities in the project area, it is possible that during construction activities CERCLA regulated substances may be encountered. USACE and the sponsor will solicit PADEP input early during the NEPA public comment period, and during the project design phase regarding completion of the CERCLA All Appropriate Inquiry (AAI) process and application of other controls for onsite contamination appropriate to ensure protection of human health and the environment. Completion of CERCLA AAI will precede issuance of Lands, Easements, Rights-of-Way, Relocations and Disposal (LERRD) requirements for sponsor to acquire during the design phase.

The final DPR will incorporate any PADEP input received to date. USACE and the sponsor will request PADEP guidance during the project design phase and identify appropriate controls to prevent release or human exposure for incorporation into project construction plans and specifications. PADEP coordination will occur and continue until the O&M plan for the project is finalized. If appropriate Federal and state regulatory processes and controls are followed, no significant impact is anticipated.

4.10.4 Alternative 4 – Preferred Alternative

The Preferred Alternative would include some ground disturbance of 1 acre to ease transitions between high and low bank areas and reestablish a more natural bank line and 0.4 acres for the construction of a wetland. Similar to Alternative 3, no soil material would be removed from the site, but rather fill material would be placed.

Based on historic industrial activities in the project area, this alternative minimizes ground disturbance and maximizes avoidance of potentially contaminated areas. However, it is likely that contaminated groundwater and soils are present, and there is a possibility that CERCLA regulated substances will be encountered during construction activities. Therefore, USACE and the sponsor will solicit PADEP input early during the NEPA public comment period and during project design regarding completion of CERCLA All Appropriate Inquiry (AAI). As a result, a Phase II ESA may be undertaken during design to complete CERCLA AAI and develop appropriate controls in the project plans and specifications to prevent exposure to or release of CERCLA regulated substance above PADEP regulatory criteria during or after construction. If a Phase II ESA is conducted, USACE and the sponsor will compare the results to PADEP standards and collaborate with the PADEP in determining what, if any, response is appropriate to mitigate unacceptable risk to human health and the environment. Completion of CERCLA AAI documentation will precede issuance of project requirements for Lands, Easements, Rights-of-Way, Relocations, Disposal (LERRD) and Borrow areas for sponsor acquisition prior to initiating construction.

PADEP coordination will proceed through design, construction, monitoring and completion of the O&M plan for the project. Application of the Federal and state regulatory processes and the appropriate controls identified above are likely to result in no significant impacts from construction or operation of this preferred alternative plan.

4.11 SOCIOECONOMICS AND ENVIRONMENTAL JUSTICE

None of the project alternatives have the potential to adversely affect minority populations, low-income populations or children. No significant impact to socioeconomics and environmental justice are anticipated.

4.12 CUMULATIVE EFFECTS

4.12.1 Alternative 4: Preferred Alternative

The project area has a history of industrial use and development which have negatively impacted both the quality and the quantity of riparian and aquatic habitat. Recent efforts to improve recreation within the project area have removed invasive species and replanted native species providing a slight improvement in habitat quality. Future development activities within the project area are expected to mostly focus on re-use of existing developed areas and should not negatively impact the quantity or quality of floodplain habitats. The preferred alternative is intended to further restore the quality and quantity of existing habitats within the project area and is not expected to have any long-term negative impacts. Therefore, in the context of the historical, current and reasonably foreseeable future actions that have impacted the project area, no significant cumulative effects are anticipated associated with the preferred alternative.

5 MITIGATION OF ADVERSE EFFECTS

As this is an ecosystem restoration project, it has been formulated to provide an overall benefit to native species and their habitats. No mitigation measures are necessary or proposed as part of the recommended plan.

6 IMPLEMENTATION REQUIREMENTS

6.1 PROJECT PARTNERSHIP AGREEMENT

The non-federal sponsor is prepared to execute a PPA for the alternatives recommended in this feasibility report. A letter of intent to accomplish this project was received on 9 December 2013 with a supporting letter of consent received from the City of Pittsburgh on 10 June 2015. The roles and responsibilities of the non-federal sponsor are listed in Section 3.6.3 of this document. Design and Implementation funds will not be requested until a PPA has been executed between USACE and Riverlife.

6.2 LANDS, EASEMENTS, RIGHTS-OF-WAY, RELOCATIONS AND DISPOSAL AREAS

There are approximately 6.81 acres required for this project. As of the date of this report, Riverlife is the non-Federal Sponsor (NFS) for this project. There are several property owners and a channel improvement, temporary work area and access easements will need to be acquired. The Sponsor, will acquire easements for the lands needed for this project and the acquired properties will be deeded into their name. The total costs for LERRDs is currently estimated at $885,000. For acquisition purposes, the acreage breakdown is as follows.

a. A total of 5.68 acres of permanent channel improvement easement is located the project route.
   This is estate #8 of EC 405-1-11, Exhibit 5-29 of the Real Estate Plan.
b. A total of 0.90 acres will be acquired for a temporary work area easement.
   This is estate #15 of EC 405-1-11, Exhibit 5-29 of the Real Estate Plan.
c. A total of 0.23 acres will be acquired for a temporary road easement.
   This is estate #11 of EC 405-1-11, Exhibit 5-29 of the Real Estate Plan.
d. There is no disposal area at the site and any materials that will be disposed of will be taken to a properly permitted, commercial disposal facility.

There is no disposal area at the site. Any materials that need to be disposed of must be taken to a properly permitted, commercial disposal facility. A full breakdown of real estate requirements, parcel information, and appraisal values is included the Real Estate Plan located in Appendix D.

6.3 MONITORING AND ADAPTIVE MANAGEMENT

In order to determine whether or not the project has achieved its ecological success in meeting the restoration objectives, the following monitoring and adaptive management plan would be implemented following project construction. This plan lays out the strategy for assessing project success based on clearly defined objectives and metrics, and potential adaptive management actions that could be implemented if the project fails to meet these objectives.

6.3.1 Uncertainties

The degree of uncertainty surrounding whether or not the project benefits will be achieved is key for scaling the monitoring and adaptive management strategy. For this particular project, the habitat quantity benefits are captured as acreages of restored habitats and habitat quality benefits are primarily derived from two analyses: the MAR FQA for floodplain habitats and the smallmouth bass HSI for aquatic habitats.

The MAR FQA measures its benefits from the mean coefficient of conservation for the species forecasted to be within the project area. These benefits derived are primarily related to the hardiness of the species and the diversity of the species within the project area. As the plantings will be installed by a contractor at the direction of the Corps, there is little risk that this will not be achieved. There is risk however that species could die over time or be out-competed by aggressive or invasive species. As such, the plan will focus primarily on this risk for floodplain habitat benefits.

The smallmouth bass HSI uses a multitude of habitat factors in order to assess suitability. In the analysis conducted for this project, two habitat conditions drove the benefits when compared to the No Action condition: dominant substrate type and percent pools. By altering the substrate, we can be fairly certain that the first condition will be achieved. However, there is uncertainty related to whether or not this material will remain over time or be washed downstream due to high flows. This uncertainty is relatively low, as an engineering analysis was conducted in order to properly size the material based on expected conditions. Pools are defined as relatively deep areas (>4.3 ft) with little or no perceptible current. There is also little risk that these conditions will not be in place due to the planned construction of a series of dikes parallel to shore that will create this type of habitat.

6.3.2 Objectives and Metrics

Clear articulation of a project's objectives is the foundation of AM; a process that iteratively compares management outcomes against these objectives and adjusts management actions or the objectives

themselves based on learning over time. An effective AM strategy requires specific success metrics and a time horizon to guide and improve decision making that facilitates progress toward the goal. For this particular project, three objectives has been identified. The success metrics associated with these metrics also represent the adaptive management triggers that would constitute a need to take an adaptive management action.

6.3.2.1 Objective 1: Greater than 75% species survival within 5 years of construction completion

This objective addresses uncertainties related to species survival and benefits associated with floodplain habitats derived from the MAR FQA model.

6.3.2.2 Objective 2: No spread of invasive species within 5 years of construction completion

This objective addresses uncertainties with continued survival of native species within the project area due to invasive species and addresses benefits associated with invasive species removal from existing areas derived from the MAR FQA model.

6.3.2.3 Objective 3: Less than 20% loss of gravel covered aquatic areas after 5 of construction completion

This objective addresses uncertainties about the stability of modified substrates in aquatic habitats and the benefits associated derived from the smallmouth bass HSI.

6.3.3 Monitoring

In order to ensure the stated objectives are met, the following monitoring is recommended:

Table 16: Proposed monitoring activities

Performance Metric	Data Gathered	Methodology	Collection Time	Associated Annual Cost	Time Frame
Native Species Cover	Plant Species Composition	Field Observations	Late July	$2,000	Every Year for 5 Years
Gravel Cover	Substrate composition	Grab Samples	Summer	$2,000	Years 3 and 5 following construction

Annual monitoring will be conducted at the site to determine species composition and identify areas where invasive species are present. An observer would perform site visits at least once during the active growing season (preferably in late July) to examine the restoration site. The total cost of this monitoring effort is estimated at $10,000. Sediment grab samples would be collected from a boat twice following construction in years 3 and 5. Approximately 10 samples would be collected which would be analyzed to determine percent gravel. The total cost for this effort is estimated at $4,000. Total monitoring costs are estimated at $14,000. Analysis and results of these efforts would be documented in an annual monitoring report.

6.3.4 Adaptive Management

In the event that the management action fails to achieve the stated objective, subsequent action may be necessary to ensure that this project is successful. In years 1-4 of monitoring, removal of non-native

plant species from the restored area may be warranted. Methods may need to be altered in order to address invasive plant communities that continue to survive. For example, targeted pre-emergent treatments may need to be employed, stumps painted, or other herbicides may need to be experimented with. It is anticipated that over the five years an additional 10% of the original area targeted for invasive species removal would need to be retreated. In year 5, this work could also involve re-planting of desired native species. Based on the survival of species observed during the monitoring period, species composition would likely need to be altered to avoid species that have failed during the 5-year monitoring period and plant species that have a higher likelihood of survival based on monitoring results using native plant communities associated with those species that seem to be thriving. The anticipated cost in year 5 for replanting are estimated to be 20% of the initial planting costs.

If, following Year 5, more than 30% of the sediment grab samples (e.g. four of ten samples) do not contain a dominant portion of the substrate modification coarse gravels, some design adjustments may be needed in order to ensure that substrate gravel is maintained at the site. For the purposes of this adaptive management plan, it is assumed that, in a scenario of greater than 20% loss or migration from the areas of substrate modification, an additional 10% of the original substrate may need to be added to amend for losses or migration and that two additional dikes placed in order to alter site conditions to address high rates of loss or migration. The costs for this are estimated below.

Table 17: Estimated Monitoring Adaptive Management Costs Over Time:

	Monitoring	Invasive Removal	Replanting	Aquatic Substrate	Dikes	Total
Year 1	$ 2,000	$ 4,208				$ 6,208
Year 2	$ 2,000	$ 4,208				$ 6,208
Year 3	$ 4,000	$ 4,208				$ 8,208
Year 4	$ 2,000	$ 4,208				$ 6,208
Year 5	$ 4,000	$ 4,208	$ 38,469			$ 46,678
Year 6				$ 110,180	$ 105,000	$ 215,180
	$ 14,000	$ 21,042	$ 38,469	$ 110,180	$ 105,000	$ 288,691

The Corps will be responsible for conducting monitoring and adaptive management for the first five years following implementation. Costs for these efforts will be shared 65% federal and 35% sponsor funds. If the full amount of funds ($288,691) is needed, the costs of implementing the monitoring and adaptive management plan would be $187,649.15 federal and $101,041.85 sponsor funds.

6.4 OPERATION, MAINTENANCE, REPAIR, REPLACEMENT, AND REHABILITATION

Costs and activities relative to the operation, maintenance, repair, replacement and rehabilitation (OMRR&R) of the finished project will be the responsibility of the Non-Federal Sponsor. These are activities other than monitoring or adaptive management and are described briefly below:

- Operation is the control of the constructed features whose regulation or other manipulation is intended or necessary to ensure the Project's performance.
- Maintenance includes those activities of a routine nature that hold the project in a well-kept condition, to keep it functioning as intended and to deter more damaging or more costly repair or replacement needs.

- Repair is the resolution of unexpected failures and problems as they arise.
- Replacement covers those activities necessary to bring a deteriorated project or condition back to its original condition. These actions would conform to the project's "as-built" plans and specifications unless other arrangements are made.

It is anticipated that the primary reason for repair, replacement and / or rehabilitation would be to address the effects of large and infrequent flooding (increase of the normal pool elevation) along the reach of the Study Area. Care in design and construction will be taken to produce a finished product capable of withstanding flooding up to a certain event level. However, given the unpredictability of the action of floodwaters as individual locations (and how each or the restoration measures) are affected, it may be necessary to repair some items during even small flood events.

When the USACE determines that the entire project is complete (except for monitoring), the Non-Federal Sponsor will be notified and will be furnished with an OMRR&R Manual including "As-Built" drawings. From that time, the Non-Federal Sponsor will be required to operate, maintain, repair, rehabilitate and replace the project in accordance with the PPA.

As with all ecologically-based projects, long term success requires continued operation and maintenance of the selected and implemented restoration measures of the recommended alternative. Operation and maintenance for this project is likely to involve some periodic maintenance of restoration plantings, control of geese populations, maintenance of trails, and periodic replacement of signs and recreational features.

Specific annual costs for each OMRR&R line item have yet to be determined. Currently it is estimated that an average annual O&M cost over 50 years is estimated at $11,139, or $556,950 over the life of the project. A breakdown of the annual estimated costs associated with Operations and Maintenance is included in the table below. Costs were based on an assumed 2% of construction costs required annually to maintain features and replacement periods of 10 years for the permeable pavement and 5 years for the signs.

Table 18: Estimated OMRR&R Costs:

Wetlands	$ 1,162
Invasive Removal / Replant	$ 1,004
Signs	$ 133
Permeable pavement	$ 7,100
Soft Trails	$ 1,390
TOTAL	$ 10,789

6.5 REGULATORY REQUIREMENTS

Under the recommended plan / preferred alternative, the following permits would be required for implementation:

Clean Water Act, Section 401: Under this section, the Corps must obtain a water quality certification from the Commonwealth of Pennsylvania prior to construction activities. The Corps will apply for a section 401 certification with the Pennsylvania Department of Environmental Protection prior to construction and ensure that all necessary permit conditions are adhered to.

Clean Water Act, Section 402: Under this section, the Corps will determine whether or not a permit is necessary and, if applicable, obtain a National Pollutant Discharge Elimination System (NPDES) from the

Pennsylvania Department of Environmental Protection prior to construction. To maintain compliance, the Corps will ensure that all best management practices and permit conditions are adhered to during construction.

Clean Water Act, Section 404: Under this section, the Corps regulates disposal of dredged or fill material into the waters of the United States. The recommended plan for this alternative would involve placement of material within jurisdictional waters for the purposes of ecosystem restoration. All Section 404 activities associated with this project will be implemented in a manner consistent with the terms and conditions of Nationwide Permit 27 (Aquatic Habitat Restoration, Establishment, and Enhancement Activities).

Pennsylvania Floodplain Management Act, Chapter 106: This act regulates the construction, modification, removal, and destruction of obstructions within the 100 year floodplain in the commonwealth of Pennsylvania. Prior to initiating of construction, the Corps will determine whether or not a permit is necessary and, if applicable, obtain the necessary permit to comply with this law.

Rivers and Harbors Act, Section 10: This act regulates the placement of structures within navigable waterways of the United States. The Corps will work with its regulatory section to provide public notification and ensure this project is implemented in a manner consistent with the provisions of Section 10.

Compliance with other applicable laws and regulations include, but are not limited to, those identified in the table below:

Table 19: Regulatory Compliance

Laws and Executive Orders	Compliance Status
Archaeological and Historic Preservation Act, 16 U.S.C. 469, et seq.	Consultation was initiated during the scoping phase of this project and a scoping letter was received from the PHMC on October 23,2015. During public review, the Corps will seek concurrence from SHPO on finding of "no effect" to protected resources during the public and agency review and comment period.
Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C.	A Phase I Environmental Site Assessment was conducted for the site to determine the potential presence of materials regulated under CERCLA. A Phase II assessment will be undertaken during the Design and Implementation phase which would be the cost-shared according to the cost-sharing provisions of the design and implementation phase and undertaken by the non-federal sponsor. The sponsor will make a determination based on the results of the Phase II testing as to whether the soil meets federal and state standards and, if not, work with the Corps, state and federal regulating agencies to determine a plan to address these issues that would be implemented during construction at the sponsor's expense.

Clean Air Act, as amended, 42 U.S.C. 1857h-7, et seq.	An air quality analysis was completed as part of this study and determined that no significant impact to air quality would result from the proposed action. The analysis conducted indicates that the project emissions are below the De Minimis levels and a conformity analysis is not required.
Clean Water Act, 33 U.S.C. 1857h-7, et seq.	As summarized above, all relevant permits will be sought and coordination completed prior to construction.
Endangered Species Act, 16 U.S.C. 1531, et seq.	Informal coordination initiated on October 7, 2015. Concurrence with the Corps' finding that the preferred alternative is "Not likely to adversely affect" listed species will be sought from USFWS during the public and agency review and comment period.
Bald and Golden Eagle Protection Act, 16 U.S.C. 668, et seq.	There are no records of Bald or Golden Eagles roosting or nesting within or adjacent to the project area.
Fish and Wildlife Coordination Act, 16 U.S.C. 601, et seq.	Comments were sought with regard to this act from the US Fish and Wildlife Service and Commonwealth of Pennsylvania via letters dated October 7, 2015. Comments received from the Pennsylvania Fish and Boat Commission were taken into account in the formulation of alternatives.
National Environmental Policy Act, 42 U.S.C. 4321, et seq.	This integrated Environmental Assessment and the result Finding of No Significant Impact was developed to ensure compliance with this act.
National Historic Preservation Act, 16 U.S.C. 470a, et seq.	Will seek concurrence from SHPO on finding of "no effect" to protected resources
Migratory Bird Treaty Act, 16 U.S.C. 703, et seq.	Construction activities will seek to avoid nesting periods of migratory birds and a survey for nesting activities will be conducted prior to clearing and grubbing to ensure compliance with this act. The Corps will seek concurrence with the FWS on this determination during the public review of the draft document.
Flood Plain Management (EO11988)	Engineering analysis of project alternatives was conducted to develop design considerations that would ensure that no increase in flood risk would arise as part of the alternatives considered. As this is a riverfront ecosystem restoration project, there is no practicable alternative to siting this project in the floodplain. More information on this analysis is contained in Appendix B.
Protection of Wetlands (EO11990)	The Corps will coordinate with its regulatory section to ensure compliance with this executive order.

Environmental Justice in Minority Populations and Low-Income Populations (EO12898)	No minority or low income populations would be negatively affected by the preferred alternative.
Invasive Species (EO13112)	The preferred alternative will seek to eradicate invasive species within the project area.

7 PUBLIC INVOLVEMENT

7.1 PUBLIC VIEWS AND COMMENTS

As the report is currently under internal review, it has not been shared with the public yet for public review and comment. Once the internal review is completed, the draft report will be shared with the public, stakeholders and agencies for review and comment. The report will be made available on the Corps' website for review and digital copies of the report will be distributed to interested parties via email. Hard copies will be made available upon request. Letters will be sent to state and federal agencies requesting comments and concurrence with Corps findings when applicable. The draft report will be made available for a 30-day review period. Comments will be accepted via email and hard-copy letter. Availability of the report will be published in local newspapers, on social media and through the sponsor website and email lists.

7.2 STAKEHOLDER, AGENCY, AND NATIVE AMERICAN COORDINATION

Informal coordination was initiated in August 2015. Emails were sent to the Pennsylvania Department of Environmental Protection (PADEP), the Pennsylvania Fish and Boat Commission (PFBC), Environmental Protection Agency (EPA), US Fish and Wildlife Service (USFWS), The Nature Conservancy (TNC), and the Ohio River Valley Water Sanitation Committee (ORSANCO) on August 14, 2015 which provided background information on the project, requested points of contact, and sought general comments on the issues to be addressed in the study. Scoping letters were sent on October 7, 2015 to PFBC, PADEP, EPA, USFWS, Pennsylvania Department of Conservation and Natural Resources (PDCNR), Pennsylvania Game Commission (PAGC), and Pennsylvania Historical and Museum Commission (PHMC) which provided further information on the types of measures being considered during alternatives formulation, requesting comments on the scope of issues to be addressed under NEPA, and any additional input pursuant to compliance with applicable environmental laws and regulations (including Clean Water Act, Endangered Species Act, Fish and Wildlife Coordination Act, and National Historic Preservation Act). The draft integrated project report and Environmental Assessment will be circulated for agency, stakeholder, and public review and comment to the following organizations:

- US Fish and Wildlife Service
- Environmental Protection Agency
- Pennsylvania Department of Environmental Protection
- Pennsylvania Fish and Boat Commission
- Pennsylvania Department of Conservation and Natural Resources
- Pennsylvania Game Commission
- Pennsylvania Historical and Museum Commission
- Ohio River Valley Water Sanitation Committee
- Riverlife Mailing List
- Local Newspaper Announcements of Availability

In addition, the following Federally-recognized Native American Tribes and Nations who have documented historic ties to the project area will be invited to comment on the draft report and, if requested, enter into government to government consultation:

- Absentee-Shawnee Tribe of Oklahoma
- Cayuga Nation (NY)
- Delaware Nation (OK)
- Oneida Indian Nation (NY)
- Oneida Nation of Wisconsin
- Onondaga Nation (NY)
- Seneca Nation of Indians (NY)
- Seneca-Cayuga Tribe of Oklahoma
- St. Regis Mohawk Tribe (NY)
- Tonawanda Seneca Nation (NY)

USACE and the sponsor will solicit PADEP input early during the NEPA public comment period and during the project design phase regarding completion of the CERCLA All Appropriate Inquiry (AAI) process and adoption of other controls appropriate to ensure protection of human health and the environment during construction. Similar PADEP coordination will occur upon completion of construction to finalize an appropriate O&M plan for the project.

8 RECOMMENDATION

This study has included an examination of all potential and practicable alternatives for meeting the study objectives of restoring natural bank conditions, improving aquatic and riparian habitat, and reducing non-native pest populations. The recommended alternative provides the maximum environmental benefit in an urban environment and meets the sponsor and public needs. The recommended alternative provides important fish and wildlife benefits at a reasonable construction and O&M cost. The plan has negligible impact on flood water surface elevations (See Appendix A, Section 2.3.4.1). The plan is consistent with national policy, statutes and administrative directives. The plan has been reviewed in light of overall public interest, which includes the views of the non-Federal sponsor and interested agencies. The District has concluded that Riverlife is capable of meeting their financial obligations and that the total public interest would be served by implementation of the recommended plan.

Based on October 2015 price levels, the estimated project first cost is $10,266,000 which includes monitoring and adaptive management costs of $376,000 (including cost contingencies). The Federal share of the project first cost is estimated to be $6,672,900 and the non-Federal share is estimated to be $3,593,100 which equates to 65% Federal and 35% non-Federal. The Fully Funded cost escalated to the midpoint of construction is estimated to be $10,798,000. The estimated total federal cost of the project (including feasibility costs) is $7,248,000). The annualized costs over the period of project performance (50 years) are estimated at $424,054. The AAHUs estimated for this project are 2.54 over this same period yielding a cost/AAHU of $166,950.It is recommended the proposed work be authorized and funding allotment of $735,728 be made available in FY16 to begin design work. A second allotment of $4,721,388 will be required in FY17 to complete design, construction, and project close-out. The proposed work would include restoration of fish and wildlife habitat within the City of Pittsburgh, as generally described in this report, with such modifications by the Chief of Engineers as may be advisable

to meet provision of Section 206 of the 1996 Water Resources Development Act, as amended. Authorization is subject to cost sharing and financing arrangements with the non-Federal sponsor, Riverlife, and is based on the cost sharing and financing requirements of the Section 206 program. Prior to construction, and during the Plans and Specifications phase, the non-Federal sponsor will: (1) provide all lands, easements, and rights of way necessary for project construction and operation and maintenance; and (2) hold and save harmless the United States from damages due to the construction or operation and maintenance of the project. The non-Federal sponsor will also operate and maintain the project after construction for the life of the project (50 years).

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Interviews:

Anthony Young, Vice President Facilities Planning & Operations, Carnegie Institute

Dannielle Cisneros, Senior Counsel, Rivers Casino (Holdings Acquisition, Inc.)

Richard Cardello, Property Manager and Owner, Cardello Properties

Thomas Ryser, Project Manager, Sports and Exhibition Authority